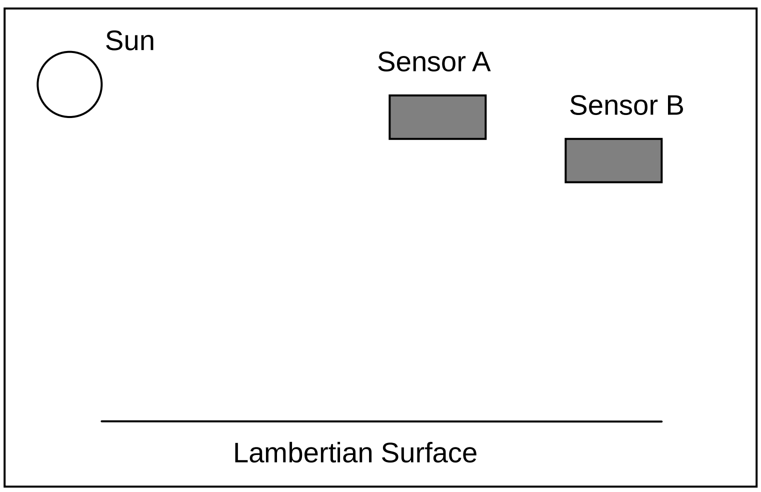
GEOG 362 Introduction to Remote Sensing
Problem Set 3, Fall 2011

1. A satellite sensor is used to investigate ground vegetation. Given the total radiance that a satellite sensor receives is $\mathbf{L}_{\mathbf{at\text{-}sensor}}$, which consists of radiance from different routes. Please describe the possible routes of radiance that reaches the sensor. (**6 points**)

   There are many possible routs of radiance being picked up by the sensor, both signal and noise. Some possible route would be reflectance and scattering caused by the atmosphere. The Ground may also send neighboring areas back up at the sensor. Lastly there is what we are interested in and that is the direct solar Radiance reflected off of the ground

2. As shown in the following picture, assume the ground is a lambertian surface, and two sensors receive radiance reflected from the ground. Please compare and answer which sensor will receive more radiant energy. (**5 points**)



Sensor B will receive less radiant energy due to the direct solor radiance having to travel through more atmosphere than it would to get to sensor A. This can be explained through Lreceived = Tv*(r(Eground)Ts*Cos(s) / pi) which models as a sensor approaches the horizon – energy declines and eventually reaches 0 once below the horizon.

3. Given total incident radiation on a surface of 100 W/m2 and the surface is known to reflect 30% of radiation and transmit 20%, then compute both the fraction and amount of the total radiation that is absorbed (HINT: start with KIRCHOFF's LAW) (**5 points**)

   p + a + T = 1 1 = .3 + a + .2 a = .5 50%*100W/m2 = 50 W/m2 absorbed
   1 - .3 - .2 = a

4. What are the units of "radiance" and explain what radiance means (**5 points**)

Radiance units are (Watts/ m2 sr) and radiance can be thought of as a single beam described as Radiant Flux per unit of solid angle in a direction per unit of projected area.

Or L = Phi/(area*omega*cos(theta)

This is what the satellite reads and uses to generate images

5. The solar top-of-atmosphere (TOA) irradiance is 1300 W/m2 and atmospheric transmission is 30% at a solar zenith angle of 45 degrees. Compute the direct-downwelling irradiance on the earth's surface. (**8 points**)

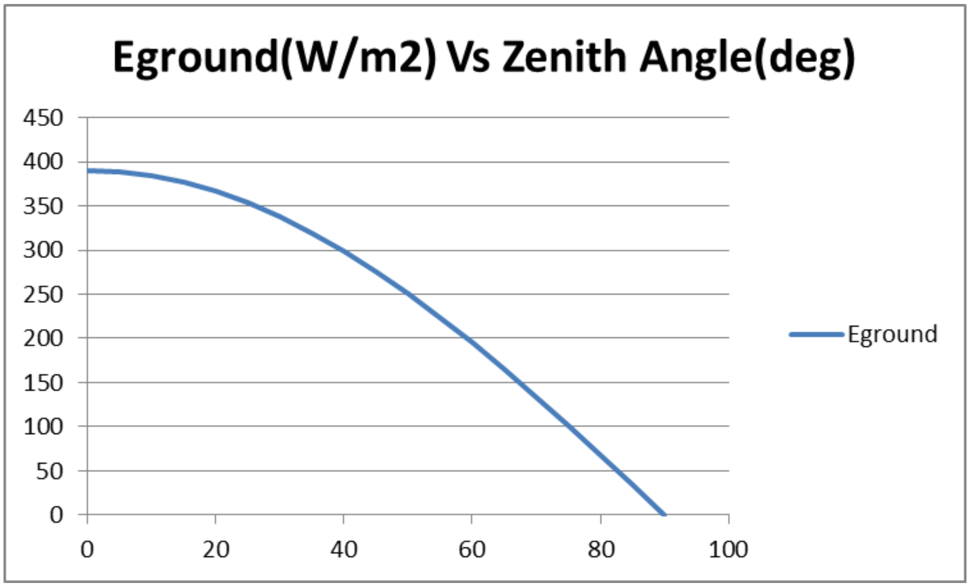
To solve for the Solar Irradiance reaching earth we use

Eground = Eatmosphere * Ts * Cos(s) + Edy

Eg = 1300 W/m2 * .3 * cos(45) = 275.772 W/m2

6. Do the same computation as you did in question 5, except change the solar zenith angle by increments of 5 degrees starting from nadir (90 degrees) to the horizon (180 degrees). Please plot this with solar zenith angle on the x-axis and computed surface direct solar irradiance on the y-axis (note: be sure to label the axis with appropriate units) (**8 points**)

Eg = 1300 W/m2 * .3 * cos(0) = 390 W/m2
Eg = 1300 W/m2 * .3 * cos(5) = 388.516 W/m2
Eg = 1300 W/m2 * .3 * cos(10) = 384.075 W/m2
Eg = 1300 W/m2 * .3 * cos(15) = 376.711 W/m2
Eg = 1300 W/m2 * .3 * cos(20) = 366.48 W/m2
Eg = 1300 W/m2 * .3 * cos(25) = 353.46 W/m2
Eg = 1300 W/m2 * .3 * cos(30) = 337.75 W/m2
Eg = 1300 W/m2 * .3 * cos(35) = 319.469 W/m2
Eg = 1300 W/m2 * .3 * cos(40) = 298.757 W/m2
Eg = 1300 W/m2 * .3 * cos(45) = 275.772 W/m2
Eg = 1300 W/m2 * .3 * cos(50) = 250.687 W/m2
Eg = 1300 W/m2 * .3 * cos(55) = 223.695 W/m2
Eg = 1300 W/m2 * .3 * cos(60) = 195 W/m2
Eg = 1300 W/m2 * .3 * cos(65) = 164.821 W/m2
Eg = 1300 W/m2 * .3 * cos(70) = 133.388 W/m2
Eg = 1300 W/m2 * .3 * cos(75) = 100.939 W/m2
Eg = 1300 W/m2 * .3 * cos(80) = 67.7228 W/m2
Eg = 1300 W/m2 * .3 * cos(85) = 33.9907 W/m2
Eg = 1300 W/m2 * .3 * cos(90) = 0 W/m2



7. READ THE ASSIGNED ARTICLE AND ANSWER THE FOLLOWING:

If large amount of sulphates are injected into the earth's atmosphere and given the TOA used in QUESTION#5 was the same. Which of the following would increase: atmospheric reflectance, absorption, or transmittance? Recompute the original atmospheric transmission provided in QUESTION#5, compensating for the impact of sulphates if they were to increase atmospheric reflectance by 10%. Once you recomputed this new atmospheric transmission, determine what the new earth surface direct solar irradiance would be assuming the same solar zenith angle as in QUESTION#5 (**10 points**)

According to the article sulfates increase the reflectance of the atmosphere without changing absorption (its ability to trap).

If the reflectance of the atmosphere were to change to 10% and the absorbtion remained the same than the Transmittance would drop 10% according to the radiation budget to 20% or .2 .

The New Eg would be = 1300 W/m2 * .2 * cos(45) = 183.848 W/m2