

Measurement of Aerosols and Trace Gases in the Free Troposphere at the Pico Mountain Observatory in the Azores



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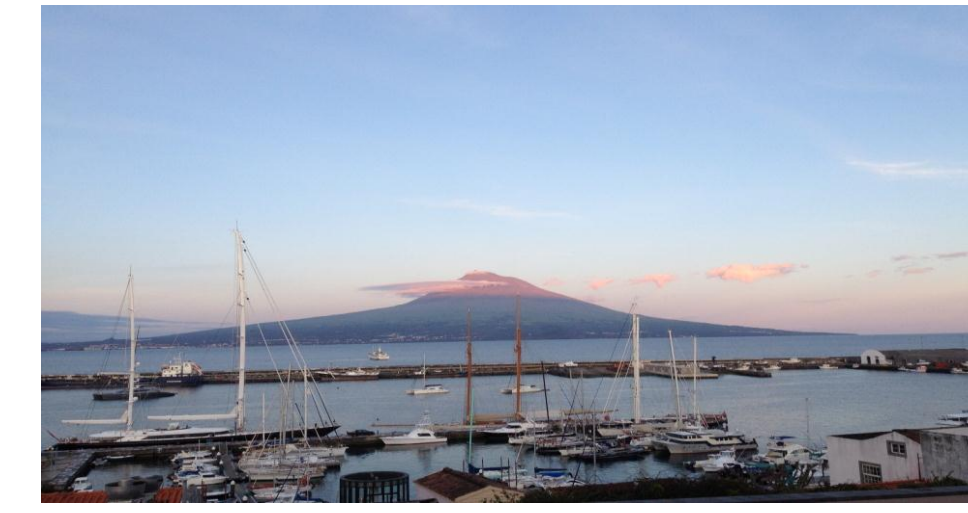
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1. Introduction

Here, we present an overview of gas and aerosol data measured at the Pico Mountain Station. The primary objective of these measurements are to enhance our knowledge of anthropogenic and biomass burning emissions from North America and their relative impact on atmospheric composition and radiative forcing in the free troposphere of the North Atlantic.

2. Pico Mountain Observatory

- Established in 2001 by Richard Honrath (Michigan Technological University) - situated on the Pico Island in the Azores, Portugal (38.47°N, 28.40°W, 2225m asl)
- Typically we sample in the **free troposphere** during the summer season



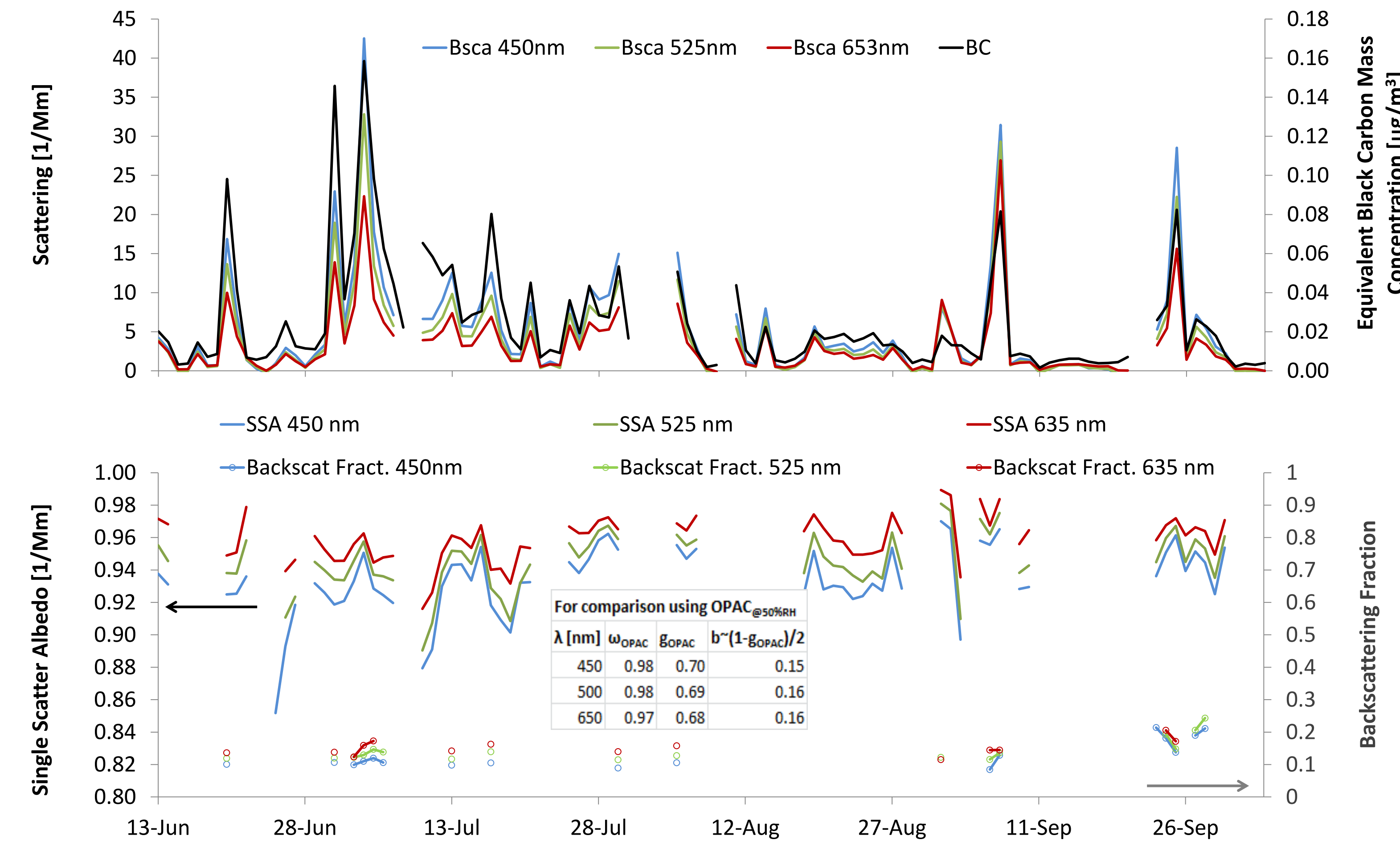
Pico Volcano from the island of Horta, with lenticular cloud

3. Measurements

Species	Measurement Period	Method
Gases		
CO	2001 - Present	NDIR-GFC
O ₃	2001 - Present	Chemiluminescence
NMHC	2004-2006, 2009 - Present	GC
NO _{x,y}	2002-2005, 2008-2010	Chemiluminescence
PAN	2008-2009	GC
Aerosols		
BC _{eq}	2001 - Present	7-λ Aethalometer
PM concentration	2010 - Present	OPSS
Aerosol scattering and backscattering	2012	3-λ Nephelometer
EC/OC and chemical analysis	2012	4 HiVol aerosol samplers
Met Data		
RH, T, P, wind speed and direction	2001 - Present	

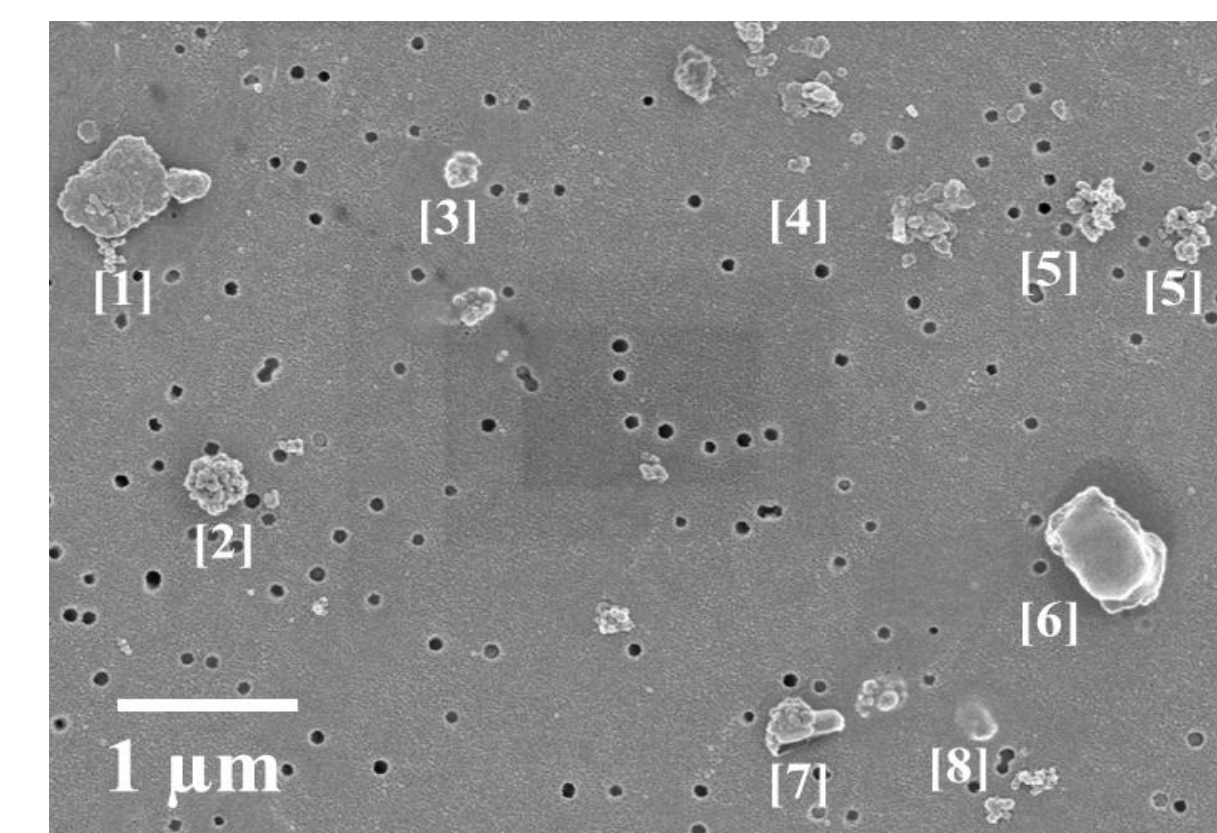
Additional information at: <http://instaar.colorado.edu/groups/pico/>

4. Aerosol Properties and Morphology



2012 daily averages of aerosol light scattering correlate with black carbon equivalent mass concentrations. Estimated* single scatter albedo and backscattering fraction are consistent with OPAC simulations

*No scattering correction for the aethalometer or truncation angle corrections for the nephelometer were applied

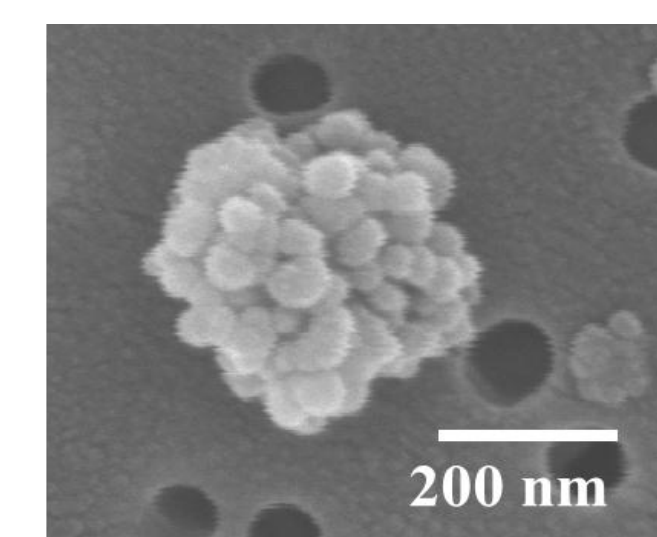
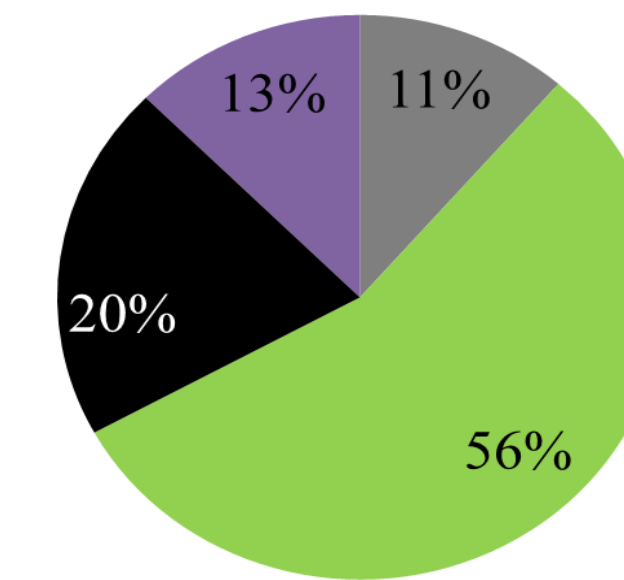


Pico SEM Sample, July 6

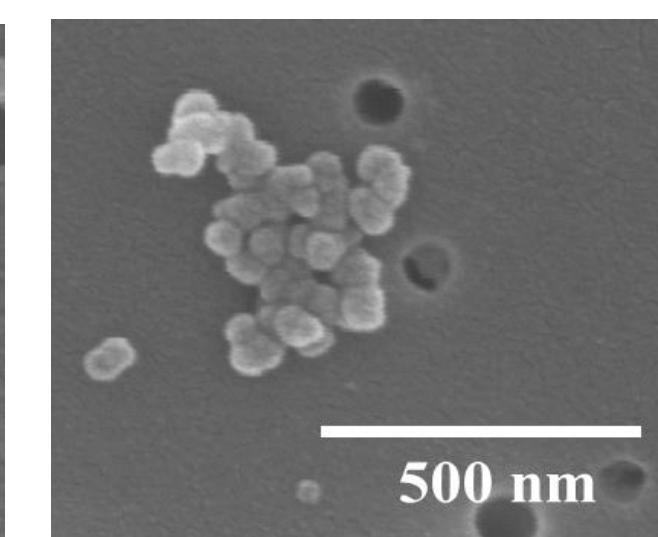
- [1] Mineral dust
- [2] Compacted soot,
- [3] Embedded soot
- [4] Irregularly shaped particle
- [5] relatively more elongated soot
- [6] evaporated particle coating
- [7] soot mixed with dust
- [8] probably liquid organic aerosol

Soot particles 20 July 2012

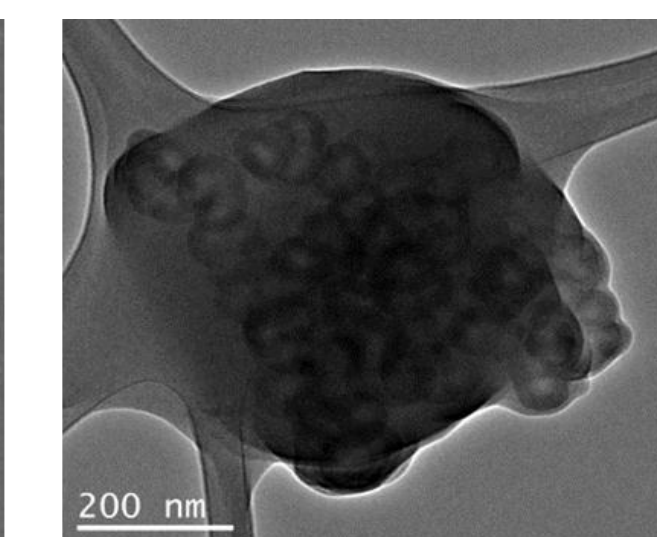
- Bare
- Embedded
- Partly-coated
- Soot-inclusion



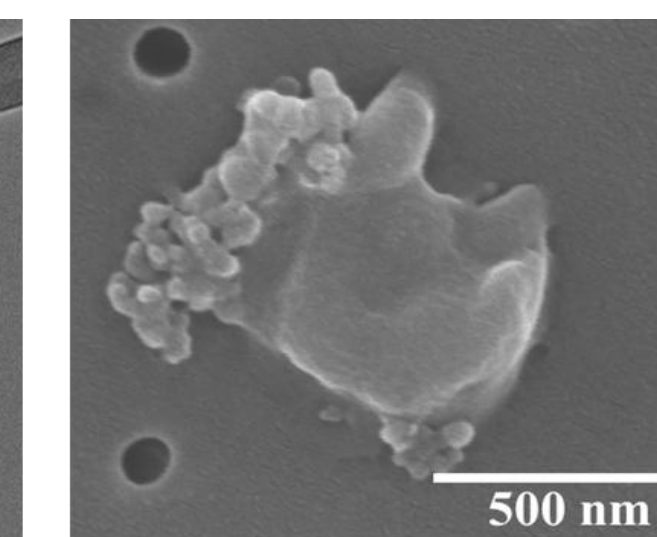
Bare and compacted soot (SEM July 20)



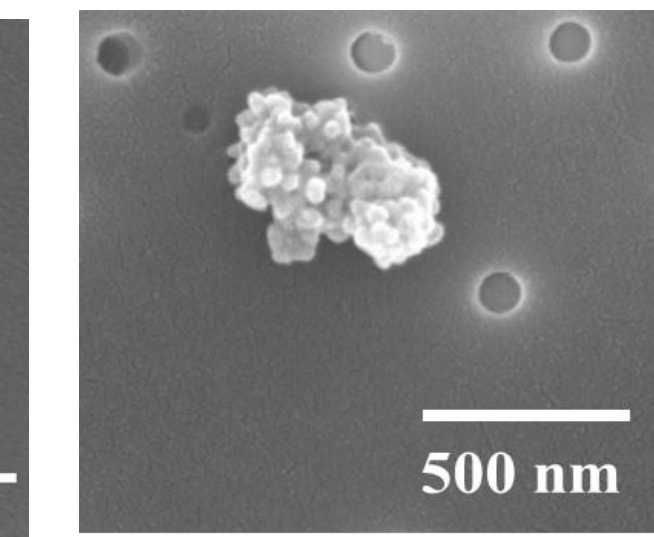
Bare soot, no visual coating (SEM July 6)



Embedded soot (TEM July 28)



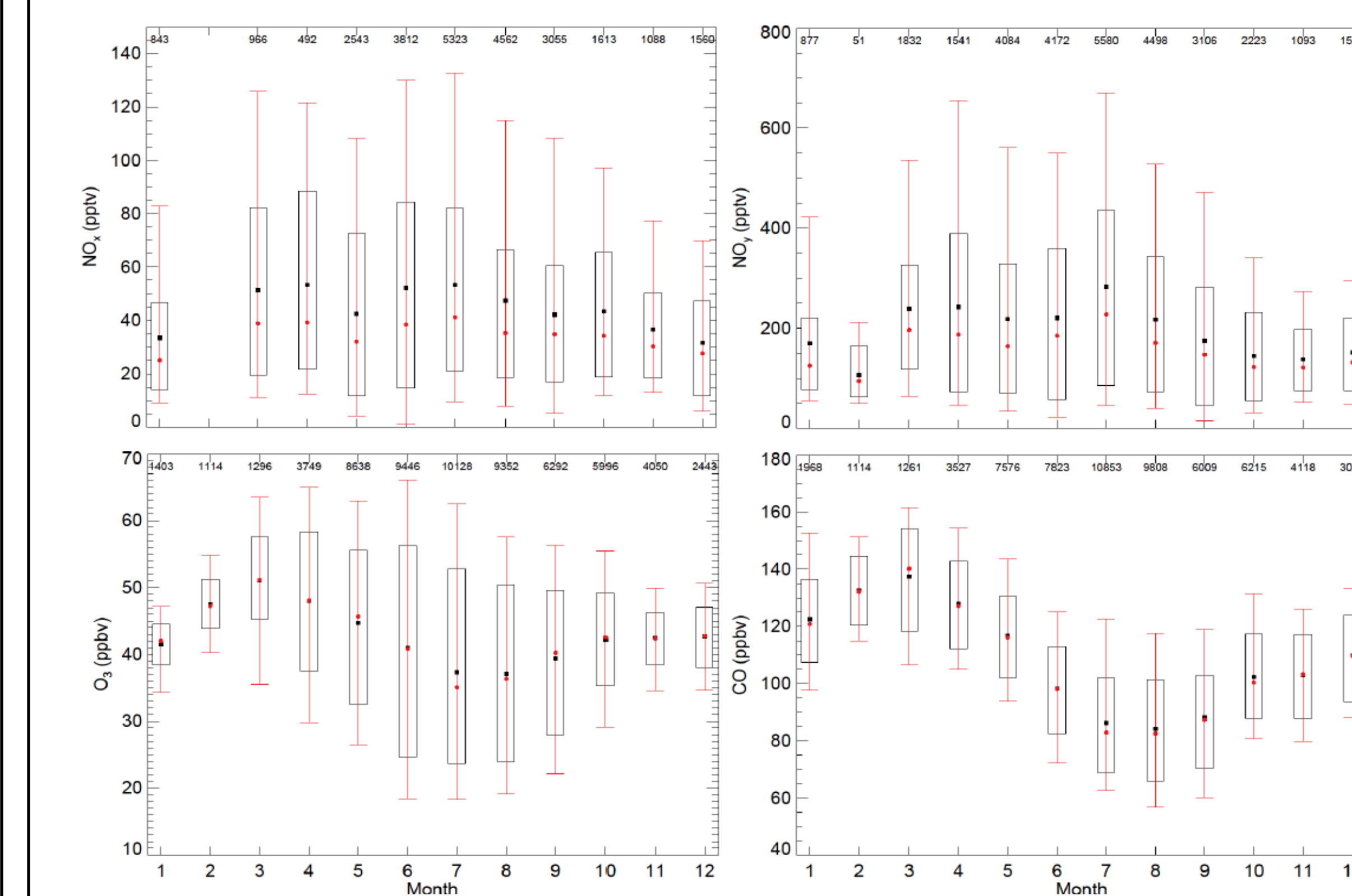
Soot-inclusion (SEM July 20)



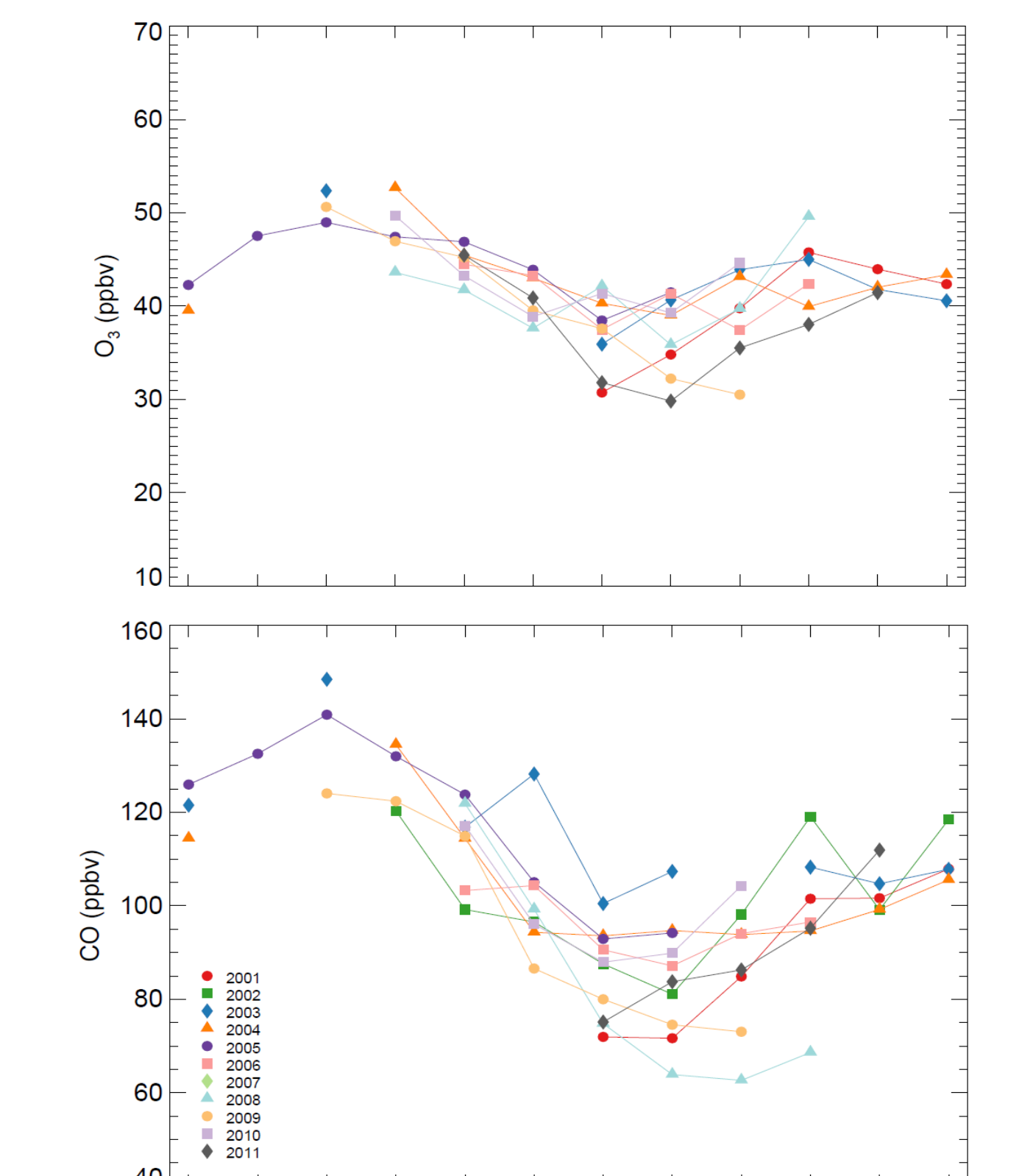
Partly-coated soot (SEM July 20)

Various types of particles have been found at Pico. Black carbon (soot) particles were classified based on mixing state and morphology. A large fraction of soot particles appeared to be partially coated and compacted.

5. Seasonal and interannual variability of gases and BC_{eq}



Seasonal cycles for CO, O₃, NO_x and NO_y for the entire measurement period. Medians (red circles), means (black squares) central 67% (box) and the central 95% (red line) are shown.

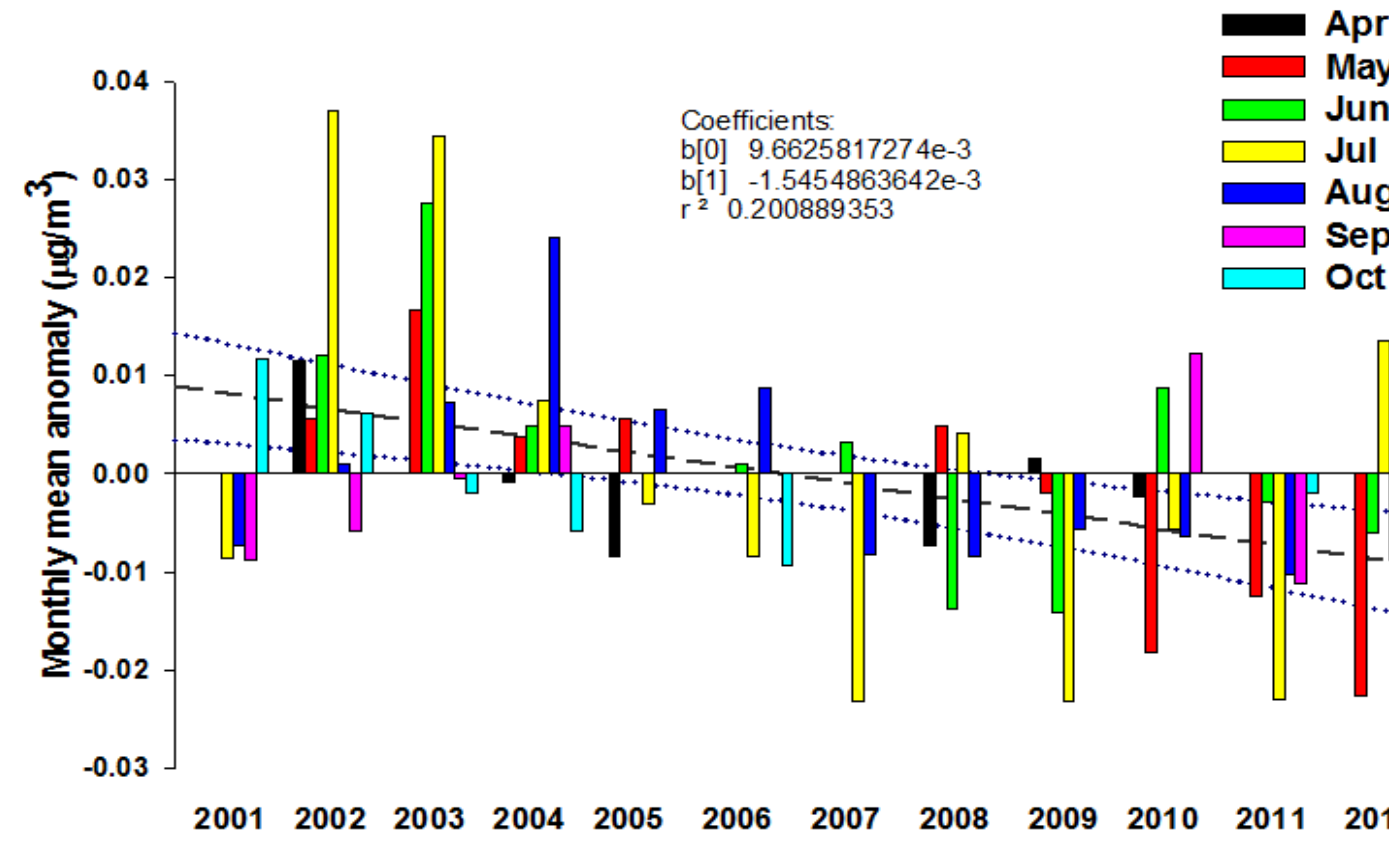


Seasonal cycles for CO and O₃ from 2001-2011

- CO, O₃, NO_x and NO_y show well defined seasonal cycles.
- Positive skews on the data are due to high values from polluted air masses transported to the site.
- Seasonal cycles for each year show interannual variability.
- Large differences in mixing ratios in the summer may be due to variability in fire events, e.g. 2001 was a low fire year and coincides with the lowest mean CO and O₃ at Pico during July - further investigation into the cause of this variability is ongoing

Trend of monthly mean BC_{eq} concentration anomalies

- BC_{eq} mass concentrations also show clear seasonal variability
- BC_{eq} monthly mean anomalies show a decreasing trend over 11 years with a slope of ~ -0.0015 $\mu\text{g}/\text{m}^3/\text{year}$



Acknowledgments

- Richard Honrath for his pioneering effort in establishing the site and building the collaboration network
- Mark Wise for assisting in the installation of the particle sizer and Mike Dziobak for his help with running the instruments
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