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Time Variability of the Saturn's Ring Atmosphere and Ionosphere

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Abstract:
The detection of O_2^+ and O^+ ions over Saturn's main rings by the Cassini INMS and CAPS instruments at SOI confirmed the existence of the ring atmosphere and ionosphere. The source mechanism was suggested to be primarily photolytic decomposition of water ice tproducing neutral O_2 and H_2 (Johnson et al., 2006). Therefore, we have predicted that there would be seasonal variation for the ring atmosphere and ionosphere (Tseng et al., 2010). However, the situation is also complicated by water products from the Enceladus' plumes, which, although variable, do not appear to have a seasonal variability (Smith et al., 2010). That is, the deposition of OH and O from the Enceladus' plumes onto the A-ring can also produce O_2 through grain-surface chemistry contributing to the ring atmosphere (Tseng and Ip, 2011). The non-detection (or upper limit) of H_2^+ ions over the B-ring by the Cassini CAPS has helped constrain the source rates . Now the importance of the seasonal variation is being tested by our examination of the CAPS plasma data between 2.5 and 3.5 R_S from 2004 to 2010 (Elrod et al. 2011). We have shown that there are significant variations over that time period in the plasma density and composition. Since the ring atmosphere is also affected by the ring particle temperatures, which were ignored in our earlier model, and, possibly, by solar high energy particle radiation, we developed a one-box ion chemistry model to explain the complex and highly variable plasma environment that was observed by the CAPS instrument on Cassini.