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REPORT ON THE NWS PREPARATIONS FOR A NO-GOES EVENT

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1. Background

Within the next few years the possibility exists that the NWS will have to operate without the aid of data from a Geostationary Operational Environmental Satellite (GOES). Present predictions have GOES-7, the only operational GOES satellite, lasting until 1993. The launch of the next GOES satellite (GOES I) is currently planned for February 1992. The GOES I launch schedule has already slipped several times and any further delays will increase the chances of a No-GOES scenario.

As the possibility of having to operate without GOES became evident, the NWS began to look at other sources of satellite information that could be made available on the Satellite Weather Information System (SWIS). These include the NOAA Polar Orbiting Environmental Satellites (POES), the U.S. Department of Defense Mapping Satellite Program (DMSP), and the European Space Agencies geostationary satellite, Meteosat. Since the POES satellites are operated by NOAA, they are the only non-GOES satellites that we will have any control over, and hence will rely upon the most.

The intent of this paper is to present some examples of the types of non-GOES satellite images that will be available on SWIS and microSWIS, and also to enlighten NWS field offices of the ongoing efforts to prepare for a possible No-GOES situation.

2. Polar Satellites

The advent of the U.S. satellite program for meteorological purposes began with the April 1, 1960 launch of TIROS-1. In 1966 the launch of ESSA-1 initiated the current POES system. This system requires that two polar satellites be in orbit and is currently being met by the NOAA-10 and 11 satellites (Rao et al., 1990). In addition, NOAA-9 is still in orbit and could provide satellite images if needed.

Polar orbiting satellites travel in a sun synchronous orbit at a mean height of about 850 km. It takes approximately 100 minutes per orbit which works out to 14 orbits per day. The rotation of the earth causes the satellite

to scan subsequent sectors with each orbit. Thus, the satellite will pass over any given point on the equator of the earth, twice per day, once in descending (north to south) mode, and once in ascending (south to north) mode. Consequently, two polar satellites provide four images per day over the continental United States (CONUS).

The organization responsible for planning, operating, producing, and distributing weather satellite products is the NOAA National Environmental Satellite and Information Service (NESDIS). Before polar images can be put on SWIS via the GOES tap line, several tasks have to be performed by NESDIS. Binary coded headers must be added to all of the NOAA polar imagery. In addition, political boundaries are needed on single orbit polar image sectors.

3. No-GOES Action and Test Plans

Over the past year, the NWS has developed a No-GOES Action Plan. Included in the plan are sections on the current GOES status, preparation requirements for a No-GOES event, and a plan-of-action at WSFO's and national centers during a No-GOES situation (NWS, 1990).

One of the early realizations was the need for testing of the No-GOES Action Plan. To accomplish this the NWS and NESDIS developed a No-GOES Test Plan. As stated in this plan, "the goal of the No-GOES test is to demonstrate the ability of NOAA's product generation and distribution system to supply imagery from non-GOES sources" (NOAA, 1990).

Thus far, three phases of No-GOES testing have been identified. Phase 1, held during the last eclipse (September-October 1990) was an initial demonstration of product generation and distribution capability. Several non-GOES images were sent over the GOES tap during the eclipse period each day and loaded into SWIS. Phase 2, held on November 7, 1990, was designed to simulate a No-GOES event by testing the product generation and distribution system for a 24 hour period. Phase 3 is scheduled for 1991 and will address improvements and additional capabilities made since Phase 2.

4. No-GOES Test Phase 2

Phase 2 was initiated November 7, 1990 at 0000 UTC and lasted for 24 hours. NWS participants included, NWS Headquarters, national centers, regional offices, and several WSFO's from each region. Central Region WSFO's taking part were Cheyenne, Des Moines, Indianapolis, and Topeka. Since the purpose of the test was to demonstrate product generation and distribution, the WSFO's were free to switch back to GOES images if significant weather was imminent. As it turned out the meteorological conditions were rather mundane over the Central Region during the test.

5. Non-GOES Images

A. GAC Images

Images were received from NOAA POES, DMSP, and Meteosat during Phase 2 of the No-GOES test. Figure 1 is an example of a POES Global Area Coverage (GAC) image. GAC data, which have a resolution of 4 km, are recorded on board the satellite and can only be recovered on the next orbit when the satellite is within communication coverage of one of the two ground stations (Wallops, Virginia and Gilmore Creek, Alaska). This, when combined with data ingest, formatting, and transmission processes, results in at least a two hour time delay.

As can be seen in Figure 1, the size of the header made it quite difficult to read. This was true for both the hardcopy printout and the screen image from SWIS.

B. HRPT Images

Several high resolution picture transmission (HRPT) images were transmitted onto SWIS during the test. Because of the high (1 km) resolution, HRPT images (Figure 2) provide a very detailed infrared or visible picture. Several features stand out including the Missouri (A), North Platte (B), and Mississippi (C) rivers. These and other smaller rivers are visible through a swath of snow (D) which covered parts of Nebraska and Iowa at the time.

Only the ability to positively identify the aforementioned rivers, combined with the knowledge of snow cover in Nebraska and Iowa, made it possible to discern the location in Figure 2. If extensive cloud cover had blanketed the area, identification would have been impossible because geographical features, such as rivers, would have been obscured by the clouds. The absence of gridded state boundaries on current HRPT images is an obvious short fall.

Since HRPT data can be transmitted directly to a ground station as the satellite passes over, the timeliness proved to be better than GAC images, with a time delay of about one to two hours.

C. Composite Images

Composite images (Figure 3) were produced by combining several of the GAC passes and then remapping the data. The composites were available on SWIS five to nine hours after imaging. Because improper headers were put on the images, they ended up going into the SWIS message file instead of an image file.

Figure 1. NOAA 11 polar satellite GAC image, November 7, 1990.

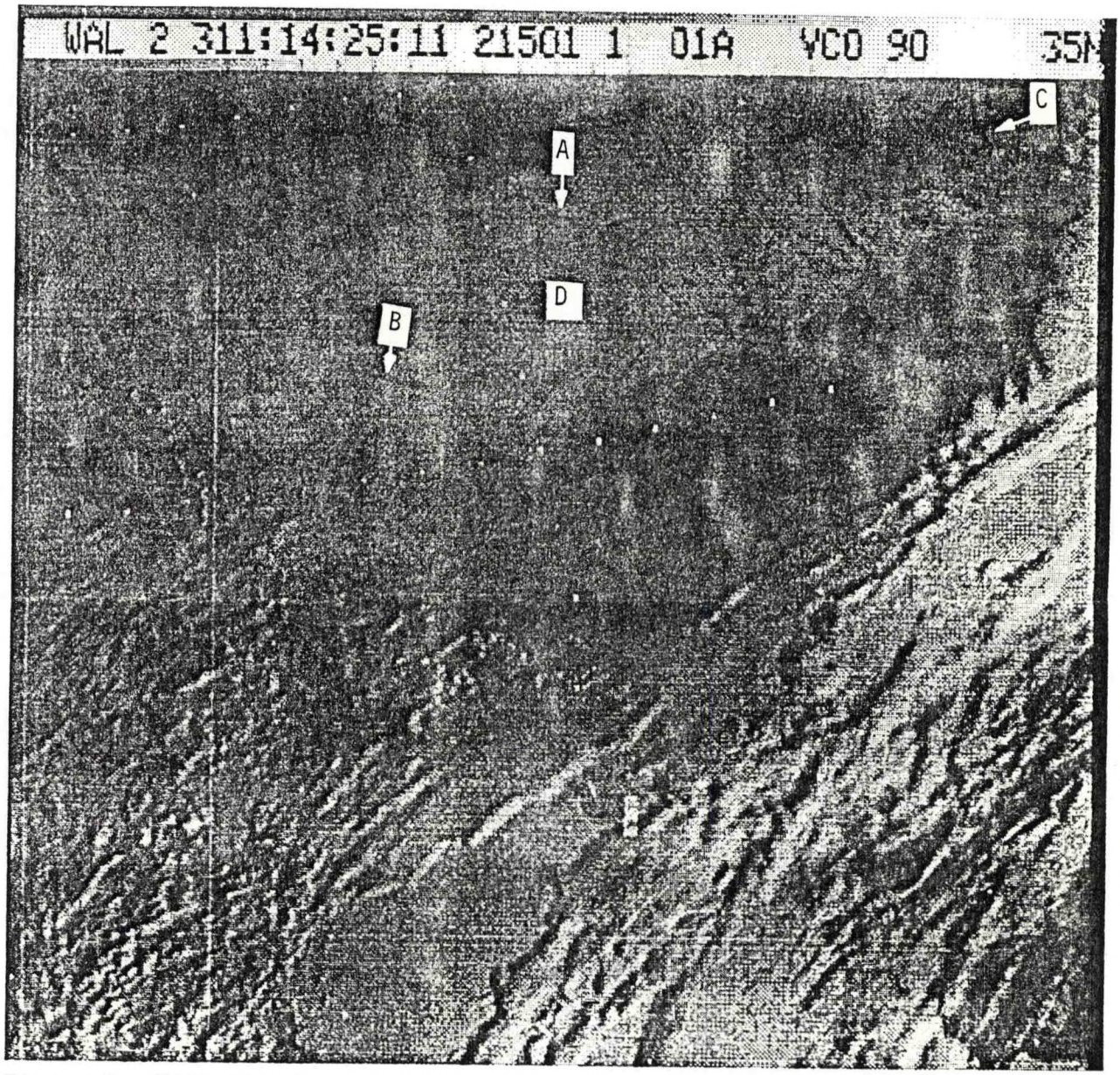

Figure 2. NOAA 11 polar satellite HRPT visible image, November 7, 1990, 1425 UTC.

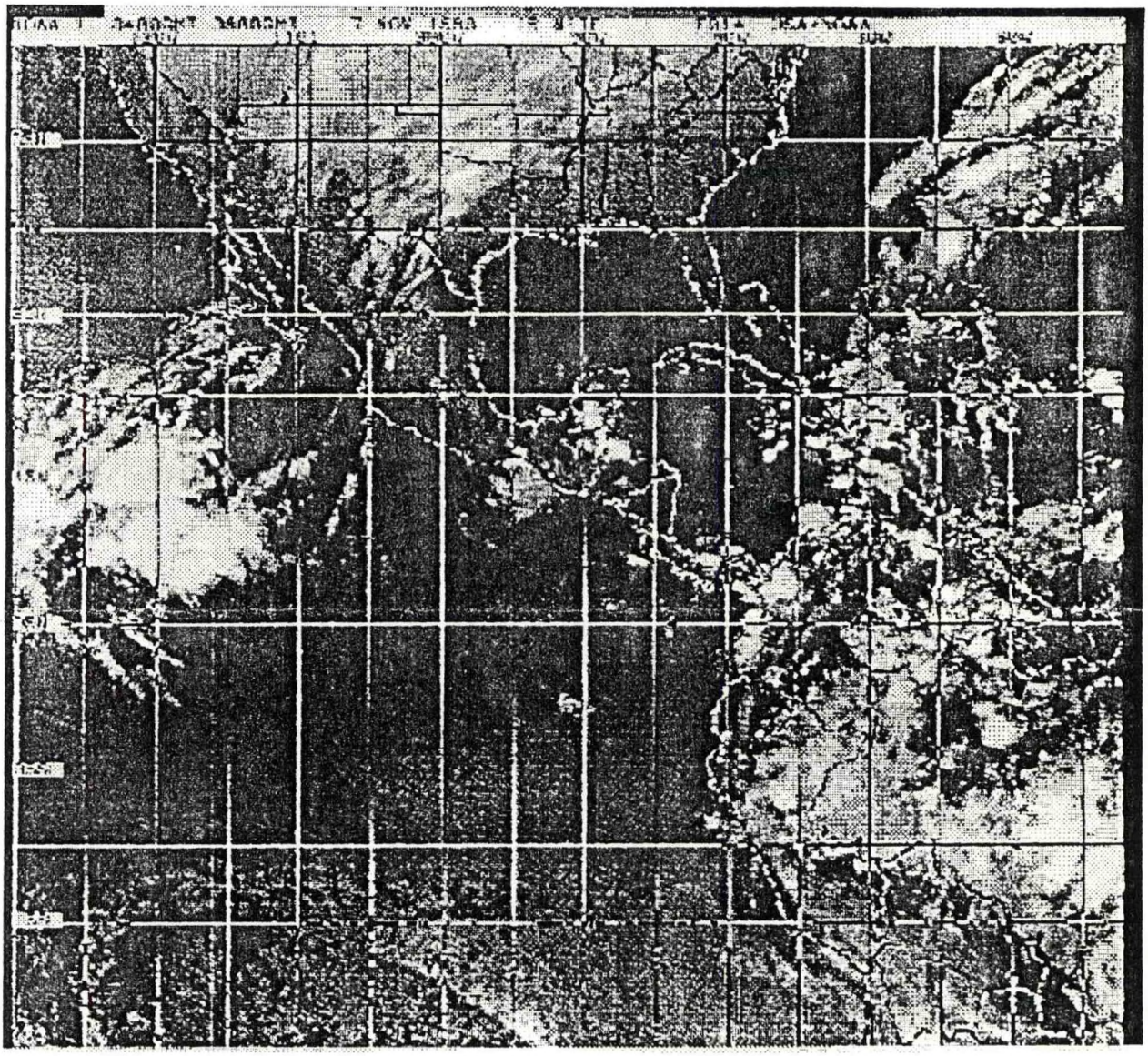

Figure 3. NOAA 11 polar composite infrared satellite image, November 7, 1990, 0400-0800 UTC.

D. Other Images

Examples of DMSP and Meteosat images are shown in Figures 4 and 5, respectively. Access to DMSP is more limited than NOAA satellite data, as NESDIS has to wait until DMSP data arrives at the shared processing facility at Suitland, Maryland. In addition, the Department of Defense sets the distribution schedule via internal considerations. This causes at least a two hour delay before NESDIS is able to access the data. As a result, the DMSP images a forecaster could see on SWIS, are far from timely. Another problem with the DMSP images on SWIS are the headers which are nearly unreadable.

Only one Meteosat image (Figure 5) was received on the Central Region SWIS during the No-GOES test. Although this type of image would not be of much utility to our forecasters at present, the Meteosat images may provide some relief in the upcoming years. At the moment, there is one Meteosat in operation at $0^{o}W$ latitude. An additional Meteosat is scheduled to be launched in 1991. If the launch is successful and the Europeans end up with two operational geostationary satellites, they have expressed a willingness to move one satellite to $50^{o}W$ latitude. A satellite positioned there would be able to image much of the CONUS.

6. WSFO Implications

In addition to the previously stated goals of the No-GOES test, WSFO forecasters participating in the test were asked how a No-GOES status did, or would, affect operations at their office. Most agreed the impact would be detrimental, especially during active weather. Many aviation forecasters noted the affect it had on timing the movement of cloud systems. The biggest complaints had to do with the fact that most of the images did not cover the central U.S., but other areas such as the middle east, eastern Pacific, etc. Surprisingly, a large number of forecasters stated that if this was the best they could receive, they might as well not have satellite data at all.

Several mentions of the test were alluded to in state forecast discussions (SFD's). An SFD issued by WSFO Indianapolis stated that "using polar images can not define speed of clearing over Iowa into western Illinois." Also, an SFD issued by WSFO Topeka after the test stated it "sure is nice to have satellite images again...No-GOES test of yesterday was like having no satellite data at all."

7. Test Results

All NWS offices that participated in the No-GOES test were asked to fill out a questionnaire. About half of the responses indicated that the test was a

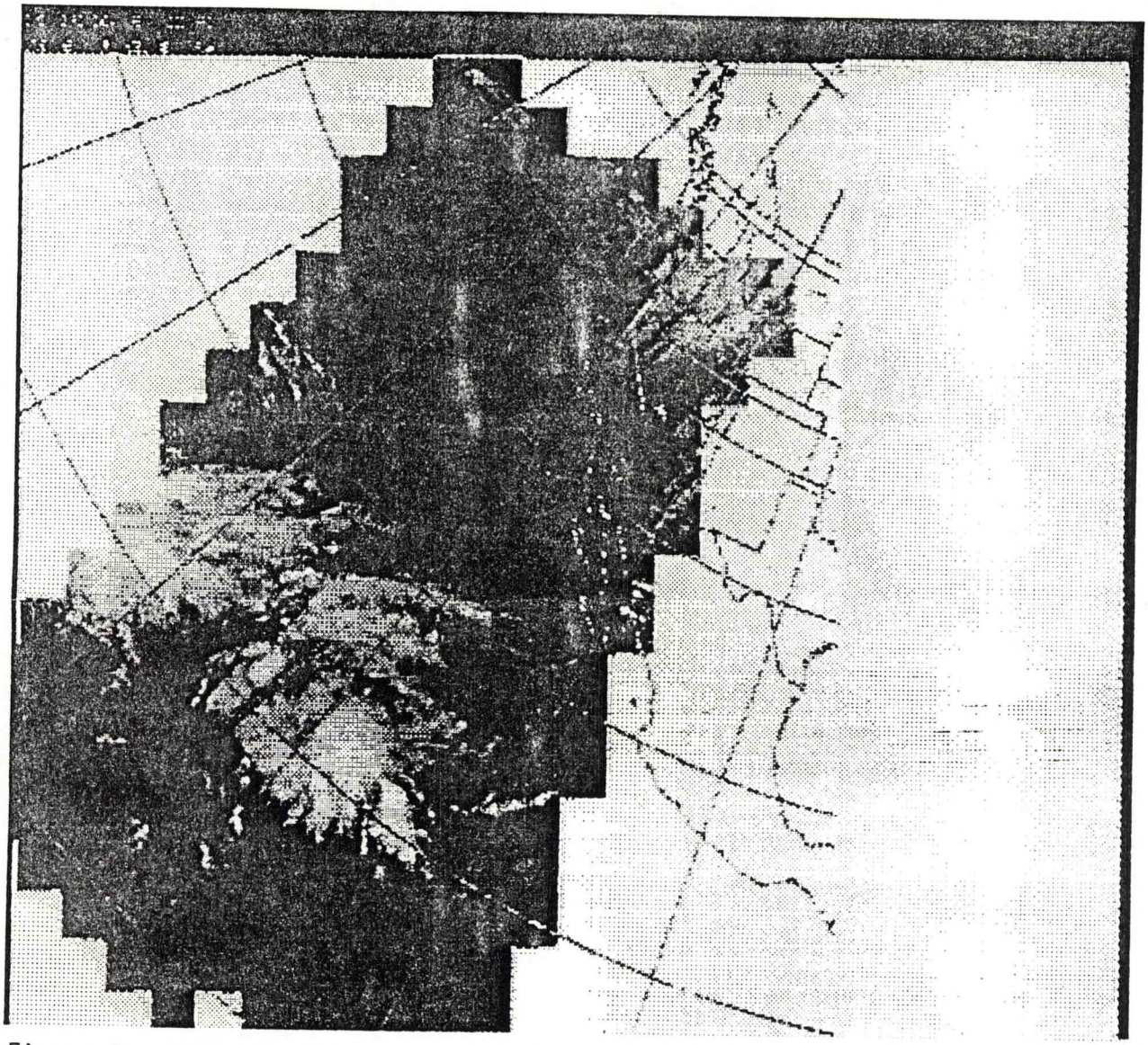

Figure 4. DMSP satellite image, November 7, 1990.

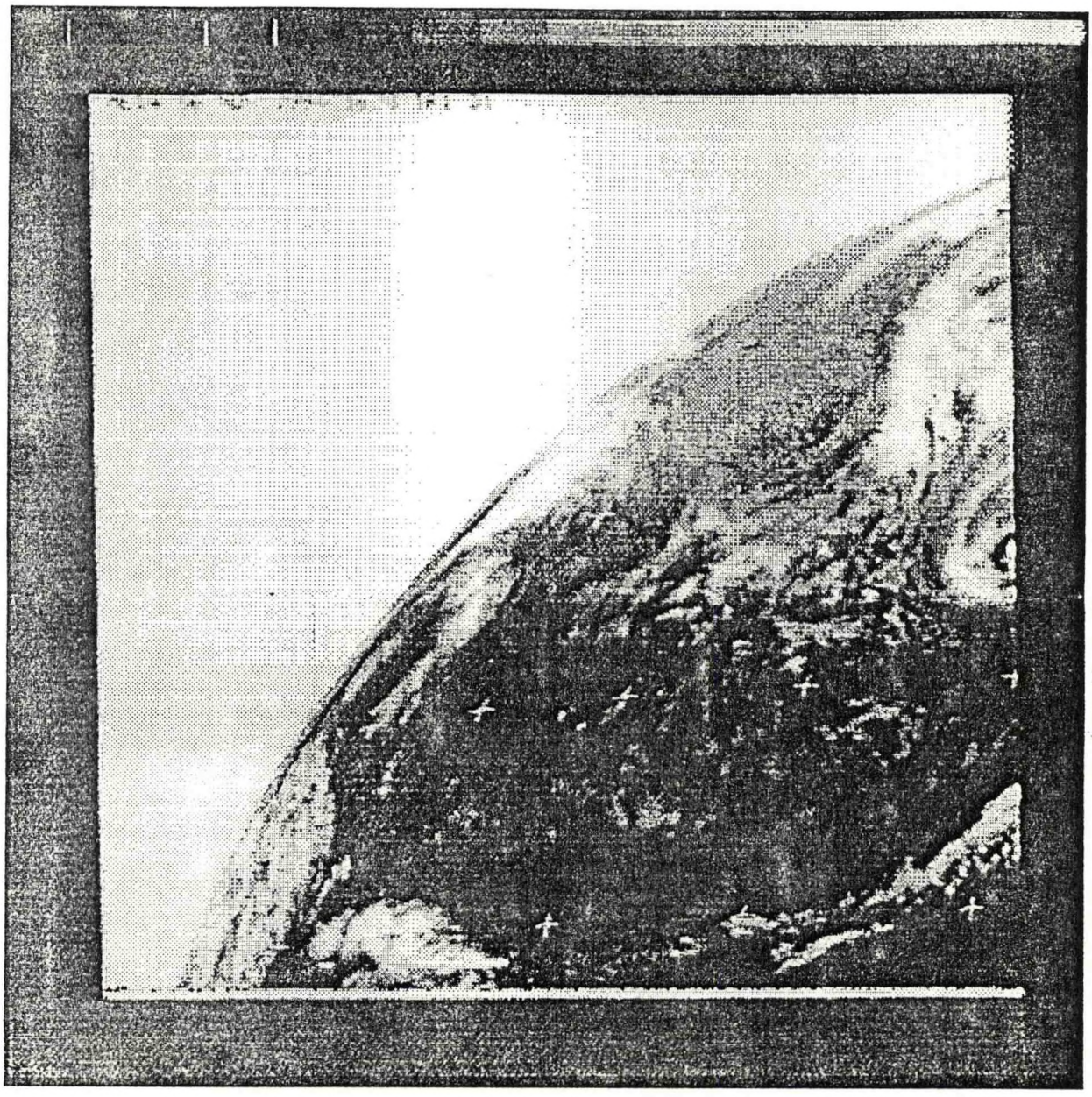

Figure 5. Meteosat infrared satellite image, November 7, 1990, 1630 UTC.

failure in terms of demonstrating the ability to generate and distribute satellite products. And yet, the test was a success in terms of identifying many correctable problems such as:

(a) unreadable headers on all images except HRPT,
(b) missing binary headers on composite images which cause them to go into the SWIS message file,
(c) too few images over the CONUS and too many images over other areas such as the middle east and India,
(d) lack of state boundaries on HRPT images,
(e) the schedule of when non-GOES images would be available was not adhered to, and
(f) timeliness of non-GOES images inadequate for operations.

Solutions to all of the above mentioned problem areas are currently being looked into and, in fact, some fixes have already been implemented.

8. Conclusions

There is no question that a No-GOES situation will seriously affect the mission of the NWS. While it is true that Polar data cannot replace GOES data, it is hoped that it can provide some utility to the forecaster and will, in fact, be better than no satellite data at all.

Results from Phase 2 of the No-GOES test indicate many improvements need to be made before reliable and timely non-GOES satellite information will be available on SWIS. It is encouraging to note however, that some of these problems have already been corrected while others are presently being addressed.

The next opportunity for field offices to view non-GOES data is during the next eclipse, late February through early April 1991. Personnel are encouraged to do so and to participate in future phases of the test in order to better prepare themselves in case a No-GOES scenario becomes a reality.

9. References

National Oceanic and Atmospheric Administration, 1990: No-GOES Test Plan. Available from National Weather Service, Office of Meteorology, Marine and Applied Services Branch, Silver Spring, MD

National Weather Service, 1990: No-GOES Action Plan. Available from National Weather Service, Office of Meteorology, Marine and Applied Services Branch, Silver Spring, MD.

Rao, P. K., S. J. Holmes, R. K. Anderson, J. S. Winston, and P. E. Lehr, Eds., 1990: Weather Satellites: Systems, Data, and Environmental Applications. Amer. Meteor. Soc., Boston, MA, 503 pp.