Black Carbon (BC) and Dust Mass Concentrations Measures at North Atlantic Free Troposphere

F. Barata, P. Fialho

G. de Química e Física da Atmosfera, Dep. de Ciênc. Agrárias, Univ. dos Açores, PT9701-851 Terra Chã, Portugal; barataf@gmail.com

Introduction

The PICO-NARE observatory is an experimental site on the Pico Island (38.470º; 28.404º; 2225 m altitude) in the Azores Archipelago, developed to provide a base for free troposphere measurements (Honrath & Fialho, 2002) (Figure 1). One Aethalometer (AE-31) was used to determine the aerosol seasonal variability for the Central North Atlantic region. Application of the separation technique, proposed by Fialho *et al.* (2005, 2006), aloud the calculation of the seasonal variability for BC and Dust.

Figure 1. PICO-NARE site

Methods

The aerosol absorption coefficients were measured by using the AE31 Aethalometer (Hansen, 2003), and by uncoupling the BC and Dust contribution to the aerosol signal (Fialho *et al.*, 2005, 2006), the variability of BC and dust was calculated.

The analysis of upper marine boundary layer (MBL) impact was done by applying the meteorological analysis proposed by Kleiss & Honrath (2005).

Results

The averaged seasonal variability of BC and Dust along the year, in the FT or in the FT plus the upper MBL is not significantly different (Figure 2 and 3).

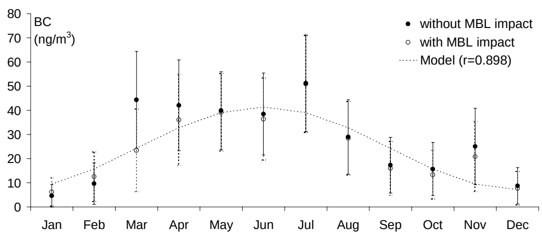

Figure 2. Black carbon variation. The dots represent BC mass concentration measured by the technique; the dotted curve line represents the equation model fitted to the data; the black line represents one standard deviation interval.

The BC average values are 27 ± 16 ng/m^3 and 24 ± 14 ng/m^3, without and with MBL impact, respectively. The dust average values are 13 ± 20 ng/m^3 and 10 ± 15 ng/m^3, without and with MBL impact, respectively. In both situations without and with MBL results are statistically not different. The BC seasonality can be translated by BC(ng/m^3) = (24±2) – (17±3) Cos ((Π/6) Month), with a r = 0.898 and σ_{xy} = 6.8 ng/m^3.

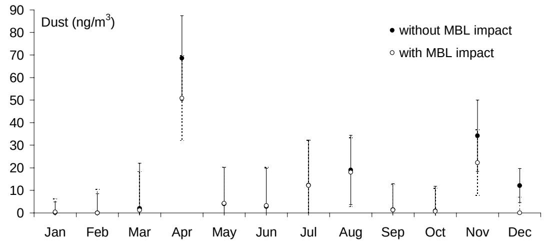

Figure 3. Dust variation. The dots represent dust mass concentration measured by the technique; the black line represents one standard deviation interval.

The dust mass concentration value is most variable, without a seasonal cycle. The higher values occur on few days' episodes, during the moths of April, July, August and November.

Discussion

The annual BC mass concentration mean is in accordance with literature data indicated for the eastern North Atlantic by Jennings *at al.*, (1993) (38 ± 11 ng/m^3) but higher than the one (14 ± 3 ng/m^3) proposed by Cooke *et al.*, (1997). It should be noted that Cooke *et al.*, (1997) used an upper limit cut of 75 ng/m^3 for BC mass concentration in background air masses, when calculating their mass averages.

In comparison with literature data indicated for the western North Atlantic, the value is in accordance with the one (30 ± 10ng/m^3) proposed by Chylec *et al.*, (1996) but lower than the one (66 ± 24 ng/m^3) proposed by Bahrmann & Saxena, (1998). It should be noted that the Bahrmann & Saxena (1998) sampling site does not imply pure marine air but rather a modified marine air caused by potential additional influence from sources between the ocean and the station used in their work.

Furthermore, in present work the attenuation signal measured was corrected for the iron oxide contamination accordingly to Fialho *et al.*, 2005, 2006, and the manufacture calibration value used for BC is K_{BC} = 14.625 μm m^2 g^{-1}, different of the one used by the others afore mentioned. The dust mass concentration value is most variable according to the expected long transport Sahara dust events influence.

References

Bahrmann, C., Saxena, V., (1998). Influence of air mass history on black carbon concentrations and regional climate forcing in southeastern United States. *Journal of Geophysical Research*, 103, D18, 23,153-23,161.

Chylek, P., Banic, C., Johnson, B., Damiano, P., Isaac, G., Leaith, W., Liu, P., Boudala, F., Winter, B., Ngo, D., (1996). Black carbon: atmospheric concentrations and cloud water content measurements over southern Nova Scotia. *Journal of Geophysical Research*, 101, 29,105-29,110.

Cooke, W., Jennings, S., Spain, T., (1997). Black carbon measurements at Mace Head, 1989 – 1996. *Journal of Geophysical Research,* 102, D21, 25,339-25,346.

Honrath, R., E., & Fialho, P. (2002). The Azores Islands: a unique location for ground-based measurements in the MBL and FT of the central North Atlantic. *IGACtivities Newsletter, 24, 20-21.*

Fialho, P., Hansen A. D. A., Honrath, R. E., (2005) Absorption coefficients by aerosols in remote areas: a new approach to decouple dust and black carbon absorption coefficients using seven wavelength Aethalometer data. *Journal of Aerossol Science* 36 (2005) 267-282.

Fialho, P., Freitas, M. C., Barata, F., Vieira, B., Hansen A. D. A., Honrath, R. E., (2006) The Aethalometer calibration and determination of iron concentration in dust aerossols. *Journal of Aerossol Science,* DOI:10.1016/j.jaerosci.2006.03.002..

Kleissl, J., Honrath, R., Dziobak, M., Tanner, D., Val Martin, M., Owen, C., Helming, D., (2006). The Occurrence of Upslope Flows at the Pico Mountaintop observatory: a Case Study of Orographyic Flows on a Small Volcanic Island. Journal of Aerosol Science DOI:10.1016/j.jaerosci.2006.03.002.

Hansen, A., D., A., (2003). The aethalometer manual. *Magee Scientific*.

Jennings, S., McGovern, F., Cooke, W., (1993). Carbon mass concentration measurements at Mace Head, on the west coast of Ireland. *Atmospheric Environment, 27A, 8, 1229-1239.*

This work was supported by the Fundação para a Ciência e Tecnologia (FCT) under grant SFRH / BD / 9049 / 2002 and project POCTI-32649-CTA-2000. program INTERREG_IIIB, Açores, Madeira e Canárias, CLIMAAT project (MAC2.3/A.3), CLIMAAT_II (03/MAC/2.3/A5) and Direcção Regional de Ciência e Tecnologia (DRCT) under project M.1.2.1/I7006/2005.