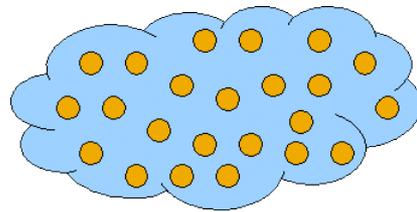


Desert dust and vertical profile importance

- Dust is a major type of tropospheric aerosol
- Direct radiative forcing: absorption, scattering, thermal emission
 - shortwave and longwave competing effects
 - depending on the vertical profile of dust concentration

Desert dust and vertical profile importance

- Indirect forcing through interactions with clouds



Modify number of clouds
Modify radiative properties
Modify microphysical properties
(→ e.g. more/less rain)

→ Depends on the relative location of clouds and aerosols

- Health issues when dust is close to the surface

Goals

Retrieving the vertical profile of dust concentration

Study the sensitivity of this to different parameters

Challenges...

- Sensitivity to the vertical profile: a lot lower than sensitivity to OD
- *A priori*???
- Aerosol micro-physical properties?
- Atmospheric state and surface description?

Strategy

IASI TIR measurements

- Clouds <10%
- Reasonable H₂O profile
- Signature of dust

Aerosol profile, total column and OD at 10 μm

Averaging kernels → 1.5 to 2
pieces of information

A priori: 6 points profile
Sa: 10%
Column

Rodgers OEM retrieval (ASIMUT + LIDORT)

900-930 cm⁻¹ & 1095-1125 cm⁻¹

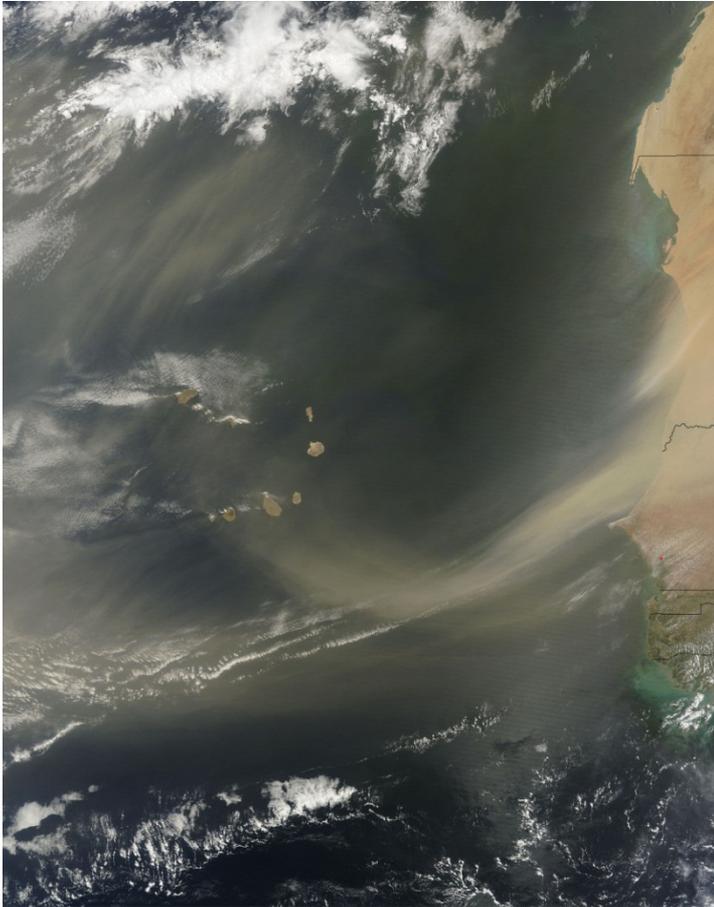
Compute an average spectrum

Max 100 km, 1h
(reduced noise)

A priori: 50part/cm³ (0-5 km alt)
Sa: 100% + Gaussian correlation 1km
Profile retrieval

Refractive index
Size distribution
+ Mie code

Case study



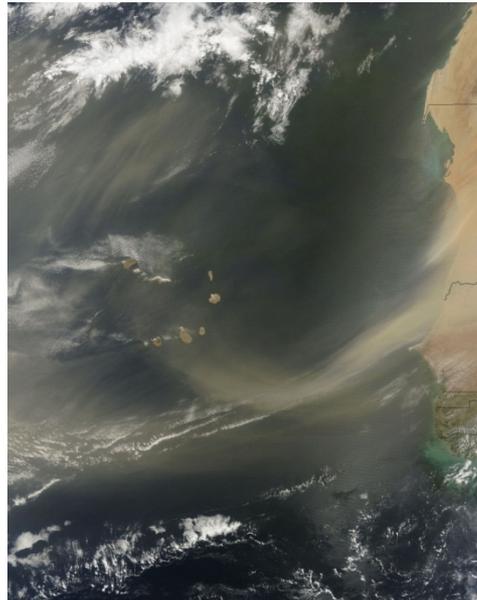
22 June 2009

Large plume off the West-Coast of the Sahara

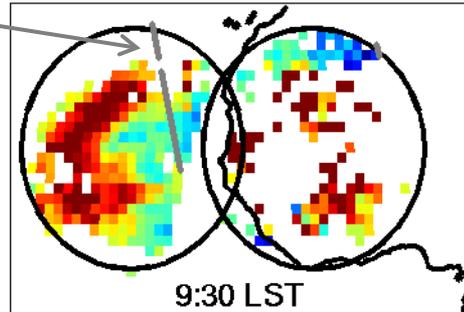
Optical depth comparisons

CALIOP track

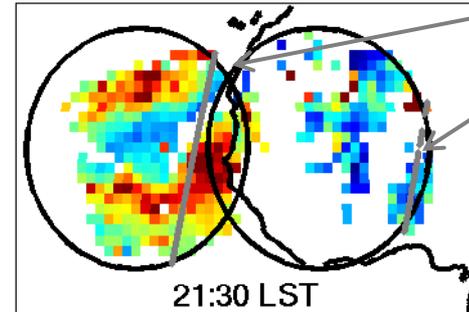
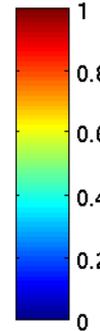
GEISA Massie
 $r=0.6 \mu\text{m}$ $\sigma=2 \mu\text{m}$



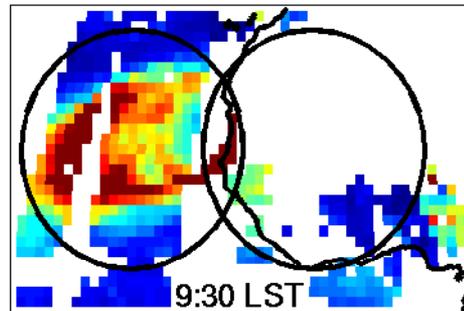
IASI Retrieved OD 10 μm



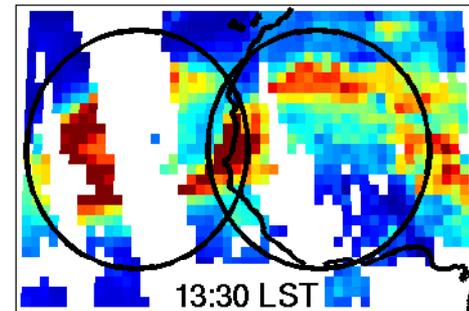
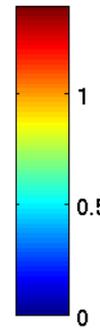
IASI Retrieved OD 10 μm



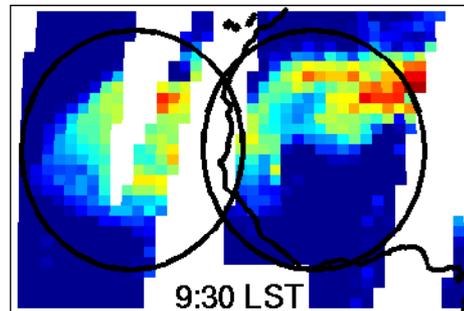
MODIS Terra OD 550nm



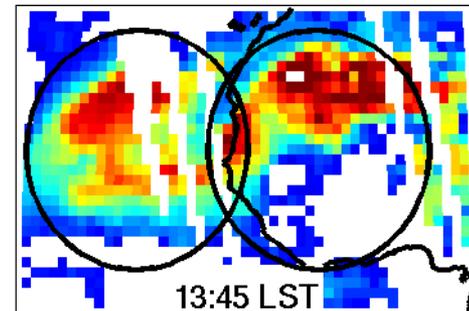
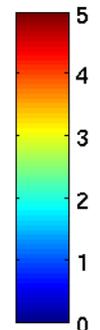
MODIS Aqua OD 550nm, DB OD 660nm



GOME-2 AAI



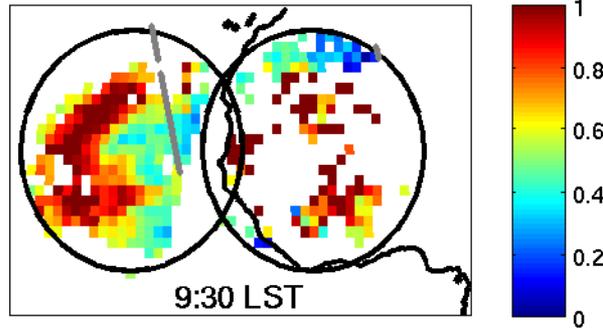
OMI AAI



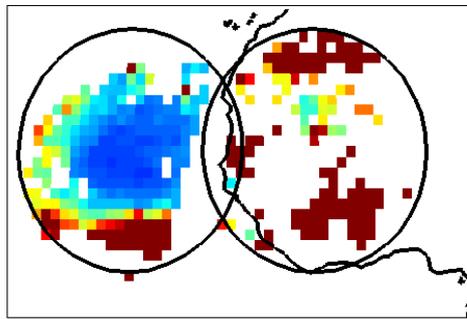
Further analysis

GEISA Massie
 $r=0.6 \mu\text{m}$ $\sigma=2 \mu\text{m}$

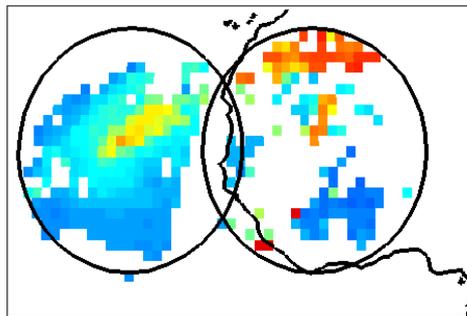
IASI Retrieved OD $10\mu\text{m}$



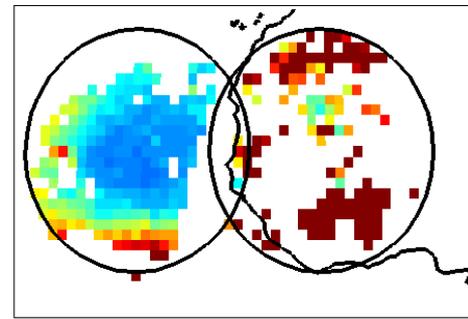
RMS of Profile Retrievals (step 1)



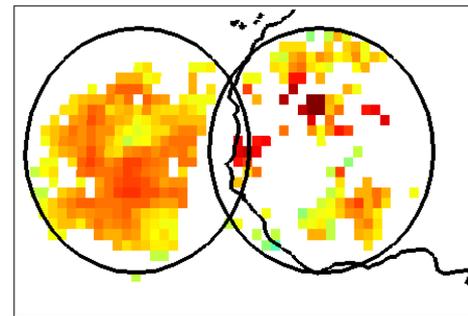
Mean Altitude of Aerosols (km)



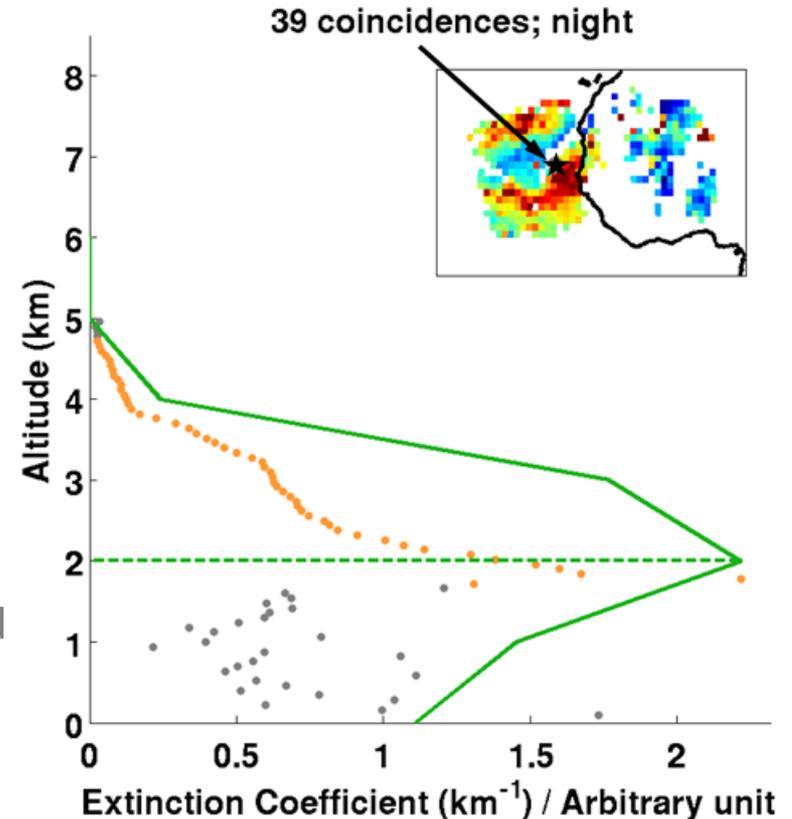
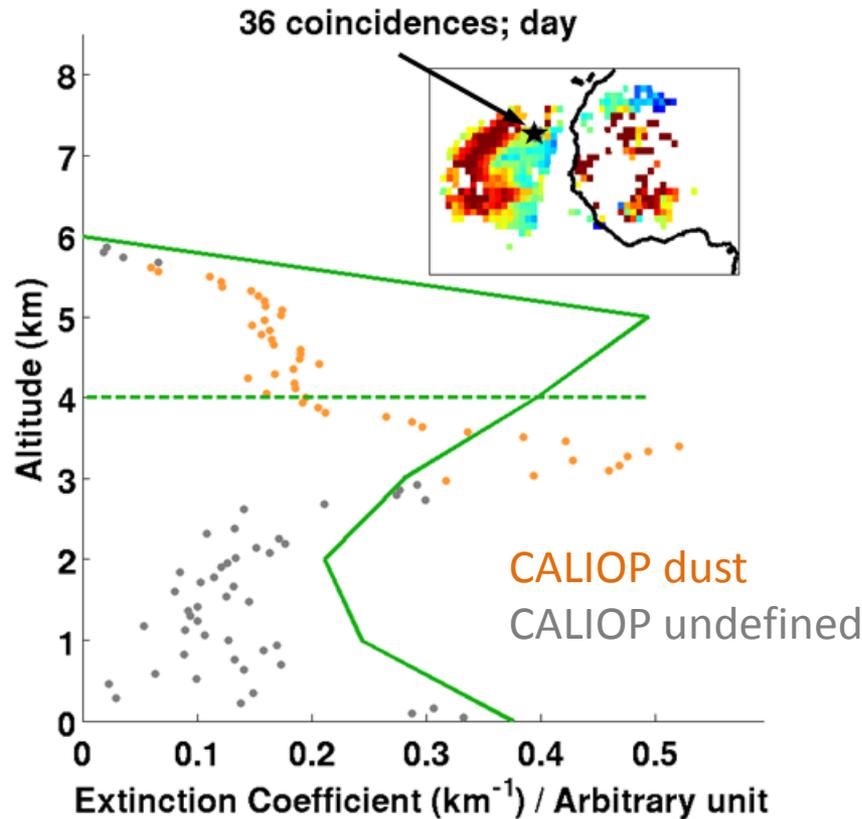
RMS of Column Retrievals (step 2)



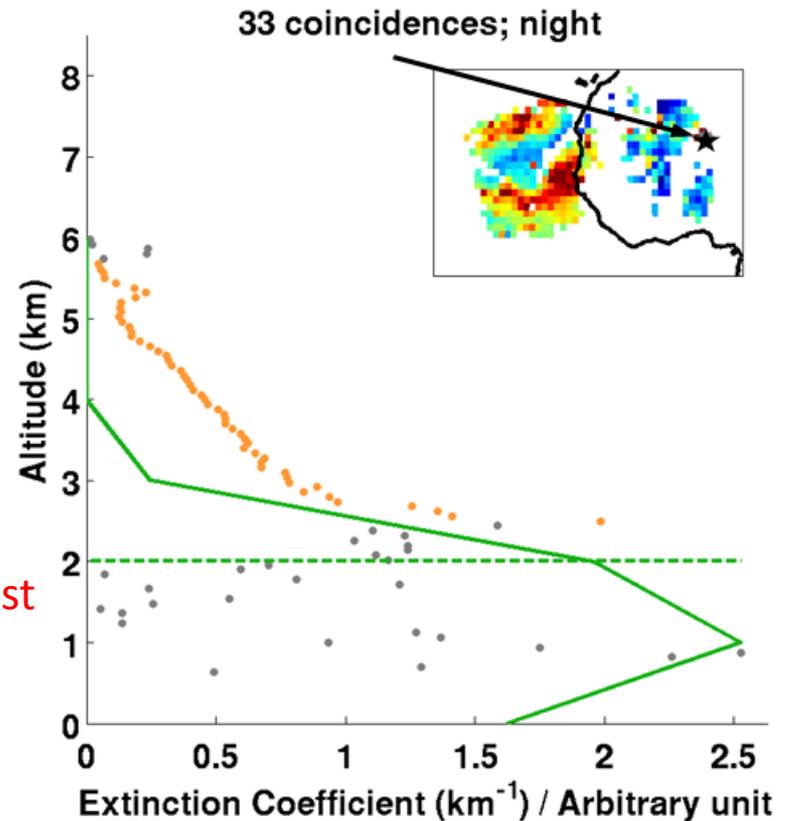
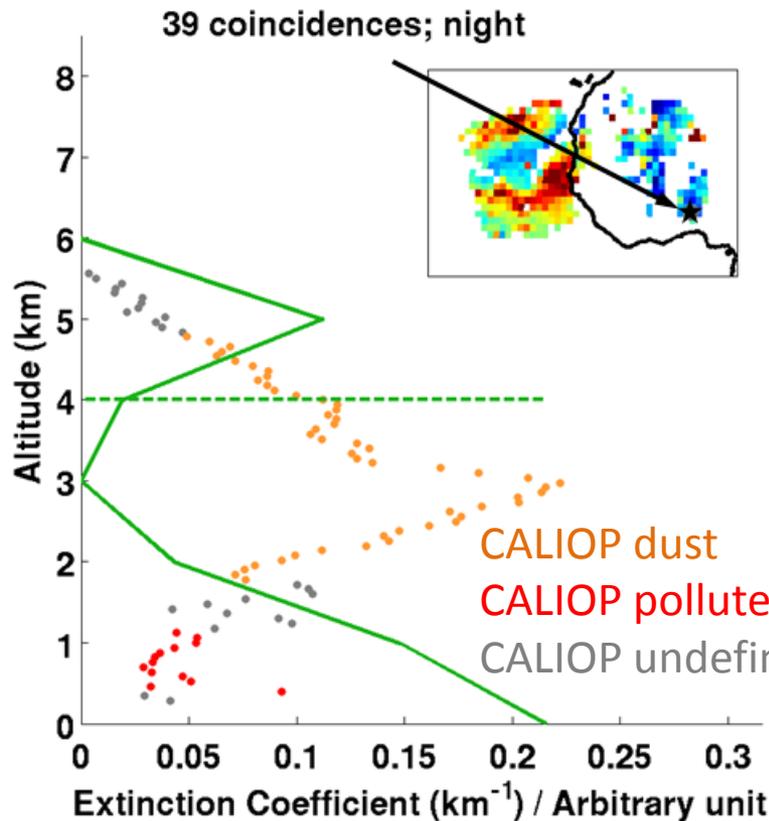
DOF for Profile Retrievals



Vertical profile comparisons: ocean



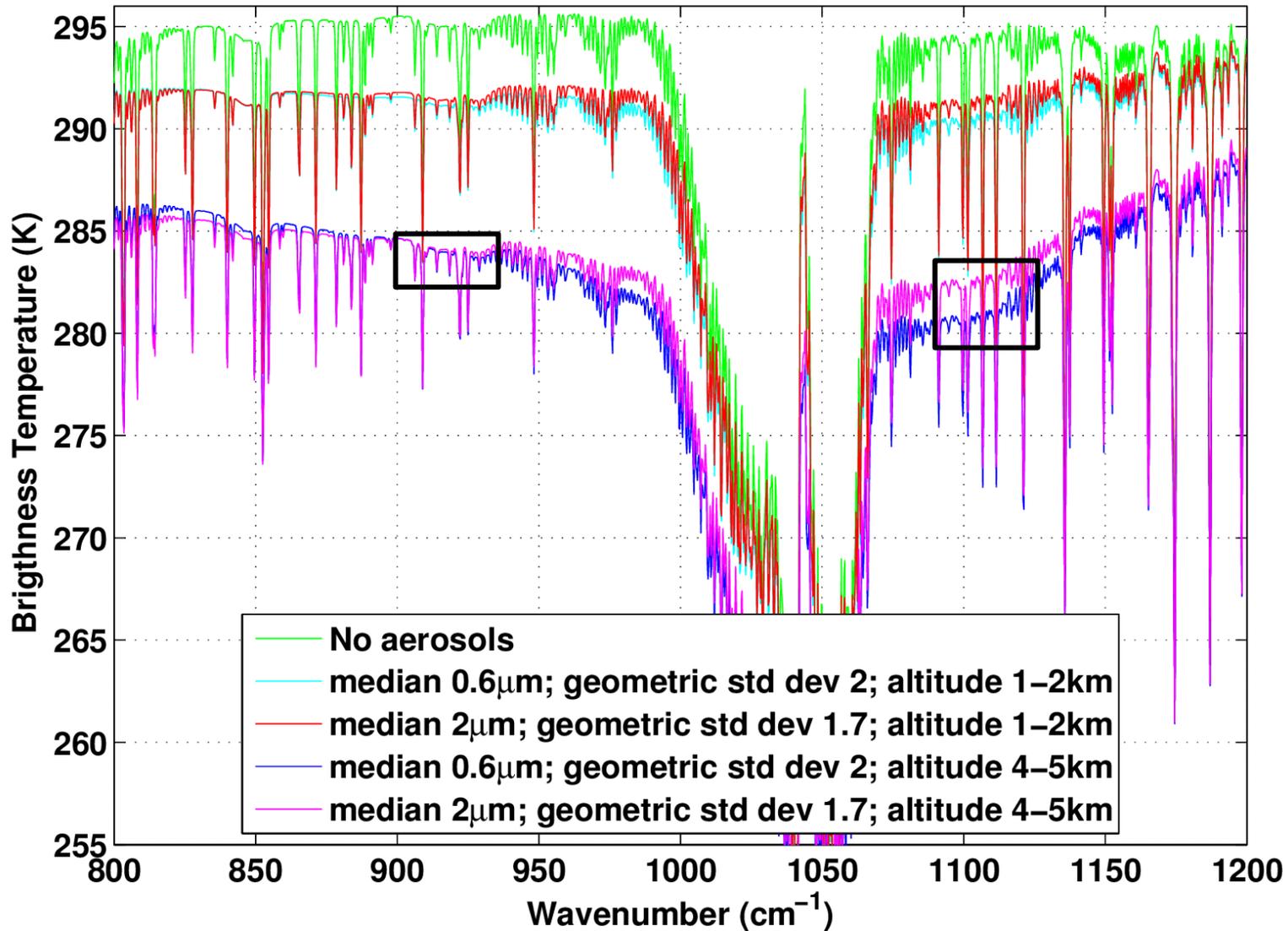
Vertical profile comparisons: desert



Comparisons: conclusions

- Ocean: good match in OD maps
Desert: difficult to conclude
- No obvious difference in quality for day / night
 - Huge OD difference over the desert (due to early morning local emissions?)
- Vertical profiles: better match with CALIOP for high OD

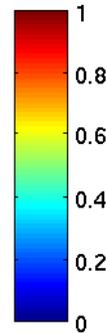
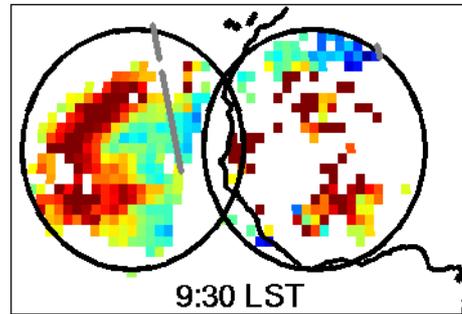
A different particle size distribution?



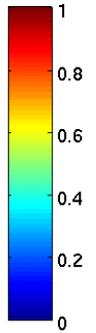
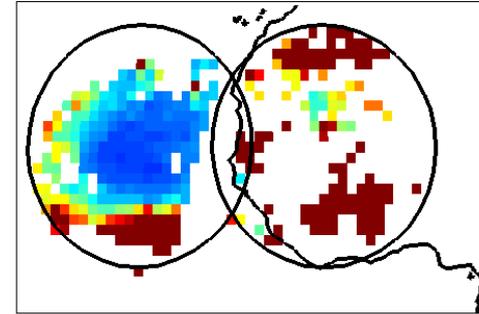
A different particle size distribution?

$R = 0.6 \mu\text{m}$
 $\sigma = 2 \mu\text{m}$

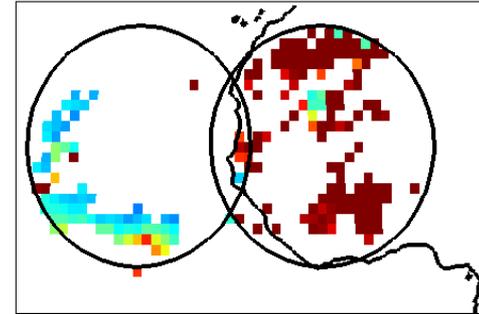
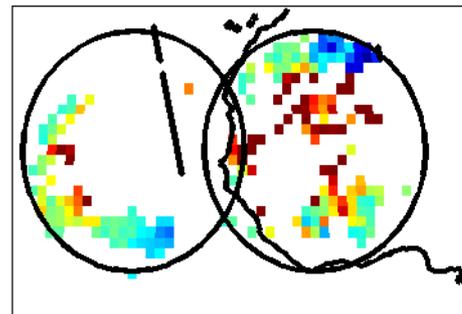
IASI Retrieved OD $10\mu\text{m}$



RMS of Profile Retrievals (step 1)



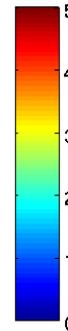
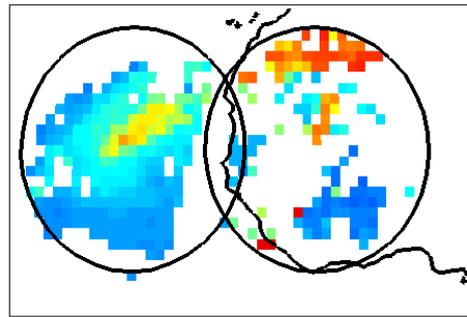
$R = 2 \mu\text{m}$
 $\sigma = 1.7 \mu\text{m}$



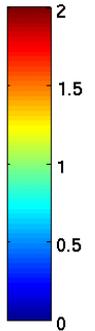
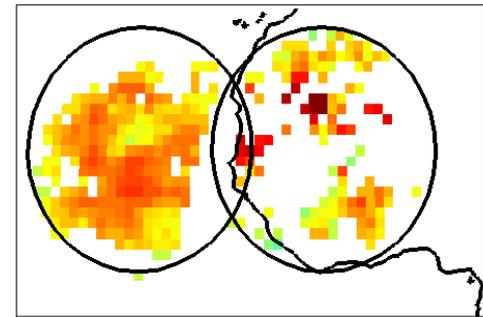
A different particle size distribution?

$R = 0.6 \mu\text{m}$
 $\sigma = 2 \mu\text{m}$

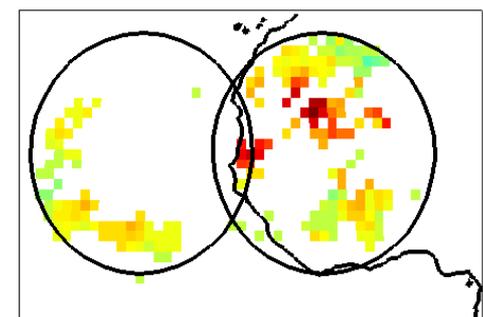
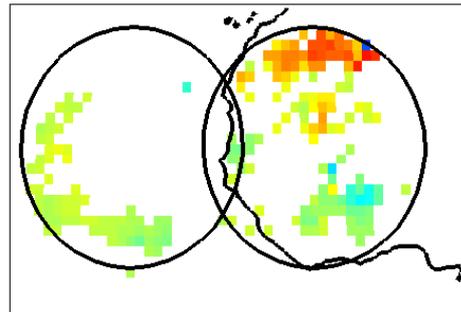
Mean Altitude of Aerosols (km)



DOF for Profile Retrievals

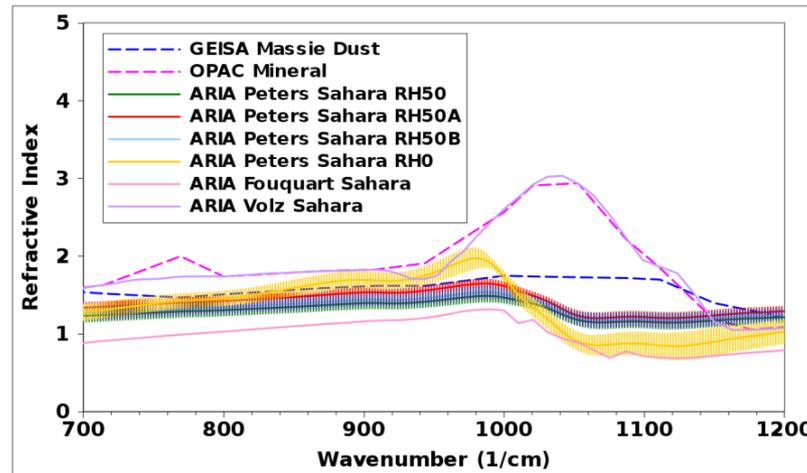


$R = 2 \mu\text{m}$
 $\sigma = 1.7 \mu\text{m}$



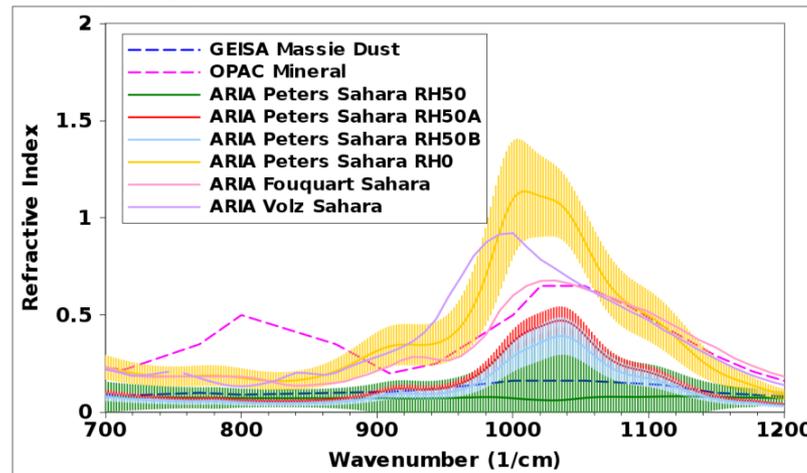
A different refractive index?

Real part of refractive index for sand aerosols



GEISA
Massie

Imaginary part of refractive index for sand aerosols

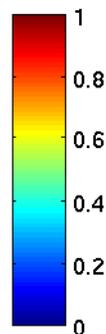
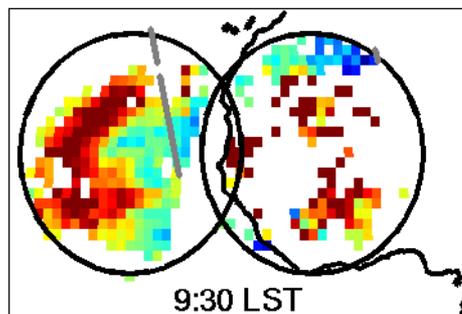


Volz 1973

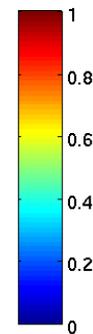
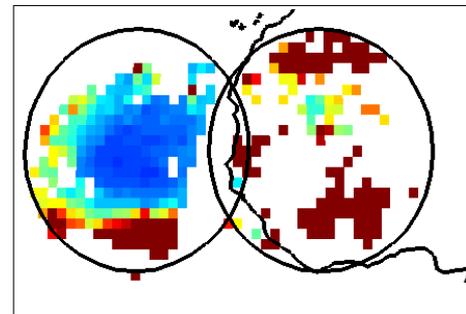
A different refractive index?

GEISA
Massie

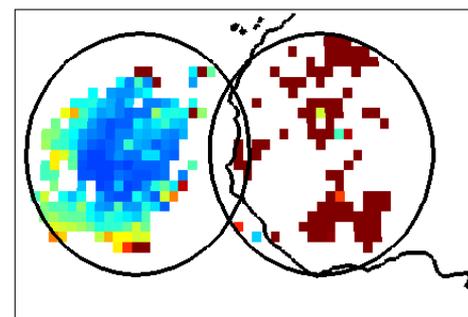
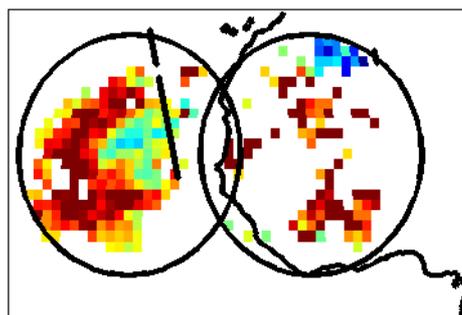
IASI Retrieved OD $10\mu\text{m}$



RMS of Profile Retrievals (step 1)



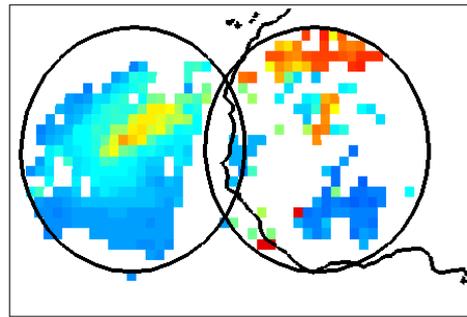
Volz 1973



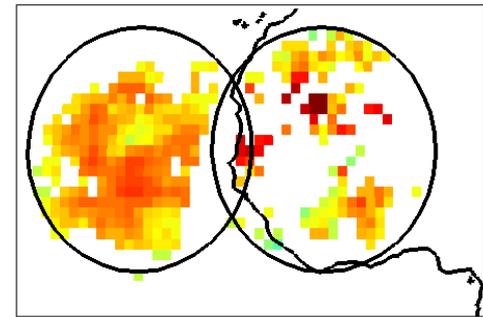
A different refractive index?

GEISA
Massie

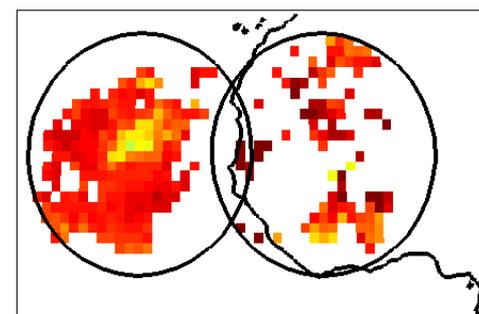
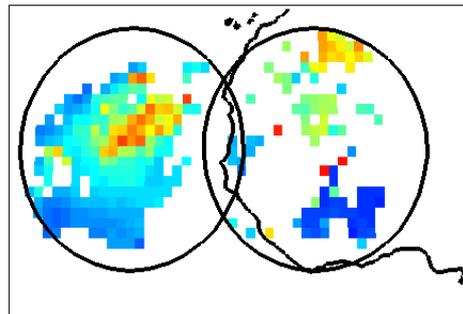
Mean Altitude of Aerosols (km)



DOF for Profile Retrievals



Volz 1973



Dust properties sensitivity: conclusions

- Results seem quite robust w.r.t. the refractive index
- Particle size sensitivity is non-negligible; assuming a wrong size could lead to strong OD and altitude biases (up to 50% and more than 1 km mean altitude)

Outline and final conclusions

- ✓ New retrieval strategy, that gives dust vertical profiles with 1.5 to 2 DOF
- ✓ Quality of those profiles is higher for a high aerosol load
- ✓ Total OD seem reasonable, more investigations needed over the desert
- ✓ Quite robust with respect to refractive index
- ✓ Sensitive to particle size distribution

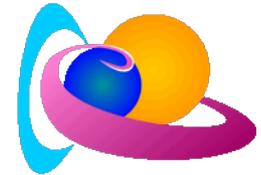
Further work ideas...

- Study sensitivity to atmospheric and surface state
- Develop retrieval of particle size
- Find other data for comparisons, especially over the desert
- Exploit MetOp-A and B in « synergy »
- Use the result of previous retrievals at close locations as *a priori* for other retrievals

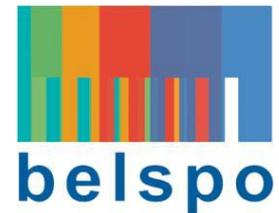
Thank you...



For fruitful discussions: R. Spurr, N. Clerbaux, S. Nevens, S. Dewitte, L. Clarisse, L. Klüser, C. Tsamalis, ...



For funding: Belspo/ProDEX SECPEA & A3C;
Solar terrestrial Center of Excellence



Challenges...

