Including PWS gauge data in radar merging improves real-time precipitation estimates

ID: 27

Methodology and 1-year evaluation for the Netherlands

Jiří Svatoš[1], Aart Overeem[2], Nathalie Rombeek[3], Claudia Brauer[1]

1 - Hydrology and Environmental Hydraulics Group, Wageningen University & Research; 2- R&D Observations and Data Technology, Royal Netherlands Meteorological Institute; 3 - Department of Water Management, Faculty of Civil Engineering and Geosciences, Delft University of Technology

Motivation

- Accuracy of real-time precipitation monitoring limited by low number of rain gauges
- **Merging radar with both official and crowdsourced rain gauges** has the largest potential to improve quantitative precipitation estimates (QPEs)
- Need to account for different quality of rain gauge observations through:
  - PWS quality control - filter out observation errors
  - PWS quality weighting - not to overwhelm official (high-quality) observations

Methodology

- For the period February 2023 – January 2024 in the Netherlands (Fig. 1):
  - 32 KNMI automatic weather stations (AWSs)
  - 4281 Netatmo personal weather stations (PWSs)
  - 319 manual network gauges (only 24-h accumulations, used for evaluation)
- Using operational KNMI merging algorithm (see poster presentation by Aart Overeem, ID: 9)
- Compare to current real-time (AWS-radar) and final reanalysis (RFCOR) products

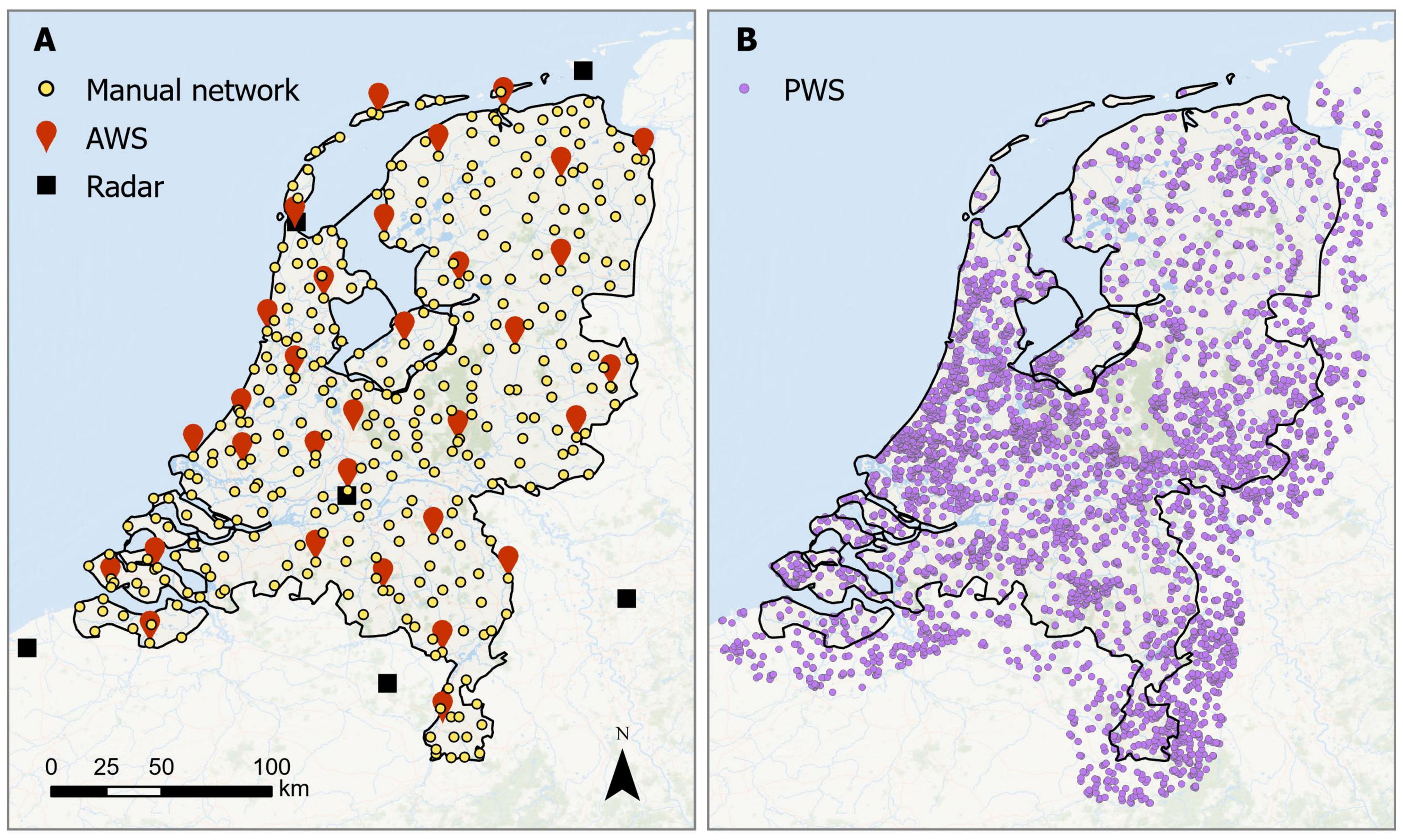

Figure 1: Locations of available **A)** radars and KNMI rain gauges **B)** Netatmo PWSs.

Merging setup

Only a simple PWS quality control needed

- Simple PWS-radar thresholds make computationally expensive PWSQC filters redundant
- Merging algorithm itself supplements quality control (interpolating adjustment factors, lower PWS quality weight)
- Bias correction is useful, but dynamic BC is not

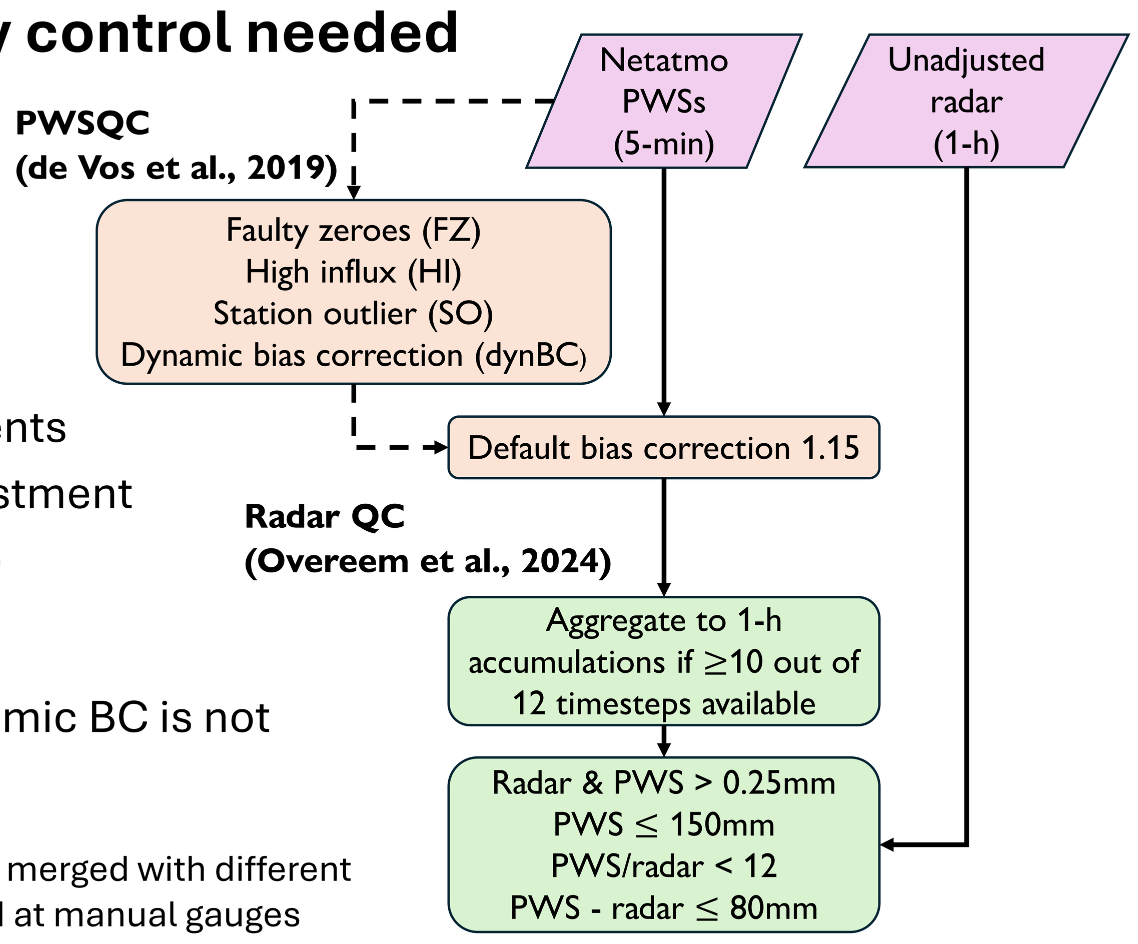

Table 1: Performance of the PWS-AWS-radar merged with different PWS quality control filters applied, evaluated at manual gauges for 24-h gauge rainfall accumulations ≥0 mm and ≥20 mm.

Quality control	Rel. bias [%]		CV		ρ^2	
For gauge [mm]	≥0	≥20	≥0	≥20	≥0	≥20
Radar QC, HI, FZ, SO, dynBC	-7.25	-10.09	0.478	0.174	0.924	0.638
Radar QC, HI, FZ, SO	-7.20	-9.93	**0.476**	0.173	**0.925**	0.643
Radar QC only	-7.42	-10.65	0.478	**0.171**	0.924	**0.645**
0.25 mm threshold only	**-6.54**	**-9.39**	0.490	0.188	0.920	0.598
AWS-radar reference	-10.29	-12.95	0.558	0.223	0.896	0.482

Quality weight of PWSs should be decreased

- Optimal PWS weight around 0.1 (one tenth of the weight of AWSs)
- Same optimum value when using 4281 or only 500 random PWSs

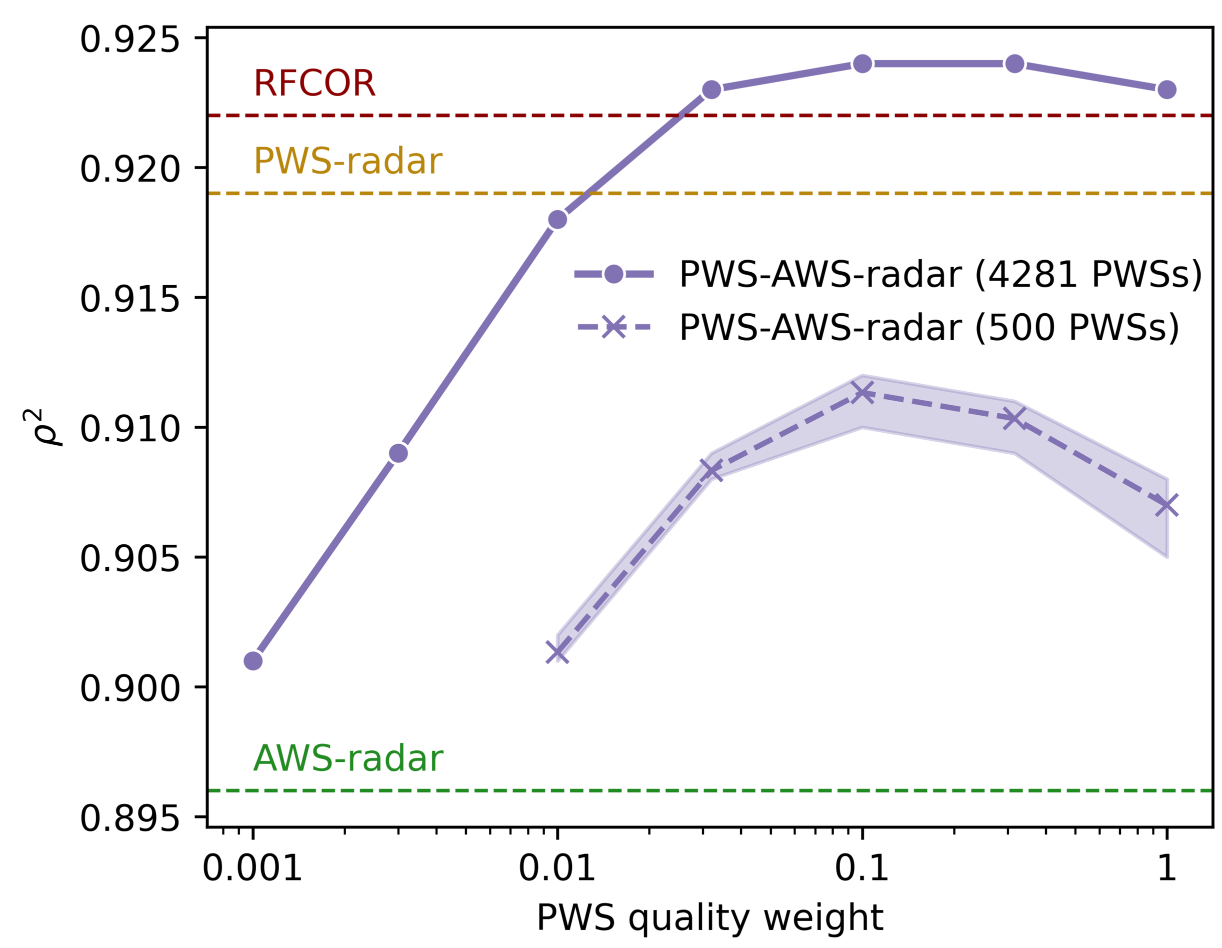

Figure 2: Performance of the PWS-AWS-radar merged product based on the assigned PWS quality weight, evaluated for 24-h precipitation accumulations at manual network gauges. The RFCOR product is evaluated with leave-one-out cross validation.

Evaluation

Adding PWSs improves QPEs, especially during heavy rainfall

- PWSs help capture local convective storms
- Largest improvement at locations far from AWSs

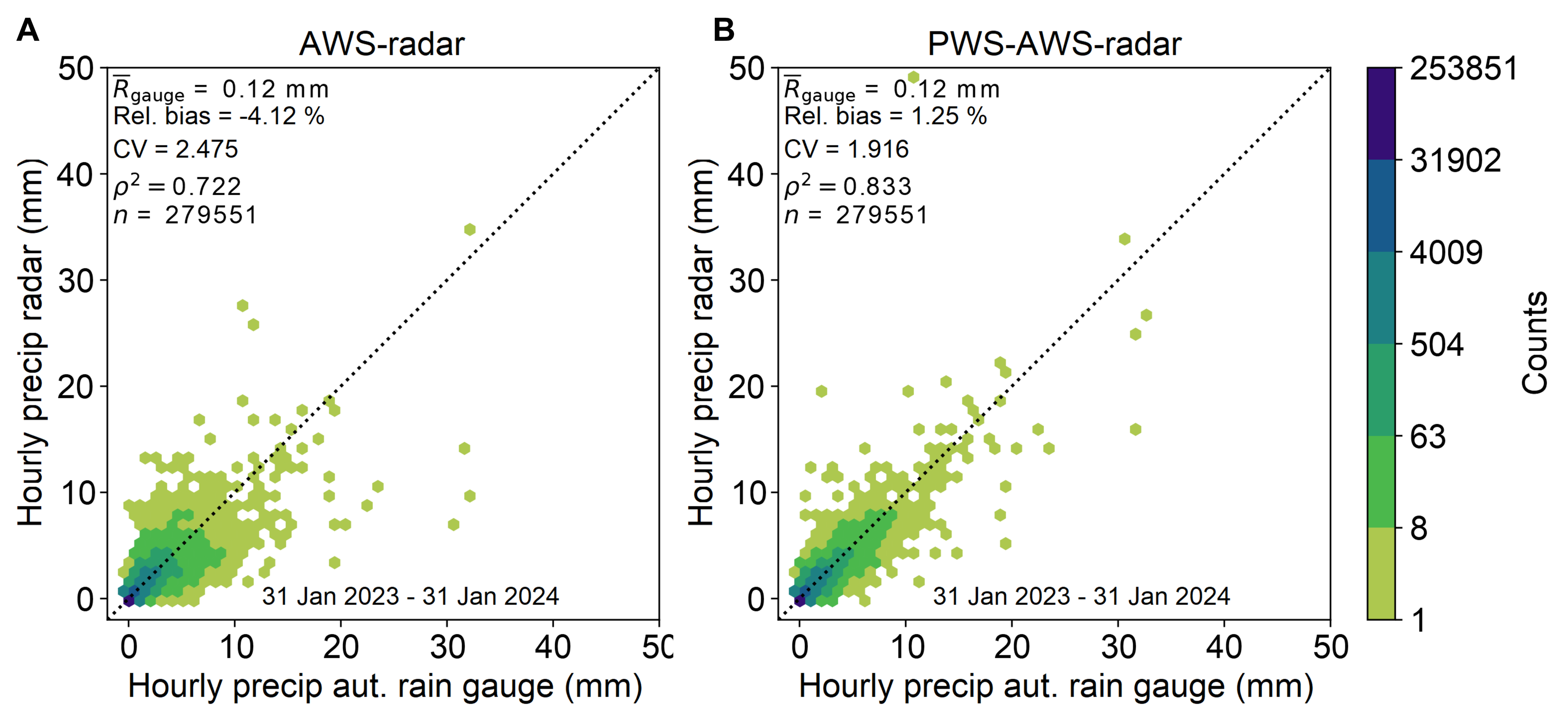

Figure 3: Scatter density plots of 1-h precipitation accumulations of the **A)** AWS-radar and **B)** PWS-AWS-radar merged products against the AWS reference provided through leave-one-out cross validation

Improvement also at lower PWS network densities

- Diminishing benefit of adding extra PWSs

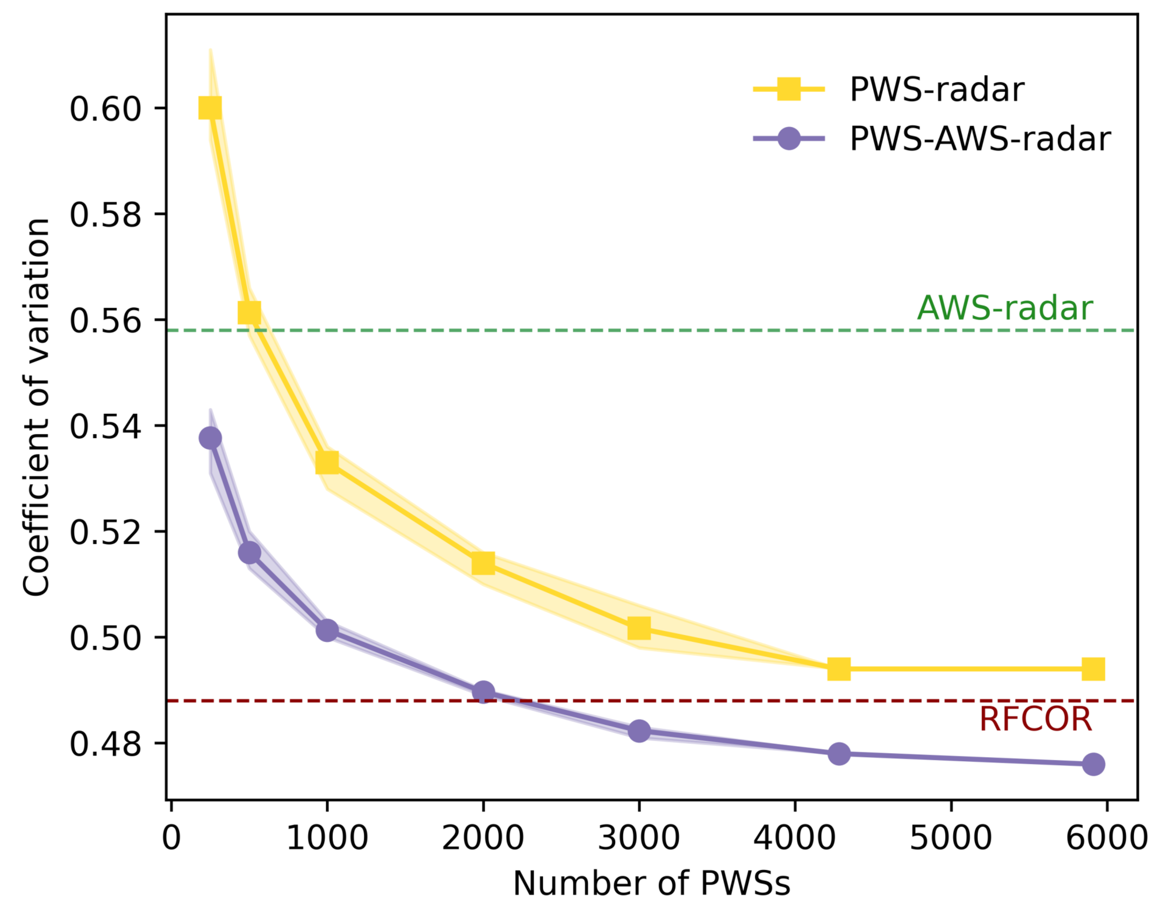

Figure 4: Performance of the merged radar products as a function of the number of used PWSs for 24-h accumulations at manual gauges (with leave-one-out cross validation for RFCOR).

Conclusions

- Merged PWS-AWS-radar product can match the performance of the final reanalysis product in real time
- Methodology is potentially suitable for operational rainfall monitoring in the Netherlands as well as countries with less dense PWS networks

Full work available at:

https://edepot.wur.nl/693405

References

de Vos et al. (2019). Quality control for crowdsourced personal weather stations to enable operational rainfall monitoring. *Geophysical Research Letters*, *46*(15), 8820-8829.

Overeem et al. (2024). Merging with crowdsourced rain gauge data improves pan-European radar precipitation estimates. *Hydrology and Earth System Sciences*, *28*(3), 649-668.