FOR 2131

Using Commercial Microwave Links for a stochastic reconstruction of precipitation field ensembles

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A. Motivation:

- Many approaches require an ensemble (ENS) of precipitation input; allowing an estimation of uncertainties of the precipitation

B. Goal:

- Generation of observation based ENSs of precipitation fields of any desired size
- Uncertainty estimation of observations and resulting 2d-fields of precipitation

C. Observation types:

- Rain gauge observations (RGs), point measurements
- Commercial microwave links (CMLs), measure of path integrated rain rate

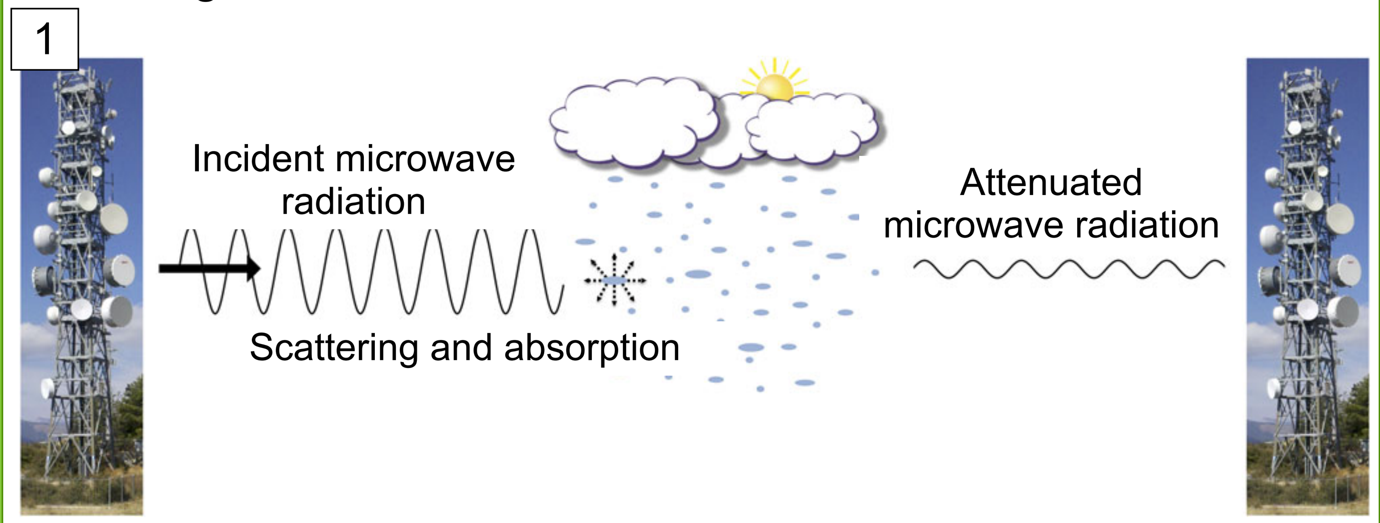


Fig. 1: Illustration of principle of CML rain fall estimation (more in Chwala & Kunstmann, 2019)

D. Synthetic data set (called VR):

- The VR is defined by regional climate simulation governing the Neckar catchment (~57.850 km^2 domain, catchment ~14.000 km^2)

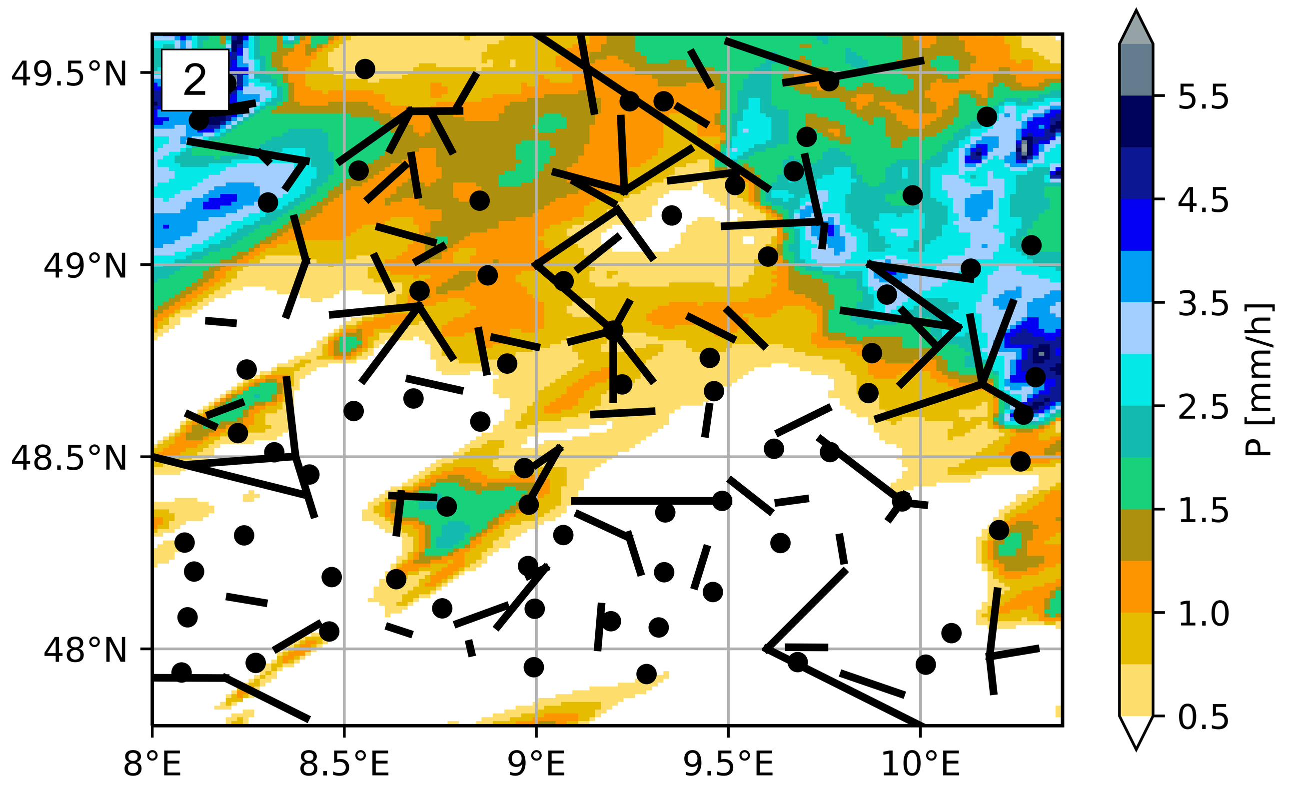


Fig. 2: VR precipitation on the for the demonstration selected time step (August 23, 2015 at 4pm). We generate 71 RGs (dots) and 100 CMLs (lines) as synthetic observations from the VR.

E. Method – Application of RMWSPy (v 1.0)

- **Idea:** Any 2d-field (Z(x)) whose spatial distribution can be described by a Gaussian copula can be expressed as a linear combination of independent random fields
- Flowchart for the two setups:

Setup 1: RGs + CMLs

Setup 2: CMLs

IF RGs = TRUE

NO → Simulate virtual RGs (VirRGs) using CMLs

YES ↓

Estimate marginal distribution of (Vir)RGs

Transform (Vir)RGs into Gaussian variable to build spatial model

IF RGs = TRUE

YES → Solve linear equation system $Z_L(x)$ given by RGs x_i: $Z_L(x) = \sum_{i=1}^{k} \alpha_i Y_i(x_i)$

NO → $Z_L(x) = 0$

$Z(x) = Z_L(x)$

Find $Z_H(x)$ with $Z_H(x_i)=0$ for all RGs x_i, described as: $Z_H = \cos\theta U_t + \sin\theta U_s$ U_t, U_s are unconditional random fields

$Z(x) = Z(x) + Z_H(x)$

Optimizing θ to satisfy CMLs by Z(x)

TRUE?

NO →

YES ↓

Transform Z(x) into 2d precipitation field

RMWSPy (v 1.0)

F. Results:

- For both setups an ENS consisting of 50 members is simulated

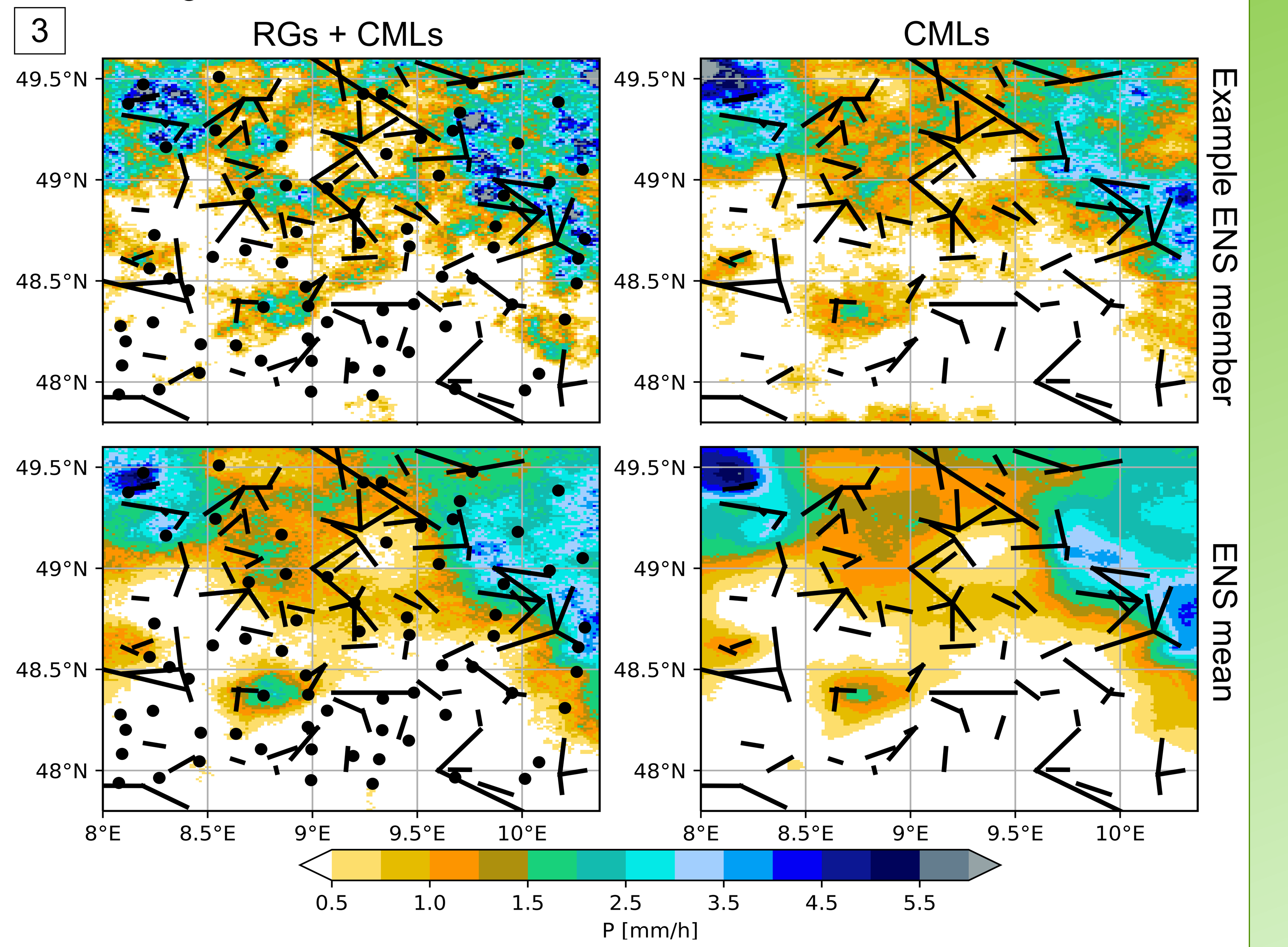
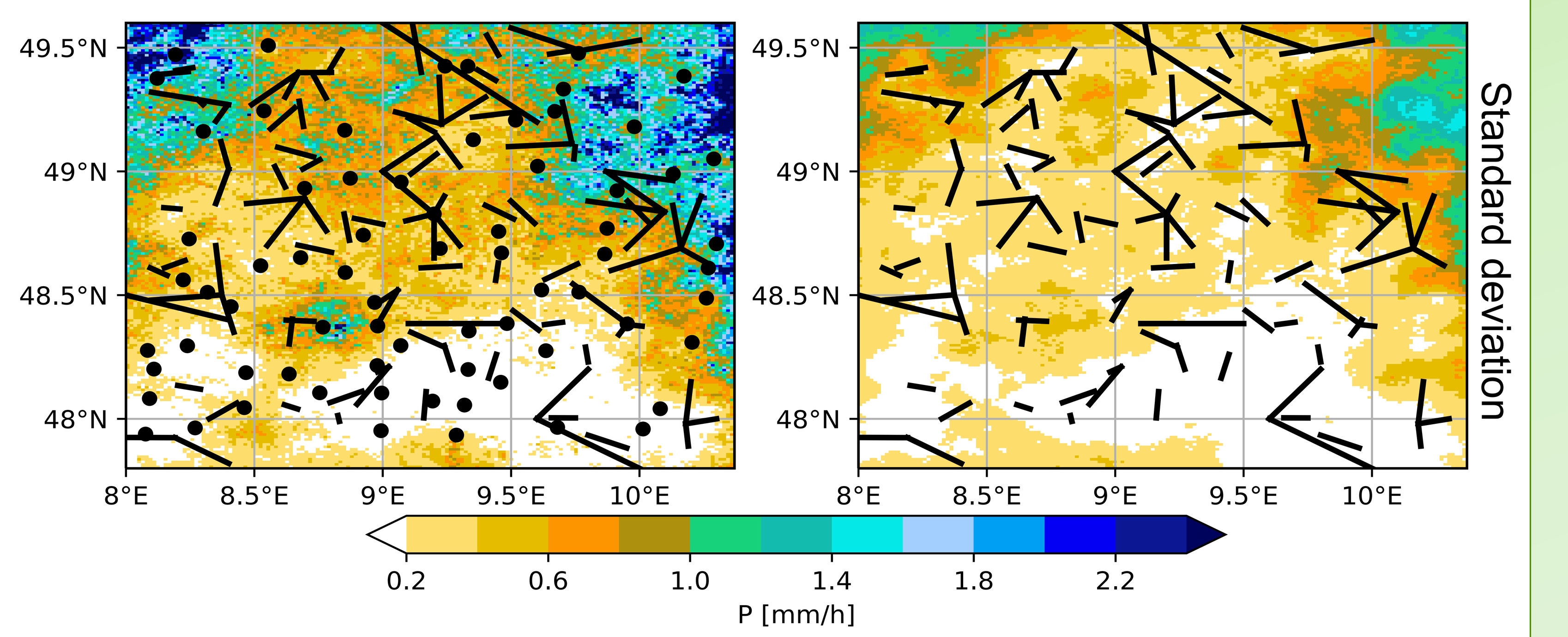


Fig. 3: Demonstration of performance; left when using RGs + CMLs and right when using CMLs only. For both setups one ENS member (upper row), the ENS mean (middle row) and the standard deviation is shown (lower row)



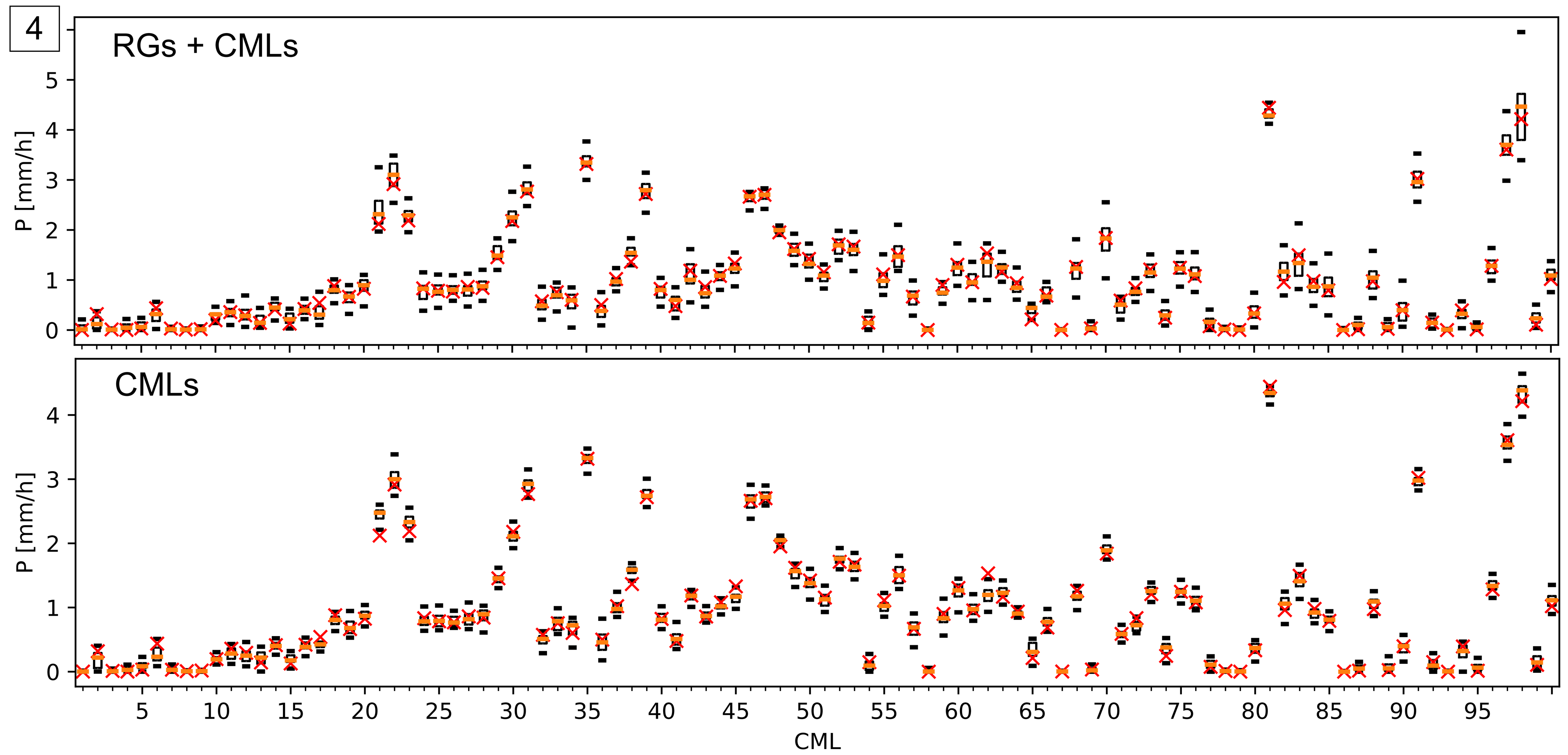


Fig. 4: Boxes show range of simulate path integrated rain rate (upper row: when using RGs + CMLs, lower row: when using CMLs) with the ENS mean indicated by the orange line for each link compared to the observed one (red crosses)

References:

[1] Haese, B., Hörning, S., Chwala, C., Bárdossy, A., Schalge, B., Kunstmann, H., 2017. Stochastic Reconstruction and Interpolation of Precipitation Fields Using Combined Information of Commercial Microwave Links and Rain Gauges. Water Resour. Res. 53, 10740-10756, doi: 10.1002/2017WR021015.

[2] Hörning, S., Sreekanth, J., Bárdossy, A., 2019. Computational efficient inverse groundwater modeling using Random Mixing and Whittaker–Shannon interpolation. Advances in Water Resour., 123, 109-119, doi: 10.1016/j.advwatres.2018.11.012.

[3] Goldshtein, O., Messer, H., & Zinevich, A., 2009. Rain rate estimation using measurements from commercial telecommunications links. IEEE Transactions on Signal Processing, 57(4), 1616–1625. doi: 10.1109/TSP.2009.2012554.

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