CHAPTER IV

SUPPORTING THE WEATHER SUPPORT FORCE

To accomplish its mission most effectively, the AWS WSF deployed to DESERT SHIELD/STORM, as did any deployed WSF, needed assistance from outside of its operational theater. This assistance included logistical as well as meteorological support. Headquarters AWS and the 5th Wing provided and/or arranged for various types of out-of-theater support, some of which have already been mentioned. AWS wings other than the 5th, especially the 2d, also contributed. AFGWC and the US Air Force Environmental Technical Applications Center (USAFETAC), its chief subordinate organization, supplied valuable centralized weather products. DMSP and other weather satellites provided vitally important satellite imagery. Several other organizations--e.g, the US Navy's Oceanographic Systems Center, furnished limited, but useful, support.

Centralized Products from AFGWC

When the DESERT SHIELD deployment began, AFGWC immediately started getting requests for weather data for the Atlantic Ocean and Mediterranean Sea as well as Saudi Arabia, Kuwait, and Iraq. Already anticipating such requests as a result of intelligence information it had received, it immediately began sending out a synoptic discussion bulletin (SWO 42), the "official forecast" for the deployed forces, and other products such as forecasts for terminal points and refueling areas, flight hazards, and cloud conditions. As DESERT SHIELD continued and expanded, it brought a sense of urgency to AFGWC. Approximately 50 AFGWC personnel came to work regularly on DESERT SHIELD support and many more part of the time. Overall, AFGWC increased its product output by about 30 percent to meet DESERT SHIELD/STORM weather data requirements.[1]

For the next several weeks, until the DSFU became operational, AFGWC functioned as the tactical forecast unit (TFU) for the DESERT SHIELD theater and supported the bulk of the requirements coming from the theater. In the early stages of the operation a lack of complete and accurate data from the theater, due largely to Saudi Arabia and other nearby countries turning off their weather data transmissions for fear of aiding Iraq, hampered AFGWC's efforts to generate the required products. To get its products to the theater, it initially used AUTODIN since dedicated weather communications channels were not immediately available. At the same time it worked with USCENTCOM and USCENTAF in getting the long-haul AWN and AFDIGS circuits into the theater as soon as possible.[2]

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[1]AWS DS/DS Report #2 (S), pp 111-112 (Secs 4.2.1.1, 4.2.1.2), info used (U); intvw (U), W.E. Nawyn, AWS/HO, with Maj Kenneth B. Stokes, Chief, AFGWC/WFO, 12 Jun 91, p 2, hereafter cited as Stokes Intvw (U); Ritchie Intvw (U); AFGWC/CC, 12 Jun 91; art (U), C.D. Marsan, "Weather Systems Give Allied Forces an Edge," AWS Observer, May 91, p 9.

[2]AWS DS/DS Report #2 (S), p 111 (Sec 4.2.1.1), info used (U); msg (S), 5WW/CAT to 7WS/DOX, et al, "AWS Concept of Operations/Operation DESERT SHIELD (U)," 291825Z Aug 90, info used (U); Waite Intvw (U), p 2; Mr K. Runk and Mr J. Albrecht in intvw (U), W.E. Nawyn, AWS/HO, with

On 21 September the DSFU became operational and, at that point, AFGWC stepped down to the role of "hot backup" to the DSFU, at the same time forming a Contingency Support Cell that was prepared to reassume the DSFU function, if necessary. It also continued to develop TFU-type products (including the SWO-42 bulletin) in a "shadow mode." But primarily it now began to provide support to the DSFU in specific areas where it did not have expertise or capability. When the DSFU ceased operations on 18 March 1991, a couple of weeks after DESERT STORM hostilities ended, AFGWC again took over the role of tactical forecast unit for the WSF, which included resuming production of the official SWO 42 bulletin.[3]

AFGWC provided weather data and centralized products, analyses, and other services for DESERT SHIELD/STORM. It developed approximately 32 different types of specialized products. It issued some for only a few days, others for the entire operation. Probably its single most important product was the SWO 42 bulletin. Other products, most of which were bulletins incorporating several parameters, included flight plans for MAC, SAC, and TAC aircraft (sometimes more than 600 per day), flight hazard forecasts, flight level winds, air refueling track forecasts, terminal forecasts, chemical downwind messages, surface and upper air winds, forecasts, point analyses, weather inputs for electro-optical tactical decision aids, cloud-free forecasts, and HF propagation predictions. It disseminated these products not only to AWS weather teams supporting the Air Force and Army, but also to Marine and Navy units (AFGWC also received some Navy weather products), as well as civilian government agencies (e.g., the State Department).[4] (See Figure IV-1.)

Medium- and Extended-Range Forecasts

During the later stages of DESERT SHIELD and during DESERT STORM, AFGWC produced an important product that included a medium-range and extended medium-range forecast plus an 11-15 day outlook. It inaugurated the product on 24 December as only a medium-range (4-7 day) forecast developed in response to a support assistance request (SAR) received from CENTAF Weather five days earlier. A little over a month later, on 29 January, AWS, responding to a request from CENTCOM, instructed AFGWC to extend its medium-range forecast to ten days and also asked it to assess its capability to extend the product out to 15 days. On 2 February AFGWC transmitted its first extended medium-range (6-10 day) forecast. On the same day it informed AWS it could develop a 10-15 day outlook or, as AFGWC preferred to call it, a "trend forecast discussion," which would, however, only

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LTC Kenneth A. Nash, AFGWC/WFM, Mr Kim Runk, Chief Forecaster, AFGWC/WFP, and Mr Jay Albrecht, AFGWC/WFM, hereafter cited as Nash/Runk/Albrecht Intvw (U), pp 4-5; Millard Intvw (U), p 4.

[3]AWS DS/DS Report #2 (S), p 111 (Sec 4.2), info used (U); rprt (U), AFGWC/DOO to AWS/DOJ, "AFGWC After Actions Report - Operation DESERT STORM," 16 Apr 91, hereafter cited as AFGWC AAR (U); Stokes Intvw (U), pp 3-4; msg (U), AFGWC to 5WW, et al, "AFGWC SITREP #4 for 22 Sep 90," 221635Z Sep 90; msg (S), AWS/CAT to AFGWC/DO, et al, "AFGWC SW Asia Products (U)," 211424Z Sep 90, info used (U); msg (S), AFGWC/WFO to 5WW/CAT, et al, "AFGWC Products to Support DESERT SHIELD (U)," 231518Z Sep 90, info used (U).

[4]AWS DS/DS Report #2, pp 111-112 (Secs 4.2, 4.2.1.2), info used (U); Millard Intvw (U), p 14; msg (U), AFGWC/DOO to 5WW/DOX, [AFGWC Products List,] n.d. [late Apr 91]; hist rprt (U), AFGWC, 1 Jan -30 Jun 91, Tab D; Stokes Intvw (U), pp 3-5, 8-9; intvw (U), W.E. Nawyn, AWS/HO, with Capt Robert L. Haase and Mr George Krause, AFGWC/WSE, pp 2-5; AFGWC AAR (U).

PRODUCTS ISSUED BY
AIR FORCE GLOBAL WEATHER CENTRAL
AS OF 25 APR 91

NUMBER	NAME	DATE REQUESTED	DATE STARTED	DATE STOPPED
1	WX SUPPORT 291B	28 JAN 91	28 JAN 91	5 APR 91
2	XRAY	-	30 SEP 90	9 FEB 91
3	FXXX36	16 AUG 90	17 AUG 90	CONTINUING
4	DOWNWIND2	13 SEP 90	14 SEP 90	22 MAR 91
5	FXU865	31 JAN 91	1 FEB 91	25 MAR 91
6	NAVY SPECIAL WX/TFU BULLETIN	-	30 JUL 90	2 MAR 91
7	TFU BULLETIN/ SWO 42	-	23 JUL 90	CONTINUING
8	WETSTUFF	5 DEC 90	17 DEC 90	10 APR 91
9	JIMBO 1,2,3,	4 JAN 91	4 JAN 91	8 FEB 91
10	DET 2 CLOUD FREE	-	1983	CONTINUING
11	DOR CHARTS	-	PRO-1990	CONTINUING
12	WINDY	18 JAN 91	TRD-CONTINGENCY	SAR
13	CASA ONE	28 DEC 90	29 DEC 90	29 DEC 90
14	SANDFLEA	7 JAN 91	8 JAN 91	14 JAN 91
15	GOLDRUSH	8 JAN 91	9 JAN 91	1 MAR 91
16	SWO 44	1 SEP 90	2 SEP 90	22 OCT 90
17	CAMEL	-	23 OCT 90	30 OCT 90
18	SHORT FUSE	-	8 AUG 90	14 AUG 90
19	HRT DEPLOYMENT	-	10 AUG 90	12 AUG 90
20	EO FAX CHART	14 AUG 90	17 AUG 90	23 AUG 90
21	3WW SUPPORT	-	15 JAN 91	30 JAN 91
22	CLASSIFIED TITLE	-	10 AUG 90	11 AUG 90
	LIST OF WSP/WOPS PRODUCTS			
1	FEME CHART	19 DEC 90	24 DEC 90	CONTINUING
2	FEME BULLETIN	19 DEC 90	24 DEC 90	CONTINUING
3	CHIEF FCSTR COMPOSITE	N/A	1 NOV 90	CONTINUING
4	FAME	15 AUG 90	15 AUG 90	CONTINUING
5	FTD CLASSIFIED	-	JAN 90	CONTINUING
6	SWO 10	-	?	CONTINUING
7	SWO 22	-	15 AUG 90	CONTINUING
8	VOLANT DOOM FOR DS	23 AUG 90	23 AUG 90	CONTINUING
	ADDITIONAL SELF-INITIATED PRODUCTS			
1	FWW WIND WINDS BULLETINS (WWXX 85, 88, 89, KGWC)	-	31 AUG 90	CONTINUING
2	ADDITIONAL RWN WINDS (FXUS 60-64, 67 KGWC)	-	5 FEB 91	CONTINUING

SOURCE: AWS DESERT SHIELD/DESERT STORM Report #2 (S), pp 115-116 (Atch 12), info used (U).

Figure IV-1

"slightly exceed pure climatology." The next day AWS instructed AFGWC to develop the longer range outlook. AFGWC issued its first 11-15 day trend forecast discussion on 11 February, but produced it for only a short time. The 11-15 day requirement ended when hostilities ended on 28 February. AFGWC continued, however, to transmit the medium- and extended medium-range forecast to the Persian Gulf theater through the redeployment period and beyond.[5]

Producing the 11-15 day outlook was one of the toughest, most challenging tasks AFGWC faced during DESERT SHIELD/STORM. Forecasting as far out as 15 days was at the outer edge of, if not beyond, the state of the art. This was probably the first time that anyone tried to put out a detailed forecast for that far into the future. Existing numerical forecast models only went out ten days. Nevertheless, AFGWC decided to give it its "best shot." The tasking for the 15 day outlook was very specific, directing forecasts for each day and for each region in the theater, and calling for specific parameters such as cloud cover, wind speeds, precipitation, and visibility. The small team assembled by AFGWC to produce the trend forecast discussion worked hard to create a respectable product that was as accurate as possible. The result, however, was more a depiction of the weather pattern that might be expected during a given 11-15 day window than a true forecast. Unavoidably it included much interpretation and guesswork. Keeping the short-, medium-, extended medium-range, and the 11-15 day forecasts internally consistent presented a problem and required daily consultations among those responsible for each type of forecast.[6]

To accomplish its task, the extended outlook team employed innovative methods and used climatology, medium-range forecast models, and other tools available. Its first and perhaps most important step was to gather and assimilate regional climatological data. USAFETAC, the Naval Oceanography Command, and the Naval Environmental Prediction Research Facility were its chief sources for this data. Once it had the data, the team carefully examined them with a view to obtaining answers to a list of questions that it had compiled. Next the team viewed and compared data that it was able to secure from ten-day global medium-range forecast models used by the US National Meteorological Center (NMC) at Suitland, Maryland, and the European Center for Medium Range Forecasting in the United Kingdom. It also utilized forecast products obtained from the United Kingdom Meteorological Office and the German Meteorological Geophysics Office. After analyzing all this data, the team met with AFGWC's chief forecaster and medium-range forecasters to discuss and reach agreement on the 7-10 day extended medium-range portion of the extended outlook.[7]

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[5]AWS DS/DS Report #2 (S), p 112 (Sec 4.2.1.2), info used (U); Phillips Intvw (U), p 7; LTC K.A. Nash in Nash/Runk/Albrecht Intvw (U), p 2; AFGWC AAR (U); msg (U), AFGWC/WFO to CENTAF/Weather and 5WW/CAT, "Routine SAR: Request for Medium-Range Forecast," 212215Z Dec 90; ltr (U), AWS/CAT to AFGWC/DO, "Medium-Range Forecast Product," 29 Jan 91; ltr (U), AFGWC/DO to AWS/CAT, "Medium-Range Forecast Product," 2 Feb 91; msg (U), AWS/CAT to AFGWC/DO, "Extended Medium-Range Forecast Product," 031723Z Feb 91.

[6]Phillips Intvw, pp 6-7; Nash/Runk/Albrecht Intvw (U), pp 2-3; intvw (U), W.E. Nawyn, AWS/HO, with Mr Jay Albrecht, AFGWC/WFM, 14 Jun 91, hereafter cited as Albrecht Intvw (U), pp 2-5, 8.

[7]Albrecht Intvw (U), pp 3-8; atch 1 (U), "Extended Range Forecasting Procedures," to memo (U), J. Albrecht, AFGWC/WFM, to [LTC K.A. Nash, Chief], WFM, "Process for Generating Eleven to Fifteen Day Forecasts for DESERT STORM," 18 Apr 91, w/1 atch; memo (U), AFGWC/WF to AFGWC/DO, "Required Assistance from the National Meteorological Center for DESERT STORM Forecast Support," 4 Feb 91; msg (U), AWS/CAT to 2WW/CAT, et al, "UKMO/STRICOM Long-Range Products for AFGWC," 102221Z Feb 91; ltr (U), Col A.A. Ritchie, AFGWC/CC, to Dr R.D. McPherson, Director, NMC, "[Request for NMC MRF Data Fields,] 14 Feb 91; memo (U), AFGWC/WFM to AFGWC/DOO, "Description of ECMWF Forecast Fields in 28WS STRIKECOM Bulletin," 19 Feb 91.

In addition, the team used two techniques to check and possibly modify the forecasts it developed from the data it had acquired, particularly the model data. The first was global teleconnections, a worldwide database which it could use to correlate features at one particular location in the northern hemisphere to every other location in the northern hemisphere to "test the model forecast wave numbers for climatological reasonability." The second was the analog forecast method known as the Baur type climatology developed by the Germans during World War II to forecast weather for central Europe. The team decided to use this because during the winter European weather features and patterns affected Middle East weather. However, the Baur method proved to be less helpful than anticipated.[8]

In spite of AFGWC's best efforts, only some of its medium-range forecasts and more extended outlooks were successful. On the whole they did not verify very well. While they were of some value (e.g., CENTAF Weather noted that the extended outlook was a useful tool), they were not accurate enough to provide forecasts for specific locations such as a particular target.[9]

Miscellaneous Support

Eager to enhance its forecast products and provide the best possible support to DESERT SHIELD, AFGWC on 27 August turned on a new, unproven forecast model, the relocatable window model. Still essentially under development, the model had never been used operationally. But on 25 August AFGWC notified the 5th Weather Wing that it had recently developed a capability to produce forecast wind fields using the relocatable window model. Two days later it began running the model's contingency window CN1 twice daily on its Cray supercomputer. The window covered the Mediterranean, North African, and Southwest Asian region with a 50-nautical mile resolution. On 17 January 1991, just as the air campaign against Iraq began, AFGWC initiated the use of a second contingency window, CN4. It covered the same region, but with a higher, 25-nautical mile resolution and focused particularly on Saudi Arabia, Kuwait, and Iraq. This, too, it ran twice every day, six hours apart from CN1. AFGWC utilized the relocatable window model primarily to build a low-level wind bulletin which it transmitted to the Persian Gulf theater to assist the WSF in predicting the dispersion characteristics of any chemical agents that Iraq might release.[10]

In January 1991, AFGWC, fearing that it might be denied surface weather data from within the Persian Gulf theater, even from friendly sources, if war should break out, initiated an attempt to make use of data transmitted by special sensor microwave imagers mounted on two DMSP weather

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[8]Albrecht Intvw (U), pp 4, 6; atch 1 (U), "Extended Range Forecasting Procedures," to memo (U), J. Albrecht, AFGWC/WFM, to [LTC K.A. Nash, Chief], WFM, "Process for Generating Eleven to Fifteen Day Forecasts for DESERT STORM," 18 Apr 91, w/1 atch.

[9]LTC R.R. Wall in AWTB Intvw (U), p 42; Ritchie Intvw (U); AWS DS/DS Report #2 (S), p 112 (Sec 4.2.1.1), info used (U); memo (U), AFGWC/WFM to AFGWC/DO, "Extended MRF Forecasting Results," 8 Feb 91, w/1 atch; msg (U), CENTAF Weather to AFGWC/DO, et al, "AFGWC Medium and Extended Range Product Feed Back," 171500Z Feb 91.

[10]Ritchie Intvw (U); ltr (U), AFGWC/DOO to 5WW/Alert Staff, "Proposed AFGWC Product - Forecast Wind Fields for Operation DESERT SHIELD, 25 Aug 90; hist rprt (U), AFGWC, Jul-Dec 90, Vol II, Tab E; intvw (U), W.E. Nawyn, AWS/HO, with Capt Keith G. Blackwell, AFGWC/SDNN, 13-14 Jun 91, pp 16-19.

satellites (the second of which, F-10, the Air Force had launched only the month before) to back up and supplement other data it received from the theater. The effort was highly successful and AFGWC was able to provide additional information useful to forecasters in the DESERT STORM theater. Innovatively interpreting the satellite sensor imagery, Forecasting Services Division personnel were able to determine clouds, winds, and even thunderstorms and from this produce work charts which included surface wind speeds over water, rainfall rates over both land and water, and surface temperatures over land. AFGWC began transmitting the charts to the DSFU twice daily on 23 January 1991.[11]

From mid-January to mid-March 1991 AFGWC provided special support to the Defense Nuclear Agency. This agency was primarily concerned with nuclear threats, but it included a chemical branch which during DESERT SHIELD/STORM had the responsibility to provide the National Military Command Center and Headquarters CENTCOM with chemical/biological agent dispersion forecasts. To provide these forecasts, the Defense Nuclear Agency required accurate chemical dispersion models and in-theater weather information. It was receiving some weather data over AUTODIN from AFGWC and additional weather information from AWS's detachment at the Pentagon. But it felt that it needed more meteorological expertise and assistance than the detachment was able to provide. Therefore, on 17 January, as the air campaign against Iraq began, the agency requested AWS to temporarily loan it three meteorological officers or NCOs to assist it in supporting DESERT STORM operations. The following day AWS instructed AFGWC to send one officer to the Defense Nuclear Agency to determine first hand its need for additional support.[12]

AFGWC appointed Captain Keith G. Blackwell from the Numerical Models Section of its Software Development Branch as the officer to go to the Defense Nuclear Agency. He arrived there on 19 January. A few days later, after he had determined that the agency needed more help, AFGWC sent three NCOs to join him. Captain Blackwell immediately made arrangements to have the Defense Nuclear Agency connected to the AWN, so that it could directly receive the more detailed weather data, particularly the in-theater observations, that it required for its chemical dispersion models. After the NCOs arrived the captain devoted all of his time to evaluating several chemical dispersion models the agency was considering using, while the NCOs provided around-the-clock meteorological support to the agency. Captain Blackwell returned to AFGWC on 8 February, but the last NCO did not leave until 9 March.[13]

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[11]LTC K.A. Nash in Nash/Runk/Albrecht Intvw (U), pp 9-13; AFGWC AAR (U); hist rprt (U), AFGWC, Jan-Jun 91, Tab J, Sup Doc DOA 2-1, "[DOA] Inputs to DO History, 1 Jan 91 through 30 Jun 91;" ltr (U), AFGWC/DO to AWS/DO, "SSM/I Tools for DESERT STORM," 28 Jan 91; telefax (U), AFGWC/WFO/WFG to CENTAF/WX, "SSMI Work Chart Description," 29 Jan 91; msg (U), AWS/CAT to 5WW/CAT, "SSM/I Analysis Work Charts," 290051Z Jan 91.

[12]AFGWC AAR (U); intvw (U), W.E. Nawyn, AWS/HO, with Capt Keith G. Blackwell, AFGWC/SDDN, 13,14 Jun 91, pp 2-3,13; msg (U), DNA/Opns to AWS/DO, "AWS Manpower Support to DNA," 171600Z Jan 91; ltr (U), AWS/DO to AFGWC/DO, "Defense Nuclear Agency Weather Support," 18 Jan 91.

[13]Intvw (U), W.E. Nawyn, AWS/HO, with Capt Keith G. Blackwell, AFGWC/SDNN, 13-14 Jun 91, pp 2-13; AFGWC AAR (U). See also, rprt (U), Capt K.G. Blackwell, AFGWC/SDNN, to AFGWC/SDNN, et al, "Report of Visit: Headquarters Defense Nuclear Agency," 12 Feb 91, w/6 atchs.

Handling Classified Weather Observations

Very early in DESERT SHIELD AFGWC ran into a problem concerning how to handle classified surface and upper air "KQ [weather] observations" it received over the unsecured, long haul weather circuits from AWS units deployed in the Persian Gulf theater. CENTCOM considered the deployed locations of American units to be classified data, hence each AWS deployed unit received an encoded four letter location identifier (which, beginning in September, AWS changed twice per month), the first two letters of which were "KQ." Weather observations of themselves were not classified, but they became classified if they included the locations of the AWS units making the observations. If weather observations were to be of value to AFGWC in developing its forecast products, it had to know where they originated and include that information along with the observations themselves in its database. But including the location immediately made the observation classified and this created the problem.[14]

The problem arose from the fact that the AFGWC computer systems were set up to ingest and manipulate only unclassified material. If AFGWC mixed in classified KQ data with unclassified data in the database it used to develop its products, the whole database became classified. AFGWC's unclassified models would then not be able to extract information from the database and AFGWC's final products became classified, which meant it could not transmit them to the theater over unsecured circuits. Nor could AFGWC customers not cleared to receive classified material access the products. Consequently, on 25 August AFGWC asked AWS for permission to ingest the KQ observations into its unclassified database. A week later AFGWC requested AWS to get definitive guidance from CENTCOM on the issue. Approximately a month later CENTCOM authorized AFGWC to use the KQ observations in its unclassified database, but only if they remained solely within the database. This, of course, did not help AFGWC a great deal since its object was not just to store the KQ data in the database, but to process and use it in developing a product that it would transmit to the theater.[15]

Meanwhile AFGWC had set to work to figure out some way to process the KQ observations and deliver a product derived in part from these observations without creating security problems. To change its whole computer system structure so that the system could use classified data was out of the question because this would take far too long. Therefore, it concentrated on finding a temporary solution. The result was a work-around whereby it masked originating locations by assigning each KQ observation to a bogus location in a part of the world where it could not possibly have originated, such as down near the South Pole or out in the Pacific Ocean somewhere. In this way AFGWC could incorporate the KQ observations into its unclassified database without showing their real locations and then send them to its automated Satellite Data Handling System where Contingency Support Cell personnel could display and manipulate them, using their true location, in a classified environment. Unfortunately, AFGWC had to expend many manhours even to devise and implement the work-around.

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[14]AWS DS/DS Report #2 (S), p 227 (Sec 5.4.1), info used (U); Phillips Intvw (U), pp 3-4.

[15]Phillips Intvw (U), pp 3-4; intvw (U), W.E. Nawyn, AWS/HO, with LTC James H. Love, Chief, AFGWC/WFG, 12 Jun 91, p 4; Millard Intvw (U), pp 11-12; ltr (U), AFGWC/DO to AWS/DO, "Ingesting DESERT SHIELD KQ Observations into AFGWC Data Base," 25 Aug 90; ltr (U), AFGWC/DOO to AWS/CAT, "DESERT SHIELD Security Issues," 1 Sep 90; AWS DS/DS Report #2 (S), p 227 (Sec 5.4.2), info used (U).

For example, it took five AFGWC software experts almost 3 months to develop the necessary software.[16]

Implementation of MEPA-AFGWC Circuit

AFGWC also encountered a problem in obtaining weather observations taken by Saudi Arabian weather stations. When DESERT SHIELD began Saudi Arabia terminated the dissemination of wind and air pressure data from its weather stations because it did not want Iraq to get this type of information. It feared that Iraq would use this data to help it plan chemical attacks. The Saudi government was not opposed per se to sharing this data with the US and the AWS WSF deployed in the Persian Gulf region, but it would not permit transmission of the data in such a way that Iraq might be able to intercept it. It allowed AWS personnel in Saudi Arabia to go in person to Saudi weather stations to get weather observations. This, of course, did not help AFGWC, several thousand miles away. The KQ observations from deployed AWS units provided AFGWC with data from some locations in Saudi Arabia, but they left rather large geographical gaps which AFGWC wanted filled to increase the accuracy of its database. It, therefore, sought ways to get additional weather observations.[17]

About 3 weeks into DESERT SHIELD, AFGWC discovered that Saudi Arabia already had a weather circuit in place from its Meteorological and Environmental Protection Association (MEPA), in effect the Saudi weather service, at Jeddah to the US National Weather Service's National Meteorological Center via New York City. The Saudi government intended that the circuit would become part of the worldwide weather network of the World Meteorological Organization (WMO). However, the circuit, although completed several months before, was not yet operational, primarily because it still had unresolved protocol and configuration problems, involving particularly modems and multiplexers. Nevertheless, AWS and AFGWC decided that this circuit could provide the means by which AFGWC could get the Saudi weather observations and began immediately to work towards this end. Colonel Riley subsequently brought up this possibility at a meeting he had with MEPA officials on 14 August. A few days later the CENTAF Forward Commander, Major General Olsen, contacted Saudi officials about using the circuit to transmit weather observations to NMC. Sometime later, the Saudi Air Force, speaking for the Saudi government, agreed MEPA could use the circuit for this purpose. Consequently, AFGWC and AWS began to make arrangements for getting the data from NMC to AFGWC via the Carswell weather switch. They completed this process by the end of September.[18]

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[16]Phillips Intvw (U), pp 3-4; intvw (U), W.E. Nawyn, AWS/HO, with LTC James H. Love, Chief, AFGWC/WFG, 12 Jun 91, pp 4-5; Waite Intvw (U), pp 11-13; msg (U), AFGWC/DO to HQ AWS/CAT, "Automating Classified Observation Handling Processes," 141930Z Sep 90; Ritchie Intvw (U); AWS DS/DS Report #2 (S), pp 114 (Sec 4.2.1.4), 228 (Sec 5.4.4), info used (U).

[17]Koenemann Intvw (U), p 20; Millard Intvw (U), pp 5-6.

[18]Koenemann Intvw (U), p 20; Millard Intvw (U), pp 5-6; Waite Intvw (U), pp 4-6; AFGWC AAR (U); ltr (U), N. Murshid, Dir, Telecommunication, MEPA, to R. Hamilton, NWS/ARSAD, [MEPA-NMC Circuit Problems,] 31 Dec 90; ltr (U), Col J.W. Goldey, OICWSF, 1690WGP/CC, to Maj Gen J.W. Collens, USAF (Ret), [Information about AWS in DESERT SHIELD/STORM,] 3 May 91, w/1 atch, hereafter cited as ltr (U), Goldey to Collens, 3 May 91; ltr (U), Maj Gen T.R. Olsen, Comdr, CENTAF Fwd, to Lt Gen Ahmed I. Behery, Comdr, RSAF, [Request for Saudi Weather Data,] 19 Aug 90; ltr (U), Lt Gen A.I. Behery, Comdr, RSAF, to Lt Gen C.A. Horner, COMUSCENTAF, [MEPA-AFGWC Circuit,] n.d. [ca Aug

The next step, once the Saudis approved using it to transmit the weather observations, was to get the MEPA-NMC circuit operational. This proved to be considerably more difficult. More than four months elapsed before it happened. The main reason for this extremely long time was not so much the insurmountability of the circuit's problems as the absence of strong leadership in resolving them. Because it was not their circuit, AWS and AFGWC could not take the lead. In their eyes, it seemed that MEPA wasn't pushing hard enough to take care of the problems. But there were other reasons too, especially the lack of coordination and communication between agencies involved in the establishment of the circuit.[19]

These agencies included, in addition to MEPA, the National Weather Service, MCI Communications Corporation and the American Telephone and Telegraph (AT&T) Corporation, as well as other Saudi agencies and American contractors. MCI International was the long-haul carrier for the Jeddah-New York City satellite segment, AT&T owned the New York City-NMC portion of the circuit, and AT&T's Paradyne subsidiary was the supplier and installer of terminal equipment at Jeddah and New York City--where the chief equipment problems existed. To get all these to work together, especially in the absence of a strong driver, was a "nightmare." But MCI especially seems to have "dropped the ball" here and, in general had been rather unresponsive to the problem.[20]

The upshot of all of this was that no real effort to solve the problem with the circuit occurred until early January when perhaps the likelihood of hostilities beginning shortly lent a greater sense of urgency to the situation. The National Weather's Service's James Fenix played a prominent role in persuading the parties to get serious. On 3 January he requested MCI's Manager for Service Delivery, Albert Malet, to correct the problem as soon as possible. The following day he repeated his request. Pointing out that the need to exchange data with MEPA was "becoming operationally critical," Fenix urged Malet to "do what will take the shortest amount of time to make this circuit sound and reliable for operational use." Four days later, on 8 January, Malet finally issued instructions to install the proper modems at both ends of the circuit, condition the circuit for the use of the modems, and, following this, take steps to increase the speed of the circuit in compliance with a MEPA request. At about the same time MEPA sent a communications engineer to the US to work with NMC, MCI, and AT&T to resolve the problems. As a result of this concerted effort, on 18 January, only a few days after installation of the proper, compatible equipment, and only a matter of hours after resolution of a final communications engineering problem, the circuit finally became operational.[21]

90]; action item #15 (U), AWS/PM, "Saudi Winds-Direct Circuit," opened 27 Aug 90, closed 2 Oct 90.

[19]Koenemann Intvw (U), pp 20, 21-22; Millard Intvw (U), pp 6-7; Waite Intvw (U), pp 5-6; msg (U), HQ AFGWC/CAT to 5WW/CAT, et al, "Establishing MEPA-NWS Data Circuit," 151715Z Nov 90.

[20]Millard Intvw (U), p 7; Waite Intvw (U), pp 5-6; msg (U), HQ AFGWC/CAT to 5WW/CAT, et al, "Establishing MEPA-NWS Circuit," 151715Z Nov 90; atch 7 (U), telefax cover sheet, J. Fenix, NWS/NOAA, to R. Hamilton, MEPA/ARSAD, 27 Nov 90, to telefax (U), J. Fenix, NWS/NOAA, to A. Malet, MCI/Mgr Svc Delivery, 4 Jan 91, w/7 atchs; telefax cover sheet (U), J. Fenix, NWS/NOAA, to R. Hamilton, MEPA/ARSAD, 7 Jan 91.

[21]Telefax (U), J. Fenix, NWS/NOAA, to A. Malet, MCI/Mgr Srvc Delivery, [Bringing MEPA-NMC Circuit to Operational Status,] 3 Jan 91, w/8 atchs (partial file of Fenix correspondence re MEPA-NMC circuit); telefax (U), J. Fenix, NWS/NOAA, to A. Malet, MCI/Mgr Srvc Delivery, [Correction of Problems on MEPA-NMC Circuit,] 4 Jan 91, w/7 atchs (partial file of Fenix correspondence re MEPA-NMC circuit); memo (U), LTC L. Irvin, 5WW/IMA, to Col J.E. Sands, Jr, 5WW/CV, "Washington-Jeddah Circuit," 10 Jan 91, w/1 atch: telefax (U), A. Malet/MCI Mgr Srvc Delivery, to P. Saxena, Jeraisy Computer, [Actions Necessary to Get MEPA-NMC Circuit Operational,] 8 Jan 91; memo (U), LTC L.

Through these 4 plus months AFGWC tried to hasten the solution of the problem through frequent contacts with the National Weather Service, MEPA, and MCI, and by enlisting the assistance of AWS, the 5th Wing, and through the latter, Colonel Goldey in the DESERT SHIELD theater. But its role was, in the nature of the case, secondary, and in spite of its efforts and those of Headquarters AWS, nothing much happened until the major players, meaning MEPA, the National Weather Service, and MCI, got together to seriously attack the problem. For AFGWC and AWS it was a long, frustrating battle trying to get organizations over which they had no control to move forward on resolving this issue.[22]

Once the circuit became operational, AFGWC almost immediately started to receive the Saudi weather observations. These observations were frequently more timely than those received from deployed AWS weather teams before they had access to the SBLC network. AFGWC also began to retransmit the Saudi observations to the WSF via the AWN. The Saudi government permitted such dissemination of the observations, but still required that they be kept out of WMO channels. Although MEPA sent the observations to AFGWC using only standard International Civil Aviation Organization location identifiers, AFGWC, in order to better protect them from unauthorized customers and/or being inadvertently sent into WMO channels, used KQ identifiers when transmitting them over the AWN. On 27 March 1991 AFGWC, following the example of Saudi Arabia itself, lifted all restrictions on the receipt and dissemination of Saudi weather data.[23]

AFGWC made a significant contribution to the weather support provided by AWS during DESERT SHIELD/STORM. AFGWC personnel felt AFGWC had done well, as did Colonel Frederick, the AWS Vice Commander, who remarked that it had done "an outstanding job." After action reports from other organizations also contained positive comments on AFGWC's role. They called AFGWC's support "timely" and "responsive" and summarized it in such terms as "outstanding" and "excellent." At the same time, however, they also pointed out weaknesses and limitations in AFGWC's products. CENTCOM Weather staff after action reports, for instance, observed that AFGWC's SWO 42 bulletin tended to be too pessimistic, especially in regards to winds and visibilities, and that its products often lacked horizontal consistency.[24]

Irvin, 5WW/IMA, to Col J.E. Sands, Jr, 5WW/CV, "Washington-Jeddah Circuit," 17 Jan 91; msg (U), AFGWC/DO to AWS/DO, et al, "NMC-Jeddah Circuit," 170005Z Jan 91; Waite Intvw (U), p 6; atch 1 (U), point paper, "Washington-Jeddah Circuit," to memo (U), LTC L. Irvin, 5WW/IMA to Col J.E. Sands, Jr, 5WW/CV, "Washington-Jeddah Circuit," 18 Jan 91 [1st memo], w/1 atch; memo (U), LTC L. Irvin, 5WW/IMA, to Col J.E. Sands, Jr, 5WW/CV, "Washington-Jeddah Circuit," 18 Jan 91 [2d memo]; mfr (U), D.G. Caviness, Asst Chief, AFGWC/DO, "NWS/Jeddah Circuit Status," [18 Jan 91].

[22]Millard Intvw (U), pp 6-7; msg (U), 5WW/CAT to USCINCCENT Weather, et al, "Items of Interest 11-19," 200345Z Nov 90; msg (U), AFGWC/DO to AWS/DO, et al, "NMC-Jeddah Circuit," 170005Z Jan 91; Koenemann Intvw (U), p 20; Phillips Intvw (U), p 8; Waite Intvw (U), p 5.

[23]Phillips Intvw (U), p 8; Millard Intvw (U), pp 12-13; Waite Intvw (U), pp 5-8; AFGWC AAR (U); AWS DS/DS Report #2 (S), p 227 (Sec 5.4.2), info used (U); ltr (U), AWS/DO to AFGWC/DO, "Saudi Observation Dissemination," 24 Jan 91; memo (U), unknown to 5WW/CAT, [Dissemination of Saudi Observations,] 25 Jan 91; ltr (U), 5WW/DOX to Det 7, AFGWC/CC, "Release of Saudi Data," 27 Mar 91.

[24]Millard Intvw (U), p 14; Stokes Intvw (U), pp 9-10; Frederick Intvw (U), p 11; AWS DS/DS Report #2 (S), p 113 (Secs 4.2.1.2, 4.2.1.3), info used (U); atch 2 (U), rprt, Maj N.E. Holtgard, USCENTCOM/ASWO, to 1690WGP/CC, "DESERT SHIELD/STORM After Actions Report," 25 Mar 91, hereafter cited as Holtgard DS/DS AAR, and atch 3 (U), rprt, Maj L.L. Moore, USCENTCOM/SWO

Climatology from USAFETAC

To operate in the unfamiliar, harsh environment of the Persian Gulf region, the AWS DESERT SHIELD/STORM WSF needed climatological information. Most weather teams deployed with some published climatological material, but even then, what they had was not sufficient for them to adequately support their customers, particularly in apprising them of the changes in the weather they could expect toward the end of the calendar year. Consequently, within hours of the commencement of the DESERT SHIELD deployment, USAFETAC, AWS's primary purveyor of climatological data, began to receive requests, usually through the 5th Weather Wing, for climatology applicable to the operational theater. USAFETAC (usually referred to simply as ETAC), responded quickly and over the next several months distributed large amounts of relevant climatological data. This data proved to be very useful to the WSF and, passed on to the customers supported, "enhanced operations and affected major strategic decisions."[25]

The climatological information distributed by ETAC consisted of documents published by ETAC or other organizations prior to the beginning of DESERT SHIELD, reports produced and published by ETAC during DESERT SHIELD/STORM, and responses by ETAC to SARs it received from the field during the operation. Most of the climatology used by the WSF came either directly or indirectly from ETAC, but some also came from other sources, both from within and outside of AWS. ETAC provided climatological data not only to the AWS WSF, but also to Headquarters AWS, US National Command Authorities, the Navy, the Marine Corps, and even to Canadian forces deployed to the Persian Gulf.[26]

Fortunately, ETAC already had developed descriptive climatologies covering the Persian Gulf area prior to the onset of DESERT SHIELD. Probably the most important was The Persian Gulf Region: A Climatological Study, originally published in May 1988, when the US Navy was escorting oil tankers transiting the Persian Gulf enroute to and from Kuwait during the Iran-Iraq war. This study became a "best seller" during DESERT SHIELD/STORM. The US Marine Corps alone distributed 10,000 copies to its units. Deployed AWS units used it extensively in teaching forecasters about weather in the operational theater and in briefing their commanders and operational staffs. In October 1988, ETAC had also come out with another extensive climatological document dealing with the Persian Gulf area, "The Persian Gulf Region: A Refractivity Study." In addition, ETAC had, using its mainframe computers, in 1989 begun to build up what it called the Relational Data Base Management System, which enabled its personnel to rapidly access all sorts of climatological information. As a result, during

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Augmentee, to 1690WGP/CV, "After Action Input - DESERT SHIELD/STORM," 23 Mar 91, to CENTCOM Weather Staff AARs (U).

[25]AWS DS/DS Report #2 (S), pp 117 (Sec 4.2.2.1), 119 (Sec 4.2.2.2c), 123 (Sec 4.2.2.3), info used (U); intvw (U), W.E. Nawyn, AWS/HO, with LTC James C. St.John, USAFETAC/CV, 14 Aug 91, hereafter cited as St. John Intvw (U), p 2; Koenemann Intvw (U), p 31; AFGWC AAR (U); tab H (U), hist rprt, USAFETAC, Jul-Dec 90, p 43, to hist rprt (U), AFGWC, Jul-Dec 90.

[26]AWS DS/DS Report #2 (S), pp 118, 120 (Secs 4.2.2.2b-d), info used (U); intvw (U), W.E. Nawyn, AWS/HO, with Maj Charles W. Tuttle USAFETAC/ECO, and Mr Kenneth R. Walters, USAFETAC/ECR, 14 Aug 91, hereafter cited as Tuttle/Walters Intvw (U), pp 5-6; tab H (U), hist rprt, USAFETAC, Jul-Dec 90, p 43, to hist rprt (U), AFGWC, Jul-Dec 90; list (U), [USAFETAC/ECR], "[Small Area Study] Distribution List," n.d.

DESERT SHIELD/STORM ETAC could respond to requests for climatology much more quickly than before.[27]

ETAC also published a number of climatological documents during DESERT SHIELD/STORM. Beginning in mid-August 1990, it issued seasonal, small area descriptive climatologies for ten regions within the Persian Gulf theater, as well as point climatologies for specific locations in the theater. In February 1991, it published another comprehensive climatological study, SWANEA (Southwest Asia-Northeast Africa): A Climatological Study, Vol II: The Middle East Peninsula, as a follow-on to the 1988 Persian Gulf study. At the time it was also working on a third volume in the series, but it was not able to issue this until June 1991, well after DESERT STORM was over.[28]

In addition, ETAC responded to at least 23 SARs during DESERT SHIELD/STORM, about half of which originated with either CENTCOM or CENTAF Weather. These asked for such information as diurnal curves of temperature and visibility for Baghdad from September through December; frontal weather for southern Iraq, Kuwait, and northern Saudi Arabia; windroses, temperature, and humidity for Riyadh and Bahrain; and diurnal dewpoint curves for Kuwait City. ETAC was usually able to respond to the requests in less than 72 hours. For a time ETAC also provided radar refractivity climatology products in addition to its 1988 refractivity study. While they were useful in providing understanding of the nature of the refractivity problem, the WSF did not use them a great deal because refractivity never became a major concern during DESERT SHIELD/STORM.[29]

Very early in DESERT SHIELD deployed SWOs requested ETAC to provide electro-optical tactical decision aids (EOTDAs) based on climatology since field units did not have enough data to create their own. Immediately assembling a special team of approximately eight people and a bank of six or seven microcomputers, ETAC inaugurated a crash program to develop the desired EOTDAs. Working every day during the next three weeks, the team, using ETAC target climatology and target data provided by field units, created some 800 EOTDAs covering the months of August through November for 160 different locations in the Persian Gulf theater. ETAC did not go beyond November because by that time units in the field would presumably be able to operate their own EOTDAs. Since the weather in the theater was very stable (hot and sunny) during the August-November period, the climatology-based EOTDAs produced by ETAC were probably about as accurate as any that units in the field would have produced during that timeframe. ETAC EOTDAs covering the December-February time period would not have been as accurate. Creating EOTDAs was as close to direct operational support for DESERT SHIELD that ETAC came. This was probably the first time ever that EOTDAs were, in effect, a centralized product.[30]

On 2 November, AFGWC, responding to instructions from Headquarters AWS, formally tasked ETAC to present a monthly climatology briefing to General Kelly, the AWS Commander. Actually,

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[27]AWS DS/DS Report #2 (S), pp 118-119 (Sec 4.2.2.2b), info used (U); St. John Intvw (U), pp 2,4-6; Tuttle/Walters Intvw (U), pp 2-3.

[28]Tab I (U), hist rprt, USAFETAC, Jan-Jun 91, p 40, to hist rprt (U), AFGWC, Jan-Jun 91; AWS DS/DS Report #2 (S), p 120 (Sec 4.2.2.2-d), info used (U); St. John Intvw (U), pp 9-10.

[29] AWS DS/DS Report #2 (S), pp 118 (Sec 4.2.2.2-b), 120 (Sec 4.2.2.2--d), 122 (Sec 4.2.2.2-e), 141-143 (Atch 19), info used (U).

[30]St. John Intvw (U), pp 2-4; Tuttle/Walters Intvw (U), p 2; AWS DS/DS Report #2 (S), p 121 (Sec 4.2.2.2-d), info used (U); AFGWC AAR (U); tab H (U), hist rprt, USAFETAC, Jul-Dec 90, p 43, to hist rprt (U), AFGWC, Jul-Dec 90.

ETAC had already twice (in August and October) briefed General Kelly on Persian Gulf climatology. But ETAC now began to prepare a comprehensive, detailed package covering synoptic, aviation, electro-optical, and refractivity climatology for each month, beginning with November. It based the information in the packages on the Persian Gulf study, but incorporated data acquired through additional research and tailored more precisely in regards to time and place. ETAC received many requests for the briefing packages. Consequently, it not only briefed each monthly package to General Kelly and his command section, but also mailed copies to CENTCOM Weather and AWS wings as well as to Navy and Army units and agencies--about 45 copies all together.[31]

As might be expected, the many different ETAC climatological products varied in their accuracy. On the whole, its descriptive climatologies were excellent. On the other hand, due to the limited state of the art, ETAC's frontal weather climatology was not accurate enough for Army ground forces to rely on it for operational decisions. ETAC's use of Saudi weather observations based on observing practices different from (and, from the AWS perspective, inferior to and less accurate than) those used by AWS observers in creating its database led to, at least potentially, inaccuracies in its climatological products. Sometimes, too, climatologies from different sources conflicted with each other. In general, however, the ETAC products were very useful and helpful to the deployed WSF and other ETAC customers.[32]

ETAC was not the only source of climatological information for the deployed WSF. For example, the 5th Wing responded to four SARs while AFGWC and Headquarters AWS's Detachment 2 at the Pentagon to one each. At the request of the 5th Wing, the US Navy's Naval Oceanographic Command, through its detachment located at Asheville, North Carolina (close to ETAC's Operating Location A), provided a particularly valuable climatological product, the personal computer version of the Summary of Meteorological Observations, Surface. Placed on approximately 75 diskettes, each of which contained observations for a number of specific stations, this summary proved to be very useful for CENTCOM Weather, the DSFU, and ARCENT Weather. Other organizations supplying climatology included the Computer Flight Plans Section at AFGWC, the climatology branches at the 2d, 5th and 7th Weather Wings, and the National Oceanic and Atmospheric Administration (NOAA).[33]

Imagery from Meteorological Satellites

Meteorological satellites orbiting the earth over Southwest Asia provided vital weather information for the deployed WSF, indeed, satellite imagery was probably its single most important source of meteorological data. To put it differently, satellite imagery was an "absolutely essential," "indispensable tool" for providing weather support to DESERT SHIELD/STORM. During most of the

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[31]Msg (U), AFGWC/CAT to USAFETAC/DO, "DESERT SHIELD Climo Briefing," 022000Z Nov 90; msg (U), AWS/CAT to AFGWC/CAT, "DESERT SHIELD Climatology," 312135Z Oct 90; Tuttle/Walters Intvw (U), pp 7-9; AWS DS/DS Report #2 (S), p 120 (Sec 4.2.2.2-c), info used (U); St. John Intvw (U), pp 5,9; AFGWC AAR (U).

[32]AWS DS/DS Report #2 (S), pp 117-118 (Sec. 4.2.2.2-a), 121 (Sec 4.2.2.2-e), 123-124 (Secs 4.2.2.3, 4.2.2.4), info used (U); note (U), Col G.F. Riley, Chief, AWS/DOT, to W.E. Nawyn, AWS/HO, [Accuracy of Climatologies Based on Saudi Data,] 1 Jul 92.

[33]AWS DS/DS Report #2 (S), pp 118-120 (Sec 4.2.2.2-b,c,d), 122 (Sec 4.2.2.2-e), info used (U); intvw (U), W.E. Nawyn, AWS/HO, with LTC Kenneth A. Peterson, 5WW/DN, 6 Jun 91, pp 5-6.

operation, the WSF used two satellite data receiving systems to acquire satellite imagery: a DMSP tactical terminal located in a Mark IV readout van, and small, portable, Wraase tactical terminals possessed by every Army support weather team. During DESERT STORM AWS deployed a new small satellite tactical terminal to the theater, the Rapid Deployment Imagery Terminal (RDIT). The DMSP van was able to receive data from European Meteorological Satellites (METEOSATs) and US NOAA civilian weather satellites as well as from DMSP military weather satellites. However, the Wraase could receive data only from the civilian satellites, the RDIT only from the DMSP satellites. The DMSP van used the TIDS at the DSFU to distribute satellite imagery to in-theater weather units.[34]

Deployment of Mark IV DMSP Van

If the WSF was to have direct access to DMSP satellite imagery, it had to have a Mark IV van close at hand, i.e., located in or near its headquarters units in Riyadh. This was easier said than done. AWS war plans, e.g., the 5th Wing's O2-FY plan, called for deployment of the van approximately three weeks after the commencement of a contingency operation, meaning, in this case, about 28 August. General Kelly, the AWS Commander, placed high emphasis on getting a van--specifically the Air Force-owned van at MacDill AFB dedicated to CENTCOM use--deployed according to plan so the WSF would have this vital resource quickly. However, for various reasons, AWS ran into problems. For one thing, the rapidly expanding DESERT SHIELD deployment placed huge demands on airlift and the van was big, bulky, and heavy. Weighing 14.8 short tons, and 25 feet long, 6 feet wide, and 8 feet high, the van, including its generator trailer, required three quarters of a C-141 aircraft for airlift. Besides, plans or no, the van had a relatively low priority. Any higher priority was hard to come by because CENTCOM at first saw little or no urgency in deploying it since the weather support in the theater was the same, i.e, sunny and hot, every day. Consequently, AWS had to work hard to get the van deployed as quickly as it wanted.[35]

Fortunately, AWS was able to obtain the support of Major General Olsen, the CENTAF Forward Commander, for the van's early deployment. On 16 August Colonel Goldey (then still at MacDill), in his capacity as the CINCCENT SWO, talked to General Burton Moore, Director of Operations for CENTCOM, about deploying the van, but with no success. When Colonel Goldey admitted that the weather in the theater would not change until around mid-October at the earliest, the general told him to come back again in late September. On 17 August General Kelly requested the USCINCCENT CAT at MacDill to expedite the deployment of the van. CENTCOM Operations replied the following day that the van would not deploy. However, by this time AWS recognized that the most effective way to get something to happen was to have it "pulled" from the theater rather than "pushed" from the US, in other words, what was needed was for a high ranking officer in the field to state a requirement for the van. Indeed, on the same day Colonel Goldey made his pitch to General Moore, Headquarters AWS instructed Colonel Riley in Riyadh to try to persuade CENTAF Forward and ARCENT to request the van. Colonel Riley made the attempt and, 3 days later, 19 August, General Olsen sent word to General Kelly

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[34]AWS DS/DS Report #2 (S), p 159 (Sec 4.5.1), info used (U); atch 2 (U), Holtgard DS/DS AAR (U), to USCENTCOM Weather Staff AARs (U); memo (U), LTC R.E. Townsend, AFGWC/WF to AFGWC/DOO, "Lessons Learned--DESERT STORM/SHIELD," 21 Mar 91.

[35]AWS DS/DS Report #2 (S), p 159 (Sec 4.5.2-b(1), info used (U); LTC R.R. Wall in AWTB Intvw (U), pp 11-12; Goldey Intvw (U), pp 3-4, 28; Koenemann Intvw (U), pp 12; notes on info sheet (U), n.a., [Manpower Force Element Listing,] 20 Dec 89.

that he believed the time had come when "it would be prudent" to deploy a DMSP terminal to DESERT SHIELD.[36]

Armed with the CENTAF Forward Commander's support, AWS was now able to get the van deployed in less than 2 weeks. General Kelly quickly forwarded General Olsen's stated requirement for the van to the USCINCCENT CAT and requested its assistance in seeing that the van received the "highest priority." On 21 August, CENTCOM Operations promised the AWS Commander it would "work to provide lift" for the van "as priorities allowed." Meanwhile, General Kelly persuaded General Johnson, CINCMAC, to advocate raising the priority of the van deployment. Two days later TAC entered the van into the TPFDD and the next day, 24 August, CENTAF Rear at Langley AFB validated airlift. The van departed MacDill aboard a MAC C-141 on 29 August and arrived in Riyadh late on the 30th. It arrived in the theater only a couple of days later than called for by operational plans.[37]

Once the van arrived, Colonels Goldey and Riley immediately set to work to get it operational. The first step was to decide where to locate it. They wanted it in Riyadh, preferably at or near the DSFU at CENTAF Weather. However, this was not feasible from a reception standpoint because CENTAF Weather was located in an urban area surrounded by high rise buildings. Consequently, they selected, as their second choice, one of three alternative sites on Riyadh AB suggested by the Saudi base commander. It was not an ideal location because the distance between the van and the DSFU, approximately five miles, would have its costs in terms of data timeliness. On 1 September the WSF leaders formally asked the Saudi base commander for permission to position the van at the site they had selected. The required permission came late the next day. Workers now unpacked and set up the van. It became operational at 2107 local time, 3 September, approximately 3 days after it arrived in Riyadh.[38]

On two occasions AWS considered deploying a second DMSP van (there were nine) to Saudi Arabia as a backup. The first time was in early October. However, CENTCOM Weather counseled against it on the grounds that, first, CENTCOM and CENTAF would not agree to such a proposal

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[36]Goldey Intvw (U), pp 3-4; Koenemann Intvw (U), p 12; SATCOM conversation (S), HQ AWS and LTC G.F. Riley, CENTAF/SWO, [Miscellaneous Items,] 16 Aug 90, info used (U); msg (S), 1WS/LN to 5WW/CC, et al, "DESERT SHIELD DMSP Concerns (U)," 272105Z Sep 90, info used (U); msg (U), AWS/CC to USCINCCENT/CAT, et al, "Request for AN/TMQ-35 Defense Meteorological Satellite Program Direct Readout Terminal (U)," 170020Z Sep 90; msg (S), COMUSCENTAF FWD/CC to AWS/CC, et al, "Meteorological Satellite Imagery for Operation DESERT SHIELD," 191230Z Aug 90, info used (U).

[37]Msg (S), 1WS/LN to 5WW/CC, et al, "DESERT SHIELD DMSP Concerns (U)," 272105Z Sep 90, info used (U); msg (S), AWS/CC to USCINCCENT/J3, et al, "Meteorological Satellite Imagery for Operation DESERT SHIELD (U)," 201800Z Aug 90, info used (U); msg (S), USCINCCENT/CCJ3 to AWS/CC, et al, "Meteorological Satellite Imagery for Operation DESERT SHIELD (U)," 211510Z Aug 90, info used (U); msg (S), AWS/CAT to 4WW/CAT, "Information on DMSP Van (U)," 112214Z Oct 90, info used (U); annex A (S), atch 1, p 1-20, to hist rprt (U), 4WW, Jul-Dec 90, info used (U); msg (S), USCINCCENT/Weather to 5WW/CC, et al, "DESERT SHIELD DMSP Concerns (U)," 010107Z Oct 90, info used (U); St. Onge Intvw (U), p 19.

[38]AWS DS/DS Report #2 (S), pp 159 (Sec 4.5.2-a(2)), 169 (Sec 4.5.4), info used (U); CENTAF SWO AAR (U), Sec C-1; msg (S), USCINCCENT/Weather to 5WW/CC, et al, "DESERT SHIELD DMSP Concerns (U)," 010107Z Oct 90 (U), info used (U); msg (S), AWS/CAT to 4WW/CAT, "Information on DMSP Van (U)," 112214Z Oct 90, info used (U).

because neither planned to establish any backup communication capabilities and second, CENTCOM had imposed a personnel ceiling for the theater. CENTCOM Weather suggested that AWS, as an alternative, continue its initiative to procure a small, tactical satellite receiver and use a Wraase satellite receiver as an interim backup. Consequently, AWS dismissed the idea for the time being and instead positioned a Wraase at Taif, the site planned for an alternate DSFU and an alternate CENTAF headquarters, if CENTAF established one. AWS also made plans to put a RDIT tactical receiver at Taif when one became available. In late December, as war in the Persian Gulf began to appear imminent and the possibility of losing the van at Riyadh became more real, AWS once more discussed the deployment of a second van, but again dropped the idea for the same reasons as it had in October.[39]

When DESERT STORM began in mid-January, TAC, at the request of CENTAF, directed AWS to source the DMSP van at Eglin AFB as an "attrition reserve asset" to replace the Riyadh van in the event it was destroyed or became inoperational for some other reason and to prepare it to deploy on 72 hours' notice. Responding quickly to the TAC directive, by 22 January Headquarters AWS had the Eglin van ready for immediate deployment. The Riyadh van, however, continued operating without a hitch through the end of DESERT STORM and AWS never deployed a second DMSP van.[40]

Disseminating Satellite Data

For the DESERT SHIELD WSF to receive satellite imagery, the deployment of the DMSP van was not sufficient. The next step was to disseminate the imagery received by the van to the weather units in the DESERT SHIELD operational theater. A deployed DMSP van used the TIDS to distribute satellite imagery to weather units deployed in the operational theater. Under the DMSP van deployment concept, each van deployed with four Harris 850 Laserfax receivers (the standard number for all AWS DMSP vans) which it would distribute to deployed CENTAF support weather units to enable them to receive satellite data. The vans, therefore, were able initially to disseminate satellite imagery to only four weather units.[41]

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[39]Msg (S), AWS/CAT to HQ AFSC/SCS, et al, "Initial Request for DMSP Van Support (U)," 032015Z Oct 90, info used (U); msg (S), 5WW/CAT to USCENTCOM/Weather, et al, "Second DMSP Van (U)," 040209Z Oct 90, info used (U); msg (S), AWS/CAT to 4WW/DO, "Initial Request for DMSP Van Support (U)," 042045Z Oct 90, info used (U); msg (U), AWS/CAT to 5WW/CAT, "Action Item Update (6 Oct 90)," 070230Z Oct 90; Riley Intvw (S), pp 29-30, info used (U); msg (S), USCINCCENT/Weather to 5WW/CAT, et al, "Backup METSAT Capability (U)," 121432Z Oct 90, info used (U); note on msg (S), AWS/CAT to 4WW/CC, et al, "DMSP Van Deployment (U)," 141300Z Oct 90, info used (U); msg (S), AWS/CAT to 2049CCSG/SCLK, et al, "DMSP Van Deployment Status (U)," 152300Z Oct 90, info used (U); msg (S), 5WW/CAT to 4WW/CAT, "Second DMSP Mk IV Van for DESERT SHIELD (U)," 211321Z Dec 90, info used (U); AWS DS/DS Report #2 (S), p 163 (Sec 4.5.2-a(12)), info used (U).

[40]Msg (S), USCENTAF/SCX to HQ TAC/SCO, "Request for Weather Radar [sic] (U)," 111335Z Jan 91, info used (U); msg (S), 5WW CAT to AWS/CAT, et al, "Mark IV Attrition Reserve (U)," 161248Z Jan 91, info used (U); msg (S), AWS/CAT to AFLC/SCS, et al, "Request for DMSP Van (U)," 171930Z Jan 91, info used (U); msg (S), HQ AFLC/SC to AWS/CAT, et al, "Request for DMSP Van (U)," 181906Z Jan 91, info used (U); msg (U), 1972CG/LG to HQ AFSC/WE, et al, "DMSP Van Status," 221458Z Jan 91.

[41]AWS DS/DS Report #2 (S), p 160 (Sec 4.5.2-a(3)(5)), info used (U); St. Onge Intvw (U), p 20.

In DESERT SHIELD there were many more than four deployed weather units requiring satellite imagery by the time the DMSP van arrived in theater, therefore, the four Harris 850 receivers with which it came were totally insufficient to meet the demand. The 5th Wing immediately took action to collect and send out an additional 13 Harris 850 receivers available from other DMSP Mark IV vans. However, this was still not sufficient; on 29 September, CENTAF Weather indicated it required seven more. By this time AWS had determined that the Alden 9315TRT-R could serve as a substitute for the Harris 850, provided operators used a special plastic base paper for receiving the imagery. Consequently, to overcome the shortage of Harris 850s, in subsequent weeks it purchased and shipped to the theater a number of additional 9315TRT-Rs as well as a quantity of the special paper. Eventually the DESERT SHIELD/STORM TIDS expanded into a network of 28 locations.[42]

Unfortunately, the WSF had problems in sending and receiving satellite imagery, due in part to the large size of the TIDS network, both in the number of stations and area covered--much larger than ever envisioned in the TIDS concept. The TIDS experienced considerable signal degradation because the DSFU had to convert the TIDS signal from analog to digital for transmission over tactical communication lines, and receiving units had to convert it back to analog in order for the Harris 850s to receive it. The large number of weather units needing the satellite imagery and the considerable distance of many units from the DSFU necessitated multiple conversions in some instances. As a result, TIDS reception was, at best, only fair and frequently poor at many of the deployed weather units, especially those farthest away. The Harris 850s were not able to receive data over a noisy circuit as well as the 9315TRT-Rs; consequently, units with the 9315s were able to receive somewhat better satellite imagery than those with Harris 850s. Some of the units with the 850s, therefore, resorted to the TACFAX circuit to receive satellite imagery (the DSFU sent some imagery from the geostationary METEOSATs during TACFAX transmissions).[43]

Additional problems resulted from separating the TIDS transmitter from the DMSP van. In concept, deployed DMSP vans would transmit satellite imagery directly to weather units in the field. In DESERT SHIELD, communications technicians at the deployed van initially used a microwave link to send imagery to the USAF Technical Control Unit in the theater which, in turn, broke it up and transmitted it to the various locations needing the data. However, using the microwave link required an analog-digital-analog conversion, and, therefore, further degraded the signal. Consequently, Colonels Goldey and Riley decided to move the TIDS transmitter from the van to the DSFU at CENTAF Weather. The DSFU would then send the imagery over land line to Technical Control which would, as before, transmit it to the weather teams scattered about the theater. This worked somewhat better, but it also caused new problems. For one thing it entailed hand delivery of satellite imagery hard copy from the van to the DSFU five miles away, which created a lot more work, was time consuming, and, most importantly, significantly increased the time it took to get imagery ready for transmission to the field. In addition, it resulted in the TIDS having to share, as previously noted,[44] a circuit with

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[42]AWS DS/DS Report #2 (S), pp 6 (Sec 2.2.2-b), 160 (Sec 4.5.2-a(5)), info used (U); St. Onge Intvw (U), pp 20-21; msg (S), 5WW/CAT to AWS/CAT, "Additional TIDS Requirements (U)," 290651Z Sep 90, info used (U); memo (U), LTC T.P. Walters, HQ AWS/APM, to [HQ AWS/] CAT, "CAT Tasker #8 (Additional TIDS Terminals)," n.d. [ca 1 Oct 90]; 5WW DESERT SHIELD Chronology (S), p 9-2, info used (U); Riley Intvw (S), pp 27-28, info used (U).

[43]AWS DS/DS Report #2 (S), pp 160-161 (Sec 4.5.2-a(6)), 168-169 (Sec 4.5.4), 209 (Sec 5.1.3.2-b), info used (U); CENTAF SWO AAR (U), Sec C-2; Riley Intvw (S), p 28, info used (U); msg (S), AWS/CAT to 5WW/CAT, et al, "AWS Review of TIDS Operations in DS (U)," 161715Z Nov 90, info used (U); note (U), Col G.F. Riley, AWS/DOT, to W.E. Nawyn, AWS/HO, 1 Jul 92.

[44]See above, Chapter III, p 69.

TACFAX (following an around-the-clock schedule of 2 hours TIDS-4 hours TACFAX), which delayed the transmission of satellite imagery even more.[45]

The DMSP Mark IV van itself performed well throughout DESERT SHIELD/STORM. This was due, in no small part, to the skill and hard work of the operator/maintenance team provided by AFCC. The van compiled an overall 98 percent uptime rate and generated over 8,600 products during the course of the operation. The Mark IV obtained data from the two METEOSAT and three NOAA as well as the DMSP F8 and F9 (and F10 after its launch, at the request of AWS, in early December) satellites. It could not, however, process data from more than one satellite at a time. It relied most heavily on the DMSP and NOAA N11 satellites, mostly because they were available at optimum times for preparing briefings and supporting the DSFU. The DMSP satellites provided high quality, high resolution imagery. High resolution enabled depiction of greater detail. Unfortunately, the van could get data from the DMSP satellites only 6 hours per day, three in the morning and three in the evening. Consequently, the DMSP refresh rate was slow, making "looping" of the data impractical. The METEOSATs, on the other hand, had a very quick refresh rate of 30 minutes but provided only low resolution imagery.[46]

The imagery provided by the DMSP van, particularly the high resolution DMSP data, was of great value to DESERT STORM decisionmakers. The high resolution DMSP and NOAA imagery was especially useful for air strike target planning, assisting Air Force commanders in choosing original targets, and, when necessary, redirecting aircraft to targets with more favorable weather. Satellite imagery provided terrain information useful to Army commanders. It also showed the smoke from oil fires started by Iraq and thereby helped commanders to determine when the fires were set, which wells were on fire, what area was covered by smoke, and the direction the smoke was drifting. In short, it provided data crucial to the success of the operation.[47]

Wraase Tactical Satellite Receiver

In view of the problems it experienced in getting the DMSP van deployed and, once this occurred, in getting the TIDS to work effectively, AWS intensified efforts already under way to introduce an alternative way to disseminate satellite imagery to the deployed weather units supporting CENTAF. Specifically, it sought to give them the capability to receive imagery directly from orbiting satellites. This would reduce the need for TIDS. Most weather units supporting Army operations

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[45]AWS DS/DS Report #2 (S), pp 160-16l (Sec 4.5.2-a(6)), 208 (Sec 5.1.3.2-a), info used (U); atch 6 (U), rprt, SSgt T.D. Taylor, 1690WGP/METSAT Coordinator, to 1690WGP/CC, "AAR Meteorological Satellite Coordinator," 23 Mar 91, to CENTCOM Weather Staff AARs (U); CENTAF SWO AAR (U).

[46]AWS DS/DS Report #2 (S), pp 159-160, 162, 164 (Sec 4.5.2-a(3)(11)(14)(15)), info used (U); point paper (U), HQ AWS/DOOF, "Defense Meteorological Satellite Program Van Capabilities," 6 Sep 90; Frederick Intvw (U), pp 7-8; Riley Intvw (S), pp 26-27, info used (U); St.Onge Intvw (U), pp 19-20. For greater detail on DMSP van operations, see atch 6 (U), rprt, SSgt T.D. Taylor, 1690WGP/METSAT Coordinator, to 1690WGP/CC, "AAR Meteorological Satellite Coordinator," 23 Mar 91, to CENTCOM Weather Staff AARs (U).

[47]AWS DS/DS Report #2 (S), pp 161-162 (Sec 4.5.2-a(7)), info used (U); Goldey Intvw (U), p 26, info used (U); Weaving Intvw (U), p 12; point paper (U), HQ AWS/XTRR/DOOF, "Environmental Satellite Support to DESERT STORM--Lessons Learned," 5 Mar 91.

already had this capability. Each Army corps and division-level weather team deployed with a Wraase tactical satellite receiver as part of its Goldwing tactical communications system. They, therefore, did not depend upon the DMSP van for their satellite imagery and, hence, were not tied into the TIDS network. The Wraase included a solid-state, battery-powered receiver, two video display monitors, a printer, a parabolic dish antenna, and an omnidirectional VHF antenna with a telescopic mast. The system was very mobile and weather teams could set it up and have it receiving data in as little as 20 minutes.[48]

The Wraase could intercept data from both METEOSAT and NOAA satellites (as well as Soviet satellites), and had a looping capability. Army weather teams looked primarily to the METEOSATs for their satellite data. The METEOSATs refreshed their data every half hour, making it virtually real time and allowing the teams to loop the imagery. The Wraase could not, however, receive the encrypted, higher resolution DMSP imagery. This posed a potential problem should the civilian satellite data become unavailable. Also, the system lacked a backup or rechargeable battery to store a loop when the weather team's customer "jumped" to another location. However, the Wraase's mobility, ruggedness, reliability, timeliness, and looping capability more than compensated for these relatively minor shortcomings.[49]

In December the Army Space Command distributed new Wraase software and larger printers to a number of deployed Army weather teams using the systems. Early in 1991 AWS was able to acquire Wraases for ARCENT Weather and two Air Force locations, the DSFU at Riyadh and the proposed alternate DSFU at Taif. When DESERT STORM ended, AWS was trying to procure an additional ten Wraases to use in support of the operation, and the Army's FORSCOM was attempting to acquire them for Army aviation brigade weather teams.[50]

The Wraase proved to be one of the most useful and reliable pieces of meteorological equipment in the DESERT SHIELD/STORM theater. Users of the system extolled its virtues and many praised its performance. Some called it the best piece of equipment in the AWS inventory. They lauded its dependability and reported that it seldom, if ever, broke down.[51]

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[48]AWS DS/DS Report #2 (S), p 164 (Sec 4.5.2-b), info used (U); Weaving Intvw (U), pp 9-10; ARCENT SWO AAR (U), p 30 (Sec III-5); atch 2 (U), "Wraase Description," to memo (U), LTC R.R. Wall, AWS/ADO, to AWS/XT, "Purchase of Tactical Communications Equipment," 17 Jan 91, w/2 atchs.

[49]AWS DS/DS Report #2 (S), p 164 (Sec 4,5,2-b), info used (U); Weaving Intvw (U), pp 9-10; St.Onge Intvw (U), pp 21-23; Boyle Intvw pp 9-11.

[50]AWS DS/DS Report #2 (S), pp 164-165 (Sec 4.5.2-b), info used (U); background paper (U), "USSPACECOM and USARSPACE Visits to DESERT SHIELD AOR," 4 Dec 90; [AWS/] CAT Tasker #15 (U), "QRCT/WRAASE Purchase," 17 Jan 91, w/2 atchs; memo (U), LTC R.R. Wall, AWS/ADO, to AWS/XT, "Purchase of Tactical Communications Equipment," 17 Jan 91, w/2 atchs; memo (U), Col J.W. Overall, AWS/XT, to AF/XOOSA, "Potential DESERT SHIELD Requirements," 17 Jan 91.

[51]AWS DS/DS Report #2 (S), p 164 (Sec 4.5.2-b), info used (U); ARCENT SWO AAR (U), pp 30 (Sec III-5), 56-57 (Sec VII-1v); Campbell Intvw (U), p 17-18; Boyle Intvw (U), pp 9-10; Capt M.H. McDonald in intvw (C), W.E. Nawyn, AWS/HO, with Capt Michael H. McDonald, 101st AAD/SWO (and Det 1, 5WS/CC) and Capt. William J. Spendley, 5SFG SOWT/OIC (and Det 1, 5WS), 17 Jul 91, hereafter cited as McDonald/Spendley Intvw (C), p 38, info used (U); Bridges/Bullard Intvw (U), pp 12-13.

The Wraase, however, was not available to Air Force weather teams, at least for the moment. Consequently, in early September, AWS took a new look at a program it had initiated in November 1988 to procure a small tactical DMSP terminal for the use of Air Force support weather units in the field. Unfortunately, under this program the new terminals were not scheduled to be fielded until 1992. AWS, therefore, in conjunction with the DMSP Systems Program Office (SPO) of Air Force Systems Command's (AFSC) Space Science Division, began to explore the possibility of acquiring some type of an interim system. On 12 September it formally asked the DMSP SPO, which was the manager of the small tactical terminal program, as well as of the overall DMSP program, to accelerate the acquisition of the terminal to make it available for use in January 1991 or suggest alternatives that would provide a similar capability at about the same time.[52]

The SPO informed AWS on 20 September that it could acquire a small tactical terminal with less capability and greater size than the existing program called for within 16 weeks, but could also field a non-ruggedized, real-time data system with essentially the same capability in the same amount of time and at approximately the same cost by using existing "off-the-shelf" technology. It also suggested two other possible alternatives. On 25 and 26 September, representatives of AWS and the DMSP SPO met together to discuss the options laid on the table by the SPO and the capabilities required for an interim small terminal. On 27 September AWS decided in favor of the real-time data, off-the-shelf interim system or, as it came to be called, the Rapid Deployment Imagery Terminal (RDIT).[53]

The program for the interim small tactical terminal moved forward rapidly. At the request of AWS, General Johnson, CINCMAC, asked General Ronald W. Yates, the Commander of AFSC, to acquire the interim system under his recently inaugurated HIGH GEAR program, which was intended to meet high priority needs of AFSC customers quickly and economically. On 1 October AFSC informed the Air Force Program Executive Officer in Washington DC that it wanted to designate the RDIT program a HIGH GEAR project and requested his concurrence. He agreed to the AFSC proposal two weeks later (15 October) and announced that it had appointed a special team to manage the effort. The same day General Yates assured General Johnson that he would give the program his personal attention. On 30 October, responding to a request from AWS, the Director of Operations at CENTAF validated the need for a small tactical satellite receiver in the DESERT SHIELD theater. On 16 November the DMSP SPO awarded contracts to two vendors--the Harris and Sea Space Corporations--for the production of a prototype RDIT for delivery in January 1991. The two prototypes

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[52]AWS DS/DS Report #2 (S), p 7 (Sec 2.1.2-g), info used (U); point paper (U), HQ AWS/XTRR, "DMSP Tactical Terminal Status and Plans," 10 Sep 90; msg (U), HQ AWS/XT to SSD/MW, et al, "Request for Improved DMSP Tactical Terminals," 121900Z Sep 90; SSS (U), AWS/XTRR, "Defense Meteorological Satellite Program Transportable Terminals," 14 Sep 90.

[53]AWS DS/DS Report #2 (S), p 165 (Sec 4.5.2-c), info used (U); msg (U), SSD/MW to HQ AWS/XT, et al, "Request for Improved DMSP Tactical Terminals," 202315Z Sep 90; "PMT History, 1 Jul-31 Dec 90," in hist input, HQ AWS/PM (U), Jul-Dec 90; "XTR History, 1 Jul-31 Dec 90," in hist input (U), HQ AWS/XT, Jul-Dec 90; mfr (U), Maj F.P. Kelly, SSD/MWS/Weather Liaison Officer, "Rapid Deployment Imagery Terminal Considerations," 27 Sep 90; msg (U), HQ AWS/XT to SSD/MW, et al, "Request for Improved DMSP Tactical Terminals," 272100Z Sep 90.

would compete for the production contract. The DMSP SPO provided funding for the program. AWS issued a concept of operations for the RDIT on 28 November.[54]

Both corporations had their RDIT prototypes ready by the end of January. The Qualification Operational Test and Evaluation took place from 4 through 7 February at the US Army's Atmospheric Sciences Laboratory at the White Sands Missile Range in New Mexico. Both systems passed the test, but on 15 February the selection authorities, on the basis of superior deployability and supportability, awarded Harris the contract for an additional five systems at a cost of $1.66 million each.[56]

The Harris RDIT was partially ruggedized and was housed in 12 containers having a total weight in excess of 1,500 pounds, but only one of the containers weighed more than 110 pounds. It required a two and one-half ton truck to transport the system on land. It was, therefore, still bulky. The system came with one spare and 16 line-item replacement units. Operationally, it had a worldwide satellite tracking display capability and could store data from up to eight satellite passes. It could, however, receive only DMSP data and produce only paper printouts (i.e, no transparencies).[56]

Inasmuch as both prototypes had performed successfully during testing, AWS decided to deploy both to the Persian Gulf as soon as possible--the Harris system to SOCCENT at King Fahd AB, and the Sea Space unit to ARCENT Weather at Riyadh. It also selected CENTCOM, the DSFU, the alternate DSFU, VII Corps, and Kuwait as the sites for the five production RDITS. The Harris prototype arrived at SOCCENT Weather on 20 February, one week before the end of hostilities. It proved to be the only RDIT to see any service during DESERT STORM. The Sea Space system reached ARCENT on 7 March, about a week after the war ended; the production systems did not become available until

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[54]AWS DS/DS Report #2 (S), pp 7 (Sec 2.1.2), 165-166 (Sec 4.5.2-c), info used (U); SSS (U), AWS/XTRR, "Defense Meteorological Satellite Program Transportable Terminals," 14 Sep 90; ltr (U), Gen H.T. Johnson, CINCMAC, to Gen R.W. Yates, Comdr, AFSC, [Fielding Rapidly Deployable Satellite Receiver,] 20 Sep 90; msg (U), HQ AFSC/XR to AFPEO/SP, et al, "HIGH GEAR Designation for Lightweight DMSP Terminal," 011710Z Oct 90; msg (U), AFPEO/SP to HQ AFSC/XR, et al, "HIGH GEAR Designation for Lightweight DMSP Terminal," 151500Z Oct 90; ltr (U), Gen R.W. Yates, Comdr, AFSC, to Gen H.T. Johnson, CINCMAC, [Support for MAC Acquisition Projects,] 15 Oct 90; msg (U), HQ AWS/CXAT to USCENTAF/WE, et al, "Interim Small Tactical Terminal Capability," 171751Z Oct 90; msg (U), USCENTAF/DO to HQ MAC/XRA, et al, "Validation of Rapid Deployable Imagery Terminal," 300400Z Oct 90; PMD 3015 (U), SAF/AQSS, "Program Management Directive for the Defense Meteorological Satellite Program," 14 Nov 90; "PMT History, 1 Jul-31 Dec 90," in hist input (U), HQ AWS/PM, Jul-Dec 90; "XTR History, 1 Jul-31 Dec 90," in hist input (U), HQ AWS/XT, Jul-Dec 90; brfg slides (U), HQ SSD/MWS, "DMSP HIGH GEAR Kickoff Briefing on the RDIT," 21 Nov 90; CONOPS (U), AWS, "Concept of Operations for Rapid Deployment Imagery Terminal," 28 Nov 90.

[56]Memo (U), 2Lt W.L. Strickland, AWS/PMT, to Dir, PMT, et al, "Executive Summary: Rapid Deployment Imagery Terminal Qualification Operational Test and Evaluation," 11 Feb 91; brfg slides (U), AWS/PMT, "RDIT Production Decision Recommendation," 15 Feb 91; point paper (U), AWS/PMA, "Rapid Deployment Imagery Terminal," 19 Mar 91. The final report on the RDIT QOT&E is found in msg (U), USAFALCENT/CC to HQ MAC/XRT, et al, "MAC Project 4-42-90, Qualification Operational Test and Evaluation of the Rapid Deployment Imagery Terminal, Final Report," 201700Z Mar 91.

[56]Brfg slides (U), AWS/PMT, "RDIT Production Decision Recommendation," 15 Feb 91; brfg slides (U), [AWS/PMT], "RDIT Capabilities," [post 15 Feb 91].

later. SOCCENT Weather subsequently reported that, based on the very limited period it used the system, it had found the RDIT, overall, to be an excellent piece of equipment.[57]

Assistance in Producing Electro-Optical Tactical Decision Aids

The performance of electro-optical weapons systems is greatly affected by atmospheric conditions. EOTDAs are computerized models used primarily to predict, on the basis of environmental and target information, the performance of visual, infrared, and laser air-to-ground electro-optical weapons systems. They can be used to support specific systems or provide information about general atmospheric conditions that affect certain types of electro-optical weapons. AWS produced EOTDAs as a means of providing assistance to mission planners and decisionmakers in selecting, for example, the type of weapons to load on aircraft and what operational tactics to employ.[58]

All DESERT SHIELD/STORM WSF units having forecasters had the capability to prepare EOTDAs for their customers. However, only six Air Force weather support units in the theater actually had a unit-level EOTDA support mission. In addition, the DSFU provided EOTDA support to the Tactical Air Control Center (TACC). Five Army weather support teams provided EOTDA support to Army combat aviation brigades with AH-64 Apache helicopters. Two other teams briefed EOTDAs to their customers for planning purposes.[59]

In the first few weeks of DESERT SHIELD, AFGWC and USAFETAC provided EOTDA support to the deployed WSF. AFGWC issued a special EOTDA bulletin for the theater. ETAC, as explained earlier,[60] initiated a crash program to quickly develop a large number of climatology-based EOTDAs which the deployed weather teams could use to support their customers. The DSFU transmitted its own EOTDA product, the "General E-O Forecast," for the first time on 5 September.[61]

On 14 September General Horner, the CENTAF Commander, specifically affirmed that CENTAF needed EOTDA support. Nevertheless, the demand for EOTDAs from CENTAF units during DESERT

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[57]AWS DS/DS Report #2 (S), p 166 (Sec 4.5.2-c), info used (U); brfg slide (S), [AWS/CAT], "RDIT Sites," 26 Feb 91; point paper (U), AWS/PMA, "Rapid Deployment Imagery Terminal," 19 Mar 91; msg (S), USCINCCENT Weather to 5WW/CAT, et al, "WSF SITREP 178 (U)," 200651Z Feb 91, info used (U); msg (S), USCINCCENT Weather to 5WW/CAT, et al, "WSF SITREP 193 (U)," 070816Z Mar 91, info used (U); SOCCENT SWO AAR (U), p 3.

[58]AWS DS/DS Report #2 (S), p 144 (Secs 4.3, 4.3.1), info used (U); info sheet (U), [AWS/XTA], "EOTDA Stuff," n.d. [ca Apr 91].

[59]AWS DS/DS Report #2 (S), pp 144-145 (Sec 4.3.1.2-a), info used (U); ARCENT SWO AAR (U), Atch 1-6.

[60]See above, this chapter, p 82.

[61]AWS DS/DS Report #2 (S), pp 144 (Secs 4.3.1.1, 4.3.1.2), 147-149 (Sec 4.3.1.2-c,d), info used (U); msg (S), 5WW CAT to AWS/CAT, et al, "5WW SITREP Nbr 29/Operation DESERT SHIELD (U)," 051658Z Sep 90, info used (U); rprt (FOUO), Capts K.F. Havener and S. Funk, HQ AWS/XTA, "The Utility of Electro-Optical Tactical Decision Aids," 10 Sep 91, p 4, info used (U).

STORM was far less than anticipated. With 2,000 or more sorties per day planned, and ten percent using electro-optical weapons, AWS expected to be swamped with requests for EOTDAs. However, this did not materialize because American and coalition air forces destroyed the Iraqi command and control capability and immobilized the Iraqi fighter defense system in a few days. Since the nature of the enemy threat determines tactics, and the nature of the Iraqi threat had altered dramatically, Air Force tactics shifted to primarily mid- and high-level bombing runs at or above 10,000 feet. The change in tactics reduced the need for EOTDAs. The main weather criteria affecting mission "go or no-go" decisions and of concern to pilots now came to be the presence or absence of cloud cover and the height of ceilings--specifically whether the ceilings were over or below 10,000 feet--over targets. Conventional weather support could provide this data. Therefore, for the remainder of DESERT STORM, the Air Force used EOTDAs mostly for "situational awareness"--i.e., providing pilots with information as to how aircraft sensors would perform in target areas so they would not be surprised--rather than for mission planning and tactical decision-making.[62]

Deficiencies in EOTDA software caused problems for deployed weather units producing EOTDAs. During most of DESERT SHIELD the weather units used computer model Mark III Version 1.1 software developed by the Air Force's Geophysics Laboratory to produce EOTDAs while they awaited the arrival of Version 2.0, which was undergoing testing. By late October AWS units in the theater suspected there was something in the EOTDA software causing inaccurate EOTDAs. Study and tests confirmed that the software did indeed have deficiencies. One of the deficiencies involved sand background models. Version 1.1 software incorporated a standard sand background using the characteristics of Florida beach sand found near Eglin AFB. It turned out that the Florida sand had a much lower reflectivity than the Saudi sand. Another part of the problem was that the software models were based on green-colored tanks instead of the tan-colored tanks employed in the Persian Gulf theater.[63]

To get a first-hand assessment of these problems, on 23 November AWS sent an experienced EOTDA forecaster, Captain Jason Tuell of the 4th Weather Wing's 2d Weather Squadron, to the DESERT SHIELD theater. While there, he was also to identify and evaluate other problems associated with EOTDA production and see what he could do to implement temporary fixes. In addition, he was

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[62]AWS DS/DS Report #2 (S), pp 144 (Sec 4.3.1.2), 146 (Sec 4.3.1.2-b), info used (U); Frederick Intvw (U), pp 16-17; rprt (FOUO), Capts K.F. Havener and S. Funk, AWS/XTA, "The Utility of Electro-Optical Tactical Decision Aids," 10 Sep 91, pp 1,4-6, info used (U).

[63]AWS DS/DS Report #2 (S), pp 149-150 (Sec 4.3.1.2-e), info used (U); msg (S), AWS/CAT to 5WW/CAT, et al, "EO Feedback Report (U)," 262250Z Oct 90, info used (U); msg (S), AWS/CAT to Geophysics Laboratory/LYA, et al, "EOTDA Feedback (U)," 302329Z Oct 90, info used (U); msg (S), AWS/CAT to 5WW/CAT, et al, "EO-TDA Questions (U)," 011255Z Oct [sic-should be Nov] 90, info used (U); intvw (U), W.E. Nawyn, AWS/HO, with Capt Steven B. Dreksler, AWS/XTX, 12 Aug 91, hereafter cited as Dreksler Intvw (U); rprt (FOUO), Capts K.F. Havener and S. Funk, AWS/XTA, "The Utility of Electro-Optical Tactical Decision Aids," 10 Dec 91, p 7, info used (U); brfg slides (paper copy) (U), n.a., "Use of Electro-Optical Tactical Decision Aids in DESERT SHIELD," n.d. [probably early or mid-Nov 90]. Additional information on EOTDA deficiencies can be found in msg (S), USCENTAF/WE to 5WW/CAT, et al, "EO Feedback on Mark III TDA Version 1.1 (U)," 030100Z Nov 90, no info used; msg (S), USCENTAF/WE to 1TFW Deployed/WE, no info used; msg (S), USCENTAF/WE to 1TFW Deployed/WE, et al, "Effects of Sand on Radar (U)," 041200Z Nov 90, no info used; msg (S), USCENTAF/WE to 5WW/CAT, et al, "Answers to EO Questions Reference AWS Message 011255Z Oct [sic-should be Nov] 90 with Same Subject (U)," 051200Z Nov 90, no info used; msg (S), AWS/CAT to 5WW/CAT, et al, "CAT-to-CAT Request (U)," 100149Z Nov 90, no info used.

to give forecasters in the theater some training in running EOTDAs. His mission accomplished, Captain Tuell returned to the US on 14 December.[64]

When by early November AWS began to understand the nature and source of some of the EOTDA problems, it requested the Geophysics Laboratory to make any modifications to the Version 2.0 EOTDA software it had under development necessary to correct the deficiencies. The laboratory passed on the task to its software contractor, the STX Corporation. On 20 December, only a few days after Captain Tuell returned from the theater, the company delivered Version 2.1 to AWS which replaced the standard sand characteristics with those of the Saudi sand and added a tan tank variant. At about the same time the laboratory instructed STX to develop a second modification of the Mark III Version 2.0 EOTDA software that would fix still another Version 1.1 deficiency, one identified by Captain Tuell while on his visit to the DESERT SHIELD theater. The company had the new modification, called Version 2.2, ready by 14 January.[65]

Meanwhile, the 5th Wing began sending the new EOTDA software versions to the weather units in the DESERT SHIELD theater as they became available after successfully completing periods of testing. It shipped the new Version 2.0 to the theater on 2 January, just in time to get there before DESERT STORM hostilities began. Version 2.1 followed only three days later. The wing sent out Version 2.2 in mid-February.[66]

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[64]AWS DS/DS Report #2 (S), pp 149-150 (Sec 4.3.1.2-e), info used (U); Dreksler Intvw (U); brfg slides (paper copy) (U), n.a., "Use of Electro-Optical Tactical Decision Aids in DESERT SHIELD," n.d. [probably early or mid-Nov 90]; brfg slides (paper copy) (U), Capt J. Tuell, 2WS/DR, "EOTDA Support for DESERT SHIELD," 22 Dec 90. For more detail on Capt Tuell's work, activities, and findings while on his trip to the operational theater, see notes (S), [Capt J. Tuell, 2WS/DR], "Notes for 5WW Debrief," n.d. [ca 15 Dec 90], no info used.

[65]AWS DS/DS Report #2 (S), p 149 (Sec 4.3.1.2-e), info used (U); Dreksler Intvw (U); atch 1 (U), ltr, HQ 2WS/DR to 4WW/DN, "TDA Quick Fix Answers," 2 Nov 90, to ltr (U) (1st ind to 2WS/DR ltr, 2 Nov 90), 4WW/DN to AWS/XTX, [2WS/DR Response on TDA Quick Fix Answers,] 5 Nov 90; msg (U), AWS/PMA to GL/LYA, "Electro-Optical Tactical Decision Aid," 142100Z Nov 90; msg (U), AWS/PMA to GL/LYA, "Electro-Optical Tactical Decision Aid," 202100Z Nov 90; ltr (U), G.J. Higgins, STX Corp, to Capt T.J. Addison, AWS/PMA, 20 Dec 90, w/1 atch; brfg slides (paper copy) (U), Capt J. Tuell, 2WS/DR, "EOTDA Support for DESERT SHIELD," 22 Dec 90; mfr (U), LTC K. Eis, Chief, AWS/XTX, "Tuell Visit," 24 Dec 90; mfr (U), Capt S.B. Dreksler, AWS/XTX, "Updates from Mark III Version 2.0 to Version 2.1 (Released 24 Dec 90)," 2 Jan 91. For details on the additional deficiency identified by Captain Tuell, see notes (S), Capt J. Tuell, 2WS/DR, "Notes for 5WW Debrief," n.d. [ca 15 Dec 90], no info used.

[66]Dreksler Intvw (U); msg (S), 5WW/CAT to USCINCCENT Weather, et al, "Items of Interest 01-2 (U)," 030241 Jan 91, info used (U); msg (C), 5WW/CAT to USCINCCENT Weather, et al, "Items of Interest 01-04 (U)," 042331Z Jan 91, info used (U); ltr (U), D.B. Hodges, Ctr Dir, STX Corp, to Maj J.K. Hancock, GL/LYA, [Mark III Version 2.2 Software,] 14 Jan 91, w/1 atch; ltr (U), AWDS/PMA to 5WW/CAT, "Mark III EOTDA Software Version 2.2," 16 Jan 91; ltr (U), P.F. Hilton, TDA Principal Investigator, STX Corp, to Maj J.K. Hancock, GL/LYA, [Version 2.2 Testing,] 11 Feb 91, w/1 atch.

Assistance in Predicting Refractivity Effects

The AWS DESERT SHIELD/STORM WSF utilized a small, computer-based software package called the Integrated Refractive Effects Prediction System (IREPS) to provide a measure of refractivity effects support to both its Air Force and Army customers. Developed and provided to AWS by the US Navy's Oceanographic Systems Center, IREPS assessed refractive effects upon radar as well as communications, electronic warfare, and weapons guidance systems. Refractivity has reference to the bending of electromagnetic energy propagated nearly horizontally through the atmosphere, such as radar beams, by moisture, temperature, and other atmospheric conditions. Deviations from standard atmospheric conditions causes "anomalous propagations," i.e., makes electromagnetic energy to curve away from the earth or downward towards the earth, the latter sometimes resulting in ducting (the energy curving downward at a degree of curvature equal to or greater than that of the earth). Using upper air soundings to obtain data on atmospheric conditions, IREPS could show the effects of refraction on electromagnetic propagation.[67]

It was important for military radar operators in the Persian Gulf theater to understand refractivity and to have information about atmospheric conditions causing abnormal refractivity and the kind of anomalous propagation that would occur. Curvature of radar beams away from the earth results in less than normal radar range, curvature toward the earth in greater. Ducting causes a "hole" above the duct where radar beams do not penetrate. Thus, refractivity can significantly affect radar protection, either positively or adversely. Greater range was to the advantage of defenders, but attacking aircraft could exploit reduced radar range, particularly the ducting phenomenon, to their advantage--for example, by using the hole created by ducting to avoid or delay radar detection until the last minute.[68]

Unfortunately, as a Navy-developed system, IREPS was designed for use over open ocean and, therefore, assumed a smooth surface and a "horizontally homogeneous atmosphere," that is, nearly identical atmospheric conditions over a considerable horizontal distance. This made IREPS inaccurate over land, since the two assumptions are usually not valid there and, consequently, the atmosphere reacts differently. AWS, shortly before the beginning of DESERT SHIELD, had initiated an effort to acquire a refractive effects capability over land, but was unable to complete it before the end of DESERT STORM.[69]

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[67]AWS DS/DS Report #2 (S), p 152 (Secs 4.3.2.1, 4.3.2.2-b), info used (U); Koenemann Intvw (U), pp 36-37; St.Onge Intvw (U), p 33; msg (S), USCINCCENT/Weather to COMSOCCENT Deployed/J2-W, et al, "Integrated Refractive Effects Prediction System (U)," 100809Z Jan 91, info used (U); msg (S), 5WW/CAT to USCINCCENT Weather, et al, "TAC Special Assessment 018-90 (U)," 090012Z Nov 90, info used (U).

[68]AWS DS/DS Report #2 (S), p 152 (Sec 4.3.2.1), info used (U); Koenemann Intvw (U), pp 36-37; St.Onge Intvw (U), p 33; msg (S), 5WW/CAT to USCINCCENT Weather, et al, "TAC Special Assessment 018-90 (U)," 090012Z Nov 90, info used (U); msg (S), USCINCCENT Weather to COMSOCCENT Deployed/J2-W, et al, "Integrated Refractive Effects Prediction System (U)," 100809Z Jan 91, info used (U).

[69]Koenemann Intvw (U), pp 36-37; mfr (U), Capt S.B. Dreksler, AWS/XTX, "Review of 5WW Guidance on IREPS over Land," 4 Mar 91; msg (U), AWS/CS to 1WW/CV, et al, "Microwave Refractive Effects Capabilities," 131335Z Jul 90.

Within a few days after the begining of DESERT SHIELD the Air Force began to recognize that its operations might benefit from IREPS support and AWS, in view of the high probability of anomalous propagation in the Persian Gulf theater, became convinced that it should, if at all possible, supply its customers in the theater with information concerning refractivity effects. Accordingly, in spite of the uncertainty about the quality of IREPS performance over land, it directed the WSF to use IREPS to support their customers where appropriate. At the same time, AWS did not want weather units to oversell their ability to predict refractive effects or to dispense inaccurate information which could, as Colonel Goldey pointed out, have "disastrous consequences" by contributing to wrong tactical decisions. The 5th Wing and CENTCOM Weather, therefore, took pains to apprise the weather units of the limitations and inaccuracies of IREPS performance and warn them to exercise caution in using IREPS forecasts.[70]

The IREPS support provided by weather units consisted primarily of summaries of refractive conditions derived by feeding weather parameters obtained through upper air soundings into IREPS and predictions of atmospheric effects on airborne radars and communications. The DSFU, beginning on 10 September, added an IREPS section, including potential ducting levels, to its twice-daily specialized support bulletin. This product was rather generic, but it proved to be useful. The AFSOC weather team provided refractive effects support to the 1st Special Operations Wing and the Riyadh Base Weather Station did the same to SAC reconnaissance and Airborne Weather and Control System aircraft. In January AWS instructed ETAC to send IREPS software to all deployed weather units. The 5th Wing put together an IREPS training package to accompany it. Fortunately, given the limitations on AWS's ability to provide specific, high quality refractivity support, refractive effects never became a major operational concern during DESERT STORM due to the rapid collapse of the Iraqi radar and air threat.[71]

Resupply Support

Operational Order 02-FY directed deploying AWS personnel to take with them expendable supplies sufficient for 30 days. Once in theater, deployed AWS weather teams were to receive logistical assistance from the military units they supported and SWOs were to make arrangements with these organizations for both routine supplies and weather-unique items. Headquarters AWS and/or the

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[70]AWS DS/DS Report #2 (S), p 153 (Sec 4.3.2.2-b), info used (U); msg (C), NAVEASTOCEANCEN/30 to NAVOCEANCOMCEN GQ/NOCC, et al, "IREPS Support (U)," 110500Z Aug 90, info used (U); msg (U), USCINCCENT Weather to ARCENT Main/G2-SWO, et al, "Radar Propagation Statement of Requirement," 261241Z Nov 90; msg (U), 5WW/CAT to AIG 8128, et al, "Refractive Effects Support," 300052Z Nov 90; msg (U), 5WW/CAT to AIG 8128, et al, "Integrated Refractive Effects Prediction System Use over Land," 111943Z Dec 90; msg (S), USCINCCENT/Weather to COMSOCCENT Deployed/J2-W, et al, "Integrated Refractive Effects Prediction System (U)," 100809Z Jan 91, info used (U).

[71]AWS DS/DS Report #2 (S), pp 152-154 (Secs 4.3.2, 4.3.2.2-b, 4.3.2.3), info used (U); intvw (U), W.E. Nawyn, AWS/HO, with LTC Kenneth A. Peterson, Chief, 5WW/DN, 6 Jun 91, p 7; msg (S), 5WW/CAT to AWS/CAT, et al, "5WW SITREP Nbr 34/Operation DESERT SHIELD (U)," 101232Z Sep 90, info used (U); ltr (U), HQ 5WW/DNS to All AWS Units, "Integrated Refractive Effects Prediction System Training Package," 18 Jan 91.

lead wing would replace meteorological equipment as necessary in response to requests from the OICWSF. So much for the theory. The reality was considerably different.[72]

AWS personnel did, in fact, generally deploy with the required 30 days worth of supplies and the 5th Wing, as has been noted earlier[73], did its best to provide the WSF with additional and replacement tactical meteorological equipment. However, the in-theater logistical support stipulated by the plan either never materialized or came much later than 30 days. CENTAF Weather, for instance, soon reported that the Air Force supply system would not be in place until 90 to 120 days after the beginning of the operation. This put the weather units in trouble as far as expendables were concerned. Obviously, they would run out before supplies became available through normal supply channels. The Air Force supply system finally came on line in December, but the Army's system never really functioned very well, at least not in regards to providing Army weather teams with weather-unique items. The SOCCENT weather teams' customers took care of most of their needs. SOCCENT Weather tried but was unable to acquire radiosondes for the Army Special Operations Forces' Marwin upper air sounding system through regular supply channels. It was, however, able to get some from Marine Corps units in the theater.[74]

In spite of the problems with the regular supply system, AWS units deployed to the Persian Gulf theater obtained both the supplies and the replacement equipment and parts necessary to perform their mission. However, they got this material only through many work-arounds and much improvising, both by weather units in the field and in the US. Moreover, the 5th Weather Wing expended much time, effort, and money to acquire and send out, mostly through unofficial channels, the needed expendables and equipment. Occasionally, other AWS units also shipped supplies to the theater. For example, the 2d Weather Wing dispatched a quantity of the different special papers used by the Harris 850s, Alden 9315s, and Wraases. The 5th and 6th Weather Squadrons also sent expendable supplies.[75]

The 5th Wing resupply effort was under the general direction of Chief Master Sergeant Grizzle, but early on the wing dedicated a supply NCO to work full time on obtaining and shipping supplies and, in some cases, equipment. With the assistance of other wing supply people, the NCO purchased and kept on hand quantities of expendable supplies. The wing also stockpiled extra equipment and spare parts, thus, in effect maintaining a mini-depot from which it could service requests from the theater.[76]

By the end of the DESERT SHIELD/STORM operation, the 5th Wing had purchased and shipped out $580,000 worth of equipment and supplies, most of it prior to the time DESERT STORM hostilities began on 16 January. MAC, under an emergency special program code it established for DESERT

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[72]AWS DS/DS Report #2 (S), p 233 (Sec 7.1), info used (U).

[73]See above, Chapter III, pp 42-43.

[74]AWS DS/DS Report #2 (S), pp 233-234 (Sec 7.2-a,d), info used (U); MSgt W.A. Brothers in Grizzle/Brothers Intvw (U), p 10; msg (U), 5WW/CAT to CENTAF Weather, "Supply," 112055Z Dec 90; Conley Intvw (U), p 16; Campbell Intvw (U), p 13; ARCENT SWO AAR (U), pp 62-63 (Sec VII-2a); SOCCENT SWO AAR (U), p 6.

[75]AWS DS/DS Report #2 (U), p 233 (Sec 7.1), info used (U); hist rprt (U), 2WW, Jul-Dec 90, p 156; St. Onge Intvw (U), pp 6-7; Grizzle/Brothers Intvw (U), pp 10-11, 14-15.

[76]AWS DS/DS Report #2 (S), p 234 (Sec 7.2-c), info used (U); Grizzle/Brothers Intvw (U), pp 14, 19-20; St. Onge Intvw (U), p 27.

SHIELD expenditures soon after the operation began, provided the money needed. The wing went ahead and bought material as the need arose, submitted a bill to MAC, and approximately three months later, MAC reimbursed the wing for the expenses it incurred with funds the command, in turn, received from the Air Staff.[77]

The 5th Wing shipped 40 TMQ-34s, 5 GMQ-33s, 24 Alden 9315TRTs, and 50 cases of Alden 9315TRT plastic paper to the DESERT SHIELD theater. In addition, it sent out 400 radiosondes and 250 balloons for the Marwins. The wing had successfully requisitioned the sondes from the Naval Aviation Supply Office in nearby Norfolk, Virginia. The material shipped to the theater by the wing also included such items as computers, thermometers, batteries, ink jet cartridges, 3.5-inch computer disks, teletype and printer ribbons, and teletype, TIDS, and Wraase paper.[78] (See Figure IV-2).

The wing sent most of the material by air. Much of it went by the TAC "rotator," a TAC EC-135 aircraft which flew between Tinker AFB, Oklahoma, and Riyadh once or twice a week, with a stop at Langley AFB. The wing soon discovered that it could utilize the rotator, on a space available basis, to send urgently needed supplies, parts, and small equipment to deployed weather units. Often this material was stowed on seats in the passenger compartment. Once on the aircraft, a shipment arrived in Riyadh in less than 24 hours. The wing could usually get supplies or equipment aboard a rotator within four or five days of their arrival at the 5th Wing. The wing also shipped material through regular MAC channels, but under this method a shipment took anywhere from four to eight weeks to arrive in theater. In this case it first had to go by land from Langley to, most often, Dover AFB, Delaware, where it might stay, because of the huge demand for airlift, two or three weeks before leaving. The wing also occasionally used the MAC "Desert Express" running from Charleston AFB to the theater. Not only was using the TAC rotator of great advantage time-wise, it also made it easier for the 5th Wing to track shipments and gave it a much greater ability to control their loading and unloading.[79]

To make for a more efficient distribution of the supplies, meteorological equipment, and spare parts after they arrived in theater, Colonel Goldey established a depot-like supply office near the DMSP van at Riyadh AB and assigned an NCO, Technical Sergeant William M. Anderson, to work full time receiving, storing, and distributing the material as it arrived in theater, usually by air. Sergeant Anderson was a weatherman, not a supply expert, but he rapidly learned his new job and his work soon became very helpful and the central depot concept worked very well. The sergeant met the planes carrying shipments as they arrived, checked the shipments, and unloaded them from the plane. He also parceled out the stored equipment and supplies to the units needing them and occasionally even delivered them in person to weather headquarters units located in Riyadh. Master Sergeant Brian J. Folk and Technical Sergeant Gibson from CENTAF Weather also assisted in the resupply effort. Sometimes personnel from headquarters units or other units traveling by land vehicle from Riyadh to units deployed elsewhere in the theater took with them needed equipment and supplies. Weather units

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[77]AWS DS/DS Report #2 (S), p 234 (Sec 7.2-c), info used (U); intvw (U), W.E. Nawyn, AWS/HO, with Mr Theodore N. Thompson, 5WW/AC, 6 Jun 91, pp 2,5-6; 5WW DESERT SHIELD Chronology (S), p 9-12, info used (U).

[78]AWS DS/DS Report #2 (S), p 236 (Atch 28), info used (U); St.Onge Intvw (U), pp 7, 26; MSgt W.A. Brothers in Grizzle/Brothers Intvw (U), pp 5-6; msg (U), 5WW/CAT to CENTAF Weather, et al, "Radiosonde Supply for Marwin Systems," 032053Z Jan 91.

[79]AWS DS/DS Report #2 (S), p 234 (Sec 7.2-c), info used (U); LTC R.R. Wall and Col T.C. Tarbell in AWTB Intvw (U), pp 35-37; MSgt J.E. Brackett in Callahan/Brackett Intvw (U), p 15; Koenemann Intvw (U), pp 11-12; MSgt W.A. Brothers in Grizzle/Brothers Intvw (U), pp 11-12.

SUPPLIES AND EQUIPMENT ORDERED, TRACKED, AND SHIPPED BY 5WW DURING DESERT SHIELD/DESERT STORM

1. Radiosondes and balloons for MARWIN systems(400 sondes and 250 balloons)
2. TMQ-34s (40)
3. GMQ-33s (5)
4. Alden 9315TRT (24)
5. Antenna tuners (2)
6. QRCT power supplies (2)
7. 10MB hard disk cartridges (35)
8. NICAD batteries
9. UGC 129 ribbons
10. Ink jet cartridges
11. Tabulating paper
12. Alps printer ribbon
13. 3.5-inch disks/cleaning kits
14. Alden 9315TRT/9315T paper
15. TTY paper (white)
16. TDS paper/film
17. Density altitude wheels
18. Wraase paper
19. Computers
20. Thermometers (small BWK, celsius)

SOURCE: AWS DESERT SHIELD/DESERT STORM Report #2 (S), p 236 (Atch 28), info used (U).

Figure IV-2

in the field often used opportune airlift to get the material they ordered. In many cases they were able to purchase supplies such as computer disks and typewriter ribbons locally.[80]

The 5th Wing's resupply program made an important contribution to the WSF's ability to perform its mission. Without the equipment and supplies the wing acquired and sent to the operational theater, weather support would have been less effective. The 5th Wing effort was appreciated in the field. After the operation was over, both CENTAF Weather and ARCENT Weather reported that the wing had done an outstanding job in providing their units with expendable supplies, especially weather-unique items. The XVIII Corps SWO remarked, in effect, that his weather team couldn't have done its job without the 5th Wing's supply efforts.[81]

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[80]AWS DS/DS Report #2 (S), p 233 (Sec 7.2-b), info used (U); Grizzle/Brothers Intvw (U), p 9; atch 4 (U), 1690WGP/LG DS/DS AAR, to CENTCOM Weather Staff AARs; note (U), Col G.F. Riley, Chief, AWS/DOT, to W.E. Nawyn, AWS/HO, 1 Jul 92; Campbell Intvw (U), p 9.

[81]CENTAF SWO AAR (U), Sec K-2; ARCENT SWO AAR (U), pp 62-63 (Sec VII-2a); Conley Intvw (U), p 16.

CHAPTER V

WEATHER SUPPORT FORCE OPERATIONS

The Air Weather Service on-the-scene participation in Operation DESERT SHIELD/DESERT STORM began on 8 August 1990 when the first few AWS deployees arrived in Saudi Arabia. For the next seven months AWS's WSF in the Persian Gulf theater provided meteorological support to the US Air Force, Army, and Special Operations components of USCENTCOM and, to a limited extent, also to the US Navy, US Marine, and several foreign military forces taking part in the operation. From their very small beginning on 8 August, weather support operations swiftly expanded geographically and functionally as DESERT SHIELD rapidly grew in size and scope.

When the operation began in early August the weather in the Persian Gulf region was hot and sunny every day. As the weather people would say, there was very little, if any, "weather," i.e., there were few if any major weather systems moving through the area and little change in weather conditions from day to day. The weather, therefore, seemingly posed little or no threat to military operations. Consequently, many military leaders including General Powell, Chairman of the Joint Chiefs of Staff; General Schwarzkopf, CINCCENT; and AWS's immediate "boss," General Johnson; CINCMAC, as well as some deployed unit commanders, questioned the need for weather support to DESERT SHIELD and wondered if it was really necessary to have as many weather personnel present as had been deployed. The Headquarters CENTCOM staff seemingly also did not initially have a high regard for weather support. On the whole, this attitude was more prevalent among Air Force commanders than among Army commanders, who were used to having AWS weather teams training in the field as integral parts of Army corps, divisions, and aviation brigades.[1]

Given the skepticism about the value of weather support, many AWS SWOs, in the US as well as in the DESERT SHIELD theater, found it necessary, as one of their first tasks, to convice the commanders they supported of the importance, indeed, the necessity, of weather support even in the "benign" Southwest Asia environment. Thus, they informed their commanders that the weather would not always remain hot and sunny, that in a few months it would change dramatically, and if the operation continued into late fall, the region would begin to have a lot of "weather" that could impact military operations. But they also pointed out that even when the weather was hot and sunny every day, there were still weather factors present that could affect not only operations, but also equipment and weapons--e.g., winds could raise sand and dust which would reduce visibility and degrade the performance of weapons, vehicles, and aircraft. Also, atmospheric conditions could have a negative impact on radar operations. Most were soon convinced. It took General Kelly about a month to turn General Johnson into a strong supporter of weather support. Those not immediately persuaded became converts by the time DESERT SHIELD turned into DESERT STORM. As predicted, the hot and sunny days of August began to give way to the cooler, but still warm and sunny days of September

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[1]AWS DS/DS Rprt #2 (S), p 75 (Sec 4.1), info used (U); Kelly Intvw (U), pp 2-3; Frederick Intvw (U), p 9; Koenemann Intvw (U), p 7; atch 5 (U), Weaving DS/DS AAR, to CENTCOM Weather Staff AARs (U).

and October. Then came the cool, increasingly cloudy days of November and December, and finally, the cloudy, blustery, wet days of January and February.[2]

Weather Observations

Weather operations begin with weather observations, whether by human beings or by sophisticated automated sensors. Weather databases are built on observation data from around the world. Accurate forecasts depend on accurate observations. In DESERT SHIELD, AWS depended upon both US military (primarily AWS) and host nation observers for its in-theater weather observations. Initially, host nation observers provided the official observations at almost all coalition bases. Eventually, the AWS WSF included 152 weather observers who were located at all but eight of the locations where US forces were stationed in the operational theater. Manning ceilings imposed by host nations prevented AWS observers from being used at some locations.[3]

Unfortunately, the quality of the indigenous observations varied considerably and they were not always as complete and accurate as AWS would have liked. While they were acceptable in the early period of the operation when the weather was good, later on, after the weather deteriorated, AWS found them to be less reliable, particularly in regards to visibility and cloud cover information. To a large extent, this could be explained by the fact that host nation observers used WMO criteria which were civilian, not military (and certainly not military aviation), oriented and, in general, not as stringent as AWS standards. But cultural factors played a role. For example, what was "timely" to the host nations was not necessarily so to Americans.[4]

Consequently, AWS felt that, in the interest of safety in air operations, if nothing else, it had to augment host nation observations with its own. On 31 October CENTCOM weather issued a directive allowing AWS observers located at host nation observing sites to "improve" indigenous observations by adding ceiling and visibility data which they themselves had collected. Doing this involved, potentially at least, the national sensitivities of the host nations. Thus, the AWS observers were to be careful to only supplement, not replace, the host nation observations. In spite of this caveat, diplomatic considerations hampered AWS actions to assign additional weather observers to locations for which the host nations already furnished observations.[5]

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[2]AWS DS/DS Report #2 (S), p 75 (Sec 4.1), info used (U); Dickey Intvw (U), p 7; atch 1 (U), "Deployed Weather History," to rprt, 1Lt J.A. Cotturone, Jr, OL-E, 1690WGP and 33TFW/WWO (and Det 10, 2WS), "DESERT SHIELD/STORM Weather History," 25 Jul 91, hereafter cited as Cotturone, OL-E, 1690WGP DS/DS Weather History (U).

[3]AWS DS/DS Report #2 (S), p 155 (Sec 4.4.1), info used (U).

[4]AWS DS/DS Report #2 (S), pp 155-156 (Sec 4.4.2-a), 158 (Sec 4.4.4), 237-238 (Sec 8.2), info used (U); Kelly Intvw (U), pp 14-15; Goldey Intvw (U), pp 18-19; St. Onge Intvw (U), pp 24-25; note (U), Col G.F. Riley, Chief, AWS/DOT, to W.E. Nawyn, AWS/HO, 7 Jul 92; Ridge Intvw (U), pp 7-8; CENTAF SWO AAR (U), Sec G-2.

[5]AWS DS/DS Report #2 (S), p 238 (Sec 8.2), info used (U); msg (S), USCINCCENT/Weather to 5WW/CAT, et al, "WSF SITREP 66 (U)," 311240Z Oct 90, info used (U).

AWS weather teams, both Air Force and Army, deployed throughout the Persian Gulf theater sent their observations via their QRCTs and Goldwings to the DSFU at Riyadh, which also received host nation observations. The DSFU passed them on to other WSF units and to AFGWC. The two Marwins borrowed from the Navy provided valuable, but limited, upper air observations. Attempts to receive upper air observations from Army units in the field through the Army Artillery Meteorological Support Section and the Forward Area Limited Observing Program were pretty much failures. The DSFU never received any significant number of observations as a result of these attempts.[6]

The deployed AWS weather teams forwarded many observations to the DSFU, but there were problems at both the sending and receiving ends of the process. The sometimes poor HF communications and the limited number of AWN terminals available hampered transmission. In addition, weather teams often made procedural, formatting, and encoding errors when sending out their observations. This made it necessary for the DSFU to "clean up" the observations before entering them into the AWN for transmission to AFGWC. Sometimes AFGWC had to manually edit them before entering them into its database. In the end, perhaps as many as 20 percent of the observations were so garbled that they had to be discarded. The relatively low experience and skill levels of the deployed observers (averaging 18 months and less than a five-skill level) were probably a major contributor to the high error rate.[7]

Forecasting Support

Centralized Support in Theater: The DESERT SHIELD/STORM Forecast Unit

The AWS tactical forecast unit for the DESERT SHIELD/STORM operation, the DSFU, played a pivotal role in weather support operations. Its basic function was to be the in-theater focal point for gathering, creating, and disseminating forecast products. As such, it collected weather data from deployed units, the DMSP van, and other available in-theater sources, received and relayed centralized products from AFGWC and other out-of-theater sources, created its own theater-tailored products based on the data it received from these varied sources, and distributed these products throughout the theater. (For a diagram of weather forecast support to DESERT SHIELD/STORM, see Figure V-1).

The process of setting up a TFU at Riyadh began before Colonel Goldey arrived on 24 August. On 18 August, the 5th Wing requested Lieutenant Colonel Riley to establish a TFU as soon as possible. When Captain Jeffrey E. Johnson from Headquarters 5th Weather Wing and Technical Sergeant James C. Parsons from the 3d Weather Squadron's Detachment 6 at Homestead AFB, Florida, arrived at Riyadh on 21 August, Colonel Riley immediately put them to work on this project. According to AWS doctrine, the DSFU would be a part of USCENTCOM Weather and, as such, collocated with Headquarters USCENTCOM. However, as pointed out earlier,[8] Colonels Goldey and Riley early on decided to keep the DSFU at CENTAF Weather because there simply was no room for it at CENTCOM Weather. On 29 August Captain John D. Murphy from the 3d Weather Squadron's Detachment 7 at

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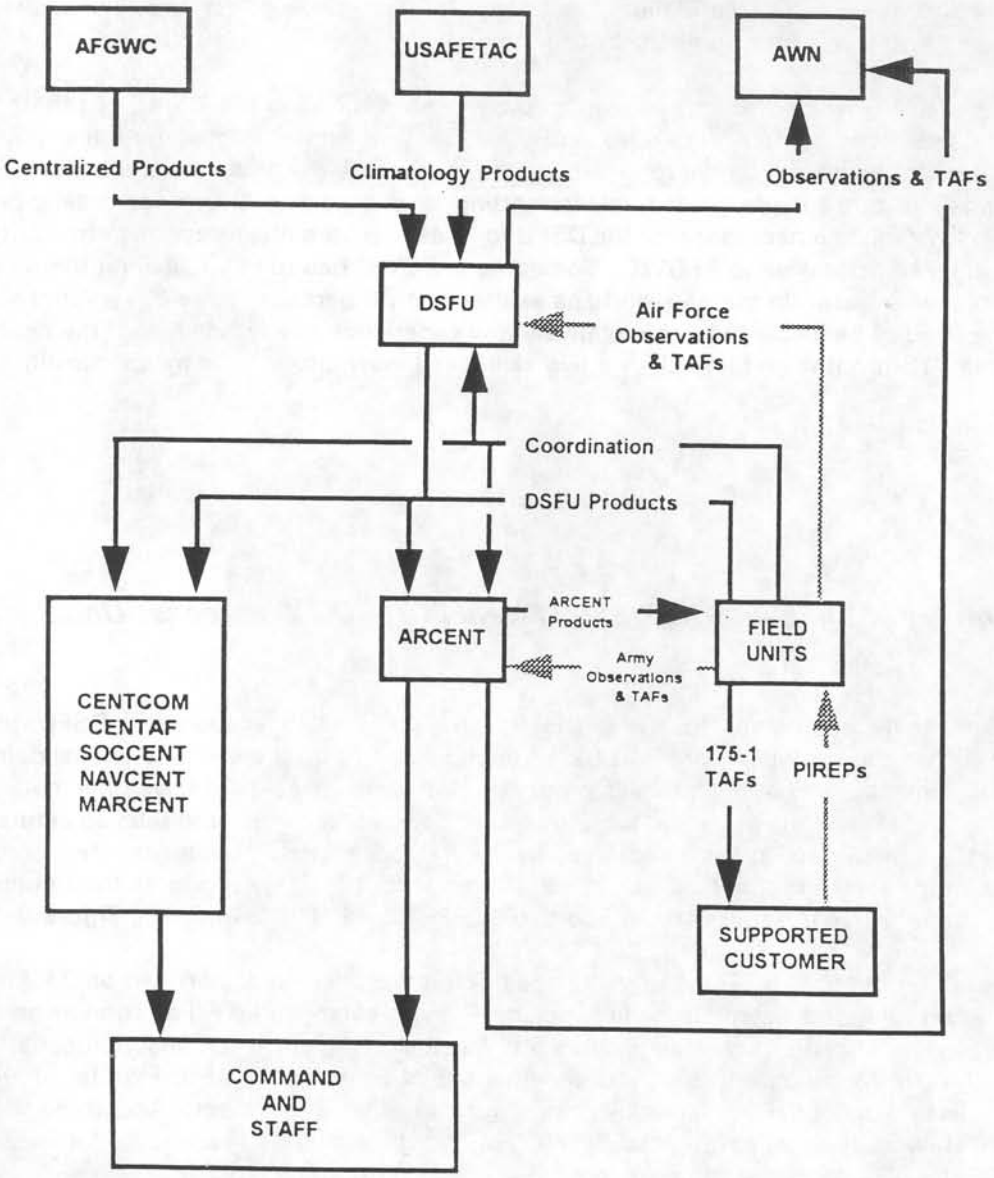
[6]AWS DS/DS Report #2 (S), pp 156 (Sec 4.4.2-b,c), 158 (Sec 4.4.3), info used (U).

[7]AWS DS/DS Report #2 (S), pp 157-158 (Secs 4.4.2-d,e, 4.4.3), info used (U).

[8]See above, Chapter II, pp 18-19.

DIAGRAM OF DESERT SHIELD/DESERT STORM FORECAST SUPPORT



The gray-colored links were the weakest, with the most problems.

SOURCE: AWS DESERT SHIELD/DESERT STORM Report #2 (S), p 76 (Atch 8), info used (U)

Figure V-1

Langley AFB, reached Riyadh to take charge of the DSFU and, a couple of days later, Master Sergeant Folk from the 25th Weather Squadron's Detachment 16 at Nellis AFB, Nevada, arrived to become the NCOIC.[9]

By 2 September the DSFU had all of its initially assigned personnel. The 5th Wing had handpicked some of them. Manning included four officers (an OIC, two team chiefs, and an electro-optical expert), eight forecasters (including the NCOIC), and six observers. Later, as part of the November-December general DESERT SHIELD force buildup, the DSFU got two additional forecasters. Four of the original eight NCO forecasters and two of the officers arrived with little or no centralized forecasting experience, which at first hampered the DSFU operations. The DSFU operated around the clock, 7 days per week with two 12-hour shifts every day. Each member of the DSFU was assigned to one of the shifts.[10]

On 27 August the newly constituted DSFU produced its first joint operational area forecast (JOAF), its most basic product. Four days later it began to send out two JOAFs per day. On 6 September it began providing a daily special support bulletin. The DSFU achieved full operational capability on 21 September.[11]

From the beginning, the DSFU operated as more than simply a tactical forecast unit. By virtue of the fact that the DSFU was collocated with CENTAF Weather, there was no clear line of delineation between it and CENTAF Weather, with the result that the DSFU wound up performing several CENTAF Weather functions--e.g., preparing briefing slides for Colonel Riley. Moreover, at the time they decided the DSFU would remain at CENTAF Weather, Colonels Goldey and Riley also made the decision to make the DSFU the Air Force's tactical weather analysis center for DESERT SHIELD, whose primary task would be to tailor general forecast products to Air Force operations. This caused more mixing of TFU and CENTAF Weather functions as well as adding to the DSFU's workload. In addition, on 31 August the DSFU became the QRCT network control station. Moreover, late in DESERT SHIELD, when the WSF began to utilize the TAC SBLC network, the DSFU received an SBLC fixed teletype terminal and DSFU personnel had to manually insert SBLC data into the AWN for further distribution.[12]

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[9]Msg (S), 5WW/Alert Staff to USCENTAF/WE, et al, "Theater Forecast Unit/Operation DESERT SHIELD (U)," 180404Z Aug 90, info used (U); Goldey Intvw (U), pp 5-6; Riley Intvw (S), p 30, info used (U); msg (S), 5WW/Alert Staff to AWS/DOJ, et al, "5WW SITREP Nbr 14/Operation DESERT SHIELD (U)," 211405Z Aug 90, info used (U); Koenemann Intvw (U), p 5.

[10]5WW DESERT SHIELD Chronology (S), p 9-6, info used (U); Koenemann Intvw (U), p 5; AWS DS/DS Report #2 (S), pp 25-26 (Sec 3.2.2), 36 (Sec 3.4), info used (U); Riley Intvw (S), pp 30-31, info used (U); Capts J.D. Murphy and J.E. Johnson in Murphy/Coe/Johnson Intvw (U), pp 12-13, 18; CENTAF SWO AAR (U), Sec G-1.

[11]5WW DESERT SHIELD Chronology (S), pp 9-5 - 9-7, info used (U); msg (S), 5WW/CAT to AWS/CAT, et al, "5WW SITREP Nbr 35/Operation DESERT SHIELD (U)," no dtg [ca 111500Z Sep 90], info used (U); AWS DS/DS Report #2 (S), p 79 (Sec 4.1.2.2), info used (U).

[12]AWS DS/DS Report #2 (S), pp 25-26 (Sec 3.2.2), 79 (Sec 4.1.2.2), info used (U); Riley Intvw (S), pp 30-31, info used (U); atch 7 (U), rprt, Capt J.D. Murphy, DSFU/OIC, to USCINCCENT/WE (1690WGP/CC), "DESERT SHIELD/STORM After-Actions Report," 21 Mar 91, w/4 atchs, hereafter cited as DSFU/OIC DS/DS AAR, pp 1, 4, to CENTCOM Weather Staff AARs (U); see above, Chapter II, p 19, and Chap III, pp 55-56.

Communications problems and shortfalls impeded DSFU operations at times. From the start the DSFU was able to receive AWN data from AFGWC, but it had no AFDIGS circuit for nearly four months. Until it obtained this circuit, it relied on HF intercept and NODDS for its facsimile data. Its access to NODDS, especially, proved to be a lifesaver for the DSFU during this time. The DSFU began to receive satellite imagery from the DMSP van on 3 September, but by hand delivery rather than electronically. Lacking meteorological data for certain specific areas in the Persian Gulf region, the DSFU relied heavily on satellite data in developing its forecasts. Already in September the DSFU put in a request for a Wraase system in order to get a looping capability, something it felt it very much needed. However, it did not get its Wraase until 1 February. In regards to transmit capabilities, the DSFU had a TIDS early on and eventually got a TACFAX circuit, but TIDS and TACFAX had to share one circuit, which hampered the operations of both.[13]

The DSFU ended up producing many more and a greater variety of products than stipulated in the O2-FY plan. It provided both area and mission-tailored forecast products. Types of products created included surface analyses, nephanalyses, and planning, tactical, and strategic horizontal weather depiction analyses and charts. The DSFU eventually produced thirteen different types of forecast bulletins. These included JOAFs, specialized support bulletins, terminal aerodrome forecasts, air refueling forecasts, electro-optical forecasts, and long-range outlooks. The JOAF was the primary forecast guidance product for weather teams. It included a synoptic discussion, sea surface data, METSAT data discussion, area forecasts, and 0- to 24-, 24- to 48-, and 48- to 72-hour outlooks. The specialized support bulletin contained forecasts for two specific cities, EOTDA and IREPS inputs, solar data, low level wind information, and a chemical downwind message.[14] (See Figure V-2.)

These products, as well as others that it received from elsewhere--such as satellite imagery and NODDS charts--the DSFU sent out to weather support units in the field. It also distributed selected products to Navy units and ships (in return, the DSFU received sea-state/surf forecasts and other bulletins from them), Marine Corps units, and to Saudi, Kuwaiti, Egyptian, British, French, and Italian forces participating in the Persian Gulf operation. It disseminated forecast bulletins by means of the AWN and AUTODIN circuits as well as the QRCT network, satellite imagery over the TIDS, and maps and charts via TACFAX, once this circuit became operational.[15]

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[13]See above, Chapter III, pp 52, 56-57, 68-69; AWS DS/DS Report #2 (S), pp 79-80, info used (U); Capts J.D. Murphy and T.E. Coe in Murphy/Coe/Johnson Intvw (U), pp 11-12, 19; atch 7 (U), DSFU/OIC DS/DS AAR, pp 2, 7, to CENTCOM Weather Staff AARs (U); atch 6 (U), rprt, SSgt T.D. Taylor, 1690WGP/METSAT Coordinator, to 1690WGP/CC, "AAR Meteorological Satellite Coordinator," 23 Mar 91, to CENTCOM Weather Staff AARs (U).

[14]AWS DS/DS Report #2 (S), pp 79-80 (Sec 4.1.2.2), 85-86 (Atch 10), info used (U); atch 7 (U), DSFU/OIC DS/DS AAR, pp 6-8, to CENTCOM Weather Staff AARs (U); Capts T.E. Coe and J.E. Johnson in Murphy/Coe/Johnson Intvw (U), pp 17-18; 5WW DESERT SHIELD Chronology (S), pp 9-6 - 9-7, info used (U). For an example of a JOAF, see AWS DS/DS Report #2 (S), pp 82-84 (Atch 9), no info used (U). For examples of the JOAF as well as other DSFU products, see atch 7 (U), DSFU/OIC DS/DS AAR (U), atchs 1-4, to CENTCOM Weather Staff AARs (U).

[15]AWS DS/DS Report #2 (S), pp 79-80 (Secs 4.1.2.1, 4.1.2.2), info used (U).

PRODUCTS ISSUED BY THE DESERT STORM FORECAST UNIT

1. JOAF (issued at 00Z and 12Z, valid through 72 hours):

    a. Synoptic discussion.
    b. Sea surface data.
    c. METSAT discussion.
    d. Area forecasts (6 areas).
    e. 24-48 hour outlook.
    f. 48-72 hour outlook.

2. SSB (issued at 00Z and 12Z, valid through 72 hours):

    a. Location specific forecasts (2 cities), 00-24 hours.
    b. Location specific forecasts (2 cities), 24-48 hours.
    c. Location specific forecasts (2 cities), 48-72 hours.
    d. EOTDA inputs (5 areas).
    e. Low-level winds (5 areas).
    f. IREPS input.
    g. HFUS bulletin (imported solar data).
    h. Chemical Downwind Message.

3. TAFS (issued at 03Z and 15Z, valid through 24 hours):

    a. In-theater TAFs (approximately 22 TAFs).
    b. CONUS TAFs (approximately 12 TAFs).
    c. European TAFs (approximately 18 TAFs).

4. MACADO (issued at 06Z, valid through 48 hours):

    a. Ceiling, visibility, and wind advisories, 00-24 hours (14 terminals).
    b. Ceiling, visibility, and wind advisories, 24-48 hours.

5. Air Refueling Forecast (issued 06Z and 18Z, valid through 24 hours):

    a. Cloud layers (10 areas).
    b. Altimeter settings and winds and temperatures.
    c. Icing.
    d. Turbulence.
    e. Thunderstorms.
    f. Contrails.

6. General EO Forecast (issued 01Z, valid through 24 hours):

    a. FLIR systems.
    b. TV/LLTV/NVG.
    c. Laser.
    d. Atmospheric conditions.

Figure V-2(1)

7. EO Forecast for Army Systems (issued 01Z, valid through 24 hours):

    a. IR.
    b. Enroute hazards (towers).
    c. TV/NVG.

8. DZ Forecast (as required, valid +/-2 hours):

    a. Cloud layers.
    b. Hazards.
    c. Winds and temperatures.
    d. Altimeter settings.

9. LZ Forecasts (as required, valid up to 24 hours):

    TAF format.

10. Wind Bulletin (issued 06Z and 18Z, valid through 24 hours):

    Surface to 35,000 feet winds for 3 areas every 6 hours.

11. Enroute Wind Bulletin (issued 03Z and 15Z, valid through 24 hours):

    Two routes, surface to 20,000.

12. Special Weather Support TOUCHE (issued 13Z, valid through 72 hours):

    a. Winds (3 areas for 00-24 hours, 24-48 hours, and 48-72 hours).
    b. Visibility and weather.
    c. Cloud layers.
    d. Altimeters settings.
    e. Hazards.
    f. Surface temperatures.

13. Long Range Outlook (issued at 14Z, valid through 14 days):

    a. Ceilings.
    b. Precipitation.
    c. Winds.
    d. Climatology data.

SOURCE: AWS DESERT SHIELD/DESERT STORM REPORT #2 (S), pp 85-86 (Atch 10), info used (U).

Figure V-2(2)

DSFU support to the WSF at first was rather shaky. However, through the hard work of its personnel, its support improved over time. In the end, users reported that DSFU products were very useful, its personnel helpful and responsive to requests, and its overall performance outstanding.[16]

During the early stages of Operation DESERT SHIELD, AFGWC served as a temporary TFU, as has been mentioned earlier,[17] but after the DSFU reached full operational capability on 21 September, AFGWC stepped down to a backup status, all the while retaining the capability to take over from the DSFU at a moment's notice. However, AWS was not satisfied with a backup TFU several thousand miles removed from the theater of operations; it felt that there should be an alternate DSFU in the theater. On 25 September it instructed the 5th Wing to develop a plan for an in-theater alternate TFU. Even though word soon came from the theater that CENTAF was not planning to fully back up its in-theater headquarters, AWS decided to press ahead anyway, but with a modified plan for what it called a "reconstituted" rather than an alternate DSFU.[18]

On 29 October Headquarters AWS approved the reconstitution plan drawn up by the 5th Wing, but later chose to site the proposed reconstituted DSFU at Taif, Saudi Arabia, rather than Thumrait, Oman, as recommended by the plan. AWS then went ahead to preposition at Taif the equipment essential for reconstitution. In January CENTCOM Weather sent a skeleton reconstituted DSFU staff to Taif. On 14 January the staff reported that it had successfully reconstituted the DSFU's capabilities and, the following day, informed CENTCOM Weather the reconstituted DSFU had reached initial operational capability. AWS now began to press toward getting it to full operational capability by 15 March. However, the rapid end to DESERT STORM negated that goal.[19]

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[16]Dickey Intvw (U), p 6; atch 2 (U), Holtgard DS/DS AAR, to CENTCOM Weather Staff AARs (U); atch 3 (U), rprt, Maj L.L. Moore, USCENTCOM/SWO Augmentee, to 1690WGP/CV, "After Action Input - DESERT SHIELD/STORM," 23 Mar 91, to CENTCOM Weather Staff AARs (U). See also, ltr (U) RADM C.C. Lautenbacher, Jr, Comdr, USNAVCENT to 1WS/CC, "Letter of Appreciation," 29 Mar 91.

[17]See above, Chapter IV, pp 71-72.

[18]AWS DS/DS Report #2 (S), pp 80-81 (Sec 4.1.2.2), info used (U); msg (U), HQ AWS/CAT to 5WW/CAT, et al, "Alternate Tactical Forecast Unit," 121841Z Oct 90; msg (S) 5WW/CAT to AWS/CAT, "Alternate TFU and DMSP Backup (U)," 142026Z Oct 90, info used (U). See also, msg (S), AWS/CAT to 5WW/CAT, "Tactical Forecast Unit Backup (U)," 250004Z Sep 90, no info used (U).

[19] AWS DS/DS Report #2 (S), p 81 (Sec 4.1.2.2), info used (U); msg (S), 5WW/CAT to AWS/CAT, "TFU Alterations [sic] (U)," 190019Z Oct 90, info used (U); msg (S) AWS/CAT to 5WW/CAT, et al, "Alternate TFU and DMSP Backup (U)," 291159Z Oct 90, info used (U); msg (S), AWS/CAT to 5WW/CAT, et al, "AWS Equipment Requirements for DESERT SHIELD (U)," 222221Z Oct 90, info used (U); msg (S), USCINCCENT/Weather to 5WW/CAT, et al, "Alternate Tactical Forecast Unit Activation Plan (U)," 271326Z Nov 90, info used (U); msg (S), USCENTAF/Weather to USCINCCENT/Weather, et al, "Test of Alternate DESERT SHIELD Forecast Unit (U)," 120543Z Jan 91, info used (U); msg (S), USCINCCENT/Weather to 5WW/CAT, et al, "RDSFU IOC (U)," 160934Z Jan 91, info used (U).

Support to US Central Command

CENTCOM Weather (officially USCENTCOM Weather Division) kept very busy providing a wide range of weather services to the CINCCENT and various CENTCOM staff agencies to assist them in their decision-making process. Colonel Goldey and his two assistant SWOs (three, beginning in mid-December) gave two formal briefings daily: in the morning to General Schwarzkopf and his senior staff, and in the evening to the general and his several component commanders. In addition to presenting standard synoptic weather information, the SWOs in their briefings categorized weather forecasts as favorable, marginal, or unfavorable for various types of operations and weapons systems (such as, e.g., close air support, reconnaissance, artillery, and helicopter operations). Later, shortly before the air offensive started, they added, at the request of the CINCCENT, the 14-day extended outlook prepared and sent to the DSFU by AFGWC.[20]

DSFU products provided the basis for all the briefings and for most of CENTCOM Weather's support services. The DSFU, although assigned to CENTCOM, was, of course, actually located with CENTAF Weather. The CENTCOM SWOs, nevertheless, in order to remain aware of the current weather situation, kept in close contact with the DSFU, usually via telephone. In order to ensure uniformity in content and consistency in forecasts, they also coordinated each briefing with their counterparts at CENTAF and ARCENT.[21]

A very important and helpful CENTCOM Weather support product was the DMSP pictures and interpretations it provided to the CENTCOM Intelligence Directorate. This imagery became particularly significant immediately before and during DESERT STORM. The CENTCOM SWOs regularly coordinated cloud-free forecasts with the CENTCOM's Strategic Reconnaissance Center in order to help CENTCOM reconnaissance planners to schedule reconnaissance missions. From September until the beginning of the war, they also furnished a written forecast for inland and coastal areas to the combined US-Arabian Coalition, Coordination, Communications, and Integration Center.[22]

Support to US Central Command Air Forces

The USCENTAF SWOs and/or deployed weather units provided weather support to all land-based air forces taking part in the DESERT SHIELD/STORM operation except for US Marine Corps airlift. CENTAF Weather support to Headquarters CENTAF consisted mostly of staff briefings and climatology for planning. During DESERT SHIELD Lieutenant Colonel Riley and his two assistant SWOs gave a daily briefing to CENTAF Commander General Horner and his staff. With the DSFU collocated with CENTAF Weather, DSFU personnel received the task of preparing the slides for the CENTAF SWO briefings. Important as these services were, CENTAF Weather's most significant task, at least during

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[20]Ltr (U), Goldey to Collens, 3 May 91; AWS DS/DS Report #2 (S), pp 77-78 (Secs 4.1.1.2, 4.1.1.3), info used (U).

[21]AWS DS/DS Report #2 (S), p 77 (Sec 4.1.1.2), info used (U).

[22]AWS DS/DS Report #2 (S), pp 77-78 (Sec 4.1.1.2), info used (U).

the war period, was to support the CENTAF Strategic Planning Cell, which planned and executed air tasking orders and included a TACC cell, a fragmentary order ("frag") shop, and a planning shop.[23]

Two weather teams subordinate to CENTAF Weather supplied vital weather services to key air operations control centers located in the Riyadh area. The TACC weather team, consisting of a SWO and three NCOs, supported the CENTAF Commander and other senior CENTAF staff members, including the Director of Operations and Director of Combat Operations, as well as the two provisional air divisions formed in the theater. It also supported the TACC Combat Plans Cell and the TACC Combat Operations Section. In addition, it provided weather services to tactical liaisons from the US Navy and Marine Corps and from British, French, Saudi Arabian, and Kuwaiti Air Forces in the theater. Another weather team composed of a SWO and an NCO furnished support to the Airlift Control Center. It briefed the Commander of Airlift Forces for DESERT SHIELD daily, not only on the weather for the theater, but also for Europe, the Atlantic Ocean, and the US east of the Mississippi River.[24]

CENTAF weather teams provided support to deployed US Air Force units, as well as a few Army and foreign aviation units engaged in various kinds of air operations, including strategic and tactical airlift, air refueling, and fighter and bomber (both tactical and strategic) practice missions. Most of the teams provided around-the-clock support. Typically, they prepared and disseminated terminal aerodrome forecasts and weather mission briefing packages ("flimsies") for aircrews four times per day. They also gave oral mass mission briefings and weather advisories and warnings as necessary. Eventually, as the weather deteriorated, the most significant support service that weather teams provided for their flying customers came to be cloud forecasting, while for their customers on the ground at the air base where they were located, it was weather advisories and warnings. The exact nature, mix, and frequency of weather support services varied from base to base depending upon the requirements of the supported units.[25]

Support to US Central Command Army Forces

AWS Army weather teams deployed to DESERT SHIELD supplied weather support to Headquarters ARCENT, VII and XVIII Army Corps, and the Army divisions, aviation brigades, and armored cavalry regiments deployed to the theater. The ARCENT SWO and his assistant SWO (a second assistant SWO arrived in early December), aided by an ARCENT enlisted weather team that reached 16 in number in December, presented daily briefings to the ARCENT Commanding General, Lieutenant General Yeosock, and his staff. ARCENT Weather provided ARCENT staff sections with daily weather packages, chemical downwind messages, information concerning weather effects on Army operations, and detailed climatological studies. It also furnished direct weather support to all Army forces in the theater who did not have dedicated AWS weather support teams assigned to them.[26]

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[23]AWS DS/DS Report #2 (S), pp 87-88 (Sec 4.1.3.2-a,b), info used (U).

[24]AWS DS/DS Report #2 (S), p 88 (Sec 4.1.3.2-c,d), info used (U).

[25]AWS DS/DS Report #2 (S), p 96 (Secs 4.1.6.1, 4.1.6.2), info used (U). For more detail on each of 20 CENTAF weather teams, see AWS DS/DS Report #2 (S), pp 96-101 (Sec 4.1.6.2-a), info all (U).

[26]AWS DS/DS Report #2 (S), pp 90-91 (Secs 4.1.4.2, 4.1.4.3), info used (U); ARCENT SWO AAR (U), p 1 (Sec I-2).

On 12 October ARCENT Weather became, in effect, a limited TFU when it took on the function of Goldwing network control station. In this capacity it dispensed and received weather data to and from Army weather teams deployed in the theater. It became even more of a TFU on 12 January 1991 when it began to produce a daily centralized support product, the tactical operational area forecast (TOAF), for the deployed Army weather teams. The TOAF was essentially the DSFU's JOAF tailored to the specific needs of Army weather support teams with the help of weather data supplied by the teams. Prior to 12 January the XVIII Corps weather team produced the TOAF, since all Army weather units in the theater were part of the XVIII Corps. However, the arrival of the VII Corps in the theater late in 1990, the positioning of the two corps in close proximity to each other, and the expectation that if and when offensive ground operations began the headquarters of both corps, along with their weather support teams, would be moving frequently, led the ARCENT SWO to conclude that it made more sense for ARCENT Weather to assume responsibility for the TOAF and issue one TOAF for the use of the weather teams of both corps. This new arrangement worked well.[27]

ARCENT weather teams in the field provided a number of important weather services to their commanding officers and their staffs. These included the usual daily briefings and weather flimsies, with additional assistance and updates as required or requested. They provided surface observations; 24-, 48-, and, sometimes, 72-hour forecasts; chemical downwind messages; and weather effects information. In addition, they issued weather warnings and advisories. Forecasts pertaining to winds, visibility, and precipitation was probably the weather information of greatest interest to their commanders. Prior to November the commanders were also concerned about possible heat stress on equipment. The teams sometimes had an input into planning future operations by briefing and analyzing climatological data. They also contributed to current decisionmaking by indicating, usually through a red-yellow-green format, the general weather impact on a particular operation. The ARCENT Weather product of greatest value to the Army weather teams in providing weather support to their customers was the TOAF.[28]

Support to US Central Command Special Operations Forces

During DESERT SHIELD the SOCCENT weather team (which eventually totaled approximately 35 people) provided support to General Lindsay, Commander, SOCCENT, and his staff, and to the commanders of AFSOC, ARSOC, and the Navy Special Warfare Task Group, all components of SOCCENT. Special operations activities during DESERT SHIELD were relatively limited; consequently, so were those of the SOCCENT weather team.[29]

The SOCCENT SWO gave three briefings daily--one to the SOCCENT commander and his staff and two to the SOCCENT Joint Operations/Intelligence Center when new shifts came on duty. The

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[27]AWS DS/DS Report #2 (S), p 90 (Sec 4.1.4.2), info used (U); ARCENT SWO AAR (U), pp 1 (Sec I-2), 3 (Sec I-3a(1)), 5 (Sec I-3a(2)); Weaving Intvw (U), pp 13-14; Campbell Intvw (U), pp 5-6; Boyle Intvw (U), pp 3-4, 6-7; Conley Intvw (U), pp 3-4.

[28]AWS DS/DS Report #2 (S), pp 96 (4.1.6.2), 101 (Sec 4.1.6.2-b), info used (U); Campbell Intvw (U), pp 19-20; Conley Intvw (U), pp 6-7. For additional detail on each of 10 Army weather support teams, see AWS DS/DS Report #2 (S), pp 101-103 (Sec 4.1.6.2-b), no info used (U).

[29]AWS DS/DS Report #2 (S), pp 94-95 (Secs 4.1.5.1, 4.1.5.3), info used (U); SOCCENT SWO AAR (U), p 1.

SWO also provided Headquarters SOCCENT with wind forecasts to assist chemical downwind predictions and furnished climatology packages to the SOCCENT Operations and Plans Directorates as part of weather annexes to the SOCCENT Operational Plan. In addition, he prepared operational forecasts for the Navy Special Warfare Task Group on an "as required" basis and made arrangements for it to receive sea state and surf forecasts via AFGWC. Like the Army weather teams, the SOCCENT SWO and the SOCCENT component SWOs depended heavily on the ARCENT TOAF in preparing weather support products.[30]

The AFSOC weather team developed an IREPS-based refractive effects product for use by the 1st Special Operations Wing and two other customers. This product depended heavily upon upper air soundings. Unfortunately, the unreliability of the IREPS product greatly reduced its value. One of the missions of the ARSOC team was to provide support to 5th Special Forces Group teams serving in an advisory and training capacity to Saudi Arabian, Kuwaiti, and Egyptian tank battalions participating in DESERT SHIELD.[31]

Joint and Combined Operational Relationships and Cooperation

Joint Coordination and Cooperation

Under Joint Chiefs of Staff Memorandum of Policy Number 5, the Air Force, through Air Weather Service, had responsibility for providing weather support to CENTCOM. The CENTCOM SWO, as head of the weather office supporting CENTCOM, had the task of coordinating joint weather support requirements and responsibilities with the CENTCOM component commands, which included not only CENTAF, ARCENT, and SOCCENT, but also CENTCOM's Naval and Marine Forces (NAVCENT and MARCENT, respectively). This was easier said than done. Planning documents called for coordinated weather support, but the coordination process broke down in practice, i.e., during actual DESERT SHIELD/STORM operations--especially between AWS and the Navy and Marine weather components and between the Navy and Marine weather forces. Indeed, a true joint weather support concept never emerged in AWS relationships with the Navy and Marine weather elements. Although coordination among CENTCOM's Air Force, Army, and special operations forces weather forces was better, it was not perfect here either. One reason was that each of these, while organizationally and administratively part of AWS, was under the operational control of its own component headquarters.[32]

This is not to say there was no cooperation between AWS and the Navy and Marine Corps. There was. CENTCOM Weather certainly wanted to work with the weather components of the other two services. Shortly after arriving in theater Colonel Goldey sent out a message via AUTODIN to the Navy and Marine SWOs announcing that CENTCOM weather and a tactical forecast unit were

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[30]AWS DS/DS Report #2 (S), p 94 (Sec 4.1.5.2), info used (U); SOCCENT SWO AAR (U), pp 1-2, 5.

[31]AWS DS/DS Report #2 (S), p 94 (Sec 4.1.5.2), info used (U); SOCCENT SWO AAR (U), p 5; Weaving Intvw (U), p 21.

[32]AWS DS/DS Report #2 (S), p 242 (Secs 9.1-a, 9.2-a), info used (U); atch 5 (U), Weaving DS/DS AAR, to CENTCOM Weather Staff AARs (U).

operational, informing them of the types of services and products the TFU was producing, and offering to make these services available to them. No direct reply came from a Navy source. However, the person in charge of the MARCENT weather element, Chief Warrant Officer Davis, who was with the 1st Marine Expeditionary Force at Al Jubayl, Saudi Arabia, responded to the messages and informed CENTCOM Weather of his weather support needs. Later in February, as the Marines were preparing for their land assault on Kuwait, he left his post in Jubayl and came to the USCENTCOM weather office in Riyadh where he used the CENTCOM SWO's field telephone to relay weather information to the Marines.[33]

Unfortunately, communications difficulties made it virtually impossible for the MARCENT weather element to receive DSFU products and, for that matter, to communicate with its own six deployed Marine squadrons. CENTAF Weather was able, however, by utilizing the expertise of the NCOIC of the Air Force DMSP van, to help the Marine weather people get one of their DMSP vans operational (they had deployed with four, none of which was operational when they arrived in theater). ETAC provided valuable assistance to the Marines by sending them copies of its climatological studies which included the Persian Gulf area. In return, the Marine weather unit at Al Jubayl sent surface and upper air observations to the CENTAF QRCT net control station via either the MAC airlift control element command and control or QRCT communications networks. But, in general, the relationship of AWS to the Marine weather units was one-sided. AWS did more for them than they did for AWS.[34]

On the whole, NAVCENT weather support personnel pretty much operated autonomously and paid little attention to the AWS weather support organizations in the DESERT SHIELD theater. For a short time the Navy did assign two enlisted persons to the AWS DSFU. Weather support to the Navy was a matter of concern to AWS WSF leaders, but other more pressing issues kept them from making this a high priority. Still, on the operational level several interchanges of weather products and services occurred. These were probably of greater benefit to AWS than to the Navy, perhaps because AWS was more interested in Navy products than the Navy was in AWS products. Mention was made earlier[35] of the great value that being able to access the Navy's NODDS was to the DSFU and of the importance of the Navy's IREPS to the WSF in its attempts to predict weather refractive effects. In addition, the DSFU received and used weather bulletins generated by Navy weather organizations which covered water areas adjacent to the Arabian Peninsula. In return, the DSFU transmitted the JOAF and other products to NAVCENT, but it was never very sure how much the Navy actually used them. Intratheater contact with Navy units was inhibited by difficulty in communication.[36]

Although AWS-Navy interfaces involving the DSFU were the most important, others also occurred. During the early weeks of DESERT SHIELD, the 5th Weather Wing coordinated with Navy officials at the neighboring Norfolk, Virginia, Naval Base on weather products that AWS was producing for the Persian Gulf theater. AFGWC and Navy weather agencies interchanged various weather

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[33]AWS DS/DS Report #2 (S), p 243 (Sec 9.2-a), info used (U); Goldey Intvw (U), p 27; note (U), Col W.S. Weaving, USAF (Ret), to W.E. Nawyn, 10 Jan 95.

[34]AWS DS/DS Report #2 (S), p 243 (Sec 9.2-b), info used (U); Goldey Intvw (U), pp 227-28; Riley Intvw (S), p 27, info used (U); Mr K.W. Walters in Tuttle/Walters Intvw (U), 14 Aug 91, p 6; note (U), Col G.F. Riley, Chief, AWS/DOT, to W.E. Nawyn, AWS/HO, 7 Jul 92.

[35]See above, Chapter III, pp 56-57 and Chap IV, p 95.

[36]AWS DS/DS Report #2 (S), pp 244 (Sec 9.2-a), 245 (Sec 9.4-2), info used (U); atch 5 (U), Weaving DS/DS AAR, to CENTCOM Weather Staff AARs (U); Koenemann Intvw (U), pp 34-37.

products. ETAC provided climatological documents to Navy organizations--including aircraft carriers and battleships operating in southwest Asian waters.[37]

Relationships with the Saudi Arabian Meteorological and Environmental Protection Association

Since most US and coalition forces deployed to the Persian Gulf were based primarily in Saudi Arabia, and since coalition forces had to use that country as a staging area to gain access to Kuwait and Iraq, the US considered amicable relations with Saudi Arabia to be crucial to the success of DESERT SHIELD/STORM. At the same time, Saudi Arabia, as the nation most threatened by Saddam Hussein and whose defense depended upon the coalition forces, also had a vital interest in maintaining good relationships with the US, by far the most important member of the coalition.

By the same token, AWS, although on a much lower level and in a much more proscribed arena, recognized that friendly relations and cooperation with its Saudi counterpart, MEPA, were vital to the success of its operations in support of DESERT SHIELD. By and large the relations between the AWS WSF and MEPA officials during the operation were, in fact, very cordial and AWS received "great cooperation and support" from MEPA. Basically, AWS got everything from the Saudis in the way of support that it asked for, although not necessarily as quickly as it would have preferred.[38]

On 14 August, only a few days after he arrived in Riyadh, Colonel Riley, then the acting OIC of the AWS WSF, at the initiative of the RSAF Director for Air Traffic Services, met for the first time with MEPA officials. Informal contacts between AWS and Saudi weather personnel had already occurred. The high-level meeting took place in Riyadh although MEPA headquarters was in Jeddah. Lasting several hours, it was both friendly and productive. Colonel Riley had as one of his main objectives to obtain access to Saudi weather data for AWS weather teams. The two MEPA officials present, Mr Nowailaty, the agency's Coordinator for the Armed Forces, and Mr Robert Hamilton, a retired US Air Force Reserve colonel, who was serving as a technical advisor to MEPA under a US Government contract, readily agreed to permit AWS personnel to utilize Saudi weather offices and data as desired. But in return, they requested AWS help in obtaining a chemical downwind forecast capability. In keeping with the agreement, AWS weather teams thereafter had almost unlimited access to Saudi weather products.[39]

During the first week of September, Colonel Goldey, who by this time had become the OIC of the AWS WSF, met twice with MEPA officials. In these meetings the Saudis agreed to install a drop-off teletype circuit from King Khalid International Airport near Riyadh to the DSFU at CENTAF Weather, and repeated their request for a chemical downwind dispersion model to assist them in defending against possible Iraqi chemical attacks. MEPA reiterated that it had no objection to person-to-person

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[37]Koenemann Intvw (U), pp 34-37 ; Stokes Intvw (U), p 3; Mr K.W. Walters in Tuttle/Walters Intvw (U), pp 6, 8-9.

[38]AWS DS/DS Report #2 (S), pp 238 (Sec 8.2-a), 240 (Sec 8.3), 242 (Sec 9.2-e), info used (U); Riley Intvw (S), pp 41-42, info used (U); ltr (U), Goldey to Collens, 3 May 91.

[39]AWS DS/DS Report #2 (S), p 239 (Sec 8.2-b), info used (U); Riley Intvw (S), p 41, info used (U); msg (S), COMUSCENTAF Fwd/WE to COMUSCINCCENT/CCJ3-W, et al, "USCENTAF Fwd Weather SITREP 05 (U)," 140000Z Aug 90, info used (U).

transfers of Saudi weather observations from MEPA to AWS, but stressed that AWS should keep complete Saudi observations out of WMO channels because it was afraid Iraq might then be able to use them in planning chemical attacks. By "complete" they meant observations that contained wind and atmospheric pressure data. MEPA had, as a matter of fact, been taking wind and pressure data out of the weather observations it transmitted over WMO circuits ever since Iraq invaded Kuwait on 2 August. For the remainder of DESERT SHIELD/STORM, Saudi Arabia remained adamant in not permitting the transmission of Saudi wind and pressure data in such a way that Iraq might obtain it.[40]

The CENTCOM and CENTAF SWOs thereafter met frequently with Nowailaty, Hamilton, and other MEPA officials to discuss various issues. In a meeting held on 12 October, MEPA approved the use of the partially completed, long-range, dedicated weather circuit from MEPA in Jeddah to the US National Weather Service's NMC at Suitland, Maryland, as a way for AFGWC to obtain the complete Saudi weather observations. The approval came after several weeks of negotiation on the subject.[41]

At the request of the Saudi Government, the AWS WSF provided several forms of weather support to Saudi military organizations. As noted before,[42] the CENTCOM SWOs provided a written forecast for inland and coastal areas to the Coalition, Coordination, Communications and Integration Center (the combined Saudi-US and coalition operations center) from September until the outbreak of hostilities. After the war began, they supplied it with a horizontal weather depiction forecast and a one-paragraph script in support of the air and ground campaigns. CENTAF Weather furnished the RSAF with copies of DSFU, AFGWC, and ETAC weather products. It also coached RSAF briefers, prepared slides for the morning RSAF general staff meetings, and occasionally briefed the RSAF command post. The RSAF Commander, Lieutenant General Ahmed I. Behery, and other high RSAF officers generally attended briefings presented by the CENTAF SWO to General Horner and the CENTAF Battle Staff. Meanwhile, the DFSU provided satellite imagery, copies of the JOAF, and slides for the evening RSAF staff meeting. It also furnished the RSAF forces with chemical downwind messages, forecasts tailored to their particular requirements, and a monthly climatological briefing.[43]

AWS relations with MEPA were, on the whole, amiable and cooperative, and AWS was appreciative of the meteorological services Saudi Arabia provided. It, nevertheless, had reservations over the reliability of some Saudi weather observations. It was also concerned over the long time it took MEPA to implement the King Khalid International Airport-DSFU and MEPA-NMC weather data circuits. The two issues were interrelated in that if and when the circuits finally became operational, their usefulness to the DSFU and AFGWC would be reduced if the observations they transmitted were inaccurate. As it was, inaccurate Saudi observations hampered rapid movement of the Army's XVIII Corps to forward positions in preparation for the ground war and contributed to the crash of an Air Force F-4 fighter at King Khalid Military City on 19 January. Following the crash, General Horner

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[40]AWS DS/DS Report #2 (S), pp 238-239 (Secs 8.2-a,c), info used (U); Goldey Intvw (U), p 17; Millard Intvw (U), p 12; ltr (U), Goldey to Collens, 3 May 91; msg (S), 5WW/CAT to AWS/CAT, et al, "Saudi Wind Data," 201744Z Aug 90, info used (U).

[41]See above, Chapter IV, p 78; AWS DS/DS Report #2 (S), pp 237 (Sec 8.2); 239-240 (Sec 8.2-c), 245 (Sec 9.2-e), info used (U).

[42]See above, this chapter, p 110.

[43]Atch 11, Brod DS/DS AAR, p 1, to CENTCOM Weather Staff AARs (U); AWS DS/DS Report #2 (S), p 242 (Sec 9.2-d), info used (U); CENTAF SWO AAR (U), Sec F; 5WW DESERT SHIELD Chronology (S), p 9-8, info used (U).

directed that in the future Air Force traffic controllers should always have AWS observations available to them.[44]

AWS was eager to get the two promised circuits operational. As matters stood, AFGWC and the DSFU--especially AFGWC, because of its distance from Saudi weather stations--could not get any wind and pressure data from locations where MEPA personnel made the weather observations. The lack of this data skewed the DSFU and AFGWC databases which, in turn, resulted in some degradation in their products. Consequently, AWS worked with MEPA to get the two circuits installed and operational as soon as possible. However, neither came on line until January 1991. MEPA activated the DSFU circuit on 16 January. Two days later the MEPA-NMC circuit finally became operational.[45]

There were several reasons why it took so long for MEPA to implement the two circuits. Saudi Arabia's culturally-determined perception of timeliness was obviously one. There were also some factors at work beyond the control of MEPA, such as the foot-dragging by commercial communications companies mentioned earlier.[46] But there may also well have been another reason--one for which the US, more specifically, the Air Force, was to blame. In the early meetings between AWS and MEPA in which the latter agreed to install the two circuits, the MEPA officials, it will be recalled, in turn asked for Air Force assistance in obtaining a chemical downwind dispersion model. The Air Force was as slow in responding to the Saudi request as MEPA was to AWS's request to implement the circuits. Coincidentally or not, AWS got its circuits about the same time that MEPA received its chemical downwind dispersion model.[47]

At least two reasons figured in why it took the Air Force so long to get a chemical downwind dispersion model to Saudi Arabia. Apparently, soon after the early CENTAF Weather-MEPA meetings, CENTAF asked CENTCOM to work the Saudi request. CENTCOM later said it never received the CENTAF request. The loss of the CENTAF request resulted in a 60-day delay in the process of obtaining the model the Saudis wanted. Eventually, on 10 November CENTAF formally asked CENTCOM to approve the Saudi request. Meanwhile, CENTCOM nuclear-biological-chemical warfare experts decided that the particular model requested by the Saudis would not be the best for use in Saudi Arabia and recommended another instead. This led to further delays. Finally, on 1 January, with CENTCOM approval, CENTAF Weather requested AFSC to provide the Saudis with a copy of a model developed by the Armstrong Aeromedical Research Laboratory at Wright-Patterson AFB, Ohio. On 15 January, AFSC approved disclosure of the model to Saudi Arabia, but informed CENTAF Weather that the Armstrong Laboratory was in the process of modifying the model to include Saudi Arabian parameters. The laboratory would, it added, ship the model to CENTAF as soon as it was ready, which should be only a few days. On 22 January the chemical dispersion model was finally on its way to MEPA.[48]

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[44]AWS DS/DS Report #2 (S), pp 237-238 (Sec 8.2), info used (U); Kelly Intvw, pp 14-15; CENTAF SWO AAR, Sec G-2.

[45]See above, Chapter IV, pp 78-79; AWS DS/DS Report #2 (S), p 240 (Sec 8.2-d), info used (U).

[46]See above, Chapter IV, pp 79-80.

[47]AWS DS/DS Report #2 (S), p 240 (Sec 8.2-d), info used (U); Goldey Intvw (U), p 17.

[48]AWS DS/DS Report #2 (S), p 240 (Sec 8.2-d), info used (U); note (U), Col G.F. Riley, Chief, AWS/DOT, to W.E. Nawyn, AWS/HO, 7 Jul 92; Goldey Intvw (U), p 17; msg (S), USCENTAF/CS to USCINCCENT/CS, et al, [classified title], 101000Z Nov 90, info used (U); msg (C), USCENTAF/Weather/CS to HQ AFSC/CS, et al, "Request for Assistance - Chemical Dispersion Model

Support to Coalition Forces

Nations participating in DESERT SHIELD/STORM had no prior agreements concerning weather support in theater. Coalition forces (except for those of the US) deployed to the Persian Gulf had little, if anything, in the way of weather support with them. Moreover, the senior coalition headquarters--the Coalition, Coordination, Communications, and Integration Center--had no provisions whatsoever for weather support. The coalition headquarters and field units, therefore, turned to AWS and its deployed WSF for assistance. Even though there were no formal agreements, AWS responded by providing them with substantial, albeit limited, support--necessarily limited because of its finite personnel resources in the operational theater and its primary responsibility to support US forces. Nevertheless, CENTAF Weather, in particular, provided considerable support to the British, French, Italian, and Saudi Air Forces through its TACC weather team and the DSFU. Much of it took the form of copies of DSFU, AFGWC, and ETAC products, but it also included briefings, target forecasts, and weather information packages, all of which created a greater workload for the TACC weather team and the DSFU.[49]

The DESERT SHIELD/STORM WSF provided more support to the British air forces than it did to any other coalition military force except for the RSAF. The TACC team prepared slides for morning briefings to the Royal Air Force staff. But for the British there, too, were limits and CENTAF Weather found it necessary to decline a request to brief the combined British military staff at its nightly meeting.[50]

Cooperation between AWS and the British during DESERT SHIELD/STORM was not limited to the Persian Gulf theater. In early November, the Meteorological Office of the United Kingdom's Strike Command asked AWS for satellite imagery directly from AFGWC. Strike Command, based in the United Kingdom, managed British participation in DESERT SHIELD and its meteorological office served as the primary forecast unit for the British forces deployed to DESERT SHIELD. AWS agreed to the request, but it was February before AWS and AFGWC were successful in arranging transmission of the imagery to the command. Meanwhile, however, AWS provided the Strike Command Meteorological Office with access to weather data originating with the AWS WSF in the DESERT SHIELD theater, including the JOAF and KQ observations and forecasts.[51]

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for Royal Saudi Air Force (U)," 010900Z Jan 91, info used (U); msg (C), HQ AFSC/CS to USCENTAF/Weather/CS, et al, "Request for Assistance - Chemical Dispersion Model for Royal Saudi Air Force (U)," 152350Z Jan 91, info used (U).

[49]AWS DS/DS Report #2 (S), pp 242 (Sec 9.1-c), 245 (Sec 9.2-d), info used (U); CENTAF SWO AAR (U), Sec F; msg (U), AFGWC/DOO to AWS/DOJ, et al, "Joint Duty Credit for Air Force Positions," 291510Z May 91.

[50]AWS DS/DS Report #2 (S), p 245 (Sec 9.2-d), info used (U).

[51]Waite Intvw (U), pp 10-11; msg (S), 2WW/CAT to AFGWC/CAT, et al, "British Request for Satellite Imagery from AOR (U)," 091352Z Nov 90, info used (U); msg (U), AFGWC/CAT to 2WW/CAT, et al, "British Request for Satellite Imagery," 092211Z Nov 90; msg (U), AFGWC/CAT to AWS/CAT, et al, "AFGWC SITREP #45 for 13 Nov 90," 131817Z Nov 90; msg (S), AWS/CAT to 2WW/CAT, "British Request for Satellite Imagery from AOR (U)," 142207Z Nov 90, info used (U); atch 1 (U), bullet background paper, 5WW/DON, "UKMO and HQSTC Support During DESERT SHIELD/STORM," 12 Apr 91, to ltr (U), HQ 2WW/CC to AWS/CC, "Allied Weather Assistance for

The benefits of cooperation did not flow only in one direction. Both the Strike Command Meteorological Office and the United Kingdom Meteorological Office extended themselves to provide AWS with products that it could use to support DESERT SHIELD/STORM. The former, for example, based on data that it had at its disposal, faxed wind analyses and forecasts as well as precipitation and fog forecasts applicable to southwest Asia to CENTCOM Weather. In January the United Kingdom Meteorological Office began to forward to AFGWC meteorological products which AFGWC needed to produce its medium-range forecast and 15-day extended outlook for the Persian Gulf theater. In addition, it transmitted 24-hour forecast upper level wind and temperature charts to MEPA, some of which, at least, MEPA passed on to CENTAF Weather.[52]

Operation DESERT SHIELD/STORM," 1 May 91, w/1 atch.

[52]Ltr (U), HQ 2WW/CC to AWS/CC, "Allied Weather Assistance for Operation DESERT SHIELD/STORM," 1 May 91, w/1 atch: bullet background paper (U), 2WW/DON, "UKMO and HQSTC Support during DESERT SHIELD/STORM," 12 Apr 91; Albrecht Intvw (U), pp 3-4; note (U), Col G.F. Riley, Chief, AWS/DOT, to W.E. Nawyn, AWS/HO, 7 Jul 92; see above, Chap IV, p 74.

CHAPTER VI

WEATHER SUPPORT TO DESERT STORM

The Storm

The US and its coalition partners commenced offensive operations against Iraq on 17 January, local time. This action followed upon Saddam Hussein's failure to comply with the UN Security Council resolution of 29 November 1990 ordering him to withdraw from Kuwait by 15 January 1991 or face possible military action by the UN coalition.[1] Having decided to begin with an air campaign, the coalition partners launched their first air attack at 0050, 17 January (1650, 16 January, Eastern Standard Time). With the onset of hostilities, DESERT SHIELD became DESERT STORM. For the next 6 weeks the US Air Force, assisted by British, French, Saudi Arabian, and Kuwaiti air forces, conducted an aggressive air campaign against Iraq, usually flying more than 2,000 sorties per day. In less than 2 weeks they removed any significant threat from Iraqi air forces. Ground anti-aircraft batteries, however, continued to pose a threat for any aircraft flying below 10,000 feet. Meanwhile, in retaliation, Iraq committed two acts of "environmental terrorism." On 22 January it set on fire the first of what eventually became more than 500 oil wells and, on 25 January, began to release millions of gallons of Kuwaiti-owned oil into the Persian Gulf.[2]

Once they gained air supremacy, the coalition air forces turned their attention primarily to Iraqi ground forces, communication lines, and Scud missile sites. Indeed, destroying the Scuds became their top priority objective since Iraq was frequently launching the missiles against Saudi and Israeli cities. In February, in anticipation of a possible ground campaign, CENTAF began to devote much of its attention to destroying Iraqi frontline positions, equipment, and military forces. By 23 February, the combined air forces had flown a total of 95,000 sorties--59,000 by the US Air Force alone. By the same date, total US forces in the Persian Gulf theater had reached 537,000, including 55,000 CENTAF personnel.[3]

Meanwhile, in early February, after Iraq was no longer capable of finding out what was going on in northern Saudi Arabia, CENTCOM began to move US and coalition forces northward in Saudi Arabia from their original positions into forward assembly and staffing areas along the Kuwaiti and Iraqi borders. This included, unknown to Iraq, moving more than 150,000 US, British, and French troops

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[1]See above, Chapter II, p 35.

[2]Art (U), "So Far, So Good," Time, 28 Jan 91, pp 18-24, 29; USAF/CAFH DS/DS Chronology (S/WN/NF), pp 252-253, 264, info used (U); TAC DS/DS Chronology (U), pp 70, 72; Title V Report (U), p 168; Information Please Almanac, Atlas, and Yearbook, 1992, p 974.

[3]USAF/CAFH DS/DS Chronology (S/WN/NF), pp 246, 249, 272, 345, 366-367, info used (U); Title V Report (U), pp 168, 176, 221; TAC DS/DS Chronology (U), p 86; AWS DS/DS Report #2 (S), p 60 (Atch 3), info used (U).

by air to positions along the Iraqi border well to the west of the other coalition forces (mostly located immediately south of the Kuwaiti border) from which they could strike deep into Iraq. All major combat units were in place for a ground offensive by 13 February.[4]

The ground war began at 0400, 24 February (2000, 23 February, Eastern Standard Time). It was over in four days--100 hours to be exact. By the 27th, coalition forces had fought their way into Kuwait City and, to the west, US, British, and French armies sweeping northward across the desert almost without opposition had reached the Euphrates River and accomplished their two main objectives of hitting the Iraqi forces in Kuwait and southeastern Iraq on their right (western) flank and sealing off their escape routes to Baghdad and central Iraq. Meanwhile, coalition air forces continued to pound Iraq and its military forces in and around Kuwait pushing their total DESERT STORM sorties to 100,000, including 66,000 by the US Air Force. Before the day (27 February) was over, Saddam Hussein agreed to accept the terms of a cease-fire offered by the UN coalition. That evening (Eastern Standard Time), President Bush, declaring Kuwait liberated and the Iraqi armies defeated, ordered a halt to military operations, effective at 2400, (0800, 28 February, in the operational theater). Hostilities never resumed.[5]

DESERT STORM Weather

By the time DESERT STORM began in mid-January, the hot, dry, sunny days of summer and fall were long past in the Persian Gulf theater. The weather gradually cooled during the fall and in late November and December the weather degenerated considerably both in terms of temperatures (lower) and cloud cover (increasing). January and February turned out to be generally cold and cloudy, sometimes rainy, causing weather to have an impact on combat operations. High temperatures in the theater varied from 4 to 25 degrees Celsius; lows ranged from minus 4 to 16. More significant for air operations, many days during the two months were cloudy. The air campaign began in the early hours of 17 January with clear skies, but thereafter, clouds frequently affected, and sometimes impeded, air operations. Indeed, target areas in Iraq had ceilings below 10,000 feet about one-third of the time during the air campaign. More particularly, ceilings over Baghdad were less than 10,000 feet 32 percent of the time in January and 22 percent in February; over Kuwait City they were below 10,000 feet 52 percent of the time in January and 29 percent in February. Once Iraq began to torch the Kuwaiti oil wells, smoke also sometimes obscured targets.[6] (For a DMSP satellite visual on 17 January, see Figure VI-1.)

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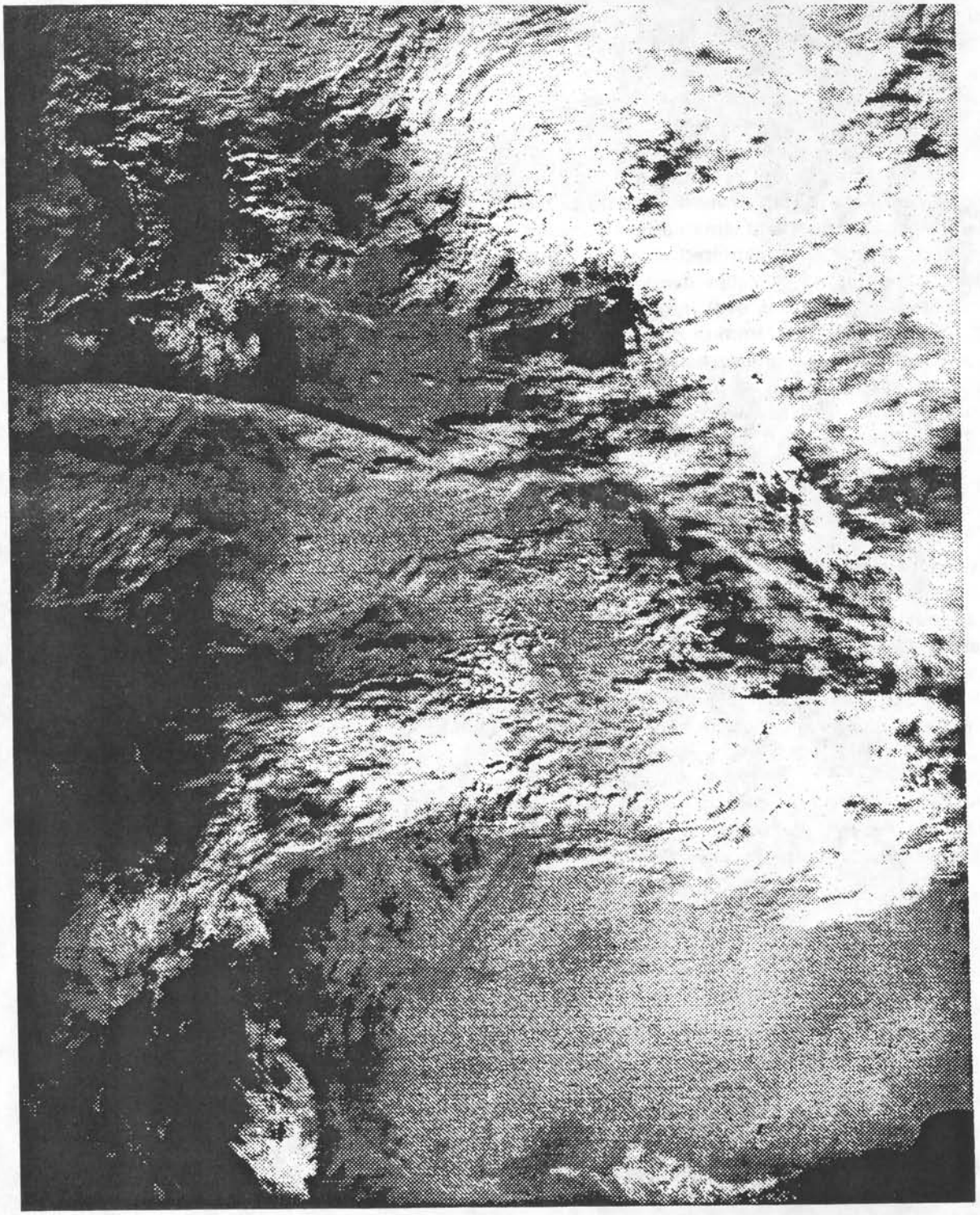
[4]HQ USAF/CAFH DS/DS Chronology (S/WN/NF), pp 313, 330, info used (U); Title V Report (U), pp 176, 341-343, art (U), "Five Decisive Moments," Time, 11 Mar 91, p 32.

[5]Art (U), "The 100 Hours," Time, 11 Mar 91, pp 22-32; USAF/CAFH DS/DS Chronology (S/WN/NF), pp 369, 382, 385, 386, info used (U); art (U), "Free at Last! Free at Last!," Time, 11 Mar 91, pp 38-39; art (U), "Five Decisive Moments," Time, 11 Mar 91, p 33; TAC DS/DS Chronology (U), pp 86-88; Information Please Almanac, Atlas, and Yearbook, 1992, p 974.

[6]Campbell Intvw, p 10; rprt (S), HQ AWS, "Operation DESERT STORM/DESERT SHIELD Report #1: Air Weather Service Contribution to Winning the War--The Value of Weather Support," 23 May 91, hereafter cited as AWS DS/DS Report #1 (S), p i (Exec Sum), info used (U); art (U), Tim Downey, American Forces Information Service, AWS Observer, "AWS Keeps Vigilant Eye on Desert Storm," Mar 91; AWS DS/DS Report #2 (S), p 125 (Atch 13), info used (U).

SATELLITE IMAGERY (DMSP VISUAL) OF DESERT THEATER 17 JAN 91, 0555Z

Fog and low clouds are visible in east central Saudi Arabia and the United Arab Emirates. The leading edge of the approaching frontal system can be seen over the Northern Red Sea.



SOURCE: Rprt (U), K. R. Walters, Sr, et al, Gulf War Weather, USAFETAC/TN-92/003, Mar 92, p 3-3.

Figure VI-1

Closer to the surface of the earth, the 2 months were marked by frequent gusty winds, blowing sand, rain, and thundershowers. Tactical assembly areas in northeastern Saudi Arabia received as much as four inches of rain during January alone. Fog was prevalent along the northwestern Persian Gulf and sometimes penetrated as much as 100-150 miles inland during the night hours and sometimes well into the following mornings. Depending on wind direction, the smoke from the burning oil wells also sometimes restricted surface visibility.[7]

The weather during the 4 days of the ground war was, if anything, worse than the average weather of the preceding 6-week air campaign. When the coalition forces began their offensive early on the morning of 24 February, the skies in southern Iraq and Kuwait were broken to overcast. However, at the time, a low pressure system was bearing down on the operational area (Kuwait Theater of Operations [KTO]) from the west. It reached the area late in the morning, bringing with it extensive low cloud cover and isolated rain showers. Winds blew out of the east-southeast at 15 to 20 knots, raising dust that restricted visibility. But the wind also drove the smoke from the oil well fires up the Tigris-Euphrates Valley deep into Iraq, keeping it away from the advancing ground forces (but hampering air operations over Iraq). Moreover, the southeasterly winds prevented the Iraqis, if they had any such intention, from using chemical weapons against the advancing coalition forces. By the end of the day the low pressure system had moved through the theater, but it was soon followed by an upper-air disturbance that brought in more clouds and rain. Temperatures on the 24th ranged from 1 to 21 degrees Celsius, which turned out to be both the low and high temperatures for the four days of the ground campaign.[8] (For a DMSP satellite visual on 24 February, see Figure VI-2.)

Over the next 3 days the weather did not improve a great deal, but General Schwarzkopf called it "great infantryman's weather." The 25th was not only cloudy and rainy, but also windy--gusts reached 40 knots per hour in the afternoon. The cloud cover continued over the battle area during the 26th. Intermittent rainshowers and thunderstorms occurred and the winds remained southeasterly. The weather finally began to improve late on 27 February. During the morning of the 27th parts of the operational theater still had cloud cover and along with it rainshowers and thunderstorms, but by early evening the entire area was clear. Winds had shifted back to the more prevailing westerly and northwesterly direction. With the shift in the wind, a smoke layer moved over much of central and southern Kuwait. Broken clouds covered the battle area on 28 February, the last day of the war. By early evening the skies were clear or had only scattered clouds. But by then the ground war was over and the cease-fire in effect.[9]

AWS knew all along, of course, that the weather would deteriorate when winter came along, and SWOs had frequently warned their customers of this fact. But the weather in the Persian Gulf region during January and February 1991 was worse than anticipated on the basis of climatology. Around the time the ground war began, General Merrill E. McPeak, Chief of Staff of the Air Force, asked AWS whether DESERT STORM weather was better or worse than climatology had led it to

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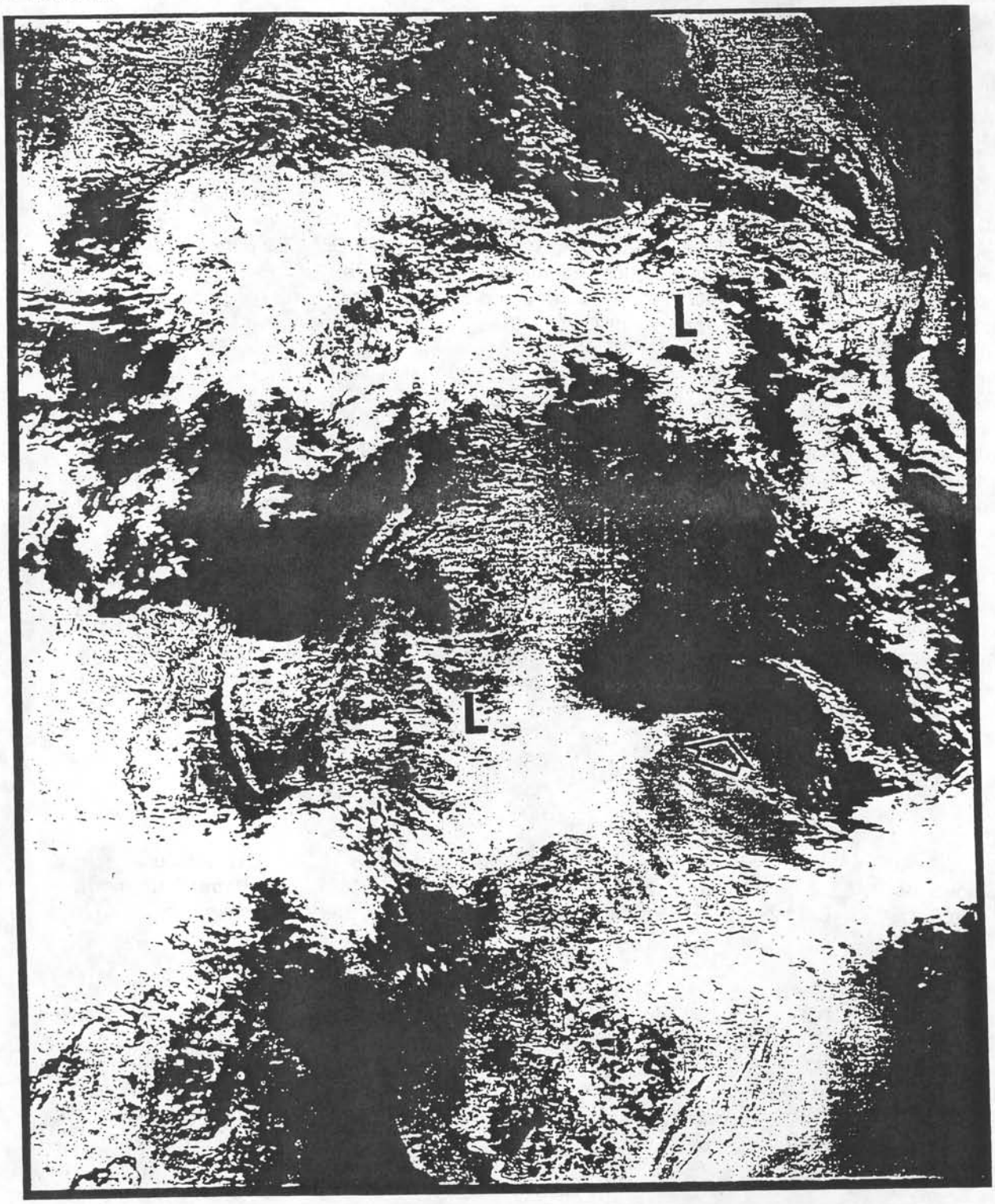
[7]Rprt (U), K.R. Walters, Sr, et al, Gulf War Weather, USAFETAC/TN--92/003, Mar 92, pp 3-2 - 3-102; Cotturone, OL-E, 1690WGP DS/DS Weather History (U); AWS DS/DS Report #2 (S), p 126 (Atch 13), info used (U); Campbell Intvw (U), p 10.

[8]Rprt (U), K.R. Walters, Sr, et al, Gulf War Weather, USAFETAC/TN--92/003, Mar 92, pp 3-87 - 3-89; Cotturone, OL-E, 1690WGP DS/DS Weather History (U); ltr (U), LTC W.S. Weaving, 1690WGP/CV, to 5WW/DO, "Weather Support to DESERT SHIELD/STORM," 6 Mar 91, hereafter cited as ltr, Weaving to 5WW/DO, 6 Mar 91; Weaving Intvw (U), p 30.

[9]Rprt (U), K.R. Walters, Sr, et al, Gulf War Weather, USAFETAC//TN--92/003, Mar 92, pp 3-90 - 3-102.; Cotturone OL-E, 1690WGP Weather History (U); ltr (U), Weaving to 5WW/DO, 6 Mar 91.

SATELLITE IMAGERY (DMSP VISUAL) OF DESERT THEATER 24 FEB 91, 1123Z

Smoke (arrow) spreads from Kuwait to central Iraq. The upper-air disturbance that affected Kuwait in the morning is now over the Persian Gulf, and the disturbance affecting it in the evening is now over the Red Sea.



SOURCE: Rprt (U), K. R. Walters, Sr, et al, Gulf War Weather, USAFETAC/TN-92/003, Mar 92, p 3-3.

Figure VI-2

expect. In response, AWS directed ETAC to conduct an exhaustive analysis of the actual weather during all of DESERT SHIELD and STORM compared to climatology. ETAC concluded, based on the 14 years' worth of weather data that it had from Southwest Asia, that the weather in the Persian Gulf area was approximately twice as bad (i.e., twice as much time with cloud cover and/or ceilings below 10,000 feet) as climatology suggested and was worse in January and February 1991 than it had been in the same 2 months of any of the preceding 14 years.[10]

More specifically, ETAC found that, overall, the operational area had ceilings below 10,000 feet about 35 percent of the time. It also determined that in January 1991 the mean cloud cover over Baghdad was 3.4 eighths and in February 2.5 eighths compared to the 14-year climatological mean of 1.7 and 1.5, respectively. Similarly, Kuwait City had a mean of 2.5 and 2.2 eighths of cloud cover in the two DESERT STORM months compared to the 1.0 and 0.8 indicated by climatology. It also discovered that low cloud cover over Baghdad in January and February 1991 was 231 percent of normal (i.e, the mean over the last 15 years, including 1991), over Kuwait City 290 percent of normal. In addition, ETAC, using statistical techniques, estimated the probability of the DESERT STORM weather actually occurring was 2.5 percent for January and 5 percent for February for Baghdad and less than 1 percent for both months for Kuwait City.[11] (See Figures VI-3 and VI-4.)

An assistant CENTCOM SWO, Major Joseph D. Brod, also analyzed the weather over Baghdad and Kuwait City in January and February 1991. Using nephanalysis charts prepared by the DSFU, satellite imagery, and Navy climatology (Summary of Meteorological Observations, Surface), he concluded that Baghdad ceilings were below 10,000 feet 32 percent of the time in January and 22 percent of the time in February compared to the 21 and 17 percent, respectively, suggested by the climatology. For Kuwait City, he found the percentages for the same categories to be 52 and 29 compared to 24 and 21.[12]

The discrepancy between the actual weather and climatology was perhaps due in part to limited and inaccurate climatological data. The database used to develop the climatology covered only the last 14 years. Moreover, incomplete and inaccurate observations over these years may have biased the climatology. Local observations were not always reliable, many cloud cover observations were missing, and changes in WMO observing practices occurred during the 14 years. In short, the quantity and quality of the observations were less than might be desired. However, the shortcomings

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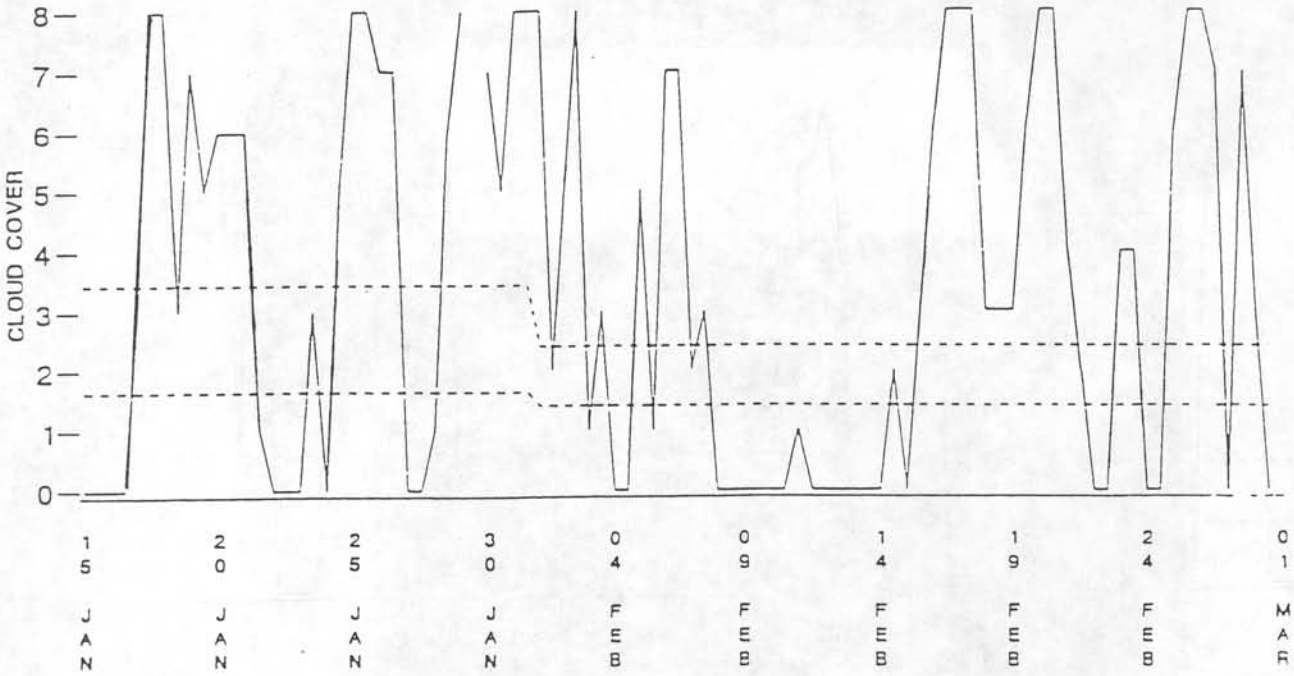
[10]LTC R.R. Wall in AWTB Intvw (U), p 41; AWS DS/DS Report #1, p 1 (Sec 3.1), info used (U); AWS DS/DS Report #2 (S), p 125 (Atch 13), info used (U); atch 5 (U), "Summary Paper," to ltr (U), LTC D.J. Pace, Det 2, HQ AWS, to AFGWC/CC, "DESERT STORM Weather Comparison for CSAF," 28 Feb 91.

[11]Brfg (S), Majs A.R. Shaffer, 5WW/DOS, and R.W. Keefer, AWS/DOJ, to Brig Gen J.J. Kelly, Jr, USAF/XOW, [DESERT STORM Analysis and Lessons Learned Briefing (U),] 12 Apr 91, hereafter cited as Shaffer/Keefer DESERT STORM Analysis Brfg (S), slides (paper) 4,5, info used (U); AWS DS/DS Report #2 (S), pp 125, 127, 128 (Atchs 13,14,15), info used (U); AWS DS/DS Report #1 (S), pp 1-2 (Sec 3.1), 4-5 (Figs 1,2), info used (U); atch 3 (U), "Explanatory Paper," to ltr (U), LTC D.J. Pace, Det 2, HQ AWS, "DESERT STORM Weather Comparison for CSAF," 8 Mar 91, w/3 atchs. See also ltr (U), AFGWC/DO to Det 2, HQ AWS, "Actual Weather for DESERT SHIELD/DESERT STORM vs Climo," 26 Feb 91, w/3 atchs.

[12]AWS DS/DS Report #2 (S), pp 125 (Atch 13), 129 (Atch 16), info used (U).

BAGHDAD WEATHER VERSUS CLIMATOLOGY
15 JAN - 1 MAR 91



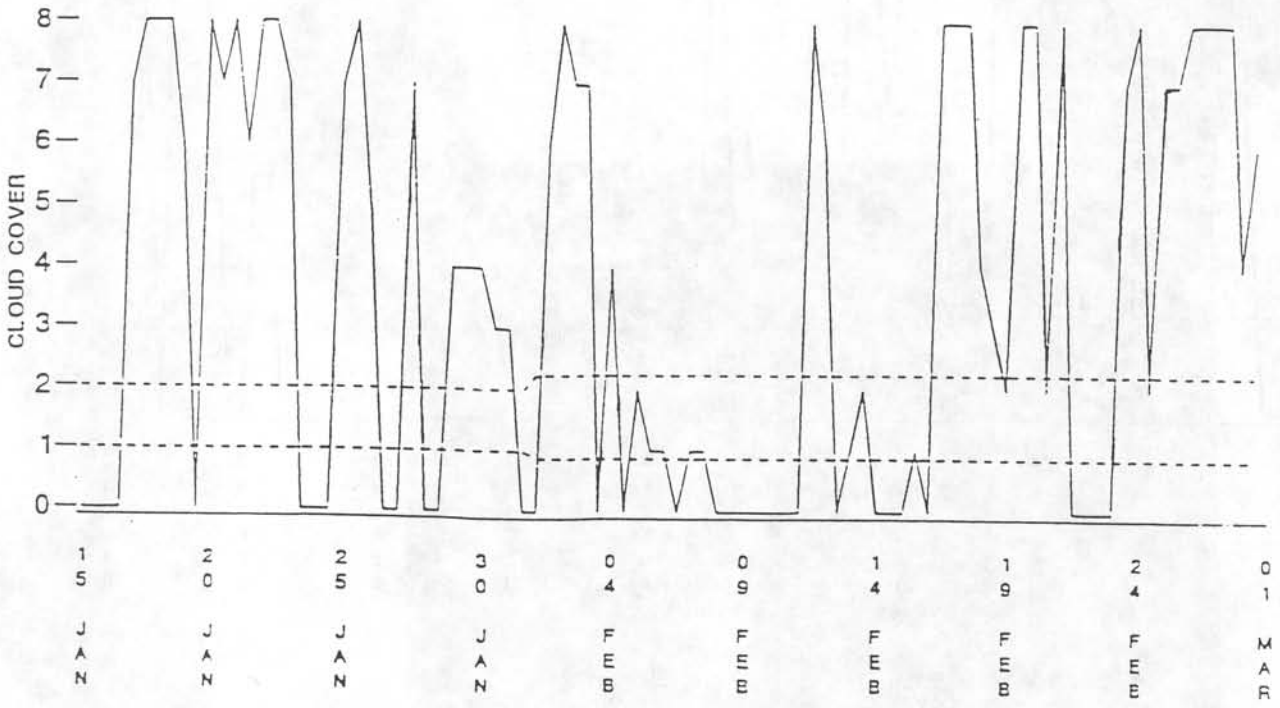
OBSERVED CLIMATOLOGY: 1991 Monthly Mean Cloud Cover below 10,000 feet.

BAGHDAD CLIMATOLOGY: The daily variation (thin solid line) of eighths of cloud cover, monthly mean cloud cover for the 14-year period of record (botton dashed line), and the 1991 monthly average cloud cover below 10,000 feet (top dashed line) for Baghdad.

SOURCE: AWS DESERT SHIELD/DESERT STORM, Report #2 (S), p 127 (Atch 14), info used (U).

Figure VI-3

KUWAIT THEATER OF OPERATIONS
WEATHER VERSUS CLIMATOLOGY
15 JAN - 1 MAR 91



OBSERVED CLIMATOLOGY: 1991 Monthly Mean Cloud Cover below 10,000 feet.

KUWAIT CLIMATOLOGY. The daily variation (thin solid line) of eighths of cloud cover, monthly mean cloud cover for the 14-year period of record (botton dashed line), and the 1991 monthly average cloud cover below 10,000 feet (top dashed line) for Kuwait Theater of Operations.

SOURCE: AWS DESERT SHIELD/DESERT STORM Report #2 (S), p 128 (Atch 15), info used (U).

Figure VI-4

of the climatology did not significantly threaten the correctness of the basic conclusion that the weather during DESERT STORM was indeed unusual.[13]

Weather Support Operations

By the time DESERT STORM began, the AWS WSF was "ready to support any operation directed by the president." Not that every last piece of equipment or communications systems was in place and operational or that the force could not further hone its skills and expand its capabilities, but essentially it was able and ready to go. DESERT STORM brought a great increase in workload for the WSF, but for the most part the nature of its weather support operations did not change a great deal. In other words, the force worked harder and more intensely, but basically continued to provide its customers with the same types of weather information, although frequently more of it.[14]

Overall, weather and weather support proved to be more critical to and had more of an impact upon combat operations during DESERT STORM than commanders originally anticipated. This was due to at least two reasons. First, the weather was worse than expected. Secondly, when anti-aircraft weapons replaced ground-to-air missiles and counter air operations as the chief Iraqi threat to the US and coalition air forces after they gained air supremacy over Iraq, CENTAF mission planners established a 10,000 feet operational threshold. This, in turn, led to a greater concern for cloud cover and ceilings.[15]

Centralized Support to the WSF from the DESERT STORM Tactical Forecast Unit

During DESERT STORM the DSFU, like the WSF in general, basically continued to operate much as it had during DESERT SHIELD and to provide the same products. Its workload increased and its personnel worked through DESERT STORM without getting a day off. The DSFU deactivated on 18 March 1991, 18 days after the cease-fire ending hostilities and 178 days after it began full operations on 21 September. At this point, AFGWC again assumed the tactical forecast unit functions.[16]

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[13]AWS DS/DS Report #2 (S), pp 125, 126 (Atch 13), info used (U); AWS DS/DS Report #1 (S), p 3 (Sec 3.2), info used (U); Goldey Intvw (U), p 21; memo (U), "Update," 19 Mar 91, to memo (U), AWS/DO to AWS/CC/CV/CC, [DS/DS Weather vs Climo,] 18 Mar 91.

[14]Frederick Intvw (U), p 12; msg (S), 5WW/CAT to AWS/CAT, et al, "Operational Readiness of the DESERT SHIELD WSF," 041308Z Jan 91, info used (U).

[15]AWS DS/DS Report #1 (S), p 32 (Sec 6.3), info used (U).

[16]Riley Intvw (S), p 31, info used (U); AWS DS/DS Report #2 (S), pp 79 (Sec 4.1.2.2), 111 (Sec 4.2), info used (U). See also, msg (S), [USCENTAF Weather to WSF,] et al, "TFU Deactivation (U)," no dtg [18 Mar 91], no info used (U).

The CENTCOM staff required twice as much weather data from CENTCOM Weather during the war period as before. The number of daily briefings increased from two to four as CENTCOM added briefings to the Joint Intelligence and Joint Operations Centers to the morning and evening CINCCENT briefings. Moreover, the number of slides briefed rose from four to nine and the scope of each briefing expanded from a simple 0- to 24-hour to a 0- to 72-hour forecast that categorized weather forecasts as favorable, marginal, or unfavorable for various types of operations and weapons systems (e.g., closeair support, reconnaissance, artillery, helicopter operations). After the war started the CENTCOM SWOs began to issue a daily horizontal weather depiction graphic forecast and a one-paragraph script for the air and ground campaigns. They also continued to brief the 14-day extended outlook for the DESERT SHIELD theater.[17]

On 29 January CENTCOM Special Plans asked CENTCOM Weather to provide, as an additional project, a 3-week, day-by-day, cloud cover outlook (clear, partly cloudy, cloudy) for western Iraq and the KTO. The purpose of this effort was to demonstrate to General Schwarzkopf the weather trands, with emphasis on cloud-free days. Its value was that it pointed out for the general the cyclical weather trends. The forecasts showed that there were frequently 3 days of clear to scattered clouds in the two areas between each weather system. A later refinement of the forecast indicated that there would be 3 clear to scattered cloud days from 21 to 24 February, which, along with other factors such as illumination data and tides, led the general to decide to start the ground offensive on 22 February. However, logistical problems caused him to delay the attack until 24 February. Overall, the 21-day forecast for the two areas combined verified at 71.4 percent.[18]

During DESERT STORM DMSP satellite imagery became even more significant than it had been before hostilities began. Consequently, General Schwarzkopf directed that DMSP transparencies be included in his daily briefings. The satellite imagery not only provided CENTCOM leaders with decision-making assistance, but also helped CENTCOM Intelligence to determine the number and location of oil well fires, the extent and direction of the resultant smoke plume, and to assess the impact of the fires and smoke. The CENTCOM Intelligence and Operations staffs frequently requested and received satellite data updates.[19]

DMSP satellite imagery provided General Schwarzkopf with the first battle damage assessment of the war. Following the air raids on Baghdad on the first night of the war, the general remarked that he wasn't getting assessments of the damage caused by the raids fast enough. Hearing of General Schwarzkopf's remark, Lieutenant Colonel Riley took two DMSP visuals covering Baghdad taken on the nights of January 16 and 17 to Brigadier General Buster C. Glosson, the Director of the CENTAF Strategic Planning Cell, who quickly passed them on to General Schwarzkopf. The one taken

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[17]AWS DS/DS Report #1 (S), p 8 (Sec 5.1.1), info used (U); AWS DS/DS Report #2 (S), p 77 (Sec 4.1.1.2), info used (U); ltr (U), Weaving to 5WW/DO, 6 Mar 91.

[18]Note (U), Col W.S. Weaving, USAF (Ret), to W.E. Nawyn, 10 Jan 95.

[19]AWS DS/DS Report #2 (S), pp 77-78 (Sec 4.1.1.2), info used (U); msg (S), USCINCCENT Weather to 5WW/CAT, et al, "WSF SITREP 150 (U)," 231000Z Jan 91, info used (U); msg (S), USCINCCENT Weather to 5WW/CAT, et al, "WSF SITREP 153 (U)," 261130Z Jan 91, info used (U); msg (S), 5WW/CAT to AWS/CAT, "DESERT STORM Weather Impacts (U)," 211459Z Jan 91, info used (U).

the night of the 16th clearly showed lights on in the city; the one taken the following night depicted nothing but darkness. The visuals thus clearly indicated that the raids had accomplished their chief objective, to knock out Baghdad's electrical systems and network.[20]

CENTCOM Weather's primary responsibility was to provide planning support to the CENTCOM staff, but it also furnished direct operational support to theater reconnaissance missions, using forecasts supplied by the DSFU and SAC's Directorate of Weather for Strategic Reconnaissance at Offutt AFB, Nebraska.[21]

Support to US Central Command Air Forces

CENTAF Weather also experienced a considerable increase in its workload during DESERT STORM. It now briefed General Horner and his staff twice daily instead of once, gave target area weather assessments, and provided General Horner and Brigadier General Buster C. Glosson, the Director of the CENTAF Strategic Planning Cell, with frequent weather updates. Like General Schwarzkopf, General Horner placed great value on satellite imagery and, therefore, directed that he receive a copy of the latest imagery as soon as it became available. He also ordered CENTAF Weather to provide and display in the TACC a continuously updated nephanalysis of the satellite imagery to help him and the TACC directors interpret it. In addition, he instructed CENTAF Weather to put together and display an air terminal weather board containing up-to-date weather information for all CENTAF bases in the theater. When CENTAF shifted its air campaign tactics, CENTAF Weather tailored its support to meet the new forecast requirements resulting from the consequent concern for cloud cover below 10,000 feet.[22]

CENTAF Weather's support to the Strategic Planning Cell became both more extensive and more critical during DESERT STORM. Particularly important was the support provided to the Planning Cell's Plans shop, (or Guidance Allocation Tasking Cell), usually referred to as the "black hole," which planned air tasking orders. The support included briefing General Glosson and his staff twice daily, posting in the black hole a daily 2-day horizontal weather depiction of the operational theater and the latest satellite imagery, and presenting numerous "on-call" briefings. In addition, Lieutenant Colonel Riley, in coordination with the Commander of CENTAF's Electronic Warfare Division, developed a new, structured planning support product. It consisted of a three page, 3-day (72-hour) weather forecast for four areas: Baghdad, Mosul (in northern Iraq), the KTO, and western Iraq. Beginning on 29 January, it issued the forecast three times daily. Black hole planners particularly wanted to know if, or which, potential target areas would be cloud free below 10,000 feet 2 days later. Indeed, the cloud forecast for target areas was the single most important weather product CENTAF Weather provided.[23]

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[20]Note (U), Col W.S. Weaving, USAF (Ret), to W.E. Nawyn, 10 Jan 95.

[21]AWS DS/DS Report #1 (S), pp 8, 10 (Sec 5.1.2), info used (U).

[22]AWS DS/DS Report #2 (S), p 87 (Sec 4.1.3.2), info used (U); AWS DS/DS Report #1 (S), p 1 (Sec 2), info used (U).

[23]AWS DS/DS Report #2 (S), pp 87-88 (Sec 4.1.3.2), info used (U); AWS DS/DS Report # 1 (S), pp 10-14 (Sec 5.2.1, Figs 5-7), info used (U); Shaffer/Keefer DESERT STORM Analysis Brfg (S), slide (paper) 11, info used (U).

CENTAF Weather also provided weather support to the Strategic Planning Cell's frag shop and TACC cell. The CENTAF SWOs provided the frag shop with a daily verbal briefing and a written horizontal weather depiction forecast to help it in building the next day's air tasking order. The CENTAF SWOs, together with the TACC SWO, furnished the TACC cell with detailed weather inputs that assisted it in executing the current day's air tasking order. Up-to-date forecasts of cloud cover over targets, for example, enabled the TACC, if necessary, to redirect attack missions, even those already underway, from targets with low ceilings to other targets with acceptable weather.[24]

CENTAF Weather provided weather inputs at four points in the planning and executing process for an air tasking order. Fifty hours prior to the planned execution time for a particular air tasking order (2400 local time) it briefed the theater weather to General Glosson, who then decided on potential targets to be "fragged" the following day. Exactly 24 hours later, 26 hours before execution, it briefed a 26-hour forecast to the black hole to assist it in selecting the final list of targets that the planners would release to the frag shop. Eighteen hours before execution (at 0800 local time), it briefed the fraggers building the next night's air tasking order. Finally, 12 hours before execution (1400 local time) it briefed the weather for a final time to General Glosson, who then made a final decision on the targets for the coming night. This was the last opportunity to change the formal air tasking order, although it did not formally close until 1800 local time, 8 hours before execution, at which time the TACC weather team provided yet another weather input.[25] (See Figure VI-5.)

CENTAF force-level and unit-level weather teams provided primarily execution support to their customers during DESERT STORM. In addition to the weather support it furnished to the Strategic Planning Cell referred to in the preceding two paragraphs, the TACC weather team, using DMSP and NOAA satellite imagery, constantly updated cloud conditions over the DESERT STORM theater. It also developed a process to continuously update current observations at, and 12-hour forecasts for, all recovery bases so that it would have available the information General Horner wanted displayed on the terminal weather board he had directed it to provide. The Airlift Control Center weather team supported General Schwarzkopf's hugely successful "Hail Mary" play, the sudden and clandestine shift of coalition ground forces by air to the Saudi Arabian-Iraqi border well to the west of Kuwait. The SWO sent an observing team to Rafha, where the aircraft transporting the troops were landing, and briefed the Commander of Airlift Forces hourly on weather forecasts for the landing zone. The amount of support required by CENTAF units in the field varied from one base to another, but typically the support consisted of oral, stand-up mission briefings and weather flimsies which pilots could use to brief themselves. Unit teams also provided EOTDAs for situational awareness to deep interdiction and close air support missions.[26]

While most CENTAF Air Force weather teams supported CENTAF's air campaign against Iraq from bases located on the Arabian Peninsula, one four-person (five after 24 January 1991) weather team provided support to a provisional SAC B-52 bomb wing stationed on the island of Diego Garcia. This wing, although removed by 2,000 miles from the Persian Gulf theater, participated in the air campaign against Iraq. The weather team furnished various kinds of weather information to wing operational planners, including wind and electro-optical data, astronomical information such as sun rising and setting times, lunar illumination, and warnings concerning weather hazards and possible

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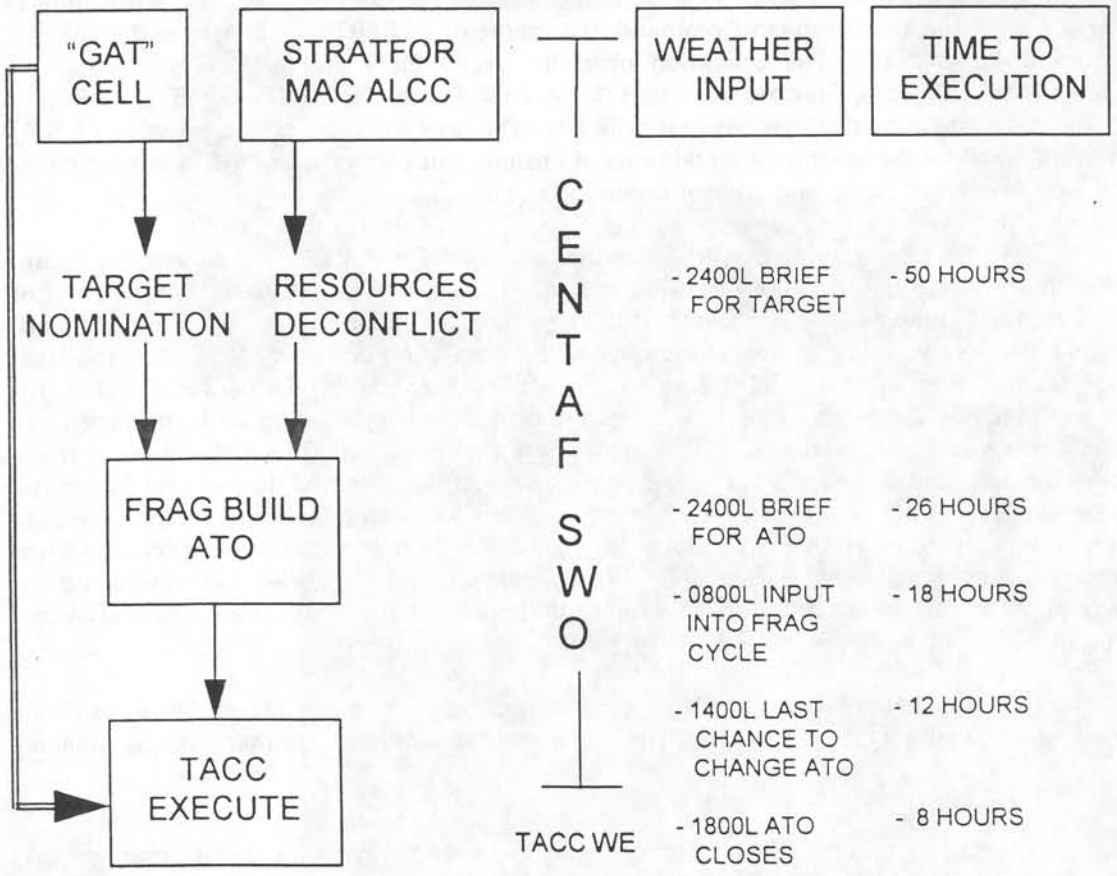
[24]AWS DS/DS Report #2 (S), pp 87-88 (Sec 4.1.3.2-b), info used (U).

[25]AWS DS/DS Report #1 (S), pp 14-15 (Sec 5.2.1, Fig 8), info used (U).

[26]AWS DS/DS Report #1 (S), pp 19, 22 (Secs 5.2.2, 5.2.2.2.1, 5.2.2.2.2, 5.2.2.2.3), info used (U); AWS DS/DS Report #2 (S), p 88 (Sec 4.1.3.3-d), info used (U).

CENTAF PLANNING CYCLE

Schematic of the target nomination, planning, and execution cycle with key weather input points.



SOURCE: AWS DESERT SHIELD/DESERT STORM Report #1 (S), p 15 (Fig 8), info used (U).

Figure VI-5

radar ducting. The team also briefed the wing battle staff daily, presented from two to four take-off briefings each day, and operated the TPS-68 tactical radar AWS had sent to the island.[27]

Support to Operation PROVEN FORCE

AWS also supported DESERT STORM from outside of the Persian Gulf theater by providing weather support for Operation PROVEN FORCE, a joint operation directed by the US Joint Chiefs of Staff and conducted by the US European Command in support of DESERT STORM from Turkey and the eastern Mediterranean Sea. The operation officially began on 7 January, 1991, when the Commander in Chief, US Forces, Europe, activated Joint Task Force, PROVEN FORCE (JTF-PF), at Ramstein AB, Germany, pending deployment to Incirlik AB. The task force consisted mostly of US Air Force aircraft and personnel drawn from several units in Europe, but also included Navy carrier-based planes as well as a few small Army and special operations units.[28]

A total of 23 AWS personnel deployed to Turkey for PROVEN FORCE. All except four came from the 2d Weather Wing (three from the 5th Wing's 5th Squadron, one from the 3d Wing). The first seven deployed on 14 January; all except two had deployed by 18 January. The 2d Wing regularly operated a peacetime base weather station at Incirlik. At the beginning of PROVEN FORCE, the base weather station team (Detachment 19, 31st Weather Squadron) consisted of 14 persons. When the JTF-PF deployed to Incirlik, the wing appointed one of the officers it was sending with the task force to augment the base weather station staff. Eleven of the other 2d Wing JTF-PF deployees (seven officers, four forecasters) supported the Air Force component of the joint task force; one forecaster (the 3d Wing deployee) directly supported SAC operations. The remaining ten weather personnel (4 officers, 5 forecasters, one observer) who deployed with the JTF-PF supported the Air Force and Army special operations forces which were part of the JTF-PF. Half stayed at Incirlik, half (including the three deployees from the 5th Squadron) went to a forward operating base. Lieutenant Colonel Robert Allen served as the OIC of the JTF-PF WSF.[29]

The OICWSF monitored the Incirlik base weather station as well as the JTF-PF WSF, but tried to keep their functions distinct and separate. The base weather station's primary responsibilities

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[27]Msg (S), OL-D, 1690WGP/OIC to CENTAF Weather, et al, "DESERT SHIELD/DESERT STORM AAR," 8 parts, 210801Z-210808Z Mar 91, info used (U).

[28]Msg (S), Ops Support Ctr/JTF PROVEN FORCE/J6 to USEUCOM/ECJ6 DT, et al, "Activation of Joint Task Force PROVEN FORCE J6 Staff (U)," 081147Z Jan 91, info used (U); msg (S), Ops Support Ctr/JTF PROVEN FORCE JTFCS to USCINCEUR ECJ6/SPACUS, et al, "JTF PROVEN FORCE SITREP 001 8 Jan 91 (U)," 081800Z Jan 91, info used (U); msg (S), 2WW/CAT to USCINCCENT Weather, et al, "PROVEN FORCE Issues (U)," 091830Z Jan 91, info used (U); msg (S), CJCS to USCINCEUR, et al, "PROVEN FORCE Support (C)," 170418Z Jan 91, info used (U); msg (S), 2WW/DOX to AWS/DOJ, et al, "PROVEN FORCE After Action Report (U)," 230800Z Apr 91, hereafter cited as 2WW PROVEN FORCE AAR (S), Sec 1 (p 1), info used (U).

[29]2WW PROVEN FORCE AAR (S), Sec 2 (pp 1-2), info used (U). For the names of all except two of the 23 AWS persons who deployed to JTF-PF, see msg (S), 2WW/CAT to HQ AWS/CAT, et al, "PROVEN FORCE Deployed Personnel Status #2 (U)," 202000Z Jan 91, no info used; and 2WW/CAT to HQ AWS/CAT, et al, "2WW PROVEN FORCE SITREP #20 as of 041800Z Feb 91 (U)," 041800Z Feb 91, no info used.

continued to be providing support for the base itself, local missions, and transient aircraft. The JTF-PF WSF, on the other hand, provided support mostly to the composite air wing (provisional) formed at Incirlik for PROVEN FORCE and the special operations units at Incirlik and the forward operating base. The weather team at the composite wing provided weather support for the planning, enroute, and execution stages of the wing's combat missions.[30]

The JTF-PF WSF regularly briefed the JTF-PF and the JTF-PF Air Force staffs--at first daily, but later 3 and 5 days a week, respectively. It also furnished a number of weather products, including a twice-daily planning flimsy, a daily 0- to 72-hour planning weather forecast for JTF Operations and the TACC's Air Tasking Order shop, a daily nephanalysis, a mission flimsy for each aircraft launch, and terminal aerodrome forecasts for the special operations forward operating base four times daily. To assist it in developing these products, the WSF was able to utilize centralized products it obtained from AFGWC, the DSFU, and from a few non-AWS sources. Probably the WSFs single most useful product was forecast wind profiles. The JTF-PF special operations weather team gave daily briefings to the JTF-PF special operations staff and personnel at the Army special forces operating base at Incirlik and forward operating location. It also provided various kinds of weather products tailored to the needs of its customers.[31]

The PROVEN FORCE WSF began redeployment to home stations a few days after DESERT STORM hostilities ended on 28 February. The first of its members to depart, two officers and two forecasters, left Incirlik on 5 March. All 23 USAF personnel had redeployed by 18 March.[32]

Support to the US Central Command Army Forces

Deteriorating weather, the movement of US Army forces into offensive positions, and eventually the ground war itself dramatically increased the demands upon the ARCENT WSF for weather products and forecasts in January and February 1991. ARCENT Weather's briefing requirement rose from two to four per day on 23 January: one for General Yeosock and his staff in the morning, two for intelligence support, and one for target assessment. Three days later the ARCENT SWOs began to brief the Operations and Intelligence Center at the twice-daily shift change times. ARCENT Weather's briefing load reached its peak of seven per day on 24 February when General Yeosock began to require an early evening (1700 local time) weather update in addition to the morning briefing. All the briefings included a synoptic discussion, a 24-hour plain language forecast for the operational theater, a light data slide portraying the periods of high and low risk for using night vision

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[30]2WW PROVEN FORCE AAR (S), Sec 1 (pp 1-2), info used (U).

[31]2WW PROVEN FORCE AAR (S), Sec I (pp 2-3), Sec II, (p 4), Sec III (pp 1-2), info used (U); msg (S), 2WW/CAT to HQ AWS/CAT, et al, "2WW PROVEN FORCE SITREP #31 as of 151730Z Feb 91 (U)," 151830Z Feb 91, info used (U); msg (S), 2WW/CAT to AWS/CAT, et al, "PROVEN FORCE Strike Products Verification (U)," 272130Z Feb 91, info used (U).

[32]Msg (U), 2WW/CAT to HQ AWS/CAT, et al, "2WW PROVEN FORCE SITREP 47 as of 051730Z Mar 91," 061730Z Mar 91; msg (U), 2WW/CAT to HQ AWS/CAT, et al, "2WW PROVEN FORCE SITREP 53 as of 181600Z Mar 91," 181600Z Mar 91.

goggles, and, beginning 17 February, a weather effects matrix (including a red-yellow-green forecast) for the theater.[33]

ARCENT Weather also provided other types of support to the Headquarters ARCENT staff during DESERT STORM. For instance, it supplied a detailed climatological analysis of the KTO to the Army's 513th Intelligence Brigade. The brigade used the analysis in developing a detailed Intelligence Preparation of the Battlefield document as part of the planning for the ground war. It also issued a 72-hour plain-language forecast for Riyadh, Dhahran, and King Khalid Military City twice every day, and a 72-hour plain-language forecast for southern Iraq and the KTO once each day. In addition, ARCENT Weather advised the ARCENT staff as to the weather impacts on electro-optical reconnaissance operations, which at times persuaded intelligence collection managers to change to collection systems that were not dependent upon weather.[34]

ARCENT Weather's responsibilities included not only planning support to Headquarters ARCENT, but also direct support to subordinate weather teams. Most importantly, it supplied them with the TOAF, but it also sent them the weather packages and chemical downwind messages it provided to the ARCENT staff and issued military weather advisories for specific points in the Army's area of operations. Providing this support, not to mention retaining operational control over the teams, became a major challenge during DESERT STORM. Indeed, maintaining any contact with them at all became difficult, especially after the ground war began. This was because in late January the teams began to "jump" with their customers. When their units jumped, the weather teams had to dismantle their weather station, pack up their weather gear and stow it aboard trucks and other vehicles, and reestablish their station at the new location. Weather teams assigned to Army divisions rapidly advancing into Iraq during the ground war--eleven teams were in Iraq by 25 February--had a hard time keeping up with their units, not to mention finding time to set up their weather equipment before jumping again. Therefore, jumping weather teams usually had to suspend operations for shorter or longer periods of time. During such times they missed out on weather being sent to the field by their corps weather team or ARCENT Weather and could not take and transmit their own weather observations.[35]

To assist weather teams in this situation, the ARCENT Weather NCOIC, Master Sergeant William J. Boyle, developed a special contingency weather package tailored for jumping weather teams. This new product was designed to bring a team back "up to speed" as soon as possible by filling its data gap and apprising it of current and forecast weather conditions. It consisted of the past weather picture, the current and forecast synoptic situation, a 12-hour forecast for the team's new location, and the latest position of all weather teams in the ARCENT operational area. Having prepared as much of the package as it could in advance, ARCENT Weather had it ready to send out as soon as a team

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[33]AWS DS/DS Report #1 (S), p 24 (Sec 5.3.1), info used (U); ARCENT SWO AAR (U), pp 7-8 (Sec I-3c), Atch I-2-3.

[34]AWS DS/DS Report #1 (S), p 24 (Secs 5.3, 5.3.1), info used (U); AWS DS/DS Report #2 (S), p 90 (Sec 4.1.4.2), info used (U).

[35]AWS DS/DS Report #2 (S), p 90 (Sec 4.1.4.2), info used (U); ARCENT SWO AAR (U), pp 7-8 (Sec I-3c); Weaving Intvw (U), pp 24-25; Campbell Intvw (U), pp 21-22, 26. For an account of weather team operations during the jumping process from the perspective of a jumping weather team, see Bridges/Bullard Intvw (U), pp 13-19; and McDonald/Spendley Intvw (C), pp 25-27, no info used (U).

reestablished communication. This proved to be of real help to the jumping weather teams. ARCENT Weather issued its first contingency weather package on 26 January.[36]

In return, jumping weather teams took weather observations whenever possible and did their best to get them to their corps team or to ARCENT Weather. Their efforts to transmit the observations were hampered not only by the disruption in communications capability caused by the jumps, but also by the radio silence frequently imposed by ARCENT. In some cases, however, the Army Signal Corps helped them out by providing access to corps, division, and regimental AUTODIN circuits. In spite of the handicaps under which its weather teams worked, ARCENT Weather received 812 observations during the 4 days of the ground war (the first on 24 February from the weather team of the 101st Air Assault Division), 84 percent of which came from jumping teams.[37]

Meanwhile, both jumping and stationary weather teams performed to the best of their ability their first responsibility, which was to support the commander of the Army unit to which they were attached. For this they normally relied primarily on the TOAF. Jumping weather teams, however, blended the information they received in the contingency weather package with the data they got in the TOAF. Army weather teams continued to support their units with the usual weather briefings and weather flimsies as well as 24-, 48-, and 72-hour forecasts. They kept their commanders apprised of current and changing weather conditions and most also informed them of weather impacts on upcoming operations, generally in a graphic form using the red/yellow/green format. Teams with aviation brigades also provided EOTDA support.[38]

On occasion, especially during the ground war, Army weather teams were able to provide their commanders with weather "windows of opportunity" that would help them to accomplish their objectives. For example, the 101st Air Assault Division's weather team informed its commander that weather would be favorable for a helicopter assault into the Tigris-Euphrates Valley deep inside Iraq from early afternoon on 26 February until 0000 local time on the 27th, at which time fog would begin to form. This came after the commander had postponed the operation both in the evening of the 25th and the morning of the 26th based on the team's predictions of unfavorable weather. Relying on the new forecast with its predicted window, the division launched its assault at 1430 on the 26th and successfully completed it before the weather again deteriorated.[39]

The XVIII Corps also successfully used a window of opportunity to which it was alerted by its weather team. On 25 February the corps wanted to immediately launch a helicopter mission to rescue a long-range surveillance team deployed in Iraq beyond the front lines which, because its position was compromised, requested extraction. The XVIII Corps SWO, Major Conley, and a forecaster, Technical Sergeant Paul A. Strickler, however, advised delaying the search and rescue effort because of cloud cover, high winds, and poor visibility at the team's location. The front containing the clouds, they

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[36]AWS DS/DS Report #2 (S), pp 90-91 (Secs 4.1.4.2, 4.1.4.4), info used (U); AWS DS/DS Report #1 (S), p 25 (Sec 5.3.2), atch 3, info used (U); ARCENT SWO AAR (U), pp 7-8 (Sec I-3c), Atch I-2-3; Frederick Intvw (U), p 15.

[37]AWS DS/DS Report #1 (S), p 25 (Sec 5.3.2), info used (U); ARCENT SWO AAR (U), p 7 (Sec I-3c), Atch I-2-3.

[38]AWS DS/DS Report #1 (S), p 25 (Sec 5.3.2), info used (U); ARCENT SWO AAR (U), p 8 (Sec I-3c); Campbell Intvw (U), p 19.

[39]AWS DS/DS Report # 1 (S), p 31 (Sec 6.3-d), info used (U); ARCENT SWO AAR (U), p 8 (Sec I-3c); Capt M.H. McDonald in McDonald/Spendley Intvw (C), pp 27-30, info used (U).

predicted, would move to the east in a few hours (it turned out to be four) and as it did so, the sky would clear and the winds would die down. When the front passed, the helicopters could fly due north and approach the team's position from the west while using the trailing edge of the cloud bank associated with the receding front as cover for the infiltration and extraction. The forecast was exactly accurate and the mission was successful. When the mission pilots returned, they made it a point to come to the corps weather station and state, "You guys get credit for that save."[40]

Both ARCENT Weather and Army weather teams in the field furnished their customers with weather information applicable to what were perhaps their three primary, weather-related concerns--chemical warfare, trafficability, and flying weather. All during DESERT STORM coalition ground forces lived with the fear that Iraq might launch a chemical attack against them. As it turned out, Iraq never did, if only because the weather, meaning primarily the prevailing northwest winds, made it risky. Not knowing this, Army units were always eager to receive the daily chemical downwind messages provided by their weather support teams predicting, based on wind and temperature data, the likely dispersion characteristics of chemical agents for the next day. They also wanted to know terrain features and weather conditions that would impede movements of tanks, vehicles, and personnel since the outcome of battle might well hinge on these factors. Weather teams provided vital support to Army combat engineers in this area. Given the Army's dependence on helicopter support, Army units, aviation brigades in particular, needed information concerning weather effects on helicopter operations. Here again, their supporting weather teams were able to help them.[41]

Support to US Central Command Special Operations Forces

SOCCENT Weather's support to the SOCCENT staff did not change with the coming of DESERT STORM. It continued to provide briefings and planning forecasts. The AFSOC weather team's work, however, increased during DESERT STORM as it began to prepare two alert packages each day in support of combat search and rescue missions. The package contained a horizontal weather depiction for the area, a plain language forecast, and forecasts for bases of interest. The AFSOC team also supplied wind forecasts for 17 leaflet drops conducted by AFSOC's Psychological Operations Section. The leaflets tried to persuade Iraqi troops to surrender. In addition, an AFSOC forecaster accompanied a psychological operations team to the Iraqi border to observe wind readings, using a Marwin upper air sounding system which he took with him, and make short-term forecasts to enhance the accuracy of the leaflet drops. During January and February 1991 the AFSOC weather team provided a total of 994 flight support briefings. Meanwhile, the weather team of ARSOC's 5th Special Forces Group furnished support for the wartime operations of its unit.[42]

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[40]AWS DS/DS Report #1 (S), pp 31-32 (Sec 6.3-e), info used (U); Frederick Intvw (U), p 15; Weaving Intvw (U), p 29; Conley Intvw (U), pp 10-11.

[41]Conley Intvw (U), pp 4-6; AWS DS/DS Report #2 (S), p 90 (Sec 4.1.4.2), info used (U); Weaving Intvw (U), p 30.

[42]AWS DS/S Report #1 (S), p 25 (Secs 5.4, 5.4.1, 5.4.2), info used (U); AWS DS/S Report #2 (S), p 94 (Sec 4.1.5.2), info used (U); msg (S), USCINCCENT Weather to 5WW/CAT, et al, "Weather Support Impacts on Leaflet Drops--DESERT STORM (U)," 121250Z Mar 91, info used (U); Capt W.J. Spendley in McDonald/Spendley Intvw (C), pp 8-9, info used (U).

An AWS special operations weather team tactical element deployed by AWS to the Persian Gulf during DESERT SHIELD also played a small role in the Gulf War. It began DESERT STORM under the operational control of the 1723d Special Tactics Squadron with the responsibility of providing weather support to combat search and rescue missions from forward operating locations. However, since there were few aircraft losses during the air campaign and, consequently, little need for search and rescue missions, SOCCENT changed the tactical element's focus. In early February it directed the element to deploy with the 1723d Squadron to airfields occupied by coalition ground forces during the anticipated ground campaign and provide the initial weather support from these airfields. On 28 February, the tactical element arrived with elements of the 1723d at Kuwait City International Airport, liberated by US Marines two days earlier, and immediately began taking weather observations and passing them back to AFSOC via SOCCENT.[43]

Wartime Experiences

Living Conditions

Most CENTAF weather support teams continued to work and live in the same facilities and under the same conditions during DESERT STORM that they had during DESERT SHIELD. For most Army support weather teams, however, it was a different story, especially in respect to living conditions. Their living conditions, very austere to begin with, became worse when their Army units moved into tactical assembly areas in northern Saudi Arabia along the Kuwait and Iraq borders during the air campaign phase. Each person now received a "shelter half," or half-tent. Two of these together created a tent of sorts which was big enough for only one person to sleep in--the idea being that two people would share the tent and sleep in shifts. The tents blew down easily and did little to shelter an individual from rain or blowing sand and dust. Many persons just tried to get by with their shelter half or slept out in the open covered only by a poncho. In short, most Army weather teams lived out in the open without much in the way of shelter.[44]

For the Army weather teams rapidly advancing into Iraq with their units during the four-day ground campaign, conditions only got worse. For the most part they lived out of vehicles and slept on the ground. It now even became difficult to find time to rest and sleep. The teams carried their weather equipment in their vehicles or on their backs, and usually had to set it up out in the open--on those occasions when their units stopped long enough for them to even unlimber their equipment. The 1st Infantry Division (Mechanized)-Main (i.e., headquarters) team, however, operated out of a mini-weather station it had set up in its 5-ton van.[45]

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[43]AWS DS/DS Report #2 (S), pp 94-95 (Sec 4.1.5.2-b), info used (U); atch 6 (U), "TE Events in Planning and Executing Ground Campaign Support," to ARCENT SWO AAR (U).

[44]Capt M.H. McDonald in McDonald/Spendley Intvw (C), pp 18-21, info used (U).

[45]Capt M.H. McDonald in McDonald/Spendley Intvw (C), pp 30-31, info used (U); Weaving Intvw (U), p 32; see above, Chapter II, pp 30-31. For an account of conditions with the 1st ID(M) during the 4 days of the war, see Bridges/Bullard Intvw (U), pp 17-29.

Exposure to Wartime Dangers

CENTAF weather support teams, for the most part, did not experience additional danger as a result of the war. Many were stationed at air bases far from the combat area and generally did not have to fear enemy attack. CENTAF Weather, as well as the other two headquarters weather units and any weather teams located in and around Riyadh, along with the teams near Dhahran, however, were exposed to Iraqi Scud missile attacks. Twenty-six of the missiles fell on Riyadh alone. The attacks occurred most often during the first two or three weeks of the air campaign and usually during the night, thereby disrupting both work and sleep. When Scud alerts sounded, personnel had to don chemical protective gear and proceed to bomb shelters. Once a Scud shot down by a US Patriot anti-missile battery landed a block away from the RSAF Building in Riyadh where CENTAF Weather was located, knocking plaster from the ceiling of the DSFU room on to the head of the QRCT operator. At another time a Patriot battery intercepted a Scud right over the building. Captain Dickey, OIC of the weather team at Dhahran International Airport, estimated that her team experienced 10 to 12 Scud alerts. On one of these occasions an intercepted Scud plunged to earth only about 50 yards from the hardened F-15 alert hangar where the base weather station was located. It shook the whole facility but did not cause any damage.[46]

On the other hand, most ARCENT weather teams entered dangerous combat areas during the DESERT STORM ground campaign as they advanced into Iraq and Kuwait with the units they supported. The 24th Infantry Division weather team jumped a total of approximately 200 miles in the 100 hours of the ground war as the division swung in a wide arc through Iraq from the Saudi border, around the west and north of Kuwait to the vicinity of Basrah, the Iraqi port city near the head of the Persian Gulf. A member of the 101st Air Assault Division's weather team, Sergeant Charles W. Lindstrom, volunteered to serve as door gunner on the CH-47 helicopter transporting an initial three-man element of the team to the forward operating base the division was establishing approximately 70 miles inside of Iraq. The element was part of the second wave the 101st deployed to the base by helicopter. Although at the time the division had not yet fully secured the base, the sergeant did not have to use his weapon.[47]

The 1st Infantry Division (Mechanized) showed great confidence in Captain F. Paul Bridges, the OIC of the weather team, when during the ground offensive it chose him to lead its entire support element convoy of about 167 vehicles into "the eye of the storm" in chase of the division's tanks and Division-Main rapidly advancing into Iraq. At one point, when the convoy got trapped in cross fire from enemy tanks, the captain quickly circled his convoy and brought them to safer ground. The division commander, Major General Thomas G. Rhame, later was lavish in his praise of the soldiering skills shown by the division's weathermen, saying that "his" Air Force weathermen "out-soldiered" his own soldiers.[48]

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[46]Riley Intvw (S), p 14, info used (U); Campbell Intvw (U), pp 27-28; Capts J.D. Murphy and T.E. Coe in Murphy/Coe/Johnson Intvw (U), pp 20-21; Conley Intvw (U), pp 8-9; Dickey Intvw (U), pp 12-15.

[47]5WW DS/DS Summary Brfg (S), slide (paper copy) 49, info used (U); Capt M.H. McDonald in McDonald/Spendley Intvw (C), pp 25, 31, info used (U); map (U), "The 100-Hour War, Feb. 24-28," Time, p 18.

[48]Note (U), Col W.S. Weaving, USAF (Ret), to W.E. Nawyn, 10 Jan 95.

Captain Bridges, along with one of the members of his 1st Infantry Division weather team, was also involved in what was perhaps the most unique wartime incident involving AWS weather teams. The episode occurred in western Iraq on the last day of the war. Shortly after midday, while his 1st Infantry Division weather team was traveling across the desert with the division's Division-Main following the rapidly advancing main forces of the division, the captain was forced to stop the vehicle in which he and Airman First Class Charles M. Limbaugh were riding because of a broken fuel filter. Captain Bridges ordered the rest of his weather team to continue with the Division-Main convoy while he and Airman Limbaugh attempted to repair their vehicle. Before they could decide what to do, 25 Iraqi soldiers emerged from a nearby bunker, initially causing the two men to fear for their lives. It soon became apparent, however, that the Iraqis merely wanted to surrender. Captain Bridges and Airman Limbaugh accepted their surrender and, after fixing their vehicle by installing a usable fuel filter they found in an abandoned vehicle nearby, told the Iraqis to wait near the road until someone came to get them. Proceeding on, the weathermen reached the Division Main, which had come to a halt about 1600, where they immediately reported the "capture" to the military police. The police then went back and picked up the "prisoners." In a similar incident, two other Iraqi soldiers surrendered to the weather team of the 1st Infantry's aviation brigade.[49]

The day before they "captured" the 25 Iraqi solders, Captain Bridges and Airman Limbaugh, along with two other men of the Division-Main weather support element, Staff Sergeant Duane P. Bullard and Airman Mark V. Thompson, experienced a momentary scare when temporarily stranded in Iraq a short distance west of Kuwait due to a battery fire in the 5-ton van that served as the team's weather station. The weathermen managed to put out the fire, caused by bouncing across the roadless desert at speeds up to 50 miles per hour as part of the Division-Main convoy trying to catch up with the rapidly advancing main forces of the division, and get the batteries working again. However, while they worked on the van two US Air Force F-15 jet fighters returning from a mission over Iraq spotted the men and their vehicles (the van and Captain Bridges' vehicle) and circled overhead. One of the F-15s then began what appeared to be a strafing run, but at the last moment veered off when apparently the pilot recognized the vehicles as American. During this same time one of two Apache helicopters flying over also seemed ready to launch an attack, but it, too, left without doing so.[50]

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[49]Rprt (U), Capt F.P. Bridges, Det 19, 1690WGP/OIC, to ARCENT SWO, "Initial After Actions Report," 6 Mar 91, para 7 (also found in atch 5 (U), excerpts from rprt, Det 19, 1690WGP to ARCENT SWO, "Initial After Actions Report," 6 Mar 91, to ltr (U), Weaving to Collens, 15 Apr 91, w/6 atchs); Capt F.P. Bridges in Bridges/Bullard Intvw (U), pp 25-27; ltr (U), 1690WGP/CV to 5WW/DO, "Weather Support To DESERT SHIELD/STORM," 6 Mar 91.

[50]Rprt (U), Capt F.P. Bridges, Det 19, 1690WGP/CC, to ARCENT SWO, "Initial After Actions Report," 6 Mar 91, para 6 (also found in atch 5 (U), excerpts from rprt, Det 19, 1690WGP to ARCENT SWO, "Initial After Actions Report," 6 Mar 91, to ltr, Weaving to Collens, 15 Apr 91); SSgt D.P. Bullard in Bridges/Bullard Intvw (U), pp 20-21.

Technical Accuracy of Forecasts

Accuracy of Initial DESERT STORM Forecasts

The forecast that CENTAF Weather provided General Horner on the afternoon of 16 January for the start of the air campaign, scheduled to begin less than twelve hours later, was very accurate. It predicted there would be no significant weather (scattered clouds at 8,000 feet and light southwest winds at 3 knots), except for some fog in low-lying river areas. Based on pilot reports, the forecast verified except for the formation of some patchy fog west of Baghdad toward morning that prevented attacking aircraft from hitting a few primary targets during the last wave of air strikes for the night.[51]

The initial forecast for the ground war, however, was less accurate. The weather proved to be considerably worse than forecasted. The latest JOAF prior to the attack (issued at 1500 local time on 23 February) predicted an 8,000 foot ceiling, 5 knot southeast winds with gusts up to 15 knots, and 2 miles visibility with smoke and haze until 0800 local time, 3 miles thereafter, for the KTO on 24 February. It also indicated the possibility of thunderstorms and rainshowers "in the vicinity" until 0700 local time. In actuality, the ceiling was 1,000 feet, the winds strong at 15-20 knots with gusts as high as 35 knots, and visibility only one-half mile in blowing sand. Isolated rainshowers occurred. Clearly, however, even if CENTCOM decisionmakers had known what the weather was actually going to be in the operational theater on 24 February, they would not, on that account, have postponed the beginning of the ground war. The weather still would not have been bad enough to cause delay and, in any event, weather was only one factor weighed in deciding when to attack. Other factors such as political considerations and troop readiness probably carried more weight.[52]

As it turned out, the weather did not impede the advance into Kuwait and Iraq. Indeed, in retrospect, it probably helped the offensive. For example, if the coalition ground forces had moved on clear calm days, they would have lost the element of surprise because the Iraqis could have seen the dust plumes created by the advancing tanks from perhaps as far away as 100 miles over the flat terrain. This would have given them at least a 2-hour warning. Instead, strong winds stirred up the dust, causing, as captured Iraqi tank commanders later confessed, the Iraqis to be unaware of the approach of coalition forces until they heard the tank engines or saw explosions. Moreover, since they would quickly disperse the chemical agents, the strong winds greatly reduced the likelihood of the Iraqis launching a chemical attack, a constant worry of General Schwarzkopf during the ground campaign.[53]

Nevertheless, the question naturally arose as to why the flawed forecast. One answer came from AFGWC. It concluded that an intense cyclogenesis--the first seen in the KTO since the beginning

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[51]Riley Intvw (S), p 32, info used (U); Shaffer/Keefer DESERT STORM Analysis Brfg (S), brfg script, slide (paper) 26, info used (U); memo (U), HQ 5WW to AWS/DO, "Answers to AWS/CC Questions on OPVER Briefing," 13 Mar 91; 5WW DS/DS Summary Brfg (S), slide (paper) 37, info used (U).

[52]Shaffer/Keefer DESERT STORM Analysis Brfg (S), brfg script, slide (paper) 27, info used (U); memo (U), HQ 5WW to AWS/DO, "Answers to AWS/CC Questions on OPVER Briefing," 13 Mar 91; 5WW DS/DS Summary Brfg (S), slide (paper) 48, info used (U); Frederick Intvw (U), p 15; Riley Intvw (S), pp 32-33, info used (U).

[53]Note (U), Col W.S. Weaving, USAF (Ret), to W.E. Nawyn, 10 Jan 95.

of DESERT SHIELD, which forecasters could not have predicted more than twelve hours in advance, was an important factor. It ascribed the cyclogenesis to the conjunction of subtropical moisture streaming into the theater from Africa and an upper air level diffluence of two jetstreams over Saudi Arabia. Colonel Goldey basically agreed with AFGWC, but theorized that the burning oil wells in Kuwait might have contributed to the intensity of the cyclogenesis, not only due possibly to the heat released by the fires, but also the tremendous local increase in condensation nuclei due to the high concentration of smoke from the oil fires.[54]

Operational Verification Policy

AWS did not establish a formal operational verification program in the DESERT SHIELD theater. Indeed, it decided early on in the operation not to require deployed units to verify their forecast products. Important considerations driving this decision were the barely adequate size of the deployed weather teams and, particularly, an earlier decision not to deploy station chiefs. Nevertheless, after the air campaign began, Headquarters AWS, with an eye to documenting the value of weather support after DESERT STORM was over, instructed the 5th Weather Wing to ascertain what deployed units were doing to verify their products. The wing discovered that they were doing very little by way of formally collecting and storing verification statistics, as might be expected given the absence of an operational verification program, and consequently little or no verification data was available. Deployed units, however, often informally obtained a sense of the accuracy of their products by getting feedback from their customers and talking to pilots.[55]

In view of Headquarters AWS's interest in obtaining verification data, the CENTCOM, CENTAF, and ARCENT SWOs, in conjunction with the 5th Wing, now set up a WSF operational verification program applicable to both the headquarters and field levels. Most units, however, did not implement the program, primarily because they had neither the manpower nor the experience to do so while the war was going on and the workload was heavy. The headquarters weather units, however, during DESERT STORM managed to compile accuracy statistics for six types of forecast products: the DSFU JOAF, CENTAF three-day Strategic Planning Cell forecast, ARCENT TOAF, unit-level terminal aerodrome forecasts, EOTDA forecasts, and Operation PROVEN FORCE forecasts.[56]

Verification Statistics for Selected DESERT STORM Forecast Products

The verification statistics collected during DESERT STORM showed forecast accuracy to be generally above 75 percent for forecasts of up to 72 hours. Thus forecasts issued by the WSF were considerably better than "no-skill" or mere "persistence" (i.e., tomorrow's weather will be just like today's) forecasts would have been--about 15 percent better. Moreover, the statistics indicated that

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[54]Shaffer/Keefer DESERT STORM Analysis Brfg (S), brfg script, slide (paper) 27, info used (U); note (U), Col W.S. Weaving, USAF (Ret), to W.E. Nawyn, 10 Jan 95.

[55]AWS DS/DS Report # 2 (S), p 105 (Sec 4.1.7.1), info used (U); ltr (S), 5WW/CAT to AWS/CAT, "DESERT STORM OPVER (U)," 13 Feb 91, w/3 atchs, info used (U).

[56]AWS DS/DS Report #2 (S), p 105 (Sec 4.1.7.2), info used (U).

accuracy improved as the operation went on. Accuracy was more like 85 percent by the end of the war.[57]

The JOAF produced by the DSFU had an overall accuracy rate of 81 percent during DESERT STORM. This far exceeded persistence forecasts, which would have been about 62 percent accurate. DSFU cloud cover forecasts for February alone verified at 87 percent for 20,000 feet ceilings and at 78 percent for 10,000 feet ceilings. CENTCOM Weather planning forecasts provided to the CENTCOM staff were approximately 77 percent accurate for Baghdad, but somewhat less, 70 percent, for the KTO. Persistence forecasts for Baghdad and the operational theater would have been right slightly more than 60 percent of the time. Forecasts that CENTCOM Weather issued for weather reconnaissance missions verified at a high 91 percent.[58]

In the aggregate, the very important 3-day (72-hour), 10,000 feet ceiling forecasts which CENTAF Weather provided for the CENTAF Strategic Planning Cell from 29 January through 28 February were correct 70 percent of the time. Forecast accuracy for the first and second days (24- and 48-hour forecasts), however, increased to 76 and 74 percent, respectively, compared to a persistence forecast accuracy during the same period of 71, 59, and 56 percent for the first, second, and third days. Obviously, the accuracy of CENTAF Weather forecasts for the second and third days far exceeded that of persistence forecasts. (See Figure VI-6.) The 24-, 48-, and 72-hour forecasts for Baghdad specifically were, respectively, 76, 79, and 75 percent accurate. At 67, 70, and 68 percent, respectively, they were somewhat less accurate for the KTO.[59]

From 8 through 28 February, ARCENT Weather verified the TOAF it produced for its Army weather teams both in respect to the two separate versions it issued for the VII Corps and XVIII Corps operational areas (i.e., east and west of 47 degrees east longitude) and to four information categories: ceilings below 3,000 feet, visibility below 4,800 meters, precipitation (yes or no), and thunderstorms (yes or no). The TOAF forecasts for the eastern operational area were approximately 83 percent accurate for 0-12 hours, 82 percent for 12-24 hours, 75 percent for 24-36 hours, and 52 percent for 36-48 hours. For the area to the west of 47 degrees east longitude, the TOAF 12-, 24-, 36-, and 48-hour forecasts verified somewhat better at 82, 71, 71, and 68 percent respectively. Overall, the 24-, 36-, and 48-hour forecasts were well ahead of persistence in accuracy. In terms of specific categories, the TOAF 12-hour forecasts verified at l00 percent for ceilings, 100 percent for visibility, 90 percent for precipitation, and 76 percent for thunderstorms, while its 12- to 24-hour forecasts were 100 percent accurate for ceilings and visibility, 74 percent for precipitation, and 86 percent for thunderstorms. These forecasts, too, exceeded persistence except for ceilings in both time periods and for thunderstorms in the 0-to 12-hour forecasts.[60] (See Figures VI-7 and VI-8.)

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[57]AWS DS/DS Report #1 (S), p i (Exec Sum), info used (U); Frederick Intvw (U), p 14.

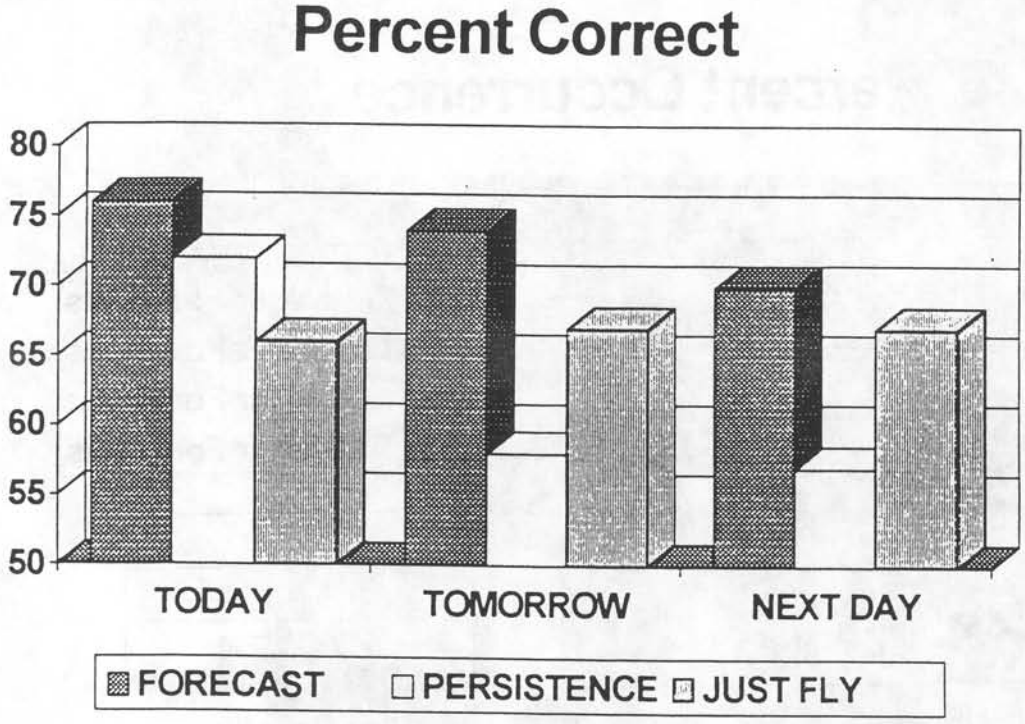
[58]AWS DS/DS Report #1 (S), pp 8-10 (Secs 5.1.1, 5.1.2, Fig 4), info used (U); AWS DS/DS Report #2 (S), p 105 (Sec 4.1.7.2-a), info used (U); brfg (S), 5WW/CAT for HQ AWS, "DESERT STORM Operational Verification," [28 Feb 91], slide (paper) 4, info used (U).

[59]AWS DS/DS Report #1 (S), pp 14, 16-18 (Secs 5.2.1.1, 5.2.1.2, 5.2.1.3, Figs 9,10,11), info used (U); AWS DS/DS Report #2 (S), pp 105-106 (Sec 4.1.7.2-b), info used (U); msg (C), CENTAF Weather to USCINCCENT Weather and 5WW/CAT, "February Operational Verification Results (U)," 041800Z Mar 91, info used (U).

[60]AWS DS/DS Report #1 (S), pp 24-27 (Sec 5.3.2, Figs 15, 16), info used (U); AWS DS/DS Report #2 (S), p 106 (Sec 4.1.7.2-c), info used (U).

AGGREGATE CENTAF PLANNING FORECAST ACCURACY

CENTAF planning forecast accuracy for all locations and all forecast issue times. Forecast is compared to persistence and "just fly" case of always assuming good weather.

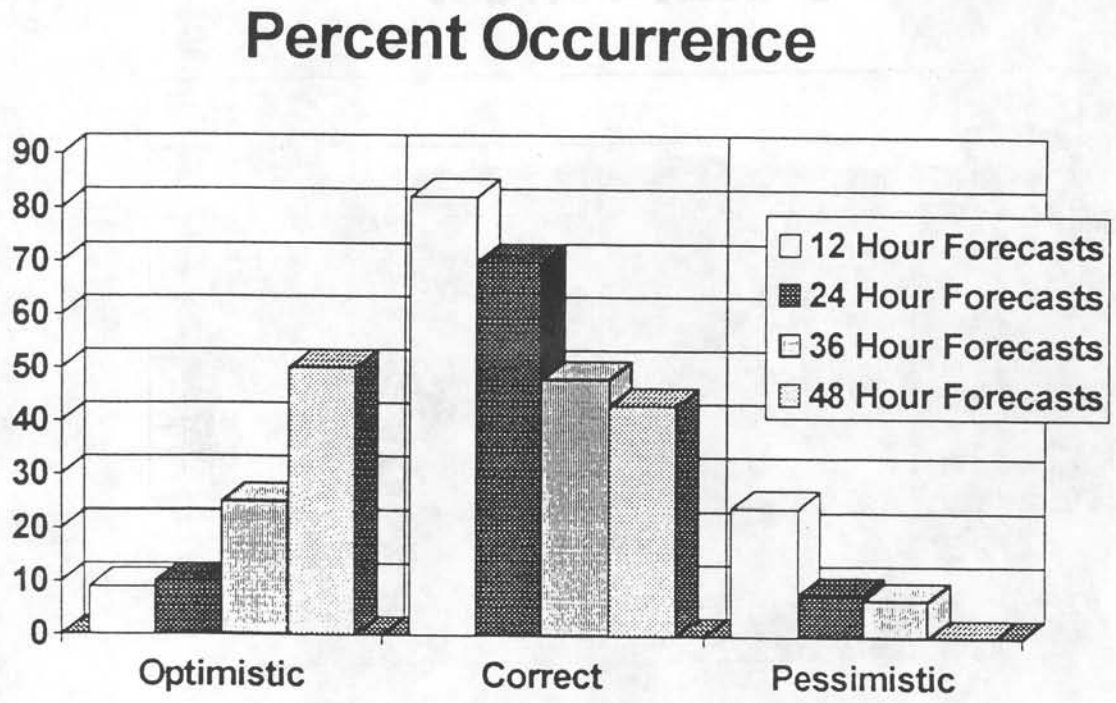


SOURCE: AWS DESERT SHIELD/DESERT STORM Report #1 (S), p 26 (Fig 11), info used (U).

Figure VI-6

ARCENT TOAF
FORECAST ACCURACY - EAST

ARCENT TOAF Forecast Accuracy east of 47° E longitude.

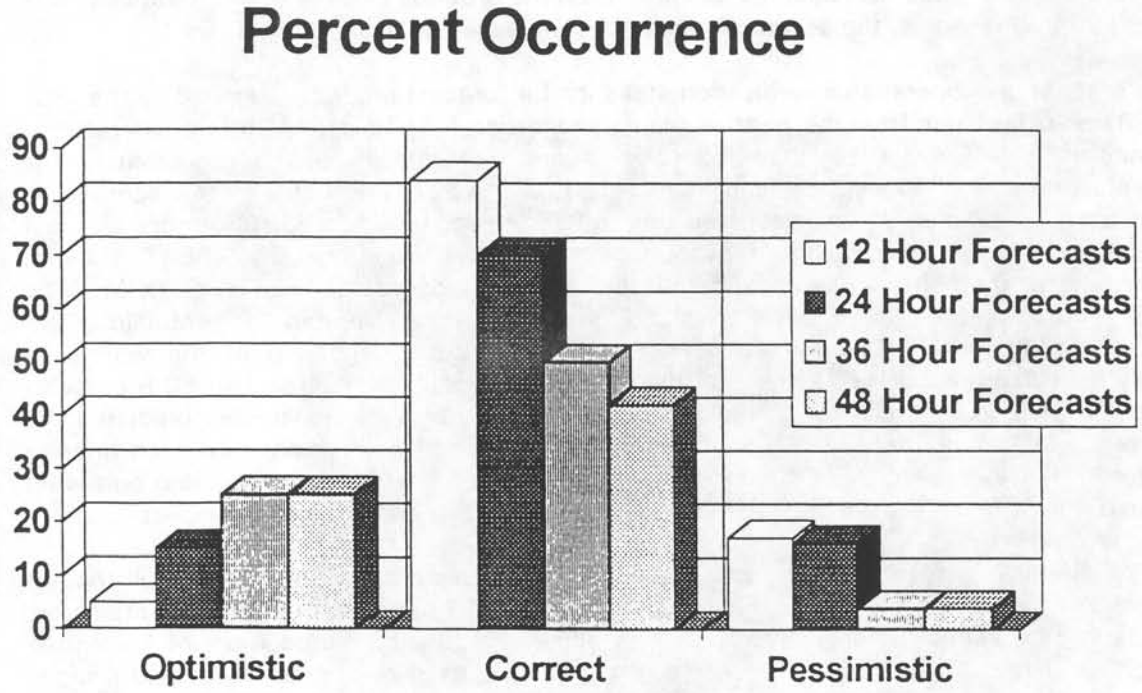


SOURCE: AWS DESERT SHIELD/DESERT STORM Report #1 (S), p 27 (Fig 16), info used (U).

Figure VI-7

ARCENT TOAF
FORECAST ACCURACY - WEST

ARCENT TOAF Forecast Accuracy west of 47° E longitude.



SOURCE: AWS DESERT SHIELD/DESERT STORM Report #1 (S), p 26 (Fig 15), info used (U).

Figure VI-8

The forecast accuracies for the remaining three types of products for which the headquarters weather units in Riyadh collected statistics varied from 76 to 100 percent. CENTAF unit-level terminal aerodrome forecasts verified at 90 percent, as did weather warnings and advisories when the weather teams had enough lead time. Weather warnings and advisories issued by ARCENT weather teams were 83 percent accurate in cases where they had sufficient lead time. Verification statistics for EOTDA forecasts were sparse since demand for mission-specific EOTDAs was very limited. CENTAF weather units verified only 32 EOTDA forecasts (31 for F-111 missions, one for an F-15 mission), all at the beginning of the air war before customers requested the more generic, situational awareness EOTDAs. All 32 were correct. Mission forecasts issued by the PROVEN FORCE WSF from 28 January through 28 February predicting favorable, marginal, or unfavorable weather conditions were correct 76 percent of the time. If, however, forecasts predicting favorable weather conditions when observed conditions were marginal were also counted as correct, on the grounds that marginal conditions were still above go/no go thresholds, the accuracy percentage increased to nearly 87 percent.[61]

Two other sets of operational verification statistics for forecast products supplied by the WSF during DESERT STORM came from the weather teams supporting F-117 "stealth" fighter aircraft and AFSOC. Since the F-117 was a new, high interest weapons system being tested in combat for the first time, the six-person F-117 support team (one officer, two NCOs, and two airmen) recorded its forecasts for each F-117 mission and debriefed the crew after each. Consequently, more forecast verification data existed for this weapons system than any other employed in DESERT STORM. Mission forecasts for the F-117 improved dramatically during the course of DESERT STORM. The coordinated products of the F-117 SWO, First Lieutenant Norman R. Modlin, and Lieutenant Colonel Riley at CENTAF Weather, the forecasts at the beginning of the war were approximately 60 percent accurate; by the end their cumulative accuracy had reached 80.5 percent. Put differently, in their joint forecasts, Lieutenant Modlin and Lieutenant Colonel Riley predicted the weather correctly in 103 of the 122 weather briefings delivered by the former, with each briefing covering 8 to 10 missions. The AFSOC support team ascertained that its wind direction and wind speed forecasts for SOCCENT's leaflet drop missions verified at 94 and 98 percent respectively.[62]

AFGWC's analysis of the medium- and extended-range forecasts for the Persian Gulf theater it issued from 24 December through 28 February also provided operational verification statistics. These forecasts, as indicated before,[63] were not very accurate. For the period from 24 December 1990 through January 1991, AFGWC's 4- to 7-day weather charts put weather fronts and troughs within 3 degrees of their actual locations only one-third of the time and pressure centers only one-fourth of the time. During the same period, however, cloud cover predictions in discussion bulletins were 67 percent accurate.[64]

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[61]AWS DS/DS Report #2 (S), p 106 (Sec 4.1.7.2-d,e,f), info used (U); brfg (S), 5WW/CAT for HQ AWS, "DESERT STORM Operational Verification (U)," [28 Feb 91], slides (paper) 8,13, info used (U); AWS DS/DS Report #1 (S), pp 22-24 (Secs 5.2.2.2.2, 5.2.2.2.4, Fig 23), info used (U).

[62]AWS DS/DS Report #2 (S), pp 62 (Atch 4), 73 (Atch 7), info used (U); AWS DS/DS Report #1 (S), pp 19-21 (Sec 5.2.2.2.1, Figs 12, 13), 25 (Sec 5.4.2), info used (U); memo (U), [HQ 5WW/CAT] to AWS/DO, "Answers to AWS/CC Questions on OPVER Briefing," 13 Mar 91; telecon (U), W.E Nawyn with Col G.F. Riley, AWS/XO, 31 Jan 95. Lieutenant Modlin was from Det 8, 25WS.

[63]See above, Chapter IV, p 75.

[64]Atch 1 (U), "Initial Verification Package," to ltr (U), AFGWC/CAT to AWS/CAT, "Extended MRF Verification," 6 Feb 91, w/ 1 atch.

In its analysis of statistics for 1-15 February, AFGWC included its 7- to 10-day extended medium-range as well as its 4-to -7 day medium-range forecast. During this period the forecast accuracy for fronts and troughs was 45 percent and for pressure centers 34 percent. Cloud cover forecasts were 47 percent accurate for the 4- to 7-day period and 32 percent for the 7- to 10-day period. Precipitation forecasts were accurate 20 percent of the time in the medium-range forecasts, only eleven percent in the extended medium-range forecasts. AFGWC added statistics for the 11- to 15-day extended outlook to its analysis of the last half of February. In general, accuracy percentages declined for this period. Predicted front and trough locations were within 3 degrees of actual locations only 18 percent of the time, pressure centers only 15 percent. Cloud cover accuracy slipped to 21 percent overall (23 for 4- to 7-day, 28 for 7- to 10-day, 16 for 11- to 15-day). Precipitation forecasts overall were 11 percent accurate (18, 5, and 10 percent for the three forecast periods).[66]

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[66]Atch 1 (U), "MRF Verification," to ltr (U), AFGWC/DO to AWS/CAT, "February 1991 MRF Verification," 4 Mar 91, w/1 atch.

CHAPTER VII

POST-HOSTILITIES OPERATIONS AND REDEPLOYMENT

After the Storm

President Bush's declaration of a provisional cease-fire on 27 February (28 February in the DESERT STORM theater) stopped offensive operations against Iraq by coalition military forces, but several weeks elapsed before the Gulf War officially ended. Three days after the President's declaration, General Schwarzkopf and other top coalition commanders met with Iraqi military officials to discuss the terms of the cease-fire. The Iraqis accepted all of the coalition's conditions, which included the immediate release of all prisoners of war and all Kuwaiti civilians held by Iraq and compliance by Iraq with all relevant UN resolutions. In keeping with a demand found in one of these resolutions, Saddam Hussein on 5 March rescinded his annexation of Kuwait.[1]

On 3 April the UN Security Council adopted a resolution proposed by the US and Britain to establish a permanent cease-fire. By so doing, it, in effect, voted to officially end the Gulf War if and when Iraq accepted the terms of the resolution. These terms included requirements that Iraq recognize the previous border between Iraq and Kuwait, "unconditionally" accept the destruction or removal of its nuclear weapons and facilities, chemical and biological weapons and facilities, and ballistic missiles with a range greater than 150 miles. The resolution also reaffirmed an earlier UN resolution stating that Iraq was liable for all losses and damage associated with its invasion and occupation of Kuwait. Although protesting that the terms were unjust, three days later Iraq agreed to accept them. The permanent cease-fire went into effect on 11 April 1991 (12 April in the Persian Gulf), the day Iraq officially accepted the resolution).[2]

Meanwhile, the coalition kept the pressure on Iraq by continuing air patrols and reconnaissance missions over the country and keeping ground forces in southern Iraq. Indeed, at one point (14 March), CENTCOM moved elements of a few Army units back to the cease-fire line as a show of force. However, at the same time the US began to reduce its forces in the Persian Gulf area. The redeployment phase of DESERT STORM officially began on 10 March, although small, symbolic troop withdrawals started on 5 March. By the time the UN adopted the permanent cease-fire resolution on 3 April, US forces in the Persian Gulf theater had already declined from their peak strength of 541,000 to about 370,000 and troops were leaving the theater at the rate of approximately 5,000 per day. By the end of April all Army forces had left Iraq and by mid-June had also departed Saudi Arabia. However, in a small counter-movement, the Army, during late May and early June, deployed a small

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[1]USAF/CAFH DS/DS Chronology (S/WN/NF), p 396, info used (U); art (U), "Bush's Demands," Time, 11 Mar 91, p 25.

[2]USAF/CAFH DS/DS Chronology (SWN/NF), pp 417, 429-430, 433, info used (U); Information Please Almanac, Atlas, and Yearbook, 1992, p 980; AWS DS/DS Report #2 (S), p 281 (App C), info used (U).

force to Kuwait to maintain a temporary American presence there. Meanwhile, as aircraft and personnel redeployed, CENTAF closed most of its bases in the theater; by late June only a few were still in operation.[3]

Neither the Air Force nor the Army had done much advance planning for redeployment; there was no overall redeployment plan. However, some action in this direction began as the end of DESERT STORM loomed. On 1 March, the day after the initial cease-fire went into effect, the CENTAF Commander, General Horner, issued a redeployment concept of operations which expressed the hope that redeployment would occur "in the same professional manner we deployed," announced the establishment of a CENTAF planning cadre, and directed deployed units to establish planning teams "to ensure an orderly...redeployment of your people and resources." The document also laid down "first in, first out" as the general redeployment principle for units to follow.[4]

In actual fact, however, redeployment,although to a large extent adhering to the first in, first out principle, was attended with a good deal of confusion. Units and personnel left at a much more rapid pace than originally envisioned. Most redeployed within three months of the end of hostilities. TAC initially attempted to establish and follow an Air Force redeployment TPFDD, but the TPFDD collapsed under the pressures of the redeployment flood which followed the permanent cease-fire.[5]

Post-War Weather Support Operations

The "combat" experiences of the 1st Infantry Division weather team did not end with the provisional cease-fire. The day it began, Staff Sergeant Bullard, Staff Sergeant John A. Walsh, Sergeant Rodney D. Swirk, and Airman Thompson came under hostile fire from a bunker occupied by Iraqi soldiers who were flying a white flag and presumably waiting to surrender. At the time the three men were on their way in a team vehicle to the 1st Division Aviation Brigade to drop off some mail and obtain some forms. Sergeant Swick, who was driving, immediately began to zigzag across the desert at high speed while the other men locked and loaded their weapons. However, they were soon out of range and neither the men nor the vehicle were hit.[6]

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[3]USAF/CAFH DS/DS Chronology (S/WN/NF), pp 395, 406, 424, info used (U); AWS DS/DS Report #2 (S), p 60 (Atch 3), info used (U); TAC DS/DS Chronology (U), pp 90,95; Capt F.P. Bridges in Bridges/Bullard Intvw (U), p 32; msg (U), USCENTAF/CC to 1TFW Deployed/CC, et al, "Redeployment Concept of Operations," 011255Z Mar 91; msg (S), USCINCCENT Weather to 5WW/CAT, et al, "Weather Support Force SITREP #216 (U)," 291100Z Mar 91, info used (U); msg (S), USCINCCENT Weather to 5WW/CAT, et al, "Weather Support Force SITREP #224 (U)," 070930Z Apr 91, info used (U); note (U), Maj J.A. White, AWS/DO, to W.E. Nawyn, AWS/HO, ca 30 Sep 92; atch 1 (S), "List of Units Still Active (U)," 25 Jun 91, info used (U), to ltr (U), AWS/DO to HQ MAC/XPMO, "Deactivation of Provisional Units," 1 Jul 91, w/2 atchs.

[4]Goldey Intvw (U), p 33; msg (U), USCENTAF/CC to 1TFW Deployed/CC, et al, "Redeployment Concept of Operations," 011255Z Mar 91.

[5]Tkach Intvw (U), pp 19, 21.

[6]SSgt D.P. Bullard in Bridges/Bullard Intvw (U), pp 29-30; rprt (U), Capt F.P. Bridges, Det 19, 1690WGP/CC, to ARCENT SWO, "Initial After Actions Report," 6 Mar 91, Sec 1, Para 9.

The 3d Special Forces Group weather team was among the first Americans to arrive in Kuwait City after its liberation. The team, which had not been directly involved in DESERT STORM operations before, entered Kuwait City with an American military convoy on 28 February. On 2 March four of its members had the honor of participating at the first post-liberation flag-raising ceremony at the American embassy in Kuwait City. Also on 28 February another weather support team deployed with a MAC airlift control element to Kuwait City International Airport.[7]

The AWS WSF continued to provide weather support to its customers as long as they remained operational regardless of where they were. But the quick redeployment pace resulted in a rapid reduction in weather support requirements and, consequently, operations. CENTAF Weather shut down the QRCT network on 15 March and turned over responsibility for transmitting weather data to the weather teams in the theater to the base weather station at Incirlik AB with its "QRCT Plus." The DSFU ceased operations and passed its tactical forecast unit and JOAF responsibilities to AFGWC on 18 March. Two days later the TACC weather team began to function as CENTAF Weather. ARCENT Weather handed off production of the TOAF to the VII Corps weather team on 26 March. By mid-April no more weather teams remained in Iraq; except for the 3d Armored Division team in Kuwait, all were now in Saudi Arabia. CENTCOM Weather shut down following the closure of CENTCOM's headquarters in Riyadh; it sent out its last situation report on 18 April. Two days later CENTCOM redeployed the DMSP van. Colonel Goldey had already wanted it redeployed it in late March, but General Moore, CENTCOM's Director of Operations, would not consent to doing so at that time on the grounds that General Schwarzkopf wanted to continue to receive satellite imagery as long as he remained in the theater. ARCENT Weather closed down on 11 May, following the departure of the VII Corps and the redeployment of Headquarters ARCENT.[8]

Air Weather Service Redeployment and Deactivations

On 8 March Colonel Goldey instructed WSF units to obtain permission to redeploy from him as OICWSF and Commander, 1690th WGP through CENTCOM channels--i.e., through the weather units at CENTAF, ARCENT, or SOCCOM headquarters, and notify 1690th WGP headquarters when

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[7]Weaving Intvw (U), p 34; msg (S), USCINCCENT Weather to 5WW/CAT, et al, "Weather Support Force SITREP 191 (U)," 051000Z Mar 91, info used (U); msg (S), USCINCCENT Weather to 5WW/CAT, "Weather Support Force SITREP 187 (U)," 011330Z Mar 91, info used (U). The four members of the 3d SFG weather team taking part in the flag-raising ceremony were TSgt Frank J. Hall III, SSgt Robert D. Patterson, SSgt Garth A. McCulloch, and A1C Aaron M. Otte.

[8]Msg (S), 5WW/CAT to AWS/CAT, et al, "5WW DESERT STORM SITREP #86--as of 18/2000Z Apr 91 (U)," 182000Z Apr 91, info used (U); Riley Intvw (S), p 34, info used (U); msg (S), USCENTAF/Weather to AIG 571, et al, "Deactivation of CENTAF QRCT Net Control Station and KQ List Freeze (U)," 131200Z Mar 91, info used (U); AWS DS/DS Report #2 (S), p 281 (App C), info used (U); msg (S), USCINCCENT Weather to 5WW/CAT, "Weather Support Force SITREP 191 (U)," 051000Z Mar 91, info used (U); msg (U), CENTAF Weather to 1690WGP BWS/WE, et al, "Weather Support Force Drawdown and Redeployment Information," 200800Z Mar 91; msg (S), USCINCCENT Weather to 5WW/CAT, et al, "Weather Support Force SITREP #211 (U)," 250746Z Mar 91, info used (U); msg (S), USCINCCENT Weather to 5WW/CAT, et al, "Weather Support Force SITREP #235 (U)," 181030Z Apr 91, info used (U); msg (S), 5WW/CAT to AWS/CAT, et al, "5WW DESERT STORM SITREP #85--as of 17/2000Z Apr 91 (U)," 172000Z Apr 91, info used (U); Kelly Intvw (U), p 29; Goldey Intvw (U), p 26; Campbell Intvw (U), p 30.

they would deploy. But this policy was easier stated than implemented and the headquarters sometimes lost track, at least temporarily, of what was going on in the field relative to redeployment. Back in the US, the 5th Wing also did its best to keep track of redeployments, but with the breakdown of the TPFDD process and with decisions as to who redeployed and when they redeployed essentially being made in the theater, it found this, to say the least, very difficult.[9]

Basically, AWS weather teams redeployed when their customers did--Army weather teams redeployed with the units they supported; Air Force weather teams redeployed after the last aircraft stationed at their base returned to its home station. WSF leaders honored the first in, first out principle whenever possible, but sometimes, mostly because of mission commitments, they were unable to do so. On some occasions, however, they reassigned recent deployees to other units so that individuals in those units who had been in the theater for a long period of time could redeploy. AWS also deployed 13 additional people to the Persian Gulf theater in March and early April to replace redeploying personnel or support residual missions.[10]

The redeployment of the DESERT STORM WSF began on 7 March. On this date two weathermen--one a member of a CENTAF weather team, the other of an ARCENT weather team--left the theater as part of the early, small "symbolic" redeployment arranged by CENTCOM.[11] Once begun, the WSF's redeployment, like that of all the other DESERT STORM forces, went extremely fast. Air Force support personnel started returning to the US in significant numbers about mid-March and continued to redeploy on into July. The XVIII Corps weather teams began to leave the theater in the last week of March; the last Army team (a VII Corps team) redeployed in early June. All members of SOCCENT weather teams except one had redeployed by 20 April. By 1 April the WSF had declined from its peak strength of 475 persons to approximately 300. One month later its size had decreased to about 120 and by the beginning of June, less than 50 AWS personnel remained in the Persian Gulf theater. The last person who had served in the WSF prior to the 28 February cease-fire redeployed on 26 July 1991.[12] (See Figure VII-1.)

Lieutenant Colonel Riley, the first top leader of the WSF to arrive in theater, was also the first to redeploy, leaving on 27 March. Major Curtis A. Reutner, who had deployed to the Persian Gulf

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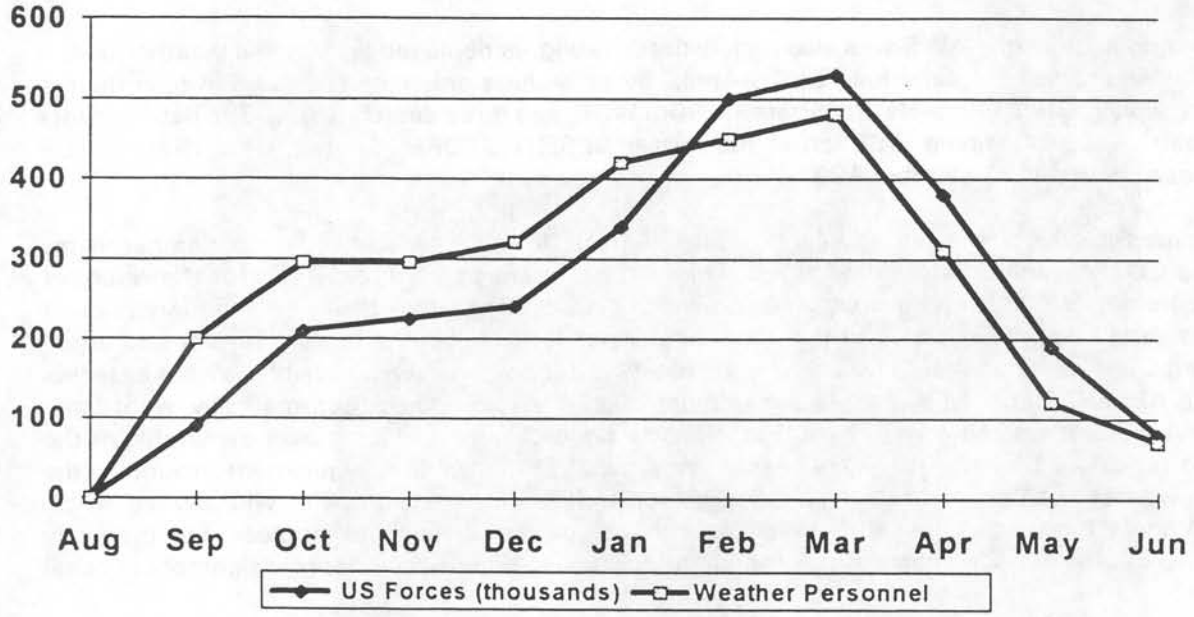
[9]Msg (U), USCINCCENT Weather to COMSOCCENT/J2-SWO, et al, "1690th Weather Group (P) Redeployment Procedures," 081200Z Mar 91; St Onge Intvw (U), p 27; Tkach Intvw (U), p 19; msg (S), 5WW/CAT to 1WW/CAT, et al, "Tentative DESERT STORM Redeployment Plans (U)," 071300Z Mar 91, info used (U).

[10]Tkach Intvw (U), p 20; Campbell Intvw (U), pp 30-31; msg (U), CENTAF Weather to 1690WGP/WE, et al, "Weather Support Force Drawdown and Redeployment Information," 200800Z Mar 91; Goldey Intvw (U), p 34; Riley Intvw (S), pp 34-35, info used (U); Tkach, List of Deployed AWS Personnel (U), Sep 91.

[11]The two weathermen were Staff Sergeant Carl H. Campbell of the base weather station at Dhahran International Airport supporting the 1st Tactical Fighter Wing and Technical Sergeant Richard L. Foster Jr., of the weather team supporting the VII Corps' 1st Armored Division. Tkach, List of Deployed AWS Personnel (U), Sep 91.

[12]AWS DS/DS Report #2 (S), pp 60 (Atch 3), 281 (App C), info used (U); Tkach, List of Deployed AWS Personnel (U), Sep 91; Campbell Intvw (U), pp 30-31. The last pre-March deployee to redeploy was A1C Jerry D. Owen, a member of the residual 1690th WGP weather detachment at Riyadh when he redeployed, but initially part of the weather team supporting SAC operations out of Cairo West AB, Egypt.

NUMBER OF U.S. FORCES AND AWS PERSONNEL DEPLOYED TO DESERT SHIELD/DESERT STORM THEATER 1 AUG 90 - 1 JUN 91



SOURCE: DESERT SHIELD/DESERT STORM Report #2 (S), p 60 (Atch 3), info used (U).

Figure VII-1

theater on 16 March and was currently the TACC SWO, succeeded him as CENTAF SWO and OIC of the CENTAF weather support element and, nominally, CENTAF Weather (it had no personnel left). Colonel Goldey departed only a few hours after Colonel Riley. Command of the 1690th Weather Group and what remained of the WSF now devolved upon several officers in rapid succession. Lieutenant Colonel Weaving, the 1690th's Deputy Commander, took Colonel Goldey's place. Three weeks later, when he redeployed with the main body of Headquarters ARCENT, Lieutenant Colonel Campbell, the OIC of ARCENT Weather and the ARCENT weather support element, replaced him. Upon Colonel Campbell's departure with part of Headquarters ARCENT on 1 May, Lieutenant Colonel Thornberry, the VII Corps SWO, took over until 12 May, when he, too, left. At this point, Major Reutner became the Commander of the 1690th WGP and OIC of the small residual WSF set up to remain in the Persian Gulf indefinitely, a position he kept until he returned to the US on 3 October 1991.[13]

During all this time AWS was also rapidly deactivating its deployed provisional weather units--four by 18 March; 18, or nearly half, by 16 April. By early June only nine remained in operation; a month later only four were left--Headquarters, 1690th WGP, and three detachments. The detachments became part of the sustaining WSF left in the former DESERT STORM theater. The 1690th WGP officially deactivated on 1 October 1991.[14]

Immediately upon the cessation of hostilities, CENTCOM Weather told deployed weather teams supporting CENTAF units that before they redeployed they were to make provision for the return of their meteorological and communications equipment to the US, specifically their home stations, where it could be sorted out and returned to the units that owned it. The 5th Wing went further and urged redeploying CENTAF personnel to take their equipment with them whenever possible. Weather teams supporting ARCENT did not need these admonitions since their equipment automatically went back with their Army unit's equipment. There was initially a good deal of confusion over ownership of the equipment redeployed by the Air Force teams since the WSF had shifted equipment around in the theater to wherever it was most needed, thereby making it hard to keep track of who owned what. The 5th Wing's logistics people, however, took charge of the sorting out process and gradually straightened out the mess, sometimes resorting to the exchange of equipment or reassignment of serial numbers.[15]

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[13]Riley Intvw (S), pp 34-35, info used (U); AWS DS/DS Report #2 (S), p 65 (Atch 7), info used (U); Goldey Intvw (U), pp 32-33, info used (U); Campbell Intvw (U), pp 29-30; note (U), Maj J.A. White, AWS/DOO, to W.E. Nawyn, AWS/HO, ca 30 Sep 92.

[14]Msg (S), USCINCCENT Weather to 5WW/CAT, et al, "Weather Support Force SITREP 204 (U)," 180800Z Mar 91, info used (U); msg (S), USCINCCENT Weather to 5WW/CAT, et al, "Weather Support Force SITREP #233 (U)," 160915Z Apr 91, info used (U); msg (S), 5WW/CAT to AWS/CAT, et al, "Provisional Weather Unit Deactivations (U)," 072000Z Jun 91, info used (U); ltr (U), AWS/DOO to HQ MAC/XPMO, "Deactivation of Provisional Units," 11 Jun 91, w/2 atchs; atch 2 (S), "List of Units Still Active," 25 Jun 91, info used (U), to ltr (U), AWS/DDO to HQ MAC/XPMO, "Deactivation of Provisional Units," 1 Jul 91, w/2 atchs; msg (S), 5WW/CAT to AWS/CAT, et al, "Final 5WW DESERT STORM SITREP #39--12/1700Z Sep 91 (U)," 121747Z Sep 91, info used (U); note (U), Maj J.A. White, AWS/DOO, to W.E. Nawyn, AWS/HO, ca 30 Sep 92.

[15]Msg (U), USCINCCENT Weather to CENTAF Weather, et al, "TACMET and TACCOM Redeployment Policy," 280911Z Feb 91; Grizzle/Brothers Intvw (U), pp 16-17.

The Sustaining Weather Support Force

Although the US rapidly removed its forces from the Persian Gulf theater following the cease-fire, it nevertheless intended to keep a small residual military presence in the region for an indefinite, but presumably limited, period of time. Consequently, CENTCOM and its component commands began almost immediately after the end of the war to make plans for a "sustaining force." AWS, in turn, began to plan for providing weather support to the sustaining force. On 10 May, and again in early June, CENTAF Weather sent the 5th Weather Wing several proposals to serve as a basis for a sustaining WSF concept of operations. On 20 June the 5th Wing issued a concept of operations that provided for a small force of 30-35 persons consisting of eight units (Headquarters 1690th WGP, CENTAF Weather Support Unit, AFSOC weather team, and five detachments) stationed at five locations. The CENTAF SWO would serve as both the OIC of the sustaining force and the in-theater Commander of the 1690th WGP.[16]

The transition from a temporary WSF intended to serve only for the duration of DESERT SHIELD/STORM to a semi-permanent sustaining force occurred largely during June 1991. CENTAF Weather shifted its operations from Riyadh to Dhahran on 22 June. The sustaining force continued to operate at as many as ten locations and its manning remained in the 40s during all of June, somewhat above the planned figures. By mid-July, however, the number of locations and personnel had both settled down to their projected levels.[17]

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[16]Msg (S), USCINCCENT Weather to 5WW/CAT, et al, "DESERT STORM Residual Forces Weather Support Force (U), 061326Z Mar 91, info used (U); msg (S), CENTAF Weather to 5WW/CAT, et al, "Weather Support Concept of Operations (U)," 101145Z May 91, info used (U); msg (S), CENTAF Fwd Weather to Det 30, 1690WGP, et al, [Proposed Manning Movements and Positions,] 041400Z Jun 91, info used (U); msg (S), CENTAF Fwd Weather to Det 30, 1690WGP/WE, et al, "Change One to Manning Movements and Positions (U)," 060800Z Jun 91, info used (U); msg (S), 5WW/CAT to USCENTAF Fwd/WE, "5WW Concept of Operations/Operation DS (Rotation) (U)," 202000Z Jun 91, info used (U).

[17]Msg (S), 5WW/CAT to AWS/CAT, et al, "5WW DS (Rotation) (DESERT CALM) SITREP #3 18/2000Z June 91 (U)," 182100Z Jun 91, info used (U); msg (U), USCENTAF Forward/Weather to USS Nimitz, et al, "Office Relocation," 220830Z Jun 91; msg (U), CENTAF Forward/Weather to 5WW/CAT, et al, "Weather Support Cell Relocation," 261100Z Jun 91; msg (S), 5WW/CAT to AWS/CAT, et al, "5WW DS (Rotation) SITREP #21 15/2000Z July 91 (U)," 152000Z Jul 91, info used (U). For June and July manning figures, see 5WW DESERT STORM SITREPS #117 through #125 (S), 1-13 June 1991; and 5WW DS (Rotation) SITREPs # 1 through #27 (S), 14 June-30 July 1991, no info used.

CHAPTER VIII

LESSONS AND CONCLUSIONS

DESERT SHIELD/STORM stretched and tested AWS in its ability to perform its mission more than any military operation in which it participated since the Vietnam War, which had ended nearly 20 years before. The challenges of the Grenada and Panama contingencies of 1983 and 1989, respectively, paled in comparison. It is not surprising, therefore, that the operation exposed a number of AWS weaknesses and problem areas, and that AWS could have done some things better than it did. But, on the positive side, from the inadequacies it discovered, the problems it struggled with, and the mistakes it made, AWS learned a large number of lessons, lessons it could use to upgrade its capabilities for and improve its performance in future contingencies.

The Value of Weather Support

During DESERT SHIELD/STORM, and particularly the DESERT STORM phase, AWS learned anew that important as weather support was in peacetime, it was far more critical during wartime. Weather support clearly was of value during DESERT SHIELD/STORM. This value, however, was not immediately apparent. Indeed, at the beginning of DESERT SHIELD leaders of the operation were skeptical of the need for weather support. By the end of DESERT STORM, however, they no longer had any doubts about its necessity. The bad weather in January and February 1991 made weather support particularly important for DESERT STORM. Now AWS no longer had to convince Air Force and Army commanders that it had value, they could see this on a day-to-day basis. During DESERT STORM General Horner, the CENTAF Commander, kept a copy of CENTAF Weather's latest day-by-day, long-range forecast in his pocket and the latest satellite imagery always prominently displayed in his warroom. After the operation was over, Brigadier General John F. Stewart, Jr., ARCENT's Director of Intelligence, remarked that weather support was a critical function that had made a major contribution to Army combat power. Weather support functioned as a force multiplier. Forecasts were a key factor in both air and ground war decisions and helped both Air Force and Army commanders to maximize the use of their weapons systems. In short, weather support made a substantial contribution to the war effort.[1]

Satellite imagery was probably the single most valuable weather support product. Providing virtually real time pictures of cloud cover, it was particularly important for air operations. Satellite data helped the CENTAF operations staff to plan the air war and to redirect strike missions to targets with more favorable weather. It also helped Army commanders by, for example, depicting areas of precipitation and blowing sand, and assisted Army terrain analysts in their work. In addition, satellite

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[1]AWS DS/DS Report #2 (S), p 107 (Secs 4.1.7.3, 4.1.7.4), info used (U); Kelly Intvw (U), pp 2-3, 29-30; Goldey Intvw (U), p 31; Riley Intvw (S), pp 35-37, 41, info used (U); Campbell Intvw (U), pp 20, 25-26; Koenemann Intvw (U), pp 29-30; 5WW DS/DS Summary Brfg (S), slide (paper) 53, info used (U); ltr (U), Weaving to 5WW/DO, 6 Mar 91; msg (S), 5WW/CAT to AWS/CAT, "DESERT STORM Weather Impacts (U)," 211459Z Jan 91, info used (U).

imagery enabled CENTCOM leaders to almost immediately find the locations of new oil well fires and determine the direction and speed their smoke was moving and increased the ability of CENTCOM's Intelligence Directorate to select the correct aircraft for reconnaissance (e.g., Scud-hunting) missions.[2]

One of the most important contributions, perhaps the most important, made by weather support was enhancing the effectiveness of air operations. Accurate weather forecasts helped air operations planners to reduce the number of sorties lost to weather by redirecting aircraft from originally planned targets to substitute targets with better weather. Weather forecasts also sometimes prompted operators to switch from guided to unguided weapons systems. An AWS quantitative analysis of weather support value concluded that weather support increased the success rate of both F-117 and F-111 missions, which translated into additional mission effective days for both weapons systems. The analysis also found that with weather support, the Air Force was able to direct more precision-guided missiles against Iraqi targets in the 43 days of the air campaign than it could have without weather support.[3]

Weather support was also a key input into decisions regarding the pace of MAC's successful airlift during the deployment phases of DESERT SHIELD and helped MAC to avoid weather aborts when airlifting the XVIII Corps from near Dhahran to Rafha. Another example of the value of weather support to air operations is found in the assistance weather teams supporting deployed SAC B-52 units provided to their customers in incorporating wind forecasts into flight plans so that B-52 missions could achieve correct time over target and increase their bombing accuracy.[4]

As previously noted,[5] Army commanders on more than one occasion took advantage of weather "windows of opportunity" (openings in low cloud cover or fog) predicted by their weather teams. Army helicopter operations, in general, benefited from weather support. Weather support also was an important factor in the success of several special operations missions.[6]

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[2]AWS DS/DS Report #2 (S), p 161 (Sec 4.5.2-a(7)), info used (U); Weaving Intvw (U), pp 12, 17-18, 26-27; point paper (U), DESERT STORM Satellite Support Lessons Learned, Mar 91; msg (S), USCINCCENT/Weather to 5WW/CAT, et al, "5WW/CAT AI #12-13, DMSP Feedback (U)," 060930Z Jan 91, info used (U).

[3] AWS DS/DS Report #1 (S), pp i (Exec Sum), 28-30 (Figs 17, 18, Secs 6.1, 6.2), 32 (Sec 7), info used (U); Frederick Intvw (U), p 13; Riley Intvw (S), p 33, info used (U); Col T.C. Tarbell in AWTB Intvw (U), p 38.

[4] Telefax (U), USAF/XOWP to AWS/CV, "AWS DESERT STORM Involvement," 13 Jun 91; AWS DS/DS Report #1 (S), pp 30-31 (Sec 6.3), info used (U); msg (S), 5WW/CAT to AWS/CAT, "DESERT STORM Weather Impacts (U)," 211459Z Jan 91, info used (U); telefax memo (U), AWS/CAT to USAF/XOW, [Value of Weather Support,] 28 Feb 91; ltr (S), 3WW/DOJ to AWS/DOJ, "3WW Input to AWS Contributions," 21 Jun 91, info used (U).

[5] See above Chapter VI, pp 137-138.

[6]AWS DS/DS Report #1 (S), p 31 (Sec 6.3), info used (U); Campbell Intvw (U), p 19; ltr (U), 1690WGP/CV to 5WW/DO, "Weather Support to DESERT SHIELD/STORM," Weaving to 5WW/DO, 6 Mar 91; telefax (U); USAF/XOWP to AWS/CV, "AWS DESERT STORM involvement," 13 Jun 91.

Lessons Learned

DESERT SHIELD/STORM may have confirmed AWS's conviction that weather forecasting had value for its customers, but it also taught AWS that there were operational and capabilities areas that needed reassessment and improvement. Taking this basic lesson to heart, AWS began immediately, even before DESERT STORM ended, to take action to ensure that it would not in the future cause or encounter the situations which gave rise to the lessons learned from DESERT SHIELD/STORM.

One of the early problems AWS encountered was the persistence of a "peacetime mentality" among AWS personnel in general and, perhaps more importantly, some senior AWS officers. There was, frequently, a feeling that DESERT SHIELD was basically only a show of force to intimidate Saddam Hussein and that it would be of short duration. Some initial uncertainty as to what the total mission of the deploying DESERT SHIELD force really was contributed to the problem. Consequently, a sense of urgency was sometimes lacking. Some time elapsed before the gravity of the situation became generally apparent and the realization fully dawned that DESERT SHIELD was not just another exercise or peacetime contingency and that herculean efforts in many areas were required. The lesson here, obviously, was that AWS personnel, leaders especially, had to sense more quickly when something was not just "business as usual."[7]

DESERT SHIELD/STORM again validated the lead wing concept, but problems emerged in executing it. While the 5th Wing effectively sourced, deployed, equipped, and sustained the WSF, the lack of a clear delineation between lead wing and Headquarters AWS functions led to a certain amount of overlapping and duplication of effort and a degree of friction between the two levels. According to doctrine, the lead wing was to take the initiative in fielding a functioning WSF and Headquarters AWS was to assist and support it in this effort; in actuality headquarters frequently led and the 5th Wing helped it. This was at least partly because as the operation rapidly expanded the wing became swamped with work and had difficulty in just keeping up with the day-to-day tasks that it had to perform. All this suggested that, first, the responsibilities of Headquarters AWS and the lead wing should be more clearly spelled out and, second, taking full responsibility for a weather support operation in support of a contingency the size of DESERT SHIELD/STORM was beyond the capability of a wing-level organization.[8]

The operation reaffirmed AWS's belief that it was important, indeed essential, to develop plans for responding to possible contingencies long before they happened. But it also reminded AWS that no pre-developed plan could fully anticipate the exigencies of a specific contingency, least of all a massive one such as DESERT SHIELD/STORM. AWS learned anew, therefore, that it had to be flexible in implementing plans, meaning it had to be ready to modify and adapt them to meet the particular circumstances of the contingency. However, it also found that its plans for manning, equipping, and operating a WSF were basically sound, although they could have been better, and that at the very least they provided a good starting point. It should not, therefore, be too quick to jettison "key building blocks"--e.g., basic manning and equipping stipulations--contained in the plans and part of AWS's

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[7]Kelly Intvw (U), pp 3, 5-6; Frederick Intvw (U), p 13.

[8]Kelly Intvw (U), p 4; Frederick Intvw (U), pp 2-4; AWS DS/DS Report #2 (S), pp ii (Exec Sum), 8 (Sec 2.1.3), 16 (Sec 2.2.4), 247 (Sec 10.0-a), 263 (App B), info used (U); 5WW/DO DS/DS Lessons Learned Brfg (U); JULLS Long Report No 32028-47974 (7400040)(U), SAC/DOWXP, "Partial Success of AWS Lead Wing Force Structure Concept," 29 Mar 91, in JEMP Report (S), 29 Mar 91; msg (U), 7WW/CAT to AWS/DOJ, "7WW Lessons Learned," 222125Z Mar 91.

weather support doctrine. Some AWS officials concluded that in DESERT SHIELD/STORM AWS had, perhaps, discarded too much of the original plans and that it would have been better in the long run if AWS had stuck closer to them than it did.[9]

Several weeks into DESERT SHIELD, as the size, scope, and probable duration of the operation became more evident, AWS came to realize that it had deployed too many junior officers and NCOs--wing weather officers instead of detachment commanders, buck and staff sergeants instead of master and senior master sergeants. In other words, it began to see that the experience level of the WSF was too low. But by this time, due to a large extent to the personnel ceilings imposed by USCINCCENT, AWS could no longer do much about it. Fortunately, the force had a few months to train and practice before DESERT STORM began. The green troops learned a lot during that time and were ready for the storm when it came. Nevertheless, the lesson was clear: in future contingencies AWS had to deploy a more experienced WSF.[10]

AWS also derived other lessons from the personnel deployment process. One was that it needed a better system, perhaps a database containing the names of all AWS personnel with their areas of expertise and experience, to identify persons who had skills in certain functional areas so that AWS could deploy people with the particular skills required in the theater by the WSF. Another was that it would have been better to form weather support units in the operational theater from persons deployed from the same home units rather than creating composite units comprised of individuals deployed from various stateside units. The reasoning here was that deployed units would operate more efficiently, at least initially, if they were made up of persons familiar with each other and used to working together.[11]

In addition, AWS found that while the overall manning of the WSF was adequate, if only barely, there were several areas where real shortages existed. AWS did not at first deploy enough persons to man the CENTCOM, CENTAF, and ARCENT SWO staffs, especially the former two. This was due in part to initial miscalculation of manning needs by leaders in the theater, but also by the reluctance of Headquarters AWS to deploy more personnel, even when requested to do so by Colonel Goldey. The imposition of DESERT SHIELD manning ceilings soon made it too late, at least for the time being, for AWS to augment the three staffs. The manning shortage was particularly acute at CENTCOM Weather since the CENTCOM SWO also served as the OIC of the entire WSF. Given the necessity of scrubbing manpower requirements to the minimum, AWS deployment planners had also shortchanged the management area. In order to operate more efficiently, larger units very much needed an NCO with

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[9]Kelly Intvw (U), pp 4, 26-28, 33; AWS DS/DS Report #2 (S), pp 36 (Sec 3.4), 225-226 (Secs 5.3.3, 5.3.4), 264 (App B), info used (U); Col T.C. Tarbell in AWTB Intvw (U), pp 38-39; Tkach Intvw (U), p 24; 5WW/DOX Lessons Learned Listing (U).

[10]Kelly Intvw (U), pp 32-33; AWS DS/DS Report #2 (S), pp ii (Exec Sum), 35-36 (Sec 3.4), 248 (Sec 10.0), 264 (App B), info used (U); Col T.C. Tarbell in AWTB Intvw (U), pp 29-30 (U); Koenemann Intvw (U), pp 9-10; Tkach Intvw (U), p 25; 5WW/DO DS/DS Lessons Learned Briefing (U); JULLS Long Report No 32049-34676 (00049)(U), SAC/DOWXP, "Deployable Detcos," 29 Mar 91, in JEMP Report (S), 29 Mar 91.

[11] AWS DS/DS Report #2 (S), p 232 (Sec 6.4), info used (U); Ridge Intvw (U), pp 3-4; atch 1 (U), "Consolidated List of All Lessons Learned--DESERT SHIELD/STORM," to ltr (U), HQ AFGWC/DO to AWS/DOJ, "AFGWC Lessons Learned," 22 Mar 91; JULLS Long Report No 31231-04449 (00005)(C), SAC/DOWXP, "Weather Experience Data Base Requirement (U)," 29 Mar 91, info used (U), in JEMP Report (S), 29 Mar 91; msg (U), 4WW to AWS, et al, "4WW DESERT SHIELD/DESERT STORM Lessons Learned," 222025Z Mar 91; Frederick Intvw (U), p 16; Koenemann Intvw (U), p 9.

management skills assigned to them. The WSF could also have used several people with special expertise in tactical communications and benefitted from a few individuals trained in the supply area. CENTCOM Weather, especially, needed a supply person. Moreover, minimal manning at most deployed units in the field precluded them from assigning someone to work on operational verification.[12]

AWS concluded that the centralized command concept it used for the WSF (one officer in charge of the entire force) in DESERT SHIELD/STORM was valid and that the provisional organization it created had been sufficiently flexible to accommodate itself to the rapid growth which the WSF experienced. It recognized, however, that structurally, especially in regards to its chain of command, the 1690th WGP had some shortcomings. There were also some persons in AWS who felt that the weather group concept violated organizational principles such as span of control.[13]

DESERT SHIELD/STORM showed AWS that the training of its personnel had been deficient in several areas. First of all, the training received during exercises was not realistic enough. Exercises had to better match conditions AWS personnel would encounter when deploying to a bare base environment and having to set up weather support operations from scratch. Further, weather teams needed more practice in operating autonomously. In addition, the operation demonstrated that AWS personnel were frequently insufficiently prepared for deployment and that AWS had to provide a greater percentage of its people with more than merely the lowest level (Phase I) of mobility training. The operation also taught AWS that it needed to provide its leadership with more training in organizing and fielding a WSF for contingency operations.[14]

A glaring training deficiency that became apparent at the very beginning of DESERT SHIELD, and probably the one with the most serious adverse effect on AWS weather support, at least in the initial stages of the operation, was the inadequate or sometimes even total lack of training that deploying personnel had on the QRCT. While this could be, to a certain extent, rationalized by the fact that the QRCT was a new system that some AWS units had not yet received or, at best, had not possessed for a very long period of time, there, nevertheless, appears to have been a general lack of urgency in getting personnel qualified in operating the system. Again, fortunately, deployed personnel had a few months to train on the QRCT and become proficient in using it before DESERT STORM began in mid-January. The lesson to be learned here was clear and urgent: it was vitally important that

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[12]Kelly Intvw (U), pp 14, 24; Frederick Intvw (U), pp 4, 7; AWS DS/DS Report #2 (S), pp 11 (Exec Sum), 20 (Sec 2.4.3), 36 (Sec 3.4), 107 (Sec 4.1.7.4), 235 (Sec 7.3), 247 (Sec 10.0-b), info used (U); telecon (U), W.E. Nawyn with Col G.F. Riley, AWS/XO, 31 Jan 95; note (U), Col C.J. Bjerkaas, Act AWS/CV, to W.E. Nawyn, AWS/HO, ca 2 Oct 92; LTC R.R. Wall in AWTB Intvw (U), p 18; Tkach Intvw (U), pp 8-9, 24; 5WW/DO DS/DS Lessons Learned Brfg (U).

[13]5WW/DO DS/DS Lessons Learned Brfg (U); JULLS Long Rprt No. 31430-44500 (00002)(U), AWS/DO, "Centralized WSF Management," n.d. [probably Mar 91]; ARCENT SWO AAR (U), p 77, (Sec VII-4h).

[14]Kelly Intvw (U), pp 3, 16-17, 32; Frederick Intvw (U), p 16; AWS DS/DS Report #2 (S), pp iii (Exec Sum), 104 (Sec 4.1.6.4), 231-232 (Sec 6.4), 248 (Sec 10.0-g), 277 (App B), info used (U); atch 9 (U), rprt, 1690WGP/CV to 1690WGP/CC, "Weather Support Lessons Learned - Operations DESERT SHIELD/STORM," 20 Mar 91, hereafter cited as 1690WGP/CV DS/DS Lessons Learned, to CENTCOM Weather Staff AARs(U); rprt (U), 1WW/DO to AWS/DO, "DESERT SHIELD/STORM Lessons Learned," 19 Mar 91; JULLS Long Report No 32033-42507 (00042)(U), SAC/DOWXP, "Mobility Responsibilities," 29 Mar 91, in JEMP Report (S), 29 Mar 91; 5WW/DOX Lessons Learned Listing (U); msg (U), 7WW/CAT to AWS/DOJ, "7WW Lessons Learned," 222125Z Mar 91.

weather personnel be thoroughly familiar with tactical communications equipment and, indeed, with tactical communications in general.[15]

Other problems also emerged in the weather communications arena during DESERT SHIELD/STORM. Many have been noted in the earlier discussion of long-range and tactical communications.[16] Some led to additional lessons learned; some served to reinforce old lessons. In the long-range area, for instance, the operation forcefully reminded AWS that it depended heavily upon a reliable intertheater communications capability, especially for a contingency operation conducted far away from the US. Moreover, it taught AWS that its units in the field should have a dial-in capability whereby they could directly access AFGWC data in a way similar to how the DSFU accessed the Navy's NODDS during DESERT SHIELD/STORM.[17]

In addition, AWS met several problems in connection with using AFDIGS and AUTODIN that it needed to address after the operation was over. For instance, the multiple analog-to-digital conversions on the AFDIGS circuits often degraded signal quality to the point where weather graphic products received were almost unusable. These and other problems plaguing the weather facsimile circuits made many work-arounds necessary. Although AWS found AUTODIN useful for both Air Force and Army weather teams, particularly the latter, it discovered that weather data flowing from the AWN to AUTODIN frequently saturated in-theater AUTODIN communications centers.[18]

However, AWS experienced its chief problems and learned the most lessons in the tactical communications area. It came to see it needed a formal concept of operations for first-in HF communications. DESERT SHIELD/STORM powerfully reinforced what AWS already knew--that tactical communications systems had to be easily transportable, that "smaller is better." AWS found that in the QRCT/Goldwing it had a first-in HF tactical communications system superior to any it had ever had before (thanks to a lesson learned in the Grenada operation) and one which also worked better than any of its predecessors. But it also discovered that the QRCTs still had shortcomings that it had to rectify before the next contingency occurred. Moreover, it found, too, as it was already aware, that as good as the QRCT/Goldwings were as a first-in system, they did not work out well for long-term use, which was understandable because they were not designed for that. The basic lesson here was that fixed tactical communications should somehow be brought on line much quicker than it was during DESERT SHIELD/STORM and that AWS should work with AFCC and/or other communications agencies to ensure that this would happen.[19]

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[15]Kelly Intvw (U), pp 17-19; AWS DS/DS Report #2 (S), pp 181 (Sec 5.1.1.4), 273 (App B), info used (U); atch 9 (U), 1690WGP/CV DS/DS Lessons Learned, to CENTCOM Weather Staff AARs (U); ARCENT SWO AAR (U), p 42 (Sec VII-1f); 5WW/DOX Lessons Learned Listing (U).

[16]See above, Chapter III, pp 52-59, 61-68.

[17]Frederick Intvw (U), p 10; 5WW/DO DS/DS Lessons Learned Brfg (U); atch 1 (U), "Consolidated List of All Lessons Learned--DESERT SHIELD/STORM," to rprt (U), HQ AFGWC/DO to AWS/DOJ, "AFGWC Lessons Learned," 22 Mar 91, w/1 atch.

[18]AWS DS/DS Report #2 (S), pp 206 (Sec 5.1.2.4), 210 (Secs 5.1.3.3, 5.1.3.4), 213 (Sec 5.1.4.4), 248 (Sec 10.0-e), 274-275 (App B), info used (U).

[19]Kelly Intvw (U), pp 19-20, 25, 32, 33; AWS DS/DS Report #2 (S), pp iii (Exec Sum), 180-181 (Sec 5.1.1.4), 247-248 (Sec 10.0-e), info used (U); atch 9 (U), 1690WGP/CV DS/DS Lessons Learned, to CENTCOM Weather Staff AARs (U); JULLS Long Report No 31952-76384 (00039)(S), SAC/DOWXP, "QRCT Training and Taskings (U)," 29 Mar 91, p 33, info used (U), in JEMP Report (S),

The operation showed AWS that it very much needed a dedicated, in-theater maintenance capability for both its communications and meteorological equipment, perhaps its own deployable maintenance element. The existing QRCT maintenance concept was "woefully deficient." Indeed, for all practical purposes, there was none for contingency operations. The TACMET maintenance concept was little better--AWS found it to be "totally unsatisfactory." The absence of a workable, dedicated in-theater TACCOM and TACMET maintenance capability created serious mission-threatening problems for the deployed WSF, pointing up the urgency in rectifying this situation before another contingency operation occurred.[20]

AWS's experience with TACMET in DESERT SHIELD/STORM, like its experience with TACCOM, strongly underscored its growing conviction that smaller was better. It almost immediately saw, for example, that its GMD-5 Upper Air Measuring Set, supposedly transportable, was, in fact, too big and bulky for AWS to easily deploy (consequently, it never deployed the system). On the other hand, it found that the much smaller Marwin upper air sounding systems that it procured on an emergency basis during the course of the operation were very mobile, and, in addition, provided a valuable new capability. AWS also learned that its new TMQ-34 Tactical Meteorological Observing Set could be unreliable, at least in the hot desert environment, and that it would have to make several improvements in the system if it was to operate satisfactorily. On the whole, though, the TACMET equipment performed reasonably well.[21]

An extremely significant lesson AWS learned from the operation, especially the DESERT STORM phase, was that meteorological satellite imagery was the single most important weather support product it supplied to its customers, a key tool for all weather forecasting. Moreover, satellite imagery was valuable to the Air Force for in-theater mission planning and the Army in determining trafficability; it provided a means for obtaining weather data from over enemy territory; and it was very helpful to AFGWC in producing its weather support products. In short, satellite imagery was indispensable. AWS also discovered that the Mark IV DMSP satellite readout van was a very reliable piece of equipment; it performed almost flawlessly.[22]

All of which is not to say that AWS did not find shortcomings, and, therefore, room for improvement, in the meteorological satellite area. Early in the operation, for instance, AWS realized

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29 Mar 91; rprt (S), 4WW/CAT to AWS, et al, "4WW DESERT SHIELD/STORM After Action Report (U)," 172222Z Apr 91, info used (U); 5WW/DO DS/DS Lessons Learned Brfg (U).

[20]AWS DS/DS Report #2 (S), pp iii (Exec Sum), 181 (Sec 5.1.1.4), 221 (Sec 5.2.4), 247-248 (Sec 10.0-e,f), 274 (App B), info used (U); Weaving Intvw (U), p 36; Koenemann Intvw (U), p 31; Atch 9 (U), 1690WGP/CV DS/DS Lessons Learned, to CENTCOM Weather Staff AARs (U); ARCENT SWO AAR (U), p 64 (Sec VII-2c); 5WW/DOX Lessons Learned Listing (U).

[21]Kelly Intvw (U), pp 25, 32; AWS DS/DS Report #2 (S), pp iii (Exec Sum), 158 (Sec 4.4.4), 221 (Sec 5.2.4), 248 (Sec 10.0-f), info used (U); 5WW/DOX Lessons Learned Listing (U).

[22]AWS DS/DS Report #2 (S), pp ii (Exec Sum), 89 (Sec 4.1.3.4), 168 (Sec 4.5.4-a), 247 (Sec 10.0-c), 270-271 (App B), info used (U); ARCENT SWO AAR (U), p 57 (Sec VII-1v); 5WW/DO DS/DS Lessons Learned Brfg (U); JULLS Long Report No 32031-9176 (00001)(U), CENTCOM Weather, "Weather Satellite," 20 Mar 91, in Atch 1 (U), CENTCOM Weather, JEMP Report, 25 Mar 91, p 1, to CENTCOM Weather Staff AARs (U); Atch 2 (U), Holtgard DS/DS AAR, to CENTCOM Weather Staff AARs (U); memo (U), AFGWC/WF to AFGWC/DOO, "Lessons Learned--DESERT STORM/SHIELD," 21 Mar 91; point paper (U), HQ AWS/XTRR/DOOF, "Environmental Satellite Support to DESERT STORM--Lessons Learned," 5 Mar 91.

that it needed a first-in meteorological satellite capability, in other words, a small tactical satellite readout terminal, for Air Force units. Army weather teams deployed with the Wraase tactical terminal which they already owned--and which, incidentally, turned out to be another very reliable, perhaps the best, piece of tactical weather equipment deployed to DESERT SHIELD/STORM. Air Force weather support units, on the other hand, had no access to meteorological satellite imagery until the DMSP van arrived about 4 weeks after the operation began. As mentioned earlier,[23] AWS managed to procure and deploy a few interim small tactical terminals before the end of DESERT STORM. They worked well, but they did not arrive in theater until very late in the operation. AWS also found that the DMSP van should, for maximum efficiency, be collocated with the tactical forecast unit and had a refresh rate that was too slow.[24]

DESERT SHIELD/STORM taught AWS the important lesson that a deployed WSF had to be flexible in doing its job. The operation demonstrated that in a real-world contingency things frequently, probably most of the time, did not go "by the book." Thus leaders and members of a WSF had to be open to new concepts of weather support and ways of doing things and be able to adapt to new, strange, and unexpected circumstances and requirements.[26]

DESERT SHIELD/STORM again proved the value of centralized weather support. The out-of-theater support provided to the WSF by AFGWC and its subordinate organization, USAFETAC, was, on the whole, excellent. ETAC's descriptive climatologies for the Middle East were essential for planning purposes, and the climatological data it provided was very useful to weather forecasters. On the negative side, AWS determined that AFGWC's ability to handle and incorporate classified data needed improvement and its data processing system had to be more flexible in tailoring point and gridded products for specific points in the world on short notice. It also saw that ETAC had to take care that inaccurate weather observations did not adversely affect its climatology database and that the climatological data in the SWO kits provided for deploying personnel was in a usable format.[26]

But the operation also revealed the importance of in-theater centralized weather support. Both the JOAF and TOAF concepts worked well. The JOAF, in addition to being a vital product for CENTAF

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[23]See above, Chapter IV, pp 90-92.

[24]AWS DS/DS Report #2 (S), pp iii (Exec Sum), 78 (Sec 4.1.1.4), 168-169 (Sec 4.5.4), 247 (Sec 10.0-c), 272 (App B), info used (U); Kelly Intvw (U), p 25; ARCENT SWO AAR (U), pp 56-57 (Sec VII-1v); JULLS Long Report No.32031-91676 (00001)(U), CENTCOM Weather, "Weather Satellite," 20 Mar 91, and JULLS Report No. 32032-97913 (00003) (U), CENTCOM Weather, "Defense Military Satellite Program Van," 20 Mar 91, both in atch 1 (U), CENTCOM Weather, JEMP Report, 25 Mar 91, pp 1,3, to CENTCOM Weather Staff AARs (U); 5WW/DO DS/DS Lessons Learned Brfg (U); 5WW/DOX Lessons Learned Listing (U); point paper (U), HQ AWS/XTRR/DOOF, "Environmental Satellite Support to DESERT STORM--Lessons Learned," 5 Mar 91; atch 1 (U), CAC/CALL, Newsletter, "Space Support to the Army: Lessons from Operations DESERT SHIELD and STORM," (Chap 2, Section A), Oct 91, to rprt (U), USAIC SWO to TRADOC SWO, "Unit Activity Report - November/December 91," 16 Jan 92.

[26]Goldey Intvw (U), p 35; Col T.C. Tarbell in AWTB Intvw (U), pp 38-39; SOCCENT SWO AAR (U), p 6.

[26]AWS DS/DS Report #2 (S), pp ii (Exec Sum), 109 (Sec 4.1.8.4), 113-114 (Secs 4.2.1.2-d(3), 4.2.1.3, 4.2.1.4), 123-124 (Sec 4.2.2.4), 228 (Sec 5.4.4), 247 (Sec 10.0-c), 267-268 (App B), info used (U); Koenemann Intvw (U), p 31; 5WW/DOX Lessons Learned Listing (U).

weather units, was also helpful for the Navy and Marine components of CENTCOM. AWS quickly recognized that the contingency weather package developed by ARCENT Weather late in the operation was a valuable new centralized product for mobile weather teams and should be incorporated into Army support doctrine.[27]

From its experience in DESERT SHIELD/STORM, AWS concluded that it should, in the future, have a pre-formed and pre-manned tactical forecast unit, probably at AFGWC, ready to deploy as a unit in the event of a contingency operation. In DESERT SHIELD, AWS had manned the DSFU, so critical to WSF operations, with mostly inexperienced personnel drawn from various AWS units, which had severely hampered its operational efficiency in the early stages of the operation. AWS reasoned that it could overcome this problem by deploying a ready-made core TFU comprised of individuals who were already used to working together as a team and proficient in TFU operations. It could later augment the unit with additional personnel if the need arose. AWS also learned that it was best not to collocate the TFU, a joint command headquarters organization, with a component command headquarters such as CENTAF, as it had done in DESERT SHIELD/STORM.[28]

In DESERT SHIELD/STORM, AWS found that it took the DSFU and weather teams too much time to produce EOTDAs. But more importantly, the operation taught AWS that EOTDA support had to be flexible and adaptable to different types of operational tactics. During the operation the demand from customers was primarily for "situational awareness" EOTDAs rather than the type it had expected. AWS concluded that the EOTDA concept was valid and EOTDAs were, and would continue to be, essential, but perhaps not in the way it had anticipated. It decided, therefore, that it should reevaluate the future role of EOTDAs and the type that customers would find most valuable. [29]

AWS found the weather services provided by host nations during DESERT SHIELD/STORM valuable for the operations of its deployed WSF. It also came to the conclusion, primarily as a result of its dealings with MEPA, that its personnel should know something about the culture of any foreign nation or nations they might have to deal with in the future and, thus, be more prepared for the cultural differences they might encounter and how these, in turn, would affect the nature and quality of the weather data provided by these nations. AWS also came to see that it would be a good idea to provide its personnel with some prior assessment of indigenous weather support they might some day use and perhaps have an advance plan as to how it would use this data.[30]

DESERT SHIELD/STORM exposed several shortcomings in the joint operations arena impacting weather support operations. For example, there was no clear cut joint doctrine to cover weather support to unified and specified commanders, nor was there a focal point for environmental support

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[27]AWS DS/DS Report #2 (S), pp 81 (Sec 4.1.2.4), 91 (Sec 4.1.4.4), 247 (Sec 10.0-c), 265-266 (App B), info used (U).

[28]Kelly Intvw (U), p 32; Frederick Intvw (U), p 11; AWS DS/DS Report #2 (U), pp 36 (Sec 3.4), 265 (App B), info used (U); Koenemann Intvw (U), p 5; CENTAF SWO AAR (U), Sec J; 5WW/DO DS/DS Lessons Learned Brfg (U).

[29]Kelly Intvw (U), p 30; Frederick Intvw (U), pp 16-17; AWS DS/DS Report #2 (S), pp ii (Exec Sum), 81 (Sec 4.1.2.4), 89 (Sec 4.1.3.4), 150-151 (Secs 4.3.1.3, 4.3.1.4), 247 (Sec 10.0-c), info used (U); 5WW/DO DS/DS Lessons Learned Brfg (U).

[30]AWS DS/DS Report #2 (S), pp ii, iv (Exec Sum), 241 (Sec 8.4), 270 (App B), 278 (App B), info used (U); Ridge Intvw (U), pp 8-9. See also AWS DS/DS Report #2 (S), pp 158 (Sec 4.1.3.4), 247 (Sec 10.0-d), info used (U).

issues on the joint level. Furthermore, the degree of coordination and cooperation among the military services in weather support operations was insufficient, an important negative result of which was a general lack of interoperability among their weather communications systems. These situations needed attention from the military agencies involved, but there was little AWS could do by itself.[31]

Conclusion

The many problems and shortcomings and the many instances of needed improvements discussed in the previous paragraphs should not obscure the fact that in every major area AWS's positive accomplishments outweighed the negatives. Sooner or later, AWS, through the efforts of its people at home and in the field, either resolved or worked-around the problems and in a relatively short time put together a large functioning WSF deployed thousands of miles from the US. In the process AWS successfully adapted itself to situations and circumstances it had never encountered before and did things it had never done before. The result was that by the time DESERT STORM began AWS had a WSF in the field that was ready to fully support the operation and do its job of providing weather support to its customers.[32]

Weather support to DESERT SHIELD/STORM was, on the whole, a success story--a "real shining moment," General Kelly called it. The credit for that success belonged primarily to the young officers and enlisted persons, both men and women, of the WSF. Working hard and long, they not only did their job, they did it outstandingly. General Kelly was strong in his praise for the members of the WSF. They put forth, he said, "a herculean effort and did a very fine job....Overall, they did great." Confirmation of the high quality of weather support came from the WSF's customers, who frequently expressed satisfaction with and appreciation for the support they received. The 5th Wing headquarters and Headquarters AWS personnel, through the support they extended to the WSF, also played a vital role. Indeed, everywhere the members of AWS--officers, enlisted, and civilians alike--worked extra hard in support of DESERT SHIELD/STORM weather operations. [33]

Weather support was not a decisive factor in winning the war, but it made a significant contribution to the military's success; **it made a difference**. Perhaps the main contribution of weather support to the Air Force was in the overall prosecution of the air war, particularly in the mission planning area--e.g., assisting planners in how to use weather to their advantage and how to select

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[31]Kelly Intvw (U), p 32; AWS DS/DS Report #2 (S), pp iv (Exec Sum), 246 (Sec 9.4), 247 (Sec 10.0-b), 278 (App B), info used (U); JULLS Long Report No. 31358-57600 (00001)(U), AWS/DO, "Incompatible High Frequency Weather Communication Systems," n.d. [probably mid-Mar 91].

[32]Kelly Intvw (U), pp 26, 30, 34; Frederick Intvw (U), p 14; AWS DS/DS Report #2 (S), p iv (Exec Sum), info used (U); Col T.C. Tarbell in AWTB Intvw (U), pp 34-35; Goldey Intvw (U), p 35.

[33]Kelly Intvw (U), pp 2, 29, 34; Frederick Intvw (U), p 12, 18, 19; AWS DS/DS Report #2 (S), pp 78 (Sec 4.1.1.4), 104 (Sec 4.1.6.3), info used (U); Col T.C. Tarbell in AWTB Intvw (U), pp 34-35; Goldey Intvw (U), pp 14-15; Riley Intvw (S), p 41, info used (U); Weaving Intvw (U), pp 26-27; Campbell Intvw (U), pp 19, 25-26, 29; Koenemann Intvw (U), p 24; msg (U), AWS/CC to AIG 8148/CC, [Appreciation for AWS Personnel Performance in DS/DS,] 011800Z Mar 91.

targets, while to the Army it was in the tactical arena--assisting Army commanders in tactical decision-making.[34]

Even though it faced many problems and challenges, could have done some things better than it did, and experienced shortcomings in several areas, AWS, overall, did well in DESERT SHIELD/STORM--due, in no small part, to "leadership foresight, years of preparation, and the commitment and sacrifice of every member of the weather community."[35] At the end of the operation AWS could, with justifiable pride, report, "Mission accomplished."

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[34]Kelly Intvw (U), p 30; Frederick Intvw (U), pp 12, 14-15; AWS DS/DS Report #2 (S), p iv (Exec Sum), info used (U); Col T.C. Tarbell in AWTB Intvw (U), p 34; Riley Intvw (S), p 40, info used (U); Campbell Intvw (U), pp 25-26; CENTAF SWO AAR (U), Sec K-3; 5WW DS/DS Summary Brfg (S), slide (paper) #53, info used (U); msg (U), AWS/CC to AIG 8148, [Appreciation for AWS Personnel Performance in DS/DS,] 011800Z Mar 91.

[35]AWS DS/DS Report #2 (S), p 248 (Sec 10.0-i), info used (U).

APPENDIX I

AWS PERSONNEL DEPLOYED TO DESERT SHIELD/DESERT STORM

RANK	NAME	DT DPLYD	DT RDPLYD
A1C	ACEVEDO, FRANK III	08/20/90	11/18/90
AMN	ADAMS, BENJAMIN D.	09/29/90	04/07/91
SRA	ADAMS, CLIFFORD G.	08/09/90	03/31/91
SSG	ADAMS, JON D.	08/25/90	03/15/91
TSG	ADAMS, STEVEN R.	04/07/91	05/11/91
A1C	ALDRIDGE, TIMOTHY A.	08/19/90	03/23/91
TSG	ALEXANDER, LAWRENCE J.	08/08/90	03/21/91
SRA	ALLEN, MARC E.	08/20/90	04/17/91
SGT	AMRHEIN, EDWARD T.	10/11/90	04/17/91
SGT	ANDERSEN, PETER	01/19/91	06/03/91
A1C	ANDERSON, DAVID W.	08/09/90	03/19/91
SSG	ANDERSON, JAMES M.	01/20/91	05/28/91
SRA	ANDERSON, STEVEN E.	02/07/91	03/21/91
TSG	ANDERSON, WILLIAM M.	11/29/90	03/27/91
SSG	APPLE, ERIC G.	08/09/90	03/19/91
SSG	ARCHER, NAOMI L.	12/18/90	06/24/91
CPT	ASATO, BLAINE A.	12/06/90	04/14/91
TSG	ASHTON, PATRICK L.	01/20/91	06/03/91
AMN	ATKINSON, STEVEN L.	02/07/91	03/19/91
SGT	AUSTIN, LORI A.	01/17/91	05/24/91
A1C	AVENARIUS, STEVEN R.	08/08/90	03/24/91
SSG	AVERY, TERRY L.	08/10/90	02/23/91
TSG	BABCOCK, BRUCE J.	08/20/90	03/14/91
SSG	BAGBY, JAMES B.	12/13/90	04/17/91
A1C	BAILEY, KIRK D.	08/11/90	04/12/91
SSG	BAKER, JOHN P.	09/19/90	04/10/91
SSG	BALSOMA, THOMAS C.	12/07/90	03/24/91
MSG	BARBER, RAYMOND A.	12/23/90	04/29/91
SSG	BARGER, TRAVIS L.	01/14/91	03/13/91
2LT	BASS, RANDALL G.	08/27/90	04/10/91
A1C	BATSON, TIMOTHY D.	08/11/90	04/04/91
SSG	BAWEK, SCOTT A.	09/02/90	04/07/91
SRA	BELL, STEVEN R.	09/09/90	04/10/91
SGT	BENEFIELD, JEFFERY S.	01/20/91	04/10/91
1LT	BERTHA, JOHN C.	08/09/90	12/31/90
1LT	BISHOP, THYRA A.	01/20/91	07/25/91
TSG	BLACKFORD, BRIK A.	11/29/90	06/03/91
TSG	BLAY, JAMES E.	12/07/90	06/13/91
SSG	BLOMQUIST, MICHAEL P.	10/01/90	03/30/91

TSG	BLUME, RICHARD A.	12/29/90	02/28/91
SSG	BLUNDELL, WARREN L.	03/16/91	06/29/91
SSG	BOBERG, THOMAS J.	12/31/90	07/04/91
SSG	BOND, GREGORY A.	12/25/90	05/24/91
A1C	BOS, PAUL P.	11/18/90	03/23/91
A1C	BOURNE, KEVIN M.	08/27/90	03/29/91
SSG	BOWDEN, TIMOTHY P.	08/27/90	05/05/91
SGT	BOWMAN, VINCE B.	08/07/90	03/10/91
MSG	BOYLE, WILLIAM J.	08/31/90	04/30/91
SMS	BRADLEY, PAUL D.	08/13/90	04/30/91
CPT	BREES, DANIEL J.	08/25/90	10/05/90
CPT	BRIDGES, FREEMAN P.	12/29/90	04/25/91
MAJ	BROD, JOSEPH D.	08/23/90	04/20/91
SSG	BROOKS, MICHAEL G.	08/31/90	03/21/91
SSG	BROWN, WILLIAM R.	08/19/90	03/23/91
TSG	BUECHER, MICHAEL M.	08/31/90	04/12/91
SSG	BULLARD, DUANE P.	12/29/90	05/12/91
CPT	BUNNAG, FREDERIC J.	10/12/90	04/29/91
SSG	BURKHALTER, RONALD J.	08/20/90	03/20/91
SSG	BUSSEY, JESSIE E.	08/08/90	02/25/91
SGT	BUSTANY, BRADY M.	12/13/90	04/28/91
A1C	BYARS, MICHAEL S.	08/11/90	04/03/91
A1C	CALDERON, DONALD M.	08/22/90	03/31/91
SSG	CAMPBELL, CARL H.	08/08/90	03/07/91
LTC	CAMPBELL, WILLIAM H.	11/15/90	04/30/91
A1C	CARDENAS, RICHARD N., JR.	09/29/90	04/07/91
CPT	CARROLL, LINDA L.	08/09/90	03/09/91
SRA	CARROLL, JOHN A.	08/21/90	04/02/91
SGT	CASTLE, SHANE P.	09/27/90	04/17/91
SGT	CEPEK, JASON J.	12/31/90	03/27/91
SSG	CERONE, JOHN J., JR.	08/25/90	03/20/91
SSG	CHAMBERS, NANCY M.	08/10/90	03/15/91
A1C	CHANEY, JEFFERY L.	08/17/90	03/30/91
AMN	CHAPMAN, ROBERT E.	12/23/90	04/29/91
AMN	CHERNAY, EDWARD S., JR.	08/27/90	03/21/91
SSG	CHESEBRO, KEVIN L.	12/11/90	06/13/91
SSG	CHOPLICK, DANIEL E., JR.	08/11/90	04/03/91
2LT	CHORNEY, DAVID L.	12/28/90	07/01/91
SSG	CHRISTIANSEN, DIRK W.	08/08/90	02/13/91
SRA	CHRISTIANSON, CARL C.	09/28/90	04/13/91
CPT	CHRISTY, STEVEN R.	01/17/91	05/15/91
AMN	CHUMNEY, WALTER L.	12/01/90	04/17/91
A1C	CLARK, MATTHEW A.	12/06/90	04/23/91
CPT	CLARK, RAY M.	12/06/90	04/23/91
1LT	CLEMENT, PETER C.	08/08/90	04/02/91
A1C	COBB, GREG	09/09/90	03/17/91
CPT	COE, THOMAS E.	08/25/90	03/24/91
A1C	COLEMAN, JOANN	08/09/90	03/09/91
CPT	COLLISON, BRYAN W.	10/11/90	04/13/91
SSG	COMTE, CHRISTOPHER A.	08/09/90	03/19/91
CPT	CONANT, PHILIP A.	12/13/90	04/28/91
1LT	CONANT, ROBERT W. JR.	08/13/90	04/07/91
MAJ	CONLEY, JOHN R.	09/22/90	03/28/91
2LT	CONNORS, MARK J.	01/24/91	03/27/91

SSG	COOK, JOHN P.	08/27/90	10/03/90
SSG	COOK, RONALD L.	12/03/90	05/11/91
SGT	COOKERLY, FRED S.	10/29/90	05/13/91
SGT	COOPER, JAMES M.	08/25/90	03/23/91
SSG	CORRIVEAU, KEVIN S.	01/17/91	05/20/91
1LT	COTTURONE, JAMES A.	09/04/90	04/15/91
CMS	COUGHRAN, BENJAMIN L.	08/27/90	03/26/91
2LT	COX, JEFFERY M.	02/14/91	03/21/91
SGT	COX, JOHN D. JR.	08/28/90	10/24/90
SGT	CRUTCHFIELD, SCOTT E.	08/14/90	03/31/91
SSG	CRUZ, JOSEPH K.	08/27/90	04/08/91
A1C	CUMBO, RICHARD A.	11/15/90	03/14/91
TSG	CUMMINGS, KEVIN J.	01/31/91	04/08/91
A1C	CUPIL, RONALD A.	08/13/90	03/18/91
TSG	CURRIN, ROBERT J.	01/08/91	05/20/91
SGT	CVITKO, KEVIN J.	08/09/90	03/31/91
A1C	DAHL, MARK A.	08/27/90	10/13/90
TSG	DANIELS, KEITH E.	08/07/90	03/08/91
A1C	DAVENPORT, DEBBIE M.	10/17/90	03/24/91
SRA	DAVIDSON, WAYNE A.	08/10/90	03/15/91
CPT	DAVISON, MICHEL	08/13/90	04/30/91
SSG	DEATHRAGE, MICHAEL A.	10/27/90	05/01/91
SSG	DEBORD, JOSHUA P.	09/12/90	03/20/91
SSG	DEELY, TIMOTHY E.	09/09/90	03/20/91
SGT	DEJEAN, GARRIGUES A.	01/08/91	04/19/91
A1C	DELMARCELLE, MICHAEL L.	08/17/90	03/30/91
AMN	DEMEYER, JEFFREY D.	08/22/90	03/25/91
TSG	DEMPSEY, ROBERT L. JR.	08/11/90	03/23/91
SSG	DENNIS, WILLIAM H. JR.	12/23/90	04/29/91
TSG	DEOLIVERA, KENNETH D.	08/10/90	03/15/91
SSG	DEROJAS, FERNANDO A.	11/20/90	03/17/91
SSG	DETRAFFORD, RICHARD J.	12/18/90	07/01/91
CPT	DICKEY, JUDITH E.	08/07/90	03/20/91
TSG	DICKINSON, DAVID C.	09/15/90	03/23/91
SSG	DISTLER JOHN S.	08/25/90	03/22/91
SGT	DIXON, JAMES S.	12/13/90	04/28/91
CPT	DOBRY, EUGENE W. JR.	12/23/90	04/29/91
MSG	DOUGHERTY, MICHAEL D.	08/24/90	09/25/90
SSG	DOUGLAS, DAVID J.	12/30/90	07/03/91
TSG	DRUMMOND, KARL E.	10/11/90	04/07/91
1LT	DUFFY, KEITH J.	08/16/90	03/21/91
TSG	DUFRANE, ROBERT F.	12/31/90	04/20/91
SSG	DUNCAN, THOMAS A.	08/11/90	03/22/91
SRA	DUNN, JAMES F.	10/17/90	03/29/91
1LT	DWYER, MICHAEL J.	01/02/91	07/04/91
AMN	EICHENBERGER, JOSEPH W.	08/31/90	03/20/91
SSG	EIERMANN, MICHAEL P.	11/24/90	05/24/91
SSG	ELFORD, CHARLES H.	12/26/90	07/01/91
SSG	ERSKINE, MICHAEL S.	11/23/90	03/18/91
TSG	ERWIN, GLYNN	08/12/90	10/12/90
SSG	ESPARZA, DAVID C.	08/28/90	03/14/91
SSG	ESPINOSA, CARLOS A.	08/11/90	04/04/91
SRA	FAHEY, DUKE E.	08/10/90	03/15/91
MSG	FARIAS, RICHARD S. JR.	01/03/91	07/08/91

SGT	FARLEY, JOHN F.	08/27/90	03/23/91
SGT	FASHING, JAMES M.	08/27/90	01/08/91
1LT	FASKING, TODD M.	08/07/90	10/14/90
SSG	FEDERICO, JOSEPH J.	08/08/90	03/24/91
MSG	FENTON, WILLIAM J.	09/09/90	11/19/90
SSG	FINCHER, DAVID A.	01/11/91	07/12/91
1LT	FIORINO, STEVEN T.	unknown	unknown
TSG	FISHER, MARK S.	12/13/90	04/28/91
MSG	FISKE, RICHARD A.	12/13/90	04/28/91
SSG	FITZGERALD, DENNIS W.	01/05/91	07/08/91
SSG	FJELLIN, KIM T.	08/31/90	04/04/91
SSG	FLANAGAN, DENNIS B.	08/30/90	04/04/91
1LT	FLEISHAUER, ROBERT	08/11/90	03/26/91
AMN	FLORES, JOE A. JR.	12/05/90	04/12/91
MSG	FOLK, BRYAN J.	08/30/90	03/26/91
2LT	FORTMEYER, ERIK J.	01/02/91	07/02/91
TSG	FOSTER, RICHARD L. JR.	12/23/90	03/07/91
A1C	FOURNIER, ROBERT G. JR.	09/05/90	04/03/91
SGT	FRAME, CHARLES E.	08/23/90	02/17/91
A1C	FROST, SUSAN L.	08/09/90	03/19./91
TSG	FULLER, ROBERT L.	08/26/90	04/10/91
SGT	FULLER, STEPHEN C.	12/04/90	04/30/91
A1C	GAMBINO, RANDALL R.	01/17/91	03/30/91
SSG	GANLEY, GIRARD R. JR.	09/01/90	04/09/91
SRA	GARCIA, GALO JR.	10/11/90	04/17/91
1LT	GARRETT, ANDREW W.	02/10/91	05/30/91
TSG	GATTO, GEORGE A. JR.	12/23/90	04/29/91
SSG	GATZ, GEOFF A.	01/12/91	07/12/91
TSG	GEIS, DANIEL J.	12/01/90	06/07/91
SGT	GEORGE, RUSSELL C.	08/16/90	03/30/91
TSG	GIBSON, KENNETH R.	08/16/90	03/23/91
TSG	GILBERT, MICHAEL P.	10/16/90	04/15/91
TSG	GOFORTH, BRYAN, K.	01/02/91	03/12/91
A1C	GOLD, LARRY D.	08/17/90	04/03/91
COL	GOLDEY, JAMES W.	08/23/90	03/27/91
1LT	GONZALES, NORMAN W.	09/01/90	04/09/91
TSG	GOODE, RONALD C. JR.	08/09/90	03/09/91
SSG	GOULD, JEFFREY M.	08/11/90	04/04/91
A1C	GRAY, DAVID	01/20/91	03/29/91
TSG	GREEN, STEPHEN G.	08/08/90	11/09/90
SGT	GRIFFITH, KEVIN R. JR.	03/27/91	07/01/91
CPT	GRIGORIAN, GARY C.	08/10/90	03/15/91
SSG	GROSS, THOMAS P.	08/14/90	03/11/91
TSG	GUNNING, DONALD D.	08/31/90	04/15/91
A1C	GURLEY, DERRICH D.	08/09/90	04/02/91
A1C	HAAVISTO, JAMES K.	12/23/90	04/29/91
TSG	HALL, CHARLES JR.	03/09/91	05/24/91
TSG	HALL, FRANK J. III	01/25/91	04/18/91
SSG	HALSEY, LANCE D.	08/13/90	03/09/91
SGT	HAM, LINDA R.	01/20/91	05/28/91
A1C	HAMLING, ROBERT J.	08/25/90	03/23/91
TSG	HANCOCK, JOHN K.	08/25/90	11/02/90
SSG	HAND, TERRY R.	09/27/90	04/21/91
1LT	HARPER, DON S. III	08/10/90	05/19/91

SSG	HARRIS, EDWARD C.	02/14/91	04/16/91
2LT	HARRIS, GETTYS N. JR.	08/14/90	03/26/91
TSG	HART, JOEL D.	01/29/91	03/24/91
SSG	HAWK, ROBERT B.	12/19/90	03/08/91
A1C	HAYES, RANDALL W.	09/10/90	04/04/91
SGT	HENDERSON, ANDREW C.	09/15/90	03/23/91
SGT	HENDERSON, ROBERT J.	unknown	unknown
TSG	HIATT, DAVID D.	12/29/90	04/23/91
A1C	HICKCOX, DAVID B.	12/19/90	05/24/91
TSG	HILDEBRAND, MARK Z.	08/10/90	03/07/91
SRA	HILL, DALE L.	08/10/90	10/05/90
SGT	HILL, DALE M.	08/10/90	03/06/91
SSG	HILL, STEVE G.	09/01/90	03/24/91
SSG	HILSDORF, DAVID M.	12/23/90	04/29/91
TSG	HINE, GILBERT C.	08/28/90	02/15/91
AMN	HINSBERGER, JOHN A.	12/05/90	06/10/91
1LT	HINSON, FRANKLIN J.	08/18/90	03/19/91
SSG	HIRL, ROBERT L.	08/18/90	03/24/91
MAJ	HOFMANN, KARAN T.	03/21/91	06/17/91
MAJ	HOLTGARD, NANCY E.	08/23/90	04/20/91
SSG	HOPKINS, BRADLEY N.	08/27/90	04/05/91
A1C	HORGAN, MICHAEL A.	03/01/91	07/01/91
A1C	HORNING, KENNETH L. II	09/19/90	04/07/91
MSG	HOSEIN, FIZAL	12/30/90	07/03/91
SGT	HOWELL, DON N. JR.	12/01/90	05/01/91
SSG	HUEBNER, VINCENT S.	08/30/90	03/30/91
SSG	HUNTER, GERALD L.	08/13/90	04/04/91
SRA	IRESON, KIRK J.	12/23/90	04/29/91
SSG	ISOM, JEFFERY L.	08/27/90	03/24/91
A1C	JACOBI, BRIAN W.	08/30/90	04/03/91
TSG	JACOBS, MICHAEL .	09/28/90	04/13/91
TSG	JANKITE, JOHN	09/13/90	03/23/91
A1C	JENSEN, FREDERICK W. JR.	12/23/90	04/29/91
TSG	JOHNSON, CARL J.	08/08/90	02/13/91
CPT	JOHNSON, JEFFREY E.	08/20/90	03/15/91
SSG	JOHNSON, JEFFREY E.	08/08/90	10/11/90
CPT	JOHNSON, STEVEN C.	08/29/90	03/24/91
CPT	JOHNSTON, KEVIN	08/12/90	11/04/90
CPT	JOHNSTON (first name unknown)	01/18/91	03/23/91
SSG	JORDAN, OLIVER L. JR	01/21/91	05/20/91
SRA	JOSEPHSON, KEVIN A.	12/06/90	04/17/91
A1C	KAHMER, ROBERT A. JR.	09/15/90	03/23/91
TSG	KALB, TIMOTHY A.	08/20/90	03/19/91
A1C	KEATON, WILLIAM B.	08/20/90	03/19/91
A1C	KEEL, PAUL J.	12/23/90	06/24/91
SSG	KEENAN, THOMAS J.	08/12/90	03/30/91
SRA	KELLER, RICHARD A.	12/06/90	04/23/91
TSG	KELLERMAN, RONALD H.	08/10/90	03/29/91
1LT	KELLY, ANDREW R.	11/01/90	05/03/91
MAJ	KENDRICK, FRANK L.	08/07/90	03/26/91
AMN	KEUP, BRYAN C.	08/30/90	04/10/91
CPT	KINCAID, LARRY W.	12/13/90	05/12/91
SSG	KING, EUGENE J. JR	09/19/90	04/10/91
SSG	KING, MICHAEL E.	01/06/91	04/02/91

SSG	KLEINBECK, KARL N.	09/27/90	04/21/91
A1C	KLINZMANN, DWAYNE E. J.	09/11/90	04/10/91
TSG	KNOWLES, CORY W.	02/21/91	03/14/91
SSG	KOCH, JEROME P. JR.	12/01/90	05/11/91
1LT	KODAMA, KEVIN R.	12/28/90	07/01/91
SSG	KOGUT, MICHEL J.	12/30/90	07/04/91
MSG	KOWALSKI, ERIC J.	12/19/90	05/24/91
SSG	KRAETSCH, ROBERT C. A.	02/07/91	03/17/91
CPT	KRASNER, RICHARD D.	08/30/90	03/27/91
2LT	KRATZER, JAMES A.	01/19/91	04/15/91
TSG	KUREK, DANIEL R.	11/01/90	03/14/91
SSG	LACOSSE, WAYNE R.	08/18/90	03/30/91
SSG	LACROIX, EDDIE P. JR.	08/28/90	03/15/91
SSG	LAMMERS, KLAUS P.	08/12/90	03/30/91
SRA	LAND, GARY W.	08/09/90	03/09/91
A1C	LATHAM, JOSEPH E.	11/16/90	05/24/91
CPT	LAUTEN, JOHN T.	01/31/91	03/28/91
A1C	LAWSON, BABE A.	08/20/90	04/03/91
A1C	LEARY, DAVID T. JR.	12/26/90	06/27/91
SGT	LEBRUN, STEPHEN A.	10/11/90	04/13/91
SGT	LEGAULT, JOHN B.	09/27/90	04/15/91
TSG	LEHR, LAWRENCE W. JR.	12/26/90	07/01/91
A1C	LEMARR, BILLY R.	08/13/90	12/10/90
2LT	LEWIS, JOHN M.	12/29/90	05/01/91
A1C	LIMBAUGH, DICK A.	12/29/90	05/12/91
SGT	LINDSTROM, CHARLES W.	09/19/90	04/04/91
TSG	LOFTON, EUGENE	08/11/90	03/15/91
TSG	LONG, JIMMY W.	08/09/90	03/09/91
MSG	LORD, STEPHEN A.	08/08/90	03/10/91
SGT	LUCIA, JUANITA A.	08/30/90	04/03/91
CPT	LUM, ROY H.	01/05/91	03/20/91
1LT	LUNSFORD, TOM D.	08/26/90	04/03/91
1LT	LUTERMAN, RICHARD H.	12/28/90	06/27/91
2LT	MAES, WILLIAM C.	10/22/90	05/05/91
SSG	MAHLER, ROBERT D.	10/23/90	04/14/91
CPT	MAHOOD, ROBERT W.	12/23/90	04/29/91
SGT	MALCHOSE, KERRY R.	08/08/90	03/20/91
SSG	MALCOMB, WILLIAM D.	01/26/91	04/18/91
SSG	MALLARD, SIDNEY D.	08/29/90	03/23/91
CPT	MALONE, EMMETT C.	08/14/90	04/02/91
TSG	MARCI, ANTHONY C.	08/08/90	03/21/91
AMN	MARSHALL (first name unknown)	08/29/90	09/24/90
SSG	MARTIN, WILLIAM J.	08/12/90	03/30/91
A1C	MATHIAS, WESLEY D.	12/25/90	05/24/91
1LT	MATTHEWS, LAILLA R.	08/18/90	04/17/91
TSG	MAVIS, TERRY W.	08/30/90	03/11/91
A1C	MAYNOR, STEPHANIE M.	08/25/90	03/24/91
MAJ	MCATEE, MICHAEL D.	12/25/90	05/24/91
A1C	MCATTEE, RACHELLE J.	10/11/90	04/17/91
TSG	MCCARTHY, THOMAS M.	08/11/90	04/03/91
SSG	MCCLELLAN, JOHN W.	08/22/90	03/31/91
SSG	MCCOY, COLIN W.	08/14/90	03/23/91
SSG	MCCULLOCH, GARTH A.	01/26/91	04/18/91
CPT	MCDONALD, MICHAEL H.	09/19/90	04/03/91

A1C	MCDONALD, TROY E.	08/31/90	03/20/91
CPT	MCKITO, MICHAEL L.	08/25/90	03/23/91
A1C	MCNEIL, DAVID P.	01/08/91	05/20/91
MAJ	MEADE, ARTHUR C.	08/12/90	03/12/91
SSG	MEDLIN, BRAD A.	12/06/90	04/28/91
A1C	MENDONCA, HOWARD J.	08/13/90	03/27/91
SSG	MIKISKA, STEPHEN J.	08/12/90	01/24/91
MSG	MILLER, ANDREW J.	12/25/90	05/24/91
MSG	MILLER, STEVEN V.	12/06/90	04/23/91
TSG	MINARD, STEVEN R.	01/13/91	05/25/91
TSG	MITCHELL, WILLIAM R. JR.	12/31/90	05/24/91
CPT	MITSCH (first name unknown)	08/28/90	12/19/90
SGT	MIZELL, STEPHEN A.	08/08/90	03/31/91
1LT	MODLIN, NORMAN R.	08/20/90	04/15/91
MSG	MOLL, MICHAEL J.	03/21/91	07/26/91
A1C	MONTY, KEITH J.	12/19/90	05/12/91
TSG	MOORE, GARY W.	10/27/90	05/01/91
1LT	MORLEY, FAWN L.	08/06/90	11/02/90
TSG	MORRIS, JEFFREY L.	08/13/90	03/29/91
A1C	MORRIS, TODD E.	02/19/91	04/14/91
SSG	MORTENSON, MICHAEL A.	01/05/91	03/11/91
SGT	MUNRO, MARK A.	12/26/90	07/01/91
CPT	MURPHY, JOHN D.	08/25/90	03/24/91
TSG	MURPHY, RICKEY J.	09/02/90	03/17/91
SRA	NAIRN, JOHN K.	09/19/90	10/27/90
MSG	NAPPIER, DENNIS E.	09/07/90	03/27/91
TSG	NARDI, MICHAEL G.	08/08/90	04/02/91
A1C	NAST, EARL D.	08/30/90	03/05/91
SRA	NATALLE, JON S.	12/04/90	04/30/91
CPT	NELMES, KENNETH W. J.	04/04/91	07/01/91
SSG	NELSON,RANDY E.	12/14/90	04/02/91
SSG	NIEMAN, RICHARD W.	03/07/91	07/04/91
SSG	NUNEZ, JOSE A.	08/28/90	03/12/91
MSG	O'CONNELL, NANCY L.	08/20/90	04/03/91
SSG	O'BRIEN, SCOTT M.	01/20/91	05/19/91
SSG	OETTING, DAVID W.	08/18/90	04/17/91
CPT	OGLESBY, ERIC A.	01/20/91	05/30/91
CPT	O'HEARN, MICHAEL J.	09/15/90	03/23/91
2LT	OLSON, WILLIAM A.	12/28/90	03/31/91
SGT	ORTIZ, OSCAR JR.	08/13/90	11/03/90
SRA	OSBORNE, DORIAN E. JR.	08/28/90	03/09/91
SSG	O'SHEA, AARON P.	08/27/90	10/18/90
AMN	OTTE, AARON M.	01/26/91	04/18/91
SGT	OVERTON, DELANE L.	12/16/90	06/17/91
A1C	OWEN, JERRY D.	01/26/91	07/26/91
SSG	PADILLO, STEFAN J.	09/13/90	03/23/91
TSG	PARSONS, JAMES C.	08/19/90	10/21/90
SRA	PASSANISI, GAIL M.	12/25/90	05/04/91
SGT	PATTERSON, JEFFREY W.	08/18/90	03/30/91
SSG	PATTERSON, ROBERT D.	01/26/91	04/18/91
A1C	PATTERSON, ROBERT J. JR.	08/17/90	04/03/91
TSG	PEEPLES, ADRIAN M.	01/19/91	04/17/91
SSG	PEGRAM, DARYL J.	03/03/91	06/03/91
A1C	PENTON, VICKY L.	11/26/90	03/23/91

SSG	PERKINS, BRUCE W.	08/12/90	11/04/90
A1C	PETERS, SCOTT M.	09/19/90	04/03/91
A1C	PETERSON, RUSSELL E. J.	08/14/90	04/02/91
SSG	PHELPS, KENNETH A.	02/14/91	05/30/91
A1C	PITRE, JERRY G. JR.	08/08/90	03/21/91
SSG	PITSENBARGER, LARRY A.	08/09/90	03/09/91
SSG	POOLE, JOHN N.	08/07/90	03/17/91
SGT	PORTA, SHAUN MARIE	08/11/90	03/05/91
AMN	PORTILLO, CHRISTOPHER G.	08/30/90	04/03/91
TSG	POTTS, CHARLES S.	08/30/90	12/18/90
SSG	POULTER, TIMOTHY D.	09/28/90	04/17/91
A1C	PRICE, CLINT C.	09/28/90	04/13/91
A1C	PRICE, DERRICK D.	12/29/90	05/12/91
SRA	PRICE, GREGORY M.	12/06/90	04/23/91
A1C	PRIEST, DEBORAH A.	09/03/90	09/30/90
SSG	PRITCHARD, DAVID A.	01/20/91	04/19/91
SSG	PRUETT, BILLY D.	08/31/90	11/16/90
SGT	QUILLEN, JOHN D.	10/28/90	04/27/91
A1C	RAINIER, LORI L.	08/20/90	04/17/91
TSG	RAMBALI, CHRISTOPHER M.	08/11/90	03/15/91
SRA	RAMSAY, GRANT A.	09/27/90	04/21/91
CPT	RAMSAY, GREGORY A.	08/29/90	01/14/91
TSG	RAMSEY, ROGER W.	09/10/90	04/10/91
SSG	RANDALL, DARRELL J.	12/06/90	04/14/91
MSG	REID, JAMES J.	12/01/90	05/06/91
SSG	REID, JOHN H.II	01/25/91	04/18/91
TSG	REID, ROBERT T.	08/12/90	03/27/91
MAJ	REUTNER, CURTIS A.	03/16/91	10/03/91
1LT	RICH, COSMO A. JR.	08/08/90	12/13/90
A1C	RICHARDSON, KENNETH M.	08/27/90	03/15/91
CPT	RIES, VINCENT T.	12/04/90	05/11/91
SSG	RIGDON, JEFFREY R.	08/31/90	03/21/91
LTC	RILEY, GERALD F. JR.	08/07/90	03/27/91
A1C	RITER, RICHARD J.	08/10/90	03/15/91
MAJ	RIVA, LOUIS J.	08/30/90	03/30/91
A1C	ROBERTS, KENNETH A. JR.	08/25/90	03/23/91
SRA	ROBERTS, MARTHA A.	08/30/90	03/05/91
CPT	ROBERTSON, BRIAN D.	12/20/90	06/18/91
SGT	ROBERTSON, JOHN D.	12/20/90	05/01/91
CPT	ROBINSON, ALAN D.	08/09/90	03/28/91
SGT	ROBINSON, LAURIE L.	12/19/90	05/24/91
1LT	ROBISON, RONALD M.	01/04/91	05/01/91
SRA	ROCCONI, JOSEPH A.	12/25/90	05/24/91
A1C	RODGERS, MATHEW W.	12/23/90	04/29/91
SGT	RODRIQUEZ, RANDOLPH	08/10/90	03/20/91
MSG	ROGERS, ALAN M.	08/29/90	03/23/91
TSG	ROGERS, FRED D. JR.	02/16/91	03/22/91
MSG	ROLL, NEAL R.	08/10/90	03/23/91
SRA	ROMERO, KAREN S.	10/11/90	04/07/91
SSG	ROSBACH, JEFFREY A.	02/07/91	03/19/91
1LT	ROSE, STEPHEN A.	01/25/91	04/18/91
AMN	ROSS, TIMOTHY R.	12/23/90	04/29/91
A1C	ROYCE, CHRISTOPHER C.	08/16/90	03/30/91
TSG	ROZICH, DOUGLAS M.	12/07/90	03/24/91

SGT	RUDD, LOREN L.	09/03/90	09/30/90
SGT	SAFREED, KEVIN L.	09/15/90	03/23/91
TSG	SAMUEL, JEREMY L.	12/06/90	04/23/91
SRA	SAND, HOWARD L.	08/20/90	03/15/91
A1C	SANTOS, FRANCISCO R.	09/01/90	04/09/91
A1C	SCARBOROUGH, STEVEN L.	08/20/90	04/17/91
SRA	SCHAFF, LORI M.	02/13/91	03/23/91
CPT	SCHMID, VALERIE J.	03/07/91	06/07/91
SGT	SCHMIDT, GREGORY A.	10/01/90	04/03/91
TSG	SCHMIDT, JEFFREY A.	12/29/90	04/23/91
TSG	SCOTT, MICHAEL E.	12/19/90	05/12/91
SSG	SECESSIONS, RAYMOND	08/12/90	04/02/91
TSG	SEIBERT, DAVID P.	03/14/91	07/04/91
SSG	SHAY, MICHAEL F.	08/27/90	11/02/90
SSG	SHERIN, WILLIE C.	12/10/90	03/19/91
AMN	SIMON, WILLIAM K.	08/30/90	04/08/91
SSG	SINCORE, MICHAEL D.	08/12/90	03/25/91
1LT	SISKANENITZ, WILLIAM	08/09/90	03/19/91
CPT	SKIDMORE, STEVEN D.	08/12/90	04/20/91
SSG	SMEBY, JEFFREY D.	09/24/90	04/17/91
SRA	SMITH, CHARLES L.	09/15/90	03/17/91
CPT	SMITH, GERALD B. II	12/25/90	05/24/91
AMN	SMITH, MICHAEL R.	08/09/90	04/02/91
TSG	SMITH, ROBIN R.	08/27/90	04/08/91
AMN	SMITH, SAMUEL	12/29/90	05/12/91
1LT	SMITH, TINA M.	08/31/90	04/12/91
A1C	SNYDER, DALE R.	08/30/90	05/05/91
SGT	SOLBERG, BENNIE G.	08/27/90	01/20/91
SGT	SOMERS, OWEN	01/26/91	04/18/91
CPT	SORLIN-DAVIS, JANET	09/27/90	05/01/91
SSG	SPACK, DENISE L.	08/30/90	05/05/91
CPT	SPENDLEY, WILLIAM J.	09/09/90	03/17/91
SSG	STARRS, SHAWN P.	09/19/90	04/04/91
A1C	STEELE, MICHAEL A.	11/26/90	05/29/91
SSG	STEENBURGH, ROBERT A.	08/24/90	03/15/91
SSG	STEPHENS, JOE SR.	08/27/90	03/27/91
1LT	STEVENSON, CHRISTIN	12/17/90	03/15/91
A1C	STEVENSON, SALLY S.	12/13/90	04/28/91
CPT	STONEHOCKER, SYDNEY	09/26/90	03/30/91
A1C	STOVALL, RODNEY L.	02/28/91	07/01/91
SSG	STRACHAN, TREVOR S.	08/12/90	03/25/91
TSG	STRICKLER, PAUL A.	08/30/90	03/27/91
MSG	STRUNK, GEORGE K.	08/09/90	03/19/91
A1C	STUART, LISA G.	02/07/91	03/21/91
SSG	STUMPH, JOHN M.	08/10/90	03/15/91
SSG	SULLIVAN, JAMES A.	08/10/90	03/17/91
AMN	SUMRALL, MICHAEL S.	08/30/90	04/08/91
SSG	SUNTYCH, BRUCE A.	12/13/90	04/28/91
SGT	SWICK, RODNEY D.	12/29/90	04/25/91
AMN	TAFT, RANDY C.	08/29/90	03/23/91
TSG	TAYLOR, DAVID A.	12/01/90	04/17/91
SSG	TAYLOR, IRVING A. JR.	12/06/90	04/23/91
SSG	TAYLOR, JOSEPH M.	08/29/90	04/04/91
SSG	TAYLOR, TONY D.	08/27/90	03/24/91

SGT	TEFFT, JOHN S.	12/05/90	06/06/91
TSG	TESORI, ANTHONY J.	08/28/90	03/09/91
SSG	THOELE, THOMAS R.	01/24/91	05/09/91
TSG	THOMAS, NATHANIEL W.	12/01/90	04/17/91
CPT	THOMAS, ROBERT B.	01/13/91	03/13/91
A1C	THOMPSON, DEAN M.	08/24/90	09/15/90
AMN	THOMPSON, MARK V.	12/29/90	05/12/91
SSG	THOMPSON, MARTIN R.	12/25/90	05/24/91
SSG	THOMPSON, SCOTT C.	09/09/90	04/04/91
LTC	THORNBERRY, JERRY R.	12/01/90	05/12/91
MSG	THORNSBERRY, STEVEN J.	08/25/90	03/21/91
SSG	TINGELHOFF, RUDY B.	09/04/90	04/15/91
2LT	TOBIN, BRIDGET F.	08/10/90	03/15/91
A1C	TUCKER, DANIEL	01/20/91	05/30/91
SSG	TURKOVICH, STEPHEN H. II	09/15/90	03/23/91
A1C	TURNER, LORRENE M.	12/25/90	05/24/91
TSG	UNDERWOOD, JOHN W.	08/30/90	03/05/91
A1C	URIBE, ANGELA L.	08/08/90	03/21/91
SGT	VANBROCKLIN, JEFFREY M.	08/12/90	03/11/91
TSG	VELASCO, JUAN M.	10/11/90	04/17/91
MSG	VIOLA, CHARLES D.	10/28/90	04/29/91
SRA	VOCI, TODD D.	12/04/90	04/30/91
SGT	VOGEL, JEFFREY W.	08/30/90	03/24/91
MAJ	WAITE, LARRY J.	01/14/91	03/27/91
A1C	WALKER, CHARLES A. JR.	12/26/90	05/16/91
SSG	WALKER, CHARLES L.	08/13/90	04/04/91
CPT	WALKER, JAMES E.	08/22/90	03/11/91
SSG	WALKER, JOHN W.	10/01/90	04/03/91
SSG	WALSH, JOHN R.	12/29/90	05/12/91
MSG	WALSH, PAUL E.	02/08/91	04/03/91
A1C	WALTERS, KEVIN R.	12/23/90	04/29/91
SSG	WARD, DANIEL K.	12/23/90	04/29/91
SSG	WAYTE, KEVIN E.	08/30/90	04/03/91
LTC	WEAVING, WILLIAM S.	09/07/90	04/20/91
SGT	WEBER, CHARLES G.	01/30/91	03/14/91
SGT	WEBER, JOHN V.	12/19/90	05/24/91
SRA	WHITE, JANE E.	12/11/90	06/14/91
MAJ	WHITE, JOHN A. III	08/08/90	09/25/90
SSG	WHITTLE, ROBERT J.	02/11/91	05/30/91
MSG	WILBURN, FRED A.	08/09/90	03/09/91
MSG	WILCOX, THOMAS L.	08/09/90	11/06/90
CPT	WILDEROTTER, STEVEN	10/11/90	04/17/91
TSG	WILLIAMS, DENNIS D.	08/16/90	04/15/91
SSG	WILLIAMS, GREGORY W.	08/09/90	03/28/91
SGT	WILLIAMS, JIMMY W.	08/20/90	03/20/91
1LT	WILLIAMS, ROBERT T.	08/10/90	03/15/91
SGT	WILLIAMS, STEVEN	12/29/90	04/23/91
SSG	WILLIAMSON, DALE F.	08/25/90	03/21/91
A1C	WILLMS, ANTHONY W.	08/11/90	04/12/91
CPT	WILLSON, JAMES A.	12/17/90	05/28/91
CPT	WILZ, THEODORE R.	09/15/90	03/23/91
SSG	WINTERS, MYRON G. JR.	02/07/91	05/01/91
SSG	WISEMAN, THOMAS D. JR.	08/09/90	03/19/91
A1C	WOLF, SHANNON L.	08/11/90	04/03/91

MSG	WOLFE, DUANE M.	12/14/90	03/30/91
1LT	WOOD, DAVID R.	08/24/90	03/24/91
TSG	YELENIC, STEVEN M.	09/24/90	03/13/91
SSG	YELTON, ROBERT S. JR.	01/02/91	06/09/91
SSG	ZILKENAT, GLENN P.	12/20/90	06/20/91
MSG	ZIMMER, MICHAEL A.	12/03/90	07/01/91

SOURCE: Tkach, List of Deployed AWS Personnel (U), Sep 94

APPENDIX II

DESERT SHIELD/DESERT STORM
FINAL WEATHER SUPPORT FORCE REQUIREMENTS
(17 FEB 91)

LOCATION		OFF	FCT	OBS	IM	TOT
1690WGP	RIYADH MIL					
	CENTCOM	5	5	0	1	11
	ARCENT	4	4	6	1	15
	CENTAF	5	1	0	1	7
	ALCC	1	1	0	0	2
	TACC	1	3	0	0	4
	DSFU	4	8	6	0	18
	BWS - E8A	2	4	3	0	9
OL-D 1690WGP	DIEGO GARCIA NAF					
	SAC SPT	1	4	0	0	5
OL-E 1690WGP	TABUK					
	TAC SPT	1	2	0	0	3
OL-F 1690WGP	JUBAIL					
	ALCE	1	1	0	0	2
OL-G 1690WGP	12AVN BDE					
	12 AVN BDE	2	3	3	0	8
OL-L 1690WGP	2BDE/A10 FOB (KKMC)					
	2 BDE	1	2	3	0	6
	A10 FOB	0	2	0	0	2
DET 1 1690WGP	SOCCENT (KING FAHD)					
	SOCCENT	2	0	0	0	2
	AFSOC	1	5	0	0	6
	SOWT	0	2	1	0	3
	5SFG SFOB	1	3	0	0	4
	3SFG (KING FAHD)					
	3SFG SFOB	1	3	2	0	6
	3SFG FOB	0	2	1	0	3
	5SFG FOB	0	5	3	0	8

LOCATION		OFF	FCT	OBS	IM	TOT
DET 2 1690WGP	AL DHAFRA					
	BWS	2	4	0	0	6
OL-A DET 2 1690WGP	BATEEN					
	BWS	1	3	3	0	7
OL-J DET 2 1690WGP	ABU DHABI INTL					
	BWS	1	3	1	0	5
DET 3 1690WGP	18ABN CRP					
	18ABN MAIN	2	5	2	0	9
	18ABN AVN	1	3	3	0	7
DET 4 1690WGP	AL MINHAD					
	BWS	1	4	3	0	8
OL-B DET 4 1690WGP	SHARJAH INTL					
	BWS	1	3	0	0	4
OL-K DET 4 1690WGP	DUBAI INTL					
	BWS	1	3	0	0	4
DET 5 1690WGP	82ABN DIV					
	82ABN MAIN	1	3	4	0	8
	82ABN AVN	1	3	3	0	7
DET 6 1690WGP	DHAHRAN INTL					
	BWS	2	4	3	0	9
OL-C DET 6 1690WGP	SHAIKH ISA					
	BWS	1	3	3	0	7
DET 7 1690WGP	24ID					
	24ID MAIN	1	3	4	0	8
	24ID AVN	1	3	3	0	7
DET 8 1690WGP	KING FAHD					
	BWS	2	6	3	0	11
	MAC SPT	1	2	0	0	3
DET 9 1690WGP	101ABN DIV					
	101AD MAIN	2	4	3	0	9
	101AD 1BDE	0	3	2	0	5
	101AD 2BDE	0	3	2	0	5
	101AD 3BDE	0	3	2	0	5
	101AD AVN	0	3	3	0	6

LOCATION		OFF	FCT	OBS	IM	TOT
DET 10 1690WGP	DOHA INTL					
	BWS	1	3	3	0	7
DET 11 1690WGP	1CD					
	1CD MAIN	1	3	4	0	8
	1CD AVN	1	3	3	0	7
DET 12 1690WGP	TAIF					
	TR1	1	0	0	0	1
	U2	1	0	0	0	1
	BWS - RDSFU	1	6	4	0	11
DET 13 1690WGP	7 CRP					
	7 CRP MAIN	2	5	2	0	9
	11 AVN BDE	1	3	3	0	7
DET 14 1690WGP	KING ABDUL AZIZ INTL-JEDDAH					
	BWS	1	4	2	0	7
	B52	2	1	0	0	3
DET 15 1690WGP	1AD					
	1AD MAIN	1	3	4	0	8
	1AD AVN	1	3	3	0	7
DET 16 1690WGP	THUMRAIT					
	BWS	1	3	3	0	7
DET 17 1690WGP	3AD					
	3AD MAIN	1	3	4	0	8
	3AD AVN	1	3	3	0	7
DET 18 1690WGP	AL AIN/BURAYMI WEST					
	BWS	1	3	3	0	7
DET 19 1690WGP	1ID					
	1ID MAIN	1	3	4	0	8
	1ID AVN	1	3	3	0	7
DET 20 1690WGP	MASIRAH					
	BWS	1	4	3	0	8
	BWS	0	0	1	0	1
DET 21 1690WGP	2ACR					
	2ACR MAIN	1	2	2	0	5
	2ACR AVN	1	2	3	0	6

LOCATION		OFF	FCT	OBS	IM	TOT
DET 22 1690WGP	SEEB INTL					
	BWS	1	3	3	0	7
DET 23 1690WGP	3ACR					
	3ACR MAIN	1	2	2	0	5
	3ACR AVN	1	2	3	0	6
DET 24 1690WGP	CAIRO WEST					
	BWS	1	4	3	0	8
DET 26 1690WGP	KHAMIS MUSHAIT					
	BWS	1	4	2	0	7
DET 28 1690WGP	KING KHALID INTL-RIYADH					
	BWS	1	3	0	0	4
DET 30 1690WGP	AL KHARJ					
	BWS	2	5	3	0	10
DET 30 1690WGP	FORWARD ALCE					
		0	2	0	0	2
SAC OL'S:						
	MORON					
	BWS	1	4	3	0	8
	FAIRFORD					
	BWS	1	4	3	0	8
	MONT/DE/MARSAN					
	SAC SPT	1	2	0	0	3
	MALPENSA					
	SAC SPT	1	0	0	0	1
TOTAL COUNT		90	229	151	3	473

SOURCE: AWS DS/DS Report #2 (S), pp 42-44 (Atch 3), info used (U)

APPENDIX III

DESERT SHIELD/DESERT STORM FORCES/CUSTOMERS SUPPORTED AS OF 17 FEB 91

UNIT	AIRCRAFT	QUANTITY
BWS GP-RIYADH	E-3	11
	E-8	2
	EC-130 (ABCCC)	7
	RC-135	7
	KC-135	10
	C-21	8
	TACC	
	ALCC	
OL-D GP-DIEGO GARCIA	B-52	20
	KC-10	7
	KC-135	5
OL-E GP-TABUK	F-15C	24
OL-F GP-JUBAIL	ALCE	
DET 02-AL DHAFRA	F-16C	72
	KC-135	7
OL-A DET 2-BATEEN	C-130	16
	EC-130 (CC)	6
OL-J DET 2-ABU DHABI	KC-135	12
DET 04-AL MINHAD	F-16	72
OL-B DET 4-SHARJAH	C-130	16
OL-K DET 4-DUBAI	KC-135	12
DET 06-DHAHRAN	F-15	48
	CRC	
OL-C DET 6-SHAIKH ISA	F-4G	48
	RF-4C	18
USMC	FA-18	78
	A6-E	32
	EA-6B	12
DET 08-KING FAHD	A-10	132
	OA-10	12
	F-16C	24
	C-130	24
	EC-130 (VS)	2
	EC-130 (JACC CP)	3
	AC-130	8
SOF	HC-130	4
	MC-130	4
	MH-53	8
	MH-60	8
DET 10-DOHA	F-16	24
DET 12-TAIF	U-2	6
	TR-1	5
	F-111F	64
	EF-111	18
DET 14-JEDDAH/KAA	B-52	16
	KC-10	13
	KC-135	62
DET 16-THUMRAIT	C-130	16
DET 18 AL AIN	C-130	40
DET 20-MASIRAH	C-130	16
	KC-135	10
DET 22-SEEB	KC-10	10
	KC-135	15
DET 24 CAIRO WEST	KC-135	15
DET 26-KHAMIS MUSHAIT	F-117	42
DET 28-KG KHALID IAP KKIA	EC-135L	2
	KC-135	46
DET 30-AL KHARJ	F-15E	48
	F-15C	24
	F-16A	24
	FA-16A	18
	C-130H	16
OL-SAC FAIRFORD	B-52	8
OL-SAC MORON	B-52	22
OL-SAC MALPENSA	KC-10	6
OL-SAC MONT DE MARSON	KC-135	7
DET 03-18 ABN CORPS 18 ABN AVN	CH-47	30
	UH-1H	32
DET 05-82 ABN DIV 82 ABN AVN	AH-64	19
	AH-1	10
	OH-58	34
	UH-60	42
	EH-60	3
COSCOM	AH-64	1
	CH-47	1
	VH-1	13
	MEDEVAC	67

UNIT	AIRCRAFT	QUANTITY
DET 07-24 ID/24 ID AVN	AH-64	18
	AH-1	8
	OH-58	31
	UH-60	18
	UH-1	11
	EH-60	3
DET 09-101 ABN DIV/101 AD AVN	AH-64	37
	AH-1	34
	CH-47	45
	OH-58	69
	UH-60	106
	UH-1	35
	EH-60	3
	MEDEVAC	12
DET 11-1CD/1CD AVN	AH-64	36
	CH-47	8
	OH-58	44
	UH-60	6
	UH-1	33
	EH-60	3
DET 13-7 CORPS AND 11 AVN		
DET 15-1AD/1AD AVN		
DET 17-3 AD/3 AD AVN		
DET 19-1 ID/1 ID AVN		
DET 21-2 ACR/2 ACR AVN		
DET 23-3 ACR AVN	CH-47	26
	OH-58	27
	UH-60	18
	EH-60	3
OL-G GP-12 AVN	AH-64	36
	CH-47	8
	OH-58	28
	UH-60	21
	UH-1	5
OL-L GP-KHALID MC	A-10	FOB
SOF	UH-60	8
	CH-47	4
	160 SOAG ACFT	
-HAFR AL BATIN	ASOC/CRC/MPC	
UNKLOCK-ARMY FIXED WG	OV-1	11
	RV-1	6
	RC-1	5
	C-21	1

SOURCE: AWS DS/DS Report #2 (S), pp 61-62 (Atch 4)

APPENDIX IV

1690TH WEATHER GROUP PROVISIONAL HERALDRY

The 1690th WGP patch decribed on this page was designed by Col James W. Goldey, 1690WGP OICWSF and, although never formally approved by the Air Force, was widely accepted and issued to all members of the AWS WSF.

1. The central tri-color disk is symbolic of AWS support to the three USCENTCOM components: yellow for the desert sand of ARCENT; blue for the skies of CENTAF; black for the special operations of SOCCENT.

2. The three-cup anemometer is the traditional AWS symbol.

3. The crossed scimitars and palm are the symbol of the kingdom of Saudi Arabia. The palm itself symbolizes health, well being, and sustenance. The color green, lushness. The crossed scimitars symbolize the justice of the kingdom.

4. The red letters and outer band are symbolic of the courage of weather personnel deployed to support U.S. objectives in DESERT SHIELD.

5. The white background of the letters symbolizes the unity of effort of the joint support, as white is the union of all colors.

6. The three white stars in the blue background commemorate our three comrades who perished in the C-5 accident at Ramstein AB.

GLOSSARY

AB	Air Base
ADWS	Automatic Digital Weather Switch
AFB	Air Force Base
AFCC	Air Force Communications Command
AFDIGS	Air Force Digital Graphics System
AFGWC	Air Force Global Weather Central
AFLC	Air Force Logistics Command
AFSC	Air Force Systems Command
AFSOC	Air Force Special Operations Command
AOR	Area of Responsibility
ARCENT	Army Forces, Central Command
ARSOC	Army Special Operations Command
AT&T	American Telephone and Telegraph
AUTODIN	Automatic Digital Network
AWN	Automated Weather Network
AWS	Air Weather Service
AWSR	Air Weather Service Regulation
BOS	Back-Up Observing System
CAT	Crisis Action Team
CENTAF	Air Forces, Central Command
CENTCOM	Central Command
CINC	Commander in Chief
COMSEC	Communications Security
CONUS	Continental United States
DCS	Deputy Chief of Staff
DMSP	Defense Meteorological Satellite Program
DSFU	DESERT SHIELD/STORM Forecast Unit
EOTDA	Electro-optical Tactical Decision Aids
ETAC	Environmental Technical Applications Center
EURDIGS	European Digital Graphics System
FORSCOM	Forces Command [Army]
HF	High Frequency
IMA	Individual Mobilization Augmentee
IREPS	Integrated Refractive Effects Prediction System
JOAF	Joint Operational Area Forecast
JTF-PF	Joint Task Force-PROVEN FORCE
KTO	Kuwait Theater of Operations
MAC	Military Airlift Command
MARCENT	Marine Forces, Central Command
MEPA	Meteorological and Environmental Protection Association [Saudi Arabia]
METEOSAT	European Meteorological Satellite
MODA	Ministry of Defense and Aviation [Saudi Arabia]
NAVCENT	Naval Forces, Central Command
NCO	Noncommissioned Officer
NCOIC	Noncommissioned Officer in Charge
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NODDS	Naval Oceanographic Data Dissemination System

OIC	Officer in Charge
OICWSF	Officer in Charge Weather Support Force
OPORD	Operations Order
QRCT	Quick Reaction Communications Terminal
RAF	Royal Air Force [United Kingdom]
RDIT	Rapid Deployment Imagery Terminal
RSAF	Royal Saudi Air Force
RSLF	Royal Saudi Land Forces
SAC	Strategic Air Command
SAR	Support Assistance Request
SBLC	Standard Base Level Computer
SM-ALC	Sacramento Air Logistics Center
SOCCENT	Special Operations Command, Central Command
SOF	Special Operation Forces
SPO	System Program Office
SWO	Staff Weather Officer
TAC	Tactical Air Command
TACC	Tactical Air Control Center
TACFAX	Tactical Facsimile
TACCOM	Tactical Communications Equipment/Systems
TACMET	Tactical Meteorological Equipment/Systems
TFU	Tactical Forecast Unit
TIDS	Tactical Imagery Dissemination System
TOAF	Tactical Operational Area Forecast
TPFDD	Time-Phased Force Deployment Data
TWAC	Tactical Weather Analysis Center
TWS	Tactical Weather System
UN	United Nations
US	United States
USAFETAC	United States Air Force Environmental Technical Applications Center
USARCENT	United States Central Command, Army Forces
USCENTAF	United States Central Command, Air Forces
USCENTCOM	United States Central Command
USCINCCENT	Commander in Chief, US Central Command
UAWS	US Army, Europe, Automated Weather System
WGP	Weather Group Provisional
WMO	World Meteorological Organization
WSF	Weather Support Force

LIST OF SUPPORTING DOCUMENTS

The documents listed below (except for a few interviews) were cited three or more times in this study. These and all of the documents cited can be found in the Air Weather Service Archives, DESERT SHIELD/DESERT STORM files.

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All interviews were conducted by W.E. Nawyn, AWS Historian.

Col Peter F. Abt, AWS DCS/DO, Lt Col (Col Sel) Ronald R. Wall, AWS/ADO, Col Terry C. Tarbell, 5WW/DO, and Maj Norman E. Buss, AWS/DOJ, 10 May 91.

Mr Jay Albrecht, AFGWC/WFM, 14 Jun 91.

Capt Keith G. Blackwell, AFGWC/SDNN, 13, 14 Jun 91.

MSgt William J. Boyle, ARCENT Weather/NCOIC (and 5WS/DOJ), 18 Jul 91.

Capt F. Paul Bridges, 1ID(M)/SWO, Det 19, 1690WGP/OIC (and Det 8, 5WS/OIC), and
SSgt Duane P. Bullard, 1ID(M)/ASWO, Det 19, 1690WGP/NCOIC (and Det 8, 5WS/NCOIC), 19 Jul 91.

Maj Robert P. Callahan, 5WW/DOK, and MSgt Joe E. Brackett, 5WW/DOK, 6 Jun 91.

Lt Col Willliam H. Campbell, ARCENT/SWO, ARCENT WSE/OIC (and 7WS/DO), 1 Jul 91.

Maj John R. Conley, XVIII Corps/SWO (and 6WS/DO), 18 Jul 91.

Capt Judith E.Dickey, Det 6, 1690WGP/CC (and Det 7, 3WS), 7 Jun 91.

Capt Steven B. Dreksler, AWS/XTX, 12 Aug 91.

Col George L. Frederick, AWS/CC (AWS/CV during DS/DS), 19 Feb 92.

Col James W. Goldey, CENTCOM/SWO, OICWSF, and 1690WGP/CC (and 1WS/CC), 16 May 91.

CMSgt Rufus D. Grizzle, 5WW/DOOF, and MSgt William A. Brothers, 5WW/DOOJ, 5 Jun 91.

Capt Robert L. Haase and Mr George Krause, AFGWC/WSE, 14 Jun 91.

Lt Col Donald R. Hood, 5WW/DOX, 6 Jun 91.

Maj Robert W. Keefer, AWS/DOJ, 23 Jul 91.

Brig Gen John J. Kelly, Jr., HQ USAF/XOW (AWS/CC during DS/DS), 25 Feb 92.

Col William S. Koenemann, 5WW/CC, 4, 5 Jun 91.

Lt Col James H. Love, Chief, AFGWC/WFG, 12 Jun 91.

Capt Michael H. McDonald, 101AAD/SWO (and Det 1, 5WS/CC), and Capt William J. Spendley, 5SFG SOWT/OIC (and Det 1, 5WS), 17 Jul 91.

Maj James P. Millard, AWS/DOO, 20 Jun 91.

Capt John D. Murphy, DSFU/CC (and Det 7, 3 WS/CC), and Capts Thomas E. Coe and Jeffrey E. Johnson, DFSU members (and 5WW/DNS), 7 Jun 91.

Lt Col Kenneth A. Nash, Chief, AFGWC/WFM, Mr Kim Runk, Chief Forecaster, AFGWC/WFP, and Mr Jay Albrecht, AFGWC/WFM, 14 Jun 91.

Lt Col John O. Nett, TRADOC/SWO, 7 Jun 91.

Lt Col Kenneth A. Peterson, 5WW/DN, 6 Jun 91.

Col James A. Phillips, AFGWC/DO, 13 Jun 91.

Maj Daniel V. Ridge, 5WW/DNC, 7 Jun 91.

Lt Col Gerald F. Riley, Jr., CENTAF/SWO, CENTAF WSE/OIC (and 3WS/CC), 29 May 91.

Col Adrian A. Ritchie, Jr., AFGWC/CC, 12 Jun 91.

Lt Col James C. St. John, USAFETAC/CV, 14 Aug 91.

Lt Col John V. St. Onge, Chief, 5WW/DOX, 3 Jun 91.

Maj Kenneth B. Stokes, Chief, AFGWC/WFO, 12 Jun 91.

Mr Theodore N. Thompson, 5WW/AC, 6 Jun 91.

Mr Stanley W. Tkach, 5WW/DOX, 3 Jun 91.

Maj Charles W. Tuttle, USAFETAC/ECO, and Mr Kenneth R. Walters, USAFETAC/ECR, 14 Aug 91.

Maj Larry J. Waite, AFGWC/DOOK, 12 Jun 91.

Col William S. Weaving, 1690WGP/CV (and 5WS/CC), 30 May 91.

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