Aerosol measurements during EUREC^{4}A campaign

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EUREC^{4}A field campaign took place in the downstream winter trades of the North Atlantic, eastward and south-eastward of Barbados, and lasted more than four weeks, during which atmospheric, surface and oceanic processes operating across a very wide range of scales were investigated [1]. The main purpose of EUREC^{4}A is to improve our understanding of the factors that influence clouds in the trades at different scales, how they will respond to warming, and their link to other components of the earth system, such as the mesoscale and sub-mesoscale dynamics of the upper ocean, the life-cycle of particulate matter, or air-sea gas exchange [1].

On the particle scale, aerosol properties and turbulence both imprint themselves on the cloud microstructure, and therefore affect the formation of precipitation [2,3,4,5]. Moreover, light-absorbing aerosol (LAA) species, such as Black (BC) and Brown (BrC) Carbon, absorb sunlight and heat the atmosphere [6]; their heating rate (HR) can influence the final radiative budget at the surface and thus act on the available energy for cloud formation and dynamics.

For this work, measurements were performed to characterize aerosols and a new methodology [7] was applied to experimentally determine the HR induced by the LAA during the EUREC^{4}A international campaign.

The R/V L'Atalante (Atalante) was used a privileged platform; it belongs to the French oceanographic research fleet and is operated by IFREMER. The ship performed a cruise from 20 January to 23 February 2020, sailing from Pointe-Pitre, Guadaloupe, and starting operations in Barbados water the following day. It collected ocean and atmosphere data from 6°N to 15°N and from 60°W to 52°W surveying the Tradewind Alley and the North Brazil Current eddy corridor (Boulevard des Tourbillons) in international waters and in the ZEEs of Barbados, Trinidad and Tobago, Guyana, Suriname, and French Guyana [1]. It was equipped with the following instrumentation: a NanoSCAN particle sizer (TSI inc.) to measure particle number concentrations from 10 nm to 400 nm and an optical particle counter (OPC by GRIMM) to measure particle number concentrations from 0.25 up to 32 µm; an Aethalometer (AE-33, Magee Scientific, 7-λ) to infer LAA concentrations and absorption coefficients; a Hyperspectral radiometer ROX (JBC hyperspectral) to measure direct, diffuse and reflected solar radiation from 350 to 950 nm and a SPN1 Pyranometer (Delta-T) for global and diffuse radiation; a high volume sampler ECHO-PUF (by Tecora) to collect TSP on filters and infer the aerosol chemical composition.

The HR can be experimentally obtained at high time resolution by integrating the synergy between LAA absorption coefficients and solar radiation (direct, diffuse and reflected) across the entire spectrum.

Preliminary results show eBC concentrations ranging from 1 to 2.2*10^3 ng m^{-3}, while the mean value of the entire campaign is 549 ± 5 ng m^{-3}. Nano-particle total number concentrations range from 200 to 4*10^4 #/cm^3 and the average value is 4.86*10^3 ± 1.1*10^2 #/cm^3. Considering eBC as a primary emission proxy for the nanoparticles and dividing the nanoparticle number concentration by the eBC mass concentration (N/eBC), we have obtained some preliminary information on the formation of secondary aerosol: its relative importance seems to be greater for the first part of the cruise (fig.1) and its trend seems to be in agreement with the size variation of nanoparticles along the cruise (generally where N/eBC is greater, the size is smaller).

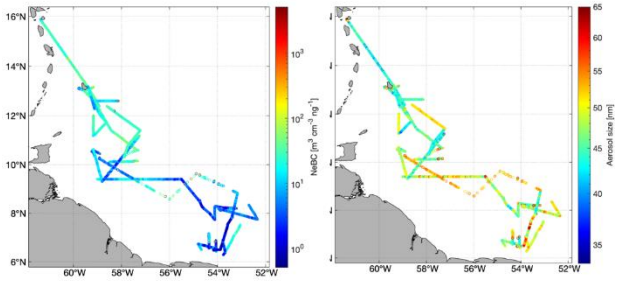

Figure 1. *N/eBC and aerosol size maps along the EUREC^{4}A campaign*.

The forthcoming chemical analyzes, which will provide information about the chemical composition of the particulate matter (soluble and carbonaceous fractions), and the calculation of the LAA HR will allow us to improve our understanding of the link between aerosols and clouds in the tropics.

References

[1] Stevens, B. et al. Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2021-18, 2021
[2] Cooper, W. A. et al. (2013) Journal of the Atmospheric Sciences, 70(6), 1727–1743.
[3] Li, X.-Y. Et al. (2018) Journal of the Atmospheric Sciences, 75(10), 3469–3487.
[4] Pöhlker, M. L. et al. (2018) Atmos. Chem. Phys., 18(14), 10289–10331.
[5] Wyszogrodzki, A. A. et al. (2013) Atmos. Chem. Phys., 13(16), 8471–8487.
[6] Bond et al., J. Geophis Res., VOL. 118, 1–173, doi:10.1002/jgrd.50171, 2013.
[7] Ferrero, L. et al. (2018) Environ. Sci. Technol. 52, 3546 3555.