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Saturn lightning storms and their implications on Saturn's atmosphere

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Abstract

Thunderstorms in Saturn's atmosphere are intermittent, lasting for a few days to several months. The storms can be observed by ground-based optical telescopes, and several instruments aboard the Cassini spacecraft deliver valuable information about them. The Radio and Plasma Wave Science (RPWS) instrument records strong radio waves from Saturn lightning termed Saturn Electrostatic Discharges (SEDs). Lightning is a good indicator of vertical convection, and the visible plumes are high-altitude clouds that overshoot the outermost ammonia cloud layer, transporting cloud particles as well as particles produced by the lightning itself to levels above 1 bar. In December 2010 the most powerful thunderstorm of the Cassini era emerged in the northern hemisphere at a latitude of 35° north with flash rates about an order of magnitude higher compared to previous SED storms. The storm reached a latitudinal extension of ~10,000 km within 3 weeks after its start, much larger than previous thunderstorms that were ~2000 km in size and observed at a latitude of 35° south. The storm developed an elongated eastward tail that encircled the whole planet by February 2011. The main SED storm cell resided in the head of the storm, but continuously broadened in longitude with time. The switch in hemispheres of the lightning storms reveals a possible seasonal influence since Saturn experienced vernal equinox in August 2009. An estimation of the power of the storm revealed quantities comparable to Saturn's total emitted power. Hence, giant storms like this might be a significant term in the internal heat budget.