Seasonal Variability of Saturn's Ring Atmosphere and Its Effects

Wei-Ling Tseng[1,2], Meredith K. Elrod[1] and Robert E. Johnson[1]
1. University of Virginia, Charlottesville, VA 22904, USA (Tseng: wt7b@virginia.edu)
2. Southwest Research Institute, San Antonio, TX 78228, USA

Introduction: The detection of O_2^+ and O^+ ions over Saturn's main rings by the Cassini INMS and CAPS instruments at Saturn orbit insertion (SOI) in 2004 confirmed the existence of the ring atmosphere and ionosphere. The source mechanism was suggested to be primarily photolytic decomposition of water ice producing neutral O_2 and H_2 [1]. In addition, the dissociated component of the ring atmosphere and Enceladus' torus material deposited on the ring particles are recycled to neutral O_2 via grain-surface chemistry [2]. Therefore, we predicted that there would be seasonal variations in the ring atmosphere and ionosphere due to the orientation of the ring plane to the sun [3,4]. This affects the both O_2 production, due to the change in the UV flux, and the ring particle temperatures due to the change in the net solar heating. The atoms and molecules scattered out of the ring atmosphere by ion molecule collisions can be injected into Saturn's upper atmosphere and into the inner magnetosphere [1,3,4,5]. This scattering component should also exhibit seasonal variations causing a seasonal variation in the magnetospheric O_2^+ ion density.

Using the data from the Cassini Plasma Instrument, we found that the plasma density, composition and temperature in the region from 2.5 to 3.5 Rs exhibited large variations between 2004 and 2010 which we proposed were seasonal [6]. Christon et al. (2011) [7] found a similar result for the energetic O_2^+. Since the plasma ions have relatively short lifetimes, and respond rapidly to the changing oxygen supply rate, we used a one-box chemistry model in this region to show that the observed temporal variations are primarily due to the predicted seasonal variation in the ring atmosphere, and are also consistent with a compressed magnetosphere at Casssini SOI [4]. In this paper we review the modeling of the seasonal ring atmosphere and discuss the potential impacts.

References:

[1] Johnson et al. (2006) *Icarus* 180, 393-402

[2] Tseng and Ip (2011) *Icarus* 212, 294-299

[3] Tseng et al. (2010) *Icarus* 206, 382-389

[4] Tseng et al. (2011) arXiv:1112.5511 *(submitted to P&SS)*

[5] Martens et al. (2008) *GRL* 35, L20103

[6] Elrod et al. (2011) accepted by JGR

[7] Christon et al. (2011) Fall AGU meeting