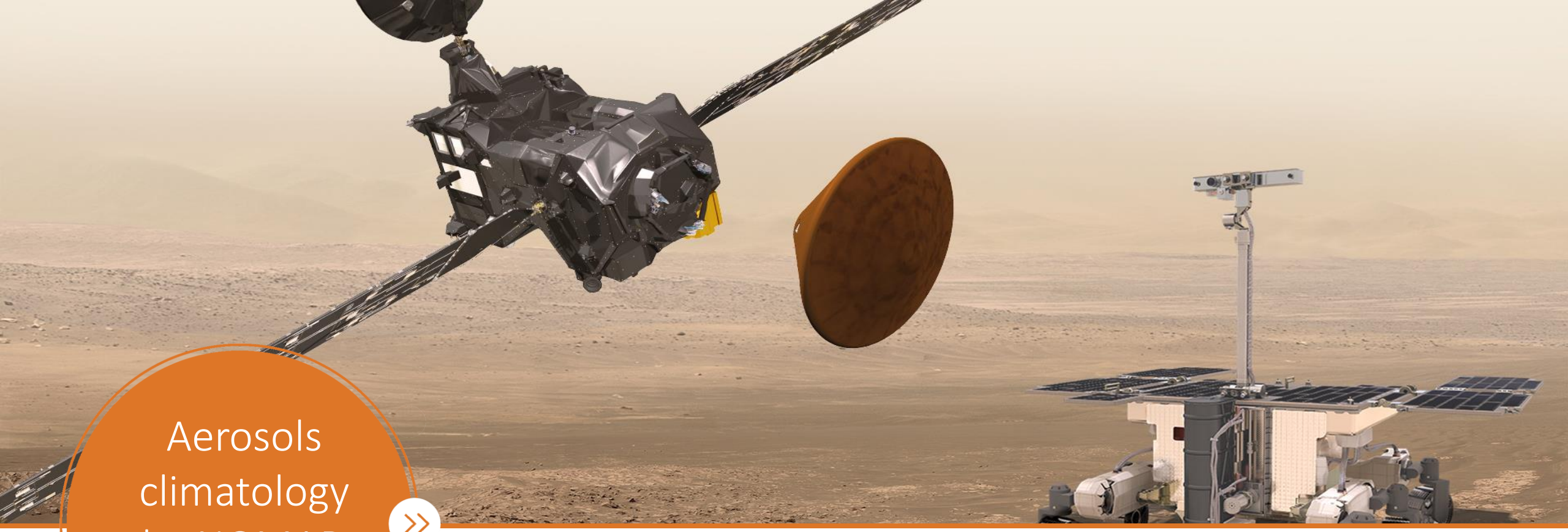


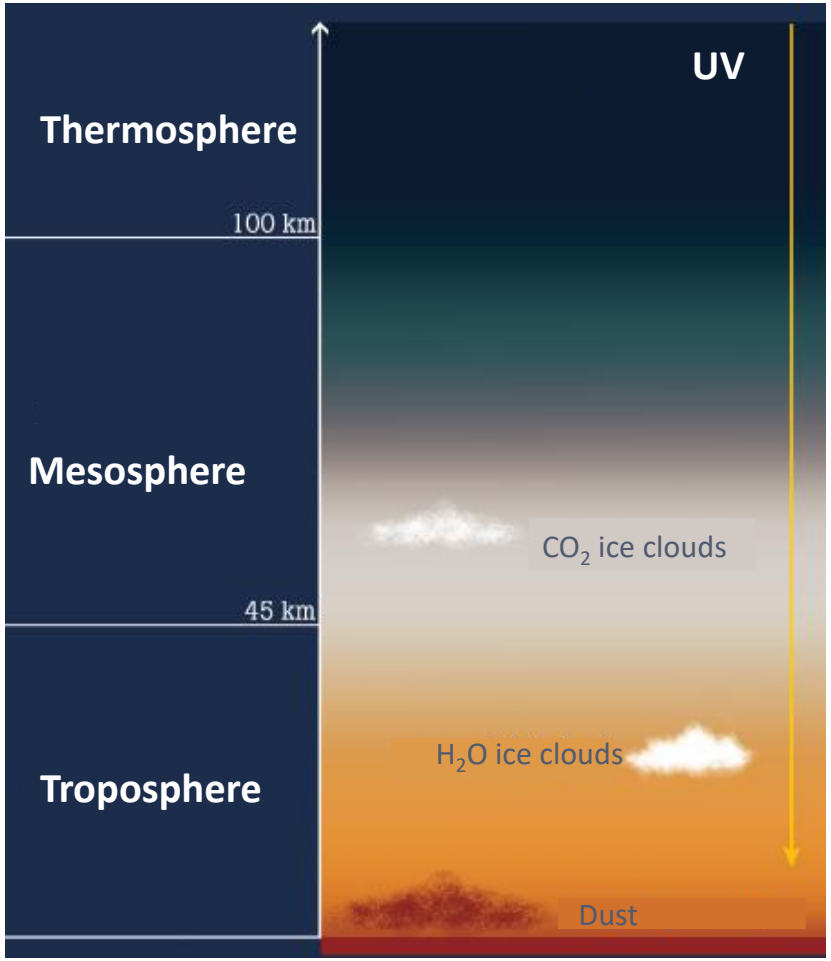
Aerosols climatology by NOMAD UVIS

Roadmap workshop

Zachary Flimon

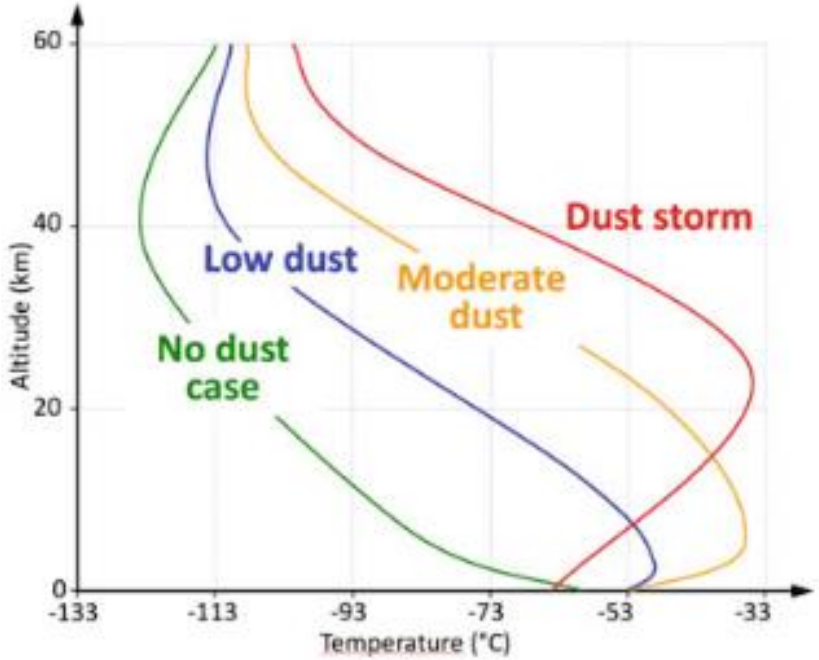
ROYAL BELGIAN INSTITUTE FOR SPACE AERONOMY

Aerosols on Mars



3 aerosols in the atmosphere :

- H_2O ice
- CO_2 ice
- Dust

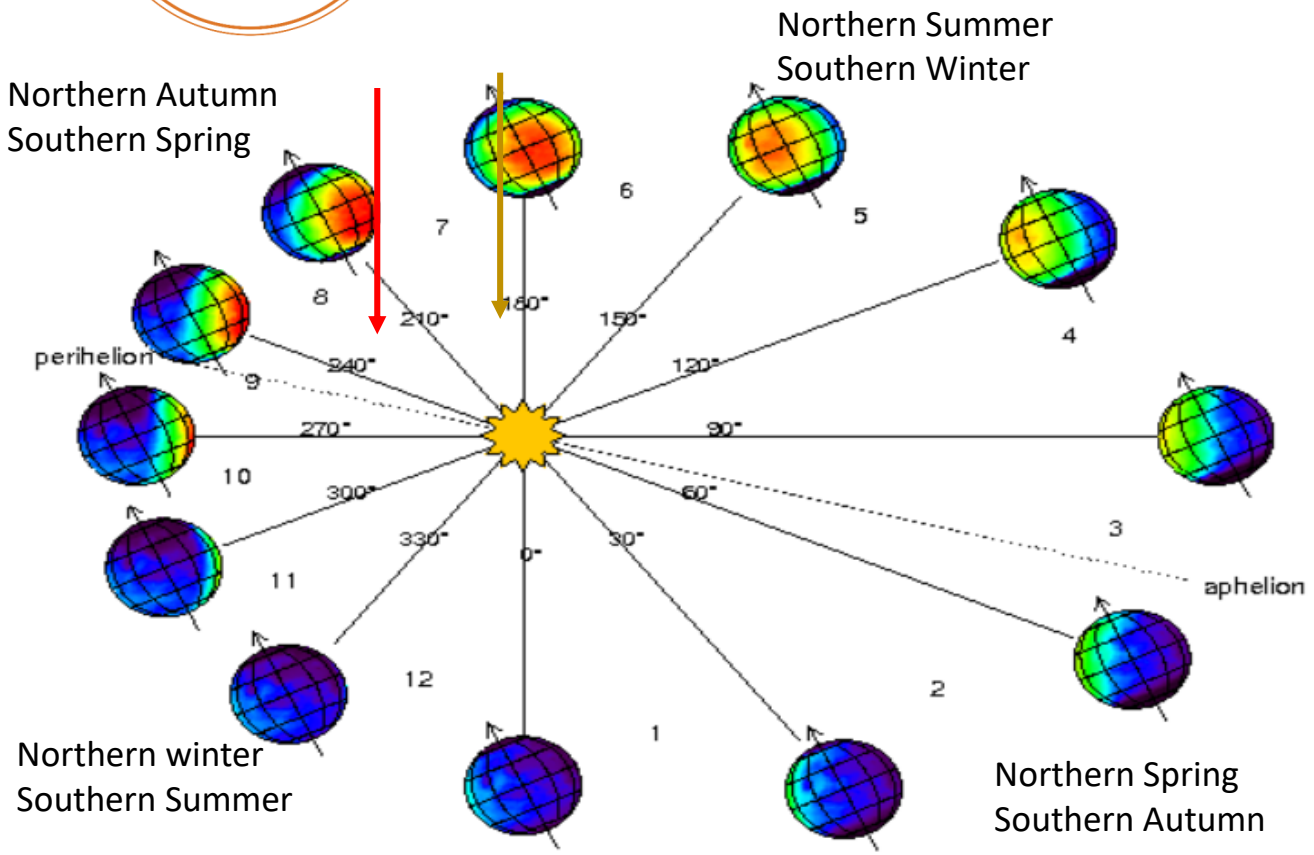


Impact of the dust on the temperature profiles

From Forget et al., 2008

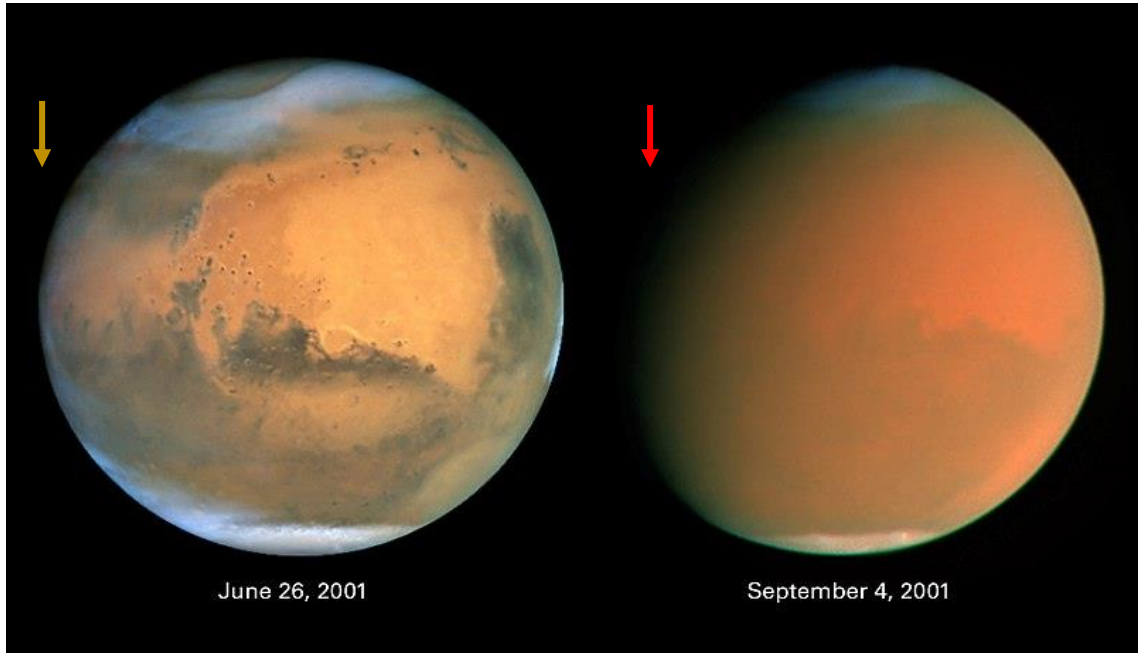
Aerosols seasonal variation

MY : Martian year, 1 MY ≈ 2 Earth years



Credit : http://www-mars.lmd.jussieu.fr/mars/time/solar_longitude.html

- Dust is present all around the planet



Credit : NASA James Bell (Cornell Univ.), Michael Wolff (Space Science Inst.), and The Hubble Heritage Team (STScI/AURA)

Aerosols seasonal variation

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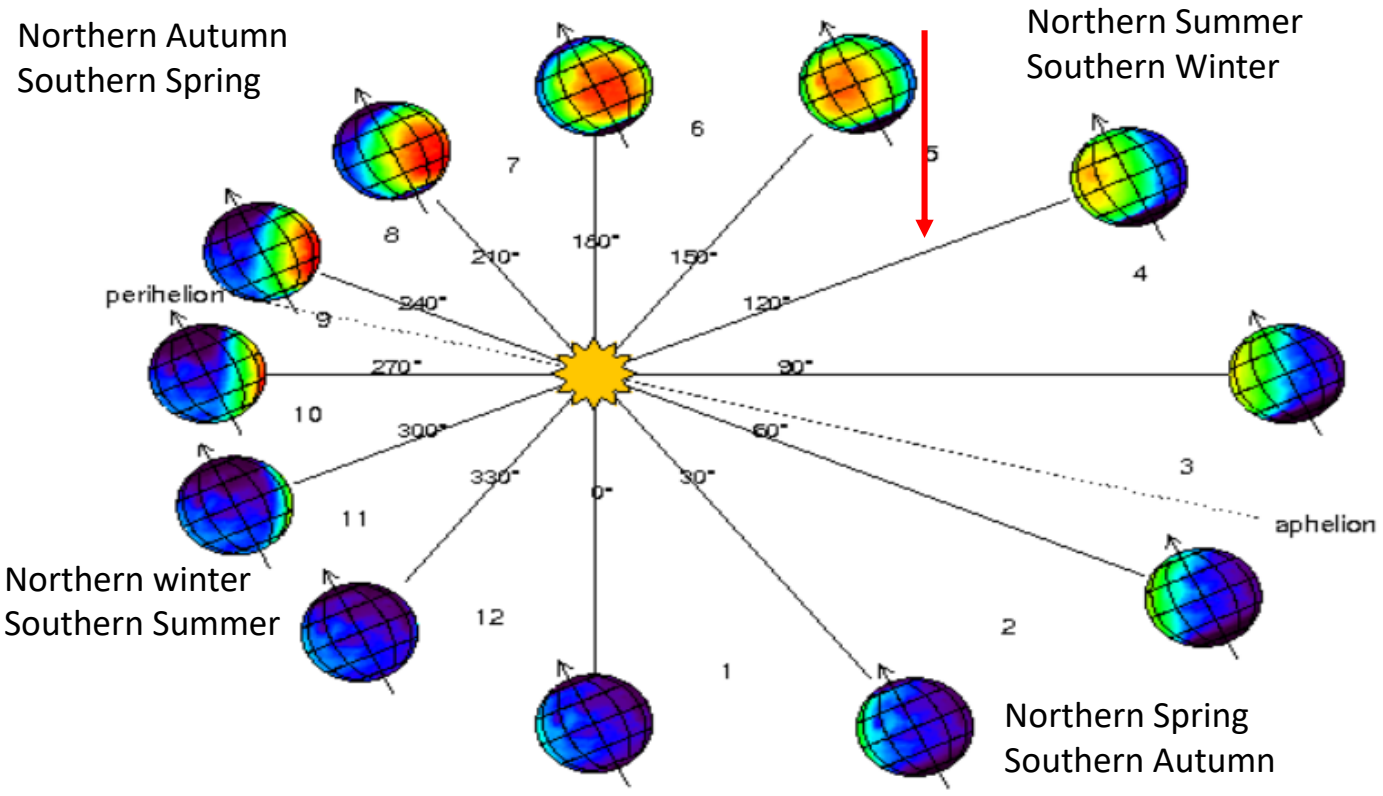
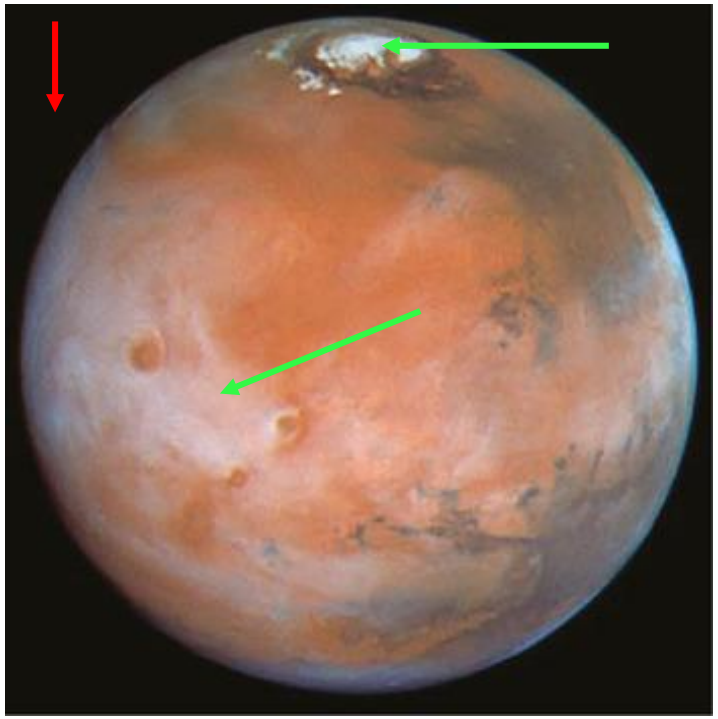


Credit : http://www-mars.lmd.jussieu.fr/mars/time/solar_longitude.html

- CO_2 ice at the pole
- Water ice cloud at the equator

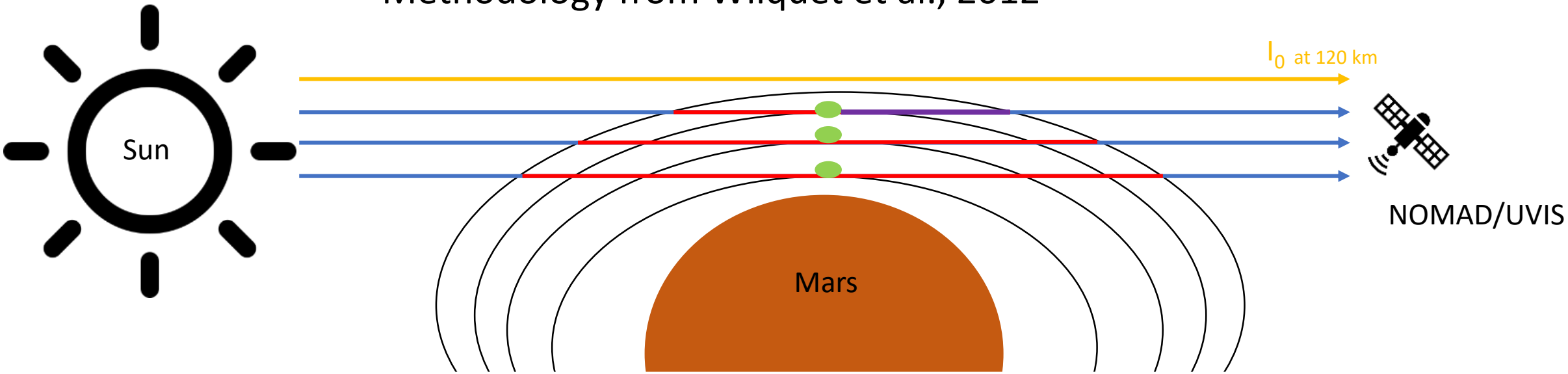


Credit : Phil James (Univ. Toledo), Todd Clancy (Space Science Inst., Boulder, CO), Steve Lee (Univ. Colorado), and NASA/ESA from Hubble Space Telescope WFPC2

Methodology (Onion peeling)

- Transmittance, T = I / I_0
- Optical depth, τ = -ln(T)
- Extinction, $\beta_{N,\lambda} = (\tau_{N,\lambda} - \sum_{k=1}^{N-1} \beta_{k,\lambda} * dz_{N,k}) / dz_{N,N}$
- Methodology from Wilquet et al., 2012

Remove ozone and Rayleigh scattering with a radiative transfer code ASIMUT



Transmittance computed from Trompet et al., 2016
Removal of ozone from Piccialli et al., 2023

From extinction to size

- $\beta = n * C_{ext}$ with β the extinction, n the number density and C_{ext} the extinction cross section

Cross section dependency:

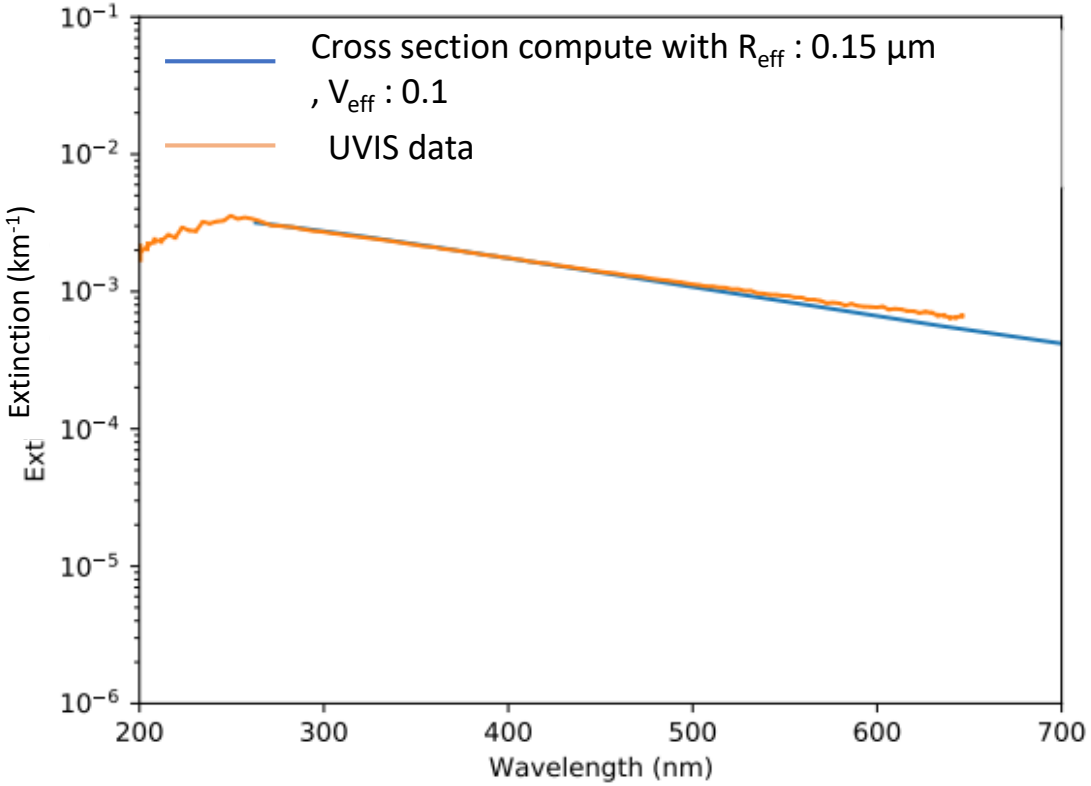
- Shape → In occultation only sensitive to the forward scattering, no sensitivity for the shape we assumed spherical shape for simpler computation

- Size → Lognormal distribution (r_{eff} : 0.05-2 µm and v_{eff} : 0.1) from Hansen et al., 1974

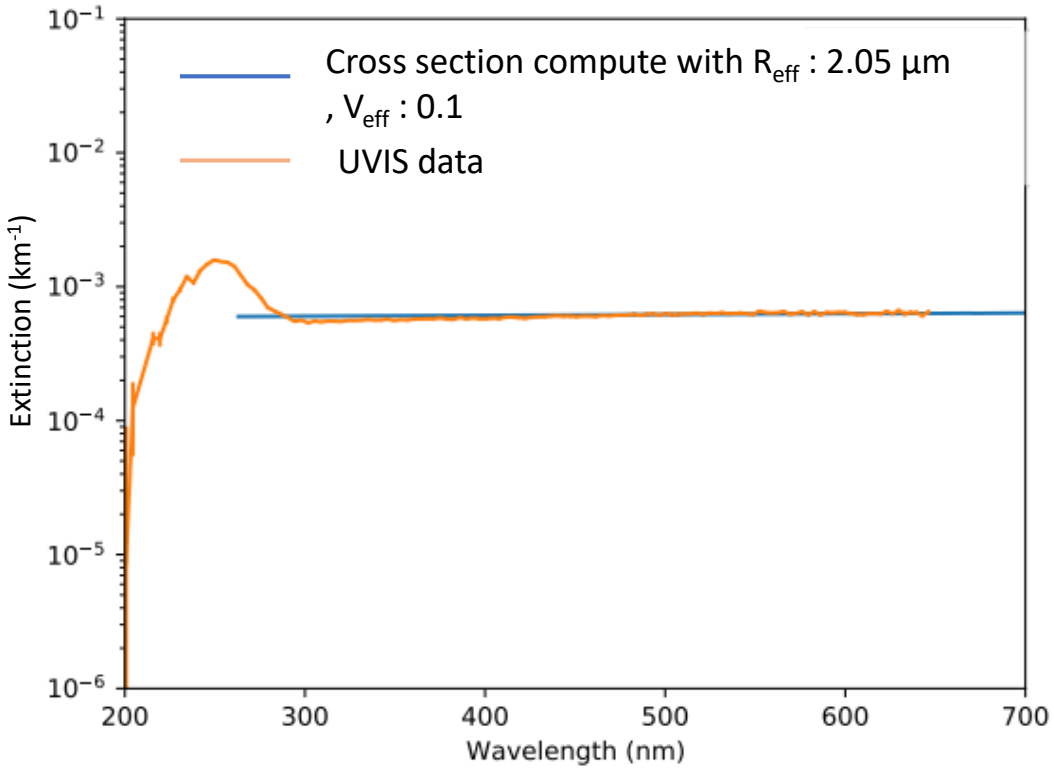
The cross section is computed for all r_{eff} and v_{eff} → we fit the cross section to the extinction with a least square algorithms and choose the best reduced chi square

Example of fits

At 40 km



At 25 km



From extinction to size

- $\beta = n * C_{ext}$ with β the extinction, n the number density and C_{ext} the extinction cross section

Cross section dependency:

- Shape → In occultation only sensitive to the forward scattering, no sensitivity for the shape we assumed spherical shape for simpler computation

- Size → Lognormal distribution (r_{eff} : 0.05-2 micron and v_{eff} : 0.1) from Hansen et al., 1974

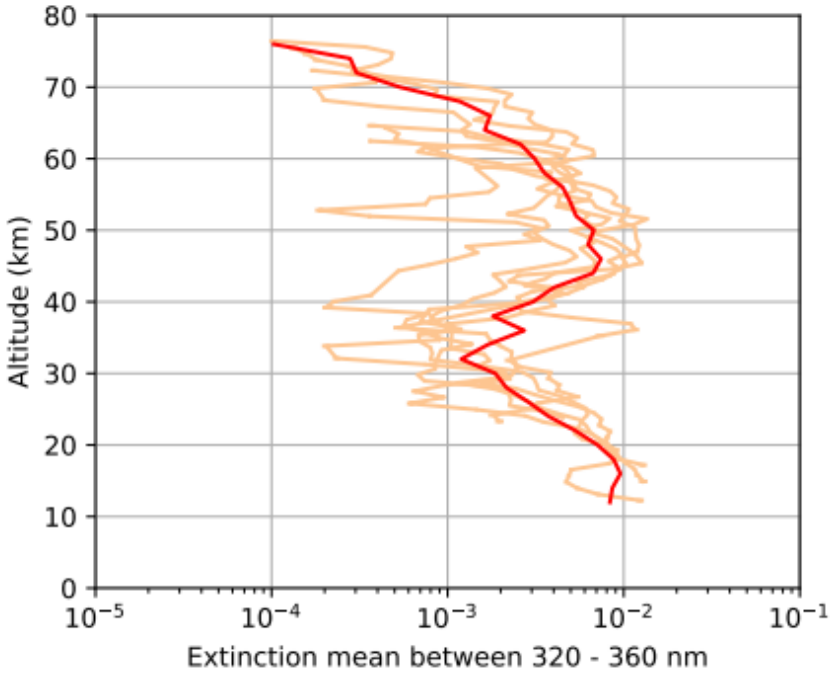
The cross section is computed for all r_{eff} and v_{eff} → fit with least square to find the best combination

- Composition → No sensitivity in the UV-Visible between Martian dust and Ice

Detection of water ice clouds

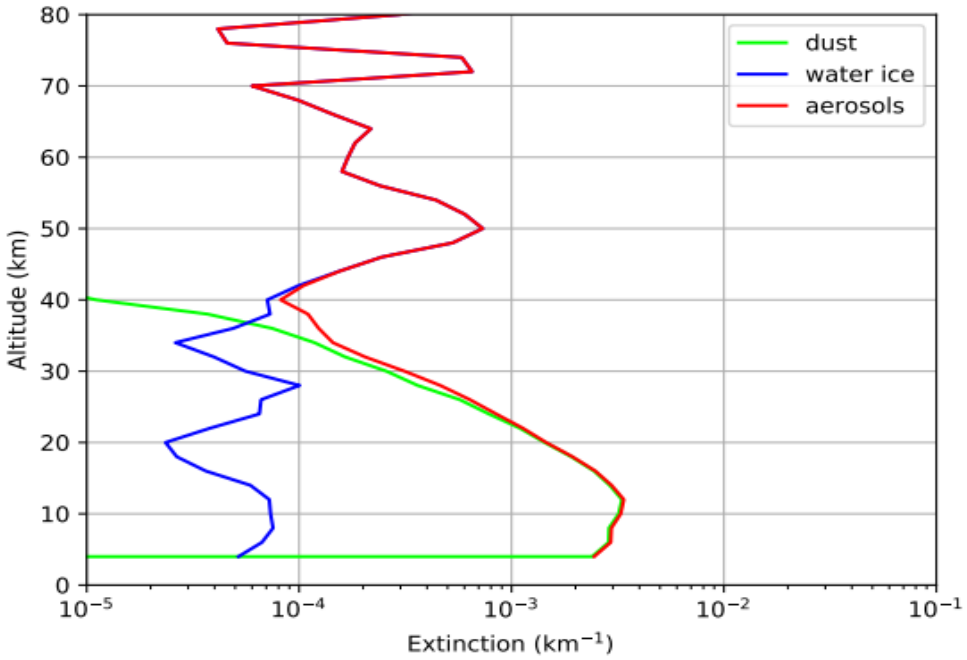
Latitude : 30° – 40°N

L_S : 270° – 280°



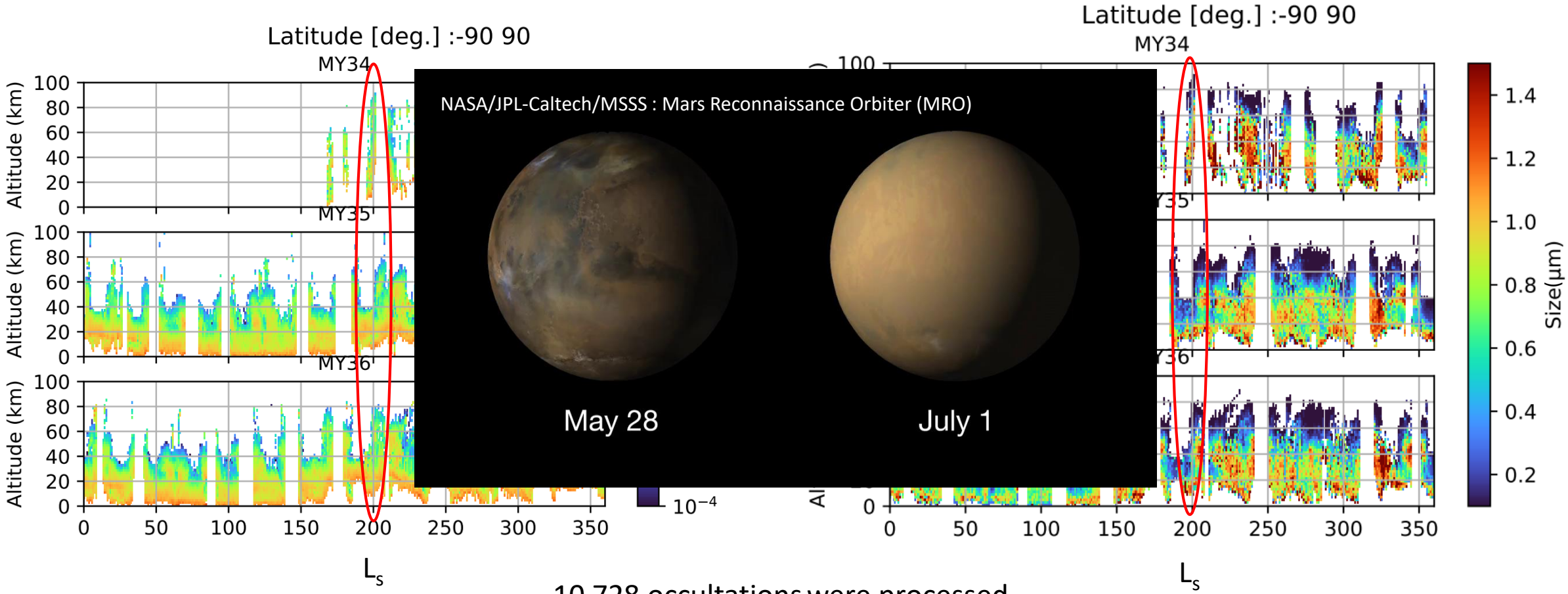
UVIS profiles

L_S : 274° – 276°



Averaged MCS profiles

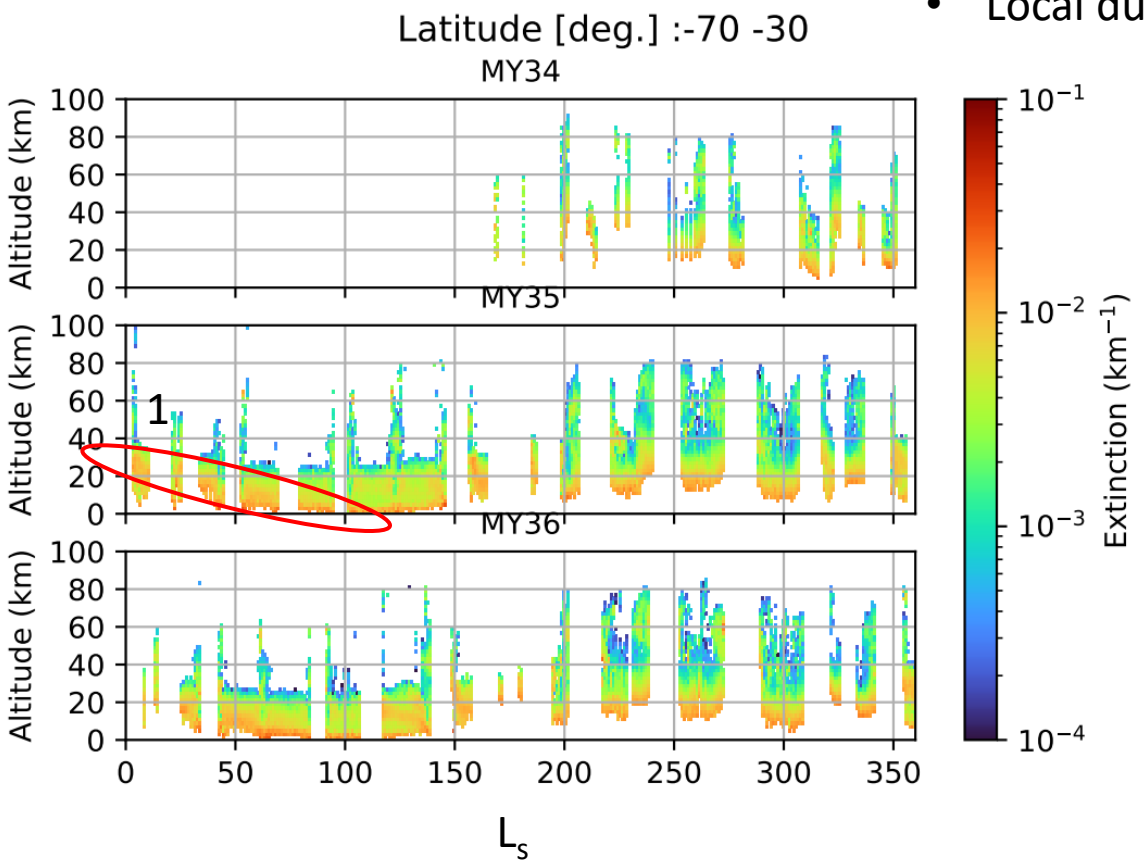
Dust Climatology : All regions

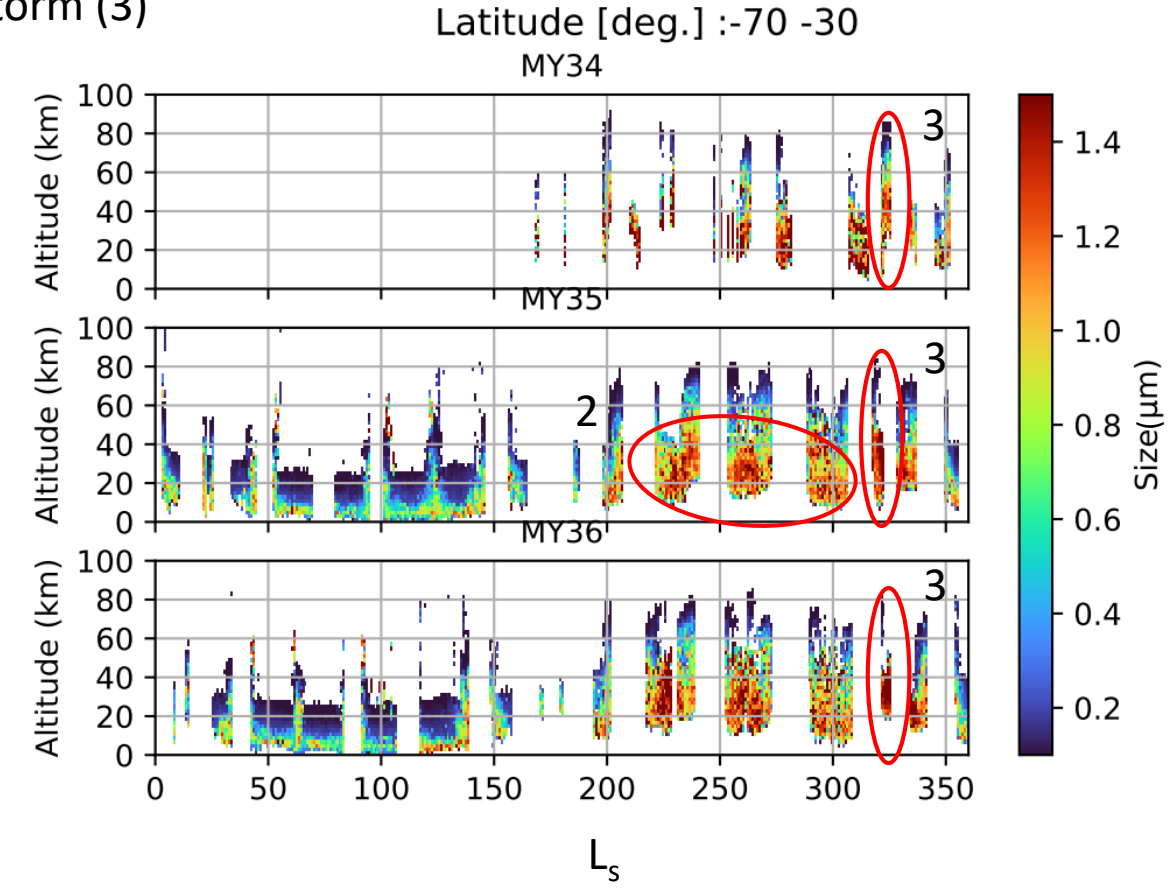


10 728 occultations were processed

Dust Climatology : Southern region

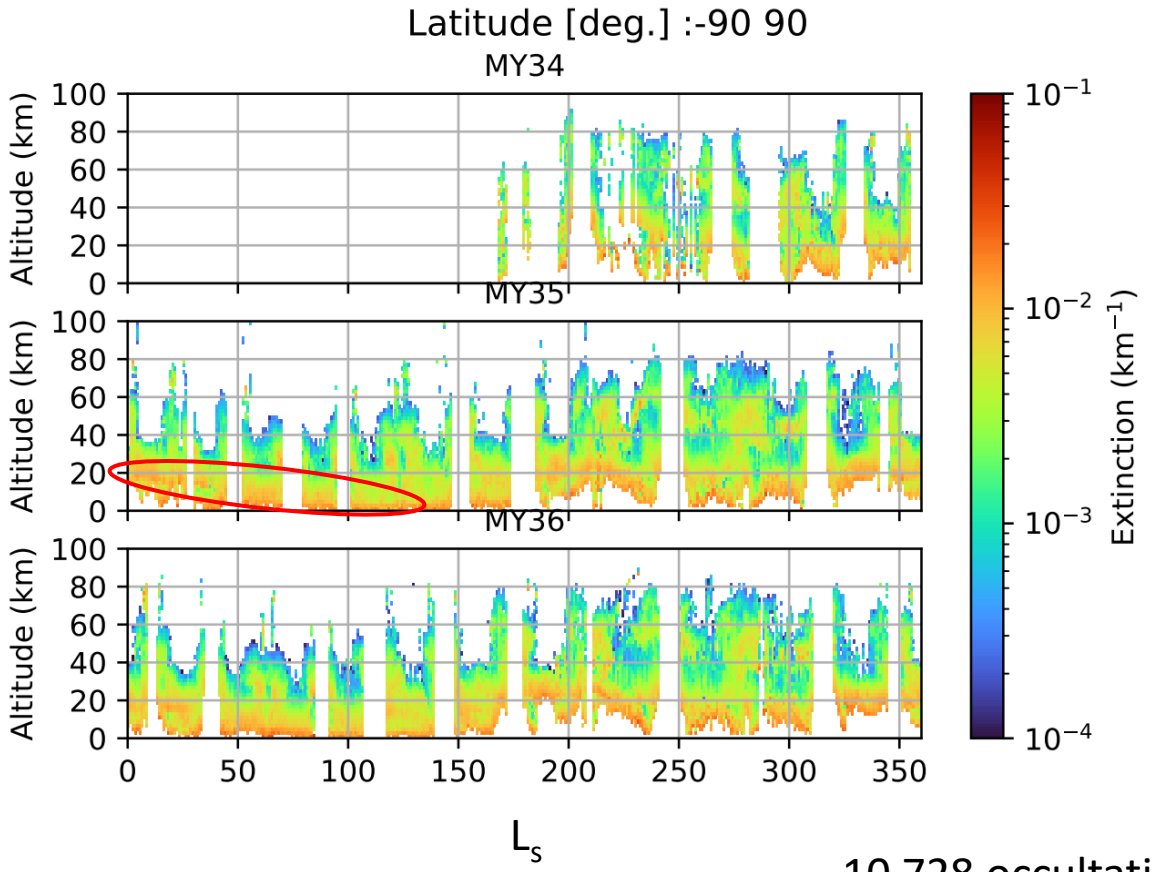
- Decrease of the extinction (1)
- Large particles at perihelion season (2)
- Local dust storm (3)

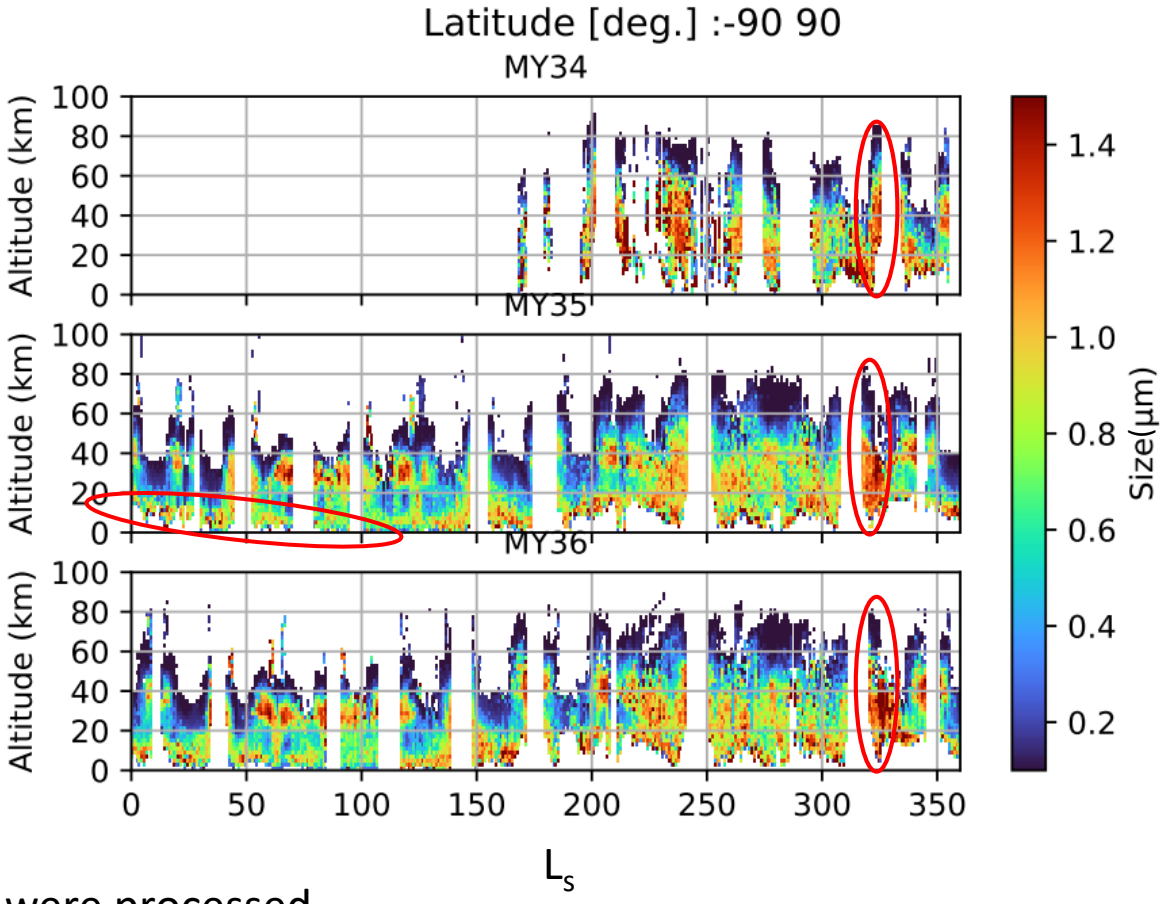




Extinction is the mean between 320 and 360 nm

Dust Climatology : All regions

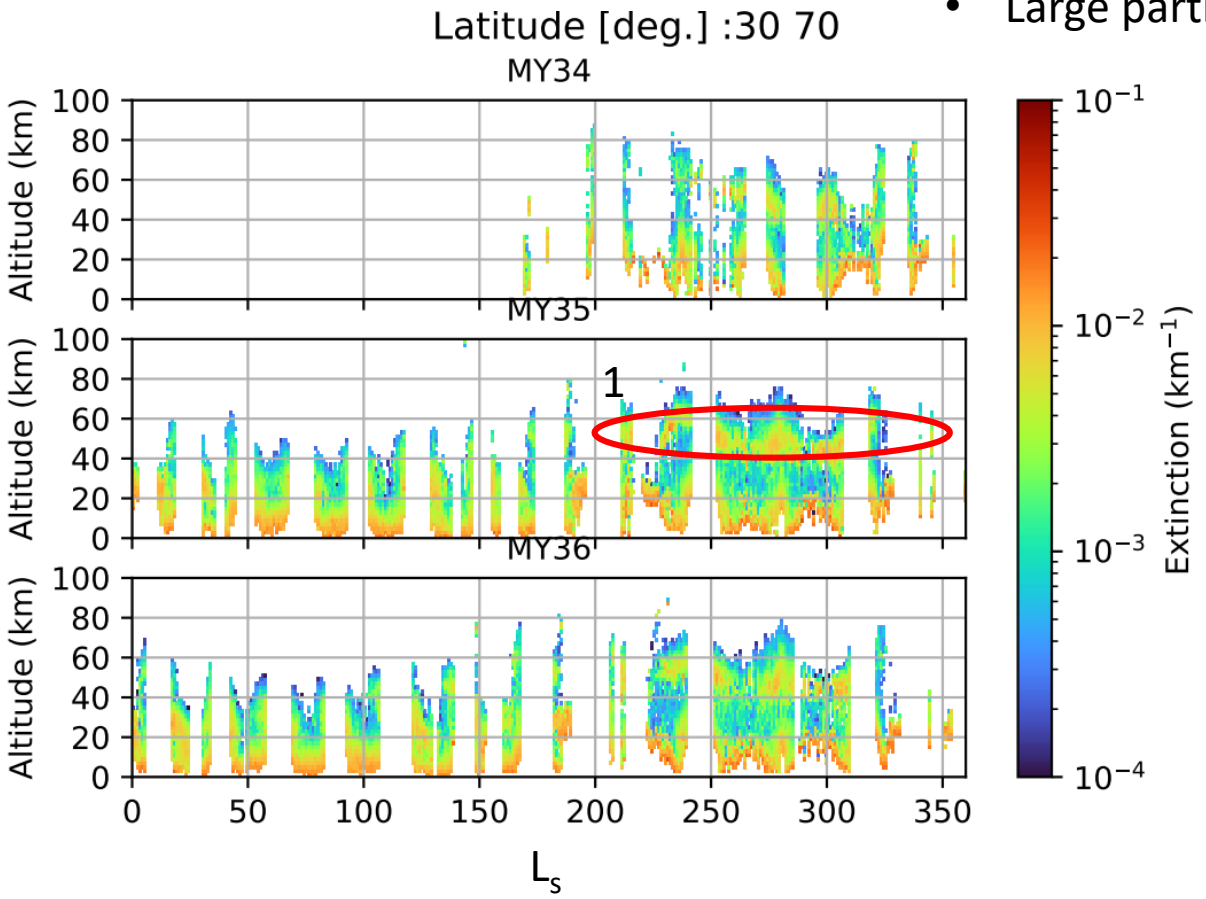


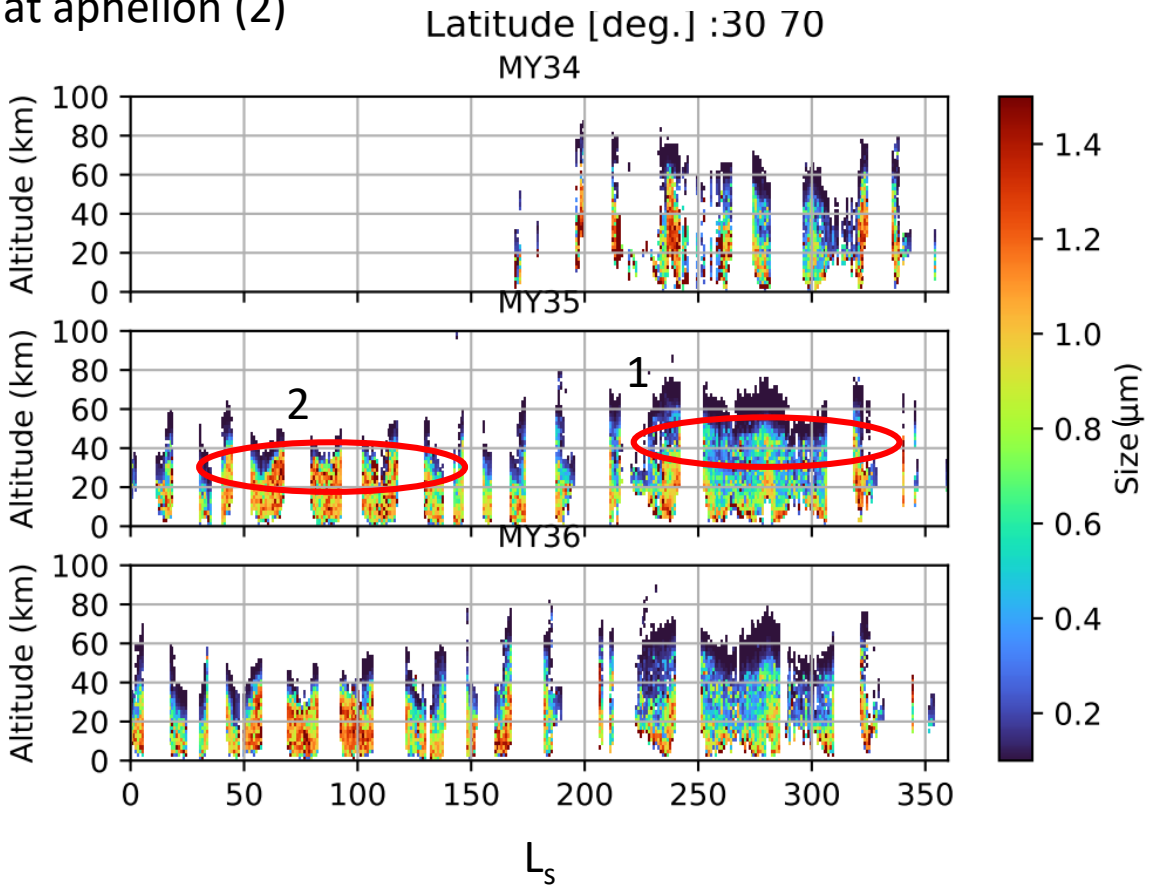


10 728 occultations were processed

Dust Climatology : Northern region

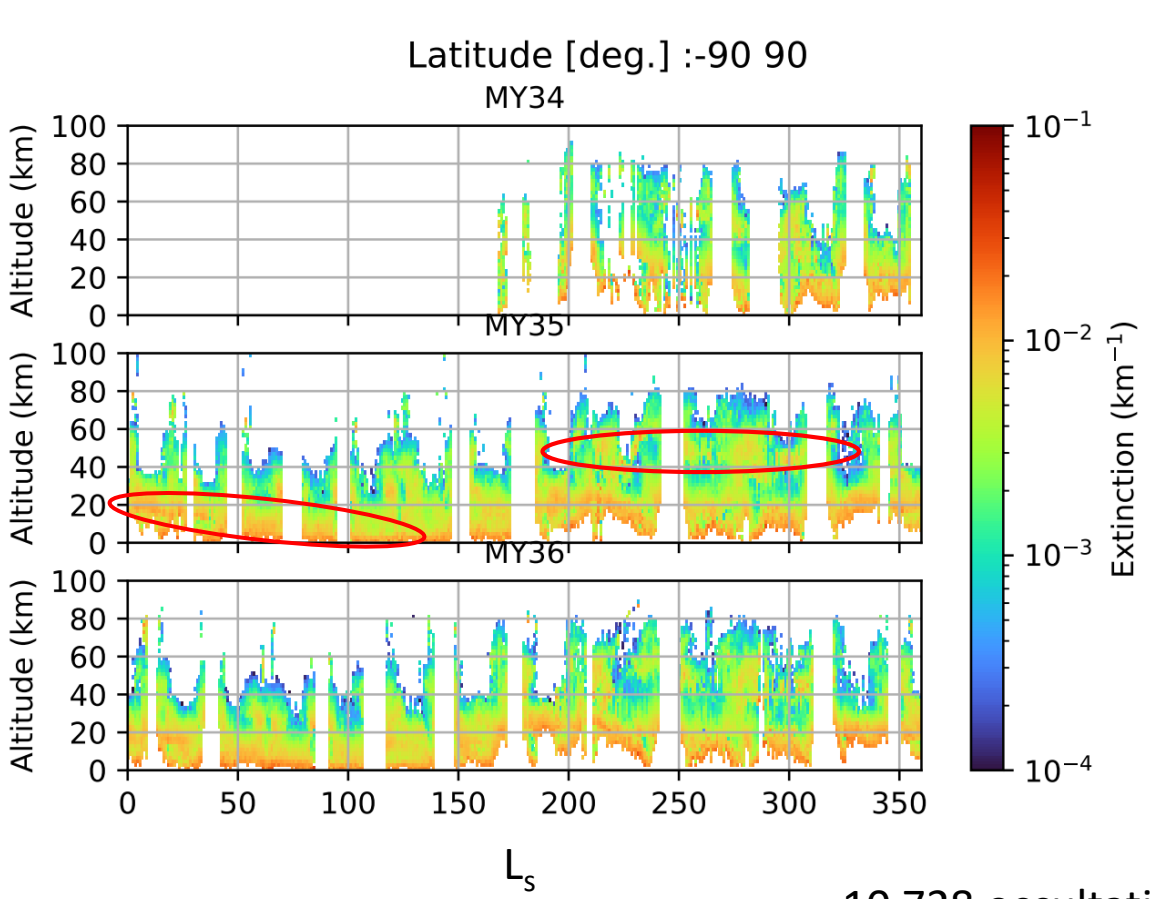
- Detached layer around 50km (1)
- Small particles in the detached layer
- Large particles at aphelion (2)

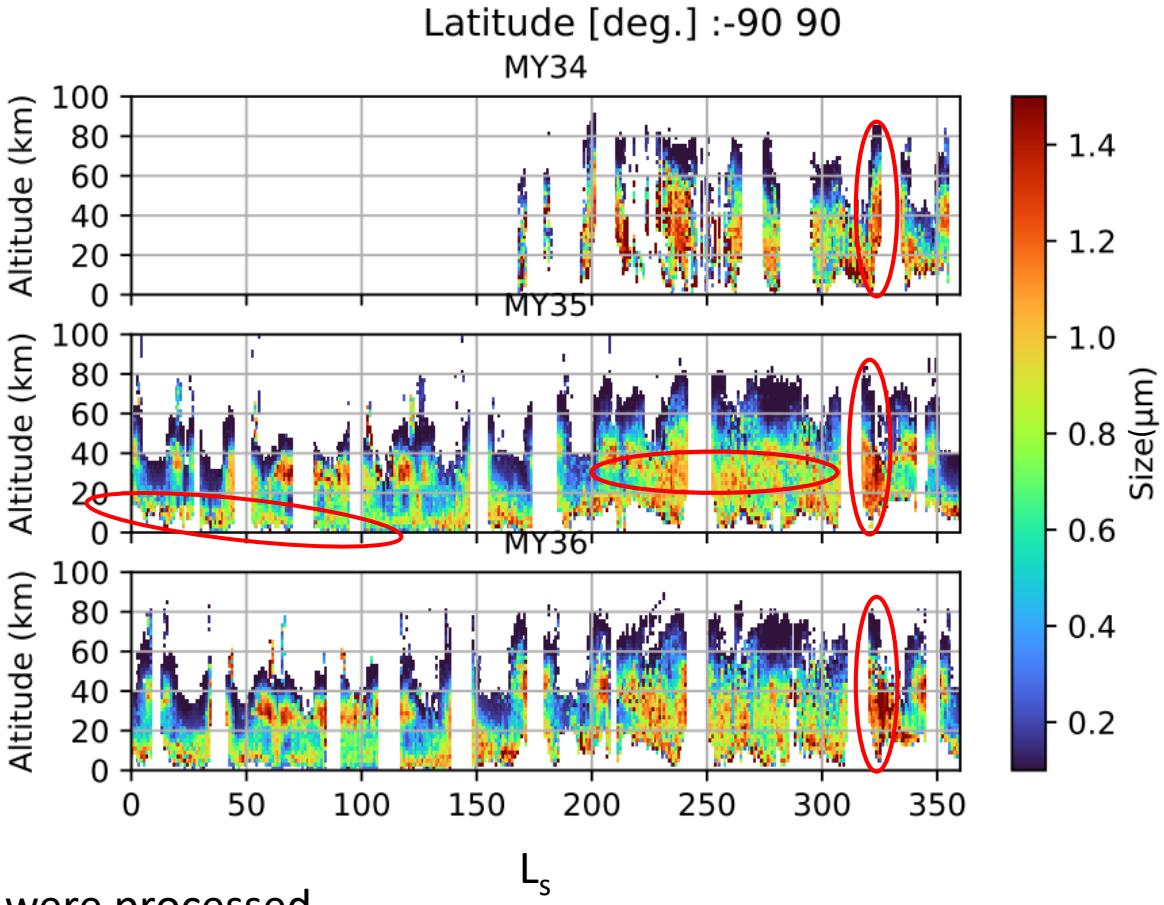




Extinction is the mean between 320 and 360 nm

Dust Climatology : All regions

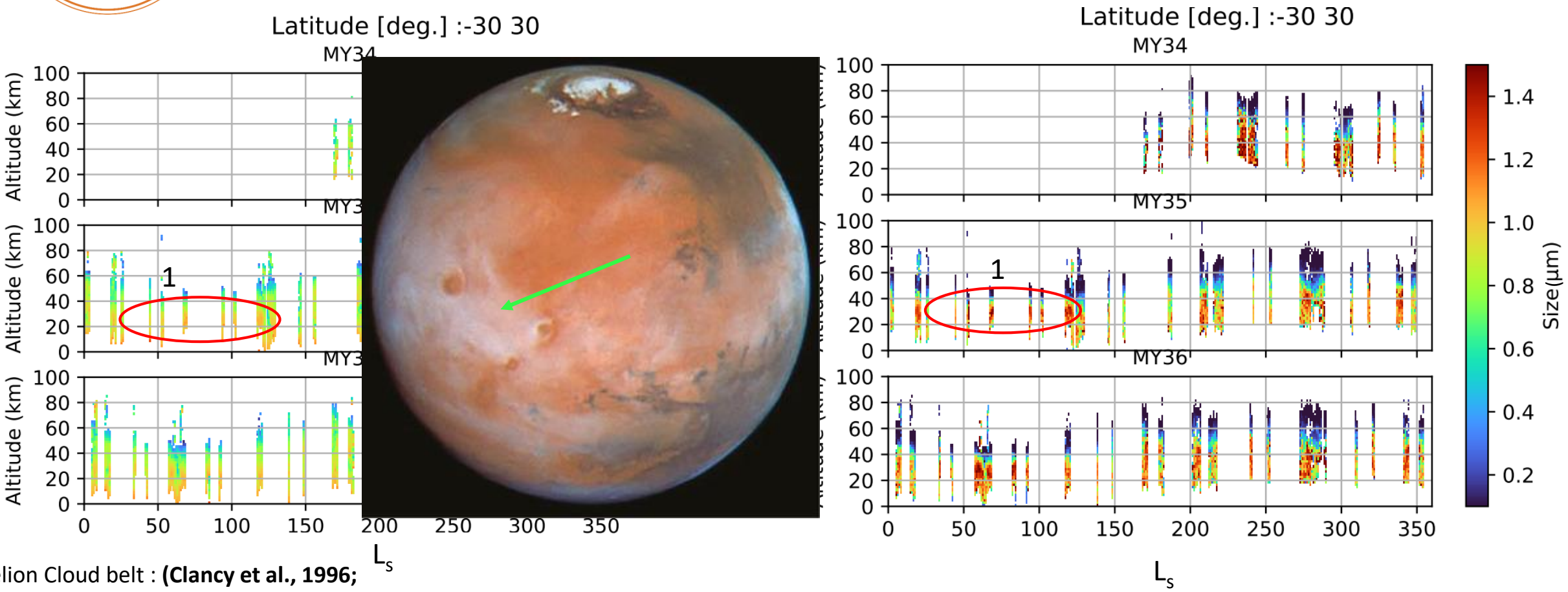




10 728 occultations were processed

Dust Climatology : Equatorial region

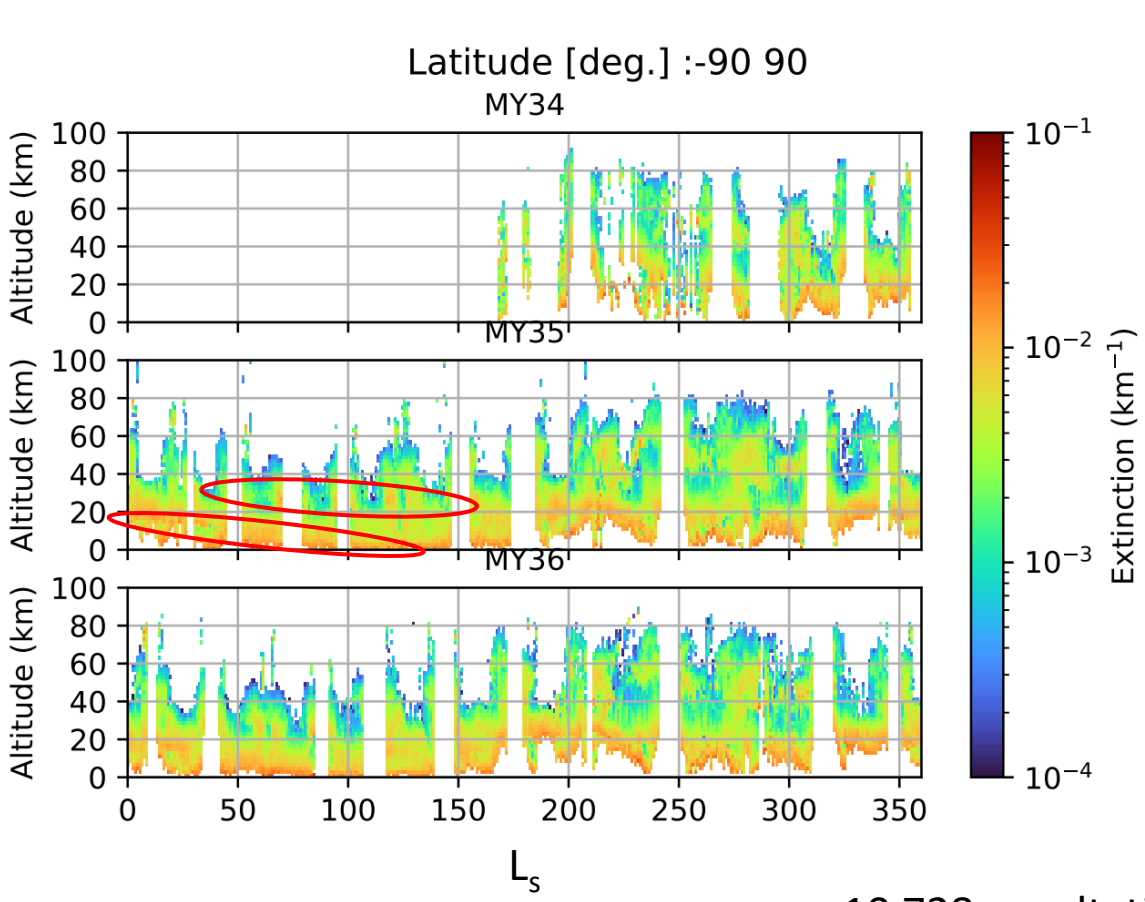
- Presence of detached layer → Aphelion Cloud belt (1)

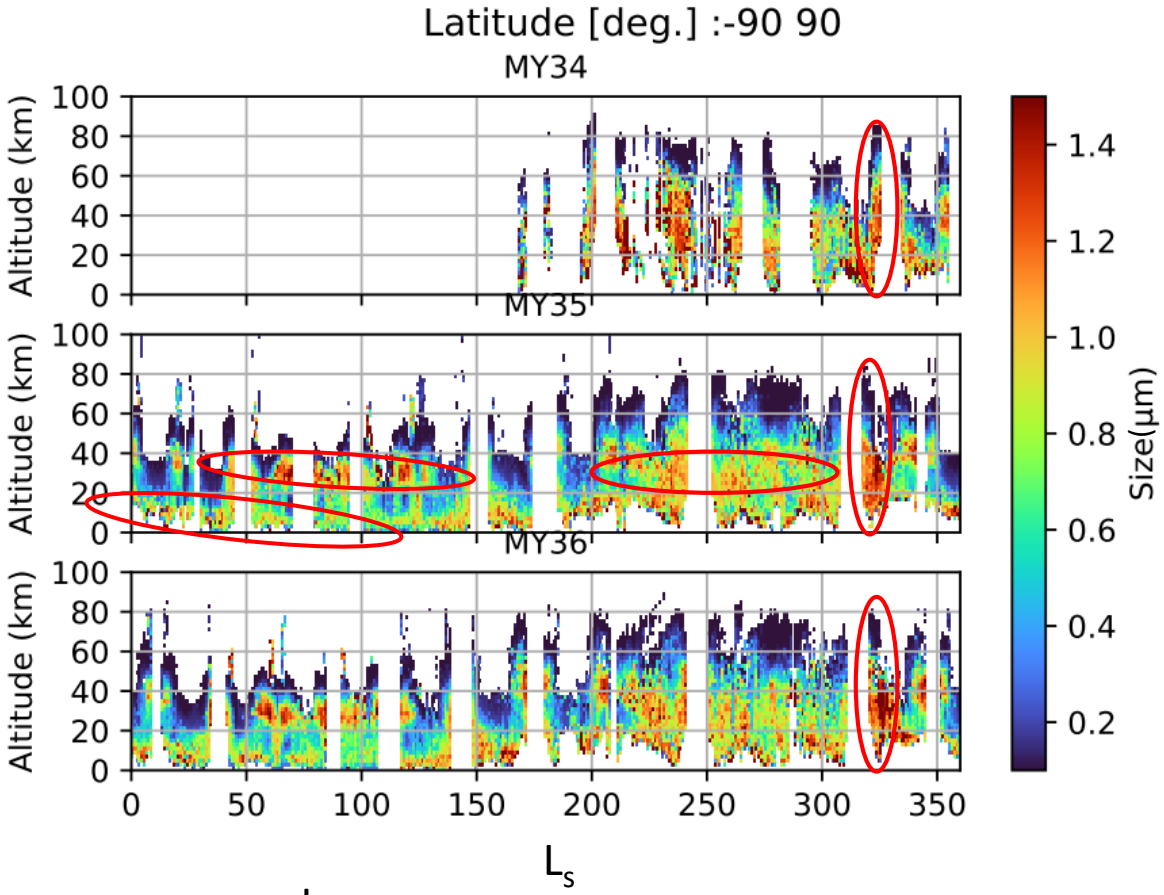


Aphelion Cloud belt : **(Clancy et al., 1996; Smith., 2004)**

Extinction is the mean between 320 and 360 nm

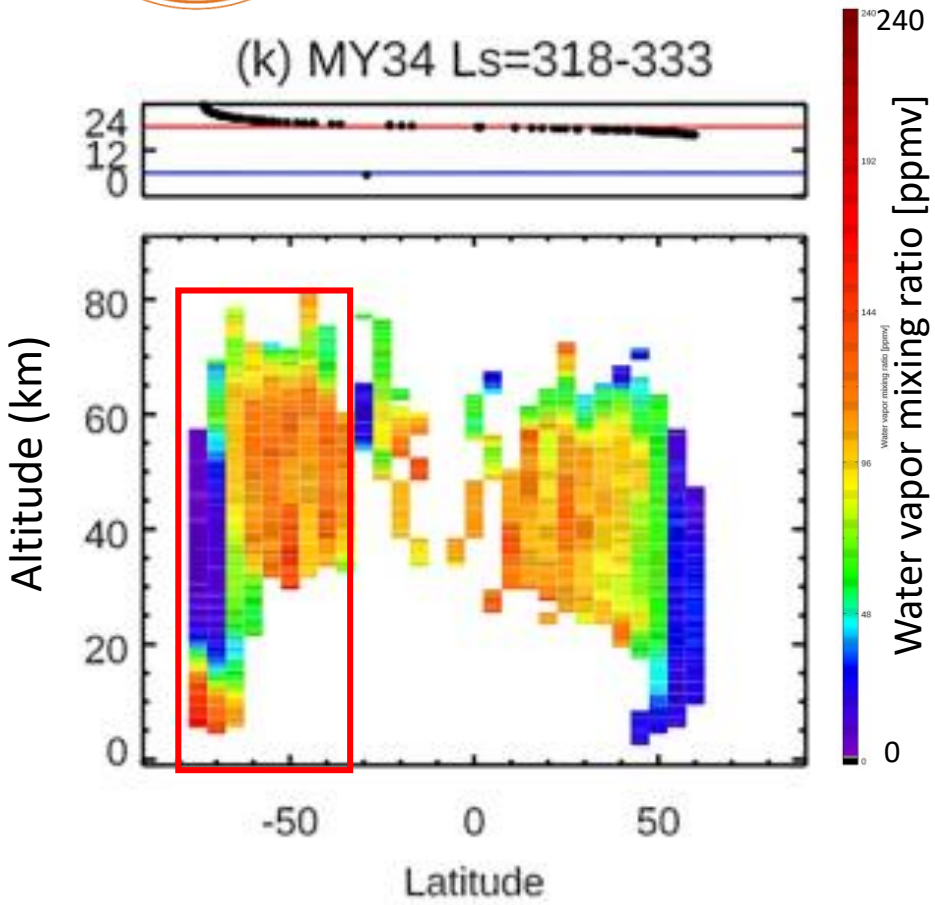
Dust Climatology : All regions

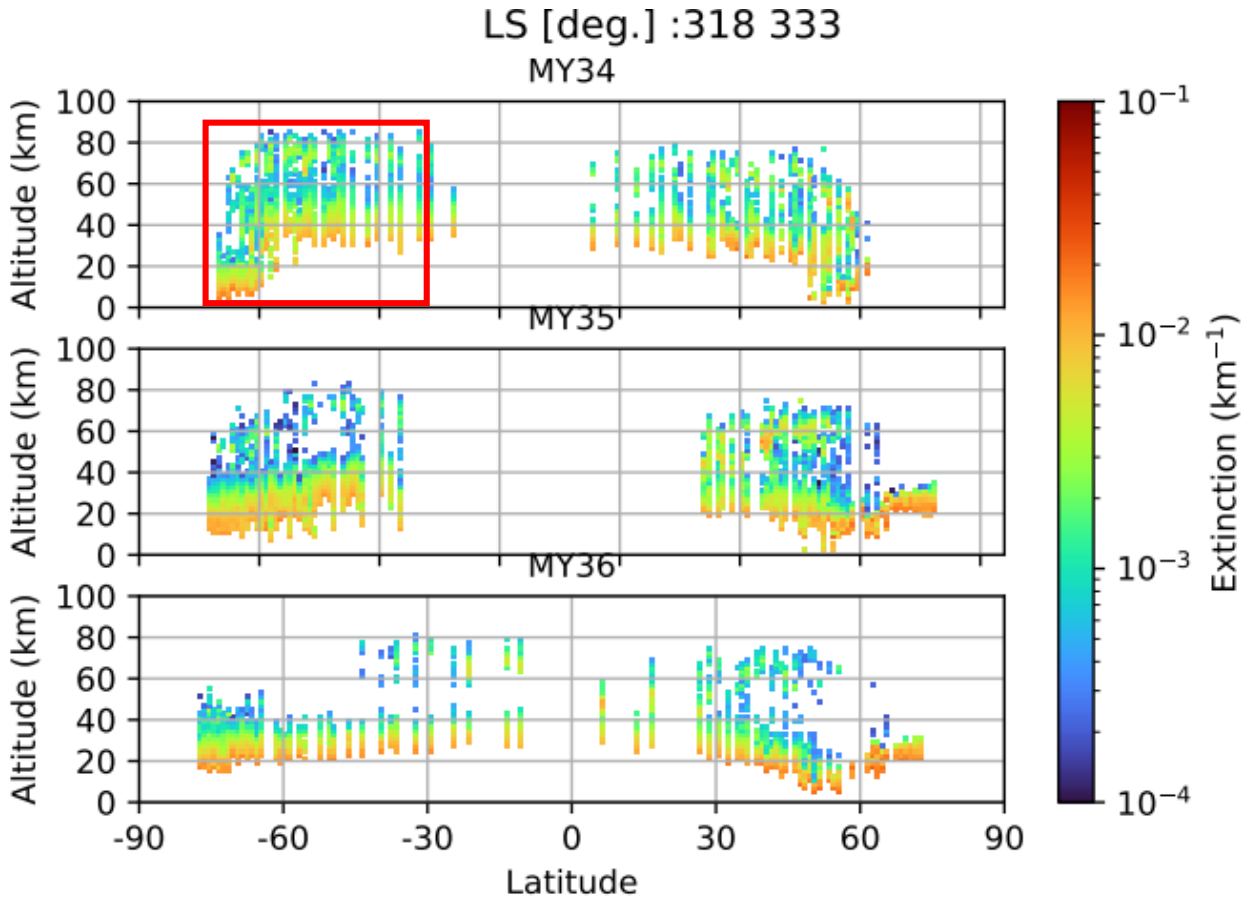




10 728 occultations were processed

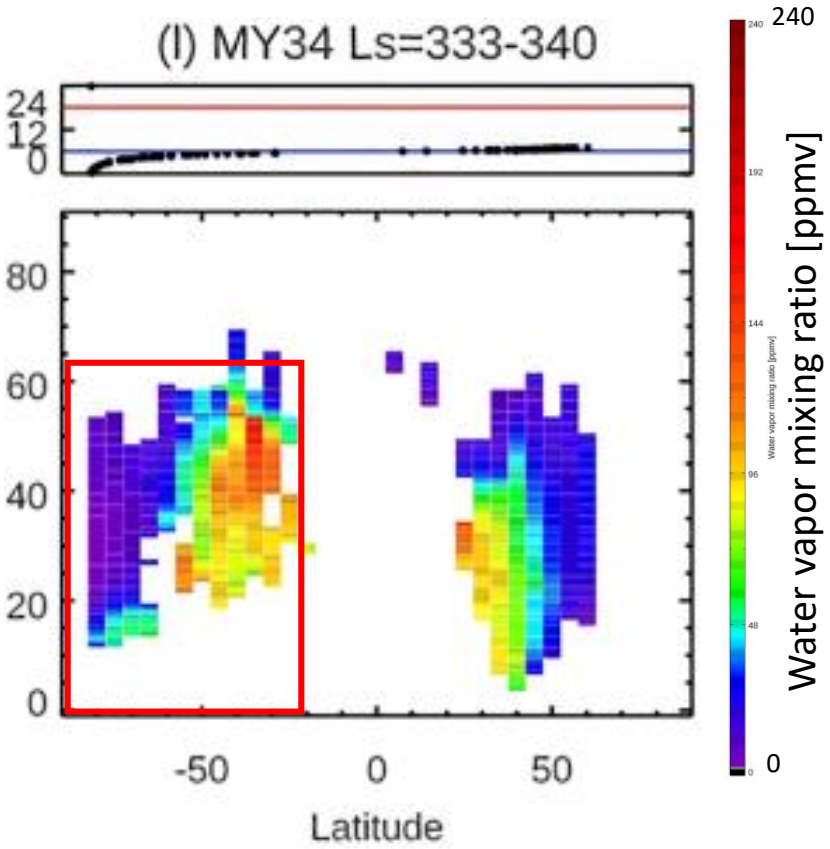
Link between dust and water vapor

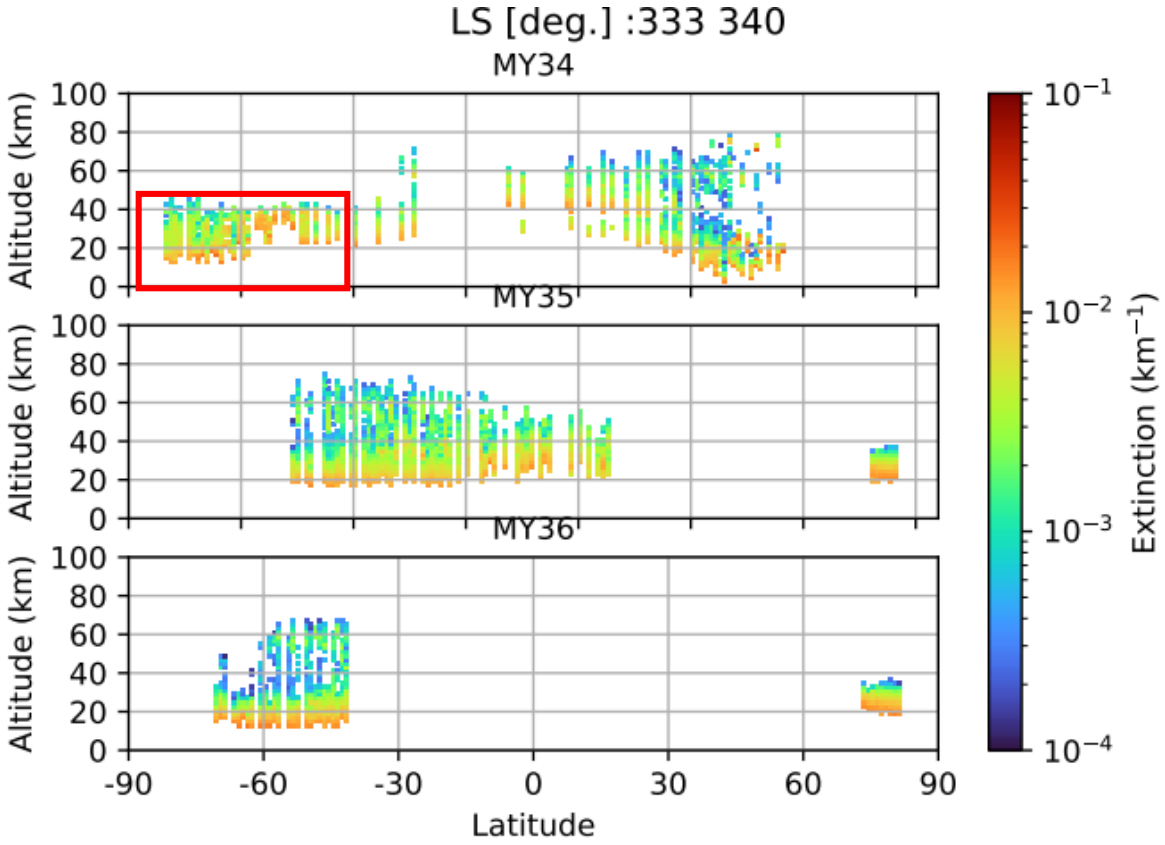




Water vapor profiles from Aoki et al., 2022 using the NOMAD SO channel

Link between dust and water vapor

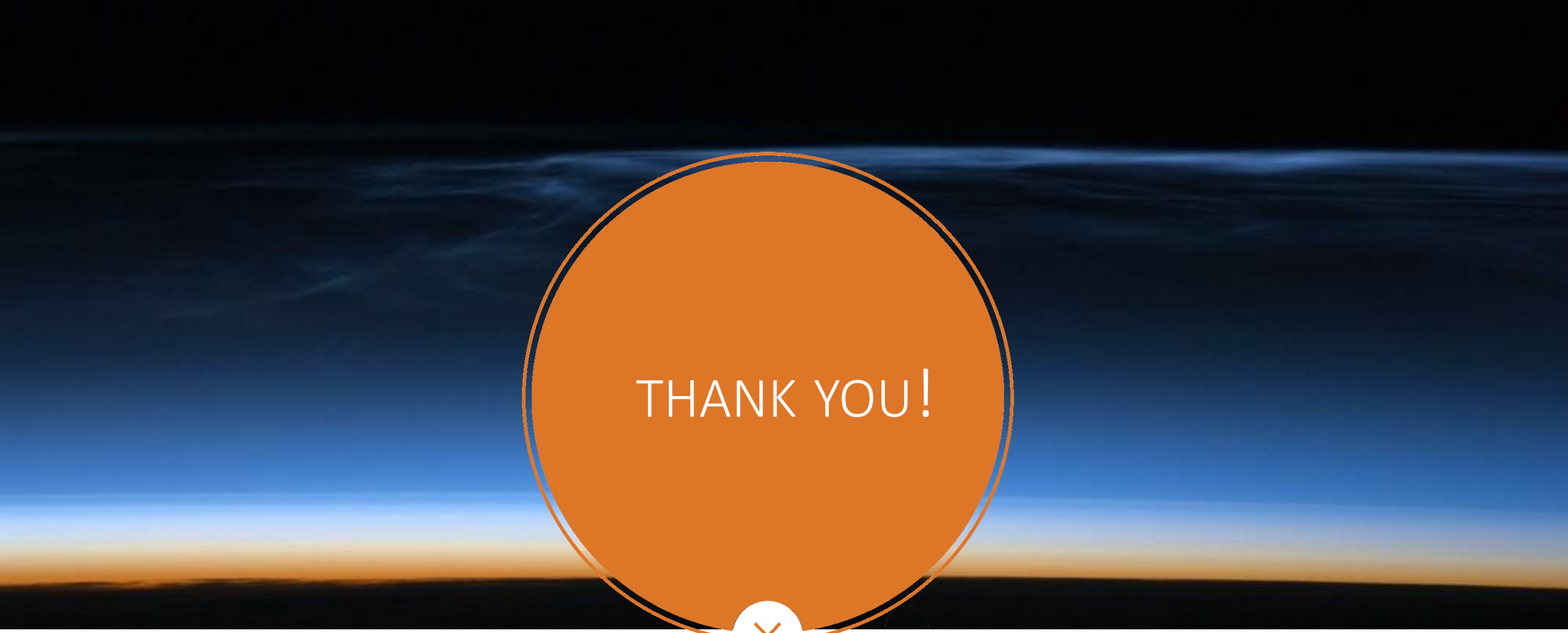




Water vapor profiles from Aoki et al., 2022 using the NOMAD SO channel

Summary

- No spectral differentiation between dust and ice in the UV-Visible
- They are seasonal and latitudinal variation for the aerosols
- Dust storm can be detected by the altitude or the particle size
- Link between the water vapor and the aerosols


THANK YOU!