Urban flood early warning system based on middle range weather forecast

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Problem

Flood is currently an issue of human life and damage risk (Herath, 2003 [1]). Considering the effect of the Climate Change, it assumes to increase the intensity of rainfall during rainy periods (IPCC AR4, 2007). Real time observations early warning flood system is essential to deal with chaotic behavior of the atmosphere. We investigate how the middle range rainfall forecast can be used to mitigate heavy rain flood impact on Urban area in Tokyo, Beijing, Bangkok and Hanoi by improving emergency plan, reservoir operation and long term urban infiltration rate.
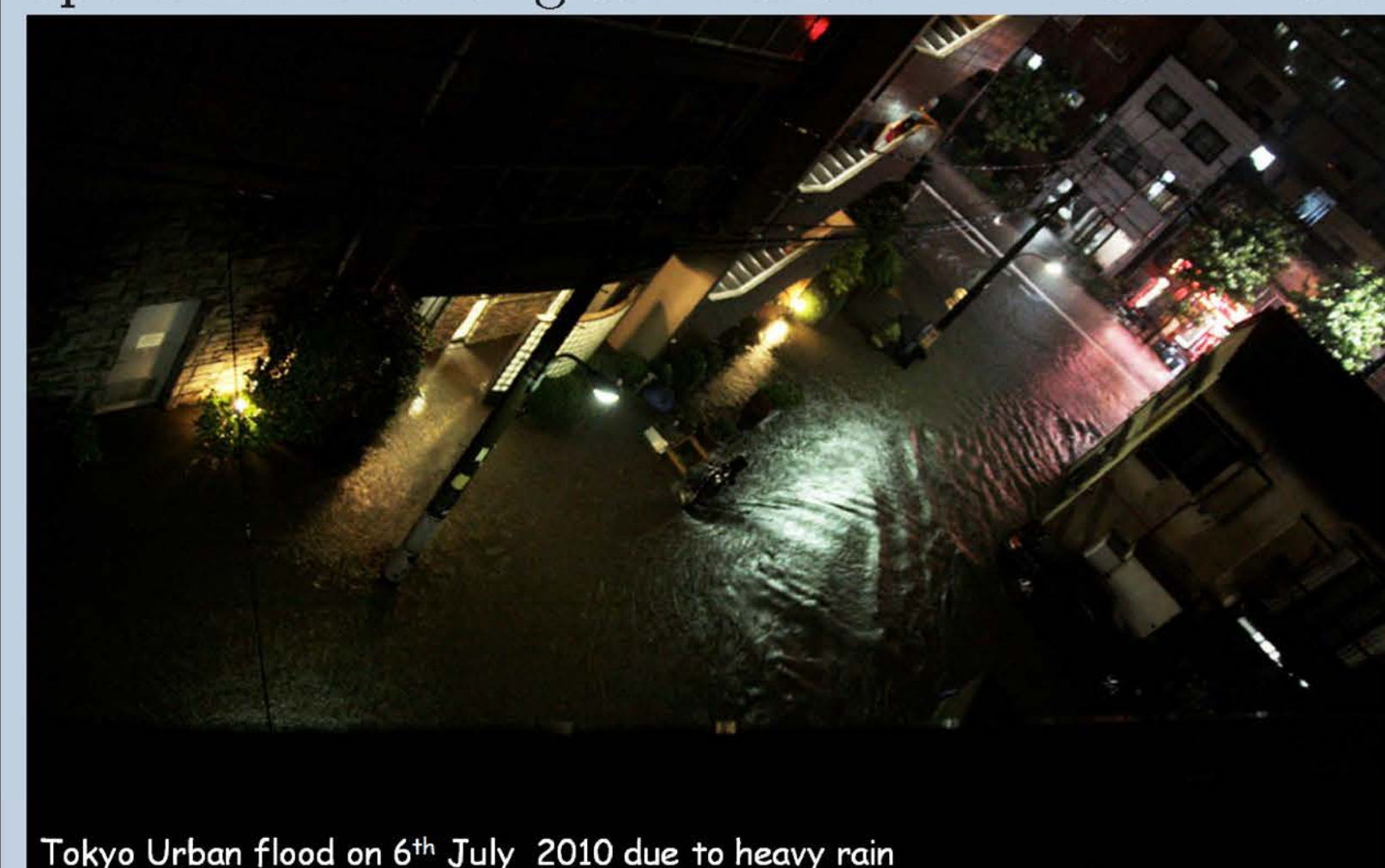
Tokyo Urban flood on 6th July 2010 due to heavy rain

Basic Concepts

In our work, we used weather rainfall forecast data provided by several meteorological agencies around the world. The accuracy of those forecasts is evaluated and flood risk estimated. We assume that extending the prior flood response time would improve the flood management strategy such as reservoir management, emergency evacuation as well a evaluated the improvement of the urban drainage infiltration system.

Weather forecast models

Primitive equations

- x-component momentum equation
- y-component momentum equation
- hydrostatic equation y-component momentum equation
- continuity equation
- thermodynamic energy equation
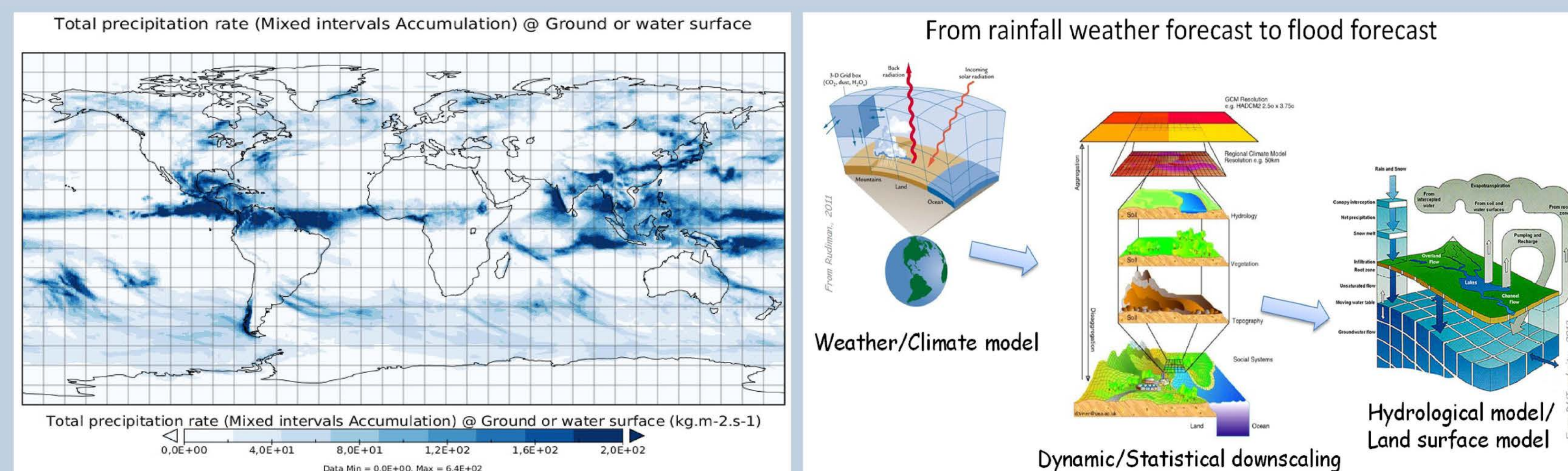- equation of state

References

[1] Herath.S., 2003 *Catastrophic Floods , Hidden Vulnerability of Mega Cities*, UNU-ISP publications.

[2] ECMWF data portal server : *http://data-portal.ecmwf.int/* and WHO Essential products *http://www.ecmwf.int/products/additional/*

[3] Cloke H.L. and Pappenberger., 2009, *Ensemble flood forecasting: A review* Journal of Hydrology 375. p 613-626.

Acknowledgements

Rainfall forecast and hydrological model for flood prediction

Rainfall intensity and schedule can be forecast up to 14 days using middle range weather forecast with some reasonable result. The results form the rainfall forecast can be used as input in a hydrological model such as MIKE by DHI as illustrated. Nevertheless, both dynamic and statistical downscaling are necessary to convert low resolution global model output to high resolution hydrological model input.

Total precipitation rate (Mixed intervals Accumulation) @ Ground or water surface

From rainfall weather forecast to flood forecast

Weather/Climate model

Dynamic/Statistical downscaling

Hydrological model/ Land surface model

## Evaluation of the rainfall middle range weather forecast

- **Deterministic forecast**

  We study the quality of the rainfall forecast during the 21th September 2011 heavy rain event in Tokyo using the ECMWF data [2]. Rainfall intensity is predicted in a good range of time but with an intensity rate under estimation.
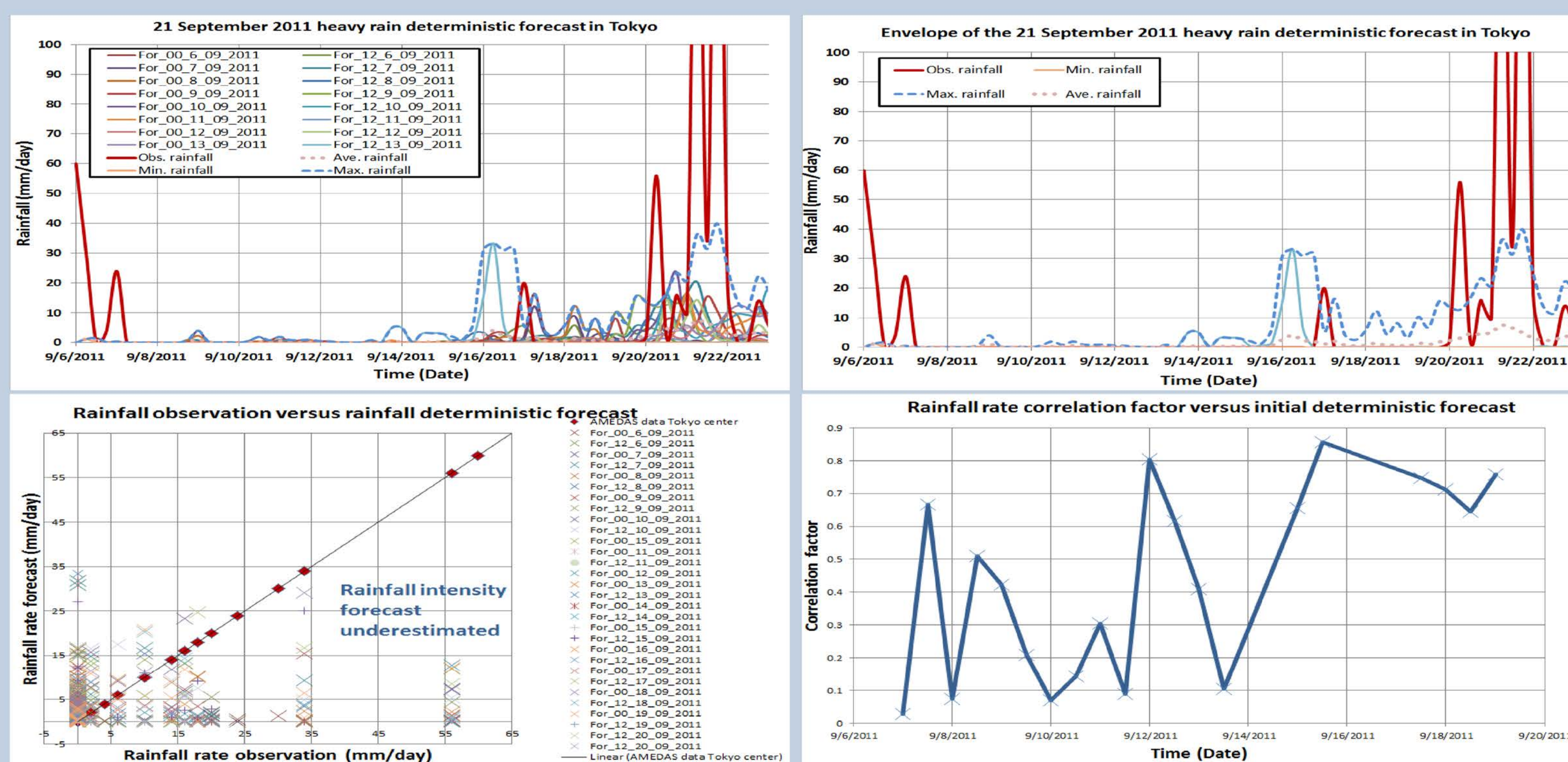
- **Ensemble Forecast Prediction (10 models)**

  We illustrate the potential of Ensemble forecast to estimate uncertainty of rainfall forecast (Cloke and Pappenberger, 2009 [3]).
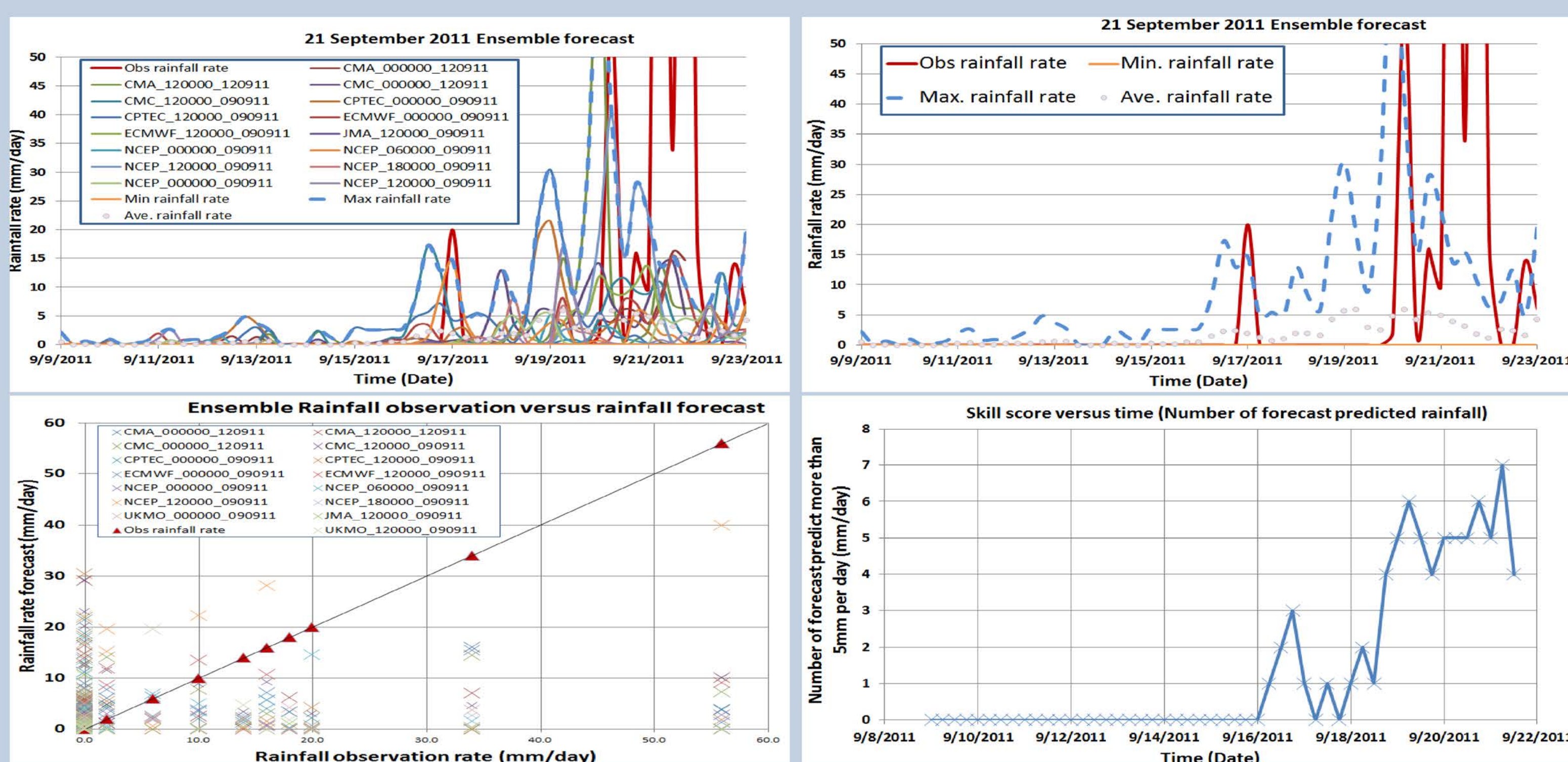
- **Further work**

  – In Tokyo, the urban hydrological model will be used coupled with the rainfall pattern

  – Actual mitigation strategy will investigate the probability of the forecast used for emergency response in urban area link to urban flood

  – Similar work will be undertaken for Hanoi, Beijing and Bangkok respectively