WATER CONDENSATION ZONES AROUND MAIN-SEQUENCE STARS

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Abstract: Understanding the set of conditions that allow rocky planets to have liquid water on their surface is a major scientific step to determine the fraction of planets potentially suitable for the emergence and development of life as we know it on Earth. This effort is also necessary to define the so-called "Habitable Zone" (HZ) in order to guide the search for exoplanets likely to harbor remotely detectable life forms (Kopparapu et al. 2013). Until now, most numerical climate studies on the subject have focused on studying the conditions required to stabilize oceans, but not to form them in the first place.

I will present recent results (Turbet et al., in preparation) we obtained using the Generic PCM, a 3-D Global Climate Model (GCM) historically developed at LMD, to simulate the conditions of early ocean formation on rocky planets due to the condensation of the primordial water reservoir at the end of the magma ocean phase (Hamano et al. 2013, Lichtenberg et al. 2022). Using these simulations, we introduce a Water Condensation Limit, which lies at significantly lower insolations than the inner edge of the HZ calculated with 3D GCM simulations (Kopparapu et al. 2017). This suggests that a significant fraction of planets in the HZ may never have condensed their oceans.

If time permits, I will also show how to connect these results to ongoing and future observations of temperate rocky exoplanets, via a combination of various observational techniques using JWST and ELT instruments.