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Interactive comment on "Turning the tide: comparison of tidal flow by periodic sealevel fluctuation and by periodic bed tilting in the Metronome tidal facility" *by* Maarten G. Kleinhans et al.

Maarten G. Kleinhans et al.

m.g.kleinhans@uu.nl

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We thank the reviewer for pointing out where the manuscript requires clarification. Minor suggestions will be followed or taken as an indication for the need of textual improvement.

(Comment 1) Discussing spatially non-uniform flows is an interesting suggestion that we will follow up in resubmission. We think two aspects relevant for morphology require such discussion. The simplest aspect of spatial non-uniformity is that the phase

of the tidal flow varies along natural estuaries but is enforced to be simultaneous in the Metronome. In order for this to have morphological effects, a the velocity gradient resulting from a phase difference would need to be so strong that it has a morphological effect. Some bar theory however proceeds from the assumption of rigid lid, suggesting no importance of phase differences for morphology. Furthermore, bar morphology develops over a great many tidal cycles for which the precise timing of the tide is not important. However, we will analyse phase differences in more detail in the resubmission because the data and model show that, even in the simplest possible conditions of a straight uniform tidal channel, the Metronome shows nonuniformity when the upstream boundary is closed and this requires brief discussion of its potential effects on morphology.

The second, more complicated difference arises at the local scale of parallel channels around bars where phase differences between the horizontal tide and the vertical tide may emerge. In natural systems the tidal wave propagation depends on the channel depth. This leads to time-varying water level differences between parallel channels that drive currents across the bars separating the channels. How this affects bar morphology, dynamics and formation of tie channels and new channel bifurcations is an open question (Swinkels et al.2009). It is known from braided rivers that water level differences are caused by backwater effects due to non-uniform depth along channels have significant effects on the braiding processes (Schuurman & Kleinhans 2015), so the expectation is that additional water level differences between tidal channels will also have significant effects on morphology. So the question is whether such tidal phase differences can arise in the Metronome given the uniformly prescribed tidal phase. One of us conducted measurements on water level and flow velocity around self-formed tidal bars in the Metronome and processing will determine how this works and compare to full-scale flows in numerical modelling to unravel effects of such phase differences. We will pay attention to this issue in future submissions on experiments with freely developing morphology, that is outside the scope of the present paper.

(Comment 2) The purpose of the comparison between the measurements and the modelling is not clear according to the reviewer, because no natural conditions are modelled, suggesting that the measurements serve to validate the modelling. This gave us the idea to use the model in the resubmission to investigate at what length scales tilting or Reynolds-type experiments begin to give realistic results and we intend to apply the model at a range of scales from a mini-metronome to the full scale of natural systems in the resubmission. At what scales tilting or Reynolds-type experiments produce periodic flows that are sufficiently similar to tidal currents in nature for the purpose of landscape experiments is still an open question. In the manuscript we targeted this question by direct flow measurement, allowing comparison to well-known properties of tidal flow, and by modelling, allowing identification of the most important terms in the physics describing tidal flow. The fact that the model is the same as often used to simulate full-scale tidal flows indicates that the relevant physical mechanisms are the same as in natural tides.

The reviewer suggests that we should have used the model for strongly non-uniform flow conditions to compare against the flows in the periodic tilting flume. We do not understand what the reviewer means by strongly non-uniform other than having bars and bends, which is beyond the scope of this paper. However, we agree that comparison between conventionally driven tidal flow is needed. We need to stress more in the manuscript that this is exactly what we did by numerical modelling of the Reynolds setup at the scale of the flume. We will also apply the model at the natural scale and analyse water level and velocity amplitudes, phase differences and sediment mobility.

(Comment 3) The indicated sentences with interpretation were originally placed in the results section for reasons of readability. We will move them to the discussion in the next manuscript version. (minor comment 1) We will add the definition of Q. Before submission we debated whether advection is indeed necessary in equation 2 and came to the conclusion that it is not, for the question at hand. For example, the advection term is about an order of magnitude smaller than the advection term. We will analyse

and discuss this in the resubmission.

(minor comment 2) We thank the reviewer for identifying this omission. The phase of the modelled water levels is indeed rather different from the observed water levels, but the magnitude is the same as measured except near the transition from the sea to the tidal channel. The reason is that the 1D model cannot reproduce a 2D phenomenon, namely the extreme and sudden convergence from the sea into the channel. In these sand-bed experiments the morphology is more realistic in the sense of roughness and channel dimensions, but less realistic in the sense of this artificial transition that arises because we chose to do the simplest idealised scenario rather than a more realistic convergent shape that is more difficult to interpret. This, in hindcast, led to qualitatively similar but quantitatively different model results.

References:

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