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Composition and properties of atmospheric particles in the eastern Atlantic and impacts on gas phase uptake rates

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Abstract. Marine aerosol composition continues to represent a large source of uncertainty in the study of climate and atmospheric chemistry. In addition to their physical size and chemical composition, hygroscopicity plays a significant role, increasing the particles' surface areas and scattering potential. Simultaneous aerosol measurements were performed on board the RRS Discovery and at the Cape Verde atmospheric observatory during the Aerosol Composition and Modelling in the Marine Environment (ACMME) and Reactive Halogens in the Marine Boundary Layer (RHAMBLE) experiments. These included online measurements of number and dry size and bulk collection for offline analysis of aqueous ions. In addition, the measurements on board the Discovery included online measurements of composition using an Aerodyne Aerosol Mass Spectrometer, optical absorption using a Multi Angle Absorption Photometer, ambient humidity size distribution measurements using a humidified differential mobility particle sizer (DMPS) and optical particle counter (OPC) and hygroscopicity measurements with a hygroscopicity tandem differential mobility analyser (HTDMA).

Good agreement between platforms in terms of the sea salt (ss) and non sea salt (nss) modes was found during the period when the Discovery was in close proximity to Cape Verde and showed a composition consistent with remote marine air. As the Discovery approached the African coast, the aerosol showed signs of continental influence such as an increase in particle number, optical absorption, enhancement of the nss mode and dust particles. The Cape Verde site was free of this influence during this period. Chloride and bromide showed concentrations with significant deviations from seawater relative to sodium, indicating that atmospheric halogen processing (and/or acid displacement for chloride) had taken place. The time dependent ambient size distribution was synthesised using

humidified DMPS and OPC data, corrected to ambient humidity using HTDMA data. Heterogeneous uptake rates of hypoiodous acid (HOI) were also predicted and the nss accumulation mode was found to be the most significant part of the size distribution, which could act as an inert sink for this species. The predicted uptake rates were enhanced by around a factor of 2 during the African influence period due to the addition of both coarse and fine particles.

The hygroscopicity of the nss fraction was modelled using the Aerosol Diameter Dependent Equilibrium Model (ADDEM) using the measured composition and results compared with the HTDMA data. This was the first time such a reconciliation study with this model has been performed with marine data and good agreement was reached within the resolution of the instruments. The effect of hygroscopic growth on HOI uptake was also modelled and ambient uptake rates were found to be approximately doubled compared to equivalent dry particles.

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