Modeling the Earth's Past

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Introduction:

Field-geological and laboratory studies allow for reconstruction of the climate of the past on a local scale. Understanding global climate through such approaches is challenging because of incomplete sedimentary records and wide expanses across the globe requiring fieldwork. One tool that can be used to overcome these limitations and supplement incomplete sections is paleoclimate modelling. These models are the same types of models used for projecting future climate, but applied to past climates. Specifically, given the distribution of continents, oceans, and mountains, as well as the atmospheric composition, the past climate can be simulated using these models.

We have developed a tool to look at climate and paleoclimate (http://www.buildyourownearth.com) using one of these models. The Fast Ocean Atmosphere Model contains a dynamic atmosphere and ocean, with a sea-ice model. Other models are also available that possess greater levels of sophistication, such as those with interactive ice, vegetation, and atmospheric chemistry. Our research group has experimented with several of these models.

There is a need to combine the skills of geoscientists and paleoclimate modelers to address questions related to the Earth's past climate. This project has a number of potential supervisors who are interested in working together to bridge these disciplinary gaps. Specifically, we aim to examine how well simulations of past climates do compared to geological evidence and climate proxies. Another aim would be look at how changing carbon dioxide or continental locations in the past have led to changes in the Earth's climate.

Project Summary:

We are looking for students who want to be challenged, develop a range of skills including theory, observations and modeling, and enjoy studying the natural world. Your background can be in geology, petroleum geoscience, geography, paleontology, environmental science, atmospheric science, computer science, physics, math, or a related field.

The student has much say in the direction of this project. Potential research projects could answer the following questions.

1. The formation of salt basins during the Triassic.

During the Mesozoic, Earth's climate was changing in part due to increasing amounts of atmospheric carbon dioxide and the rifting of Pangea. Large evaporite deposits in Pangea are evidence of the dry climate in the tropics and subtropics. Yet, the Intertropical Convergence Zone, a climatological region of precipitation near the equator, must have been present. The rock record in North Africa and Spain suggests oscillations of wetter and drier climate. What are the causes of these oscillations? Are oscillations in the location the ITCZ responsible? This project will involve both investigation of the rock record and interpreting paleoclimate model output to answer these questions.

2. The early Cretaceous climate and ocean circulation in the early Atlantic Ocean.

The early opening of the Atlantic Ocean during the Cretaceous led to a profound change in sedimentary environments in North Africa. Oceanic anoxic periods in this shallow marine environment produced black shales. Various causes for the anoxic events have been suggested, and this project will attempt to understand the causes of these anoxic events using both interpretation of the rock record and interpreting paleoclimate model output.

3. Paleoenvironmental change as drivers for major evolutionary changes.

Major evolutionary advances often follow large changes to the Earth's climate. For example, the Ediacaran metazoans occurred after a period of extensive (possibly global) glaciation. What kind of surface conditions did the first land plants and animals experience? Given the known distribution of fossil evidence, what can paleoclimate modeling tell us about the environments (e.g., temperature, precipitation, salinity) in which these advances occurred?

4. Changes in atmospheric composition, changes in climate.

Mass extinctions are often associated with the emplacement of large igneous provinces, which result in increasing atmospheric carbon dioxide, abrupt temperature changes, and anoxic events in the ocean. How important is the rate at which carbon dioxide is emitted to the changes in the climate?

Students are also encouraged to suggest their own research project. Please contact Prof Schultz or one of the other potential cosupervisors to discuss your ideas.

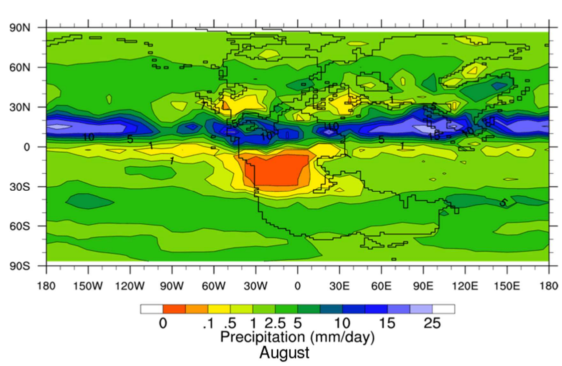

Image 1– Average daily August precipitation amount during the Jurassic (170 million years ago).

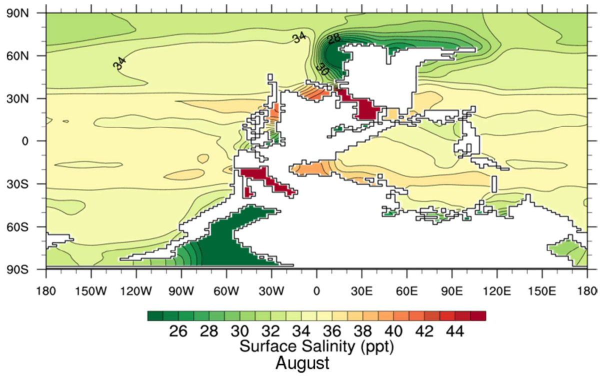

Image 2- Average salinity of oceanic surface waters in August during the Carboniferous (300 million years ago).

References

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