February 3, 2022

Response to reviewers: "Observations of Shoaling Internal Wave Transformation Over a Gentle Slope in the South China Sea" By S. R. Ramp et al.

The authors are grateful to Peter and the other anonymous reviewer for their helpful and constructive comments that have improved the manuscript. I will begin by addressing their major points while deferring changes to the figures to the end.

<u>Reviewer #2 (Peter Diamessis)</u>

1. Overlooked references: Thanks for pointing these out. As noted in a previous communication, this paper sat around for a while before submission. Sorry about that. I have added references to these and in fact several other recent publications to update the manuscript. With regard to Chang et al., [2021] on marginal instability, there is another paper on the same data set, here referenced as Chang et al., [2021b] that is more useful to reference. Since these sand dunes waves aren't breaking, marginal instability isn't so interesting as other aspects. Since NPG will graciously allow references to papers in revision, I have also added references to Ramp et al., [2022] which is the same data set as Chang et al., [2021b] (co-authors on both papers). I can provide a preprint of this if you like. The R-R [2020] is an excellent paper, but again, it is more concerned with breaking and trapped cores, which are of no concern in the sand dunes data set. I nevertheless found a few useful ways to reference it. Chang et al., [2021] (long term-observations) again has a lot on breaking but also some nice material on the basics, fortnightly cycles, seasonal cycles, etc. which has now been referenced.

2. The a- vs. b-waves. I have tried to shorten and clean this up a bit, specifically as it applies to shoaling and transformation, rather than generation, which isn't so much the point of this paper. Seven years and two more field programs later, we no longer believe (or at least I don't) in the a-wave on ebb, b-wave on flood generation scenario, so this has been expunged from the manuscript! The various possible generation mechanisms do not need to be discussed in the paper.

3. The primary reason the waves are not breaking is that they are 50% smaller than the waves shoaling to the southwest. This is now more obvious in the new Figure 3, which can be directly compared to a similar figure in Ramp et al., [2022] from off Dongsha Atoll.

4. Breaking criteria: As I re-read R-R 2020 and V&H 2002 I realized that their criteria, which includes the bottom slope, is only applicable for steeper slopes than the mean slope in the sand dunes area (which is very slight). I have fallen back to earlier, simpler expressions which produce much more reasonable numbers for the breaking wave criteria. The result is unchanged: the observed amplitudes were too small to break.

5. We did not get into background shear/density since I think it is secondary to the bottom depth, thermocline depth, and wave amplitude. And the waves weren't breaking anyway.

Reviewer #1 (anonymous)

1. Focus: Our intent is definitely to focus more on transformation than generation. I agree the first part on arrival patterns was too long and laborious and have shortened it in the revision. I also explained how the waves labeled in Figure 3 were identified using additional information. I've added some words as to why a- vs. b-type waves matters. The all-new Figure 3 is much clearer. I deleted Figure 4a because one of these types of figures is sufficient.

2. Energy budget: Theory is great, and very sophisticated these days, but there is still no substitute for field observations that confirm or conflict with published theoretical ideas. I think that the energy and energy flux changes as the waves progressed upslope agreed well with the theoretical expectation is both encouraging and useful.

3. Near-bottom currents. Unfortunately, the reason there is not more about this is that the near-bottom currents were not well observed. Prior to this experiment, we didn't know whether the large dunes were moving or stationary. The instruments were intentionally arrayed such that they would not be buried and lost by migrating dunes. This precluded placing instruments in the bottom boundary layer. Now that we know the dunes are essentially stationary (migrating a few tens of centimeters per year) we could go back and put more instruments on the bottom. Funding for this exercise remains to be seen. We also attempted to measure the bottom currents with lowered instrumentation, but there was just no way to keep the package near the bottom. The drag on the wire due to wave-induced currents lifted the package about 150 m off the bottom when a wave went by, no matter how much weight we hung on it.

Changes to Figures

Table 1: I am fine with this being an appendix, if the editors concur.

Figure 1: This figure is all new, including the color bar. It's a big improvement over the original.

Figure 2: The pink line is just the base line used to compute wave propagation direction. This is now stated in the figure caption.

Figure 3: An all-new figure. Per the reviewer's suggestion it now shows displacement rather than temperature fluctuations. The new labeling technique makes the waves clearer.

Figure 4: We eliminated one of these to shorten the paper/discussion. We think one of these suffices. Maybe it is just experience, but I am certain beyond a shadow of a doubt that the waves are labeled correctly.

Figures 5-7: I'm sticking to my guns on this one. To me (and the sponsor) the temperature fluctuations/gradients are more interesting and instructive than the displacements. It also shows where the waves are in relation to the internal tides.

Figure 8: I like the bar graph! I changed the description in the text a bit though. Small waves (less than 50 m) advanced unchanged or continue to grow. Large waves max out at YPO1, then decrease slightly to CPO, then decrease a lot to RPO.

Figure 9: I adjusted the image brightness and contrast in photoshop and displaced the yellow lines a bit more so they do not mask the wave fronts. I think it's better.

Figure 10 and 11: I quite agree with the reviewer and the velocity color maps have been changed to red/blue to match Figures 12-14.

Figures 12-14: It's hard to choose which ones to show! Some of the packet structure is out of view to the right in Figures 12-13, at the expense of showing the details of the velocity structure. I'd call the wave packet in Figure 14 evenly spaced, rather than rank ordered. Clearly though, the b-wave behaved differently from the a-waves.

Figure 15. The figure is a little dense, but I've played around with it a bit and have not come up with anything better. With a little patience you can make it out. I also improved the words in the text describing the figure.

Figure 16. Is unchanged.