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Comment on nhess-2021-325

Anonymous Referee #1

Referee comment on "Reconstruction of wind and surge of the 1906 storm tide at the German North Sea coast" by Elke Magda Inge Meyer et al., Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2021-325-RC1>, 2021

The paper describes the numerical modelling of an extreme storm surge in 1906 in the North Sea using the atmospheric forcing from various reanalysis products and from a reconstruction based on station observations published in contemporary weather reports. The studied event is among the most severe storm surges that affected the German North Sea coast and, therefore, it deserves great attention.

The paper objectives appear clear but the part of the methodology is very questionable, particularly the manual reconstruction of pressure fields. Moreover, the text is often unclear.

Due to several problems, that are listed below, the work requires a major revision to make the paper suitable for publication.

Major remarks

1) Manual reconstruction of the pressure field.

Why was it done when many objective techniques are available?

At page 8, line 7, the authors say that the synoptic maps obtained manually were digitised on a 0.07° grid. So, why didn't the authors interpolate the weather report data onto such a grid directly?

I can see at least two critical issues related to a manual reconstruction. The first is that an objective approach allows to estimate the reconstruction error, which is clearly not possible from a manual reconstruction. The second is that, at least in principle, other scientists should be able to reproduce the results described in the paper and this is only possible if the reconstruction procedure is described mathematically, or, at least, if a standard software is used.

I also noted that, at least from the weather report in fig. 3, pressure used to be measured at different times between 7 and 8 CET, depending on the country. How did the manual reconstruction take into account different times? A 1-hour lag can be significant, particularly with regard to the simulations sensitivity to the astronomical tide shifts, discussed in sect. 3.3.

2) Page 13, lines 16-20. The text reads:

'Two inferences can be made: First, the similarity between the pressure charts suggests that the additional digitized data did not add value to the simulation of the wind fields compared to the used 20CRv3 reanalysis, because most of the new data are located in Central Europe. Second, in regions with a high density of assimilated data, ensemble variability in the reanalysis is substantially smaller compared to areas where no such data exists. The similarity supports the reliability of the reanalysis for this event adding some confidence in the available wind and pressure fields.'

What does 'similarity' mean? I understand that it is not a quantitative measure of how different the two charts are, but rather that it means that they look more or less the same. Then the conclusions are totally subjective.

At least for the purpose of wind reconstruction, the authors conclude that the weather report data do not seem to be useful. Therefore, considering the questionable way in which those data are used (point 1 above), it would be reasonable to drop everything connected with them.

Last but not least, I cannot agree that the reanalyses are reliable because they are similar to maps drawn by hand!

3) 3.2 Ensemble simulations.

The authors say that 148 simulations were made (page 14, line 2). Only after magnification, fig. 11 reveals a large number of curves (all 148?), most of which cannot be discriminated from each other, causing the display to be almost useless. Besides improving the curve visibility (e.g. using larger figures), the authors should provide a synthetic assessment of their results, for instance by means of standard errors between simulations and observations. This would enable to specify to what extent the simulations succeed in reconstructing the storm surge: At the moment, the sentences at page 17, lines 9-10 ('It was tested to what extent ... It was found that some ...') are inconclusive.

4) Page 17, lines 16-21: Results 1 and 2. The text reads:

'1. Atmospheric wind and pressure data from some of the available atmospheric reanalyses (in particular some realizations from 20CRv3 and 20CRv2c) as well as from the manual synoptic reconstruction are appropriate to reproduce observed water levels using a tide-surge model.

2. The manual synoptic reconstruction exploits additional available data, but does not add value to available 20 reanalyses in the sense that additional relevant synoptic features emerge. However, it helps in assessing the reliability of selected realizations from the reanalyses.'

Concerning result no. 1, fig. 11 shows that only the times of high/low waters are reproduced well, and, with regard to this, note that the astronomical tide is dominant. By contrast, the considerable spread among the peaks heights, up to over 1 m on 13 March, raises the problem of uncertainty. The authors should explain what they mean by 'appropriate' by discussing what is considered to be a useful or acceptable uncertainty for a specific purpose, for instance coastal defence planning.

Result no. 2 can certainly depend on the spatial data coverage, which favours Central

Europe as explained by the authors at page 13, lines 16-17, but also on the availability of the atmospheric forcing only every 12 hours. For comparison, the reanalyses are available every 3 or 6 hours. This point should also be discussed.

Minor problems

1) Please make it clear when sea-level pressure and surface pressure are used. For instance, at page 4, line 17, in reference to the weather report of fig. 3 'surface pressure' is used, but pressure is actually reduced to the sea level (bottom of the figure). Similarly, the text at page 13, line 8 reads 'surface pressure', the caption of fig. 10 'pressure' and the legend of fig. 10 'sea level pressure'.

2) Page 16, line 11: I understand that the few centimetres differences refer to the peak heights. Please clarify this point. At a given time, differences can be as large as 1 m.

3) Figures are often hard to understand because they are full of information and colours, namely:

a) In fig. 6 the green labels in the bottom panels are difficult to see.

b) In figs. 7, 8 and 9 the complex symbols require a full description: mean, +/- STD, extremes ... Moreover, what do the small circles represent?

c) In fig. 13 what are the thick dark green curves? The caption misses this information. Moreover, the abscissa labels should show the hour while the month is not important.

4) Page 17, lines 33-36: 'Concerning the mean sea level rise, the observed mean high waters in 1906 are expected to be lower. ...'

The whole paragraph is unclear. In particular, the mean high waters in 1906 are expected to be lower than what and why? They are said to be observed (line 33). Please explain.

5) Page 17, line 40: 'different sources ...'

I do not understand if the reported measurements come from tide gauges or not. The 3.84 m height at Norderney seems to have been used in fig. 11, but what is the role of the 4.30 m height in the comparisons? Please explain.