Modeling the Atmospheric Contribution to the Interior Characterization of sub-Neptunes and its Effect on Habitability

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As the number of confirmed exoplanets has increased, so too has the diversity in their physical parameters, namely their mass and radius. A common practice is to place these planets on a Mass-Radius diagram with various calculated density curves corresponding to some bulk composition. However, these lines don’t necessarily correspond to the structure of the planet found using interior models, particularly for low mass planets with masses less than 20 M⊕ and 4 R⊕, which we call “sub-Neptunes.” Planets in this range can have highly degenerate solutions with no solar system analog, from so-called “ocean worlds” to small dense cores with extended primary composition atmospheres. We have created a model that is able to cover the range of solutions possible for sub-Neptunes, with various levels of complexity for both the interior and atmosphere. This includes both an isothermal and semi-grey atmosphere, along with a high-pressure solar composition envelope when atmospheric pressures exceed approximately 1000 bar. We then apply this model to known sub-Neptunes located in the extended habitable zone of their star using a hydrogen-helium dominated atmosphere. An atmospheric escape model is used to investigate the longevity of the atmosphere and its effect on the overall habitability of the planet.