Probabilistic radar nowcast for hydrological modelling

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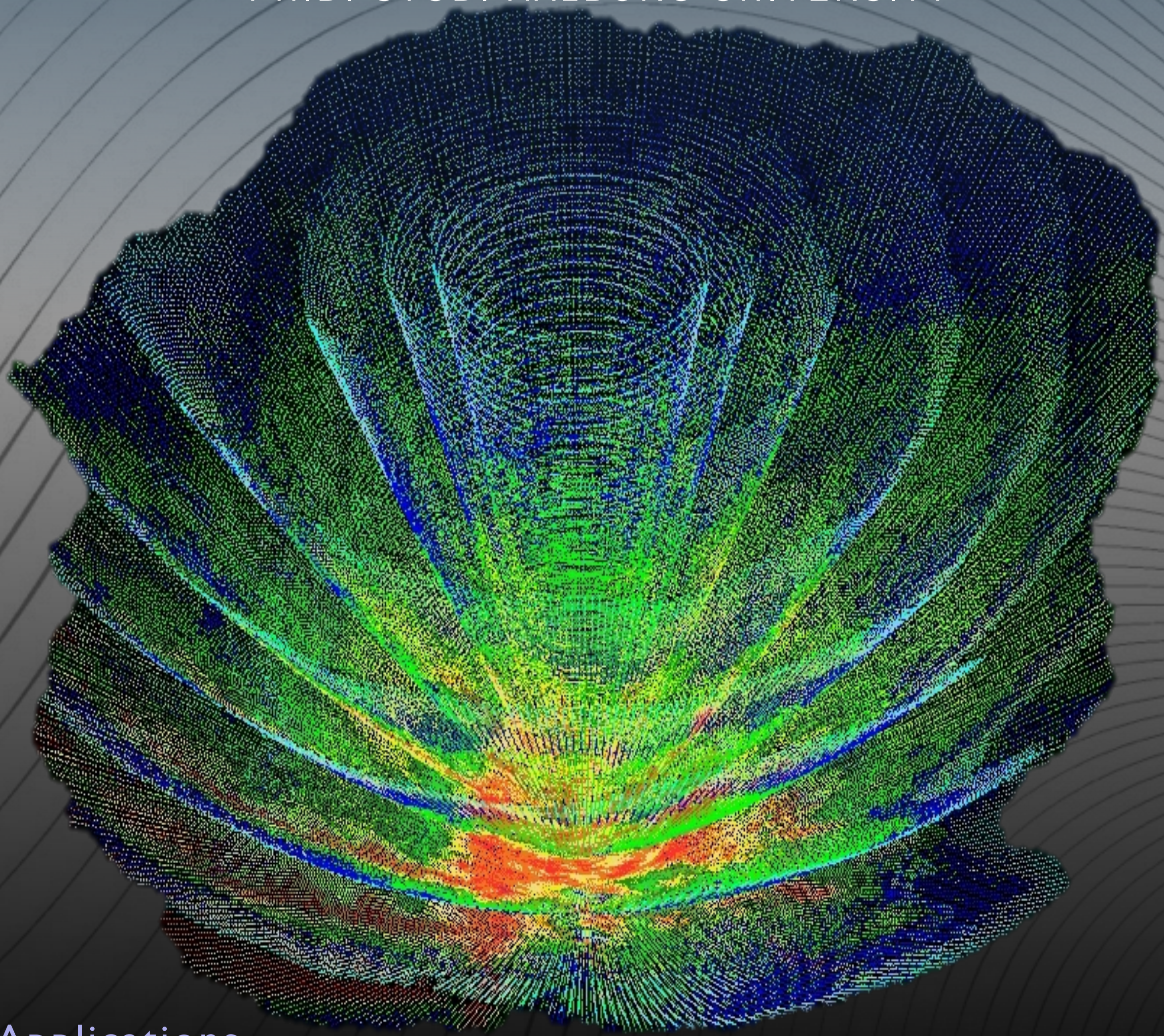

URBANWATER
Weather Radar Applications

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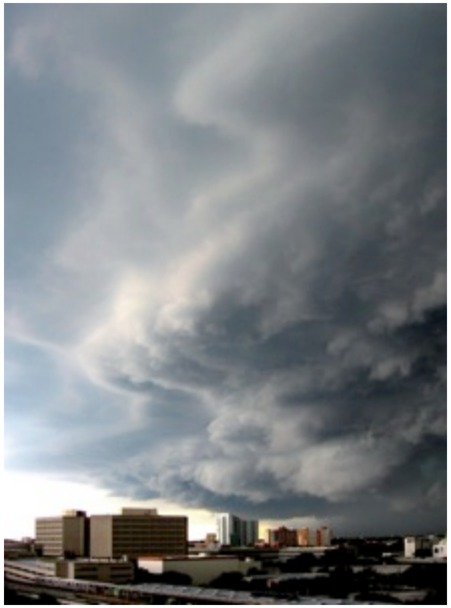
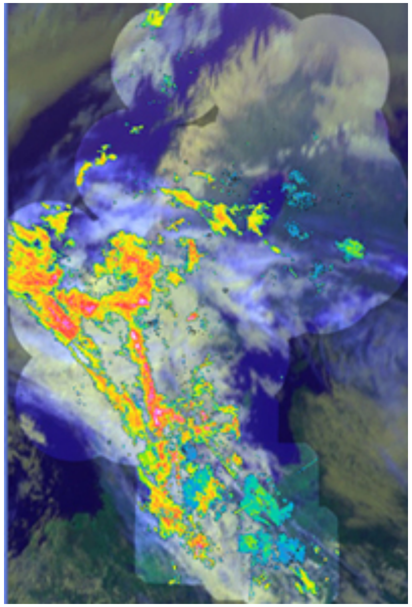
Agenda

- Purpose
- Deterministic radar nowcaster
- Advection uncertainty estimation
- Process uncertainty estimation
- Hydrological model
- Results

Purpose

To create a probabilistic uncertainty model for Co-TREC radar based nowcast systems that separates advection and process uncertainty for hydrological modelling.

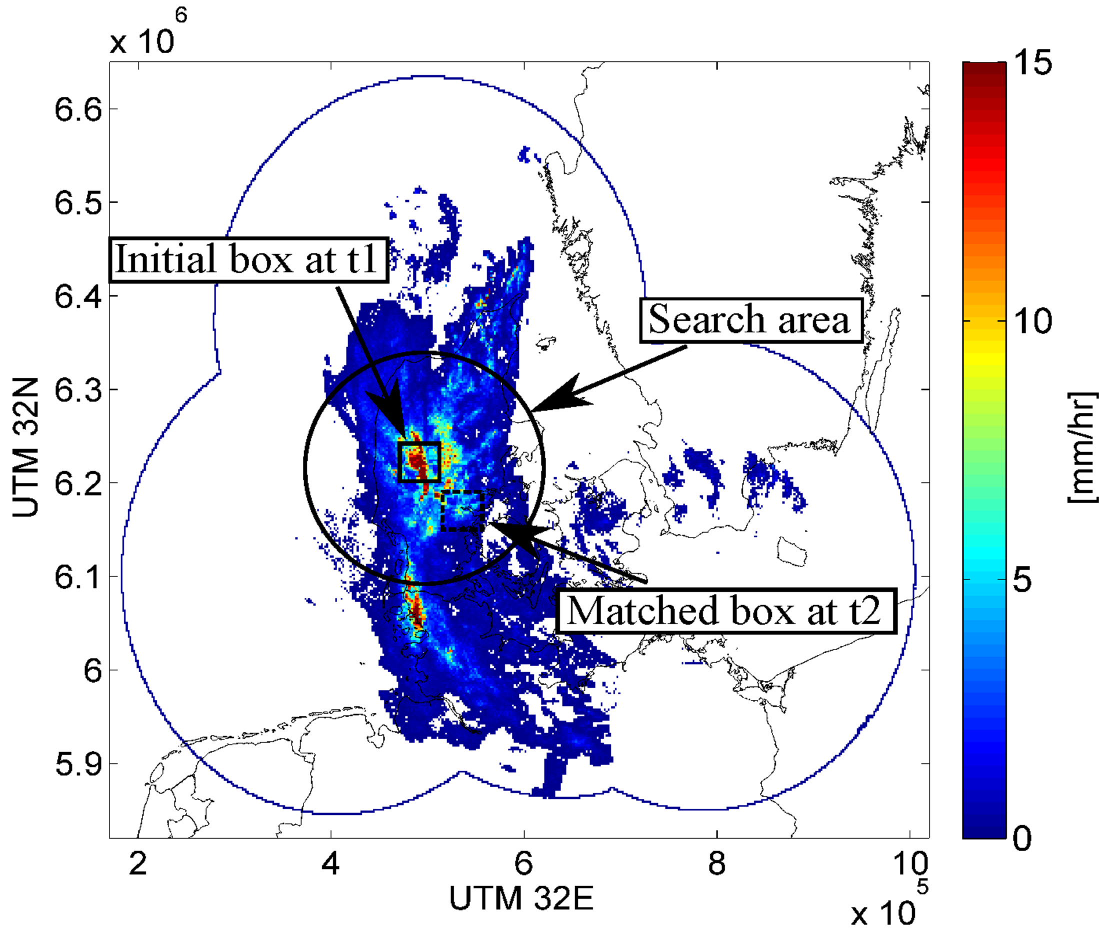




Deterministic radar nowcast: TREC vectors

TREC-vectors

- Divides area into a number of grid boxes
- Compute the maximum correlation within search area
- From the maximum correlation is the TREC vector found



(Rinehart and Garvey, 1978)

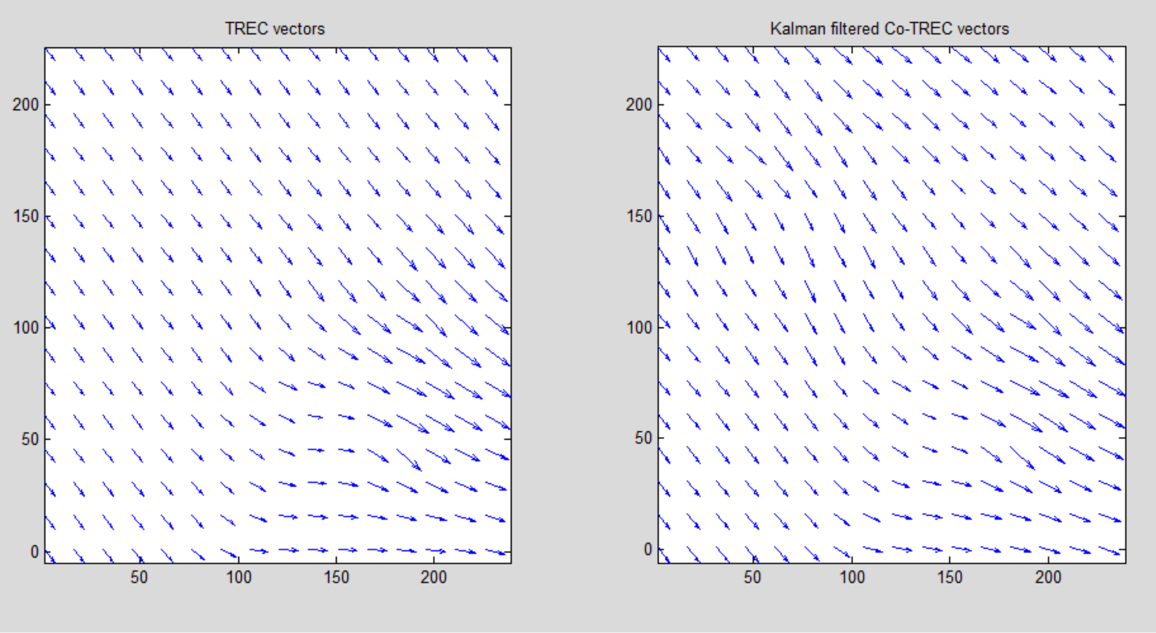
Deterministic radar nowcast: Kalman filtered Co-TREC vectors

<u>Co-TREC (Li et al. 1995)</u>

- Firstly deletes the apparently incorrect vectors
- Secondly uses variational analysis to smoothen the vector field spatially (minimization of a cost function under the constraint of continuity)

<u>Kalman filtering</u>

- Recursive filter to temporally smoothen the Co-TREC vectors
- Ensures that the advection vectors can not change dramatically from time step to time step due to "noise"



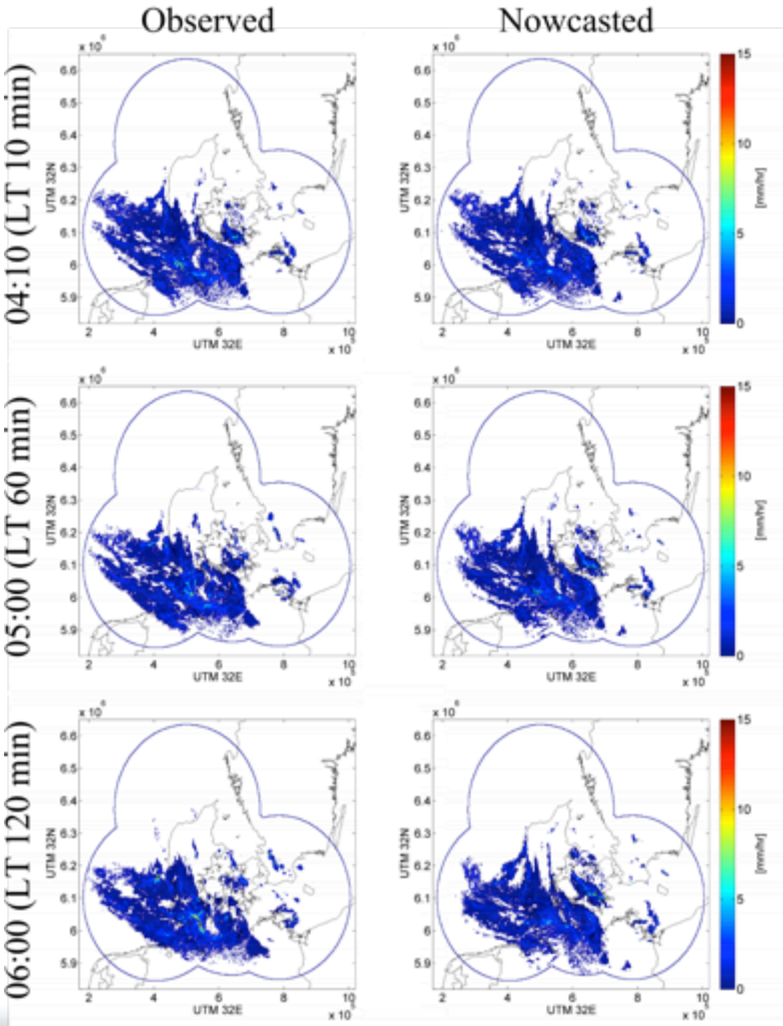
Deterministic radar nowcast: Extrapolation method

Advection scheme

- Advection scheme is a semi-Lagrangian interpolate once forward scheme
- Advection on a fine grid as scatter points
- Only one interpolation per lead time
- Smallest power loss on small scale features

(Germann and Zawadzki 2002)

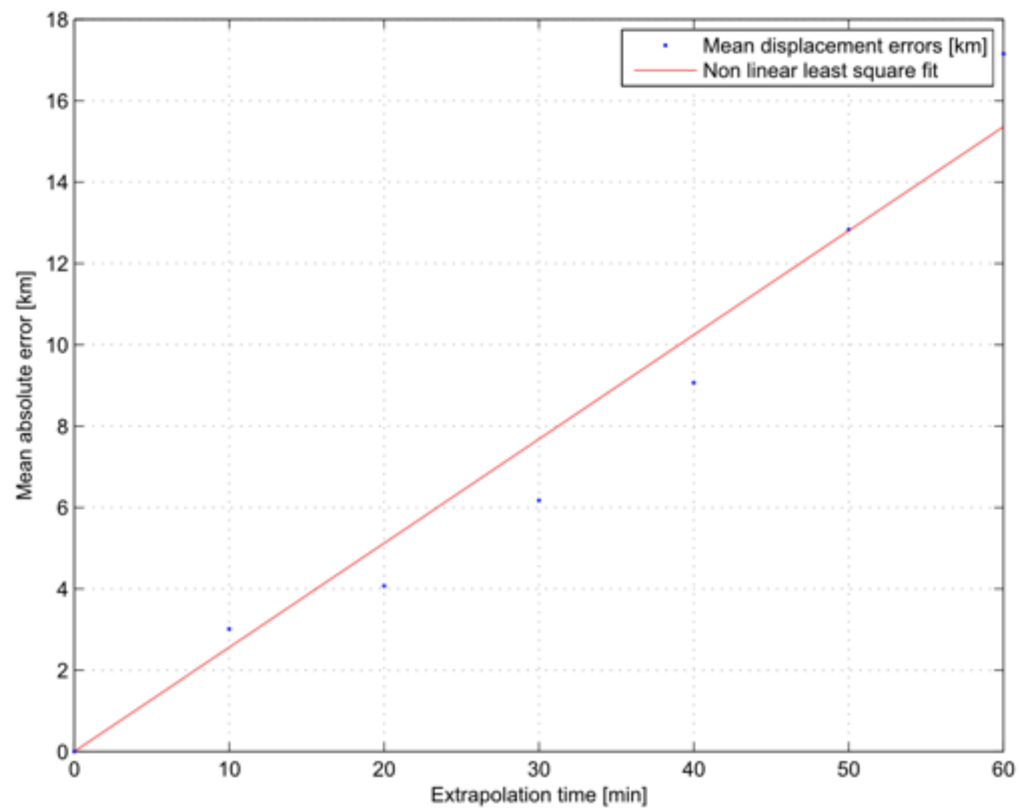
Nowcast issused
18 August 2010 04:00



Probabilistic advection uncertainty component

- Advection error is assumed linear
- X and Y component of error is Gaussian distributed
- Not correlated in X and Y
- 2-dimensional Gaussian distribution with same standard deviation are used to perturbed the advection field

$$J_{(x,y),t,i} = I_{(x,y),t} + \delta_{(x,y),t,i}$$

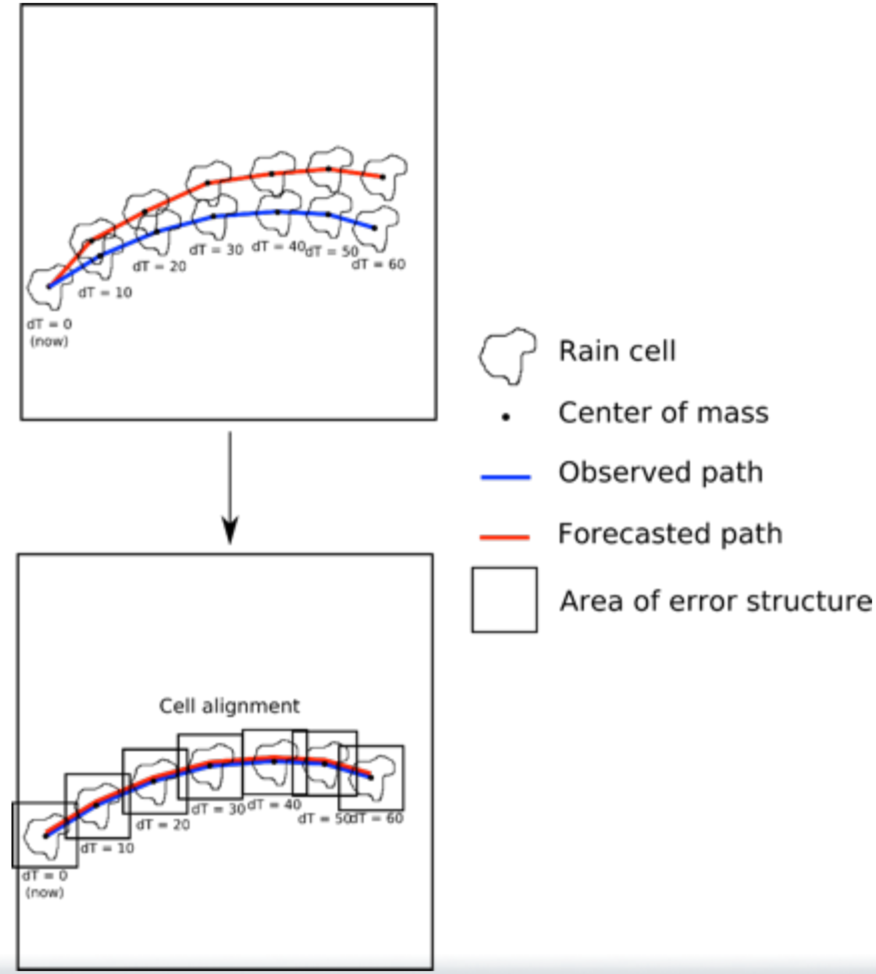


(Schmid et al. 2000)

Probabilistic process uncertainty component

- Historical knowledge of nowcast performance are used to perturb current nowcast.
- Rain cells found using Otsu's method are compared with the equivalent observed cells.
- The cells are aligned according to their center of masses to separate advection and process uncertainty.
- Error structure and perturbation according to the REAL method (Germann et al. 2009):

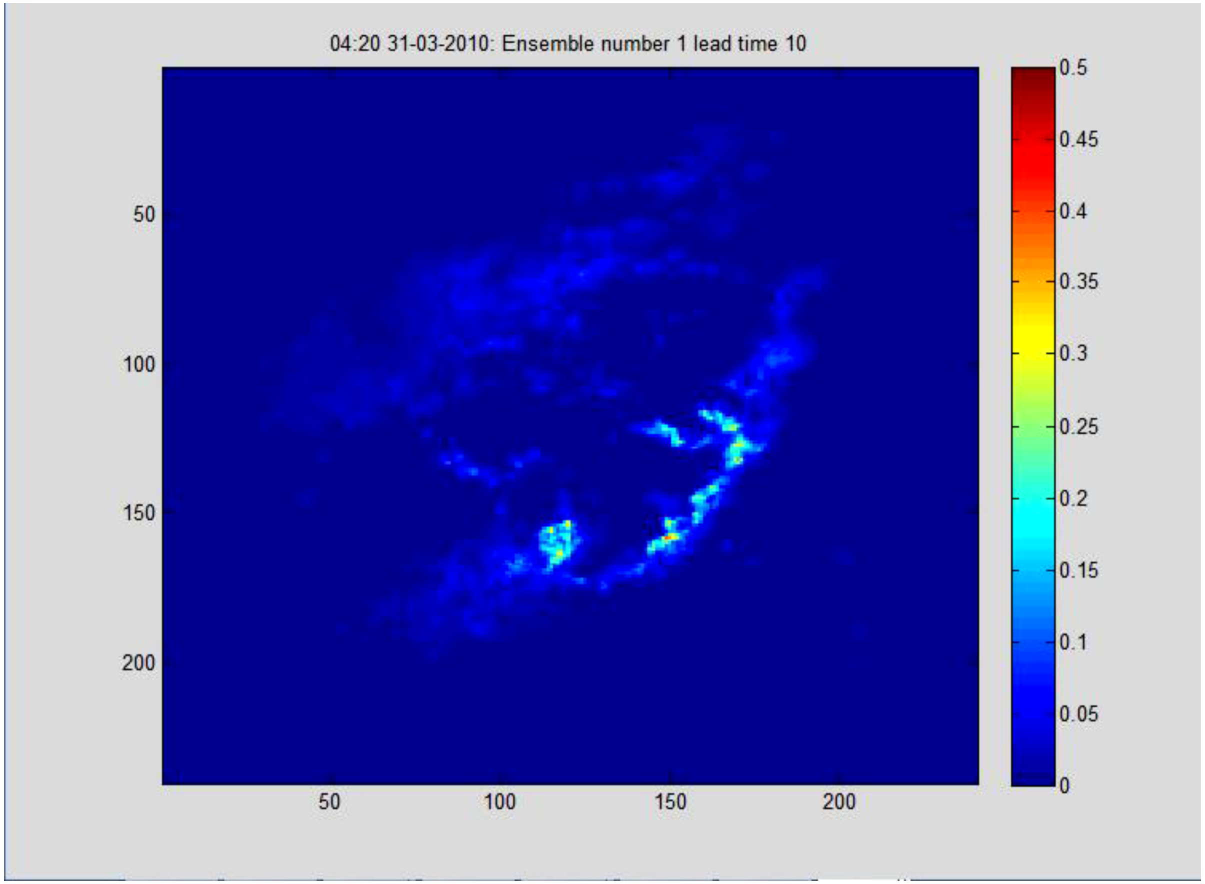
$$\Phi_{t,i} = R_t + \delta_{t,i}$$



Procedure

- Generate normal Co-TREC nowcast
- Translate image according to 2D Gaussian perturbation of advection field
- For every advection ensemble the process uncertainty is applied
- Result: Number of ensembles with both advection and process uncertainty

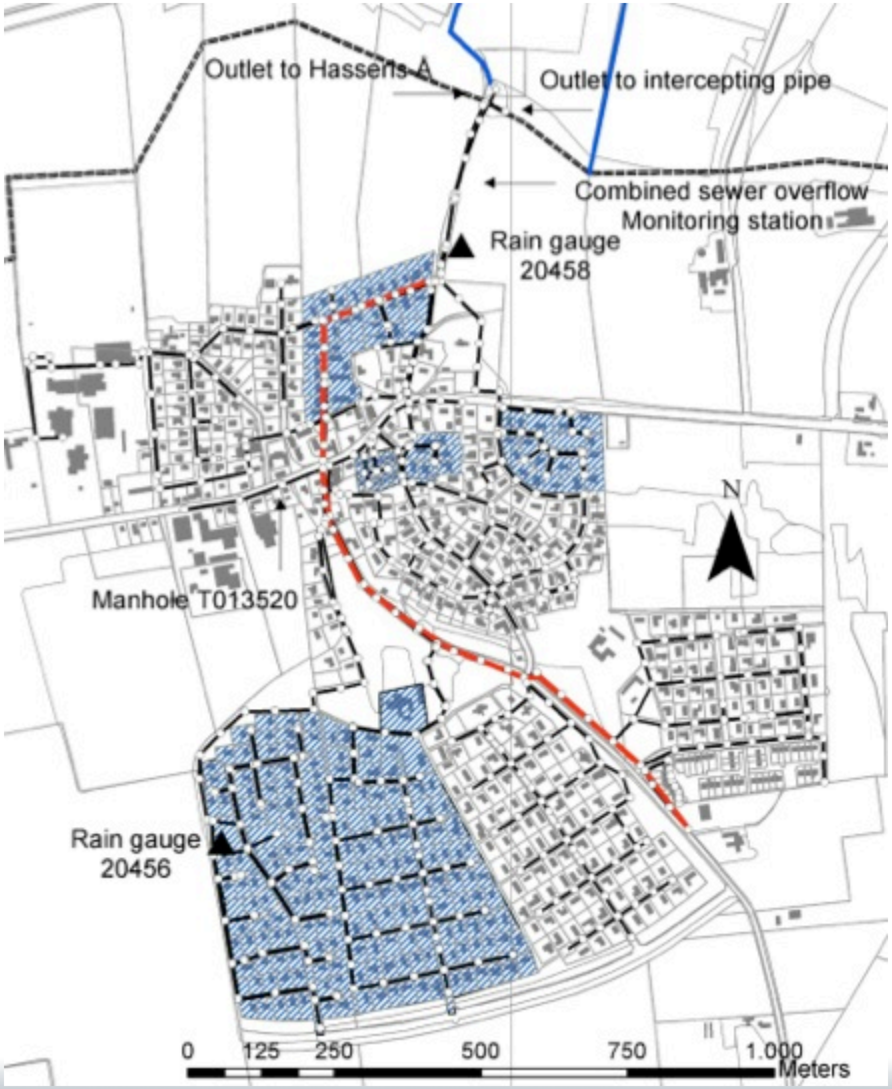
Probabilistic nowcast example



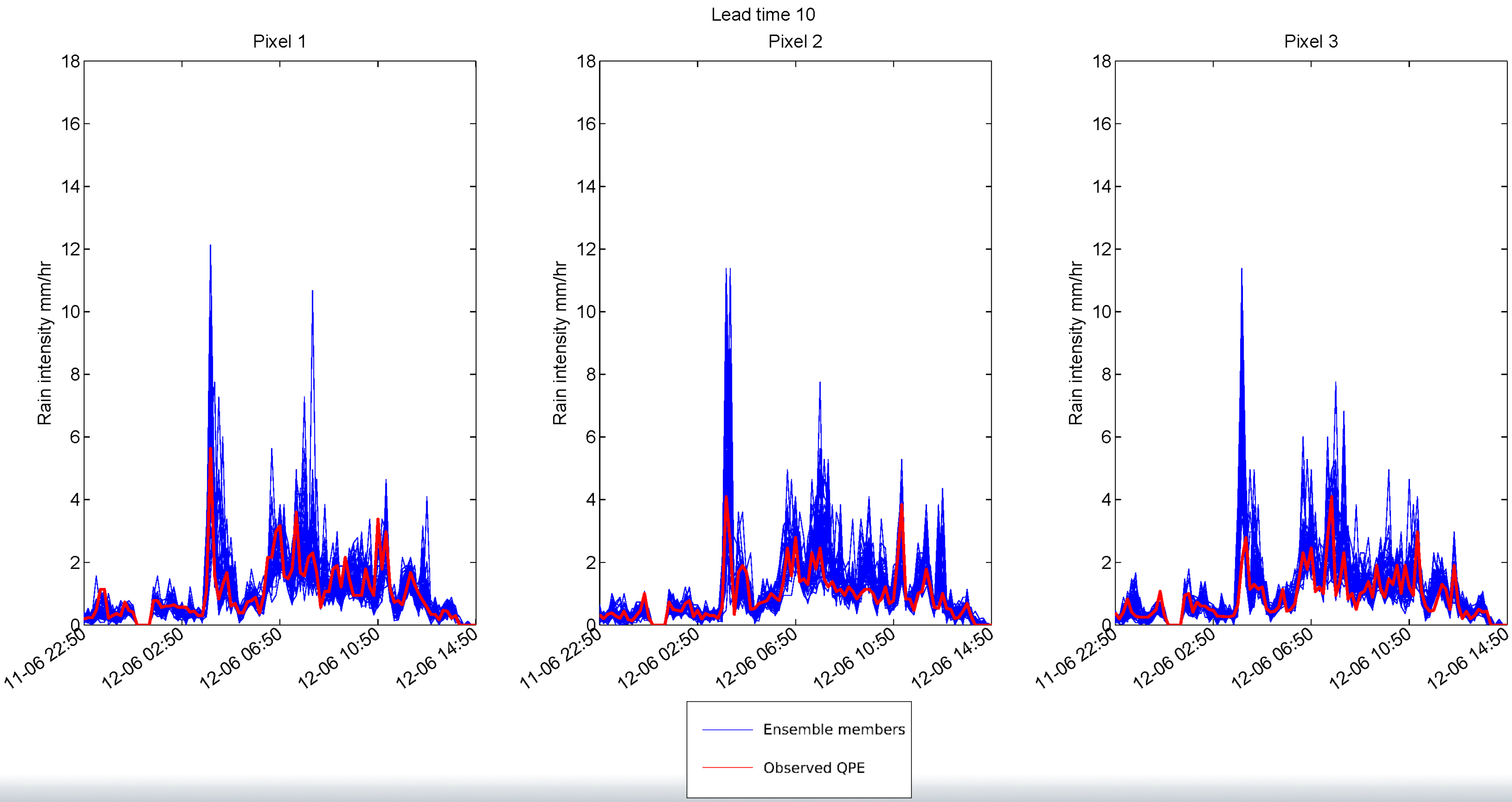
The urban catchment Frejlev

- Partly combined and partly separated sewer system
- 0.8 km^2 urban area
- 40% impervious area
- 2000 inhabitants

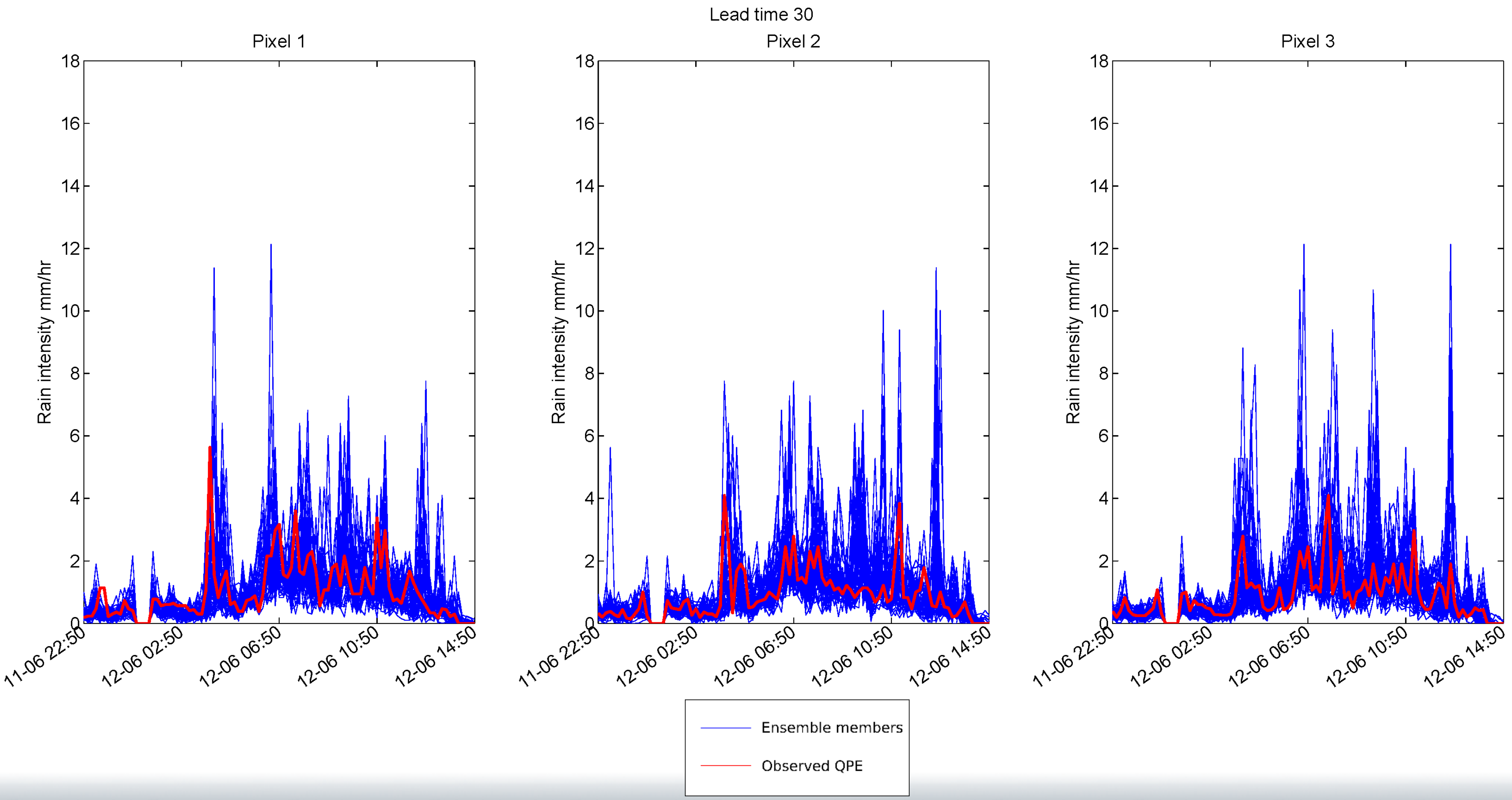
- Fully distributed and well calibrated runoff model based on the core of MOUSE/MIKE URBAN model
- Time/Area surface runoff model
- Dynamical pipe flow model (St. Vernant equations)



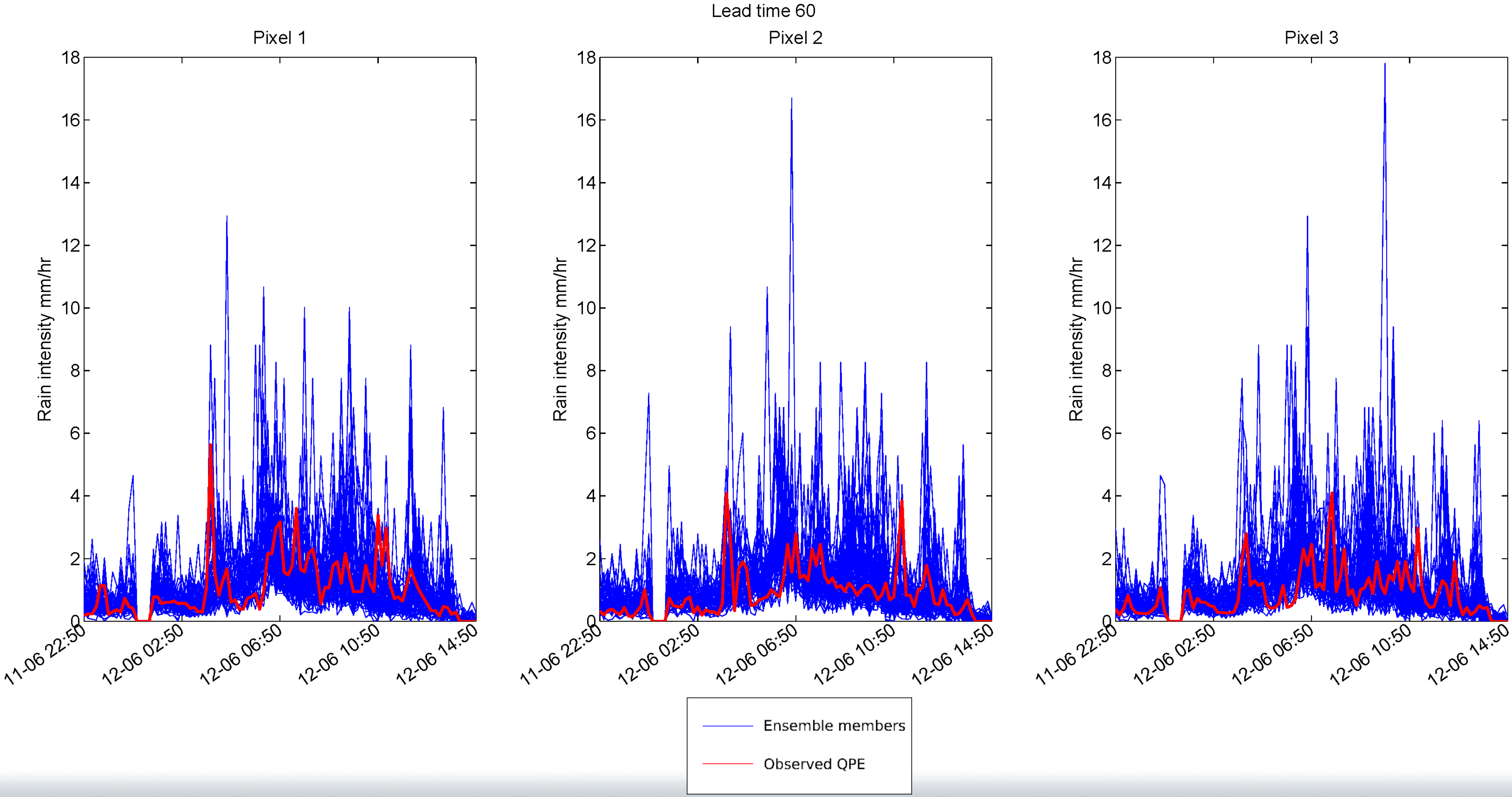
Example 1: Input rain fall prediction 10 min lead time



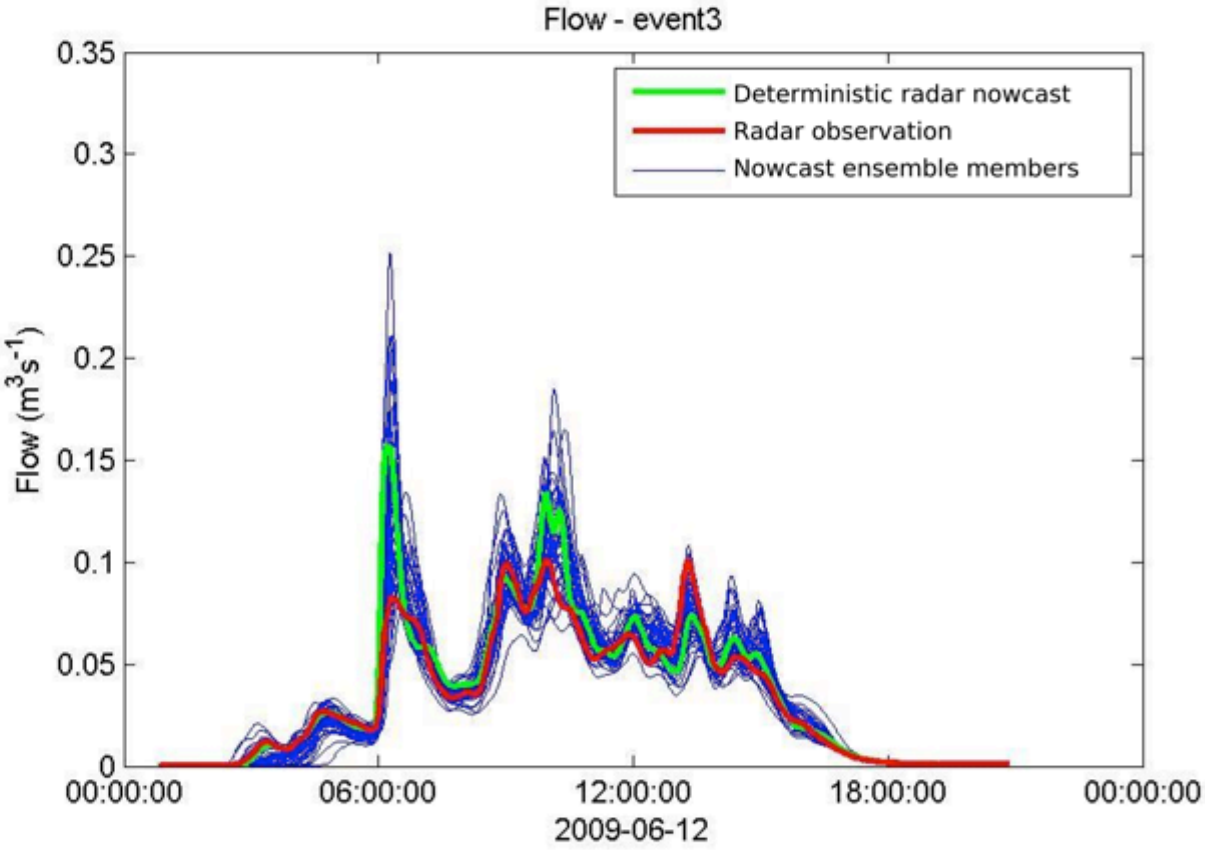
Example 1: Input rain fall prediction 30 min lead time



Example 1: Input rain fall prediction 60 min lead time



Example 1: Frejlev flow prediction lead time 10 min.



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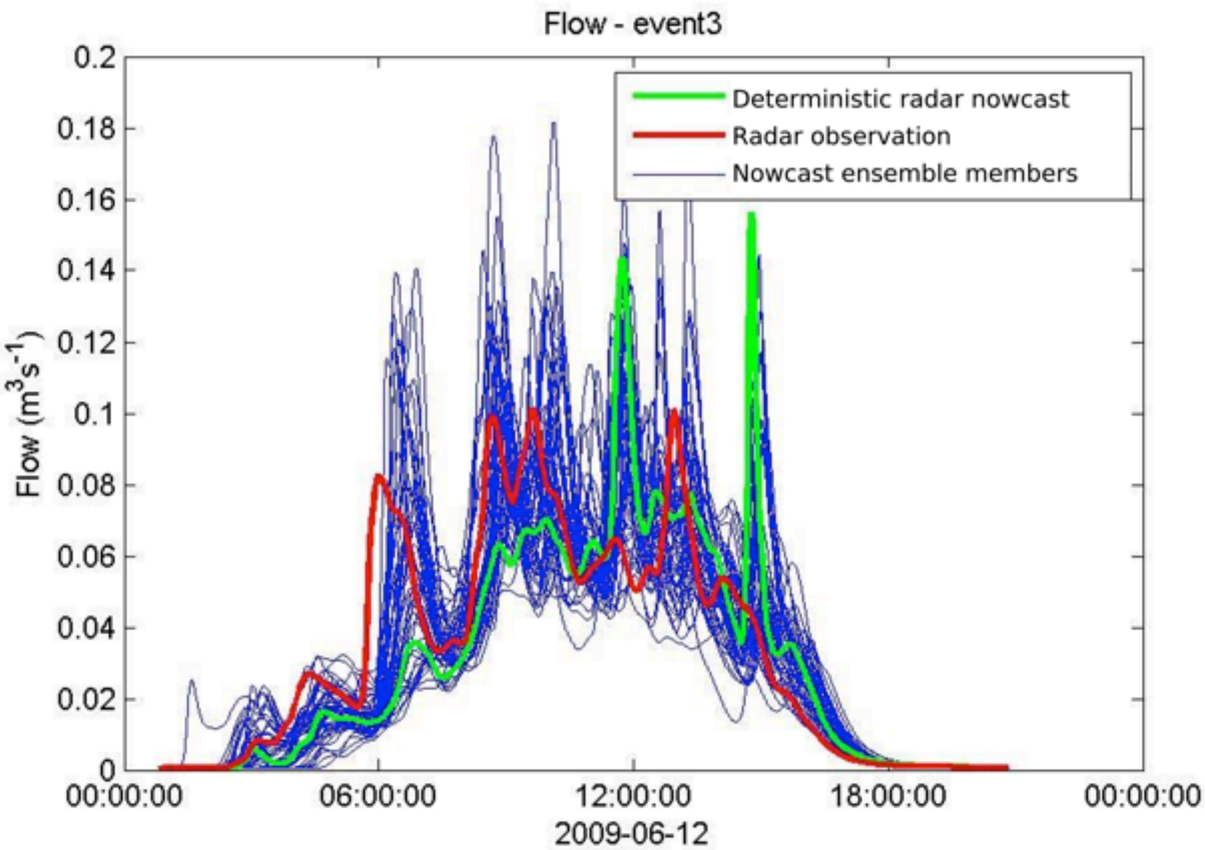

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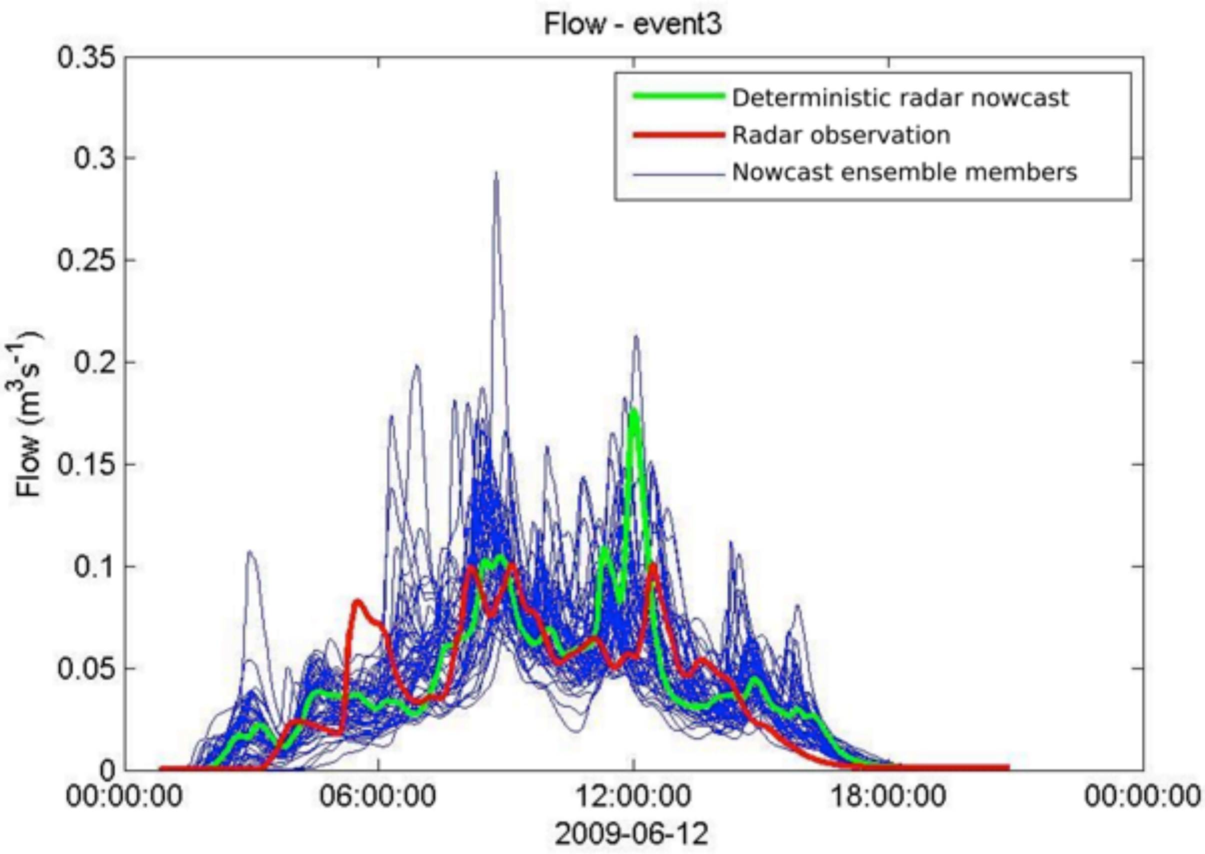
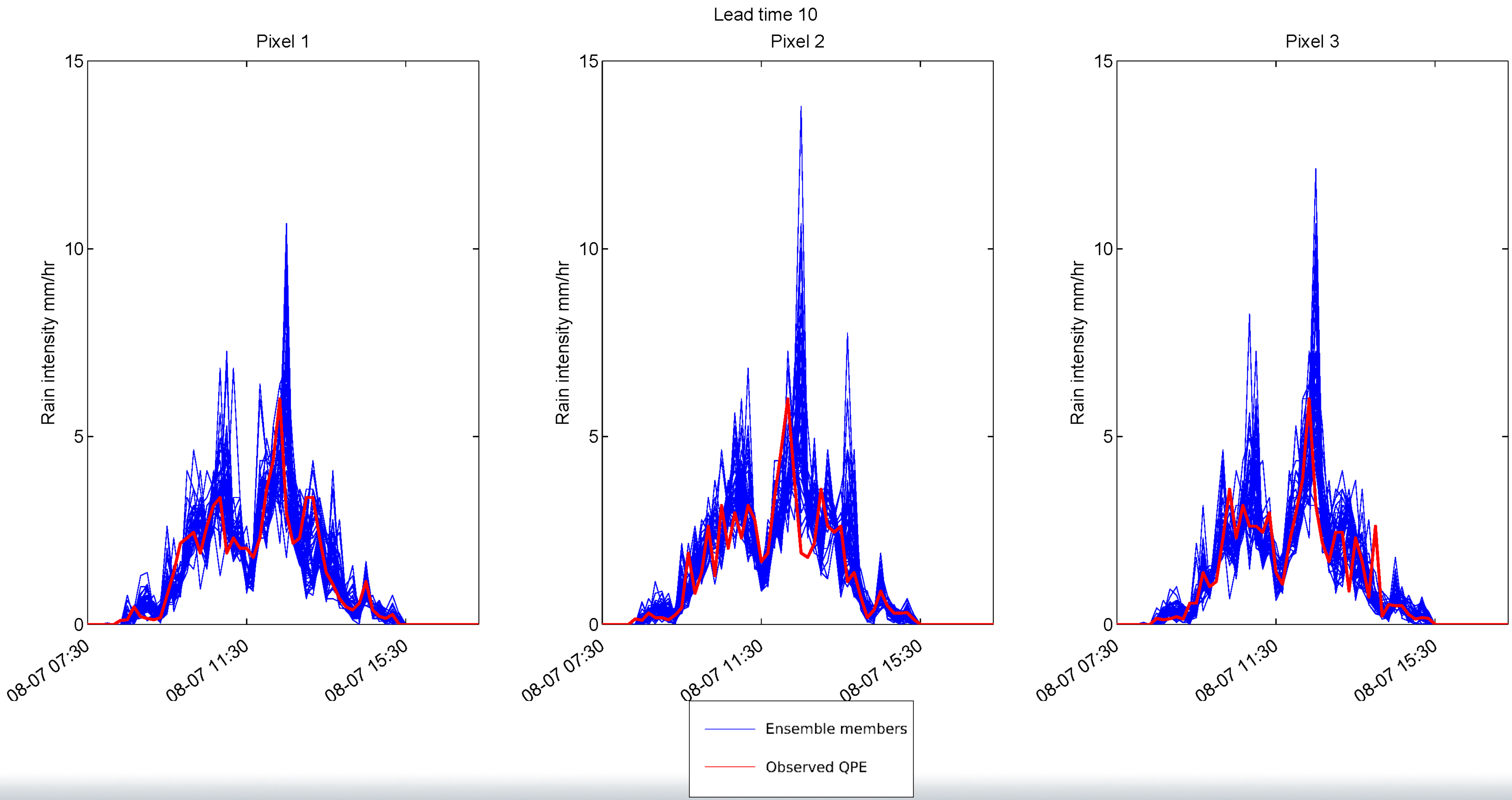


Example 2: Input rain fall prediction 10 min lead time



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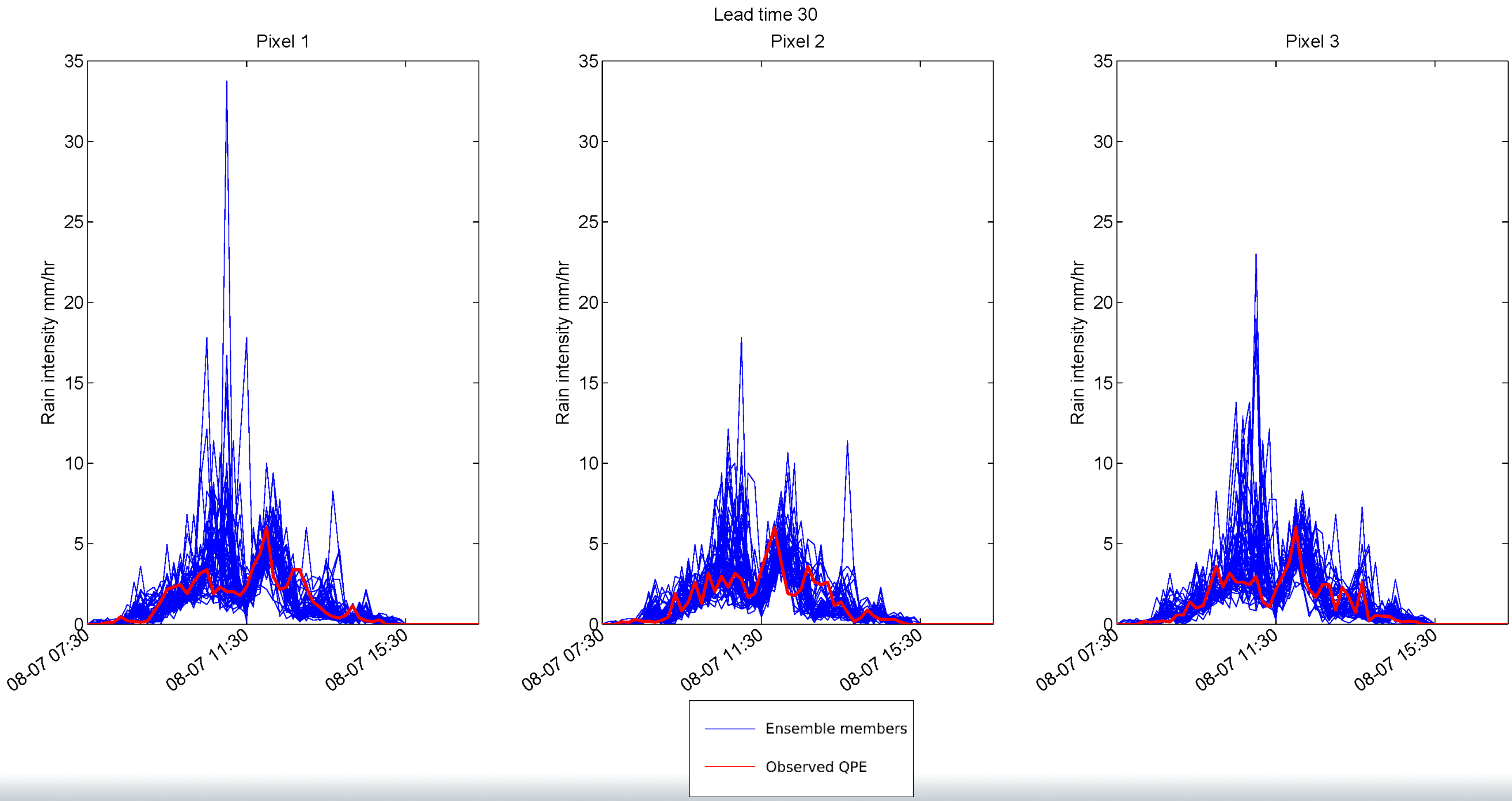

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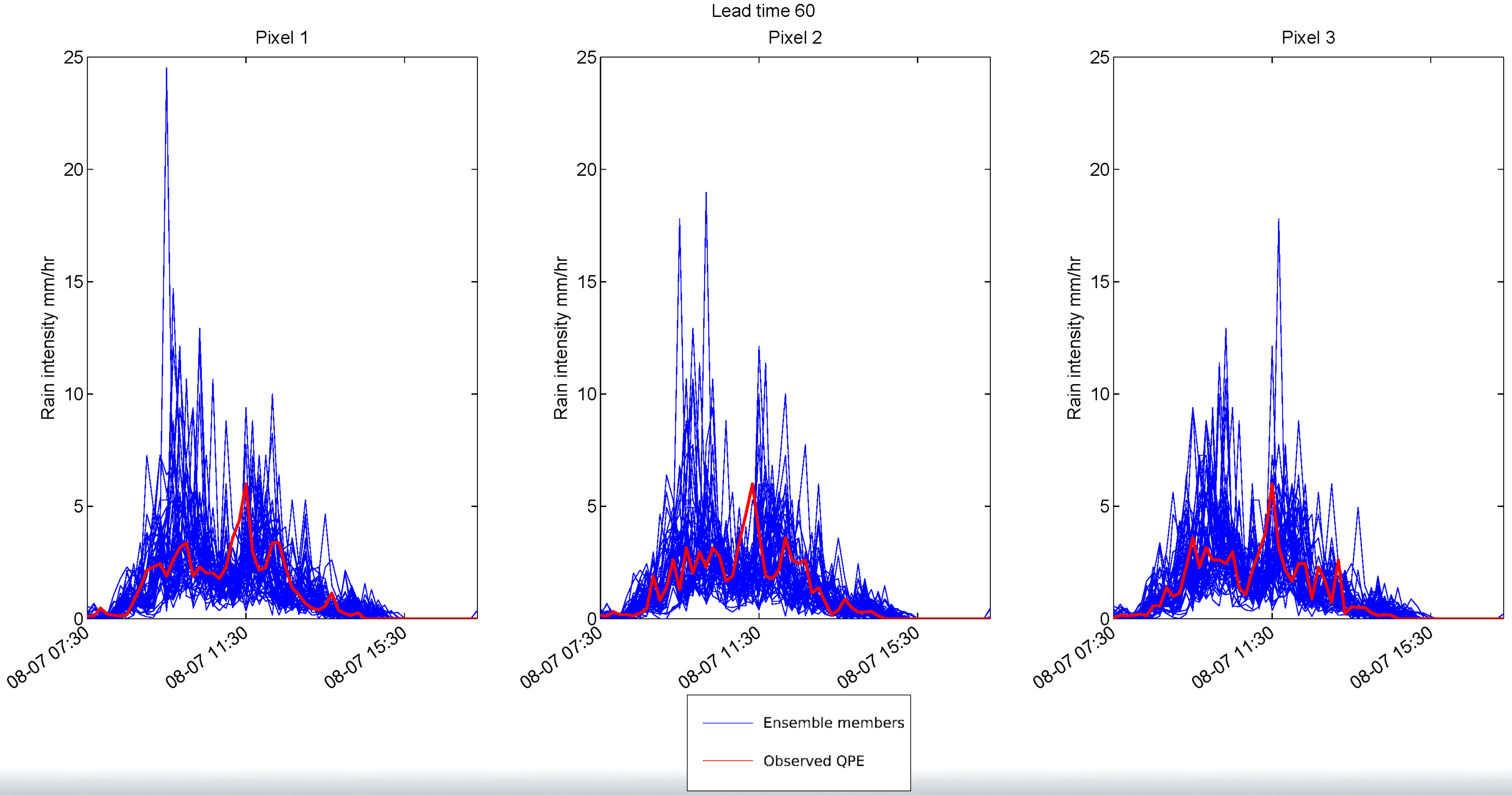

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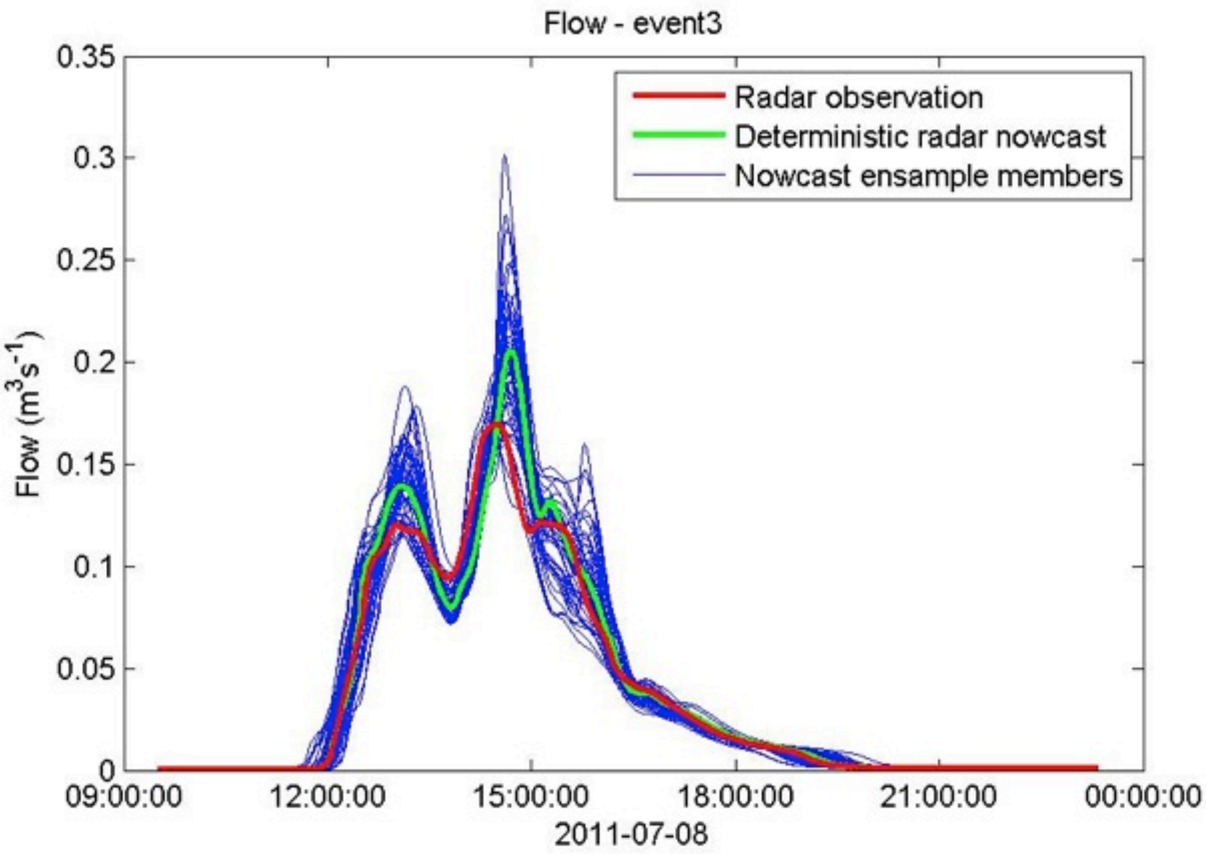

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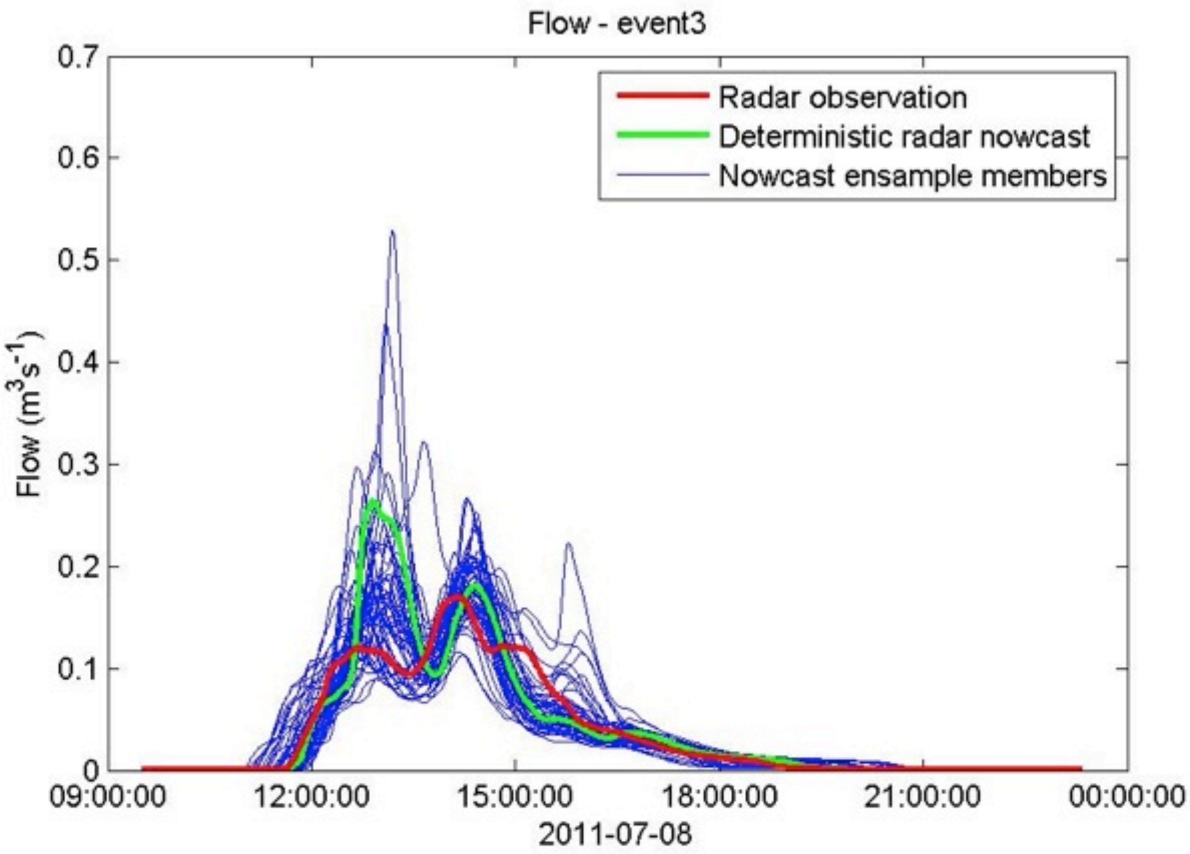

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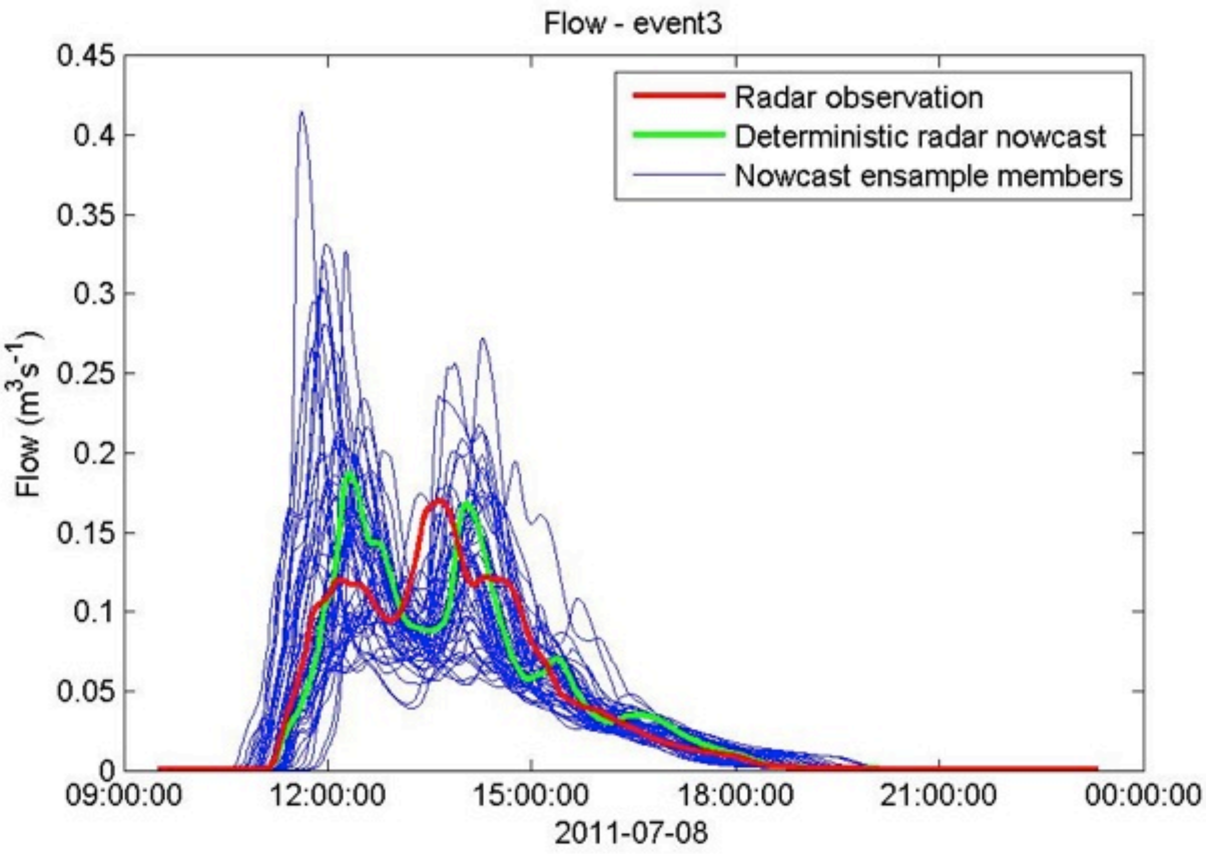

Questions?