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Effects of Ocean Salinity and Planetary Obliquity on Exoplanet Climate and Complex Habitability

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Planets in the outer Habitable Zone (HZ) could have many bars of atmospheric CO_2 (Kopparapu et al., 2013), which would be toxic to the development of complex life (Schwieterman et al., 2019). Past work has shown that salty oceans can warm planets in the outer HZ (Olson et al., 2022), potentially with consequences for the distribution of complex life in the HZ. However, previous studies of the effects of ocean salinity have primarily explored Earth-like scenarios (Cullum et al., 2016, Olson et al., 2020), and the impacts of salinity under a variety of orbital scenarios remains relatively unexplored.

We use ROCKE-3D, an ocean-atmosphere general circulation model, to address this gap. We simulate the climates of planets across a large range of salinities and obliquities, each with stellar fluxes relevant to the outer HZ but low pCO_2. We find that increasing ocean salinity in our model results in non-linear warming and ice loss due to the ice-albedo feedback, sometimes causing abrupt transitions to different climate states. Changes in ocean salinity in tandem with orbital obliquity can produce distinct climate states, including ice-free, ice cap, ice belt, and globally glaciated scenarios between simulations with the same stellar flux and pCO_2.

This presentation will explore how these climate effects may impact planetary habitability, both in steady-state climate simulations and over geologic timescales. We are especially interested in how salinity and obliquity may expand the region of the HZ where complex life can survive and how these effects could be recognized with future observations.

References:

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