Written Homework – Module 5 Name:

1) Paleoclimate data reveal that ice ages in the Northern Hemisphere coincide with colder summers. Which orbital extremes would be most conductive in producing colder summers in the Northern Hemisphere?
   a) When obliquity is at its largest (24.5˚) or smallest value (22.1˚)?
   b) When aphelion or perihelion occurs during summer?
   c) When eccentricity is at its largest (0.058) or smallest (0.0034) value?

   Explain your answers in terms of radiative equilibrium and deviations from it. There is 600-character limit for each question.

Glacial maximum 15,000 years ago

2) Explain why periods of glacial advance in the higher latitudes of the Northern Hemisphere tend to occur with colder summers, but not necessarily with colder winters. (Hint: consider the impact of temperature on glacial melt during summer and on saturation vapor pressure during winter.)

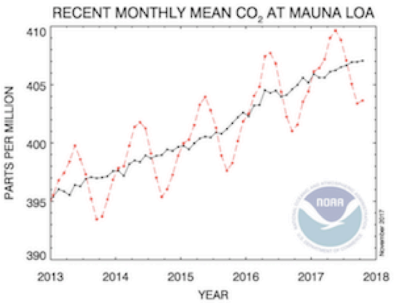
3) Describe four meteorological factors that frequently occur together during summer and early fall over the Los Angeles Basin that set the stage from a major buildup of photochemical smog, being certain to explain how each factor would contribute to a buildup. You can neglect seasonal differences in the input of primary pollutants that are the ultimate cause of photochemical smog.

Los Angeles Basin shrouded by smog.
Photo: Robert S. Donovan

4) The figure shows monthly mean CO2 levels (ppm) at the NOAA Mauna Loa laboratory over the period Jan 2013 to Nov 2017 (4 years, 10 months). The red line gives monthly values that include seasonal variations; the black curve gives the long-term trend with the seasonal cycle removed. Dots are the mean for the middle of the month. Use the graph to answer the following questions.

a) What was the average annual rate of increase in CO2 in ppm per year for the period 1 Jan 2013 to 1 Jan 2017?

b) How large is the seasonal increase in CO2 (to the nearest whole ppm) at its peak value from its value 6 months earlier? How large is the seasonal decrease from its value 6 months earlier? Your answers must be consistent with your answer in part a).



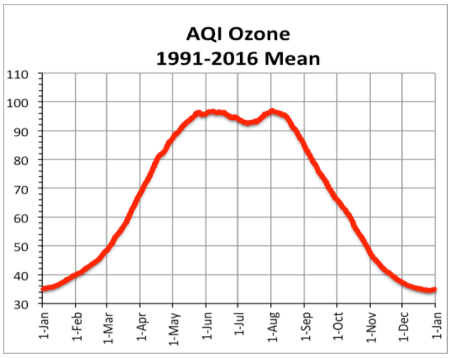
CO2 levels at the top of Mauna Loa HI.
Units are in parts per million (ppm).
Click link to get most recent graph.

c) In which month is the average CO2 concentration the highest? In which month is it the lowest?

d) What is the primary cause for a seasonal cycle of CO2? Explain. (Hint: Fig. 1.18 of Ahrens.)

5) The graph to the right shows the daily average value of the Air Quality Index (AQI) for ozone in Phoenix, Arizona. Describe the two primary meteorological reasons why ozone levels are higher during the four calendar months (May-June-July-August) than the four months (Nov-Dec-Jan-Feb), being certain to explain how each factor contributes to the buildup. You can neglect seasonal differences in the input of primary pollutants that are the ultimate cause of photochemical smog.

What is the meteorological reason for the dip in AQI in July?



Air Quality Index (AQI) for ozone at Phoenix, Arizona. Data are from the Environmental Protection Agency.