Earth Surface Dynamics Discussions

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Comment on esurf-2021-60

Anonymous Referee #2

Referee comment on "Linear stability analysis of plane beds under flows with suspended load" by Koji Ohata et al., Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2021-60-RC2, 2021

General comments

The manuscript deals with a linear stability analysis of flow over an erodible bed with suspended load. The topic of dune-antidune formation has been deeply investigated in the past in terms of linear stability analysis, but the effect of suspended load has been neglected in recent theories, which assume bedload only. The inclusion of suspension represents therefore an interesting development. I have no major concerns on the way the problem is formulated and the linear analysis performed, except for the way suspended and bed loads are arbitrarily turned on and off using the binary alpha coefficients, which I will discuss in the following section. The choice of the governing parameters is unfortunate, with an unnecessary and awful mix of dimensional and non dimensional quantities which makes the analysis of the results quite cumbersome. Finally the discussion is too concise and leaves many points unaddressed. This is true for the conclusions as well.

My main concern on this manuscript is about the choice of focussing on the upper plane bed regime rather than discussing in depth the effect of suspension on the formation of dunes and antidunes, the former being a byproduct of the latter. Moreover, results are poorly presented and it is difficult to draw any conclusion except for some very general statements about the broadening of the stable region. My suggestion is therefore to reject the manuscript. I would favor a resubmission, though, which however should involve a great deal of revision of the present manuscript, in particular in the way results are obtained, presented and discussed.

Specific comments

1) The analysis is based on the perturbation of a uniform flow on an erodible bed with active sediment transport. Stability plots like the one presented in Figure 1 (those in figure 2 and 3 follow as a direct consequence) are obtained by varying the wavenumber of the mode AND the Froude number of the basic state. The Shields stress increases with Fr, and so I would expect the suspended load to be negligible at low Fr (where there is bedload only) and to become increasingly important as Fr increases (and dominant over bedload for very large Fr). It is not clear if this behaviour is correctly represented in the model, where the alpha_s coefficient is abruptly set to 1 as the the threshold for suspension (69) is exceeded. The latter condition, which implies a specific value Shields stress (and Fr) for the basic flow, should also correspond to a negligible amount of suspension with respect to bedload. Is that so?

2) In the search for the growth rate, the use of a spectral collocation method does not seem to be able to provide the required resolution: isolines in Figures 2 and 3 are quite wiggly, in particular close to the thresholds for transport and suspension. Perhaps more collocation points are needed?

3) The choice of the parameters is really unfortunate and provides an awkward mix of dimensional and nondimensional quantities. Indeed, (101) provides the parameters of the problem, so figures 2 and 3 can be more meaningfully represented in the Fr-Cz space for different values of Rp. Moreover, plots of the wavenumber of maximum amplification are confusing: is the wavenumber plotted that of a dune or of an antidune? Plot the growth rate of maximum amplification instead. Section 2.2 should be rewritten accordingly.

4) Since the work of Engelund it is well known that the role of suspension should be to inhibit the formation of dunes and to enhance that of antidunes. This is the picture I would like to see emerge from the linear analysis. Apart from a generic broadening of the upper plane region, which is compatible with the above framework, this picture does not surface clearly from the analysis of Figures 2 and 3.

5) In the stability plots with suspension some inconsistencies or, at least, some strange behaviours, appear. More precisely, in 2b and for relatively deep flows, the bed becomes plane as soon as the threshold for suspension is reached, even though the amount of suspension should be negligible there. The same happens in 2c, but not for the deepest flows. In 3b the modifications with respect to the bedload only case (3a) are inexplicable and unexplained.

6) The appearance of a sheet flow regime has been invoked in the past as the mechanism controlling the transition between dunes, plane bed and antidunes. Although this may be more a consequence than a cause, the bedload model adopted does not handle sheet flow transport mode. I would rather drop the starred experimental observations from Figure 3 than attempt to fit them in the picture.

Technical corrections

23) Therefore ... must be considered - Therefore, the influence of suspended load on the formation of dunes and antidunes is worth investigating.

33) Therefore ... we performed linear stability analyses - we performed a linear stability analysis

62) The section starts with the same sentence than 41. Please rephrase.

224) amplification -> amplitude

333) wider -> larger, broader

368) reasonably?

371) Ultimately, our linear analysis provides a possible explanation ...

376) We -> we

380) I would drop the whole section: the discussion about sheet flows is totally speculative, since the model adopted does not consider bed
load moving as sheet flow.