

AOS/IES 171 - Prof. Hitchman

Study Guide for 2nd Mid-Term

The format will be short answer, fill in the blank, matching, and multiple choice. The material will be based on lectures since the first mid-term.

1. Climate dynamics

What is equilibrium?

What is a perturbation?

What is a stable system?

What is an unstable system?

What is a negative feedback? Give an example.

What is a positive feedback?

How does the ice-albedo feedback work?

What is the boreal forest feedback?

How does the greenhouse feedback work?

What is the idea of multiple equilibria?

What is the butterfly effect?

Briefly contrast Chaos theory and determinism.

2. Proxies of past temperatures

What is an isotope?

What is deuterium?

What are ^{16}O and ^{18}O and how are they useful?

Why is H_2^{18}O enhanced relative to H_2^{16}O in deep ocean sediments when the surface waters are colder?

3. Paleoclimate When were the following:

Eemian Interglacial, Wisconsin Glacial Maximum, Bolling/Allerod Warm Period, Younger Dryas event, Holocene maximum, Medieval Warm Epoch, and the Little Ice Age?

What are the three Milankovich orbital parameters?

How could a weak axial tilt favor growth of continental ice sheets?

How long might it take to build an ice sheet 1000 m thick?

When might we expect to have our next glacial period?

What might have caused the Younger Dryas period?

What might have caused the Little Ice Age?

What are Millennial variations?

How did they differ during the last ice age and during the Holocene?

What might cause these variations?

4. The last 100 years and the next 100 years.

How much has average global surface temperature increased over the last century (in K and F)?

What are some changes that have already occurred associated with this warming?

What did Svante Arrhenius predict around 1900?

What is the current flux of anthropogenic carbon into the atmosphere?

Most climate forecast models predict a surface warming of 3-6 K by the year 2100. What are some likely consequences of this?

5. Clouds and global warming.

What would an increase in high clouds do to the average temperature?

What would an increase in low clouds do?

6. Global warming.

Would you expect greater temperature changes at low or high latitudes?

What two main factors would contribute toward a rise in sea level?

What aspect of Antarctica might actually contribute to a drop in sea level?

What aspect of Antarctica might lead to a rise in sea level?

7. Volcanic eruptions.

What gas in large volcanic eruptions leads to the stratospheric aerosol layer?

What is this aerosol layer made of?

How can these aerosols affect stratospheric ozone?

In which directions does the Brewer-Dobson circulation transport the aerosol and ozone?

After a major volcanic eruption, how long and by how much will the planet's temperature be affected?

8. Stratospheric ozone.

What ingredients are needed to make stratospheric ozone?

Ozone protects life by absorbing ultraviolet radiation.

What is another primary result of absorbing uv?

Why does column ozone tend to be largest at higher latitudes?

Why is there usually less ozone over the south pole than over the north pole?

What reaction creates ozone?

What are HO_x, NO_x, ClO_x, and BrO_x?

What are the primary surface source gases that supply these families in the stratosphere?

What is a catalytic destruction cycle?

What is the observed trend in ozone outside of the polar regions over the past two decades?

What probably caused it?

What do scientists think will happen to stratospheric ozone over the next 50 years?

9. Ozone hole.

Where and when do little crystals form in the stratosphere?

What are the resulting clouds called?

What do they do to chlorine species?

What happens when the sun comes up in the springtime?

How did the eruption of Mt. Pinatubo in July 1991 lead to one of the biggest ozone holes ever?

10. Burning fossil fuels.

Where does the N and S come from that make NO_x and SO_x during burning?

What is the “tropospheric cleanser” that converts these to nitric and sulfuric acid?

List three effects of sulfuric acid in the troposphere.

What does an increase in CO_2 do to the daily average temperature?

What does an increase in CO_2 do to the diurnal range in temperature?

What does an increase in sulfate aerosol do to the daily average temperature?

What does an increase in sulfate aerosol do to the diurnal range in temperature?

11. Acid rain.

What are the pHs of pure water, natural rain water, and “acid rain”?

What is the range of pH that freshwater fish and amphibians can tolerate?

What kind of bedrock makes ecosystems less sensitive to acid rain?

How can ancient glaciers affect the sensitivity to acid rain?

What can be used to buffer a lake?

What are mycorrhizae?

How do acid rain and ozone act together to damage forests?

12. Tropospheric ozone.

Compare the relative amounts of ozone in the troposphere and stratosphere.

Why is tropospheric ozone a problem?

Why is there a diurnal cycle in ozone concentration in big cities in the summertime?

What causes high ozone concentrations over the South Atlantic ocean in September?

13. Coral bleaching.

What is the temperature range for healthy coral growth?

What are zooxanthellae and how do they help coral?

What is coral bleaching and what can cause it?

14. Life as climate stabilizer.

What is Daisy World and what are its competitive and cooperative aspects?

How might phytoplankton regulate the amount of tropical clouds?

What is the Gaia hypothesis?

15. Geophysical budgets.

What are a reservoir, source, sink, and flux?

What leads to a trend?

What might make it difficult to diagnose a trend?

What are some of the ways that we are reducing the complexity of the ecosystem?

How might this affect the stability of the system?

16. Carbon budget.

List a unit commonly used to describe the global carbon budget.

What is the current reservoir of atmospheric carbon and its current rate of increase?

How big are the fossil fuel, land biosphere, and ocean carbon reservoirs?

What are the main natural sources and sinks for atmospheric CO₂?

What are the main anthropogenic sources of atmospheric CO₂?

What is the “missing sink” problem and where might it be?

What are some of the uncertainties in the carbon budget?

What is the “biological pump”?

What is the residence time of carbon dioxide in the deep ocean?

In the IPCC scenarios, what is the range of CO₂ concentration expected in the year 2100?

How much methane is stored in the high latitude continental shelf relative to the known fossil fuel supply?

What will happen to the ability of the ocean to take up CO₂ as surface temperatures rise?

17. Vegetation and climate.

List 5 of the major plant biomes.

What main factors influence the ability of plants to grow?

What is a cold-adapted plant?

What is a growing degree day?

How is this related to latitudinal extent of a plant species?

What processes might help or hinder plant migration when climate changes?

What are the effects of deforestation in the Amazon on temperature, evaporation, and precipitation?

18. Boreal forest.

What is the boreal forest and what is the primary species in it?

What is “CO₂ fertilization”?

Why is the rate of plant migration important to global change?

How long does it take a spruce tree to mature?

What would likely happen to atmospheric carbon dioxide concentrations from warming high latitude soils?

19. Diversity.

What is germ plasm?

Who was Nikolai Vavilov?

Why would we care about maintaining seed banks?

20. Water cycle.

About how much rain falls over the globe each year?

How long does a water vapor molecule typically reside in the atmosphere?

How far will it typically travel?

Over continents, rainfall exceeds evaporation. What maintains an equilibrium?

What might happen to continental rainfall if plant cover were reduced?

What might happen if a river were diverted?

21. Desertification.

What is the ITCZ?

What is the Sahel?

How could overgrazing lead to an expansion of the Saharan desert?

22. Human water use.

In the U.S., how much water does each of us use each year?

What is most of it used for?

How many food calories does the average person need?

How much heat do we emit?

How much land is required to grow a year's worth of food for a vegetarian, compared to a person who gets most of their calories from meat?

How much agricultural land per person is available on earth right now?

What is net primary productivity?

About what percentage of the earth's net primary productivity is used by humans?

Given "business as usual", how many more people could the earth support?

***23. Energy.**

Where are most of the world's oil and gas reserves?

By what factor does the per capita emission of CO₂ in the US exceed that of the average person in the world?

What kinds of "hidden costs" might there be associated with low U.S. gas prices?

What problems are there with nuclear power?

What are a few alternative energy sources besides fossil fuels?

What is the most promising energy pathway that we can develop which can save us lots of money and greatly alleviate the threats of pollution and global warming?

What is the Kyoto Protocol and what is the current United States policy regarding global warming?

***24. Climate forecast models.**

What conservation laws are used?

What is the relationship between grid spacing and parameterization?

Give two examples of fluxes between parts of the earth system that need to be accurately represented.

What is an ensemble forecast?

How accurately do climate models represent the current distribution and type of clouds?

How accurate are their surface temperatures?

How accurately is tropical convection represented?

How accurately is deep water formation represented?

What happens to tropical rainfall and temperatures if the tropical rainforest is cut down?

What happens to atmospheric CO₂ trends if NABW formation is turned off. What happens to global temperature?