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Modeling DSX Plasma Interactions Using Nascap-2k

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Wave Particle Interaction Experiment (WPIx) will be conducted on the DSX (Demonstration and Science eXperiments) mission to be launched in 2019. WPIx broadcasts VLF (Very Low Frequency) into the MEO (Medium Earth Orbit) environment using an 80 meter tip-to-tip dipole antenna biased to kilovolt potentials. The spacecraft-plasma interactions code Nascap-2k is used to model the dynamic plasma sheath during VLF transmission. Simulations have been performed for several cases of plasma density, plasma temperature, VLF frequency, and applied voltage. Because a positive antenna element easily collects electrons from the environment, most of the time one antenna element is near zero potential and the other is negative near the full applied bias. The sheath around the negative element is very large at MEO densities. While a small ion current is collected by the antenna, most of the ions accelerated into the sheath orbit the antenna and leave at high energy when the potential is relaxed. The current flow in the antenna is computed from the surface electric field using a pseudopotential method. This current is used to obtain the antenna impedance (capacitance and phase shift) and its dependence on plasma and operational parameters. A similar pseudopotential approach gives the electron current in the near-field plasma, along with the energy imparted to plasma electrons and their flow along magnetic field lines. Finally, the spectrum of ions to the LEESA (Low Energy ElectroStatic Analyzer) particle detector during VLF transmission is obtained from ion macroparticles striking the surface containing LEESA. These analyses will aid in planning operations and understanding results for WPIx.

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