Dust fall in Dushanbe, Tajikistan: Composition and Size Distribution by Electron Microscopy

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Introduction

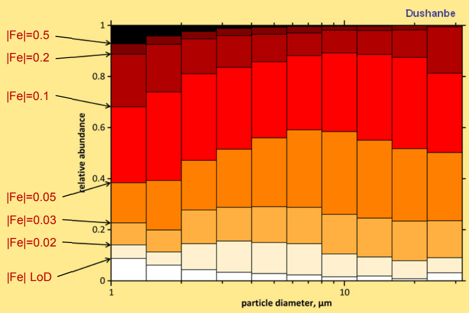
Mineral dust is one of the major aerosol types on a global scale. In Central Asia, it may dominate the total aerosol burden for considerable periods of the year. During a two weeks phase of the Central Asian Dust Experiment CADEX, dust dry deposition was sampled east of the city of Dushanbe, which lies in an orographic depression in Tajikistan and is surrounded by high mountains.

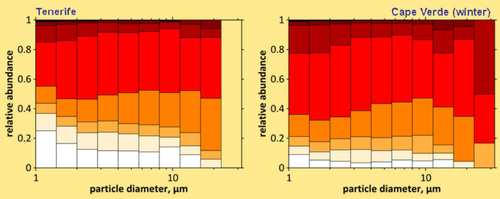
Atmospheric circulation

5-day backward trajectories have been calculation for the sampling location at altitudes of 500 m, 1500 m and 3000 m above (model) ground, using the HYSPLIT model based on GDAS data. Circulation pattern was nominated 'local', if all trajectories stayed close to Dushanbe for 5 days, 'medium', if the 1500-m-trajectory had a travel distance of at least 1000 km, and 'distant', if the 500-m-trajectory traveled such a distance. From Aug 28, 2016 to September 9, the circulation around Dushanbe was dominated by local airmasses with only few advection from distant regions.

Iron distribution

- iron index (|Fe|): ratio of Fe atomic concentration to all other major elements except H, C, N, O
- graphs show different index classes for silicate particles
- tendency of higher abundance of iron oxide/hydroxide towards smaller particles (similar to Saharan dust)
- Dushanbe considerable higher abundances of iron rich particles for the small particles sizes
- Tenerife has lower iron contents, consistent with more NW sources in Africa





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Sampling and Analysis

Locations

- Dushanbe, Tajikistan, 38.5594°N, 68.8561°E 864 m a.s.l. August/September 2016

for comparison:

- Praia Airport, Santiago, Cape Verde, 14.9479°N, 23.4838°W 102 m a.s.l. January/February 2008
- Izaña Atmospheric Observatory, Tenerife, Spain, 28.3093°N, 16.4992°W 2394 m a.s.l. July/August 2005

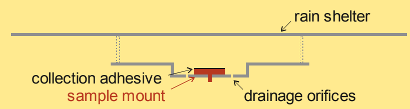


Fig. 1: Cross section of sedimentation trap

Particle dry deposition collection

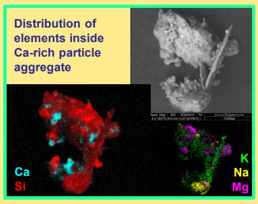
- VDI Sigma-2 sampler / sedimentation trap with rain shelter (Fig. 1)
- particle collection on adhesive carbon-substrates
- sampling time between 12 h and 4 d

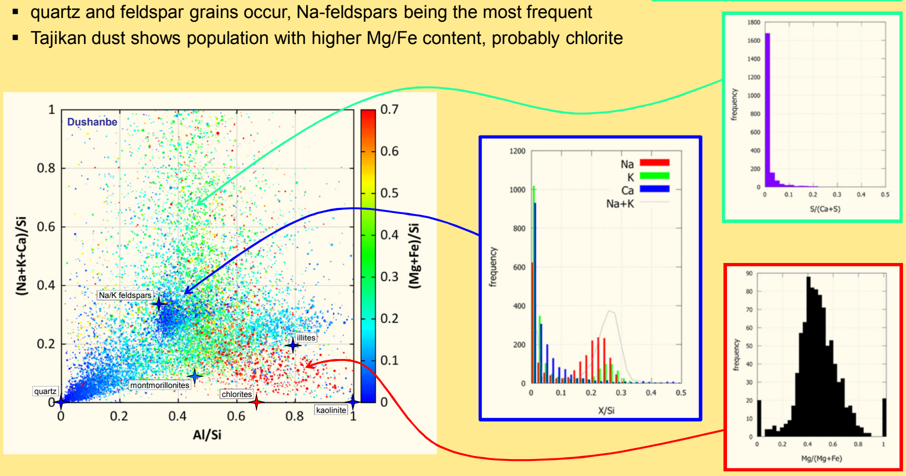
Analysis

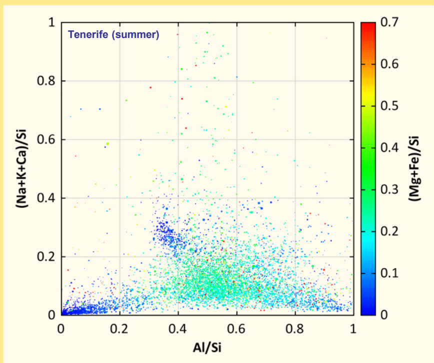
- automated scanning electron microscopy with energy-dispersive X-ray detection
- statistical significant numbers of particles are analyzed (for this work, 27 000)

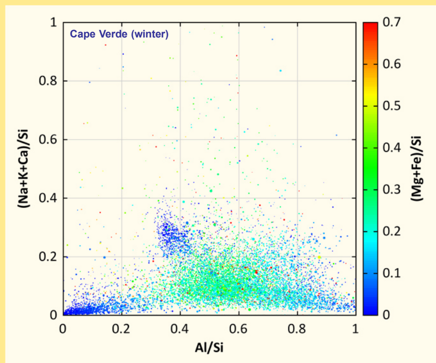
Geochemical fingerprints of dust particles

- graphs below show mainly particles between 1 and 100 µm in diameter (indicated by symbol size)
- most particles are aggregates, with an 'apparent' composition not matching a particular mineral
- aggregation with Ca carbonate occurs for silicates
- particles contain more iron than pure minerals
- quartz and feldspar grains occur, Na-feldspars being the most frequent
- Tajikan dust shows population with higher Mg/Fe content, probably chlorite



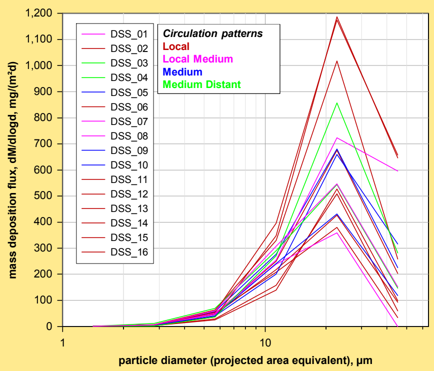






Microphysics and dust partitioning

- size distributions are classified according to the transportation pattern (local, medium, distant)
- no obvious link between transport pattern and size distribution
- in general, large particles dominate (average mass median aerodynamic diameter 32 µm, range 24 – 41 µm)
- mass deposition rates are high, with a mode between 200 and 400 mg/(m²d)
- nearly constant ratio of dust/non-dust components of 0.86 ± 0.01 (1 σ), indicating a well-mixed dust reservoir
- non-dust components are mainly sulfate compounds



Mass size distribution (left) and mass deposition rates (below)