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Bed form dynamics in distorted lightweight scale models

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The adequate prediction of flow and sediment transport over bed forms presents a major obstacle for the solution of sedimentation problems in alluvial channels because bed forms affect hydraulic resistance, sediment transport, and channel morphodynamics. Moreover, bed forms can affect hydraulic habitat for biota, may introduce severe restrictions to navigation, and present a major problem for engineering structures such as water intakes and groynes. The main body of knowledge on the geometry and dynamics of bed forms such as dunes originates from laboratory and field investigations focusing on bed forms in sand bed rivers. Such investigations enable insight into the physics of the transport processes, but do not allow for the long term simulation of morphodynamic development as required to assess, for example, the effects of climate change on river morphology. On the other hand, this can be achieved through studies with distorted lightweight scale models allowing for the modification of the time scale. However, our understanding of how well bed form geometry and dynamics, and hence sediment transport mechanics, are reproduced in such models is limited. Within this contribution we explore this issue using data from investigations carried out at the Federal Waterways and Research Institute in Karlsruhe, Germany in a distorted lightweight scale model of the river Oder. The model had a vertical scale of 1:40 and a horizontal scale of 1:100, the bed material consisted of polystyrene particles, and the resulting dune geometry and dynamics were measured with a high spatial and temporal resolution using photogrammetric methods. Parameters describing both the directly measured and up-scaled dune geometry were determined using the random field approach. These parameters (e.g., standard deviation, skewness, kurtosis) will be compared to prototype observations as well as to results from the literature. Similarly, parameters describing the lightweight bed form dynamics, which were derived from the measured time series, will be critically discussed with regard to available results from bed form dynamics in sand beds reported in the literature. Last but not least, the significance of the presented results with regard to up-scaling and averaging techniques for stochastic processes related to granular processes will be highlighted.