Emission events characterization of marine aerosol in a shoreline site

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Ocean derived aerosols play an important role in cloud formation and properties, radiation balance and chemistry of the marine atmosphere. In addition to primary particles, ocean derived aerosols also contain inorganic and organic species produced through secondary (gas to particles) processes. Determination of marine aerosol and sea spray emission from the sea surface is a necessary step in attempts to parameterize the mass exchange between sea and atmosphere.

An intensive observation campaign was performed at Mace Head (Ireland) from 1 to 30 August 2015. The aim of the campaign was to characterize the sea aerosol emission in the clean North Atlantic Marine Boundary Layer (MBL). Size-segregated aerosol flux measurements by eddy-covariance (EC) could provide important information on the emission of marine aerosols.

Measurements were carried out using a micrometeorological flux system installed on the tallest Mace Head tower at 22 m height (above ground level). The system included a condensation particle counter (CPC; Grimm Aerosol Model 5.403) that measured the total particle number concentrations at 1 Hz. Wind components (u, v, w) were measured at 20 Hz with an ultrasonic anemometer (Gill Instruments R3), which also measured sonic temperature. During the campaign, the wind velocity was relatively high, but typical at Mace Head, up to 16 m/s (average 7 ± 3 m/s), the average temperature varied between about 10° and 18°C, and the average relative humidity varied between 58% and 95%. The predominant wind directions at the site are westerly (W), south westerly (SW).

The CPC system used was able to detect particles between 20 and 1000 nm. Aerosol was sampled roughly at the same height as the sensing head of the anemometer (about 10 cm from its sensing volume) through a 30 m long sampling inlet (copper) of 10.7 mm internal diameter. A pump was used to maintain a flow rate of 35 L/min in the inlet tube, maintaining a turbulent flow. A portion of 1.5 L/min was taken from the main flow at the end of the inlet tube using a 0.45 m long conductive plastic tube (6 mm internal diameter) connecting to the CPC. The size-segregated fluxes and the particle size distributions were measured by an OPC (Model 1.109, Grimm aerosol) with a sampling frequency of 1Hz. The OPC sampled air on the top of the tower was operated using a second inlet tube 2.45 m long (internal diameter, 4 mm) with a flow rate of 1.2 L/min. OPC was configured to evaluate particle number concentrations in the size range 0.25-2.5 µm using 16 channels.

During the measurement campaign the tower was upwind of the sea sector (190°-300°) for 75% of the time, offering westerly exposure to the North Atlantic Ocean. The flux and concentration footprints were evaluated using the model for scalar passive tracer described in Schmid (1994). Results are reported for fluxes and concentrations respectively. The surface area for concentration was significantly larger than that for fluxes.

In figure 1 the combined average particle size distributions are reported, taking into account aerosol measurement with nanoSMPS + SMPS and OPC. A good overlapping in the common size range is observed with the presence of a mode in the nanoparticles range (Dp<0.05 µm) and an accumulation mode (around 0.20 µm). Size-segregated particle fluxes obtained in the measurement period will be discussed to investigate marine aerosol/sea spray emission events, also according to a distinction for air masses coming from open sea and land sector. The events will also be characterized by aerosol chemical composition derived from Aerosol Mass Spectrometer (AMS) measurements, to evidence, in particular, the occurrence of marine primary organic plumes (Ovadnevaite et al., 2011).

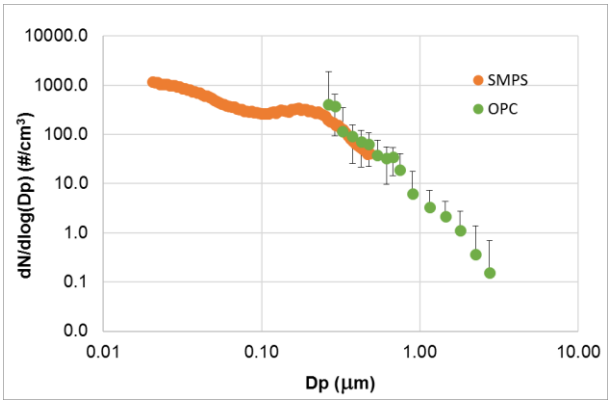

Figure 1. Average combined number size distribution with SMPS (in orange) and OPC (in green).

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