The Exosphere of Ganymede from Sputtering and Sublimation Processes Combined

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moons

Measurements taken by the Galileo plasma instrument when the spacecraft passed Ganymede at an altitude of only 261 km indicated the presence of a supersonic outflow of gas composed solely of H+. The source of this gas is plainly water vapor and other molecules sputtered from or sublimated from the surface. The model presented here is a look at processes near the surface, leading to the formation of the exosphere. The magnitude of the neutral atmosphere source from both sublimation and sputtering was calculated as a function of latitude, longitude, and local hour angle, for a particular subset of Ganymede longitudes. The sublimation model is a surface-thermal model; an integration of a 1-D heat conduction equation, subject to a surface boundary condition, over the entire surface, for a diurnal cycle. The surface itself was modeled as a segregated surface, with differing thermal terrain types (ice vs. rock) modeled accordingly. Surface brightness temperatures from the Galileo PPR experiment were used to estimate the extent of varying terrain types on the surface, and Voyager albedo measurements on a 1° x 1° scale were folded into the surface temperature calculation. The magnitude of volatile sublimation was calculated from the temperature distribution of the selected satellite surface area. Diurnal variation of sputtering was estimated using a function for volatile production from sputtering which is dependent upon the surface temperature of the substrate, after Bar-Nun, et al., [1985]. Results from the model were used to construct a Knudsen number map of the near surface vapor on a 10° x 10° scale.

Results from this model show a maximum (noon) subsolar surface temperature of 153 K, very spotty regions of vigorous sublimation, a total global water production from (upward) sublimation of 10^{27} molecules/s. These results in large part are contingent upon the assumed near surface regolith conditions and the ice/silicate volume fraction. The atmosphere resulting solely from the sublimation process is in a nearly collisionless environment with potential collisional environments near very icy regions at local noon. Preliminary estimates of the diurnal variation in sputtered flux do not appear to change this environment. The sublimated volatiles do not appear to be sufficiently energetic for molecules to make large lateral excursions in the atmosphere. A statistical study of the trajectories and energies of molecules released from the surface as a result of the sublimation and sputtering processes, after Sieveka and Johnson [1982], will be conducted this summer, and results will be presented.