EPSC Abstracts
Vol. 8, EPSC2013-503-2, 2013
European Planetary Science Congress 2013

Progress and challenges in understanding magnetosphere-atmosphere coupling and space weather on Saturn

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Abstract

The giant planets in our solar system such as Saturn and Jupiter represent fascinating worlds which exhibit a range of electro-magnetic, collisional and chemical processes coupling the upper atmospheres with the magnetospheres and some of their moons. Calculations of the coupling between these regimes require uniting different modelling approaches for each of the physical regimes, a major practical challenge. Yet, key currently unresolved science questions, including the giant planet "energy crisis", the origin of highly variable and structured ionospheres of Jupiter and Saturn as well as the variation of Saturn's apparent rotation rate all rely on understanding magnetosphere-atmosphere coupling.

Using our Saturn Thermosphere-Ionosphere model (STIM) with inputs from the University of Michigan Block Adaptive Tree Solar wind Roe-type Upwind Scheme (BATSRUS) MHD model, we calculate the magnetosphere influence on Saturn's upper atmosphere in unprecedented detail. We show results from recent calculations which form important puzzle pieces to help resolve the above science questions. In particular, we also present time-dependent calculations of the response of Saturn's upper atmosphere to changes in solar wind pressure – a step towards understanding "space weather" on Saturn.