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Discussion

Reply to comment on "Size distribution of sea-salt emissions as a function of relative humidity"

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We appreciate the insightful comments provided by Lewis and Schwartz (2005). We became aware of their parameterization of sea-salt's size dependence on relative humidity (Lewis and Schwartz, 2004) only after our original manuscript was in press and agree that Eq. (4) of Lewis and Schwartz (2005) is an improvement over the expression for the size-correction factor (C^0, defined as the ratio of sea-salt particle diameter at formation to that at ambient relative humidity, RH) in Zhang et al. (2005) due to its physical basis rather than derivation from a polynomial fit to laboratory data. Although both parameterizations are useful for general atmospheric modeling applications, the Lewis and Schwartz parameterization can be applied not only to typical ocean environments, but also to the few locations where salinity departs significantly from 35‰, and is more accurate at times and locations where the ambient RH exceeds 98%.

Another noteworthy issue raised by Lewis and Schwartz (2005) is that the diameter at formation (i.e., D_{p0} or D_{form}) may be an ambiguous measure of particle size because it depends on both the dry mass of sea-salt in a particle and the salinity of the water from which the particle originated. Hence, Lewis and Schwartz recommend that the particle radius at a specified RH (e.g., r_{dry}, r_{80}, or r_{98}) be used as the reference size when defining an RH-dependent sea-salt particle size-correction factor. One of the motivating factors for using D_{p0} as the reference size in Zhang et al. (2005) is that we wish to adjust both open-ocean and surf-zone emissions to ambient RH for incorporation into air quality models. Currently, the only available parameterization of surf-zone emissions is that given by de Leeuw et al. (2000) and it is expressed as a function of D_{p0}. To satisfy our original intention while avoiding the use of D_{p0} as a reference size in air quality models, the surf-zone-flux parameterization of de Leeuw et al. (2000) can be rewritten as

$$\frac{dF_{N\text{-}Surf}}{dr_{80}} = \frac{dF_{N\text{-}Surf}}{dD_{P0}} \frac{dD_{P0}}{dD_{P80}} \frac{dD_{P80}}{dr_{80}} = 2\,\frac{dF_{N\text{-}Surf}}{dD_{P0}} \frac{dD_{P0}}{dD_{P80}}, \quad (1)$$

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where $dF_{N\text{-}Surf}/dD_{p0}$ is given in Eq. (15) of Zhang et al. (2005) and dD_{p0}/dD_{p80} is calculated using Eq. (4) of Lewis and Schwartz (2005).

Following Eq. (4) of Lewis and Schwartz (2005), we produce an expression for C^{80} (the particle diameter at 80% RH divided by the particle diameter at ambient RH, i.e., D_{p80}/D_p) that is *independent of salinity*.

$$C^{80} = \frac{D_{p0}/D_p}{D_{p0}/D_{p80}} = \frac{3.7((1-\mathrm{RH})/(2.0-\mathrm{RH}))^{1/3}(35/S)(\rho_S/\rho_{35})^{1/3}}{3.7((1-0.8)/(2.0-0.8))^{1/3}(35/S)(\rho_S/\rho_{35})^{1/3}} \cong 1.82\left(\frac{1-\mathrm{RH}}{2.0-\mathrm{RH}}\right)^{1/3}. \quad (2)$$

This revised expression for C^{80} can be used to correct the size distribution of sea-salt emissions in open oceans, as described in Eqs. (13) and (14) of Zhang et al. (2005).

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