DEPARTMENT OF THE AIR FORCE
WASHINGTON, D.C. 20330

OFFICE OF THE SECRETARY

16 February 1979

MEMORANDUM FOR DR. COOK

SUBJECT: IRS^3 - Civil Requirements for Polar Orbiting Metsat Data

The civil metsat program is managed by the National Environmental Satellite Service (NESS) of NOAA and consists of two satellite systems: geostationary (2 s/c) and polar orbiting (2 s/c). In general, the overall public safety (tornado/hurricane) and commercial (TV, etc.) civil U.S. responsibilities are satisfied by the civil geostationary metsats (see TAB A). The polar orbiting satellites primarily provide data for the global numerical forecast models. Both systems support international data exchange programs. The following summarizes the current civil plan and the primary civil requirements for polar orbiting metsats:

A. Civil Plan:

1. Spacecraft: Two Polar Orbiting TIROS-N S/C

1 - 1500L Descending (launched Oct 78)

2 - 0730L Ascending (planned 1st Qtr CY 79)

2. Orbits: Nodal times selected to balance following requirements:

1 - Maximize worldwide total coverage

2 - Meet timelines to run forecast models at 0320/1520Z with priority coverage in eastern Pacific to maximize data for storms approaching the west coast.

3 - Meet power (solar panel exposure)/lifetime/orbit stability requirements.

B. Civil Requirements:

Direct Users (TAB B summarizes type observations needed)

1 - National Meteorological Center (NMC) at NOAA

2 - U.S. and International receivers of real-time broadcast of visual imagery.

1. National Meteorological Center (NMC): primary organization supplying products derived from civil polar metsat data to users. NMC bases most of its support on numerical forecast models which require only temperature profile (T) and pressure (P) height data to run. Necessary data usually provided by

balloon soundings of T and P taken worldwide at 0000 and 1200Z. Start time of model processing controlled solely by time of receipt of balloon data. Satellite IR "sounders" measure radiance of CO_2 in atmosphere at 14-16 micron wavelength to determine approximate temperature of atmosphere at several heights. Satellite data are not as good as balloon data; therefore, primary benefit of satellite soundings is over data sparse areas; e.g., oceans, tropics, and southern hemisphere. Wind, moisture and cloud forecasts are derived from these models.

a. Three Models

Model	Start Time(Z)	Coverage	Use of Metsat
(1) Limited Fine Mesh	0130 1330	N.America	Probably not
(2) 7-Level	0320 1520	N.Hemisphere	Moderate (if timelines met)
(3) 9-Level	1000 2000	Global	Major (S. Hemisphere)

b. Output

1. Winds, temperature, pressure and moisture, global analyses and forecasts to (1) local forecast offices,(2) airlines, and (3) other users.

2. Recorded satellite imagery: cloud, snow and ice cover for land and ocean shipping.

3. Satellite thermal imagery: land and sea surface temperature.

c. NMC Summary: TAB C summarizes the NMC evaluation of their total metsat requirements.

2. U.S. and International Users with appropriate inexpensive equipment receive unencrypted real-time broadcasts of visual imagery.

3. All Others:

a. Space environment monitoring - STS and communications support.

b. Ozone and Global Cloud Reflectance - Climate forecast support.

c. Others as indicated in TAB B.

TAB D summarizes the polar metsat requirements as indicated in the POOMBSCOB report. DOD could meet all of these civil metsat requirements by modifying some existing DOD sensors and by carrying the NOAA-unique sensors.

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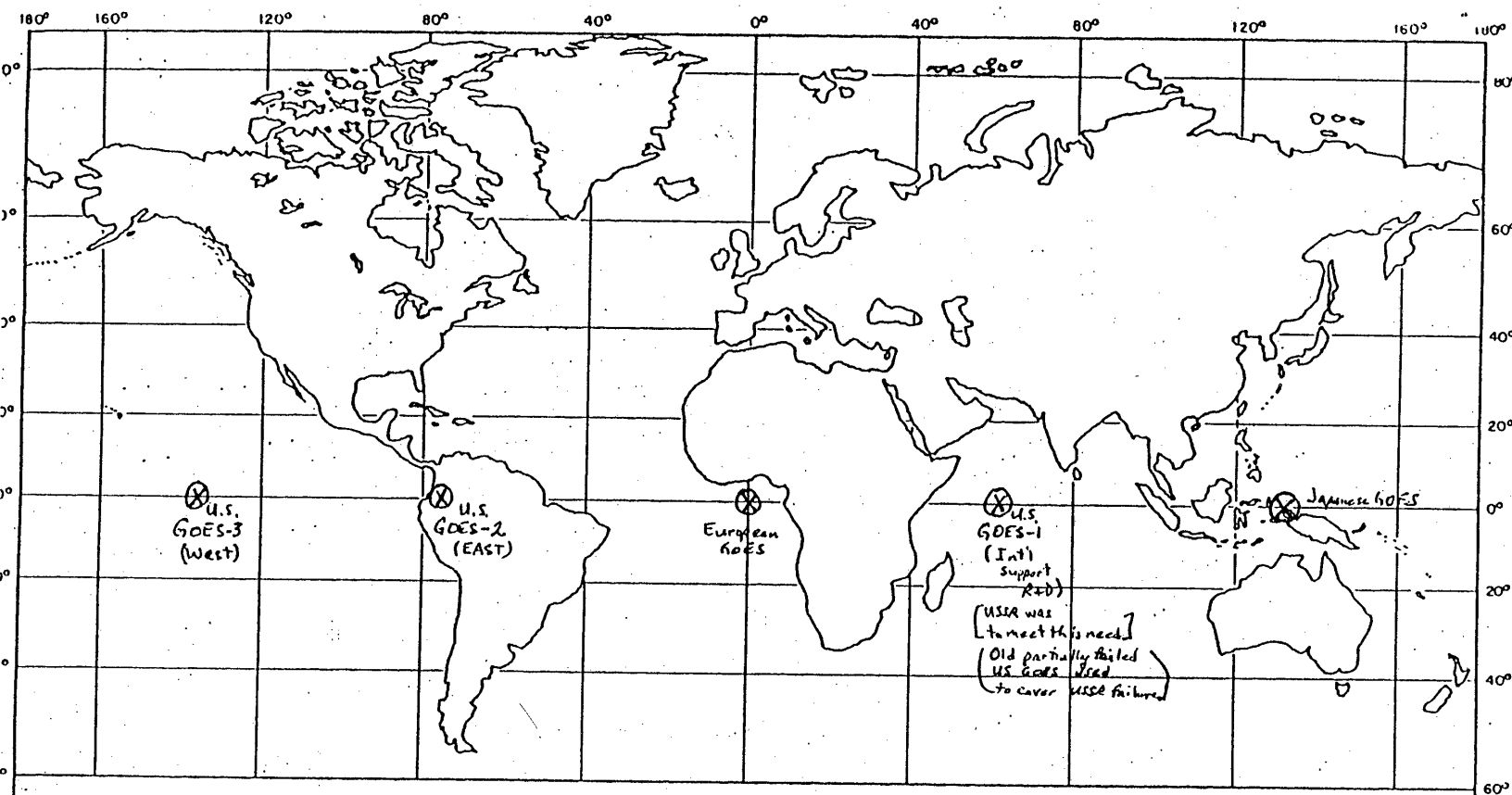
Lt Colonel, USAF



GEOSTATIONARY METSAT NETWORK

[Two Primary U.S. GOES (east & west)]

GOES = GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE

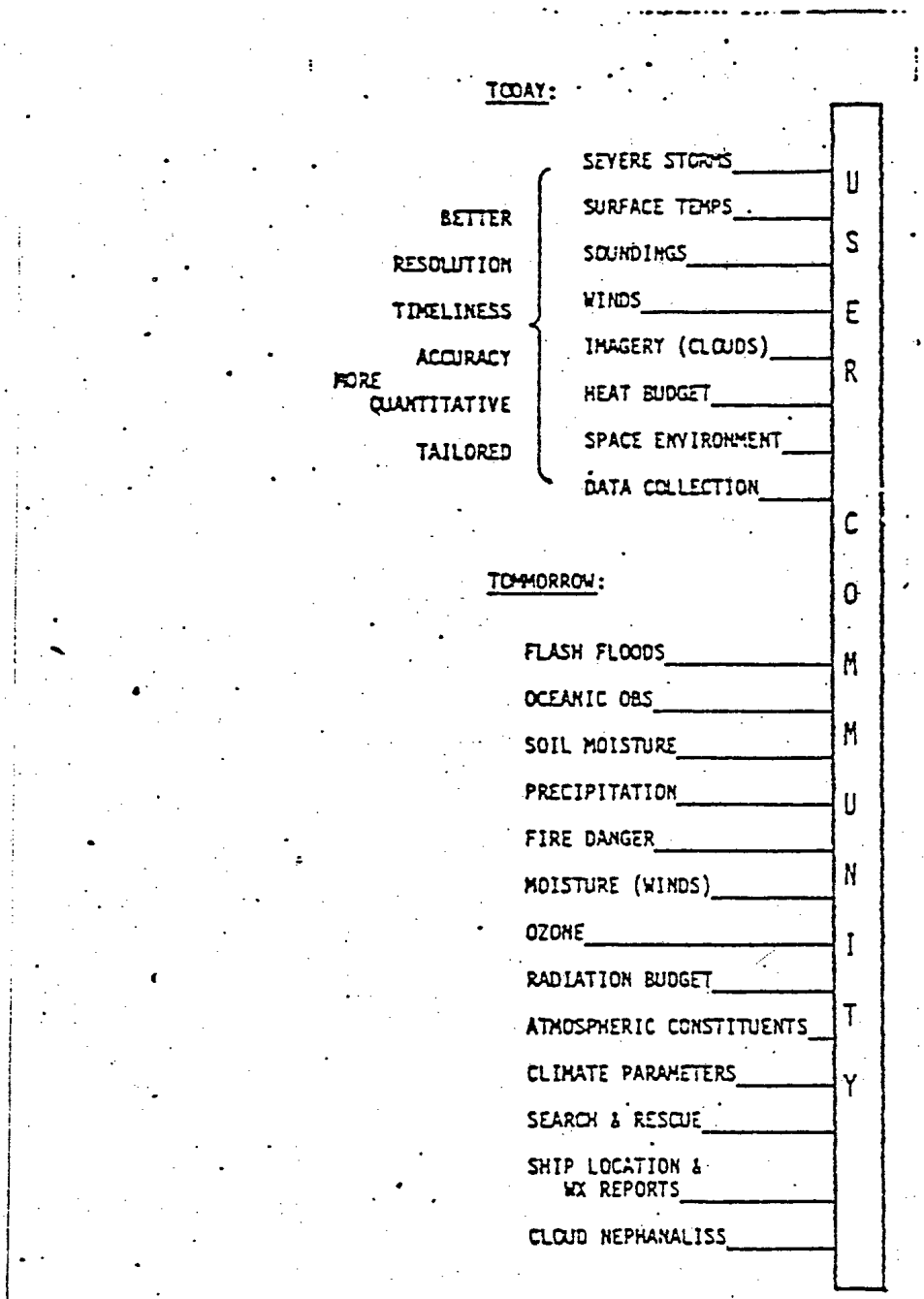


FIGURE 4. Today's Observational Needs with a Preliminary List of Tomorrow's Most Urgent Needs

Examples of Civil Support Requirements

G = Geostationary Satellite System

P = Polar Orbiting Satellite System

Examples:

Activities Directly Benefiting from Current Environmental Civil Satellite Programs

1. Gulf Stream Navigation for Fuel Savings - P
   Location by IR
2. Florida Citrus Industry - G
   Freeze warnings - IR
3. Hawaii Sugar Cane Industry - G & P
   Rain forecast
4. Search and Rescue - P
   Cloud cover
5. Arctic and Great Lakes Ice Monitoring - P & G
   Ice coverage & location
6. General Agriculture Industry - G
   General forecasting
7. Snow Cover Mapping - P
8. West Coast Fishing Industry - P
   Sea Sfc Temperature via IR
9. Disaster Warning - P & G
   (1) Typhoon/Hurricane (Polar) (2) Tornadoes/Thunderstorm (Geostationary) (3) Floods: US & International (Polar)
10. Large Scale Weather Forecasting - P & G

Summary of anticipated qualitative satellite measurements on NMC products (views of N. Phillips)

Measurement	N. Hemisphere	Tropics	S. Hemisphere
Temperature	Moderate, mostly in 48 hr fcsts for western N. America	None	Major
Ozone	Major	Moderate (if measurements good enough)	Major
Wind	Little (possibly major in hurricane tracking)	Major	Major
Moisture	?	?	?
Snow/Ice	Minor	None	None
FUTURE PRODUCTS			
Soil moisture	Possible effect in a) Diurnal Cycle b) 10 day forecasts	?	None
Sea Sat	Little	Little	Moderate
Surface pressure	Little	None	Major

"Major", "Little", etc. are stated with respect to other types of data.

The NMC Report on the Data Systems Test (NASA Contract S-70252-AG)

National Meteorological Center
Development Division
World Weather Building
5200 Auth Road
Camp Springs, Maryland

March 1978

I. INTRODUCTION

The Data Systems Test (DST) was designed to test some of the observational, data processing, and numerical prediction systems planned for the First GARP Global Experiment (FGGE). The National Meteorological Center's (NMC) primary roles were:

(1) to collect, process, and archive data from diverse meteorological observational systems (Level II data),

(2) to produce and archive global analyses from these data (Level III data),

(3) to determine the relative impact of satellite-derived temperatures on NMC's analysis-forecast system, and

Summary & Conclusions

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(4) to develop improved methods for the optimal extraction of useful information from the various observational systems.

A major part of this document addresses the first three goals. This, of course, is not intended to demean the importance of an improved data assimilation system. Instead, it merely reflects that only preliminary results were available at the completion of NASA Contract S-70252-AG in September 1977. The effort continues with high priority so that NMC's numerical weather analysis-prediction system will satisfy as fully as possible the Center's FGGE and operational commitments.

The results of the data collection, processing, and distribution of the Level II data sets are described in Chapter II for the DST-5 period (18 August to 4 September 1975) and DST-6 (1 February to 4 March 1976). Presented here also is a description of the quality of the Nimbus-6 soundings and the University of Wisconsin wind data.

D. The NMC Satellite Data Impact Study

Parallel assimilation runs were made for both the DST-5 and DST-6. The temperature data from the experimental Nimbus-6 and the operational NOAA-4 were included in one run (SAT) and excluded in the other (NOSAT). Prognoses generated by NMC's operational 6-layer primitive equation model for days drawn from the DST-5 indicated no significant impact through 72 hours in the Northern Hemisphere. Fifteen pairs of forecasts generated from DST-6 analyses reflected a small, statistically significant, improvement due to the satellite temperature data. Within the context of this NMC analysis-forecast system, the DST remote soundings apparently added little useful information to that already available from the combination of a good analysis guess provided by the forecast model and the conventional data base in the Northern Hemisphere.

Although this study reflects little beneficial impact of satellite remote soundings on forecasts, there were important synoptic differences between the SAT and NOSAT analyses. Weather systems as depicted by the SAT height and thermal fields are generally weaker, i.e., have less amplitude. This reduced amplitude reflects an inherent deficiency in the remote soundings; namely, the tendency for these satellite temperature retrievals to underestimate the spatial variance in the thermal structure of the atmosphere.

These impact results are disappointing. We are confident that improvements in both the NMC data assimilation system and the forecast model can be made to better account for the data and model errors, respectively. However, a greater capability of accounting for observational errors in the assimilation system does not necessarily imply an ability to compensate for such errors. Rather, it signifies the ability to recognize poor-quality observations and to accord them less influence in the analysis. Thus, it is essential to improve the quality of the data also. Together, the improvements in the analysis scheme, the forecast model, and the data quality may lead to beneficial impacts.

E. Preliminary Results of Increased Model Resolution

Limited testing was conducted to determine the impact of the satellite soundings using a forecast model more sensitive to the differences between the SAT and NOSAT analyses. Forecasts to 3 days were made with a higher horizontally resolved version of the Shuman-Hovermale 6-layer model and compared with the corresponding forecasts obtained with the coarse-mesh version. The horizontal grid distances of 60°N latitude on the polar stereographic projections (true at 60°N) were 190 km and 381 km.

The higher resolution model produced forecasts of significantly greater accuracy.[1] However, forecasts were improved equally well whether

[1] A version of this higher resolution model replaced the coarse-mesh version operationally at NMC in January 1978.

Table A-1

Summary of METSAT Data Requirements

Requirement	NOAA	DOD
Imaging for met use (Cloud cover)	2	1
Thermal mapping	1	1
Vertical profiling	1	2
Precipitation mapping	2	1
Snow cover	1	1
Ice cover	1	1
Radiation Balance	2	
Space Environment	2	2
Ionospheric Electron Density		1
Atmospheric Constituants	2	
Soil Moisture	2	2
Flood Expanse	2	2

1 = Highest priority
2 = Second priority