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Solar forcing and the ionospheric heavy ion escape from Mars

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Solar forcing is the main driver for ionospheric plasma escape from the Earth-like planets. Solar X-ray, EUV and UV and the solar wind plasma, main ingredients in solar forcing, interacts directly or indirectly with the planetary ionosphere and atmosphere. This interaction/forcing may vary substantially with time, a consequence of the variable solar X-ray, EUV, UV and solar wind output. The "short-term" solar variability varies with time ranging from hours (e.g. CMEs) to decades (solar cycle).

We have studied the orbit-by-orbit short-term variability of the ionospheric ion outflow from Mars, using data from the ASPERA-3 experiment on Mars Express. 46 orbits were selected covering a range of solar wind properties, from high to low solar wind dynamic pressure. Solar wind properties were obtained from the inbound and outbound parts of each orbit. Assuming stable solar wind conditions throughout the traversal of the Mars induced magnetosphere, a comparision may be performed between the ionospheric outflow and the solar wind/sheath flux.

The study give evidence for a strong coupling between ion escape and solar wind momentum and energy flux. A fairly high correlation coefficient (R=0.85) between the solar wind dynamic pressure and the ion escape mass flux is obtained. The inferred ion escape mass flux varied up to two orders of magnitude in the data set. By normalizing the Mars obstacle response/size with the solar wind/sheath flux the correlation coefficient increases substantially (R=0.95)

We interpret the strong variability of the escape mass flux from Mars as being the consequence of variable solar forcing, solar forcing here based on the incident energy- and momentum of the solar wind flux. Both the solar EUV/UV and the solar wind variability matters, the latter being measured, the former inferred from the obstacle size (ionospheric boundary) that without any changes of EUV/UV would be mainly controlled by the solar wind/sheath flow.