

Landscape Water information: Operational modelling, assimilation & future directions

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Australia's Hydroclimate

Driest inhabited continent

Water Availability

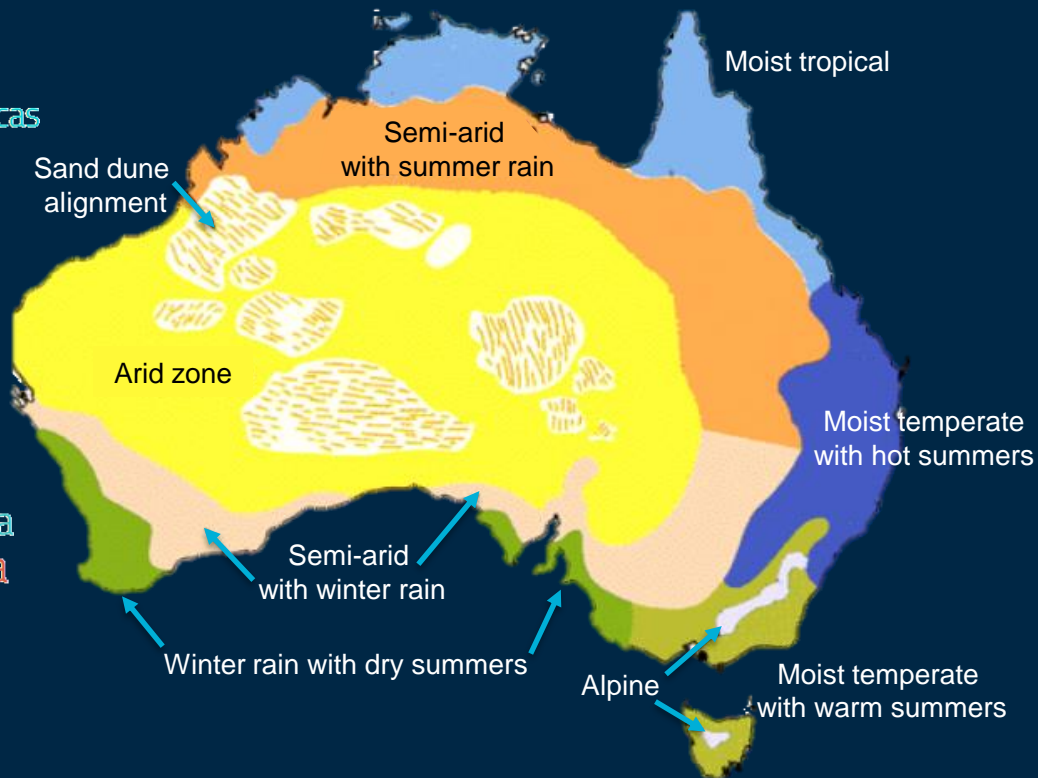
Annual streamflow per km²



High water use per capita

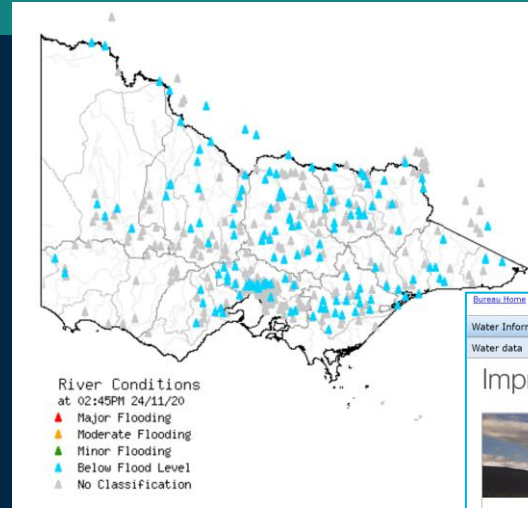
Water Use

Daily consumption per capita



A brief history of water in the BoM

1. Flood forecasting, IFDs
2. Water Division ~ 2007
 - Water Act
 - Collating data
 - monitoring, reporting, forecasting
3. 2020 Restructure:
 - Customer focus (BSG)
 - Services (CSG)
 - **Water R&D in SIG!**



Flood forecasting service
www.bom.gov.au/water/floods

Water Information
www.bom.gov.au/water

Moving towards a consolidated Australian Water Outlook service

Local outlook

Flood forecasting

Catchment modelling

Streamflow forecasts

Continental water outlook

Landscape modelling

Hydrological projections

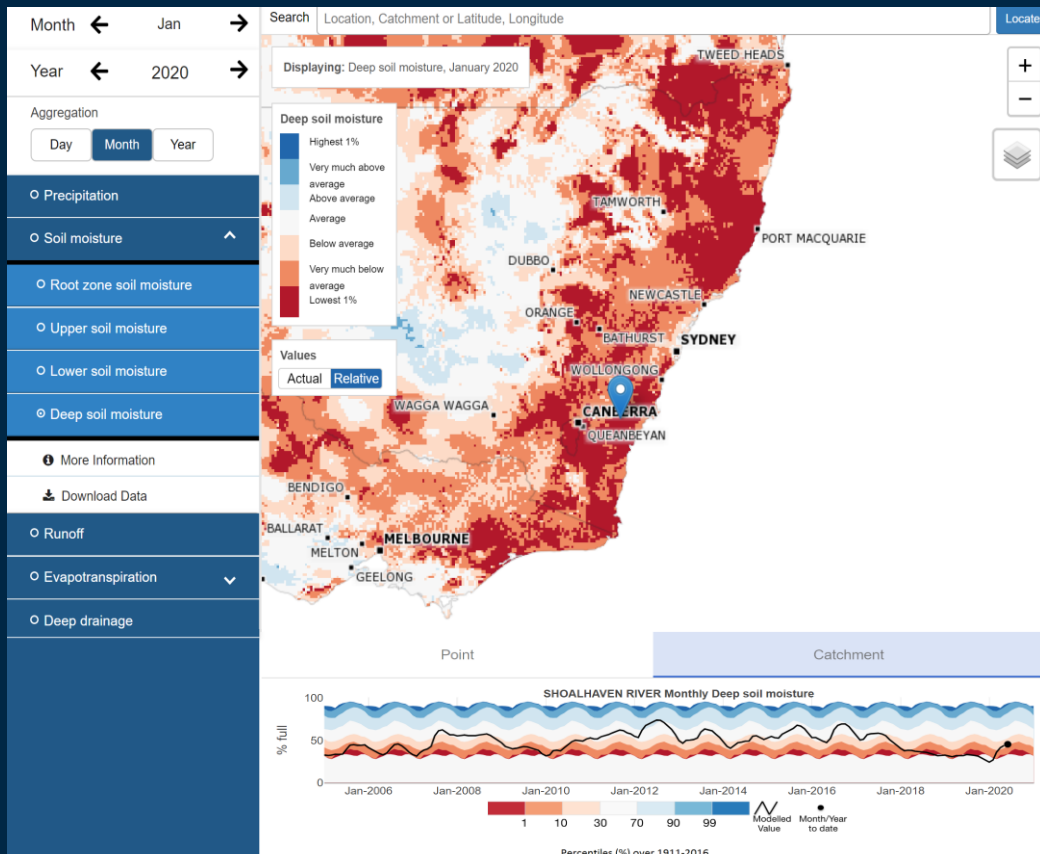
Hydrological forecasting

Hydrological monitoring

Existing Australian Landscape Water Balance web application

www.bom.gov.au/water/landscape

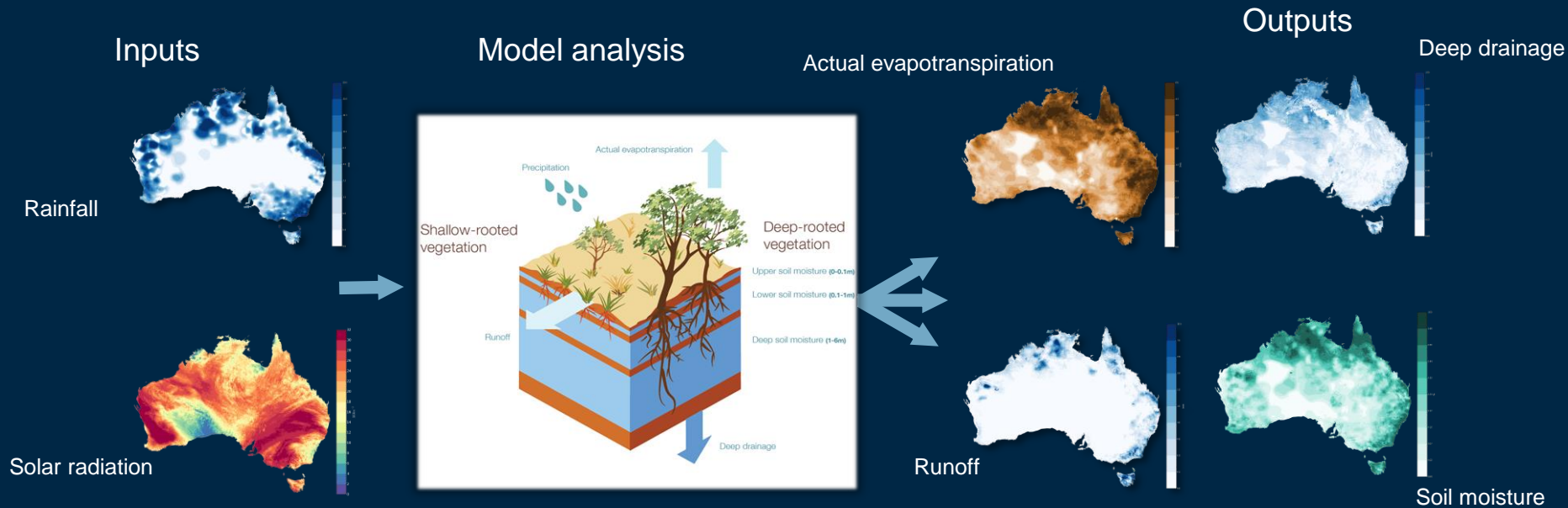
- A unique service!
- Updated daily
- See all variables at daily, monthly or annual time slices
- Download the grids at a resolution of 5km x 5km
- Past 15 years data available to all
- Registered users access >100 years and tailored products
- Model details available under 'About the AWRA-L model'



Overview and outputs: AWRA-L

The Australian Water Resources Assessment Landscape model

National, daily time-step, 5 km resolution



AWRA-L v5 operational in the Bureau since 2016, AWRA v6 late 2018
AWRA v7 early 2021



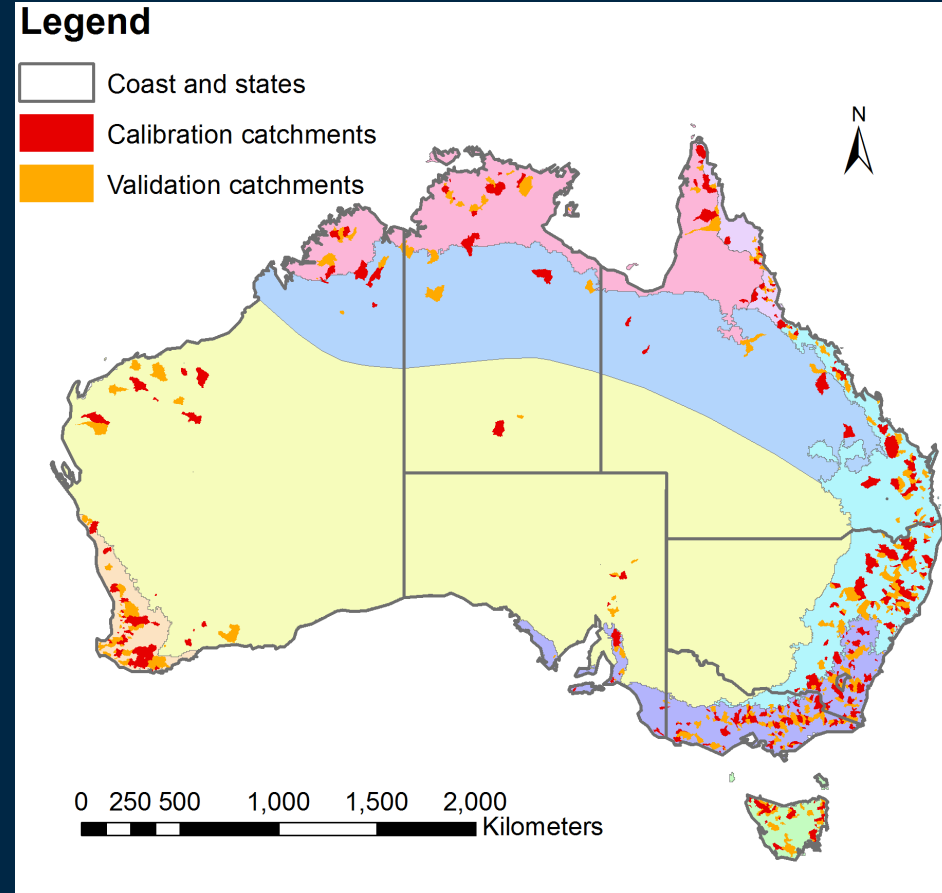
Australian Government
Bureau of Meteorology



Development and testing

- CSIRO/BoM development 2009-2018
- Key static parameters calibrated via (may change with new version):
 - catchment streamflow
 - satellite ET
 - AMSRE soil moisture

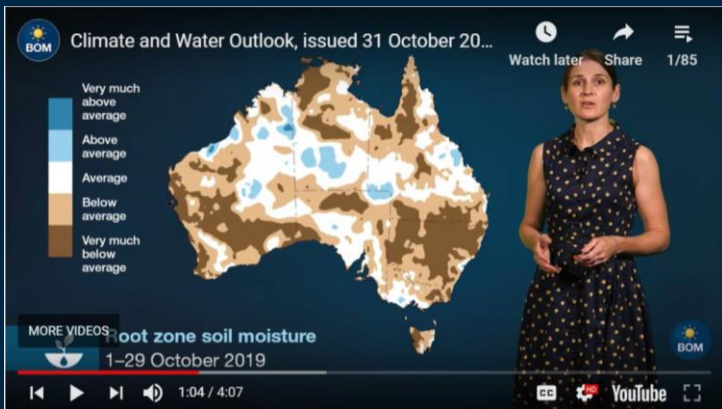
Calibration/Validation catchments and calibration regions



AWRA-L: Past to present

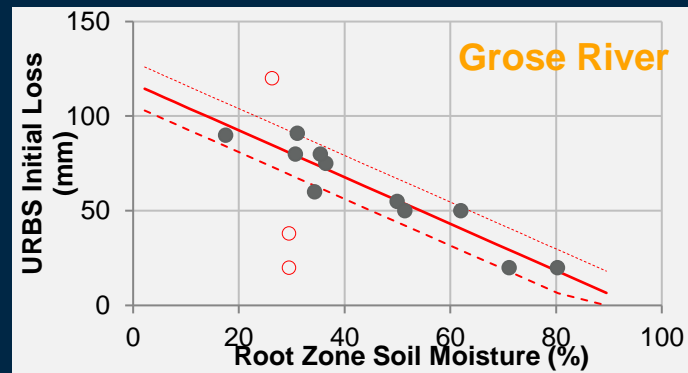
Monitoring/reporting:

National Climate and Water Briefings, Special Climate Statements, NWA, Water In Australia, Regional Water information, Landline, Fire risk

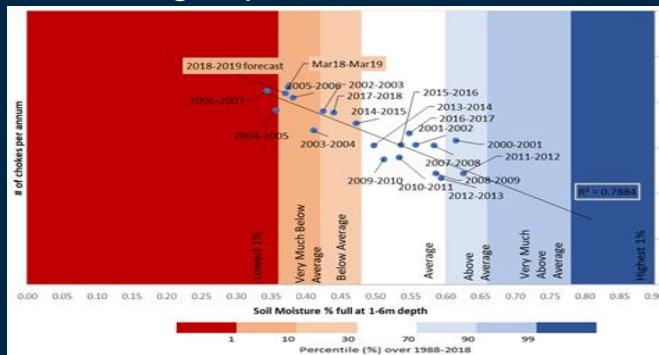


Emergency Services:

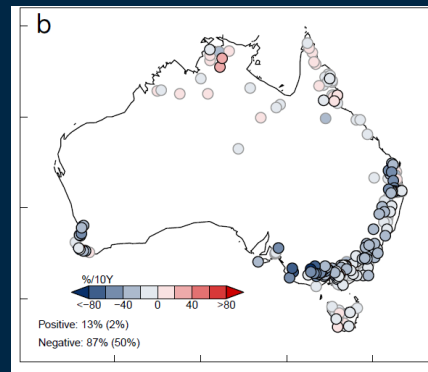
Flooding initial loss, fire dryness: eg. BoM initial loss estimation from model calibration correlated with AWRA-L Root Zone Soil Moisture



Water Utilities: eg. Pipe chokes vs. soil moisture



Design: Australian Rainfall & Runoff design initial loss and trends in soil moisture/floods



Wasko and Nathan (2019) Influence of changes in rainfall and soil moisture on trends in flooding



Forecasting service

ASCAT/SMAP



Data Assimilation

NWP

Climate outlook

AWRA-L

9 days forecasts

6 months outlook

Derived products - User generated

1-10 day
forecast

Seasonal
forecast

Variables include:

- Soil moisture (output from AWRA-L)
- Runoff (gridded) (output from AWRA-L)
- ET (output from AWRA-L)

Short-term forecast:

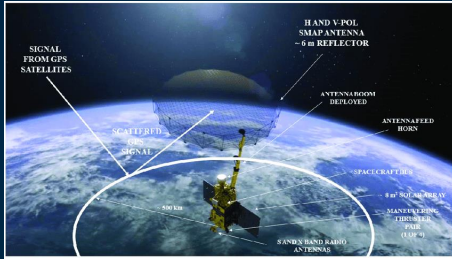
- Daily, 5x5 km for 10 days, released daily
- 99-member ensemble

Seasonal forecast:

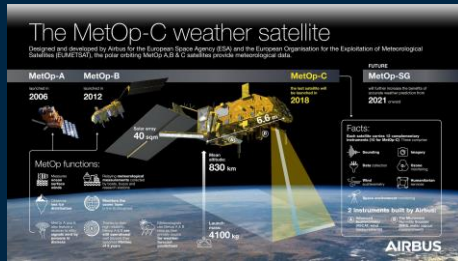
- Monthly, out to 6 months, released monthly
- 99-member ensemble



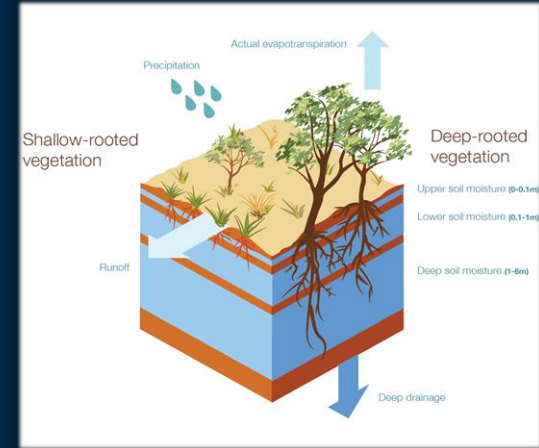
Data Assimilation



SMAP Enhanced L2 Radiometer Half-Orbit 9 km



ASCAT NRT 12.5 km (Metops -A,-B and -C)



AWRA-L upper layer soil moisture:

Assimilation produces daily soil moisture analysis using AWRA-L daily scheduled run (with observed forcing)

Initial states for forecasting



Data Assimilation - Approach

- 1) SMAP and ASCAT rescaled: Mean and variance matching with AWRA-L upper layer moisture (rescaling parameters derived from June 2015 – July 2019 data)
- 2) Spatially varying error parameters for SMAP, ASCAT and AWRA-L upper layer moisture: Derived using Triple Collocation over period June 2015 – July 2019



$$\sigma_x^2 = \left(Q_{x,x} - \frac{Q_{x,y}Q_{x,z}}{Q_{y,z}} \right)$$

$$\sigma_y^2 = \left(Q_{y,y} - \frac{Q_{x,y}Q_{y,z}}{Q_{x,z}} \right)$$

$$\sigma_z^2 = \left(Q_{z,z} - \frac{Q_{z,y}Q_{x,z}}{Q_{x,y}} \right)$$

Error variances (Q = covariances)
Triple Collocation e.g. McColl et al. (2014)

[x, y, z represent AWRA, ASCAT, SMAP respectively]

$$k_B = \frac{\frac{1}{\sigma_x^2}}{\frac{1}{\sigma_x^2} + \frac{1}{\sigma_y^2} + \frac{1}{\sigma_z^2}}$$

Gain/weighting

For gaps in satellite coverage, $K_B=1$
(Example here for AWRA gain K_B ,
same process for calculating K_{ASCAT} and K_{SMAP})

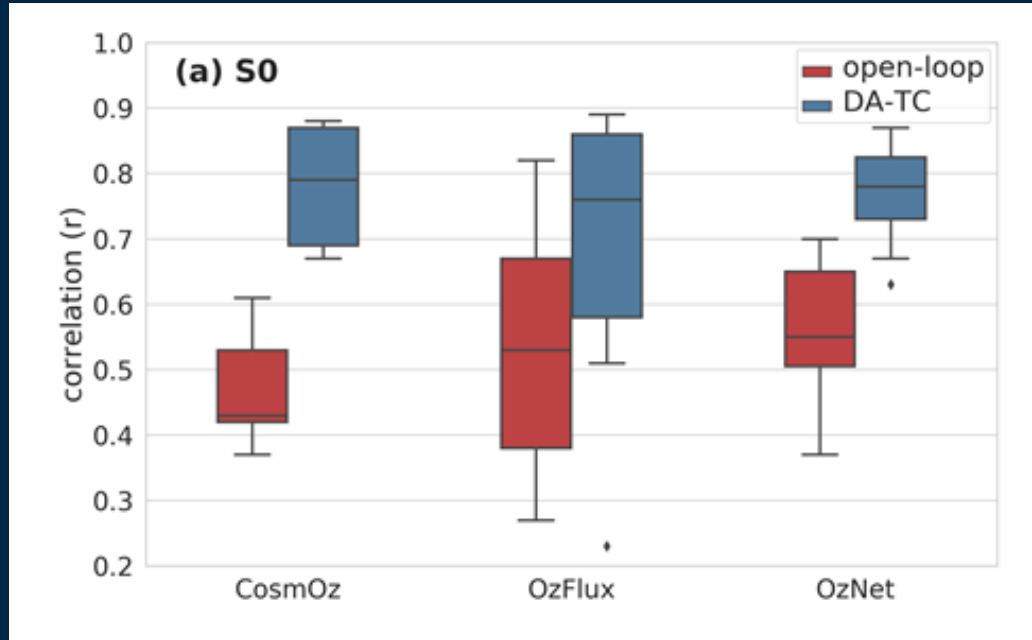
$$X_t^a = k_B X^f + k_{ASCAT} Y_{ASCAT} + k_{SMAP} Y_{SMAP}$$

Daily state updating

(X^a and X^f are updated/analysed and forecast model state respectively; Y is rescaled satellite data)



Data Assimilation – Summary results



Difference in correlation between AWRA-L upper layer moisture from open-loop and after assimilation (DA-TC), against in-situ observations from three Australian monitoring networks

Future

- Assess monthly/seasonal scale error parameters from Triple Collocation
- Single land surface and water balance model (next 5-10 years) → Hydro-JULES
- Scope enhanced data assimilation
 - Vegetation indices
 - Land surface temp
 - GRACE
 - Streamflow

