Analysis of Spicam UV solar light scattered at the limb by aerosols

Rannou[1], P., Bertaux[1], J.-L., Quemerais[1], E., Perrier[1], S., Korablev[2], O., and Federova[2], A.
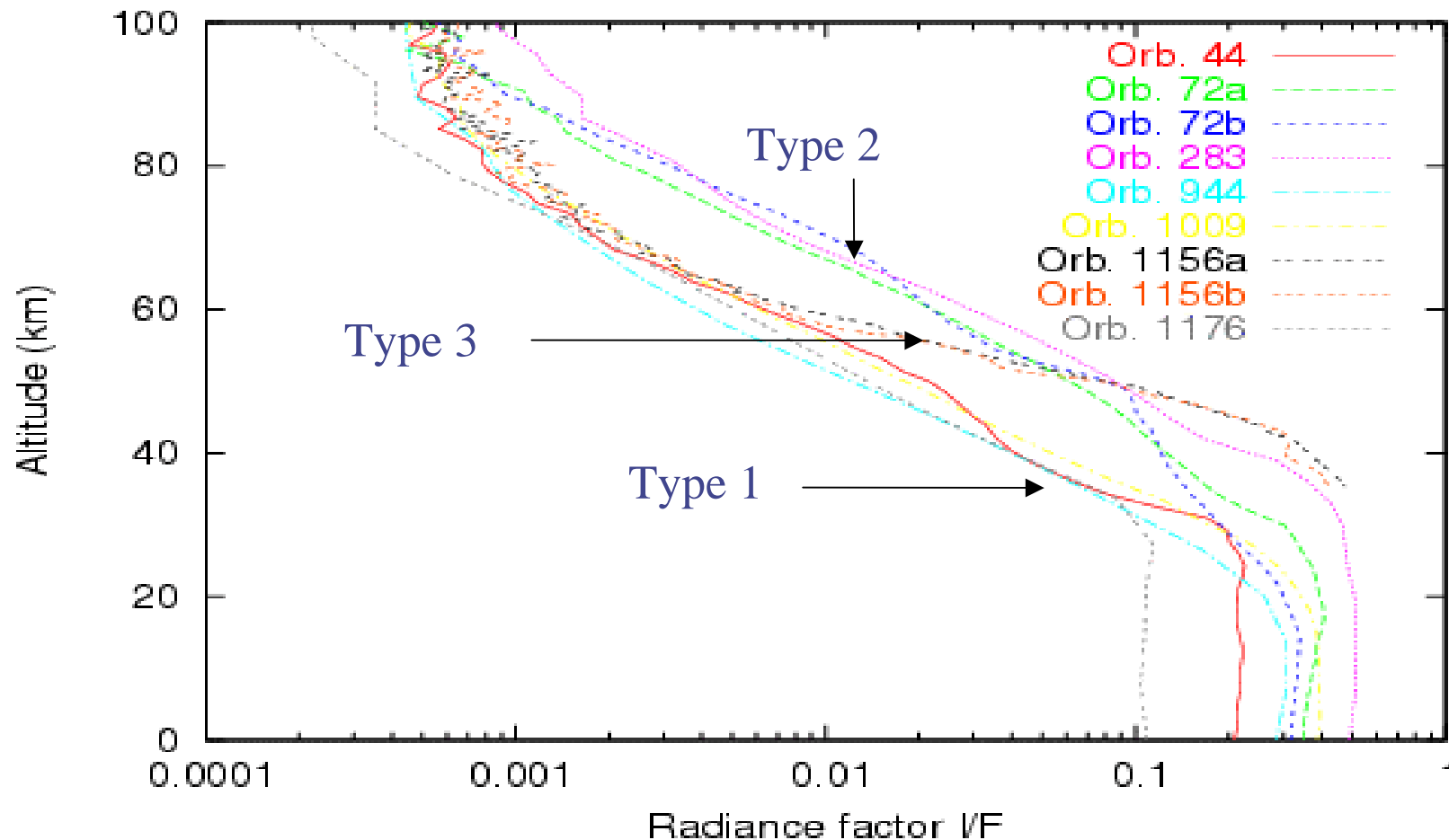
[1] Service d'Aéronomie, UVSQ/CNRS, B3, 91371, Verrières le buisson, FRANCE

[2] Space Research Institute (IKI), 84/32, profsouyouznaya, 117810, Moscow, RUSSIA

First Mars Express Science
Conference, ESTEC 23 Feb. 2005
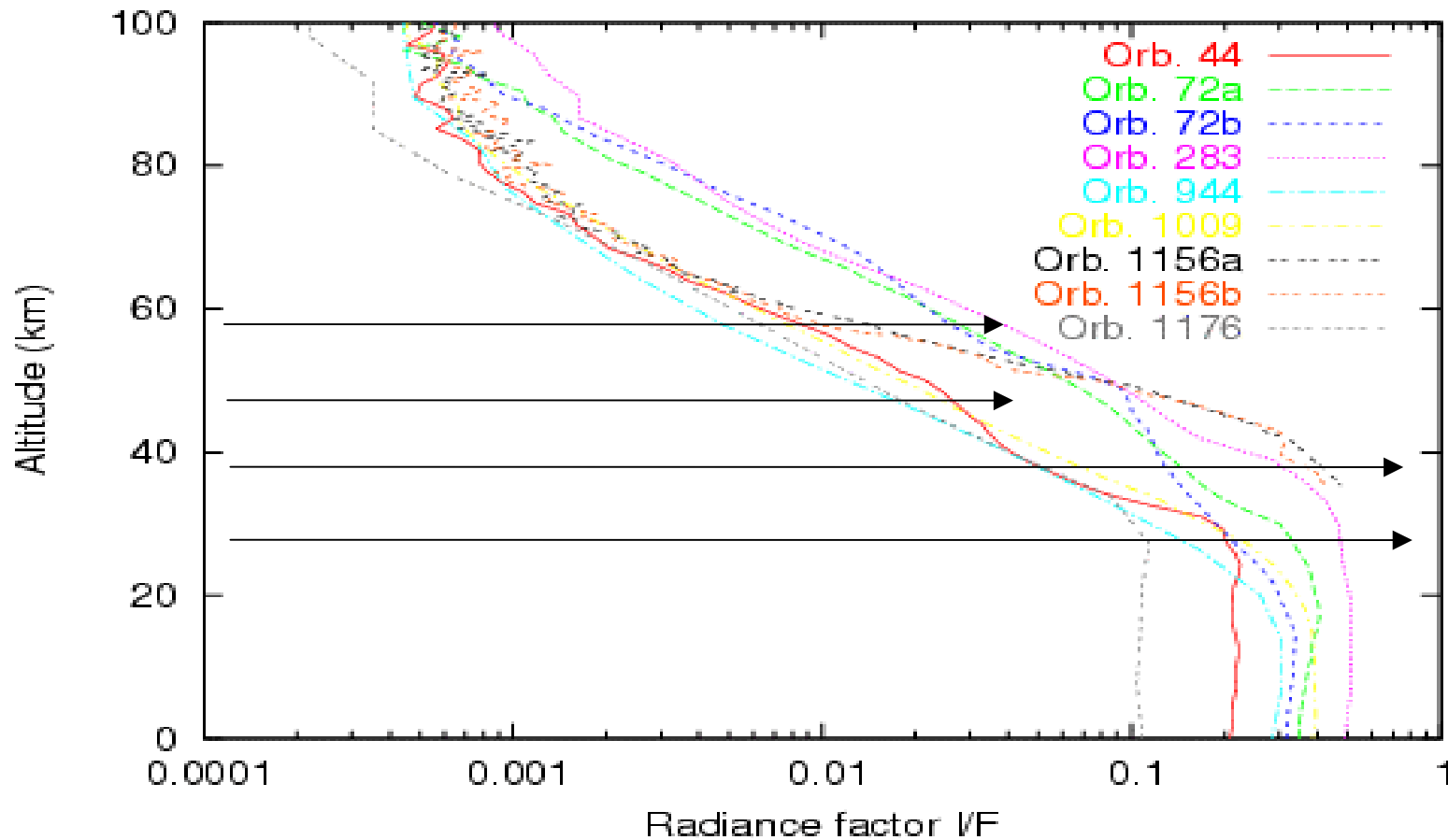SPICAM UV LIMB

SPICAM UV channel: 180-310 nm

◆ Sensitive to CO_2, O_3, ... and dust in the range 220-300 nm.

◆ Analysis of dust at limb with the radiance factor (I/F)

◆ 9 limbs analyzed here between Orb. 1 and Orb. 1176

Nine limb profiles at 250 nm (average 240-260 nm)

Three types of profile : low dust (type 1), high dust (type 2) and cross over (type 3)

We look at four different levels:

◆ Level 1= 35 km, level 2 = 45 km, level 3= 55 km and level 4 = 65 km

◆ Low tangential opacity above 30 or 40 km (depending on cases).
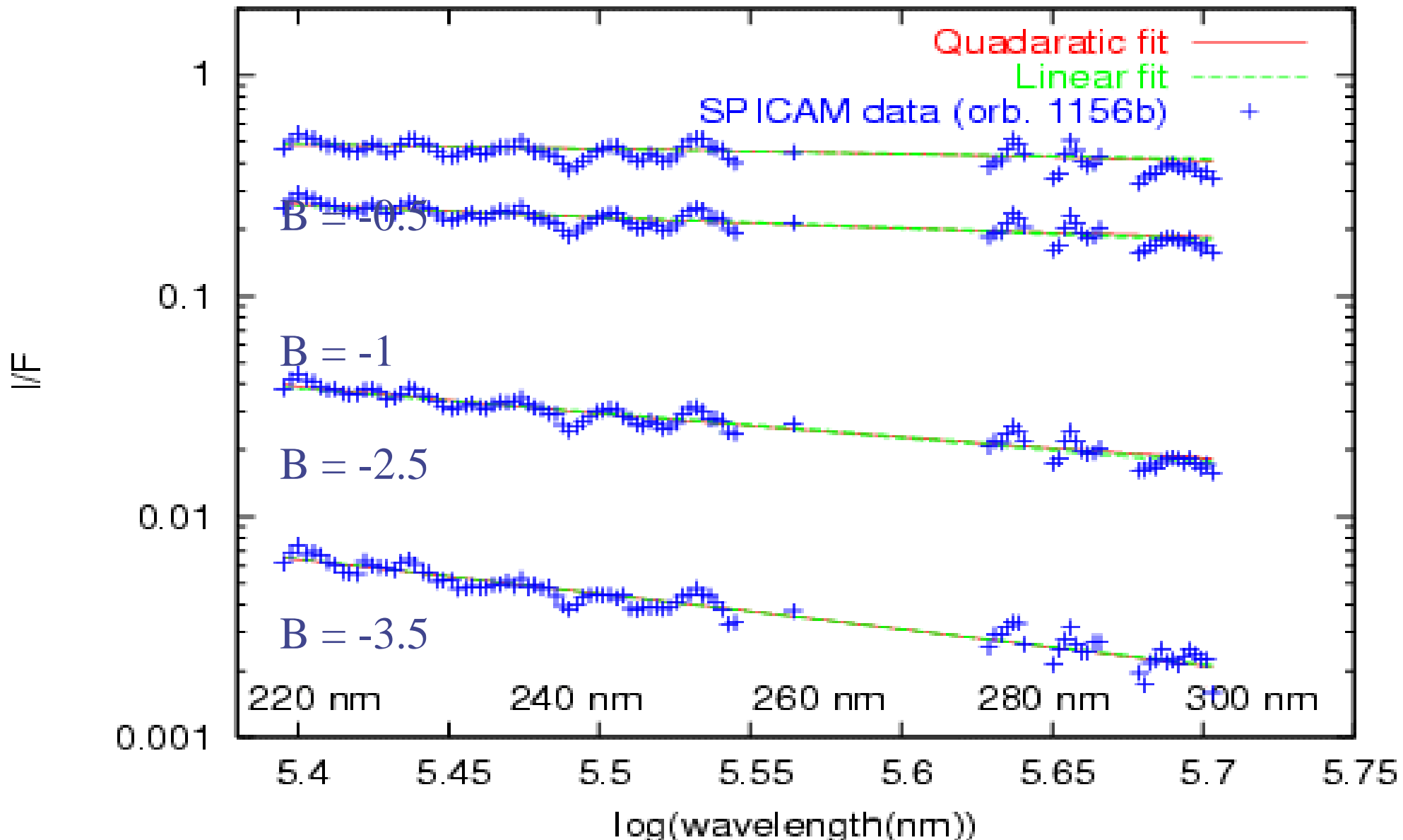
First, we study the spectral behavior of I/F

◆ For each of 4 levels, and each orbit, we seek for a law
$\log(I/F) = A + B \log(\lambda)$

◆ At limb, high altitude scattered intensity primarily depends on the quantity
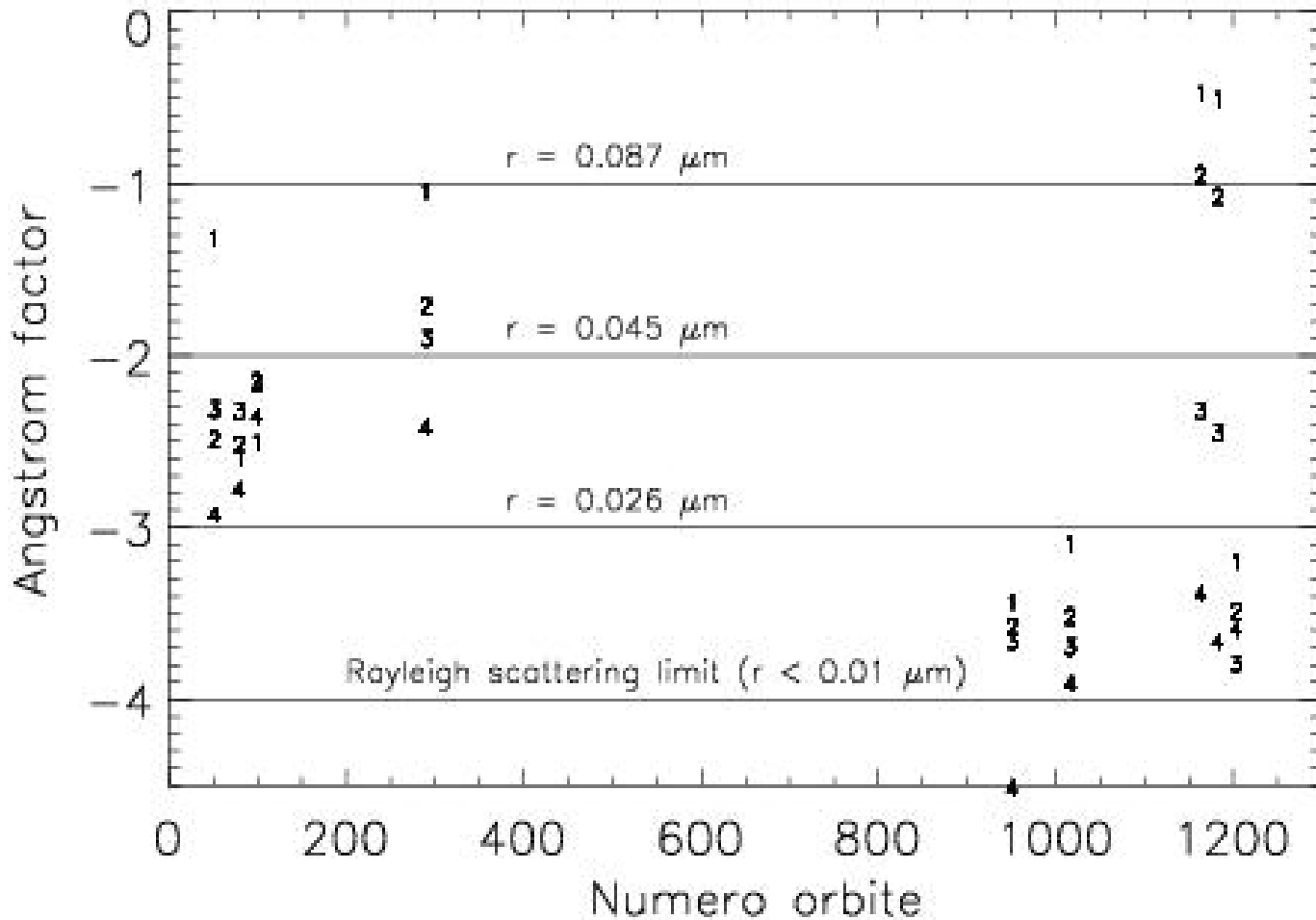
*

$I/F \sim \beta \omega P(\phi),$
where β – extinction coefficient; ω – single scattering albedo

◆ The coefficient B (Angstrom coefficient) gives information on the colour index, and thus on particle size.

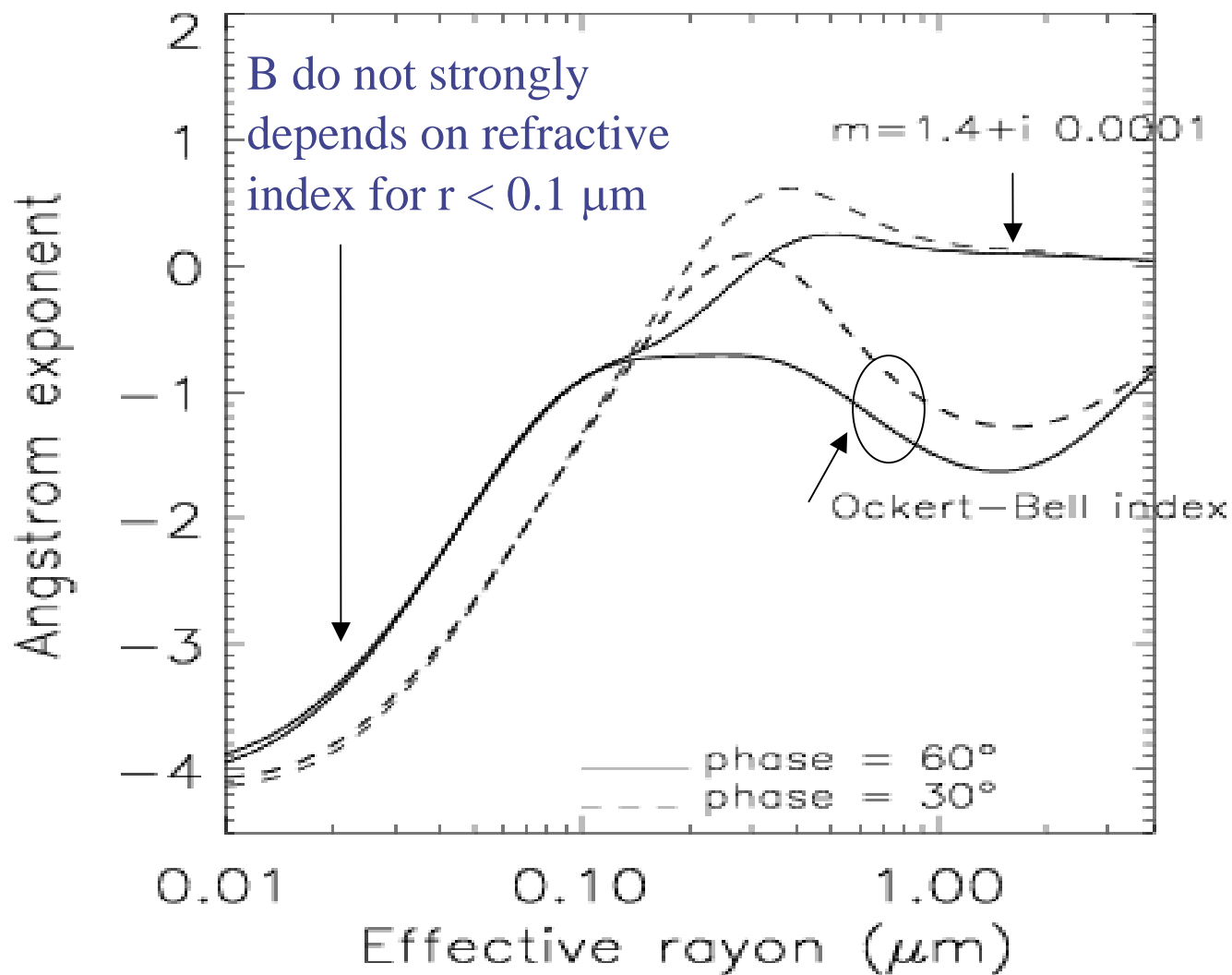◆ We used the routine of Pollack and Cuzzi, (1980) for irregular particles

First Mars Express Science
Conference, ESTEC 23 Feb. 2005
SPICAM UV LIMB

Angstrom factor B: I/F~Aλ^B

Numbers: altitude layers

B do not strongly depends on refractive index for r < 0.1 μm

m=1.4+i 0.0001

Ockert—Bell index

phase = 60°
phase = 30°

Angstrom exponent

Effective rayon (μm)
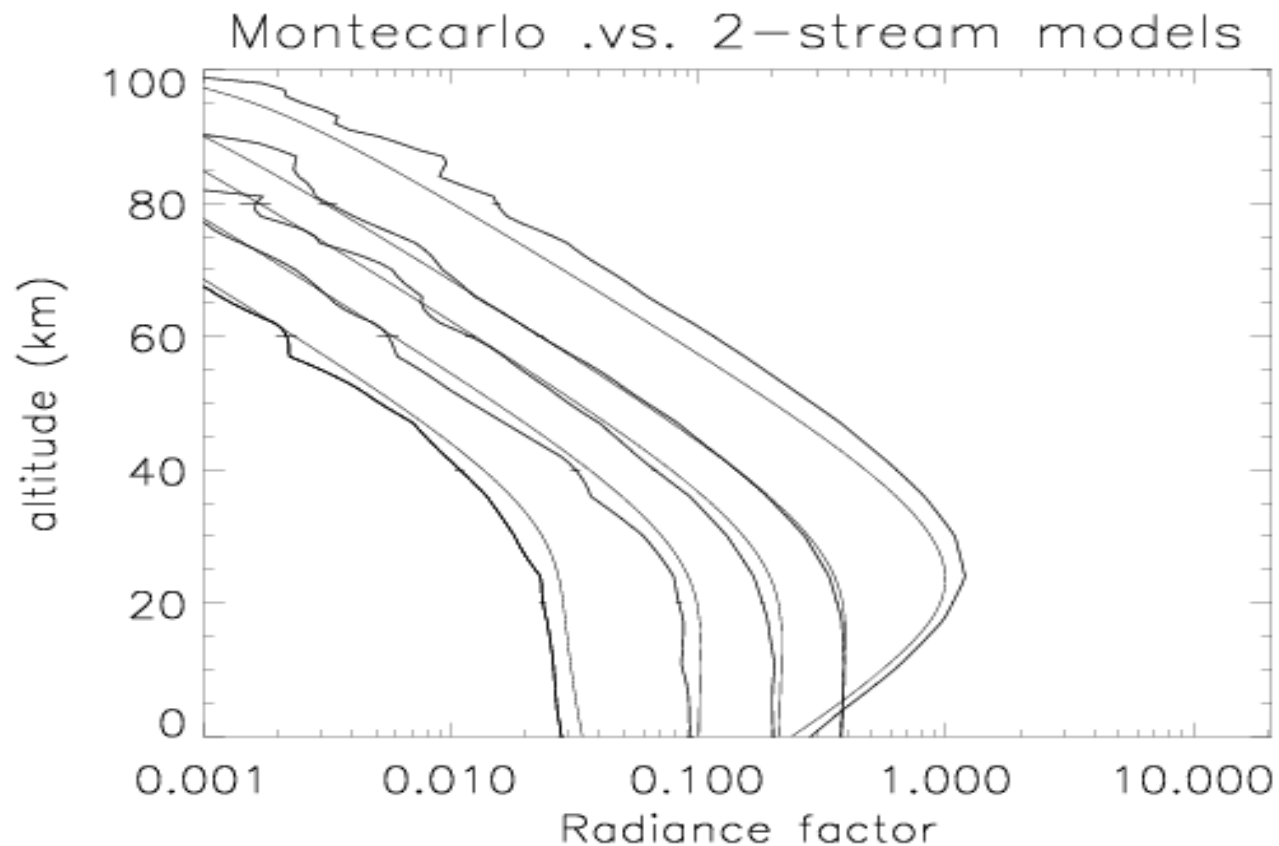
Procedure to retrieve extinction

- ◆ Program of light scattering at limb. Already used for Titan (Rannou et al., 1997) and Mars (Montmessin et al., 2002).
    - ▪ Ray tracing for single scattered light
    - ▪ Two-stream RT model for multiple scattering
    - ▪ Validation with a 3D spherical Monte-Carlo model (Tran et al., 2005)

- ◆ Retrieval procedure:
    - ▪ Onion peeling procedure
    - ▪ **Two inputs**:
    - ▪ Dust radius (estimated from colour ratio) set at each level
    - ▪ Effective variance assumed as $v = 0.3$ everywhere
    - ➔ Cross sections, Phase functions

- ◆ Due to high opacity in UV, retrieval can not be performed down to surface
    - ▪ THEN a **third input** is needed: multiple scattering ratio estimated by tests and prescribed at the beginning of the retrieval

- ◆ Retrieved quantities are the dust extinction σ and the number of particles.

First Mars Express Science
Conference, ESTEC 23 Feb. 2005
SPICAM UV LIMB

Verification of the model

Montecarlo .vs. 2−stream models
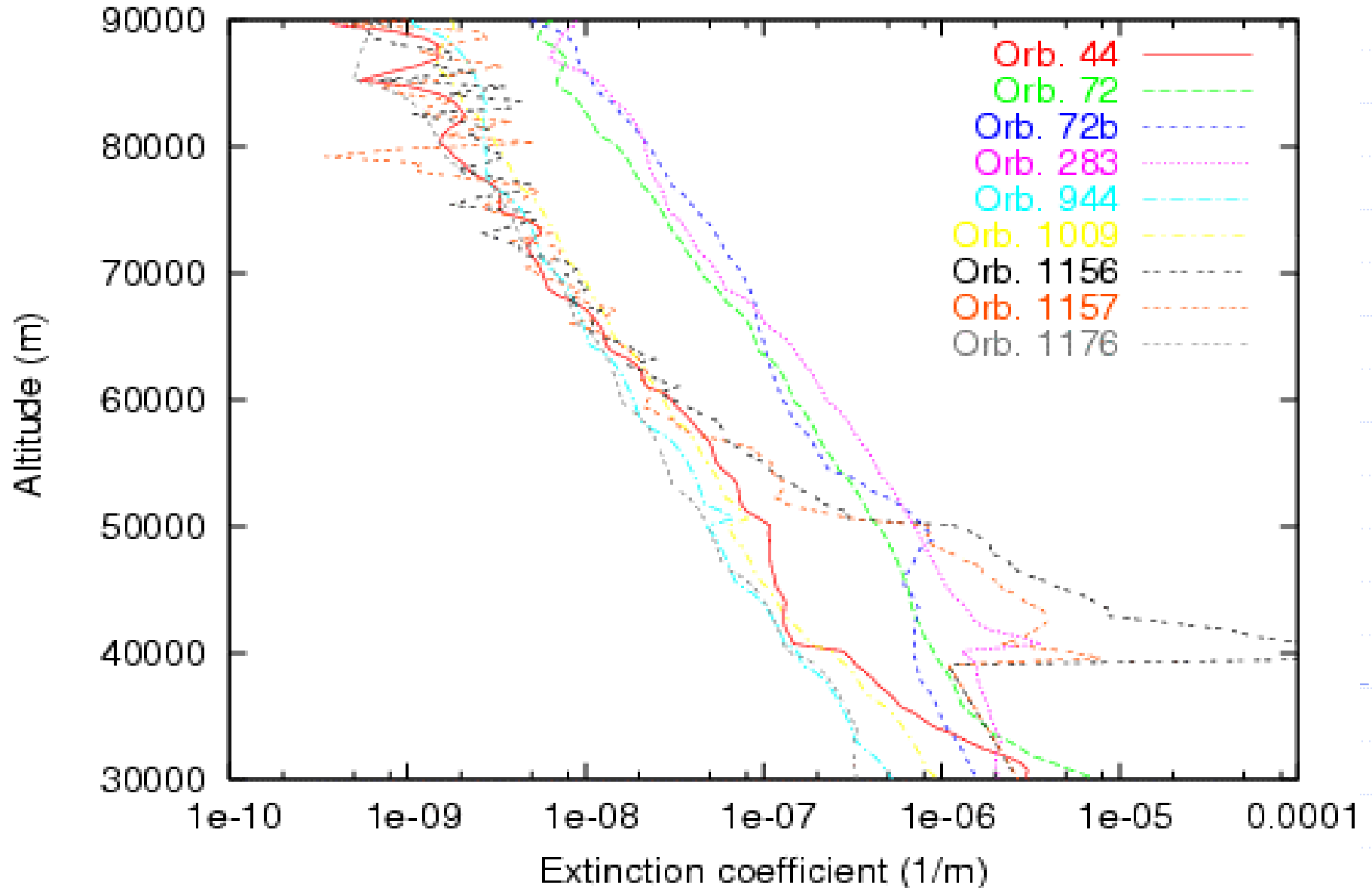
- Mars case comparison (Tran et al., 2005): ω =0.7 g=0.6 τ =0.5 H=10 km and Henyey-Greenstein phase function
- Radiance factor profiles at phase angle 0°, 60°, 120°, 140° and 175° (from the left to the right)

Extinction profiles

Height scales about H ≈ 10km (except Orb. 1156)

Discussion of results

◆ Different I/F between orbits are almost directly proportional to extinction.

◆ At 50 km, dust number density is
  - $n = 10$ cm^{-3} for type 1 profiles
  - $n = 10^3$ cm^{-3} for type 2 profiles

◆ Stability versus coagulation (for monodispersion populations)
  - $\tau = (K\,n)^{-1}$ with $K = 2\ 10^{-16}$ m^{-3}/s
  - Type 1 :   15 terrestrial years !!!
  - Type 2 :   57 terrestrial days

◆ Stability versus sedimentation
  - Between 20 and 57 days depending on radius

◆ Type 1 profiles looks like a background distribution
◆ Type 2 and type 3 are "perturbed" distributions

First Mars Express Science
Conference, ESTEC 23 Feb. 2005
SPICAM UV LIMB

Summary of SPICAM UV limb observations

#Orb.	Phase	Lat.	Sza	date	Ls	Type
0044	59.9710	14.5935	34.3493	2004-01-23	338.2	1
0072a	29.4962	-59.3476	75.2714	2004-02-01	343.0	2
0072b	28.2664	34.5112	64.3579	2004-02-01	343.0	2
0283	34.7105	45.8955	53.1791	2004-04-08	016.5	2
0944	74.3406	68.2625	52.5812	2004-10-14	100.8	1
1009	57.3092	78.0800	59.0015	2004-11-01	108.9	1
1156a	35.8132	41.0000	52.1296	2004-12-12	128.0	3
1156b	35.9353	1.98193	53.2386	2004-12-12	128.0	3
1176	25.5906	-64.1312	85.4343	2004-12-18	130.9	1

First Mars Express Science
Conference, ESTEC 23 Feb. 2005
SPICAM UV LIMB