Aerosol measurements during the SOPRAN experiment in the Heidelberg Aeolotron

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Introduction

➢ During the joint SOPRAN laboratory experiment in Heidelberg, the annular wind-wave tank Aeolotron was filled with 20 m^3 seawater from the Atlantic Ocean to study exchange processes between ocean and atmosphere.

➢ Besides gas exchange measurements, aerosol particles were sampled in order to investigate

I: *To what extent organic material from the sea surface micro layer (SML) is transported into the aerosol particles.*

II: *How the presence of biogenic material in the seawater can potentially impact on the marine aerosol production process.*

➢ Such system allows studying transfer processes taking place at the air-sea-interface under controlled conditions, which are difficult to reach during field campaigns.

➢ Eleven wind speeds ranging from 1.54m/s to 21.2m/s (u 10) were applied during the experiment.

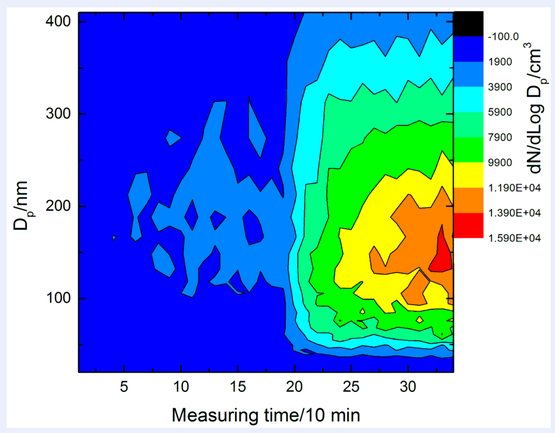
➢ Additionally, an aerator was used to simulate strong breaking waves with bubble entrainment and spray formation.

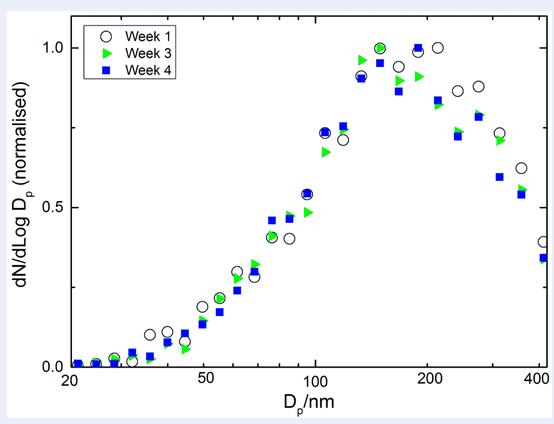
Wind speeds (u 10) of 5.21+/-0.34 m/s (left), 17.25+/-0.90 m/s (middle) and 13.7+/-1.3 m/s + bubbles from the aerator (right) in the Aeolotron.

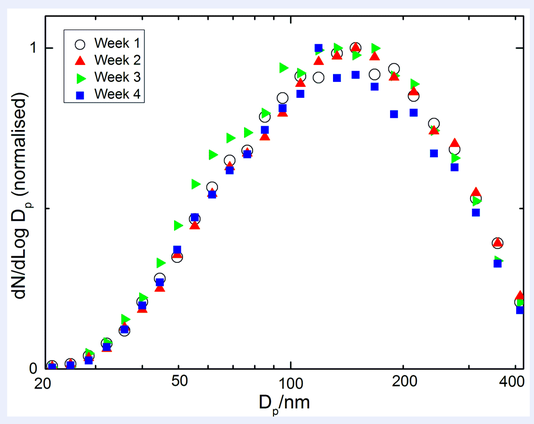
Preliminary Results and Discussion

1. Physical particle measurements

➢ Preliminary results for the marine aerosol size distributions measured with the SMPS are presented on the right picture. A time series of particle size distribution measurements demonstrates the relative contribution of air bubbling (at measuring time >18) to the aerosol production at constant wind speed of 10.6 m/s, noting in particular that a stable output in concentration of generated marine aerosol was obtained after ~60 minutes.







The Figures above shows a comparison of normalise averaged (at measuring times > 60 minutes) particle size distributions obtained without (Fig. left) and with air bubbling (Fig. Right at wind velocity of 10.6 m/s.

➢ *A noticeable shift of the marine submicron size distribution to smaller sizes with air bubbling can be observed (Fig. right).*

Summary and Outlook

Analytical measurements of organic compounds and EDX analysis of the whole sample set will follow. Further analysis is warranted to interpret and justify theoretically the observed results on size distributions and determine cloud droplet activation of the produced marine aerosols.

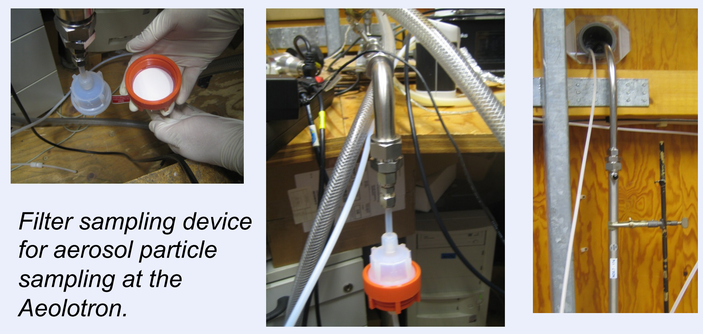
Instrumental set up

Different approaches of aerosol particle sampling:

I. Offline aerosol particle sampling with filters

➢Aerosol particles were collected on different filter materials (Teflon, quartz, polycarbonate) at a flow rate of 16.7 L/min.

➢Analysis of the total organic content and of different groups of organic compounds such as carbohydrates will be performed.

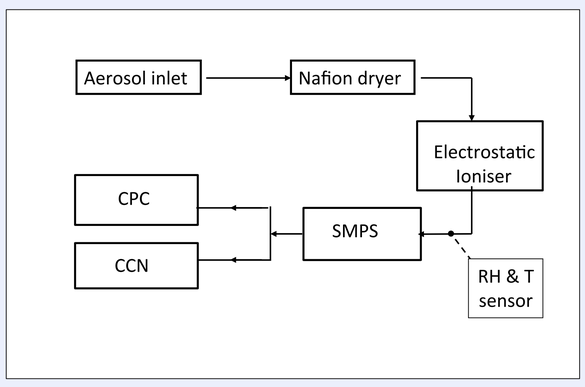


Filter sampling device for aerosol particle sampling at the Aeolotron.

➢ Moreover, a MPS (mini-particle sampler) was applied which is a particle collection technique based on filtration on TEM porous grids.

➢ Further Transmission Electron Microscopy (TEM) coupled with energy-dispersive X-ray (EDX) analysis will, give information on size, morphology and elemental composition of the deposited particles.

II. Online aerosol particle analysis



A schematic diagram and a picture of the experimental setup employed for online aerosol measurements.

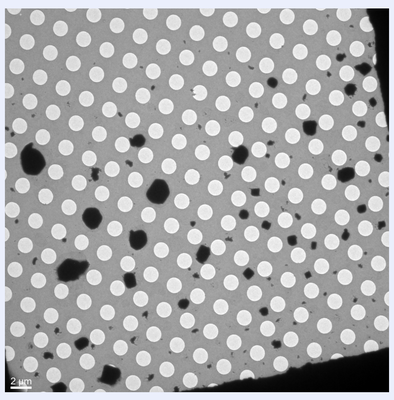
Online marine aerosol measurements were made continuously online from an aerosol inlet mounted on the wind tunnel using following instruments:

SMPS TSI 3080 (Scanning Mobility Particle Sizer) coupled to a CPC TSI 3776 (Condensation Particle Counter), and DMT-CCNc (Droplet Measurement Technologies-Cloud Condensation Nucleus counter). Aerosol measurements of dry particle size distributions were carried out in the size range from 20 nm to 410 nm during 10 minutes measurement periods and CCN activated fraction were calculated as function of particle dry size and super-saturation (SS).

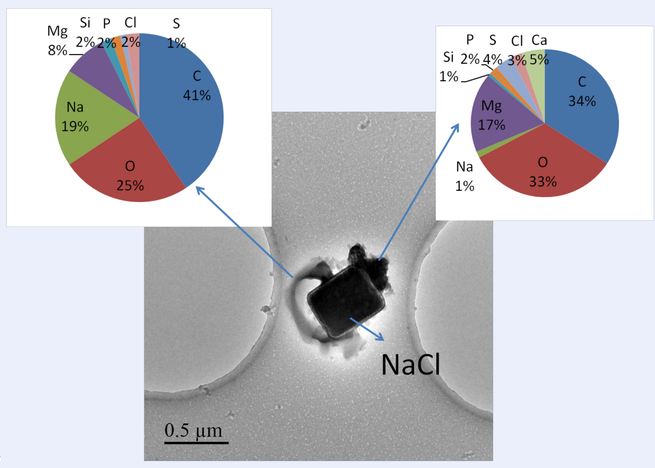
2. Chemical particle measurements and morphology of the particles

First organic carbon (OC) measurements suggest that while at low wind speeds OC concentrations were below the detection limit (ca. 10 nmol/ m^3) at higher wind speeds a detectable amount of OC is transferred to the atmosphere.

➢ 700 nmol/ m^3 OC on aerosol particles was found at a wind speed (u10) of 13.7+/-1.3 m/s.



General view of a full square of the TEM porous grids at wind speed of 10.9 m/s and bubbles, NaCl is covered or associated to other inorganic and organic material.



TEM picture: NaCl is covered or associated to other inorganic and organic material.

➢ TEM pictures and EDX analysis show that NaCl dominates in terms of mass but it is always associated with other particles (inorganic and an organic fraction) adsorbed to its surface.