Homework 1: assigned: Tues, Mar 28                    due: Mon, Apr 10

Readings:
Earth System intro: KKC Chap 1 (all)
Nature of Science: Popper article "Knowledge without authority"
Stratospheric Ozone Depletion: KKC Chap 17 (all)

NOTE: Choose any eight problems (80 points possible). For extra credit, try all 10; you will get extra credit for your two lowest-scoring problems (up to 20 extra credit points).

1. **Weather vs climate:**
   (a) Distinguish “a change in weather” from “a change in climate” [4 pts]  
   (b) Which type of change is harder to detect and why? [3 pts]  
   (c) List three observable properties that are involved in both "weather" and "climate". [3 pts]

2. **Long-term climate:** 
   Earth’s climate is largely determined by the amount of solar energy impinging upon the planet. 
   (a) By how much has solar luminosity changed during the past 4.6 billion years of Earth’s history? [4 pts]  
   (b) Explain in two or three sentences the "faint young Sun paradox." [6 pts]

3. **Evidence of global warming:**
   (a) How far back in time (approximately) do direct measurements of the Earth’s surface temperature extend? [2 pts]  
   (b) Give two reasons why it is difficult to use these data to determine the long-term temperature trend for the globe? [8 pts]

4. **Climate forcings:**
   (a) It is thought that emissions from coal-burning create two types of climate forcing that act in opposite directions. Explain. [6 pts]  
   (b) If all coal-burning were to stop, approximately how long would it take for each of these climate forcings to go away? [4 pts]

5. **The nature of scientific knowledge:** 
   In regard to some assertion of knowledge, Popper considers the questions, "How do you know? What are the sources of your assertion?" and concludes that these are bad questions - that is, they do not help us to understand the nature of what we know and they do not point toward a sensible program for improving our knowledge. If forced to answer, he would say, "I do not know. My assertion was merely a guess."  
   (a) What does Popper propose as a better, more useful question? [2 pts]  
   (b) Explain how this question relates to Popper's philosophy of critical rationalism. [8 pts]

6. **Definitions from text and lectures:** 
   Define the following terms in the context of this course: “fossil fuels”, “climate forcing”, "GAAST", “catalyst”, "dynamic equilibrium" [2 pts each]

7. **Stratospheric ozone:**
   (a) Write the ozone photolysis reaction - the main process that shields the Earth's surface from harmful UVB radiation. [2 pts]  
   (b) Give two reasons why the flux of UVB radiation to the surface (and thus the danger of sunburn) is higher
in the tropics than it is at high latitudes. [4 pts] (c) What is the relationship between polar stratospheric clouds and heterogeneous reactions? [4 pts]

8. **Ozone hole**: (a) Write down the two reactions that represent catalytic ozone destruction in the stratosphere due to chlorine. Then add these two reactions together to calculate the net reaction. [4 pts] (b) Explain how this illustrates the behavior of a catalyst. [6 pts]

9. **Nature of scientific knowledge**: Even if we accept Popper's claim that "There is no criterion of truth at our disposal", we still know that some assertions are more reliable than others. Consider the assertion that human activity has caused global warming. Using Popper's philosophy of critical rationalism, explain how this assertion could become more reliable over time, as a result of scientific research. (Hint: Popper does not directly provide a theory for knowledge becoming "more reliable". Your answer requires extrapolation from the ideas expressed in Popper's essay.) [10 pts]

10. Chap 17, Critical-Thinking Problems: 1a, b [4 pts], 2a, b [6 pts]