Regional climate modelling for the Rhine basin

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Regional climate modelling at KNMI

- Regional climate scenarios
  - Statistical downscaling (Buishand, Beersma *et al*)
  - Weather generators
  - Since late 2001: RACMO = HIRLAM + ECMWF physical package
- RegioKlim project
  - Verification and improvement of RACMO
  - Production of scenarios
  - Participation in (inter)national projects (PRUDENCE, new FP6-projects, ICES/KIS)

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# Verification and improvement of RACMO

- Free interior, atmospheric forcing at lateral boundaries
- 15yr simulation with "observed" boundaries (ERA15, 1979-1993)
- Verification using synops data, ECA-data and meteorological analyses

Surface geopotential RACMO domain

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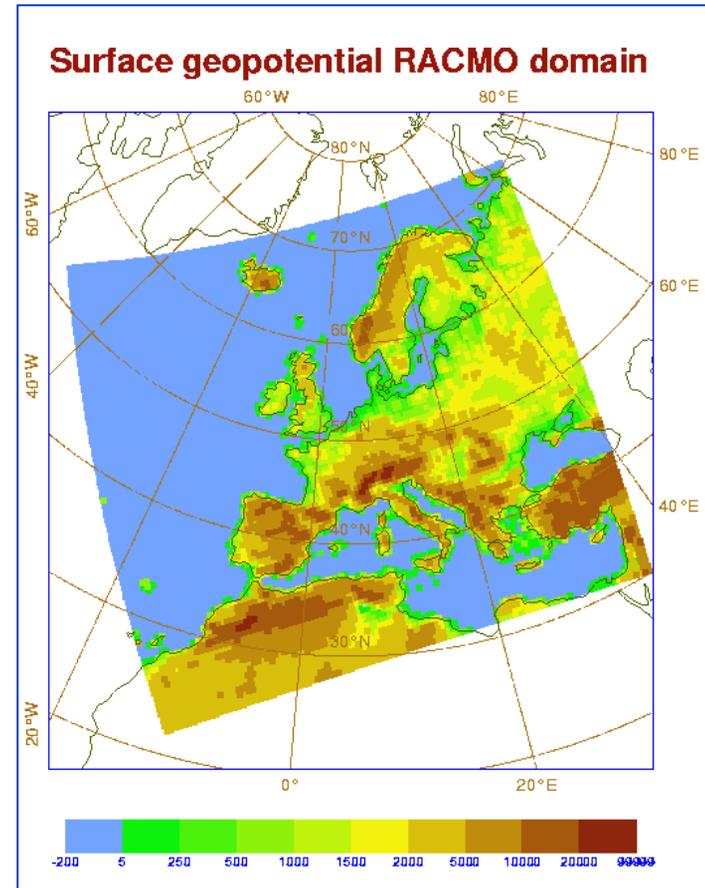
Basic problems of control version of RACMO (1)

- Summertime dry warm bias
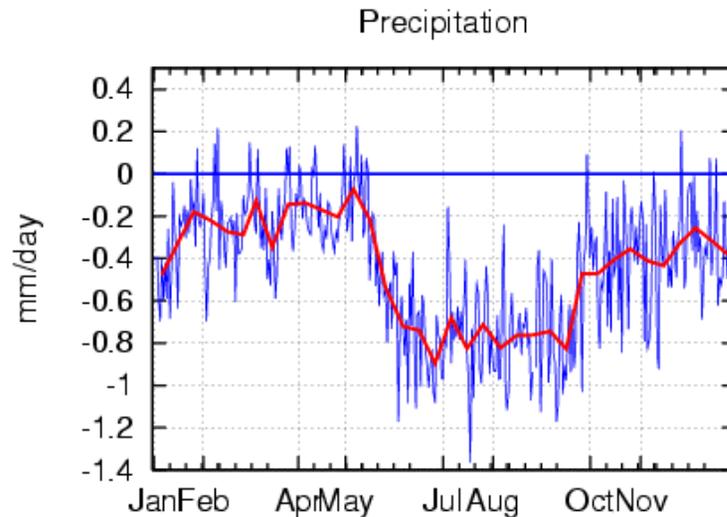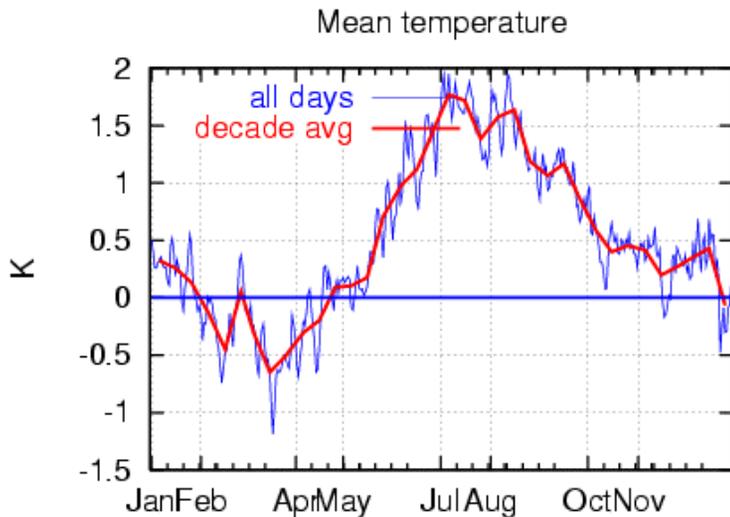
Bias compared to all ±220 ECA-stations

Solution

- Increase hydrological memory of the soil
  - Deeper soil reservoir
  - Smaller sensitivity of transpiration to soil water content

Basic problems of control version of RACMO (2)

- Too much precipitation over mountains

Total (large scale + convective) precip
19810301 to 19810501 reference_RKL
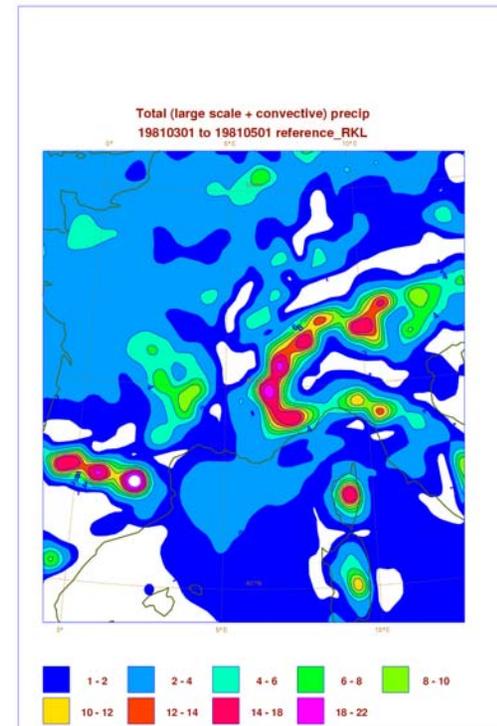
Solution

- Filter orography and reduce horizontal diffusion

Total (large scale + convective) precip
19810301 to 19810501 allmodh

1 - 2   2 - 4   4 - 6   6 - 8   8 - 10
10 - 12   12 - 14   14 - 18   18 - 22
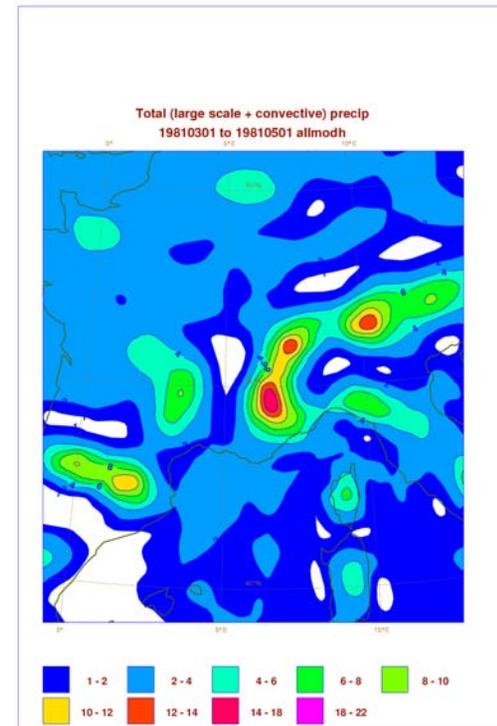
Basic problems of control version of RACMO (3)

- Different synoptic patterns compared to driving meteorological fields

ERA15   RACMO

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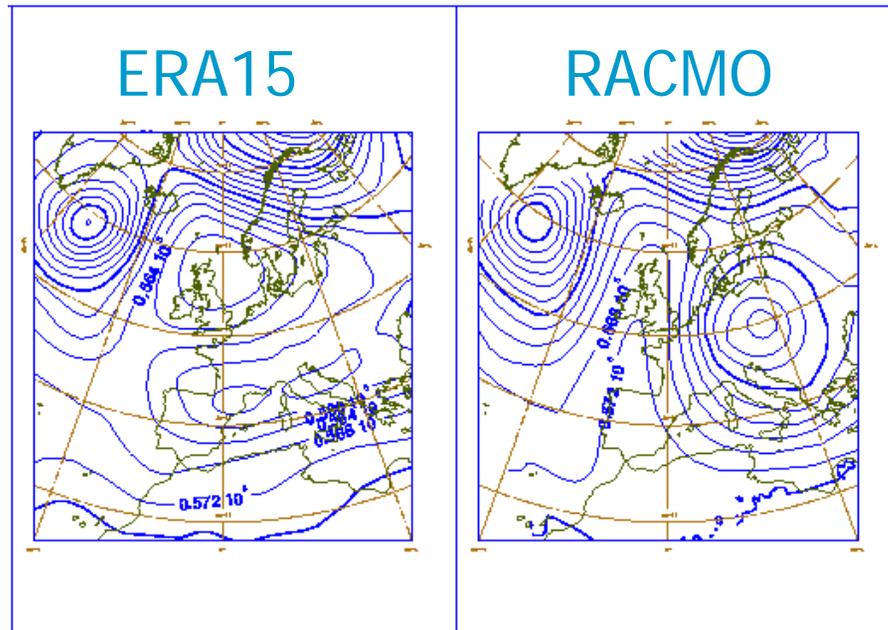
Solution

- Optimize procedure to import information in lateral boundary

RACMO   ERA15
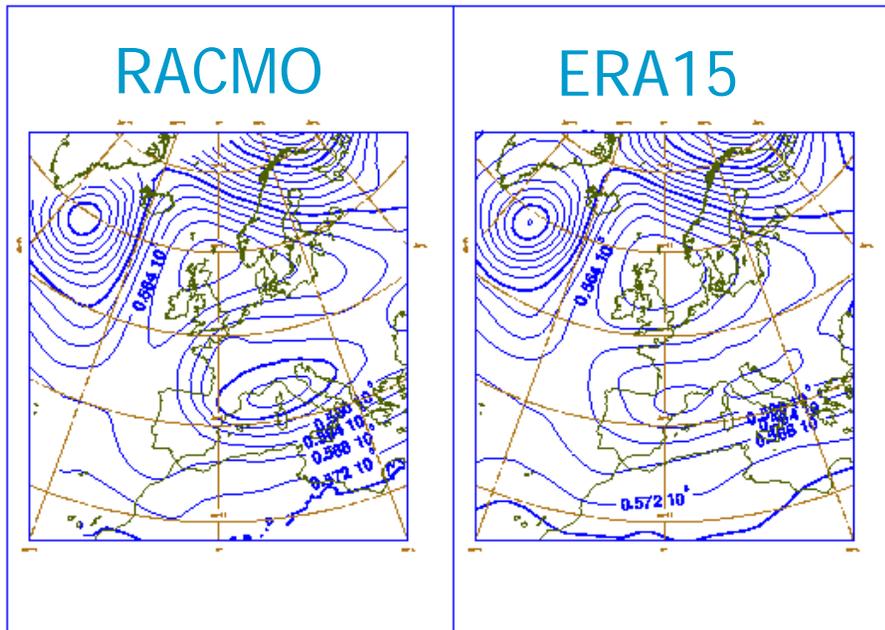
Precipitation over the Rhine basin (present-day climate)

- Ingredients (1)
  - **CHR daily precipitation data** 1961-1995 over 134 sub-catchments
 - Aggregated to RACMO model grid (69 gridpoints)

HBV Districts
- Erft
- Lahn
- Lippe
- Lower Rhine
- Main
- Middle Rhine
- Moselle
- Nahe
- Neckar
- Ruhr
- Schweiz
- Sieg
- Upper Rhine
- Upper Rhine 2

Staatsgrenze
Gewässer

CHR-workshop june 2003
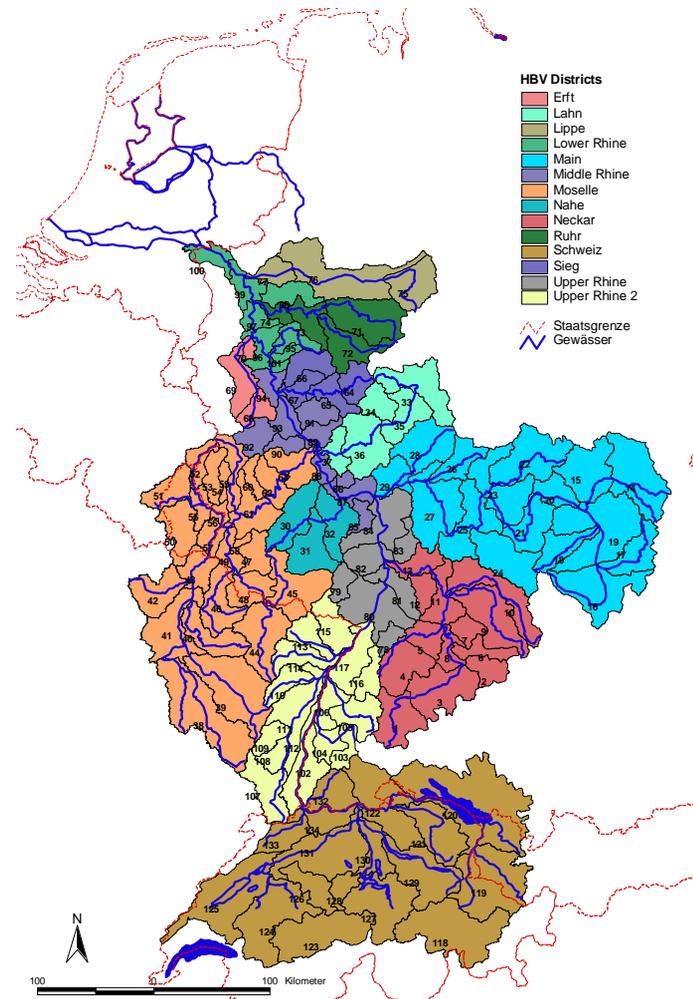
Precipitation over the Rhine basin (present-day climate)

- Ingredients (2)
  - **ERA15: RACMO reference simulation** (1979-1993)
  - **HadAM3: RACMO simulation with modifications** control climate (1961-1990, only first 10yrs analysed) (included in PRUDENCE project)
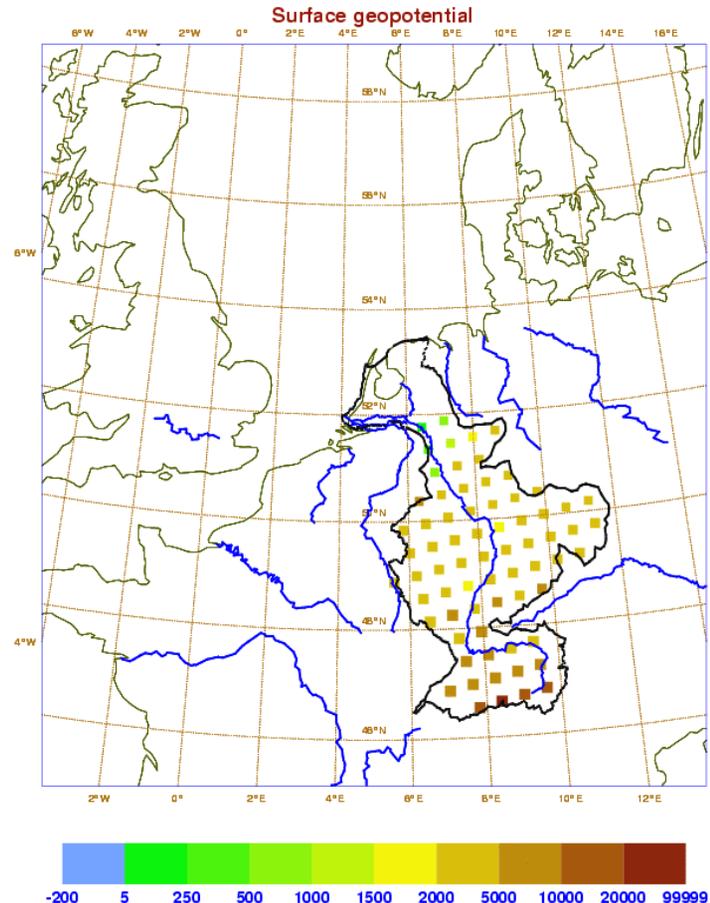

Surface geopotential

-200 5 250 500 1000 1500 2000 5000 10000 20000 99999

Average annual cycle aggregated over domain

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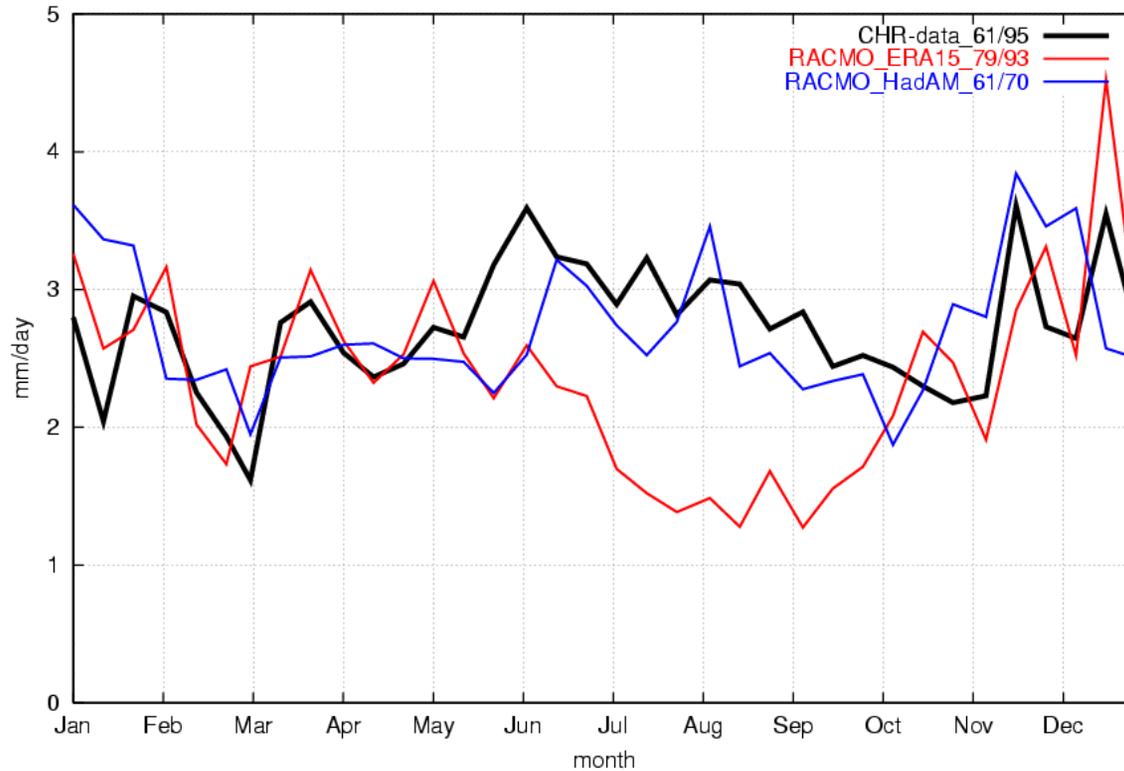
Average annual cycle aggregated over domain

Effect of soil drying

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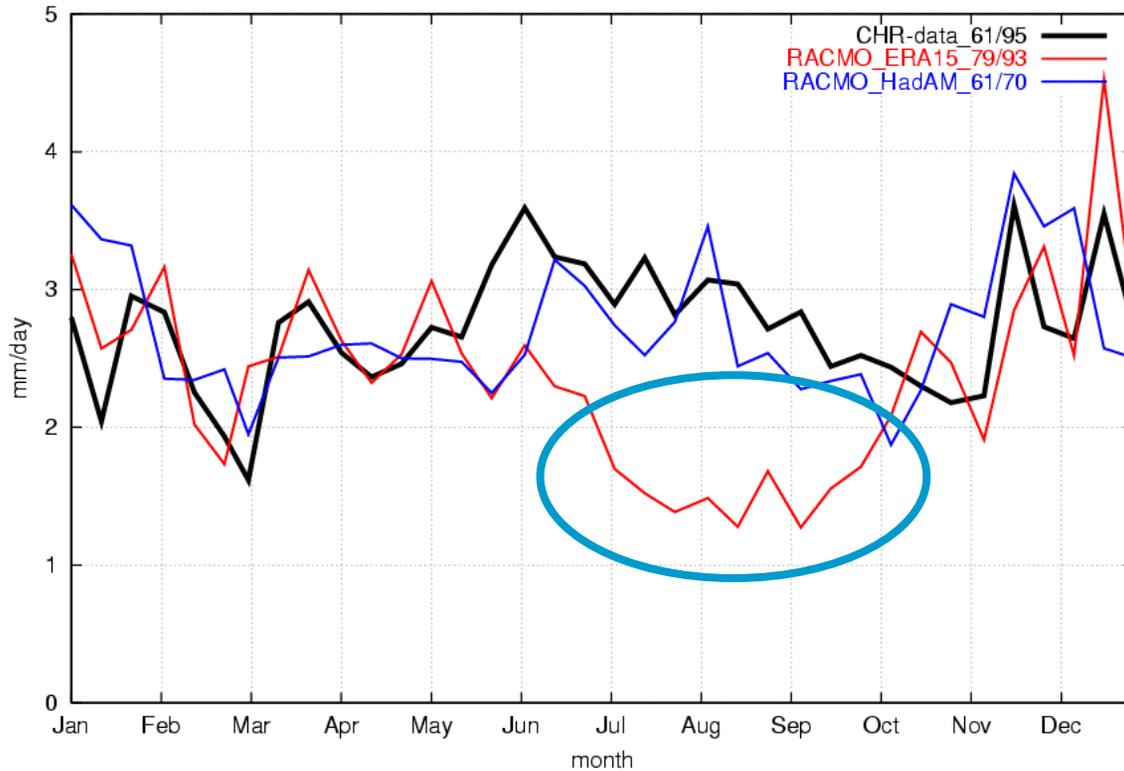
Pattern of average bias in HadAM run
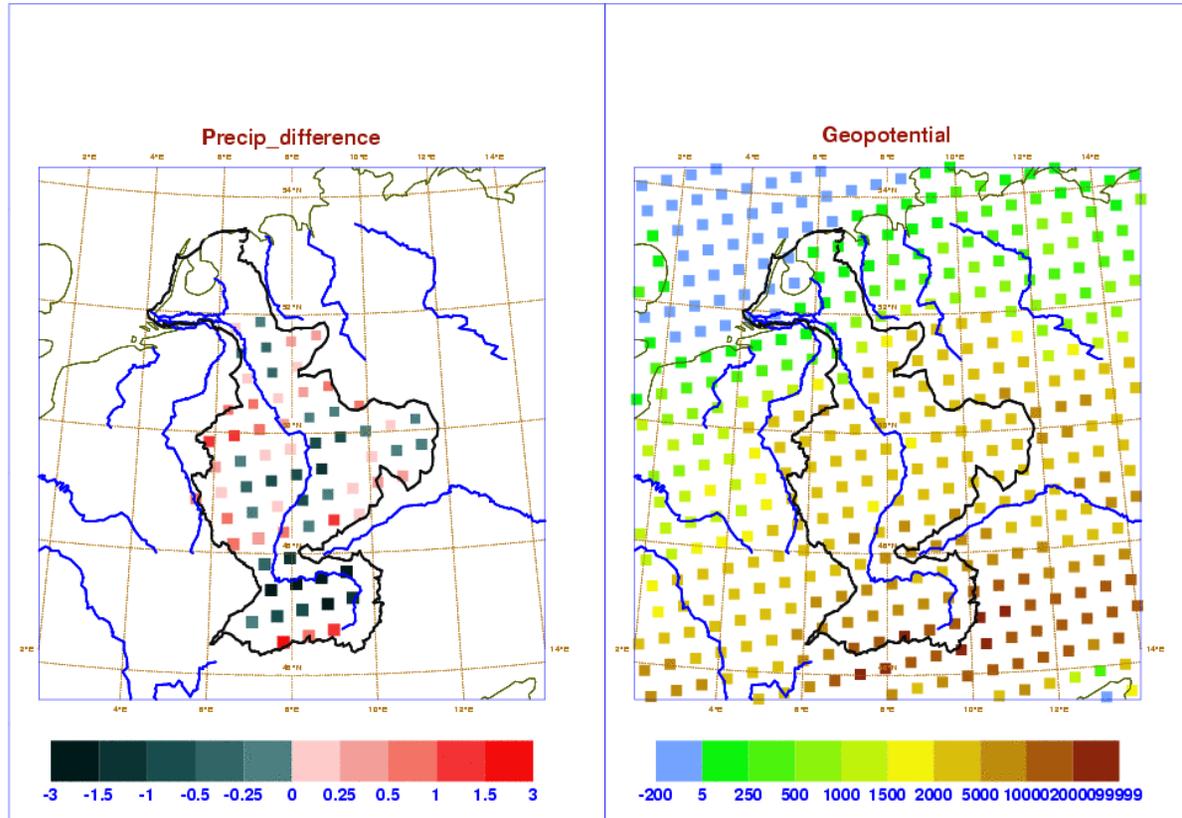
Lower areas surrounded by mountains too dry, mountains too wet

Autocorrelation of timeseries
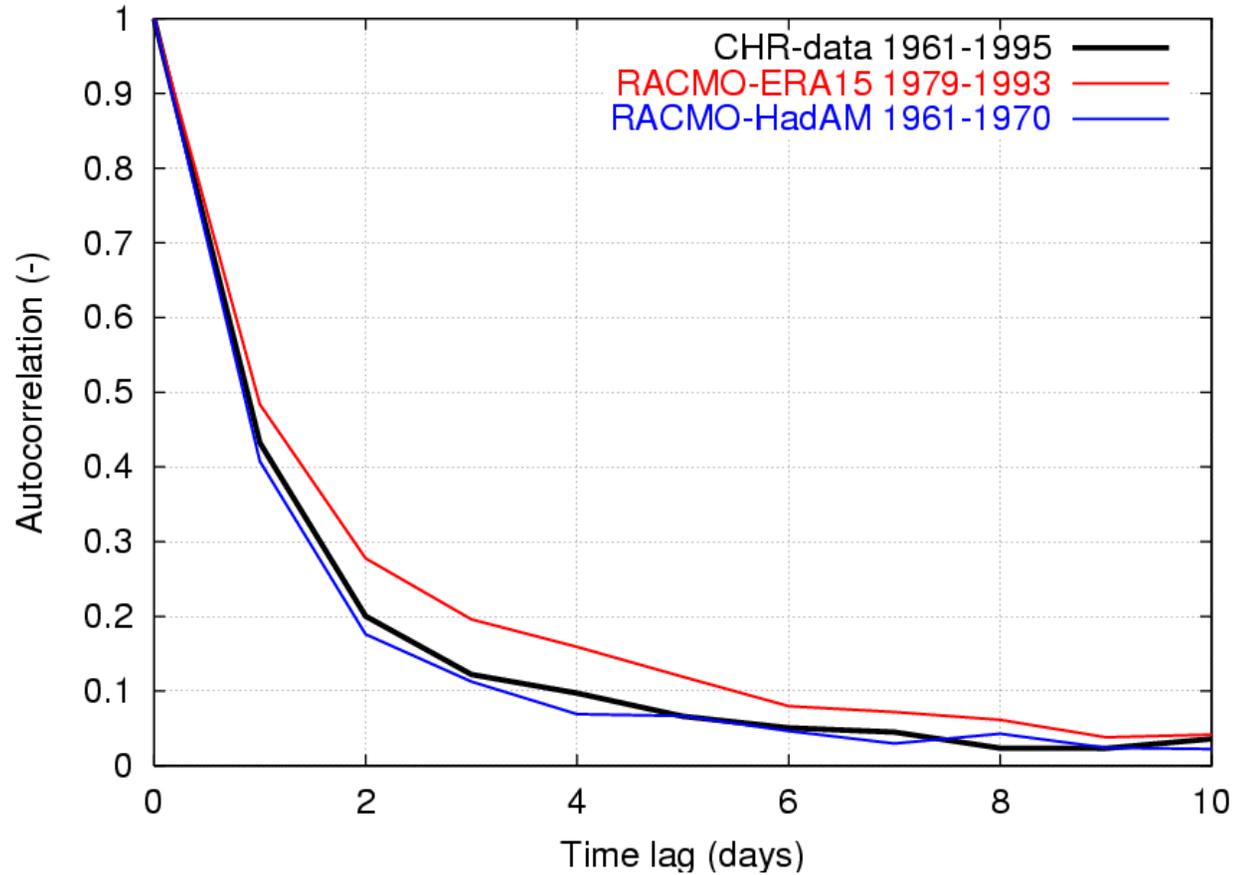
# Frequency distribution of areal averages
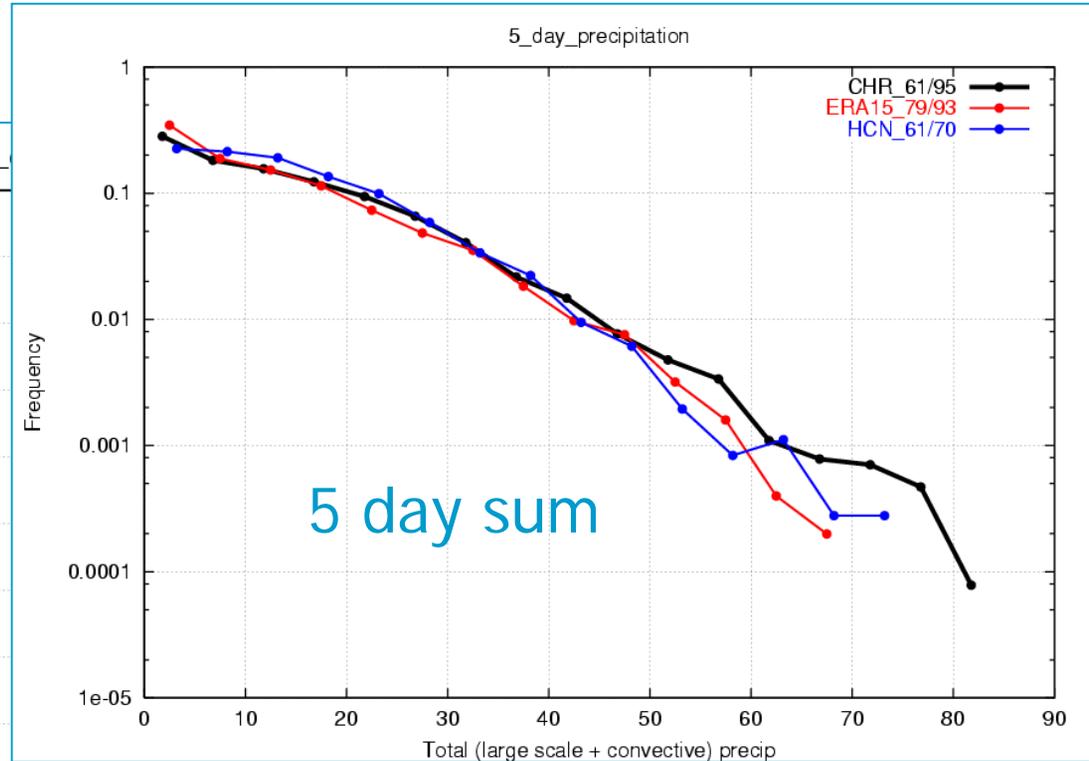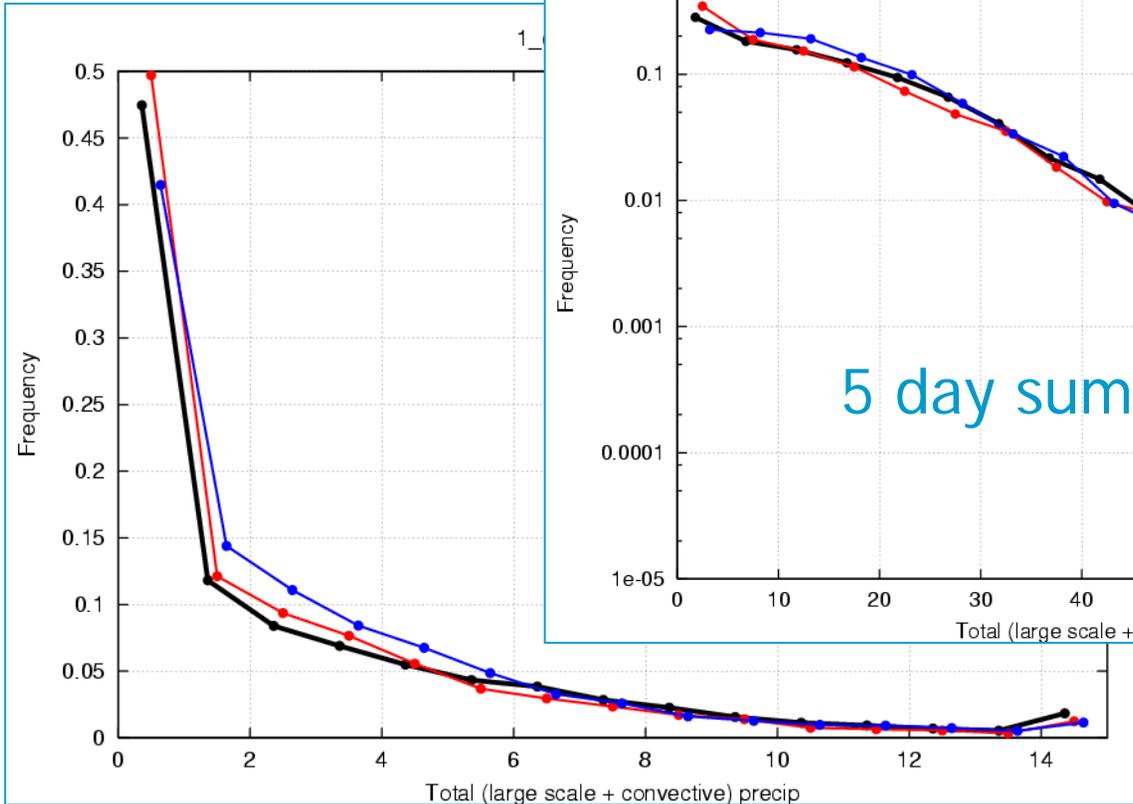
Individual events
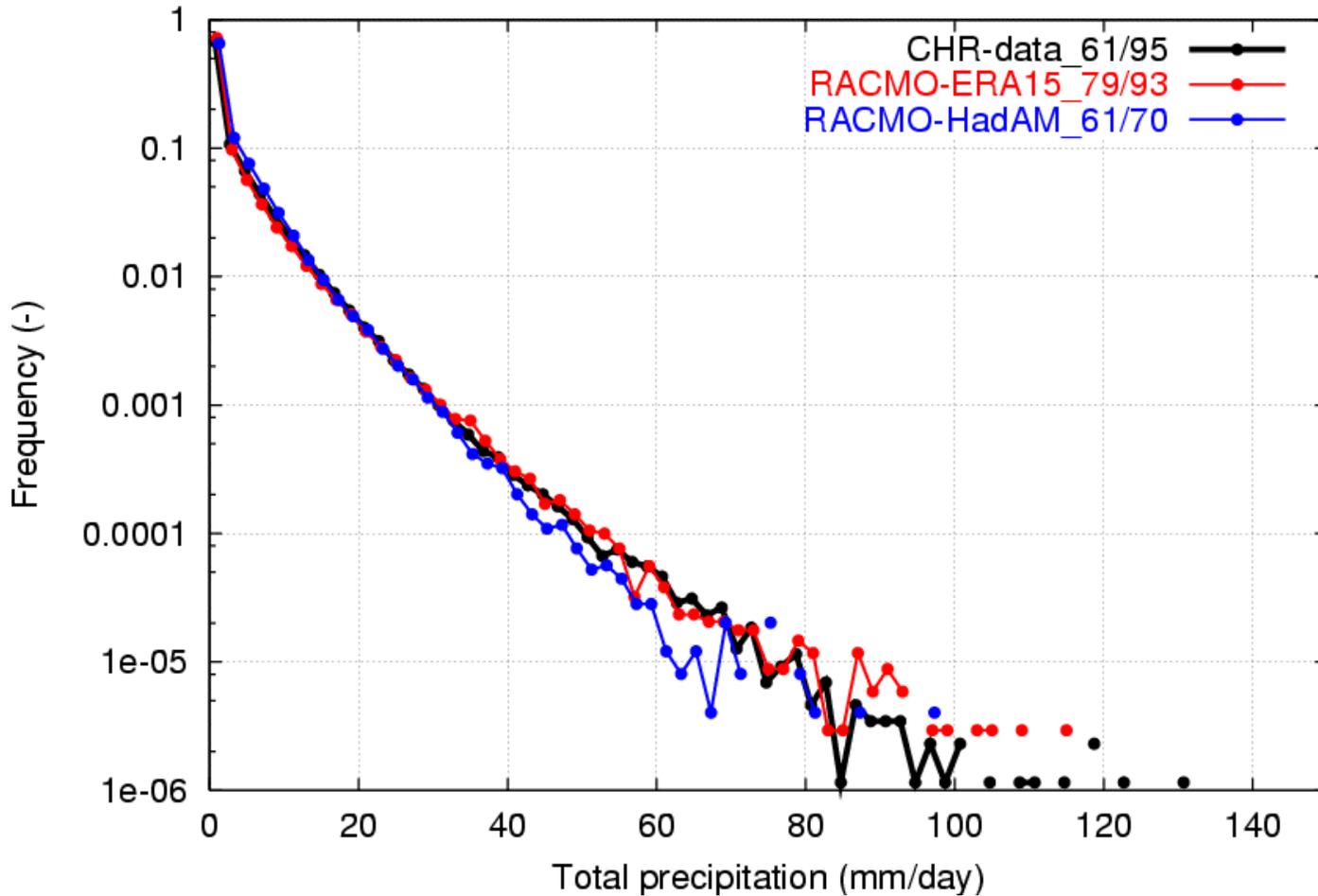
Pattern correlation

- Correlate daily field on day t with day $t+lag$

- For each lag, average correlations for all events

- Expresses temporal consistency of spatial patterns

Pattern correlation

Pattern Correlation of log(Precip)
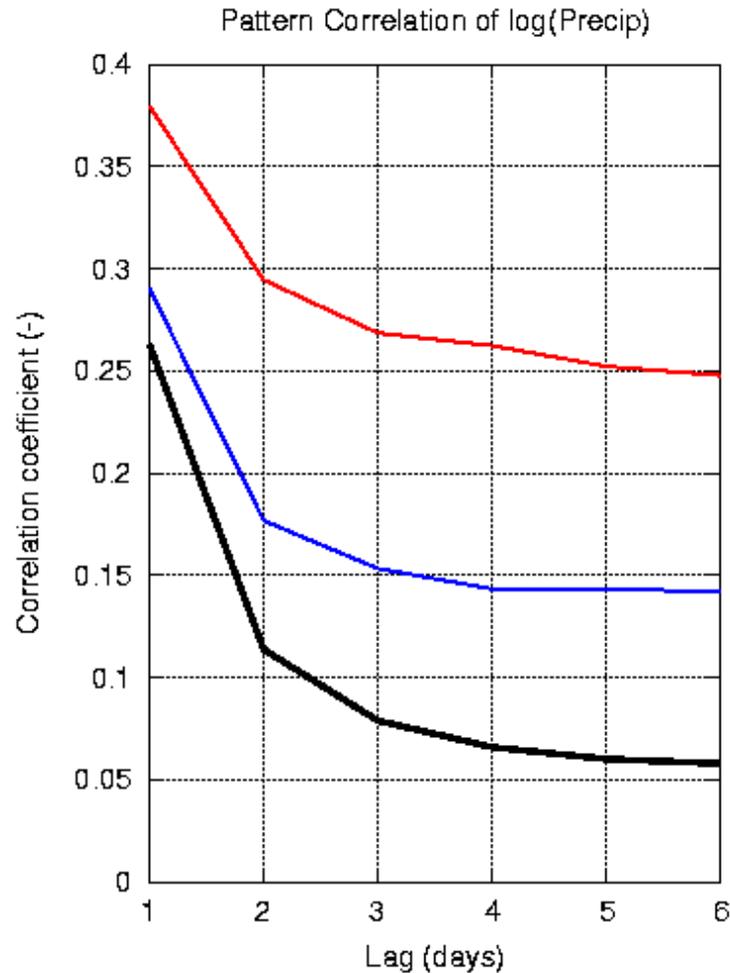
Strong persistence of precipitation patterns, partially by (too) strong orographic control in the models

Pattern correlation
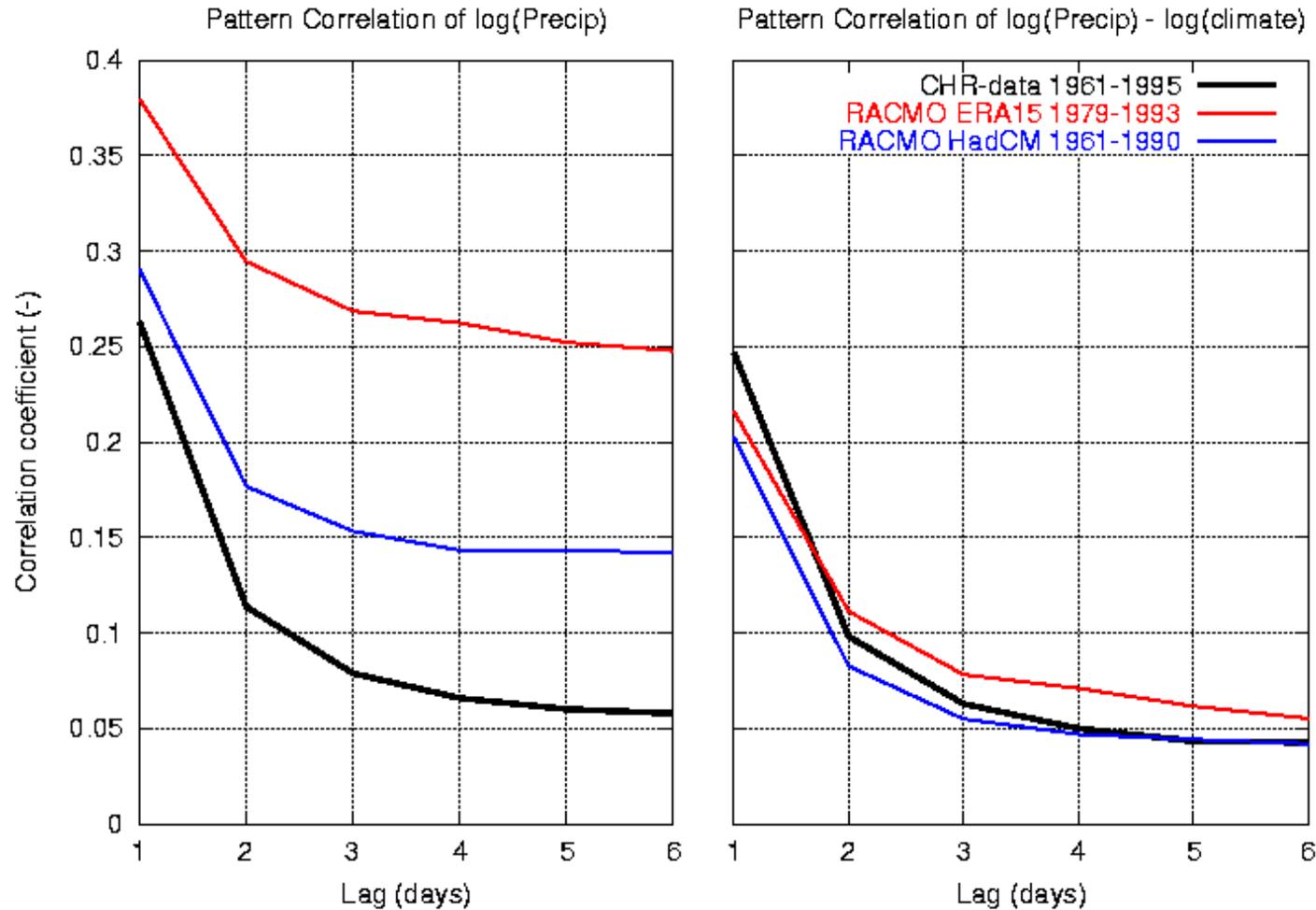
Conclusions

- Model modifications improved hydrological cycle and its seasonal time scale
- Average annual cycle of precipitation well simulated, but systematic spatial errors
- Small overestimation of light events on 1-day timescale
- Small underestimation of extreme events on 5-day timescale

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