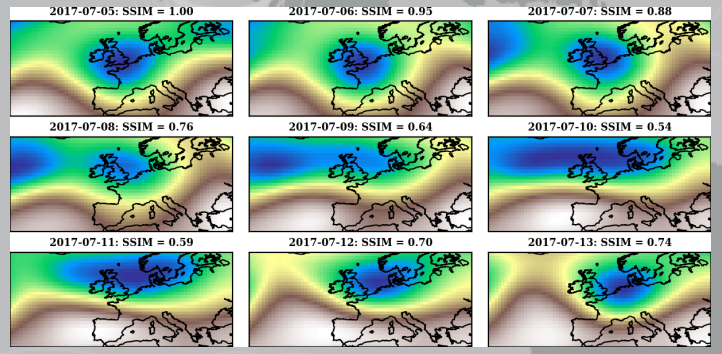
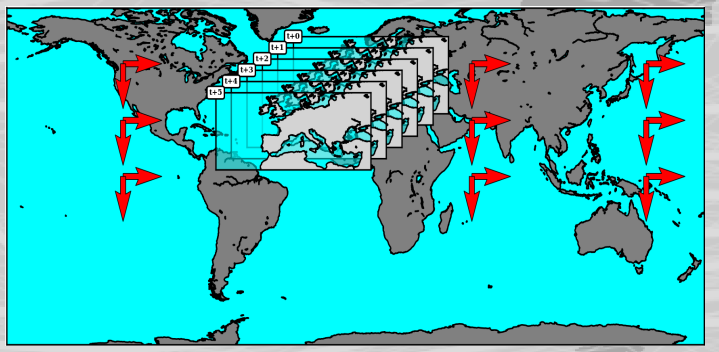
New method to detect and quantify weather persistence associated with hydro-climatic extremes by Hoffmann et al. (EGU21-8044)

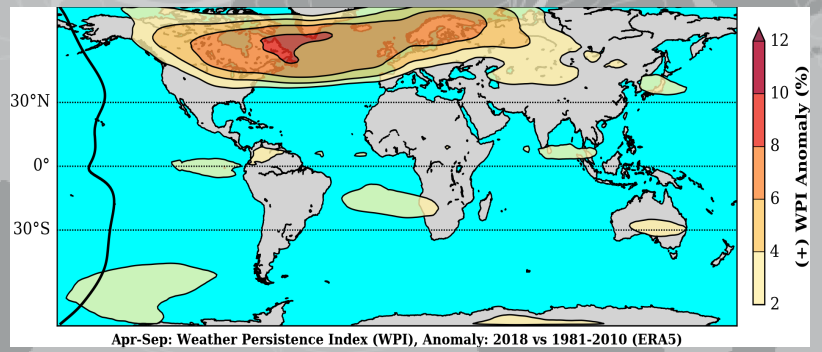
`weather persistence index := similarity of consecutive atmospheric fields`

Data and Method

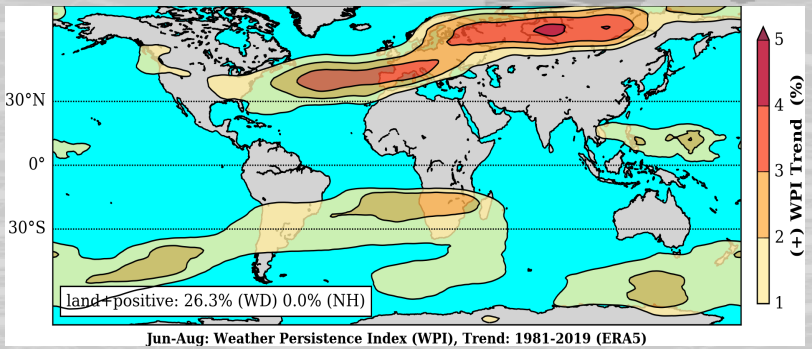




Anomalies and Trends

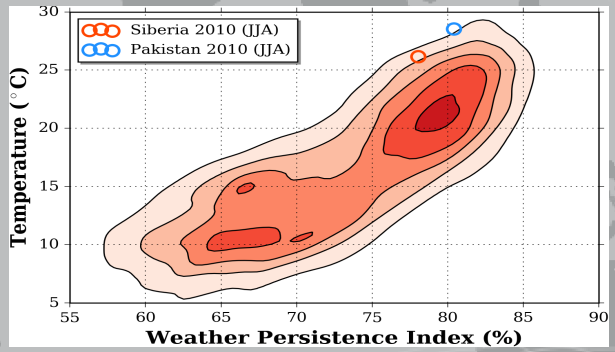


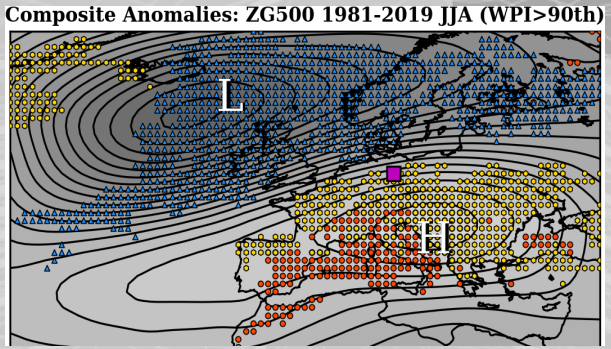
Apr-Sep: Weather Persistence Index (WPI), Anomaly: 2018 vs 1981-2010 (ERA5)



Jun-Aug: Weather Persistence Index (WPI), Trend: 1981-2019 (ERA5)

Patterns and Risks





Introduction

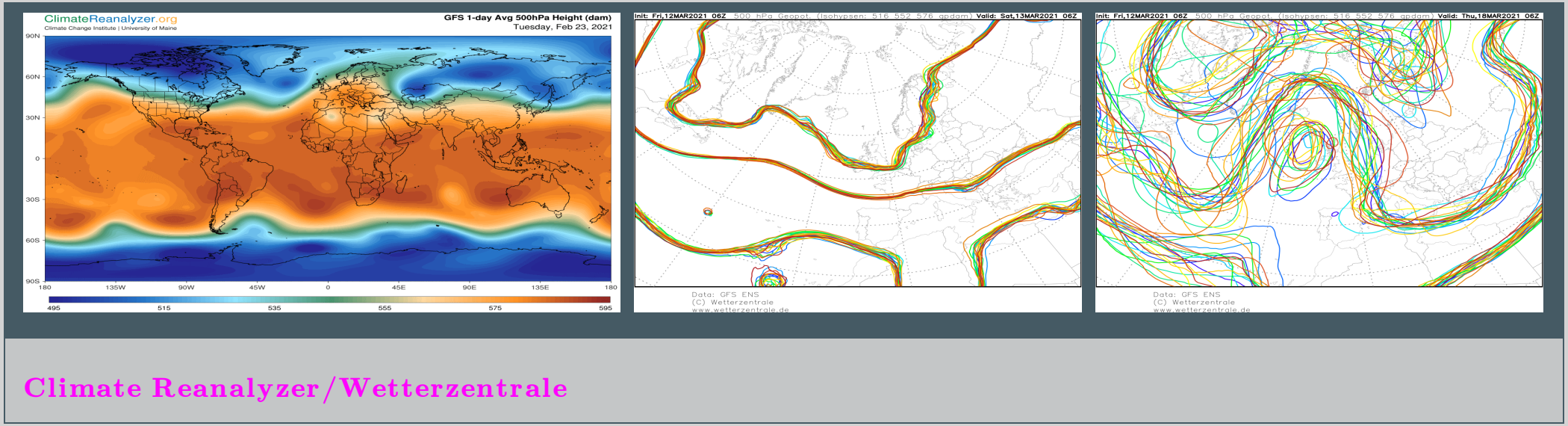
- **climate change has two components**
  - thermodynamic and dynamic changes
- **hydro-climatic extremes**
  - are mainly triggered by dynamic factors
- **weather persistence**
  - is one relevant dynamical factor that effects hydroclimatic risks
- **diagnostic measure**
  - structural similarity of consequtive atmospheric patterns
  - detection and quantification of regional weather persistence

Research Questions

- **Q1:** When, where and how long do isolines of atmospheric geopotential height fields run in similar tracks?
- **Q2:** Are there long-term trends in weather persistence and where?
- **Q3:** Is there a correlation between weather persistence and hydroclimatic extremes?
- **Q4:** Are climate models able to capture trends in weather persistence?

Data

- middle troposphere - geopotential height 500 hPa (ZG500)

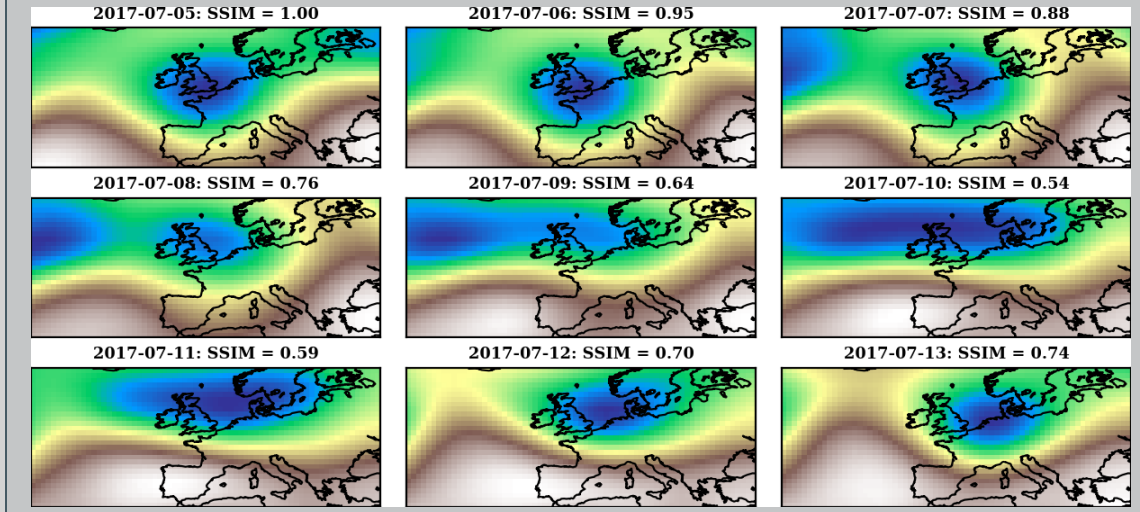


Climate Reanalyzer/Wetterzentrale

- global reanalysis data (ERA5)
- global climate scenarios (CMIP5)

Method

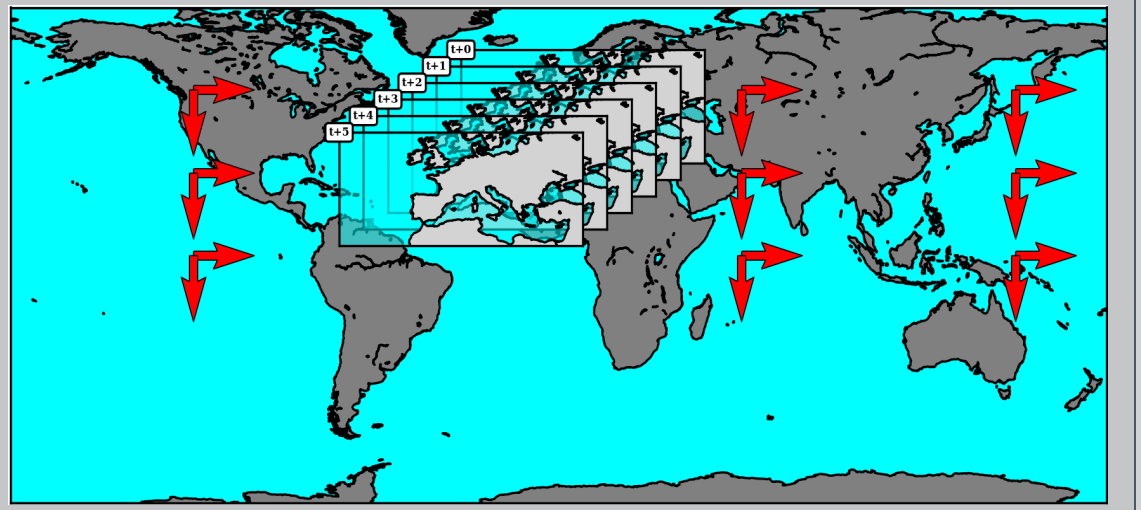
Structural SIMilarity



`cdo sellonlatbox,-30,40,30,70`

$$\mathbf{WPI} = \frac{1}{10} \sum_i \mathbf{SSIM}(\mathbf{IMG_1}, \mathbf{IMG_i})$$

Screening



`dlon/dlat/dtim = 1°/1°/1day`

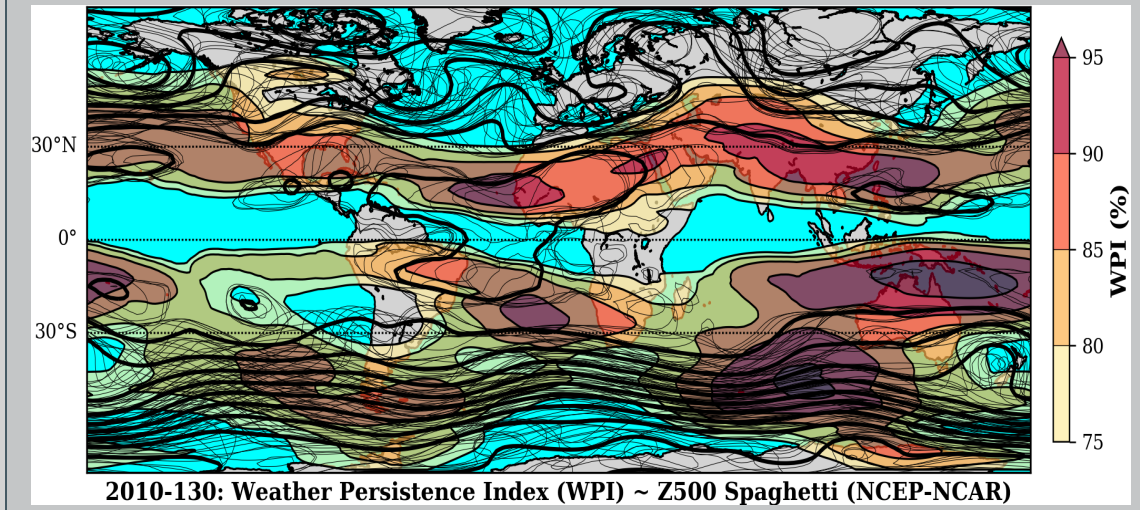
`cdo timmean -selmon,6/8 ..`

python library: `scikit-image.StructuralSIMilarityIndex` by Wang et al. 2004

Validation

Order of successive ZG500 isolines

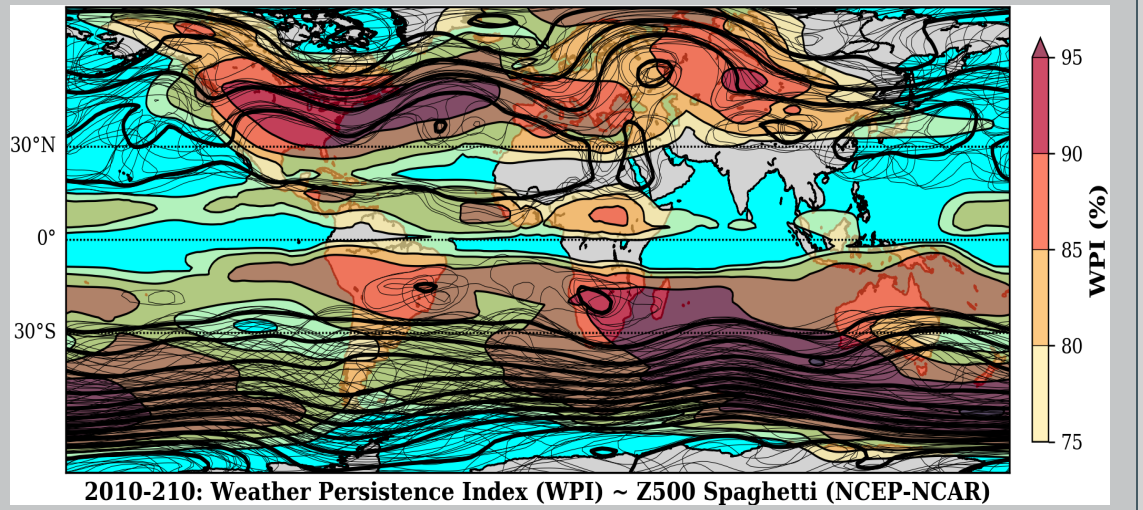
Europe: low WPI



2010-130: Weather Persistence Index (WPI) ~ Z500 Spaghetti (NCEP-NCAR)

DOY 130 in 2010: +1..+10 Days

Europa: high WPI

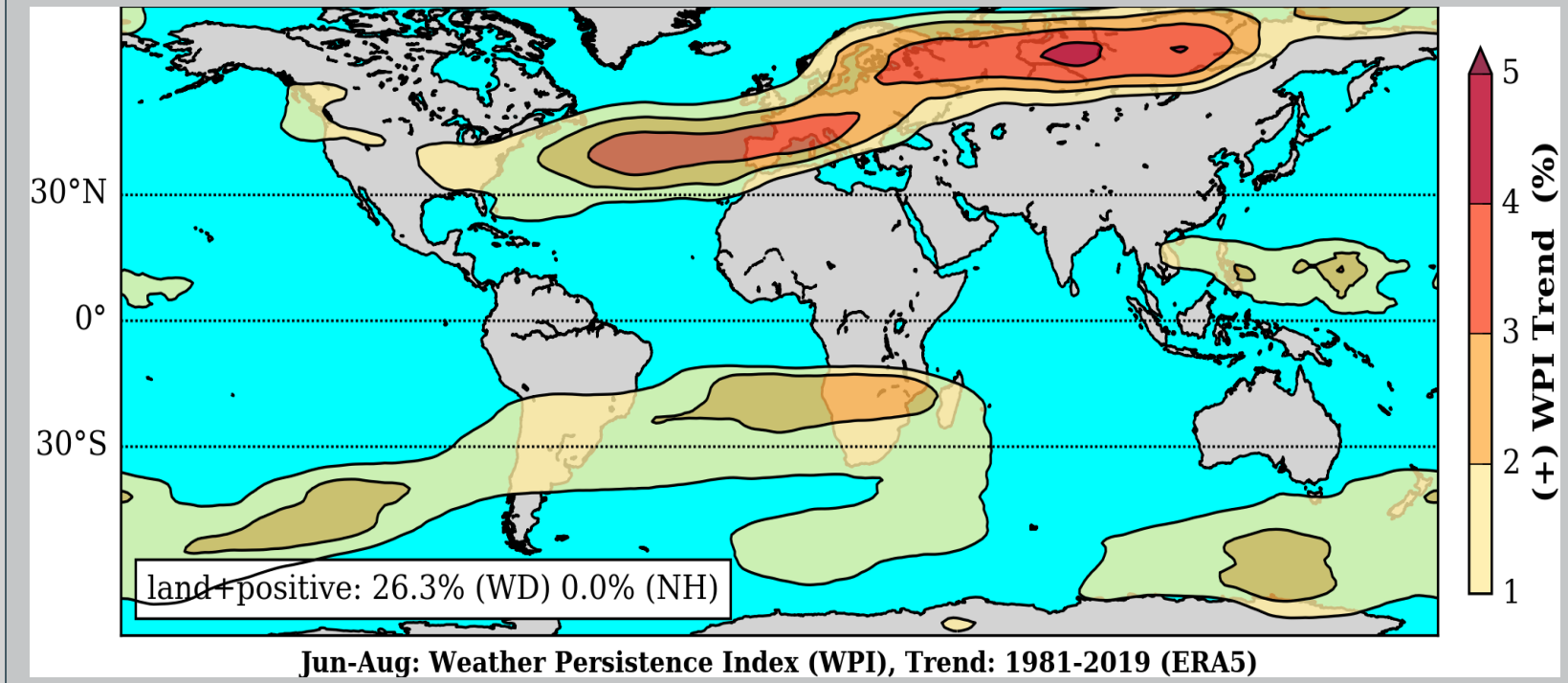


2010-210: Weather Persistence Index (WPI) ~ Z500 Spaghetti (NCEP-NCAR)

DOY 210 in 2010: +1..+10 Days

Results

WPI long-term Trends: 1981-2019 (JJA)

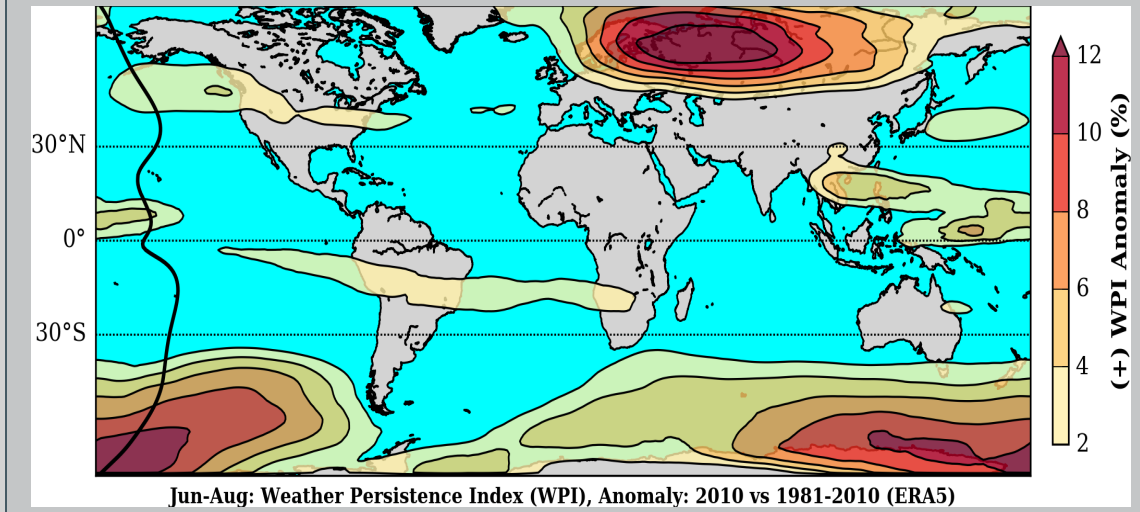
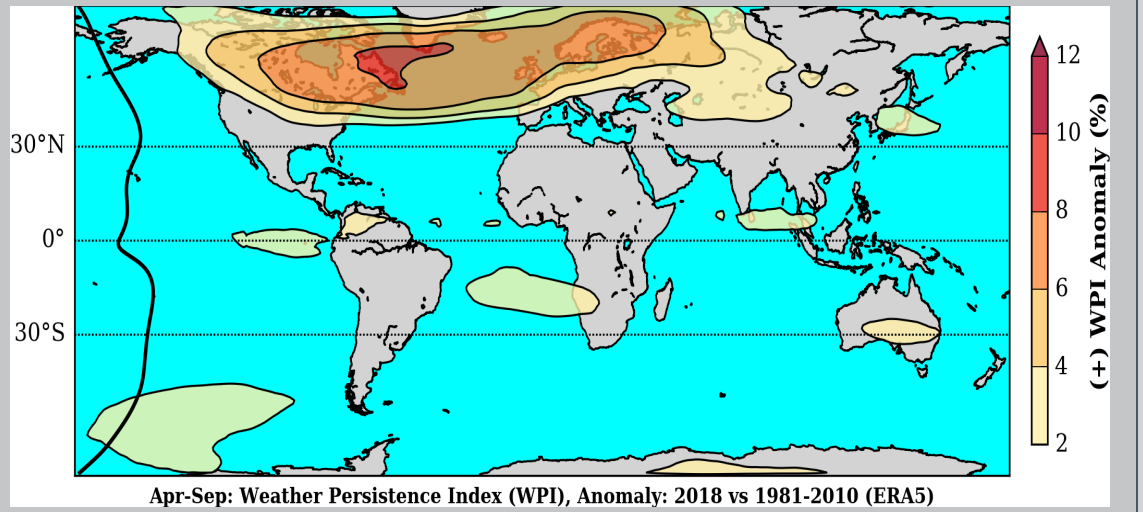


Jun-Aug: Weather Persistence Index (WPI), Trend: 1981-2019 (ERA5)

WPI inceases in NH mid-latitude summer - **Europe most affected**

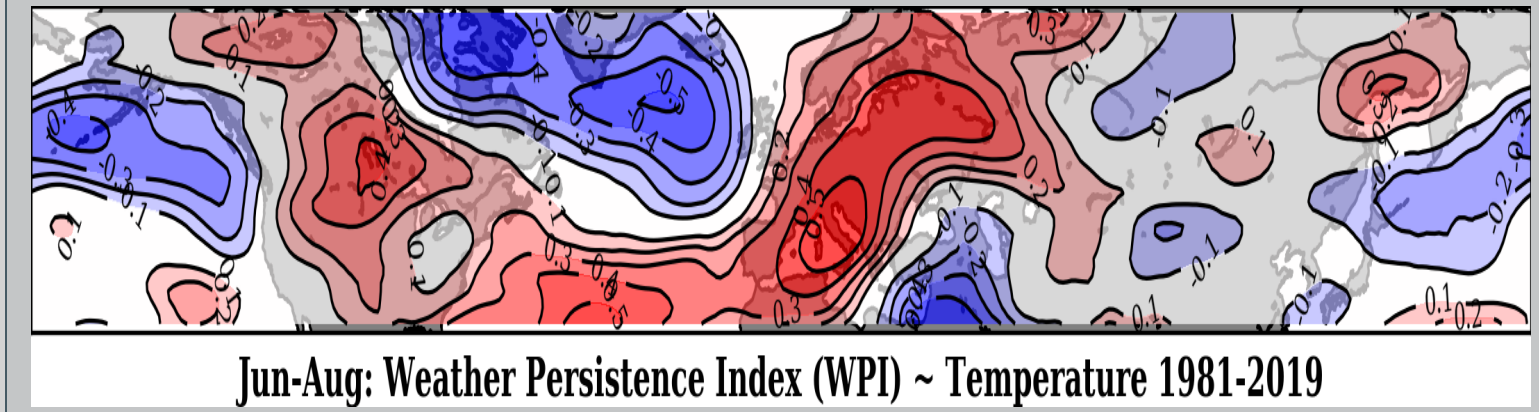
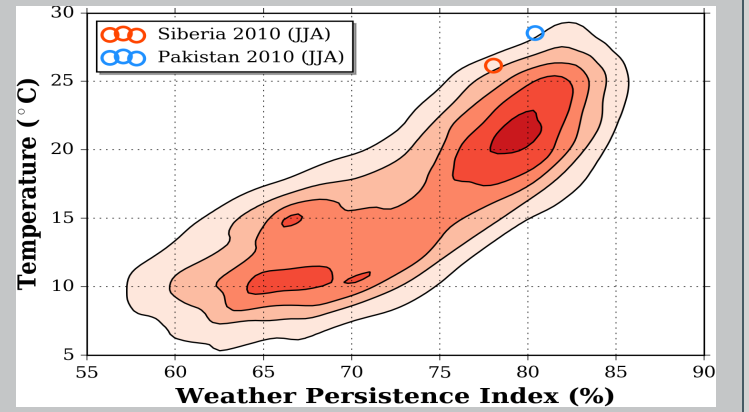
Results

WPI Anomalies vs 1981-2010

2010: Jun-Aug	2018: Apr-Sep
 Jun-Aug: Weather Persistence Index (WPI), Anomaly: 2010 vs 1981-2010 (ERA5)	 Apr-Sep: Weather Persistence Index (WPI), Anomaly: 2018 vs 1981-2010 (ERA5)
Russian heat wave / Pakistan flood	European drought

Results

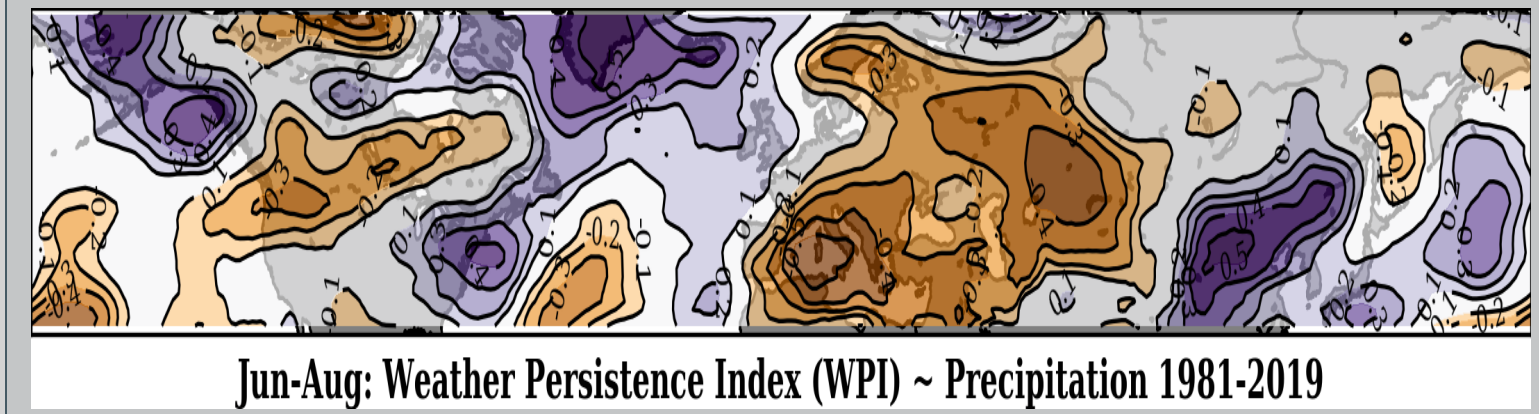
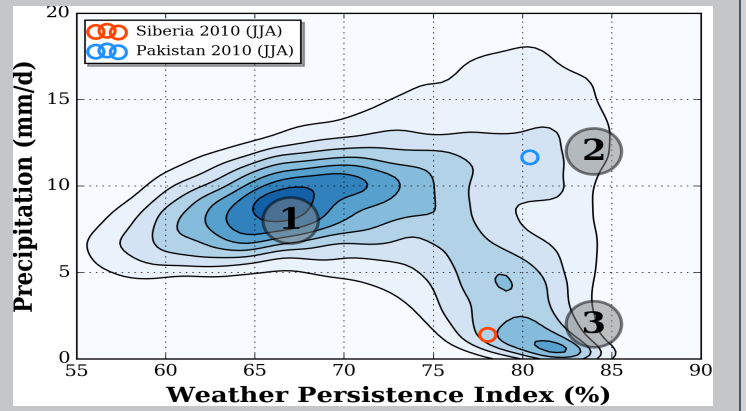
NH Correlation between WPI and temperature (JJA)

Correlation Pattern 30°N-70°N	2D-PDF
	
high WPI favor **heat waves** in Europe	Siberia/Pakistan 2010

Teleconnections between the North-Atlantic and Europe

Results

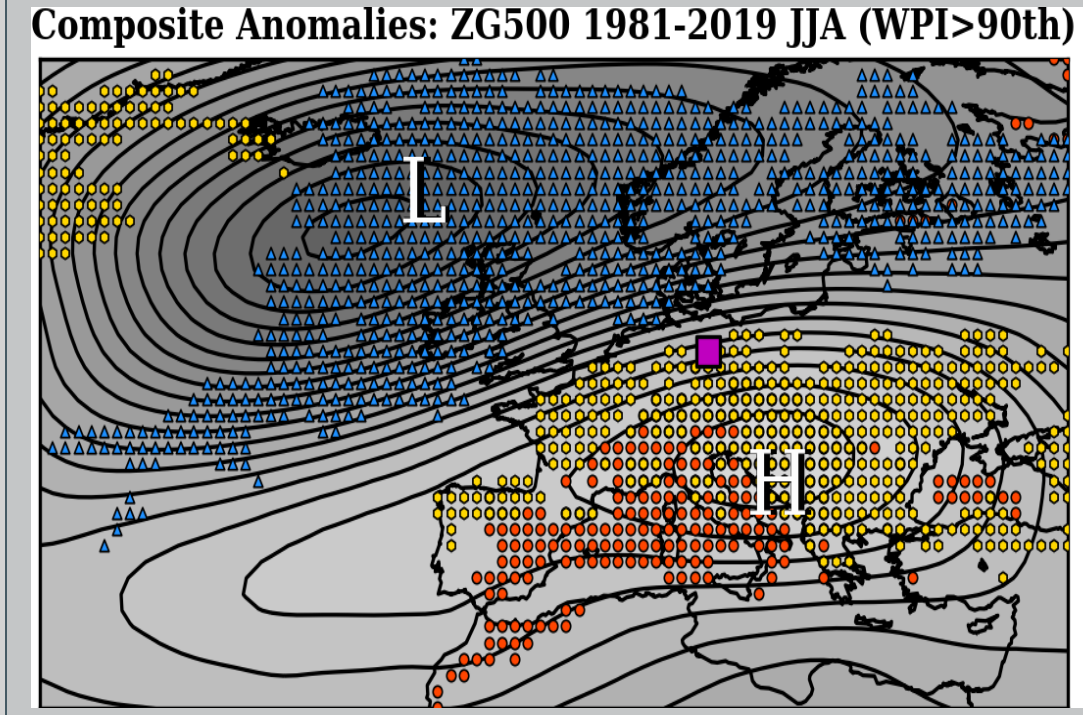
NH Correlation between WPI and precipitation (JJA)

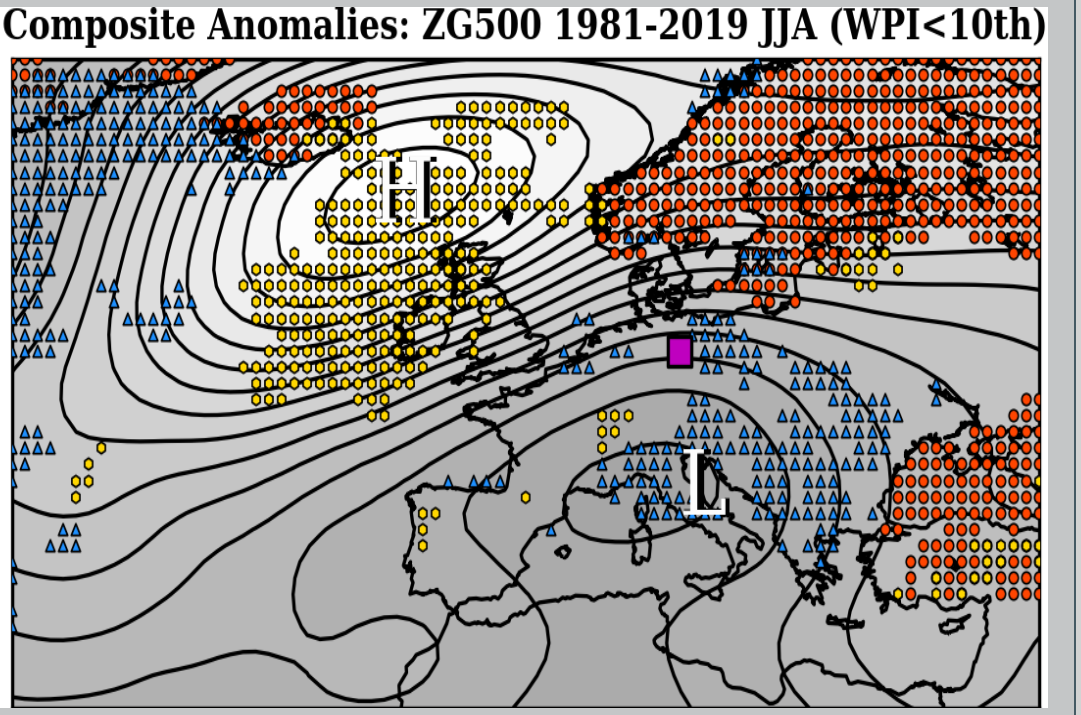
Correlation Pattern 30°N-70°N	2D-PDF
	
high WPI favor **drouhts** in most parts Europe	Siberia/Pakistan 2010

Teleconnections between the North-Atlantic and Europe

Results

Composite patterns of `high` and `low` WPI

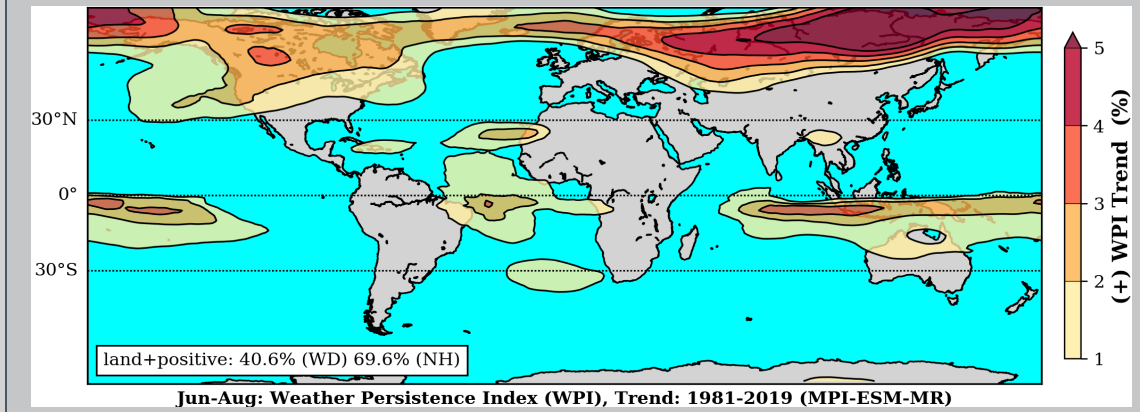




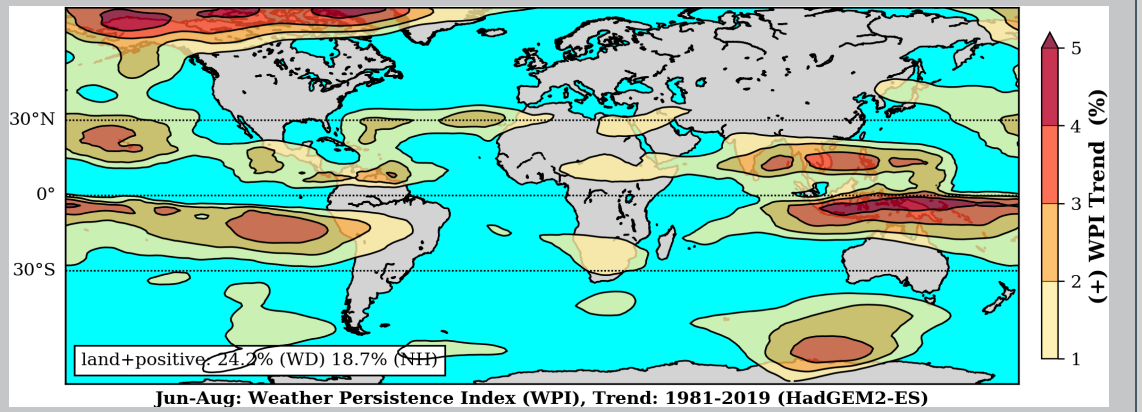
high WPI: high pressure over Central Europe ↷ mostly hot and dry

Results

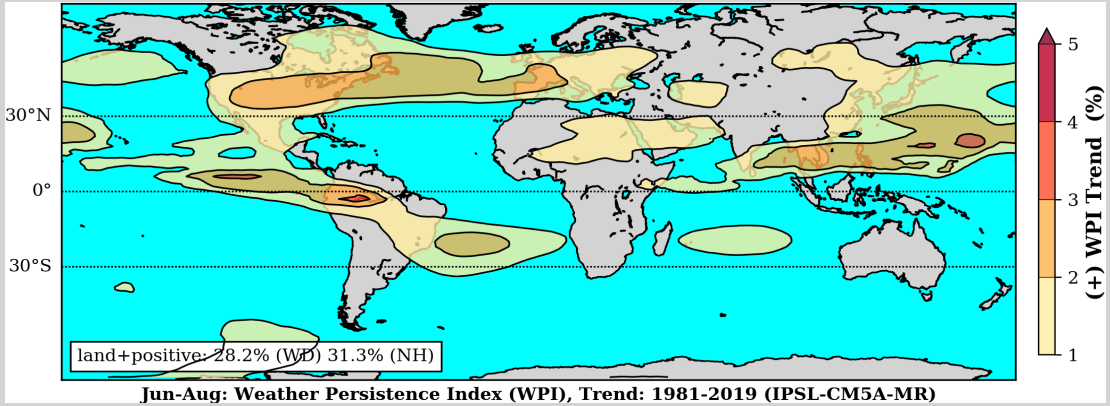
Trends of WPI in CMIP5 Simulations from 1981-2019



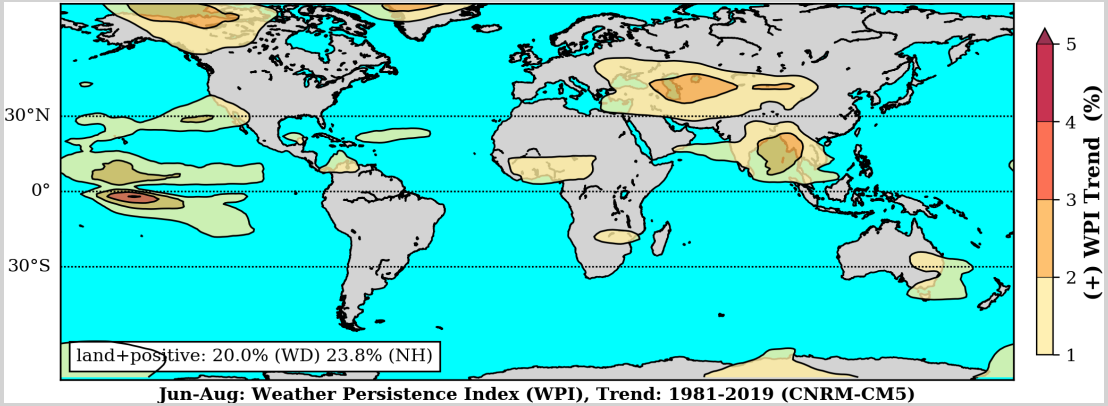
Jun-Aug: Weather Persistence Index (WPI), Trend: 1981-2019 (MPI-ESM-MR)



Jun-Aug: Weather Persistence Index (WPI), Trend: 1981-2019 (HadGEM2-ES)



Jun-Aug: Weather Persistence Index (WPI), Trend: 1981-2019 (IPSL-CM5A-MR)



Jun-Aug: Weather Persistence Index (WPI), Trend: 1981-2019 (CNRM-CM5)

Conclusions

- **WPI:** Weather Persistence Index
  - indicator for **dynamical changes**
  - predictor for **hydroclimatic extremes**
  - strong positive anomalies associated with **extreme seasons**
  - increasing long-term trends favor hydroclimatic **risks**
  - most affected region is **Europa**
  - **underestimated** or shifted in **CMIP5** climate scenarios

Thank you for Listening