Experiences with WRF in EURO- CORDEX

Kirsten Warrach-Sagi
IPM, Uni-Hohenheim

Thanks to the following contributions to the presentation:

All EURO-CORDEX modellers, especially Robert Vautard for letting me show their graphs

- Current state of EURO-CORDEX
  - → *groups, models, experiments*
- Getting started with WRF in EURO-CORDEX
  - → *some troubles and fixes*
- *WRF within the EURO-CORDEX ensemble*

  - →*Heat Waves*
- *Precipitation in 0.11° WRF - results from 3 setups*
  - → *Europe*
  - → *Germany*
- Discussion: WRF-setup for Europe

EURO-CORDEX - Coordinated Downscaling Experiment - European Domain

=> http://www.euro-cordex.net/   => registered are 19 Institutions from 11 countries
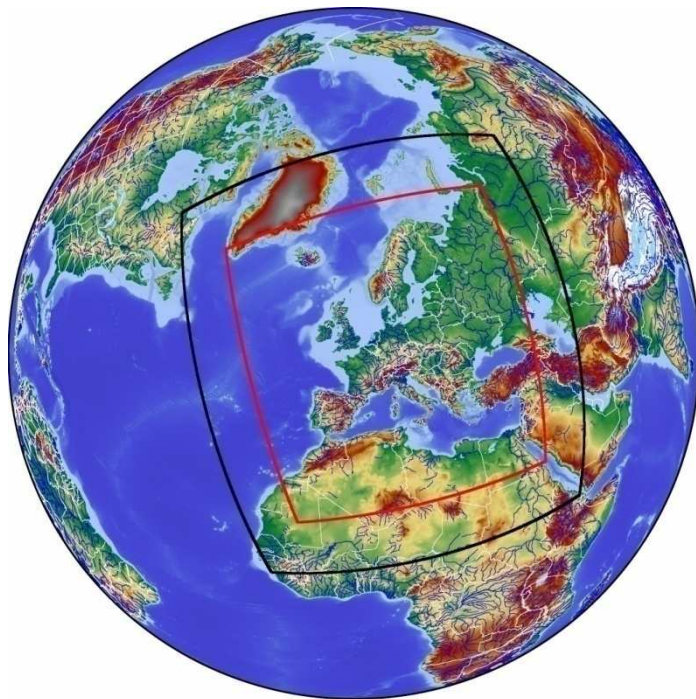
Domain *(like ENSEMBLES)*

Grid resolution: **0.11°** and 0.44°
(426*411 grid cells at 0.11°)

Grid: rotated grid with equator in central Europe

Currently applied observational data sets for evaluation:

- station data
- EOBS – a data set of gridded precipitation and 2m-temperature at 0.25° from ENSEMBLES

Hindcast simulations (1989-2008 forced with ERA-interim)

⇒*some models like WRF331 are run with several setups*

At 0.11°
running/finished: ARPEGE, CCLM, RCA4, REMO, WRF331
planned: ALADIN, HIRHAM, PROMES

At 0.44°
running/finished: ARPEGE, CCLM, RCA4, RegCM, REMO, WRF331
planned: ALADIN

Publications:
Submitted: Vautard et al., „Heat waves"
In preparation: Keuler, Kotlarski et al.: Evaluation of mean PREC, PSL, T_2m

⇒ 0.11°: ARPEGE, CCLM, RCA4, REMO, 2*WRF331
⇒ 0.44°: ARPEGE, 2*CCLM, RCA4, REMO, WRF331

Control/Scenario(1950-2100 forced with CMIP5-data)

⇒*Most models are run with different forcing*

At 0.11°
running/finished: ARPEGE, CCLM, RCA4, REMO, WRF331
planned: CCLM, HIRHAM, PROMES, RACMO, WRF331

At 0.44°
running/finished: ARPEGE, CCLM, RCA4, RegCM, REMO, WRF331
planned: ALADIN, CCLM, RCA4, RegCM, REMO, WRF331

In 2009 **WRF version 3.1** was set-up for the EURO-CORDEX domain

a) On 0.44° by ICARUS (Ireland, Pricilla Mooney)
b) On 0.11° by University of Hohenheim (Germany, Kirsten Warrach-Sagi)

Troubles in 0.33°/0.11°:
- gravity wave drag coefficient => crash over greenland
- tmn_update problems in SW of the domain => crash after 9 months
- setting up on rotated domain => took time to configure namelist.wps

Heat Waves (Vautard et al.. 2012. in revision)

90th centile of daily T_2m
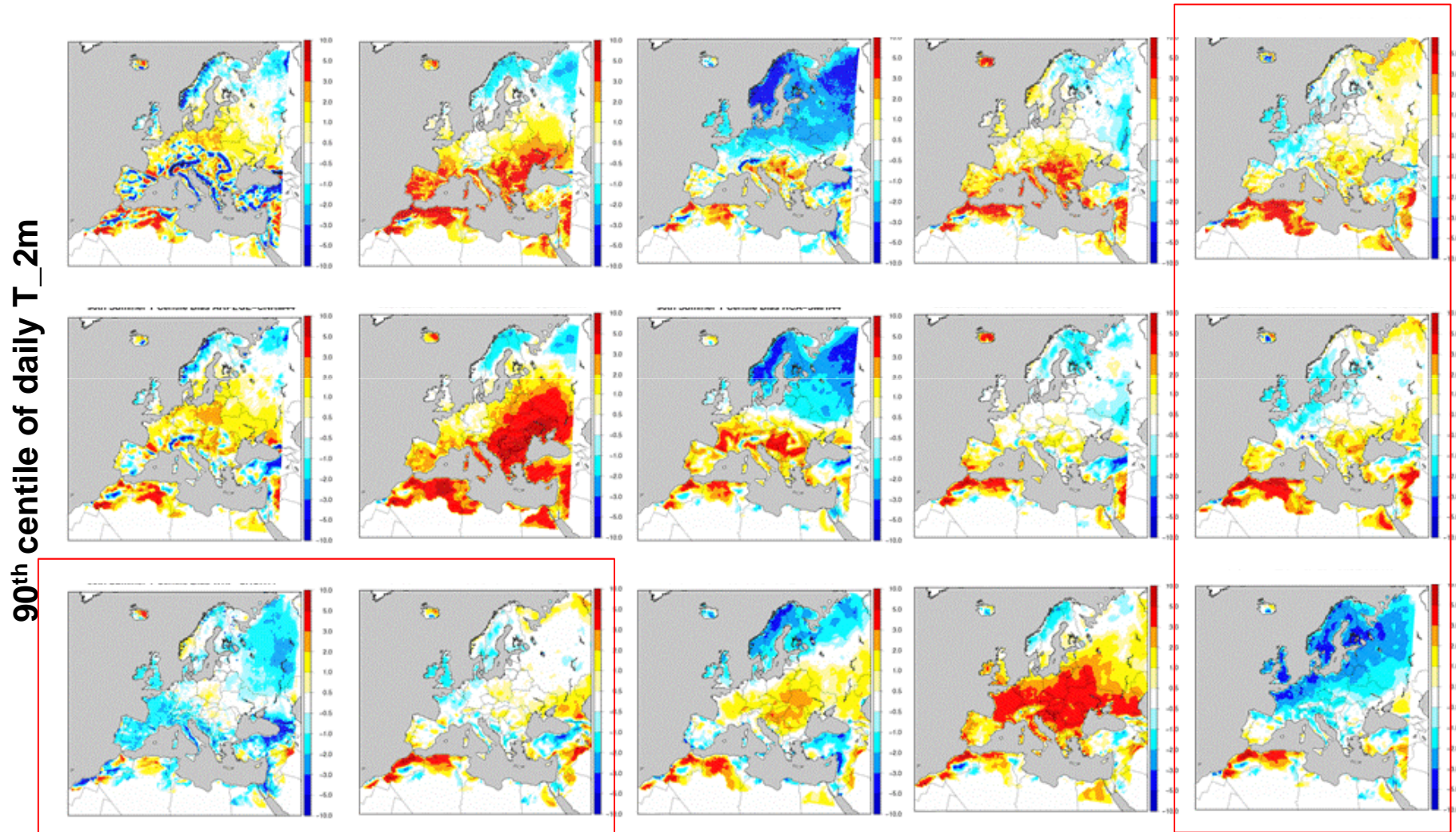
Colorbar: -5 K (blue) to 5 K (red)

Courtesy Robert Vautard (IPSL)

Heat **Waves (Vautard et al., 2012, in revision)**

Number of simulations [0-15] for which the 90th centile exceeds that of observations
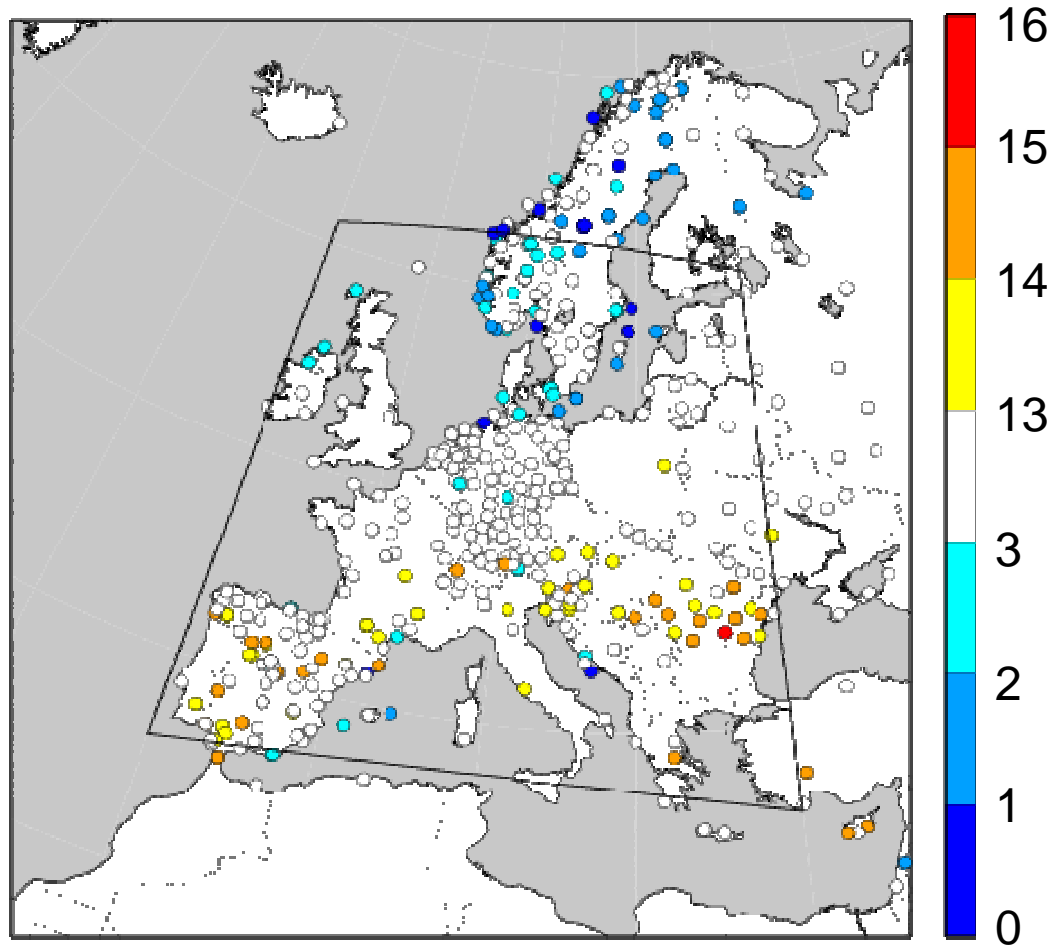
Courtesy Robert Vautard (IPSL)

Heat Waves (Vautard et al., 2012, in revision)
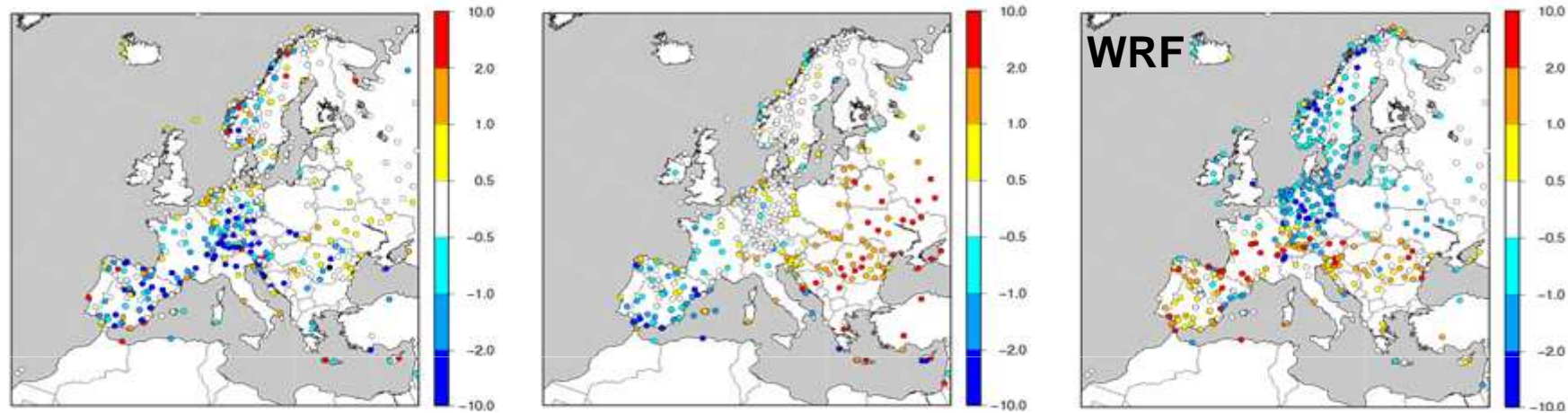
**Improvement
by higher
resolution
(positive)**
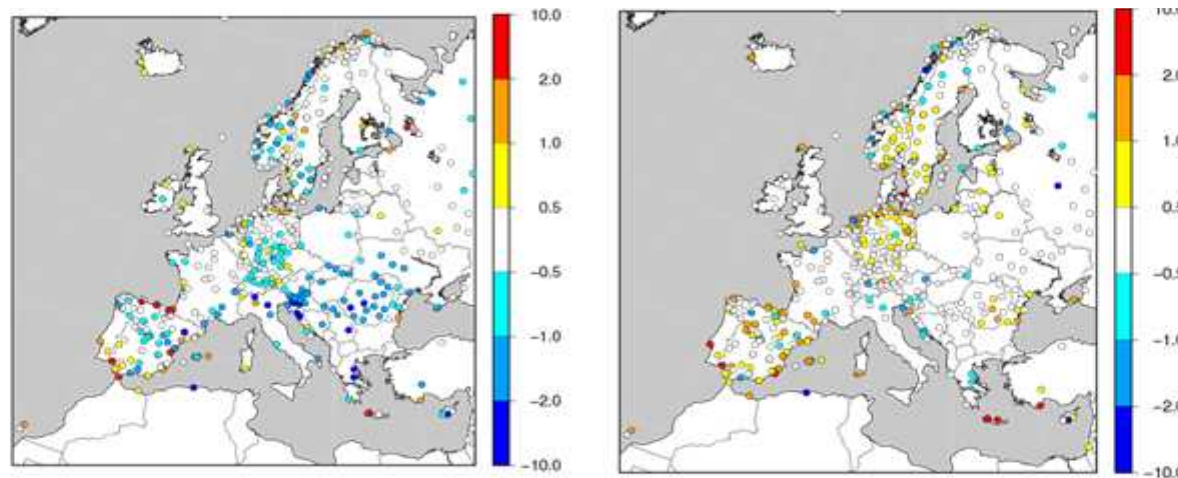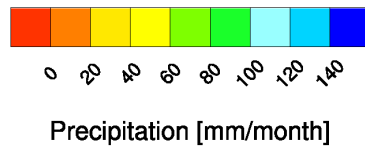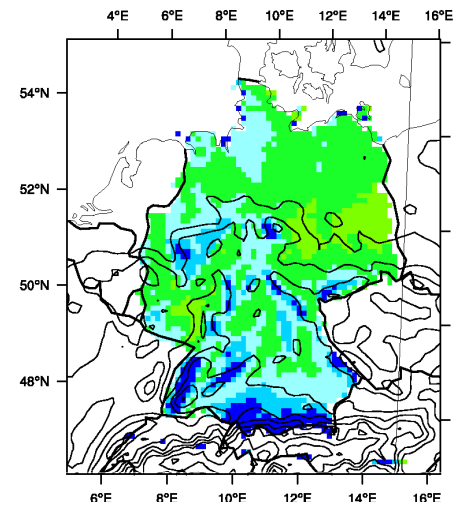
Courtesy Robert Vautard (IPSL)

WCRP CORDEX

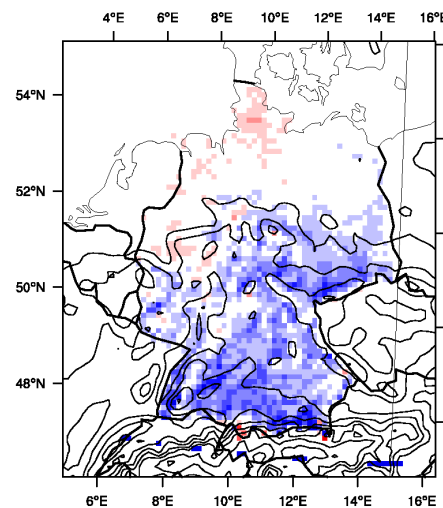**JJA, WRFUHOH, 0.11**
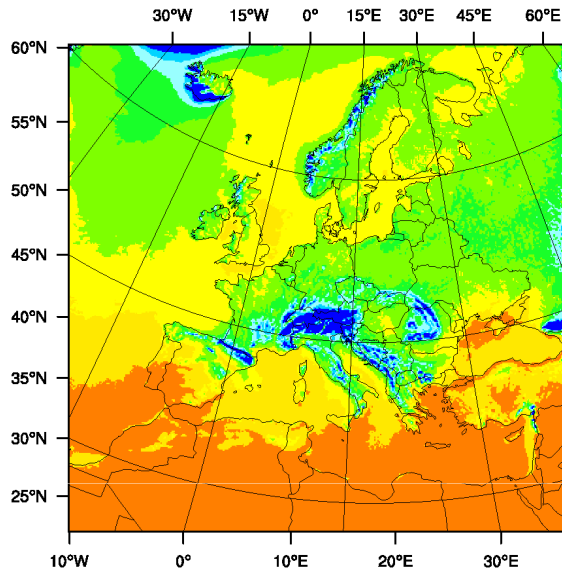
JJA, WRFCRPGL, 0.11
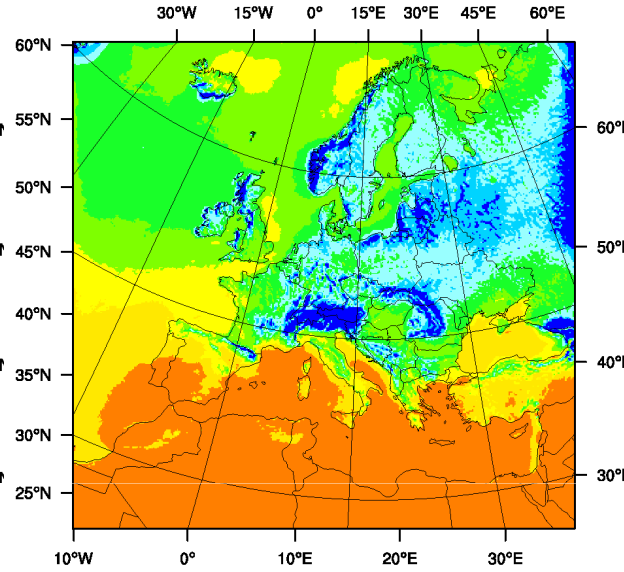
JJA, WRFIPSL, 0.11
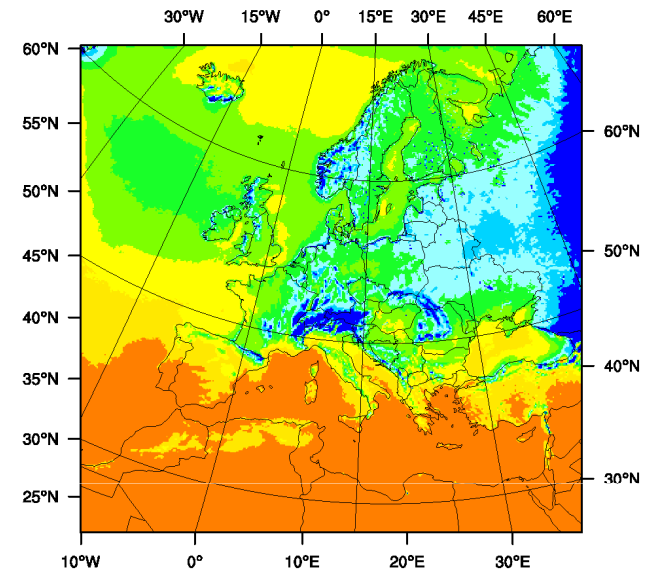
Precipitation [mm/month]

Morrison

Kain-Fritsch, CAM

Modified 50L / 20hPa

30 grid cell boundary

WSM6

Kain-Fritsch, CAM

50L / 20hPa

Nested 0.44 => 0.11°

WSM6

Grell-Deveny, RRTMG

32L / 50hPa

10 grid cell boundary

Precipitation: WRF 0.11°

UNIVERSITÄT HOHENHEIM

Precipitation [mm/month]

-50 -40 -30 -20 -10 10 20 30 40 50
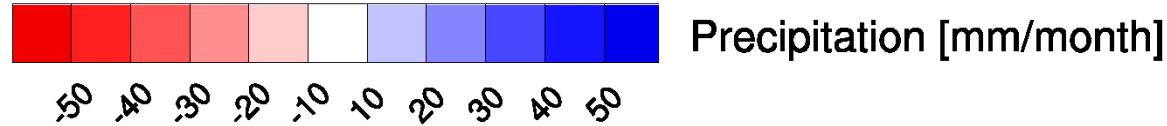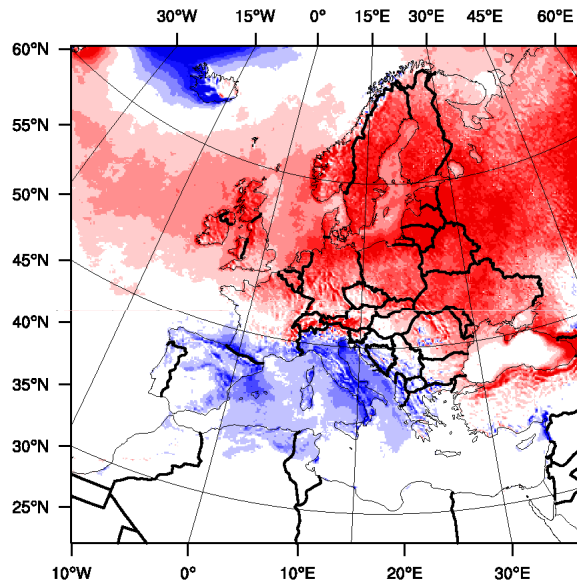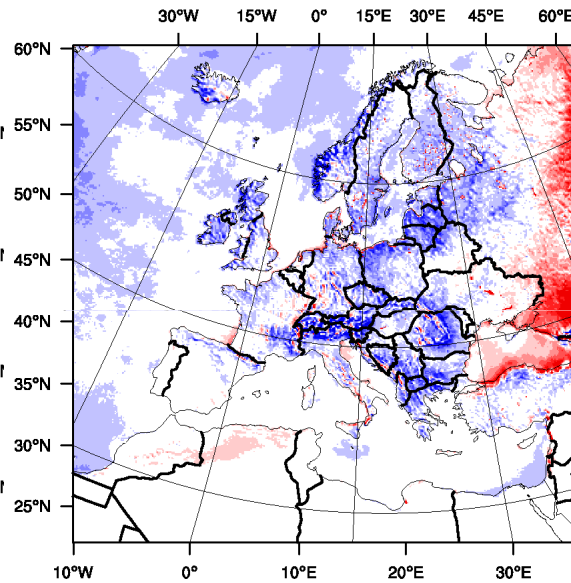
JJA, WRFUHOH-WRFCRPGL, 0.11   JJA, WRFCRPGL-WRFIPSL, 0.11   JJA, WRFUHOH-WRFIPSL, 0.11
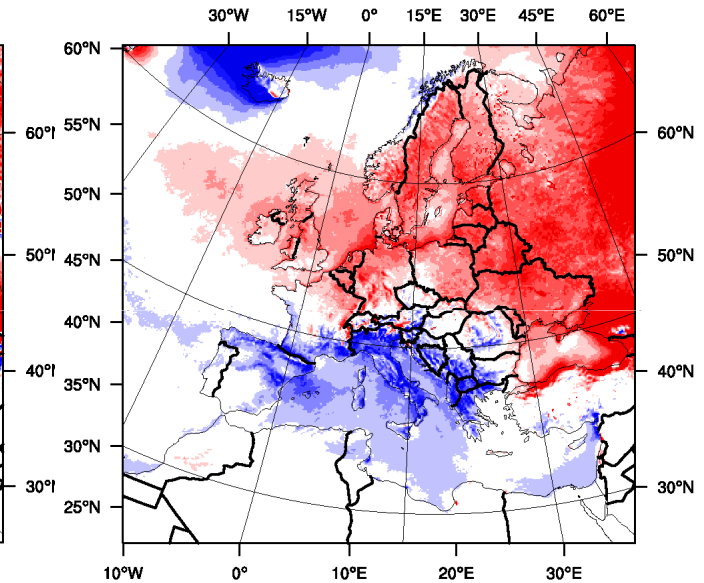
Morrison vers. *WSM6*   *WSM6, KF* vers. *GD*   *Morrison* vers. *WSM6*

KF, CAM, 50 levels   *CAM* vers. *RRTMG*   *KF* vers. *GD*

No nest vers. *0.44° nest*   *50L* vers. *32L*   *CAM* vers. *RRTMG*

                                  No nest vers. *0.44° nest*   *50L* vers. *32L, no nest*
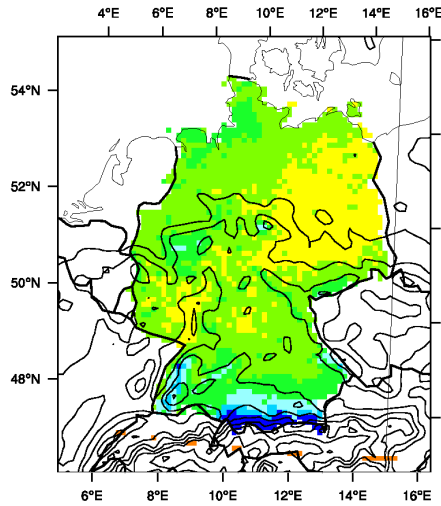
Precipitation: WRF 0.11°

UNIVERSITÄT HOHENHEIM

JJA, REGNIE, 0.11
JJA, WRFUHOH, 0.11
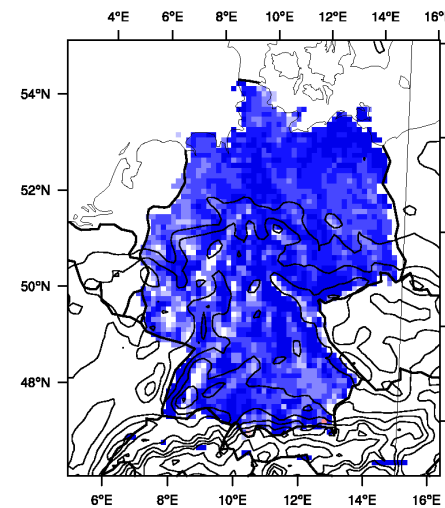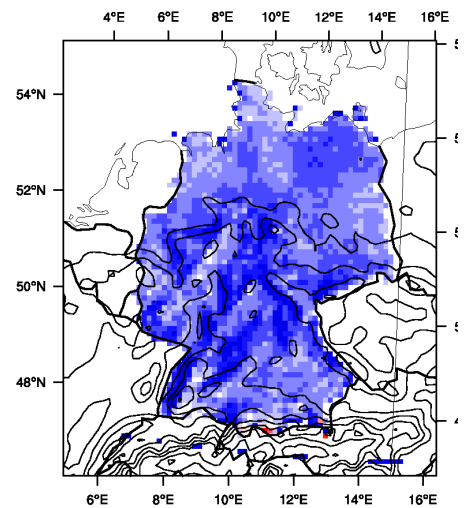JJA, WRFCRPGL, 0.11
JJA, WRFIPSL, 0.11
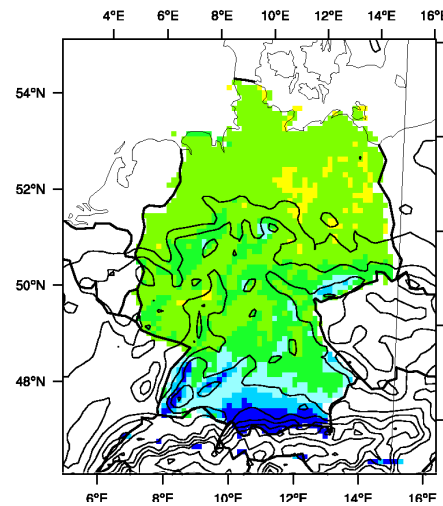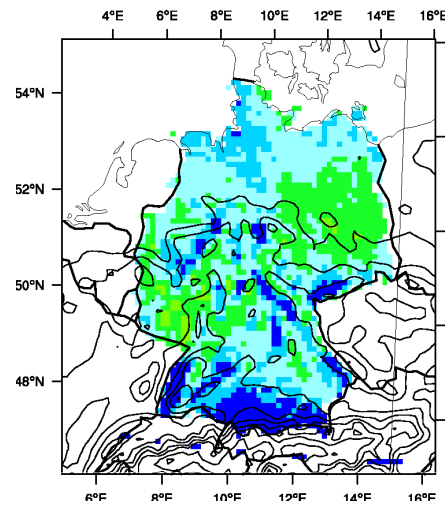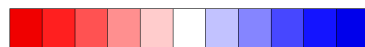
Precipitation [mm/month]

JJA, WRFUHOH-REGNIE, 0.11
JJA, WRFCRPGL-REGNIE, 0.11
JJA, WRFIPSL-REGNIE, 0.11

Precipitation [mm/month]

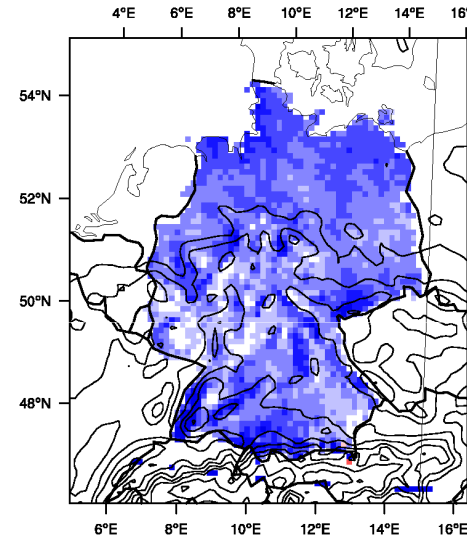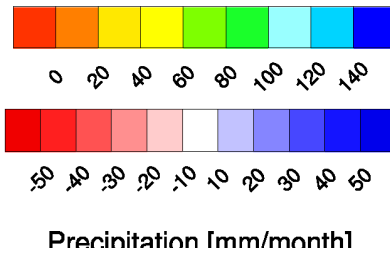*Kirsten Warrach-Sagi, First CORDEX-WRF Workshop, October 2012*
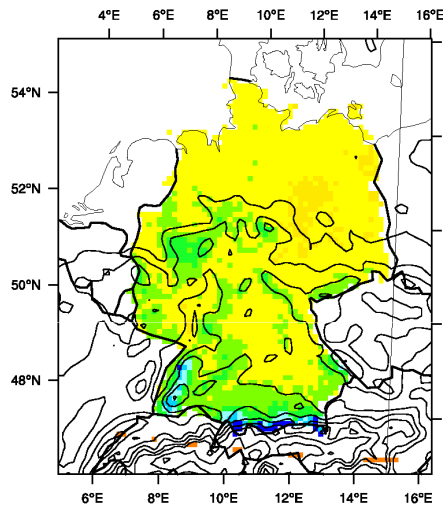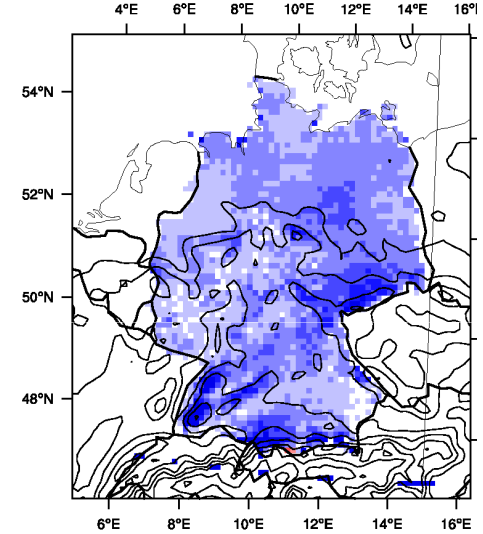
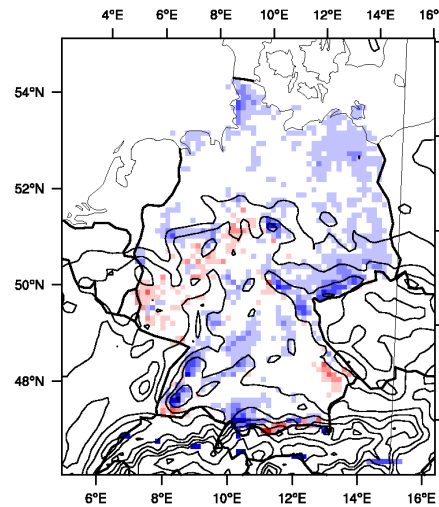MAM, REGNIE, 0.11

MAM, WRFUHOH-REGNIE, 0.11
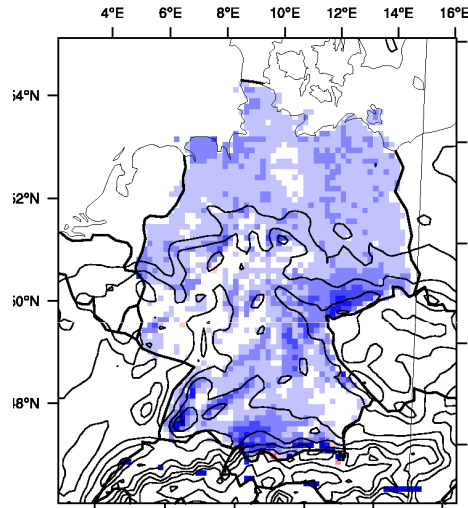
MAM, WRFCRPGL-REGNIE, 0.11

MAM, WRFIPSL-REGNIE, 0.11

Precipitation [mm/month]

Precipitation: WRF 0.11°

UNIVERSITÄT HOHENHEIM

DJF, REGNIE, 0.11
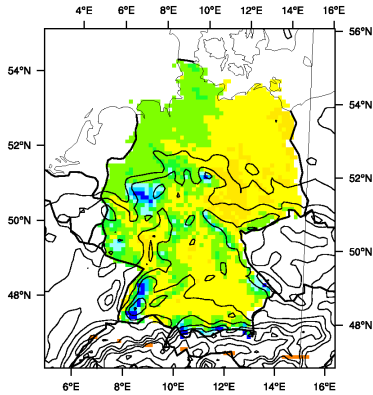
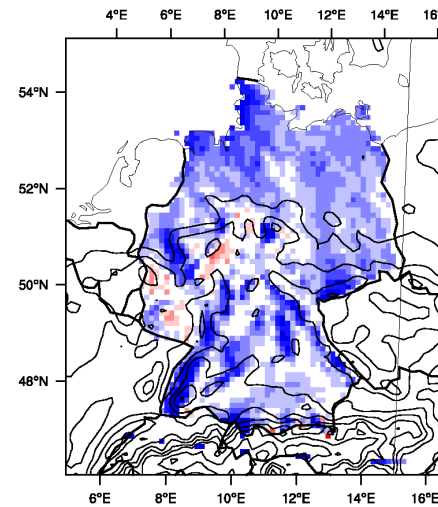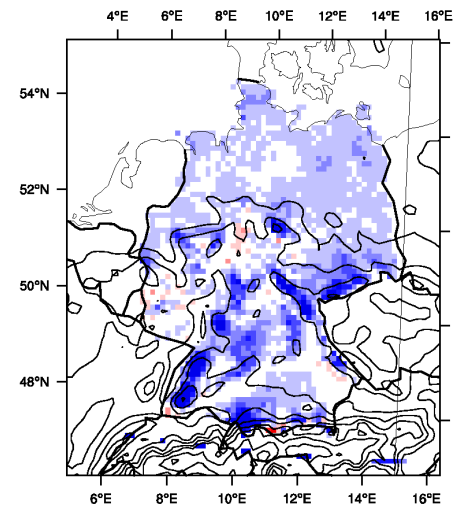SON, REGNIE, 0.11
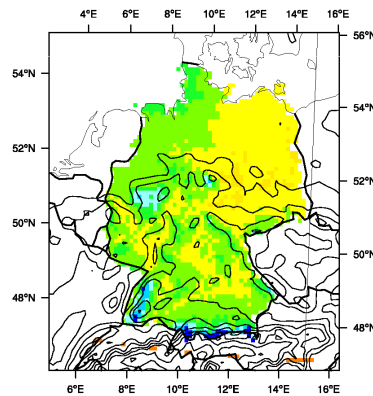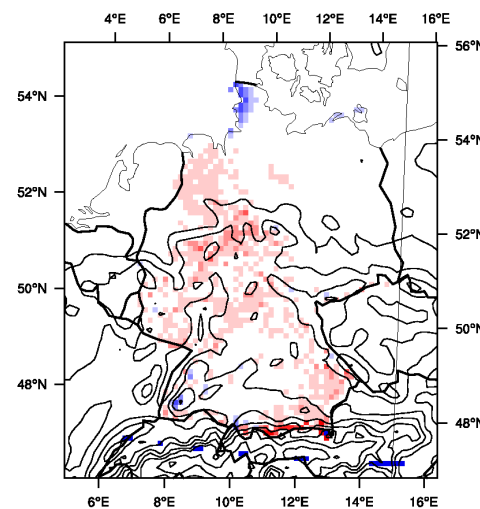
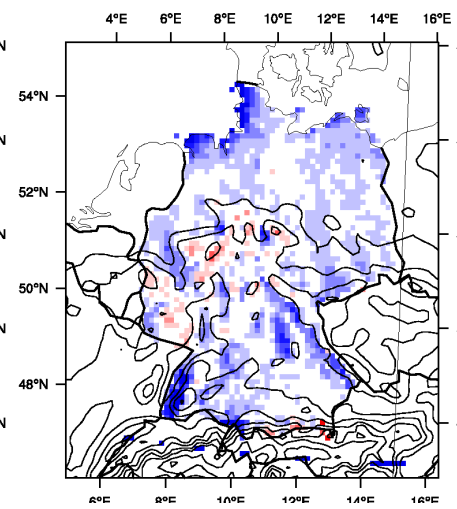DJF, WRFUHOH-REGNIE, 0.11

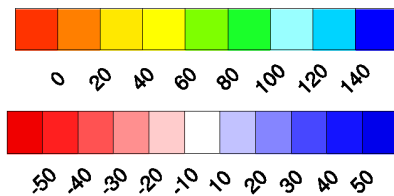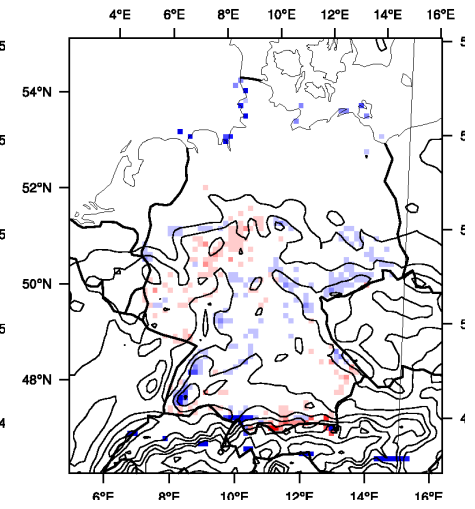DJF, WRFCRPGL-REGNIE, 0.11

DJF, WRFIPSL-REGNIE, 0.11

SON, WRFUHOH-REGNIE, 0.11

SON, WRFCRPGL-REGNIE, 0.11

SON, WRFIPSL-REGNIE, 0.11

Precipitation [mm/month]

WRF-Setup for Projection Runs

WRF has a tendency towards a wet and cold bias in Europe

Southern half of Europe worse than northern half

Setup leads to different biases:

- WRFUHOH better in northern half, WRFIPSL better in southern half

- Biases depend on the season

WRF-Setup for Projection Runs

Now the data is there to investigate more in depth

Precipitation and temperature variability anaysis (spatial and temporal)
Further analysis on resolution dependence

Dependence on parameterizations:
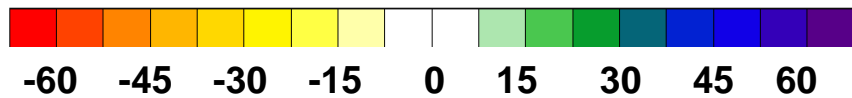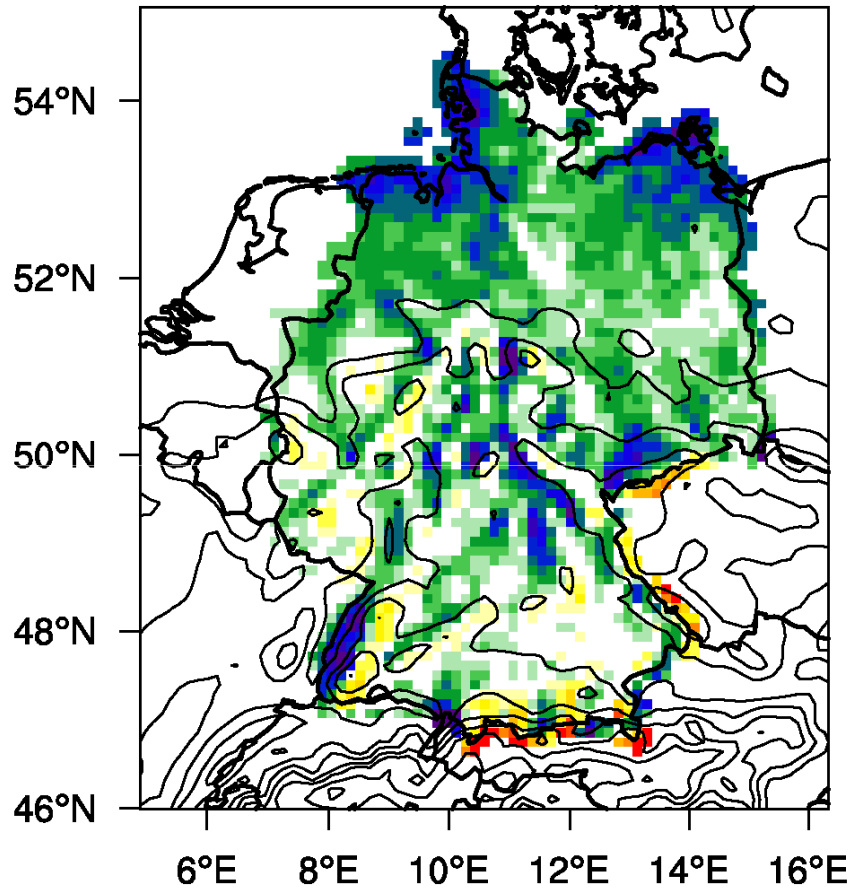-Microphysics
-Convection Scheme
-Combination of both

Dependence on Nesting?
Dependence on Vertical Layer Distribution?
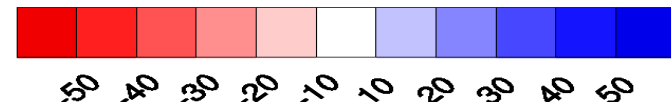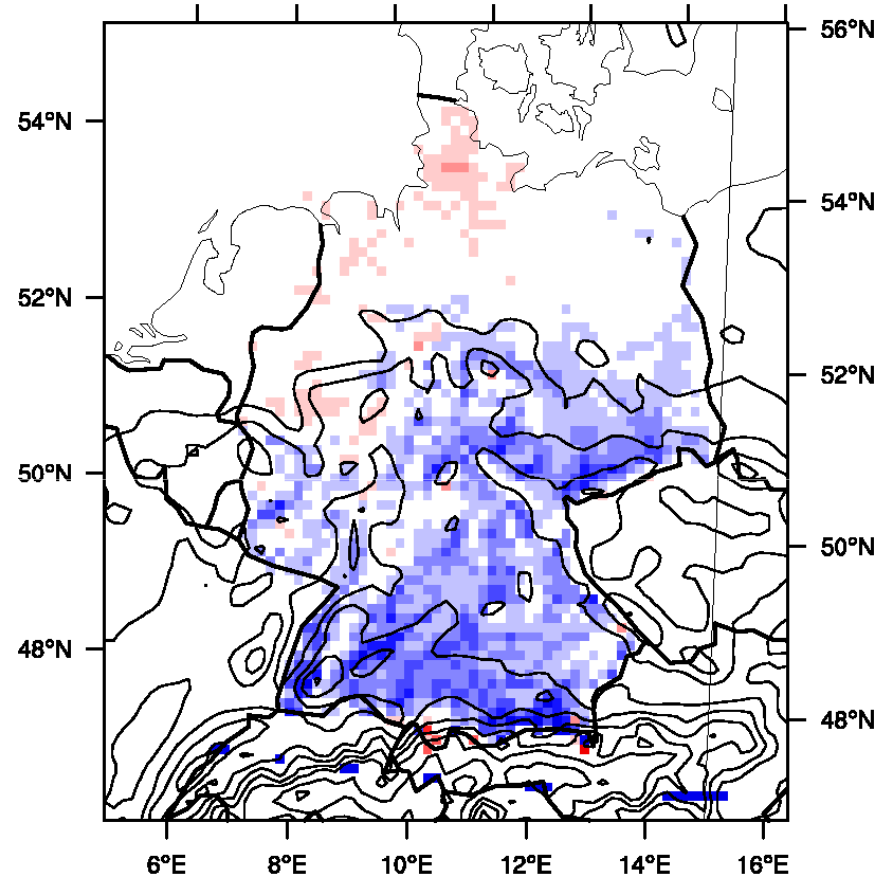Dependence on Soil Moisture Initialization/Spin-up?
Dependence on Vegetation Map/ Soil Texture Map?
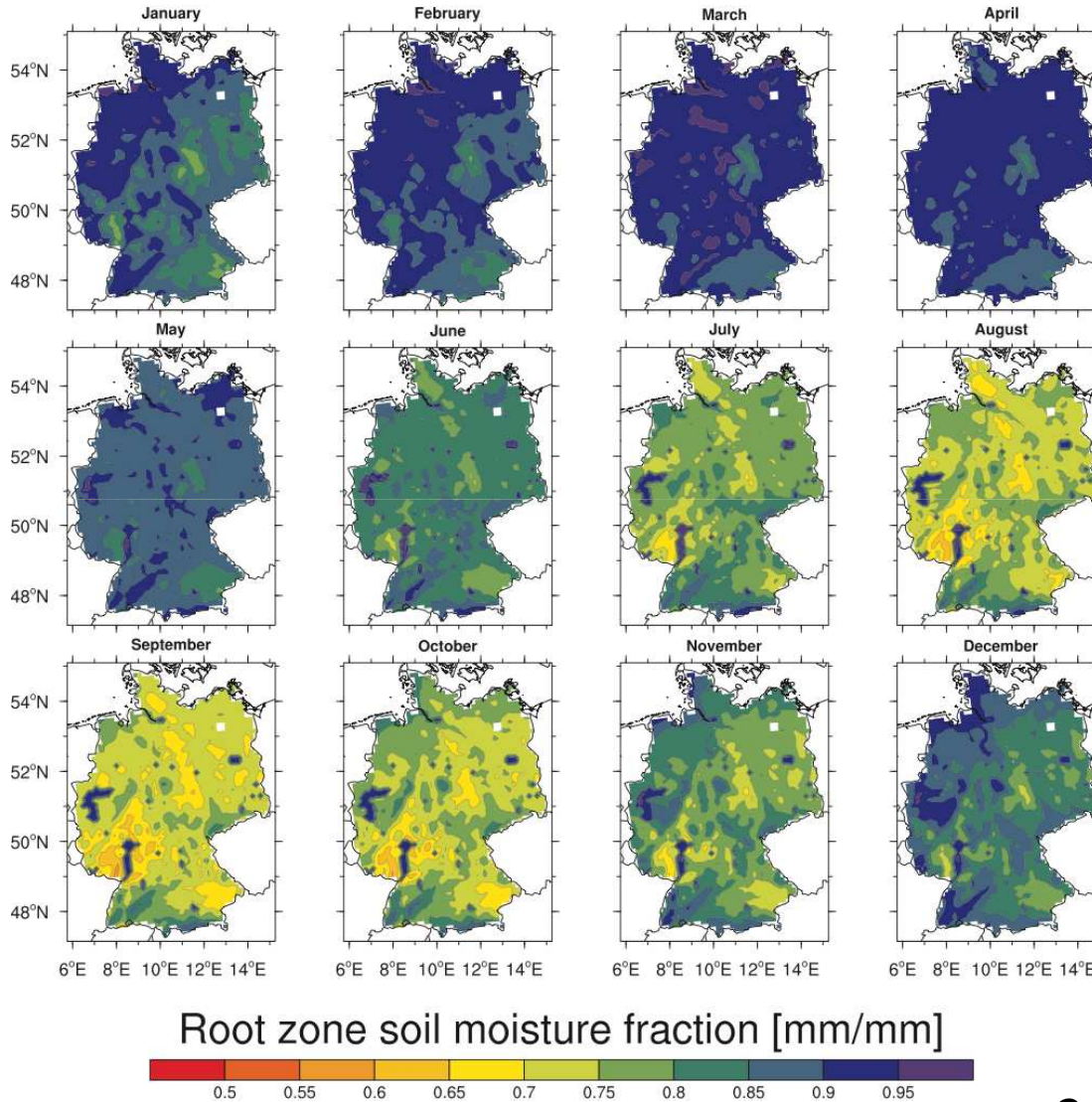
JJA: WRF 3.1.1 - REGNIE

WRF 3.3.1 - REGNIE

Precipitation [mm/month]

Precipitation [mm/month]

CORDEX Europe WRF331

Root zone soil moisture fraction [mm/mm]

Differences are mainly due to a combination of precipitation bias and different soil texture. However, first EOF analyses indicate that CORDEX results start recovering structures due to soil and vegetation properties.

Courtesy Luis Samaniego, (UFZ-Leipzig)

WRF-Setup for Projection Runs

-Discuss these issues with other CORDEX-Domains!

-Analyse more variables to find the best set-ups

Suggestion: Start discussion about

agreement on 2-3 setups and run them with different CMIP5-Forcings?