AC1) A comparative study of the ionic composition of aerosols from the North Sea and a North Sea coastal area

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1. Introduction

It is well known that atmospheric aerosols play an important role in the radiation balance of the earth and meteorological processes as well as in atmospheric chemistry. Aerosols may origin from both natural and/or anthropogenic sources. Thus, the chemical composition of aerosols can vary considerably. For example, the chemical composition of marine aerosol has been the subject of a considerable number of investigations, including the evaluation of long-range transport of anthropogenic constituents on the chemistry of the remote marine boundary layer. There is evidence that the deposition of mineral dust from the continents enhances biological productivity in the oceans. On the other hand, the production of Non-Sea-Salt (NSS) sulfate from oceanic sources influences the formation of clouds and injection of sea-salt aerosols can affect the removal of ozone in the troposphere. Consequently, the study of aerosols near the ocean/atmosphere interface is a key to understand short and long term changes of the global environment.

In the study presented here we have investigated the ionic composition of marine aerosols collected at the isle of Helgoland in the North Sea and in Bremerhaven (Germany) a city which is located at the coast of the North Sea. A low-volume air sampling technique with a combination of a teflon and a nylon filter in series was applied which has been frequently used for marine aerosol sampling in previous studies (Mcinnes et al 1996). Ion chromatography was applied for the analysis of the aerosol samples. The air volume of each sample ranged from 1.0 to 1.6 m3 except for overnight sampling. In total, 10 ionic species have been analysed. Aerosol samples collected at Helgoland represent the air quality of the remote North Sea boundary layer, whereas aerosols collected at the roof of an AWI building in Bremerhaven originate form the atmosphere of the marine/continental interface where the ionic aerosol composition can be strongly influenced by anthropogenic sources. Due to the short period of sampling at both locations, the amount of data is not sufficient in order to determine a general air quality. However, throughout the statistical approach for data interpretation, comparable results were obtained and provided understandable properties of short-term ion distributions in aerosols. The main goals of this study were to obtain an improved perception of aerosol composition in the North Sea and its coastal areas and the investigation of the relationship between aerosols collected at different environments.

2. Experimental Procedure

Atmospheric aerosols were collected at two different sites for several days. The first sampling site was the isle of Helgoland (54°10N, 7°54E) which is located in the North Sea as shown in figure 1. A low volume air sampler was installed at the station built for atmospheric investigations, which is located on the hill of the island about 100 a.s.l. and about 1 km away from the residential and commercial area. The other sampling site was the roof of an AWI building (about 20 m a.s.l.) in Bremerhaven (53°32N, 8°35E). The building represents a measuring site at the interface between Sea and coastal/continental area. The north-western side of the building is close to the open Sea and its eastern side is close to the downtown area of Bremerhaven. Roads are passing by in a short distance to the building along the coast line. Exhaust gases from automobiles and stack gases emitted from industrial plants approximately 3 km away in western direction can have an influence on the collected aerosols. Thus, depending on the direction and speed of the wind, exhaust gases deriving from automobiles and plants are thought as relatively significant anthropogenic sources for aerosol formation apart from sea salt.

The low-volume air sampling system for field aerosol collection consists of a filter holder containing a teflon filter (TF-1000, 47 mm diameter & 1μm pore size) and a nylon filter(Nylon membrane filter, 47 mm diameter & 1μm pore size) in series, a gas meter and an air pump as shown in figure 2. The teflon filter is

used to collect particulate matter, and the nylon membrane filter is used to capture nitric acid which can be volatilised from particulate matter collected with the teflon filter. In the laboratory, the vials holding collected filters were filled with about 20ml of Milli-Q water and then they were sonicated for 15 minutes. The concentrations of the major ionic components of the collected aerosol samples were analysed using ion chromatography.

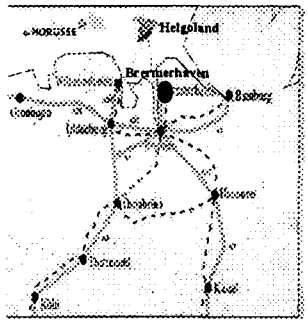

Figure 1. Sampling location

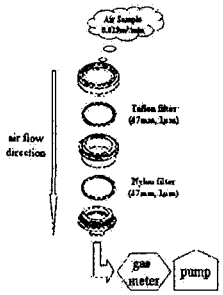

Figure 2. Schematic diagram of sampling system

3. Results and discussion

Aerosol samples have been collected at Helgoland representing North Sea air quality, and on the roof of an AWI building in Bremerhaven, the interface of Sea and continent. In total, the amounts of 10 major ionic components - five anions and five cations F^-, Cl^-, NO_3^-, SO_4^{2-}, MSA, Na^+, NH_4^+, K^+, Mg^{2+}, and Ca^{2+} - were determined as illustrated in figure 3. Since ionic aerosol composition varies depending on time and area due to temporary horizontal and vertical air mixing, data interpretation was accomplished by considering the meteorological conditions such as wind speed, wind direction, humidity, temperature, and regional characteristics as well. Especially, since sea salt is one of the most significant aerosol constituents in Helgoland, its influence was investigated in detail. On the other hand, it was found that earth crust elements contribute relatively strong to the composition of aerosols in Bremerhaven. Thus, the distributions of the ionic constituents of aerosols of Helgoland and Bremerhaven are somewhat different from what we expected. However, as a whole, in the view of sea salt components, the ionic compositions of Helgoland aerosols indicate a considerably higher sea salt contribution than those of Bremerhaven due to the different origin of the air masses.

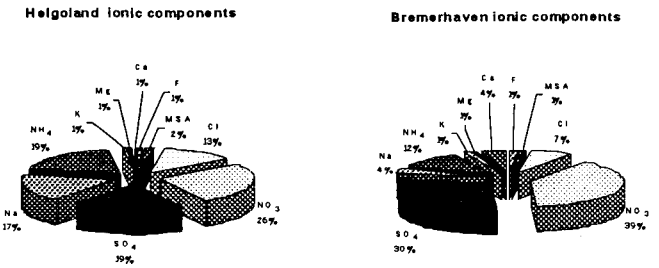

Figure 3. Distributions of ionic components in aerosols collected at Helgoland and Bremerhaven

4. References

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