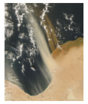

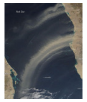

Saharan dust coarse mode effective radius retrieved from IASI over the Atlantic Ocean

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Introduction:

Observation from space, being global and quasi continuous, is a first importance tool 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. On the opposite, remote sensing of aerosols in the infrared domain still remains marginal. Yet, not only the remote sensing in the infrared domain is needed for the evaluation of the total radiative forcing of aerosols but also Infrared sounders provide a way to retrieve other aerosol characteristics, including their mean altitude and their size [1,2].

We present here results obtained from IASI sounder, and comparisons with other aerosol datasets including MODIS and MISR (AOD), CALIOP (Altitude) and AERONET (coarse mode effective radius).

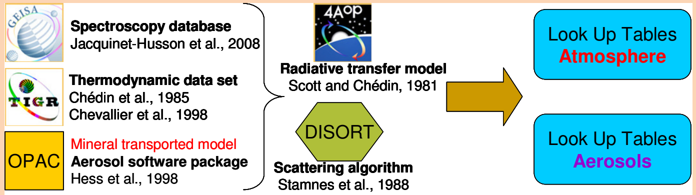
Method to determine the IASI-10µm AOD and mean altitude

We have developed a method to retrieve simultaneously coarse mode dust aerosol 10 µm optical depth (referred hereafter to as DOD, i.e., specific of dust particle) and mean layer altitude from high spectral resolution infrared sounders observations. The method is based on Look Up Tables (LUT): all the radiative transfer modeling are performed off-line, once and for all, with 4A/OP model[3] coupled with DISORT algorithm [4].

The method follows in two steps:

1.Radiative transfer simulations

➢Computation of the LUTs



2.Inversion

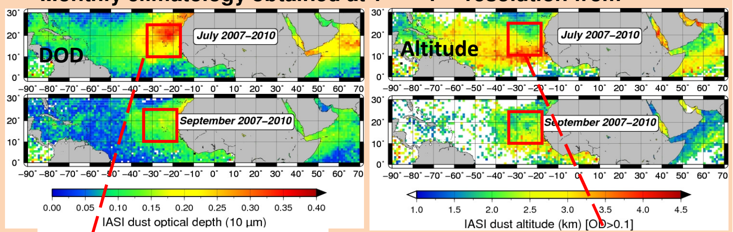
➢Determination of an atmospheric situation the closest to the situation observed (AIRS or IASI) using channels mostly sensitive to temperature and water vapor,

➢Simultaneous retrieval of aerosol properties (DOD, altitude) from BTs of channels mostly sensitive to aerosols. The proximity recognition in the LUT is made only for atmospheric situations found in step 1.

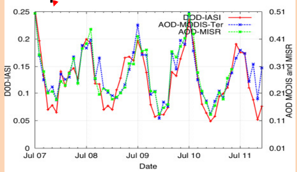
Results for DOD and mean altitude

The method has been applied to more than 9 years of AIRS and 4.5 years of IASI observations with results being obtained at a space-time resolution of 1 degree-1 month [1,2]. Results have been validated by comparisons with MODIS and MISR for the DOD and CALIOP for the mean altitude.

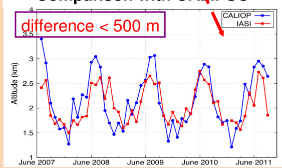
Monthly climatology obtained at 1°×1° resolution from



Comparison with MODIS and MISR



Comparison with CALIPSO



Regions far from the sources (and not shown here) also compare well with both MODIS, MISR et CALIOP.

Method to retrieve the coarse mode effective radius

The method follows that developed for AIRS [5]. The different orders of magnitude of the sensitivity to DOD and altitude on the one hand (1st order), and to the particle size (2nd order) on the other, allows estimating DOD and altitude with an a priori on Reff (here Reff comes from the MITR aerosol model, i.e ~2.5µm) first, and Reff second.

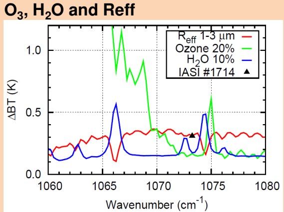
The method follows several steps:

➢ 1 channel at 1073.75 cm^{-1} is selected for its high sensitivity to the particle size and relative low sensitivity to O_3 and H_2O;

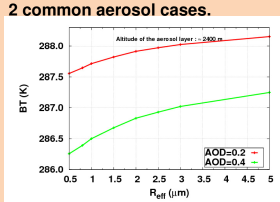
➢ radius-LUTs are computed for every atmospheric situation, DOD and altitude used in the first step and for 11 values of Reff between 0.5 and 5 µm. The optical properties are calculated using a Mie code [6] and the refractive indices of MITR. This is performed "off line", once and for all;

➢ after having determined DOD and altitude, Reff can be deduced from a simple BT=f (Reff) relationship as show in the bottom right.

Sensitivity of IASI channels around 1070 cm^{-1} to O_3, H_2O and Reff



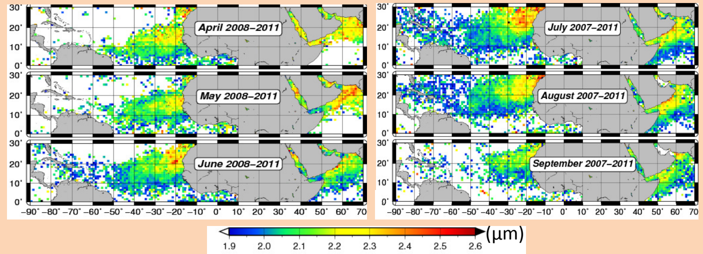
BT=f(Reff) relationships calculated for 2 common aerosol cases.



Results for the effective radius

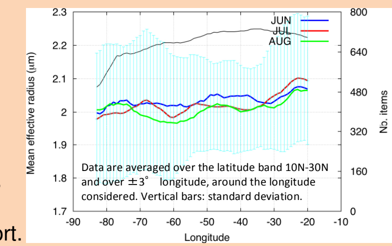
The monthly mean 1°x1°, dust coarse mode effective radius is retrieved from IASI over the Atlantic Ocean for the period July 2007 to December 2011.

Climatology 1° x1° of the dust coarse mode effective radius

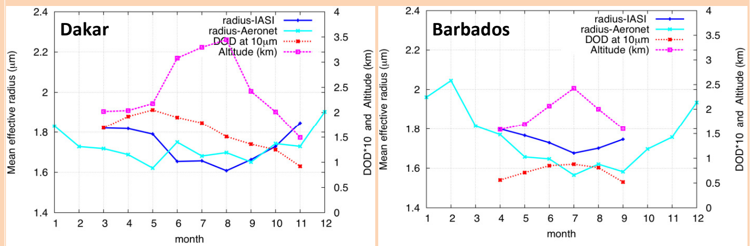


During the dust season (summer), we found that Reff remains almost constant, from 2.1 µm close to the African coasts to 2.0 µm at the Caribbean. This behavior is compatible with the findings of the PRIDE campaign ([7],[8]) where the authors conclude that small particles (Reff<7.3µm) were not preferentially removed during atmospheric transport.

2007-2011 averaged zonal evolution of Reff



Comparisons between the IASI-retrieved dust coarse mode effective radius and observations from the Aerosol Robotic Network (AERONET) sun photometers [9], at sites close or far from the dust sources, show a good agreement apart from a systematic bias of about +0.3 µm between IASI and AERONET, still not explained.



Dust coarse mode effective radius climatology (2007/8-2011) from IASI and AERONET

NB : here, a systematic bias of 0.3 µm is subtracted to IASI results

Conclusion

These results should contribute to better characterize dust aerosol size distribution, especially the coarse mode part, for which there are large uncertainties, and improve our knowledge of the effect of dust aerosols on the terrestrial radiation. Overall, these results illustrate the dust westward transport characterized by a relatively rapid decrease of the dust optical depth compared to the much slower decrease of both the altitude and the radius.

References

[1] Peyridieu et al., Atmos. Chem. Phys., 10, 1953-1967, 2010
[2] Pierangelo et al., Atmos. Chem. Phys., 4, 1813-1822, 2004
[3] Scott and Chédin, J. Appl. Meteor., 20, pp. 802-812, 1981; Available on http://www.noveltis.net/4AOP
[4] Stamnes et al., Appl. Optics., 27, 2502–2509, 1988
[5] Pierangelo et al., Geophys. Res. Lett., 32, L20813 , 2005
[6] Mishchenko et al., Cambridge University Press, Cambridge, 2002.
[7] Maring, et al., J. Geophys. Res., 108, 8592, doi:10.1029/2002JD002536, 2003.
[8] Reid et al., J. Geophys. Res., 108, 8586, doi:10.1029/2002JD002493, 2003.
[9] see: http://aeronet.gsfc.nasa.gov/new_web/optical_properties.html