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Variability of precipitating ion flux on Mercury's surface

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This paper presents new tracings of ions in Mercury's magnetosphere that model the variability of the solar wind, sodium and potassium ion fluxes on the surface. The magnetic field is given by a modified version of the analytic Toffoletto-Hill (TH93) open magnetosphere model, which also gives the electric potential along open field lines. Its applicability is extended into the closed field line region by the Ding (1995) potential solver, which computes the realistic electric potential that is self-consistent with the magnetic field. Four cases of the solar wind and the interplanetary magnetic field (IMF) are tested, two at aphelion and two at perihelion. Photoions are launched from the scale height for each species, while solar wind ions are backtraced from the surface to the magnetopause. Photoion results reveal that impacts dominate. The prediction that recycling reduces by a factor of 1.5 at perihelion could help explain why the sodium atmosphere is denser at aphelion. In addition, tracings of Hermean ions show that differential escape losses do not exist for potassium photoions such that may explain the variable Na/K ratio in the Hermean atmosphere. Solar wind ion tracings (H+; O+7) confirm that precipitation to Mercury's surface may happen along closed field lines not only at perihelion, but even at aphelion for realistic cases of southward IMF. The computed total sputtering flux increased by a factor of 1.7 from aphelion to perihelion. We conclude that ion sputtering caused by the solar wind can explain the high-latitude variability seen in imaging data of Mercury's sodium atmosphere.