

differential equation instead of a difference equation was presented by Hoppel *et al.* [2002], but the resulting dry deposition velocities differ little from those given by Eq. 2.7-7; §4.6.3). Because of the complexity of the processes occurring over the oceans, the idealized nature of dry deposition models and their treatment of the marine atmosphere and of dry deposition of SSA particles limit the confidence that can be placed in numerical results obtained from such models (§4.6.5).

The dry deposition velocity v_d is expected to increase with increasing r_{30} over nearly all of the size range comprising SSA particles primarily because of the contribution from gravitational sedimentation. Additionally, v_d is expected to increase with increasing U_{10} because of increased vertical mixing in the surface layer, increased diffusion through the viscous sublayer due to decreased thickness of that layer, and increased impact velocity. Because gravitational sedimentation does not depend on a difference in concentrations, a simple resistance analogy, commonly made for dry deposition of gases, no longer holds [Slinn, 1983a], although a more complex resistance analogy can be used [Seinfeld and Pandis, 1998, p. 961].

The dry deposition velocity given by (2.7-7), if used with the concentration at z_{ref} (typically near 10 m), yields the downward flux of SSA particles at this height. Under steady state conditions, this downward flux is equal to the upward flux of SSA particles at this height. This effective SSA production flux, $f_{eff}(r_{30})$, is the quantity that is desired for atmospheric chemistry considerations and for inputs into large-scale transport and chemistry models, as it comprises only those particles that are expected to remain in the atmosphere for an appreciable length of time. It is assumed that particles that

attain this height remain in the atmosphere long enough to participate in the various processes of interest, while those that do not attain this height are not important in (§2.1.6). However, comparison with other methods for estimating SSA production fluxes that yield the production flux at the surface of the ocean, $f_{im}(r_{30})$, such as that using whitecaps extrapolated to ocean conditions (§2.1.6) involving bubble populations and the number of bubbles (§3.4), requires some method of relating the SSA production flux $f_{eff}(r_{30})$ and the interfacial sedimentation flux $f_{im}(r_{30})$. As noted above, there is no general method for relating these quantities, although several methods have been proposed that are expected to yield results that are reasonably valid (§2.9.4; §4.6.5; §5.1).

2.7.2.3. Mean atmospheric residence time of particles. The mean atmospheric residence time of particles of a given r_{30} with respect to dry deposition is denoted by $\tau_{dry}(r_{30})$, analogous to the quantity τ_{wet} in §2.7.1. The quantity τ_{dry} depends strongly on particle size and on meteorological conditions such as wind speed. Furthermore, it is expected to be inversely proportional to the dry deposition velocity and directly proportional to the height over which the particles are mixed (§2.9.6). At $U_{10} = 10 \text{ m s}^{-1}$ and for a boundary layer height of 0.5 km (§2.4), estimate τ_{dry} for SSA particles with $r_{30} = 1, 5, 15$, and 25 μm on arguments presented in §2.9.6 and on model estimates of sedimentation velocities presented in §4.6.2, are approximately (~ 1.5 wks), $3.3 \cdot 10^4 \text{ s}$ (~ 10 h), $5 \cdot 10^3 \text{ s}$ (~ 1.5 h), and 5 min, respectively (Table 8). Implications of these residence times and their dependence on particle size are discussed in the next section.

Table 8. Characteristic Times and Distances for Removal of Sea Salt Aerosol Particles by Dry Deposition as a Function of Particle Size and Wind Speed $U_{10} = 10 \text{ m s}^{-1}$

$r_{30}/\mu\text{m}^a$	1	2	5	10	15	20
Dry deposition velocity, $v_d/(\text{cm s}^{-1})^b$	0.05	0.25	1.5	3	5	7
Mixing height, H_{mix}/m^c	500	500	500	500	230	60
Dry deposition residence time, τ_{dry}/s^d	$1 \cdot 10^6$ (1.5 wks)	$2 \cdot 10^5$ (2.3 d)	$3.3 \cdot 10^4$ (10 h)	$1.7 \cdot 10^4$ (5 h)	5000 (1.5 h)	850 (15 min)
Transport distance, X/km^e	$1 \cdot 10^4$	2000	330	170	50	8.5

^a Assumed to have equilibrated at 80% RH.

^b From §4.6.2.

^c Taken to be the lesser of the height of the marine boundary layer height (assumed to be 0.5 km) and z_{50} , the height at which the steady state c is 50% of its value at 10 m (§2.9.5).

^d Defined by H_{max}/v_d .

^e Defined by $H_{max} U_{10}/v_e$.

Copyright