Response to reviewer

September 26, 2025

We would like first to thank Dano Roelvink for his careful reading and constructive criticism. The suggested modifications have been decisive help to revise and improve our manuscript. Specific comments are addressed one by one hereafter. The comments are recalled below in bold, while text extractions from the revised paper are in italic font.

1 Major Comments

1. **In the introduction, the authors refer to some, but only very limited, research on coral reefs, which have similarly high roughness; e.g. in van Dongeren et al., (2013), where the roughness, with similar values, was found to dominate the energy balance. But similarly, much work has been done on the effects of vegetation, which has similar effects as high roughness; van Rooijen et al (2013) for instance elucidate the mechanism through which vegetation can lead to lowering of the setup, namely through streaming and skewness of the waves, which leads to an onshore force on the vegetation (and similarly on the rocky bottom in this case). In the discussion of the resulting empirical relationship I miss this kind of analysis**

Additional elements, including physical interpretation and associated bibliographical references, have been added in the Introduction section (see last part of the second paragraph) and in the Discussion section (first paragraph).

2. **The authors refer to Feddersen et al. (2000) for the mean longshore shear stress due to current and waves, but only very briefly. The cited work contains an in-depth analysis of possible approximations of the resulting mean shear stress, and based on their data select and fit one. I can see that the cross-shore mean shear stress is more complicated because of the effects of skewness but one could at least try better to explain the relationships that are found.**

Thank you for pointing this out. The physical interpretation of the time-averaged shear stress is quite challenging for the cross-shore setting considered in this study, and deserves further discussion. When considering the alongshore bottom stress parameterizations as discussed by Feddersen et al. (2000) and former pioneering studies (e.g. Longuet-Higgins, 1970, Thornton and Guza, 1986), the wave direction has no net impact onto the direction of the mean alongshore stress that is conformal with the mean alongshore current. The magnitude of the mean alongshore bottom stress is further shown to depend on both the mean alongshore current and the full statistics of orbital motion, and can be reasonably well approach by an empirical form following Wright and Thompson (1983) as shown by Feddersen et al. (2000) (see their Fig. 8). For the cross-shore component of the mean bottom stress, the wave direction is closely aligned with the mean cross-shore current, as a result, the direction (i.e. the sign) of the mean bottom stress can change depending on vector composition. The resulting stress depends on the mean cross-shore current and the statistics of the orbital motion in a complex non-linear fashion. The wave skewness should a crucial role, and we take advantage of the reviewer comment to propose an informational formal analysis of the bed shear stress term following Feddersen et al. (2000) (see the new Appendix A).

3. **To support the claim that the relationship(s) for the cross-shore bed shear stress can be used in circulation models, we would have to know how in a general 2DH setting the cross-shore and longshore shear stresses should be computed, somehow combining these relationships with Feddersen's model (?)**

and

4. **Perhaps the parametric relationships by Soulsby et al. could be useful in this context, as they give relationships for taum/(tauc+tauw) as a function of tauc/(tauc+tauw), where taum is the mean shear stress, tauc the current-related and tauw the wave-related shear stress. The parametric relations are fitted to various wave-current interaction models, for arbitrary magnitudes and angles between current and waves. But maybe the authors have a better idea how to approach my point 3.**

Both comments are addressed hereafter. The present study provides insights on the particular case of waves propagating against the mean flow, as observed in the cross-shore direction of a closed, beach-like, system when an undertow starts to develop, and is further complemented with idealized numerical simulations of both open and closed systems. Neither the dataset nor the numerical simulations allow to investigate the contribution to the momentum balance nor the form of the alongshore component of the bottom stress. As such, in its current form, the empirical parameterization proposed should be restricted to the cross-shore component of the bottom stress. As the mean alongshore bottom stress can be reasonably well approached by an empirical form following Wright and Thompson (1983) as shown by Feddersen et al. (2000), a combination of both parameterizations could be presumably employed in a general 2DH setting. Classically used, the parametric relationships by Soulsby (1995) present the practical advantage of providing a similar form for both components of the wave enhanced bottom shear stress. For complementary insight, two subplots have been added in the Figure 4 of the revised paper (reproduced below) to display the ratio between the full and wave-averaged velocity based stress (τ_f/τ_{avg}) with respect to the ratio between the wave-shear stress (τ_w) and the magnitude of the wave-averaged stress ($\tau_w/|\tau_{avg}|$), comparing observations and predictions from Soulsby's model. The Soulsby's parameterization gives an amplification of the mean bottom stress between 1.4 and 2.2 for the range of conditions considered in this study, which is consistent with the observations for weak relative contribution of the waves, i.e. the lowest $\frac{\tau_w}{|\tau_{avg}|}$ values. However, by definition, the Soulsby's parameterization cannot capture the sign reversal of the wave contribution in the bottom drag as the wave stress increases, which yields wrong estimates of the mean (wave-enhanced) bottom stress for $\tau_w/\tau_{avg} > 10$.

The relative performance of Soulsby's parameterization is presented in Section 3.1.3 of the revised version of the paper, while the practical relevance of the proposed parameterization is discussed in Section 4 (second paragraph).

2 Minor comments

1. **l. 190 depend $\longrightarrow$ depending**

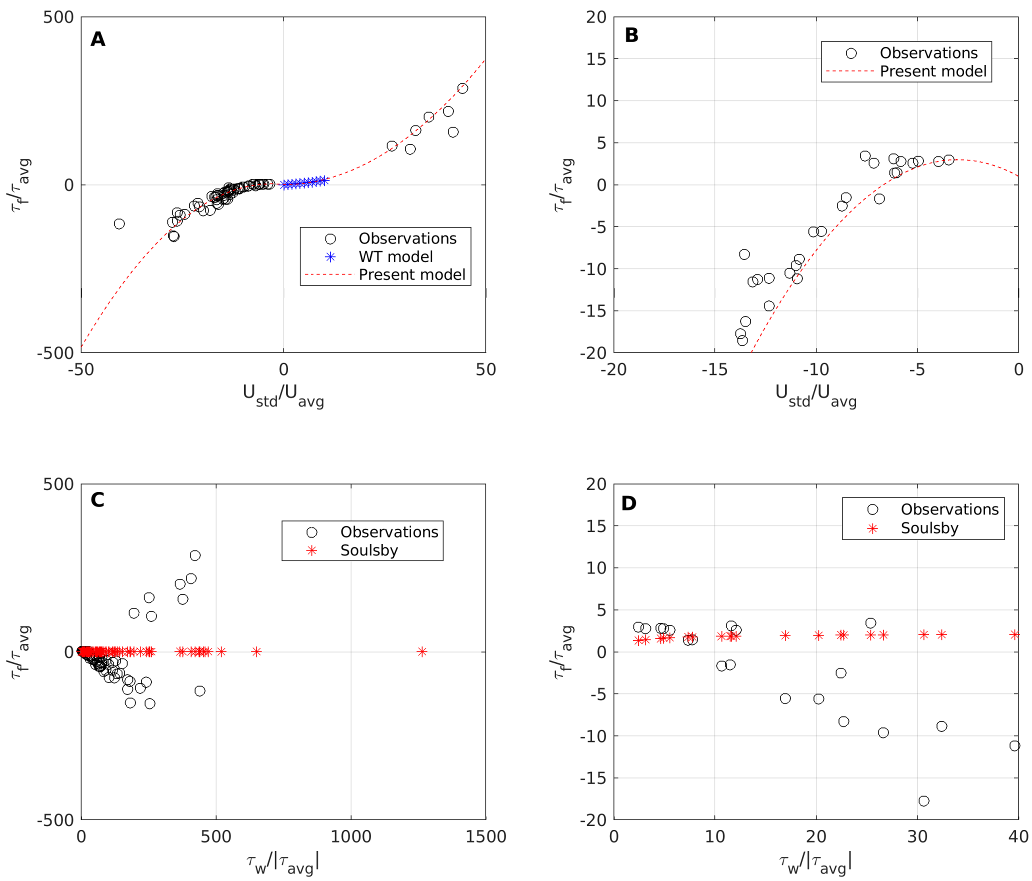

Figure 1: A and B (zoom of A): ratio between full shear stress based on instantaneous velocity (including wave motion) and wave-averaged shear stress. Present data are in black circle, the Wright and Thompson (1983) model in blue crosses and the proposed parameterization from Equation **??** in red line. C and D (zoom of C): comparison between the observed ratio of full vs wave-averaged shear stress vs the ratio wave-shear stress over wave-averaged shear stress and the predictions from the Soulsby's model (Soulsby, 1995).

Done

2. **l. 277 For Chezy, drag coefficient does not depend on depth ($C_d = g/C^2$)**

Right, Chezy has been removed from the list.