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

**P. Laux[1], S. Vogl[2], G. Mao[1], T. Dang[3,1], H. Kunstmann[1]**

1 Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research IMK-IFU, 82467 Garmisch-Partenkirchen, Germany
2 Technical University Deggendorf, 94469 Deggendorf
3 Institute of Meteorology, Hydrology and Environment (IMHEN), Hanoi, Vietnam

## 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.

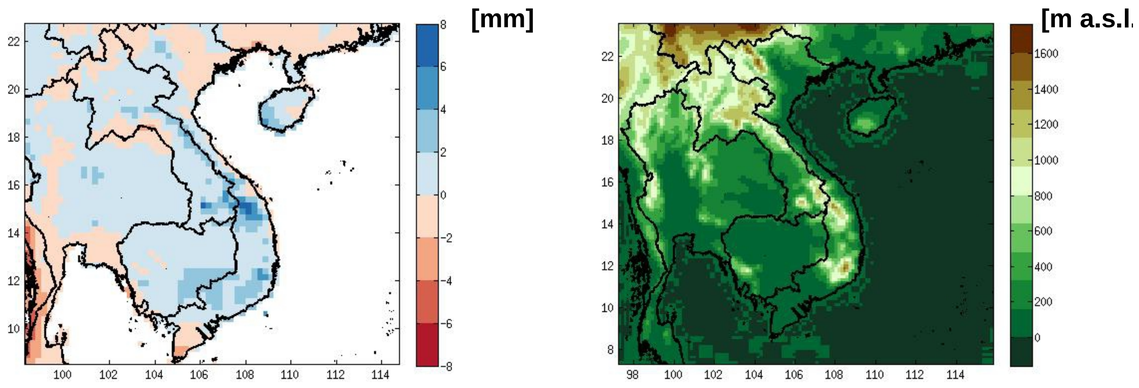



**Fig. 1:** Mean daily precipitation bias (WRF-ERA40 minus APHRODITE) for 1971-2000, (left). WRF-ERA40 **(@Domain2: 15x15 km)** is re-gridded onto the APHRODITE grid (0.25°) using bilinear interpolation. Digital elevation model (DEM) as used in the WRF-ERA40 simulations (right).

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

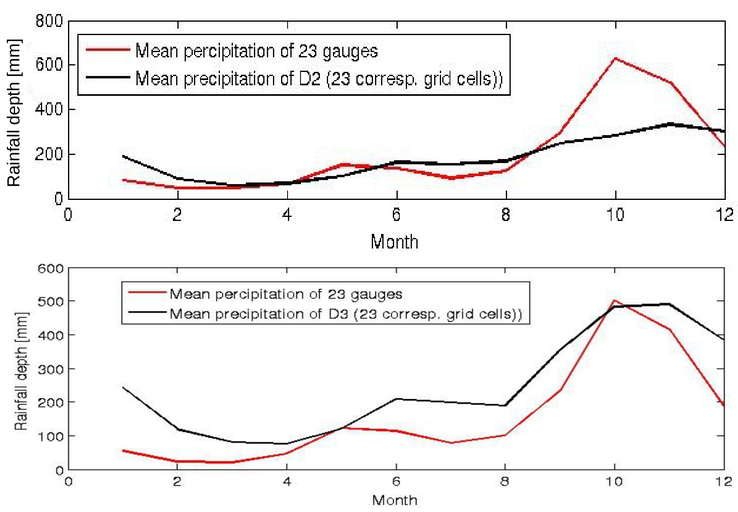



**Fig. 2:** Mean monthly precipitation amount obtained by WRF-ERA40 for **Domain 1, 5x5 km (top) and Domain 2, 15x15km (bottom)** at grid cells corresponding to **23 rain gauges** in the Vu Gia-Thu Bon basin (1971-2000).

**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:

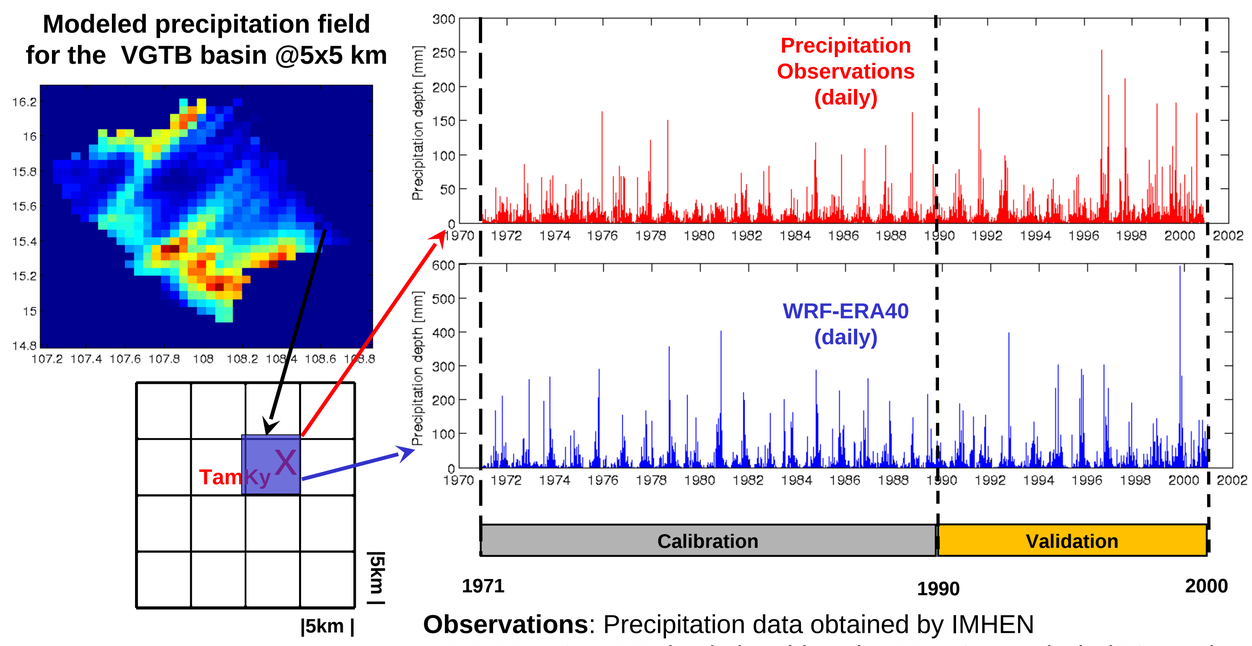
1. Mean correction:
   - Linear approach based on long-term monthly correction factors
   - Easy applicable for future climate projections
2. Quantile mapping:
   - Corrects for the statistical distribution (here: performed for extreme and normal part of distribution separately)
   - Easy applicable 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

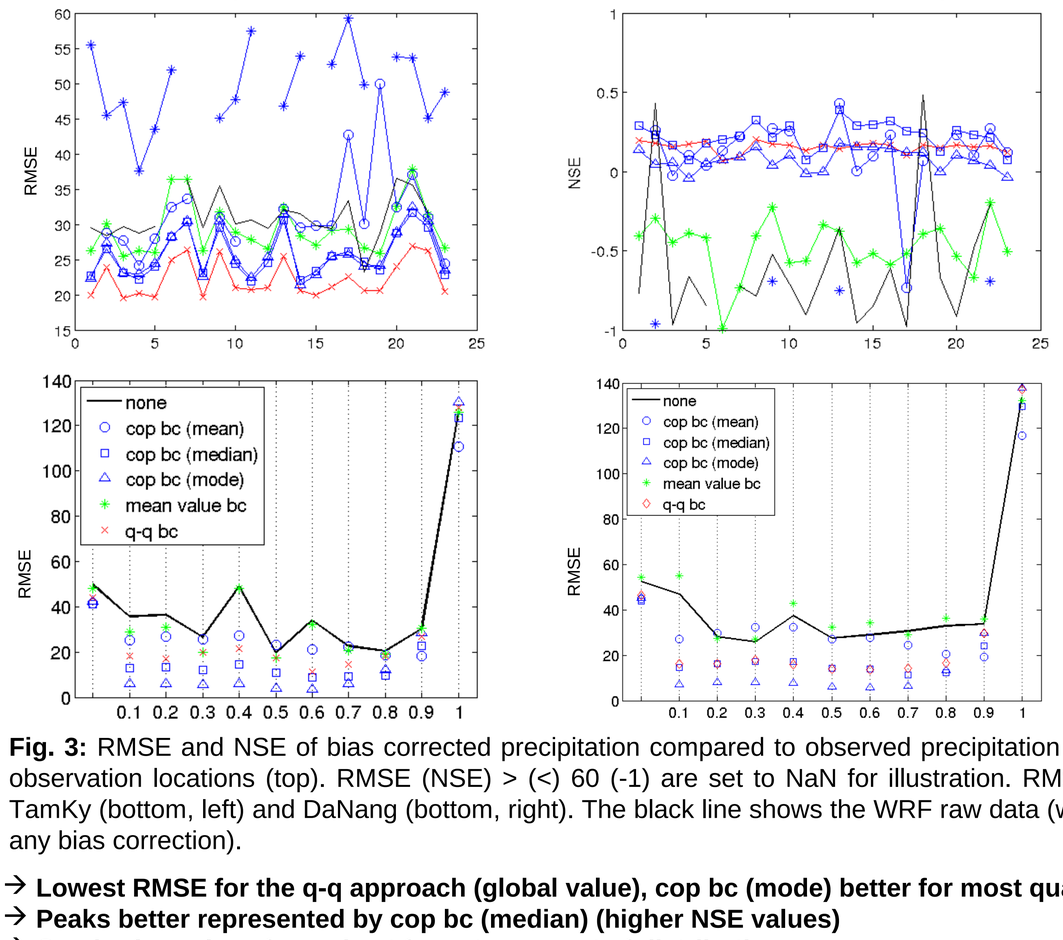



**Fig. 3:** RMSE and NSE of bias corrected precipitation compared to observed precipitation for 23 observation locations (top). RMSE (NSE) > (<) 60 (-1) are set to NaN for illustration. RMSE for TamKy (bottom, left) and DaNang (bottom, right). The black line shows the WRF raw data (without any bias correction).

→ **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 ...

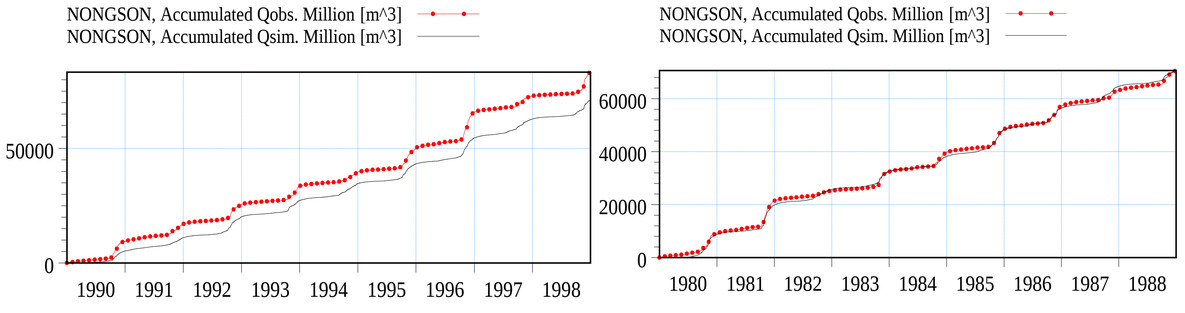



**Fig. 4:** First simulations using hydrological model Mike-SHE for Domain 2 (15 km, left) after bias correction and for Domain 3 (5 km) after bias correction.

**- 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.**

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