The Bureau of Meteorology

JULES in Australia – The Bureau of Meteorology's plans for seamless land surface modelling

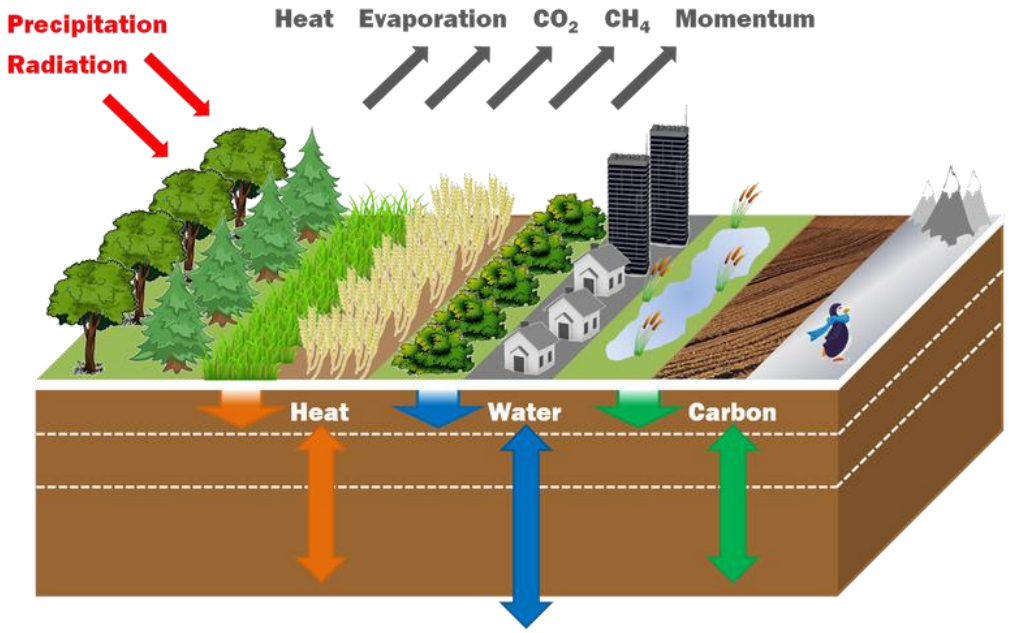
Hydrological Sciences Section

Presented by Christoph Rüdiger

JULES science meeting, 14-15 September 2023

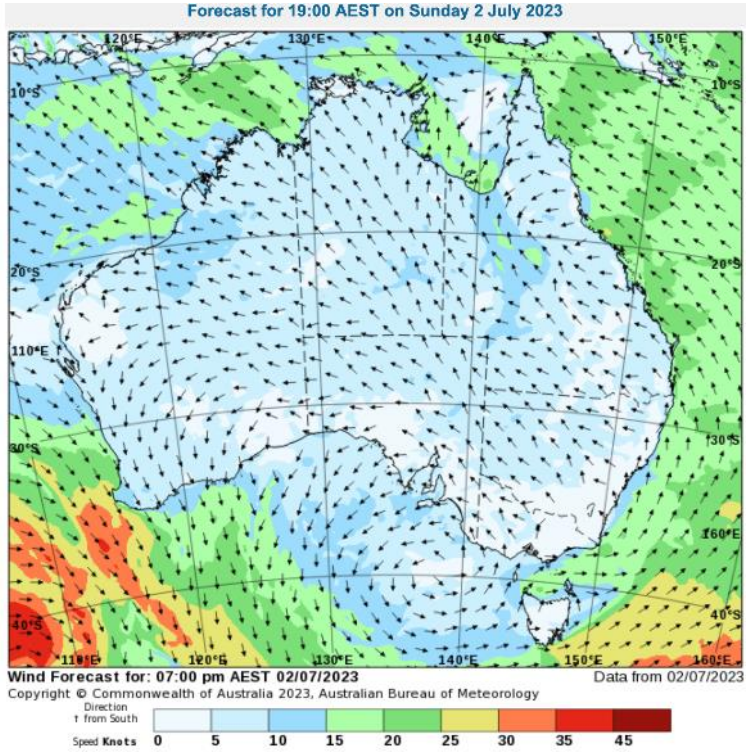
Land Surface Model: JULES

Joint UK Land Environment Simulator

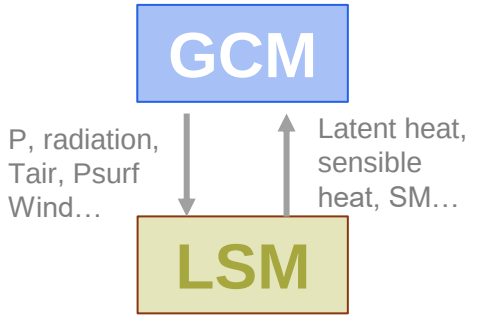


JULES
Joint UK Land Environment Simulator

Met Office



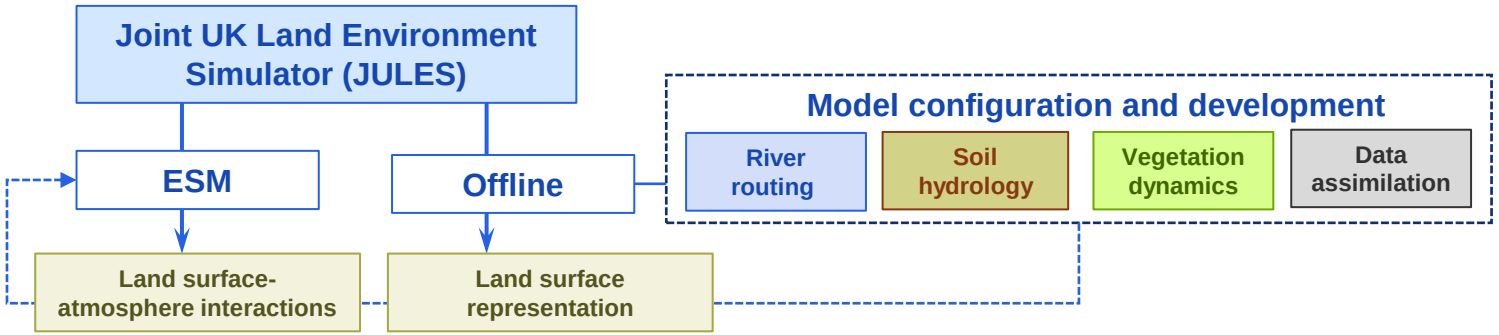
The Australian Community Climate and Earth-System Simulator (ACCESS) weather model



- better understanding of land-atmosphere interaction
- improve atmospheric prediction
- seamless weather, climate, hydrological predictions

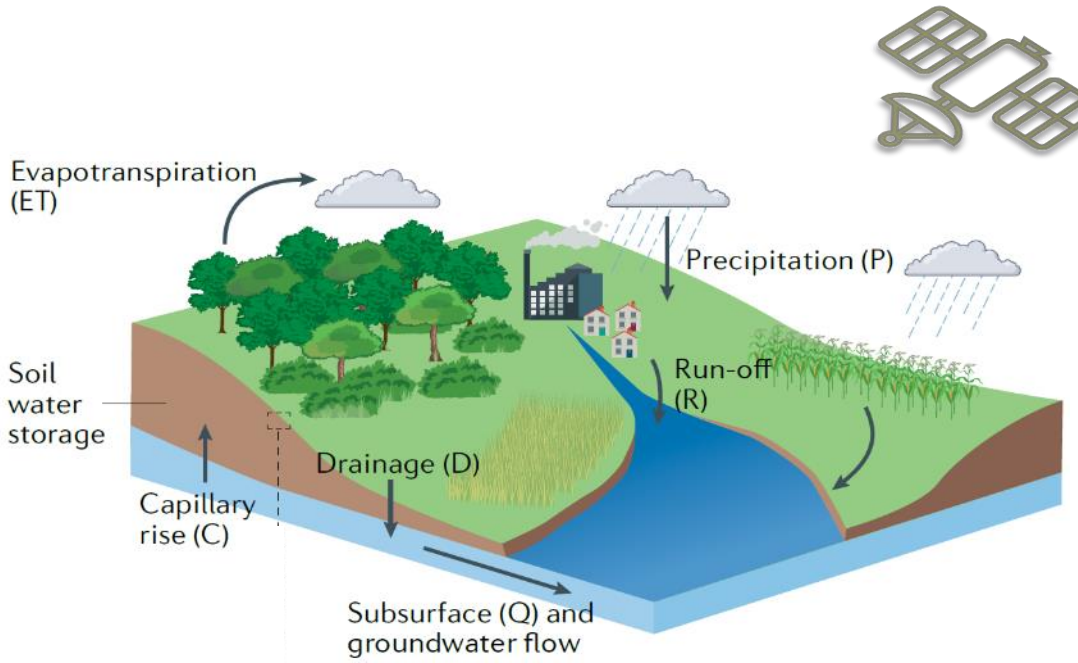
Bureau of Meteorology 2020-2030 R&D plan--Objective 3: an Earth system numerical prediction capability: fully integrated atmosphere, ocean, sea-ice and hydrology models

Seamless Hydrological Modelling



Remote Sensing
- Current data
- Future strategy & new data
- Benchmarking
- Data Assimilation

Soil Physics
- Model
- Parameters
- Layers
- Ancillaries
- Flow direction



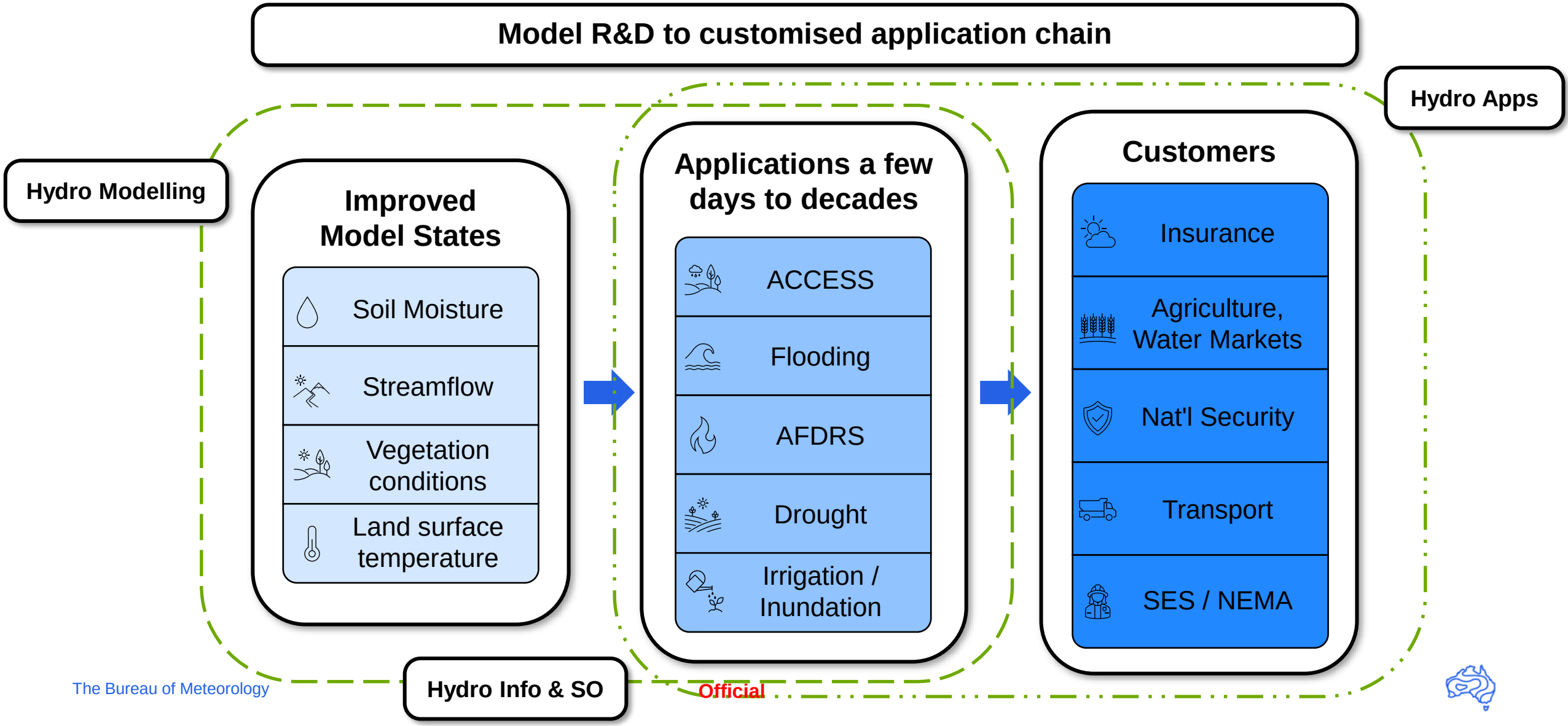
Streamflow
- Routing
- Parameters
- Geofabric
- Characteristics
- GW/SW interactions

Vegetation
- Interactive
- Parameters
- Land cover
- Fire

Other
- Urban hydrology
- Fires
- High-resolution
- Coupling

Image from Vereecken et al, 2022

From Hydrology Science to our Customers



Adapting JULES to the Australian Environment

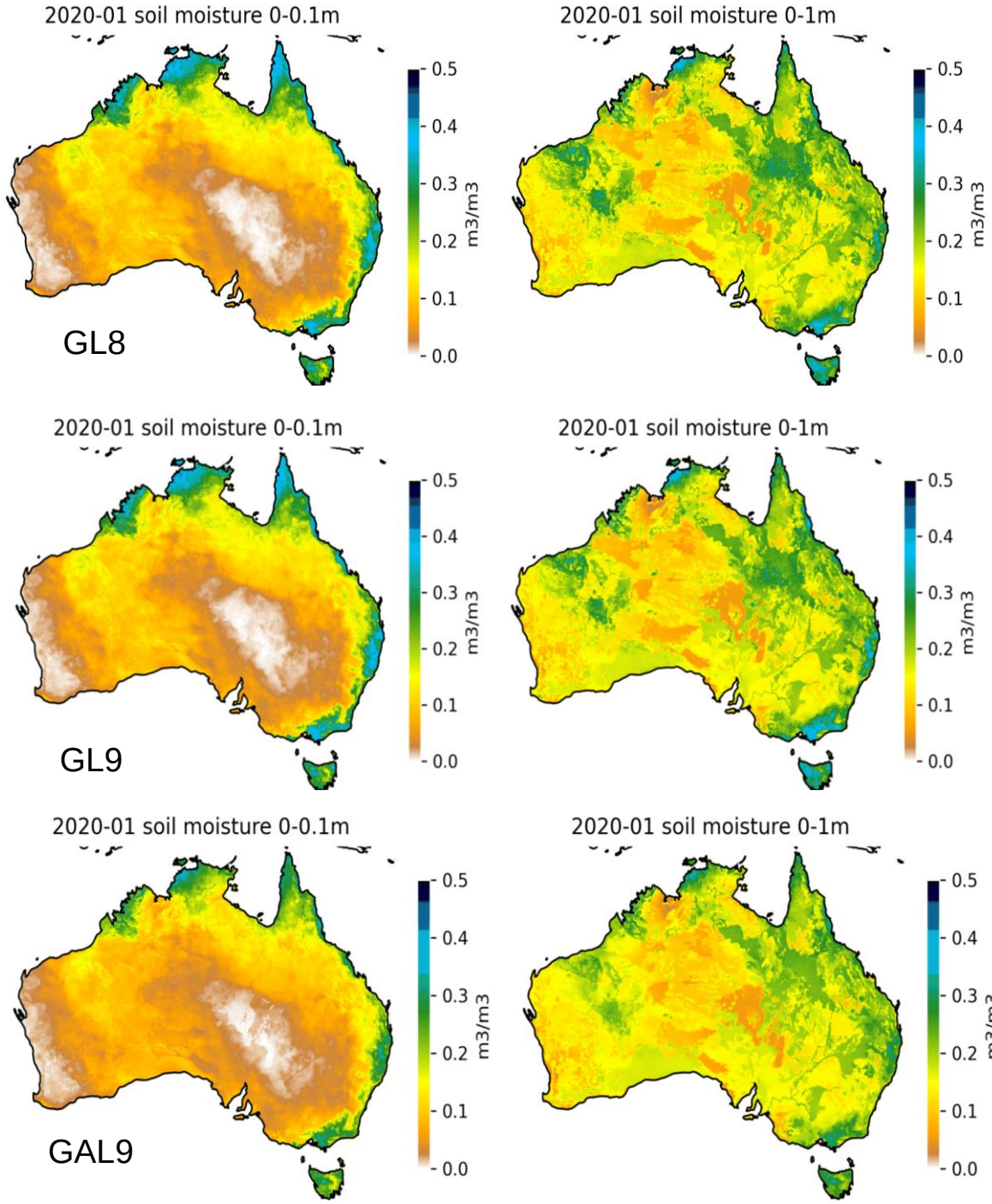
Model Configuration

Version: v7.2 (just upgraded to v7.3)

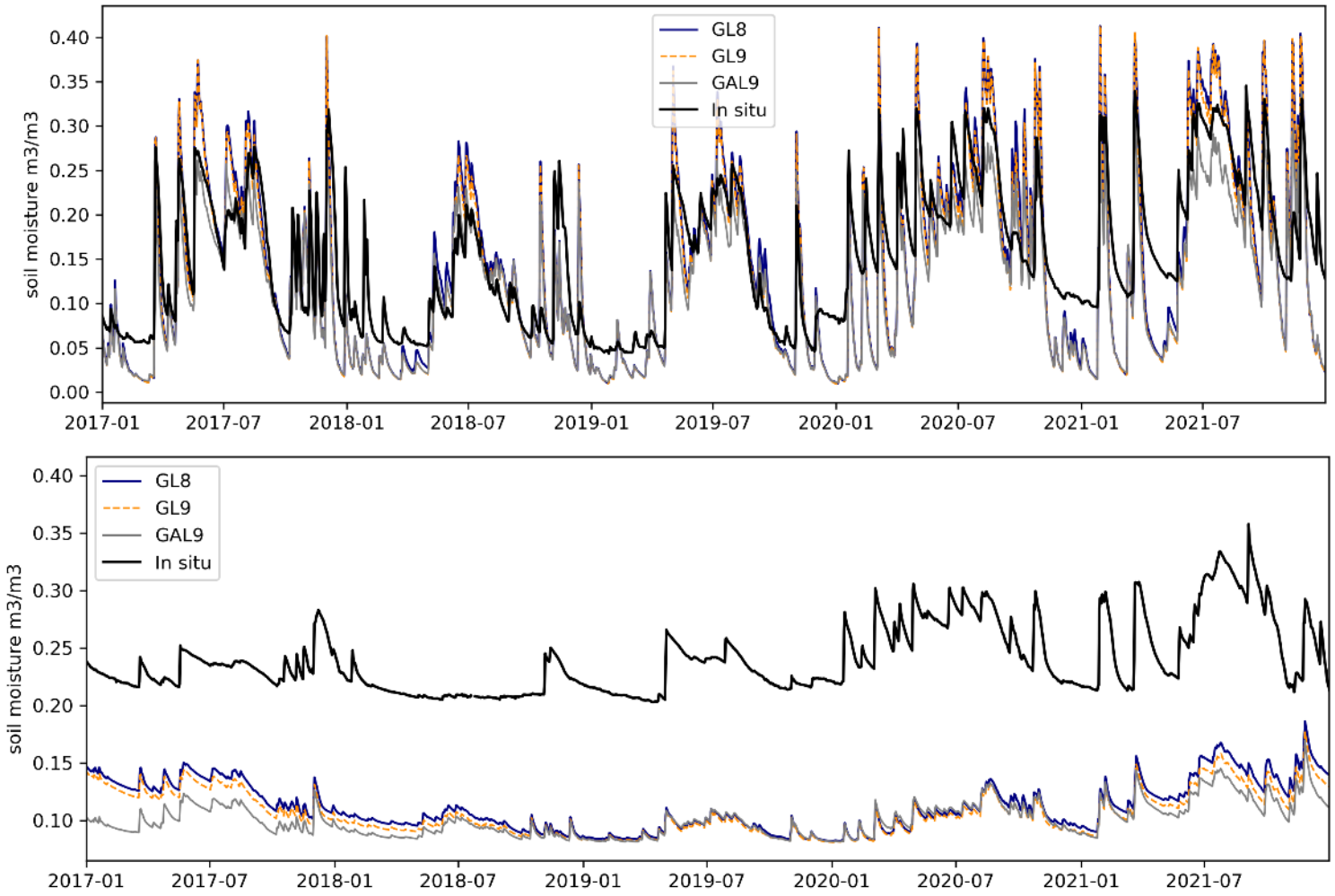
Science configurations: GL8, GL9, GAL9

Forcings: rainfall, snowfall, air temperature, surface pressure, solar radiation, thermal radiation, specific humidity, windspeed

Ancillaries: soil properties, topographic index, land cover fractions, LAI and canopy heights

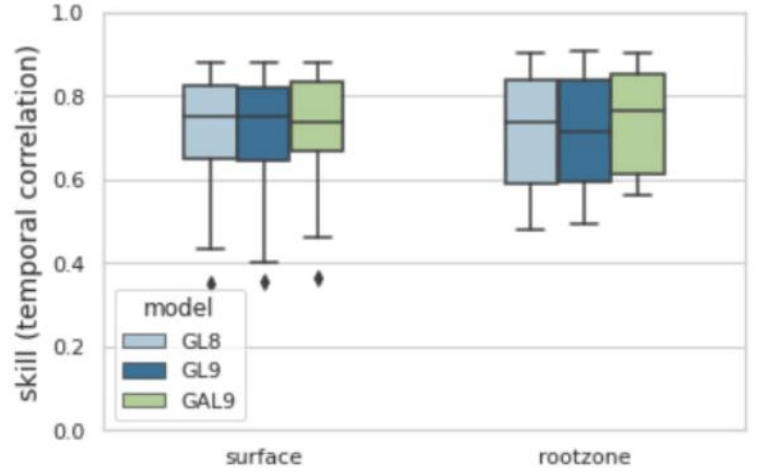


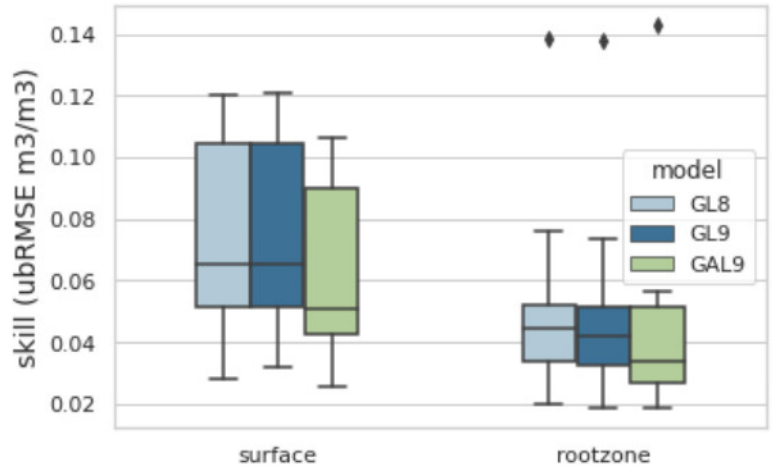
Model Configuration



Surface (top) and root-zone (bottom) soil moisture simulations from JULES at Yanco site

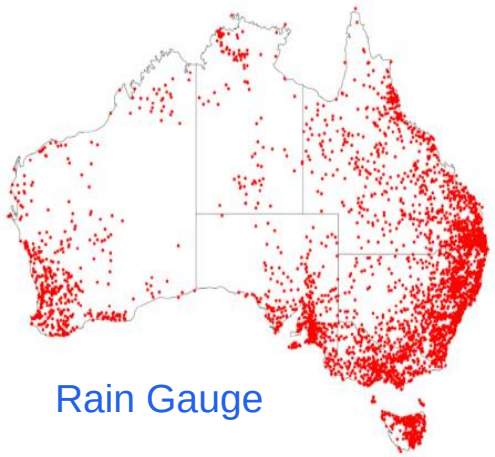
Validation with OzFlux observations



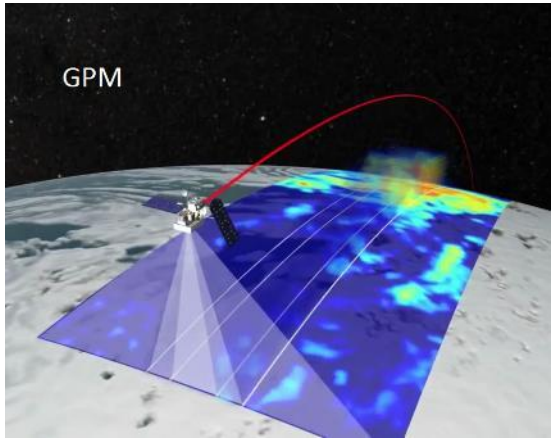


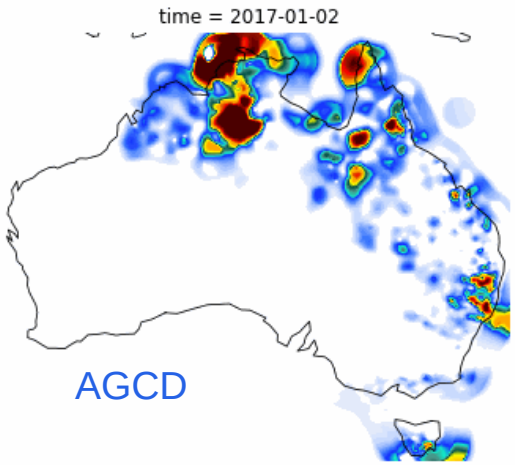
GL8/GL9: van Genuchten model
GAL9: Brooks and Corey model

Forcing data

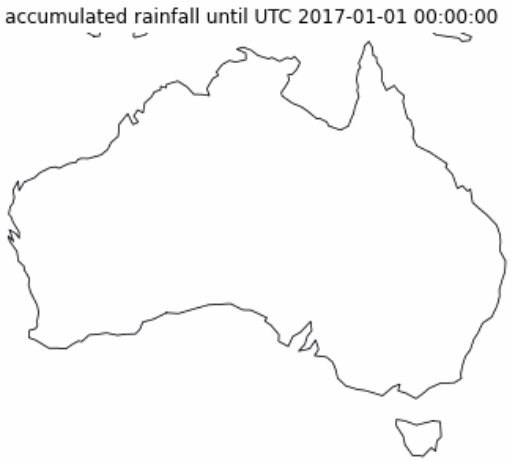


Rain Gauge

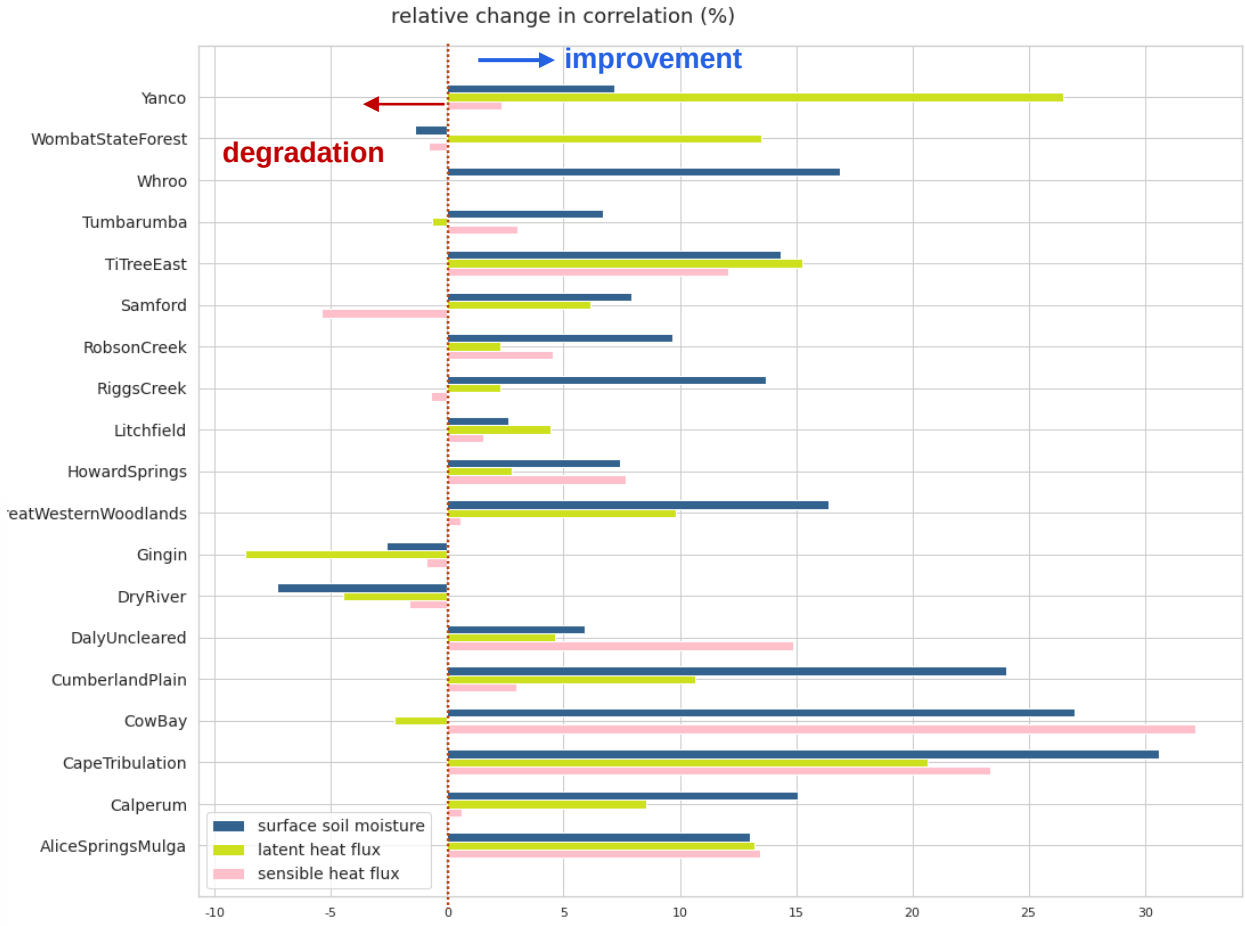




AGCD



Precipitation: AGCD (Australian Gridded Climate Data)+GPM (Global Precipitation Measurement)

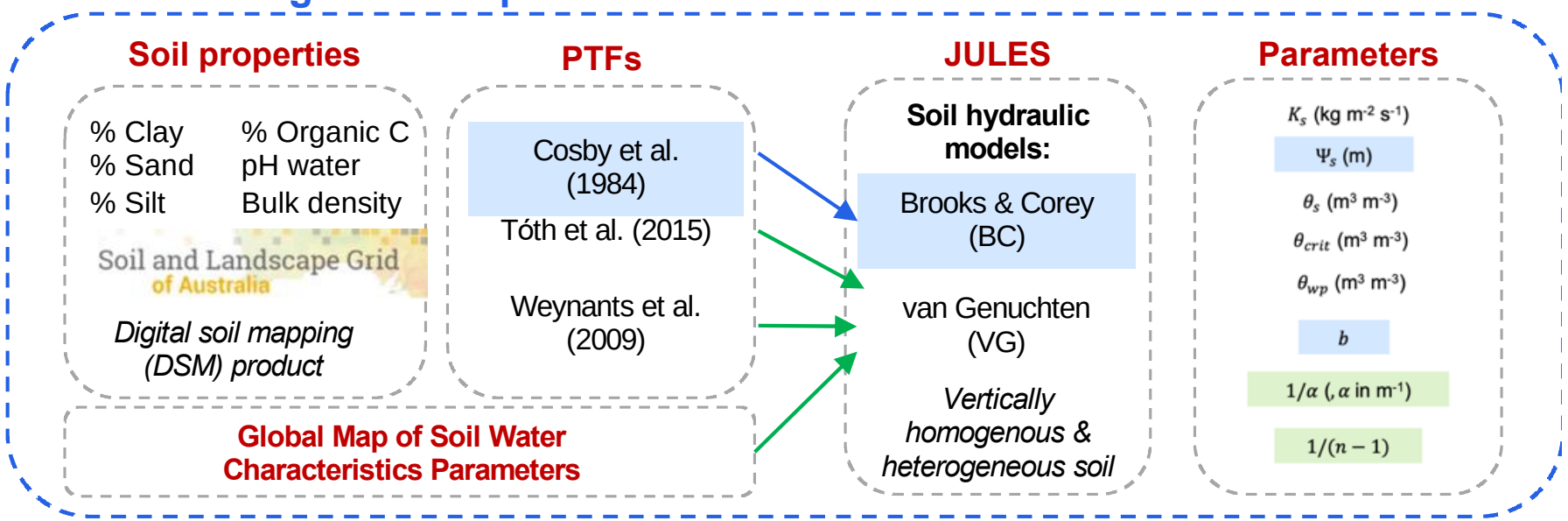


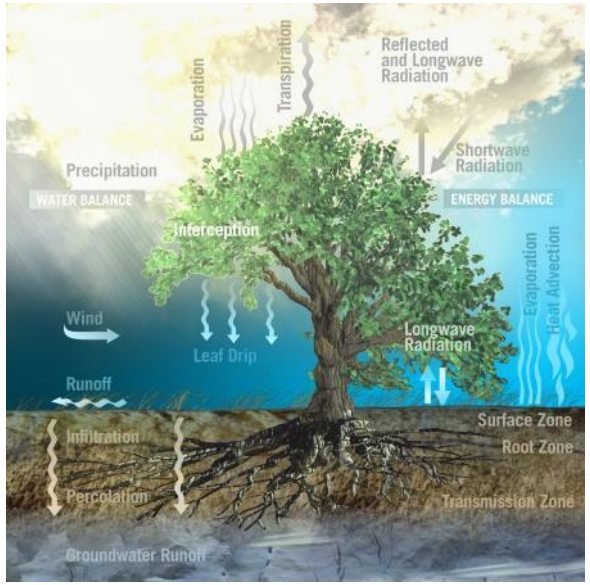
improvements in surface soil moisture, latent heat flux and sensible heat across majority of sites

Soil Physics and Vegetation Modelling

Soil properties, vegetation attributes (e.g., rooting depth), and land-use patterns jointly shape water, energy, and carbon fluxes, also affecting extreme events such as heat waves and droughts

Soil configurations options





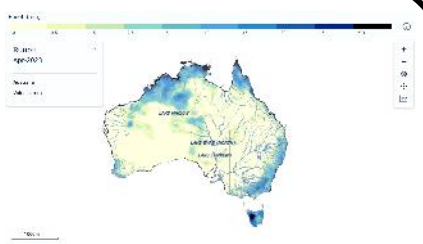
Source: European Space Agency

Vegetation Modelling

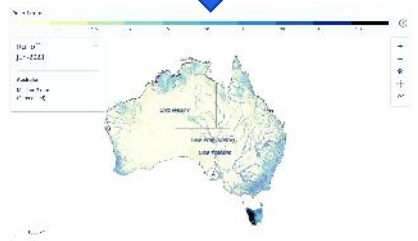
- More PFTs
- Parameterizations of interactive model
- Rooting depths
- Dynamic land cover changes

Probabilistic Flood Inundation Mapping (ProFIM) Modelling Chain

Across disaster management timeline

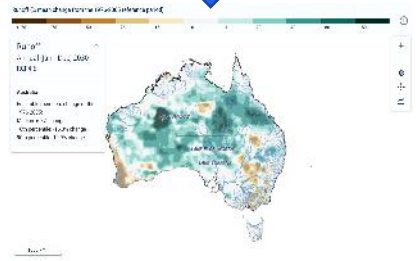


Reanalysis & Historical



Forecasts

a few days to seasons

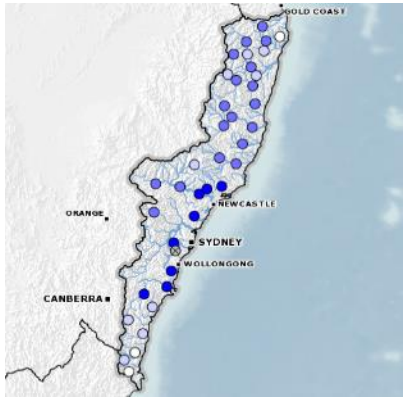


Projections

years to decades

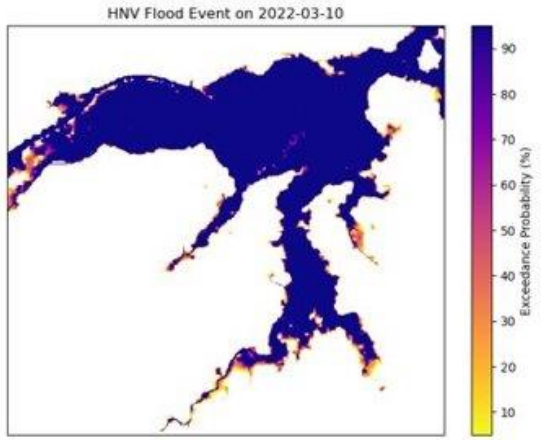
Products - National Coverage

Gauge PoE

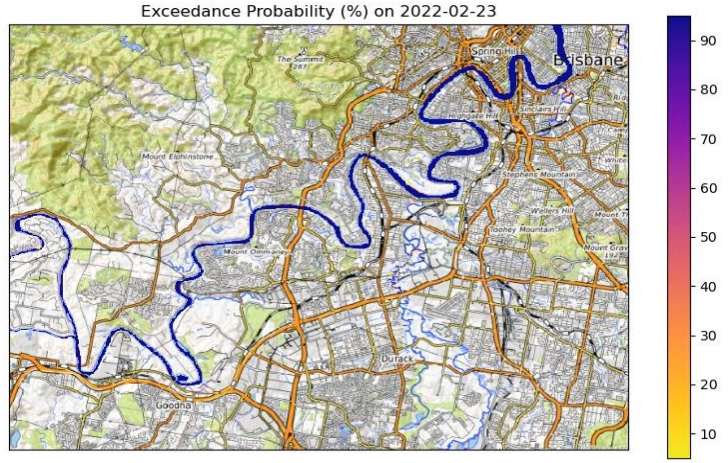


5% 25% 50% 75% 95%

Flood Inundation Probability

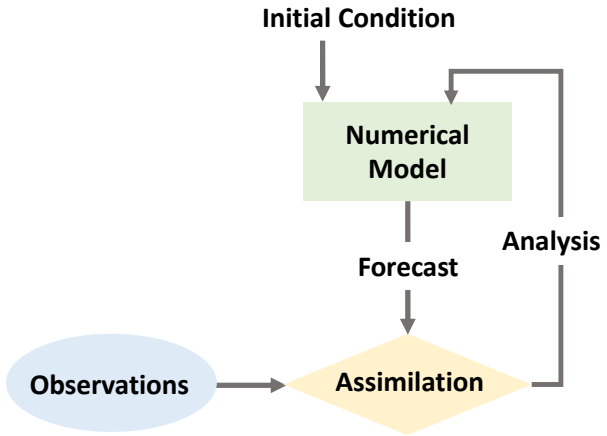


Modelled Flood Evolution

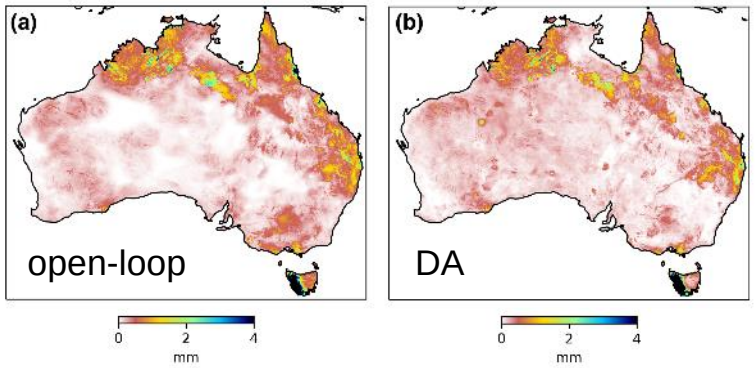


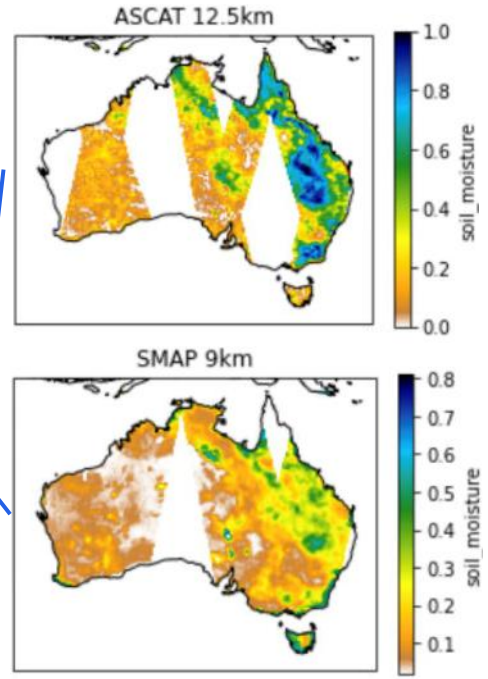
Land Data Assimilation

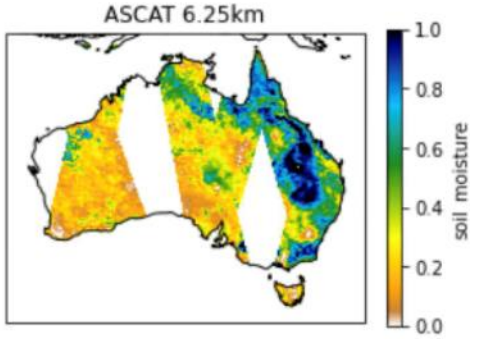
Assimilation of satellite soil moisture and leaf area index



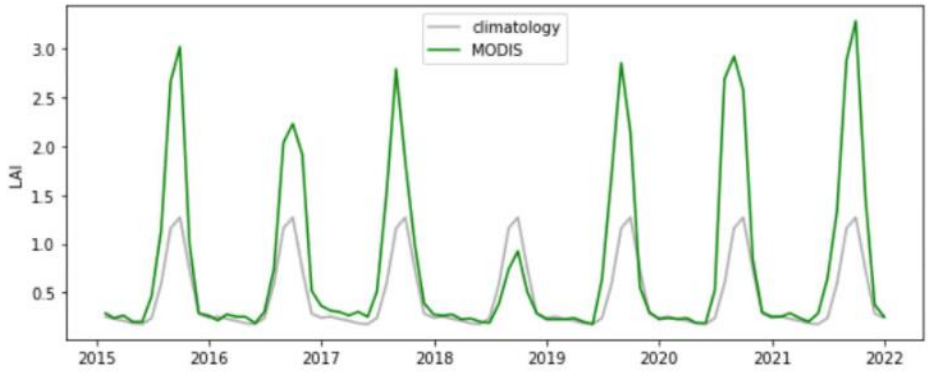
surface soil moisture estimation





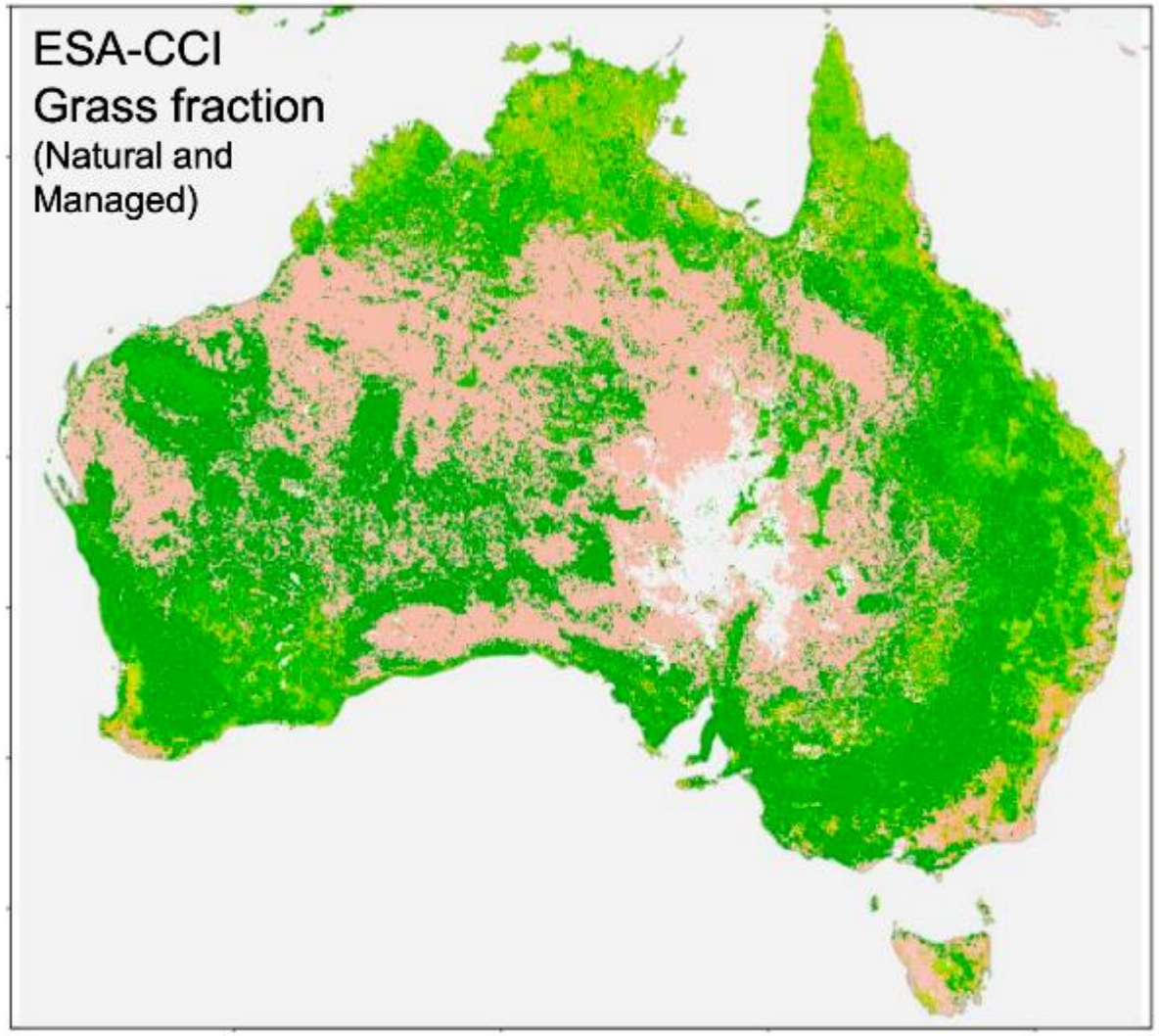


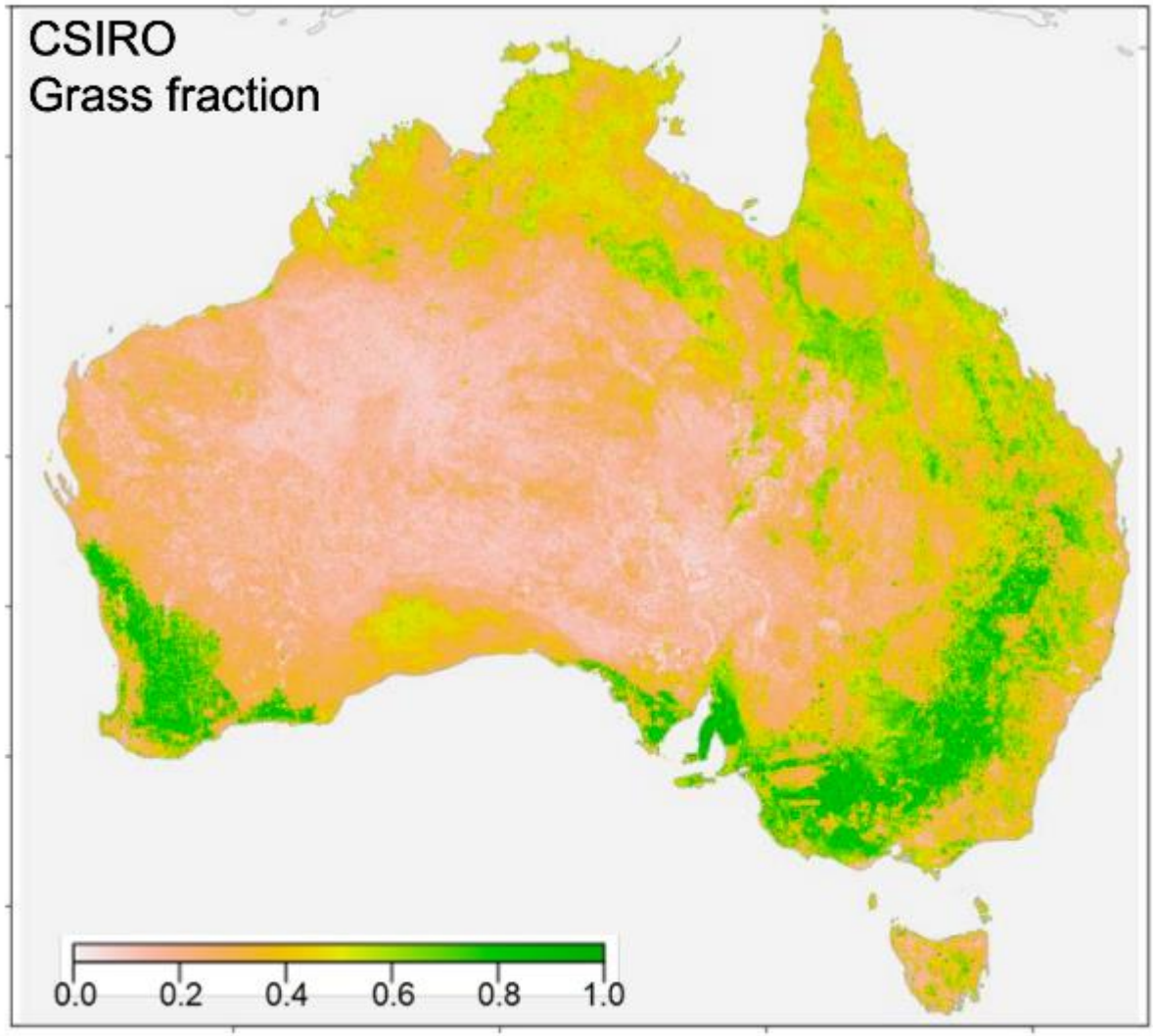
Assimilation of high-resolution ASCAT in offline and coupled model



Assimilation of high-resolution LAI to replace the prescribed LAI dynamics

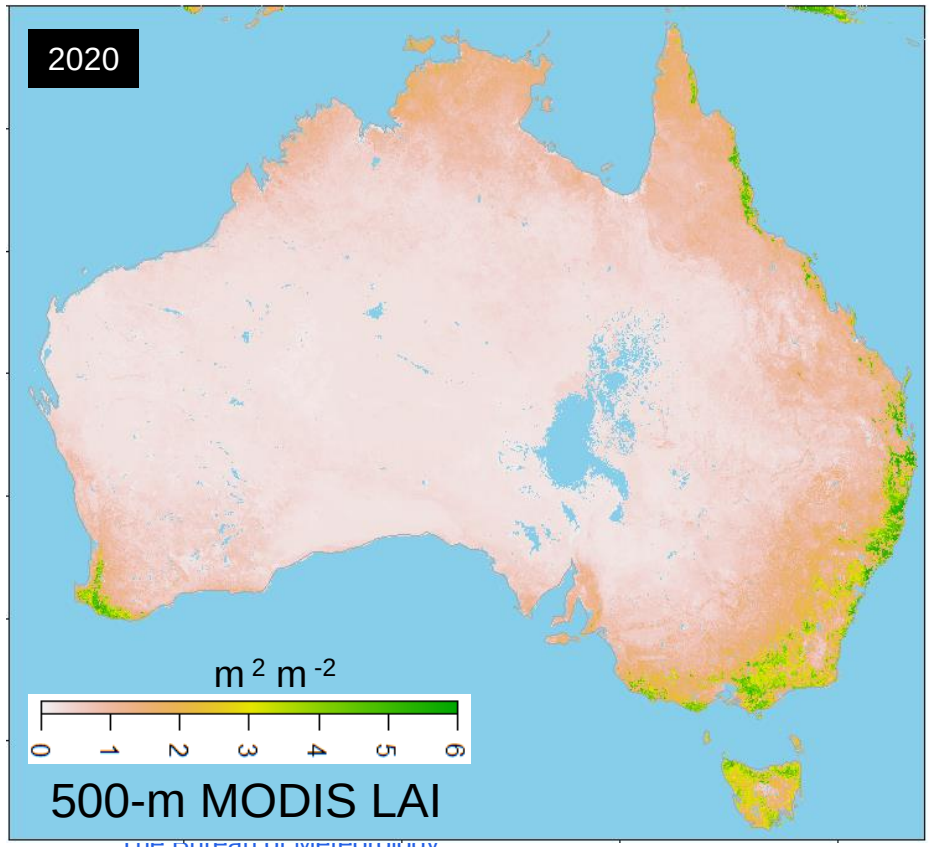
Modification of PFTs for Australia

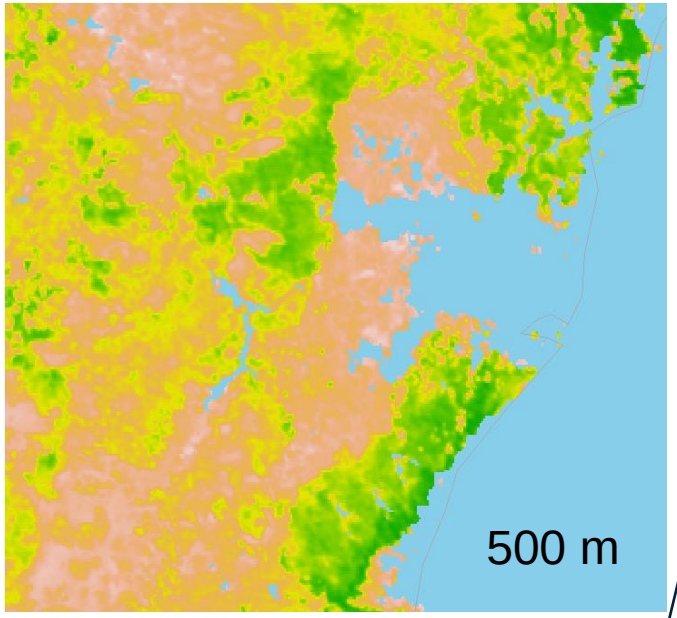


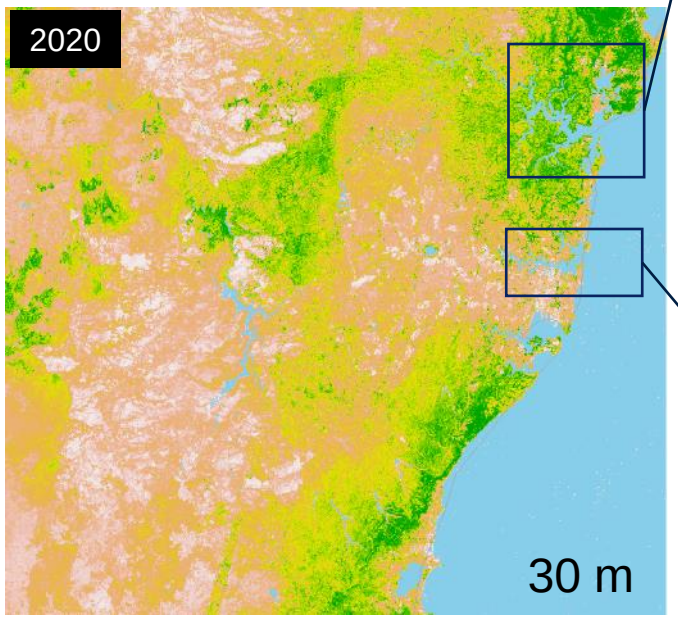


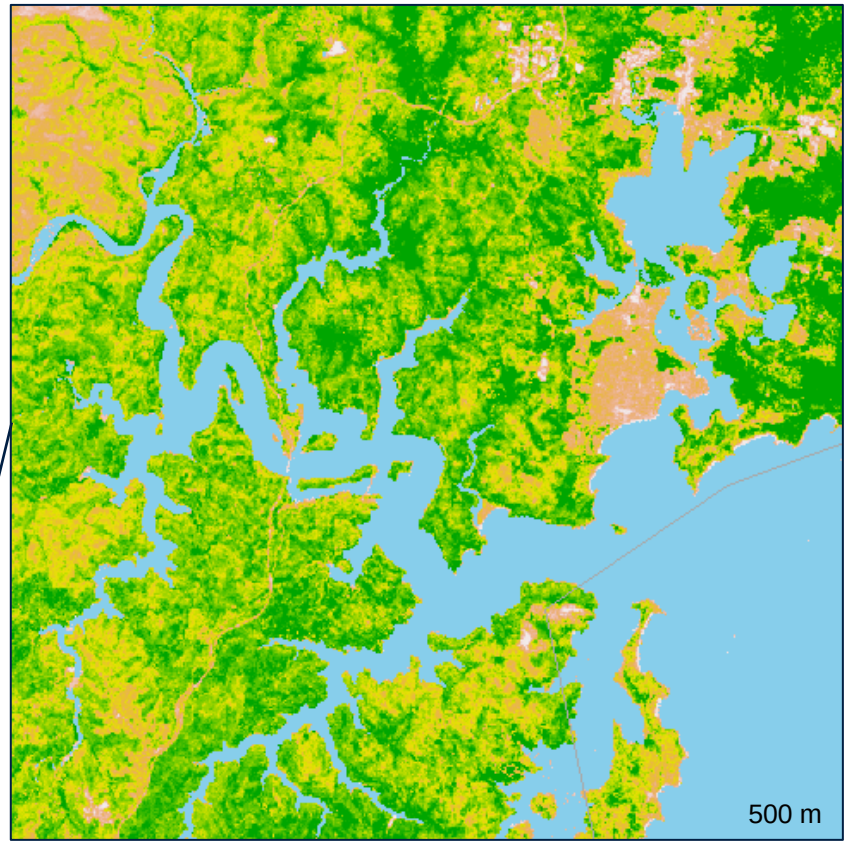
High resolution LAI for urban-scale modelling

- derived from Landsat 30-m PV fraction









Summary

Physical Modelling

- Adapt vegetation and introduce new types
  - Increased use of EO for parameterisation
  - Produced a new PFT map for Australia
  - Updating LAI climatologies
- Soil physics
  - Test different physical models
  - Link parameters to soil maps
  - Heterogeneous soils
- Earth Observation data
  - Validation and evaluation
  - Increased Land DA
- Urban modelling
  - Hydrology and vegetation
- Routing
  - Continuous and continental scale
  - Coupling (land-atmosphere, ocean)
- Offline and fully coupled
  - Offline, quicker (regional) implementation
  - Coupled, through UM Partnership

Ancillaries

- Soils
- Vegetation
- LULC (annually updated)
- High-resolution urban

Benchmarking

- Gridded and point-wise

The Bureau of Meteorology

Thank you

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