

# Variability of daily winter wind speed distribution over Northern Europe during the past millennium in regional and global climate simulations.

S. E. Bierstedt<sup>1</sup>, B. Hünicke<sup>1</sup>, E. Zorita<sup>1</sup>, S. Wagner<sup>1</sup>, J. J. Gómez-Navarro<sup>2</sup>

contact: svenja.bierstedt@hzg.de

## Abstract:

We analyse the variability of the probability distribution of daily wind speed in wintertime over Northern and Central Europe. The focus of the study lies in identifying the link between the variations in the wind speed distribution to the regional near-surface temperature, to the meridional temperature gradient and to the North Atlantic Oscillation.

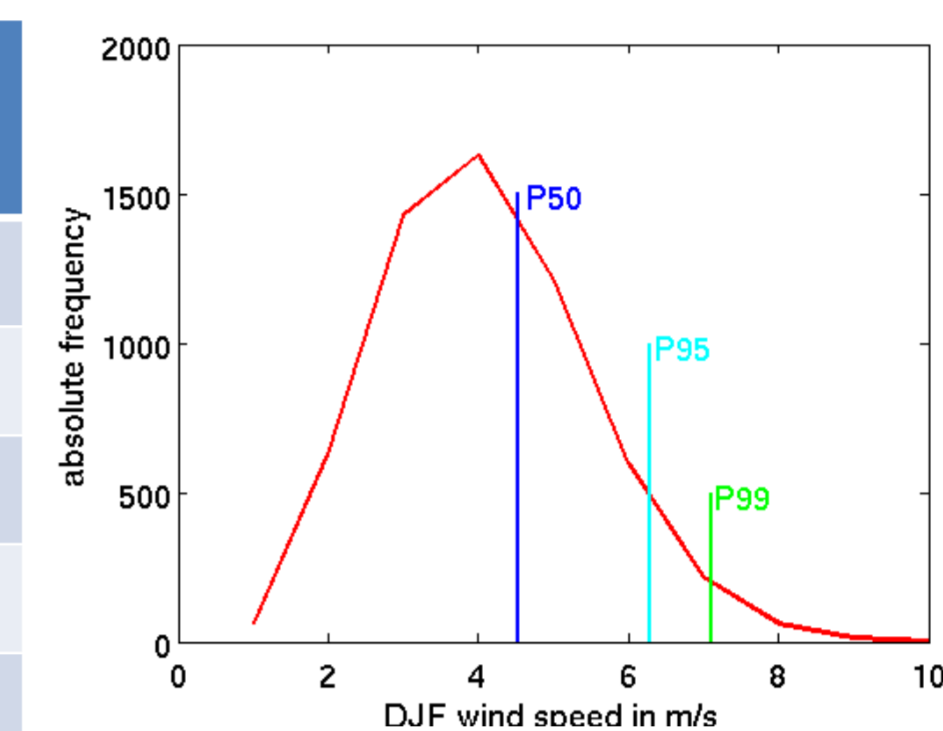
Our main result is that the link between the daily wind distribution and the regional climate drivers is strongly model dependent. In addition, considering multi-centennial time scales, we find in two global simulations a long term tendency for the probability distribution of daily wind speed to widen through the last centuries. The cause for this widening is likely the effect of the deforestation prescribed in these simulations.

The understanding of past and future changes in the distribution of wind speeds, and thus of wind speed extremes, will require a detailed analysis of the representation of the interaction between large-scale and small-scale dynamics.

## Data & Method

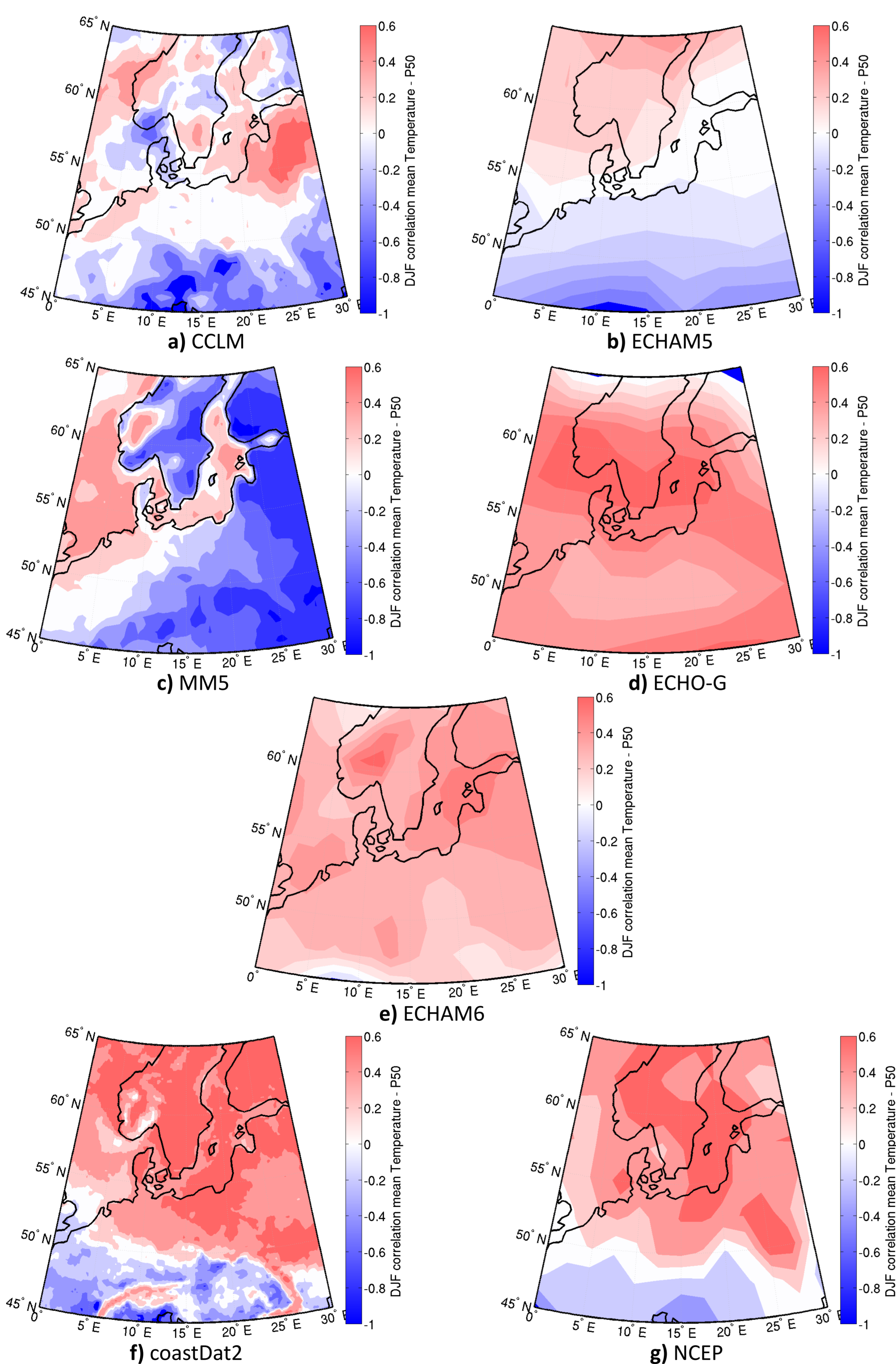
	Simulation	Atmosphere	Ocean	Boundary	Atm. spatial resolution	Vegetation	Period
GCM	ECHO-G	ECHAM4	HOPE-G		3.75°	Constant	1001-1990
	ECHAM5	ECHAM5	MPI-OM		3.75°	Time dependent	850-2005
	ECHAM6	ECHAM6	MPI-OM		1.875°	Time dependent	850-2005
RCM	MM5	MM5		ECHO-G	0.5°	Constant	1001-1990
	CCLM	CCLM		ECHAM5	0.5°	Constant	1655-1999
Reanalysis	coastDat2	CCLM*		NCEP	0.22°	Constant	1948-2012
	NCEP				2.5°	Constant	1948-2012

\* with spectral nudging



- Investigate changes in distribution shift and/or shape with: P50, STD, P90, P95 and differences between P95-P50 and P99-P95
- 30y running values (simulations) 5y running values (reanalysis)
- Correlations with potential drivers: mean temperature, meridional temperature gradient, NAO

## mean Temperature – 50<sup>th</sup> percentile

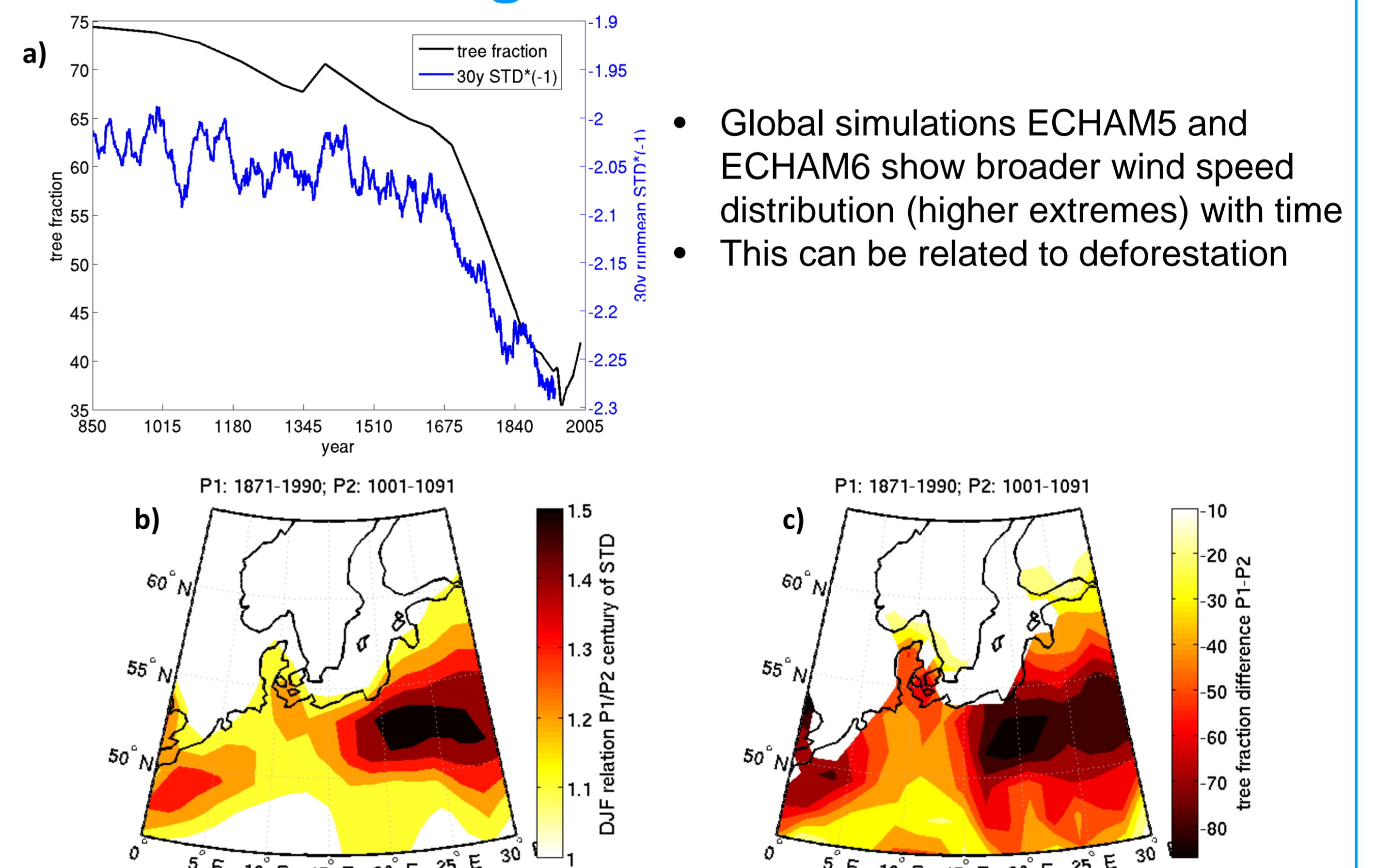


Correlation of field mean temperature and 50th percentile of wind speed for 7 different data sets: (a) CCLM (1655–1999 AD), (b) ECHAM5 (850–2005 AD), (c) MM5 (1001–1990 AD), (d) ECHO-G (1001–1990 AD), (e) ECHAM6 (850–2005 AD), (f) coastDat2 (1948–2012 AD), (g) NCEP (1948–2012 AD).

## Temporal Correlation

- all data sets show reasonable connections between the large-scale drivers (mean temperature, temperature gradient and NAO)
- RCMs (MM5 and CCLM) exhibit a relationship between cooler temperatures and a shift and changing shape towards higher wind speeds
- regional data sets (MM5, CCLM and coastDat2) show a positive link between stronger winds and stronger temperature gradients

## Land-Use Change



(a) tree fraction after Pongratz et al. (2008) (black) averaged over the whole area. ECHAM6 30y running mean STD of wind speed (multiplied by -1) (blue). (b) Relation between part 1 (P1: 1871–1990) and part 2 (P2: 1001–1091) STD of wind speed (ECHAM6). (c) Tree fraction difference of P1 minus P2

## Conclusion

The links are strongly model dependent:

- Global simulations show comparable results
- Regional simulations are also comparable but surprisingly different from driving global simulations
- Reanalysis results resample global simulation results
- There is no clear relation between mean temperature, temperature gradient, NAO and wind speed distribution
- Further investigations regarding the interaction between small-scale and large-scale drivers is needed

## Publication:

Bierstedt, S.E., Hünicke, B., Zorita, E., Wagner, S. and Gomez-Navarro, J.J. (2015): Variability of daily winter wind speed distribution over Northern Europe during the past millennium in regional and global climate simulations. *Clim. Past Discuss.* 11, 1479-1518.