Phys. Met. and Radiative Transfer Assignment I

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Assigned: Aug. 23, 2017; Due: Sep. 6, 2017. Total points: [210]

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1. Check the following routines in the Python/Numpy online documentation and describe their usages. [24]

   (1) `np.zeros((4,3), dtype=np.uint16)`

   (2) `np.zeros((4,3), dtype=np.int64)`

   (3) `np.zeros((4,3), dtype=np.uint32)`

   (4) `np.zeros((4,3), dtype=np.uint64)`

   (5) `numpy.full((4,3), 5, dtype=np.int)`

   (6) `np.zeros((4,3), dtype=np.str)`

2. Write Python codes to calculate the value of A: [16]

   (1) $A = \frac{2^3}{5} - 7 \times 3$

   (2) $A = 2^{\frac{3}{5}} - 7 \times 3$

   (3) $A = 2^{\frac{3}{5} - 7 \times 3}$

   (4) $A = 2^{\frac{3}{5 - 7 \times 3}}$

3. Compute the value of A in the following Python expressions. [30]

   (1) `A = min(5,8,9,3)`
   (2) `A = max(min(5,8),max(7,3))`
   (3) `A = min(5, max(8, max(7,3)))`
   (4) `A = 3/5 * 3./5`
   (5) `A = 3/(5 * 3.)/5`
   (6) `A = 3/((5*3.)/5)`
   (7) `A = 3/5**2`
   (8) `A = 3/5.**2`
   (9) `A = 3/max(min(5**2,3),2.)`
   (10) `A = 3/(5.**(max(min(2,3),2.)))`

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

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

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

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

where day is the julidan day number, and θ is the solar zenight angle. Write a Python program to calculate the F on the first day of February, May, August, and November in year 2003. Plot your results as a function of θ, where $\theta \in [0, pi]$. Pay attention to both mathematical expression and the physical meaning of your results. [30]

5. Do problem 1.1 (page 5) in the textbook [40]

6. Do problem 2.11 (page 40-41) in the textbook [20]