EPSC Abstracts
Vol. 14, EPSC2020-202, 2020, updated on 27 Nov 2021
https://doi.org/10.5194/epsc2020-202
Europlanet Science Congress 2020

Ultra-low frequency foreshock waves at Venus and Mercury in a global hybrid simulation

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We study the solar wind interaction with Venus and Mercury in a 3-dimensional global hybrid simulation where ions are treated as particles and electrons are a charge-neutralizing fluid. We concentrate on the formation of large-scale ultra-low frequency (ULF) waves in ion foreshocks and their dependence on the solar wind and interplanetary magnetic field conditions. The ion foreshock forms in the upstream region ahead of the quasi-parallel bow shock, where the angle between the shock normal and the magnetic field is smaller than about 45 degrees. The magnetic connection with the bow shock allows backstreaming of the solar wind ions leading to the formation of the ion foreshock. This kind of beam-plasma configuration is a source of free energy for the excitation of plasma waves. The foreshock ULF waves convect downstream with the solar wind flow and encounter the bow shock. We compare the waves between Venus and Mercury, and analyze the coupling of the ULF waves with the planetary ion acceleration at Venus.

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