O^+ escape rates at Venus under two IMF configurations

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Due to the lack of an intrinsic magnetic field at Venus, its upper atmosphere is directly exposed to the solar wind. The solar wind comes down to the top of the ionosphere and sweeps out its components into the space. The main component of the upper ionosphere of Venus is O^+ ions and their escape rate has been examined and estimated to be in the range of 10^{24}-10^{25} s^{-1} in previous studies [e.g., Fedorov et al. 2011]. However, it is still an open question what kind of solar wind conditions could cause significant O^+ outflow from Venus.

In the present study, we investigate O^+ escape rates depending on upstream interplanetary magnetic field (IMF) directions by using data from Analyser of Space Plasma and Energetic Atoms (ASPERA-4) and magnetometer (MAG) aboard Venus Express. The IMF condition has been classified into two cases: the perpendicular IMF case and the parallel IMF case, where the upstream IMF directs nearly perpendicular to the Venus-Sun line and nearly parallel to it, respectively. Using the data obtained in the period between 20 Jun 2006 and 20 Dec 2009, we collected 141 perpendicular IMF cases and 71 parallel IMF cases. Anti-sunward fluxes in the nightside region are statistically examined and the total O^+ escape rates are estimated: 2.4-5.8 x 10^{24} s^{-1} for the perpendicular IMF case and 2.0-2.8 x 10^{24} s^{-1} for the parallel IMF case. The escape ratio between the two cases is 1.2 to 2.1. Thus, we conclude that the upstream IMF direction does not significantly affect to the amount of O^+ outflow from Venus, while it changes the O^+ escape ratio by a factor of 2 at most.