Referee #1

Q1. The manuscript "Extreme waves and climatic patterns of variability in the Eastern North Atlantic and Mediterranean basins" by Morales-Márquez et al. describes an analysis of the 99percentile of significant wave height focused during winter months over NE Atlantic and Mediterranean Sea. The study is interesting and some outcomes show novel information and wave climate variability patterns (eg. the contribution of seasonality into variability, historical trends over the 30-year period used, correlation with climate indices).

> *Reply #1. We deeply thank Referee's comments and the effort that she/he made in reviewing carefully our work. We have introduced in the new version of the Manuscript (hereinafter Ms) all points raised in the review. We sincerely think that the new version of the Ms has been improved, thanks to this discussion.*

Q2. From my point of view, however, the manuscript requires an improvement in the wording to better describe some technical steps. One of the main weaknesses of the work is that it seems that the SWH has not been validated against observations, neither the SHW99 magnitude nor its variations.

> *Reply #2. As suggested, all technical aspect raised by the Reviewer have been modified following her/his suggestions. In particular we have included a comparison between the wave reanalysis and available in situ buoys. All Referee's concerns are explained in detail in the following replies.*

SPECIFIC COMMENTS

Q3. English grammar needs to be checked.

> *Reply #3. The Ms. has been revised in detail and typos corrected.*

Q4. Lines 11-12 "Besides, extreme waves influence the upper ocean by enhancing vertical mixing through the Stokes layer". A reference of the statement would be desirable.

> *Reply #4. As suggested by the Reviewer, a new reference has been included in this sentence of the manuscript. Lines #11-12 read,*
>
> > *"Besides, extreme waves influence the upper ocean by enhancing vertical mixing through the Stokes layer (Polton et al., 2005).*

Q5. Line 13. I do not completely understand the message about the role of the extreme waves in coastal flooding at 'intra-annual' scale. Please, consider rewriting.

> *Reply #5. Coastal flooding depends on the combined effect of Sea Level, Storm Surges and Wave Setup. While the first impact is a large-scale effect, surges and wave setup have a clear seasonality (see Figure 2 panels c and d). Thus, larger impacts in flooding are related with maximum waves and large surges that are intra-annual processes.*

Q6. References of the journal articles are odd worded at the end of the manuscript, making difficult find the referenced information sources.

> *Reply #6. We followed the Ocean Science template for the References.*

Q7. I suggest removing 'methods' of the title of section 2 since EOFs, correlation significance estimation, composites, etc. methods are not described in this section.

> *Reply #7. We modified the Section title as "Data and extreme wave values".*

Q8. Section 2.1 "Waves and Atmospheric Data" requires organisation and adding relevant details for the analysis of extreme wave climate. I am confused by some aspects that are ambiguously mentioned. Some examples: a) What is the time resolution of the used winds to generate the waves by forcing WaveWatch model? Â£winds fields at 0.5deg are used over the Mediterranean Sea? Â£is this spatial resolution enough to simulate wave extremes? b) What is the time resolution of SWH from the database? Averaged 3hourly values? One hourly value each 3 hours? c) Â£has the used wave data source been validated in the study area? A comparison against buoy records in the analyzed domains shown in figure 1 is crucial to validate the further analysis of extreme waves.

Reply #8.

a) The temporal resolution of the winds forcing the wave model is 1 hour. It is defined at lines #54-57 of the Ms.:

> *"This dataset (i.e. WAVEWATCH III 30-yearHindcast Phase 2, (Chawla et al., 2012)) has been generated by forcing the "state-of-the-art" wave model WAVEWATCH III (Tolman, 2009) with 10-m height high-resolution wind fields from the NCEP Climate Forecast System Reanalysis and Reforecast (CFSRR) a 30-year homogeneous data set of hourly 1/2^o spatial resolution winds."*

Regarding the wind resolution at the Mediterranean Sea the hindcast fits better in this basin than in the North Atlantic Ocean according to the buoys data from CMEMS (see Table 1 of the Ms), having largely been used in the North Atlantic to analyze the mean and the extreme waves (see for instance Forte, M.F. et al., 2012; and Gonçalves, M. et al., 2018).

b) The wave model provides outputs every 3 hours, which is largely accepted to be a sea state.

c)Thanks to referee's suggestions we compare the hindcast at the Mediterranean Sea and NE Atlantic Ocean with buoys available at Copernicus (https://marine.copernicus.eu/). In addition, we write the following sentences in order to include this comparison in the Ms. (Lines #71-79):

> *"The hindcast is validated at the two basins with available buoys following the methodology described in Morales Márquez et al. (2018). For 13 buoys in the Atlantic and 11 in the Mediterranean Sea, we compute the correlation coefficient (R^2), the Scatter Index (SCI and the Relative Bias (RB) defined as:*

$$R^2 = \frac{\mathrm{Cov(b,m)}}{\sigma_{\mathrm{b}}\sigma_{\mathrm{m}}},$$

$$SCI = \frac{\mathrm{rms_{m-b}}}{\max(\mathrm{rms_b}, |\langle \mathrm{b} \rangle|)},$$

$$RB = \frac{\langle \mathrm{m-b} \rangle}{\max(\mathrm{rms_b}, |\langle \mathrm{b} \rangle|)},$$

> *where m is the hindcast at buoy location and b the buoy data.*

> *Table 1 shows the comparison between the WAVEWATCH III 30 hindcast and the buoys from Copernicus Marine environment monitoring service (CMEMS, https://marine.copernicus.eu/). See Fig. 1 for buoy locations.*

Table 1. Statistical comparison between the WAVEWATCH III 30 hindcast and CMEMS buoys.

Basin	R^2(%)	SCI	Relative bias
Mediterranean Sea	73.09 ± 0.17	0.39 ± 0.00	-0.13 ± 0.00
North Atlantic	72.67 ± 0.96	0.33 ± 0.02	0.16 ± 0.02

"

Additionally, Figure 1 has been modified in order to show location of buoys.

Q9. I wonder how robust figure 2c and 2d are, as they are calculated from the maximum 99percentile value of a month and year. Are the monthly spatial patterns preserved for the averaged month of highest 99percentile value?

> *Reply #9. Figure 2 shows the maximum value of all monthly 99 percentiles. Panels a and b correspond to the value and panels c and d to the month when it occurs. The monthly patterns are not preserved (each grid point has its maximum at a specific month). The interest of this Figure is thus the homogeneity in the obtained months since the most of extreme waves are concentrated in few months (Dec-Mar).*

Q10. Is semi-annual cycle statistically significant in the regression model? (eq.1). Panels of figure 3 do not show clear semiannual cycles for points 1 & 2. Maybe the variance reduction is only due to annual cycle

> *Reply #10. We compute the level of significance for the annual and semiannual cycle being both significant in the whole basins. As Referee points out, most of the variance reduction is due to the annual cycle but the semiannual variation is also significant both in the North Atlantic Ocean and in the Mediterraean Sea. In addition, we show that the intra-annual frequencies of the SWH_{99} signal have to be removed if we want to analyze the long-term variability of the extreme waves.*

Q11. Lines 90-93. Please, review the grammar. I do not completely understand the insights in the sentences. How 'generation wave areas' have been estimated/detected? What does development wave area mean?

> *Reply #11. Thank you for your advice. We rewrite the lines #99-102 of the Ms. as,*
>
> > *"In the Mediterranean Sea, there are two different areas in terms of seasonality. One is located in the central basin where seasonality explains up to a 70% of extreme waves and the other located in the Gulf of Genova and the Alboran Sea, where seasonality explains less than 10% of the signal (Fig. 3b). These areas are very active in terms of ciclogenetic activity (Trigo et al., 2002) and thus the seasonal signal is relatively less important here.*
>
> *Regarding the estimation of the generation areas, we distinguish between Sea and Swell waves the first generated by local winds and the second including intensity, duration and distance (waves travelling across large areas). Swell waves are more ordered, presenting a more regular appearance with larger periods and wavelengths in a narrower frequency range than Sea type waves. The wave generation areas can be estimated analyzing wave features (SWH and wavelength, or period since they are related through the dispersion relationship) and local winds.*
>
> *In these lines of the Ms., we explain how the local wind dominates the areas where the seasonality describes a smaller value of the extreme wave; corresponding with the generated waves areas. On the other hand, the higher values of the seasonality take place in regions where the waves can be developed better because they travel large distances. In these areas the dominant sea state corresponds to Swell.*

Q12. I do not see the relationship (alignment) of the historical estimated SWH99 trends (1979-2009) with future projections of surface wind (referenced from Gallagher et al. 2016). Please, clarify this statement.

> *Reply #12. Figure 3a and b of Gallagher et al, 2016., show the projected changes for the period of 2070-2099 relative to 1980-2009. There, they obtain a similar wind variation pattern than the trend of SWH_{99} map that we present. We want to remark that the tendency of the SWH_{99} most likely will follow the same pattern that we have calculated.*
>
> *We have rewritten these lines in order to clarify it, in #108-110 of the Ms. as,*
>
> > *"This aligns with the obtained results in Gallagher et al. 2016., where the future projections of mean surface wind show an average decrease over the North Atlantic Ocean for winter season, so likely the extreme waves continue with the same pattern in terms of long-term variability.".*

Q13. Line 116. Please, provide details about how the 5yr-periodicity is estimated. I cannot see clearly in Fig.5-1.

Reply #13. We modified the Ms and we now explain that we computed it through a FFT analysis of the PC. For that, we add this information in #125-126 lines of Ms. as,

"The first EOF, which explains a 28.5% of the winter SWH_{99}, presents a periodicity in its PC around 5 years (calculated through FFT analysis of Fig. 5-1)."

Q14. White color of colorbar in figures 7 & 9 must be centered on zero.

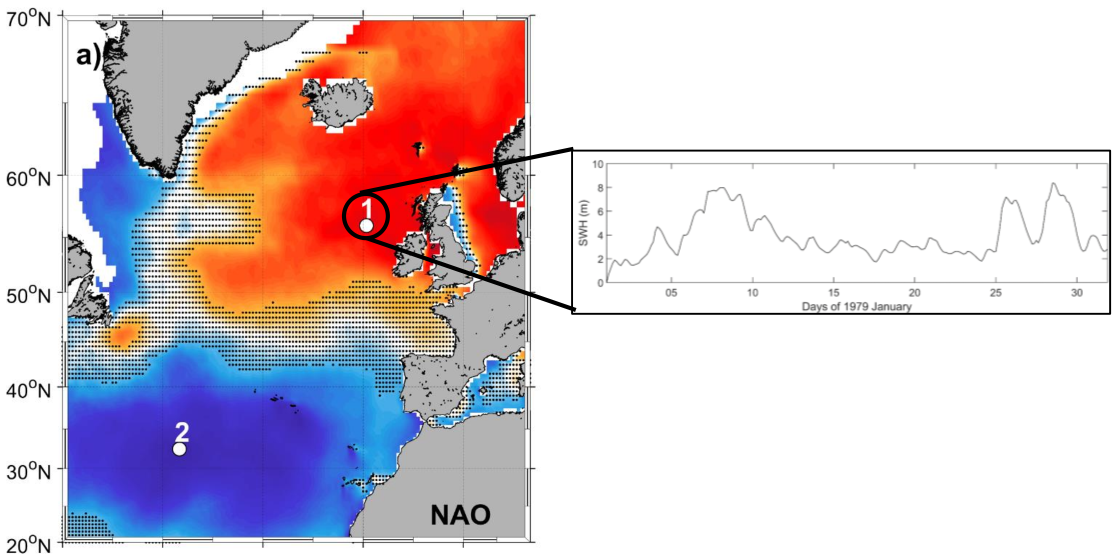
Reply #14. This has been fixed. In addition, we change the colors of the colorbar in order to distinguish better the values of the correlation. We modify also the colorbar of the Fig. 4 in order to have the same colors tones in all the figures.

Q15. Line 186-87. Please, clarify the step 2 to build the composite. I do not understand what the authors refer as 'time steps' and why only 2 values per month are obtained.

Reply #15. We clarify the methodology used for obtaining composites with the following example for the positive NAO phase. The steps are the following:

1. *We select the grid point with maximum correlation (both positive and negative values) between SWH_{99} and the climatic index.*

In this case point #1 presents the maximum positive correlation with the NAO and for simplicity we plot SWH for January 1979 (the process is done for the whole time series, repeating this methodology for all the months).

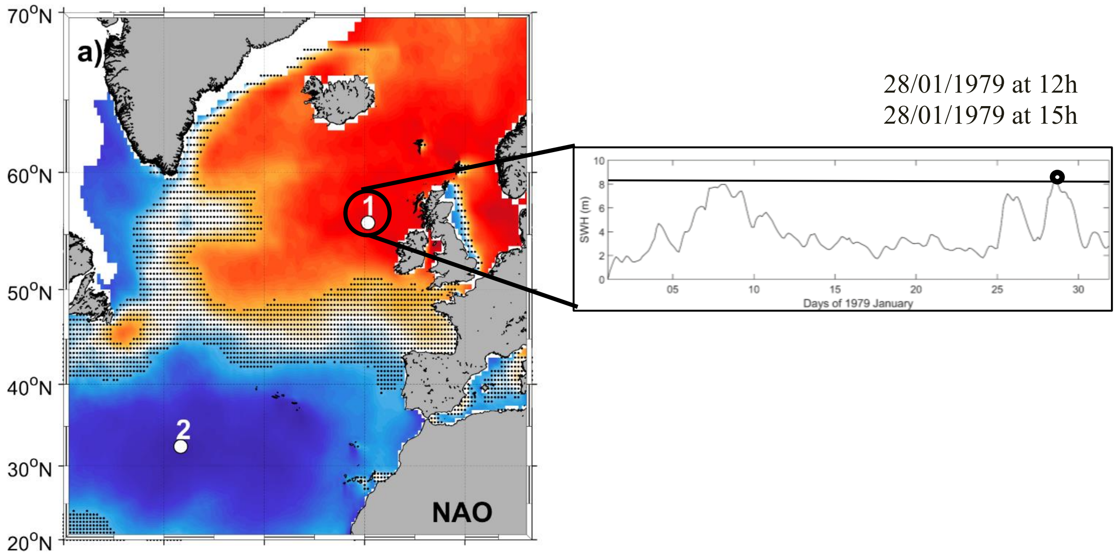


2. *From the 3-hourly dataset the following data are selected:*

$$SWH_{3-hours} \geq SWH_{99\,month}$$

As the SWH time series are of 3-hourly time step, we have 224 data in months of 28 days, 232 data in months with 29 days, 240 data in months with 30 days, and 248 in months with 31 days. The 99th percentile is defined as the value that only the 1% of the time series exceed it. And with our time step, the 1% of the number of data for each month those are higher than SWH_{99} is only 2 values.

For January 1979 and for the positive phase NAO composite is concerned, the values that exceeded than SWH_{99} for that month occur at 12h and at 15h on 28th of January 1979.



3. *The U10, SLP and SWH values for the chosen moments in point #2 of this methodology are selected in whole study area.*

For our example, we take the values of U10, SLP and SWH for the 12h and 15h on 28th of January 1979 in all the grid points.

4. *The mean value of the selected data in point #3 of this methodology is calculated for each spatial point. The results are shown in figures 9-12 of the Ms.*

We calculate the mean value for U10, SLP and SWH on 28th January 1979 at 12h and 15h in all the grid points.

In addition, we have added this sentence in order to help to understanding better the fact of referee comments, in lines #197-198 of the Ms.

"- We select the time steps for which the original 3-hourly SWH time series at points #1 and #2 exceed SWH_{99} (2 values each month are selected because the monthly number of data are 224-248 depending on the month of the year)."

Q16. Lines 189-91. As far as I understand how the composite is built, the composite maps only represent spatial patterns for a target location with a high correlation between winter SHW99 and a climate index. They are not synoptic maps (a map for a given moment of time).

Reply #16. Yes. The composites represent the mean situations of U10, SLP and SWH that take place when the extreme waves and the different climatic indices have the higher value of correlation with each specific index. We use the term 'synoptic' for the spatial dimension (similar to the 'mesoscale' term largely used in oceanography) where a map is obtained for the whole basin.

Q17. Figures 9 & 10. The magnitude of the wind vector and SLP would help the reader to better understand the resulting maps.

Reply #17. The wind speed reference is defined in the bottom left part of each subplot as a red vector of 5 m/s. And regarding the reference of SLP, if we put the values of each contour, the visualization of the wind arrows will be difficult, for this reason we decided to remove them. In addition, the important point of these figures is to know the low and high pressure distribution, and how the gradient pressure determines the wind speed and therefore the extreme waves.