Review of

Towards using state-of-the-art climate models to help constrain estimates of unprecedented UK storm surges

by T. Howard and S. Williams

Recommendation

Minor / major revisions - dependign on editor's decision on investigating a Gumbel fit (see Discussion section below).

Synopsis

The paper investigates whether it is possible to exploit long climate model runs to estimate long return times of surges along the UK coast. To this end, the output of a 483-year integration of HadGEM3-GC3-MM is used to force the CS3 barotropic surge model. CS3 results are then compared to the (much shorter) observational records. Extreme Value Theory is used to infer long return times. A great deal of effort is put into estimation of the parameters of a GEV fitted to the model results. The shape parameter of a GEV distribution is found to be the source of the largest uncertainty in the return-level estimate.

The paper mainly deals with the skew surge because this measure has been shown to be independent of the tidal phase. In the case of Shearness, the modelling results contradict this view. The skew surge created by a specific wind storm differs by 20%, depending on whether the wind storm occurred during neap tide or during spring tide, respectively.

Discussion

Coastal protection works (dykes, flood barriers, etc) should protect against events of a magnitude that has not been reached during the observational record. Typically, such works are designed to protect against a water level occurring once in 1000 or 10,000 years. This time is much longer than the length of the observational records, which are usually not longer than 100 years. Extrapolating over orders of magnitude naturally leads to large uncertainties. Replacing observations by model-generated series, which often are much longer than the observational record, is therefore a good idea. The approach has been introduced nearly 20 years ago by Van Den Brink et al. (2004): Improving 10^4-year surge level estimates using data of the ECMWF seasonal prediction system. Geophys. Res. Lett., 31, L17210, doi: 10.1029/2004GL020610. This fact should be acknowledged in the present paper.

The authors fit the three parameter (location, shape, scale) GEV distribution to the model results and find that the largest uncertainty comes from the scale parameter. That the scale parameter is the most uncertain parameter in a GEV fit is well known. It is most heavily determined by the highest values in the annual-maximum series. A way around is to use the two parameter (location and scale) Gumbel distribution. Especially for long time series, it often gives superiour results. Looking at Fig. 2c and d, a value of zero for the scale parameters is not inconsistent with at least the observational estimates. Whether the Gumbel distribution is a good approximation can be tested by the procedure explained in Van den Brink and Können (2011): Estimating 10000-year return values from short time series. Int. J. Climatol., 31:115-126, doi: 10.1002/joc.2047.

I am aware of the fact that it would require a lot of work to calculate the Gumbel-fits and test for its suitability. However, I feel that the results shown in the paper could be much improved by eliminating the uncertainty that is inherent in the scale parameter. The editor should decide whether (s)he requires this analysis to be done.

Detailed comments

The paper is very well written, and I have only a few minor comments.

p 12, l 300/301 Discussing Fig. 2c you refer to the "spread of the shape parameters diagnosed [...] from the simulation", but I cannot see any spread in the simulation-derived shape parameters. Spread is only depictied for the CFB estimates. Please clarify.

sec. 6.1 / Fig. 6 You introduce a kernel. How did you obtain it? A short explanation of the procedure would be helpful. I am also not sure about the purpose of the kernel. Is it to extend the length of an episode, or its magnitude?