

Solar wind interaction with early and extrasolar planets

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We have investigated the solar (stellar) wind interaction with early planets in our solar system as well as extrasolar planets using a three-dimensional multi-species magnetohydrodynamic model. A particular emphasis is placed on the resulting atmospheric escape from the upper atmospheres of the planets. For the early planets in our solar system interacting with the solar wind, we apply observational data of solar proxies with different ages from the Sun in Time program for reconstructing the past Sun's radiation and solar wind intensities. As for the exoplanets we consider those exposed to intense X-ray and EUV radiation and stellar wind from an active M-type star. Because of the closer orbital distance of the habitable zones of low-mass active M-type stars compared to that of the solar system, terrestrial exoplanets within M-type star habitable zones are expected to be much more strongly influenced by stellar winds and dense plasma ejected from the host star by coronal mass ejections. Our study shows that intense X-ray and EUV radiation of active M-stars, together with the photochemical production of excited atomic oxygen results in atmospheric expansion and extended exospheres which can interact with the stellar plasma flow. We show the efficiency of nonthermal atmospheric erosion of CO₂-rich exoplanets, having the size and mass similar to that of the Earth, due to dense stellar plasma flows within close-in habitable zones of an active M-type star. The consequences of our results for the evolution of habitable planets within active M-type star environments are discussed.

Keywords: Solar wind interaction, Early planets, Extrasolar planets