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Solar wind ion precipitation on Mars

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Solar wind ions (protons and alpha-particles) frequently precipitate onto the atmosphere of Mars. The precipitating particles contribute to the energy and matter flux into the ionosphere. The main reason for the solar-wind precipitation is likely the large gyroradii of hot particles in the magnetosheath compared to the size of the induced magnetosphere/magnetic barrier. Precipitating particles may modify the composition of the neutral atmosphere. As an example solar wind alpha-particles have been suggested to be an important source of neutral helium in the Martian atmosphere.
We use ion data from the ASPERA-3 instrument onboard Mars Express to estimate the net transfer of energy and matter from the solar wind to the atmosphere. Our results indicate that the Martian ionosphere is better protected from penetrating solar wind ions than previously thought, at least during solar minimum conditions. In addition, our findings suggest that the contribution of solar wind alpha-particles to the helium balance of the atmosphere is smaller than expected.
We also compare the ion precipitation during periods of quiet solar wind conditions and periods of solar wind pressure pulses. We show that the occurrence frequency of precipitation events is reduced by a factor 2-3 during periods when a solar wind pressure pulse reaches Mars, suggesting that the during this time the magnetic barrier becomes thicker in terms of solar wind ion gyroradii, making it more difficult for ions to precipitate.