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European winter storms and their modification under climate change from a multi-model perspective

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Winter storm events (ONDJFM) and their changes due to increased anthropogenic greenhouse gas concentrations over Europe are investigated. In order to assess the uncertainties due to model formulation, 4 regional climate models (RCMs) with 5 high resolution experiments, and 4 global models (GCMs) are considered. Firstly, cyclone systems as synoptic scale processes in winter are investigated, as they are mainly relevant for the occurrence of extreme, damage causing wind speeds. This is achieved by use of an objective cyclone identification and tracking algorithm, applied to the GCMs. Secondly, changes in extreme near surface wind speeds are analysed. Based on percentile thresholds, the studied extreme wind speed indices allow a consistent analysis over Europe and take systematic deviations of the models into account. Relative changes in both intensity and frequency of extreme winds and their related uncertainties are assessed and related to changing patterns of extreme cyclones. Common feature of all investigated GCMs is a reduced track density over Central Europe under climate change conditions if all systems are considered. If only extreme (i.e. the 5% strongest) cyclones are taken into account, an increasing cyclone activity for western parts of Central Europe is analysed, although the climate change signal reveals reduced spatial coherency as compared to all systems, partly revealing contrary results. With respect to extreme wind speeds, areas with significant positive changes in intensity and frequency are identified. Location and extension of the affected areas, as well as the levels of changes are shown to highly depend on the driving GCM, whereas differences between RCMs when driven by the same GCM are relatively small.