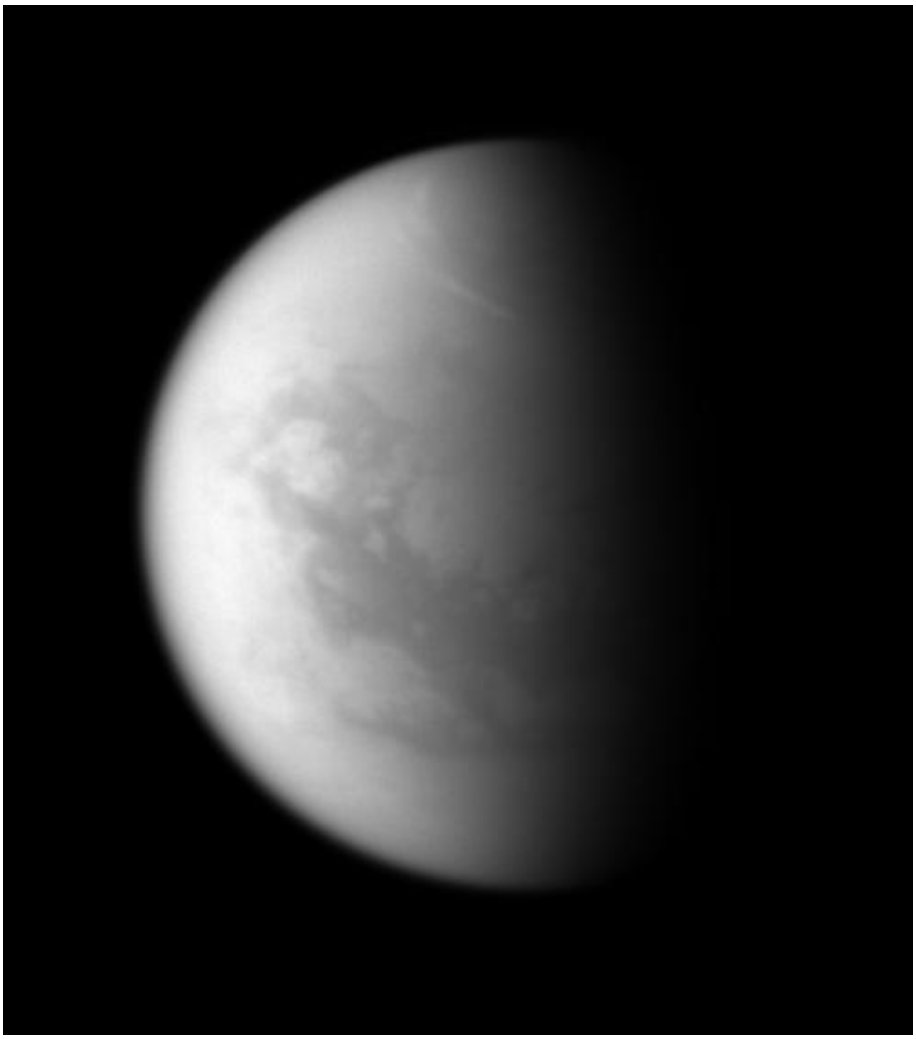
C A S S I N I



T I T A N **0 9 7 T I (T 4 9)** MISSION DESCRIPTION

December 21, 2008

Jet Propulsion Laboratory
California Institute of Technology

Cover image: Titan's Northern Streaks November 12, 2008

Bright clouds circumscribe Titan's north polar region -- a frigid land of methane seas.

The clouds seen in this image and other recent Cassini spacecraft views are at higher latitudes than similar streak-like clouds observed in the southern hemisphere. Scientists are working to understand why such clouds appear preferentially at certain latitudes on Saturn's largest moon.

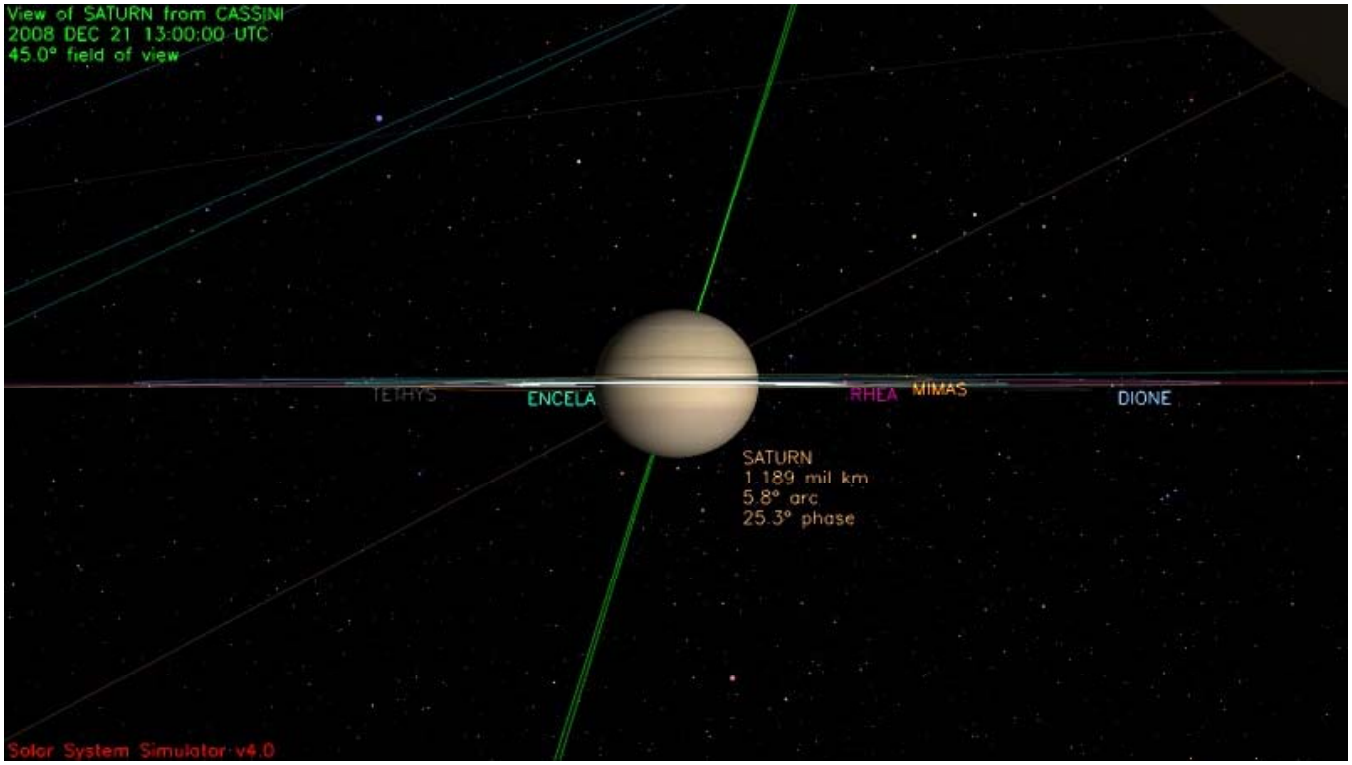
While the streaks that grace Titan's southern hemisphere are often seen at 40 degrees south latitude, similar to Wellington, New Zealand, the streaks in the northern hemisphere are farther from the equator, near 56 degrees north latitude, which is similar to Glasgow, Scotland.

North on Titan (5,150 kilometers, 3,200 miles across) is up and rotated 16 degrees to the right. The image was taken with the Cassini spacecraft narrow-angle camera on Sept. 30, 2008 using a spectral filter sensitive to wavelengths of infrared light centered at 938 nanometers. The view was obtained at a distance of approximately 1.2 million kilometers (776,000 miles) from Titan and at a Sun-Titan-spacecraft, or phase, angle of 71 degrees. Image scale is 7 kilometers (5 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

With only sixteen days having passed since its previous flyby, Cassini returns to Saturn's largest moon for the mission's fiftieth targeted encounter with Titan. The closest approach to Titan occurs on Sunday, December 21, at 2008-356T12:59:53 spacecraft time at an altitude of 970.0 kilometers (~603 miles) above the surface and at a speed of 6.3 kilometers per second (14,000 mph). The latitude at closest approach is 43.9 degrees S and the encounter occurs on orbit number 97.

This encounter is set up with two maneuvers: an apoapsis maneuver on December 13, and a Titan approach maneuver, scheduled for December 17. T49 is the thirteenth in a series of outbound encounters and the fifth Titan encounter in Cassini's Solstice Mission. It occurs just under four days after Saturn closest approach.


View of SATURN from CASSINI
2008 DEC 21 13:00:00 UTC
45.0° field of view
TETHYS
ENCELA
RHEA
MIMAS
DIONE
SATURN
1 189 mil km
5.8° arc
25.3° phase
Solar System Simulator v4.0

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 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-49 SCIENCE HIGHLIGHTS

- **RADAR**: T49 features altimetry across Ontario Lacus, the first time in the mission RADAR has obtained altimetry across a known or suspected lake. The topography profile will help us understand the slopes driving drainage into Ontario as well as providing evidence about whether it is presently liquid-filled. T49 also includes SAR of the almost completely unmapped southwestern quadrant of Titan, as well as of south polar terrain.
- **INMS** On T49, INMS will be riding with RADAR during a relatively rare wakeside pass. INMS will get good ridealong meaurements of non-reactive neutrals, and limited coverage of the ionsphere near closest approach.
- **VIMS** will acquire mid-resolution and high resolution images South of Xanadu. We expect VIMS to point to the Hotei region and to acquire a 2x2 mosaic at 10 km/pixel of this 5 micron bright region. The instrument will then map a part of the Southern hemisphere that has never been mapped at 5 km/pixel resolution. Observation of Titan's bright side will end with a glance at Ontario Lacus if pointing is possible. On the dark side, VIMS will observe Titan's limb looking for some more CO and CH4 emission features.
- **ISS** will acquire global- and regional-mapping mosaics of Titan's leading hemisphere at mid-southern latitudes and will ride along with VIMS to acquire high-resolution coverage at higher southern latitudes.
- **CIRS** continues to extend spatial and temporal coverage of our Titan dataset, performing most major observational activity types. These include: global temperature mapping, vertical profiles of minor gas species in the mid-infrared, and global mapping of far-infrared trace species such as CO, H2O and HCN.
- **MIMI** measures energetic ion and electron energy input to Titan's atmosphere.

- **MAG**: T49 is an upstream flank-out flyby with a minimum altitude of 1000 km. The geometry of this flyby is suitable to study the magnetic pileup region and the pressure balance between the magnetic pressure in the magnetic barrier and the thermal pressure in the ionosphere. T49 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.

- **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.

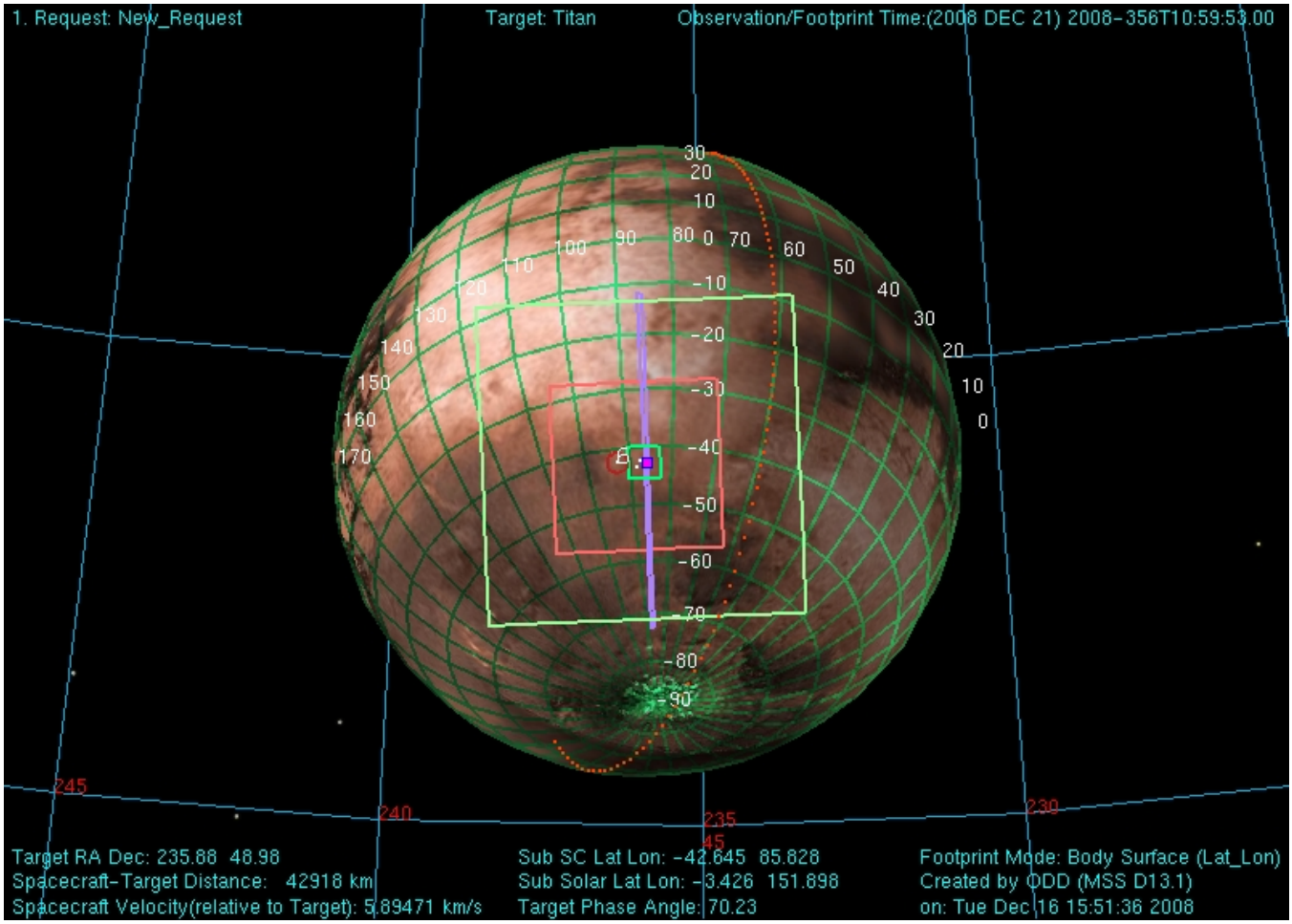
SAMPLE SNAPSHOTS

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.

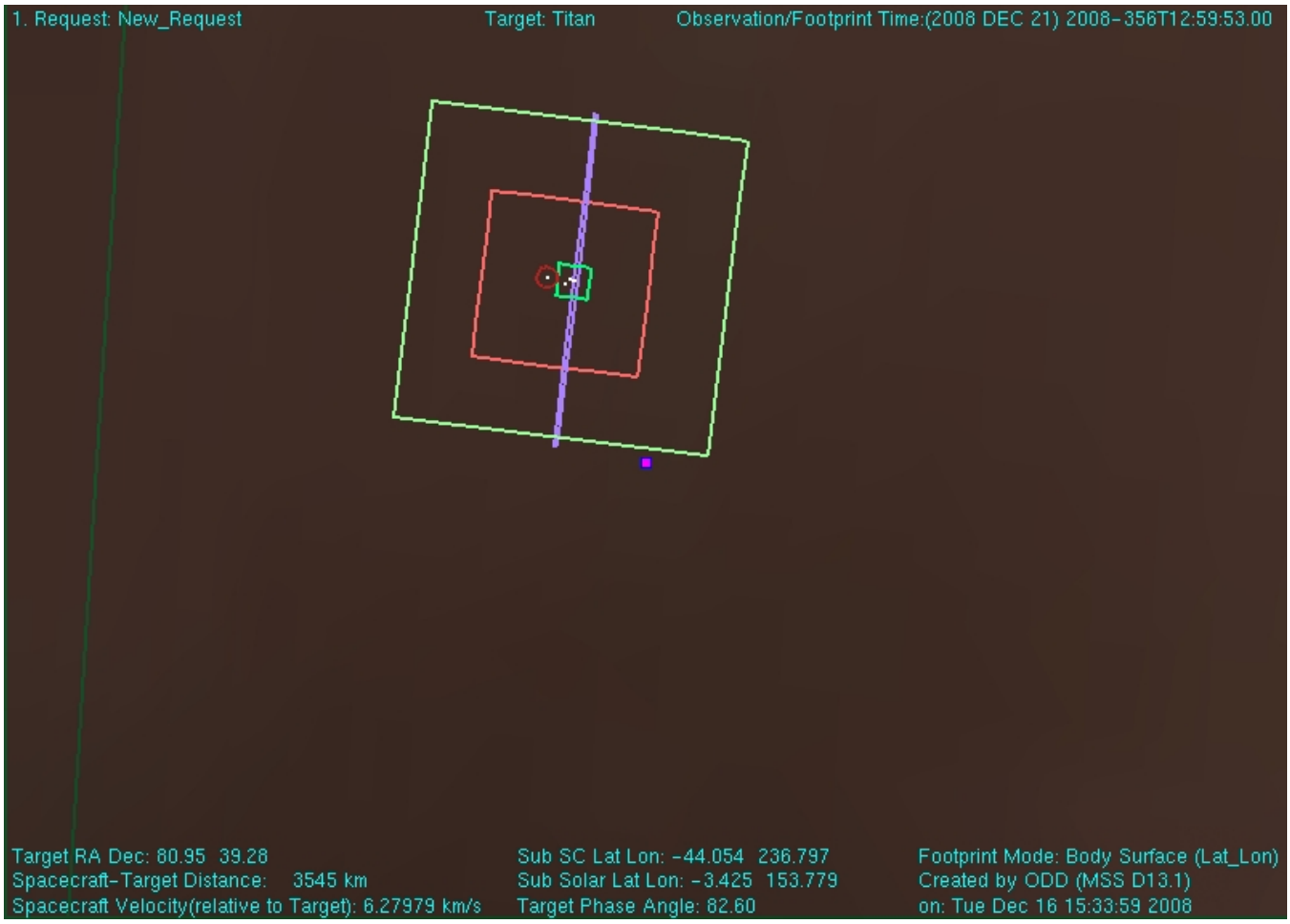
Key to ORS Instrument Fields of View in Figures

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

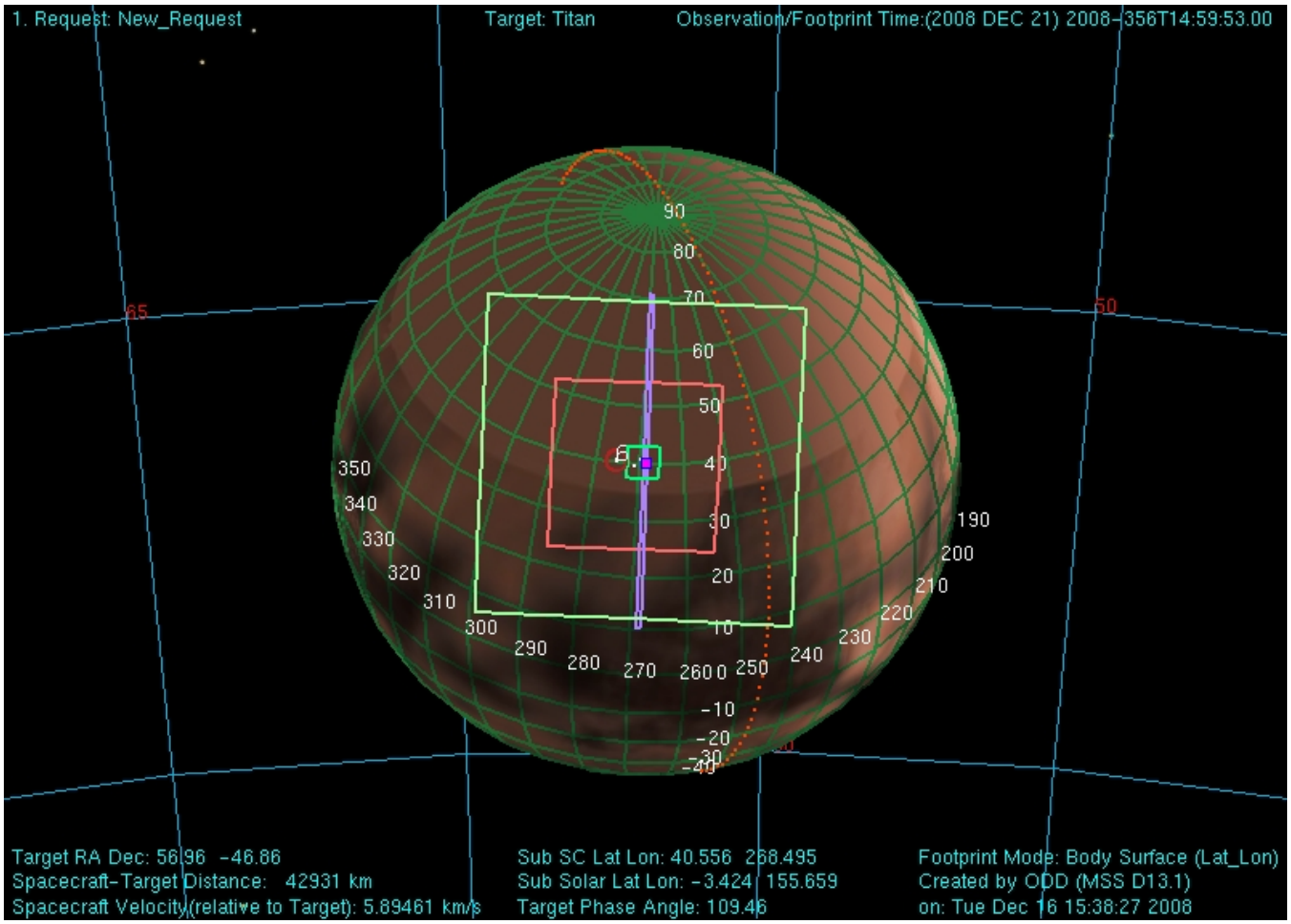
View of Titan from Cassini two hours before Titan-49 closest approach



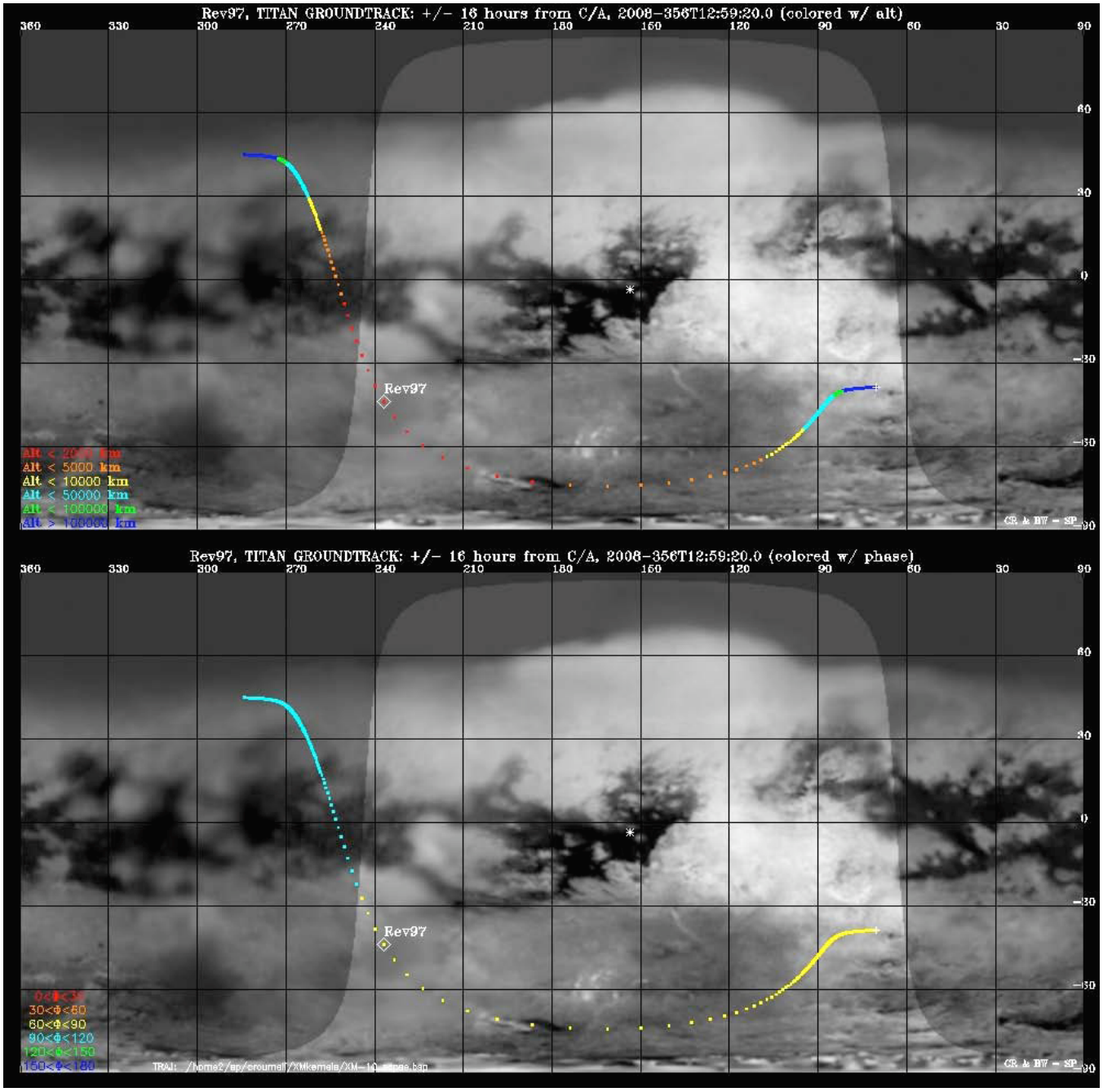
View of Titan from Cassini at Titan-49 closest approach



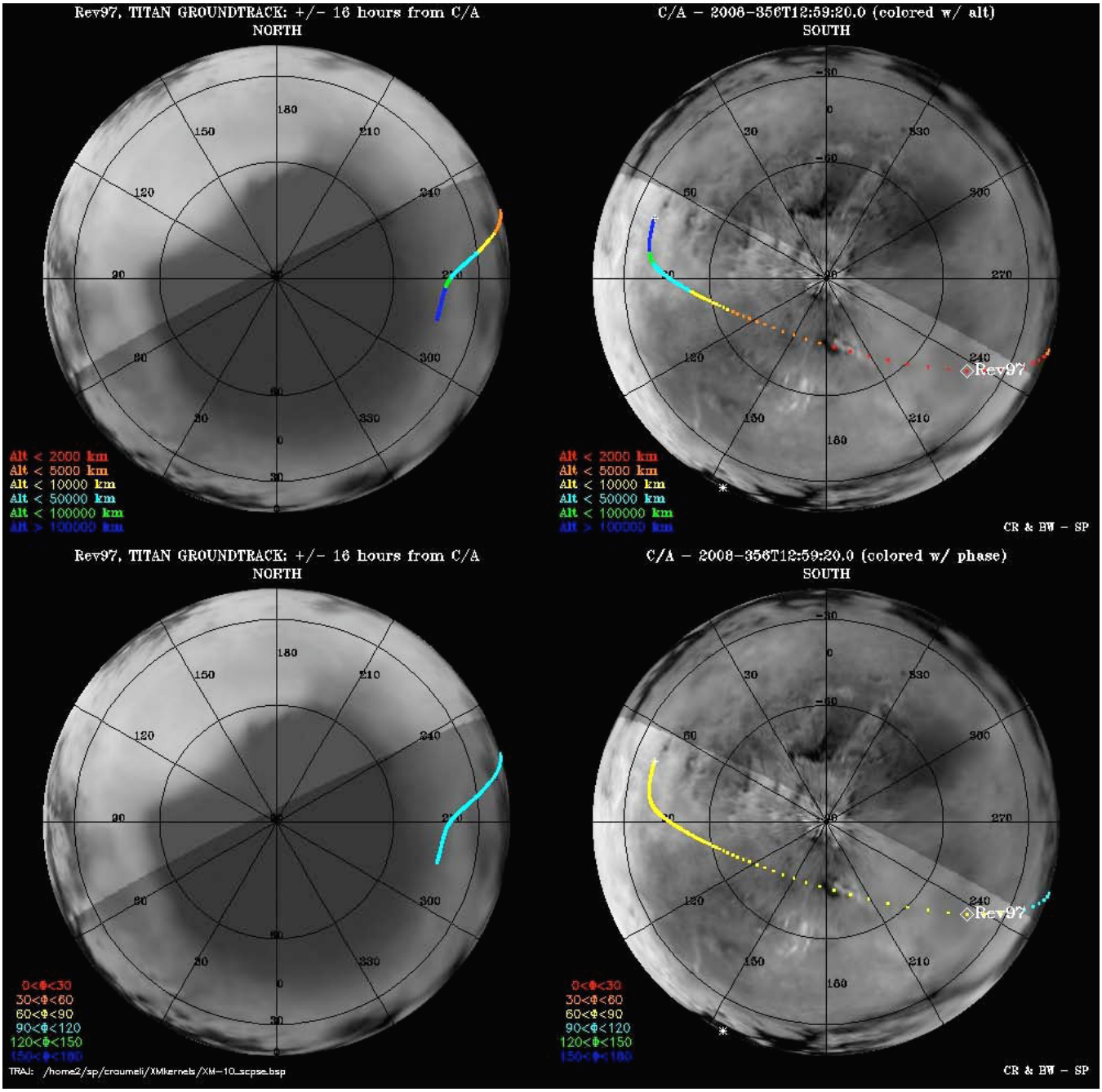
View of Titan from Cassini two hours after Titan-49 closest approach



Titan Groundtracks for T49: Global Plot



Titan Groundtracks for T49: Polar Plot



The T49 timeline is as follows:

Cassini Titan-49 Timeline - December 2008

Colors: yellow = maneuvers; blue = geometry; pink = T49-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T49	Activity	Description
331T17:55:00	Nov 26 19:11	Wed Nov 26 11:11 AM	T49-24d19h	Start of Sequence S46	Start of Sequence which contains Titan-49
352T13:58:00	Dec 17 15:14	Wed Dec 17 07:14 AM	T49-03d23h	OTM #178 Prime	Titan-49 targeting maneuver.
352T17:25:26	Dec 17 18:41	Wed Dec 17 10:41 AM	T49-03d20h	Periapse	
353T23:58:00	Dec 19 01:14	Thu Dec 18 05:14 PM	T49-02d13h	OTM #178 Backup	
355T16:29:00	Dec 20 17:45	Sat Dec 20 09:45 AM	T49-20h30m	Start of the TOST segment	
355T16:29:00	Dec 20 17:45	Sat Dec 20 09:45 AM	T49-20h30m	Turn cameras to Titan	
355T17:09:00	Dec 20 18:25	Sat Dec 20 10:25 AM	T49-19h50m	New waypoint	
355T17:09:00	Dec 20 18:25	Sat Dec 20 10:25 AM	T49-19h50m	Deadtime	15 minutes 32 seconds long; used to accommodate changes in flyby time
355T17:24:32	Dec 20 18:40	Sat Dec 20 10:40 AM	T49-19h35m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
355T23:59:52	Dec 21 01:15	Sat Dec 20 05:15 PM	T49-13h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
356T03:59:52	Dec 21 05:15	Sat Dec 20 09:15 PM	T49-09h00m	Titan surface observations-ISS	NAC Global Map
356T07:59:52	Dec 21 09:15	Sun Dec 21 01:15 AM	T49-05h00m	Titan surface observations-ISS	NAC Regional Map
356T09:59:52	Dec 21 11:15	Sun Dec 21 03:15 AM	T49-03h00m	Titan atmospheric observations-CIRS	Vertical sounding of stratospheric compounds on Titan, including H2O. Integrations at 2 locations on the limb displaced vertically.
356T10:59:52	Dec 21 12:15	Sun Dec 21 04:15 AM	T49-02h00m	Titan surface observations-VIMS	Regional Map
356T12:13:52	Dec 21 13:29	Sun Dec 21 05:29 AM	T49-00h46m	Transition to thruster control	
356T12:14:52	Dec 21 13:30	Sun Dec 21 05:30 AM	T49-00h45m	Titan surface observations-VIMS	Regional Map during transition to thruster control
356T12:35:52	Dec 21 13:51	Sun Dec 21 05:51 AM	T49-00h24m	Titan RADAR Observations	Inbound HiSAR
356T12:50:52	Dec 21 14:06	Sun Dec 21 06:06 AM	T49-00h09m	Titan RADAR Observations	Inbound Altimetry over Ontario
356T12:55:52	Dec 21 14:11	Sun Dec 21 06:11 AM	T49-00h04m	Titan RADAR Observations	Outbound SAR
356T12:59:53	**Dec 21 14:15**	**Sun Dec 21 06:15 AM**	**T49+00h00m**	**Titan-49 Flyby Closest Approach Time**	**Altitude = 970 km (~603 miles), speed = 6.3 km/s (14,000 mph); 83 deg phase at closest approach**
356T13:04:11	Dec 21 14:20	Sun Dec 21 06:20 AM	**T49+00h05m**	Apoapse	
356T13:17:52	Dec 21 14:33	Sun Dec 21 06:33 AM	T49+00h18m	Titan RADAR Observations	Outbound Altimetry
356T13:29:52	Dec 21 14:45	Sun Dec 21 06:45 AM	T49+00h30m	Titan RADAR Observations	Outbound HiSAR
356T13:34:20	Dec 21 14:50	Sun Dec 21 06:50 AM	T49+00h35m	Ascending Ring Plane Crossing	
356T13:49:52	Dec 21 15:05	Sun Dec 21 07:05 AM	T49+00h50m	Transition off of thruster control	
356T14:11:06	Dec 21 15:27	Sun Dec 21 07:27 AM	T49+01h12m	Titan RADAR Observations	Outbound Scatterometry
356T14:59:52	Dec 21 16:15	Sun Dec 21 08:15 AM	T49+02h00m	Titan RADAR Observations	Outbound Radiometry
356T18:29:52	Dec 21 19:45	Sun Dec 21 11:45 AM	T49+05h30m	Titan atmospheric observations-CIRS	Obtain vertical profiles of temperatures in Titan's stratosphere. The arrays are stepped along the limb at two altitudes at 5 degree latitude intervals
356T21:59:52	Dec 21 23:15	Sun Dec 21 03:15 PM	T49+09h00m	Titan surface observations-VIMS	Cloud mapping
357T01:59:52	Dec 22 03:15	Sun Dec 21 07:15 PM	T49+13h00m	Titan surface observations-ISS	monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes
357T02:29:52	Dec 22 03:45	Sun Dec 21 07:45 PM	T49+13h30m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
357T05:59:52	Dec 22 07:15	Sun Dec 21 11:15 PM	T49+17h00m	Titan surface observations-ISS	Long range monitoring
357T06:29:52	Dec 22 07:45	Sun Dec 21 11:45 PM	T49+17h30m	Deadtime	17 minutes 30 seconds long; used to accommodate changes in flyby time
357T06:34:00	Dec 22 07:50	Sun Dec 21 11:50 PM	T49+17h35m	Turn to Earth-line	
357T07:14:00	Dec 22 08:30	Mon Dec 22 12:30 AM	T49+18h15m	Playback of T49 Data	Goldstone70m
357T14:29:00	Dec 22 15:45	Mon Dec 22 07:45 AM	T49+01d02h	Playback of T49 Data	Canberra 70m

OWLT (mins)	76
C/A Time	Sun Dec 21 06:15 AM