

Interactive comment on “Multidecadal variability in seasonal mean sea level along the North Sea coast” by Thomas Frederikse and Theo Gerkema

Anonymous Referee #2

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This study investigates the importance of interannual variability in seasonal sea level records in the North Sea region and its relation to atmospheric drivers. To do so, long-term tide gauge records are analysed and compared to atmospheric forcing agents such as local wind stress and sea level pressure as well as large scale atmospheric patterns. The authors find that variability is largest for the winter season and show, by using a simple linear regression model, that a large part of this variability can be explained by atmospheric forcing – though varying regionally. Other possible drivers are not discussed. The study expands on previous studies that were confined to one record or focused on annual means of sea level.

In that respect, it is an interesting study that deserves publication. I have a few, mostly minor, comments though that I think should be addressed. Most importantly, the de-

C1

scription of the analysis could be improved to be more concise and consistent. In particular, the relation between local wind and pressure should be examined in more detail, as they are both used as predictors in the model and are surely not independent of each other. For this, and other comments, see below.

(Page and line numbers refer to the manuscript as downloaded from <https://www.ocean-sci-discuss.net/os-2018-102/os-2018-102.pdf>)

Page 1

Line 2: "... we quantify low-frequency seasonal variations from annual-mean sea level..." - I'm not sure I understand what you mean. Maybe "quantify the relative importance of seasonal variations to annual variability" or "separate seasonal variability from annual variability"?

Line 8: "... which have their cause in ..." - although it makes sense, I would be careful with implying causal relationships from the analysis in this study. We are actually talking about two interpretations of the same thing. I would suggest you replace the phrase with "which are related to". Line 20: Replace "with a view" with "with respect"

Page 2

Line 17: Do you mean the NAO or really the North Atlantic Ocean?

Line 24: maybe clarify a bit? What do you mean by "The difference of the (...) difference"?

Page 3

Line 3: Is the year missing after PSMSL? Also, I can't find PSMSL in the References. You can check the psmsl referencing recommendation here: <http://psmsl.org/data/obtaining/reference.php>

Line 6: "...a single record..." without the "s"

C2

Line 6: "... over the period..." or shorten to "over the common period".

Line 26: "average to get seasonal anomalies": the same way you treated the tide gauge data, i.e. you subtract the annual mean and then average over the seasons?

Page 5

Equation 4: I can imagine that sea-level pressure and wind stress are correlated? Did you test for this? In that case, did you do a stepwise regression in order to check whether the inclusion of additional predictors increases the explained variance significantly?

Line 9-14: It is implied that you use monthly data, but please mention it for completeness. Also, it might not be clear for the reader why you do not treat the reanalysis data the same way as the other data sources. For example, why do you remove the seasonal cycle, do you detrend it before the EOF analysis, and which data do you use in Equation 5: surely, you have to compute season-mean PCs in order to use the regression model?

Line 29: Replace while with with.

Page 6

Figure 2: I would prefer to have the label standard deviation next to the colorbar.

Line 3: "... each season..." without the "s"

Line 5: Here, I'm not sure but I would suggest to replace between with in.

Line 12: Maybe add "after vertical land movement due to GIA has been accounted for"? Or "secular trend in absolute sea level".

Page 7

Line 6: "In spring and summer, ..." - there is something wrong with this sentence. Please check.

C3

Page 8

Figure 5, caption: Instead of "red lines" you might as well write "red arrows".

Line 3: Replace by with with.

Page 9

Line 1: I would suggest to replace "whose results" with "and the results"

Line 11: "Interestingly,..." This sounds as if you mentioned the fact for the first time, but in fact you have done so already in the previous paragraph (Line 5). I would rewrite this sentence together with the next ones. They seem, somehow not consistent: you mention that amplitude and temporal behaviour differ in this region (Line 13) but it is a bit unclear which region you are referring to. The southern part of the North Sea?

Line 13: A parenthesis is missing after Figure 4.

Line 25-26: How did you compute the fraction of explained variance of each predictor? Did you use the regression coefficients computed from Equation 4 and 5 (so, the full model), or did you perform the regression again with only one predictor? The results might be different, especially if the predictors (pressure and wind stress) are correlated.

Page 10

Figure 6 (and other Figures): it would be easier for the reader who is not that familiar with the region if you could also include the station numbers, not just the name, in the figures. This way it would be easier to find the location of the station by looking only at the upper part of Figure 1.

Page 11

Figure 7: If this is only about the relative importance of the different predictors, I would consider to normalize the explained variances with the total variance. That way, differences between stations are more obvious and easier to assess.

C4

Line 3: Replace are (first word) with is.

Page 12

Figure 9, caption: There are no top or bottom panels.

Page 13

Line 3: "The major driving mechanism...." - at the risk of being pedantic, wind and pressure are not really a mechanism but rather a forcing. The question is through which mechanisms these forcing agents cause the variability in seasonal sea level.

Line 13-17: First you state that the sea-level response to local changes in wind and pressure is mostly barotropic, only to write in the next sentence that it isn't strictly barotropic. While there is no contradiction, the reader might be confused about what you are aiming at (I was). I would suggest to rephrase the sentence.

Line 17: "... and local and large scale atmospheric changes do not explain all variability." - Can you think of other processes that could be responsible for the variability in seasonal sea level?

Line 20: "... multi-decadal trends in annual sea level are in general not representative for the trends of the winter record..." - I agree to this general statement! But is it true for this region? It seems that the variability in winter could dominate the interannual variability as it is so large compared to the other seasons (except autumn). Have you looked at annual multi-decadal trends and compared them to the winter multi-decadal trends? Maybe, in this region, they are very similar and one might indeed infer winter decadal variability from annual means?

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