GEOG661 - Digital Image Processing **Dr. Andrew Klein**
Laboratory Exercise 1

Introduction

This lab is meant as an introduction to the regions of the electromagnetic spectrum commonly used for terrestrial remote sensing. It is designed to give you a feel for the sources and magnitudes of energy available in various regions of the electromagnetic spectrum as well as an introduction to the wavelengths and frequencies used in typical remote sensing applications.

Assignment

1. Generate two Plank curves: one for the sun (T=6000° K) and one for the earth (T=300° K). Each spectral curve should run from 0.2 to 15 ∝m with a spectral interval of 0.1 ∝m.
   I would do this using a Spreadsheet and can give you hints if you need.
2. Using Wein's Displacement Law calculate the wavelength of maximum emission for both curves (show your work).
3. Calculate the amount of solar and terrestrial radiation in the following regions of the electromagnetic spectrum and the ratio between the solar and terrestrial radiation at each wavelength.

   Before comparing numbers it is necessary to realize that only a small fraction of the energy emitted by the sun is incident upon the earth. The sun has a radius of $6.96 x 10^8$ m while the distance from the earth to the sun is $1.50 x 10^{11}$ m. Thus all the energy emitted by the sun with an area of $4\pi r(6.96 \text{ x } 10^8 \text{ m})^2$ expands to cover an area $4\pi(1.5 \text{ x } 10^{11} \text{ m})^2$ at the distance of the earth to the sun. Thus to compare the terrestrial and solar emittance values the solar values have to be adjusted by a factor of $(6.96 \text{ x } 10^8 \text{ m})^2 / (1.5 \text{ x } 10^{11} \text{ m})^2$ or $2.15 \text{ x } 10^{-5}$

   A. The visible region of the spectrum (0.5 ∝m)

   B. The thermal infrared region of the spectrum (10 ∝m)

   C. A bandpass located at 3.9 ∝m. This wavelength is employed in the GOES Imager instrument that is flown aboard NOAA's Geostationary Operational Enviornmental Satellites that provide coverage of the United States, primarily for meteorological applications.

      Now I want you to think about diurnal (day/night) changes in the energy received over a desert region that heats up during the day and cools down at night at this wavelength.

      i) Will solar or terrestrial radiation dominate during the day?

      ii) Will solar or terrestrial radiation dominate during the night?

      iii) Make a simple graph showing what you believe to be the contributions of solar and terrestrial components over the course of a day (I would like to see two curves – one for solar and one for terrestrial. While, I am not so interested in the absolute magnitudes of the incident radiation, I am interested in the relative contributions)

   D. A bandpass at 89 GHz. Also explain what wavelength this corresponds to and what region of the electromagnetic spectrum it is in.

4. List in order from highest to lowest spatial resolution, the relative pixel size you would feel would be required to obtain an equally precise measurement of the amount of energy in each of the bandpasses in (3).

5. Complete the following table. For entries with a range of wavelengths or frequencies use the number in parenthesis.

EM Region	Wavelength (λ)	Frequency (υ)
passive microwave		19 GHz
passive microwave		22 GHz
passive microwave		37 GHz
passive microwave		85 GHz
Radar - X band	2.40 - 3.75 (3 cm)	
Radar - C band	3.75 - 7.5 cm (5 cm)	
Radar - L band	15 - 30 cm (20 cm)	
Radar - P band	30 - 100 cm (50 cm)	
Thermal Infrared	8 - 14 ∝m (10 ∝m)	
Short Wave Infrared (SWIR)	1.3 - 3.0 ∝m (2.1 ∝m)	
Near Infrared (NIR)	0.7 - 1.3 ∝m (0.9 ∝m)	
Visible (VIS)	0.4 - 0.7 ∝m (0.55 ∝m)	