KLIWAS
Climate · Water · Navigation

Departmental Research Programme
- National Meteorological Service in Germany (DWD)
- German Maritime and Hydrographic Agency (BSH)
- German Federal Institute of Hydrology (BfG)
- German Federal Waterways Engineering and Research Institute (BAW)

Wind Fields in the North Sea Region - Past and Possible Future Changes

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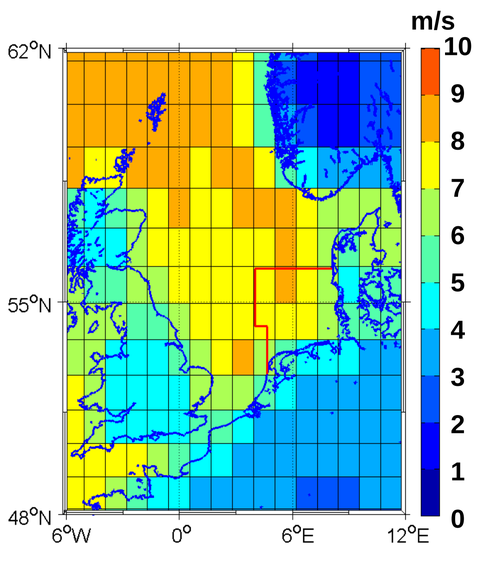
One aim of the research program KLIWAS is the analysis of the potential consequences of climate change for navigation on coastal waterways and for the safety of the coasts. Changes in wind fields can influence the safety of these, for example when the number or strength of storm floods rises with increasing wind speed, or the local tide water levels increase with modified wind climate. Therefore the important question arising is whether evidence can be found, indicating that in the North Sea region wind speeds will change in the future, as an effect of climate change. These possible changes are investigated by examining results of climate model runs, made available by the ENSEMBLE project (Hewitt et al., 2004).

ERA-40-wind fields over the North Sea 1971 - 2000:



For validation purposes for today's climate, model results are compared to ERA-40 re-analysis wind fields (Uppala et al., 2005). Over the North Sea mean 10 m wind speed decreases from North to South. All following comparisons of climate model and ERA-40 wind fields are restricted on results for the German Bight area, shown in figure 1.

Figure 1: *Mean values of 10 m wind speed (1971 - 2000), calculated from daily means of ERA-40. Red lines show the boundaries of the German Bight.*

Comparison of ERA-40 and Regional Climate Model wind speeds over the North Sea 1971 - 2000:

Method: Probability density functions (pdfs) of daily means of 10 m wind speeds over sea are calculated for all comparisons of ERA-40 wind fields to those of Regional Climate Models (RCMs). For this task the North Sea area is divided into 14 regions, including the German Bight in fig. 1. Pdfs are calculated for each region by concatenation over all sea grid points and all days of the regarded time period.

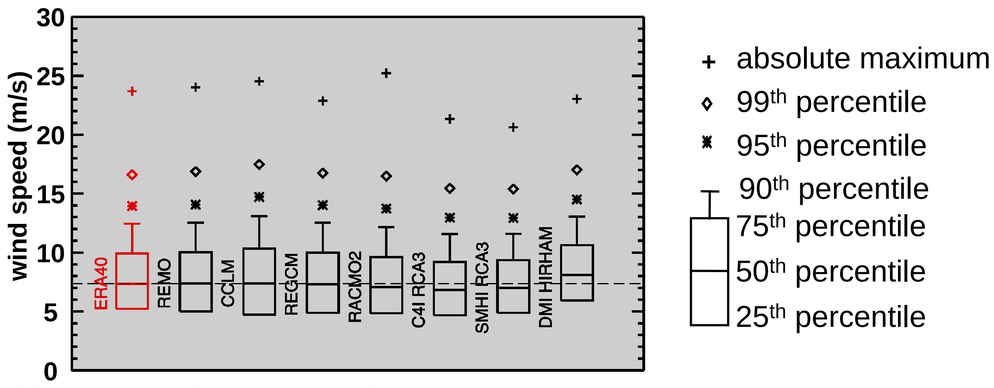
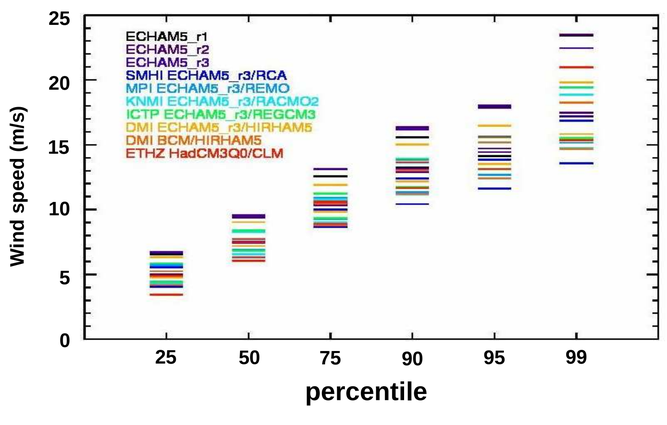


Figure 2: *Box Plots: Pdfs of ERA-40 and RCM wind speeds, where all RCMs were driven with ERA-40 data.*

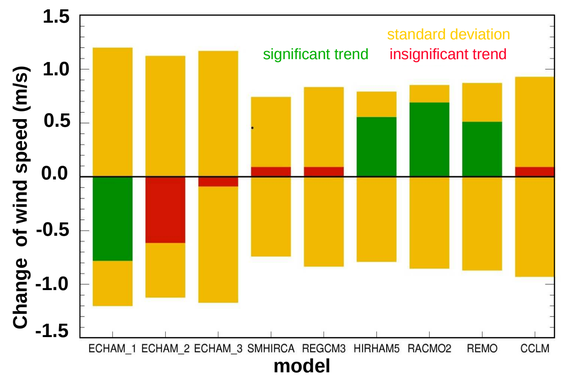
Ranges of percentile values, calculated with different climate models (1950 - 2099, A1B)

Figure 3: *Minimum and maximum values taken from time series of specific percentiles from yearly pdfs. Time series are calculated from daily wind speeds of 6 RCMs of the ENSEMBLES project and 3 different members of the global climate model ECHAM5.*



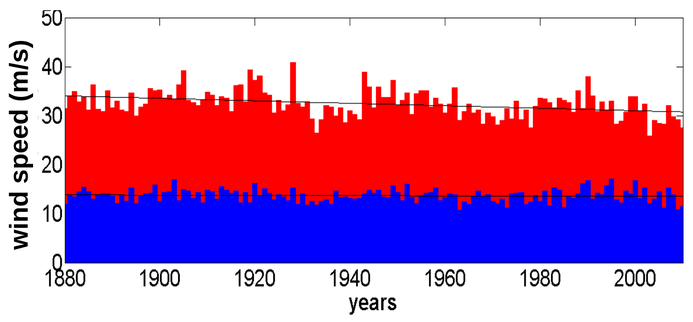
Standard deviations and trends of the 99th percentile , calculated with different climate models (1950 - 2099, A1B)

Figure 4: *Standard deviations and linear trends of time series of the 99th percentile of yearly pdfs of wind speeds, calculated by 6 RCMs and 3 members of ECHAM5. Mean changes of the 99th percentiles for 150 years, caused by significant linear trends, are indicated in green, for insignificant trends in red.*



Temporal changes of geostrophic wind over the German Bight 1880 - 2010:

Figure 5: *Time series of mean (blue) and 99th percentile (red) of yearly pdfs of geostrophic wind, calculated from measured sea level air pressure values (Three values a day). Measuring sites are close to the islands of Sylt and Borkum and to Hamburg. (See Schmidt and von Storch, 1993.)*



Literature

Hewitt, C. D. and D. J. Griggs, 2004: Ensembles-based Predictions of Climate Changes and their Impacts. Eos, 85, p 566.

Schmidt, H. and H. von Storch, 1993: German Bight storms analysed. Nature 365, p. 791.

Uppala, S. M. et al., 2005: The ERA-40 re-analysis. Q. J. R. Meteorol. Soc., 131, 2961-3012.

Conclusions

- Mean wind speeds in 10 m height over sea are decreasing from North to South over the North Sea.
- The comparison of climate model wind fields to ERA-40 re-analysis fields for the period 1971 -2000 shows good agreement for the medians of most models, but a larger spread for higher percentiles.
- For the period 1950 - 2099 and scenario A1B, yearly probability density functions (pdf) show high temporal variability, especially for higher percentiles. The range of specific percentiles for several model runs is large, e.g. 6.5 m/s for the 99th percentile (ECHAM5).
- No consistent trend can be found in time series of the 99th percentiles of yearly pdfs (1950 - 2099), which were calculated for various runs of regional climate models and a global climate model (all A1B). Also several runs of the same GCM (Runs 1 - 3 of ECHAM5) have trends which are not homogeneous in significance and sign. Additionally, the results of the RCMs SMHIRCA, REGCM3, HIRHAM5, RACMO and REMO, that were all forced with ECHAM5 (run3), differ in their trends from that of ECHAM5. Inhomogeneous trends in significance and sign are also found in all North Sea regions.
- The 99th percentile time series, calculated from yearly frequency distributions of geostrophic wind over the German Bight for the time period 1880-2010, indicates a high multidecadal temporal variability and a small negative significant trend. The annual means of geostrophic wind, however, show no significant trends.

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