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Discussions

Interactive comment on "Identification of storm surge events over the German Bight from atmospheric reanalysis and climate model data" *by* D. J. Befort et al.

Anonymous Referee #1

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Review of

Identification of storm surge events over the German Bight from atmospheric reanalysis and climate model data

by D.J. Befort, M. Fischer, G.C. Leckebusch, U. Ulbrich, A. Ganske, G. Rosenhagen, and H. Heinrich

Recommendation

Major Revisons.

Synopsis

A statistical relation between storm surges in Cuxhaven and wind characteristics on the North Sea is constructed, and this relation is used to investigate possible changes in surge frequency due to climate change. A combination of strong winds from west-north-west (295°) and the presence of a large-scale wind storm field over the North Sea is found to be a pre-requisite for storm surges in Cuxhaven. Having established this relation from observations (with ERA-40 as pseudo-observations of wind), the relation is applied to the output of a climate model (ECHAM5/MPI-OM) forced by historic + A1b GHG concentrations. Three runs are available. The number of potential surge-generating weather situations is found to increase, but their severity (max. intensity) stays the same. The increasing number is mainly due to relatively modest events with return periods of less than 10 years. Furthermore, the increase is statistically significant only in one of the three runs, which is due to the large inter-annual and inter-decadal variability of the number of potentially surge-generating situations.

Discussion

The paper addresses an important question (will the number of storm surges change due to global warming?) and attempts to solve it by identifying potentially dangerous weather situations, thus avoiding to run costly surge models, and count their number. The simplicity of this approach is, however, the main weakness of the paper. There are 82 surge events in the observational (= ERA-40) period, but these only constitute 5.5% of all weather situations that *potentially* (high wind + large-scale wind field) lead to a surge. In other words, the rate of *false positives* is larger than 94%! So the big question is: What does an increase of *potentially* surge-generating events say about the *actual* number of surges, if the false-positive rate is so large?

Taking the low significance of the found increase into account, and adding the uncertainty originating from the high false-positive rate (can that be quantified?), I doubt that any firm conclusions can be drawn about changes of the *actual* number of surges. This aspect needs to be discussed in the revised paper.

There are some other methodological problems that need to be addressed. They are detailed below under *Major Remarks*.

Major remarks

The first number denotes the page, the second one the line.

general Sterl et al. (2009) (referenced in the present paper) use winds from the same model (ECHAM5/MPI-OM) as used here to drive a surge model. They find no change of storm surges in Cuxhaven (their Fig. 7). So what is the value of the present paper?

3938, 16-20 De Winter et al. (2012) also find no increase in more extreme wave heights (up to return period of 1000 years, see their Figs. 8 and 11). However, they do not consider the German Bight. Note that they drove their wave model with winds from the same model as used in this paper (ECHMA5/MPI-OM).

sect. 3.1 This definition of U_{eff} suggests that you look at winds *coming from* WNW, which is reasonable. However, later (Fig. 2) it appears that there are also events

with a negative U_{eff}, which are probably winds from ESE (and thus do not project on 295°, but on 115°). First, this is a *contradictio in terminis*, as by definition a speed cannot be negative, and secondly it does not make sense to consider these events, as winds from ESE can never cause a surge at Cuxhaven.

sect. 3.2 In which region do you look for large-scale wind fields? There are a lot of severe storms in the north-east Atlantic that affect Cuxhaven not at all. In the next section you suggest that storms should at least have one point in the North Sea. Seems reasonable, but even then a storm that has only one point within the North Sea, while its centre moves hundreds of kilometres further north, might not be relevant at all. Perhaps better to discuss the choice of area here in greater depth and sharpen the criteria to improve the false positive rate.

sec. 4.1, Fig. 3 A linear trend is plotted. However, GHG concentrations as the driver of climate change grow exponentially, and temperature increase is much larger during the 21st century (3 K or so) than over the 20th century (< 1 K). So if climate change were to impact surge frequency, one would expect a larger increase in the later 21st century than during the 20th century. Taking this into account, is the small increase still significant?

sect. 4.2 A comparison with ERA-40 is missing! Are the average numbers of relevant situations equal in ERA-40 and ECHAM5?

sect. 4.2.3 Stationarity is required for the EVS/GPD approach to be valid. If you apply the method for the whole 21st century you thus implicitly assume that there is no long-term trend over that century. If there is no trend, although the forcing (GHG concentration) has one, why would you expect a difference with the 20th century, when the forcing was even lower?

Minor points

The first number denotes the page, the second one the line.

3936, 22 over → at

3937/38, 28/1,2 raise → rise; not *either* - all these effects contribute; mean sea level change does not contribute to the *rise* of the water level *during* a surge (it is far too slow), but it contributes to the water level *reached* during a storm. Please reformulate this sentence.

3938, 25 Reference for CMIP5 needed.

3938,27/28 GCM IPCC-AR4 ECHAM5/MPI-OM - what's this?

3940, 9 comprising → taking into account

3941, 1 and 3 subcluster → sub-clusters

3941, 7/8 Please reformulate. Hard to understand.

3941, 8 Eventually → Finally

3941, 22 their → its

3942, 24 deviated → derived

3943, 4-7 Sentence too long. Please reformulate.

3943, 10/11 What does the ratio of 3.7% mean? No interpretation is given. To me it suggests that the method is useless (see major remark).

3943, 2nd para Here you come with the North Sea argument (see also major remark). That all those storms that do not enter the North Sea are irrelevant for Cuxhaven could have been anticipated.

3944, 19 comparable → comparably

3944, 20 comma needed after surge

3944/45, 27-2 Please reformulate. Clumsy sentence.

3946, 2 9.84 $>$ 9.45, but you employed the percentile-correction because you expected that winds in ECHAM5 would be *lower* than those in ERA-40. Explanation? Comment? Do your results depend on the correction? Do you need it at all?

3946, 7 significant → significantly

3946, 22+23 statistical → statistically

3946, 27 what do you mean by "and for whose mean values"?

3947, 1 As well → Furthermore

3947, 4 of → over

3947, 5/6 from its → of their

3947, 4-17 In this para you use absolute wind speeds and exceedence wind speeds at the same time. This is extremely confusing! Please reformulate, using only one measure of speed, and stick to it. This also applies to Fig. 5.

3847, 15-17 Is this statement true for $U_{exceed} > 14$ m/s, or for the whole distribution?

3948, 12 comma needed after as

3948, 27 amount → number

3939, 7 bigger → larger

3950, 7-10 Not to follow. Please reformulate.

3953, 15 KÅllberg → Kållberg

3958, 1 amount → number

3961 caption says *numbers*, y-axis label says *percentage*. Presumably, numbers is correct.

3962, 4 of the exceeding what?