Detection of the Saharan dust air layer in the North Atlantic free troposphere with AERONET, OMI and in-situ data at Izaña Atmospheric Observatory

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We have performed a comparative study on the detection of Saharan dust events in the North Atlantic free troposphere with different and complementary techniques: in situ measurements of dust are compared to Aerosol Optical Depth (AOD) from Aerosol Robotic Network (AERONET) and satellite-retrieved OMI (TOMS-like) Aerosol Index. These in-situ dust and AOD measurements were performed at the Izaña Global Atmospheric Watch Observatory. This site is located at 2,367 m.a.s.l. on Tenerife (Canary Islands, Spain) and is representative of the North Atlantic free troposphere (Rodríguez et al., 2010).

The following data set was analysed: (1) in-situ PM_{10} mass concentration diurnal averages (7h-19h), (2) AERONET Level 1.5 Aerosol Optical Depth (AOD) diurnal averages (7h-19h), and (3) OMI Level 2 Aerosol Index (AI) instantaneous measurements at overpass time (between 13h-15h) over Tenerife (only positive values corresponding with absorbing aerosols). The data set covers the time period from 2004/07/01 to 2009/12/31 (Figure 2). Chemical characterization studies show that Saharan mineral dust is the only aerosol component that significantly contributes to in-situ PM_{10} concentrations at Izaña (Rodríguez et al., 2010).

The objective of the study is to assess if these three parameters provides the same information on the behaviour and evolution of the Saharan dust air layer. We address the following questions:

- Is the Saharan dust air layer detected in a day-to-day basis with the three parameters?,
- Is it possible to have a reliable estimation of the remote sensing parameters from in-situ measurements, and vice versa, on the basis of experimentally determined equations?, to what degree, daily, monthly, seasonally?
- Does the year to year variability in the remote and in-situ dust concentrations provide the same information for long term (decades) dust monitoring?

For the purpose of this study, dust events resulting in PM_{10} concentrations greater than 25 $\mu g/m^3$ were only considered, being the event intensity defined by the following scale: major >100 $\mu g/m^3$, intermediate 50-100 $\mu g/m^3$ and minor 25-50 $\mu g/m^3$.

During the study period, 211 Saharan dust events were identified by the in-situ measurements: 27 major, 76 intermediate and 108 minor dust episodes. AERONET detected 82% of all events, detection defined by the simultaneous increase of AOD and PM_{10} values. Excluding the events in which AERONET data is missing, 96% of all events were successfully detected, as 96% of major, 97% of intermediate and 96% of minor events. OMI detected 70% of all events, detection defined by AI values >0.5. Excluding the events in

which OMI data is missing, 86% of all events were successfully detected, as 86% of major, 91% of intermediate and 82% of minor events.

Results show that it is possible to perform reliable estimations of monthly average PM_{10} concentrations using AOD data, and vice versa. Observe in Figure 1 how the monthly means of these two parameters show a linear relationship. This high correlation is not observed between AI and the other two parameters. Although only 5 years have been studied, the preliminary results suggest that there are not significant differences in the information provided by AOD and PM_{10} on the year-to-year evolution on the Saharan dust air layer over the study region. This indicates that dust transport events at altitudes above Izaña are rather infrequent. We use this data set for studying the origin of the year-to-year variability in the dust exportation to the North Atlantic ocean at subtropical latitudes.

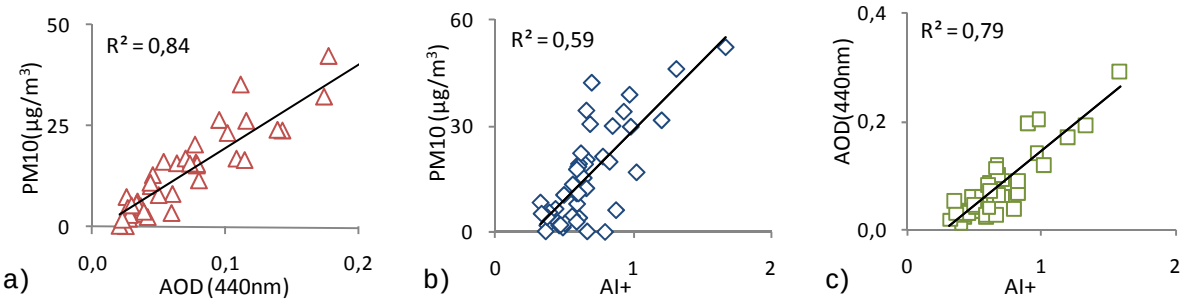

Figure 1. Scatterplot of monthly means of a) AOD vs PM_{10}; b) AI positive values vs PM_{10}; c) AI positive values vs AOD.

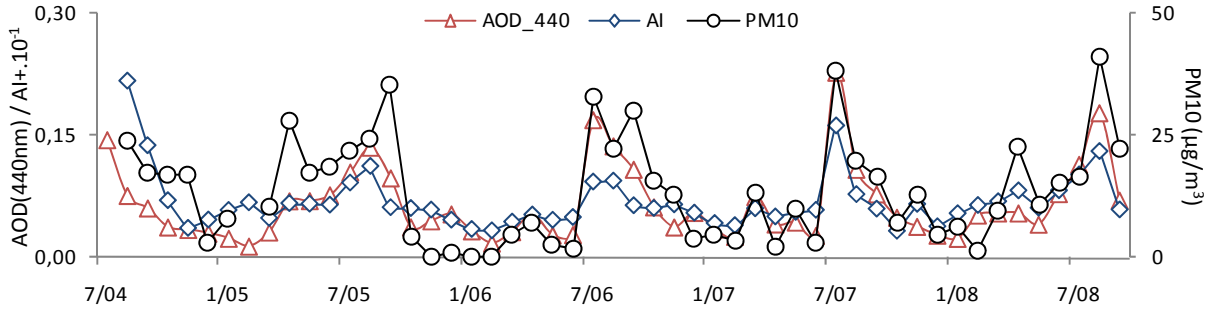

Figure 2. Monthly means of PM_{10} (µg/m^3), AOD and AI positive values.

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