Extreme Environments of Exoplanets Around Cool Evolved Stars. V. S. Airapetian[1] , K. G. Carpenter[1], J. Leake[1] , W. C. Danchi[1], L. Rastaetter[1] , [1]NASA/GSFC, Greenbelt, MD, US (Vladimir.airapetian@nasa.gov).

Introduction: Recent observations performed with the Kepler Space Telescope and radial velocity techniques using ground-based telescopes have discovered over 300 confirmed exoplanets. While a great majority of exoplanetary systems were discovered around main sequence K, G and M type stars, a number of Jovian type exoplanets have recently been detected around cool evolved stars [1,2]. Atmospheres of Neptune, Jupiter and super Jupiter-sized ($5\text{-}10M_J$) planets around K-M type giants, including α Tau, should be subject to large dynamic pressures from their massive and slow winds [3]. Here, we discuss the role of dynamic pressure from winds from giant stars on the magnetospheres of Jovian and Juper-Jovian planets.

Mass Loss From Giant Stars. Late-K and M-type giants (the 'non-coronal' giants) show signatures of extended chromospheres (0.16–0.4 stellar radii) and massive slow winds (from 10^{-11} to 10^{-6} M_{sun} yr^{-1}), whose typical velocities of ~40 km s^{-1} are considerably smaller than the expected escape velocities at the stellar surface. We have recently performed the first comprehensive analysis of physical conditions in the atmospheres of red giants and developed a 1.5D MHD model of the atmospheric dynamics using as a test case α Tau, a K5 III giant, driven by Alfvén waves generated by intensive convection in its photosphere. The model suggests that as waves propagate upward along open magnetic field lines in the stellar atmosphere, they become non-linear, develop plasma motions perpendicular to the background field in a partially ionized stellar chromosphere, and thus, introduce perpendicular electrical currents. These electric currents can be efficiently dissipated as Joule heating via Pedersen resistivity and explain the observed heating rates in the chromosphere of α Tau. The Lorentz force exerted by Alfvén waves on chromospheric plasma above the top of the chromosphere can explain the plasma acceleration to the terminal velocity, which is consistent with the observationally derived terminal wind velocity from α Tau (Robinson et al. 1998). The massive wind reaches its terminal velocitry at ~ 1 R_{star}. What effects would such wind have on magnetosphers of Jovian and terrestrial type exoplanets?

Effects on Magnetospheres of Jovian Exoplanets. We model the effects of a wind from a giant star, using the Space Weather Modeling Framework (SWMF) available through the Community Coordinated Modeling Center (CCMC). We assumed a steady state wind at mass loss rate of 10^{-11} M_{sun}/yr at the terminal velocity of 40 km/s. The dynamic pressure of this wind squezzes the magnetosphere of a Jovian planet with the magnetic moment varying between 0.1-1 μ_J up to 1-2 planetary radii and introduces a large Joule heating in the polar regions of a planet caused by the dissipation of the induced electric currents its ionosphere. Such heating (up to a few W/m^2) increases the ionospheric pressure scale height that promotes the mass loss from the planet.

Habitability of Terretsrial Type Exoplanets:
Exoplanets around cool evolved stars may be habitable for long periods of time, because as stars evolve of the main sequence up to the first ascent along the red giant branch, the luminosity of the stars increases very gradually, causing the habitable zone to move outward and to increase in width [5,6]. Because of this slow evolution planets and moons around giant planets at distances between 1.5 and several AU are habitable for periods from a few hundred million years to a few billion years depending on initial stellar mass and metallicity [6]. However, habitability as stars evolve is also affected by stellar winds, which can cause stripping of the atmospheres, depending on the type and strengths of the winds. We will discuss how these additional processes affect the potential for life around planets around evolved stars.

Conclusion. We have shown that extreme environments introduced by massive winds emanating from red giants promote large mass loss from exoplanets around them.

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