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Precipitation observations for operational flood forecasting in Scotland: Data availability, limitations and the impact of observational uncertainty

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The Scottish Environment Protection Agency (SEPA) has a statutory responsibility to provide flood warning across Scotland. It achieves this through an operational partnership with the UK Met Office wherein meteorological forecasts are applied to a national distributed hydrological model, Grid- to- Grid (G2G), and catchment specific lumped PDM models. Both of these model types rely on observed precipitation input for model development and calibration, and operationally for historical runs to generate initial conditions.

Scotland has an average annual precipitation of 1430mm per annum (1971-2000), but the spatial variability in totals is high, predominantly in relation to the topography and prevailing winds, which poses different challenges to both radar and point measurement methods of observation. In addition, the high elevations mean that in winter a significant proportion of precipitation falls as snow. For the operational forecasting models, observed rainfall data is provided in Near Real Time (NRT) from SEPA's network of approximately 260 telemetered TBR gauges and 4 UK Met Office C-band radars. Both data sources have their strengths and weaknesses, particularly in relation to the orography and spatial representativeness, but estimates of rainfall from the two methods can vary greatly.

Northern Scotland, particularly near Inverness, is a comparatively sparse part of the radar network. Rainfall totals and distribution in this area are determined by the Northern Western Highlands and Cairngorms mountain ranges, which also have a negative impact on radar observations. In recognition of this issue, the NCAS mobile X-band weather radar (MXWR) was deployed in this area between February and August 2016.

This study presents a comparison of rainfall estimates for the Inverness and Moray Firth region generated from the operational radar network, the TBR network, and the MXWR. Quantitative precipitation estimates (QPEs) from both sources of radar data were compared to point estimates of precipitation as well as catchment average estimates generated using different spatial averaging methods, including the operationally applied Thiessen polygons. In addition, the QPEs were applied to operational PDM models to compare the effect on the simulated runoff. The results highlight the hydrological significance of uncertainty in observed rainfall.

Recommendations for future investigations are to improve the estimate of radar QPEs through improvement of the correction for orography and the correction for different precipitation types, as well as to analyse the benefits of the UK Met Office radar-raingauge merged product. In addition, we need to quantity the cost-benefit of deploying more radars in Scotland in light of the problems posed by the orography.