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Characterization of rocky exoplanets in habitable zones: An astrobiological approach

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Abstract

1 Introduction

The study of rocky exoplanets, in particular earth liked and super earths planets, has become one of the most important focus in astronomy and planetary sciences. Currently, there are over 5000 confirmed exoplanets [1]. With taht in mind, we may asking, which of these worlds coudl potentially harbor life?. To adrees this, scientifics classify habitability having into account orbital, stellar and atmospheric parameters by defining the concept of Habitable zone (HZ). The HZ designates the region around the host star where liquid water could exist on the planet's surface, analogous to Earth's conditions [2]. To determine this zone is commonly use climate models to set the boundaries accuretly.

1.1 Climate modelling approaches

One dimensional (1D) climate models are widely used to set the boundaries of the HZ. These models consider parameters such as stellar radiation, albedo, relative humidity profiles and greenhouse gas effects (particulary gases like CO_2, H_2O and N_2). They provide insights into the temperature distribution and potential habitability of planets in different orbital configurations [3]. However, these models have limitations, as they often oversimplify complex atmospheric processes and fail to account for variations in planetary conditions. That is why three dimensional models (3D) are also implement, nverthless these models requeire more computational resourcess.

1.2 Boundaries of HZ

The boundaries of the HZ are defined by the following conditions:

- **Inner boundary(Moist greenhouse):** The inner boundary of the HZ is determined by the runaway greenhouse effect, where the planet's surface temperature becomes too high for liquid water to exist. This occurs when the stellar flux exceeds is too hight that the mixing ratio of water vapor reaches an amount of 10^{-3} (vs Earth's $10^{-}6$), leading hydrogen lost via photolysis.
- **Intermedium boundary (runway greenhouse):** The intermedium boundary is where water is completely evaporated, the atmosphere becomes opaque

to outgoing thermal radiation, creating a heating scenario where the surface's temperature could exceed 1500k like in Venus.

- **Outer boundary (Maximum greenhouse):** The outer boundary is where the CO_2 induced warming reaches its maximun effectiveness, with concentrations between 6-10 bars. However, despite the high gas greenhouse concentrations, due to the increasing of Rayleigh scattering, the planet's surface experience a cooling effect.

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2 Methodology

3 Results and Analysis

4 Discussion

5 Conclusions

Acknowledgments

References

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