The Abdus Salam International Centre for Theoretical Physics

2165-11

International MedCLIVAR-ICTP-ENEA Summer School on the Mediterranean Climate System and Regional Climate Change

13 - 22 September 2010

Extremes and storms: Extreme Mediterranean Cyclone and Wind Events under increasing GHG Climate Forcing

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Mediterranean Extremes under Climate Change

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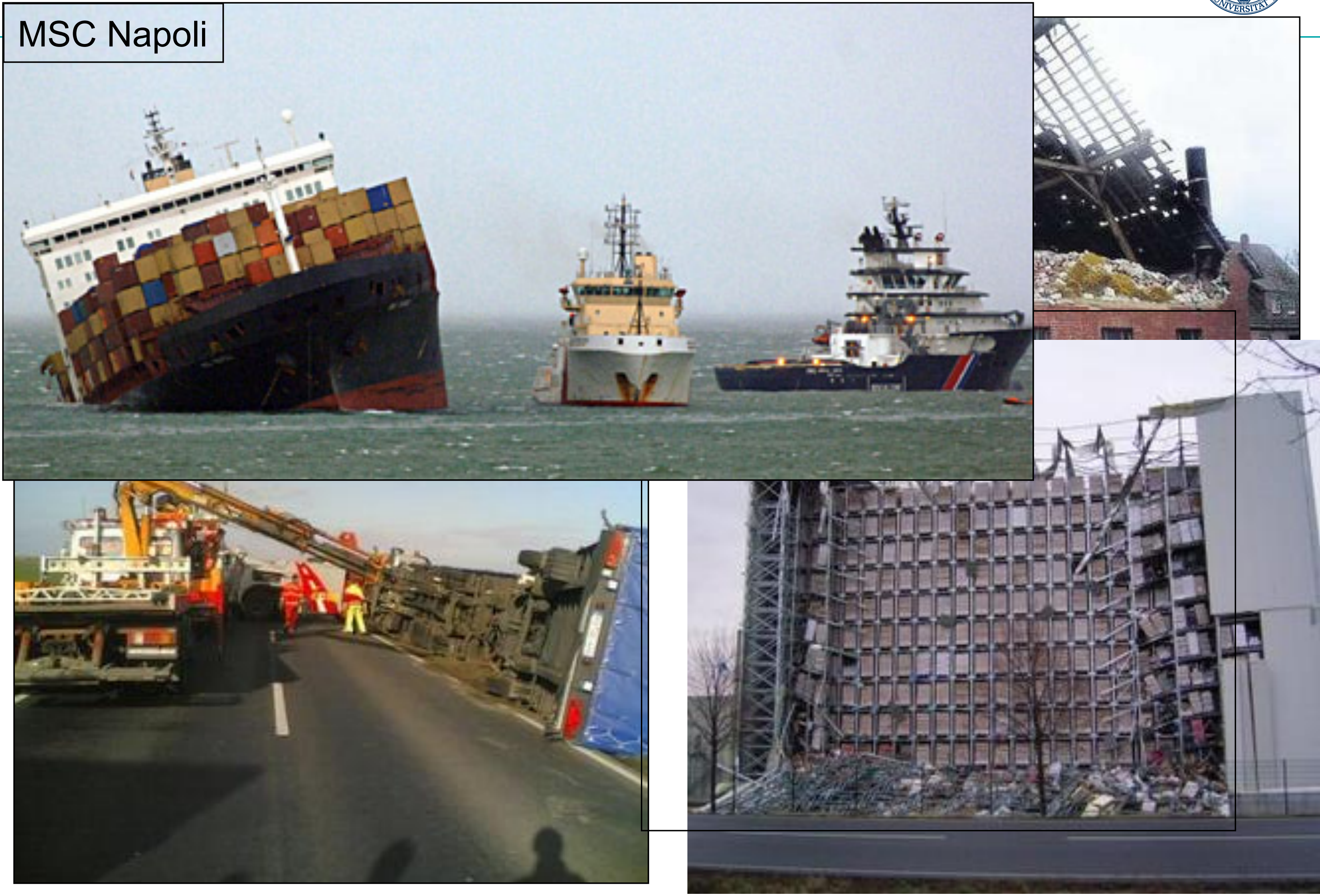
RE Dresden Hbf

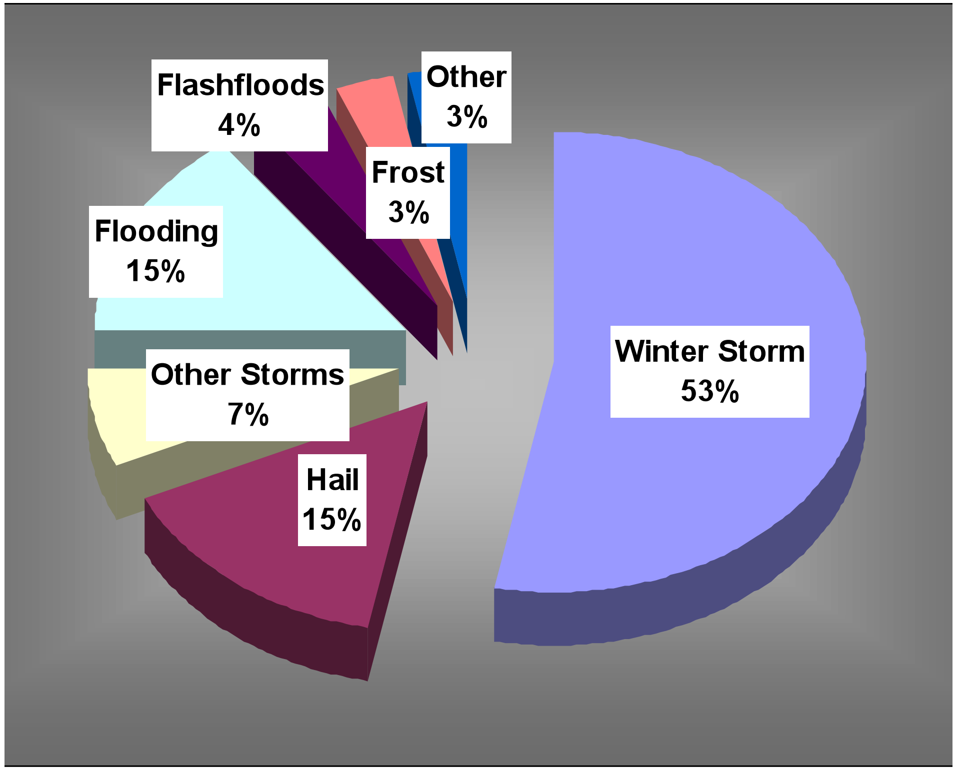


MSC Napoli

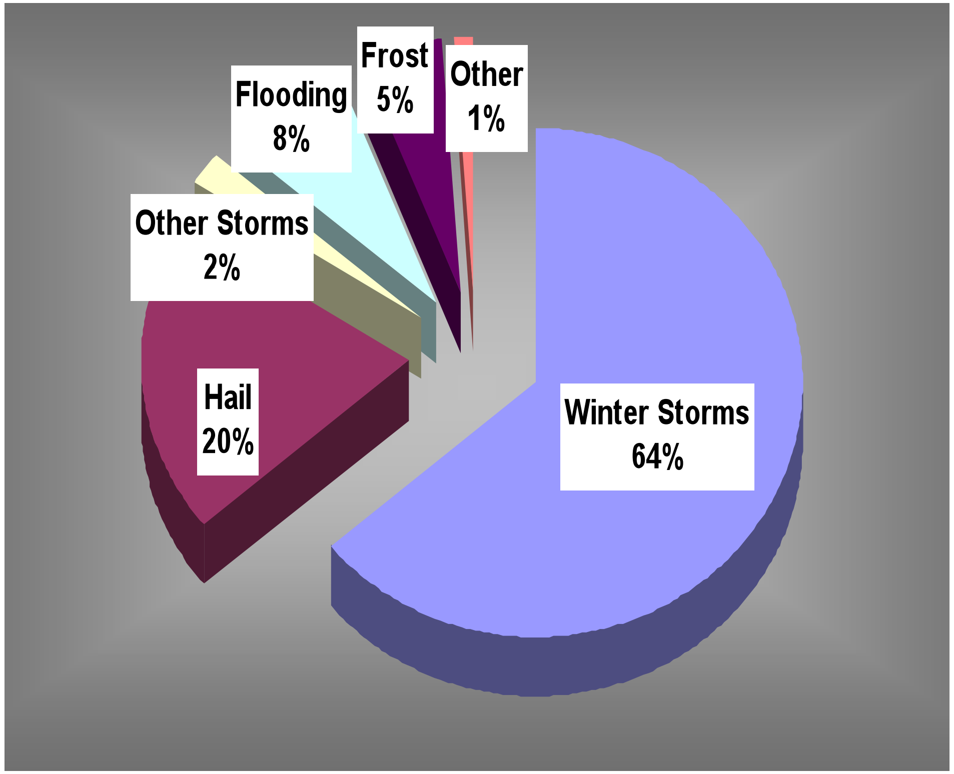
Kyrill, 18.01.2007

Loss distribution Germany, 1970-1998

Total loss



Insured loss



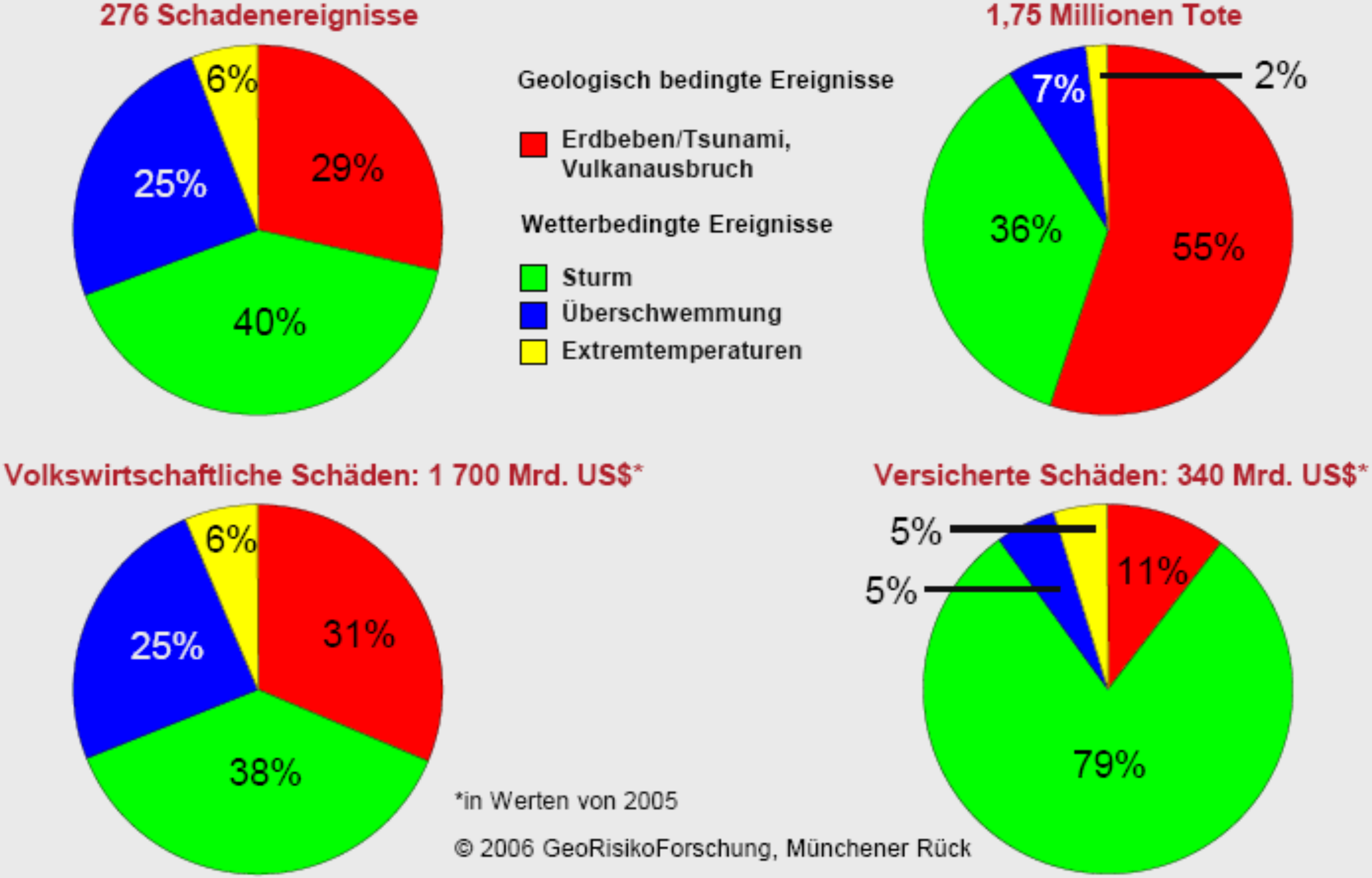
Source: Munich Re: Naturkatastrophen in Deutschland.

Schadenerfahrungen und Schadenpotentiale, München 1999

Große Naturkatastrophen 1950 - 2005

prozentuale Verteilung weltweit

Münchener Rück
Munich Re Group

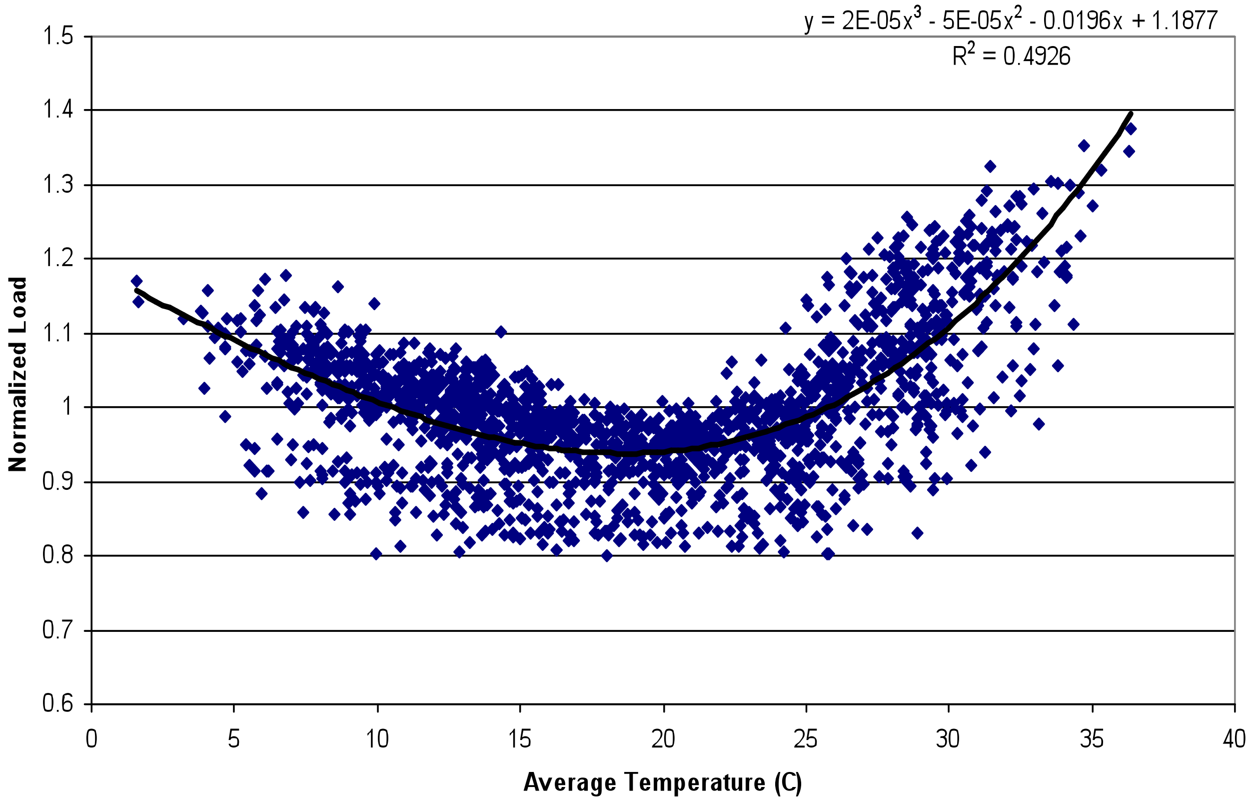


*in Werten von 2005

Exteme events and their impacts:

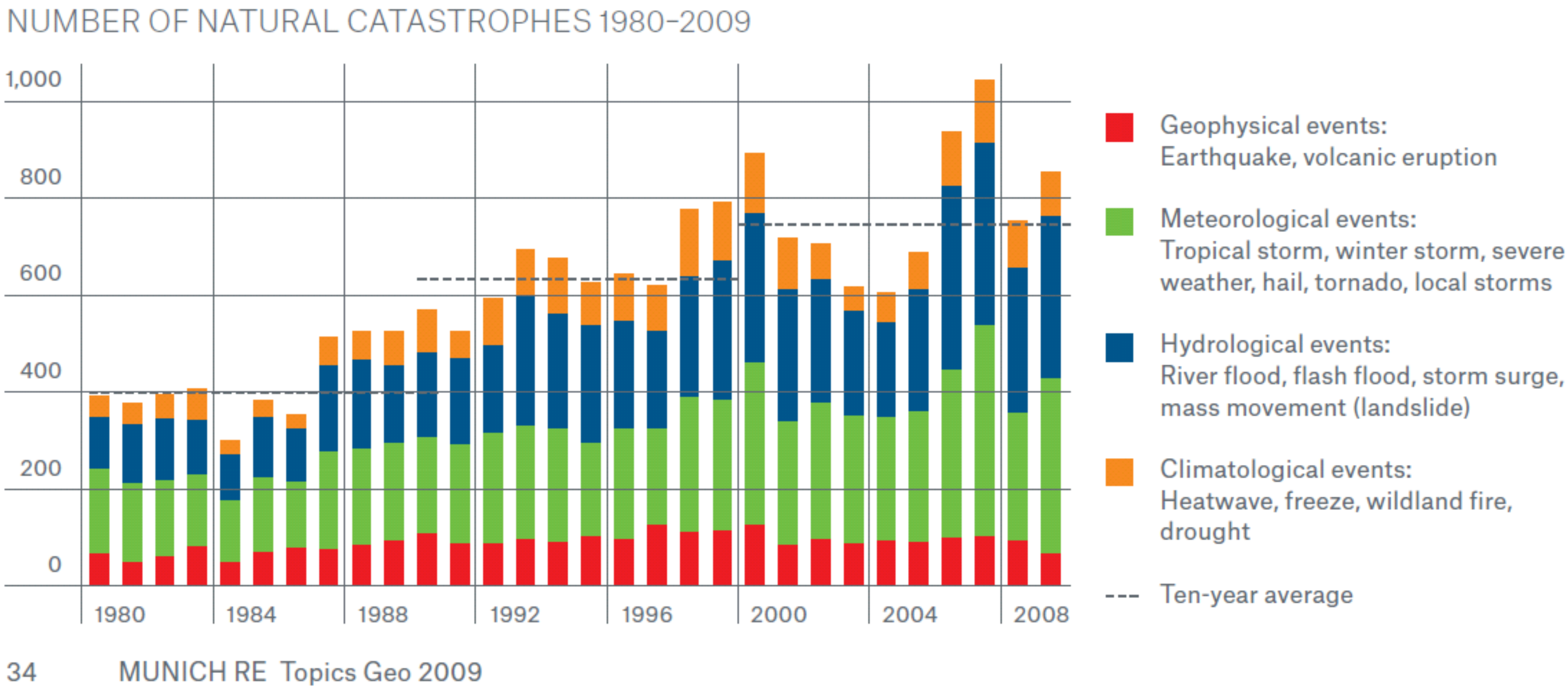
- Natural ressources: beaches, snow
- Heat waves - comfort
- Droughts – water needs
- Vegetation – landscape impression
- Wildfires – risk, pollution
- Electricity – air conditioning, comfort

Relating temperature and electric load demand



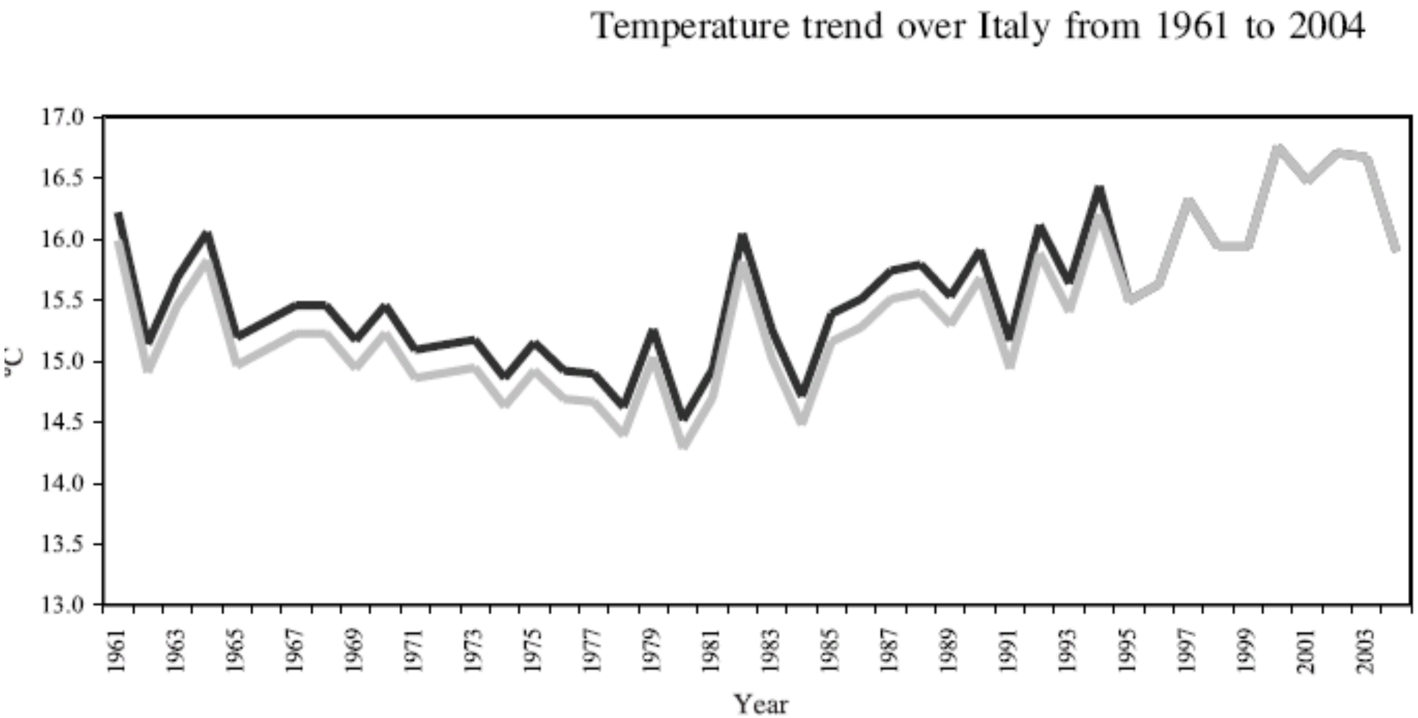
•Excluding the national holiday days improves only slightly the correlation coefficient

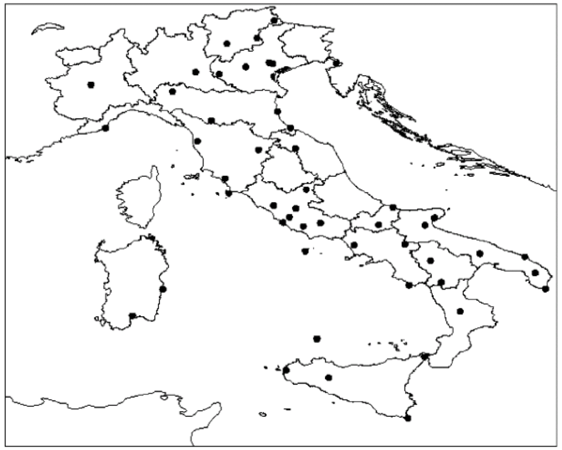
Number of Natural Catastrophes 1989-2009 distinguishing event types



Source: Munich Re Topics Geo 2009

Annual Mean Temperature Change in Italy 1961-2004





Area average:

+0.96°C

Toreti and Desiato, Th Appl Clim 2008

Global Mean Temperature Change

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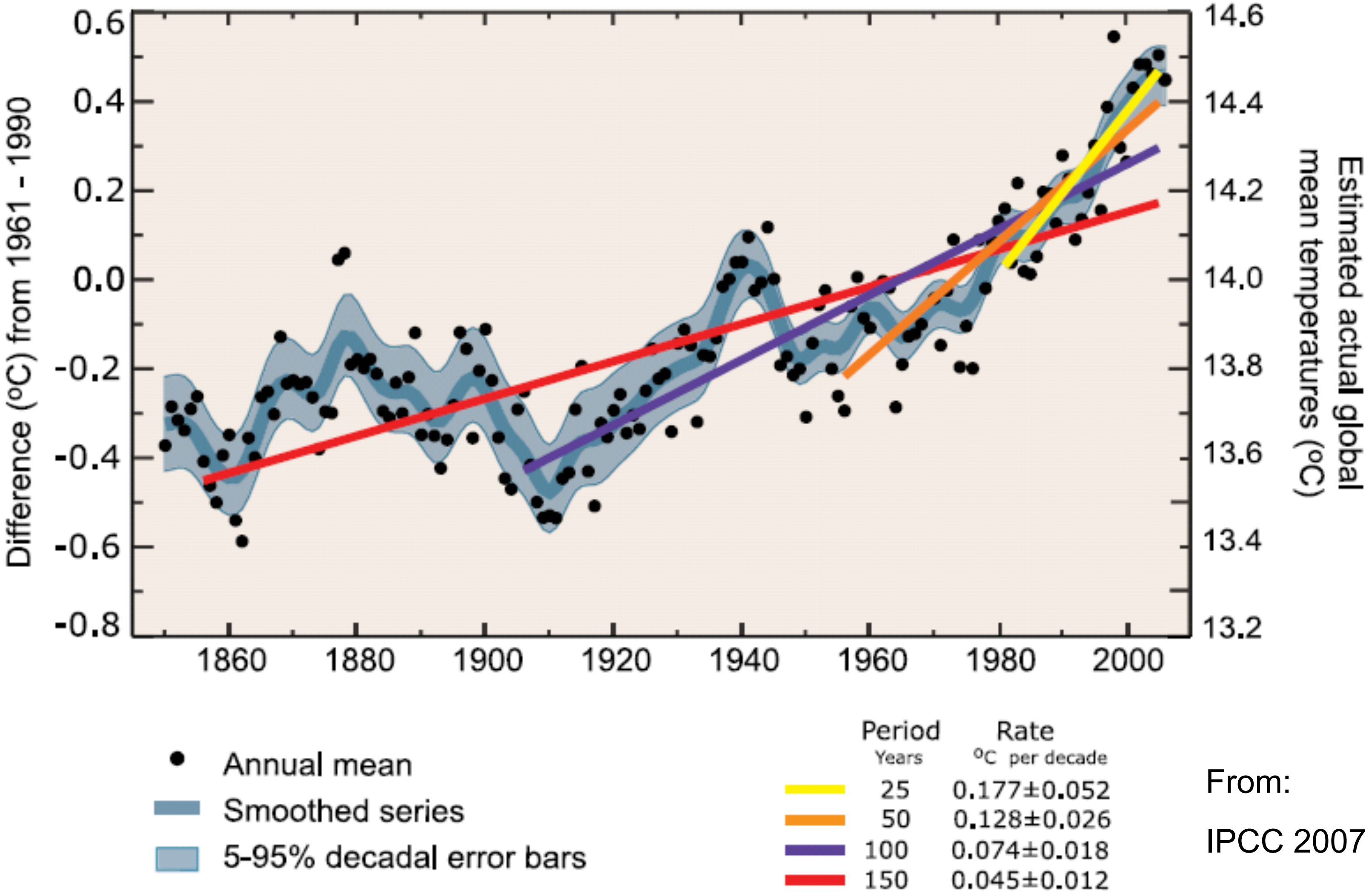
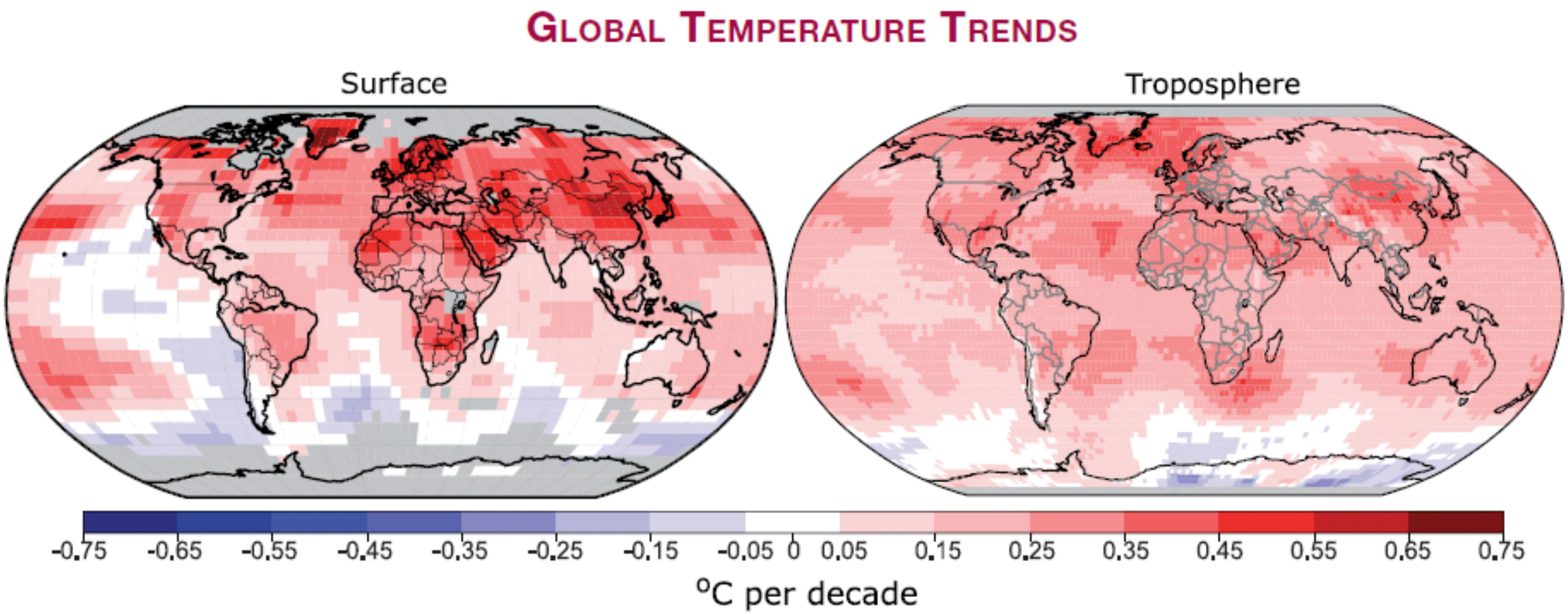


From:

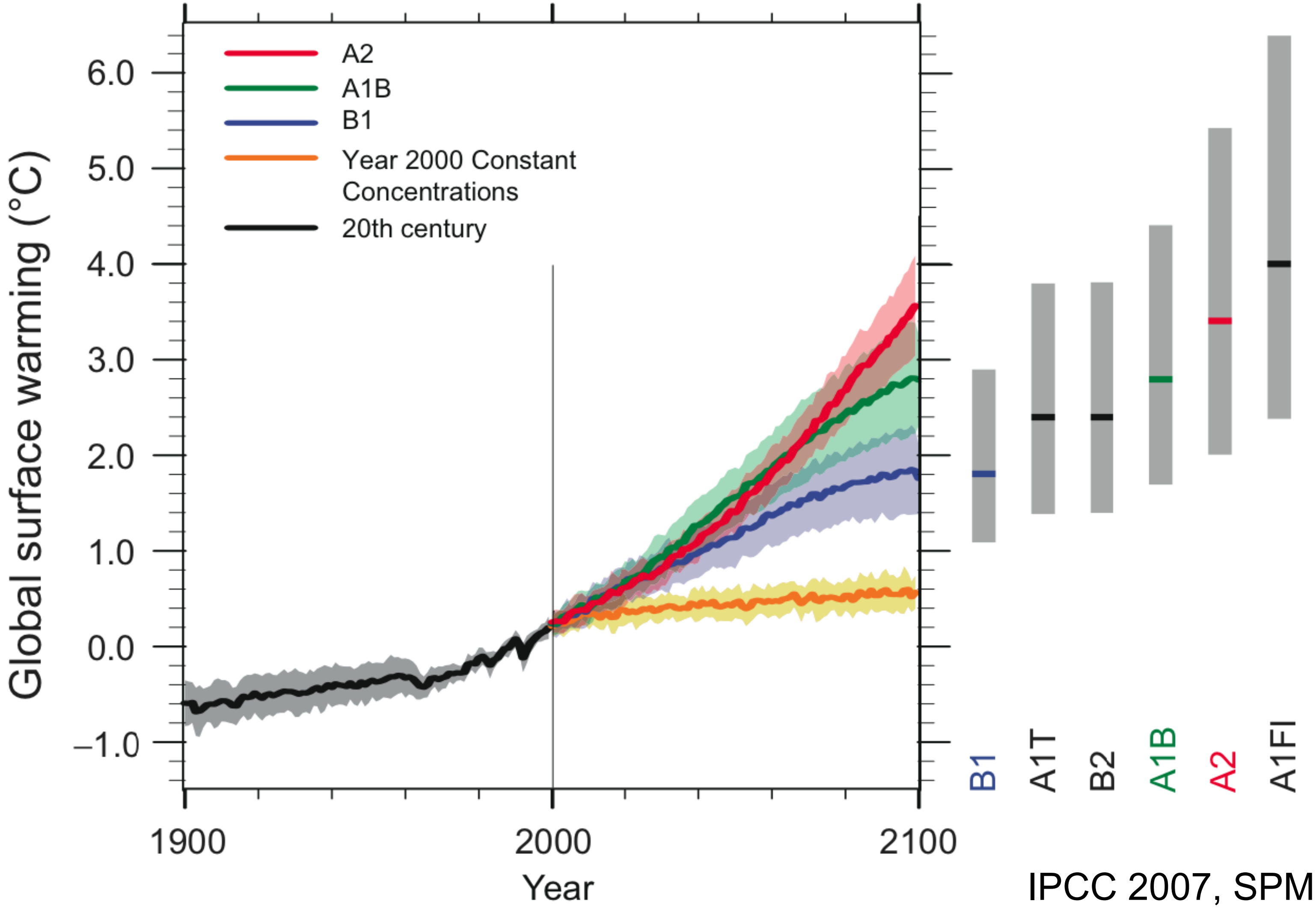
IPCC 2007

Temperature Trends 1979-2005



Source: IPCC 2007

Multi-model Averages and Assessed Ranges for Surface Warming



IPCC 2007, SPM

Outline

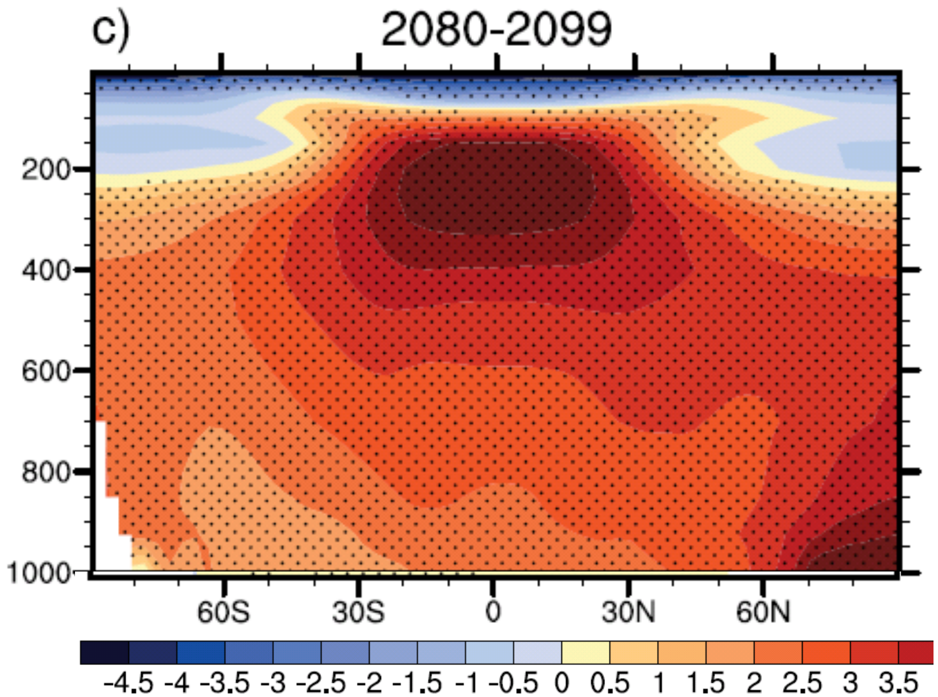
- Results from numerical modelling of the Earth System response to rising greenhouse gas concentrations

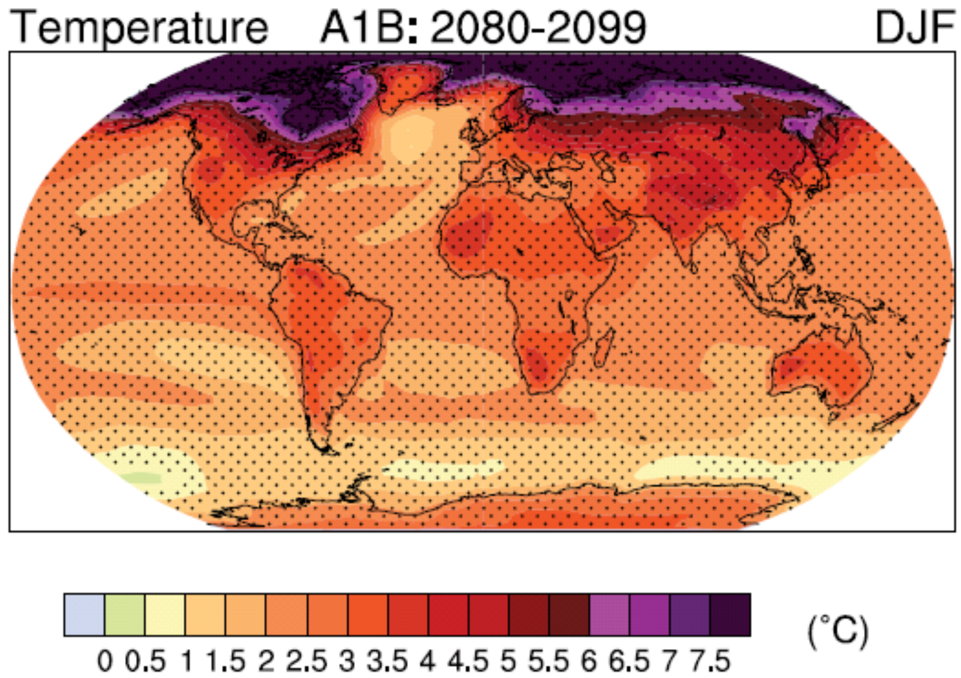
- Extremes in …

- Temperatures
- Precipitation
- Cyclones
- Wind

What kinds of changes in extremes would you expect for the Mediterranean region?

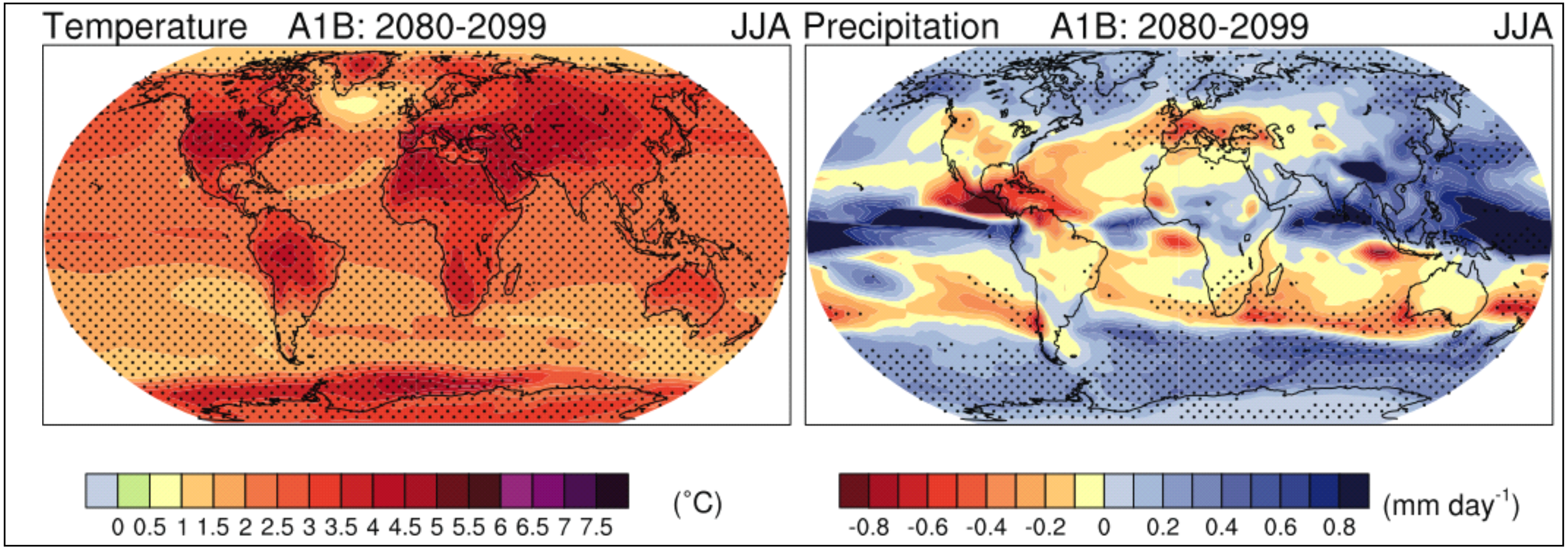
Temperature signals
2080-2099 vs. 1980-1999 forcings





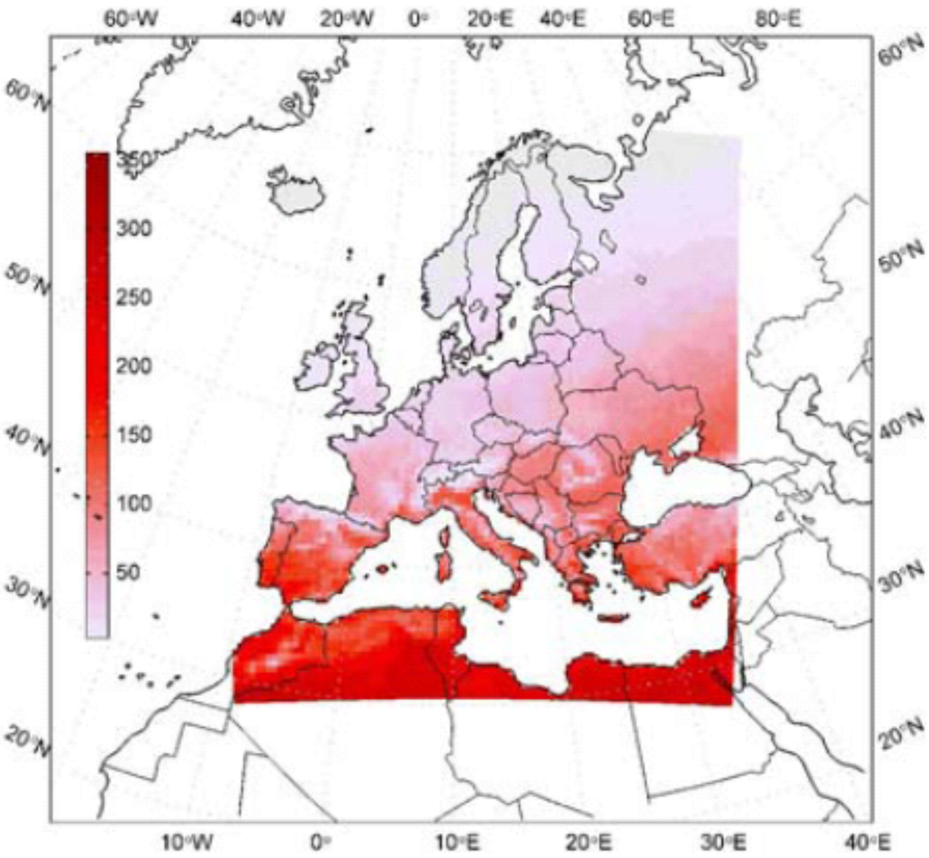
IPCC 2007, SPM

Temperature signals
2080-2099 vs. 1980-1999 forcings



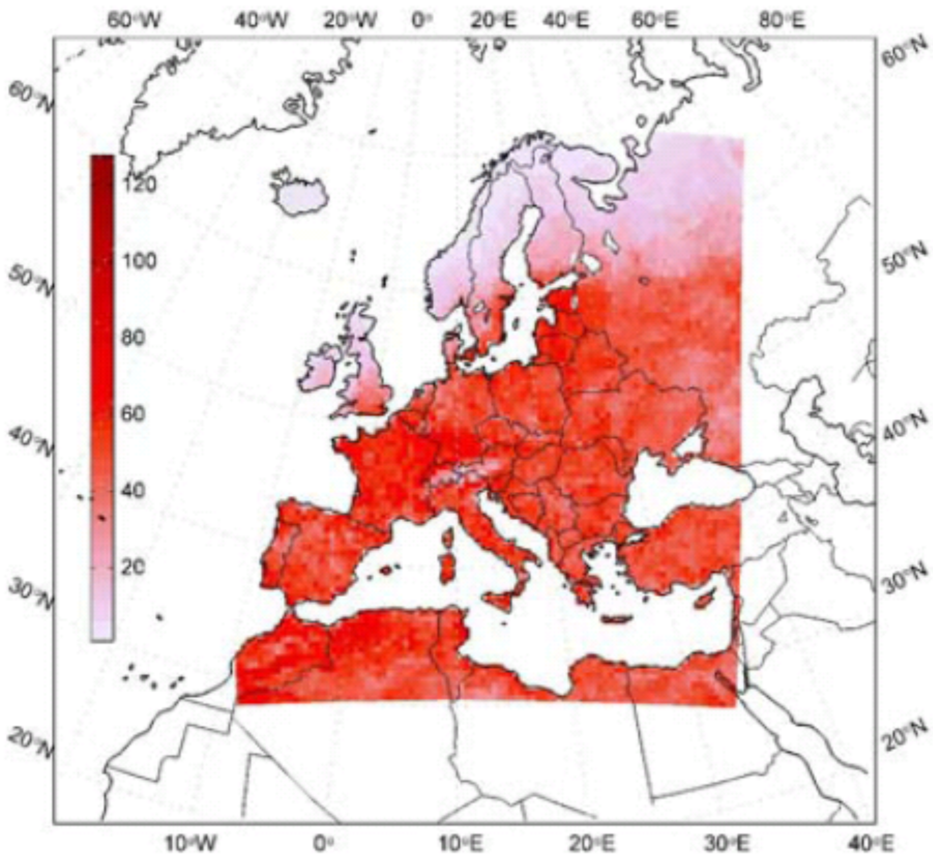
IPCC 2007, SPM

Consecutive summer days with Tmax > 25°C



Present day

(1961-90)



Scenario A2 signal
(2070-2099)

Annual mean cloud signals 2080-2099 A1B vs. 1980-1999 forcings

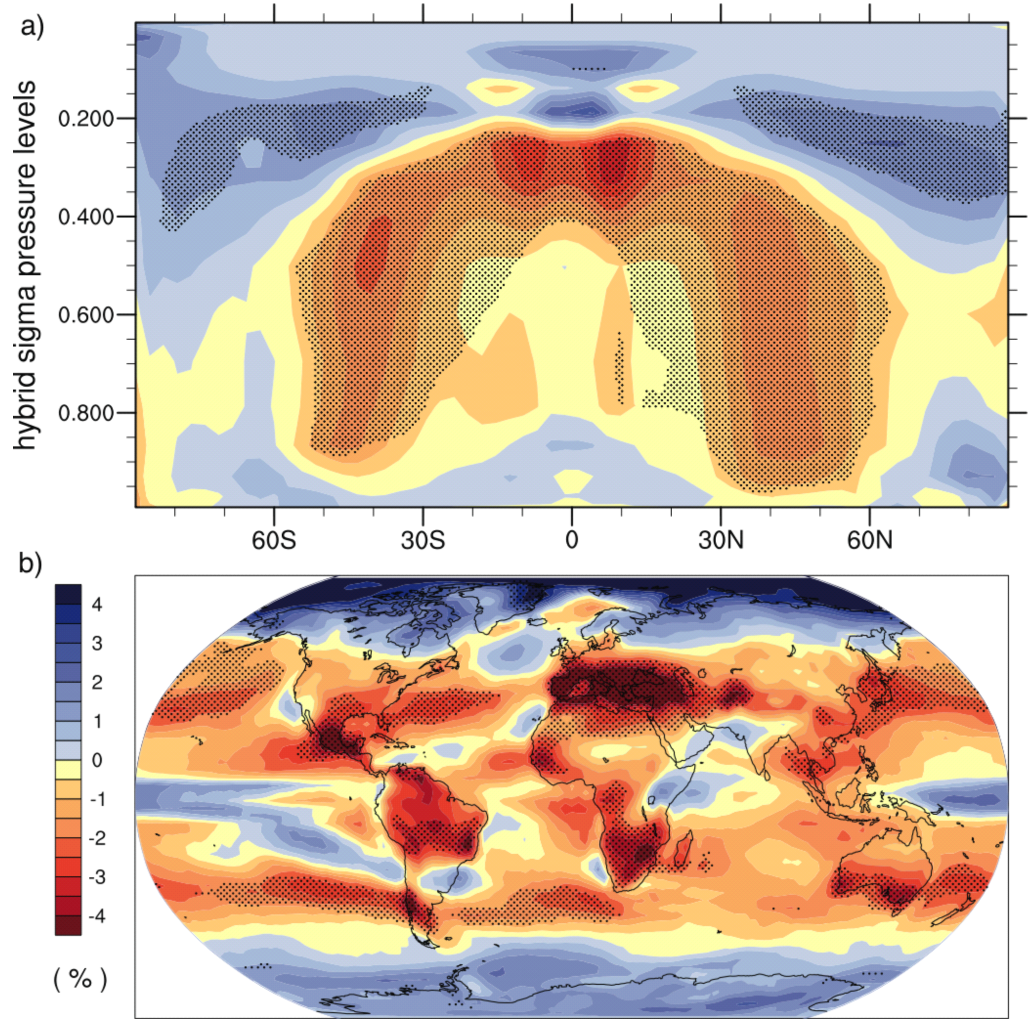


Figure 10.10

IPCC 2007, chapter 10

MSLP signals
2080-2099 A1B vs. 1980-1999 forcings

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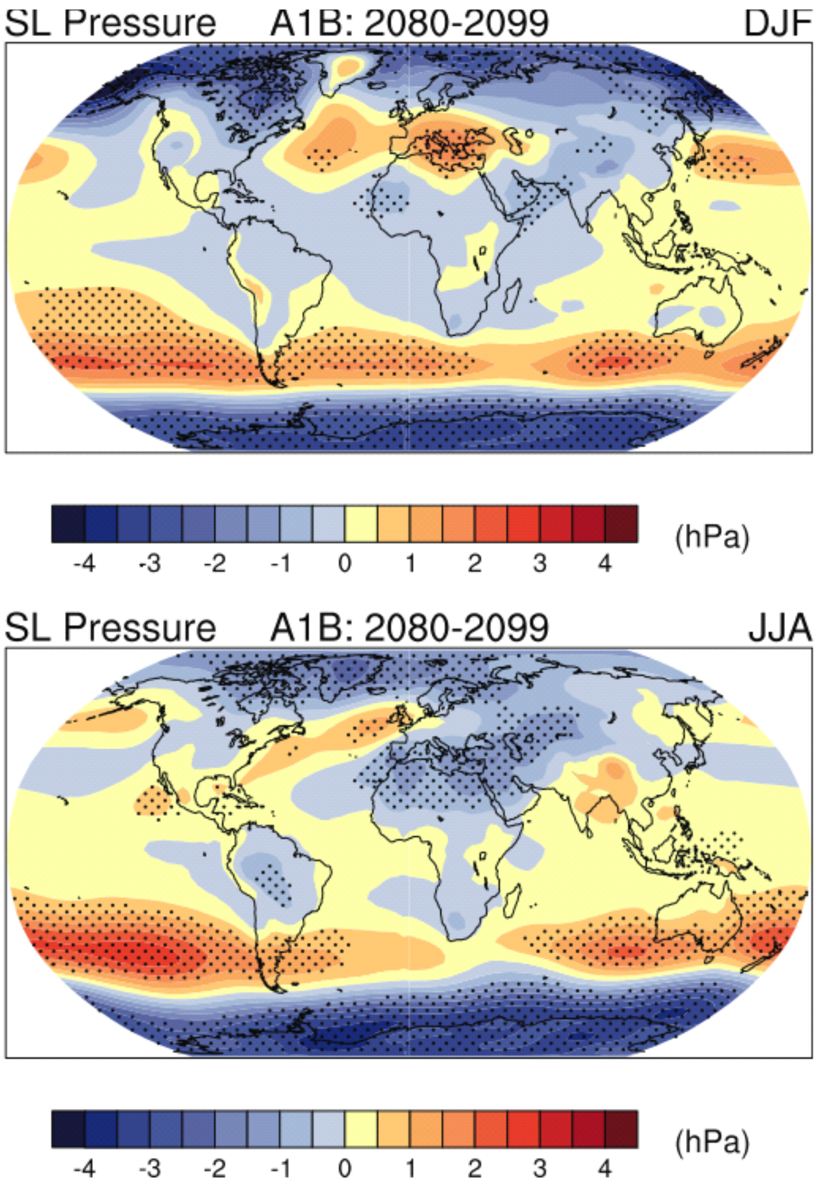

IPCC 2007, chapter 10

Annual mean soil moisture
2080-2099 A1B vs. 1980-1999 forcings

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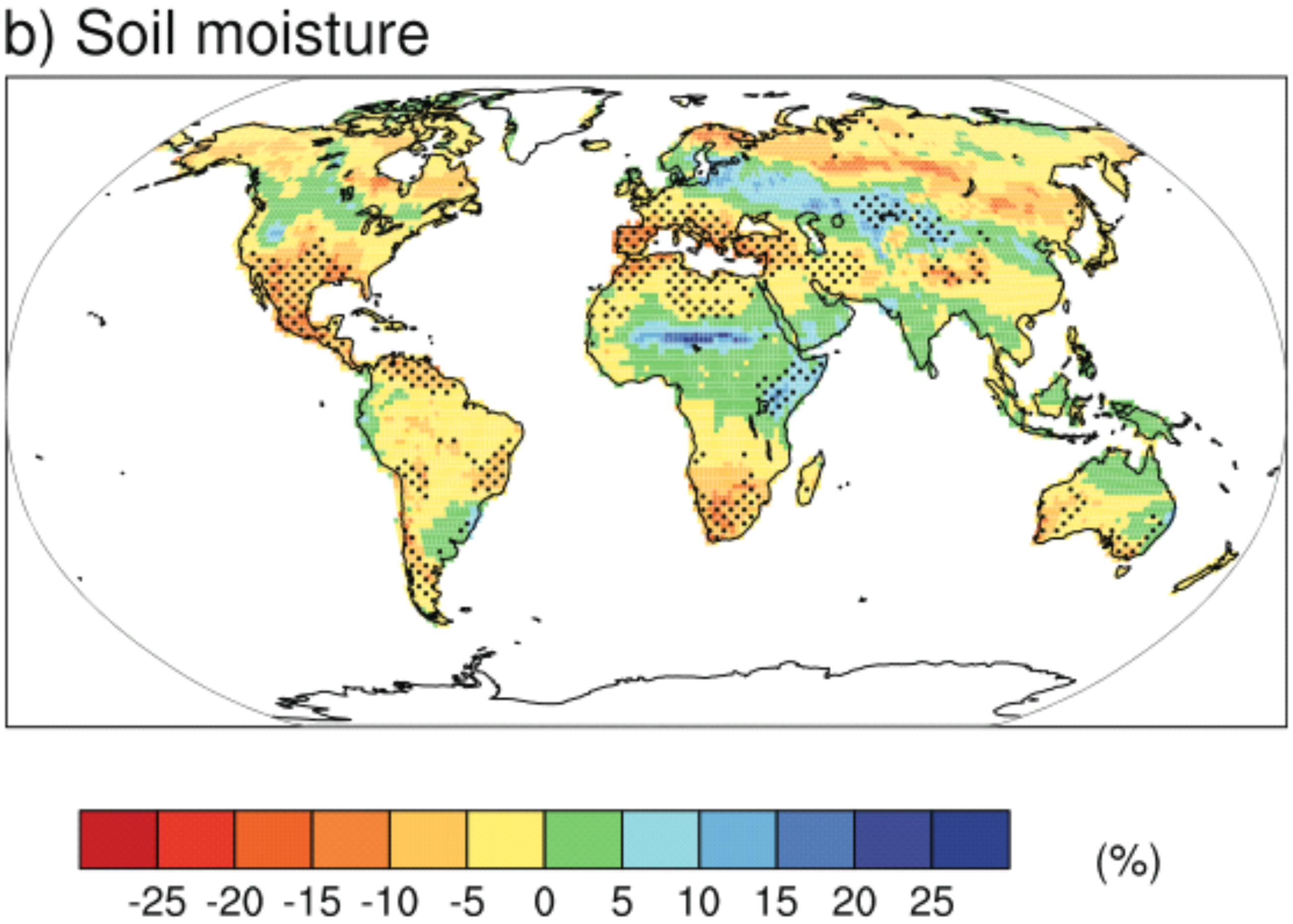
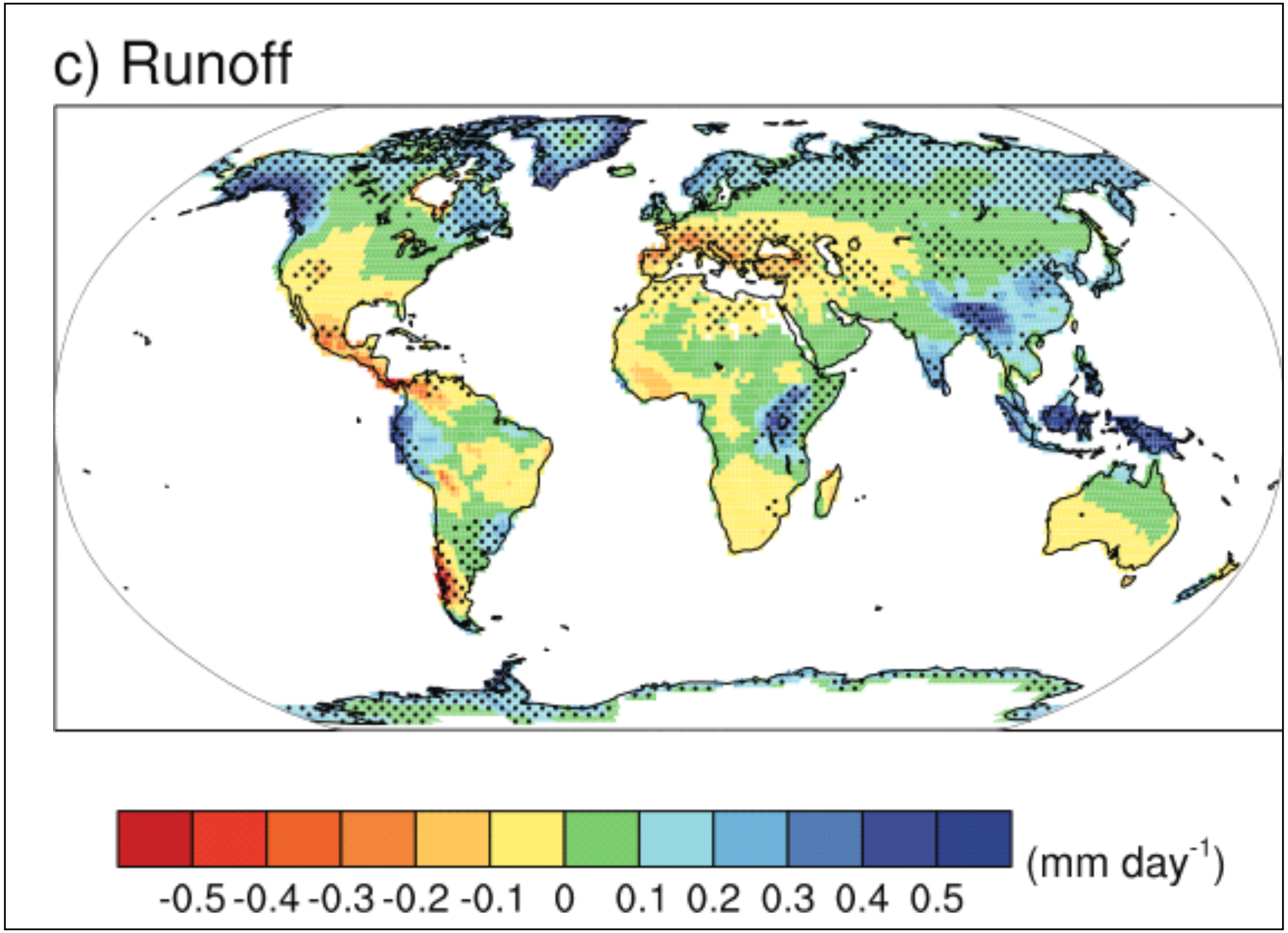


IPCC 2007, chapter 10

Annual mean runoff
2080-2099 A1B vs. 1980-1999 forcings

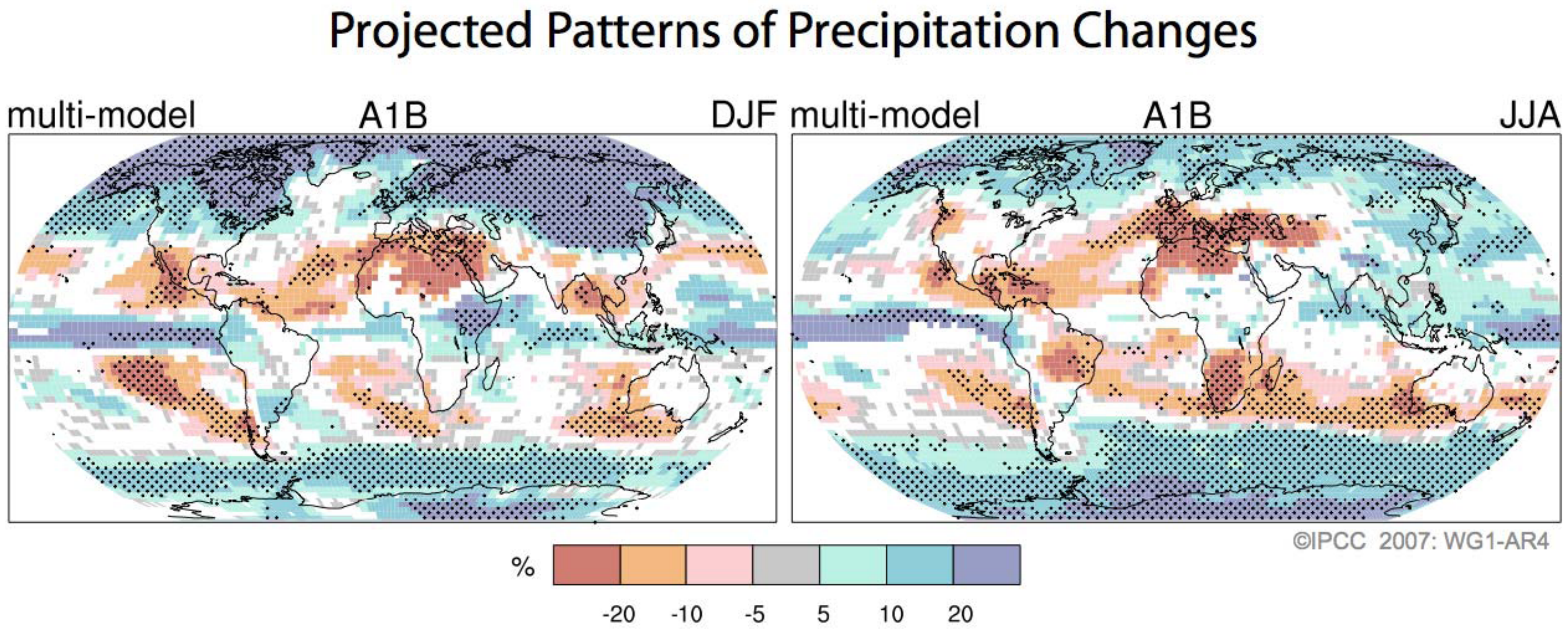


IPCC 2007, chapter 10

But: Are annual mean quantities suitable for measuring extremes?

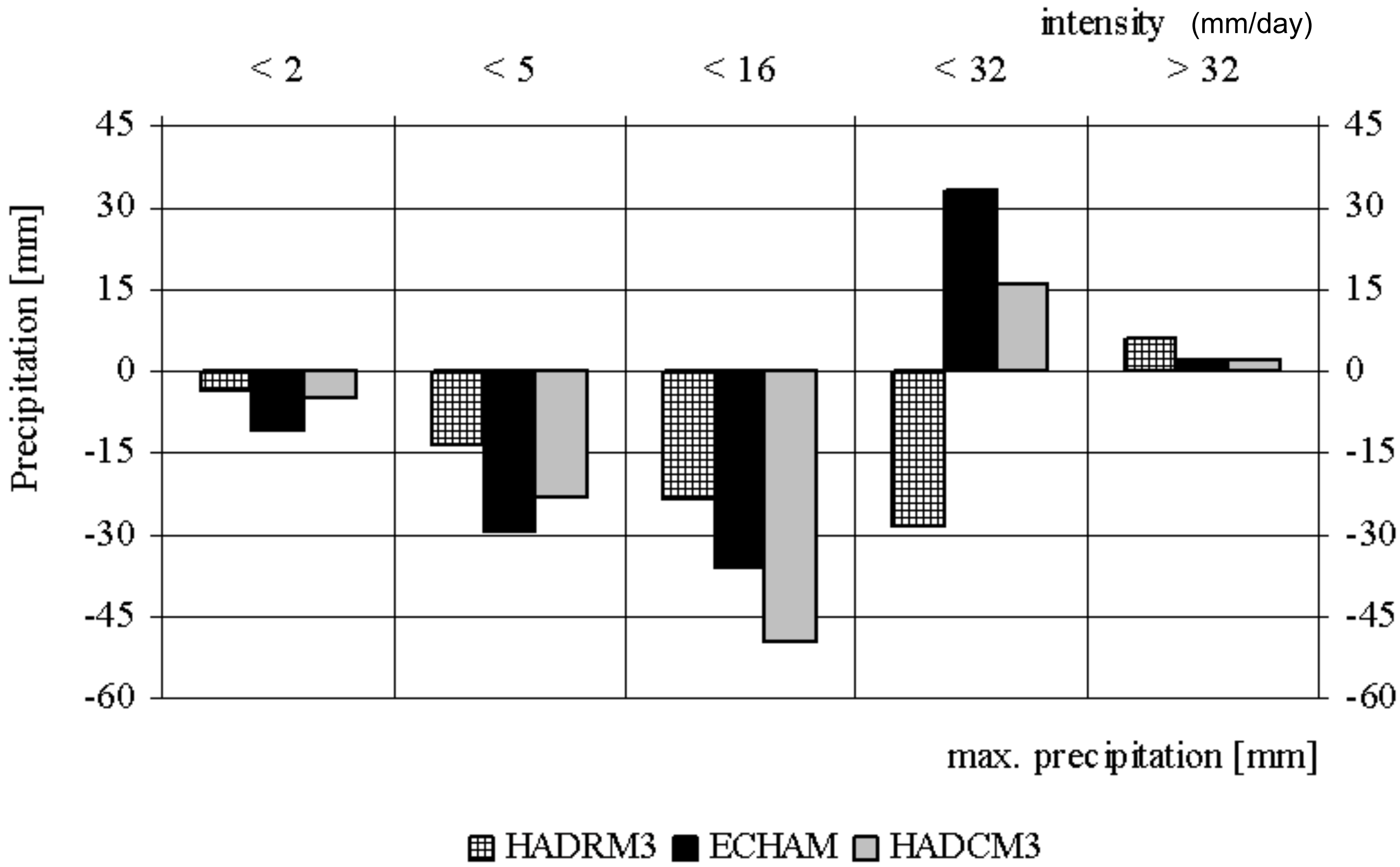
Answer: Some of them are.

Others just set a perspective



Dotted areas:
at least 5 out of 9 Models produce a statiscally significant change

Example of contradicting trends: Summer Rainfall signals in Erz mountain area



RCM and GCMs

Change 2071-2100 (A1b) vs. 1961-1990 mean frequency of daily precipitation (in %)

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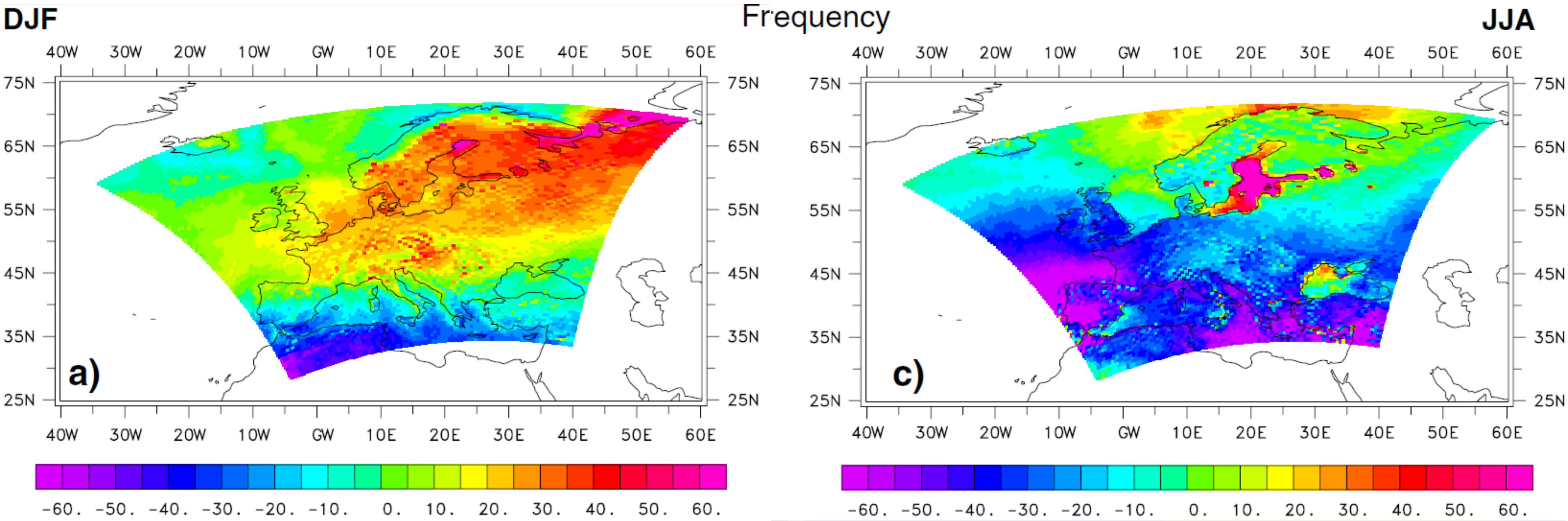
How many wet days in a season?



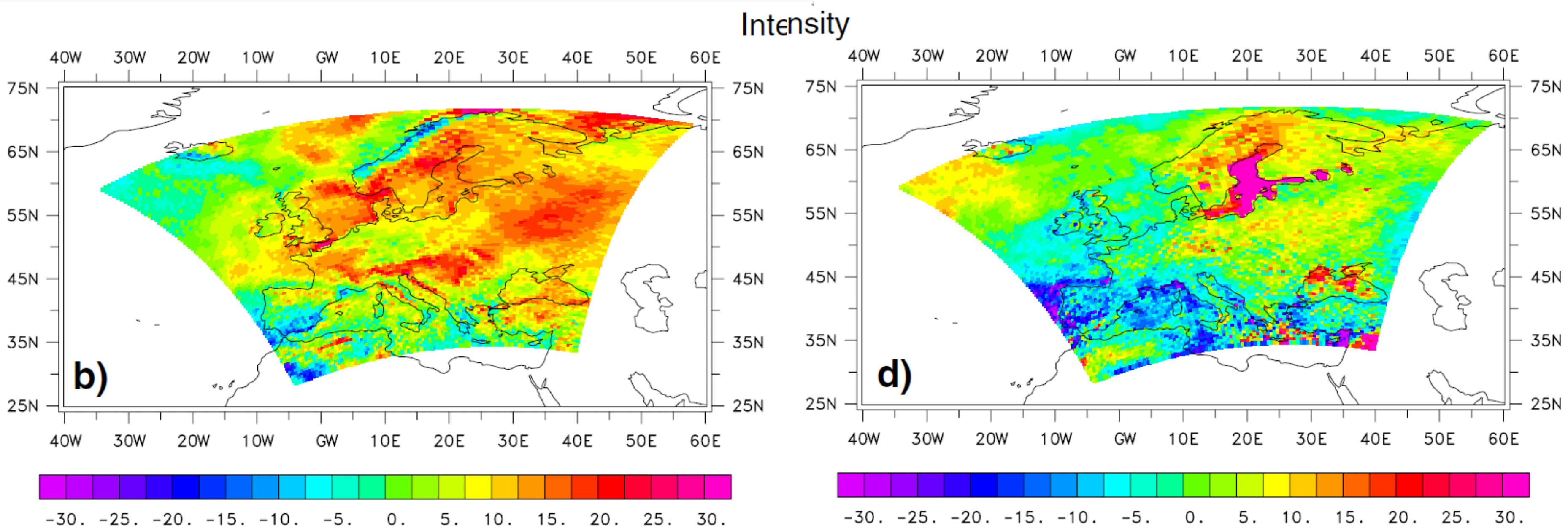
Drought indicator?

May, 2008, Climate Dynamics

Values normalized to present day 1961-1990 simulation period values

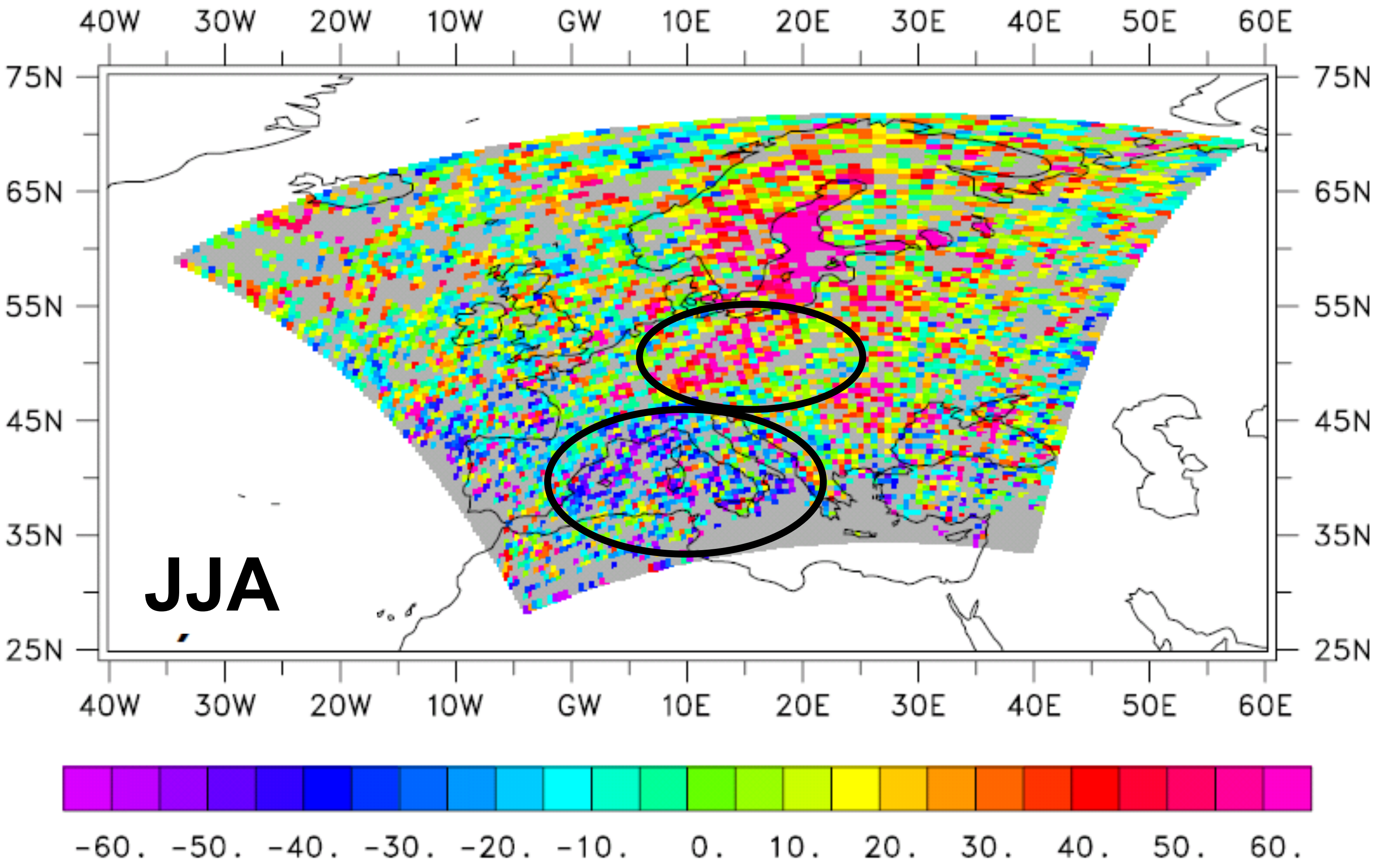
3 member ensemble of Hirham regional model, forced with HadAM3H

Change mean intensity of daily precipitation amount (in %)



May, 2008, Climate Dynamics

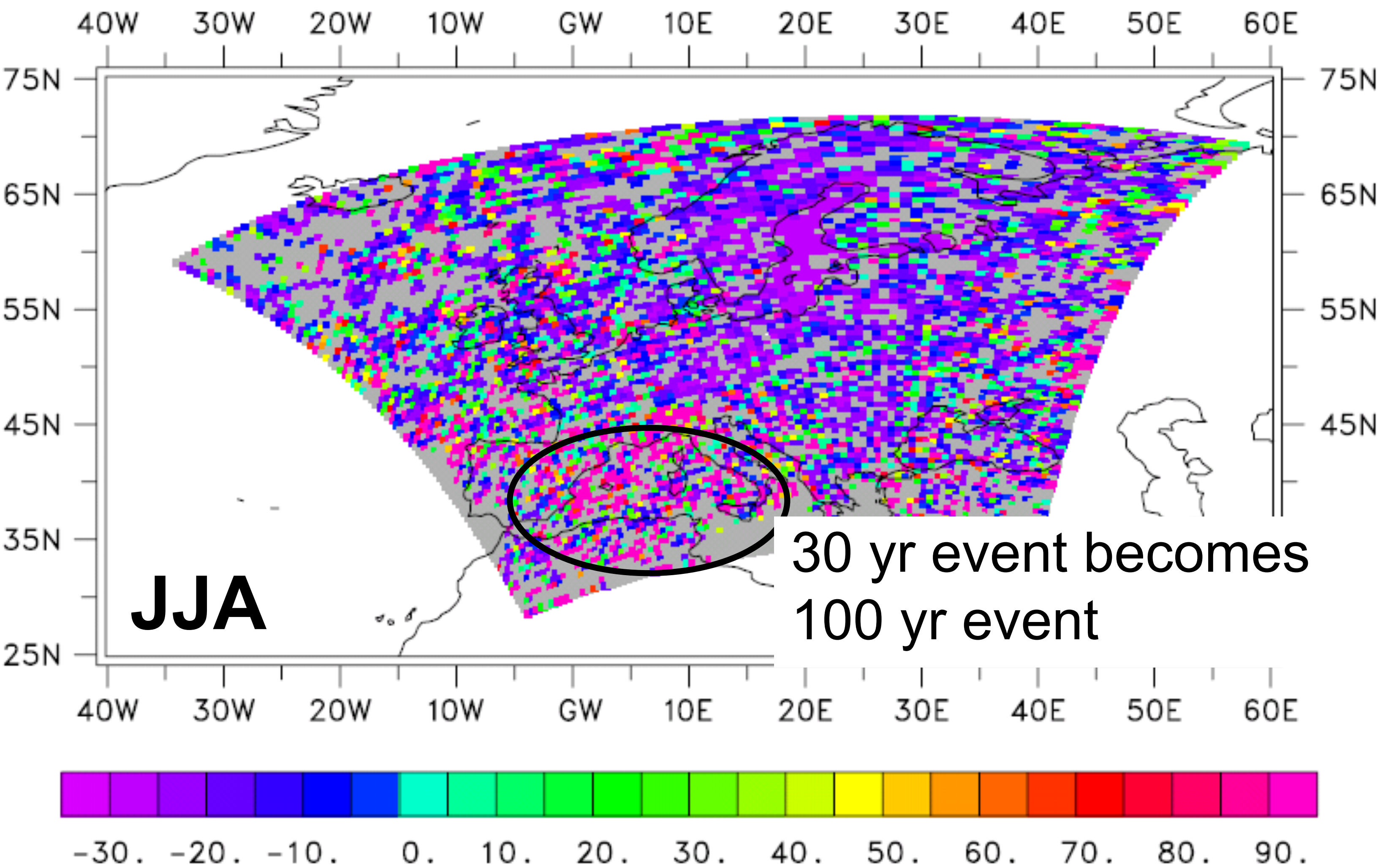
Change of 30 yr return level (in %)



Return level normalized by value of 1961–1990 period

May, 2008, Climate Dynamics

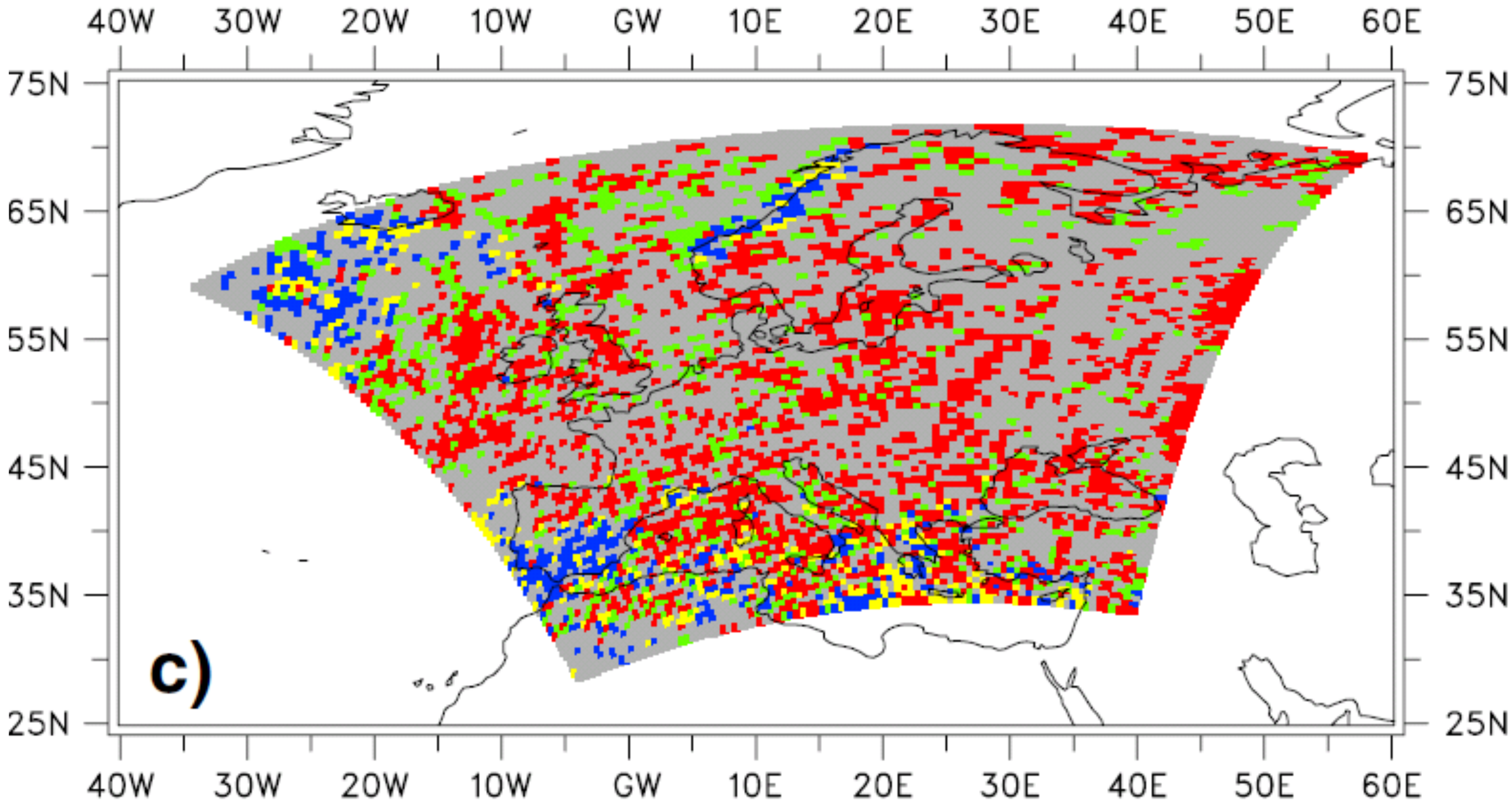
Change of 30 yr return period (in yr)
To what degree is a return period is a 30 year event changed?



May, 2008, Climate Dynamics

Combined change of 30 yr return level and daily mean intensity

Freie Universität Berlin



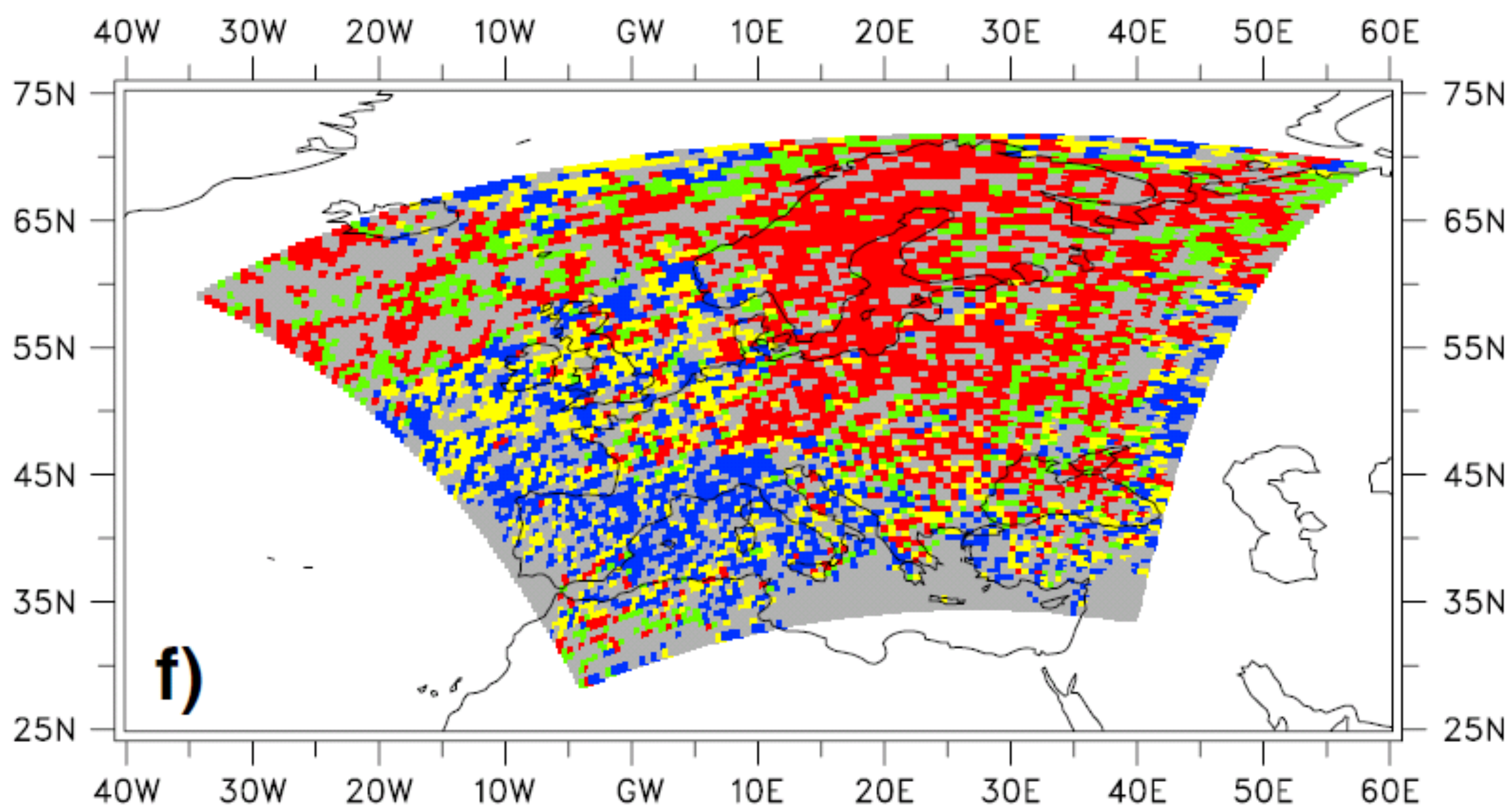
Δ ret lev > 0 & Δ int > 0

Δ ret lev > 0 & Δ int < 0

May, 2008, Climate Dynamics

Combined change of 30 yr return level and daily mean intensity

Freie Universität Berlin



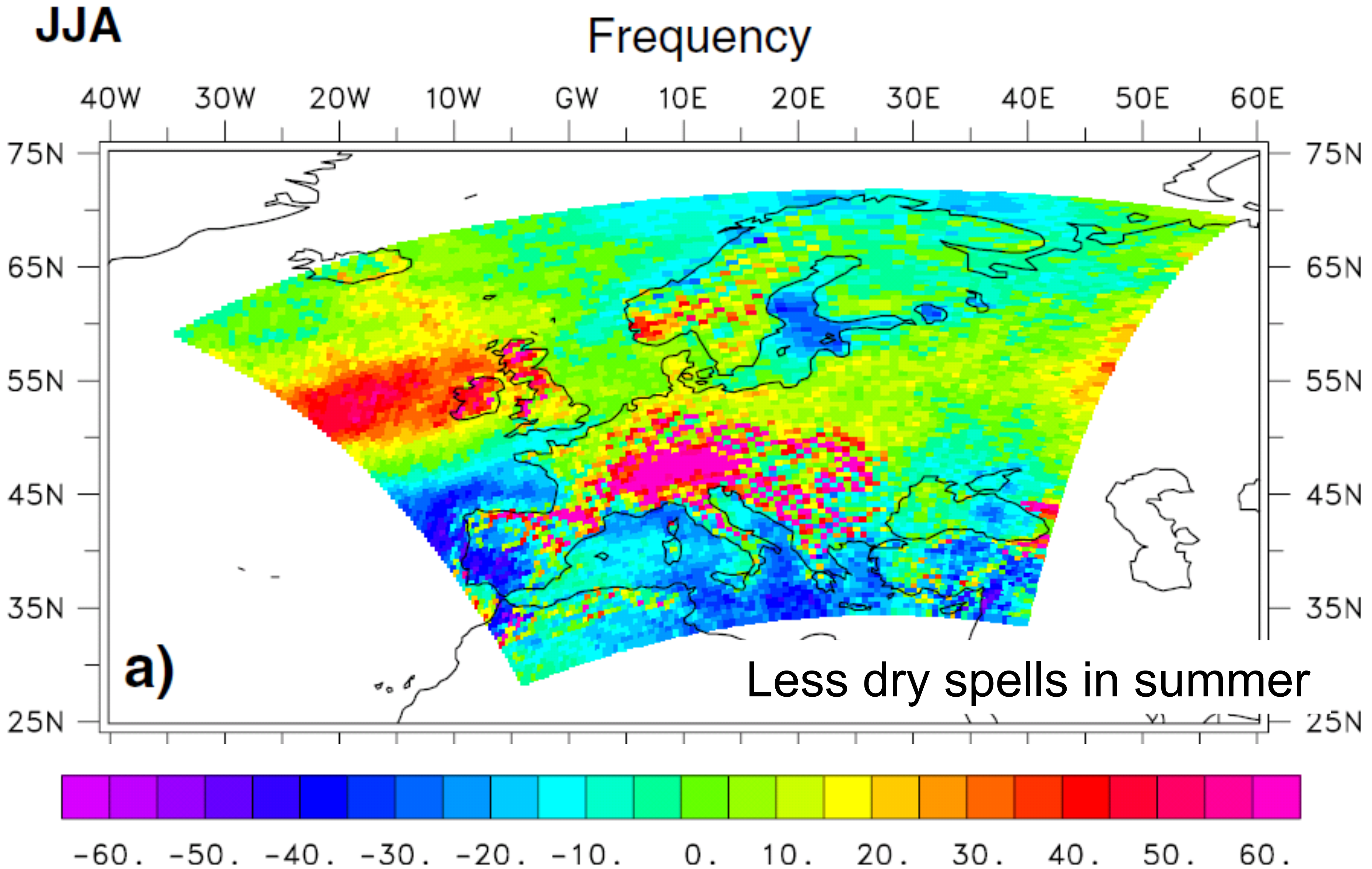
Δ ret lev > 0 & Δ int > 0

Δ ret lev > 0 & Δ int < 0

May, 2008, Climate Dynamics

Change of 7 day dry spells (%)

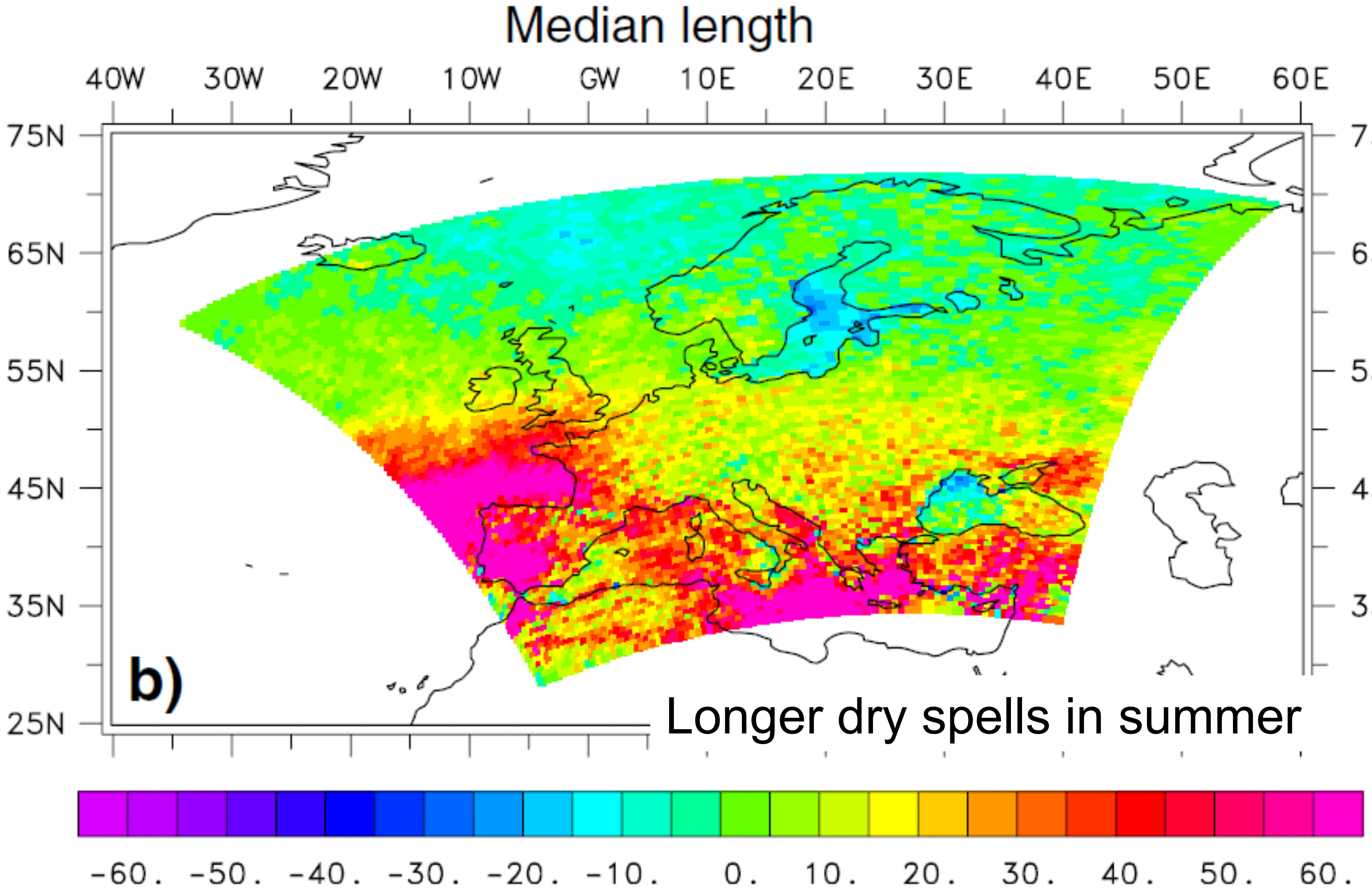
Freie Universität Berlin



Less dry spells in summer

May, 2008, Climate Dynamics

Change of dry spells (%)



May, 2008, Climate Dynamics

Changing convective extreme events

- Turbulence
- Downdrafts
- Tornadoes
- Hail
- Lightning
- Heavy local rainfall induced effects

Tornado Micheln, DE, 23.06.2004

Variance of vertical wind speed at 200 hPa

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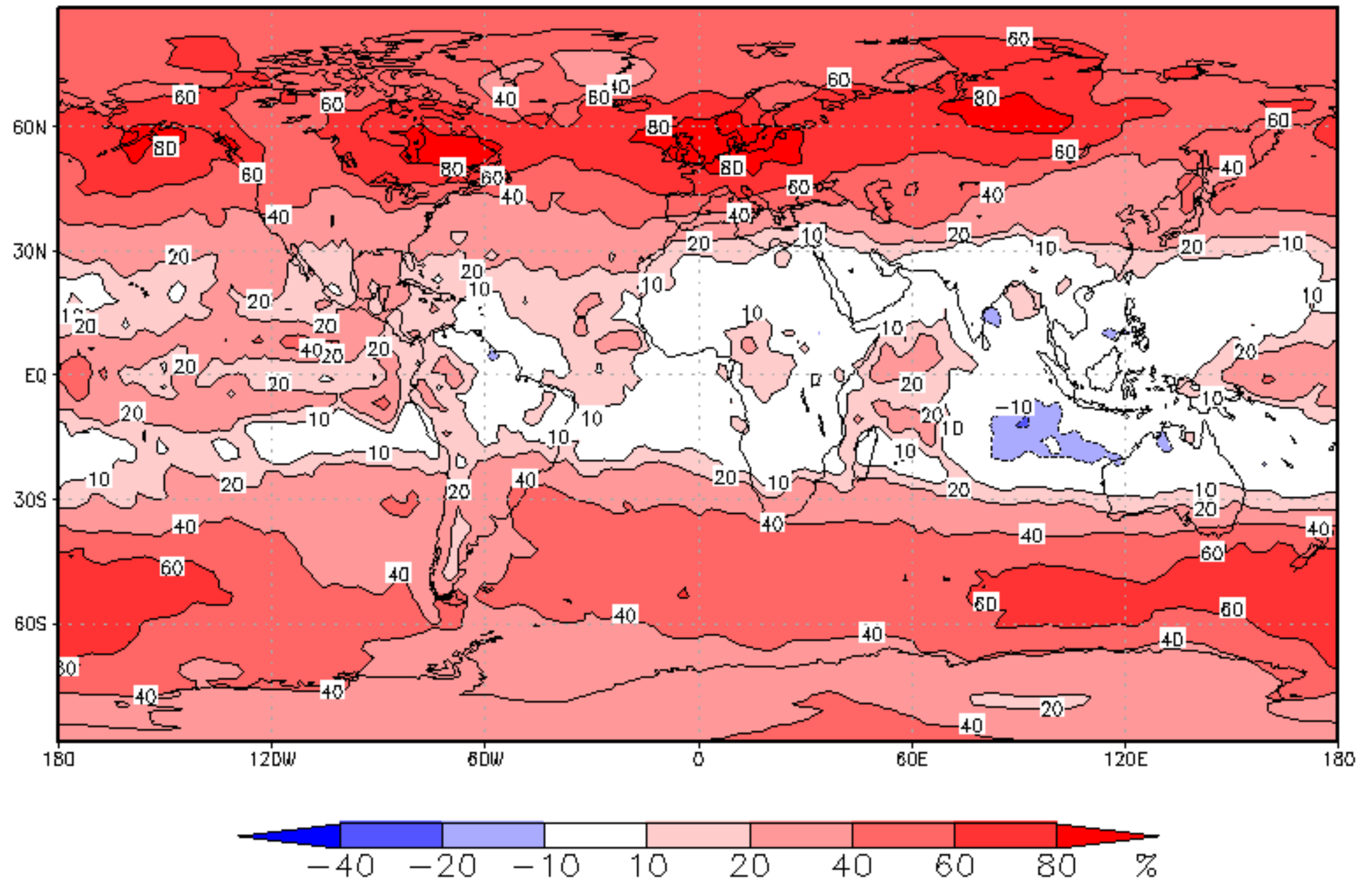
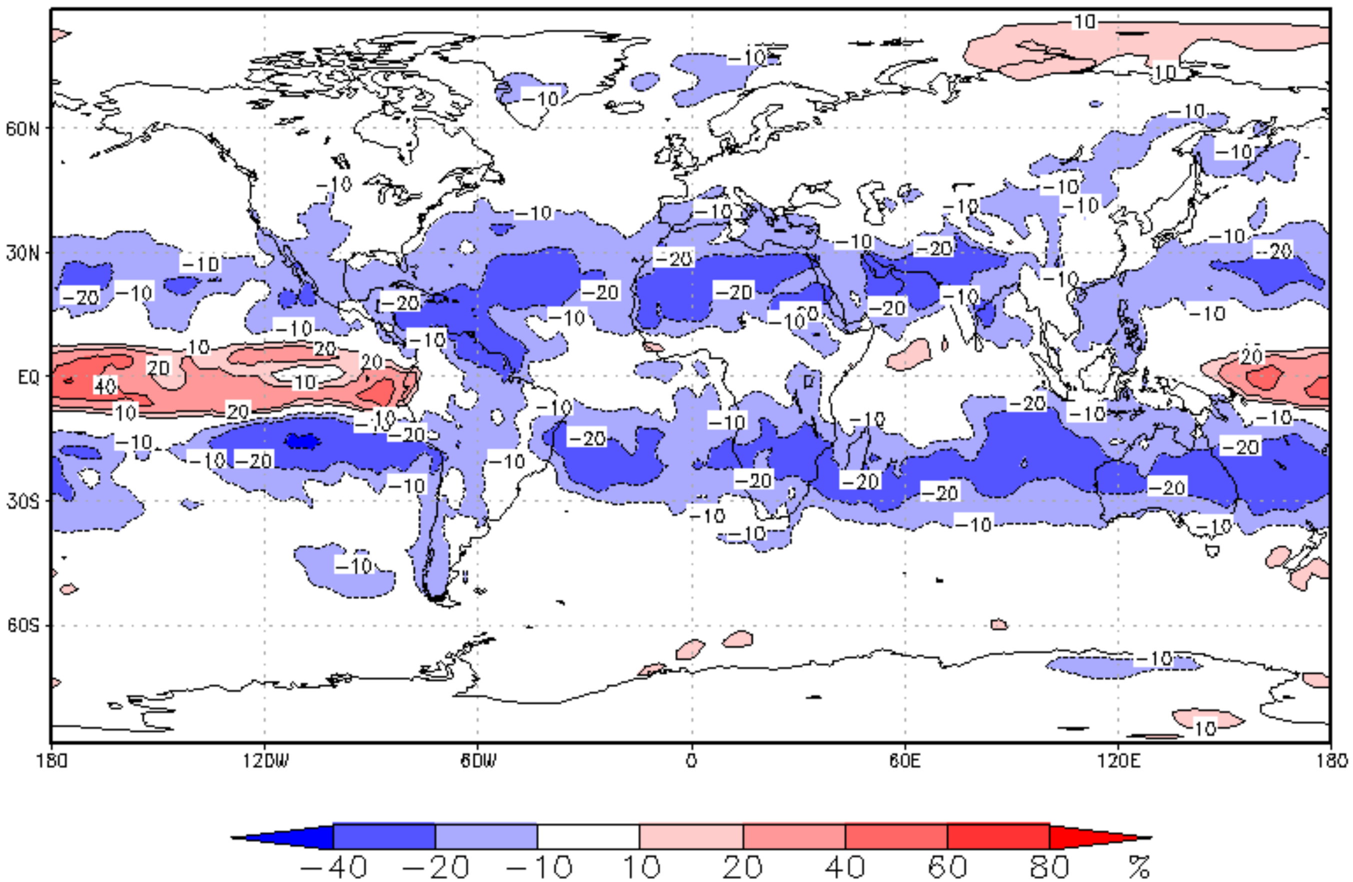


Model ECHAM5 A1B (2070-2100) – 20C (1970-2000)

Variance of vertical wind speed at 500 hPa



Model ECHAM5 A1B (2070-2100) – 20C (1970-2000)

Variance of vertical wind speed at 925 hPa

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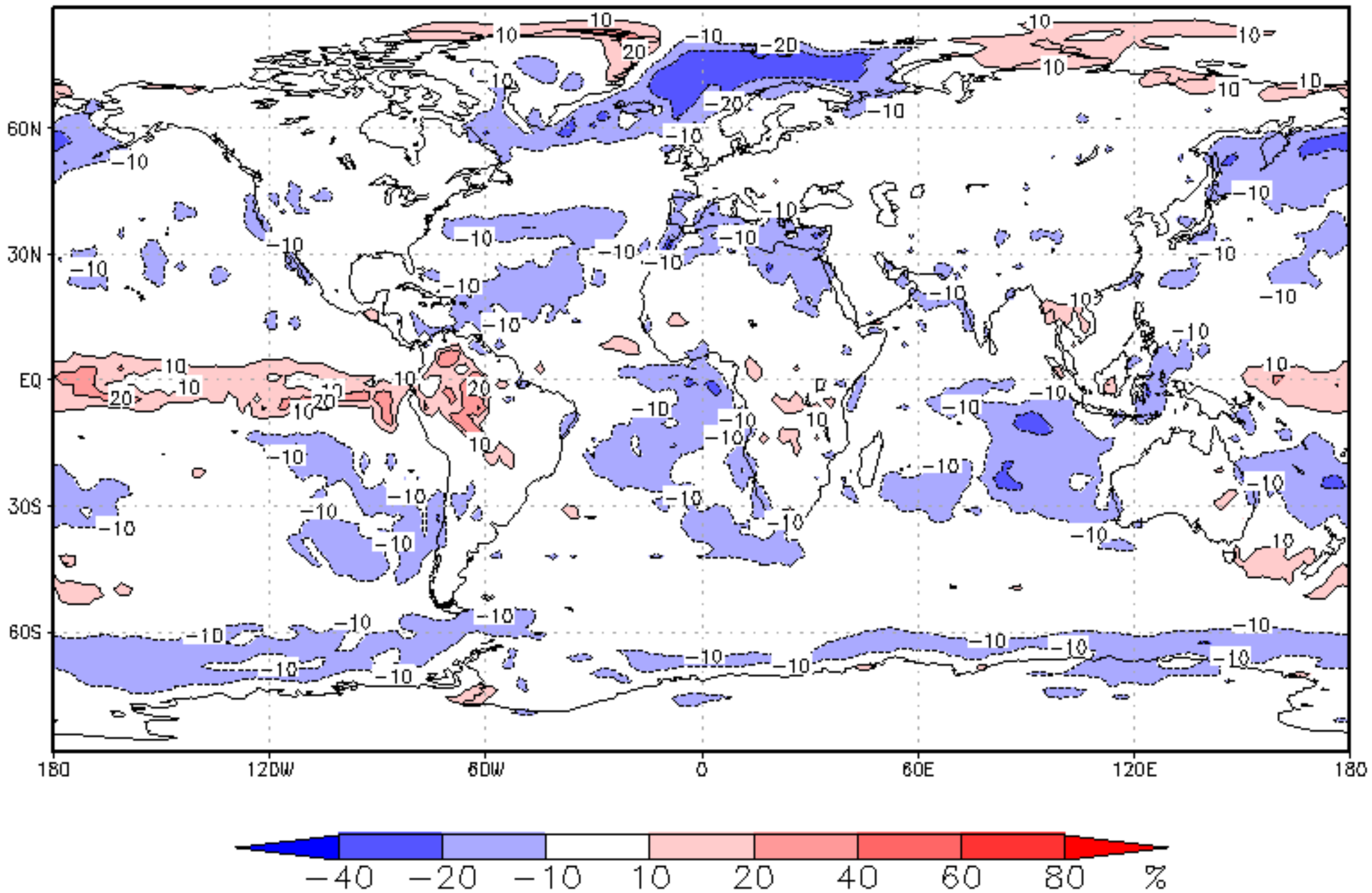

Model ECHAM5 A1B (2070-2100) – 20C (1970-2000)

Variance of vertical wind speed, zonal mean

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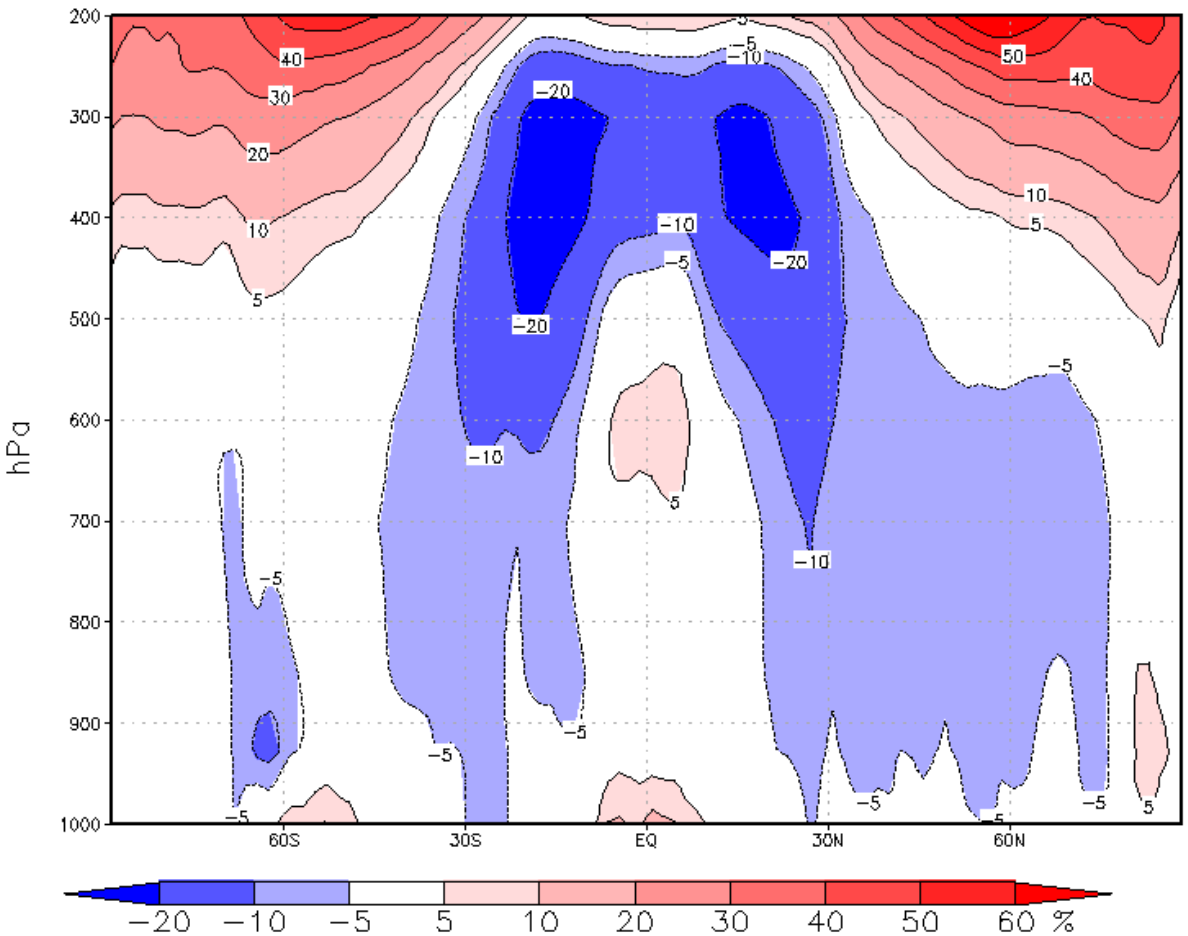

Model ECHAM5 A1B (2070-2100) – 20C (1970-2000)

How much do we know about present day convective event climatology?

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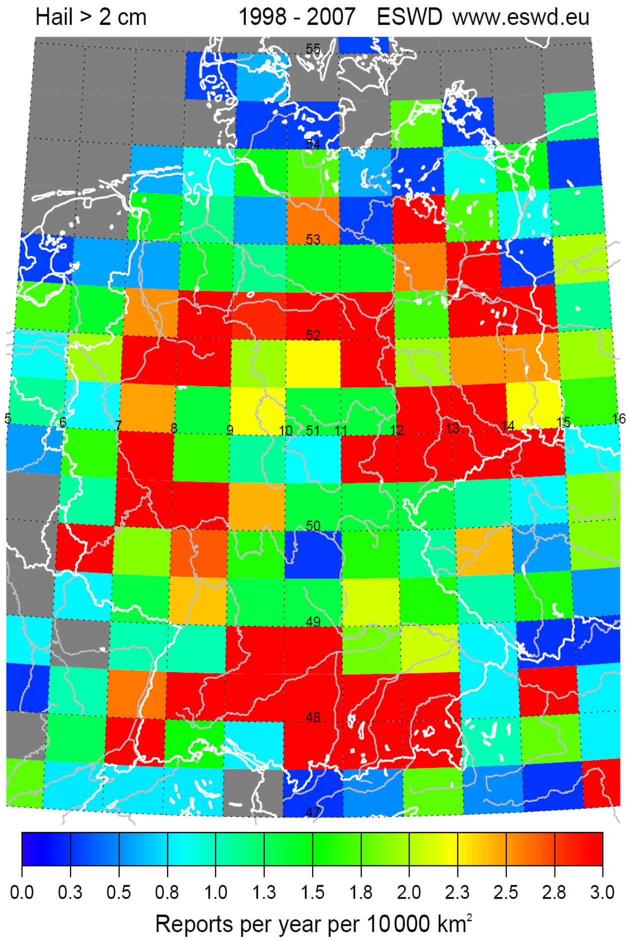
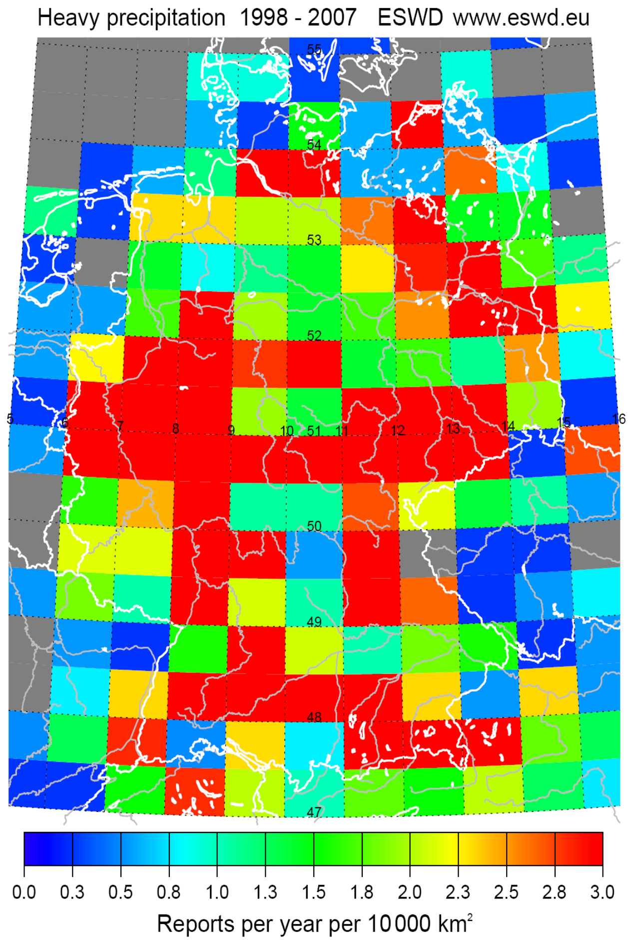
Reports per year
and 10000 km^2
1998-2007

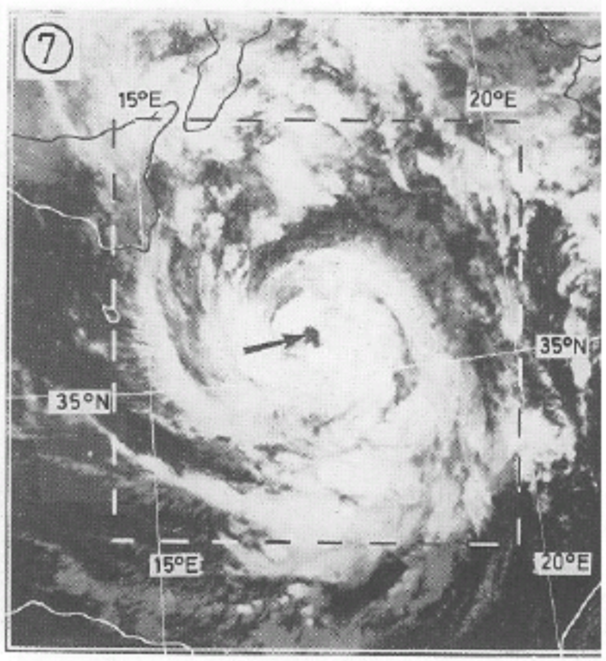


Hail

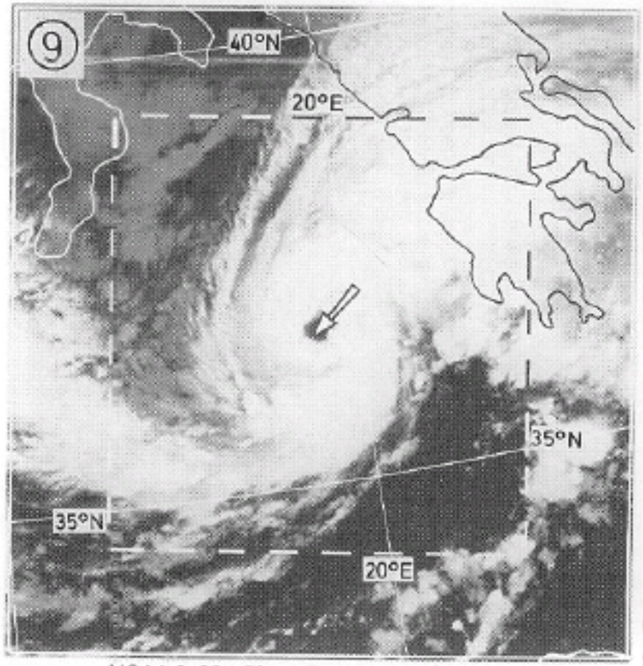


Heavy precip.

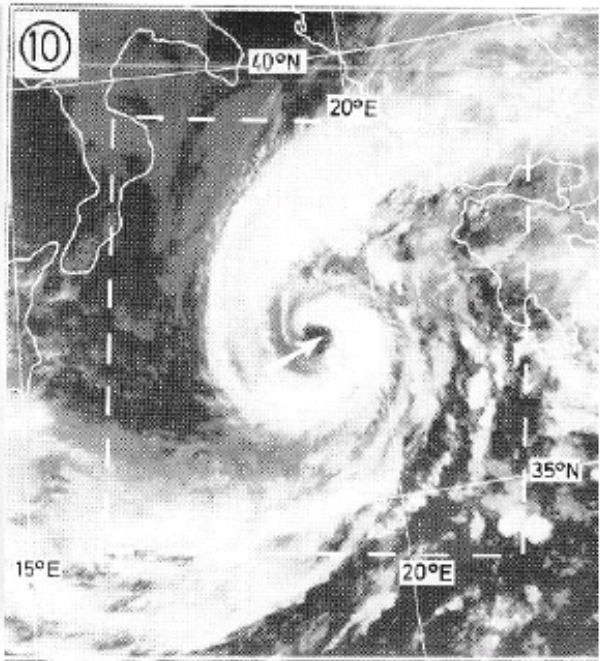
Medicanes



NOAA 7, 25.1.82, Uml. 3050 - 12.49 z, IR



NOAA 6, 26.1.82, Uml. 13420 - 06.39 z, IR

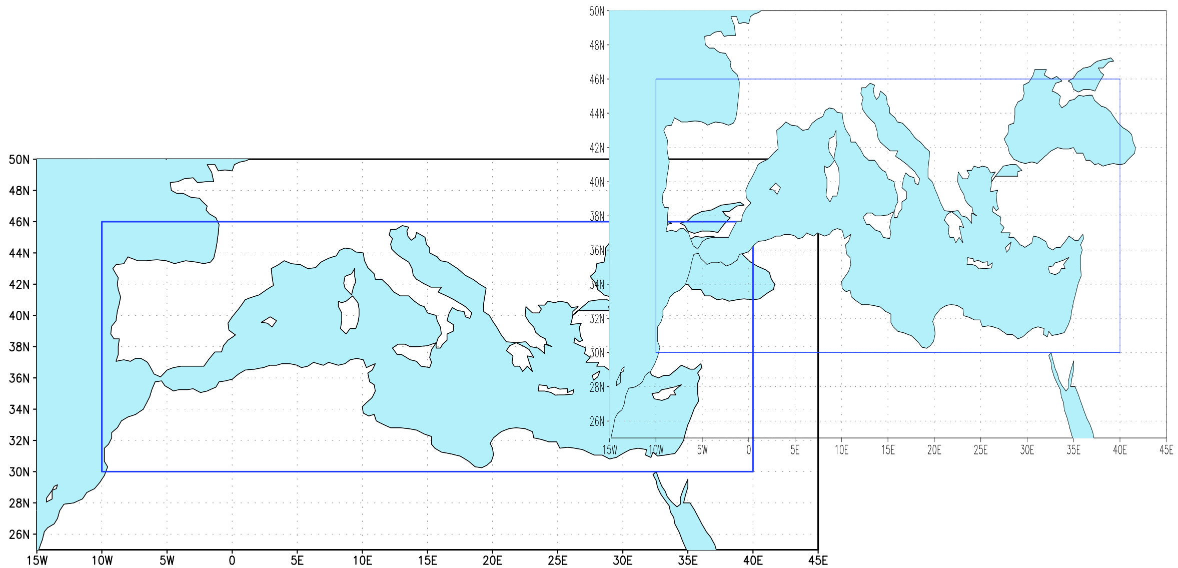


NOAA 7, 26.1.82, Uml. 3064 - 12.32 z, IR

- INVESTIGATING:
- Frequency and spatial distribution of
- Cyclones
- Wind tracks
- Cyclones with wind track affecting the Mediterranean region

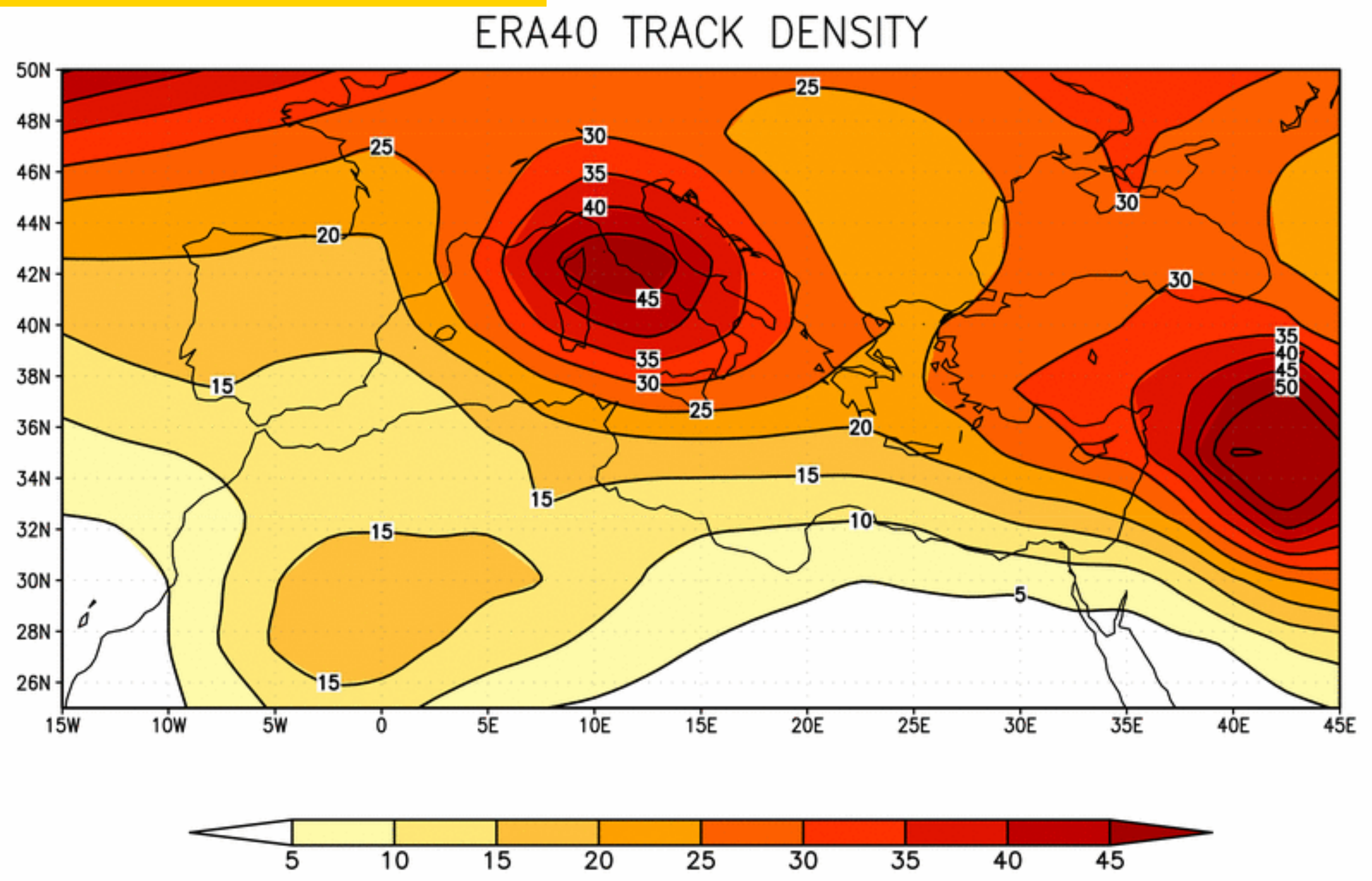
- Intensity of
- Wind storms

Analysis for the extended winter season (October-March)

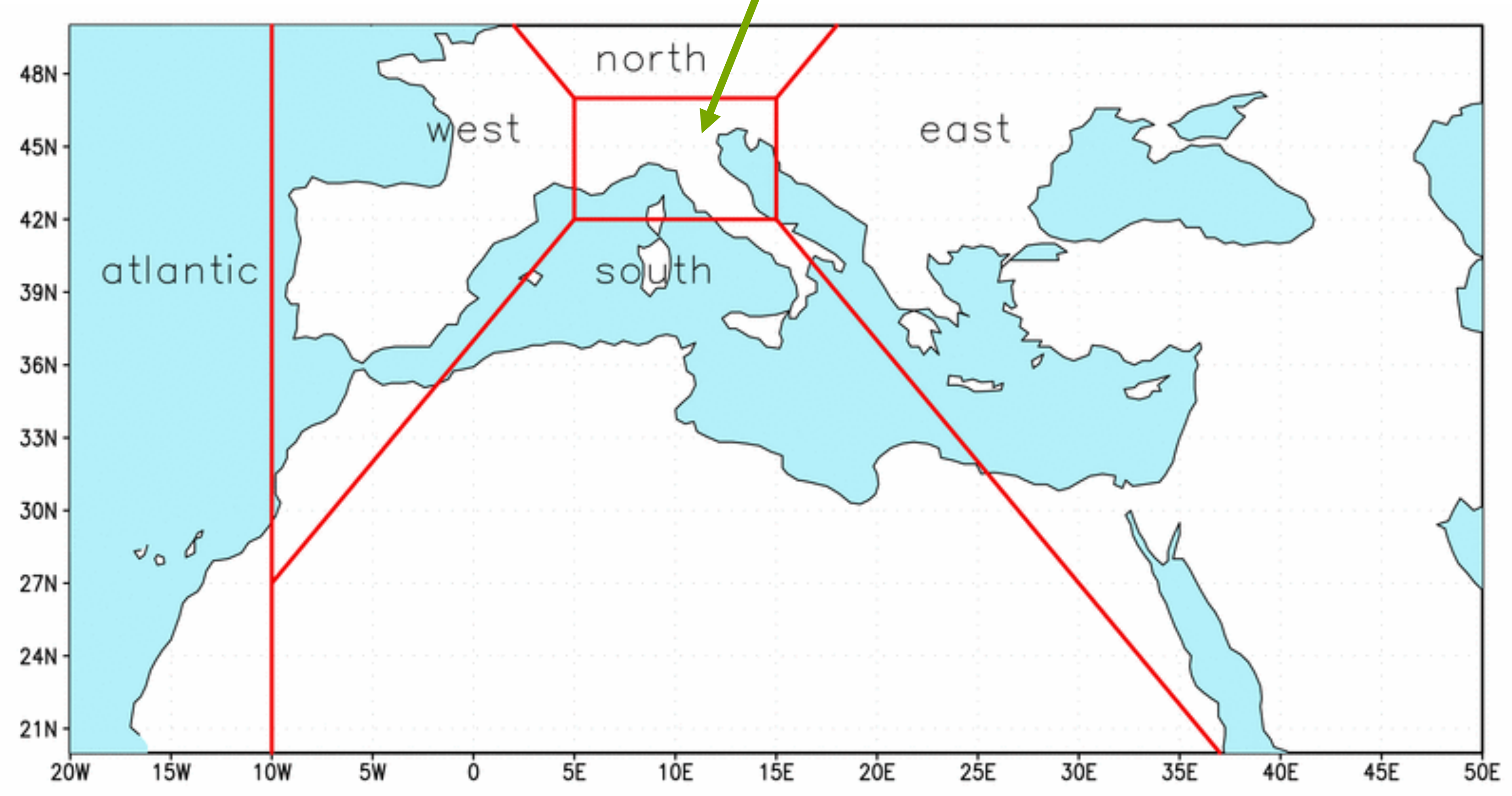


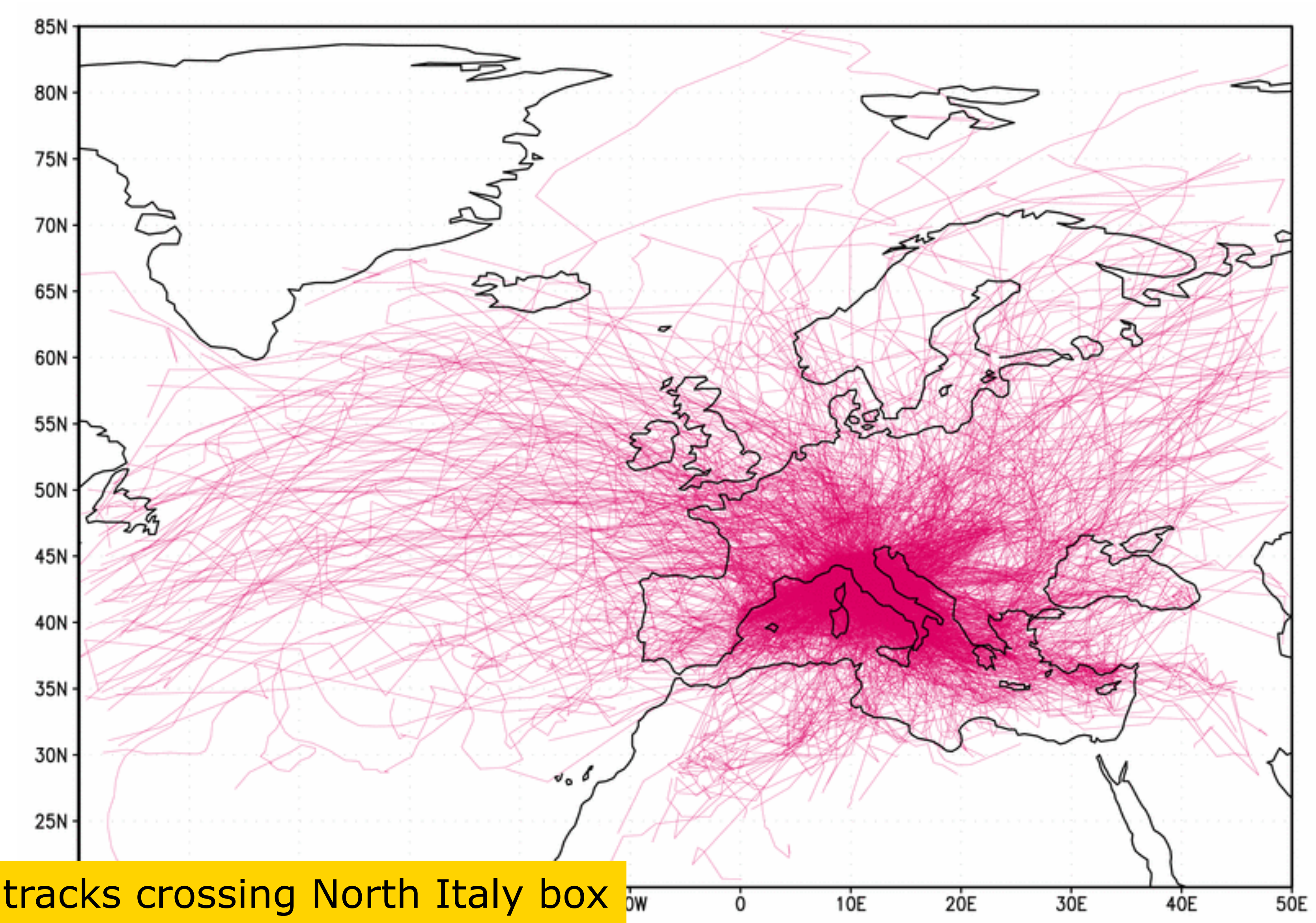
CLIMATOLOGY of TRACK DENSITY

Number of cyclones per year



FOCUS AREA


Northern Italy Box
north
west
east
atlantic
south
48N
45N
42N
39N
36N
33N
30N
27N
24N
21N
20W
15W
10W
5W
0
5E
10E
15E
20E
25E
30E
35E
40E
45E
50E



All tracks crossing North Italy box

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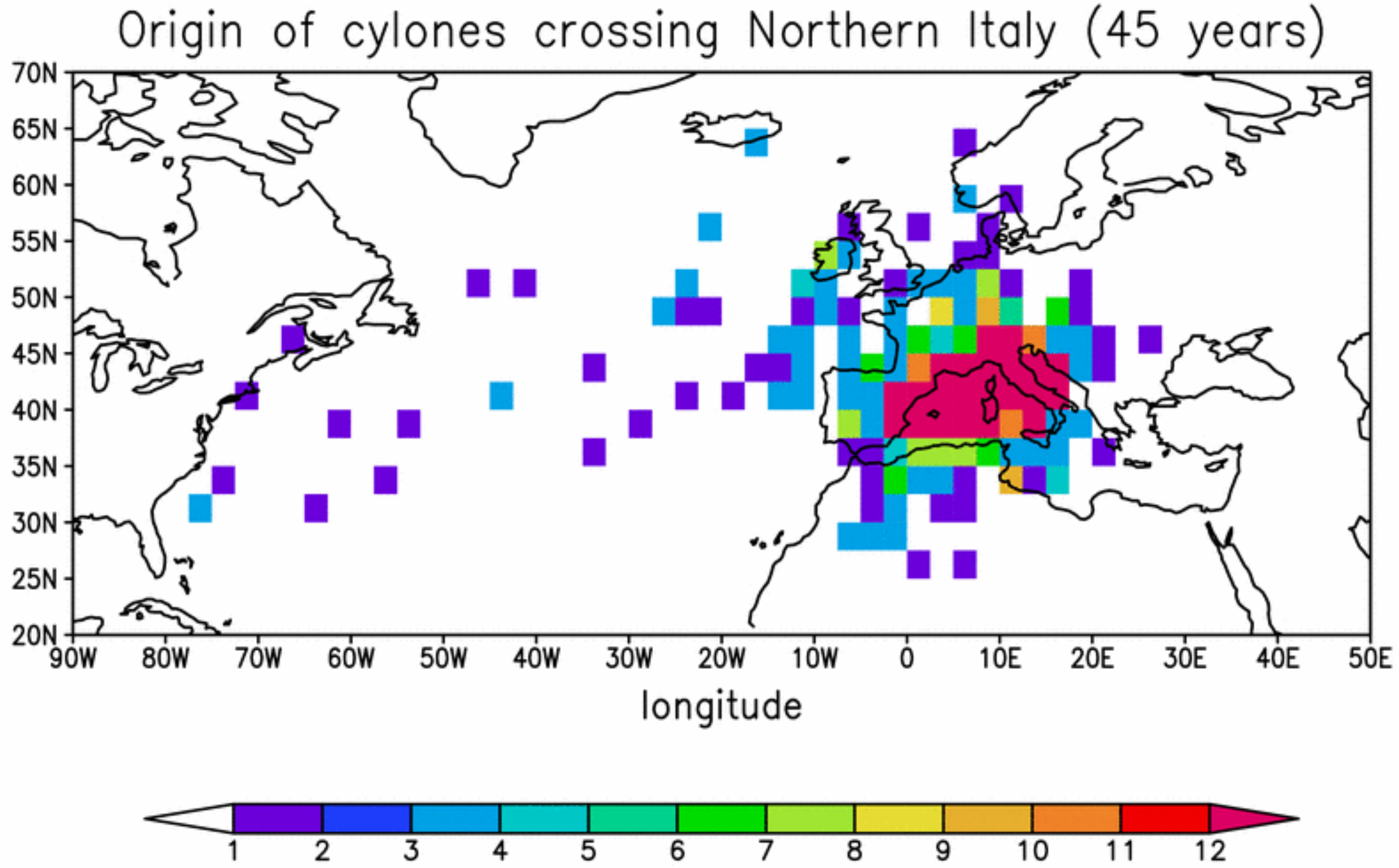
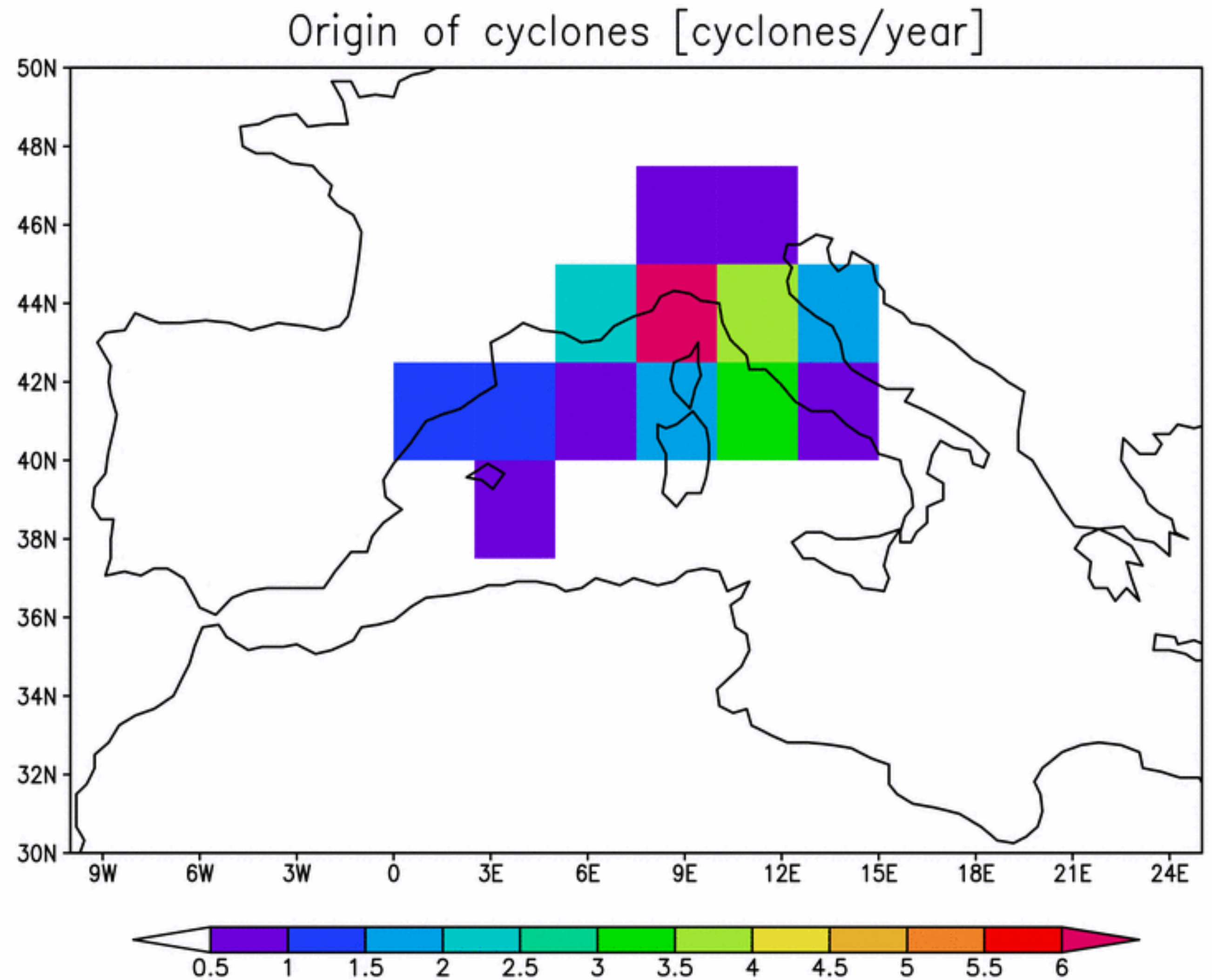


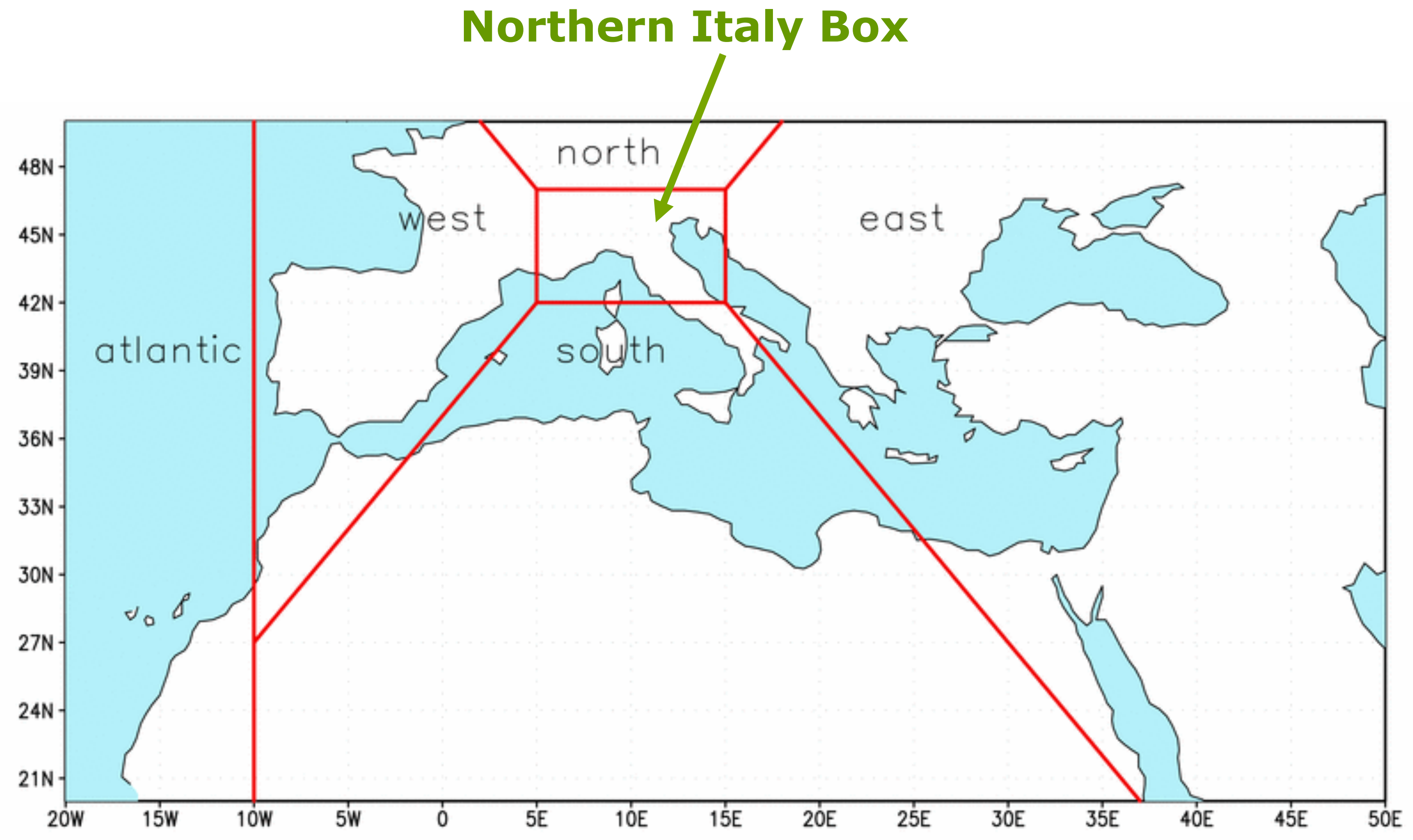
Area of **genesis** for cyclones crossing North Italy box
Total count in 2.5°x2.5° boxes



Zoom to Mediterranean region
Number originating in 2.5°x2.5° boxes [cyclones per year]

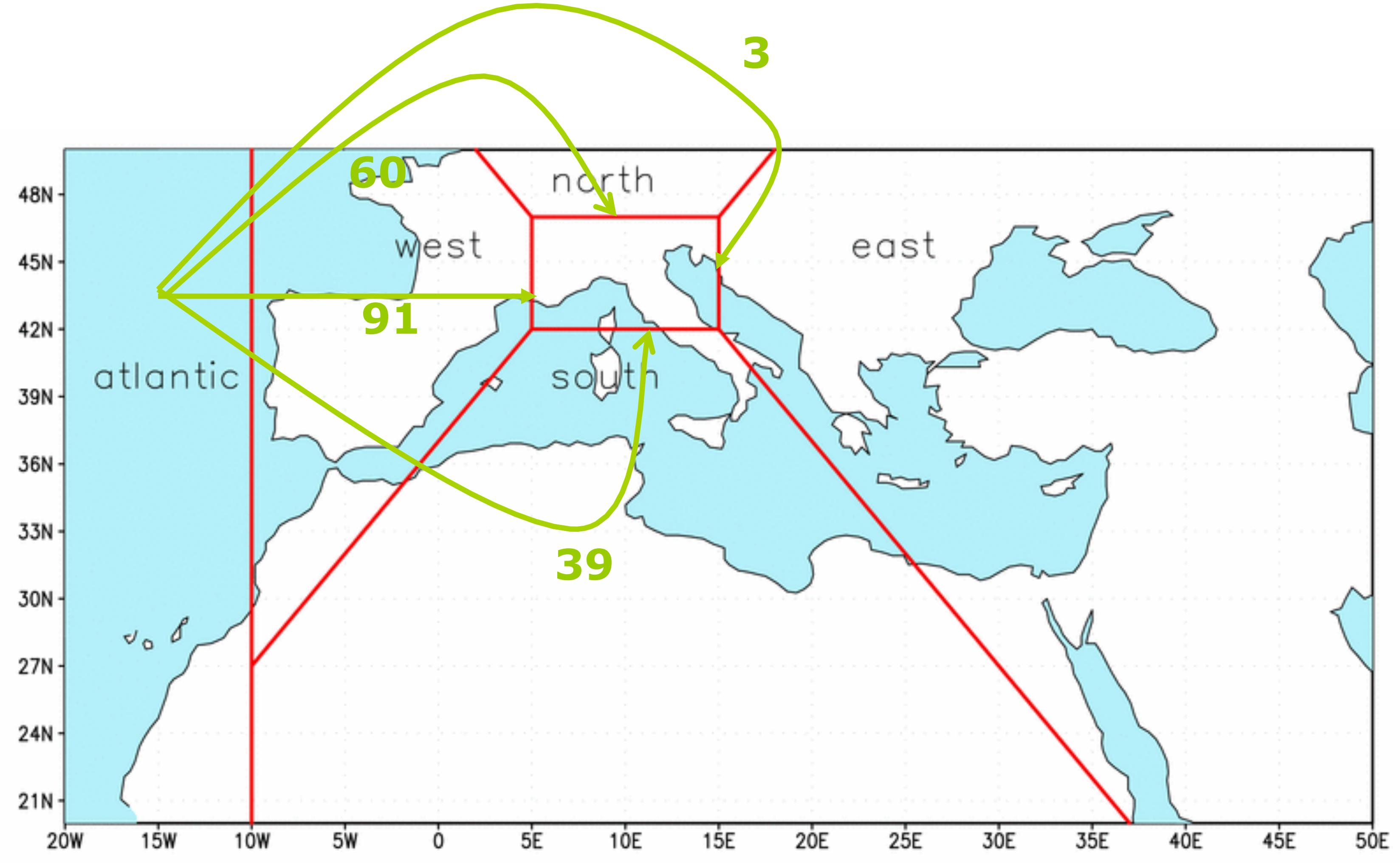
ANNUAL STATISTICS

Freie Universität Berlin



Total affecting North Italy box: 1839 cyclones
Local genesis : 810 (44%)

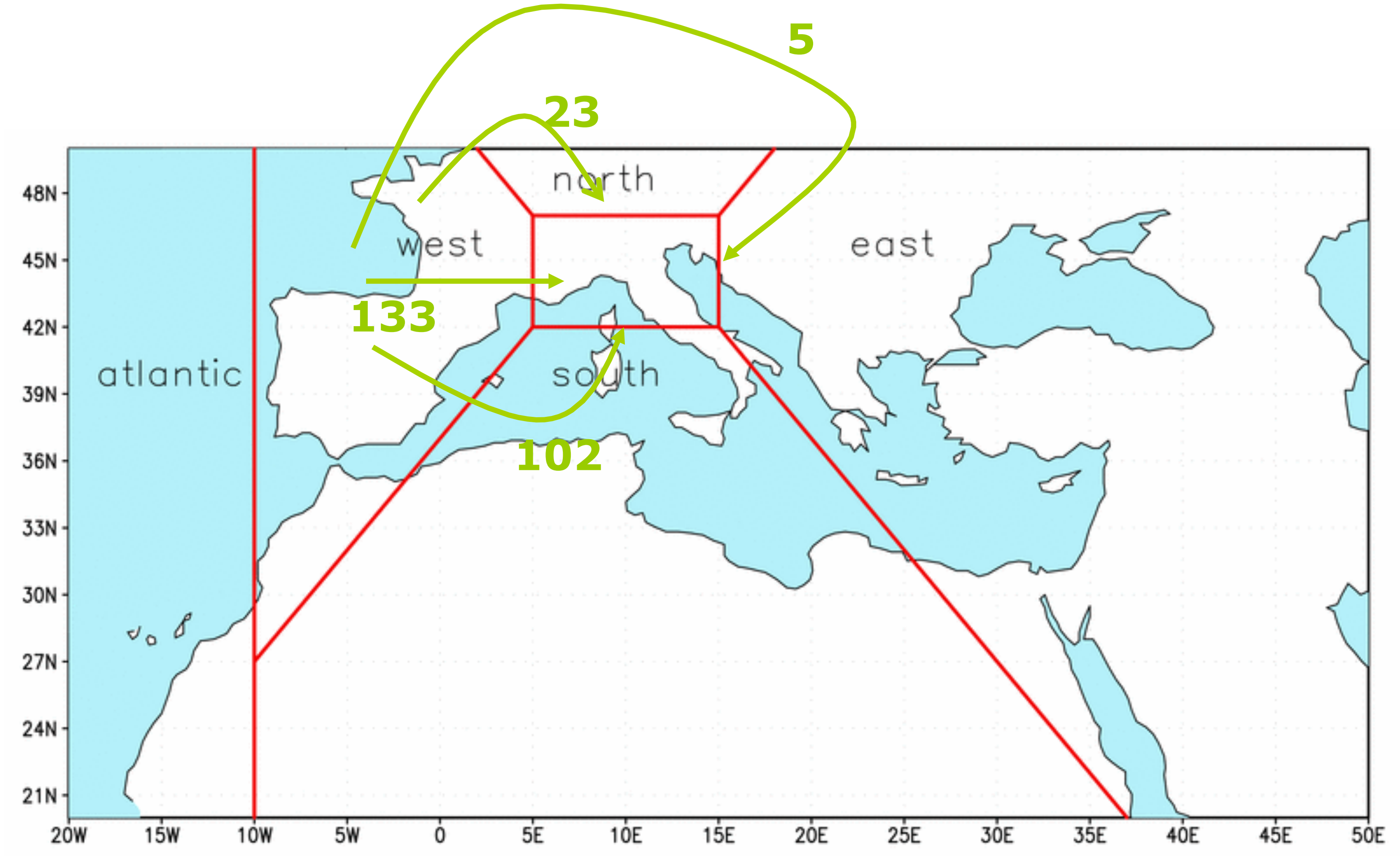
PATH STATISTICS



Total affecting North Italy box: 1839 cyclones
Originating over Atlantic: 193

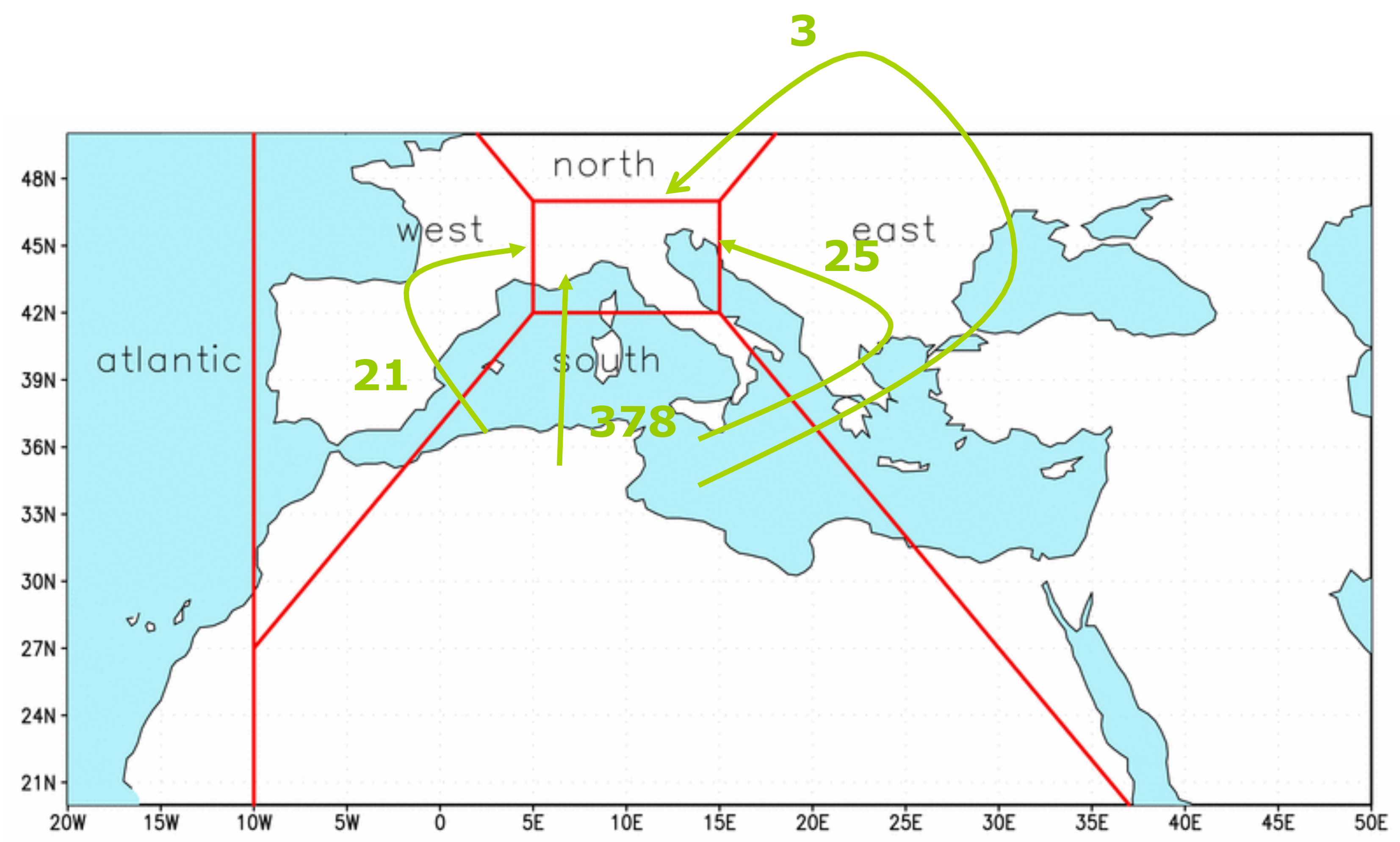
PATH STATISTICS

Freie Universität Berlin



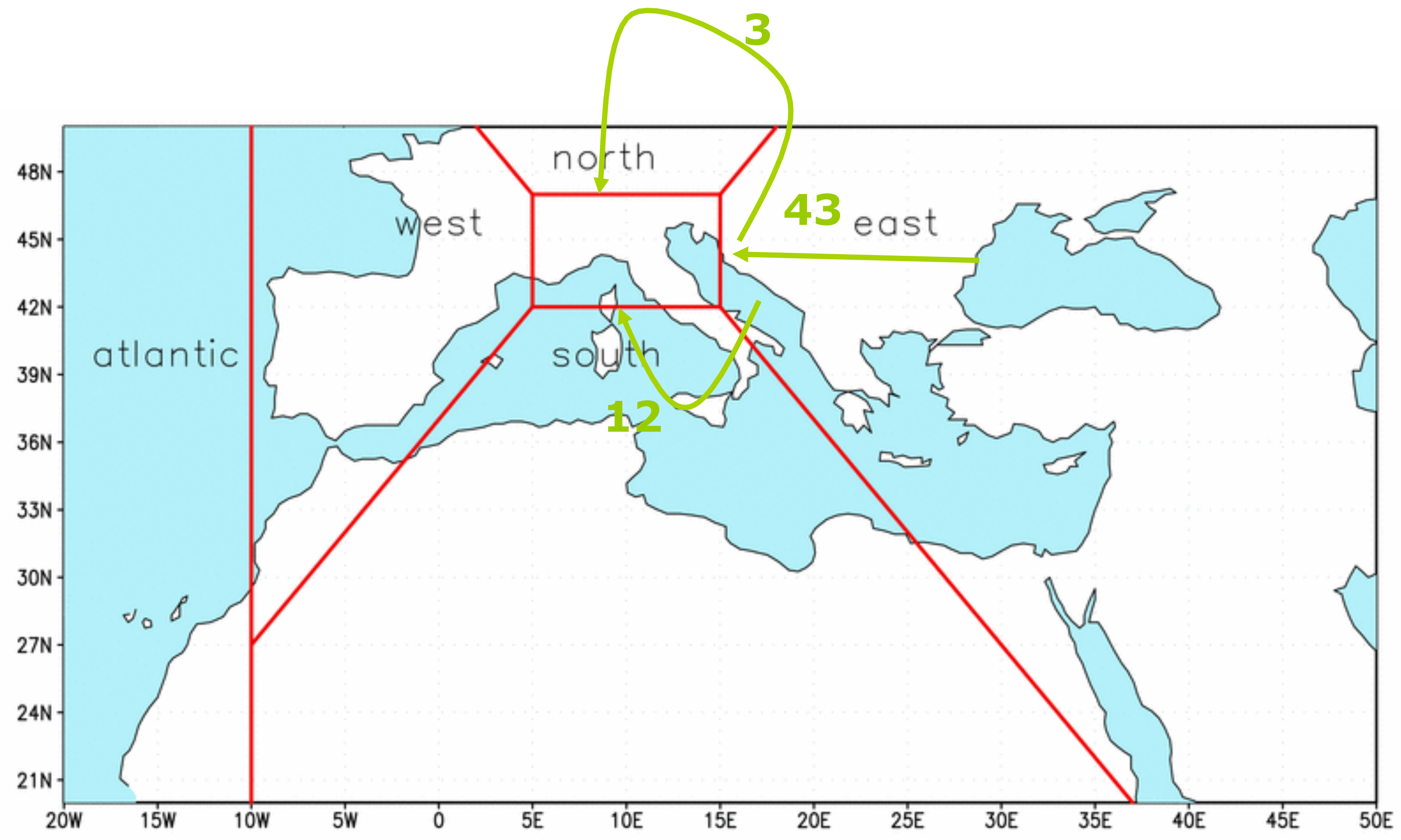
Total affecting North Italy box: 1839 cyclones
Originating west (without Atlantic): 263 (with Atlantic): 456 (25%)

PATH STATISTICS



Total affecting North Italy box: 1839 cyclones
Originating south of North Italy box: 427 (23%)

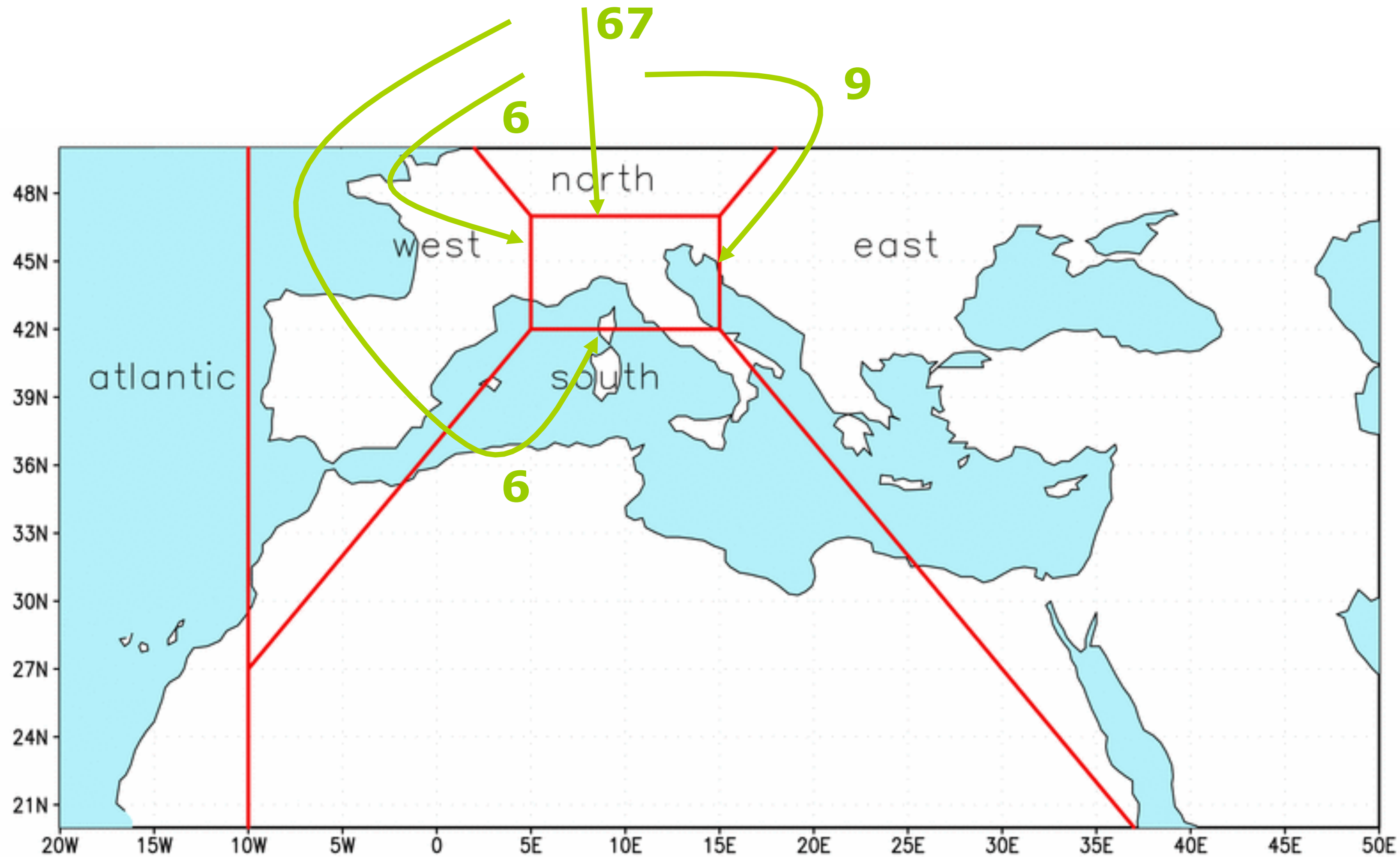
PATH STATISTICS



Total affecting North Italy box: 1839 cyclones
Originating east of North Italy box: 58 (3%)

PATH STATISTICS

Freie Universität Berlin



Total affecting North Italy box: 1839 cyclones
Originating north of North Italy box: 88 (5%)

Conclusions I

- Changes in extreme weather occurrences are difficult to detect in observations :

  Main reasons:

  - extreme events are rare – effect on statistical significance
  - climate variability

  Consequence

  - need to collect more historical data, new data
  - estimating changing risk of convective events from larger scales

Conclusions II

- Climate Change effects on extreme events are found in GHG simulations

- Confidence in model results must be gained from
  - agreement between ensembles of simulations
  - downscaling

- It is a challenge to identify parameters that
  - are indicative of relavant local extremes and
  - at the same time produce statistically reliable (not just locally significant) results

- Confidence should be gained by understanding what a model does!