Stratigraphic Feedbacks on Alternate Bar Morphology

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Abstract. As rivers aggrade, they can develop subsurface stratigraphy consisting of heterogeneous grain size distributions in the downstream, cross-stream, and vertical directions. During subsequent periods of degradation, this heterogeneity stored in stratigraphy may be exhumed and potentially feedback on the processes that drive morphodynamic evolution. However, these surface-stratigraphy feedbacks are poorly understood and difficult to predict. Here we investigate these feedbacks by implementing the ability to store, track, and access bed stratigraphy in the 2-dimensional morphodynamic model FaSTMECH. We use a modified active layer approach, in which the active layer is allowed to exchange sediment with bedload as well as the highest stratigraphy layer. In cases of aggradation, fractions of sediment in the active layer and bedload are released to and stored in the highest stratigraphy layer. During degradation, the active layer takes on the sediment properties stored in the stratigraphy. A validation of the stratigraphy model is performed against flume experiments with stratigraphic datasets. We then investigate the effects of stratigraphic feedbacks on the coevolution of surface patchiness and alternate bar morphology. In the case of forced alternate bars, the effects of stratigraphic feedbacks on bed topography and surface sorting are minimal. For freely migrating alternate bars, stratigraphic feedbacks appear to have a significant control on the degree of sediment sorting, as well as the overall bed morphology. We present some possible explanations for these simulation results.