Particle size and composition in dry deposition and aerosol on Barbados and Cape Verde during Summer 2013 – an electron microscopy perspective

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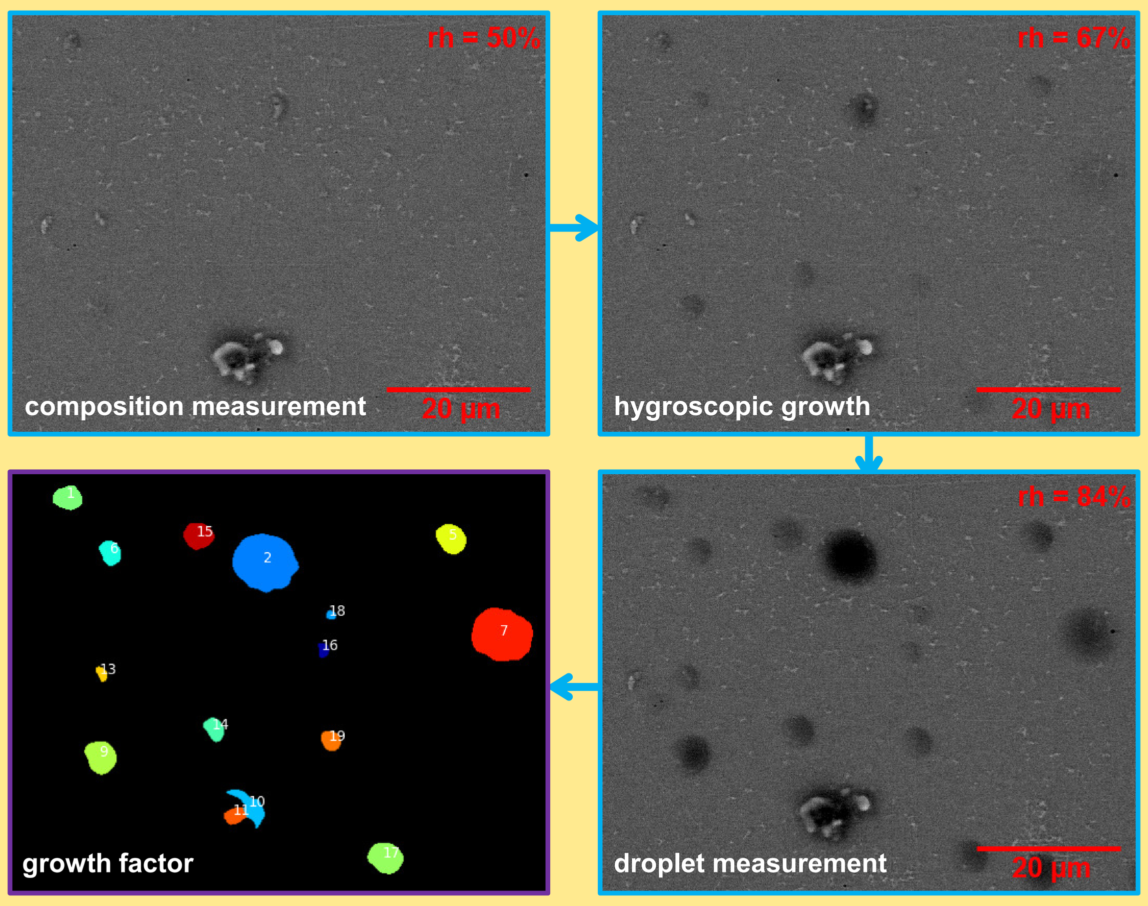
Introduction

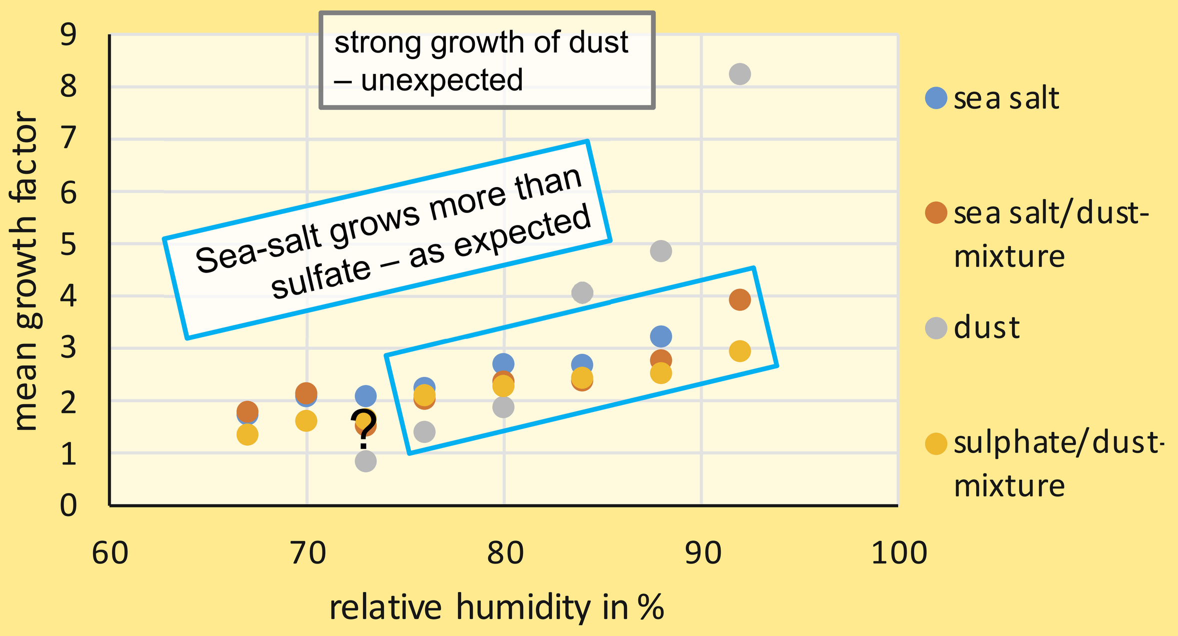
Mineral dust is frequently transport during summer time from the Saharan desert across the Atlantic Ocean to the Caribbean[1]. On its way, dust particles may undergo ageing and acquire secondary materials like sulfate or organics or may mix with sea-salt particles.

From June to July 2013, in parallel at Ragged Point (RP), Barbados (N 13.165, W 59.432) and at Cape Verde Atmospheric Observatory (CV; N 16.864, W 24.867) dust dry deposition and aerosol samples were collected during the Saharan Aerosol Long-range Transport and Aerosol-Cloud-Interaction Experiment (SALTRACE).

Hygroscopicity of supermicron particles

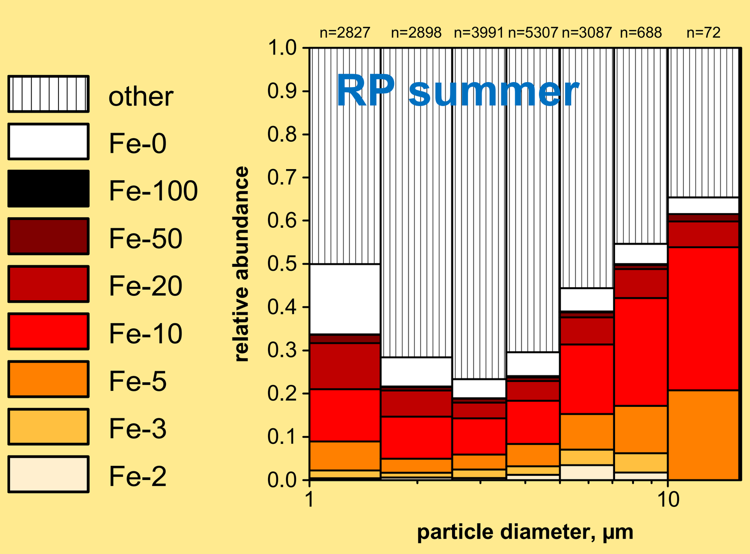


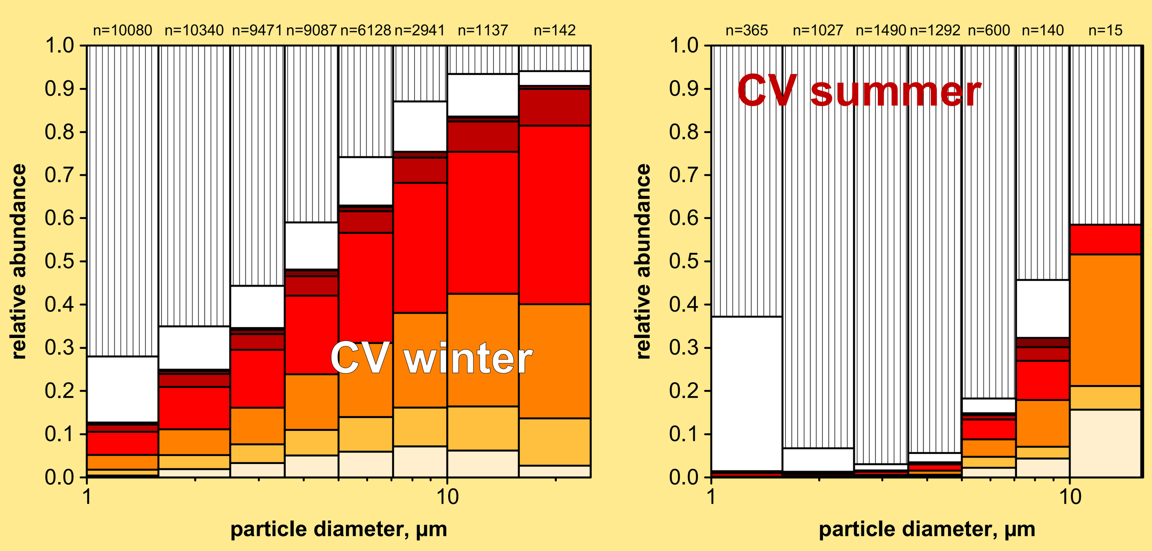
Apparent growth factors, uncorrected for surface effects
(preliminary results of one sample)



Iron distribution

- similar behavior during SALTRACE as reported before for Cape Verde[2] for particles smaller than 10 µm
- higher iron content for larger particles
- "other" particles are mixtures of dust with sulfate / sea-salt
- low variation in iron distribution during these particular dust events
- RP summer with respect to iron more similar to CV winter than to CV summer





References
1 Trapp, J. M., et al. (2010). doi: 10.1016/j.marchem.2008.10.004
2 Kandler, K., et al. (2011a). doi: 10.1111/j.1600-0889.2011.00546.x
3 Kandler, K., et al. (2011b). doi: 10.1111/j.1600-0889.2011.00550.x

Sampling and Analysis

Particle dry deposition collection

- sedimentation trap with rain shelter (Fig. 1)
- mainly by sedimentation dominated by particles larger than approximately 1 µm
- particle collection on adhesive carbon-substrates
- sampling time between 1 d and 4 d

Aerosol collection

- sampling by nozzle impactors and rotating free-wing impactor (FWI, Fig. 2)
- particle collection on adhesive carbon-substrates
- sampling time between 20 s (impactors) and 2 h (FWI)

Analysis

- automated scanning electron microscopy with energy-dispersive X-ray detection
- particle size (projected area diameter) and shape measurements by image analysis (Fig. 3)
- scanning of 80% of the particle cross section with electron beam to get chemical information representative for the total particle
- quantification of single particle chemical composition with particle size correction
- statistical significant numbers of particles are analyzed (for this work, 50 000)
- classification according to chemical composition

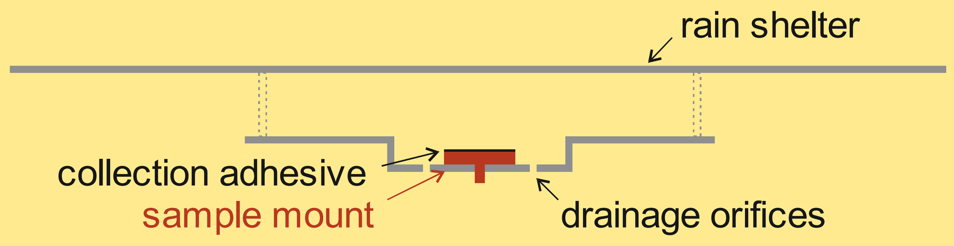
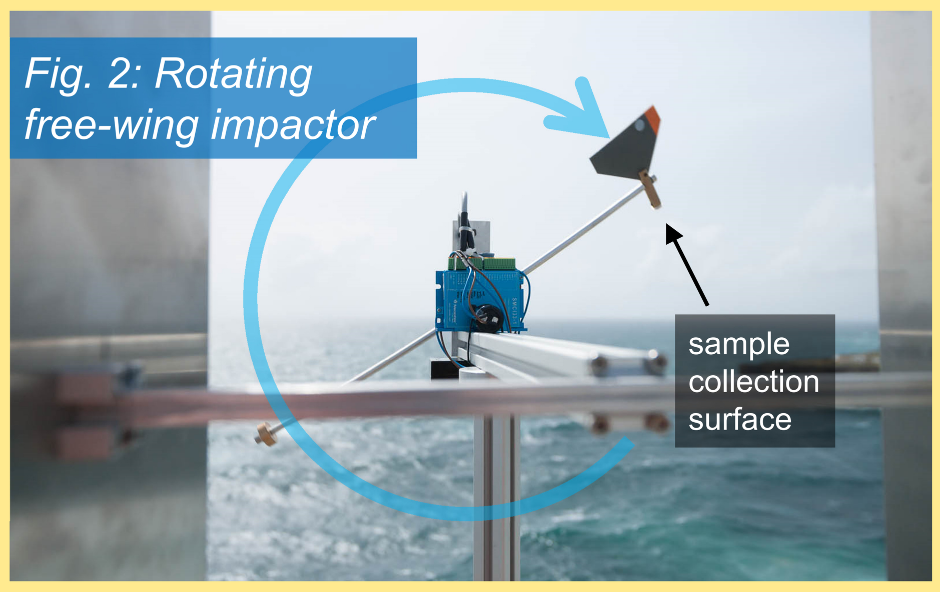


Fig. 1: Cross section of sedimentation trap

Fig. 2: Rotating free-wing impactor



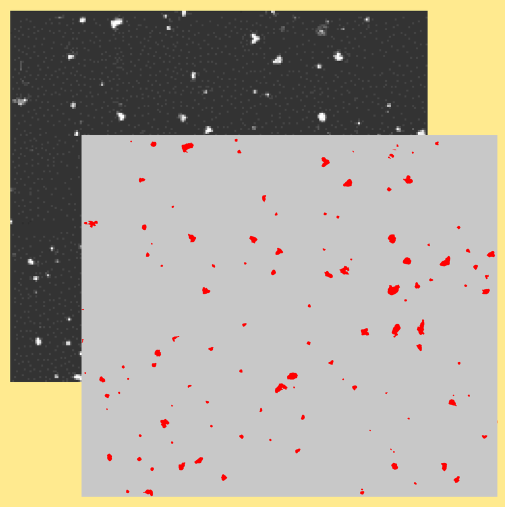
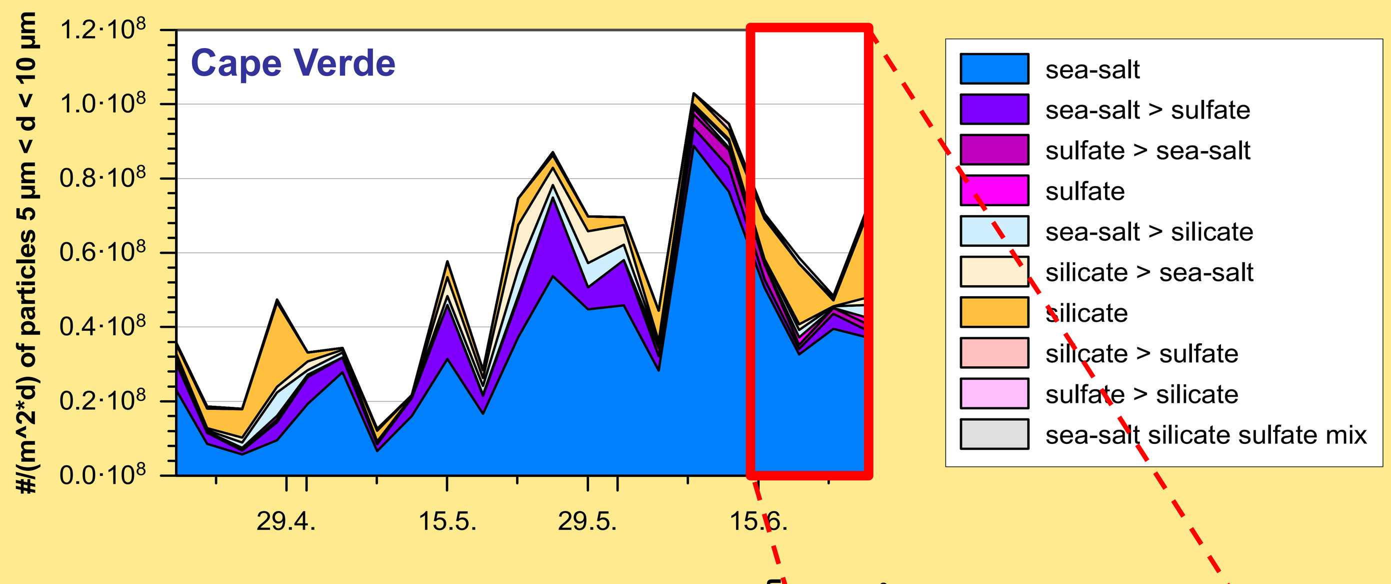


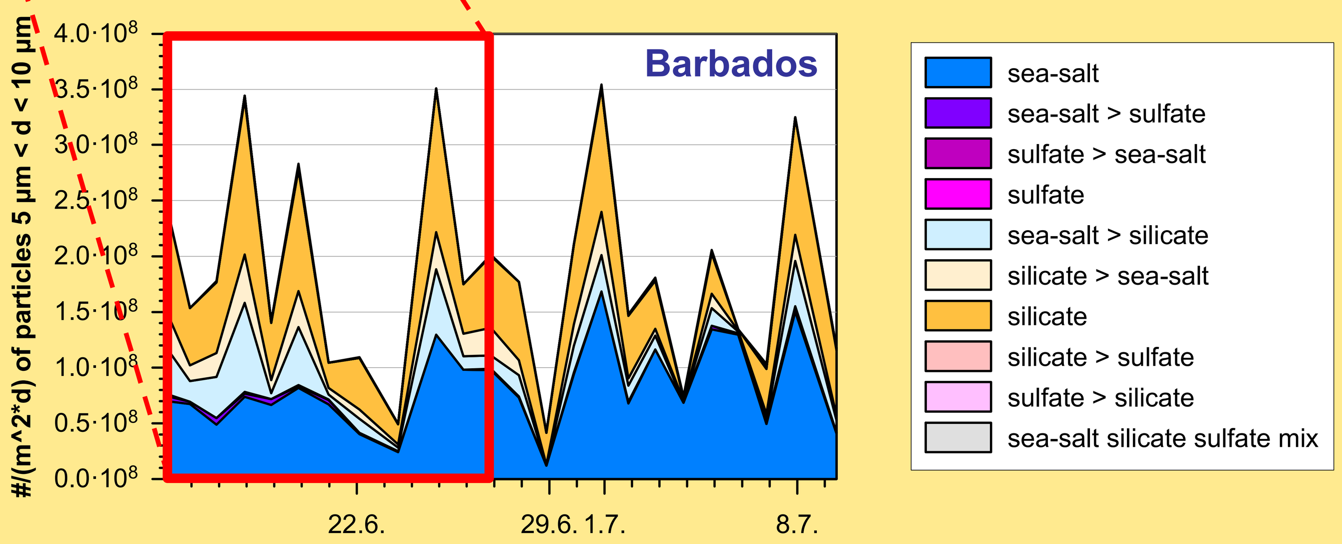
Fig. 3: Backscatter electron image of sampling substrate (left) and particle masks used for analysis (right); image width is 370 µm (180 nm/pixel)

Composition and mixing state of dry deposition at Cape Verde and Barbados

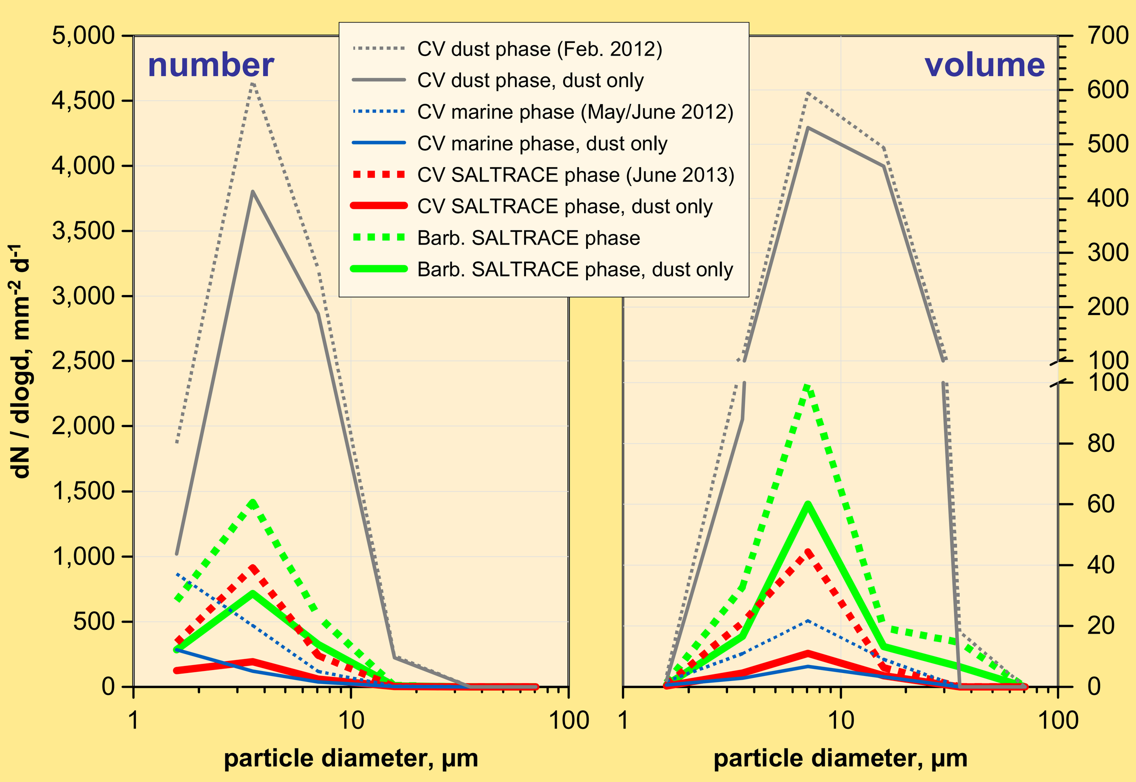
- deposition rates of similar magnitude
- sea-salt dominates total deposition
- few nearly pure marine days



- dust intrusions on Cape Verde are more pronounced than on Barbados
- more aged (sulfatic) sea-salt on Cape Verde
- dust/sea-salt ratio comparable for both stations, but more internally mixed particles at Barbados



Size distributions of deposition



- SALTRACE long-range transport phase:
  - no considerable mode shift in total deposited aerosol size distribution between Cape Verde and Barbados
  - at CV similar to former measurements[3]
  - considerably higher absolute and relative dust deposition at Barbados → Saharan Air Layer Transport pattern
- one order of magnitude less deposition than during CV winter dust events
- non-dust deposition variation: factor of 3

Composition of airborne large particles (10 µm < d < 25 µm)

- aerosol dominated by sea-salt, even more evident for 25 µm < d < 100 µm (not shown)
- variation in sulfate (and complex mixture) contribution
- dust events visible