Liquids Discovered on Titan's Surface

Image Credit: NASA/JPL/Space Science Institute

Cassini's radar instrument was the first to confirm the presence of liquid lakes on Titan's surface – in the north polar region.

Titan's surface from Huygens DISR

- The Huygens Probe landed in a dark floodplain, amid rounded "rocks" of water ice
- The rounded nature of the water ice rocks show erosion due to tumbling down liquid CH_4 streambeds
- These are analogous to small pebbles found in rivers on Earth
- After landing, the probe's batteries survived another 72 minutes

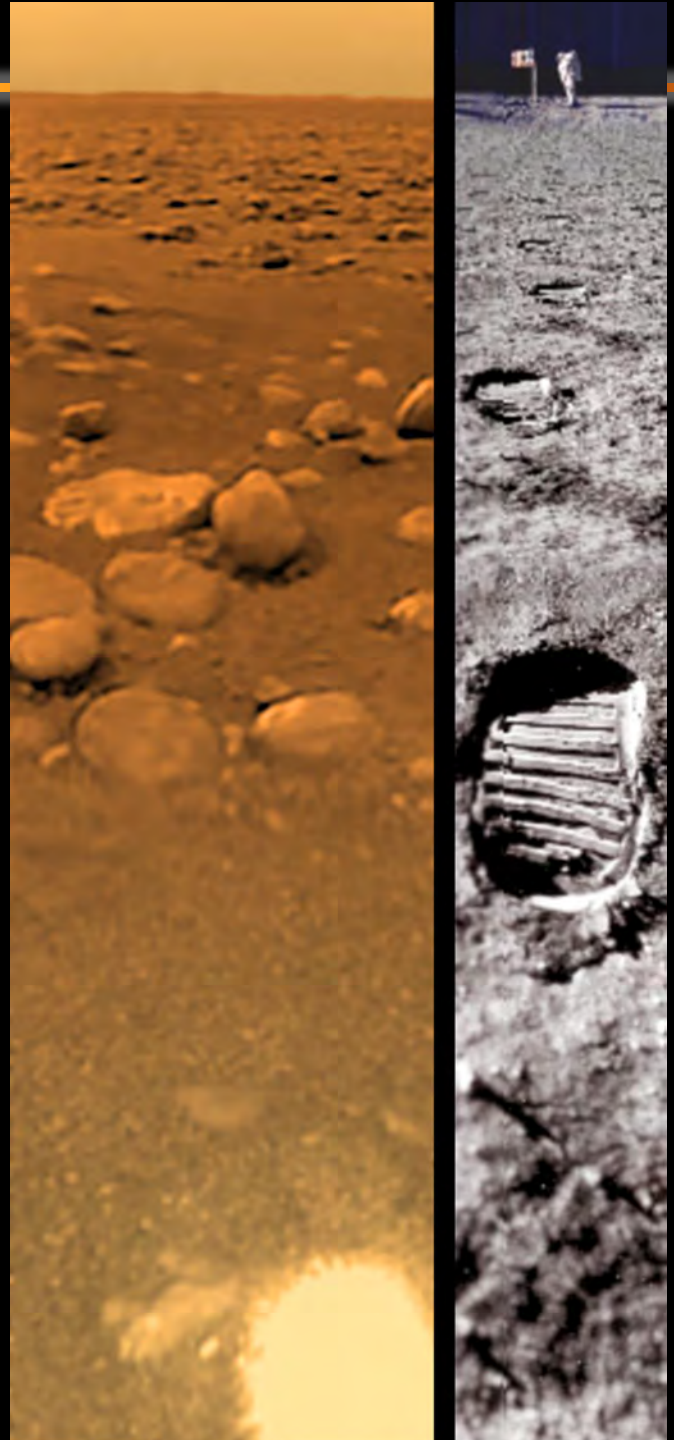


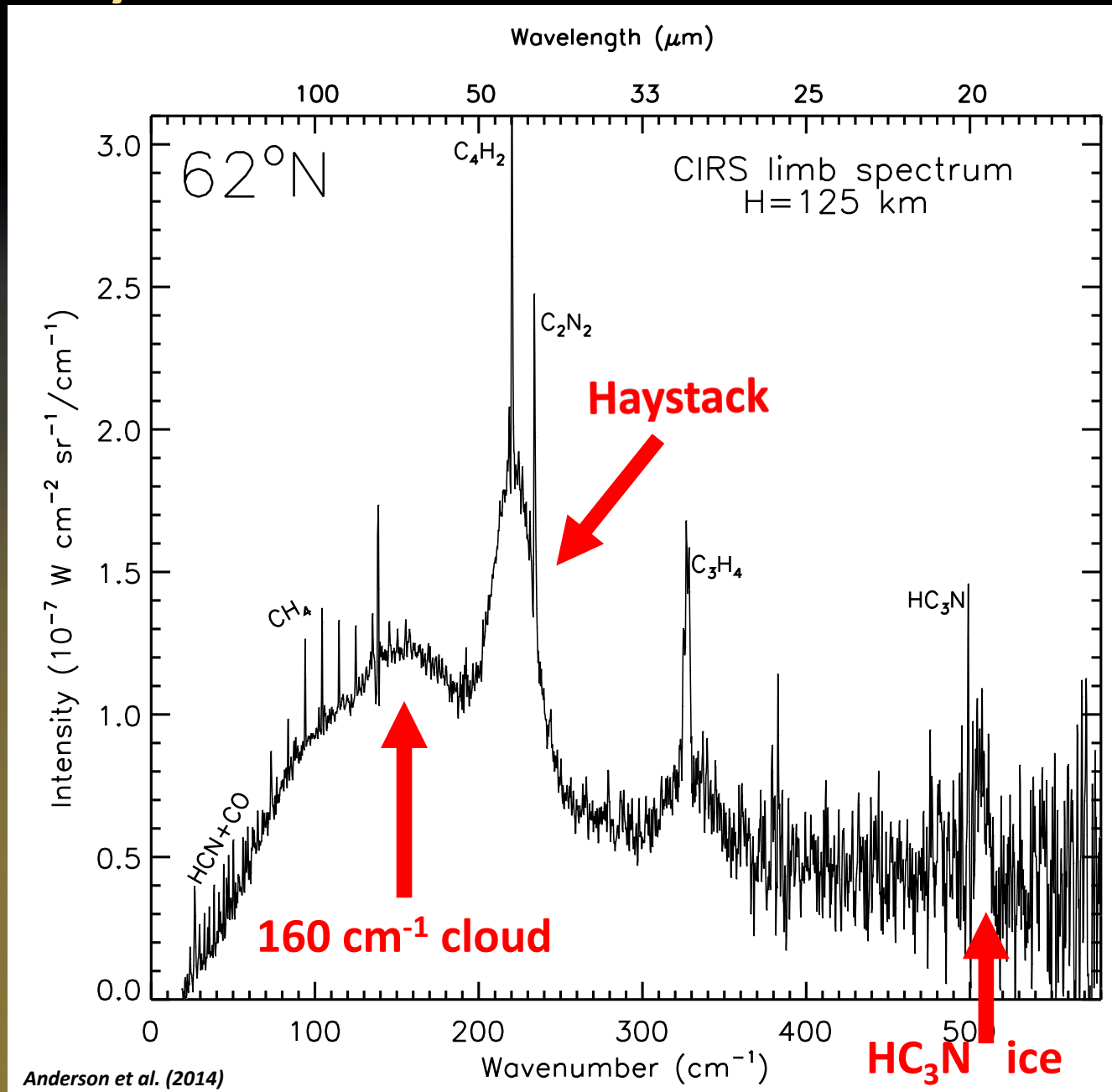
Image credit: ESA/NASA/JPL/University of Arizona

Titan's Stratospheric Clouds

- In Earth's stratosphere, clouds rarely form due to it being very dry
- Titan's stratospheric ice clouds are very different, and by far the most complex of any observed in the solar system
- Titan's stratospheric clouds form as a direct result of the general circulation pattern
- There are over a dozen organic vapors condensing out to form a suite of pure and co-condensed ices, typically observed at high winter polar latitudes
- Co-condensation processes commence when some of these organic vapors enter altitude regions where they can simultaneously saturate
- Most of these ices will diffuse throughout Titan's lower atmosphere and eventually precipitate to the surface, where they are expected to contribute significantly to Titan's regolith

First Stratospheric Clouds Detected by CIRS

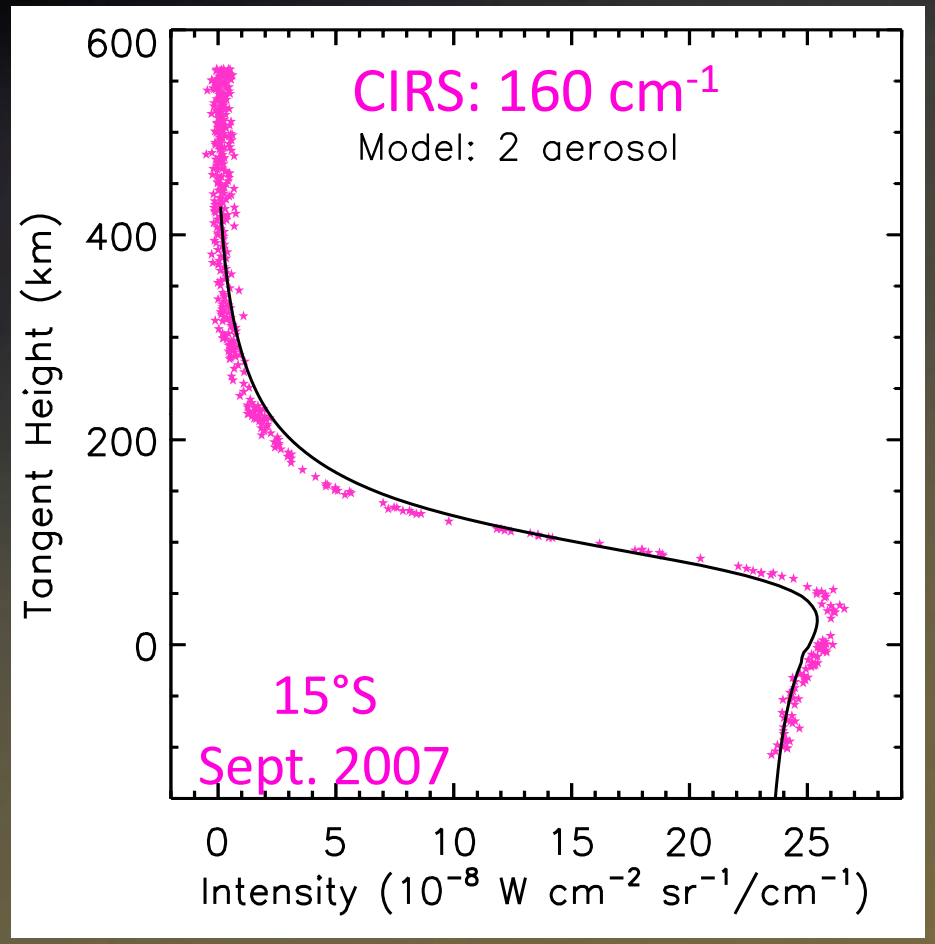
- Titan spectra recorded at 62°N in July 2006 with the Cassini CIRS far-IR FOV centered on ~125 km tangent height
- Season was northern winter
- Numerous gases and ices are visible
- The CIRS far-IR limb integration spectrum shows three chemically-different stratospheric ice clouds: co-condensed HCN/HC_3N, the Haystack, and the ν_6 band of HC_3N

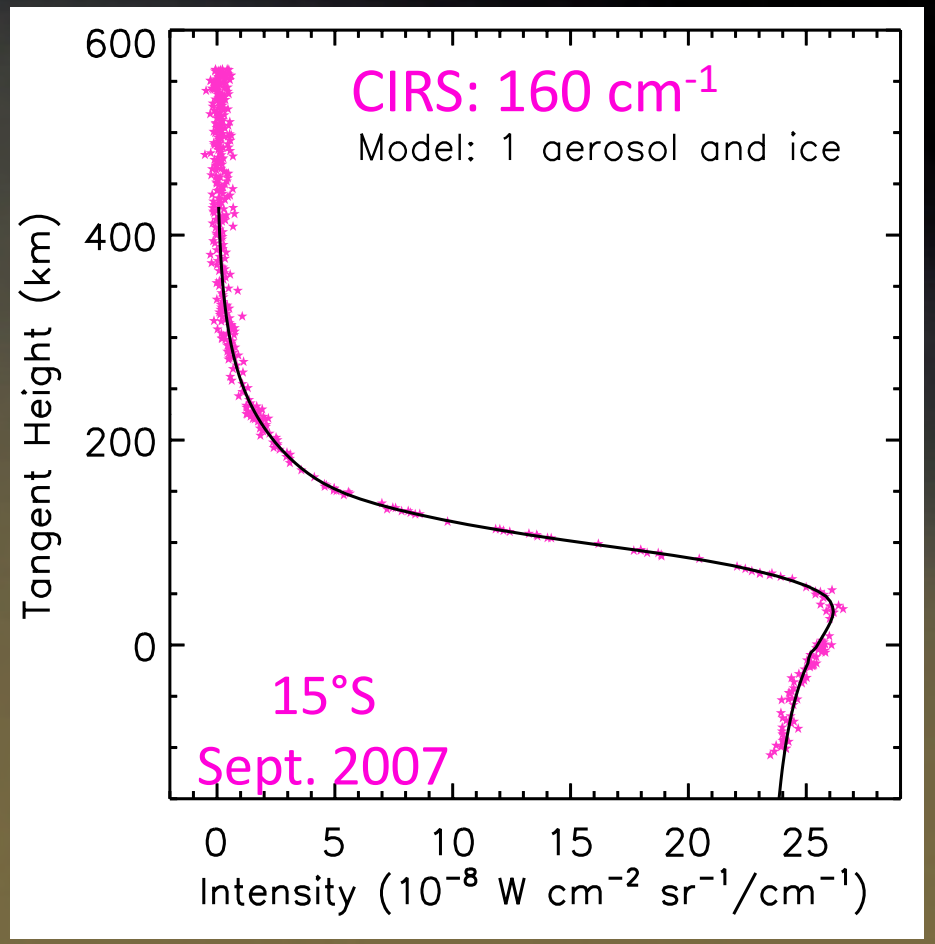


Anderson et al. (2014)

Discovery of co-condensed ice clouds

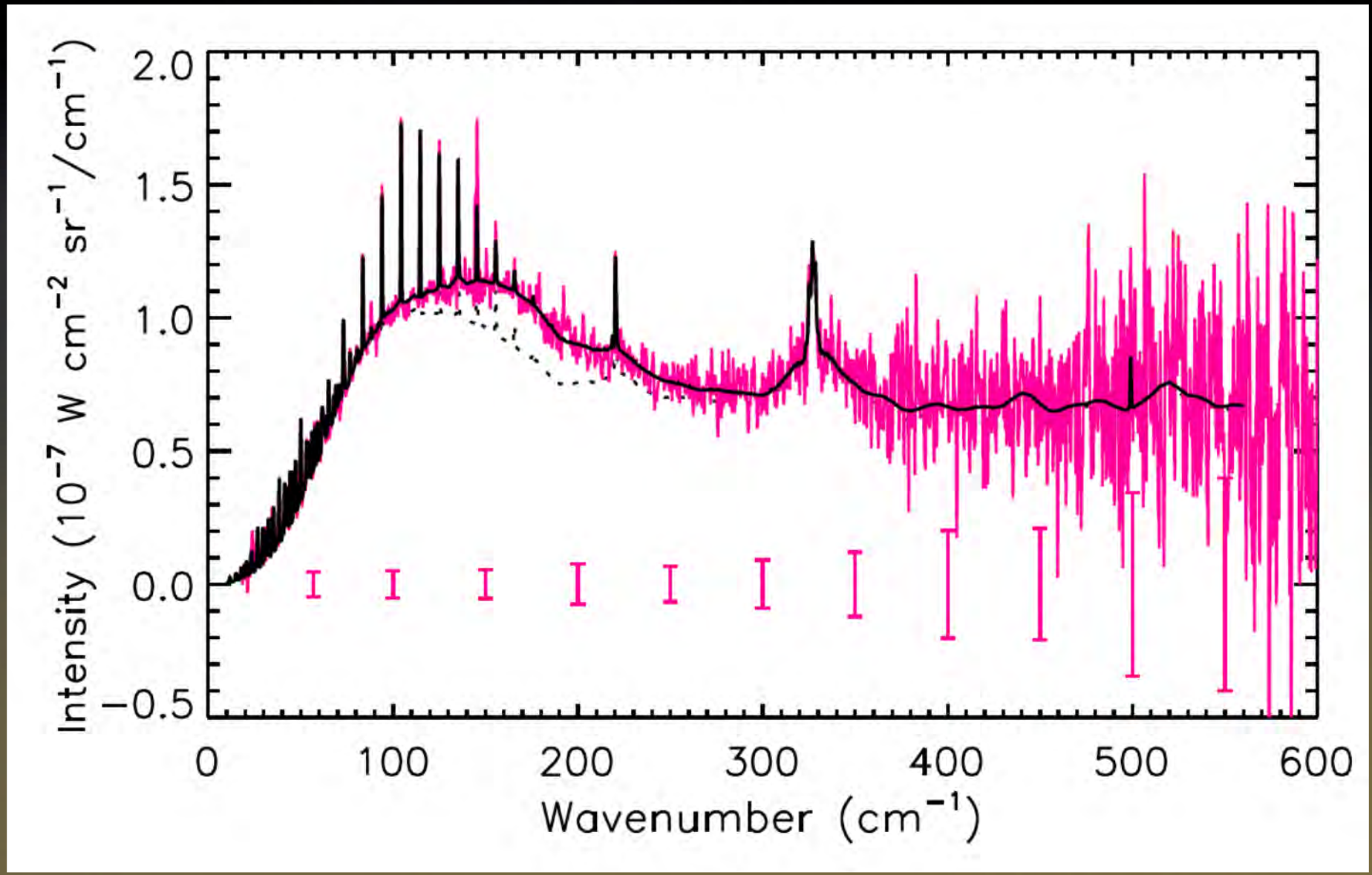
Based on the cloud top altitude and thickness, we already knew that the 160 cm^{-1} ice cloud should predominately contain HCN and HC_3N ices.





Anderson and Samuelson, 2011

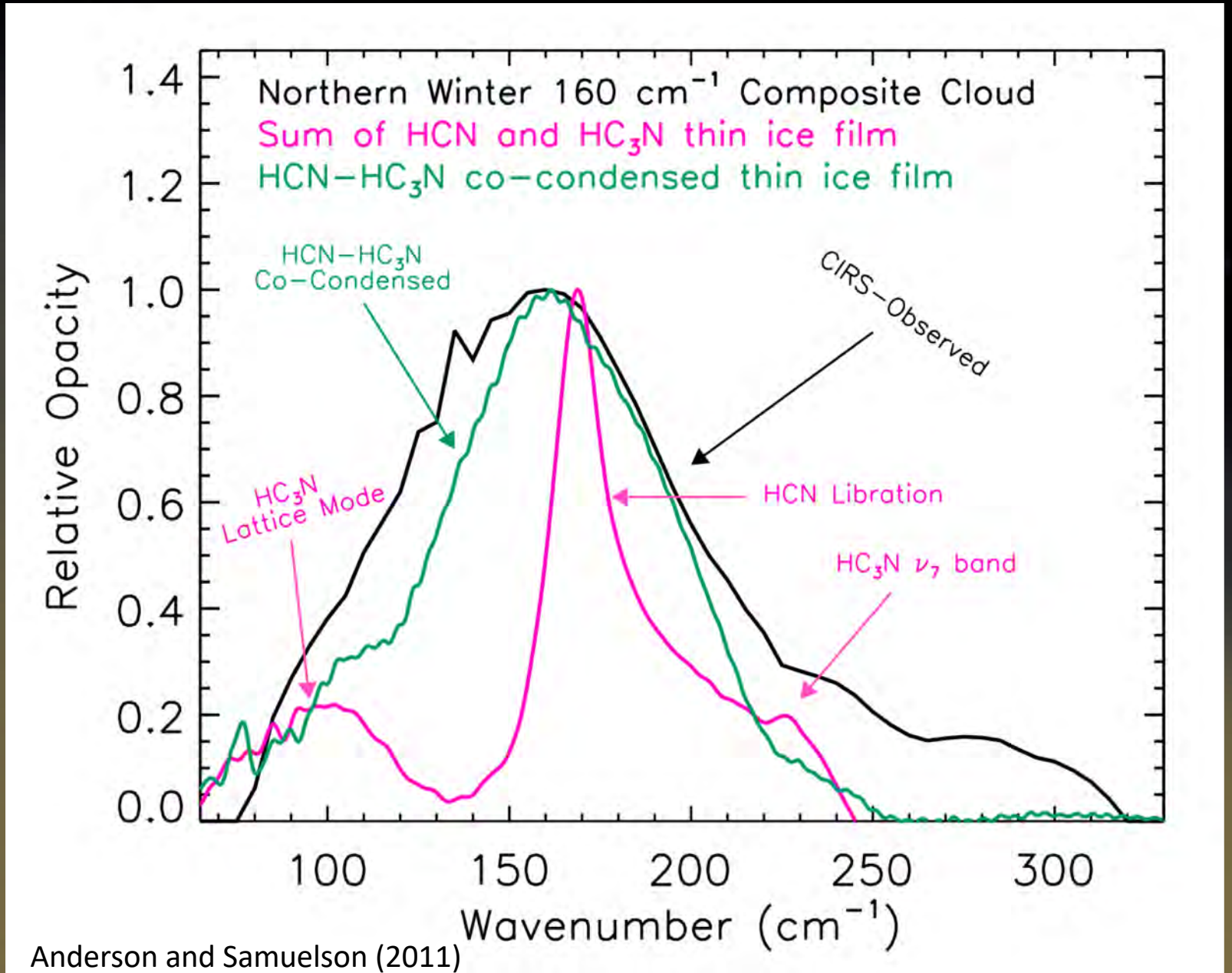
Discovery of 160 cm^{-1} ice cloud



Anderson and Samuelson, 2011

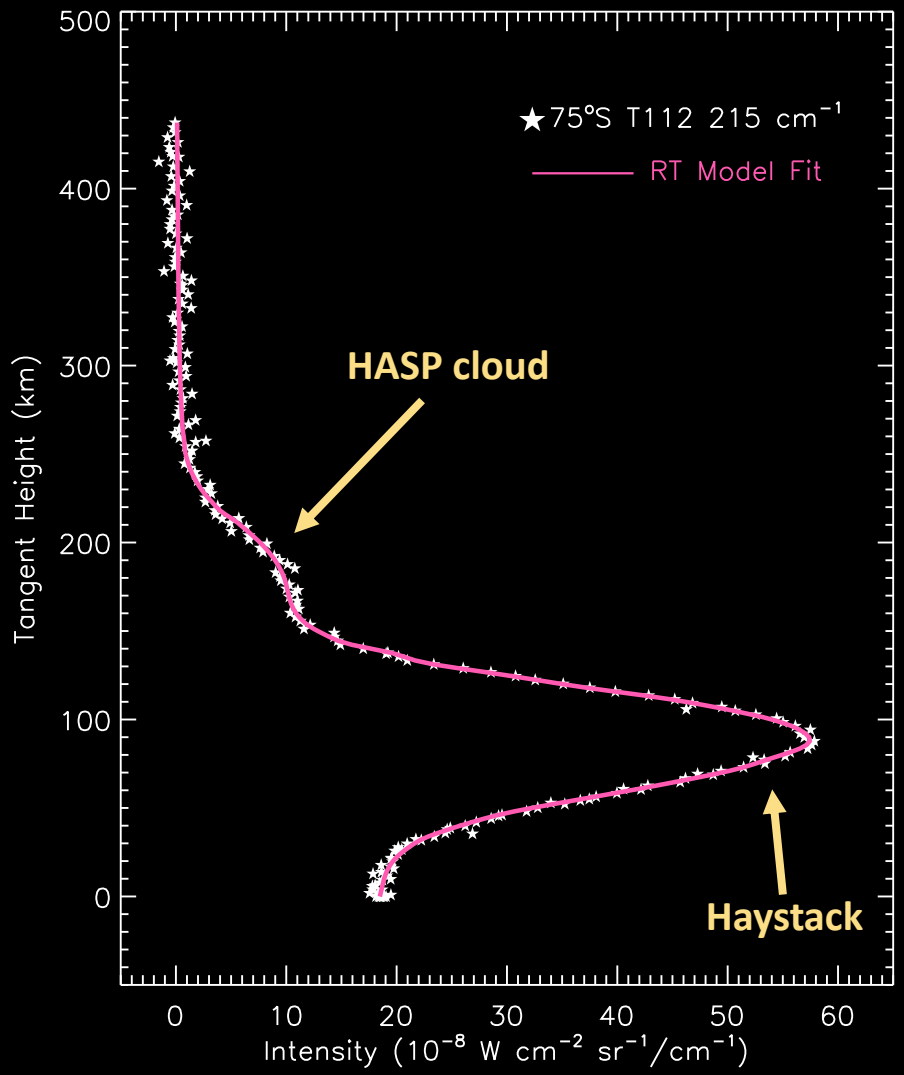
CIRS 160 cm^{-1} ice cloud

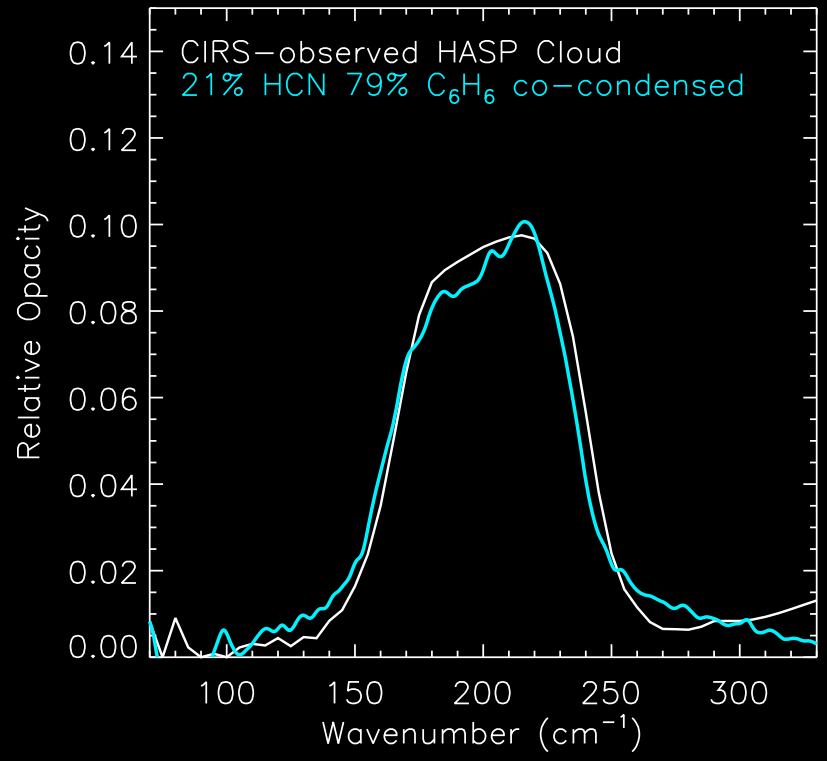
Thin ice films of layered HCN and HC_3N ice do not reproduce the CIRS-derived cloud opacity spectral dependence.



Anderson and Samuelson (2011)

CIRS-discovery of another co-condensed ice cloud





Anderson et al. (2018)

Iapetus

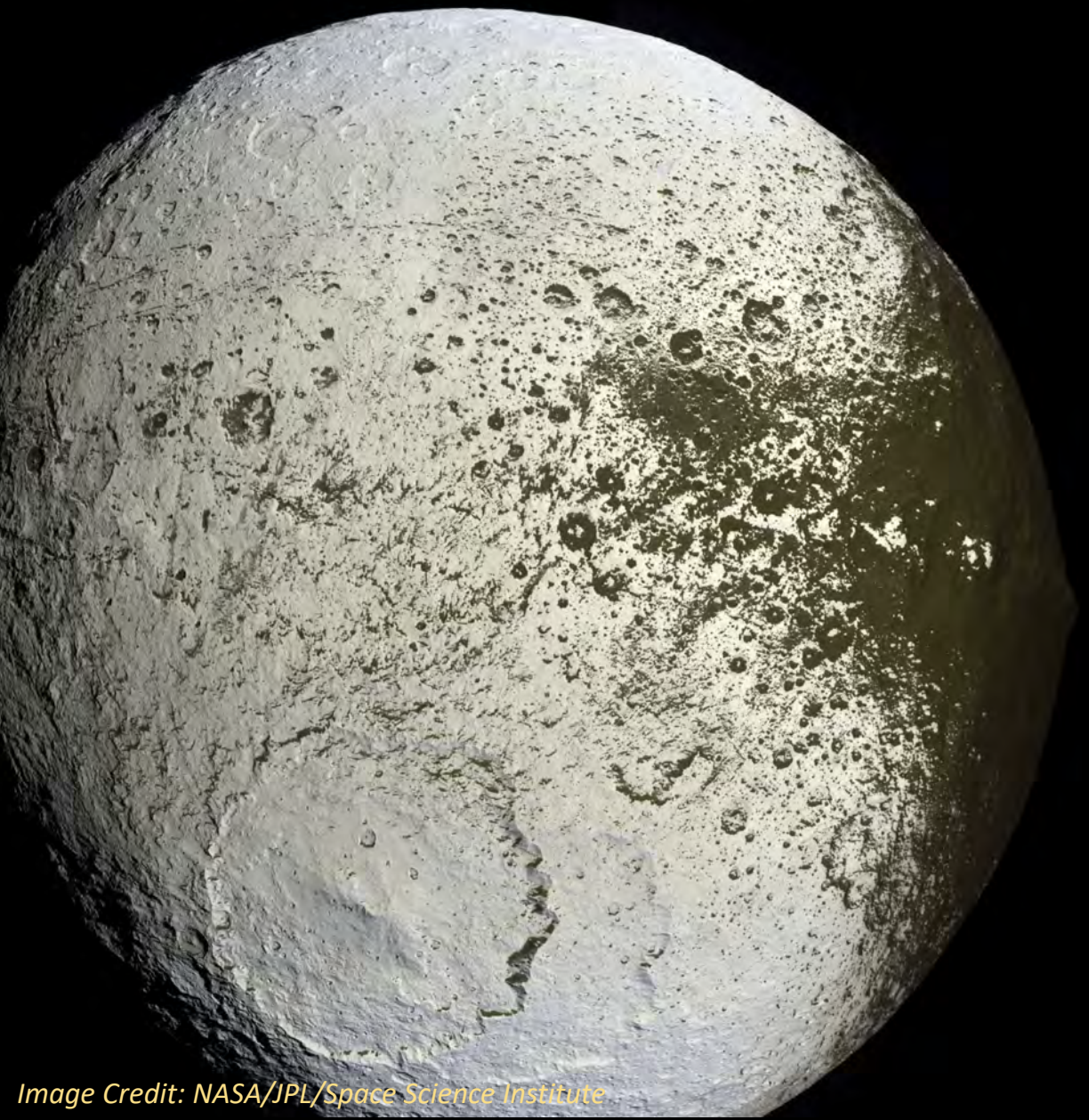
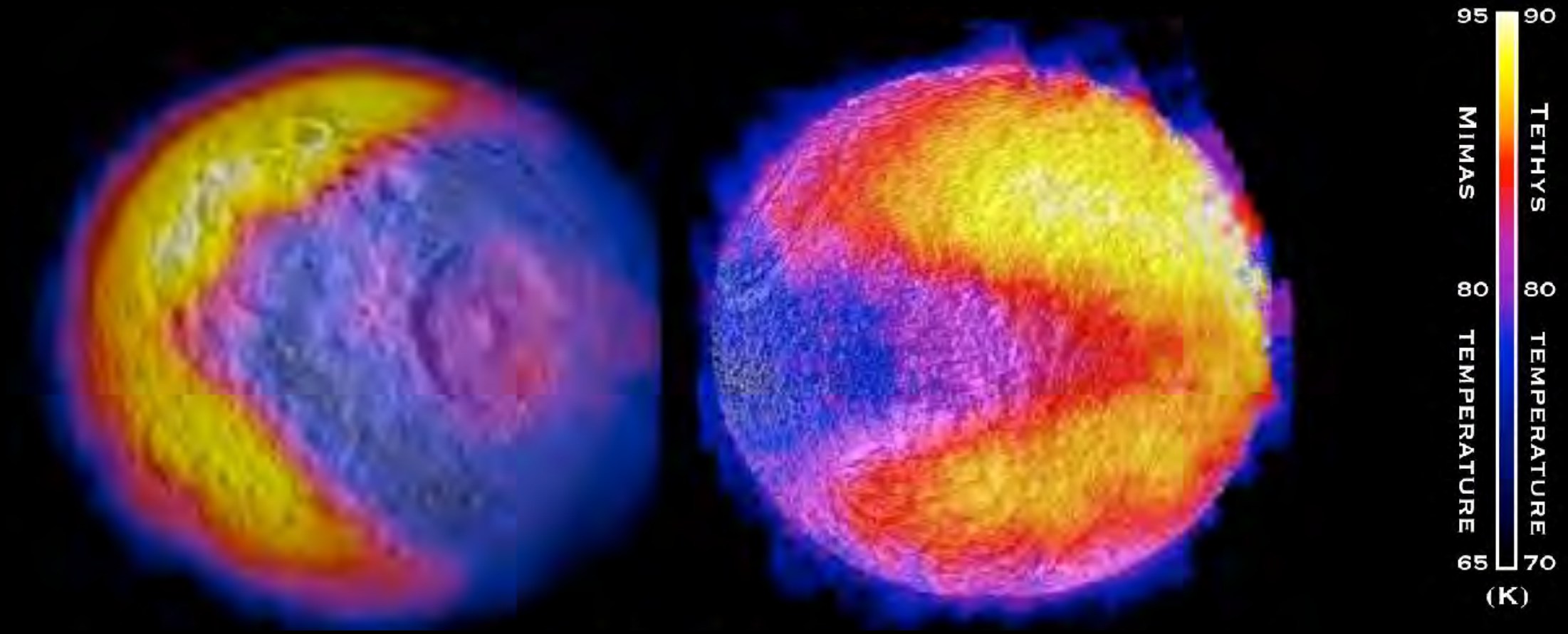


Image Credit: NASA/JPL/Space Science Institute

- Cassini observed the first high-spatial resolution image of Iapetus' trailing hemisphere - as bright as snow
- The bottom half shows a 280-mile wide impact basin. This is just 1 of 9 on the moon
- The leading hemisphere is as dark as coal, most likely covered in condensed nitrile ices, hydrated minerals, and other carbonaceous minerals
- The dark material may be due thermal segregation, a result of Iapetus' slow, 79-day rotation

Mimas, Tethys, and “Pac-Man”

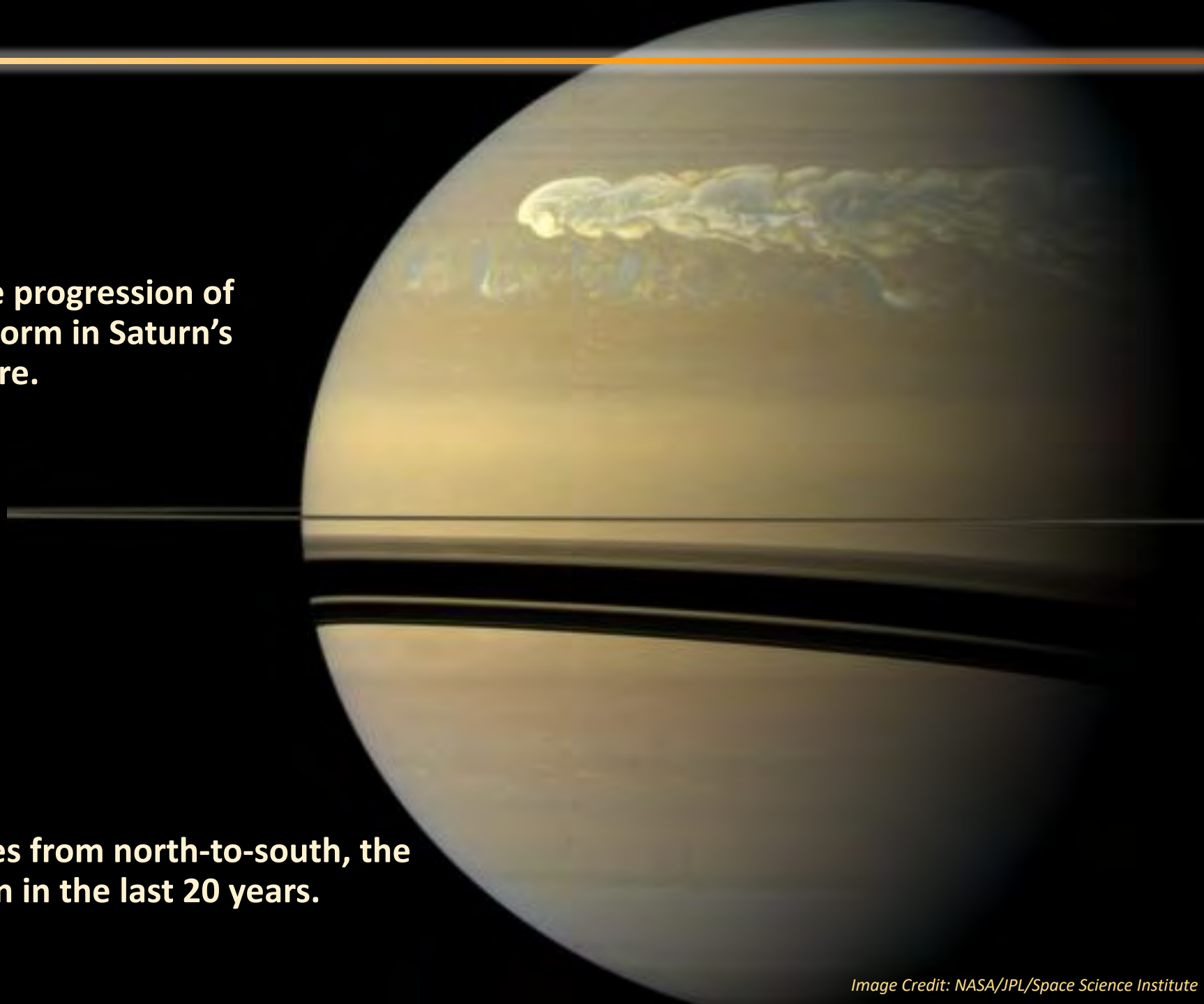


High spatial resolution temperature and image maps revealed unexpected hot regions that resembled “Pac-Man.”

Image Credit: NASA/JPL/Space Science Institute

Saturn

Cassini detected and tracked the progression of an early northern spring large storm in Saturn's northern hemisphere.



The storm extended ~9,000 miles from north-to-south, the largest observed on Saturn in the last 20 years.

Image Credit: NASA/JPL/Space Science Institute

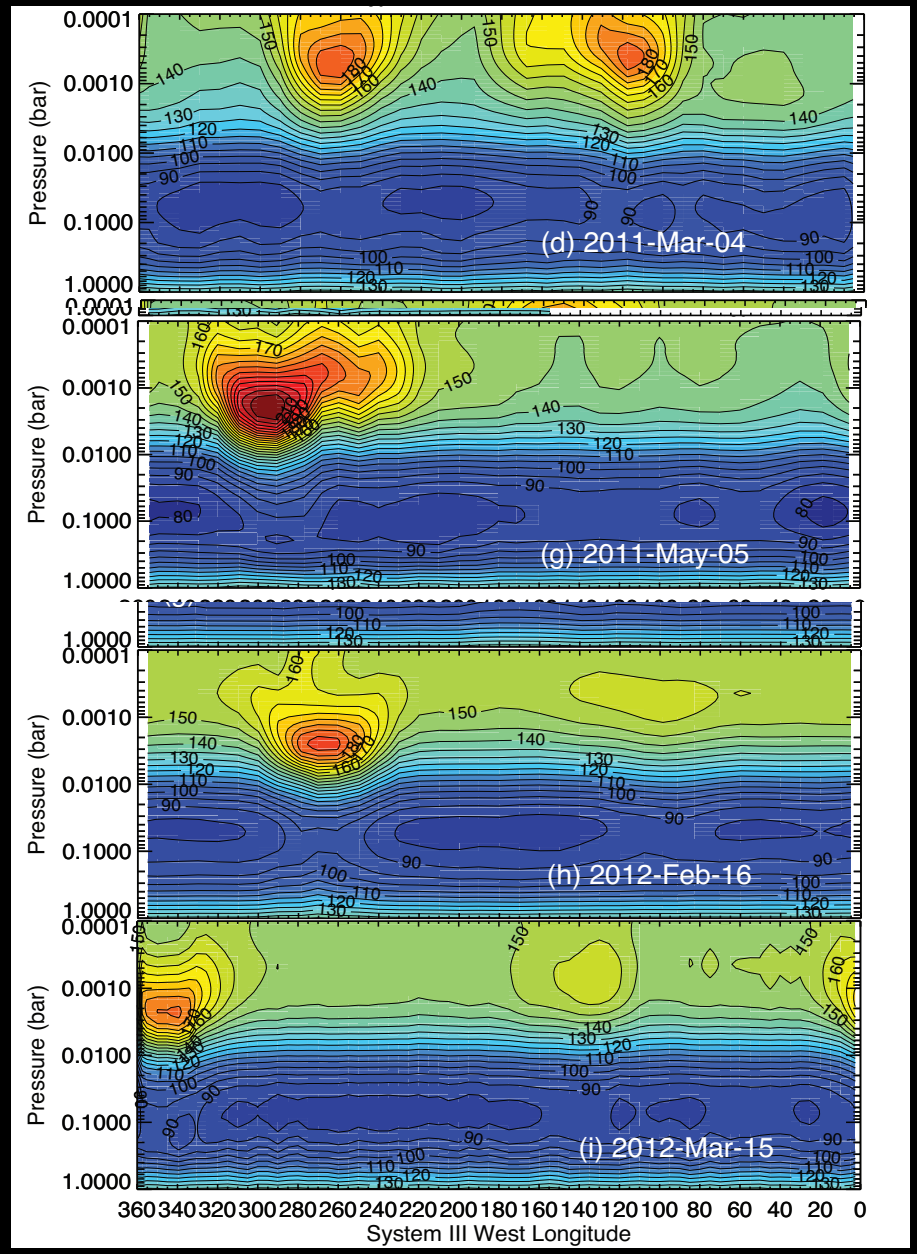
IR Hotspots in Saturn's Monster Storm

Over the next 2 years, when the storm was invisible to Cassini's camera, CIRS observed two vast beacons of hot air in Saturn's stratosphere.

As the tropospheric cloud formed, waves of heat travelled hundreds of miles upwards, depositing their energy as two vast "beacons" of hot air in Saturn's stratosphere.

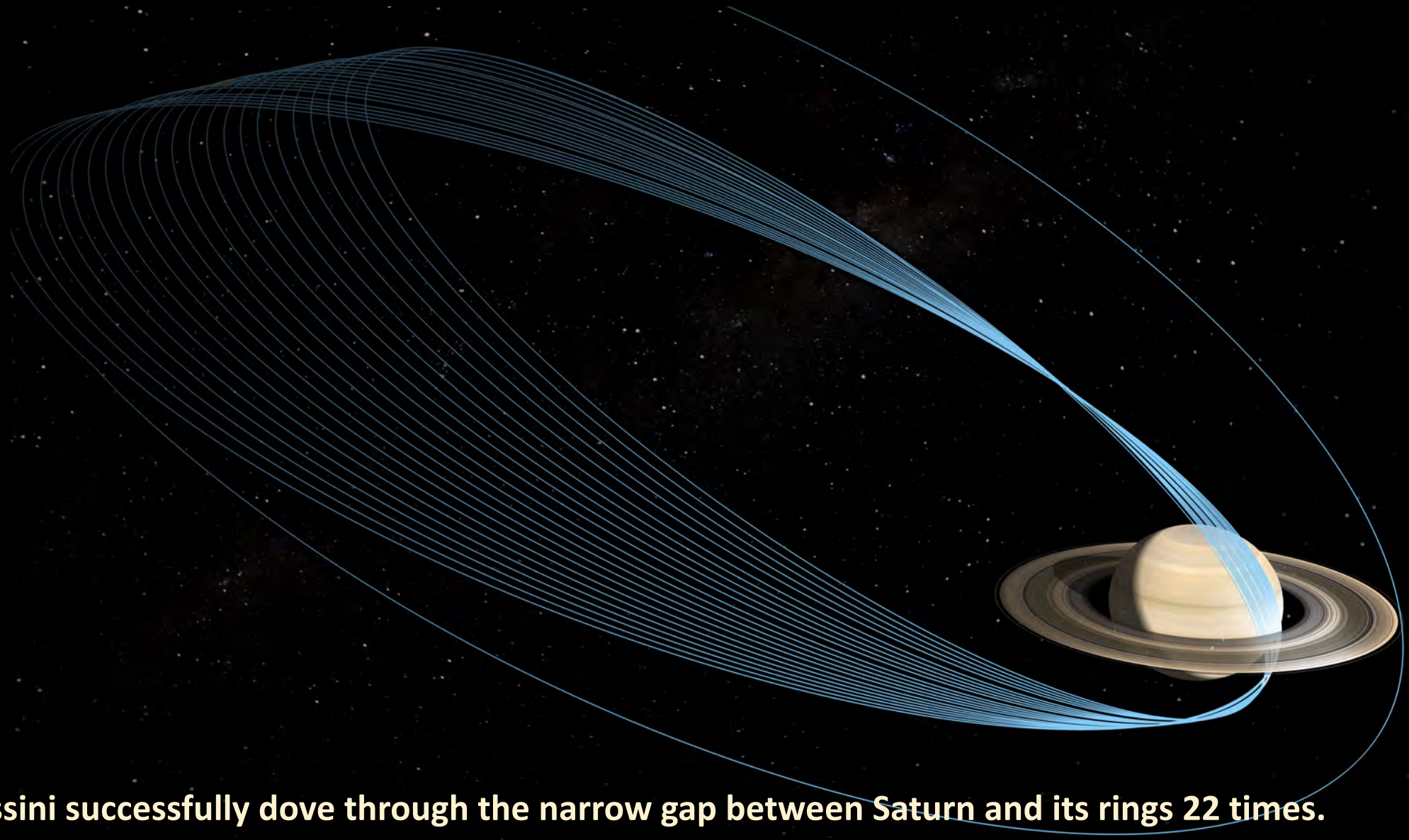
Image Credit: NASA/JPL/Space Science Institute

Saturn's Monster Storm



Fletcher et al. 2012

The Grand Finale Begins – 26 April 2017



Cassini successfully dove through the narrow gap between Saturn and its rings 22 times.

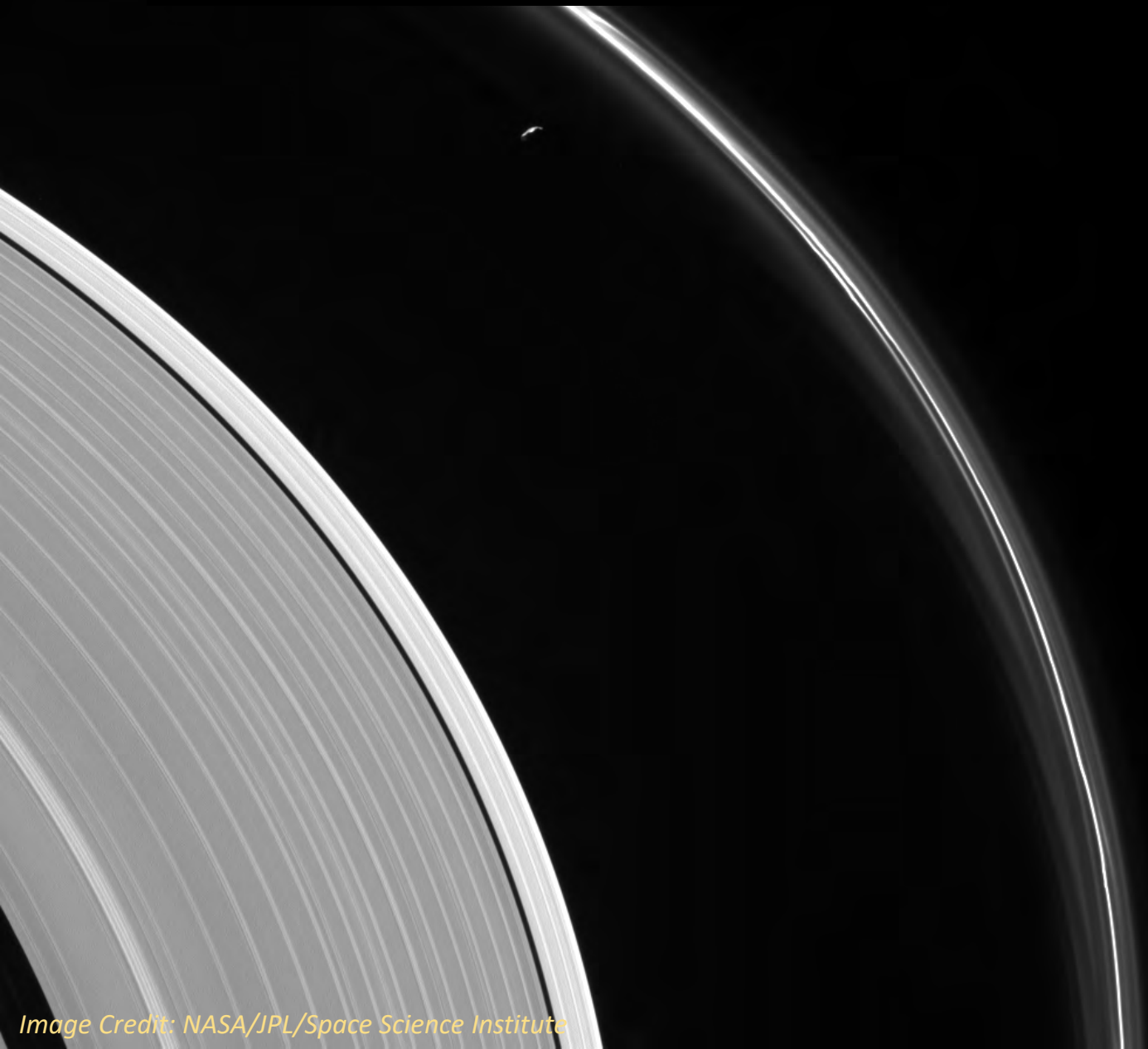
Image Credit: NASA/JPL/Space Science Institute

Farewell to Titan – 21 April 2017

- Throughout the entire mission, Cassini has used Titan's gravity for major trajectory changes in nearly all of its close flybys of the moon
- During T-126, Cassini passed within 600 miles of Titan and used the moon's gravity as a pivotal point to alter the shape of Cassini's orbit in a tragic way
- Even if we lost communication with Cassini, the spacecraft was now on an eventual collision course with Saturn
- T-126 marks the end of Cassini's Ring-Grazing Orbits, and sets the stage for the beginning of the mission's Grand Finale

Image Credit: NASA/JPL/Space Science Institute

Prometheus and the F-ring



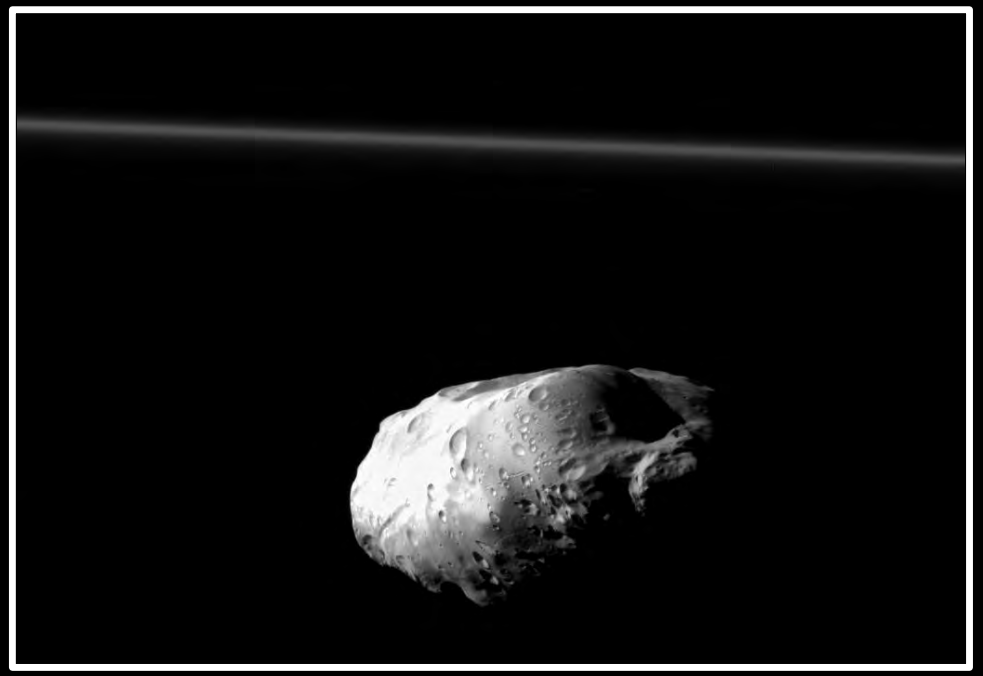
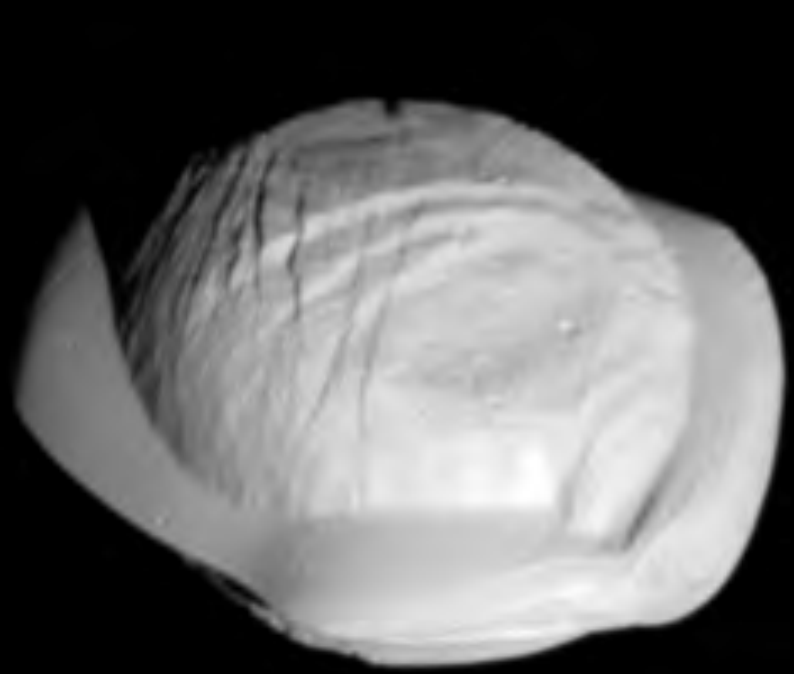
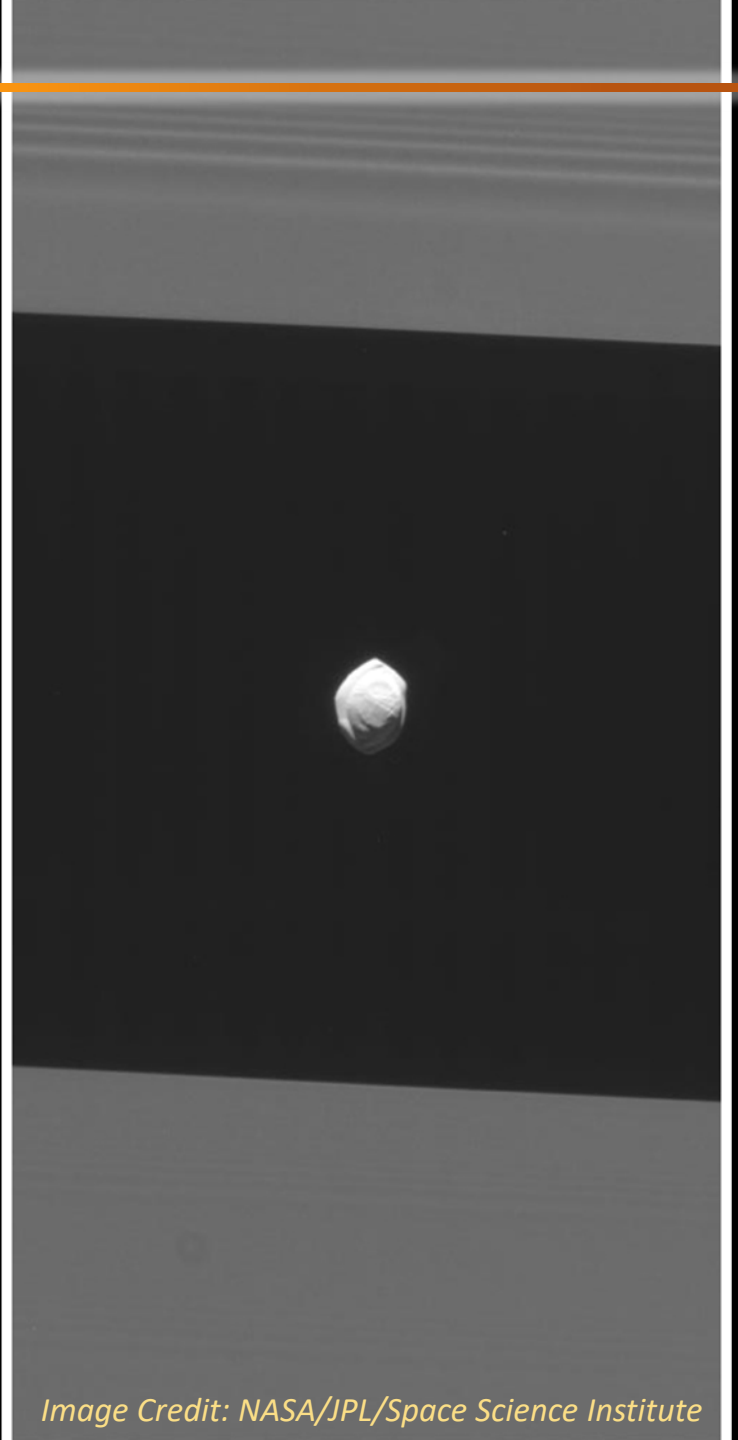


Image Credit: NASA/JPL/Space Science Institute

Pan Up Close





Pan is embedded in Saturn's A ring, causing a gap – the Encke gap – in the ring as it orbits.

Image Credit: NASA/JPL/Space Science Institute

Saturn Up Close

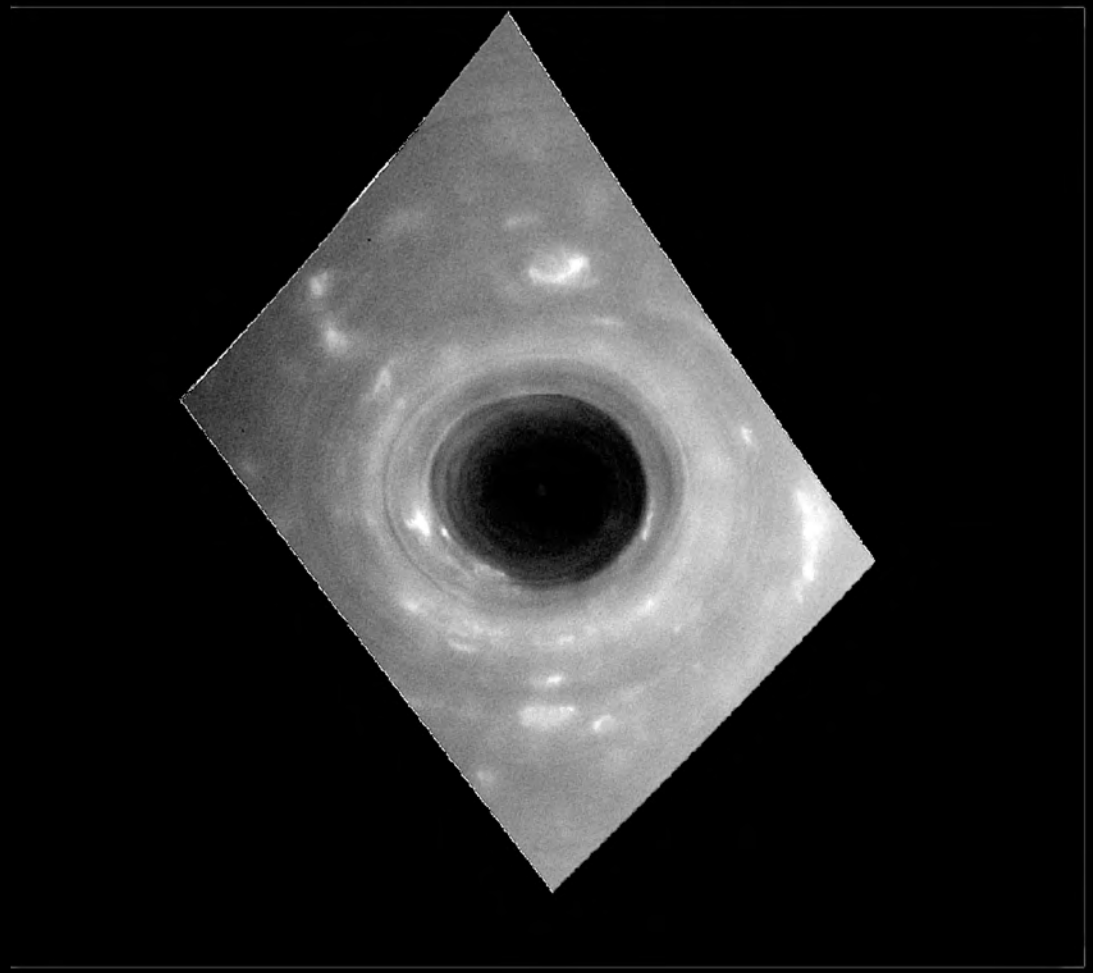
Saturn's hexagon-shaped jet stream around the planet's north pole

Each side of the hexagon is about as wide as the Earth.

Image Credit: NASA/JPL/Space Science Institute

First Dive between Saturn and its Rings

Camera View



Reference View

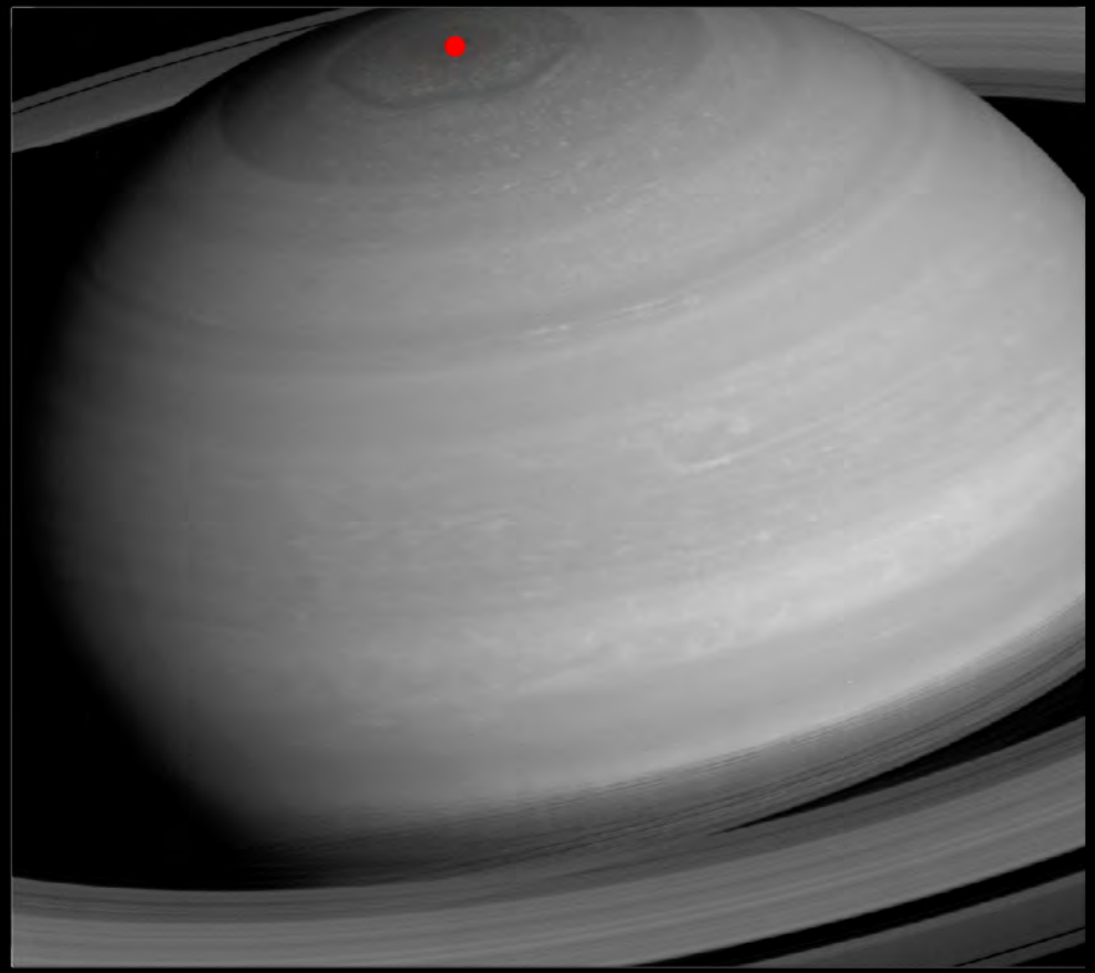


Image Credit: NASA/JPL/Space Science Institute

Last Enceladus Plume Observation

28 August 2017

Image Credit: NASA/JPL/Space Science Institute


Cassini ISS Observation of Impact Site
14 September 2017
Image Credit: NASA/JPL/Space Science Institute

VIMS Observation of Impact Site

14 September 2017

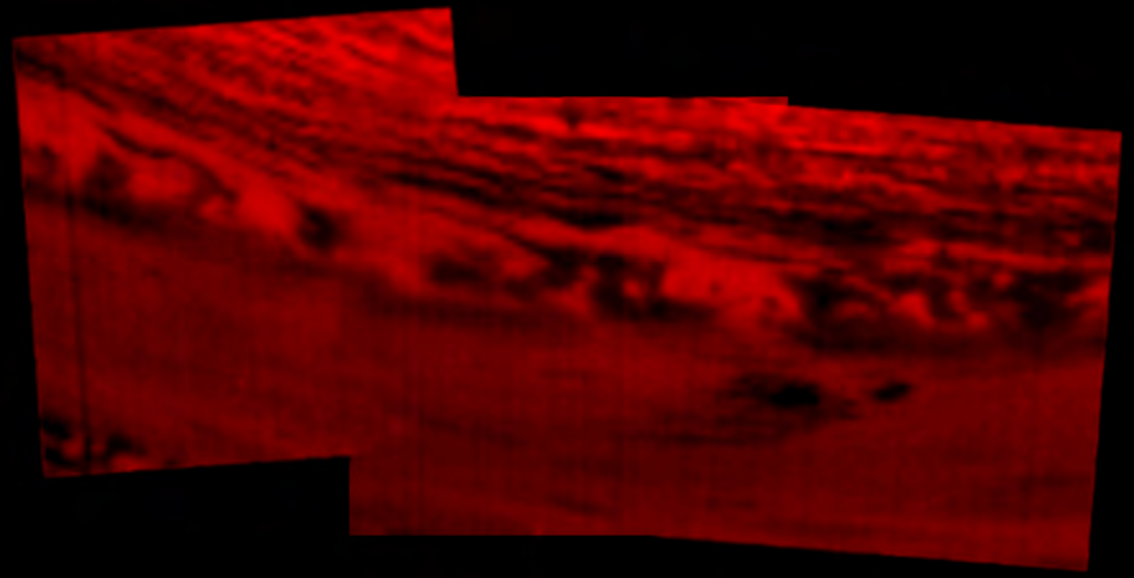


Image taken in the thermal IR at 5 µm. Cassini's atmospheric entry site was at 9.4°N 53°W.

Image Credit: NASA/JPL/Space Science Institute

CIRS' Final Uploaded Command

- **What was uploaded (in hexadecimal)**

436F6E67726174756C6174696F6E7320746F
2074686520436173696E69204349525320
7465616D20666F722064656361646573206F
66207472656D656E646F757320616368696
76656D656E74732C20657370656369616C6C
7920746F2074686F7365206C697374656420
62656C6F7720286173207656C6C20617320
74686F736520696E6164766572746E746C
79206C656674206F666620746869732061C69
7374293A0A0A

- **What it means**

Congratulations to the Cassini CIRS team for decades of tremendous achievements.

Cassini's Final Hour

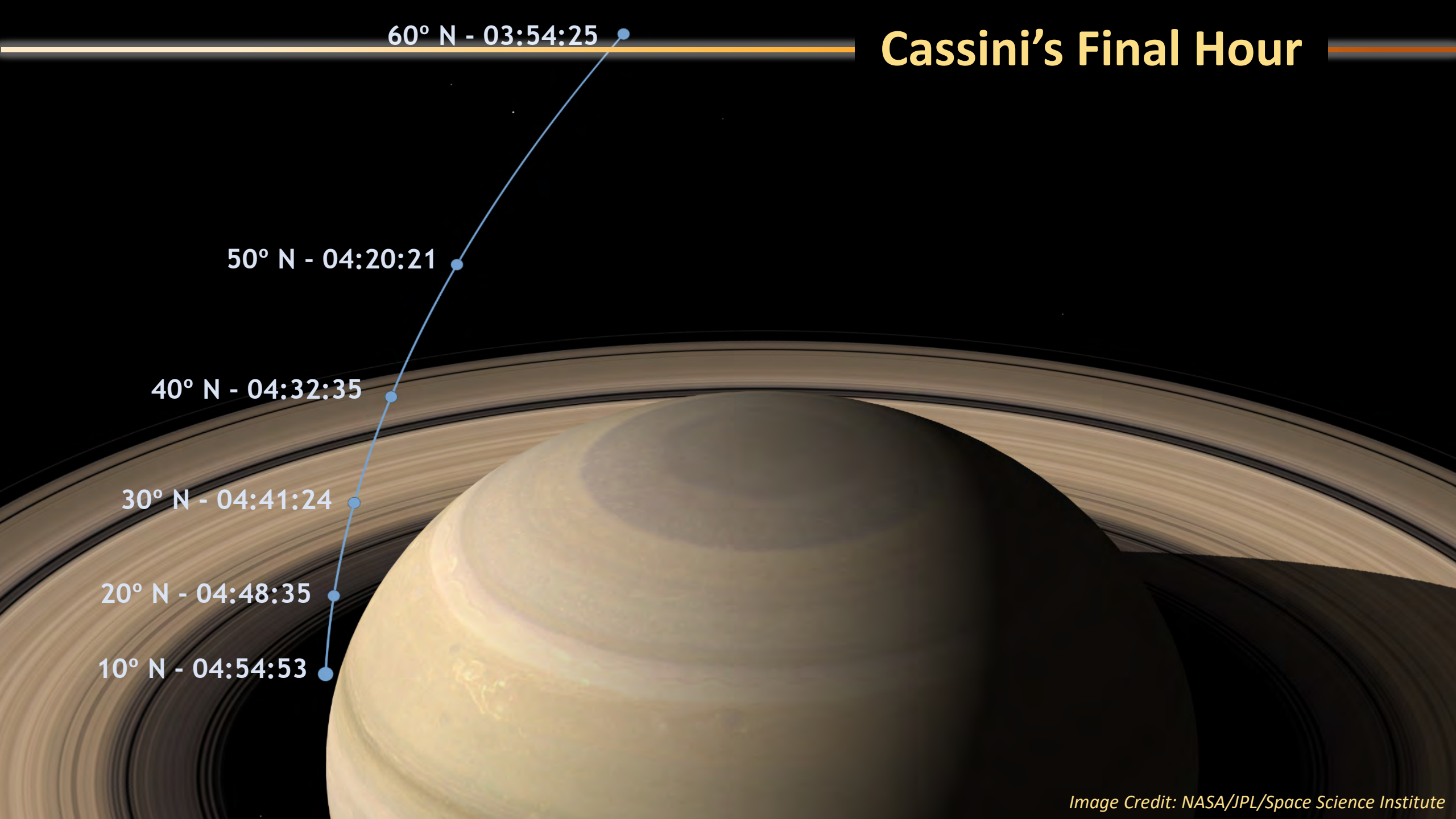
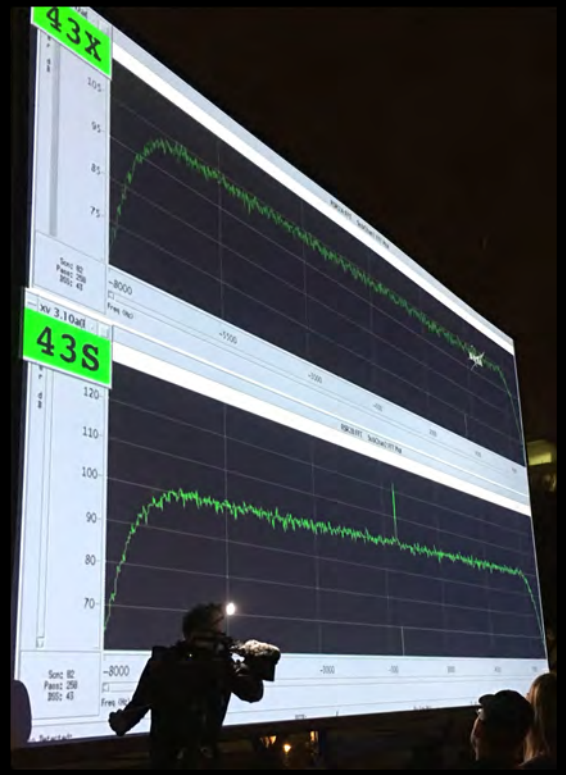
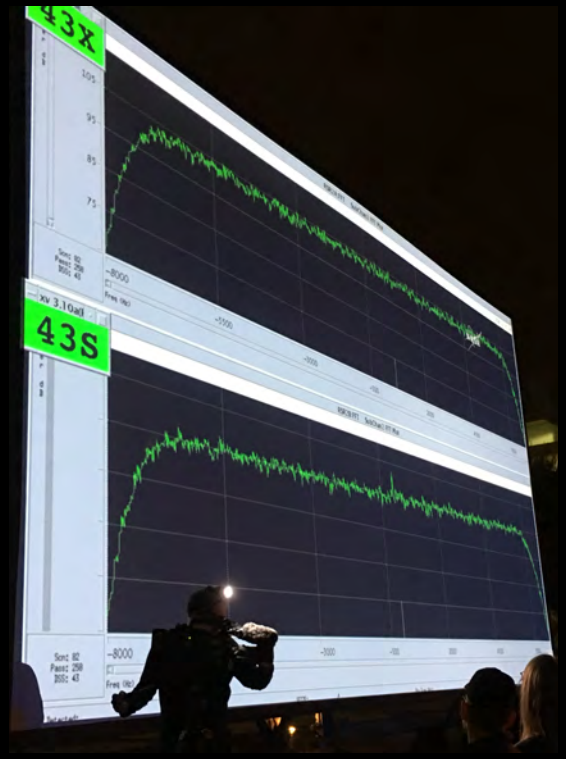
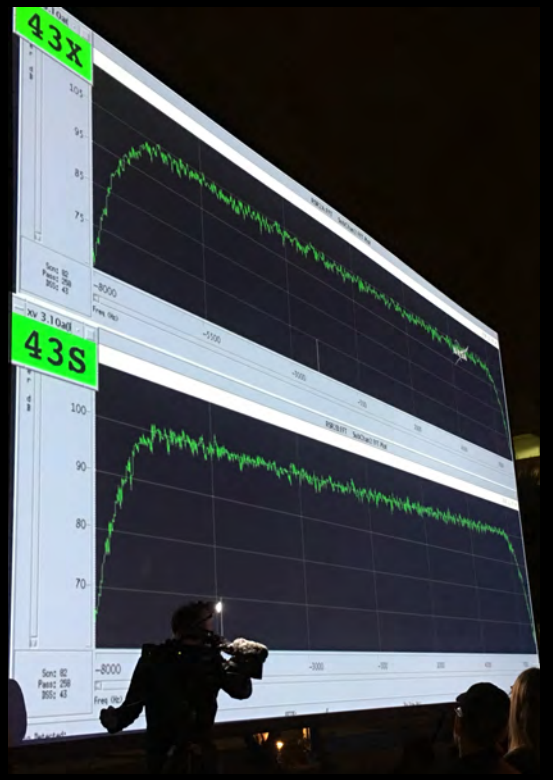


Image Credit: NASA/JPL/Space Science Institute

Cassini's Last Communication to Earth







Cassini Composite Infrared Spectrometer: Investigation Team 1990-2017

Mian Abbas
Richard Achterberg
Peter Ade
Shane Albright
Phil Alley
Carrie Anderson
Andrew Annex
Todd Ansty
Jennifer Ash
Shahid Aslam
Sachi Babu
Sarabjit Bakshi
Mark Baratz
Richard Barney
Antonella Barucci
Sophie Baudouin
Porfy Beltran
Yves Bénilan
David Bergmann
Wali Beyah
Bruno Bézard
Gordon Bjoraker
Willie Blanco
Ken Blumenstock
Vince Bly
Jeff Bolognese
Jean-Francois Bonnal
Renan Borelli
Neil Bowles
David Boyd
Robert Boyle
Scott Bradley
John Brasunas
Mike Brill
Ron Broadhurst
Alex Brooks
Shawn Brooks
Gary Brown
Steve Brown
John Robert Brucato
Jason Budinoff
Andre Bugess
Simon Calcutt
Nga Cao
Ronald Carlson
Frank Carroll
Jorge Carvano

Catherine Césarsky
Robert Chalmers
Cheong Chan
Craig Charlton
Bob Clark
Gustave Comeyne
Barney Conrath
Angioletta Coradini
Donald Cornwell
Valeria Cottini
Régis Courtin
Athena Coustenis
Jacky Cretolle
Daniel Crick
Julie Crooke
Mark Cushman
Vatant d'Ollone
Martin Davis
Mitchell Davis
Phillipe de Antoni
Mark De Cates
Remco De Kok
Héctor E. Delgado Díaz
Rebecca Derro
Ravindra Desai
Michael Dittman
Elisabetta Dotto
Thomas Duffy
Steven Edberg
Scott Edgington
Kevin Edwards
Rick Eichen
Bill Eichhorn
Majed El Alami
Matthew Elliott
Kimberly Engle
Audrey Ewin
Lester Farwell
Steve Fawcett
Cécile Ferrari
Raymond Ferrer
Rainer Fettig
Jim Fitzgerald
Michael Fitzmaurice
Michael Flasar
Leigh Fletcher
Thierry Fouchet

Torn French
Daniel Gautier
Peter Gierasch
David Glenar
Donald Glenn
Alessio Gorius
Nicolas Gorius
Steven Graham
Klaus Grossman
Ever Guandique
Sandrine Guerlet
John Hagopian
Claef Hakun
Rudy Hanel
Jamie Harper
Tom Hartman
Bill Hayden
Patricia Hayes
Jim Heaney
Lawrence Herath
Alfonso Hermida
Mike Hersh
Brigette Hesman
Catherine Homens
Carly Howett
Kelly Hu
Terry Hurford
Jane Hurley
Patrick Irwin
Edgar Jackson
Jason Jen
Donald Jennings
Nancy Jensen
Sid Johnson
Antoine Jolly
Tony Josephson
Eva Kadar
Monte Kaelberer
Gabe Karpati
Gabriel Karpati
Mike Kasten
Karen Keene
Carl Kellebenz
Ernest Kidhart
Ki Kim
Terry King
Gary Kinsella

Don Kirkpatrick
Valerie Klavans
Ron Kolecki
Carl Kotecki
Danny Krebs
James Krise
Jim Krise
Virgil Kunde
Brook Lakew
Peter Lansing
Suong Le
Andre LeClair
Chiachung Lee
Ken Lee
Steve Leete
Henning Leidecker
Emmanuel Lellouch
Liming Li
John Lindsay
James Lohr
Nicholas Lombardo
Chris Lorenston
Jack Lorenz
Tom Lusco
Jim Lyons
Patricia Lyons
Eric MacDonald
Tom MacDonald
Dave Maite
William Mamakos
Andrei Mamoutkine
Sridhar Manthriprageda
Andre Marten
Carolyn Martin
Robert Martineau
Anthony Martino
Joe Marzouk
Katia Matcheva
Mark Matsumura
Peter Maymon
Will Maynard
John McCloskey
Mark McGinnis
William McGunigal
Dan Mchugh
Kim Mehalik
Tony Melak

Jean-Paul Meyer
Guy Michel
Avery Miles
Scott Milne
Fredrick Moline
Jacqueline Mondellini
Armando Morell
Carol Mosier
Andreea Mosila
Brent Mott
Israel Moya
Dan Musinski
Nishi Narula
Conor Nixon
Michael Oben
Glenn Orton
Toby Owen
Larry Pack
Edward Packard
Bert Pasquale
John Pearl
Brendon Perkins
Thomas Perry
Frank Peters
Lois Pettit
Dave Pfenning
Charles Phelps
Kirk Piegari
Stuart Pilorz
Mike Plants
John Pocius
Steve Potter
Renée Prangé
François Raulin
Peter Read
Malena Rice
Dwight Roberts
Justin Roberts-Pierel
David Robinson
Louis Rodriguez
Paul Romani
Pedro Sada
Kusum Sahu
Robert Samuelson
Ernest Santoro
Marc Sarrel
William Schaefer

Paul Schinder
Steve Schmidt
Marcia Segura
Sharon Seipel
Mark Showalter
Goujun Si
Amy Simon
James Sinclair
Michael Smith
John Spencer
Linda Spilker
John Stewart
Vicky Stokes
Darrell Strobel
Carl Strojny
Mélody Sylvestre
Masrifa Tasnim
Fred Taylor
Nicholas Teanby
Nick Teti
Haydar Teymourlouei
Janet Thomas
John Thomason
Felix Threat
James Tingley
Eduardo Torres
Michelle Troeltzsch
Cathy Trout
Carlos Trujillo
Glenn Unger
Timothy John Vellacott
Anne Verbiscer
Laurent Vigroux
Sandrine Vinatier
Angelo Wade
Kenneth Wagner
Brad Wallis
David Walser
Brooke Webster
Paul Weir
Steve Werrett
Louis Worrel
Cindy Young
Eric Young
Madison Young
Diane Yun
John Zaniewski