



taken from: www.spc.noaa.gov (Storm Prediction Center)

High resolution climatology of lightning in Central Europe

Kathrin Wapler^{1,2}

¹Hans-Ertel Centre for Weather Research (HErZ)

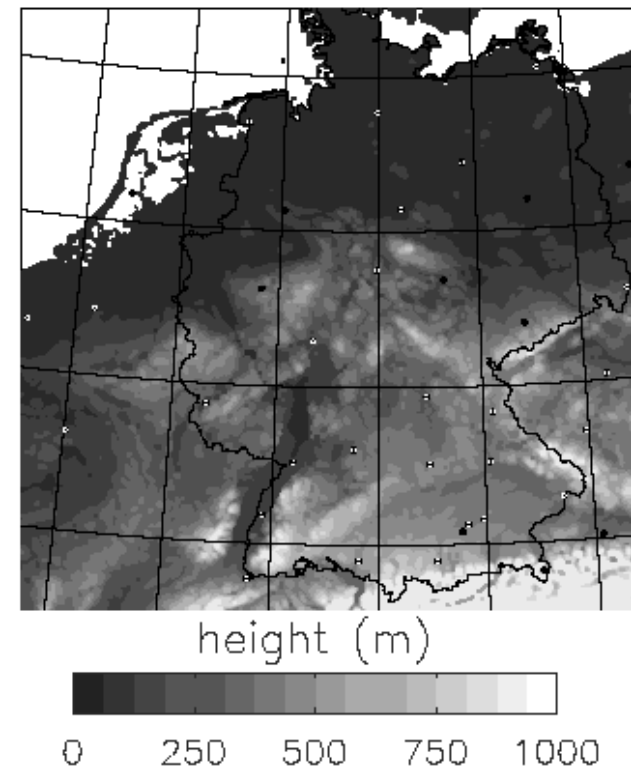
²German Weather Service (DWD)

Objectives

- Analyse occurrence of thunderstorms in Germany (and neighbouring areas)
- Determine spatial and temporal distribution of thunderstorms
- Study lightning characteristics
- Determine thunderstorm dependence on synoptical situation

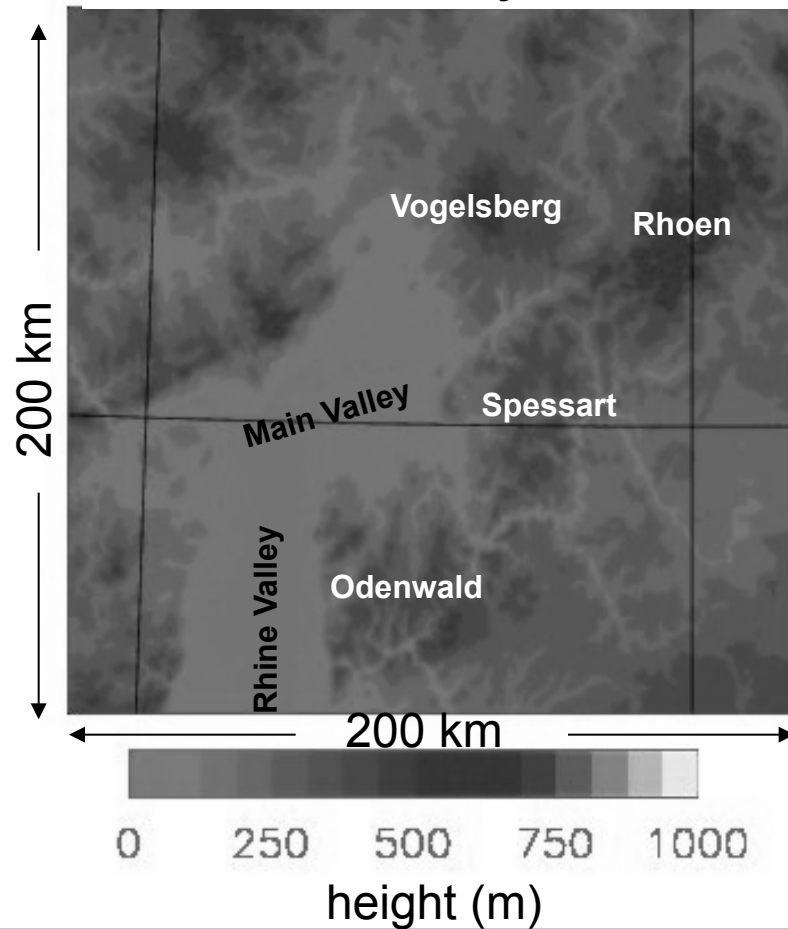
Data

- Lightning detection network LINET:
 - 2007 – 2012
 - 36 million strokes
 - Mapped on a 1 km * 1km grid
- Human thunderstorm observations:
 - 20 weather stations
 - 1961-now



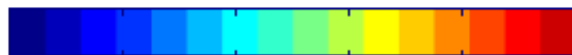
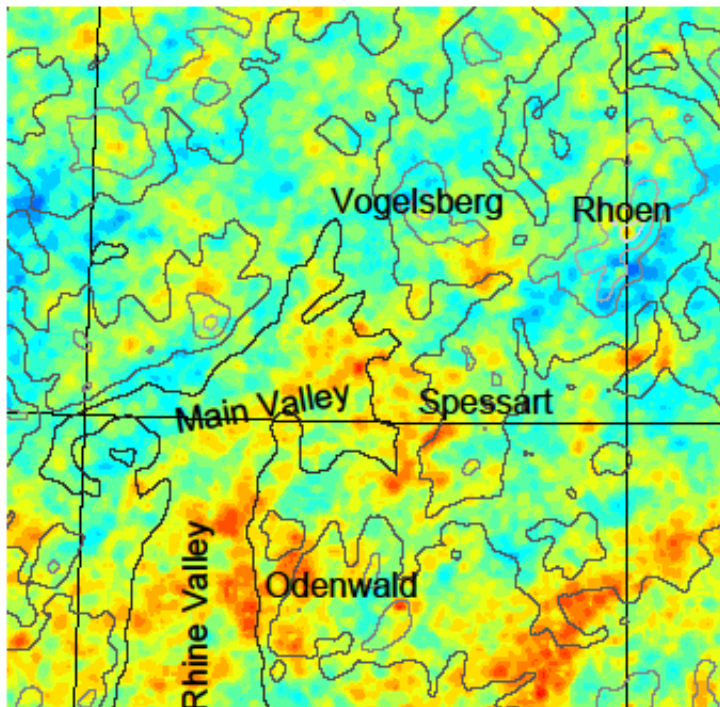
Spatial distribution

Rhine-Main-Valley



Spatial distribution

Rhine-Main-Valley

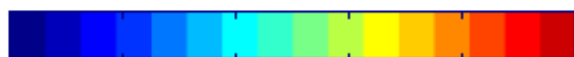
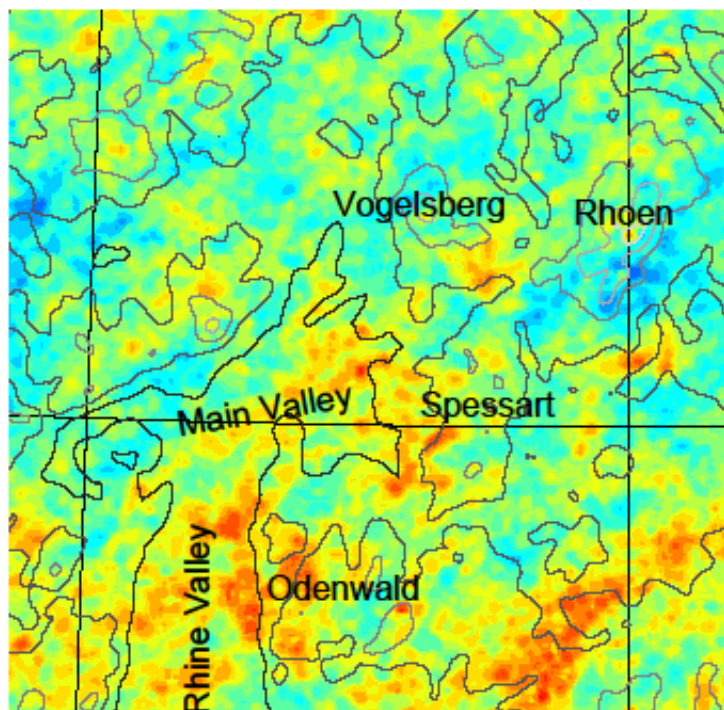


0.0 1.0 2.0 3.0 4.0 5.0

days (> 1 stroke/km²)

Spatial distribution

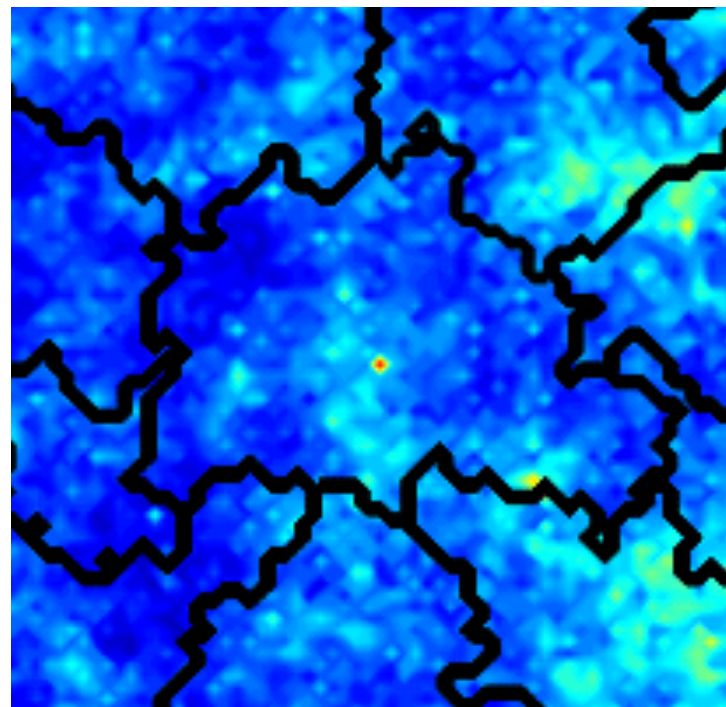
Rhine-Main-Valley



0.0 1.0 2.0 3.0 4.0 5.0

days (> 1 stroke/km²)

Berlin



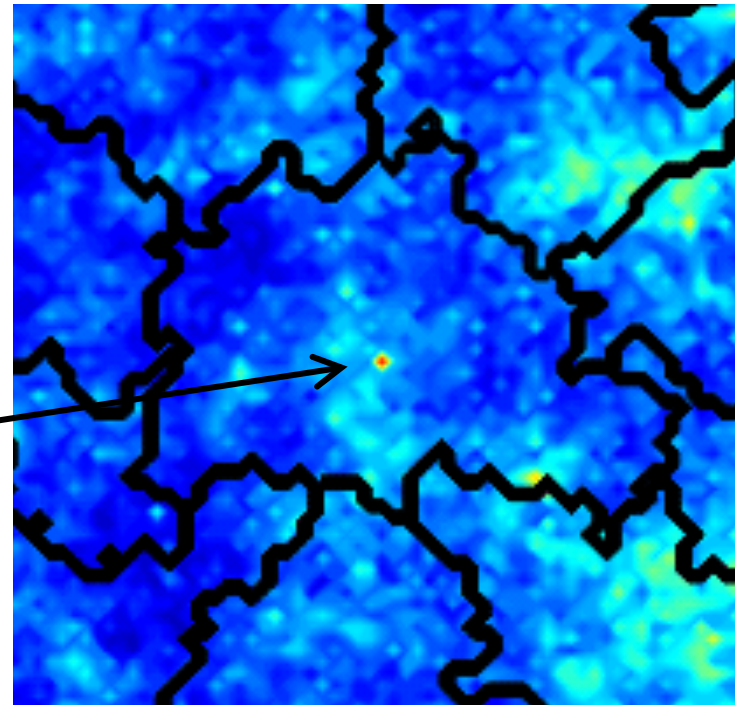
0.0 6.0 12.0 18.0 24.0 30.0

strokes

Spatial distribution



Berlin

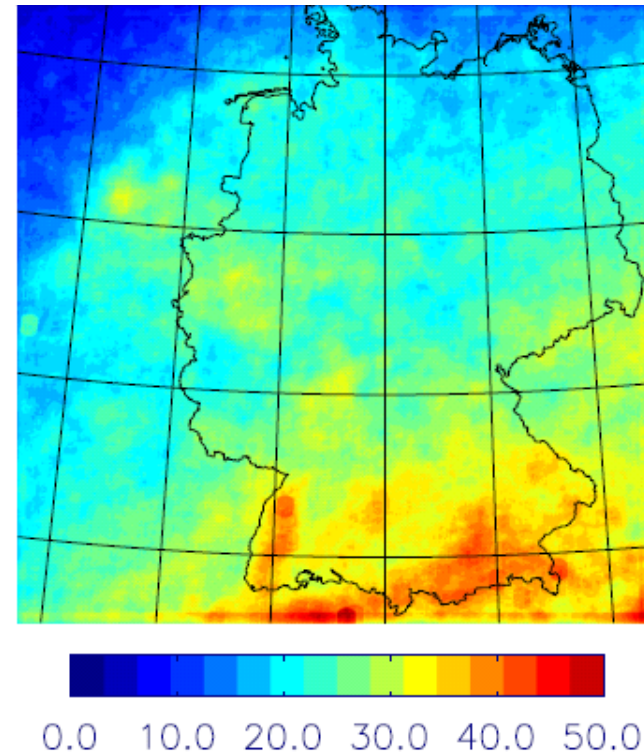


0.0 6.0 12.0 18.0 24.0 30.0

strokes

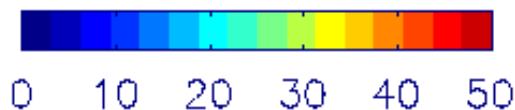
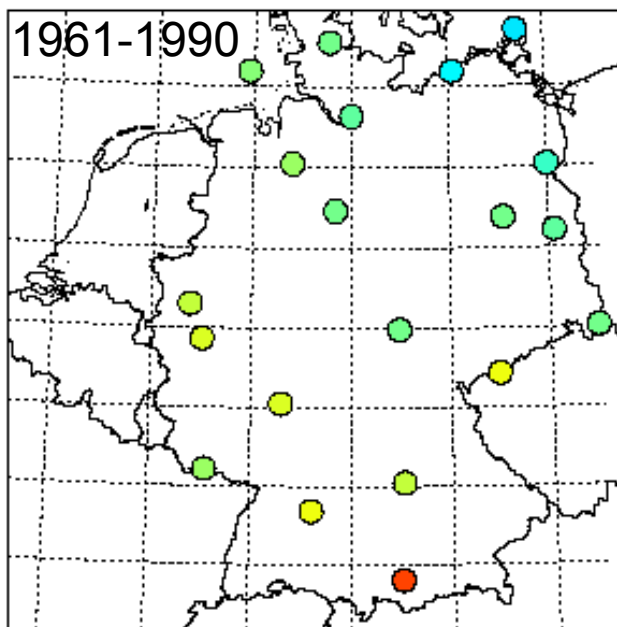
Spatial distribution

Mean annual number of
days with >2 strokes $<15\text{km}$

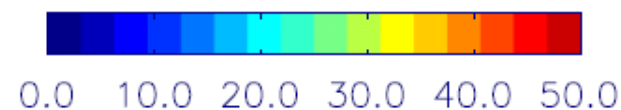
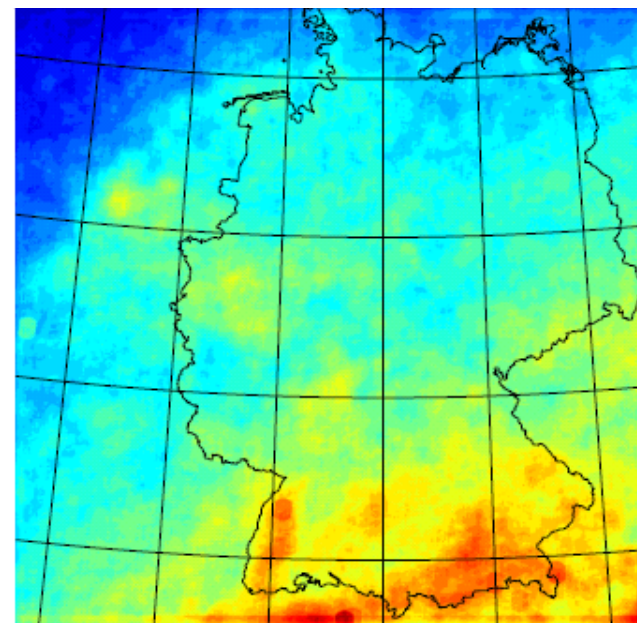


Spatial distribution

Mean annual number of
days with thunderstorm

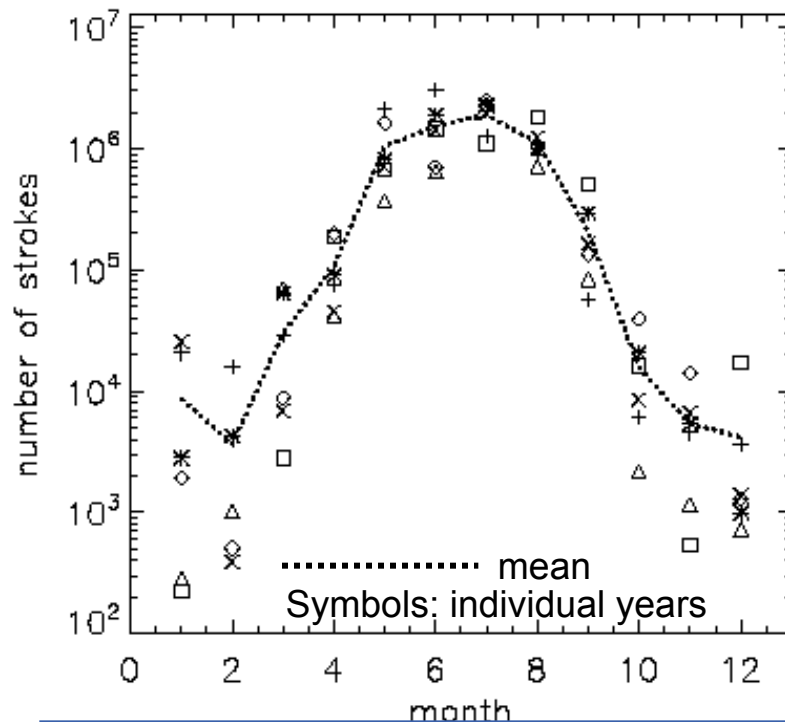


Mean annual number of
days with >2 strokes <15km



Temporal distribution

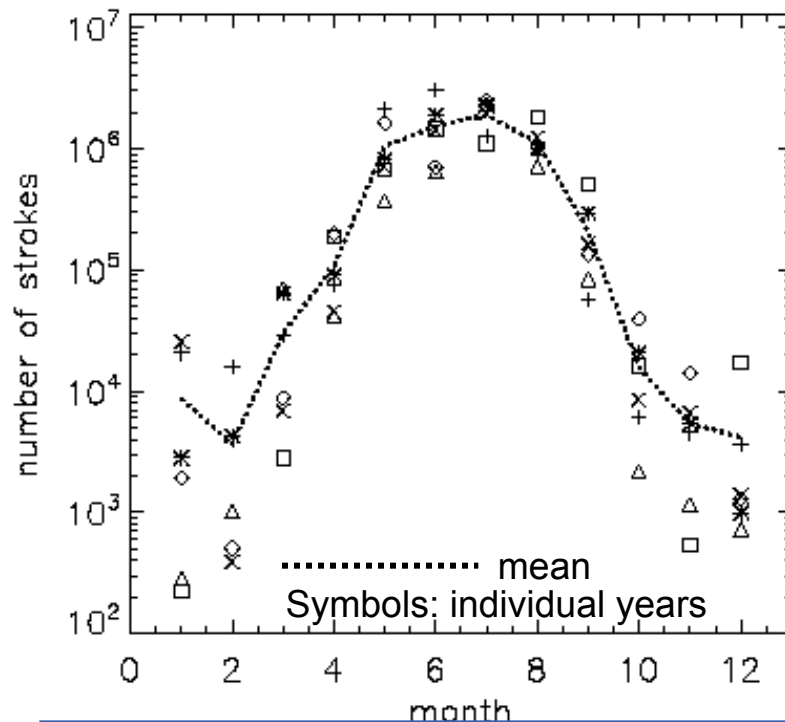
annual cycle



- Annual cycle (geographically varying)
- High year-to-year variability

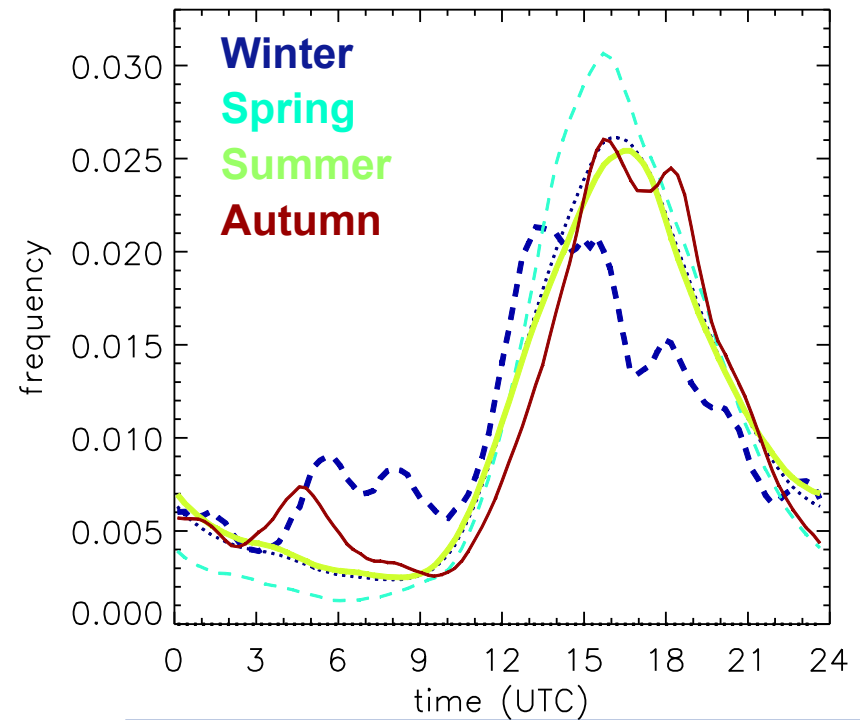
Temporal distribution

annual cycle



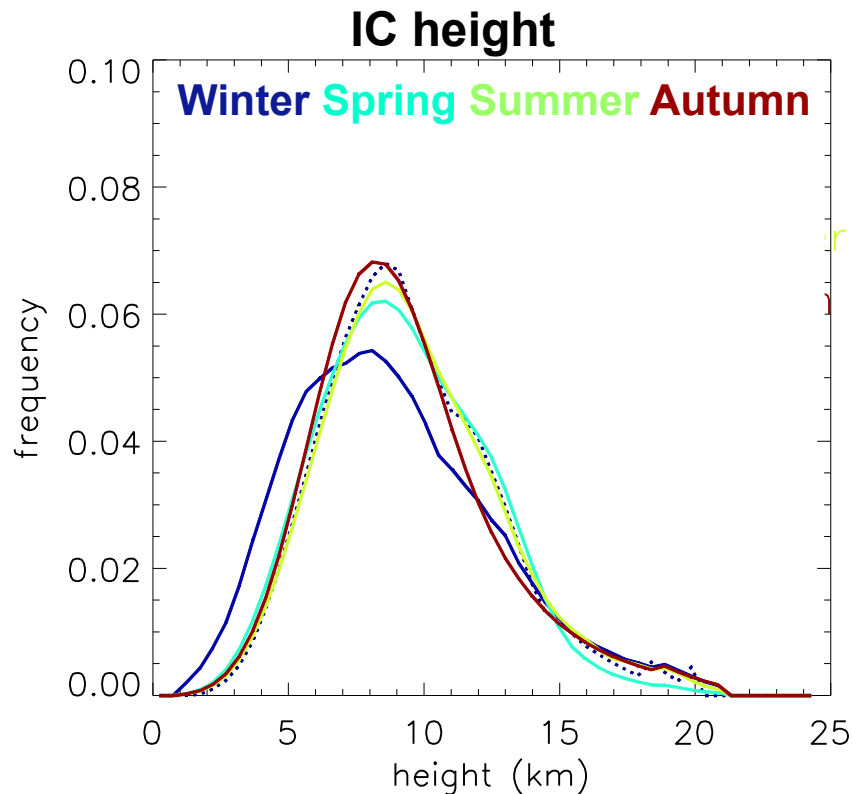
- Annual cycle (geographically varying)
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diurnal cycle



- Diurnal cycle
- Diurnal cycle has an annual cycle

Lightning characteristics



- annual cycle of IC height

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Synoptical classification

Wa	Anticyclonic Westerly
Wz	Cyclonic Westerly
Ws	South-Shifted Cyclonic Westerly
Ww	Maritime Westerly (Block E.Europe)
SWa	Anticyclonic South-Westerly
SWz	Cyclonic South-Westerly
NWa	Anticyclonic North-Westerly
NWz	Cyclonic North-Westerly
HM	High over Central Europe
BM	Zonal Ridge across Central Europe
TM	Low over Central Europe
Na	Anticyclonic Northerly
Nz	Cyclonic Northerly
HNa	High Norwegian Sea, Ridge C.Europe
HNz	High Norwegian Sea, Trough C.Europe

HB	High over the British Isles
TrM	Trough over Central Europe
NEa	Anticyclonic North-Easterly
NEz	Cyclonic North-Easterly
HFa	Scandinavian High, Ridge C.Europe
HFz	Scandinavian High, Trough C.Europe
HNFa	High Norw. Sea to Finland, Ridge C.Eur.
HNFz	High Norw. Sea to Finland, Trough C.Eur.
SEa	Anticyclonic South-Easterly
SEz	Cyclonic South-Easterly
Sa	Anticyclonic Southerly
Sz	Cyclonic Southerly
TB	Low over the British Isles
TrW	Trough over Western Europe
Ü	Transitional Days

Following Hess and Brezowsky 1952, based on global NWP analysis



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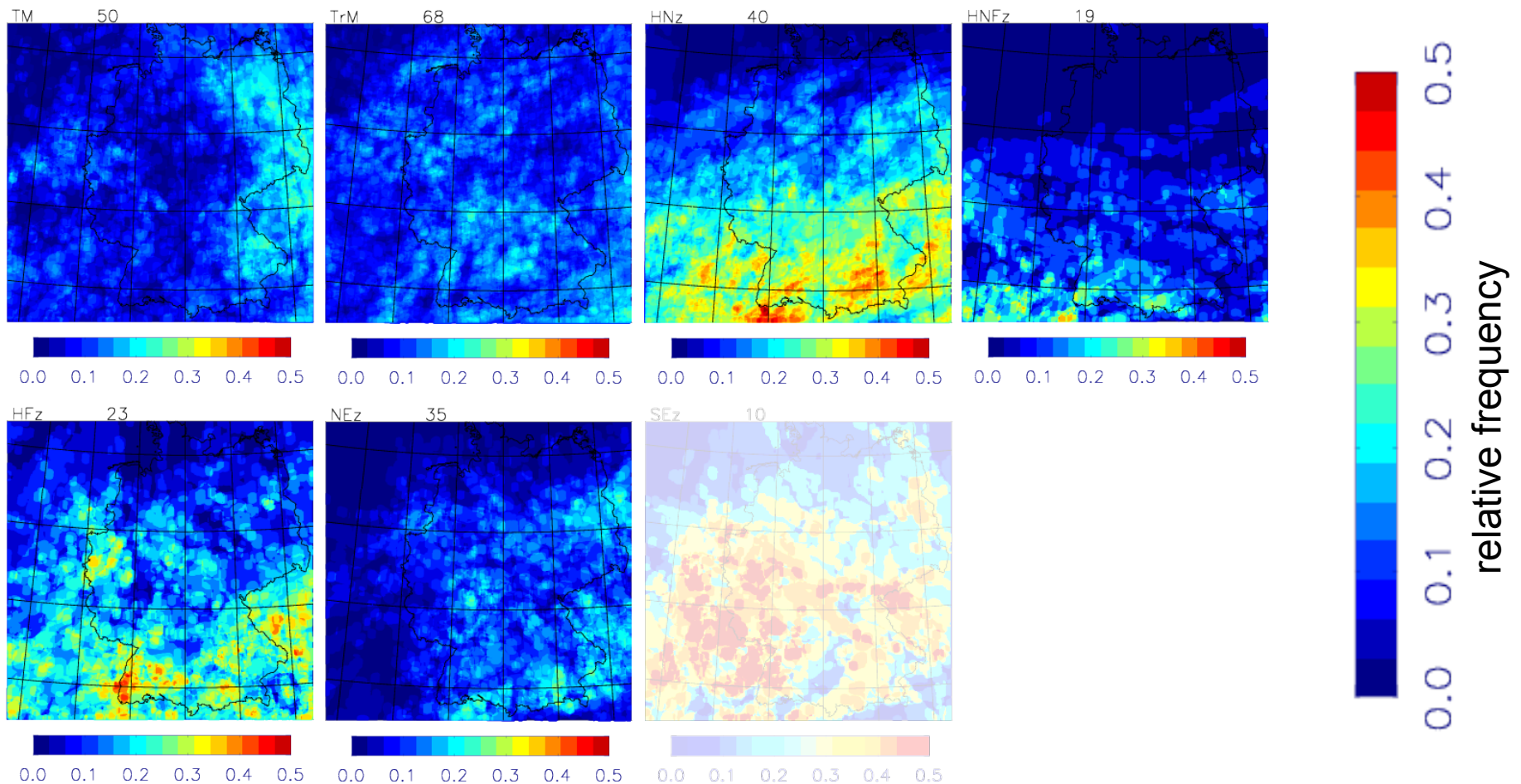
How often do thunderstorms occur under certain synoptical conditions?

→ For each class calculate thunderstorm occurrence.

Following Hess and Brezowsky 1952, based on global NWP analysis



Thunderstorm activity vs synoptic pattern

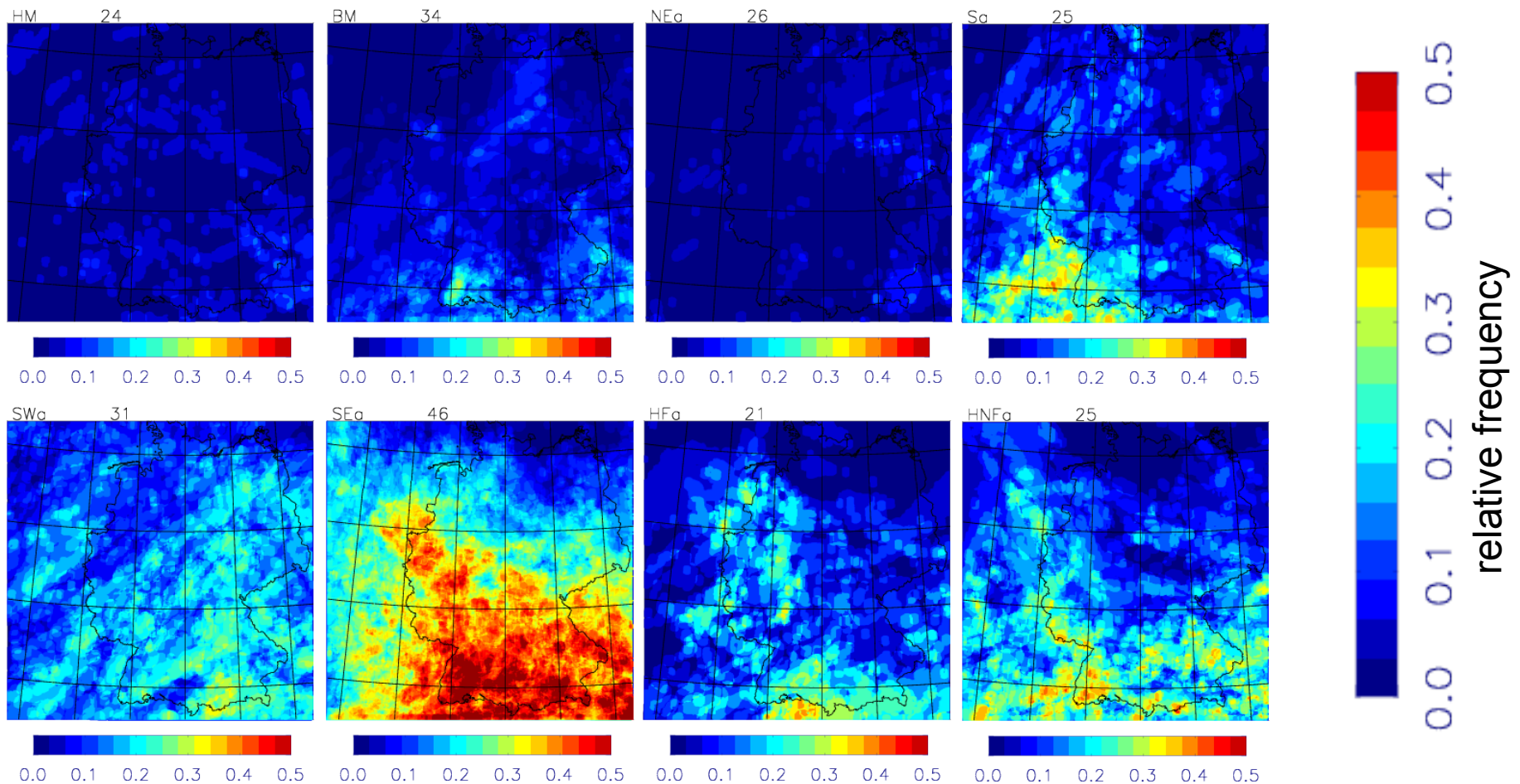


T (Central Europe low pressure)

summer (AMJJAS) 2007-2012



Thunderstorm activity vs synoptic pattern



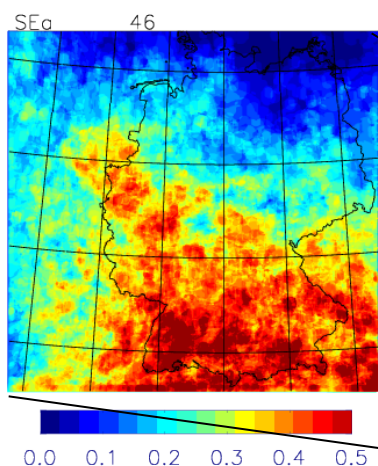
H (Central Europe high pressure)

summer (AMJJAS) 2007-2012

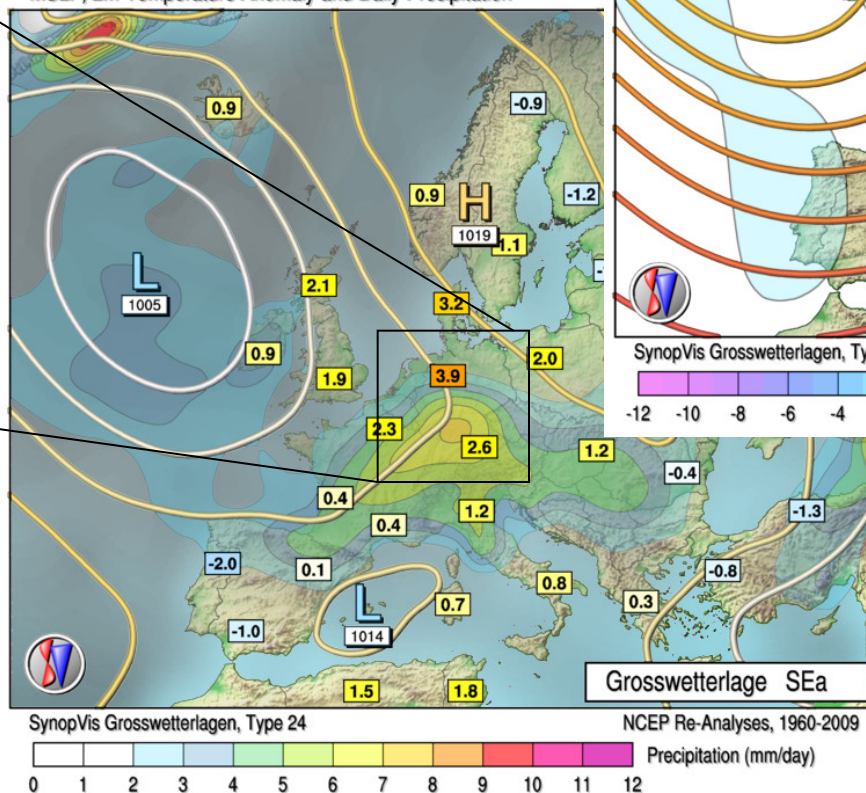


Thunderstorm activity vs Synoptic pattern

Example: Anticyclonic South-Easterly

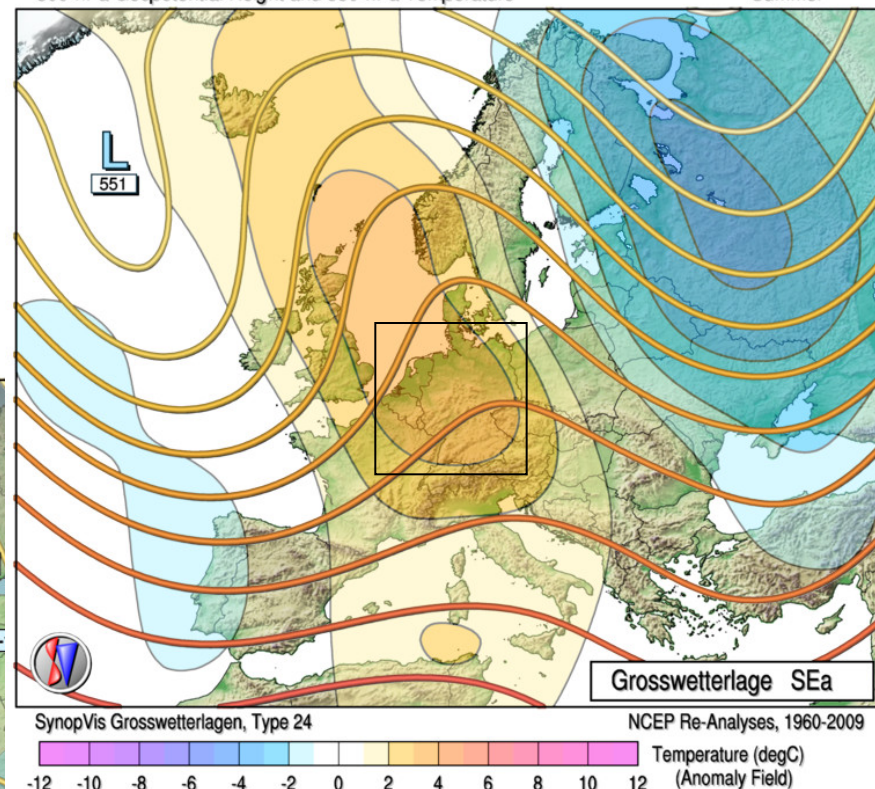


MSLP, 2m-Temperature Anomaly and Daily Precipitation



500-hPa Geopotential Height and 850-hPa Temperature

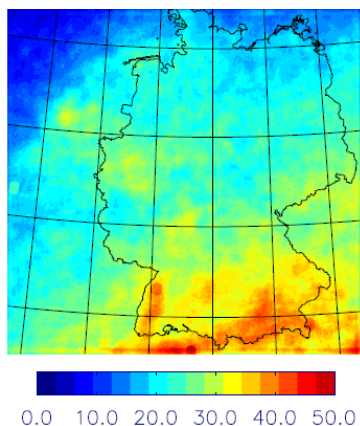
Summer



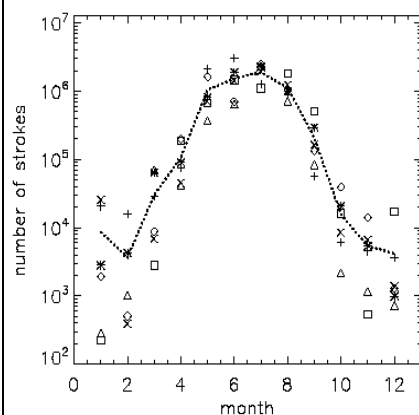
Courtesy: Paul James

Summary

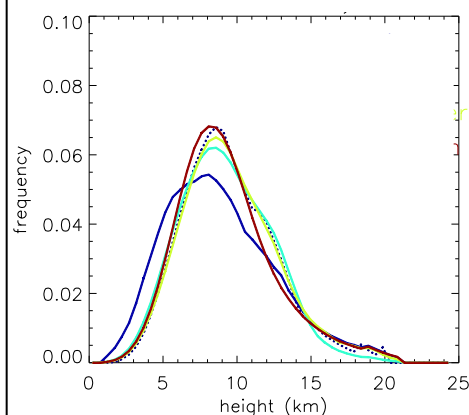
- Spatial distribution



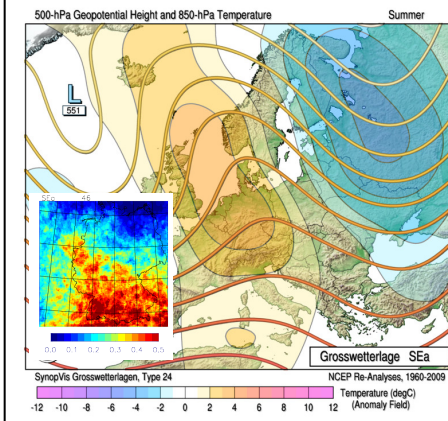
- Temporal distribution



- lightning characteristics



- dependence on synoptical situation



Outlook

- Extension of synoptical pattern statistics
- thunderstorm characteristics depending on synoptical situation

More information

Wapler (2013): High-resolution climatology of lightning characteristics within Central Europe, submitted to MAP.

Wapler and Frank (2013): Analysis of lightning flash characteristics in Central Europe, **Poster 92**.

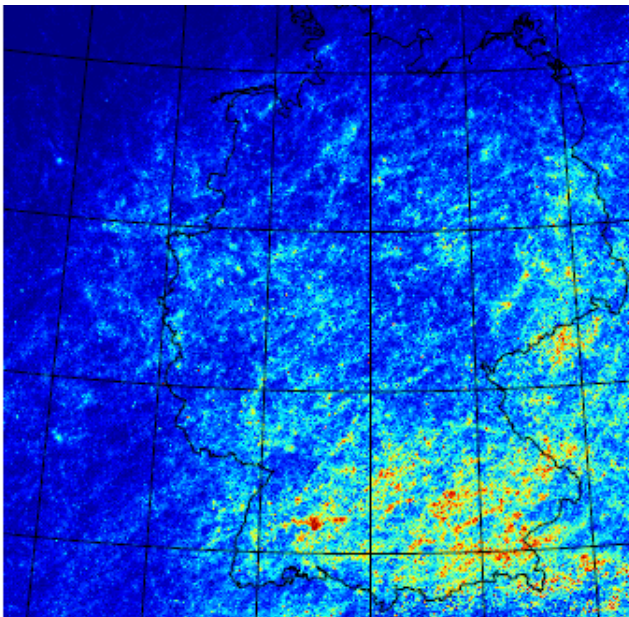
Wapler, Trömel, Bick, Deneke, Diederich, Horvath, Senf, Simmer, Simon (2013): The OASE project, **Poster 134**.



Appendix

Spatial distribution

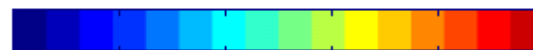
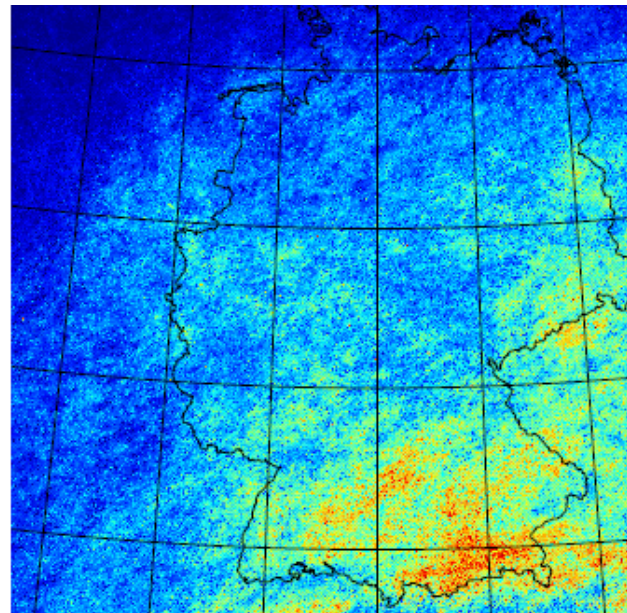
Mean annual number of
strokes per km²



0.0 7.5 15.0 22.5 30.0

Spatial distribution

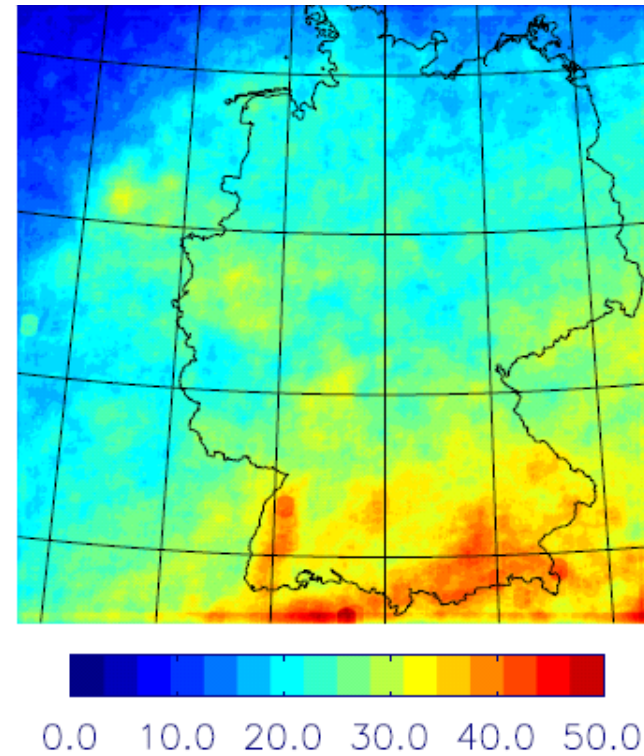
Mean annual number of
days with > 1 stroke per km²



0.0 1.5 3.0 4.5 6.0 7.5

Spatial distribution

Mean annual number of
days with >2 strokes $<15\text{km}$

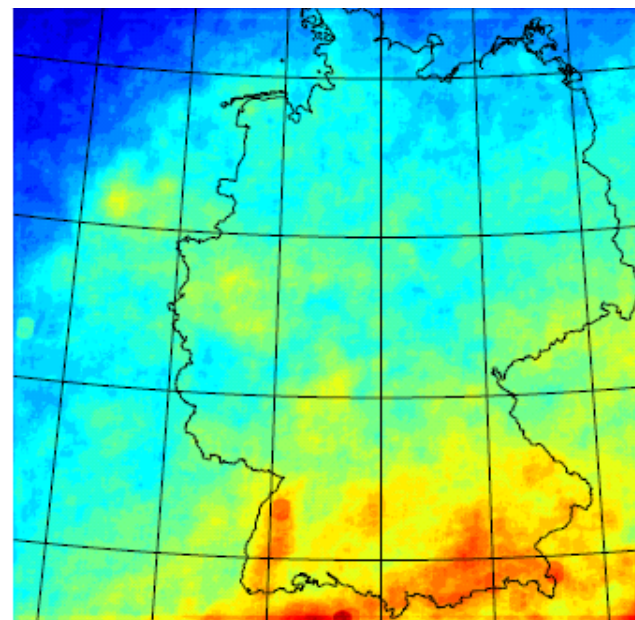
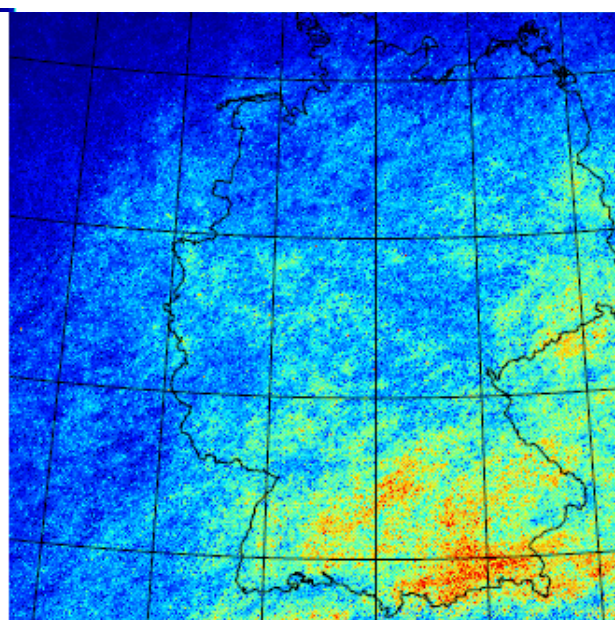
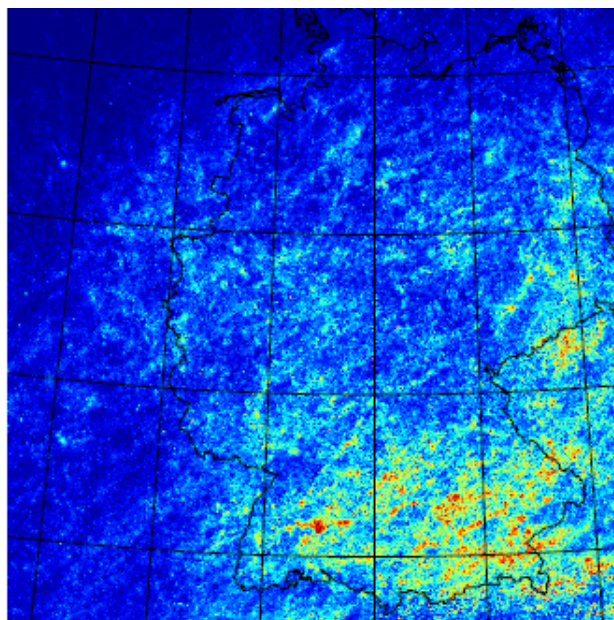


Spatial distribution

Mean annual number of
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Mean annual number of
days with > 1 stroke per km²

Mean annual number of
days with >2 strokes <15km



0.0 7.5 15.0 22.5 30.0

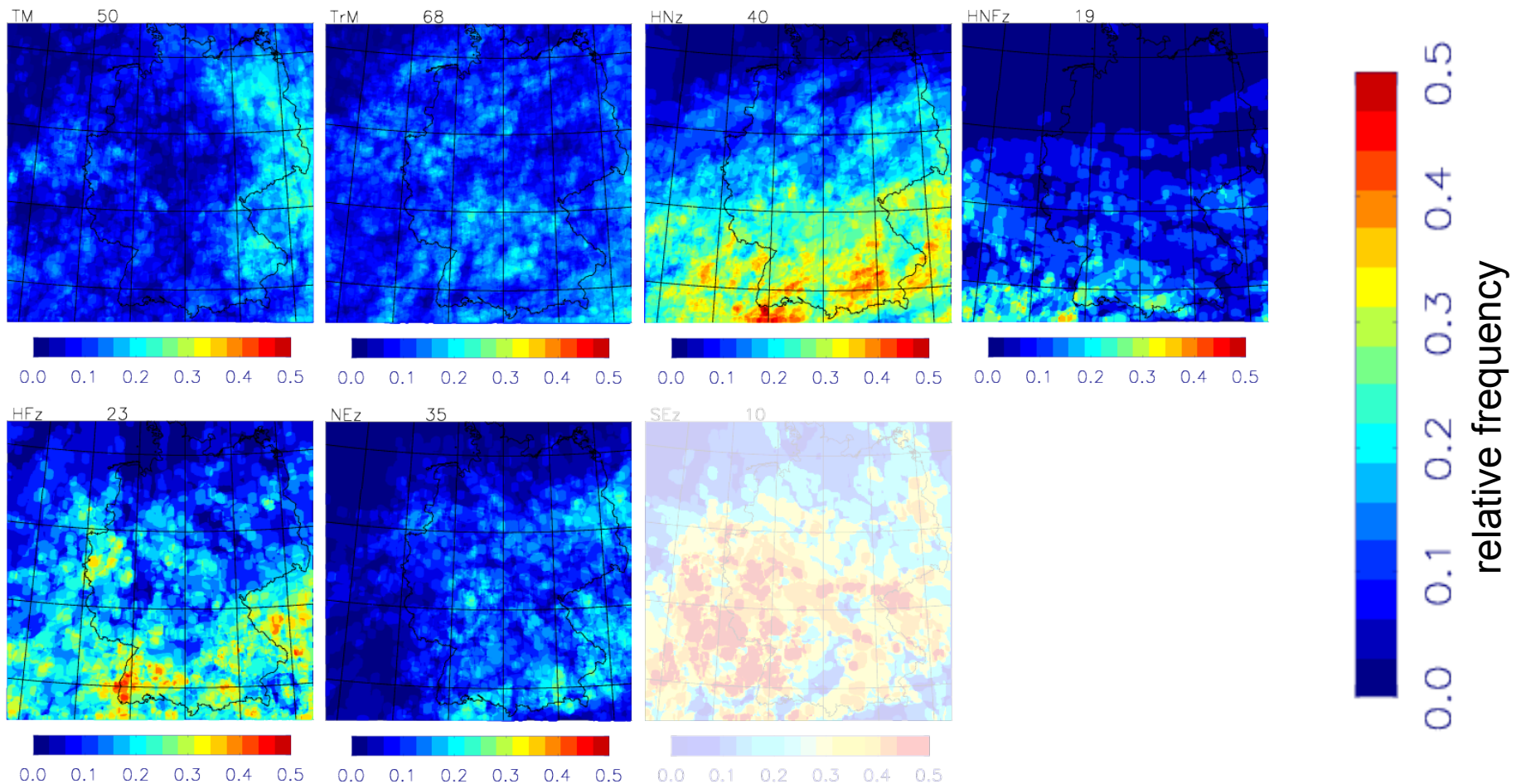


0.0 1.5 3.0 4.5 6.0 7.5



0.0 10.0 20.0 30.0 40.0 50.0

Thunderstorm activity vs synoptic pattern

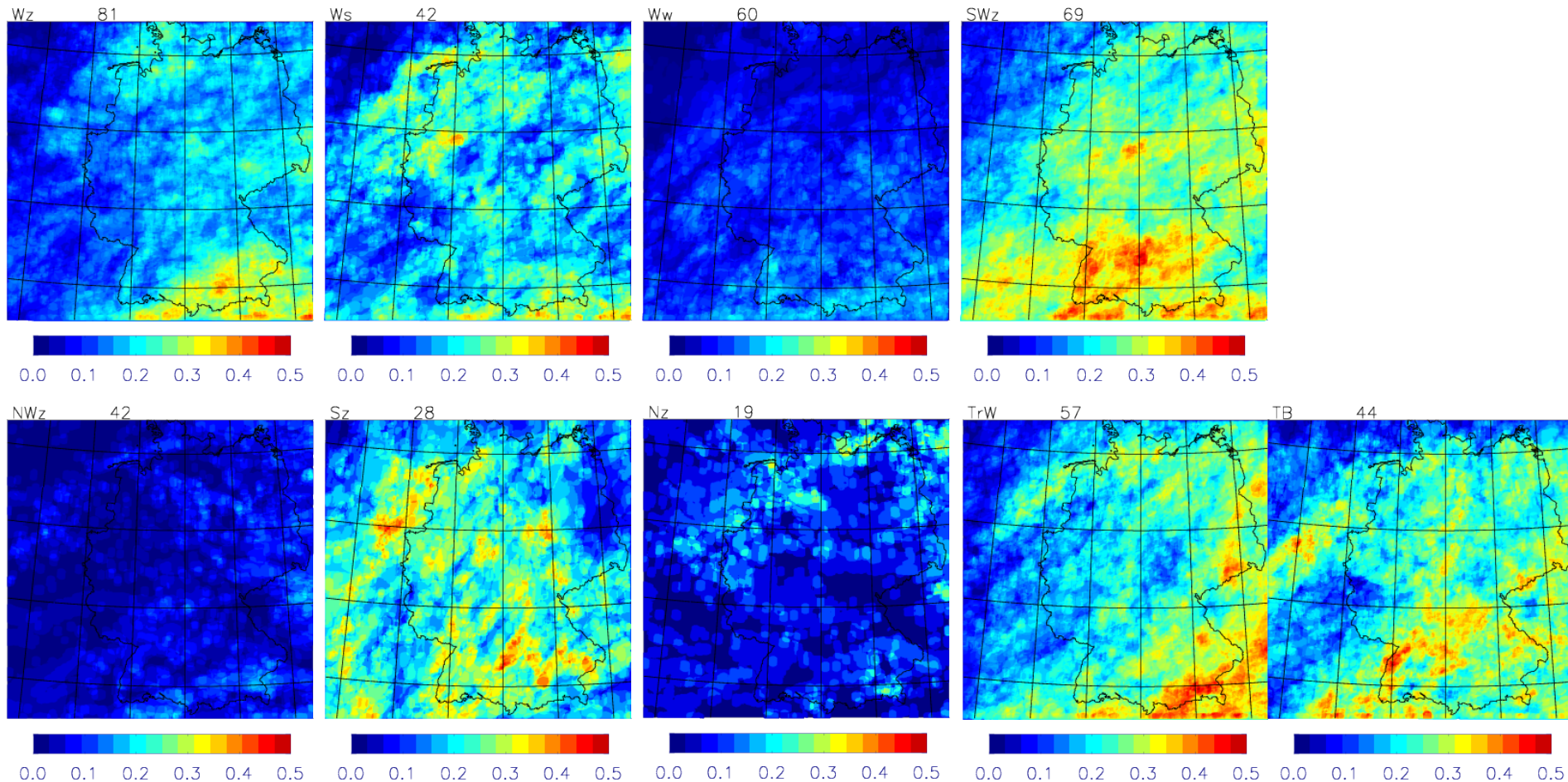


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summer (AMJJAS) 2007-2012



Thunderstorm activity vs synoptic pattern

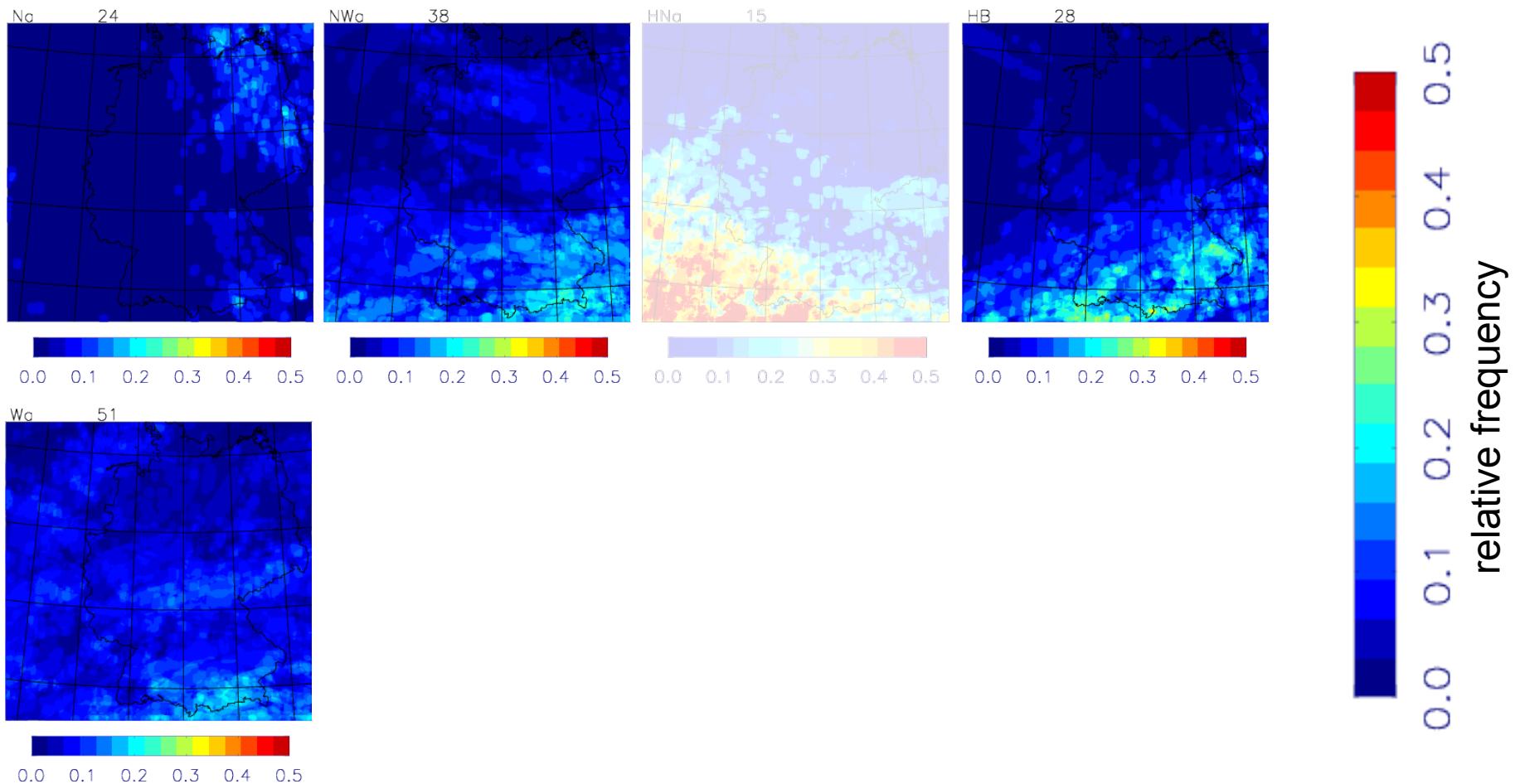


Z (general cyclonic)

summer (AMJJAS) 2007-2012



Thunderstorm activity vs synoptic pattern

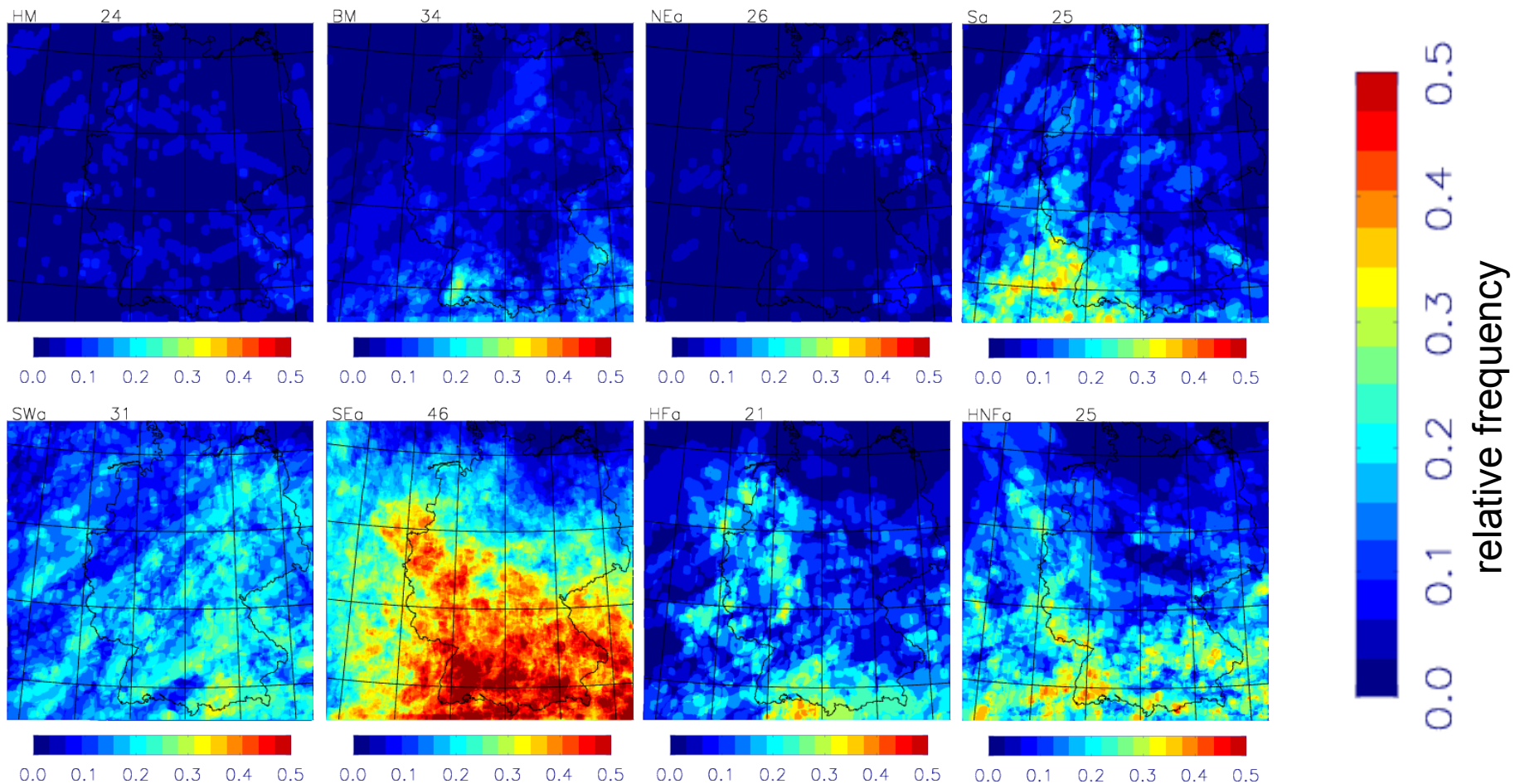


A (general anticyclonic)

summer (AMJJAS) 2007-2012



Thunderstorm activity vs synoptic pattern



H (Central Europe high pressure)

summer (AMJJAS) 2007-2012

