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A high-resolution C-band radar composite for urban hydrological modelling

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The RainGain project, supported by Interreg IVB NWE, aims to improve understanding of flood processes in urban environments, refining flood forecasting and water management solutions to increase cities' resilience to localised flooding events. Given the small-scale variability of hydrological properties in these regions, accurate and effective flood prediction requires very high resolution observations of current rainfall.

Four urban catchments, each part of a major European city, have been selected for pilot studies of high resolution radar techniques. Each of the catchments in Leuven, Paris and Rotterdam has available one or more X-band radars for rainfall monitoring. For the London catchments, however, it was decided to use the existing C-band network to generate a new, higher-resolution rainfall product.

The London catchments of Cranbrook and Purley are covered by two C-band radars, at Chenies and Thurnham, each at distances of 50km or less. Both radars have a half-power beam width of one degree, and can operate at pulse lengths of 300m (long-pulse) or 75m (short-pulse). In order to drive the street-scale hydrological modelling that Rain Gain aims to provide, data from these radars should ideally be downscaled to a grid-length of 100m.

In this work we describe and compare methods of constructing a 100m-gridded rainfall product from C-band radar observations. The effects of pulse length on output quality are discussed, as is the potential for independent information to be extracted from oversampled long-pulse data. We also consider additional processing steps needed to ensure accuracy at the 100m scale, including azimuth weighting to sharpen beam resolution, and a wind drift correction.

The extent to which increasing spatial resolution can improve radar composites is limited by the temporal resolution of the observations, and by spatial offsets between the radar measurement and the surface. The assumption that hydrometeors fall vertically through a non-sheared wind field from the radar beam to ground level is justifiable at kilometre resolutions, but leads to significant misplacement of rainfall at shorter grid-length scales. In addition to existing processing, a correction for this "wind drift" has been developed for 100m composite generation.

The physical representivity of the 100m product is assessed through radar-raingauge comparisons. Separate statistics are presented for downscaling and correction methods, along with an overall assessment of composite quality. These results are used to select and justify a method of generating a high-resolution product from C-band data over London catchments.