

Atmos. Chem. Phys. Discuss., referee comment RC1  
<https://doi.org/10.5194/acp-2021-239-RC1>, 2021  
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## Comment on acp-2021-239

Anonymous Referee #1

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Referee comment on "Towards kilometer-scale ocean–atmosphere–wave coupled forecast: a case study on a Mediterranean heavy precipitation event" by César Sauvage et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-239-RC1>, 2021

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### General comments

This paper (acp-2021-239-manuscript-version2) presents a coupled modelling system facilitating a better representation of the processes at the air–sea interface. The system consists of the AROME atmospheric mode, the NEMO ocean circulation model, and the WaveWatchIII ocean wave model. Coupled ocean–atmosphere–wave simulations were performed for a heavy precipitation event (HPE) that occurred between 12 and 14 October 2016 in the South of France, comparing atmosphere-only, coupled atmosphere–wave and ocean–atmosphere simulations. The results are interesting showing that the HPE fine-scale forecast is sensitive to both couplings. The atmosphere-ocean coupling leads to significant changes in the heat and moisture supply of the HPE intensifying convection. The atmosphere-wave coupling mainly leads to changes in the low-level dynamics, affecting the location of the convergence that triggers convection over sea. It is a very good work carefully written with interesting findings supporting the global research trend regarding multi-model coupled systems. So, I can suggest it for publication after some minor revisions and technical corrections.

### Specific Comments

- Lines 236-238, 246-248, 266-276, Table 2: I have a concern about the methodological design. In studies revealing physical interactions, it is important to change few parameters in each numerical experiment isolating the processes studied. This better supports the scientific reasoning of the study and advantages of coupling can be highlighted. For example, if the initialization of the numerical experiments is based on different data, it is very difficult to explain the reasons of result differences. They may be partially explained by the different initialization and partially by the coupling processes. It is important to note that the aim of the implementation of atmosphere-wave-ocean coupled systems is the "online" physical enrichment of simulations and not the investigation of initialization effects. Sensitivity experiments on initialization is

feasible using even uncoupled systems. Lines 266-276: I appreciate the discussion of Lines 266-276, however, as regards the atmospheric component, did you try to initialize AOW and AO runs using SST analysis instead of the NEMO 7-day SST forecast (spinup)? Also, did you try to initialize atmosphere-only simulations using the NEMO 7-day SST forecast (spinup)? I am wondering how much the result differences are attributed on atmosphere-wave-ocean interactions and how much on different SST initializations. This has to be clarified because determines the scientific findings of this work. I believe that the numerical experiments are comparable only if they have common initial conditions facilitating a more accurate investigation of atmosphere-wave-ocean interactions. An initial SST difference of e.g. 1°C may cause differences in surface fluxes, convection, atmospheric circulation etc, and thus, hiding coupling benefits. Overall, my suggestion is to perform some additional numerical experiments using either SST analysis or 7-day SST forecast fields, respectively, ensuring that all the experiments are initialized using common SST data. If the new experiments will not result to substantial differences it is not needed to be included in the manuscript.

- Line 102: A time step of 50 s seems very large to meet CFL criterion in such a high horizontal and vertical resolution. Please check for any typographical error or clarify it.
- Line 111: Do AROME and SURFEX models use exactly the same grid with 1.3 km horizontal resolution? I suppose yes (Line 152). What topography, vegetation, land use and soil data are used? Also, how are you manage land-sea, land-lake and land-river transitions?
- Line 151: Is the 1-hour coupling frequency sufficient for such a high resolution coupled system (1.3 km horizontal resolution)? Have you tried more frequent coupling?
- Line 174: Equation 4 mostly results to negative wind stress values as wind values are almost always larger than surface current ones. Also, Figure 5a shows positive wind stress values. Also, in Equation 1 of your previous study Sauvage et al. (2020) the wind stress is always positive. Please clarify. What is the relation between wind stress and friction velocity as regards the surface layer represented by AROME?
- Line 194-195: Which is exactly the Charnock coefficient formula used in this study? Equation 10 in combination with Equation 9 of Sauvage et al. (2020) presents deep water approximation for wave modelling. Shallow water approximation could be more suitable especially for the coastal areas studied in this work. Please provide explanations for your choice.
- Table 6: Why did you use different number of processes for NEMO (i.e. 8 and 16) in the numerical experiments? Is this affect the results?
- Lines 470-493 and Table 6: I recommend to move technical details and Table 6 in the Appendix.
- Sections 4, 5, and 6: The presentation of result differences and the explanations are very good, however, is not clear to me which numerical experiment is the best as regards the overall statistical evaluation using observational data. I am not sure that AOW is the best as expected due to the better physical representation. Please clarify it.

## Technical corrections

- Lines 4-7: The sentence "In order...simulations" could be split to two sentences.
- Lines 5-6: Be careful with the date format used by the journal. It can be written as "12 and 14 October 2016" similarly to Line 87 of the manuscript.
- Lines 10-14: The sentence "Even if...forecasts" has to be split to two sentences.
- Lines 21-22: ECMWF had been adopted atmosphere-wave-ocean full coupling approach before 2019. <https://www.ecmwf.int/en/research/modelling-and-prediction/marine>
- Line 66: "over a warm" -> "over warm"

- Line 68: Please clarify "WMED"
- Line 70: "re-assert" -> "reasserted"
- Lines 88-91: I suggest to write Section 2, Section 3 etc. instead of Sect. 2, Sect. 3 etc.
- Line 95: "models configurations" -> "model configurations"
- Line 121: "has 2 two open" -> "has two open"
- Line 132: "consists in" -> "consists of"
- Line 142: Maybe "adopted"?
- Lines 177-178: Please better clarify  $\Delta\theta$  and  $\Delta q$  of Equation 5. E.g., do you mean  $(\theta_s - \theta_a)$  for  $\Delta\theta$ ?
- Line 281: "couplings" -> "coupling"
- Table 1: "meridian" -> "meridional"