NATS 1780 A (Fall 2020): Assignment 1 - Version 1.0, September 20, 2020

Due: October 28, 2020 by 11 pm EDT via Moodle

The assignment consists of two questions.

(Late Penalty: 10% per day - including weekends; 100% deduction after solutions are posted.)

Instructions:

- You are expected to provide answers for *every* question. You are encouraged to show all of your work so that marks can be awarded for partially correct answers.
- Although you are encouraged to collaborate with your classmates, each of you is expected to submit a separate and distinct assignment. Two or more students choosing the same date for Question 1 will be scrutinized closely for academic integrity.
- ***For Question 1, your EMOS data must be from a date since June 30, 2020. Assignments making use of data from earlier dates will be disqualified, and receive a grade of 0 marks.***
- ***For Question 2, your CO_2 data must include results from September 2020. Assignments making use of data from earlier dates will be disqualified, and receive a grade of 0 marks.***

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1. From the UV Index to irradiance to temperature, in Earth's atmosphere, relationships exist. The purpose of this question is to expose these relationships on a day of your choosing.
    a. Use the UV Index calculator here to:
        i. Estimate the maximum value of the UV Index for the day you have chosen.
        ii. Estimate the time of day when this maximum is reached.
        iii. Keep this Web page open, as you will need it again for Question 1(d).
    b. Use the EMOS archives for your chosen day to locate the corresponding irradiance versus time graph. (Note: A copy of this graph *must* be included with your submission.)
        i. Estimate the maximum value of the downwelling shortwave irradiance in W/m^2. State the time of day when this maximum is reached.
        ii. How closely in time do your answers for 1(a)(ii) and 1(b)(i) match?
        iii. Why might you expect your answers for 1(a)(ii) and 1(b)(i) to match closely in time?
        iv. Estimate the maximum value of the upwelling longwave irradiance in W/m^2. State the time of day when this maximum is reached.

v. Estimate the time of day when the value of the downwelling shortwave irradiance (in W/m^2) *is equal to* the value of the upwelling longwave irradiance (in W/m^2). State the common value of irradiance at this time of day in W/m^2.

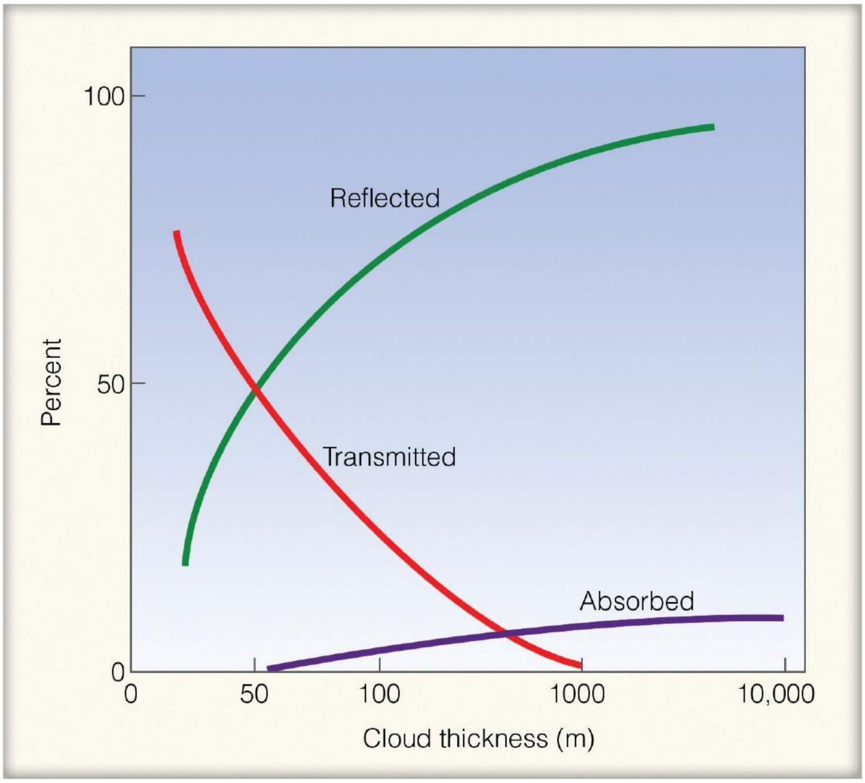
c. Use the [EMOS archives] for your chosen day to locate the corresponding temperature versus time graph. (Note: A copy of this graph *must* be included with your submission.)
   i. Estimate the maximum value of temperature in °C. State the time of day when this maximum is reached.
   ii. How closely in time do your answers for 1(b)(i) and 1(c)(i) match?
   iii. How closely in time do your answers for 1(b)(iv) and 1(c)(i) match?
   iv. How closely in time do your answers for 1(b)(v) and 1(c)(i) match?
   v. Why would you expect a closer match in 1(c)(iv) than in 1(c)(ii) or 1(c)(iii)?
   vi. In simple terms, what does this tell us about the way in which Earth's atmosphere is heated?
d. In the irradiance-versus-time data from EMOS for the day you chose, locate an event that you can assume corresponds to the passage of a cloud. (Passage of clouds typically appears as a 'negative' spike in the irradiance-versus-time data.)
   i. Estimate the reduction in downwelling shortwave irradiance as a percentage, and the time at which this event occurred.
   ii. Assuming the estimated percentage reduction is completely due to reflection of downwelling shortwave irradiance by a cloud, estimate the thickness of the intervening cloud cover. (Hint: Make use of Figure 19.3 below.)
   iii. Using the calculator (Question 1(a)), estimate the UV Index at the time the cloud passes. Capture this Web page, and submit it as a component of your assignment.

2. Obtain a copy of [CO_2] over time from here - the full record dating back to the 1960s.[1] Answer the following questions:
   a. Estimate the slope for *each* of the following three, 10-year periods using the black curve:
      i. 1965 to 1975
      ii. 1985 to 1995
      iii. 2005 to 2015
   b. Explain in words the meaning of these slopes.
   c. For *each* of the three slopes calculated:
      i. Estimate [CO_2] in ppm in 2100.
      ii. Estimate the temperature increase for 2100 implied by each of these three [CO_2] estimates via EBCM.[2]

[1] Your data ***must*** be current to May 2020.
[2] To make use of EBCM, make a copy of the spreadsheet provided. Adjust only the temperature-difference value in cell D6 to obtain the desired [CO_2] value in cell D8.

iii. Suppose that the target for 2100 is to limit global temperature rise to *less than* 2 °C.[3] Based upon your estimates above, if nothing changes, what is the likelihood that these targets will be met? Justify.

d. State the most-recent monthly average value for [CO_2] in ppm. (This value is enclosed in a green box at the top of the GML webpage.)
    i. Relative to this average value, what is the percentage increase implied by each of the three slopes for 2100?
e. Estimate the rates with which the slopes change by dividing the:
    i. 1985 to 1995 slope by the 1965 to 1975 slope
    ii. 2005 to 2015 slope by the 1985 to 1995 slope
    iii. 2005 to 2015 slope by the 1965 to 1975 slope
f. Explain in words the meaning of these rates with which slopes change.
g. Do the slopes themselves, or rates with which slopes change, provide a more compelling representation of the trends emerging from this data set? Explain.
h. If the 2025 to 2035 slope is *exactly* equal to the 2005 to 2015 slope, estimate the rate with which the 2025 to 2035 slope changed relative to the 2005 to 2015 slope. [1 mark]



● **FIGURE 19.3** The average percentage of radiation that is reflected, absorbed, and transmitted by clouds of various thicknesses.

[3] This scenario is inspired by the Paris Agreement.

****** THE END ******

