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Storm and Substorm Dynamics at Saturn?

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The Ion and Neutral Camera (INCA) on board the Cassini mission imagesmagnetospheric proton and O+ distributions in the ∼10-300 keVrange in the Saturnian magnetosphere. The most outstanding feature ofthe global energetic ion distributions is the occurrence of gradualincreases (∼1 d) on the nightside of Saturn, followed bycorotation lasting several days of a localized distribution. We havestudied the interplanetary magnetic field (IMF) obtained from theCassini Magnetic Field Experiment (MFE), and solar wind speed obtainedfrom the Cassini Charge Energy Mass Spectrometer (CHEMS), when Cassiniwas outside the magnetosphere. Through comparisons with the dynamicsand morphology of the global energetic ion distributions obtained byINCA images, we find a behavior the resembles that global behavior ofthe terrestrial ring current during geomagnetic storms observed by theHigh Energy Neutral Atom imager on board the IMAGE mission: Gradualincreases on the nightside at Saturn appear to be related toconditions that lead to high convection (northward IMF and highsolar-wind pressure) - the storm mainphase. At Earth, such periodscorrespond to strong magnetospheric convection and a small Alfvenlayer, so that hot plasma is convected from the tail sunward to thenightside, where particle distributions reach their highest intensity (partial ring current). The sudden transition to a localizeddistribution corotating with a period about the same as theperiodicity determined from Saturn Kilometric Radiation (SKR)measurements, appears to be related to changes in the solar windleading to decreased convection (southward IMF and lower solar windspeed) - the storm recovery phase. At Earth, such periods correspondto weak magnetospheric convection and a larger Alfven layer enclosingthe previously convection-dominated plasma so that the region becomesdominated by magnetic drifts (corotation dominated at Saturn). In association with the storm-like periods, substorm-like activityhave also been observed at Saturn and reveals a tendency for efficientenergization of oxygen relative to hydrogen in energetic ionacceleration events. Efficient energization of O+ (over protons) isalso observed during terrestrial substorms, when O+ is extracted fromthe ionosphere and non-adiabatically energized during the substormdipolarization process.