Deep-time large scale circulation patterns

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Searching in Earth's climate history for analogues for our future climate leads to the Early Eocene Climatic Optimum (EECO, ~56-48 Myr ago). Paleoclimate model simulations in contrast to future projections, have the advantage, that there are proxy data available, which help to assess the model's response to the climate constraints. To learn from the past, it is advantageous to asses which changes are due to the change in CO_2 concentration and, which are due to other boundary constraints, such as the paleogeography, vegetation, or lack of continental ice sheets. In our previous work, which relay on model simulations from the Deep-Time Model Intercomparison Project (DeepMIP), we studied the different meridional energy transport processes in the atmosphere and identified changes in large scale circulation patterns. The Hadley cell overturns more energy in the climate of the EECO, as a result of a more intense hydrological cycle and also shows an asymmetric response with the northern cell being stronger and the southern cell being weaker in the past. The energy transport of monsoon systems increases with rising CO_2 concentrations, but this effect is offset by the changes in topography, which results in less monsoon area and thus less energy transport via monsoons in the Eocene simulations. At the mid-latitudes, the energy transport via transient eddies increases mainly due to the paleogeography, implying changes in the polar front.
Our aim is to investigate these large scale circulation patterns, namely the Hadley cell, the monsoonal systems and the mid-latitude cyclones' response to CO_2 and non-CO_2 constraints in the EECO. Building on results from DeepMIP, we plan to run CESM2 in a paleo-calibrated version, on a higher resolution with newly developed vegetation set up.
Our work is part of the VeWA (Vergangene Warmzeiten als natürliche Analoge unserer ‚hoch-CO_2 Klimazukunft) project, which is an interdisciplinary Earth Science project funded by the LOEWE program, involving both proxy and climate modelling research from the Goethe University Frankfurt and the Senckenberg – Leibniz Institution for Biodiversity and Earth System Research.

Project webpage: www.vewa-project.de