Nonlin. Processes Geophys. Discuss., author comment AC2
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Reply on RC2

Marek Stastna et al.

Author comment on "The effect of strong shear on internal solitary-like waves" by Marek Stastna et al., Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2021-16-AC2, 2021

We thank the reviewer for their helpful and constructive comments. Below the reviewer comments are given with our reply.

In this paper numerical experiments are used to investigate the effect of background shear on internal solitary waves (ISWs). Cases of wave propagation both with and against a background shear current (travelling from left to right) are considered by using a numerical domain in which a stratified adjustment problem in the centre of the domain generates both leftward (against shear) and rightward (with shear) wave propagation. The waves are classified with respect to classical DJL theory. The paper shows that ISWs generated by stratified adjustment in the presence of background shear are not necessarily free waves and can differ markedly from DJL solutions. In particular they can have a propagation speed close to the maximum value of the background current and can exhibit strong recirculating cores.

The paper raises and asks important questions on how classical theory and simulations may be linked to the field; it highlights the need for more investigation in this area. The work is original, clearly presented and of significant interest to communities including physical oceanographers and fluid modellers. As such I have no hesitation in highly recommending this paper for publication in NPG subject to the minor comments/revisions given below.

line 60 typo and and

Reply: we have fixed the typo

A figure/graphic showing the initialisation of the numerical simulations would aid the reader. I didn’t fully understand the stratification adjustment until I saw fig 3(a).

Reply: a new figure of the initialisation has been added

fig 2 and fig 3 - these are really interesting results. Can the authors give a physical explanation why the leftward propagating waves (those going against the shear) are steeper, shorter and have larger amplitude than the right ward ?

Reply: this was identified as a point needing clarification by both reviewers and hence has had a discussion added at several point. Links to the KdV theory have been made, via the dependence of the nonlinearity and dispersion coefficients when the background current changes.

fig 4 (a) The N^2 plot is interesting but doesn't show anything that can't be discerned from 4(b) and as such I wonder if illustrating density (like fig 3) would be more appropriate ?

Reply: after some thought we agree with the reviewer, and have chosen to show the Ri field for two different times. This allowed us to expand the discussion of the types of instability observed in a new paragraph. Much appreciated!

fig 6. The authors say these waves look more like Stokes waves than typical solitary waves - can they give more justification or an appropriate reference. Could a comparison be drawn to cnoidal waves ?

Reply: we have added a reference for cnoidal waves (there are others, but this one seemed the clearest). It is somewhat subjective whether a reader sees the resemblance to cnoidal waves or Stokes waves (turned upside down). The latter is perhaps more generally known, so we have kept the term, adding cnoidal waves as well and focusing the reference on the latter, more thoroughly documented case.

fig 7. This is fascinating - what causes the instability in the top layer ? The waves are out running the manifestation of the instability so if the waves are not the cause (or continual cause) what is ? Is the rigid lid in the simulations important ?

Reply: This has been commented on using the new version of the Ri figure (see response above). There are three instability types, two of which are visible in this figure. One is a stratified shear instability triggered by the finite amplitude perturbations due to the developing wave train (i.e. the ISW-like waves take time to sort from the perturbations, so there is enough energy to trigger a very busy field of instabilities), the other is the vortex cores of the emerging ISW-like waves.

fig 9 caption (c) is not detailed

Reply: this has been fixed in the revised manuscript

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Reply: the typo has been fixed