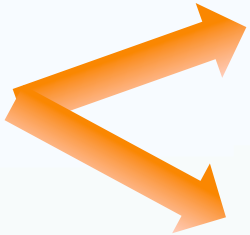
Three-dimensional distribution of a major Saharan dust outbreak in June 2011 derived from IASI

J. Cuesta[1], C. Flamant[2], M. Eremenko[1], G. Dufour[1], B. Laurent[1], G. Bergametti[1], F. Aires[3] and C. Ryder[4]

(1) (2) (3) (4)

Scientific motivation

3D distribution of desert dust



Life cycle of dust:
uplift, transport and deposition

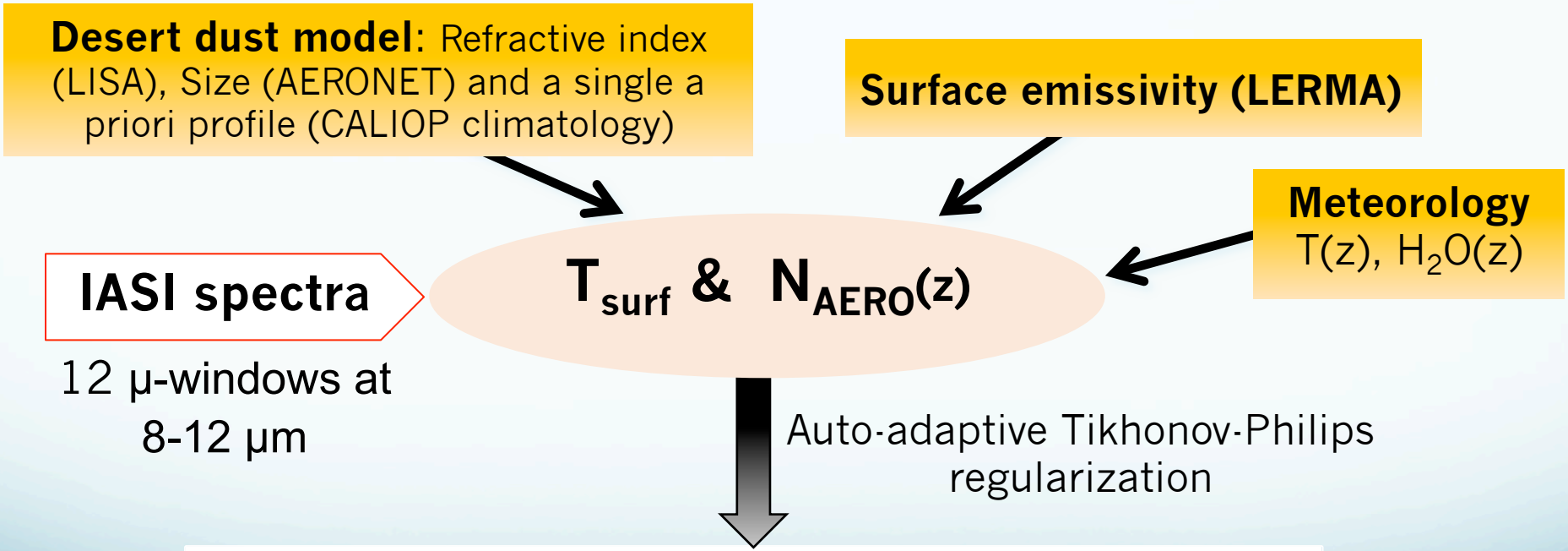
Environmental impacts:
Air quality, radiative budget, atmospheric dynamics, etc.

➔ Satellite observations are key for observing desert dust distribution, but most standard products only provide a 2D distribution (horizontal and transects) or a mean altitude of dust layers.

➔ We propose to describe the full 3D distribution of dust with **AEROIASI**

AEROIASI:

An auto-adaptive iterative fitting method using IASI thermal infrared spectra

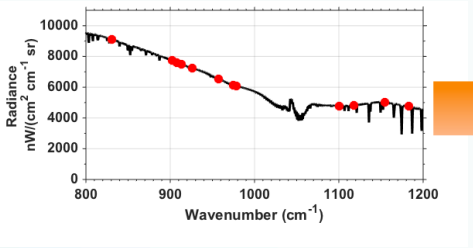


Aerosol extinction profiles at 10 µm $\alpha^{ext}(z)$
for each cloud-free IASI pixel

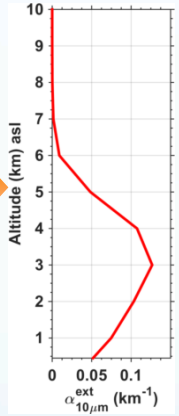
AEROIASI:

Retrieval of the 3D distribution of desert dust for each IASI overpass

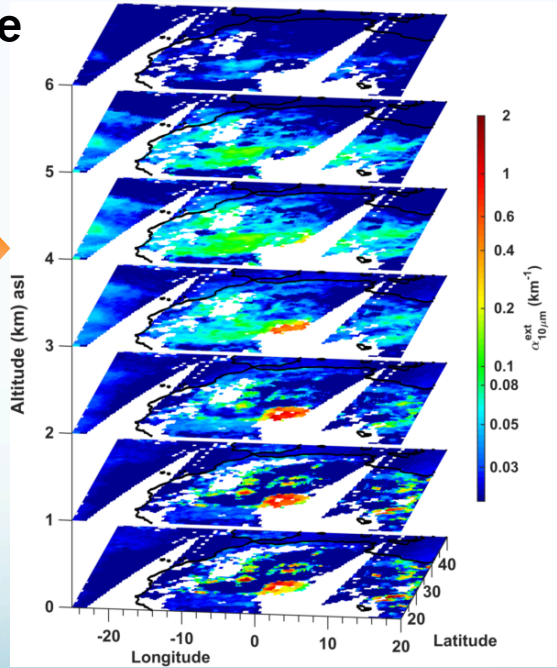
Cloud-free IASI spectra



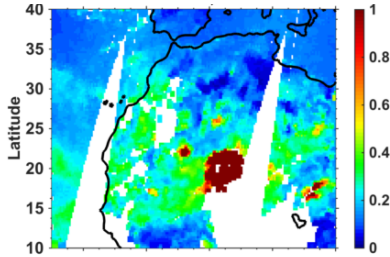
Dust extinction profile



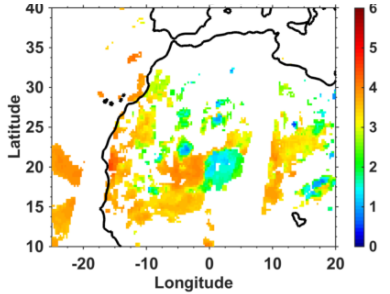
3D distribution of dust



AOD at 10 µm



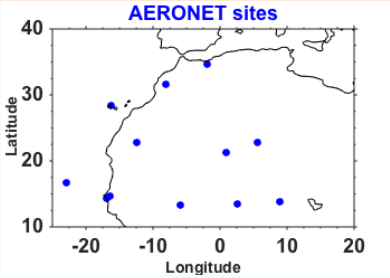
Altitude of dust

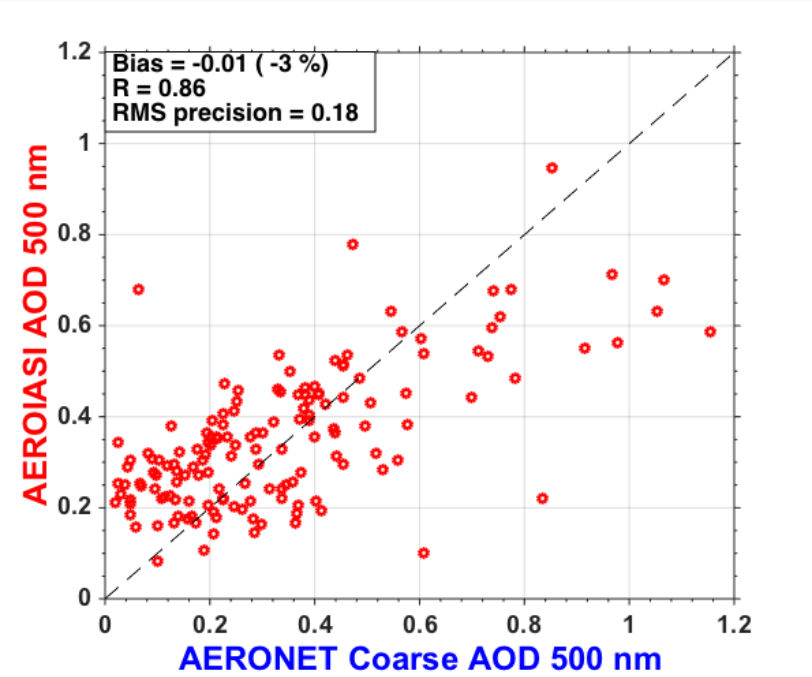


AOD from AEROIASI vs AERONET

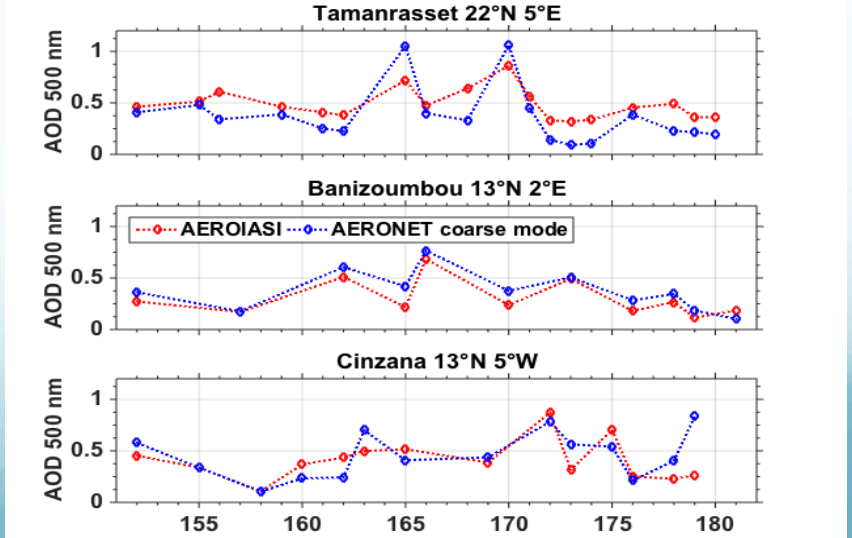
Daily comparison of AEROIASI with AOD^{Coarse} from 12 AERONET sites in June 2011

- ✓ Low mean bias : <3%
- ✓ Good correlation: R=0.86
- ✓ Precision : 0.18
- ✓ From this comparison we estimate $\frac{AOD_{500nm}^{Total}}{AOD_{10\mu m}} \approx 1.7$



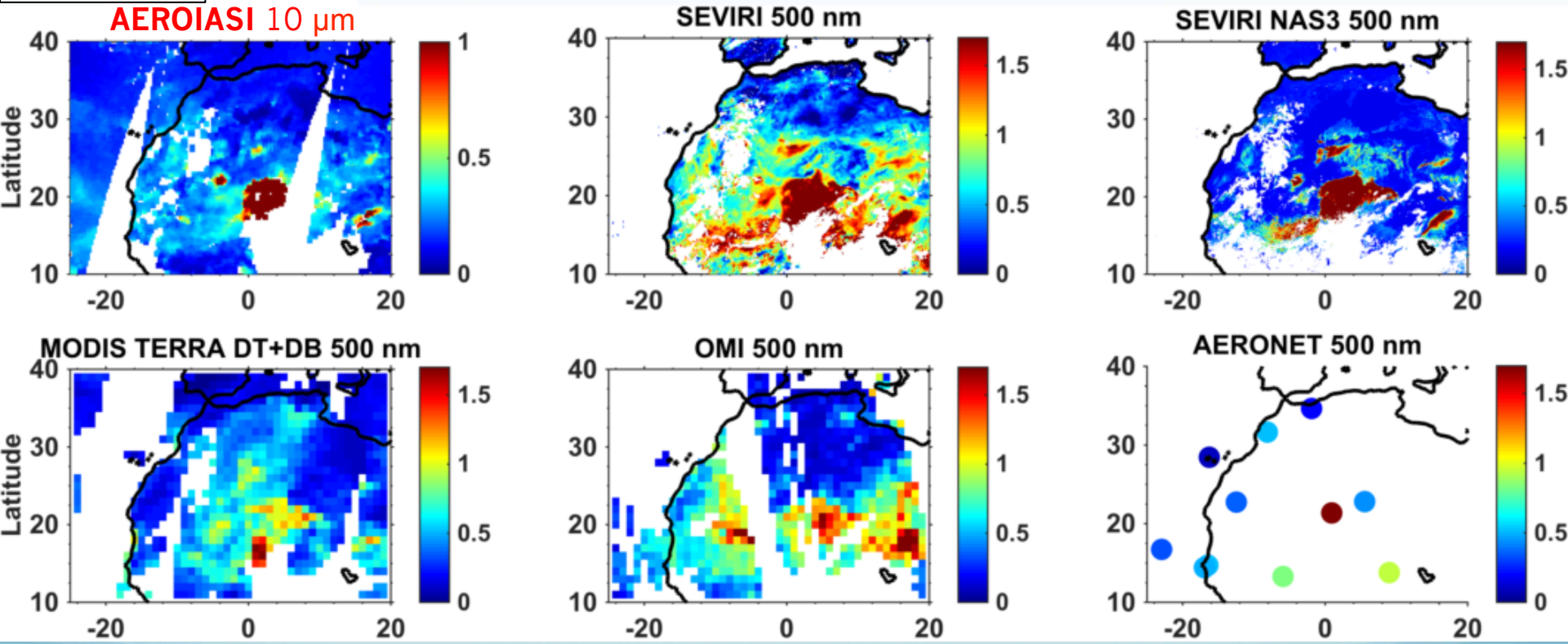


- ✓ Good tracking of dust content evolution



Dust horizontal distribution: AEROIASI vs other products

17 June 2011

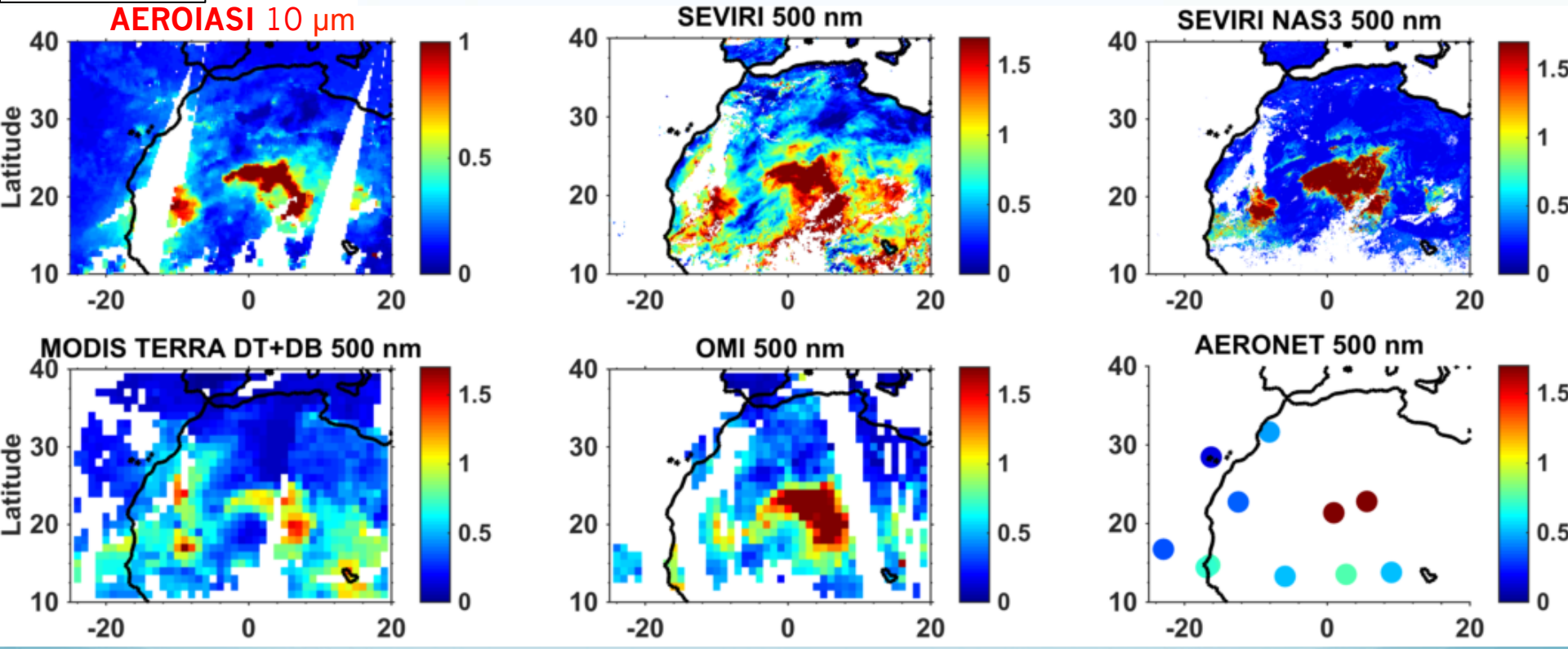


➔ *AEROIASI: dust structures in close agreement with SEVIRI and quantitative agreement with AERONET*

➔ *Underestimation for MODIS and OMI with respect to other products and AERONET*

Dust horizontal distribution: AEROIASI vs other products

18 June 2011

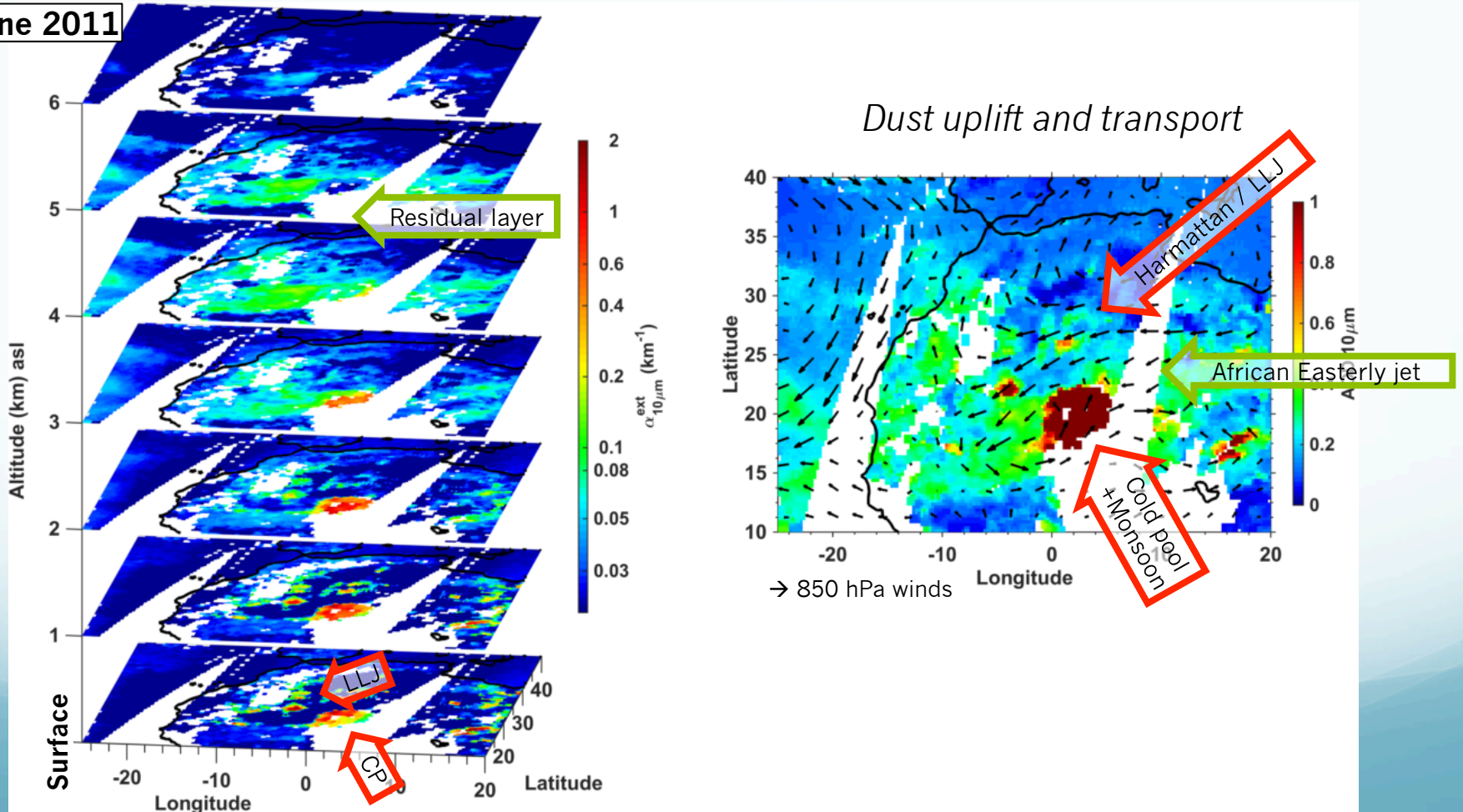


➔ *AEROIASI: dust structures in close agreement with SEVIRI and quantitative agreement with AERONET*

➔ *Underestimation for MODIS over the Sahara with respect to other products and AERONET*

➔ *Agreement of AEROIASI and MODIS over the Atlantic*

Saharan dust in 3D from AEROIASI



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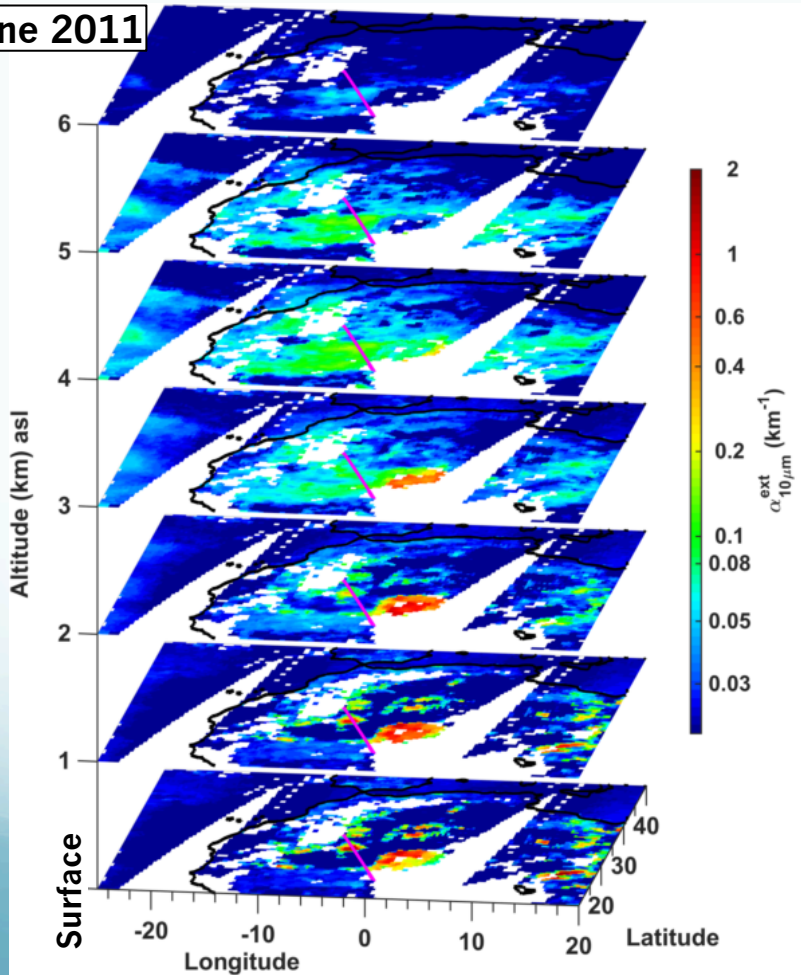

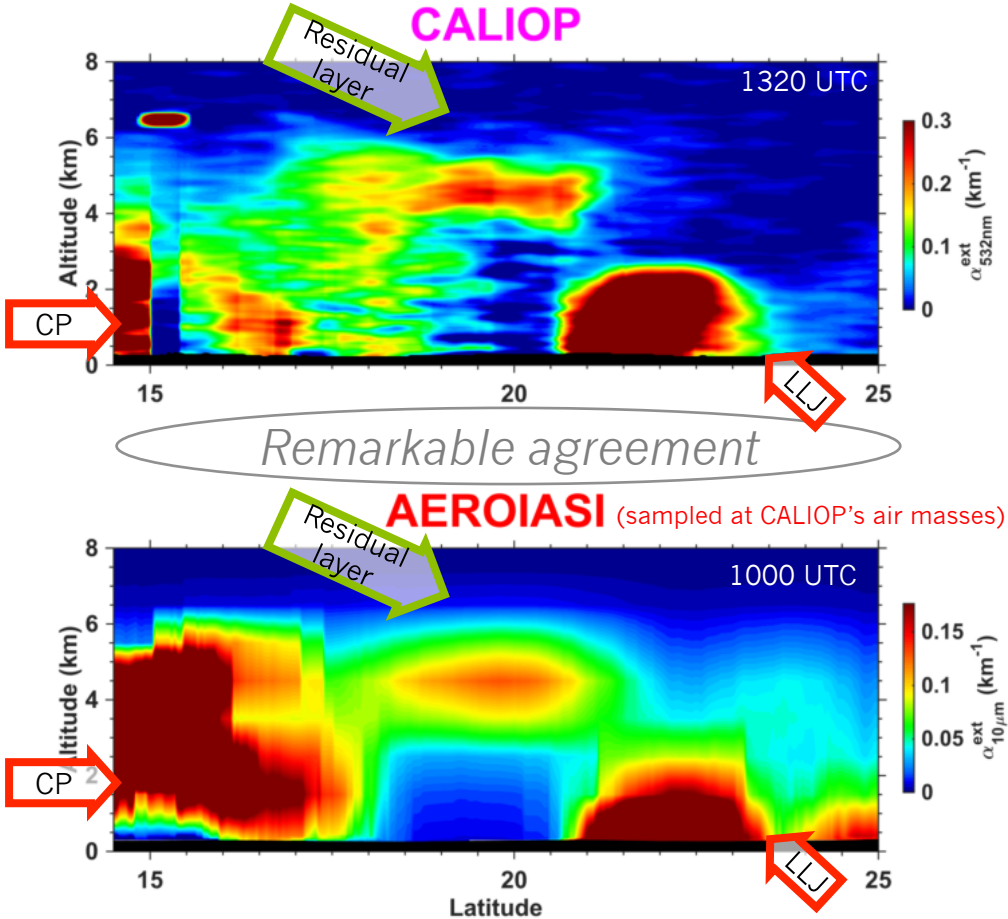

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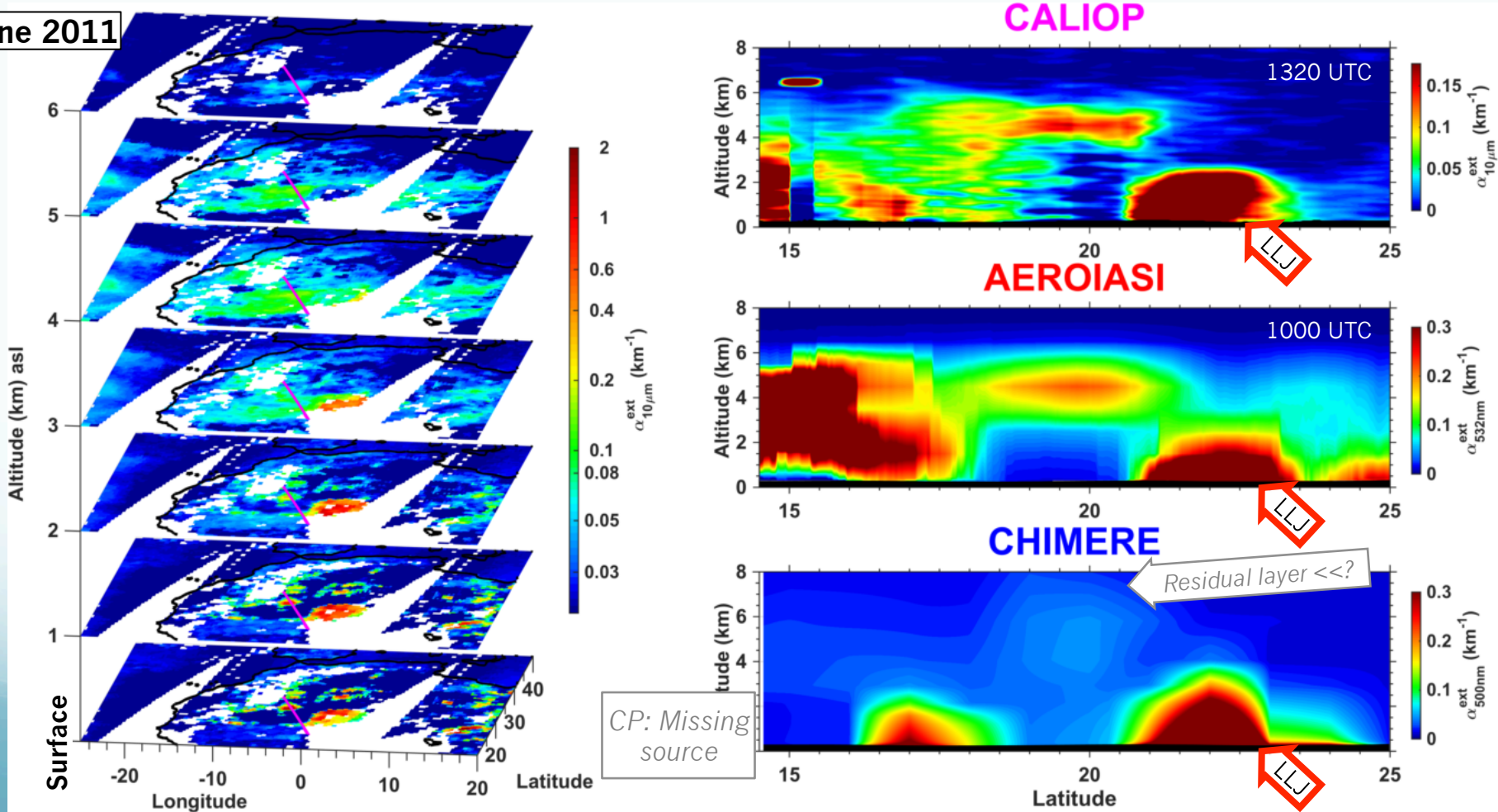

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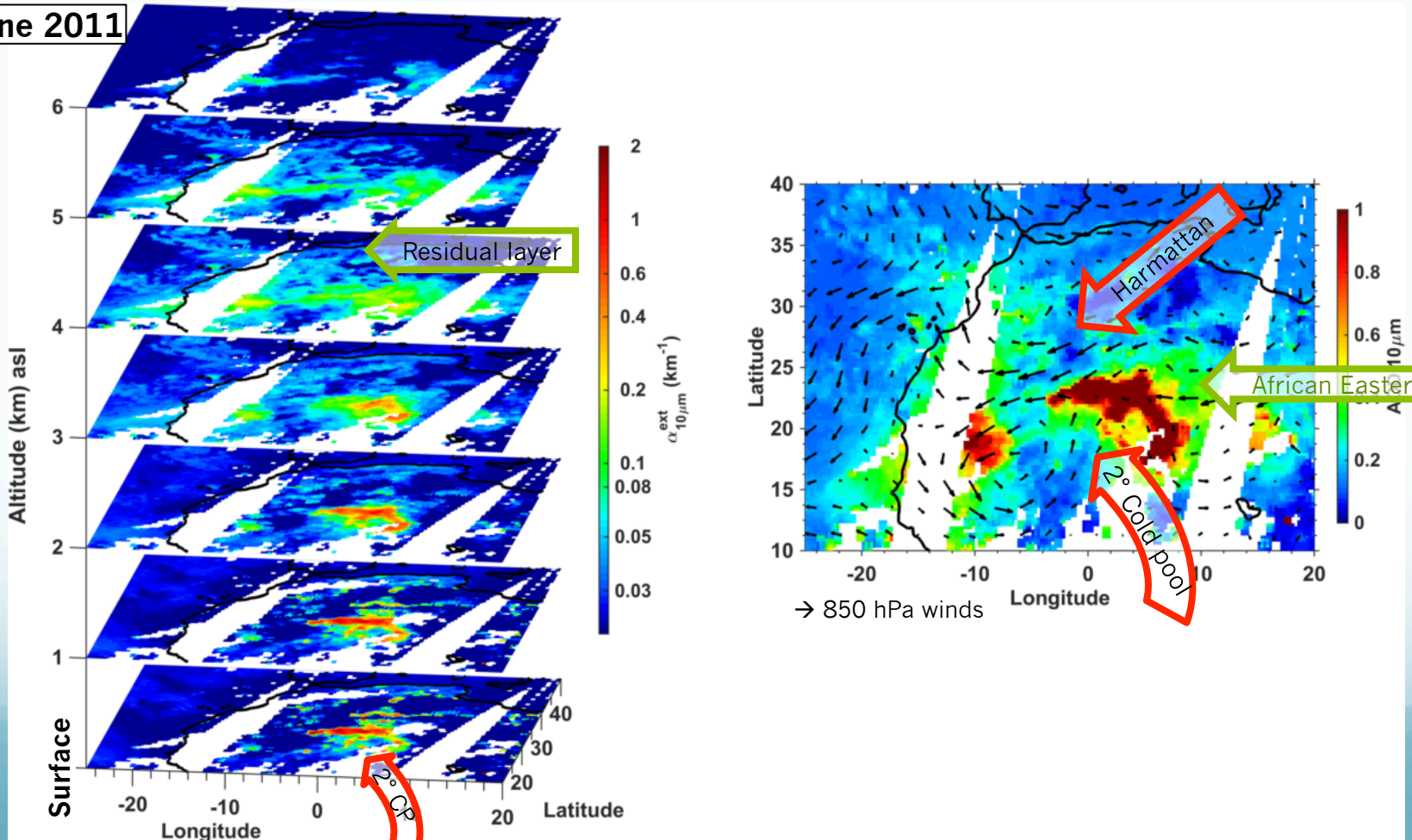
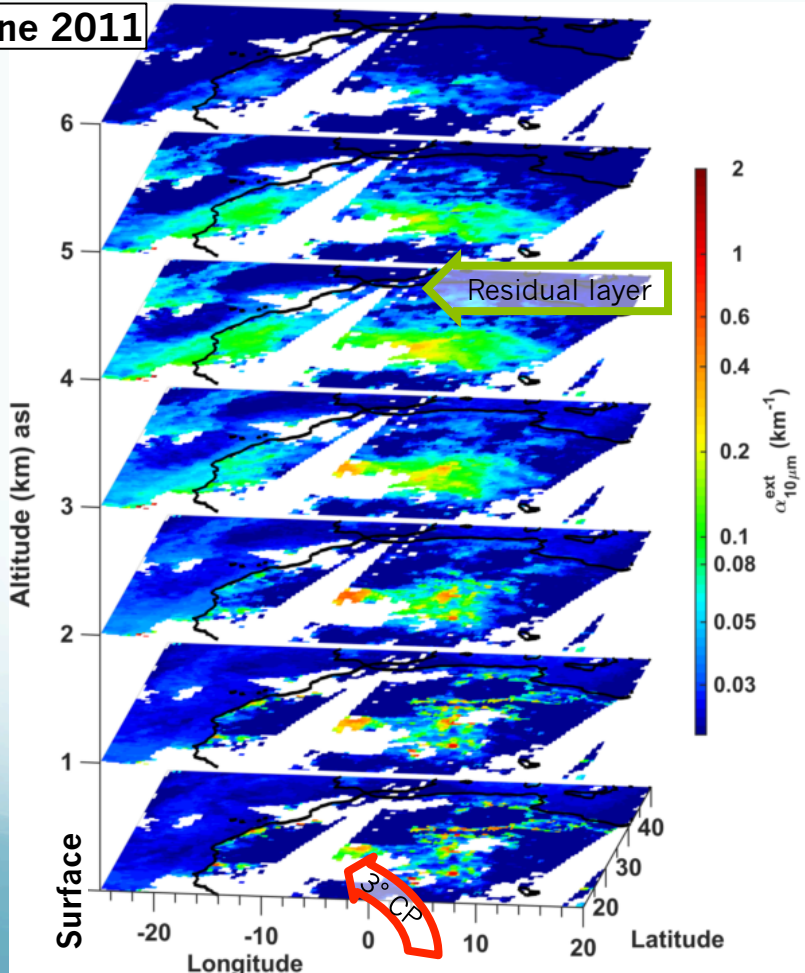
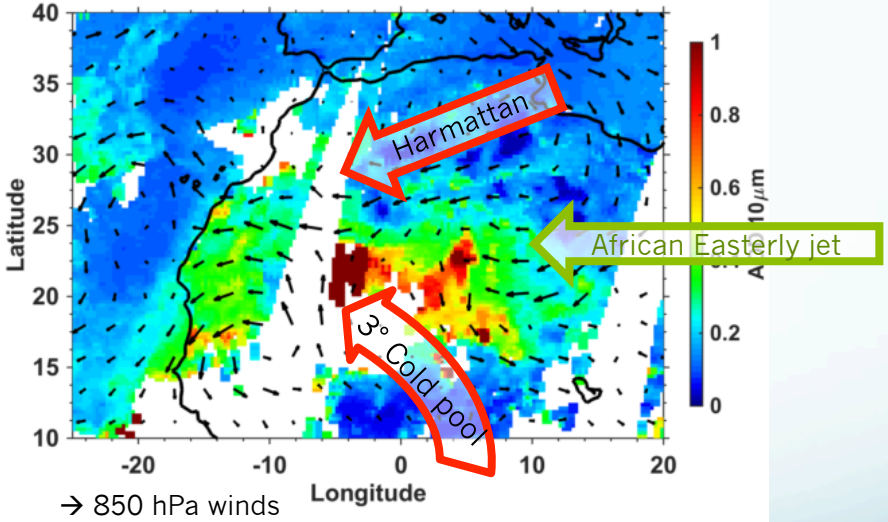


Saharan dust in 3D from AEROIASI

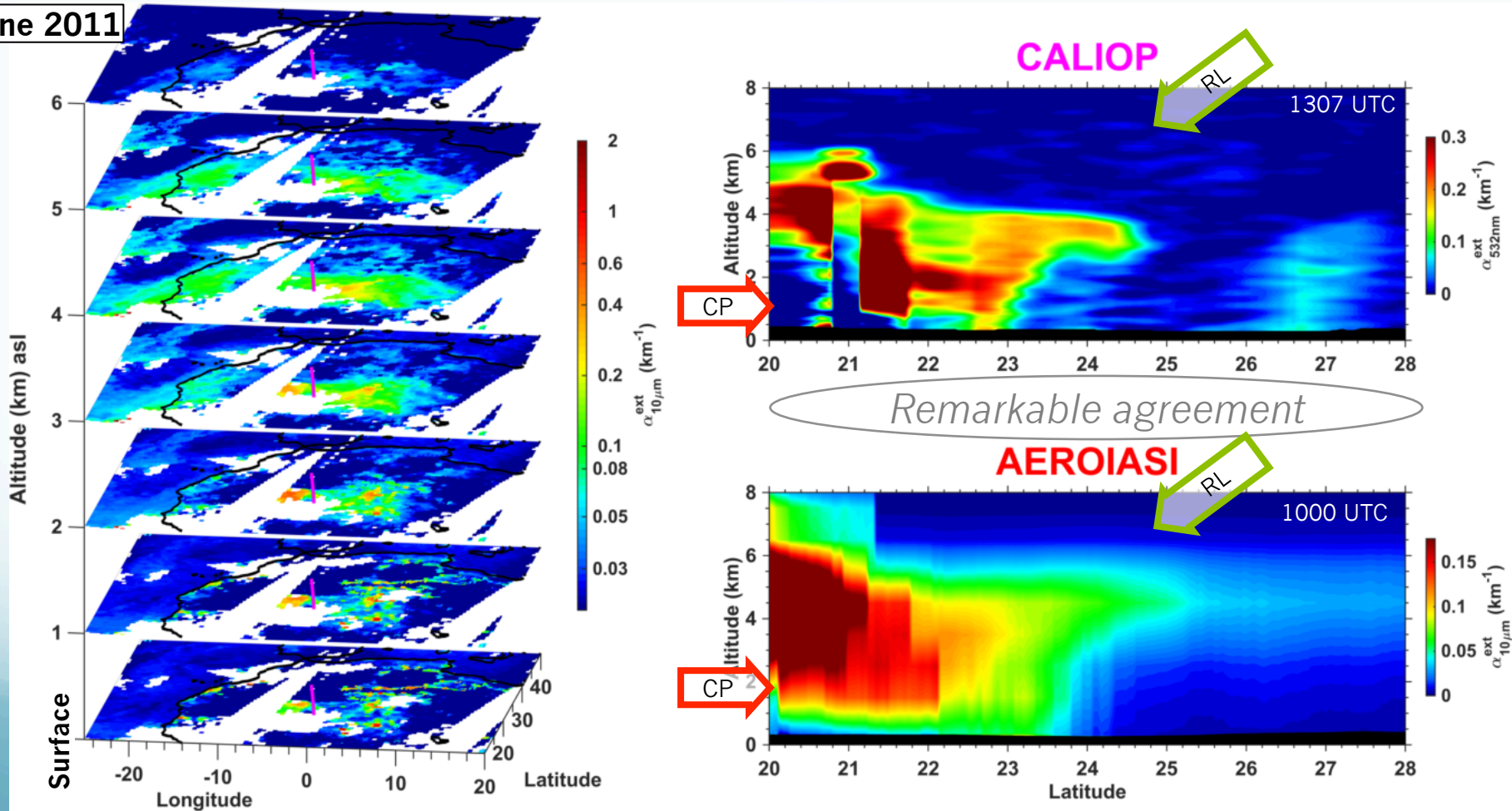
19 June 2011





→ 850 hPa winds

Saharan dust in 3D from AEROIASI



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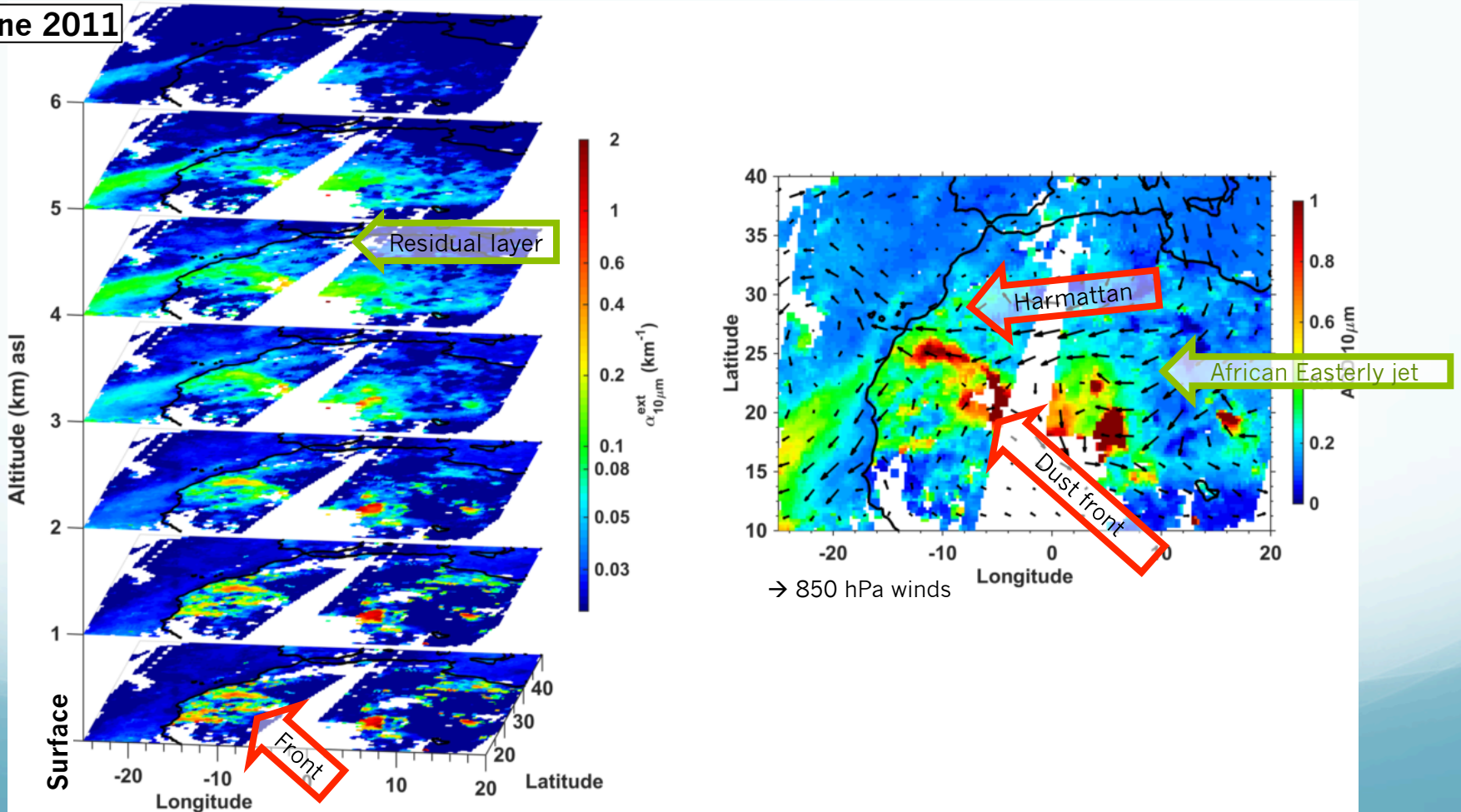

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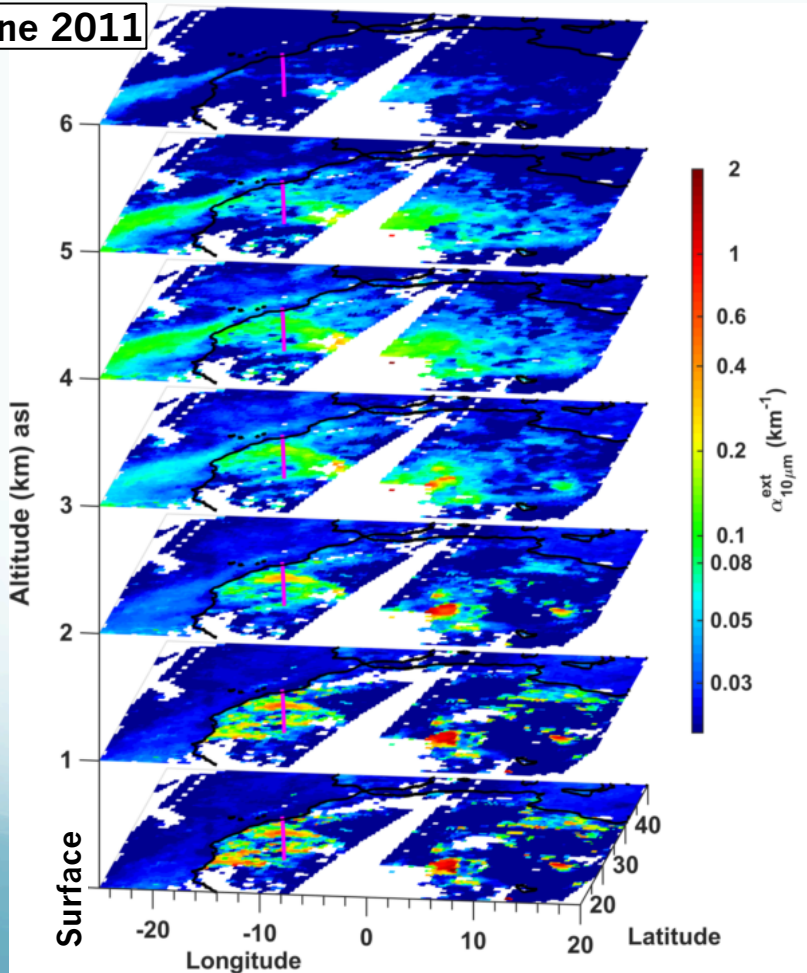

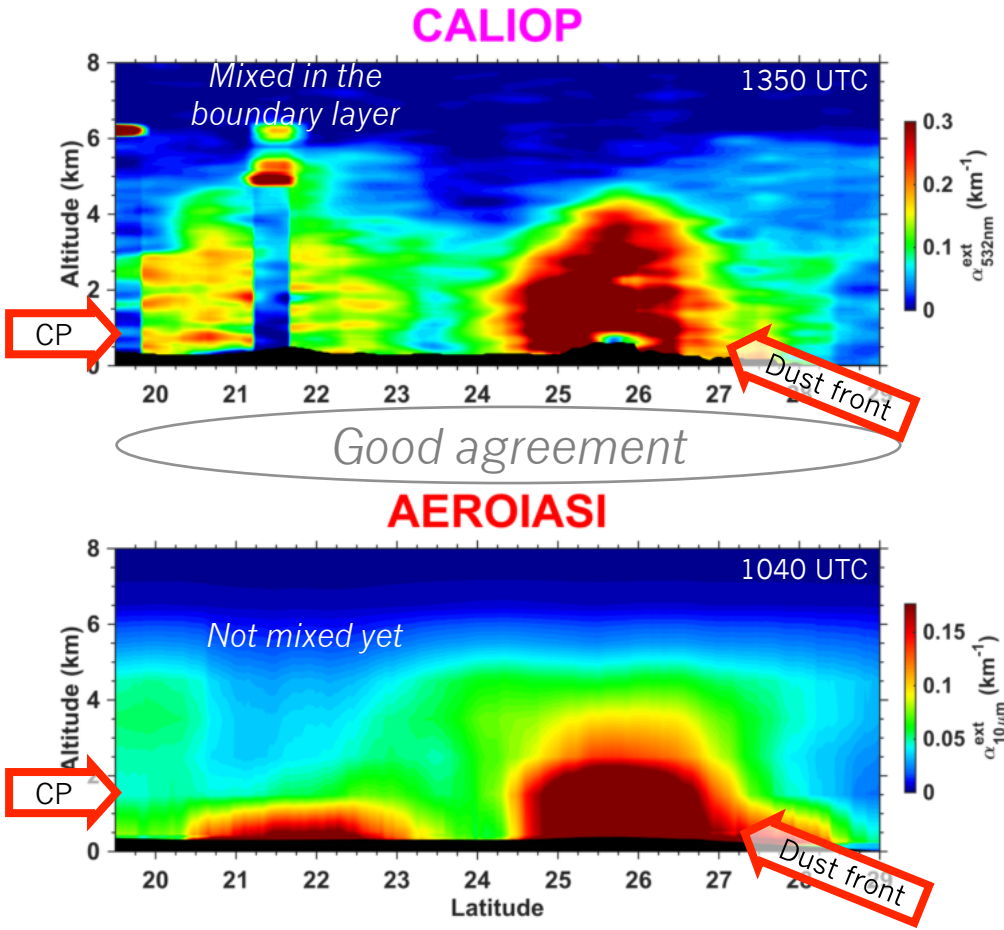

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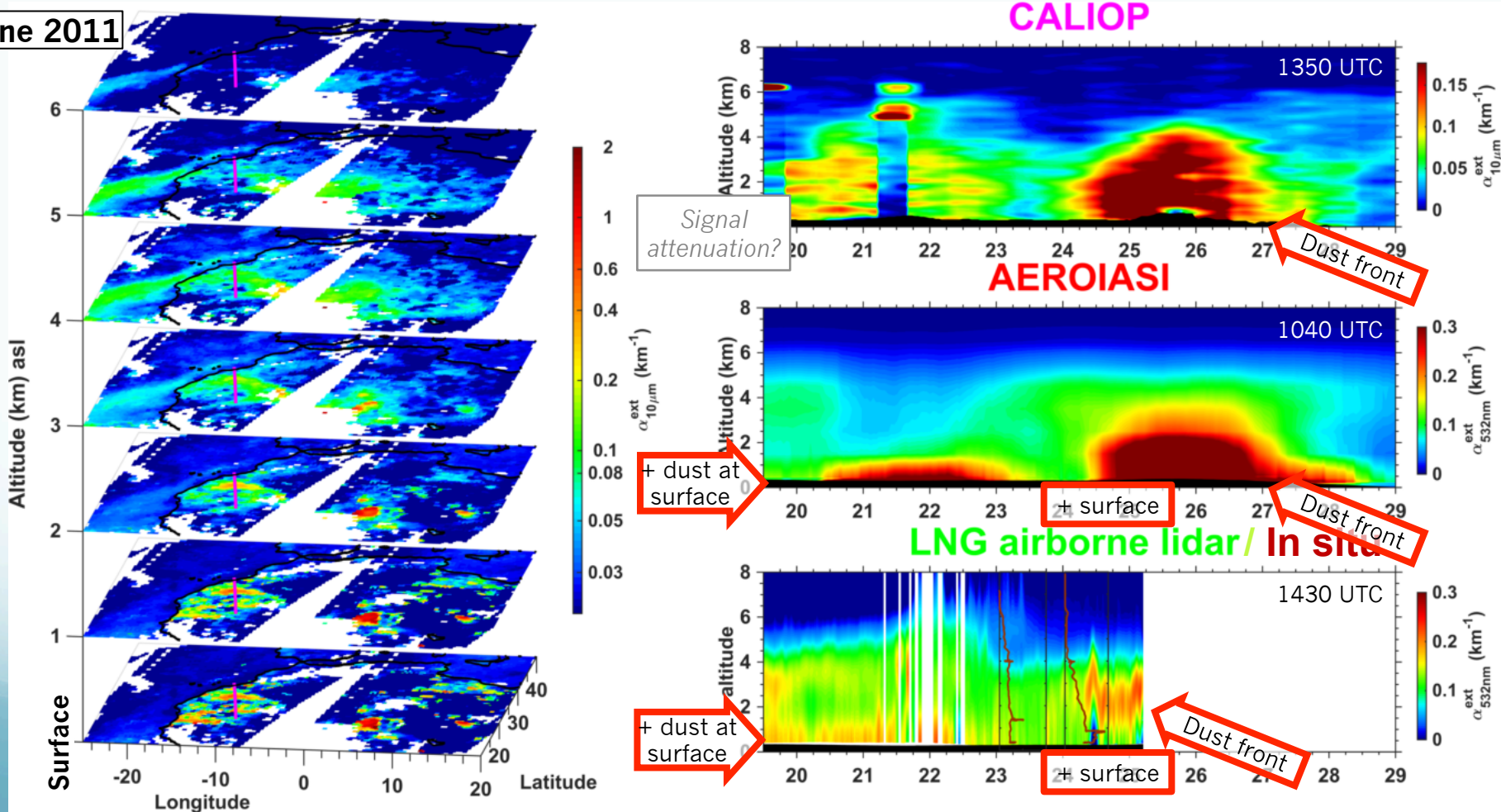

Summary

- ✓ AEROIASI shows remarkable skills for describing the 3D distribution of dust, over land/sea for most IASI cloud-free pixels (Cuesta et al., JGR 2015)
  Over the land (Sahara) and sea:
  → Vertical structure of dust plumes: Agreement with CALIOP lidar transects
  → AOD in good agreement with AERONET (coarse mode)
  → Horizontal distribution of dust plumes in agreement with SEVIRI products over the Sahara and MODIS over sea

- ✓ AEROIASI 3D distribution of dust provides new insights on:
  → Saharan dust emission mechanisms, 3D transport pathways of dust and advection over the Atlantic

- ➢ On-going & upcoming:
  - ➢ Inter-comparisons with other products: vertical distribution of dust in the framework of CCI Aerosol and AOD/dust properties within a CNES/AERIS project
  - ➢ Comparisons with chemistry-transport models (CHIMERE, WRF-Chem)

Acknowledgements

Principle for observing dust vertical distribution with IASI

Aerosols in the thermal infrared

- Absorption (AAOD)
- Scattering (SAOD=AOD-AAOD)
- Emission (T_{layer})

IASI spectra

Differences in IASI spectra

Optical properties of dust