Estimation of extreme storm and precipitation events in climate scenarios

Dr. G.C. Leckebusch

GCL@MET.FU-BERLIN.DE

Prof. Dr. U. Ulbrich

ULBRICH@MET.FU-BERLIN.DE

With special thanks to: Andreas Krüger, Tim Brücher, Andreas Weimer and Joaquim Pinto

What do we know about extreme events?

(E.g. with respect to intensities, frequencies, or physical causes)?

Past conditions:

- Information from paleo climate **proxi data**,
- Historical ship records, especially from trading routes from the NA

Existing: mostly local information,
Missing: **large-scale conditions**, information about physical processes

Actual climate conditions:

- Information from **observations**, or e.g. **re-analysis** data projects

Existing: very short time span of local and large-scale information
Missing: **long** enough **time series** to estimate **natural climate variability**

Future climate conditions:

- Information from **climate model simulation** based on scenario assumptions

Existing: Large-scale information, detection of causing physical processes possible
Missing: **local information** to adopt impact assessments and mitigation strategies

What do we know from global coupled climate model simulations (AOGCM'S)?

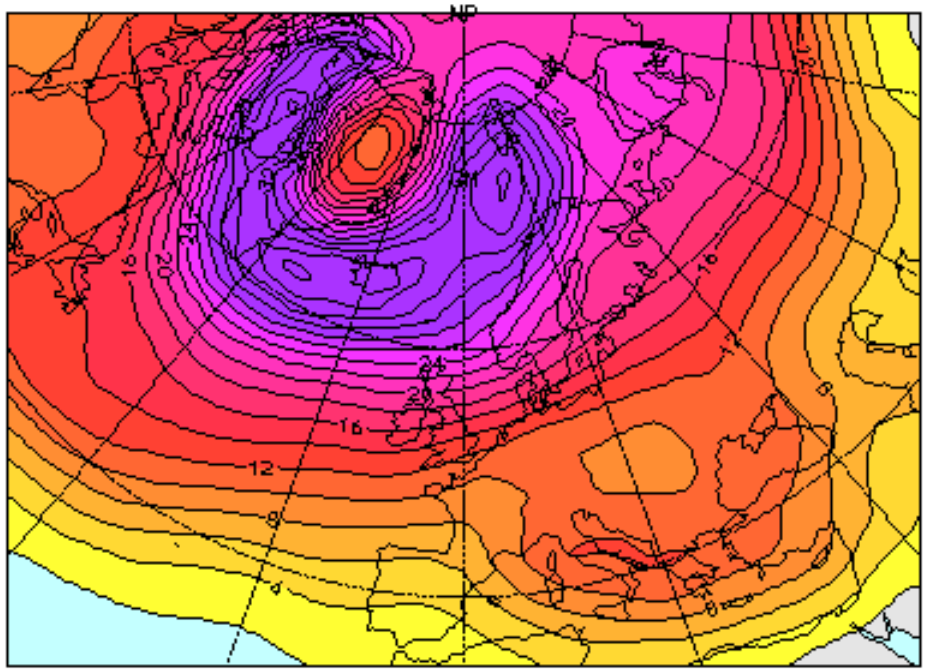
For actual climate and climate change conditions:

- **Due to the horizontal resolution of AOGCM's:**
- **Information only direct usable on well resolved scales of the model, e.g. synoptic or large scale**
- **Extremes in the model context are not necessarily reproduced in a similar amount as in reality**
- **Thus, it is more valuable to investigate relative extremes (e.g. percentile technique) or to diagnose scaled phenomena responsible for the occurrence of local extremes**

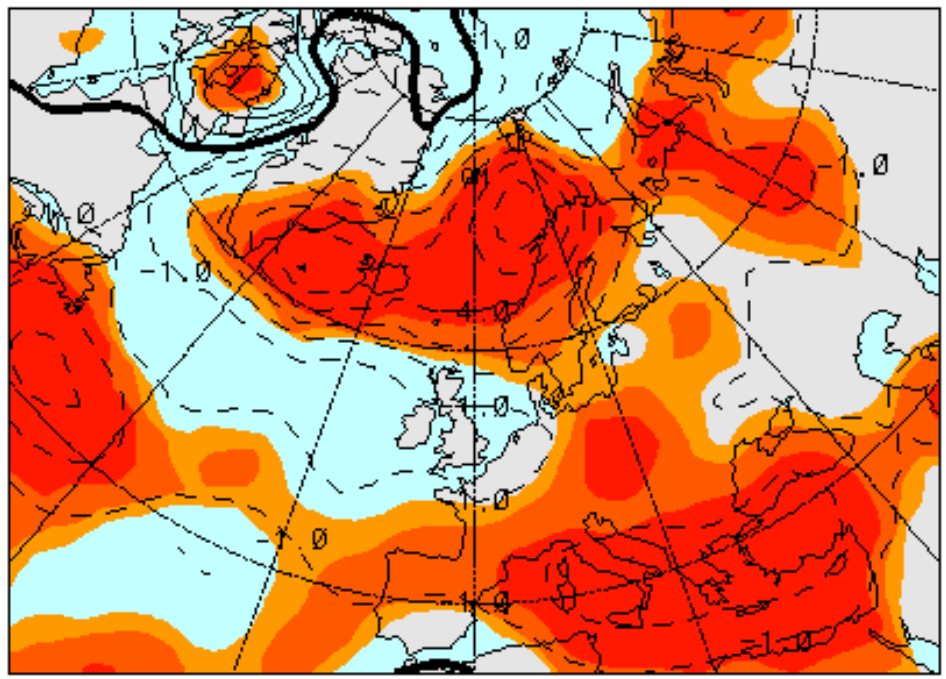
HadCM3

Cyclone Track Density **Winter (=ONDJFM)**

1960-1989; Common period | „all systems“ | A2a – COM; 2070-2099



Contour interval 2.0



Contour interval 1.0

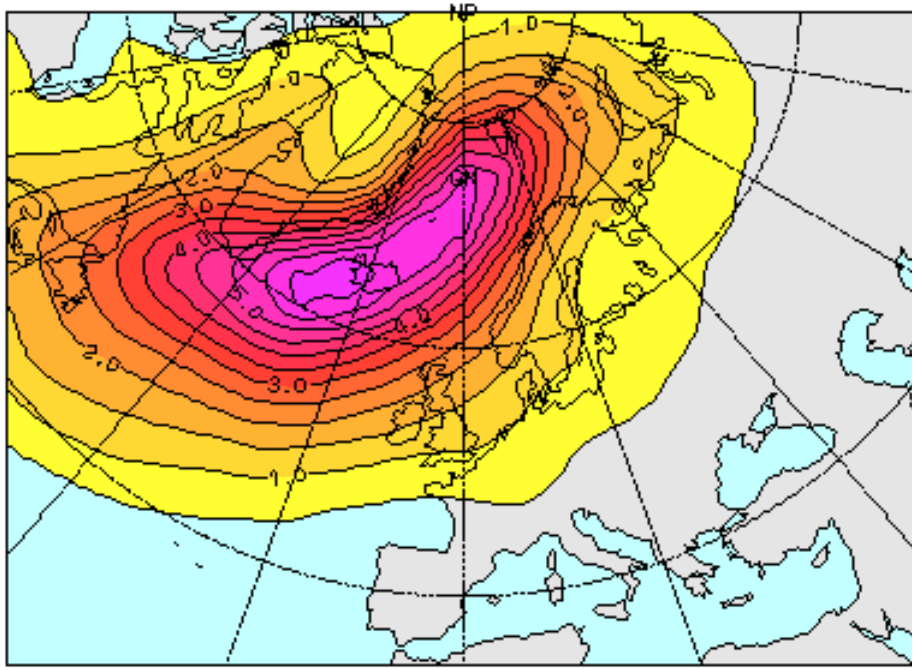
Unit: Systems / Grid Unit / Winter

Coloured: statistical significance (90%, 95%, 99%) according to a Students-t-Test

HadCM3 **Cyclone Track Density** **Winter (=ONDJFM)**

Extreme cyclones > 95th percentile

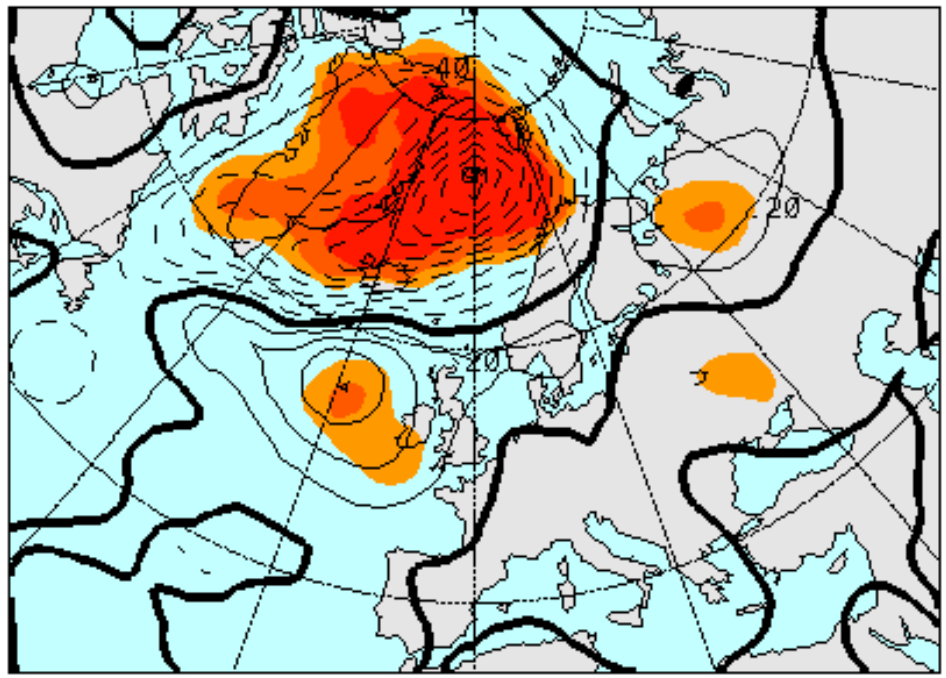
1960-1989; Common period



Contour interval 0.5

Unit: Systems / Grid Unit / Winter

A2a – COM; 2070-2099



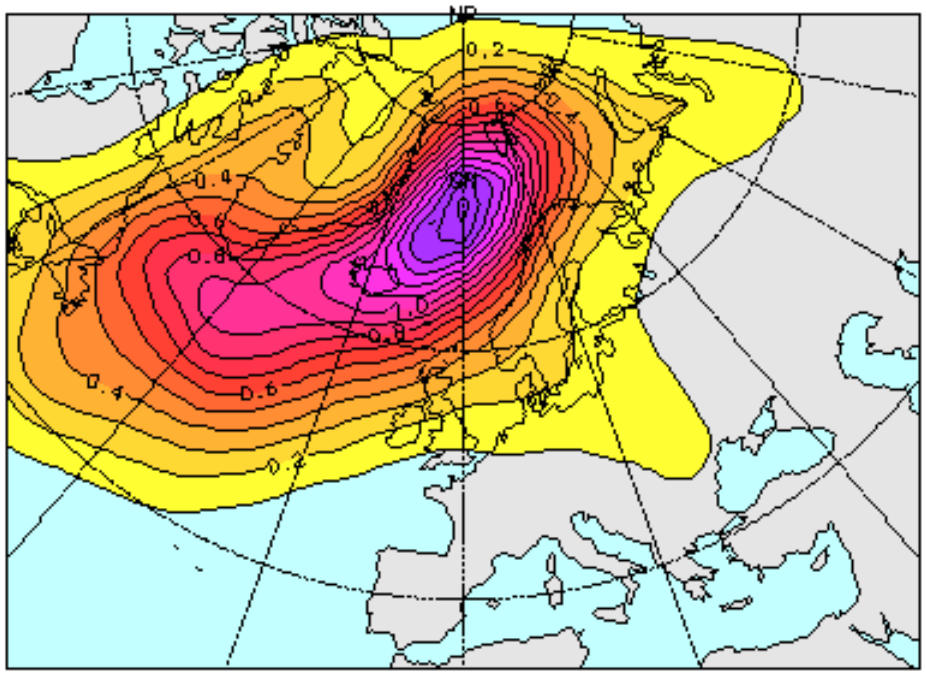
Contour interval 0.2

Coloured: statistical significance (90%, 95%, 99%) according to a Students-t-Test

HadCM3 **Cyclone Track Density** **Winter (=ONDJFM)**

Extreme cyclones > 99th percentile

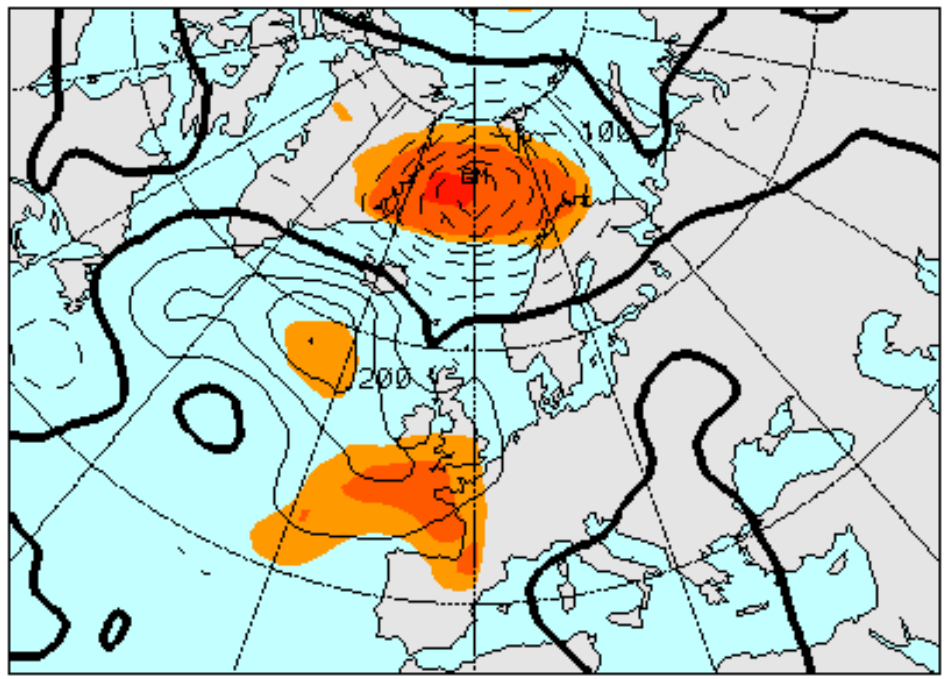
1960-1989; Common period



Contour interval 0.1

Unit: Systems / Grid Unit / Winter

A2a – COM; 2070-2099



Contour interval 0.1

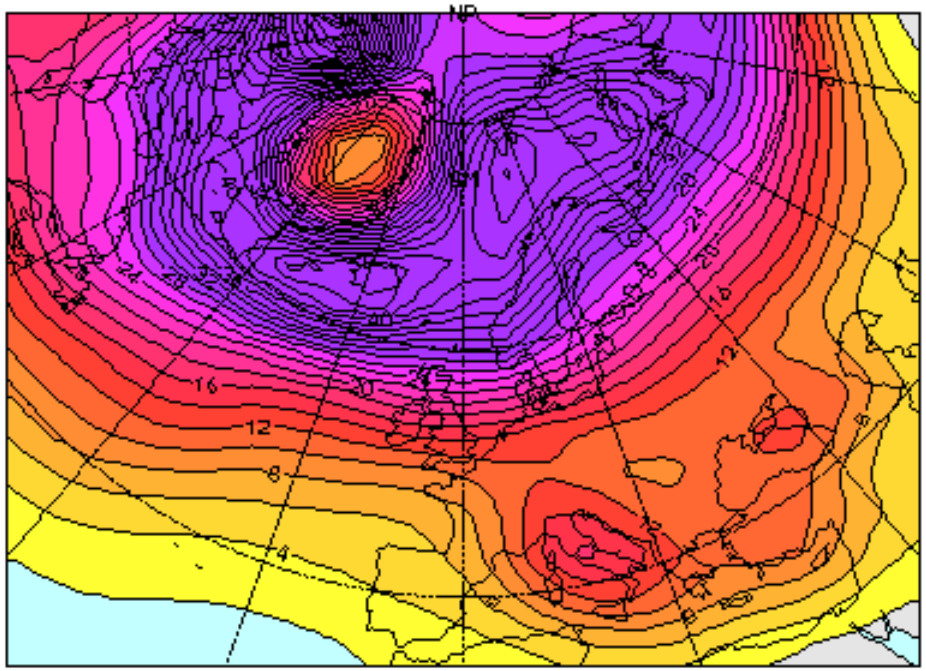
Coloured: statistical significance (90%, 95%, 99%) according to a Students-t-Test

HadAM3P **Cyclone Track Density** **Winter (=ONDJFM)**

1960-1989; Common period

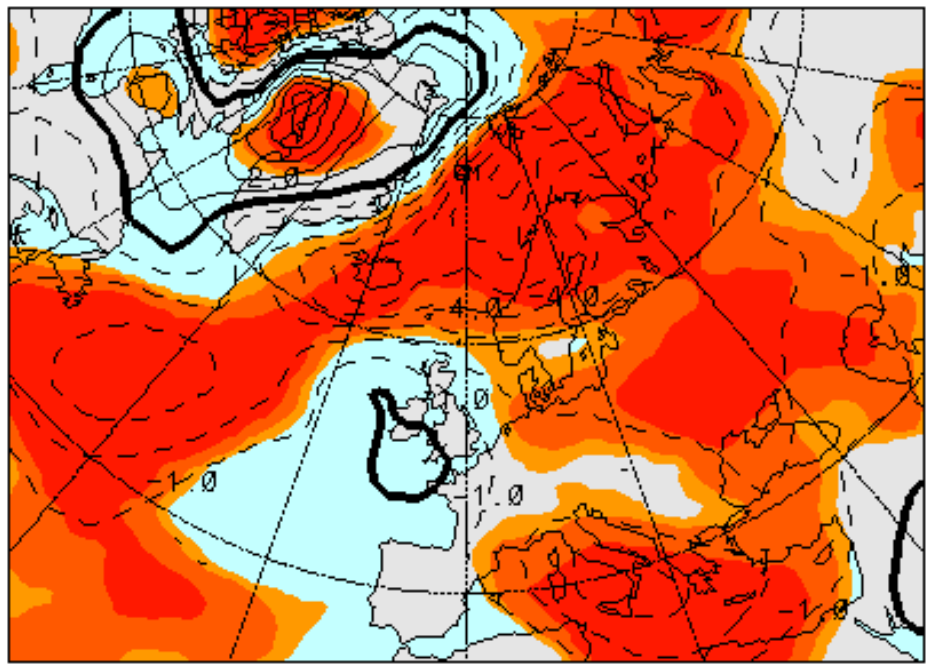
„all systems“

A2a – COM; 2070-2099



Contour interval 1.0

Unit: Systems / Grid Unit / Winter



Contour interval 1.0

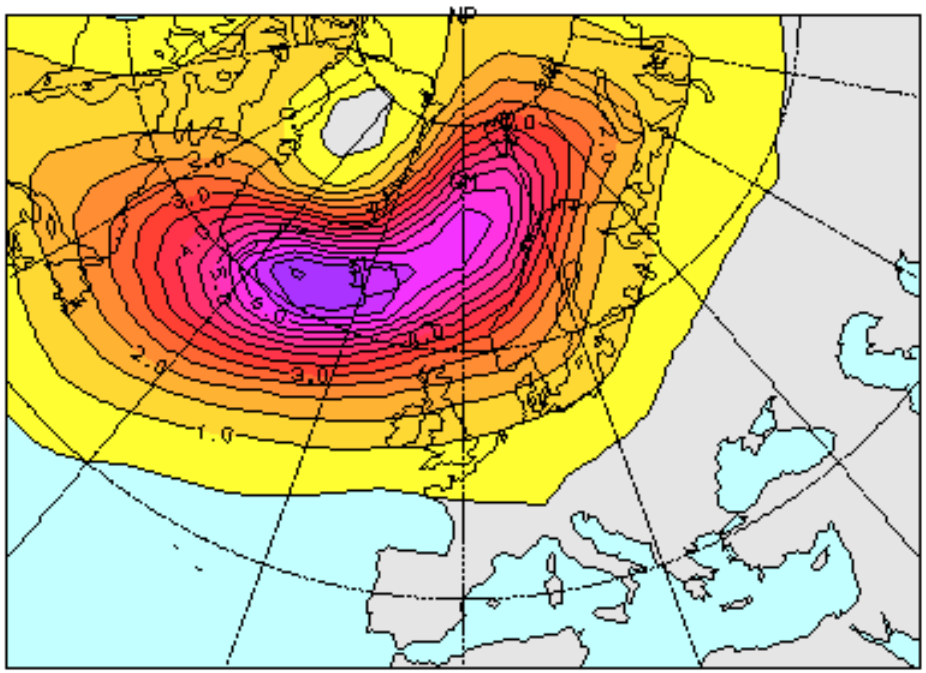
Coloured: statistical significance (90%, 95%, 99%) according to a Students-t-Test

HadAM3P **Cyclone Track Density** **Winter (=ONDJFM)**

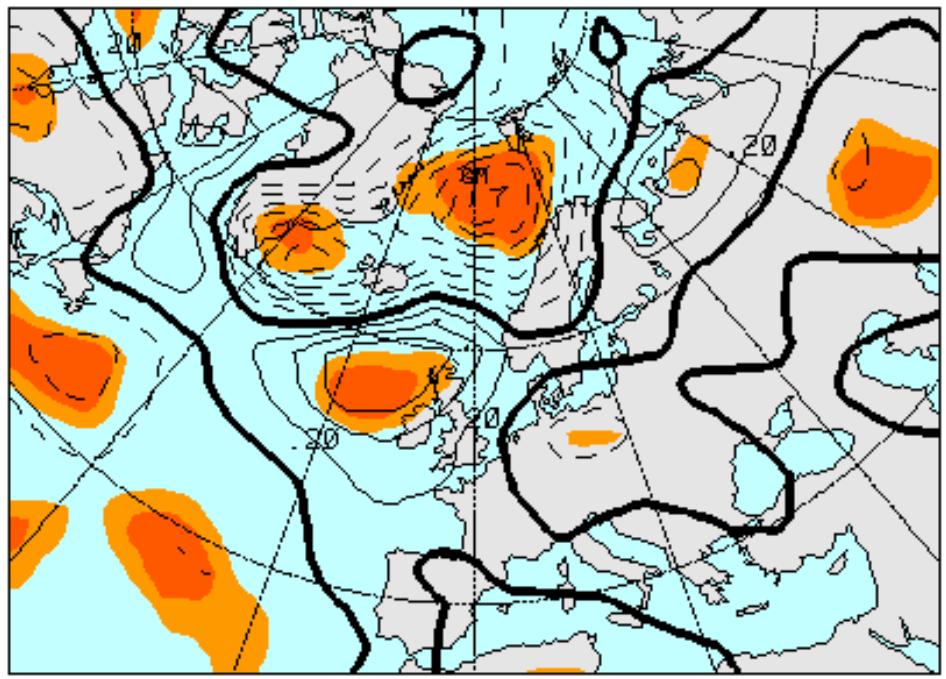
Extreme cyclones > 95th percentile

1960-1989; Common period

A2a – COM; 2070-2099



Contour interval 0.5



Contour interval 0.2

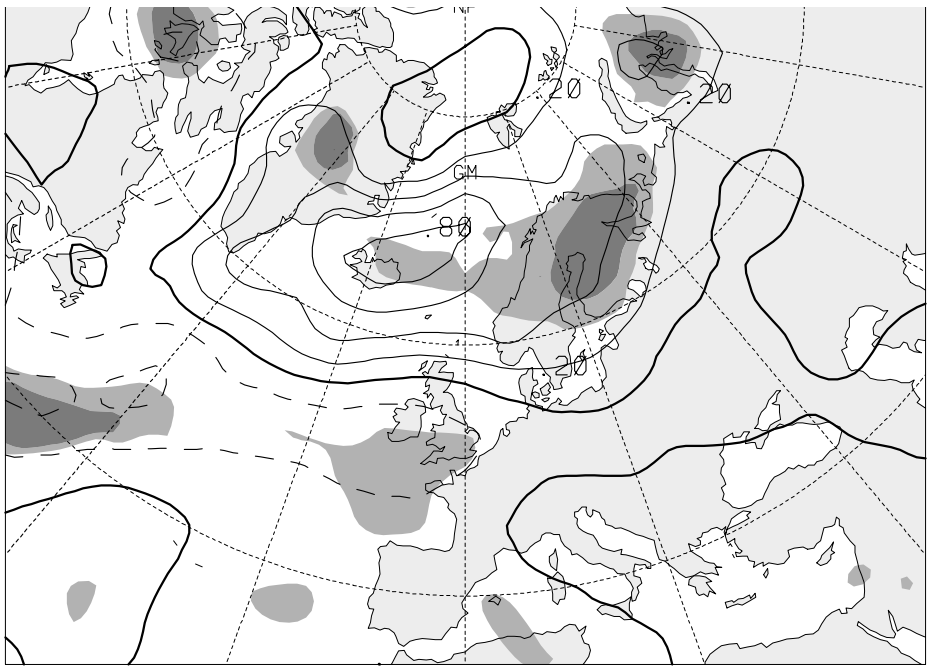
Unit: Systems / Grid Unit / Winter

Coloured: statistical significance (90%, 95%, 99%) according to a Students-t-Test

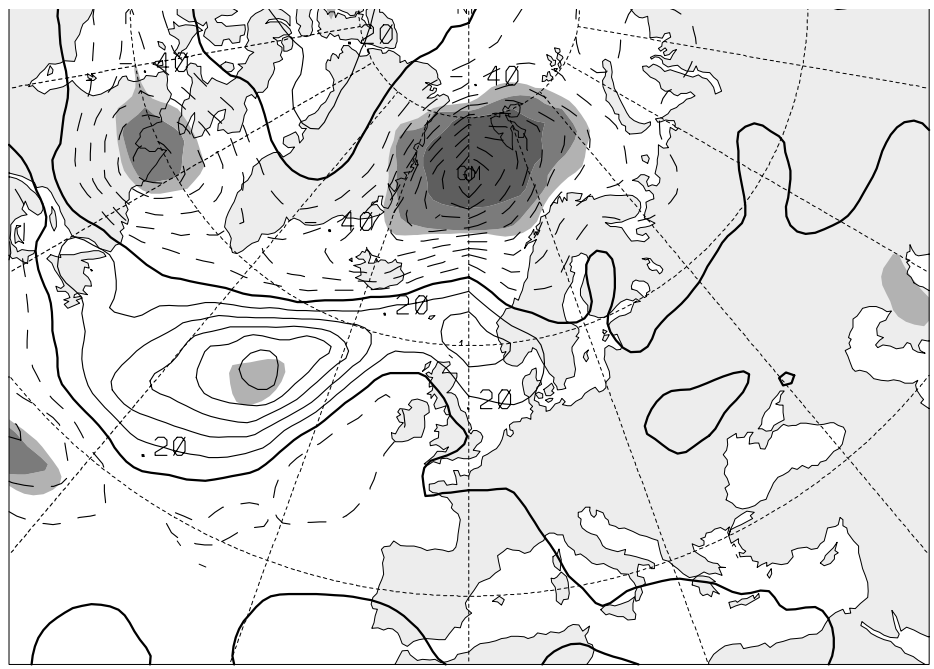
ECHAMx Cyclone Track Density Winter (=ONDJFM)

Extreme cyclones > 95th percentile

ECHAM4/OPYC3

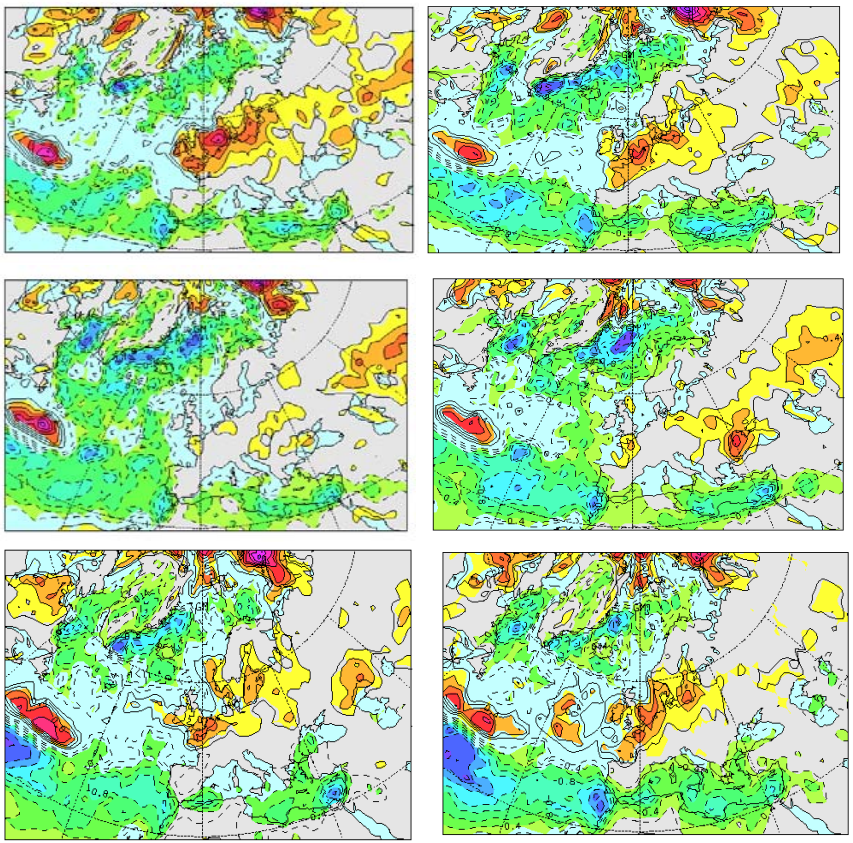


ECHAM5/OM1

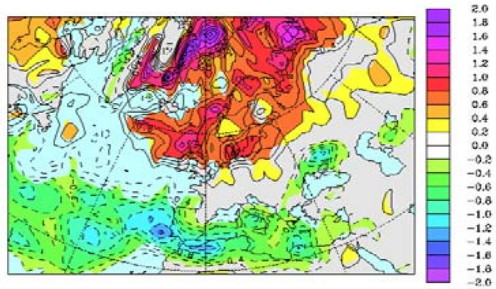


10 m Wind, 98th percentile, climate change signal (2061-2100 vs. 1961-2000)

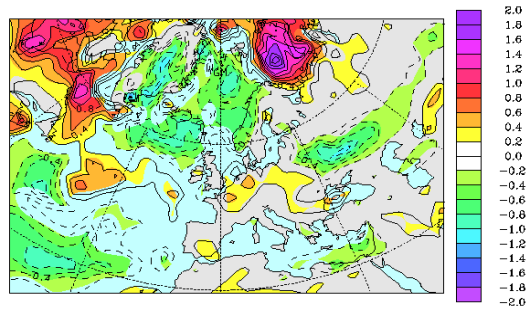
ECHAM5, A1B ECHAM5, A2



ECHAM4, IS92a



HadCM3, A2



What do we need to know on meso- or local scale?
(Where local decisions affect local actions)

For future climate conditions:

- **Will a changed large scale extreme occurrence influence the occurrence of local- or meso-scale extreme events?**

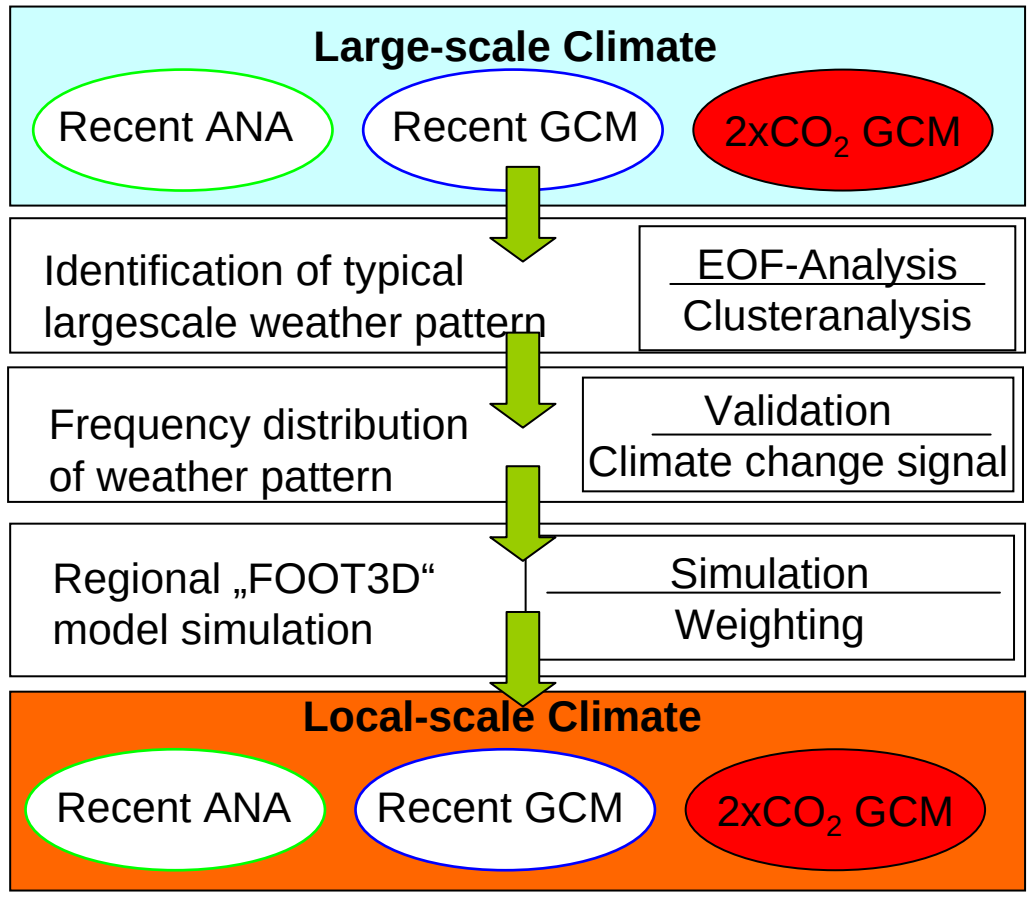
- **Remains the relationship between the large-scale extreme event occurrence and local extremes deduced from recent climate conditions stable for future climate conditions?**

- **Or do changing conditions lead to non-linear feedback mechanisms?**

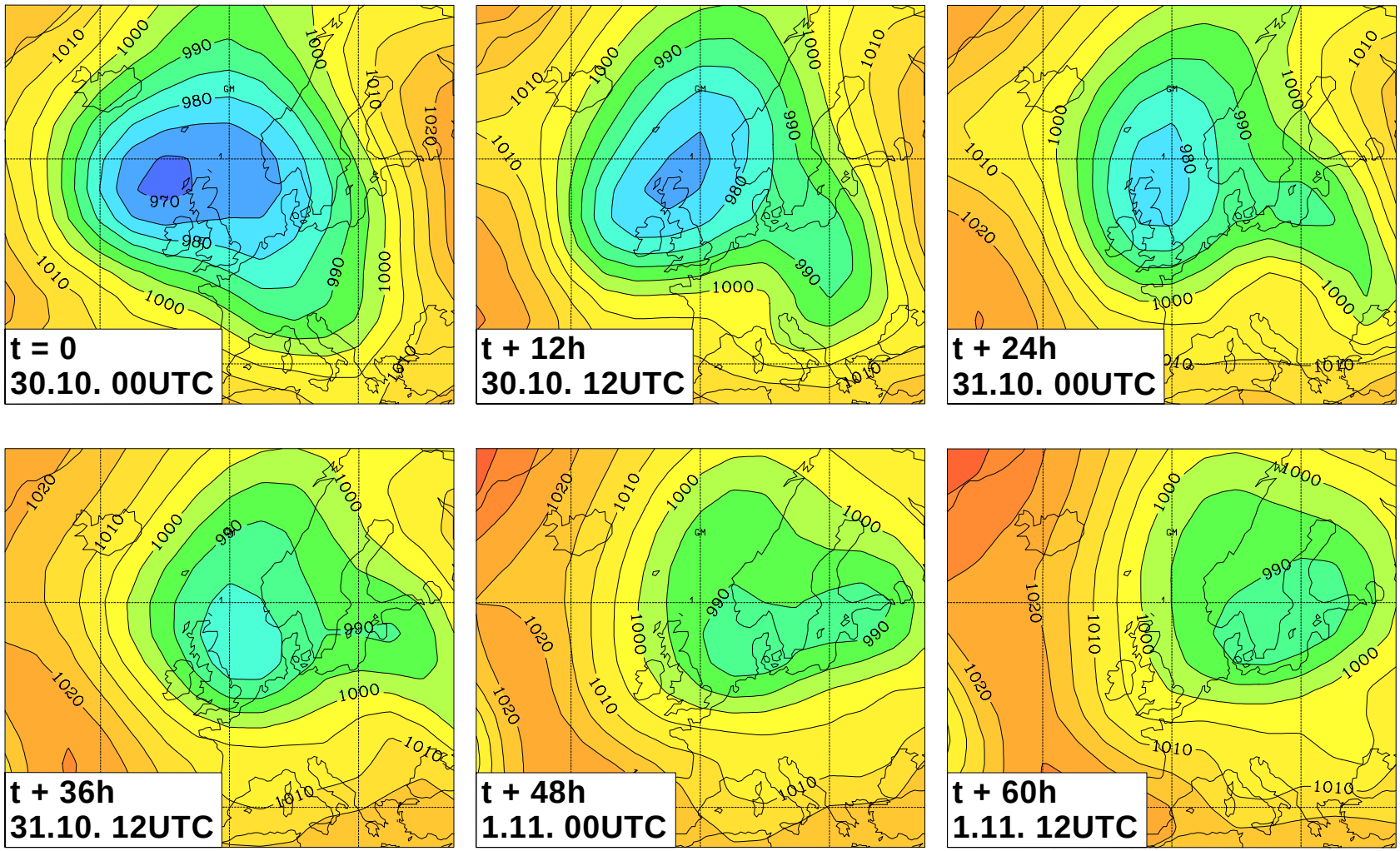
Statistic-dynamical Downscaling

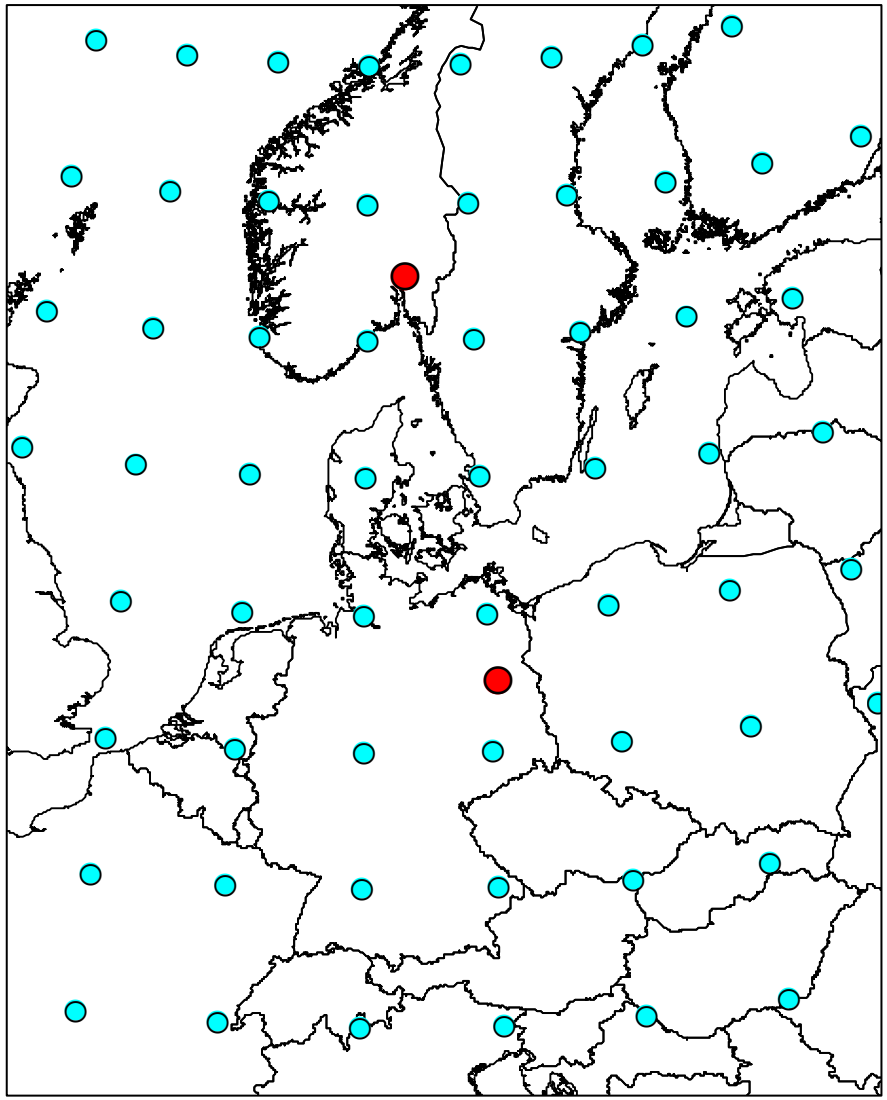
Synoptic / large scale

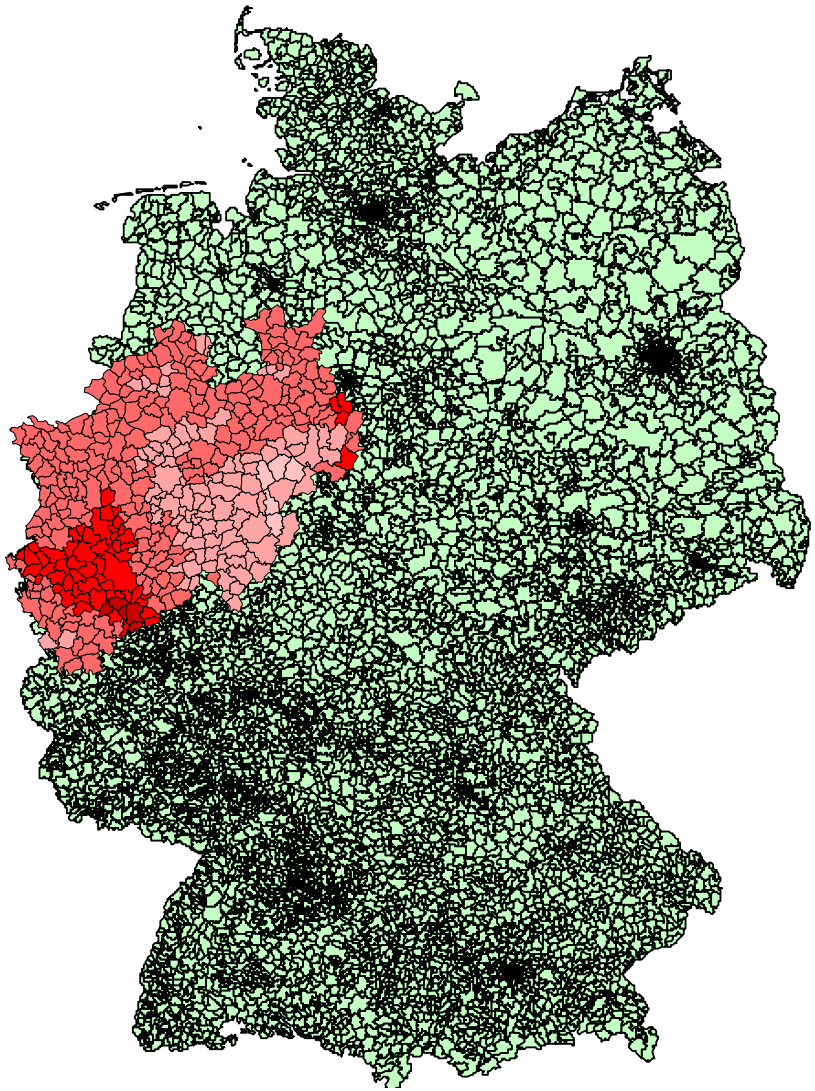
Meso / local scale



NCEP Re-analysis : 30.10. – 1.11.1990

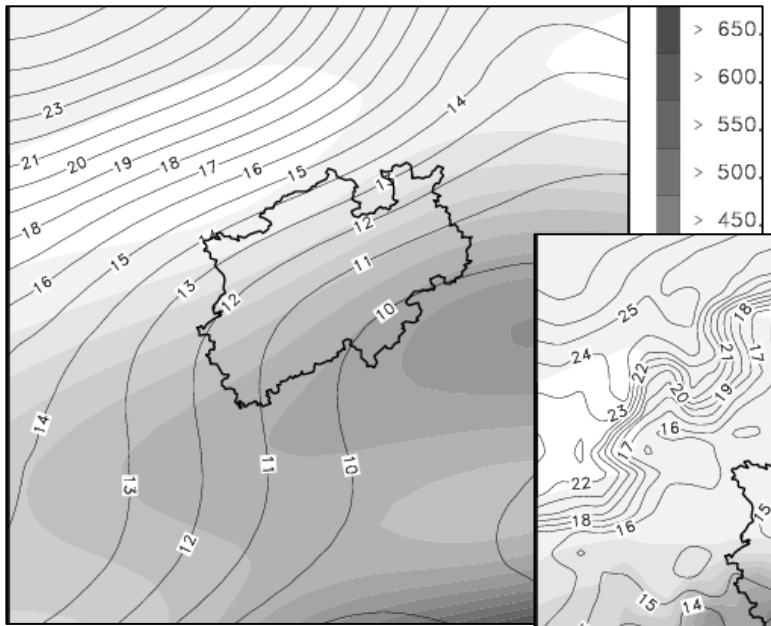






2 Step Mesoscale Simulation (FOOT)

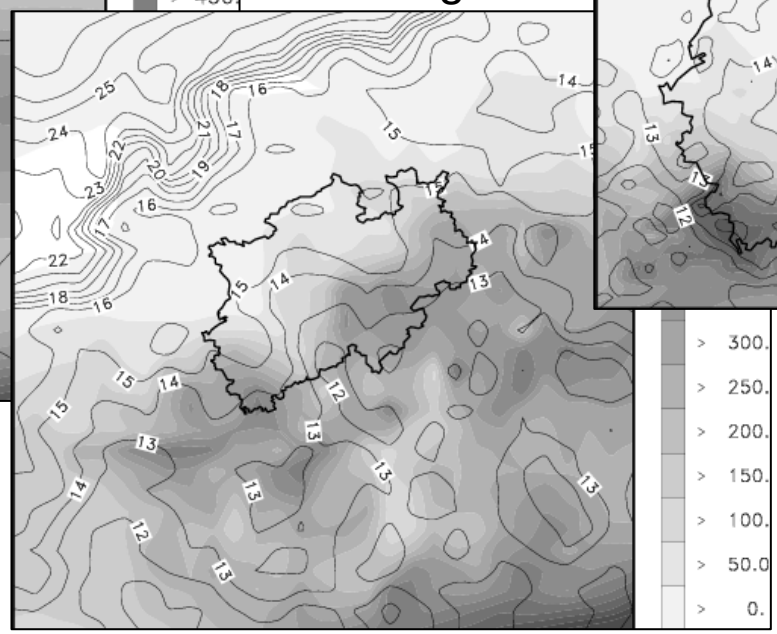
Nesting-Input:
ECMWF-Re-Analysis



Zeitl. Auflösung: 6 h
hor. Auflösung: ca. 1,8°
50N = ca. 130 km

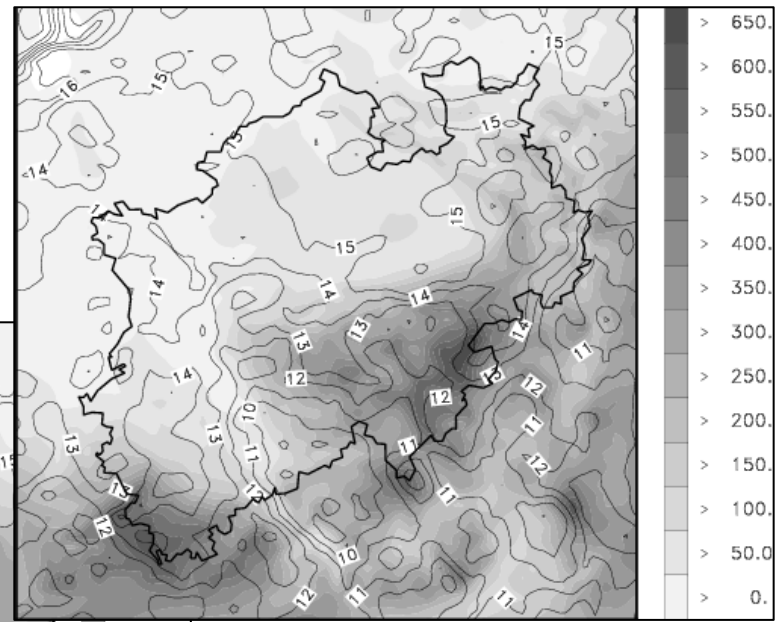
Nesting

FOOT-Output:
1.Nesting



20x20 km

FOOT-Output: 2. Nesting

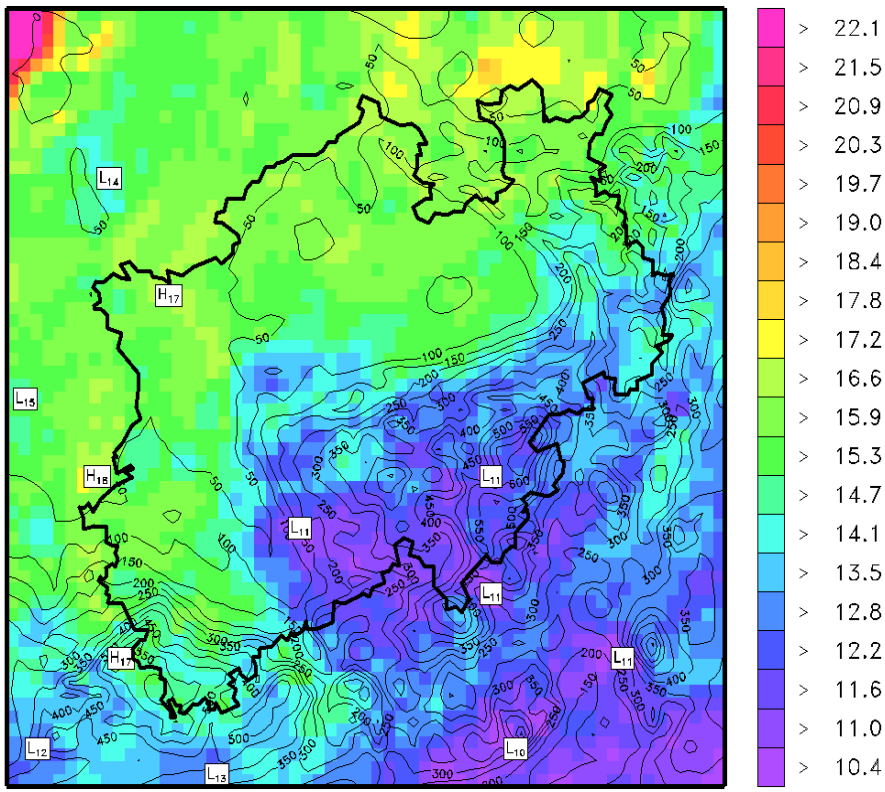


5x5 km

Storm *„Daria“ (25.01.1990)*

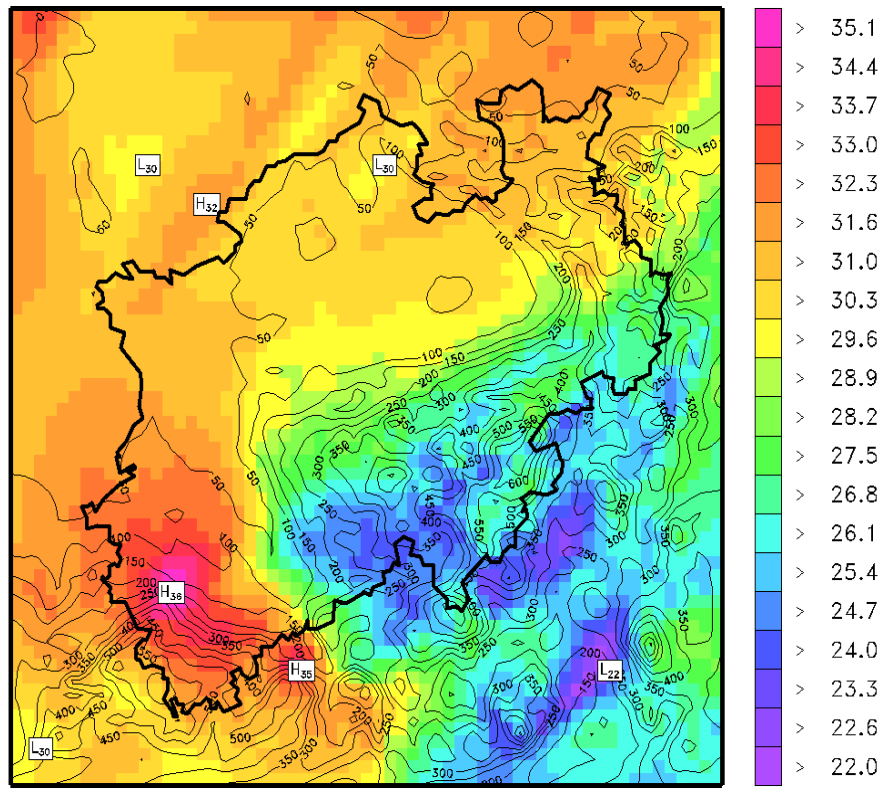
Max. wind in m/s

1. Model level (25 m)

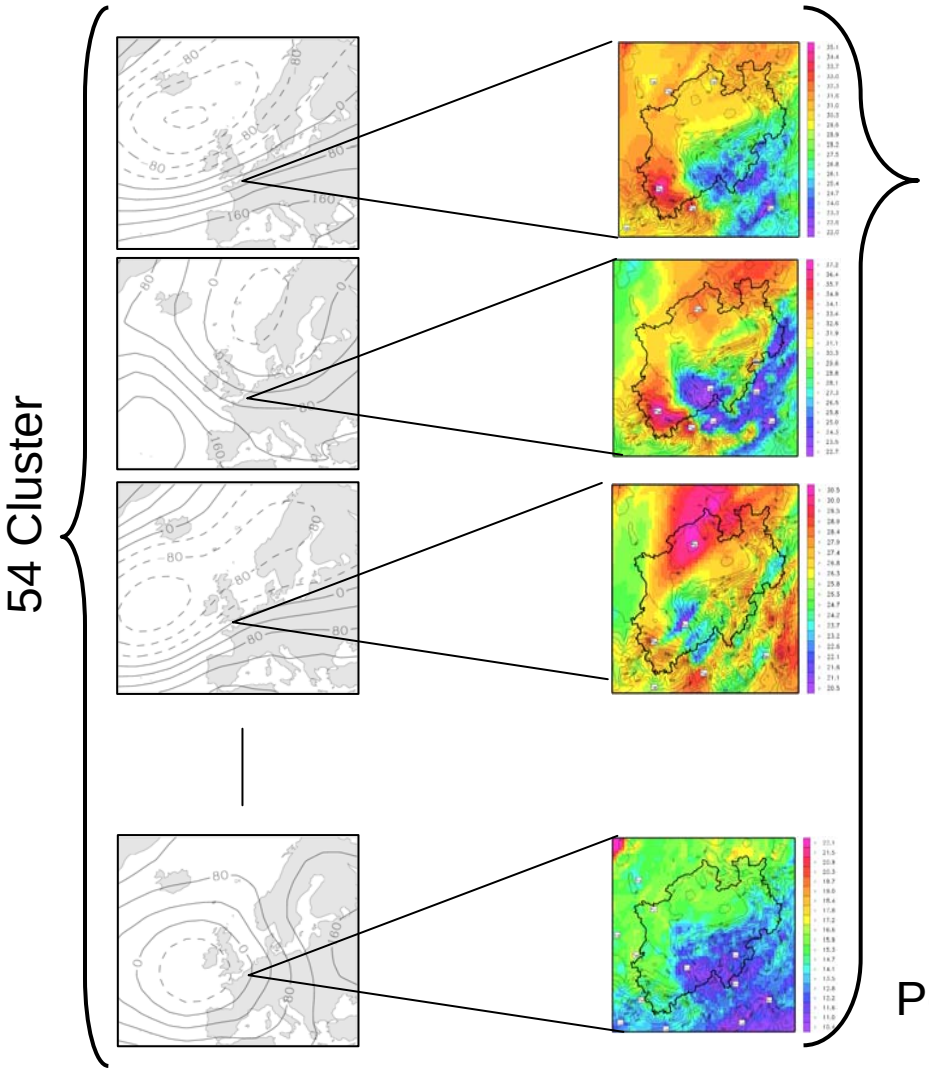


Max. wind in m/s

5. Model level (350 m)



Normalization by 98th percentile of the daily max. wind



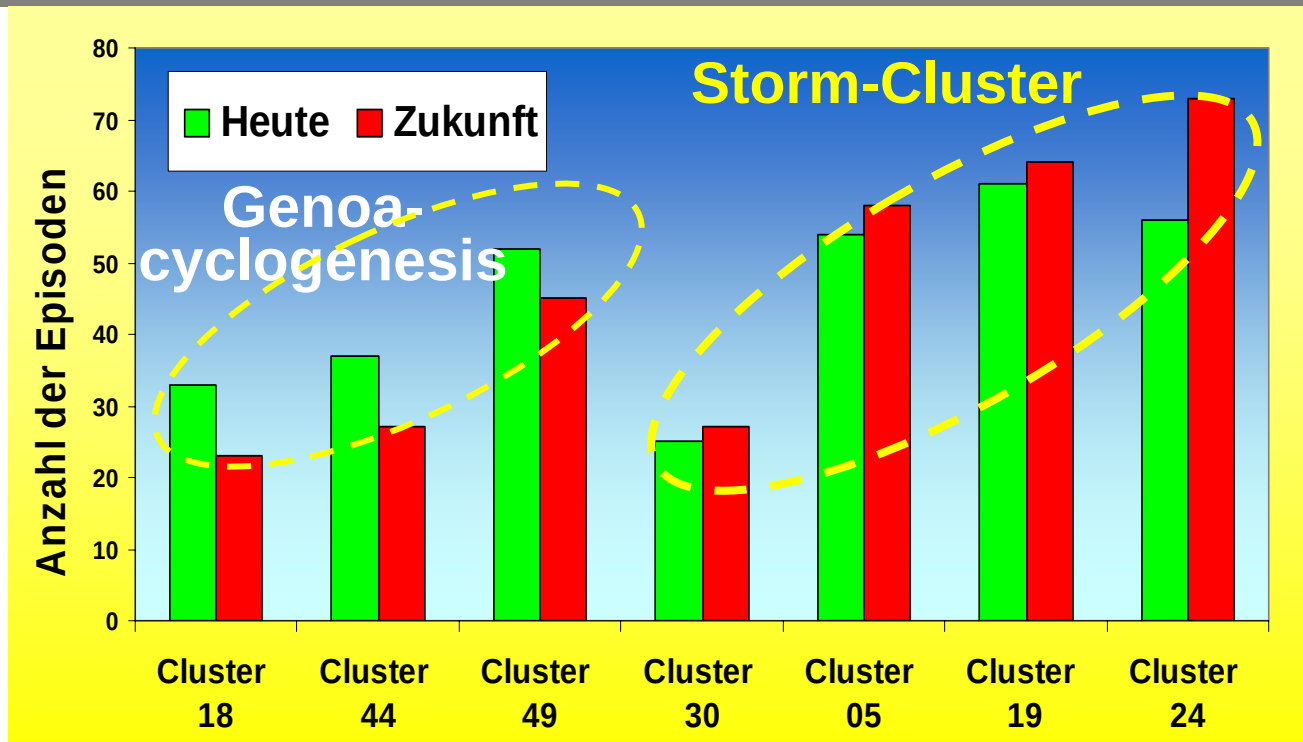
FOOT-Simulation per cluster

Production of local-scale daily maximum wind speed climatology

98th percentile

Possible normalization for impact studies

Meteorological meaning of some cluster

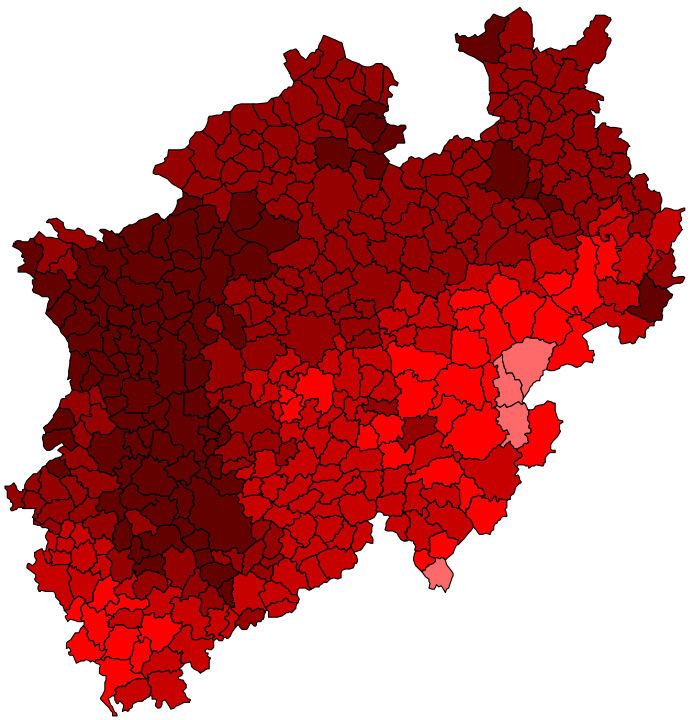


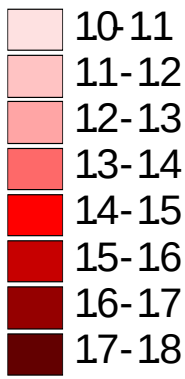
Cluster 30: Steering low pressure system over the Northeast-Atlantic incl. secondary disturbances (z.B. „Daria“)

Cluster 24: Low pressure system over UK, passing the North-Sea area to the Baltic Sea, weakening (e.g. „Anatol“)

Storm „Daria“ (25.01.1990): Max. wind speed, normalized by the 98th percentile

Max. wind (normalized)
1. Model level (25 m)





Max. wind (normalized)
5. Model level (350 m)