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The origin of cold ion escape from Mars

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Cold ionospheric ions dominate the plasma escape from Mars. The flow pattern versus altitude, latitude and local time suggests a fairly symmetric transport of ionospheric plasma from the dayside into the nightside/tail region of Mars. An interesting aspect of the plasma escape from Mars is the large abundance of molecular ions. This implies that the outflow source region extends down to the lower ionosphere where molecular ions dominate. It also implies that the primary energization does not contribute much to the molecular dissociation. The gentle increase of ion velocity leading to escape may explain another finding, the outflow of ionized molecular hydrogen, H2+.
Because the cold ionospheric ion outflow is dominated by H+, H2+, O+ and O2+, we have made a stoichiometric analysis of the escape. Adding the total outflow of hydrogen and oxygen respectively, and taking their ratio ($\sum$H/$\sum$O), we get $\sum$H/$\sum$O $\approx$1.5. Considering measurement uncertainties and other hydrogen escape processes, such as thermal/Jeans escape, the escaping H and O atoms most likely originate from water. The obvious implication is that water, a minor constituent in the Martian atmosphere, is not only highly unstable and prone to escape Mars, but in fact dominates the non-thermal mass escape from Mars.