Implementing short range, high resolution precipitation forecasts in hydrological ensemble forecasts

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Overview:

- Review of FFC – role, products, modelling
- Introducing high resolution ensemble forecasts
- Challenges with high resolution ensembles
- Next steps
What is the FFC?

- Partnership between the Met Office and Environment Agency
- Created following the Pitt Review of 2007 flooding
- Operational since April 2009, delivering 24/7 services to government and emergency responders
- Forecasts for all sources of flooding: river, tidal & coastal, surface water and groundwater
- Combining expertise in meteorology and hydrology
- Providing best possible intelligence and early warning of potential flood impacts – communicated via a number of products, including the Flood Guidance Statement (FGS)
Flood Guidance Statement

- An assessment of flood risk (likelihood & impact)
- Probabilistic in nature, considers both meteorology and hydrology
- Most of our products/services are probabilistic (eg HRAs/Wind Alerts)
Hydrological Modelling

Transforming rainfall and evaporation data into river flow to help determine fluvial impacts

Current hydrological modelling:

- Grid-to-Grid (G2G) – 1 km gridded hydrological model /15 min
- Based on PDM (rainfall-runoff) approach

Performs the following forecasts:

- 6-hr (ensemble nowcast)
- 32-hr (ensemble short range)
- 5-day (deterministic medium range)
Gauging station

One model for each gauging station
Many parameters calibrated to observed flow location
Flow estimates for one location only
Uses catchment average rainfall

Distributed Model (G2G)

One model for large regions (UK)
Small set of regional parameters, strong support from digital datasets
Flow estimates in each grid (1km²)
Uses gridded rainfall estimates
Impact of location of rainfall on flood response.

Moore et al. (2006), IAHS Pub. 305
G2G model concept
Deterministic Data
Forecast data (gridded rainfall)
Deterministic Data
gridded river flow – flood severity display

Convert 1km² G2G flow outputs into flood return periods using Q(T) maps
Ensemble Data
Forecast rainfall data (MOGREPS-UK)

6 hour accumulations to 15GMT on 1 May 2104, 12 (of 24)
MOGREPS-UK members
Probabilistic data

Probabilistic depth/duration rainfall data

Probability of exceeding pre-defined depth/duration thresholds for key rapid response catchments (RRCs)
Probabilistic data

Probabilistic return period data

Probability of exceeding pre-defined return period thresholds for each model cell, for each time step in the forecast.
Ensemble data
Ensemble of flow forecasts at gauged locations

G2G model forecast resulting from MOGREPS-UK ensemble members
Probabilistic data flow and rainfall data at gauged locations

G2G model forecast resulting from MOGREPS-UK ensemble members – summary data
Challenges with high resolution ensembles:

- Is the process adding any value?
- What about the hydrological uncertainty?
- Is the ensemble reliable at an appropriate scale?
- Can we afford it?
Is the process adding any value?

- Little point if the uncertainty fed into the hydrological system is identical to the uncertainty coming out of it.

- Current use of G2G is to identify general signals across larger areas (not % likelihood of flow y at location x).

- We are interested in identifying differences between the forecast meteorological spread and the hydrological spread – this tells us something interesting ......
Insensitive hydrological system

Rainfall

large spread

Flow

small spread

Flood Threshold
What about the hydrological uncertainty?

- Ideally we would include all the elements of uncertainty, including hydrological uncertainty:
  - Model structural errors, Model parameter errors and data errors (eg river level and raingauge data errors, ratings)

- However, given the dominance of rainfall uncertainty, no plans currently to tackle hydrological uncertainty

- Instead, we are concentrating on the input data and ways of increasing ensemble size to better represent the forecast uncertainty

- Time lagging (effective and inexpensive)
Is the ensemble reliable at an appropriate scale?

- Verification must be appropriate to catchment size (work ongoing)
- Ensembles generally reckoned to be under-spread
- Objective cost-loss decisions not readily accepted
Can we afford it?

- Ensembles need to be large to give sufficient spread to better capture uncertainty (may be 100s, rather than 10s).

- 100s of members will be computationally expensive (ensemble generation and post processing).

- Hydrological model can be run on supercomputer, but still need to process the output (computer and forecaster processing).

- Need sufficient lead time to make sensible short range decisions (cannot add too much lag into the process).
Next Steps:

- 5-day high resolution ensemble
- Create a robust verification scheme
Summary

- High resolution ensembles show promise
- Underpin UK strategy for overall flood risk and RRCs
- Supercomputer will enable larger, longer period ensembles to be run
- Need sound verification and continued model improvement
- Need effective and efficient post processing of meteorological and hydrological ensemble data sets
Thank you

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