MONITORING THE CHESAPEAKE BAY

USING SATELLITE DATA

FOR SUPERFLUX III*

Fred M. Vukovich and Bobby W. Crissman
Research Triangle Institute
Research Triangle Park, North Carolina

SUMMARY

TIROS-N and NOAA-6, and GOES visible infrared satellite data were used to identify and locate surface oceanographic thermal fronts for the purpose of issuing daily and pre-mission advisory briefings in support of the Superflux III in situ and remote-sensing experiment in the Chesapeake Bay region. Satellite data were collected for the period 1 - 22 October 1980. A summary of that data is presented.

INTRODUCTION

The Research Triangle Institute participated in the Superflux III experiment by using data from TIROS-N, NOAA-6, and GOES to monitor ocean surface temperature discontinuities in the Chesapeake Bay region. Both infrared and visible satellite data were utilized for the monitoring. RTI also used these satellite data to prepare preoperational briefings of expected conditions for the Superflux field operations office during the operating period of Superflux III.

SATELLITE DATA

TIROS-N, NOAA-6, and GOES visible and infrared satellite data were used to monitor continuously the Chesapeake Bay region from 1 to 22 October 1980. Satellite data were collected by the satellite receiving station (RTI/SRS) located on the campus of RTI. This facility has the capability to interrogate the TIROS-N and NOAA-6 satellites in real time and to acquire quasi-real time (within 15 minutes of acquisition) GOES satellite data through a link with the Washington, D.C. GOES facility.

---

*Work performed for U. S. Department of Commerce , National Oceanic and Atmospheric Administration, National Marine Fisheries Service, the Northeast Region, under Contract No. NA-81-FA-C-00002.

The visible and infrared satellite data depict observed features in contrasting shades (or levels of gray). The visible imagery (0.55-0.9 μm for TIROS-N and NOAA-6 and 0.55-0.7 μm for GOES) can be used to delineate land, water, and cloud/fog fronts or boundaries. The infrared imagery (10.5-11.5 μm for TIROS-N and NOAA-6 and 10.5-12.6 μm for GOES) can be used to delineate surface oceanic thermal fronts associated with a variety of features characterized by contrasting temperatures. The primary effort in this project was to identify and locate thermal fronts in the Chesapeake Bay region.

In order to satisfy the objectives of this project, considerable satellite imagery was collected from the period 1 through 22 October 1980. The data for TIROS-N and NOAA-6 are outlined in Table 1 and the data for the GOES satellite are outlined in Table 2. The data represent those days when skies were sufficiently clear for the ocean surface in the Chesapeake Bay region to be observable.

The availability of NIMBUS 7 data from the coastal zone color scanner (CZCS) was examined. These data would complement the ocean color data collected by aircraft. Table 3 shows the potential data availability from the CZCS.

It was of interest to examine our data files to determine the data availability for Superflux I and Superflux II which were conducted prior to the initiation of this contract. Table 4 gives the dates for which clear-sky images are available from the NOAA-6 and TIROS-N satellites. We also contacted NASA's Goddard Space Flight Center to determine the availability of infrared data from the Heat Capacity Mapping Mission (HCMM) satellite. Data processing had not yet been completed for 1980 data. Therefore, no determinations could be made.

DATA ANALYSIS

Figures 1 through 7 yield examples of the TIROS-N and NOAA-6 infrared imagery for the period 8 October through 22 October 1980. In the imagery, black is warm and white is cold. The levels of gray treat intermediate values of temperature. These images are generally characterized by the same features. The Gulf Stream warm water region off the coast of the Carolinas and departing from the coastal region at around Cape Hatteras is the main current feature found off the southeast coast of the United States (see Figure 1). In the Chesapeake Bay region, there is a narrow zone (a darker shade of gray relative to the immediate surrounds, in Figure 1) of warm water oriented north-south found along the coast. East of that narrow zone of warm water is a larger mass of cold water also oriented in a north-south direction (the lighter shade of gray in Figure 1). East of that zone is a large mass of warm water which appears to be warmer than the near coastal warm water because it has a darker shade of gray and which has fingers of warm water protruding into the cold mass on the western side. Immediately south of the Chesapeake Bay mouth and stretching as far south as the Oregon Inlet in many cases, is a narrow zone of cold water (the lighter shade of gray in Figure 1) trapped along the shoreline.

Figures 8 through 10 together with Figure 4 present the infrared imagery collected on 16 October 1980 through the period 0047 GMT to 2000 GMT. These data essentially give a temporal description of the water mass off the coast near the Chesapeake Bay mouth for that day. The imagery shows the same general features off the coast near the Chesapeake Bay previously discussed; i.e., the narrow zone of warm water stretching north-south along the coast, the colder water further east, the warmer water much further east, and the narrow zone of cold water trapped along the coast just south of the mouth of the Chesapeake Bay. Of interest in these images is the small zone of cold water developing off the coast due east of the Oregon Inlet. This feature is evident on the 0835 GMT and the 1305 GMT images, but is not evident at 0047 GMT or at 2000 GMT. It is believed that this is cold water outflow through the Oregon Inlet. We have not checked the tidal tables as yet to determine whether this outflow was produced by the tides. The images do indicate that the waters in the Pamlico Sound were cold relative to the waters immediately off the coast. This suggests that the water in the Chesapeake Bay may be cold and that the cold water trapped from the Chesapeake Bay mouth southward along the shoreline may be the outflow from the Chesapeake Bay. The other alternative explanation is upwelling along the coast. We hope that analysis of digital satellite data combined with <u>in situ</u> data collected during Superflux III will clarify this point.

Table 1. Hard-copy of TIROS-N and NOAA-6 satellite imagery collected.

Satellite: TIROS-N		
DATE	ORBIT	TIME (GMT)
10/08/80	10240	08:26
10/12/80	10304	20:47
10/13/80	10311	09:10
10/13/80	10318	20:36
10/14/80	10325	08:58
10/14/80	10332	20:25
10/15/80	10339	08:47
10/15/80	10346	20:12
10/16/80	10353	08:35
10/16/80	10360	20:00
10/17/80	10367	08:25

Satellite: NOAA-6		
DATE	ORBIT	TIME (GMT)
10/08/80	6666	12:42
10/10/80	6695	13:40
10/11/80	6709	13:17
10/13/80	6744	23:50
10/16/80	6773	00:47
10/16/80	6780	13:05
10/17/80	6787	00:25
10/17/80	6794	12:42
10/20/80	6837	13:17
10/21/80	6844	00:37
10/21/80	6851	12:53
10/22/80	6858	00:14
10/22/80	6865	12:31
10/22/80	6872	23:52

Table 2. Hard copy of GOES satellite imagery collected.

DATE	TIME (GMT)	DESCRIPTION
10/07/80	17:00	1
10/07/80	21:00	1
10/08/80	14:00	1
10/08/80	17:00	1
10/11/80	18:30	2
10/12/80	18:30	2
10/13/80	18:30	2
10/14/80	18:30	2
10/14/80	19:00	3
10/15/80	14:00	3
10/15/80	18:00	3
10/15/80	18:30	2
10/17/80	18:30	2
10/19/80	18:30	2
10/20/80	13:00	3
10/20/80	18:00	2
10/20/80	20:00	3
10/21/80	18:00	3
10/21/80	18:30	2
10/22/80	01:30	4
10/22/80	18:00	3
10/22/80	18:30	2

1- Enhanced 3.2-km resolution sector centered at 26° N, 90° W
2- Enhanced 1.6-km resolution sector centered at 37° N, 75°W
3- Enhanced 1.6-km resolution DA1 sector
4- Standard 3.2-km resolution DB5

Table 3. Ocean color data from NIMBUS 7 CZCS.

DATE	ORBIT NO.	TIME OVER AREA (EST)	EQUATOR CROSSING
10/15	9948	1140	77°W
10/16	9998	1159	81°W
10/17	PASS	NOT	GOOD
10/18	PASS	NOT	GOOD
10/19	10039	1111	71°W
10/20	10053	1130	75°W
10/21	10067	1149	80°W
10/22	PASS	NOT	GOOD
10/23	PASS	NOT	GOOD
10/24	10108	1120	72°W

Table 4. Satellite infrared data available for SUPERFLUX I and II from NOAA-6 and TIROS-N

SUPERFLUX I	SUPERFLUX II
(16 - 20 March 1980)	(18 -28 June 1980)
12 March 1980	11 June 1980
14 March 1980	12 June 1980
15 March 1980	13 June 1980
18 March 1980	16 June 1980
	17 June 1980
	20 June 1980
	27 June 1980
	1 July 1980

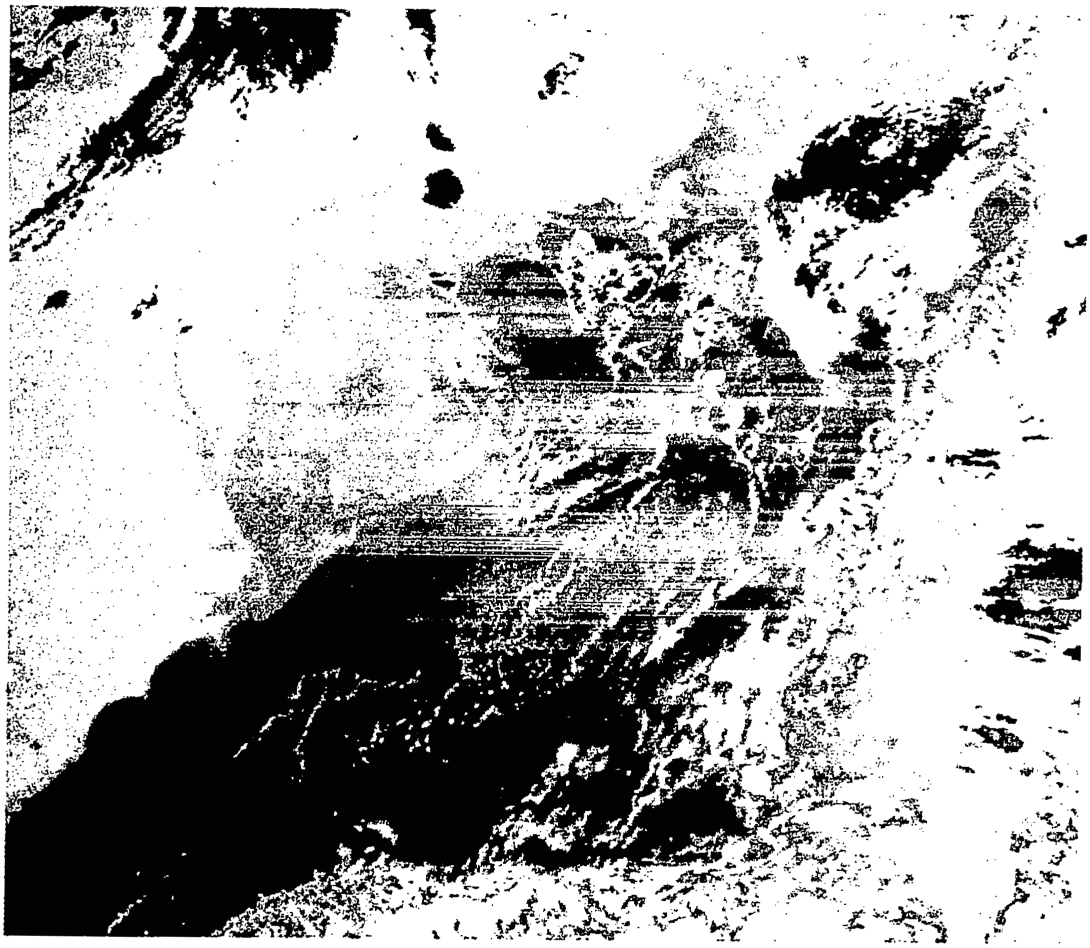

Figure 1. NOAA-6 infrared image for 8 October 1980, 12:42 GMT.

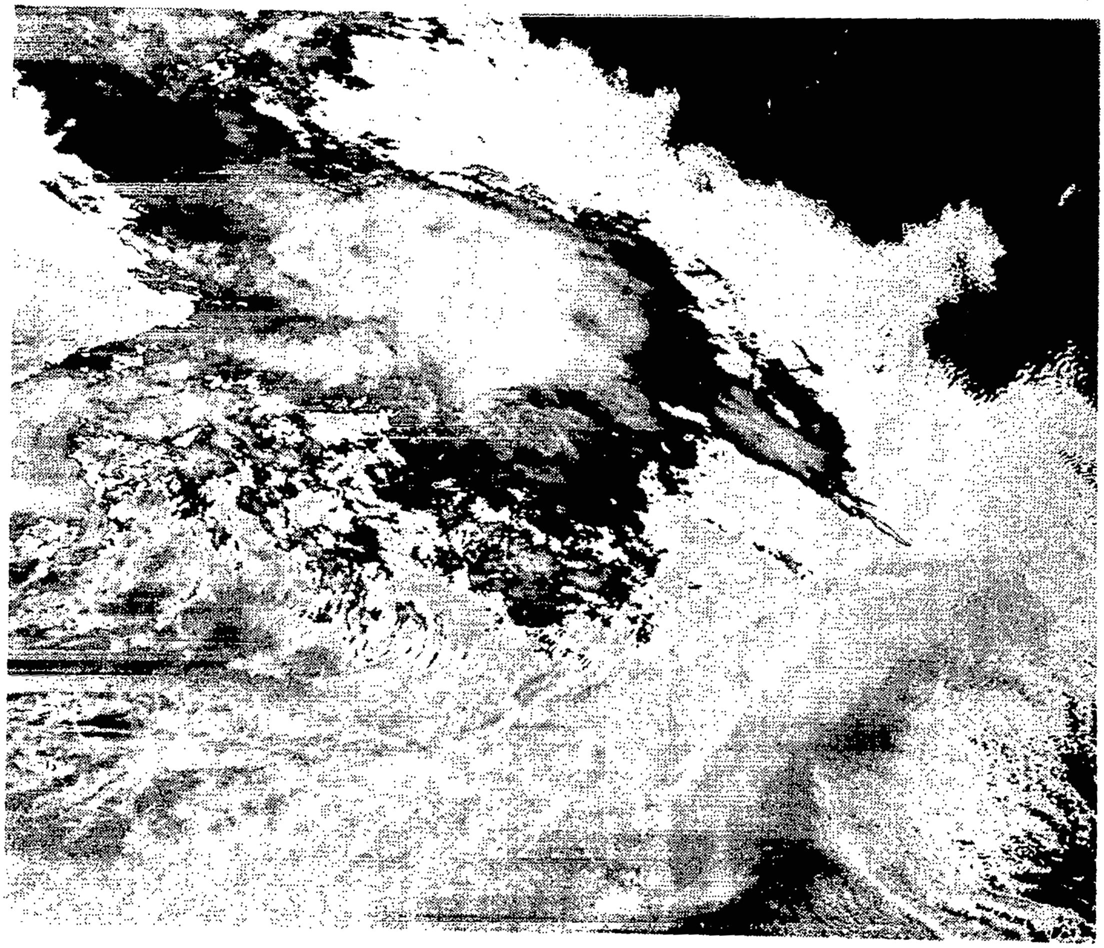

Figure 2. TIROS-N infrared image for 14 October 1980, 2025 GMT.

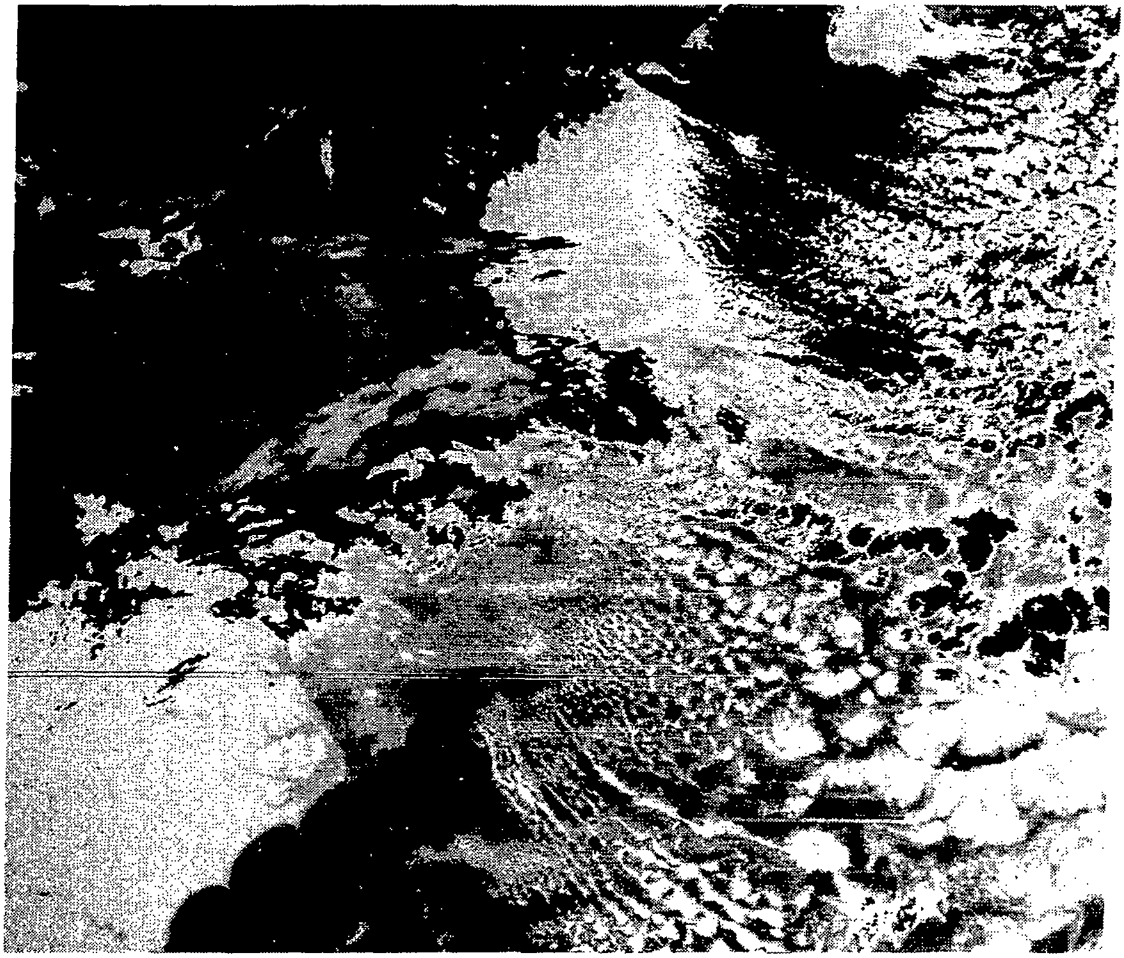

Figure 3. TIROS-N infrared image for 15 October 1980, 0847 GMT.

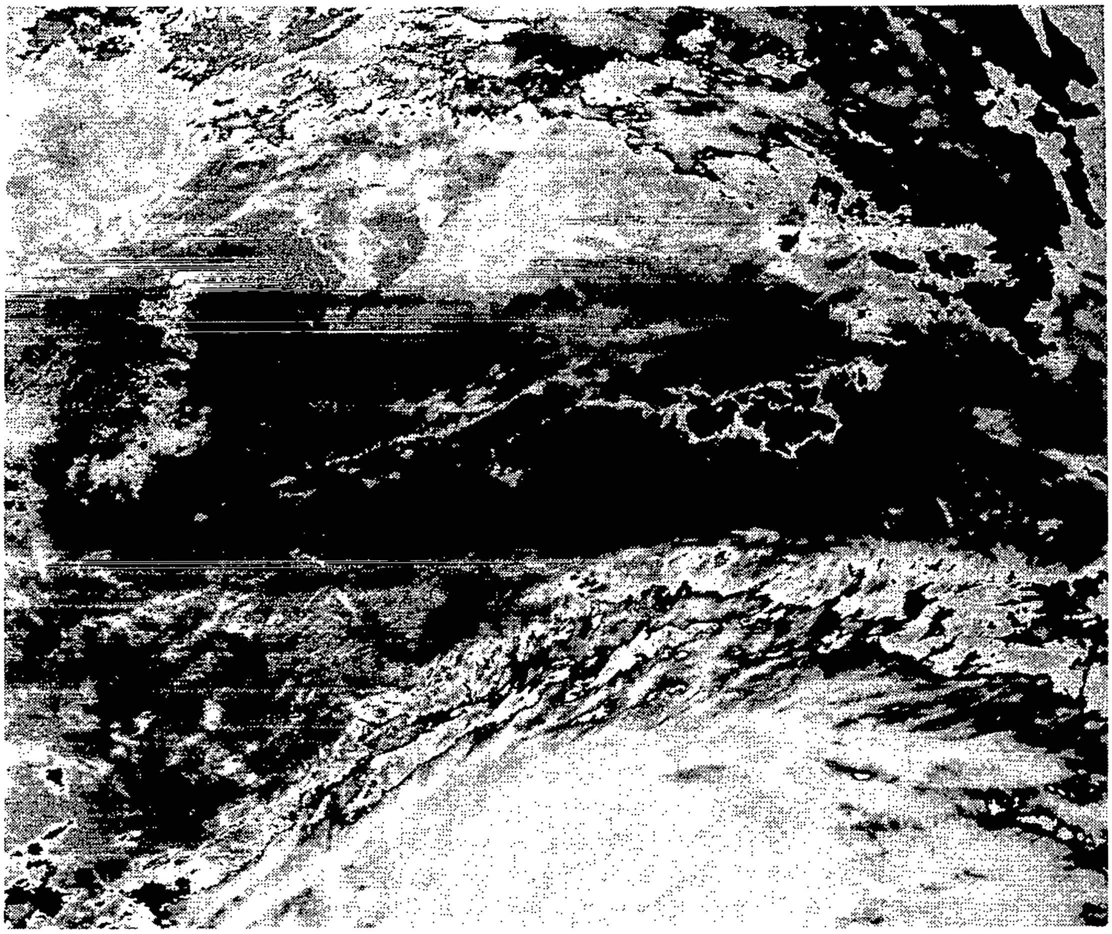

Figure 4. TIROS-N infrared image for 16 October 1980, 2000 GMT.

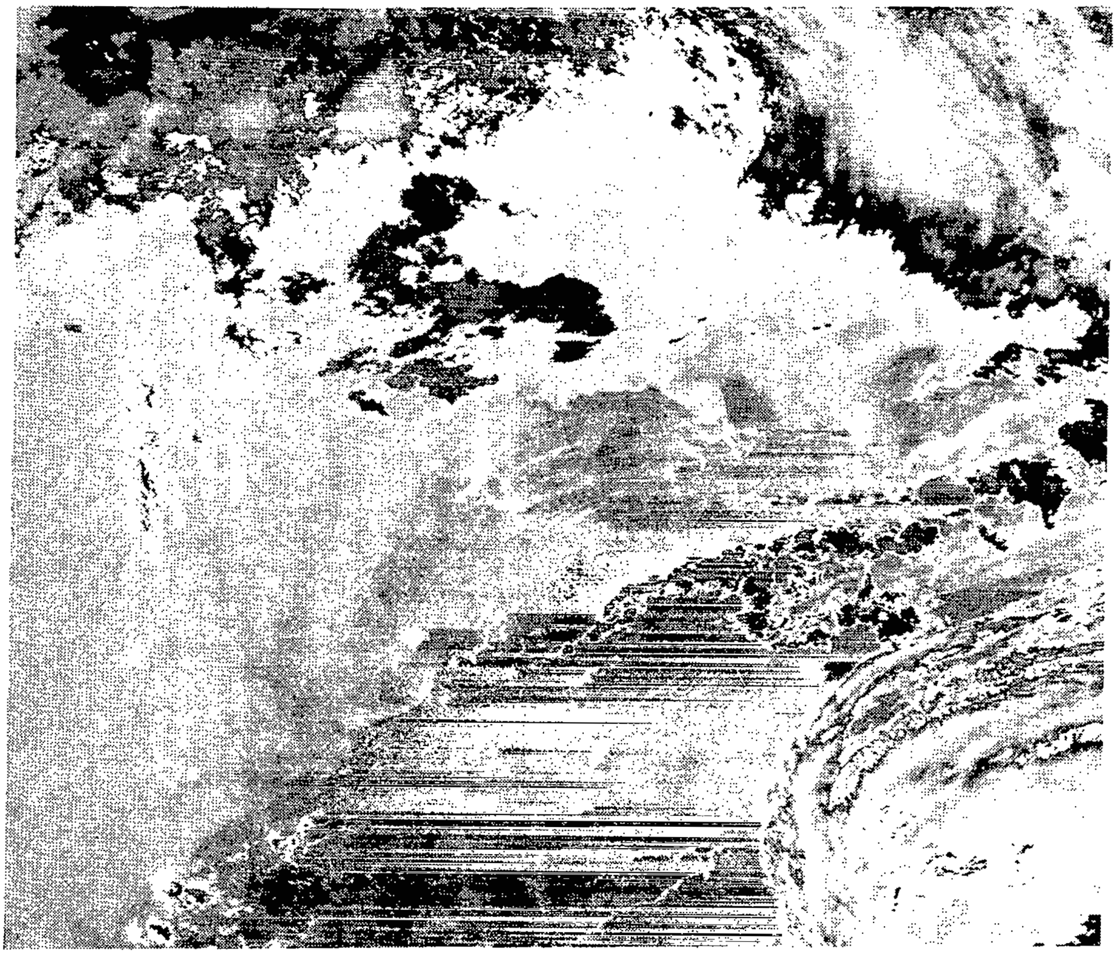

Figure 5. NOAA-6 infrared image for 17 October 1980, 1242 GMT.

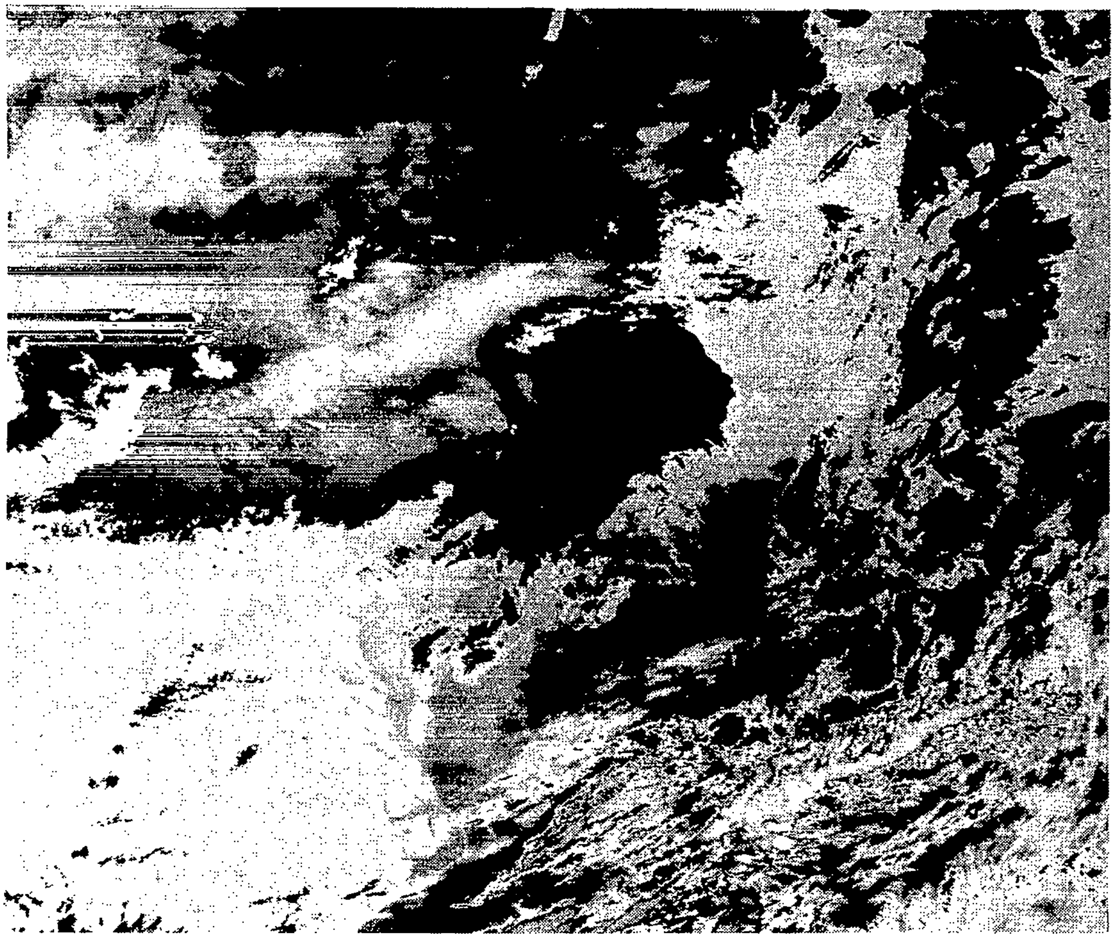

Figure 6. NOAA-6 infrared image for 21 October 1980, 1253 GMT.

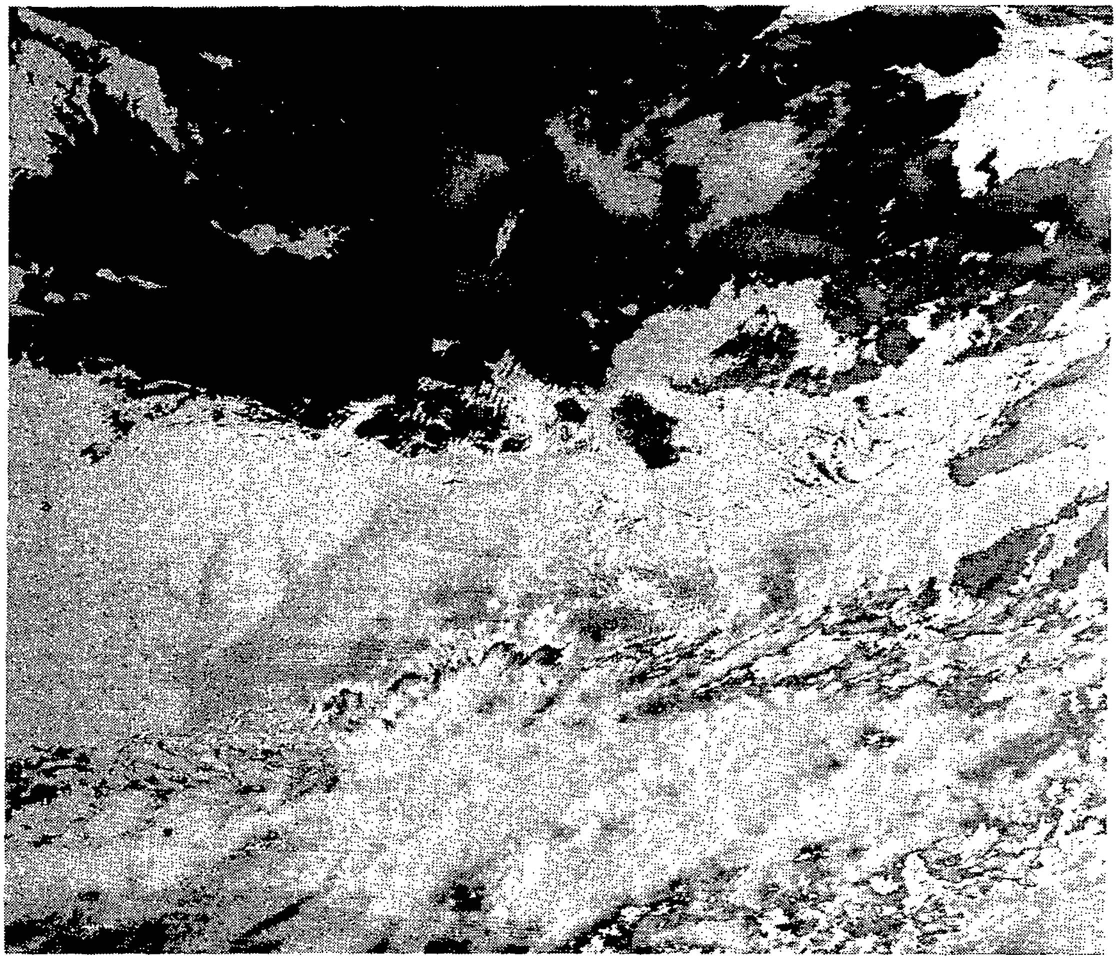

Figure 7. NOAA-6 infrared image for 22 October 1980, 2352 GMT.

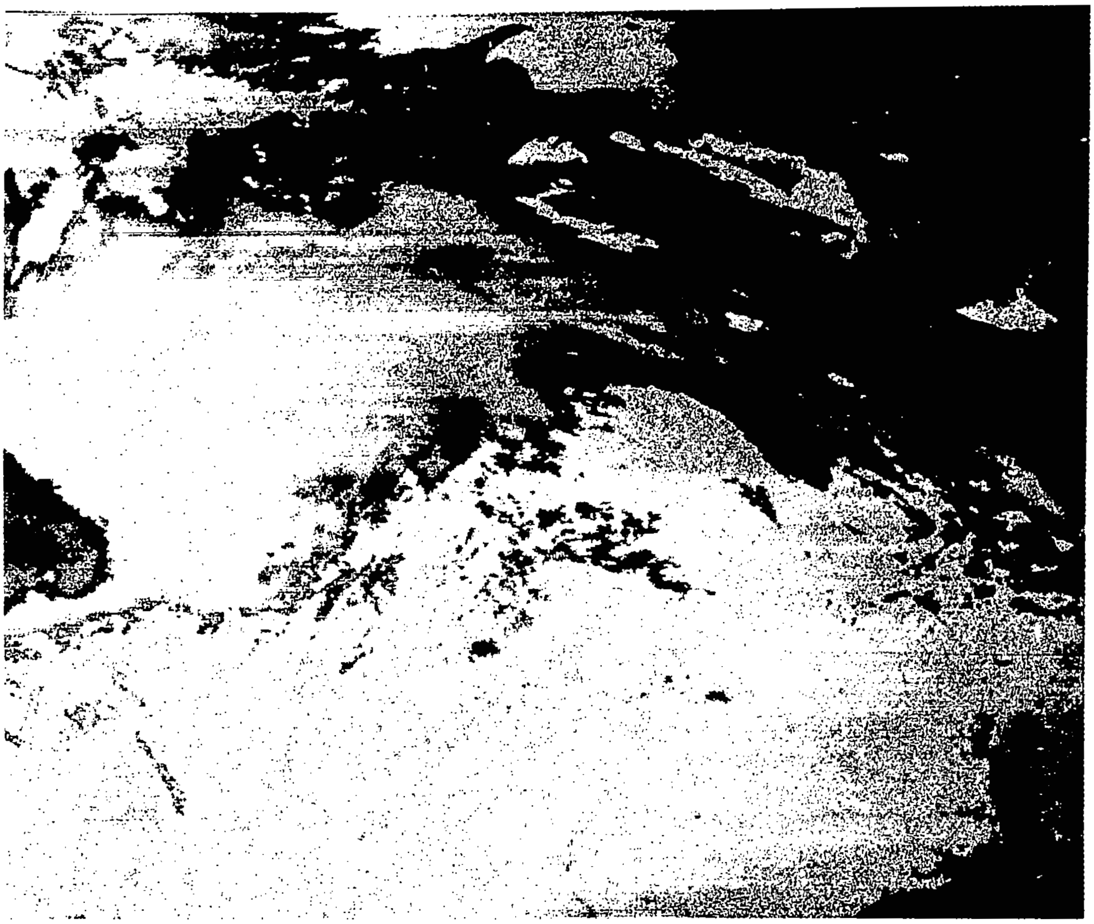

Figure 8. NOAA-6 infrared image for 16 October 1980, 0047 GMT.

Figure 9. TIROS-N infrared image for 16 October 1980, 0835 GMT.

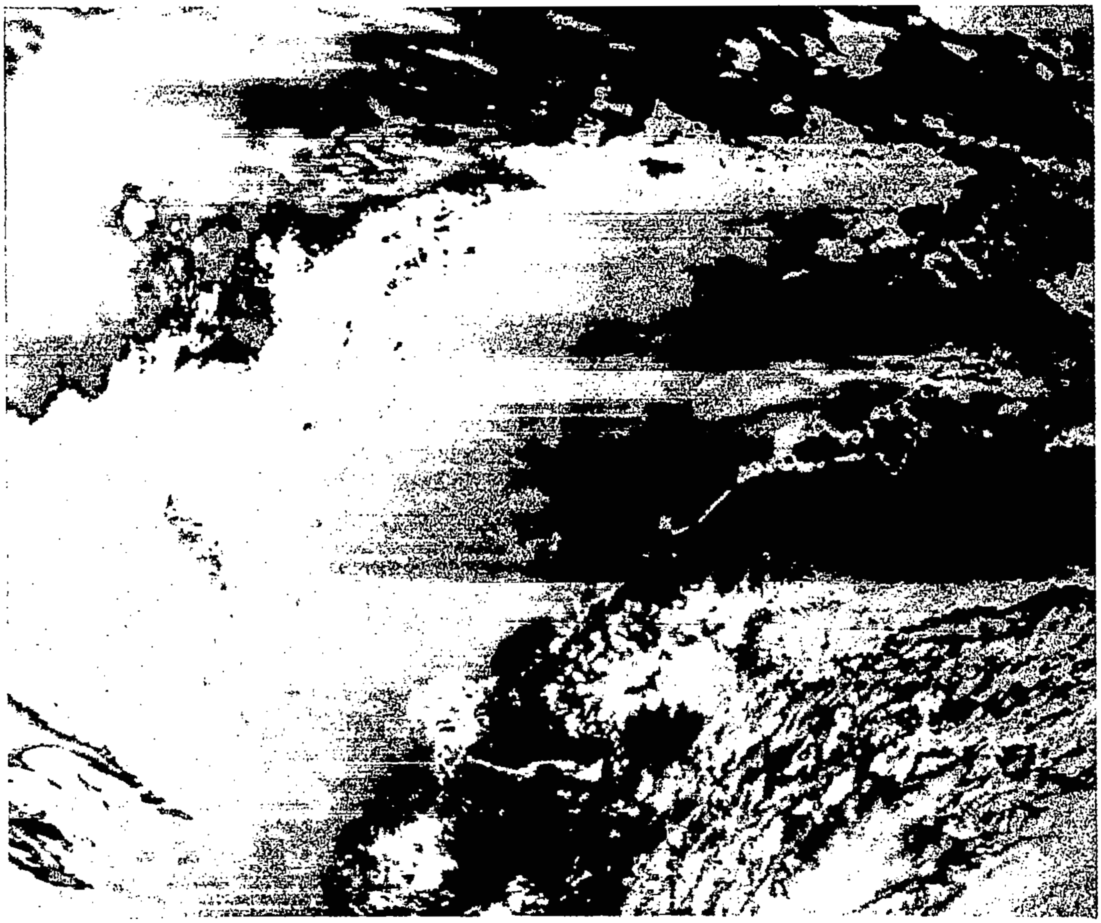

Figure 10. NOAA-6 infrared image for 16 October 1980, 1305 GMT.