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Earth Surface Dynamics Discussions

Interactive comment on "Predicting the roughness length of turbulent flows over landscapes with multi-scale microtopography" *by* J. D. Pelletier and J. P. Field

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The paper presents an approach for modeling velocity profiles and bed shear stresses for turbulent flows with topographic roughness at multiple scales. The authors used playas as test landscapes for their approach, which are advantageous due to their relative smoothness at scales greater than 1-10 m, as well as the lack of vegetation and mobile sediment. A computational fluid dynamics model is used to calculate the effective roughness length for simulated topography with a single scale of roughness set by the amplitude and slope of the surface. An effective roughness model based on superposition of roughness heights determined from the simulations with a single

roughness scale is broadly consistent with measured roughness heights for the playa landscapes with roughness at multiple scales (i.e., 10ˆ-2 to 10ˆ0 m).

We would be interested in more discussion of the broader applicability of the model results in section 4. Considering that the success of the linear approach is somewhat surprising, we would be especially interested in the authors' views of the conditions under which the linear formulation might be expected to break down, or conversely under what conditions might the linear formulation be extended to more complicated topography. As discussed earlier in the manuscript, the playas have key attributes that differentiate them from many landscapes: they lack both vegetation and mobile sediment, and they are extremely smooth at moderate to large lengthscales (i.e., >= 10 m). The vegetation and mobile sediment would seem likely to enhance nonlinearity in the roughness behavior; in any case, further explanation is needed regarding the known or postulated effects of vegetation and mobile sediment, in eolian or other settings. If one were to repeat the velocity measurements in an evolving or vegetated landscape with microtopography, are there reasons to expect that the linear formulation would be less successful?

The restricted scale of roughness in the playa landscapes also bears further discussion, especially given the motivation in the introduction eventually to predict effective roughness height of natural landscapes for parameterizing global climate models. We would be interested in the authors' views as to if and how the intriguing results for the microtopographic playa landscapes could be extended to parameterizing roughness height over natural topography with roughness on scales up to hundreds of kilometers. One might expect that the longest length scales of the roughness do not affect the available shear stress for moving sediment, which would shrink some of the scale gap between the playas and other landscapes. In any case, we agree that characterizing the effect of multi-scale roughness in a simple, small-scale landscape is an important first step towards predicting behavior at larger scales. We would be interested to read more from the authors about the difficulties their linear formulation is likely to encounter

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in moving to larger scales, and scale ranges.

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