Moisture, Clouds, and Precipitation: Clouds and Precipitation

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What Processes Lift Air?

Clouds require three things: water vapor, a **condensation nucleus**, and cooling

Cooling usually comes from air rising upward

Four processes can cause air to go higher:

- Orographic lifting
- Frontal wedging
- Convergence
- Localized convective lifting

Orographic Lifting and Frontal Wedging

- Orographic lifting occurs when air flows up over a mountain
- Air on the windward side cools **adiabatically**
- This results in heavy rains, such as those in the Cascades (Seattle and Portland are known for their wet weather)

- Frontal wedging occurs when more dense cold air flows under less dense warmer air (**cold front**)
- Or warmer air can flow over cooler air (**warm front**)
- This produces much of our mid-latitude weather

Convergence and Convective Lifting

- Convergence occurs when two **air masses** flow toward each other, and must rise
- A good example is the FL peninsula, where air from the Atlantic and Gulf of Mexico come together to create many thunderstorms
- When the ground warms, the air above it warms , becoming less dense and rising
- Air over a paved road will be warmed, while air over a pond will be cooler
- Local “thermals” can form afternoon storms

Condensation

- As air rises, it cools
- As air cools, its RH increases toward 100%
- If it reaches saturation and there are **condensation nuclei** available, cloud droplets can form

http://www.davidadamsonline.com/images/cumulonimbus_5.jpg

Cloud Types

- **Cirrus** (feathery)

- Stratus

- Cumulus (fluffy)

- Cumulonimbus

http://www.carlwozniak.com/clouds/CloudPix.html

Fog
low-lying stratus cloud

Precipitation

- Rain

http://www.eontarionow.com/images/Rain.jpg

- Snow

http://www.wyorange.net/images/snowflake.jpg

- Sleet

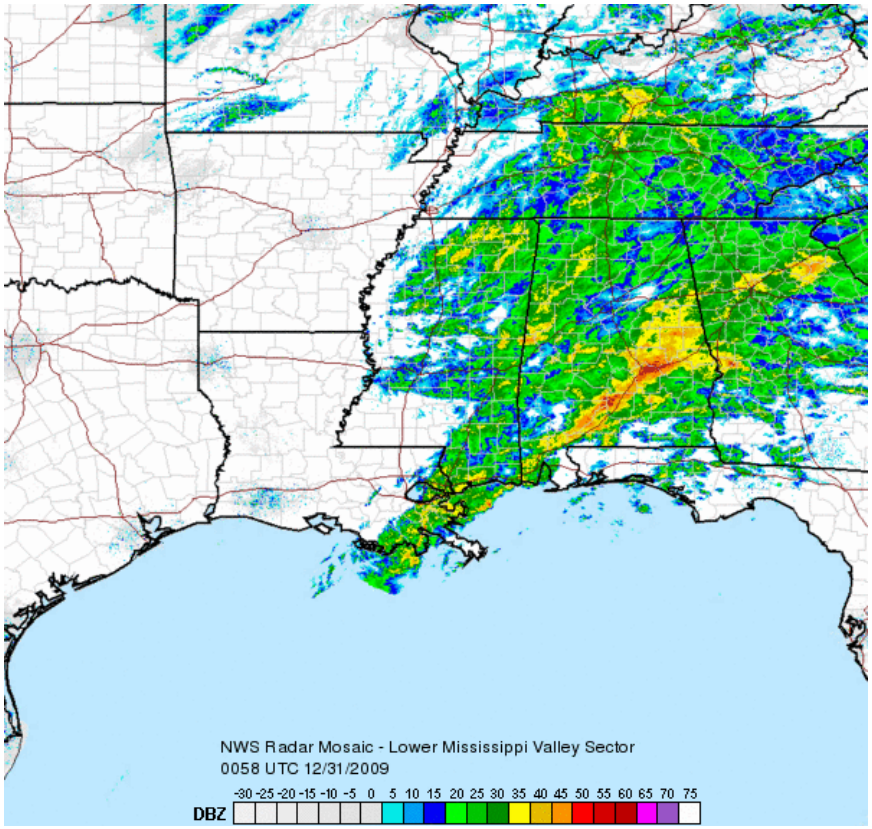
http://www.crh.noaa.gov/images/lmk/sleet_med.jpg

Drizzle

Hail

http://severe-wx.pbworks.com/f/hail.jpg

Clouds, rain, and Doppler radar

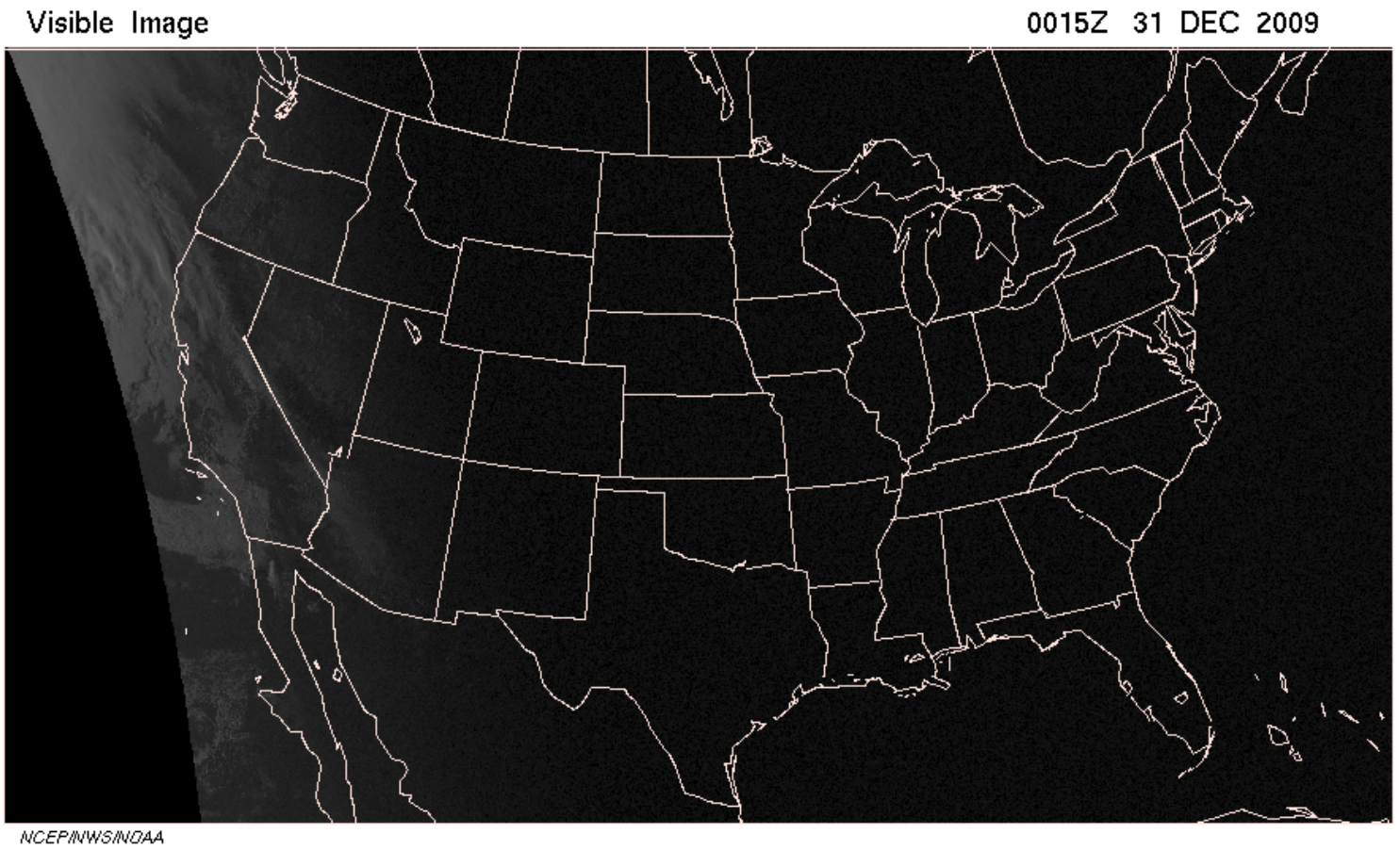


- NWS Doppler radars use color codings to represent different types of precipitation
- With advanced training and loops, weather forecasters can make relatively accurate predictions from radar imaging

http://radar.weather.gov/Conus/southmissvly.php

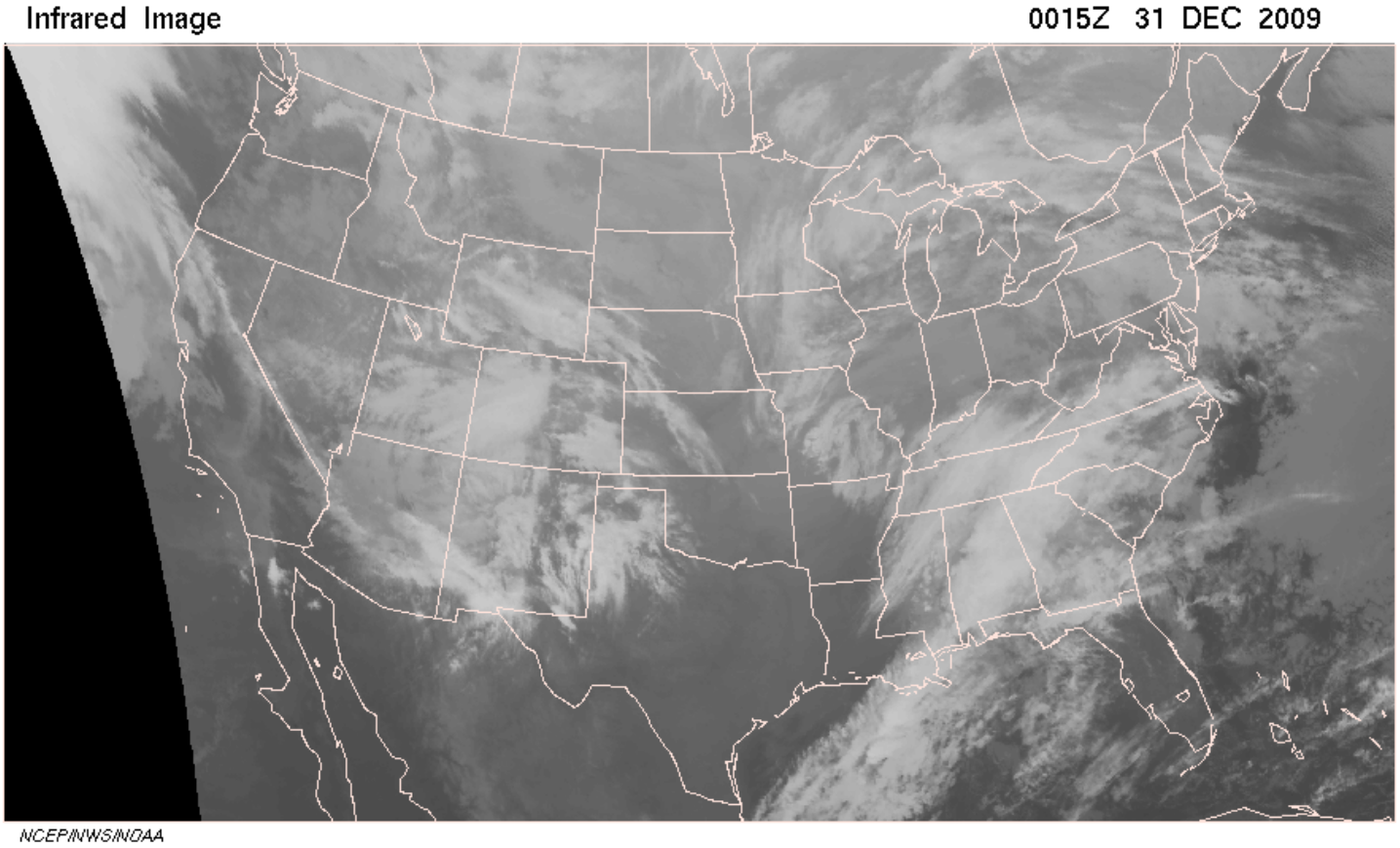
Clouds, rain, and satellites
Visible imagery

7:15 pm
30 Dec



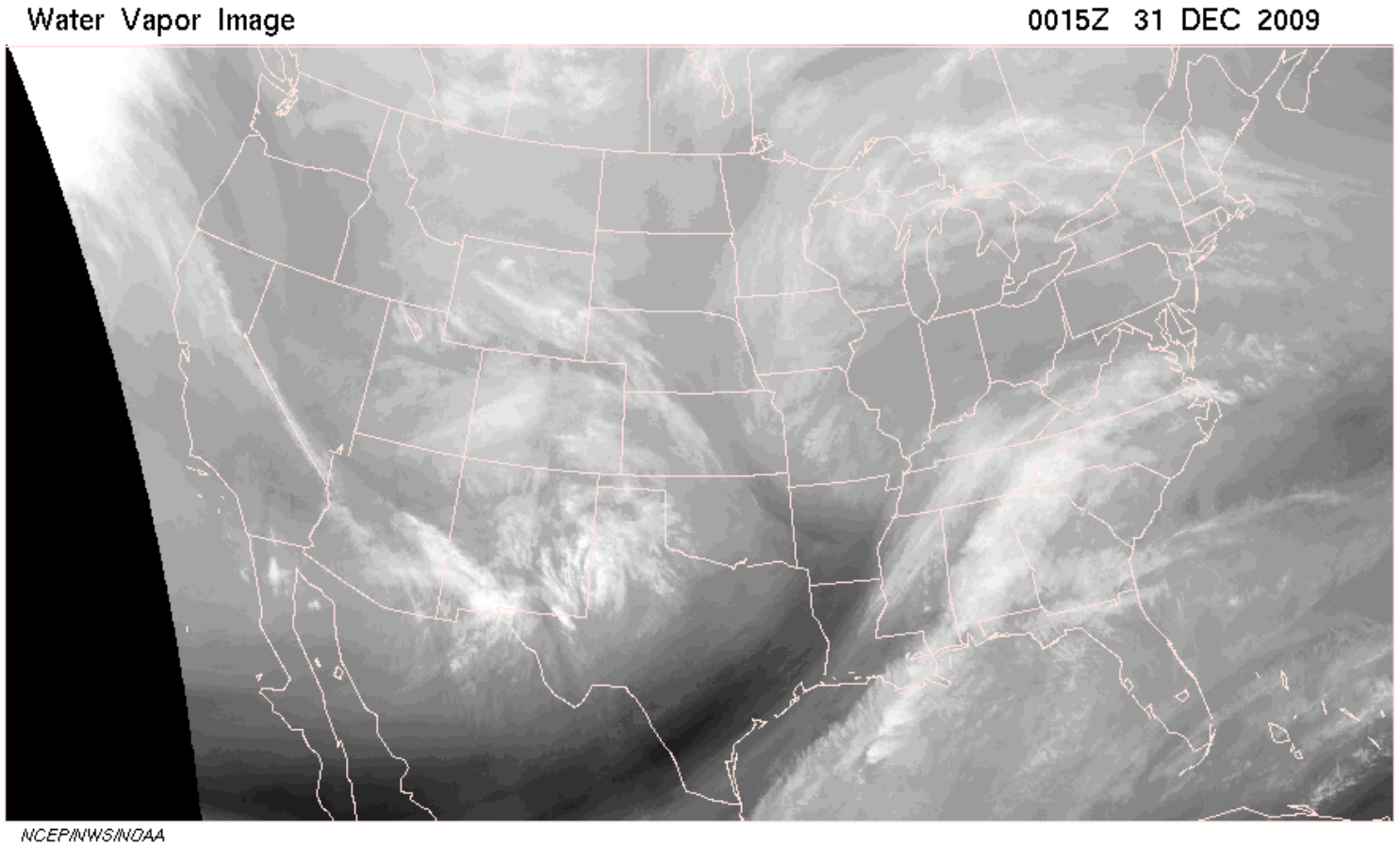
As night moves over the eastern US, visible images become less useful.

Clouds, rain, and satellites
Infrared imagery



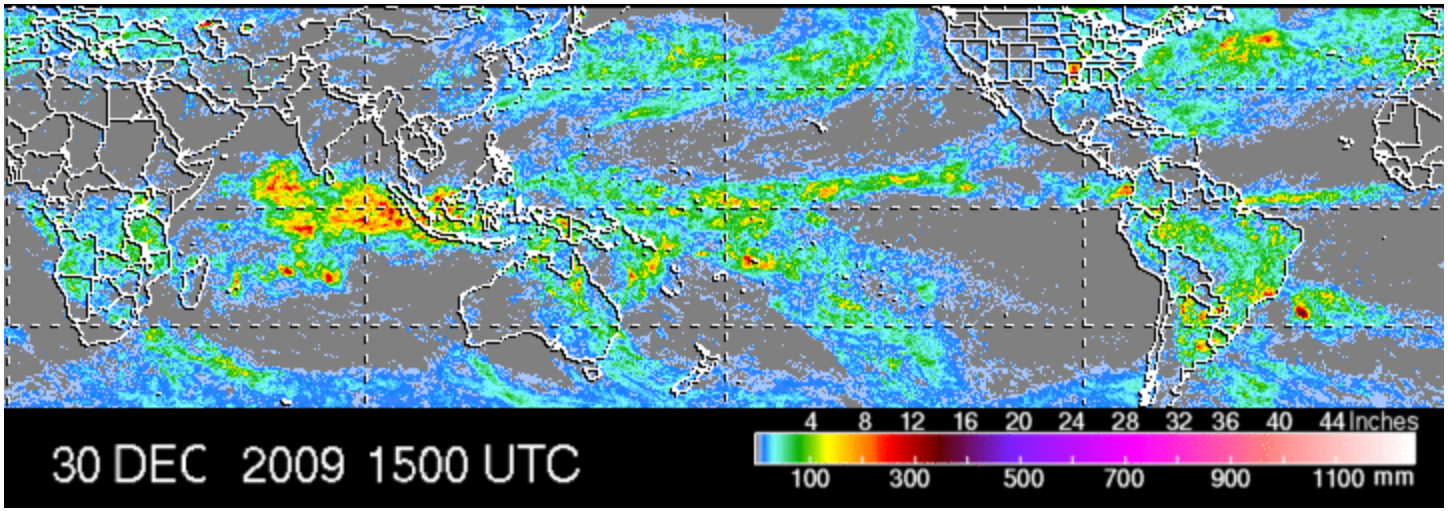
IR (heat) images can show the location of clouds at any time day or night.

Clouds, rain, and satellites
Water Vapor imagery



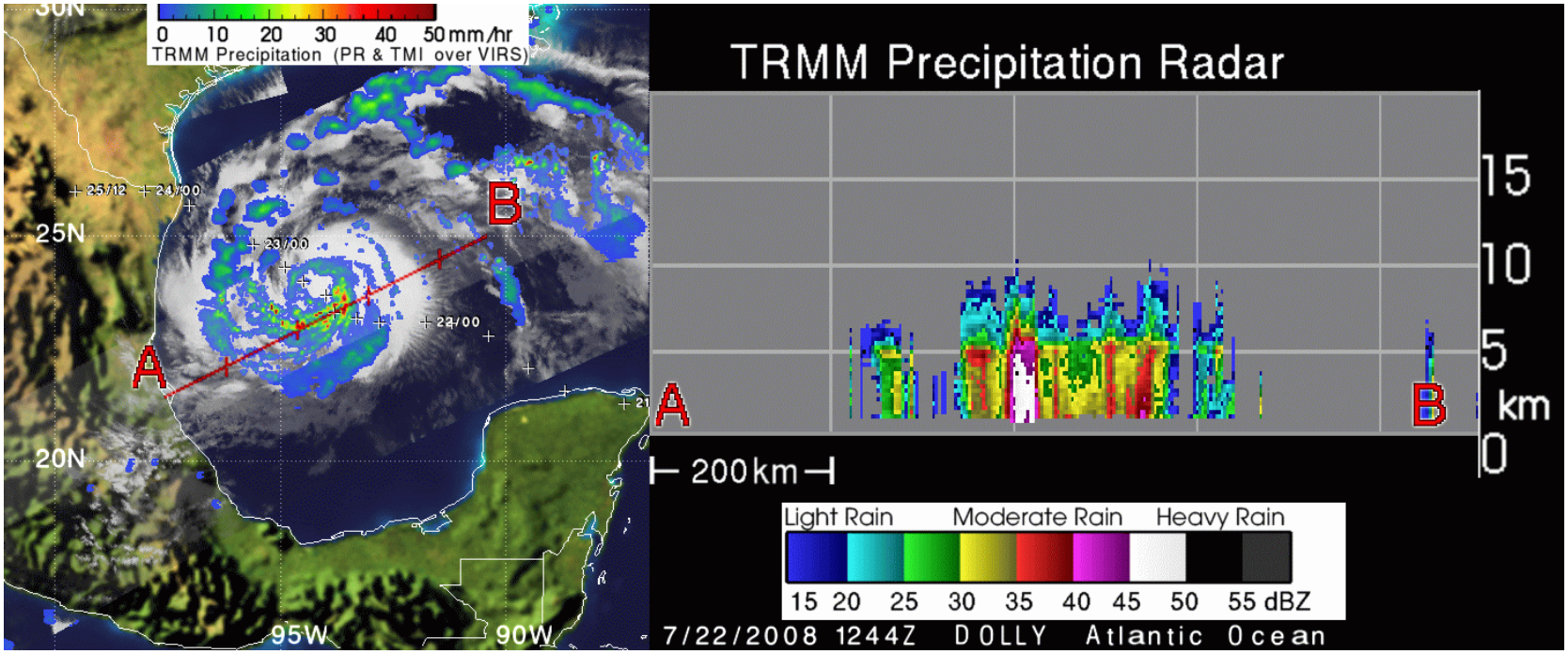
Other sensors detect concentrations (white) of water; darker areas are drier air.

TRMM (Tropical Rainfall Measuring Mission) satellite images show where precipitation occurs between 30 º N and 30 º S, where there are relatively few observation stations on land or ocean



http://trmm.gsfc.nasa.gov/affinity/affinity_3hrly_rain.html

TRMM sensor data, such as these from the Precipitation Radar, can be processed by powerful computers to create color-coded images and “cross-sections” that help atmospheric scientists understand much more about water in the atmosphere.



http://trmm.gsfc.nasa.gov/trmm_rain/Events/ATLA/ATLA.2008-7-22T1244Z_____DOLLY.gif

There's more to rain than just getting you wet!

- You may be interested in whether today will be "hot/cold/wet/dry", but meteorologists want to know much more
- Local rain gages or instruments as simple as a ruler to measure snow depth now combine with radar, weather satellites, and specialized space-based sensor platforms (such as TRMM) to provide global understanding of moisture in the Earth System