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Using the Rouse Concentration Model to Represent Vertical Flux Profiles of Wind Blown Sand

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From studies of suspended sediments in water or dust in air it is recognized that the Rouse profile represents a theoretically sound, first approximation of characteristic concentration gradients. Rouse (1938) combined the influence of grain size and shear velocity changes into a universal equation for concentration gradients. The Rouse number relates sediment size (in the form of settling velocity, w_0) to shear velocity, the von Kármán constant (0.4) and the Schmidt Number, typically assumed to be equal to 1.0 but with much larger values reported. The shape of the Rouse concentration profile is controlled by the Rouse number exponent. We applied the Rouse profile model to 14 vertical flux profiles of wind-blown sand measured during a field experiment in Jericoacoara, Brazil in 2008. These data were supplemented with 96 vertical flux profiles obtained from fourteen wind tunnel and field experiments reported in the literature, for a total of 110 profiles. A fall velocity equation for particles falling in air was derived using a grain size (d) dependency: w_0 (in m/s) = 4.248 (in mm) + 0.174 (r^2=0.88). The Rouse model performs poorly when the value of the β (a form of the Schmidt number in the Rouse number exponent) is assumed to be unity. The values of β were modeled using a relationship derived from a dependency of β on the w_0/u_* ratio: β = *3.277(w_0/u_*) - 0.4133* (r^2=0.65). The Rouse profiles calculated using this approach predict very similar vertical distributions to the observed data and predicted 86% and 81% of the observed transport rate in field and wind tunnel experiments respectively. The analyses show that the performance of the Rouse model is not sensitive to changes in the range of variability we can expect to observe in values of fall velocity, shear velocity and the von Kármán constant but is very sensitive to changes in the values of the Schmidt number. The Rouse approach is more physically meaningful than current approaches that use standard curve fitting functions to represent the vertical flux data but do not provide any explanatory power for the shape or magnitude of the profile.