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Modulation of ion escape by ultra-low frequency waves at Venus and Mars in a global hybrid simulation

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We investigate the effect of foreshock ultra-low frequency (ULF) waves on the solar wind induced heavy ion escape from Venus and Mars in a global hybrid model. The foreshock ULF waves are excited by backstreaming ion populations scattered at the quasi-parallel bow shock, and convect downstream with the solar wind. In the model, the waves affect magnetic and electric fields in the Venusian and Martian plasma environments causing fluctuations in the heavy ion acceleration processes such as the solar wind ion pickup. This leads to significant modulations in global escape rates of ionized planetary volatiles at the ULF wave frequency. We study this process in a global hybrid model, where ions are treated as particle clouds moving under the Lorentz force and electrons are a charge-neutralizing fluid. The analyzed simulation runs use more than 200 simulation particle clouds per cell on average to allow enough velocity space resolution for resolving foreshock, wave phenomena and ion escape processes self-consistently. We find that at Venus the global ion escape is modulated by the ULF waves even under nominal solar wind and IMF upstream conditions, while at Mars the modulation becomes significant under a strongly radial IMF orientation.