Impact of Extreme UV fluxes on Atmospheric Escape of the Hadean Earth and Earth-like Exoplanets

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Upper atmospheres of the Hadean Earth and Earth-like exoplanets were (are) exposed to large fluxes of X-ray and Extreme UV radiations. To understand the impact of XUV fluxes on atmospheric erosion, we adapted the Earth Global Ionosphere-Thermosphere Hydrodynamic Model (GITM). In particular, we examined the response of the upper atmospheres when the solar/stellar flux is increased up to 100 times of the current solar XUV flux. We find that while the early (Hadean) Earth’ s atmospheric erosion is driven by ion (O^+ and N^+) escape via polarization electric field, atmospheres of Earth-like exoplanets located in habitable zones around active K and M dwarfs should undergo massive hydrodynamic escape. We model the atmospheric expansion of both N_2-dominated atmospheres and quantify the effect of its potential enhancement to the rate of atmospheric escape. We also derive the response of the key cooling mechanisms: CO_2 and NO at an Earth-like exoplanet and discuss their observational signatures in the mid-IR band.

Keywords: Hadean Earth, exoplanets, atmospheric escape

