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The precipitation of keV energetic oxygen ions at Mars and their effects during the comet Siding Spring approach

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Abstract

On October 19, 2014, the Siding Spring C/2013 A1 comet passed in the vicinity of Mars with a closest approach of ∼130,000 km with a heliocentric distance of 1.38 AU. The coma of the comet interacted with Mars, leading to the precipitation of molecules, ions, and dust particles. The most important atmospheric effect was the precipitation of atoms/molecules/ions, and especially atomic oxygen atoms and O^+ ions. Although the main gas forming the corona of comets is H_2O, the cometary coronal gas is partially ionized and dissociated by the EUV-XUV solar flux. To understand the atomic and molecular precipitation effects during such an encounter, it is therefore necessary to evaluate the flux of the neutral gas ejected from the comet, and to compute its composition after the dissociation/ionization.

We computed the photodissociation of the cometary gas for different solar conditions, and for the conditions of the comet encounter. In addition, using a pickup ion code, we computed the fluxes of the O^+ ions accelerated by the solar wind at energies greated than a keV. Using the Planetocosmic model, we computed the ionization in the atmosphere of Mars due to these species, and, using the M-GITM model, we computed the associated increase of the ion/electron density.

For the first time, an estimate of the flux of energetic O^+ ions picked up by the solar wind from the cometary coma is shown, with an increase of the O^+ flux above 50 keV by two orders of magnitude. While the ionization of Mars' upper atmosphere by precipitating O^+ ions is expected to be negligible compared to solar EUV-XUV ionization, it is of the same order of magnitude at 110 km altitude during the cometary passage.

References

[1] Gronoff, G., A. Rahmati, C. S. Wedlund, C. J. Mertens, T. E. Cravens, and E. Kallio (2014), The precipitation of keV energetic oxygen ions at Mars and their effects during the comet Siding Spring approach, *Geo. Res. Let.*, *41*, 4844–4850, 10.1002/2014GL060902.