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Association

Weather Variability over Europe in the Context of Climate Change

by **Peter Hoffmann**

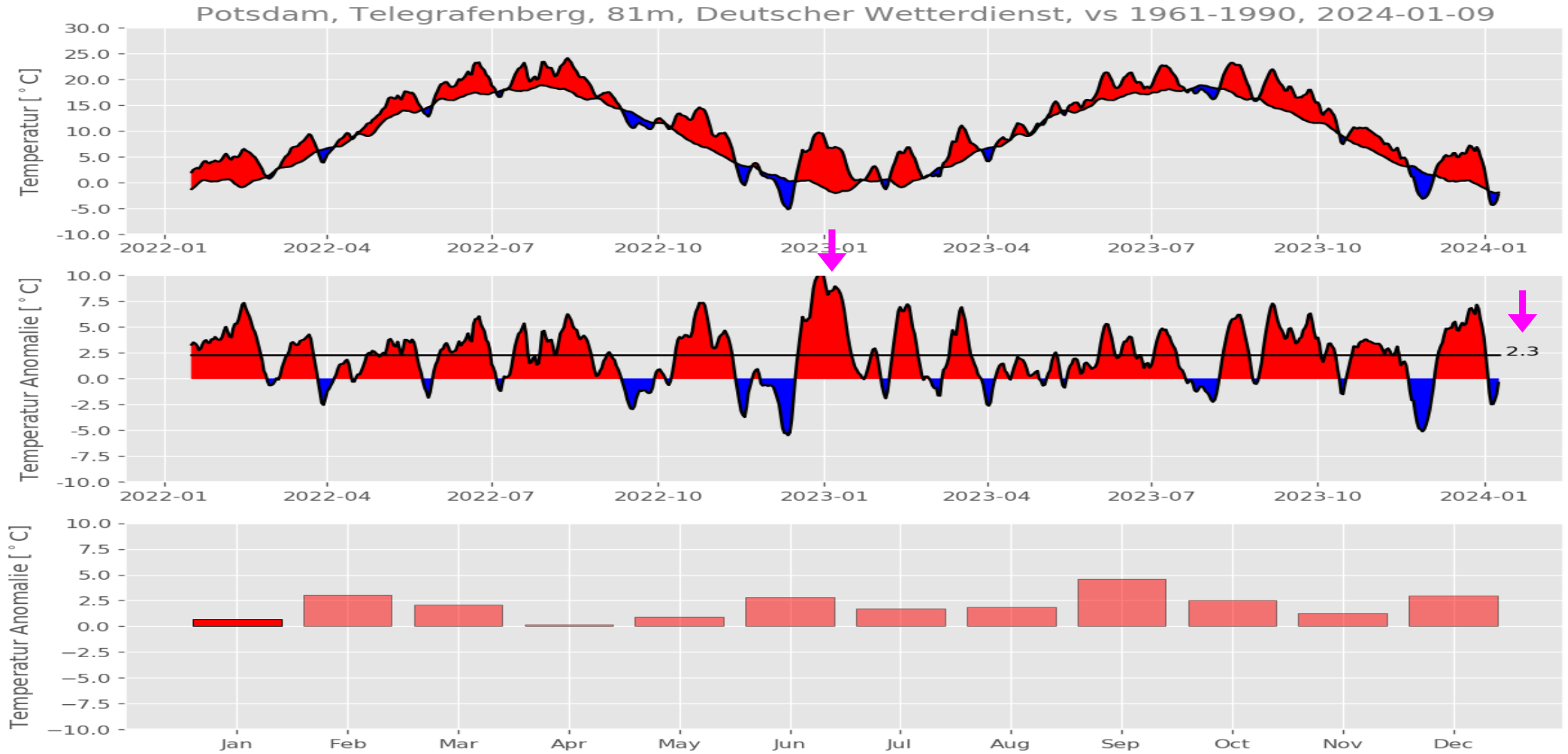
Hydro-Climatic Risks





Temperature Anomalies

Weather in a Climatic Context



Temperature Anomalies in Potsdam over the past 2 years

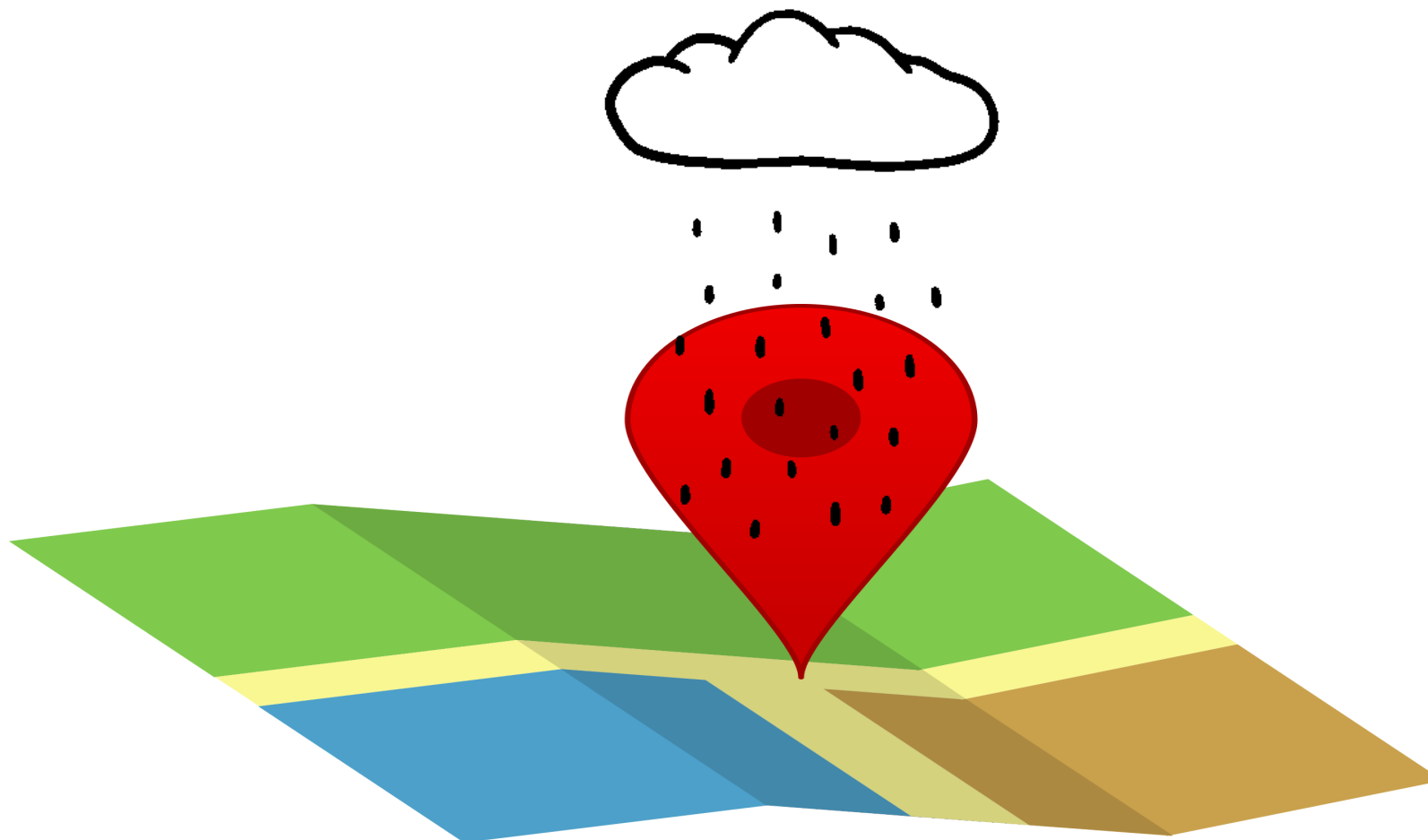


Local Weather in a larger Context

Transport of Air Masses

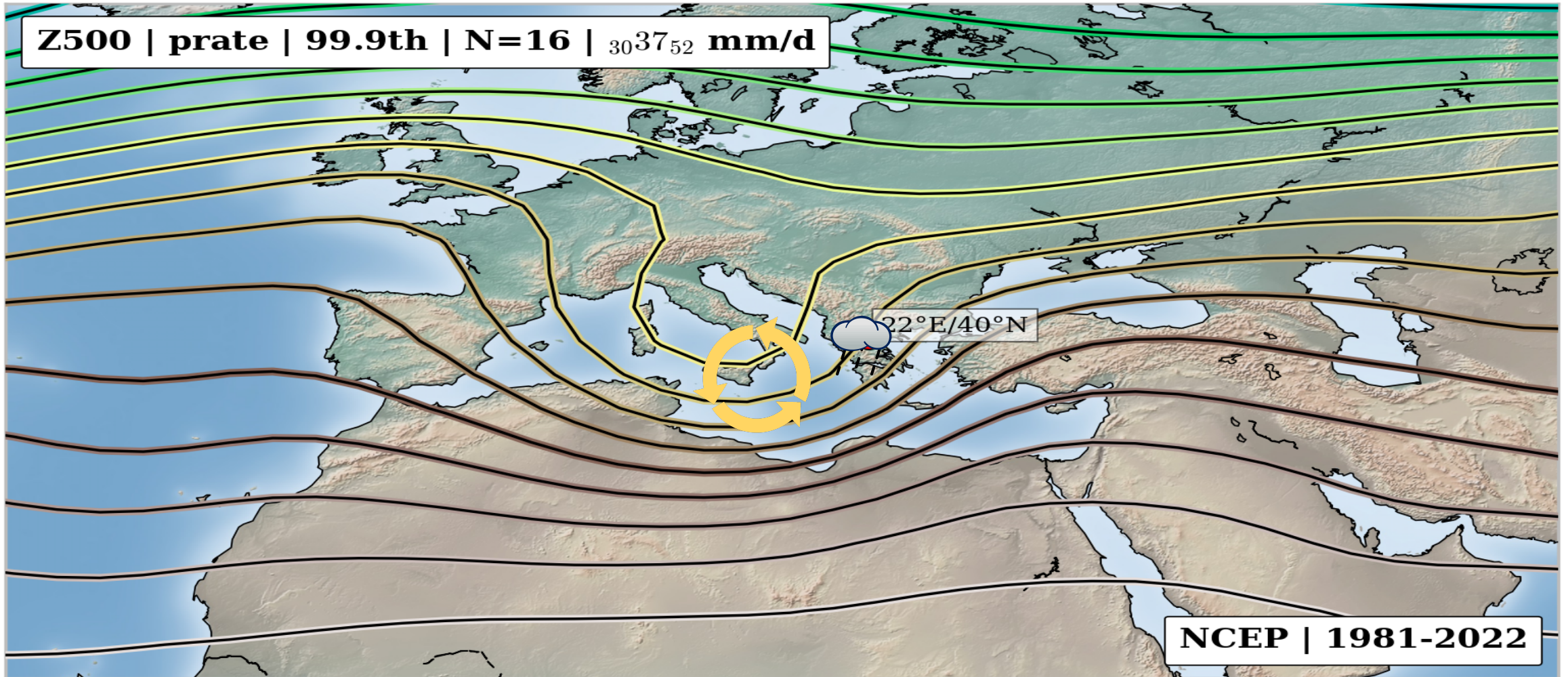


Every local Weather Phenomenon has a large-scale Context



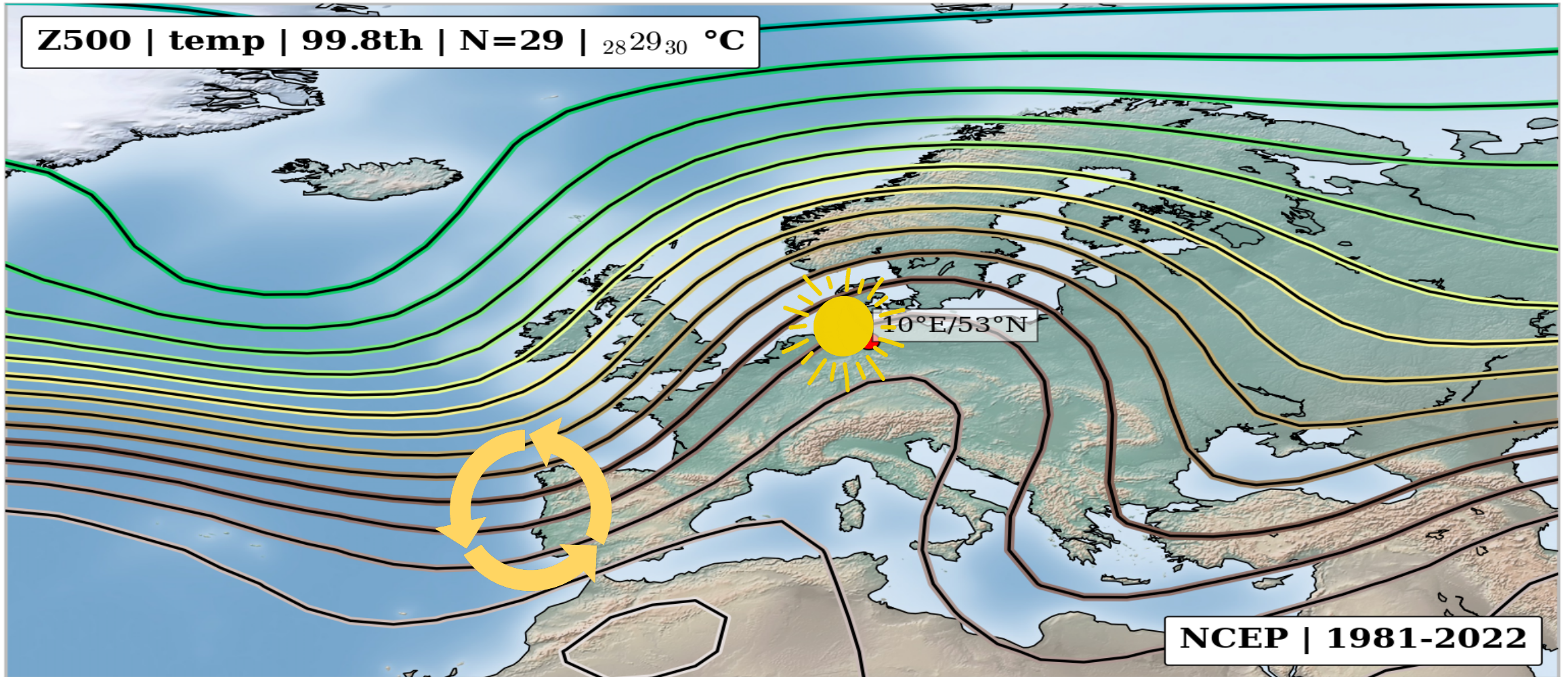


Greece: Heavy Rainfall





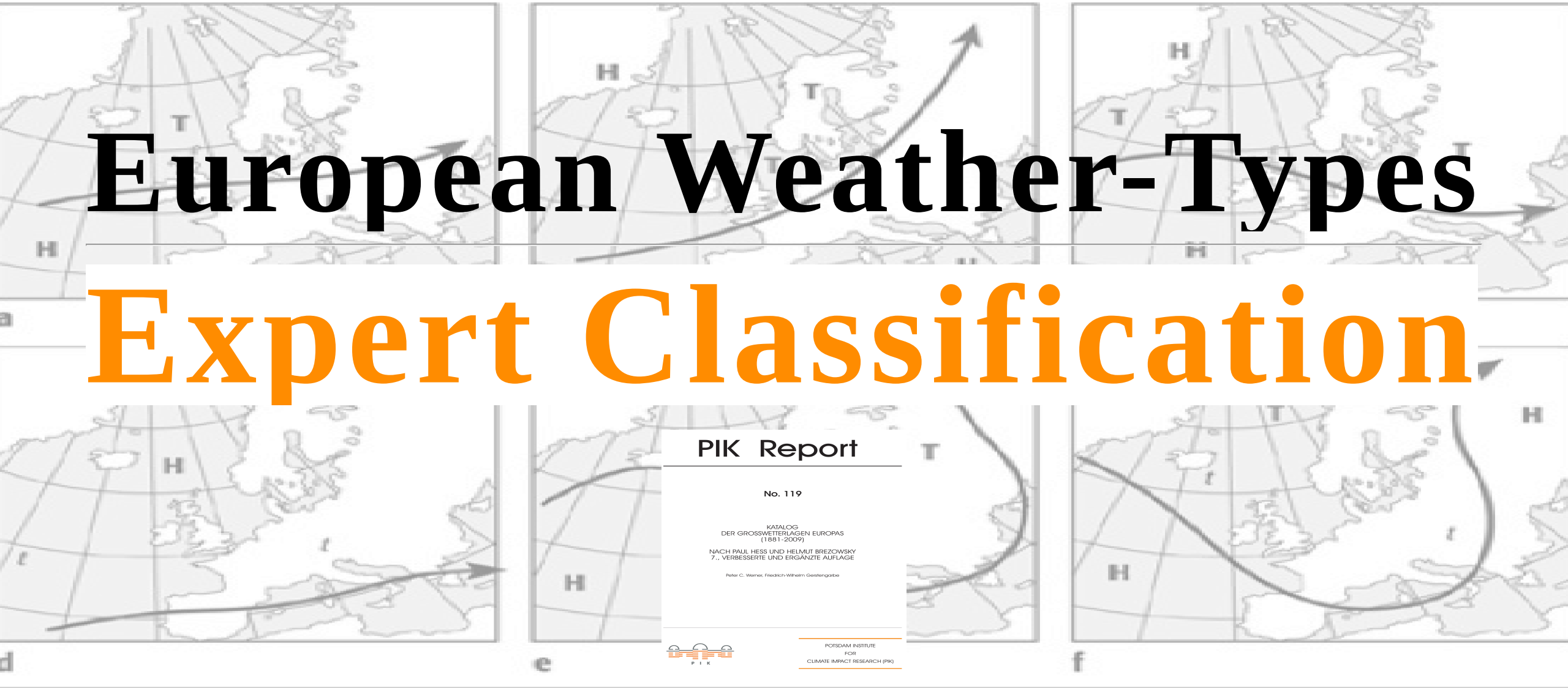
Hamburg: Hot Temperature





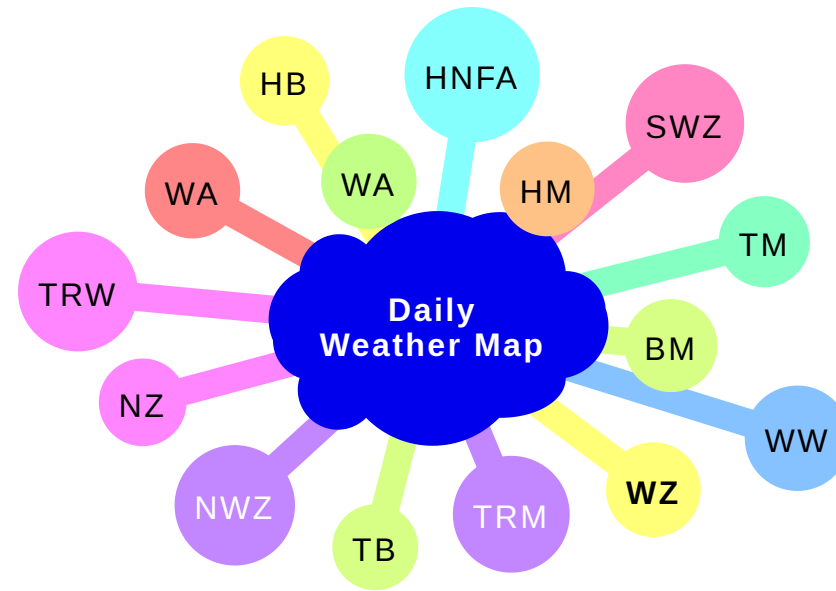
European Weather-Types

Expert Classification





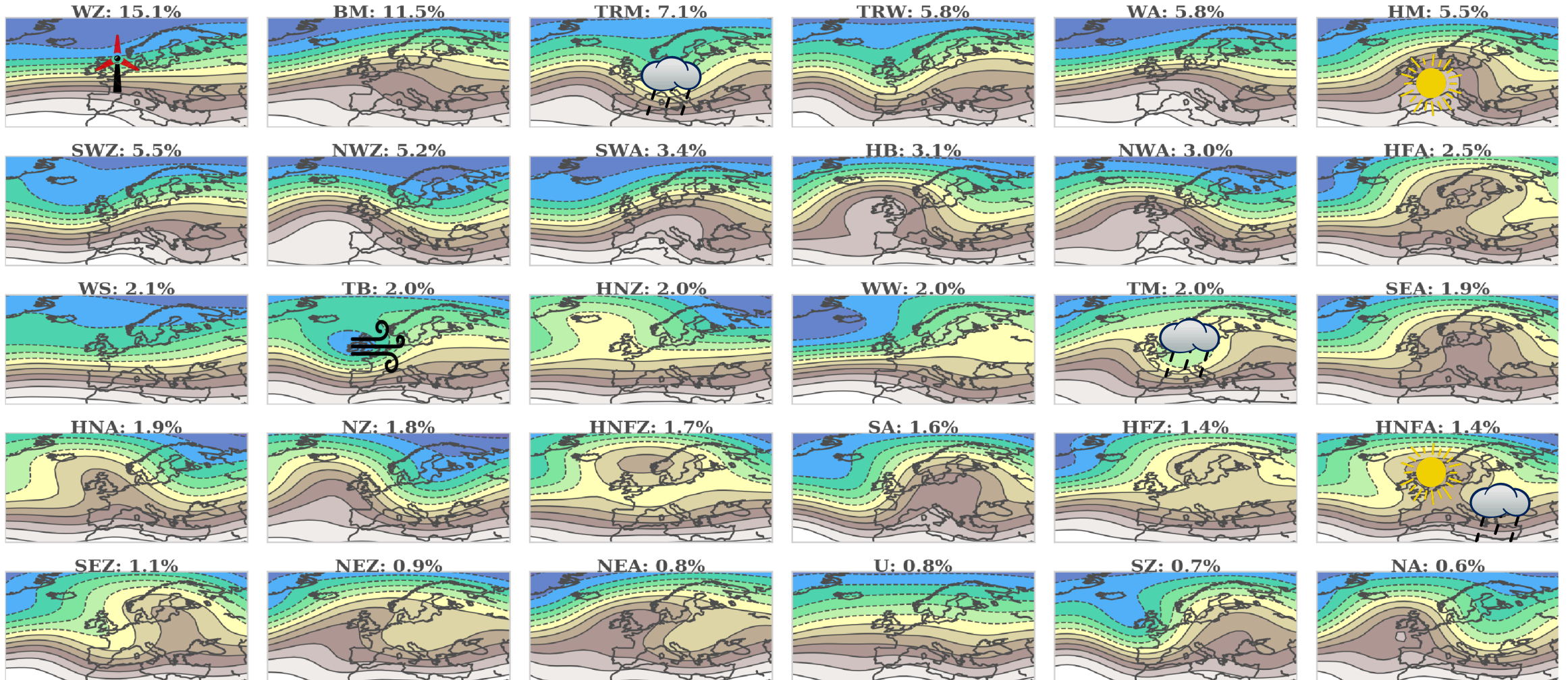
Temporal Development of Weather Patterns



Sequences of Categorical Data



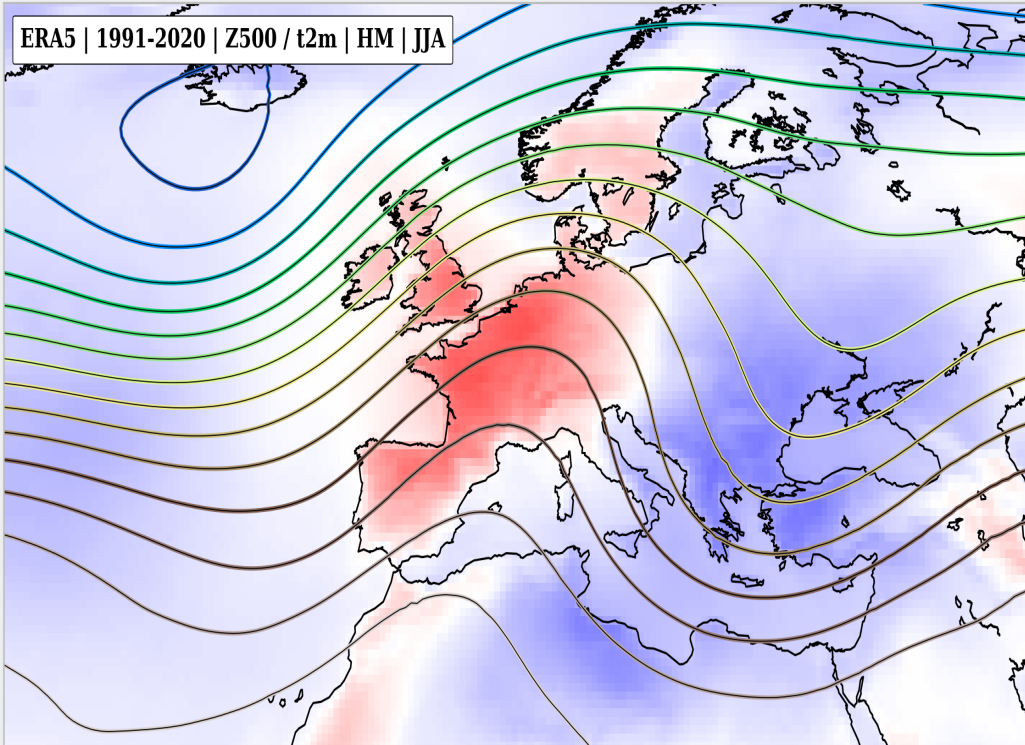
Großwetterlagen - Shapes of the Circulation





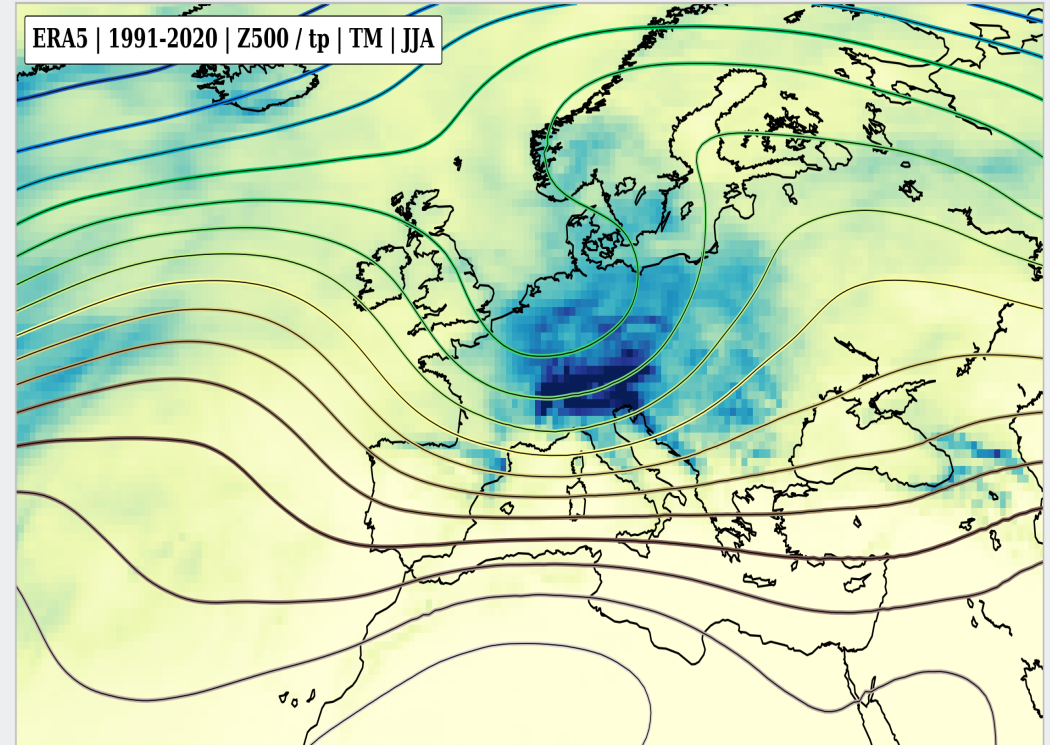
Regional Weather Characteristics

Temperature



HM: High over Central Europe

Precipitation



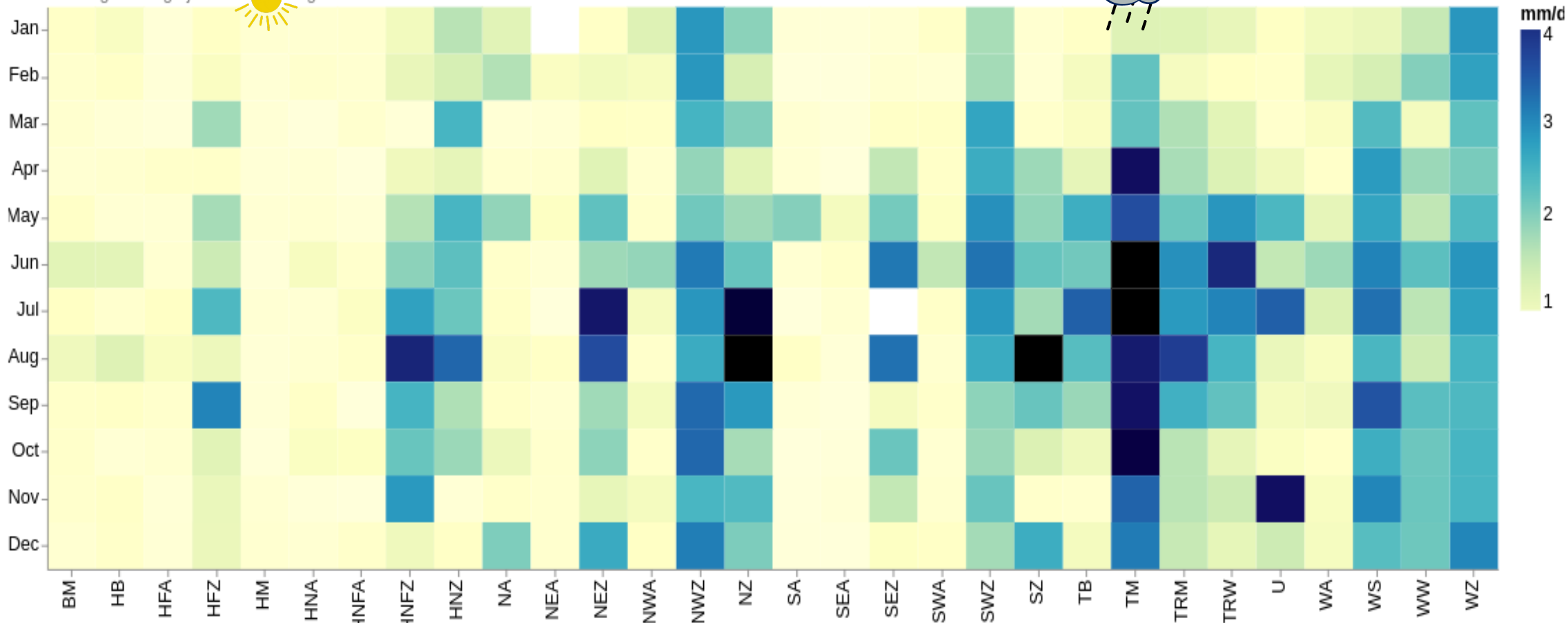
TM: Low over Central Europe



Local Precipitation Characteristics

Klimatrends, Potsdam

Mittlere Regenmenge je Großwetterlage und Monat in Potsdam





Weather-Type Sequences

Extreme Weather Events



May 2013: 100-year Flood of the Rivers Elbe

22.05-02.06.2013: TRM,TRM,TRM,TRM,TRM,TRM

January 2019: Heavy Snowfall in the north

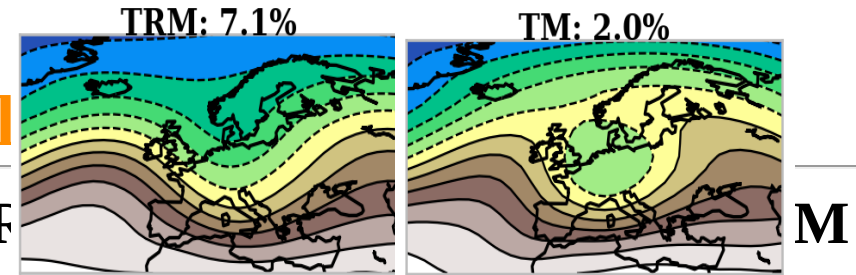
01.-13.01.2019: NZ,NZ,NZ,HB,HB,HB,NWA,NWA

July 2021: Ahrtal Catastrophe

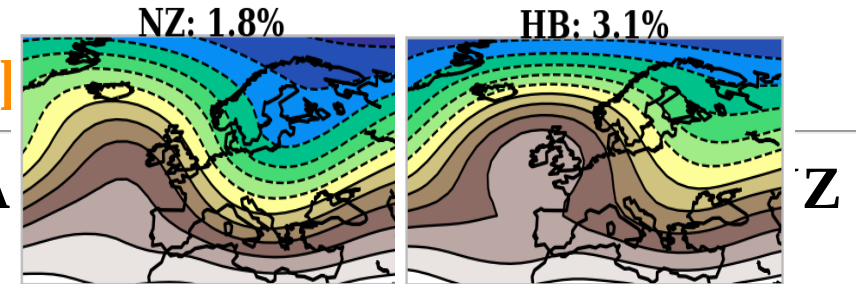
10.-18.07.2021: TRW,TRW,TRW,TRW,TRW,TRW,NEZ

July 2022: 40°C in Hamburg

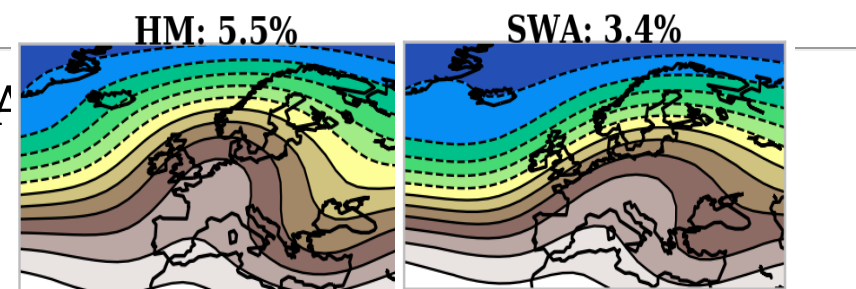
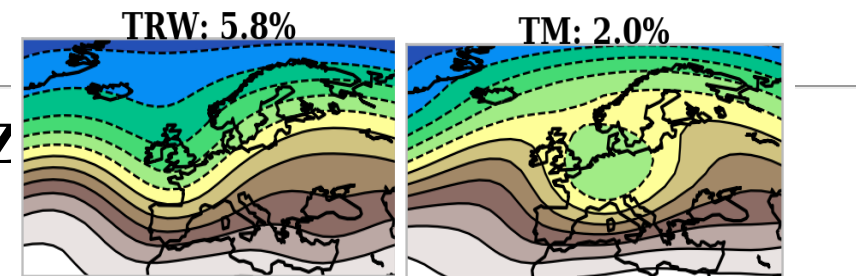
16.-25.07.2022: HM,HM,HM,SWA,SWA,SWA,SWA



M



Z





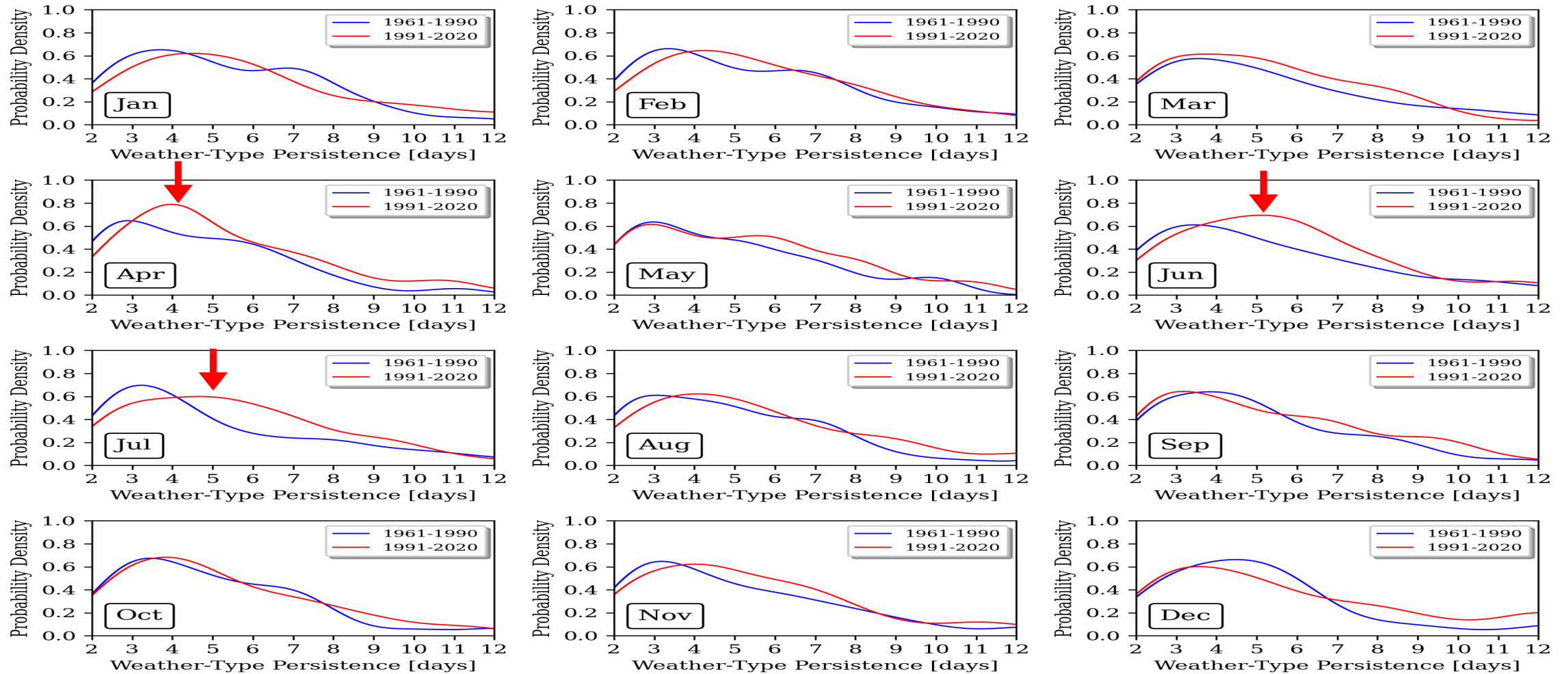
Attributes of the Weather-Types Variability

Frequency, Persistence, Transition

Long-Term Changes of Weather-Types?



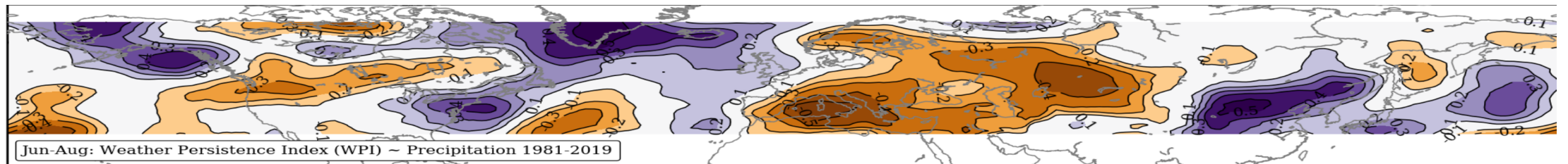
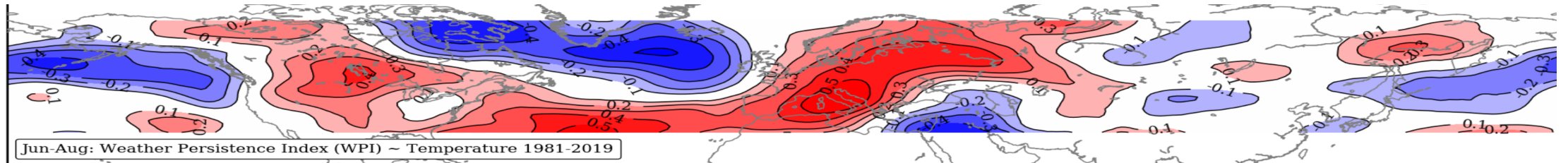
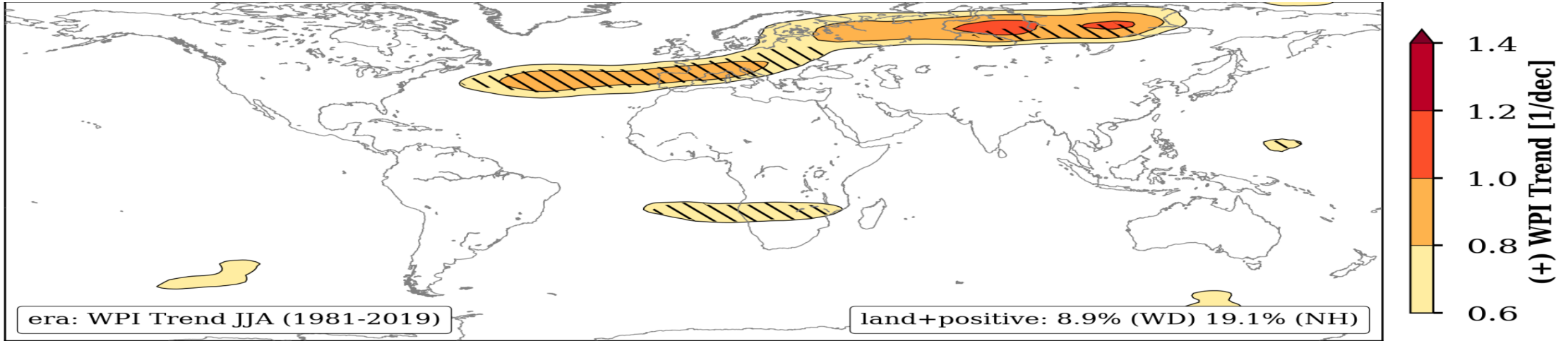
Weather-Type Persistence



Significant Increase in Apr, Jun, July

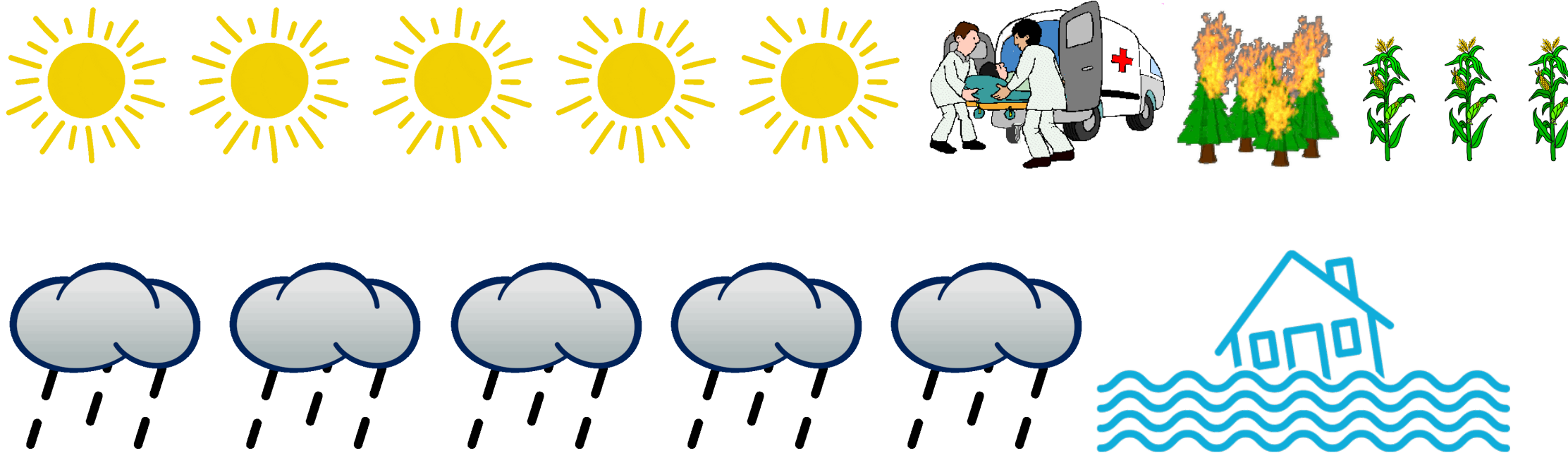


Day-to-Day Atmosphere Similarity





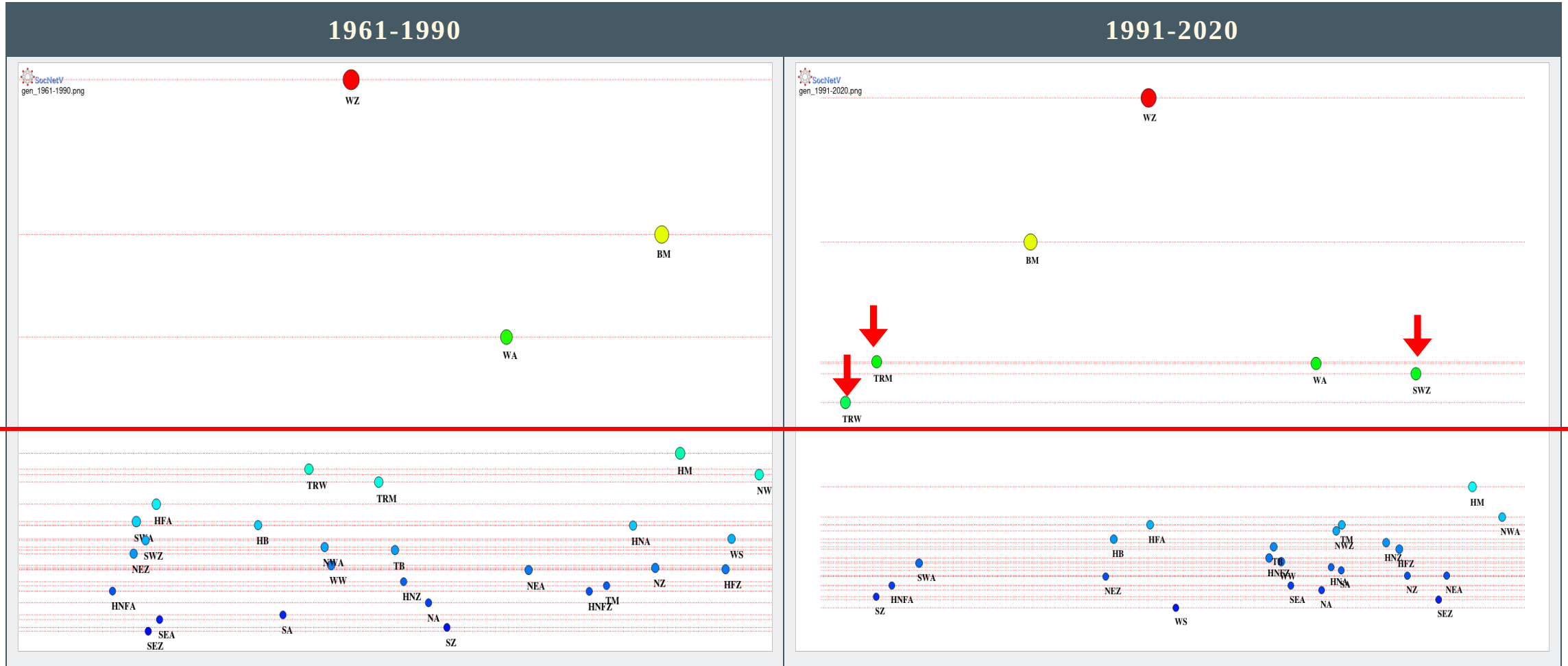
Impacts of Weather Persistence



The longer Weather-Types persist, the stronger the Impacts

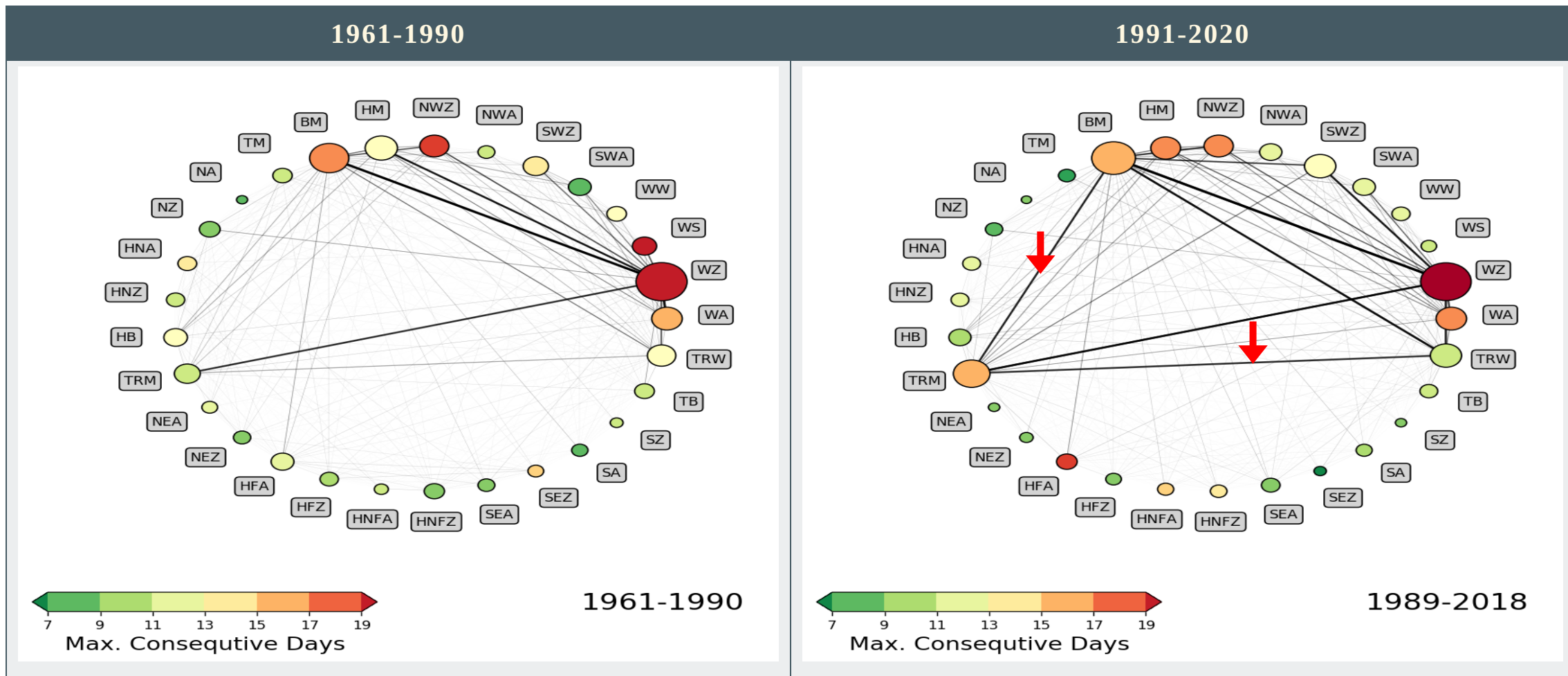


New dominant Weather-Types





New dominant Weather-Type Transitions

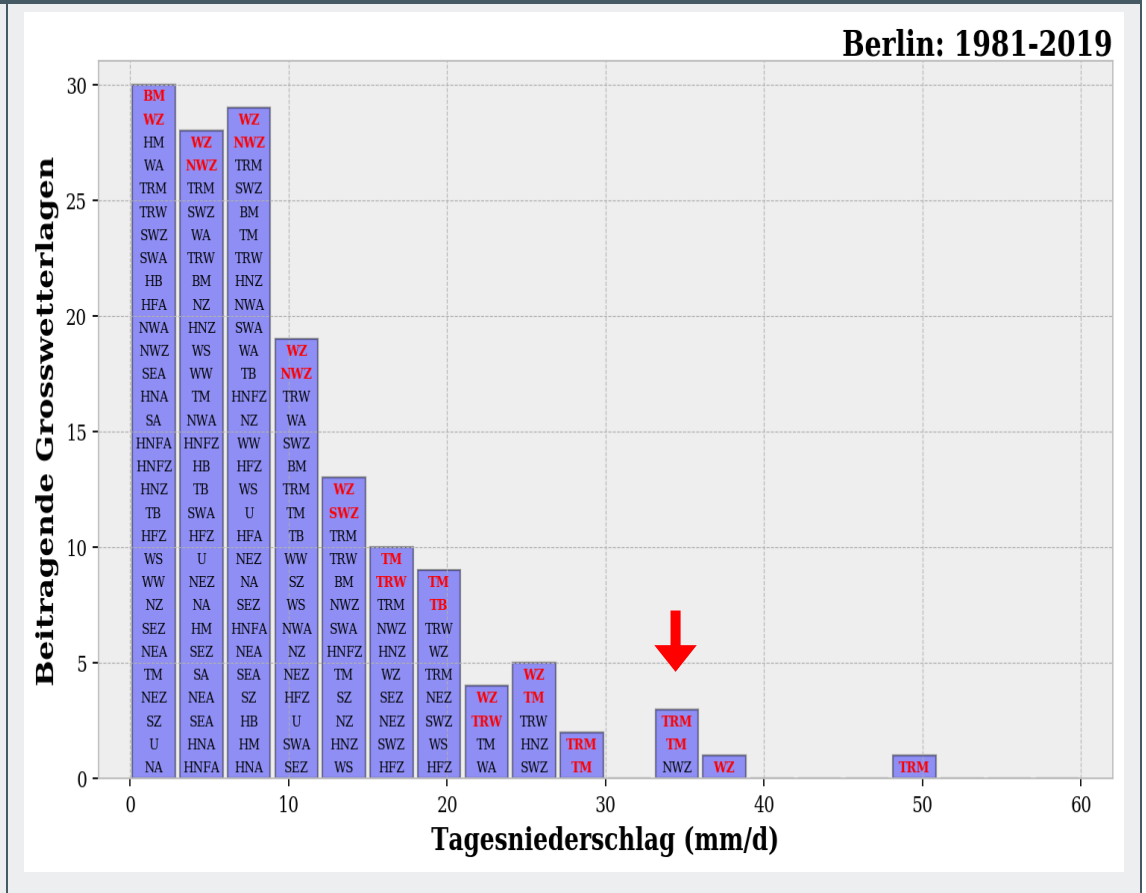
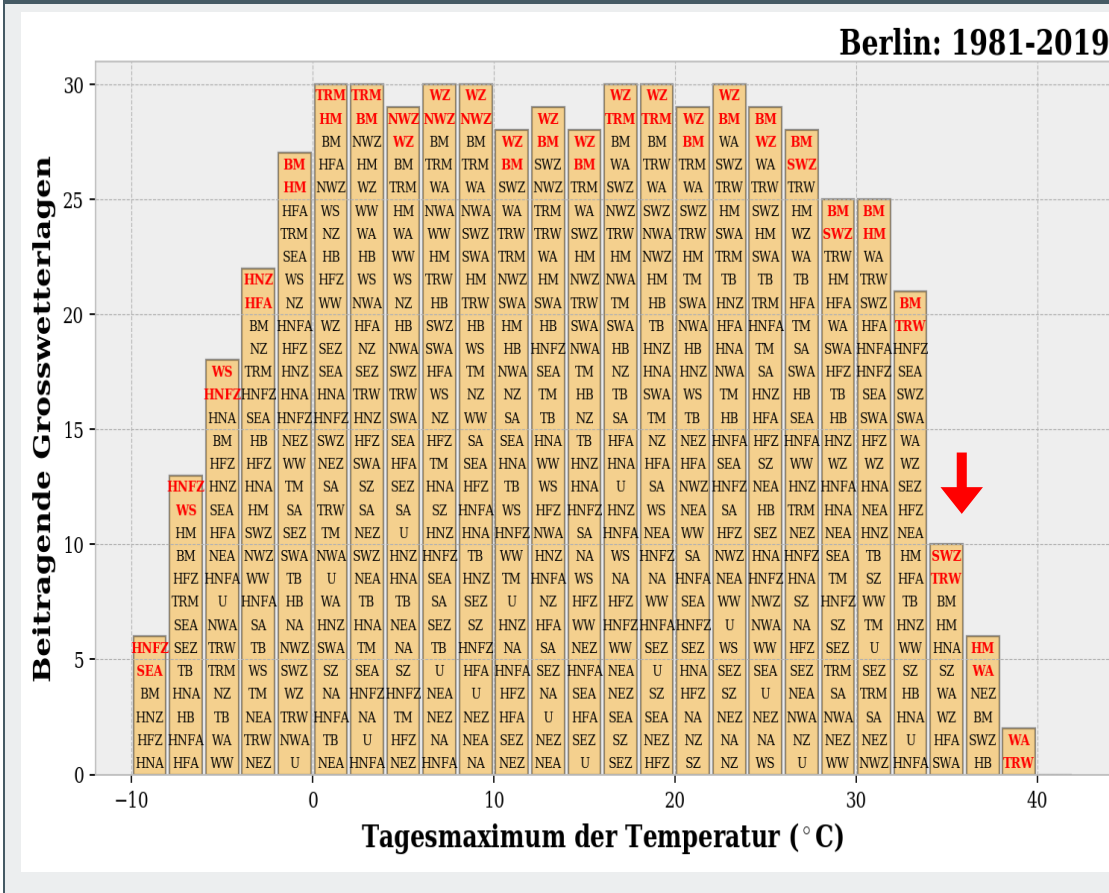




Criticality of Weather-Types

Temperature, Berlin

Precipitation, Berlin





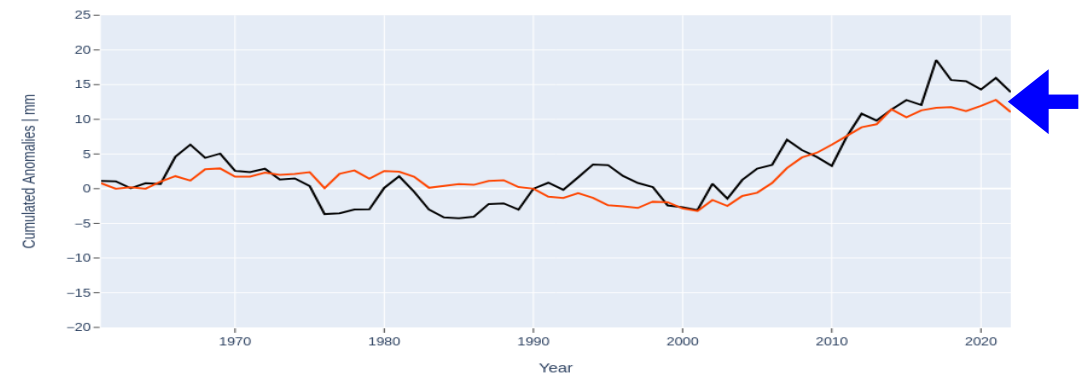
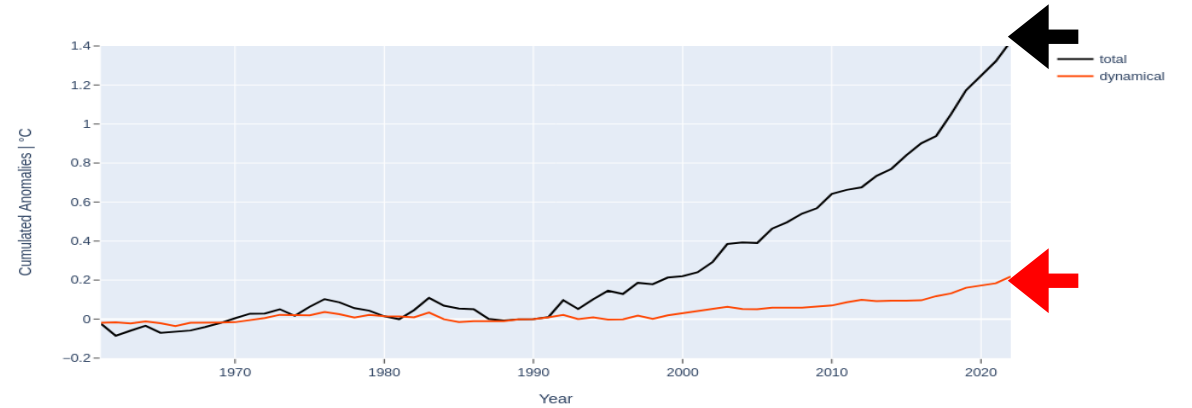
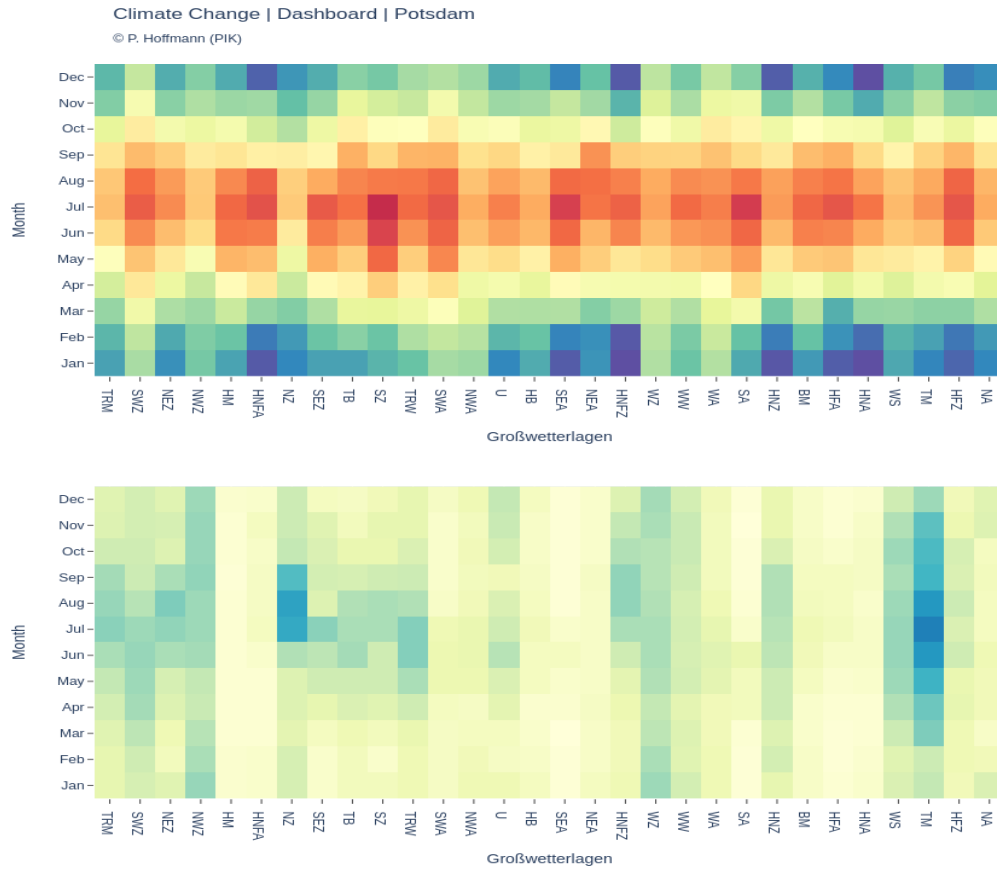
Attribution Study

Role of Dynamic Factors on Temperature rise



Decomposition into a Dynamical Component (June-August)

Temperature



Precipitation



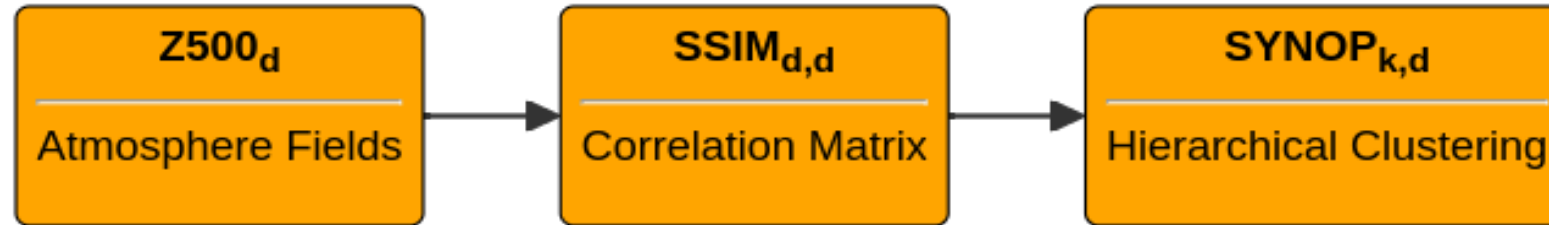
European Weather-Types

Objective Classification

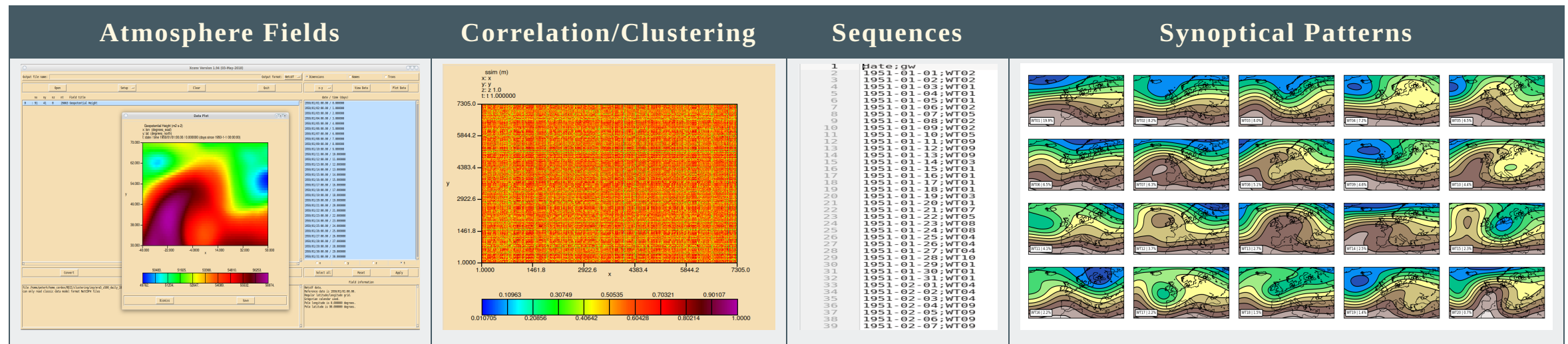


Identification of Weather-Types

Workflow



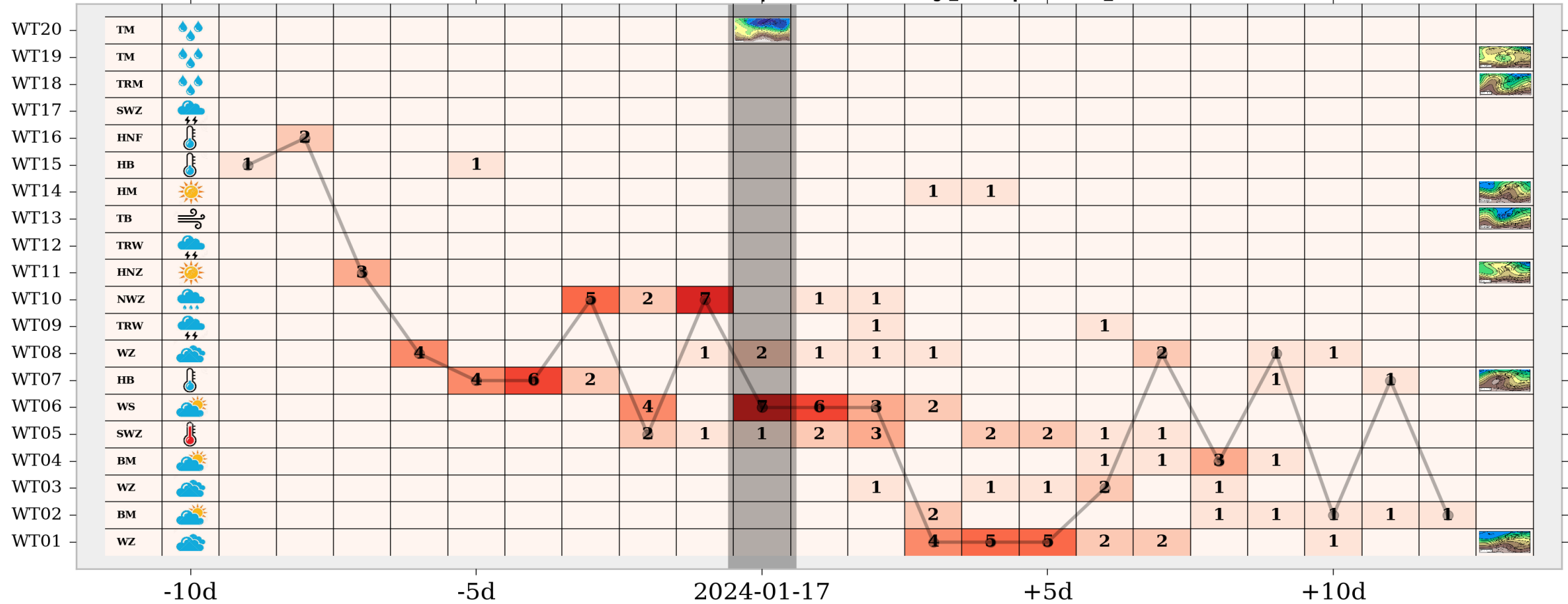
Data Processing





Application to Weather-Type Prediction

GFS 00 Forecast | Weather Types | Europe

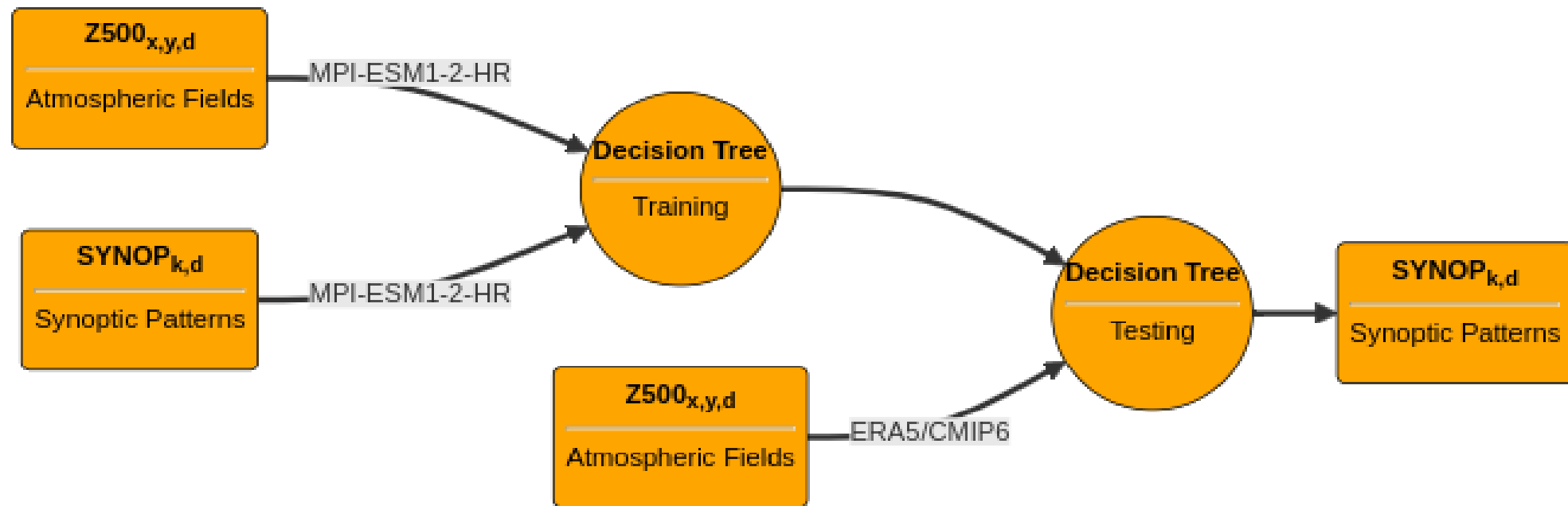




Re-Identification of Weather-Types in Climate Models

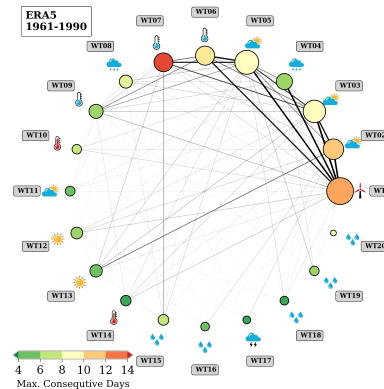
Training a Decision Tree between Atmospheric Fields and Weather-Types

Scheme



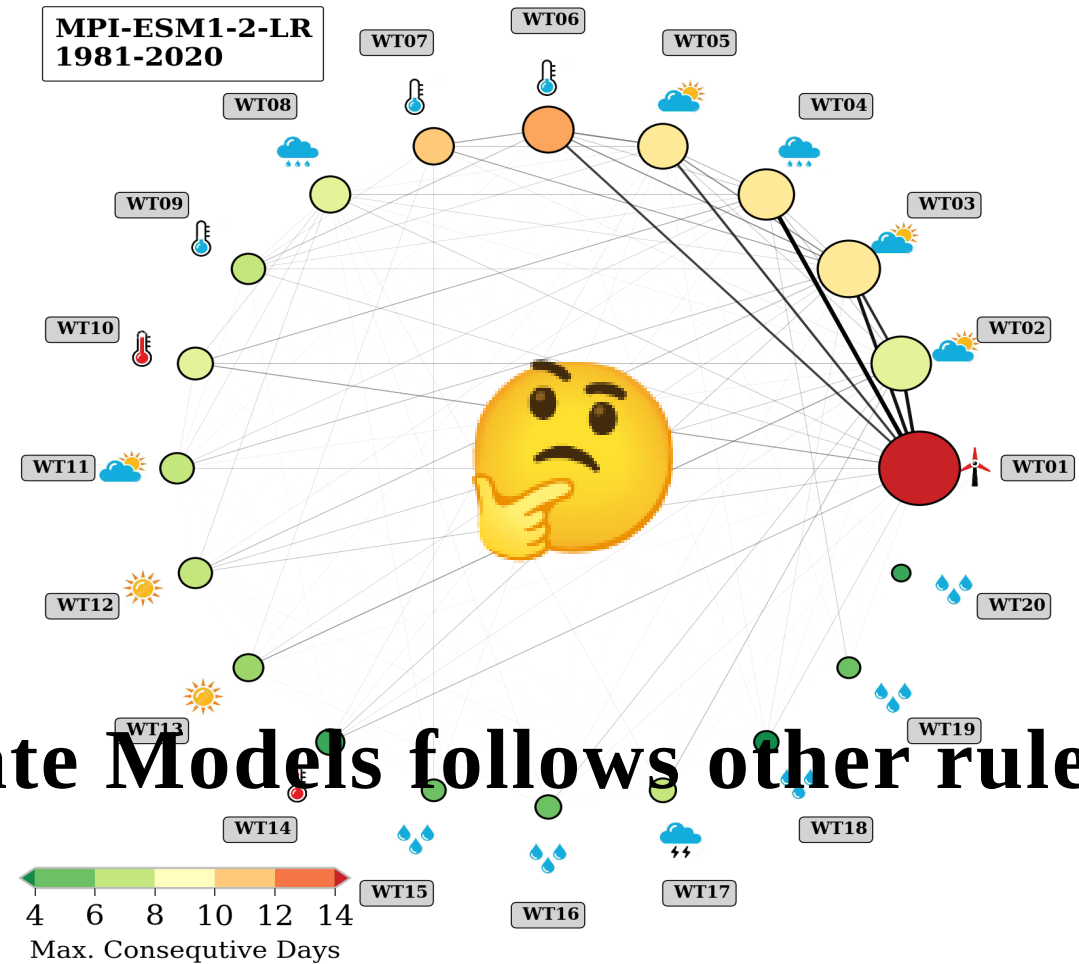
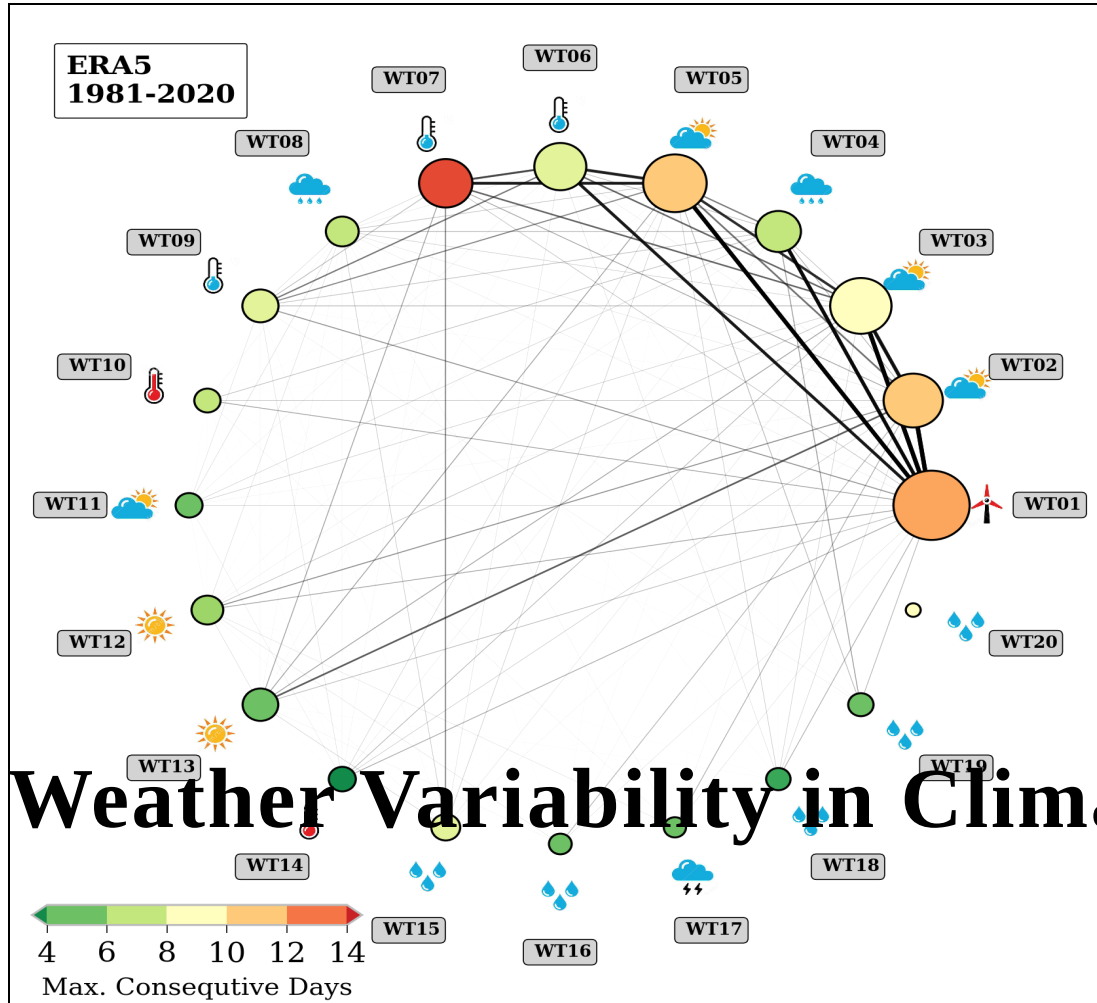


Comparison of the Weather Variability using Network Graphs in Reanalyses and Climate Models





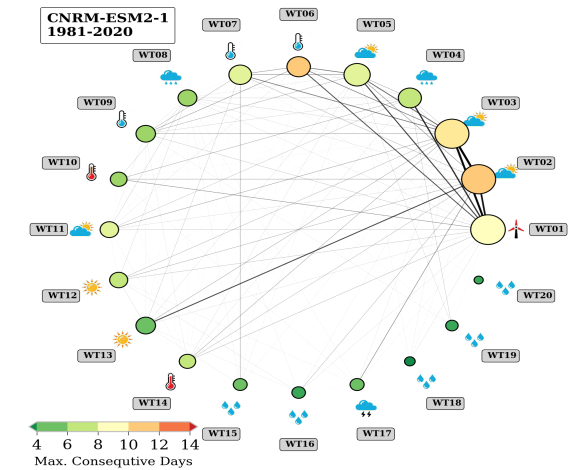
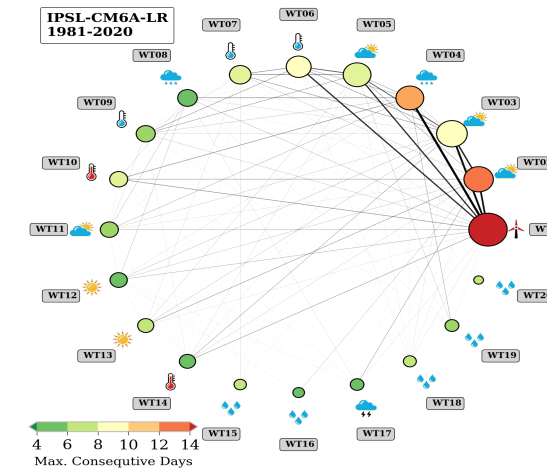
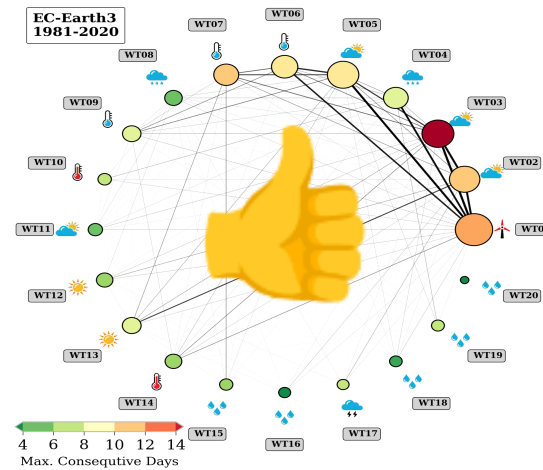
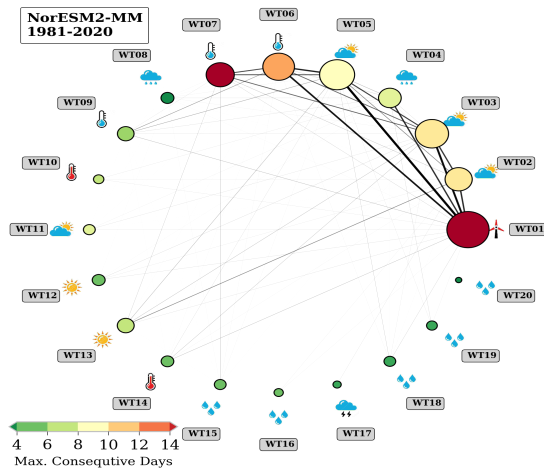
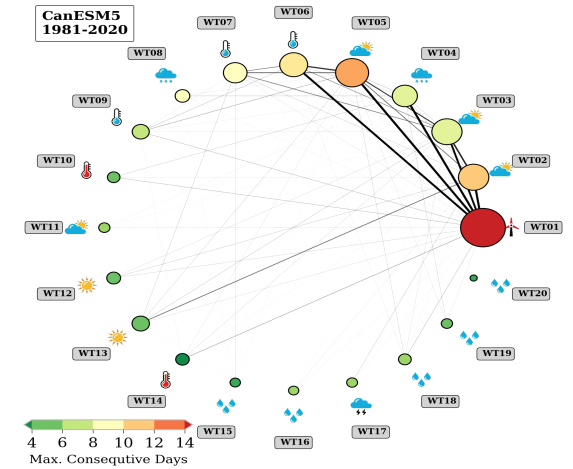
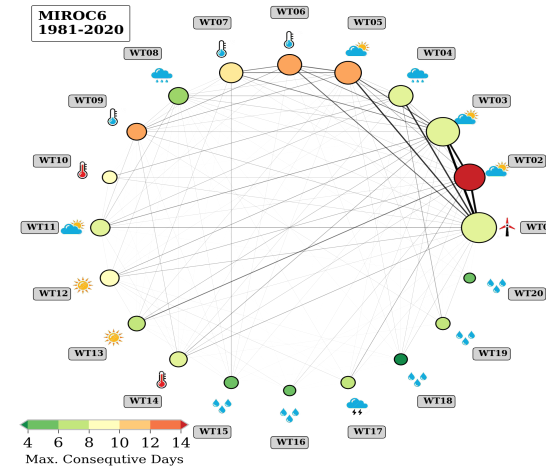
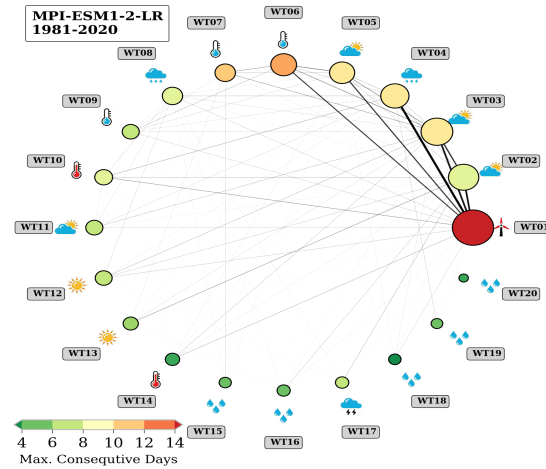
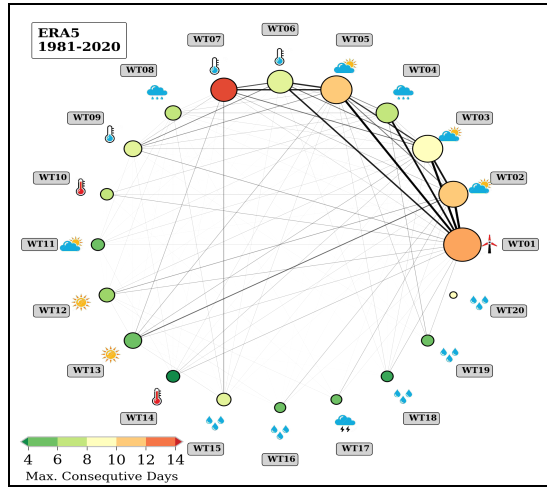
Weather Variability in Climate Models - Assessment



Weather Variability in Climate Models follows other rules

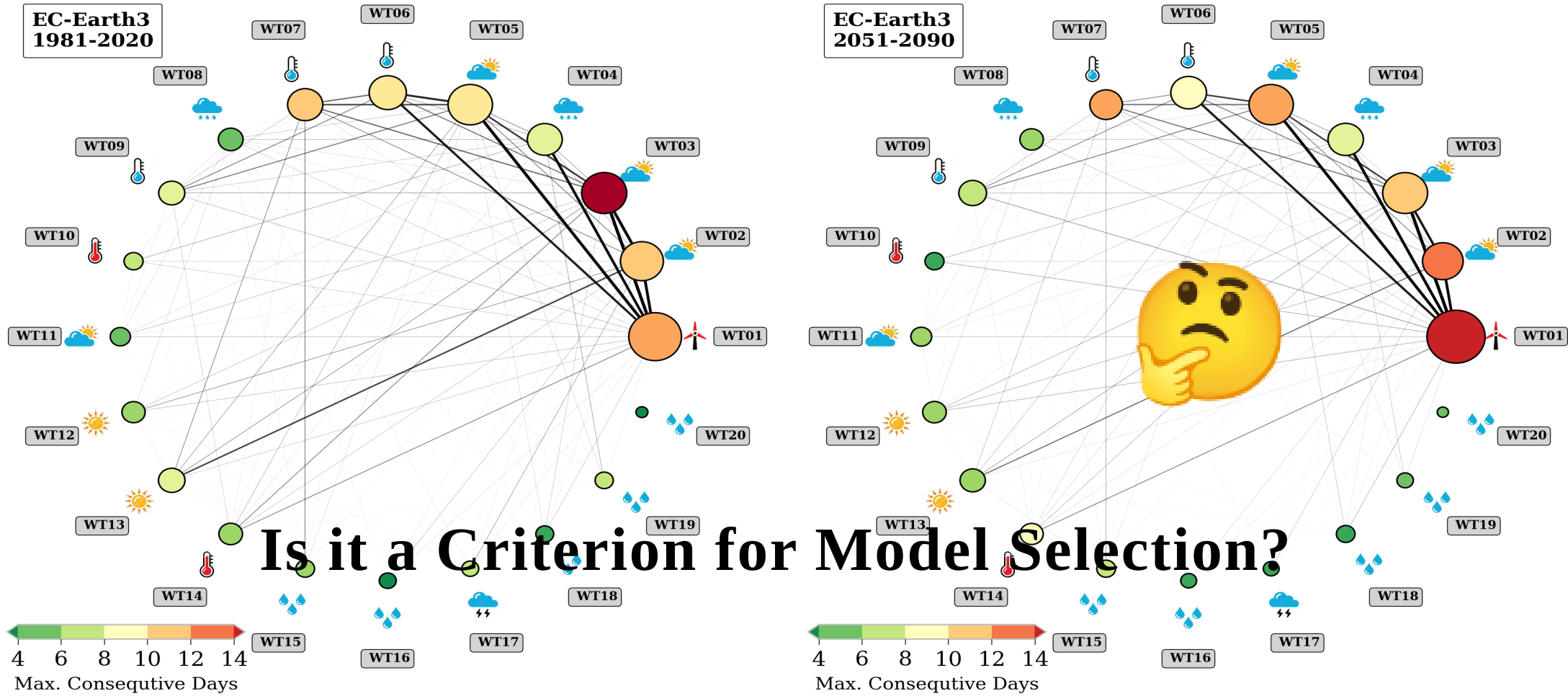


Weather Variability in Climate Models - Assessment





Weather Variability in Climate Models - Sensitivity





Three Concluding Remarks

- Analyses of the Weather Variability over Europe are generally underrepresented in the Context of Climate Change



- New dominant and persistent weather-types explain a higher percentage of the weather variability and they are often associated with hydroclimatic extremes

- Weather Variability in climate model simulations follow slightly other rules with possible effects on projected rainfall patterns

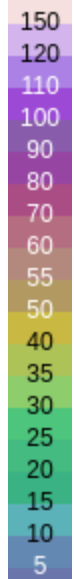
Thank you for listening!



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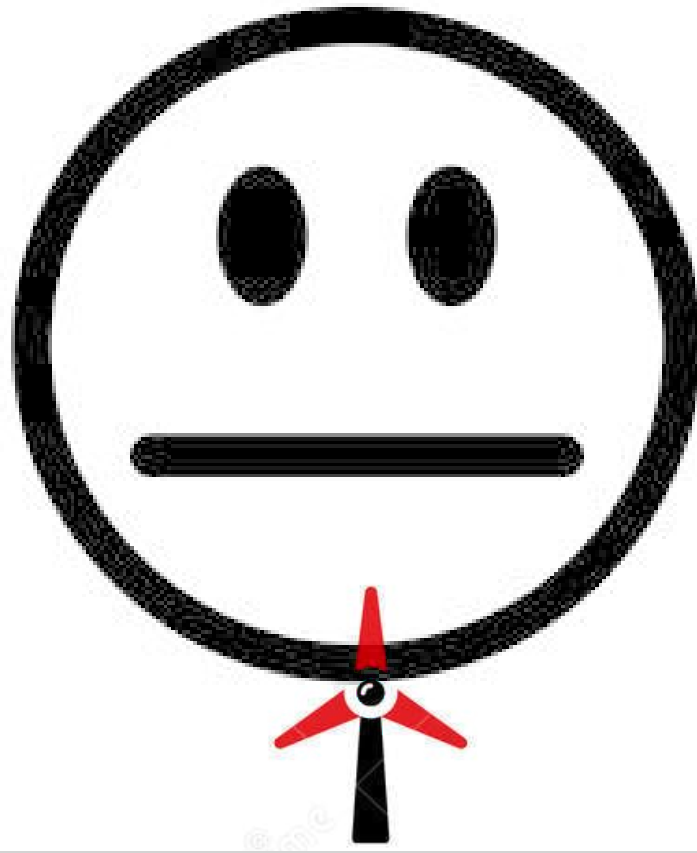


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Shapes and Structures





Weather Variability in ERA5 Reanalysis

