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Dust altitude climatology based on CALIPSO observations

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Dust aerosols are important constituents of the earth climate as they influence many processes of the planet. Their deposition in the ocean supplies it with iron, which in turn affects the ocean biogeochemistry, they act as cloud condensation and ice nuclei and therefore have strong implications in the hydrological cycle, they impact the concentrations of trace gases, like ozone, via heterogeneous reactions, while they also affect the earth's radiative budget either via the direct effect though reflection and absorption of both the incoming solar radiation and the outgoing infrared radiation, or via the indirect effects by altering cloud properties.

An important parameter of the dust aerosols is their altitude as it defines their impact on the aforementioned processes. But this parameter is not easily measurable except from lidars and more recently from passive remote sensors like AIRS or IASI. Nevertheless, ground based lidars are situated at specific locations and cannot offer a complete estimation of the dust altitude impact on the earth climate, while dedicated campaigns using lidars and in situ measurements are restricted in time. On the other hand, the passive instruments AIRS and IASI offer a very good spatial coverage, but their new established results need further validation.

The satellite CALIPSO with the on board two wavelength depolarisation lidar CALIOP, which was launched on 28 April 2006, permits an accurate determination of the aerosols altitude. Moreover, the depolarisation at 532 nm allows discriminating between the dust aerosols and the other types of aerosols, which do not depolarize light. Nevertheless, the beam diameter of 70 m at the earth's surface makes difficult to interpret statistically the results, as the 16 days repetition cycle of CALIPSO does not cover all the earth. In order to overcome this difficulty, the L2 5 km aerosol layer product (version 3.01) is used here to calculate seasonal climatology for all the available night time data (for a better signal to noise ratio) of 4.5 years (June 2006 – December 2010) with a horizontal resolution of 1 degree. Two classes of aerosols are used from the L2 product: desert dust and polluted dust. It is known that the polluted dust class may also contain biomass burning aerosols, but for the 0-30°N region, their impact is not important as the desert dust is the dominant type of aerosol in this region in summer, when the peak of dust activity is observed.

Results show that although the export of dust from Sahara to Atlantic ocean during summer happens essentially between 10-20°N, as already known, the mean dust altitude is more elevated in the region 20-30°N than in the former region, even if the geometrical depth of the dust plume is more important in the 10-20°N region. Also, during the transport of the dust plume from the Sahara to the Caribbean, the mean altitude diminishes confirming previous studies. Moreover, in the region between east Africa and Arabian Peninsula, CALIOP results during summer demonstrate that the mean dust altitude is higher than off the coast of west Africa, even if the optical depth of the former is more important. This can be explained by the strong convection occurring in that region as shown by ECMWF ERA-interim climatological results during the CALIOP measurement period.