Climate variations on water-rich circumbinary planets and their impact on habitability

M. Popp[1*]; S. Eggl[2]

[1]LMD, Paris, France
[2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, United States of America

Planets orbiting close binary-star systems experience strong variations in insolation due to the non-trivial evolution of the distance between the planet and the two stars. Insolation variability on such a scale can have a significant influence on a planet's climate and, thus, on its habitability. Pervious work on the topic was based on one-dimensional climate models that lack important dynamical processes. We performed the first simulations of a hypothetical Earth-like circumbinary planet with a three-dimensional atmospheric general circulation model coupled to an analytic orbit propagator [1]. Choosing a Kepler-35-like setup we substituted the gas giant present in the actual system with an aqua-planet (fully water-covered planet) serving as a proxy for the Earth. We could show that an Earth-like circumbinary world has a similar climate to an identical planet orbiting our sun, if it receives the same amount of sunlight in the annual mean. Moreover, the absolute extent of the region around the binary star is somewhat larger than the habitable zone in single star systems. This makes rocky, circumbinary planets prime targets in the search for habitable worlds. The variations in insolation a terrestrial planet experiences in a binary star system have, however, various other effects on planetary climates. Signatures of periodic variations in important climate indicators such as surface temperature and precipitation appear. Those may make the interpretation of observations of such planets more challenging.

[1] Popp M. and Eggl S.: Climate Variations on Earth-like circumbinary planets, Nature Communications, 8:14957, 2017

Short Summary

We performed the first simulations of a hypothetical Earth-like circumbinary planet with a three-dimensional atmospheric general circulation model coupled to an analytic orbit propagator and show thus that rocky, circumbinary planets can be prime targets in the search for habitable worlds.