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Water isotopic imprints of the Pliocene Pacific Walker Circulation

Theodor Mayer[1], Ran Feng[1], and Tripti Bhattacharya[2]
[1]University of Connecticut , Department of Geosciences, Storrs, CT, United States of America (theodor.mayer@uconn.edu)
[2]Syracuse University, Earth and Environmental Science, Syracuse, NY, United States

Ocean-atmosphere coupled models predict pronounced weakening of the Pacific Walker Circulation (PWC) with increasing CO_2 concentration due to enhanced tropospheric stability and reduced convective mass overturning. However, current observational results are inconsistent and do not confirm a clear weakening signal. The detection of the signature of increasing CO_2 is in part impeded by substantial internal variability and anthropogenic aerosol forcings. Here we explore the possibility of using a paleoclimatic analogue to understand the contemporary PWC sensitivity to CO_2 changes. We focus on the interval from mid-Piacenzian (MP, 3.3 – 3.0 Ma) to early Pleistocene (~2.4 Ma). The MP had elevated CO_2 concentrations (~400ppm) and geography, topology, and vegetation similar to today. Following the MP global CO_2 and temperature decreased, leading to the intensification of the Northern hemisphere glaciation. We seek to identify potential proxy constraints on model simulated PWC sensitivity to CO_2 forcing by focusing on changes in the hydroclimatology during this time interval. We developed several sets of isotope-tracking enabled CESM version 1.2 simulations, which utilize pre-Industrial and Pliocene boundary conditions, different CO_2 levels, and water tagging of 11 oceanographic regions to track the life cycles of various water species (H216O, H218O and HD16O). Preliminary results show that Pliocene boundary conditions have little impact on the relationship between the CO_2 forcing and the intensity of PWC. The precipitation δD contrast between the eastern and western tropical Pacific, scales well with the PWC strength, suggesting high potential for developing PWC strengths proxy with precipitation isotopic records from both sides of the tropical Pacific. Our ongoing work will further identify physical processes responsible for the simulated precipitation isotopic signals: i.e., whether they reflect changes in the moisture source, moisture transport, or moist convection at the destination. Additionally, prescribed-SST simulations will also be conducted to quantify the isotopic imprints of changing tropospheric instability from SST changes.