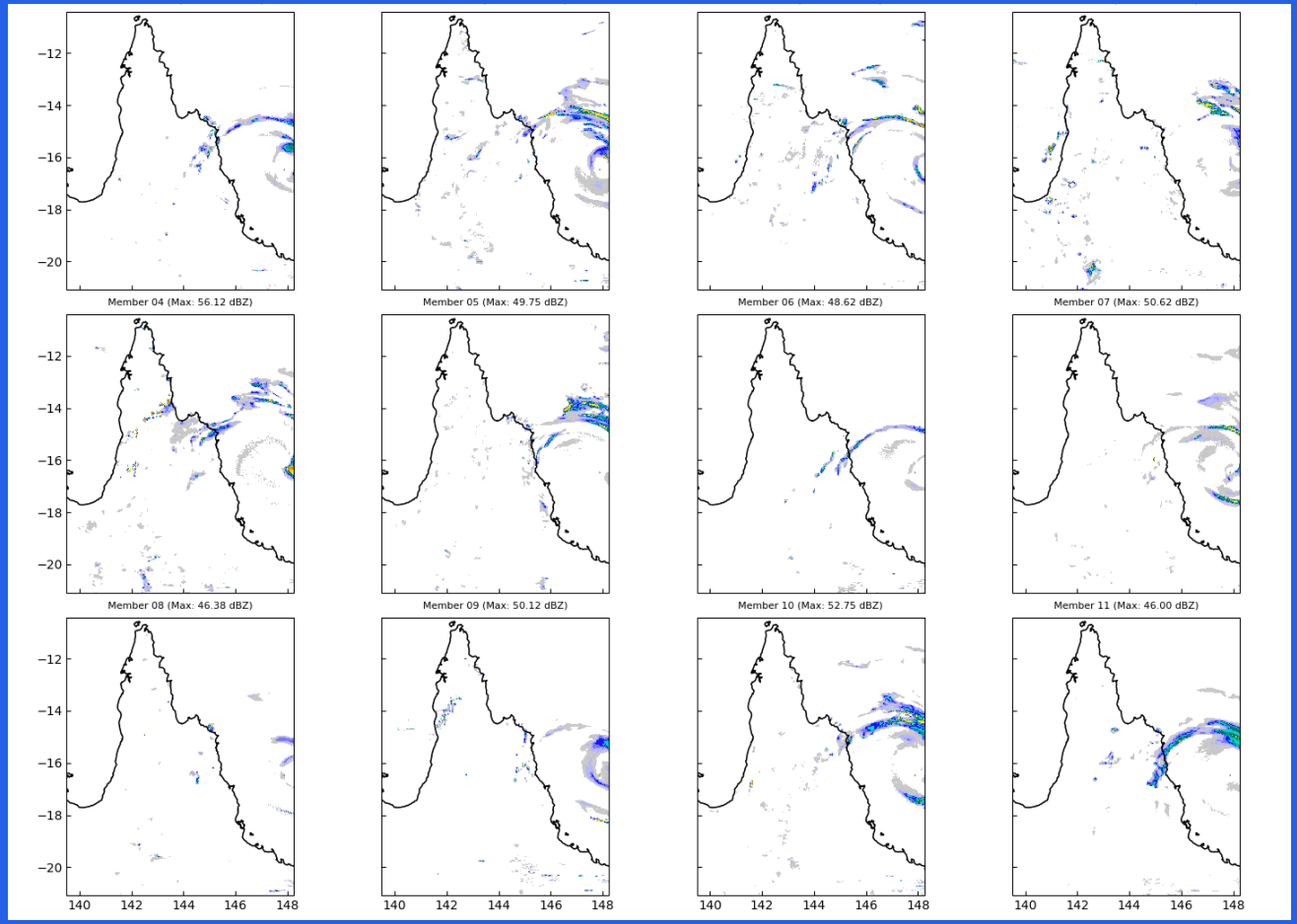
The Bureau of Meteorology

RAL3 Implementation at the Bureau



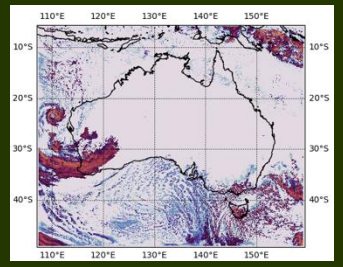
Charmaine Franklin

Belinda Roux, Chris Bladwell, Christian Stassen, Chun-Hsu Su, Emma Howard, Frank Colberg, Greg Roff, Harvey Ye, Mika Peace, Shaun Cooper, Susan Rennie, Vinod Kumar plus many others especially from the DA Team, Satellite DA Team, Next Gen Modelling Team

Regional convective-scale modelling activities at the Bureau

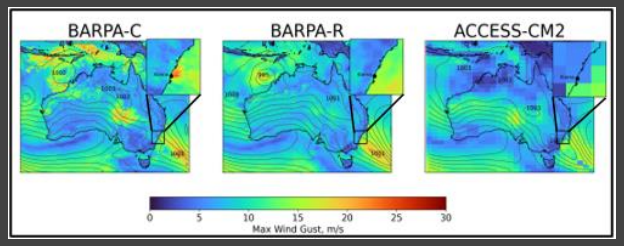
Short-range weather prediction

Advance regional hazard forecasting capability on weather timescales



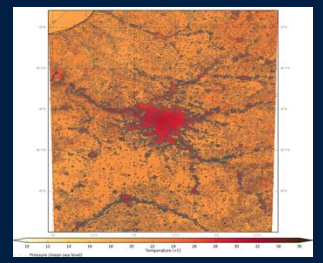
Climate projections & reanalysis

Advance regional hazard forecasting capability on climate timescales



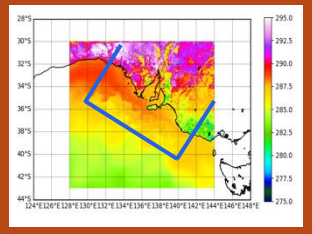
Urban-scale

Support improved weather predictions and warnings on neighbourhood scales



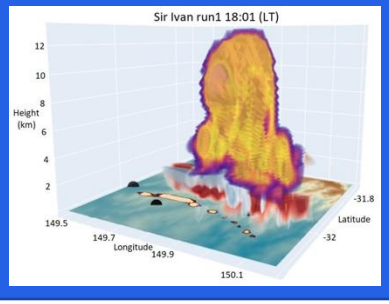
Regional coupled modelling

Developing prediction systems for multi-hazard compound events and future weather and climate systems



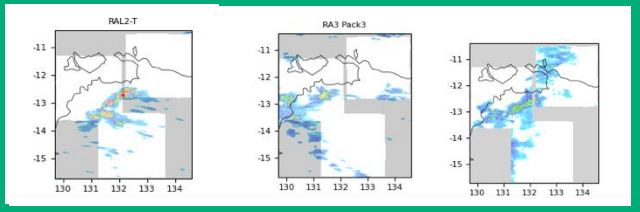
Coupled fire model

Research atmosphere-fire interactions to understand fire behaviour



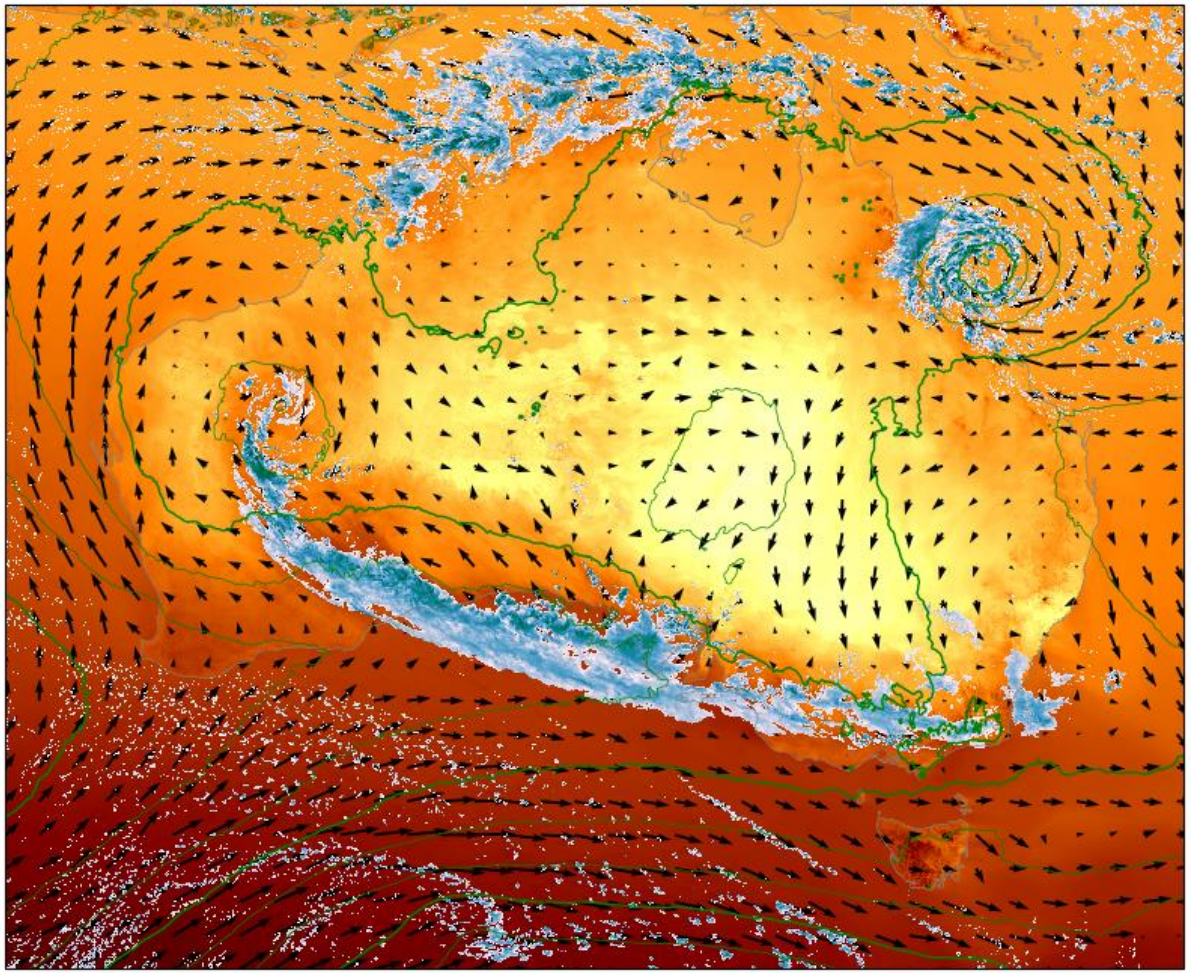
Regional model development

With the Partnership to test improved model configurations that underpin regional NWP and climate



ACCESS-A

- NWP system at 1.5km across Australia,
- Hourly 4D-Var, assimilating a wide range of conventional, radar and satellite observations, with land DA and large-scale blending
- Supports National Analysis System
- Nested in ACCESS-G
- RAL3.2 science configuration

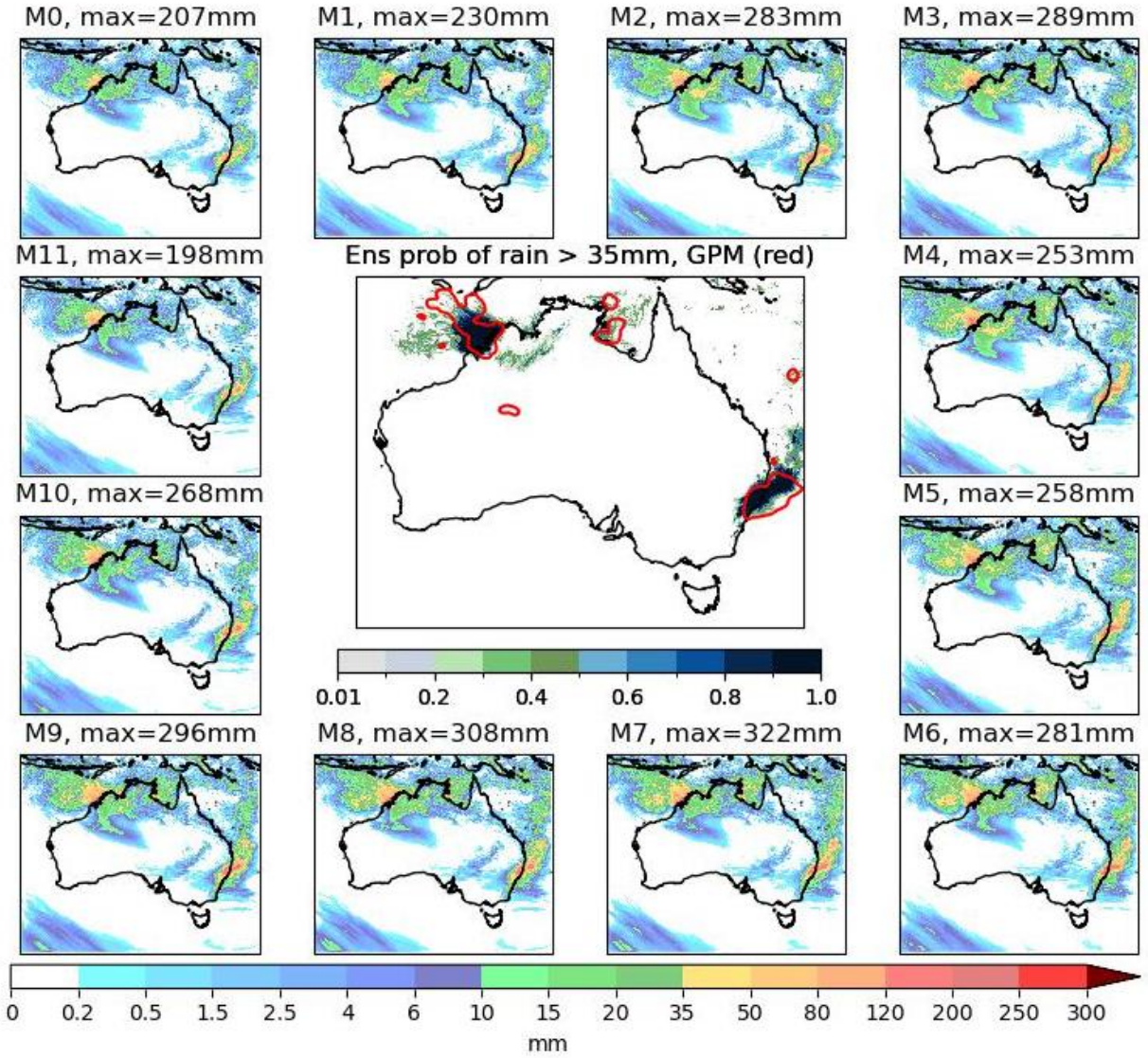


Roadmap:

1. Initial version configuration ready mid-2025
2. Operational in 26/27 FY

ACCESS-AE: national convective scale probabilistic forecasts

- The ACCESS-AE storm-scale ensemble system quantifies uncertainties in the forecast and enables the probabilistic prediction of higl impact events.
- 2.2km grid length, 12-member ensemble
- RAL3.2 science configuration that includes more complex moist physics
- Will be nested inside ACCESS-GE4



Roadmap:

1. Testing science configuration with new RP scheme 2024
2. Initial version configuration ready mid-2025
3. Operational in 26/27FY

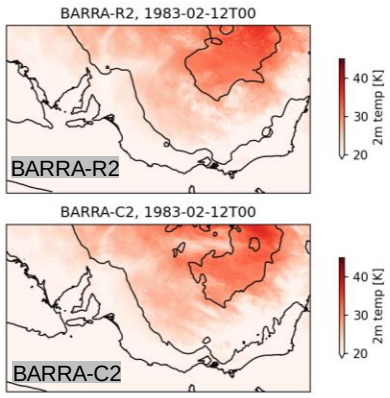
Downscaled regional reanalysis BARRA-C2

- 4.4 km, L70/40km, short hindcast to +12h across Australia
- Nested in BARRA-R2 12km 6-hourly 4D-Var analysis (nested in ERA5)
- RAL3.2 science configuration & improved land cover following ACCESS-A

Roadmap:

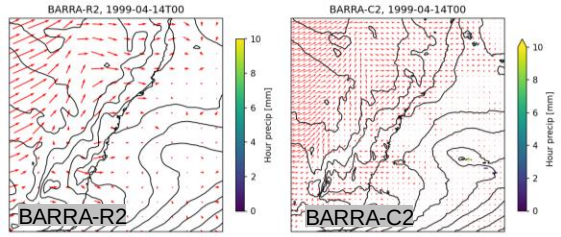
1. The suite of BARRAv2 product is being updated forward in time; historical production completed
2. Next version BARRAv3 to focus on convective-scale DA nested in ERA6

Ash Wednesday | FEB 1983



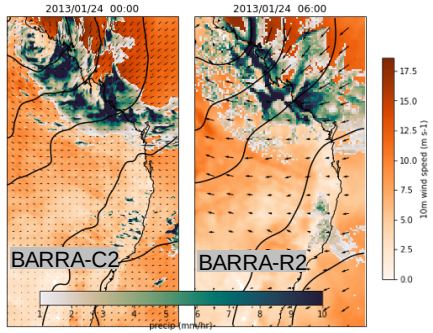
(Temperature, MSLP)

Sydney Hailstorm | APR 1999



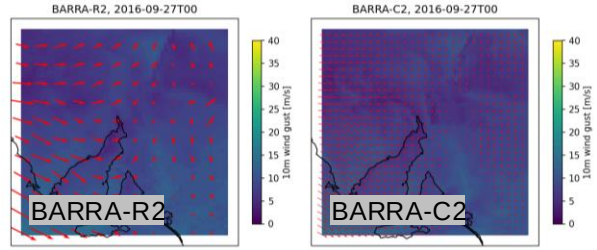
(Precipitation, 10m wind, MSLP)

TC Oswald | JAN 2013



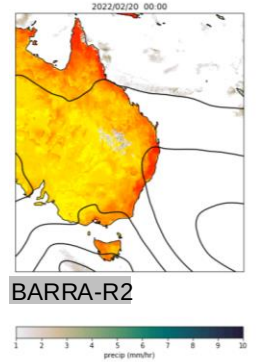
(Precipitation, 10m wind, MSLP)

South Australian Black Storm | SEP 2016



(10 m wind gust, 10 m wind vector)

East. Aus. Floods, FEB 2022



(Precipitation, MSLP, Soil moisture)

BARRAv2 providing 45-year of high resolution reanalysis from 1979 at 4.4 km across Australia

BARPA-C Climate Projections

- 4.4km forced by BARPA-R 17km nested in Global Climate Models
- UMv13.0, RAL3.2 configuration with local ancillary changes based on ACCESS-A (NWP)
- Greenhouse gases, volcanic and EasyAerosol radiative forcing
- Spectral nudging: 12-hour timescale, 1500 km length-scale, U, V, T above boundary layer

Roadmap:

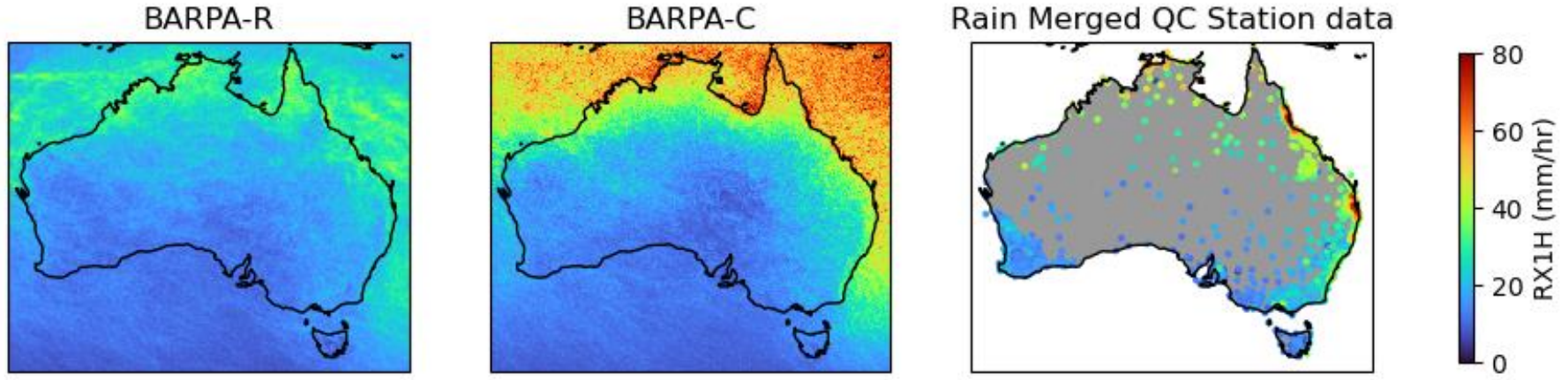
Research simulations

- ERA5 evaluation experiments (2023-24)
- CMIP6 Time slice experiments (historical, SSP370) downscaling EC-Earth3 and ACCESS-ESM1.5 (2024-25)
- Configuration testing and experimental design sensitivity (2025–27)
- Downstream hazard index development (2025-27)

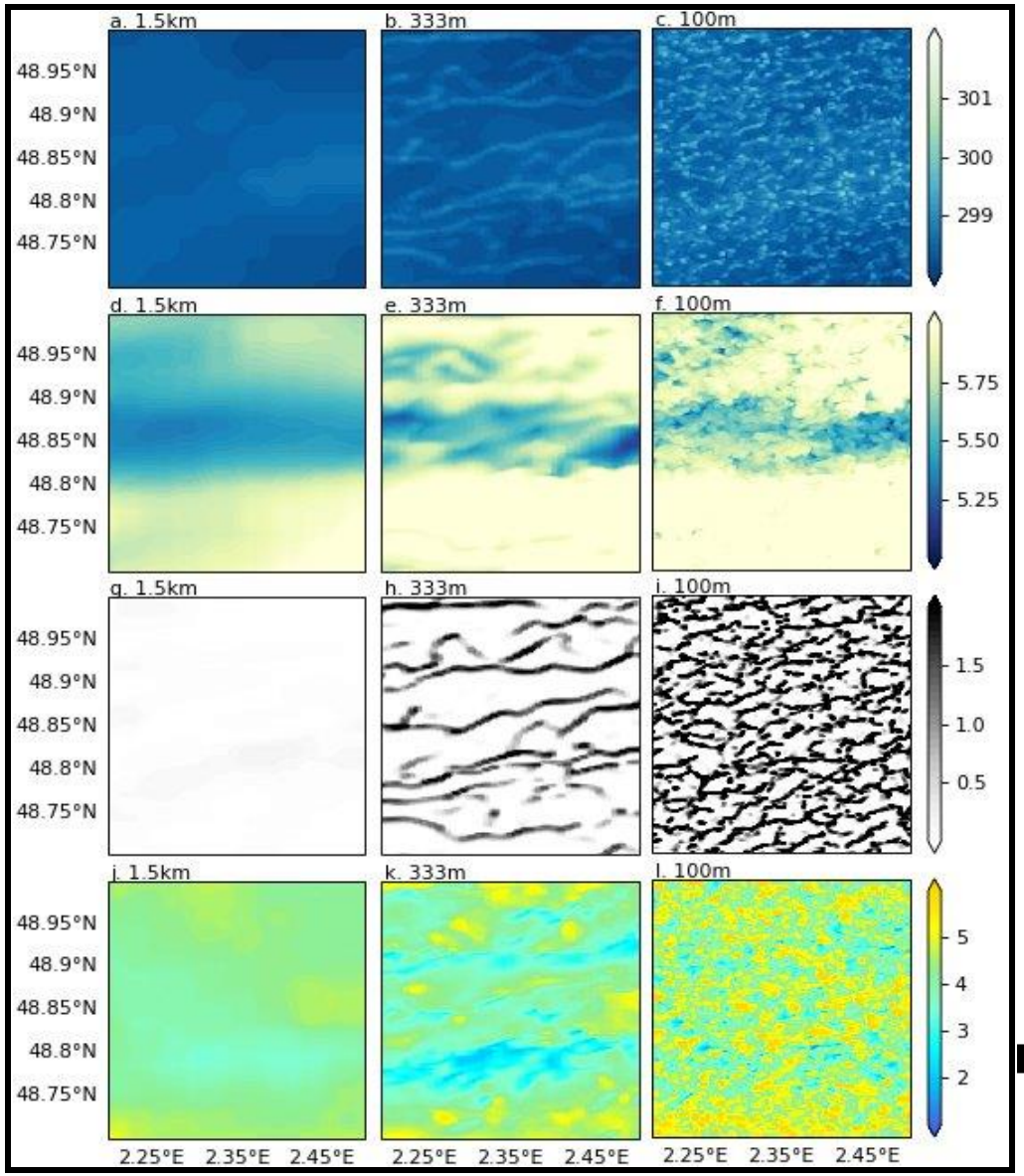
Production (TBC)

- Transient downscaling of CMIP7 fast track experiments (2027 onwards)

Step change improvement in representation of annual max hourly precip (RX1H)



Urban-scale Modelling: Paris Olympics Research Demonstration Project



- Research system – developed for RDP model inter-comparison exercise.
- Three one-way nested domains:
  - 1.5km, L70/40km, 900 x 600 grid
  - 333m, L140/40km, 1800 x 1200 grid
  - 100m, L140/40km, 2000 x 2000 grid
- RAL3.1 + MORUSES, 36-hr forecast
- Updated urban ancillaries

Roadmap:

Focussing on heat events

- New case studies in 2023, 2024.
- Use latest observations for model evaluation.
- Assist with model intercomparison.

Potential temperature in Kelvin (top panel), Specific humidity in g.Kg^{-1} (second panel from top), vertical wind velocity in m.s^{-1} (third panel from top) and horizontal wind speed in m.s^{-1} (bottom panel) from 1.5km, 33m and 100m experiments valid on 16th July 2022 12 UTC.

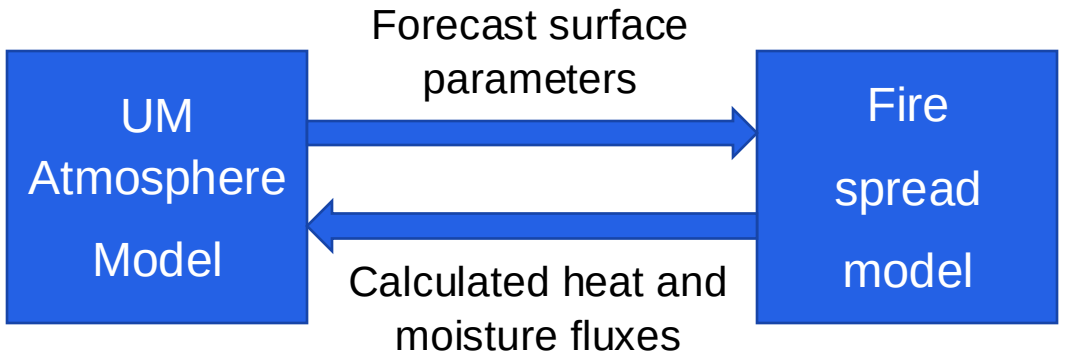
ACCESS-Fire: coupled fire-atmosphere model

- Research model: developed to study fire-atmosphere interactions and the impacts on fire behaviour.
- Initialised with ACCESS-G. Finest resolution (with fire coupling turned on) 300m or 100m.
- RAL3.2 science configuration with updated land cover ancillaries.

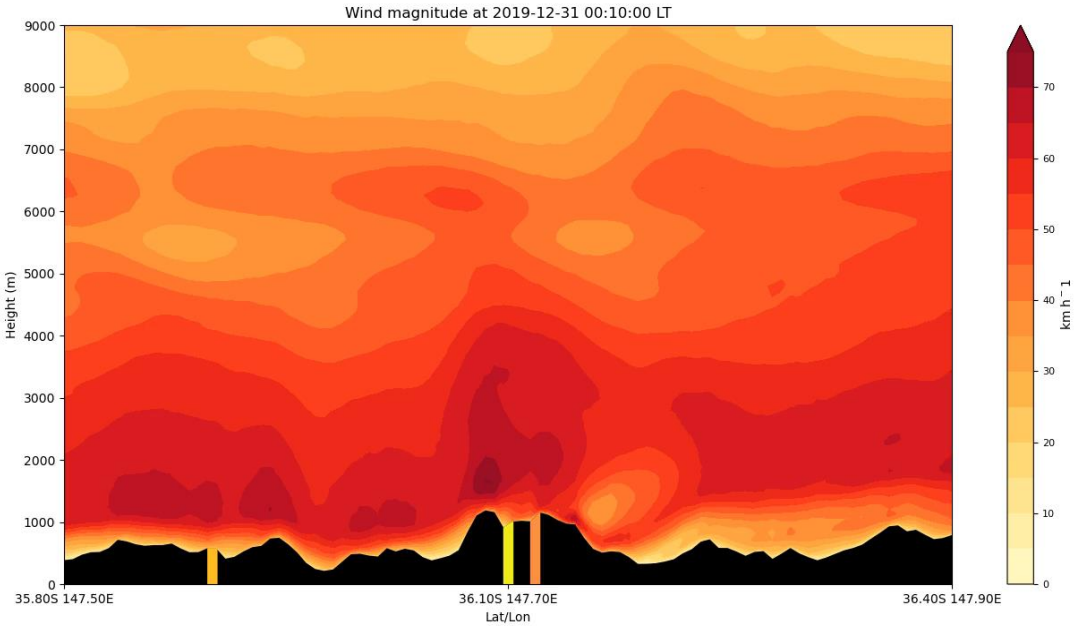
Roadmap:

- Has been run on 10 fire case studies, with many key fire-atmosphere interactions and unexplained fire behaviour resolved.
- The fire-coupling code is being prepared to be included in the UM (JULES) trunk, possibly by mid-2025.

Basic structure of ACCESS-Fire

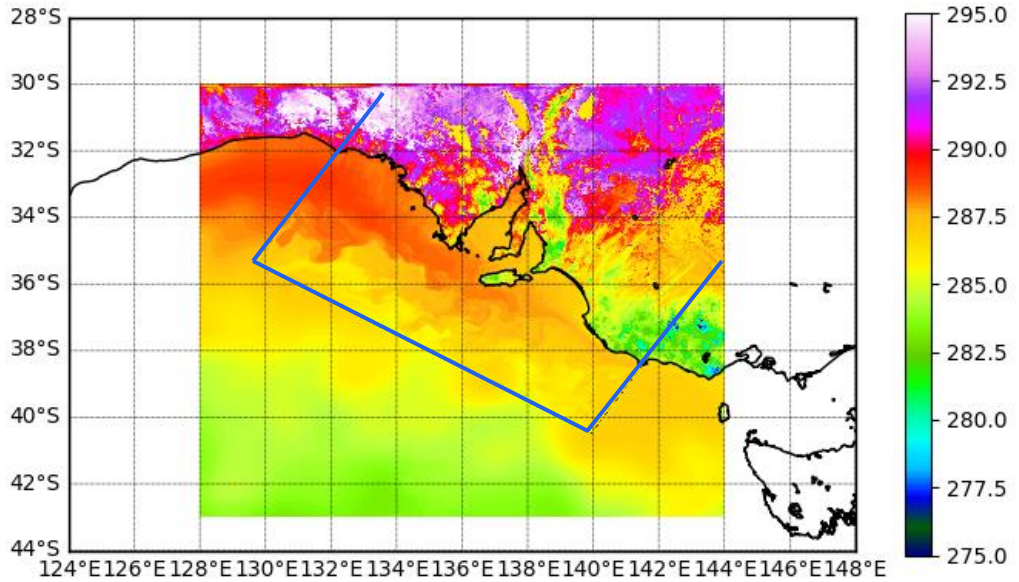


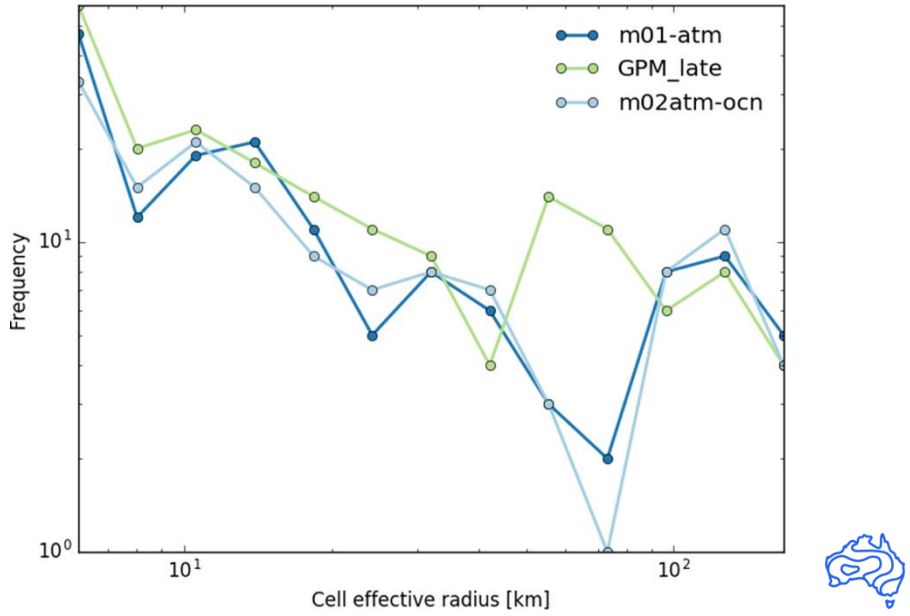
Nocturnal low level jet impacting the Corryong fire



Regional Coupled System over South Australia

- *Ocean* - **NEMO 4.0.4**
  - 2.5 km horizontal resolution, rotated grid
  - 31 vertical levels (s-sigma coordinates)
- *Atmosphere* – **ACCESS-City** (UM 12.2, RAL2M)
  - South Australian configuration
  - 1.5km horizontal resolution
  - 80 vertical levels
- First regional coupled system using the **RCS** over Australia



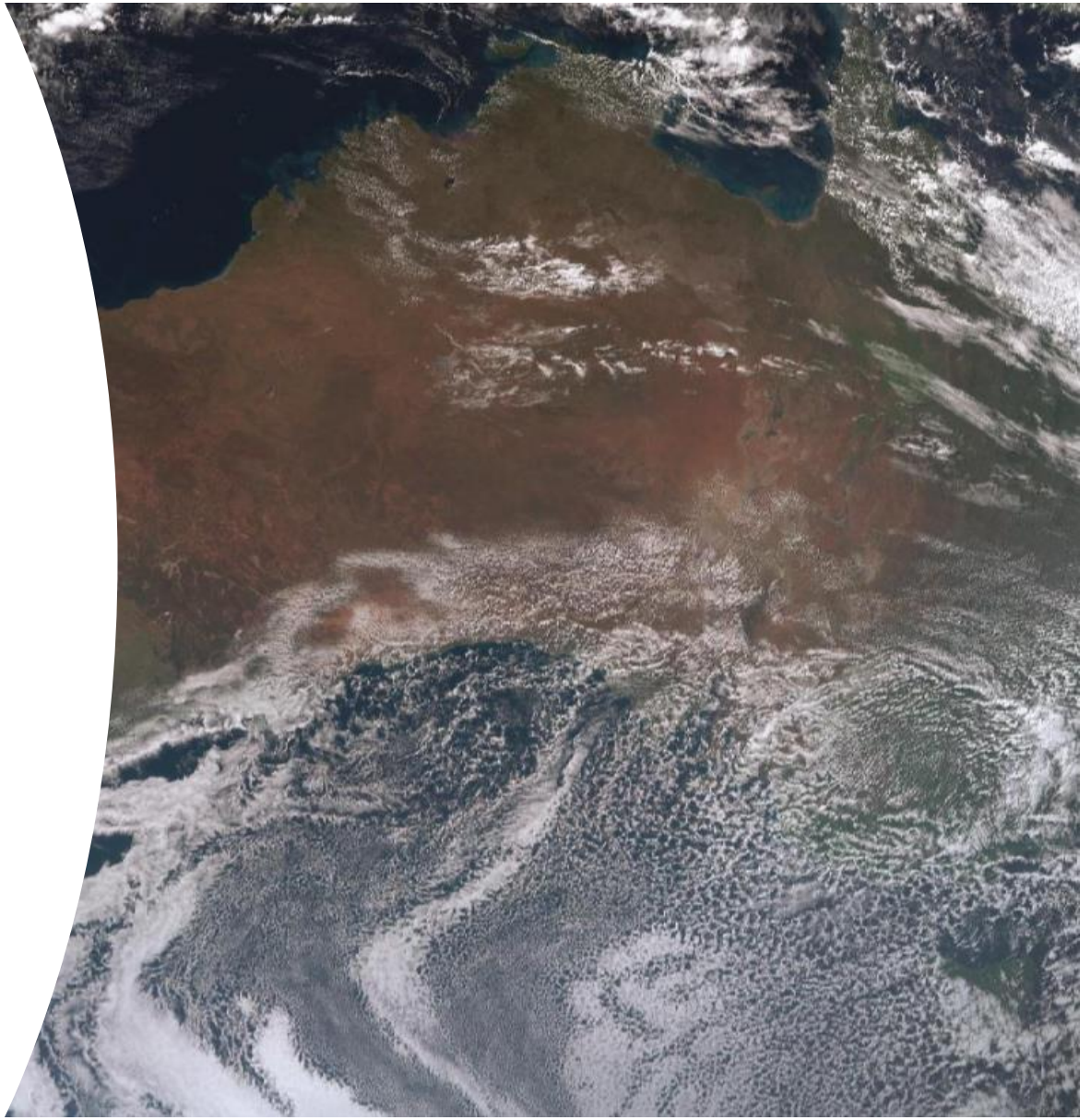


Roadmap:

1. 2023-2024 first prototype ocean-atmosphere coupled model developed
2. 2024-2025 adding wave coupling and develop a new domain over the NW Shelf

Summary

- Regional high-resolution (RAL3.2) modelling systems being developed for:
  - Australian national domain for km-scale weather, climate and reanalysis
  - Paris 100m model (in collaboration with the Met Office) for the Paris 2024 Olympics RDP
  - Regional km-scale coupled model for weather forecasting and future climate and reanalysis models
  - Sub-km scale coupled fire model to study fire-atmosphere interactions and fire behaviour
- Collaborating with the Met Office and Momentum Partnership to test and improve model configurations that underpin regional Australian weather and climate prediction



The Bureau of Meteorology

Thank you

Charmaine Franklin

charmaine.franklin@bom.gov.au