Limb observations of dust vertical profiles

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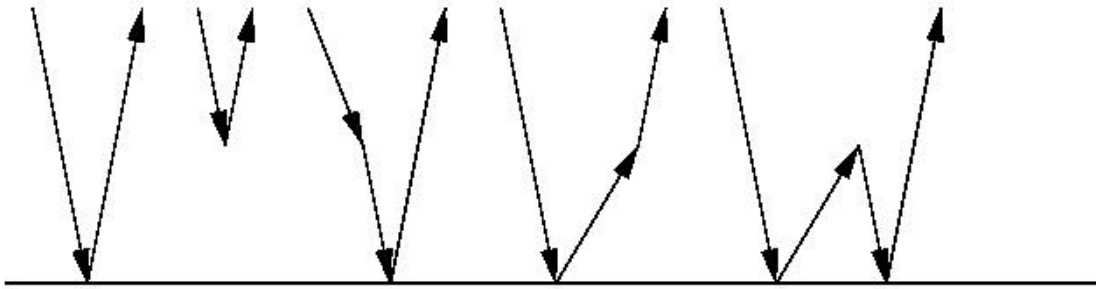
LESIA, IAS, MPI

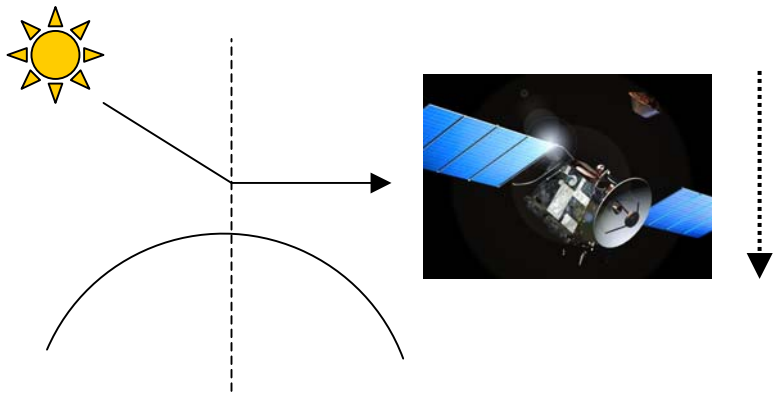
Aerosol observations on Mars

- Direct nadir observations : surface & atmospheric reflection



- Knowledge of surface albedo
- Or ….
  - Observations at optically thick wavelength
  - Observations of same region at different epochs
  - Observations with different phase angles
  - Limb observations

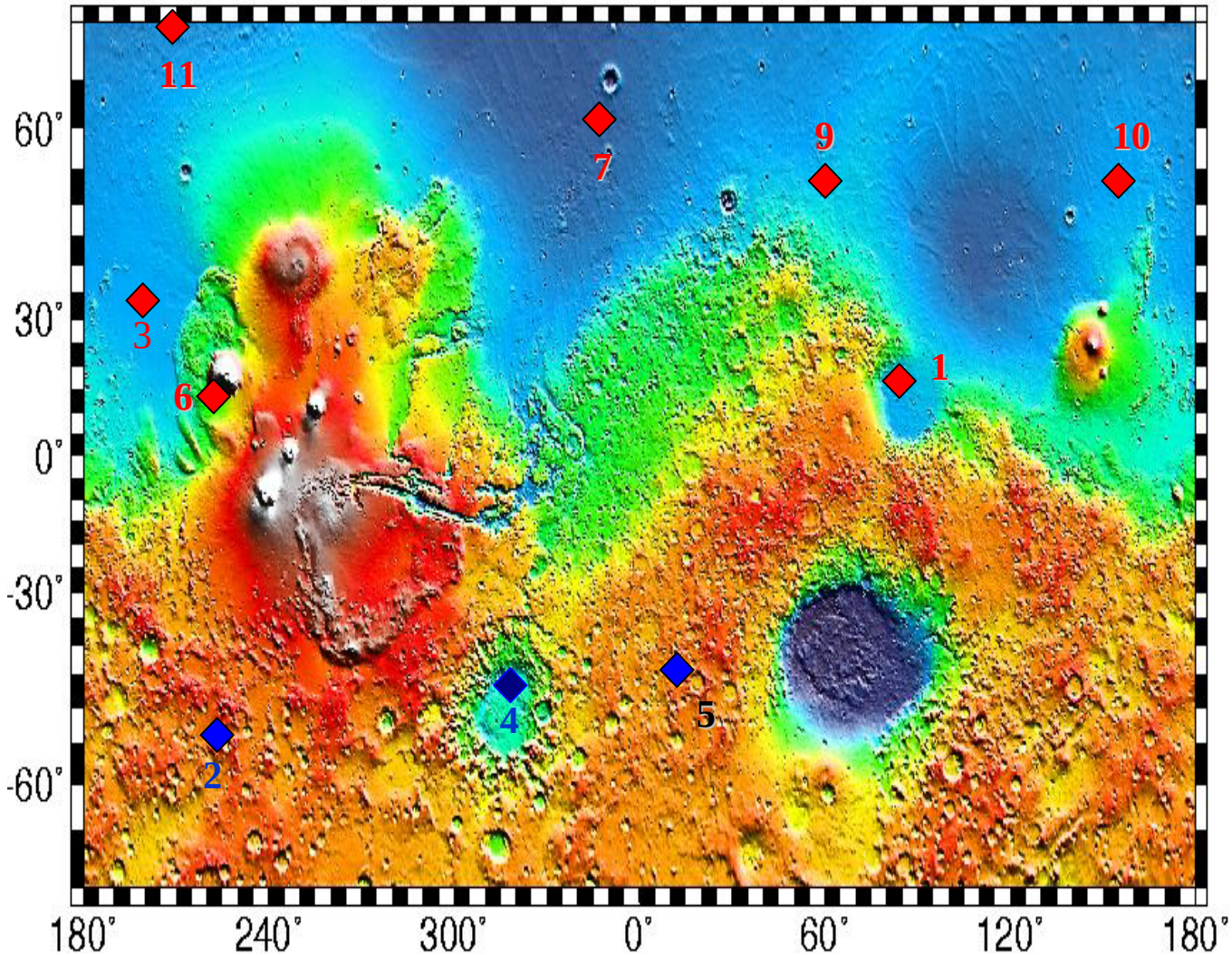
Limb observations of Mars



- Vertical scanning due to three-axis movement of the S/C : vertical resolution of ~2 km
- Omega is a mapping spectrometer : horizontal resolution of ~2 km
- 352 channels from 0.35 to 5.1 μm

Position of OMEGA limb observations

#	L_s
1	338°
2	343°
3	343°
4	17°
5	18°
6	54°
7	64°
8	73°
9	77°
10	113°

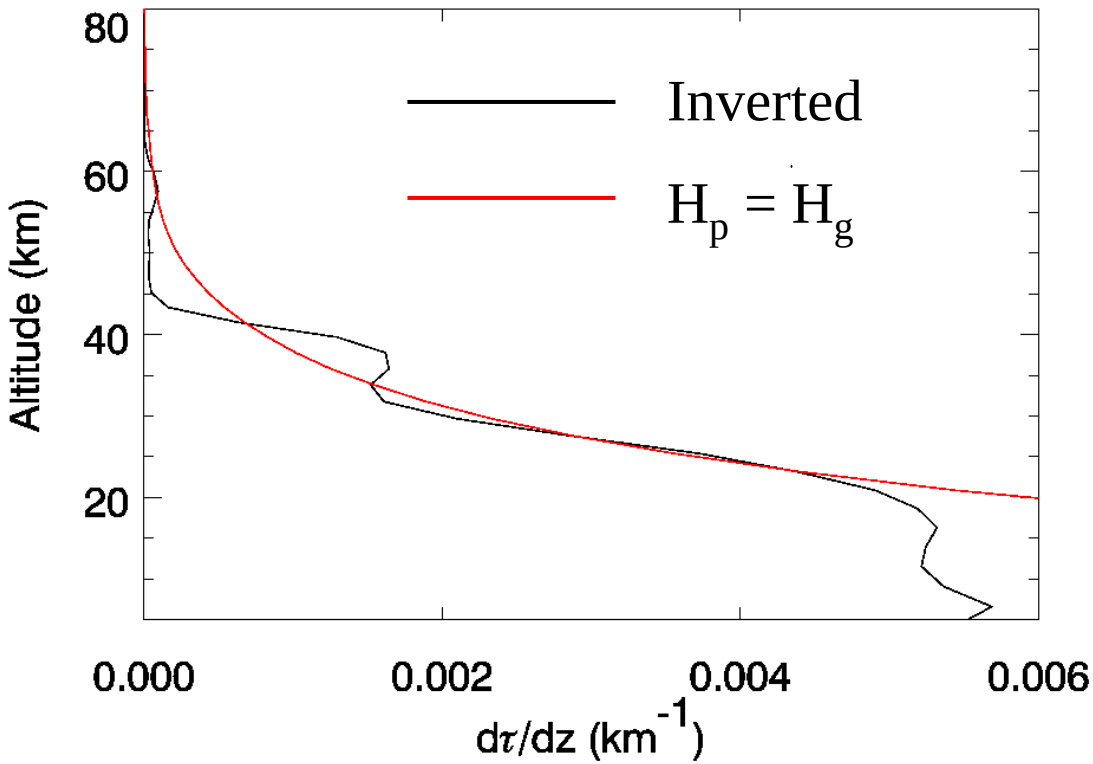


Radiative transfer code

- Two streams approximation
- ω_0 and τ_{ext} scaled for the forward scattering peak
- Source function calculated for horizontal layers and isotropic diffusion
- Emergent radiance calculated for horizontal or spherical geometry
- Coupled with line-by-line opacities
- Surface albedo retrieved from OMEGA nadir observations

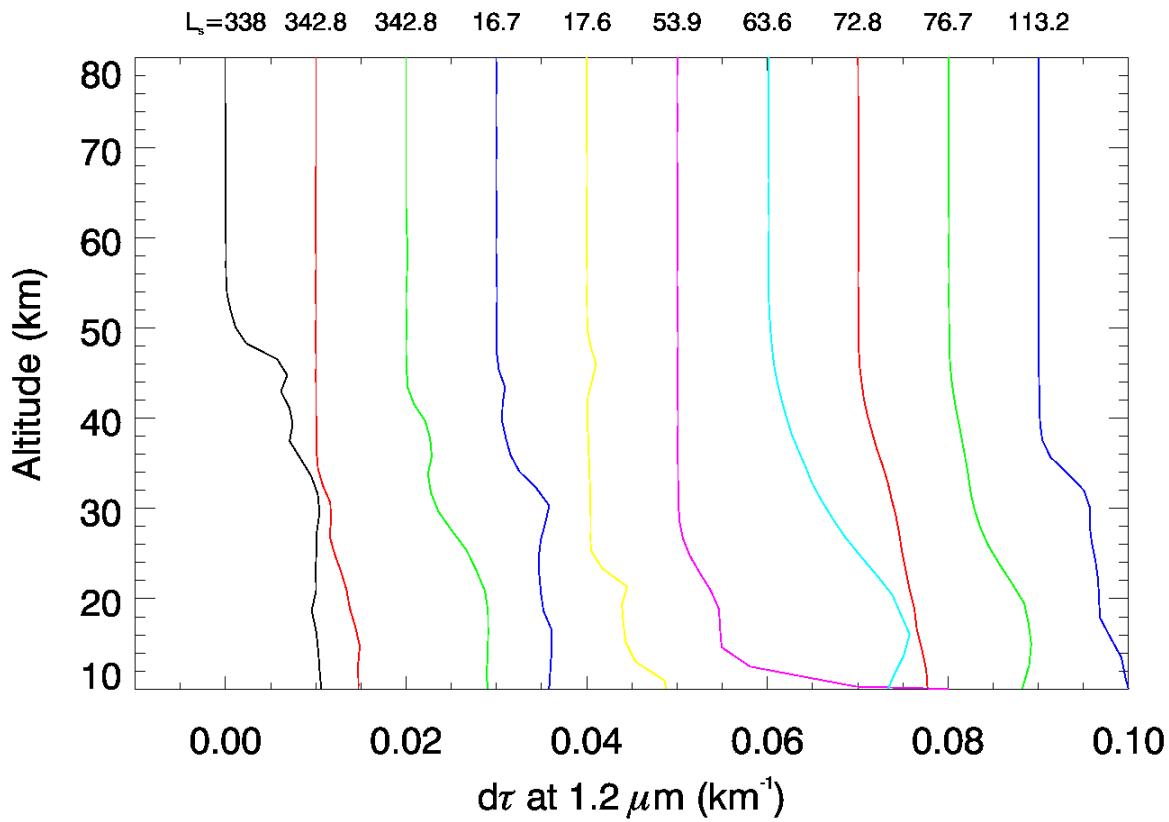
Inversion method

- Suggested by Jaquin et al (1986)
  - First estimation of source function $S = \omega_0 F_0 / 4\pi$
  - Invert the profile for $\tau(z)$
  - Update source function…Three iterations needed.



- L_s=342.8°
- λ=1.2 μm

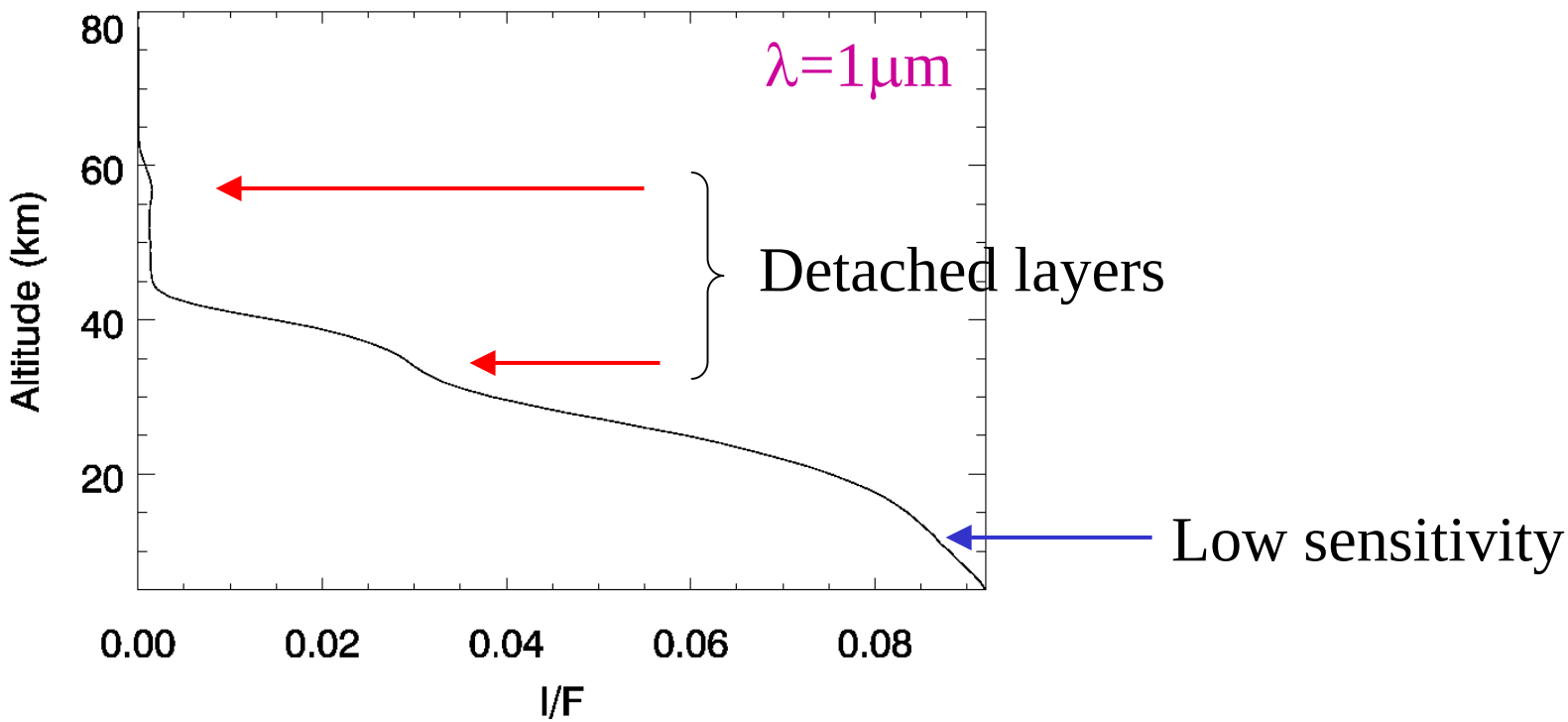
Vertical profiles at 1.2 μm



- Wide variety of vertical profiles
- Several detached aerosol layers
- Particles present up to 60 km high

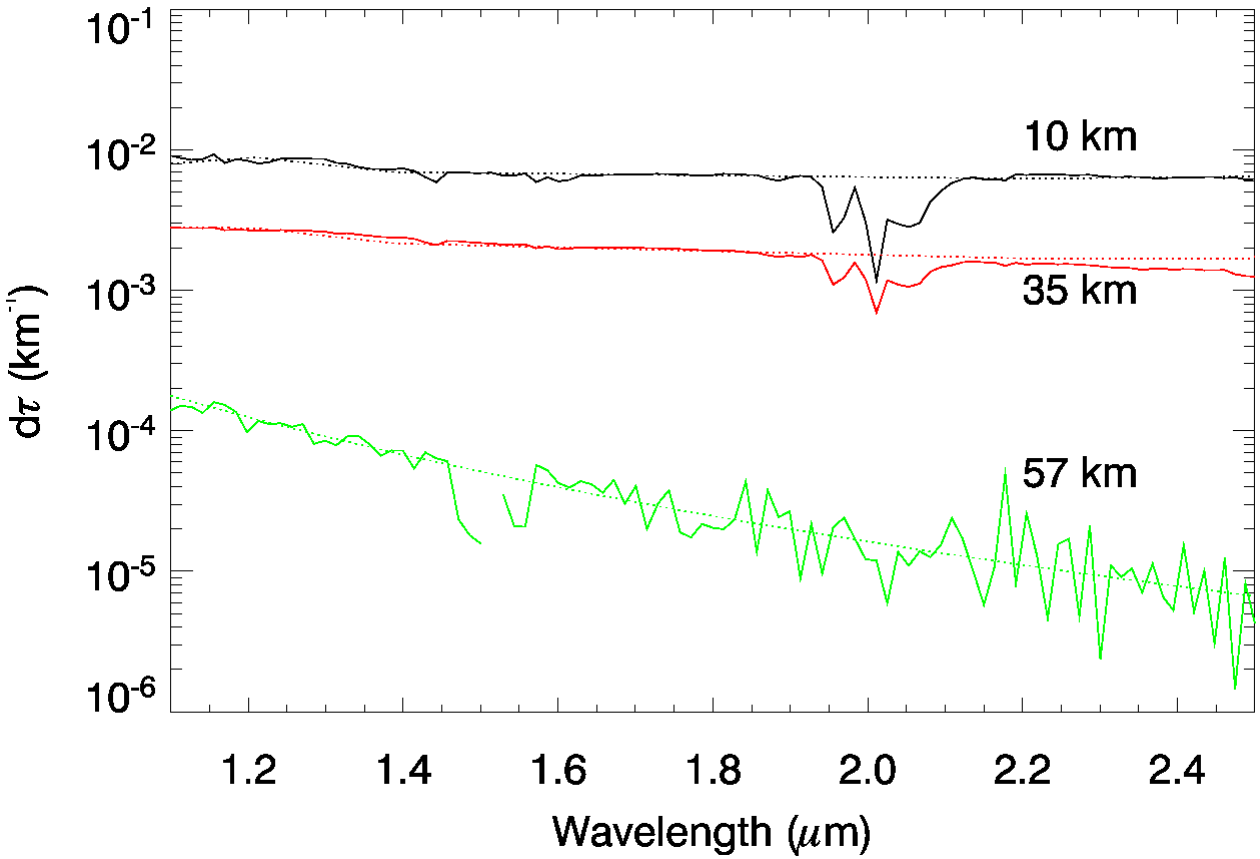
One particular profile

- Orbit # 72
- L_s = 342.8°, Lat=31.2°, E Long = 202°
- Horizontal average of 16 spectra



Dust particles size

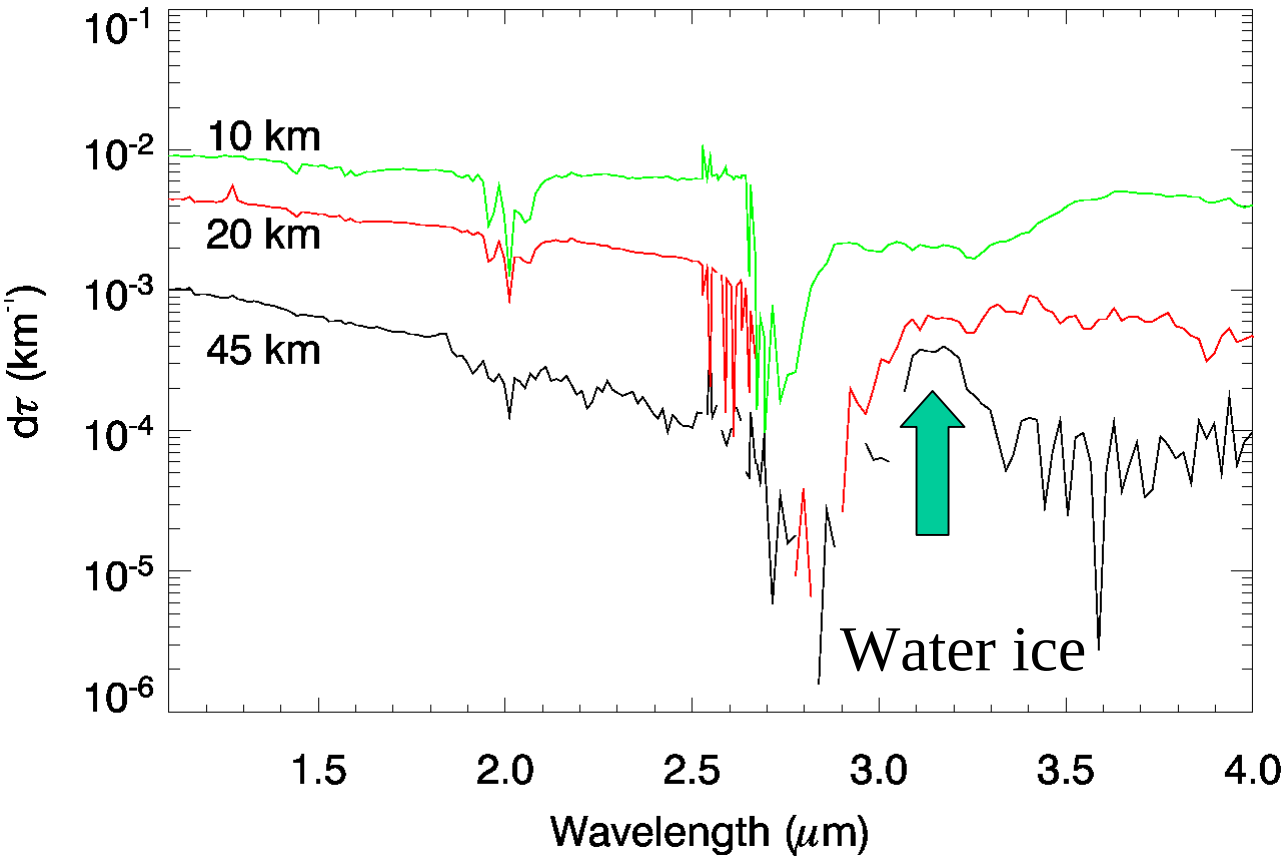
- Strongly varies with altitude
- Bimodal size distribution



- r =1.5 μm (20%) + r = 0.2 μm
- r =1.5 μm (1%) + r = 0.2 μm
- r < 0.2 μm

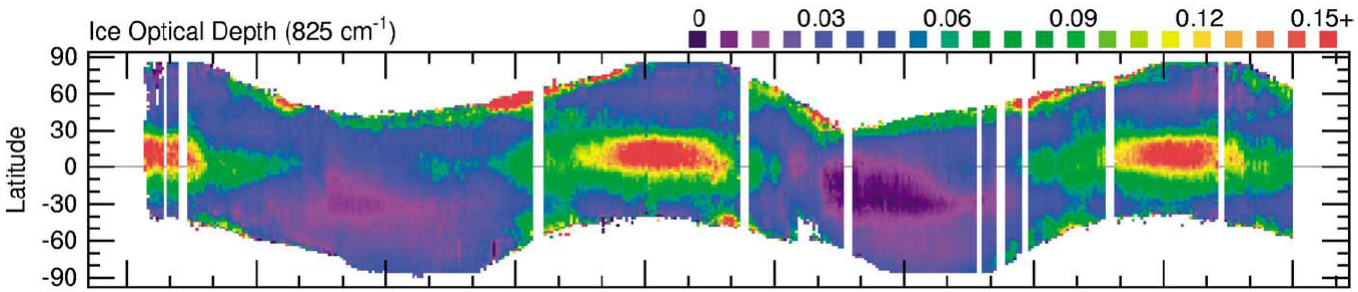
Sedimentation

- Detached haze layers are usually caused by particle sedimentation after by water condensation
- Do we see water ice associated with sedimentation?



τ_{ice} ~0.01

Water ice occurrence



L_s

Smith et al 2004

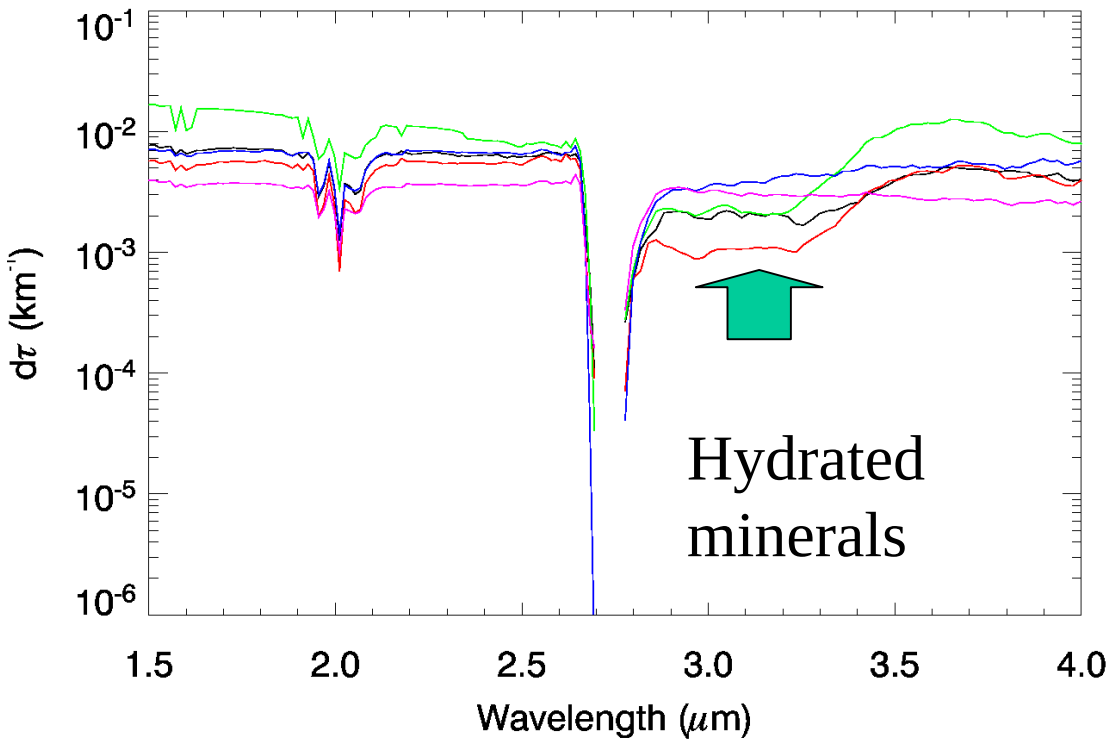
- Water ice layers around 40°S at L_s=17°

  11°N at L_s = 53

- Detached layers without water ice around L_s~340°
- No detached layers at L_s~70° in the Northern hemisphere
  - Polar cap retreat induces condensation close to the surface

Hydrated minerals

- The band intensity varies from orbit to orbit
- No clear relations with latitude and longitude
- Possible relations with L_S

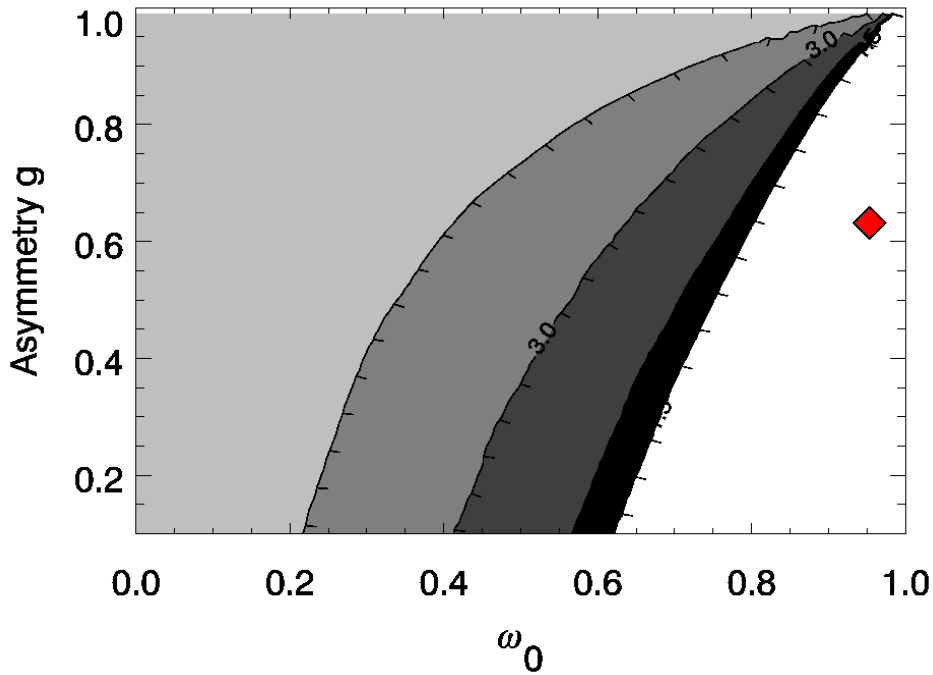


The band depth increases from L_s=340° to L_s=72°

Albedo and asymmetry parameters

Infrared channels

χ^2 for λ= 1 μm

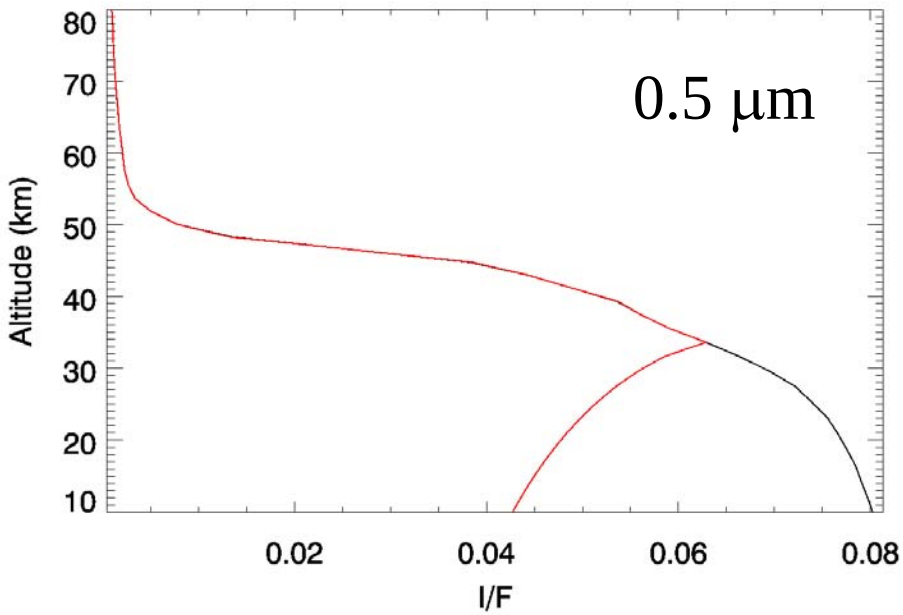


- ω_0 decreases or g increases $\Rightarrow \tau_{ext}$ must increase
- Saturation is reached at higher altitudes
- Reducing the goodness of fit

Lower (upper) limits consistent with Ockert-Bell model

Albedo and asymmetry parameters

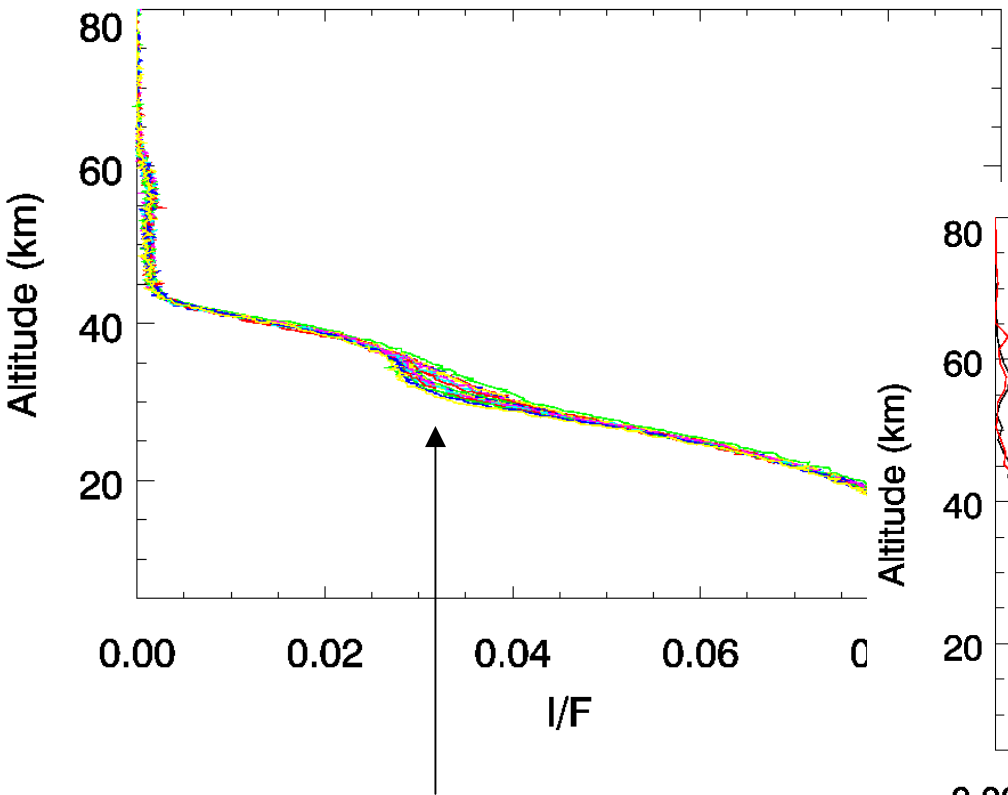
•In the visible channel, Ockert-Bell parameters must be change



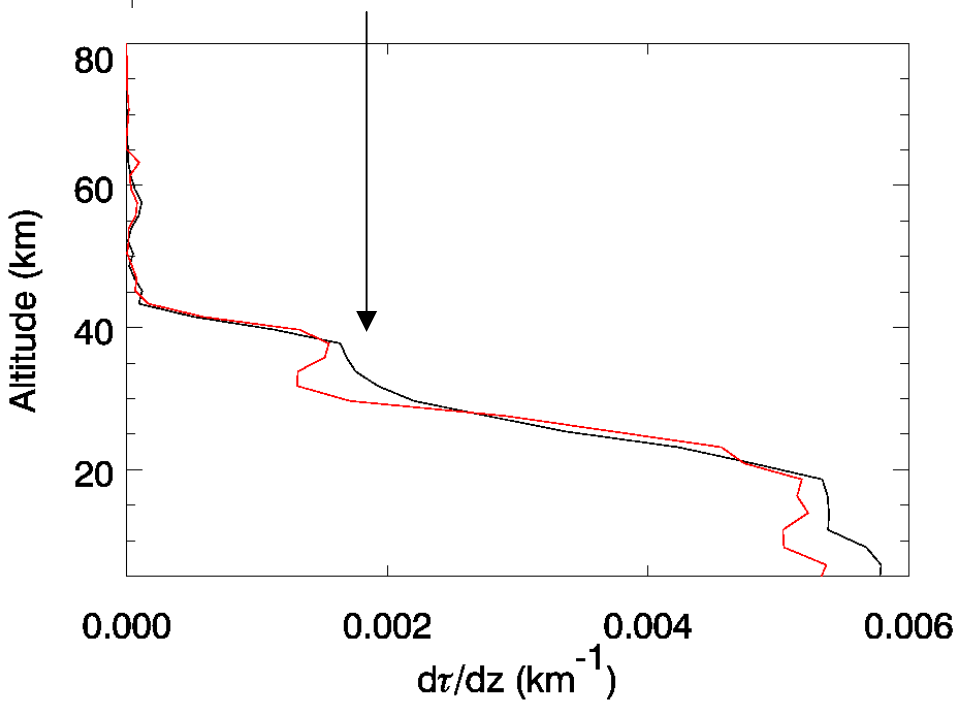
- $\omega_0 > 0{,}85$ at 0.4-0.6 μm
- Ockert-Bell : $\omega_0 = 0{,}6$
- Mineralogy implications

Horizontal gradients

Orbit 72, egress



- Opacity change of 25%
- Hints of steeper gradient
- Difference due to sedimentation?



Horizontal gradient in 30 km

Conclusions & Perspectives

- Evidence for particles segregation with size
  - Evidence for sedimentation and water ice clouds
- Large spatial and temporal variations
    - More limb observations to come
- Analyze spectral signatures of minerals
- See also CO_2 fluorescence by P. Drossart