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Hygroscopic properties of different aerosol types over the Atlantic and Indian Oceans

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Abstract. Hygroscopic properties of atmospheric particles were studied in the marine tropospheric boundary layer over the Atlantic and Indian Oceans during two consecutive field studies: the Aerosols99 cruise (Atlantic Ocean) from 15 January to 20 February 1999, and the INDOEX cruise (Indian Ocean Experiment) from 23 February to 30 March 1999. The hygroscopic properties were compared to optical and chemical properties, such as absorption, chemical inorganic composition, and mass concentration of organic and elemental carbon, to identify the influence of these parameters on hygroscopicity.

During the two field studies, four types of aerosol-sampling instruments were used on board the NOAA (National Oceanic and Atmospheric Administration) Research Vessel Ronald H. Brown: Hygroscopicity Tandem Differential Mobility Analyzer (HTDMA), seven-stage cascade impactor, two-stage cascade impactor, and Particle Soot Absorption Photometer (PSAP). The HTDMA was used to determine the hygroscopic properties of atmospheric particles at initial dry sizes (*Dp*) of 50, 150, and 250 nm and at relative humidities (*RH*) of 30, 55, 75, and 90%. Simultaneously, a seven-stage cascade impactor of which 3 stages were in the sub-µm size range was used to determine the molar composition of the major inorganic ions such as ammonium and sulfate ions. A two-stage cascade impactor (1 in the sub-µm size range, 1 in the sup-µm size range) was used to determine the mass concentration of organic and elemental carbon. The PSAP was used (at a wavelength of 565 nm) to measure the light absorption coefficient of the aerosol.

During the two field studies, air masses of several different origins passed the ship's cruise path. The occurrence of different air masses was classified into special time periods signifying the origin of the observed aerosol.

All time periods showed a group of particles with high hygroscopic growth. The measured average hygroscopic growth factors defined by the ratio of dry and wet particle diameter at 90% *RH* ranged from 1.6 to 2.0, depending on the dry particle size and on the type of air mass. Particles with low hygroscopic growth occurred only when continentally influenced

air masses arrived at the ship's position. Distinctions in hygroscopic growth of particles of different air masses were more significant for small relative humidities (30% or 55% *RH*). High concentrations of elemental carbon corresponded with high light absorption coefficients and with the occurrence of less-hygroscopic and nearly hydrophobic particle fractions in the hygroscopic growth distributions.

A key finding is that clean marine air masses that had no land contact for five to six days could clearly be distinguished from polluted air masses that had passed over a continent several days before reaching the ship.

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