

Properties of Aerosol in the North Atlantic Free Troposphere at the Pico Mountain Observatory, Azores

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Pico Mountain Observatory

Est. in 2001 by Richard Honrath (Michigan Technological University)

Location: Pico Island in the Azores, Portugal (38.47°N, 28.40°W, 2225m asl)

Sampling characteristics: typically above the boundary layer during summertime

Air transported: often from North America, seldom from Europe or North Africa

Gases Measured: CO (NDIR-GFC) (since 2001), O₃ (chemiluminescence) (since 2001), NMHC (GC) (2004-2006 and 2009-present), NO_x (2002-2005 and 2008-2010), PAN (2008-2009)

Aerosols data: BC_{eq} (7-λ aethalometer) (since 2001), PM concentration (OPSS) (since 2010), Aerosol scattering and backscattering (3-λ nephelometer) (since 2012), sampler collector for electron microscopy (since 2012), EC/OC and detailed chemical analysis (4 HiVol aerosol samplers) (since 2012)

Meteorological parameters: RH, T, P, wind speed and direction (since 2001)

Additional information at: <http://instaar.colorado.edu/groups/pico/>



The Azores (Portugal):

- Located in the **North Atlantic Ocean**
- The air flow is typically **Westerly**
- The summit of the Pico volcano, at an elevation of more than 2200 m asl, lays typically in the **free troposphere** during the summer season



Pico Volcano from the island of Horta, with lenticular cloud

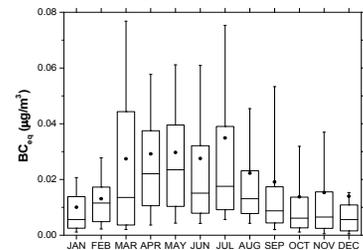


Shadow of the Volcano over clouds from the summit caldera



Pico Mt. Observatory and the Hi-Vol Samplers

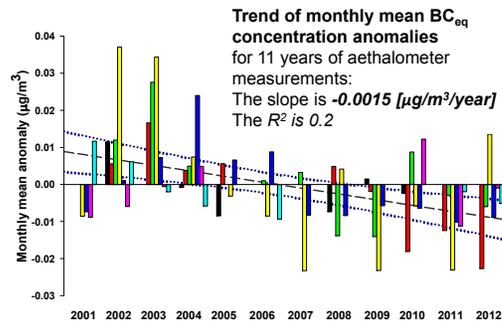
Eleven Years of BC Measurements



Seasonal BC_{eq} variability

Box Plot:

- Horizontal middle lines in the boxes represent the median
- Dots represent the mean
- lower and upper edges represent the 25th and 75th percentiles
- whiskers indicate the 10th and 90th percentiles



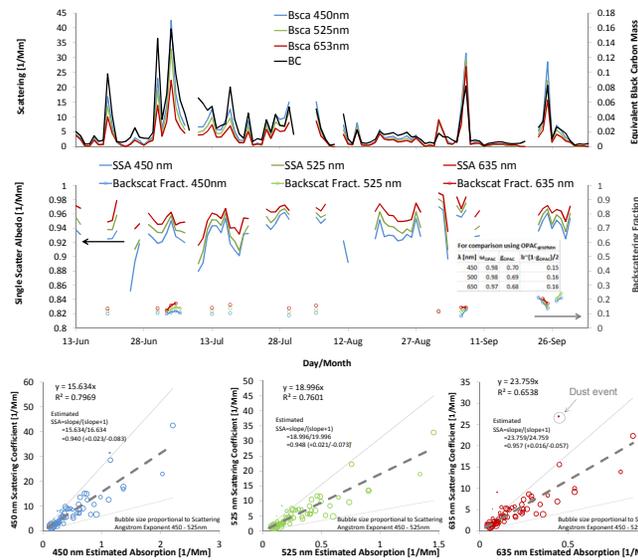
Trend of monthly mean BC concentration anomalies for 11 years of aethalometer measurements:
The slope is **-0.0015 [μg/m³/year]**
The R² is 0.2

Legend for months:
Apr (black), May (red), Jun (green), Jul (yellow), Aug (blue), Sep (magenta), Oct (cyan)

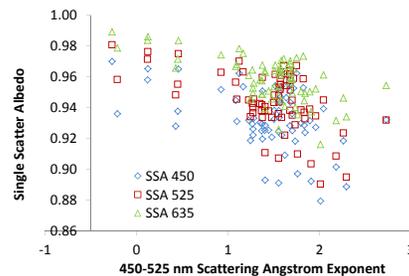
Key Points:

- The Pico Mountain Observatory is in an ideal location to sample free tropospheric aerosol transported from North America
- BC_{eq} mass concentrations show clear seasonal variability
- BC_{eq} monthly mean anomalies show a decreasing trend over 11 years with a slope of **-0.0015 μg/m³/year**
- Estimated mean single scattering albedo ω for the 2012 season was ω_{450nm}=0.93(σ=0.02) ω_{525nm}=0.95(σ=0.02) ω_{635nm}=0.96(σ=0.02)
- Estimated mean hemispherical backscattering fraction b was: b_{450nm}=0.13(σ=0.04) b_{525nm}=0.14(σ=0.04) b_{635nm}=0.15(σ=0.02)
- Particle morphology changes during transport and soot is more compacted (higher roundness and convexity) compared to soot collected closer to the sources

Aerosol Optical Properties - 2012

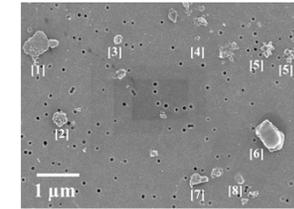


Absorption estimated from the BC_{eq} concentration assuming a mass equivalent absorption of 1.6·λ^{-2.71} with λ in μm, as that given by Moosmüller et al. at JGR 1998
No scattering correction for the aethalometer or truncation angle corrections for the nephelometer were applied. Single scattering albedo (SSA) and hemispherical backscattering fraction calculated only for daily average scattering ≥ 1 Mm⁻¹



Smaller particles (larger scattering Angstrom exponent) are "darker" and larger particles have higher single scattering albedo

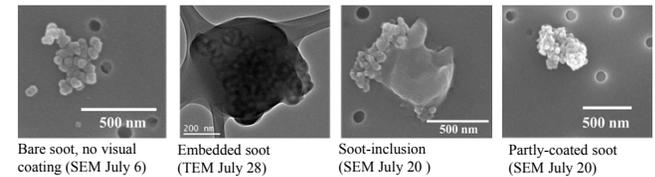
Aerosol Morphology - Summer 2012



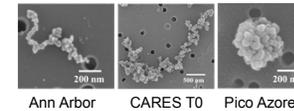
Pico SEM Sample, July 6

- [1] Mineral dust
- [2] Compacted soot
- [3] Embedded soot
- [4] Irregularly shaped particle
- [5] relatively more elongated soot
- [6] evaporated particle coating
- [7] soot mixed with dust
- [8] probably liquid organic aerosol

Morphological Classification of soot particles

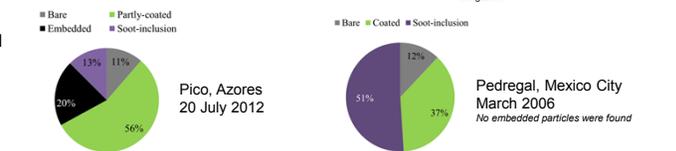
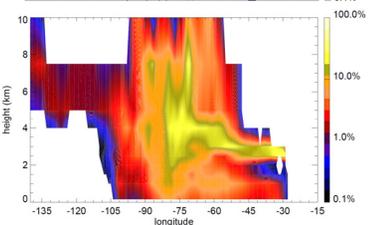
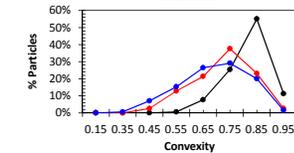
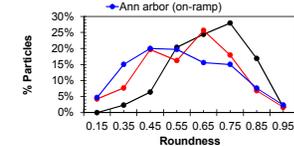
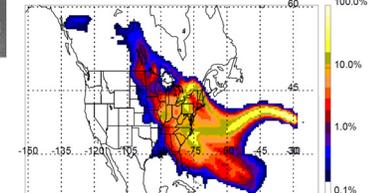


A Case Study: Soot at Pico, July 20th compared to CARES, Mexico City (2006) and Freeway On-Ramp Samples in Ann Arbor, MI (2010)



Ann Arbor CARES T0 Pico Azores

FLEXPART Retroplumes Pico, July 20



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