High Impact Weather Applications of Space-Based Precipitation Estimates

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Beth Ebert[1], Bob Adler[2], Bob Kuligowski[3], Paul Kucera[4]

[1] CAWCR, [2] NASA GSFC, [3] NOAA/NESDIS, [4] NCAR

Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

Flooding and landslides are major hazards

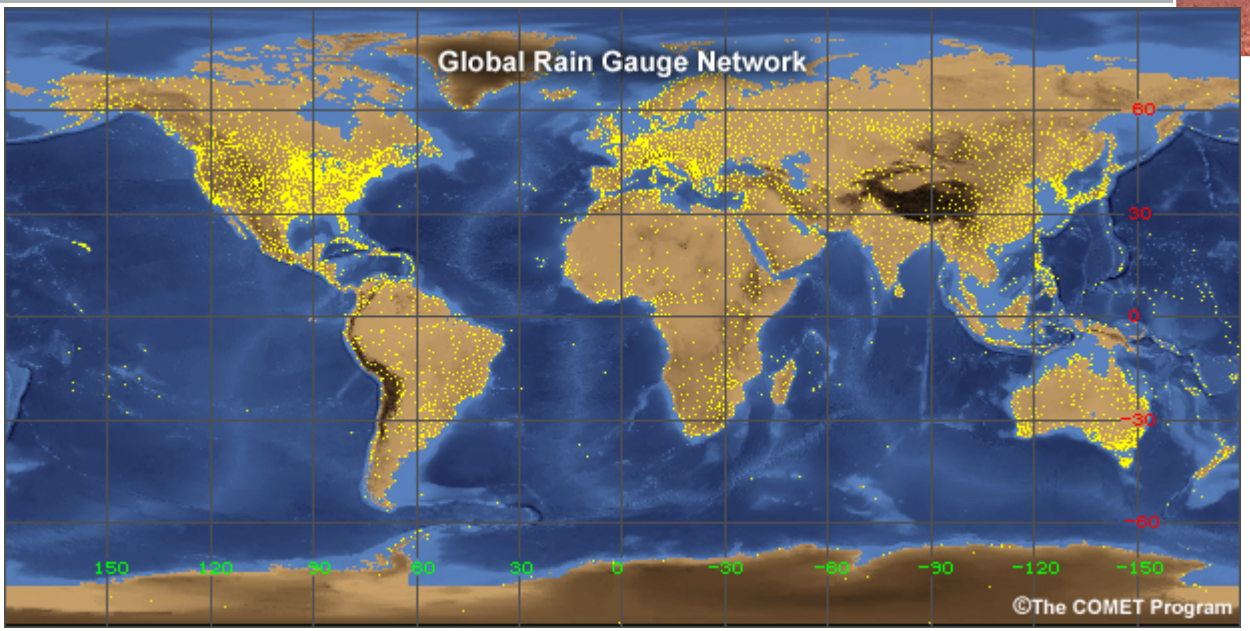
In 2002-2011:

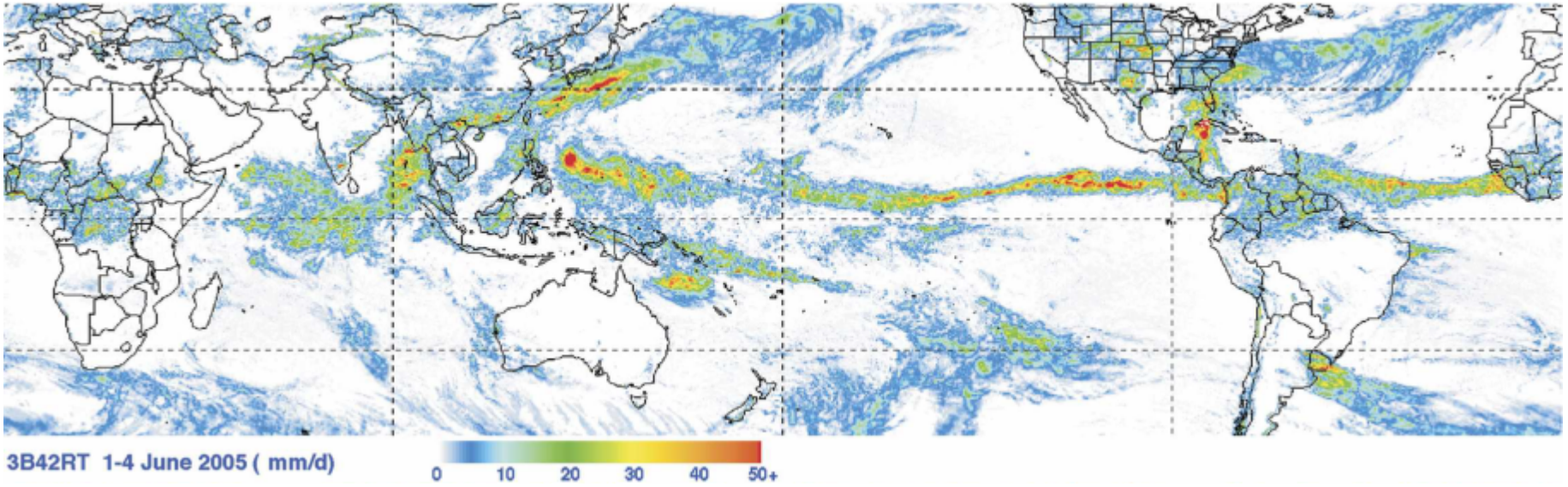
- 55% of significant natural disasters
- > 65,000 deaths

- Affected over 1.1 billion people
- $280 billion

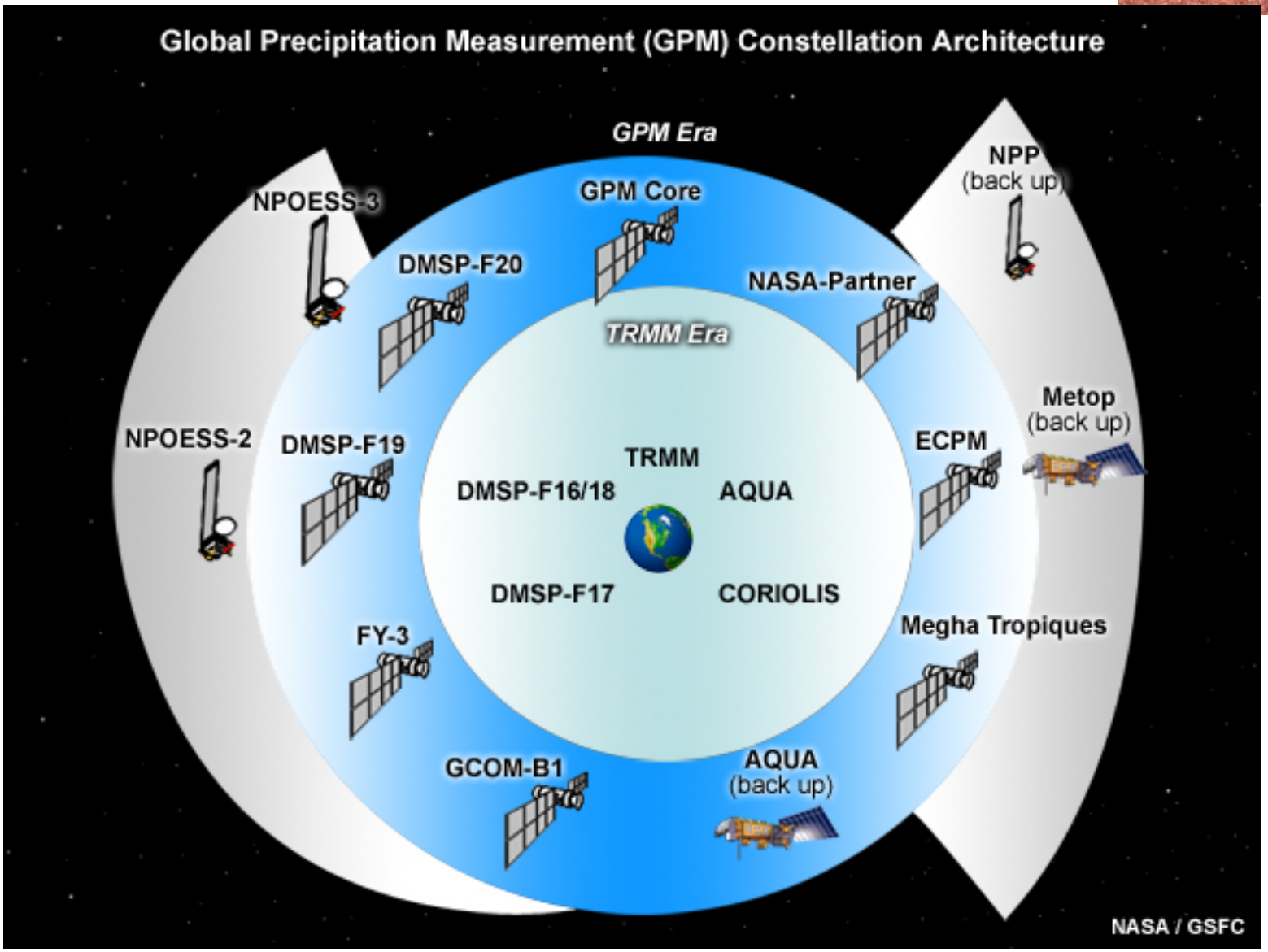
World Disaster Report (2012)

Satellite precipitation fills the gaps

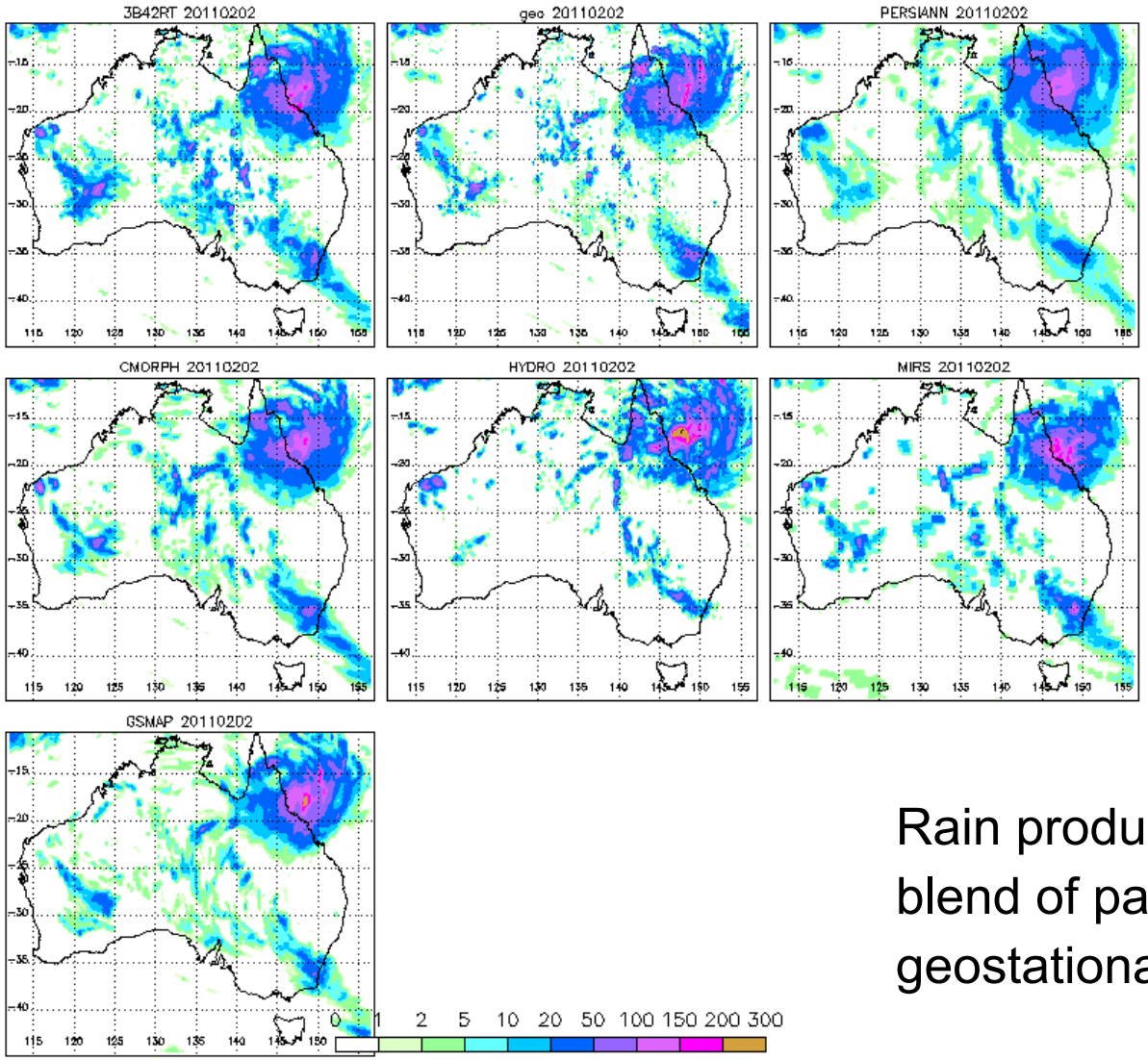




Constellation of satellites measuring rain



Near real-time ~global precipitation

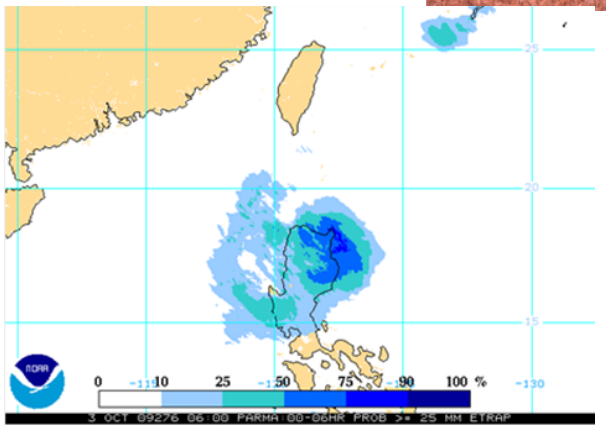


Product	Source	Resolution
TMPA	NASA	0.25º, 3 hr
NRLblend	NRL	0.10º, 1 hr
PERSIANN	UC Irvine	0.25º, 1 hr
CMORPH	NOAA	8 km, 30 min
HYDRO	NOAA	5 km, 1 hr
MIRS	NOAA	0.25º, daily
GSMaP	JAXA	0.10º, 1 hr

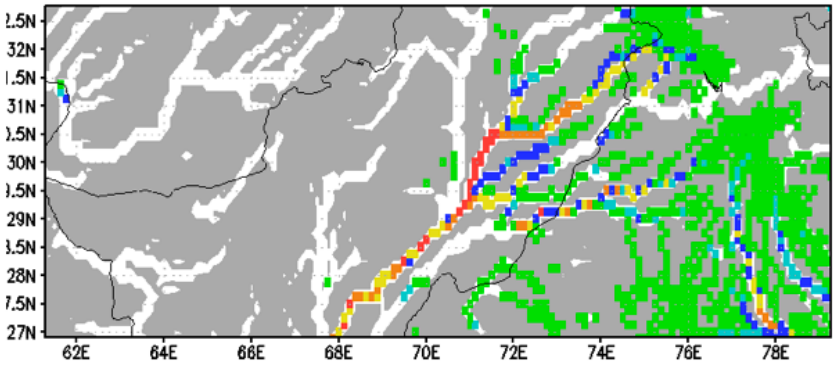
Rain products generated from blend of passive microwave and geostationary IR

Today

- Ensemble Tropical Rainfall Potential (eTRaP)



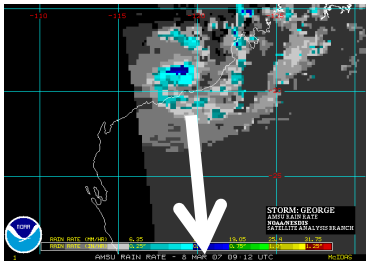
- Global Flood Monitoring System (GFMS)



- Not covered:
  - HydroEstimator
  - Assimilation into NWP
  - Other precipitation applications

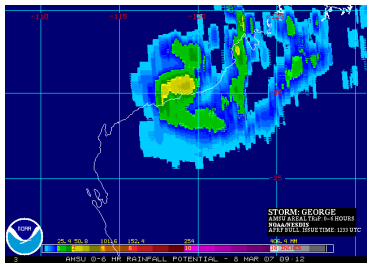
Tropical Rainfall Potential (TRaP) – estimated rain in landfalling TC

Rain rate



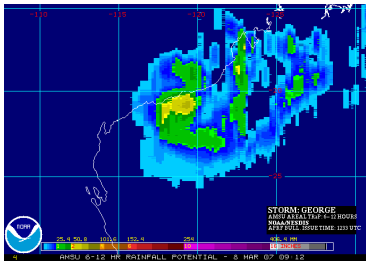
Rain accumulation depends on

- rainfall intensity
- size of tropical cyclone
- speed of tropical cyclone



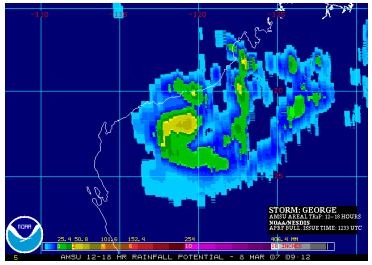
Forecast hrs 0-6

+



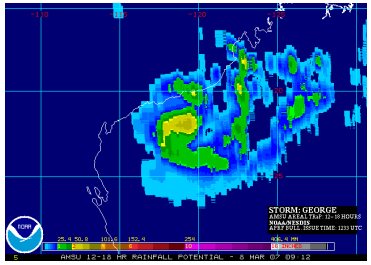
Forecast hrs 6-12

+



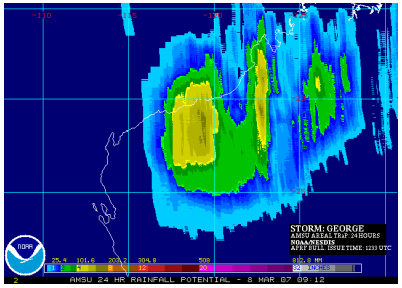
Forecast hrs 12-18

+



Forecast hrs 18-24

=



Forecast hrs 0-24

Tropical Cyclone George,
8 March 2007,
northwestern Australia

Ensemble TRaP (eTRaP)

eTRaP uses rain rates and track forecasts from

- several microwave sensors
- at least two observations in each 6hr period
- several track forecasts

Predicts

→ Consensus precipitation forecasts (mm)

→ Probabilistic forecasts (%)

http://www.ssd.noaa.gov/PS/TROP/etrap.html

Ensemble Tropical Rainfall Potential (eTRaP)

The eTRaP is a simple ensemble whose members are the 6-hourly totals from the single-orbit TRaPs.
More information may be found at these links: eTRaP product information and Digital eTRaP Formats.
(Last Run for active storms: 2013-10-05-23Z)

eTRaP Home

- ▼ Atlantic
  - KAREN
  - East Pacific
  - Central Pacific
- ▼ Northwest Pacific
  - FITOW
  - DANAS
  - North Indian
  - Southeast Pacific
  - Southwest Pacific
  - Northern Territory
  - Southeast Indian
  - Southwest Indian

Archives:
2009
2010
2011
2012
2013

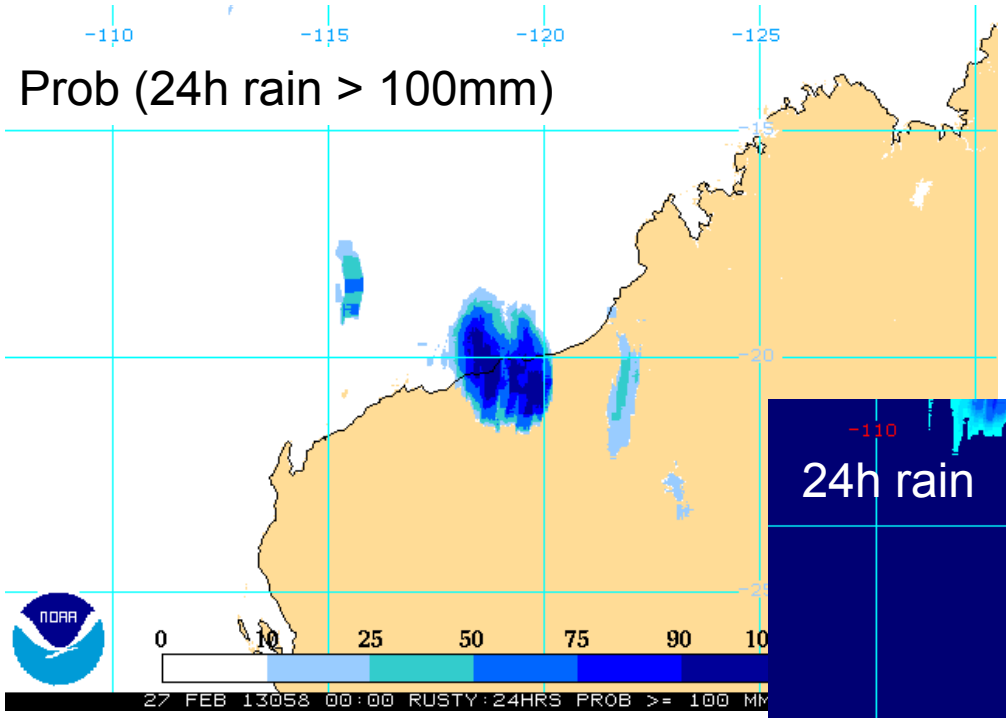
2013-02-27 00Z eTRaP for RUSTY

Forecast Period	PoP ≥ 25mm	PoP ≥ 50mm	PoP ≥ 75mm	PoP ≥ 100mm	Rain Amount
0-6hr (10 TRaP members)					
6-12hr (6 TRaP members)					
12-18hr (3 TRaP members)					
18-24hr (3 TRaP members)					

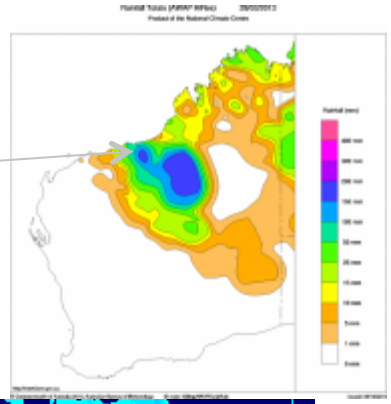
Forecast Period	PoP ≥ 50mm	PoP ≥ 100mm	PoP ≥ 150mm	PoP ≥ 200mm	Rain Amount
24hr Total (10 Independent TRaPs)					

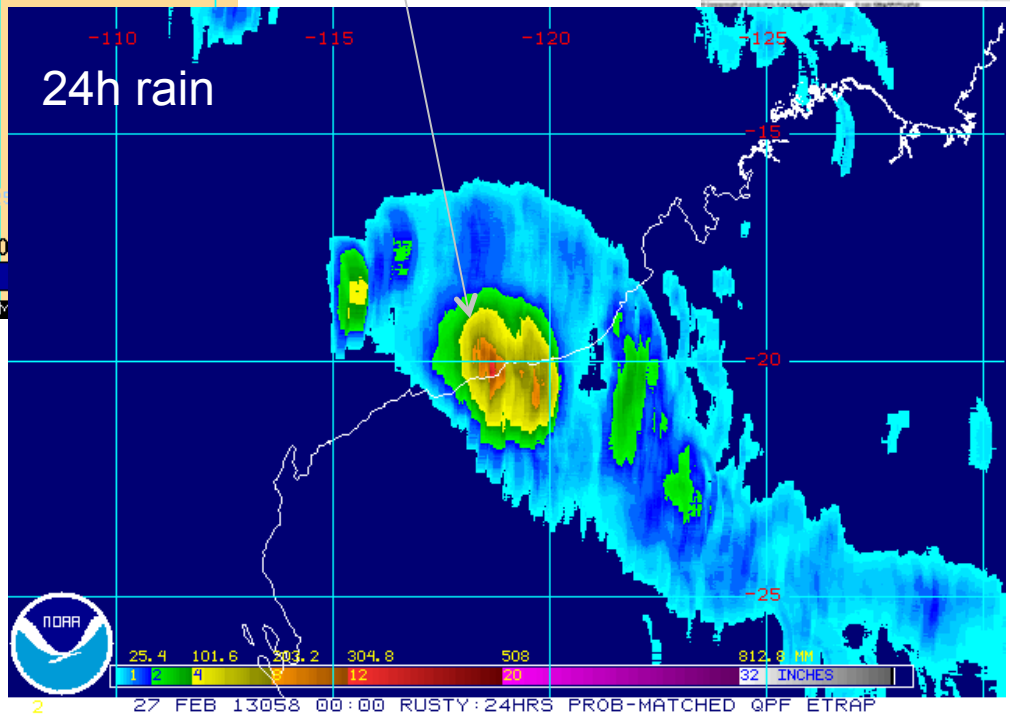
RUSTY Archive

eTRaP forecasts for TC Rusty



Observed > 263mm
Predicted = 300mm



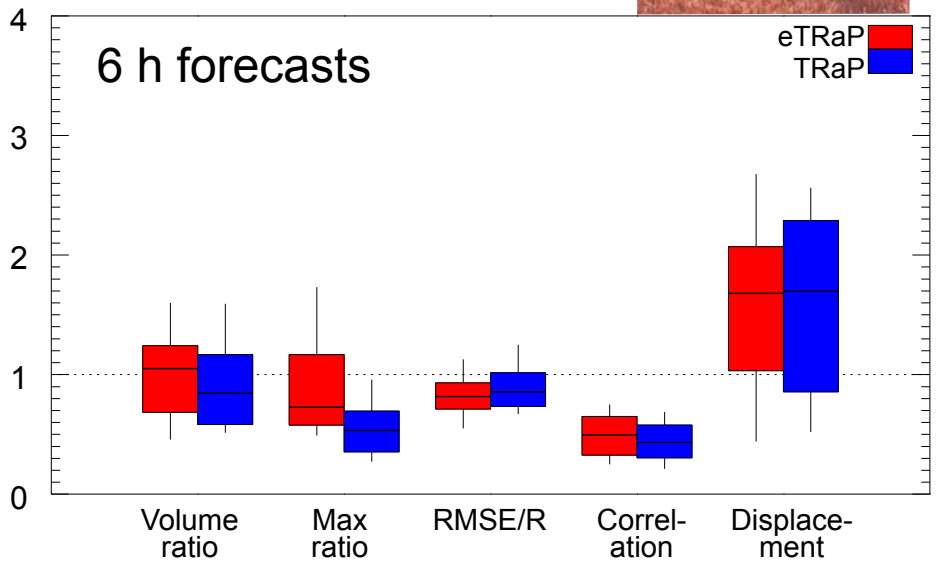


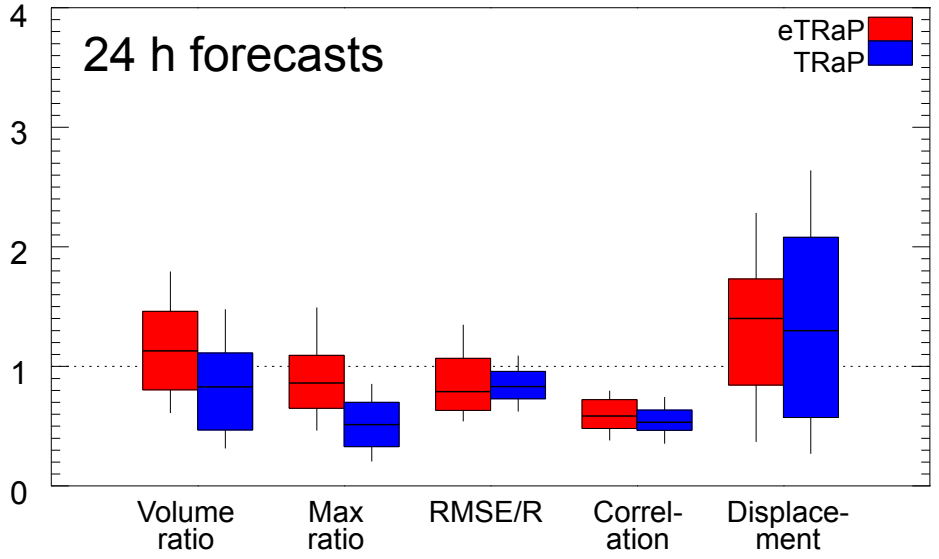
eTRaP performance

16 Atlantic hurricanes and tropical storms

2004-2008

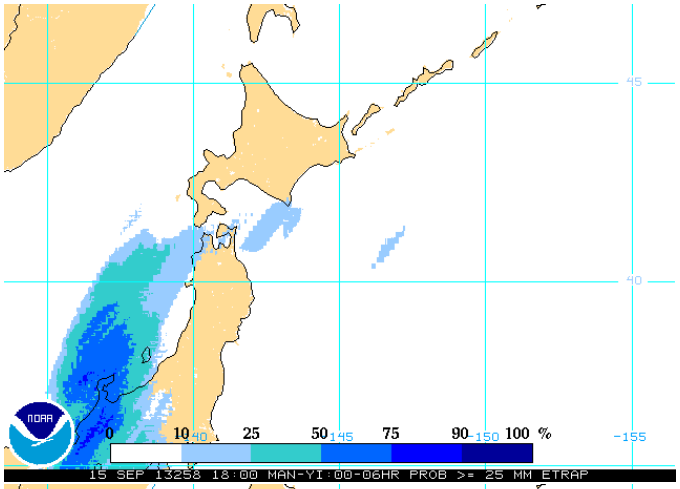
Verified against Stage IV gauge-radar composite in USA using CRA (object) approach



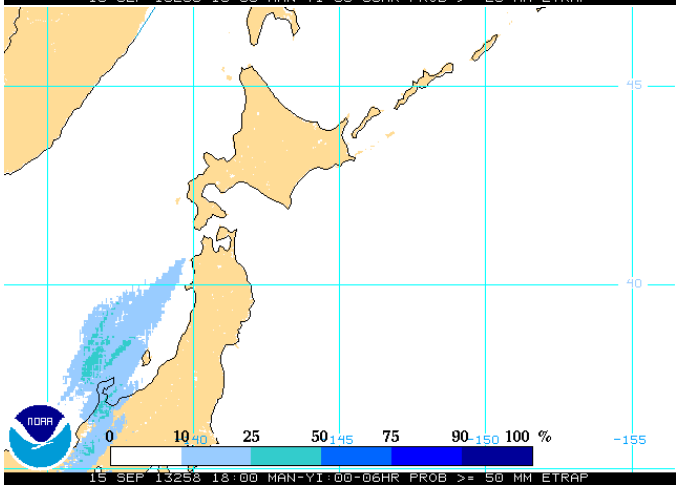


Probability calibration

Without probability calibration

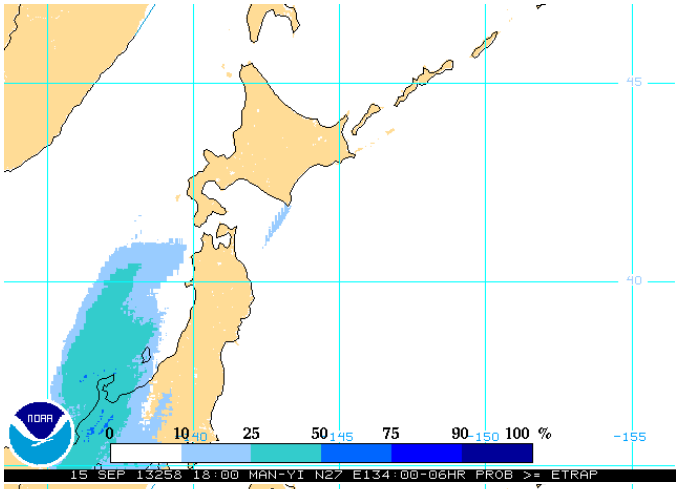


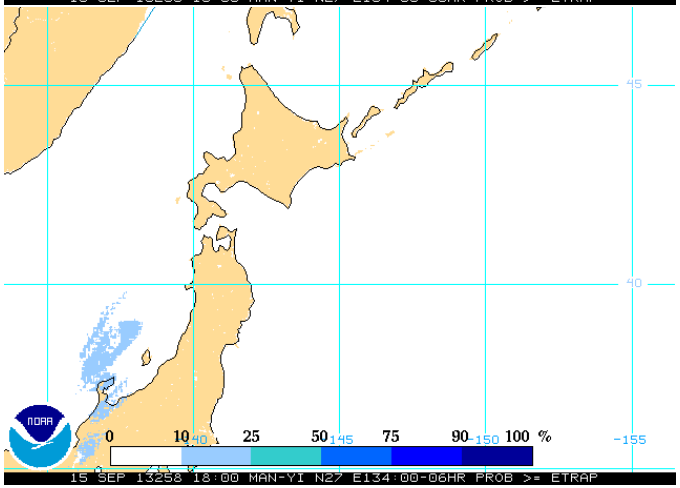
Probability of > 25 mm in 00-06 h



Probability of > 50 mm in 00-06 h

With probability calibration





Future improvements to eTRaP

- November 2013 major upgrade
  - Calibrated probabilities
  - Global HydroEstimator TRaPs added
- Later
  - R-CLIPER TRaPs included
  - Storm rotation
  - Additional microwave sensors

Global Flood Monitoring System (GFMS)

GFMS uses rain rates and hydrological forecasts from

- TRMM multi-sensor precipitation (3B42RT)
- DRIVE routing model for streamflow

Predicts

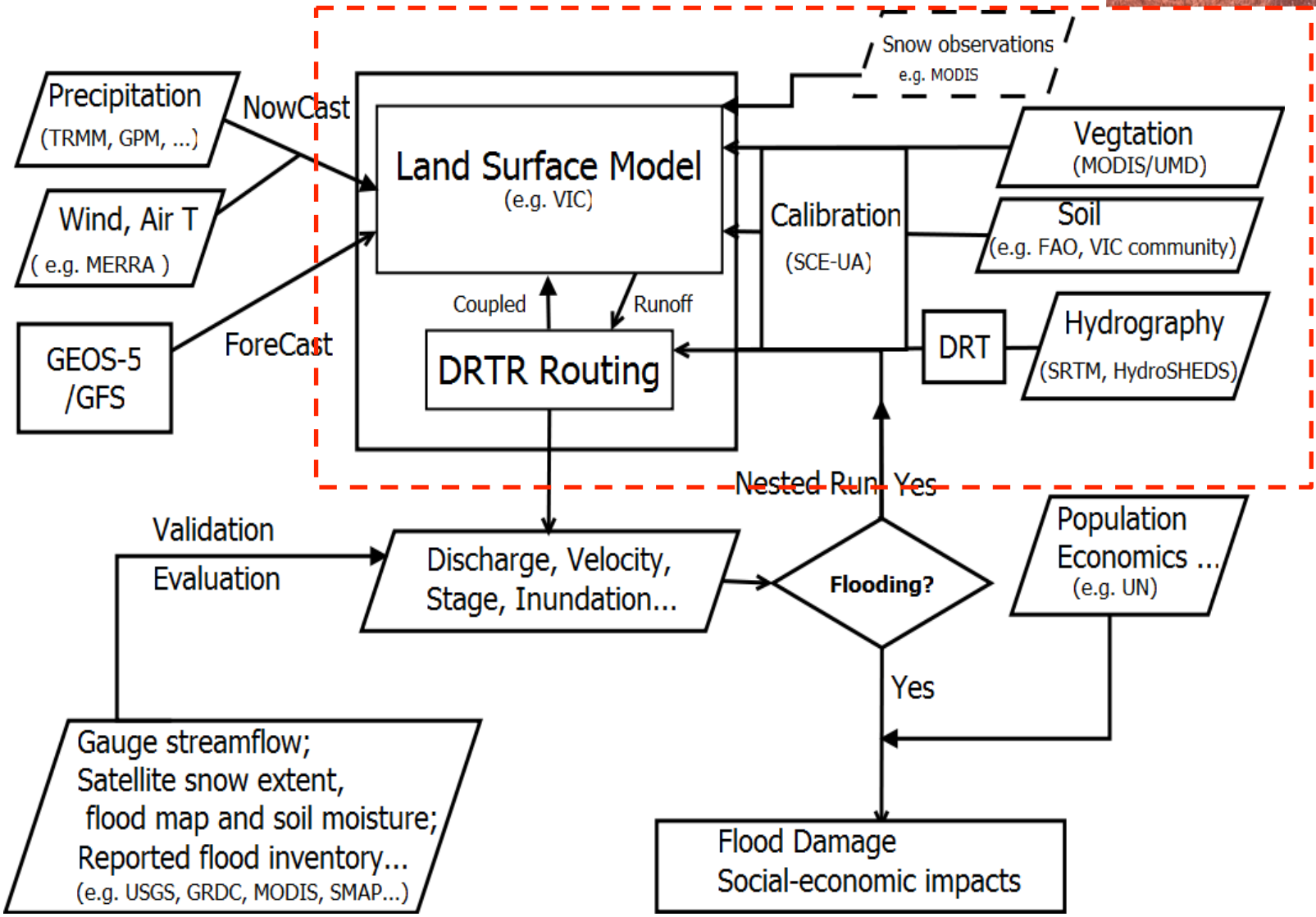
→ Flood depth above threshold (mm)

→ Flood streamflow above threshold (m^3/s)

→ Streamflow (m^3/s) including 1 km routing

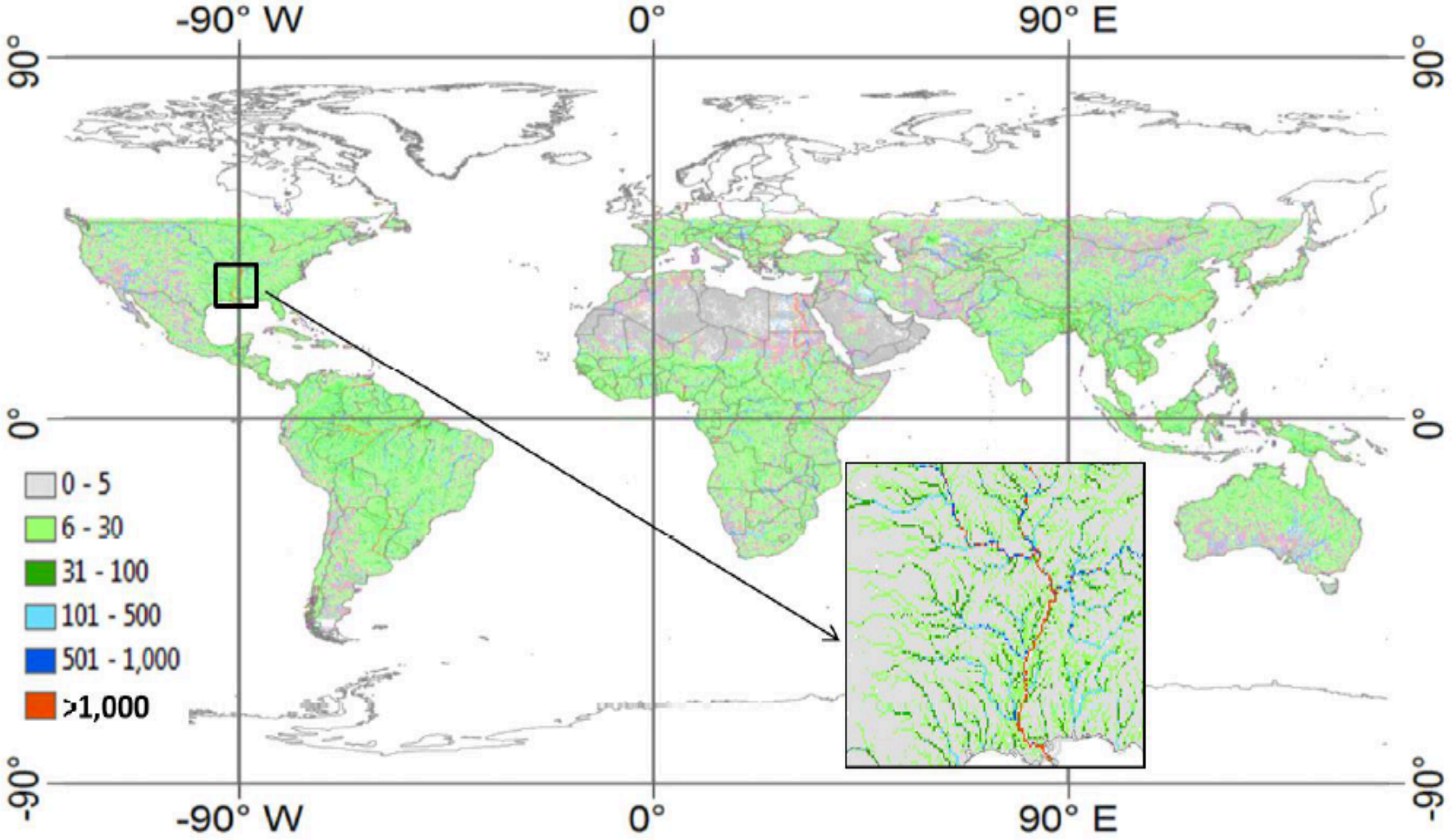
GFMS model framework



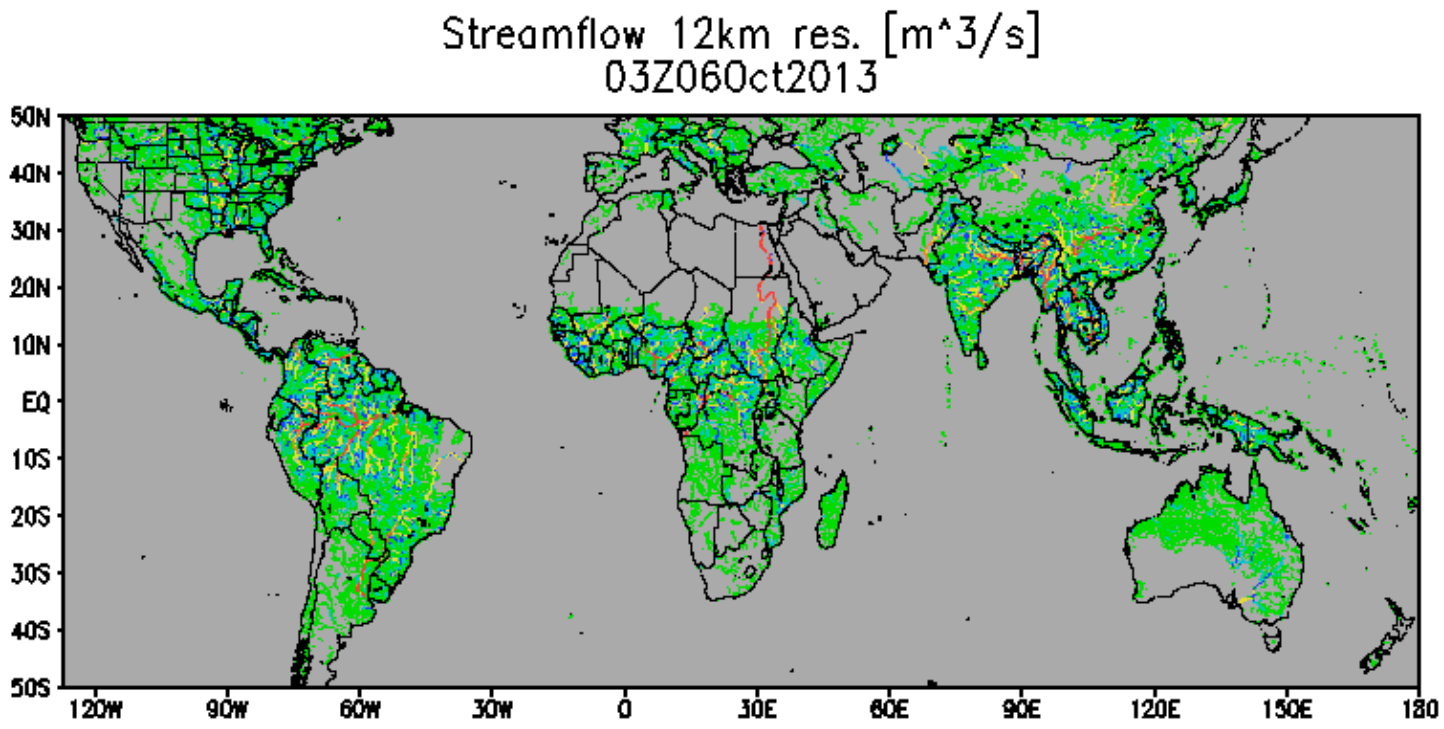


Flood threshold map

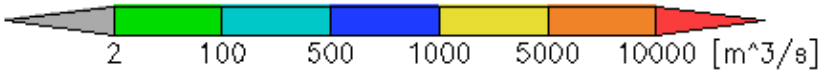
Routed Runoff (RR) > $RR_{95th\ Percentile}$ + δ and Q (streamflow) > 10 m^3/s, where δ is temporal standard deviation of RR



http://flood.umd.edu



50°N - 50°S
1/8th degree
3-hr time steps



Pan the map

Zoom in

Zoom out

Plot time series for an individual point (lat, lon):
(Tips: Zoom in enough to define the point)

0 26.375

T1: 03Z03Oct2013

T2: 03Z06Oct2013

See time series

Plot different variable:

Streamflow 12km res.

Plot

Previous time step << **>> Next time step**

Reset

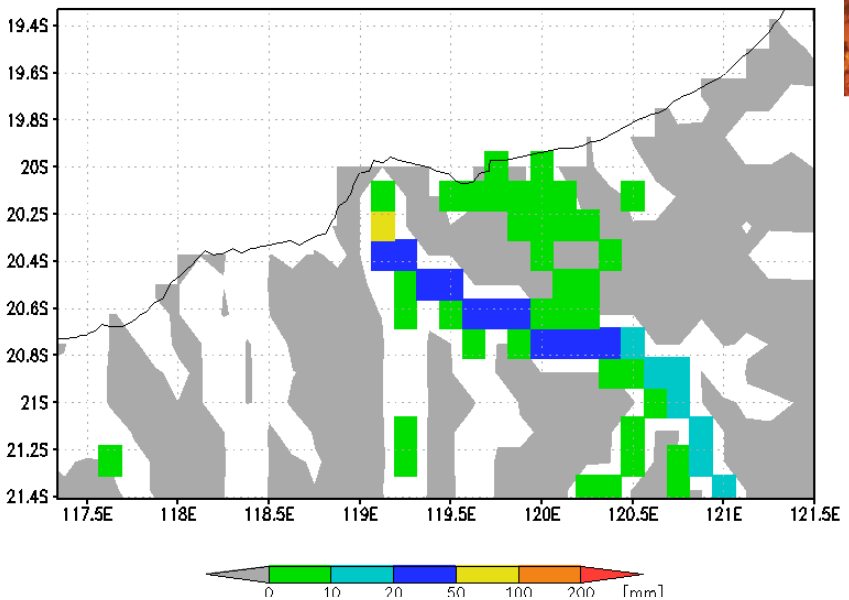
Start time: 03Z03Oct2013 End time: 03Z06Oct2013 Animate

TC Rusty case

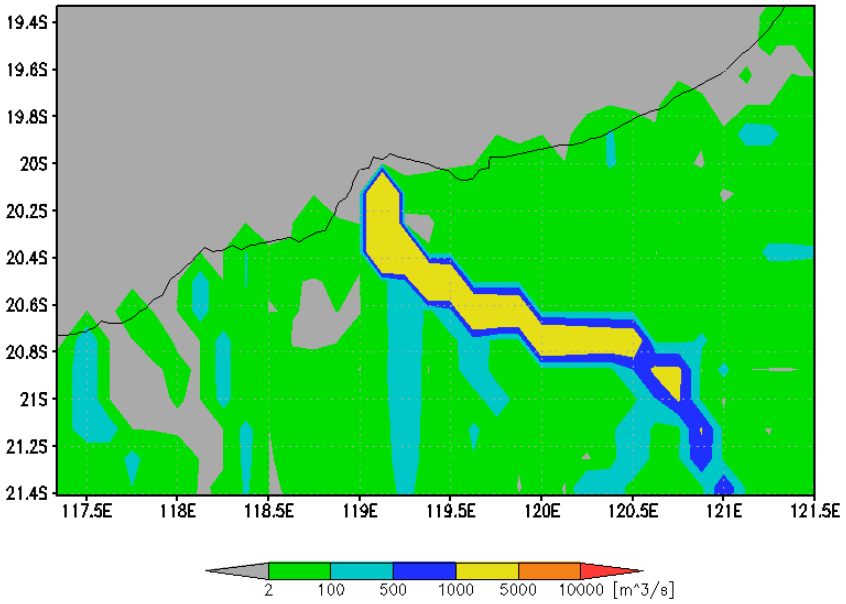
Moderate flooding along the De Grey River

06UTC 28 February 2013

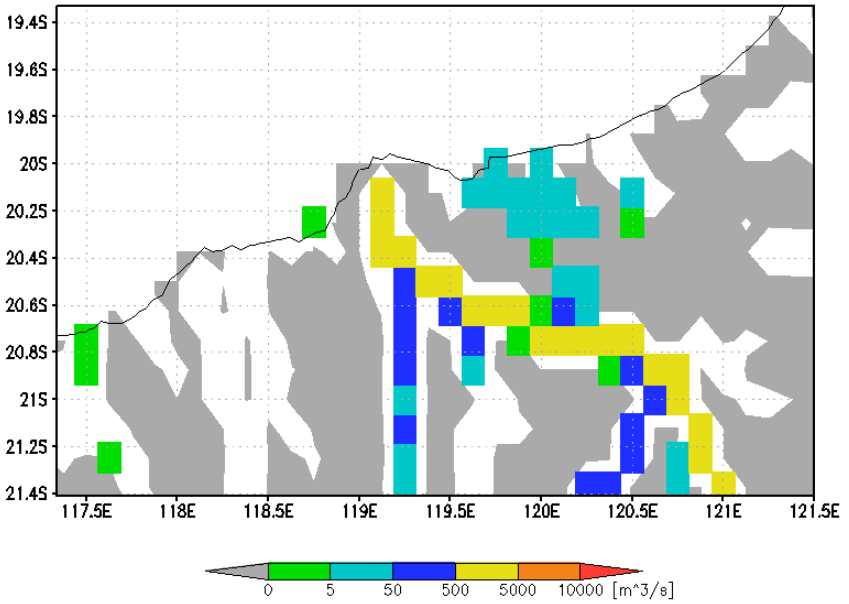
Flood depth above threshold (mm)



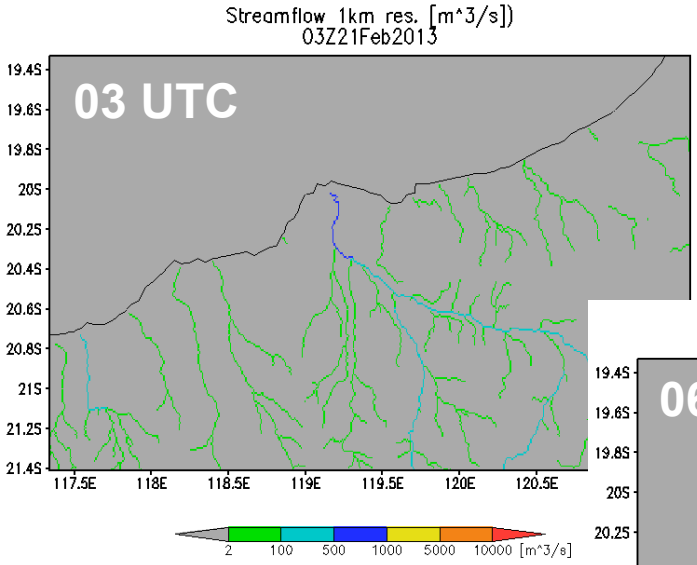
Streamflow (m^3/s)

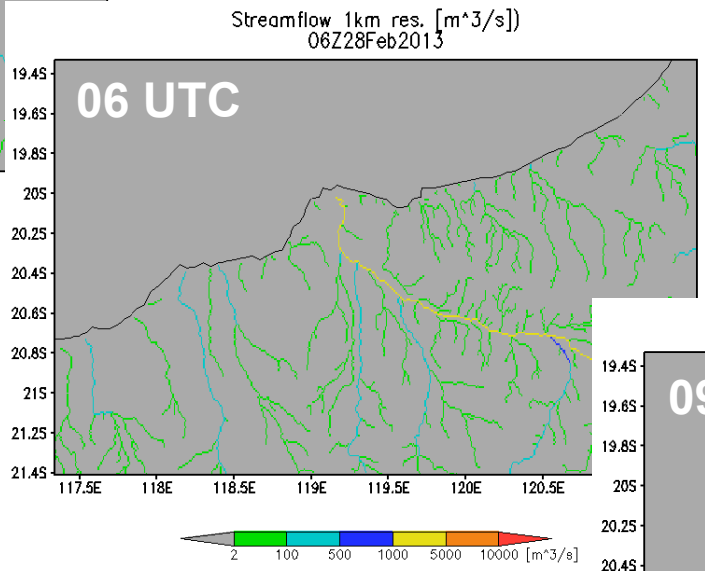


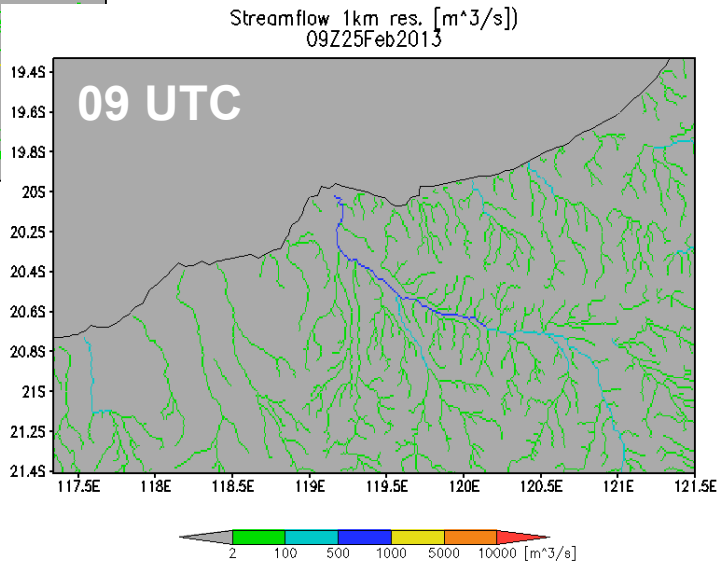
Streamflow above flood threshold (m^3/s)



1 km routing in latest streamflow version





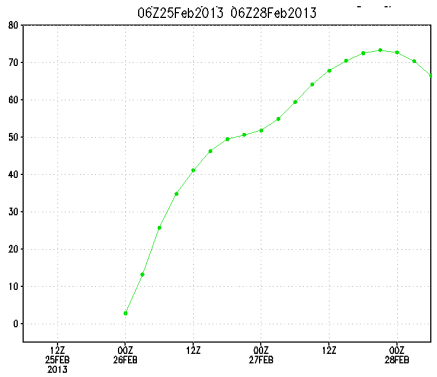


Moderate flooding along the De Grey River

06UTC 28 February 2013

Predicted and observed flood depth

Flood detection/ intensity (depth above threshold [mm])



20.25S, 119.18W

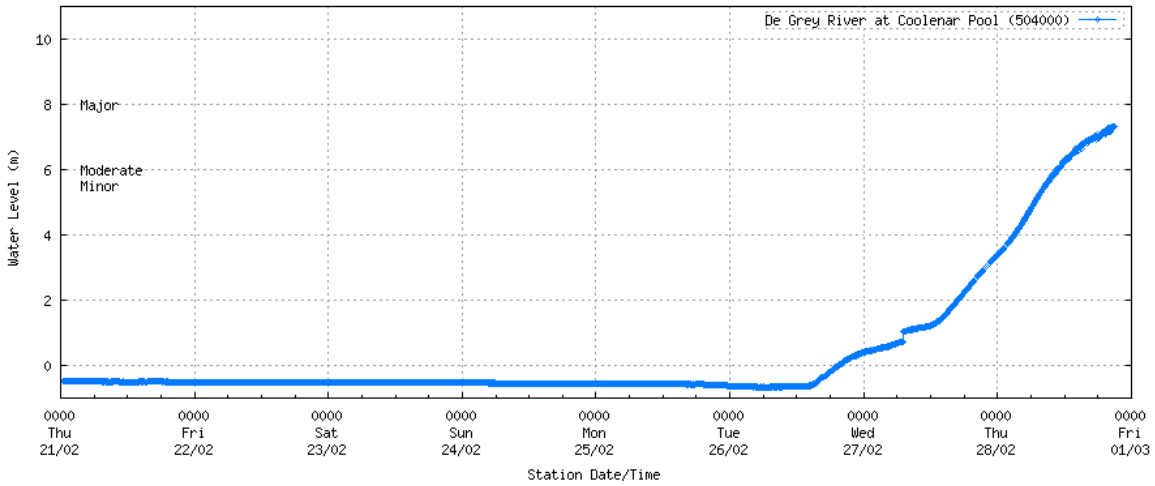
Latest River Heights for De Grey River at Coolenar Pool

Issued at 10:28 pm WST Thursday 28 February 2013

ⓘ About river height plots | About this Plot

Station details: Station Number: 504000 Name: De Grey River at Coolenar Pool Owner: DoW
Flood levels: Minor: 5.50 Moderate: 6.00 Major: 8.00

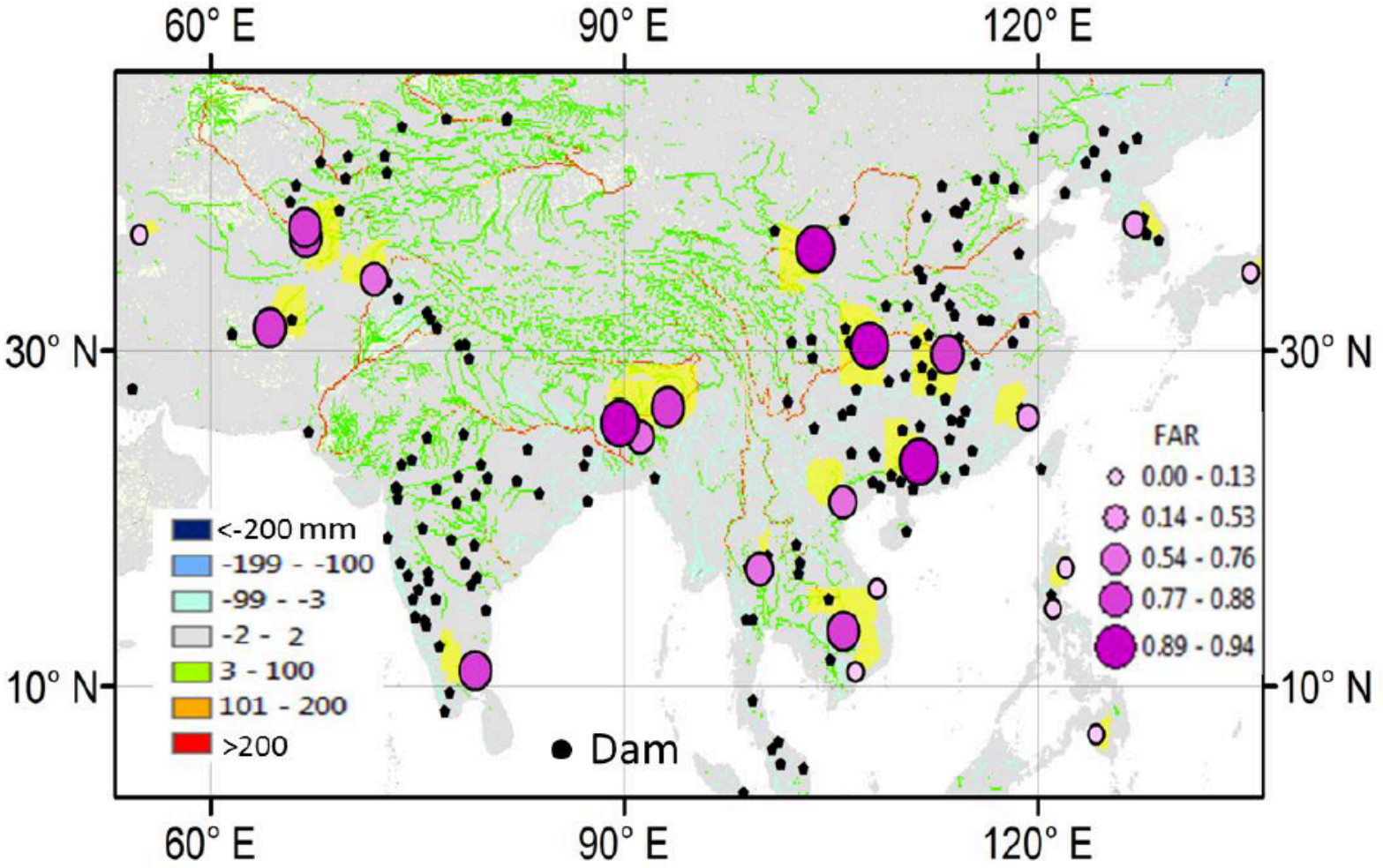
Data from the previous 7 days.



Australian Government Bureau of Meteorology (Generated: 28/02/2013 22:28:03)

Validation against global flood events

Well reported areas (shaded in yellow) and their corresponding FAR metrics for all floods with duration >1 day



Source of observations: Dartmouth Flood Observatory

GFMS performance

- For 1-day floods in basins with few dams
  - Probability of detection POD ~ 0.9
  - False alarm ratio FAR ~ 0.8
- For 3-day floods in basins with few dams
  - Probability of detection POD ~ 0.9
  - False alarm ratio FAR ~ 0.7
- Dams control flow → higher FAR
- Precipitation accuracy likely to be the most important factor
- Better performance in tropics

Future improvements to GFMS

- "Dam module"
  - Include the impact of man-made structures on the calculations
- High resolution inundation maps
- Use forecast precipitation from numerical weather prediction models (adjusted by the satellite estimates)
  - Extend calculations a few days into the future

International Precipitation Working Group (IPWG)

http://www.isac.cnr.it/~ipwg/

- Meetings
- Data
- Algorithms
- Training
- Reports
- Newsletter
- Links
- (etc.)

CGMS IPWG International Precipitation Working Group

IPWG Objectives

IPWG was established under CGMS to:

- Promote standard operational procedures and common software for deriving **precipitation estimates from satellites**
- Establish standards for **validation** of precipitation estimates
- Foster the exchange of data on **inter-comparisons of operational** precipitation estimates from satellites
- Stimulate increased international scientific **research and development** in this field
- Provide **recommendations** to national and international agencies regarding the utilization of current and future satellite instruments
- Encourage regular **education and training** activities

IPWG Future Direction

New IPWG co-chairs have been nominated for 2013-2014:

- Kazumasa Aonashi (JMA/Meteorological Research Institute)
- Nai-Yu Wang (ESSIC/University of Maryland)

IPWG7: Next meeting is tentatively planned for Tsukuba Space Center, Tsukuba, Ibaraki, Japan, Oct. 21-25, 2014

IPWG is a community effort. We welcome anyone that has interest in precipitation research to join and contribute to the future direction of IPWG.

Please visit the IPWG website for more information:
http://www.isac.cnr.it/~ipwg/

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A partnership between CSIRO and the Bureau of Meteorology

CSIRO

Kucera P. and co-authors, 2013: Precipitation from space: Advancing earth system science. *Bull Amer. Meteorol. Soc.*, **94**, 365-375.

Thank you

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