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Long-Term Solar Cycle Effects on the Ion Escape from Mars

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The planetary ion escape rate from Mars is solar cycle dependent. During the recent transition from cycle 23 to cycle 24, the escape rate increased by a factor of 10, from 1·1024 s-1 (solar minimum) to 1·1025 s-1 (solar maximum) (Lundin et al., 2013). A regression analysis gives a high correlation between ion escape fluxes and the monthly averaged solar activity proxies F10.7 and Ri (sunspot number). Furthermore, there is a high correlation (0.89) between the monthly F10.7 and Ri, i.e. both proxies are related to the same phenomena, most likely the solar magnetic flux. Similarly, the concentration of radiogenic isotopes in the Earth's atmosphere is controlled by the solar-heliospheric magnetic flux, i.e. the concentration of radiogenic isotopes (e.g. C14 and Be10) can also be used as proxies for the solar magnetic flux. Radiogenic isotopes therefore offers another means to model the long-term ion escape, C14 data going back in time by 12 000 years. From a regression analysis of the relation between C14 and Ri, the empiric model can now be applied to derive Martian ion escape rates much further back in time, compared to that achieved using historic Ri data records (1700 years).
Notice that the model does not account for geological and atmospheric effects that may significantly vary on a long-term basis. Furthermore, the model cannot describe short-term effects caused by episodic solar events. Nevertheless, the model may serve as a useful tool to describe long-term effects of solar cycle activity on the Martian atmosphere and ionosphere.

References

Lundin, R., S.Barabash, M. Holmström, et al., Solar cycle effects on the ion escape from Mars, Geophys. Res Lett., 40, 6028-6032. 2013