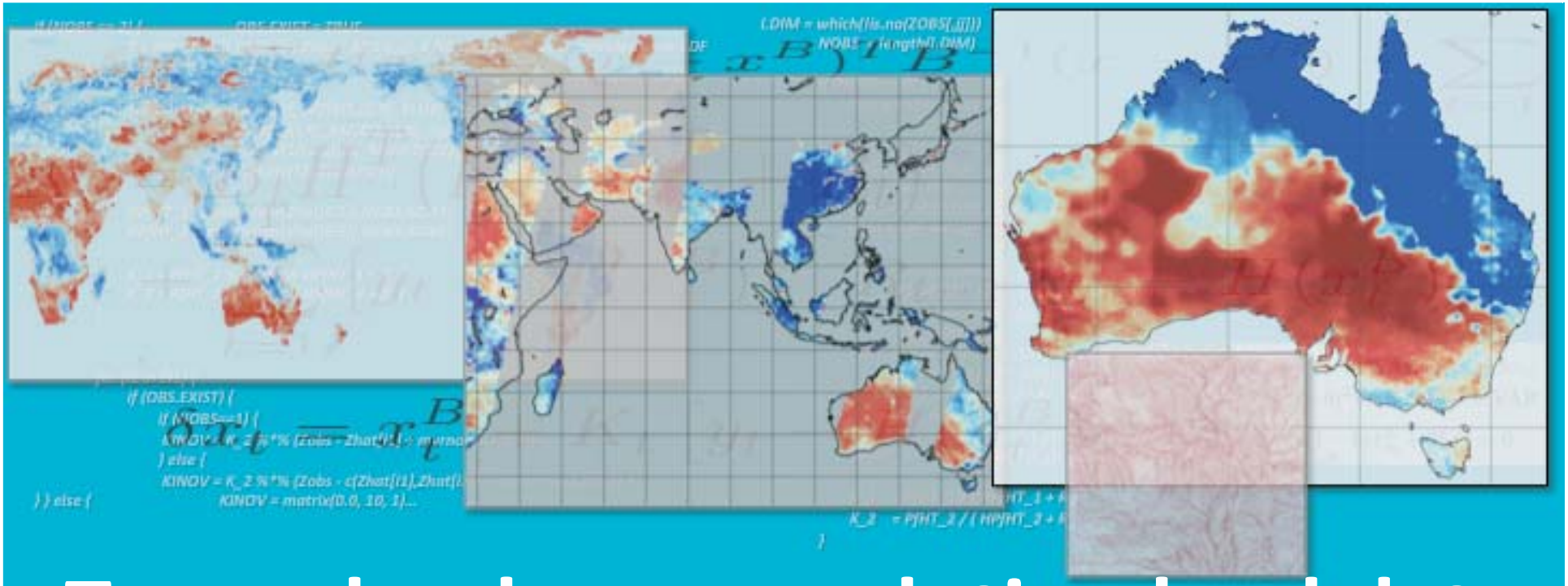

Towards a hyperresolution land data assimilation system for Australia

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The Australian Energy and Water Exchange Initiative
OzEWEX 2014
1st national workshop | Canberra, ACT | 28-29 October

The *Grand Challenge*

Wood et al. (2011), *Water Resources Research*, doi:10.1029/2010WR010090

- Issued the 'grand challenge' to the international hydrological [land surface] modelling community to model –
  - ~ 1-km globally
  - ~100 m continentally
  - 1 hourly – daily
- Why?
  - Push existing models to the limits => refine process understanding, model development
  - Exploit new/next generation satellite earth observations
  - Utilise & challenge massively parallel computing resources
    - *'Infrastructure to support the data needs of the initiative is also needed. This is more complicated and costly and requires people to help develop and integrate the supporting data sets and to host, maintain, and disseminate the data. These needs would presumably require a dedicated center or effort appended to an existing center.'*
- Facing & overcoming the challenge requires '*concentrated & coordinated effort by the hydrologic community.*'
  - => societal benefits through improved drought and flood prediction, and deeper understanding of water-energy-biophysical processes.

Hyperresolution modelling for Australia …

- Suitable challenge for OzEWEX?
- Is a our computing infrastructure up to scratch for the modelling & observational storage demands?

Hyperresolution modelling

Some drivers for hyperresolution information

Agricultural production

Improved yield estimation

- Grains R & D Corporation "Strategic R & D Plan 2012-2017"
- *'… growers integrate weather data with other resource inputs to [better] predict, plan and assess farm performance.'*
- *'… researchers incorporate farm-scale data in the improvement of climate and weather modelling.'*

Global Agricultural Monitoring

- Group on Earth Observations (GEO) "Strategy for Global Ag. Monitoring, 2007" (=> GEOGLAM)
- *'… agricultural production be factored into the design and implementation of future operational satellites'*
- *'… increase on spatial resolution of [geostationary satellite data] to 500 m would greatly increase their utility for Agriculture.'*
- *Coarse, moderate and high resolution = 5 km-250 m; 60 m – 10 m; < 10 m respectively*

Water & food security

- United Nations policy brief for Rio+20 "Water Security for a planet under pressure" March 2012
- *'… [growing need to] improve the availability of data and information, particularly on transboundary water resources and planetary thresholds.'*
- *… 'information has the of relevance to decision making process … grounded in evidence… '*
- Global Water Systems Project + FAO + ESA: "Earth Observation and the Water-Food-Energy Nexus" Conference, March 2014
- *'… Earth observations in conjunction with in situ data … support advice on water resource management, monitor trade- offs between land use and measuring local water consumption by crops… '*

Carbon accounting

Satellite Earth Observations

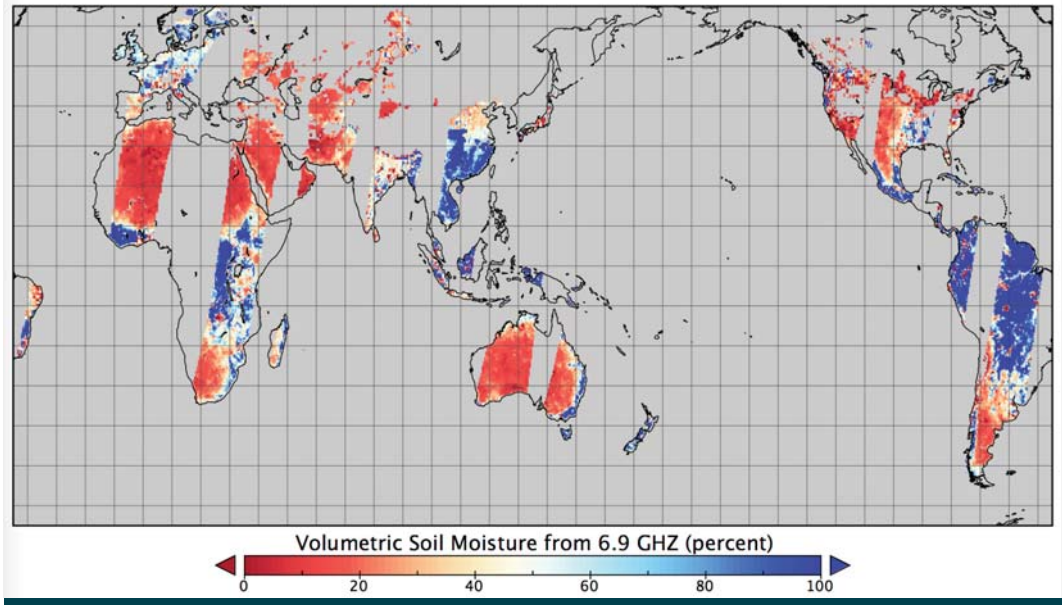
- EO of the terrestrial water cycle
  - traditionally coarse, i.e. ~10 – 100 km's compared with 10 m – 1 km
  - higher frequency than 'optical' counterparts

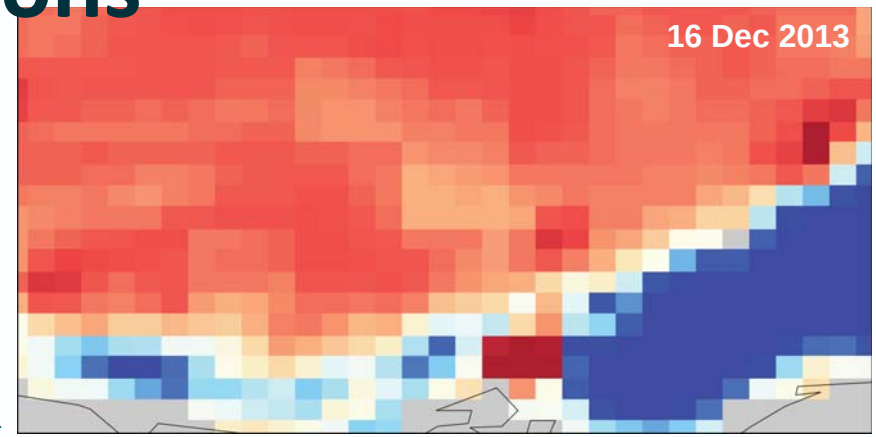
- There is (slow) trend in EO data toward higher resolution
- SMAP mission (launch Nov 2014) ~ <= 10-km resolution, <= 3-days
  - Entekhabi *et al.* 2010: *in proc* IEEE

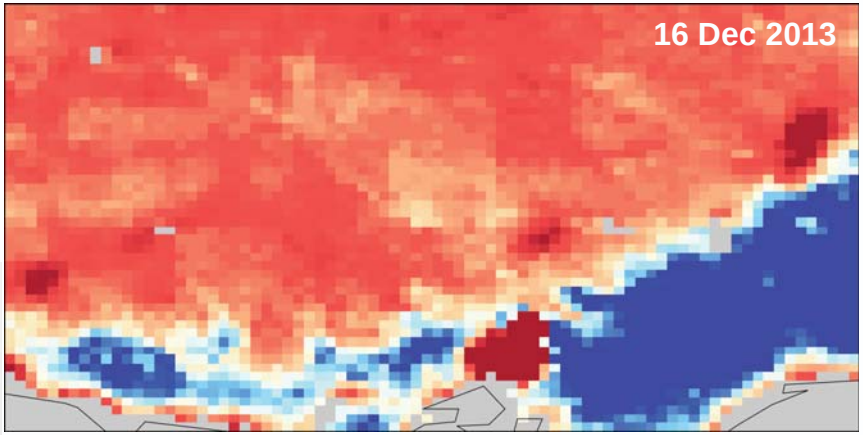
- Sentinel-1 (up and running) - EODC for Water … 100's m, low repeat
  - Wagner *et al.* 2014: *ISPR Annals Vol II-7*

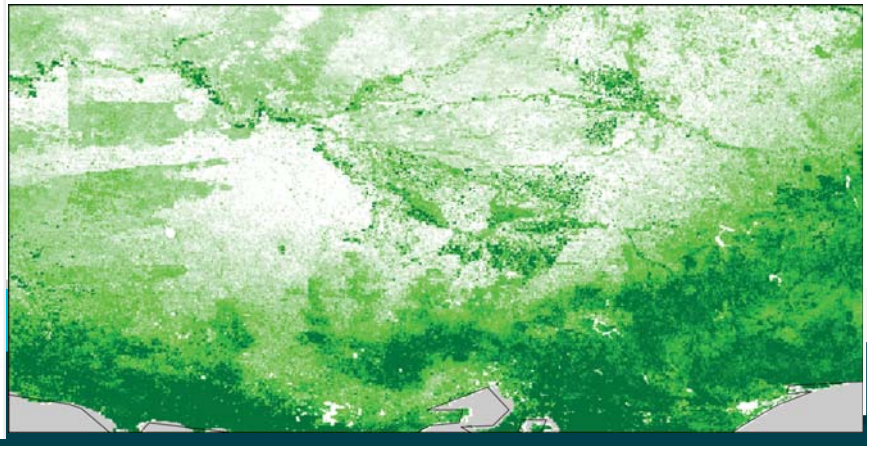
- AMSR-E / AMSR2 downscaling using Ka-band ~ 10-km, <=3-days
  - De Jeu et al. 2014: *J Hydrol.*, 516

AMSR2



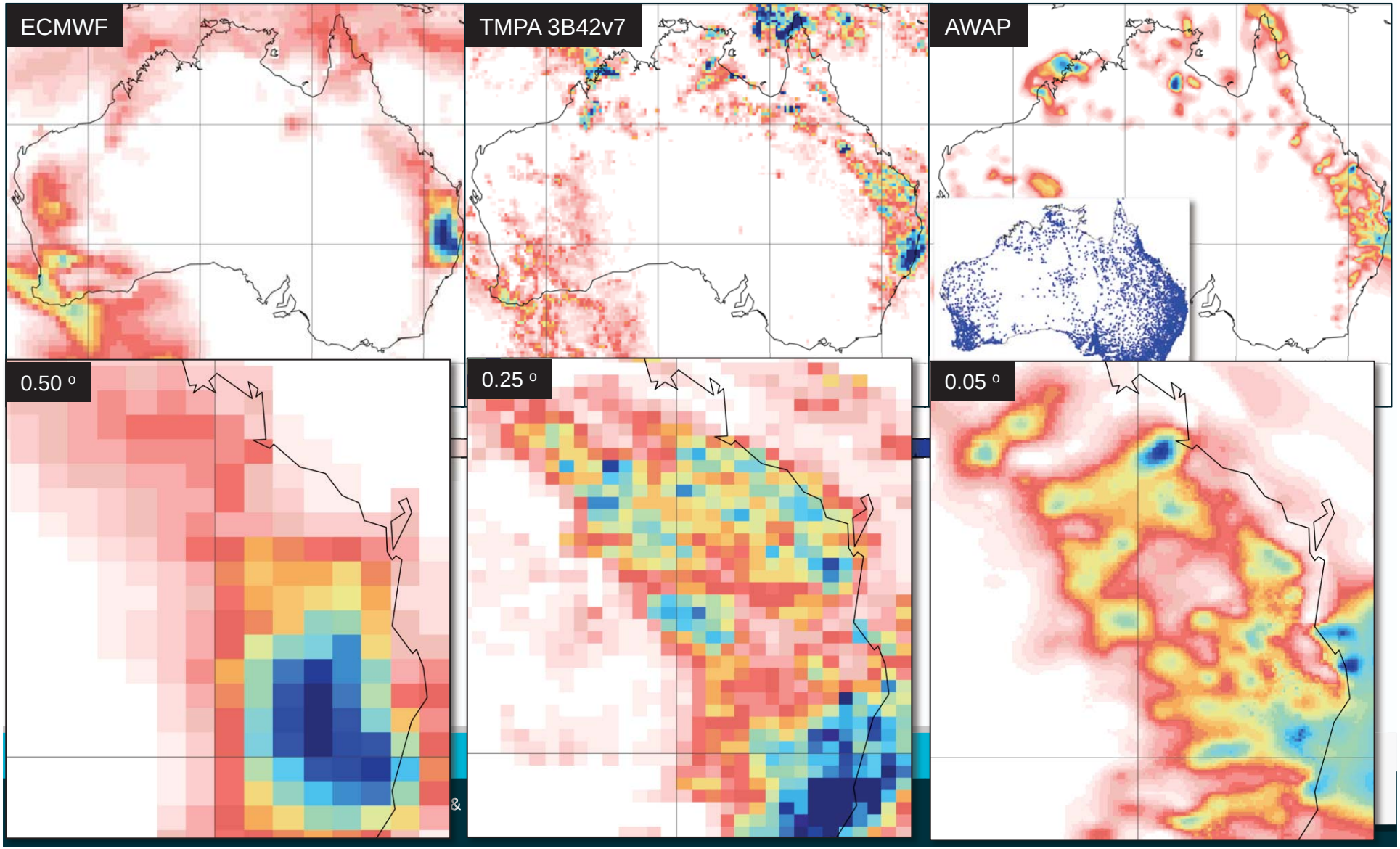






Model Parameterisation & Meteorological Driver data

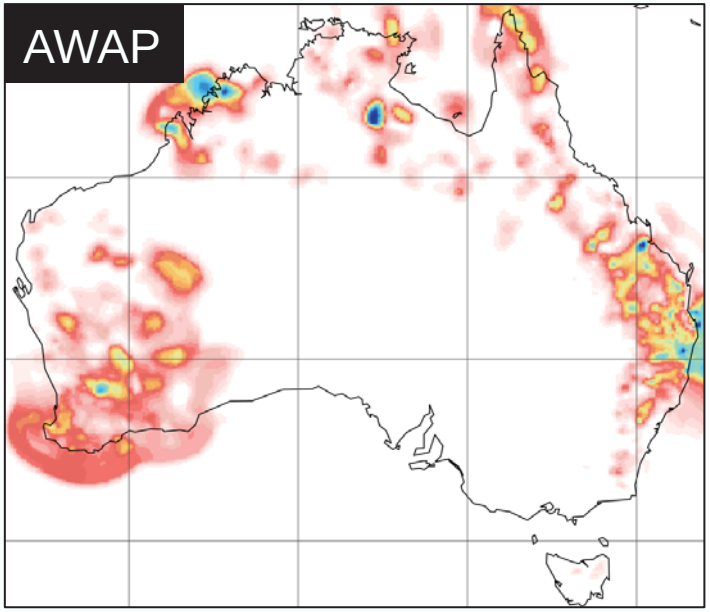
24 accumulated rainfall 6 Jan 2011 (9 am EDST)

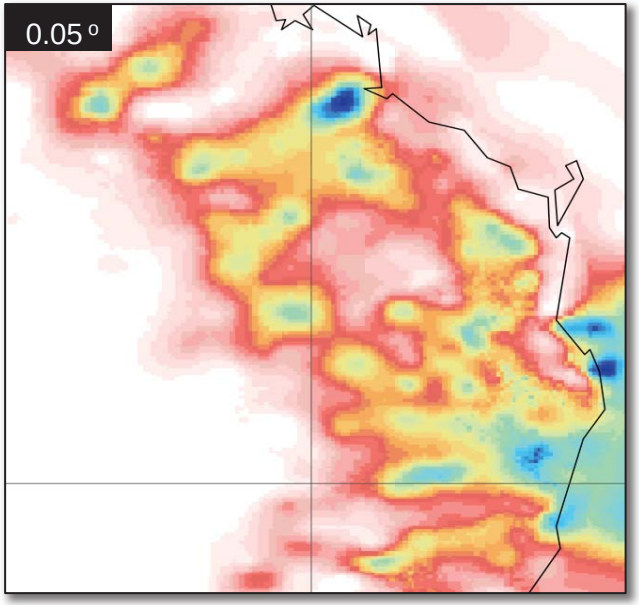


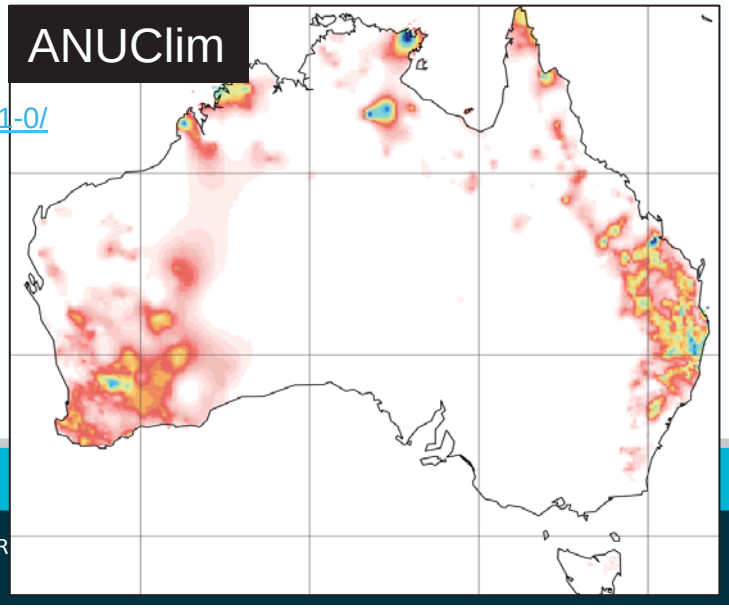
Model Parameterisation & Meteorological Driver data

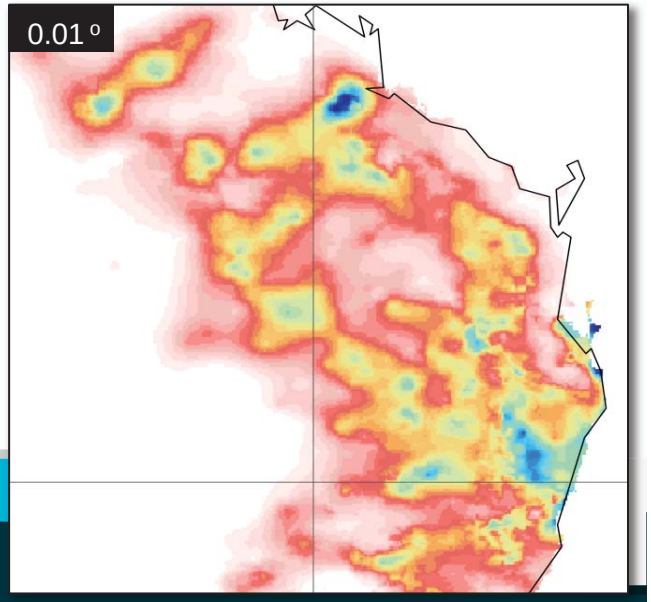
Jones, D. A., Wang, W., & Fawcett, R. (2009). *Australian Meteorological and Oceanographic Journal*, 58, 233–248.

Michael Hutchinson *et al.*
ANUClimate 1.0
www.emast.org.au/models/anuclimate-1-0/



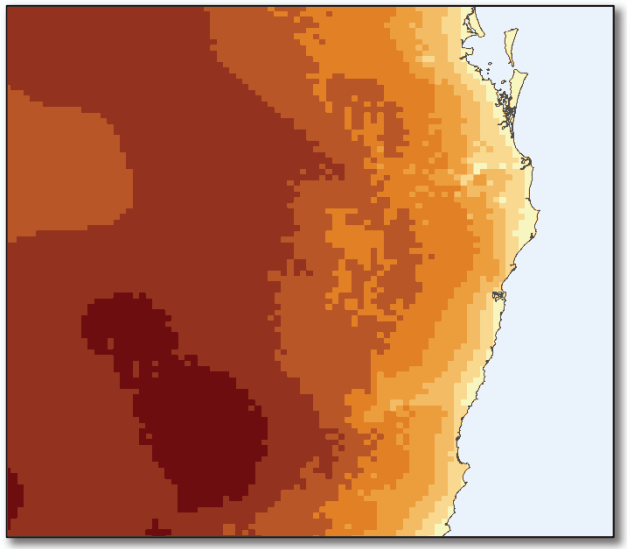


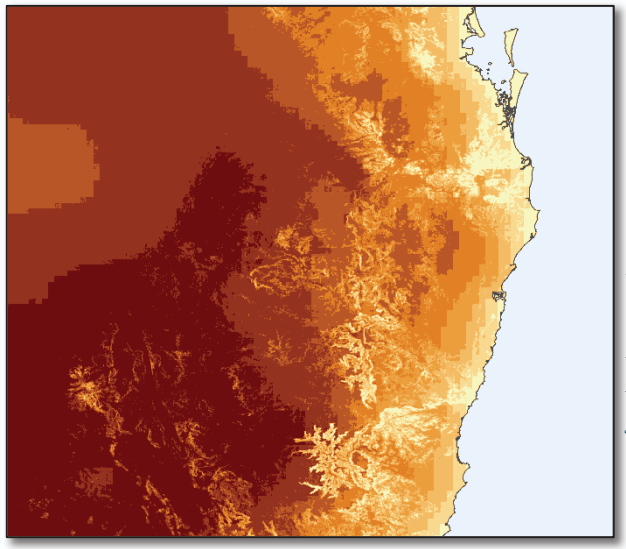




Model Parameterisation & Meteorological Driver data

AWAP 5km incoming SW radiation



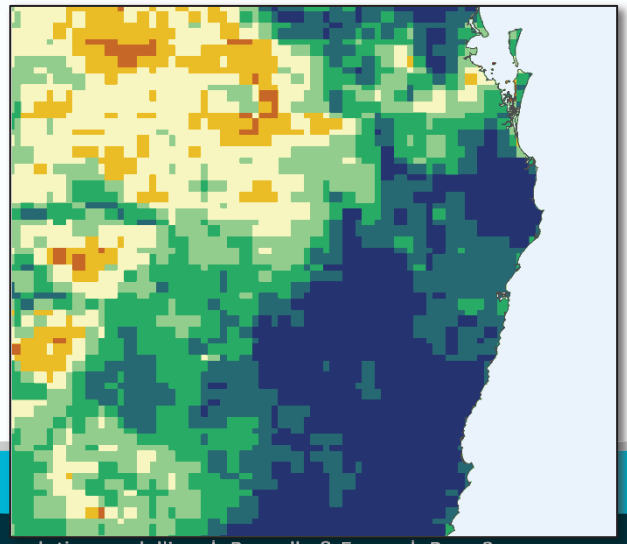


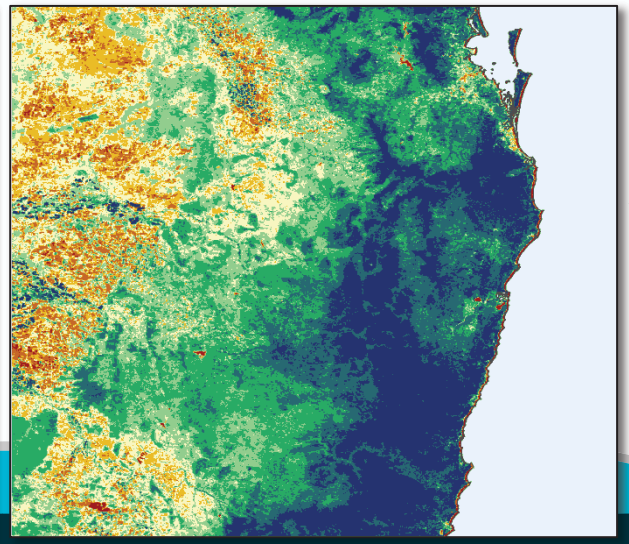
250m incoming SW radiation

Method by J. Gallant & J. Austin used in:

Donohue, R.J., *et al.* (2014). *Remote Sensing of Environment*, DOI: 10.1016/j.rse.2014.09.007

5km vegetation cover



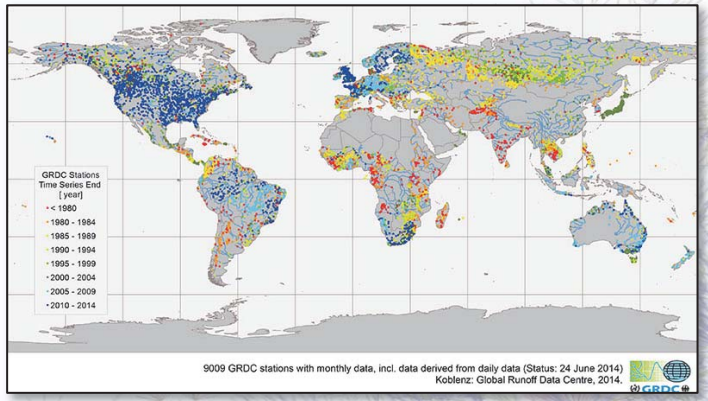


MODIS 250m vegetation cover

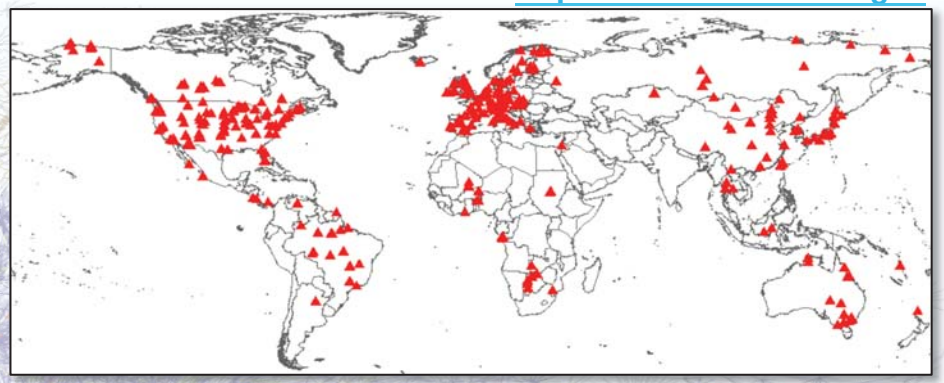
Surface Observation Networks

For constraining and/or evaluating model

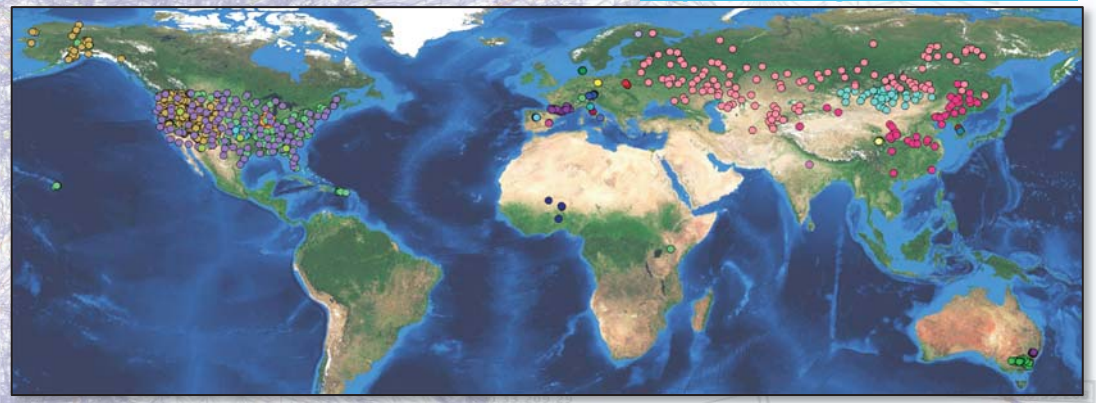
GRDC: www.bafg.de/GRDC/EN/Home/



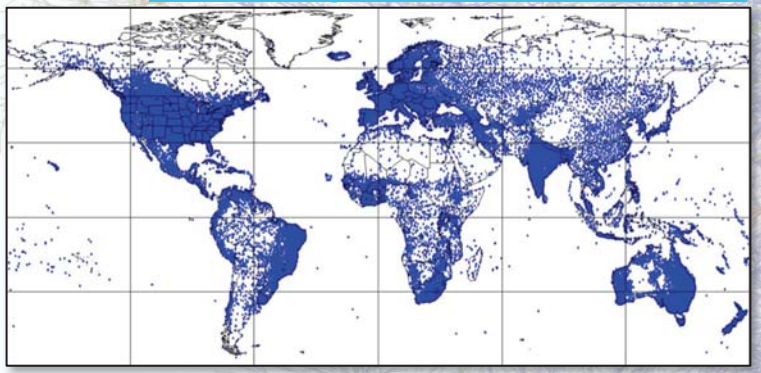
Fluxnet: http://www.fluxnet.ornl.gov



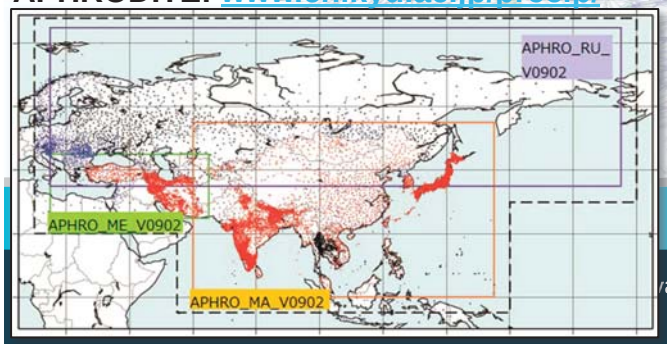
International Soil Moisture Network: https://ismn.geo.tuwien.ac.at



GPCC: climatedataguide.ucar.edu/climate-data



APHRODITE: www.chikyu.ac.jp/precip/



COSMOS cosmos.hwr.arizona.edu

An Australian hyperresolution modelling case study

Is 100 m resolution too ambitious?

- e.g. 250 m resolution daily rainfall data (if it existed) for 2 decades = 7.7 Tb

- 1-km modest requirements in comparison?

Earth Observations and forcing data trending in right direction, especially through merging of multi-data sets. **Are we building confidence that there is value added?**

- alternative to disaggregating coarse data may be aggregating model states & fluxes to coarse resolution. Imparting constraint through the obs operator.

Community computing resources. Is the NCI the (only) way to go?

- is the community on board with this?

- copying global data to local computing versus computing access where the data reside, eg EODC Wagner et al 2014 approach.

What about community modelling and data integration / assimilation systems?

- Modelling developed / sophisticated enough to application of hyperresolution

- CABLE, AWRA, ... how are we managing code and access across community computing resources? Is it freely available for all?

- DART, LIS, own code ... How do I get 'my' model / method in there?

OzEWEX data assimilation methods inter-comparison & computational requirements study

- requires *'concentrated and coordinated effort'*