Analysis of the atmospheric circulation and cyclone tracks concerning the occurrence of wind storm events in Central Europe

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1. Motivation / Objective

Windstorms are the most loss-intensive natural hazards in Central Europe. In this study, characteristics of European storm events are investigated. Two different methods of storminess identification are applied. The identified events are classified into circulation weather types and the associated wind speeds and cyclone tracks are investigated in order to provide an insight into synoptical features of storms in the different classes. Analysis are performed for ERA40 reanalysis and an ensemble of 9 GCM simulations for 20th century (20C) and the 21st century following the SRES A1B scenario (A1B) *.

2. Detection of storm events and classification of circulation weather types

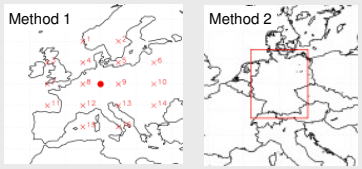
Method 1 (based on flow characteristics; Jenkinson and Collison, 1977):

- Calculation of geostrophically approximated flow based on MSLP data on a surrounding 2.5°x2.5° grid
- Classification of flow: directional, (anti-) cyclonal, hybrid
- Gale day: if sum of directional flow and vorticity exceeds a certain threshold

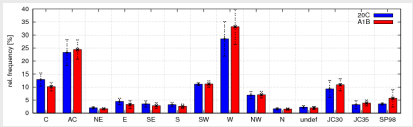
Method 2 (based on occurrence of extreme wind speeds):

- Storm day: if 98th percentile of daily maximum wind speeds is exceeded in at least 25% of investigation area (scaled to identification of important historical events)

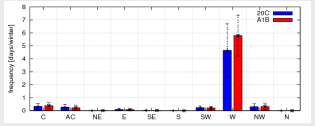
a) Investigation areas for identification of storm days



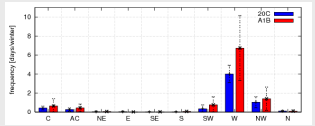
b) Relative frequency of circulation weather types (CWTs)



c) CWTs on gale days (method 1)



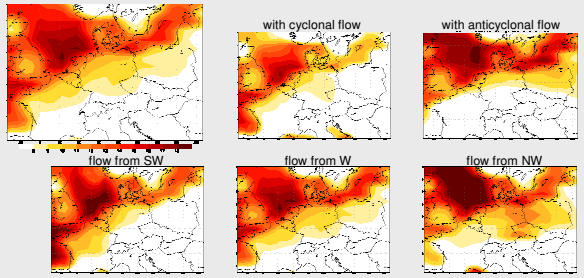
d) CWTs on storm days (method 2)



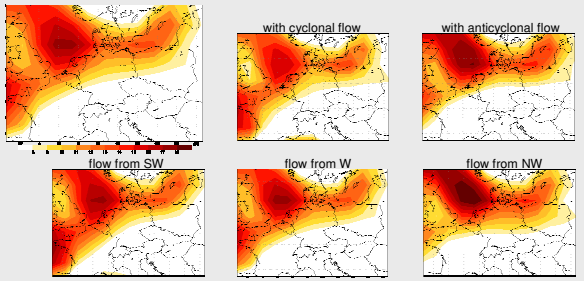
Solid bars: Ensemble Mean*
Uncertainty bars: Standard deviation of the 9 simulations

3. Wind speed on gale days (method 1)

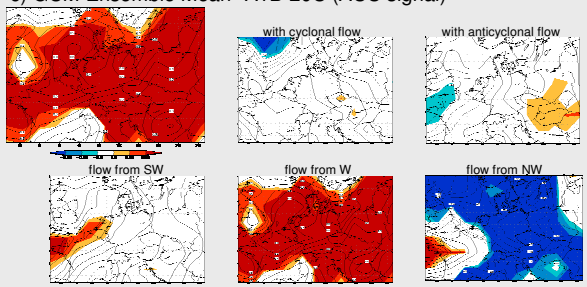
a) average over all gale days in ERA40 [m/s]



b) GCM Ensemble Mean* 20C [m/s]

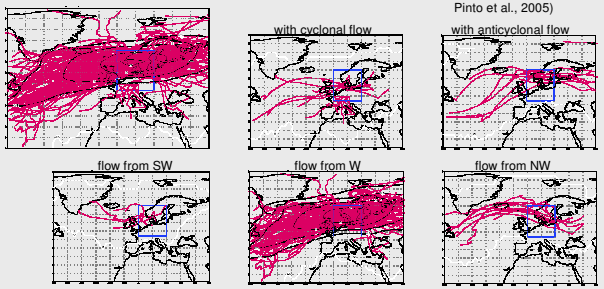


c) GCM Ensemble Mean* A1B-20C (ACC signal)

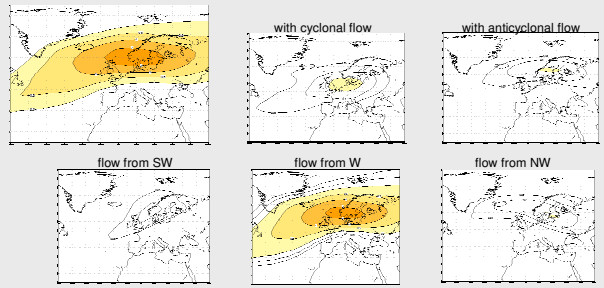


4. Cyclone tracks assigned to gale days

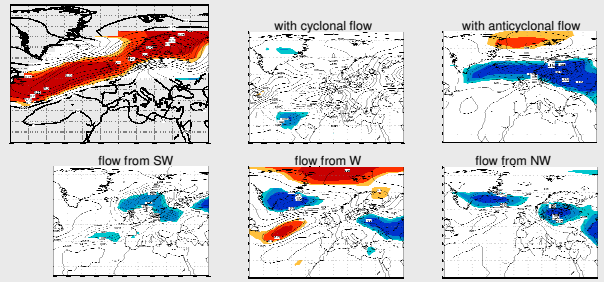
a) Cyclone tracks associated to storm in ERA40 (tracking after Murray & Simmonds, 1991; Pinto et al., 2005)



b) GCM Ensemble Mean* 20C



c) GCM Ensemble Mean* A1B-20C



References:
Jenkinson and Collison (1977), Memorandum No. 62, UK Met Office, Bracknell
Murray and Simmonds (1991), Aust Met Mag 39:155-166
Pinto et al. (2005), Meteorol Z 14:823-838

* GCM Ensemble consists of ENSEMBLES-Project setup: BCCR-BCM2, CNRM-CM3, DMI-ECHAM5OM1, FUB-EGMAM, HadGEM1, IPSL-CM4, MPI-ECHAM5OM1 runs 1,2,3

5. Summary and Conclusions

- The majority of detected storm days are connected with westerly flow
- Most frequent pathway of cyclone systems leading to storm in Central Europe is from North-Atlantic via the northern part of the British Isles, North Sea and southern Scandinavia to the Baltic Sea
- The mean intensity of the systems reaches its maximum around the British Isles
- Highest wind speeds over inland areas occur with flow from NW
- Under anthropogenic climate change conditions the number of detected windstorm events over Europe increases in almost all models
- The increased number of storm days is connected with a more frequent westerly flow
- The mean intensity of storm cyclones increases by more than 10 per cent in the area of Eastern Atlantic, around British Isles and into the North Sea
- Also the windspeed in relation with storm events increases significantly, mainly on days with westerly flow
- Similar results for storm days (method 2) underline robustness of results