

## Leveraging the Exoplanet Ensemble to Empirically Test for the Existence of the Habitable Zone (HZ)



Figure 1: (Left) Simulated transmission spectra for a group of exoplanets that exhibit an atmospheric CO<sub>2</sub> trend (right) predicted by carbonate-silicate weathering feedback.



Figure 2: Constraints on atmospheric CO<sub>2</sub> for individual exoplanets (error bars) are used by HBAR to constrain the population trend (purple) and empirically test for the existence of the HZ.

We developed a novel Hierarchical Bayesian Atmospheric Retrieval (HBAR) approach to infer population-level atmospheric trends from the spectra of numerous exoplanets.

- The concept of the HZ rests on the assumption of a functioning carbonate-silicate weathering feedback cycle, which predicts a trend of increasing atmospheric  $CO_2$  from the inner edge of the HZ to the outer edge (Figure 1).
- We applied HBAR to test this hypothesis using simulated JWST observations and, although we robustly recovered the CO<sub>2</sub> trend (Figure 2), we required a large sample of high SNR spectra that renders this hypothesis infeasible to test in the near term.
- The HBAR approach may prove useful for inferring atmospheric trends from giant planet spectra with *JWST* and *Ariel.* Lustig-Yaeger, Sotzen, Stevenson, Luger, May, Mayorga,

Mandt, and Izenberg (2022) The Astronomical Journal