Enabling the comparison of high-resolution precipitation observations with numerical weather prediction model simulations at every model time-step

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Precipitation characteristics are expected to change in the future as a consequence of global climate change. For example, high-intensity precipitation is expected to become more frequent in some areas of the world. The short time scales and small spatial scales of intense precipitation events pose challenges for numerical weather prediction (NWP) models. Measurements of precipitation characteristics from in-situ and remote sensing instrumentation are often available at much higher time resolution than common NWP model output, and need to be aggregated for validation studies. Here we present a methodology to enable the comparison of precipitation observations and model output at the time scale of the model time steps. Our analysis is focused on an extreme, convective precipitation event during 30th July 2019 in Bergen, Norway (60.38ºN, 5.33ºE, 12 m a.s.l.). We use high-resolution measurements of precipitation characteristics from a Micro Rain Radar Metek MRR-2, an Ott Parsivel2 Disdrometer, and a TPS-3100 Hotplate Pluviometer. Model precipitation was extracted from the operational NWP model MetCoOp that uses a horizontal grid spacing of 2.5 km and 65 vertical levels as part of the HARMONIE AROME model configuration. Using DDH (Diagnostics par Domaines Horizontaux), a novel tool for extracting prognostic variables from the model at a time-step resolution, we extracted a detailed dataset from a NWP model reforecast at every time step (75s), for a 62.5 by 62.5 km subdomain centred around the measurement site. We characterised precipitation by investigating five parameters, namely rain rate, liquid water content, mean volume diameter, the normalised intercept parameter, and terminal fall velocity. The newly developed methodology enabled a direct comparison of the observed precipitation characteristics with corresponding parameters from the model prediction for the convective rainfall event. Despite a generally reasonable correspondence between all parameters in the model and observations, the model struggled with underestimation of rainfall intensity during the high-intensity periods. The onset and intensity of precipitation depended strongly on location for the investigated event. Higher time resolution provided more detailed insight into intensity, timing and spatial variability of the modelled precipitation compared to the more commonly used hourly interval. Our new methodology can be easily applied to other precipitation events, such as frontal rainfall events, and thus provide process-level understanding of precipitation characteristics simulated by high-resolution NWP models.