

## **Response to Editor Comment #1 (Philip Woodworth)**

We thank the Editor for his comments and detailed technical corrections. The Editor comments are in bold, our replies are in normal font.

**I have some detailed, most technical comments on this draft with an editor hat on. The two formal reviews should be inspected for more on the science. There are rather a lot of them but many are trivial.**

**Philip Woodworth**

We carefully answered to the two formal reviews, the details are in the response to comments.

**Title - what does 'climate-scale' mean? At line 9 you refer to 'large-scale' which seems a more sensible description. Or 'basin-scale' maybe.**

We meant at large timescale (decadal to secular). We agree that large-scale is here more relevant. Following Editor suggestion, we changed the title to "large-scale", instead of "climate-scale".

**6 - The trends in M2 amplitude**

It has been corrected.

**7 - from one station to another**

It has been corrected.

**7 - 0.7 mm/yr in the period since 1910**

It has been corrected.

**10 - distribution of water level**

It has been changed.

**14 - Tides have been changing .. factors since the XIXth century ..**

It has been changed.

**22 - large-scale (cf. Line 9)**

It has been corrected.

**31 - scale -> scales**

It has been corrected.

**32 - ditto**

It has been corrected.

**43-44 - I would drop this sentence**

The sentence has been removed.

**45 - thus only an accounted for change in ...**

This sentence has also been removed, as it was linked to the previous one (which has been removed).

**47 - years of data**

Here, we meant 80 years with at least 75% of data (to avoid the seasonal effect – see below). To be clearer, we corrected “years with data” by “years of data”, and added that we selected only years with at least 75% of data.

**49 - On the east side of the North Atlantic**

It has been added.

**50 - due to too small an M2**

This has been corrected.

**52 - On the west side of the North Atlantic**

It has been added.

**52 - due to too small a tidal**

It has been corrected.

**55 - in Figure**

It has been corrected.

**60 - synthesised → summarised**

It has been corrected.

**61 - in 1846 and 1896 respectively**

It has been added.

**64 - performed in order to compute**

It has been added.

**65 - similar to the**

It has been added.

**66 - I would drop 'largely .. community'. It may be true but its wide use is not relevant.**

It has been deleted.

**67 - of the yearly**

It has been corrected.

**69 - M2 correctly.**

It has been corrected.

**70 - seasonal variation of typically a few ..**

**A better reference for this would be:**

**Pugh, D. T. and Vassie, J. M. 1976. Tide and surge propagation off-shore in the Dowsing region of the North Sea. Deutsche Hydrographische Zeitschrift, 29, 163–213, doi:10.1007/BF02226659.**

We added the reference Pugh and Vassie (1976).

**71 - instead of the 50% here**

It has been corrected.

**Table 1 caption line 1 - tide gauge records selected**

It has been corrected.

**Table 1 caption line 3 - .... modulation, estimated trends in M2 amplitude since**

It has been corrected.

**Table 1 - I don't see why you have column 5 (MSL average) which has no importance to this study, MSL being measured relative to an arbitrary datum at each site.**

The column 5 was here to give the average MSL over the period 1910-2010, but we agree with the Editor that it has no importance, as the reference is an arbitrary datum at each site. Reviewer #2 also made a similar comment. This column has been removed.

**73 - lead to the exclusion of more years.**

**This is obvious isn't it? So how did your results change with 75%?**

As suggested by the Editor, we tested with 75% instead of 50%. This led to exclude on average 2.92 supplementary years per station. Results are quite similar, but some values of M2 that showed some significant variation are now removed (e.g. first value of Newlyn in 1915 on Figure 3 (a)). We now adopt this new value of 75% (instead of 50%), to avoid the seasonal variation.

**74 - retrieved → removed**

It has been corrected.

**(Simon, 2007,2013) as described briefly below.**

It has been added.

**Drop 'Here .. method'**

It has been removed.

**75 - reword:**

**.. an 18.6 modulation, separated from a neighbouring line in the tidal potential (m2) whose Doodson number differs in its 5th frequency ... respectively) (cf. Doodson and Warburg, 1941; Pugh and Woodworth, 2014). This .., the negative of the ..**

It has been rephrased and the references were added.

**79 - but it is negligible, its amplitude in the tidal potential being ..**

It has been corrected.

**81 - .. and m2 cannot be separated by a yearly harmonic ..**

It has been corrected.

**83 - expressed schematically**

It has been added.

**86 - are the amplitude and phase lag [not phase shift]**

It has been corrected.

**88 - shift → lags astronomic → astronomical is given by**

It has been corrected.

**93 - The negative of the mean ... is expressed simply**

It has been corrected.

**99 - from one station .. We added the default ..**

It has been corrected.

**103 - to this detrended**

It has been corrected.

**110 - drop the comma**

It has been removed.

**113 - please replace the hyphen with a colon. A hyphen looks like a minus sign.**

It has been replaced.

**Fig 2 caption. This should better say:**

**(a) Estimation of the modulation of M2 amplitude (mean removed) at Newlyn, (b) Impact of M2 amplitude ...**

We corrected with the following caption “(a) Estimation of the nodal modulation of M2 amplitude (mean removed) at Newlyn (b) Impact on M2 amplitude of the nodal modulation correction at Newlyn”.

**123 - ... (NAM) (Hurrell reference). These climate ...**

It has been changed. We referred to Thompson and Wallace (2000), and Thomson et al. (2000).

**125 - stations) over long periods**

It has been changed.

**127 - what does 'Variations in the NAO are essential' mean? You mean important?**

Yes, we meant that the variations of NAO are important as they drive the climate variability. It has been rephrased following reviewer #2 suggestion “Variations of NAO drive the climate variability...”

**132 - The normalization involves ..**

**drop 'long-term'**

It has been corrected.

**134 - what do you mean by 'with yearly values' when you have said you are using wintertime values? I would drop these 3 words**

We meant that we had one (winter) value per year. We removed this 3 words.

**This section should mention the AMO also as you use it below.**

As we focus in the present paper on pressure indices (NAO and AO), we finally did not mention the AMO in the paper.

**143 - the eastern**

It has been added.

**146 - consistent with the temporal coverage of the tide gauge measurements.**

It has been changed.

**153 - Brest and Newlyn**

We corrected “Brest, Newlyn and Cuxhaven” instead of “Brest/Newlyn and Cuxhaven”.

**154 - drop the brackets**

It has been done.

**155 - .. changes must be at least ..**

It has been done.

**159 – flattened**

We corrected “is flattening” by “flattens” as suggested by reviewer #2.

**yet → already**

It has been corrected.

**161 - of the tidal**

It has been corrected.

**Fig 3 - nice plot**

We thank the Editor for this comment.

**Fig 3 caption line 3 - The blue star in**

It has been corrected.

**164 - allow to confirm at larger timescale (?)**

We corrected “at larger spatial scale”, instead of “at large-scale”

**174 - in Figure**

It has been corrected.

**175 - into two groups**

It has been corrected.

**177 – ditto**

It has been corrected.

**179 - drop 'globally' (twice). They are not global which means 'worldwide' to most people**

We removed “globally”.

**181 - ditto  
increases overall**  
It has been corrected.

**182 - decrease, and since 1990 only**  
It has been corrected.

**183 - one station**  
It has been corrected.

**191 - which provides some confirmation of the hypothesis**  
It has been corrected.

**192 - from the Brest**  
It has been corrected.

**196 - drop globally  
decreases overall**  
It has been corrected.

**202 - synthesised → summarised**  
It has been corrected.

**204 - one station  
drop globally  
positive overall**  
It has been corrected.

**207 - found previously**  
It has been corrected.

**214 - Lewes? You must mean Portland?**  
We mean Lewes, and not Portland. We are here mentioning the stations with negative trends since 1910, i.e. Lewes and Halifax – Portland has a positive trend. We rephrased to be clearer: “6 stations have post-1990 negative trends (Atlantic City, Lewes, Charleston, Brest, Newlyn, Cuxhaven), whereas only 2 stations have post-1910 negative trends (Halifax, Lewes).”

**the latest → recent  
and (2)**  
It has been corrected.

**226 - in the tide**  
It has been corrected.

**227 - mean sea level rise can result in an increase in M2 of .. of the MSL rise ... the same sign as mean ..**

It has been corrected.

**238 - define SONEL**

“Système d’observation du Niveau des Eaux Littorales” has been added.

**240 - falling slightly**

It has been corrected.

**241 - give reference to GoM land movements**

The reference here is SONEL website. This paragraph has been rewritten, as we now correct MSL for land movement (see model 1, in the response to reviews).

**fig 6 caption - remove (see Table 1 column 5) and remove that column - it has no importance.**

It has been removed in the caption, and column 5 of table 1 has also been removed.

**249 - catch → account for**

It has been corrected.

**when they are forced with a meteorological field. What does this mean?**

Huess and Andersen (2001) run a barotropic model in the North Sea, forced (1) with tides only and (2) with both tides and meteorological fields. Results show that the seasonal modulation is better captured when the model is forced with both tides and meteorological fields (Plate 2, top right, amplitude higher than 10 cm in the German Bight) rather than with tides only (Plate 2, top left, amplitude lower than 5 cm in the German Bight). We rephrased to be clearer, “Huess and Andersen (2001) showed that simulations better account for the seasonal variability of M2, when they are forced with tides and meteorological fields, rather than tides only.”

**250 – affect**

It has been corrected.

**254 - in long-term**

We have rephrased following reviewer #2 suggestion “Ray and Talke (2019) suggest a possible role of stratification on secular tidal trends by long-term warming of the Gulf of Maine waters.” This suggestion also keeps our aim to suggest a cause.

**256 - and the Atlantic ..**

**The AMO is not referred to as an index in section 2.2.1. Also it is an SST index and not an air pressure one**

As we focus in the present paper on pressure indices (NAO and AO), we have removed the AMO analysis from the paper.

**Fig 7 caption line 1- you said before you used wintertime values not annual ones**

By “annual”, we meant that we had one value per year, which is confusing. We corrected with “winter values” instead of “annual values”.

**271 - .. could be due to differences in the spatial heights → level**

It has been corrected.

**273 - year → winter**

It has been corrected, as well as line 276.

**276 – usual**

It has been corrected.

**278 distributed differently ... south**

We corrected with “southerly” instead of “southern”, as suggested by the reviewer #2.

**281 - height → level**

It has been corrected.

**287 – volume**

It has been corrected.

**288 -precipitation**

It has been corrected.

**289 - on the scale**

It has been corrected.

**Fig 8 caption line 1 - .. pressure over the NE Atlantic**

It has been added.

**297 - coldest → lowest sea surface temperatures were ..**

It has been corrected.

**Fig 9 line 1 - Changes in mean sea level due to the difference ... (NAO-) assuming an IB response of sea level.**

Figure 9 shows now directly the difference of winter sea-level pressure, expressed in hPa (see response to reviewer #1). However, as suggested by the Editor, we rephrased the line 281 of submitted paper: the changes in terms of water level may vary from -21 cm to 12 cm, assuming an inverse barometer response of sea level.

**307 – differences**

**calls for → indicates**

It has been corrected.

**311 - explain the variations alone.**

It has been corrected.

**314 - heights → level**

It has been corrected.

**317 analysis of the phase lag**

It has been added.

**332 - right! See above. How does that change the results?**

The results are in the response of line 73 (see above). Finally, we removed this limitation, as we now select years with at least 75% of data.

**333 - deep → fuller**

It has been corrected.

**336 - tide gauges are obviously on the coast! Drop that. Harbours is relevant.**

We rephrased, the tide gauges are located mainly in harbours.

**363 - the e20... refers to Haigh et al. This reference needs correcting.**

It has been corrected.

**Also you have some names with initials before the surname e.g. Trimble.**

It has been corrected.

**Finally, you might want to refer to Talke and Jay (Annu. Rev. Mar. Sci. 2020. 12:121–51) especially from the perspective of changing tides in estuaries such as Cuxhaven.**

We now refer to Talke and Jay (2020), see the response to reviewer #2.