Dynamical downscaling of North Sea storm surges driven by RCM simulations

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Storm surges are one of the more direct effects of windstorms with a potential of high impact damage. The interaction between low pressure systems which determine the area of highest windspeeds and the astronomical tidal cycle leads to storm surge events the details of which depends on the geomorphological coastal structure. Storm surges and their statistics can be modelled with dynamical models (Kauker and Langenberg, 2000).

To investigate possible changes in North Sea storm surges under perturbed climate conditions, storm surge climate and extremes were derived by the barotropic storm surge model TRIM (Tidal Residual and Intertidal Mudflat) developed by Casulli and Catani: Casulli & Catani (1994) and Casulli & Stelling (1998). As forcing, a series of 30-year atmospheric regional simulations under present-day and enhanced greenhouse gas conditions were used. The effect of the expected rise in mean sea level is not taken into account. These regional simulation were prepared in the EU project (PRUDENCE (Christensen et al., 2002). The research strategy of PRUDENCE is to compare simulations of different regional models (RCMs) which are driven by the same global control and climate change simulations. These global conditions, representative for 1961-1990 and 2071-2100 were prepared by the Hadley center. Here we show results obtained by using regional model output from two models, namely HIRHAM (DMI) as well as RCA (SMHI).

The statistical analysis is carried out for the coastal cells of the modelled area, since impact damage due to human loss is expected mainly here in the coastal zone (Langenberg et al., 1999). Therefore, the model output was archived every 30 minutes at 209 coastal cells for each experiment This selection takes place from North to South of all coastal grid cells of Great Britain, then follows the continental coast from Belgium, Netherlands and Germany and ends in the North of Denmark. To identify a possible shift in the occurrence of high surge events (extremes) the resulting time series were studied with a focus on the statistical distribution, in particular on the upper tail of the distribution, i.e. the high percentiles. Since the aim of the study is the assessment of the resulting range of high surges due to the meteorological forcing simulated by different RCMs, figures 1 and 2 show a comparison between the surge along the selected 209 coastal cells forced with HIRHAM and RCA data for the winter season. Two different percentiles of storm surges, the 50- and the 99- percentiles) are shown, in each case for the CTL simulation (solid line) and the A2 SRES scenario (dashed line).

[1]

[1] **References:**

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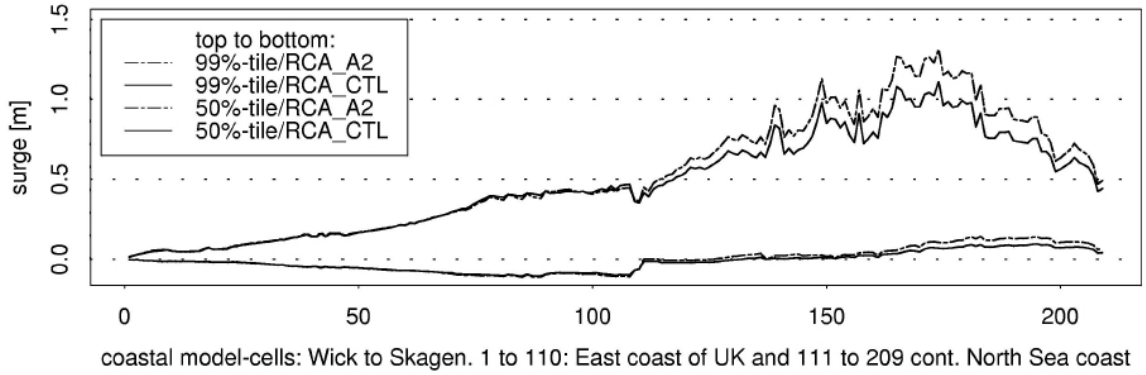

Fig.1 : Intra-annual percentiles (50 and 99) of storm surge (winter) CTL and A2 along 209 selected coastal cells. Modelled surge with meteorological forcing coming from RCA (SMHI)

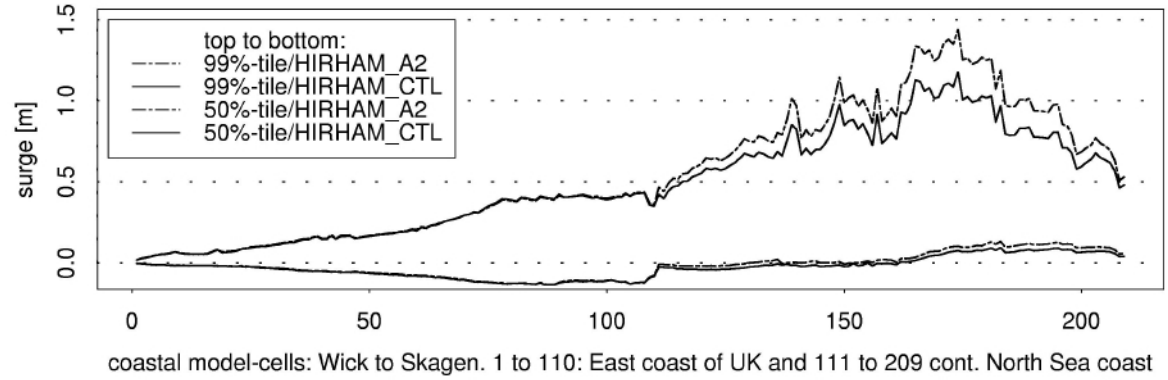

Fig.2 : Intra-annual percentiles (50 and 99) of storm surge (winter) CTL and A2 along 209 selected coastal cells. Modelled surge with meteorological forcing coming from HIRHAM (DMI)

For the control time slice, the percentiles of the modelled surge are very similar for both the HIRHAM and the RCA forcing. For the A2 SRES scenario, there is a regionally limited shift in the percentiles. An increase is noticeable only along the continental coast (right hand side of fig.1) but not along the UK coast. Furthermore, there is only a substantial increase in the high percentiles and not in the mean. The 99-percentile shows an increase of storm surge highs of up to 30 cm over several coastal cells along the Dutch coast and the German Bight. The percentiles of modelled surge with RCA forcing show a very similar pattern but are slightly weaker in the change between CTL and A2 scenario (~ up to 25 cm increase).

In respect to meet a statement about the statistical uncertainty of these estimations these first results will be extend by producing additionally storm surge model runs forced by comparable meteorological forcing data sets in the next month. Emphasis will be given to the analysis of possible changes in the occurrence of extreme storm surge events and the range of these storm surges regarding the ensemble of all available storm surge model runs.