THERMAL REMOTE SENSING

Due April 11, 2006

PART 1. GALILEO OBSERVATIONS OF IO

The Galileo spacecraft continues on an extended mission mapping the surfaces of the 4 largest satellites of Jupiter: Io, Europa, Ganymede and Callisto (termed the Galilean satellites as he was the first to record them through a telescope). Galileo carries the Solid State Imager (SSI) which measures 0.4 to 1.2 microns (an 8 position filter wheel over a 800X800 CCD) and the Near-Infrared Mapping Spectrometer (NIMS) which measures 0.7 to 5.2 microns.

Open 3bands.jpg. This is three views of a region ~1.6x10^6 km^2 (about the size of the "4 corner" states). A feature named Prometheus is located near the center of the image. Locate Prometheus on the map of Io, it lies ~0°, 150°W.

1. **What is the diameter of this feature?**

The SSI mosaic is a false-color image where red = 756 nm, green = 559 nm, and blue = 404 nm. The 2nd and 3rd images are taken with the NIMS spectrometer where the band centers are indicated below the images.

There are 4 material units visible in the SSI image, red, yellow, black and white.

2. **Sketch spectra of each of these materials from 0.4 to 5.0 microns.**

3. **Use the spectra and your knowledge of geomorphology to identify the dark (in SSI) material in the center of Prometheus.**

4. **What is the nature of the ring around Prometheus?**

5. **What is Prometheus?**

Examine overview.jpg. Note the position of Prometheus in this thermal image. The features labeled "new" were not seen by Voyager when it imaged Io in 1979.

6. **What does this tell you about the geology of Io?**

Finally (and do this last), examine plumes.jpg.

7. **What is your final conclusion about the ring around Prometheus?**
PART 2. THERMAL INFRARED MULTISPECTRAL SCANNER (TIMS)

The TIMS instrument is a multispectral scanner that is flown on high altitude jets for NASA. It has a spatial resolution of 7.6 m/pixel at 10,000 feet altitude. The channels are as follows:

- Band 1: 8.2-8.6 microns
- Band 2: 8.6-9.0
- Band 3: 9.0-9.4
- Band 4: 9.4-10.2
- Band 5: 10.2-11.2
- Band 6: 11.2-12.2

In this exercise you will examine TIMS data from Silver Lake playa. This playa lies in the Mojave desert ~ 3 km N of Baker (home of the world’s tallest thermometer, located at approximately 193, 2625 using the pixel locator). Baker is midway between LA and Las Vegas. In the class folder on condor is a directory entitled thermal → TIMS → timsbands.img, also present are 6 files of TIMS data (one per channel) as TIFF images 638X3152 pixels.

Page 4 of this lab contains spectra for some major rock-forming minerals in the thermal that may exist in Silver Lake playa.

8. **First, think about what types of rocks you expect in a playa setting. What do you expect to be on the playa and why?**

We are interested in understanding the geologic units in this area.

9. **Which bands are most useful in discerning carbonates? Silicates? Clays?**

Use this information to answer the questions.

10. **What is the composition of the bedrock here?**
11. **What is the composition of Silver Lake playa? How does this differ from the composition of the smaller playa to the north?**

Look at the rock outcrops in several places in the image.

12. **Identify a contact within the bedrock and indicate the location.**

13. **Using your observations from TIMS and any knowledge of the region, write a paragraph about the geologic history of this area beginning with the bedrock to present day. Include rock type and inferred geologic and geomorphic processes that operated through time.**
PART 3 ASTER IMAGES OF CONNECTICUT

In the Thermal folder you will find an ASTER image of Hartford. Three files are included: a Level 1B product, a Level 2 07 product and a Level 2 09 product (VNIR & SWIR).


15. Is this a daytime IR or nighttime IR image? How do you know?

16. What are typical radiance values (in W m$^{-2}$ sr$^{-1}$ m$^{-1}$) for water, forest, urban areas, fields? Tell me the location of each pixel where you made the measurement.

17. Compare VNIR and TIR images of the inside of a meander on the east side of the CT river at about 697730.86E, 4618644.23N. What accounts for the variations in radiance seen in the TIR image?

18. Develop a metric that will allow you to identify and isolate all of the hottest pixels in the scene. Describe what you did and save the final product. (Hint: interactive stretching may be useful here)

19. Develop a metric that will allow to identify and isolate all urban and paved regions of the scene (or a portion of it if you prefer). (Hint: you have all ASTER bands at your disposal! Another hint: SAM – you can import z-profiles).