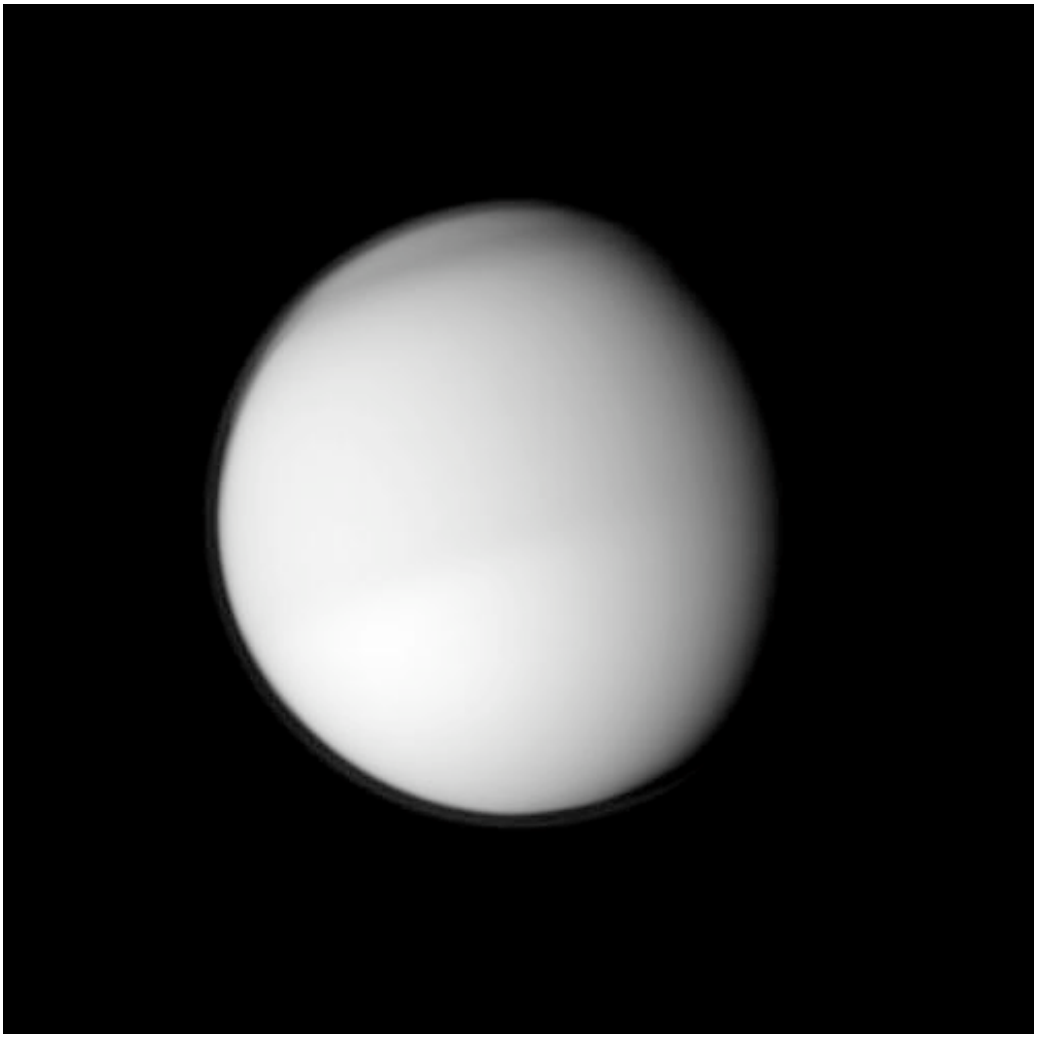
C A S S I N I



T I T A N 1 3 1 T I (T 6 8)
MISSION DESCRIPTION

May 20, 2010

Jet Propulsion Laboratory
California Institute of Technology

Cover image: Titan's Two Halves

Two different seasons on Titan in different hemispheres can be seen in this image. The moon's northern half appears slightly darker than the southern half in this view taken in visible blue light by the Cassini spacecraft.

See Two Halves of Titan to learn more about seasonal change on Titan.

Also visible in this image are hints of atmospheric banding around Titan's north pole. To learn more about the northern bands, see Northern Bands.

This view looks toward the Saturn-facing side of Titan (5,150 kilometers, or 3,200 miles across). North on Titan is up and rotated 45 degrees to the left.

The image was taken with the Cassini spacecraft narrow-angle camera on March 22, 2010. The view was obtained at a distance of approximately 2 million kilometers (1.2 million miles) from Titan and at a Sun-Titan-spacecraft, or phase, angle of 38 degrees. Image scale is 12 kilometers (7 miles) per pixel.

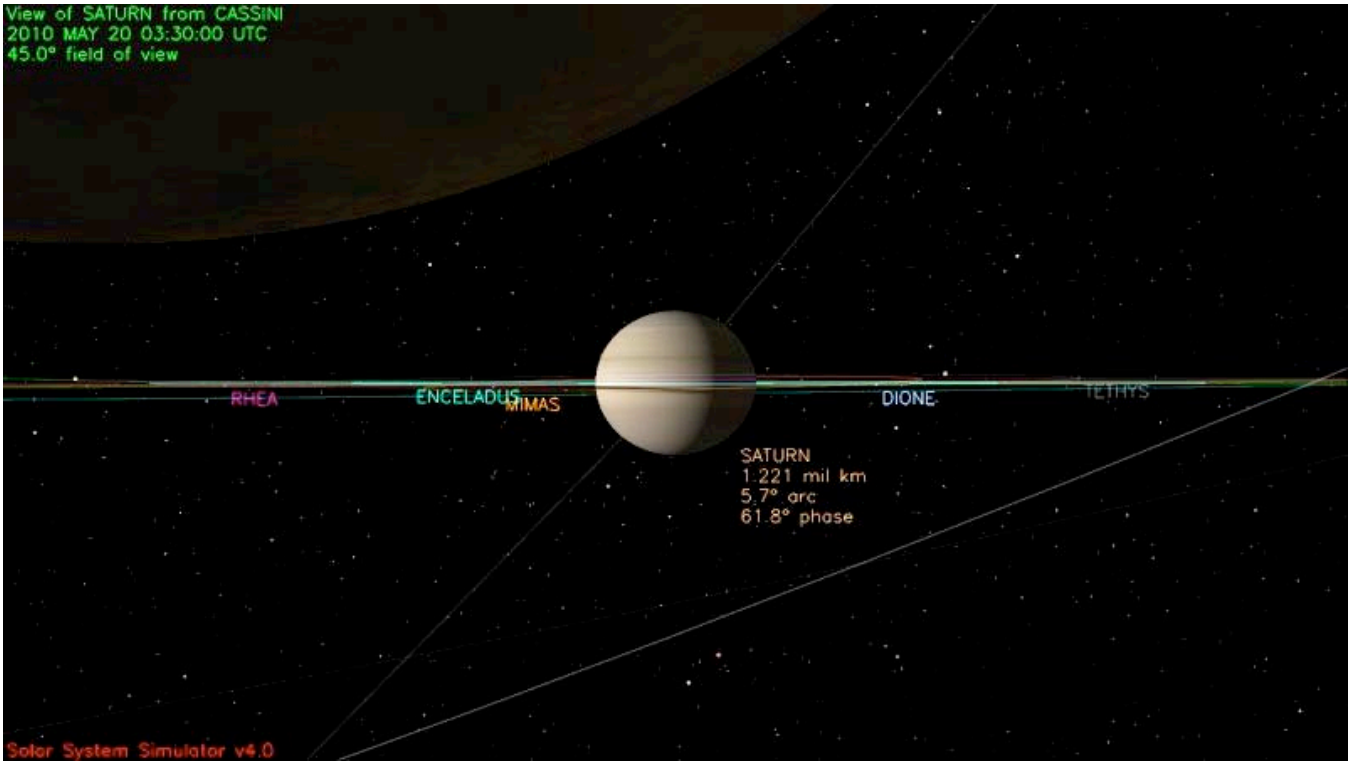
The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. The Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, manages the mission for NASA's Science Mission Directorate, Washington, D.C. The Cassini orbiter and its two onboard cameras were designed, developed and assembled at JPL. The imaging operations center is based at the Space Science Institute in Boulder, Colo.

Credit: NASA/JPL/Space Science Institute

1.0 OVERVIEW

After a 45 day interval since last visiting Titan, Cassini returns to Saturn's largest moon for the mission's sixty-ninth targeted encounter with Titan. The closest approach to Titan occurs on Thursday, May 20 at 140T03:24:20 spacecraft time at an altitude of 1,400 kilometers (~870 miles) above the surface and at a speed of 5.9 kilometers per second (~13,250 mph). The latitude at closest approach is 49 degrees S and the encounter occurs on orbit number 131.

This encounter is set up with two maneuvers: an apoapsis maneuver on May 10, and a Titan approach maneuver, scheduled for May 15. T68 is the first outbound flyby in the final set of three outbound encounters in the extended mission. It occurs just under two days before Saturn closest approach.


View of SATURN from CASSINI
2010 MAY 20 03:30:00 UTC
45.0° field of view
RHEA
ENCELADUS
MIMAS
DIONE
TETHYS
SATURN
1.221 mil km
5.7° arc
61.8° phase
Solar System Simulator v4.0

ABOUT TITAN

Titan, although a satellite of Saturn, is larger than the terrestrial planet Mercury. It has a dense atmosphere of nitrogen and methane and a surface covered with organic material. In many ways it is Earth's sister world, which is one reason why the Cassini-Huygens mission considers Titan among its highest scientific priorities. Our knowledge and understanding of Titan, Saturn's largest moon, have increased significantly as a result of measurements obtained from the Cassini spacecraft following its arrival at Saturn in June, 2004 and with measurements from the descent of the Huygens probe through Titan's atmosphere and onto the moon's surface in January, 2005.

Although Titan is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the surprisingly complex organic chemistry that takes place in Titan's atmosphere, prompts scientists to believe that Titan could provide a laboratory for seeking insight into the origins of life on Earth. Data from the Huygens probe and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – impact cratering, wind, possible volcanism, as well as rain, river channels, lakes and even seas all contribute to shaping Titan's surface. However, at an inhospitable -290 degrees Fahrenheit (-179 degrees Celsius), the chemistry that drives these processes is fundamentally different from Earth's. For example, methane plays many of the roles on Titan that water does on Earth. Large tectonic structures seem to be lacking from Titan; however, as on Earth, such structures would be eroded by flowing liquid and material blowing across the surface, making them difficult to identify.

The Huygens probe landed near a bright region now called Adiri. Images sent back to Earth showed light hills cut by dark river beds that empty into a dark plain. Before the Huygens probe arrived, scientists believed that this dark plain could be a lake or at least a muddy material. But Huygens actually landed *in* this dark plain, revealing a surface of gravel and small boulders made of water ice. Scientists believe it only rains occasionally on Titan, but that the methane rains are extremely fierce when they come, carving channels in the surface similar to those observed in arid regions on Earth.

Only a small number of impact craters have been discovered. This suggests that, like Earth, Titan's surface is constantly being resurfaced by erosion, caused by both flowing liquid and wind. Cryovolcanism may be another resurfacing mechanism, with the lava consisting of a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobe-shaped flows, appear to be volcanic in origin, giving further support to the cryovolcanism theory. In addition, volcanism is now believed to be a significant source of methane in Titan's atmosphere, since there are no oceans of hydrocarbons as had been hypothesized previously.

Dunes cover large areas of the surface. The dunes may be made of hydrocarbon particulate material, or possibly solid accumulations of hydrocarbons. Whatever their nature, the dunes contain less water ice than other parts of Titan's surface, and might consist of haze particles produced in the atmosphere rather than being composed of the equivalent of sand produced by erosion.

The existence of oceans or lakes of liquid methane on Saturn's moon Titan was predicted more than 20 years ago. Radar, imaging and spectral data from Titan flybys have provided convincing evidence for large bodies of liquid near Titan's north and south poles. With Titan's colder temperatures and hydrocarbon-rich atmosphere, these lakes and seas contain a combination of liquid methane and ethane (both hydrocarbons), not water. Ongoing monitoring of the lakes will tell us more about Titan's methane cycle and methane table, and if these are subject to seasonal change. Radar mapping and gravity data suggest that Titan has an interior ocean of liquid water and ammonia, perhaps 100 km (60 miles) below the surface.

Cassini-Huygens arrived at Saturn during the planet's northern winter and southern summer (roughly the equivalent of mid-January on Earth). During Cassini's four-year nominal mission, as Saturn has moved towards its vernal equinox (which it reached in August 2009), changes in Titan's cloud distribution have been observed that may be due to the advancing seasons. In the early part of the Cassini mission, large convective cloud systems were observed at the south (summer) pole, but these have become less common, while long streaks of clouds have been seen progressively further north. Titan's detached haze layer may also be subject to seasonal changes that push its altitude higher.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, continues to reveal more of Titan and answer long-held questions regarding Titan's interior, surface, atmosphere, and the complex interaction with Saturn's magnetosphere. While many pieces of the puzzle are yet to be found, with each Titan flyby comes a new data set that furthers our understanding of this fascinating world.

1.1 TITAN-68 SCIENCE HIGHLIGHTS

- **RSS:** T68 is the fifth flyby of the Cassini mission that will be devoted to Titan gravity science. There are two related goals for gravity science flybys at Titan: measuringthe fluid and dynamic Love number of Titan and determining Titan's geoid. The determination of the fluid Love number is the only way to find out with confidence whether Titan has a liquid ocean. The determination of the geoid is crucial to understanding the internal structure of Titan through correlative analysis of the gravity

and RADAR planetary radii data.

- **CIRS** takes advantage of the furthest south temperature and composition profiles of the Extended Mission at 80 degrees South.
- **ISS** will ride along with CIRS to track clouds and will continue to monitor clouds and the evolution thereof for an extra day after the Titan encounter. (No illuminated prime observations.)
- **UVIS** will obtain an image cube of Titan's atmosphere at EUV and FUV wavelengths by sweeping its slit across the disk. These cubes provide spectral and spatial information on nitrogen emissions, H emission and absorption, absorption by simple hydrocarbons, and the scattering properties of haze aerosols. This is one of many such cubes gathered over the course of the mission to provide latitude and seasonal coverage of Titan's middle atmosphere and stratosphere.
- **MAG**: T68 is a south polar, dusk flyby, with a minimum altitude of 1,400 km. In nominal upstream conditions, Cassini would explore the south lobe of Titan's magnetic tail, close to the moon
- **RPWS** will measure thermal plasmas in Titan's ionosphere and surrounding environment; search for lightning in Titan's atmosphere; and investigate the interaction of Titan with Saturn's magnetosphere.

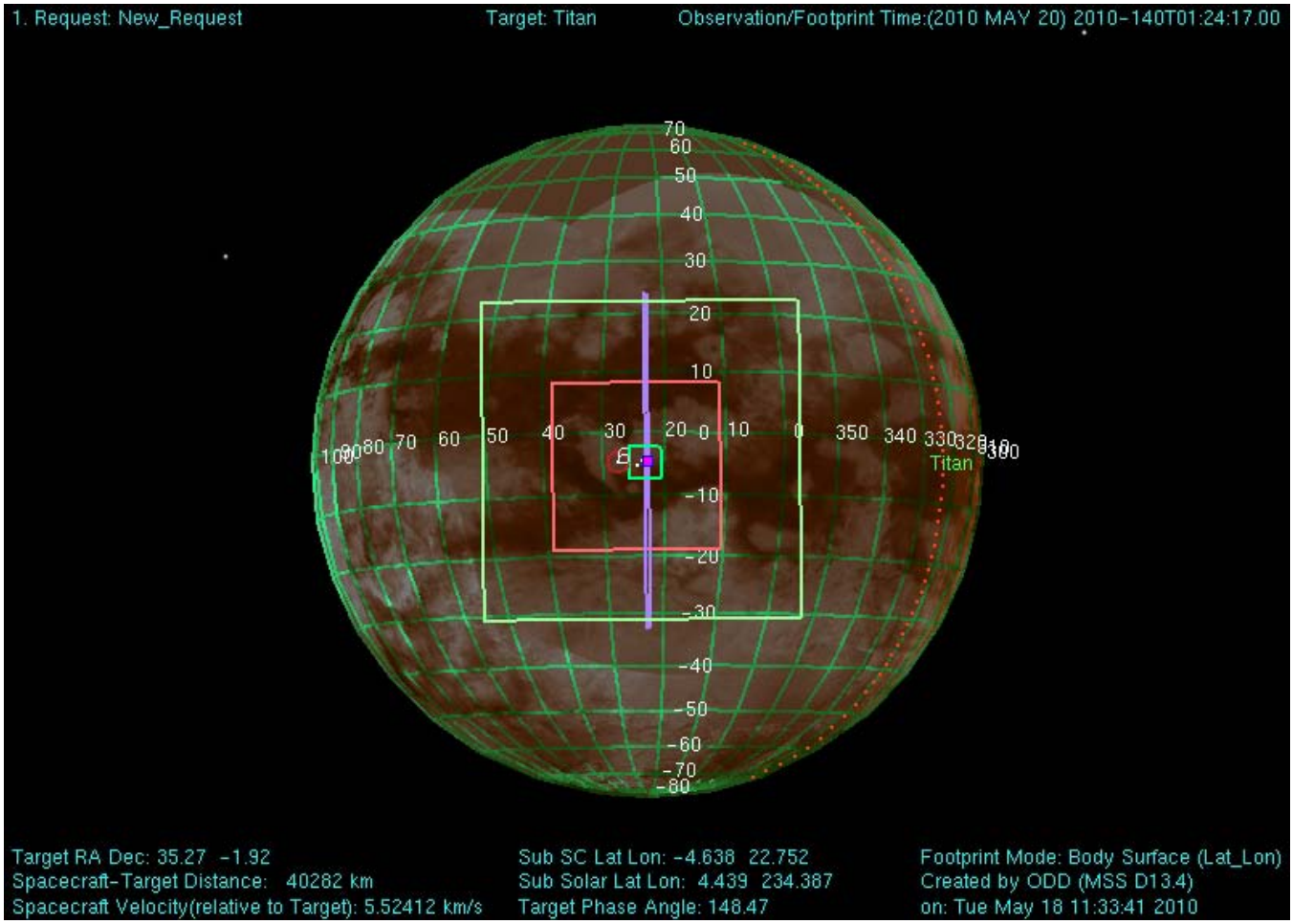
SAMPLE SNAPSHOTS

Three views of Titan from Cassini before, during, and after closest approach to Titan are shown below. The views are oriented such that the direction towards the top of the page is aligned with the Titan North Pole. The optical remote sensing instruments' fields of view are shown assuming they are pointed towards the center of Titan. The sizes of these fields of view vary as a function of the distance between Cassini and Titan. A key for use in identifying the remote sensing instruments fields of view in the figures is listed at the top of the next page.

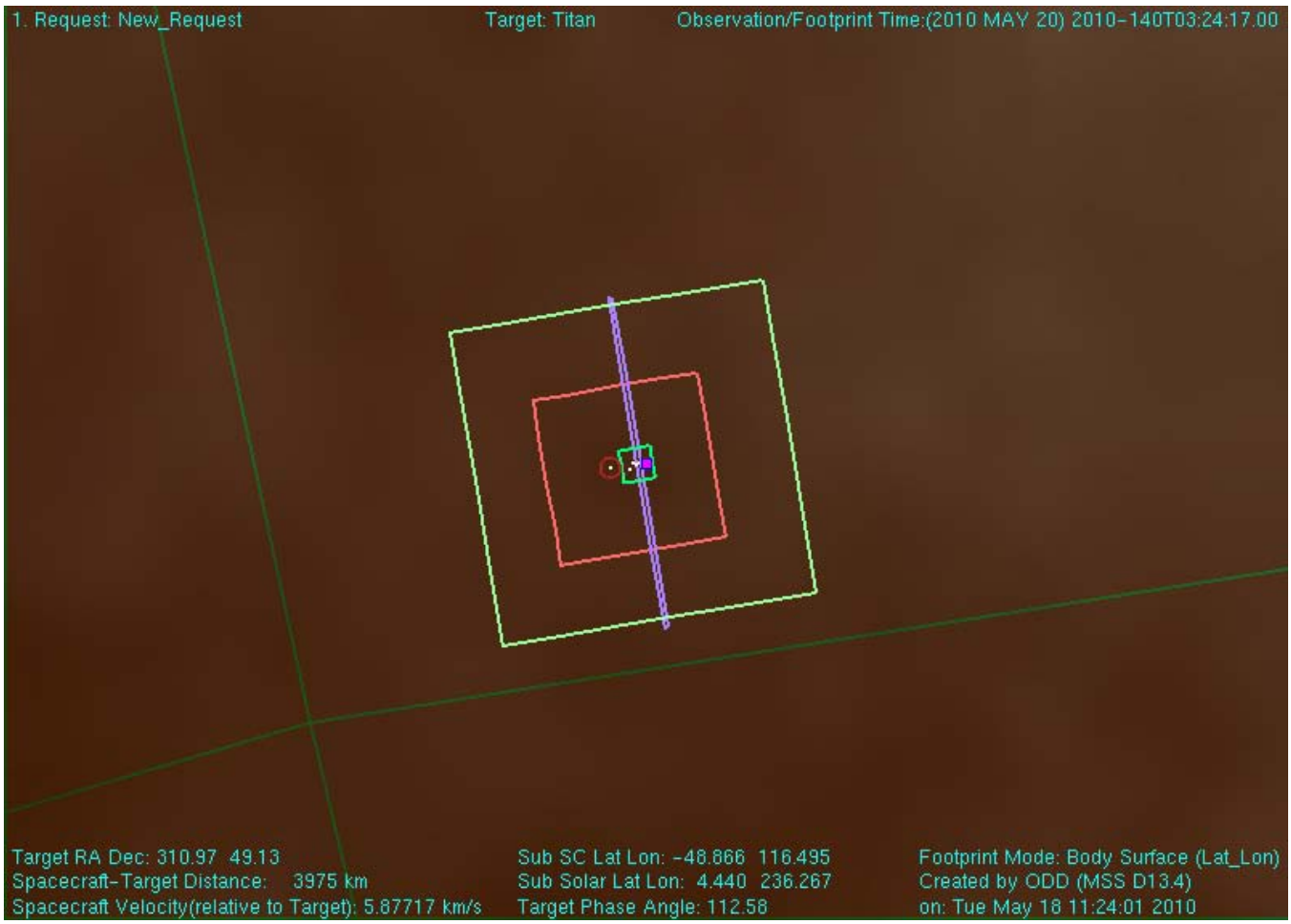
Key to ORS Instrument Fields of View in Figures

Instrument Field of View	Depiction in Figure
ISS WAC (imaging wide angle camera)	Largest square
VIMS (visual and infrared mapping spectrometer)	Next largest pink square
ISS NAC (imaging narrow angle camera)	Smallest green square
CIRS (composite infrared spectrometer) – Focal Plane 1	Small red circle near ISS_NAC FOV
UVIS (ultraviolet imaging spectrometer)	Vertical purple rectangle centered within largest square

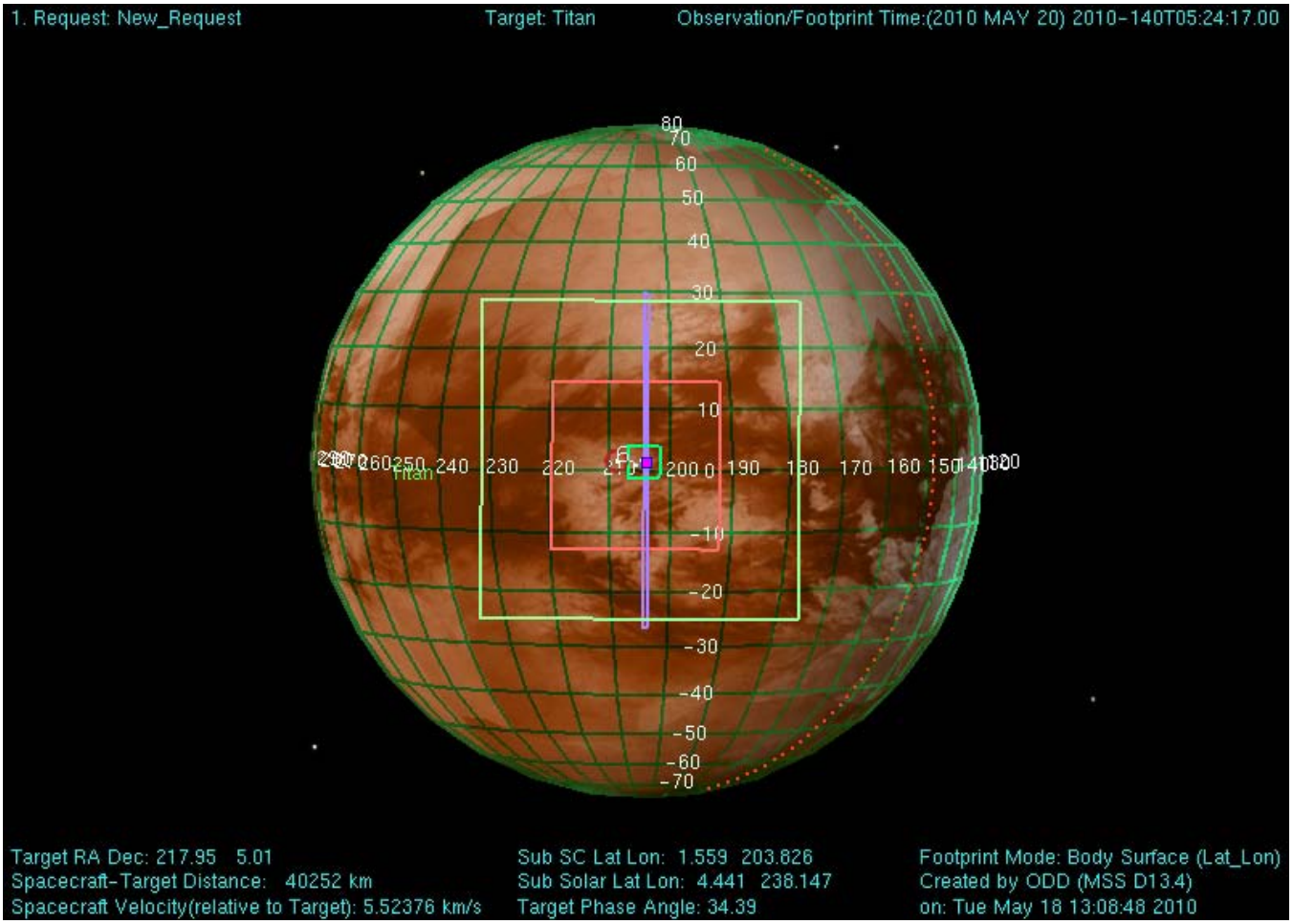
View of Titan from Cassini two hours before Titan-68 closest approach



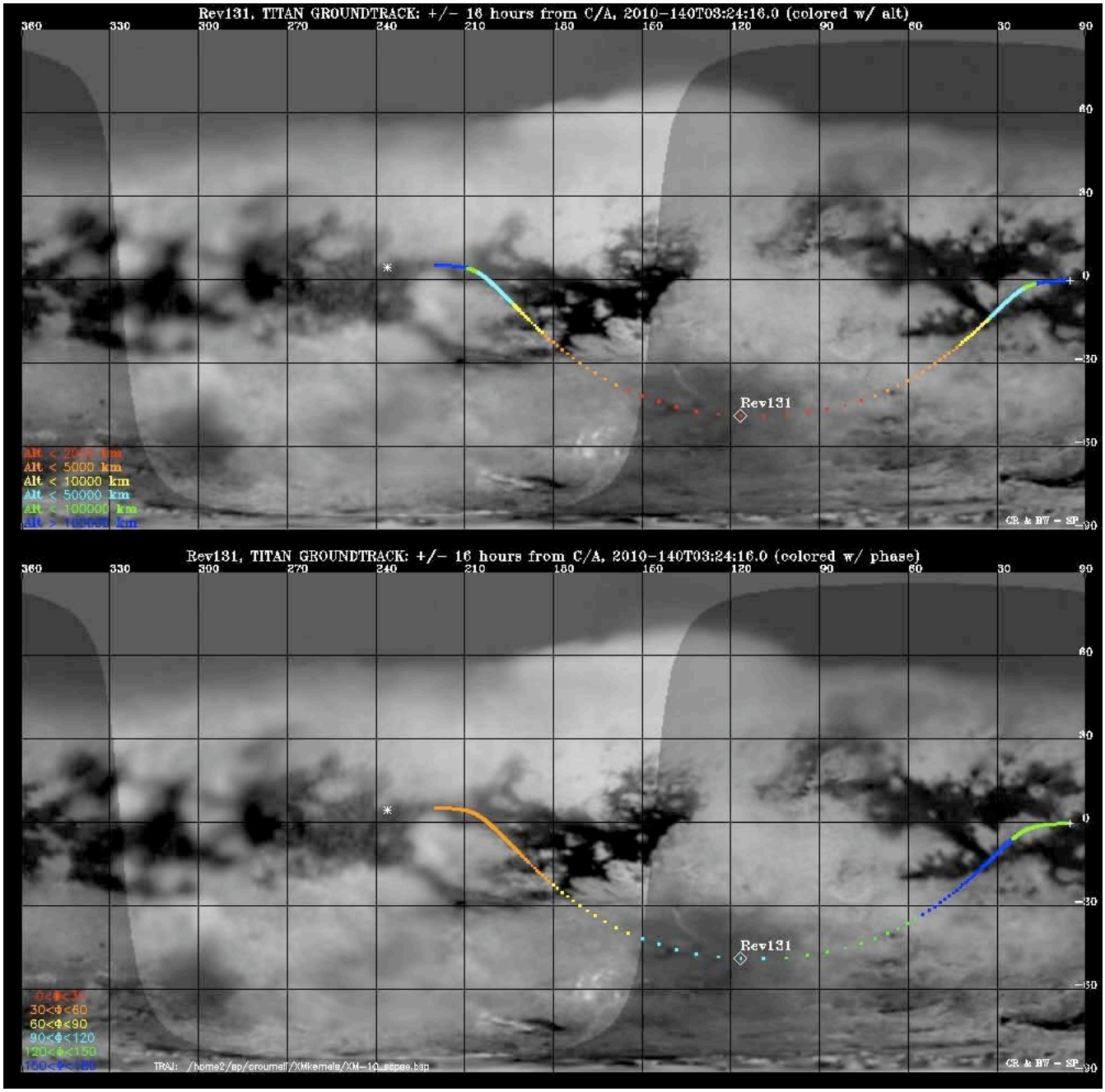
View of Titan from Cassini at Titan-68 closest approach



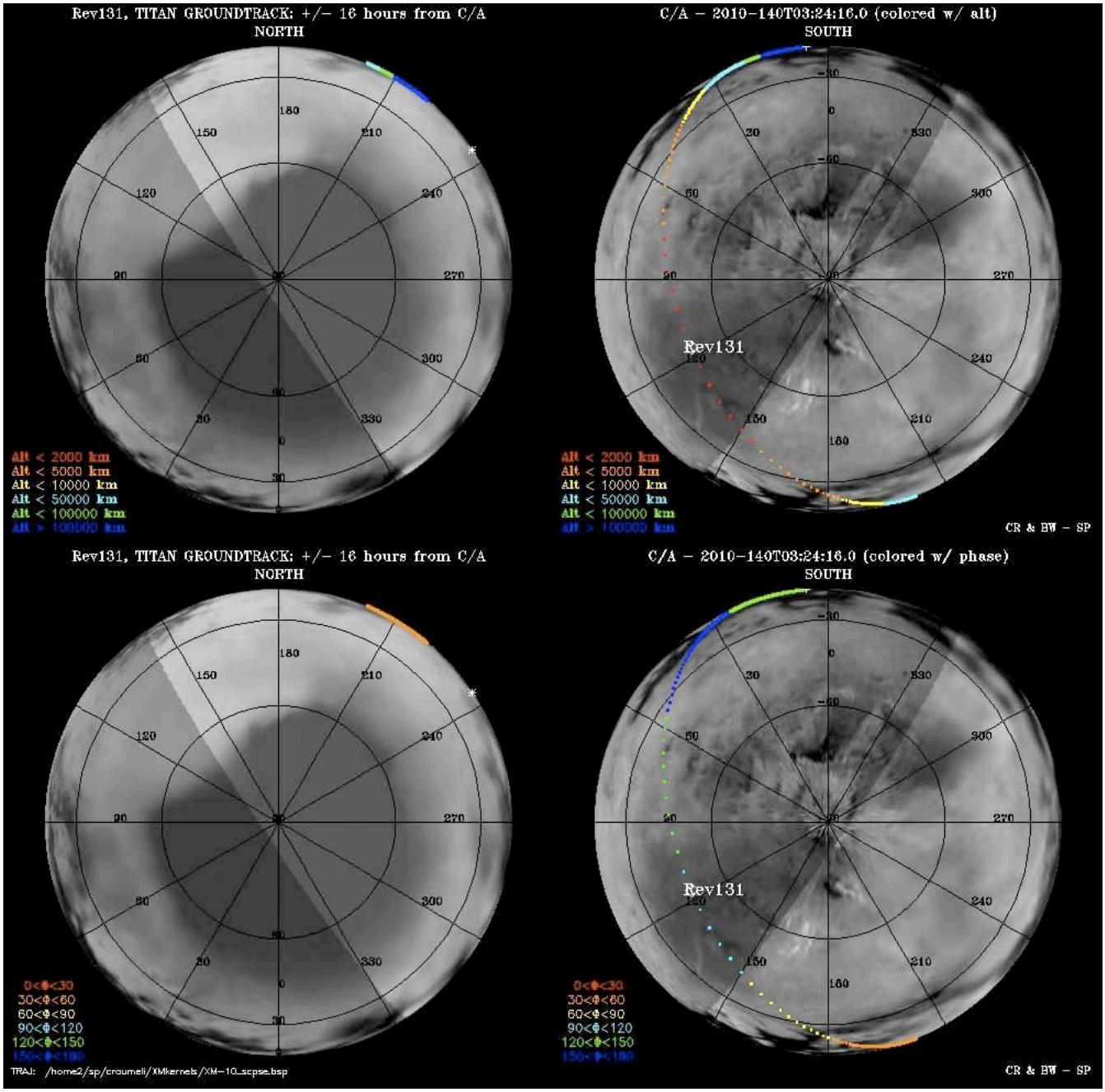
View of Titan from Cassini two hours after Titan-68 closest approach



Titan Groundtracks for T68: Global Plot



Titan Groundtracks for T68: Polar Plot



The T68 timeline is as follows:

Cassini Titan-68 - May 2010

Colors: yellow = maneuvers; blue = geometry;
pink = T68-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time (PDT)	Time wrt T68	Activity	Description
135T22:31:00	May 15 23:47	Sat May 15 04:47 PM	T68-04d05h	OTM #247 Prime	Titan-68 targeting maneuver.
137T04:31:00	May 17 05:47	Sun May 16 10:47 PM	T68-02d23h	OTM #247 Backup	
137T13:31:00	May 17 14:47	Mon May 17 07:47 AM	T68-02d14h	Start of Sequence S60	Start of Sequence which contains Titan-68
139T07:15:00	May 19 08:31	Wed May 19 01:31 AM	T68-20h09m	Start of the TOST segment	
139T07:15:00	May 19 08:31	Wed May 19 01:31 AM	T68-20h09m	Turn cameras to Titan	
139T07:55:00	May 19 09:11	Wed May 19 02:11 AM	T68-19h29m	New waypoint	
139T07:55:00	May 19 09:11	Wed May 19 02:11 AM	T68-19h29m	Deadtime	15 minutes 04 seconds long; used to accommodate changes in flyby time
139T08:10:04	May 19 09:26	Wed May 19 02:26 AM	T68-19h14m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
139T13:54:20	May 19 15:10	Wed May 19 08:10 AM	T68-13h30m	Titan surface observations-ISS	Long range monitoring
139T14:24:20	May 19 15:40	Wed May 19 08:40 AM	T68-13h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
139T17:24:20	May 19 18:40	Wed May 19 11:40 AM	T68-10h00m	Titan atmospheric observations-ISS	WAC Photometry
139T18:24:20	May 19 19:40	Wed May 19 12:40 PM	T68-09h00m	Turn to Earth-line	
139T18:24:20	May 19 19:40	Wed May 19 12:40 PM	T68-09h00m	Titan Gravity Field Experiment-RSS	Experiment to determine Titan's gravity field, including its Love number, and infer constraints on its internal structure.
140T03:09:35	May 20 04:25	Wed May 19 09:25 PM	T68-00h15m	Titan solar occultation	4 minute duration
140T03:24:20	**May 20 04:40**	**Wed May 19 09:40 PM**	**T68+00h00m**	**Titan-68 Flyby Closest Approach Time**	**Altitude = 1400 km (~870 miles), speed =5.9 km/s (~13,250 mph); 112 deg phase at closest approach**
140T11:59:20	May 20 13:15	Thu May 20 06:15 AM	T68+08h35m	Turn cameras to Titan	
140T12:24:20	May 20 13:40	Thu May 20 06:40 AM	T68+09h00m	New waypoint	
140T12:24:20	May 20 13:40	Thu May 20 06:40 AM	T68+09h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
140T16:24:20	May 20 17:40	Thu May 20 10:40 AM	T68+13h00m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
140T21:05:04	May 20 22:21	Thu May 20 03:21 PM	T68+17h41m	Deadtime	14 minutes 55 seconds long; used to accommodate changes in flyby time
140T21:20:00	May 20 22:36	Thu May 20 03:36 PM	T68+17h56m	Turn to Earth-line	
140T22:00:00	May 20 23:16	May 20 16:16	T68+18h36m	Playback of T68 Data	Madrid 70m
141T00:30:00	May 21 01:46	May 20 18:46	T68+21h06m	Playback of T68 Data	Goldstone 34m
141T07:00:00	May 21 08:16	Fri May 21 01:16 AM	T68+01d04h	Turn cameras to Titan	
141T07:40:00	May 21 08:56	Fri May 21 01:56 AM	T68+01d04h	New waypoint	
141T07:40:00	May 21 08:56	Fri May 21 01:56 AM	T68+01d04h	Titan surface observations-ISS	Titan cloud monitoring and gap filling
141T09:40:00	May 21 10:56	Fri May 21 03:56 AM	T68+01d06h	Titan atmospheric observations-CIRS	Titan composition
141T17:40:00	May 21 18:56	Fri May 21 11:56 AM	T68+01d14h	MAPS survey	MAPS Survey w/ prime pointing
141T19:50:00	May 21 21:06	Fri May 21 02:06 PM	T68+01d16h	Turn to Earth-line	
141T20:30:00	May 21 21:46	Fri May 21 02:46 PM	T68+01d17h	Reaction Wheel bias	
141T22:00:00	May 21 23:16	May 21 16:16	T68+01d19h	Playback of T68 Data	Madrid 70m
142T00:30:00	May 22 01:46	May 21 18:46	T68+01d21h	Playback of T68 Data	Goldstone 34m