

Identification of black carbon aerosol events at the Azores PICO-NARE station during the ICARTT experiment

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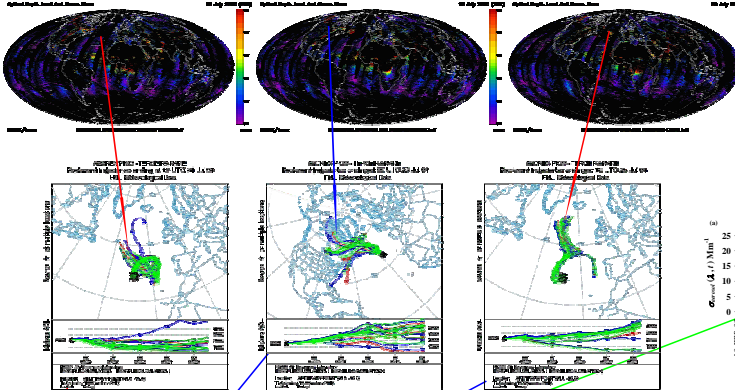
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Introduction

During the International Consortium for Atmospheric Research on Transport and Transformation (ICARTT) experiment (July – August 2004), aerosol samples were taken and their aerosol absorption coefficients measured. At the same time the levels of carbon monoxide and ozone were also monitored. These measurements were taken at PICO-NARE site on Pico mountain summit (2225 m ASL) in the Azores Islands. This site is in the pathway of air masses that travel from the surrounding continents (Africa, Europe and North America) that carry with them, among other species, aerosols resulting from combustions (black carbon) and/or natural emissions (dust). In particular, transport from Africa may bring soil dust particles, rich in iron oxides, which are involved in the biogeochemical cycling of iron, an essential micronutrient to marine phytoplankton (Arimoto, Balsam, & Schloesslin, 2002). During this period the sampled masses mainly came from the North American and during sometimes carried with them pollutants resulting from forest fires that occurred in Canada and Alaska.

For the selected regions we show pictures representing the optical depth (MODIS) day average for the starting day of the five days back trajectories (HYSPLIT) that represent the selected events. From those pictures and simulations we associated the enhancements of the measured concentrations of CO, O₃ and BC with the occurrence of forest fires in Canada.



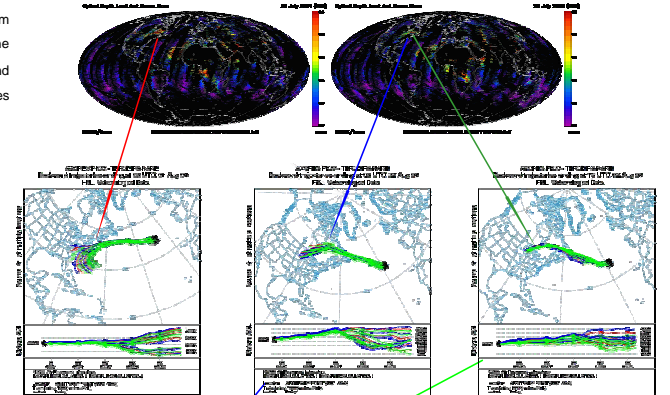
	dC_{CO}/dC_{CO} (ng/m ³ /ppbv)	dC_{O_3}/dC_{BC} (ppbv/ng)	dC_{CO}/dC_{CO} (ppbv/ppbv)
...	0.577±0.030
3.72±0.20	0.0434±0.0033	0.158±0.012	
4.03±0.18	-0.431±0.048	0.850±0.032	
	-0.0401±0.0034	-0.248±0.020	

Conclusions

As a conclusion of the analysis we got the ratios shown in the table for the geometrical means taken from the 2-side regressions. From there we see that when the values of CO and BC concentration are correlated the ratio dC_{BC}/dC_{CO} are not statistically different (errors correspond to one standard deviation).

The results obtained for the ratios, dC_{O_3}/dC_{BC} , from the data corresponding to the blue set selection of the period between 22-26, July and the data of the blue and green sets of the period between 1-3, August, show values of the same magnitude but of opposite signs. In the first

period (blue set) the ozone and black carbon both correlates positively, while in the second period (blue and green sets) they correlate negatively. This same behavior is also observed in the ratios of dC_{O_3}/dC_{CO} for the same sets of data, although statistically the values are not so similar. The ratio for dC_{O_3}/dC_{BC} for the red set of the second period (1-3, August) is positive and with a magnitude 10 times higher than the data associated with the Canadian forest fire (blue and green set). For this same set of data, the ratio dC_{O_3}/dC_{CO} compares well with the results previously reported by Honrath et al. (2005) for the same site.

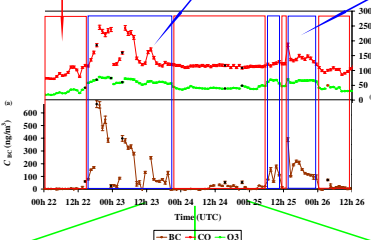


Data Analysis

We selected just the two most enhanced periods to analyze in detail (region 1, in green; from 0h, 22 July through 12h, 26 July 2004; and region 2, in red; from 0h, 01 August through 6h, 03 August 2004).

Color codes were used to show the data responsible for the estimation of the ratio values for, dC_{O_3}/dC_{CO} (ppbv/ppbv), dC_{BC}/dC_{CO} (ng/m³/ppbv) and dC_{BC}/dC_{O_3} (ng/m³/ppbv) from the correlation established between the measurements of CO, O₃ and BC concentrations.

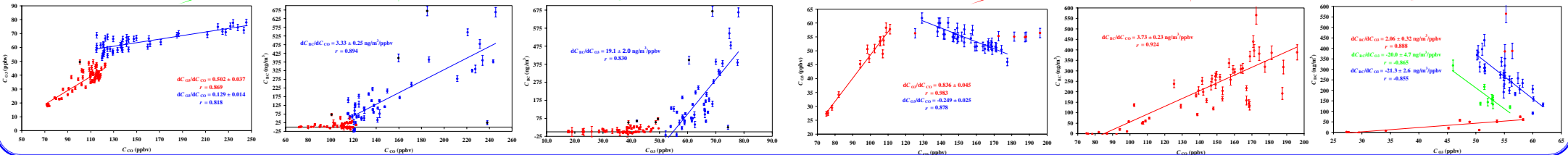
The solid black dots in every plot represents the data not used in the estimation of the ratios.



$$C_{BC}(t) = \sum_{i=1}^4 \sigma_{aerosol}(\lambda_i, t) \lambda_i / 4K_{BC}$$

Where: λ_i stands for one of the four wavelength (470, 521, 590 or 660 nm) in the region of the visible light; K_{BC} is an empirical constant resulting from calibrating the Aethalometer to BC aerosol (we used as an approximation the value suggested by Hansen, 2003); and $\sigma_{aerosol}(\lambda_i, t)$ are the absorption coefficients measured at each wavelength for the sampled aerosol.

During these periods there was no trajectory evidence for contamination with iron oxide aerosol (associated with Saharan dust, Fialho et al., 2005) and for that reason we assumed the absorption coefficient of BC to be numerically equal to the measured values of the aerosol absorption coefficients obtained for the wavelengths in the region of the visible light (iron oxides and BC are the only none significant species that absorb light in the region of the visible (Bohren & Huffman, 1998)).



References

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- MODIS, Imagery by Haberkamp, P.A., Renner, L.A. & Kaufman, Y.J., available from the MODIS-Atmosphere web site (<http://modis.atmos.gsfc.nasa.gov>).