Effect of self-stratification on sediment diffusivity in channel flows and boundary-layers: a study using Direct Numerical Simulations

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Earth Surface Dynamics - Discussions

March 3, 2014

General comments

The paper reports a very interesting numerical analysis of the effect of self-stratification on sediment diffusivity. The result that self-stratification reduces the sediment diffusivity agrees qualitatively with experimental data.

The authors may want to consider the following comments:

1. The results show that the sediment diffusivity differs considerably from the Rouse profile. It would be interesting to quantify the relevance of these results; i.e. what is the difference in sediment concentration profiles based on the Rouse profile and the improved profiles of the sediment diffusivity ?
2. Is the following interpretation correct: because of the reduced turbulence activity with increasing self-stratification, more energy is available for the mean flow, which explains the increase in mean flow velocity ? What is the physical process that causes the increase in turbulence activity in the upper part of the channel ?
3. The effects of self-stratification seem to be much less important in the boundary layer flow (Figure 8) than in the channel flow (Figure 4). How can this be explained ?
4. The authors may want to consult experimental data and analysis of the sediment diffusivity by Cellino Massimo.

Specific comments

P926 L19-20 and Figure 1: What is the accuracy in the estimation of Kz/Hu*? The uncertainty in shear velocity estimations is known to be rather large, and the important near-bed gradients in concentration may also generate considerable uncertainty.

P927 L8: The sentence “this issue stems from the break down of Prandtl’s analogy, due to the inertial effects….” is somewhat confusing. The result in this paper are obtained by neglecting inertial effects (P928 L12), and suggest that stratification effects are the main reason for the deviations between the Rousian profile and experimental data. The statement in the text may be redrafted.

P929, equation (6): It may be useful to explain why diffusive terms appear in a DNS.

P931: It would be useful to provide the grid size in terms of wall units.

P934 L25: This sentence is confusing. The DNS results for the channel case show an increase in velocity over the entire water column, which is different from the observed behaviour shown in Figure 7.

P935-936 – Figure 8: Are the differences between the different profiles larger than the uncertainty in the estimation of the diffusivity from the experimental data ? And does the interpretation on P936 accounts for this experimental uncertainty ?

P936 L20 and Figure 1: It is a strange choice to introduce the topic by means of Figure 1, which shows a trend that is opposite (increase of diffusivity with V) to the subsequent results of the paper.

Technical corrections

P924 L12: replace “were” by “are”: present tense is used elsewhere in the abstract

P927 L9: drop “was”

P927 L15: drop “of sediment”