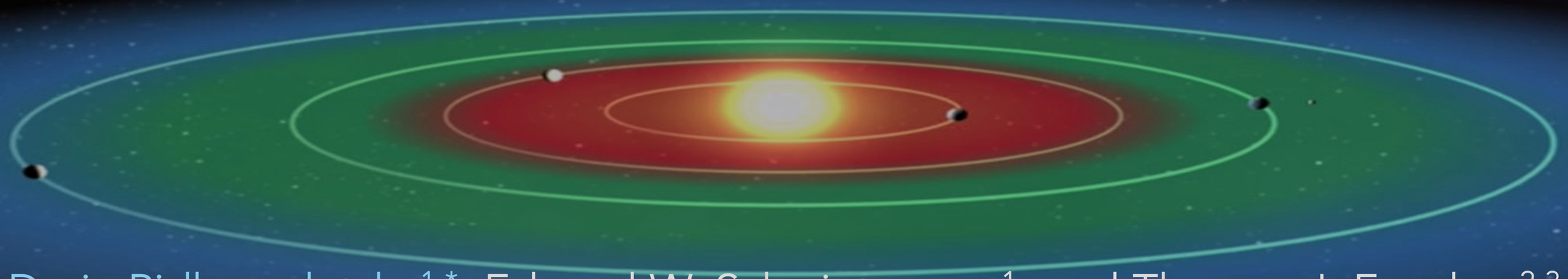
HIGH CO_2 CLIMATES AND OBSERVABLES IN THE OUTER HABITABLE ZONE (OHZ)



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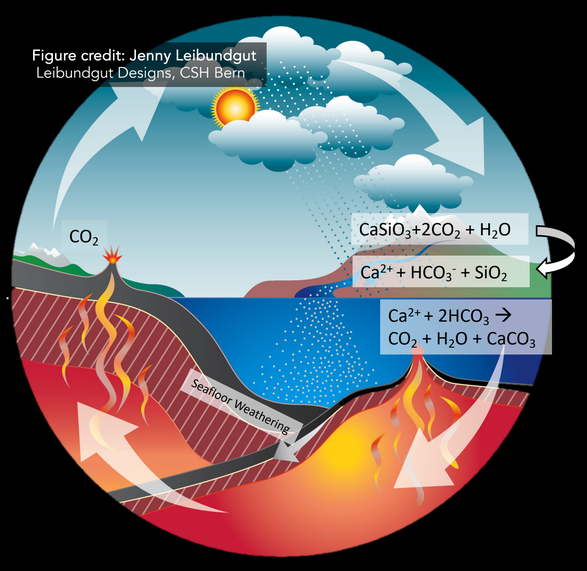
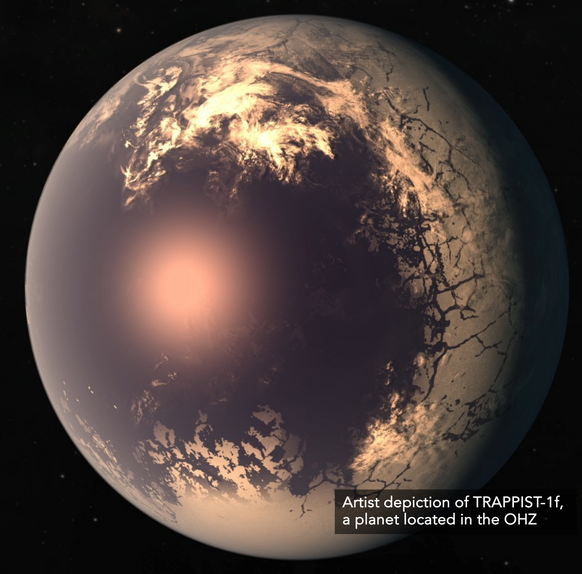
motivation



The habitable zone (HZ) is a fundamental concept that guides our search for temperate exoplanets with stable surface liquid water that could sustain remotely detectable biospheres. Most advanced 3D climate studies of HZ planets have focused on inner HZ worlds that receive stellar radiation similar to Earth's and would consequently maintain relatively low (e.g., hundreds of ppm) atmospheric CO_2. We investigate planets in the outer HZ (OHZ) which would require high levels of CO_2 to maintain clement conditions and compare our findings to previous 1D predictions.

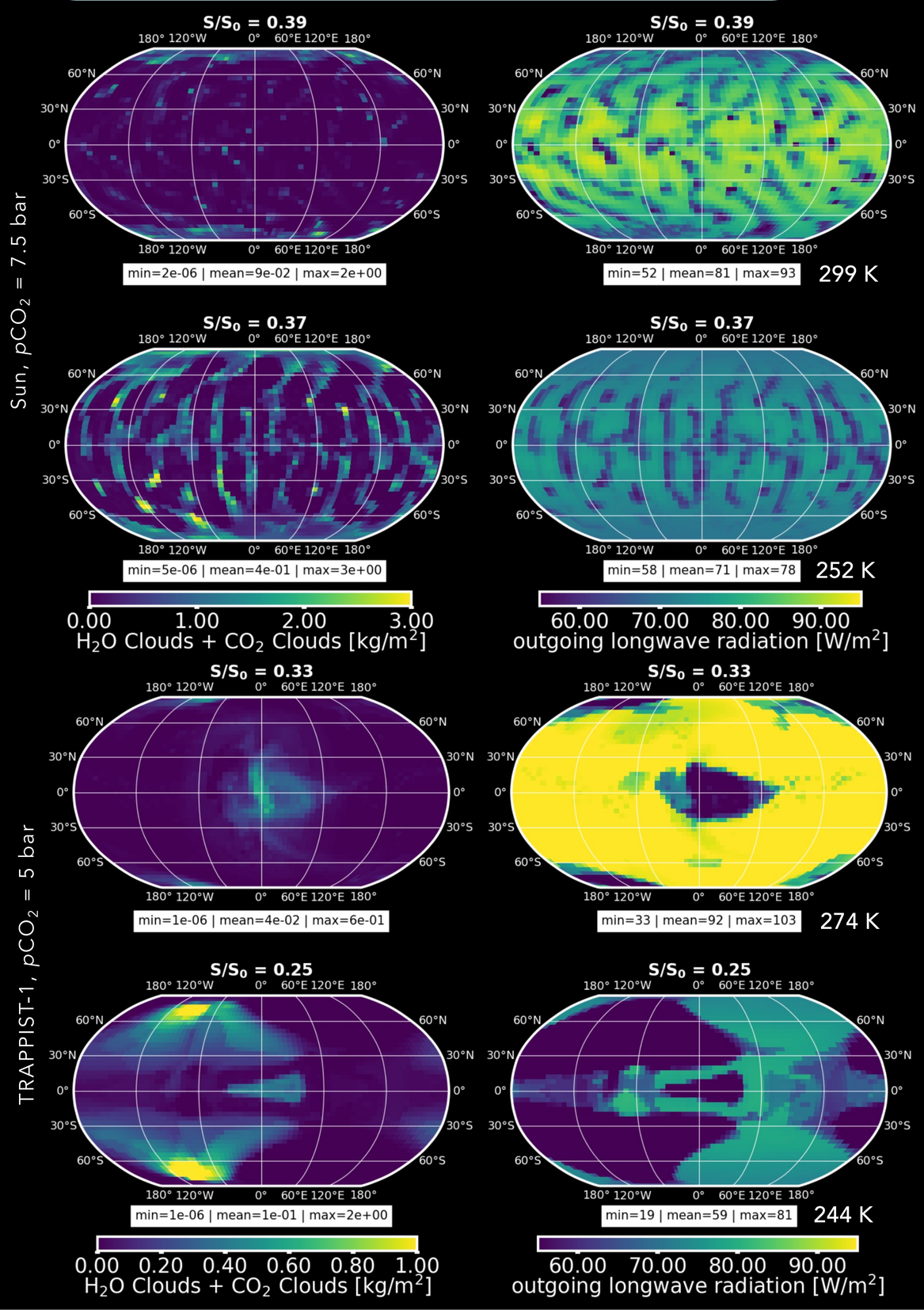


Artist depiction of TRAPPIST-1f, a planet located in the OHZ

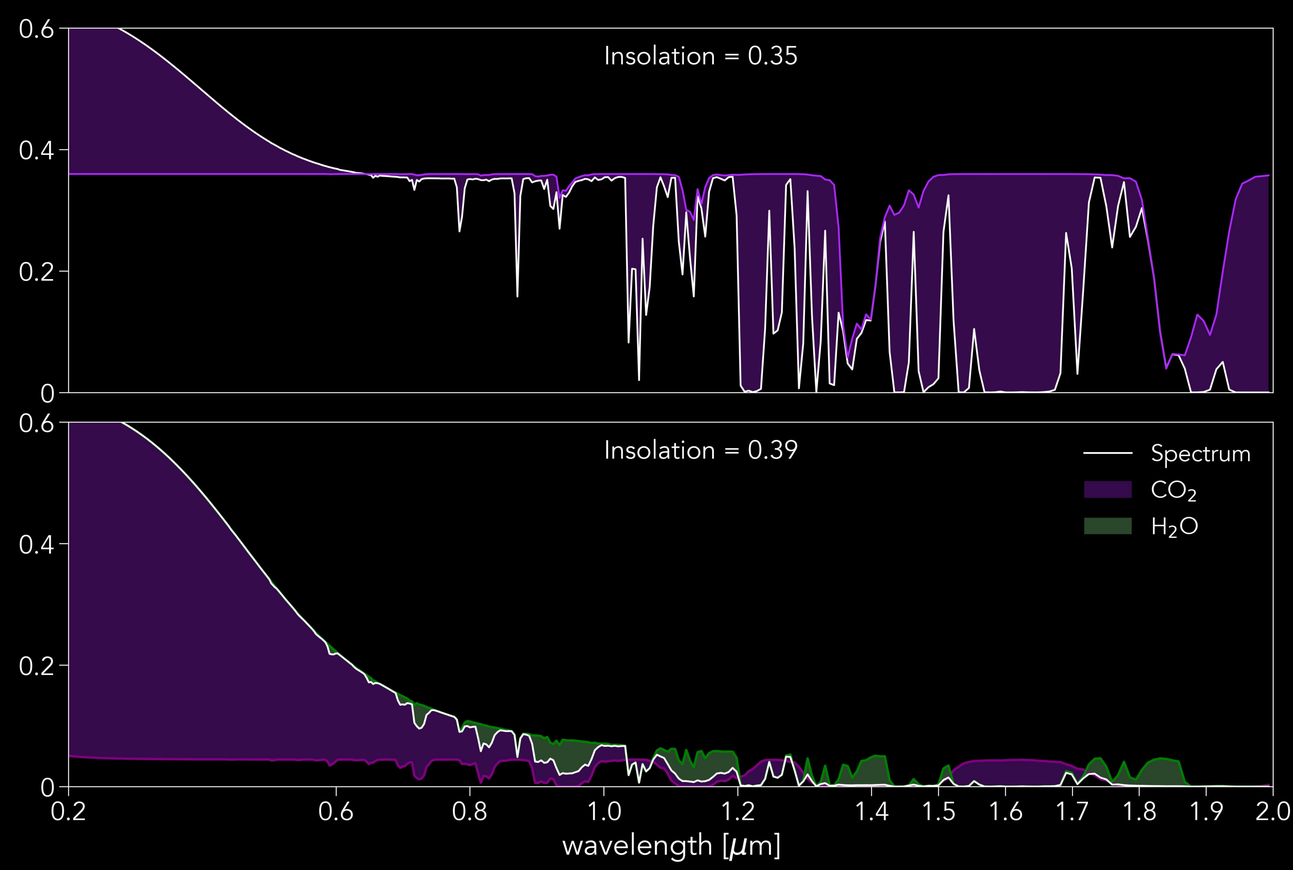
methods

Climate simulations for a variety of planetary conditions are ran using the LMD-G GCM [1,2] which includes CO_2 condensation physics crucial for studying high pCO_2 scenarios at the OHZ. Synthetic spectra is generated using the Planetary Spectrum Generator (PSG) [3,4].

planetary parameter [units]	values	
pCO_2 [bar]	5, 7.5, 10, 20	
insolation [S/S_0]	0.1-0.5	
salinity [ppt]	5, 35, 50	
spectral type	Sun (G2V)	TRAPPIST-1 (M8V)
orbital obliquity [degrees]	23.5, 0	0
day length [hrs]	12, 24, 48	tidally locked



results



main takeaways

pCO_2 and insolation play a much larger role than obliquity and salinity

cloud coverage for OHZ planets around M-dwarfs echo similar results seen in Fujii+2017 and Turbet+2023

reflected light spectra can help us understand a planet's potential habitability when considering an observatory such as HWO

the atmospheres of habitable worlds may be difficult to probe in transit due to refraction limits

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