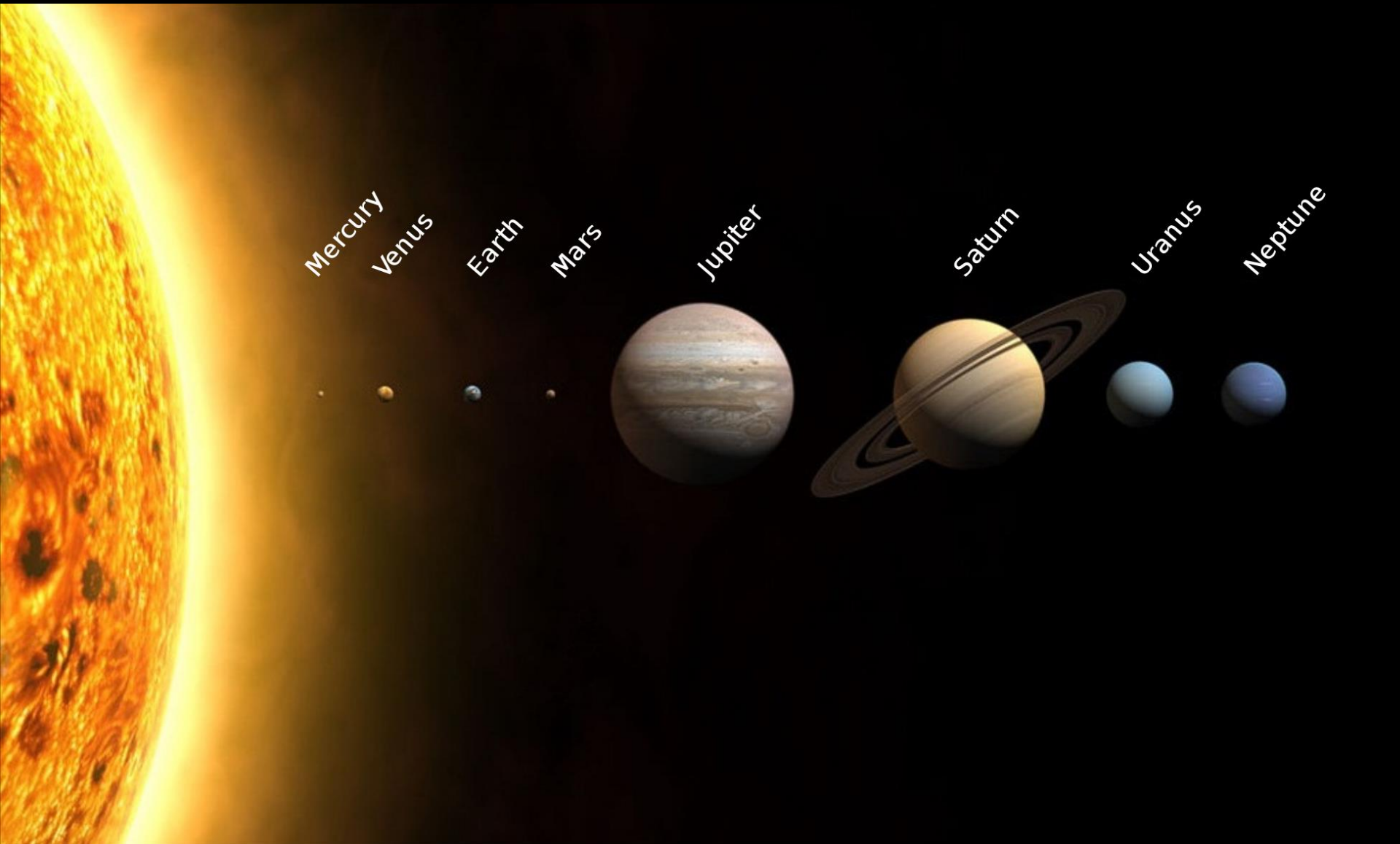


# *La mission Cassini/Huygens*



*Christophe Sotin  
Nantes Université, France*



# Jupiter after Galileo, Saturn before Cassini-Huygens



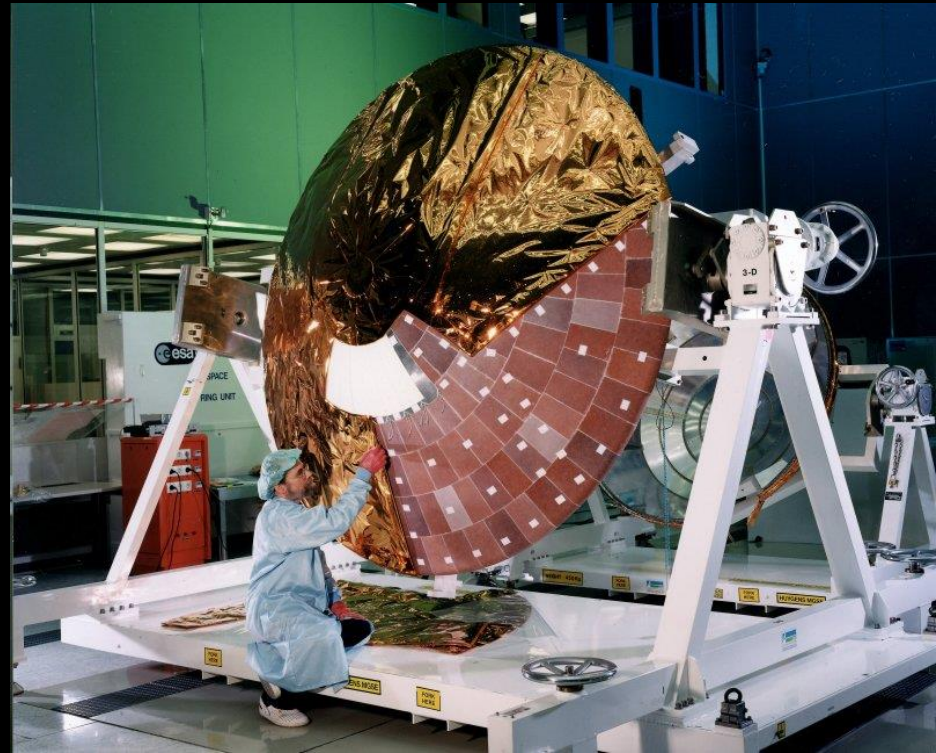
November 15, 2022

Cassini - Genève





NASA Cassini Orbiter



European Space Agency (ESA) Huygens Probe



DENMARK



BELGIUM



FRANCE



UNITED STATES



GERMANY



ITALY



ISRAEL



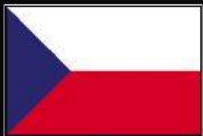
UNITED KINGDOM



POLAND



NETHERLANDS



CZECH REPUBLIC



AUSTRIA



SPAIN



FINLAND



SWITZERLAND



IRELAND



HUNGARY - Genève



SWEDEN



NORWAY



INTERNATIONAL PARTICIPATION IN  
**CASSINI**  
SATURN ORBITER AND  
HUYGENS TITAN  
PROBE

Saturne

Les anneaux

Titan

Les satellites de glace

Plasma et magnetosphere

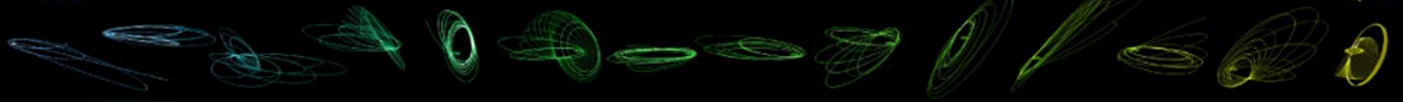


12 instruments sur Cassini

6 instruments sur la sonde Huygens

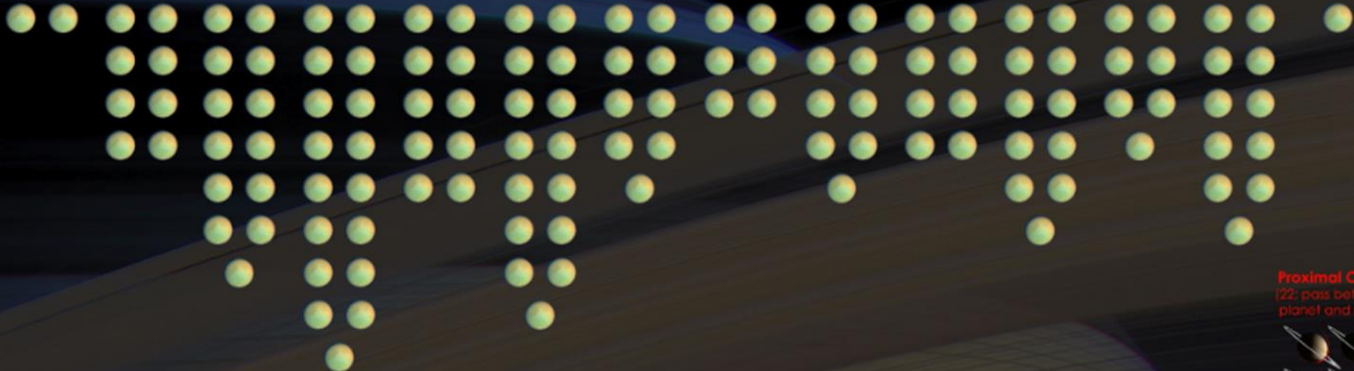
Saturn arrival  
June 2004

End of Mission (Saturn entry)  
Sep. 2017



<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
3 orbits	17 orbits	17 orbits	19 orbits	44 orbits	24 orbits	20 orbits	16 orbits	19 orbits	22 orbits	11 orbits	18 orbits	26 orbits	38 orbits

### Titan flybys (127)



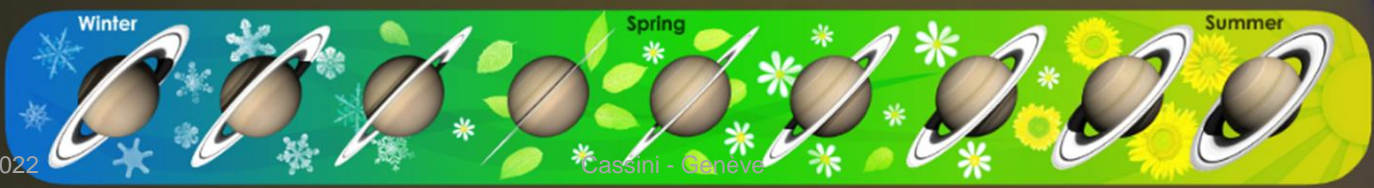
### Enceladus Flybys (23)



### Icy Satellite Flybys (15)



### Saturn seasons (northern)



Proximal Orbits  
(22, pass between planet and rings)

Saturn atmospheric entry  
Sep. 15, 2017



# Quelques dates durant 30 ans de travail

**15 Novembre 1990: sélection des équipes scientifiques**

**15 Octobre 1997: Lancement de Cassini**

**1 Juillet 2004: Mise en orbite autour de Saturne**


**26 Octobre 2004: Premier survol de Titan**

**15 Janvier 2005: Atterrissage de la sonde Huygens**

**15 Septembre 2017: Fin de la mission Cassini**

November 15, 1990

TO: *Cassini VIMS Science Team*

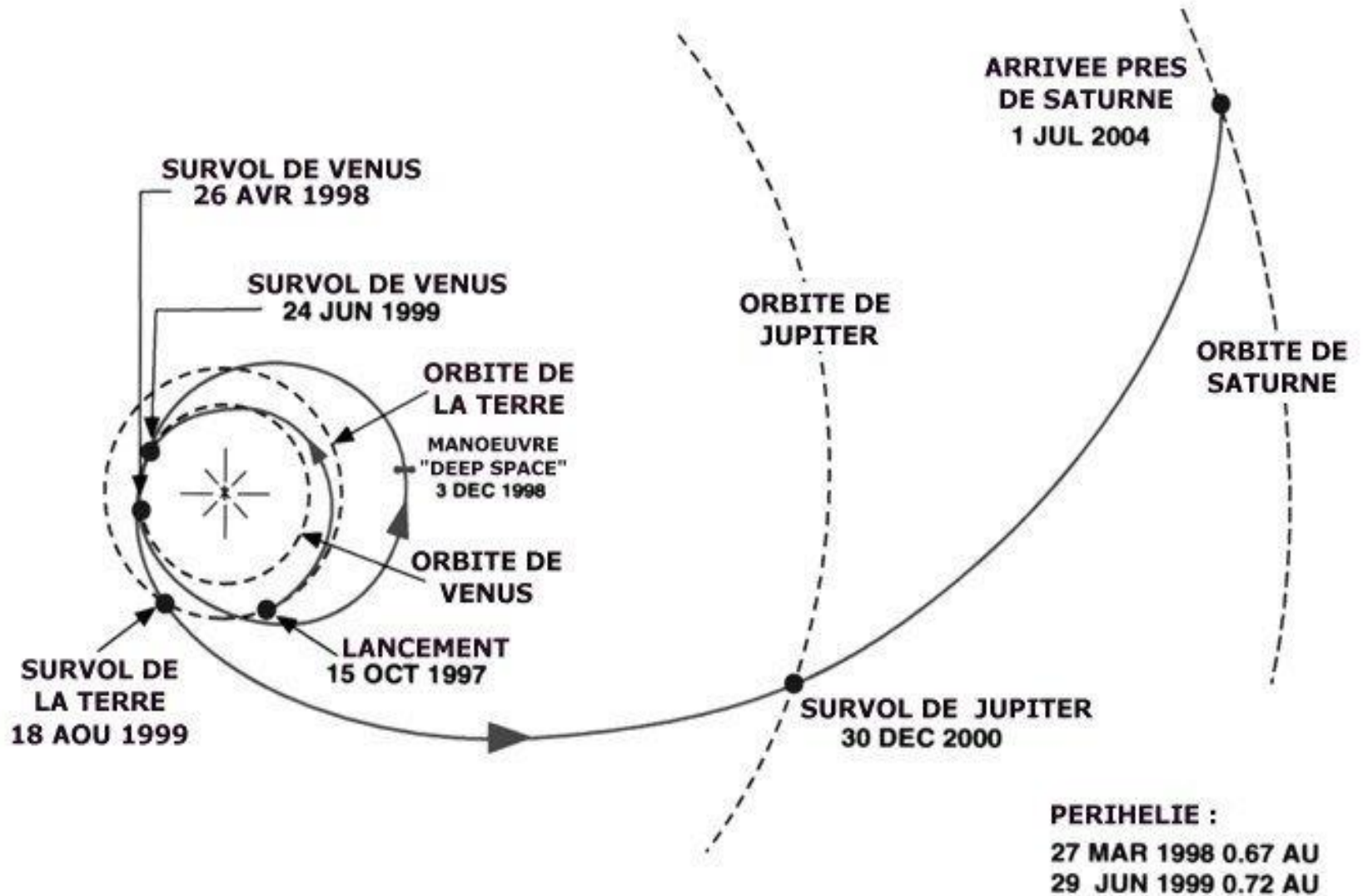
FROM: *Bob Brown, Cassini VIMS Team Leader* 

SUBJECT: *Our first team meeting*

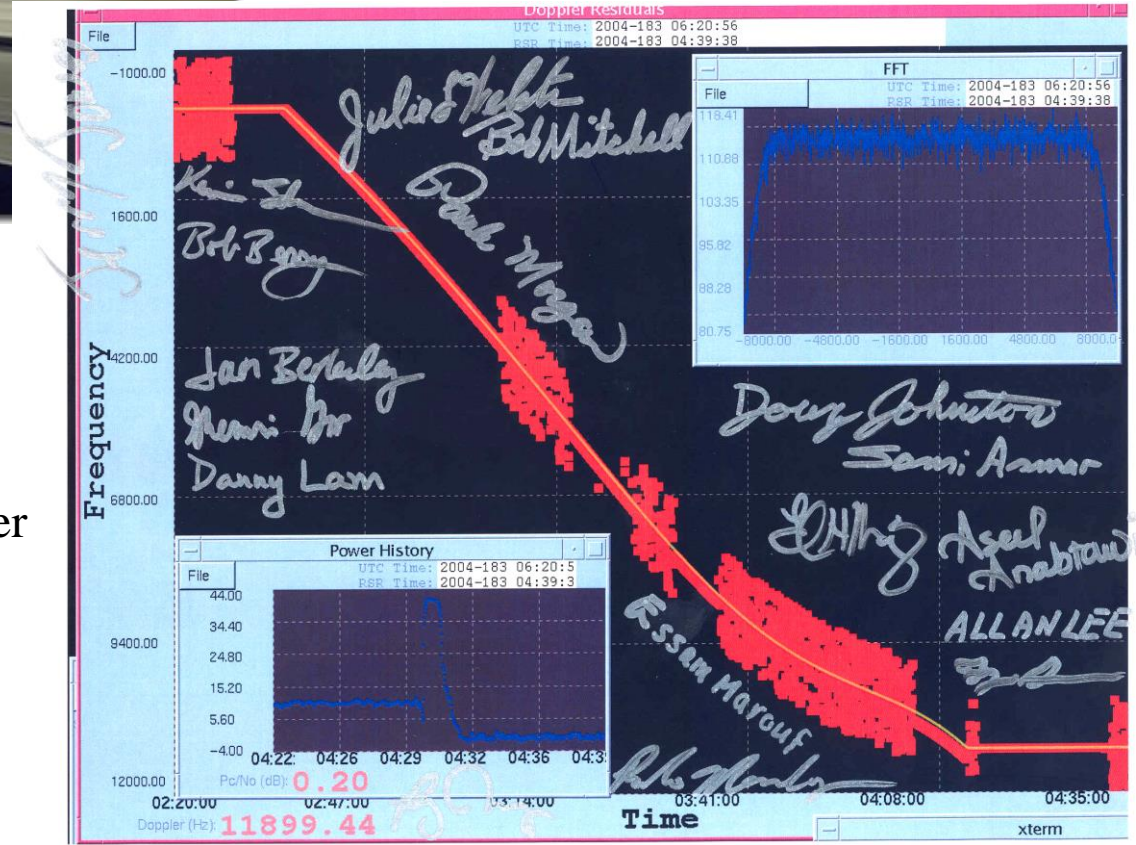
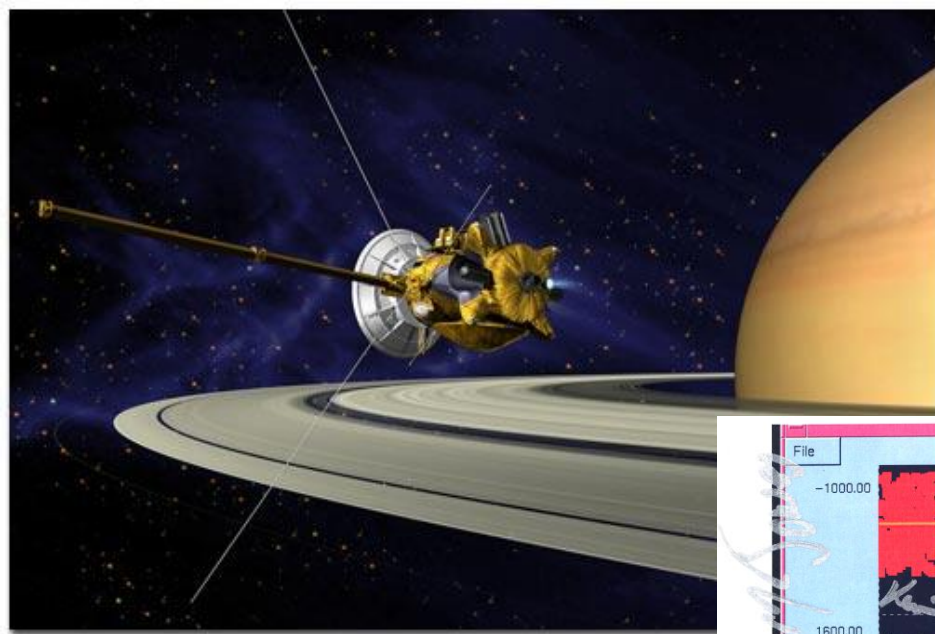
First let me congratulate all of you on being selected a member of the Cassini VIMS Science Team. We have an excellent team and VIMS science stands out as one of the most important contributions to the Cassini mission. As many of you already know, however, the selection of the VIMS instrument on Cassini is tentative and, as it stands now, VIMS will only be officially added to the Cassini payload if there is enough money in the Cassini project budget at the time of confirmation (about 1 year from now). Thus, we have a lot of work ahead of us in the next year to ensure that VIMS is confirmed. In particular, our major task will be to convince the Cassini PSG and other members of the science community that VIMS science is of paramount importance for the Cassini mission. Accordingly, I would like to have a meeting of the team at JPL on December 10, 1990, one day before the first Cassini Project Science Group meeting (on 11 and 12 December). I know that this is very short notice and I apologize for that, especially to our European colleagues. Nevertheless, we have a big task ahead of us and not much time in which to accomplish it. Please let me know by November 21 whether you will be attending. My FAX number is 818-354-0966 and I would appreciate it if you would FAX your reply or call me at 818-354-1799. In the near future I will be sending you an agenda for the meeting and additional information on the meeting time and room. Also, when you reply please include your complete address, phone number(s), FAX number(s) and an electronic mail address. For our European colleagues, please let me know if you would like me to arrange for a hotel room for you. Thank you for your cooperation and I look forward to a long and rewarding collaboration with all of you over the next several years.



# TRAJECTOIRE INTERPLANETAIRE DE CASSINI



# 01/07/2004: Orbit insertion



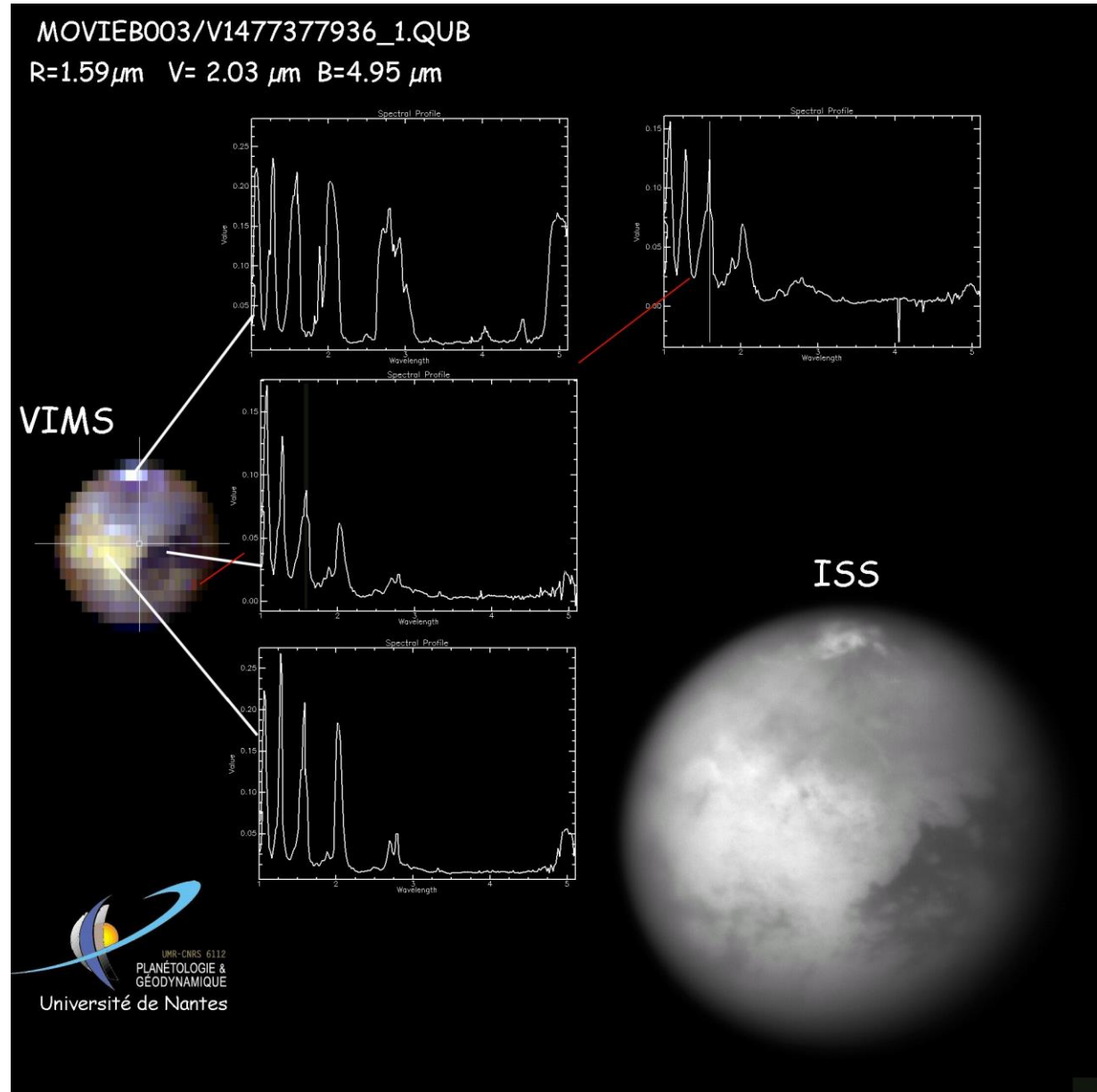
Comparaison entre le signal Doppler (vitesse de la sonde) prédit et le signal observé

# 26 Octobre 2004: Premier survol de Titan (TA)

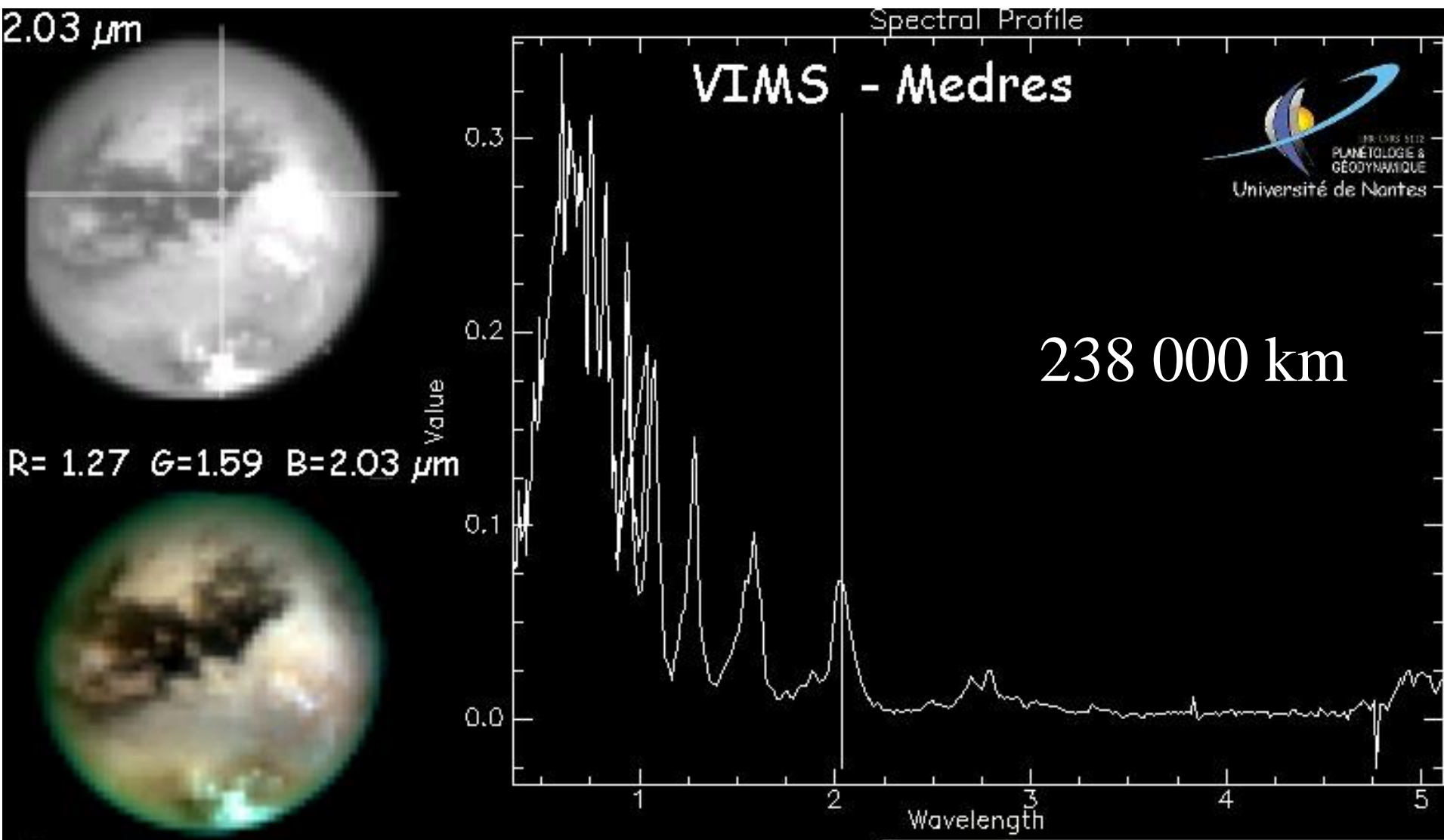


- 700 000 km de Titan
- Vitesse de la sonde 6 km/s
- Partage du temps avec les autres instruments
- Choix des sites pour les images HR

November 15, 2022

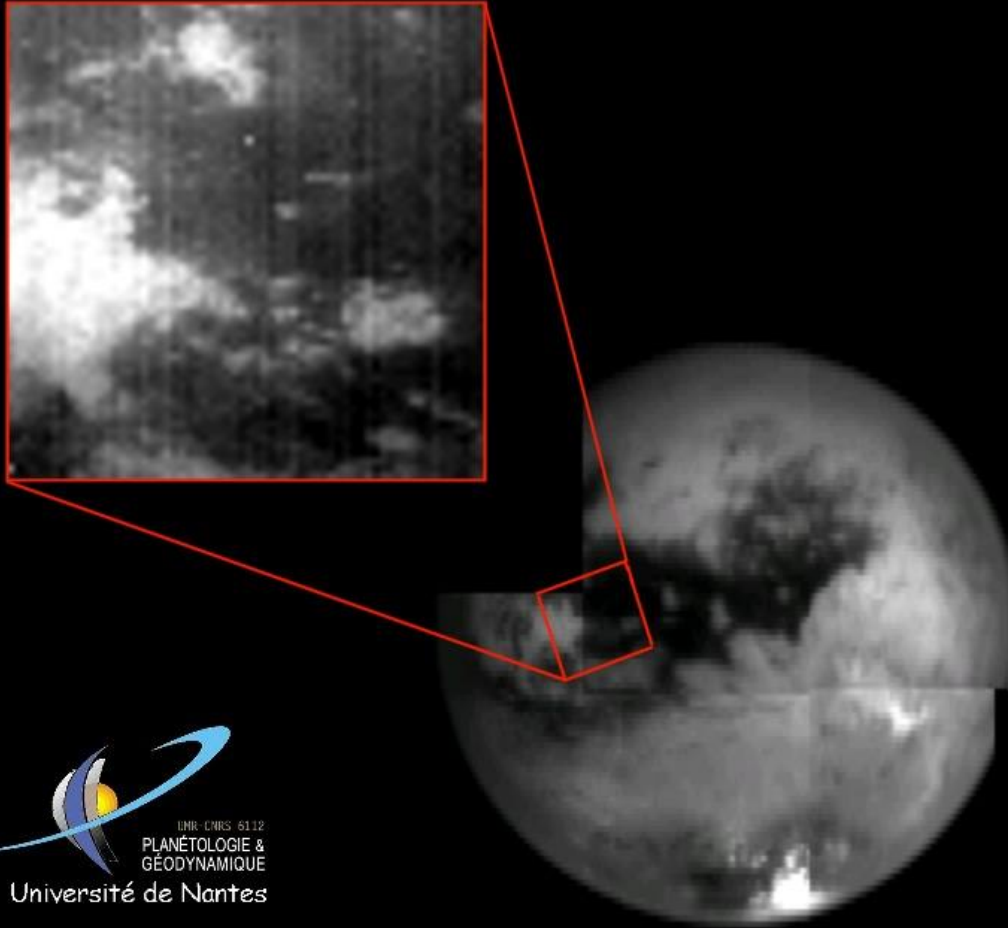


# 26 Octobre 2004: Premier survol de Titan (TA)



# 26 Octobre 2004: Premier survol de Titan (TA)

## Huygens landing site

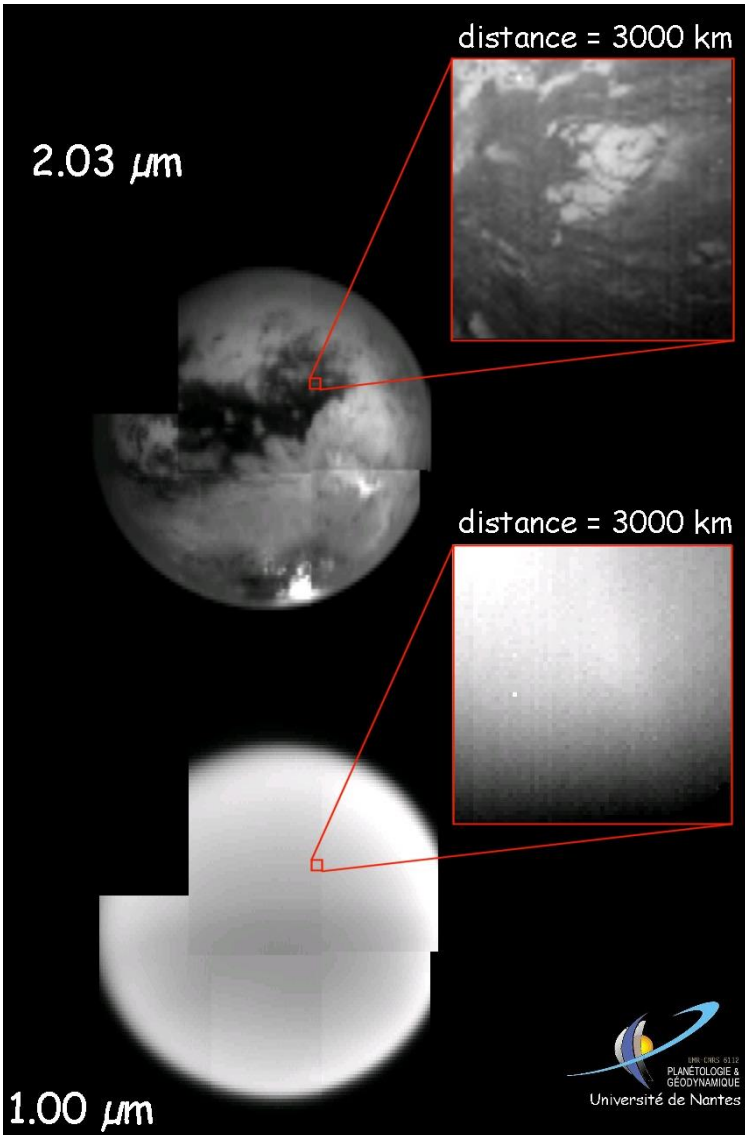


32 000 km

Première  
observation du site  
d'atterrissage de  
Huygens



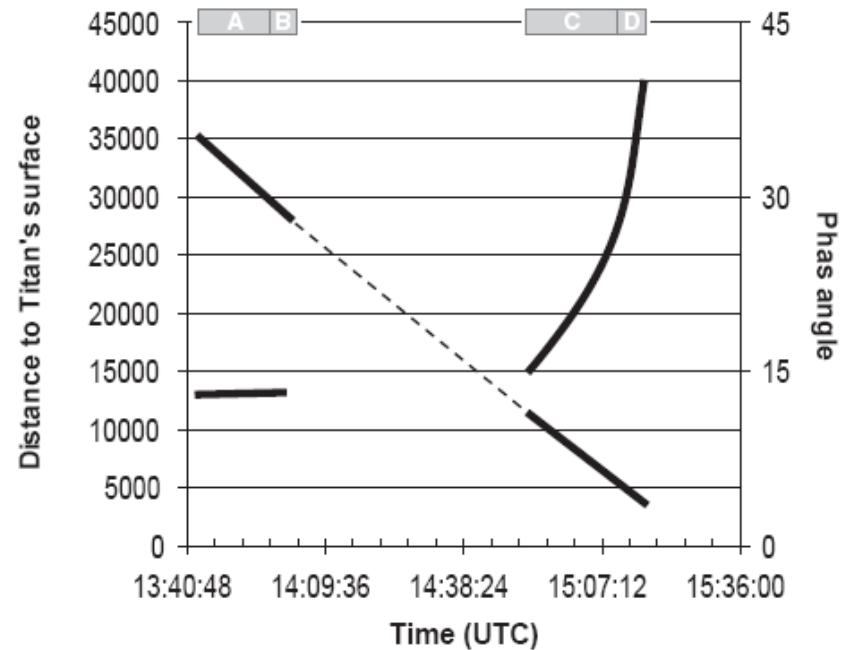
# 26 Octobre 2004: Premier survol de Titan (TA)



November 15, 2022

Tortola facula (aka the snail)

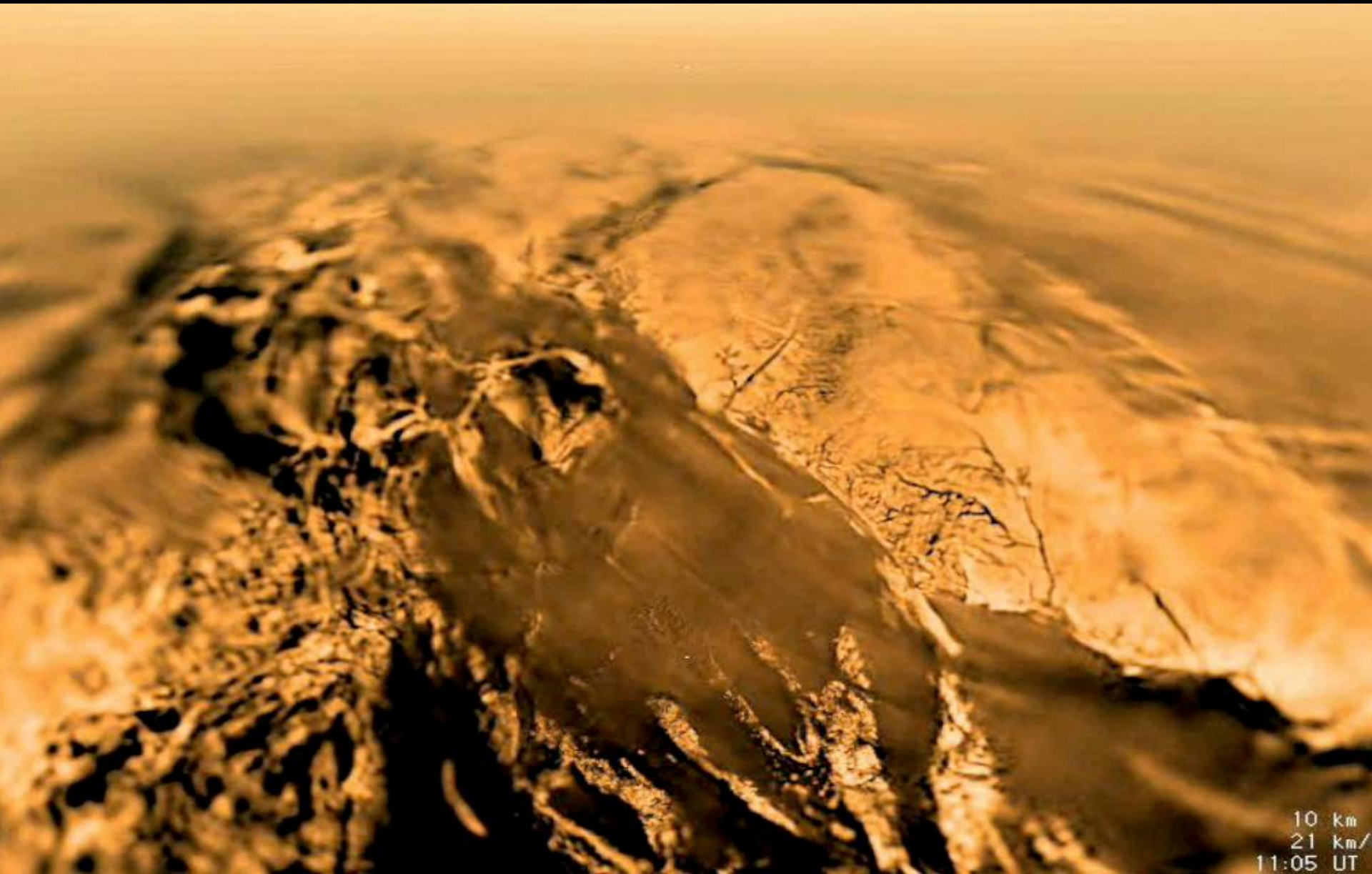
- Nuage ?
- Transport (dune, bancs de glace,..)
- Cratère
- Dôme
- cryo volcan ?



Cassini - Genève

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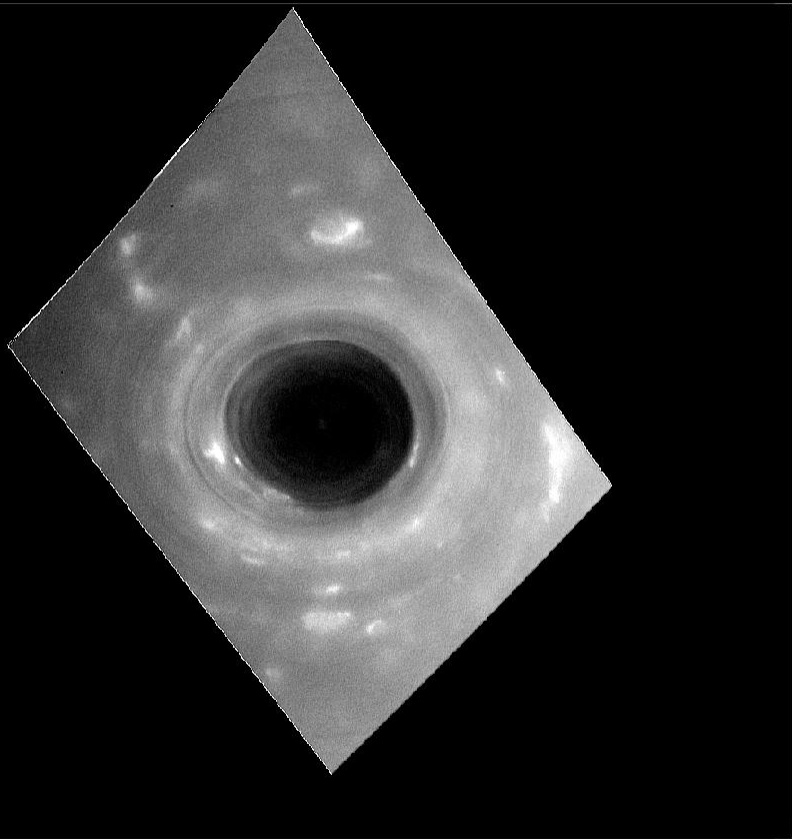
# 15 Janvier 2005: Atterrissage de la sonde Huygens



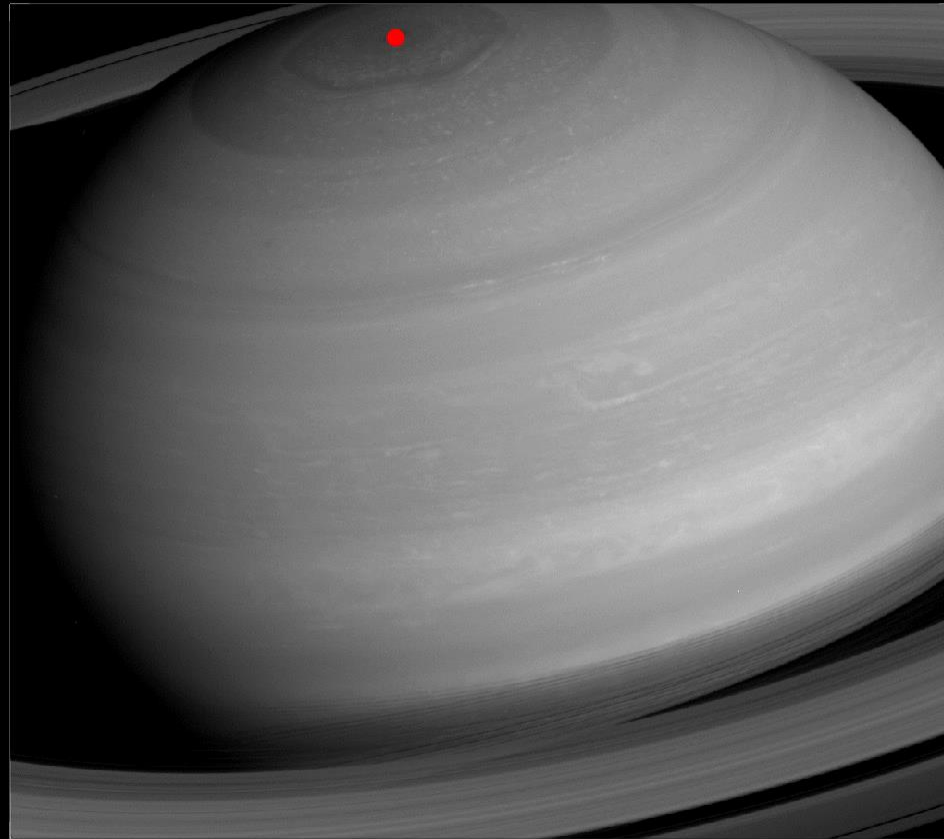
10 km  
21 km/  
11:05 UT

# Saturn Noodle

Camera View



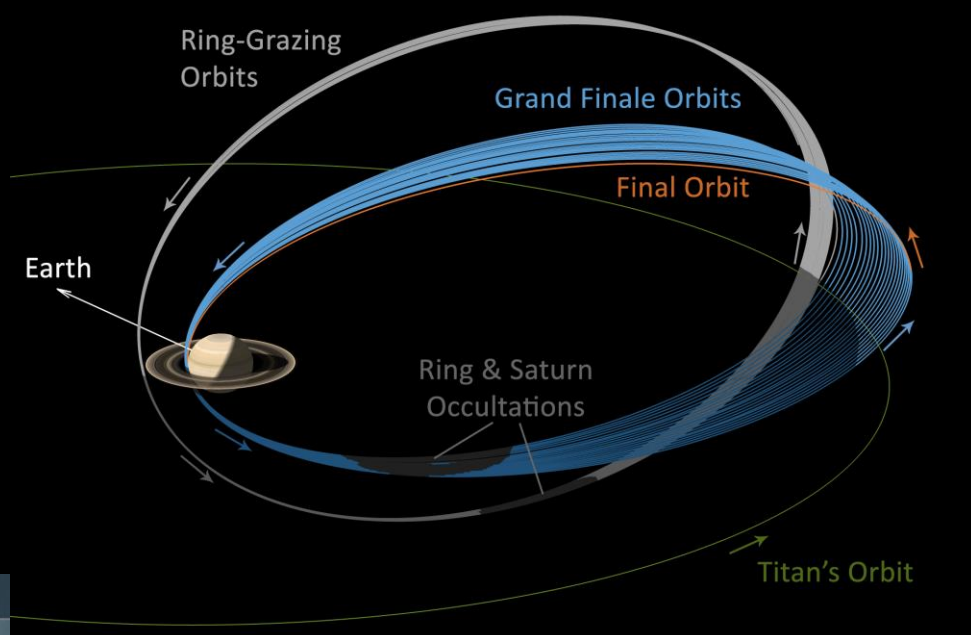
Reference View



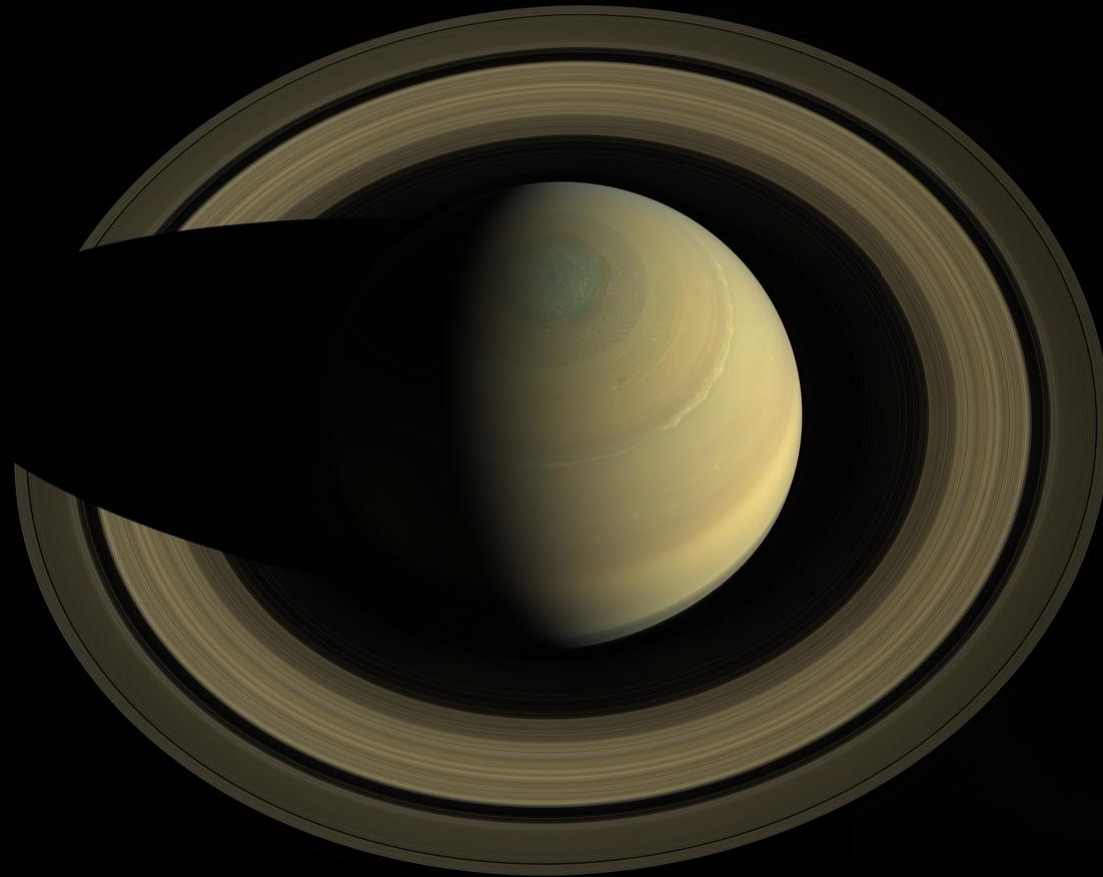
Smallest features in atmosphere changed from 8.7 kilometers to 810 meters per pixel

Movie by Kunio Sayanagi and colleagues

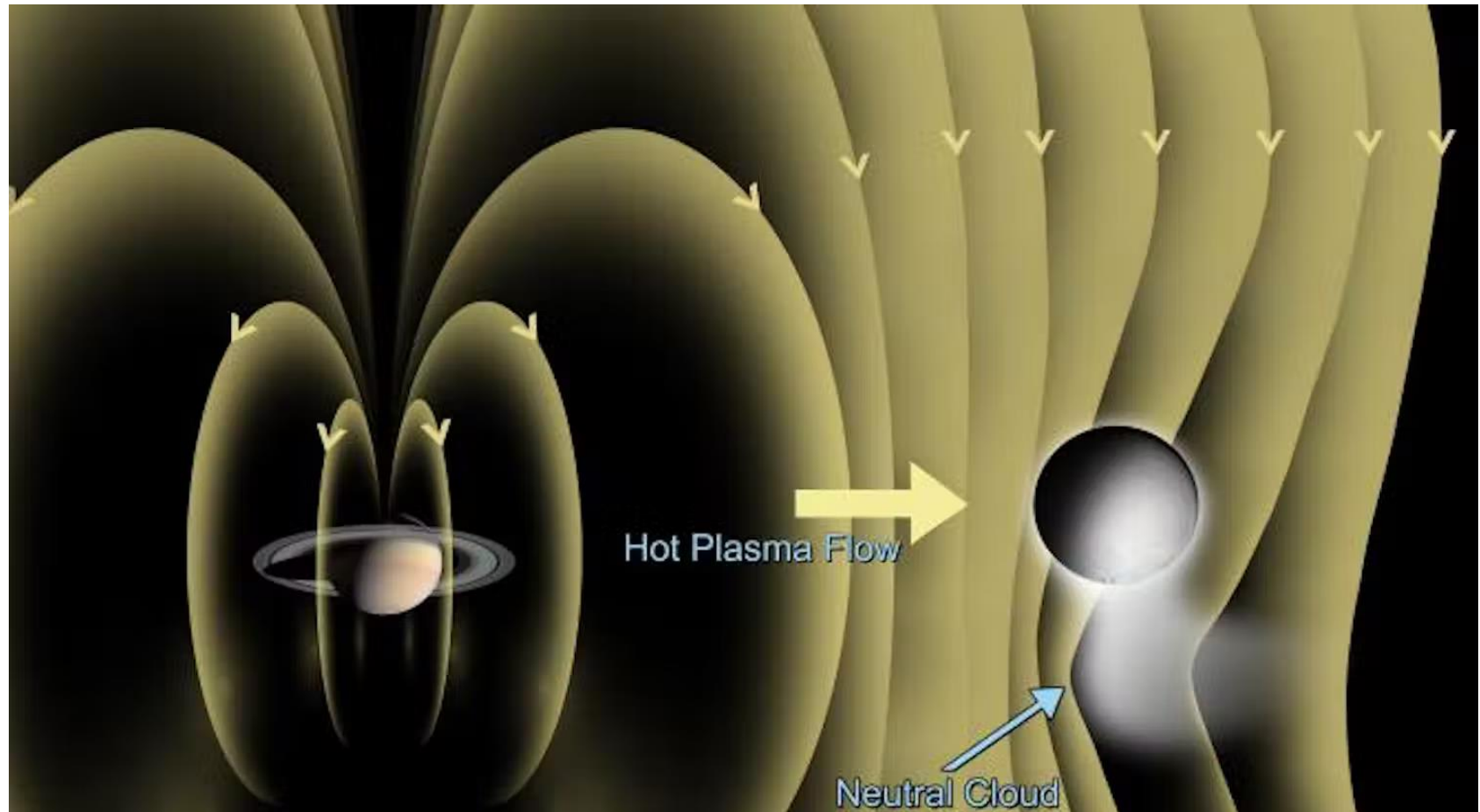
# 15 Septembre 2017: End of mission



# Résultats scientifiques

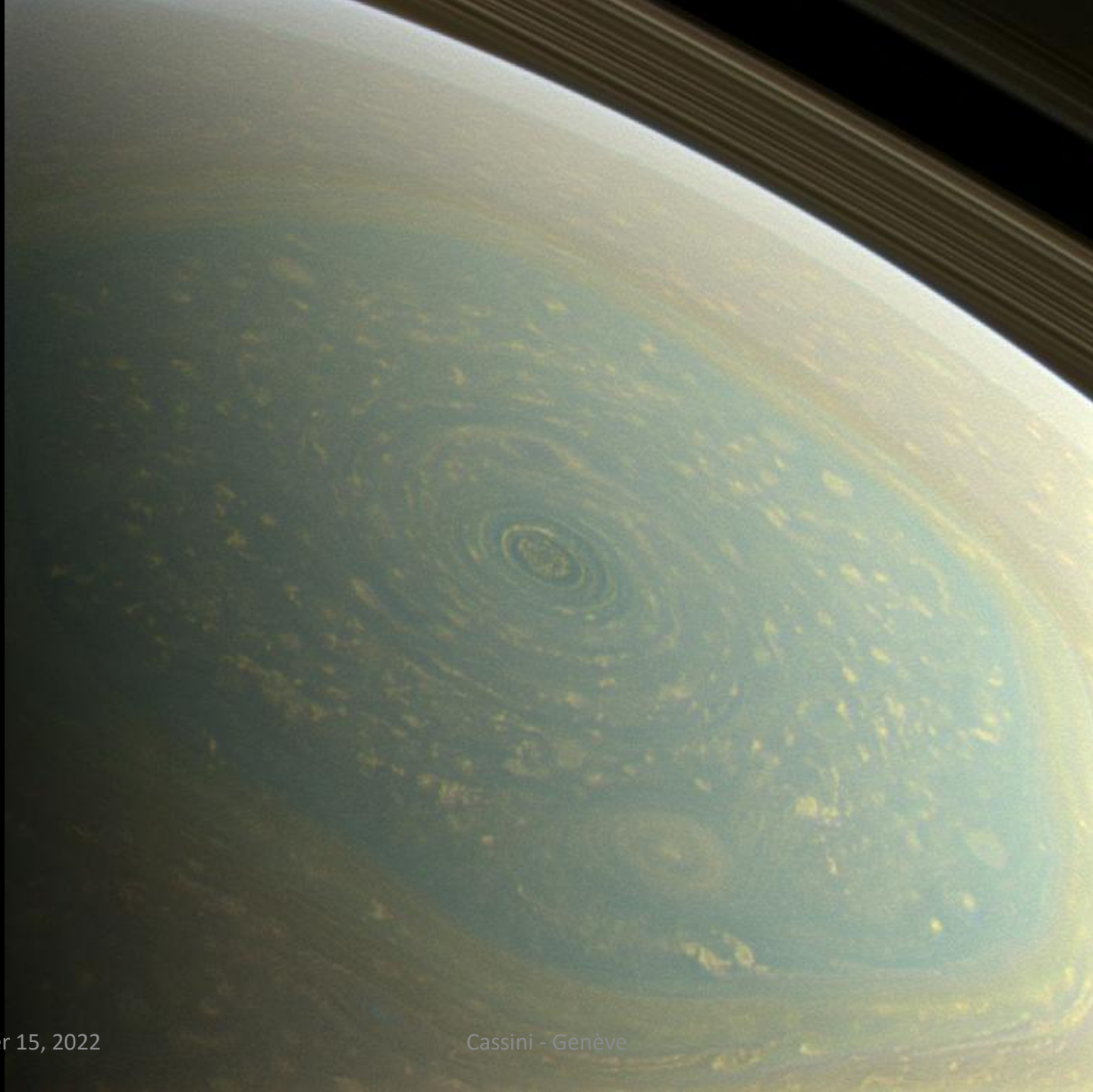


# Le champ magnétique de Saturne



2005: First flyby close to Enceladus is 1000 km, unusual comet-like magnetic field signature detected, Third flyby altitude decreased to 175 km (Dougherty et al 2006)

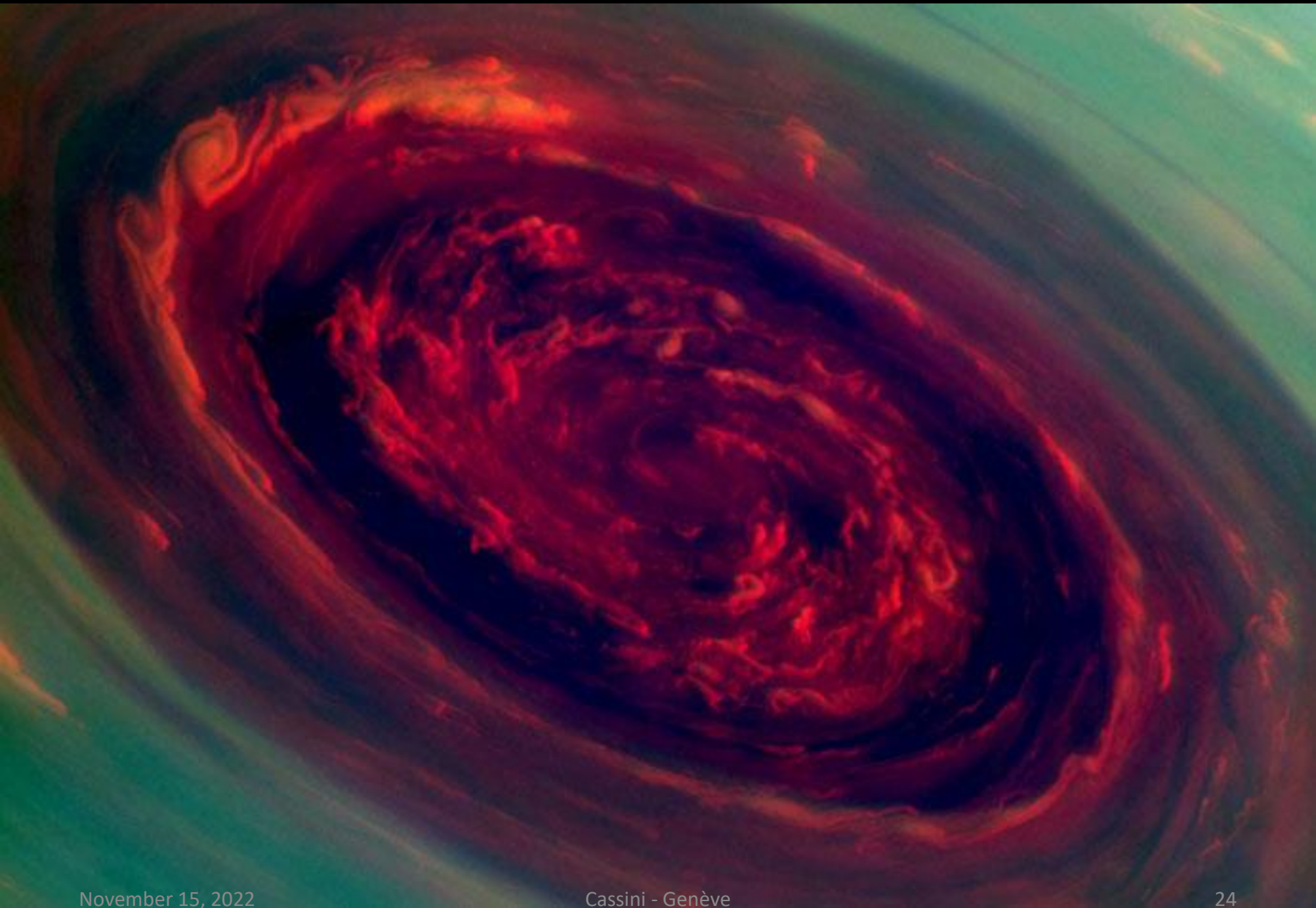
2017: Magnetic field is aligned with spin axis



November 15, 2022

Cassini - Genève

23

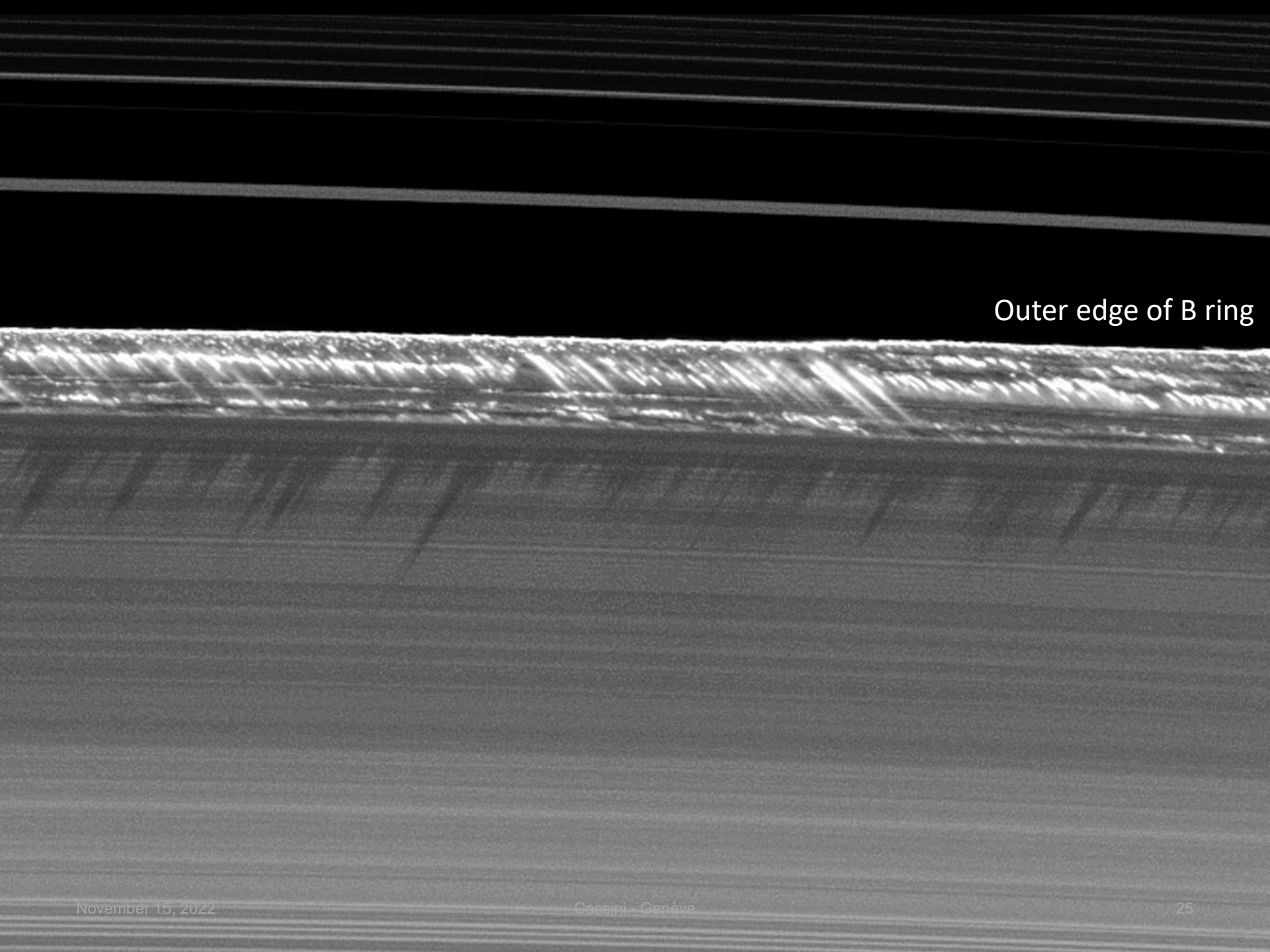


November 15, 2022

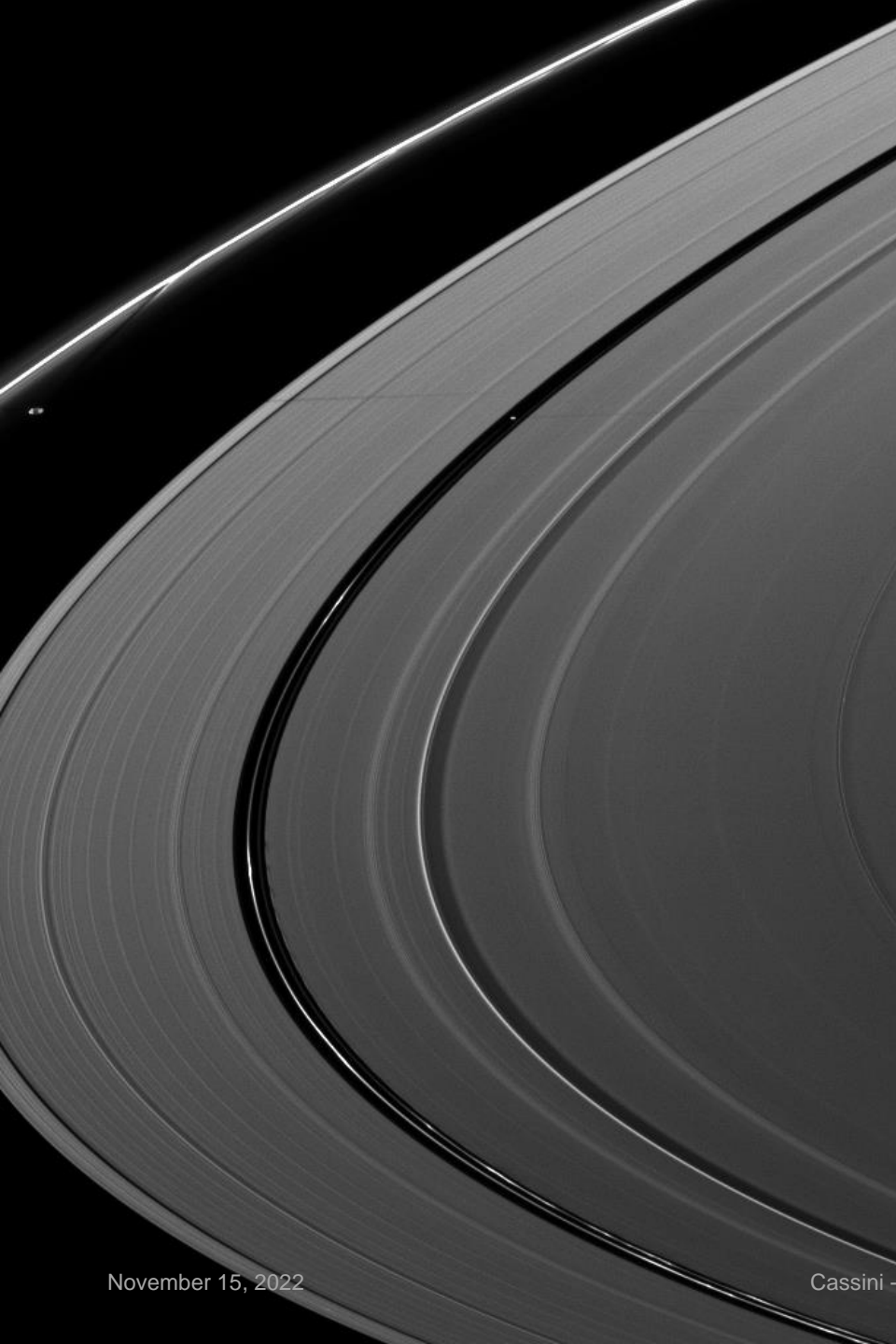
Cassini - Genève

24

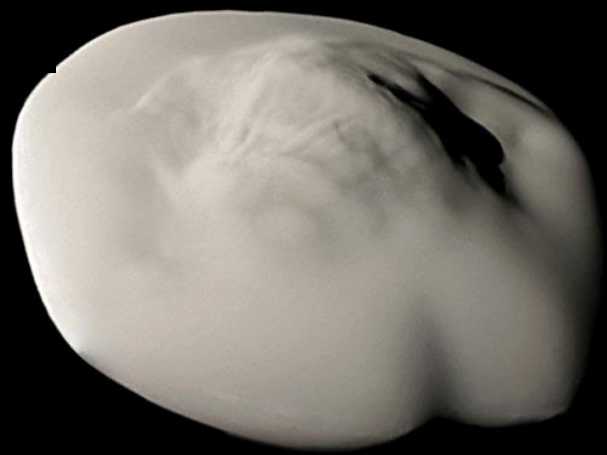




Outer edge of B ring



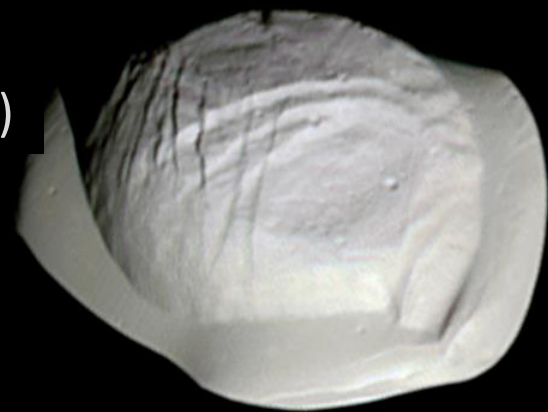
Atlas



Daphnis  
(Keeler)

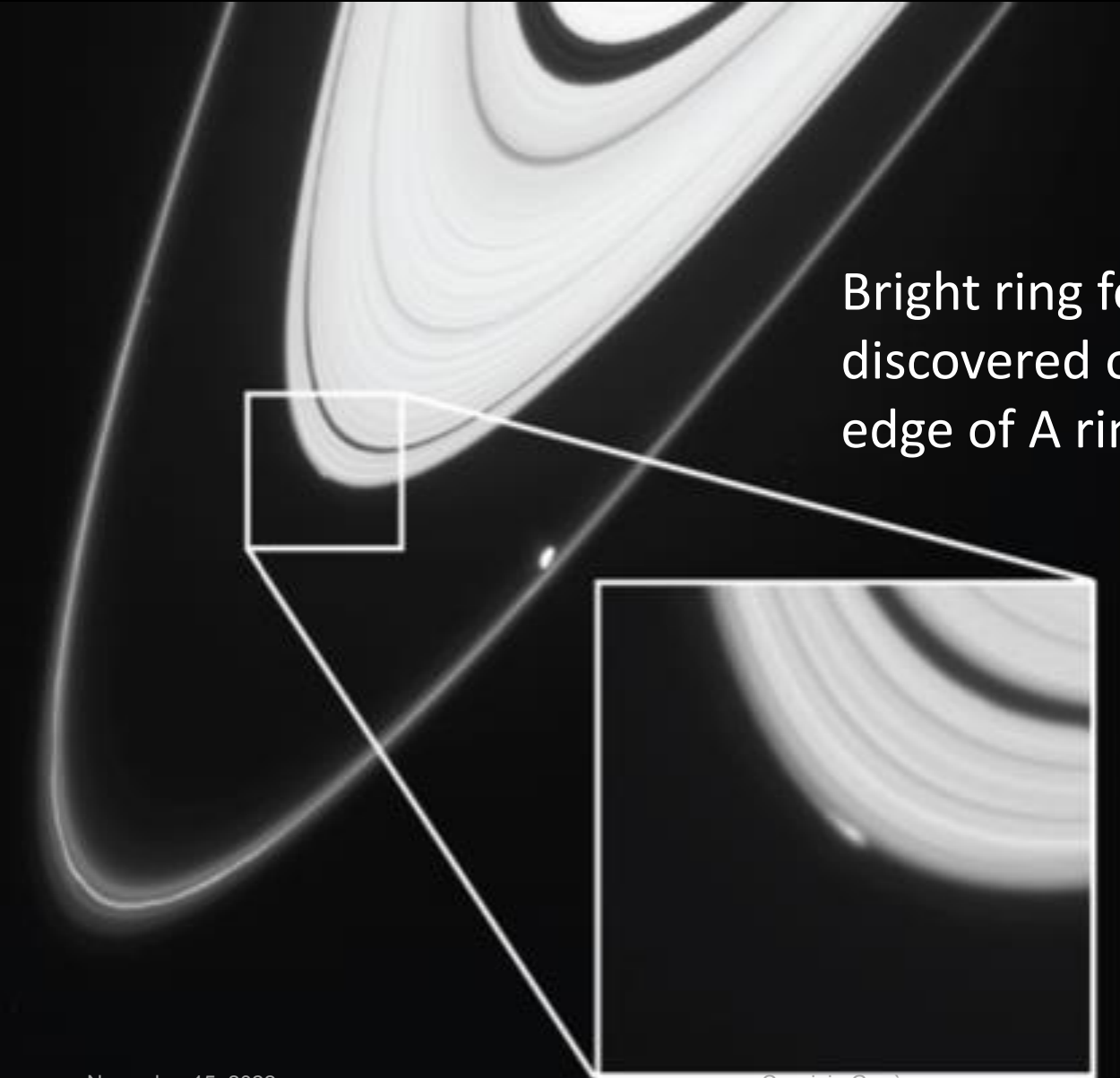


Pan  
(Encke)



10km  
26

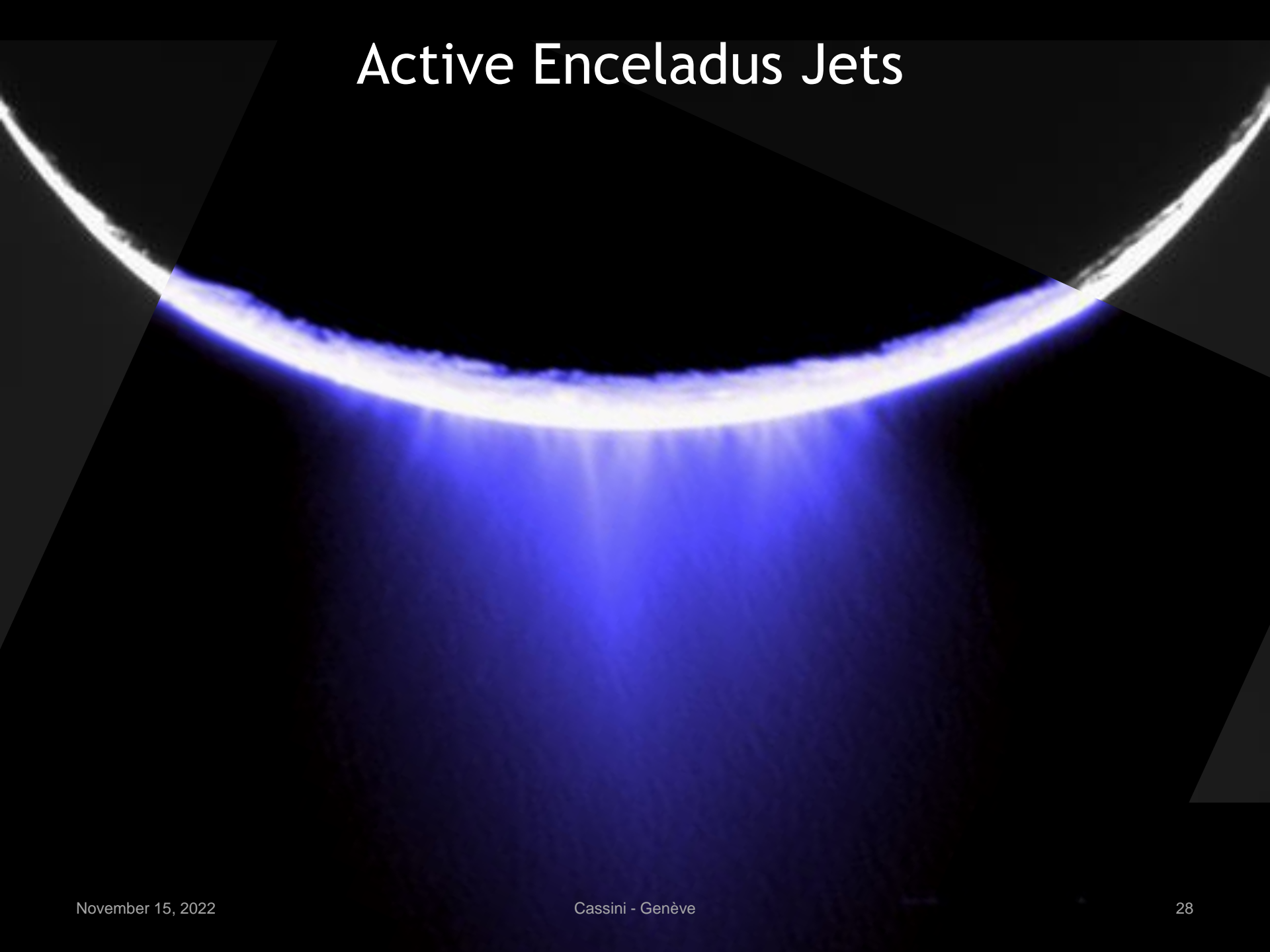
# *A New Moon is Born???*

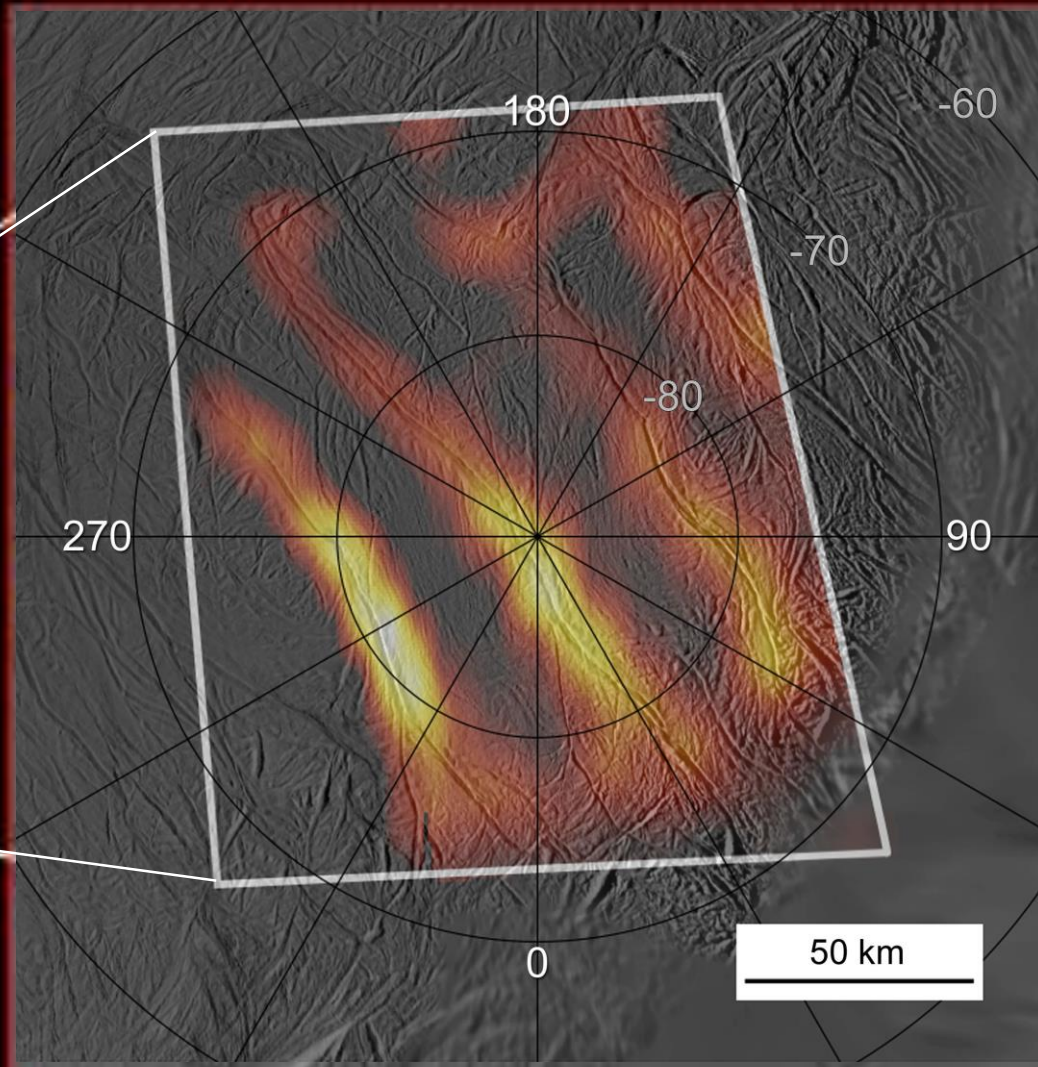
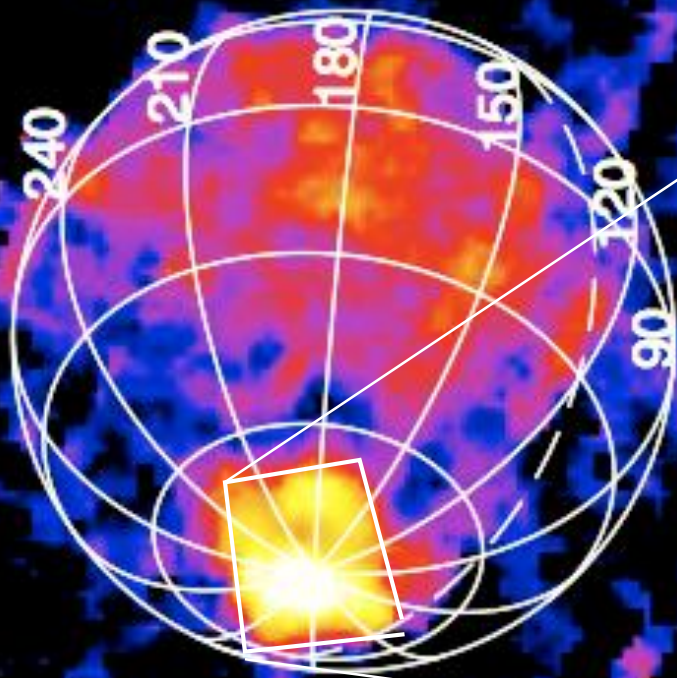


Bright ring feature  
discovered on outer  
edge of A ring

Appears to be  
associated with birth  
of small, icy infant  
moon nicknamed  
Peggy

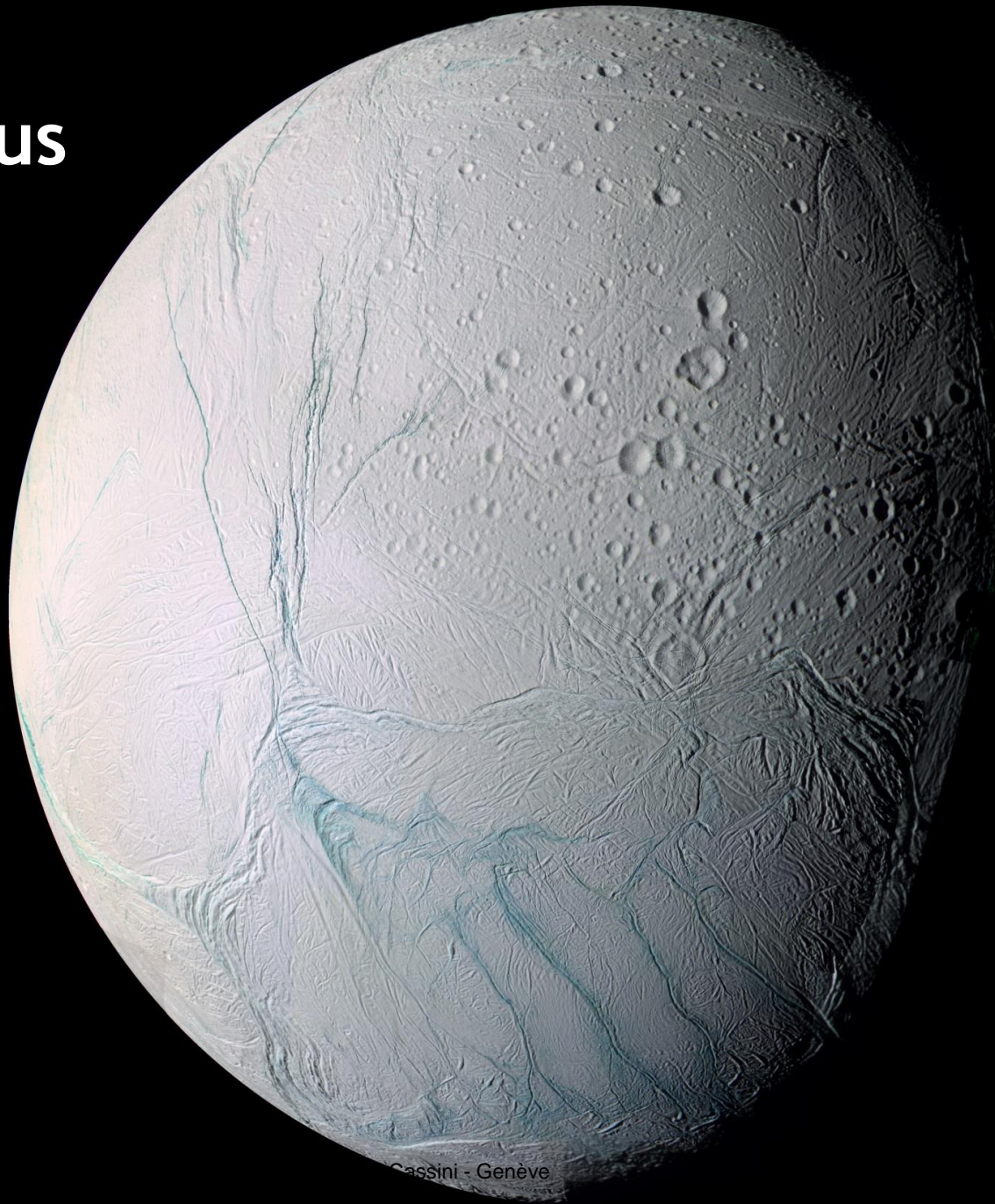
# Active Enceladus Jets



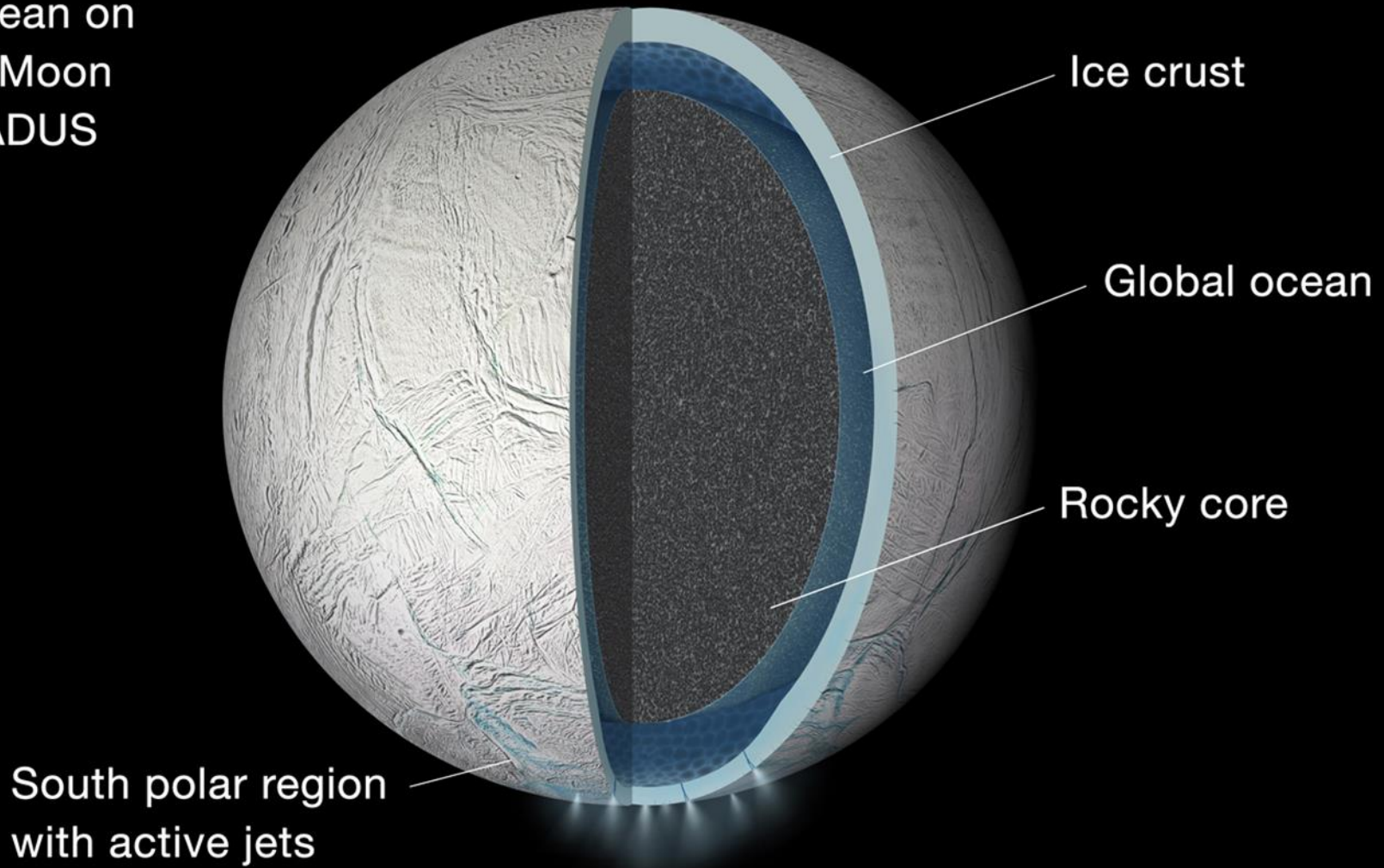


- Excess heat at south pole
- Coming from tiger stripes (Spencer et al., 2006)

# Enceladus



Global Ocean on  
Saturn's Moon  
ENCELADUS



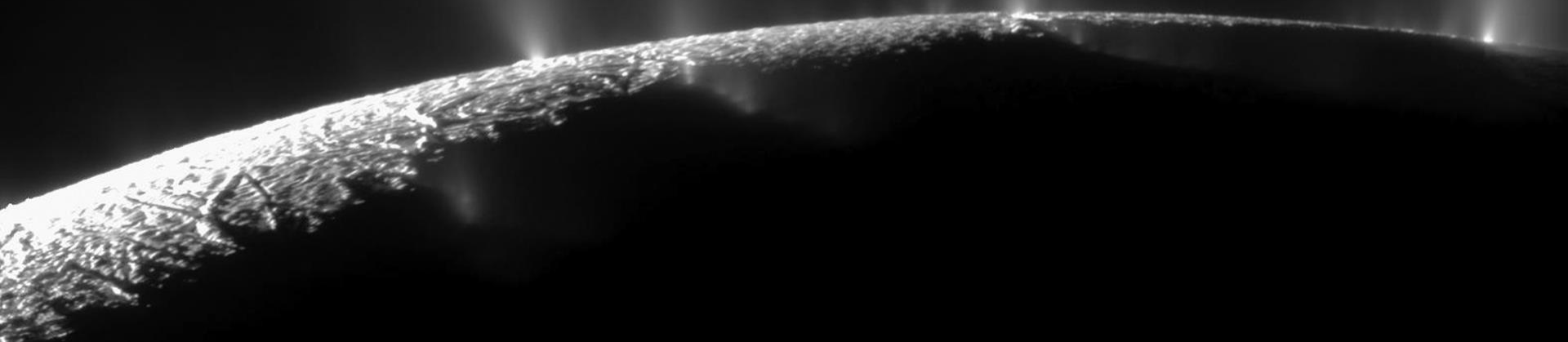
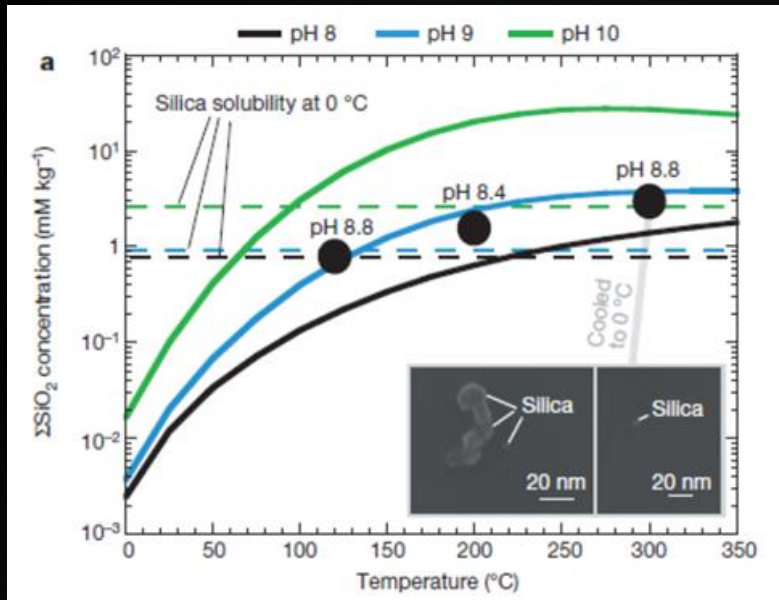
Ice crust

Global ocean

Rocky core

South polar region  
with active jets

# Frozen Seawater in Icy Grains



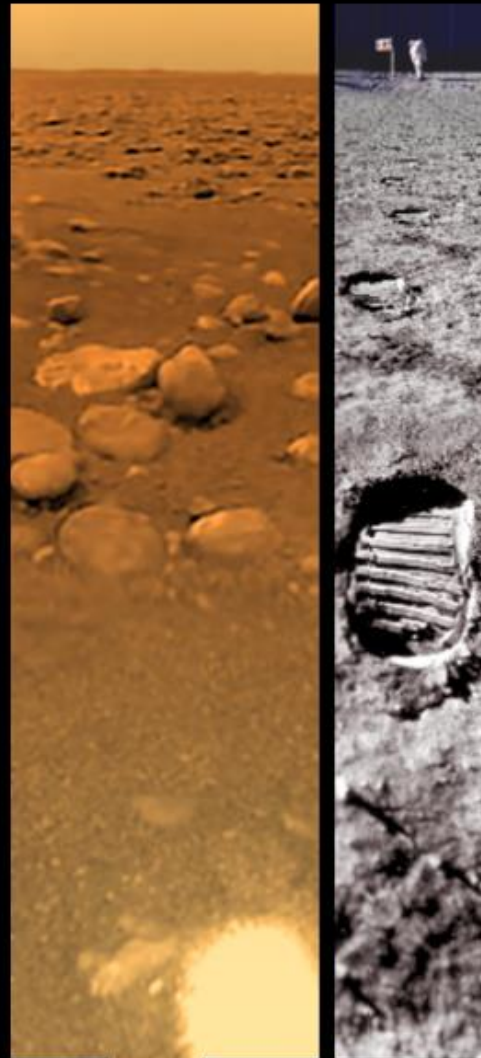
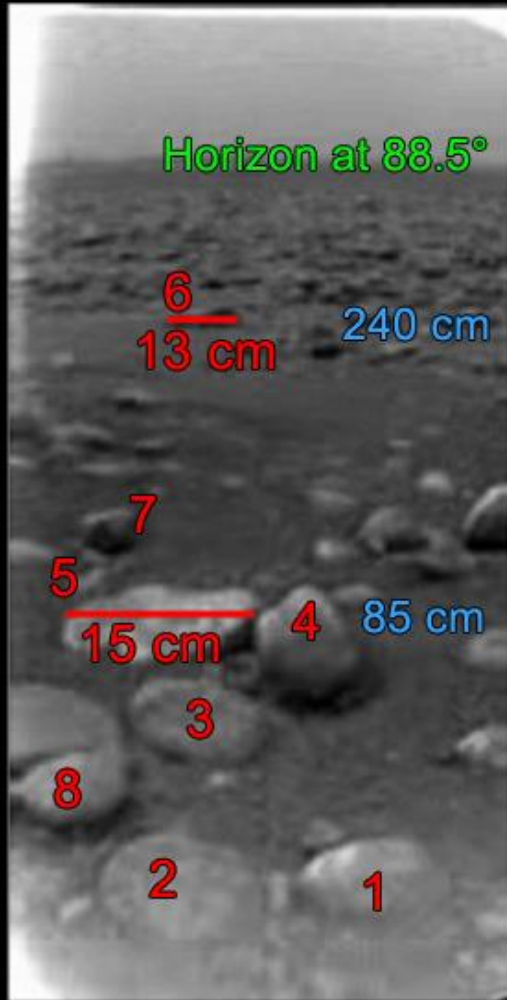




# Iapetus' equatorial mountain

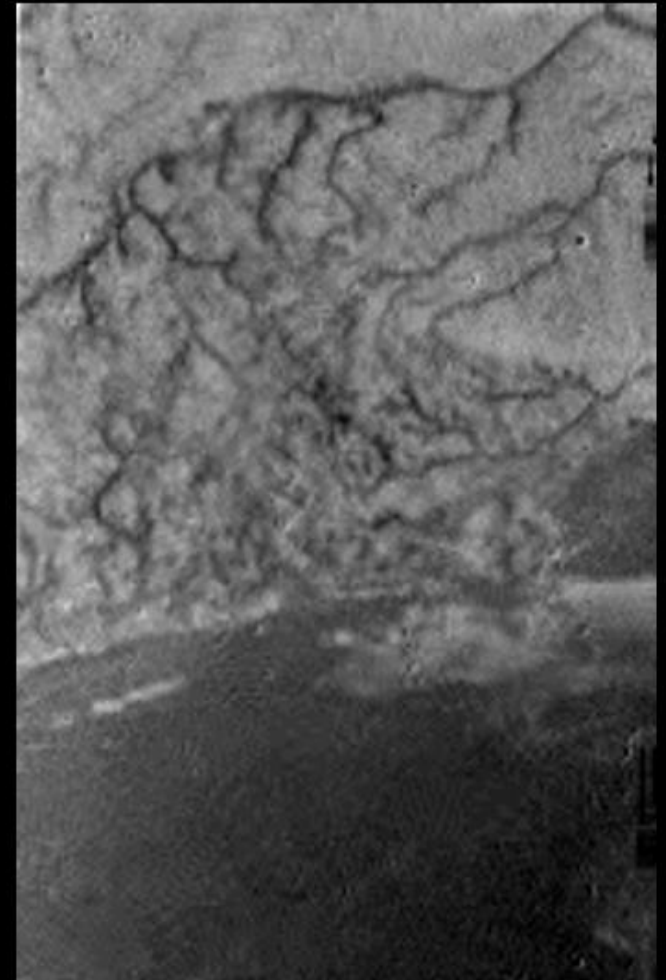
**~2000 km mountains chain!  
Ridges over 20 km high**

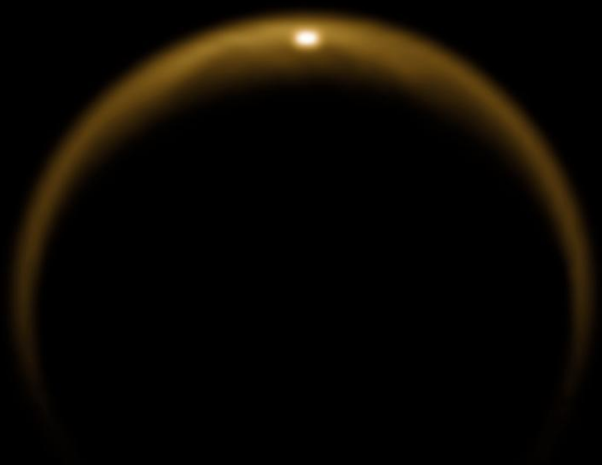
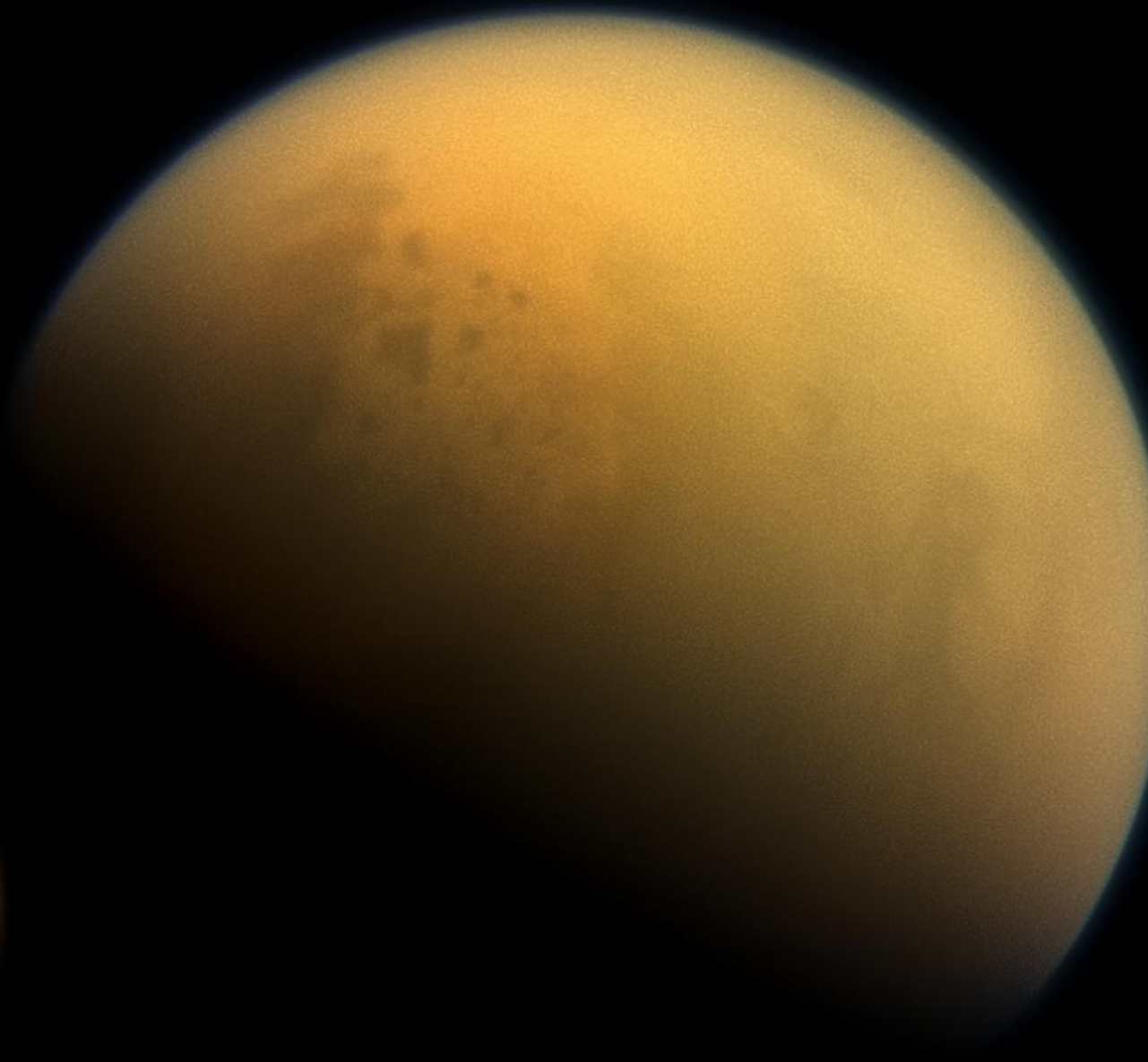
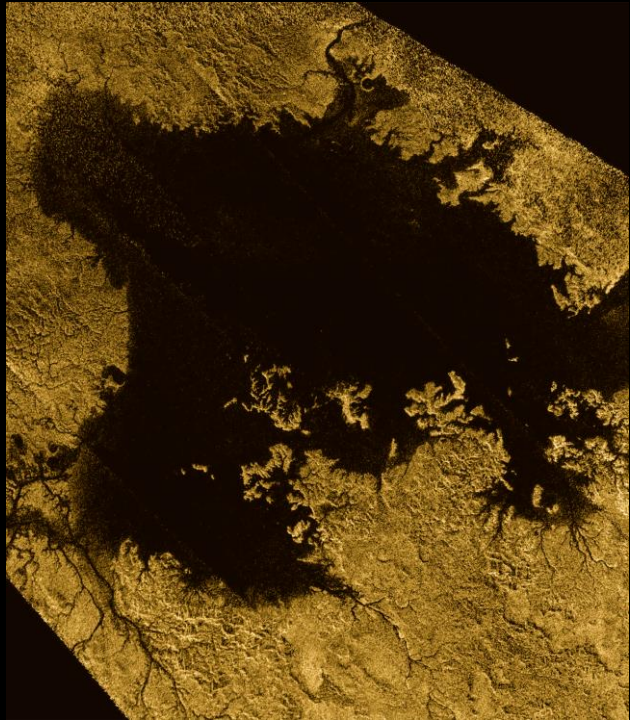
# Huygens Images



Titan

Moon at  
Similar  
Scale



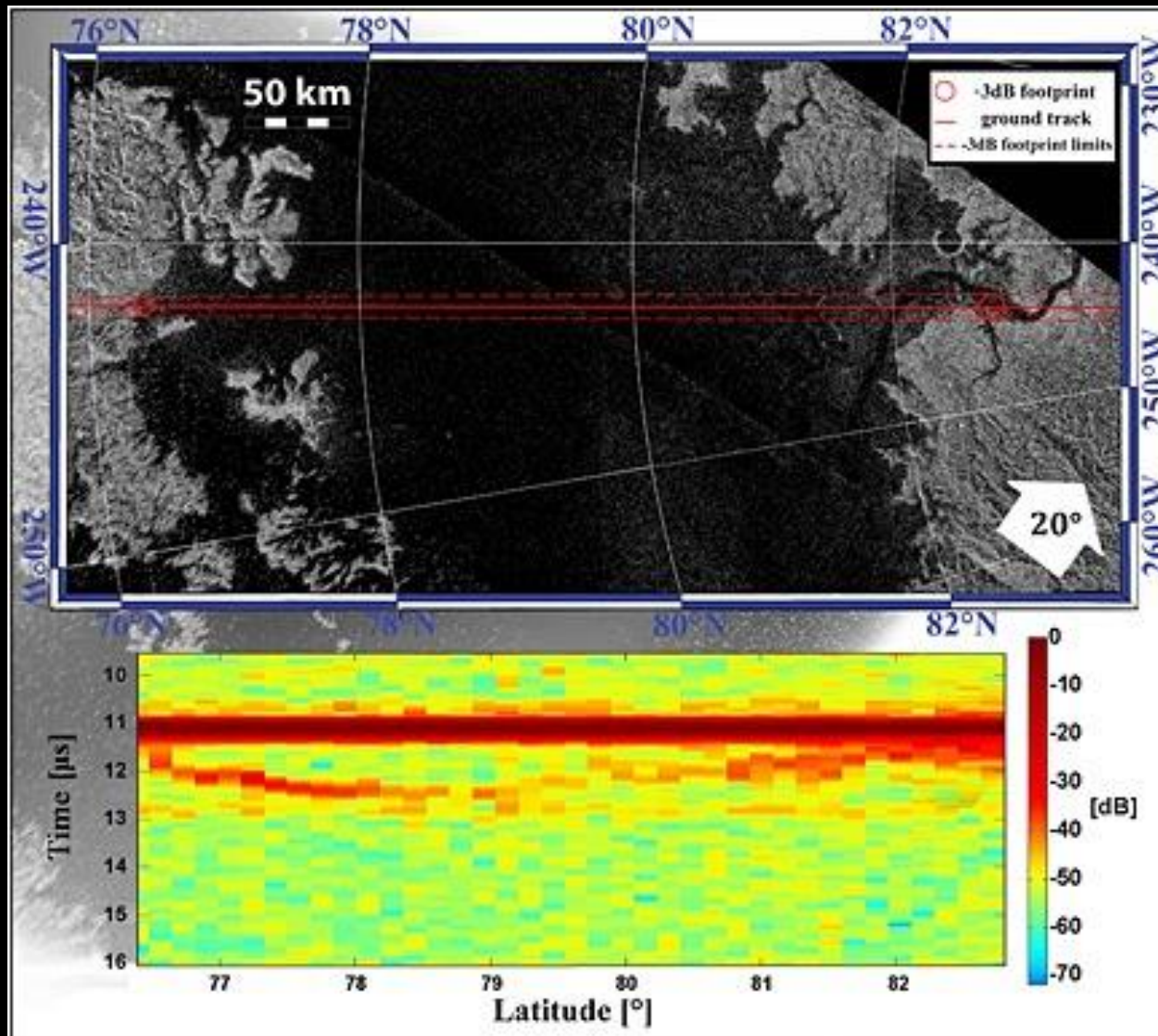


November 15, 2022

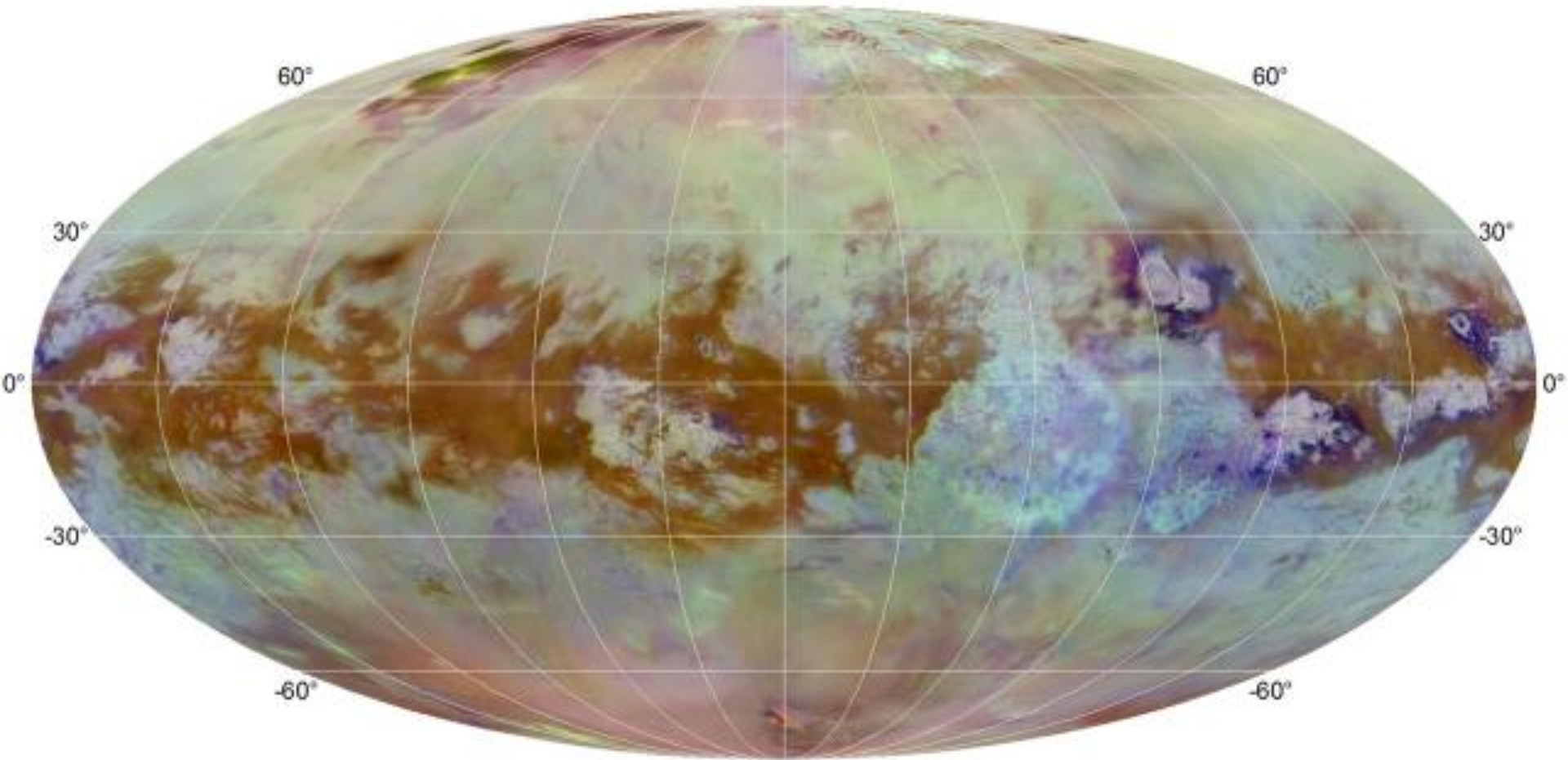
Cassini - Genève

35

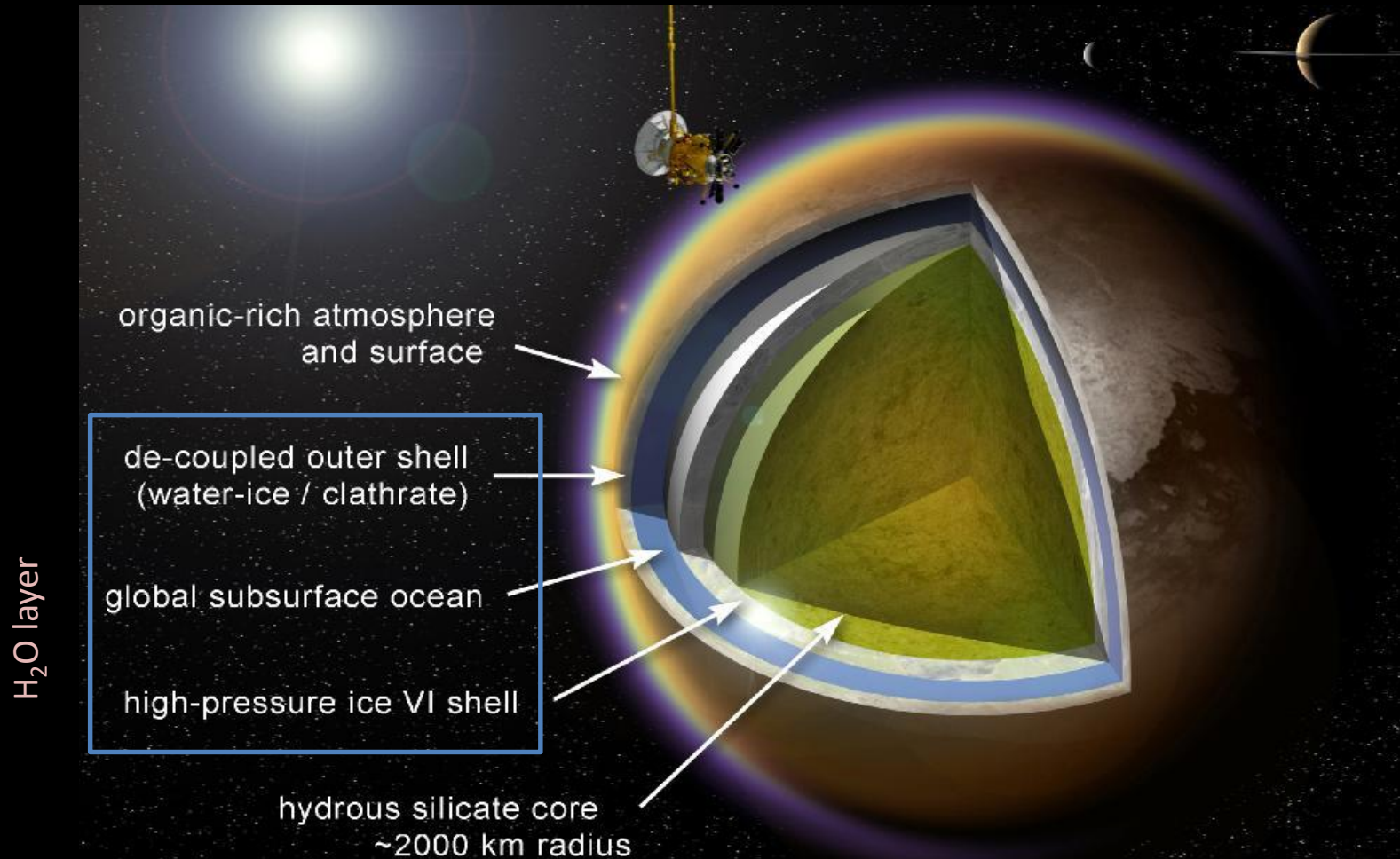
# Depth and composition of the hydrocarbon seas



# Géologie de Titan



# Structure interne de Titan déduite des observations



La mission Cassini-Huygens a été une épopée scientifique internationale remarquable

La suite de l'exploration s'oriente vers l'habitabilité des mondes océan

- **JUICE (ESA): lancement en 2023**
- **Europa Clipper (NASA): lancement en 2024**
- **Dragonfly (NASA): lancement en 2027**
- **US Decadal Survey 2023-2033: Uranus orbiter & probe – Enceladus orbilander**
- **ESA Voyage 2050: Large mission to explore an icy moon**

# Dragonfly (NASA New Frontiers program)



**Direct investigation of  
prebiotic chemistry and  
habitability**