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A novel metric to assess the “extremeness” of cyclones

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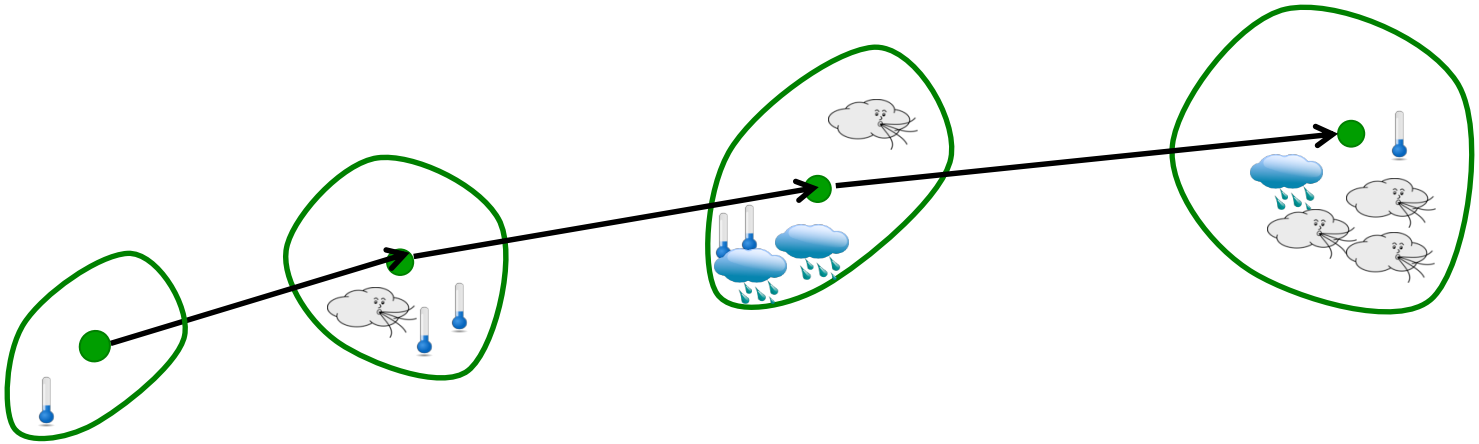


Motivation

- Cyclones can cause high impact weather (HIW) over large regions
  - Heavy precipitation (e.g. Brig flood 1993)
  - Strong winds (e.g. winterstorm Lothar 1999)
- Do extreme cyclones have specific characteristics?

Photo: Roberto Loat, BAFU, planat.ch

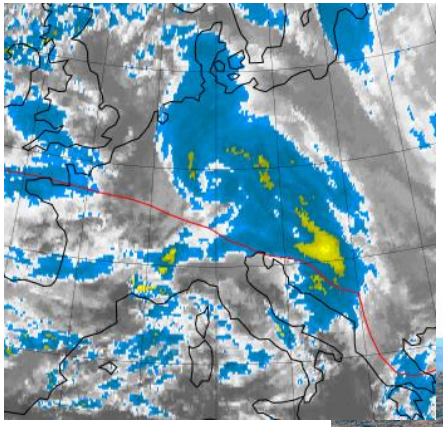
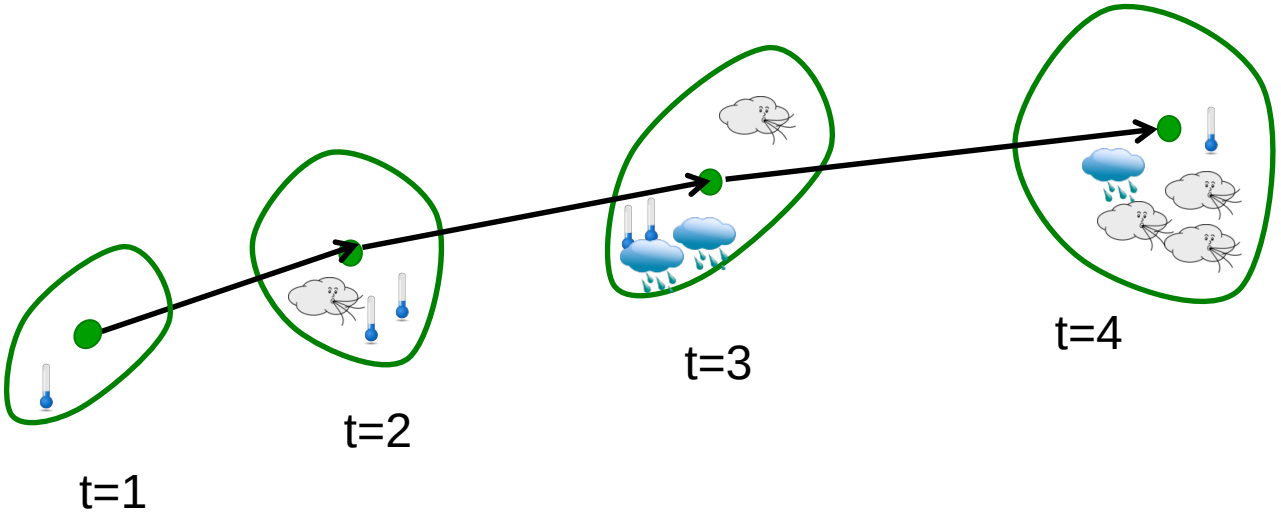



Photo: Badische Zeitung

Approach & Data

- ERA-Interim reanalysis (1979-2013)
  - 1° horizontal lat-lon grid spacing,
  - 6h temporal resolution



- "HIW" flag at each time step and grid point
- match with individual cyclone

area affected by HIW linked to individual cyclone at each time step

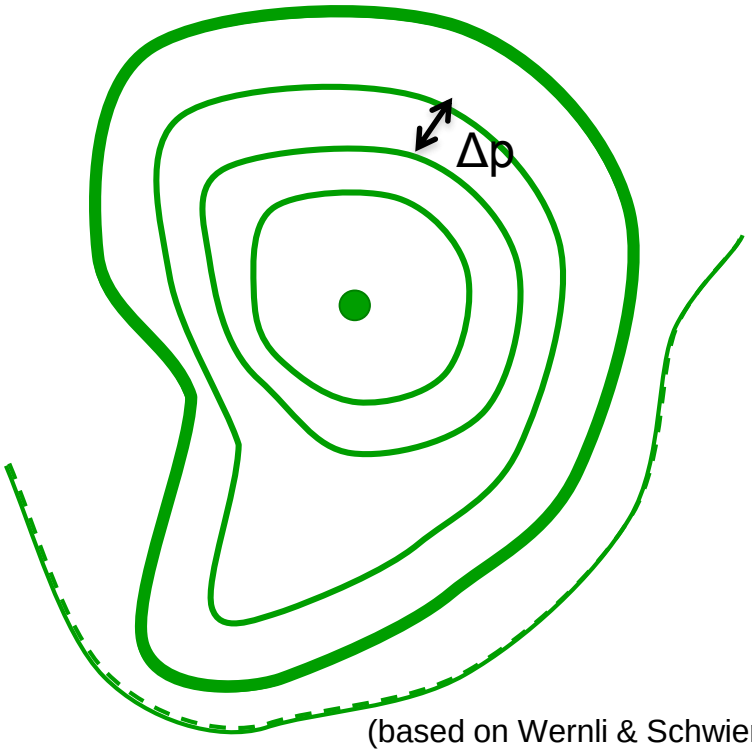
Cyclone identification and tracking

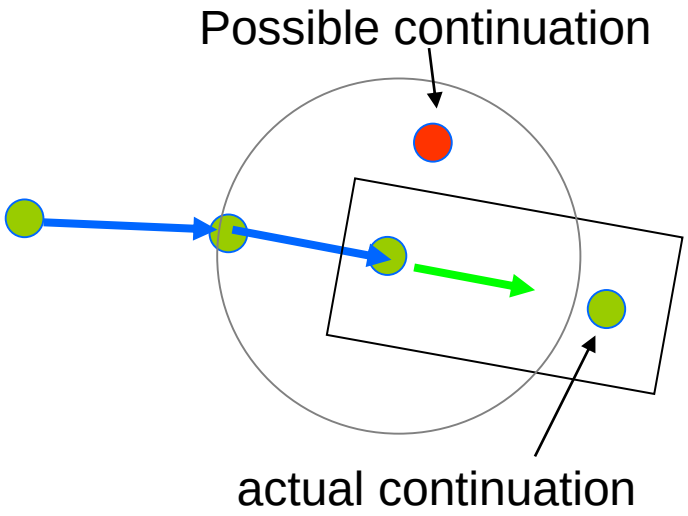
- detection of pmsl minima
- detection of enclosing contour
- contour splitting if necessary

→ cyclone object

↓

tracking

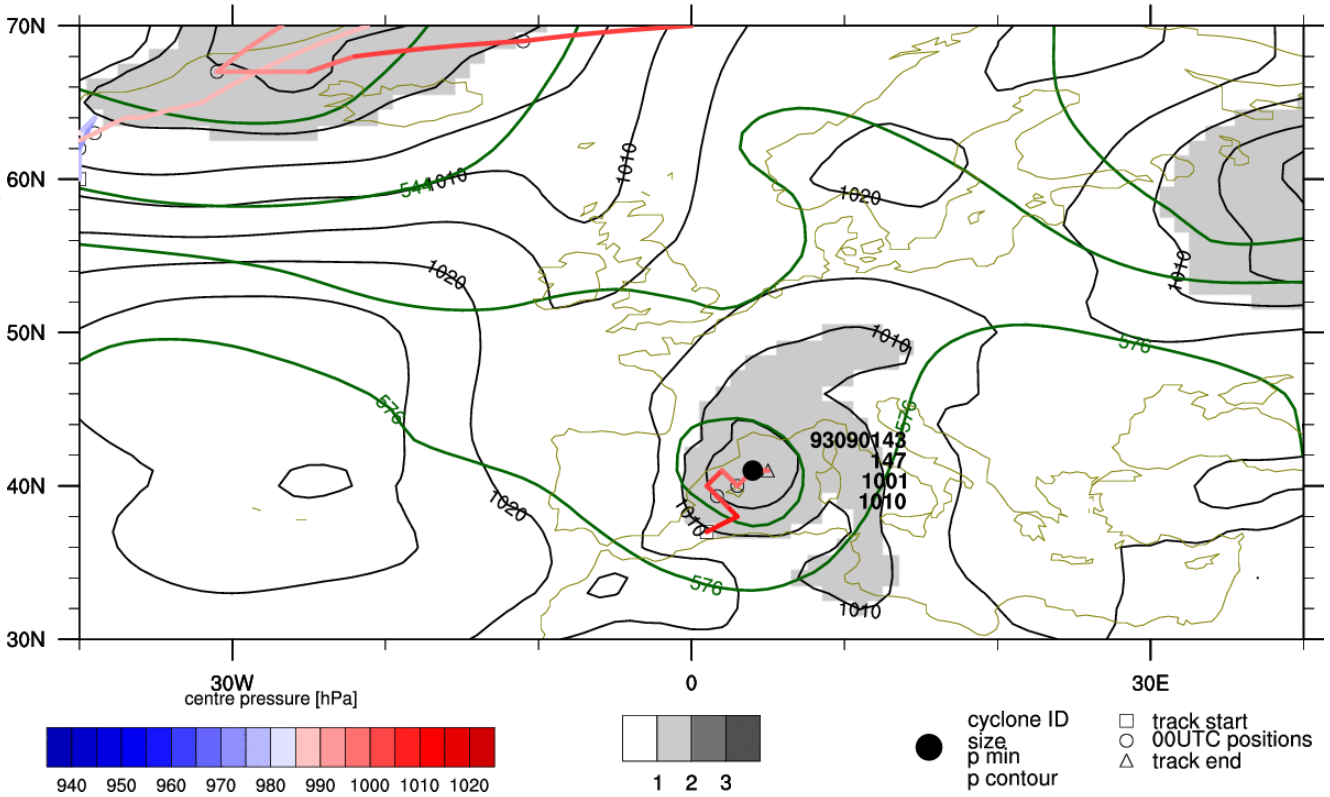




(based on Wernli & Schwierz (2006) adapted by M.Sprenger & C.M. Grams)

Cyclone objects & HIW

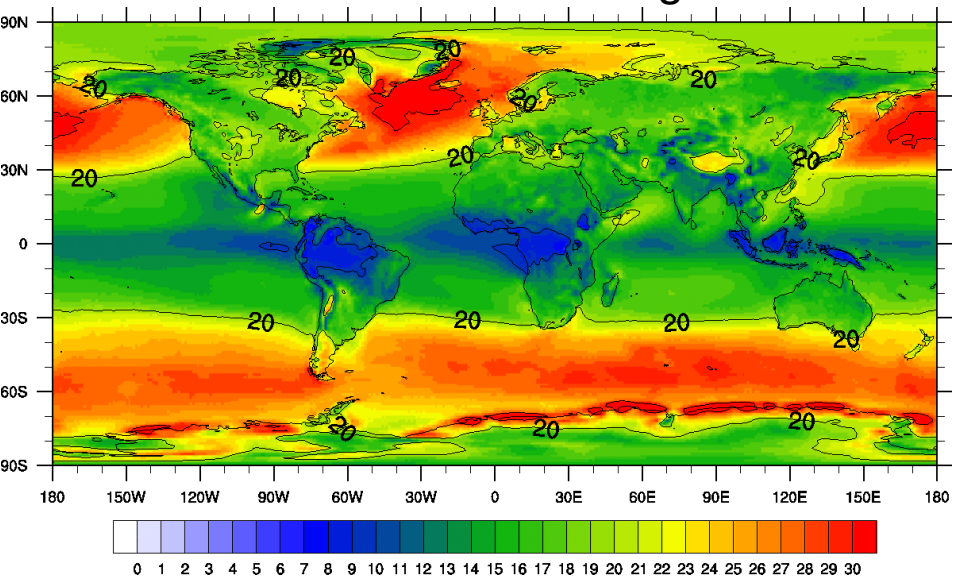
- characteristics emerging directly from the diagnostics:
  - size
  - lifetime
  - track



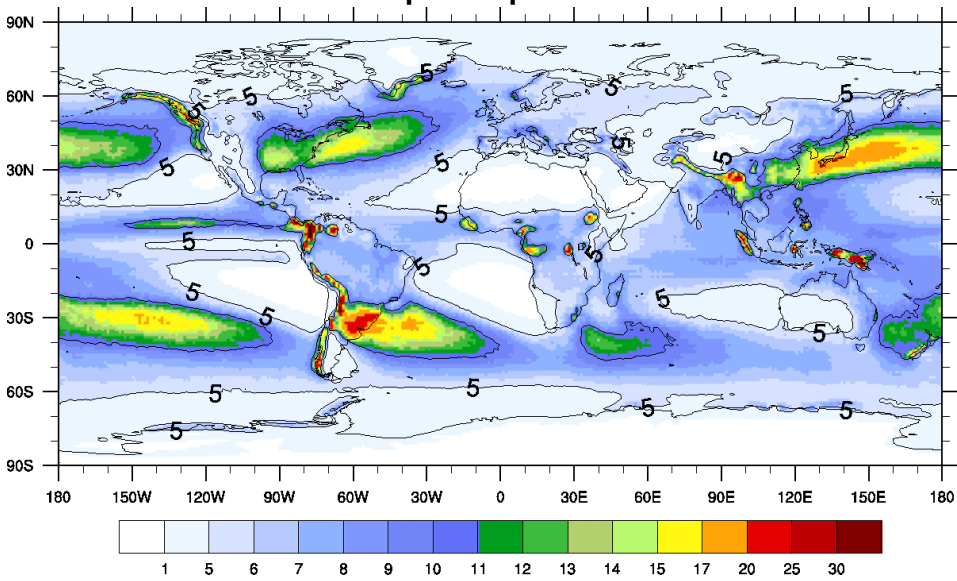
HIW definition

- grid-point based extremes: > 99% percentile (1989-2009)
  - 2m min/max temperature, precipitation, 10m wind gusts
  - six-hourly data

99% P for 10m wind gusts



99% P for precipitation

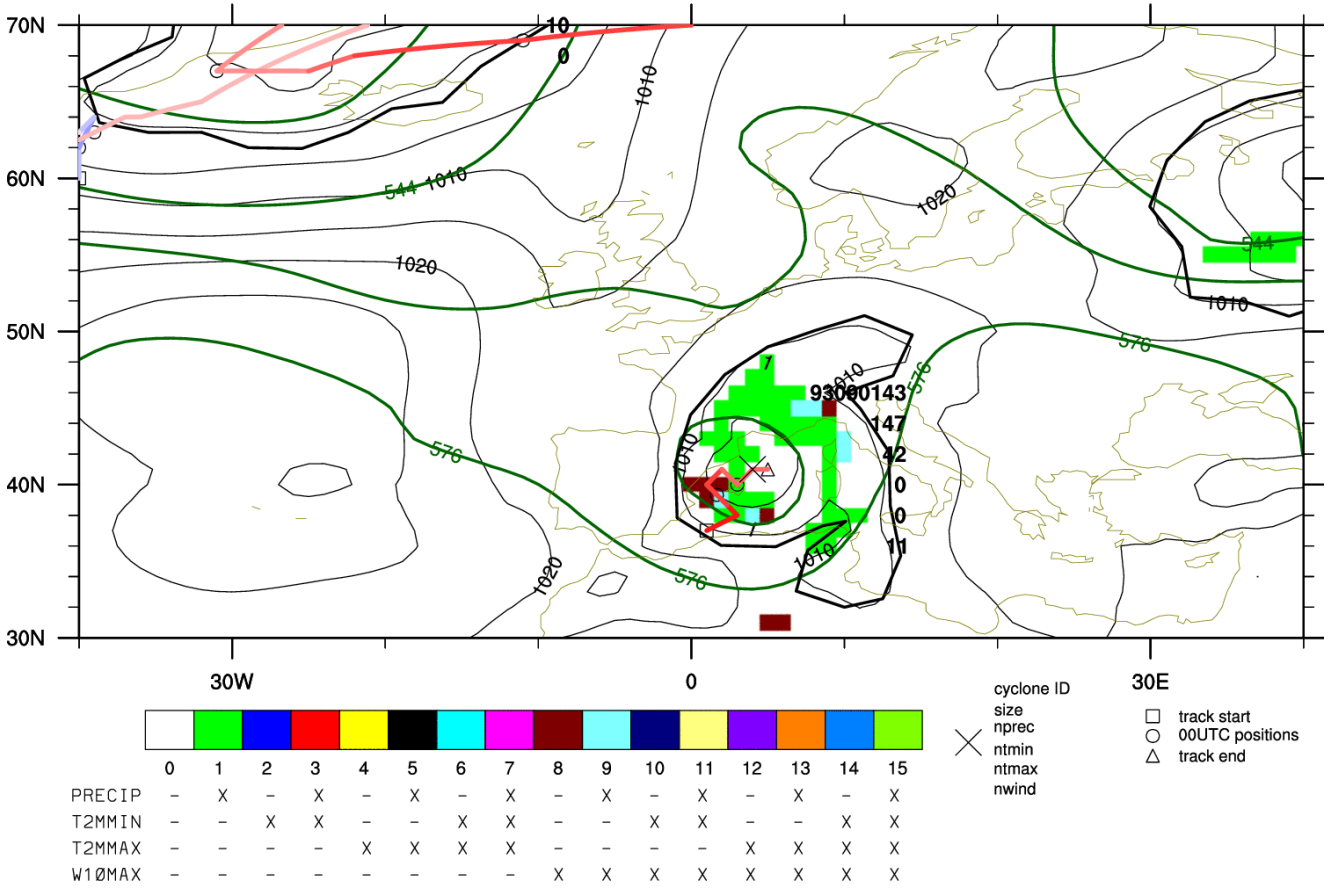


Pfahl S. and Wernli H., 2012. Quantifying the relevance of atmospheric blocking for co-located temperature extremes in the Northern Hemisphere on (sub-)daily time scales. ***GRL***., doi:10.1029/2012GL052261.

Pfahl S. and Wernli H., 2012. Quantifying the relevance of cyclones for precipitation extremes. ***J. Climate***, doi:10.1175/JCLI-D-11-00705.1.

Cyclone objects & HIW

- characteristics in terms of HIW area affected by extreme …
  - temp.
  - wind
  - precip.

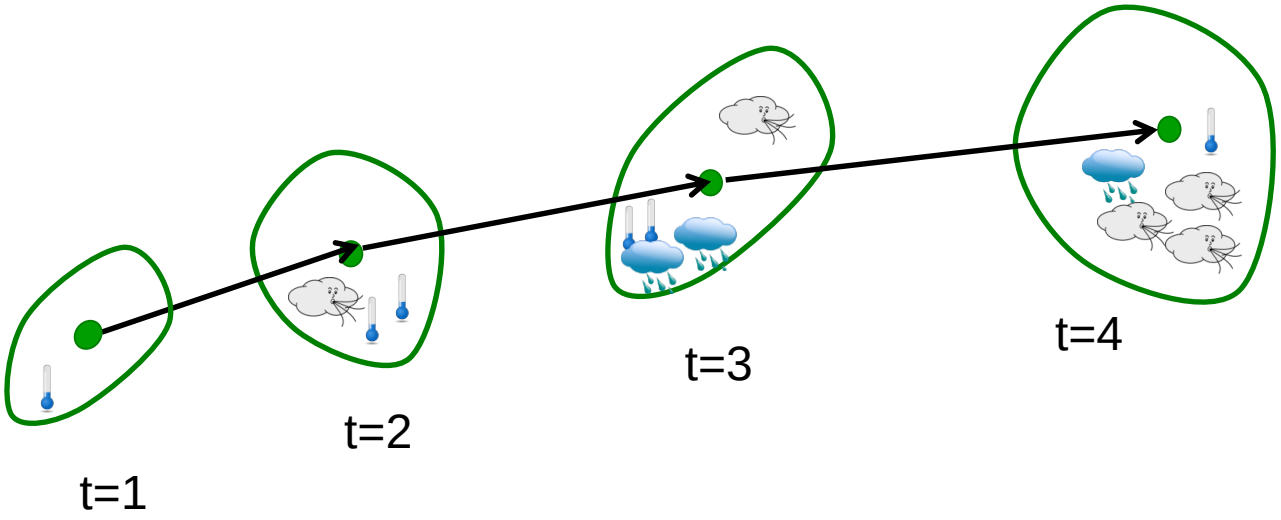


Directions of investigation

- Definition of extremeness:

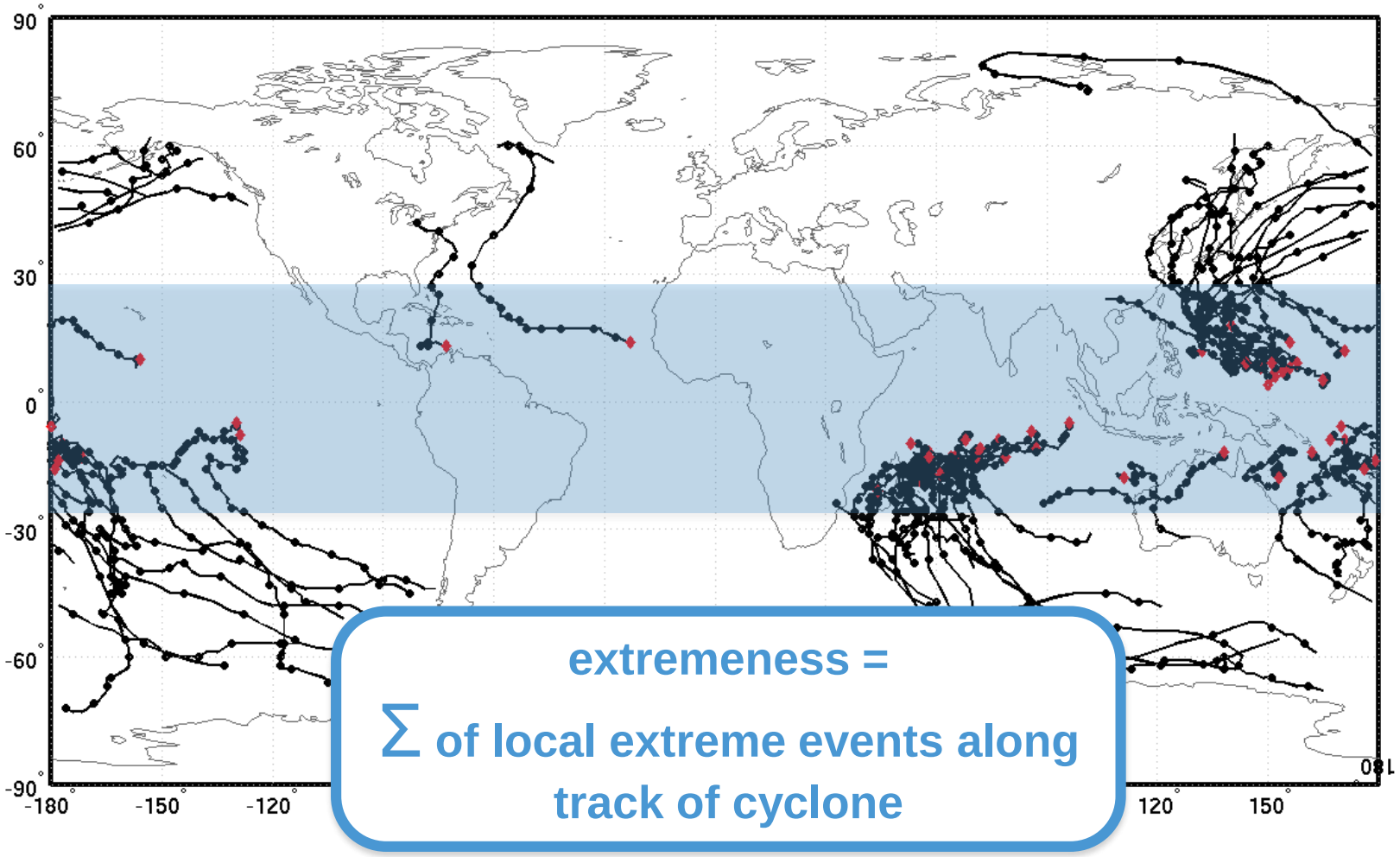
extremeness =

Σ of local extreme events along track of cyclone



TOP50 most extreme cyclones

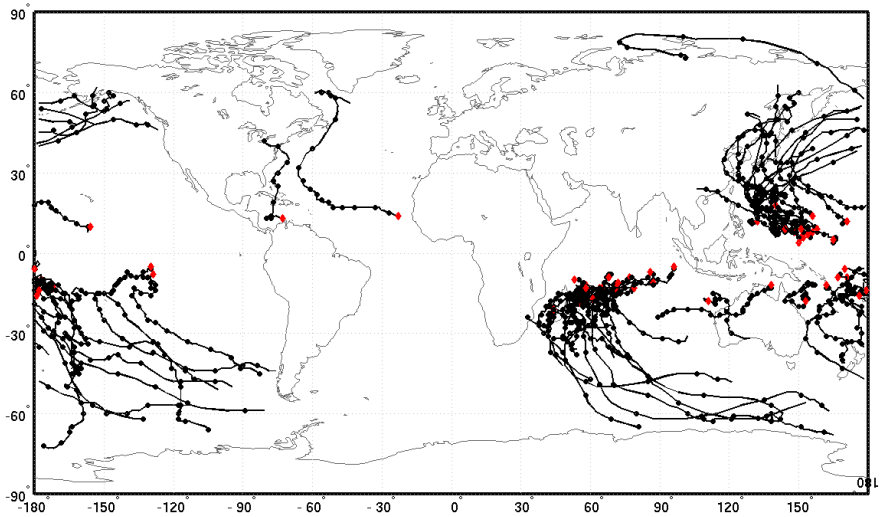
(extreme area accumulated over lifetime, TOP50 of 94522 cyclones)



→ most extreme cyclones have tropical origin and undergo ET

Directions of investigation

- Definition of extremeness:
  - **Σ of local extreme events along track of cyclone**
    - of specific type of extreme?
    - at specific times during cyclone lifecycle?

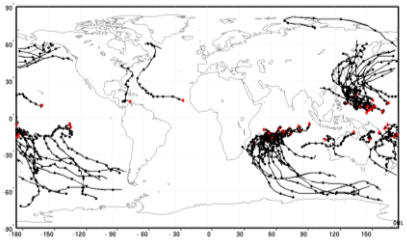


- Regional aspects
  - cyclones affecting a specific region?

- Cyclone characteristics
  - cyclone type?
    - tropical vs. extratropical cyclones matching with IBTrACS
  - differences extreme vs. non-extreme cyclones?

Global perspective

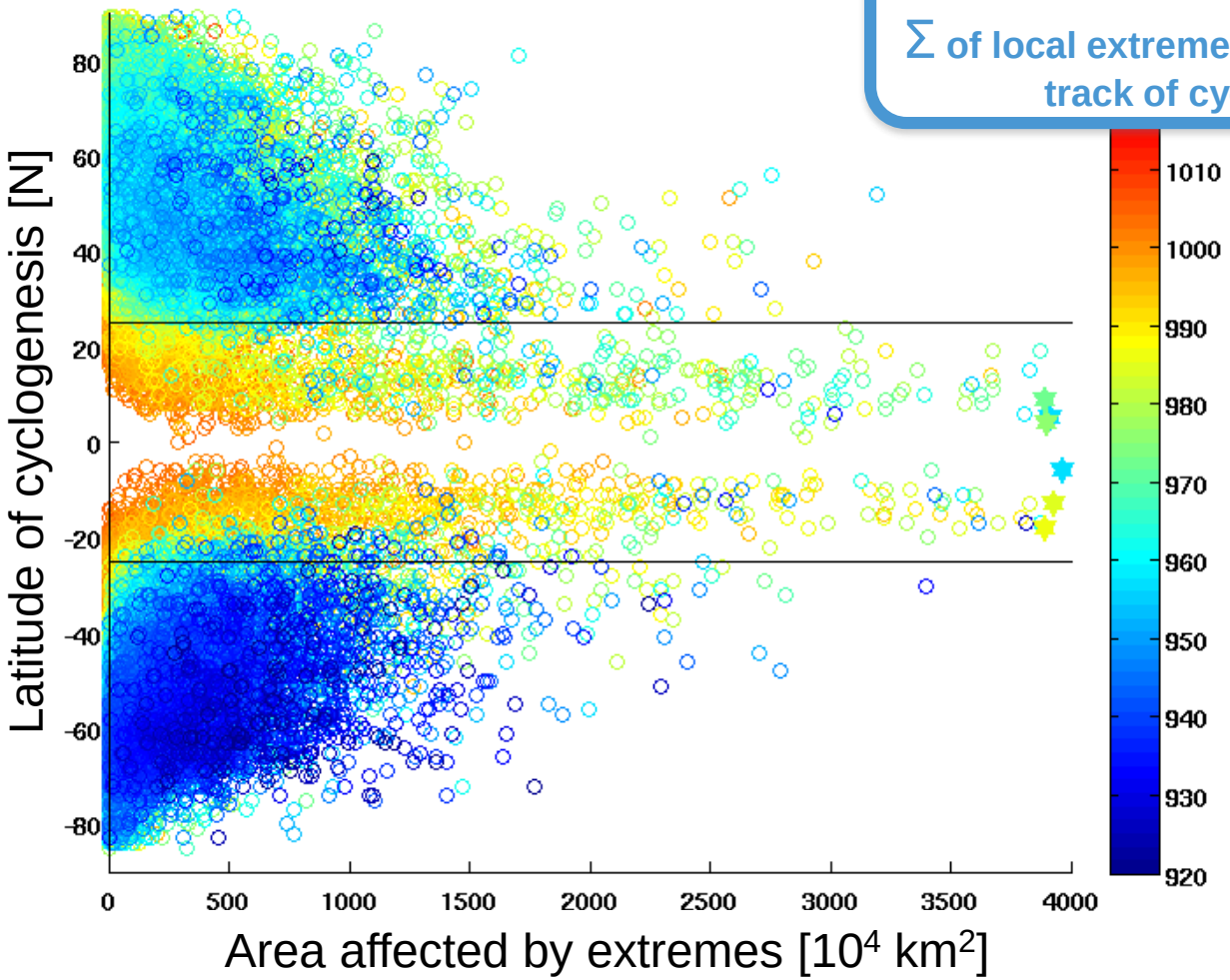
(94522 cyclones 1979-2013)



- Extremeness and latitude of cyclogenesis

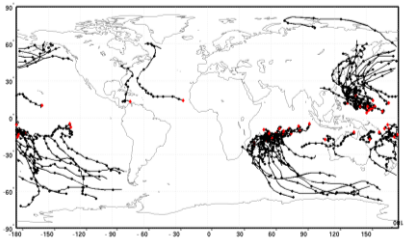
extremeness =

Σ of local extreme events along track of cyclone

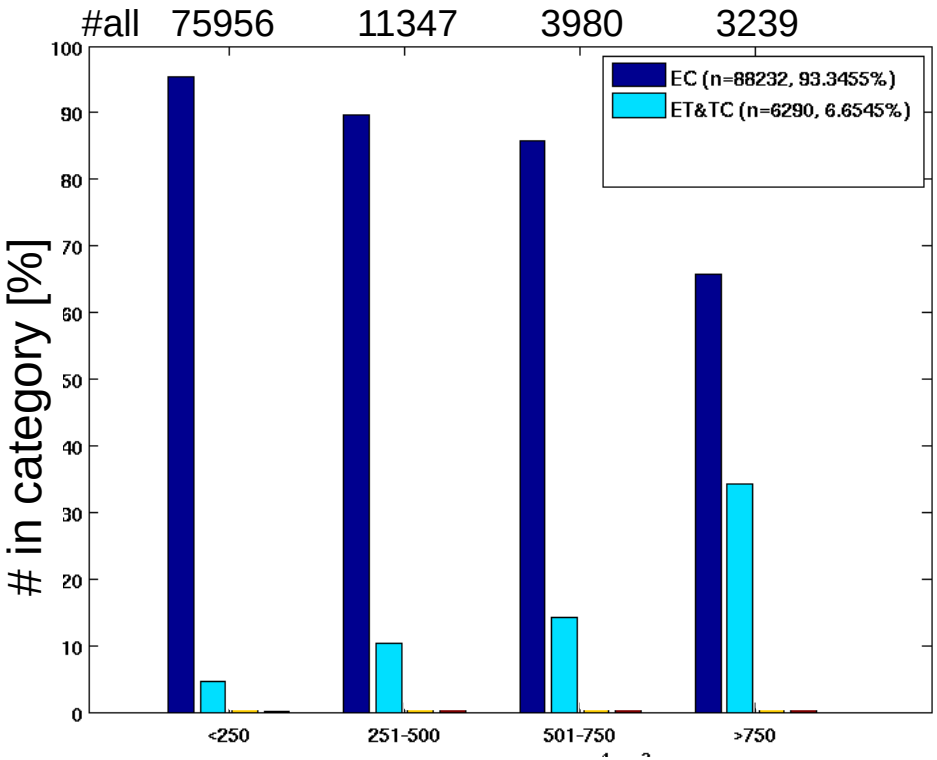


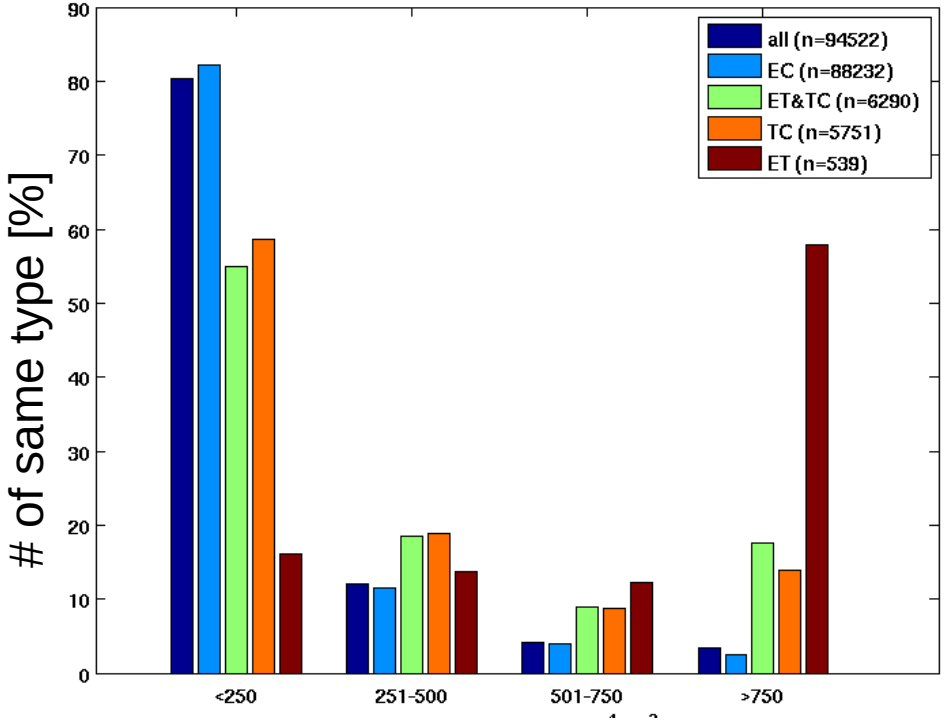
Global perspective

(94522 cyclones 1979-2013)



- Extremeness and cyclone type



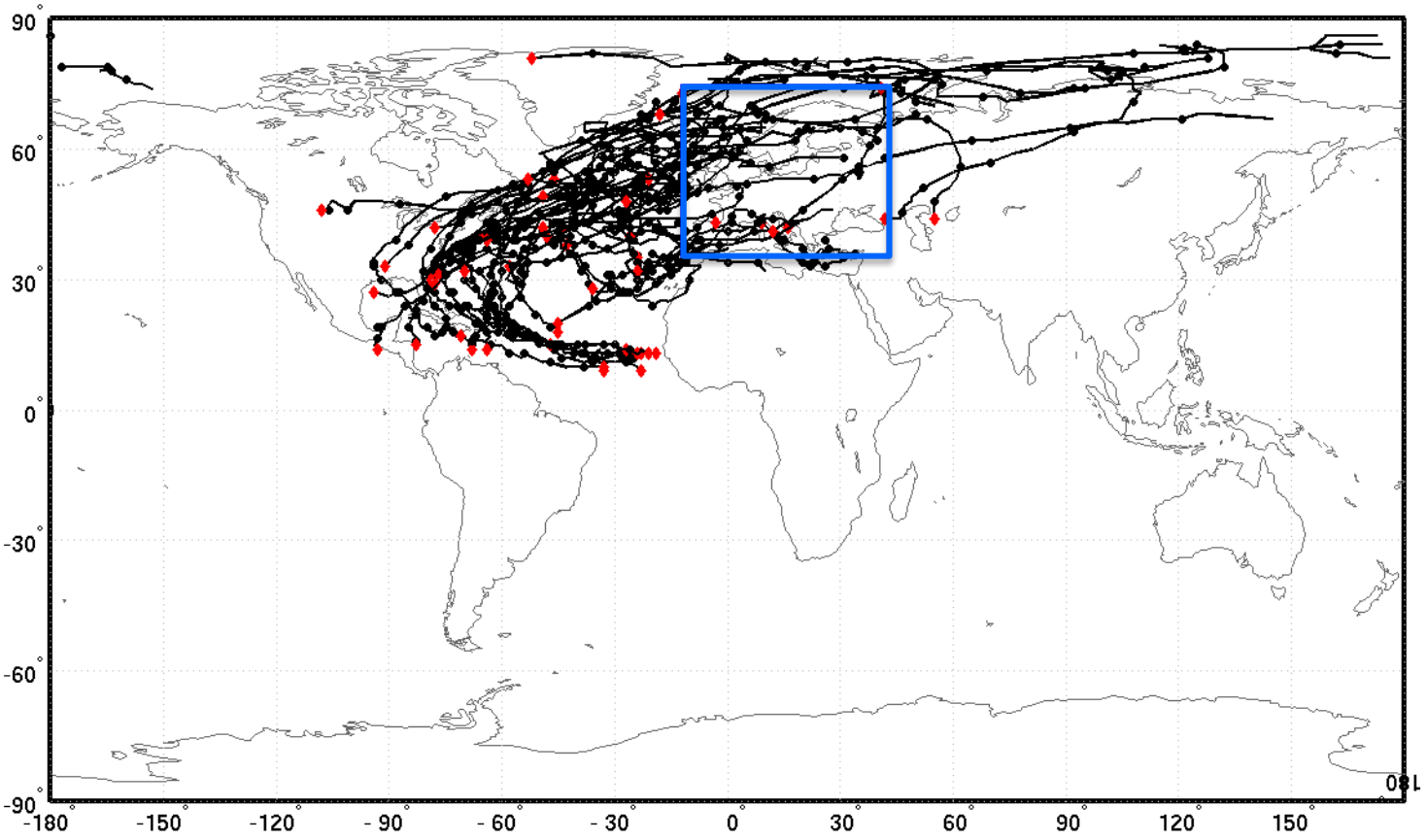


Regional perspective: Europe

(TOP50 of 9085 cyclones 1979-2013)

- TOP50 most extreme cyclones affecting Europe

(extremes counted during entire cyclone lifetime)

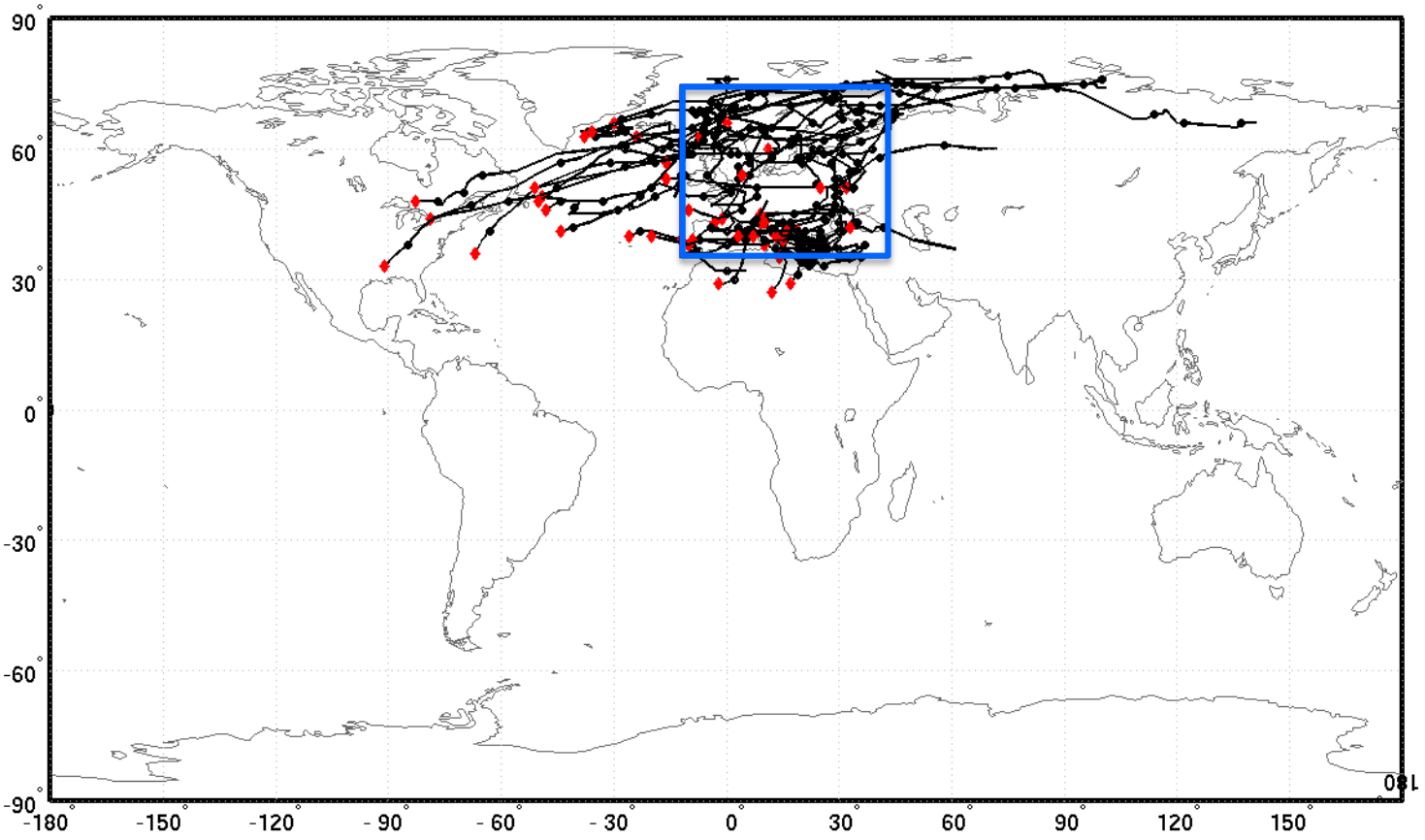


Regional perspective: Europe

(TOP50 of 9085 cyclones 1979-2013)

- TOP50 most extreme cyclones affecting Europe

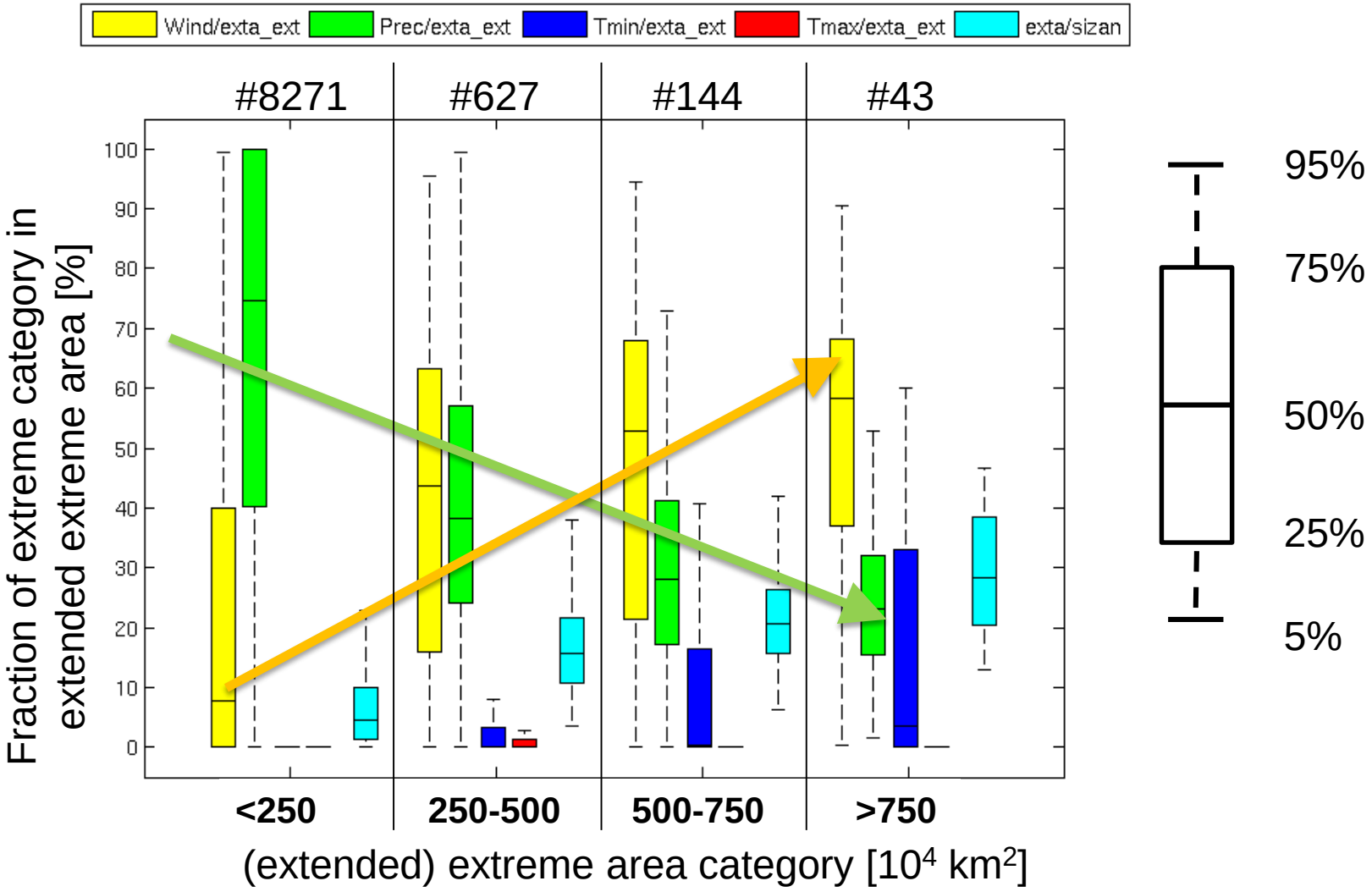
(extremes counted when *cyclone centre in "Europe box"*)



Regional perspective: Europe

(9085 cyclones 1979-2013)

- Which type of extremes contribute to total extreme area?

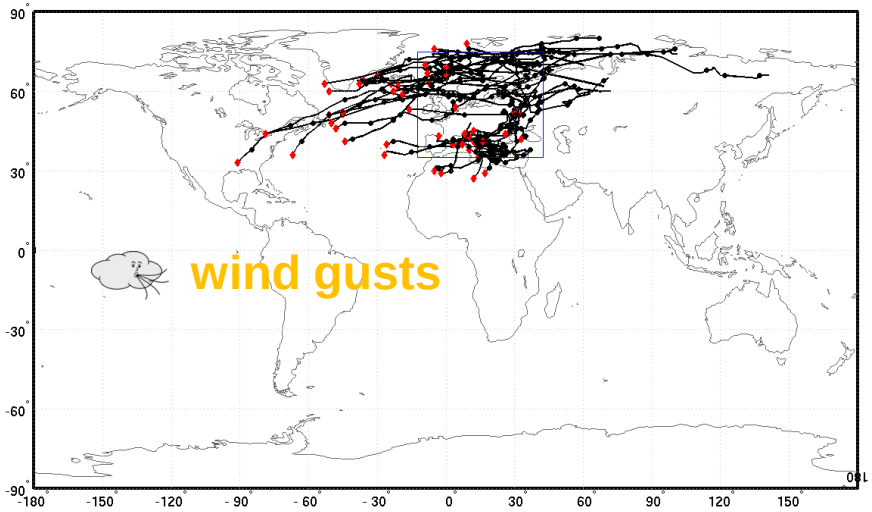


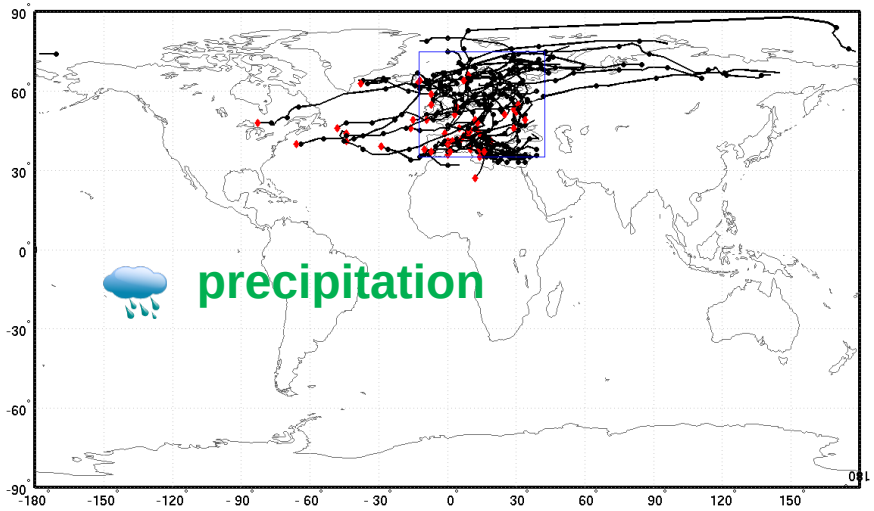
Regional perspective: Europe

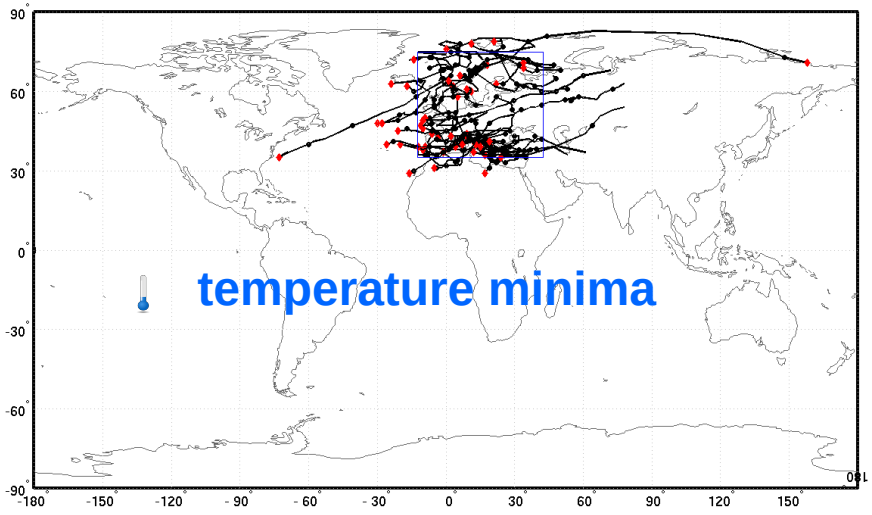
(9085 cyclones 1979-2013)

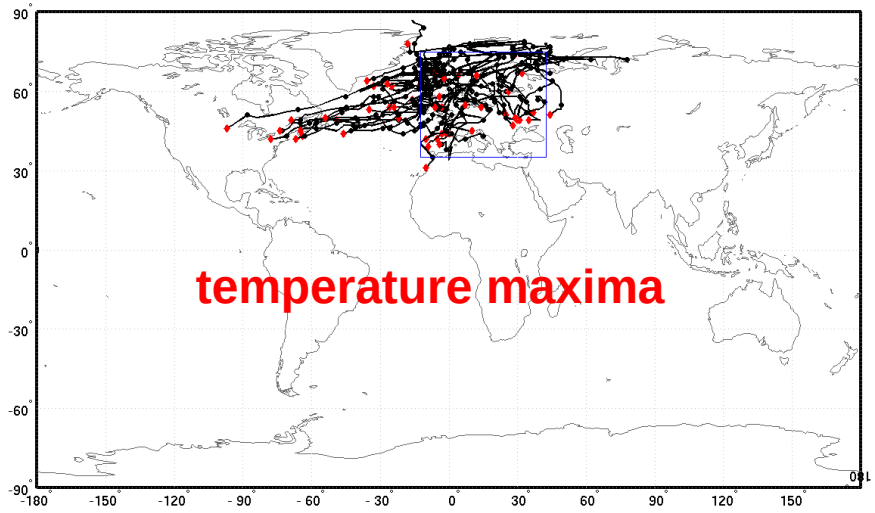
- TOP50 most extreme cyclones affecting Europe

Extremeness based on accumulated area affected by ….









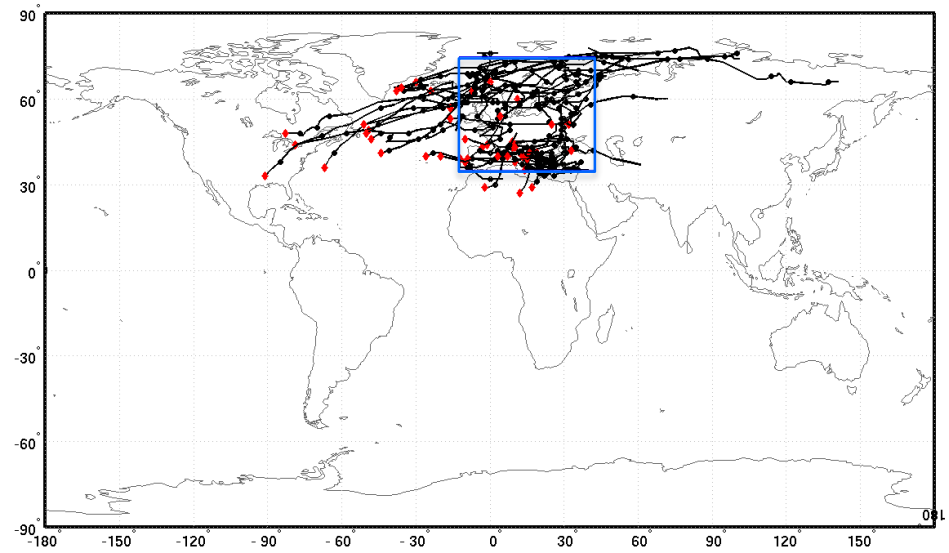
Regional perspective: Europe

(TOP50 of 9085 cyclones 1979-2013)

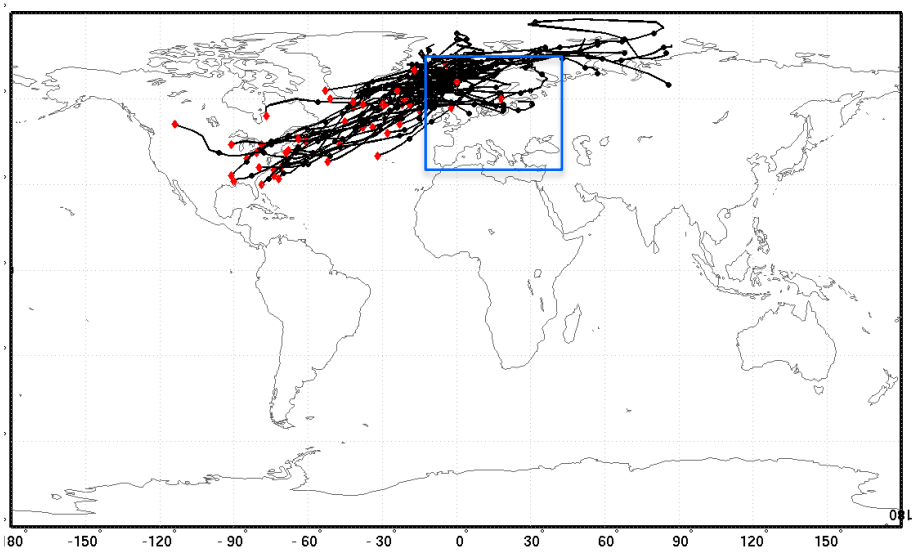
- TOP50 most extreme cyclones affecting Europe

Extremeness based on ….

Accumulated area affected by **any type of extreme**



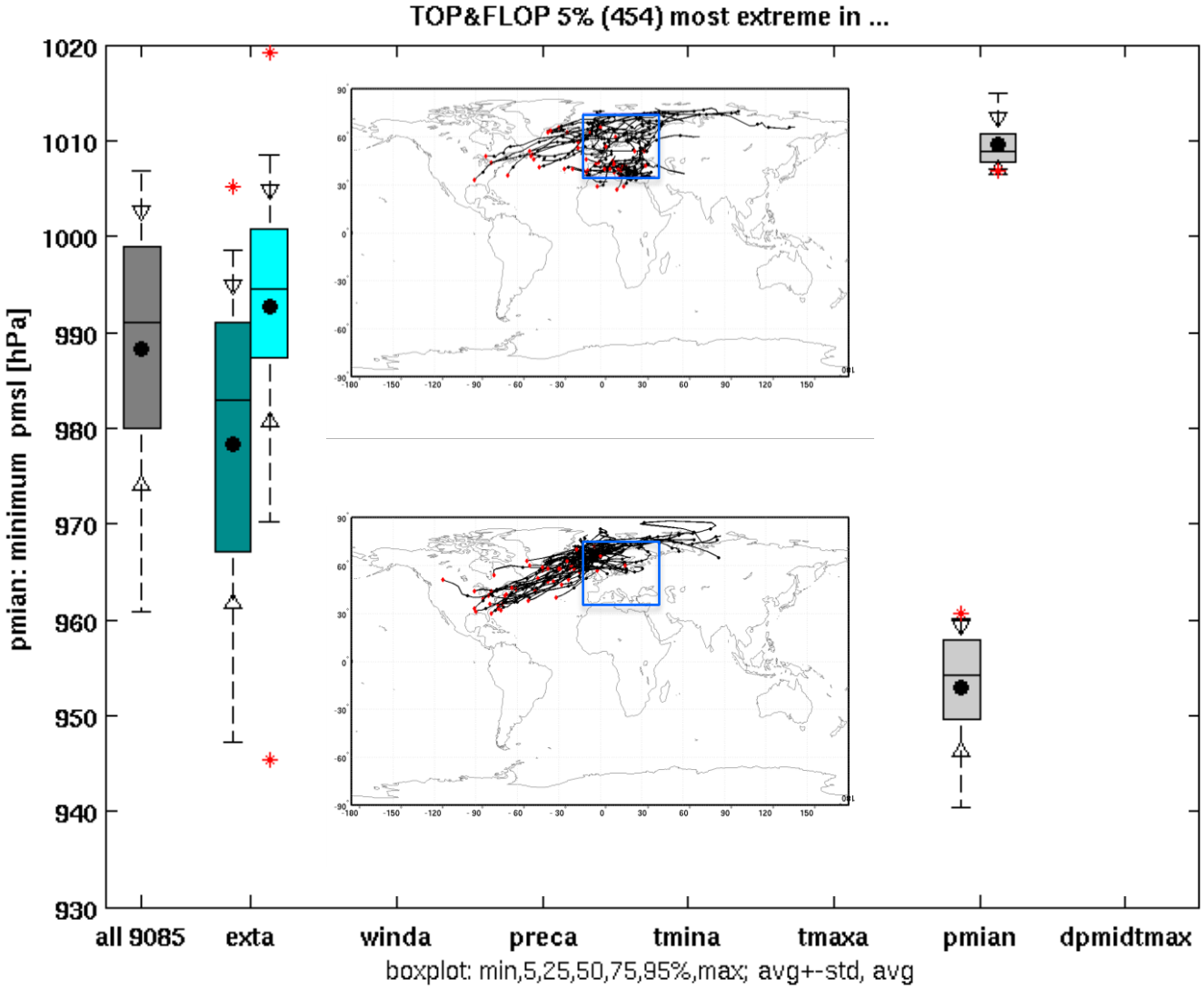
Minimum pmsl

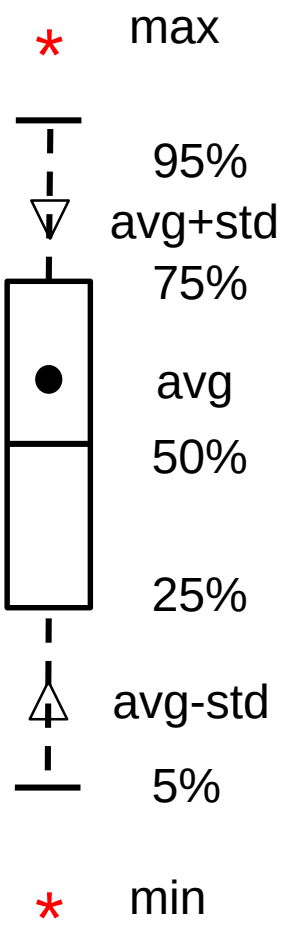


(*when cyclone centre in "Europe box"*)

Cyclone characteristics (Europe)

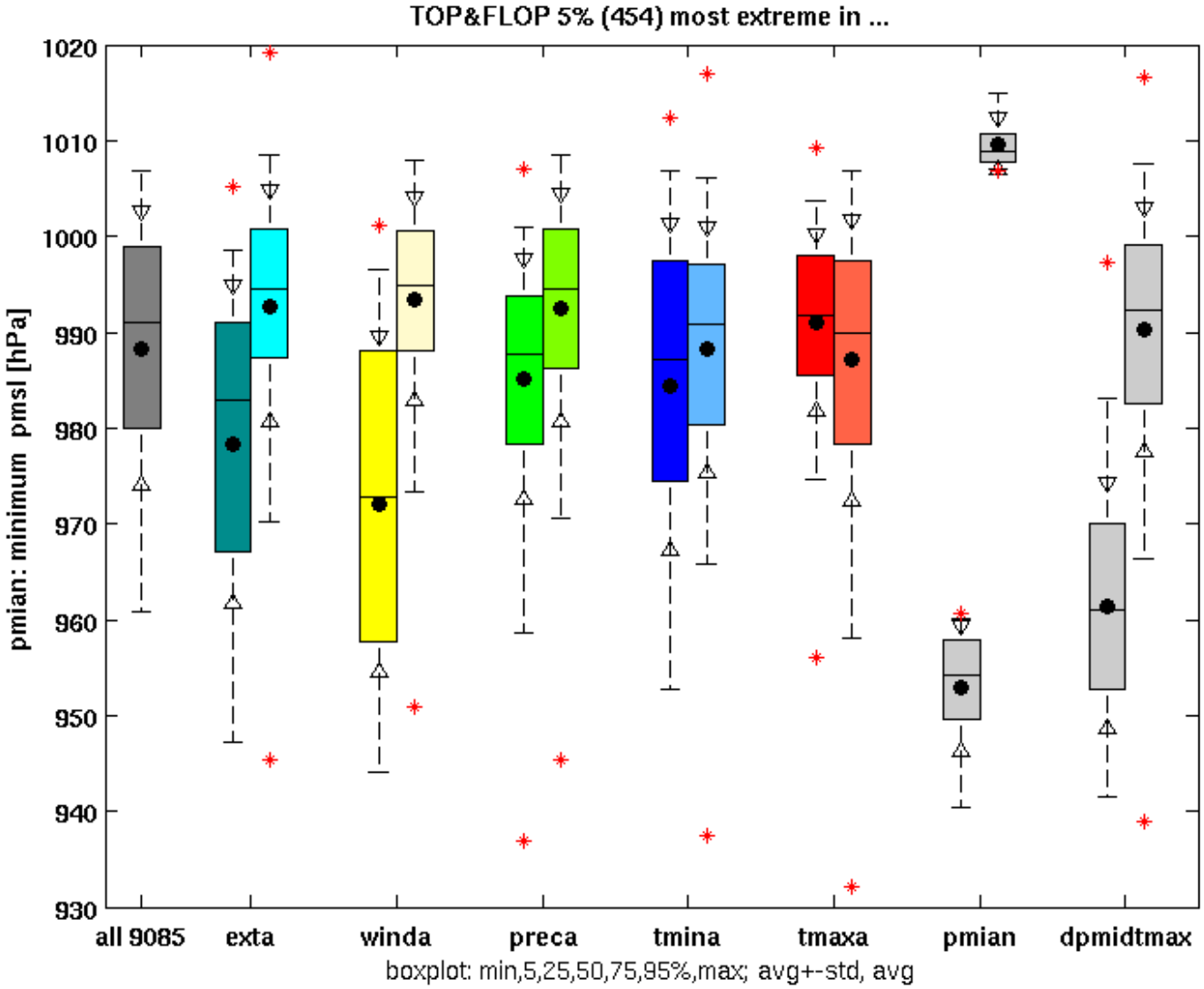
minimum centre pressure (9085 cyclones 1979-2013)

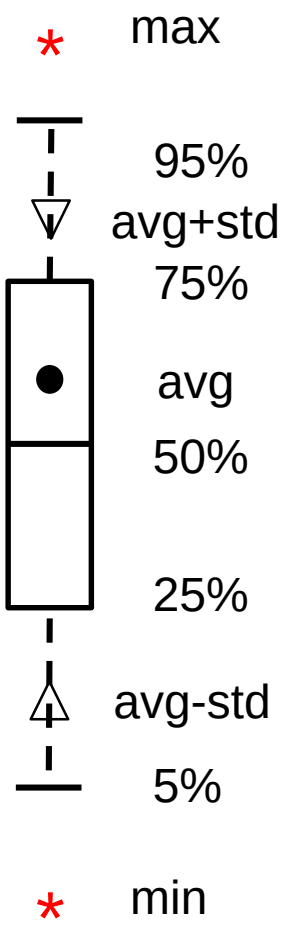




Cyclone characteristics (Europe)

minimum centre pressure (9085 cyclones 1979-2013)

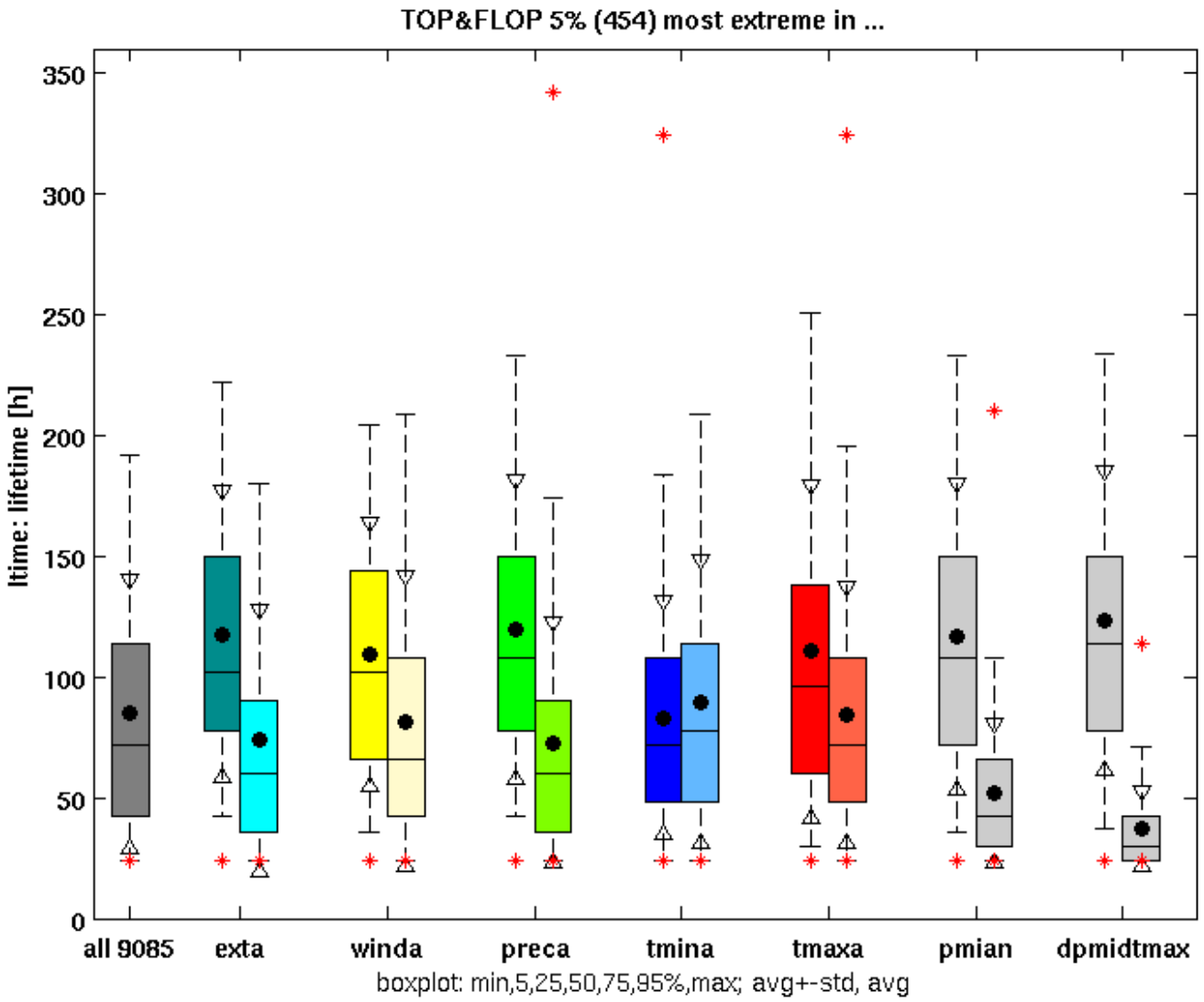


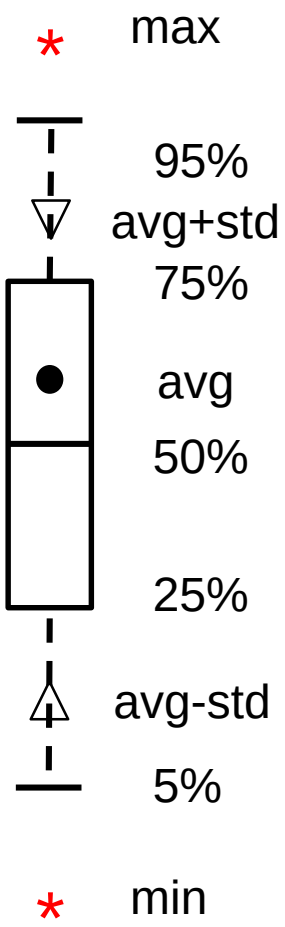


Cyclone characteristics (Europe)

lifetime

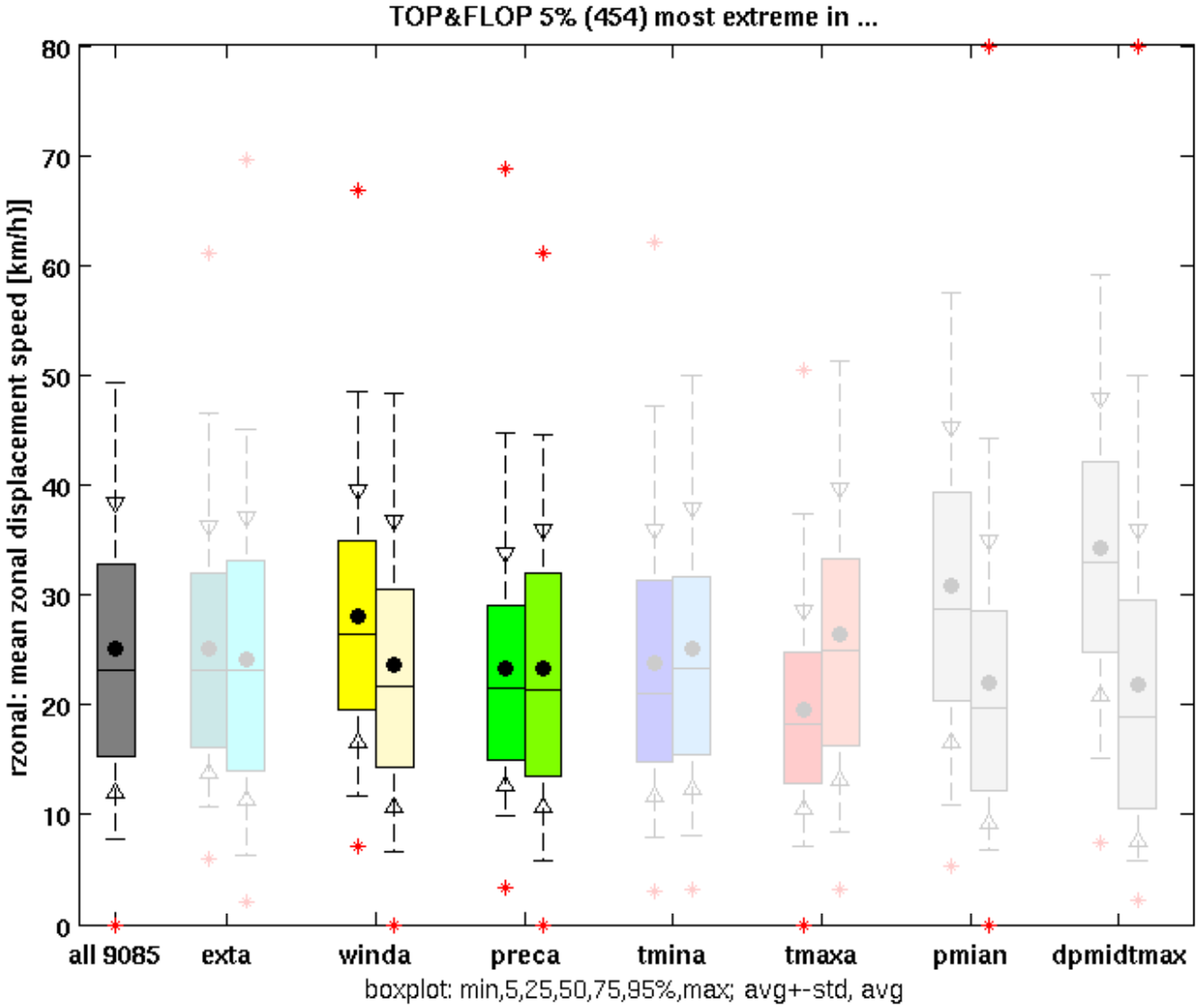
(9085 cyclones 1979-2013)

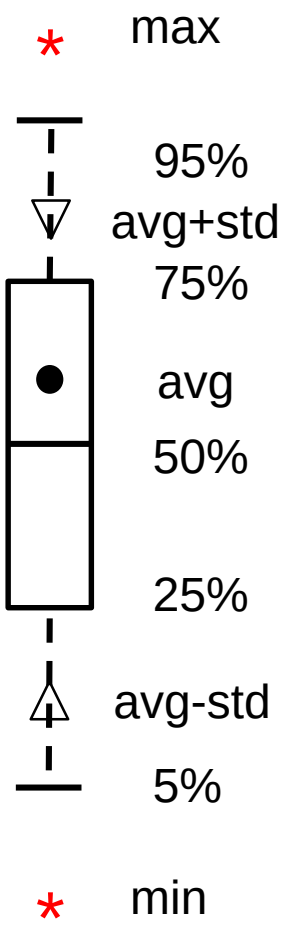




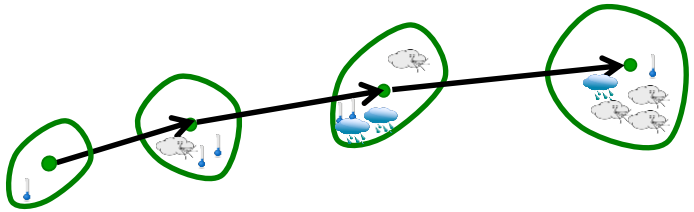
Cyclone characteristics (Europe)

zonal propagation speed [km/h] (9085 cyclones 1979-2013)

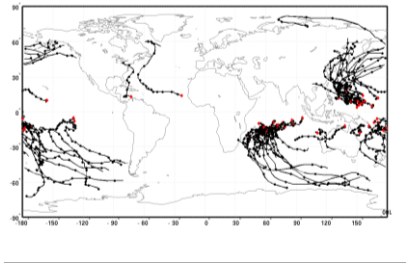




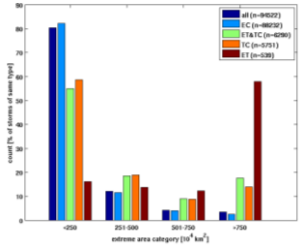
Summary



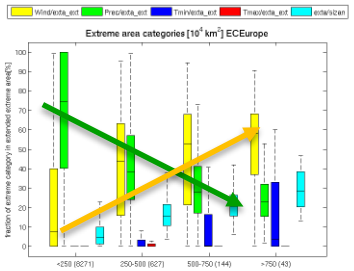
- novel diagnostic to study cyclone objects
- extremeness = Σ of local extreme events along cyclone track



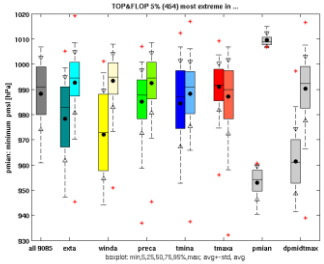
- TCs undergoing ET are globally most extreme cyclones



Europe:



- the larger the extreme area the more likely affected by wind
- cyclones extreme in …
  - precip.: form over continent, high pmin, less zonal
  - wind track over N.Atl. or Med. Sea



Cyclone objects & HIW

Example: winterstorm “Joachim” 16 December 2011