Properties of free tropospheric aerosols at the Pico Mountain Observatory in the Azores

C. Mazzoleni[1], P. Fialho[2], S. China[1], B. Scarnato[3], K. Wright[1], N. Niedermeier[1], S. Kumar[1], K. Dzepina[1], M. Dziobak[1], M. Amapadu[1], J. Hueber[4], D. Helmig[4], B. Zhang[1], J. Perlinger[1], and L. Mazzoleni[1]

[1]Atmospheric Sciences Program, Michigan Technological University, Houghton, Michigan, 49931, USA
[2]University of the Azores, Angra do Heroismo, Azores, Portugal
[3]Naval Postgraduate School, Monterey, California 93943, USA
[4]Institute of Arctic and Alpine Research (INSTARR), University of Colorado, Boulder, Colorado, 80309, USA

Keywords: Free troposphere, aerosol, North Atlantic, marine atmosphere, soot.
Presenting author email: cmazzoleni@mtu.edu

In the summers of 2012, 2013, and 2014 we deployed several aerosol instruments and samplers at the remote Pico Mountain Observatory (Figure 1), near the top of the Pico volcano in the Azores, Portugal (38.47°N, 28.40°W, 2225m asl) in the Eastern North Atlantic. This site is typically above the marine boundary layer and is ideal to study aerosol transported over long distances in the free troposphere. Air masses reaching the observatory are often transported from North America and the Arctic, and more rarely from Africa and Europe. Aerosol instrumentation deployed at the site included: 1) a 2-channel optical particle counter, 2) a 7-wavelength aethalometer to measure black carbon equivalent mass concentration, 3) a 3-wavelength nephelometer to measure total and backward light scattering, 4) four high-volume samplers for aerosol chemical characterization, and 5) a sequential aerosol sampler and a 4-stage impactor to collect particles on different substrates for microscopy and ice nucleation analysis. We used the FLEXible PARTicle (FLEXPART) dispersion modeling retroplume analysis to determine the origin and transport pathways of the air masses. Single particle imaging was performed using electron microscopy, while organic aerosol molecular composition was studied with Fourier transform ion cyclotron resonance mass spectrometry, and organic carbon and elemental carbon aerosols were quantified with a carbon analyzer (Dzepina et al. 2014). The optical properties of selected types of single particle morphology were simulated numerically using the Discrete Dipole Approximation (Scarnato et al. 2015).

In this presentation we will provide an overview of the physical and chemical properties of the aerosol collected at Pico Mountain Observatory, including the optical properties and the single particle morphology (shape and mixing state). In particular, soot particles often mixed/coated with other material, were found to be highly compact in shape. DDA simulations showed that compaction results in substantial changes of the soot single scattering albedo (China et al. 2015). Finally, we will present highlights of a comparison between aerosol properties measured in the free troposphere at the Pico Mountain Observatory and those measured in the marine boundary layer at the nearby Graciosa Island at the sea-level Eastern North Atlantic permanent facility of the U.S. Department of Energy.

The results of this study have implications on how aerosols chemical composition and morphology can be represented in numerical models for the description of remote marine region aerosols.

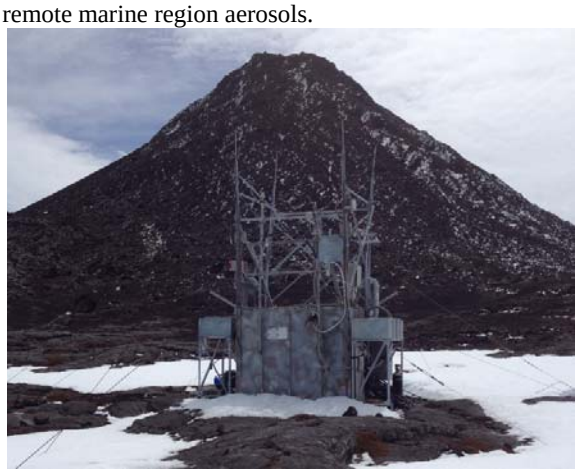

Figure 1. Pico Mountain Observatory, 2225 m above sea level, Pico Island, Azores, Portugal (April 2014).

China, S., Scarnato, B., Owen, R. C., Zhang, B., Ampadu, M. T., Kumar, S., Dzepina, K., Dziobak, M. P., Fialho, P., Perlinger, J. A., Hueber, J., Helming, D., Mazzoleni, L. R., and Mazzoleni, C. (2015), *Morphology and mixing state of aged soot particles at a remote marine free troposphere site: Implications for optical properties*, Geophysical Research Letters, 42, doi: 10.1002/2014GL062404.

Dzepina, K., Mazzoleni, C, Fialho, P, China, S., Zhang, B, Owen, R. C., Helmig, D., Hueber, J., Kumar, S., Perlinger, J. A., Kramer, L., Dziobak, M. P., Ampadu, M. T., Olsen, S., Wuebbles, D. J., and Mazzoleni, L. R. (2014), *Molecular characterization of free tropospheric aerosol collected at the Pico Mountain Observatory: a case study with long range transported biomass burning plumes*, Atmospheric Chemistry and Physics Discussion 14(17): 24753-24810, doi: 10.5194/acpd-14-24753-2014.

Scarnato, B., China, S., Nielsen, K., and Mazzoleni, C. (2015), *Perturbations of the optical properties of mineral dust particles by mixing with black carbon: A numerical simulation study*, Atmospheric Chemistry and Physics Discussion 15: 2487-2533, doi: 10.5194 /acpd-15-2487-2015.