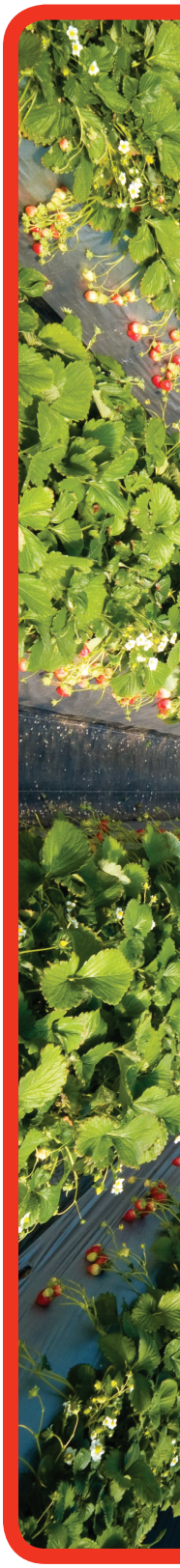


Guiding questions to be addressed in your report:

(a) What does it mean that the atmosphere is already saturated with respect to LW absorption at the CO_2 absorption bands? Why is temperature still increasing in response to CO_2 increase?

(b) What is the radiative forcing of CO_2, and how is it calculated?

(c) Should we worry about CO_2 increase given that H_2O is a much more powerful greenhouse gas?

(d) What are the sources of uncertainty in a calculation of radiative response to CO_2 increase by year 2100?

(e) How is the temperature expected to increase as the CO_2 doubles once? Twice?

(f) How do we quantify the effects of other greenhouse gases, and how would you use that to set a policy regarding the use of coal versus natural gas?

Guiding questions to be addressed in your report:

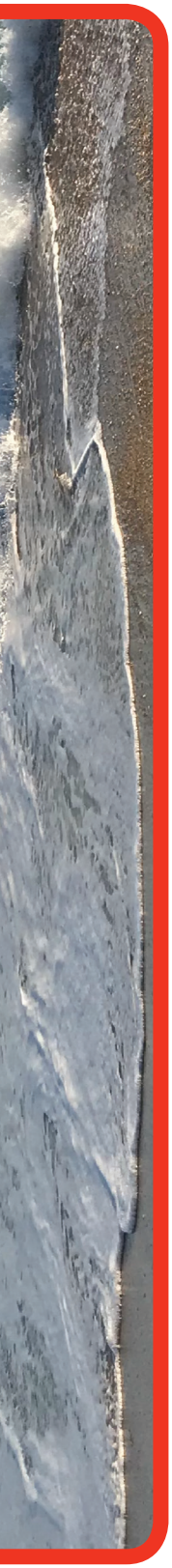
(a) Describe the extent of surface warming so far, and its distribution as a function of latitude, for land versus ocean and for winter versus summer.

(b) Explain the latitudinal dependence; what are the implications for high-latitude countries? For Greenland melting and thus for other regions?

(c) Explain how future warming is evaluated from present-day data in addition to the use of climate models.

(d) If a doubling of CO_2 from 280 to 560 ppm leads to a, say, 3 K warming, what warming do you expect at an equivalent CO_2 mixing ratio of 450 ppm? Explain why the warming by 2020 was only about 1.1 K.

(e) Should we be concerned about global warming given that it is said to have stopped recently for 15 yr? Will it stop again?



Guiding questions to be addressed in your report:

(a) How and why is sea level changing along the Atlantic coast of the United States?

(b) How is past GMSL rise calculated, and what are the uncertainties (touch on spatial patterns and observational coverage of ocean warming now versus two hundred years ago, wind changes, isostatic response to glacial melting, coastal erosion, gravitational fingerprint effects, and so on).

(c) What is the projected GMSL rise by year 2100 based on RCP8.5?List the main processes responsible for the expected rise, quan-tify the contribution of each process, and describe the sources of uncertainty in each.

(d) Discuss the possible effect of anthropogenic global warming on storm surges and GMSL rise, and their interaction in specific regional sea level rise events.

(e) Discuss the expected effect of the projected GMSL rise by 2100 on New York City and Bangladesh. What are your recommendations in each case?

Guiding questions to be addressed in your report:

(a) What is ocean acidification, and why is it an important concern?

(b) What is the current state of ocean acidification relative to 1850, and what is expected by the year 2100 in a business-as-usual scenario?

(c) What is the ocean carbonate system?

(d) How and why does the concentration of the carbonate ion CO_3^{2-} affect the dissolution of calcium carbonate?

(e) Based on the approximate solution to the carbonate system, how does the addition of CO_2 to the atmosphere change the dissolved CO_2, the bicarbonate ion, the carbonate ion, and thus calcium carbonate dissolution? Discuss the buffer effect.

(f) What are the economic consequences of ocean acidification? (Research this beyond what was presented in class.)

(g) What are the implications of ocean acidification for the utility of solar geoengineering?

Guiding questions to be addressed in your report:

(a) What is the AMOC, and why is it important?

(b) What controls its strength? Why might it change in a future climate? What are the implications of such a change?

(c) Discuss climate tipping points and explain why the AMOC may be an example.

(d) What are the consequences of such climate tipping points, in general, in terms of restoring climate to its preindustrial state once CO_2 is reduced back to preindustrial levels?

(e) What are the consequences of climate tipping points in terms of our ability to predict the occurrence of abrupt climate change and in terms of our ability to gradually adjust to changes?

Guiding questions to be addressed in your report:

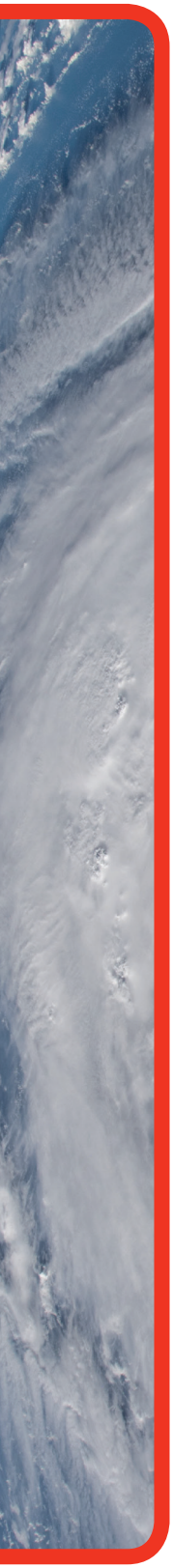
(a) Why are clouds important in the current climate? Why are they important in the context of global warming?

(b) How do clouds form and dissipate, and what are the uncertainty sources in representing them in climate models?

(c) What are the mechanisms by which clouds can play a role in affecting the response to increased concentration of CO_2?

(d) What are the uncertainty sources in identifying and quantifying each of the mechanisms by which clouds affect the response to increased CO_2?

(e) Should we not worry about global warming because of the large uncertainty due to clouds?



Guiding questions to be addressed in your report:

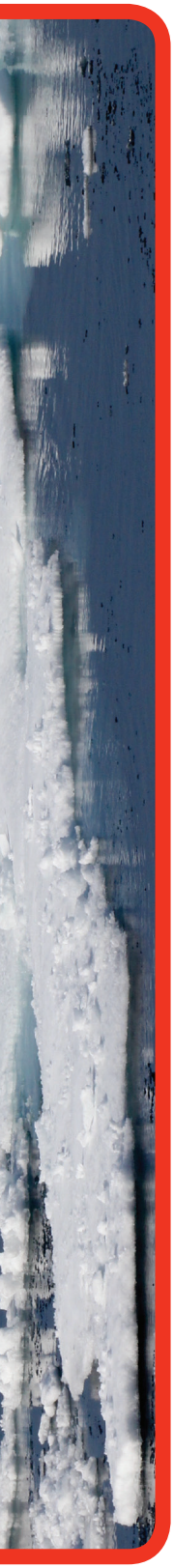
(a) Have hurricanes (as quantified by the PDI, number of hurricanes per year, and the fraction of major hurricane winds) already been getting stronger?

(b) What are the factors affecting hurricane strength?

(c) How can the maximum possible (potential) hurricane strength be estimated from the SST? Why is it only a *potential* maximum?

(d) Will hurricanes get stronger in an RCP8.5-like global warming scenario? If so, by how much? (Consider both hurricane wind velocity and destructiveness.)

(e) What are the sources of uncertainty?



Guiding questions to be addressed in your report:

(a) Describe the changes in Arctic sea ice over the past decades.

(b) Why is the Arctic sea ice cover important?

(c) Why do these changes happen? Discuss all the positive and negative feedback mechanisms you can list and their possible roles in the observed changes.

(d) Can a climate change be detected? Can the observed trend be attributed to anthropogenic global warming? Explain the difference between detection and attribution in this case.

(e) What are sources of uncertainty in ACC detection? In the attribution to greenhouse forcing?

Guiding questions to be addressed in your report:

(a) What are the climate and socioeconomic effects of a possible Greenland ice sheet melt in a warmer future climate?

(b) List, explain and compare different processes that may lead to future changes to the ice sheets in Greenland and Antarctica.

(c) Discuss processes that may lead to a *rapid* ice sheet collapse/retreat.

(d) Discuss factors that may make this retreat irreversible on a timescale of hundreds and possibly thousands of years. Which portions of which ice sheets may be affected?

(e) Suggest what elements of Greenland and Antarctica should be monitored to identify early warning signals.

Guiding questions to be addressed in your report:

(a) Why are mountain glaciers important?

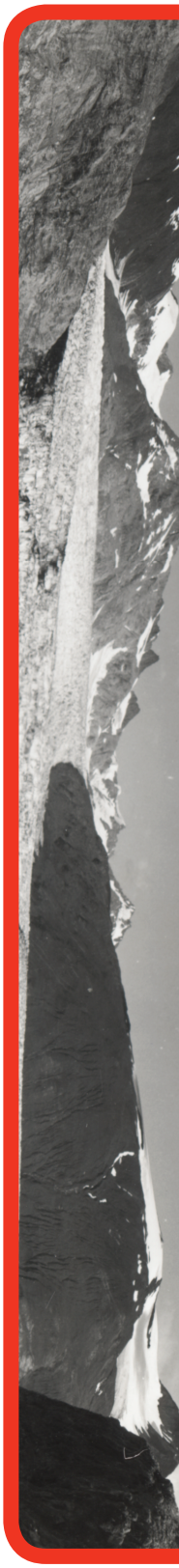
(b) How did they change over the past 200 yr?

(c) What are possible reasons for changes seen in mountain glaciers over different periods during the past 200 yr?

(d) What are the timescales of observed and expected changes?

(e) Investigate and discuss projections for the next 20, 50, and 100 yr for different glaciated mountain regions at both low and high latitudes, not including Greenland and Antarctica.

(f) Discuss the socioeconomic consequences of the projected further retreat of mountain glaciers, focusing on a couple of key regions as examples.



Guiding questions to be addressed in your report:

(a) Why are droughts important to understand and predict?

(b) Why and how can they change due to natural climate variability?Due to anthropogenic climate change?

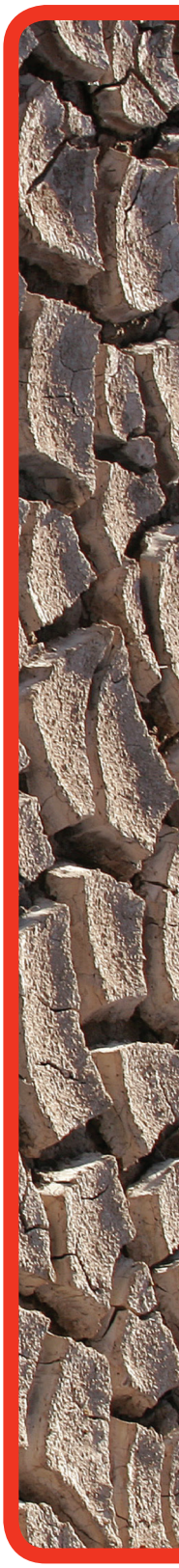
(c) How does a deficit in precipitation affect soil moisture? What are the roles of the duration and magnitude of such a deficit?

(d) How and based on what data can we determine if a given drought may be attributable to anthropogenic climate change? What are the uncertainties in such a determination?

(e) Discuss projected drought conditions for the Southwest United States and for the Sahel and their expected socioeconomic consequences.

(f) What can we say about the projection of global-scale precipitation changes in a warmer climate? What about regional changes?

(g) What are extreme precipitation events, why are they expected to increase, and what are some socioeconomic consequences?



Guiding questions to be addressed in your report:

(a) Why do heat waves occur in the present climate?

(b) What are the different factors playing a role in their mechanism?

(c) How is the character of these events expected to change in a warmer future climate? Why?

(d) What are the implications for human health, agriculture, other activities? In your answer, consider separately regions that are currently classified as having temperate climates versus regions that are currently deserts or semi-arid climates, according to the *Köppen climate classification*.

(e) Given that heat waves are defined to be extreme and therefore rare events, what are the expected difficulties in attributing individual such events to anthropogenic climate change? Why is it still easier to attribute heat waves to ACC than drought events?

Guiding questions to be addressed in your report:

(a) Describe trends in burnt forest area in the western United States and Canada for the past decades.

(b) Discuss all *non-climate*-related anthropogenic influences on forest fires and anthropogenic factors that affect fire damage.

(c) Explain the different ways warming and increases and decreases in precipitation rates may lead to changes in fire trends.

(d) Discuss the uncertainty sources involved in making future projections of fires on regional and global scales; discuss two specific regions as examples.

(e) Recommend action apart from an effort to reduce greenhouse emissions.