Regional downscaling of global climate simulations from CMIP5 with WRF: climate extremes in Europe

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Outline

- Introduction: ReKliEs-De
- Data and Method: Applied scenarios and GCMs
- Results: historical & RCPs (1970-2000 & 2070-2099)
  - Average precipitation Comparison to E-OBS
  - Indices: number of wet days
  - Indices: consecutive wet Periods
- Summary/Outlook

Introducing Regional Climate Ensembles for Germany

ReKliEs-De
Regionale Klimaprojektionen Ensemble für Deutschland

Goal: providing evaluated robust data of future climate with climate Indices for Germany based on model ensembles of 12 km resolution.

GCM +RCP	CCLM	REMO	WRF	WETTREG	STARS
MPI-ESM-LR 2.6					
MPI-ESM-LR 8.5	EURO-CORDEX				
CNRM-CM5 8.5					
HadGEM-ES 8.5		ReKliEs-De			
EC-EARTH 8.5					
CanESM2 8.5					
MIROC5 8.5					

- 6 GCMs of CMIP5.
- RCP 8.5 and RCP 2.6
- Simulation time 1950-2100.
- 5 different RCMs.
- 7 contributing Institutes.

Contributing to EURO CORDEX

Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD
b-tu Brandenburgische Technische Universität Cottbus
GERICS Climate Service Center Germany
HLUG
DKRZ DEUTSCHES KLIMARECHENZENTRUM
Bundesministerium für Bildung und Forschung

Simulations with WRF @ University of Hohenheim

WRF forcing	Resolution	Sim. Period	Scenrios	WRF 3.6.1 setting
MIROC5	0.11° & 0.44°	1958-2005 2005-2100	Historical RCP8.5	Land surface model: **NOAH** Microphysics: **Morrison** PBL: **YSU** Convection: **Kain-Fritsch-Eta** Radiation: **CAM**
EC-EARTH	0.11° & 0.44°	1958-2005 2005-2100	Historical RCP8.5	
HadGEM-ES	0.11° & 0.44°	1958-2005 2005-2100	Historical RCP8.5	
MPI-ESM-LR	0.11° & 0.44°	1958-2005 2005-2100	Historical RCP8.5/RCP2.6	
ERA-Interim	0.11° & 0.44°	1990-2015	Hindcast	

Note: Our results represent one ensemble member only

- 0.44° resolution
- Historical-RCP changes: 1990-2000/1971-2000 & 2070-2099
- The 0.11° Simulations are still in progress and will be published within a **large Model Ensemble** of the **ReKliEs-De Project.**

Results: WRF Simulations 0.44°

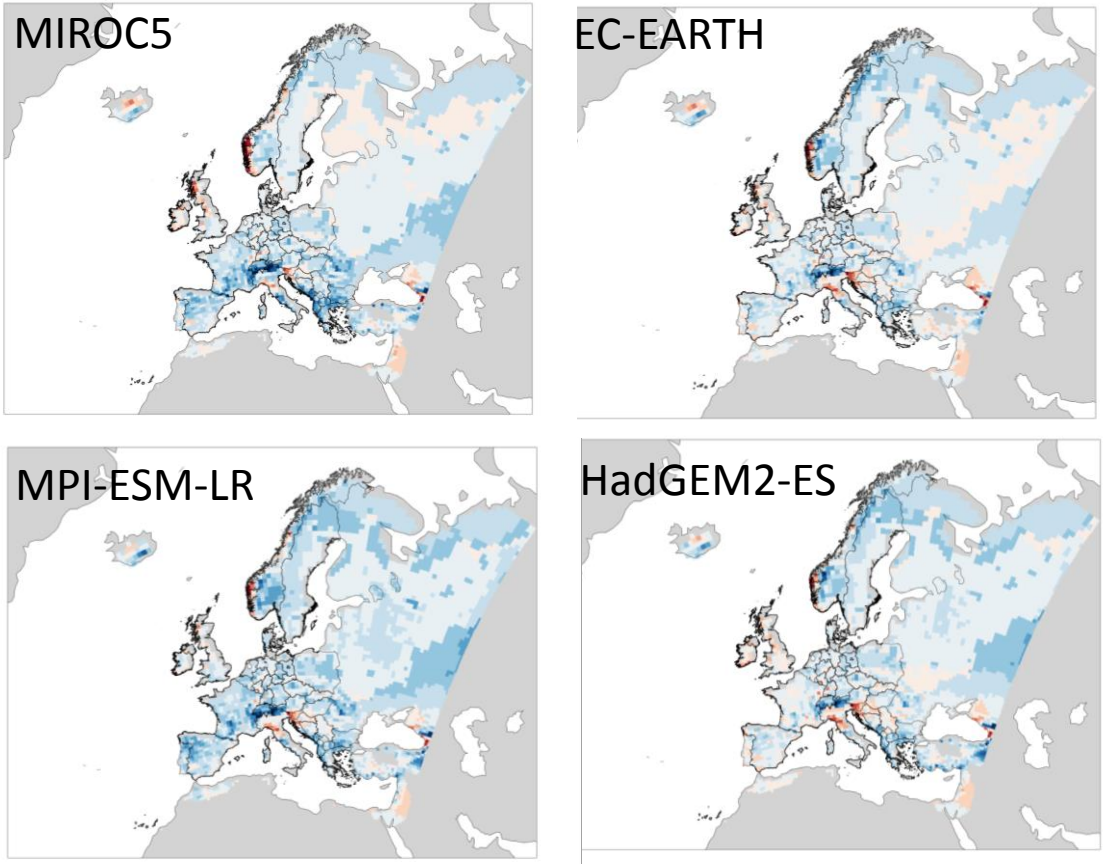
- Average precipitation
- Average number of wet days

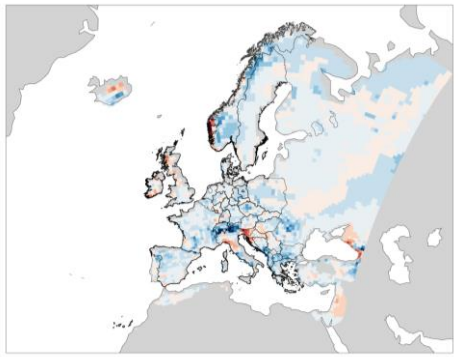
  ⇨ DPD: RR >= 1 mm/day
- Number of Episodes of consecutive wet days DPD

  ⇨ Episodes: 4-5, 5-6, 6-7, 7-8… consecutive days within a timeslice

Comparison WRF Simulations to E-OBS

GCMs – E-OBS 1971-2000



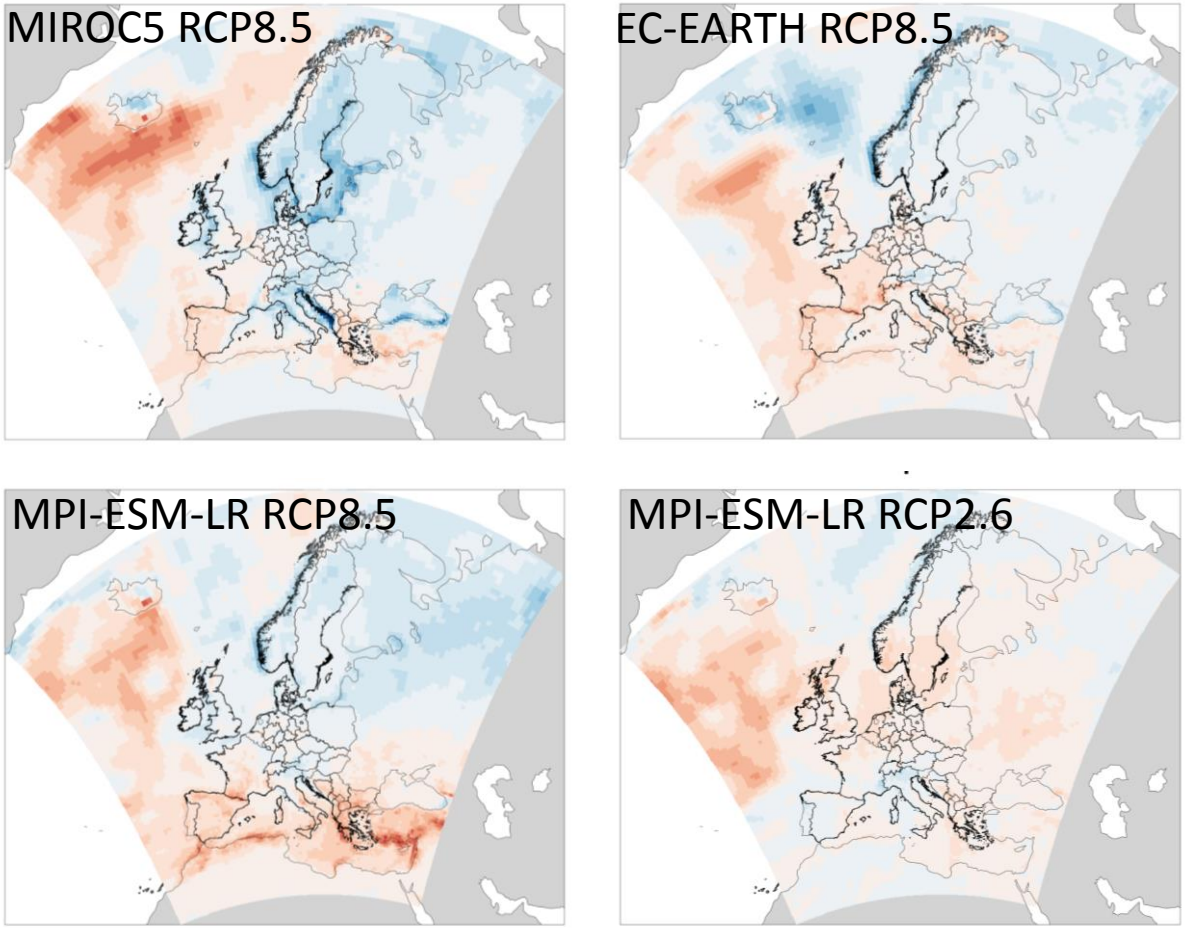


ERA-Interim – E-OBS 1990-2000

- WRF simulations with GCMs and ERA-Interim forcing agree in the precipitation-pattern.
- Generally overestimation by WRF (Kotlarski et al., 2014, Garcia-Diez et al., 2014, Katragkou et al., 2015…)

Average Precipitation changes historical to RCPs

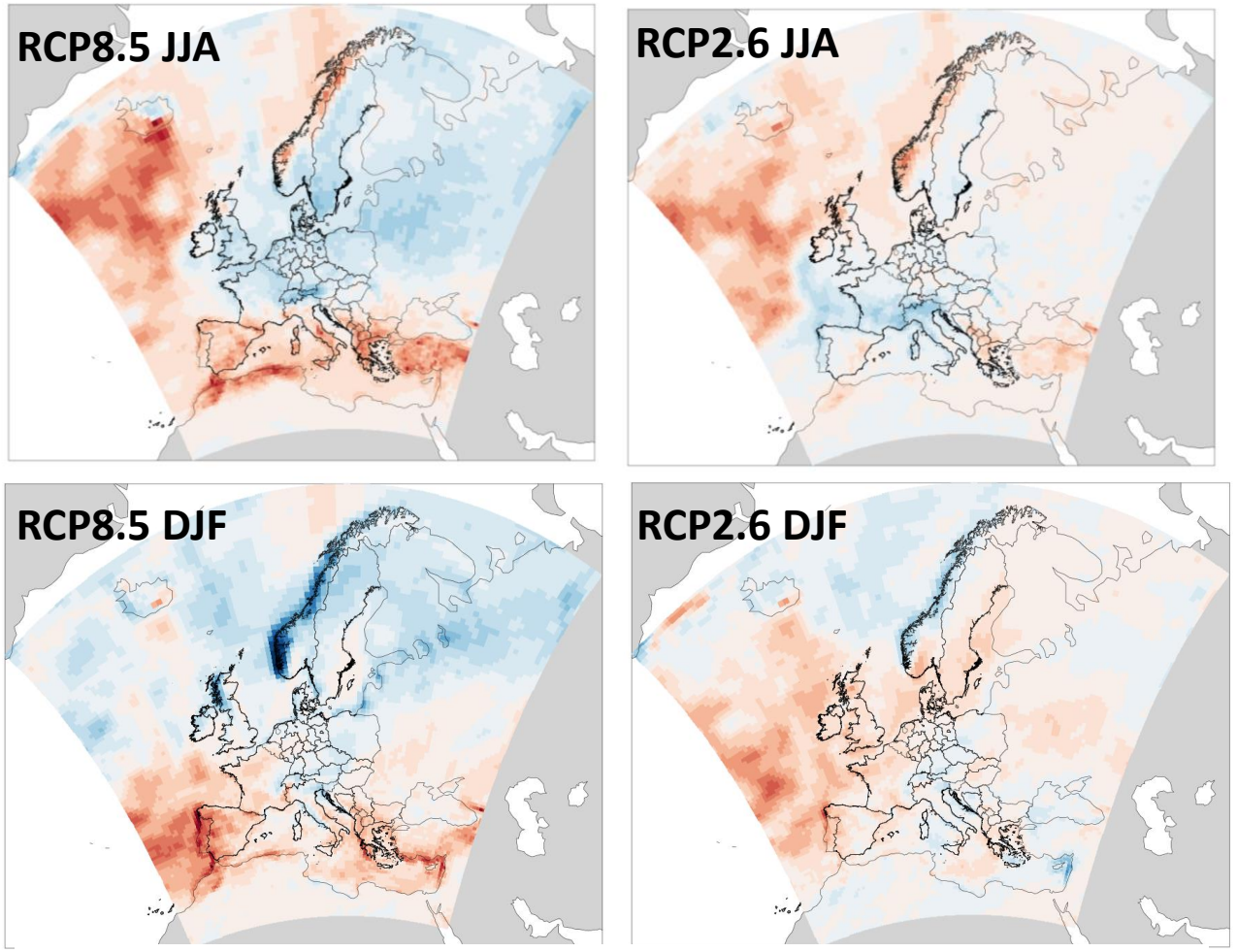
GCMs RCPs 2070-2099 – historical 1971-2000



- Decrease of precipitation in North Atlantic and Southern Europe.
- RCP2.6 drier in Mid-Europe than RCP8.5.

Seasonal Precipitation changes historical to RCPs

MPI-ESM-LR 2070-2099 – 1971-2000



- Increase of precipitation in Mid-Europe during summer.
- Strong increase of precipitation at the norwegian coast during winter.

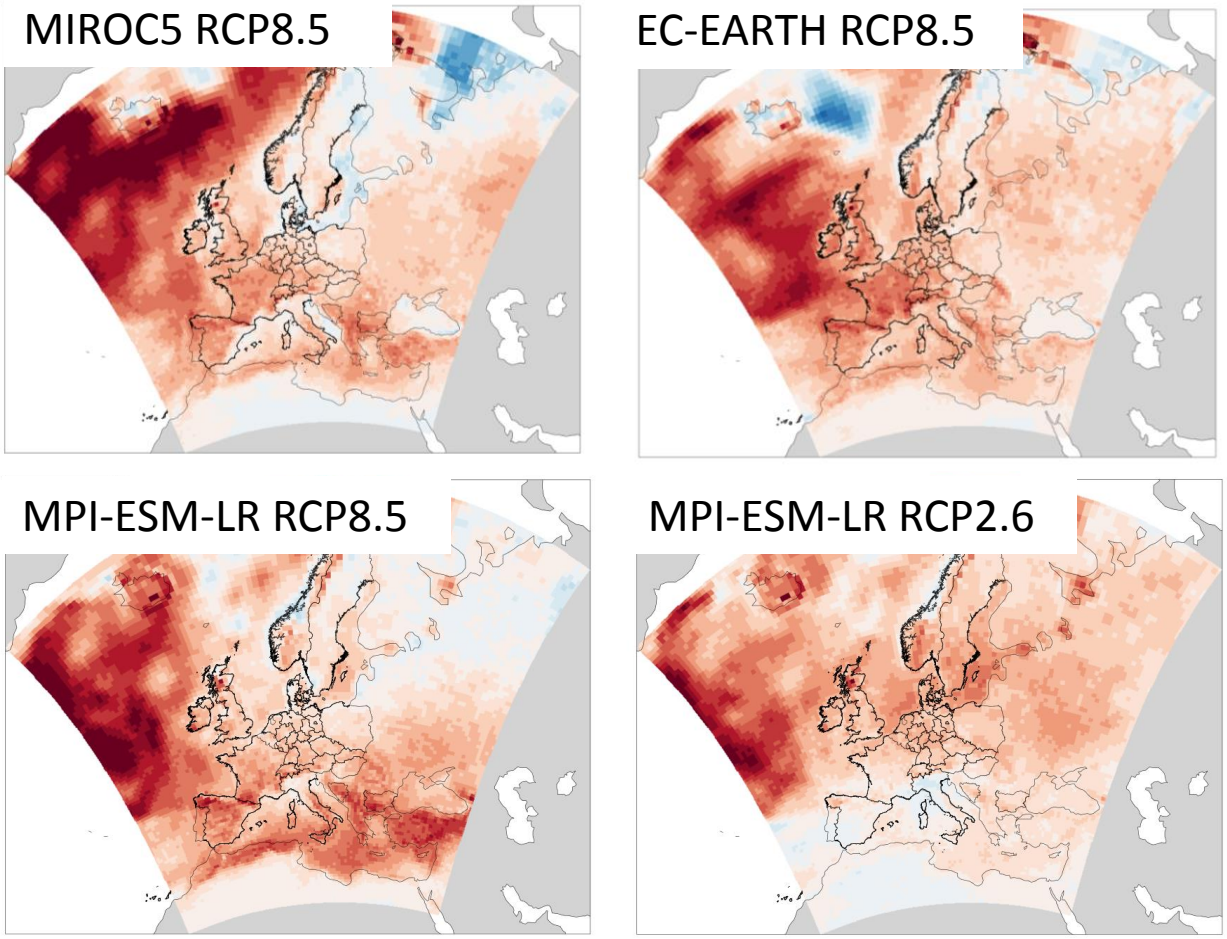
➡ More pronounced in RCP8.5.

Results: WRF Simulations 0.44°

- Average precipitation
- Average number of wet days
  - ➡ DPD: RR >= 1 mm/day
- Number of Episodes of consecutive wet days DPD
  - ➡ Episodes: 4-5, 5-6, 6-7, 7-8… consecutive days within a timeslice

Average Changes of DPD historical to RCPs

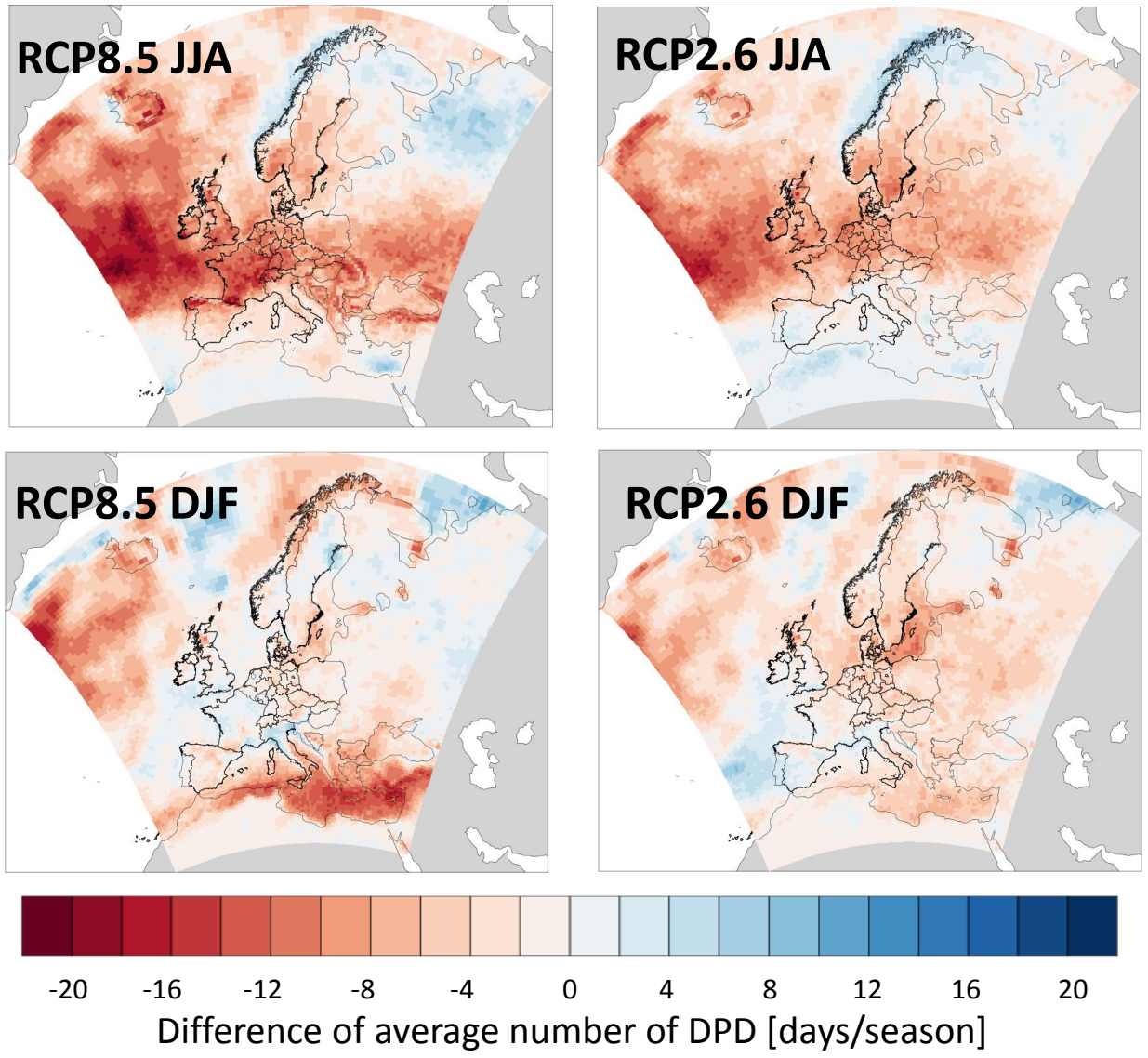
GCMs RCPs 2070-2099 – historical 1971-2000



- Decreasing number of wet days.

Seasonal Changes of DPD historical to RCPs

MPI-ESM-LR difference 1971-2000 to 2070-2099



Generally decreasing number of DPD in Mid-Europe

- In JJA stronger in RCP8.5 than RCP2.6.
- In DJF stronger in RCP2.6.
- RCP8.5 scenario simulates decreasing number of wet days in Mediterranean in DJF.

Results: WRF Simulations 0.44°

- Average precipitation
- Average number of wet days

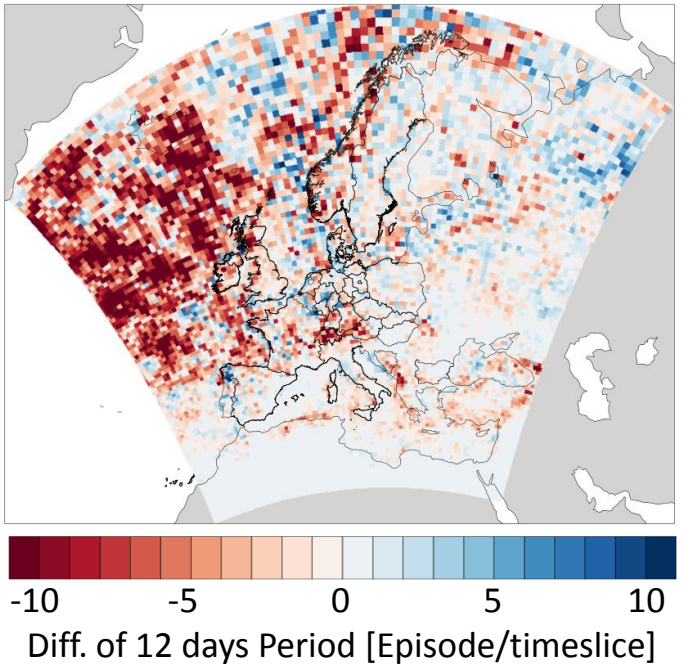
  ⇨ DPD: RR >= 1 mm/day

- Number of Episodes of consecutive wet days DPD

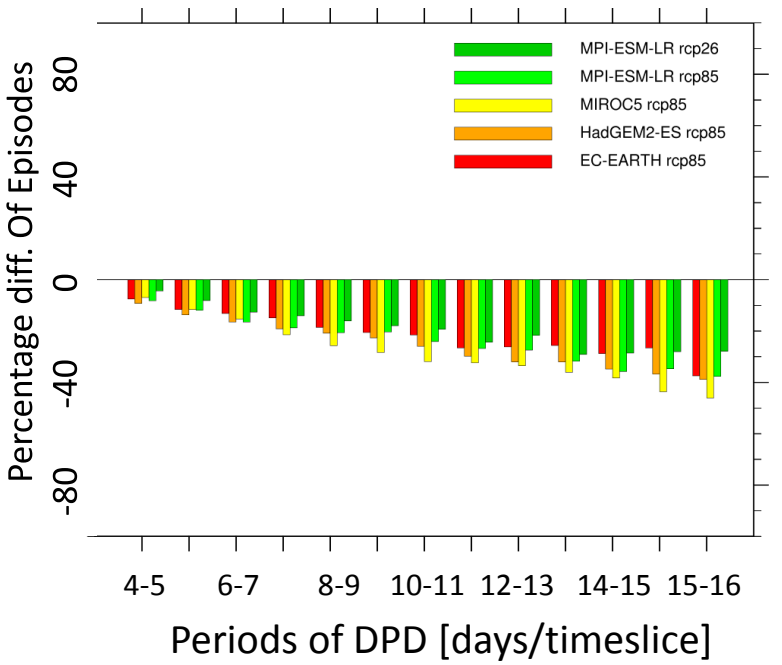
  ➡ Episodes: 4-5, 5-6, 6-7, 7-8… consecutive days within a timeslice

Average Changes of DPD Periods historical to RCPs

MPI-ESM-LR RCP8.5 DPD for 12 period



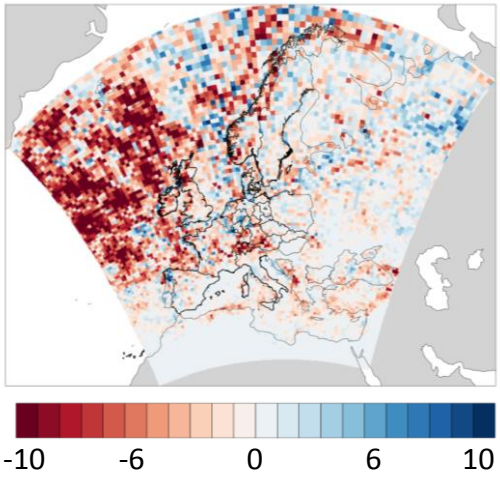
DPD EURO-CORDEX domain



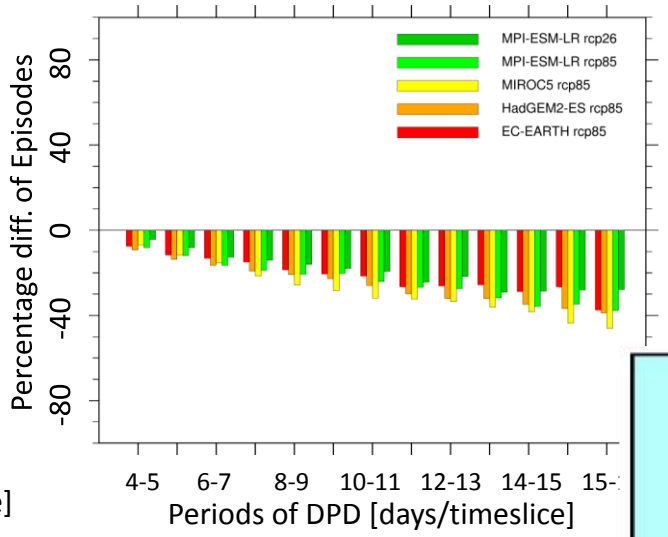
- North Atlantic indicating decreasing episodes of 12 days period of precipitation
- DPD number of episodes is decreasing in entire EURO CORDEX domain for all period-lengths.

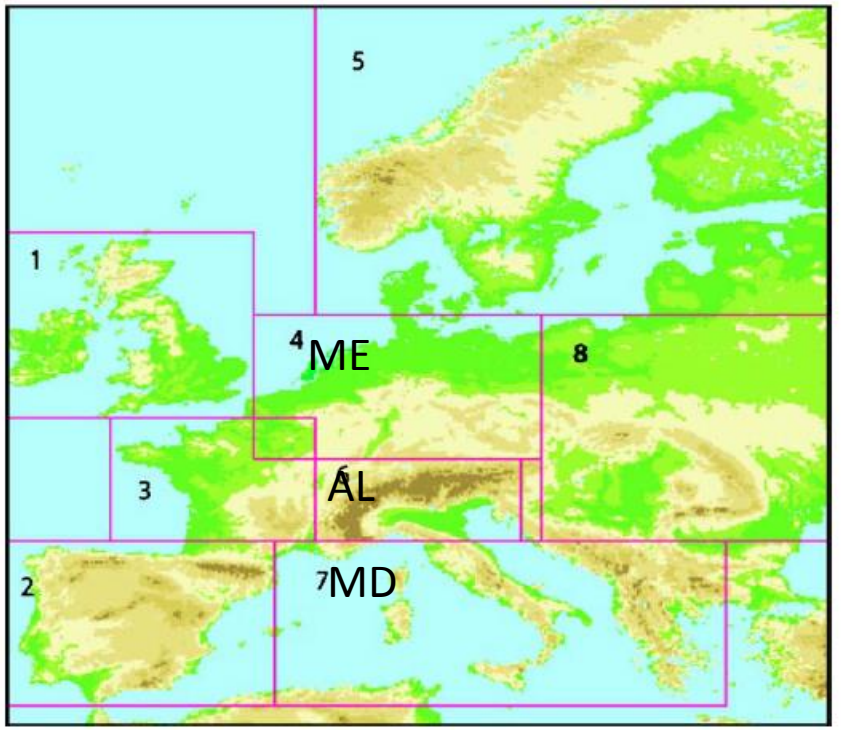
Average Changes DPD and DDD Periods

MPI-ESM-LR RCP8.5 DPD



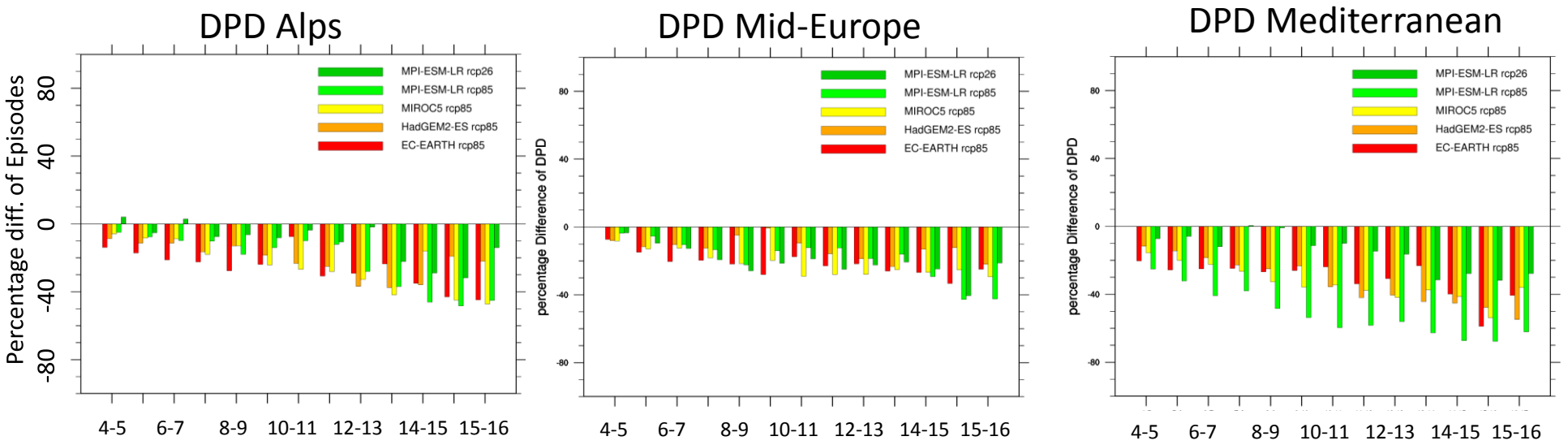
DPD EURO-CORDEX domain





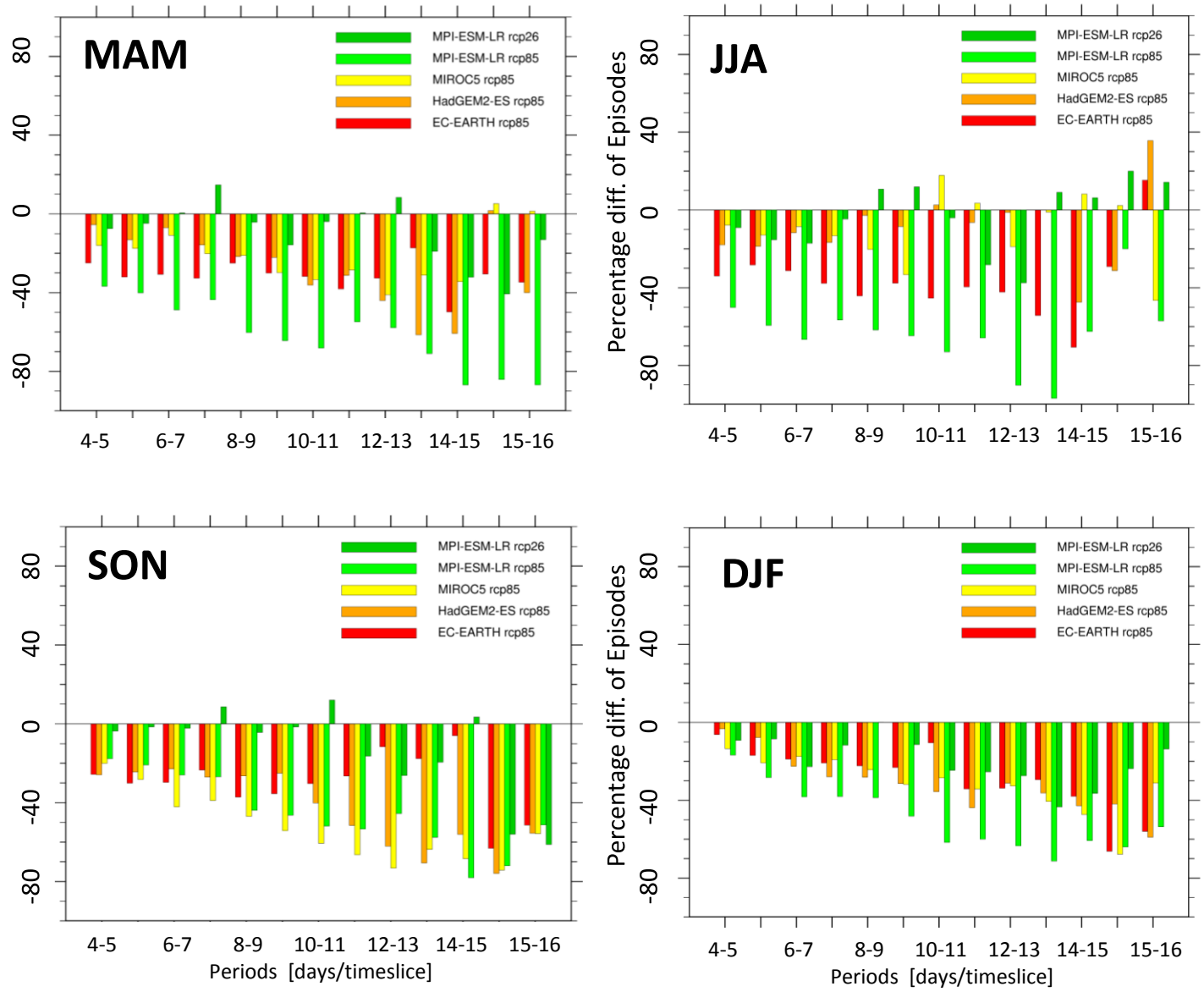
Separation into Subdomains: (Christensen and Christensen, 2007)

Average changes DPD Periods: subregions



- Precipitation days DPD are decreasing in all three regions.
- Stronger decrease of longer periods.
- MPI-ESM-LR RCP8.5 shows strong decrease in ME

Seasonal changes DPD Period: Mediterranean



- Decrease of DPD Periods in in all seasons strong pronounced by MPI-ESM-LR RCP8.5 sceanrio.
- In RCP2.6 hardly changes in MAM and JJA

Summary

- Preliminary results of climate indices of one model ensemble member
- WRF-GCM and WRF-ERA-Interim Simulations agree with the basic structure and the average precipitation amount
  → Overestimation in WRF compared to E-OBS.
- decreasing number of wet days in the EURO-CORDEX domain especially in JJA in RCP8.5.
- On the yearly average, consecutive wet days of longer durations show a strong decrease for all subregions.
- Precipitation days are indicated to decrease in the Mediterranean during all seasons.
  → Stronger pronounced in RCP8.5 than RCP2.6.

Outlook

Evaluation and analysis of these results and other climate indices in more detail using a **large Model Ensemble** of different RCM/GCM combinations based on the **0.11°** grid.

- → Comparison to dry days indices.
- → Very long periods of dry days (<20 days).

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Thank you for your attention

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