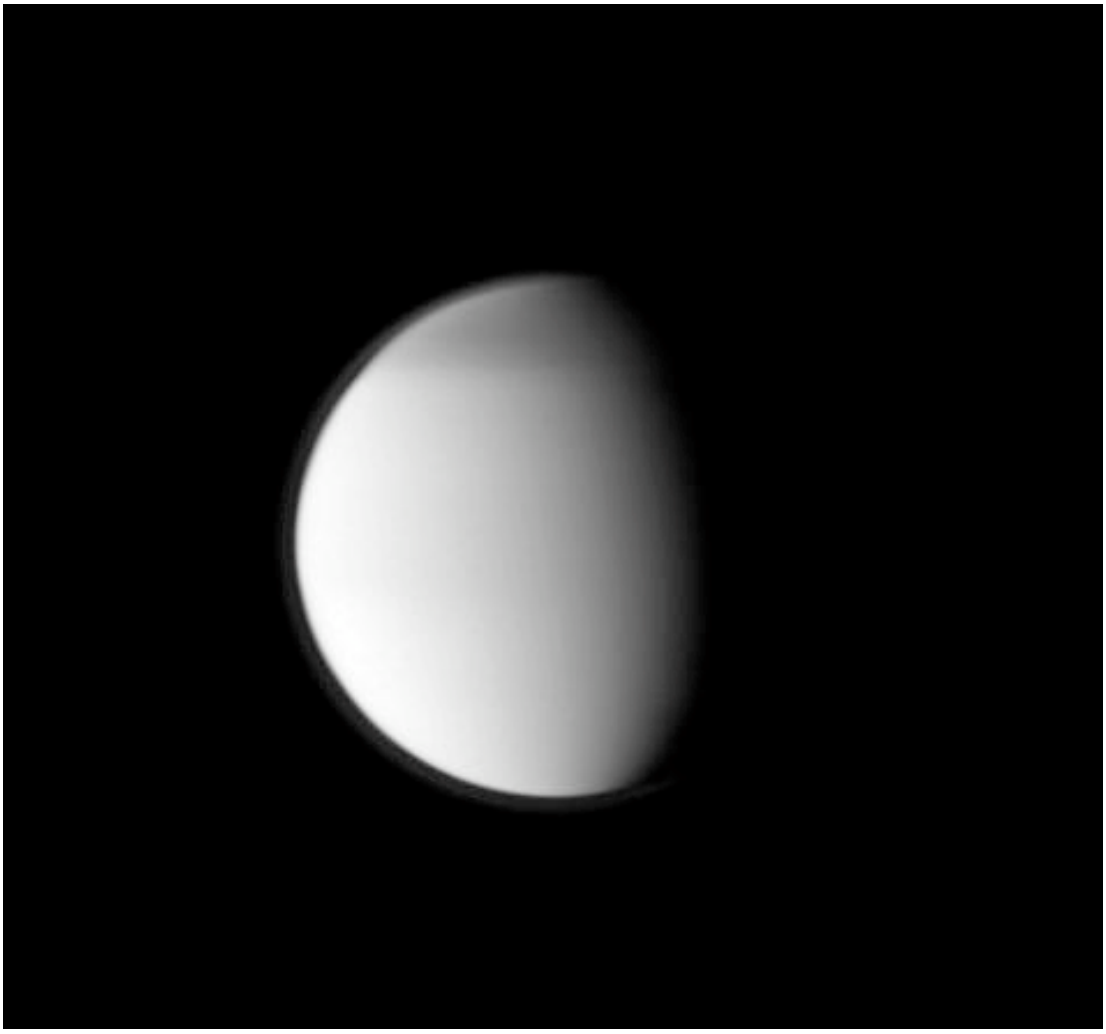
C A S S I N I



T I T A N 119TI(T62)
MISSION DESCRIPTION

October 12, 2009

Jet Propulsion Laboratory
California Institute of Technology

Cover image: Titan's North Polar Hood

This ultraviolet view of Titan shows the moon's north polar hood and its detached, high-altitude haze layer.

See Haze Layers on Titan to learn more. 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 2 degrees to the left.

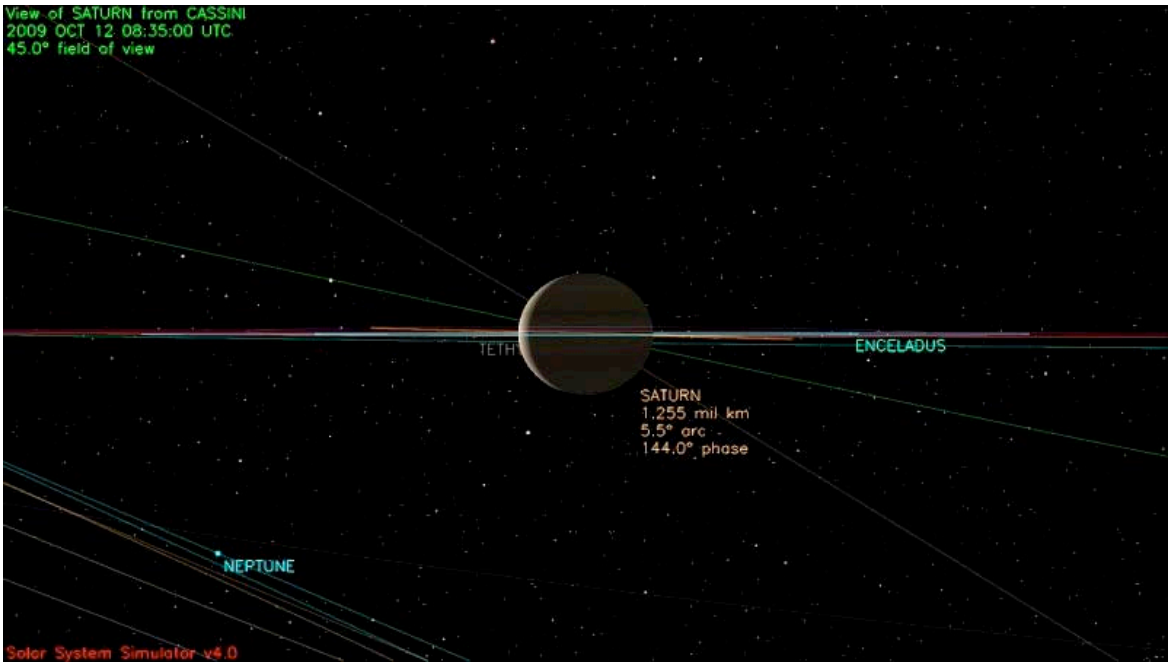
The image was taken with the Cassini spacecraft narrow-angle camera on Aug. 13, 2009 using a spectral filter sensitive to wavelengths of ultraviolet light centered at 338 nanometers. The view was acquired at a distance of approximately 2.2 million kilometers (1.4 million miles) from Titan and at a Sun-Titan-spacecraft, or phase, angle of 61 degrees. Image scale is 26 kilometers (16 miles) per pixel.

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. Credit: NASA/JPL/Space Science Institute

1.0 OVERVIEW

After forty-eight Titanless days, Cassini finally returns to Saturn's largest moon for the mission's sixty-second targeted encounter with Titan. The closest approach to Titan occurs on Monday, Oct. 12 at 285T08:36:24 spacecraft time at an altitude of 1300 kilometers (~808 miles) above the surface and at a speed of 6.0 kilometers per second (~13,400 mph). The latitude at closest approach is 64 degrees S and the encounter occurs on orbit number 119.

This encounter is set up with two maneuvers: an apoapsis maneuver on September 4, and a Titan approach maneuver, scheduled for October 8. T62 is the final flyby in a series of eleven inbound encounters and the eighteenth Titan encounter in Cassini's Solstice Mission. It occurs just under two days before Saturn closest approach.



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-62 SCIENCE HIGHLIGHTS

- **UVIS** observes a solar occultation on T62. Solar occultations are among the most valuable Titan observations for UVIS because they provide detailed vertical profiles of N, N2, and some hydrocarbons to more than 3000 km altitude. Solar occultation measurements give a measure of the density profile of the main constituent of the atmosphere, and the rate of change of the N2 density with altitude gives information on

the temperature. UVIS also conducts EUVFUV observations during this flyby. These observations give information on airglow, hydrocarbon absorptions, haze and optical properties globally, but with lower vertical resolution

- **VIMS** will observe the formation, evolution, and decay of clouds, particularly mid-latitude and equatorial clouds. In ride-along mode, a solar occultation will provide information on the vertical structure and composition of Titan's atmosphere and haze layer. VIMS will also obtain a global map of the western region of Senkyo
- **CIRS** carries out far-infrared limb sounding at 70 and 75 degrees latitude South. Observations collect information on the atmospheric temperature, aerosols and composition near 75S.
- **ISS** will acquire a full-disk mosaic of western Senkyo at low phase angles and ride along with VIMS to monitor clouds.
- **INMS:** T62 is a UVIS Occultation pass where the pointing is not likely to be favorable for INMS. However it is the only low altitude in nose side magnetospheric interaction pass in the extended mission.
- **MIMI**. Energetic ion and electron energy input to atmosphere; Energetic Neutral Atoms (some sun obscuration)
- **MAG**: T62 is a south polar, post-dusk flyby, with a minimum altitude of 1000 km. MAG measurements will provide a description of the draping and the pileup of the external magnetic field around Titan near the terminator. It will be also a good complement to T52-T61 in order to characterize the background field for a similar local time with respect to Saturn and different SKR longitudes.
- **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.

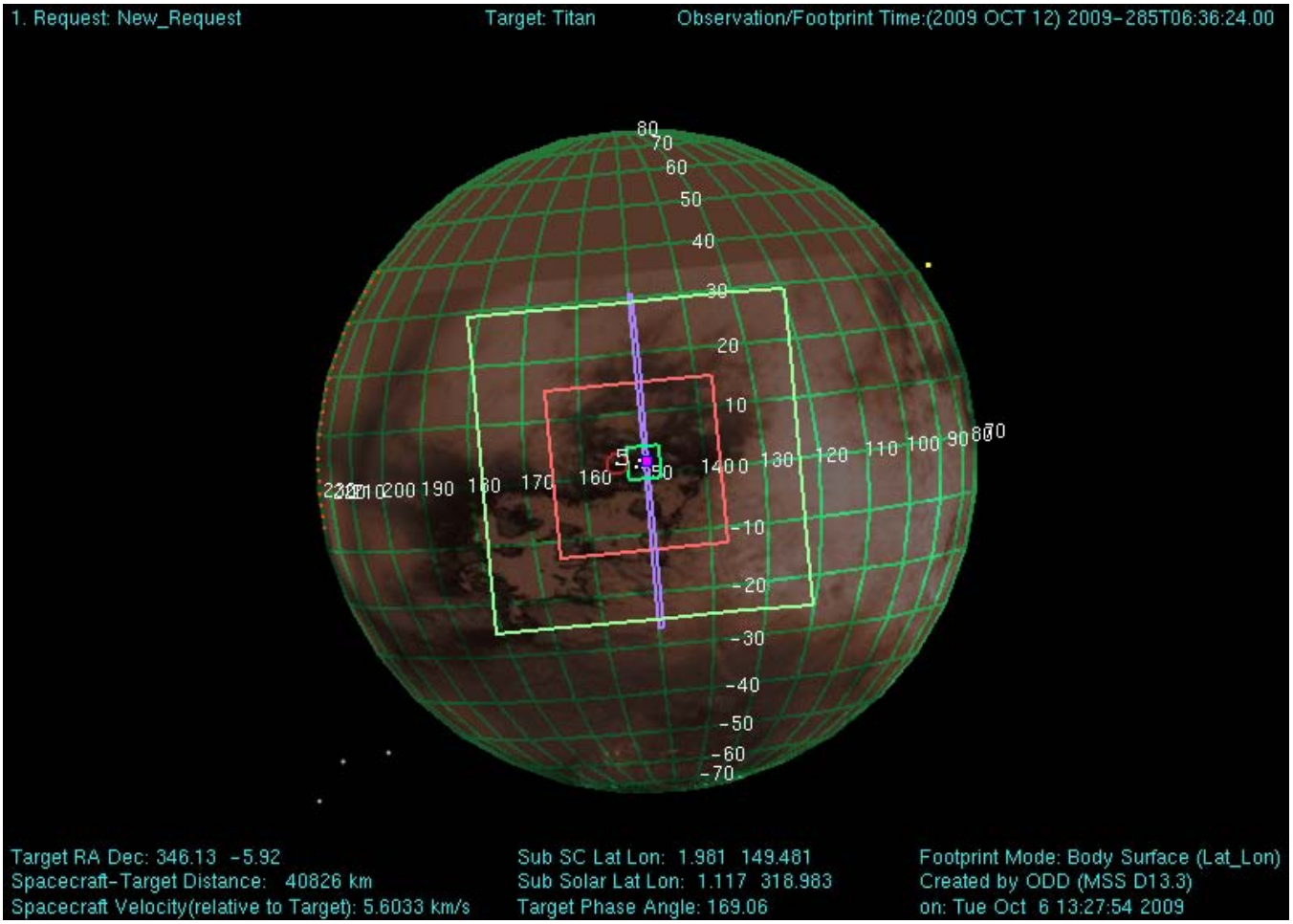
SAMPLE SNAPSHOTS

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.

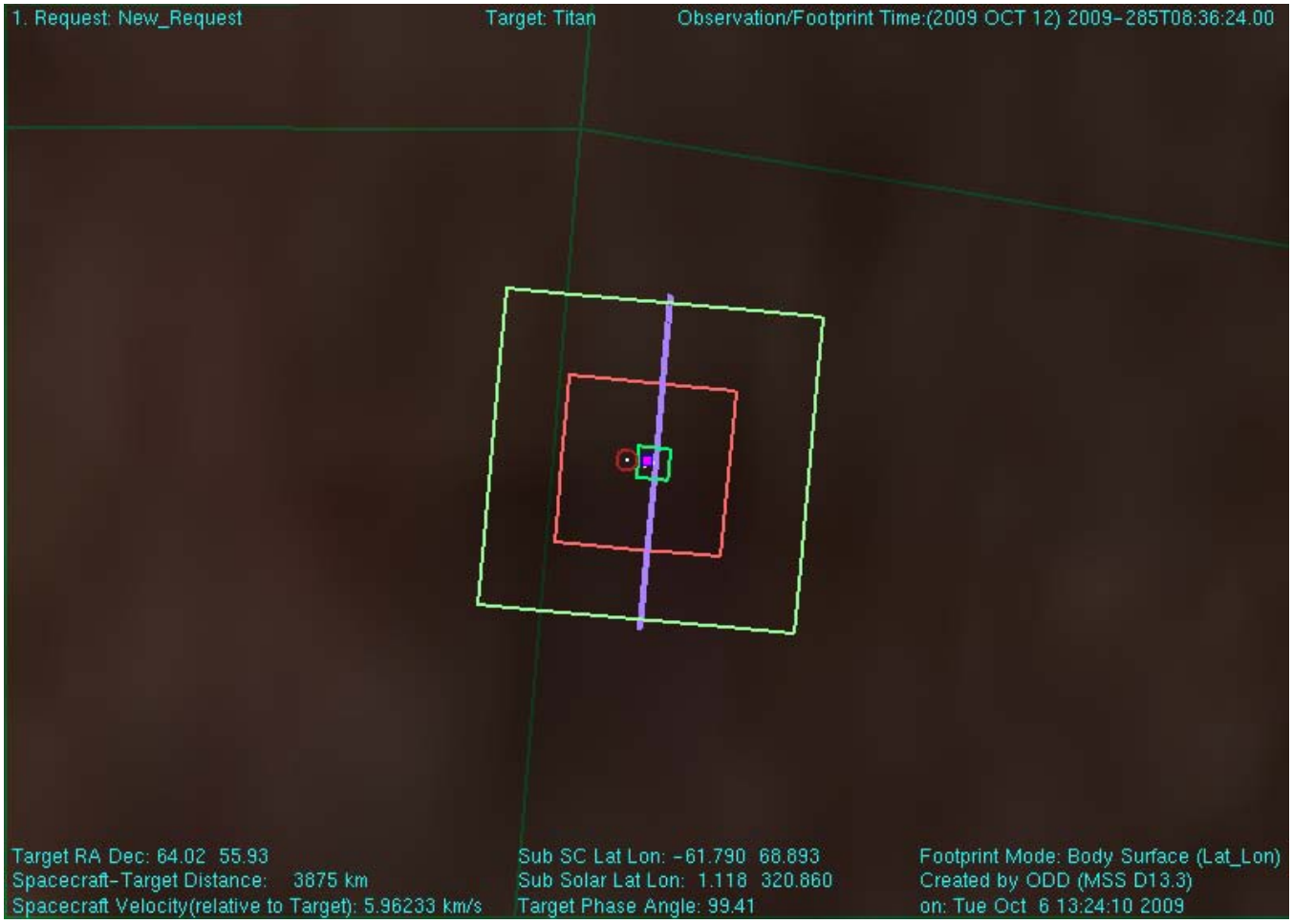
Key to ORS Instrument Fields of View in Figures

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

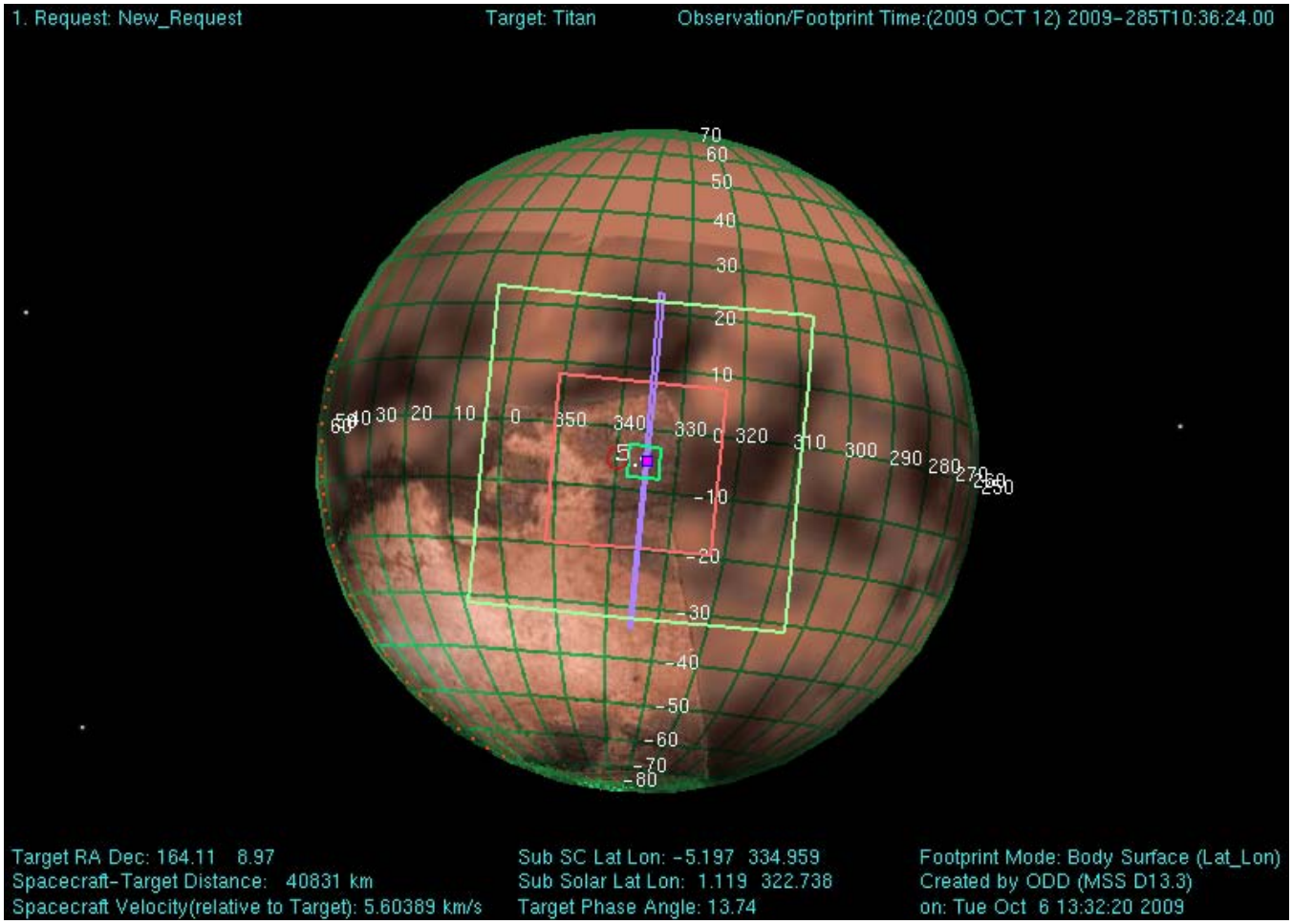
View of Titan from Cassini two hours before Titan-62 closest approach



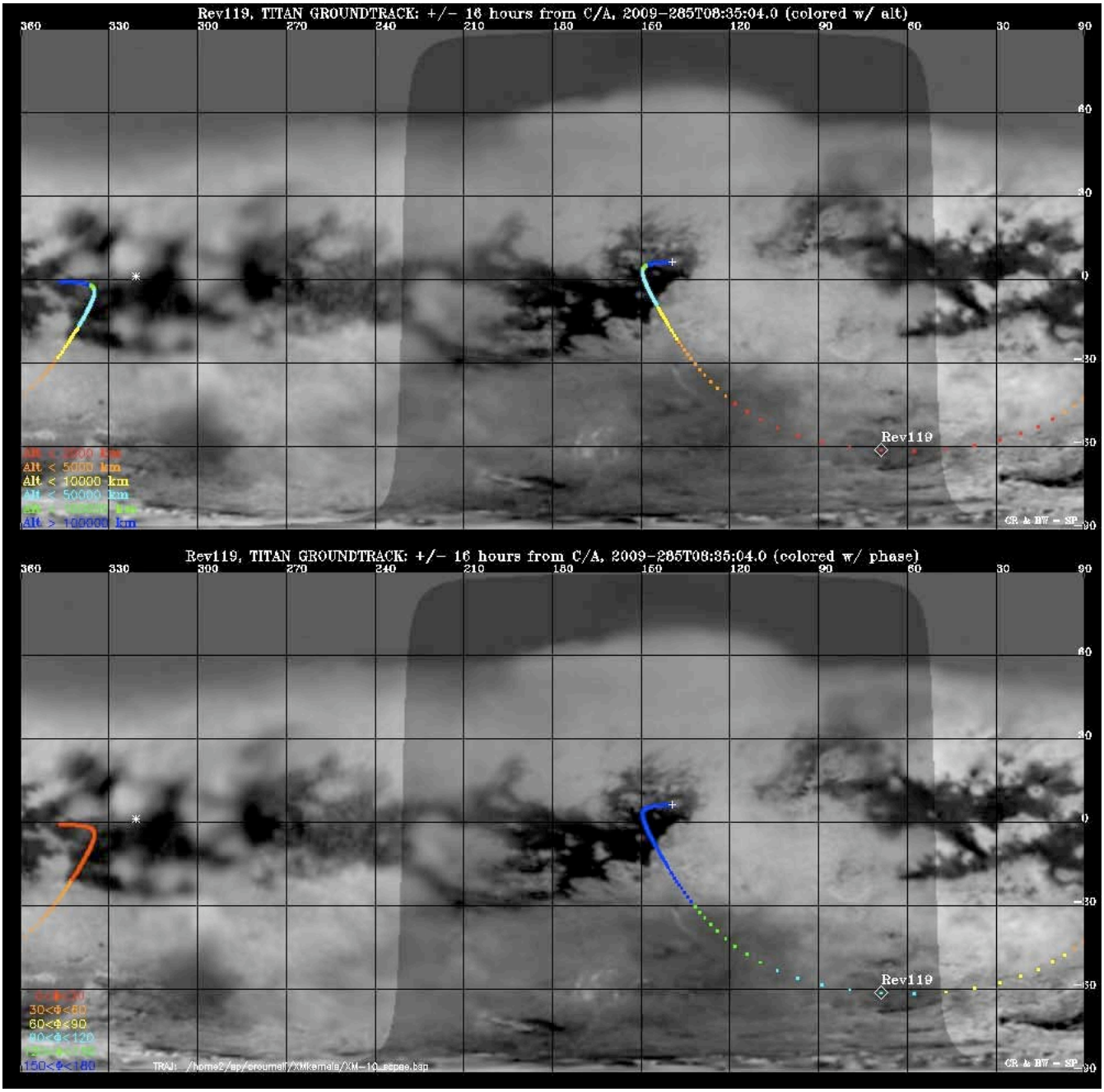
View of Titan from Cassini at Titan-62 closest approach



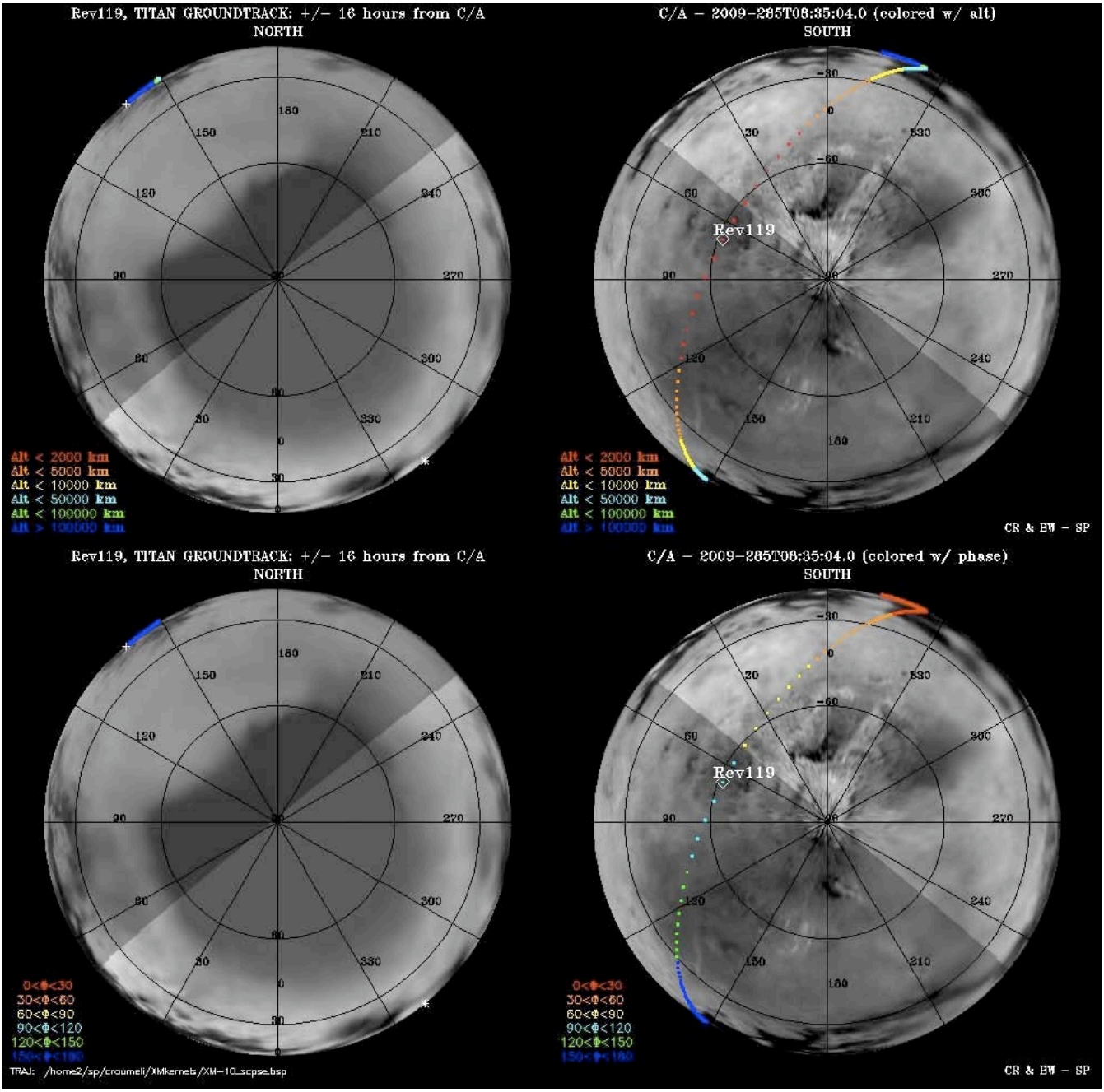
View of Titan from Cassini two hours after Titan-62 closest approach



Titan Groundtracks for T62: Global Plot



Titan Groundtracks for T62: Polar Plot



The T62 timeline is as follows:

Cassini Titan-62 Timeline - October 2009

Colors: yellow = maneuvers; blue = geometry; pink = T62-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time (PDT)	Time wrt T62	Activity	Description
278T04:03:00	Oct 05 05:29	Sun Oct 04 10:29 PM	T62-07d05h	Start of Sequence S54	Start of Sequence which contains Titan-62
282T05:04:00	Oct 09 06:30	Thu Oct 08 11:30 PM	T62-03d04h	OTM #217 Prime	Titan-62 targeting maneuver.
283T05:04:00	Oct 10 06:30	Fri Oct 09 11:30 PM	T62-02d04h	OTM #217 Backup	
284T13:49:00	Oct 11 15:15	Sun Oct 11 08:15 AM	T62-18h47m	Start of the TOST segment	
284T13:49:00	Oct 11 15:15	Sun Oct 11 08:15 AM	T62-18h47m	Turn cameras to Titan	
284T14:29:00	Oct 11 15:55	Sun Oct 11 08:55 AM	T62-18h07m	New waypoint	
284T14:29:00	Oct 11 15:55	Sun Oct 11 08:55 AM	T62-18h07m	Deadtime	16 minutes 21 seconds long; used to accommodate changes in flyby time
284T14:45:21	Oct 11 16:11	Sun Oct 11 09:11 AM	T62-17h51m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
284T19:36:25	Oct 11 21:02	Sun Oct 11 02:02 PM	T62-13h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
284T23:36:25	Oct 12 01:02	Sun Oct 11 06:02 PM	T62-09h00m	Titan atmospheric observations-UVIS	Several slow scans across Titan's visible hemisphere to form spectral images
285T06:27:25	Oct 12 07:53	Mon Oct 12 12:53 AM	T62-02h09m	Transition to thruster control	
285T06:48:16	Oct 12 08:14	Mon Oct 12 01:14 AM	T62-01h48m	Titan atmospheric observations-UVIS	Solar occultation
285T07:38:51	Oct 12 09:04	Mon Oct 12 02:04 AM	T62-00h58m	Solar Occultation	41 minute duration
285T07:45:25	Oct 12 09:11	Mon Oct 12 02:11 AM	T62-00h51m	Titan atmospheric observations-CIRS	Vertical temperature sounding of Titan's tropopause & stratosphere.
285T07:46:02	Oct 12 09:12	Mon Oct 12 02:12 AM	T62-00h50m	Solar Occultation	36 minute duration
285T08:15:25	Oct 12 09:41	Mon Oct 12 02:41 AM	T62-00h21m	Titan atmospheric observations-UVIS	Solar occultation
285T08:36:24	**Oct 12 10:02**	**Mon Oct 12 03:02 AM**	**T62+00h00m**	**Titan-62 Flyby Closest Approach Time**	**Altitude = 1300 km (~808 miles), speed =6.0 km/s (13,400 mph); 99 deg phase at closest approach**
285T09:01:25	Oct 12 10:27	Mon Oct 12 03:27 AM	T62+00h25m	Titan atmospheric observations-CIRS	Limb scanning for aerosols
286T05:35:36	Oct 13 07:01	Tue Oct 13 12:01 AM	T62+20h59m	Descending Ring Plane Crossing	
285T09:51:25	Oct 12 11:17	Mon Oct 12 04:17 AM	T62+01h15m	Titan atmospheric observations-CIRS	Vertical sounding of stratospheric compounds on Titan, including H2O.
285T10:51:25	Oct 12 12:17	Mon Oct 12 05:17 AM	T62+02h15m	Transition off of thruster control	
285T11:12:30	Oct 12 12:38	Mon Oct 12 05:38 AM	T62+02h36m	Titan atmospheric observations-UVIS	Several slow scans across Titan's visible hemisphere to form spectral images
285T17:36:25	Oct 12 19:02	Mon Oct 12 12:02 PM	T62+09h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
285T20:36:25	Oct 12 22:02	Mon Oct 12 03:02 PM	T62+12h00m	Titan surface observations-ISS	NAC monitoring
285T22:36:25	Oct 13 00:02	Mon Oct 12 05:02 PM	T62+14h00m	Titan surface observations-VIMS	Global mapping
286T03:36:25	Oct 13 05:02	Mon Oct 12 10:02 PM	T62+19h00m	Deadtime	32 minutes 35 seconds long; used to accommodate changes in flyby time
286T04:09:00	Oct 13 05:35	Mon Oct 12 10:35 PM	T62+19h33m	Turn to Earth-line	
286T04:49:00	Oct 13 06:15	Oct 12 23:15	T62+20h13m	Playback of T62 Data	Madrid 70m