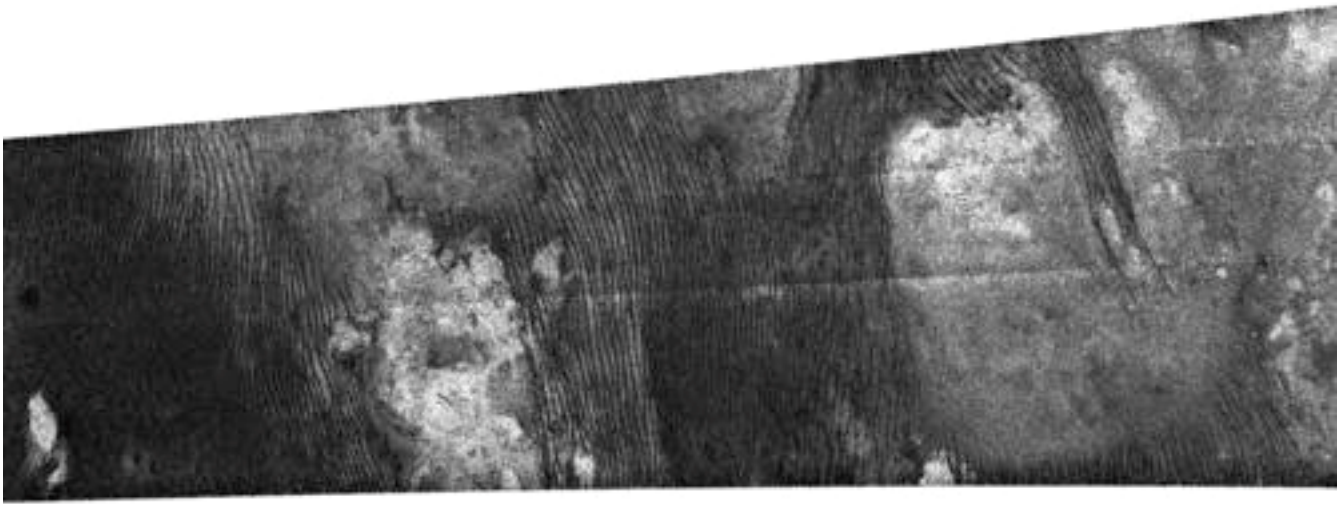
C A S S I N I



T I T A N 1 1 4 T I (T 5 8)
MISSION DESCRIPTION

July 8, 2009

Jet Propulsion Laboratory
California Institute of Technology

Cover image: The Story Titan's Dunes Tell

An intricate, fingerprint-like pattern of dunes is seen in this dramatic radar image of Saturn's moon Titan captured by NASA's Cassini spacecraft on May 21, 2009 from an altitude of 965 kilometers (about 600 miles). The dunes likely consist of sand-sized particles made of organic material.

On Earth, dunes preferentially form in low-lying regions as hills or mountains present an obstacle to the movement of sand-sized particles. The general absence of dunes on the bright patches seen here supports the notion that they are likely topographically high regions or mountains that block the dunes. The forked tongue of dunes crossing the bright patch at right may have formed in a relatively low-lying valley in the bright terrain.

The significant variations in spacing and density of the dunes indicate a variation in the sand supply and/or local differences in winds at the surface. The dunes are roughly symmetrical around the irregular bright region in the left half of the image, suggesting that the bright region is somehow responsible for creating the pattern.

The area imaged is 225 by 636 kilometers (140 by 395 miles), centered just north of the equator at 0.5 deg N latitude, 154.2 degrees W longitude. Radar illumination is from the top at an incidence angle of 24 degrees. North is to the right in this image. The obvious horizontal stripes across the center and top of this preliminary version are artifacts of the way the image is produced.

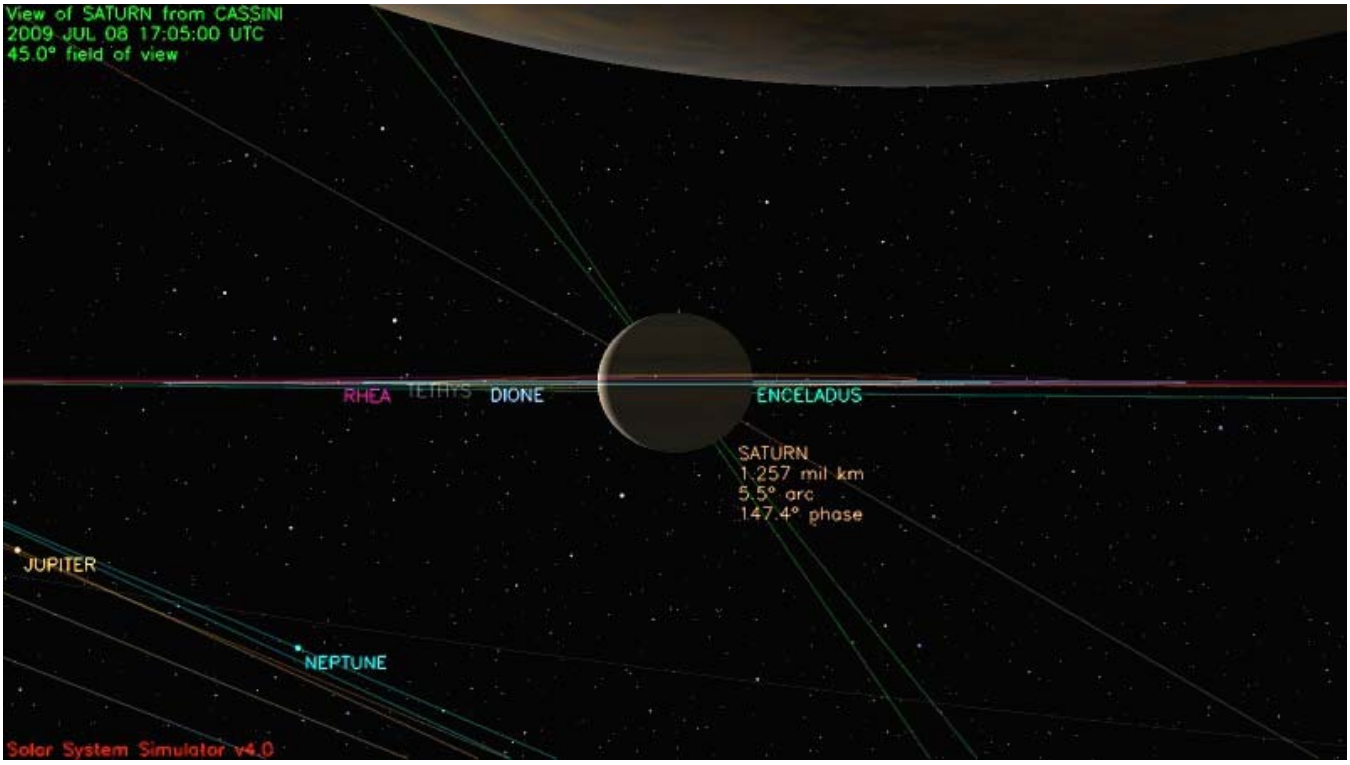
The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency.

Credit: NASA/JPL/Space Science Institute

1.0 OVERVIEW

Barely less than 16 days since its previous visit, Cassini returns to Saturn's largest moon for the mission's fifty-ninth targeted encounter with Titan. The closest approach to Titan occurs on Wednesday, July 8 at 189T17:04:03 spacecraft time at an altitude of 965 kilometers (~600 miles) above the surface and at a speed of 6.0 kilometers per second (~13,400 mph). The latitude at closest approach is 52.2 degrees S and the encounter occurs on orbit number 114.

This encounter is set up with two maneuvers: an apoapsis maneuver on June 30, and a Titan approach maneuver, scheduled for July 5. T58 is the seventh flyby in a series of eleven inbound encounters and the fourteenth Titan encounter in Cassini's Solstice Mission. It occurs just over two days before Saturn closest approach.


View of SATURN from CASSINI
2009 JUL 08 17:05:00 UTC
45.0° field of view
RHEA
TETHYS
DIONE
ENCELADUS
SATURN
1.257 mil km
5.5° arc
147.4° phase
JUPITER
NEPTUNE
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-58 SCIENCE HIGHLIGHTS

- **UVIS**: Solar and stellar occultations by Titan are the most valuable Titan observations for UVIS because they provide detailed vertical profiles of nitrogen (in the EUV channel during solar occultation) and hydrocarbons, HCN, and aerosols (in the FUV channel during stellar occultations). On T58 UVIS observes a long stellar occultation and a solar occultation. The two occultation observations probe different parts of the atmosphere. The solar occultation, using the EUV channel, samples the northern polar vortex region, something we haven't done well before, from above about 900 kilometers altitude up to about 2,300 kilometers. This range overlaps the atmospheric region sampled by INMS and by Cassini's attitude control system, or AACS. 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. There has been a long-running controversy about the density of the high atmosphere. AACS gets a consistently higher number than INMS and UVIS. This is one of the questions we want to attack with this measurement, but in all likelihood it will not be resolved until the extended extended mission when we will have some additional measurements (such as flybys where the navigation team will measure the acceleration, and flybys where UVIS and INMS will conduct atmospheric measurements at the same time). Both the solar and stellar occultations show a complex picture of the upper atmosphere. Density profiles and mixing ratios cannot be described as a simple function of latitude and longitude. There is more going on, perhaps gravity wave activity, perhaps some other phenomena which make the upper atmosphere more variable than simple models would predict. Continued observations like the ones in T58 will help us sort out these issues**.**
- **INMS:** On T58, INMS is riding along with RADAR on the night side outer flank at mid Southern latitudes, at slightly higher altitudes (1,143 km).
- **RADAR:** SAR runs along the western edge of Xanadu to study boundary with Shangri-La. The swath runs parallel to the T55/56/57 mapping sequence and covers Ontario Lacus. SAR swath will be altimetered on the T60 flyby.
- **CIRS** performs a surface temperature scan and disk integration to search for new gases in far-IR.
- **ISS** will acquire full-disk, global-mapping, and regional-mapping mosaics of the region

southwest of Senkyo and northeast of Tsegihi at low phase angles and will ride along with VIMS for high-resolution imaging as well as cloud monitoring.

- **VIMS:** On the inbound, the phase angle is much larger than 90 degrees and VIMS ridealong observations will provide information on the composition of Titan's atmosphere. After radar observations, VIMS will be ridealong with UVIS for a stellar occultation that will provide information on the composition of Titan's atmosphere. Then the new area mapped during T57 will be observed at a better resolution of 20 km/pixel.

- **MIMI** measures energetic ion and electron energy input to Titan's atmosphere.
- **MAG**: T58 is the fourth consecutive flank-out, post-dusk flyby with a relatively low altitude at closest approach (1144 km). As in T55, T56 and T57, MAG measurements will provide a description of the draping and the pileup of the external magnetic field around Titan on the nightside hemisphere. It will be also a good complement to T52, T53, T54, T55, T56 and T57 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.

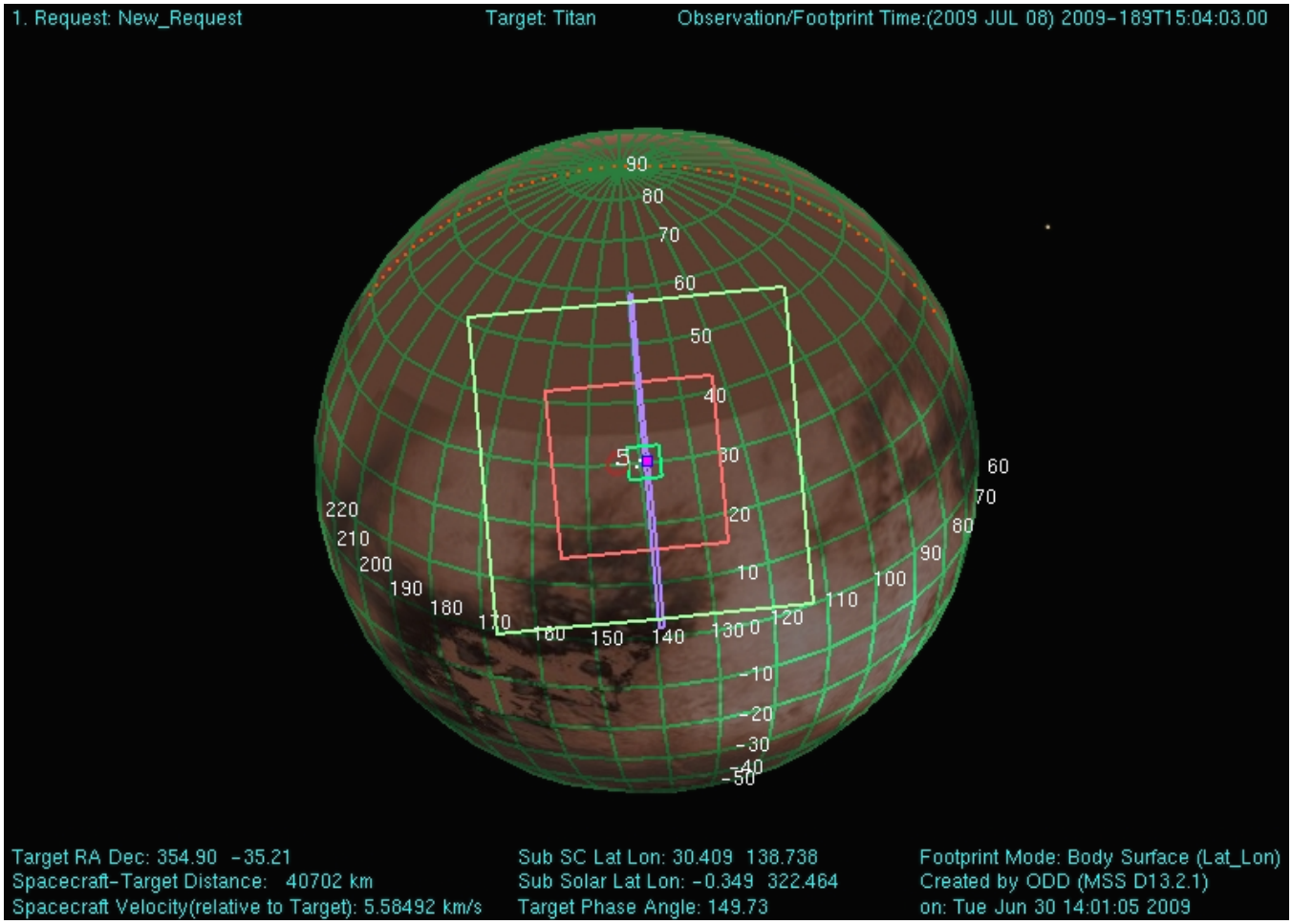
SAMPLE SNAPSHOTS

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.

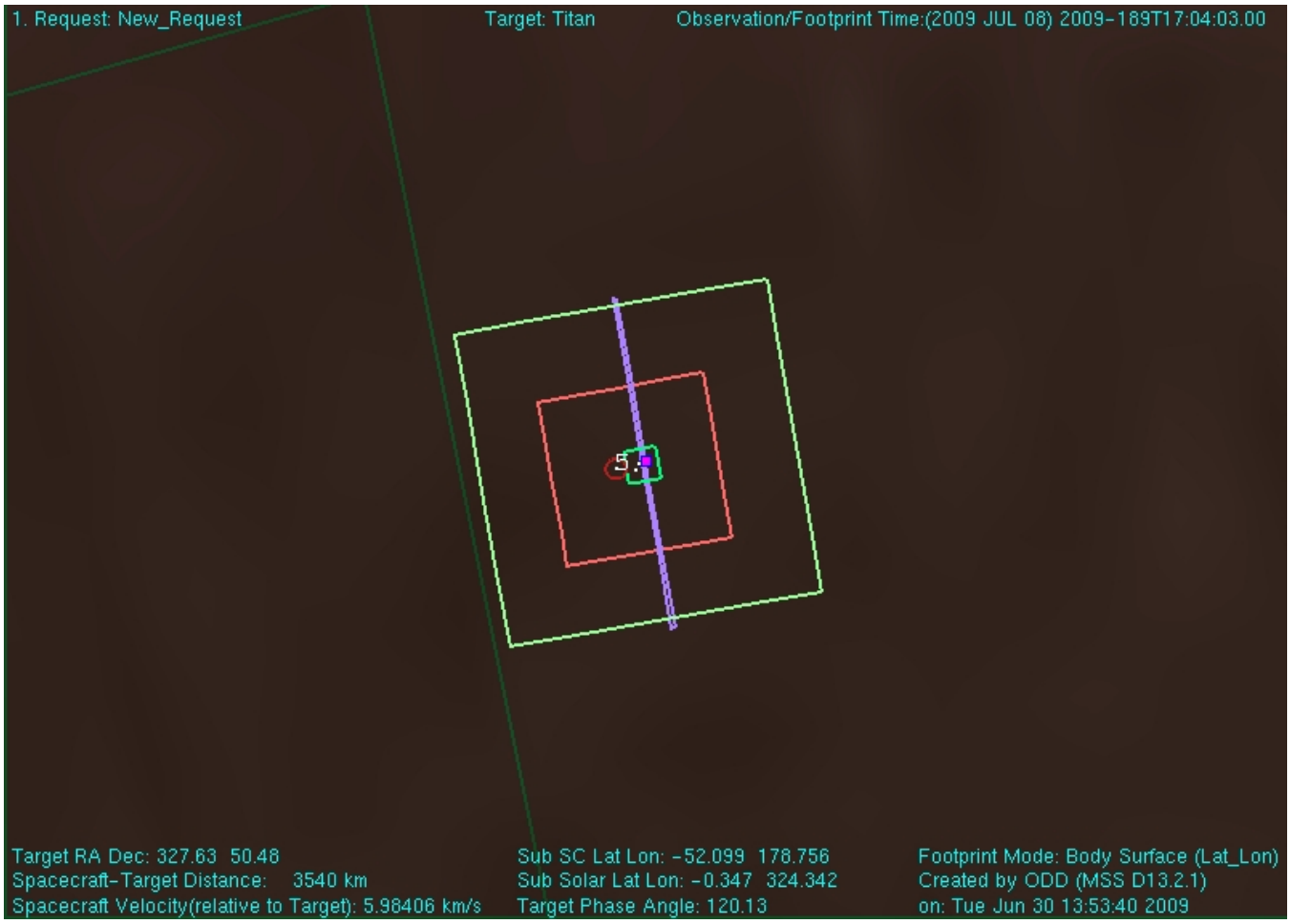
Key to ORS Instrument Fields of View in Figures

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

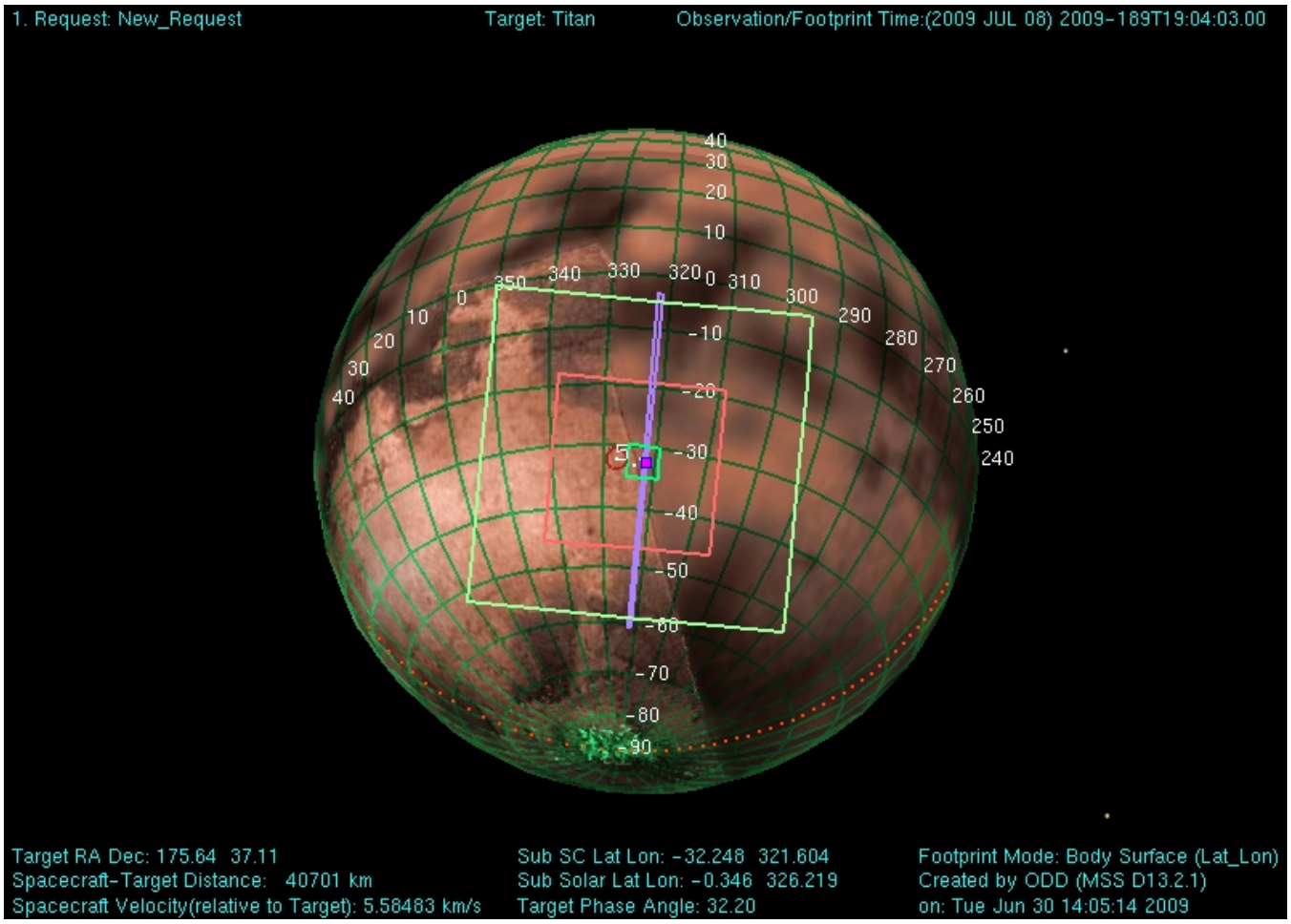
View of Titan from Cassini two hours before Titan-58 closest approach



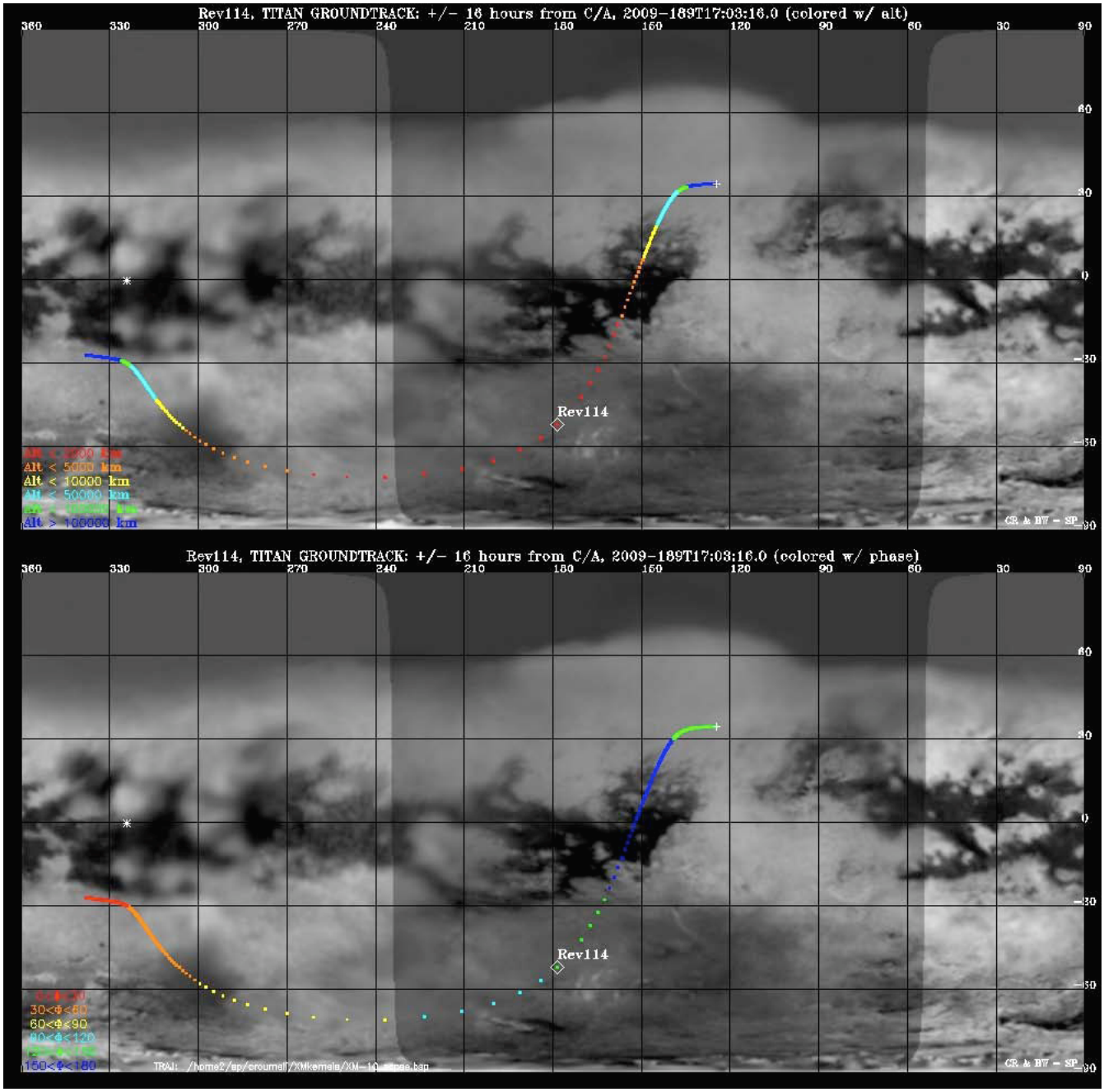
View of Titan from Cassini at Titan-58 closest approach



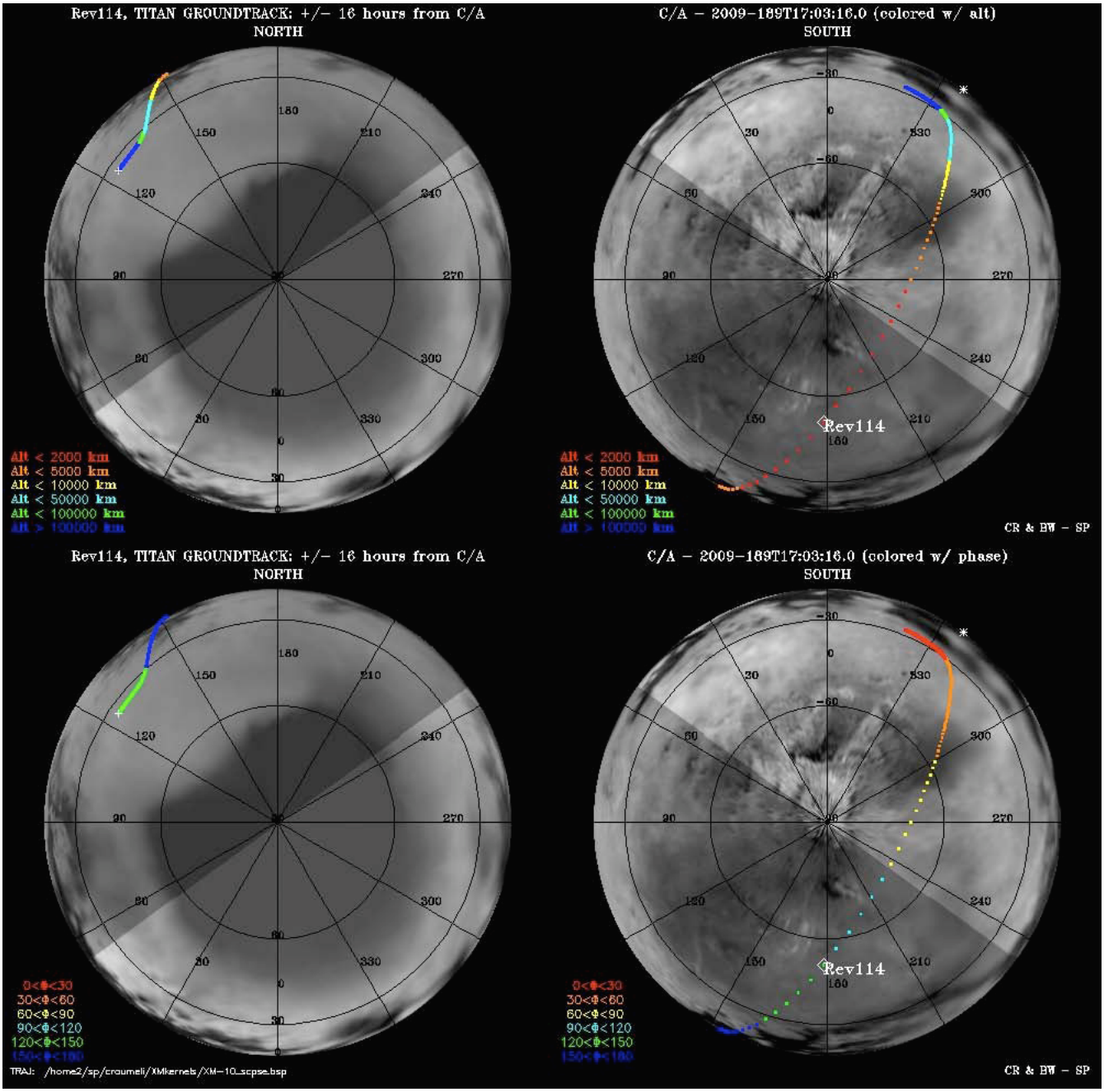
View of Titan from Cassini two hours after Titan-58 closest approach



Titan Groundtracks for T58: Global Plot



Titan Groundtracks for T58: Polar Plot



The T58 timeline is as follows:

Cassini Titan-58 Timeline - July 2009

Colors: yellow = maneuvers; blue = geometry;
pink = T58-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time (PDT)	Time wrt T58	Activity	Description
164T04:41:00	Jun 13 06:03	Fri Jun 12 11:03 PM	T58-25d12h	Start of Sequence S51	Start of Sequence which contains Titan-58
186T10:38:00	Jul 05 12:00	Sun Jul 05 05:00 AM	T58-03d06h	OTM #205 Prime	Titan-58 targeting maneuver.
187T10:38:00	Jul 06 12:00	Mon Jul 06 05:00 AM	T58-02d06h	OTM #205 Backup	
189T04:00:00	Jul 08 05:22	Tue Jul 07 10:22 PM	T58-13h04m	Start of the TOST segment	
189T04:00:00	Jul 08 05:22	Tue Jul 07 10:22 PM	T58-13h04m	Turn cameras to Titan	
189T04:30:00	Jul 08 05:52	Tue Jul 07 10:52 PM	T58-12h34m	New waypoint	
189T04:30:00	Jul 08 05:52	Tue Jul 07 10:52 PM	T58-12h34m	Deadtime	14 minutes 59 seconds long; used to accommodate changes in flyby time
189T04:44:59	Jul 08 06:06	Tue Jul 07 11:06 PM	T58-12h20m	Titan surface observations-VIMS	Global and cloud mapping
189T08:04:03	Jul 08 09:26	Wed Jul 08 02:26 AM	T58-09h00m	Titan atmospheric observations-UVIS	EUVFUV Imaging of Titan. Several slow scans across Titan's visible hemisphere to form spectral images
189T11:54:03	Jul 08 13:16	Wed Jul 08 06:16 AM	T58-05h10m	Titan atmospheric observations-UVIS	EUVFUV Imaging of Titan. Several slow scans across Titan's visible hemisphere to form spectral images
189T14:44:03	Jul 08 16:06	Wed Jul 08 09:06 AM	T58-02h20m	Titan surface observations-VIMS	Titan mosaic
189T15:32:03	Jul 08 16:54	Wed Jul 08 09:54 AM	T58-01h32m	Titan atmospheric observations-UVIS	Solar occultation
189T16:37:03	Jul 08 17:59	Wed Jul 08 10:59 AM	T58-00h27m	Transition to thruster control	
189T16:38:03	Jul 08 18:00	Wed Jul 08 11:00 AM	T58-00h26m	RADAR	Inbound and Outbound SAR
189T16:33:19	Jul 08 17:55	Wed Jul 08 10:55 AM	T58-00h31m	Earth occultation	29 minute duration
189T16:35:31	Jul 08 17:57	Wed Jul 08 10:57 AM	T58-00h29m	Solar occultation	27 minute duration
189T17:04:03	**Jul 08 18:26**	**Wed Jul 08 11:26 AM**	T58+00h00m	**Titan-58 Flyby Closest Approach Time**	**Altitude = 965 km (~600 miles), speed =6.0 km/s (13,400 mph); 120 deg phase at closest approach**
189T17:27:46	Jul 08 18:49	Wed Jul 08 11:49 AM	T58+00h23m	Descending Ring Plane Crossing	
189T17:30:03	Jul 08 18:52	Wed Jul 08 11:52 AM	T58+00h26m	Transition off of thruster control	
189T17:51:08	Jul 08 19:13	Wed Jul 08 12:13 PM	T58+00h47m	Titan atmospheric observations-UVIS	Titan Occults Eta UMa
189T18:29:03	Jul 08 19:51	Wed Jul 08 12:51 PM	T58+01h25m	Titan surface observations-VIMS	Titan mosaic
189T19:04:03	Jul 08 20:26	Wed Jul 08 01:26 PM	T58+02h00m	Titan atmospheric observations-CIRS	Obtain information on surface & tropopause temperatures, and on tropospheric CH4. Scan or contiguous steps across disk.
189T20:34:03	Jul 08 21:56	Wed Jul 08 02:56 PM	T58+03h30m	Titan surface observations-ISS	Regional mapping. Monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes, 1-3 km/px
189T22:04:03	Jul 08 23:26	Wed Jul 08 04:26 PM	T58+05h00m	Titan surface observations-ISS	Global mapping. Monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes, 1-3 km/px
190T02:04:03	Jul 09 03:26	Wed Jul 08 08:26 PM	T58+09h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
190T05:04:03	Jul 09 06:26	Wed Jul 08 11:26 PM	T58+12h00m	Titan surface observations-ISS	NAC monitoring. Monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes, 1-3 km/px
190T07:04:03	Jul 09 08:26	Thu Jul 09 01:26 AM	T58+14h00m	Titan surface observations-VIMS	Global mapping
190T16:04:03	Jul 09 17:26	Thu Jul 09 10:26 AM	T58+23h00m	Deadtime	8 minutes 56 seconds long; used to accommodate changes in flyby time
190T16:13:00	Jul 09 17:35	Thu Jul 09 10:35 AM	T58+23h09m	Turn to Earth-line	
190T16:53:00	Jul 09 18:15	Jul 09 11:15	T58+23h49m	Playback of T58 Data	Goldstone 70m
191T02:53:00	Jul 10 04:15	Jul 09 21:15	T58+01d10h	Playback of T58 Data	Canberra 70m