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GEOG-361-502

Due 4 Apr. 2019

Lab 5 – Extracting Information from Thermal Remote Sensing Data

Question 1. What is the spectral range of thermal image etm6_1999 in terms of wavelength?

Band 6 on Landsat 7 has a spectral ranges of 10.40-12.50μm.

Question 2. How does this wavelength differ from the non-thermal bands of Landsat ETM+ in terms of the recorded radiation energy?

The highest that the other non-thermal bands go is 1.75μm, so the thermal band has a high degree of separation for collecting only thermal data vs. visible/IR/etc. data.

Question 3. Do you expect strong correlation between DN values in the thermal band and other non-thermal image bands? Why or why not? Please explain.

Looking at the figures from Table 1, I would expect bands 5 and 7 to have similar DNs to band 6, as their spectral radiance range is similar. This may be slightly less the case with band 5, but none of the other bands besides 5 and 7 are remotely near band 6's radiance range.

Question 4. What is the spatial resolution of the thermal image? Why is the spatial resolution of the thermal image much lower than that of non-thermal bands?

While the image has a resolution of 30m, this is actually after resampling as Band 6 on Landsat 7 is captured at a resolution of 60m. The lower resolution is due to the much larger amount of resources that thermal detection requires due to the larger captured wavelength and processing.

Question 5. Compare the panchromatic and thermal band images, and explain the tonal differences between the visible (panchromatic) and thermal images. What types of surface features generally have high or low emission in the thermal band (assuming surface temperatures are the same across the image)?

The thermal image has more visible variance in its values, with much brighter and darker areas than the general panchromatic image. The much lighter areas come from the many fields and agricultural developments, and the darker areas come near the rivers and lakes, indicating water saturation that cools the area.

Question 6. Determine the LMAX, LMIN, QCALMAX, QCALMIN values for the low gain representation of ETM+ band6, and construct the correct formula for converting the DN values in band 6 to the absolute radiance.

Note: All radiance measurements are W/(ster * m^2)

From the table and provided date, we can determine that we need to be using the pre-2000 Low-Gain range for band 6. By looking at the statistics for this subset, the max DN was 181 and the min. DN was 122.

LMAX: 17.04 LMIN: 0.0 QCALMAX: 181 QCALMIN: 122

Formula: Radiance (L) = ((17.04-0.0)/(181-122)) * ([DN_VALUE]-122) + 0.0

Question 7. Now apply (using band math – see below for hints) this formula to the entire image to calculate the absolute radiance for each pixel, and determine the range of radiance values for this sub image using the compute statistics function.

Radiance Range is 0.534588 to 17.040001.

Question 8. Determine average radiance values for typical pixels of water, grass, forest, buildings and roads.

Water: 3.1378 Grass: 5.1972 Forest: 5.3637 Buildings: 8.9589 Roads: 7.1937

Question 9. Write out the formula to convert the absolute radiance to temperature. Using band math apply this formula to each pixel in the image to calculate the effective at-satellite temperatures, and find out the temperature range for this sub image and also determine the temperatures for the typical pixels of water, grass, forest, buildings and roads you analyzed in Question 8.

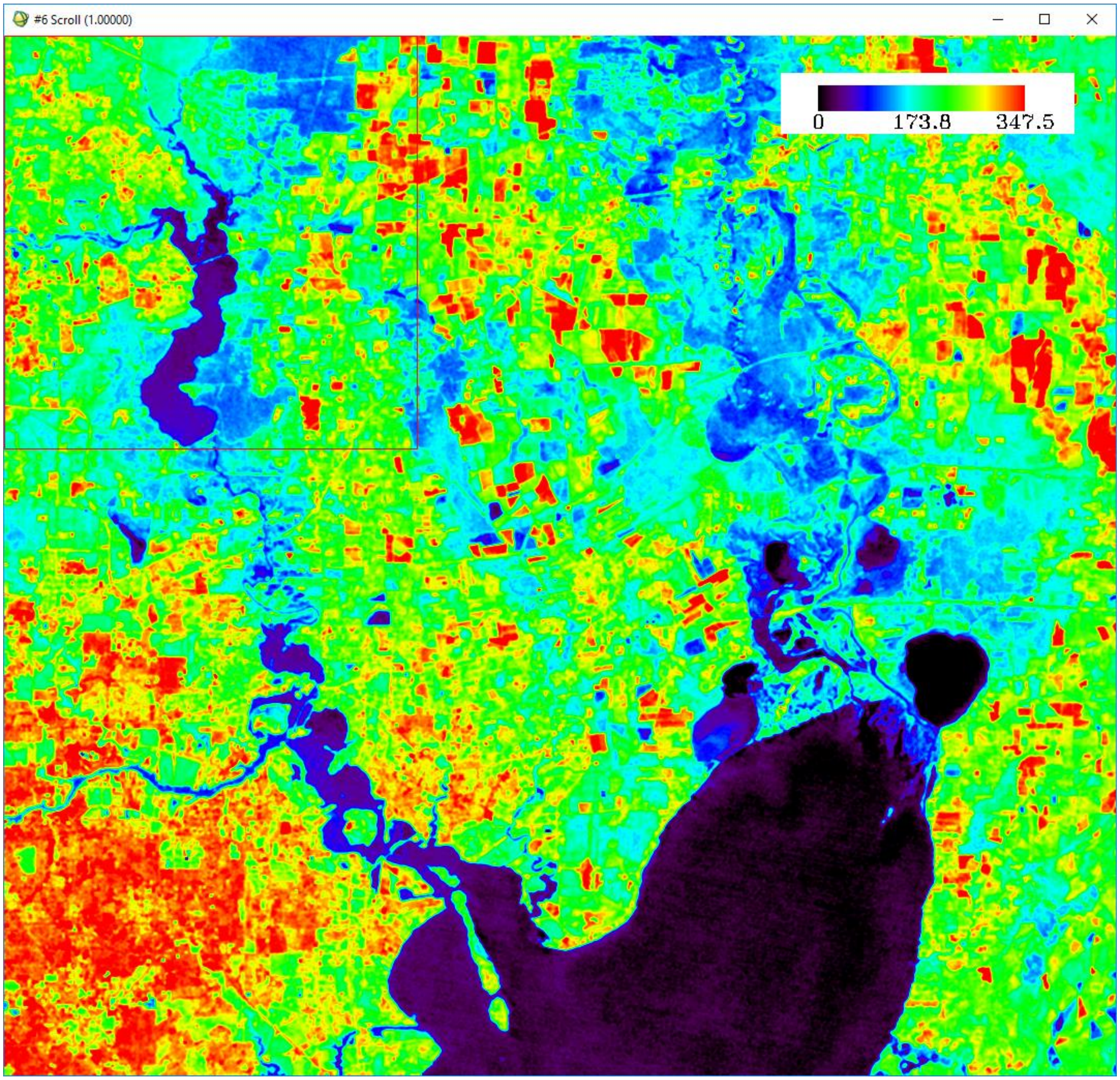
Note: All temperatures are in Kelvin

Temperature = (1282.71) / ln((666.09/[RADIANCE_VALUE]) + 1)

Temperature Range: 215.321308 to 347.512238

Water: 239.0988 Grass: 263.6901 Forest: 265.4420 Buildings: 296.5789 Roads: 282.0615

Question 10. Smooth the temperature image using a low-pass filter and display the temperature image using the pseudo-color mode and select an appropriate color table to display surface temperature. Make a hardcopy map to show the spatial distribution of the temperature.



Question 11. What features are located in the region H? Explain why the features appear bright in the nighttime thermal image.

This feature appears to be a forest. Aside from the non-building texture and apparent round treetops, trees are very visible on thermal sensors at night when the surroundings have cooled.

Question 12. Some light spots can be seen on the rooftops of buildings D and E in the thermal image. What are these features? Explain why they appear light.

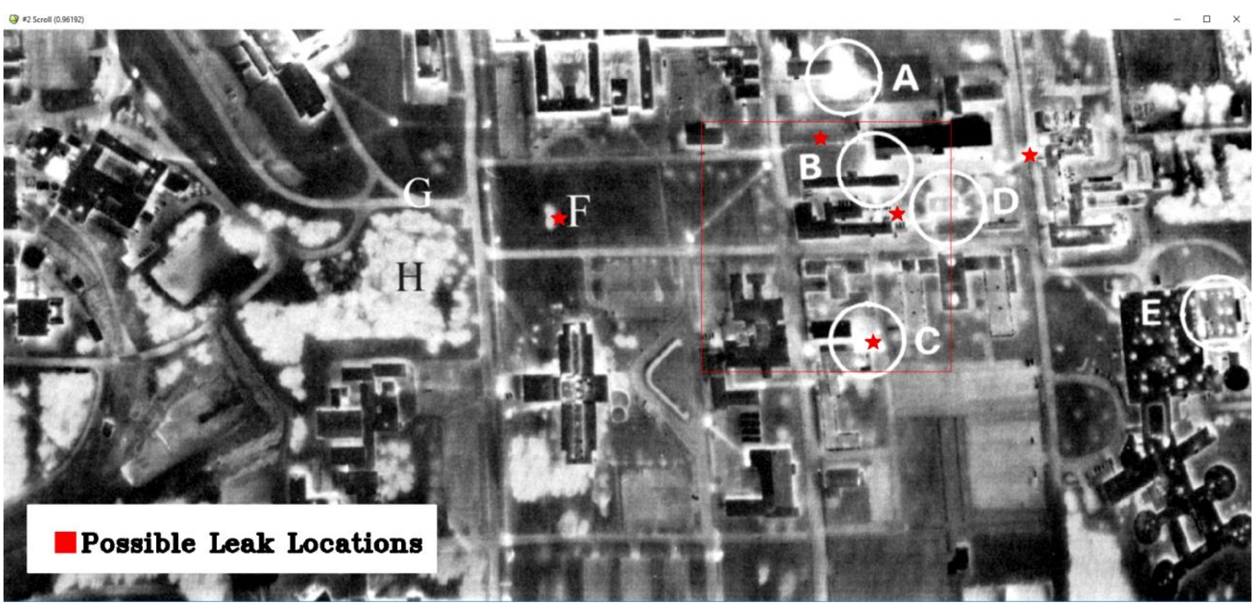
These are likely heating vents. The brightness and shape of the white spots indicates this is steam or hot air leaving the building at those points.

Question 13. What do the pavement (G) and the lawn grass look like in the thermal image?

The pavement is somewhat bright, which makes sense as pavement has a high tendency to absorb heat due to its composition. The grass is dark, as its thermal processes even as a whole are not remotely near the scale of trees, and thus do not give off a significant thermal footprint.

Question 14. The Brookhaven maintenance staff suspects that the steam lines were leaking the heat because pipe insulation had deteriorated. Visually interpret the thermal image and identify the possible locations for major leaks. Please attach a screenshot of the map and identify possible leaks using the annotation tool.

Most of the issues seem to be coming from the area around Areas A, B, and D, as the lost heat coming off is enough for the pipes to be thermally visible, when only the manholes as direct access points should only be faintly thermally visible.



Question 15. Which image is the daytime thermal image and which is the nighttime image? Explain why?

The daytime image is atlanta0.jpg. The trees are visible as dark relative to most other elements, as sunlight warms most buildings, pavements, and similar structures up much faster than trees, which are only more relatively visible during the night.

Question 16. Why do the lakes appear dark in the daytime thermal infrared image and light in the nighttime thermal infrared image?

The same principles as the trees applies, water is relatively much brighter during the night when everything else has cooled off, but is relatively cool compared to moth other pictured elements in sunlight.

Question 17. Can you observe the shadows from tall building on the daytime thermal image? Explain why the Georgia Dome (round shaped object) appears dark in both images?

Yes, the shadows are visible in the daylight image, as the reduced sunlight is enough to cause a significant temperature difference between the shadow and the surrounding area. The dome is likely dark because it is reflective and doesn't gather heat as much as many other buildings, by design or otherwise.

Question 18. Several objects appear very dark in the nighttime image while are relatively bright in the daytime image. What are these objects?

Those are buildings, which follows as most buildings are not in use and thus produce vastly less heat during the night than in the day. Roofing is also designed to reinforce that principle.