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Simulated solar wind plasma interaction with neutrals exospheres: Mars and Titan comparison

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Venus, Mars and Titan do not possess a strong magnetic field and the incident plasma interacts directly with the ionosphere and the upper atmosphere of the body. The exosphere is ionized by solar photons, solar wind electrons and charge exchange between incident plasma ions and neutral constituents of the exosphere. This interaction is strong enough to modify the atmospheric escape and resulting atmospheric erosion of the body.
Titan spends most of its time in the magnetosphere of Saturn, but at times it can be in the magnetosheath or in the solar wind. When Titan is in the magnetosheath of Saturn, the interaction of the incident plasma, principally the solar wind plasma, is very similar to the interaction of the solar wind plasma with the Martian exosphere.
The solar wind plasma interaction with the neutral atmosphere is investigated for Mars and Titan with a three-dimensional multi-species hybrid model. The assumed neutral coronae of the two bodies have spherical symmetry and their radial density profiles are provided by Chamberlain's model. The Martian exosphere is made of atomic hydrogen and oxygen; the main constituents of the Titan exosphere are molecular hydrogen, nitrogen and methane. Ionization processes are included self-consistently through the specification of the ionization frequencies and cross sections.
Although the two bodies have similarities, the different chemical composition of the coronae, which have different ionization frequencies, induces a different planetary ion production and dynamics. Pickup ions densities and energies are presented and compared for Mars and Titan. The ion production is more efficient on Titan and lead to a strong interaction between the accelerated pick-up ions and the magnetic environment around the body.

Keywords: Solar wind and interactions with unmagnetized bodies; Ionization processes; Numerical simulation suites.