Trace element distribution in size separated aerosols from Ny Alesund during the ASTAR 2000 campaign

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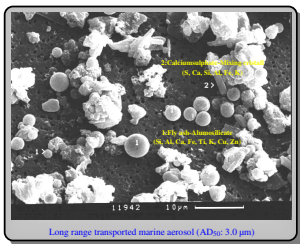


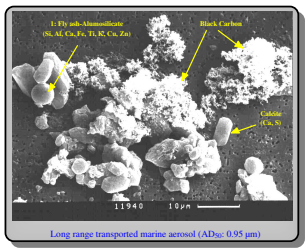
Long range transported marine aerosol (AD_{50}: 3.0 µm)

INTRODUCTION

The influence on climate, ecosystems and human health by atmospheric particles is undoubted but measurements to quantify the emissions from natural and anthropogenic sources as well as the transport and deposition behaviour in polar regions are still incomplete. To study these processes in combination with remote sensing techniques like LIDAR, Sunphotometer and Nepheleometer, it is necessary to analyse different properties of aerosol particles like size distribution, chemical composition, isotope ratios etc. because suche data enter into global modelling.

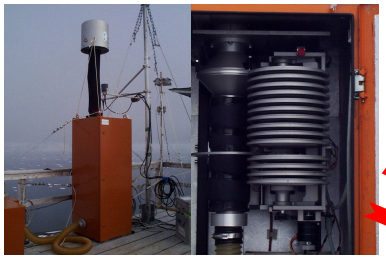
During the ASTAR campaign in March/April 2000 ground based aerosol sampling was performed by two different sampling systems, which were installed on top of the roof at the Japanese station Rabben 8 m above ground level.

We will present results fror trace element analyses carried out by solution ICP-MS and ETV-ICP-MS. In addition data from electron microscopy measurements will be presented to have information about morphology and composition of main constituents.



Long range transported marine aerosol (AD_{50}: 0.95 µm)

EXPERIMENTAL



High-Volume aerosol sampler (left) and automatic filter changer with 15 single stage impactors (right)

Aerosol characterisation by ICP-MS

Characterisation of aerosol samples was performed for 49 isotopes by ICP-MS. Typical tracer elements for mineral dust are Al, Ca Co, Fe, K, REE (Rare Earth Elements), Th and U. Na, Mg, Sr and Rb present sea salt sources. Anthropogenic sources are characterised by Ag, Cd, Cr, Cu, Ni, Pb, S, Tl and Zn.

Aerosol sampling with a single stage impactor

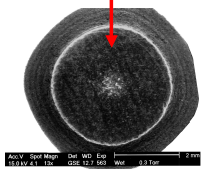
Size classified aerosol sampling was performed by a flow rate of 35 m³/h on precleaned silicon oil covered cellulose filters. With this setup the cut off diameter is at 2 µm. The sampling time was between 24 and 48 hours depending on the atmospheric aerosol particle load. Element analyses were carried out after a wet oxidative digestion for the aerosol particles under clean room conditions (U.S. class 100) by solution ICP-MS.

Single stage impactor with a cut off diameter at 2 µm (left) and silicon oil covered cellulose filter as well as abackup filter (right)

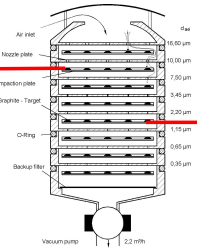
Aerosol sampling with an eight stage cascade impactor

Size classified aerosol sampling was carried out during special events 24 hourly with an eight stage impactor on grapite targets for subsequent multielement analysis by ETV-ICP-MS. In addition SEM/EDXA studies were carried out to characterize the morphology of the aerosol particles and to get informations about the major components. The pump rate for the eight stage impactor was 2.2 m³/h.

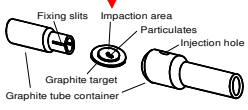
Eight stage cascade impactor



SEM picture of a graphite target with impacted particles



Schematic diagram of the cascade impactor



Graphite tube for ETV-IVP-MS

Aerosol characterisation by ETV-ICP-MS

Aerosol characterisation was carried out for typical tracer elements by ETV-ICP-MS: (mineral dust: Mn, Fe, Co and anthropogenic sources: Pb, Ni, Sb, Pt, Cd, Ag and Tl).

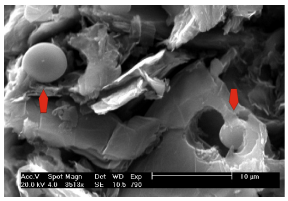
RESULTS

Morphological and main component determination by SEM/EDXA

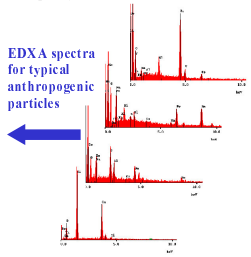
Typical aerosol particles from anthropogenic sources, sea salt as well as from mineral dust and ammonium sulphate are exemplarily shown together EDXA spectra in the following section.

Aerosol characterisation by SEM/EDXA

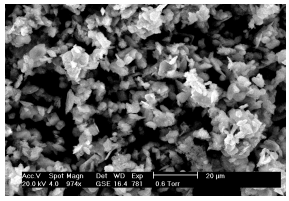
Morphological characterisation of aerosol samples as well as determination of main components were performed by SEM/EDXA.



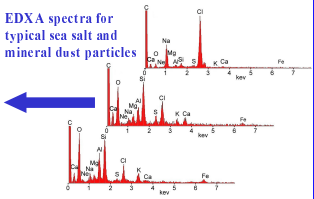
SEM picture for typical anthropogenic particles from high temperature combustion processes stage 3.45 µm for Impactor 4.



EDXA spectra for typical anthropogenic particles



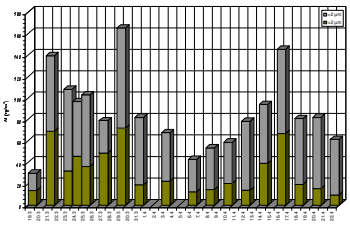
SEM picture for typical sea salt and mineral dust particles for impactor 10, stage 3.45 µm.

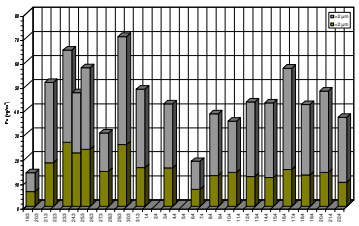


EDXA spectra for typical sea salt and mineral dust particles

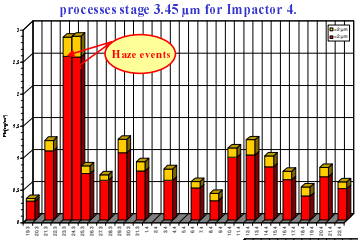
ICP-MS results

Size distribution and time series for some typical tracer elements (Al, Fe as tracers for mineral dust, Na, Mg as tracers for sea salt and Cd, Pb as tracers for anthropogenic sources are exemplarily shown.

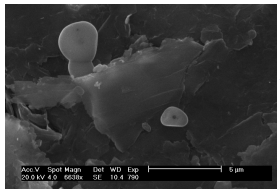




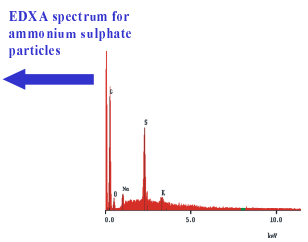
Al and Fe concentration during ASTAR 2000



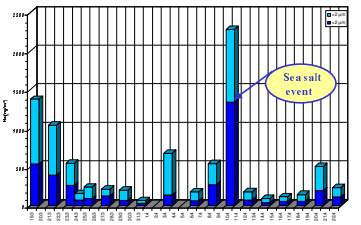
Optical properties of the atmosphere obtained by LIDAR, Sunphotometer, Nephelometer and Optical Particel Counter have shown that there was a Haze event at 23rd and 24th of March. This is in a good agreement with the chemical composition of the sampled aerosol particles They have an high load of anthropogenic material.



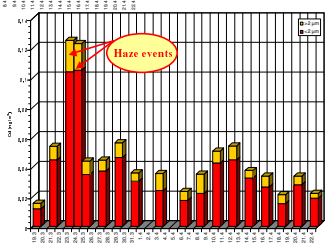
SEM picture for two ammonium sulphate particles for impactor 4, stage 0.35 µm.



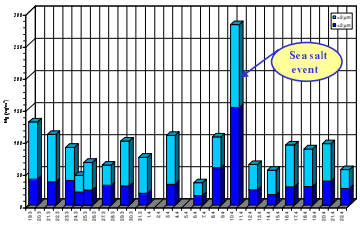
EDXA spectrum for ammonium sulphate particles



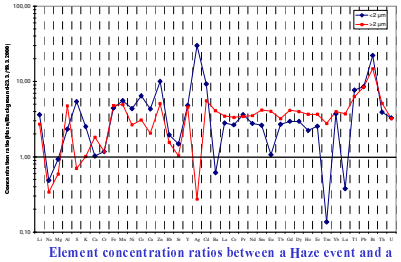
Ground based measurements performed with a Nephelometer and an Optical Particel Counter at Rabben as well as DMPS data from Zeppelin mountain have shown a high aerosol concentration at 10th of April. This is in not a Haze event. The high aerosol load is due to aerosol particles originated from sea salt.



Pb and Cd concentration during ASTAR 2000



Na and Mg concentration during ASTAR 2000

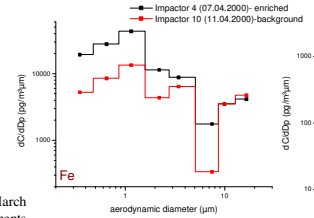


Element concentration ratios between a Haze event and a background aersol during ASTAR 2000

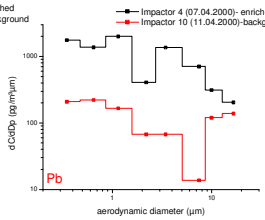
During the Haze event on March 23rd all anthropogenic elements and mineral dust elements are enriched up to factor of 30 in comparison to a background situation on March 19th. This is in a good agreement with the evaluation of 120 hours backward trajectories, which have shown that the air masses arryving Ny Alesund on March 23rd were coming from the European continent.

ETV-ICP-MS results

Fe size distributions (tracer for mineral dust) and Pb size distributions (tracer for anthropogenic sources) are exemplarily shown for two different atmospheric situations. Impactor 4 represents an enriched aerosol, while impactor 10 shows the distribution for a background aerosol.



Fe size distribution for an enriched and a background aerosol



Pb size distribution for an enriched and a background aerosol

SUMMARY AND OUTLOOK

* Concentrations of mineral dust and anthropogenic components are a factor 3-30 higher during Haze events than in background situations in spring time.
* This is in a good agreement with data from remote sensing methods (Lidar, Sunphotometer).
* Measurements with the eight stage impactor show higher element concentrations for mineral dust and anthropogenic elements as well as different size distributions.
* A high temporal variability of Arctic aerosols in the Arctic springtime has been observed.
* Further investigations have to be done to connect the chemical and morphological data with remeote sensing data.
* Future campaigns (spring 2004) will be used also for measurements of aerosol concentration with improved systems.