Australian National University

Towards spatially and temporally continuous hydrological forecasting

and some obstacles to clear on the way

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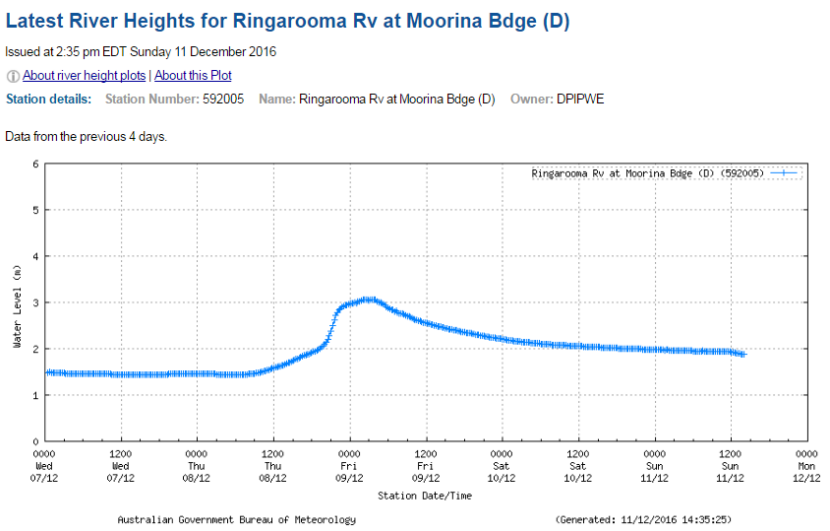
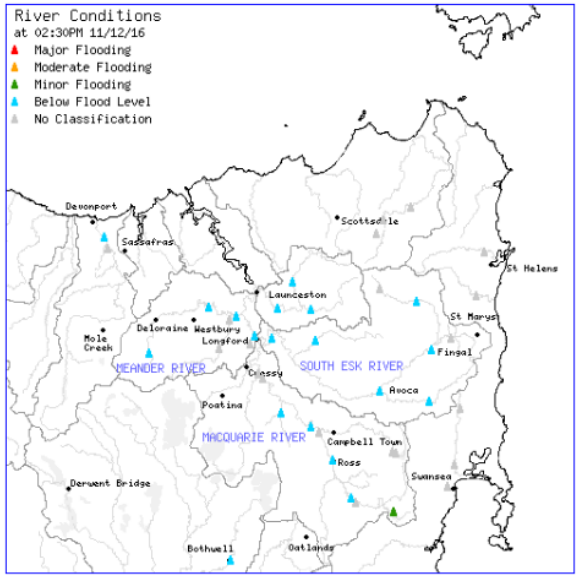
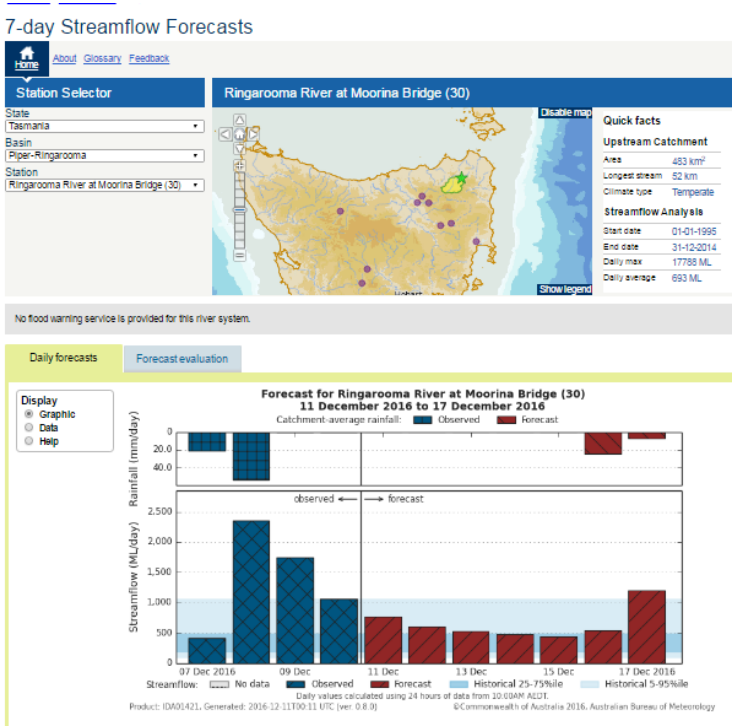
with thanks to Albrecht Weerts, Jaap Schellekens, David Maidment

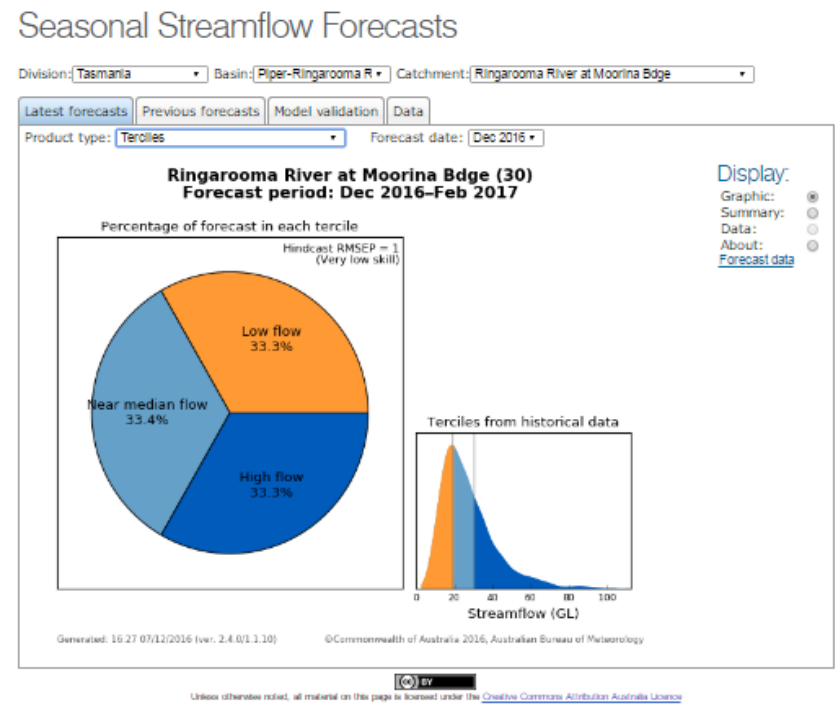
OzEWEX, 15 December 2016

The case for continuous forecasting









- Why three different sources of information?
- What happens where there's no gauge?
- Where might it actually get flooded?
- What about soil moisture or crop water requirements?

Is that so hard?

Australian Government
Bureau of Meteorology

No – it's being done!

	Analysis & Assimilation	Short-Range	Medium-Range	Long-Range
Cycling Frequency	Hourly	Hourly	Daily at 06Z	Daily Ens (16 mem)
Forecast Duration	- 3 hrs	0-15 hours	0-10 days	0-30 days
Forecast Latency (latency of external forcing data accounts for most of delay)	1 hour	1 hour 45 mins	6 hours	19 hours
Meteorological Forcing	MRMS blend/ HRRR/ RAP bkgnd.	Downscaled HRRR/RAP blend	Downscaled GFS	Downscaled & bias-corrected CFS
Spatial Discretization & Routing	1km/250m/NHDPlus Reach	1km/250m/NHDPlus Reach	1km/250m/NHDPlus Reach	1 km/NHDPlus Reach
Assimilation of USGS Obs				
Reservoirs (1260 water bodies parameterized with level pool scheme)				

US National Water Model

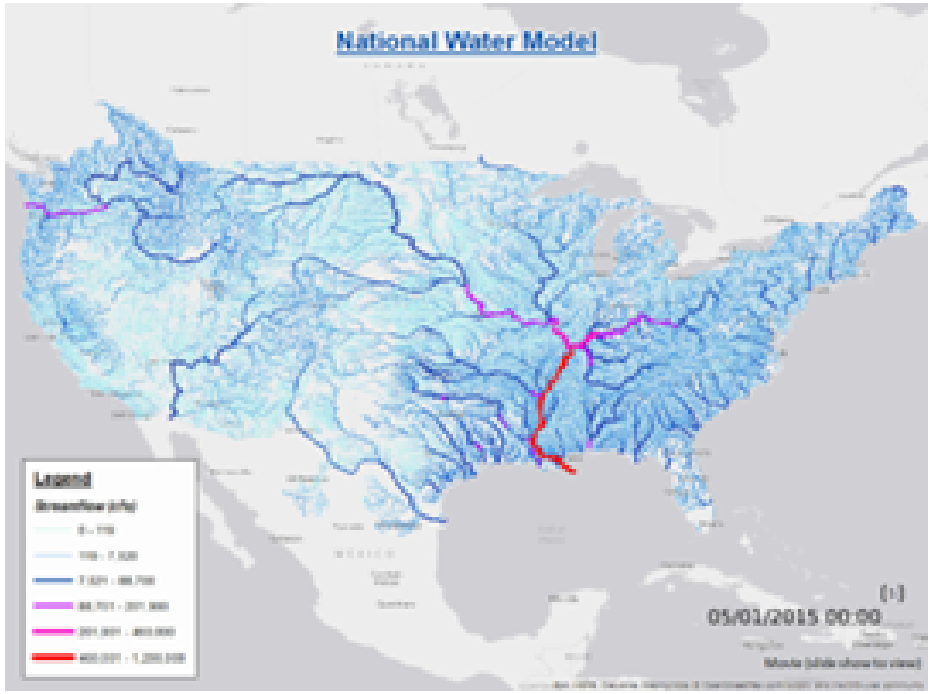
Australian National University

OWP | OFFICE OF WATER PREDICTION

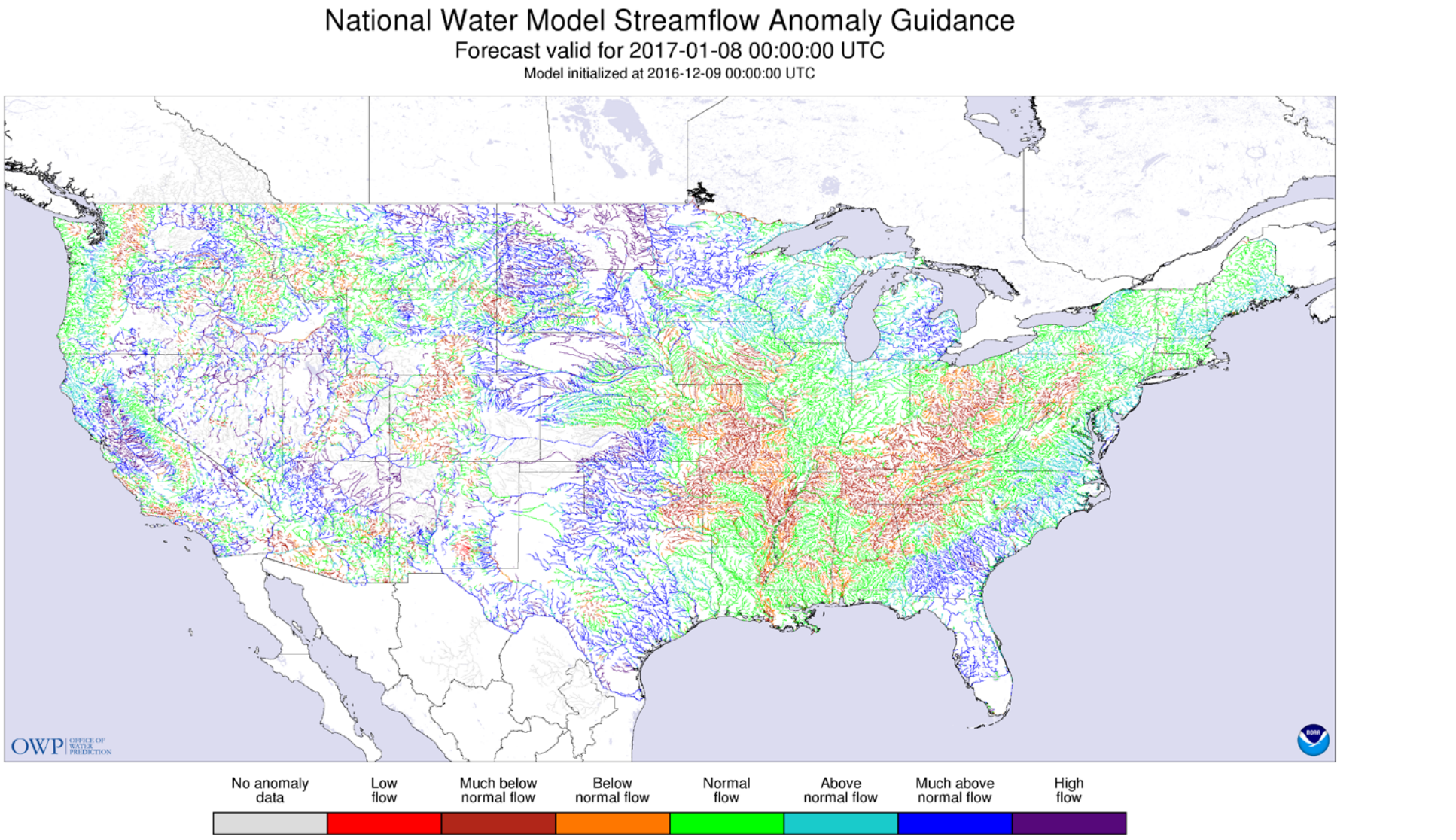
Current River Forecast Points (~3,600)

+

NWM Streamflow Output Points (~2.7 mil)



US National Water Model



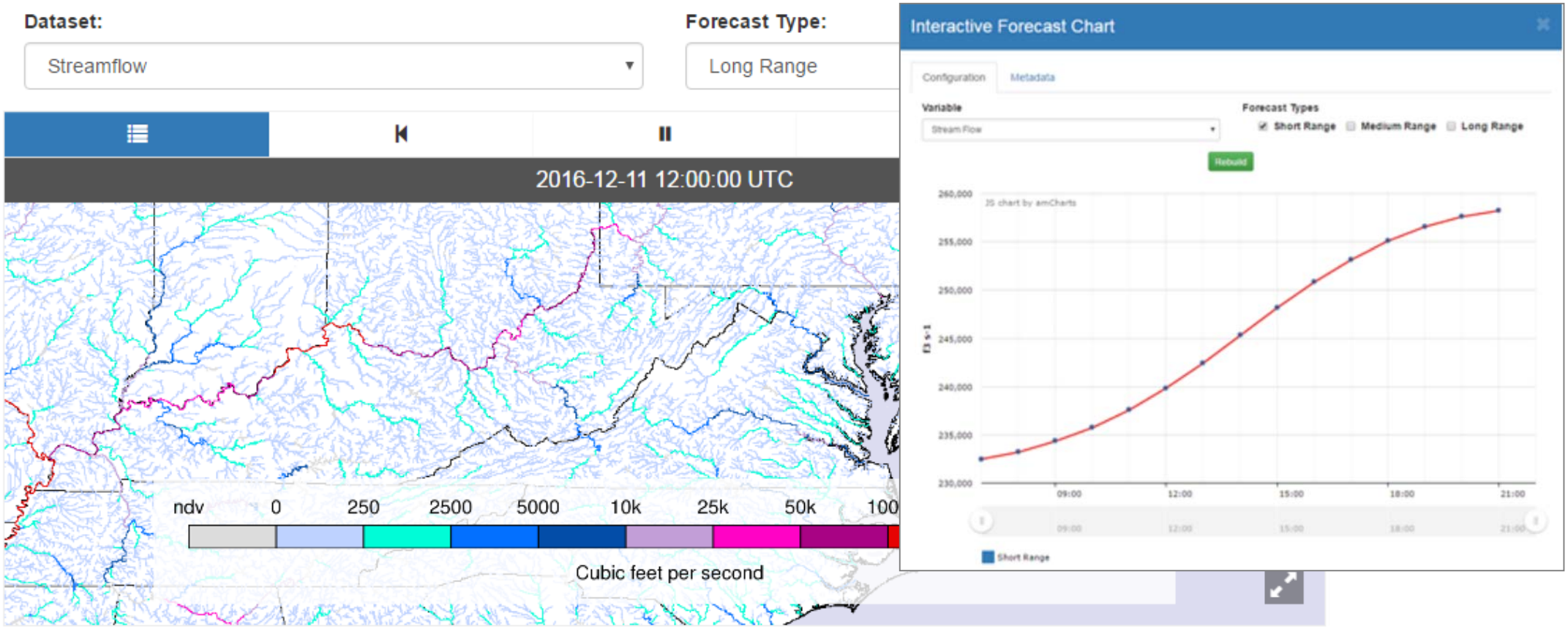
US National Water Model

OWP | OFFICE OF WATER PREDICTION

http://water.noaa.gov/tools/nwm-image-viewer

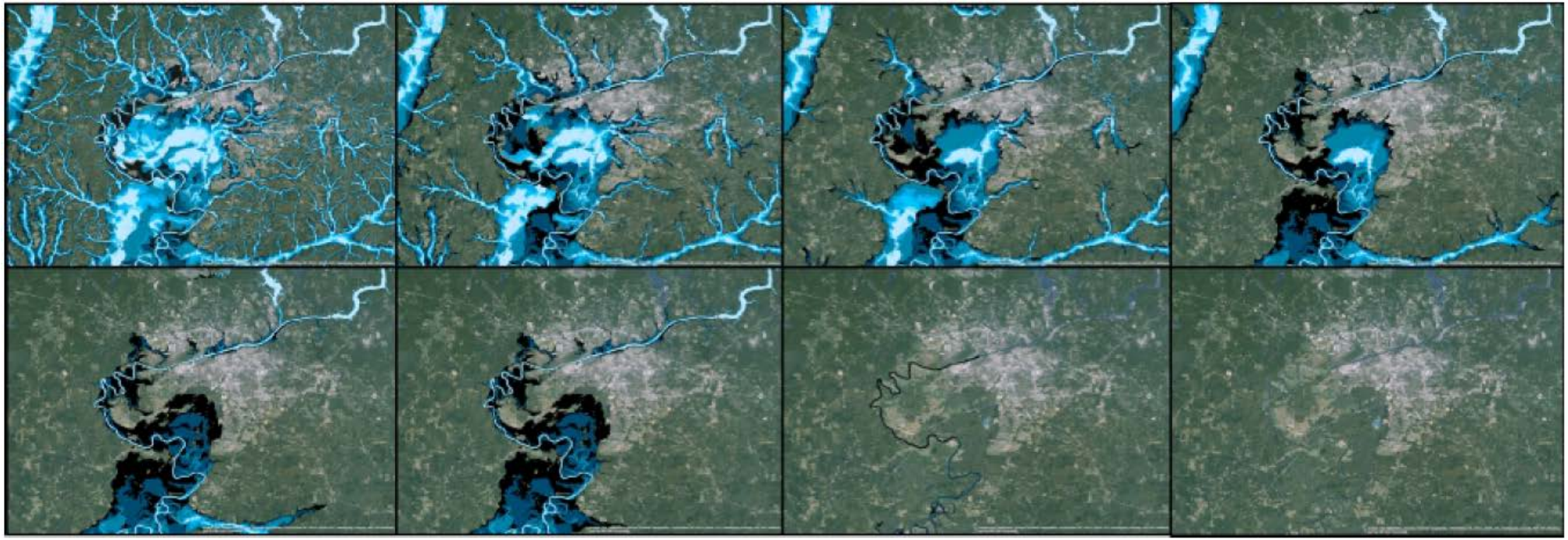
National Water Model Experimental Image Viewer

The viewer below has been made available to view the pre-generated imagery depicting output from the National Water Model. For direct access to the imagery shown in the viewer, visit the following location: http://www.nohrsc.noaa.gov/pub/staff/keicher/WRFH_ppd/web/static_images/



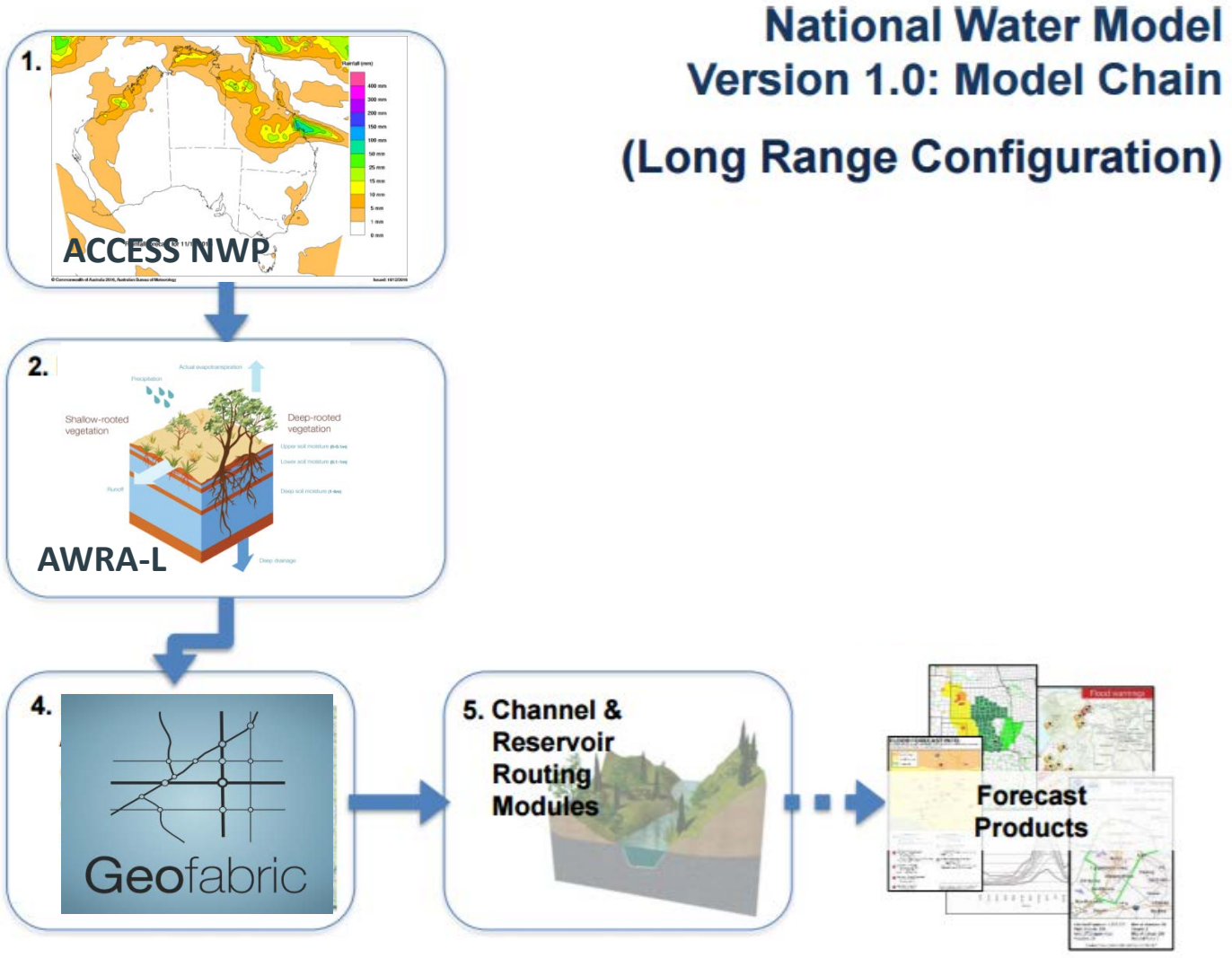
US National Water Model

Inundation depth around Tuscaloosa (Ala.) for different river heights. Estimated using a modified ‘Height Above Nearest Drainage’ (HAND) DEM analysis method.

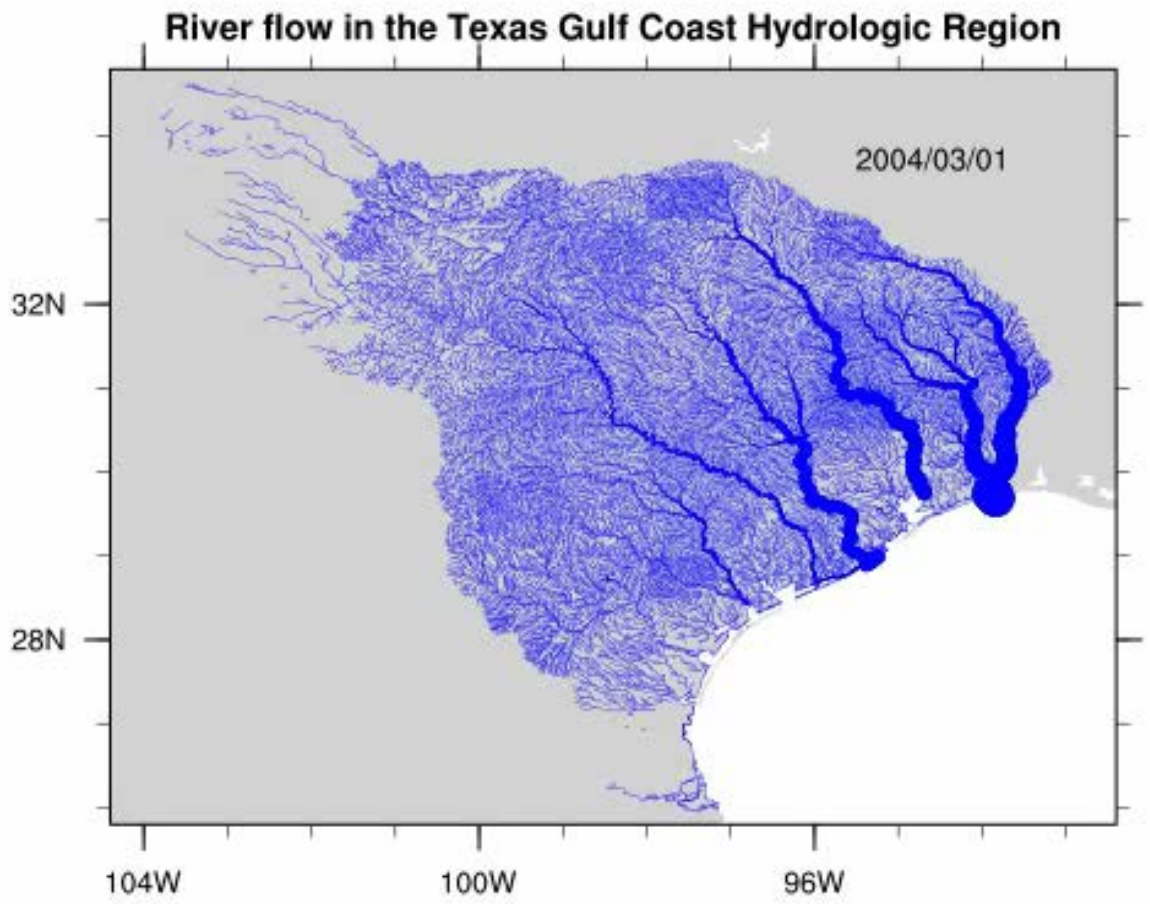


McGehee, Li & Poston, in: Maidment et al (Eds., 2016)

We have the technology..

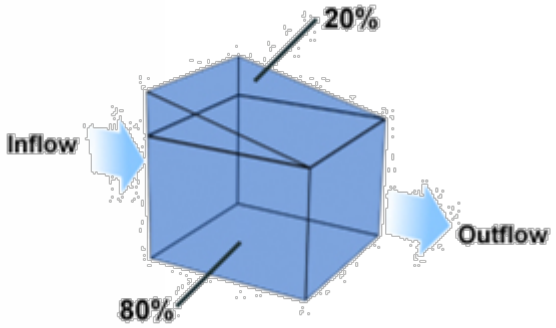


Streamflow routing: RAPID?



http://www.geo.utexas.edu/scientist/david/rapid.htm

David et al. (201x), in preparation



Muskingum

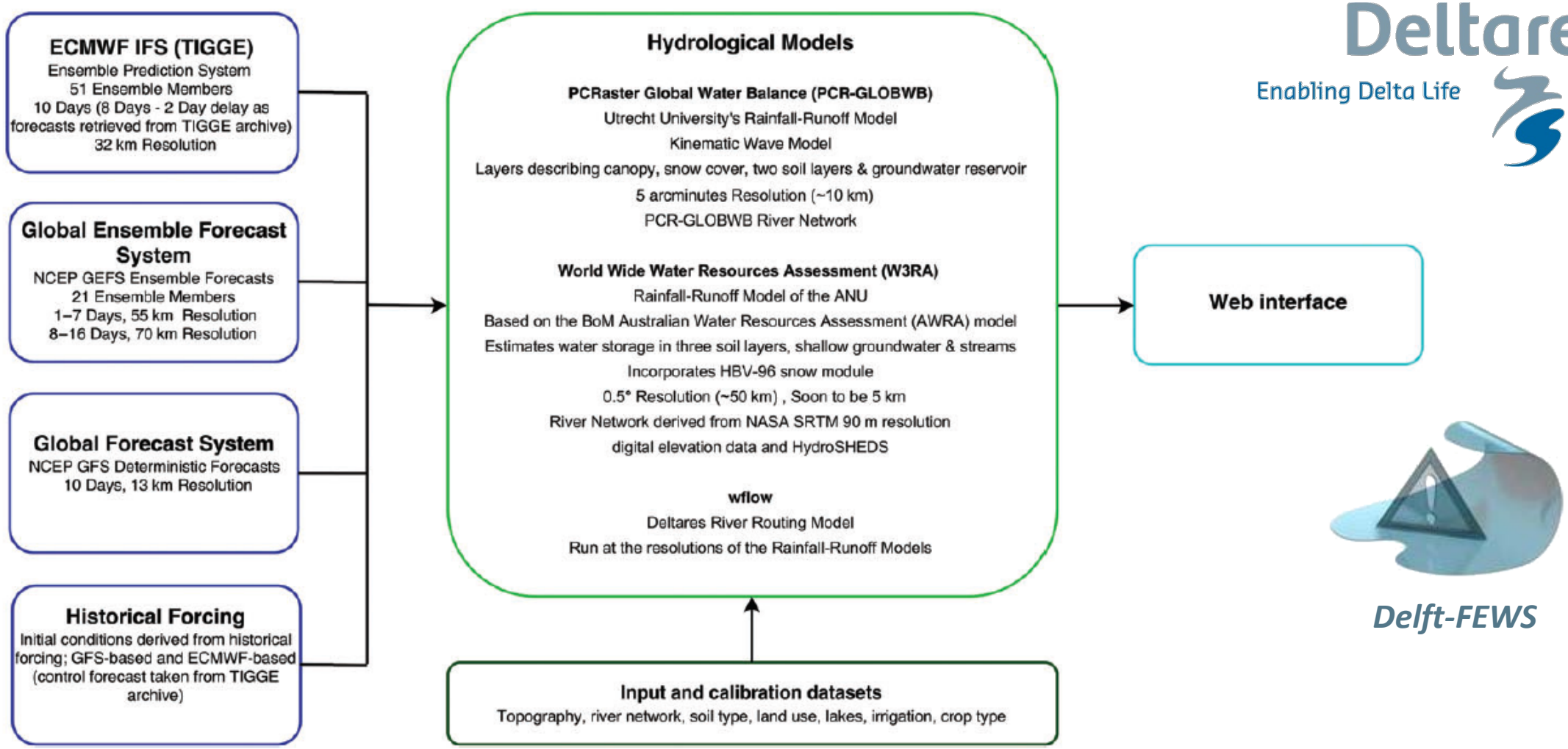
NCI
NATIONAL COMPUTATIONAL INFRASTRUCTURE

Python, NCI

http://rapid-hub.org/

Australia's already being forecasted

GLOFFIS



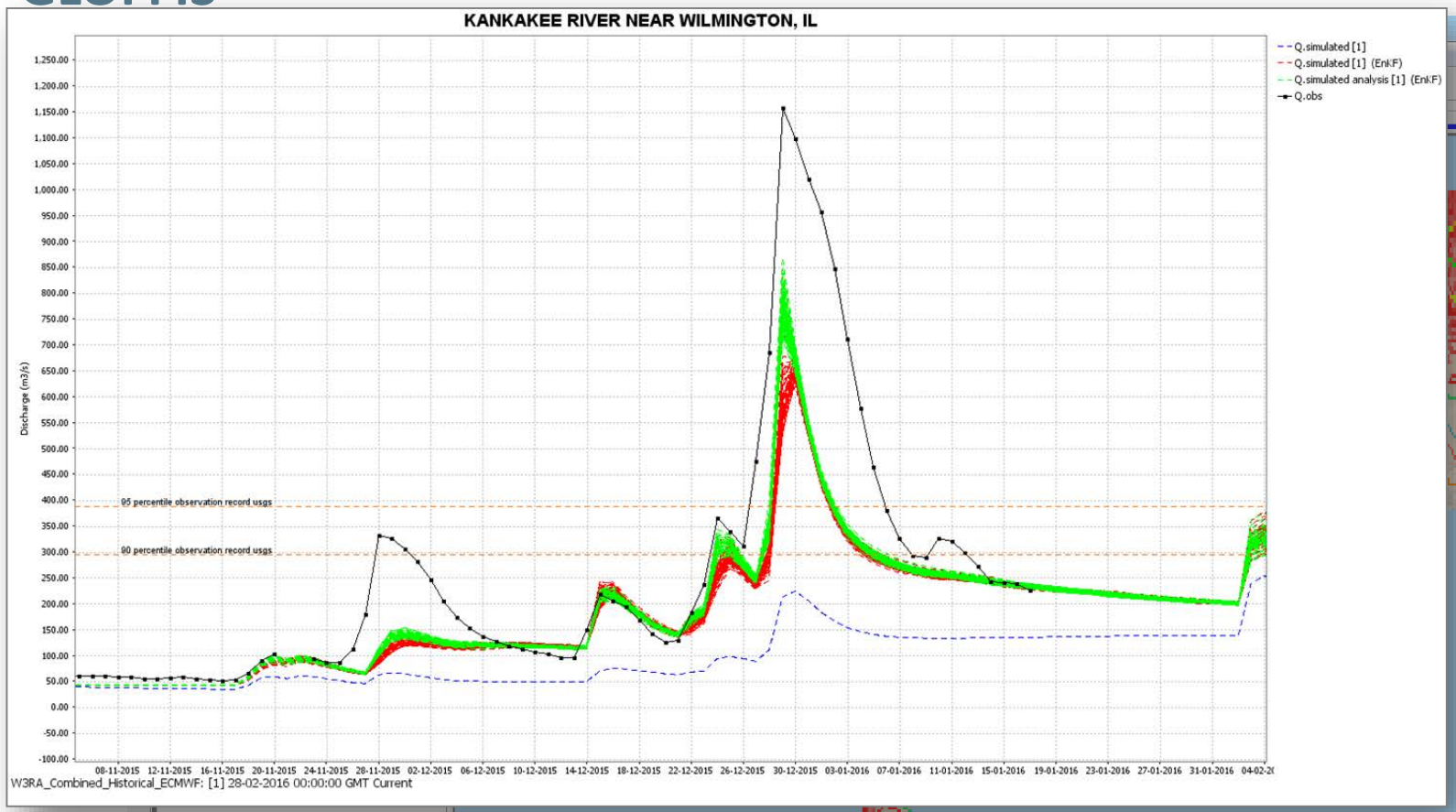
Deltares
Enabling Delta Life

Delft-FEWS

FIGURE 12 | Components of the Global Flood Forecasting Information System (GLOFFIS).
Emerton et al., 2016

Australia's already being forecasted

GLOFFIS



Capacity

Forecasting systems are intricate, dynamic and bespoke.

We need to develop many more researchers and operational staff with the necessary understanding of:

- NWP forecasts
- The hydrological core model(s)
- Forecast systems
- Forecast interpretation and delivery

.. and, since data assimilation is essential in automated forecasting systems,

- Data assimilation techniques
- Weather and water and satellite observations & their errors

All combined in each individual!

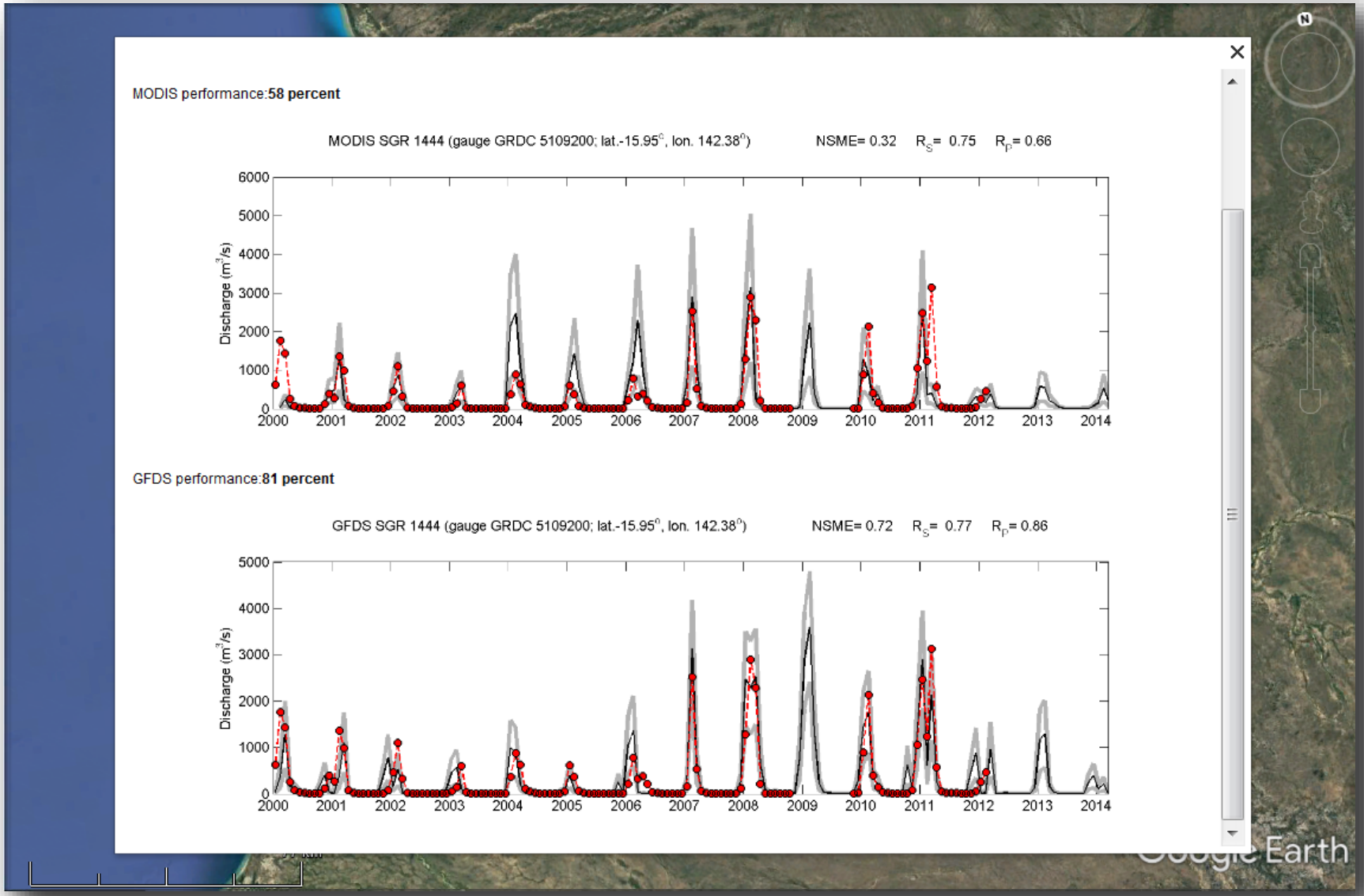
Data assimilation: satellite gauging

Australian National University

Dartmouth Flood Observatory

European Commission
Joint Research Centre

Deltares
Enabling Delta Life



Van Dijk et al (2016)

Forecasts are precious..

source: Bureau of Meteorology

..so why is forecasting research rare?

Our unis are spinning their wheels

Universities should be able to multiply Bureau and CSIRO's effort in forecasting by ca. 16 times.. but we don't

source: Bureau of Meteorology, CSIRO, Universities Australia

What's going on?

- Every year hundreds of clever academics and students waste their talent and time on irrelevant projects
- There will always be competition for funding (sadly), but there is unnecessary competition for knowledge and access.
- All of us - BoM, CSIRO, unis - are lousy at engaging and collaborating widely and deeply.

There's no more cake (?)

Some ideas

1. **Educate**: documentation and training around BoMs forecasting systems, for student coursework and for researchers (courses? webinars?)
2. **Prioritise**: communicate the knowledge gaps and research priorities.
3. **Testbeds**: shared data and tools, at least for relevant case studies, that mimic operational realities.
4. **Joint supervision**: a well-coordinated scheme for student projects co-supervised by uni, BoM and CSIRO staff.
5. **Community project**: an Australian continuous water forecasting system (Summer Institute? Hackathon?)

(discuss)