

The final is: Monday, Dec. 16 2:45 to 2:30 pm

Content: This test will be cumulative from the beginning of the semester, however, most of the questions will be concerned with satellite imagery and interpretation. You will need to know techniques and information that was covered before the midterm such as using two lists to identify an object in an image, the E/M spectrum and the remote sensing process.

Format of the test: This test will be similar to the midterm that we had in this class. There will be a section of short answers and a section of longer answers.

Materials: Bring a calculator and your satellite information cheat sheet to the class. Please do not write on your cheat sheet. If you have written on your cheat sheet, I will provide another.

Observations from space platforms

The same processes apply to satellite images as to aerial photographs

- 1) Energy source
- 2) Energy propagation through the atmosphere
- 3) Energy-surface interactions
- 4) Re-transmission of energy through the atmosphere
- 5) Airborne/spaceborne sensing system
- 6) Analysis-product generation

4 fundamental considerations for satellite sensors. Know how the following four characteristics affect the satellite that would be used for a particular application.

1) Spectral resolution of the sensor:

In which wavelength regions of the electromagnetic spectrum does the sensor make observations? Are these particularly good wavelength regions for distinguishing the phenomena of interest? What is a spectral signature? Be able to relate those for vegetation, clouds, water, urban areas and bare soil to sensor channels.

Sensors that observe low energy waves, eg. Microwaves, generally have low spectral and spatial resolution, why?

2) Spatial resolution:

Define the **IFOV**.

The smaller IFOV, the higher the level of detail that can be discriminated--but a larger IFOV allows more energy to be detected.

3) Radiometric resolution

This refers to the precision with which radiance is measured by the sensing system. e.g. number of gray levels, which is determined by the number of bits of data. ie. quantization levels. Landsat TM – 8 bit. AVHRR- 10 bit, MODIS – 12 bit.

4) Temporal resolution

How frequently does the sensor provide coverage over the same geographic area? This is a satellite platform issue--related to orbital characteristics, not a detector issue. How might a pointable sensor change the temporal resolution and what is a problem associated with pointable sensors?

Know these terms; passive sensor, active sensor, orbit, ground track, swath width, sun synchronous orbit, geostationary orbit.

How is the temporal resolution of a sensor related to its orbital characteristics?
**implications of orbit pattern: consistent illumination conditions for observations of a given location

The NOAA satellites (AVHRR instrument) drifts with time so that it does not go over at the same time each day.

Geostationary Orbit equatorial, west to east orbiting satellite-very high orbit 36,000 km--makes one revolution in 24 hours, in sink with Earth's rotation. Satellite stays in one place above the earth and travels parallel to earth. e.g. GOES

Know these terms

descending orbit: day orbit for Landsat.

ascending orbit: night orbit for Landsat

Wiskbroom – across track scanning such as with a rotating mirror.

Pushbroom – along track scanning, accomplished with a linear array of detectors (CCD).

How does view angle affect spatial resolution for AVHRR. As the satellite sweeps out its sensor swath, the IFOV gets larger near the edge of the scan swath.

Worldwide Reference System (WRS)- gives the path and row for Landsat imagery. Landsat 1, 2, 3 (WRS-1) are different from Landsat 4, 5, and 7 (WRS-2) due to changes in the orbit.

Histogram shows the distribution of values in a dataset--the frequency of occurrence (frequency on y axis, data value/class on x axis).

Contrast manipulation:

Contrast stretching--need to know what radiometric resolution of sensor is for spectral bands...e.g. if 8 bit, can display 256 gray tones (0-255). Typically data do not extend over the entire range of radiometric resolution...in contrast stretching we expand the more narrow range of brightness over a wider range of gray values so we can see contrast better in an image.

Image classification - rather than visual analysis of digital data, use quantitative techniques. Categorize pixels in an image into land cover classes or themes

Unsupervised--Use statistics to sift through the satellite data and define natural clusters/classes within the data (concepts similar to nearest neighbor, texture analysis, minimum distance...etc).

Supervised -- Use apriori information which helps to analyze the digital satellite data. If we know the cover type at a given location through a map/photograph, we can establish **training sites** for land cover types--the computer evaluates the statistical characteristics of the satellite data for those training sites and that forms the basis for the classification of the image--basically matching spectral signatures throughout the image with the training sites.

What is the difference between land use and land cover?

Explain how statistical regressions may be used to extract information.

Know the other Vegetative indices, and what they comprise.

Review your notes from all of the talks, Tim's and Dr. Lawrence's talk about wetlands and Modis snow cloud product and satellites/Globe.

Landsat – What is the Landsat acquisition plan?

Thermal Remote Sensing – in the atmospheric window region. What makes up the thermal signal that the satellite receives? T_s (80% of signal), air temperature and water vapor (very indirect). What is the split window equation and what does it do? – corrects T_s for the atmosphere. How does water vapor affect the T_s estimation? Be able to relate the Stefan Boltzmann Equation to the energy observed by the sensor and the emissivity.

Local Energy Balance

$$R_n + LE + H + G = 0$$

R_n = Net Radiation

LE = Latent Heat Flux, flux of energy due to evapotranspiration.

H = Sensible Heat Flux

G = Heat Flux into the ground.

Sensible heat flux is the heat that we can feel.

Latent heat flux is the evaporation/transpiration of water from the surface.

How does the surface affect the amount of latent and sensible heat flux, for example between an area covered by forest and one covered by sand.

Be able to discuss things that alter the local energy balance especially human activities.

Microwave remote sensing – What wavelengths penetrate to the surface in a forest? What wavelengths are intercepted in the canopy? What is the difference between active and passive microwave?

Urban Remote Sensing

Which resolutions matter in Urban remote sensing, and why? Name the 3 ways we can classify the utility of an image. NIIRS, AWAR, GRD.

Physical Geography

What is the boundary layer? It is from the surface to about 1 or 2 km and contains most of the pollution and water vapor.

Be able to describe the general circulation. How are the highs and lows around the world associated with clouds and precipitation? Could you say whether a high or low pressure system influences a location during a specific time of year?