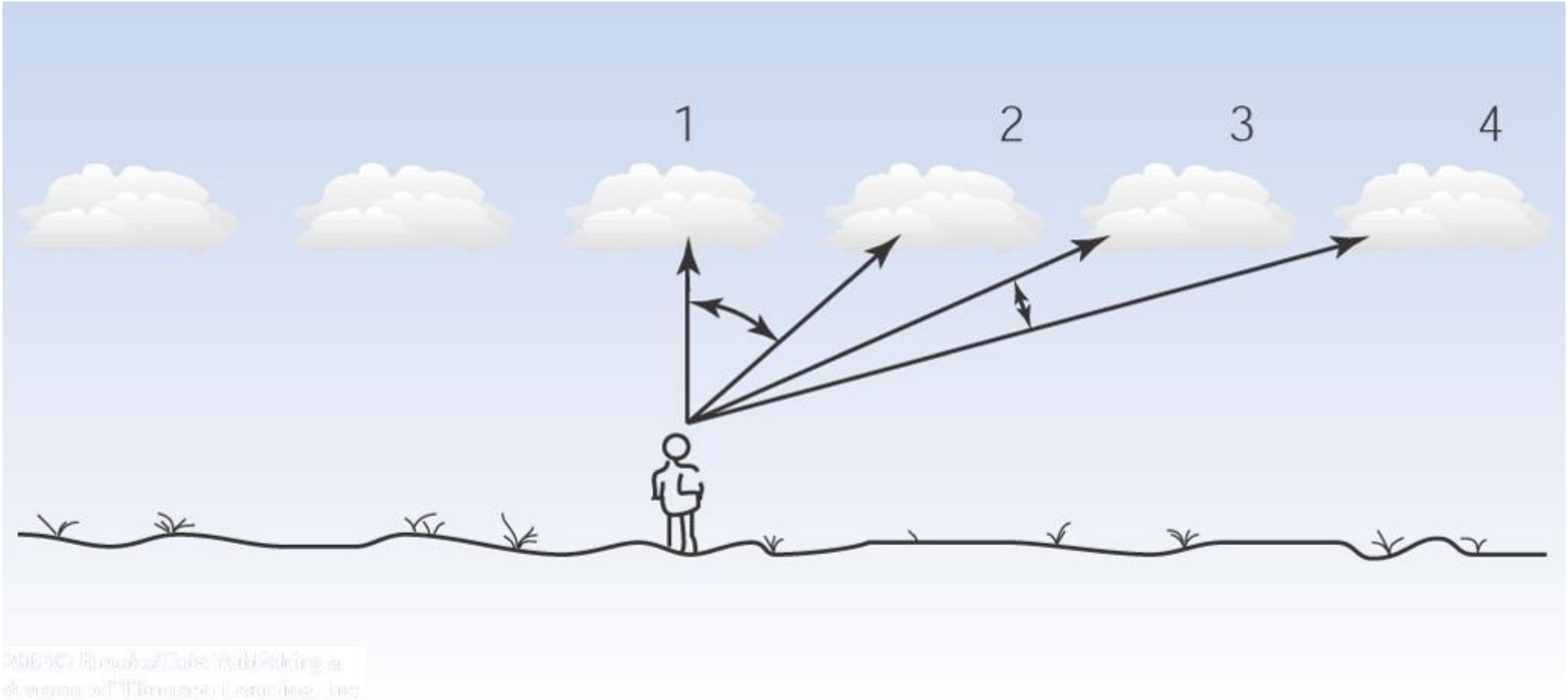
Monitoring the Weather with Technology

Interpreting Satellite

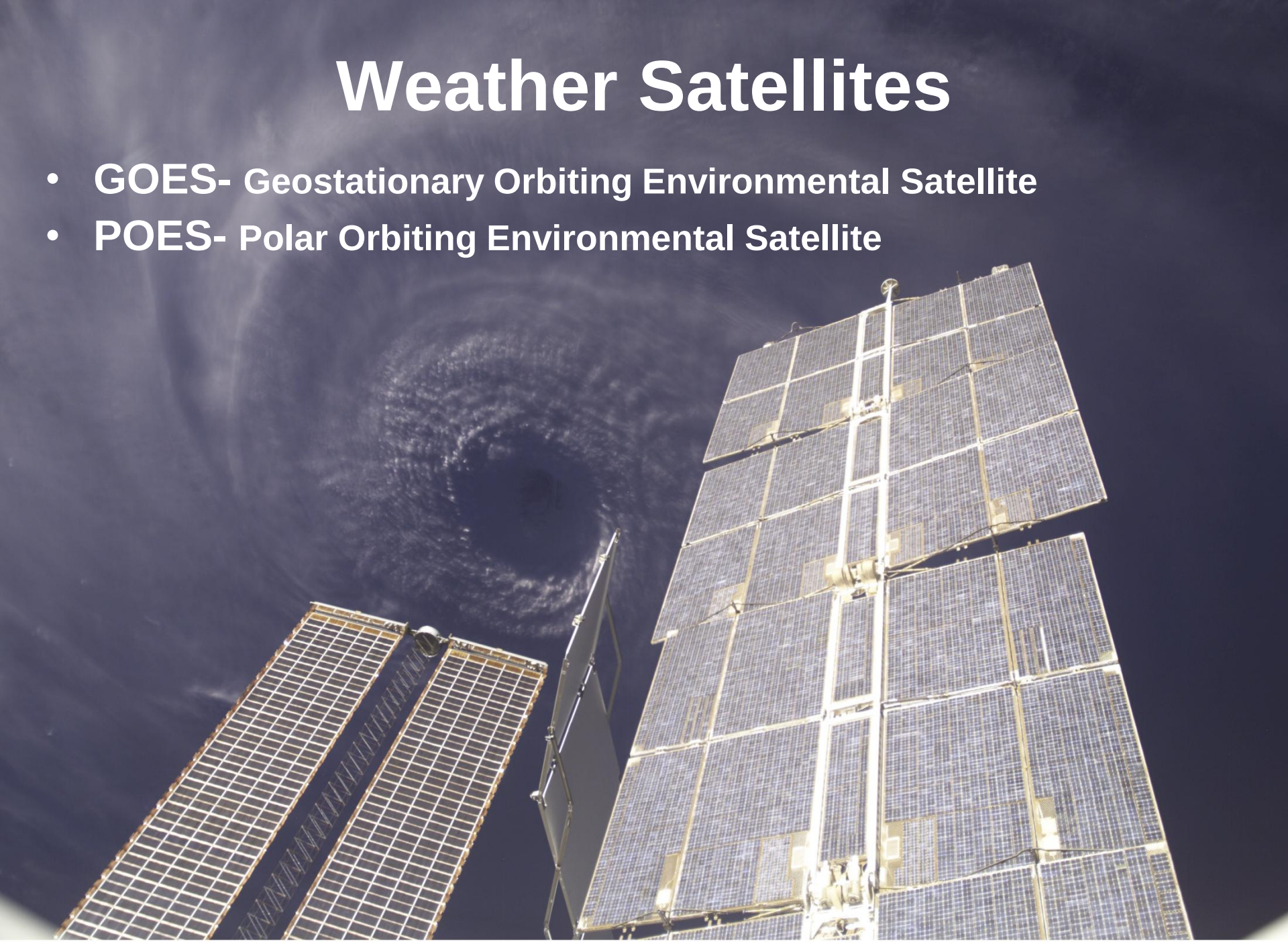
Why Satellites?



Allow meteorologists to obtain a bird's eye view of clouds on a global scale
Clouds can be observed both day and night using satellites
Cloud structures, depth, and height can fully be observed

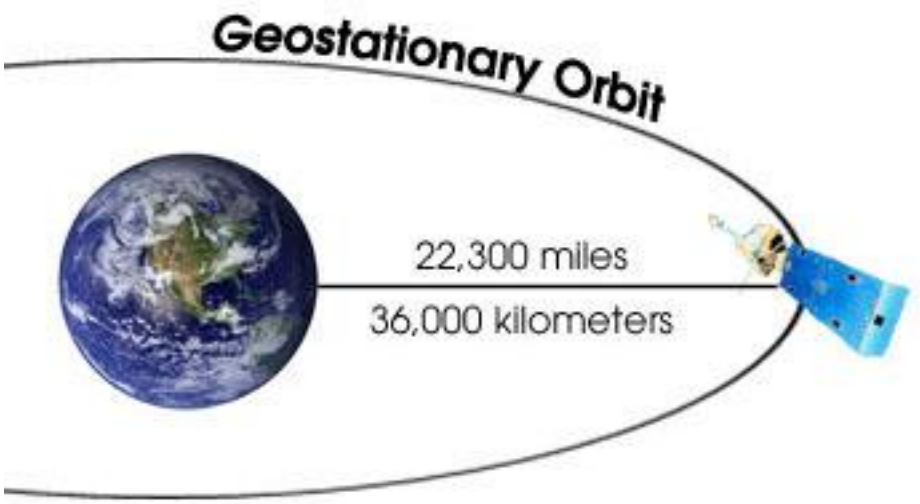
Weather Satellites

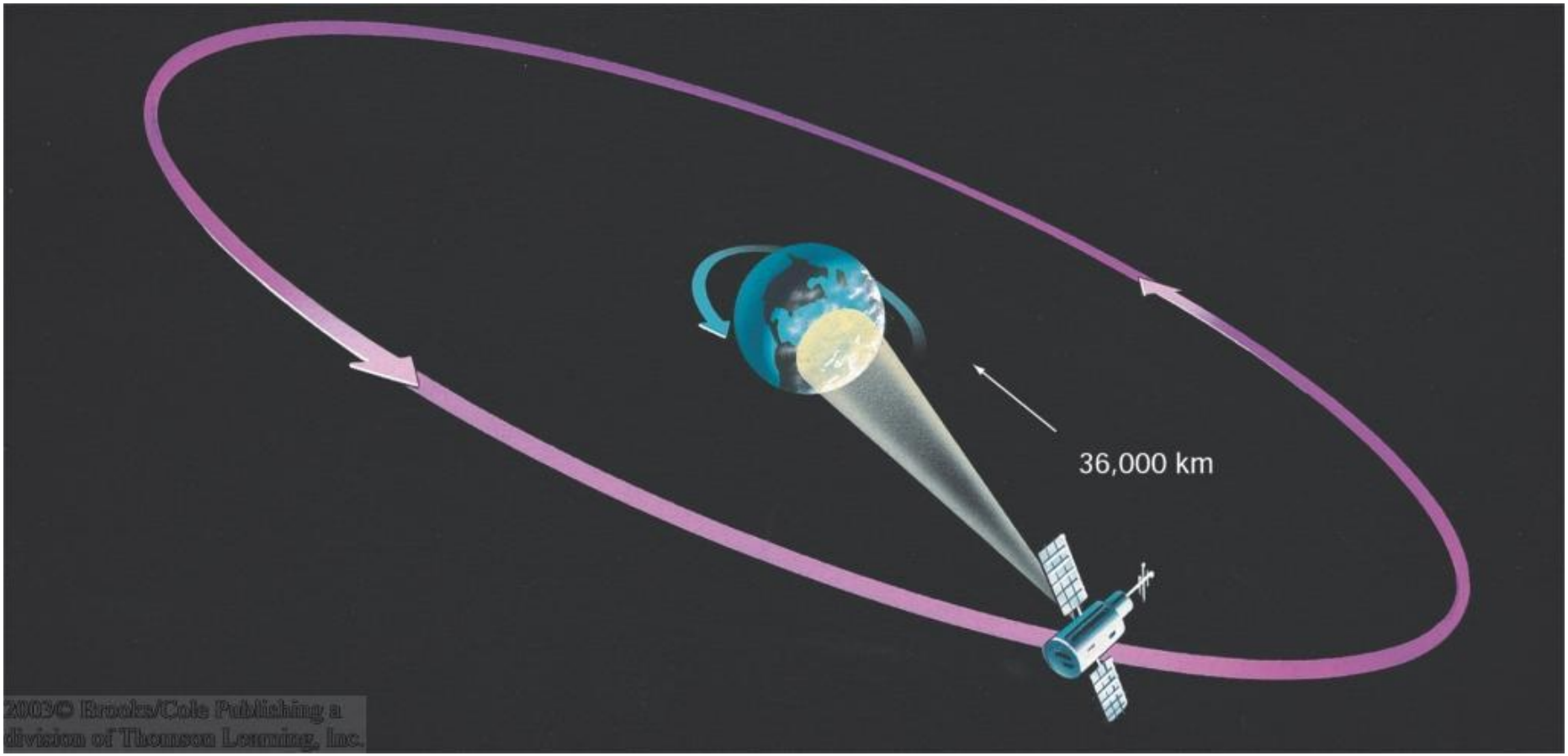
- **GOES- Geostationary Orbiting Environmental Satellite**
- **POES- Polar Orbiting Environmental Satellite**



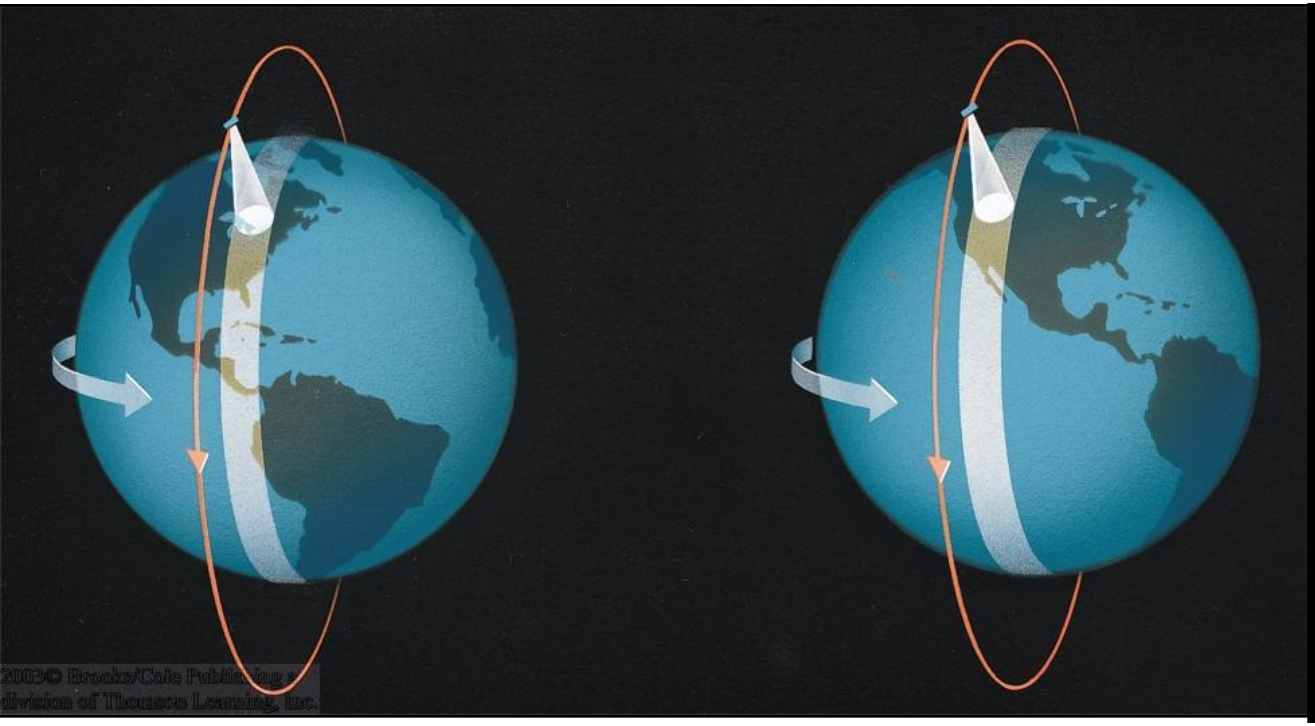
ISS009E22187

Geostationary Orbit





Polar Orbit


2003© Brooks/Cole Publishing
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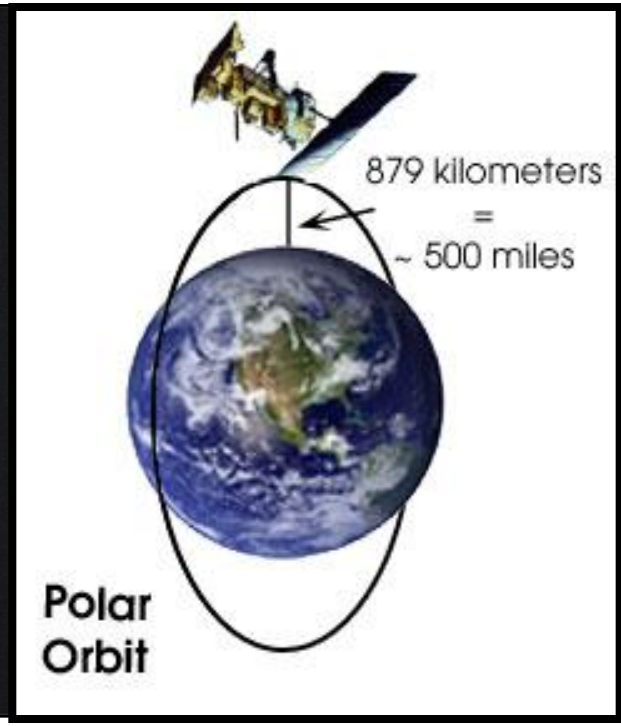
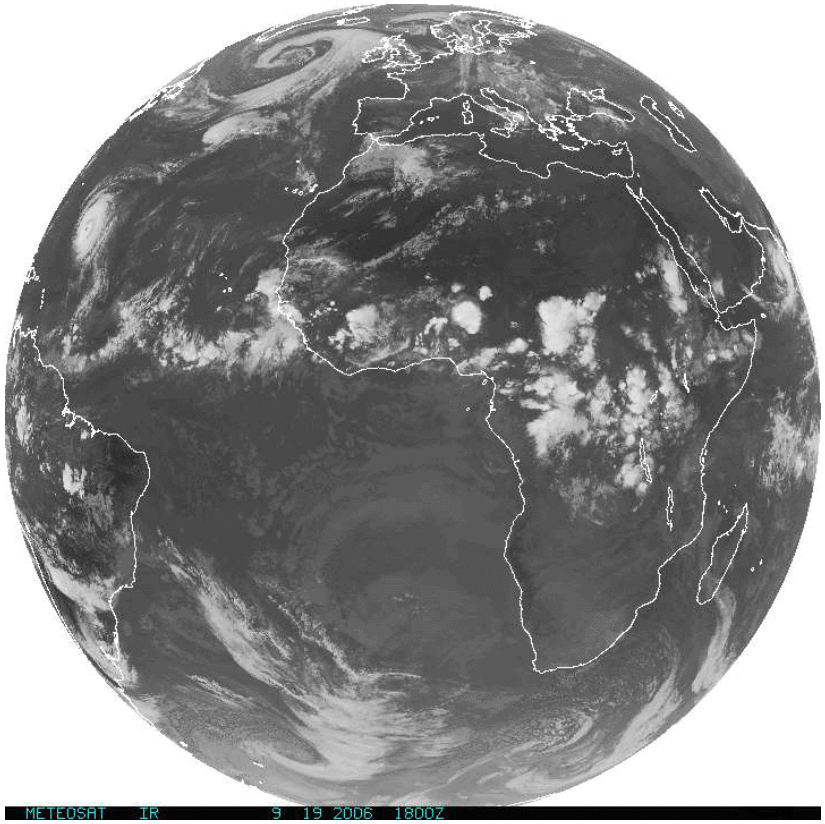
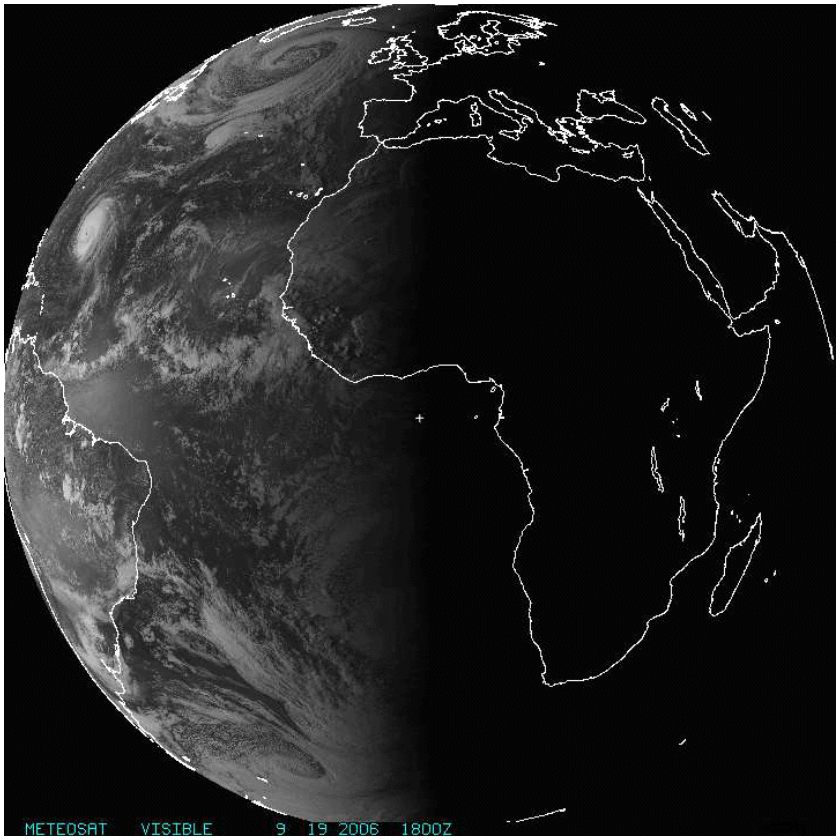

879 kilometers
=
~ 500 miles
Polar
Orbit

Types of Satellite Imagery



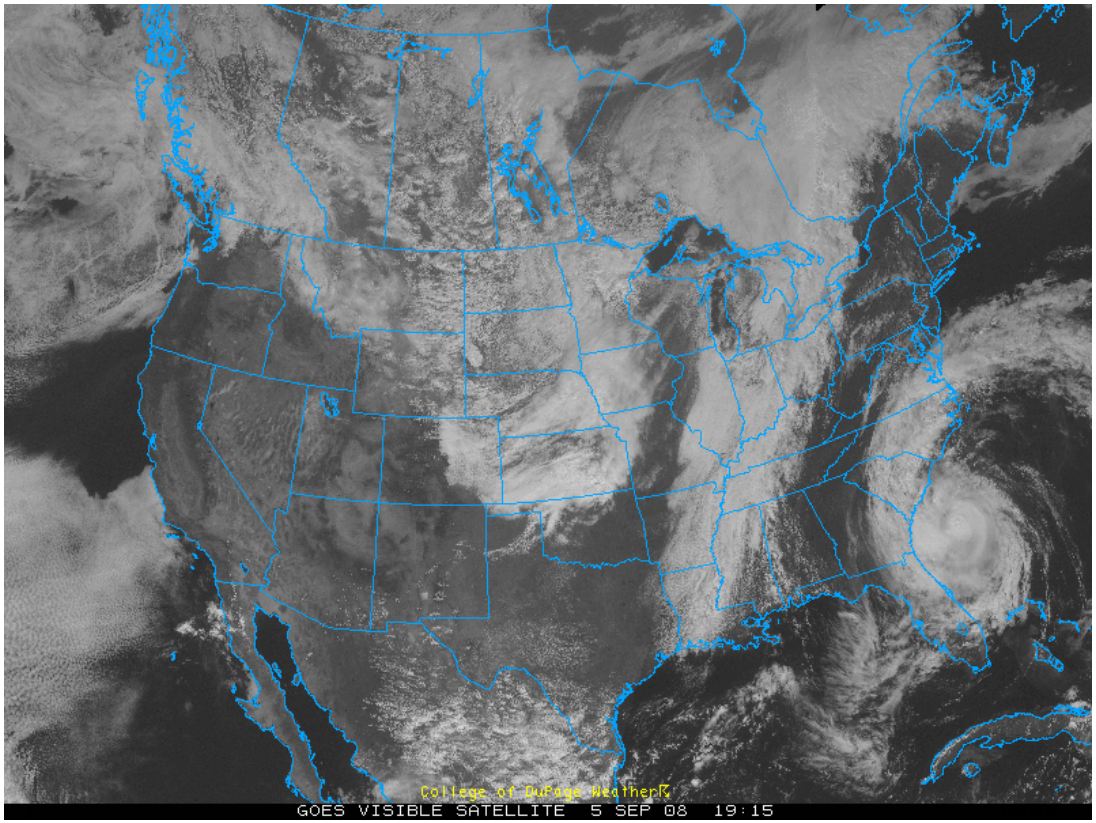
Infrared Imagery



Visible Imagery

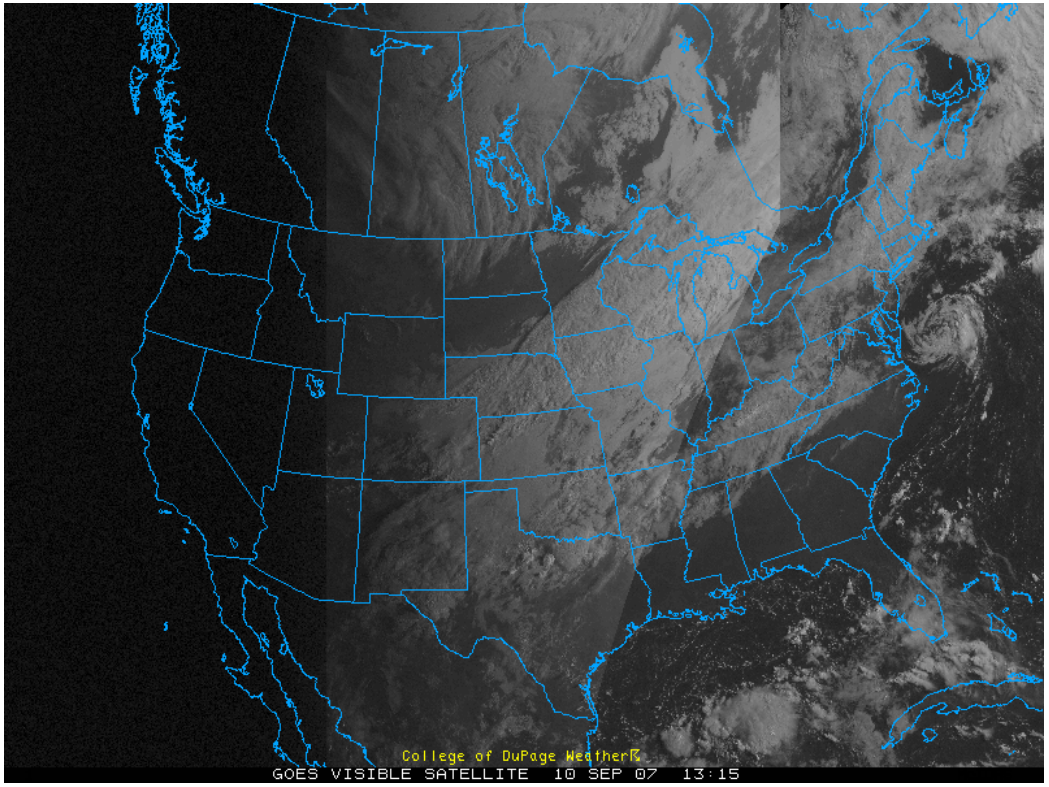
Visible Satellite (VIS)

- The visible channel of the satellite measures light using the same wavelengths as the human eye. (In other words, looking at a visible satellite picture is the same as if an astronaut took a photo of the clouds and sent it to you.)



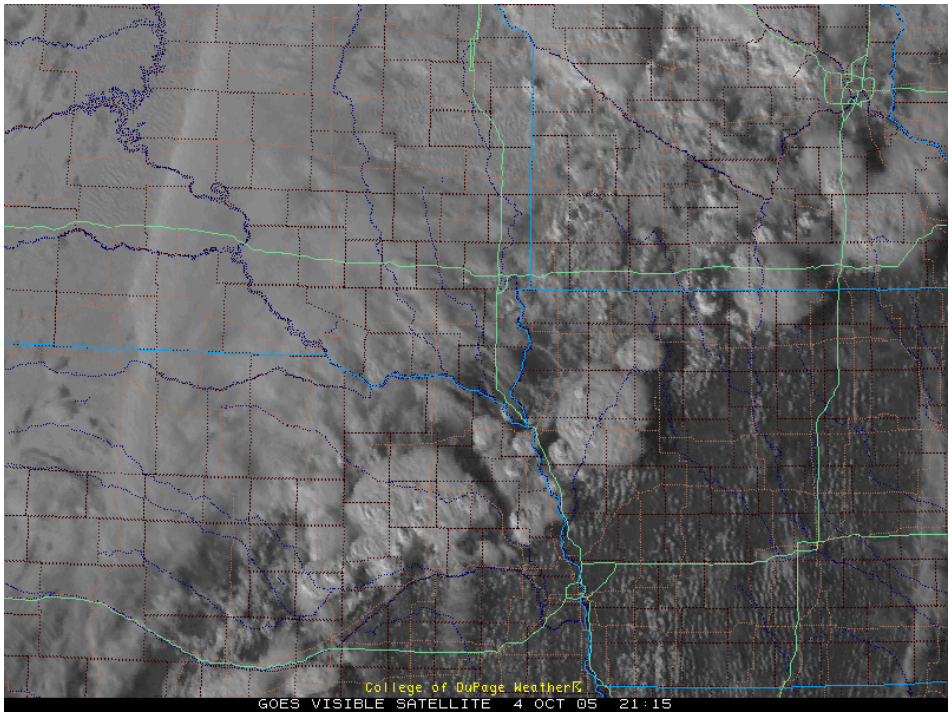
Visible Satellite (VIS)

- Objects with higher albedo (ability to reflect sunlight) appear brighter on the satellite image.
- Objects with lower albedo appear dark on the satellite image.
- Visible satellite is only available during the daylight (the picture to the right shows the west coast still has not seen sunrise yet.)



Visible Satellite (VIS)

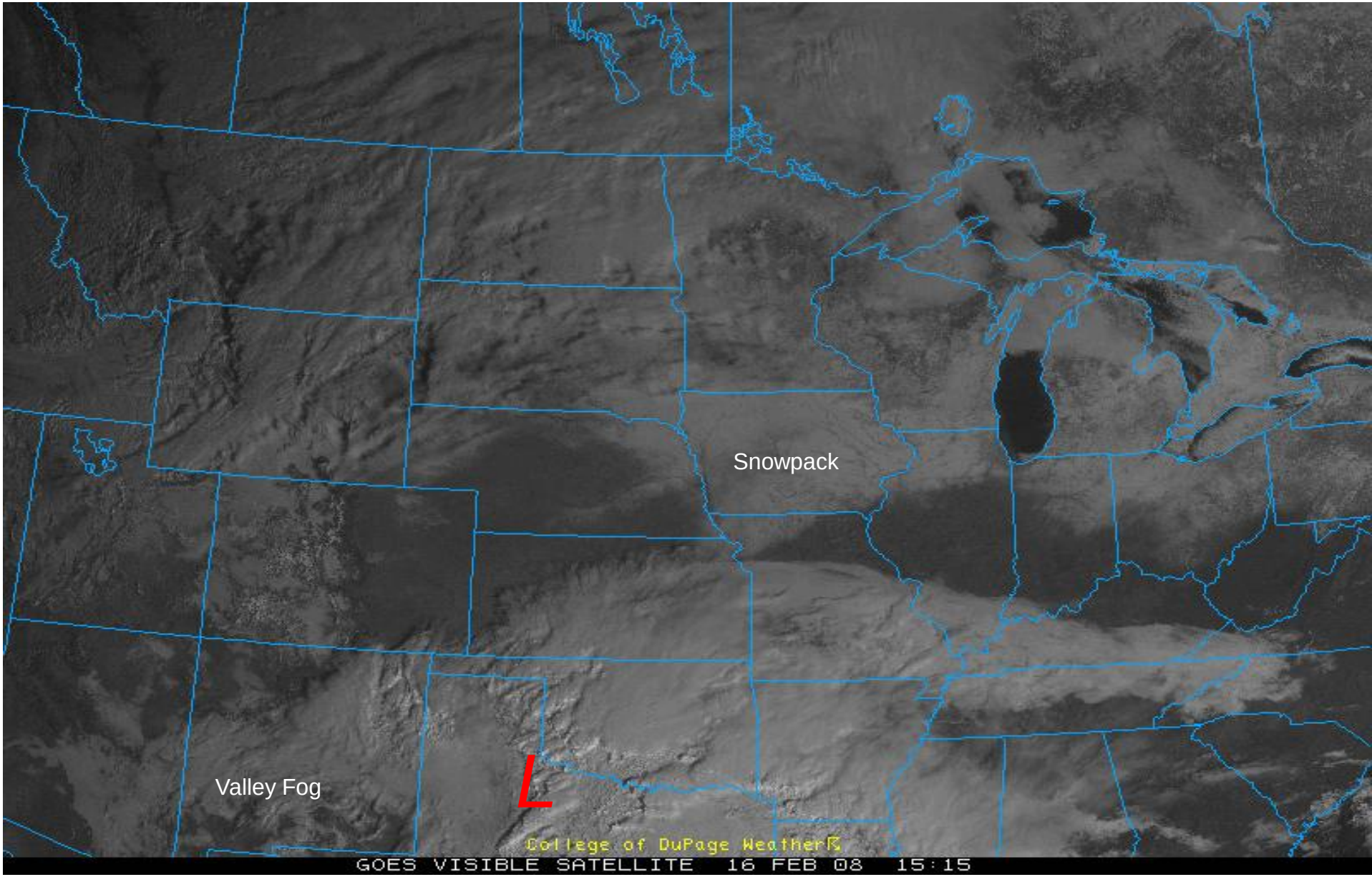
- Good uses of visible include
  - Thunderstorm features such as overshooting tops and anvil shadows
  - Snow cover
  - Cumulus (most importantly towering cumulus, or TCU)
  - Fog
  - Marine Layer clouds
  - Outflow boundaries from convection
  - Hurricane features (especially anticyclonic flow aloft)
  - Fronts, Lows, and other large scale features
  - Lake effect features
  - Cirrus streaks (jet stream features)



Visible Satellite (VIS)

Can you see the snow pack?

Hint: The clouds move, the snow doesn't.

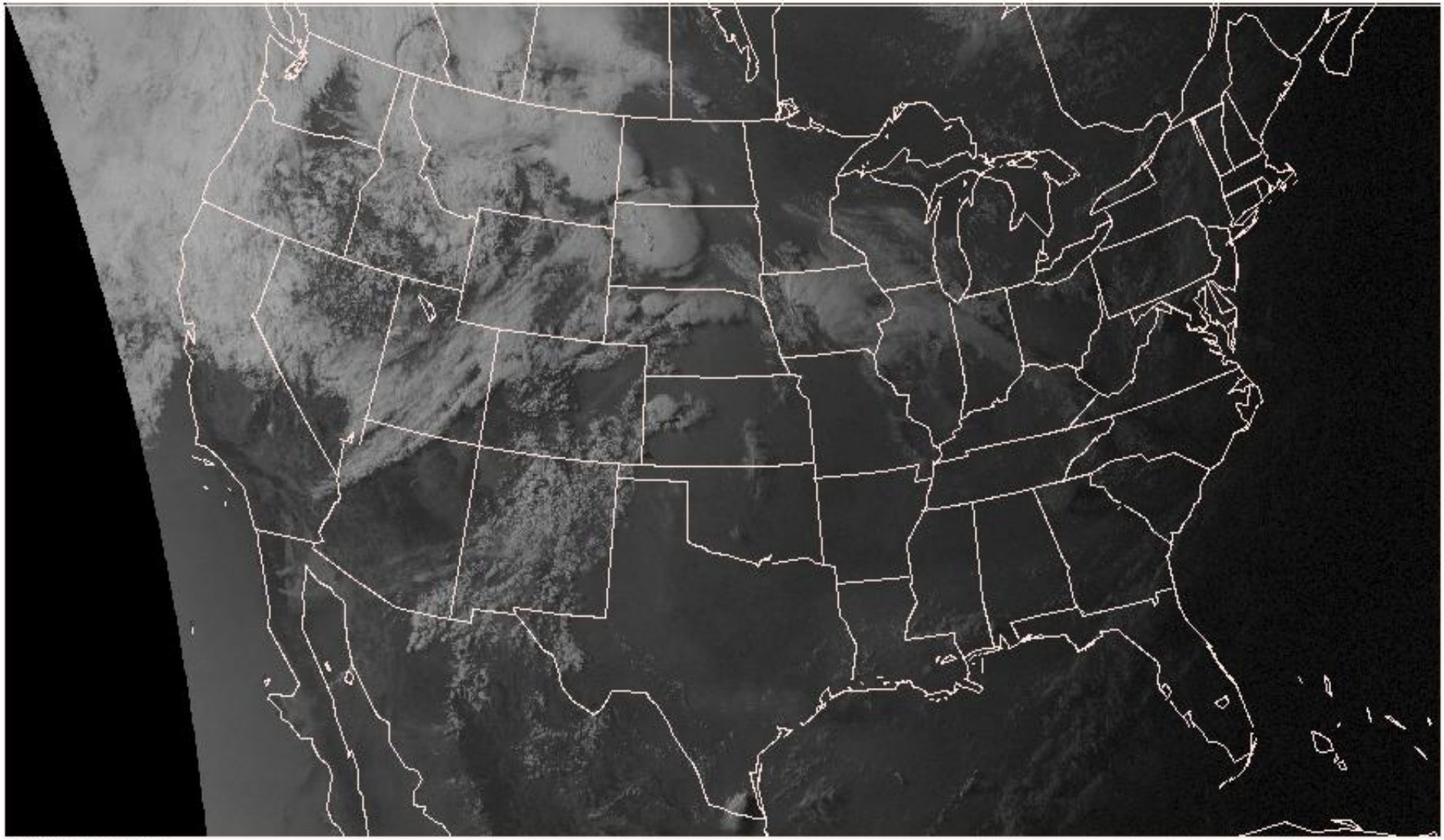


Visible Satellite Imagery

- ***Advantage:*** *You can see where clouds are developing, long before showers and thunderstorms are visible on radar.*
- *Since all clouds are visible, you can see different motions in the winds in the atmosphere.*
- ***Disadvantage:*** *Obviously, only useful during daylight hours.*
- *All clouds, whether low to the ground or high in the atmosphere appear the same so you cannot determine heights.*
- *Also, in winter, it is often difficult to tell the difference between snow cover and clouds with the visible image.*

Visible Image

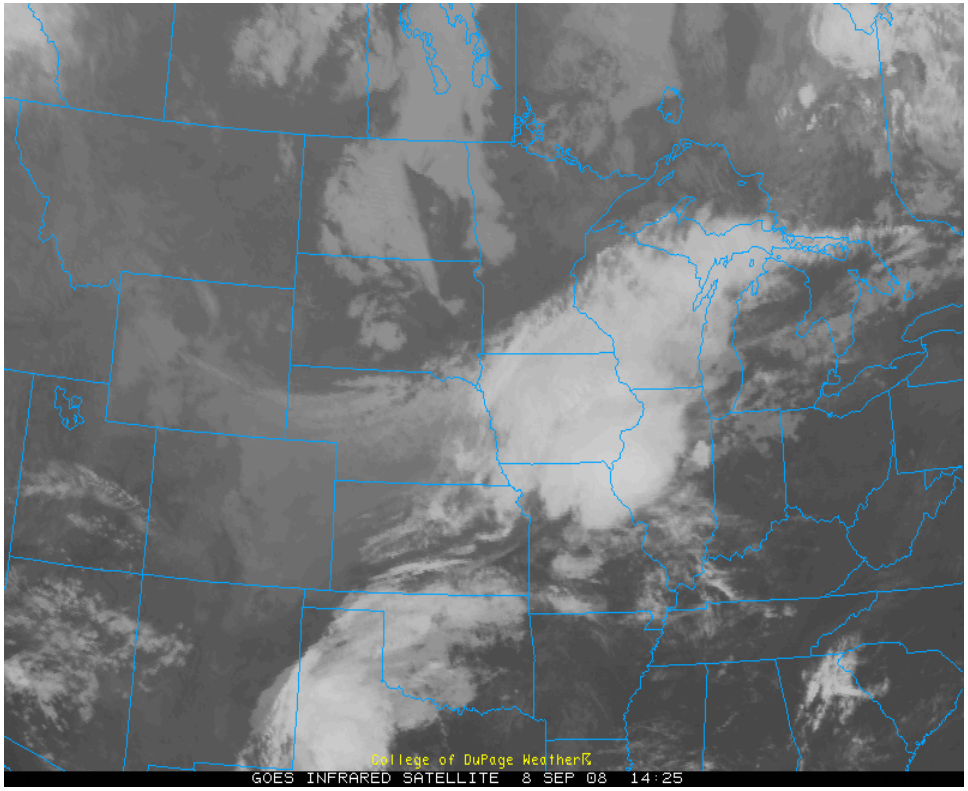
0015Z 15 JUN 2006



NCEP/NWS/NOAA

Infrared Satellite (IR)

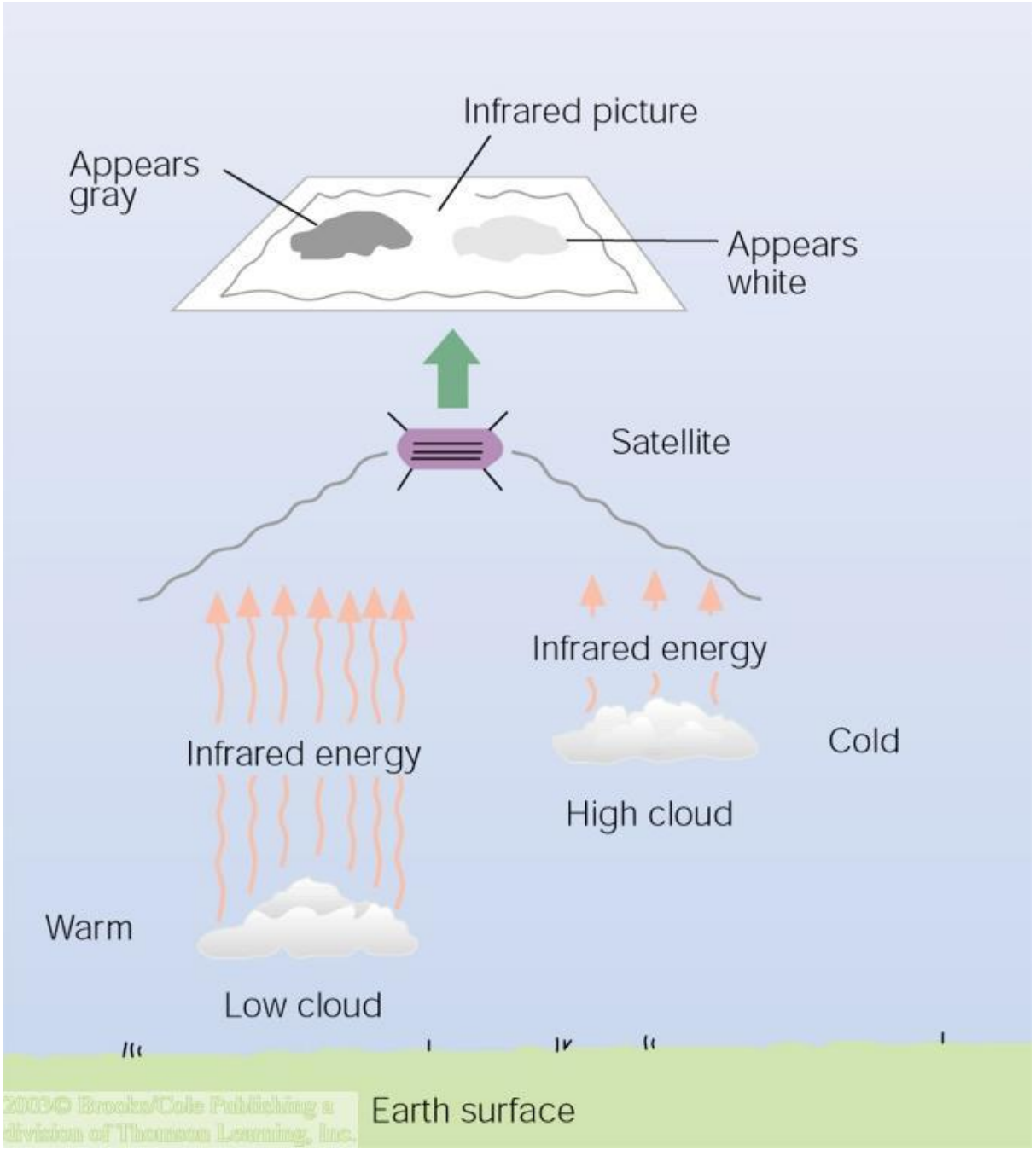
- Infrared satellite measures radiation output from the earth into space. In other words, it measures temperature and one can infer clouds based on the different temperatures being measured.
- The colder an item is, such as a high cloud or a cold air mass, the brighter it is.
- The warmer an item is, such as a warm lake or clouds near the ground, the darker it is.



What the Satellite Sees…

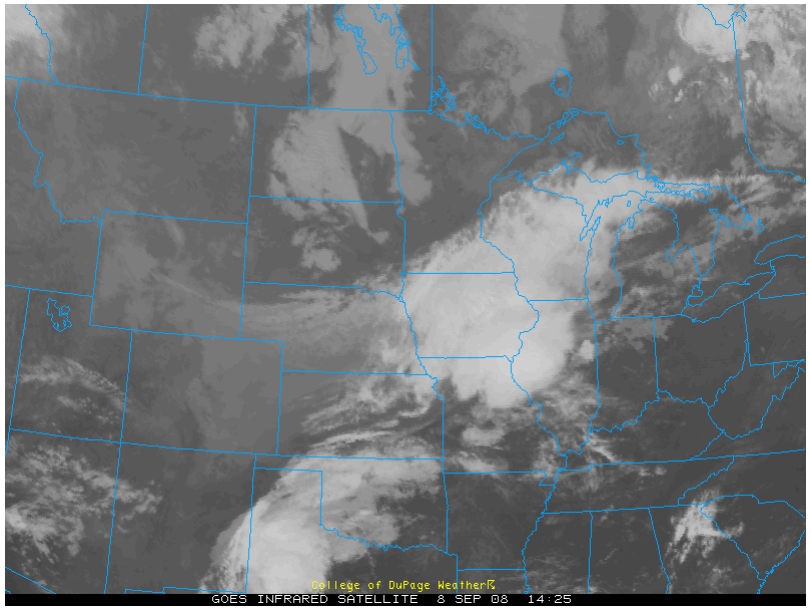
Infrared
Thermal
Temperature

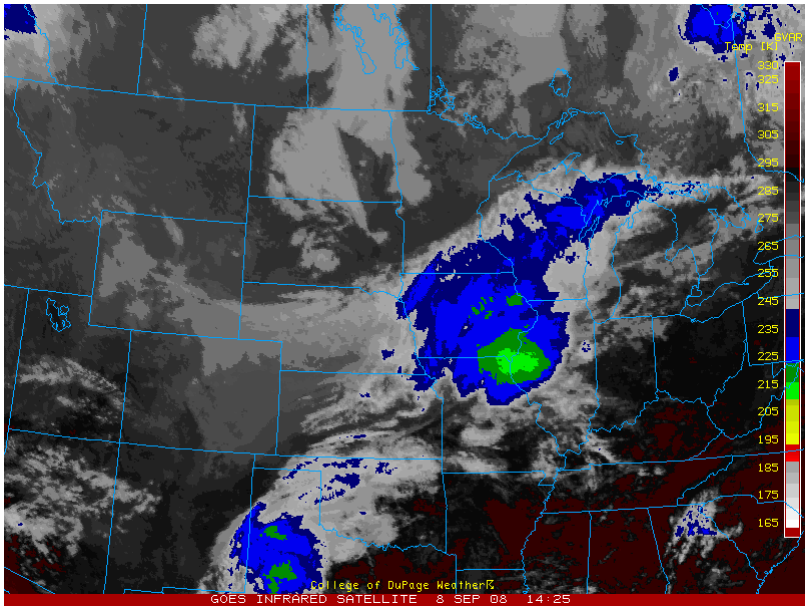
Brightness
Visible



Infrared Satellite (IR)

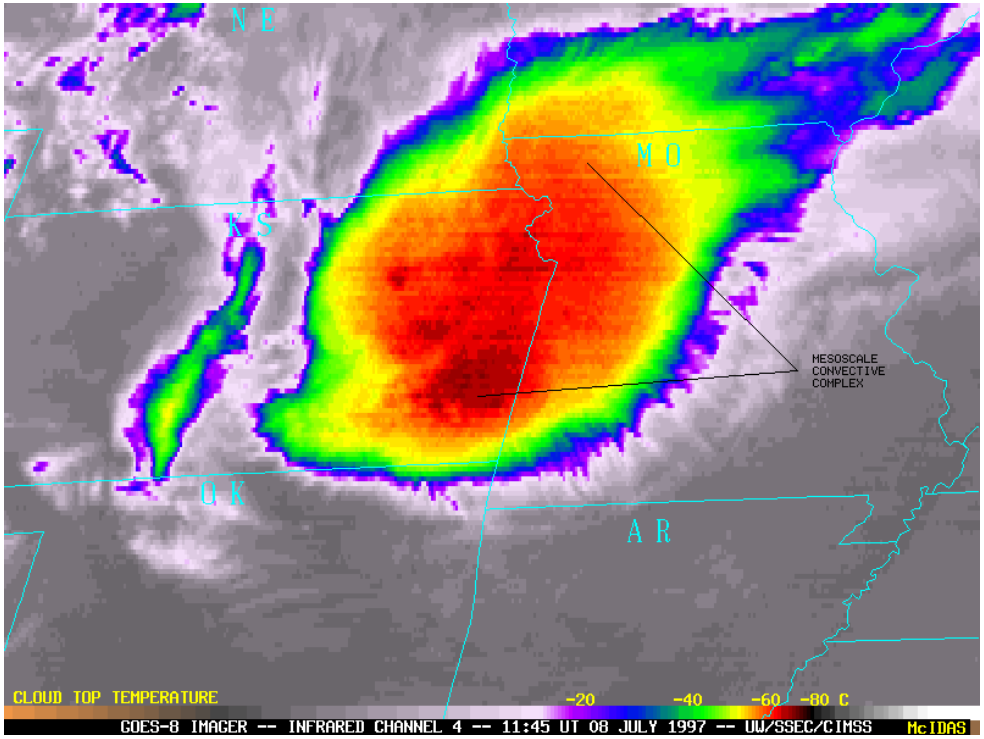
- Often, colored enhancements are added to the pictures to aid in interpretation. This will often allow the user to see more detail.
- The user should compare the colors to the color bar (or key) to determine the temperature of the clouds (usually in Kelvin).
- The higher the cloud, the colder it is but beware - a very cold air mass or new snow pack can mislead you!





Infrared Satellite (IR)

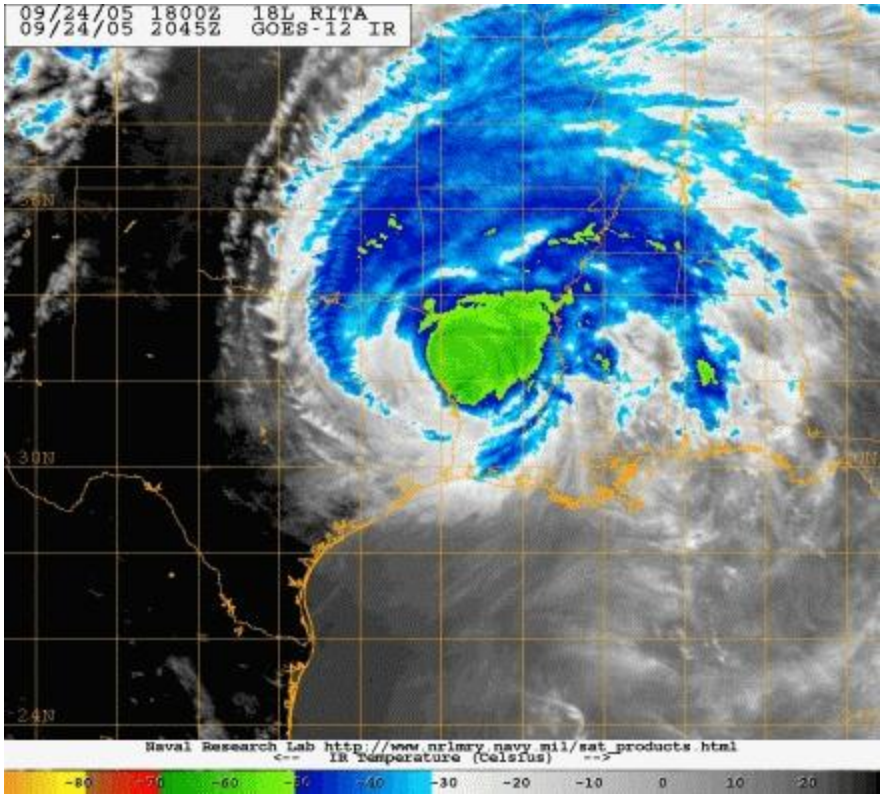
- Good uses of IR include
  - Nighttime satellite use
  - Strength/weakness of convection, especially MCS/MCC activity
  - Approach of cold air masses
  - Drylines during the afternoon
  - Cyclone development
  - Troughs and ridges within the jet stream
  - Hurricane strength and analysis



Infrared Satellite (IR)

This is an animated gif of hurricane Rita. Notice how the cloud tops warm as the hurricane moves over land and begins to weaken. This shows that the thunderstorm activity is not as strong, as warmer tops mean they are not reaching as high in the atmosphere.

The color bar on the bottom of the image correlates to the temperatures of the clouds in Celsius.

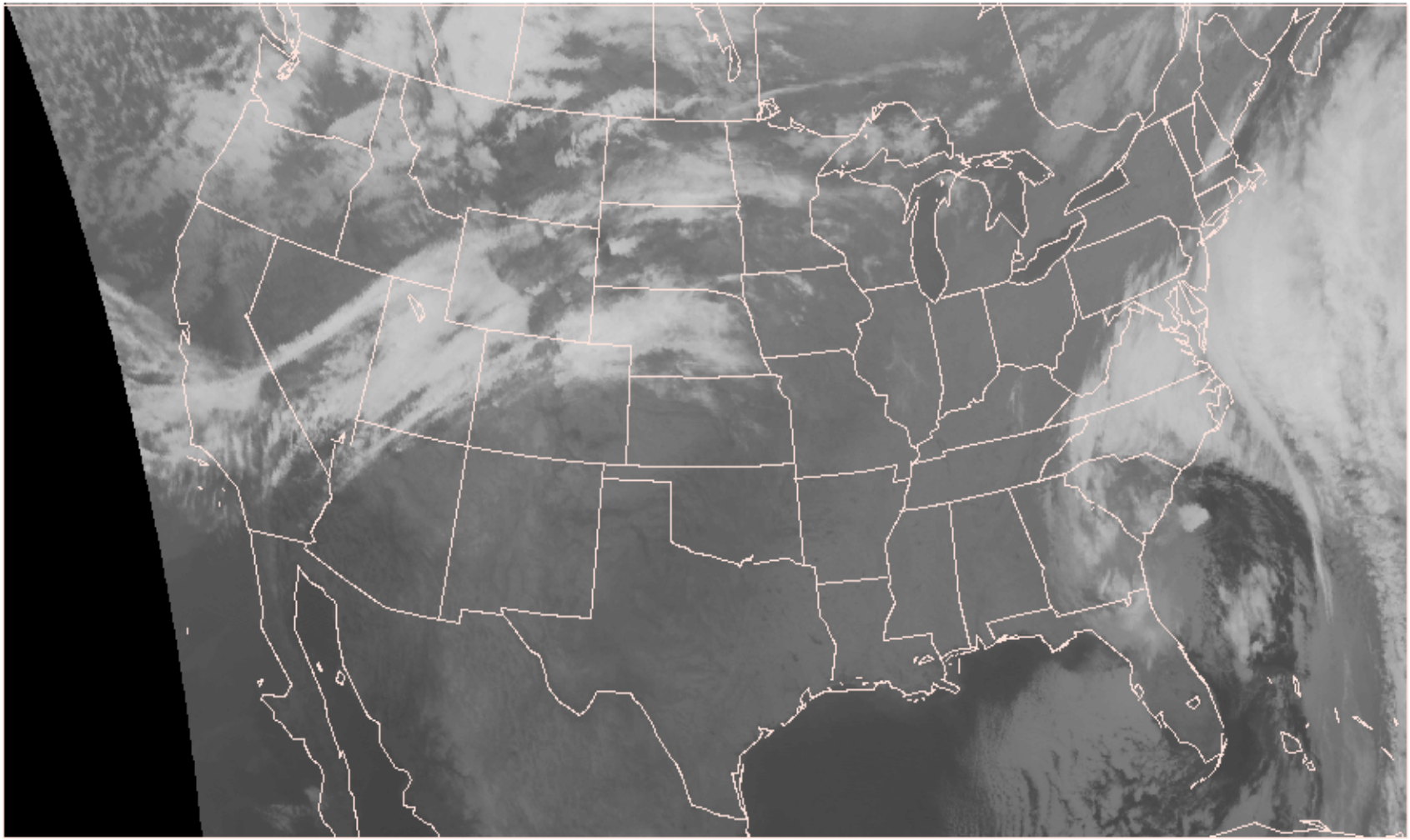


Infrared Satellite Imagery

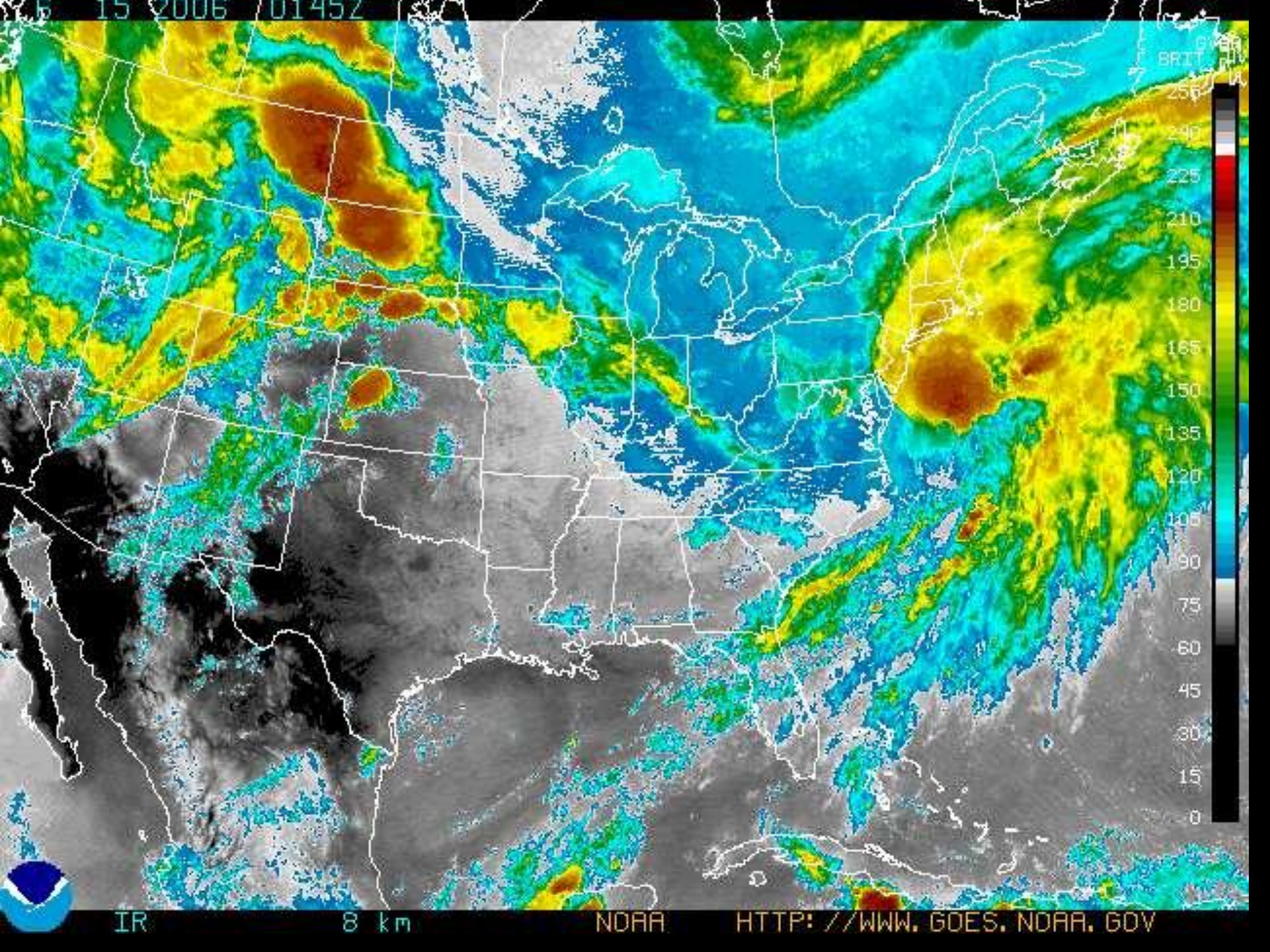
- ***Advantage:*** *We can see cloud patterns at night.*
- *You can determine the differences in cloud elevations.*
- *Developing thunderstorms are fairly easy to spot due to the very tall cumulonimbus clouds.*
- ***Disadvantage:*** *The ability of seeing low clouds at night is greatly hampered since the temperature difference between the ground and the low clouds is usually very small.*

Infrared Image

0315Z 22 NOV 2006

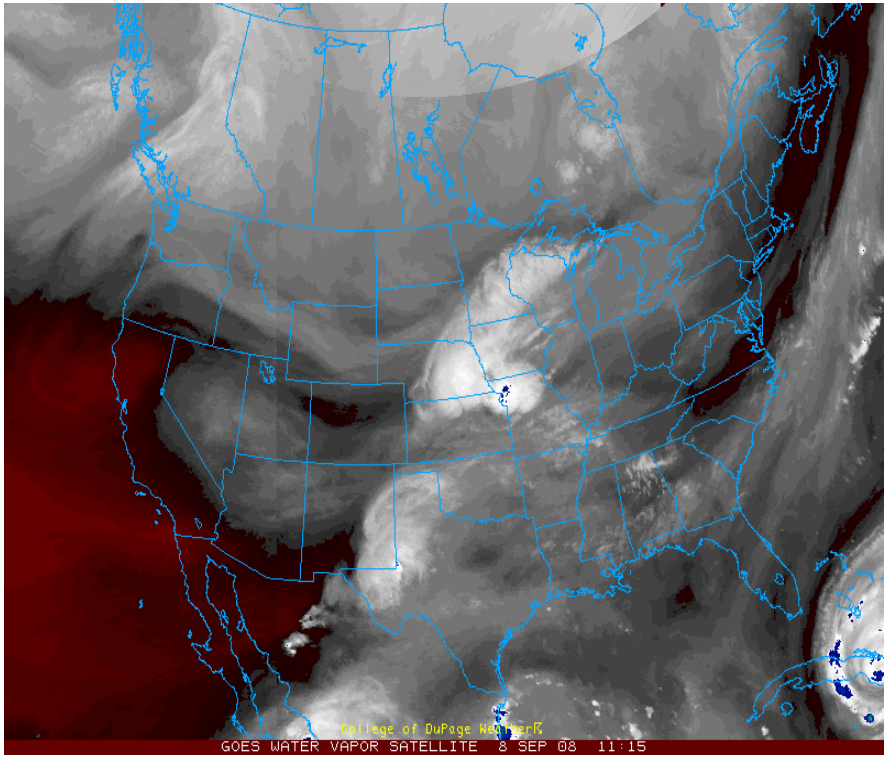


NCEP/NWS/NOAA


6 15 2006 01452
GVAR
BRIT
256
240
225
210
195
180
165
150
135
120
105
90
75
60
45
30
15
0
IR
8 km
NOAA
HTTP://WWW.GOES.NOAA.GOV

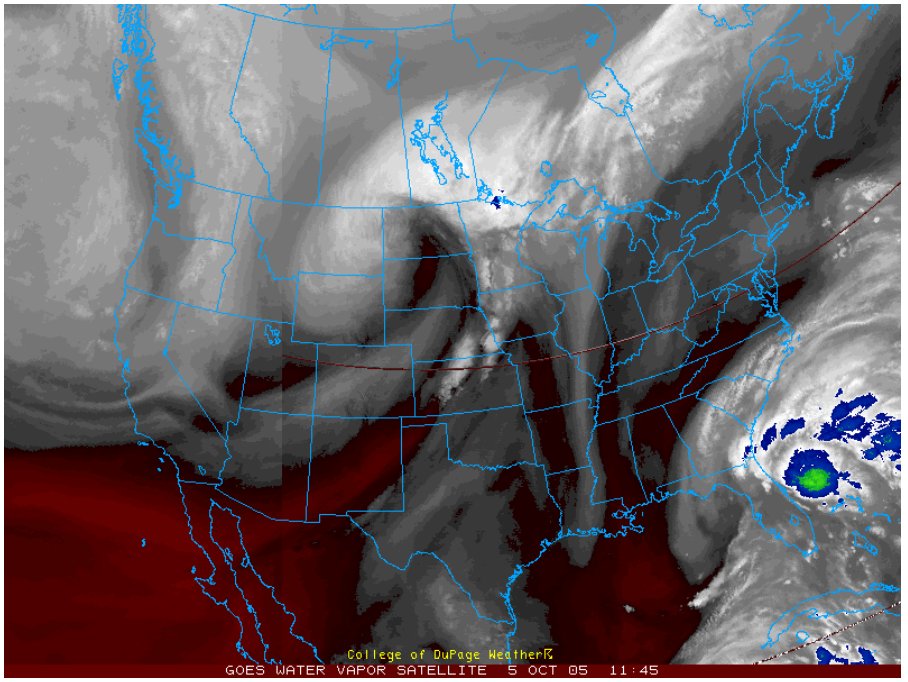
Water Vapor Satellite (WV)

- Water vapor satellite measures radiation output just as infrared imagery does, but at a different wavelength (a wavelength of radiation that is heavily absorbed by moisture.)
- Brighter areas on the images represent greater areas of moisture in the mid and upper levels of the atmosphere.
- Darker areas represent drier areas of moisture in the mid and upper levels.
- Very cold air can also show up fairly bright, just as in infrared.



Water Vapor Satellite (WV)

- Good uses of WV include
  - Excellent for large scale features such as longwave troughs, ridges, lows, etc.
  - "Dry intrusions" within a cyclone.
  - Large scale moisture transport.
  - Vertical motions (areas of subsidence and rising air.)
  - Nicely developed shortwave troughs and ridges.



Water Vapor Satellite (WV)

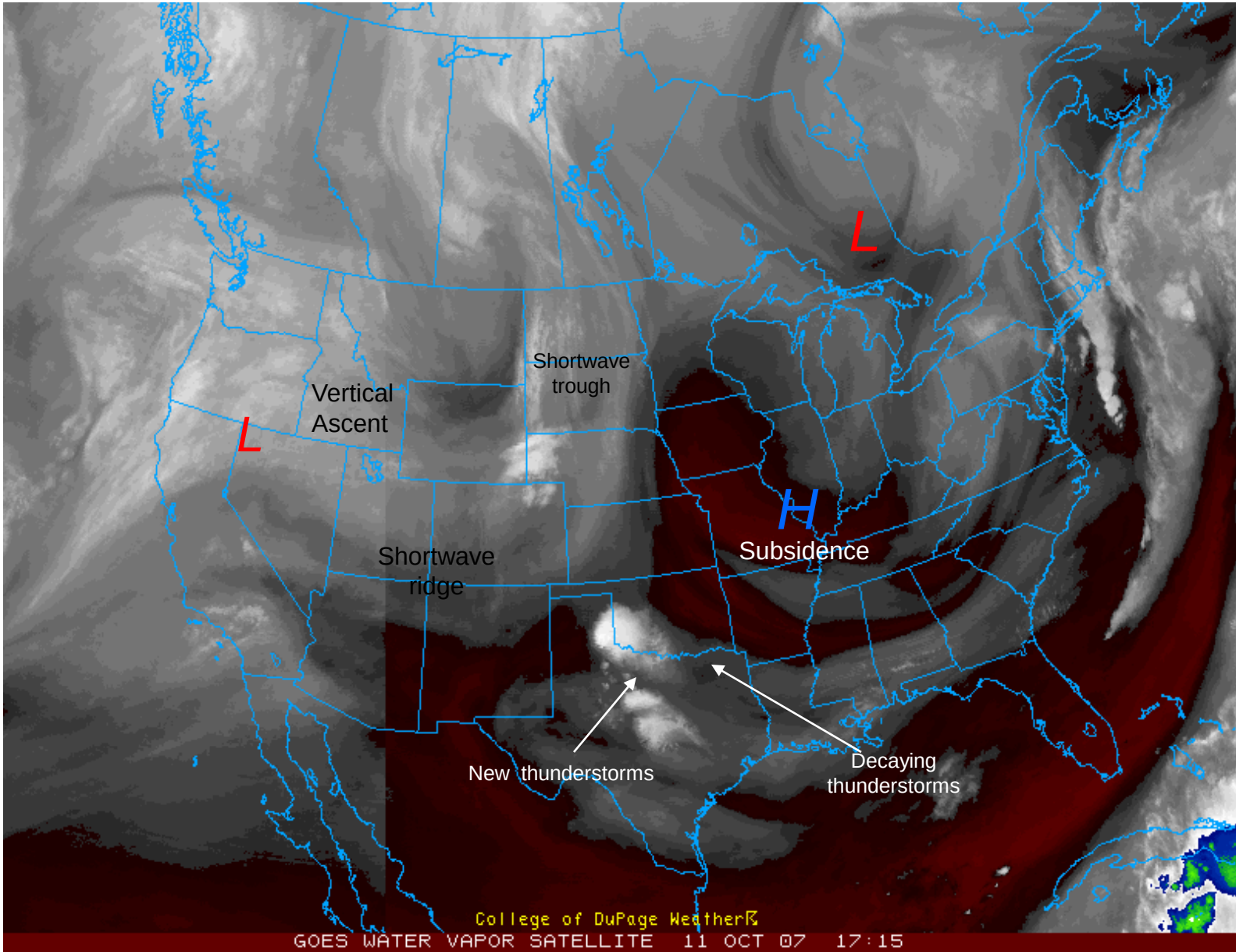
Can you see the troughs and ridges?

Can you see areas of subsidence or rising air?

A shortwave trough is moving through the Dakotas, can you pick it out?

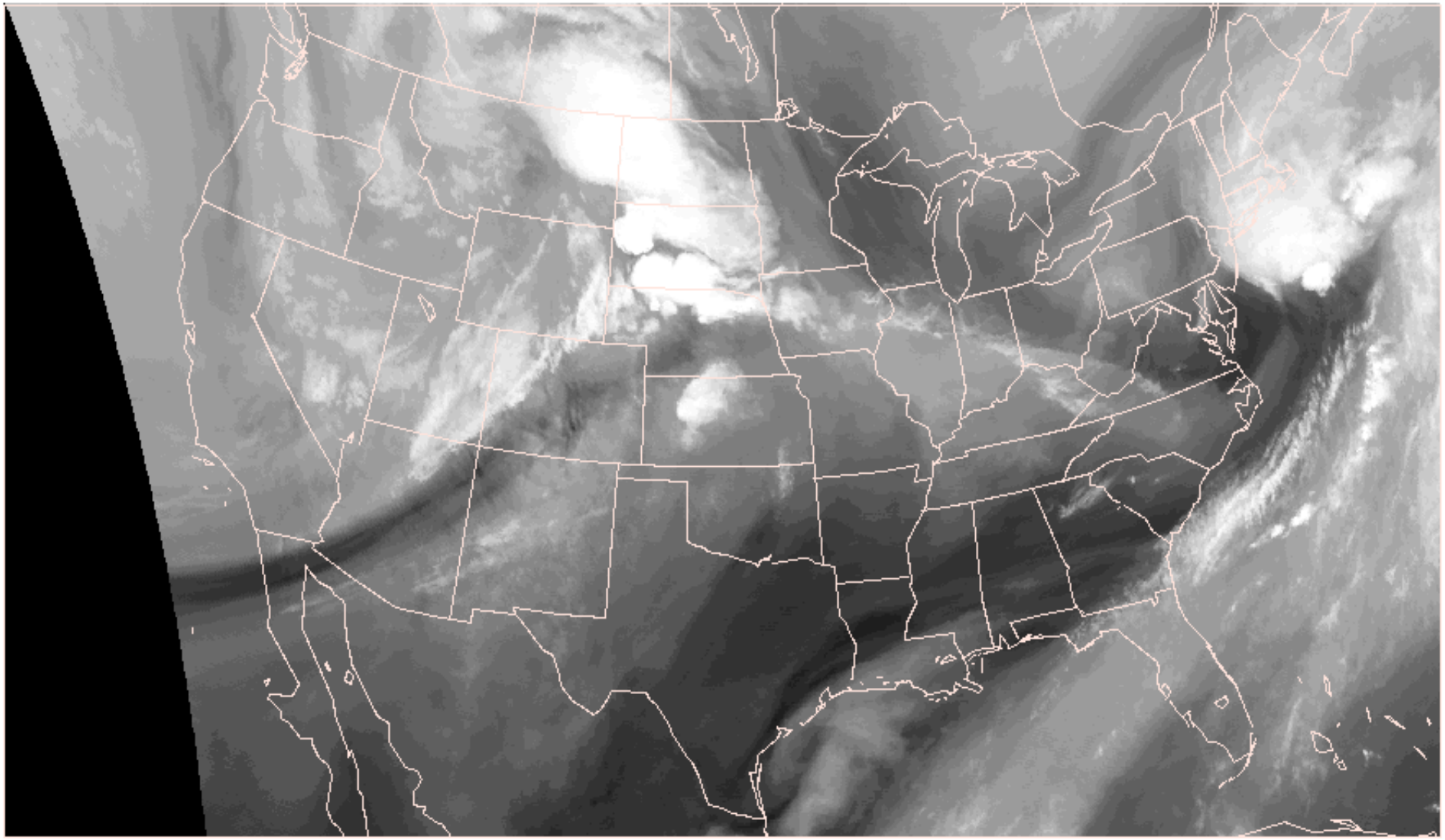
Can you see the area of low pressure in Ontario and Quebec?

Can you see the overall pattern (the flow) over North America?

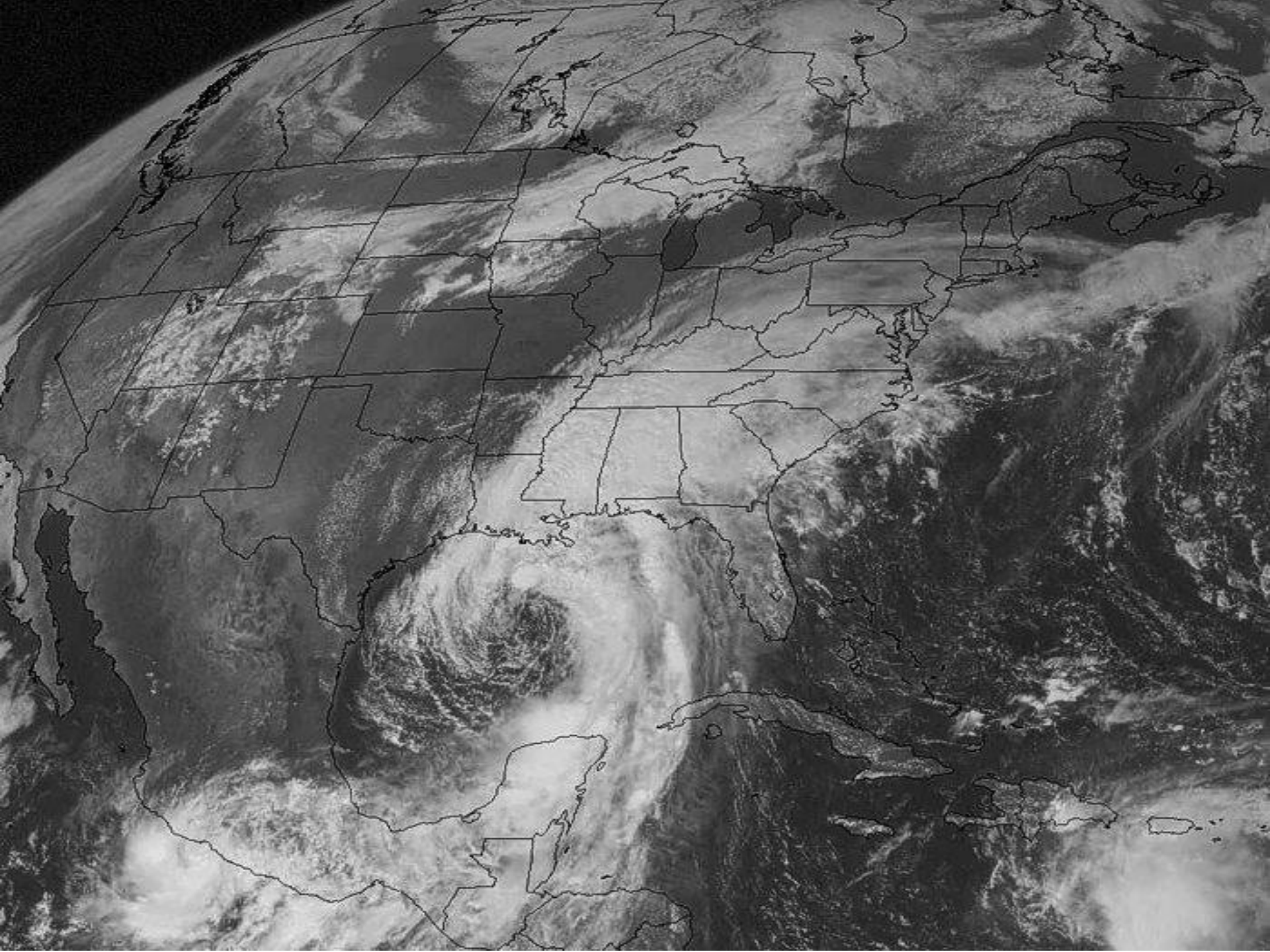


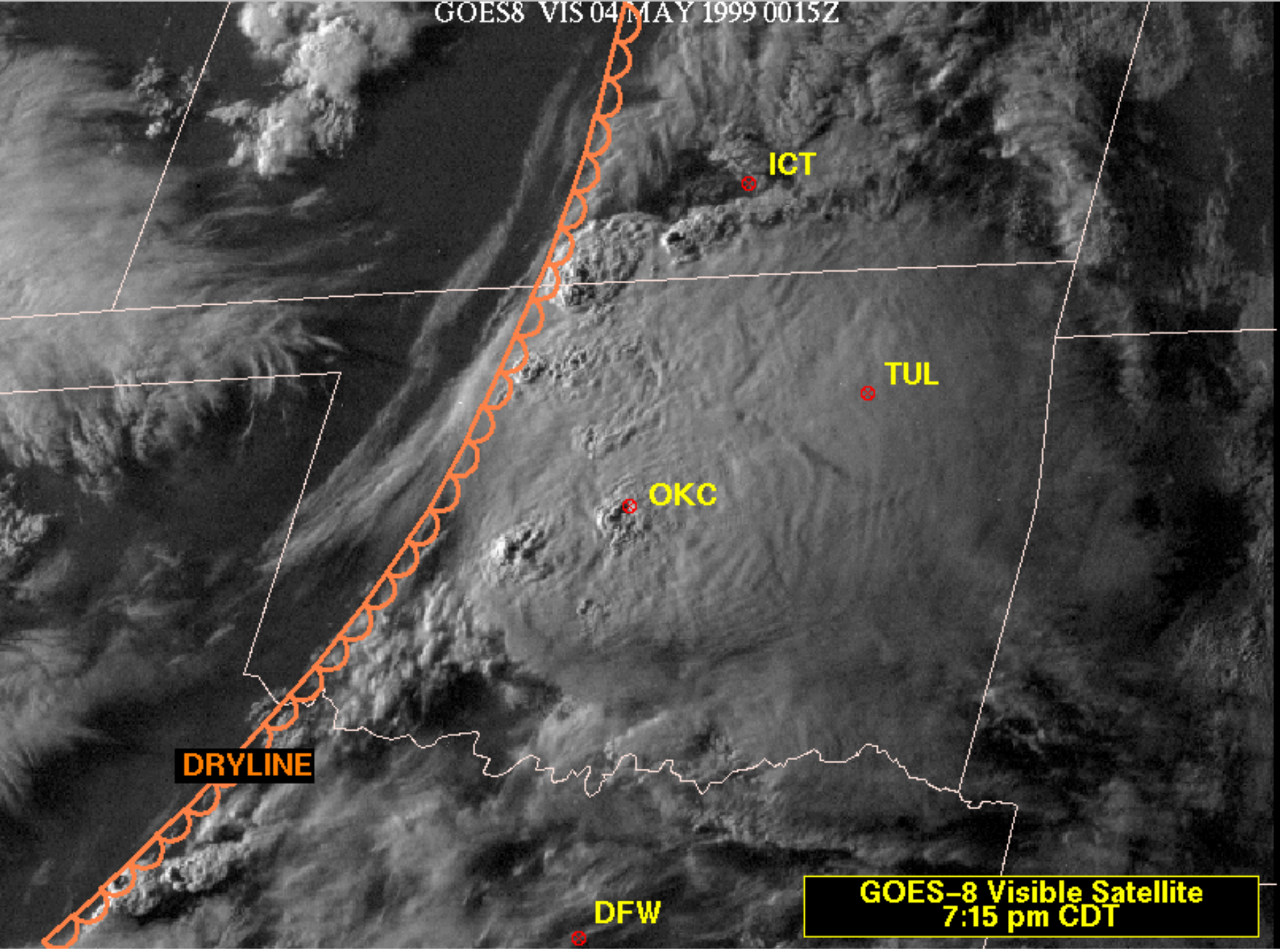
Water Vapor Image

0315Z 15 JUN 2006



NCEP/NWS/NOAA




GOES8 VIS 04 MAY 1999 0015Z
ICT
TUL
OKC
DRYLINE
DFW
GOES–8 Visible Satellite
7:15 pm CDT

Applications of Satellite Products

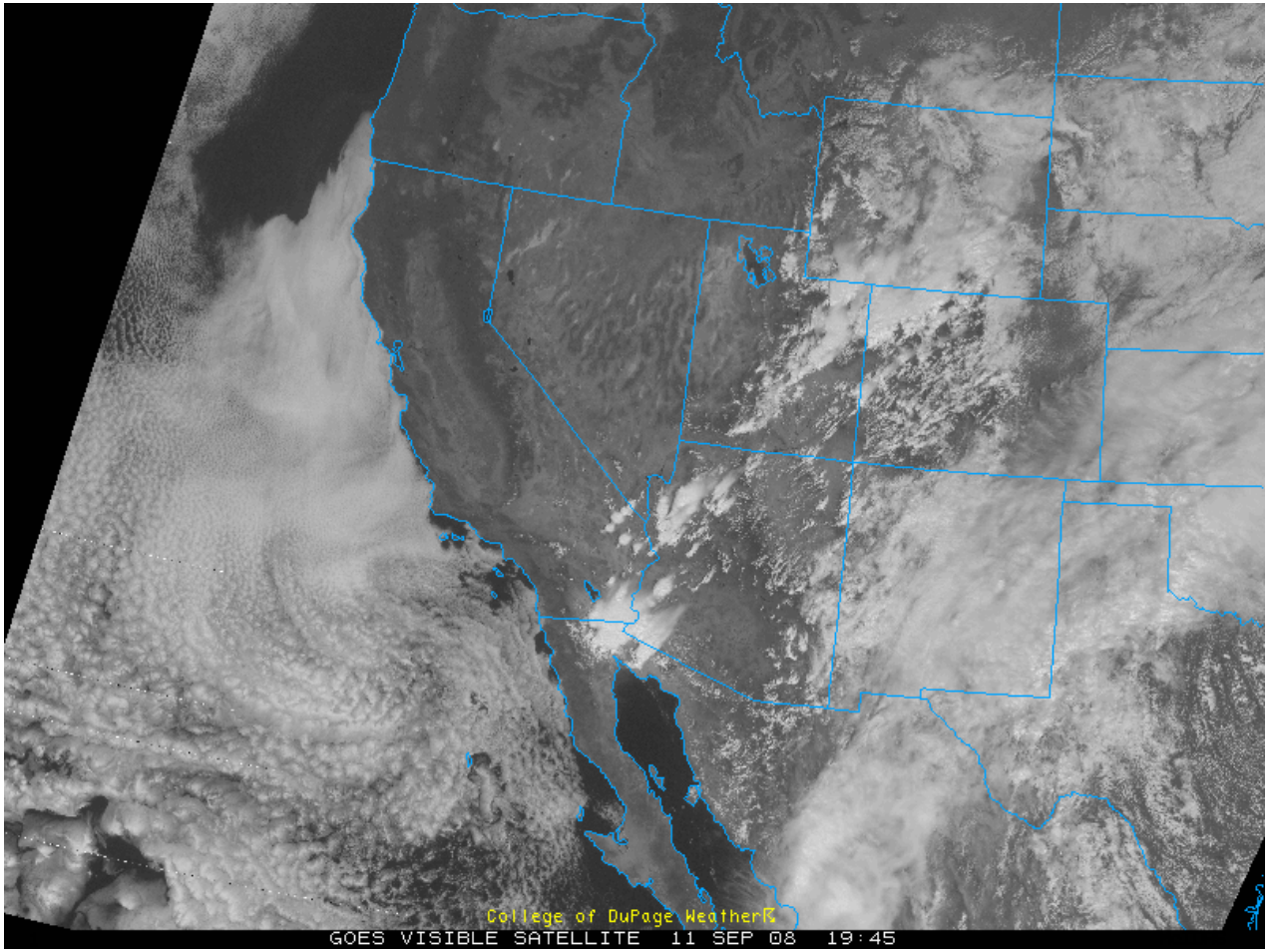
- It is difficult to use just one type of satellite imagery to accurately discern the current weather situation.
- Each satellite has strengths and weaknesses. Knowing those will allow you to properly interpret satellite information.
- Satellite should never be looked at briefly but examined thoroughly and patiently.
- Remember that satellite is only one tool and should be used in conjunction with other forecast products to properly do an analysis.

Applications of Satellite Products

This is a visible satellite image of a fairly cloudy regime over the SW US.

Can you tell which clouds are low clouds and which clouds are high clouds?

Maybe we should compare this to another type of satellite image to help us?

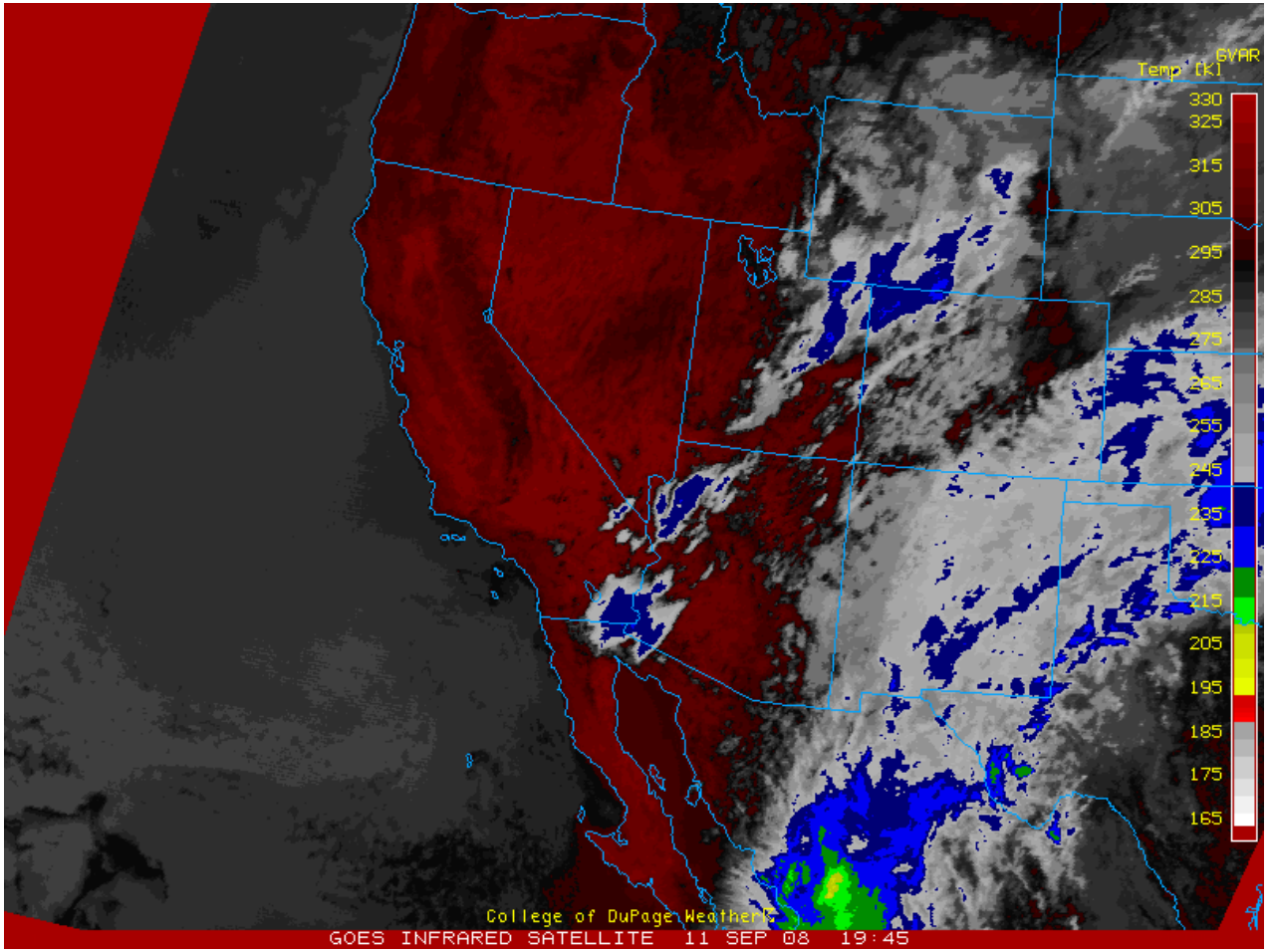


Applications of Satellite Products

This is an infrared satellite picture at the same time as the previous slide (the visible pic).

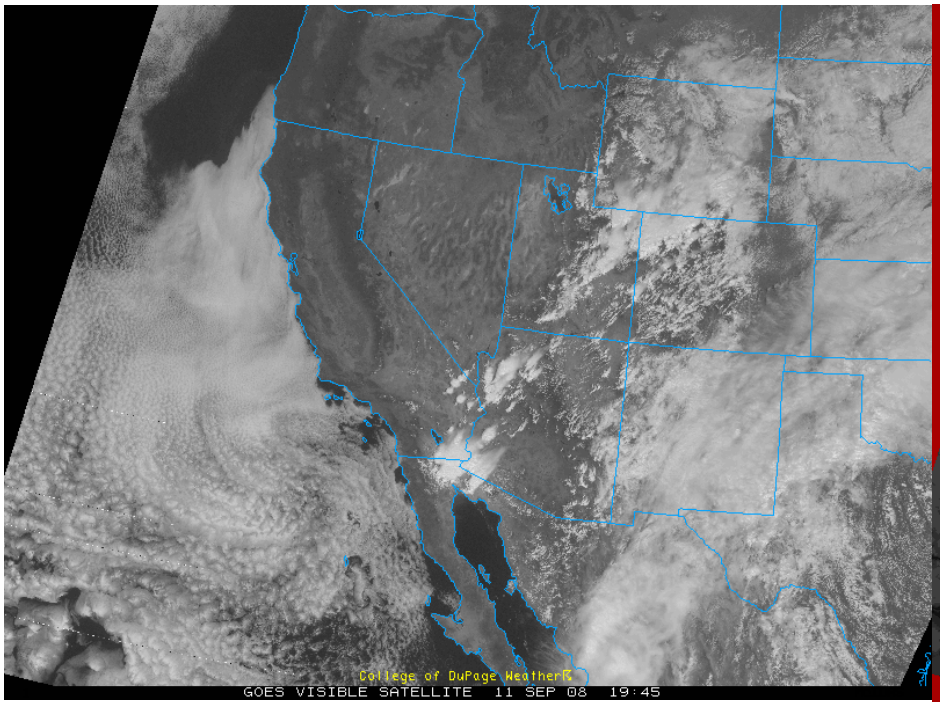
Can you see the differences?

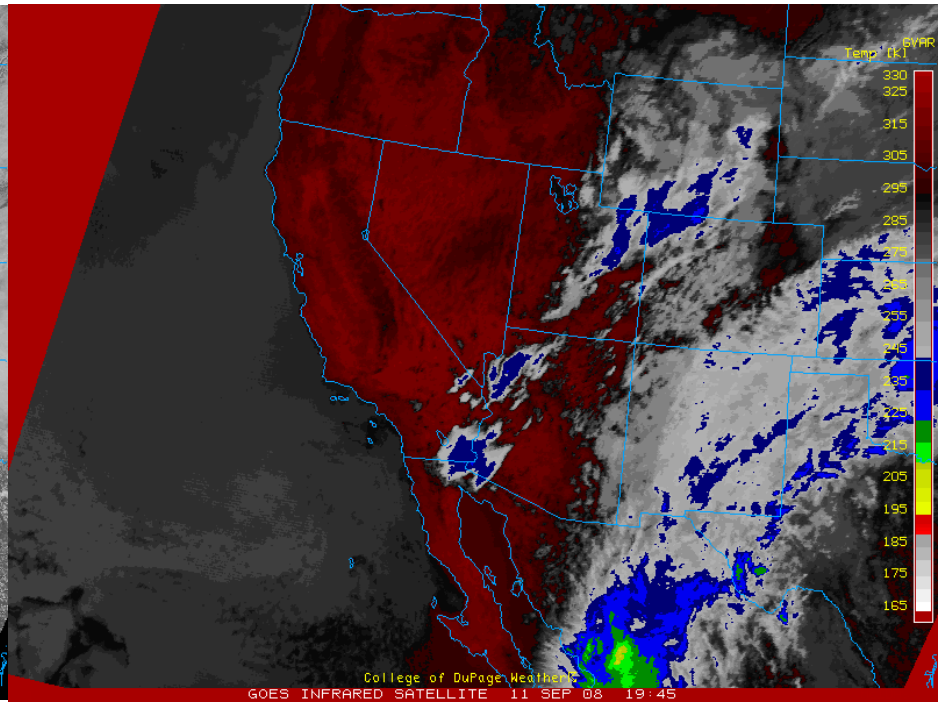
The clouds off the coast of California and in western Nebraska are much harder to see!



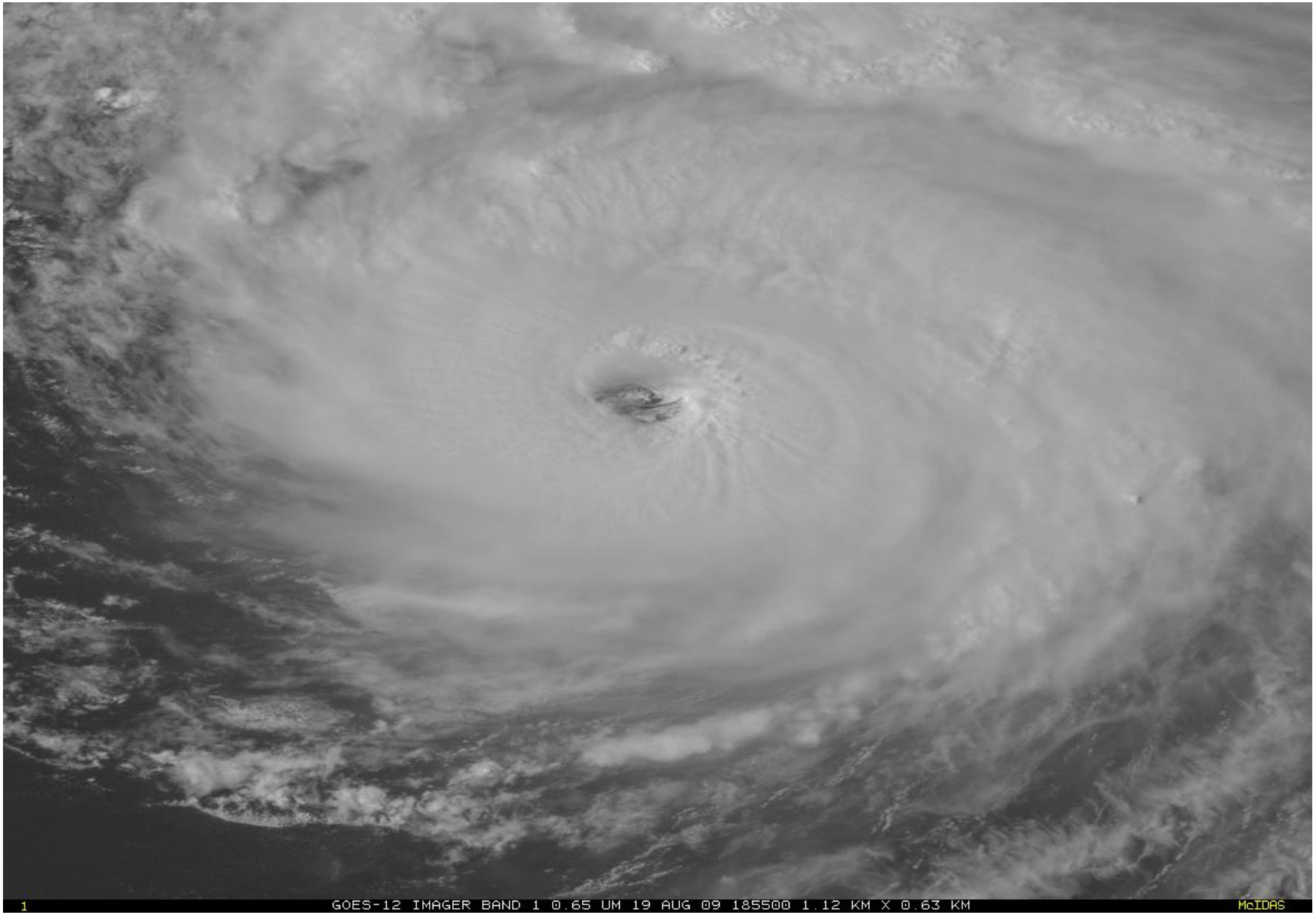
Applications of Satellite Products

- **Those clouds off the CA coast are the "Marine Layer". They are very low clouds and basically the same temperature as the ocean below. That is why they don't show up well on IR. The clouds in the Dakotas and Nebraska also are low, and show up as milky gray on IR. Visible satellite shows them better, but IR allows you to know they are low clouds.**
- **Clouds from Mexico into Texas and Kansas are high cirrus. IR shows you they are higher, especially by using the MB-curve & color enhancement. It is tough to see the difference on visible imagery.**





Applications of Satellite Products



This Concludes Weather Satellite Imagery

Technology Enhancing the Monitoring of Weather

www.hebus.com