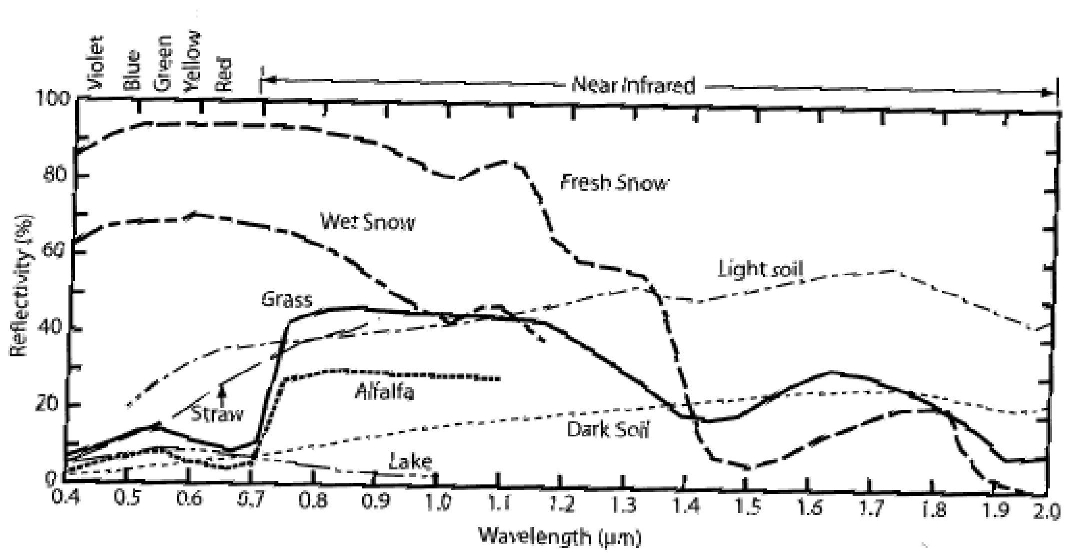
Radiative transfer in the environment. Weitzmann, fall 2008.

Problem set II:



1. (based on Petty, 2006, pr. 5.5, p.112) Above is a figure from Petty, 2006, describing the reflectivity of different surfaces. A particular satellite sensor is being designed to measure reflectivities at two wavelengths. Based on this figure, choose to wavelengths so as to optimize the ability of the satellite to discriminate different surface types (assume the atmosphere is transparent). Start by drawing $R(\lambda_1)$ as function of $R(\lambda_2)$ for different surfaces. Plot points corresponding to each surface type and label them. Try to develop a simple mathematical algorithm (e.g. a series of tests based on inequalities) that would allow you to correctly classify the surface as snow, soil, growing vegetation, dry vegetation, or water based on the observations of $R(\lambda_1)$ and $R(\lambda_2)$. You may want to consider differences in reflectivities and/or ratios and/or the value of the reflectivities in

one wavelength, as possible variable in the algorithm. Whatever criteria depict them graphically as curves separating surface types on your plot of $R(\lambda_1)$ as function of $R(\lambda_2)$. Not that in order for an algorithm to be successful the classifier should be spread enough on your plot that uncertainties in R will not compromise your scheme. There are multiple solutions to this problem - be creative!

2. (based on Petty, 2006, pr. 6.2) Sometimes Planck's function (B(T) may be expressed as function of frequency instead of wavelength (see last class for expression of $B_\lambda(T)$). Find the correct expression for $B_\nu(T)$. Hint: think about energy conservation and watch for units.

3. The simplest model of the greenhouse effect involves a slab encircling the air assumed to be in thermal equilibrium. This slab (the atmosphere) is assumed to be transparent to the sun's radiation yet absorbing to the radiation that emitted by the Earth with transmissivity τ for long wave radiation. This layer emits radiation according to its own temperature to both the Earth and outer space. a. assuming S to be the solar irradiance absorbed by the Earth's surface (its value you derived in the previous homework), and that the atmosphere behave as a blackbody, derive and expression for the Earth's temperature as function of S and τ. Using S you derived in the previous homework plot the Earth temperature as function of τ. Are they reasonable?