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Reactive Halogens in the Marine Boundary Layer (RHaMBLe): the tropical North Atlantic experiments

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Abstract. The NERC UK SOLAS-funded Reactive Halogens in the Marine

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Boundary Layer (RHaMBLe) programme comprised three field experiments. This manuscript presents an overview of the measurements made within the two simultaneous remote experiments conducted in the tropical North Atlantic in May and June 2007. Measurements were made from two mobile and one ground-based platforms. The heavily instrumented cruise D319 on the RRS Discovery from Lisbon, Portugal to São Vicente, Cape Verde and back to Falmouth, UK was used to characterise the spatial distribution of boundary layer components likely to play a role in reactive halogen chemistry. Measurements onboard the ARSF Dornier aircraft were used to allow the observations to be interpreted in the context of their vertical distribution and to confirm the interpretation of atmospheric structure in the vicinity of the Cape Verde islands. Long-term ground-based measurements at the Cape Verde Atmospheric Observatory (CVAO) on São Vicente were supplemented by long-term measurements of reactive halogen species and characterisation of additional trace gas and aerosol species during the intensive experimental period.

This paper presents a summary of the measurements made within the RHaMBLe remote experiments and discusses them in their meteorological and chemical context as determined from these three platforms and from additional meteorological analyses. Air always arrived at the CVAO from the North East with a range of air mass origins (European, Atlantic and North American continental). Trace gases were present at stable and fairly low concentrations with the exception of a slight increase in some anthropogenic components in air of North American origin, though NO_x mixing ratios during this period remained below 20 pptv (note the non-IUPAC adoption in this manuscript of pptv and ppbv, equivalent to pmol mol^{-1} and nmol mol^{-1} to reflect common practice). Consistency with these air mass classifications is observed in the time series of soluble gas and aerosol composition measurements, with additional identification of periods of slightly elevated dust concentrations consistent with the trajectories passing over the African continent. The CVAO is shown to be broadly representative of the wider North Atlantic marine boundary layer; measurements of NO, O_3 and black carbon from the ship are consistent with a clean Northern Hemisphere marine background. Aerosol composition measurements do not indicate elevated organic material associated with clean marine air. Closer to the African coast, black carbon and NO levels start to increase, indicating greater anthropogenic influence. Lower ozone in this region is possibly associated with the increased levels of measured halocarbons, associated with the nutrient rich waters of the Mauritanian upwelling. Bromide and chloride deficits in coarse mode aerosol at both the CVAO and on D319 and the continuous abundance of inorganic gaseous halogen species at CVAO indicate significant reactive cycling of halogens.

Aircraft measurements of O_3 and CO show that surface measurements are representative of the entire boundary layer in the vicinity both in diurnal variability and absolute levels. Above the inversion layer similar diurnal behaviour in O_3 and CO is observed at lower mixing ratios in the air that had originated from south of Cape Verde, possibly from within the ITCZ. ECMWF calculations on two days indicate very different boundary layer depths and aircraft flights over the ship replicate this, giving confidence in the calculated boundary layer depth.

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Irwin, M., Jones, C. E., Jones, R. L., Keene, W. C., Lawler, M. J., Lehmann, S., Lewis, A. C., Long, M. S., Mahajan, A., Methven, J., Moller, S. J., Müller, K., Müller, T., Niedermeier, N., O'Doherty, S., Oetjen, H., Plane, J. M. C., Pszenny, A. A. P., Read, K. A., Saiz-Lopez, A., Saltzman, E. S., Sander, R., von Glasow, R., Whalley, L., Wiedensohler, A., and Young, D.: Reactive Halogens in the Marine Boundary Layer (RHaMBLe): the tropical North Atlantic experiments, Atmos. Chem. Phys., 10, 1031-1055, 2010. Bibtex EndNote Reference Manager