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Climate Change Outline from AP Environmental ScienceCourse
Taught by Eugene S. Vann at the Head-Royce School
Text Used: Withgott and Brennan, 2nd Ed., TheEnvironment.

Homework Assignment #1

Read 505-511
Understand the following:
1. What climate is, and how it differs from weather.
2. What global climate change and global warming are.
3. What three factors influence earth's climate the most.How these 3 factors play a role as illustrated in Figure 18.1.
4. Which greenhouse gases absorb and emit the most energy,and why CO2 is still the GHG of greatest concern.
5. Why water vapor, which is the most abundant greenhousegas, is not so much of a concern.
6. What aerosols are, how they impact climate change, andwhat sorts of natural events release them.
7. What radiative forcings and albedo are.
8. What the three types of Milankovitch cycles are (seeFigure 18.5), and how they can impact climate.
9. How CO2 absoprtion affects climate, and why it cannot beseen as a solution to removing CO2 from the atmosphere.
10. How the ENSO works (during normal and El Ninoconditions), and how it impacts climate on either side of the Pacific.
11. Know what thermohaline circulation is refering to (thinkthermo and haline), how it impacts climate, and the concern over the melting ofthe Greenland's ice sheet.

Class, Day 1

Discuss HW, HW Quiz (not everyday, but always a possibility)

Video clip from "What's Up With the Weather?" – showing theimpact of a greenhouse gas (CO2) on heat emitted from a person

Milankovitch Cycles **Animation**(100K - circ-ellip, 40K - 22-25 deg, 25K - wobble)
ENSO **Animation**
NOAA ENSO **Animations**
Thermohaline Circulation **Image**

Solar radiation and the different fates of electromagneticenergy
Emission, transmission, reflection, absorption,(re-emission)

Dynamic Equilibrium and its relation to Earth's Energy Budget

Dynamic Equilibrium Bottle Demo (from LHS GSS curriculum)
Explain what the following elements/actions from the bottledemo represent in the Earth system.
a) the flow of water from the faucet

b) the water that escapes through the holes in the bottle
c) the volume of water held in the bottle
d) a low flow of water in the bottle versus a high flow(think seasons)
e) stopping up some of the holes with your finger, and thechange that occurs afterwards

Electromagnetic Spectrum **Image**
Black Body Radiation fromthe Sun and Earth - **Image**
Radiation transmitted by theatmosphere - **Image**
Radiation (in and out) andabsorption by CO2, O2+O3, Total - **Image**

Resources:
PG Chapter on Earth'sClimate - **Site**
FAQs Answered by the IPCCabout Climate Chage - **Site**
Earth's Energy Budget **Animation**
Earth's Radiant EnergyBalance **Site**

Homework Assignment #2

Read Earth, Mars, and Venus Compared from George Philander's"Is the Temperature Rising?" Chapter AND
Understand the following:
1. What the continuous curve in Figure 3.1 shows.
2. Why the concept of equilibrium is significant in determininghow much heat the earth radiates.
3. What the open circles in Figure 3.1 represent, and whythey are below the continuous curve.
4. What the black dots (or solid circles) in Figure 3.1represent, and why they are above the continuous curve.
5. What the length of the dotted lines between the open andclosed circles in Figure 3.1 represent.
6. The significance of Earth's atmosphere in maintaining astable 15 degrees Celsius.
7. What percent of Earth's atmosphere is CO2, and how manyppm that is.

Class, Day 2

Discuss HW, HW Quiz?

Introduce Heat-Trappers Lab (modified from LHS GSScurriculum)
Show box with 1) reflective exterior, 2) absorptiveexterior, 3) transparency with reflective interior, 4) transparency withabsorptive interior
Review the different fates of electromagnetic energy in thecontext of the Heat-Trappers Lab

Work Heat-Trappers Pre-Lab
Answer the following:
1. Draw one set of temperature vs time axes (make itlarge!), and title it Heat Trapper Prediction.
2. Then, on the same set of axes, predict what sort of datayou expect to see from a) the closed box with an absorptive exterior, b) theclosed box with a reflective exterior, c) the box with 1 transparency and anabsorptive interior, and d) the box with 1 transparency and a reflectiveinterior.
3. Then explain why you expect to see the results that youpredicted in #2 (this should include comparisons between a) and b), c) and d),and closed (a and b) vs boxes with transparencies (c and d). Think about theconcepts we have learned regarding earth's energy budget (absorption,reflection,

emission, dynamic equilibrium, greenhouse gases, etc).

Homework Assignment #3

Complete Heat-Trappers Pre-Lab from class

Class, Day 3

Heat-Trappers Lab
Discuss predictions
Add two other conditions (5) box with no transparency, and6) box with transparency with brown interior)

Procedure
1. place cardboard cover securely on thermometer bulb
2. seal the box with masking tape,
3. start the clock to record the t=0 reading, and record thetemperature every minute for the next 25 minutes (5 indoors, and then 20 in thesunlight)
4. avoid direct sunlight hitting the bulb when experiment isoccurring, and keep all boxes consistent in orientation.)
5. enter data into Excel when done

Make some general observations about the results
Do the results match with your predictions?

Begin work on lab write-up (see Homework below)

Homework Assignment #4

Format for Write-Up: (the first 3 items are from thepre-lab)
1. Title
2. Predictions (graphs)
3. Explanations for predictions
4. Labeled Diagram
5. Conditions (independent variables) for whole class
6. Data table (your group's)
7. Copy of class data
8. Graph of class data
9. Answers to analysis questions (see below)

Analysis Questions (to be handed in before the end of class)
1. How did your predictions (for the 4 boxes) compare to theresults? If there was a difference, what did you not consider when making youroriginal prediction?
2. Were there any results that seem so unusual that youcannot account for why they did not match what you predicted? If so, which oneswere they, and why do you find them so unusual? Explain.
3. Consider the box as a system, and that energy enters andleaves the box system.
a) Why did the temperature not change in the first 5minutes?
b) Why did the temperature change once it was taken outside?

c) Why did the temperature eventually stabilize again?
d) How well did this compare to the shape of your predictedgraph?
e) What would have happened if we had taken it back insideand monitored the temperature for another 20 minutes? Why?
4. Identify a scenario on Earth (or another planet) thateach of these boxes model (with the exception of the reflective exterior andthe absorptive exterior), and explain why they do so.

Class, Day 4

Discuss HW, HW Quiz?
(We had a no class for a faculty work day)

Homework Assignment #5

Read 512-520 (Stop at Melting ice and snow...)
Understand the following:
1. What proxy indicators are, why we must rely on them whenwe study climate change, and examples of them. (NOAA Paleoclimatology Site)
2. Why the EPICA ice team was interested in measuring theratio of deuterium isotopes to normal hydrogen in the ice cores
3. What the air bubbles in the ice cores revealed. Note thehighest concentration that was recorded in the core. Compare that to thecurrent concentration in the atmosphere.
4. What the EPICA scientists still trying to find anexplanation for from the data they collected.
5. What information the Keeling curve shows.
6. What climate models do, and what Figures 18.11a, b, and cshow.
7. What the IPCC's Fourth Assessment Report included in it.What do the footnotes correspond to in Figure 18.12.
8. Note the major predictions made about earth's climate bythe IPCC from pages 518-520.

Class, Day 5

Discuss HW, HW Quiz?

Proxy indicators, and what can we infer from the deuteriumand oxygen levels on page 515
EPICA Glaciology project
WAIS Ice Core **Site**
Isotope analysis (2H(deuterium), and 18O) - Temperature proxy
CO2 bubbles

Explain the features of theKeeling curve to a classmate
Direct measurement - MaunaLoa CO2 Measurement **Site**
Keeling curve
(how do present dayconcentrations compare to the historical record?)

A Carbon Tide - **Interactive**

Homework Assignment #6

Read 520-529
Understand the following:
1. Evidence that ice and snow are melting, and the concernswith that.
2. What findings about melting ice was absent from theIPCC's Fourth Assessment Report?
3. What outlet glaciers and moulins are, and why they aresignificant.
4. What Rignot and Kanagaratnam discovered about Greenland'sice sheet.
5. How positive feedback is related to the melting of ice,snow, and permafrost.
6. Why people living in coastal areas are particularlyconcerned about climate change, and what options they have. (Locally, whatconcern do we in the Bay area have about this?)
7. How climate change is impacting the oceans.
8. How it is impacting species other than humans.
9. An early argument by skeptics of climate change was thatvegetation will grow more with more CO2 in the atmosphere. Why this is not assimple as it sounds.
10. In what ways climate change is expected to impactagriculture, forestry, public health, and economics.
11. What the USGCRP report showed, and how politics playedinto its release.
12. How the IPCC report affected the acceptance of theperception that climate change is human caused (at least at the time the bookwas written).

Class, Day 6

Discuss HW, HW Quiz?

Positive feedback and itseffects on dynamic equilibrium
Methane Release in SiberianArctic **Article**

IPCC **Site**
List of Countries by CO2Emissions - **Wiki**
Climate Change ProposalSimulation using Climate Interactive - International Climate Change Simulation **Site**
The Climate Scoreboard **Site**

Homework Assignment #7

Read 529-536
Understand the following:
1. What mitigation and adaptation mean, and why mitigationis more important.
2. Two ways we can reduce fossil fuels usage, and examplesof each.
3. What the second largest source of greenhouse gasemissions are, the efficiency of automobiles, the potential for them to becomemore efficient, and the role that public transportation can play.
4. How Pacala and Socolow suggest we should approachreducing CO2 emissions, and the strategies they suggest to keep C emissions at7 billions of tons per year (try to remember 7 of them).
5. What the FCCC was, and what happened afterwards.
6. What the Kyoto protocol originally mandated of nations,and why the U.S. refused to ratify it.
7. What U.S. state and local governments did in response toit.
8. How cap-and-trade and carbon-offsets are supposed towork, and the problems associated with them.

Class, Day 7

Discuss HW, HW Quiz?
EPA Expected to Regulate CO2- NYT **Article**(Last year)
Recent News: Republicans toblock legislation giving EPA the right to regulate CO2 emissions - NYT **Article**(Last month)
Naomi Oreskes, author ofMerchants of Doubt - Answering Climate Change Skeptics **Lecture**
(16:40 - Counterpoints to 2Arguments by Skeptics, 27:50 - Marshall Institute, doubt mongering, and thenature of science)
Skeptical Science **Site**