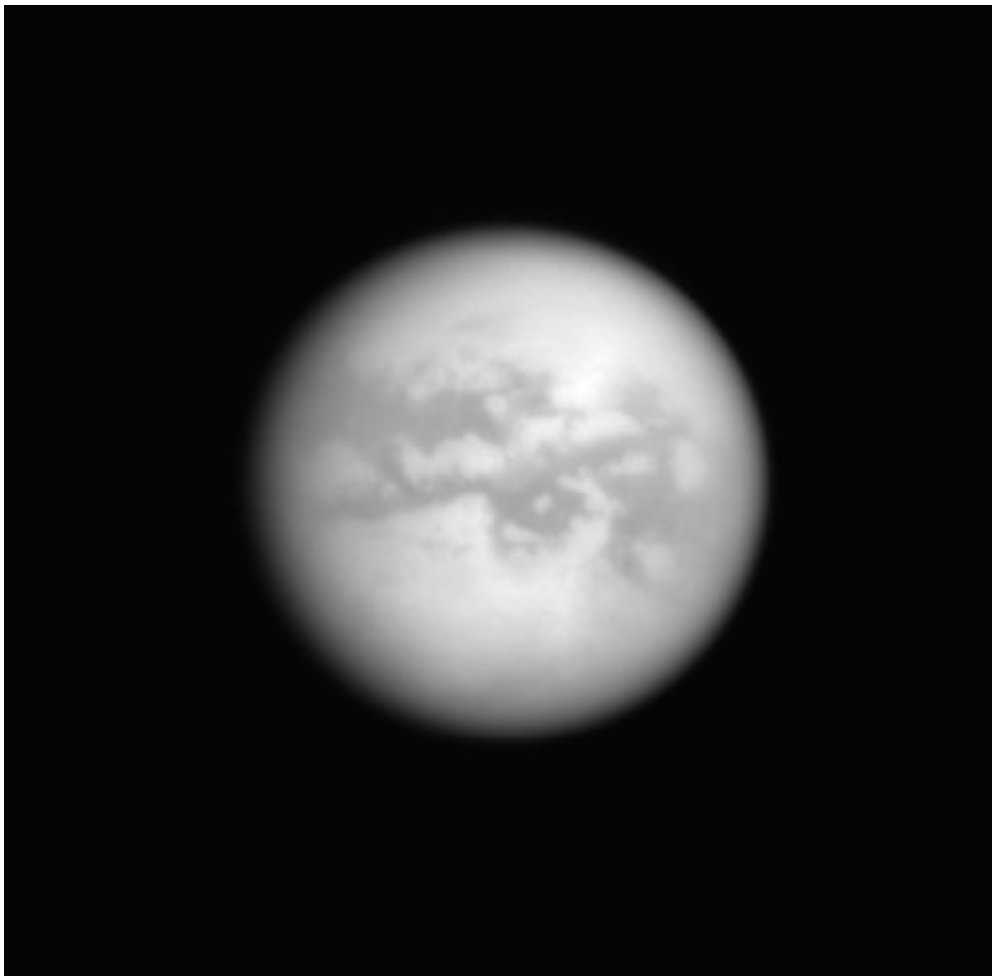
C A S S I N I



T I T A N 0 9 5 T I (T 4 8)
MISSION DESCRIPTION

December 5, 2008

Jet Propulsion Laboratory
California Institute of Technology

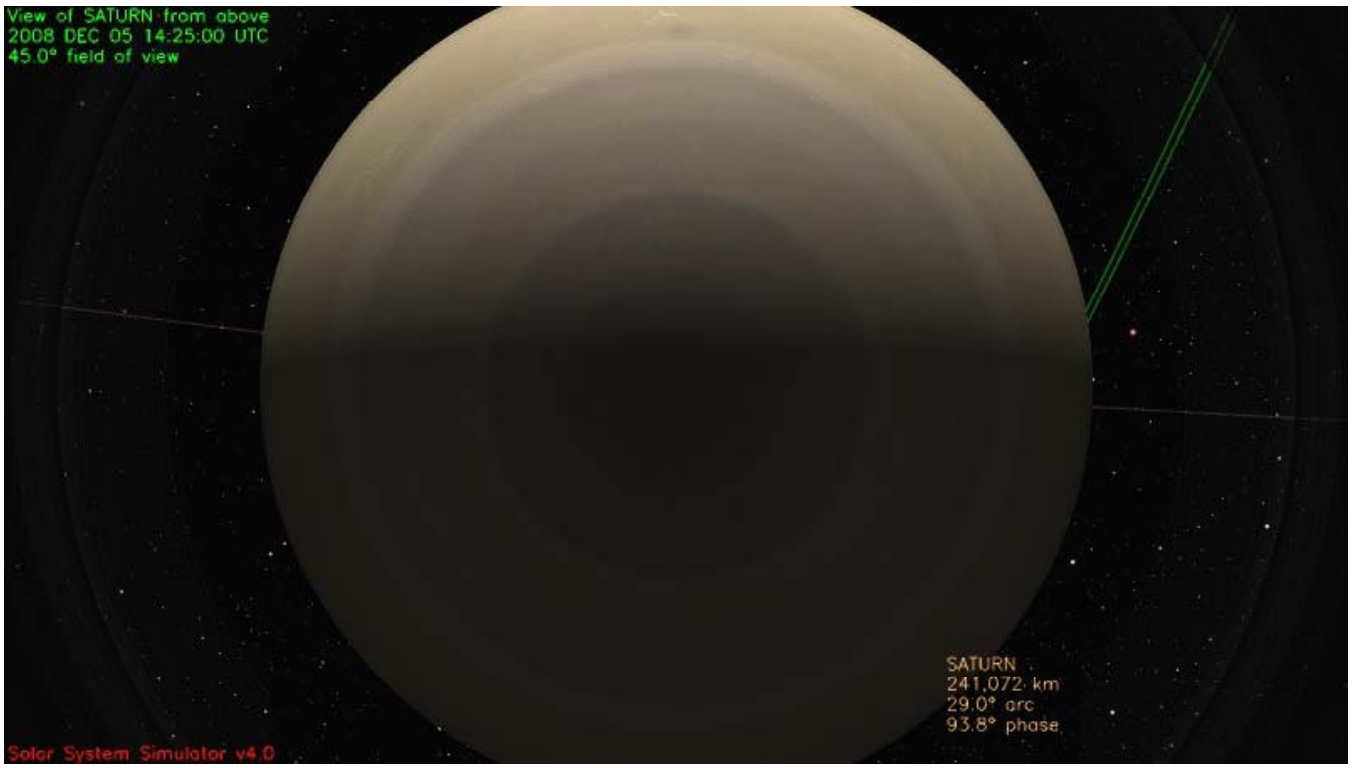
Cover image: Saturn's View of Titan November 17, 2008 Full-Res: PIA10514 The Cassini spacecraft looks through Titan's thick atmosphere to reveal bright and dark terrains on the Saturn-facing side of the planet's largest moon. North is up.

The image was taken with the Cassini spacecraft narrow-angle camera on Oct. 11, 2008 using a spectral filter sensitive to wavelengths of infrared light centered at 938 nanometers. The view was obtained at a distance of approximately 2.222 million kilometers (1.381 million miles) from Titan and at a Sun-Titan-spacecraft, or phase, angle of 10 degrees. Image scale is 13 kilometers (8 miles) per pixel. Credit: NASA/JPL/Space Science Institute

1.0 OVERVIEW

A mere sixteen days after its previous flyby, Cassini once again approaches Saturn's largest moon for the mission's forty-ninth targeted encounter with Titan. The closest approach to Titan occurs on Friday, December 5, at 2008-340T14:25:45 spacecraft time at an altitude of 960.0 kilometers (~597 miles) above the surface and at a speed of 6.3 kilometers per second (14,000 mph). The latitude at closest approach is 10.3 degrees S and the encounter occurs on orbit number 95.

This encounter is set up with two maneuvers: an apoapsis maneuver on November 27, and a Titan approach maneuver, scheduled for December 1. T48 is the twelfth in a series of outbound encounters and the fourth Titan encounter in Cassini's Equinox mission. It occurs just over three days after Saturn closest approach.



ABOUT TITAN

If Titan were a planet, it would likely stand out as the most important planet in the solar system for humans to explore. Titan, the size of a terrestrial planet, has a dense atmosphere of nitrogen and methane and a surface covered with organic material. It is Titan that is arguably Earth's sister world and the Cassini-Huygens mission considers Titan among its highest priorities.

Although it is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the 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, which touched down on Titan's surface in January 2005, and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – wind, rain, volcanism, tectonic activity, as well as river channels, and drainage patterns all seem to contribute in 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 it is methane that performs many of the same functions on Titan that water does on Earth.

The Huygens probe landed near a bright region now called Adiri, and it photographed light hills with dark river beds that empty into a dark plain. It was believed that this dark plain could be a lake or at least a muddy material, but it is now known that Huygens landed in the dark region, and it is solid. Scientists believe it only rains occasionally on Titan, but the rains are extremely fierce when they come.

Only a small number of impact craters have been discovered. This suggests that Titan's surface is constantly being resurfaced by a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobate flows, appear to be volcanic structures. Volcanism is now believed to be a significant source of methane in Titan's atmosphere. However, there are no oceans of hydrocarbons as previously hypothesized. Dunes cover large areas of the surface.

The existence of oceans or lakes of liquid methane on Saturn's moon Titan was predicted more than 20 years ago. Radar and imaging data from Titan flybys have provided convincing evidence for large bodies of liquid. With Titan's colder temperatures and hydrocarbon-rich atmosphere, these lakes and seas most likely contain a combination of liquid methane and ethane (both hydrocarbons), not water.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, is methodically and consistently revealing Titan and answering 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 world as we attempt to constrain scenarios for the formation and evolution of Titan and its atmosphere.

1.1 TITAN-48 SCIENCE HIGHLIGHTS

T-48 is a unique flyby (along with T-47) with low phase and high resolution imaging opportunities for the imaging instruments.

- **INMS:** T48 is the only dayside pass near Titan's equator in the Prime tour *or* the Equinox Mission. This INMS prime observation will measure nonreactive neutrals while simultaneously observing the dayside ionosphere. This flyby also gives INMS coverage of the boundary between the outer flank and wake magnetospheric interaction regions. Outbound, INMS will collect measurements from closest approach to the ionospheric peak and into the transition from thermal to corotating particles
- **RADAR**: T48 represents the end of a series of flybys that observe territory that may be cryovolcanic. RADAR has the opportunity to look at part of Tui Regio inbound, prior to turning to INMS's preferred attitude. VIMS observations suggest that this region may resemble Hotei Arcus, with an anomalous composition and possible cryolava flow morphologies. Near closest approach, RADAR will observe the dark dunefields of Shangri-La while riding along on the INMS observation. HiSAR in south midlatitudes will look at a possible impact structure feature seen in ISS data.
- **CIRS** conducts far-IR limb composition measurements, and maps vertical distributions of CO, CH4, H2O and others. In addition, CIRS continues its campaign of mapping the planet in the mid and far-infrared to obtain the spatial and temporal variation of temperature and more abundant hydrocarbon and nitrile molecules, which provide information on seasonal changes in weather, climate and chemistry that may be occurring.
- **ISS** returns to getting much higher resolution observations of the leading hemisphere with a mosaic along a portion of Hotei Arcus. The instrument will also collect global and regional mosaics of Titan's leading hemisphere, including a view of Hotei Arcus in its entirety, as well as southern Xanadu and the western reaches of Tsegihi.
- **VIMS** will conduct global mapping.
- **MIMI:** T48 is part of Titan MAPS Campaign. Investigate micro-scale and near aspects of the Titan interaction by observing during about one hour period around an encounter. With -Y pointed toward Titan, when within 30 minutes of the targeted flyby, optimize secondary axis for corotation flow as close to the S/C -X, +/- Z plane as works with the other constraints on pointing. Also, measure Titan exosphere/magnetosphere interaction by imaging in ENA with INCA (when sun is not in INCA FOV).

- **UVIS** will have its FUV Occultation slit boresite on the star Epsilon CMa as Titan occults the star. Over the course of the mission and XM UVIS stellar occultations will sample about 12 latitudes and this sampling will help constrain photochemistry, dynamics and aerosol microphysical processes in the upper stratosphere and mesosphere.

- **MAG**: T48 is very similar to T47, with a minimum altitude of 1000 km. Therefore, we will be able to look for temporal effects in response to changes in the upstream conditions (i.e. the flyby occurring at a different SKR phase). T48 also takes place in Saturn's near-noon sector (10.5 hours SLT), where Titan could be found in the magnetosheath if the solar wind pressure is high.

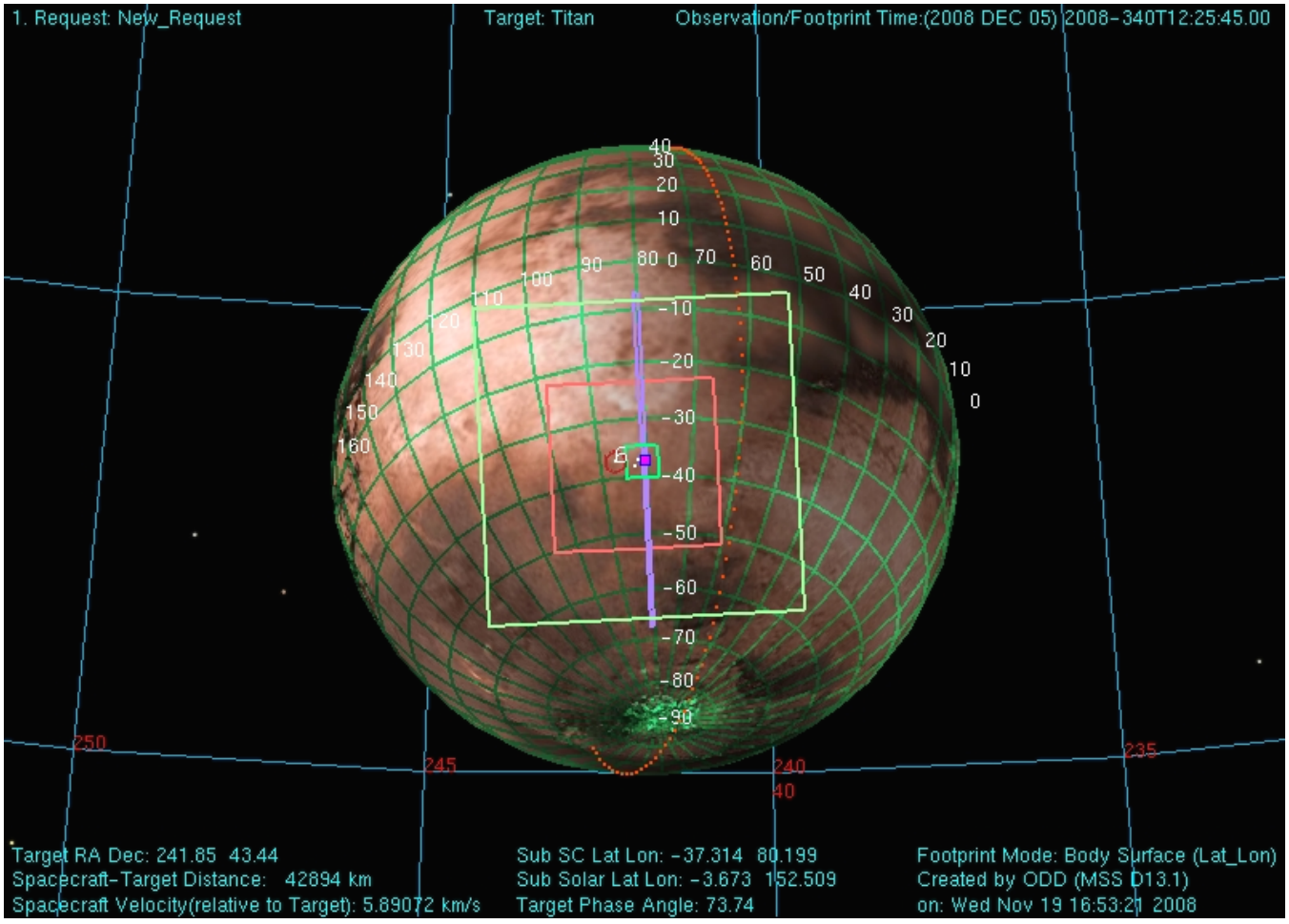
SAMPLE SNAPSHOTS

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.

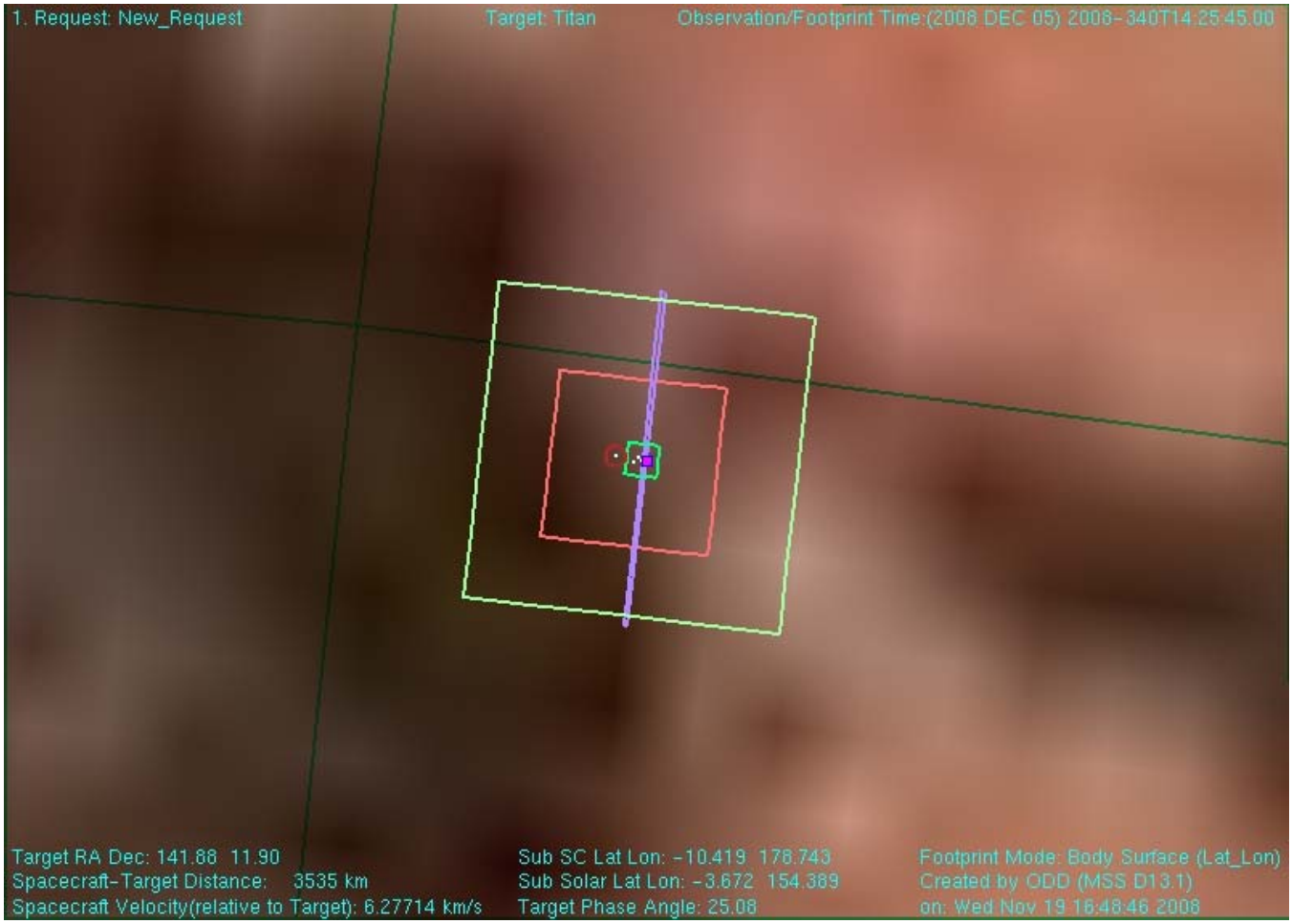
Key to ORS Instrument Fields of View in Figures

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

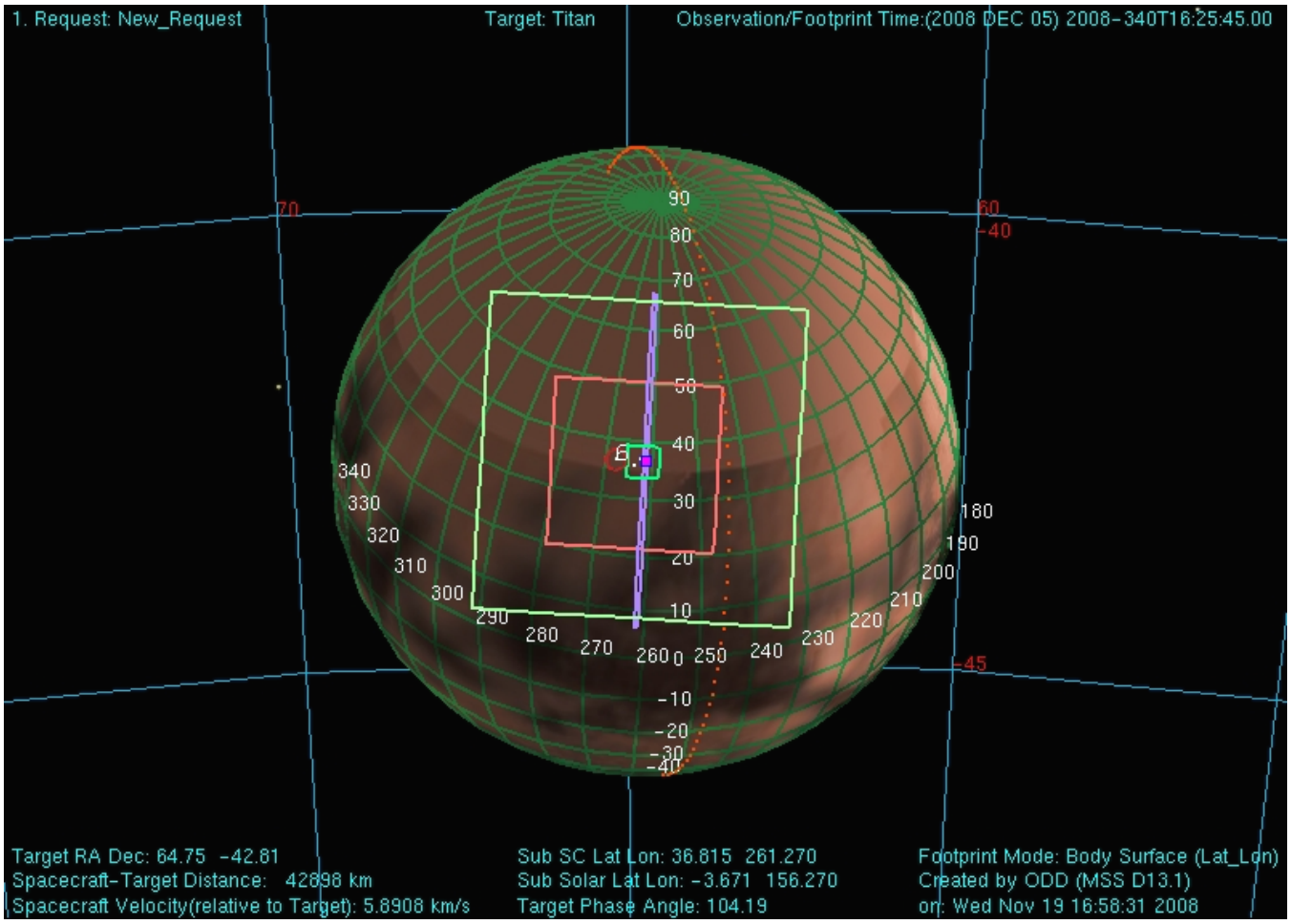
View of Titan from Cassini two hours before Titan-48 closest approach



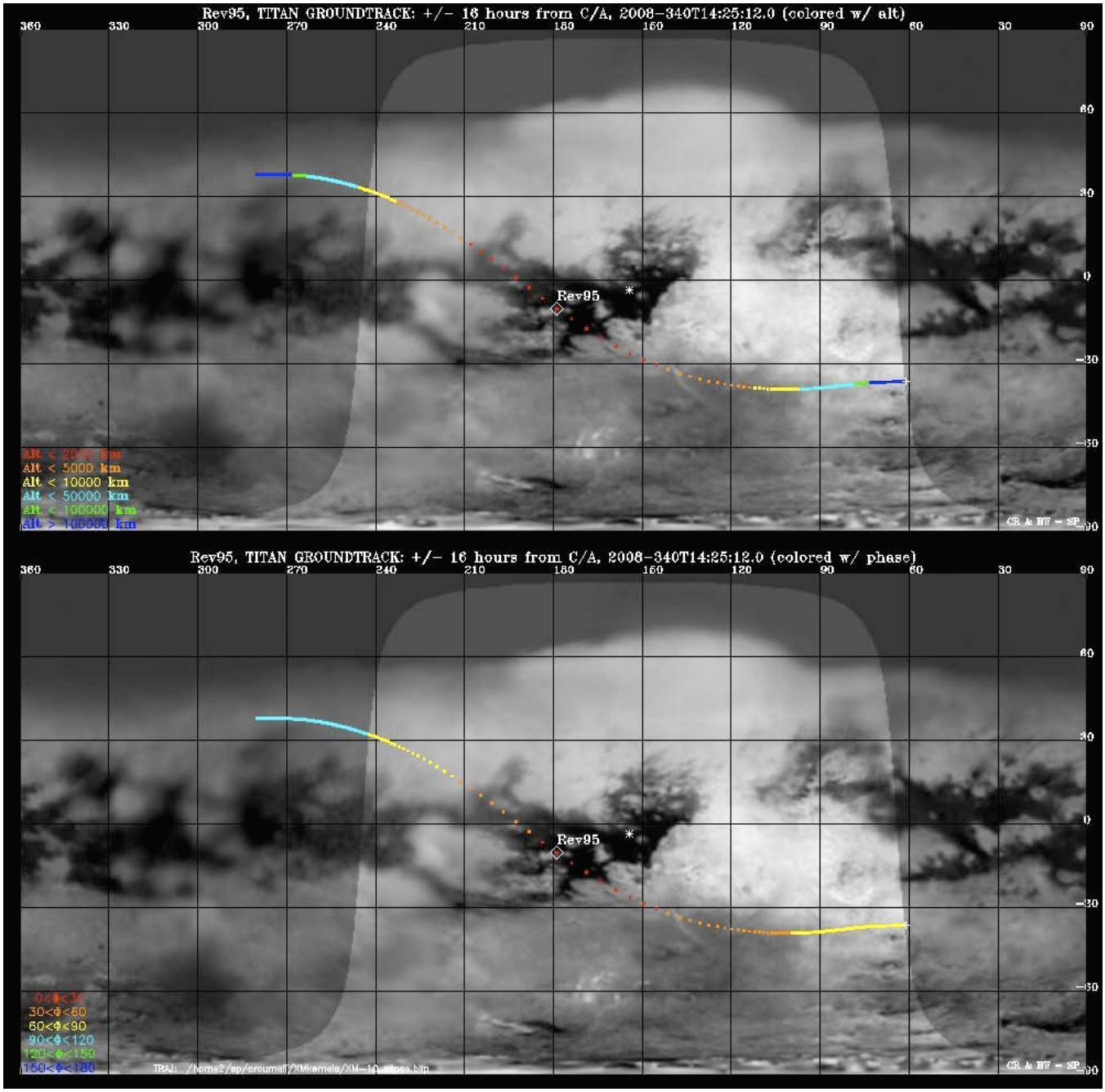
View of Titan from Cassini at Titan-48 closest approach



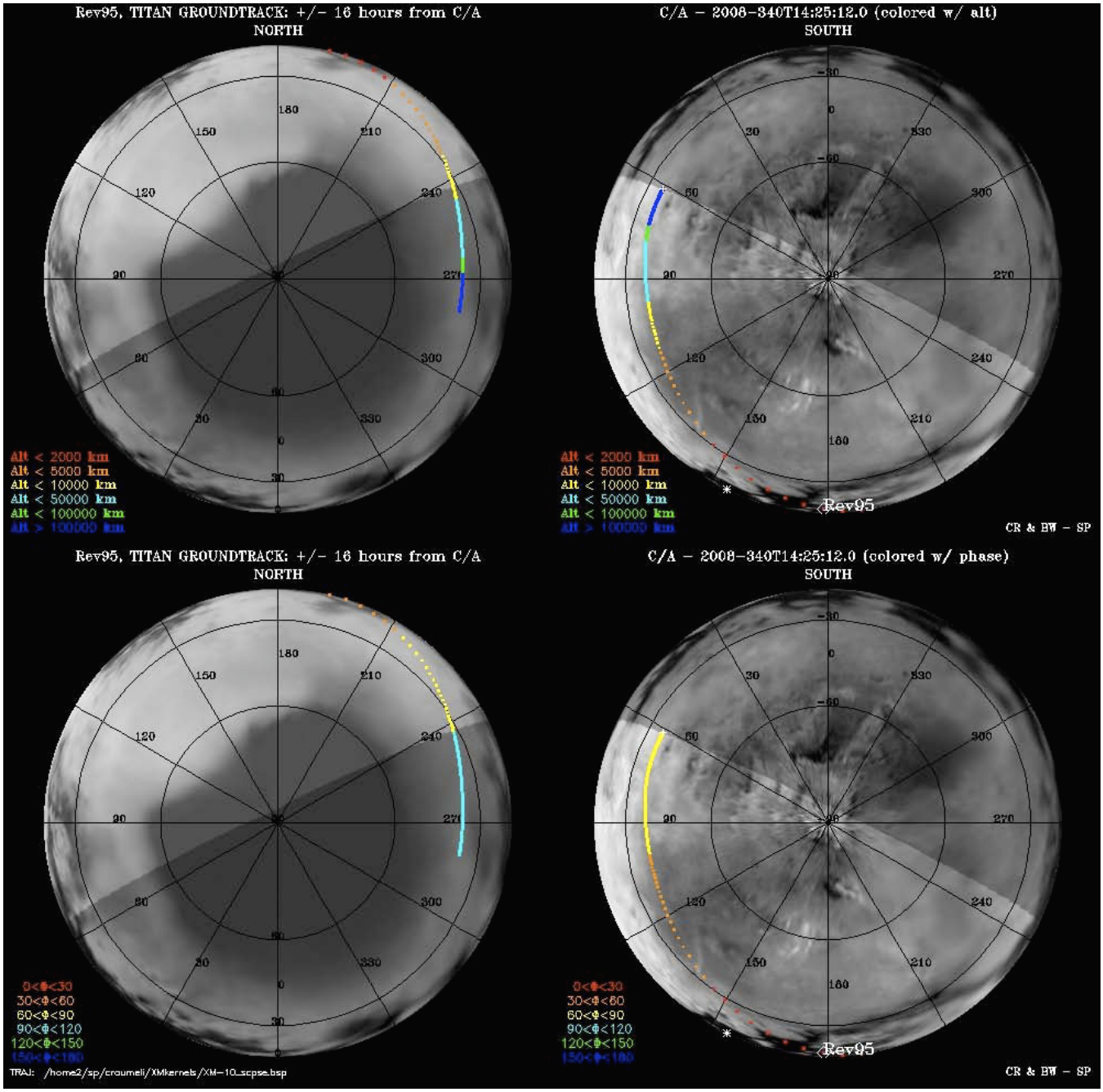
View of Titan from Cassini two hours after Titan-48 closest approach



Titan Groundtracks for T48: Global Plot



Titan Groundtracks for T48: Polar Plot



The T48 timeline is as follows:

Cassini Titan-48 Timeline - December 2008

Colors: yellow = maneuvers; blue = geometry; pink = T48-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T48	Activity	Description
331T17:55:00	Nov 26 19:14	Wed Nov 26 11:14 AM	T48-08d20h	Start of Sequence S46	Start of Sequence which contains Titan-48
336T14:56:00	Dec 01 16:15	Mon Dec 01 08:15 AM	T48-03d23h	OTM #175 Prime	Titan-48 targeting maneuver.
337T14:56:00	Dec 02 16:15	Tue Dec 02 08:15 AM	T48-02d23h	OTM #175 Backup	
339T17:26:00	Dec 04 18:45	Thu Dec 04 10:45 AM	T48-20h59m	Start of the TOST segment	
339T17:26:00	Dec 04 18:45	Thu Dec 04 10:45 AM	T48-20h59m	Turn cameras to Titan	
339T18:06:00	Dec 04 19:25	Thu Dec 04 11:25 AM	T48-20h19m	New waypoint	
339T18:06:00	Dec 04 19:25	Thu Dec 04 11:25 AM	T48-20h19m	Deadtime	15 minutes 33 seconds long; used to accommodate changes in flyby time
339T18:21:33	Dec 04 19:40	Thu Dec 04 11:40 AM	T48-20h04m	Titan surface observations-VIMS	Global map
340T01:25:45	Dec 05 02:44	Thu Dec 04 06:44 PM	T48-13h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
340T05:25:45	Dec 05 06:44	Thu Dec 04 10:44 PM	T48-09h00m	Titan surface observations-ISS	NAC Global Map
340T09:25:45	Dec 05 10:44	Fri Dec 05 02:44 AM	T48-05h00m	Titan surface observations-ISS	NAC Regional Map
340T11:25:45	Dec 05 12:44	Fri Dec 05 04:44 AM	T48-03h00m	Titan atmospheric observations-CIRS	Vertical sounding of stratospheric compounds on Titan, including H2O. Integrations at 2 locations on the limb displaced vertically.
340T12:25:45	Dec 05 13:44	Fri Dec 05 05:44 AM	T48-02h00m	Titan surface observations-ISS	NAC Regional Map
340T13:13:45	Dec 05 14:32	Fri Dec 05 06:32 AM	T48-01h12m	Transition to thruster control	
340T13:14:45	Dec 05 14:33	Fri Dec 05 06:33 AM	T48-01h11m	Titan surface observations-ISS	NAC Regional Map during transition to thruster control
340T13:35:45	Dec 05 14:54	Fri Dec 05 06:54 AM	T48-00h50m	Titan RADAR/INMS Observations	Inbound HiSAR
340T13:55:45	Dec 05 15:14	Fri Dec 05 07:14 AM	T48-00h30m	Titan RADAR/INMS Observations	Inbound Altimetry
340T14:07:45	Dec 05 15:26	Fri Dec 05 07:26 AM	T48-00h18m	Titan RADAR/INMS Observations	Inbound SAR for Tui Regio
340T14:20:45	Dec 05 15:39	Fri Dec 05 07:39 AM	T48-00h05m	Titan RADAR/INMS Observations	RADAR ride-along SAR with INMS
340T14:25:45	**Dec 05 15:44**	**Fri Dec 05 07:44 AM**	**T48+00h00m**	**Titan-48 Flyby Closest Approach Time**	**Altitude = 960 km (~597 miles), speed = 6.3 km/s (14,000 mph); 25 deg phase at closest approach**
340T14:47:45	Dec 05 16:06	Fri Dec 05 08:06 AM	T48+00h22m	Transition off of thruster control	
340T14:56:57	Dec 05 16:15	Fri Dec 05 08:15 AM	T48+00h31m	Ascending Ring Plane Crossing	
340T15:08:49	Dec 05 16:27	Fri Dec 05 08:27 AM	T48+00h43m	Titan atmospheric observations-UVIS	Titan occults Eps Cma
340T15:20:45	Dec 05 16:39	Fri Dec 05 08:39 AM	T48+00h55m	Titan atmospheric observations-CIRS	Vertical sounding of stratospheric compounds on Titan, including H2O. Integrations at 2 locations on the limb displaced vertically.
340T16:40:45	Dec 05 17:59	Fri Dec 05 09:59 AM	T48+02h15m	Titan atmospheric observations-UVIS	EUVFUV imaging of Titan. Several slow scans across Titan's visible hemisphere to form spectral images
340T18:19:47	Dec 05 19:38	Fri Dec 05 11:38 AM	T48+03h54m	Apoapse	
340T23:25:45	Dec 06 00:44	Fri Dec 05 04:44 PM	T48+09h00m	Titan surface observations-VIMS	Global map
341T03:25:45	Dec 06 04:44	Fri Dec 05 08:44 PM	T48+13h00m	Titan surface observations-ISS	Nightside monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes
341T04:25:45	Dec 06 05:44	Fri Dec 05 09:44 PM	T48+14h00m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
341T07:32:33	Dec 06 08:51	Sat Dec 06 12:51 AM	T48+17h07m	Deadtime	14 minutes 27 seconds long; used to accommodate changes in flyby time
341T07:47:00	Dec 06 09:06	Sat Dec 06 01:06 AM	T48+17h22m	Turn to Earth-line	
341T08:27:00	Dec 06 09:46	Sat Dec 06 01:46 AM	T48+18h02m	Playback of T48 Data	Goldstone704m