Crimson Skies and Another Pale Blue Dot: Can Life Begin Again?

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INTRODUCTION

Enceladus is one of the most promising moons in our Solar System for housing an environment necessary for prebiotic synthesis or life itself. This is due to the fact that aqueous plumes ejecting form the subsurface ocean penetrate the ice shell dispersing water and subsequent organics (if present). We hypothesize that as our Sun evolves into a red giant, the increase in stellar flux will result in higher average temperatures leading to increase the potential of habitability for Enceladus.

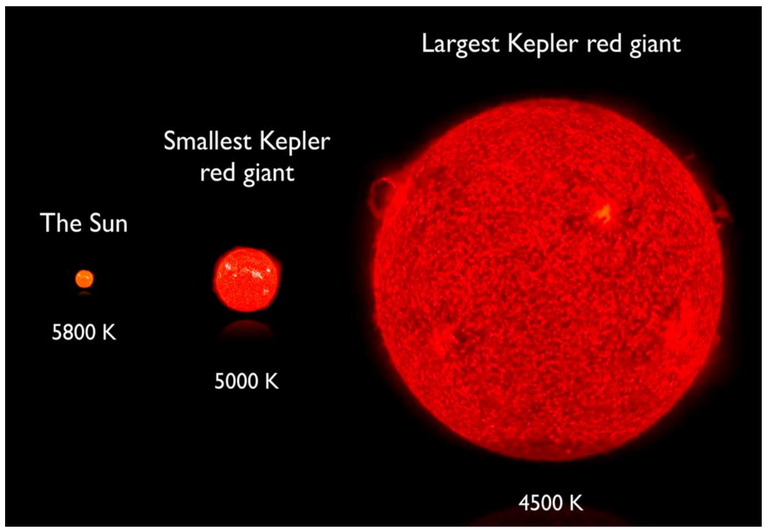

Figure 1: Evolutionary comparison between our current Sun and its predicted future.

METHODOLOGY

Using a Fortran based simulation modeling tool and a python API, ExoPlaSim, was used to model Enceladus. Running inside of terminal, we used our completely custom model parameters to run varied duration simulations. This was done to determine whether the increased flux from a transient main-sequence star would provide sufficient energy to the distant moons of Saturn to sublimate its thick ice shell creating more water and a habitability window through greenhouse effects of an exosphere. The primary alterations were made to flux of the parent star and atmospheric conditions.

METHODOLOGY

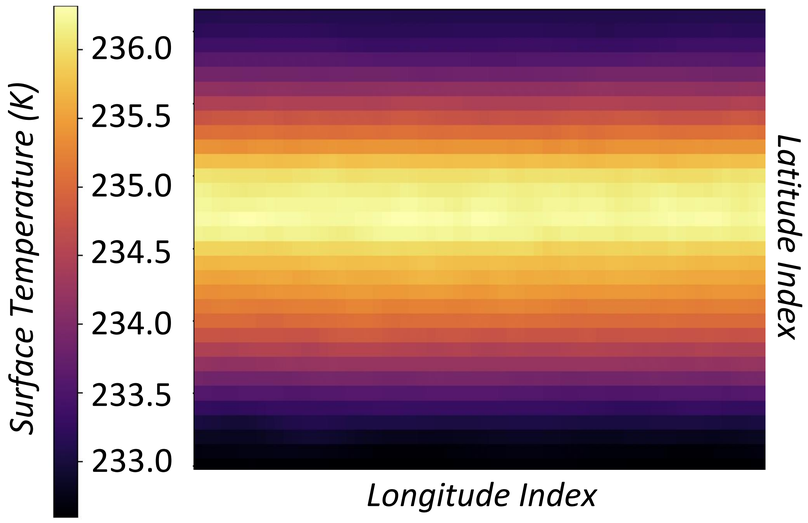

Figure 2: Enceladus Proxy Surface Temp. at 340 W/m^2 flux. Global coordinate map under present-day solar conditions.

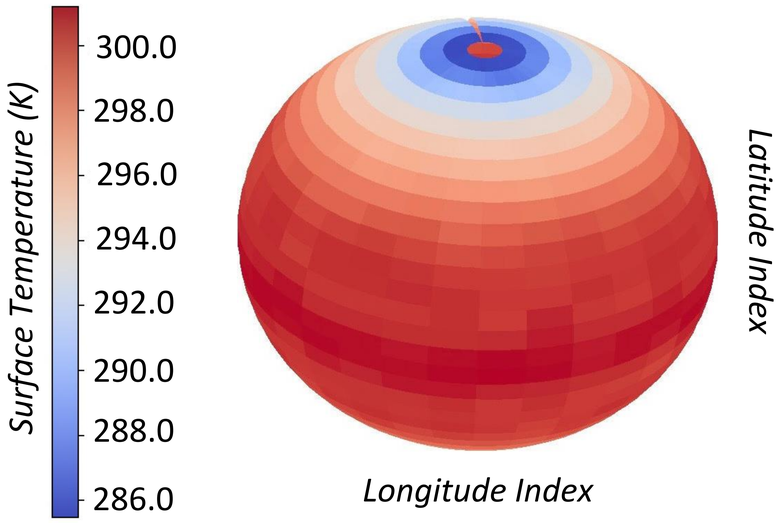

Figure 3: Surface Temp. under low atmospheric conditions and 1800 W/m^2 flux from present solar values.

CONCLUSION

After thorough testing, it is found that the transition from Main Sequence to Red Giant will create a secondary habitable environment capable of increasing prebiotic activity. These results provide crucial predictive data for future missions to icy moons, suggesting that post-main sequence stars may create transient habitable zones.

RESULTS

During the Main Sequence phase, habitability will remain hindered by the ~20km thick ice shell. However, as the Sun radially expands and the increase in radiative heating reaches Enceladus, we observed a dramatic increase in average maximum temperature. Based on the significant increase, the data collected supports our initial hypothesis of sublimination and melting at the subgiant phase. Based on the upper and lower flux boundaries, as the Sun transitions into the final White Dwarf phase, Enceladus will likely lose all potential for life in a deep freeze. After plotting the simulated observed maximum temperature, the relationship between surface temperature and stellar flux is $y = 64.5x^{0.204}$.

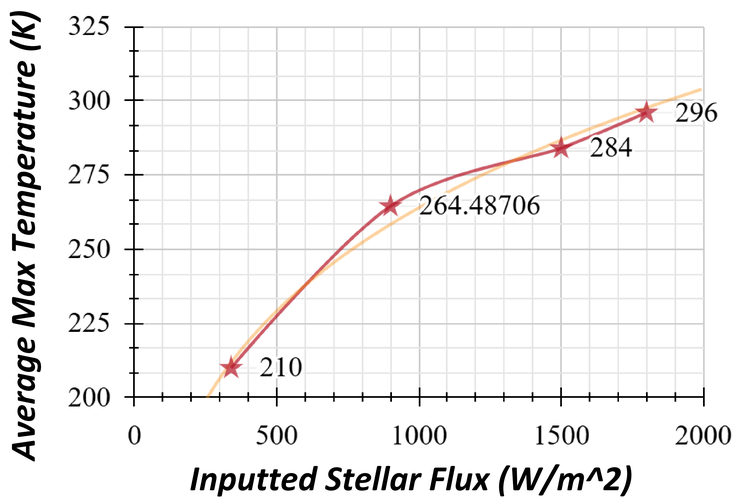

Figure 4: Simulated average max temperatures at various stellar fluxes.

REFERENCES

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