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Impact of Ocean Salinity and Planetary Obliquity on Climate in the Outer Habitable Zone

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The habitable zone (HZ) is the circumstellar region where liquid water could exist on a planet's surface assuming CO_2-based weathering feedbacks regulate surface temperature (Kasting et al. 1993). Atmospheric CO_2 could range from parts per million for inner HZ planets, to many bars for outer HZ (OHZ) planets (Kopparapu et al. 2013). High CO_2 in the OHZ negatively impacts the development of life, especially complex life, through ocean acidification and direct physiological stresses (Kurihara, 2008). However, the OHZ can also be extended by non-CO_2 warming mechanisms. Thus, there is a need to consider other mechanisms that can warm planet climate, extend the HZ, and increase the fraction of the conventional HZ that may be suitable for development of animal-grade complexity (Schwieterman et al., 2019). This will impact the target selection of future biosignature searches and our understanding of the evolution of early Earth.

We use a GCM called ROCKE-3D to simulate ocean and climate conditions in the OHZ of both Sun-like stars and M-dwarfs. We consider the effects of stellar spectrum, instellation, orbital obliquity, and ocean salinity to determine how characteristics influence climate stability in the OHZ. Higher ocean salinity and orbital obliquity can lead to reduced ice coverage and higher average surface temperatures, which modifies the predicted insolation-CO_2 relationship and extends the OHZ boundary (Colose et al. 2019, Olson et al. 2020). We compare the effects of ocean salinity orbiting Sun-like stars and M-dwarfs, where the ice on M-dwarf planets is less reflective making the ice-albedo feedback weaker (Shields et al. 2013).

References:

Colose, Christopher M., et al. *The Astrophysical Journal* 884.2 (2019): 138.

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.

Kurihara, Haruko. *Marine Ecology Progress Series* 373 (2008): 275-284.

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.

Shields, Aomawa L., et al. *Astrobiology* 13.8 (2013): 715-739.

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