EPSC Abstracts,
Vol. 2, EPSC2007-A-00152, 2007
European Planetary Science Congress 2007

Solar Forcing and the loss of volatiles from the Earth-like planets - a comparison between Earth, Mars and Venus

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The solar wind and the solar XUV/EUV radiation constitute a permanent forcing of the upper atmosphere of the planets in our solar system. Solar forcing is a climate driver with evolutionary impact, affecting the habitability and chances for life to emerge on a planet. However, climate evolution is a complex issue that couples strongly to the evolution of the atmosphere and ionosphere on the planets. Earth is the benevolent climate case, while Venus and Mars marks the hot and cold extremes. This makes a comparison between the three planets particularly intriguing. New data from Mars Express (MEX) and Venus Express (VEX) is gradually increasing our understanding of the consequences of solar wind forcing of the upper atmosphere and ionosphere of Venus and Mars. A strong dependence of the ionospheric mass escape with solar wind forcing is observed. Besides solar wind forcing we also have the solar X-ray, EUV and UV radiation interacting with the planetary ionosphere and upper atmosphere. The combined solar forcing may vary substantially with time, on short-terms ranging from hours (e.g. CMEs) to decades (solar cycle). The long-term variability/trend is even more pronounced and important for the evolution of a planetary atmosphere, considering that the forcing terms may have been up to a factor of 1000 times higher in the early period of the solar system. However, knowing the impact of the short-term variability (up to a factor of 10) better, we should be able to improve our understanding of the long-term evolution as well. An empiric solar forcing model, comparing Earth, Venus and Mars, will be presented. The model provides a possible scenario for the climate digresses between the Earth-like planets.