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Seasonal Effects in the Saturn System

L. Spilker

(1) Jet Propulsion Laboratory/Caltech, Pasadena, CA, USA, (Linda.J.Spilker@jpl.nasa.gov/1-818-354-1647)

Abstract

The Cassini-Huygens exploration of the Saturn system has returned a wealth of scientific data on Saturn, Titan, Enceladus, and the other icy satellites, the rings, and the magnetosphere. Seasonal changes are being observed in the Saturn system as northern spring progresses toward summer.

After more than seven years of close study, Cassini still unveils new scientific discoveries that continue to amaze us. Some highlights of recent seasonal discoveries are given below.

1. Introduction

Cassini-Huygens arrived at Saturn in July 2004, roughly two years after the northern winter solstice, and has been in orbit around Saturn through spring equinox (August 2009), to date completing its Prime and Equinox Missions, and the first two years of a seven-year phase called the Solstice Mission. The Solstice Mission will return science in a previously unobserved seasonal phase from northern spring to summer solstice. The Solstice Mission continues to provide new science; first, by observing seasonally and temporally dependent processes on Saturn, Titan, Enceladus and other icy satellites, and within the rings and magnetosphere; second, by addressing new questions that have arisen during the mission thus far, for example providing qualitatively new measurements of Enceladus and Titan which could not be accommodated in the earlier mission phases; and third, by conducting a close-in mission at Saturn that would provide a unique comparison to the Juno observations at Jupiter.

2. Saturn Storm

On Dec. 5, 2010, Cassini first detected a Saturn storm that continued for over eight months at ~35 degrees north latitude. Images from Cassini's cameras showed the storm wrapping around the entire planet covering approximately 4 billion square kilometers, about eight times the surface area of Earth. Both professional and amateur astronomers also observed the storm, complementing Cassini data. The visible signs of the storm disappeared in July although a far infrared signature remains as the turbulent atmosphere equilibrates.

The signals from the new storm's lightning strikes were analyzed using data from the radio and plasma wave science (RPWS) instrument which showed the lightning flash rate as much as 10 times more frequent than during other storms monitored since Cassini's arrival in 2004. At its most intense, the storm generated more than 10 lightning flashes per second.

3. Spring Rain on Titan

Northern spring brought large showers to Titan, soaking and darkening its surface. Methane rain fell in the equatorial region, and its effects were clearly seen in Cassini's images. Extensive rain from large cloud systems, spotted by Cassini's cameras in late 2010, darkened a portion of the equatorial region. The best explanation is these areas remained wet after methane rainstorms. These surface changes appear to be an effect of the changing seasons. Later observations show the surface drying out and returning to its earlier appearance.

4. Proximal Orbits

The final 42 orbits of the Cassini Solstice mission will offer unique opportunities for new discoveries and groundbreaking science as well as further prospects to observe seasonal and temporal change. This Proximal orbit phase, proceeded by multiple orbits passing close to Saturn's F ring, is similar in many ways to the Juno mission at Jupiter. The final orbits are situated in between the innermost ring and the top of Saturn's atmosphere. This phase would end with the spacecraft ultimately vaporizing in Saturn's atmosphere in accord with anticipated planetary protection requirements.

These orbits enable unique science, including: determination of Saturn's internal structure, the higher order moments for both the gravity and magnetic fields, and possibly the internal rotation rate for Saturn; measurement of Saturn's ring mass, currently uncertain by about an order of magnitude; in situ measurements of Saturn's ionosphere, innermost radiation belts, and D ring, and possibly in situ measurements of Saturn's auroral acceleration region; highest resolution studies of the main rings; and high resolution Saturn atmospheric studies. The Cassini magnetometer would determine the higher order coefficients of the magnetic field, which may allow a determination of the depth of Saturn's metallic core.

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