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Photochemistry in Saturn's Ring-Shadowed Atmosphere: Modulation of Key Molecules and Observations of Dust Content

Scott G. Edgington (1), Sushil H. Atreya (2), Eric H. Wilson (2,3), Kevin H. Baines (1,4), Robert A. West (1), Gordon L. Bjoraker (5), Leigh N. Fletcher (6), and Tom Momary (1)

(1) Jet Propulsion Laboratory/CalTech, Pasadena, United States (scott.g.edgington@jpl.nasa.gov), (2) University of Michigan, Ann Arbor, MI, USA, (3) Space Environment Technologies, Los Angeles, CA, USA, (4) University of Wisconsin-Madison, WI USA , (5) NASA Goddard Space Flight Center, MD, USA, (6) University of Oxford, Oxford, UK

Cassini has been orbiting Saturn for over ten years now. During this epoch, the ring shadow has moved from covering a large portion of the northern hemisphere to covering a large swath south of the equator and continues to move southward. At Saturn Orbit Insertion in 2004, the ring plane was inclined by ~24 degrees relative to the Sun-Saturn vector. The projection of the B-ring onto Saturn reached as far as 40N along the central meridian (~52N at the terminator). At its maximum extent, the ring shadow can reach as far as 48N/S (~58N/S at the terminator). The net effect is that the intensity of both ultraviolet and visible sunlight penetrating into any particular latitude will vary depending on both Saturn's axis relative to the Sun and the optical thickness of each ring system. In essence, the rings act like venetian blinds.

Our previous work [1] examined the variation of the solar flux as a function of solar inclination, i.e. ~8 year season at Saturn. Here, we report on the impact of the oscillating ring shadow on the photolysis and production rates of hydrocarbons in Saturn's stratosphere and upper troposphere, including acetylene, ethane, propane, and benzene. Beginning with methane, we investigate the impact on production and loss rates of the long-lived photochemical products leading to haze formation are examined at several latitudes over a Saturn year. Similarly, we assess its impact on phosphine abundance, a disequilibrium species whose presence in the upper troposphere is a tracer of convective processes in the deep atmosphere.

We will also present our ongoing analysis of Cassini's CIRS, UVIS, and VIMS datasets that provide an estimate of the evolving haze content of the northern hemisphere and we will begin to assess the implications for dynamical mixing. In particular, we will examine how the now famous hexagonal jet stream acts like a barrier to transport, isolating Saturn's north polar region from outside transport of photochemically-generated molecules and haze.

[1] Edgington, S.G., et al., 2012. Photochemistry in Saturn's Ring Shadowed Atmosphere: Modeling, Observations, and Preliminary Analysis. Bull. American. Astron. Soc., 38, 499 (#11.23).