# Vertical distribution of the Saharan Air Layer from 5 years of CALIPSO observations

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## Introduction

The Saharan Air Layer (SAL) forms as dry and hot air moves across the Sahara desert. SAL, containing substantial amounts of mineral dust, is a dominant feature that influences the large scale environment from West Africa to eastern tropical America (Karyampudi et al., 1999). The SAL has been studied with dedicated campaigns at the two sides of the Atlantic (Reid et al., 2002, Ansmann et al., 2009) or using space observations due to lack of systematic in situ measurements away from the continents (Huang et al., 2010). However the campaigns are restricted in time, while satellite observations of thermodynamic variables are affected by the presence of dust. Moreover, satellite measurements of aerosols, particularly in the visible, mostly provide column integrated properties like the optical depth, without information about the vertical distribution. On the other hand, new generation infrared sounders now bring reliable information on the dust layer mean altitude (Peyridieu et al., 2010), but their new established results need further validation. However, the two-wavelength space lidar CALIOP, launched on board CALIPSO in April 2006, permits an accurate determination of the aerosol vertical distribution.

## Data

Thanks to depolarization at 532 nm, CALIOP is able to discriminate between dust and other types of aerosols, which generally do not depolarize light (Winker et al., 2010). Here, the L2 5 km aerosol layer product (version 3.01) is used to calculate the seasonal vertical distribution of the dust aerosols above the Atlantic during the 5 year period June 2006 – May 2011 with a horizontal resolution of 1 degree. More specifically, two classes of aerosols are used from the L2 product: dust and polluted dust, in order to take into account the change of dust aerosols optical properties with transport. In addition, the MODIS (AQUA) aerosol optical depth (collection 051) for the same period is used in order to give the spatial extension of the SAL. Also, as the emission and the transport of dust aerosols are governed by wind, the ECMWF ERA-Interim wind fields are used to assess their influence on the SAL shape.

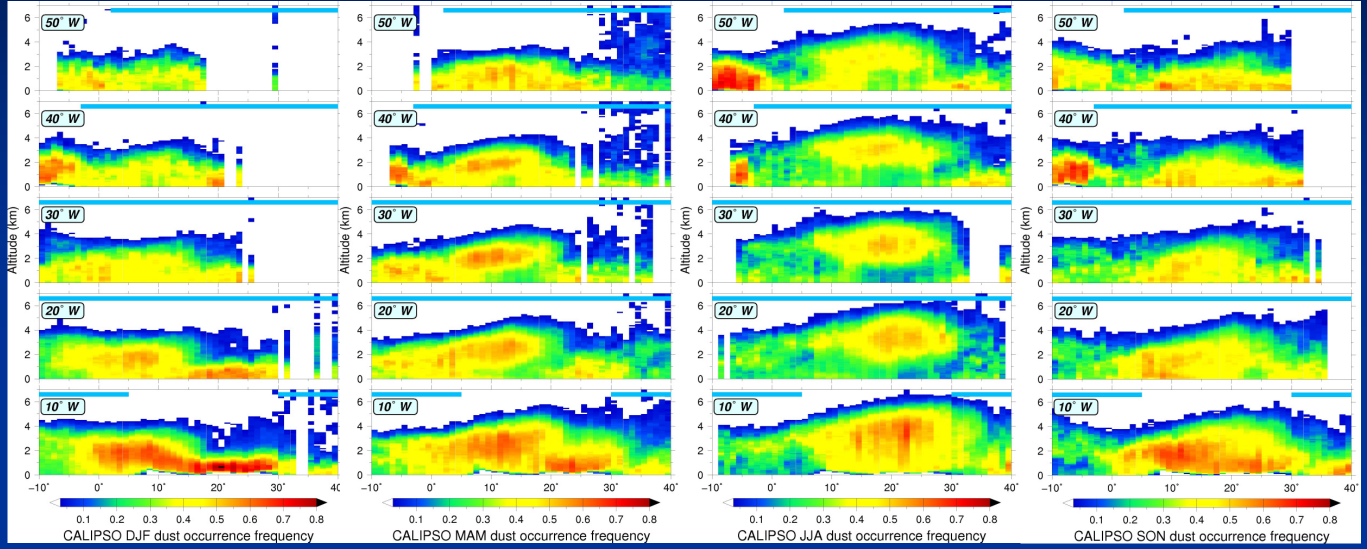


**Figure 1:** Seasonal vertical distribution of dust aerosols above the Atlantic Ocean at five longitudes (10°, 20°, 30°, 40° and 50°). The cyan line at the top of each cross section marks the ocean.

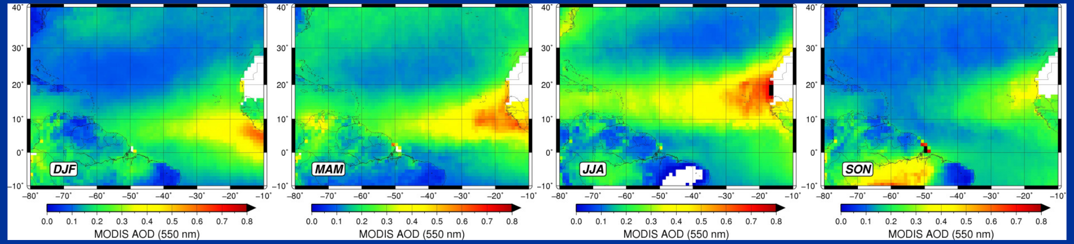


**Figure 2:** Seasonal maps of aerosol optical depth at 550 nm from MODIS (AQUA).

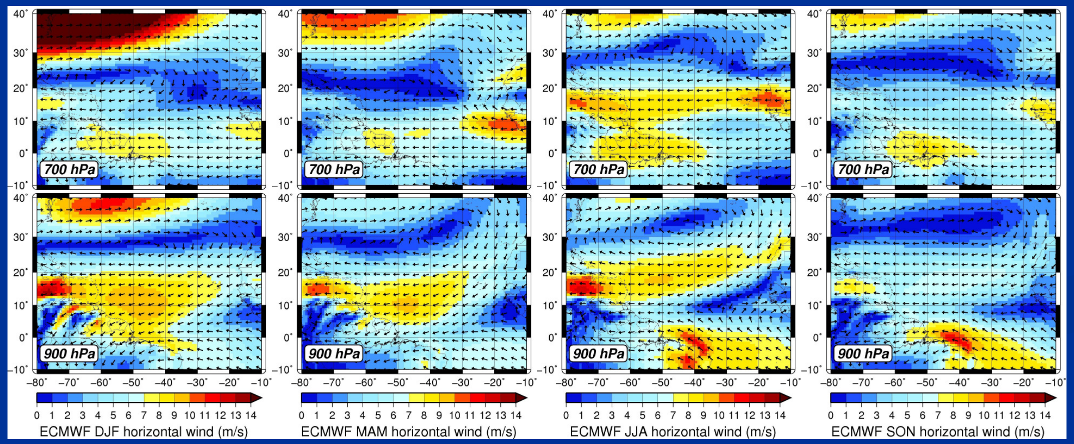


**Figure 3:** Seasonal maps of ECMWF horizontal wind at 700 and 900 hPa.

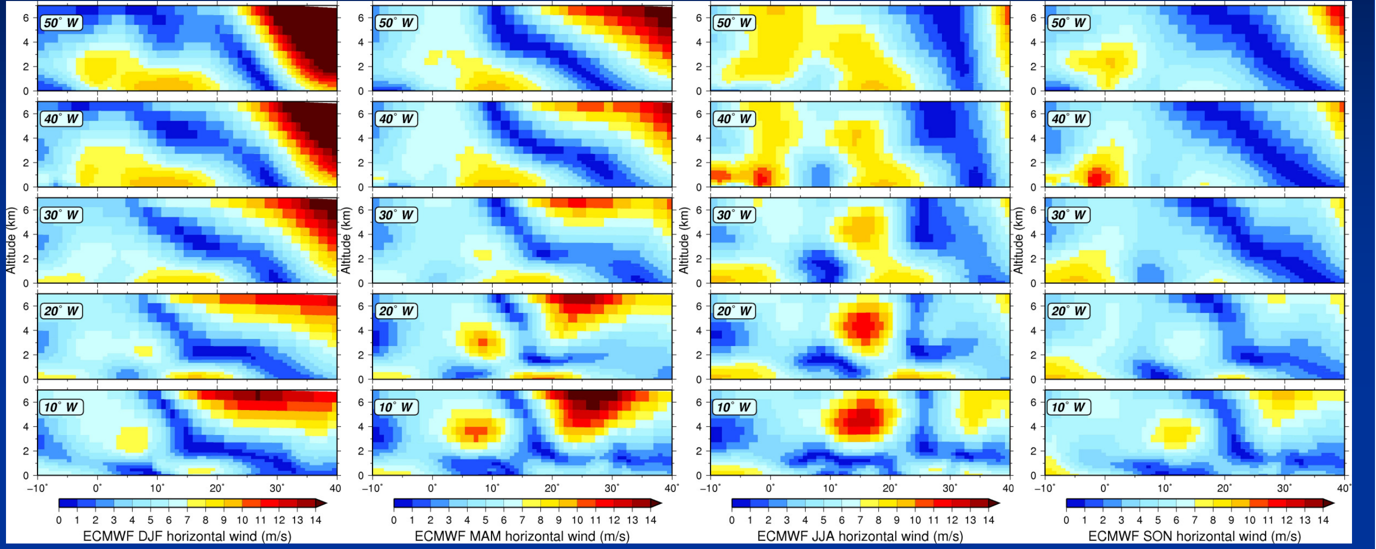


**Figure 4:** Seasonal cross sections of horizontal wind speed from ECMWF at five longitudes (same as Figure 1).

## Results and conclusions

The seasonal vertical distribution of the SAL based on CALIOP observations can be found in Figure 1, while MODIS (Figure 2) gives its spatial distribution.

- **Winter:** Off West Africa, SAL is found between [-5, 15]°N and between the surface and 3 km. By approaching South America its top goes down to about 2 km.
- **Spring:** Near Africa, it occurs between [0, 20]°N in the altitude range 1-4 km. Towards South America (and South Caribbean this time) its top altitude drops to 2-2.5 km. At longitudes [20, 30]°W, now the influence of the trade winds can be observed (see also Figures 3, 4).
- **Summer:** Over East Atlantic, it is found between [10, 30]°N, in the altitude range 1.5 to 5 km. At the Caribbean Sea, it occurs between [5, 25]°N, where the top altitude is at 4 km. Again, the influence of the trade winds decouples SAL from the ocean surface (Figures 3, 4).
- **Fall:** SAL turns southwards in comparison to summer, and lies between [0, 25]°N, from the surface up to 4 km off West Africa. Close to America, its top altitude drops to about 2 km.

These results, at 1 degree horizontal resolution, offer a better description of the SAL, not accessible up to now, at least vertically. Moreover, they could be helpful for testing model capabilities to reproduce the SAL vertical distribution or as input climatological data. Also, they can be used as a priori information to UV (like TOMS or OMI) or IR (like AIRS or IASI) satellite instruments, which are known to be sensitive to the vertical distribution of dust aerosols, in order to improve the quality of their geophysical retrievals.

### References

Ansmann et al., GRL, 36, 2009
Huang et al., JGR, 115, 2010
Karyampudi et al., BAMS, 80, 1999
Peyridieu et al., ACP, 10, 2010
Reid et al., GRL, 29, 2002
Winker et al., BAMS, 91, 2010



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