18–22 September 2017, Pula, Croatia
ECSS2017-181
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Towards real-time high-resolution precipitation forecasts for the city of Rotterdam

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Accurate and timely model simulations of rainfall in cities are of critical importance for reliable prediction of water levels and flows, overflow from sewers, and predicting urban flood events. Ongoing development of forecasting systems are happening for the cities of Aalborg, Helsinki, Rotterdam, and Stockholm in the framework of the MUFFIN (Multi-scale Urban Flood Forecasting) project. During an experimental campaign in the city of Rotterdam, numerical simulations of atmospheric variables including precipitation, air temperature, mixing ratio, and wind speed and direction from the WRF-ARW (Weather Research and Forecasting – Advanced Research WRF) mesoscale meteorological model are evaluated against a ground-based observational network. The WRF-ARW model offers the choice between a large number of microphysics and land surface parameterization schemes. Each microphysics scheme uses a unique method of parameterizing the atmospheric heat and moisture tendencies and microphysical rates, while each land surface scheme parameterizes land surface characteristics such as snow, soil, and vegetation. Assessment of the performance of high-resolution model simulations from WRF are validated against rainfall observations from X-band and micro-rain radars, and standard atmospheric measurements from in-situ meteorological sensors. The high-resolution X-band rainfall radar has been installed and tested during the last few years in the centre of Rotterdam, as part of the RainGain project. Characteristics of the radar include dual polarimetry and Doppler capability, measuring just above the urban canopy at approximately 150 m altitude. Observations are recorded with a resolution as fine as 100 m and 1 min, at a range of about 30-40 km. The radar offers unique opportunities to study the structure and dynamics of rainfall in an urban setting. In addition to the X-band radar, a dense ground-based network of 10 professional weather stations, several disdrometers, citizen rain gauge networks, GNSS water vapour retrievals, and vertical profiling radar (MRR-PRO) are used to evaluate the WRF model performance. One of the main objectives of this work is to assess the sensitivity of model-simulated rainfall to different microphysics and land surface parameterization schemes. In parallel, other objectives include an evaluation of the impact of data assimilation from the X-band radar, and the potential use of WRF model ensemble runs for probabilistic rainfall forecasting.