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Data Acquisition and Processing Program: A Meteorological Data Source

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PROGRAM: A METEOROLOGICAL DATA SOURCE

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ABSTRACT

The Data Acquisition and Processing Program (DAPP) is a unique and valuable data system. The sensors, communications, and data processing contribute to form the most responsive operational system of its kind. Data from DAPP will soon be routinely available to the meteorological community.

INTRODUCTION

This report introduces a unique and valuable data system. It is known as the Data Acquisition and Processing Program, or DAPP for short, and its data have recently become available to the public in order to make maximum use of this National resource. While certain aspects of the data system remain classified, meteorological data which are gathered from space and all specifications necessary to make full use of the meteorological data are now available.

SYSTEM OVERVIEW

The various features of DAPP contribute to form the most responsive operational data system of its kind. Note the stress on responsive and operational. The meteorological aspects of DAPP were designed under a total system concept in which not only platform and sensors, but communications and ground processing facilities were developed with the primary objective of providing maximum responsiveness to the operational decision maker, whether supported by a tactical field weather unit, or from a centralized, computer-based, weather facility. The basis for this development and existence is the closed-loop (Figure 1) requirements cycle, with feedback, among the Air Weather Service, the DAPP system designers, and the supported organizations, which, through the various staff weather officers, provide a concentrated focal point of well-defined support requirements.

The major factors which comprise operational responsiveness are shown in Figure 2. DAPP's unique attributes in relation to the factors are described below.

First is timing. The DAPP platform and sensors are designed to function at any local sun time. This unique attribute has proved vital to optimum operational support. We currently receive data sensed near dawn and near local noon, and during the hours of darkness from all regions of the globe.

Second is data processing. As is well known, the operational utility of weather data is perishable with time. The DAPP communications and ground processing system are designed to produce a usable product within five minutes of termination of the data stream. For direct readout, this means a data age of 5 to 20 minutes when ready for application to operational decisions. The central processing facility, Air Force Global Weather Central, Offutt AFB NE, is linked to its permanent readout facilities by realtime, wideband communications. Wideband communication channels allow for realtime recovery of (stored) recorded data such that the only timing increment added to the processing time is the transit time of the DAPP sensors from scene to readout circle.

The display form has been designed to facilitate data interpretation by the following features listed in Figure 3. The data are compensated for altitude differences; foreshortening at the edges is removed; the nominal scale is switch selectable between 1:7.5M and 1:15M; and for visual data, variations in solar illumination are compensated. Thresholding will be described later with an example.

The entire ground system for direct, local readout is contained in a self-enclosed unit, including antenna, which is air transportable, making overseas deployment to full scale operation a matter of hours. The centralized processing facility has, in addition to the display capability shown, the added capability to input the data stream directly into a computer, where the raw data are converted into cloud parameters and collated with conventional meteorological data into a comprehensive numerical cloud analysis.

As indicated earlier, the third factor of responsiveness is provided by the characteristics of the sensors and associated data streams. The major parameters are as indicated in Figure 4. An additional sensor not covered here is an 8-channel radiometer for the determination of vertical temperature profiles. Note that the visual and infrared sensors contain both a 0.3 nautical mile resolution capability for limited areas and 2.0 nautical mile resolution for global coverage. The spectral bandwidth of the visual sensors was selected to optimize distinction among clouds, ground, and water. Electronic circuitry in the infrared (IR) sensor converts the sensed IR energy directly into equivalent blackbody temperature, making temperature the directly displayed parameter within the limits indicated, once again demonstrating the operational responsiveness of the system. The sensitivity of the 2 n mi visual channel covers seven orders of magnitude which provides useful meteorological information from full daylight over highly reflective scenes to an illumination level roughly equivalent to half moon light.

DATA EXAMPLES

The first three examples (Figures 5-7) are simultaneous observations by three different sensors. The scene is Western Europe and the Mediterranean at local noon. Figure 5 is a 2 n mi visual presentation showing extensive cloudiness north of the Alps, snow cover in the Alps, and a band of clouds through the Mediterranean. Figure 6 shows a 0.3 n mi visual presentation of the same scene. Note the fine detail in the wave structure in the upper left and lower left, the valley stratus is Northwestern Spain, and the small scale cumulus along the North African shore line. The above features are not clearly discernable in the 2 n mi data. Figure 7 is the 2 n mi IR presentation with the white end of the grey scale corresponding to coldest temperatures. Note the uniformity of the cloud mass north of the Alps and the presence of well-developed convective cells in the Mediterranean cloud band. The simultaneous availability of mutually-coherent visual and IR data enables a much more complete description of cloud conditions than could be obtained from either alone.

Just as the 0.3 n mi visual data provides more cloud detail than the 2 n mi visual data, so does the 0.3 n mi IR data with respect to the 2 n mi IR data. Figure 8 shows the effects of a cold air mass streaming off the coast of the Eastern U.S. as seen by the 2 n mi IR sensor. Note the western edge of the cloud band off the East Coast. Figure 9 shows the same scene using the 0.3 n mi IR sensor. Note the detail in the cloud edge mentioned above. The added resolution greatly enhances data interpretability.

The thresholding feature of data display will now be discussed. By processing IR data in a computer in conjunction with conventional upper air information, one can obtain accurate cloud top altitudes. At a tactical site without computational capability, an interpreter, prior to the implementation of the thresholding feature, could obtain estimates of cloud tops only through subjective interpretation, possibly be means of a sample grey scale wedge. The thresholding feature, however, enables him to dial in up to three temperatures which, with the aid of sounding information or climatology, can correspond to operationally significant altitudes. Selecting regions for mid-air refueling is one obvious application. Figure 10 shows an IR presentation of Typhoon Rita just south of Korea as seen last summer (1972). Suppose the forecaster selected temperature threholds of 250K, 230K and 210K corresponding to altitudes of about 27,000 ft, 37,000 ft, and 46,000 ft, respectively. The result is shown in Figure 11 which is a four grey shade presentation of Figure 10 with clear differentiation of temperature (and by inference, altitude) ranges.

The capability of sensing nighttime scenes at visual wavelengths has not only enhanced operational support, but has provided a new and exciting research tool. Figure 12 shows a nightime visual view of Scandinavia under a full moon. Note the abundance of cloud information. Various bright dots which appear are city lights. In the upper right, there appears a very bright, elongated band which is a portion of the aurora borealis. In the absence of moonlight, the appearance of the aurora is often striking (Figure 13). Such broadscale depictions of the aurora are believed to be a first for DAPP. Finally, for academic and esthetic interest, Figure 14 shows a moonless night view of the Eastern United States which pictorially illustrates why we occasionally have power shortages.

CONCLUSION

In conclusion, it is re-emphasized that the operational responsiveness of DAPP has been attained by keeping the various components in balance with the goal of serving operational decision-makers. The capabilities outlined here greatly enhance the United States Air Force's Air Weather Service ability to meet its military commitments. The timeliness of high quality data serves to expand the scope and the importance of weather support as a decision factor.

The source of these data for the scientific community will be the National Environmental Satellite Service of NOAA. The data will be available in the near future.

REQUIREMENTS CYCLE

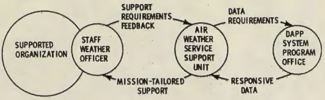

Figure 1.

OPERATIONAL RESPONSIVENESS

TIMING

DATA PROCESSING (TIMELINESS AND FORMAT)

DATA CHARACTERISTICS

Figure 2.

IMAGE GENERATION

ORBITAL NORMALIZATION

EQUAL AREA PROJECTION

LARGE SCALE POSITIVE TRANSPARENCY

ENHANCEMENT OPTIONS (VISUAL DATA)

THRESHOLDING AND SCALE EXPANSION (IR DATA)

Figure 3.

IMAGERY DATA CHARACTERISTICS

	VISUAL		INFRARED	
RESOLUTION (N.M.)	2.0	0.33	2.0	0.33
BANDWIDTH (μM)	0.4-1.1	0.4-1.1	8.0-13.0	8.0-13.0
SENSITIVITY ($WCM^{-2}\ ST^{-1}$)	8.8(-9)-2.54(-2)	8.6(-5)-2.54(-2)		
(^{o}K, EBT)			210-310	217-307
COVERAGE	GLOBAL	PARTIAL	GLOBAL	PARTIAL

Figure 4.

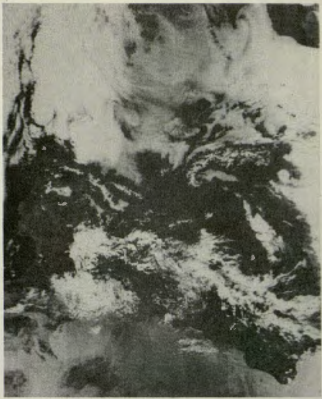

Figure 5. Two naut mi resolution visual depiction of Western Europe and the Mediterranean at local noon.

Figure 6. 0.3 naut. mi visual depiction of the same scene as Figure 5.

Figure 7. Two naut. mi IR depiction of the same scene as Figure 5.

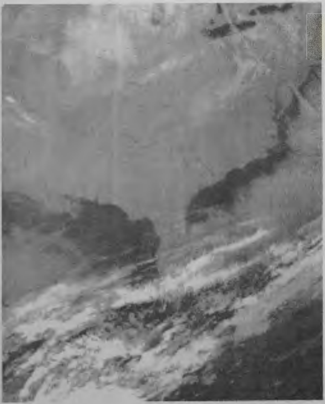

Figure 8. Two naut. mi IR depiction of the Eastern United States.

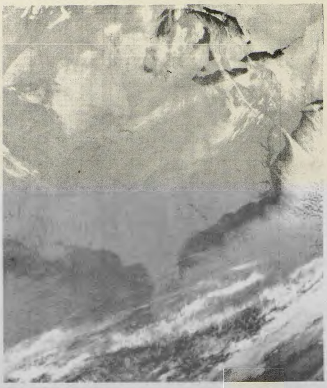

Figure 9. 0.3 naut. mi IR depiction of the same scene as Figure 8.

Figure 10. Two naut. mi standard IR depiction of Typhoon Rita in the vicinity of Korea.

Figure 11. Threshold IR depiction. The data of Figure 10 has been separated into four temperature ranges with delineation at 250K, 230K, and 210K.

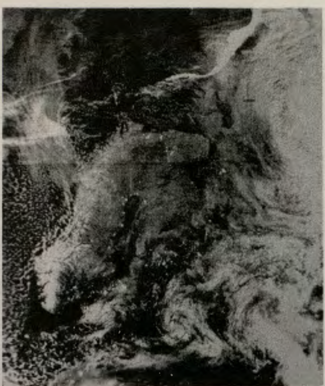

Figure 12. Two naut. mi visual depiction of Scandinavia at night under a full moon.

Figure 13. Two naut. mi visual depiction of the Aurora Borealis in the vicinity of Scandinavia at night in the absence of moonlight.

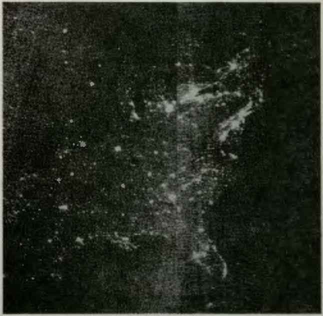

Figure 14. Two naut. mi visual depiction of the Eastern United States at night in the absence of moonlight.