OS-2020-38 - Response to short comment

This paper presents a study of the impact of a medicane on the oceanic upper layer using a high resolution model. The authors used a high coupling frequency of 15 min which is rather high. In our team, we worked on the impact of the wind forcing temporal resolution on the sea dynamics. Indeed, it is recommended to use a high temporal resolution. Could authors give few words on the added value of using such a high frequency (as high as 15 min)? If a lower frequency was used (for example hourly coupling) would the results be different?
Marwa Ouni PhD student Modelling team, INSTM

Thank you for this comment. We did not test the impact of the coupling on the simulation before choosing a coupling frequency of 15 min. We did not test either the impact of using a fully coupled configuration with respect to an atmospheric model forcing the oceanic simulation (see our response to the referees' comments). From previous experiences on tropical cyclone, sea surge modelling, or other stormy events we inferred that the atmospheric forcing and its time evolution must be represented with a "sufficient" sampling. Sufficient here depends on the time step of the oceanic model (in our case 5 min), on its resolution (1/36°), on the scale of the processes we want to represent and on, typically, the translation speed of the event.
We think that quantifying the effect of using an hourly rather than a 15 min coupling is not directly feasible without testing the two configurations. However, first insights may be given by comparing the mean exchanged fields. For that, the coupled fields (wind stress components, total heat flux, net freshwater flux) can be inferred a posteriori by hourly averaging the 15 min exchanged fields. This permits to estimate the fields potentially transmitted to NEMO if a lower frequency had been chosen. In the present case, the Fig. 1 and 2 below show the time series of the mean values of the total heat flux on the strong flux area (SFA) and of the water flux on the heavy precipitation zone (HR) during the first 16 h of the event, sent by the atmospheric model to the oceanic model at 15 min or 1 h coupling frequency. It can be seen that, in addition to the smoothing effect due to averaging the field over 1 h versus 15 min, coupling at 1 h induces a time lag than can result in strong discrepancies when the field is evolving rapidly. For instance, at 11:30 UTC, the mean total heat flux extracted on the SFA is 92 W m^{-2} stronger with a 1 h coupling than with a 15 min coupling. At 05:30 UTC, the mean water flux on HR is 2.4 mm h^{-1} weaker with a 1 h coupling than with a 15 min coupling. Two snapshots corresponding to these examples (Fig. 3) show that local discrepancies are much larger than that.
The smoothing and lag effects were already highlighted by the sensitivity study to forcing frequency done by Lebeaupin Brossier et al. (2009) on a heavy precipitation event over the Mediterranean using the same atmospheric model but a different oceanic model. The main conclusion of this study is that even if the integrated exchanges at the interface are well represented in the forcing applied, the vertical diffusion could respond differently under severe and rapidly evolving conditions from that under moderate conditions, and consequently, the exchanges across the OML base could be different. In particular, a high coupling frequency (1 hour or less) appeared necessary to well reproduce the formation and the persistence of low salinity internal boundary layer which are very sensitive to the precipitation rate and the high precipitation duration. In summary, it cannot be concluded formally that using a coupling frequency of 1 h would significantly change the oceanic simulation, but these examples illustrate that the fluxes transmitted to the ocean are significantly changed in doing so and that the OML response may be underestimated, in particular under such short and intense meteorological event.

Lebeaupin Brossier, C., Ducrocq, V., and Giordani, H. (2009). Effects of the air–sea coupling time frequency on the ocean response during Mediterranean intense events. Ocean Dynamics, 59(4), 539-549.

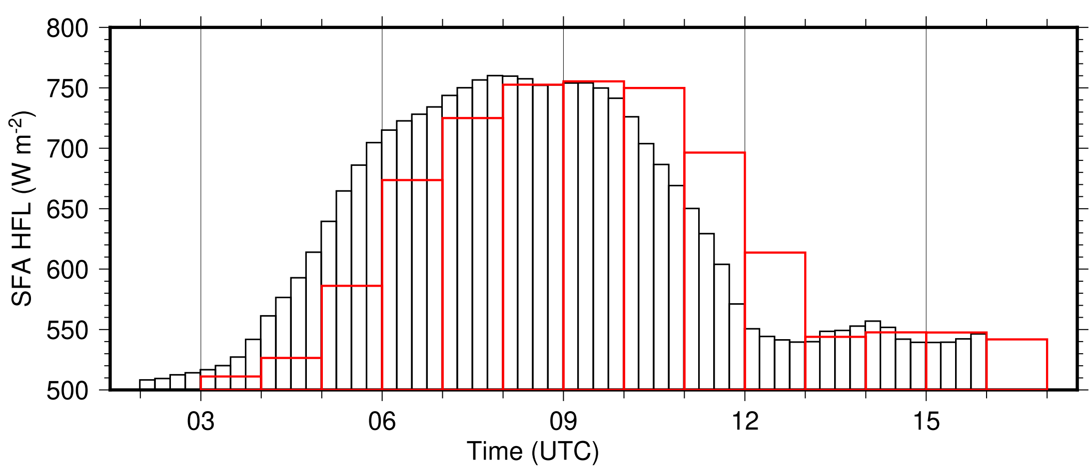

Figure 1: Time series of the mean values of the total heat flux extracted from the ocean (W m^{-2}) in the SFA between 01 and 16 UTC on 7 November for the coupling frequencies of 15 min (black) and 1 h (red).

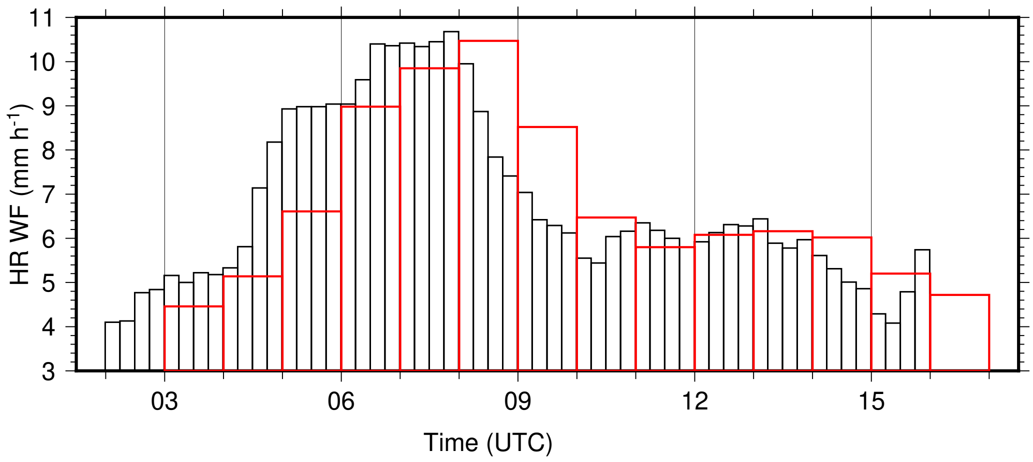

Figure 2: Time series of the mean values of the water flux transmitted to the ocean (mm h^{-1}) in HR between 01 and 16 UTC on 7 November for the coupling frequencies of 15 min (black) and 1 h (red).

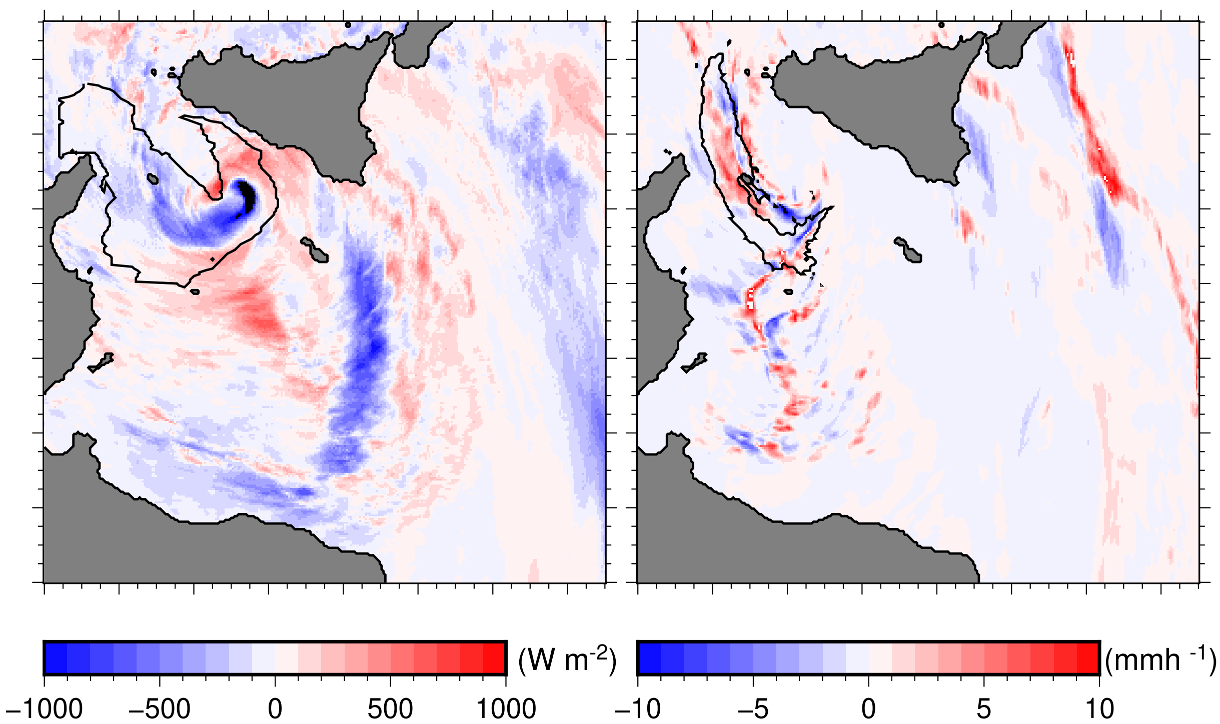

Figure 3: Maps of the instantaneous differences of the total heat flux extracted from the ocean at 11:30 UTC (left) and of the water flux transmitted to the ocean at 05:30 UTC (right), between a 15 min coupling frequency and a 1 h coupling frequency (as estimated a posteriori). The black contours indicate the SFA and HR, respectively.