

Occurrence of extratropical cyclones and windstorms in multi-model simulations for recent and future climate

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1. Motivation / Objective

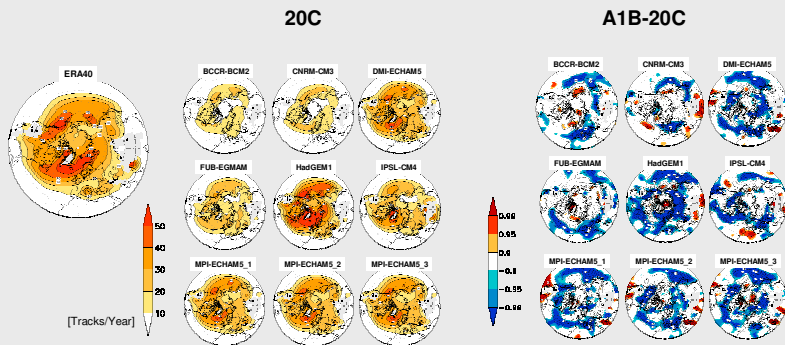
Cyclone tracks, extreme wind speeds and storm loss potentials are analysed in an ensemble of climate model simulations in order to

- Estimate changes of cyclone activity and occurrence of extreme wind speeds under ACC
- Obtain a range of possible changes with increased GHG forcing
- Address uncertainties arising from different signals in different models

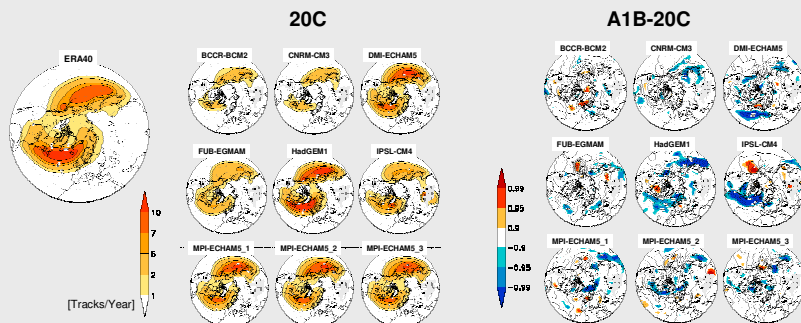
Analysis is performed for ERA40 reanalysis and an ensemble of 9 GCM simulations for 20th century (20C) and the 21st century following the SRES A1B scenario (A1B), following the ENSEMBLES-Project setup

2. Cyclone Tracks in individual simulations

a) Track Density of all cyclone systems (tracking after Murray & Simmonds, 1991; Pinto et al., 2005)



b) Track Density of extreme cyclones (strongest 5% with respect to $\nabla^2 p$)

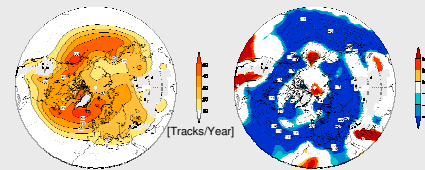


(Plots of climate change signals: difference A1B-20C is displayed by contour lines, coloured areas indicate the level of statistical significance (Student t-test))

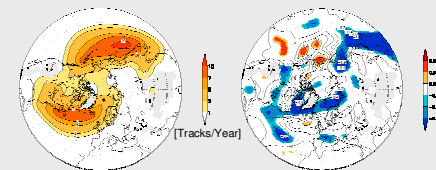
3. Ensemble Mean

Ensemble means for different parameters are calculated by equally weighting all regarded GCM simulations.

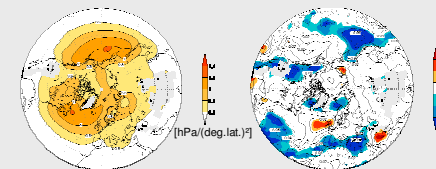
a) Track Density of all Cyclone Systems



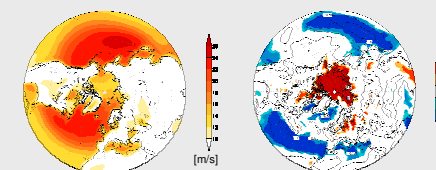
b) Track Density of extreme Cyclones (strongest 5%)



c) Mean Intensity of Cyclones ($\nabla^2 p$)



d) 98th percentile of daily max. wind speed



References:
Murray and Simmonds (1991), Aust Met Mag 39:155-166
Pinto et al. (2005), Meteorol Z 14:823-838

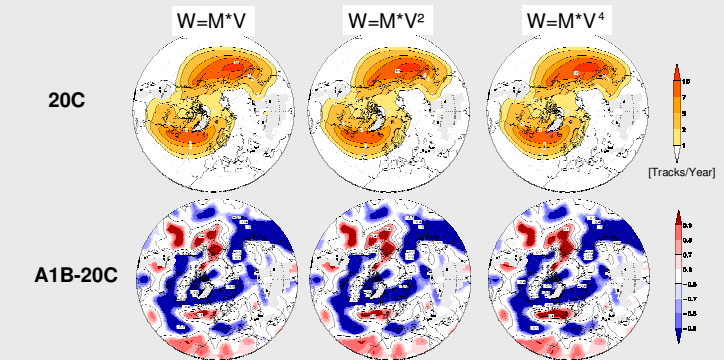
4. Weighted Ensemble Mean

Weighting factors are based on the ability of each model to reproduce the present day climatology.

a) Spatial correlation of mean track density and variance GCM vs. ERA40

	DMI	BCCR	CNRM	FUB	Had-GEM1	IPSL	MPI1	MPI2	MPI3
MEAN M	0.94	0.88	0.87	0.90	0.93	0.81	0.94	0.94	0.94
Variance V	0.82	0.79	0.71	0.75	0.76	0.69	0.74	0.75	0.74
$W=M*V$	0.77	0.70	0.62	0.68	0.71	0.56	0.70	0.71	0.70
$W=(M*V)^2$	0.59	0.49	0.38	0.46	0.50	0.31	0.49	0.50	0.49
$W=(M*V)^3$	0.46	0.34	0.24	0.31	0.36	0.18	0.34	0.36	0.34
$W=(M*V)^4$	0.35	0.24	0.15	0.21	0.25	0.10	0.24	0.25	0.24

b) Weighted Ensemble Mean of extreme cyclones



5. Summary and Conclusions

- Considered GCMs reveal partially different signals with increased GHG forcing
- Majority of models shows largely reduced number of cyclone systems, whereas number of extreme cyclones over NE-Atlantic is increased in most simulations
- Ensemble Mean (with equal weights for all models) reveals
 - decrease of cyclone track density in large areas of Northern Hemisphere
 - slightly significant increase of extreme cyclones track density over north-eastern parts Atlantic and Pacific Ocean
 - increased mean intensity of systems over north-east Atlantic
 - higher extreme wind speeds over parts of northern Central Europe
 - lower extreme wind speeds over Southern Europe
- A weighted ensemble mean (favouring models which are able to better reproduce the present day climatology) reveals a higher significance of signals e.g. for extreme cyclones track density