Australian Government | Australian Climate Service

BARRA2: Australian Regional Atmospheric Reanalysis

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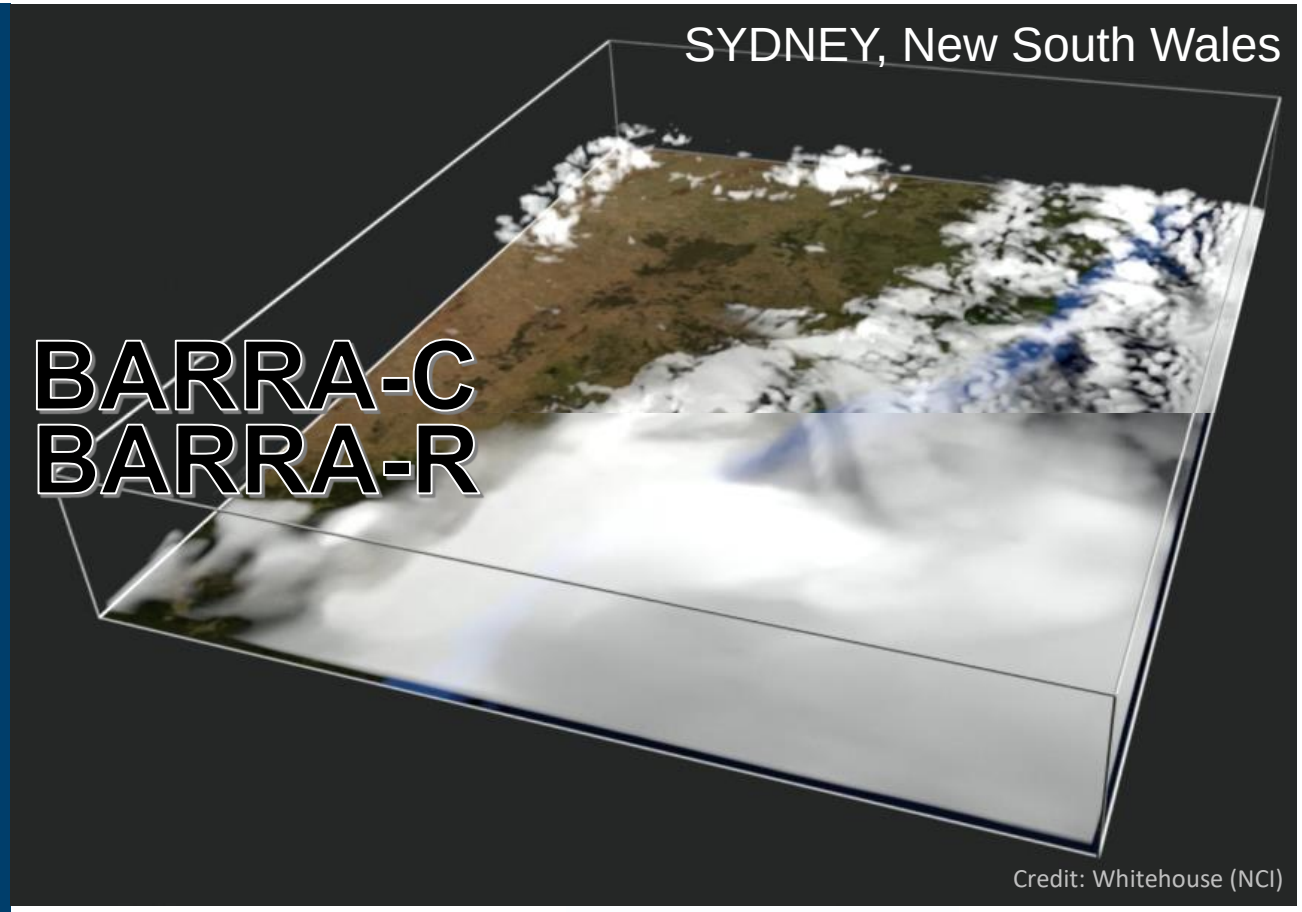
(with contribution from team members & collaborators)

Research Program, Bureau of Meteorology
- Team Leader for Data Assimilation
- Project Lead for Regional Reanalysis
- Science Lead for Regional Climate Projections

25 April 2024



The Bureau of Meteorology

NCI AUSTRALIA

A Short History

2016-2019: BARRA (BoM Atmos. Regional Reanalysis for Australia)

Full-input DA 12km BARRA-R, nested in ERA-Interim.

1.5km downscaler BARRA-C.

"Demonstrator", with Fire Services as primary customers.

2021-2024: BARRA2 – Production Completed

Full-input DA 12km **BARRA-R2/RE2**, nested in ERA5.

4km downscaler **BARRA-C2.**

As an operational product, with Climate Service as primary customers.

Part of establishing seamless capability: climate & hazard modelling, data and intelligence across all time and spatial scales – national, regional & local, past to climate projections.

2026-2028: BARRA-Next

Focus on convective-scale reanalysis, nested in next-generation global reanalysis.

BARRA2 (1979-Present day)

BARRA-R2/RE2 is a 12 km reanalysis (R2) & 24 km 22 lagged-member ensemble (RE2)

- Based on UK Met Office Unified Model for atmosphere & JULES for land surface.
- Based on GA7.2/GL8.1 science with parameterised convection scheme.
- R2 - 6-hourly 4D-Var, nested in ERA5 HRES boundary & SST.
- RE2 – Nested in ERA5 EDA, with EDA perturbations.

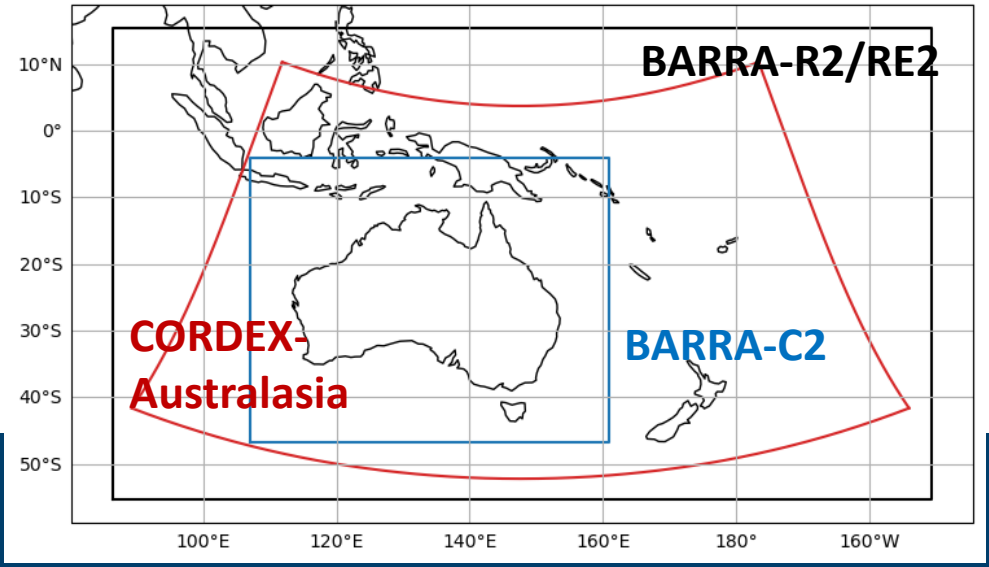
BARRA-C2 is a 4.4 km downscaled reanalysis

- Based on latest RAL3.2 science.
- Nested in BARRA-R2.
- Km-scale physics: Explicit convection, double moment cloud microphysical scheme (CASIM), bimodal cloud scheme.

Comparing BARRA2 with BARRA1

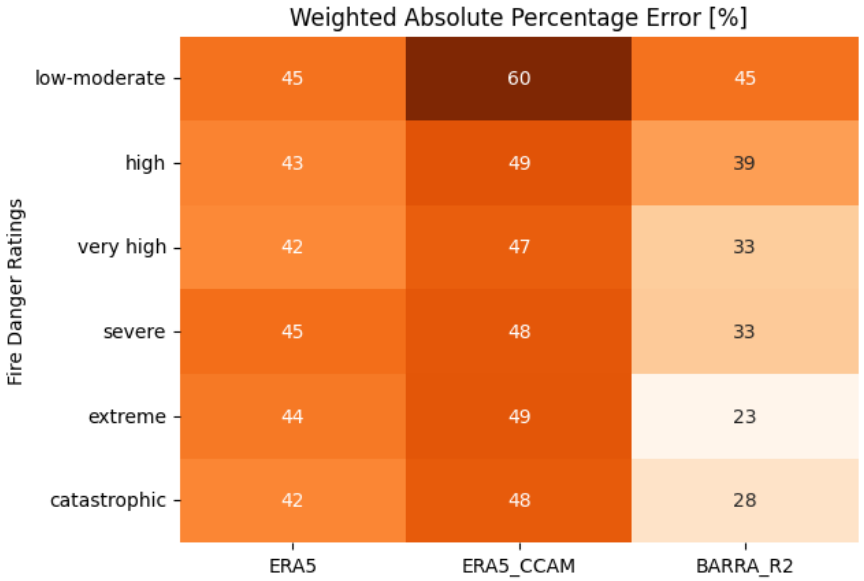
	BARRA2			BARRA (v1)	
	BARRA-R2	**BARRA-RE2**	**BARRA-C2**	**BARRA-R1**	**BARRA-C1**
Final range	1979-present	1979-present	1979-present	1990-2018	1990-2018
Realisations	1	22	1	1	1
Bound. Cond.	ERA5 HRES	ERA5 EDA	BARRA-R2	ERA-Interim	BARRA-R1
Grid Spacing	0.11 deg	0.22 deg	0.04 deg	0.11 deg	0.0135 deg
Assimilation	4D-Var	--	--	4D-Var	--
Domain	CORDEX-Australasia	CORDEX-Australasia	All of Australia	Aus, NZ, SEA	Adelaide, Perth, Sydney, Hobart

BARRA2 domains



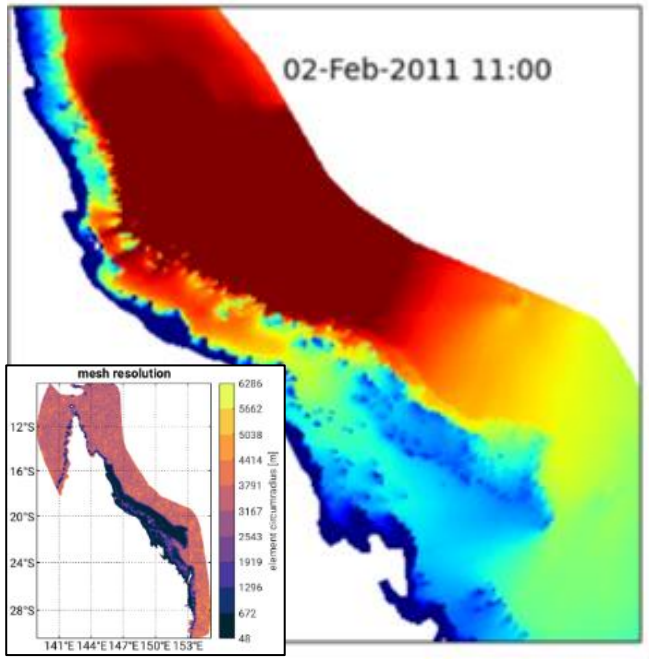
BARRA2 Applications

Fire weather application



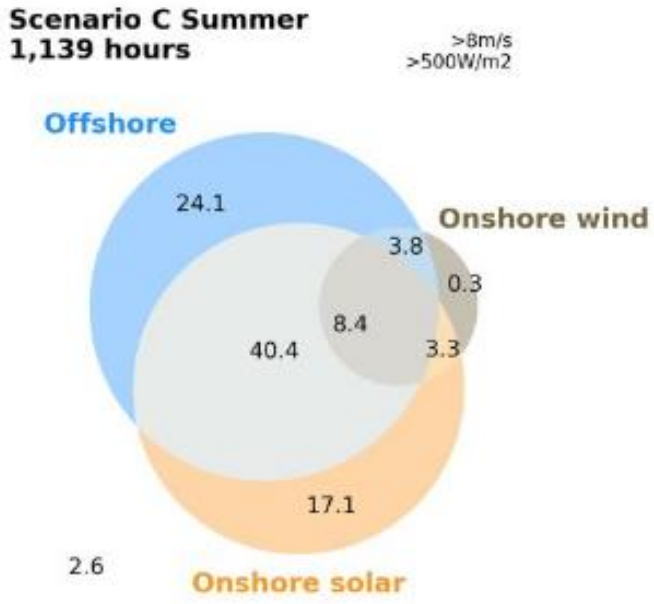
Error in estimating past fire danger rating, showing better capturing the severe to catastrophic levels (Alessio Arena, CSIRO)

Ocean hazard modelling with coupled hydrodynamics/wave model



Simulating wave propagation across Great Barrier Reef during TC Yasi Feb 2011 (Vanessa Hernaman, CSIRO)

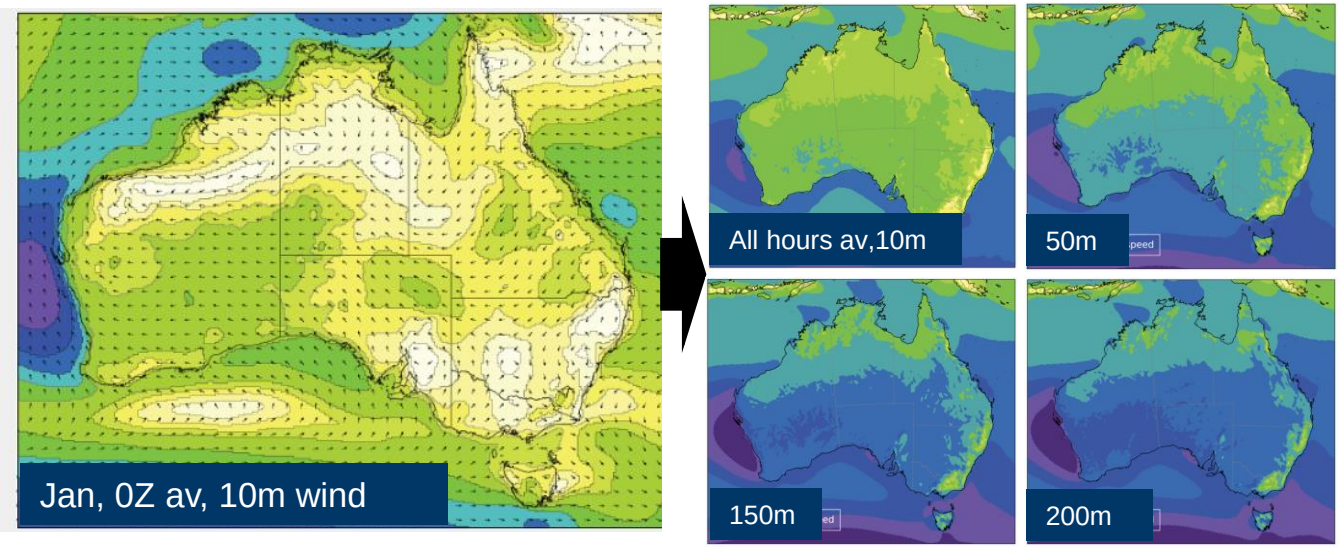
Resource analysis for offshore wind development



Threshold analyses under different scenarios, for advising customers on offshore wind locations (Aurel Griesser, BOM)

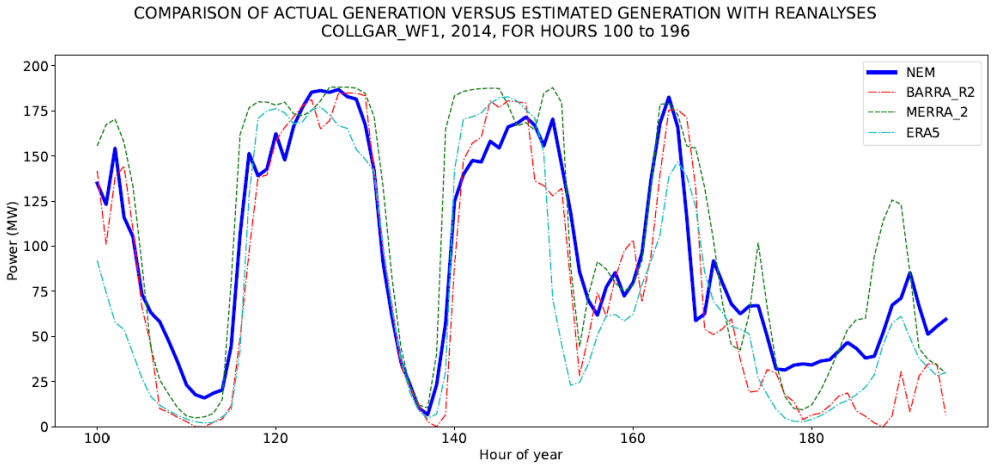
BARRA2 Applications

Updating Australian wind climatology



Current (Monthly 0Z analyses, 2004-2008), to be replaced with climatology based on all-hours, 1991-2020, at 10, 50, 100, …, 200 m heights (Aurel Griesser, BOM)

Historical wind energy generation



Use of reanalyses for simulating wind power at 50+ Australian wind farms (Graham Palmer et al. 2024, Monash University)

Key messages

- Bureau is expected to continue development of regional reanalysis.
- Towards convective (km)-scale reanalysis, to provide better historical information for hazards at local scales.
  - Observation requirements to do this well
  - Exploring ensemble DA method, moving from variational to EnKF
  - Transition to next-generation DA software – JCSDA-JEDI
- Collaboration on observational data, evaluation and supporting downstream applications
- BARRA2 shown to add value to global reanalyses for near surface winds, but still work to be done (see extra slides)

Questions for
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Jan 2024: BARRA-R2 1979-2023 published at NCI Data Collection, licensed CC-BY-4

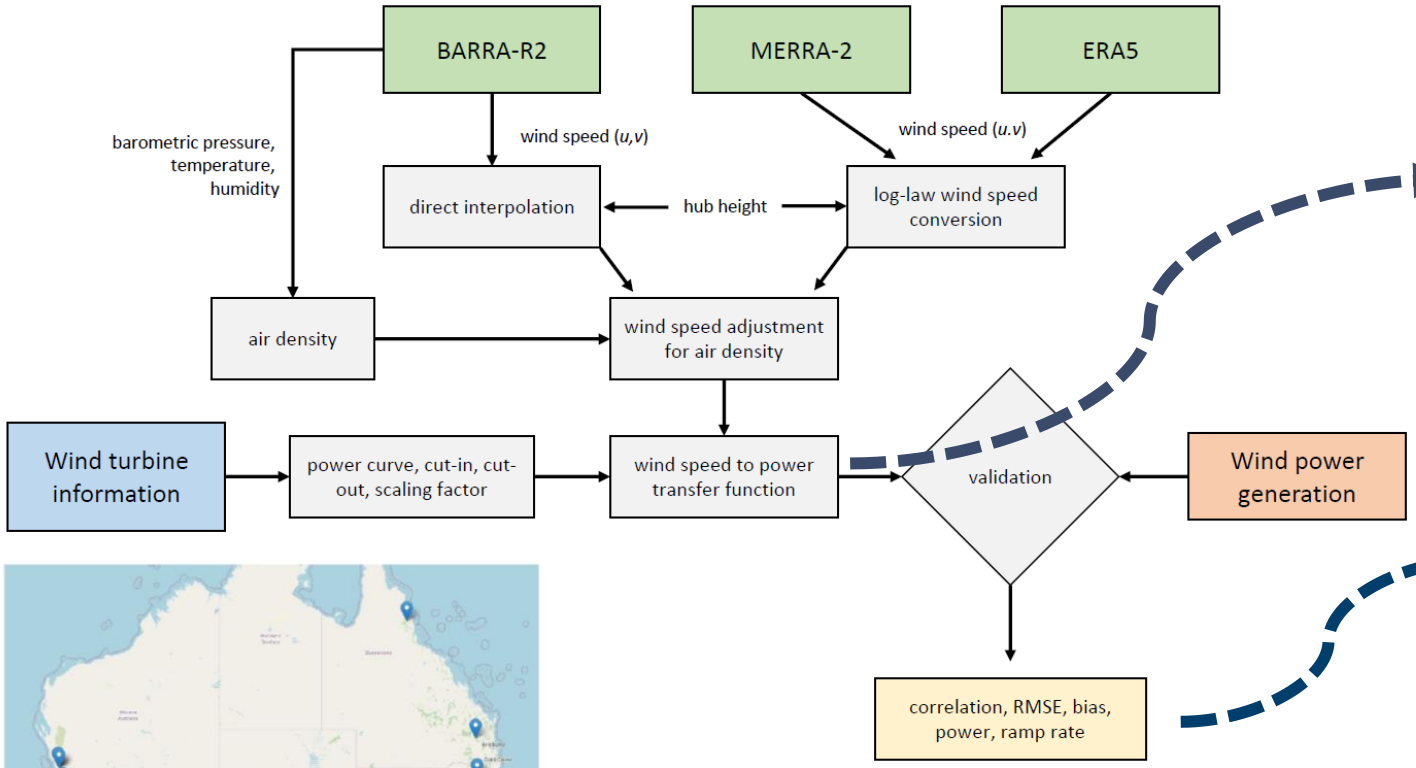
Next few months 2024: BARRA-RE2 and BARRA-C2 to be published

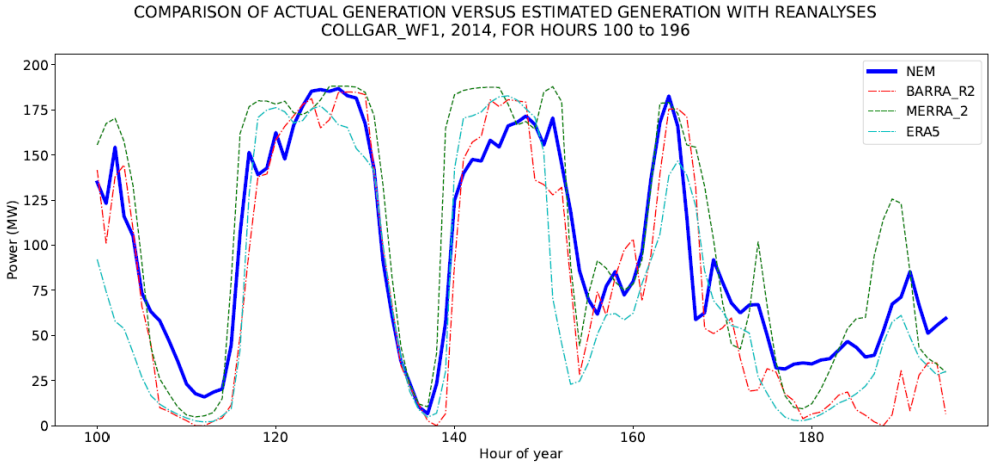
Useful Links for BARRA2 Access:
BOM BARRA2 (ob53) - NCI Data Collections & Publishing - Opus - NCI Confluence

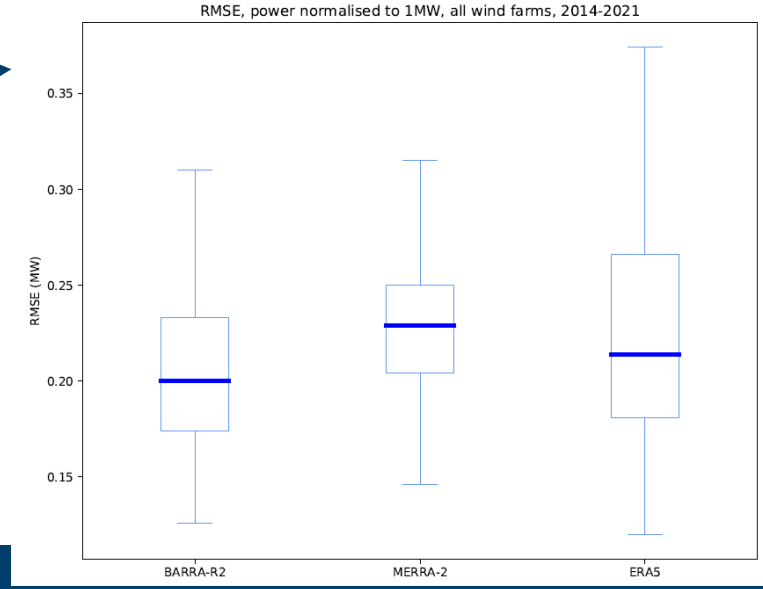
NCI Data Catalogue - NCI Data Catalogue

Or simply search "`nci barra2`" on Google

Hub height wind validation of BARRA-R2: Palmer et al. (2024)

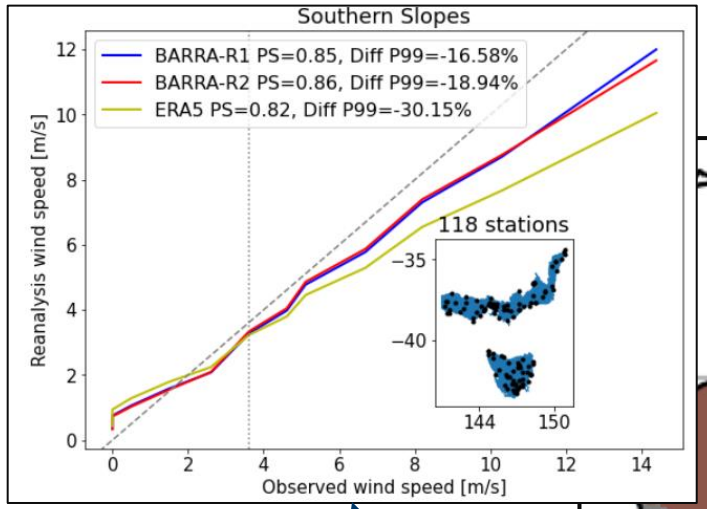


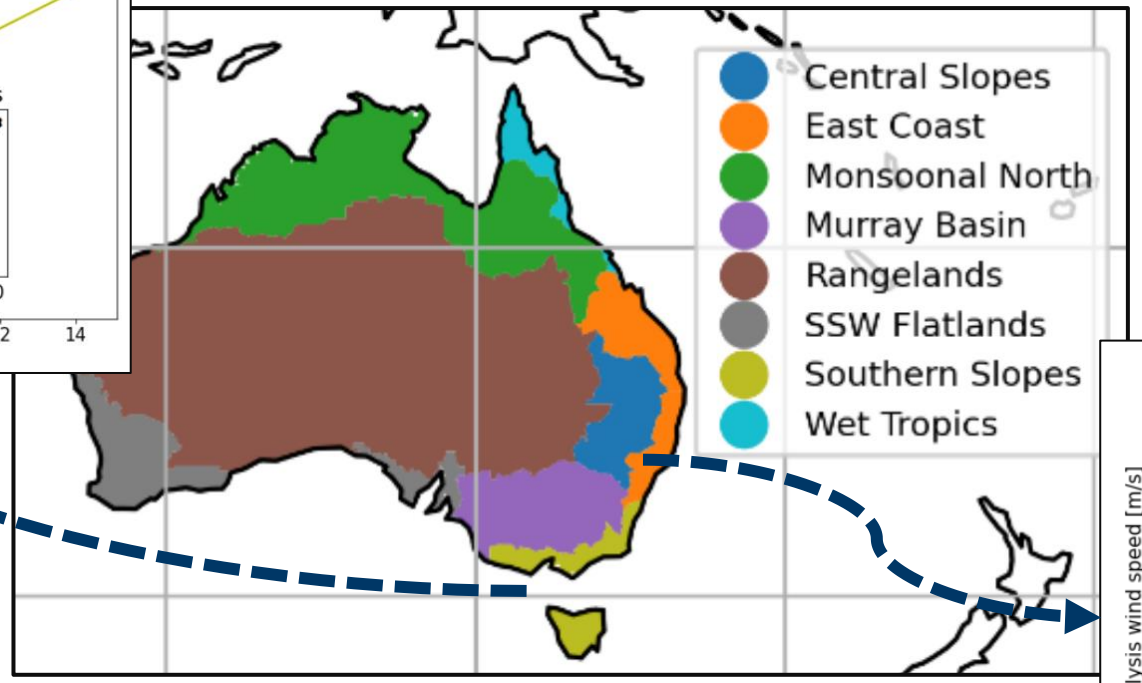


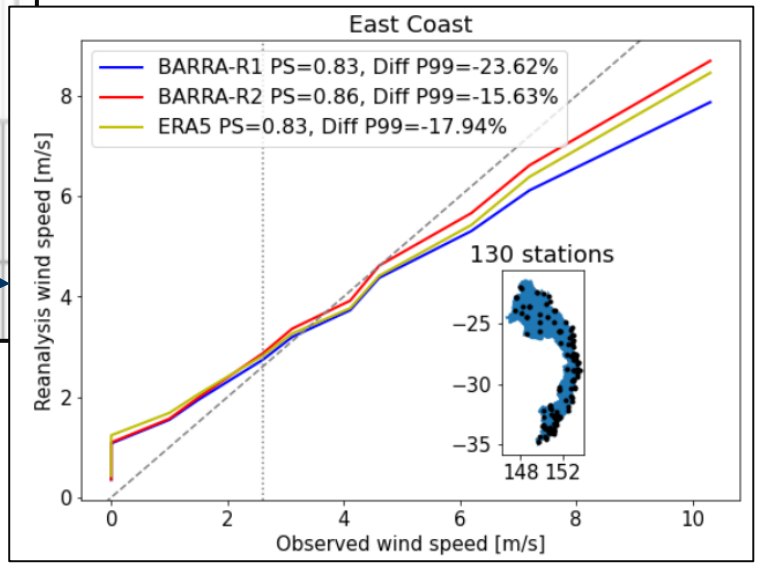


Workflow to intercompare reanalyses based on simulated wind power generation.

10m wind validation of BARRA-R2: Su et al. (2023)

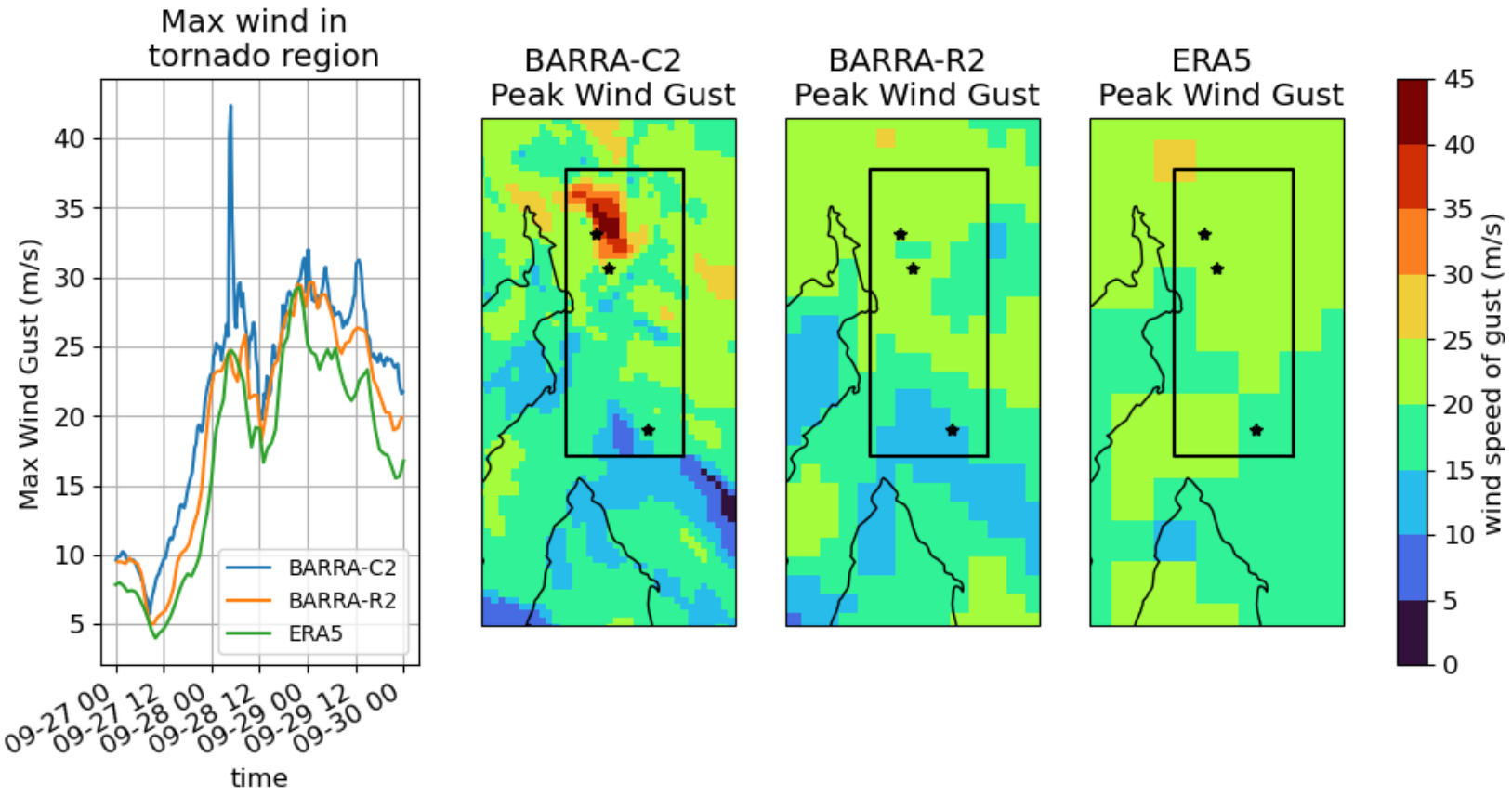






Quantile-quantile plot of observed and reanalysis 10 m wind speed, showing biases in wind speeds during low and high wind conditions,

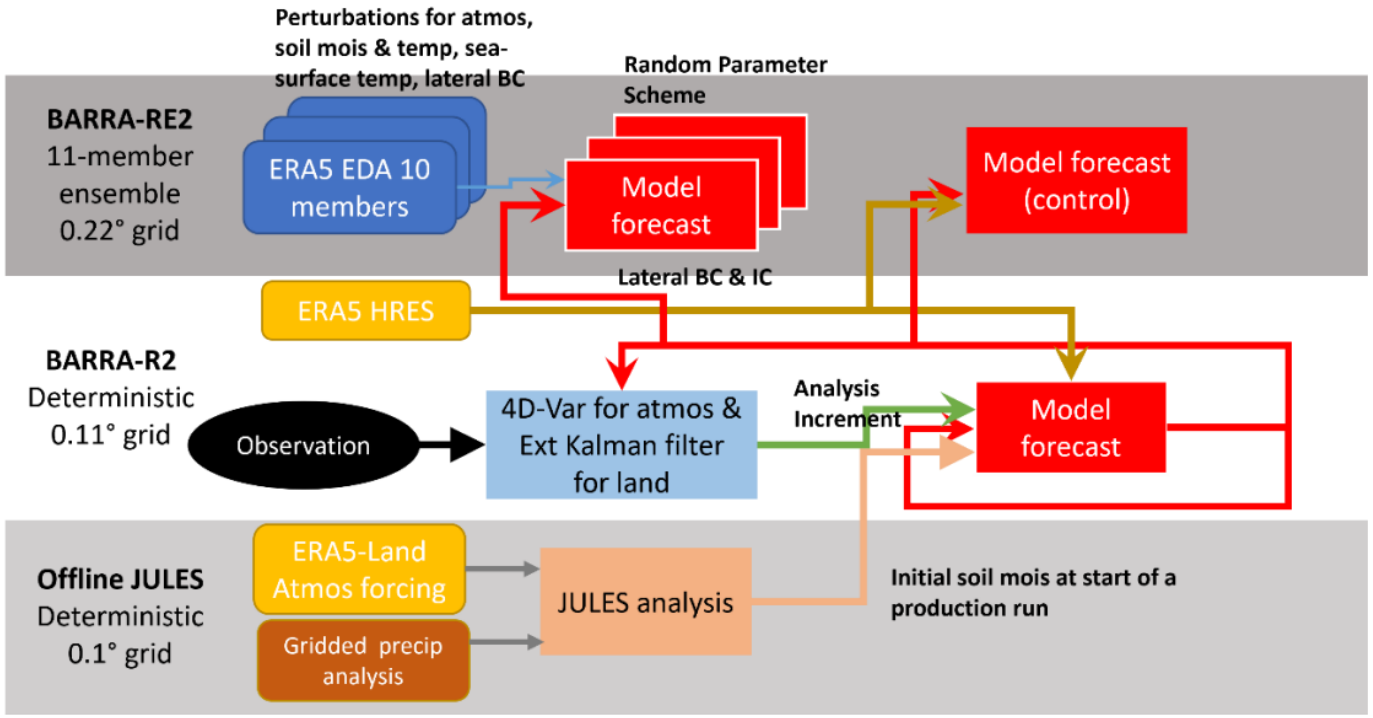
Extreme wind gust in BARRA-C2



Maximum wind gust during September 2016 wind storm over South Australia, which caused major energy infrastructure damage and widespread energy outage (Emma Howard, BOM)

Asterixis mark the observed tornado locations.

6-hourly 4D-Var analysis of observations (Su et al. 2022)



Observations from,

- Surface – land & sea
- Sondes
- Aircrafts
- Satellite sounding
- Satellite retrieved satwinds & scatwinds
- GPS and ground-based GNSS
- Satellite microwave soil moisture
- Tropical cyclone central pressures from IBTracs

References

Su et al. (2022), BARRA2: Development of the next-generation Australian regional atmospheric reanalysis, Bureau Research Report 067, access online: http://www.bom.gov.au/research/publications/researchreports/BRR-067.pdf

Su et al. (2023), Preliminary assessment of regional moderate-resolution atmospheric reanalysis for Australia, Bureau Research Report 084, access online: http://www.bom.gov.au/research/publications/researchreports/BRR-084.pdf

Palmer et al. (2023), Validation of BARRA2 and comparison with MERRA-2 and ERA5 using historical wind power generation, submitted, preprint online: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4646493

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