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Nonlinear Processes in Geophysics
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Discussions

Interactive comment on "Large eddy simulation of sediment transport over rippled beds" *by* J. C. Harris and S. T. Grilli

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Thank you for your comments. Modifications have been made to the text to reflect the suggestions.

Section 3.1: In part the inclusion of buoyancy was due to the simplicity in this additional term. Other fluid-sediment interactions are much more complex mathematically, and as you mention, seemingly negligible for much of the domain.

Section 3.2: For the ADV, acoustic reflections may indeed be a problem near the bed. This possibility has been included in the text.

Section 3.3: There are two reasons for choosing the lateral boundary conditions – the width of the domain matches that of the physical experiments, and while numerically

no-slip walls for such a domain would not replicate the effect physically produced by a wall, presumably, as in the laboratory experiments, the specifics of the wall boundary layers should not be important on the resulting flow given the dimensions of the experiment. For a large-eddy simulation, unlike other techniques of modeling turbulent flows, it is necessary to resolve some aspects of the 3D turbulence field, and it was found that the use of no-slip walls stimulated turbulence production effectively.

Section 3.4: The extra eddy viscosity is also related to the large-eddy simulation approach – it is a known difficulty with LES to obtain a reasonable eddy viscosity near a surface, and many approaches have been developed to handle this. In the current approach, the vertical resolution is refined close to the surface, but this results in computational cells with a large aspect ratio, which do not resolve the smallest eddies. The added viscosity is one of the simplest forms possible to predict the eddy viscosity as a result of the current flow, and has been used before in Harris and Grilli (2012) with good success when compared with more detailed turbulence measurements (albeit in a simpler domain). Of course this could be a source of error, but proper modeling of this type of boundary layer can be quite difficult, and it is an approach used by others in recent years, such as Chow and Street (2004), so it was viewed as sufficient for now. Additional description has been added to the text.

Section 4.5, 4.6: An estimate of potential errors due to missing ADV or other measurement difficulties can be made by considering the difference for the ripple-averaged total net suspended transport rate given for case Mr5b63 by van der Werf et al. (2007), in the original experiments, of -8.2 mm^2/s, versus van der Werf et al. (2008), in the re-analysis and modeling, of -11.9x10^{-6} mm^2/s, when integration of the suspended sediment flux measurements included the data closest to the seabed. While of course there could be additional errors, they are likely smaller than this difference.

Section 4.7: It is certainly possible that other equations for the seabed boundary conditions could result in improved predictions of sediment transport. While sometimes a steady state formulation can be used in an instantaneous sense if the boundary responds very quickly to changes in the flow, the reference concentration approach was developed assuming a balance between settling and sediment pickup, which would not be strictly true in this case. Practically, though, the differences in results given by a pickup function or a time-varying reference calculation may not be very large, as discussed by Davies et al. (A.G. Davies, J.S. Ribberink, A. Temperville, and J.A. Zyserman. 1997. Comparisons between sediment transport models and observations made in wave and current flows above plane beds. Coastal Engineering. 31: 163-198). We found that early attempts at using a pickup function gave numerical problems, whereas the earlier reference concentration approach, which had been used by Gilbert et al. (2007), was much more robust. Certainly the switch to a pickup function is worthwhile for future work.

Finally, the technical corrections mentioned are much appreciated.

Interactive comment on Nonlin. Processes Geophys. Discuss., 1, 755, 2014.