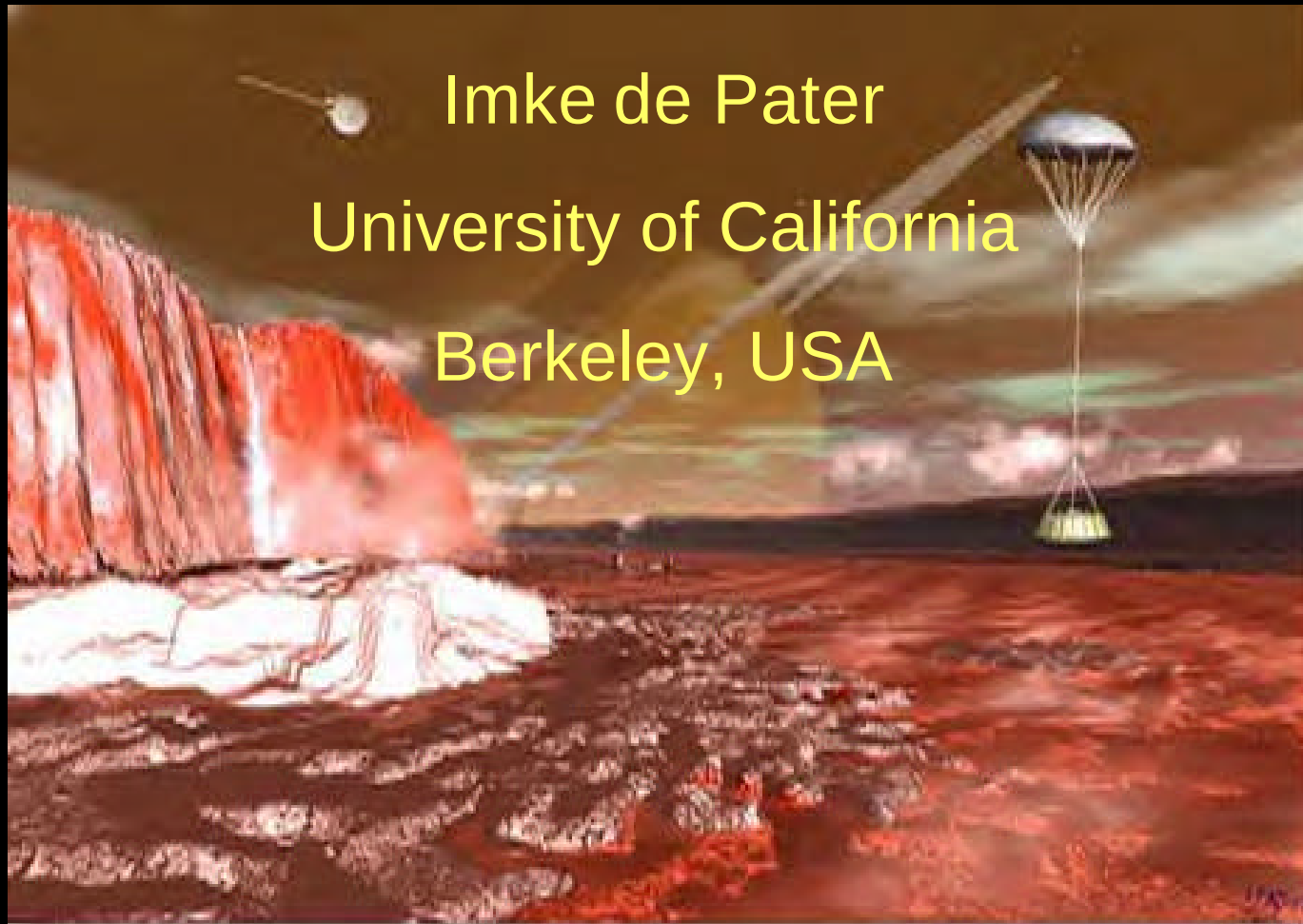
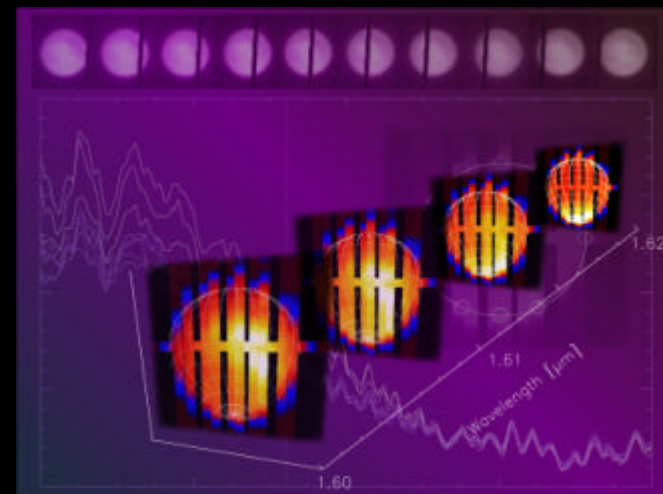
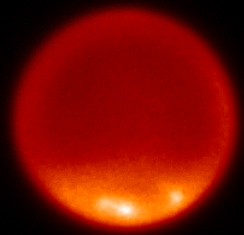
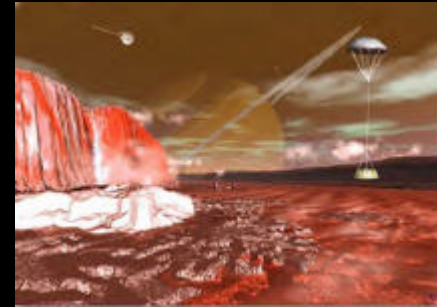


Titan: Saturnus' mysterieuze maan nog steeds in nevelen gehuld?

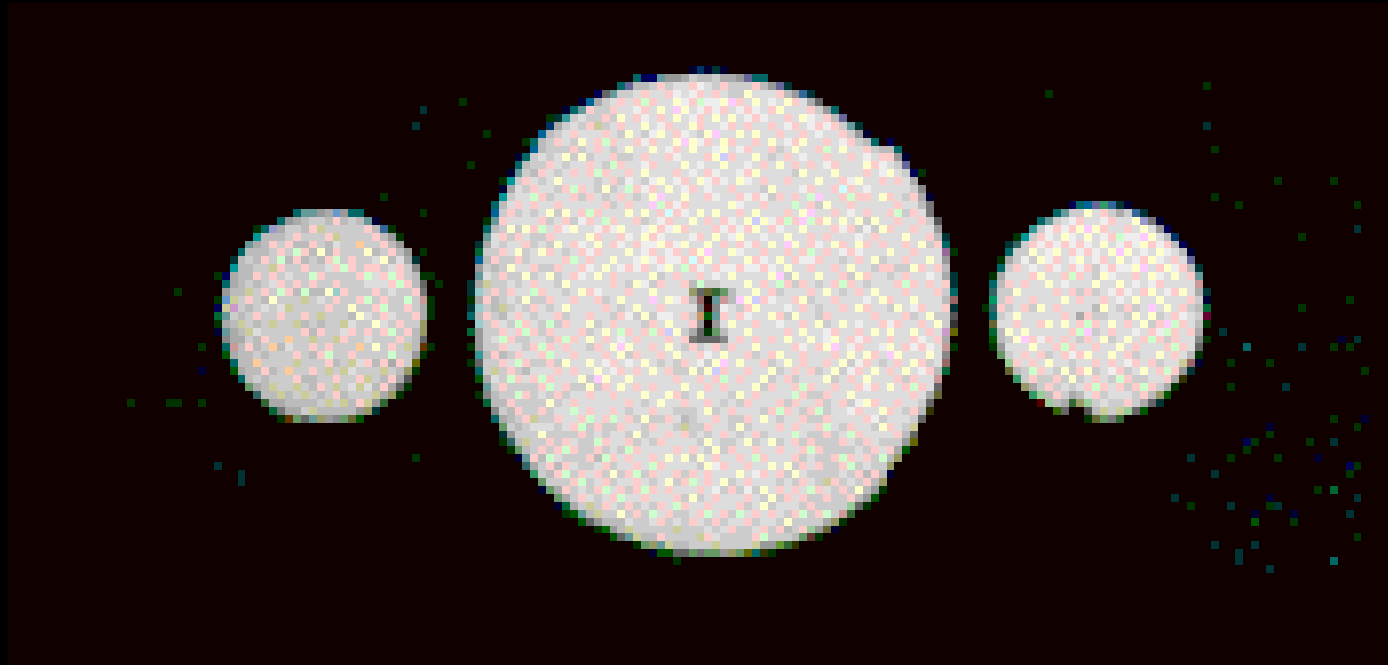


Overzicht van het praatje:

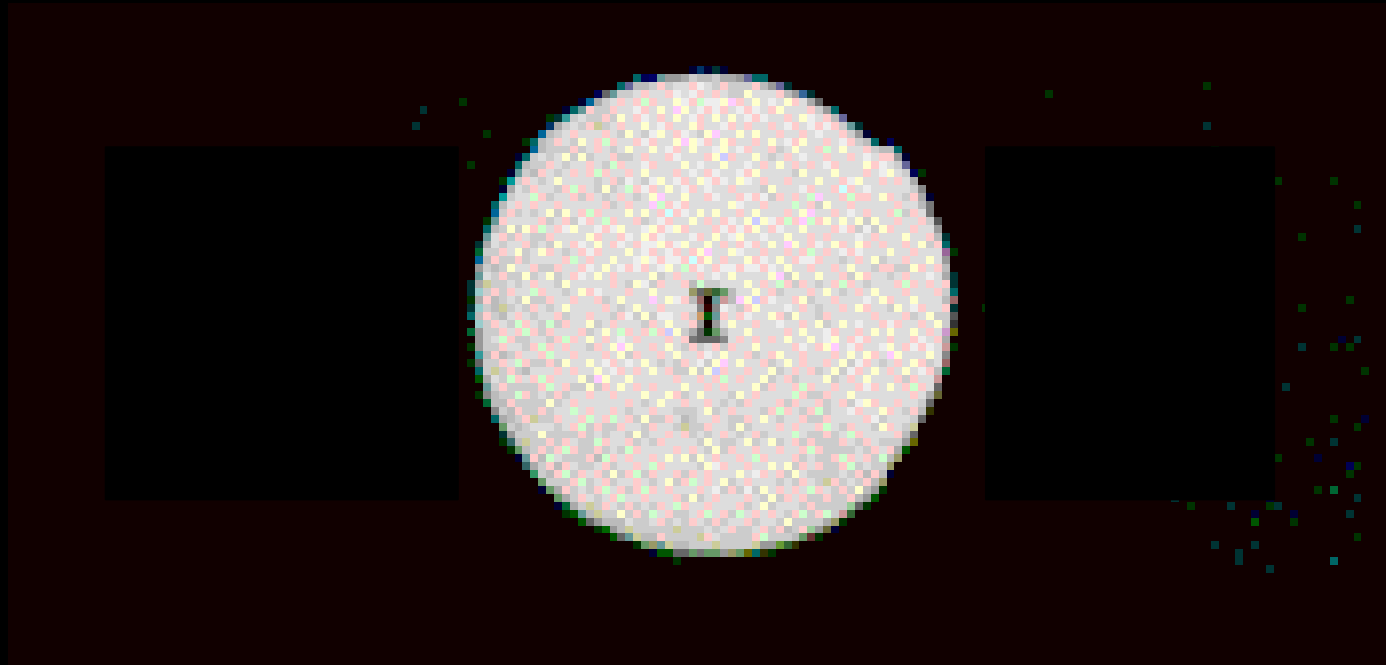
- Geschiedenis
- Oppervlak
- Wolken
- Vlieg-vlucht door Titan's atmosfeer



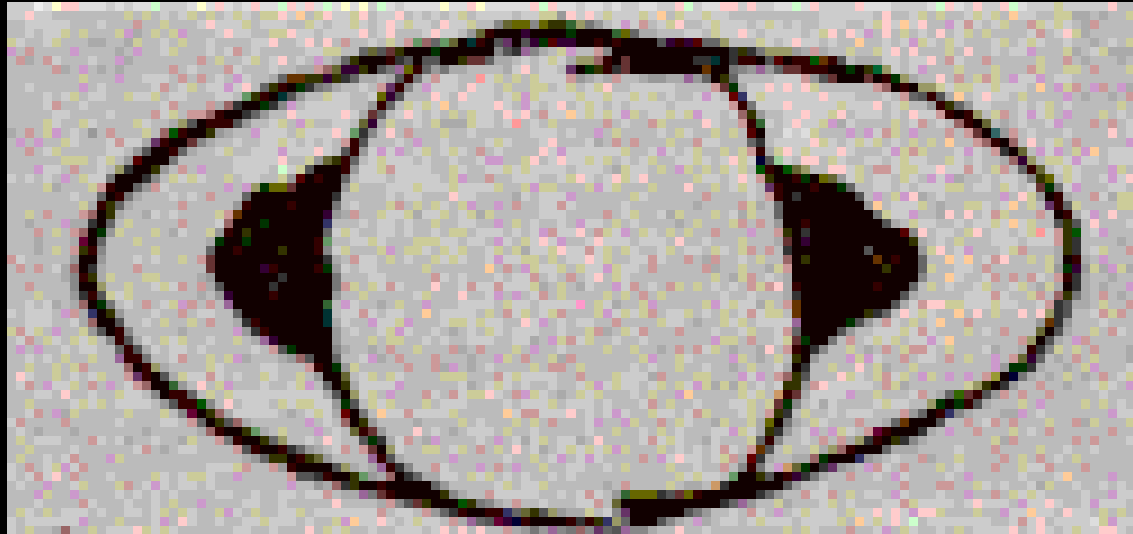
Saturnus: Galileo's view in 1610



Saturnus: Galileo's view in 1612



Saturnus: Galileo's view in 1616



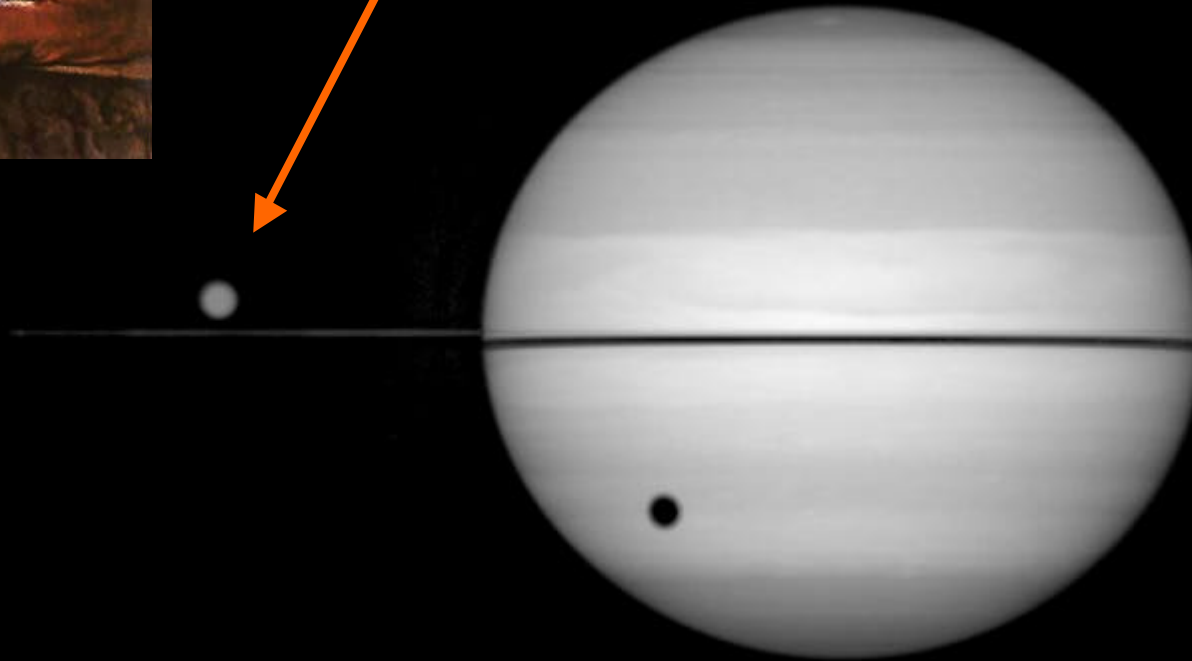
Saturnus: Huygens' sketch in 1655: ringen!



+ Ontdekking Titan



**Huygens ontdekte
Titan in 1655**

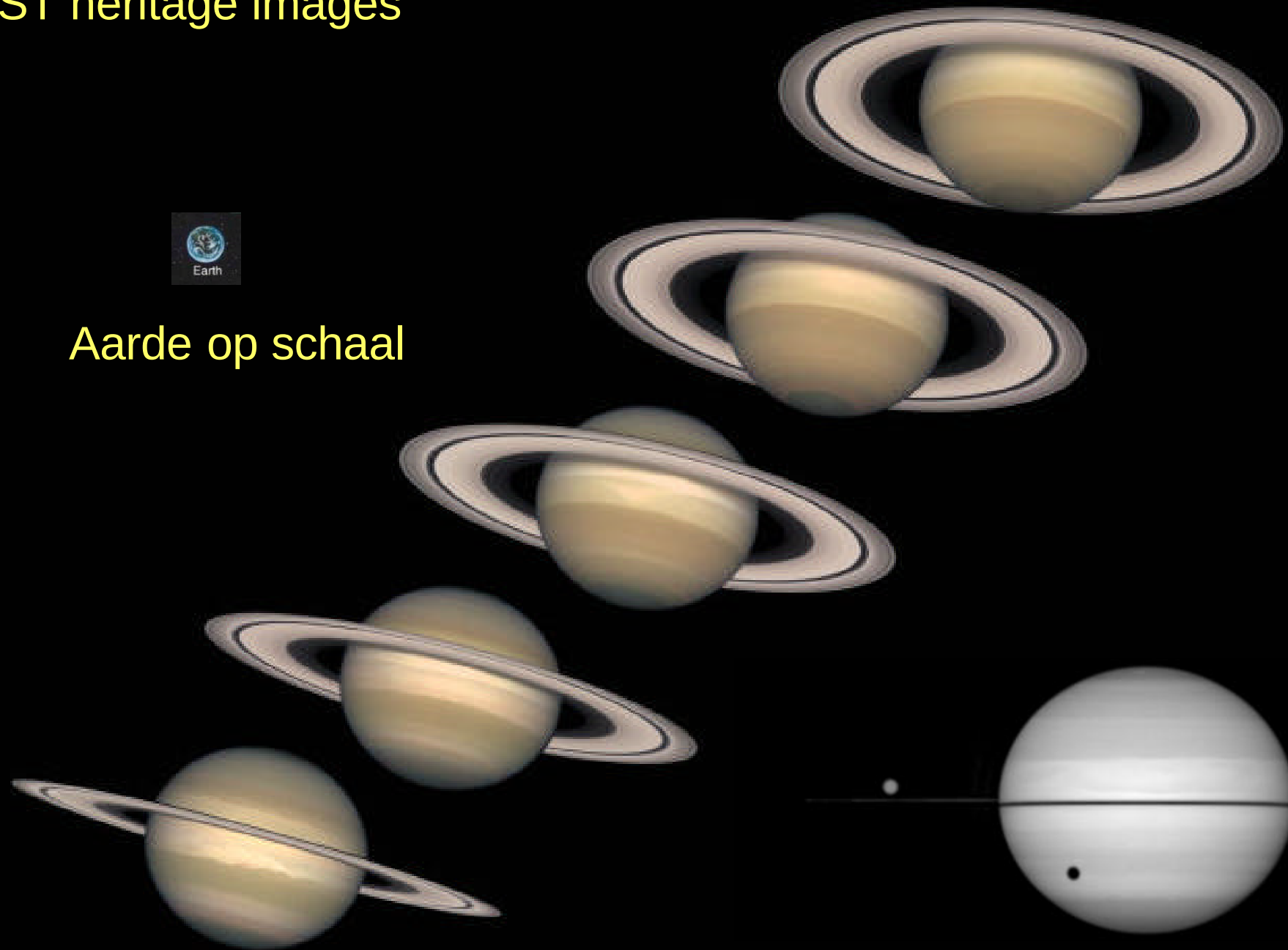


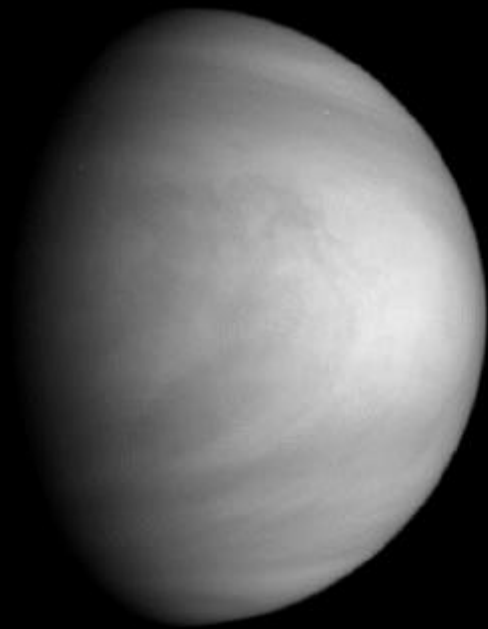
Hubble Space Telescope, 6 August 1995

HST heritage images



Aarde op schaal

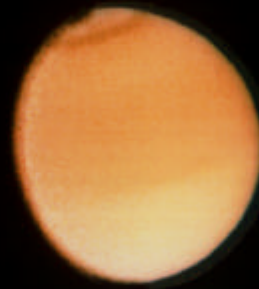




Venus:
R= 6052 km



Ganymede:
R= 2634 km



Titan:
R= 2575 km
surface only



Callisto:
R = 2403 km



Moon:
R = 1737 km

*This is to scale

1943/44: Kuiper ontdekte metaan
gas (CH_4) + oranje kleur

Atmosfeer:

90% Stikstof

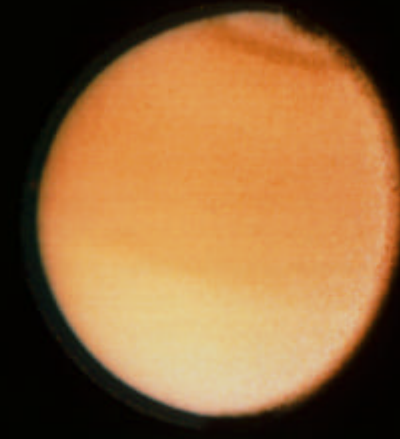
few% Metaan, Argon

Druk op oppervlak: 1.5 atm

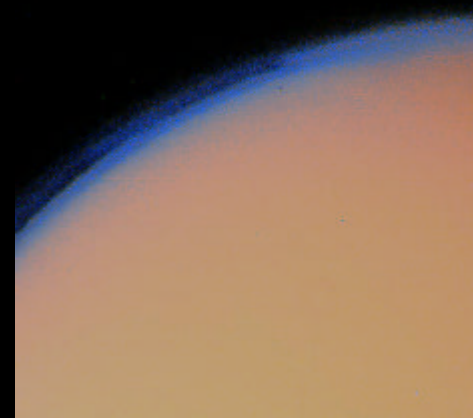
Temperature: 94 K = -180°C

Soortelijk gewicht: 1.88 g/cc
(steen + ijs)

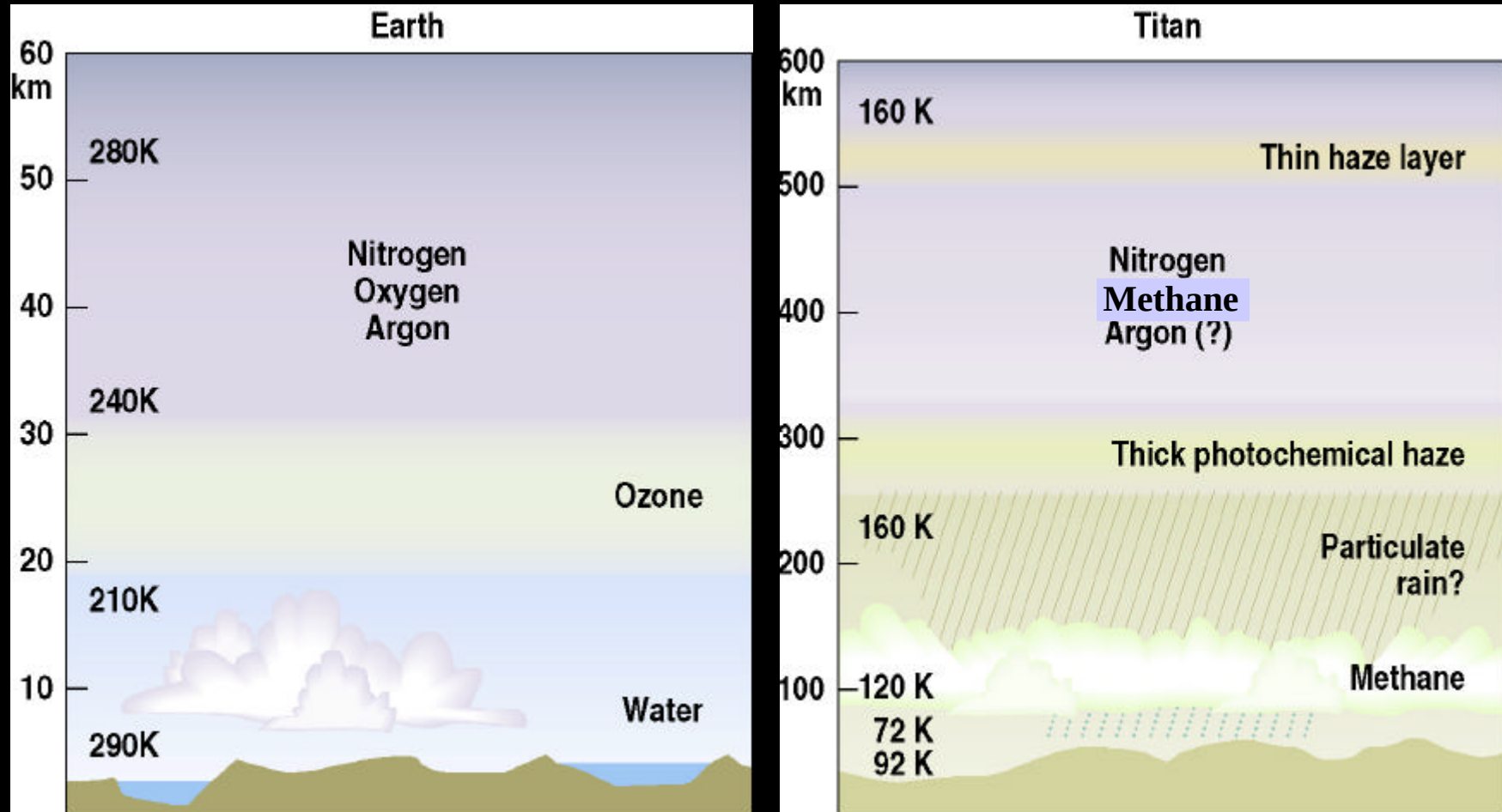
Zwaartekracht: <<Aarde



Voyager plaatjes Titan

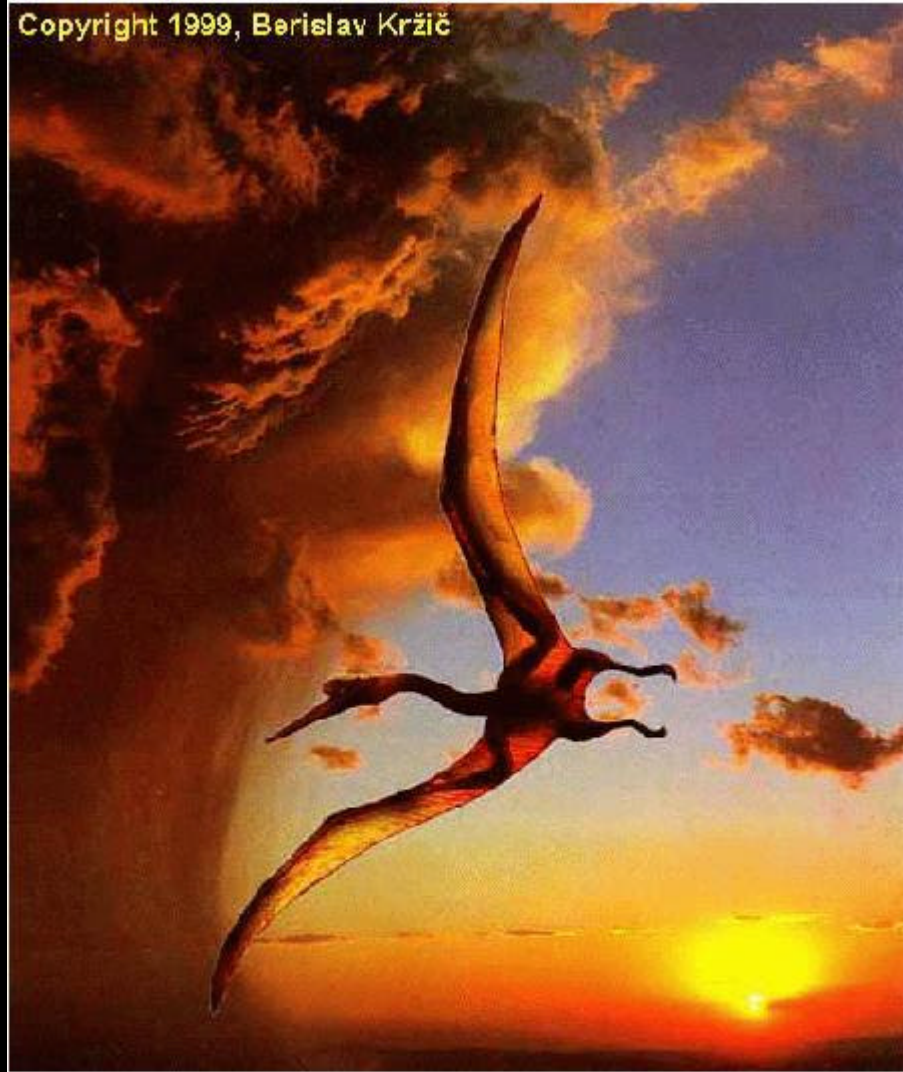


Atmosferen Aarde en Titan



(Impey and Hartmann)

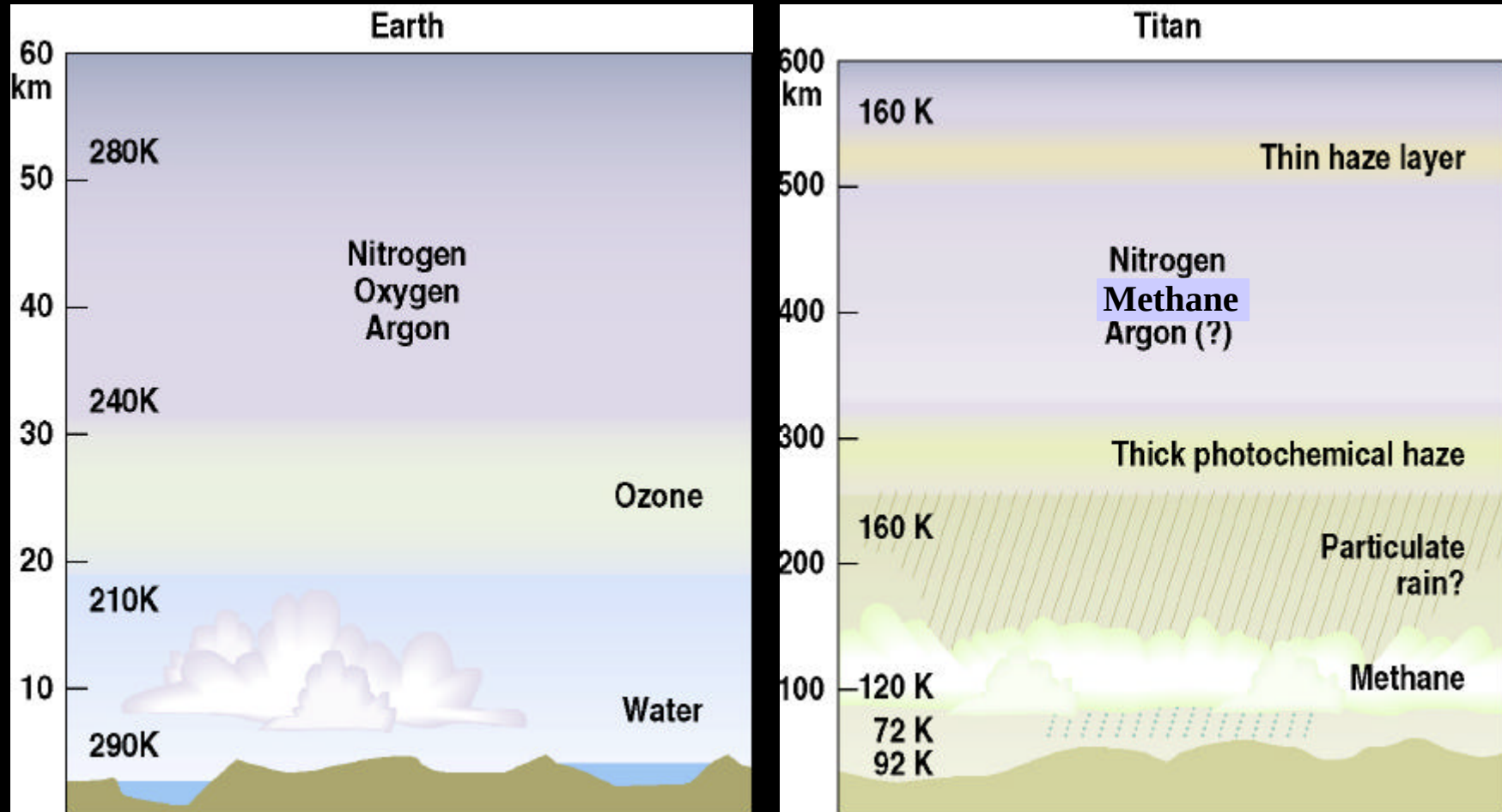
Copyright 1999, Berislav Kržić



Life on Titan?

Prebiotic perhaps -----

Atmosferen Aarde en Titan



(Impey and Hartmann)

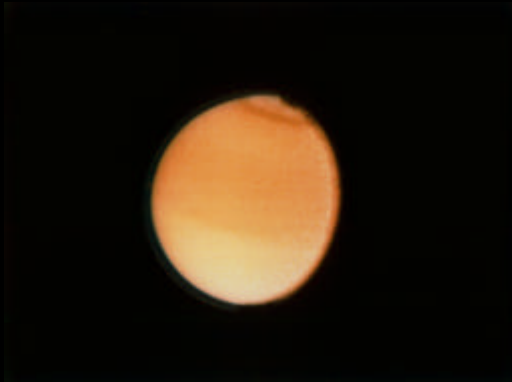
**CH₄ + UV zonlicht
+ chemische reakties**



Hydrocarbons C_xH_y



Photochemische MIST

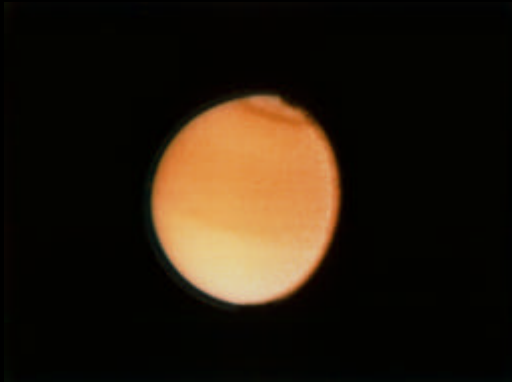


Mist is ondoorzichtig op optische golflengten

CH_4 + UV zonlicht
+ chemische reakties



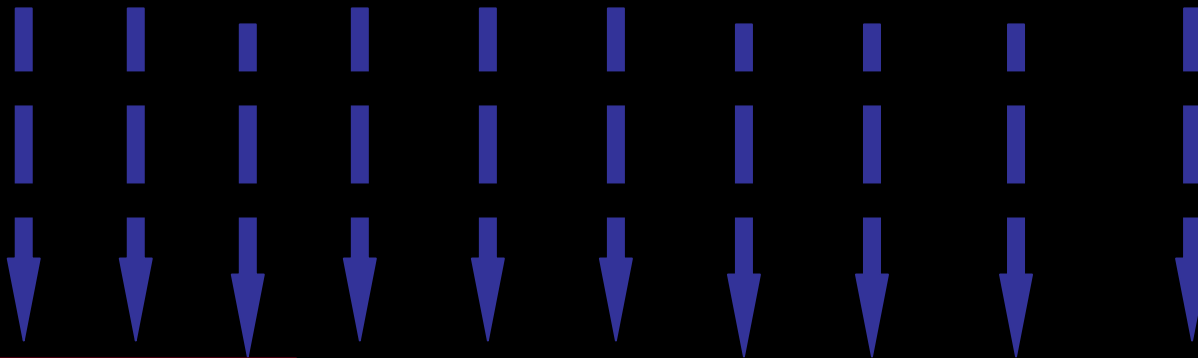
Hydrocarbons C_xH_y



Photochemische MIST



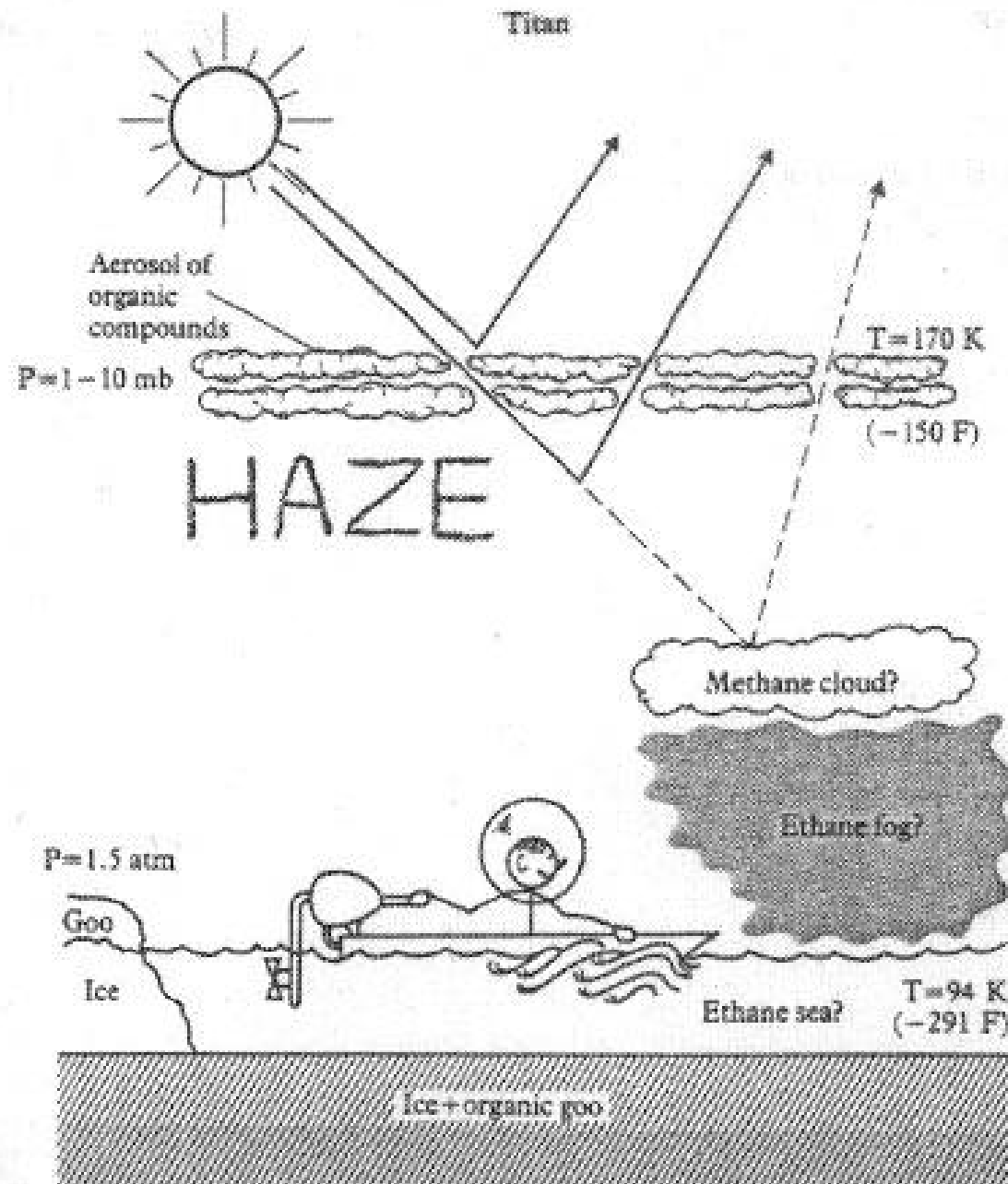
Mist is ondoorzichtig op optische golflengten



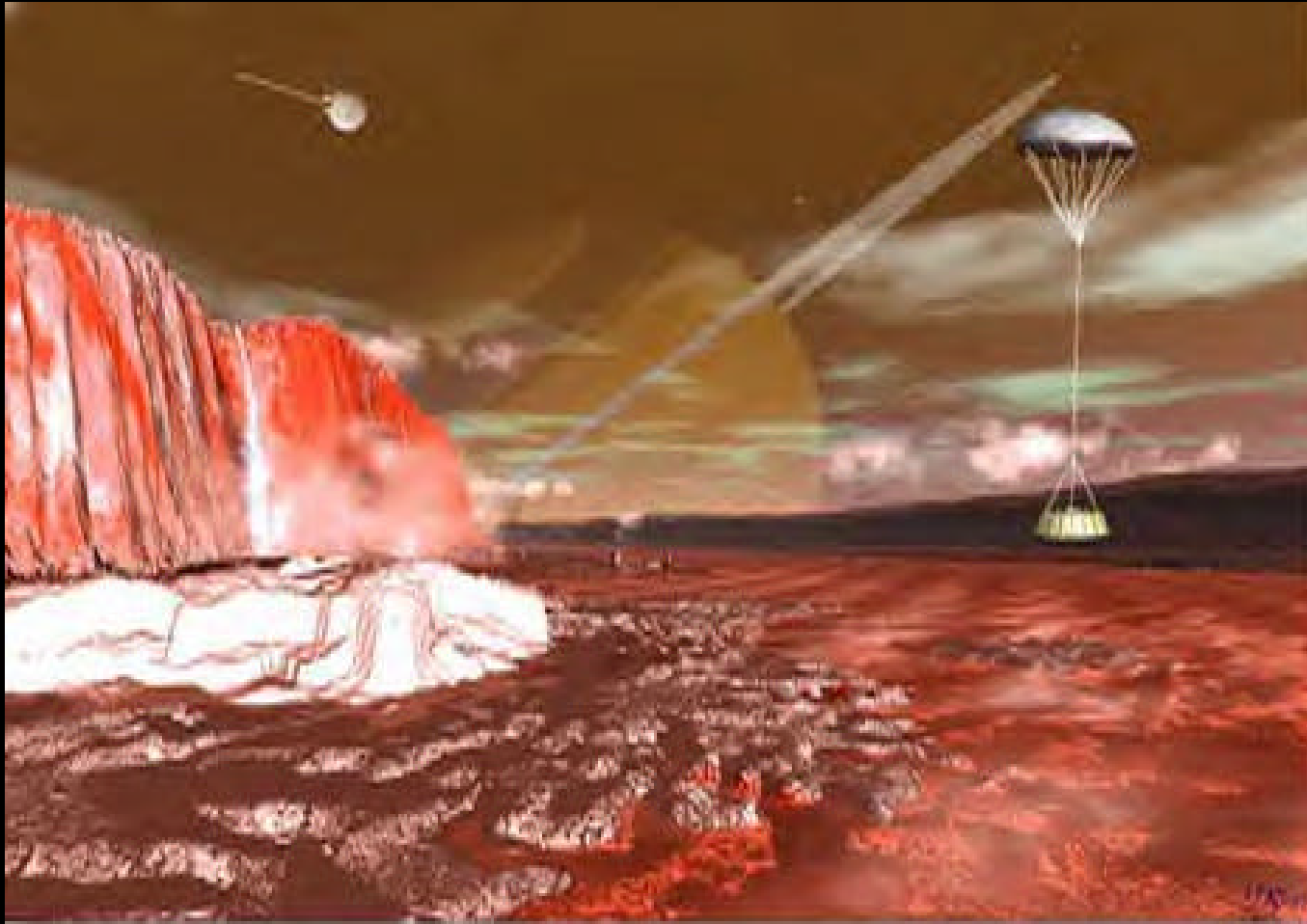
Mist regent naar
beneden



Hydrocarbon Oceanen??



Een zee
van
benzine/
olie/ teer
??



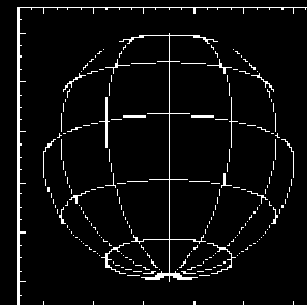
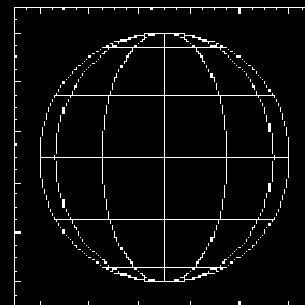
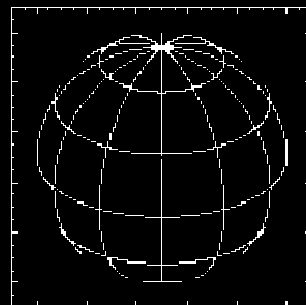
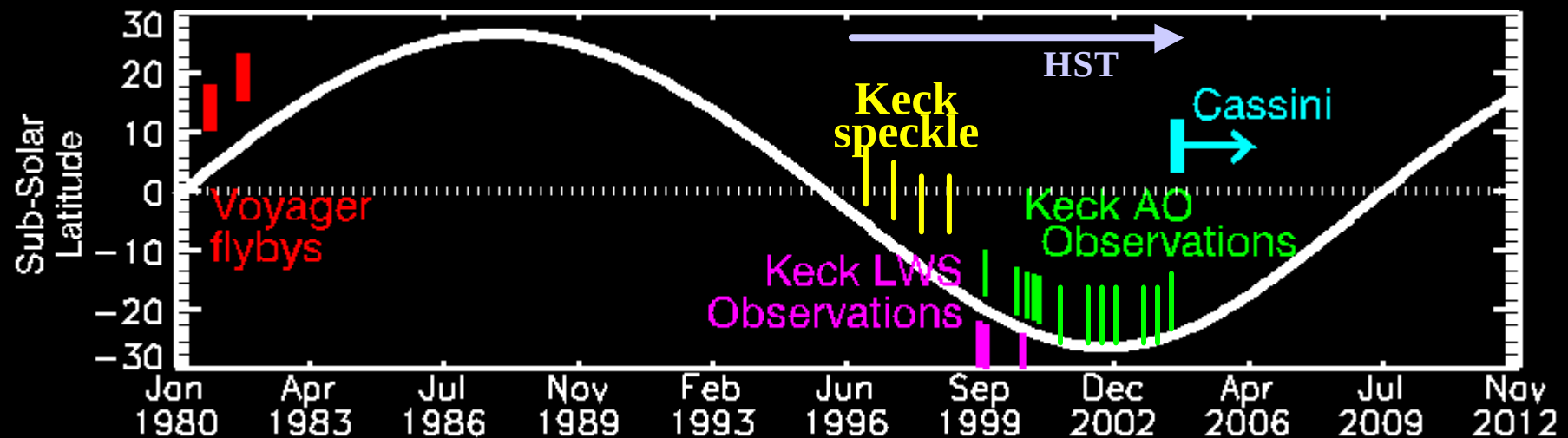
Crater Lake and Methane-fall on Titan (D. Seal)

Zijn er hydrocarbon oceanen? Metaan wolken?

Seizoenen op Titan:

1 Titan dag = 1 x om Saturnus heen = 16 dagen op Aarde

1 Titan jaar = 1 x om de Zon heen = 30 jaar op Aarde

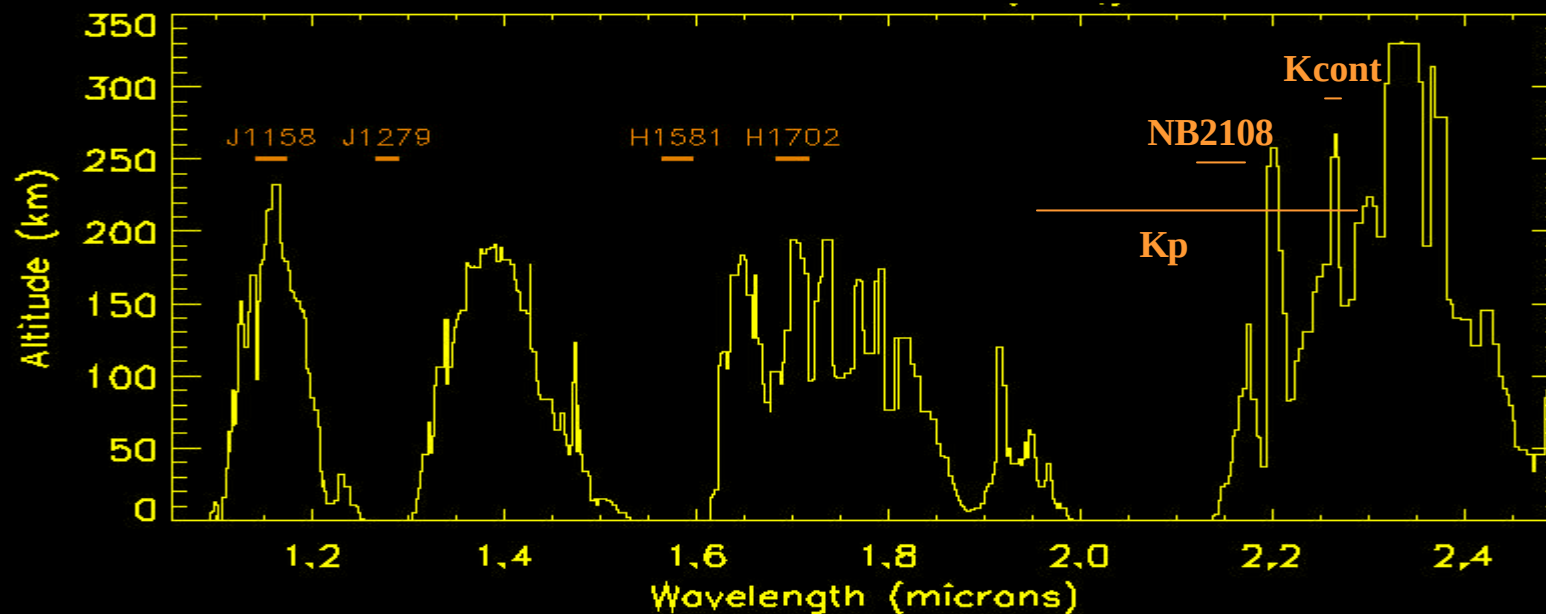


Infra-rood waarnemingen van Titan.

Gereflecteerd/verstrooid zonlicht:

- Stof/mist deeltjes
- Molekulen (Rayleigh)
- Oppervlak
- Metaan gas absorbeert licht

Hoe diep kijk je in de atmosfeer?

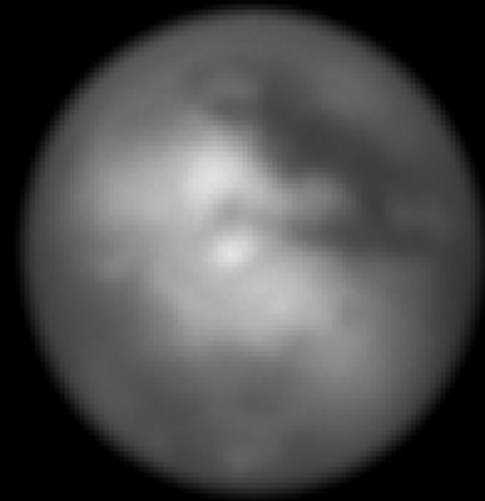


Titan: beelden van het oppervlak (Keck)



1.6 μm CML=228⁰

(Roe et al. 2004)



2.2 μm CML=69⁰

(Bouchez, 2004)

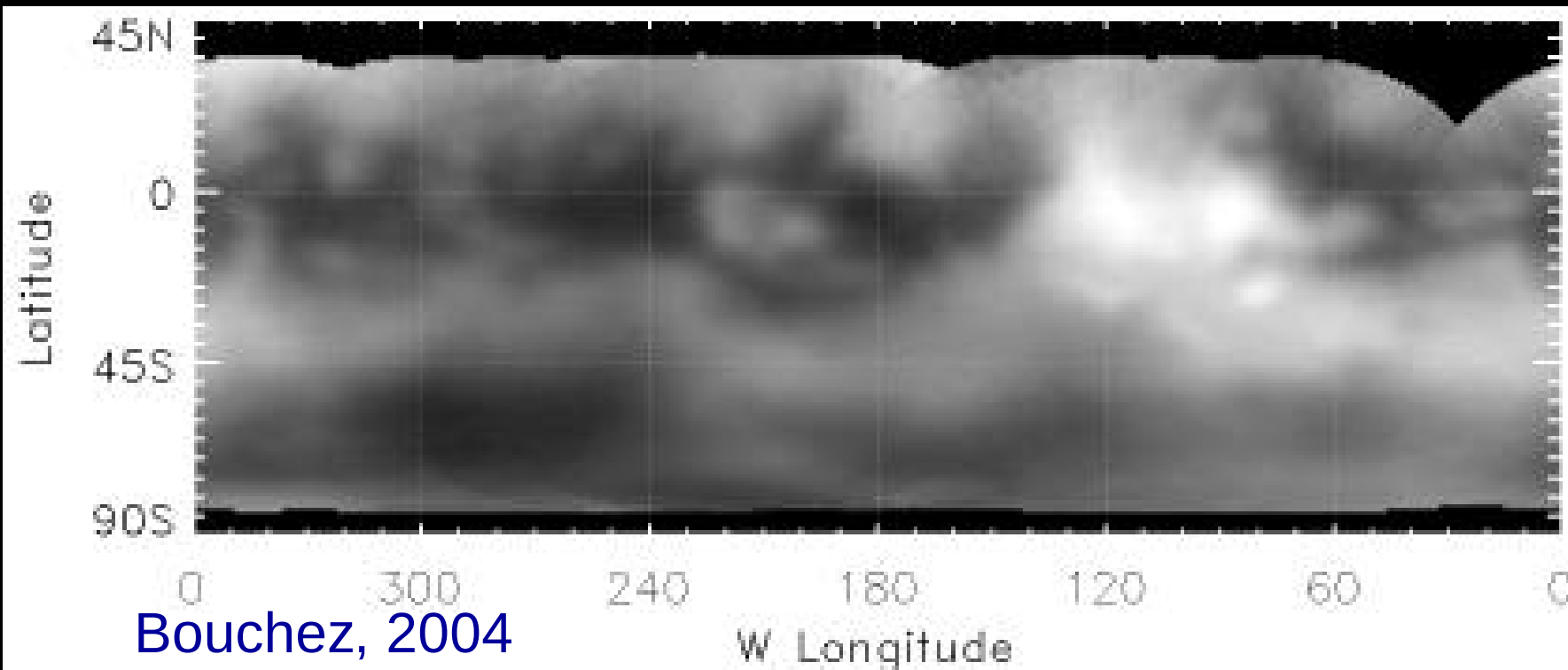
Reflektie van het oppervlak:

Heldere gebied: 1.6 mm ~ 18-20% 2.1mm ~10%

waarschijnlijk water ijs met steen

Donkere gebieden: < 4% < 4%

Oceanen met hydrocarbons?



~800kW radar signaal uitgezonden en ontvangen door de
~300m Arecibo radio teleskoop → aanwezigheid van
oceanen. (Campbell et al. 2003)



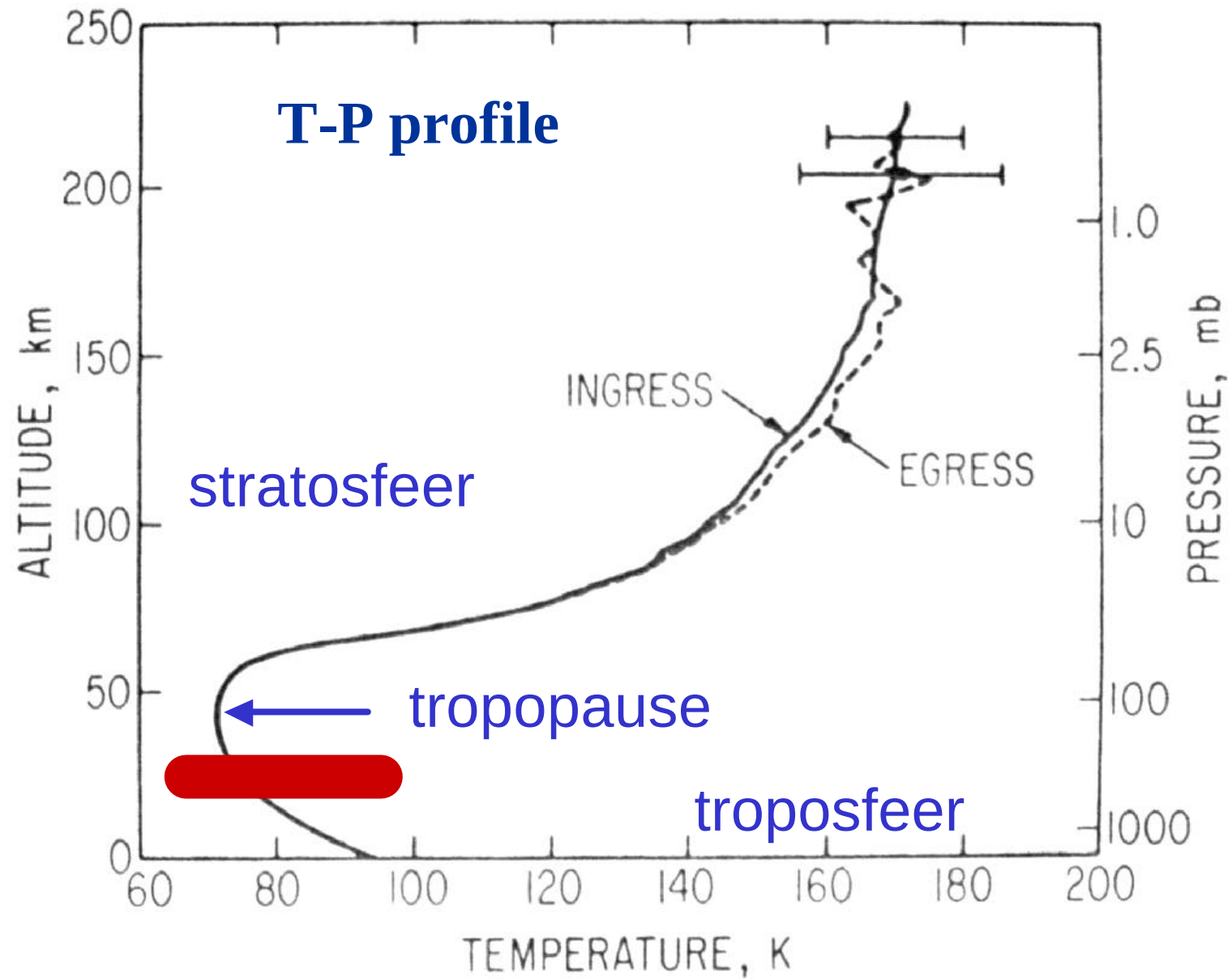
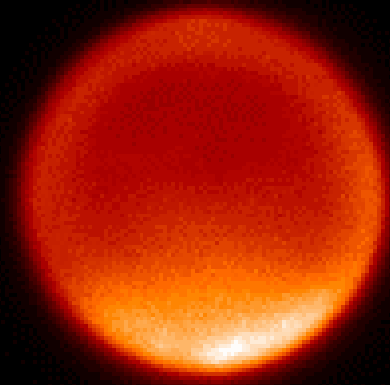


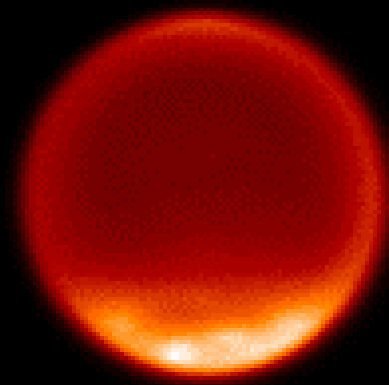
Fig. 1. Temperature profile from Voyager 1 (Lindal et al. 1983).

**Clouds
and
Haze**

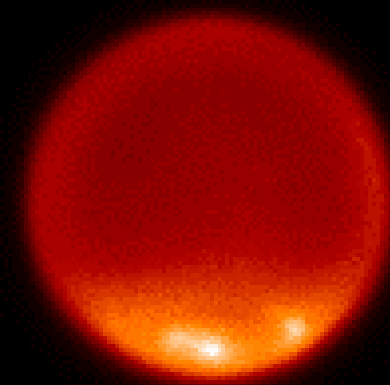
18 Dec 2001



20 Dec 2001



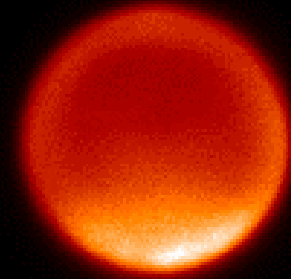
21 Dec 2001



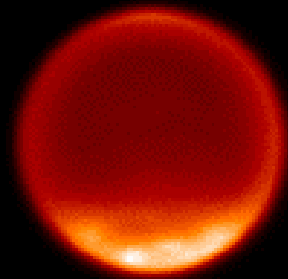
**Roe et al. 2002
NIRC2/AO**

Clouds
and
Haze

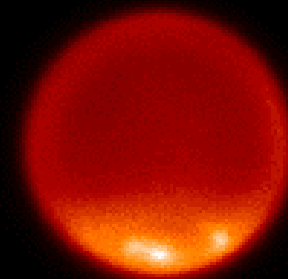
18 Dec 2001



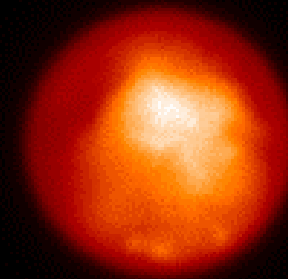
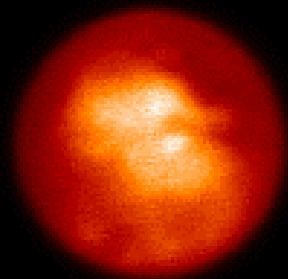
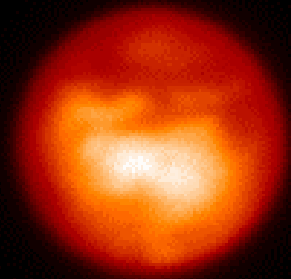
20 Dec 2001



21 Dec 2001

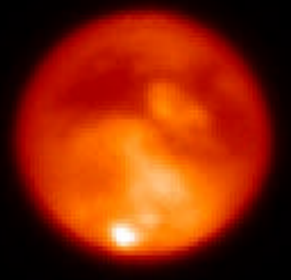


Surface
and
Clouds



Surface
and
Clouds

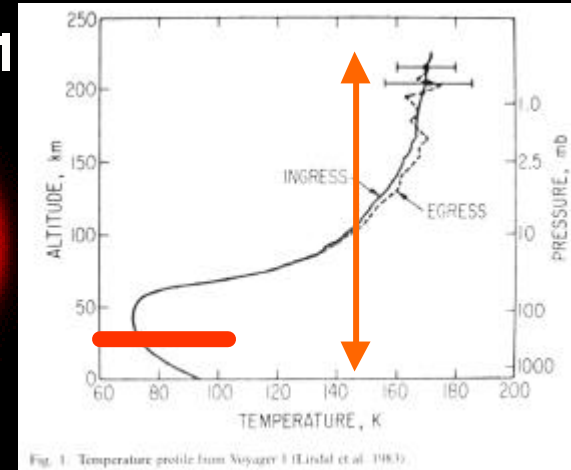
10 Dec 2001



11 Dec 2001



28 Feb 2002



Roe et al. 2002
NIRC2/AO

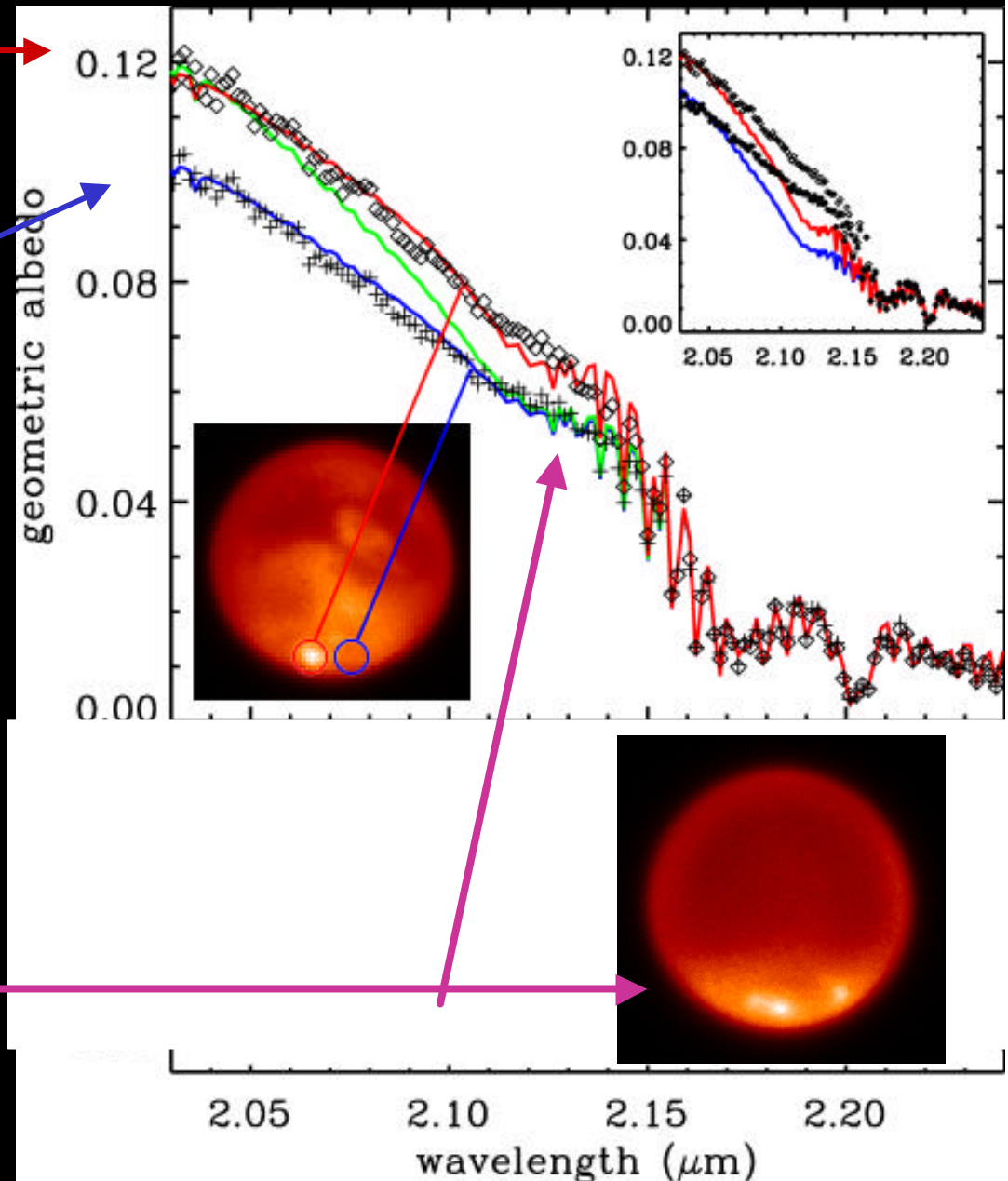
Brown et al.
2002
NIRSPEC/AO

**Wolk/storm op
18 km hoogte**

Geen wolken

**Beste fit als
reflektie is veroorzaakt
door helder gebied op
het oppervlakte.**

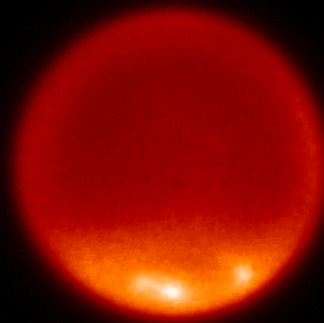
**Tropopause cirrus
30-50 km**



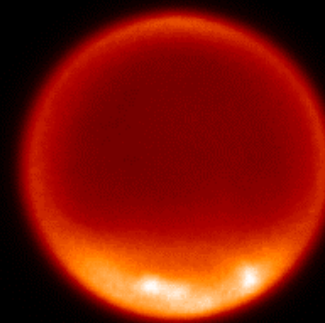
Brown et al. 2002

Veranderingen in de wolkjes

21 Dec. 2001
H₂ (2.11-2.14 μm)
Roe et al. 2002

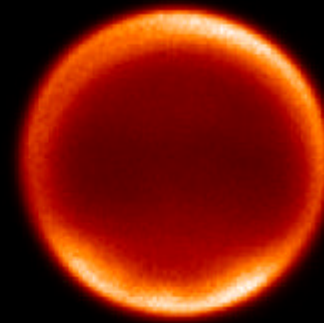
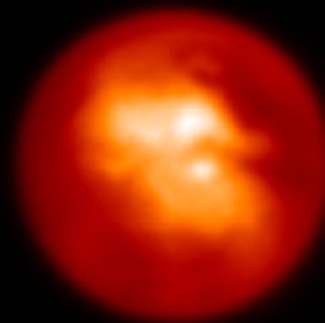


9:40 UT



12:15 UT

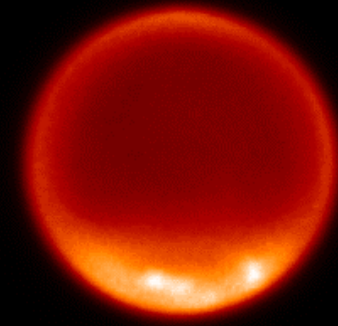
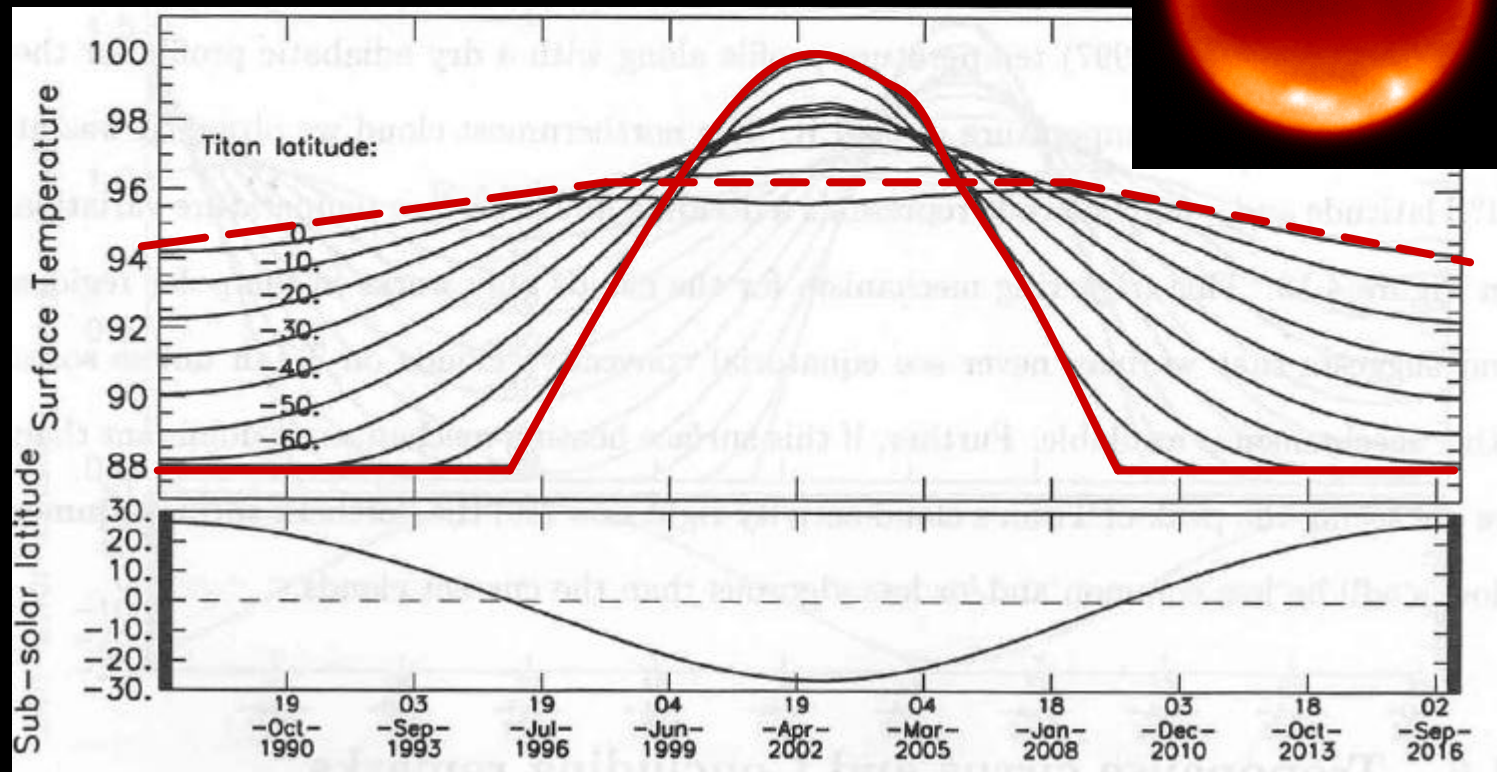
25 Dec. 2003
K' (1.95 – 2.30 μm)
H₂ (2.11-2.14 μm)
Bouchez, 2004



2003 Dec. 25 06:31 UT

Waarom alleen bij de Zuidpool?

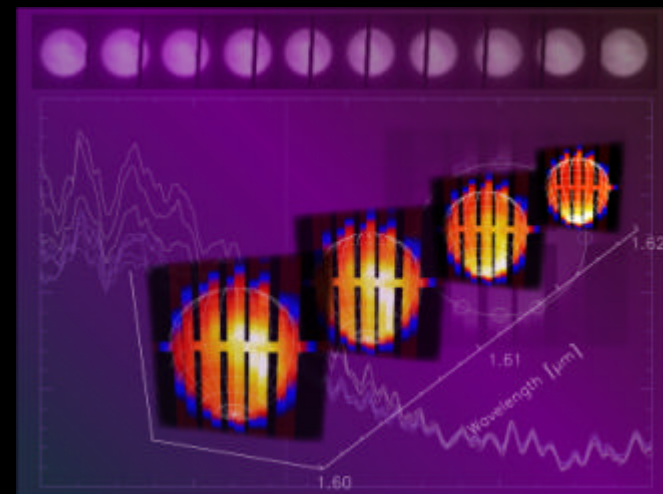
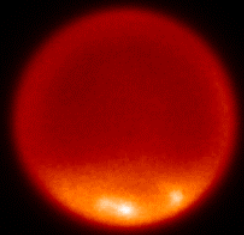
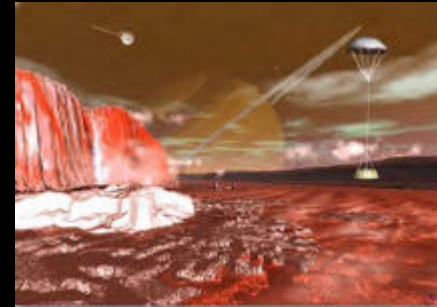
Temperatuur is het hoogst → onweersbuien??



Roe, 2002

Overzicht van het praatje:

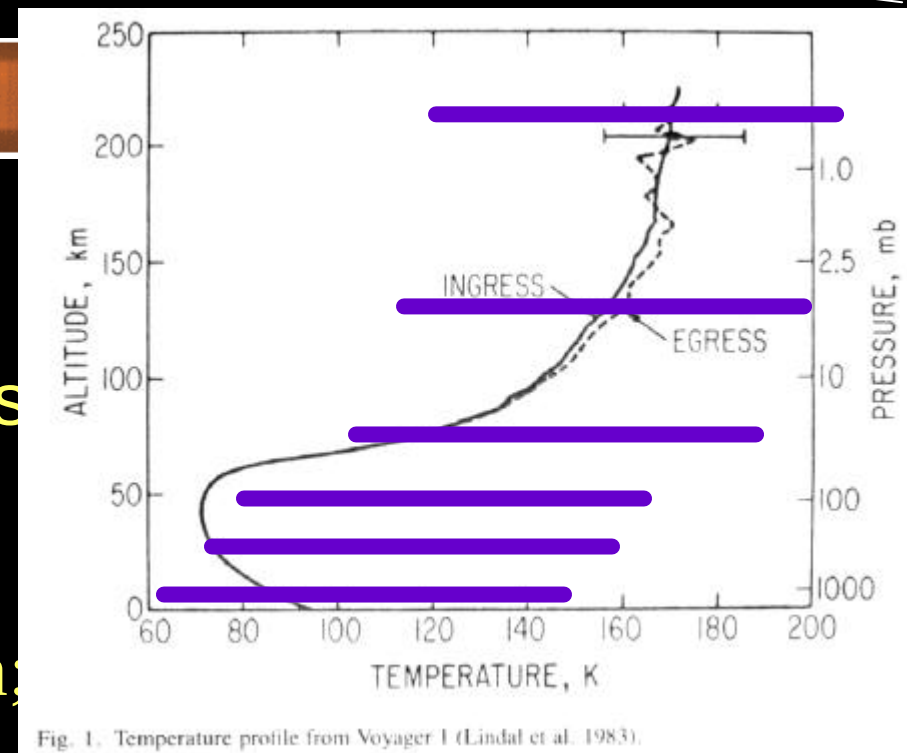
- Geschiedenis
- Oppervlak
- Wolken
- Vlieg-vlucht door Titan's atmosfeer



Spatially-resolved spectroscopy observations



Keck 2 NIRSPEC/AO, res
3 Nights of data from 19,
Spectrum 1.48 – 1.74 μm ,
(Adamkovics et al. 2004)



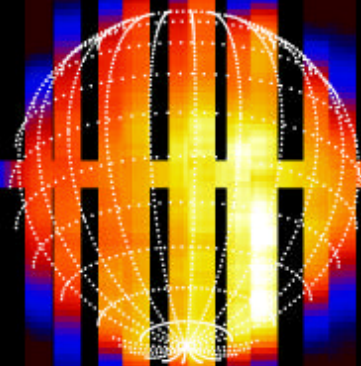
1.5469 μm



1.5546 μm



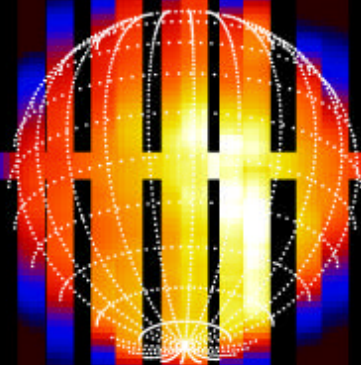
1.5624 μm



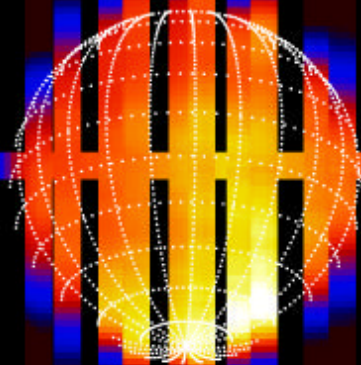
1.6028 μm



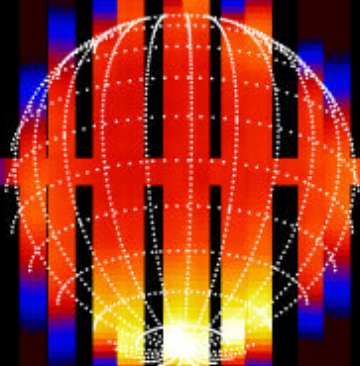
1.6071 μm



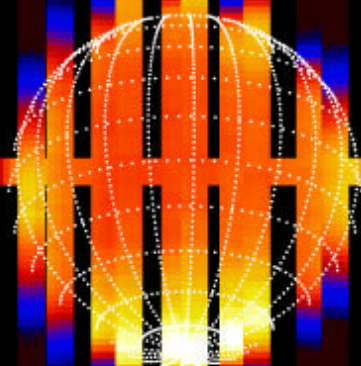
1.6107 μm



1.6218 μm



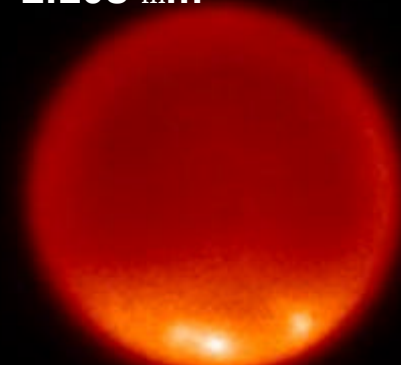
1.6297 μm



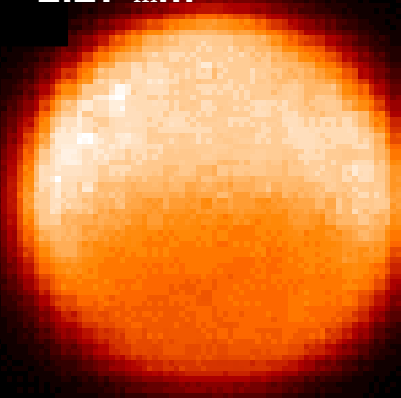
1.6912 μm



2.108 mm

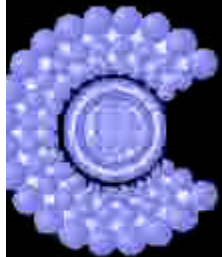


2.27 mm



Vlucht door Titan's Atmosfeer

Center for Integrative Planetary Science



A Flight Through Titan's Atmosphere

by

Mate Adamkovics

with

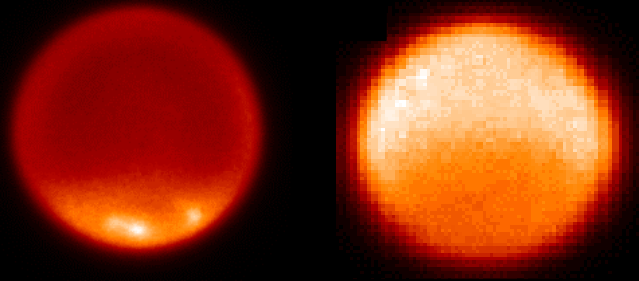
Imke de Pater, Henry G. Roe, Seran G. Gibbard, and Caitlin A. Griffith



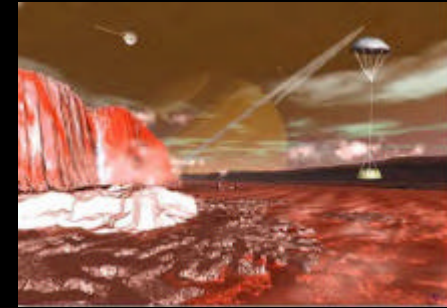
Data source: W. M. Keck Observatory, 1.4 – 1.8 μm NIRSPAO, February 2001

Scientific details: see Adamkovics et al., Geophysical Research Letters, 2004 (Titan Special Issue)

Adamkovics et al. 2004



Conclusies



- Oppervlak: wrsch zowel water ijs/steen als oceanen/meren van hydrocarbons.

Highlands $\leftrightarrow$ lowlands?

- Wolken: Hoge T op Z. pool $\rightarrow$ convection $\rightarrow$ stormen.

- Stof/mist in de stratosfeer: onstaat boven in atmosfeer $\rightarrow$ getransporteerd naar winter pool $\rightarrow$ valt langzaam naar beneden.

- Vlucht door Titan's Atmosfeer:
OSIRIS/SPIFFI

