16th International Conference on Particle-Induced X-ray Emission
24-29 marzo 2019 · Cultural and Congress Centre of Caldas da Rainha
Europe/Lisbon timezone
Unravelling secrets from atoms to planets

PIXE analysis of desert dust aerosols collected on Whatman 41 cellulose filters

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The North Atlantic receives huge amounts of desert dust from North Africa, the largest and most active dust sources region, whose emissions accounts for 50 to 70% of global dust emissions. Ice core records have shown that dust has been negatively correlated with temperature and CO_2 during the last million of years (Martínez- García et al., 2009), pointing to a strong connection of dust and climate. Dust blowing in the troposphere scatters incoming sunlight, dust plays a role as Ice Nuclei and its deposition in the open ocean provides nutrients to phytoplankton that influence on the exchanges of CO_2 between the ocean and the atmosphere (Schulz et al., 2012). It is believed that some of the key properties of dust relevant for climate related processes changes during the "aging" of dust in the atmosphere (Schulz et al., 2012).

This study is part of the project AEROATLAN, whose objective is to assess how emissions of aerosols and their precursors in continental regions are impacting in the remote troposphere (García et al., 2017a, 2017b) and how these emission are affecting key dust properties related to climate (Ravelo et al., 2016). As part of AEROATLAN we also studied the transatlantic transport of dust from North Africa to the Americas, focusing our attention on the nature of transatlantic transport of dust, the mixing with pollutants and the changes in iron solubility during transatlantic transport. For this purpose we collected samples of aerosols in Izaña Observatory – Tenerife (off North Africa), Barbados Island (Caribbean) and Miami. PIXE technique is usually applied to determine the elemental composition of aerosols. It is usually applied to aerosols samples collected in Teflon filters. In this study we present the results of applying PIXE technique to aerosol samples collected in Whatman™ 41 (W41) cellulose filters. To standardize the PIXE technique in W41 filters may significantly contribute to decrease the costs of aerosols observations.

PIXE is an unrivaled technique for the study of the dust component of aerosol, due to its high sensitivity to crustal markers (in particular Si, which is in principle detectable with chemical techniques such as Inductively Coupled Plasma – Atomic Emission Spectroscopy, ICP-AES, but whose quantification might be poor). However, it is necessary to correct the underestimation of PIXE in quantifying the concentration of the lighter elements due to X-ray self-absorption inside the individual aerosol particles and inside the filter itself. PIGE is not useful in this case because the energy loss within the depth of the deposit (a priori unknown) is higher than the width of any plateau region in the gamma-ray cross-section e.g. for Na or Al.

We have determined the correction factor by comparing the concentrations obtained for the aerosol collected simultaneously on Teflon and Whatman paper filters, both by PIXE and ICP-AES.

Measurements sites:

Tenerife Island. The samples were collected at Izaña Observatory, located at 2400 m.a.s.l. This site is located above the marine boundary layer and directly impacted by the Saharan Air Layer carrying the dust particles just exported from North Africa.

Barbados Island. Samples were collected at Ragged Point, located a few meters above sea level in the eastern side of island, directly exposed to the trade winds prevailing in the marine boundary layer.

Miami. Samples were collected in the facilities of the RSMAS University of Miami, directly exposed to the trade winds prevailing into the marine boundary layer.

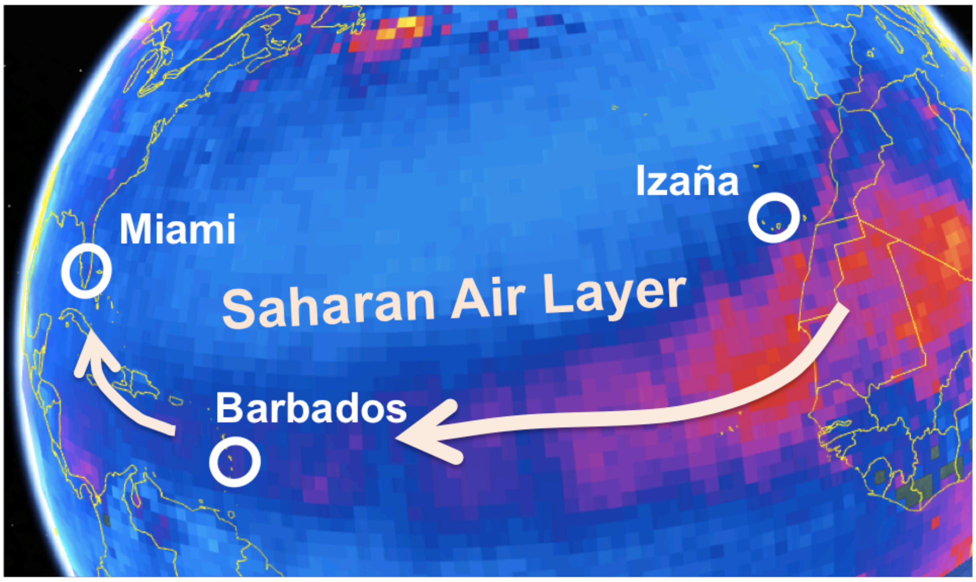

Figure 1. Illustration of the sampling sites and the Saharan Air Layer based on Dust Optical Depth measured with MODIS (dark target – deep blue combination, provided by Giovanni NASA System).

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