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Reply on RC2

Gwendal Marechal and Charly de Marez

Author comment on "Variability of surface gravity wave field over a realistic cyclonic eddy" by Gwendal Marechal and Charly de Marez, Ocean Sci. Discuss., https://doi.org/10.5194/os-2021-53-AC2, 2021

Dear Dr. Romero,

We really would like to thank you for your very helpful remarks and accurate corrections. All the typos have been corrected and complements have been added for points that missed accuracy. You will see that the parametrization of the wave model has been changed, so results as well. Also a quick remark on nonlinear wave-wave interactions on wave parameter gradients has been performed at the end of the manuscript (proposed by Referee #3).

The paper describes a numerical study of the modulation of the wave field by currents at meso- and submesoscales. The analysis focuses on narrow spectra without the influence of winds, nonlinear energy fluxes, and breaking dissipation. The authors could do a better job justifying the motivation for neglecting the source terms (wind input, dissipation, and nonlinear energy fluxes) and discuss the potential impacts for their analysis and findings The novel aspect of the study is the introduction of a relationship for estimating the current gradients based on the spatial gradient of the significant wave height. There is a need to be able to measure ocean currents from satellite and inverting surface currents from wave observations is promising. However, the derivation of the scaling used to invert the surface current gradient magnitude is not well described in the paper. The manuscript could be improved by revising the appendix showing a step-by-step derivation and clearly stating the assumptions made.

A comparable scaling in terms of the peak wave direction was proposed by Villas-Boas et al. 2021 and used to infer the current gradients. Neither method can accurately invert the current gradients, which is mainly because the effects of refraction are non-local. However, the present work would benefit from applying the scaling of Villas-Boas et al. 2021 to invert the current gradients and comparing them to the current gradients estimated using their method. Also, it would be helpful to apply the current gradient inversions not just for the 7 s waves but to the other cases. Overall, the manuscript needs

substantial revisions. Several paragraphs are not well structured. Below I provide several specific comments/suggestions to improve the manuscript.

Here we answer the main remarks and propositions for manuscript improvement. The relation proposed by Villas Boas et al. 2020 between surface current gradients and significant wave height gradients have been here demonstrated step by step, some lines have been added in the Appendix. The final relation presented in equation 8 is the same than the one proposed by Villas Boas et al. 2020 but in another form. We highlighted that significant wave height gradients are proportional to the wave steepness (kHs), making among other, non linear wave-wave interactions crucial in the intensity of significant wave height gradient. Thanks to referee #3 we have proposed a complementary numerical experiment to show the contribution of the non-linear wave-wave interaction source term in comparison to the results proposed in a very idealised case (S=0). The scatterplot proposed in Villas Boas et al. 2020 (see their Fig.12) have been extended to our study in Fig.7 (for all initial frequencies and with the contribution of the divergence of the flow). The non-local aspect of the current on waves have been even more highligted thanks to the new parametrization of the wave model (waves are emitted from the left boundary continuously every hour rather than studying a unique wave train). The signatures of an isolated eddy on wave parameters reveal that the modulation induced by current on waves have a strong effect downstream the eddy field making the wave parameter inversion to infer current gradient limited.

The following typos have been corrected and expressions reformulated. Some remarks have not been taken into account due to reformulations but most of the proposed semantic have been included.

1: small scale --> small-scale

8: The word "retrieved" is overly optimistic based on your analysis. You can at most "identify" the current gradients.

23: gaz--> gas

26-28: This paragraph is very short. It could be improved. It is unclear what is the paragraph trying to convey. Is it about mesoscales or submesoscales?

41: "anticipation" do you mean prediction?

43: "?"?

47: Reads "…numerical model built from Ardhuin et al. (2017) without source terms." What does this mean? Is basically WAVEWATCHIII without source terms. What is the relationship to Ardhuin et al. 2017? Please revise.

56: Parameterization of what? Please explain.

62: refer --> refers

63: Delete "During the simulation,"

92: ". g" --> ", g"

100: "performances" --> performance. "have" --> has.

99-102: The studies cited used the source terms (wind input, etc). It is worth specifying.

109: “Indeed, dealing with high” --> High. “allows a better” --> is required for a

110: current --> currents

114: “the wave one” --> that of the waves

122: There is not need for a new paragraph. I suggest the author revise their use of paragraphs. In several instances the paragraphs are too short.

122: “are propagating in the current” --> propagate. Also the next sentences (“T_p= 7 s…than longer wavers”) can be replaced with “For T_p=7, 10.3, and 16.6 s the corresponding group velocities are 11, 16 and 26 m/s.”

126: “modulate amplitude” --> “modulate the wave amplitude”

127: “respond” --> variabililty. “waves” --> wave. “for a prescribed underlying current” --> such

Figure 2g – line colors would help distinguish the lines better

132: “Wave train is propagating” --> The waves propagate

148: “occurring” --> apparent

150: “actions”--> heights. “is”--> are

163: “is function of both” --> depends on

165: “with perturbed” --> with the perturbed

166: insert “the” at the beginning

167: “the current was turbulent” --> turbulent the current is

169: “trajectory” --> trajectories. "current” --> currents

171: Add “(Kenyon 1971; Dysthe 2001)” at the end.

182-184: What does this mean? Please be more explicit in terms of the physical processes.

185: what do you mean you "guess". Please choose a better scientific word. Also, the text reads “… would be more impacted…” please elaborate more impacted relative to what?

186: is --> are

197: Does not make sense. Please revise.

200: “wave field” --> the wave field. Train --> trains

201: “kinematic: --> kinematics

202: “unperturbed” --> the unperturbed

203: “initial” --> the initial

205: “Indeed, the” --> The

206-207: delete “confirmed by theoretical works performed by”

261-=263: please revise is not very clear.

263: “Here, knowing” --> Knowing. Delete “spatial”.

264: “such perturbed” --> an

265: delete “that the different”. Replace “that occur in” with “within”

266: “approached” you could instead say infer (?).

263-265: The closing statement is rather promising but is not fully supported by the findings. The analysis does show that you can detect the presence of an eddy. But the details of the structure are not reproduced, which is in part because as mentioned earlier in the text the main mechanism for the modulation of the wave field is non-local.

268: Opening sentence of the conclusion is no clear. Please revise.

270: frequency --> frequencies

275: delete “all the”. Replace “shorts” --> short

274-275: You mention the current energy. What about the current gradients.

278: “order” --> terms

280: delete “until”. Replace “dynamic” with dynamics

281: delete “the used of a constellations of:

283: what do you mean by approach?

Appendix: Equation A4 – what is Cte