Spatial variations and source apportionment of the marine organic aerosol over the Atlantic Ocean

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The marine aerosol plays an important role in global climate regulation and marine biogenic system. The organic compounds are found in both primary and secondary marine aerosol and related to the number size distribution, hygroscopic growth and optical properties of particles. However, the contribution and formation mechanisms of marine organic aerosol are still poorly understood (O'Dowd and De Leeuw, 2007). In this study, physicochemical properties of the marine boundary layer aerosol were measured by a comprehensive suite of on-line instrumentation on the research vessel Polarstern during 4 cruises over the Atlantic Ocean. The cruises details are shown in Table 1.

Table 1. The starting/terminal ports and duration of 4 cruises

Expedition	Port	Duration
Cruise I (ANT-XXVII/4)	Cape Town - Bremerhaven	20.04.2011 - 20.05.2011
Cruise II (ANT-XXVIII/1)	Bremerhaven - Cape Town	28.10.2011 - 01.12.2011
Cruise III (ANT-XXVIII/5)	Punta Arenas - Bremerhaven	10.04.2012 - 15.05.2012
Cruise IV (ANT-XXIX/1)	Bremerhaven - Cape Town	27.10.2012 - 27.11.2012

Table 2. Mass fraction of the main species for 3 cruises

Species	Cruise I	Cruise II	Cruise III
Organics	24%	29%	30%
Sulfate*	58%	56%	54%
Ammonium	13%	10%	11%
Nitrate	4%	3%	4%
Chloride*	1%	2%	1%

*non-sea salt sulphate and non-sea salt chloride

The chemical composition of non-refractory submicrometer particles was derived from High Resolution Time of Flight Aerosol Mass Spectrometer (HR-ToF-AMS) measurements from the first 3 Polarstern cruises. Table 2 provides the mass fraction of each main species measured by AMS. Sulfate is the dominant component, accounting for more than 50% of the total measured particle mass concentration. Organics are the second important species, taking 24-30% of total particle mass concentration. Ammonium contributes 10-13% to the total particle mass concentration. Nitrate and non-sea salt chloride showed very low concentrations during the cruises.

As an example, the spatial variations of organic component mass concentration for cruise I-III are given by Figure 1. High concentrations are observed when the ship is close to the continent, possibly influenced by both the air mass transport from the continents and the phytoplankton blooming depending on the season.

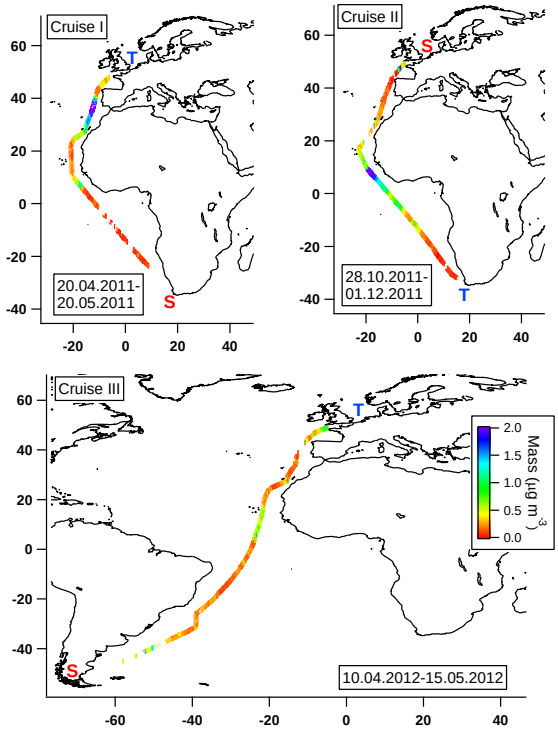

Figure 1. Organics mass concentration along the ship track for the first 3 cruises (S: starting port, T: terminal port)

Based on the high resolution mass spectra of HR-ToF-AMS, methane sulfonic acid (MSA) and sodium chloride (NaCl) are extracted from the original signals, providing clues of the secondary marine aerosol and the primary marine aerosol, respectively. They are being validated by filter sample results and being used to improve the source apportionment by Positive Matrix Factorization (PMF) method. The AMS-PMF analysis is on-going and more detailed results will be shown in the presentation.

C.D. O'Dowd and G. De Leeuw, Marine aerosol production: a review of the current knowledge, *Philos T R Soc A* **365**(2007), pp. 1753-1774.