Geophysical Research Abstracts
Vol. 21, EGU2019-1458-1, 2019
EGU General Assembly 2019

Energetic constraints on the evolution of the water cycle from endorheic lake basins to continent-scale runoff

Daniel Ibarra (1), Tyler Kukla (1), Jessica Oster (2), Matthew Winnick (3), Jeremy Caves Rugenstein (4), Kimberly Lau (5), and C. Page Chamberlain (1)

(1) Geological Sciences, Stanford University, Stanford, California, USA (danieli@stanford.edu), (2) Earth and Environmental Sciences, Vanderbilt University, Nashville, Tennessee, USA, (3) Geosciences, University of Massachusetts, Amherst, Massachusetts, USA, (4) Earth Sciences, ETH Zürich, Zürich, Switzerland, (5) Geology and Geophysics, University of Wyoming, Laramie, Wyoming, USA

Terrestrial geologic deposits preserve information on the sign, magnitude and spatial heterogeneity of past changes in the water cycle. Reconstructing these changes requires constraining both moisture delivery (precipitation) and removal (evapotranspiration and runoff) from a landscape. Energy fluxes, through the partitioning of sensible and latent heating, play a crucial role in these water cycle dynamics. Here, we illustrate how the energy budget refines the solution space of past water cycle changes. By linking this mechanistic modeling approach with geologic observations, we can develop meaningful predictions of hydroclimate change from regional to global scales.

In this contribution we reconstruct water availability in mid- to high-latitude regions using two approaches that incorporate energetic constraints. First, to illustrate the utility of these approaches at a regional scale, we use lake area scaling relationships with Budyko curve constraints to forward model the size and spatial distribution of lakes in endorheic basins. We focus here on forward modeling Cenozoic water availability in western North America. In doing so we predict that warmer-than-present periods, such as the Eocene and mid-Pliocene, would have required substantial increases in precipitation to supply sufficient water to develop large lake systems in the now-arid continental interior. Second, at a global scale, we incorporate changes in albedo (due to for example, vegetation changes and ice sheet growth), as well as changes in continental configuration, into a moist energy balance model of the hydrologic cycle. Applying these parameterizations to Phanerozoic paleogeographic changes, we make first-order temporal predictions for changes in continental runoff, and discuss implications of these results for terrestrial water storage and silicate weathering over geologic time.