LUCCi
Land Use and Climate Change Interactions in Central Vietnam

KIT Karlsruher Institut für Technologie

Improved regional climate model data for climate change impact studies in the VGTB basin of Vietnam

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Introduction

Hydro-meteorological information is crucial for regional and local impact studies. Regional Climate Models (RCMs) are suitable to downscale large-scale climate information to regional (SE Asia, Fig. 1) and local (VGTB basin, Fig. 2) scales. After downscaling, there remains still a mismatch between observation data and high resolution RCM results. This holds especially true for precipitation, which is highly variable in space and time, and thus difficult to correct.
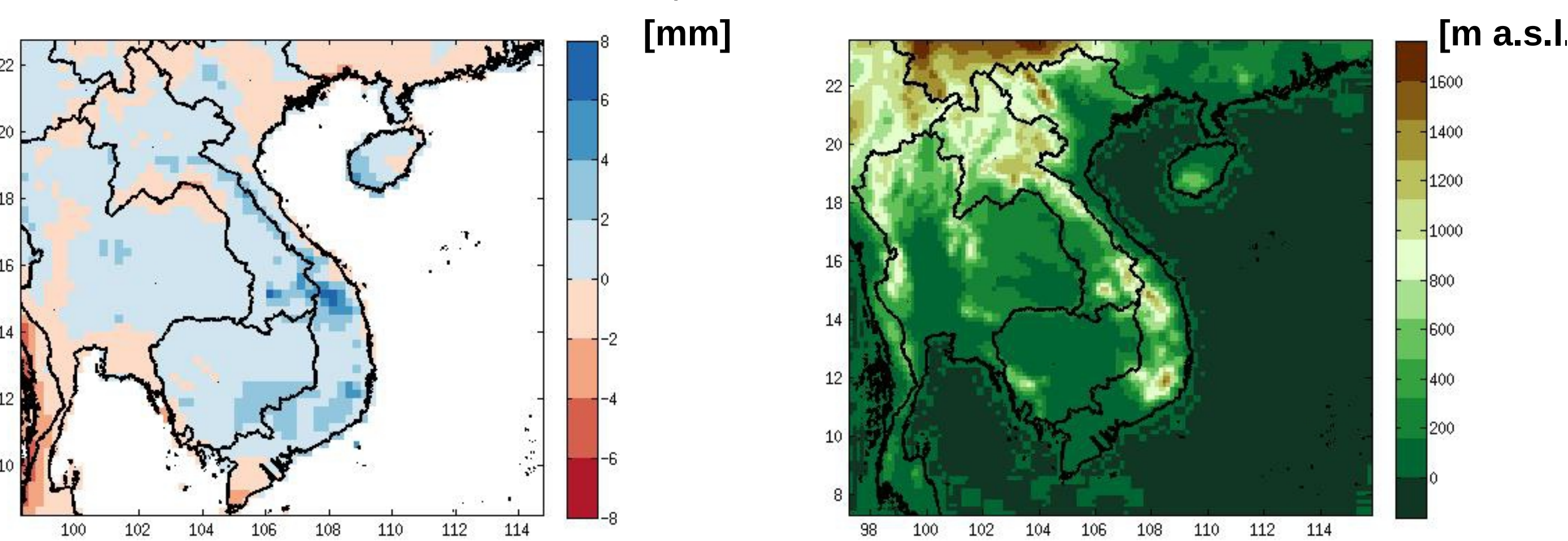

Fig. 1: Mean daily precipitation bias (WRF-ERA40 minus APHRODITE) for 1971-2000, (left). WRF-ERA40 (**@Domain2: 15x15 km**) is re-gridded onto the APHRODITE grid (0.25°) using bilinear interpolation. Digital elevation model (DEM) as used in the WRF-ERA40 simulations (right).

→ **Wet bias of WRF-ERA40 @Domain2 is observed, which is higher for complex terrain (Fig. 1)**
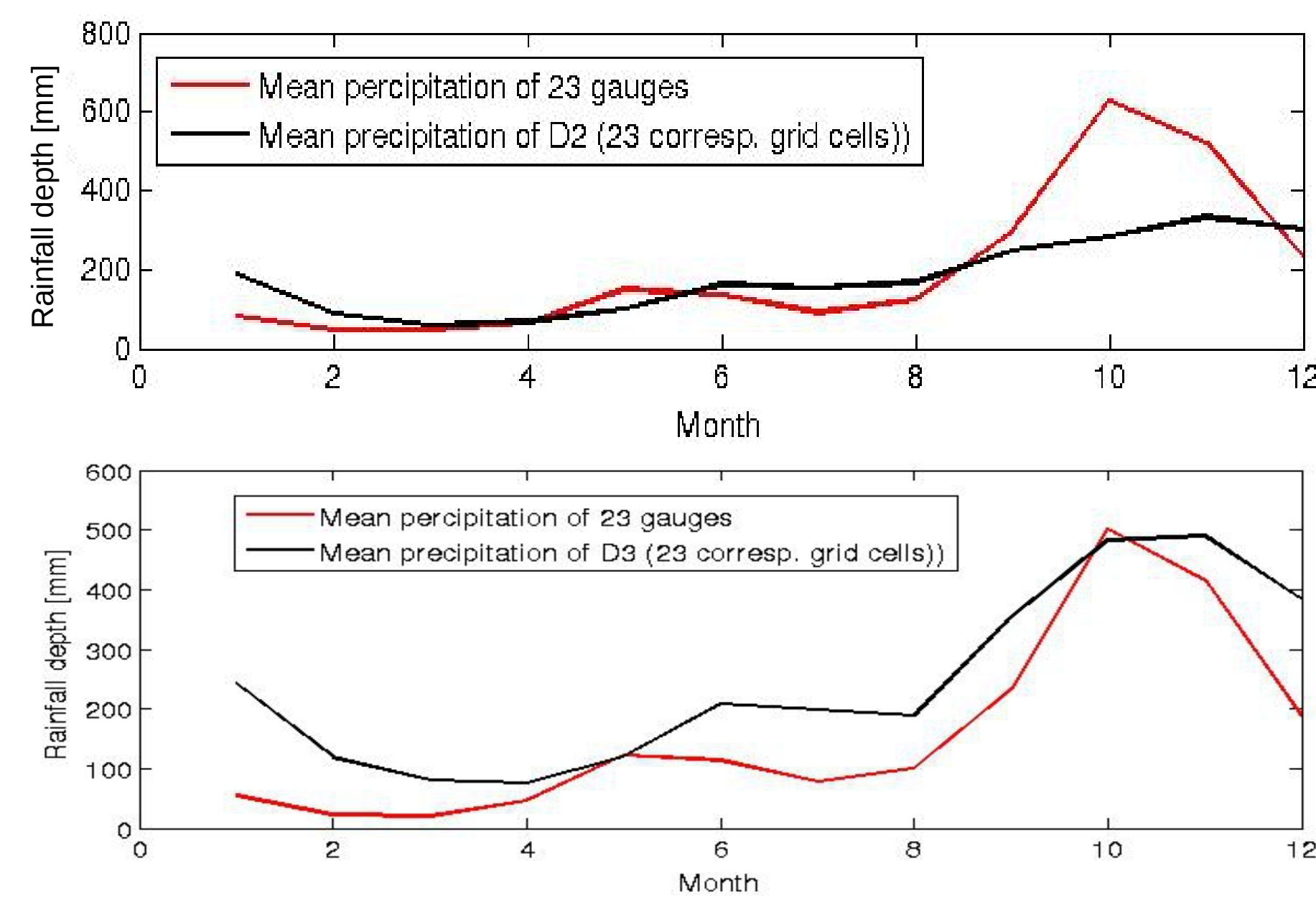→ **Problems to capture seasonality (Fig. 2, top)**

Fig. 2: Mean monthly precipitation amount obtained by WRF-ERA40 for **Domain 1, 5x5 km (top) and Domain 2, 15x15km (bottom)** at grid cells corresponding to **23 rain gauges** in the Vu Gia-Thu Bon basin (1971-2000).

For WRF-ERA40 @Domain3:
→Still wet bias, but significantly reduced during the rainy period (SOND)
→ Seasonality of precipitation well captured (Fig. 2, bottom)

Bias correction methods:

1. **Mean correction:**
   • Linear approach based on long-term monthly correction factors
   • Easy applicable for future climate projections

2. **Quantile mapping:**
   • Corrects for the statistical distribution (here: performed for extreme and normal part of distribution separately)
   • Easy applicable to future climate projections, but historical (daily) values cannot be exceeded

3. **Copula-based correction (still experimental stage):**
   • Dynamic approach (performed for each time step separately) and based on the concept of Copulas.
   • Models dependence structure (Copula) between variables (here: RCM and observed precipitation, but can be extended to multivariate)
   • Generates a probability density function (PDF) for each time step → allows uncertainty estimation
   • Spatial extension: Estimate time series for location between the observation stations (based on concept of similarity)
   • New and promising approach (Laux et al., 2011; Vogl et al., 2012), but not yet applicable to correct future climate projections

Objectives

→Analyze **skill** of different bias correction methods
→ Provide a **set of corrected data** to local stakeholders in the VGTB basin and to LUCCi consortium

Procedure & Results

→ Split series into Calibration/Validation period
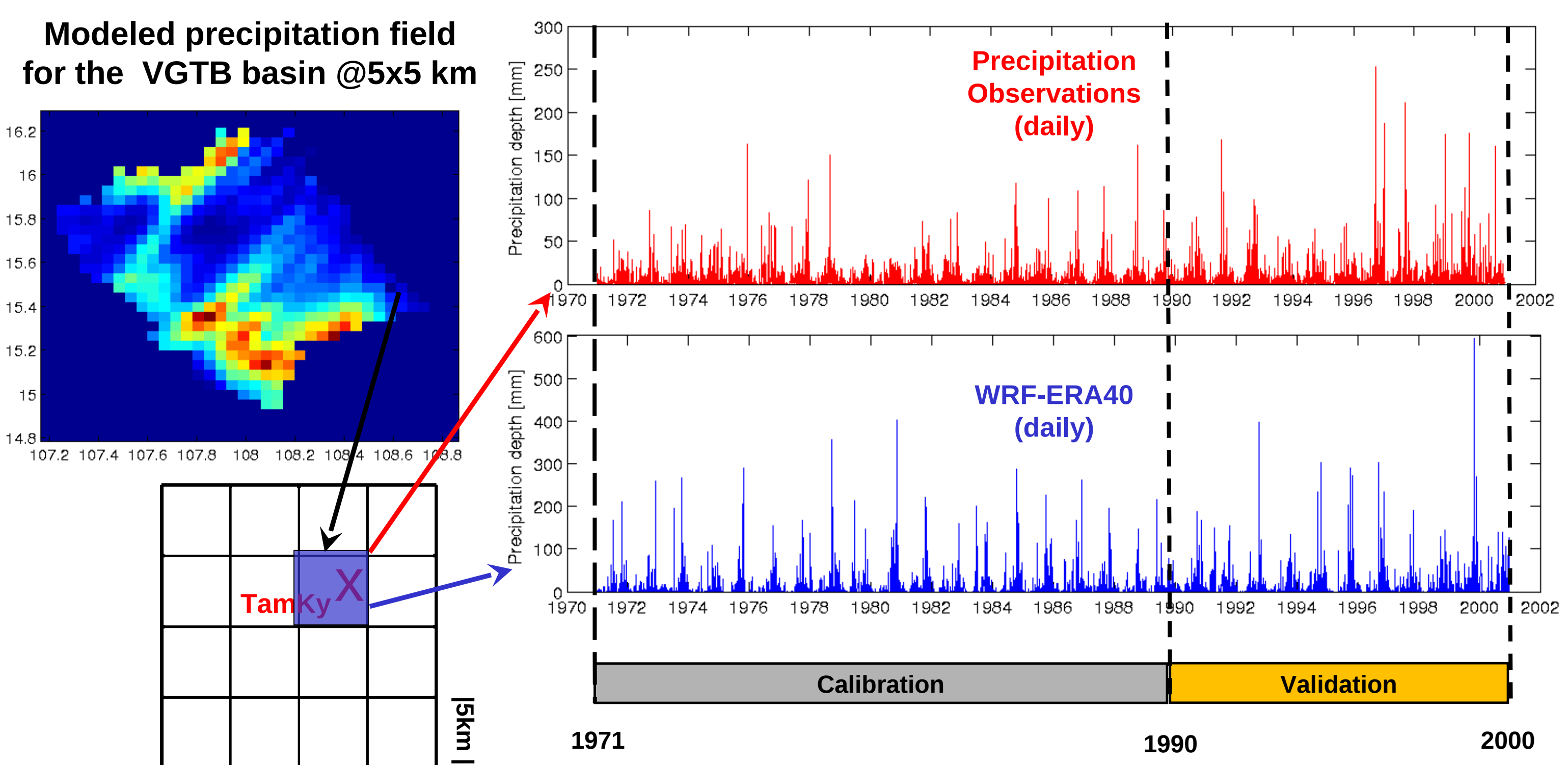
Observations: Precipitation data obtained by IMHEN
WRF-ERA40: WRF simulation driven by ERA40 reanalysis (ECMWF)

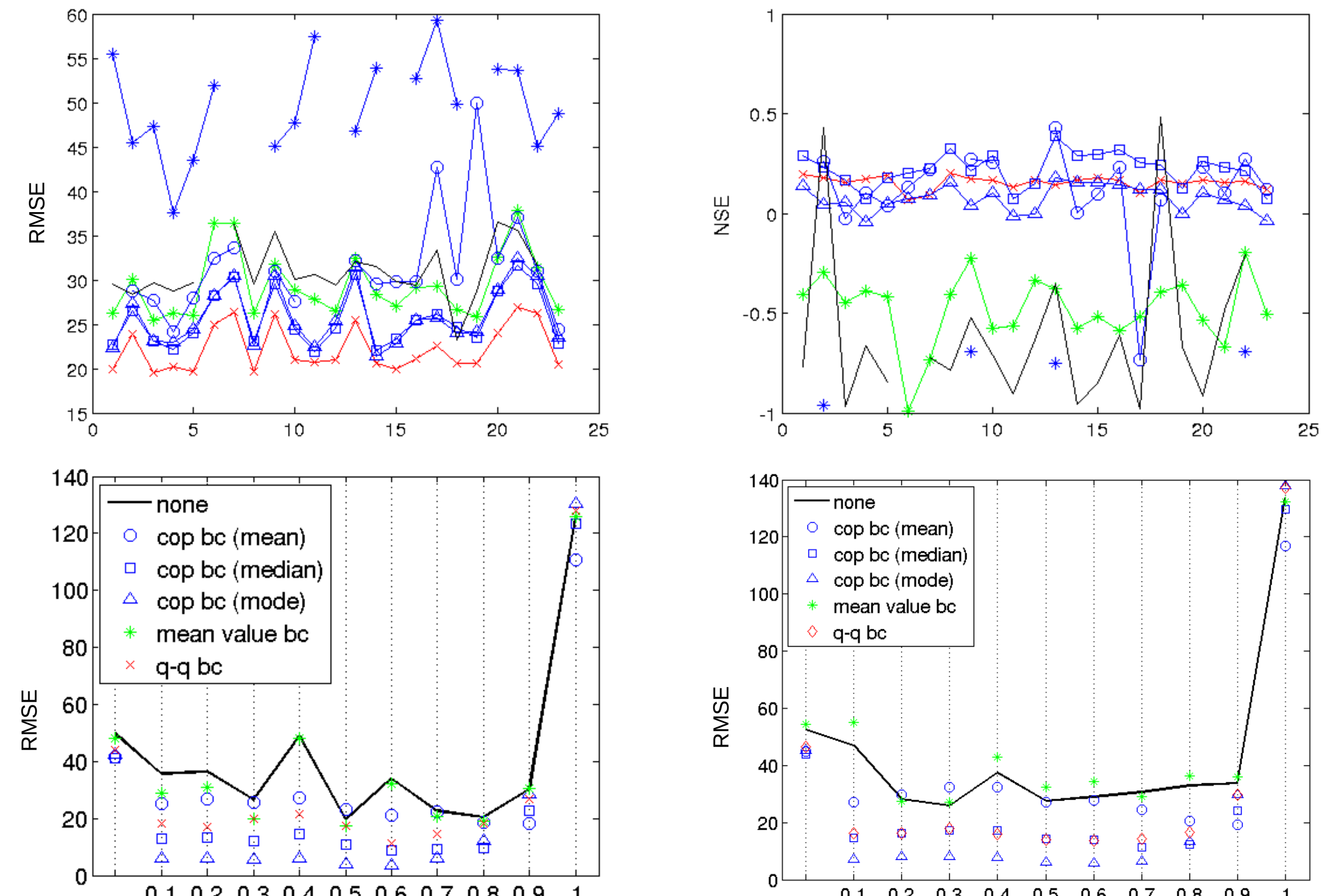→ Calculate performance measures for the validation period

Fig. 3: RMSE and NSE of bias corrected precipitation compared to observed precipitation for 23 observation locations (top). RMSE (NSE) > (<) 60 (-1) are set to NaN for illustration. RMSE for TamKy (bottom, left) and DaNang (bottom, right). The black line shows the WRF raw data (without any bias correction).

→ **Lowest RMSE for the q-q approach (global value), cop bc (mode) better for most quantiles**
→ **Peaks better represented by cop bc (median) (higher NSE values)**
→ **Cop bc (mean) performs best for extreme part of distribution**
→ **Combination of bc mode (normal part) and bc mean (extremes) could improve the results**

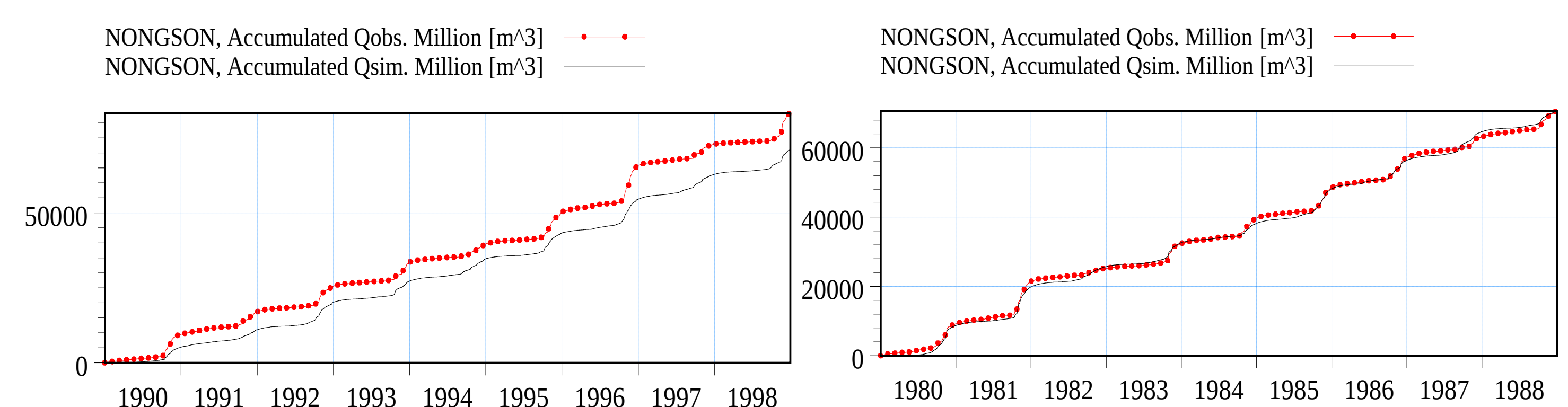## Towards hydrological impact studies ...

Fig. 4: First simulations using hydrological model Mike-SHE for Domain 2 (15 km, left) after bias correction and for Domain 3 (5 km) after bias correction.

- P. Laux, S. Vogl, W. Qiu, H.R. Knoche and H. Kunstmann (2011). Copula based statistical refinement of precipitation in RCM simulations over complex terrain. Hydrology and Earth System Sciences, 15, 1-19.
- S. Vogl, P. Laux, W. Qiu, G. Mao and H. Kunstmann (2012). Copula-based assimilation of radar and gauge information to derive bias-corrected precipitation fields. Hydrology and Earth System Sciences, 16, 2311-2328.