Nonlinear Processes in Geophysics Discussions

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Comment on npg-2021-29

Anonymous Referee #1

Referee comment on "Observations of shoaling internal wave transformation over a gentle slope in the South China Sea" by Steven R. Ramp et al., Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2021-29-RC1, 2021

The manuscript by Ramp et al.: "Observations of Shoaling Internal Wave Transformation Over a Gentle Slope in the South China Sea" describes an interesting set of mooring measurements from the South China Sea. The study region is subject to the regular passage of large-amplitude nonlinear internal waves (NLIWs) and wave packets. Fascinatingly, the sea-bed in the region is characterized by enormous underwater “sand dunes.” The relationship between these bed-forms, the observed NLIWs, and the attendant impact on shallow water acoustics motivated the field observations reported here. This manuscript focuses on the NLIWs observed from the mooring array, which covers a region of the seafloor spanning 388 m to 266 m depths. The waves and wave packets are described as they move through the mooring array, allowing the authors to draw some conclusions regarding the shoaling behavior that occurs over the variable depth of the mooring array.

These observations are from a very interesting region. The nonlinear internal waves spawned by the interaction of the barotropic tide and the dual ridge system in the Luzon Strait are among the most energetic found anywhere in the world. The authors have contributed to the current understanding of these waves in the South China Sea. The mooring measurements provide an opportunity to observe the NLIWs far from their generation region, in a depth where transformations begin to occur that ultimately lead to the dissipation of the impinging waves, and finally where the waves are impacting the sediment distribution and bed-form in a major way. Thus these observations should be published. However, in its current form, I don’t think this paper adds as much as it could state of knowledge in the field. I believe it would be improved by a major revision to recast the interpretation of the observations.

MAJOR COMMENTS:

I am outside of the community that has sprung up in the past few decades studying the internal waves of the South China Sea. While I am generally familiar with the regional oceanography, I was not familiar with the phenomenology of the NLIWs found in the central South China Sea. This phenomenology is categorized as the NLIWs falling into two bins: A-waves and B-waves. Notwithstanding the title of the manuscript, much attention is spent "categorizing" the observed NLIWs into these two classes. This does little for a reader that is outside of the South China Sea internal wave community. In fact, I really had a hard time even generally agreeing with the categorization that the authors advance… many alleged B-waves seemed to me to have trailing waves much like the author-provided description for A-waves. Much is likewise made of another occurrence of "split" A-waves, which is, I think, counter to the definition of the A-waves as rank order packets provided by the authors. I don't doubt that the authors are far more experienced categorizing South China Sea waves than I am. I just am not sure why it is necessary here. The justification seems to be that the pattern of arrival of the A- and B-waves hints at the formation process for the waves, specifically at which beat of the tide that waves are formed. This conclusion, unhappily, is left to twist in the wind when the authors state that they are unable to conclusively prove that their generation hypothesis is correct with the observations that they have.

About 50% or more into that analysis sections of the manuscript, the authors turn to the question of transformation of the NLIWs across the mooring array. I will note that the title of the paper is "Observations of Shoaling Internal Wave Transformation Over a Gentle Slope in the South China Sea." The analysis of "transformation" relies on a descriptions of individual waves whose form appears to change between the moorings. The only quantitative analysis brought to bear is the attempt to estimate the terms in the energy flux budget from the mooring observations (ignoring the nonlinear terms). I found that the descriptive, individual wave based approach was again hard to follow for someone like me who hasn't looked at these waves from observations for a couple of decades. I agree with most of the conclusions of the authors draw from the energy budget, but I don't think that the analysis really advances the state-of-the-art when it comes to NLIW transformation.

In the end, I am left somewhat confused about what this manuscript is actually about. Is it about the generation of A- and B-waves? If not, why is that analysis included here? If it

is about transformation, I'd like to see that come front and center more. I also think that the transformation analysis could be expanded. There are several papers that have made attempts at this in the recent past. Otherwise, this manuscript is a better fit for a regional journal publishing papers about the South China Sea.

Finally I am pretty surprised that the near-bottom currents, and their possible impact on sand dune formation, are not a focus of this paper. The authors mention that the analysis of the sand dunes will be presented in a future manuscript. I wonder at that. I am not sure that splitting the present manuscript from that effort is necessary. I don't know what is really new about the findings in this manuscript that necesitate it being split off from an effort to describe/quantify the obviously interesting seabed/NLIW interaction, outside of the regional interest mentioned earlier.

FIGURES:

Fig. 1: No colorbar for the bathymetry. Latitude and longitude should include indication of N/S and E/W.

Table 1: This is not necessary in the main manuscript, perhap include in an appendix?

Fig. 2: Blue text is very difficult to read. Red/pink line is not explained in the caption.

Fig. 3: I am not sure about this figure. First of all, I would have much preferred to be looking at estimated NLIW displacement, rather than temperature. Displacement would be calculated from the temperature change in time via an estimate of the vertical gradient in temperature from the mooring. I am perfectly unable to tell the difference between A and B waves in this picture. I agree that the figure shows the general correspondence of the tidal beat in Luzon and the rapid increases in temperature, but this figure doesn't help much in terms of understanding A and B waves.

Fig. 4: I am not an expert, but I can say that I would have a very difficult time telling A and B waves apart based on this figure. Many of the A waves (A3, A4, A8, A9) look like individual waves or wave pairs, while B waves often appear to have dispersive tails. The appearance of "prime" waves is also confusing. I don't know how to improve this. I can say that I defer to the authors on the wave identification, but cannot myself judge what these waves should or should not be characterized as.

Fig. 5: Again, I prefer NLIW displacement to temperature, since the magnitude of the temperature change depends on both the NLIW amplitude and the structure of the vertical temperature gradient. I am not sure I follow what is in the circles, and why they would be called "b-waves." Wave packets can be formed in deep water from nonlinear steepening that is unrelated to water depth, and they can be formed via dispersion during interaction in the bottom. While both a wave-packets, I don't know why they would be both called B-waves here. Based on the authors definitions, B-waves are wave packets that have formed independent of bottom interaction.

Fig 6: this I believe shows that individual waves can be tracked across the array? Why not show displacement?

Fig. 7: ditto

Fig 8: Here, finally, is amplitude. How this is calculated should be explained more fully. Why is this a bar graph? What is the uncertainty in this estimate? Are we supposed to be comparing amplitudes across the moorings here? If so, what are the patterns we are supposed to see?

Fig. 9: This image is very hard to read. Can the image contrast be enhanced to more clearly show the wave packets?

Fig 10: Pet peeve: this color scale is misleading since the 0 velocities are yellow/green, Suggest a colormap with white at 0. Also, why aren't the velocities rotated into the direction of wave propagation? I don't know what I am supposed to get out of this figure and figure 11.

Fig 11: Ditto. I'll also note the beautiful pulse of NLIW velocities near the sea floor, why aren't these investigated in detail?

Fig 12: I like this colormap much better and would suggest it for all velocity figures.

Fig 13 and Fig 14.: these are cool observations, but somehow the B wave is rank-ordered, while the A wave is more solitary-looking. I get that the authors are invoking local processes here, but how is a reader supposed to interpret these plots as clear resulting from local processes. Wouldn't the approach

Fig 15 Is tough to read. I'll note that Fig. 14, 15, and 16 are the only figures that I can see that are related to the analysis of "wave transformation," the title of the manuscript.