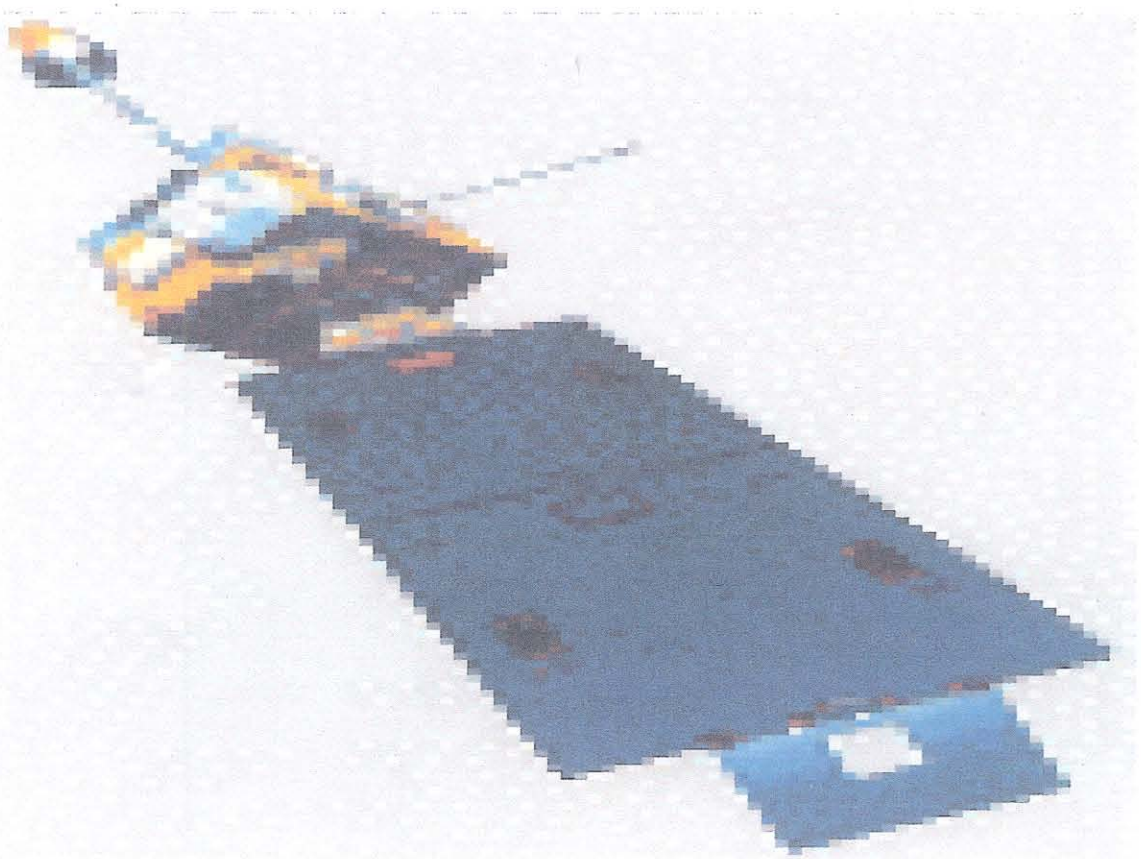
EYE SEE YOU!



Written by
Yovonda Ingram and Teisha Taylor
2000

EYE SEE YOU

Table of Contents

EYE SEE YOU

TASK OVERVIEW

Content Area(s)/ Course: Earth Science

Grade Level: 6^{th}-9^{th}

Indicators:
Explain the chemical and physical interactions (i.e. natural forces and cycles, transfer of energy) of the environment, Earth, and the universe that occur over time.

Explain that some changes in a planet's surface are due to slow processes (i.e., erosion, weathering) and some changes are due to rapid process (i.e., landslides, tornadoes, hurricanes, volcanic eruption, earthquakes, flooding and tsunamis).

Project 2061 Benchmarks:
Weather (in the short run) and climate (in the long run) involves the transfer of energy in and out of the atmosphere. Solar radiation heats the land masses, oceans, and air. Transfer of heat energy at the boundaries between the atmosphere, the land masses, and the oceans result in layers of different temperatures and densities in both the ocean and atmosphere. The action of gravitational force on regions of different densities causes them to rise or fall—and such circulation, influenced by the rotation of the earth, produces winds and ocean currents.

Description:
In this task, the student will examine satellite data to look at the formation and development of a hurricane. In this task, the student will be able to make predictions about the landfall of a hurricane using remote-sensing images of Hurricane Floyd as provided by NOAA (National Oceanic and Atmospheric Administration). They will also be able to track the actual path of Hurricane Floyd on a map. Students will use this map to answer various questions related to the path and direction of the hurricane. Finally, students will write a report summarizing their findings. This task was designed to be used as an enrichment instructional task with embedded assessments and to be added into the lesson plan, where appropriate.

Appropriate Time Required: Two 45-minute periods.

Prior Knowledge/Skills Required for Task:
Working knowledge of climate and atmospheric changes.

Materials and Resources Needed:
For each group of students:
Erasable markers
Transparency of tracking map

Date _____

Name(s) _____

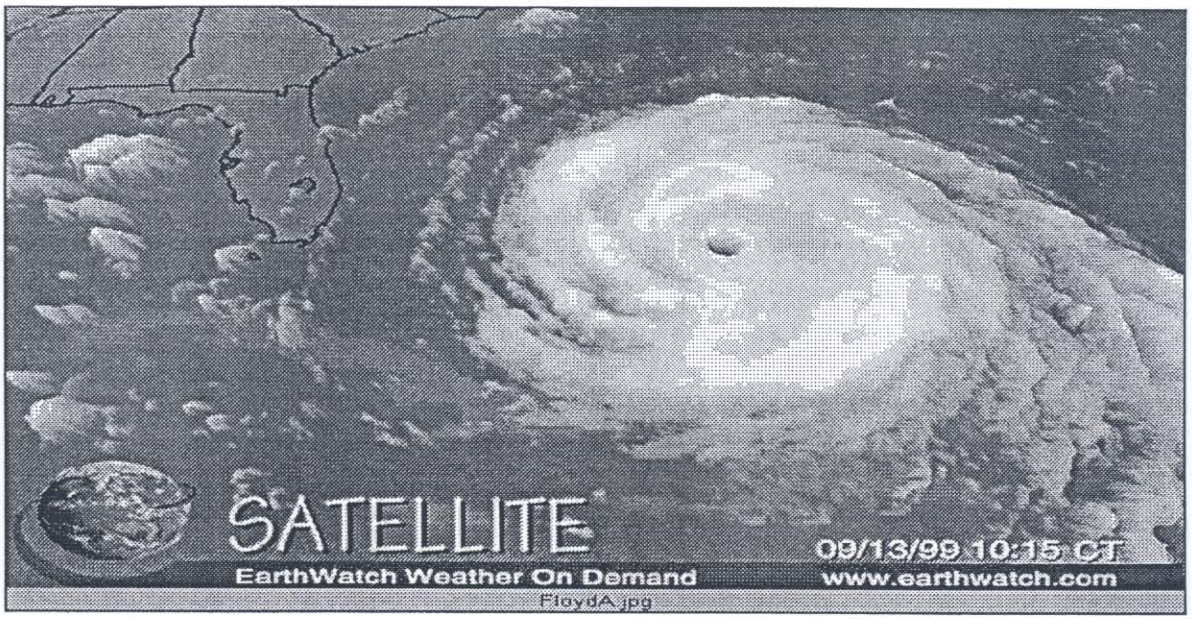
STUDENT ANSWER BOOKLET

EYE SEE YOU!

ENGAGEMENT

Did you know that hurricanes are the largest most destructive storms on Earth? Hurricanes are also known as typhoons and tropical cyclones in other parts of the world, but they are basically the same types of storm. Hurricanes can produce tornadoes, severe flooding and beach erosion. Due to satellite technology and scientists who volunteer to fly directly into the storms to take data, the ability to monitor and forecast hurricanes has improved greatly. By studying the information sent back by the National Oceanic and Atmospheric Administration (NOAA) Hurricane Hunter planes and Air Force personnel, it is possible to measure how strong a hurricane is and make an estimate of what direction it may move.

NOAA manages the U.S. civil operational remote-sensing satellite systems, as well as global databases for meteorology, oceanography, solid-earth geophysics, and solar-terrestrial sciences. From these sources, it develops and provides environmental data and information products and services. Imagine that you are a meteorologist who has just been employed by NOAA to track and predict landfall of a hurricane that threatened the United States.



You will be working with other NOAA scientists to gather data pertaining to hurricanes. Your team will consist of four members. Each individual in the group will have a specific responsibility based on the following jobs.

- **Principal Investigator-** is in charge of all operations associated with the group activity. The "PI" checks the assignment, communicates the directions of the teacher, provides assistance to other group members, and conducts group discussions about results.
- **Materials Manager-** the "MM" obtains and dispenses materials and equipment for activity. The "MM" also sets up and operates the activity equipment in cooperation with the "PI".
- **Recorder/Reporter-** the "RR" is in charge of collecting and recording information on the group worksheet(s). Also reports results to the class.
- **Maintenance Director-** the "MD" is in charge of cleaning up the workstation and can assign other members to assist. Also is in charge of group and individual safety. Also verifies the work of the "RR".

To learn how to track hurricanes, it's useful to begin by looking at how they appear in satellite images and how they behave as they move across the earth's surface. As an example, study the GOES images showing the path of Hurricane Floyd and read hurricane basics located in your student resource book.

Question 1a

The "eye" of the hurricane is its center. After viewing the images, describe the eye as the storm progresses.

_____

_____

_____

_____

Question 1b

How would you determine the eye of the hurricane if it were not visible?

_____

_____

_____

_____

Question 1c

Enumerate what your team knows and will need to know about hurricanes to make predictions about them.

EXPLORATION

Using Hurricane Floyd remote-sensing images from the NOAA weather satellites, you will plot the hurricane's progress on a map and make predictions about its landfall.

Materials Needed
NOAA satellite images
Transparent tracking map
Transparency marker

Activity 1
Place the transparent map on top of satellite images 1 and 2. Using a marker, draw a line showing your prediction of the hurricane's direction.

Explain your prediction.

Activity 2

A hurricane's speed and path depend on complex ocean and atmospheric interactions, including the presence or absence of other weather patterns. Some hurricanes follow a fairly straight course, while others loop and wobble along the path.

Using all images, plot a series of points that follows the course in which the hurricane travels. Note: the eye of the hurricane is where you plot your points.

EXPLANATION

Question 2a:

Compare your prediction to the actual hurricane path.

Question 2b:

According to the hurricane's path, which state(s) received the most damage? Explain your answer.

Question 2c:

Explain why the hurricane changed its path.

Question 2d:

Describe the strength of the hurricane as it traveled across land. Explain your answer.

Question 2e:

Explain how GOES data help save lives.

Question 2f:

Without GOES images, how do you think a meteorologist would track hurricanes?

ELABORATION

Activity 3

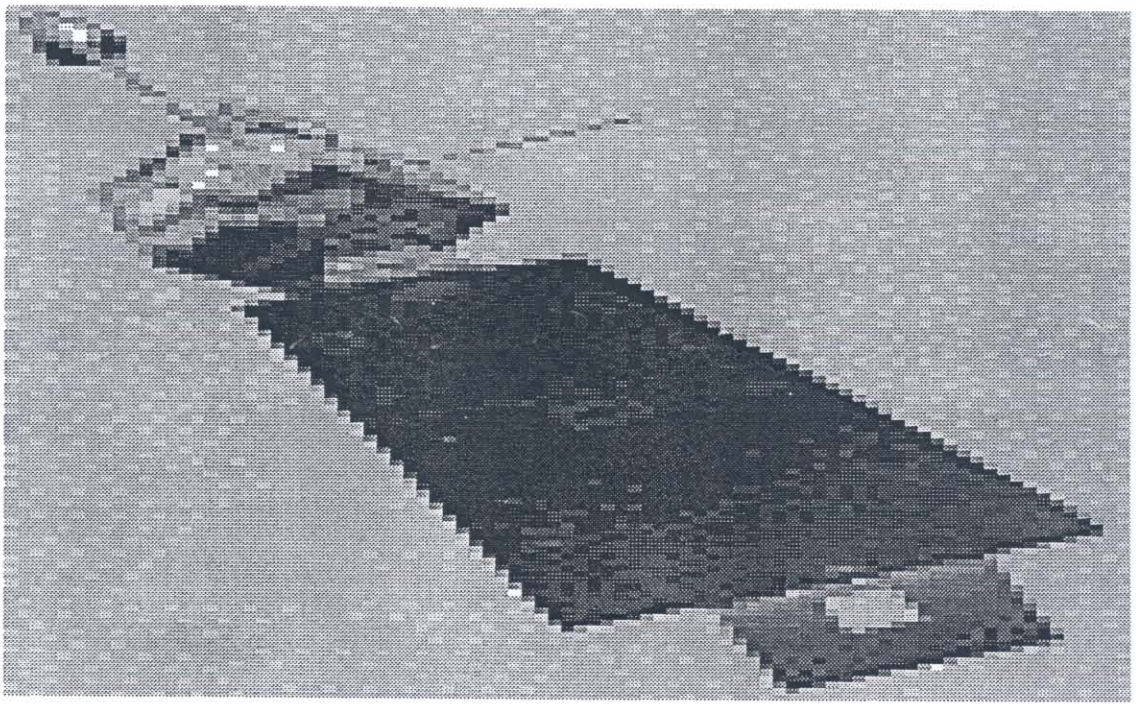
Congratulations! You have just finished tracking your first hurricane. The National Environmental Satellite, Data and Information Service has asked you to present your data on Hurricane Floyd at the next hurricane convention. The committee would like you to write a report on your findings. This information will be shared with other scientists as they continue to predict and track the path of hurricanes.

Before you write your report:

Think about how hurricanes are formed.
Think about the hurricane's speed and path.
Think about the hurricane's strength over land and water.

Now write your report for the committee.

STUDENT RESOURCE BOOKLET



HURRICANE BASICS

Hurricanes are severe tropical storms that form over the warm moist waters of the Atlantic and Pacific Oceans near the equator. They cannot form right on the equator because there is no Coriolis Force on the equator. Hurricanes obtain heat and energy through contact with the warm water from oceans. The warm water and warm air near the surface help to cause hurricanes to form. As the moisture evaporates it rises until enormous amounts of heated moist air are twisted high in the atmosphere. While a hurricane is over waters of 79°F or warmer, it continues to pull moisture from the surface and grow in size and force. When a hurricane crosses land or cooler waters, it loses its source of power and its winds gradually slow and eventually end.

Formation of hurricanes occurs during hurricane season, "officially" from June 1 until November 30 each year. The peak period for hurricane development is in early to mid September.

The winds of a hurricane rotate counter-clockwise north of the equator or clockwise south of the equator. The relatively calm, clear center of the hurricane is called the eye. The dense wall surrounding the eye has the strongest winds within the storm. Around this center, winds move at speeds between 74 and 200 miles per hour.

A hurricane's speed and path depend on interactions between the storm and the earth's atmosphere. A hurricane is steered by the wind currents that are blowing around it. Because the speeds of these winds vary, the speed that a hurricane travels also varies considerably. Other features such as high and low pressure systems can greatly alter the speed and the path of the hurricane. Some hurricanes follow a fairly straight course, while others loop and wobble along the path. As indicated previously, the life of a hurricane depends on many factors for development, survival, and intensification. These include warm ocean water, humid air, and weak upper level winds. When all of the ingredients are present, conditions are favorable for development and strengthening of a hurricane. Hurricanes also weaken when the ingredients are removed.

Hurricanes have sustained winds of at least 74 mph (64 knots). The winds in some hurricanes become much stronger. To address this, hurricanes are categorized on a scale of 1 to 5 based on their wind speed and resultant destructive potential. This is known as the Saffir-Simpson Scale, named after its originators, Herb Saffir and Dr. Robert Simpson. The hurricane categories are as follows:

***Category 1** – wind speeds of 74-95 mph
***Category 2** – wind speeds of 96-110 mph
***Category 3** – wind speeds of 111-130 mph
***Category 4** – wind speeds of 131-155mph
***Category 5** – wind speeds greater than 155 mph

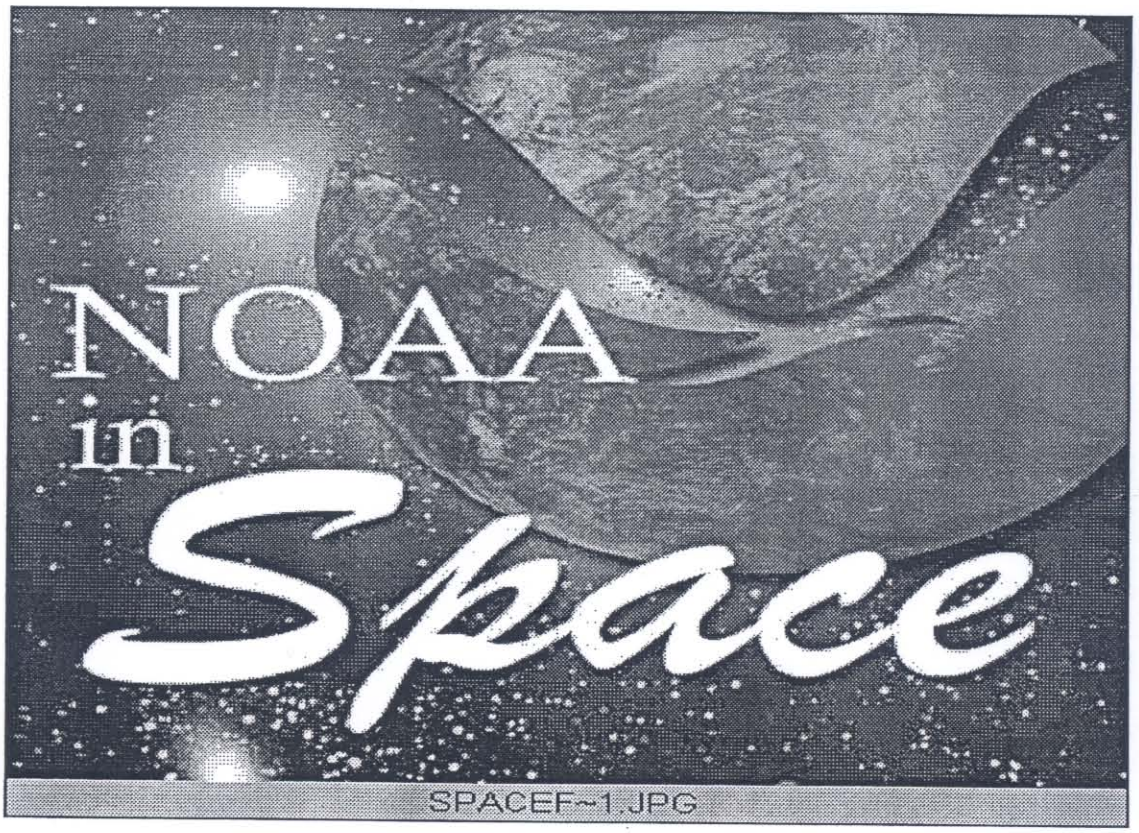
The hurricane's right side (relative to the direction it is travelling) is the most dangerous part of the storm because of the additive effect of the hurricane wind speed and speed of the larger atmospheric flow. The increased winds on the right side increase the storm surge.

The main hazards associated with hurricanes are storm surge, high winds, heavy rain, and flooding, as well as tornadoes. The intensity of a hurricane is an indicator of potential damage. However, impacts are a function of where and when the storm strikes. Hurricanes cannot be controlled, but our vulnerability can be reduced through preparedness.

GLOSSARY

Atmosphere- the air surrounding Earth.
Condensation- the change of a vapor to liquid.
Continental air mass- an air mass that forms over land, making it generally dry. It may be warm or cold.
Coriolis Effect- the apparent curving motion of anything, such as wind, caused by Earth's rotation.
Doppler radar- radar that measures speed and direction of a moving object, such as wind.
Drought- period of abnormal dryness for a particular region.
Environmental Modeling Center (EMC) - National Weather Service center in Camp Springs, MD, that prepares worldwide computer forecasts. Hurricane and Severe Storms Centers are part of EMC.
Eye- the calm, usually clear center of the hurricane.
Eye Wall- the dense wall of winds and clouds surrounding the eye.
Flash flood- flooding with a rapid water rise.
Fog- a cloud with its base on the ground.
Hurricane- a tropical cyclone with winds of 74 miles per hour or more.
Jet stream- a narrow band of wind in the upper atmosphere with speeds greater than 57 miles per hour.
National Environmental, Satellite, Data, and Information Service (NESDIS)- operates the U.S. civilian Earth-observing satellite systems, as well as global databases for meteorology, oceanography, solid-earth geophysics and solar-terrestrial sciences.
National Hurricane Center (NHC)- National Weather Service office in Miami, FL, that tracks and forecasts hurricanes and other weather in the Atlantic, Gulf of Mexico, Caribbean Sea, and parts of the Pacific.
National Weather Service- Federal agency that observes and forecasts weather. Formerly the U.S. Weather Bureau, it is part of the National Oceanic and Atmospheric Administration, which is part of the Department of Commerce.
Rain- falling water drops with a diameter greater than .02 inch.
Severe thunderstorm- a thunderstorm with winds faster than 57 miles per hour or hailstones ¾ of an inch or larger in diameter. They also can produce tornadoes.
Storm surge- quickly rising ocean water levels associated with hurricanes that can cause widespread flooding.
Storm tracks- paths that storms generally follow.
Thunder- sound produced by a lightning discharge.
Thunderstorms- localized storms that produce lightning, and therefore, thunder.
Tornado- a strong, rotating column of air extending from the base of a cumulonimbus cloud to the ground.
Tropical cyclone- a low-pressure system in which the central core is warmer than the surrounding atmosphere. It is also the early stage of a hurricane.
Water Vapor- water in a gaseous state.

GOES AND POES SATELLITES



GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITES (GOES)

INTRODUCTION

One of the most important weather satellites used today is called the Geostationary Operational Environmental Satellite (GOES). These satellites are designed to provide information about the Earth's atmosphere, temperature, climate and the surface of the Earth and sea. They gather pictures and other information and send them to ground terminals for use by The National Weather Service. The GOES satellites circle the earth in a "geostationary" or "geosynchronous" orbit over the equator. This means that the satellites observe the Earth from the same place at all times and their orbit is "in sync" or the same as the Earth.

INSTRUMENTS

Each satellite carries two major instruments. The first instrument is the Imager that operates in the visible spectrum. It sends back pictures, which provide information on clouds, water vapor in the atmosphere, smoke, wind, fire and temperature. The other instrument is known as the Sounder and it operates in the infrared spectrum. The Sounder sends back information and data on the atmosphere, land and sea surface. It also transmits data on ozone, clouds and water vapor in different layers of the atmosphere. These two instruments are used to assist weather forecasters in the prediction of severe storms and other types of weather.

The GOES satellites are operated by the National Oceanic and Atmospheric Administration (NOAA). Within NOAA, the National Environmental Satellite, Data, and Information Service operates and manages the system. The National Aeronautics and Space Administration (NASA) is responsible for launching the spacecraft.

LOCATION

NOAA operates two GOES satellites. One satellite is located over the equator at 75 degrees west, while the other satellite is located over the equator at 135 degrees west. Working as a team, these two satellites can view most of the Western Hemisphere and much of the Pacific and Atlantic Oceans. They can take pictures during both the day and the night that show almost all of this area, or they can focus on much smaller areas in order to observe severe weather activity quickly in local areas.

POLAR-ORBITING ENVIRONMENTAL SATELLITES (POES)

INTRODUCTION

Polar orbiting satellites circle the Earth in a sun-synchronous orbit: the orbital plane of a polar orbiting satellite remains stationary with respect to the sun. As the satellite moves through its orbit, the Earth rotates below it. The result is that the satellite scans a different strip of the Earth during each orbit. From a fixed point on Earth, a polar orbiting satellite will always cross the equator at approximately the same local time relative to the sun. Each orbit

has a period of approximately 102 minutes. Therefore, in one day, the satellite makes roughly 14 orbits (1440 minutes per day/ 102 minutes per orbit).

POES have provided continuous observations of the land ice, oceans, and atmosphere from the tropics to the polar regions. These global observations have led to dramatic improvements in weather prediction and to significantly enhanced understanding of how the Earth works.

INSTRUMENTATION

AVHRR/3 – Advanced Very High Resolution Radiometer
Application: Surface & Cloud Imaging, Sea Surface Temperature, Vegetation Index, Aerosols, Radiation Budget, Snow/Ice Cover

HIRS/3 – High Resolution Infrared Sounder
Application: Temperature Profiles, Ozone, Cloud Detection, and Radiation Budget

AMSU-A - Advanced Microwave Sounding Unit A
Application: Temperature Profiles

AMSU – B – Advanced Microwave Sounding Unit B
Application: Water Vapor Profiles

SBUV/2 – Solar Backscatter Ultra Violet spectral radiometer
Application: Total and Profile Ozone Products

SEM/2 – Space Environment Monitor
Application: Solar Environment Monitoring and Solar Terrestrial Phenomena

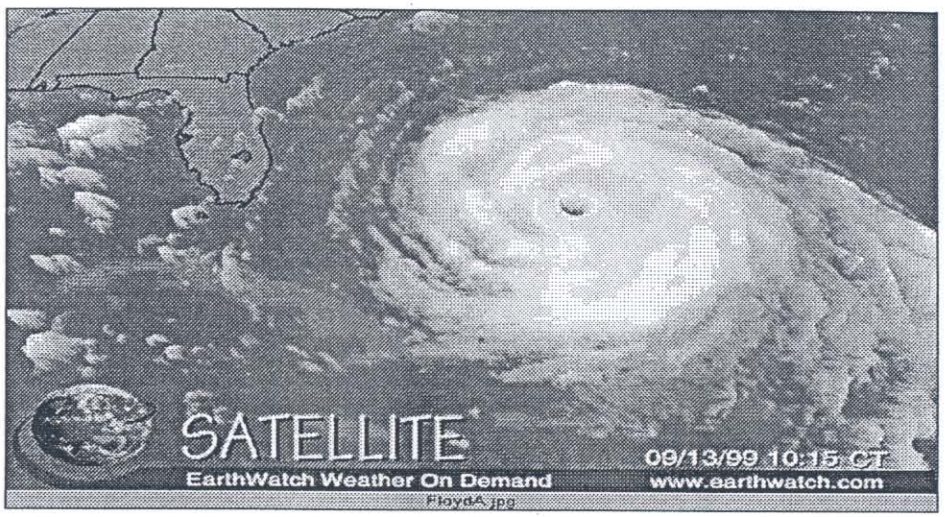
SAR – Search and Rescue
Application: The Search and Rescue system is designed to detect and locate emergency beacons.

DCS – Data Collection System
Application: The Data Collection system measures environmental factors such as atmospheric temperature and pressure, velocity and direction of the ocean and wind currents. Data is collected from buoys, free-floating balloons, and remote weather stations.

LOCATION

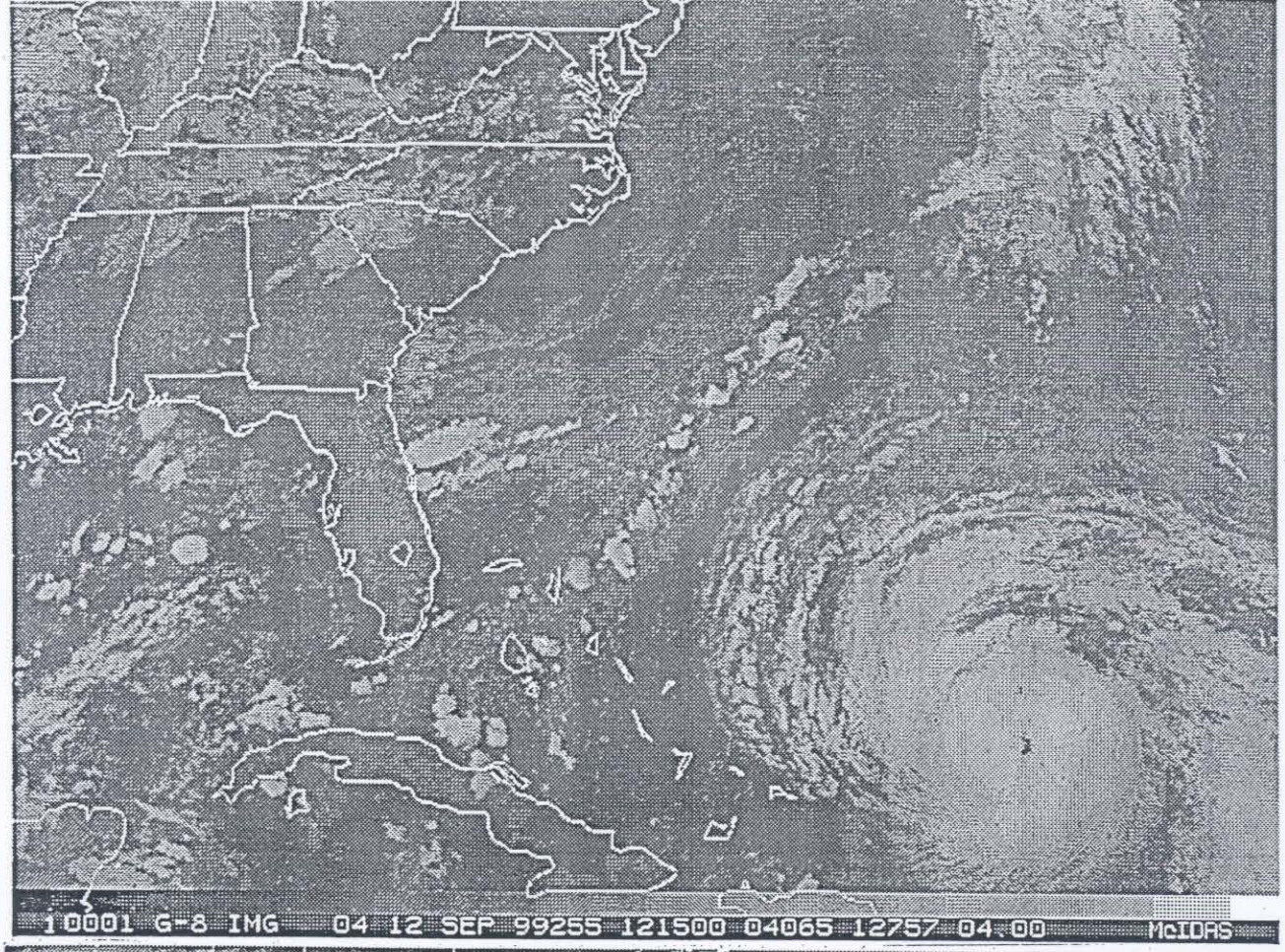
The orbits of the polar orbiting satellites are nearly from pole to pole, with an inclination of 98 degrees. Each day as the Earth rotates around the sun the orbit also rotates in the other direction. This keeps the angle between the sun and the orbit (nearly) constant. Because the angle between the orbit and the sun is constant the orbit always crosses the equator at the same time of day.

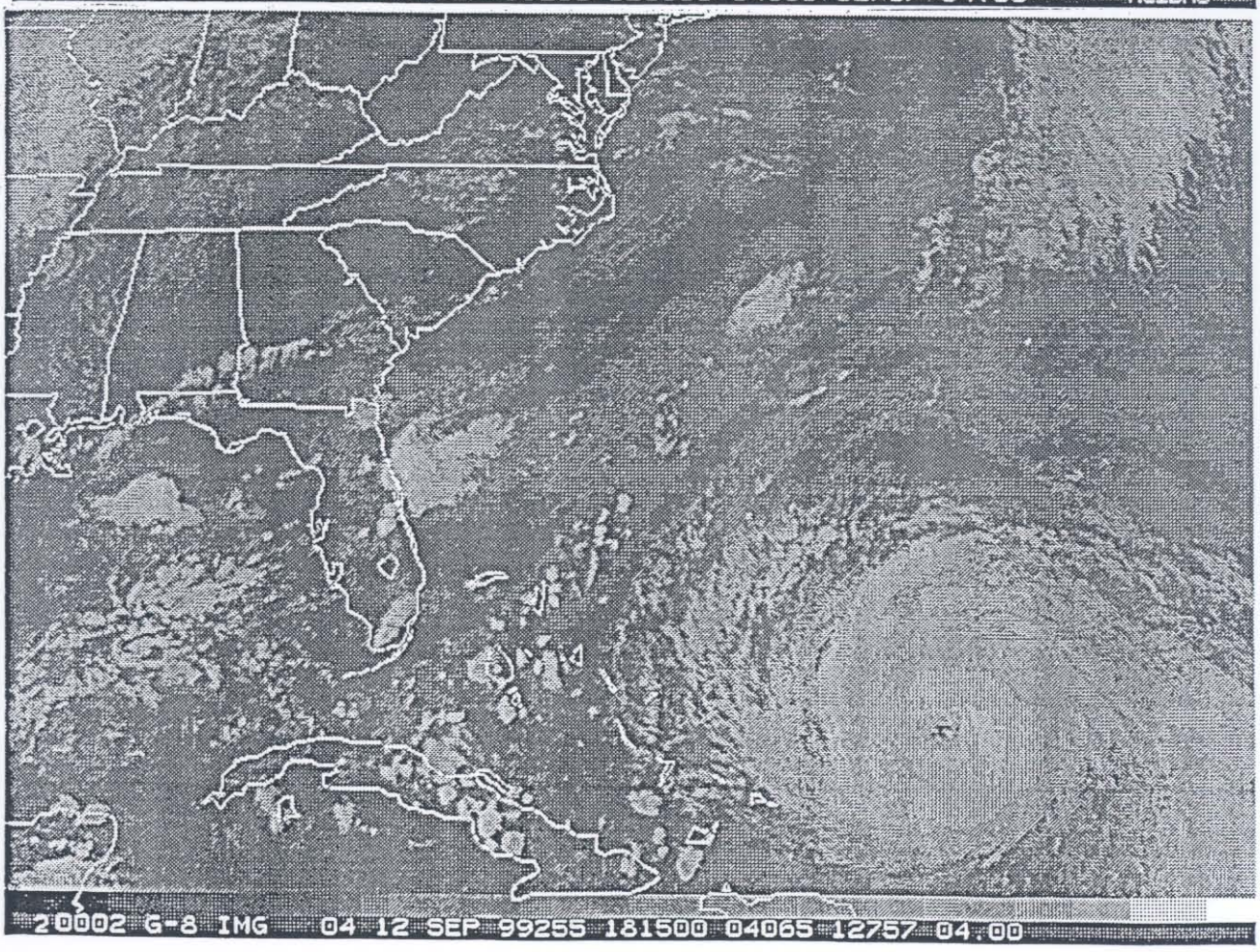
HURRICANE FLOYD
7-17 September, 1999

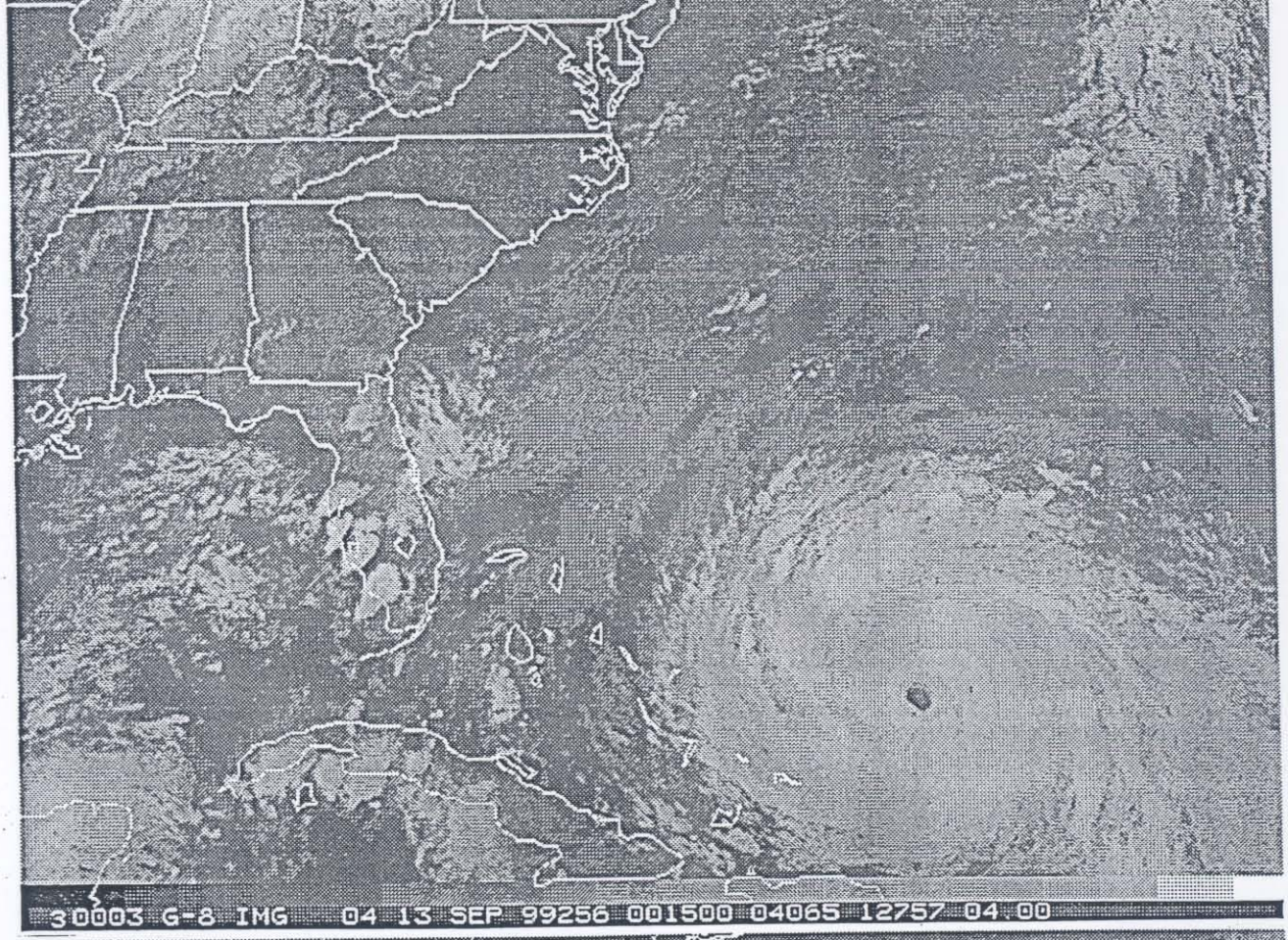


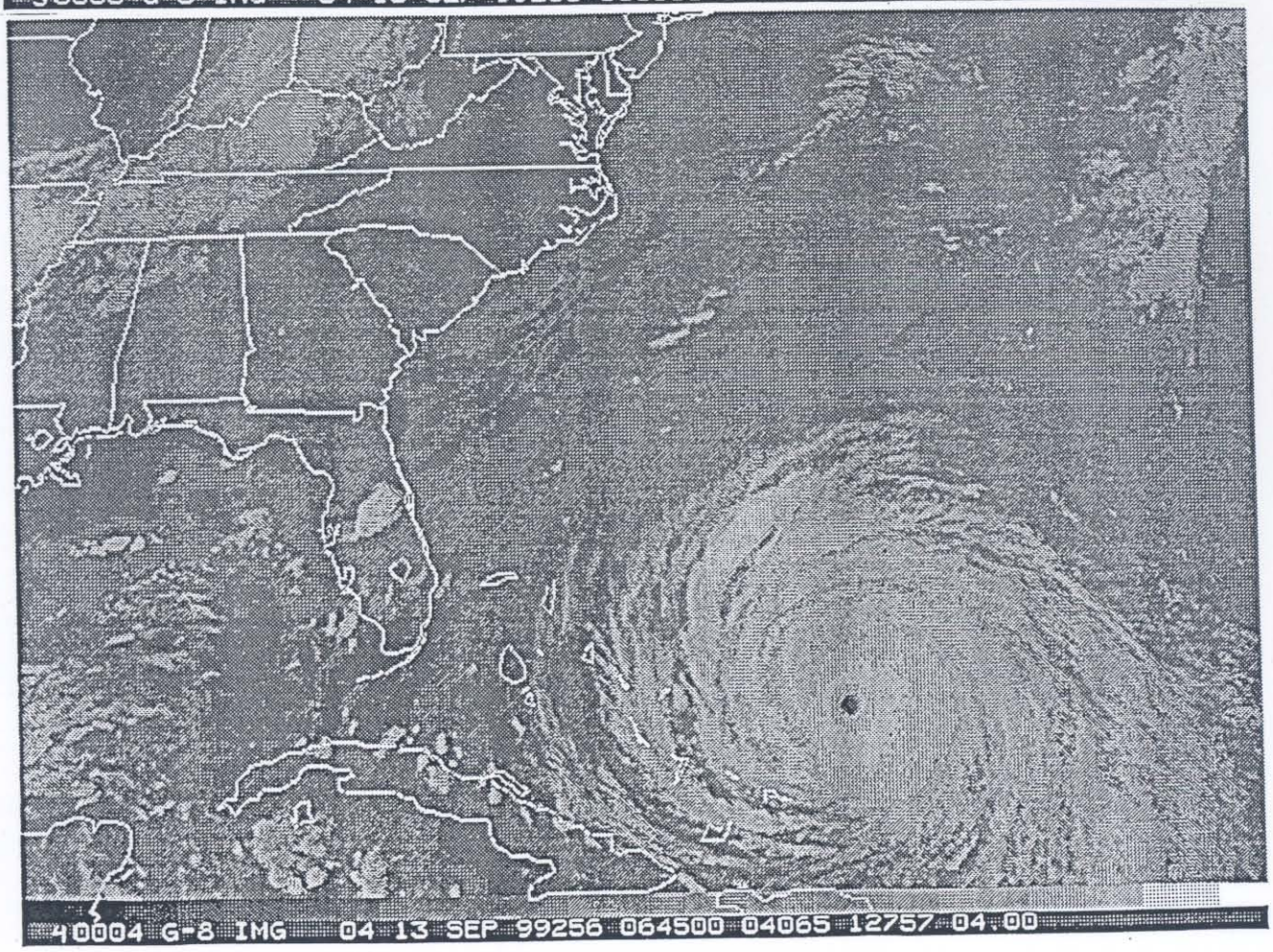
An unusually large hurricane nearly the size of Texas, Hurricane Floyd caused over $6 billion in damages. The large and intense hurricane pounded the central and northern Bahama Islands, seriously threatened Florida, struck the coast of North Carolina and moved up the United States east coast into New England. It neared the threshold of category five intensity on the Saffir/Simpson Hurricane Scale as it approached the Bahamas, and produced a flood disaster of immense proportions in the eastern United States, particularly in North Carolina. The hurricane made landfall on the 16th near Cape Fear, North Carolina with category two winds of 105 mph. Approximately 2.6 million people evacuated their homes in Florida, Georgia, and the Carolinas- the largest peacetime evacuation in U.S. history.

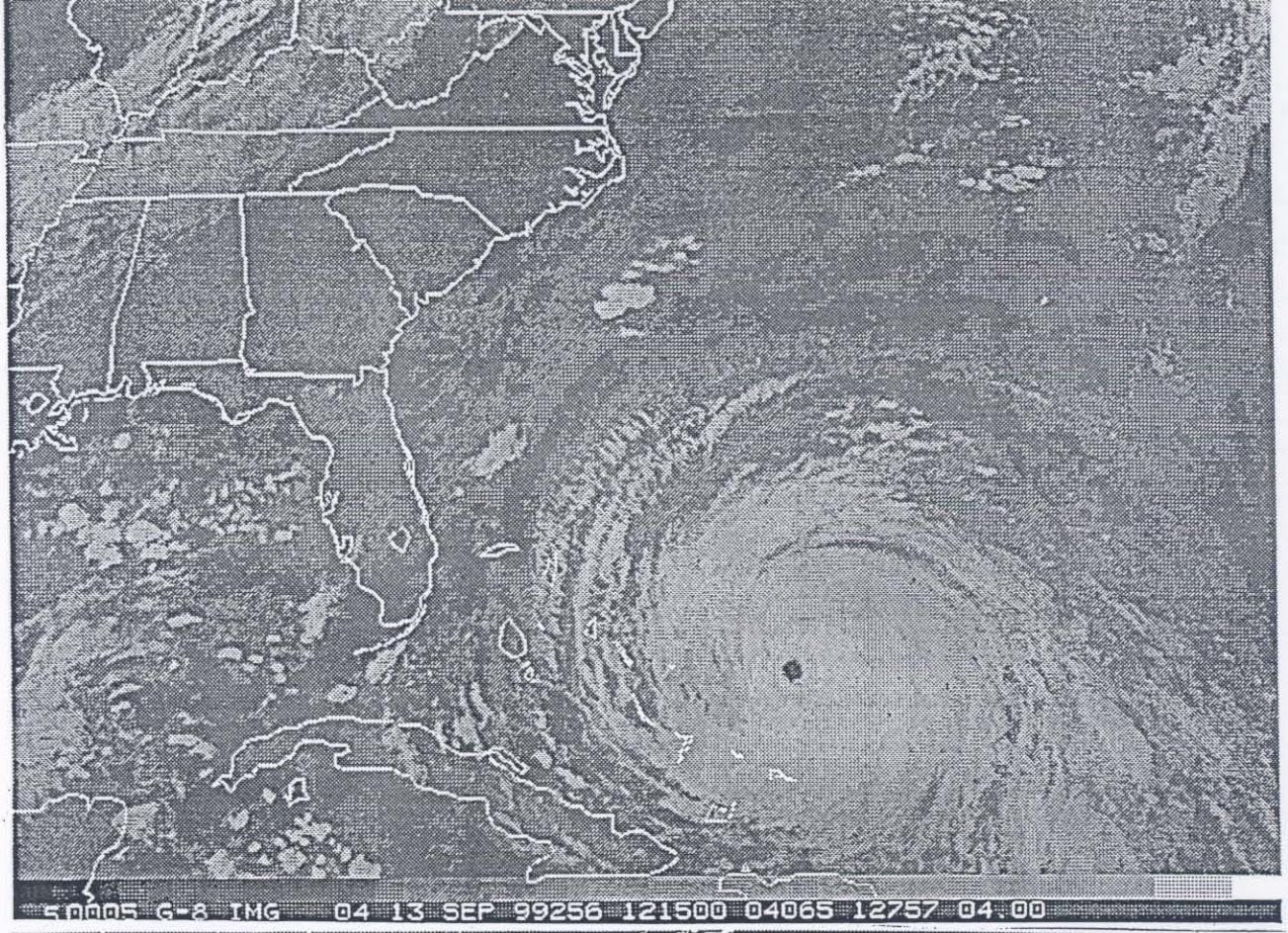
These images were provided by the Geostationary Operational Environmental Satellite (GOES 8). The GOES satellites circle the Earth in a geosynchronous orbit at the same speed as the Earth turns, 22,300 miles above the surface. Because they stay above a fixed spot on the surface, the satellites provide a constant vigil for severe weather conditions such as tornadoes, flash floods, hail storms and hurricanes. The satellites are operated by NOAA's National Environmental Satellite, Data, and Information Service.

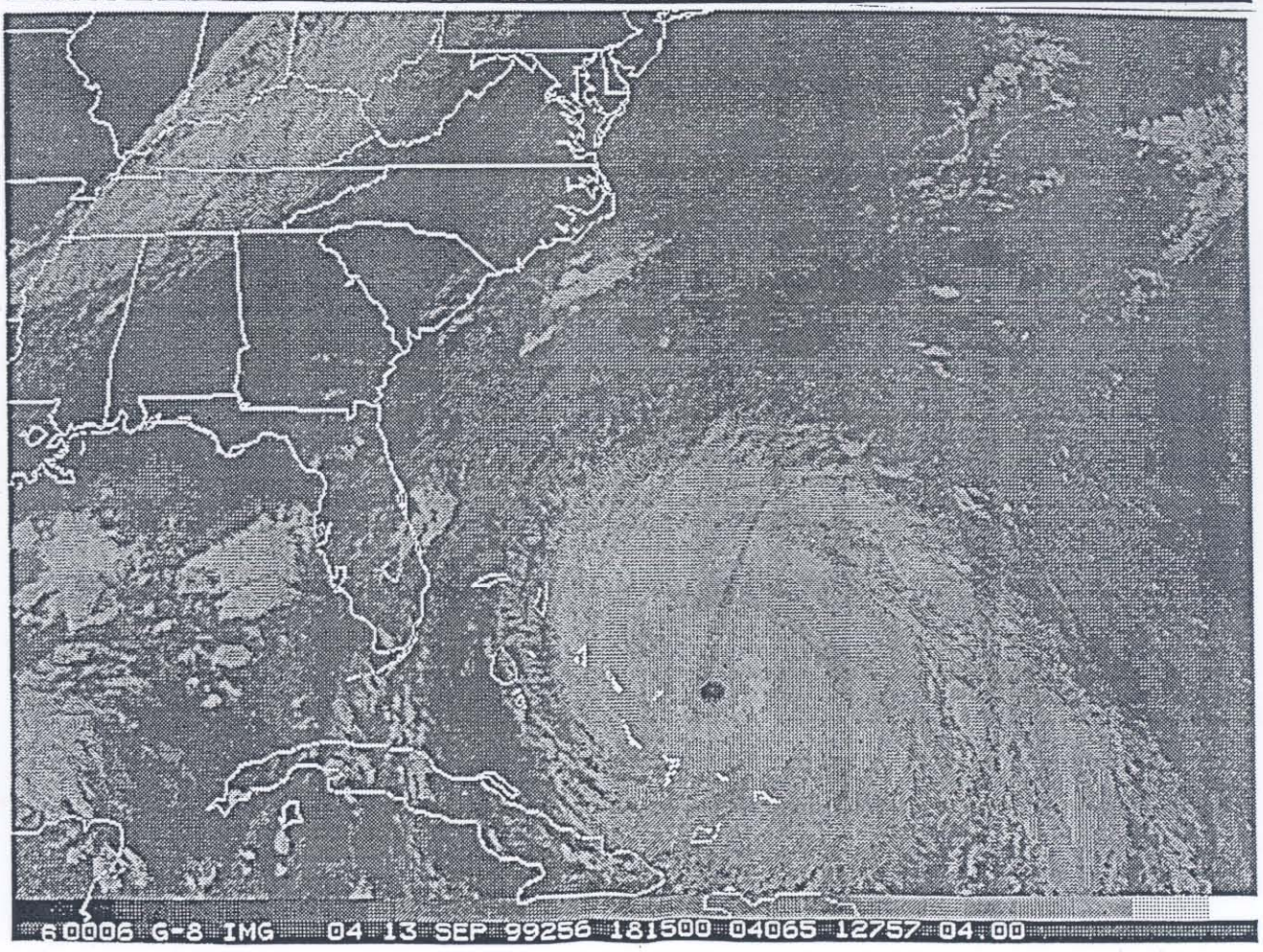

1 0001 G-8 IMG 04 12 SEP 99255 121500 04065 12757 04.00 McIDAS

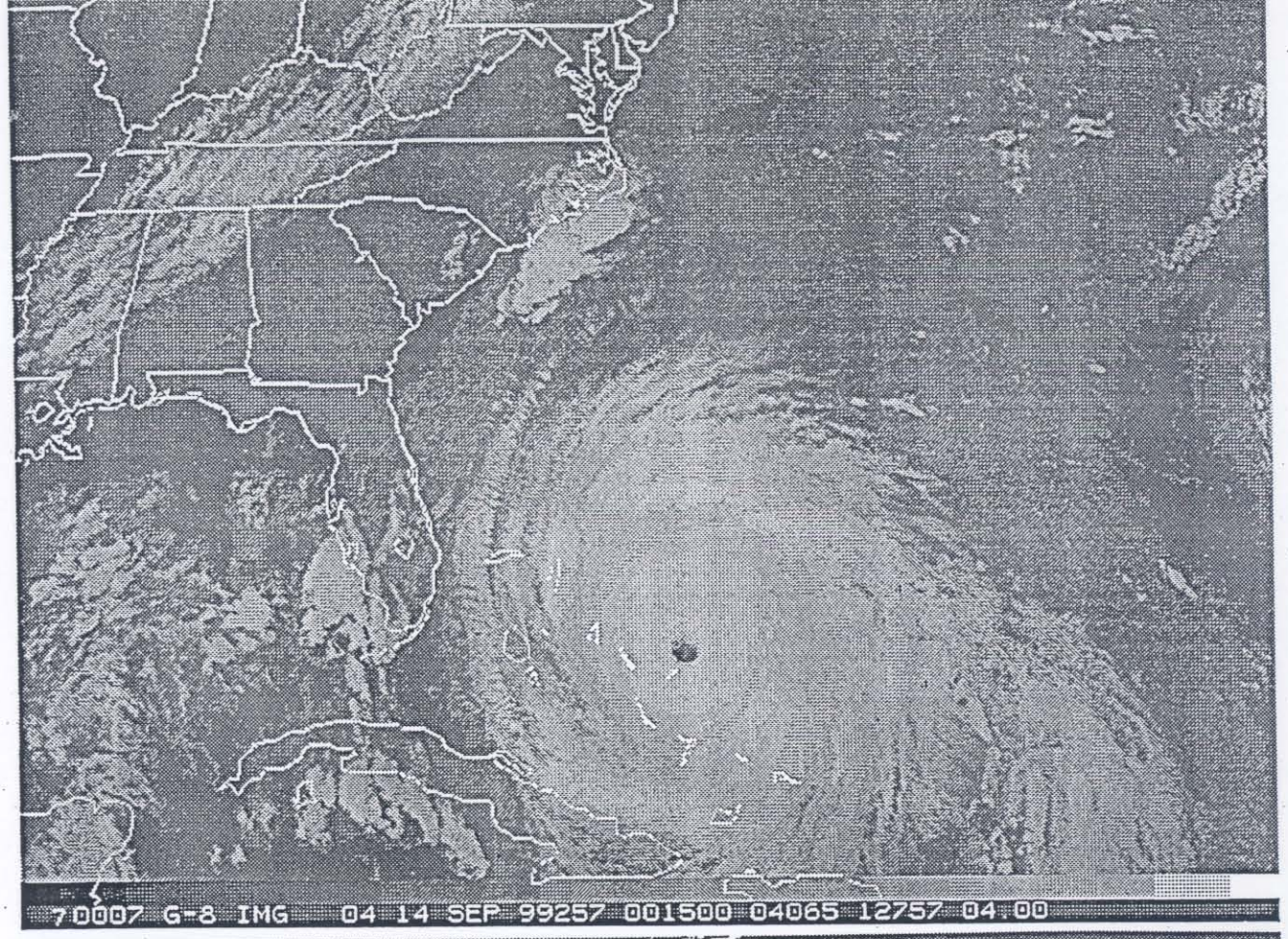

2 0002 G-8 IMG 04 12 SEP 99255 181500 04065 12757 04.00

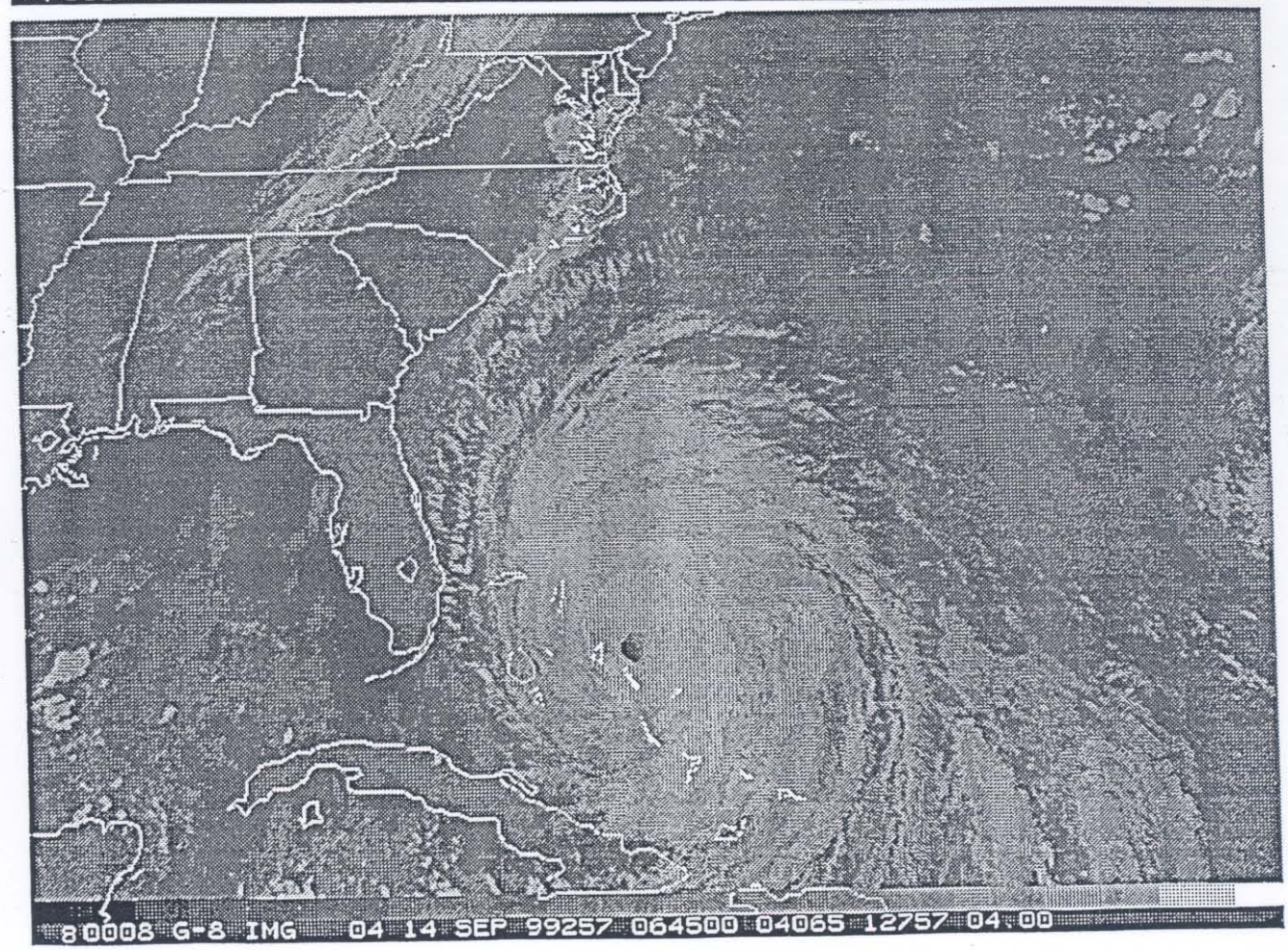

30003 G-8 IMG 04 13 SEP 99256 001500 04065 12757 04.00

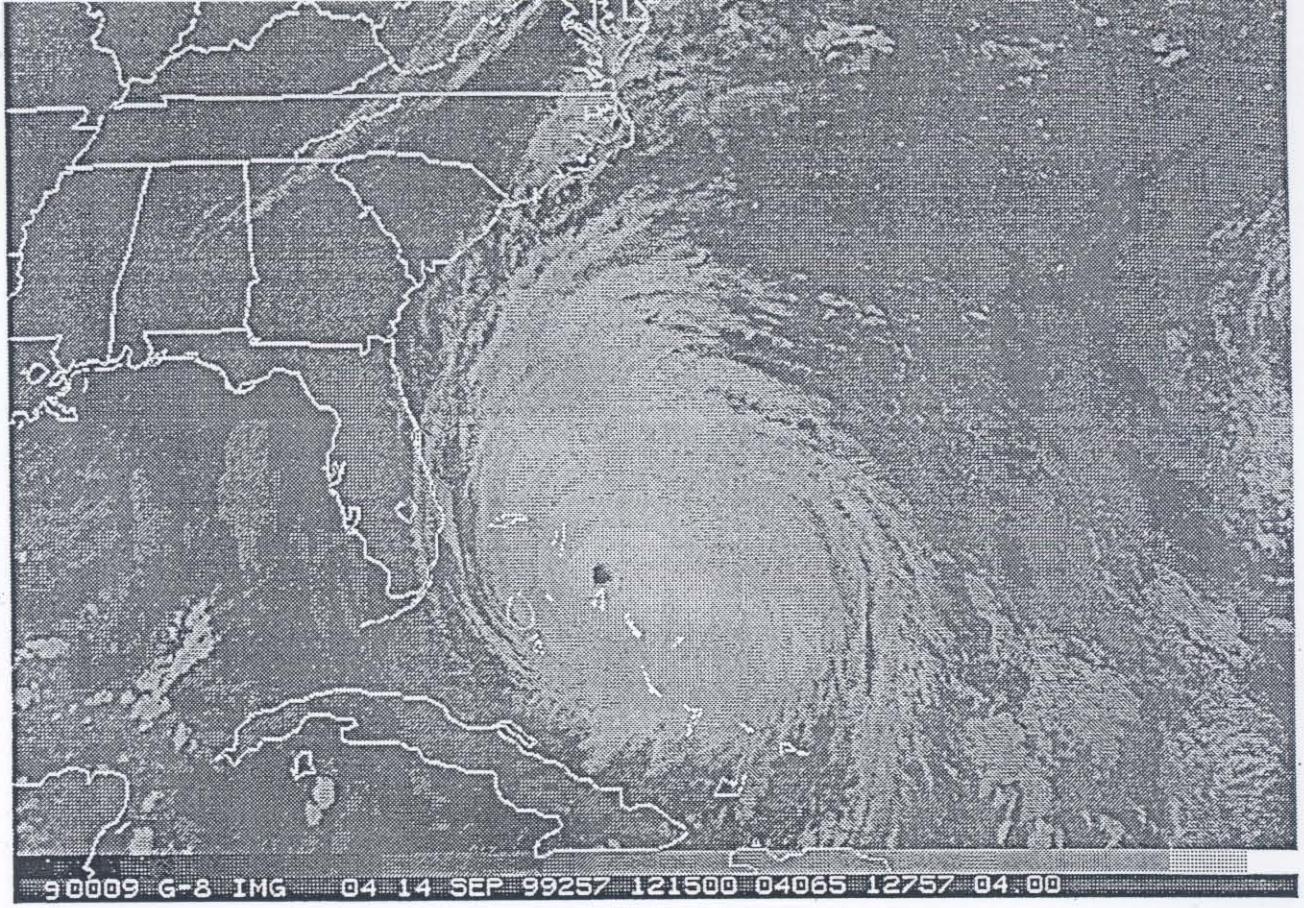

40004 G-8 IMG 04 13 SEP 99256 064500 04065 12757 04.00

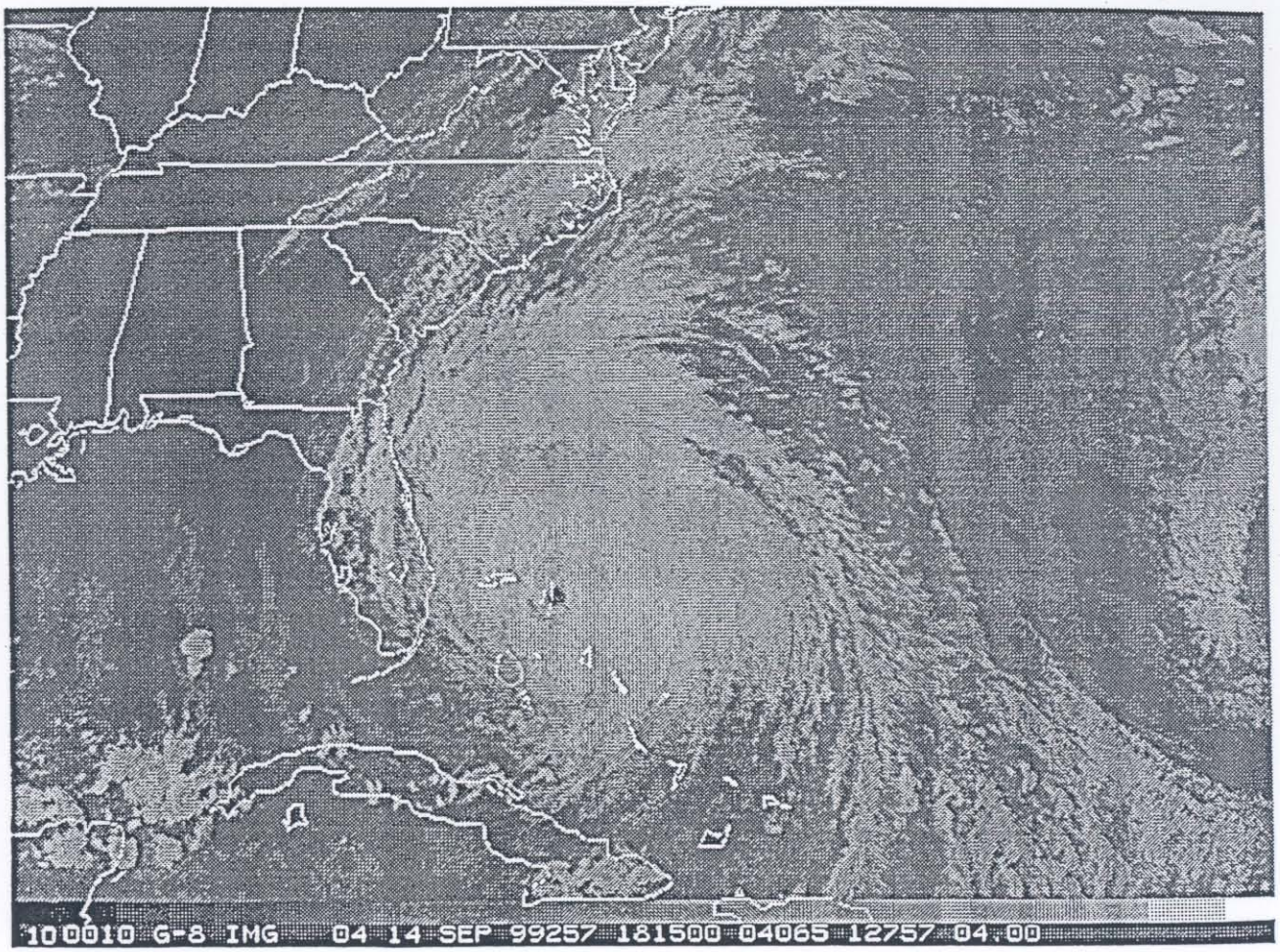

G-8 IMG 04 13 SEP 99256 121500 04065 12757 04.00

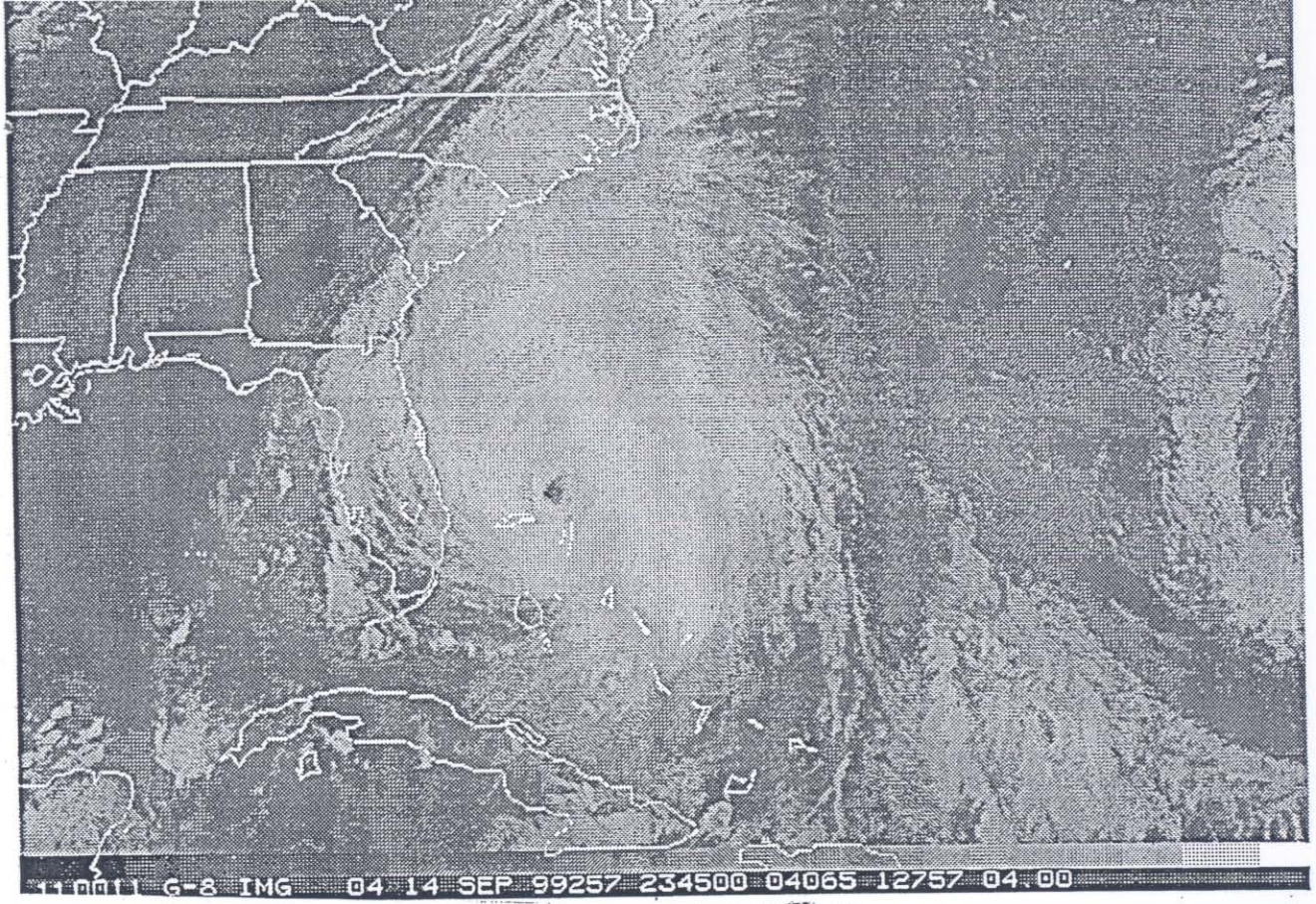

G-8 IMG 04 13 SEP 99256 181500 04065 12757 04.00

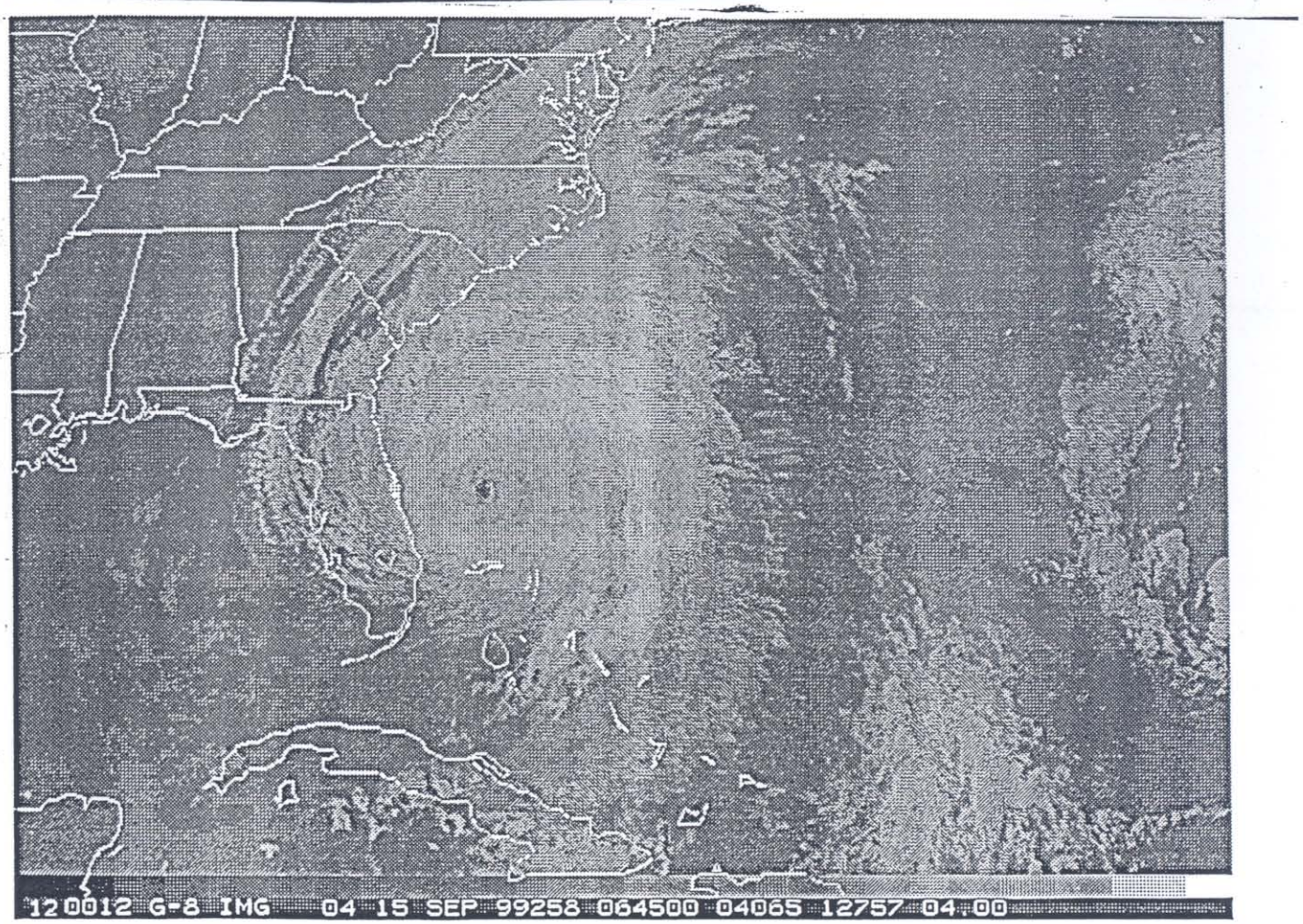

7D0007 G-8 IMG 04 14 SEP 99257 001500 04065 12757 04 00

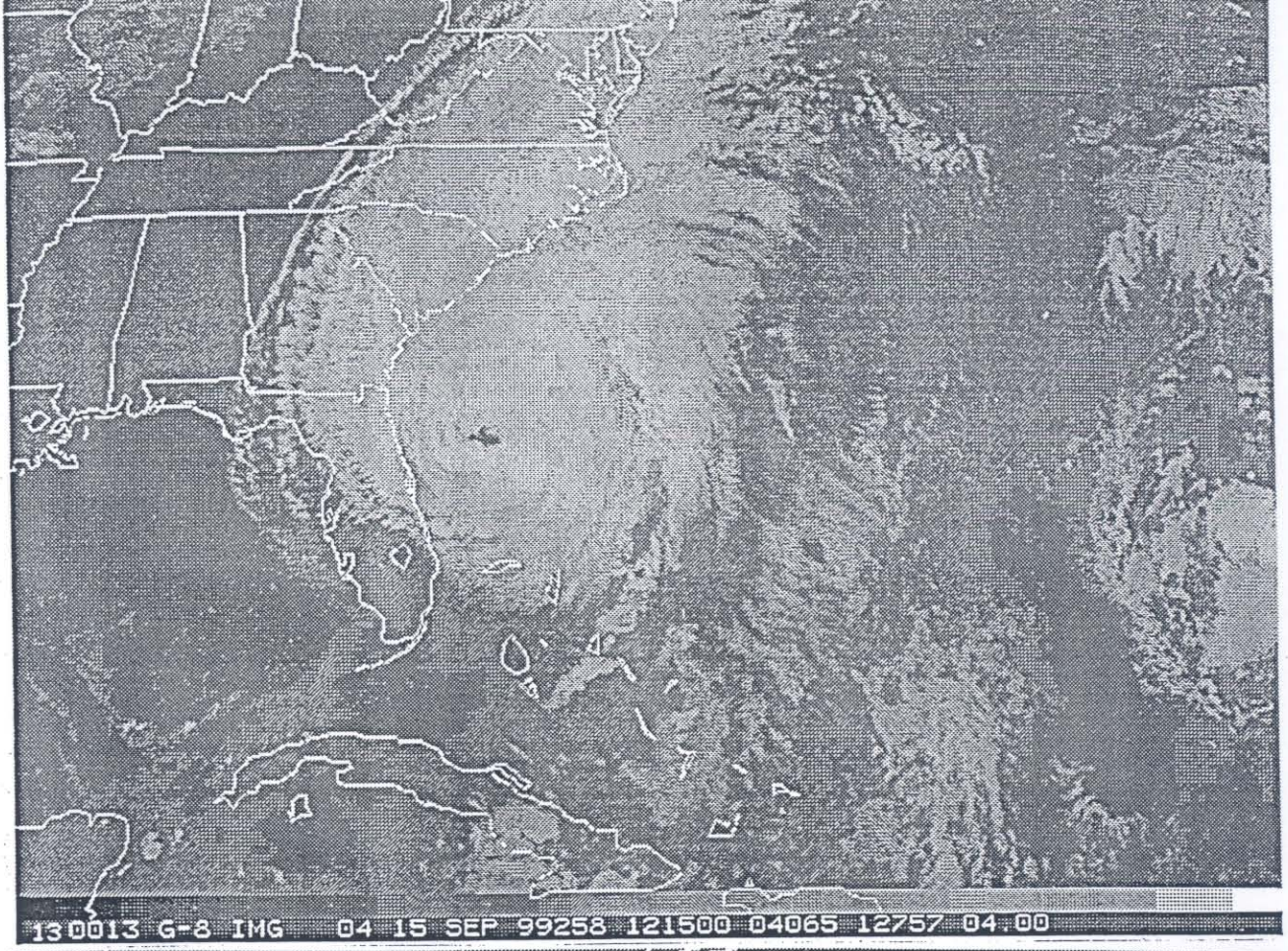

8D0008 G-8 IMG 04 14 SEP 99257 064500 04065 12757 04 00

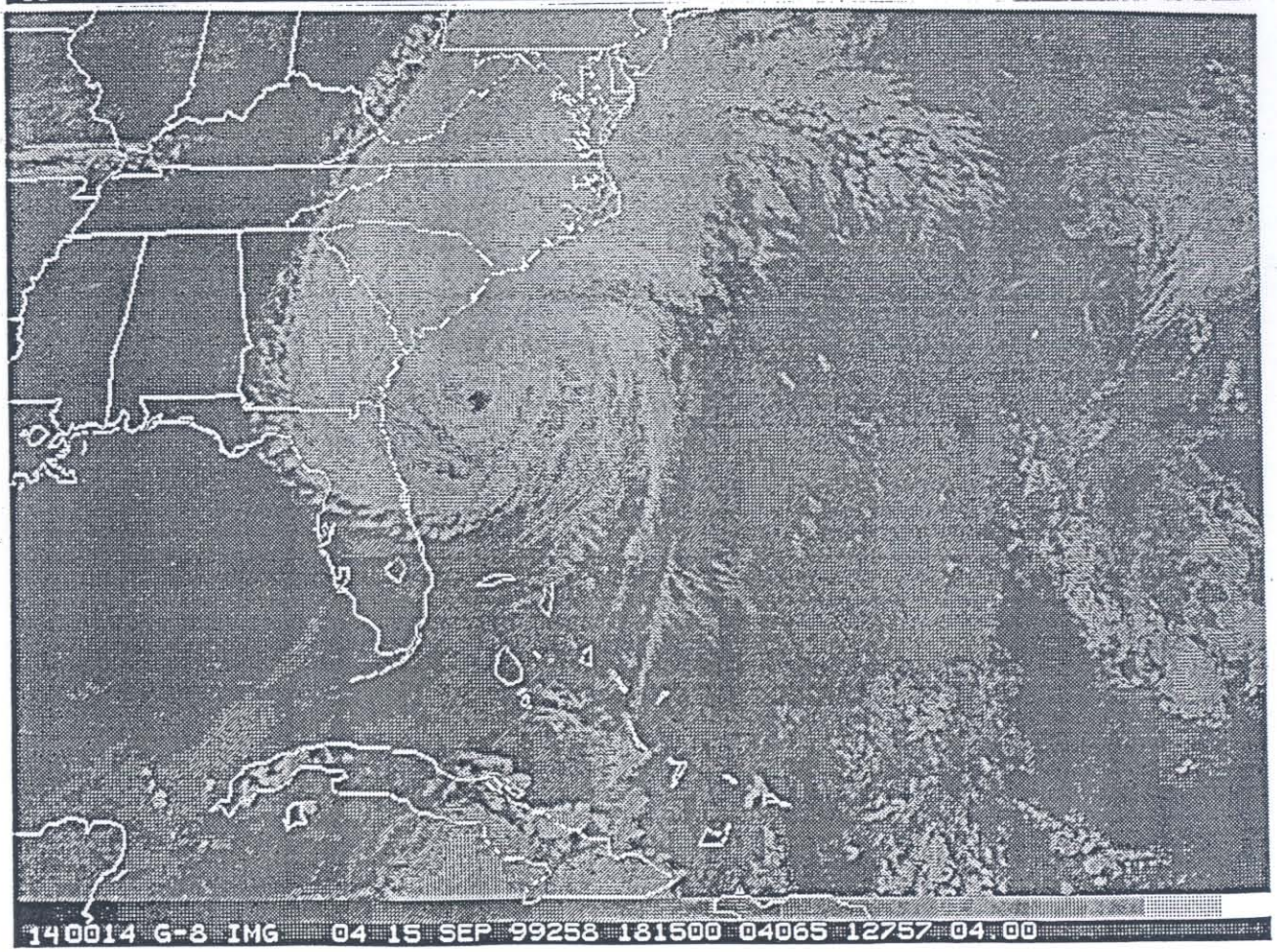

90009 G-8 IMG 04 14 SEP 99257 121500 04065 12757 04.00

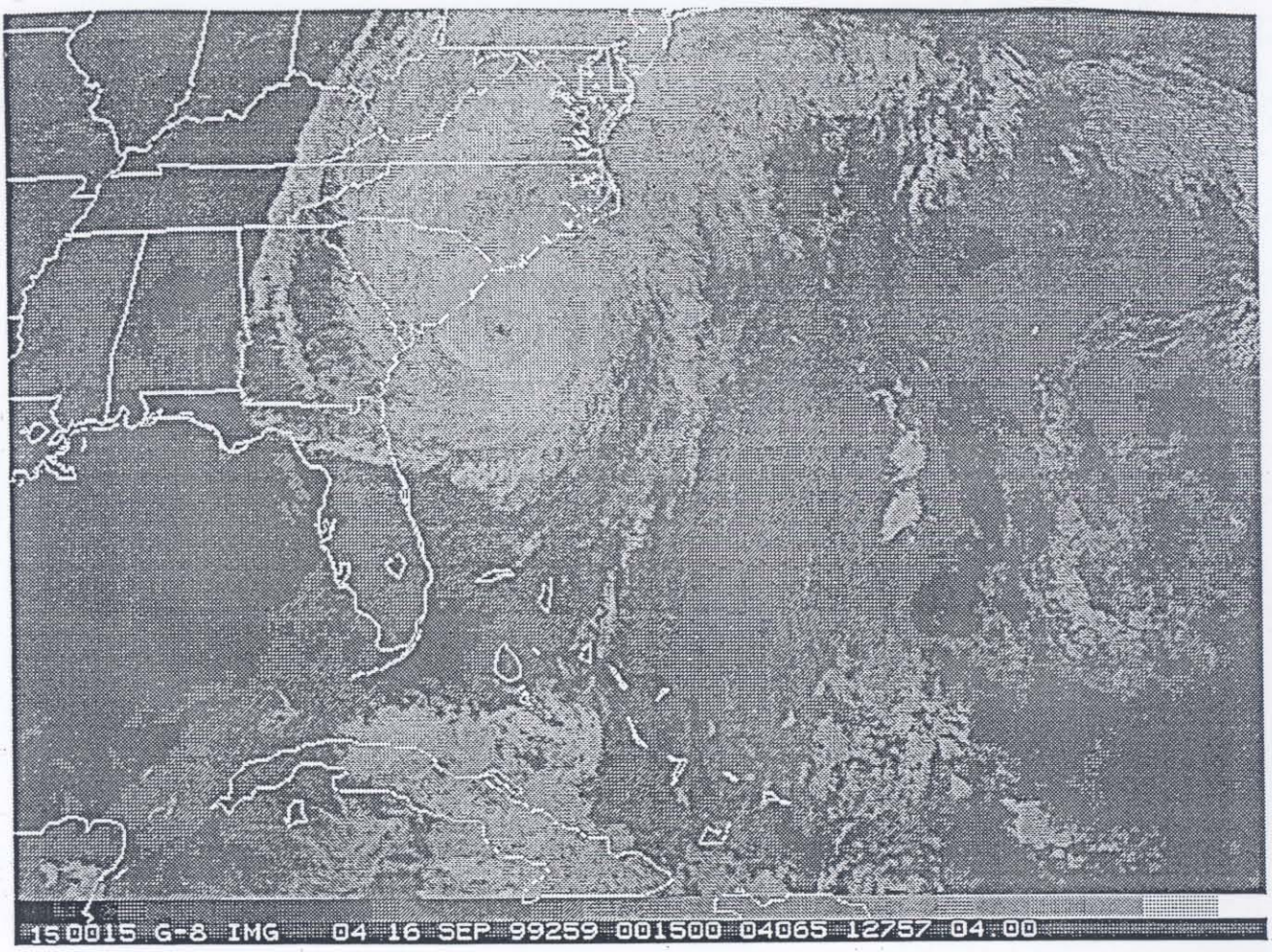

100010 G-8 IMG 04 14 SEP 99257 181500 04065 12757 04.00

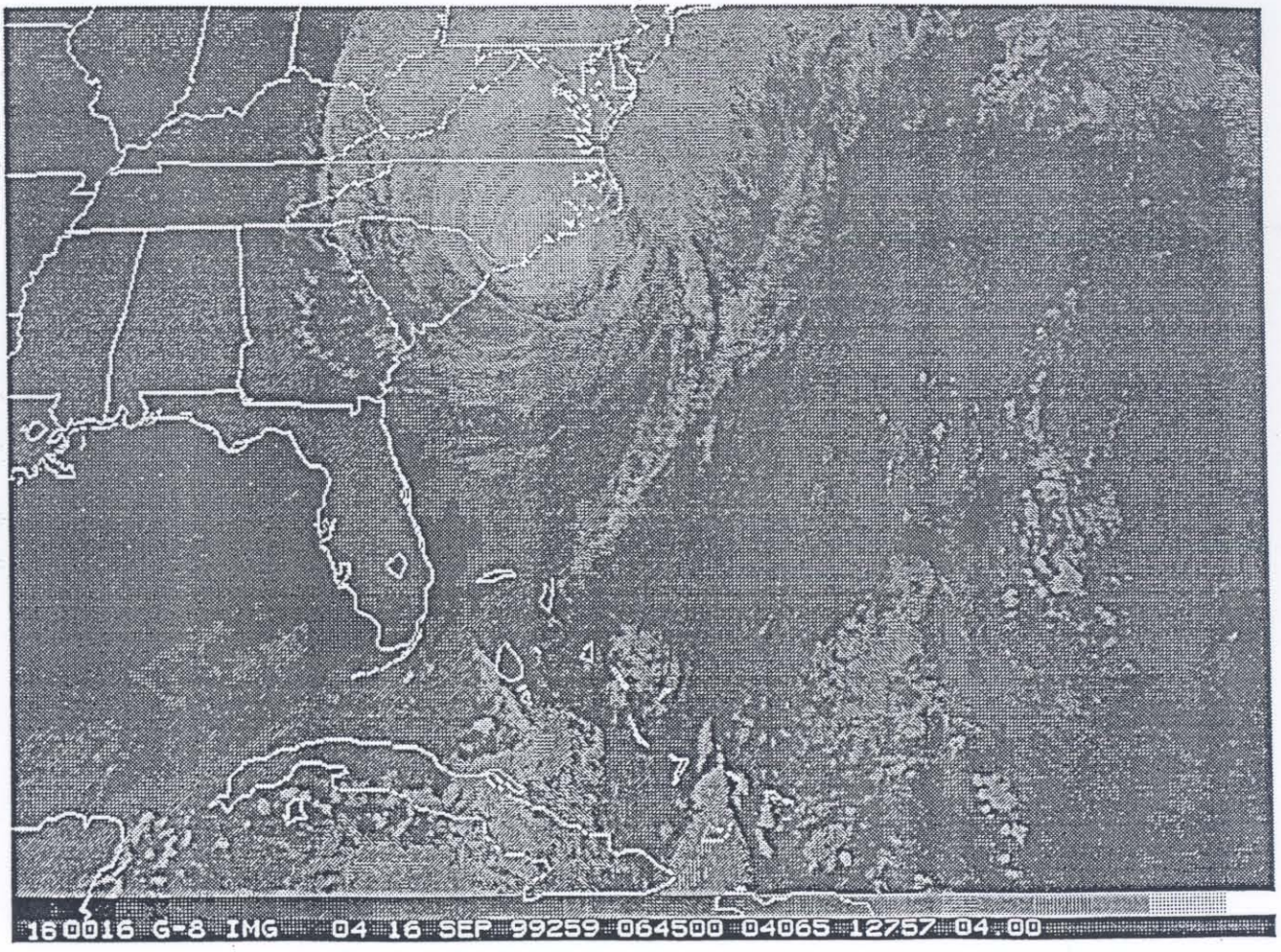

11 0011 G-8 IMG 04 14 SEP 99257 234500 04065 12757 04.00

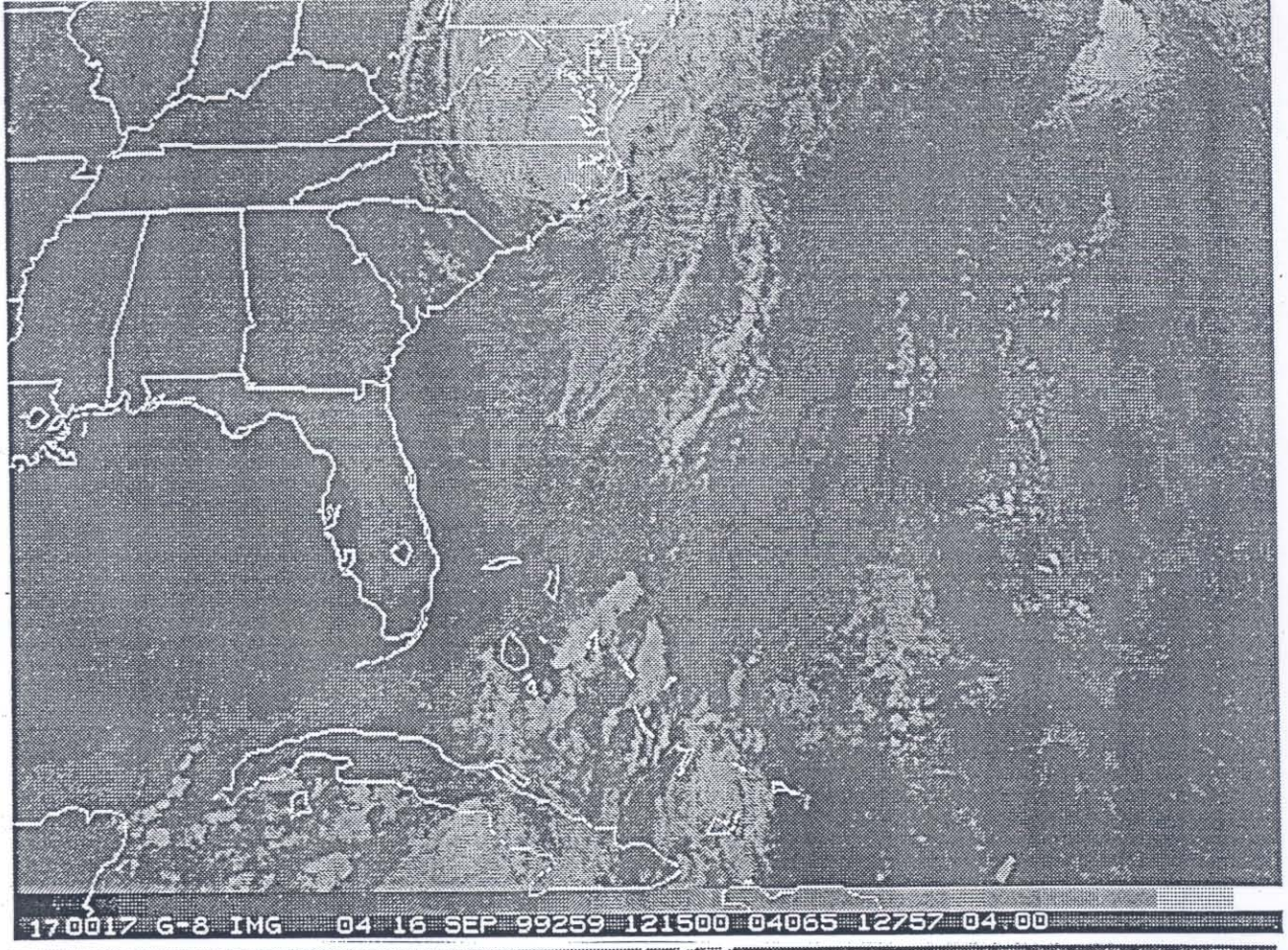

12 0012 G-8 IMG 04 15 SEP 99258 064500 04065 12757 04.00

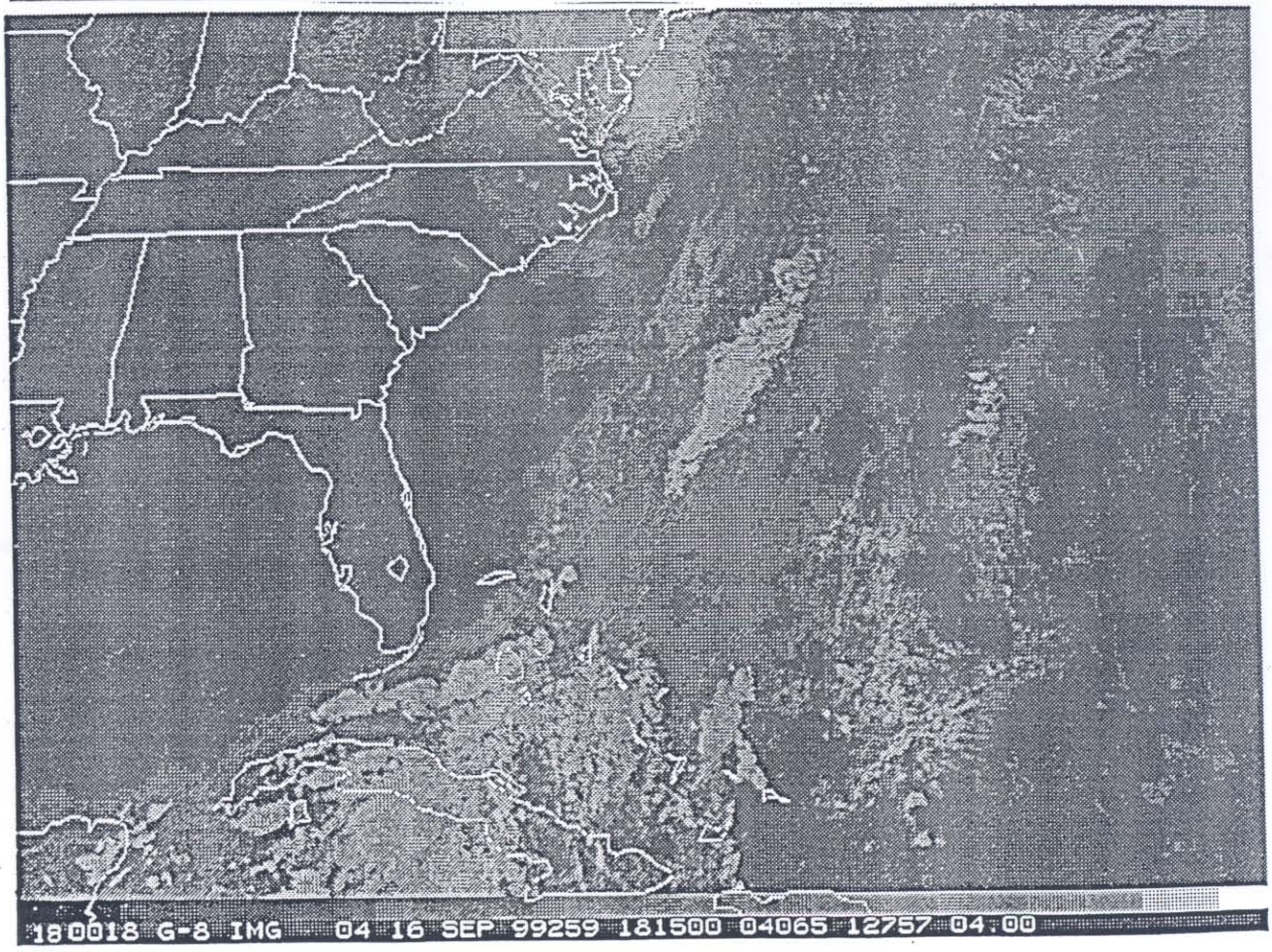

130013 G-8 IMG 04 15 SEP 99258 121500 04065 12757 04.00


140014 G-8 IMG 04 15 SEP 99258 181500 04065 12757 04.00

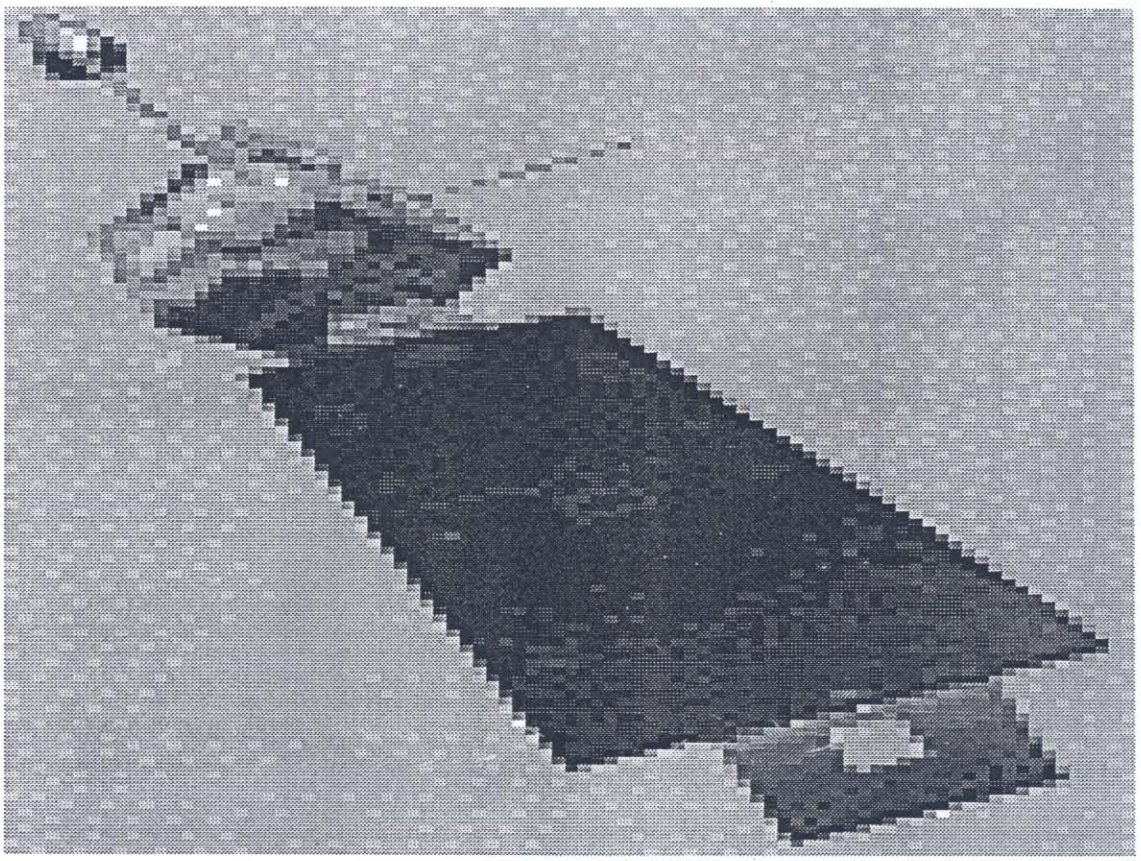

15 0015 G-8 IMG 04 16 SEP 99259 001500 04065 12757 04.00


16 0016 G-8 IMG 04 16 SEP 99259 064500 04065 12757 04.00


17 0017 G-8 IMG 04 16 SEP 99259 121500 04065 12757 04.00


18 0018 G-8 IMG 04 16 SEP 99259 181500 04065 12757 04.00

TEACHER'S GUIDE



TEACHERS GUIDE

Prepare a plan for separating the students into groups of four.

Before beginning activity 1, you must make transparency copies of the blank tracking map. It is recommended that you make a class set and use them throughout the day.

Make sure that the students use erasable markers so that the transparencies can be used more than once.

The student resource booklet may be separated from the student response booklet to decrease copying. It is recommended that each student receive a student response booklet to complete his or her answers. It is also recommended to make one class set of the student resource booklet to use throughout the day.

Before beginning this activity, make sure that the students have an understanding that weather patterns are predicted by using space-based instruments.

Please instruct students on how to use the resource booklet.

Related Careers

Meteorology

Atmospheric Science

Statistics

Engineering

Computer Science

Mathematics

Oceanography

Related Web Sites

www.noaa.gov

http://orbit-net.nesdis.noaa.gov/ora/

http://www.osei.noaa.gov/OSEIiod.html

www.nhc.noaa.gov/1999floyd.html

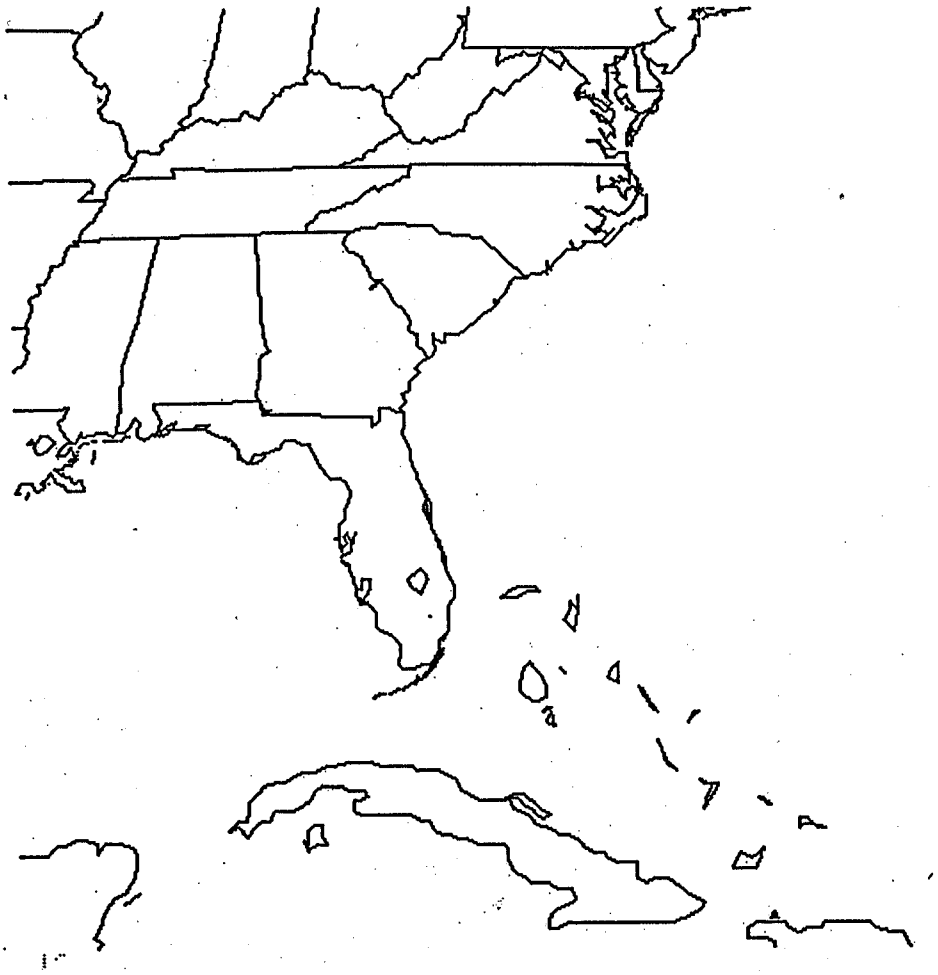
www.fema.gov/kids/hurr.html

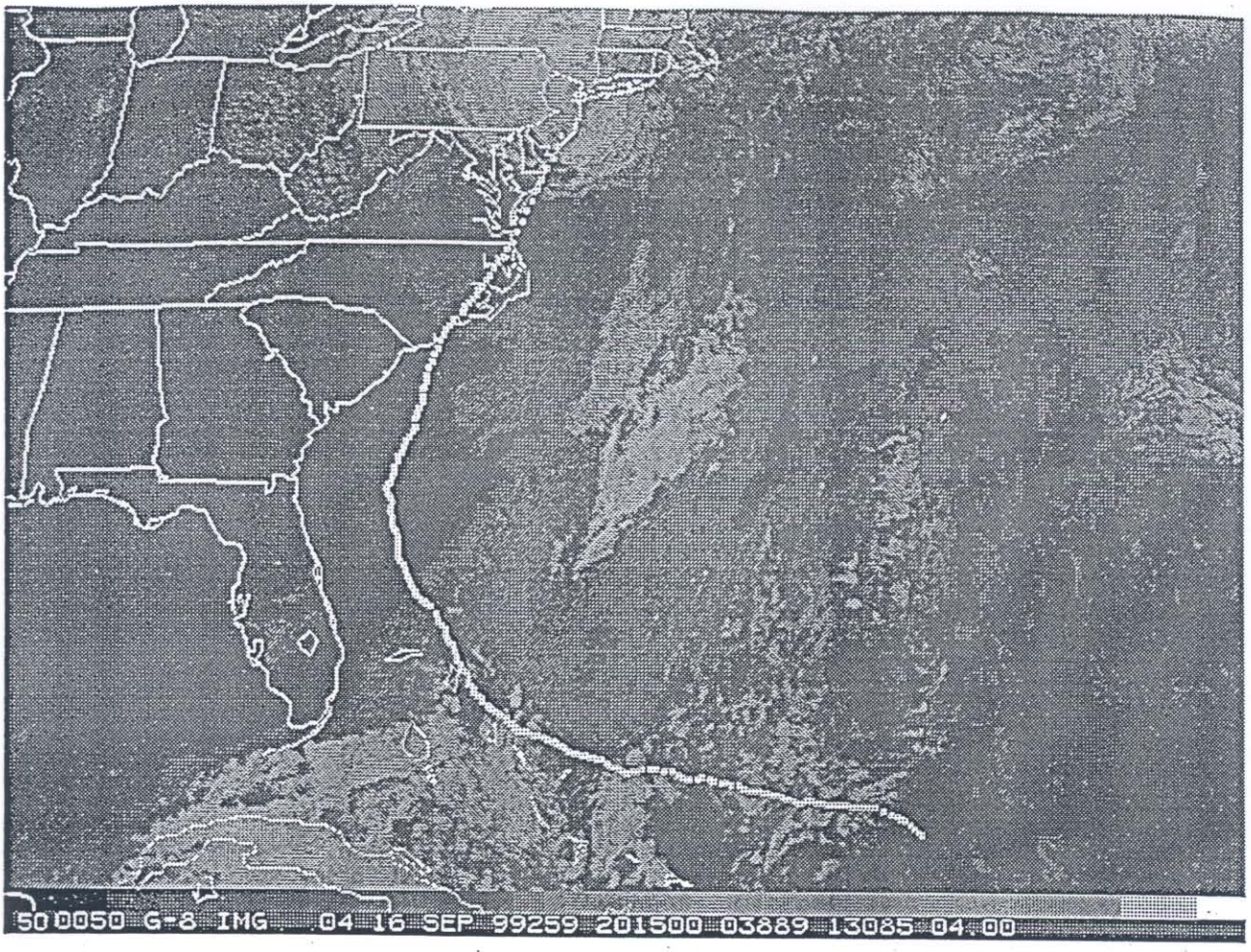
www.hurricanehunter.com

www.almc.noss.gov/hrd

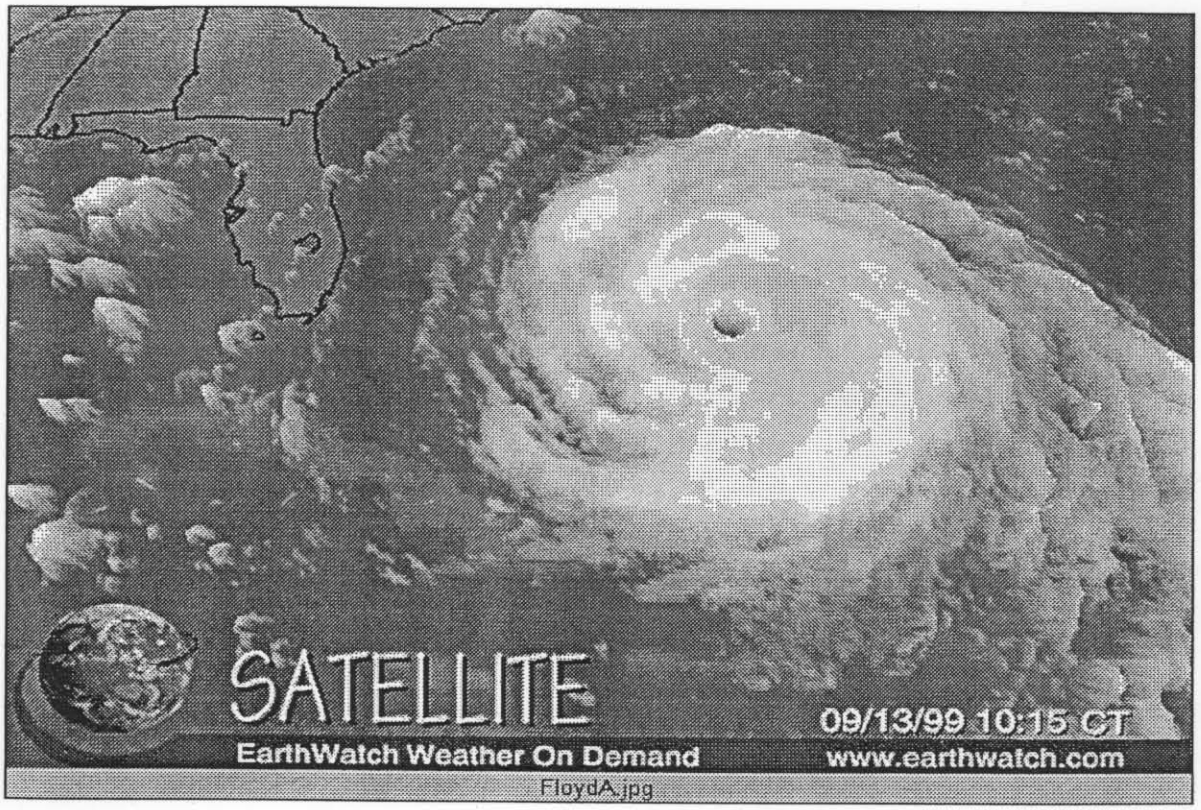
www.nasa.gov

www.nhc.noaa.gov




50 0050 G-8 IMG 04 16 SEP 99259 201500 03889 13085 04.00

SCORING GUIDE



SCORING GUIDE

Question 1a
Score 2 = Response identifies a change in the size of the eye (increases then decreases)
Score 1 = Response identifies a change in the size of the eye (increases only)
Score 0 = No response

Question 1b
Score 1 = Response identifies locating the center of the hurricane
Score 0 = Response does not identify the center of the hurricane

Question 1c
Do not score

Activity 2
Score 2 = Tracking map shows a curved path traveling north
Score 1 = Tracking map shows a straight path traveling west
Score 0 = No response

Question 2a
Score 2 = Response describes prediction and the actual hurricane path
Score 1 = Response describes prediction or the actual hurricane path
Score 0 = No response

Question 2b
Score 2 = Response identifies North Carolina supported by data from tracking map
Score 1 = Response identifies other states along the coast supported by data from tracking map
Score 0 = No response

Question 2c
Score 3 = Response identifies wind currents, ocean temperature and air pressure systems.
Score 2 = Response identifies at least two of the above items.
Score 1 = Response identifies at least one of the above items.
Score 0 = Incorrect or no response.

Question 2d
Score 2 = Response identifies hurricane weakening and is supported by data
Score 1 = Response identifies hurricane weakening and is not supported by data
Score 0 = Incorrect or no response

Question 2e
Score 2 = Response identifies that the data collected from space based instruments (GOES) are used to predict weather patterns and issue weather warnings.
Score 1 = Response identifies an understanding of the GOES instrument but does not relate it to predicting weather patterns to save lives.
Score 0 = Incorrect or no response

Question 2f
Do not score

Activity 3
Score 4 = This presentation has been exceptionally well drafted. It has a clearly stated title and several paragraphs that develop the overall idea. It is directed to the appropriate audience. The focus statements have all been thoroughly addressed, and supported. Errors in grammar, spelling, and punctuation, if present, do not deter from the impact of the presentation. Scientific terminology is used correctly. The writing is neat and legible. The organizational pattern is well established. Additional resources may have been referenced. The writing is focused, and consistently on topic.

Score 3 = This presentation is similar to a 4 above. Minor errors in grammar, spelling, and punctuation, if present, have little impact on the paper. Scientific terminology is used correctly. Additional resources are unlikely to have been referenced. Only minor deviations from the organizational pattern occur. Some of the focus statements may need additional support. The paper is legible.

Score 2 = Several key elements of the prompt are not addressed. One or more of the focus statements may not have been completely ignored. Errors may occur in the use of scientific terminology. The letter is inadequately focused on the topic, and an organizational pattern, if established, is inconsistently followed. Gross errors in grammar, spelling, and punctuation may significantly impact the paper. The paper is legible.

Score 1 = Few important points of the prompt are addressed. The organizational pattern, if established, is virtually ignored. Scientific terminology is not used, or is used incorrectly. Gross errors in grammar, spelling, or punctuation may severely impact the paper. The article may not be in the correct format. The paper may be illegible.

Score 0 = The writing is off task, completely illegible, or scientifically inaccurate.