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**GEOL 432: Paleoclimatology**

**Fall 2017, Midterm Exam I**

**Due on Tuesday, October 10th @ 1200 PM**

The goal of this exam and this exam format is to assess your understanding of climate change and climate history. This format will involve more work on the exam itself than your usual exams. You can subtract from this extra exam time the amount of time you would normally spend studying and stressing over it. Also important is that I expect you will learn nearly as much from preparing this exam as you have in class…maybe a lot more?! Work on each question, providing text and example plots where needed. MAKE SURE that you provide references for any material included. Submit your exam electronically to you Sakai drop-box by the deadline at noon. Good Luck!

1. Discuss B.L.A.a.c.H. Model of the Geosphere’s relationship to the depositional record and its ability to accurately record and preserve environmental records. Include information on the resolution of the record that various (at least (3) three) depositional records provide, how accurate they are, how trustworthy they may be. (20%)

The BLAacH model of the geosphere is comprised of the Biosphere, Lithosphere, Asthenosphere, Atmosphere, Cryosphere, and Hydrosphere. These correspond to the layer of living biota, the outer crust of the Earth, the plastic upper mantel of the Earth immediately below the Lithosphere, the gaseous layer above the Lithosphere, the ice layer of the Earth, and the water layer of the Earth.

All of these components interact to both vary and be varied by insolation energy, which informs global climate. The way in which they have been varied over geologic time presents us with the means to understand how that global climate has also varied.

Depositional records:

1: Atmospheric gases that entered hydrosphere can influence sediment record of lithosphere i.e. carbon and oxygen isotopes reflect weather patterns and climate type at time of deposition and sequestration of atmospheric carbon and oxygen.

2: Atmospheric gases that entered hydrosphere that froze and became incorporated into cryosphere in form of continental glaciers, leaving atmospheric gases present at time of deposition perfectly preserved along with isotopes in air bubbles in glacier.

3: Members of the biosphere can become fossilized into upper lithosphere and give us direct ecosystem compositional record during time of death – as plants and animals have optimum ecological niches, they often have thermal and environmental limits that influence their distribution. Using the presence or absence of certain species can help paleoclimatologists and paleoecologists infer what the landscape climate and weather patterns must have been like at the fossilized individual’s time of death.

2) How will gaining a better understanding of climate change in the past lead to a better understanding of climate change in the future? Include examples at least two (2) examples. (10%)

Taking a position of geologic uniformitarianism, the past informs the present. Investigating past climate change events and contexts will help us develop a greater understanding of how climate works on multiple temporal and spatial scales. It also gives us a higher quality of information to inform current projections and necessary adaptations for climate change.

3) Discuss how climate may have changed in the past on the full range of timescales from 100s of thousands of years to subannual change. Include examples and causal mechanisms (i.e. what caused it to change). (20%)

At all timescales, variation in insolation (energy input from the sun) is the key driver behind climatic changes. The mechanisms and extent of that variation in insolation are what govern the scale and extent of the corresponding climatic changes. Starting from current time and working backwards:

Earth’s tilt, wobble, and spin create day-to-day and seasonal variation latitudinally across the globe. Its eccentricity of orbit decreases and increases insolation on a time scale of approximately every 10-11k years. We can expect that this alone will influence the magnitude and length of whether or not the globe is experiencing global cooling or heating based on where Earth is in the eccentricity of its orbit, placing it closer or further from the sun. Sure enough, ice ages are spaced approximately every 10-11k years from each other in a periodic fashion. However, other changes affecting insolation can introduce slight variation in that fashion, hastening or furthering an ice age from its ‘due date’. The presence of white ice

4) How is heat transported around the globe, and what controls pole-to-equator thermal gradients? How is this thermal transport related to ice sheet stability in an ‘icehouse’ world? Discuss at least two possible heat transport variations in a warm world. (15%)

Energy from insolation (largely transformed into heat energy) disperses across Hadley cells and is absorbed by darker colors. Greater and more consistent insolation occurs around the equator than anywhere else on the globe. Insolation is fairly uniform at the equator even in the instance of Earth’s tilt, wobble, and spin, which cause insolation to vary in latitudinal belts corresponding with the presence or absence of seasons in those belts. Earth’s tilt, wobble, and spin do influence the direction energy moves as it enters – creating gyres of wind called Hadley cells, along which heat energy may travel and continue to disperse. This energy can also enter ocean gyres and currents. These gyres of air and water dictate weather patterns, as warm air can hold more evaporated moisture than cold air, and so warm air supports more frequent precipitation. As air cools over time, it releases the moisture in the form of precipitation.

In an icehouse world, the presence of glaciers and ice on the poles reflects a large amount of insolated energy back out into space. The icehouse self-regulates in a feedback loop: ice is present and so less insolated energy is taken into the system because a large portion of it is reflected. Less warm air is generated, less precipitation occurs and the ice does not melt but instead persists.

In a warm world, insolated energy is continually absorbed by dark ocean water rather than being reflected back. Energy is continually added to the system, hastening ice melt of any remaining glaciers and increasing precipitation frequency and intensity. With a dwindling ice presence on the Earth’s surface, less and less insolated energy is reflected back into space, and more energy is absorbed, furthering the disappearance of the moderating ice.

5) Discuss current climate model (GCMs) and their ability to accurately hindcast and forecast climate records. Find some examples in the literature and comment on the resolution of the record that they provide, how accurate they are, how trustworthy they may be. (15%)

Current global climate models have tremendous complexity in terms of how many layers of data they can account for simultaneously – currently they incorporate 38-40 layers of data for the terrestrial and ocean layers, adding up to ~80 layers total. In the 1990’s, the models could only account for about 19 layers of data terrestrially, 20 for ocean, for a total of 40 layers. Using CO2 levels from the Cretaceous period, these models can hindcast the degree of radiative forcing occurring at the global scale, allowing for fairly reliable hindcasting of climate anomalies and conditions.

6) Discuss climate change and its influence on early “historic” humans (40,000-10,000BC). Provide some examples of adaptations and changes in technology. (5%)

Early humans evolved and persisted in an icehouse climate. Humans and human civilizations have never existed within the context of a true hothouse/greenhouse climate.

7) Discuss the complexity of anthropogenic climate change, highlighting at least three major ethical dimensions given the long temporal and geographical disconnect between GHG emissions and their impacts. (10%)

We are continually making the planet worse and worse for every future generation, which is the opposite of what we should be doing.

Climate change is projected to and already has disproportionately and negatively affected poor equatorial and island regions, particularly Bangladesh, Sub-Saharan Africa, and island nations in the South Pacific. However the bulk of climate change emissions and resource use contributing to emissions is carried by countries like the United States, Russia, Canada, and Northern China, which will be affected much less relative to equatorial and island nations.

First world nations that have benefitted the most from exploratory research and development initiatives into alternative energies and chemical synthetics have only done so with the wealth and infrastructure directly resulting from their high use and extraction of resources that increase greenhouse gases.

8) *Historical documents contain a wealth of information about past climates. Observations of weather and climatic conditions can be found in ship and farmers' logs, travelers' diaries, newspaper accounts, and other written records*. Explain how you would properly evaluated historical data in order to yield both qualitative and quantitative information about past climate. (5 %)

I would try to look for alignments in the literature using word-search analysis to highlight textual patterns and consistencies, taking into account the locations across the globe and latitudes that those texts originated from. I would then corroborate my text-pattern analysis with other proxy records, like tree rings from nearby locations, to see if they potentially matched up.

References:

***Suggestions and warnings***

*You may use graphics (including maps, figures, photos, tables, etc.), to make your point in answering questions. Be sure to* ***document your sources*** *(that means list your references). DO NOT exchange files with each other. This is NOT a group effort.* ***Do not*** *cut and paste my Powerpoint notes or webpage text (easy to determine) into your exam as answers! Your exam will be graded on quality and your understanding of material not by weight (i.e. a 100-page exam is not necessarily better than a 20-page exam). Use spelling and grammar checkers. Complete your exam questions, then read/correct them. Rinse/Repeat.*