

Detection of Aerosol Growth Rate Using a Mass Balance Model Constrained by Water Isotopes Measurements at Mauna Loa

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While the chemistry that governs the formation of sulfate aerosols is well known, point measurements of aerosol abundance cannot be easily used to quantify new particle formation because of transport processes. In this study, we use a novel approach to distinguish between changes in aerosol distributions due to advection from those due to *in situ* nucleation and growth. We isolate advective changes by strictly defining periods of atmospheric mixing using high-frequency stable water isotope measurements of vapor. Vapor isotopologues were measured at the Mauna Loa Observatory (MLO) in the Fall of 2008. During periods of air mass mixing, the ratio of deuterated (HDO) to normal water (H₂O) follows very clear mixing lines (identified in our record when the linear slope between the HDO/H₂O ratio and the inverse of water exhibits an R² greater than or equal to 0.95). During these periods, distinct air masses, such as the marine boundary layer (Figure 1 a-b, green curve) and the free troposphere (Figure 1 a-b, blue curve), mix without undergoing condensation or evaporation. The evolution of aerosol size spectra, measured with an Ultra-High Sensitivity Aerosol Spectrometer, during these events is modeled through a mass balance approach (Figure 1b), in which the mixing term is constrained by the water isotopologue data at each 5-minute time step. Chemical or physical aerosol growth that is independent of the mixing signature can then be evaluated in terms of the differences between observed and modeled distributions, with aerosol source appearing as a residual (Figure 1c). The resulting difference distributions are analyzed to discriminate amongst new particle formation, accumulation growth, and ablation.

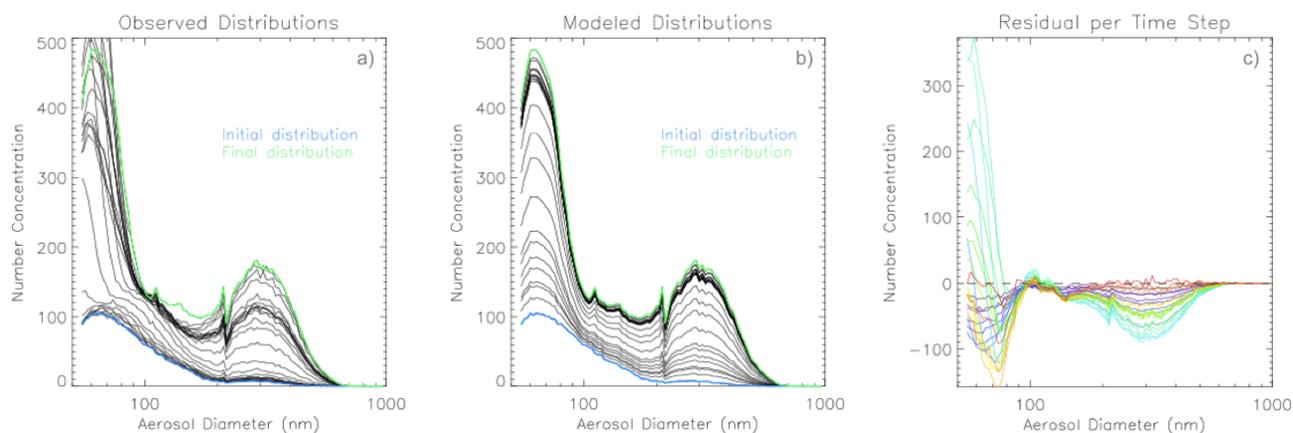


Figure 1. Evolution of a) aerosol number spectra measured on October 21, 2008 at MLO, b) a mass balance box model, which accounts for air mass mixing, and c) differences between the observed and modeled spectra, which describe the chemical source, for every 5-minute time step.