

Modelling the future – are our models fit for the purpose?

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UNIVERSITET

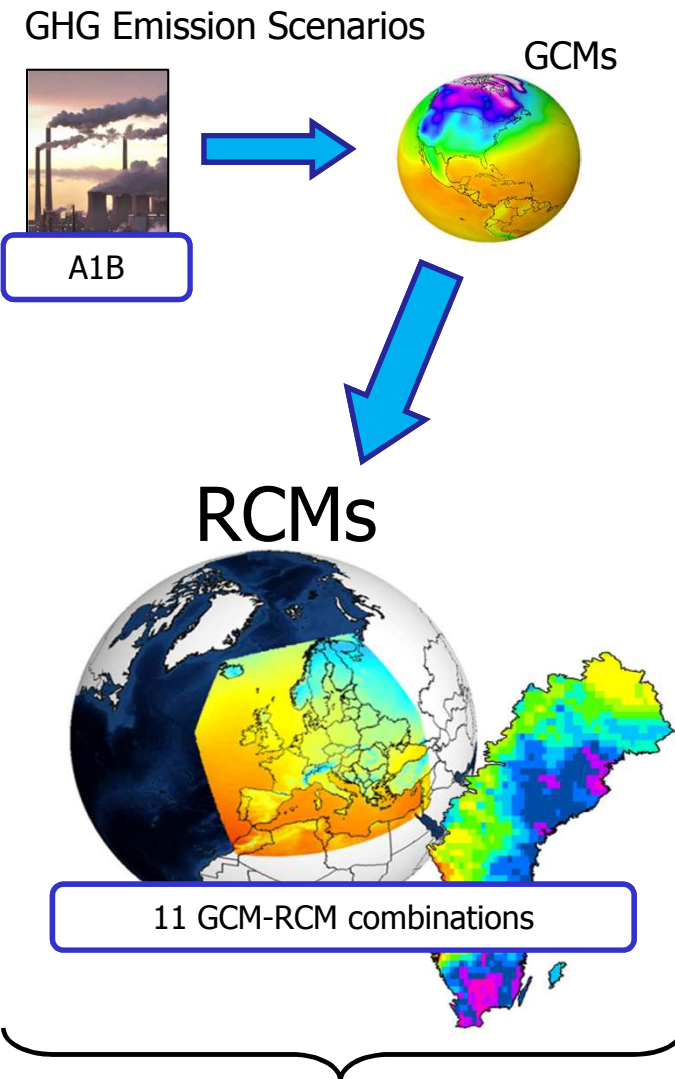
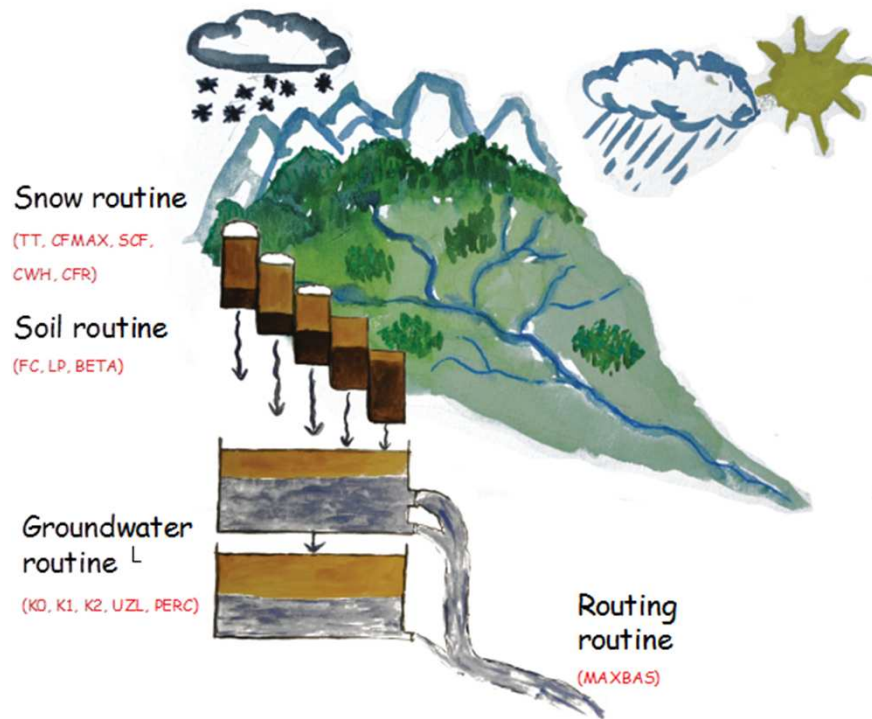




Prediction is very difficult, especially about the future.

(Niels Bohr, Danish physicist, 1885-1962)

Predicting the future – simulations for changed conditions

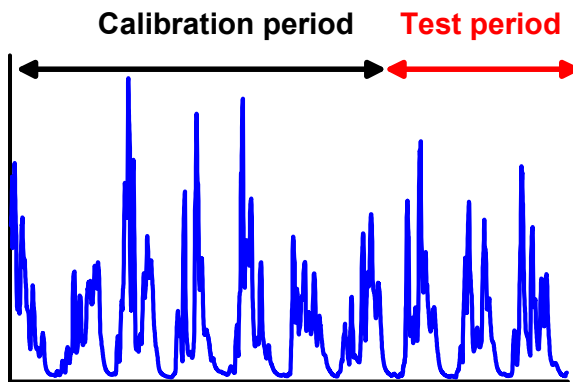


from ENSEMBLES EU project
[van der Linden & Mitchell, 2009]

Challenge: Extrapolation of hydrological models

Split-sample test

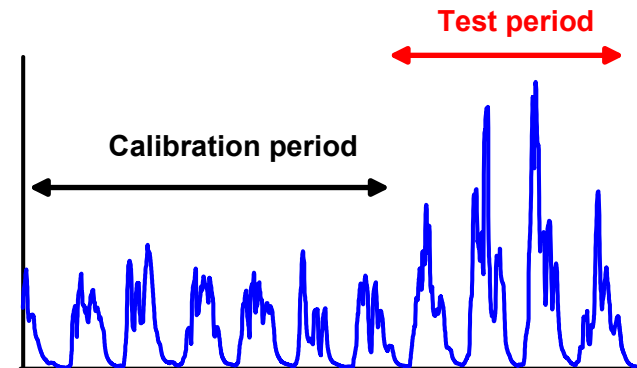
How does the model perform during an independent period with similar conditions?



Usual test

Differential split-sample test

How does the model perform under different conditions?
Extrapolation?



More powerful test

Study catchments

Size: 6-18 km²

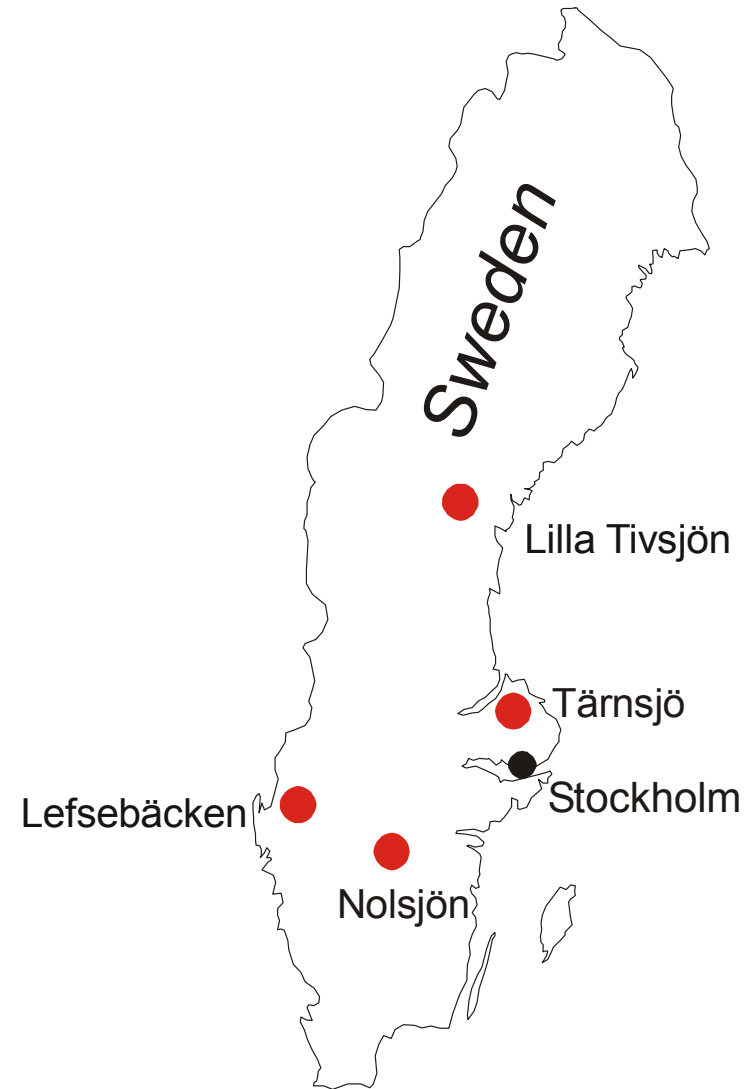
Mainly forested

Annual precip.: ~600-700 mm

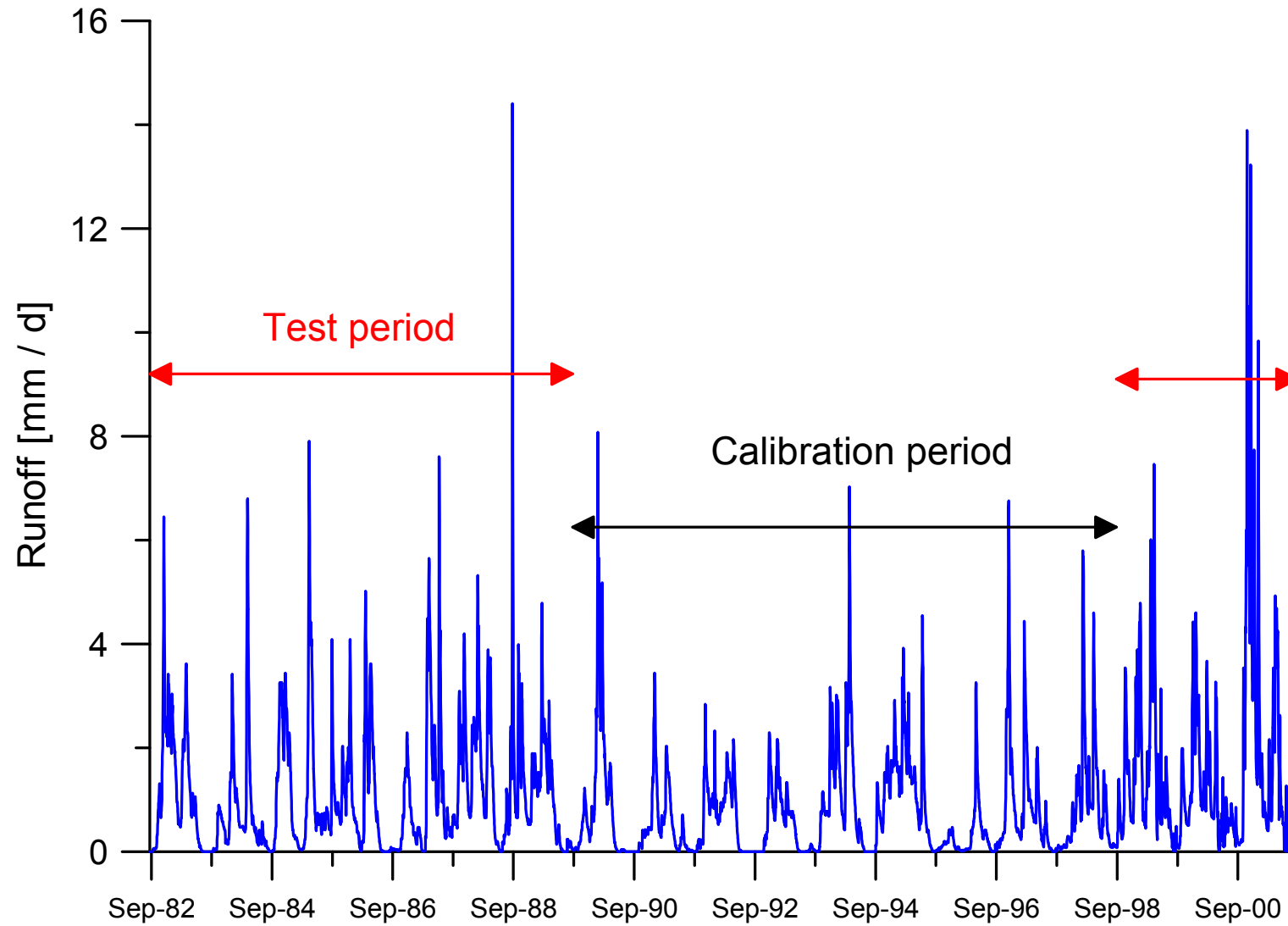
Annual runoff: ~250-300 mm

Application of the HBV model

Monte Carlo approach with 3
million model runs in each
catchment

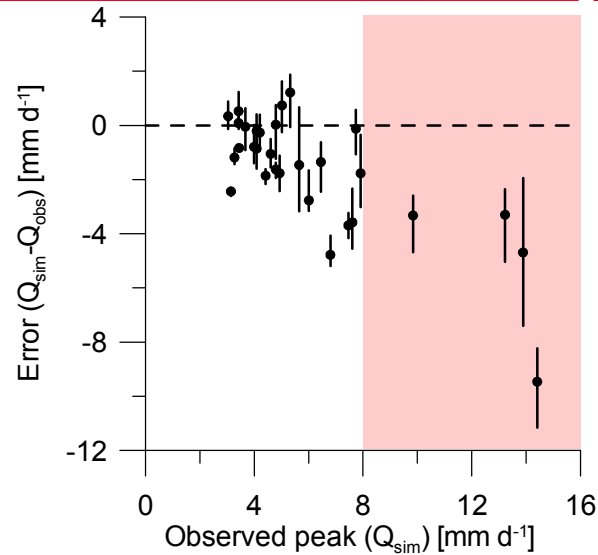


Lefsebäcken

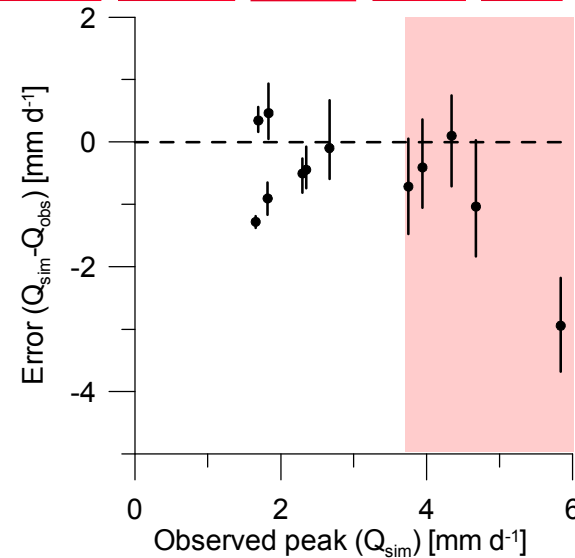


Error in peakflow predictions

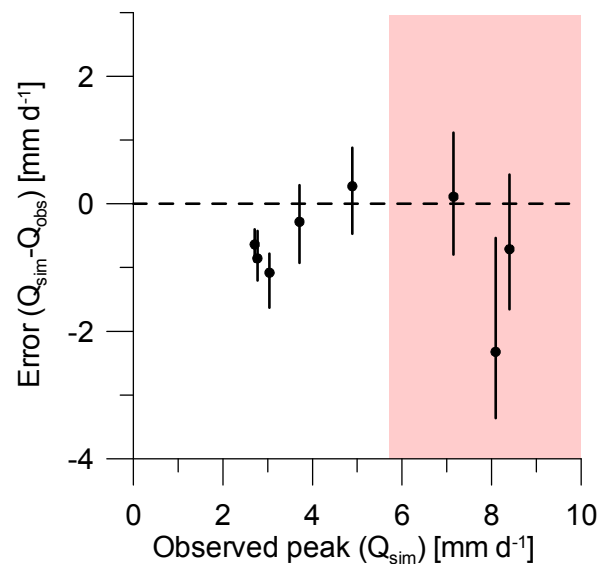
Lefsebäcken



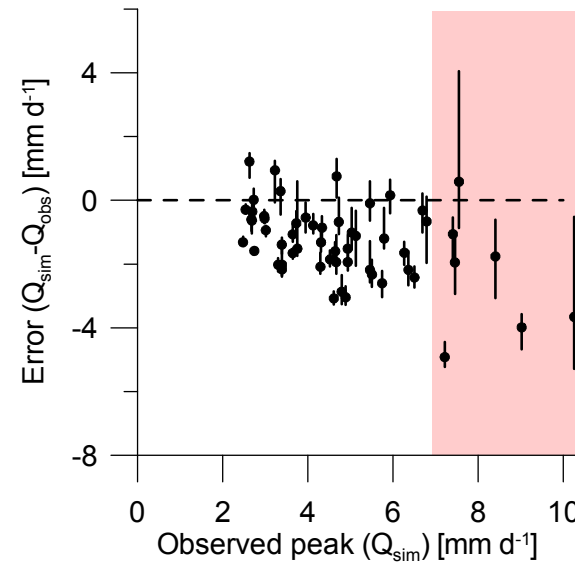
Tärnsjö



Lilla Tivsjön



Nolsjön



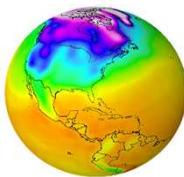
Challenge: Hydrological Impact Studies

GHG Emission Scenarios

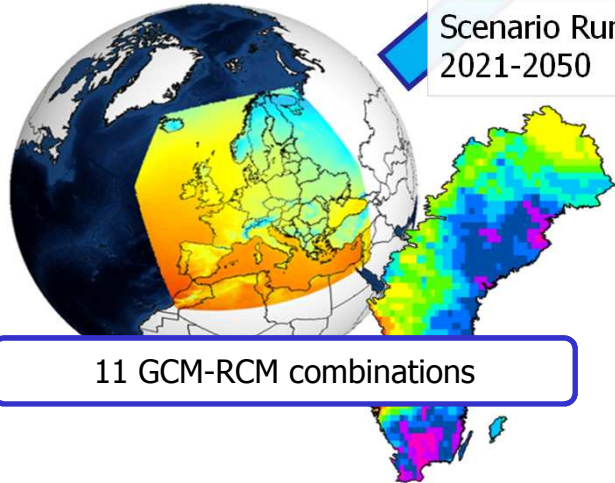


A1B

GCMs



RCMs



11 GCM-RCM combinations

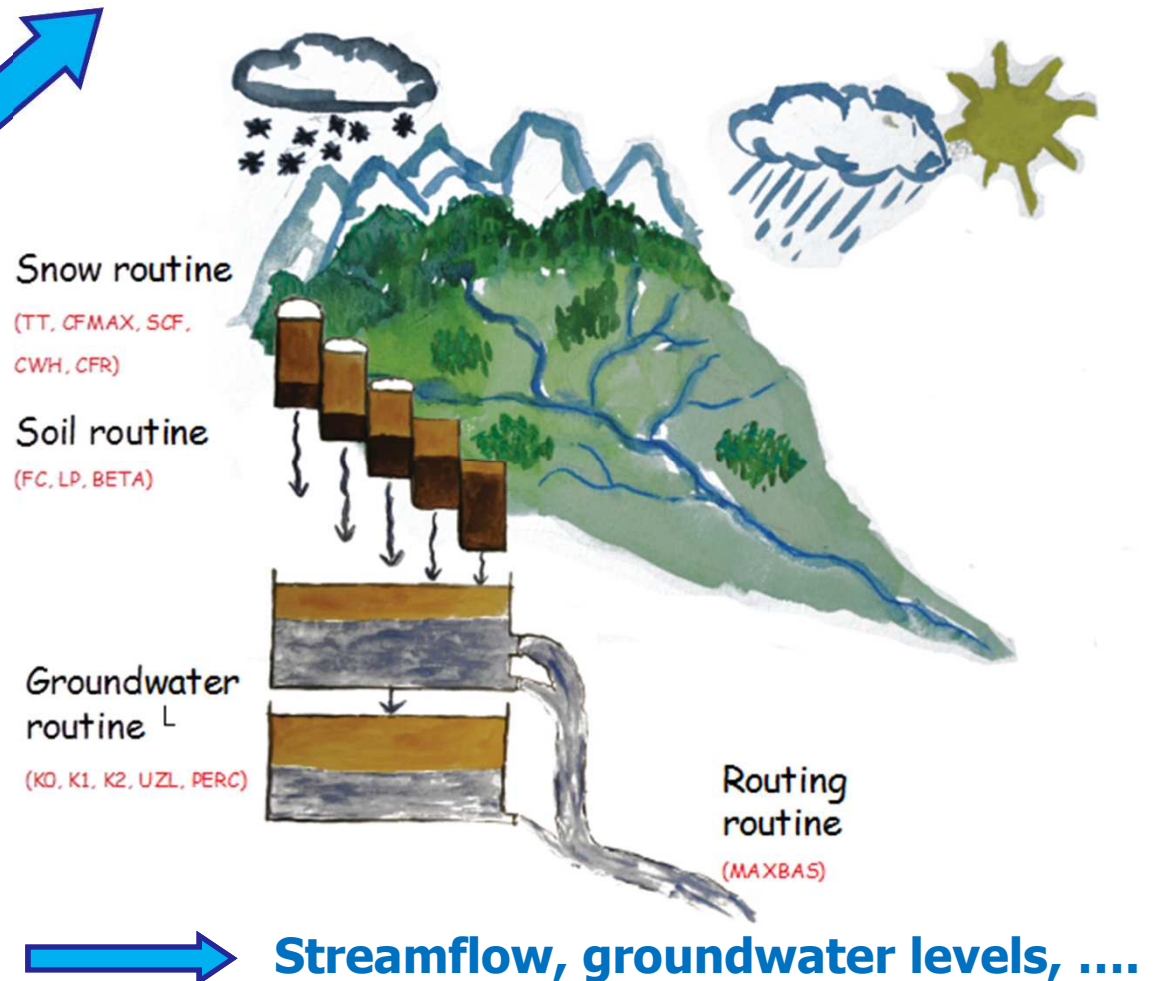
Control Run
1961-1990

Scenario Run
2021-2050

from ENSEMBLES EU project
[van der Linden & Mitchell, 2009]

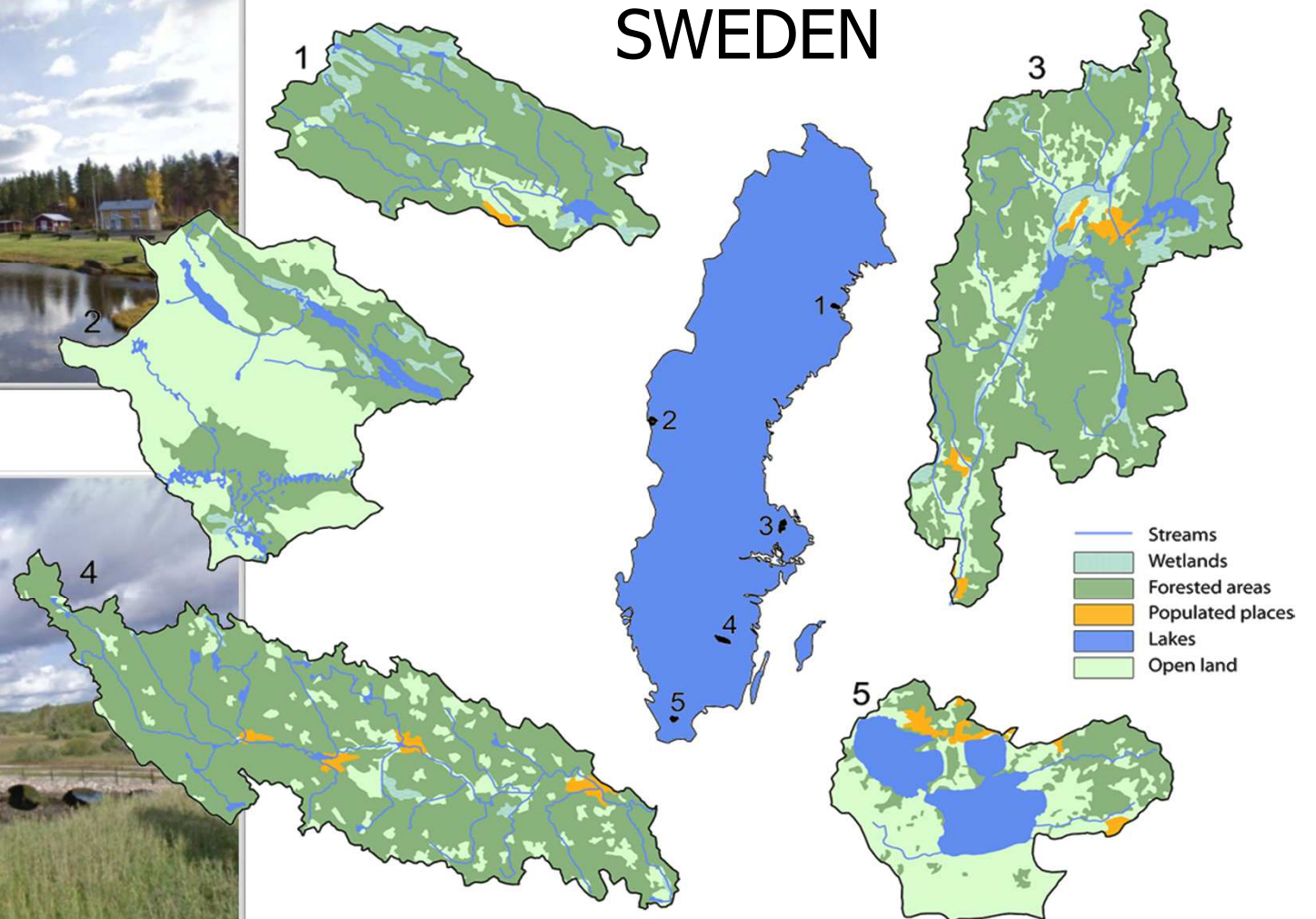
Temperature
Precipitation

Hydrological model
(e.g., HBV)

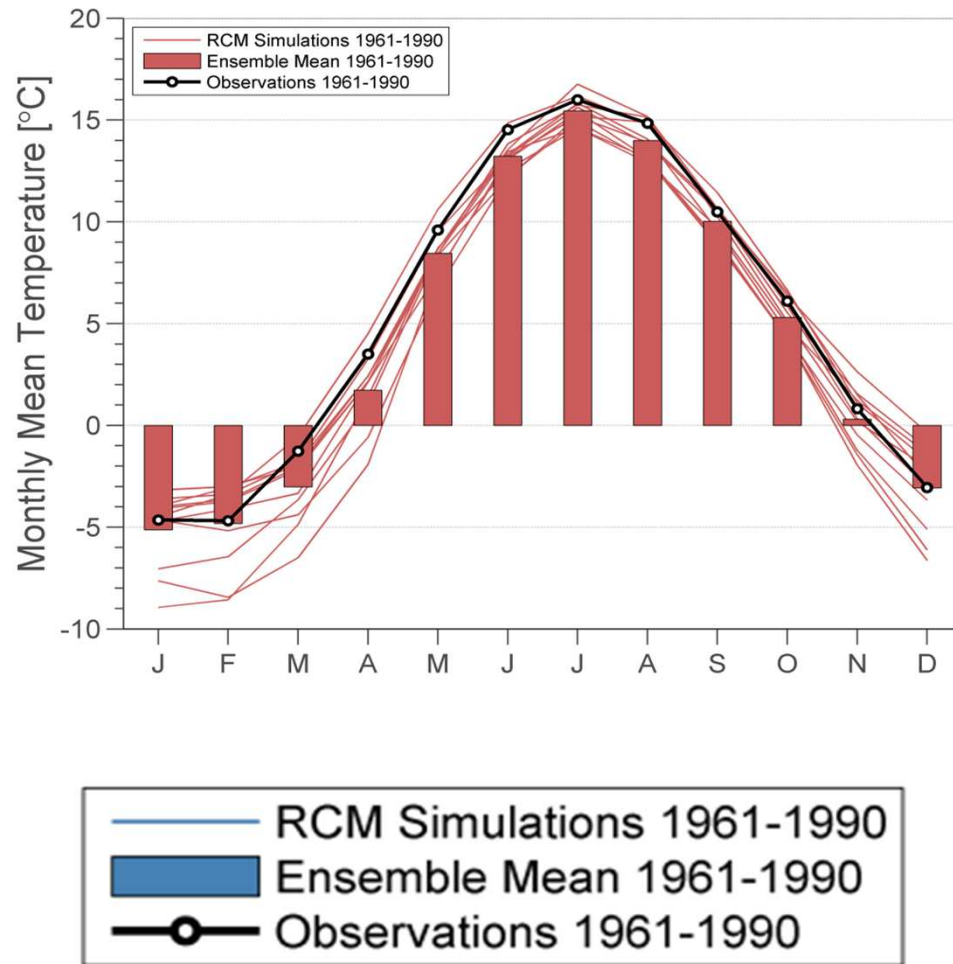


Streamflow, groundwater levels,

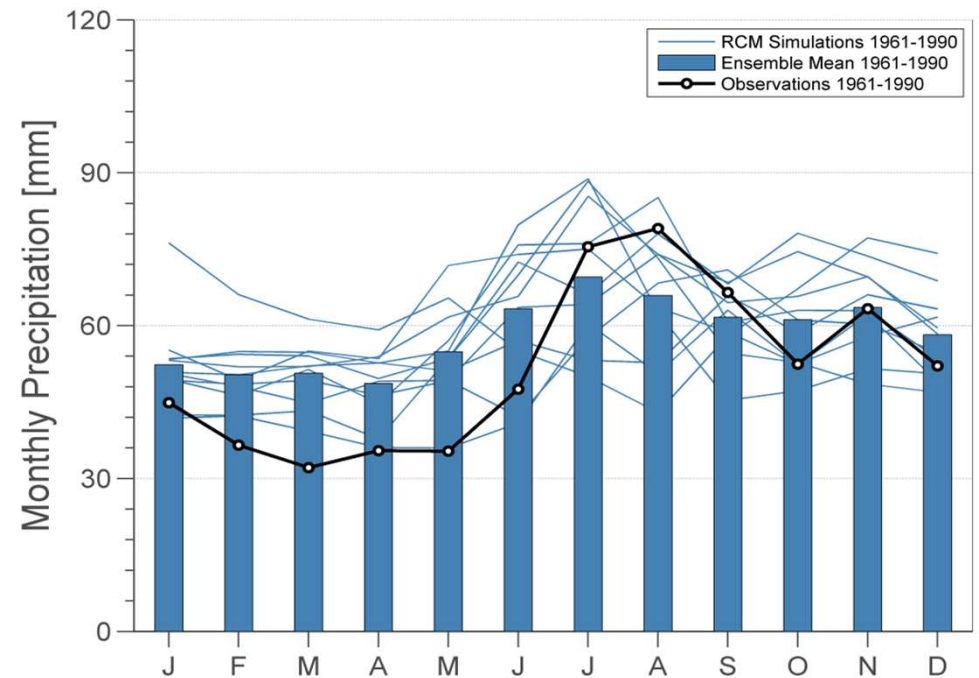
Study catchments in Sweden



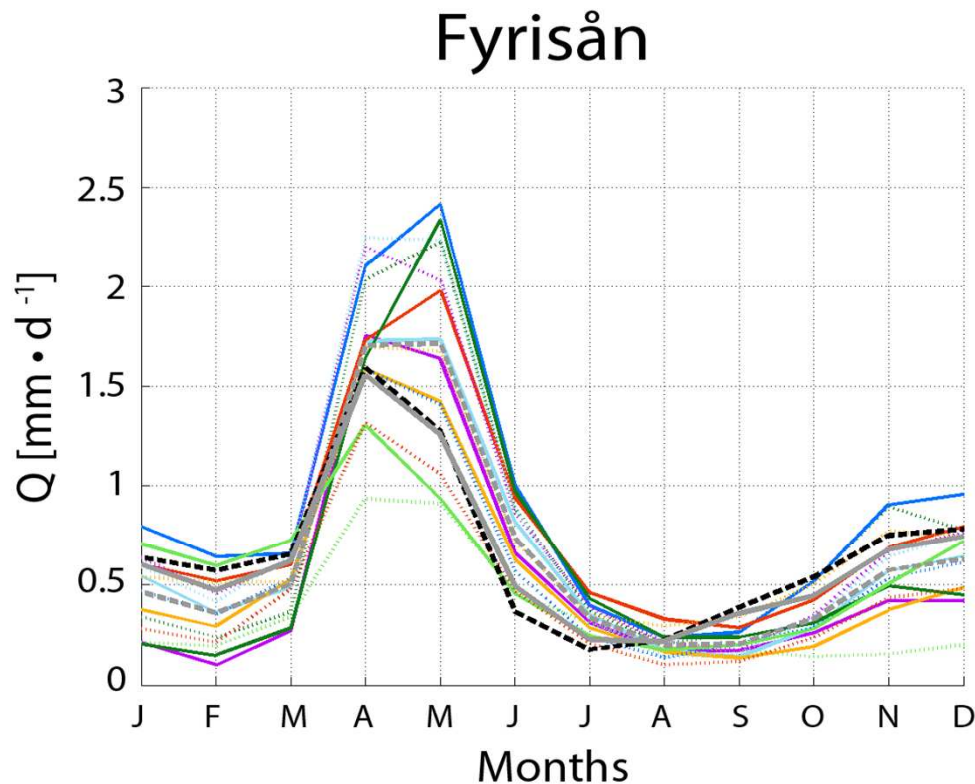
Raw RCM Output for current conditions



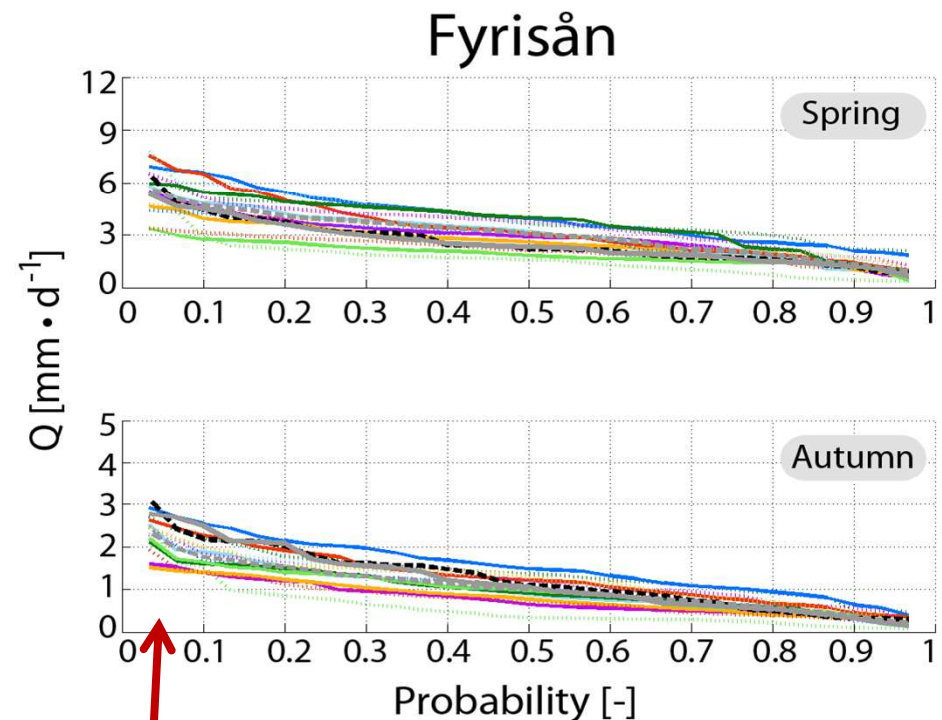
Control run 1961-1990



Raw RCM simulations: Simulated Streamflow and Flood Peaks

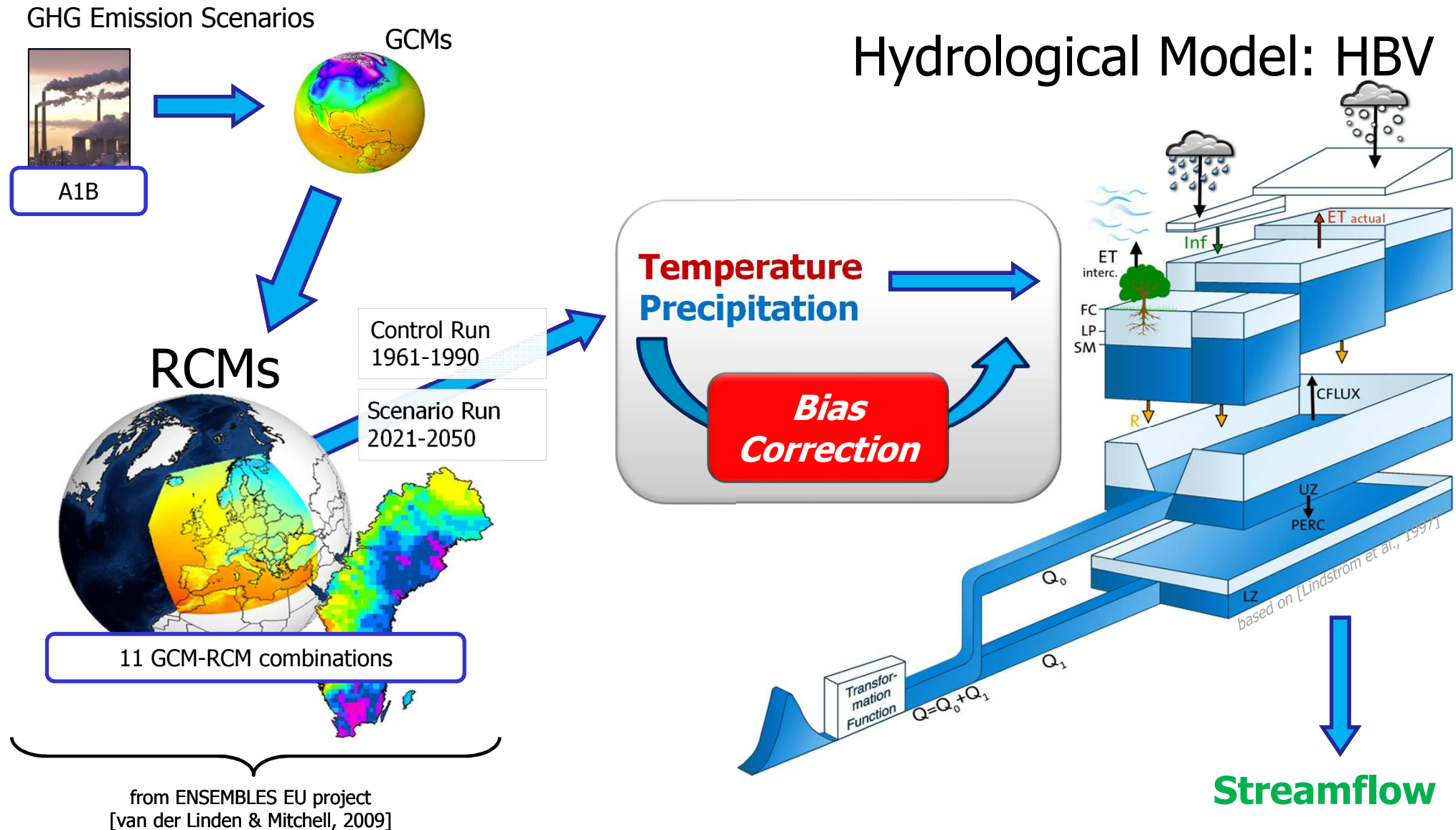


Control run 1961-1990

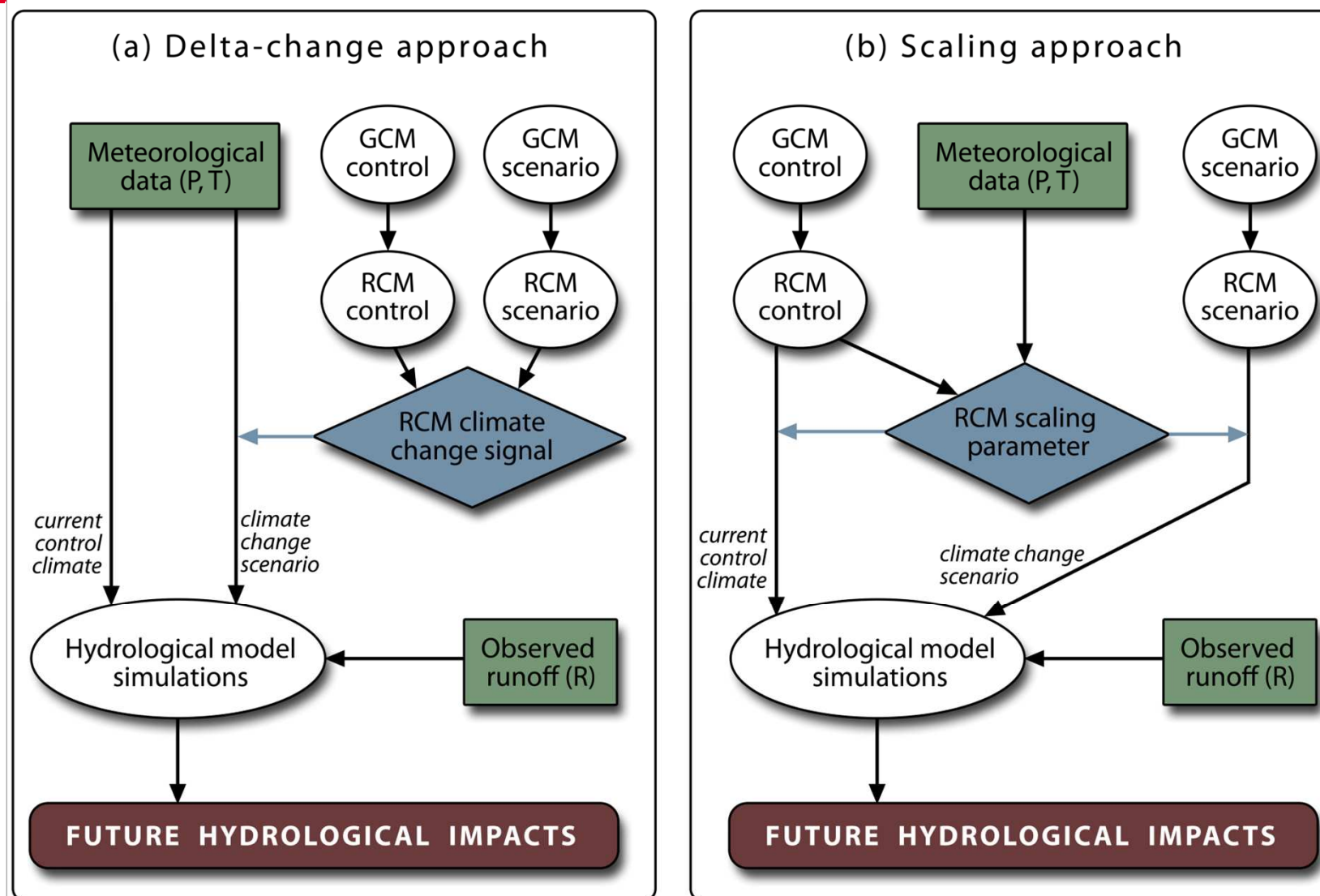


'30-year flood'

Design of Hydrological Impact Studies

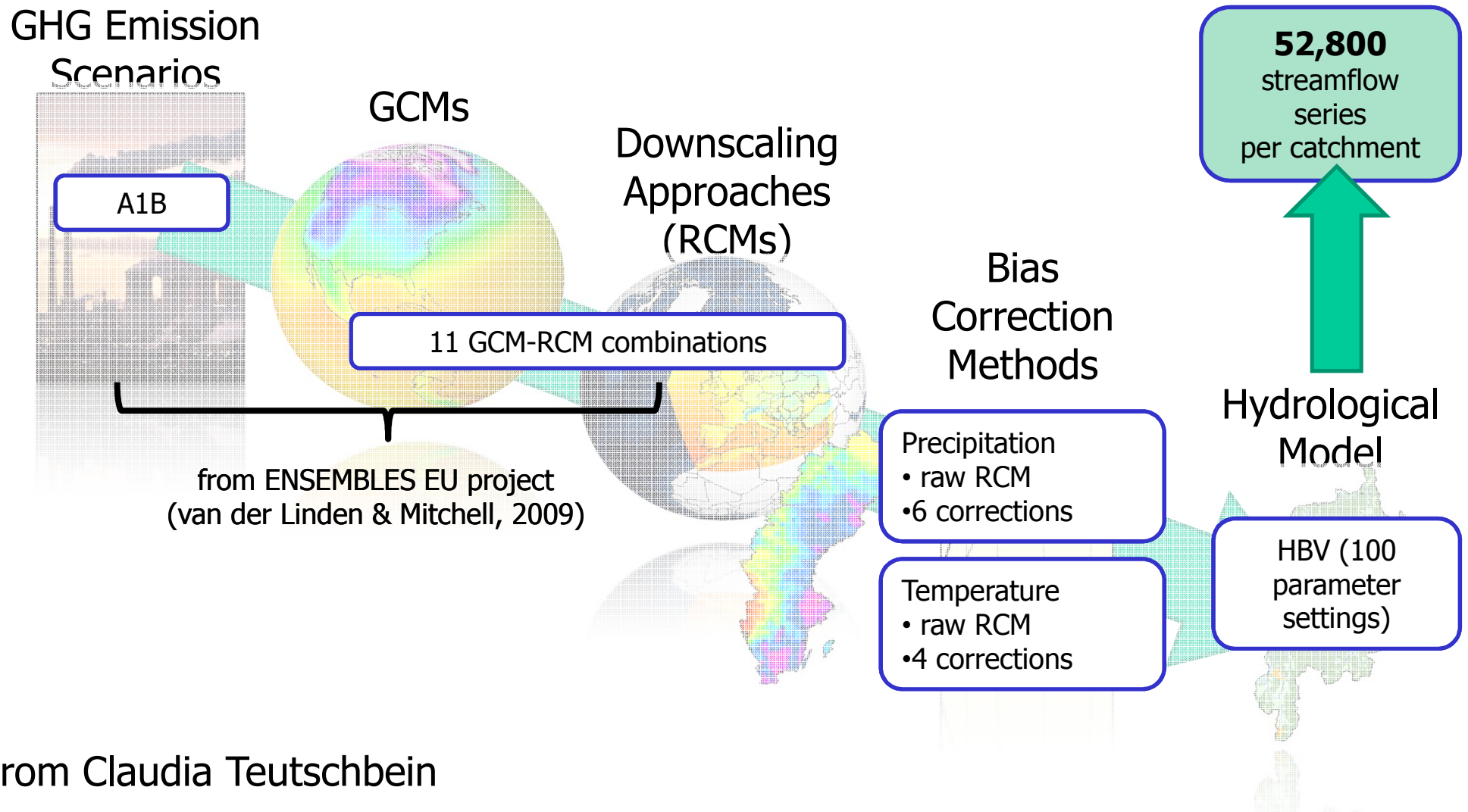


Bias-correction for RCM simulations in impact studies



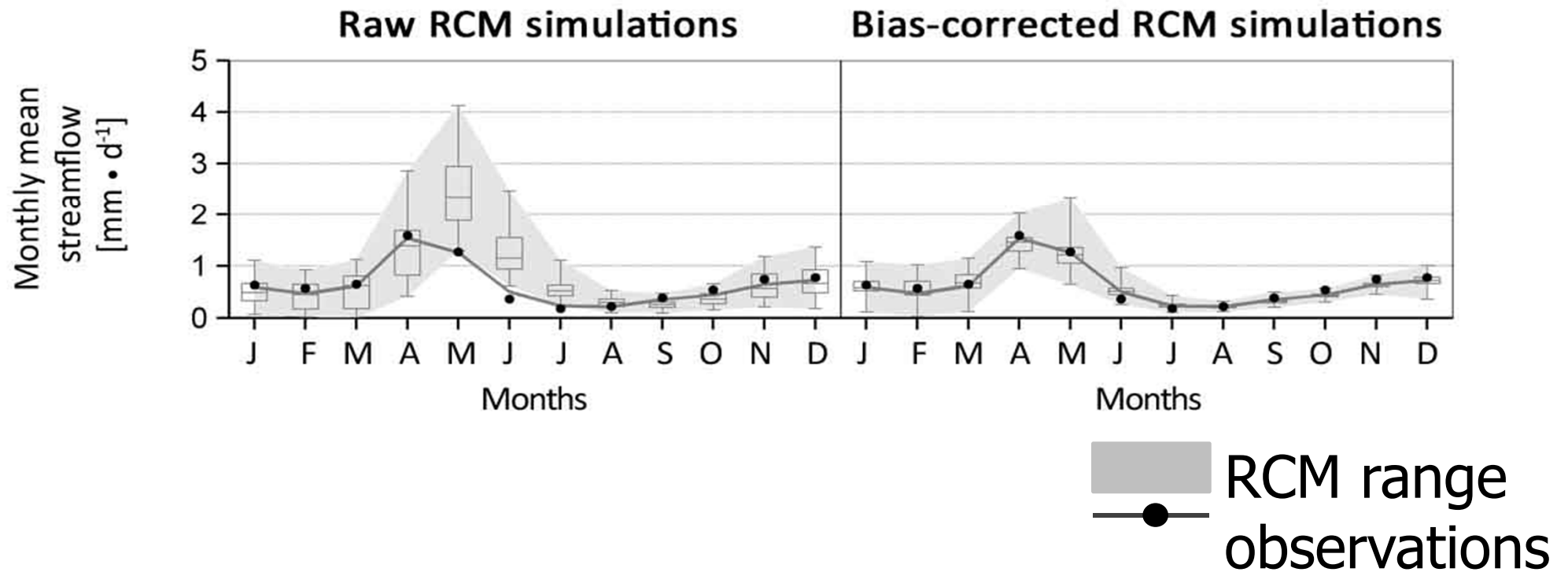
From Teutschbein and Seibert, 2010

Hydrological climate impact - modeling chain



From Claudia Teutschbein

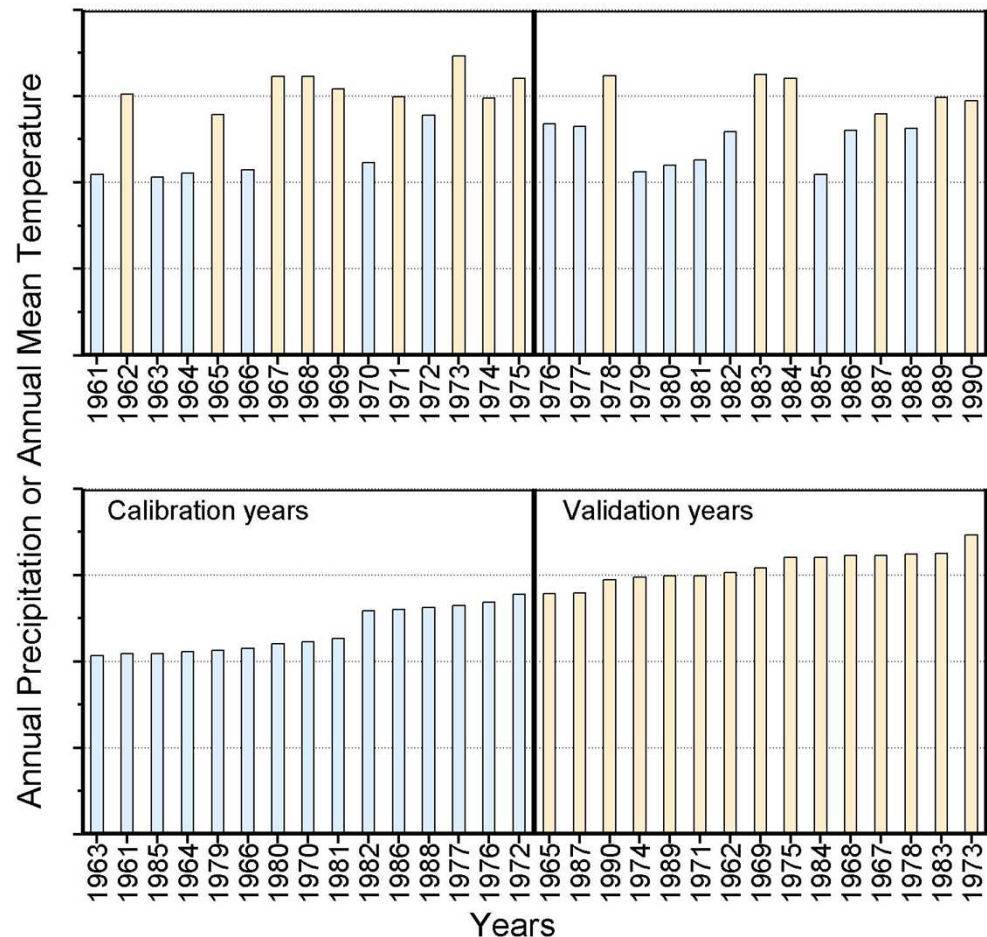
Results: Q_{seasonal} original vs. bias-corrected



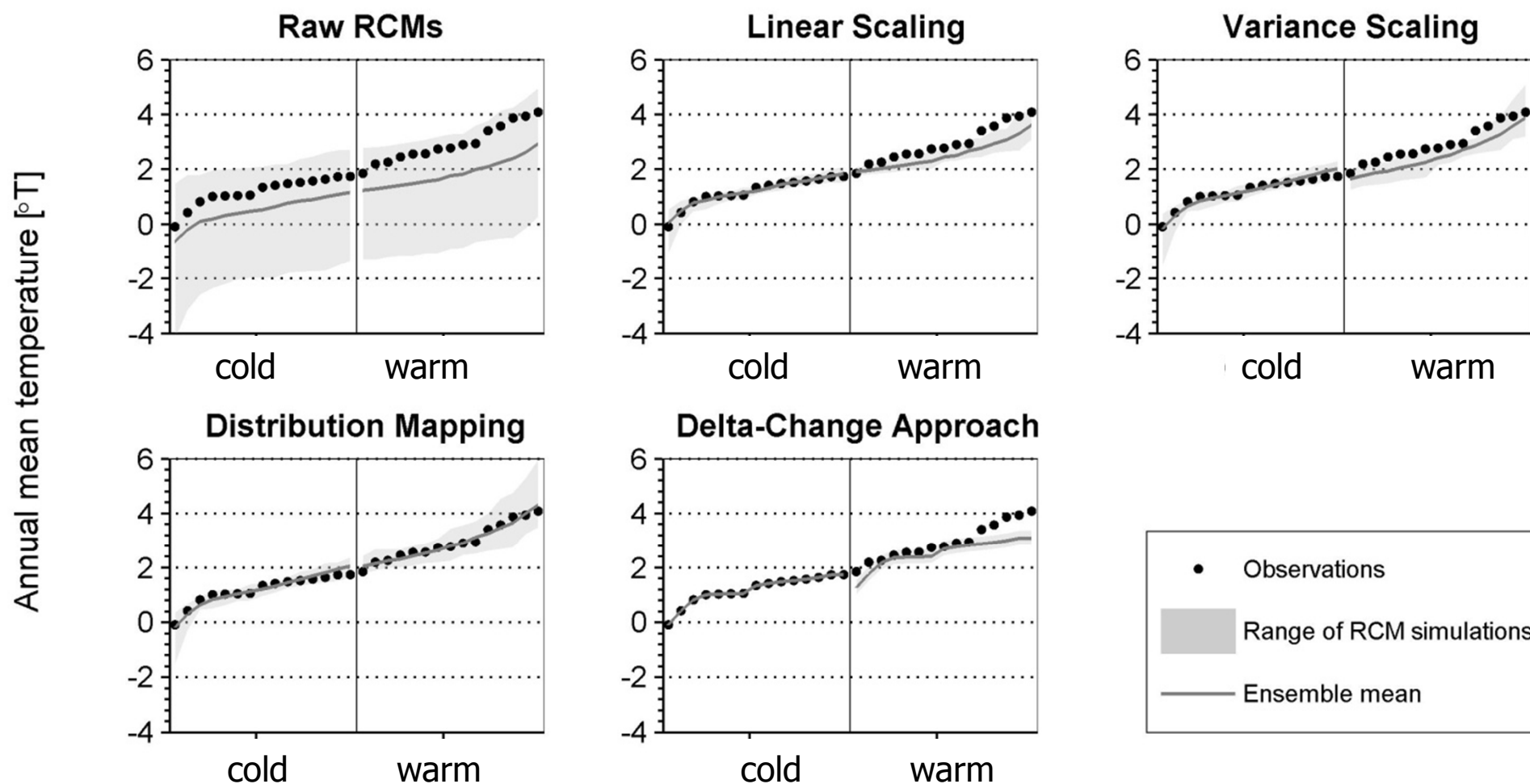
Bias correction for changed conditions?

Main assumption of
bias-correction
procedures:
**model errors are
stationary**

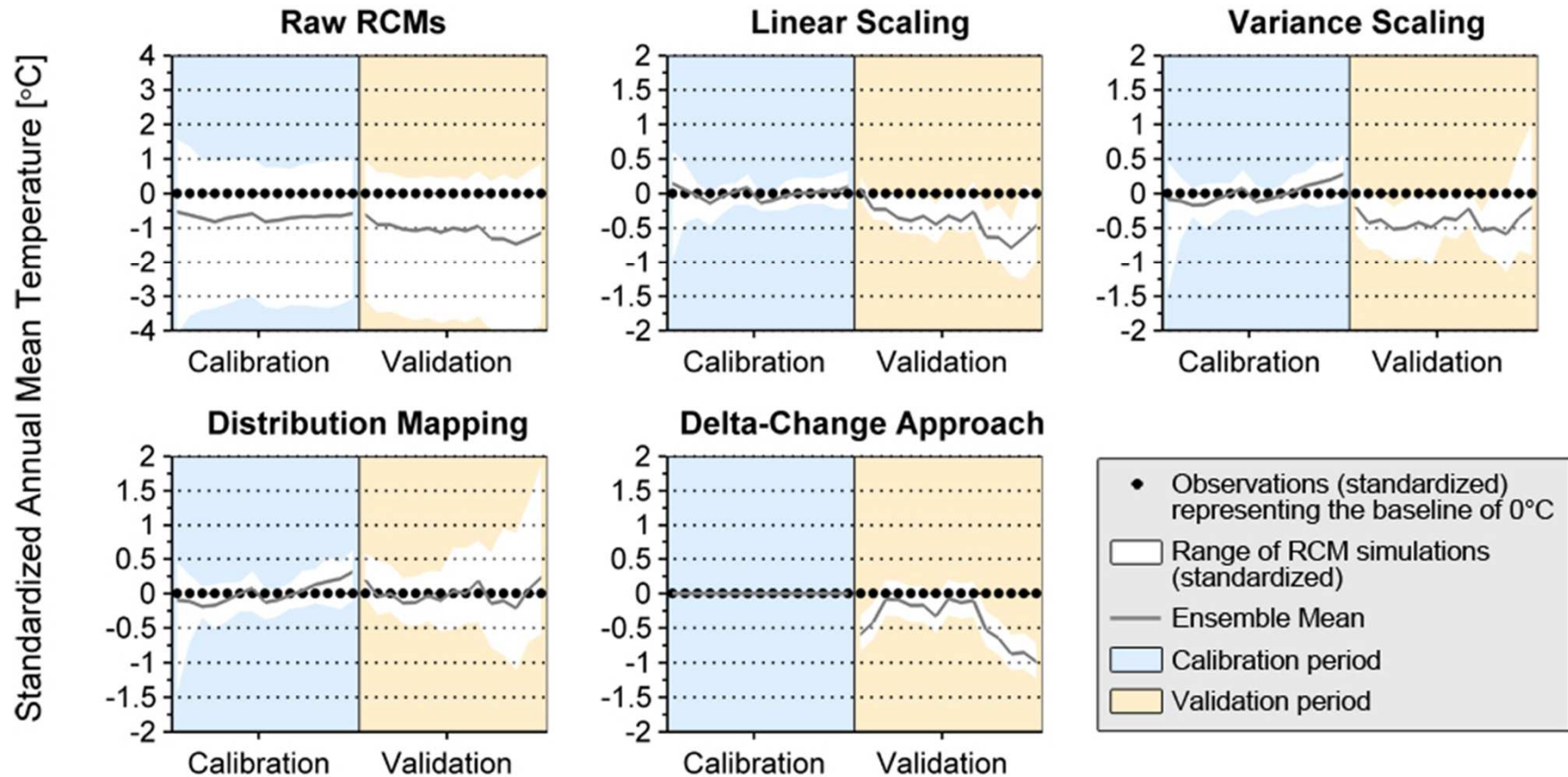
Differential split sample test



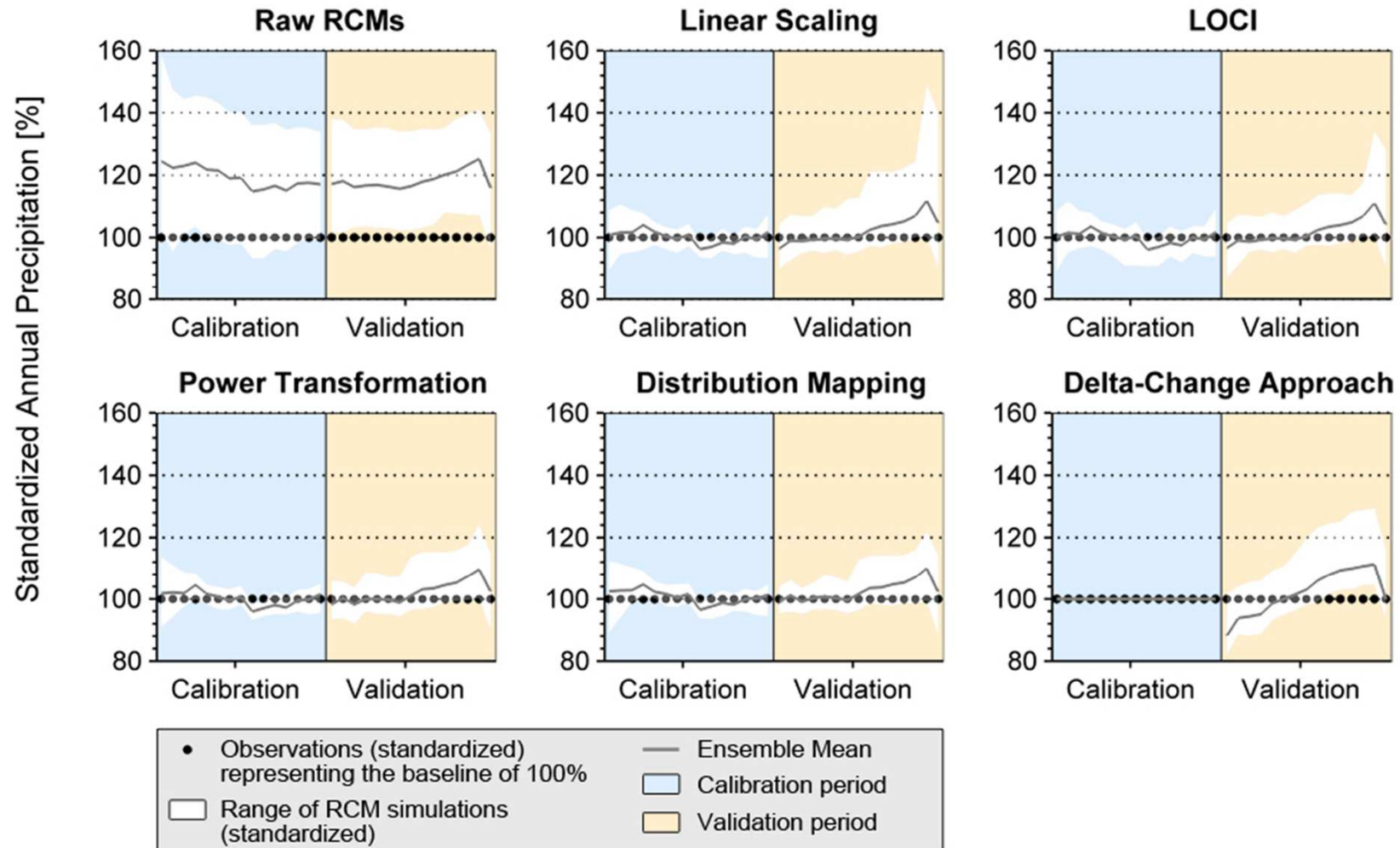
Temperature - Tännfors



Temperature - Storbäcken

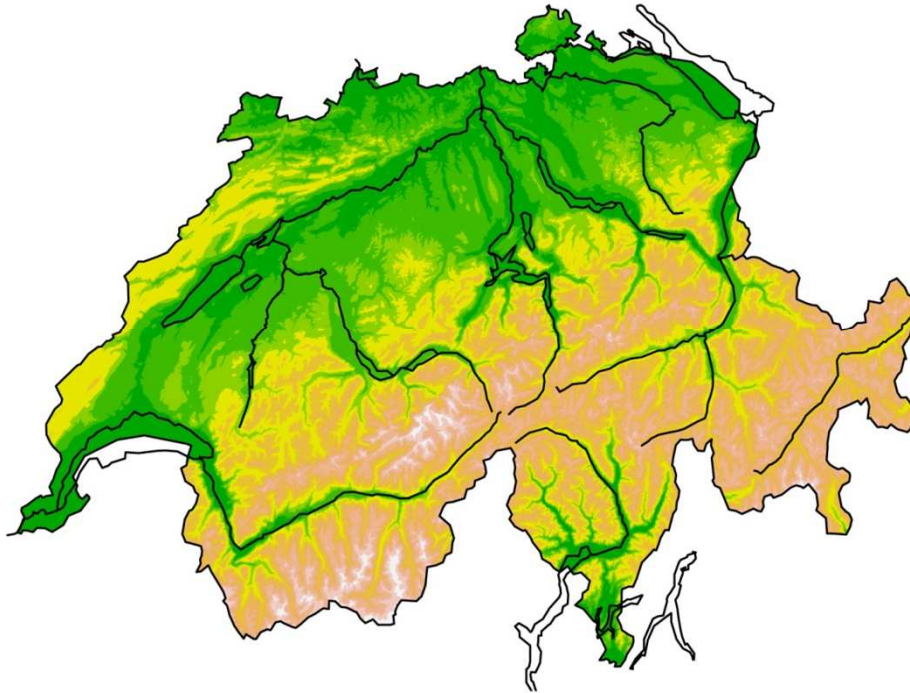


Precipitation - Brusafors

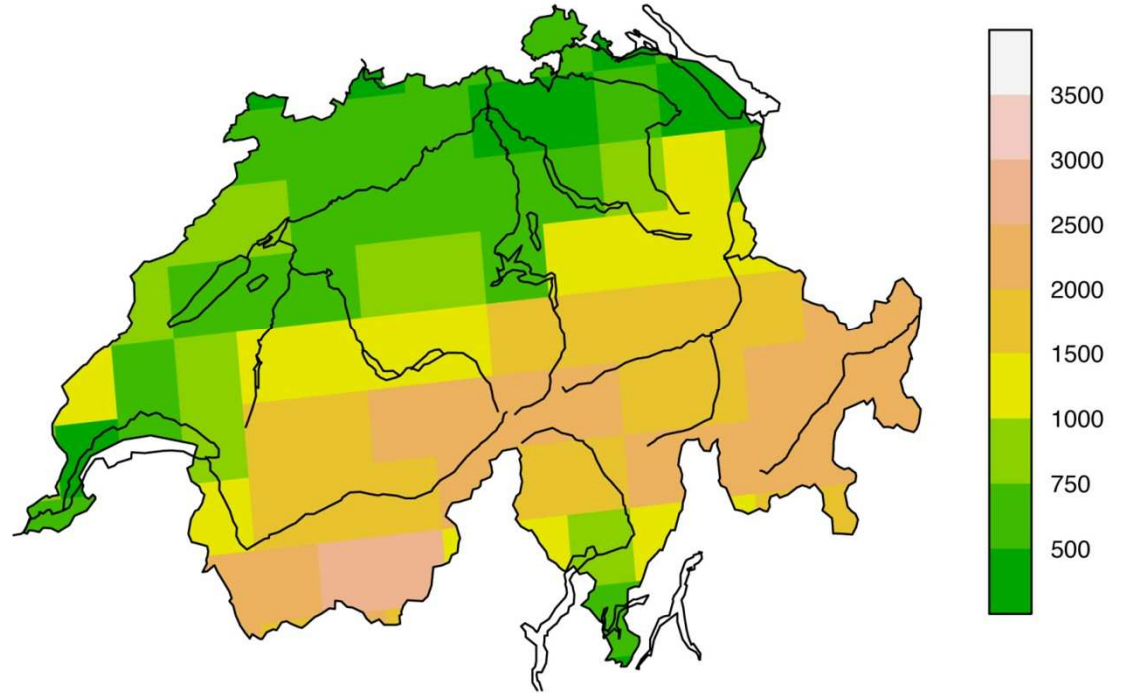


How does a RCM see Switzerland?

Altitude of swisstopo DEM (200m resolution) [masl]



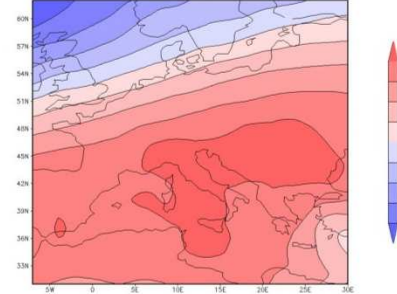
Altitude of ENSEMBLES ETHZ-CLM model grid points (25km resolution) [masl]



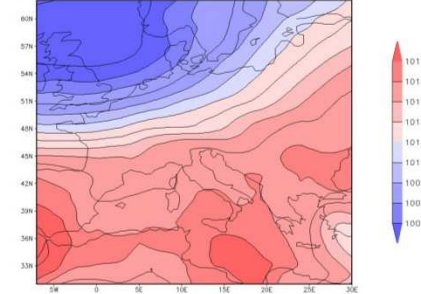
Weather patterns

(COST733 – Domain 06: Alps Cluster Analysis of Principal components)

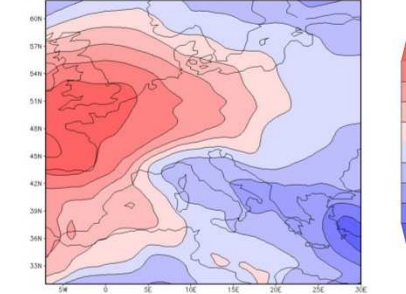
MSLP(year) for CAP09_YR_S01_SP_D06 type #03



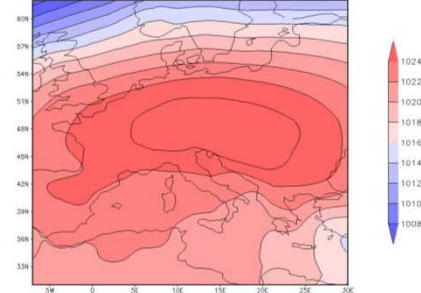
MSLP(year) for CAP09_YR_S01_SP_D06 type #02



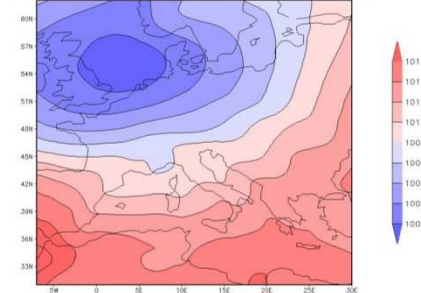
MSLP(year) for CAP09_YR_S01_SP_D06 type #01



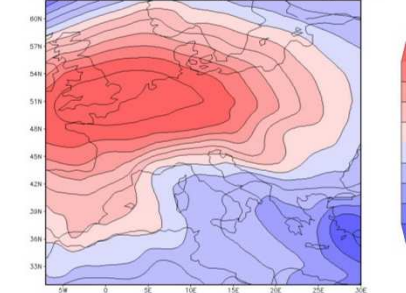
MSLP(year) for CAP09_YR_S01_SP_D06 type #05



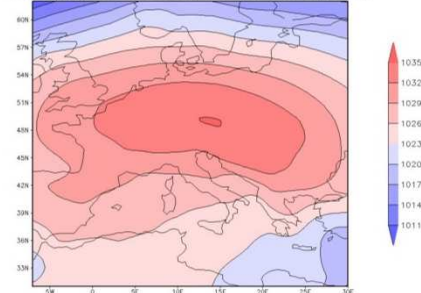
MSLP(year) for CAP09_YR_S01_SP_D06 type #07



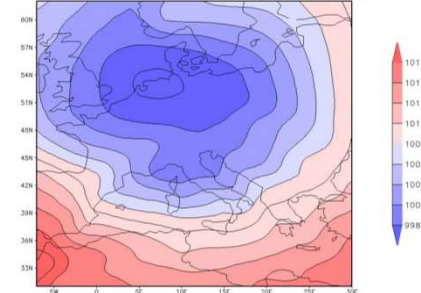
MSLP(year) for CAP09_YR_S01_SP_D06 type #04



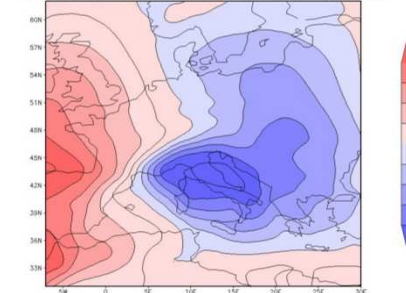
MSLP(year) for CAP09_YR_S01_SP_D06 type #08



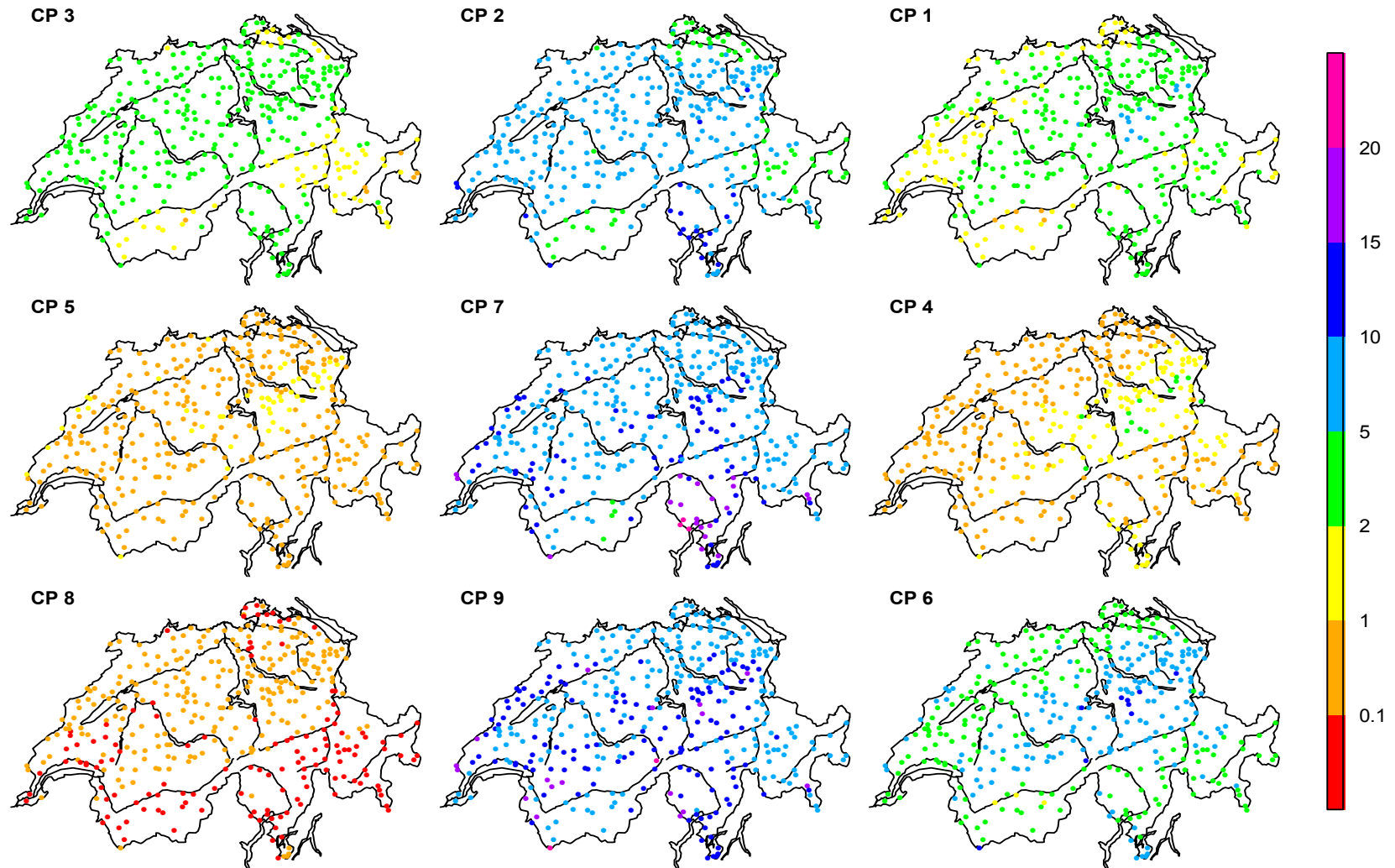
MSLP(year) for CAP09_YR_S01_SP_D06 type #09



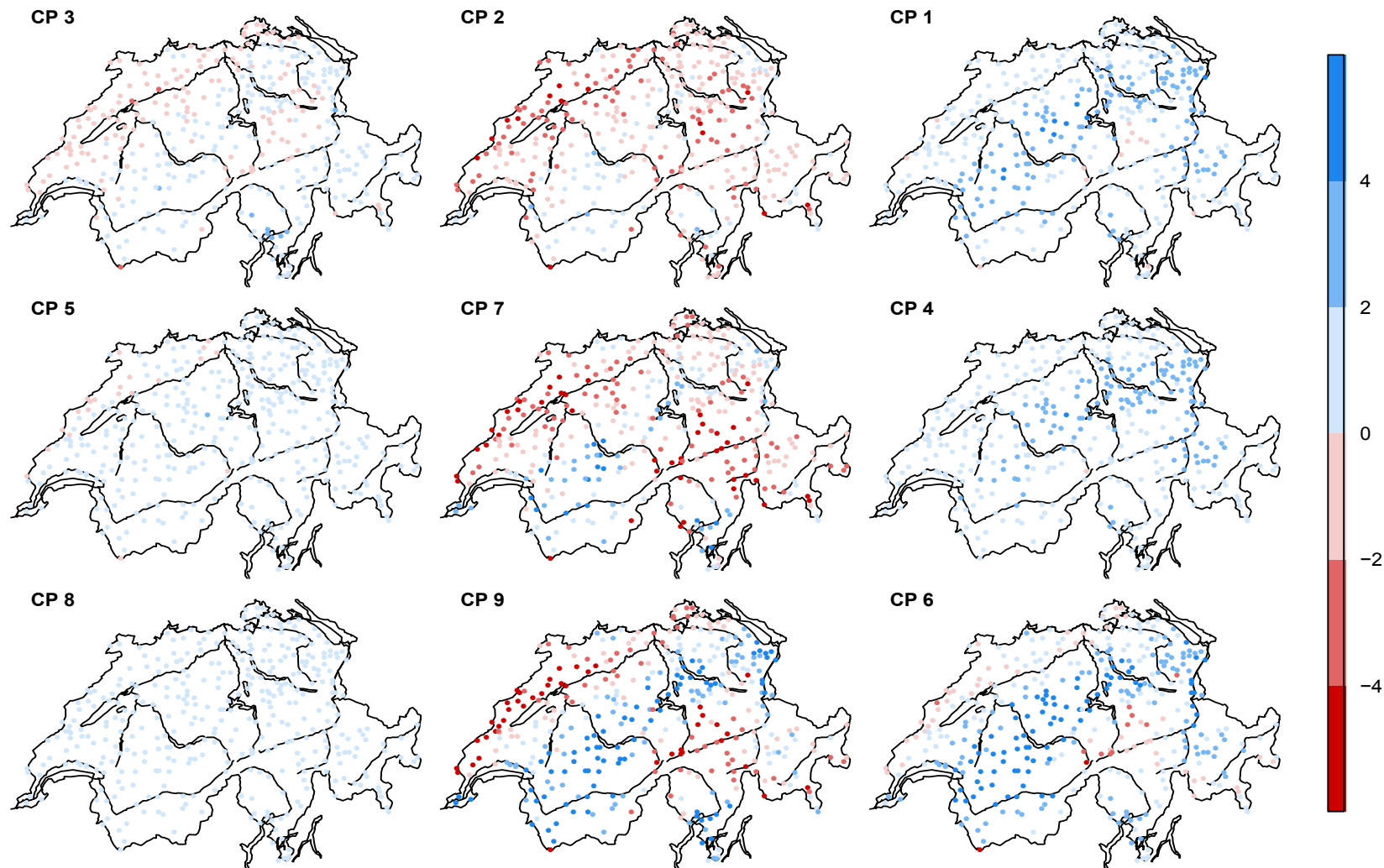
MSLP(year) for CAP09_YR_S01_SP_D06 type #06



Mean daily precipitation [mm/d]

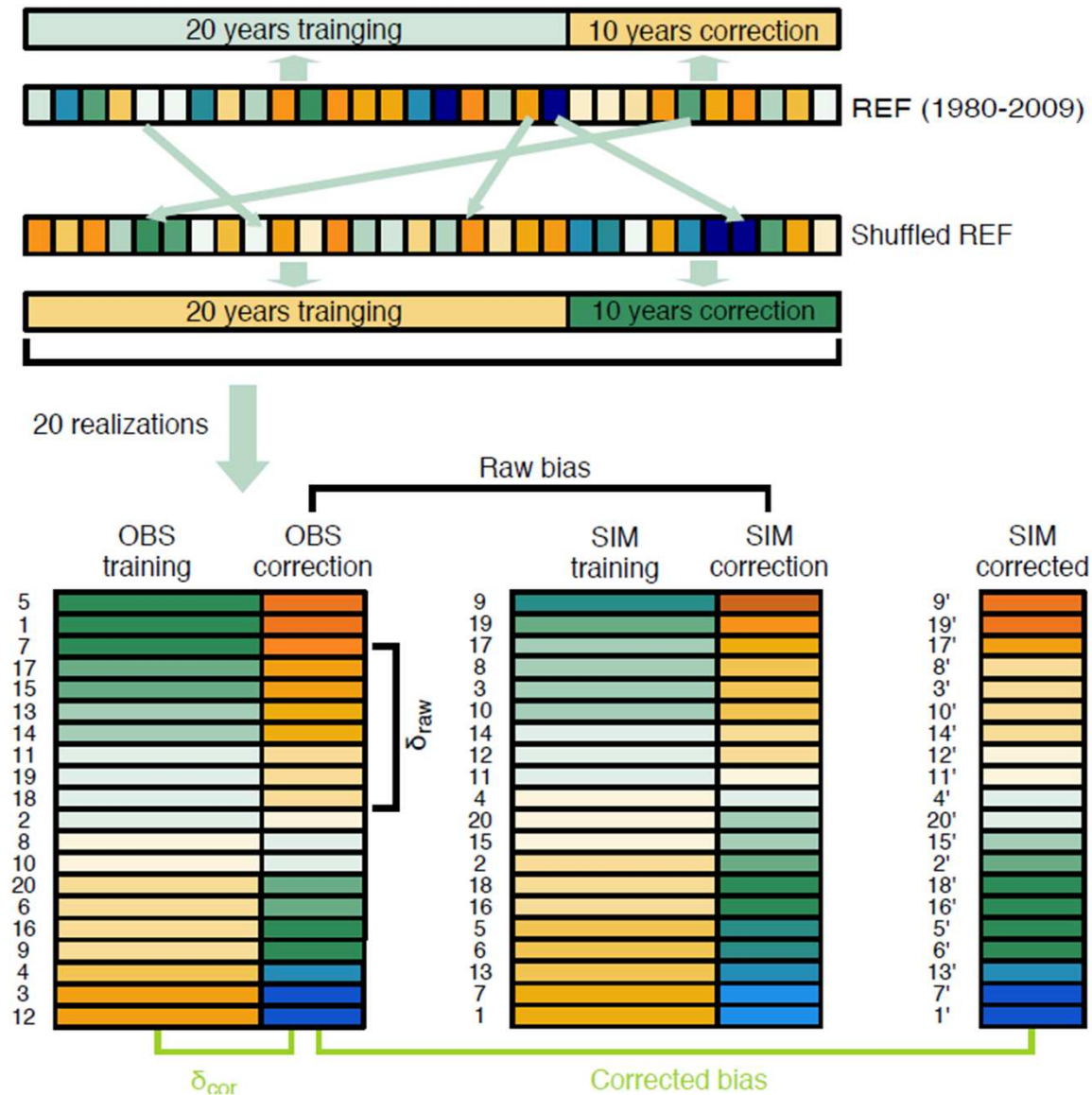


RCM bias for mean daily precipitation RCM – OBS [mm/d]

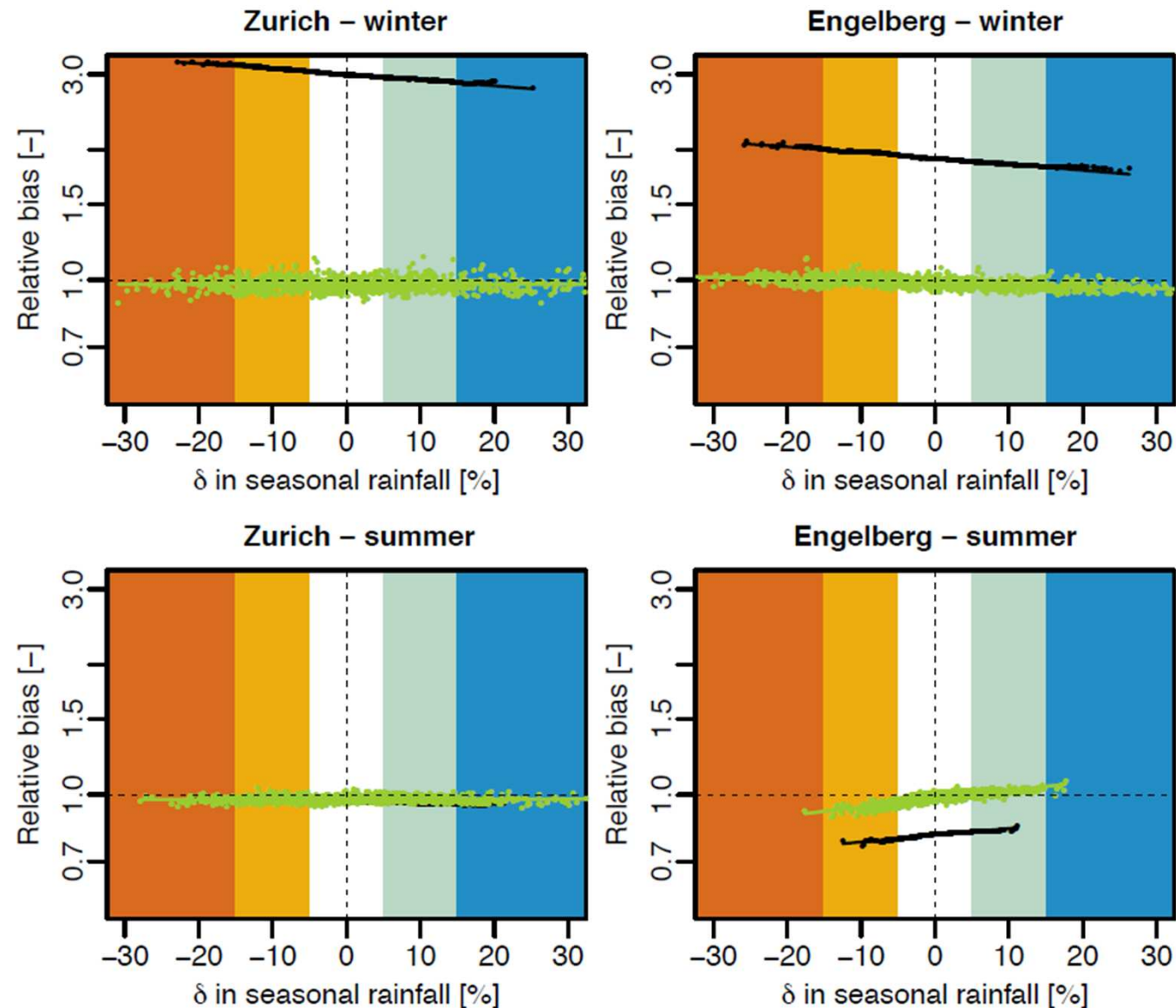


'Advanced' differential split sample test

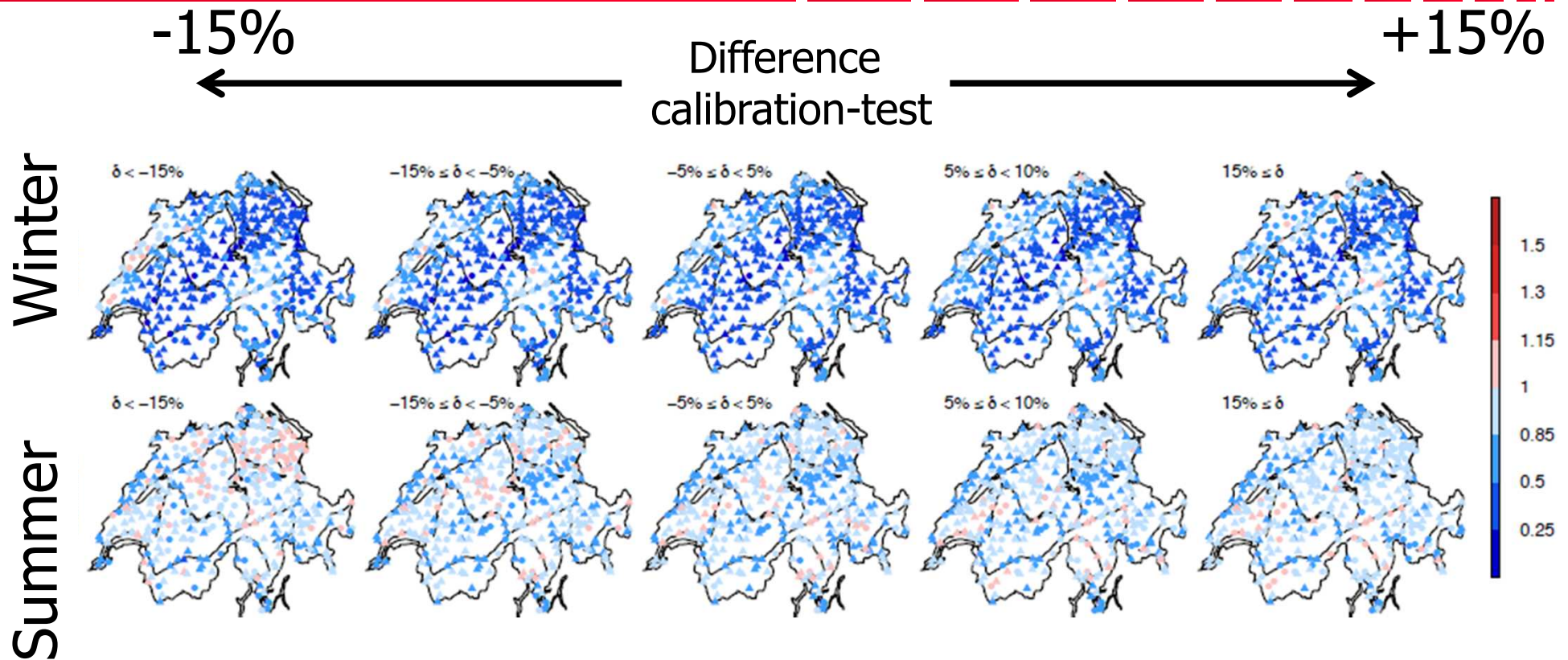
Nans Addor (based on Coron et al, 2012)



Quantile mapping of precipitation



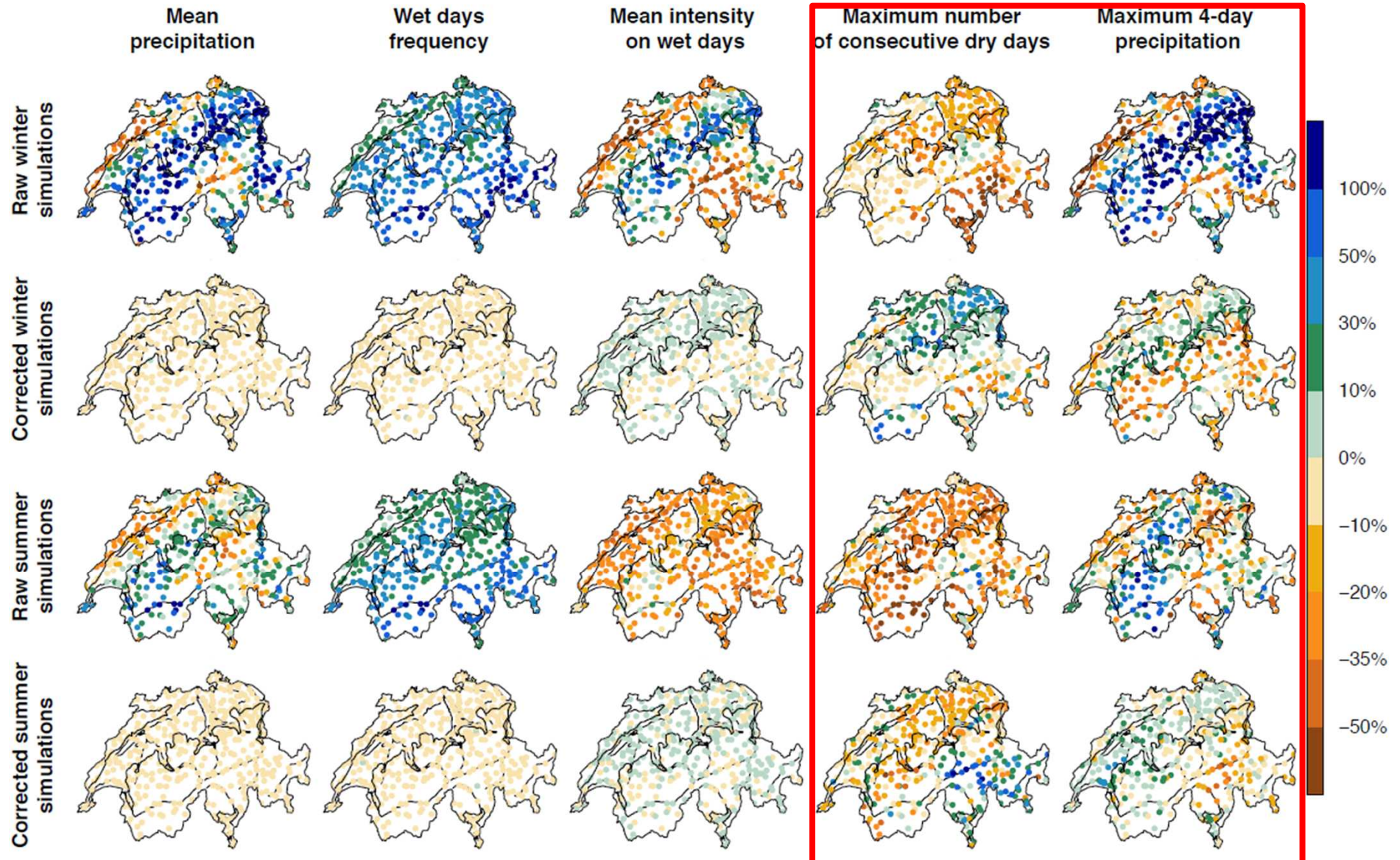
Differential split sample evaluation of precipitation bias correction



Blue: Bias correction reduces biases

Bias after correction: circles: $> 10\%$, triangles: $< 10\%$

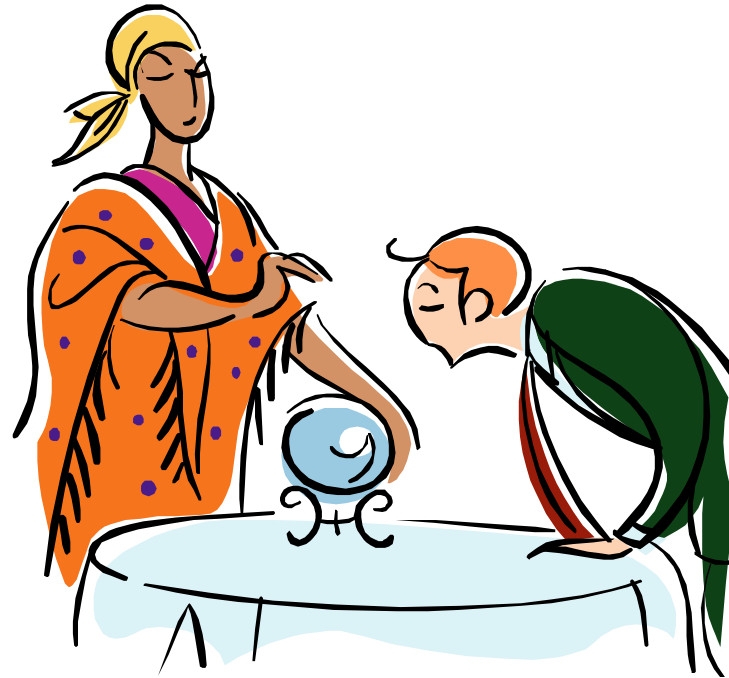
Hydrological relevant variables?



Short summary

Hydroclimatic modeling of the future
is an uncertain business!!!

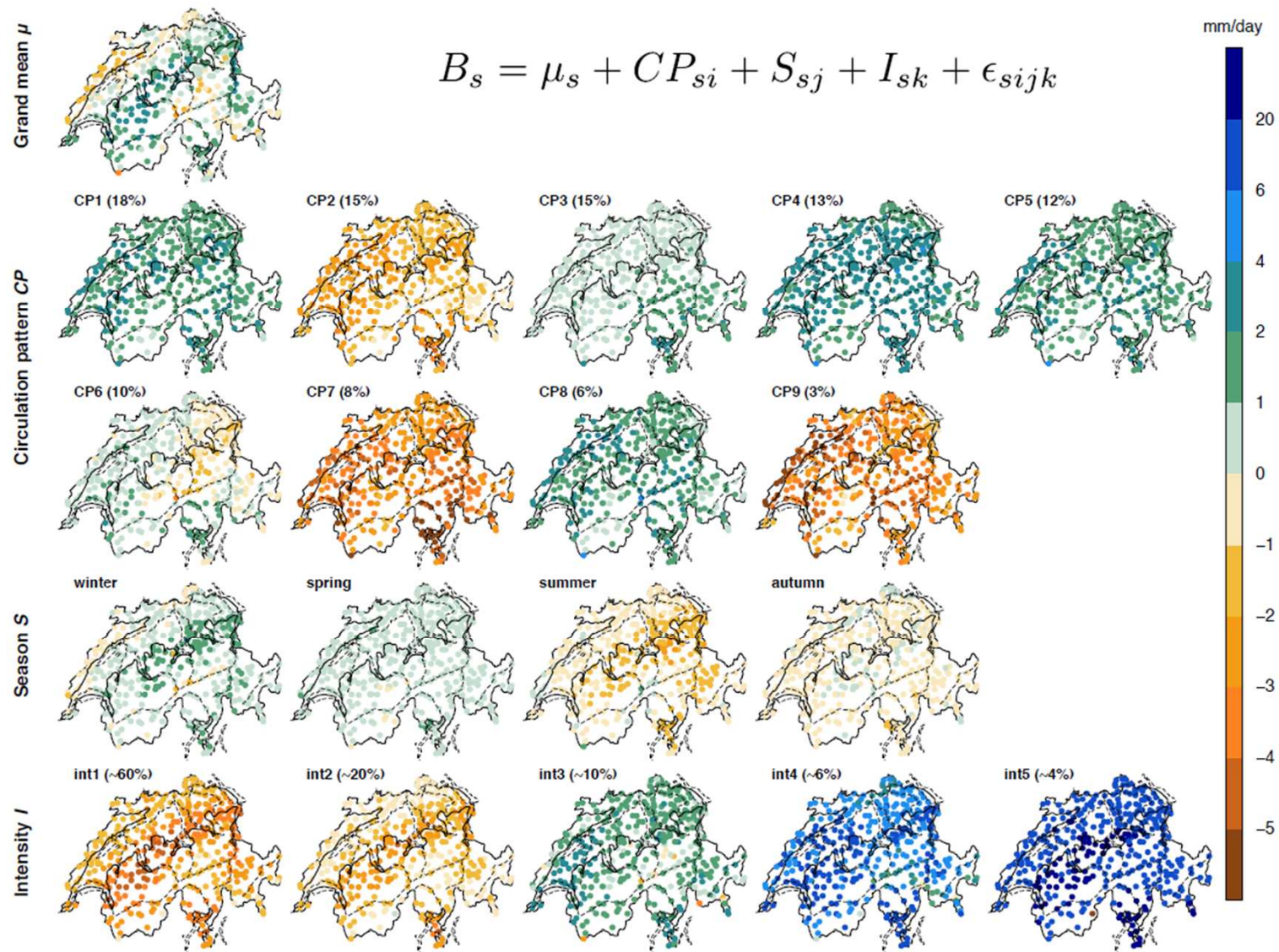
Be aware and
communicate
uncertainties!



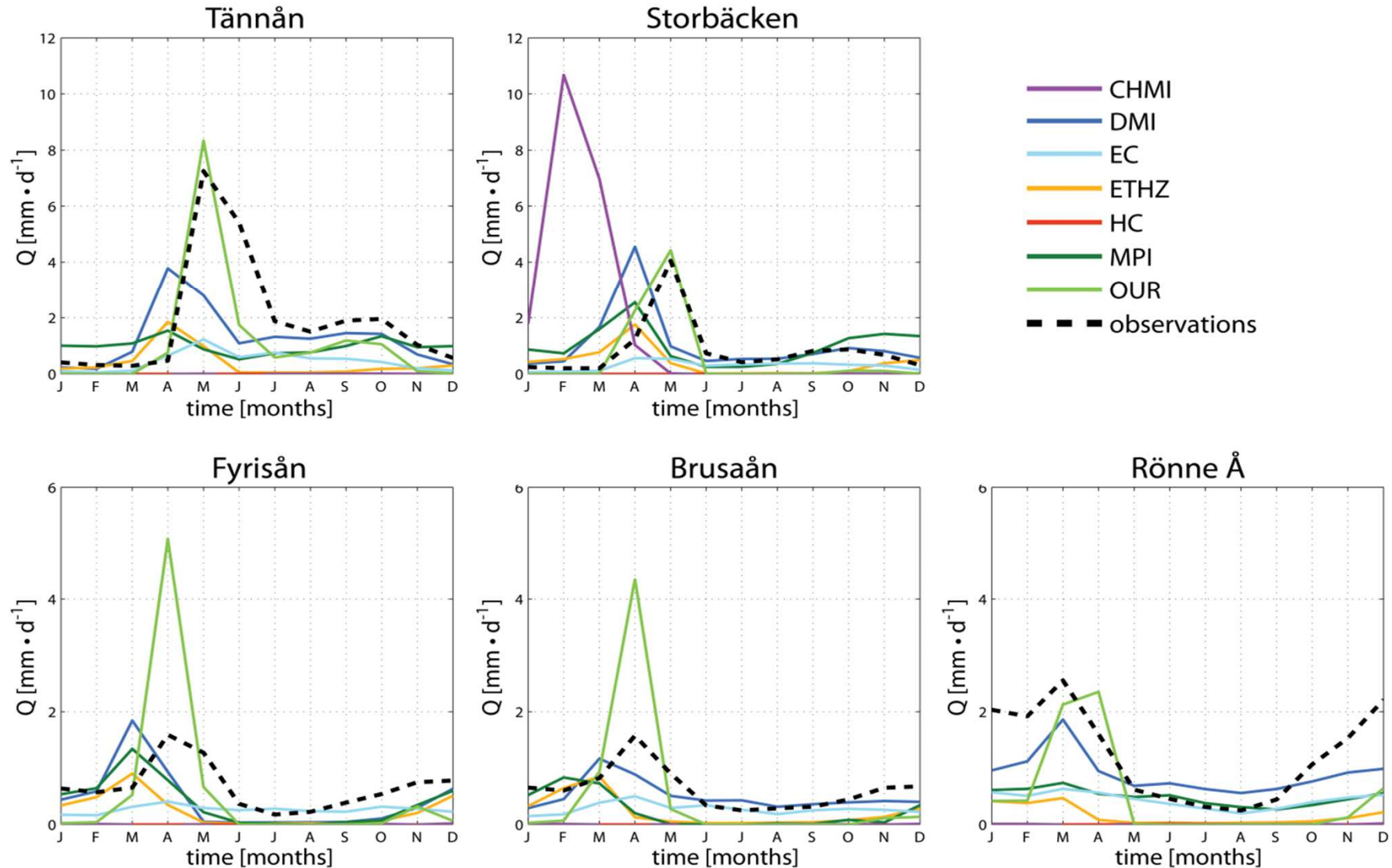
Challenge
model(s) with
hard tests!

Thank you!





Direct use of RCM streamflow?



Distribution mapping

