Phys. Met. and Radiative Transfer Assignment I

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Assigned: Aug. 23, 2017; Due: Sep. 20, 2017. Total points: [85]

1. The instantaneous solar irradiance F at the top of atmosphere can be computed as:

$$F = S_0 \times \frac{a^2}{r^2} \times cos(\theta) \quad (1)$$

where S_0 is the solar constant (1368Wm^{-2}) and θ is the solar zenith angle. $\frac{a^2}{r^2}$ is the ratio of the instantaneous Sun-Earth distance to the average Sun-Earth distance:

$$\frac{a^2}{r^2} = 1.0 + 0.034 \times cos(\frac{(day-3)}{365} \times 2\pi) \quad (2)$$

where *day* is the julidan day number. The value of θ depends on the latitude ϕ, declination angle of the sun δ (from 23.45°N on June 22 to -23.45°S on Dec 22) and the hour angle h (from 0 at local noon time to 2π in the midnight) :

$$cos(\theta) = cos(\phi)\, cos(\delta)\, cos(h) + sin(\delta)\, sin(\phi) \quad (3)$$

$$\delta = -23.45^\circ \times cos((day + 10.)/365 \times 2\pi) \quad (4)$$

$$h = \frac{2\pi}{24. \times 3600} \times (Lt - 12. \times 3600.) \quad (5)$$

where Lt is local time in seconds, e.g., $Lt = local\ hour \times 3600, local\ hour \epsilon [1, 24]$.

Note in above equations, h is unit of radiance, while δ is unit of degree.Based upon above equations, Write Python program to calculate the F at Omaha (NE, latitude 41.15°) local noon time on each day in year 2017. Plot your results (y-axis) as a function of Julian day number(x-axis). Compare you results with the downward solar irradiance measured at a location (such as , as described below) on a specific clear-sky day (say 10 September 2017), and estimate the absorptivity in the atmosphere. [50]

Note: please check the solar irradiance measured at Bellevue, Nebraska, on this website:
http://twospringswx.net/;
or you can visit
http://www.wrh.noaa.gov/mesowest/

and click any regional network, and select a station as a reference. You will be directed to the list of current weather observations in that station. From the list, you can select a particular location of your interest. After clicking on the name of that location, you will be shown meteorology data including solar data observed by that station.

3. Read chapter 2 and solve problems 2.1 (p17, 10 points), 2.8 (p32, 10 points), 2.10 (p2.10, 15 points), 2.16 (p48, 15 points). [50]

4. Read chapter 4 and solve problem 4.3 (p89). [15]

5. Read chapter 5 and solves problems 5.2 (p108, 20 points) and 5.5 (p112, 20 points). [20]