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A 16-year radar-based high-resolution precipitation climatology for Germany – methodology, products, and applications

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Urban flooding and flash floods induced by heavy precipitation events have caused significant damage and even fatalities in Germany during the summer of 2016. In contrast to fluvial events like the Elbe flood in 2002, where persistent areal precipitation lead to a catastrophic flooding of large areas in eastern Germany, pluvial floods are caused by intensive rainfalls that can even be restricted to a rather small horizontal extent. These pluvial floods occur in discharge areas with short response times, either in regions with a strong orography or in urban areas with an infrastructure that is prone to flooding.
Local, small-scale events are difficult to detect in situ by ground-based gauges. With radar-based remote sensing, however, all events can – at least qualitatively – be monitored. With the completion of the Germany-wide radar network in 2000, the Deutscher Wetterdienst (DWD) laid the foundation for an area-covering precipitation climatology. Within the framework of a project financed by the federal agencies' strategic alliance 'Adaptation to Climate Change', 16 years of radar data have now been reanalyzed in order to gain a quality-controlled, high-resolution precipitation data set suitable for analyzing extreme events in a climatological approach. Although the time series is still rather short, for the first time the data set allows an insight into the distribution, size, life cycle, and duration of extreme events that cannot be measured by point measurements alone.
DWD currently operates 17 C-Band Doppler radar systems with dual-polarization technique. Reflectivity data of the complete network is available since 2001. The quality of the radar-based precipitation estimates is optimized by the adjustment with quantitative gauge data. Newly developed climatological correction methods have been applied to the data set: an improved detection of radar-specific errors like e.g. clutter; a correction of the signal reduction with height and distance caused by overshooting, attenuation, and the increase of the measurement volume; and the correction of spokes caused by partly shaded radar beams.
The data set has been thoroughly analyzed, especially with respect to the occurrence of extreme events. It allows the generation of hot spot maps for meteorological events and sophisticated risk analyses in combination with hydrological impact modeling. New products have been established for customers in water and risk management, urban planning, agriculture, soil erosion modelling, and for policy makers. The results constitute an important contribution to the German adaptation strategy to climate change.