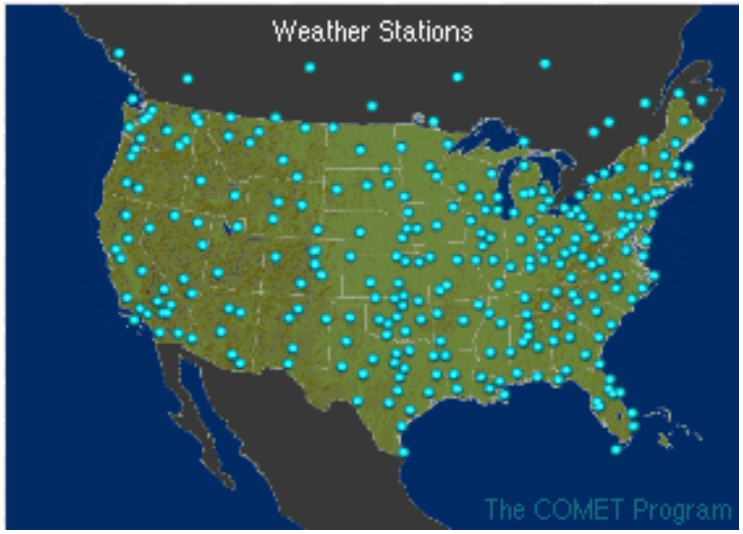
Meteorology 3110

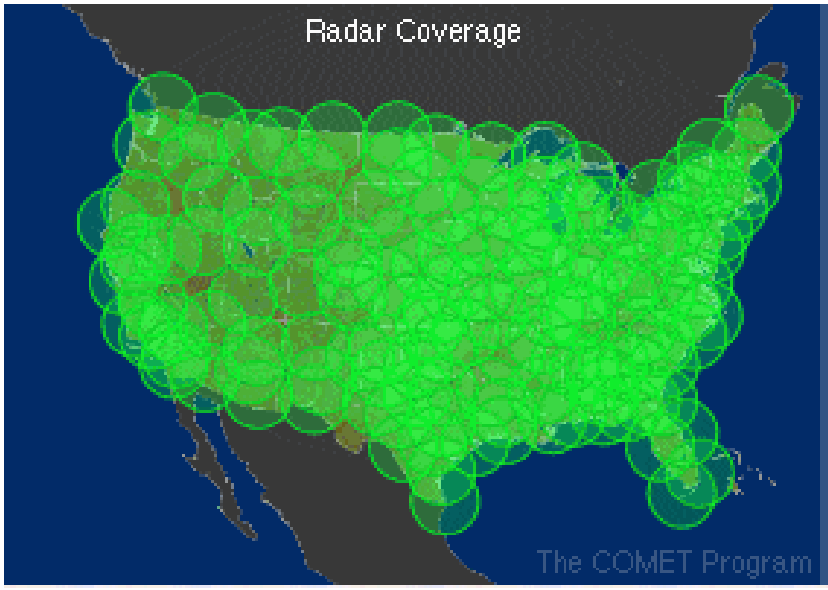
Remote Sensing

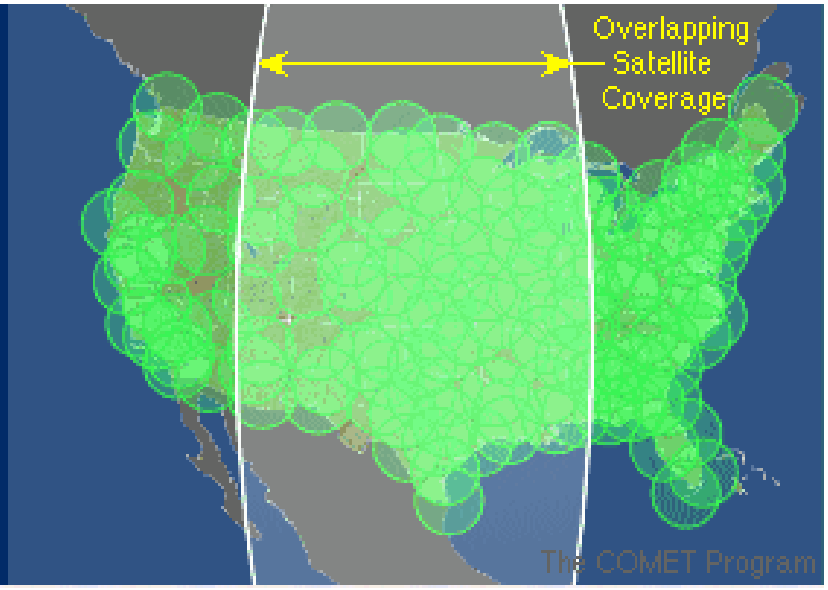
What is it?

- Measurement using devices not in direct contact with the object they sense.
  - Remote sensing involves observing objects indirectly either actively or passively.
- In-Situ measurements: Devices in contact with the medium they are sensing.
- Anemometer, Satellite, camera, radar, thermometer, windsock, hand in boiling water, lidar, metal detector, x-ray
- In-Situ meaurements: measure atmospheric conditions at discrete locations/points and time.
  - Gaps in the observation network.

Types of Sensing







Satellite Observations

- Geostationary : Remains stationary over a specific point on the earth
  - GOES (Geostationary Operational Environmental Satellite)
  - Cover a region of interest defined by the owner.
  - Elevation ~ 22,000 miles above sea level.
  - Less detail than POES, but provides many more images.
- Polar-Orbiting or Low-Earth Orbiting : Track from pole to pole.
  - Do not cover the same area.
  - Cover small strips. Each pass sees an area to the west of previous pass.
  - Sun synchronous: path does not change with respect to sun relative coordinate system.
  - Elevation ~ 600 miles (complete rotation about every 1.5 hours).
  - Passes any point on earth twice a day.
  - NOAA uses two of these so no image is over six hours old.
  - Great detail, but only sample a given area a few times per day.

Visible Images

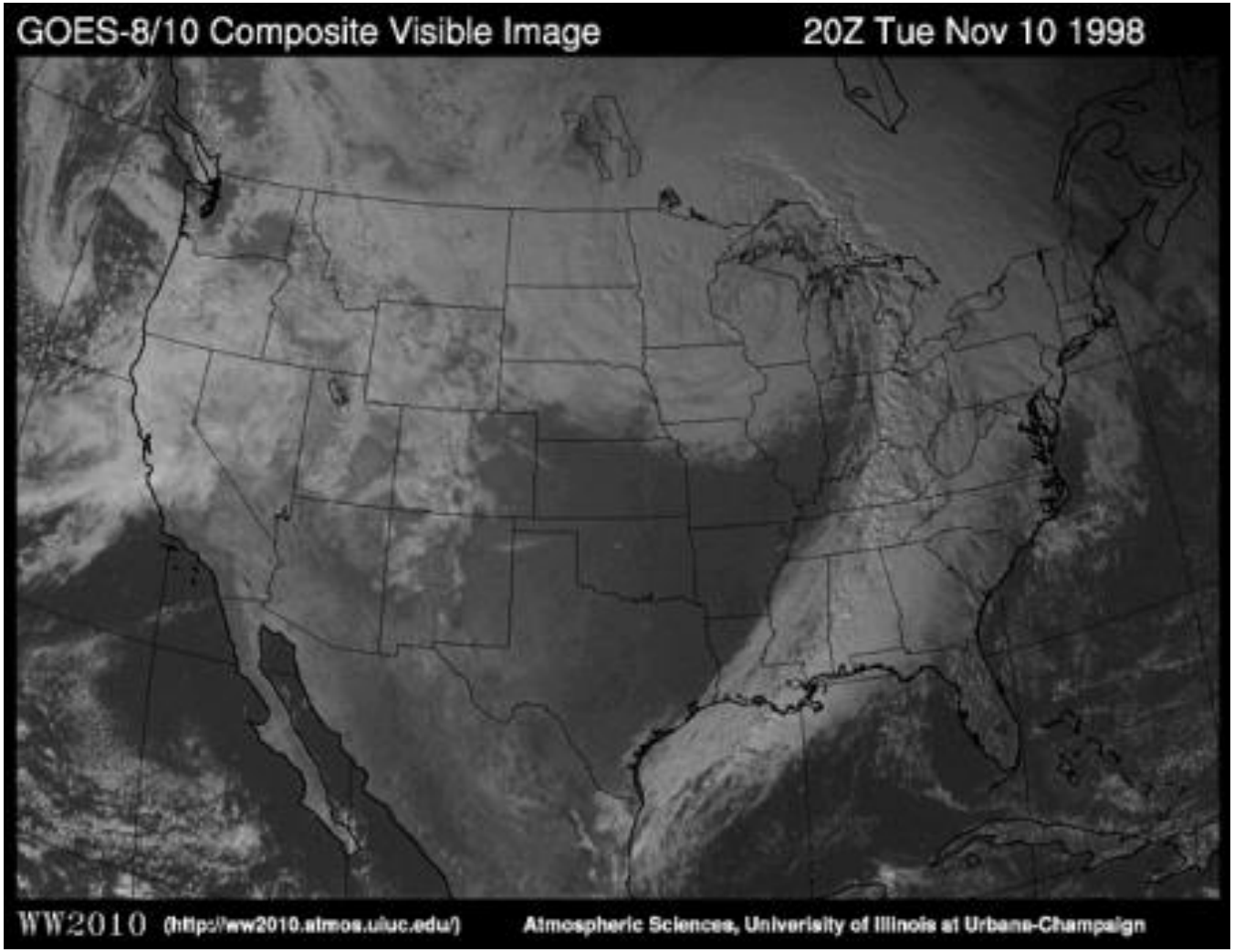
- Record visible light from the sun that is reflected from cloud, land, oceans, snow, or ice.
  - Albedo.
  - $\lambda = 0.52 – 0.72$ microns.
- Bright clouds indicate a lot of reflecting particles.
- High and low clouds look equally as bright and are often indistinguishable.

Visible Images - Albedos

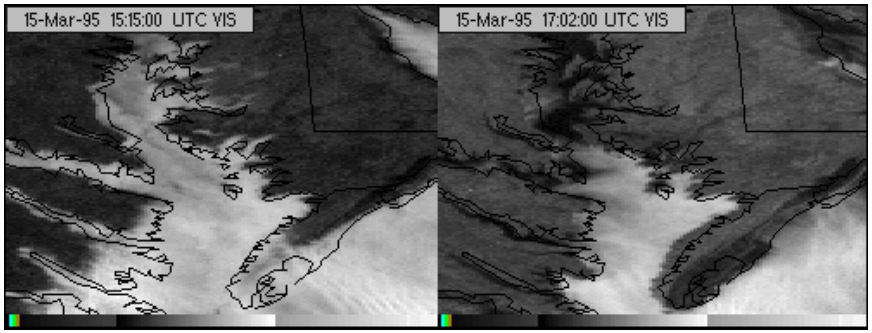
- Thunderstorm – 80-90%
- Cumulus – 70%
- Stratus – 60%
- Thin stratus – 50%
- Cirrus – 40%
- Thin cirrus – 30%
- Smoke – 20%
- Blackbody – 0 %

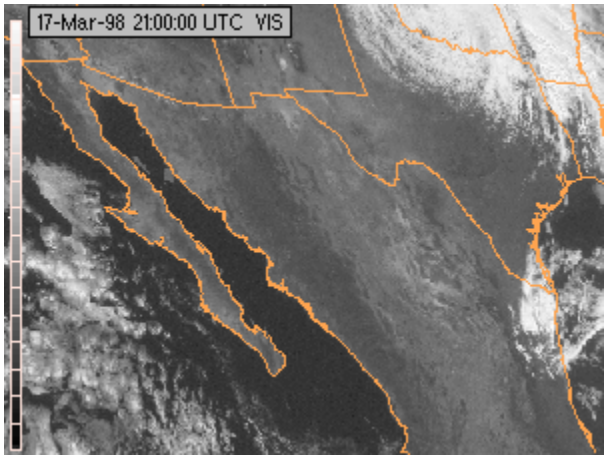
- Fresh snow cover – 80%
- White Sands, NM – 60%
- Melting snow, salt flats - 50%
- Dry, sandy soil – 40%
- Clay, granite, glaciers – 30%
- Tundra, bare soil – 20%
- Oceans, lakes, forest – 10%

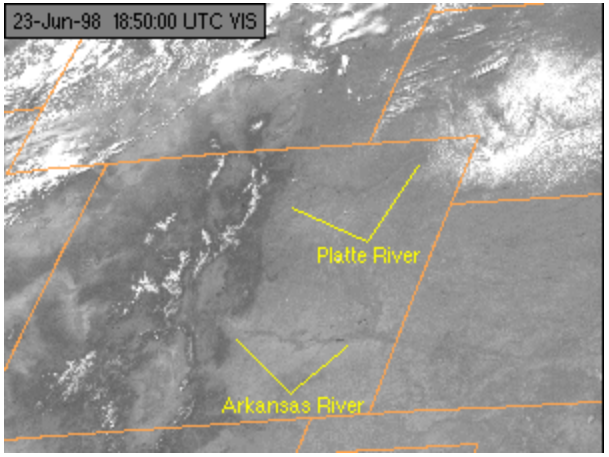
Visible Image

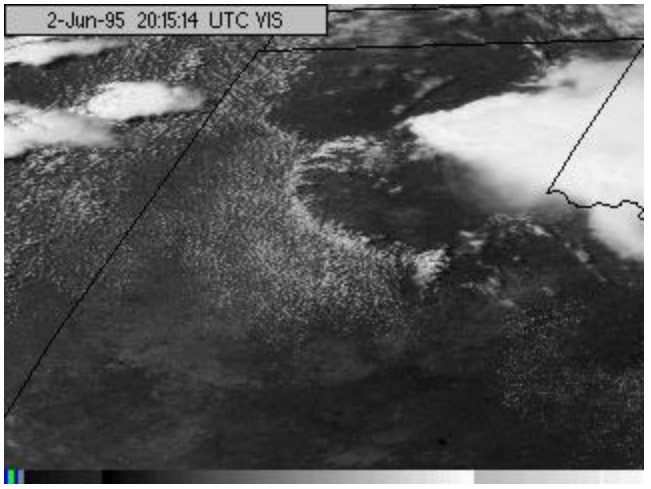


Visible Imagery

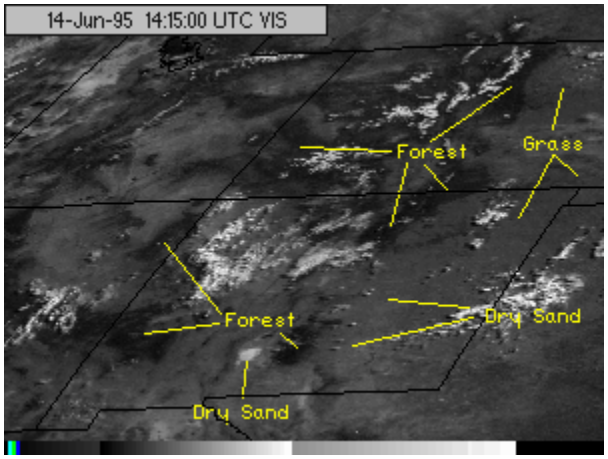


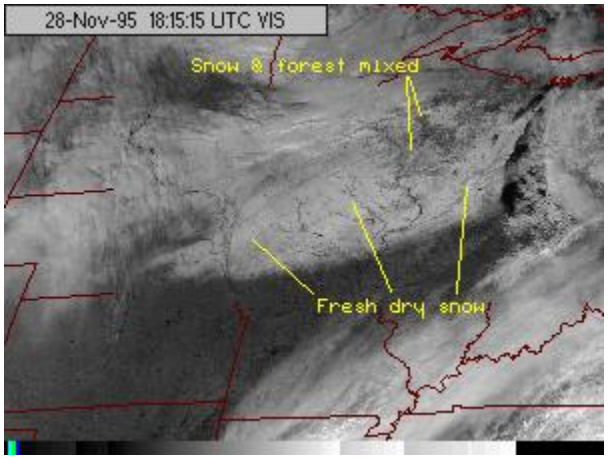


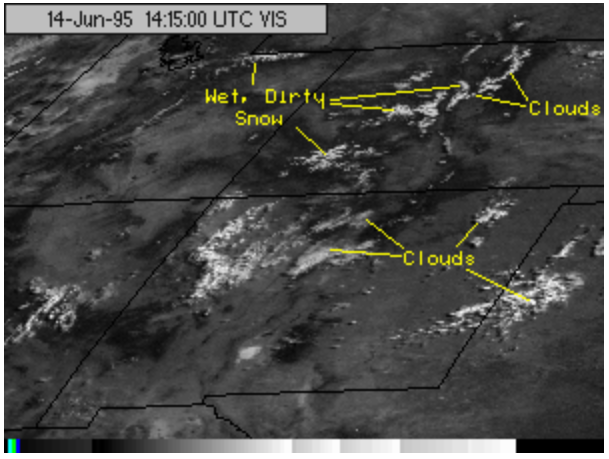


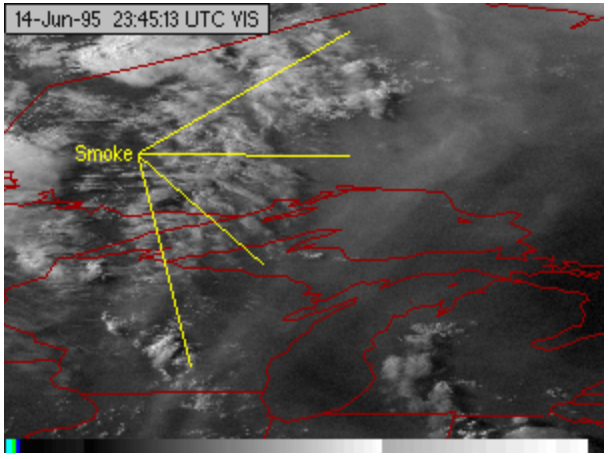


Visible Imagery





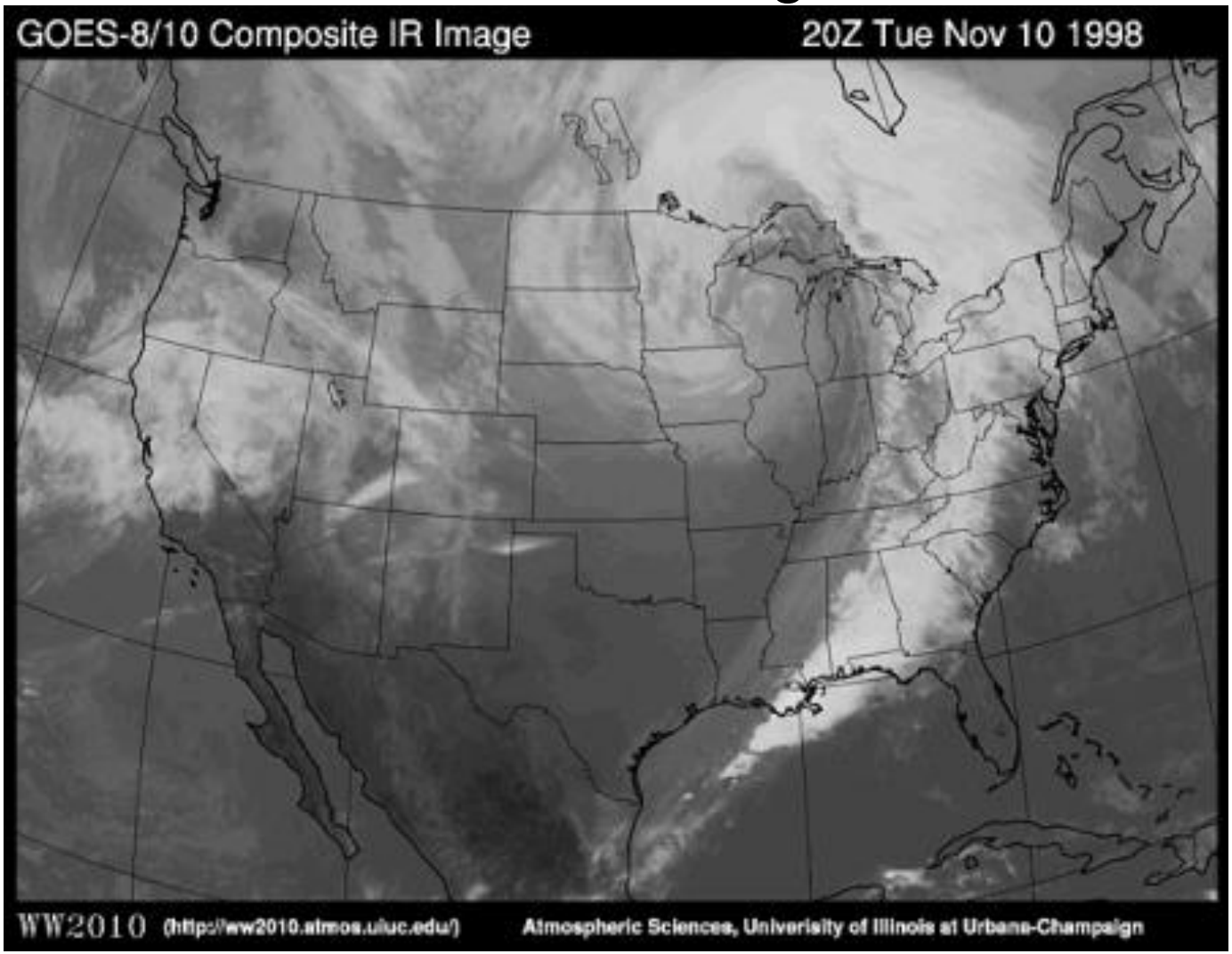




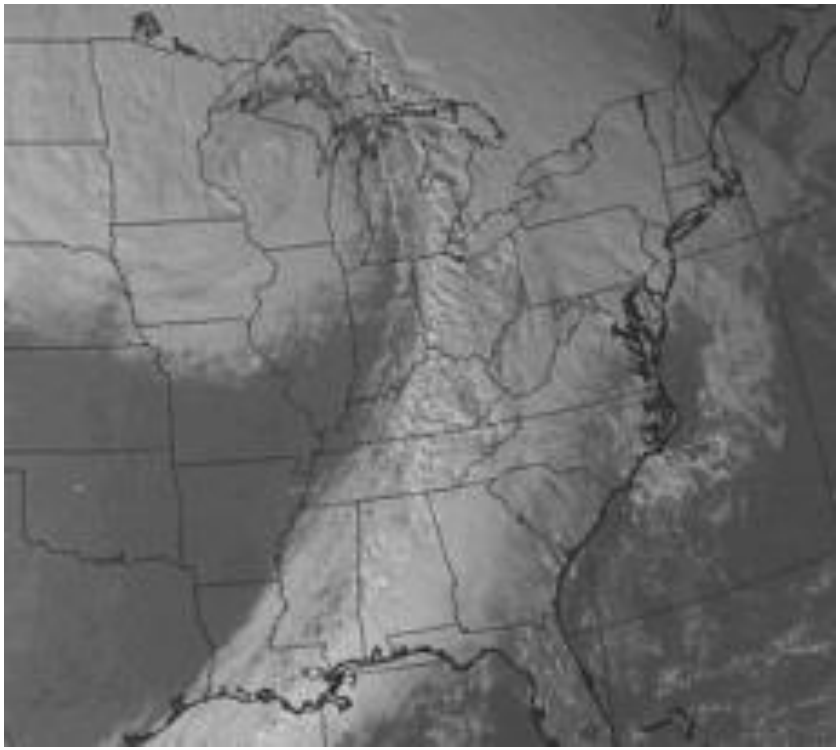
Infrared Images

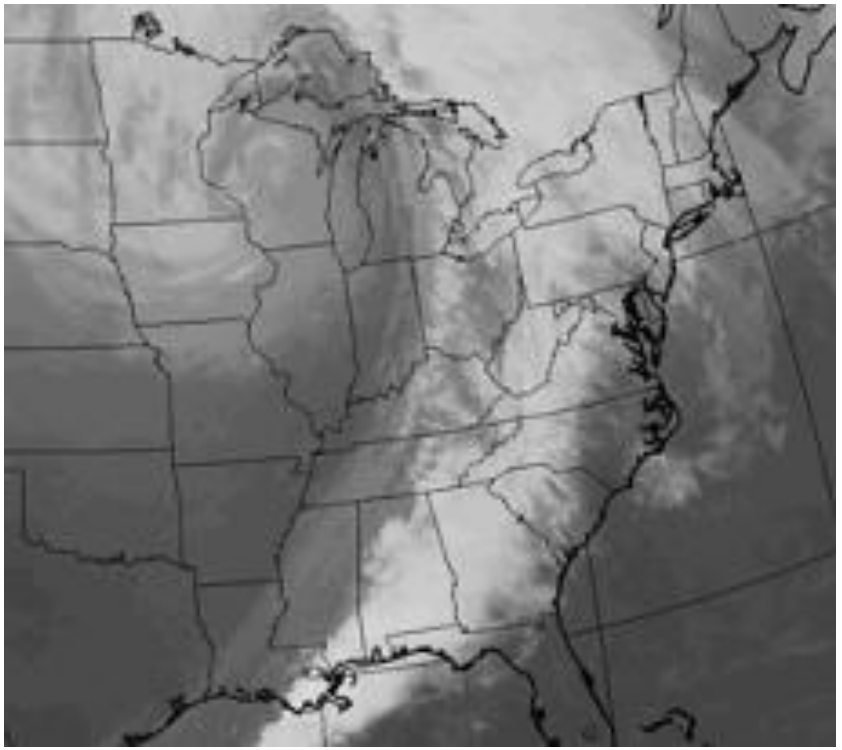
- Record blackbody temperature of an object.
  - Amount of radiation ~ T^4.
  - Measures λ = 10.2-11.2 microns = 10.2-11.2 μm.
- Shows cloud top temperatures in cloudy regions, and, possibly, surface temperature in clear regions.
- Bright clouds are COLD clouds, which are usually high.
- Low clouds are hard to distinguish from the surface. Why?

Infrared Images

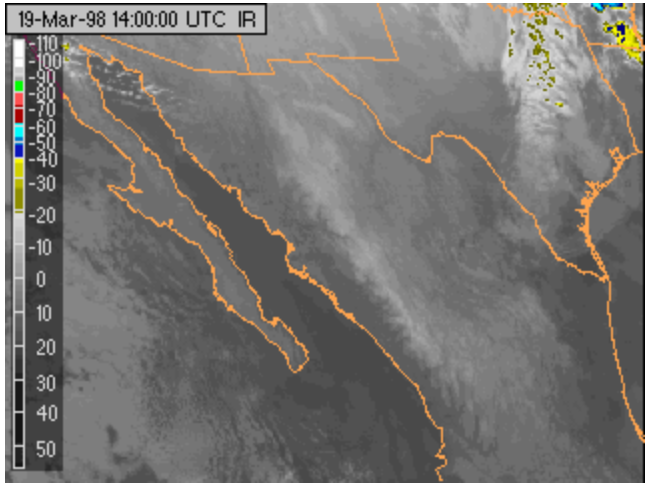


Comparison





IR Imagery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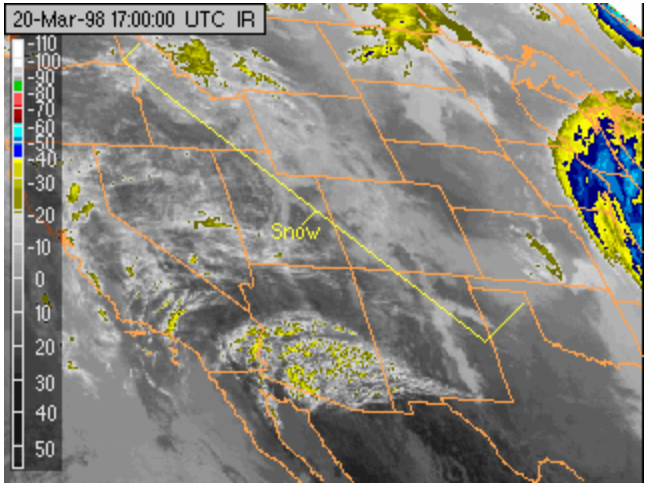
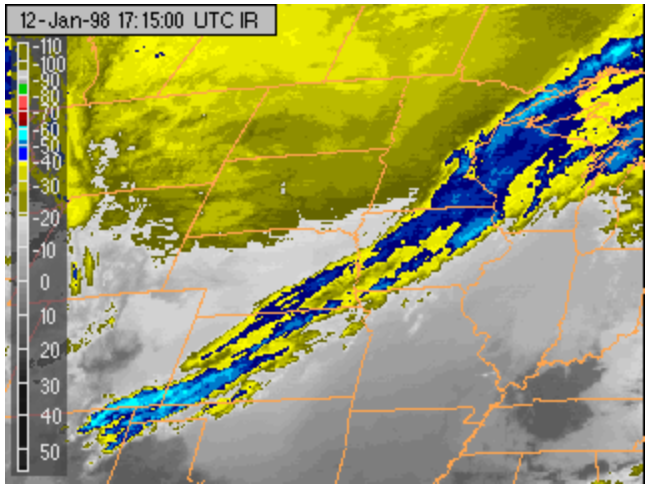
-110
-100
-90
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50

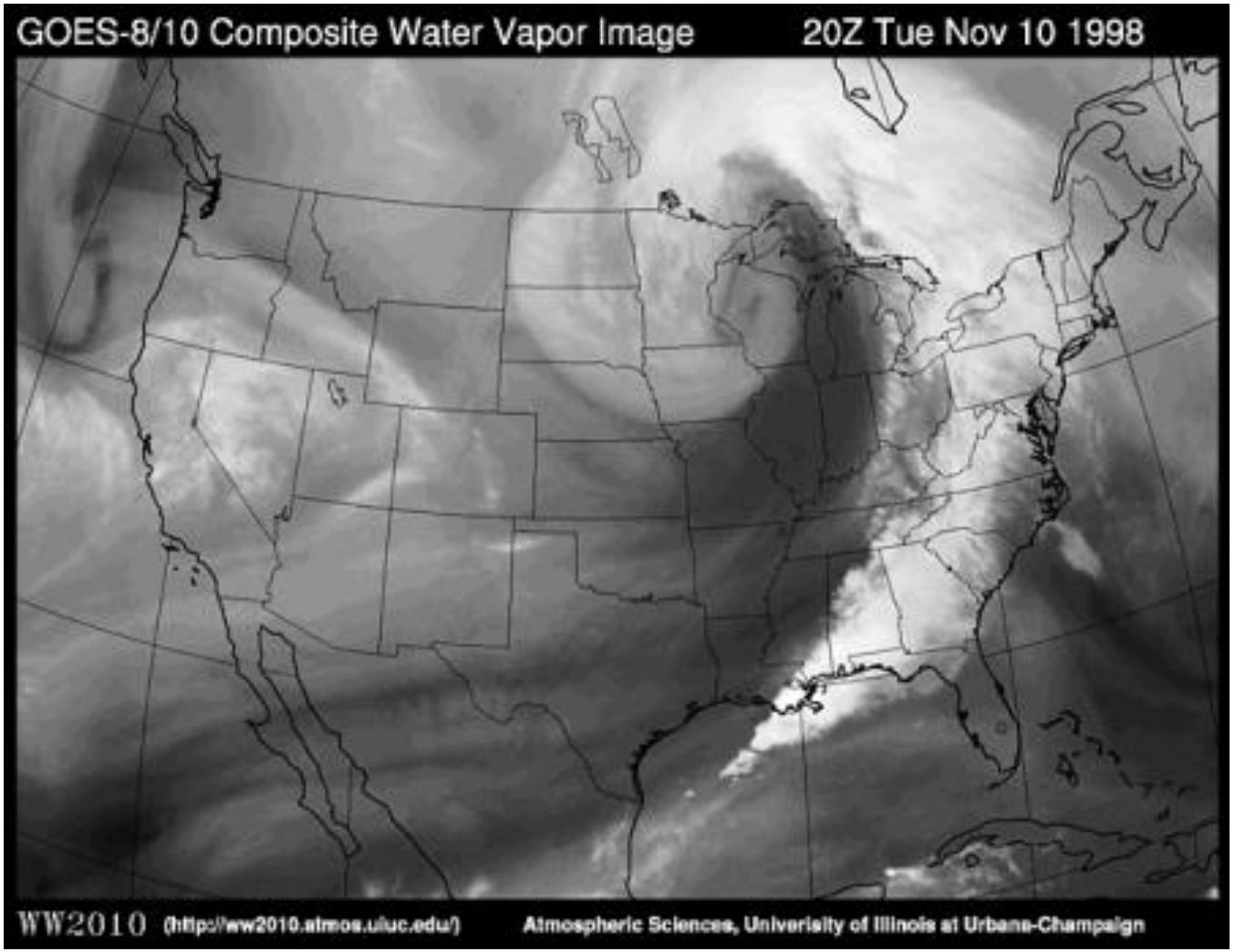

20-Mar-98 17:00:00 UTC IR
-110
-100
-90
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
Snow


12-Jan-98 17:15:00 UTC IR
-110
-100
-90
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50

Water Vapor Images

- Integrated measure of moisture in the atmosphere.
  - Measures amount of raditation emitted at 6.7 microns = 6.7 μm.
  - Water vapor heavily absorbs radiation at this wavelength.
- Absorption is greatest in the mid/upper troposphere between 600 and 250 mb.
- Good measure of mid/upper level moisture.
- Impossible to draw conclusions about low level moisture.
- Look for regions of changing characteristics (drying/moistening).

Water Vapor Image



Comparison #2