Review and Comparison of Radar Rainfall Bias Adjustment Methods

applying a 10-year dataset from Denmark

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– Applying a 10-year dataset from Denmark

1. Concept

- To develop a complete 10-year dataset of the best possible adjusted radar rainfall data in the best possible spatial and temporal resolution.

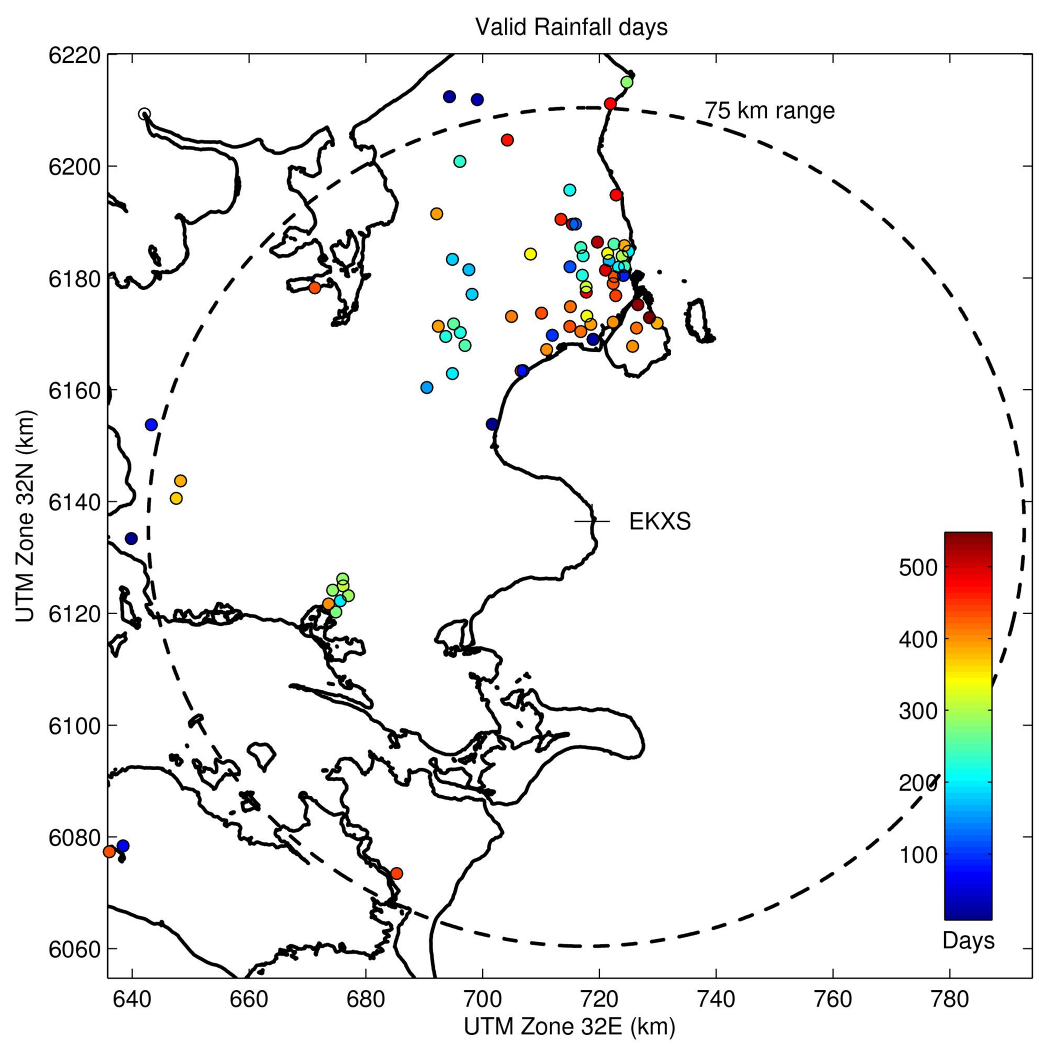
2. Objectives and Methods

Based on the 10 year dataset we investigate and evaluate the following:

- **Mean Field Bias (MFB) adjustment** with special focus on the temporal integration.
  We assume a constant multiplicative bias between rain gauge observations and radar rainfall estimates (with fixed Z-R relationship) at different time scales.
- **Conditional Mean Field Bias adjustment (CMFB)**
  We allow bias to change as a function of the rain rate in order to improve adjustment during heavy rain (convective events).
- Implementation of **Advection Interpolation** to increase the temporal resolution of radar rainfall estimates.
  We apply weighted forward and backward advection interpolation based on the COTREC scheme (Continuity Tracking Radar Echoes by Correlation).

3. Data

- 10 years of radar observations (2002-2012) from DMI C-band radar at Stevns (EKXS).
- DMI CAPPI product (resolution: 500 x 500 m^2, 10 min.)
- Reflectivity - rain rate conversion following Marshall-Palmer, A=200, B=1.6
- 49-79 rain gauges within the 75 km range (resolution: 0.2 mm, 1 min.)
- Gauge density within the 75 km range: 1 gauge per 260 km^2



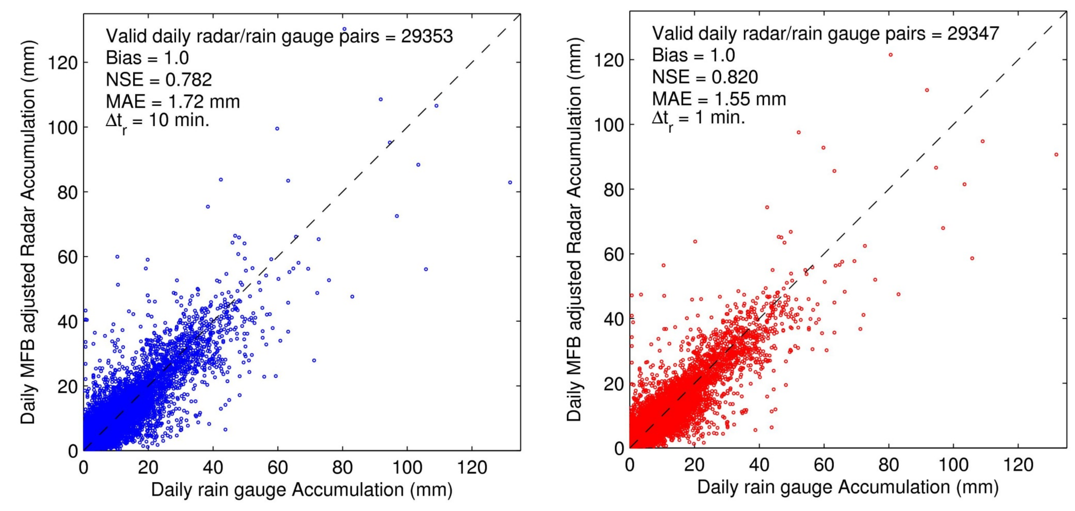
4. Performance measures

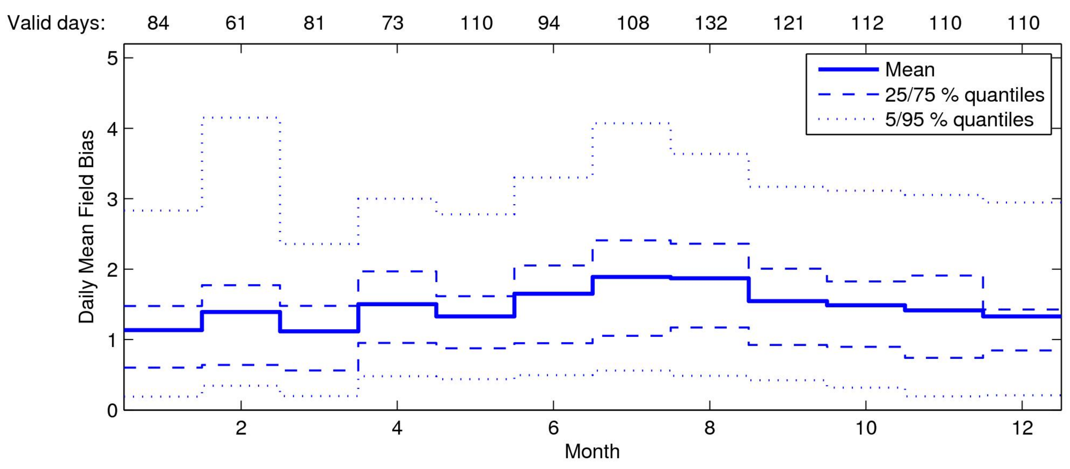
- Bias
- Nash-Sutcliffe-Efficiency **(NSE)**
- Mean Absolute Error **(MAE)**

5. Nomenclature

- **Blue:** Original temporal resolution of data (Δt_r=10 min.)
- **Red:** Advection interpolated data (Δt_r=1 min.)

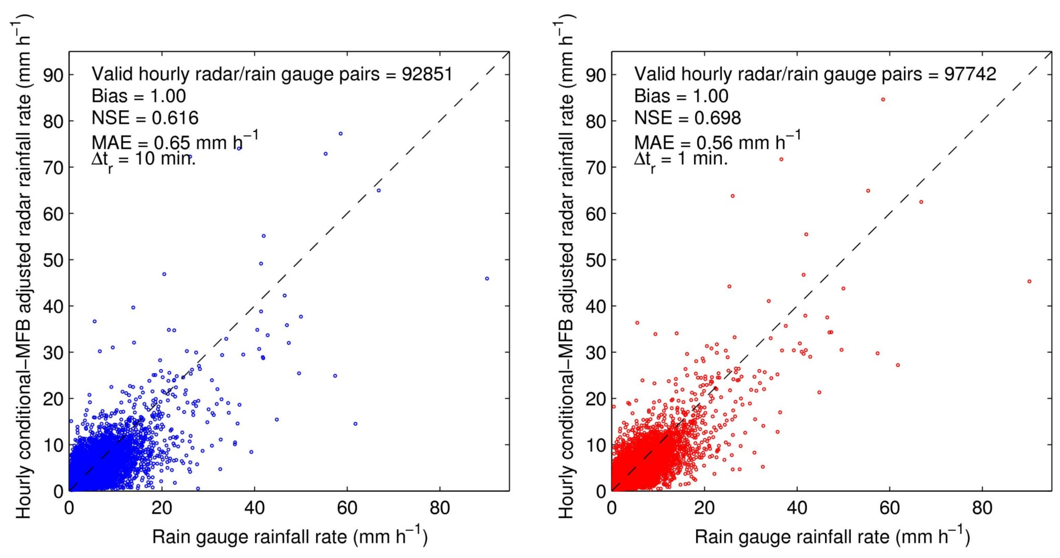
6. Daily Mean Field Bias Adjustment





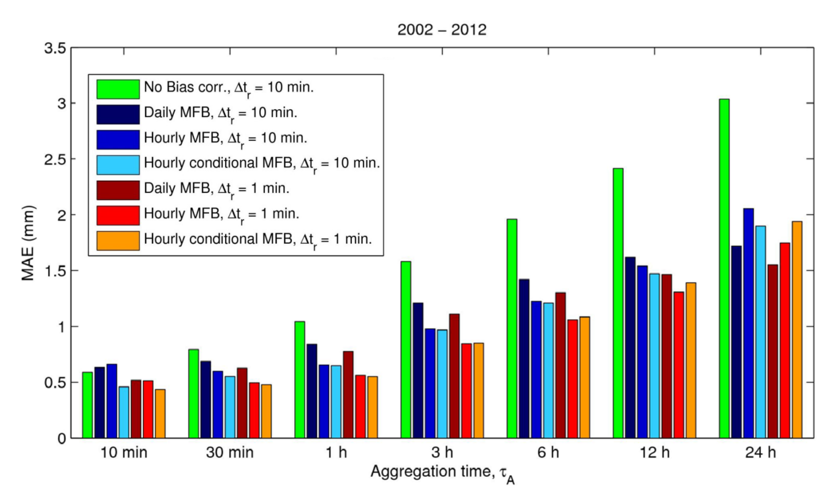
- Reduction of uncertainty (higher NSE and lower MAE) implementing advection interpolation
- Larger mean field biases during summer time (convective events)
- Larger bias variability during summer periods indicating large shifts in biases from day to day

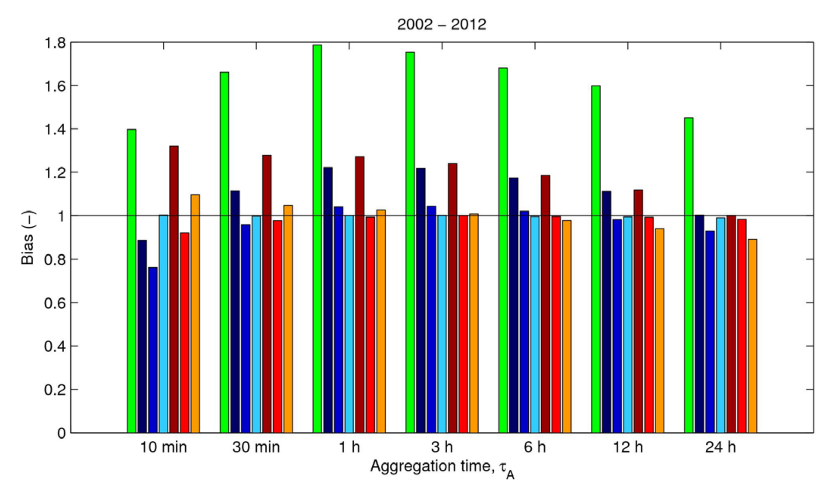
7. Conditional Hourly Mean Field Bias Adjustment



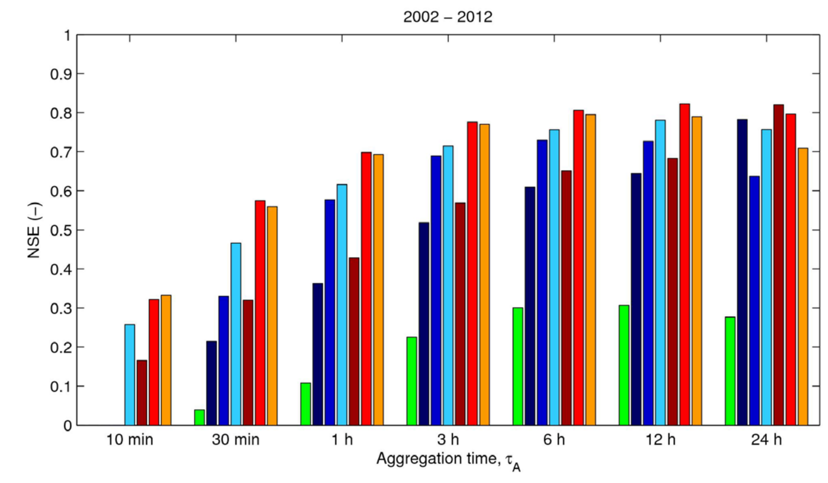
- Conditional bias adjustment improves hourly rainfall estimates compared to hourly mean field bias adjustment (not shown)
- Advection interpolated data provides better rainfall estimates
- Daily rainfall estimates is improved applying hourly bias adjustment (not shown)

8. Performance at different time scales





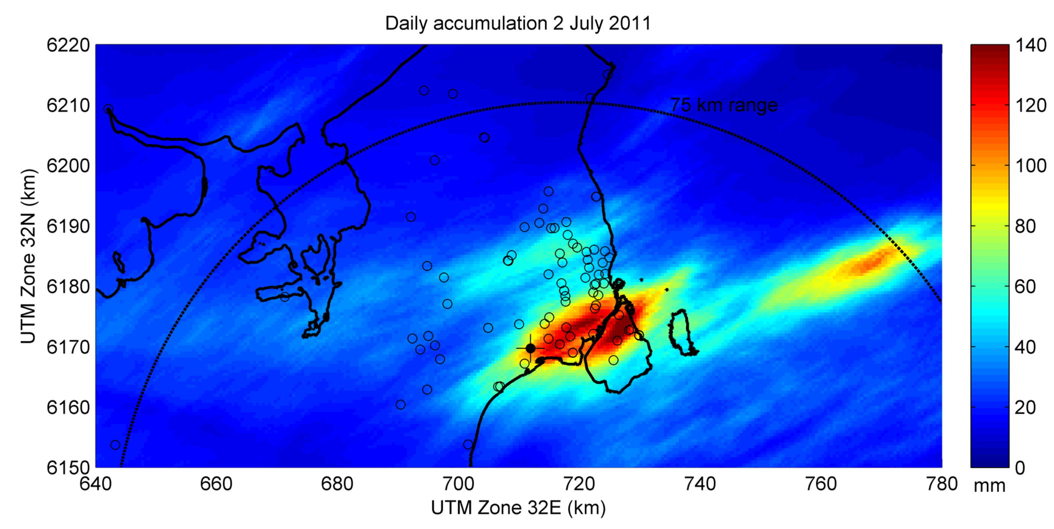
8. Performance at different time scales (cont.)



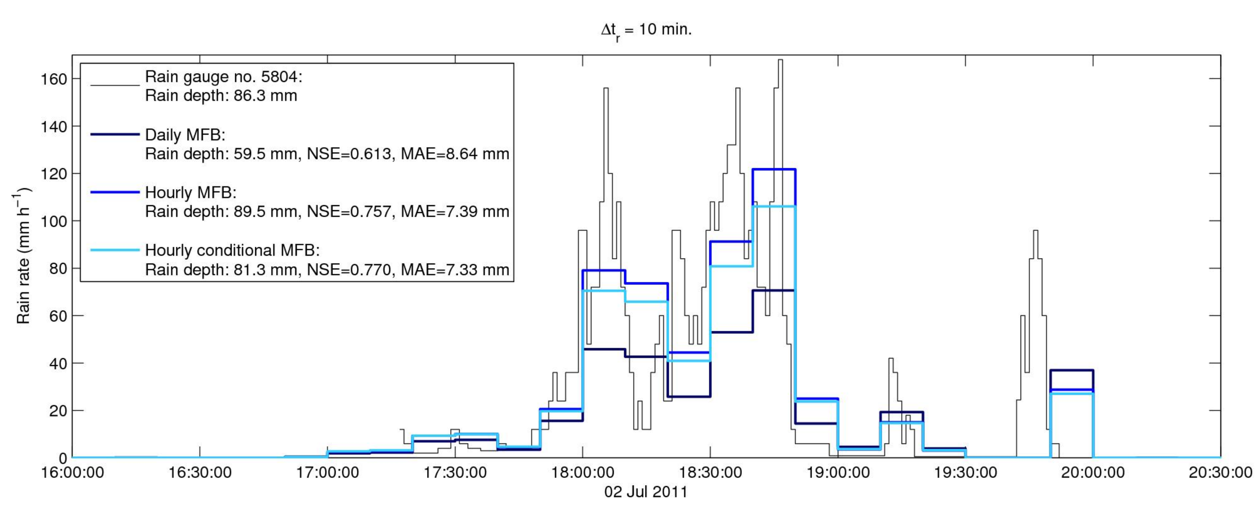
- Bias adjustment is crucial
- Hourly and conditional hourly mean field bias adjustment improves rainfall estimates at every time scale compared to daily adjustment (non-interpolated data)
- Applying advection interpolation improves both daily and hourly adjustments at every time scale
- No significant improvement of conditional bias adjustment on advection interpolated data
- Applying advection interpolation it is possible to generate reasonable 10 min. rainfall estimates which is not possible using non interpolated data.

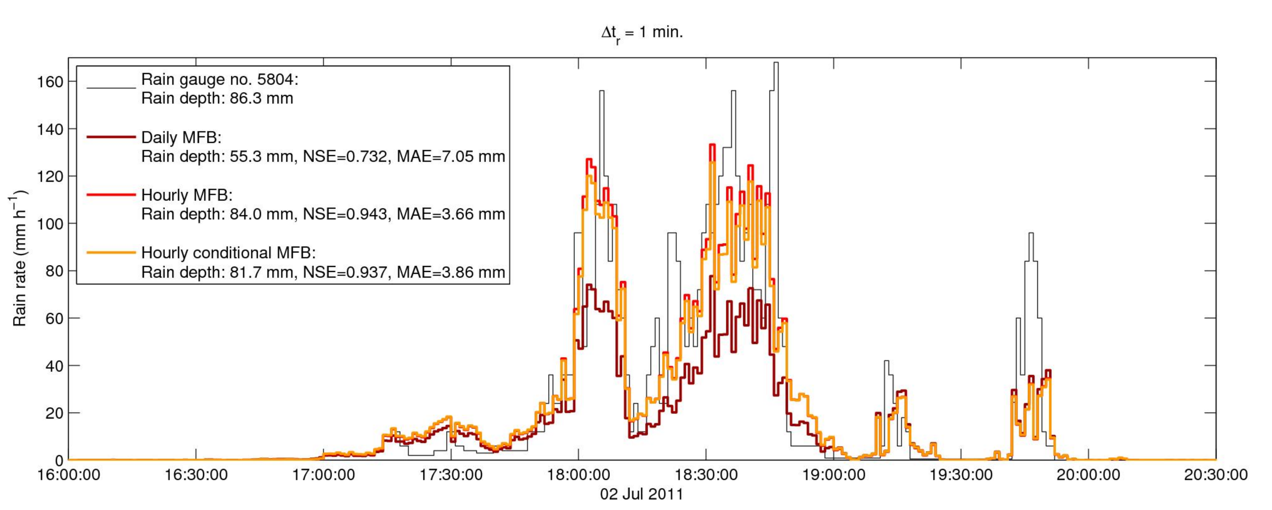
9. Example of an extreme event: 2 July 2011

- This event produced record flooding in the greater Copenhagen area.
- In some areas daily rainfall accumulation exceeded 140 mm (Daily accumulation estimated by hourly bias adjusted interpolated rainfall fields below)



- Daily mean field bias is not sufficient in order to estimate rainfall totals nor peak rain rates.
- Timing is improved significantly implementing advection interpolation.
- Conditional bias adjustment is not crucial when advection interpolation is applied.





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