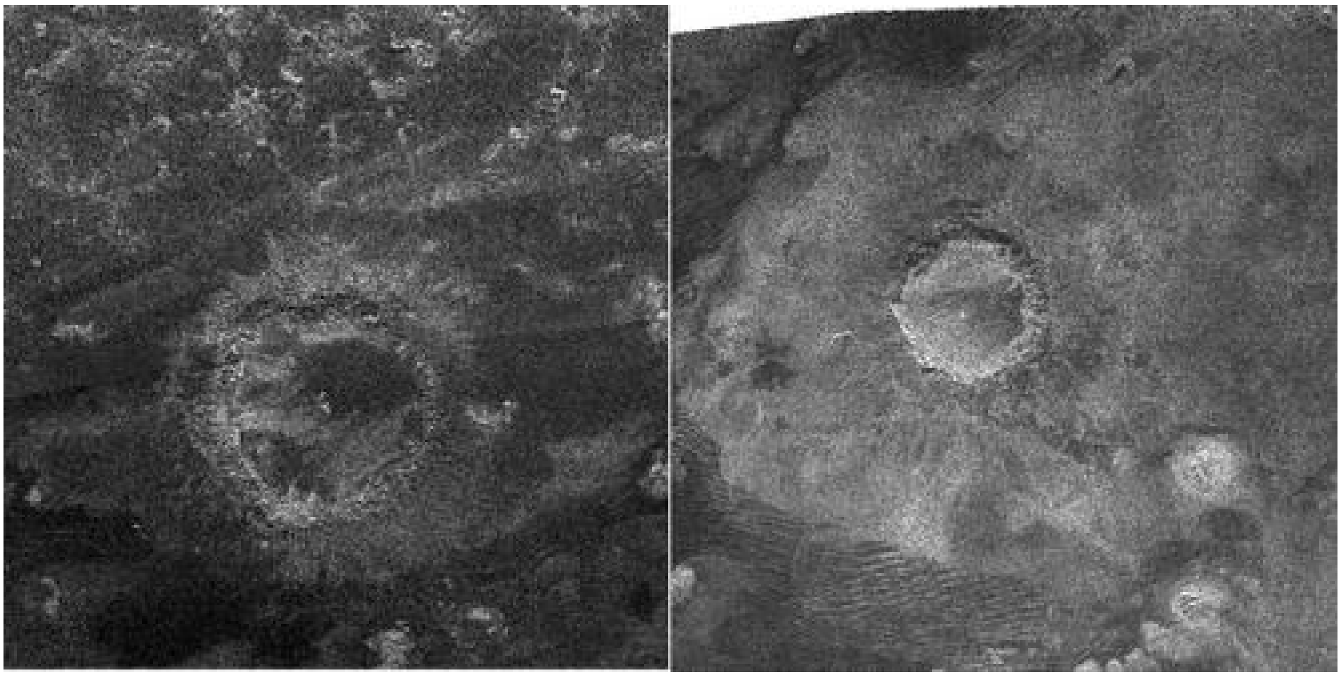
C A S S I N I



T I T A N 0 7 8 T I (T 4 5)
MISSION DESCRIPTION

July 31, 2008

Jet Propulsion Laboratory
California Institute of Technology

*Cover image: **Impact Craters***

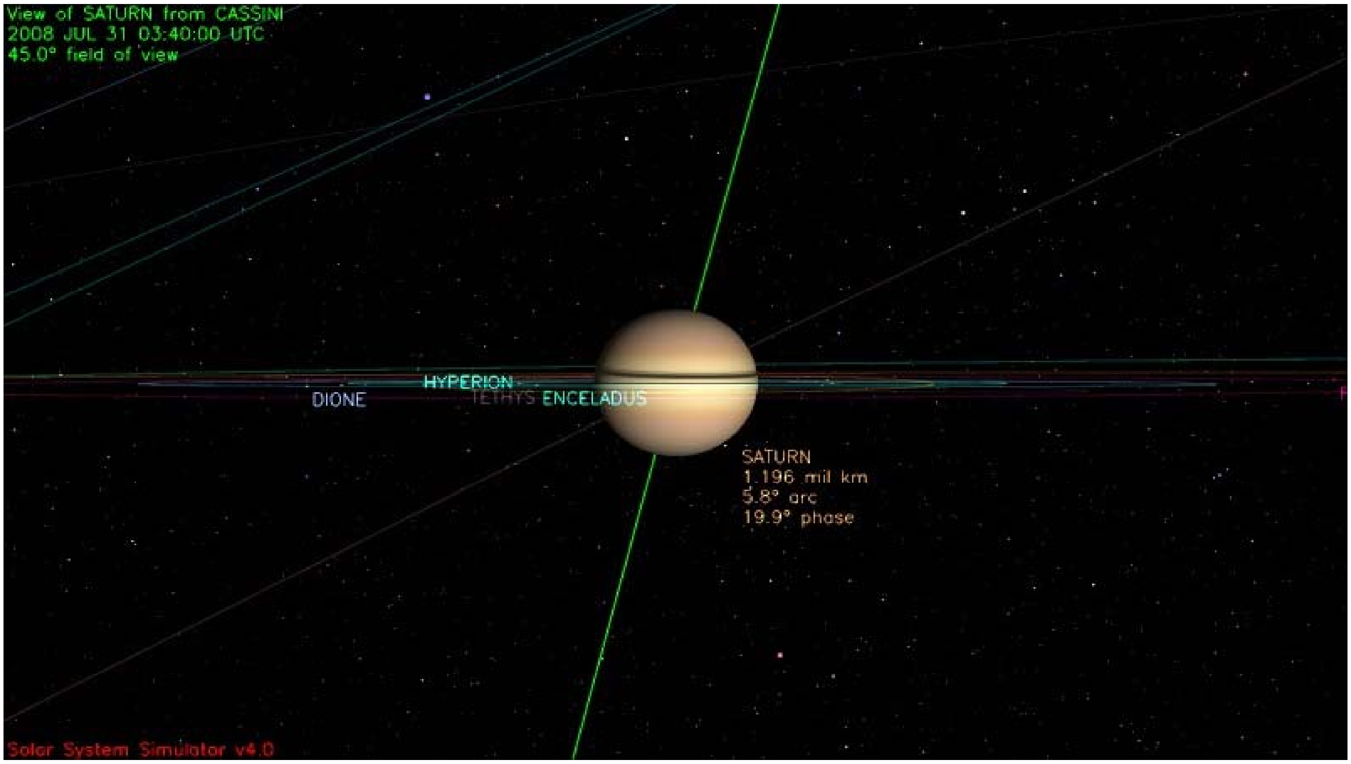
May 21, 2008

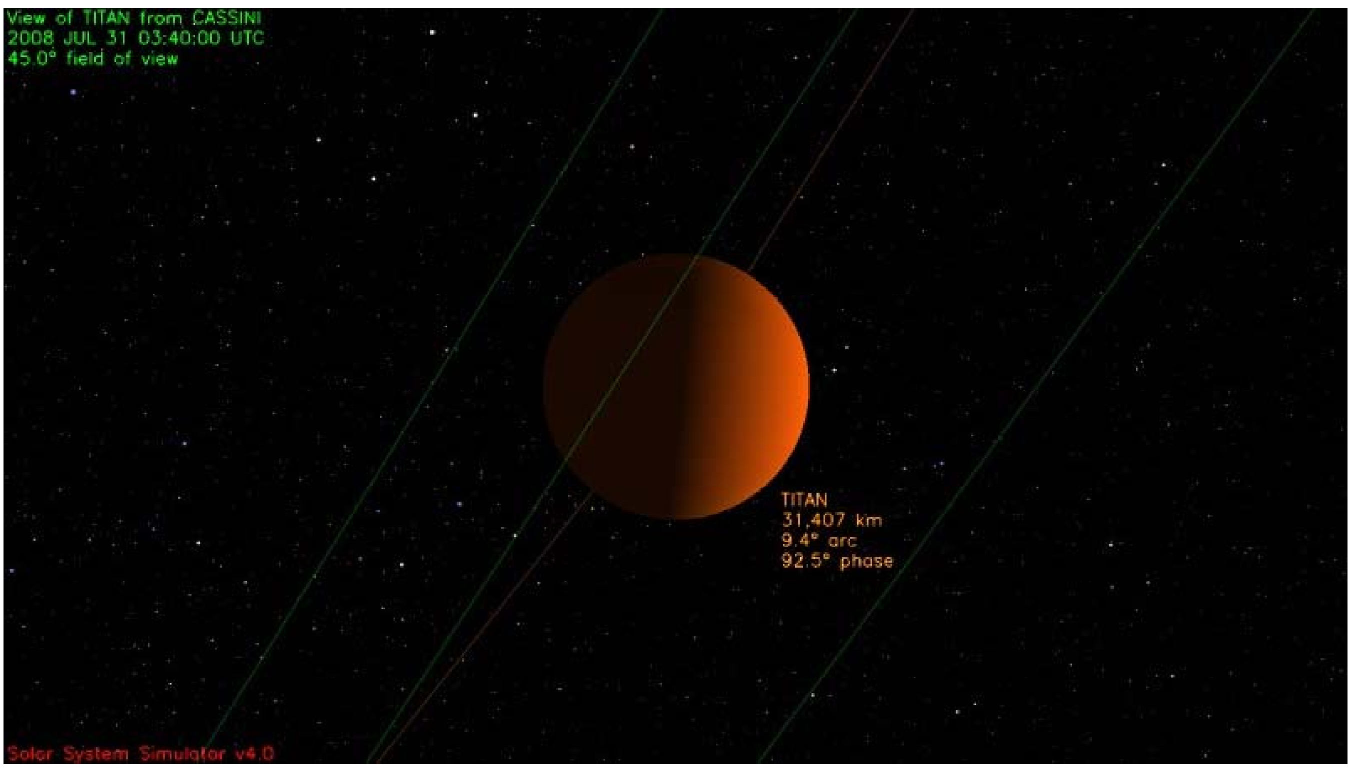
This side-by-side view shows a newly discovered impact crater (at left) compared with a previously discovered crater (at right). The new crater was just discovered by the Cassini spacecraft's radar instrument during its most recent Titan flyby on May 12, 2008. This makes the fourth feature definitely identified as an impact crater so far on Titan -- fewer than 100 features are regarded as possible impacts. Compared with Saturn's other moons, which have many thousands of craters, Titan's surface is very sparsely cratered. This is in part due to Titan's dense atmosphere, which burns up the smaller impacting bodies before they can hit the surface. Geological processes, such as wind-driven motion of sand and icy volcanism, may also wipe out craters. Both images are about 350 kilometers (217 miles) in width. The crater on the right was discovered by Cassini in 2005 and is shown here for comparison. It is 80 kilometers (50 miles) in diameter (see Impact Crater with Ejecta Blanket), with the radar illumination from above. Called Sinlap, this crater is estimated to be about 1,300 meters (4300 feet) deep. The new feature pictured on the left, which has not been named yet, is bigger than the Sinlap crater with a diameter of about 112 kilometers (70 miles). The new crater is located at about 26 degrees north latitude, 200 degrees west longitude, in the bright region known as Dilmun, about 1,000 kilometers (600 miles) north of the Huygens landing site. In its image, also illuminated from above, it appears slightly irregular, suggesting that it was modified after it was formed, perhaps by collapses of segments of its rim onto the floor. The crater floor appears flat, and two small bright spots indicate a likely central peak complex. The ejecta blanket (surrounding material) from this crater is less prominent than that of the Sinlap crater. The crater's more degraded character suggests it could be older than Sinlap (assuming that erosive processes are the same at both locations, which are at similar latitudes). Credit: NASA/JPL

1.0 OVERVIEW

After a 64 day hiatus since its previous visit, Cassini once again approaches Saturn's largest moon for the mission's forty-sixth targeted encounter with Titan. The closest approach to Titan occurs on Wednesday, July 31, at 2008-213T02:13:11 spacecraft time at an altitude of 1610 kilometers (~1002 miles) above the surface and at a speed of 6.3 kilometers per second (14,000 mph). The latitude at closest approach is 43.3 degrees S and the encounter occurs on orbit number 78.

This encounter is set up with two maneuvers: an apoapsis maneuver on June 22, and a Titan approach maneuver, scheduled for July 27. T45 is the ninth in a series of outbound encounters and the first Titan encounter in Cassini's Equinox Mission. It occurs roughly two and a half days after Saturn closest approach.


View of SATURN from CASSINI
2008 JUL 31 03:40:00 UTC
45.0° field of view
HYPERION
DIONE
TETHYS
ENCELADUS
SATURN
1.196 mil km
5.8° arc
19.9° phase
Solar System Simulator v4.0


View of TITAN from CASSINI
2008 JUL 31 03:40:00 UTC
45.0° field of view
TITAN
31,407 km
9.4° arc
92.5° 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-45 SCIENCE HIGHLIGHTS

- **RSS** : This flyby was designed to be an optimized gravity field determination flyby for Radio Science, the prime instrument at closest approach. An instrument might be given a couple of hours near closest approach for a typical Titan flyby, but in this special case, RSS was given over *16* hours straddling closest approach. RSS observations of Titan's gravity field should allow us to determine the internal structure of Titan, with the exciting possibility that Titan may have an interior ocean below its frozen surface. Complicating matters is Titan's shifting shape: the moon deforms as it rotates and as it orbits around Saturn. That means that Titan's gravity field changes, as well. If Titan has a subsurface interior ocean, gravity field measurements from this flyby as well as T11, T22 and T33 may be able to confirm its presence. Regardless, RSS's data will return more information about the internal structure of Titan.
- **ISS** will be acquiring a full-disk mosaic of Titan's leading hemisphere, including coverage of Hotei Arcus. The instrument will also continue to monitor clouds.
- **CIRS**: The instrument will continue to search for trace atmospheric molecular species in Titan's winter polar (northern) hemisphere by limb sounding of the stratosphere. CIRS also continues a mapping campaign in the mid and far-IR to obtain the spatial and temporal variations of temperature and hydrocarbon and nitrile molecules, providing information on seasonal changes in weather, climate and chemistry that may be occurring.

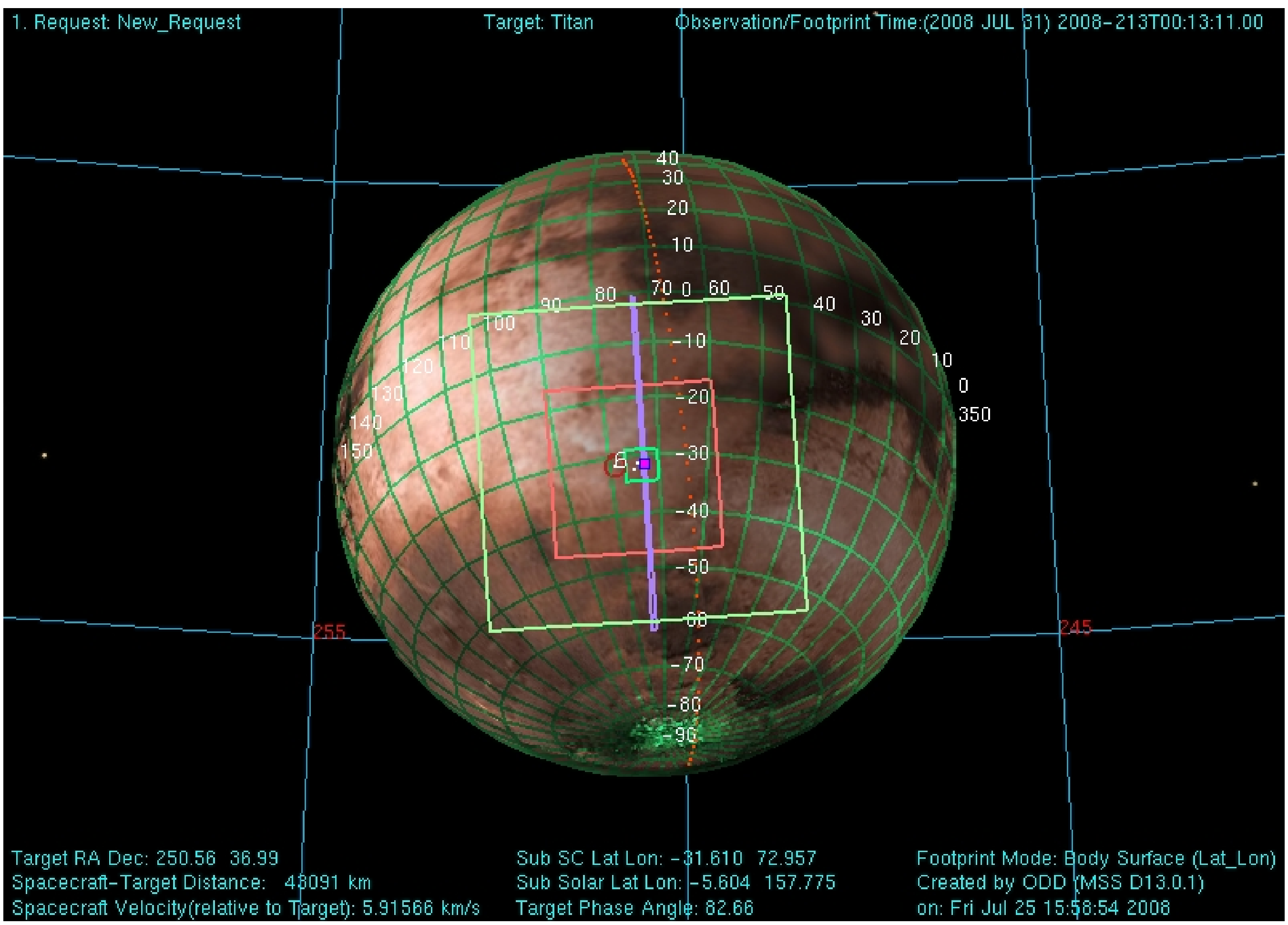
SAMPLE SNAPSHOTS

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.

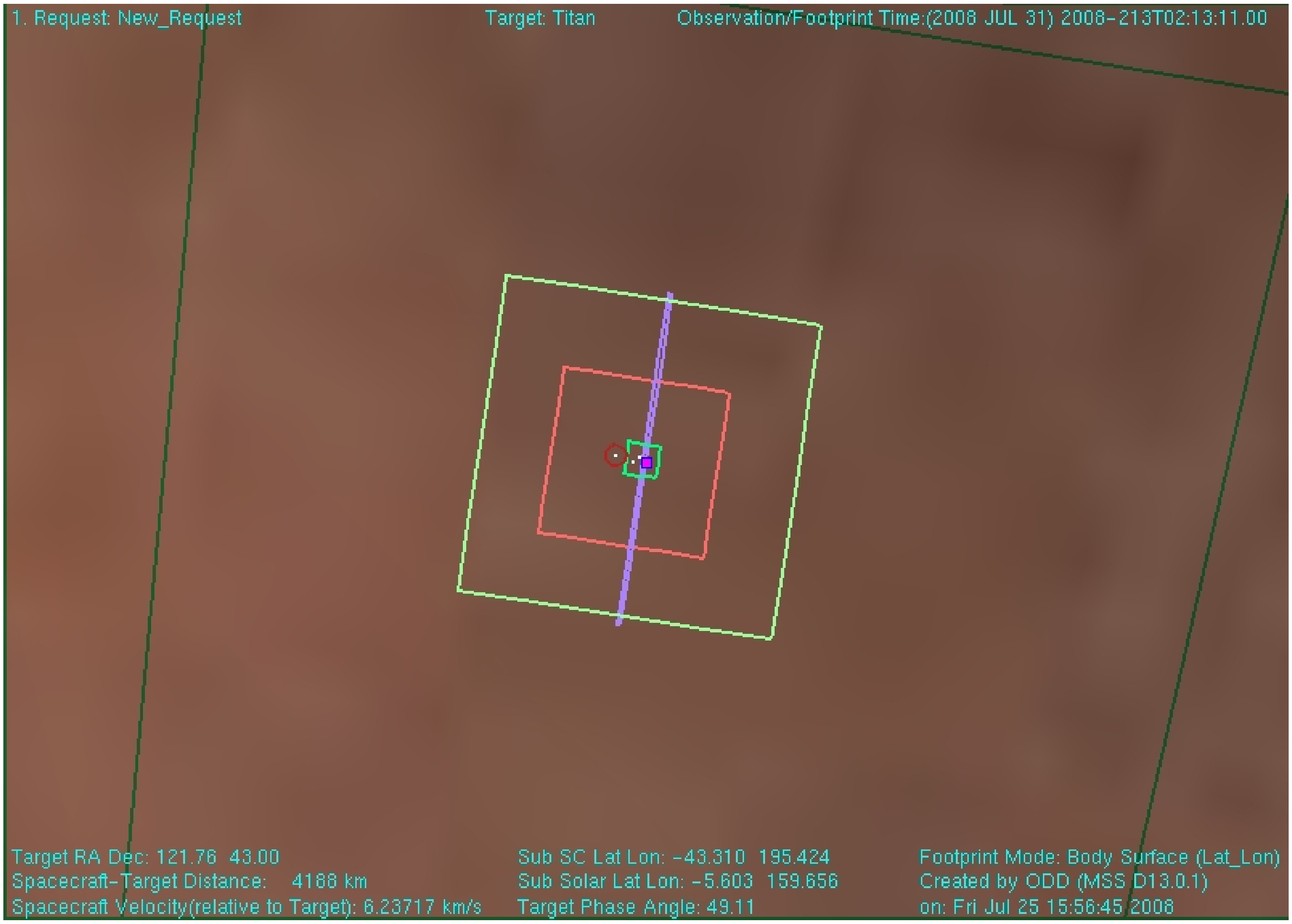
Key to ORS Instrument Fields of View in Figures

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

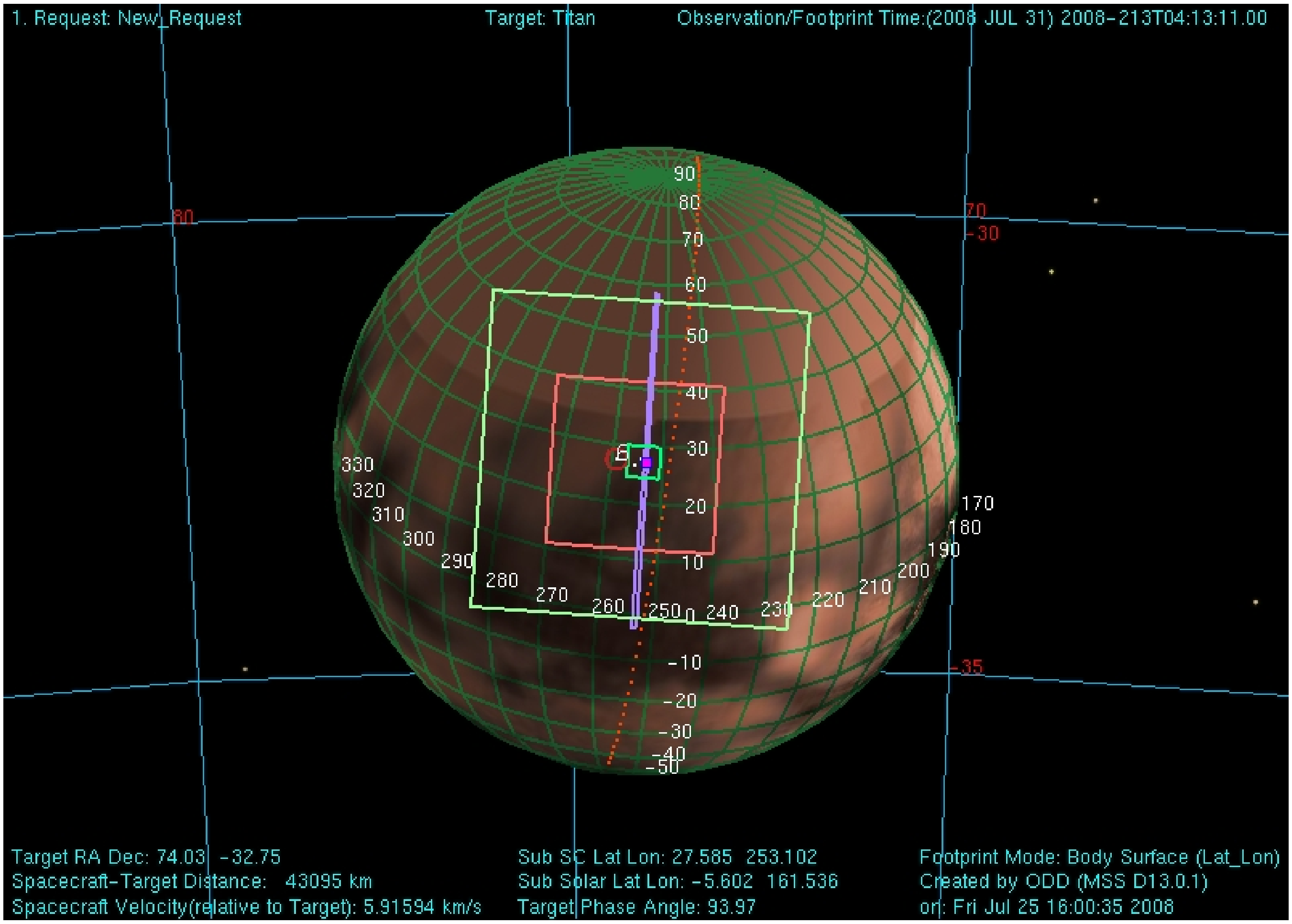
View of Titan from Cassini two hours before Titan-45 closest approach



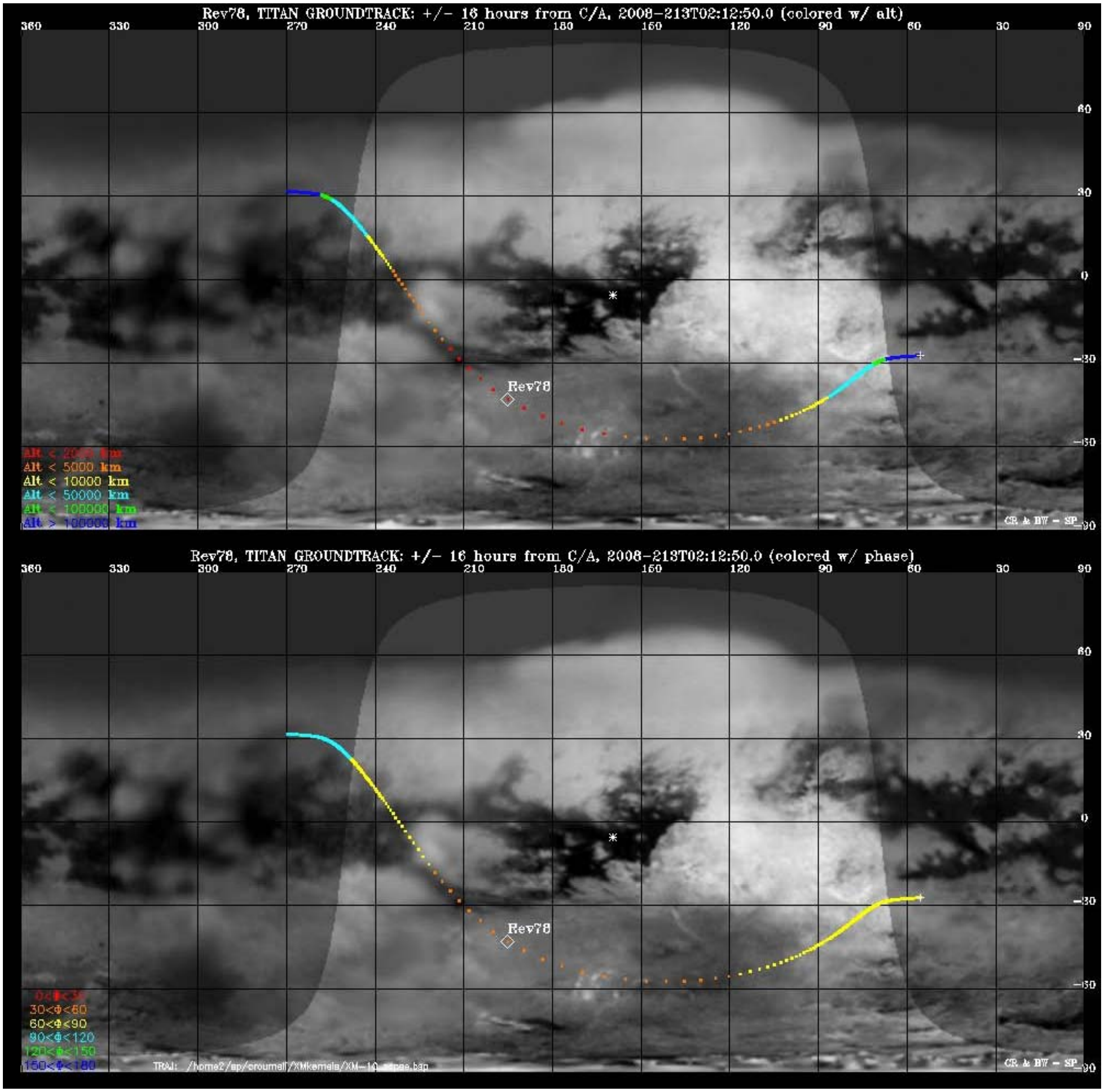
View of Titan from Cassini at Titan-45 closest approach



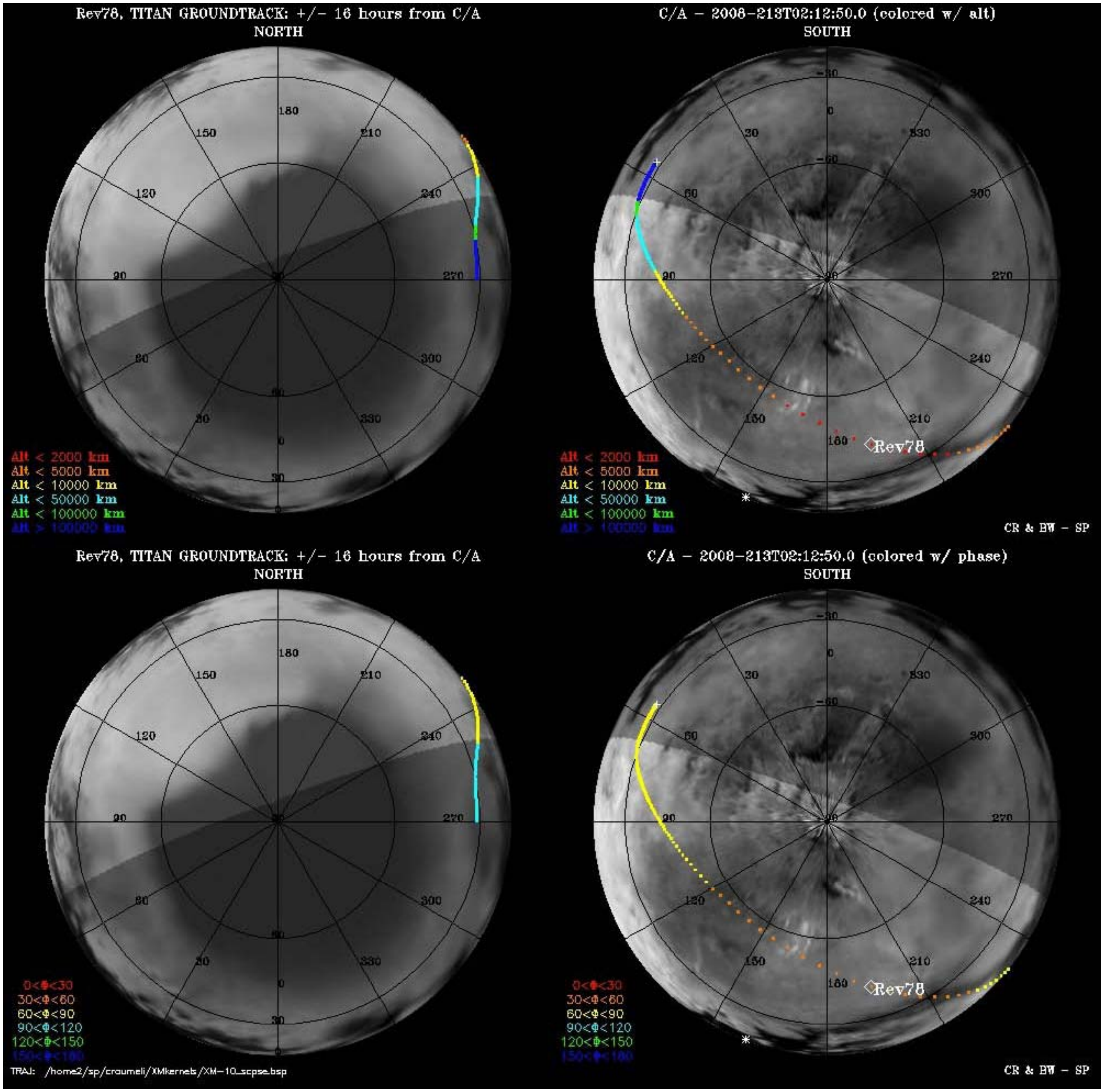
View of Titan from Cassini two hours after Titan-45 closest approach



Titan Groundtracks for T45: Global Plot



Titan Groundtracks for T45: Polar Plot



The T45 timeline is as follows:

Cassini Titan-45 Timeline - July 2008

Colors: yellow = maneuvers; blue = geometry; pink = T45-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T45	Activity	Description
183T19:08:00	Jul 01 20:33	Tue Jul 01 12:33 PM	T45-29d07h	Start of Sequence S42	Start of Sequence which contains Titan-45
209T08:36:00	Jul 27 10:01	Sun Jul 27 02:01 AM	T45-03d18h	OTM #160 Prime	Titan-45 targeting maneuver.
210T11:25:30	Jul 28 12:50	Mon Jul 28 04:50 AM	T45-02d15h	Pan Non-Targeted Flyby	Altitude = 97,453km (~60,553 miles)
210T12:14:41	Jul 28 13:39	Mon Jul 28 05:39 AM	T45-02d14h	Descending Ring Plane Crossing	
210T12:18:39	Jul 28 13:43	Mon Jul 28 05:43 AM	T45-02d14h	Prometheus Non-Targeted Flyby	Altitude = 24,652 km (15,318 miles)
210T12:37:41	Jul 28 14:02	Mon Jul 28 06:02 AM	T45-02d14h	Saturn Periapse	Saturn periapse, R = 2.693 Rs, lat = -10 deg, phase = 158 deg
210T13:01:44	Jul 28 14:26	Mon Jul 28 06:26 AM	T45-02d13h	Epimethius Non-Targeted Flyby	Altitude = 106,964 km (~52,745 miles)
210T17:00:00	Jul 28 18:25	Mon Jul 28 10:25 AM	T45-02d09h	OTM #160 Backup	
212T07:20:00	Jul 30 08:45	Wed Jul 30 12:45 AM	T45-18h53m	Start of the TOST segment	
212T07:20:00	Jul 30 08:45	Wed Jul 30 12:45 AM	T45-18h53m	Turn cameras to Titan	
212T07:50:00	Jul 30 09:15	Wed Jul 30 01:15 AM	T45-18h23m	New waypoint	
212T07:50:21	Jul 30 09:15	Wed Jul 30 01:15 AM	T45-18h23m	Deadtime	15 minutes 0 seconds long; used to accommodate changes in flyby time
212T08:05:21	Jul 30 09:30	Wed Jul 30 01:30 AM	T45-18h08m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
212T12:13:11	Jul 30 13:38	Wed Jul 30 05:38 AM	T45-14h00m	Titan surface observations-ISS	Global map
212T14:13:11	Jul 30 15:38	Wed Jul 30 07:38 AM	T45-12h00m	Turn cameras to New Waypoint	
212T14:43:11	Jul 30 16:08	Wed Jul 30 08:08 AM	T45-11h30m	New waypoint	
212T14:43:11	Jul 30 16:08	Wed Jul 30 08:08 AM	T45-11h30m	Titan gravity measurements-RSS	Experiment to determine Titan's gravity field, including its Love number, and infer constraints on its internal structure.
213T02:13:11	**Jul 31 03:38**	**Wed Jul 30 07:38 PM**	**T45+00h00m**	**Titan-45 Flyby Closest Approach Time**	**Altitude = 1613 km (~1002 miles), speed = 6.3 km/s (14,000 mph); 49 deg phase at closest approach**
213T06:58:11	Jul 31 08:23	Thu Jul 31 12:23 AM	T45+04h45m	Titan atmospheric observations-CIRS	Obtain vertical profiles of temperatures in Titan's stratosphere.
213T03:01:23	Jul 31 04:26	Wed Jul 30 08:26 PM	T45+00h48m	Ascending Ring Plane Crossing	
213T10:29:00	Jul 31 11:54	Thu Jul 31 03:54 AM	T45+08h16m	Titan gravity measurements-RSS	Experiment to determine Titan's gravity field, including its Love number, and infer constraints on its internal structure.
213T15:06:11	Jul 31 16:31	Thu Jul 31 08:31 AM	T45+12h53m	Deadtime	13 minutes 49 seconds long; used to accommodate changes in flyby time
213T15:20:00	Jul 31 16:45	Thu Jul 31 08:45 AM	T45+13h07m	Turn to Earth-line	
213T15:50:00	Jul 31 17:15	Thu Jul 31 09:15 AM	T45+13h37m	Playback of T45 Data	Goldstone 34m array
213T19:51:47	Jul 31 21:16	Thu Jul 31 01:16 PM	T45+17h38m	Apoapse	