Remote Sensing
Fall 2017
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 measurements: measure atmospheric conditions at discrete locations/points and time.
  – Gaps in the observation network.
Types of Sensing

- Weather Stations
- Radar Coverage
- Overlapping Satellite Coverage
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 Imagery
Visible Imagery
Infrared Images

• Record blackbody temperature of an object.
  – Amount of radiation $\sim T^4$.
  – Measures $\lambda = 10.2-11.2$ microns $= 10.2-11.2 \mu m$.
• 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
Water Vapor Images

• Integrated measure of moisture in the atmosphere.
  – Measures amount of radiation 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).