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Improved QPE for the Ahr flooding event using weather radar and CML data

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Extreme floods are one of the most severe natural disasters. In a recent example, long-lasting heavy rainfall over central Europe led to devastating flooding in several catchments in Germany and Belgium on the 14th and 15th of July 2021. The valley of the river Ahr in the German state of Rhineland-Palatinate was heavily affected by this flooding with over 100 casualties and a loss of over 20 billion Euros. Quantitative precipitation estimation (QPE) during this event was affected by several issues. Rain gauge measurements suffered from underestimation and were not available due to power outages towards the end of the event. Weather radar measurements underestimated the rainfall amount due to pronounced vertical gradients of precipitation below the melting layer. Rainfall products from these two sensors were not able to explain the discharge values within the Ahr catchment. A potential solution to improve the rainfall estimation for the Ahr event and radar rainfall estimation in general is to add additional rainfall information. This is commonly done by adjusting the radar derived rainfall fields to rain gauges. Here we use opportunistic sensors, namely commercial microwave links (CMLs), which have previously not been used for radar adjustment. We show QPE based on different radar products, each of them with and without an adjustment via CML rainfall estimates. We use the unadjusted RADOLAN product RY and two own polarimetric radar QPEs, of which one is enhanced with specific corrections based on MRR data and combined with a local X-Band gap-filling radar. We perform additive and multiplicative adjustment of the radar QPEs on an hourly basis with CML data, taking into account the path-averaging nature of the CML observations. Our results show that the CML adjustment significantly improves RADOLAN-RY and the polarimetric product without enhancement. The enhanced polarimetric product is already in very good agreement with the reference data and hence is not improved much. The applied enhancements from MRR and X-Band radar data are currently not suitable for operational usage, though. Radar-adjustment with CML data, which is available in real-time without delay, hence provides a suitable solution to improve operational QPE.