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Estimating planetary habitability in a wide parameter-space modelling study

Giuseppe Murante (1), Michele Maris (1), Elisa Palazzi (2), Antonello Provenzale (3), Laura Silva (1), Giuliano Taffoni (1), and Giovanni Vladilo (1)

(1) INAF - Trieste Astronomical Observatory, Trieste, Italy (murante@oats.inaf.it), (2) ISAC - CNR, Torino, Italy (e.palazzi@isac.cnr.it), (3) IGG - CNR, Pisa, Italy (antonello.provenzale@cnr.it)

Planetary habitability is usually defined in terms of the limits for the existence of liquid water on the surface of the planet, or of even the more stringent temperature limits allowing for the presence of complex organisms able to produce atmospheric biomarkers (Silva et al 2016). Often, however, the astronomical (obliquity, eccentricity), geological (density, composition) and climatic (atmospheric CO_2 content, pressure, composition) planetary parameters are poorly constrained. In such case, one should consider an ensemble of possible parameter values and estimate the probability of the planet to be habitable. To do so, a simple enough climate-habitability model should be adopted, in order to allow running a very large number of possible cases. Here we follow this approach and discuss a new and extremely wide exploration of the planetary parameter space, to check under what conditions the criteria for planetary habitability are met. To this end, we use the one-dimensional, zonally and vertically averaged ESTM modelling approach developed in Vladilo et al (2015) and recently applied to the case of Kepler 452b (Silva et al 2017). We vary planetary obliquity, eccentricity of the orbit, atmospheric pressure and atmospheric CO_2 concentration. For each parameter set, we consider several initial conditions for planetary temperature, in order to search for the possible presence of multistability in the planetary climate. From the ensemble of $\sim$10**5 runs, we extract a huge amount of information on the range of parameter values for which climate bistability is present (as in the case for the Earth) and define the chance of habitability in parameter space.

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