Evaluation of IASI derived dust aerosols characteristics over the tropical belt

Capelle, Virginie[1]; Chédin, Alain[1]; Pondrom Marc[1]; Siméon, Mathilde[1]; Tsamalis, Christoforos[3]; Pierangelo, Clémence[2]; Armante, Raymond[1]; Crevoisier, Cyril[1]; Crépeau, Laurent[1]; Scott, Noëlle[1]

1. LMD, CNRS/IPSL, Palaiseau (France) ***http://ara.lmd.polytechnique.fr*** *2. CNES, Toulouse (France) 3. Met Office, Exeter, United Kingdom*

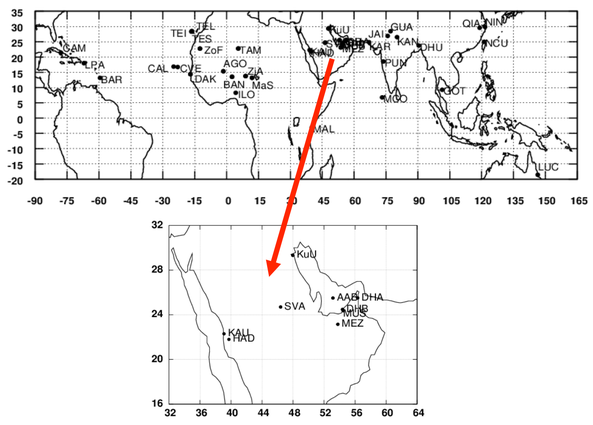
virginie.capelle@lmd.polytechnique.fr

1 Introduction

Observation from space, being global and quasi-continuous, is a tool of prime importance for aerosol studies. Remote sensing in the visible domain has been widely used to obtain better characterization of these particles and their effect on solar radiation.

Yet, infrared domain is not only essential to estimate aerosol total radiative forcing, but it also provides a way to retrieve new aerosol characteristics, including their **mean altitude** or **size**. Moreover, observations are possible both at **night** and **day**, over **sea** and **land** and more specifically over deserts [3,4,5]. Finally at 10µm, the detection is essentially due to dust aerosol **coarse mode**.

IASI-derived monthly mean infrared (10 microns) dust aerosol optical depth (AOD) and altitude are evaluated against ground based **AERONET** measurements of the 500 nm **coarse mode AOD** and **CALIOP** measurements of the altitude.



⇒ **38 AERONET** sites selected to evaluate IASI aerosols retrievals from July 2007 to June 2013 (when **AERONET** data are available).

⇒ Comparisons are made over boxes of size ~1.5°X1.5°

3 Coarse Mode AOD (CMo)

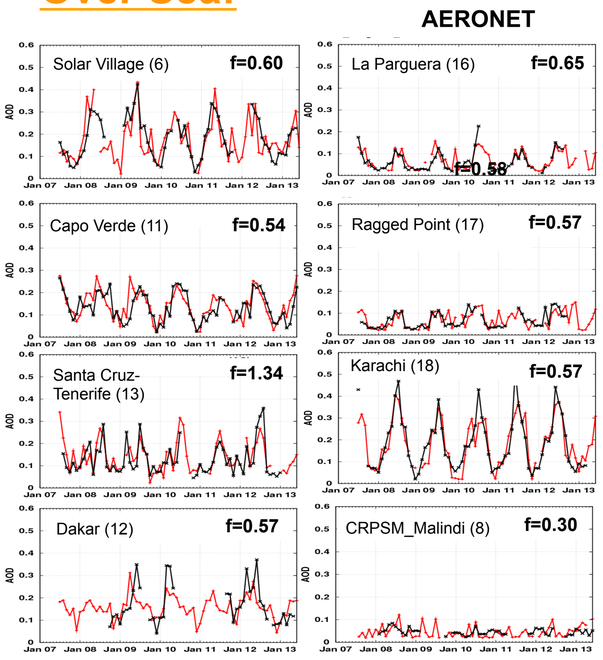
Comparing visible to 10 µm AODs is not trivial:

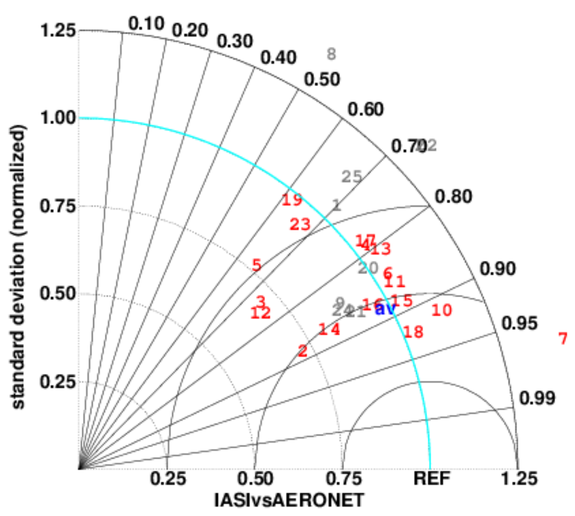
- **the metric is not the same**
- the relationship depends on an accurate **knowledge of the size distribution and of the particle size.**

➢ comparisons are made after applying, site by site, a scaling factor to visible AERONET CMo AOD

➢given this "scaling factor" estimated **once and for all for each site**.

Over Sea:





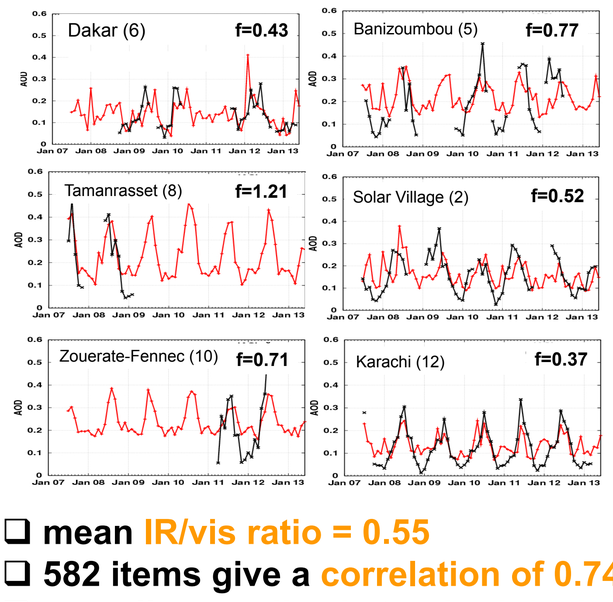
Taylor diagram (normalized) summarizes:
• the correlation between IASI and AERONET AOD
• the ratio of their variances (i.e how the amplitude of the seasonal variations are similar).
• the RMS difference
(in grey AERONET "level 1.5", in red AERONET "level 2.0" products

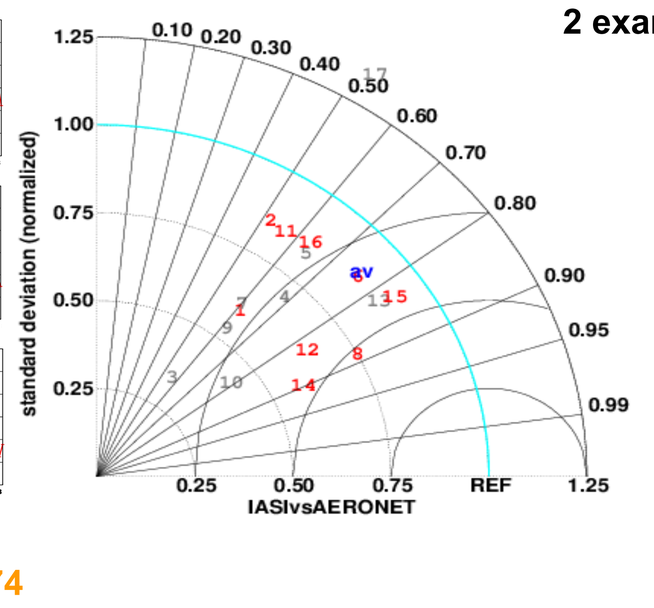
❑ **Mean ratio IR/VIS 0.6±0.17 consistent with expected values (slightly smaller than "theoretical")**

❑ **713 items give an overall correlation of 0.88**

❑ **overall normalized standard deviation of 0.96**

Over Land:





❑ **mean IR/vis ratio = 0.55**

❑ **582 items give a correlation of 0.74**

❑ **overall normalized standard deviation of 0.87**

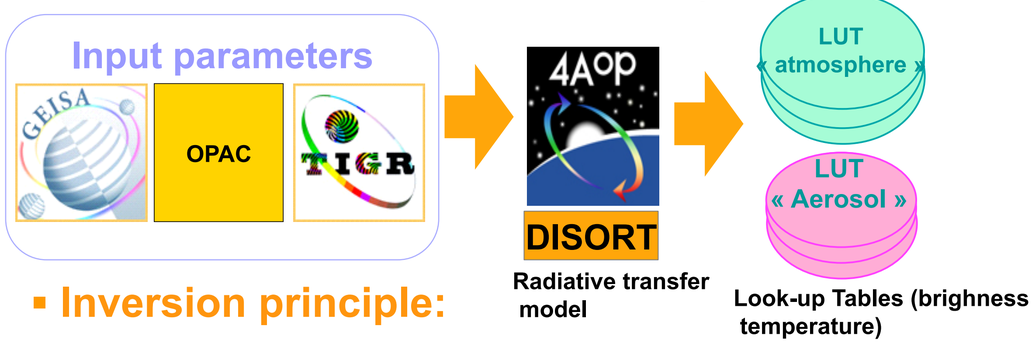
❑ **smaller amplitude for almost all sites with respect to AERONET reference**

➢ more level 1.5 AERONET (no final calibration) + less AERONET data (monthly averages calculated only from a few days of measurement).

➢ large terrain heterogeneities lead to uncertainties on surface properties (emissivity, temperature) and thus on aerosol properties retrievals

2 Method

▪ **Radiative transfer simulations : performed off-line once and for all**



- Spectroscopy from GEISA [1]
- Atmospheric state from TIGR[2]
- Aerosol Model (OPAC)
- Surface parameters : Emissivity & temperature[6]

Radiative transfer model

Look-up Tables (brighness temperature)

▪ **Inversion principle:**

1 - Determination of the atmospheric state :

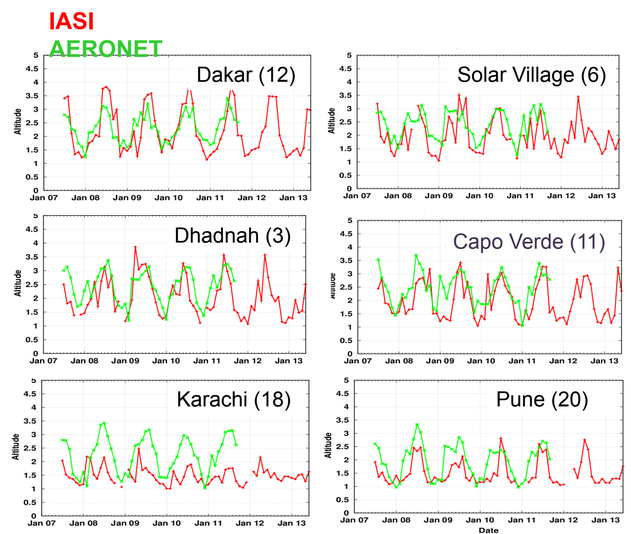
Determination of the best atmospheric situation (temperature, water vapor profile) using channels mostly sensitive to temperature and water vapour.

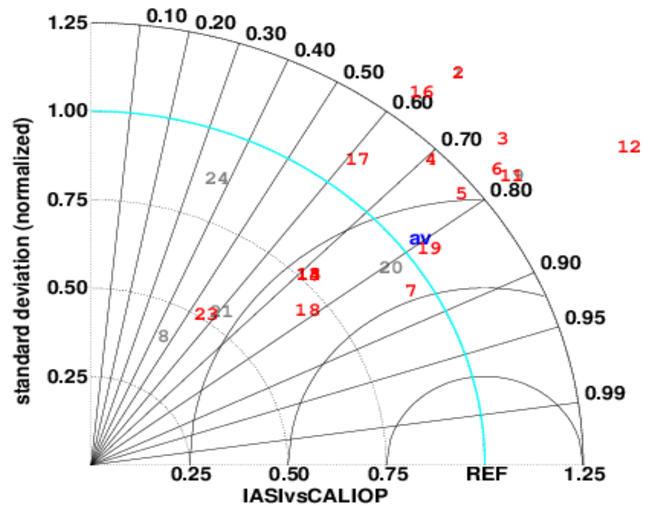
2 - Simultaneous retrieval of aerosol properties :

Dust coarse mode optical depth (AOD) at 10 microns, altitude of the layer and effective radius are retrieved from channels mostly sensitive to aerosols [1,2].

4 Mean altitude Comparison with CALIOP data (monthly, 3°x3°)

In the infrared, the mean altitude retrieved is the altitude at which half of the AOD is above and half of the AOD is below. We used CALIOP Level-2 aerosol layer product to compare with IASI retrievals at the same AERONET sites.





❖**Over sea:**

❑ **Mean difference IASI/CALIOP of ~450m**

❑ **925 items give a correlation of 0.78**

❑ **overall normalized standard deviation of 1.03**

❖ Over Land, work is in progress

❑ **satisfactory results given the differences :**

- ➢ different definitions of the two altitude products
- ➢ different space-time resolutions
- ➢ sensitivity of IASI lower to altitude than to AOD

5 Conclusion - Future work

➢In general, the overall agreement between IASI and other data is satisfactory.

➢Difficulties remains to compare numerically AOD from IR and from visible given the different metric between the two domains

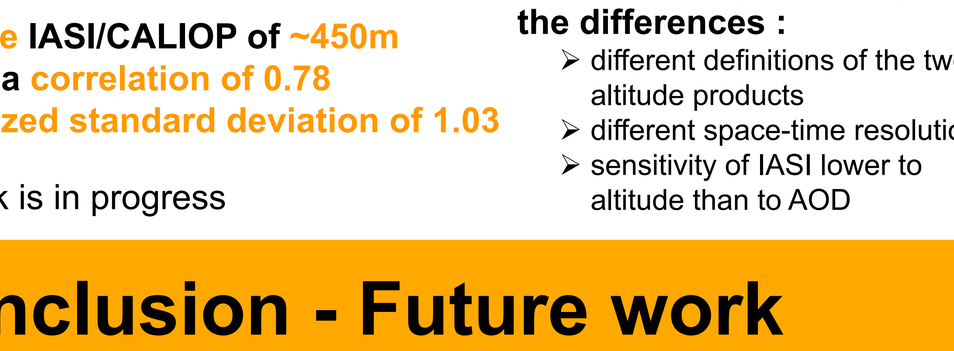
➢Over land work is in progress to solve remaining difficulties especially for altitude.

=>This demonstrates the usefulness of IASI data as an additional constraint to a better knowledge of the impact of aerosols on the climate system (see also [7]).

Current and future work include :

=> **Daily results**: First results are promising and show that IASI daily AOD are in agreement with AERONET data given the IR/vis ratio determined per site in part 1.

2 examples at Dakar:



=> Extend the method to **extra-tropical** latitudes

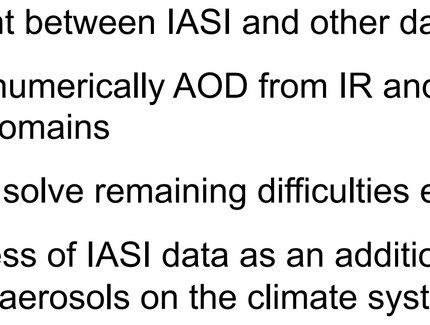
Example: case of large event in Mediterranean region in April 2008

❑ The aerosol detection follows the MODIS AOD in the middle of the month

❑ IASI daily AOD are consistent with the variations observed by AERONET.

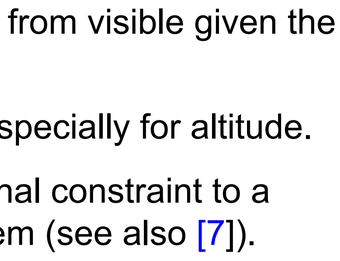
=> Extend the method to **daytime retrievals**

Aerosol detection:



Aerosol retrieval:

=> IASI 10µm CMo AOD compared with AERONET 870nm total AOD at "Forth-Crete"



References

[1] Jacquinet-Husson et al., JQSRT, 109, 1043–1059, 2008
[2] Chédin et al., JCAM, 24, 128–143,1985
[3] Pierangelo et al., ACP., 4, 1813–1822, 2004
[4] Peyridieu et al., ACP., 10, 1953-1967, 2010
[5]Peyridieu et al. ACP, 13, 6065-6082 2013,
[6] Capelle et al., JAMC, 1164-1179, 2012
[7] Capelle et al. ACPD, 13, 30143 2013,