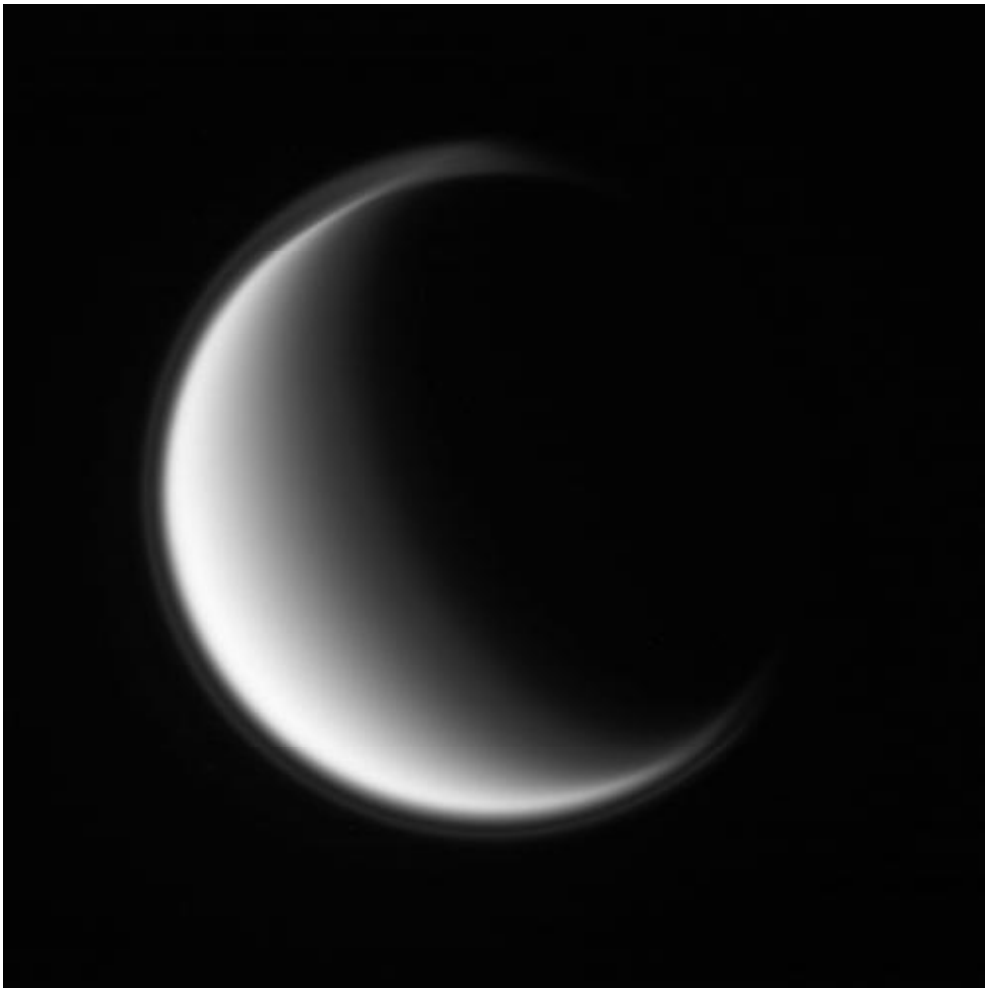
C A S S I N I



T I T A N **0 6 7 T I (T 4 3)** MISSION DESCRIPTION

May 12, 2008

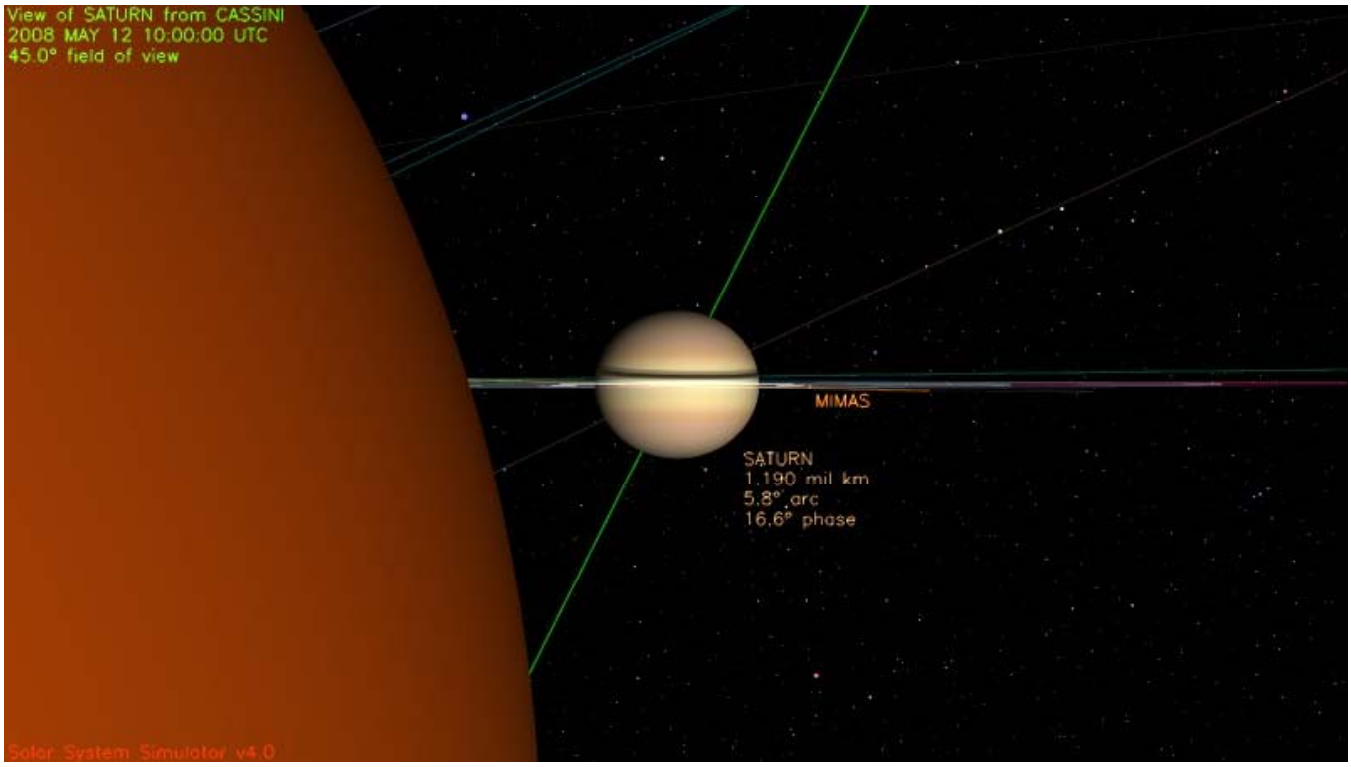
Jet Propulsion Laboratory
California Institute of Technology

Cover image: Violet Titan. The Cassini spacecraft peers at the smooth globe of Titan, wrapped in its photochemical haze. The moon's thin, detached, high-altitude haze layer is best viewed at shorter wavelengths of light, as in this violet light image and ultraviolet views. North on Titan (5,150 kilometers, or 3,200 miles across) is up. The image was taken with the Cassini spacecraft wide-angle camera on Feb. 22, 2008. The view was obtained at a distance of approximately 214,000 kilometers (133,000 miles) from Titan and at a Sun-Titan-spacecraft, or phase, angle of 119 degrees. Image scale is 13 kilometers (8 miles) per pixel. Credit: NASA/JPL/Space Science Institute

1.0 OVERVIEW

Almost 48 days after its previous visit, Cassini revisits Saturn's largest moon for the mission's forty-fourth targeted encounter with Titan. The closest approach to Titan occurs on Monday, May 12, at 2008-133T10:01:58 spacecraft time at an altitude of 1000 kilometers (~621 miles) above the surface and at a speed of 6.3 kilometers per second (14,000 mph). The latitude at closest approach is 17.1 degrees N and the encounter occurs on orbit number 67.

This encounter is set up with two maneuvers: an apoapsis maneuver on April 25, and a Titan approach maneuver, scheduled for May 8. T43 is the eighth in a series of outbound encounters that will last until the end of the prime mission, and occurs less than two days after Saturn closest approach. This is the first of two Titan northern hemisphere encounters that close out the prime mission.



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-43 SCIENCE HIGHLIGHTS

- **RADAR** captures SAR imagery of the bright region Xanadu, only part of which was previously observed in T13. The RADAR team has targeted Hotei Arcus, as well as the possible cryovolcanic feature Tortola Facula (informally known as the 'Snail') which is seen near closest approach. T43 will also feature high-altitude SAR(1-2 km/pixel) of the west end of Tui Regio. This will be the first RADAR coverage of Tui Regio, which we know from VIMS observations to be compositionally distinct from the rest of Titan. Observations of the dunes northwest of Xanadu may show how wind is diverted around Xanadu. In combination with T13 data, T43 SAR may help measure Titan's topography and the possibly changing spin rate.

- **INMS** rides along with RADAR to get low latitude coverage in the north.

- **CIRS** continues to extend spatial and temporal coverage of Titan, from low-spectral resolution disk maps to high spectral resolution nadir and limb integrations. Getting good time resolution is very important because we are looking for seasonal changes in the stratosphere, especially the expected break-up of the northern polar vortex in northern spring. During T43, CIRS will make a number of important maps on the outbound leg, including a far-IR surface/troposphere temperature scan from +2 to +5 hours, a mid-IR limb temperature map for stratospheric temperatures from +5 to +9, and then, after a short downlink, a complete mid-IR temperature map of visible hemisphere, for inferring dynamics, winds and waves. CIRS also has two far-IR composition links to search for new molecular species in the far-IR and sub-mm ranges beyond the capability of Voyager IRIS.

- **VIMS** observations concentrate on determining time scales for cloud formation and dissipation.

- **ISS** will capture night side photometry. As the geometries of the T41 through T44 flybys are very similar, we'll be able to monitor how the clouds change in this region every few weeks. The instrument will utilize ride-along observations with CIRS.

- **RPWS:** As Titan is out "in front" of Saturn, the T41 through T44 flybys put the spacecraft in an ideal location to have another opportunity to see Titan outside of Saturn's magnetosphere, in shocked solar wind ahead of the magnetosheath as happened on T32. We are interested in duplicating the flyby geometry to look for shorter time-scale phenomena in Titan's plasma environment, so this series of four flybys, especially T41 through T43, will offer that opportunity.

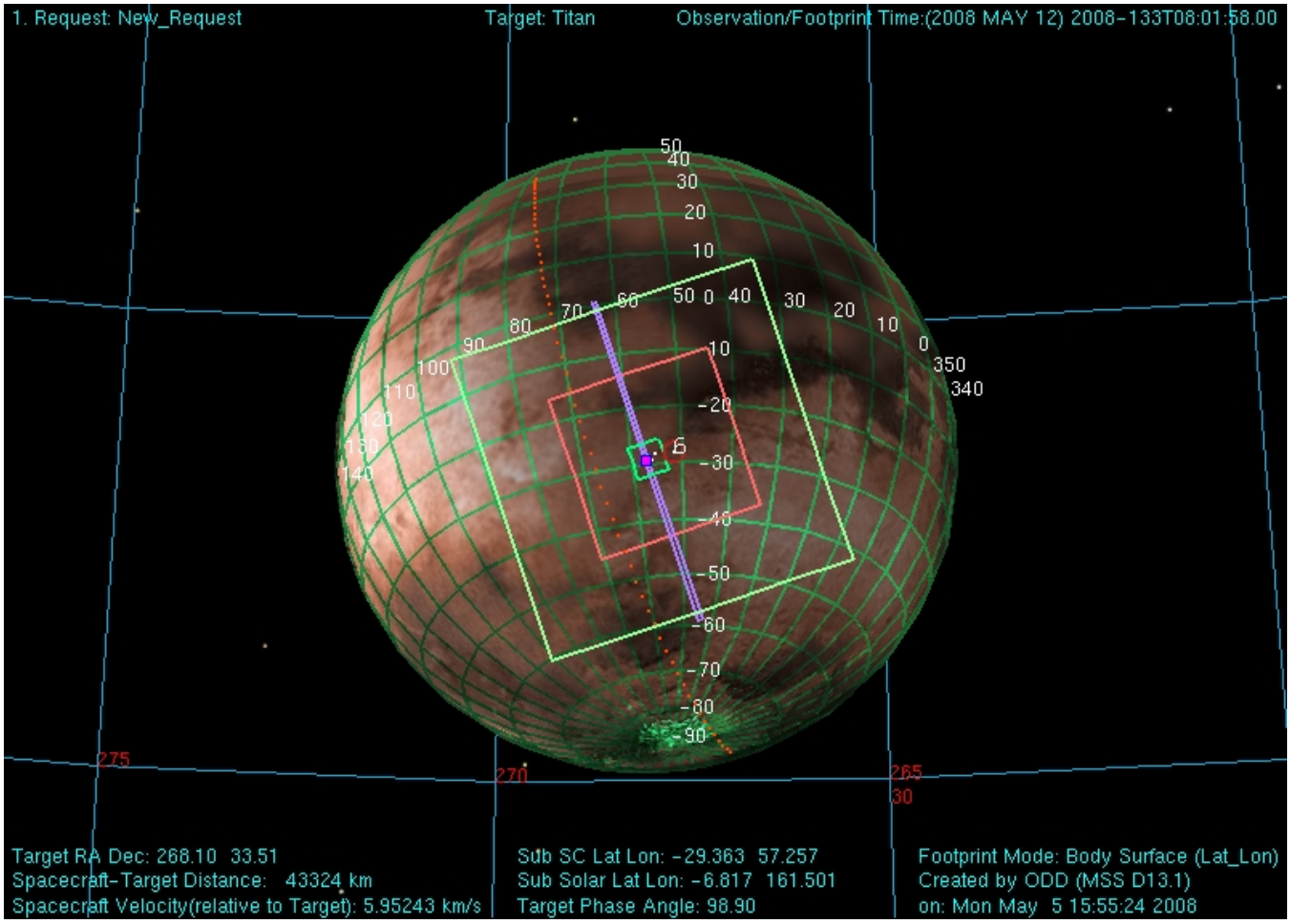
SAMPLE SNAPSHOTS

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.

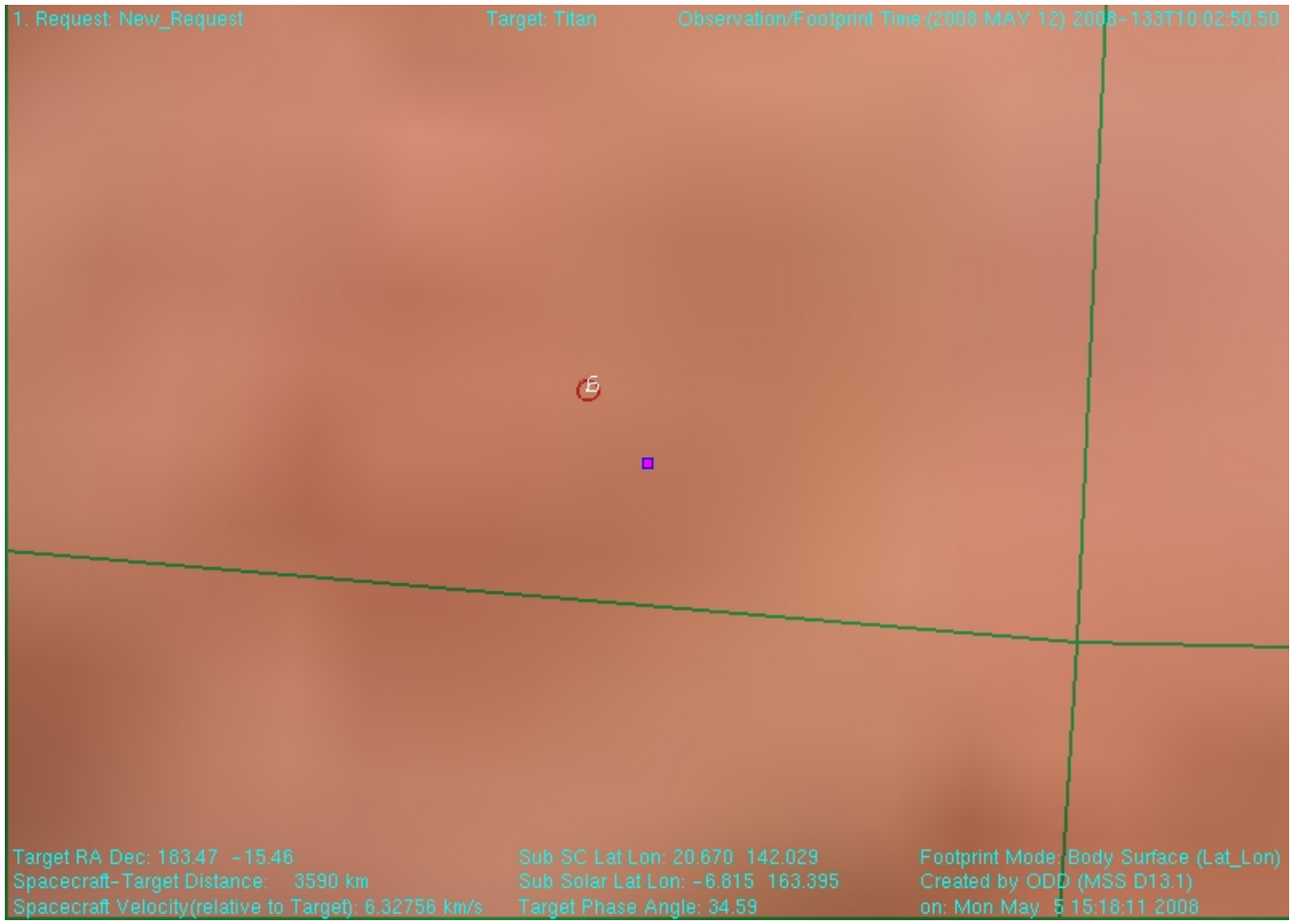
Key to ORS Instrument Fields of View in Figures

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

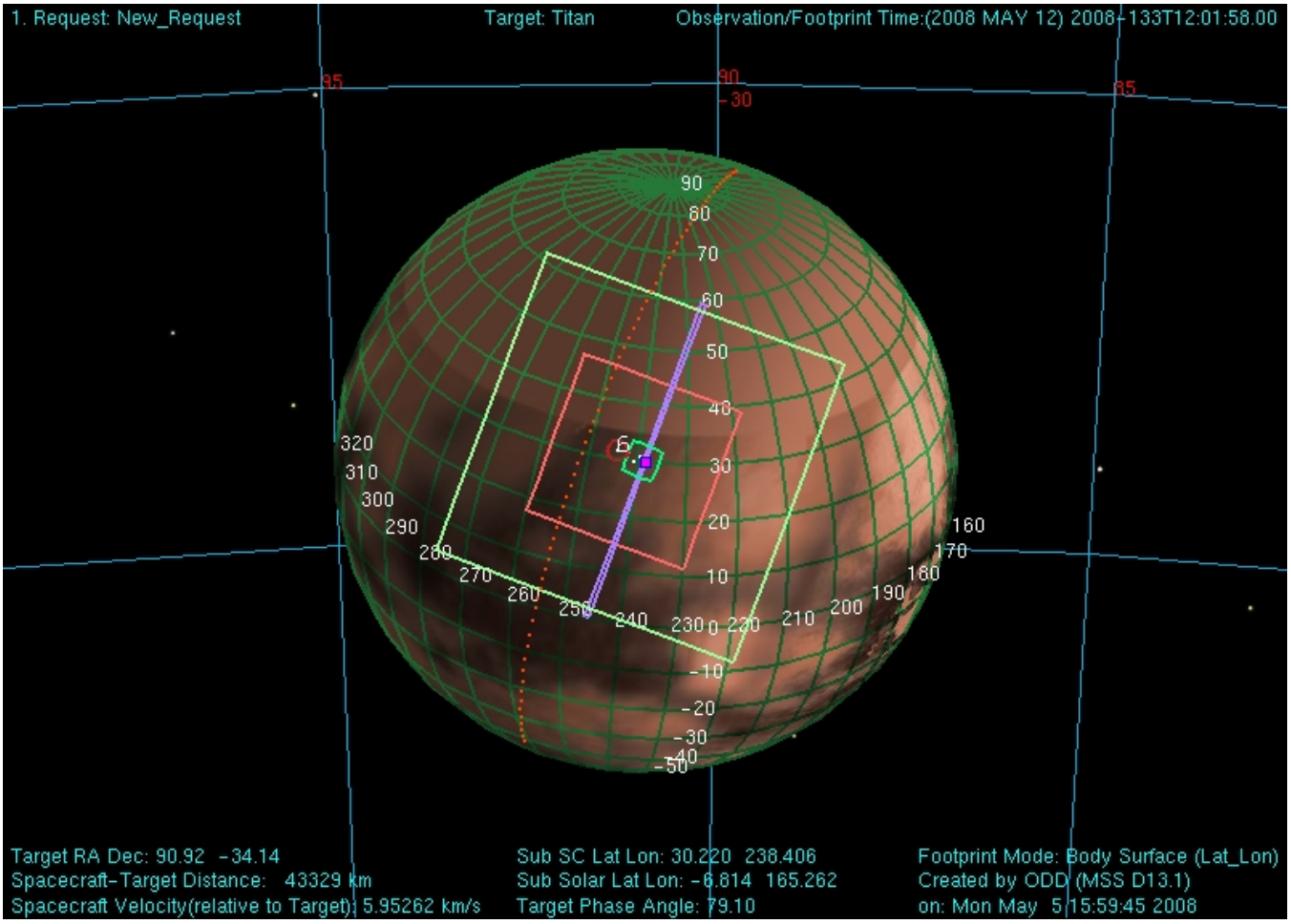
View of Titan from Cassini two hours before Titan-43 closest approach



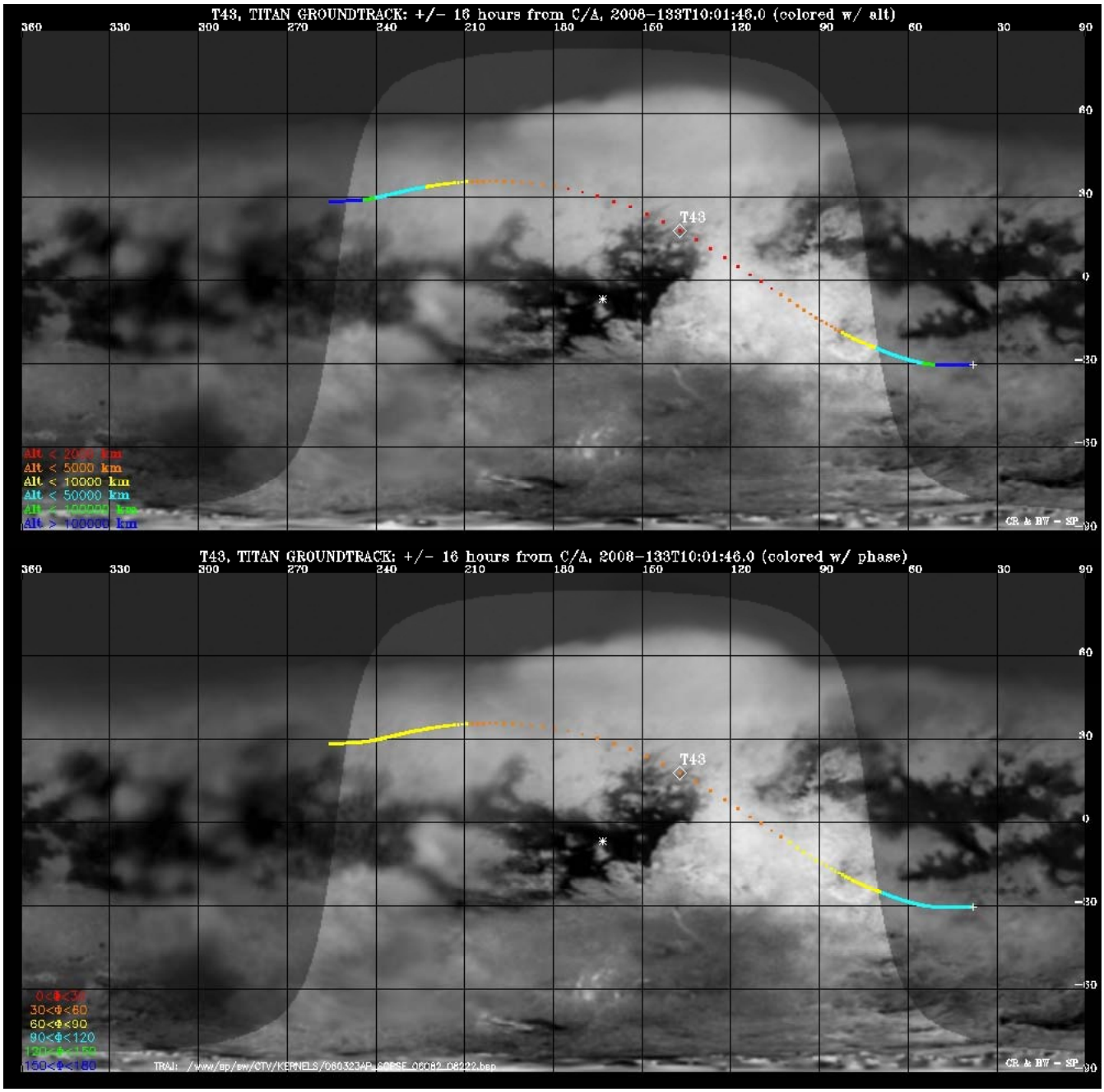
View of Titan from Cassini at Titan-43 closest approach



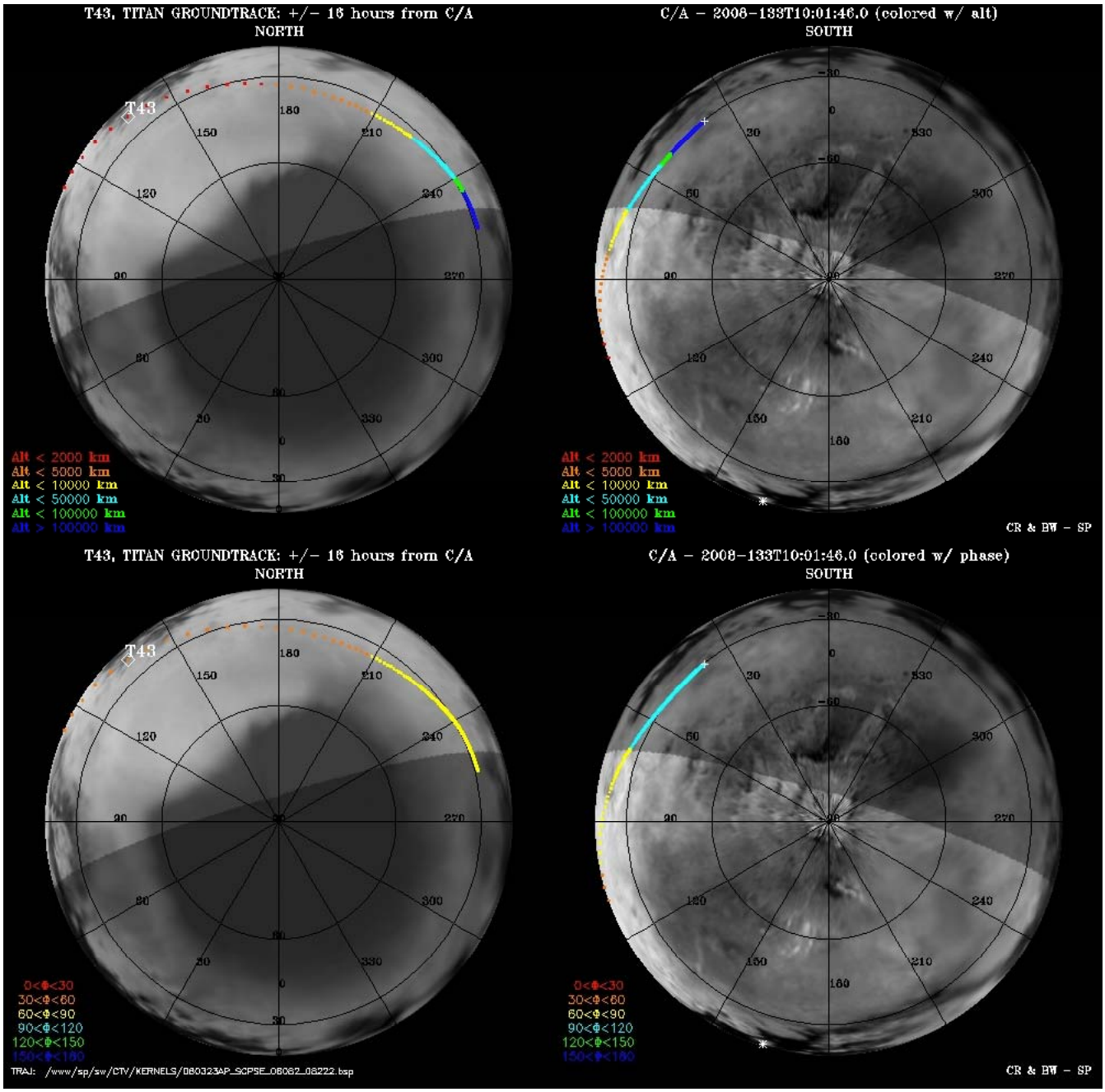
View of Titan from Cassini two hours after Titan-43 closest approach



Titan Groundtracks for T43: Global Plot



Titan Groundtracks for T43: Polar Plot



The T43 timeline is as follows:

Cassini Titan-43 Timeline - May 2008

Colors: yellow = maneuvers; blue = geometry; pink = T43-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T43	Activity	Description
129T21:00:00	May 08 22:15	Thu May 08 02:15 PM	T43-03d13h	OTM #154 Prime	Titan-43 targeting maneuver.
110T07:18:00	Apr 19 08:33	Sat Apr 19 12:33 AM	T43-23d03h	Start of Sequence S40	Start of Sequence which contains Titan-43
130T23:35:35	May 10 00:50	Fri May 09 04:50 PM	T43-02d10h	Methone Non-Targeted Flyby	Altitude = 95,865 km (~59,568 miles)
131T00:04:44	May 10 01:19	Fri May 09 05:19 PM	T43-02d10h	Descending Ring Plane Crossing	
131T00:05:52	May 10 01:20	Fri May 09 05:20 PM	T43-02d10h	Janus Non-Targeted Flyby	Altitude = 120,801 km (~75,062 miles)
131T02:12:02	May 10 03:27	Fri May 09 07:27 PM	T43-02d08h	Saturn Periapse	Saturn periapse, R = 4.293 Rs, lat = -23 deg, phase = 150 deg
130T12:00:00	May 09 13:15	Fri May 09 05:15 AM	T43-02d22h	OTM #154 Backup	
132T22:30:00	May 11 23:45	Sun May 11 03:45 PM	T43-11h31m	Start of the TOST segment	
132T22:30:00	May 11 23:45	Sun May 11 03:45 PM	T43-11h31m	Turn cameras to Titan	
132T23:00:00	May 12 00:15	Sun May 11 04:15 PM	T43-11h01m	New waypoint	
132T23:00:00	May 12 00:15	Sun May 11 04:15 PM	T43-11h01m	Deadtime	7 minutes 58 seconds long; used to accommodate changes in flyby time
132T23:07:58	May 12 00:22	Sun May 11 04:22 PM	T43-10h54m	Titan atmospheric Observations-CIRS	Obtain information on CO, HCN, CH4.
133T00:01:58	May 12 01:16	Sun May 11 05:16 PM	T43-10h00m	Titan atmospheric observations-ISS	WAC Photometry and NAC Nightside Imaging
133T01:01:58	May 12 02:16	Sun May 11 06:16 PM	T43-09h00m	Titan surface observations-VIMS	Regional map
133T04:54:58	May 12 06:09	Sun May 11 10:09 PM	T43-05h07m	Turn cameras to New Waypoint	
133T05:12:58	May 12 06:27	Sun May 11 10:27 PM	T43-04h49m	New waypoint	
133T05:12:58	May 12 06:27	Sun May 11 10:27 PM	T43-04h49m	Titan surface observations-RADAR	Inbound radiometry of unique southeast territory, contiguous with T39
133T08:31:58	May 12 09:46	Mon May 12 01:46 AM	T43-01h30m	Titan surface observations-RADAR	Inbound scatterometry of unique southeast territory, contiguous with T39
133T09:09:58	May 12 10:24	Mon May 12 02:24 AM	T43-00h52m	Transition to thruster control	
133T09:10:58	May 12 10:25	Mon May 12 02:25 AM	T43-00h51m	Titan surface observations-RADAR	Inbound altimetry
133T09:46:58	May 12 11:01	Mon May 12 03:01 AM	T43-00h15m	Titan surface observations-RADAR	Inbound low rate SAR
133T09:54:58	May 12 11:09	Mon May 12 03:09 AM	T43-00h07m	Titan surface observations-RADAR	High rate SAR
133T10:01:58	**May 12 11:16**	**Mon May 12 03:16 AM**	**T43+00h00m**	**Titan-43 Flyby Closest Approach Time**	**Altitude = 1000 km (628 miles), speed = 6.3 km/s (14,000 mph); 36 deg phase at closest approach**
133T10:08:58	May 12 11:23	Mon May 12 03:23 AM	T43+00h07m	Titan surface observations-RADAR	Outbound low rate SAR
133T10:16:58	May 12 11:31	Mon May 12 03:31 AM	T43+00h15m	Titan surface observations-RADAR	Outbound altimetry
133T10:30:45	May 12 11:45	Mon May 12 03:45 AM	T43+00h29m	Ascending Ring Plane Crossing	
133T10:31:58	May 12 11:46	Mon May 12 03:46 AM	T43+00h30m	Transition off of thruster control	
133T10:53:58	May 12 12:08	Mon May 12 04:08 AM	T43+00h52m	Titan surface observations-RADAR	Outbound scatterometry of unique northwest territory, contiguous with T39
133T11:51:58	May 12 13:06	Mon May 12 05:06 AM	T43+01h50m	Turn cameras to New Waypoint	
133T12:11:58	May 12 13:26	Mon May 12 05:26 AM	T43+02h10m	New waypoint	
133T12:11:58	May 12 13:26	Mon May 12 05:26 AM	T43+02h10m	Titan atmospheric observations-CIRS	Obtain information on surface & tropopause temperatures, and on tropospheric CH4.
133T15:01:58	May 12 16:16	Mon May 12 08:16 AM	T43+05h00m	Titan atmospheric observations-CIRS	Obtain information on trace constituents in Titan's stratosphere. Integrate on limb at two positions.
133T19:01:58	May 12 20:16	Mon May 12 12:16 PM	T43+09h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4.
134T00:01:58	May 13 01:16	Mon May 12 05:16 PM	T43+14h00m	Turn to Earth-line	
134T00:31:58	May 13 01:46	Mon May 12 05:46 PM	T43+14h30m	Playback of T43 Data	Goldstone 70
134T02:16:58	May 13 03:31	Mon May 12 07:31 PM	T43+16h15m	Turn cameras to New Waypoint	
134T02:46:58	May 13 04:01	Mon May 12 08:01 PM	T43+16h45m	New waypoint	
134T02:46:58	May 13 04:01	Mon May 12 08:01 PM	T43+16h45m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
134T09:16:58	May 13 10:31	Tue May 13 02:31 AM	T43+23h15m	Titan atmospheric observations-CIRS	
134T12:20:58	May 13 13:35	Tue May 13 05:35 AM	T43+01d02h	Deadtime	23 minutes 2 seconds long; used to accommodate changes in flyby time
134T12:44:00	May 13 13:59	Tue May 13 05:59 AM	T43+01d03h	Turn to Earth-line	
134T13:14:00	May 13 14:29	Tue May 13 06:29 AM	T43+01d03h	Playback of T43 Data	Madrid 70 arrayed