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Auroral energy deposition at Saturn

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Abstract

Like all giant planets in the Solar System, Saturn is known to have an upper neutral atmosphere far hotter than what is expected from solar EUV heating alone. While the measured low to mid-latitude exospheric temperatures on Saturn range from 300 to 500 K, solar heating alone induces an exospheric temperature below 180 K. A major, additional source of energy originates in the high latitude regions, where magnetospheric currents can deposit globally several tens of TW, more than 50 times the absorbed solar EUV value, as thermal energy, primarily via Joule heating.

Using a General Circulation Model (GCM) of the Saturn upper atmosphere and a kinetic, transport model applied to suprathermal electrons, we have assessed the response of Saturn ionosphere to auroral electron precipitation in a self-consistent manner and evaluated the importance of the auroral ionosphere at Saturn as a heating source of the neutral atmosphere. We find that including the effects of ion drag is also crucial for redistributing energy from the polar to equatorial regions. Ion drag reduces polar temperatures, bringing them closer to values observed through H_3^+ emissions. As for mid- and low latitudes, the temperatures are somewhat increased. Our calculations suggest that magnetosphere-ionosphere-thermosphere coupling may play a key role for solving the energy crisis at Saturn and other gas giants.