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Ocean Salinity and Climate in the Outer Reaches of the Habitable Zone

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The habitable zone (HZ) is the circumstellar region where liquid water could exist on a planet assuming CO2-based weathering feedbacks regulate surface temperature as on Earth (Kasting et al. 1993, Walker et al. 1981). Although water is essential for life on Earth, it is an insufficient criterion for habitability. Atmospheric CO_2 could range from parts per million for inner HZ planets like present-day Earth, to many bars for outer HZ (OHZ) planets like early Earth (Kopparapu et al. 2013). High CO_2 can negatively impact the development of life through ocean acidification and direct physiological stresses (Schwieterman et al. 2019). In addition to atmospheric chemistry, recent work suggest that ocean chemistry can exert a significant climate influence (Cullum et al. 2016, Del Genio et al. 2019, Olson et al. 2020). However, how salinity has varied and impacted climate throughout Earth's history is poorly understood. Thus, the climate consequences of low vs. high salinity must be explored.

We use a GCM called ROCKE-3D to simulate ocean and climate conditions in the OHZ. We consider the effects of ocean salinity and atmospheric CO_2 for various planetary and orbital scenarios. We find that atmospheric chemistry and ocean chemistry jointly modulate climate. Higher ocean salinity increases average surface temperatures and reduces ice coverage, modifying the predicted insolation-CO_2 relationship inside the HZ extending the OHZ boundary. We will discuss implications of low and high ocean salinity for life on early Earth.

References:

Cullum, J., Stevens, D. P. and Joshi, M. M. *Proceedings of the National Academy of Sciences* 113.16 (2016): 4278-4283.

Del Genio, Anthony D., et al. *Astrobiology* 19.1 (2019): 99-125.

Kasting, James F., Daniel P. Whitmire, and Ray T. Reynolds. *Icarus* 101.1 (1993): 108-128.

Kopparapu, R. K., et al. *The Astrophysical Journal* 765.2 (2013): 131.

Olson, S. L., Jansen, M., and Abbot, D. S. *The Astrophysical Journal* 895.1 (2020): 19.

Schwieterman, Edward W., et al. *The Astrophysical Journal* 878.1 (2019): 19.

Walker, J. CG., Hays, P. B., and Kasting, J. F. *Journal of Geophysical Research: Oceans* 86.C10 (1981): 9776-9782.

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