ICL contribution to WP1: Installation and testing of radars

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RainGain Project Meeting, Paris, 21st October 2013

REVIEW – WP1 A1

A1: Radar acquisition

Output:
Radars NL, F

- A Rainscanner® RS90 (low-cost, small X-band radar) was provided on loan (free of charge) by Selex Systems Integration for a period of 6 months.
- The radar was installed in March 2013
- The loan period has recently been extended to 9 months (until Jan 2014)

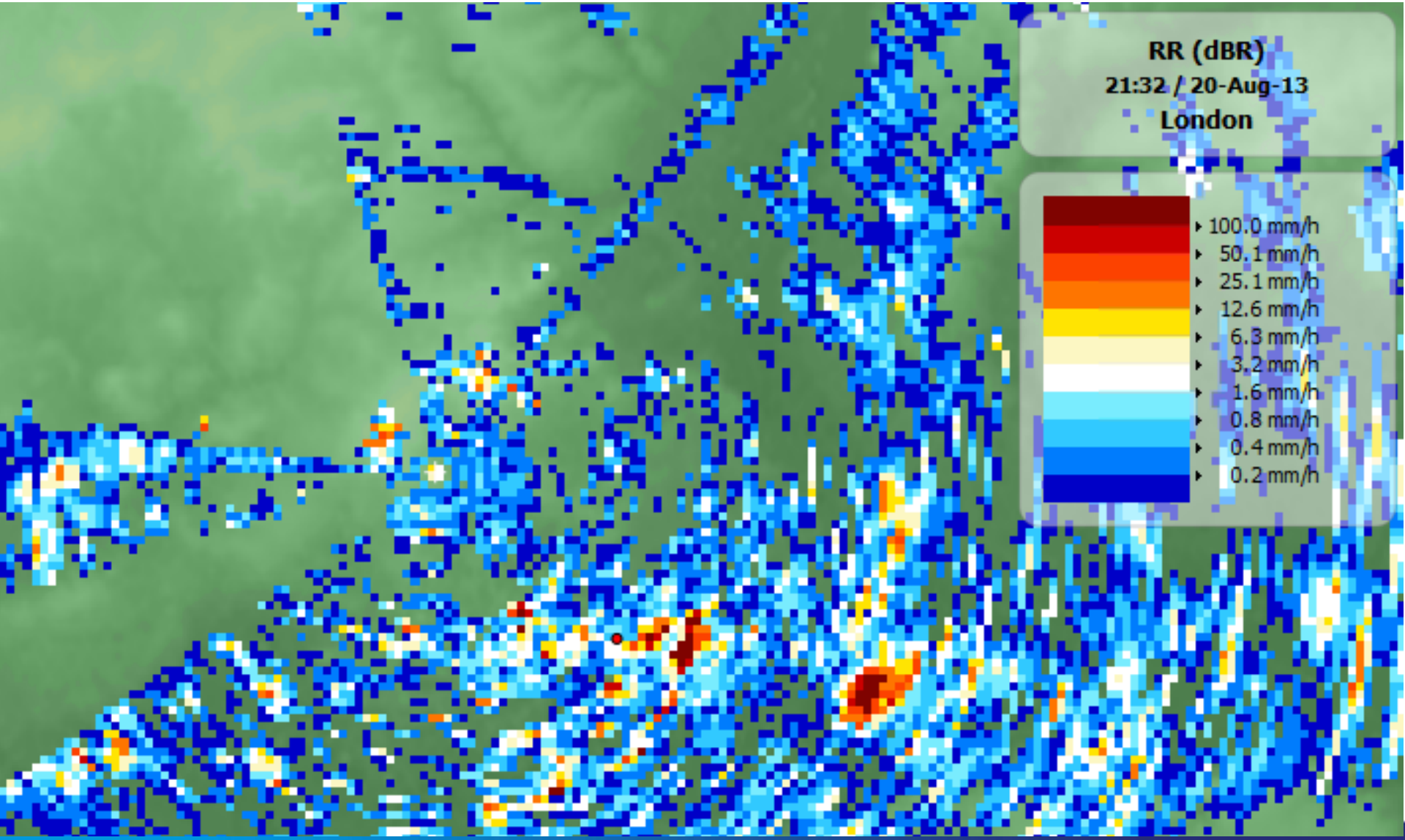
REVIEW – WP1 A2

A2: Radar installation and testing

Output: report on testing

- London's X-band radar was installed in March 2013
- Several problems arose during the installation and start of operation of the radar. Important lessons were learnt in this process and will be summarised in the report on the installation and testing of radars in urban areas (see separate presentation)
- Initial tests of the radar were carried out in order to assess overall quality of the data (in collaboration with the Met Office team in charge of providing weather forecast for Wimbledon Tournament 2013). This was based on visual inspections of the data.
- It was found that the clutter from 'diffuse' sources (including other communication devices) in the London area is big and problematic (although the radar is installed in a tall building at a high point of the city). To resolve this issue, the elevation of the antenna was slightly increased in two occasions and a combination of static + dynamic clutter removal algorithms was implemented (A2-A3).

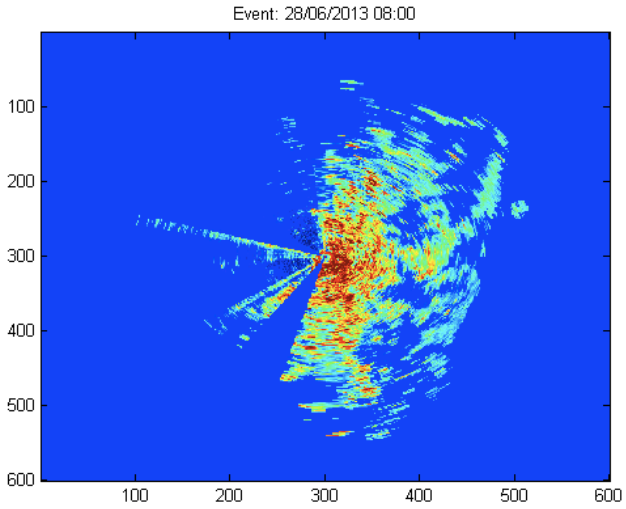
X-band radar data suffer from a particular clutter issue: affected by numerous antennas in the city



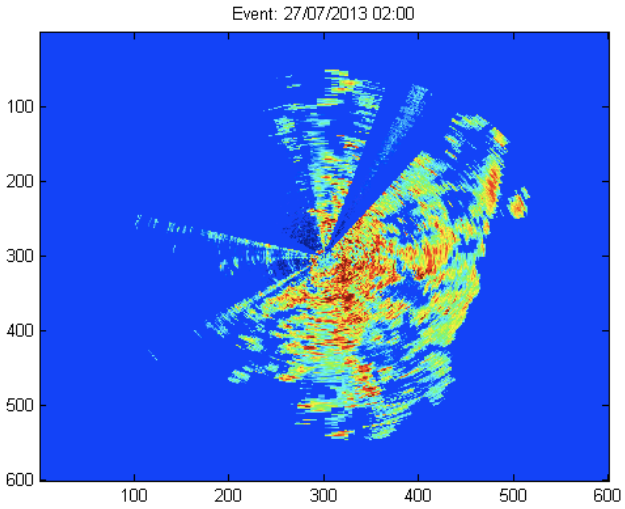
Antenna elevation adjustment

Physical increase of the elevation of the radar antenna has been done twice after initial installation

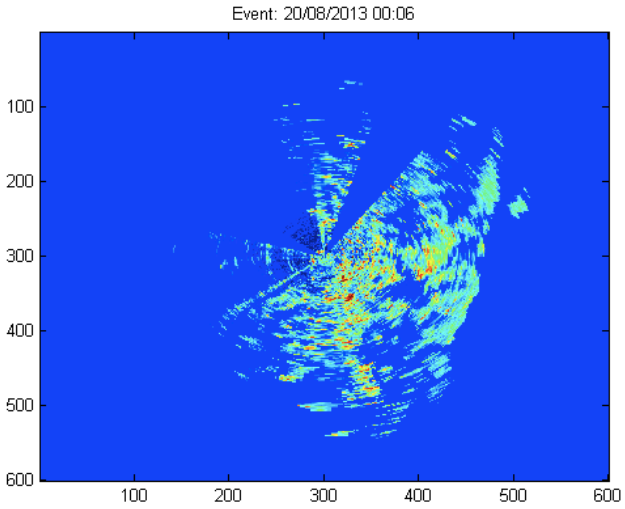
0.5 Degree



1.5 Degree



2.5 Degree



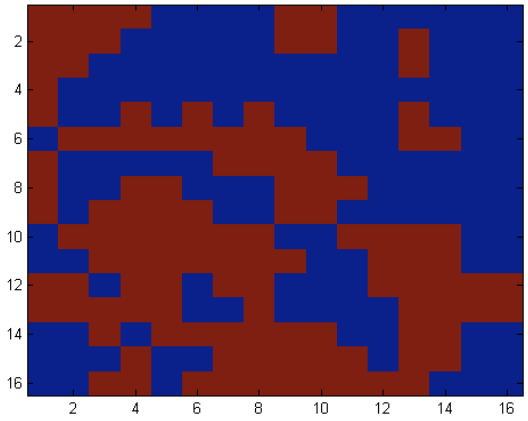
Dry weather images at each antenna elevation

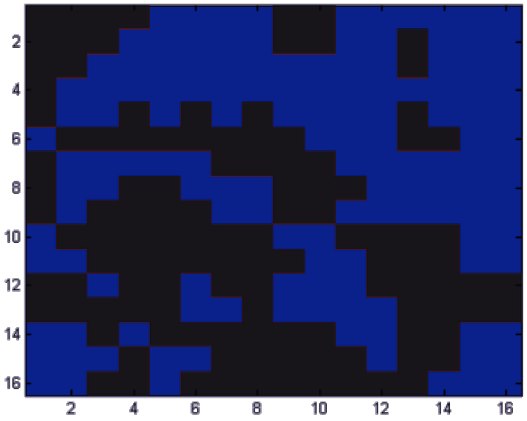
Change of antenna elevation

21st August 2013

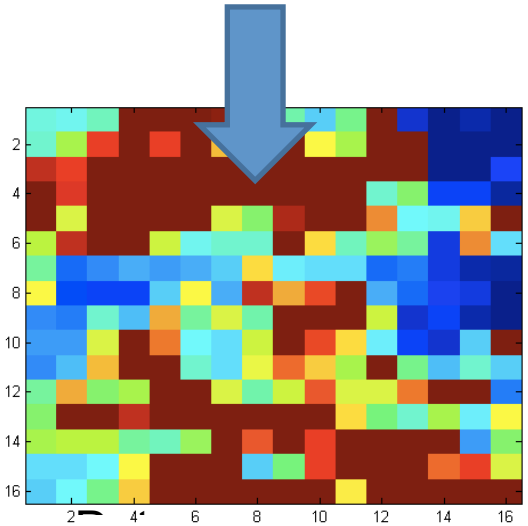
Dry Weather Condition

27/07/2013 20:00





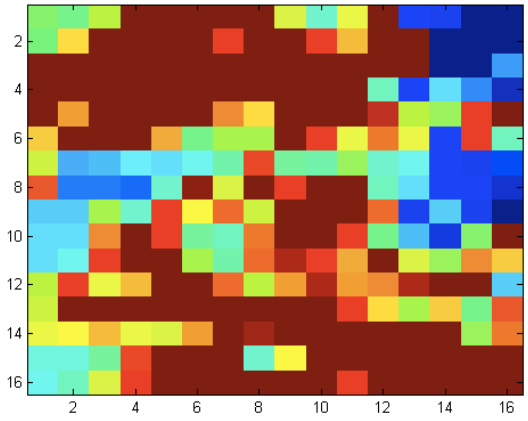
Results of Subtraction

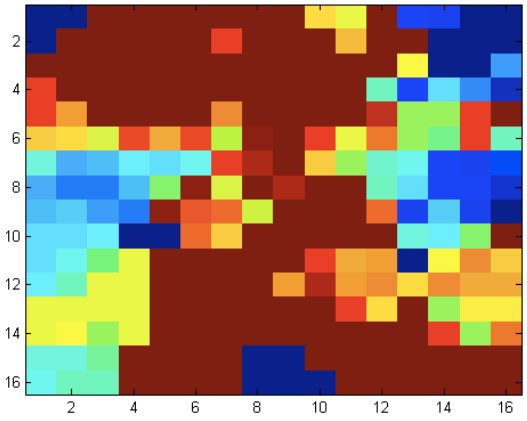


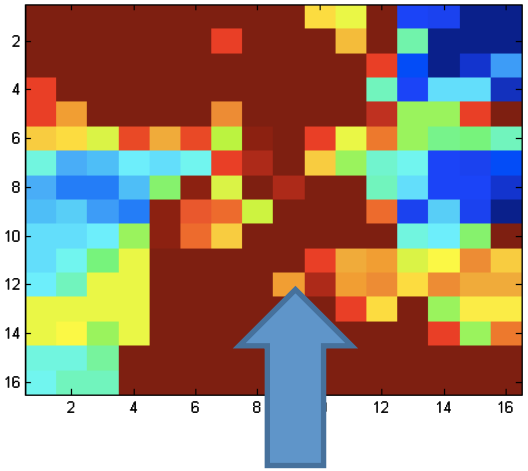
Wet Weather Condition

Original Data

Static Filtered Data







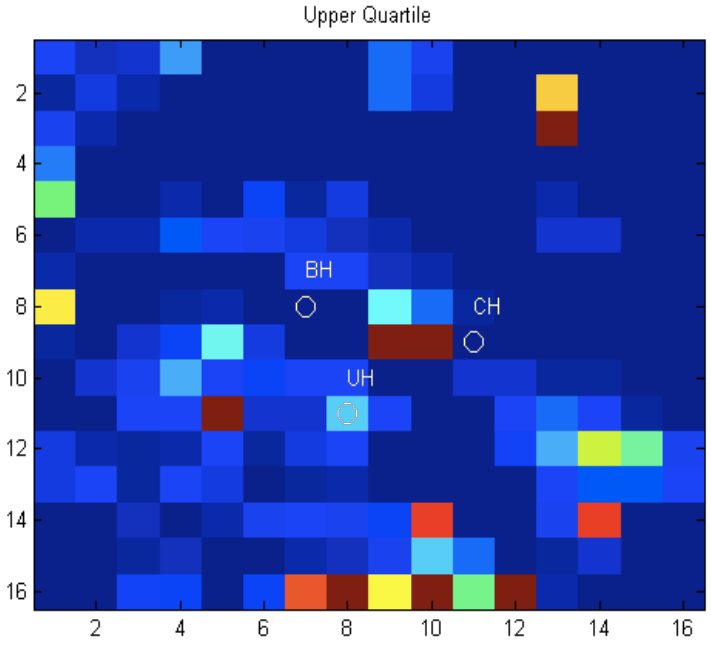
Results of F&I + dynamic

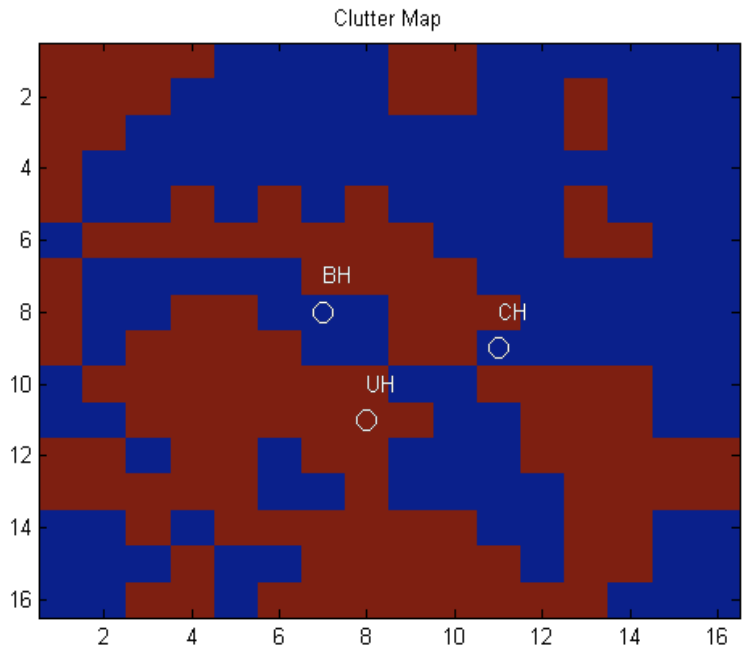
Clutter Filtering

- Static filtering
  - Subtraction
  - Flag & interpolation
- Dynamic filtering
  - Compare each grid with their surrounding grids:
  - If 1/3 of its value is still greater than more than 2 grids surrounded -> clutter (Johann et al. 1999)
- Flag & interpolation + dynamic (+ Kriging)

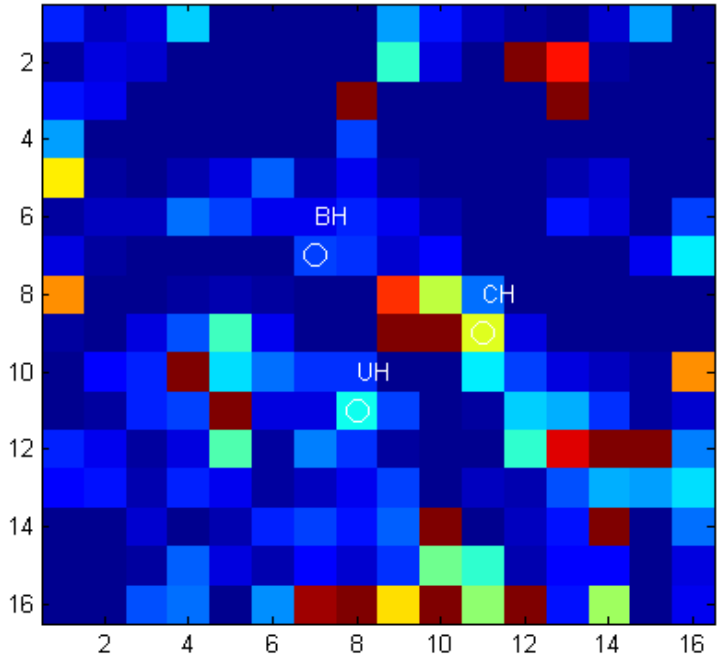
Johann, et al. (1999). PHYS CHEM EARTH PT B, 24(8), 895-901.

Upper Quantile



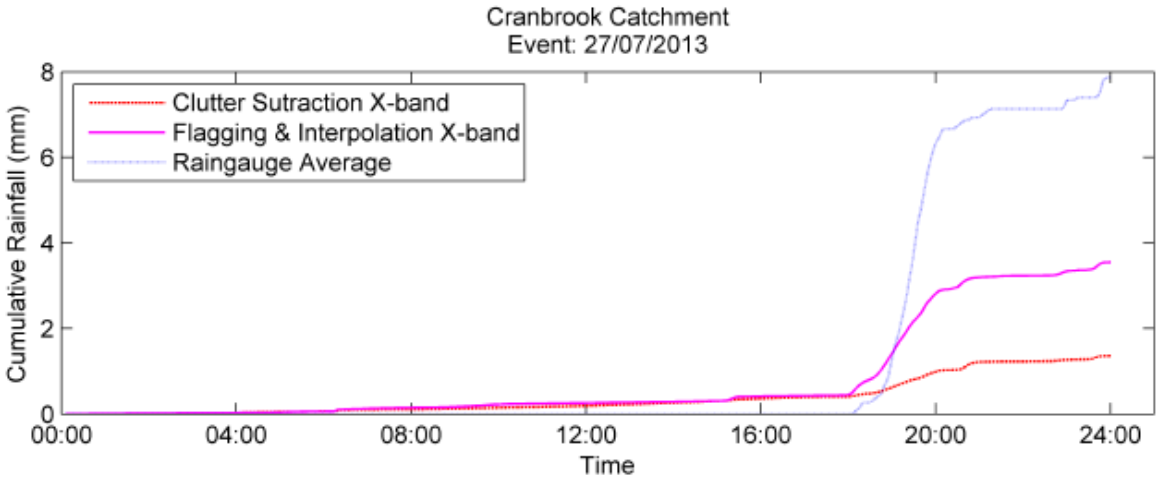


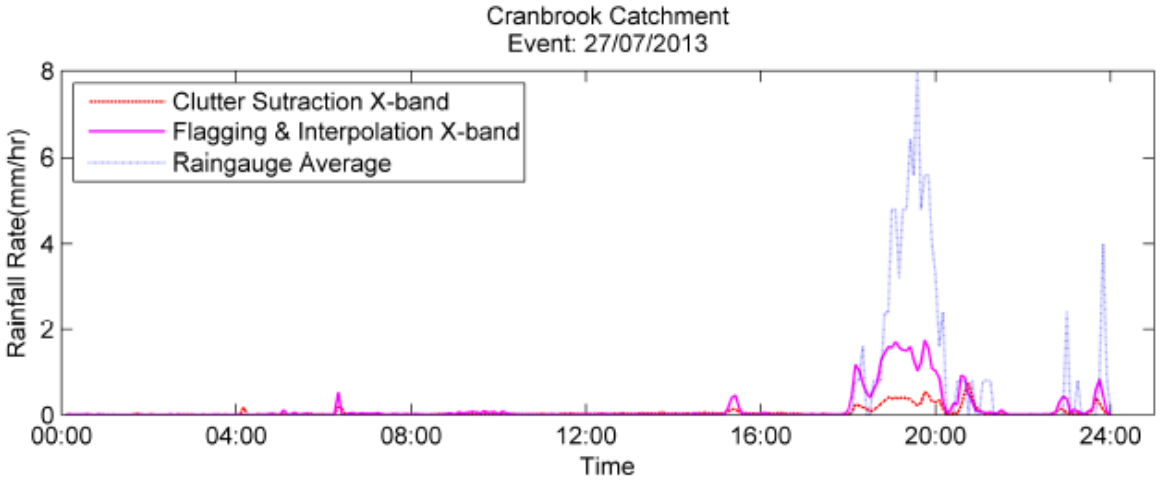
Max



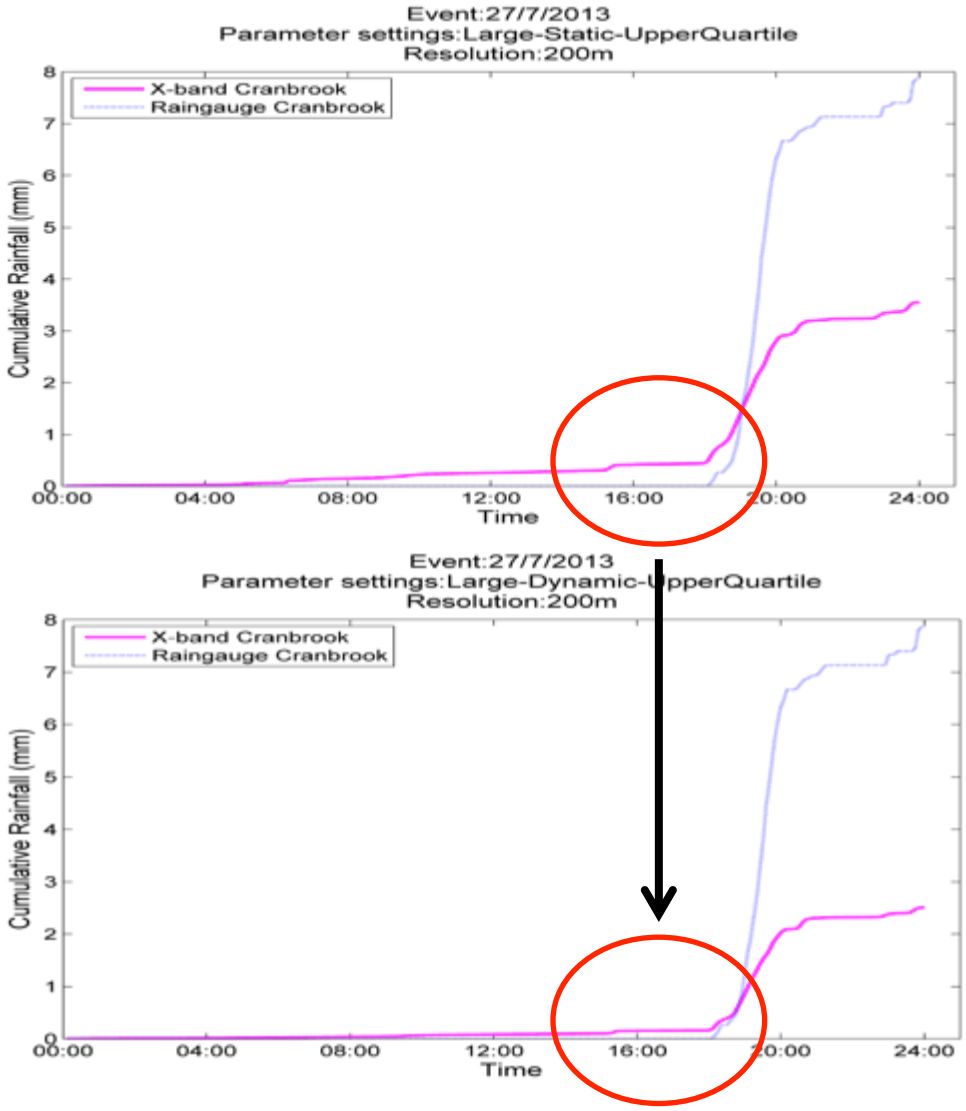
The static clutter map was generated using upper quartiles, but there are occasional clutters appearing. Part of them can be removed using dynamic filtering, but not all of them.

A better performance in cumulative rainfall depth can be seen using flag & interpolation static clutter filtering

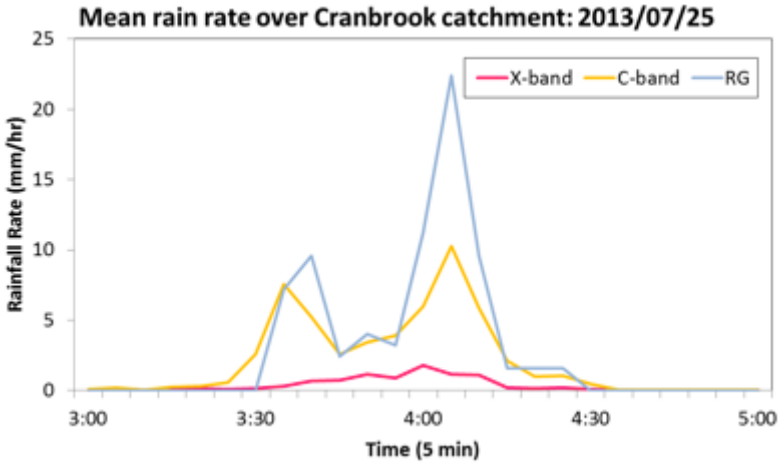


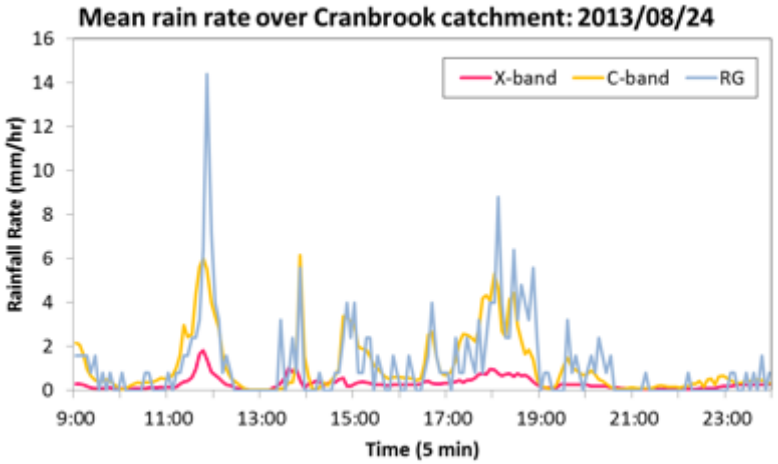


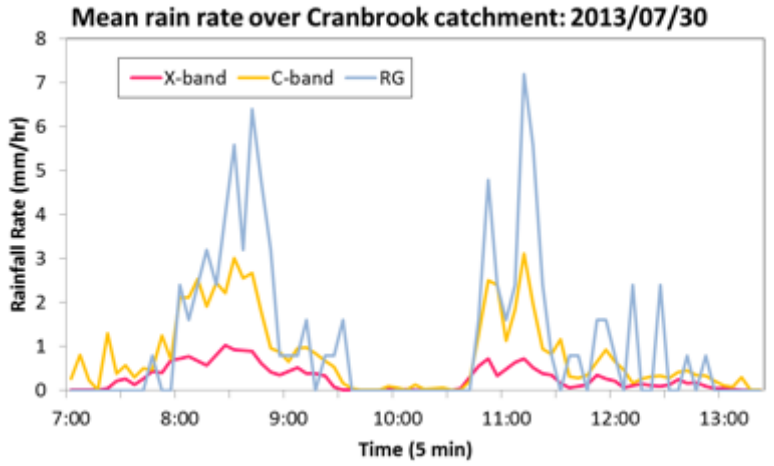
A better performance in cumulative rainfall profile can be seen by applying dynamic clutter filtering

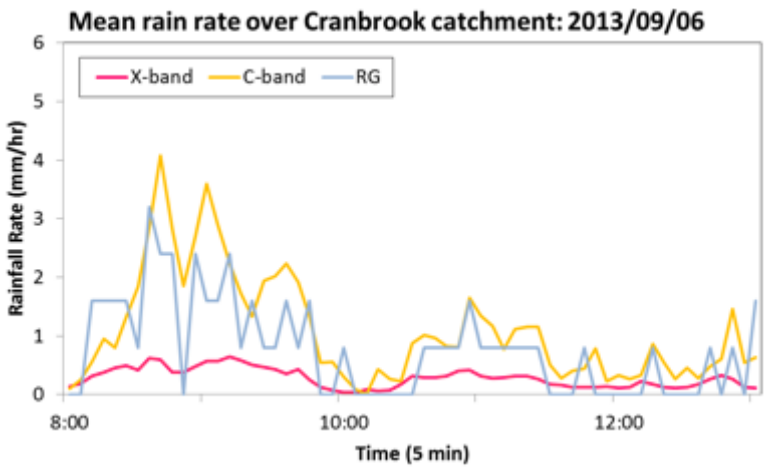


Performance of current X-band rainfall estimates is worse than Nimrod product

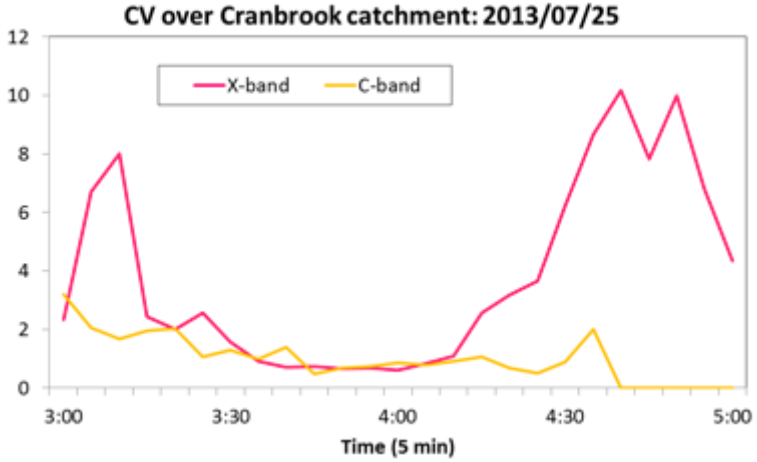


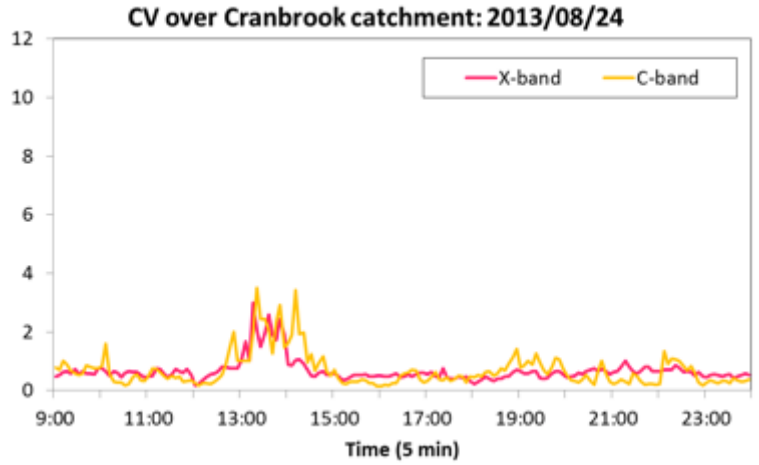


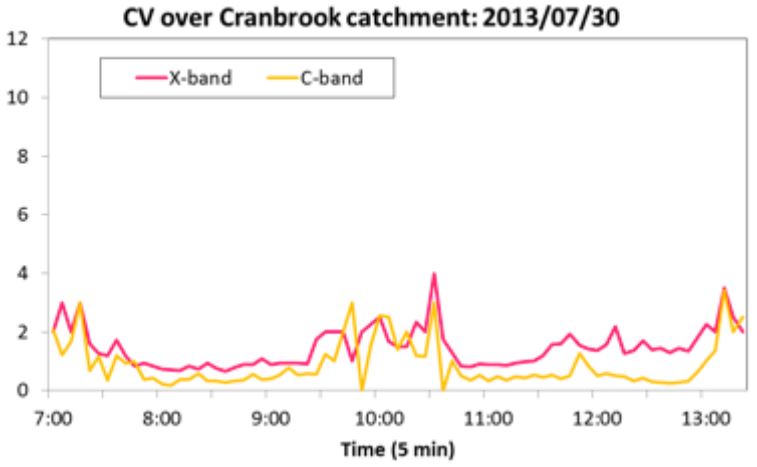


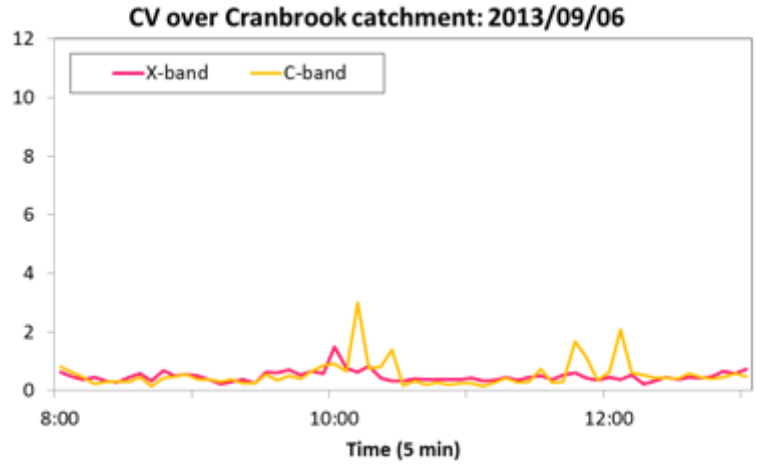


A large difference in CVs between X- and C-band estimates was only found in a convective-like storm









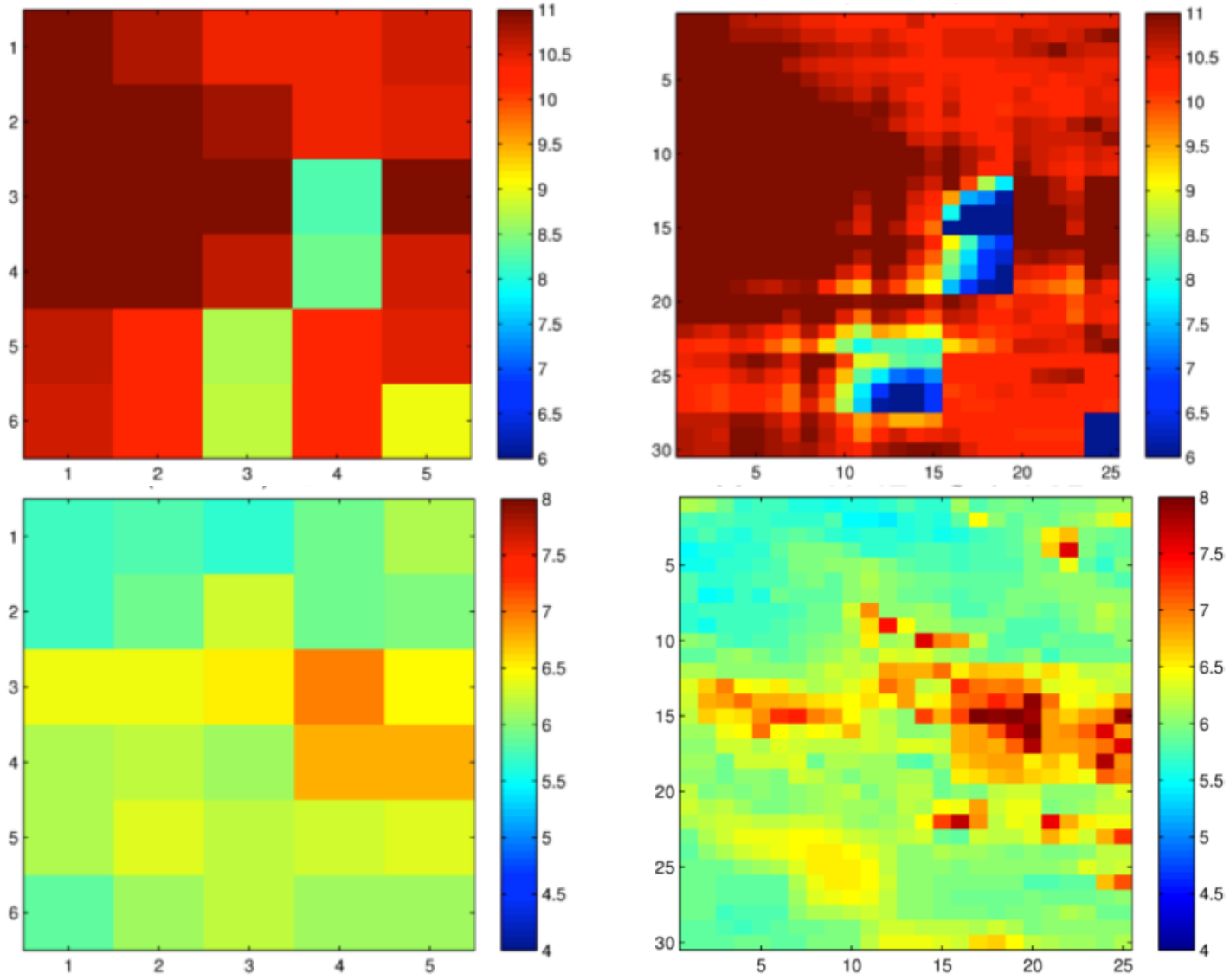
REVIEW – WP1 A3

A3: Appraisal of existing rainfall data

Output: presentations at pilots (Nat Obs Groups)

- High-resolution (200 m, 1-min) radar rainfall data (raw reflectivity and rainfall rates) of a number of rainfall events crossing Central London have been recorded.
- Until now, X-band radar QPEs have been obtained by first removing and substituting clutter and afterwards applying Marshall-Palmer Z-R conversion equation ($a = 200$; $b = 1.6$)
- The accuracy of the current QPEs is very low. However, from visual inspection and comparison of X-band radar images vs C-band radar images it can be seen that in the case of convective storms, there is higher spatial variability in the rainfall field and this can be captured by the X-band radar

Very detailed storm structure can be observed over urban areas using X-band radar



REVIEW – WP1 A3

A3: Appraisal of existing rainfall data

Output: presentations at pilots (Nat Obs Groups)

- More processing is required in order to obtain better QPEs from the X-band radar.
- The following corrections will be implemented:
  - Control of signal stability (as in Sempere-Torres et al. 2003).
  - Clutter filtering as previously explained (static + dynamic masks). Substitution will be done with Kriging.
  - Attenuation correction: still unsure about method.
  - Extrapolation of reflectivity to the surface (VPR correction): possibly based on Kitchen et al (1994) – using UKMO RadarNet system.
  - Single Z-R conversion
  - Adjustment with raingauge and C-band radar data. This adjustment will aim at improving accuracy while preserving spatio-temporal structure of the rainfall field as captured by the X-band radar (this procedure is part of WP2)

REVIEW – WP1 A3

A3: Appraisal of existing rainfall data

Output: presentations at pilots (Nat Obs Groups)

- The performance of the resulting QPEs in terms of accuracy will be evaluated using data from an independent network of raingauges.
- Added value of the higher-resolution estimates will be assessed by inputting them into the hydraulic model of the Cranbrook and Croydon pilot sites. The hydraulic outputs will be compared against flow and depth records, as well as against the results obtained using raingauge and Nimrod data as input to the model.

ICL'S OVERALL CONTRIBUTION TO WP1

- Assessment of the added value of a low-cost small X-band radar for urban hydrological applications

- Recommendations regarding deployment and operation of a radar in the heart of a dense urban area such as London