Statistical study on tropospheric Ozone and total Ozone column under Saharan Outbreaks

Andrey, Javier[1,*], Gil, Manuel[1], Alonso-Pérez, Silvia[2,3], Parrondo, M. Concepción[1], Redondas, Alberto[2], Cuevas, Emilio[2]

[1]Instituto Nacional de Técnica Aeroespacial (INTA), Ctra. Torrejón Ajalvir km. 4, E-28850, Torrejón de Ardoz, Spain, *javier.andrey@gmail.com
[2]Centro de investigación Atmosférica de Izaña, Agencia Estatal de Meteorología (AEMET), C/ La Marina 20, 28071, Sta. Cruz de Tenerife, Spain
[3]Instituto de Diagnóstico Ambiental y Estudios del Agua (CSIC), C/Lluis Solé i Sabarís, s/n, 08028, Barcelona, Spain

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There is long evidence of negative correlation between O_3 and aerosols on desert dust outbreaks. In situ measurements show significant reduction in ozone concentration under intense dust storms (Prospero et al, 1995, Bonasoni et al, 2004, de Reus, 2009, etc). Three pathways have been proposed to explain the O_3 reduction a) Decrease in formation rates as photolysis is reduced by extra-scattering, b) Direct uptake of O_3, and c) HNO_3 heterogeneous removal, but the relative importance of each one is still a matter of discussion. Rates of reduction as a function of dust loading have been mostly calculated from laboratory measurements, or estimated from models, since direct measurements are not common. Moreover, the actual decrease in O_3 vertical distribution has been almost unexplored due to the scarcity of ozonesonde programs downwind of large deserts.

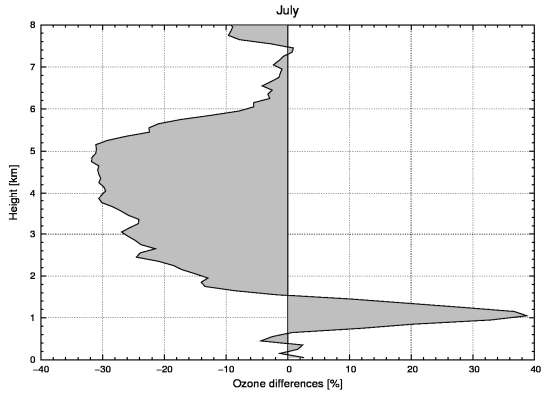

Fig. 1 Differences in July mean ozone vertical profile under dust and non-dust conditions.

Saharan dust transport over The Canary Islands mainly occurs in summer, when the North African anticyclone is located above 850 hPa, where the dust transport occurs. The strong heating of the ground in the Sahara desert leads to a surface thermal low while the North African anticyclone shifts up to higher levels. African dust intrusions at high altitudes over the Canary Islands are associated to air flow from the second or the third quadrant.

Ozonesonde dataset at Tenerife Island (28º N, 16º W) has been used to quantify the impact of dust loading on ozone vertical distribution. A 10-year subset of the data (1999-2009) have been separated in "dusty" and "clean" days in order to find out the dust impact on tropospheric ozone in a statistical basis. A ratio between two wavelengths in the solar spectrum measured by a visible spectrograph has been used as index for aerosols (colour index) after calibration by an AERONET CIMEL sunphotometer for profile classification. This preliminary study has focused on July when the Saharan Air Layer over the North Atlantic shows thick vertical extensions of up to 6-6.5 km.

Results show significant reductions in O_3 at all levels within the dust layer. Maximum reduction takes place between 3.8-5.2 km reaching -30%. Below 1.5 km the situation reverses and O_3 increases during the Saharan outbreaks, peaking to +40% at 1.0 km.

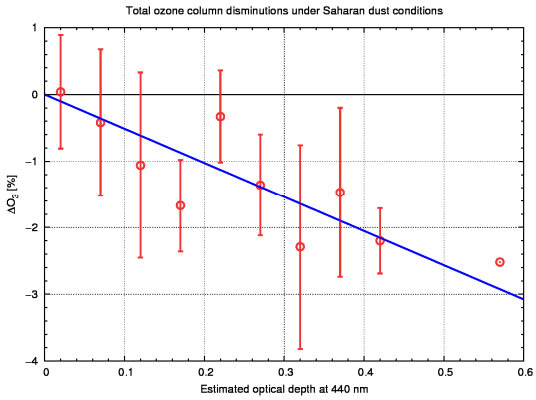

Fig 2. Total ozone column reduction versus calibrated 'dust index'

A linear dependence between ozone total column (ozonesoundings integrated to the top of the atmosphere) and aerosol optical depth has been found with a slope of 2% per 0.4 AOD at Izaña observatory