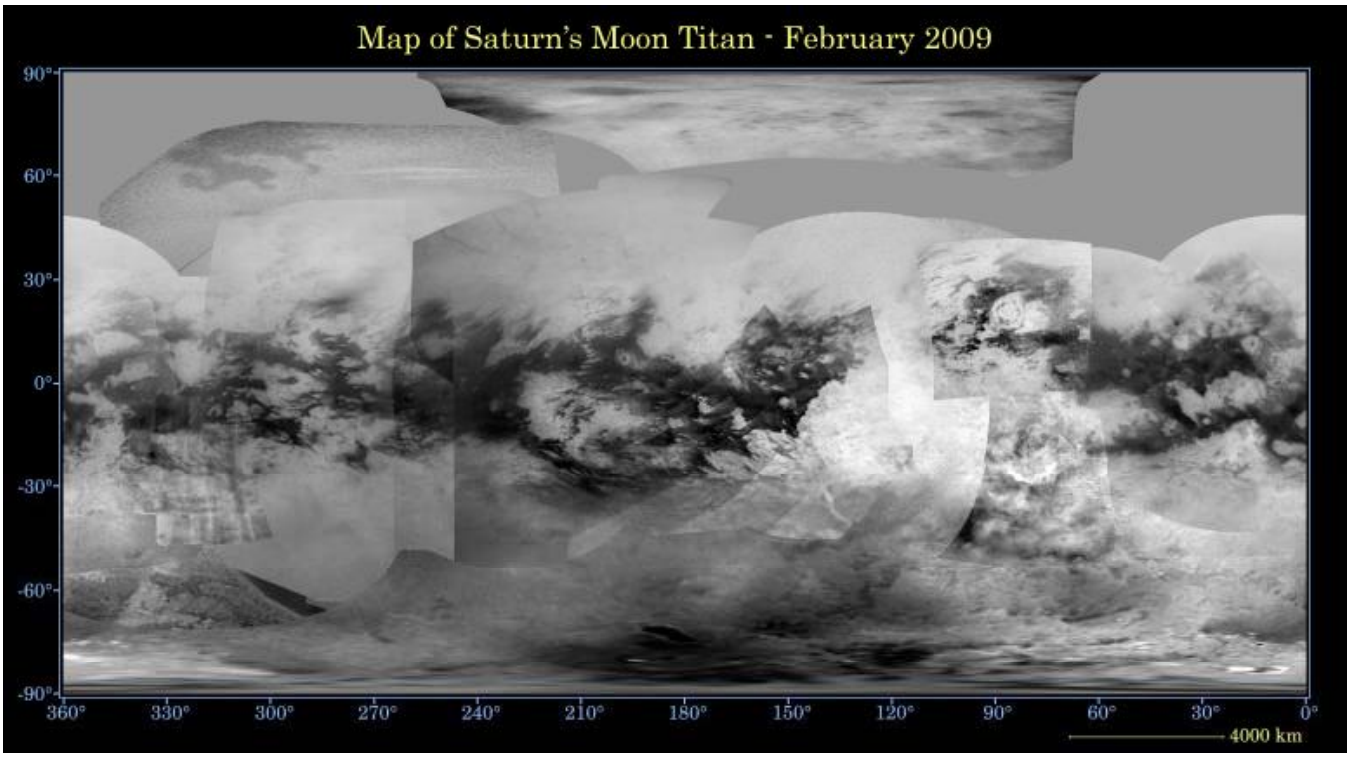
C A S S I N I



T I T A N 106TI(T51) MISSION DESCRIPTION

March 27, 2009

Jet Propulsion Laboratory
California Institute of Technology

Cover image: Map of Titan - February 2009

This global digital map of Saturn's moon Titan was created using images taken by the Cassini spacecraft's imaging science subsystem.

The images were taken using a filter centered at 938 nanometers, allowing researchers to examine variations in albedo (or inherent brightness) across the surface of Titan. Because of the scattering of light by Titan's dense atmosphere, no topographic shading is visible in these images.

The map is an equidistant projection and has a scale of 4 kilometers (2.5 miles) per pixel. Actual resolution varies greatly across the map, with the best coverage (close to the map scale) near the center and edges of the map and the worst coverage on the leading hemisphere (centered around 120 degrees west longitude).

Imaging coverage in the northern polar region continues to improve as Titan approaches northern vernal equinox in August 2009 and the north pole comes out of shadow. Large dark areas, strongly suspected to be liquid-hydrocarbon-filled lakes, have been documented at high latitudes (see PIA11146).

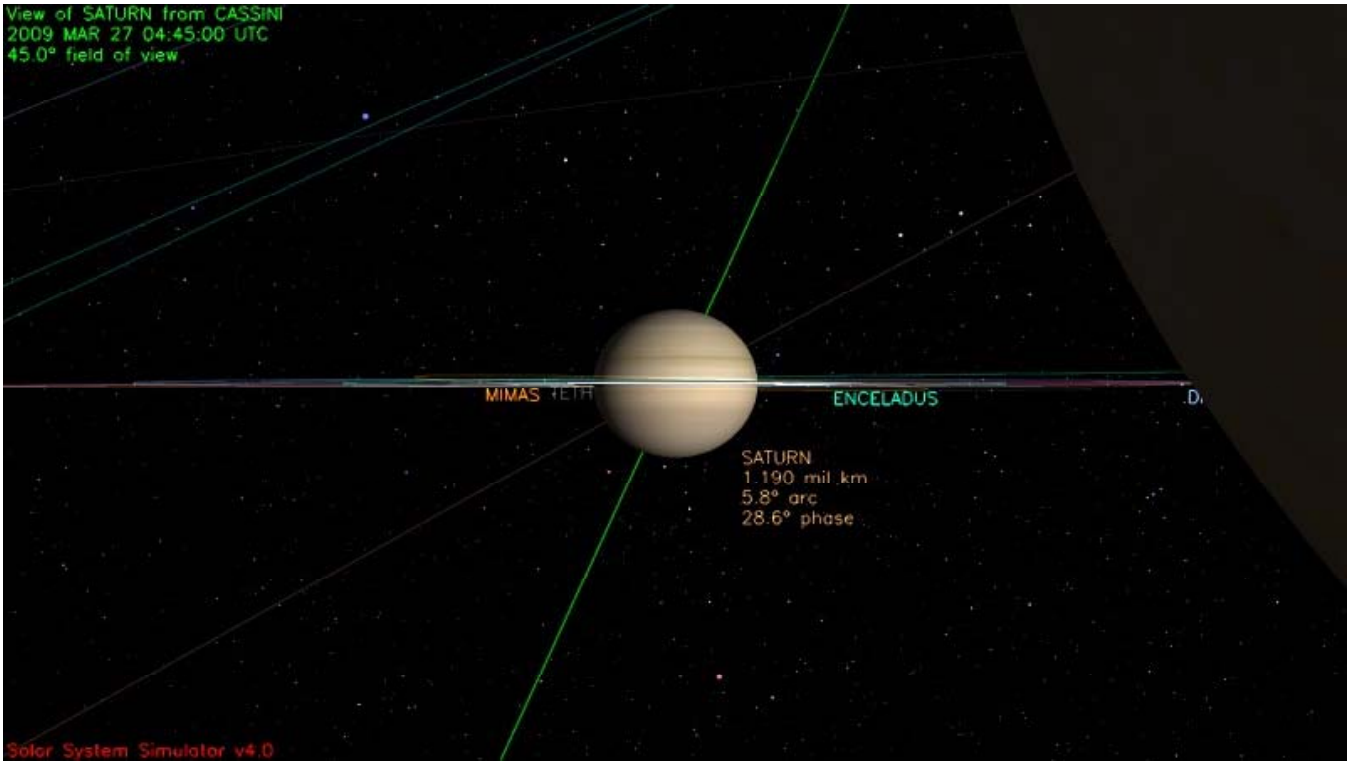
The mean radius of Titan used for projection of this map is 2,575 kilometers (1,600 miles). Until a control network is created for Titan, the satellite is assumed to be spherical. The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency.

Credit: NASA/JPL/Space Science Institute

1.0 OVERVIEW

Following 48 days since its previous visit, Cassini returns to Saturn's largest moon for the mission's fifty-second targeted encounter with Titan. The closest approach to Titan occurs on Friday, March 27, at 2009-086T04:43:36 spacecraft time at an altitude of 960.0 kilometers (~600 miles) above the surface and at a speed of 6.3 kilometers per second (14,000 mph). The latitude at closest approach is 30.9 degrees S and the encounter occurs on orbit number 106.

This encounter is set up with two maneuvers: an apoapsis maneuver on March 8, and a Titan approach maneuver, scheduled for March 23. T51 is the fifteenth and final flyby in a series of outbound encounters and the seventh Titan encounter in Cassini's Solstice Mission. It occurs just over five days after Saturn closest approach.


View of SATURN from CASSINI
2009 MAR 27 04:45:00 UTC
45.0° field of view
MIMAS
ENCELADUS
SATURN
1.190 mil km
5.8° arc
28.6° 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-51 SCIENCE HIGHLIGHTS

- **RSS** observes bistatic scattering from Titan's surface on the outbound side. The observation probes the midnorthern latitude regions of Titan's surface (30-40 degs; ~190-200 degs west longitude). Same- and crosspolarized components of the quasi-specular surface echo, if detectable, provide information about the dielectric constant and physical state of the surface region probed.
- **INMS:** On T51, INMS is Prime on the flyby's outbound leg. The observation is designed to measure the day side ionosphere,and the wake/outer flank of the magnetospheric interaction region. This pass fills in coverage of mid to high latitudes.
- **VIMS** will observe Ontario Lacus (-75, 180W) after the equinox and will be able to see any change from observations taken before the equinox (Brown et al., Nature, 2008). VIMS will also look for changes in the south pole area as it is less and less illuminated. The instrument will also monitor tropical clouds during the flyby in an area west of Tsegihi (30-60South, 60-100 W) at a resolution between 5 and 10 km per pixel.
- **CIRS** Low southern latitude limb composition sounding, mid and far-infrared.
- **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.
- **ISS** will acquire full-disk and global-mapping mosaics and high-resolution imaging of Titan's leading hemisphere at high southern latitudes. ISS will attempt very high-resolution imaging of the south-polar region, including Ontario Lacus, in ride-along with VIMS.
- **MIMI** measures energetic ion and electron energy input to Titan's atmosphere. The ENA imaging is considered high value science
- **MAG**: T51 is another near-noon (10.5 h SLT), upstream flank-out flyby, with a minimum altitude of 1000 km, which is almost parallel to T50. Therefore, the measurements will be complementary to T50, providing a description of the draping

and the pileup of the external magnetic field around Titan on the dayside hemisphere. As in the previous flybys, Titan could be found in the magnetosheath during T51.

- **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.

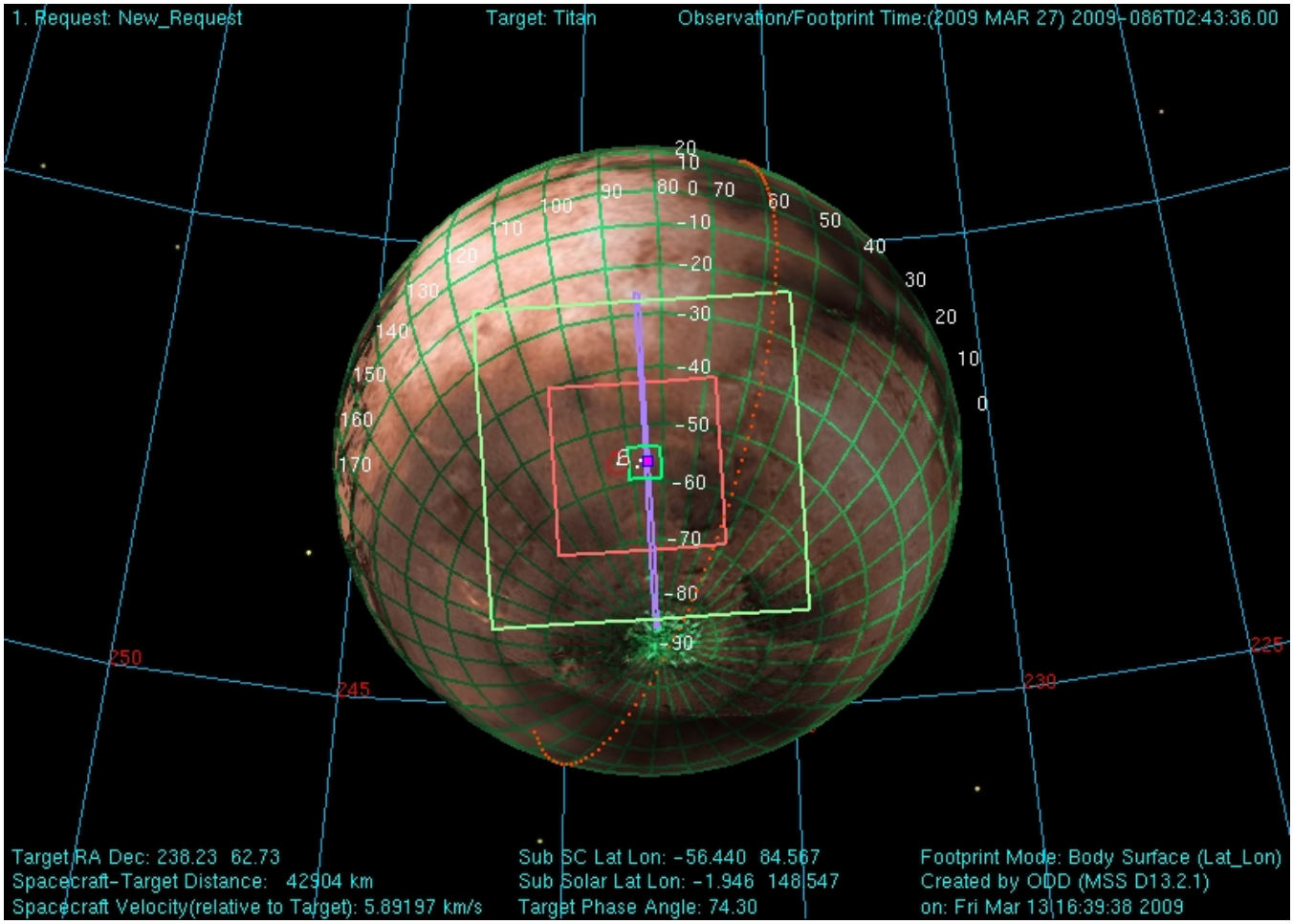
SAMPLE SNAPSHOTS

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.

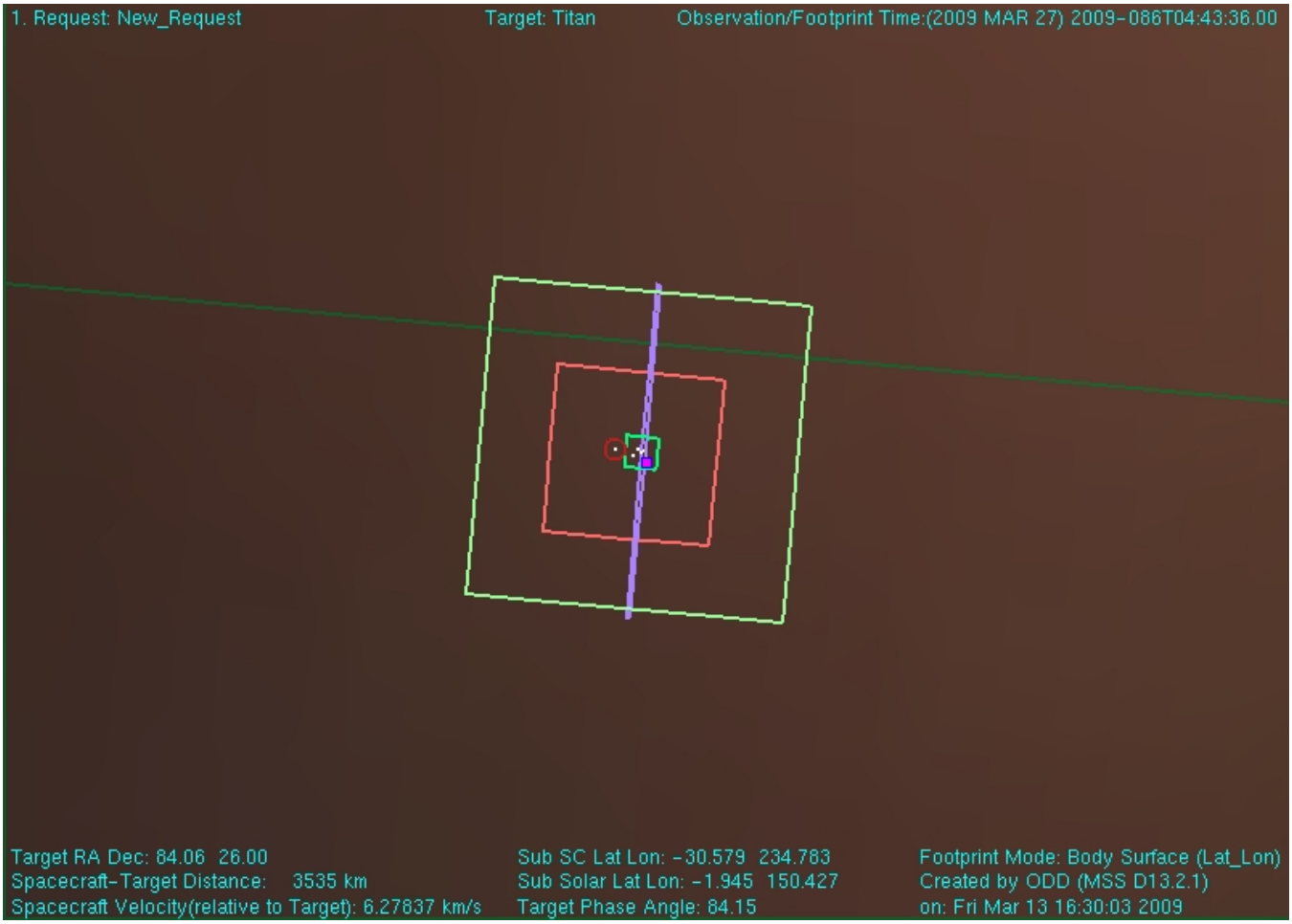
Key to ORS Instrument Fields of View in Figures

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

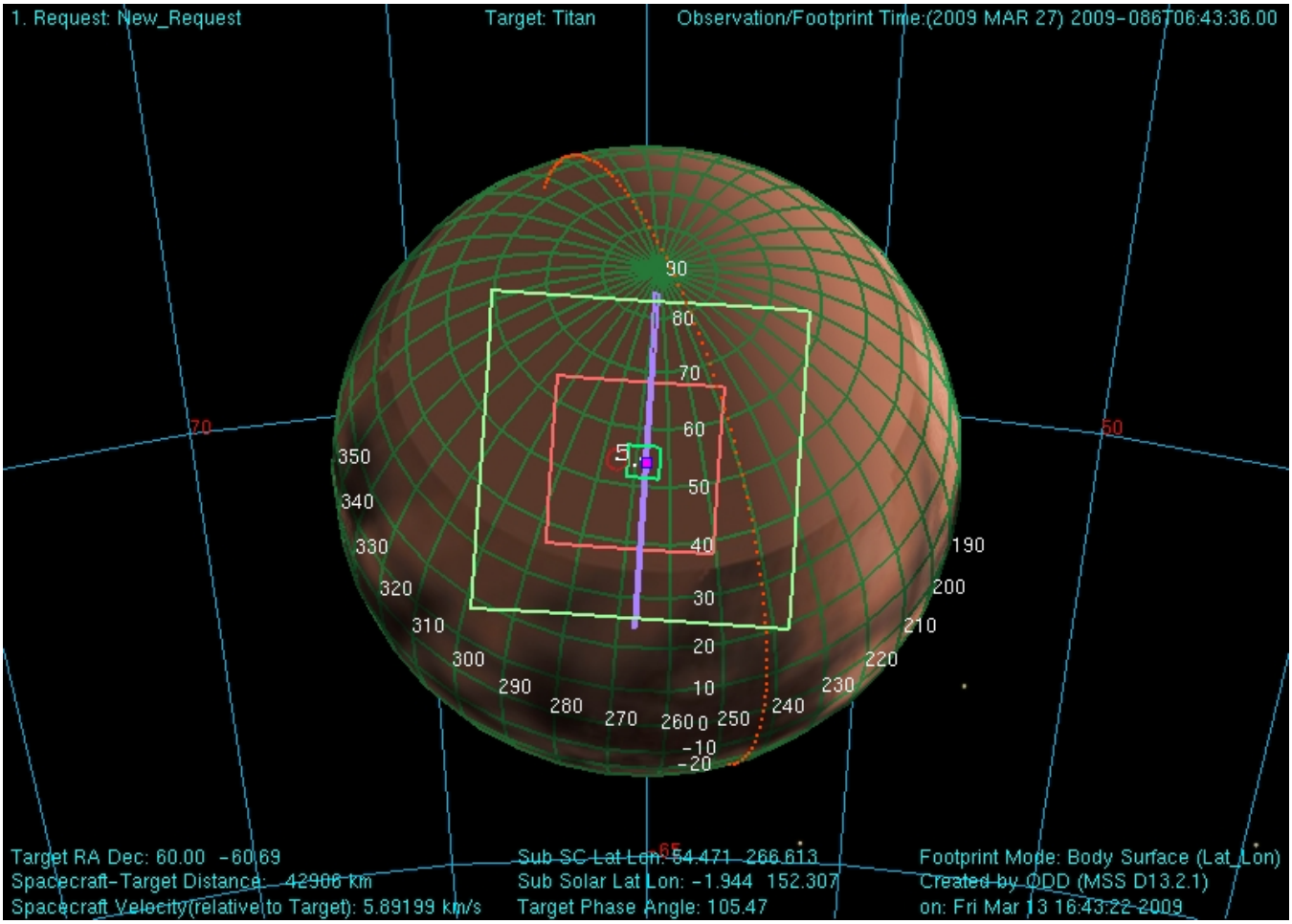
View of Titan from Cassini two hours before Titan-51 closest approach



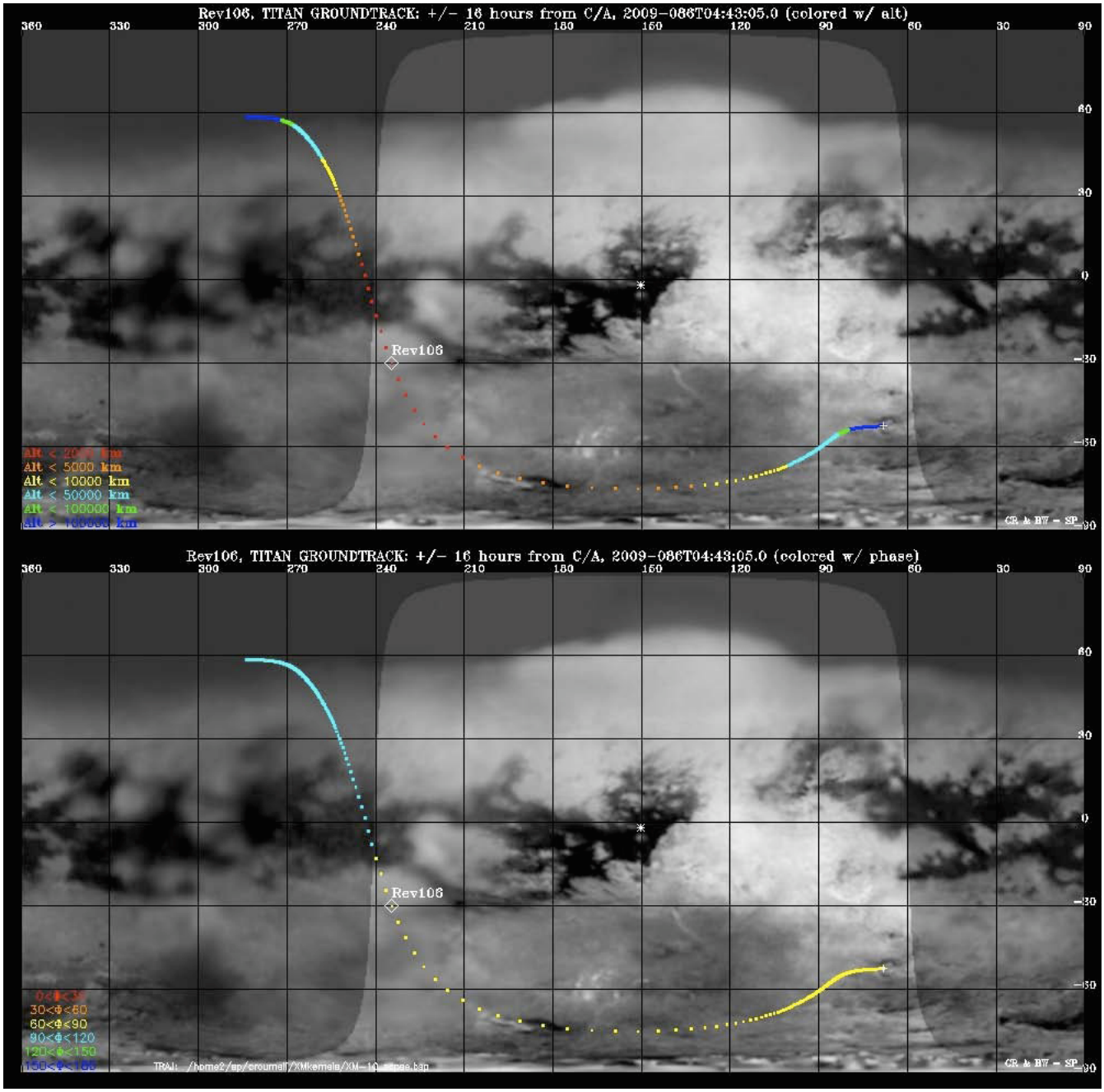
View of Titan from Cassini at Titan-51 closest approach



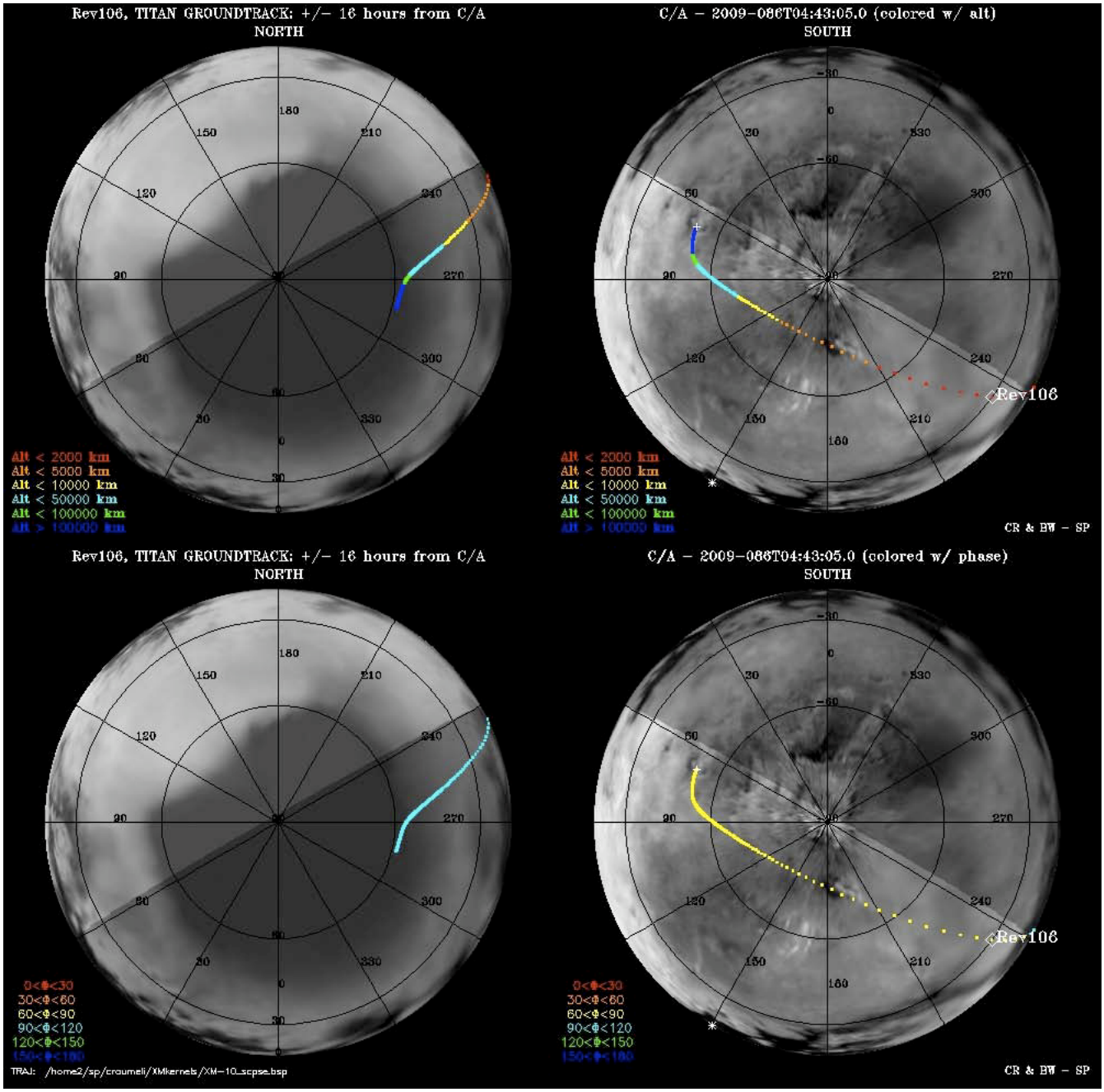
View of Titan from Cassini two hours after Titan-51 closest approach



Titan Groundtracks for T51: Global Plot



Titan Groundtracks for T51: Polar Plot



The T51 timeline is as follows:

Cassini Titan-51 Timeline - March 2009

Colors: yellow = maneuvers; blue = geometry; pink = T51-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T51	Activity	Description
083T01:20:00	Mar 24 02:30	Mon Mar 23 06:30 PM	T51-03d03h	OTM #184 Prime	Titan-51 targeting maneuver.
084T01:05:00	Mar 25 02:15	Tue Mar 24 06:15 PM	T51-02d04h	OTM #184 Backup	
085T10:05:00	Mar 26 11:15	Thu Mar 26 03:15 AM	T51-18h38m	Start of Sequence S49	Start of Sequence which contains Titan-51
085T10:05:00	Mar 26 11:15	Thu Mar 26 03:15 AM	T51-18h38m	Start of the TOST segment	
085T10:11:00	Mar 26 11:21	Thu Mar 26 03:21 AM	T51-18h32m	Turn cameras to Titan	
085T10:53:00	Mar 26 12:03	Thu Mar 26 04:03 AM	T51-17h50m	New waypoint	
085T10:53:00	Mar 26 12:03	Thu Mar 26 04:03 AM	T51-17h50m	Deadtime	7 minutes 31 seconds long; used to accommodate changes in flyby time
085T11:00:31	Mar 26 12:10	Thu Mar 26 04:10 AM	T51-17h43m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
085T14:43:36	Mar 26 15:53	Thu Mar 26 07:53 AM	T51-14h00m	Titan surface observations-ISS	monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes
085T16:43:36	Mar 26 17:53	Thu Mar 26 09:53 AM	T51-12h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
085T19:43:36	Mar 26 20:53	Thu Mar 26 12:53 PM	T51-09h00m	Titan Global Map-ISS	monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes
085T23:43:36	Mar 27 00:53	Thu Mar 26 04:53 PM	T51-05h00m	Titan surface observations-VIMS	Regional map
086T02:43:36	Mar 27 03:53	Thu Mar 26 07:53 PM	T51-02h00m	Titan Regional Map-ISS	monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes
086T03:51:36	Mar 27 05:01	Thu Mar 26 09:01 PM	T51-00h52m	Transition to thruster control	
086T03:52:36	Mar 27 05:02	Thu Mar 26 09:02 PM	T51-00h51m	Titan mosaic-VIMS	Path over Ontario lake 12 minutes before closest approach with images at 1.5 km/pixel.
086T04:43:36	Mar 27 05:53	**Thu Mar 26 09:53 PM**	T51+00h00m	**Titan-51 Flyby Closest Approach Time**	**Altitude = 960 km (~600 miles), speed = 6.3 km/s (14,000 mph); 84 deg phase at closest approach**
086T04:51:35	Mar 27 06:01	Thu Mar 26 10:01 PM	T51+00h08m	Apoapse	
086T04:58:36	Mar 27 06:08	Thu Mar 26 10:08 PM	T51+00h15m	Titan RSS Observations	Bistatic scattering measurments at three radio wavelengths to determine the physical properties of Titan's surface, including reflectivity, dielectric constant, and roughness.
086T06:11:36	Mar 27 07:21	Thu Mar 26 11:21 PM	T51+01h28m	Transition off of thruster control	
086T06:32:43	Mar 27 07:42	Thu Mar 26 11:42 PM	T51+01h49m	Titan atmospheric observations-CIRS	Obtain information on surface & tropopause temperatures, and on tropospheric CH4.
086T09:43:36	Mar 27 10:53	Fri Mar 27 02:53 AM	T51+05h00m	Titan atmospheric observations-CIRS	Obtain vertical profiles of temperatures in Titan's stratosphere.
086T13:43:36	Mar 27 14:53	Fri Mar 27 06:53 AM	T51+09h00m	Titan WAC photometry-ISS	monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes
086T14:43:36	Mar 27 15:53	Fri Mar 27 07:53 AM	T51+10h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4.
086T05:09:51	Mar 27 06:19	Thu Mar 26 10:19 PM	T51+00h26m	Ascending Ring Plane Crossing	
086T17:43:36	Mar 27 18:53	Fri Mar 27 10:53 AM	T51+13h00m	Nightside NAC Imaging-ISS	monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes
086T18:13:36	Mar 27 19:23	Fri Mar 27 11:23 AM	T51+13h30m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
086T23:25:36	Mar 28 00:35	Fri Mar 27 04:35 PM	T51+18h42m	Nightside NAC Imaging-ISS	monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes
086T23:55:36	Mar 28 01:05	Fri Mar 27 05:05 PM	T51+19h12m	Deadtime	14 minutes 23 seconds long; used to accommodate changes in flyby time
087T00:10:00	Mar 28 01:20	Fri Mar 27 05:20 PM	T51+19h27m	Turn to Earth-line	
087T00:50:00	Mar 28 02:00	Fri Mar 27 06:00 PM	T51+20h07m	Playback of T51 Data	Goldstone70m
087T03:20:00	Mar 28 04:30	Fri Mar 27 08:30 PM	T51+22h37m	Playback of T51 Data	Goldstone 34m
087T05:33:15	Mar 28 06:43	Fri Mar 27 10:43 PM	T51+01d01h	Periapse	
087T09:50:00	Mar 28 11:00	Sat Mar 28 03:00 AM	T51+01d05h	Playback of T51 Data	Canberra 34m