Land Remote Sensing
Assignment #5: Thermal infrared and microwave remote sensing
Due: Monday, Nov 23, 2015

Name_______________________________________

The files you'll need are at:
http://wray.eas.gatech.edu/remotesensing2013/RS_Lab4_files.zip

Radar

1. Open the image *sar.img*. In the space below, write a basic image description, indicating which parts of the image you think are corner, specular, or diffuse reflectors, etc.

2. The default linear 2% stretch is usually not the best choice for displaying RADAR images. If you pull up the *interactive stretching* dialog, you'll see a menu item called *Stretch Types*. Ignoring the last two items in that menu, which of the stretch types are best for displaying RADAR data, and why did you conclude this?

3. Now we'll investigate some spatial filtering. Try applying each of the filters under the Enhance → Filter menu in your image window. Which do you think provides the most useful result, and why?

ENVI has additional filters designed specifically to improve RADAR images by removing speckle. Try a *frost filter* (RADAR → Adaptive filters → Frost).

4. Density slicing (Overlay → Density Slice, in the image window) is assigning colors to ranges of values in a single band image. Density slice the original RADAR image, using ranges already set up for you in the file *dslice.dsr*. ***Email me the result***.

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5. Two recently published papers both use circular polarization of radar data (from the same instrument!) to determine whether polar impact craters on Earth's Moon contain H_2O ice … and they reach opposite conclusions. In your own words, (1) ***summarize the respective arguments made by Spudis et al. and by Fa and Cai***. Also, (2) ***describe the evidence from other remote sensing instruments*** for or against polar water on the Moon. (3) ***Which side of the debate do you favor***, and why?
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Thermal IR

This series of questions asks you to understand how albedo and surface temperature affect the radiance on sensor (L_{sat}) for different planetary bodies. We're going to explore an odd spectral region, "the thermal crossover region," where both reflectance and emission influence the radiance on sensor. The overall goal is to understand how albedo and surface temperature can influence the detectability of various minerals. Please turn in all ***plots***.

1. Using what you know of radiative transfer and neglecting atmosphere, compute and ***plot*** L_{sat} vs. wavelength for the Moon, Mars, and Europa. Use the parameters below and assume albedo is 0.2 and constant with wavelength. Use the provided solar spectrum (*E490_solarSpec_extended.txt*) to plot modeled L_{sat} from 0 to 50 µm. Discuss $L_{sat}(\lambda)$ and variation by planetary body.

Daytime Surface Temp.		Distance from Sun
Moon	380 K	1 A.U.
Mars	250 K	1.52 A.U.
Europa	110 K	5.2 A.U.

2. ***Make a plot*** of % of radiance on sensor that is reflected light. At approximately what wavelength is the "crossover wavelength" for each planetary surface, i.e. at what point is it the case that more radiance on sensor is from thermal emission rather than reflected sunlight?

3. Using the same model, now consider the more natural case in which the reflectance and emissivity of the surface vary as a function of wavelength. Consider the crossover region where thermal emission can start to influence the depth of absorption features.
As an example, we'll take a synthetic spectrum with absorption bands of 30% strength at 2.5µm, 3.0 µm, 3.5 µm, 4.0 µm, and 4.5 µm. These are some of the locations of major vibrational absorption features in reflectance spectra of hydrated minerals and salts (sulfates, carbonates).

Using the synthetic surface spectrum, ***make a plot*** of I/F (not radiance) vs. wavelength over the 2-5 µm wavelength range for the Moon and Mars surface cases. I have provided a file (*simSpec_30pct_extended.txt*) that has 30% absorption features at these wavelengths that you can simply scale. Compute I/F for four different albedos for the continuum: 0.05 (dark, organic-rich surface), 0.2 (typical basalt), 0.5 (ice+rock), 0.8 (ice).

What is happening to band strength and why? How does the surface temperature influence band strength? How does this change as a function of albedo? Use the back to continue your answers…

4. Finally, synthesize these findings into some comments on mineral detectability in different wavelength regions for different planetary surfaces. Consider, for example, what are the prospects for the detection of the 4.5 μm feature in sulfates on Mars?