Technical Report 98-01

1997 Atlantic Tropical Storms

Views from the NOAA Satellites

By the
NCDC Research Customer Service Group
January 1998

Introduction

This report, produced by the National Climatic Data Center (NCDC) in cooperation with the Tropical Prediction Center (TPC), is a preliminary summary of the 1997 Atlantic Hurricane season. It provides a synopsis of each named tropical storm using textual information based on the TPC Preliminary Hurricane Reports authored by Lawrence, et al, and remotely sensed and in-situ data received at the NCDC. Satellite imagery for each storm were taken by the eastern Geostationary Operational Environmental Satellite (GOES-8). Additional meteorological data for Hurricane Danny, the most destructive hurricane affecting the U.S. mainland, includes a NEXRAD Doppler Radar derived storm total precipitation map, a table of stations reporting five inches or more rainfall from the storm, and a map of total precipitation created from an extensive collection of cooperative and National Weather Service stations. The statistics on deaths and damages were obtained from the TPC's Preliminary Hurricane Reports and are subject to revision.

The GOES-8 infrared and visible satellite images were created using McIDAS (Man-computer Interactive Display and Access System). The visible channel measures the reflectance (albedo) of the objects scanned. Clouds are generally more reflective than most surface objects which can appear dark. The infrared channel measures emitted long-wave radiation from the earth and atmosphere. Energy emitted from cloud tops has a much lower brightness temperature and can be easily distinguished from warmer objects on or near the Earth's surface. The brightness values have been scaled to a color range designed to display areas of convective activity in the atmosphere. The scale ranges from black, indicating the warmest surfaces, to maroon, indicating the coldest surfaces (fig. 1). Land and ocean surfaces are usually much warmer than cloud tops, and hence appear from gray to almost black in the series of infrared images in this report.

Ordering and Accessing Data

The NCDC archives and distributes climate and satellite data and products in a variety of formats. To order satellite data or to obtain more information please contact the NCDC's Satellite Services Group at 704-271-4850 or e-mail your inquiry to ncdc.ncdc.satorder@noaa.gov sure to visit our web site where hundreds of satellites images can be viewed and downloaded at no charge. The Tropical Prediction Center's web site, besides posting the latest tropical storm advisories for the Atlantic and eastern Pacific basins, offers historical hurricane data, including hurricane tracks from 1921 to 1997, reports on the costliest, deadliest, and most intense hurricanes of this century, the deadliest hurricanes since 1492, and the Preliminary Hurricane Reports for 1996 and 1997.

1997 Atlantic Hurricane Summary

The 1997 hurricane season was lackluster compared to the previous two years. Only seven named tropical storms formed and just three of those reached hurricane strength. In fact there were no tropical storms or hurricanes during the month of August for the first time since 1961, and just one in September, which is normally the most active month of the season. The long term yearly averages for tropical storms and hurricanes are about nine and six, respectively. With the exception of Hurricane Erika, the tropical storms were relatively short-lived and weak. Erika was the only intense hurricane to reach a category 3 on the Saffir/Simpson Hurricane Scale. The main contributing factor to this season's less than anticipated hurricane activity was the El Nino event. It is a weather phenomenon marked by warmer than normal sea surface temperatures along the eastern equatorial Pacific and is known to impact the weather patterns around the globe. The 1997 El Nino event was likely the strongest on record and was the key factor that reduced the overall activity in the Atlantic basin. Its presence created strong westerly winds in the upper atmosphere near the equatorial part of the Atlantic Basin and created an unusually strong wind shear, which is known to inhibit the development of potential storms. It is interesting to note that of the seven named storms, six formed north of the 25th parallel. A more detailed discussion on the El Nino/Southern Oscillation's impact on this year's Atlantic hurricane season can be found at the Climate Prediction Center's web site.

Table 1 gives the name, date range, minimum central pressure, maximum sustained wind speed, highest Saffir-Simpson category, estimated number of U.S. deaths, and U.S. damage estimates of each storm.

Table 1 - 1997 Atlantic Basin Tropical Storms and Hurricanes

	Name	Dates	Minimum Pressure (millibar)	Max Wind Speed*	Cat **	Deaths ***	U.S. Damages
1	Ana	6/30-7/04	1000	40	n/a	0	none reported
2	Bill	7/11-7/13	986	65	1	0	none reported
3	Claudette	7/13-7/16	1003	40	n/a	0	none reported
4	Danny	7/16-7/26	984	70	1	4	$100 million
5	Erika	9/03-9/15	946	110	3	2	none reported
6	Fabian	10/04-10/	1004	35	n/a	0	none reported
7	Grace	10/16-10/17	999	40	n/a	0	none reported

* Estimated maximum 1-minute average wind speed
** Saffir-Simpson Hurricane Scale. Indicates maximum strength of the storm during its lifetime.
Categories: 1(64-82 kts), 2(83-95 kts), 3(96-113 kts), 4(114-135 kts), and 5 (over 135 kts)
*** Estimated number of deaths from direct causes for the U.S. Does not include indirect deaths.

Following is a synopsis of each storm.

Ana- About 30 days into the hurricane season, Tropical Storm Ana formed near the South Carolina coastline. It moved slowly eastward and reached tropical storm status on July 1. Ana maintained nearly minimal tropical storm strength for sixty hours while moving further away from the U.S. mainland. The GOES visible image (fig. 2) taken at 18:15 UTC on July 1 shows an unimpressive tropical system with mostly narrow banding curving counter clockwise into an open center. Most of the convective activity was on its east flank being sheared away from the lower circulation by a deepening mid-latitude short-wave trough to its west.

Bill- The first hurricane to form for the season, Bill developed from an upper-level low pressure system that became detached from the main trough northeast of Puerto Rico. This system began to show increasing shower activity and a consolidation of clouds on July 7. The first indication that a tropical depression might be forming was a 3 millibar pressure drop in the eastern Bahamas. Convection then gradually became organized, and it is estimated that a tropical depression formed near 0600 UTC on July 11. The system had already taken a northeastward course away from the U.S. ahead of a cold front in the eastern U.S. It reached tropical storm status by 1200 UTC that same day. Tropical Storm Bill continued moving northeastward on July 12. Despite cooler ocean temperatures, satellite image analyses using the Dvorak classification from the Tropical Analysis and Forecast Branch indicated Bill reached hurricane strength with maximum intensity of 65 knots at 1500 UTC on July 12. Two GOES satellite images, a colorized IR (fig. 3) and visible (fig. 4), are provided showing Bill at maximum strength. A small area of intense convection indicated by a deep red oval spot near the center is noted in the IR image. At higher resolution a small eye can be detected. There were no reports of casualties or damages associated with Bill as it passed by Bermuda a day earlier.

Claudette- Claudette became a tropical depression early in the day on July 13 from the same frontal system that absorbed Bill. The depression became Tropical Storm Claudette that afternoon based on 45-50 knot winds measured during a reconnaissance aircraft mission. Satellite classifications and aircraft data suggest that Claudette retained 30-40 knot winds from the 13th to the 16th. Figure 5 shows a GOES visible image of a weak Tropical Storm Claudette off the North Carolina coastline. Claudette was moving northeastward and eventually merged with an approaching frontal system on the 16th.

Danny- The first and only hurricane to form in the Gulf of Mexico this season, Danny will be the most memorable of all Atlantic basin tropical storms of 1997. Like the previous three tropical storms, Danny was spawned from a non-tropical weather system. On July 13, a broad upper-tropospheric trough over the southeastern United States triggered a cluster of thunderstorms over the lower Mississippi River valley, which drifted southward over the northern Gulf of Mexico coastal waters. It appears that a small, weak surface low was forming near coastal Louisiana on the 14th which grew over the next couple of days. By 1200 UTC on July 16 deep convection became more organized near the center of the system. Surface observations from NOAA buoys and oil rigs confirmed that the circulation had become defined well enough to call it a tropical depression placing the center about 125 nautical miles south of the southwestern Louisiana coastline. In a little over 24 hours, Danny was elevated to tropical storm status using information gathered from the Air Force Hurricane Hunter plane and satellite intensity estimates. Danny continued to strengthen and was a hurricane by 0600 UTC on the 18th. By this time the center was nearing the Mississippi River delta.

Hurricane Danny crept east-northeastward and finally made its first landfall just northwest of the delta near the towns of Empire and Buras early on July 18. Since Danny was a compact hurricane, the area of maximum winds was confined to the vicinity of the eye. After passing over extreme southeastern Louisiana, the center of the storm moved back over the warm waters of the Gulf of Mexico, south of the coast of Mississippi, during the day on July 18. The colorized IR GOES image (fig. 6) and coincident visible image (fig. 7) show the center of Danny near the Chandeleur Islands at 18:15 UTC. A small eye is apparent in both GOES shots with uniform convection all around the center. Sustained surface winds were estimated at 70 knots with a minimum central pressure of 988 mb. The slow-moving hurricane wobbled to the east, then north-northeastward bringing the eye to the mouth of Mobile Bay, near Fort Morgan, Alabama, near dawn on July 19. The western edge of the eye and eyewall crossed over Dauphin Island, where torrential rains and hurricane force winds were experienced. The center, stalled over Mobile Bay area for most of the day, finally crossed the coast on the southeast shore of Mobile Bay near Mullet Point, Alabama. Danny weakened to a depression by 1800 UTC on July 20 and moved north to northeastward over Alabama for the next two days.

Danny continued to maintain its identity as it trekked eastward across northern Georgia and South Carolina on July 22 and 23. During this time Danny exhibited a ‘pulsing’ phenomena seen in the remnants of some tropical storms, with its core precipitation area becoming centralized at night and spreading out during the day. Around midday on July 24 the low pressure, centered near the North Carolina/Virginia border, began to strengthen while still partially over land. The re-intensification was

probably due to an approaching front situated just north of the cyclone. Danny quickly reached tropical storm strength once again as it moved off the Virginia coast later in the afternoon. The storm then turned north-northeastward and slowed dramatically as it appeared to be drawn in toward an extratropical cyclone over the northeastern United States. Figure 8 is a GOES visible image taken on the morning of July 25 showing the center of Tropical Storm Danny at approximately 100 miles south-southwest of Nantucket Island. Sustained maximum winds were estimated at 50 knots. After coming within 25 nautical miles of the island, Danny turned out to sea and diminished in strength.

Danny will be remembered mostly for the extremely heavy rains in the Mobile Bay area which exceeded 30 inches in some areas. The highest reported amount was 36.71 inches measured at Dauphin Island Sea Lab, Alabama. Further inland, along the path of the storm from western Alabama to Virginia, many areas received on average one to three inches of rain with some areas reporting up to eight inches of rain (see fig. 9). Table 2 provides a listing of weather stations receiving over five inches of rain from Danny. Additional rain gauge data, not published in NCDC's monthly Climatological Data report, are added for stations reporting over twenty inches of rain. The WSR-88D Doppler radar at Mobile, Alabama, pinpointed the event remarkably well. The totals shown on figure 10 are for the period, July 17, 0726 UTC to July 21, 1224 UTC. Note that the maximum value inferred by the radar is 43.2 inches.

Damage to power lines and poles was widespread, cutting power to more than 20,000 homes and business along the path of the hurricane. Roof damage from the wind was observed on some coastal houses. Winds also caused the collapse of a four story condominium under construction and several tornadoes were also associated with the storm.

Danny was directly responsible for four deaths. A man was killed when he was caught in the Gulf of Mexico on his sailboat near Fort Morgan, Alabama. A woman was killed by a tornado in Lexington County, South Carolina. In Charlotte, North Carolina, a girl drowned when floodwater swept her into a creek, and a woman drowned while trapped in her car in floodwater. Five other deaths were indirectly associated with Danny.

According to the American Insurance Services Group, insured losses from Danny were about $60 million. The National Hurricane Center estimates overall damages around $100 million.

Erika- The strongest Hurricane of the 1997 season, Erika became a category three hurricane and was the only hurricane to form from a tropical wave at low latitudes.

Erika was first tracked as a tropical wave originating from Africa. By the time it was 1,000 miles east of the Lesser Antilles on September 3, the low level circulation was defined well enough for it to be upgraded to a tropical depression. Soon thereafter, the storm strengthened into a hurricane as it slowly moved west-northwestward at 15 knots. On the 5th through the 8th, Erika's forward motion gradually decreased, as it came to within 75 nautical miles of the northeastern most islands of the Lesser Antilles. Fortunately, the islands were spared as Erika turned more to the north on the 8th. Hurricane Erika reached peak intensity of 110 knots at 1800 UTC that day (see Figs. 11 & 12). Two days later, Erika passed about 300 nautical miles east of Bermuda. It became embedded in the westerly steering currents on the 11th, which caused it to turn toward the east-northeast back into the mid-Atlantic Ocean.

Two deaths were caused by Hurricane Erika. Large waves and swells generated by the storm drowned two surfers in the northeastern waters off the coast of Puerto Rico.

Fabian- Fabian formed from a tropical wave and became a tropical depression on October 4 at 1800 UTC. Convective activity fluctuated considerably during the cyclone's lifetime, and the low-level center was intermittently under convection. It is estimated that the depression reached tropical storm status at 1800 UTC on October 5 and reached minimum pressure at 1200 UTC on October 7 during one of the convective bursts (see fig. 13). Fabian moved toward the northeast and became extratropical early the next morning.

Grace- The last tropical storm of the season, Grace developed from one of several lows that formed along

a frontal trough extending east-northeastward from the Caribbean Sea to the central North Atlantic Ocean on October 16. Surface observations indicated that the extratropical low that became Grace was initially centered just north of Hispaniola, and that it reached gale strength near 0000 UTC on October 15. A day later, a large area of deep convection developed over, or just northeast of, the low-level circulation center as shown in the GOES IR image on fig. 14. At this time the system was considered a tropical storm with sustained winds of 40 knots. The storm appeared to weaken later on the 16th, and by the morning of the 17th all of the deep convection had dissipated.

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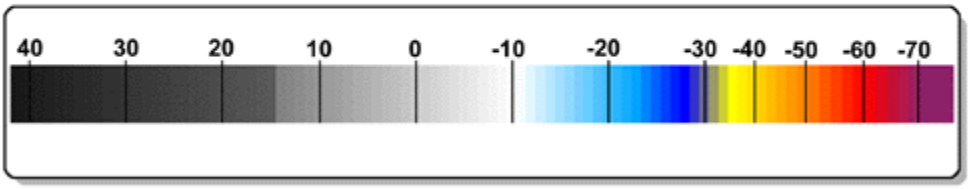
2	T.S. Ana	GOES-8 Visible	07/01/1997 18:15
3	H. Bill	GOES-8 Infrared	07/12/1997 15:15
4	H. Bill	GOES-8 Visible	07/12/1997 15:15
5	T.S. Claudette	GOES-8 Visible	07/14/1997 18:15
6	H. Danny	GOES-8 Infrared	07/18/1997 18:15
7	H. Danny	GOES-8 Visible	07/18/1997 18:15
8	T.S. Danny	GOES-8 Visible	07/25/1997 11:45
9	H. Danny	Rainfall Analysis	07/20-25/1997
10	H. Danny	NEXRAD Storm Total Precipitation	07/21/1997 12:18
11	H. Erika	GOES-8 Visible	09/08/1997 18:15
12	H. Erika	GOES-8 Infrared	09/08/1997 18:15
13	T.S. Fabian	GOES-8 Infrared	10/07/1997 12:15
14	T.S. Grace	GOES-8 Infrared	10/16/1997 00:15
15	Tracks of 1997	Atlantic Tropical Systems	

Figures

Figure 1. Color vs. Temperature (C) Scale For GOES Infrared Imagery



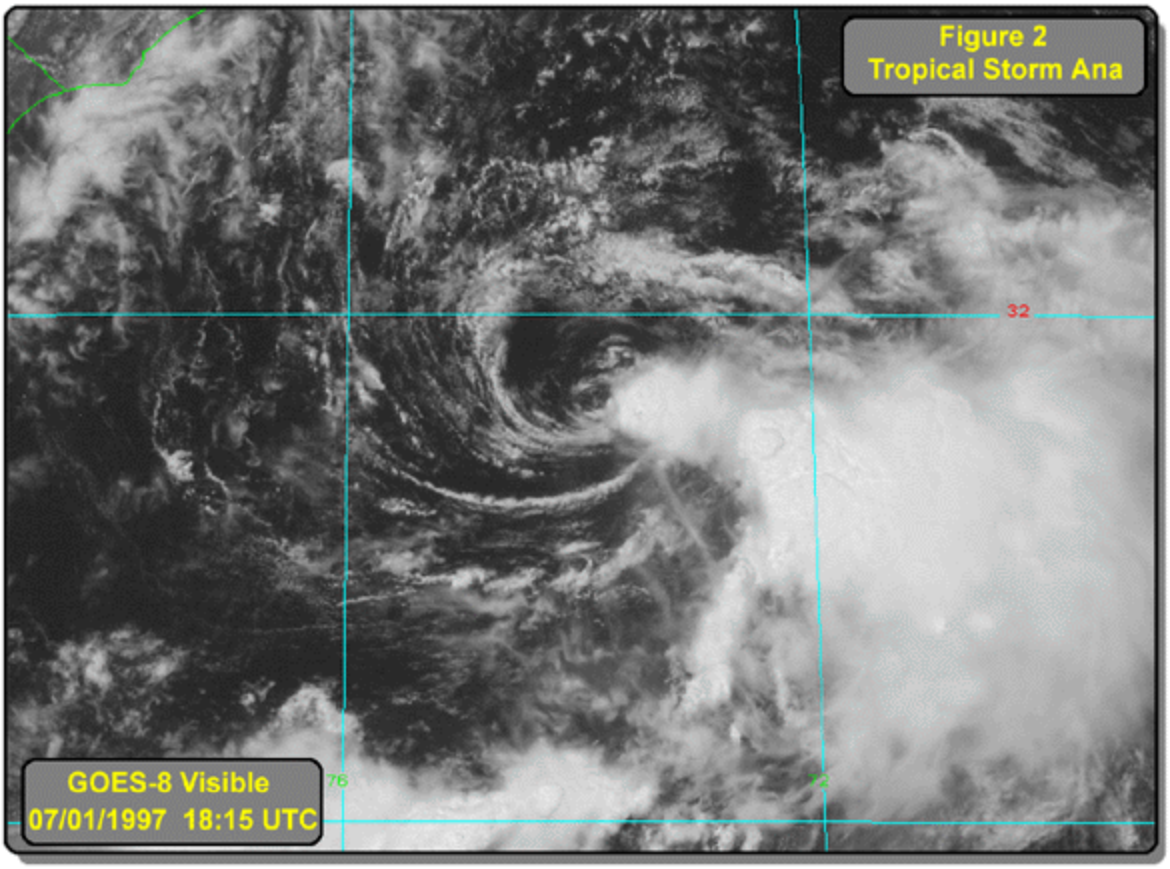


Figure 2
Tropical Storm Ana
32
76
72
GOES-8 Visible
07/01/1997 18:15 UTC

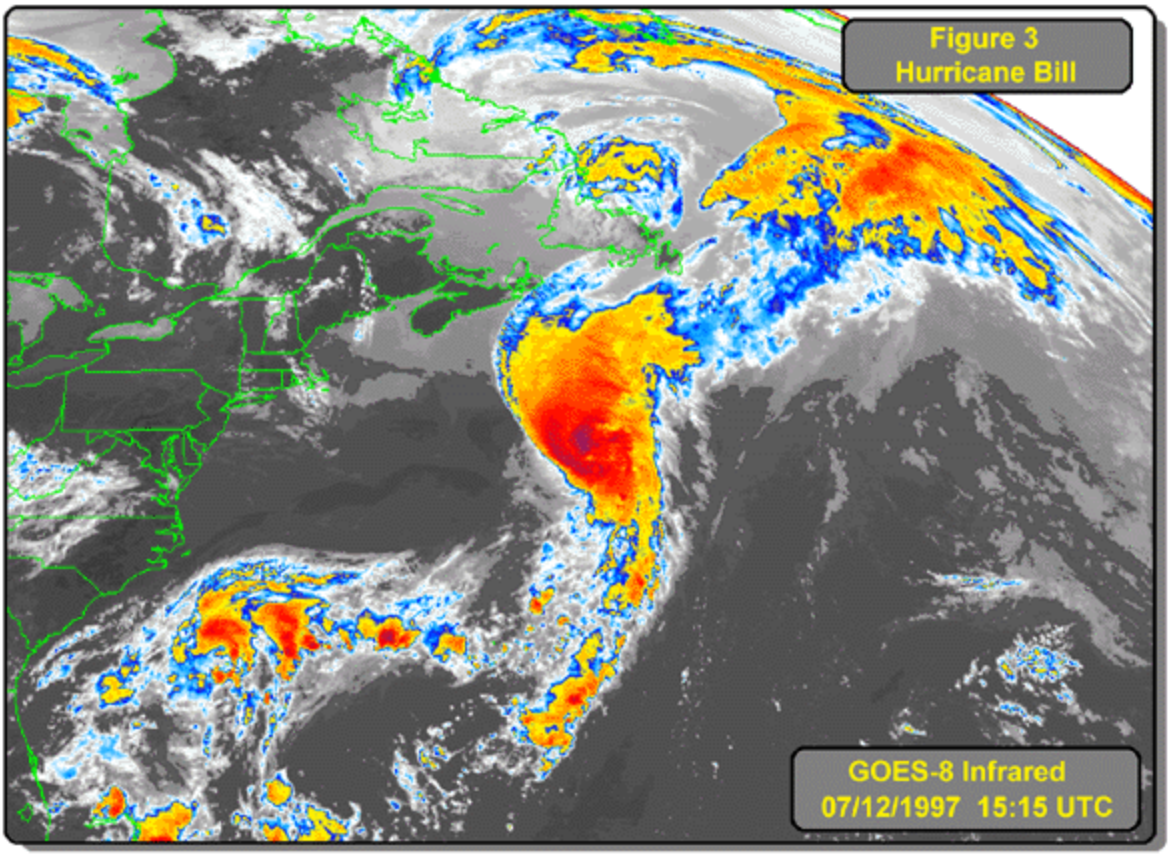


Figure 3
Hurricane Bill
GOES-8 Infrared
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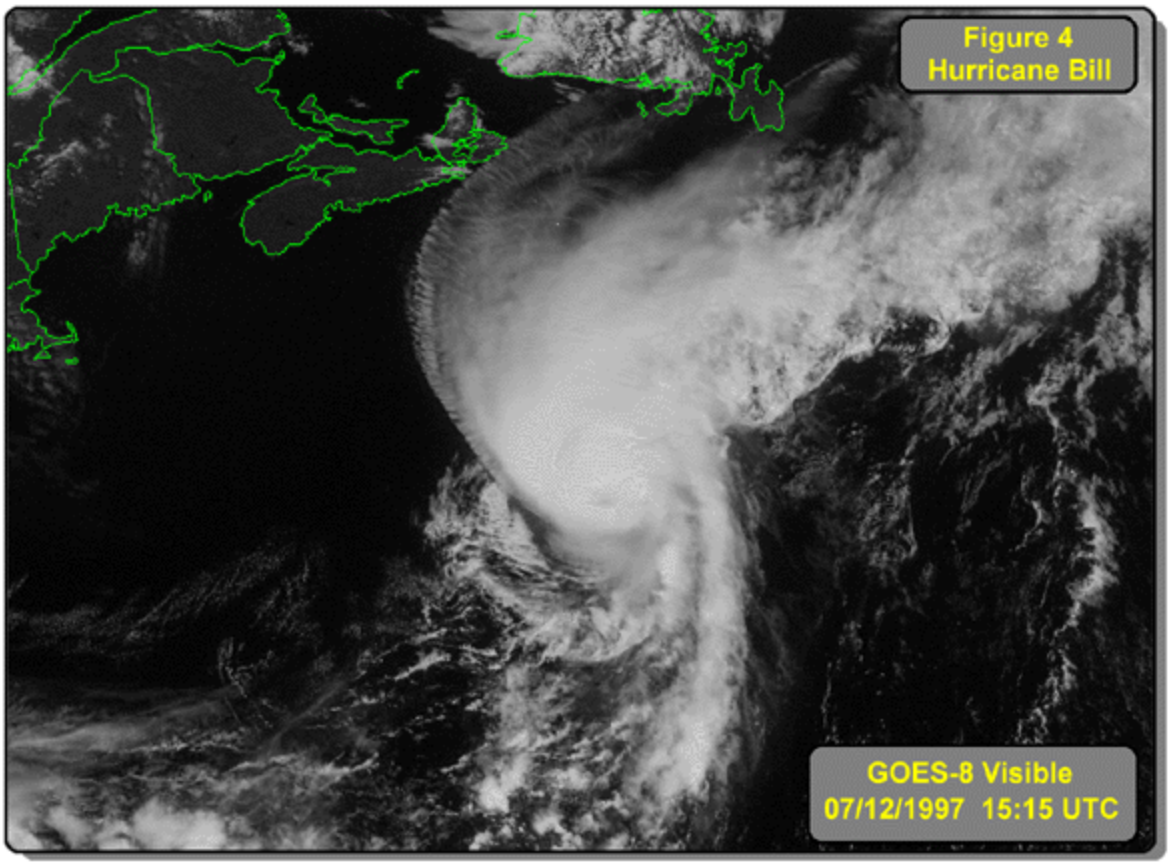
Figure 4
Hurricane Bill
GOES-8 Visible
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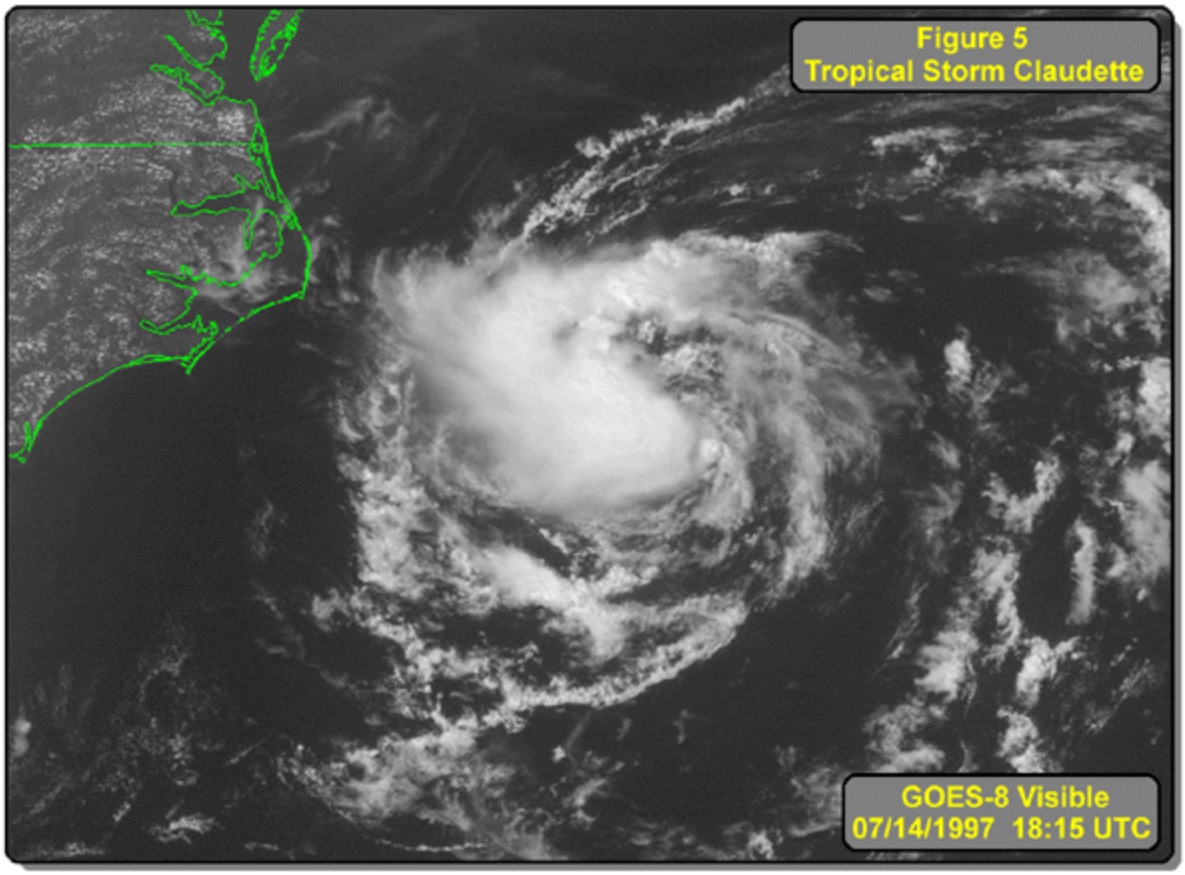
Figure 5
Tropical Storm Claudette
GOES-8 Visible
07/14/1997 18:15 UTC

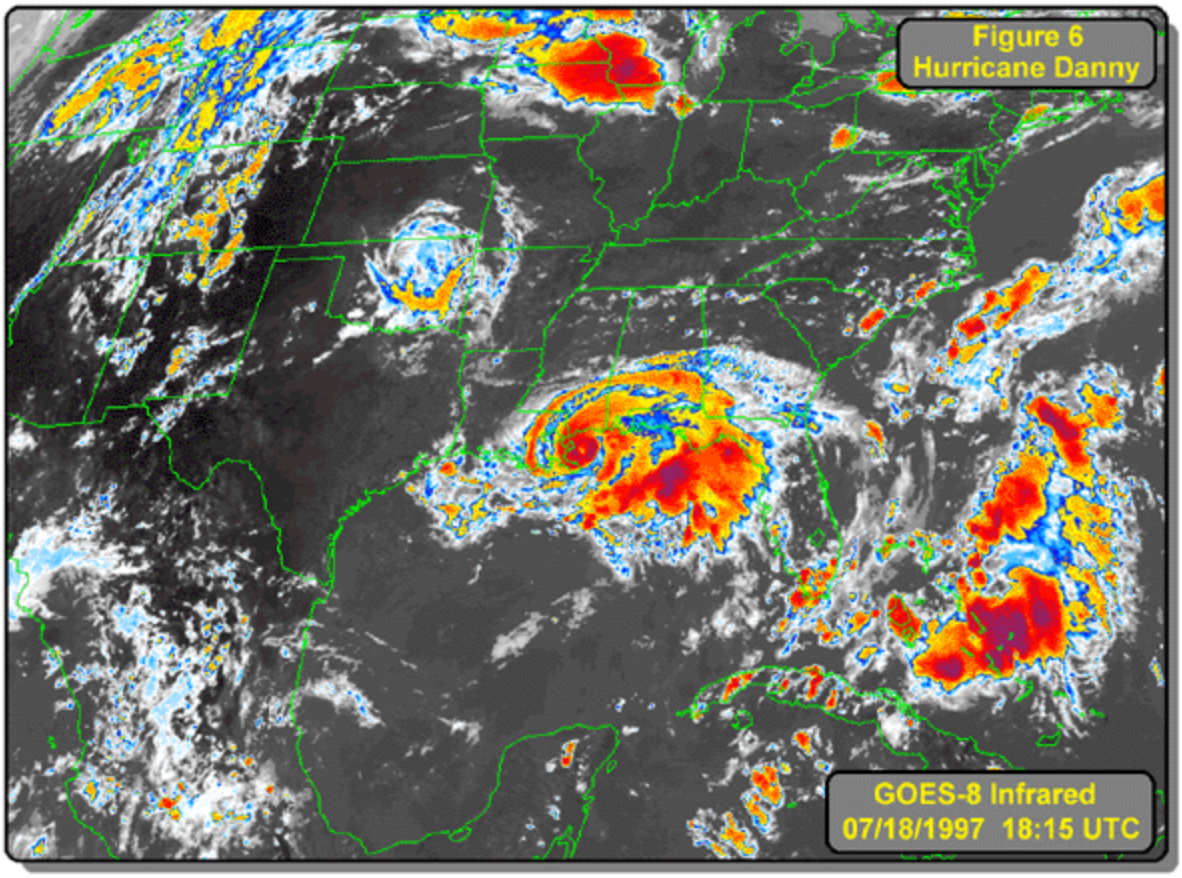
Figure 6
Hurricane Danny
GOES-8 Infrared
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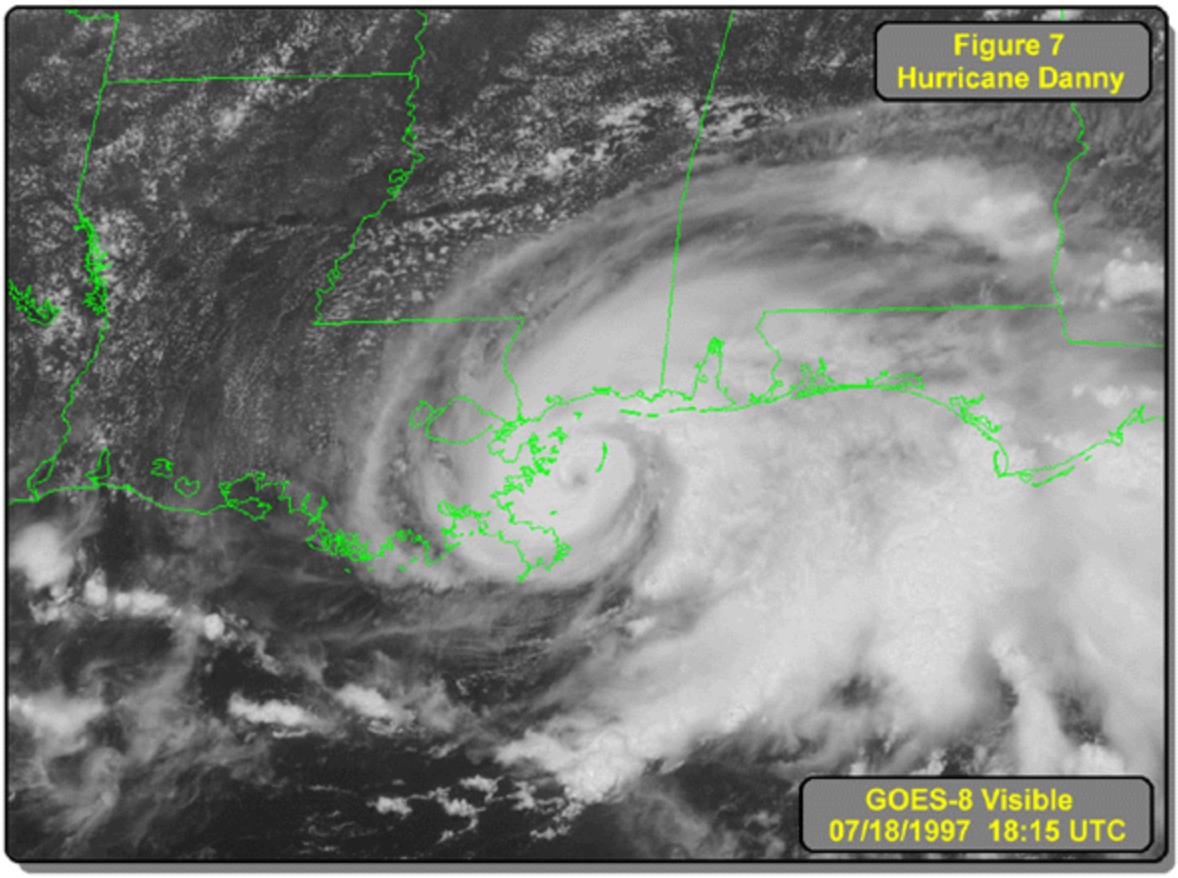
Figure 7
Hurricane Danny
GOES-8 Visible
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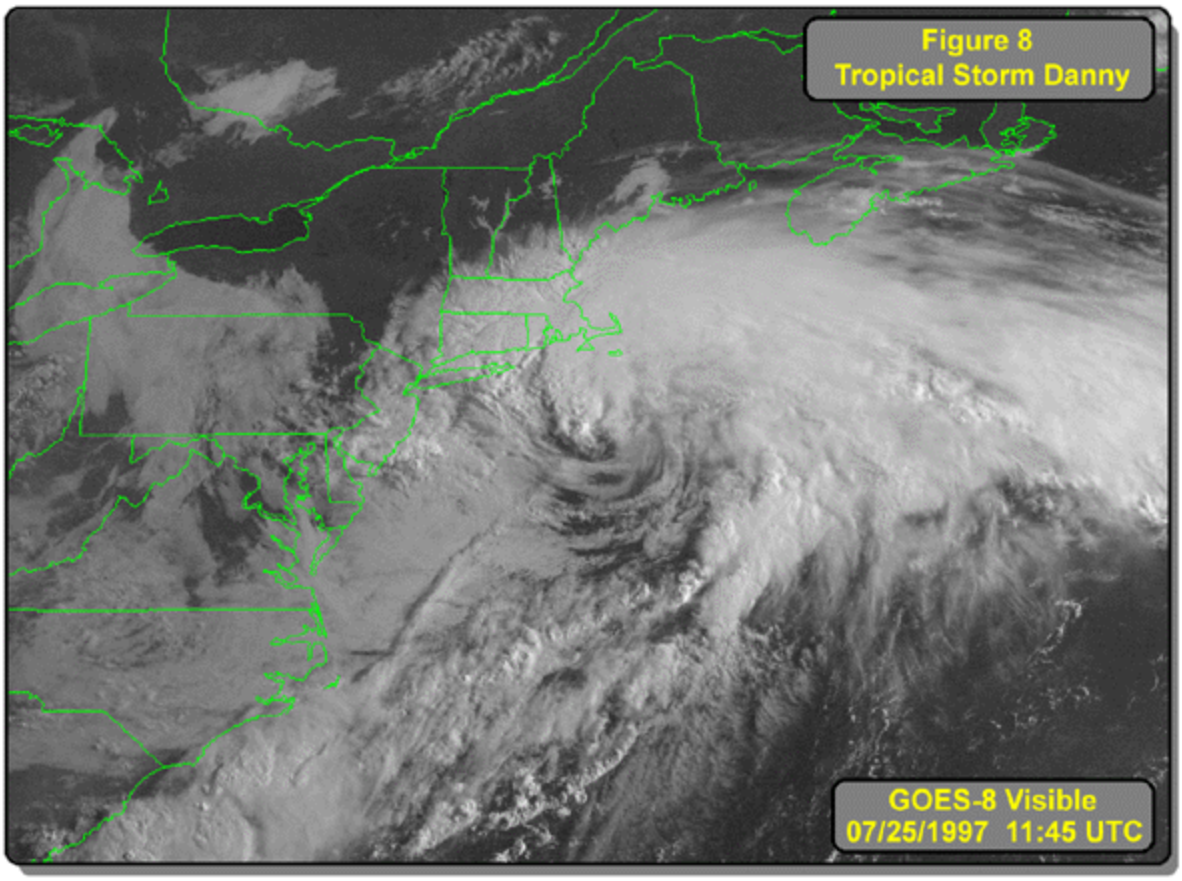
Figure 8
Tropical Storm Danny
GOES-8 Visible
07/25/1997 11:45 UTC

Tropical Rains in Southeast Related to Hurricane Danny*

*** Rainfall totals for each state are comprised of observations for only the days listed for each state in the table below.**

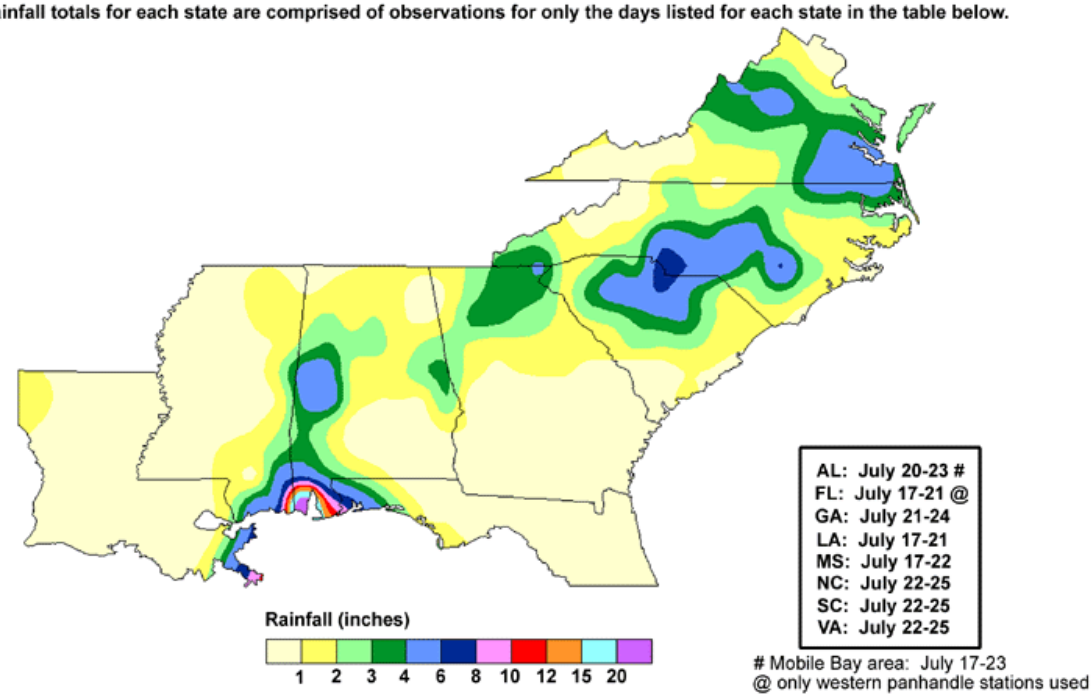

Figure 9

NEXRAD Storm Total Precipitation for Hurricane Danny: July 17-21, 1997

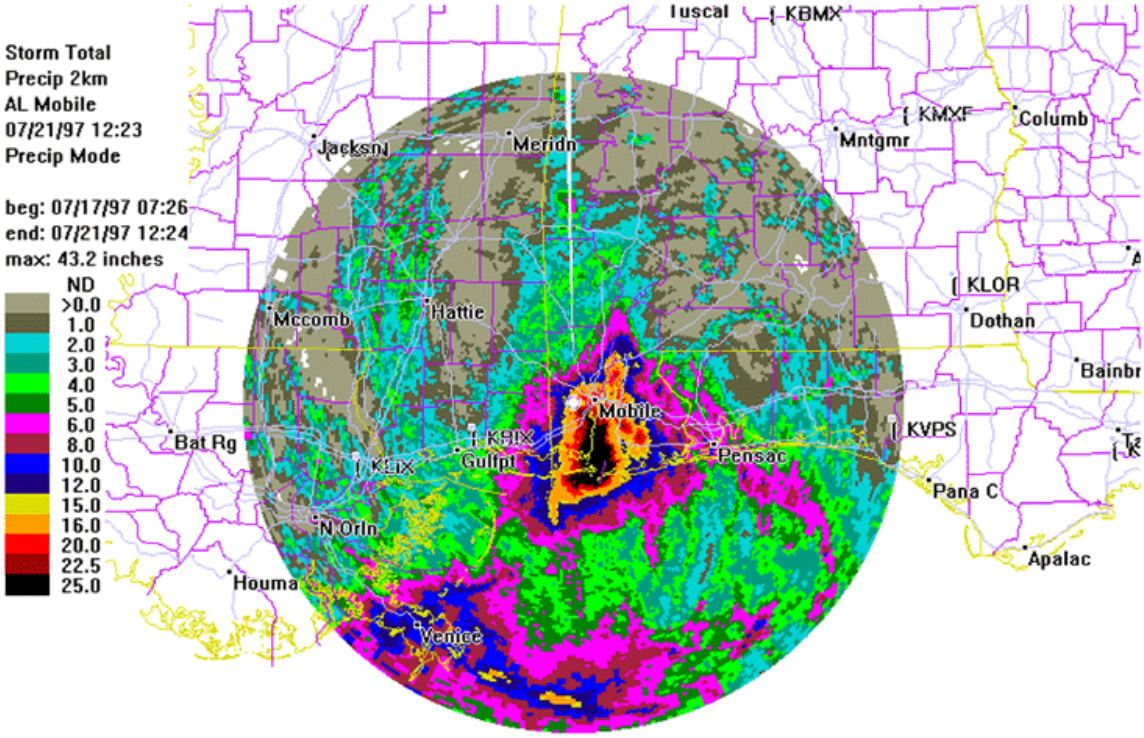

Figure 10

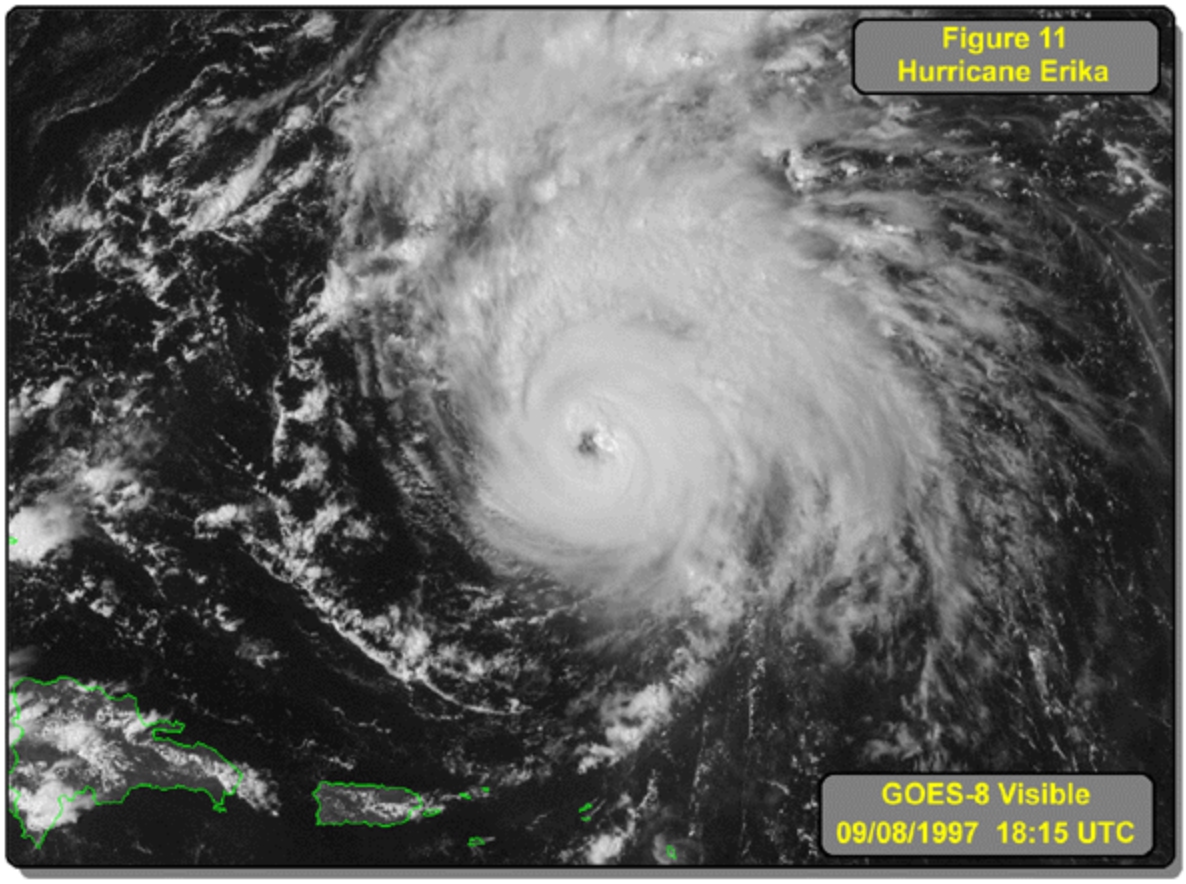
Figure 11
Hurricane Erika
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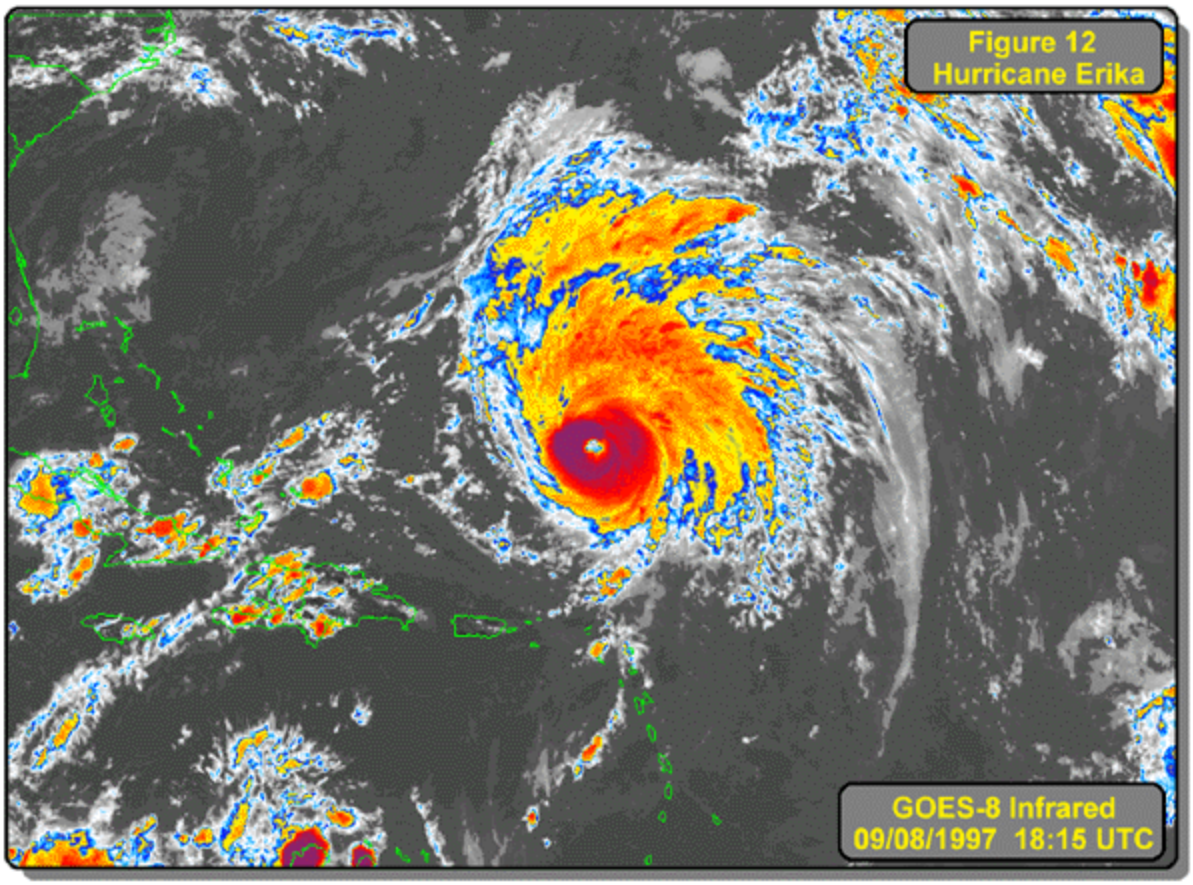
Figure 12
Hurricane Erika
GOES-8 Infrared
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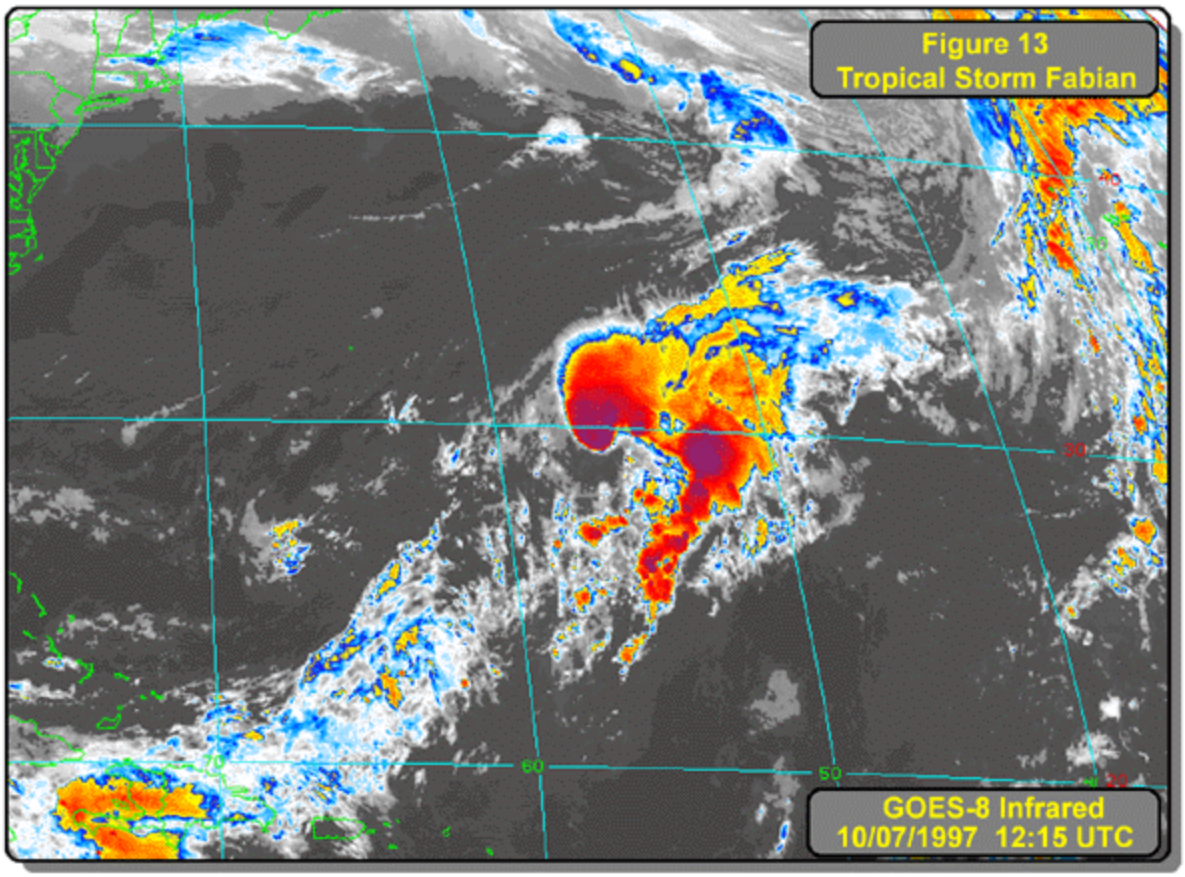
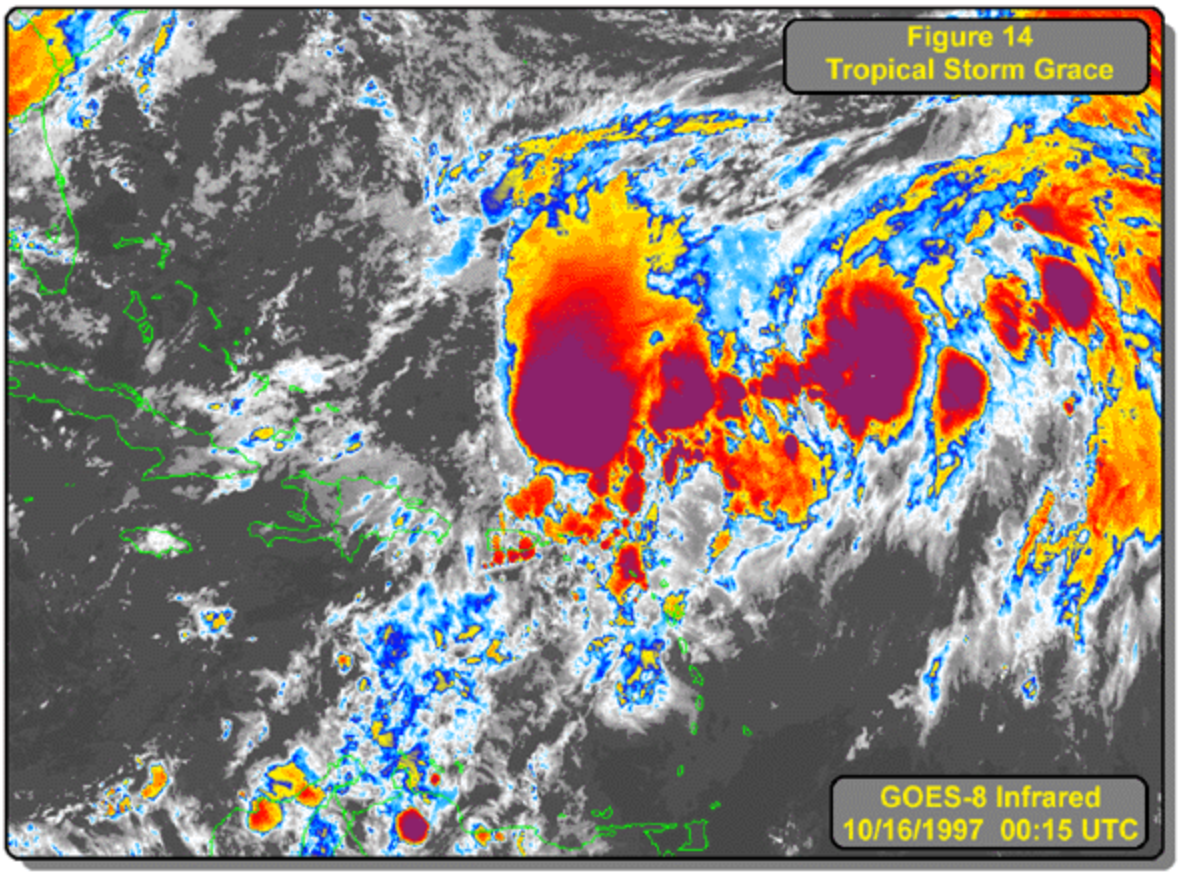


Figure 13
Tropical Storm Fabian
GOES-8 Infrared
10/07/1997 12:15 UTC
60
50



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