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VERTICAL AND TEMPORAL VARIATION OF SIZE DISTRIBUTION AND COMPOSITION OF AEROSOL PARTICLES ABOVE DISTINCT POPULATED REGIONS WITH RESPECT TO PRIMARY BIOLOGICAL AEROSOL PARTICLES

Introduction

Primary biological aerosol particles (PBAP) play an important role in the atmosphere; for instance they contribute to cloudforming processes. Meanwhile there exist a number of ground based measurements of their size distribution and composition (mean percentage of about 25% of the total aerosol, Matthias-Maser, 1998), but up to now less is known about their vertical distribution. Because of their physical characteristics (density, shape etc.) they are easily transported into higher altitudes and become part of cloud forming processes. Therefore the information of their vertical profile is interesting.

During this project a new impaction system MOCIS (Mobile Cascade Impaction System) was developed. It allows the size fractionated sampling of atmospheric aerosol particles with radii larger 0.2 µm and is suitable for a single particle analysis to determine their biological components.The aim of the first part of this project was to show the feasibility of this instrument.

Characteristics

- Possibility for single particle analysis,
- size fractionated sampling of particles with r > 0.2 µm,
- automatic operation:
  + automatical adaption of the sampling time to actual particle concentration,
  + constant cut-off´s for all sampling conditions, e.g. volume flow control dependent on air density,
  + Automatic changing of the sampling plates.
- compact, modular construction,
- adaptable to different sampling platforms (i.e.for ground-based or airborne measurements).

Description

The principle of the new instrument is based on the Two Stage Impaction System ZSI (Matthias-Maser und Jaenicke, 1994) used in several former projects on which comprehensive improvements necessary for the use aboard aircraft were performed. It is built modular and allows automatic, size fractionated sampling of particles with radius larger than 0.2 µm. It consists of four two-stage slit impactors (ZSI) with different cut-off's, and an automatic changing mechanism of the sampling plates. For the planned project they were combined in two modules (MOCIS 1, 2) each equipped with two ZSIs and the necessary periphery, i.e.vacuumsystem (PU), volume flow control unit (LFE) and optical particle counter (LPSC) (see Fig. 1).

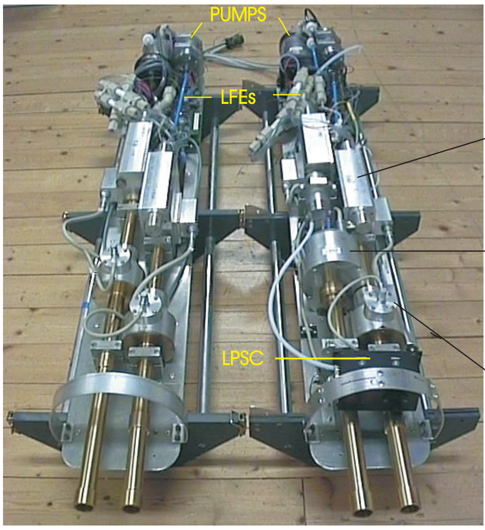

Fig. 1: The two modules with the 4 two stage impactors.

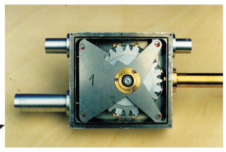
Fig. 2: Stage 2: 12-edged-cylinder, side-view .

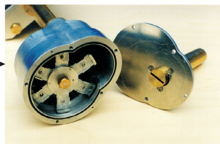
Fig. 3: Stage 1: star-shaped Sampling array with 6arms.

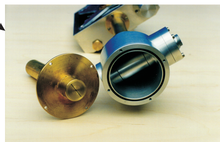
Fig. 4: Stage 1 : pre-seperator.

Figs. 2 to 4 show some details of the ZSIs. The first stages of three of the 4 ZSIs consist of rotating cylinders which serve as pre-seperator . The evaluated samples are mounted on a star-shaped sampling array respectively on four 12-edged-cylinders. The single impaction stages consist of a changing mechanism which allows sampling on 12 resp. 6 different sampling plates during one cycle. For sampling glass slides or graphitic foils can be used for later single particle analysis.The control of automatic change of sampling plates, sampling time, and volume flow dependent on the real real particle concentration is performed by a PC-based steering unit.

Control of the sampling time

Single particle analysis requires an optimal particle density on the sampling substrates.
Realized by:

- empirical determination of the relation between the sampling time and particle concentration of all stages,
- determination of the real sampling time of all stages dependent on the real particle concentration,
- replacement of the impaction plates and steering of the pumps by PC.

Control of the volume flow

Stabilisation of the cut-offs and isokinetic conditions requires control of the volume flow .
Realized by:

- Measurements of real conditions within the system by laminar-flow-elements (LFE), Δp, T-sensors,
- calculation of the real volume flow,
- comparison with the pre-selected values,
- adjusting the voltage of the pumps for the correct volume flow.

The two modules can be integrated alternatively into an underwing pod (Fig. 5) of a research aircraft, or can easily be mounted on a wind vane (Fig. 6) for ground based measurements, while the PC is installed in the cabin of the aircraft respectively in a container.

Fig.5: Research aircraft with underwing pod.

Literatur:

Matthias-Maser S., Jaenicke R. (1994), Examination of Atmospheric Bioaerosol Particles with Radii > 0.2 µm, J. Aerosol Science, Vol.25 No. 8 p 1605-1613.

Matthias-Maser S. (1998) Primary Biological Aerosol Particles: Thei Significance, Sources, Sampling Methods and Size Distribution in the Atmosphere, Harrison R.M., Van Grieken R. (Eds) Atmospheric Particle , IUPAC Series , Volume 5, p 349-368.

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Fig. 6 : Wind vane for ground based measurements.

State of the project

After first successful measurements with MOCIS 1 the second phase could be started in October 1999. We built and calibrated a second module MOCIS 2 and are now able to cover the complete size range of interest with the four stages. A second underwing pod was manufactured and a wind vane was built for ground-based studies.

Due to problems while operating the two systems in combination we modfied the steering unit comprehensively. To minimize electronic noise we now operate the modules with own micro processors which are controlled by PC via a serial interface.

At present we are the phase of sampling and evaluation. The results of our measurements will be presented in our final report, after the end of the project.