Geophysical Research Abstracts
Vol. 13, EGU2011-7636, 2011
EGU General Assembly 2011

Changes in severe wind gust frequencies by the 2050s in Europe

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Future changes in the European windstorm frequencies and intensities have been a widely researched topic. Different studies have used e.g. mean wind speeds, geostrophic wind speeds or vorticity maxima to determine how the strong wind patterns and intensities are expected to change. However in the end the final cause for widespread damages to e.g. infrastructure and forestry are the brief wind gusts usually related to severe low pressure systems. Therefore this paper casts a look on how severe wind gust occurrences will change by the middle of this century in Europe according to an ensemble of six downscaled regional climate models (RCMs).

Three wind gust thresholds (17, 25 and 32 m/s) were selected and changes in exceedance days were analyzed. Six RCMs with 25 km spatial resolutions from the ENSEMBLES-project were used in this study. The SRES A1B emission scenario was used in every model combination (SMHI-RCA-ECHAM5-r3, SMHI-RCA-HadCM3Q3, SMHI-RCA-BCM, MPI-REMO-ECHAM5-r3, KNMI-RACMO-ECHAM5-r3 and C4I-RCA3-HadCM3Q16).

Annual wind gust frequency changes were examined by using two slightly different ways. The first process used the delta methodology. The simulated change in the average wind gust speed between the time periods 1989-2009 and 2041-2070 was used to modify the ERA-Interim daily wind gust speed data from the period 1989-2009. Changes in the wind gust frequencies could then be determined by comparing the original and modified datasets. In the second method the wind gust frequency changes were directly calculated from the RCM simulations.

European-wide maps were produced with both methods showing the multi-model mean changes for the three thresholds as well as areas where all six RCMs agreed on the sign of the change. In addition maps with the most extreme changes of any model were made to indicate the range of changes.

The multi-model mean results show that an increase in the severe wind gusts can be expected to occur especially over the Baltic Sea and in parts of the Central Europe and around the Aegean Sea. The area with the strongest model agreement lies over most of the Northern Atlantic where a decrease in annual severe gust frequencies is expected. Also the Mediterranean, in general, is expected to endure fewer severe wind gusts. A decrease over land areas is shown in the Atlantic influenced countries like Norway, Iceland and Ireland.

Modeled wind gust changes are not as unanimous as e.g. the simulated temperature or precipitation changes. RCMs use different kinds of parameterization schemes and there is a large disparity between the model outcomes especially due to the influences of the driving GCMs. A larger available model ensemble with parameterized wind gusts and possible improvements in the wind gust parameterization schemes are expected to be helpful for future studies.