The role of mantle convection in understanding sea level and cryospheric changes during past warm periods

Jacqueline Austermann, *Harvard University, United States of America* (*jaustermann@fas.harvard.edu*)
Jerry X. Mitrovica, Harvard University, USA; David Pollard, Pennsylvania State University, USA; Peter Huybers, Harvard University, USA.

Mantle convection has a major impact on the Earth's long-term shape and climate. On ice age timescales, however, mantle convection is regarded as having a negligible affect on both the direct response of the Earth system to climatic changes and on the geologic record of these changes. In this talk we will argue that this notion is incorrect and, after reviewing the basic physics of mantle convection, we will present two case studies that illustrate how mantle-driven changes in topography, so-called dynamic topography, can have an important affect on the sea level record and ice sheet dynamics during past warm periods.

In the first case study, we revisit the analysis of sea level highstands during the Last Interglacial (LIG), ~125 kyrs ago. Glacial isostatic adjustment has long been known to introduce a strong geographic variability in LIG highstand elevations. We demonstrate, using a state-of-the-art numerical model of the mantle convection process, that dynamic topography changes can also significantly perturb these elevations, even at sites well away from tectonically active margins. We conclude that any effort to infer peak global mean sea level during the LIG (or, equivalently, minimum ice volumes) to an accuracy better than a few meters must account for the contamination of the sea level record by dynamic topography.

Second, we turn to the mid-Pliocene warm period, ca. 3 Ma ago. Dynamic topography has been shown to deform the elevation of shoreline markers of mid-Pliocene age, particularly along the U.S. Atlantic coastal plain. We will demonstrate that models of dynamic topography also predict altered bedrock topography within parts of Antarctica over the same time period. To explore the implications of this perturbation for the Antarctic Ice Sheet, we present the results of modelling in which numerical simulations of dynamic topography changes are coupled to a 3-D Antarctic Ice Sheet model. Our results demonstrate that this previously unrecognized connection between mantle dynamics and ice sheet stability may have had a significant impact on ice sheet retreat in the marine-based Wilkes basin suggesting levels of ancient instability consistent with offshore geological records from the region.