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Summertime Precipitation in Finland under Recent and Projected climate

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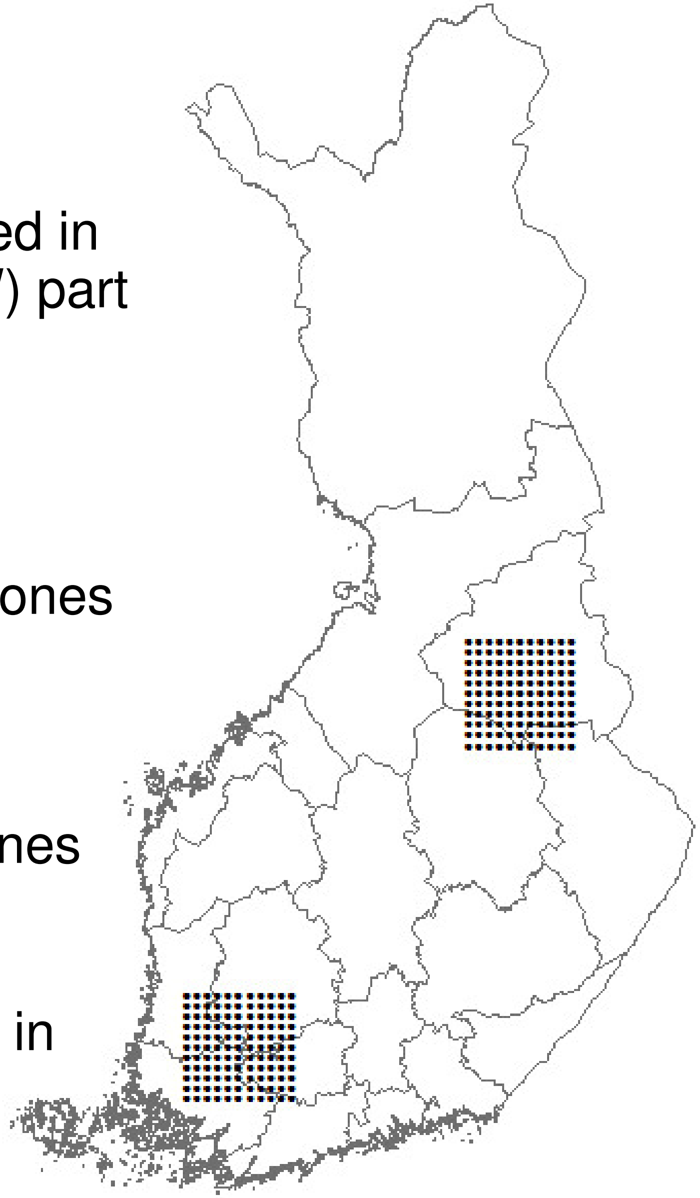
Motivation and objective

- In northern Europe, precipitation amounts are expected to increase with increasing temperatures in the projected future climate
- The largest fractional increase in precipitation is expected to take place in winter, whereas the increase is more modest in summertime
- Changes in summertime precipitation during the last 100 years were analyzed based on high-resolution observed data set
    - Comparison of three different data sets
- Future precipitation projections until 2100 were studied based on an ensemble of 13 RCM's

Study area

- Two study areas sized 100 x 100 km located in north-eastern (NE) and south-western (SW) part of Finland
- Climatologically different zones:
  - **NE**:
    - between middle- and north-boreal zones
    - continental climate
  - **SW**:
    - between hemi- and south-boreal zones
    - maritime influence
- Past and future monthly precipitation sums in May-September



Data and Methods

3 observational data sets

FMI grid

- Longest and highest-resolution data set
- Observed monthly precipitation
- 1908-2008
- 10 x 10 km grid size

E-OBS 2.0 (Haylock *et al.*)

- Monthly values calculated from daily values
- 1961-2000
- 0.25 degree grid

CRU TS2.1 (Mitchell and Jones)

- Global monthly data
- 1961-2000
- 0.5 degree grid

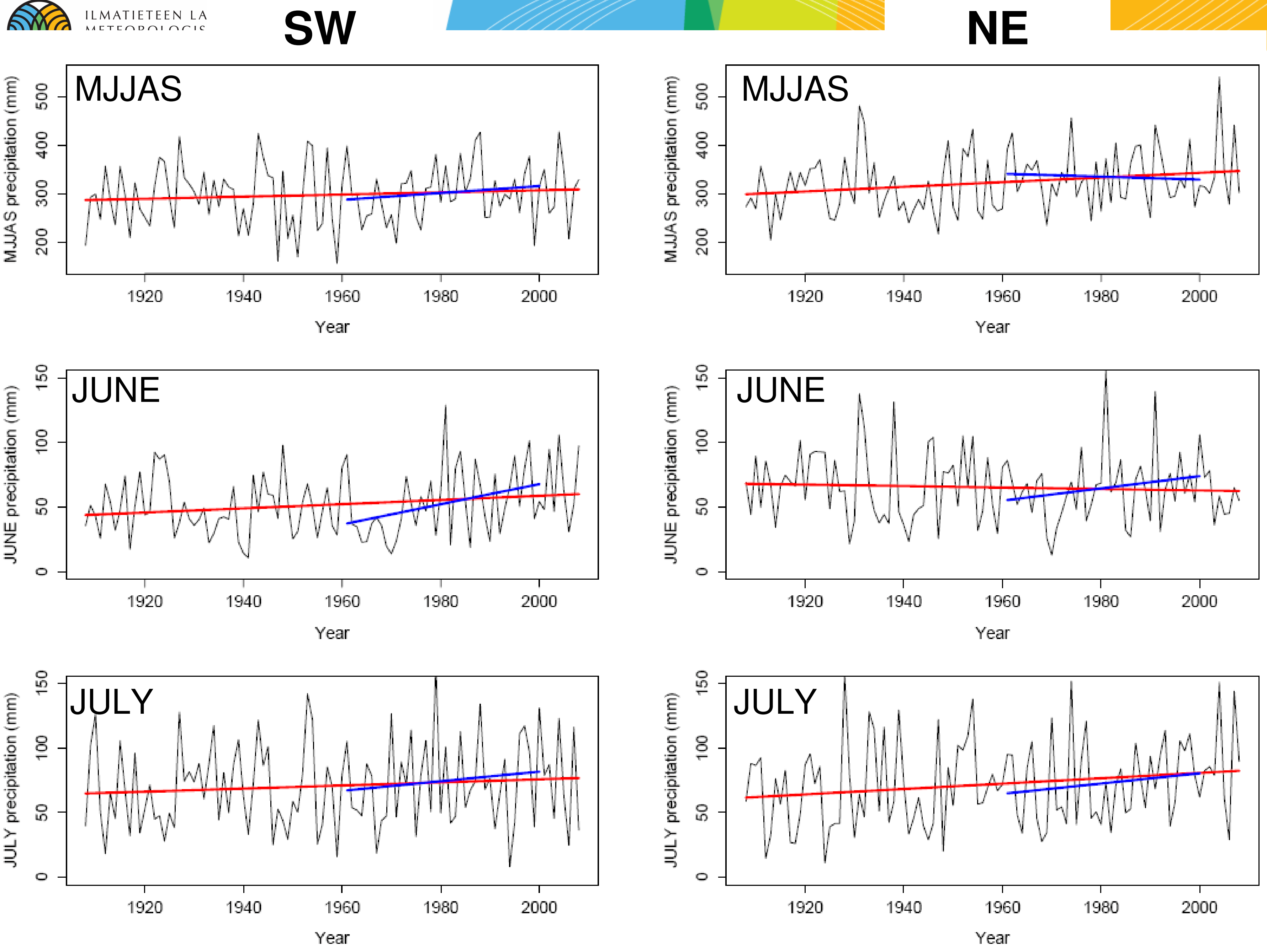
Data and Methods

ENSEMBLES

13 regional climate model (RCM) simulations

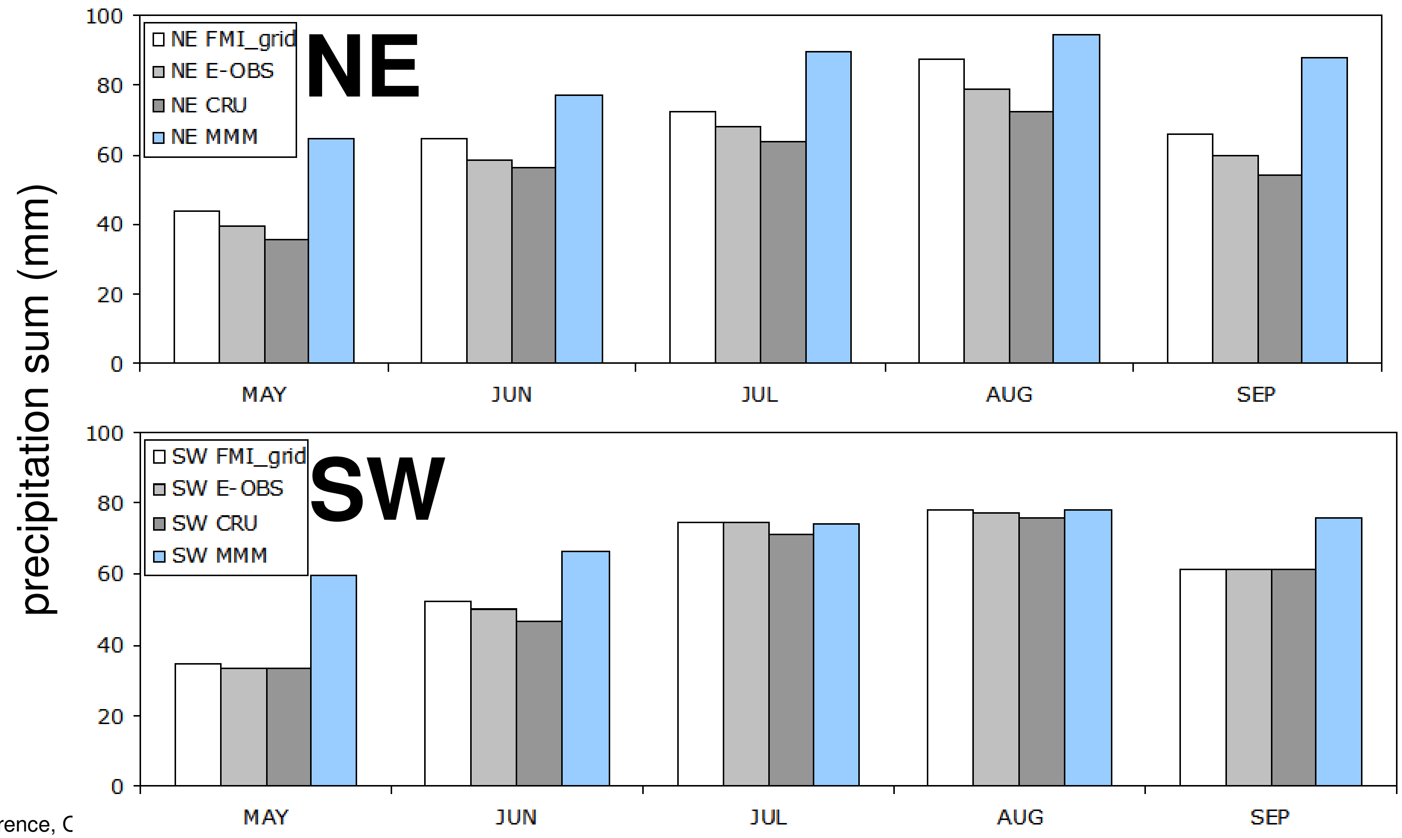
- provided by the EU FP6 ENSEMBLES project
- SRES emissions scenario A1B
- 0.25 degrees resolution
- 1961-2100

Simulation	Global model	Regional model
C4I-HC16	HadCM3Q0	RCA3
DMI-ARPEGE	ARPEGE	HIRHAM
DMI-ECHAM5	ECHAM5-r3	DMI-HIRHAM5
ETHZ-HC0	HadCM3Q0	CLM
ICTP-ECHAM5	ECHAM5-r3	RegCM
KNMI-ECHAM5	ECHAM5-r3	RACMO
METO-HC0	HadCM3Q0	HadRM3Q0
METO-HC3	HadCM3Q3	HadRM3Q3
METO-HC16	HadCM3Q16	HadRM3Q16
MPI-ECHAM5	ECHAM5-r3	REMO
SMHI-BCM	BCM	RCA
SMHI-ECHAM5	ECHAM5-r3	RCA
SMHI-HC3	HadCM3Q3	RCA



SW
NE
MJJAS
JUNE
JULY
MJJAS precipitation (mm)
JUNE precipitation (mm)
JULY precipitation (mm)
Year

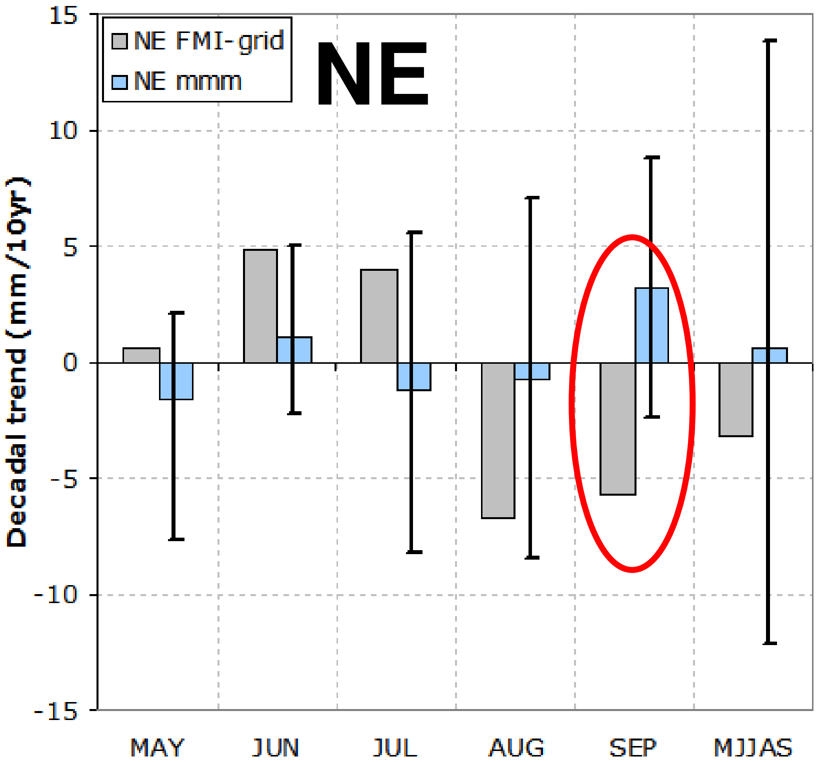
- Comparison of **monthly precipitation sums** in **1961-2000** between different data sets and the multi-model mean (MMM)
- Differences between the observed data sets are smaller in SW than in NE
- MMM overestimates precipitation, but is closer to observations in SW than NE → Better observational coverage in SW

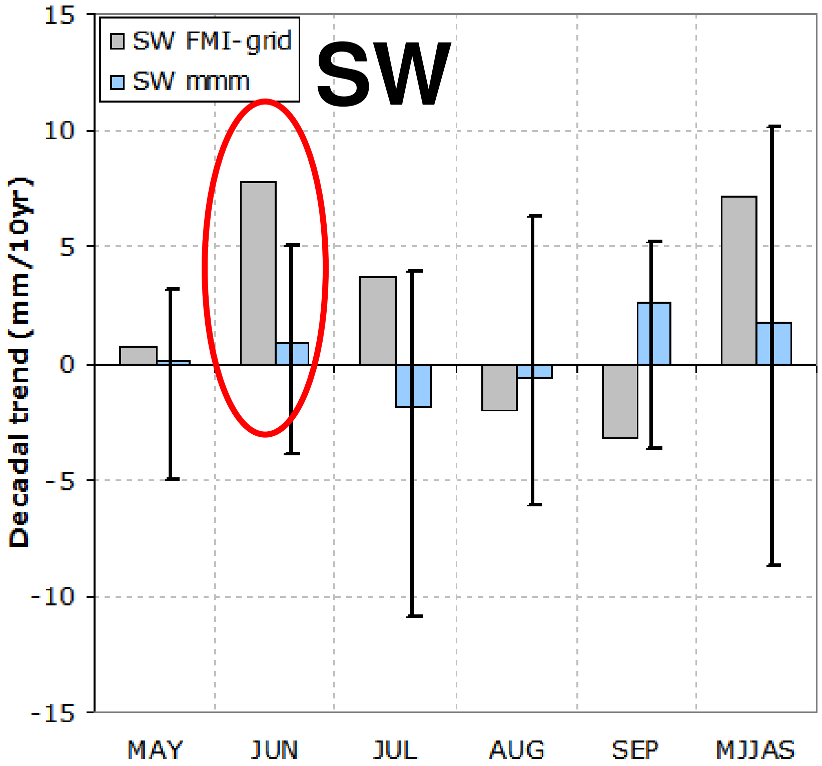


- Precipitation trends (mm / 10 yr) in **1961-2000** according to **observations** and **model simulations** (MMM)
- Including the range of simulations (whiskers in the plot)

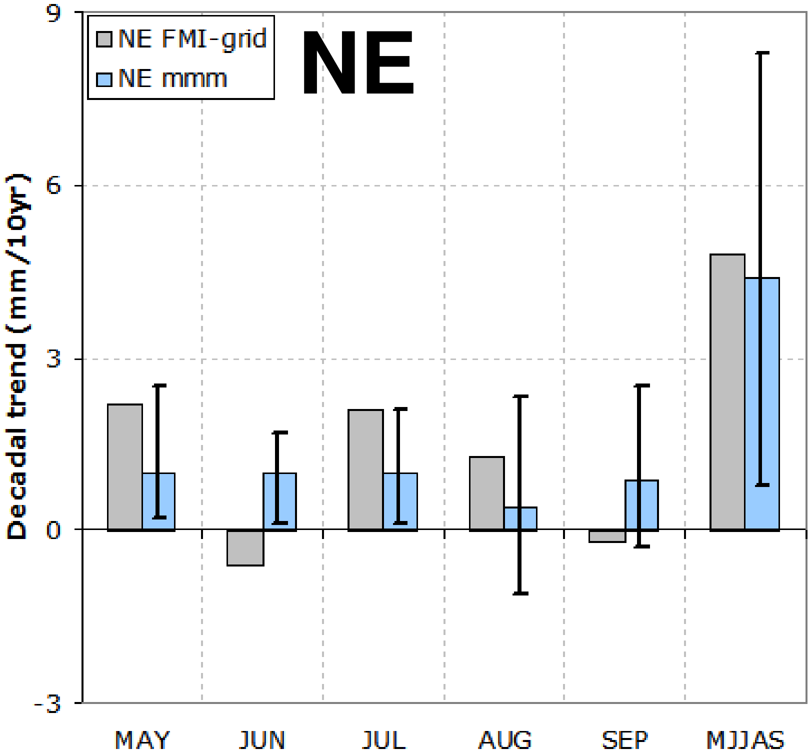
→ Range is very large because of the climate's internal variability

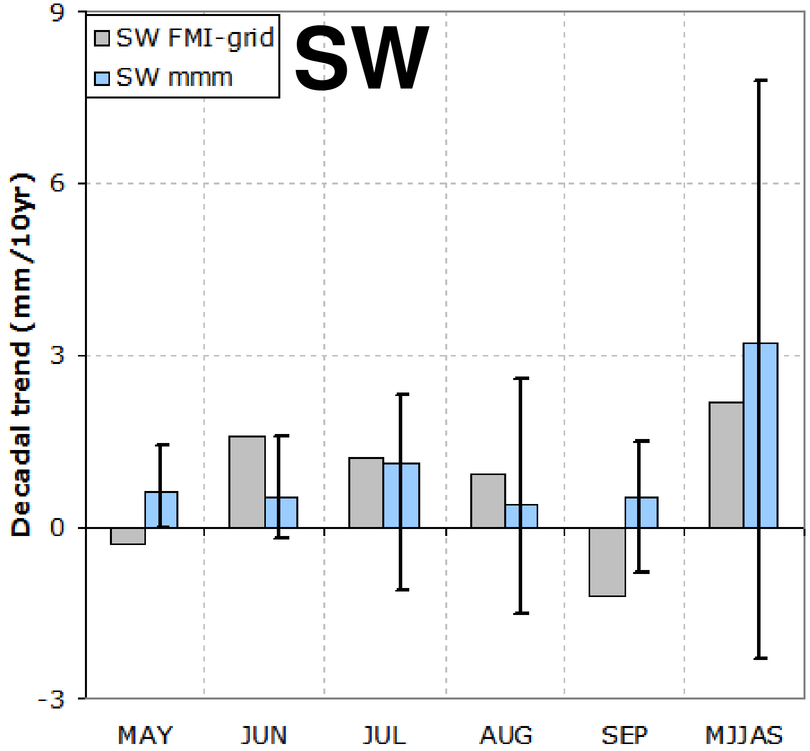
→ In every case, the observed trend does not even fit the simulation range

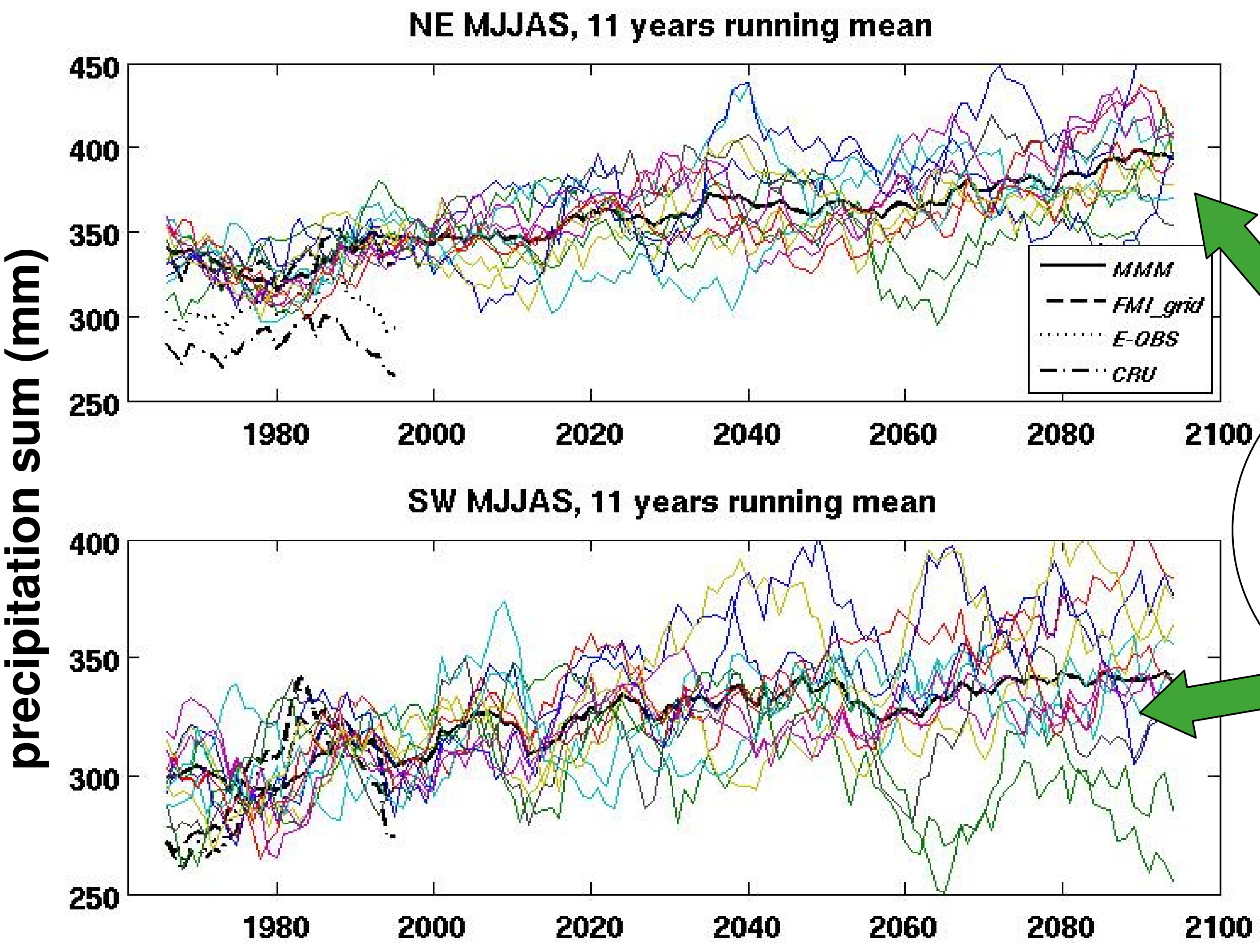




- Long-term precipitation trends (mm / 10 yr) in the
  - **PAST** as observed **1908-2008** and
  - **FUTURE** as multi-model-mean (MMM) **1961-2100**
- Future MMM trends are all increasing
  - MMM is not “a realization of the real-world” but heavily smoothed

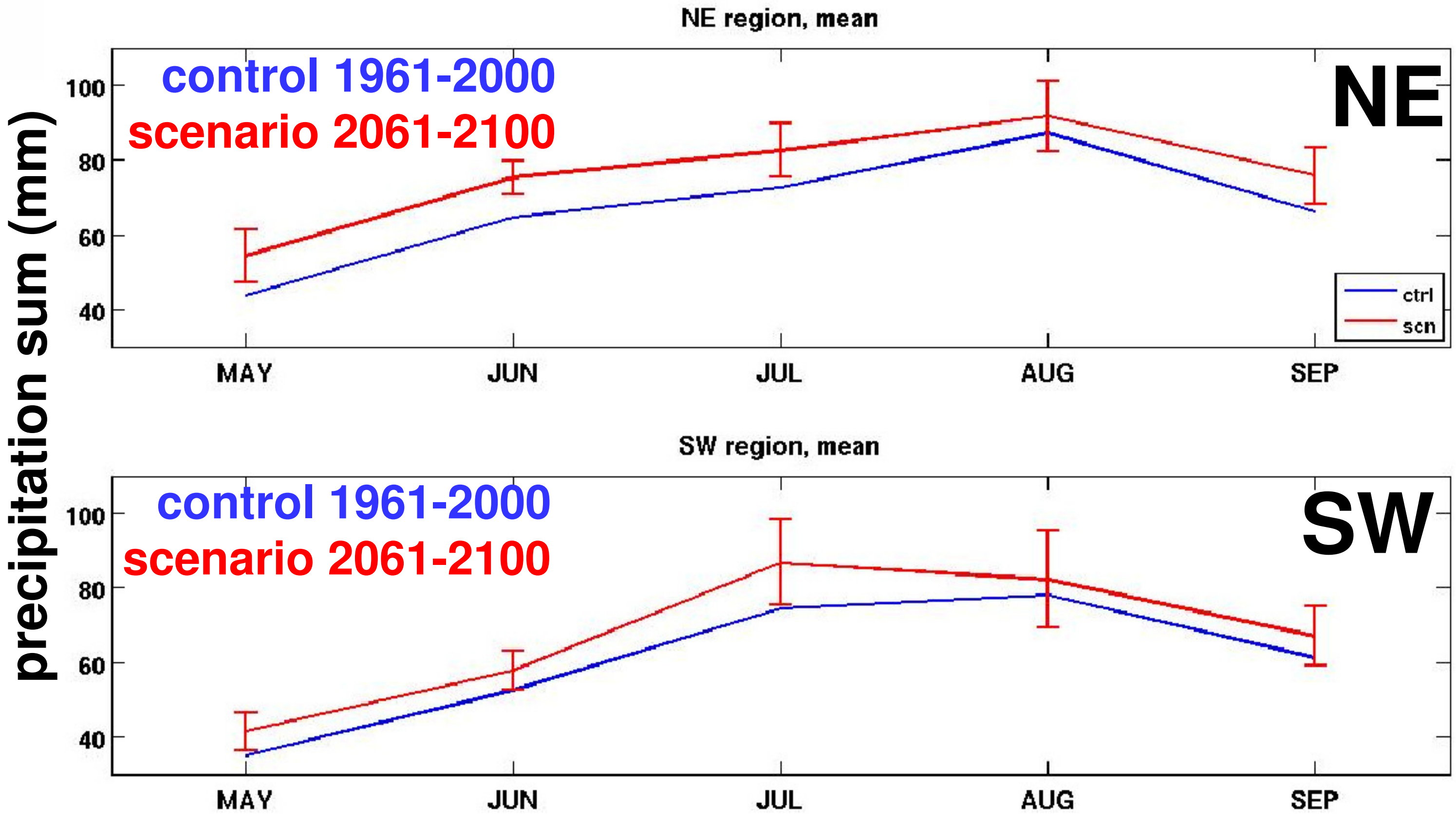






Large variation between model simulations = climate's internal variability

Increase in summertime precipitation by the end of the 21st century



- Relative increase largest in **May**
- **NE:** Absolute increase largest in **May-June** → the difference between the driest and wettest summer months will decrease
- **SW:** Absolute increase largest in **July** → increasing the inter-monhtly differences in precipitation
- Smallest increase in August in both areas

Conclusions

- Most of the past precipitation trends are statistically not significant
    - During the last decades precipitation has increased in early summer (May-July) and decreased in late summer (August-September)
- Model projections for the future indicate increase in precipitation by 2100
    - In SW, increasing the difference between the wettest and driest summer months
    - In NE, vice versa
    - Very large range within the simulations
- Larger number of observation stations in the study area leads to
    - better compatibility between different observational data sets
    - smaller bias in the model simulations

References

- Haylock, M. R., Hofstra, N., Klein Tank, A. M. G., Klok, E. J., Jones, P. D. and New, M. 2008. A European daily high-resolution gridded dataset of surface temperature and precipitation. *Journal of Geophysical Research (Atmospheres)* 113, D20119.
- Mitchell, T. D. and Jones, P. D. 2005. An improved method of constructing a database of monthly climate observations and associated high-resolution grids. *International Journal of Climatology* 25, 693-712.