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Retrieval of aerosol optical and micro-physical properties with 2D-MAX-DOAS

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Recent retrievals of 2 dimensional (2D) Multi-AXis Differential Optical Absorption Spectroscopy (2D-MAX-DOAS) have highlighted its importance in order to infer diurnal horizontal in-homogeneities around the measurement site. In this work, we expand the capabilities of 2D measurements in order to estimate simultaneously aerosol optical and micro-physical properties. Specifically, we present a retrieval method to obtain: (1) aerosol optical thickness (AOT) in the boundary layer (BL) and free troposphere (FT) and (2) the effective complex refractive index and the effective radius of the aerosol column size distribution. The retrieval method to obtain AOT is based on an iterative comparison of measured normalized radiances, oxygen collision pair (O4), and absolute Raman Scattering Probability (RSP) with the forward model calculations derived with the radiative transfer model McArtim based on defined aerosol extinction profiles. Once the aerosol load is determined we use multiple scattering phase functions and single scattering albedo (SSA) obtained with Mie calculations which then constrain the RTM to forward model solar almucantar normalized radiances. The simulated almucantar normalized radiances are then compared to the measured normalized radiances. The best-fit, determined by minimizing the root mean square, retrieves the complex refractive index, and effective radius. We apply the retrieval approach described above to measurements carried out during the 2012 intensive operation period of the Two Column Aerosol Project (TCAP) held on Cape Cod, MA, USA. Results are presented for two ideal case studies with both large and small aerosol loading and similar air mass outflow from the northeast coast of the US over the West Atlantic Ocean. The aerosol optical properties are compared with several independent instruments, including the NASA Langley airborne High Spectral Resolution Lidar (HSRL-2) for highly resolved extinction profiles during the overpasses, and with the co-located Multi Filter Rotating Shadow band Radiometer (MFRSR), and the Cimel Sun photometer for aerosol load at several wavelengths. To test aerosol horizontal homogeneity we use quantitatively analysis of asymmetry of solar azimuth normalized radiances and RSP. The aerosol column microphysical properties will be compared with merged size distribution of several in-situ instruments from airborne measurements during overpasses of the DoE-G1 aircraft around the ground measurement site.