Geophysical Research Abstracts,
Vol. 10, EGU2008-A-00193, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-00193
EGU General Assembly 2008

Turbulence and Aeolian sand transport

H. – J. Schönfeldt (1)

(1) Institute of Meteorology, University of Leipzig, Germany (schoenfeldt@uni-leipzig.de / Fax: +49 341 9732899 / Phone: +49 341 9732860)

The relationship between wind velocity and sand transport is commonly parameterized by the friction velocity, the threshold friction velocity, air density and grain parameters. Different model equations have been derived in order to capture the parameter dependence. In general, these equations converge asymptotically at high wind speeds, but they relate sand flux and erosion threshold quite differently.

Bagnold (1941) showed that there are two thresholds for saltation: the fluid threshold, which is defined as the speed at which particles start moving due to the forces of wind only, and the impact threshold, which is the speed at which the combined action of wind forces and saltation impacts can just sustain movement, or alternatively, the speed at which the energy received by the average saltating grains becomes equal to that lost (by impact) so that motion is sustained. These two threshold wind speeds differ by 20% and are determined in nature by analysis of gust intervals where the wind speed rises and the saltation begins, and lull intervals with decreasing winds and stopping saltation. Common sand transport equations use only one threshold.

The sediment transport depends on how frequently the wind speed exceeds the fluid threshold and how long the wind speed stays over the impact threshold. Therefore, if one observes the saltation process in nature and describes the sediment transport by only one threshold and without taking turbulence into account, one will receive ambiguous results, because the sand transport rate does not only depend on the mean wind speed, but also on spectral parameters of the wind.

We determine the sand transport using synthetic time series constructed by a first-order autoregressive Markov process. These time series are not only characterized by

the mean wind speed but also by the turbulence parameter c (c = standard deviation of the wind speed related to the mean wind speed) and the autocorrelation r (r = the autocorrelation of the wind with a time-shift of one second). These turbulence parameters are varied and the resulting mean transport is computed. As transport equations we first used the ones derived by Sørensen (2004) in wind-tunnel experiments. This yields a "mean" threshold one can use in a transport equation. It is a function of the turbulence parameter and autocorrelation of the wind. Varying, for instance, the turbulence parameter from 0.1 to 0.2 and keeping the autocorrelation fixed at 0.8, the threshold differed from the value determined originally in a wind tunnel by between one and twelve percent. Rassmussen and Sørenson (1999) found that, when the threshold varies by only 10%, the predicted mass transport can vary by up to 50%.

In our model, the different powers of the friction velocity appearing in any (polynomial) transport equation are substituted by effective terms derived from the wind field statistics. They are parameterized by the following dimensionless parameters: the relative friction velocity V (V = friction velocity / impact threshold friction velocity), the turbulence parameter c, and the autocorrelation r. To that end, both Gaussian and Weibull velocity distributions have been evaluated (numerically).

The friction velocity is no longer a single constant in the transport equation, but the whole spectrum of wind speeds – subsumed in the model parameters V, c and r – contributes to sand transport.

Thus, a transport equation derived from wind tunnel data may be adapted to field measurements via these parameters.