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DUE: week of 3/22
25 points

Project #2 – Climate Change Projections and Impacts

Part 1: Background reading

1. **What are "greenhouse gases"? In a couple sentences, explain in your own words how increased concentrations of "greenhouse gases" in the atmosphere would lead to increased global temperatures.**

   Greenhouse gases consist of mainly Carbon Dioxide and Water Vapor. Greenhouse gases allow the suns energy to pass through as light but reflect the heat off the surface of the earth back to the earth instead of passing back through the atmosphere into space. In higher concentrations of these gases the effect intensifies.

2. **Describe briefly the purpose of a general circulation model (GCM), and how one works.**

   A GCM is a computer model able to forecast future temperatures and climate change using a mathematical model and various types of data taken from the atmosphere, land, and even ocean samples.

3. **What is a "scenario" for use with a GCM?**

   Forecast scenarios are used to simulate global warming by varying the amount of carbon dioxide and seeing how temperatures change.

4. **Describe two possible impacts of the projected changes in global climate, and for each one, explain why an increase in global temperatures could have this effect.**

   Two possible impacts of the project changes would include a rise in sea level due to the mountain glaciers and snow melting due to higher temperatures as well as an increase in average atmospheric water vapor as warmer air can absorb more water vapor.

Part 2: Projected Future Temperatures

5. **Which GCM did you choose? What does the abbreviation stand for? What organization created this model?**

   I selected the HasCM3 GCM model, which stands for Hadley Centre Coupled Model and was developed by the Hadley Centre in the United Kingdom.

6. **Which scenarios did you choose? Describe each scenario in your own words.**

   I chose the A1F and the B2b Scenarios. The A1F scenario is based more upon wealth and rapid economic growth instead with less attention to the environment. The B2b Scenario focuses on solutions at local scales rather than global.

7. **Latitudinal variation: Looking at your first map and graph, which latitude ranges (i.e., tropics, polar (N or S), sub-tropics (N or S), or mid-latitudes (N or S) are projected to experience the greatest and least temperature changes?**

   The North Pole will see the highest temperature change, with a raise in temperature of about 2.5 degrees C. Slightly above the south pole will see the least amount of change with only about 0.5 degrees C and the rest of the world will see the average 1.0-1.5 degrees C change.

8. **Land / water variation: Looking at your results for "land only" and for "land + ocean," how are the projected temperature changes different for continents and oceans? Is either the latitudinal pattern or the magnitude of change different when you add in the oceans? How?**

   The data on land doesn't change between the two maps but the ocean's data significantly changes the average temperatures latitudinal with about the same global average. The pole's average temperatures go up meaning more of the temperature change is in the ocean. This must mean that water is more effected than land. The rest of the world has a more constant, but lower average change in temperature when combined with ocean data. The Global averages are very similar with the ocean map only slightly lower than the land map.

9. **Based on these projections, what can you infer about the differential impact of climate change on continental vs. oceanic locations?**

   The ocean temperature rises and becomes more uniform, with a greater increase in temperature in previously colder areas such as the poles. Land seems to see a more constant heating.

10. **Seasonal variation: compare the N. hemisphere winter map & graph, the N. hemisphere summer map & graph, and the annual map & graph. What are the seasonal differences in the projected warming? How do the different seasonal changes contribute to the annual average change?**

    During the winter the N. hemisphere sees the greatest change in temperature in the ocean, and a fair amount over land as well. During the summer there is no change to the ocean and only a slight change over land.

11. **What physical processes might account for these seasonal differences?**

    During the winter the Earth is closer to the sun in its orbit and therefore is subject to stronger radiation and greenhouse gases will trap more radiation than they would in the summer.

12. **Variations in human input: are there differences in magnitude or latitudinal pattern of projected temperature changes between the two scenarios? Describe any differences seen either in the spreadsheets or the maps.**

    There is a significant difference between the two scenarios. The A1F scenario sees extreme change over all land mass while the B2b scenario still has moderate change, just not as extreme.

13. **Variations over time: for each of your chosen scenarios, what are the differences, if any, in magnitude and latitudinal pattern of projected temperature change between the 2020s and 2080s time slices?**

    The obvious difference between 2020 and 2080 is in magnitude which is nearly doubled in both scenarios. The latitudinal patterns of both seem similar from 2020 to 2080 in both scenarios.

14. In questions 8-11, you inferred seasonal and land vs. water differences in projected temperature changes. Do these inferences hold true for your randomly chosen maps / graphs?

    Yes, the same trend was seen, increased magnitude in the N. Hemisphere for winter as well as overall increased magnitude globally.

Part 3: Climate Change Projections and Ecological Impacts

15. **Which climate scenarios does the Tree Atlas use for its future forest projections?**

    The Tree Atlas uses the FIA, Hadley, PCM, and the GFDL scenarios.

16. **What are the forest types currently present in Pennsylvania (*hint*: the help menu gives explanations for the abbreviations on the map)?**

    There are mostly Maple, Beech and Birch trees in PA, with some Oak, Hickory, Elm, Ash and Cottonwood.

17. **Based on the modeled projections of future forest types, how might the dominant forest types change in Pennsylvania if the climate warms?**

    Visually the tree types shift up with temperature making PA have a higher Oak and Hickory density.

18. **In general terms, how do the ranges of various forest types in the eastern U.S. change from the present to the projected future?**

    The southern trees, the ones associated with warmer weather spread up and cover more area than they did before. The trees in Maine, currently Spruce and Fir Trees become sparse if any.

19. **What are some reasons that the actual forests of the future might differ from those projected by the model, even if the climate projections are accurate (*hint*: explore the contextual / background information in the help box)?**

    The data shown per block is just the dominant tree in that zone, there still may exist other trees, new or old. There are three methods upon which they predict, creating 3 different outcomes, only one will occur if any. The predictions are based on someone else's scenarios which may be inaccurate as well.

For each of your three species, answer the following questions:

a. In general terms, what types of habitat does this species thrive in (e.g., moisture level, soil conditions, topography, shade / sun, etc.)?
b. What is the current range of the species?
c. How does the future modeled distribution differ from current estimates of species' distributions?

20. Species 1: <u>American Beech</u>

a. In general terms, what types of habitat does this species thrive in (e.g., moisture level, soil conditions, topography, shade / sun, etc.)?

This tree grows on well-drained, coarse-textured soils and on some poorly drained sites. It is extremely tolerant of understory conditions and persists in subdominant positions for many years

b. What is the current range of the species?

United States east of the Mississippi up to into Maine excluding Illinois and Florida.

c. How does the future modeled distribution differ from current estimates of species' distributions?

In the future these trees become sparse in nearly all the US with some remaining trees in the Mountains.

21. Species 2: <u>Northern Red Oak</u>

a. In general terms, what types of habitat does this species thrive in (e.g., moisture level, soil conditions, topography, shade / sun, etc.)?

Common upland oak found in mixed-species forests on deep, moist, well-drained soils; grows best on lower slopes and in deep ravines

b. What is the current range of the species?

Similar to the American Beech, this tree is found from Missouri to the north and to the east up to Maine, again not so much in Florida or the SE coast.

c. How does the future modeled distribution differ from current estimates of species' distributions?

Very sparse, only some remaining in the northern states.

22. Species 3: <u>Florida Maple</u>

a. In general terms, what types of habitat does this species thrive in (e.g., moisture level, soil conditions, topography, shade / sun, etc.)?

Understory tree, grows well on fertile, moist but well drained sites, such as stream terraces, ridge tops and bluffs. They can be a major component of the understory stand. It is assumed to be very similar to sugar maple in most respects.

b. What is the current range of the species?

This tree is currently growing mainly the states around the Gulf of Mexico. They can range from eastern Texas thru the Carolinas.

c. How does the future modeled distribution differ from current estimates of species' distributions?

In future predictions this already sparse tree appears to become **extinct** in the United States.

23. Are there any differences between the projected responses of the three species?

Yes, all of the current trees diminish in numbers; if any remain they are located in the northern part of their current native region.