Investigating the Habitability of Hot, Rocky Exoplanets using Modern Terran Ecosystems as a Guide

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A multitude of different criteria have been employed to assess the habitability of extraterrestrial environments but these models have seldom been tested using modern ecosystems on Earth. Historically, the presence of liquid water has been widely used as a proxy for habitability. Yet even on Earth, environments exist where liquid water is effectively sterile due to high temperatures or low water activity. How well do models of habitability apply when compared with observations of modern Earth systems? We have investigated the distribution of living organisms in model terran ecosystems with reference to four commonly used metrics of habitability (raw materials, liquid water, physical-chemical limits, and energy) to evaluate their applicability to life as we know it. Each model was individually parameterized in order to assess the distribution of habitable niches in space and time and their consistency with observational data. Examples can be found where environments appear habitable by some of the described metrics, but other parameters are transcended and the system is rendered uninhabitable. These data suggest that multiple metrics of habitability should be simultaneously applied to the study of natural systems. We then discuss the results of our findings with reference to published studies of Martian and Europan environments and models of extrasolar planets. These data provide a framework to translate the habitat data on Earth to extraterrestrial systems and may be useful in focusing life detection efforts.