Global hybrid simulation of the solar wind interaction with the ionosphere of Venus: ion escape processes

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Due to the lack of a substantial intrinsic magnetic field, the upper atmosphere of Venus (and also Mars) is directly exposed to the solar wind flow, hence a large number of ions are expected to be removed by the solar wind interaction. While the ion escape via the pickup of exospheric particles has been intensively studied by many authors (cf. review by Moore and McComas [1992]), possible ion loss processes that take place at and below the ionopause, such as the Kelvin-Helmholtz (K-H) viscous process at the ionopause, are less well understood. As pointed out by Luhmann and Bauer [1992], processes operative ``at and below'' the ionopause may be important for the ion escape from Venus (and also from Mars) because the estimated rates of the ion production ``above'' the ionopause [e.g., Zhang et al., 1993] are small compared to the ion escape rates suggested by the spacecraft measurements [Brace et al., 1987]. In this paper, a two-dimensional global hybrid simulation model of the solar wind-Venus ionosphere interaction is used to investigate the relative importance of the ion escape processes. Our two-dimensional model predicts that the K-H processes at the ionopause (viscous process, diffusive process, and possibly plasma cloud ejection) would play a dominant role in the ion removal from the planet.