Aerosol Measurements in the Free Troposphere at the North Atlantic Pico Mountain Observatory in the Azores

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Abstract

Pico is a small island (447 km2) in the archipelago of the Azores, Portugal in the North Atlantic Ocean. The island has a very steep inactive volcano. An atmospheric monitoring station (Pico Mountain Observatory) was established close to the summit of the volcano by the late Dr. Richard Honrath and colleagues in 2001. The station's uniqueness and significance lie in its location that allows studying the transport and evolution of gases and aerosols from North America in the free troposphere.

Until recently, the focus was on the measurement of trace gases (ozone, carbon monoxide, non-methane hydrocarbons, nitrogen oxides) and light absorbing aerosol (black carbon and iron oxide). A three-wavelength nephelometer, to measure the aerosol total- and back-scattering, and aerosol samplers for morphological and chemical analysis will be installed at the site in 2012.

The objectives of the new aerosol research program are to: a) assess background as well as specific event tropospheric aerosol properties, b) compare aerosol measurements with model outputs, c) estimate the radiative properties of free tropospheric aerosol. This research is anticipated to enhance our understanding of the interactions between tropospheric aerosols, clouds and climate by allowing for example the analysis of North American outflows and seasonal changes, the assessment of different source regions, the estimation of aerosol radiative forcing above marine clouds and in clear sky, and the study of the relative contribution of anthropogenic versus biomass burning emissions.

Measurements

Current

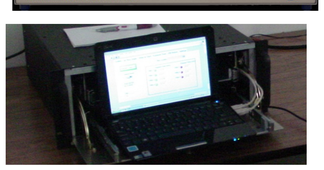
Gases (since 2001):

1. Carbon monoxide (NDIR-GFC)
2. Ozone (chemiluminescence)
3. Non Methane Hydrocarbons (GC)

Aerosol:

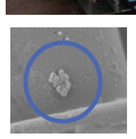
1. 7-wavelength aethalometer (Mass equivalent Black Carbon) (since 2001)
2. PM intra-cavity Laser aerosol sizer (Aerosol optical Size from 0.09 to 1μm) (since 2010)

Meteorological data (since 2001)



Planned

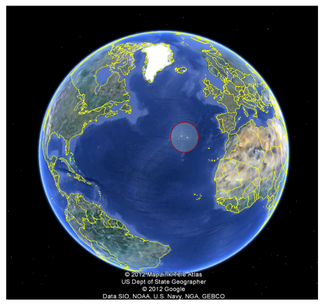
1. 3-wavelength nephelometer (Aerosol total and back-scattering)
2. Electron microscopy filter sampler (Custom Samplet for nuclepore filters and TEM grids)
3. 4 HiVol aerosol samplers (For subsequent EC/OC and detailed chemical analysis)



Compacted soot particle from Pico deposited on a quartz fiber

The Pico Mountain Observatory

The Pico Mountain Observatory station is far from persistent local sources on the summit caldera at an altitude of 2225 m. The station lays typically above the boundary layer during summertime. Air masses reaching the station are often transported from North America and seldom from Europe or North Africa.



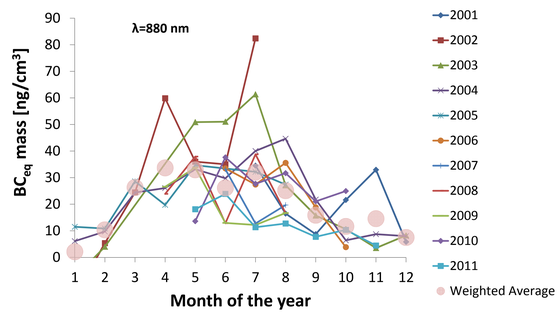
The Location: The Azores are located in the middle of the North Atlantic Ocean where airmasses flow is typically Westerly.

The conditions can be extreme during winter

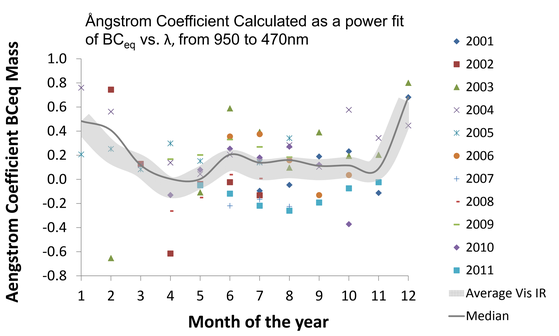
The measuring location often lays above the clouds

Decadal Black Carbon Dataset

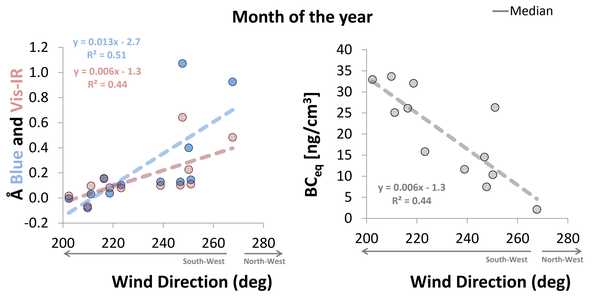
The aethalometer measures the light attenuation through a quartz fiber filter at seven wavelengths. The measured attenuation is calibrated to an equivalent mass of black carbon with an assumed 1/λ dependence. Data were collected since 2001 over different periods of the year. In 2004 the instrument was operated for the entire year.



- Monthly averages of the black carbon equivalent-mass show an evident seasonal cycle with a broad maximum during the summer months

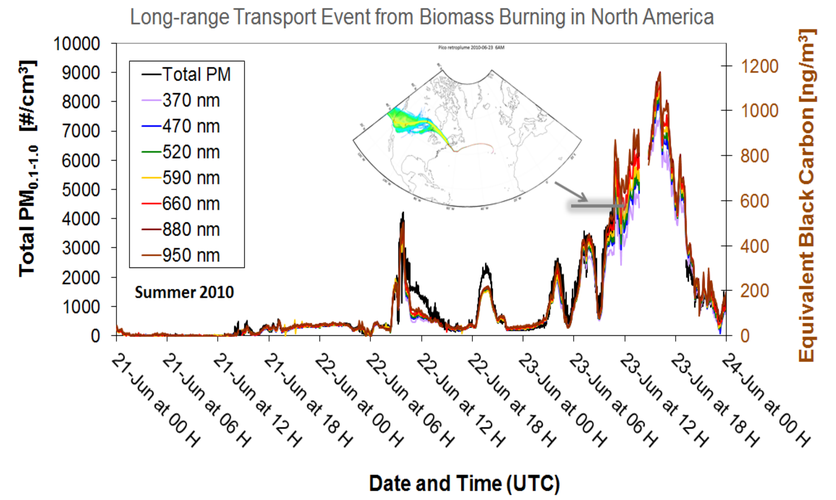


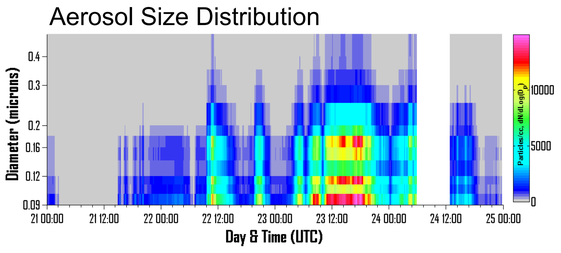
- Monthly averages of the Ångstrom coefficient for the black carbon equivalent-mass also show a seasonal cycle with a minimum during the summer months



- Monthly black carbon equivalent-mass averages and Ångstrom coefficients correlate with the wind direction. Higher black carbon equivalent-mass and lower Ångstrom coefficients correspond to airmasses from the southwest

Biomass Plume Event (June 2010)





Long range transport events from North America of biomass burning plumes such as this in June 2010, are seen in summer periods

Research Plans/Opportunities

1. Study of aerosol physical, chemical and morphological properties
2. Estimation of aerosol radiative properties above marine clouds and in clear sky
3. Research on aerosol aging and lifecycle, and long range transport
4. Study of aerosol and gases sources types and regions, and seasonal variability
5. Integration with ARM research at Graciosa (radiation, aerosol, clouds)

References

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Acknowledgments

1. Richard Honrath for his pioneering effort in establishing the site and building the collaboration network
2. Mark Wise for assisting in the installation of the particle sizer
3. The Regional Government of Azores has supported politically and financially the Pico Mountain observatory and operation trough the Regional Secretariat for Science, Technology and Infrastructures (Project M1.2.1/I/006/2005); (Project M1.2.1/I/001/2008); (Project M1.2.1/I/002/2008) and also the Secretariat for the Environment and the Sea.

Supported by ASR Atmospheric System Research · U.S. DEPARTMENT OF ENERGY Office of Science · National Science Foundation WHERE DISCOVERIES BEGIN · BORTAS