

Outer worlds enter the habitable zone multiple times during late stages of Sun-like stellar evolution

Multiple Habitable Phases on Outer Exosolar Worlds

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INTRO

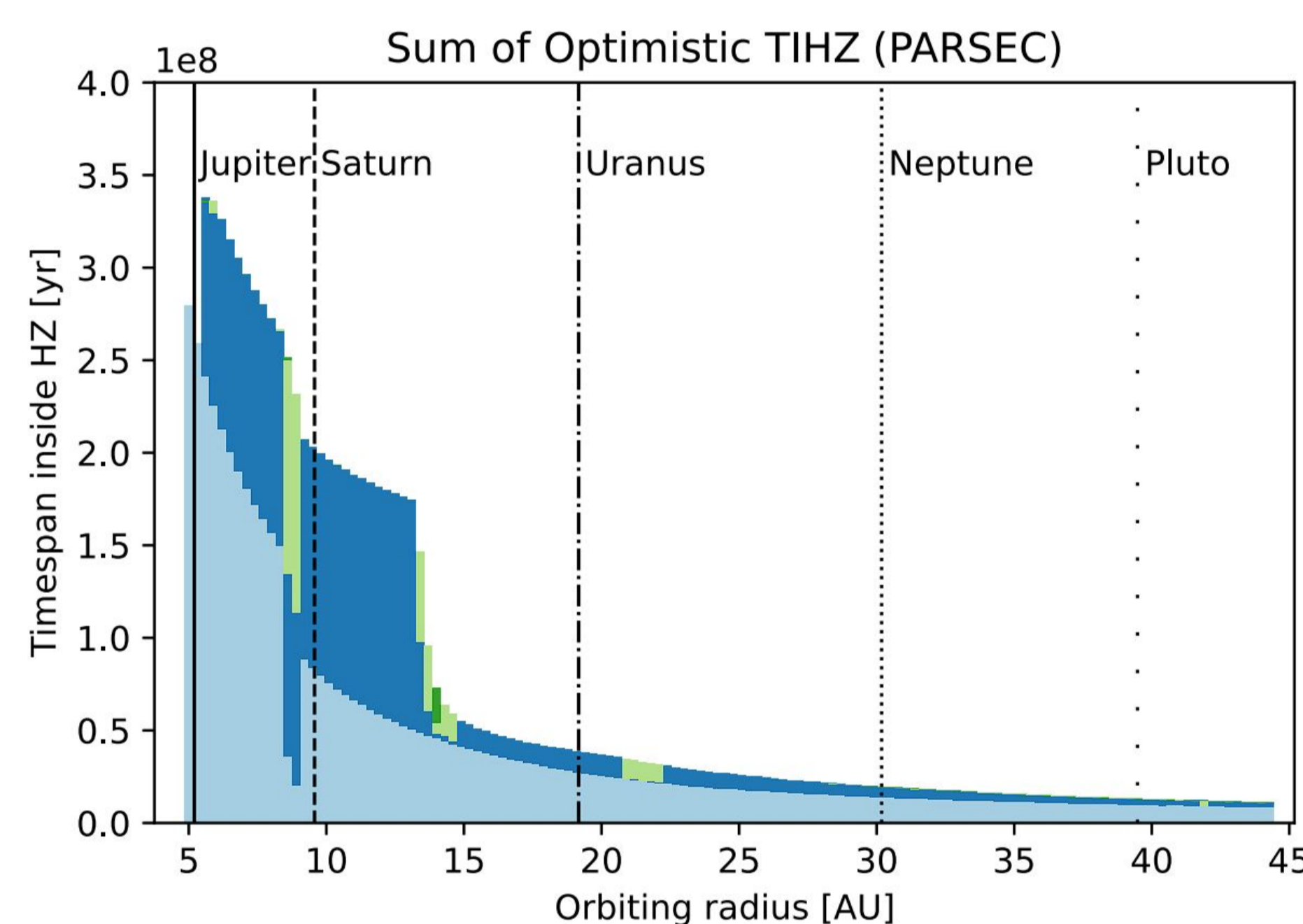
All outer planets of the solar system will enter the habitable zone as the Sun evolves to higher luminosities during post-main sequence phases of stellar evolution. How much time is spent inside the habitable zone informs us of the possibility for life to arise (and evolve) on that world.

METHODS

1. Extract evolution of luminosity and effective temperature for a Sun-like star from the PARSEC v2 and the Dartmouth stellar evolution databases.
2. Calculate the optimistic and conservative habitable zone limits of Kopparapu *et al.*, (2013) as a function of time.

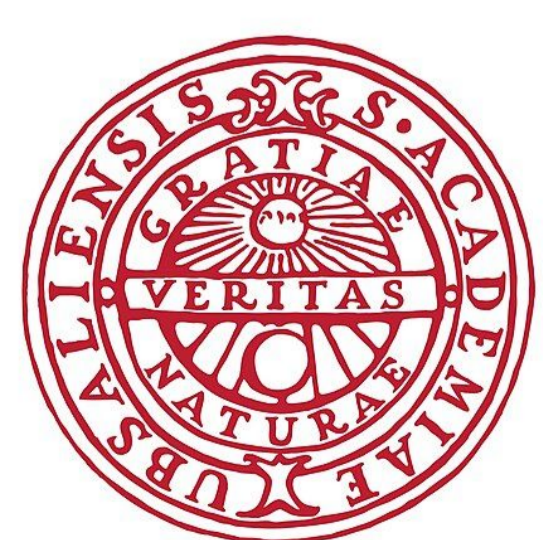
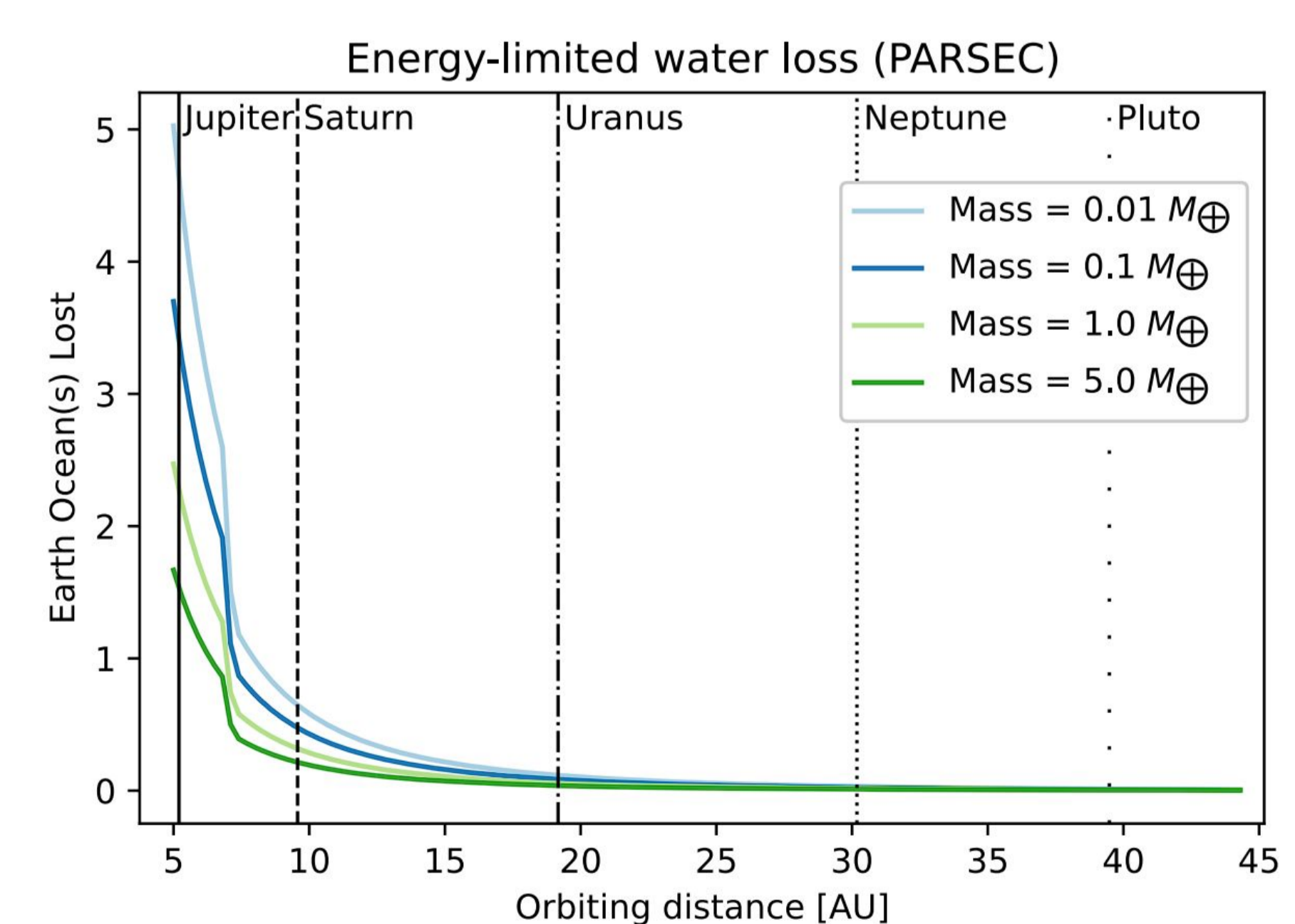
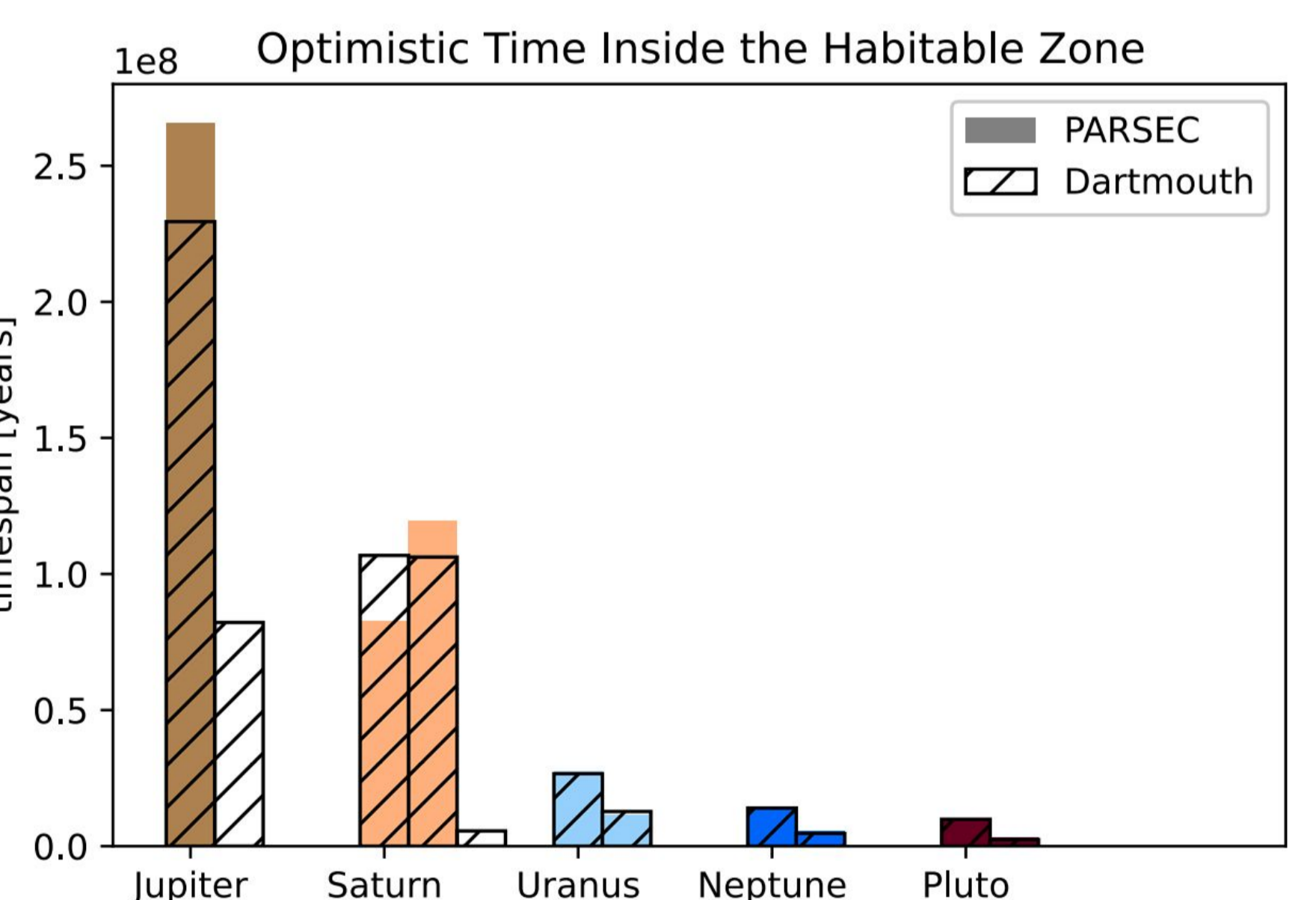
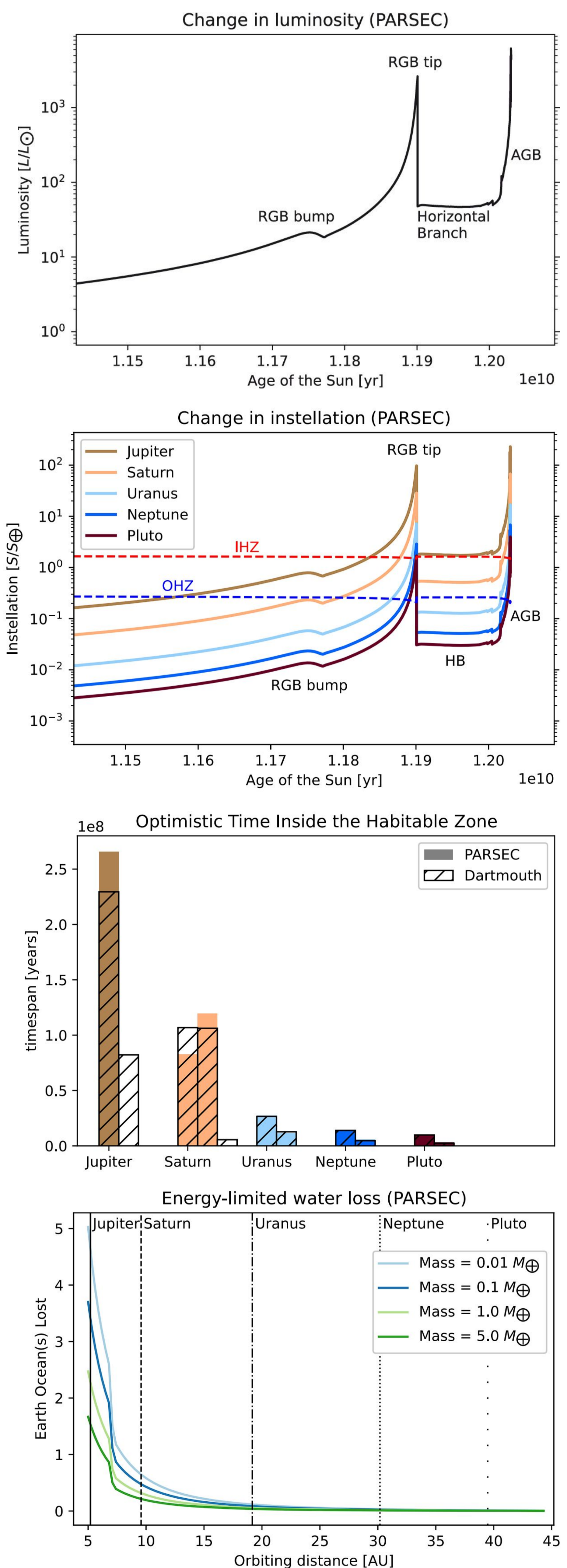
3. Identify habitable phases and calculate the time spent inside the habitable zone as a function of orbiting distance.

RESULTS



DISCUSSION

- Multiple habitable phases are found for the orbiting distances of all outer planets in the solar system.
- Outer worlds are habitable for a time comparable to the time for life to arise on Earth.
- At least one outer world is inside the habitable zone for a continuous ~5% of the star's total pre-AGB lifetime.



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