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Modeling Atmospheric Depth Effects of the Jovian X-ray Auroras

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Auroral emissions from Jupiter have been observed across the photon spectrum including ultraviolet and X-ray wavelengths. X-ray emissions with a total power of about 1 GW were observed by the Einstein Observatory, the Roentgen satellite, Chandra X-ray Observatory, and XMM-Newton. Previous theoretical studies [Cravens et al. 1995, Kharchenko et al. 1998, Liu and Schultz 1999, Kharchenko et al. 2006, 2008, Hui et al. 2009 and Ozak et al. 2009] have shown that precipitating energetic sulfur and oxygen ions can produce the observed X-rays. Sulfur and oxygen ions in the outer magnetosphere are presumably accelerated by field-aligned potentials up to energies of about 1 MeV per nucleon, before they precipitate into the high latitude atmosphere [Cravens et al. 2003]. Most of the incident ions are stripped from their electrons in collisions with atmospheric neutrals and subsequent charge-transfer collisions of highly-charged ions emit X-ray photons as they de-excite to the ground state. This study presents the results of an ion precipitation Monte Carlo simulation, where X-ray luminosities are determined and atmospheric altitude effects as well as incident angle dependence are considered. Updated cross sections for ionization, charge transfer and stripping collisions are used in the model, as well as an empirical stopping power. The results of this simulation will be compared to the equilibrium charge model presented by Ozak et al. [2009], which found opacity of the atmosphere for the outgoing X-ray photons to be important for the simulated spectrum for incident ion energies greater than a 2 MeV per nucleon. The quenching of long-living metastable oxygen and sulfur ions and their effect for the spectrum will also be analyzed.