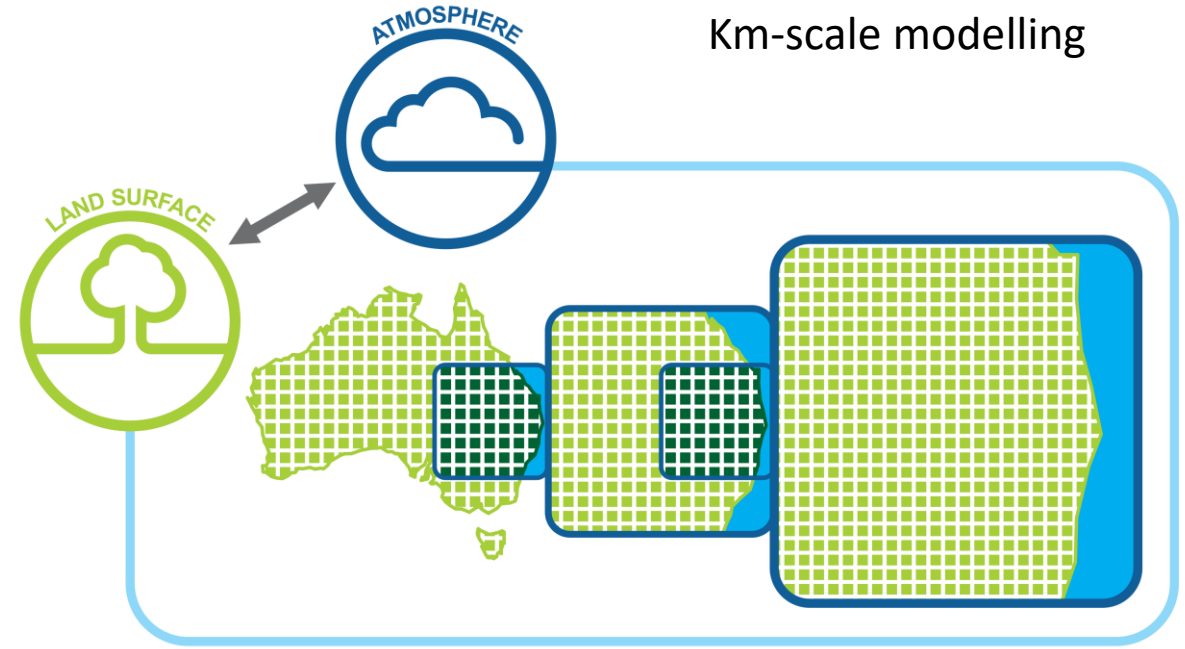
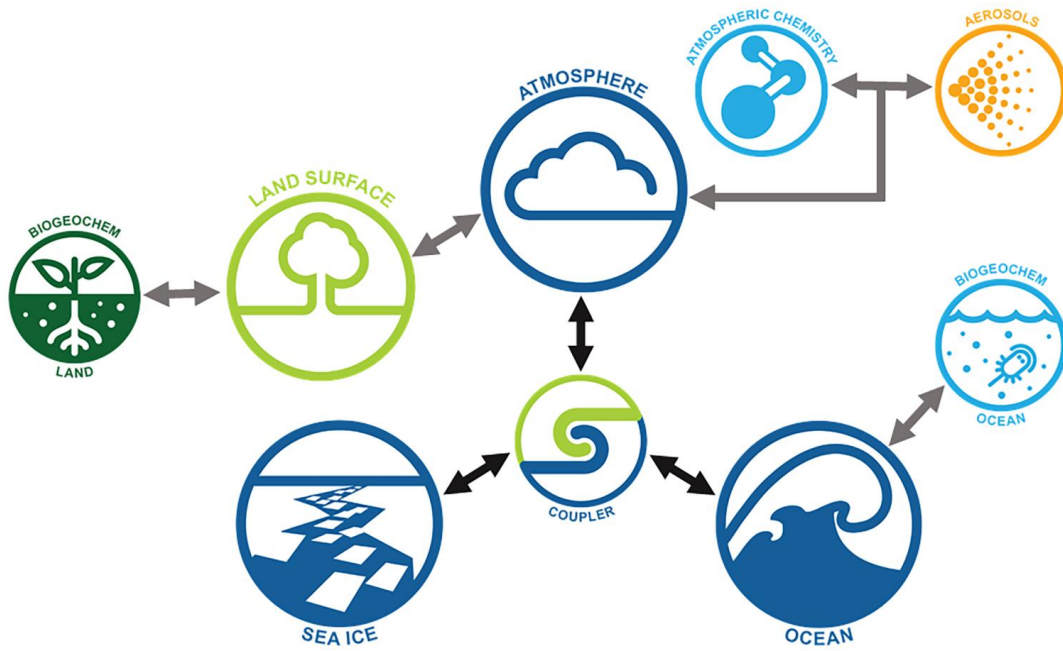


# High-resolution ACCESS regional nesting suite for research purposes

Chermelle Engel, Senior Research Software Engineer,  
Atmosphere Team, ACCESS-NRI

Acknowledging: Atmosphere and Release Team at ACCESS-NRI along with many colleagues from the Australian Bureau of Meteorology, UNSW, The University of Melbourne, Monash University and the Met Office

# Australian Community Climate and Earth System Simulator (ACCESS) modelling National Research Infrastructure (NRI) – ACCESS-NRI



# If km-scale global models exist why use regional?

Useful for testing out new ideas & learning

Faster & Cheaper

Not easier

# Diverse research community

Researchers at universities tend to explore other dates/regions and niche topics than operational centers and sometimes have different goals.



Source: Microsoft PowerPoint stock images



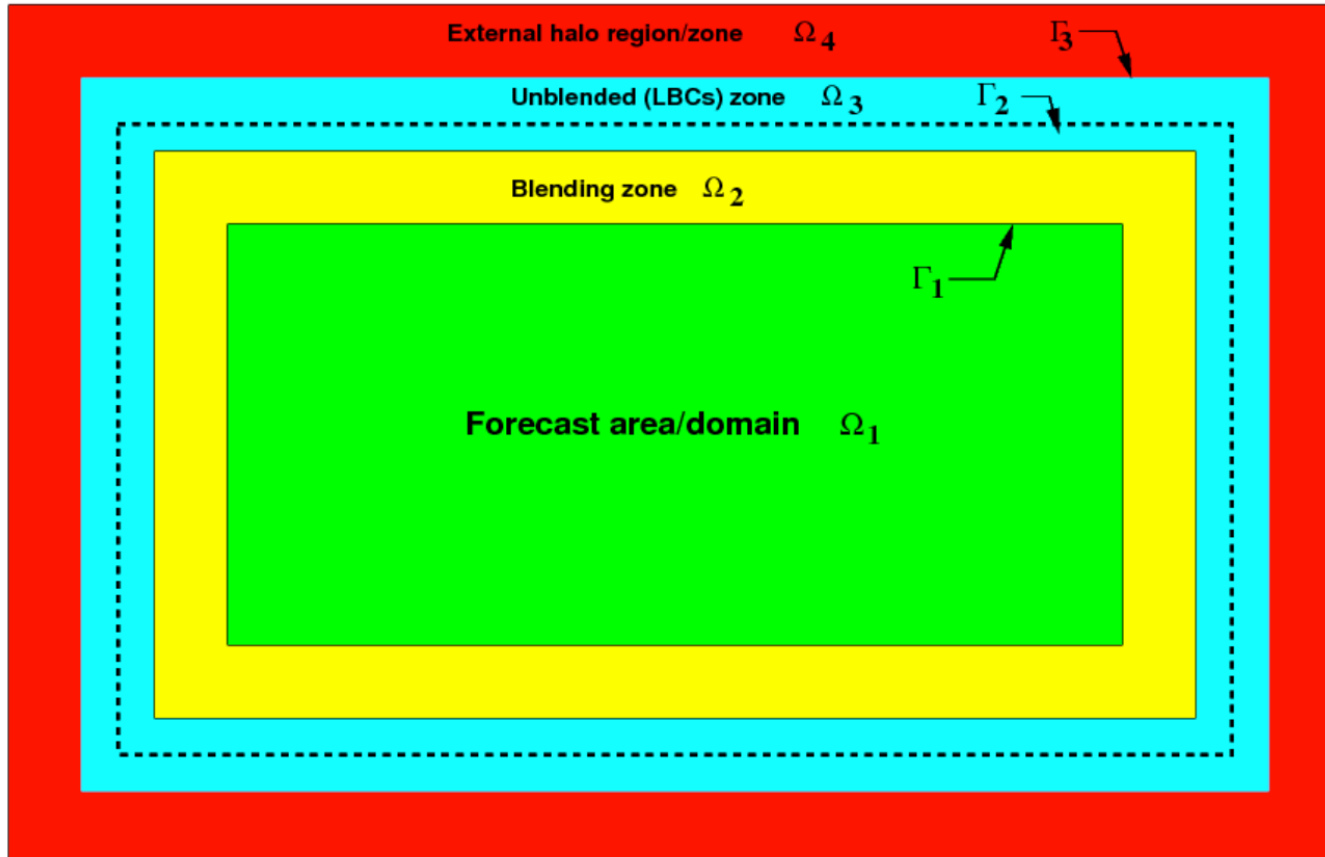
Source: Adobe Stock



Source: Adobe Stock



# Plethora of choices



## The first Met Office Unified Model–JULES Regional Atmosphere and Land configuration, RAL1

Mike Bush<sup>1</sup>, Tom Allen<sup>1</sup>, Caroline Bain<sup>1</sup>, Ian Boutle<sup>1</sup>, John Edwards<sup>1</sup>, Anke Finnenkoetter<sup>1</sup>, Charmaine Franklin<sup>2</sup>, Kirsty Hanley<sup>1</sup>, Humphrey Lean<sup>1</sup>, Adrian Lock<sup>1</sup>, James Manners<sup>1</sup>, Marion Mittermaier<sup>1</sup>, Cyril Morcrette<sup>1</sup>, Rachel North<sup>1</sup>, Jon Petch<sup>1</sup>, Chris Short<sup>1</sup>, Simon Vosper<sup>1</sup>, David Walters<sup>1</sup>, Stuart Webster<sup>1</sup>, Mark Weeks<sup>1</sup>, Jonathan Wilkinson<sup>1</sup>, Nigel Wood<sup>1</sup>, and Mohamed Zerroukat<sup>1</sup>

<sup>1</sup>Met Office, FitzRoy Road, Exeter, EX1 3PB, UK

<sup>2</sup>Bureau of Meteorology (BoM), Melbourne, Victoria, Australia

**Figure 1.** Schematic of the LAM configuration. In this configuration a LAM with a physical (or forecasting) region denoted by  $\Omega_1$  is shown in green. On the periphery of the forecasting area there is an extended computational domain ( $\Omega_E = \Omega_2 + \Omega_3 + \Omega_4$ ) that includes a blending (yellow) zone  $\Omega_2$ , an unblended (blue) zone  $\Omega_3$  and an external halo (red) zone  $\Omega_4$  (which arise from the parallel domain decomposition). Note that in general the relative sizes of ( $\Omega_2, \Omega_3, \Omega_4$ ) are a lot smaller than  $\Omega_1$ , but they are exaggerated here for clarity. Also, the use of the word RIM refers to the whole size of LBCs, which are all the grid points that lie in the region  $\Omega_R = \Omega_2 + \Omega_3$  (yellow and blue).

- Global driving model
- Nesting strategies (single, multi-level nests)
- Lower boundaries (land/ocean)
- Many more ...

& the MODEL itself



Idealized model



Research model



Operational center model

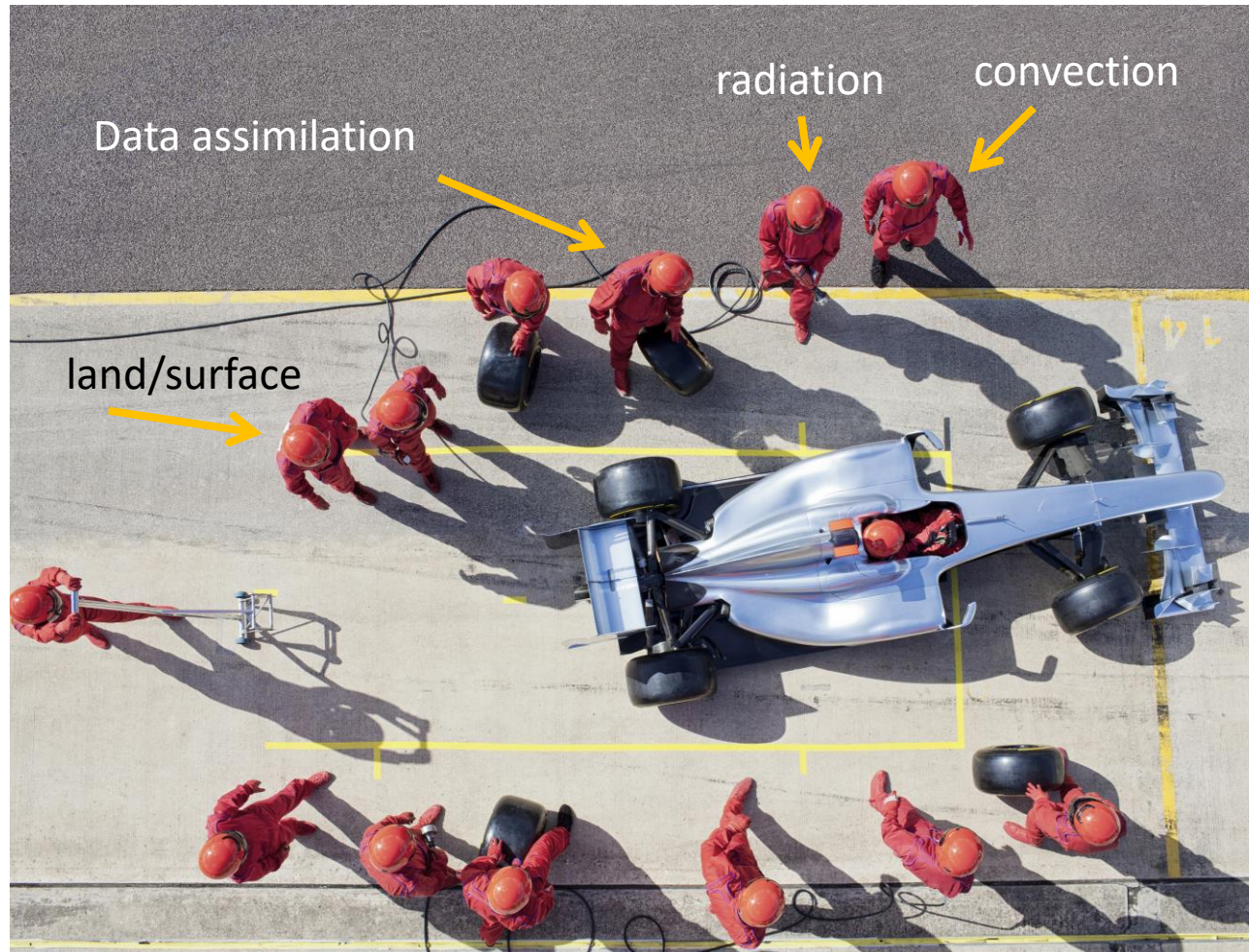
Source: Microsoft PowerPoint stock images

Researchers at universities are time-strapped and have different levels of experience.



many more teams!

## Momentum Partnership



Source: Microsoft PowerPoint stock images

Researchers benefit from the wisdom of many teams.

May have the honor to contribute.

But it is intimidating and there are hurdles in non-operational settings.

## Operational setting

Local global model -> local regional model



Source: Microsoft PowerPoint stock images

## Academic research setting

Foreign global model -> local regional model  
(or reanalysis)



Source: Microsoft PowerPoint stock images

Access to different input datasets

## ACCESS-NRI aims

- Support research needs using the ACCESS/UM model
- Create scientifically sound start points with guard-rails using openly accessible data
- Simplify hurdles for researchers

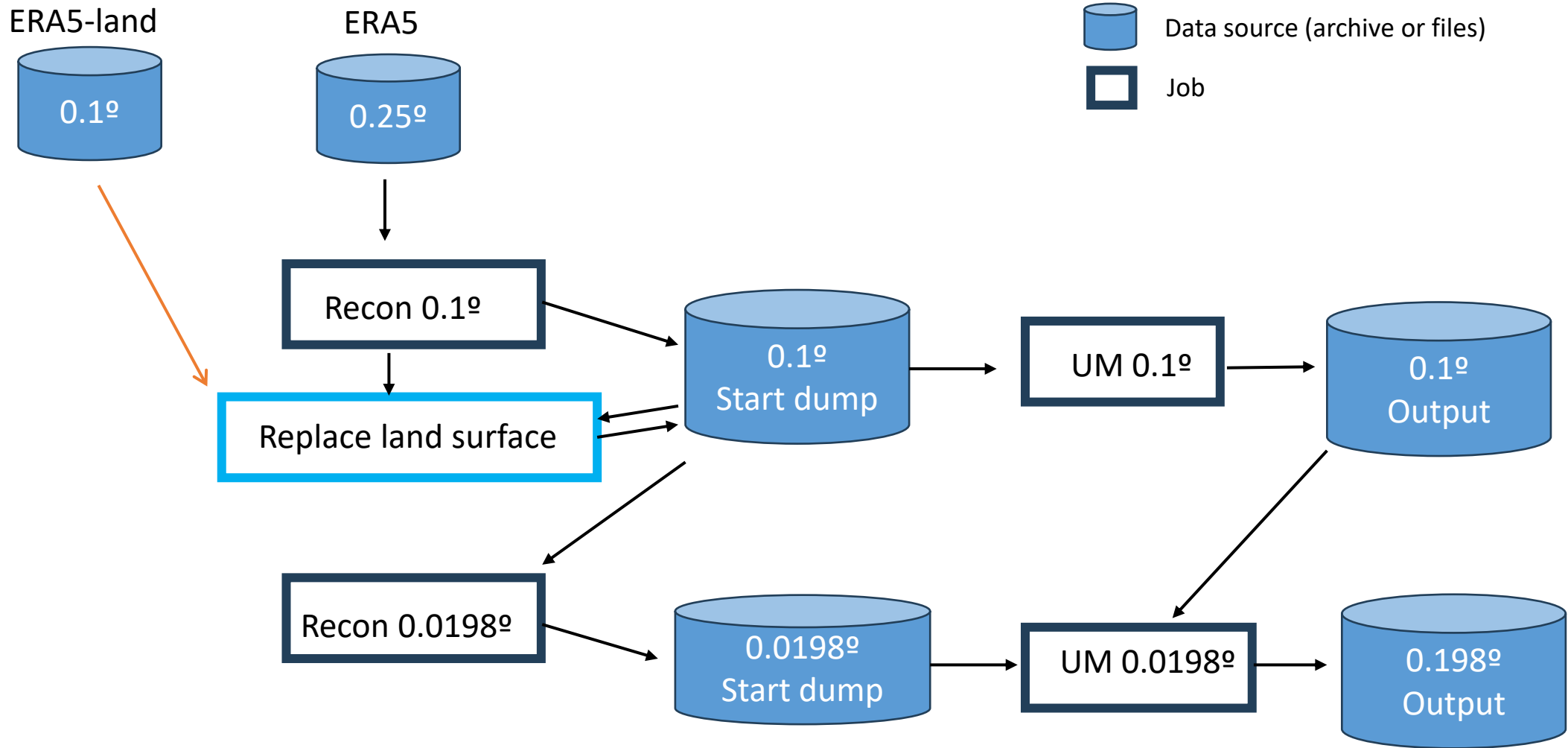


Source: Microsoft PowerPoint stock images

Driving with guardrails.

## Acronyms and other information

Acronym	Description	Scale
ERA5	ECMWF Reanalysis (v5)	0.25°
ERA5-land	Replay of land component of ERA5	0.05°
BARRA-R2	Australian regional reanalysis	0.11°
OSTIA	Operational Sea Surface Temperature and Sea Ice Analysis	0.05°
AGCD	Australian Gridded Climate Data	0.05°
UM	Unified Model	n/a



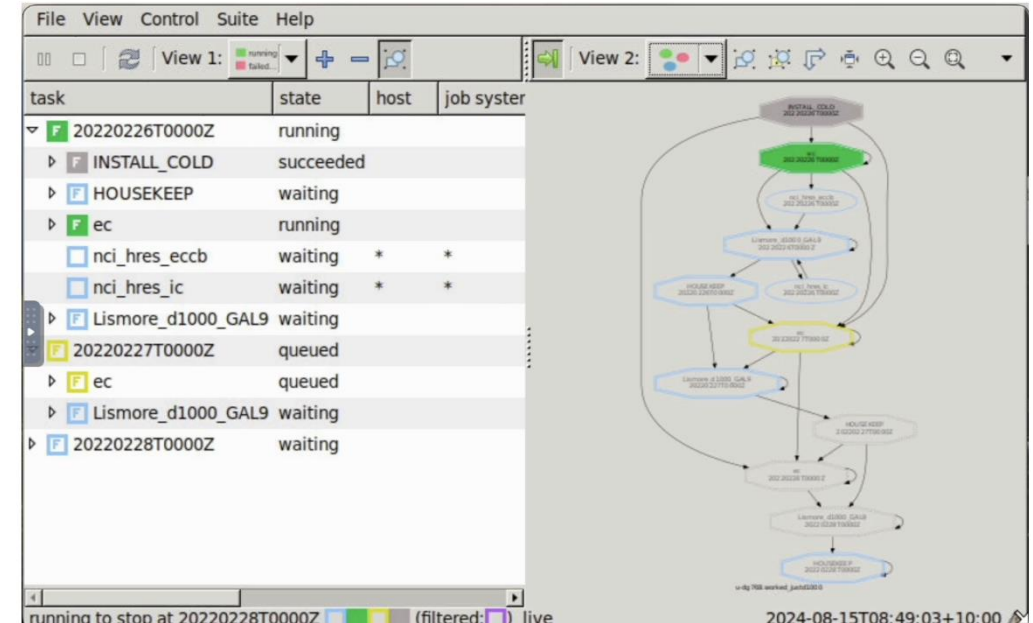
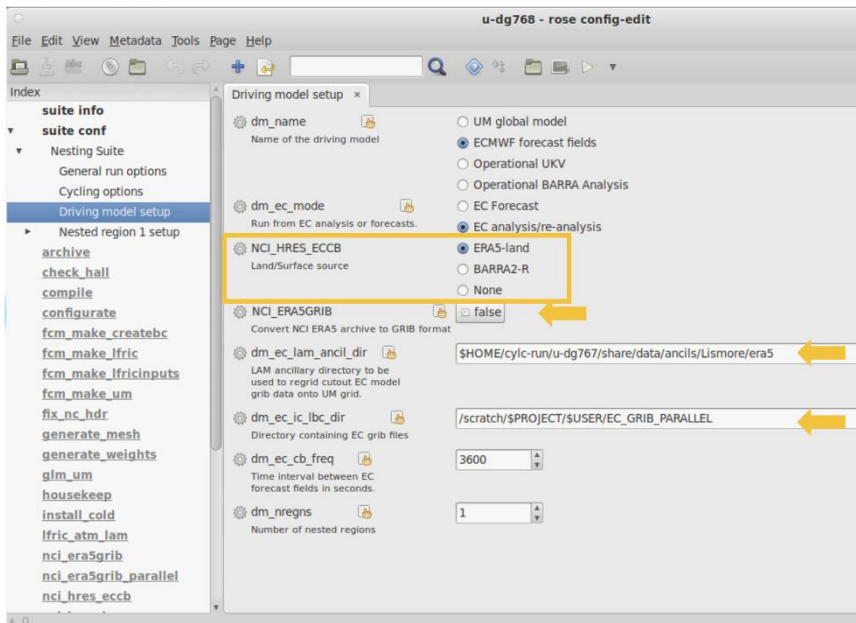
We suggested a nest configuration similar to this one

2-level

Domain	NX	NY	$\delta x$ (°)	$\delta t_{bc}$ (min)	$\delta t$ (s)	$T_0$ 26/02/2022	Levels	physics
ERAS	1440	720	0.25°	-		1200 UTC		
Nest 1	450	450	0.1 or 0.11	60	120	1200UTC	80kmL70	GAL9
Nest 2	450	450	0.0198	30	60	1200UTC	40kmL90	RAL3P2

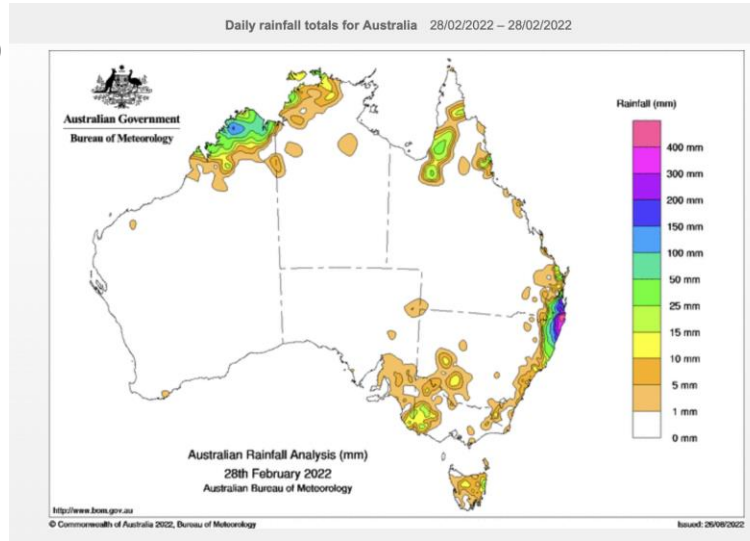
Resolution jumps: 3 & 4.5

Enabled daily varying SSTs (OSTIA)

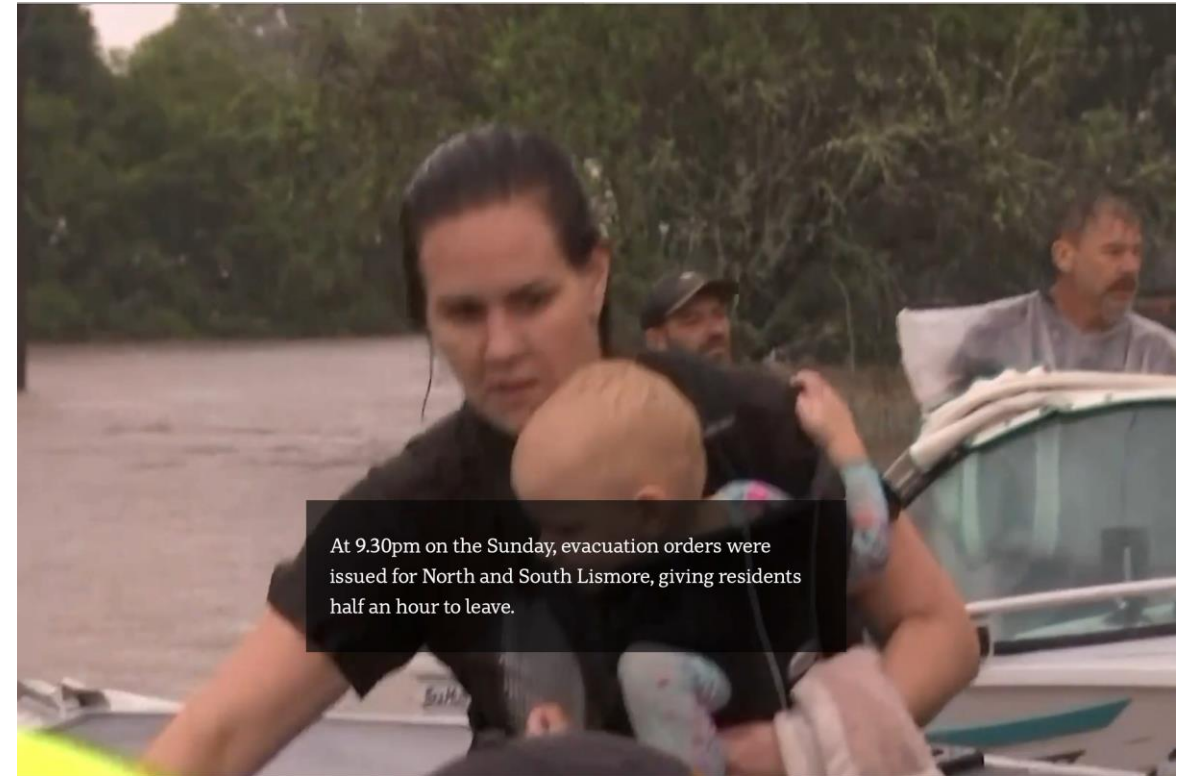
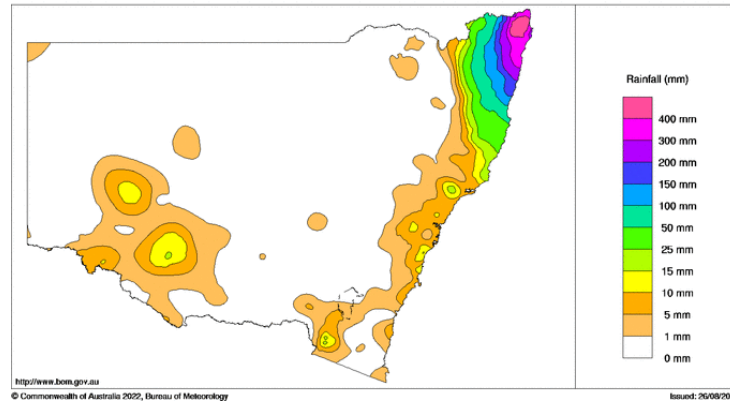


# 2022 Lismore Floods: a working example for researchers

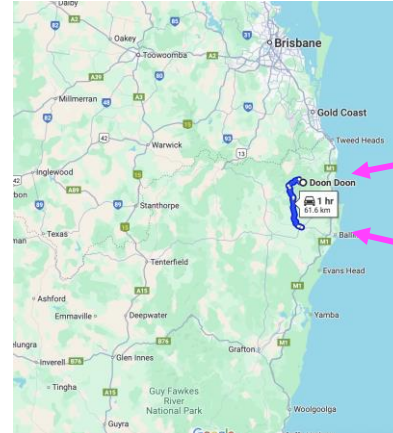
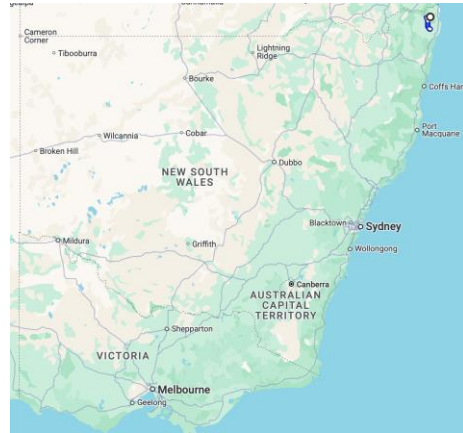
AGCD



New South Wales Rainfall Totals (mm) 28th February 2022  
Australian Bureau of Meteorology



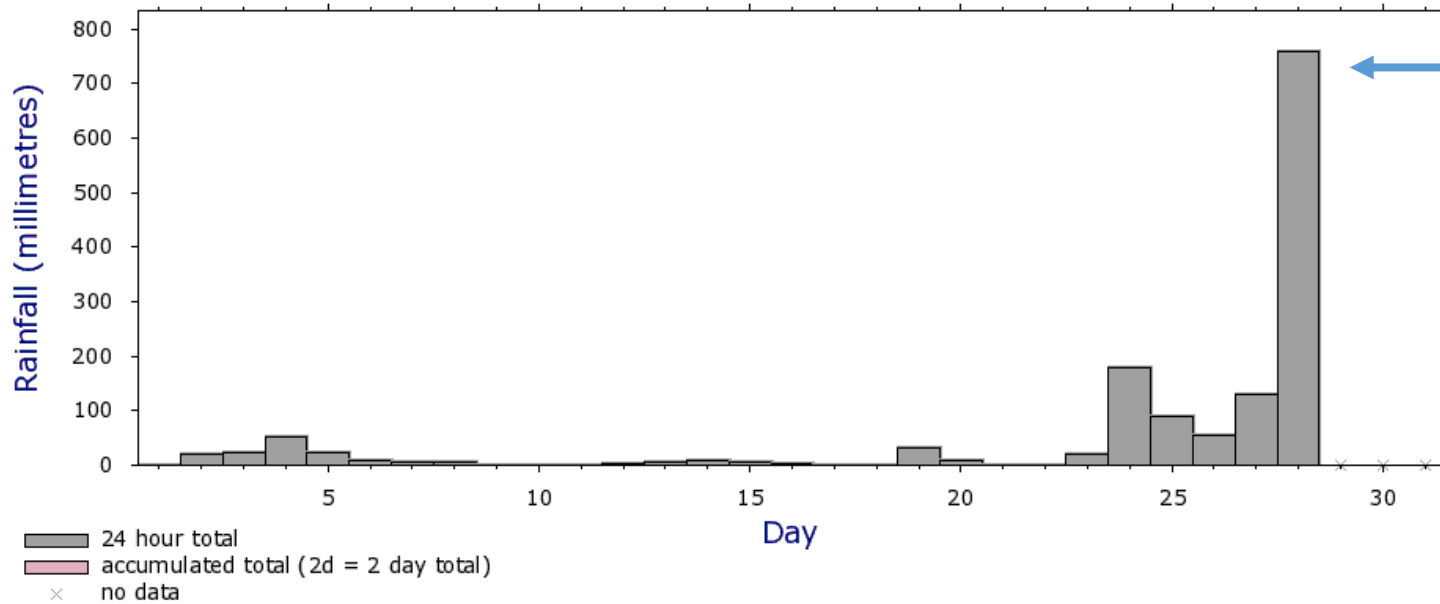
<https://www.abc.net.au/news/2023-02-27/have-lessons-been-learned-from-2022-lismore-flood-disaster/101863278>



Doon Doon

Lismore

Doon Doon (McCabes Road) (058019) Feb 2022 rainfall



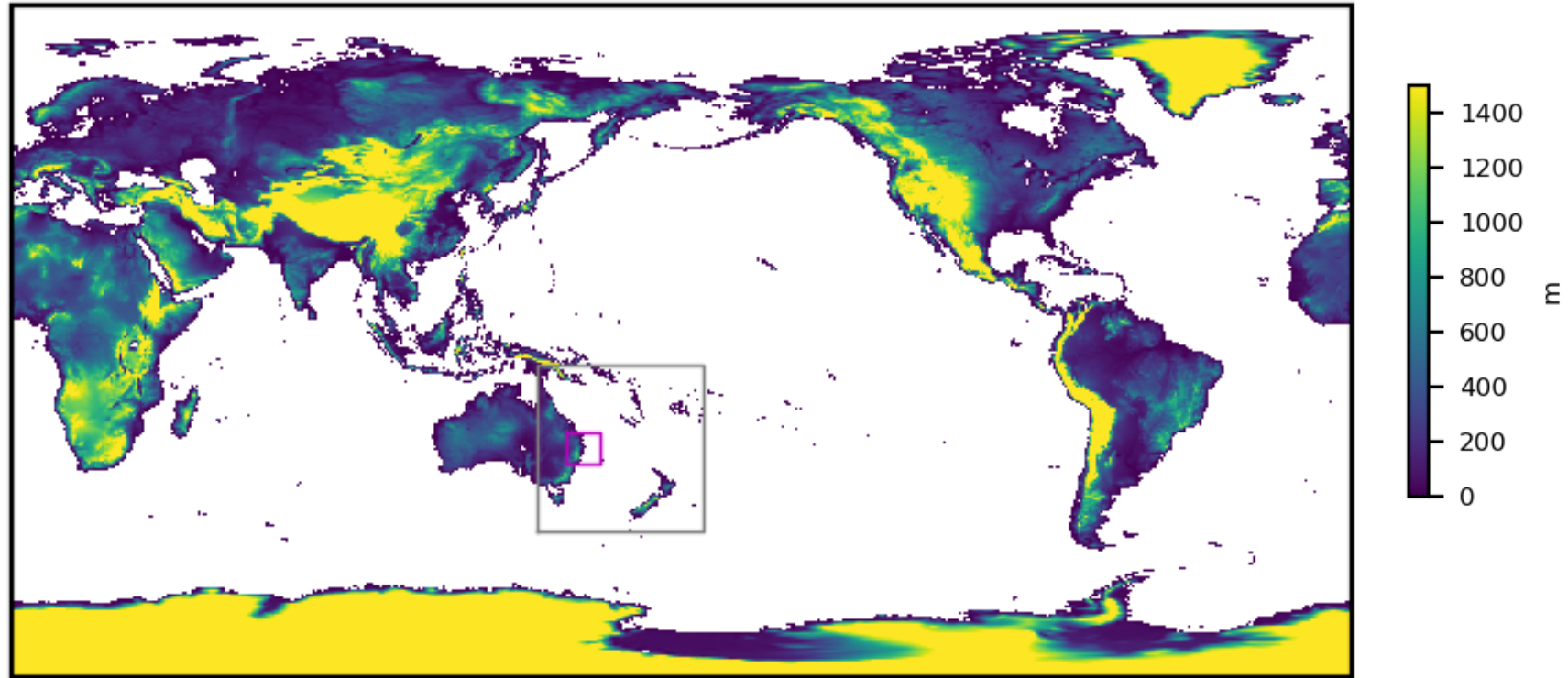
758mm  
Rainfall accumulation  
24 hours ending  
00Z 20220228

Note: Data may not have completed quality control.

Climate Data Online, Bureau of Meteorology  
Copyright Commonwealth of Australia, 2025

# Connection between global and regional model

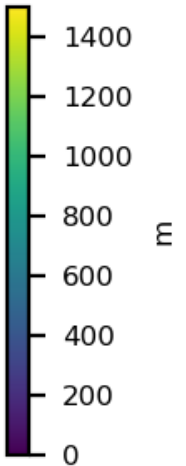
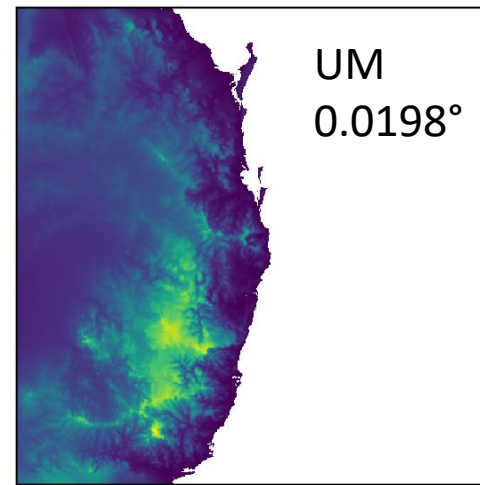
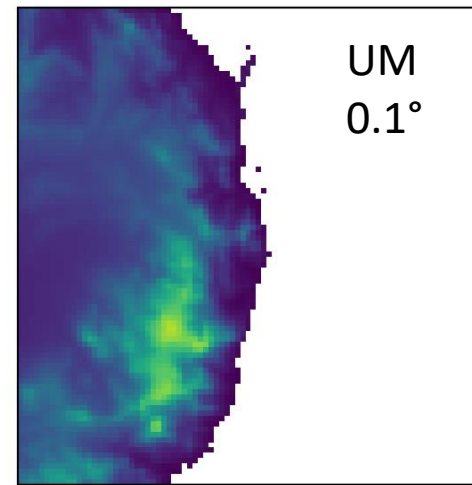
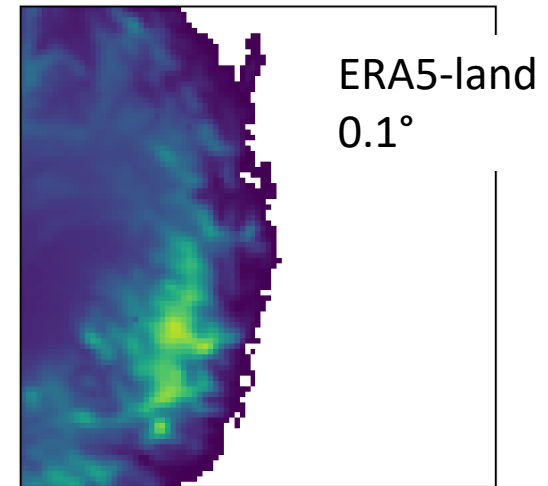
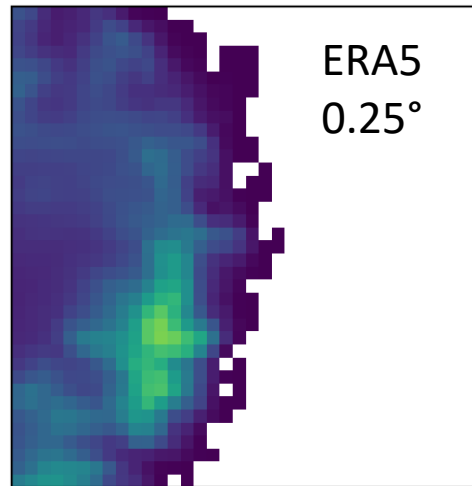
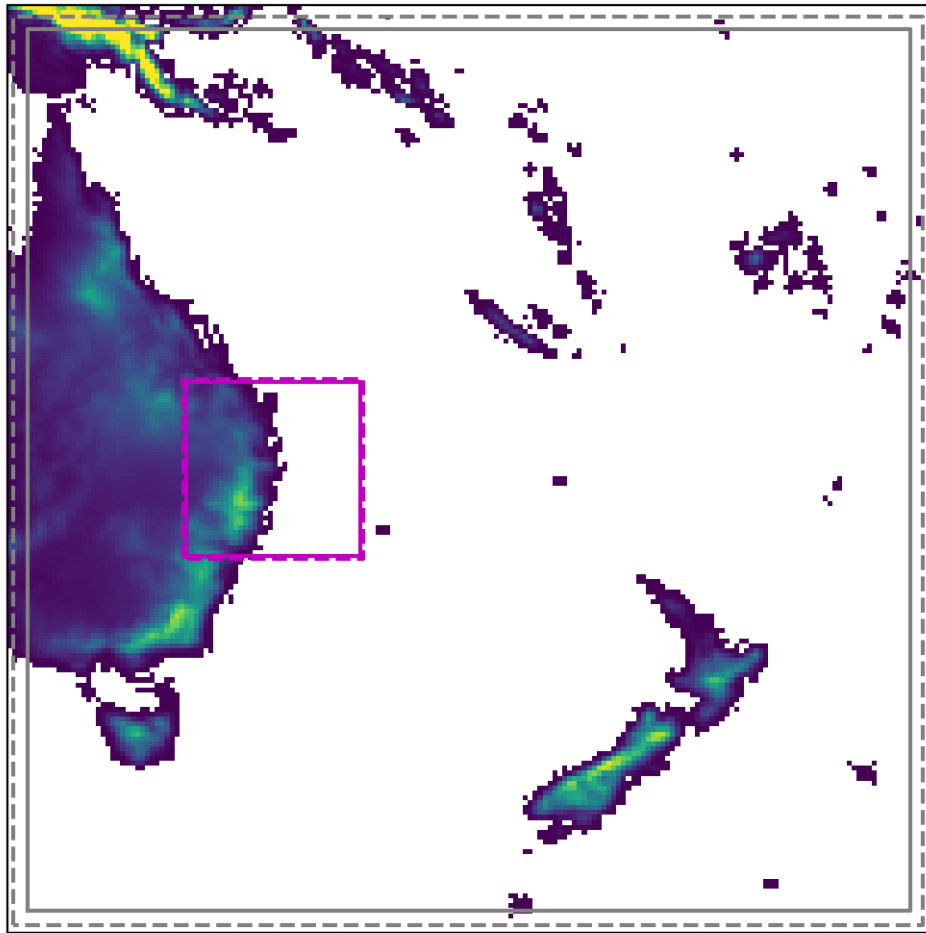
ERA5 OROGRAPHY (m)



0.25°      0.1°      0.0198°

# DEMONSTRATE IMPACT OF SCALE - USING OROGRAPHY (m)

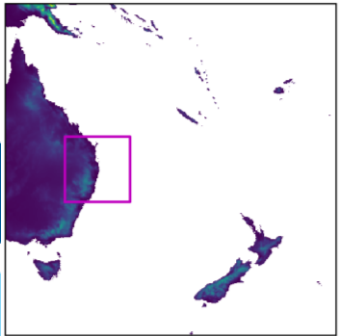
ERA5 0.25°



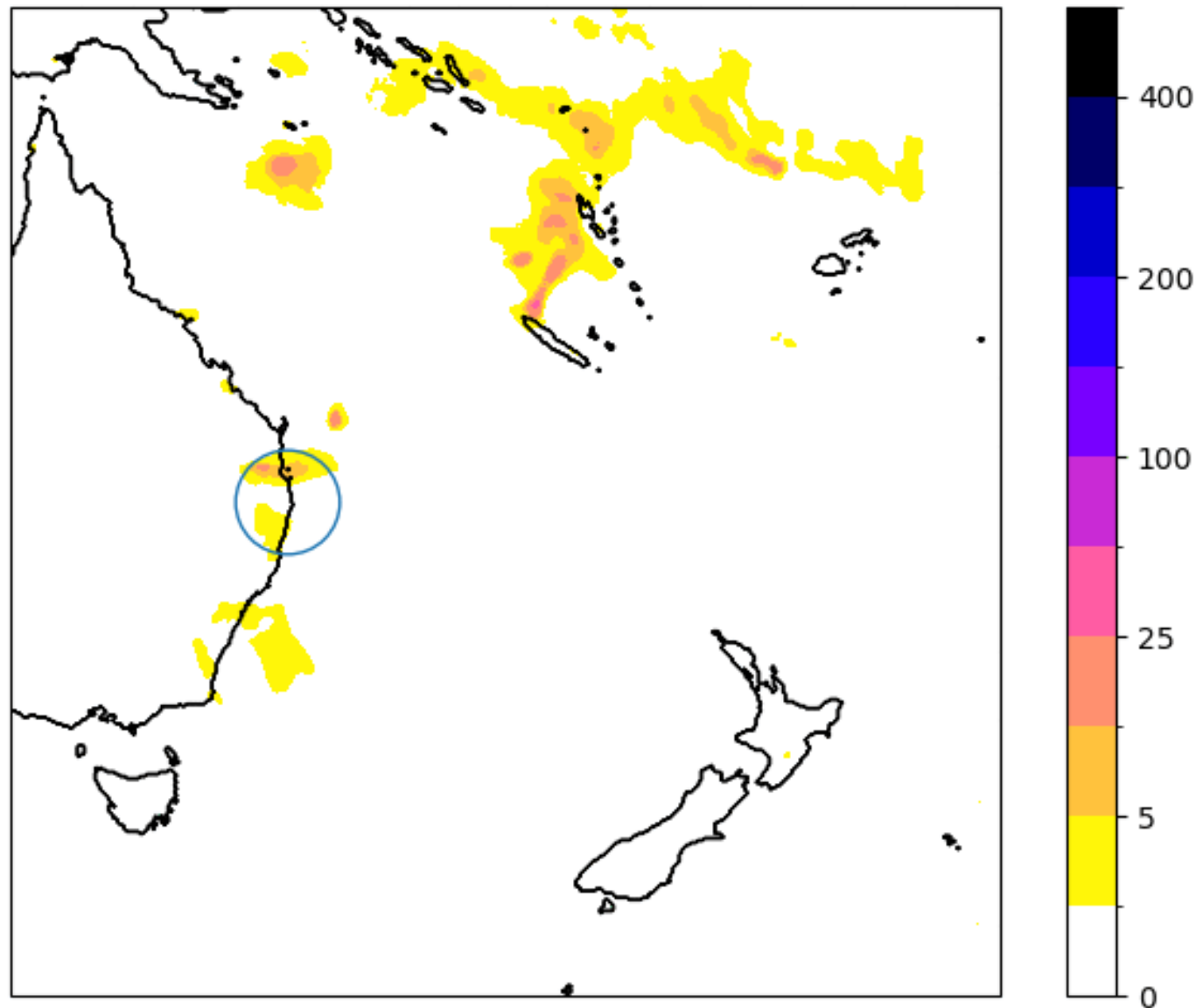
- 0.1° Outer domain (LBCs)
- 0.1° Inner domain
- - - 0.0198° Outer domain (LBCs)
- 0.0198° Inner domain

Higher spatial resolution  
More detail

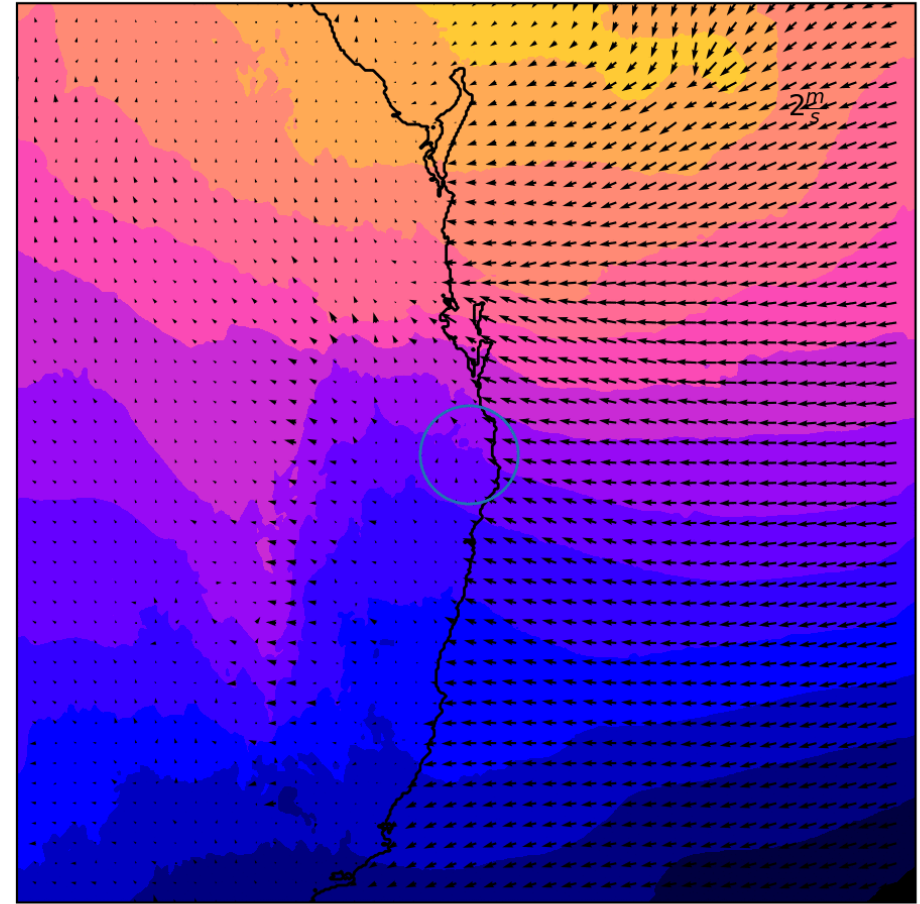
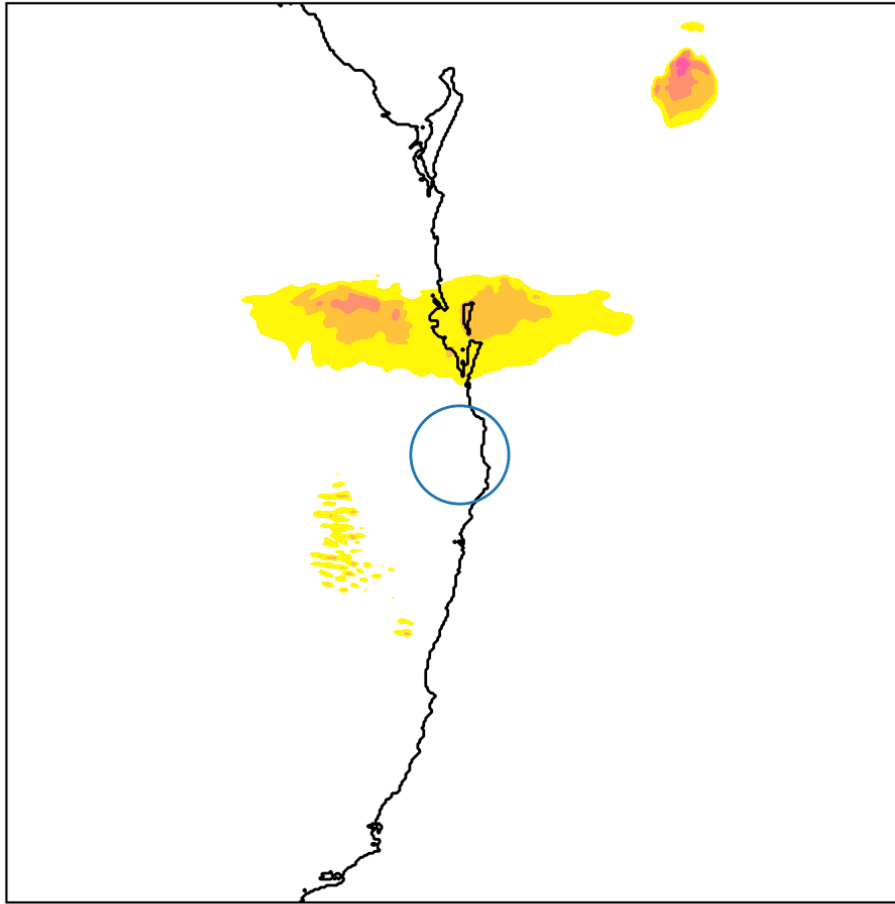
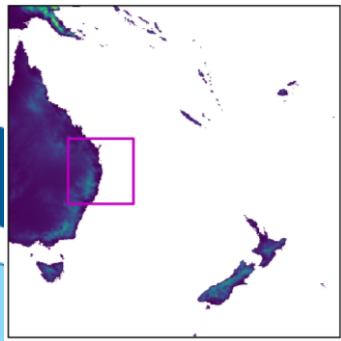




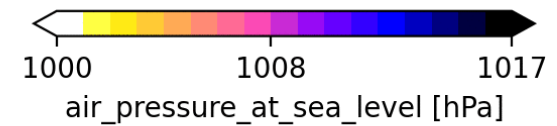
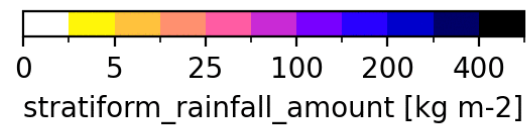
hourly accumulated rainfall [mm] 20220226T1202 to 20220226T1300



GAL9. 120 sec timestep radiation ts (1800, 600). ERA5+ERA5-land + OSTIA varying.

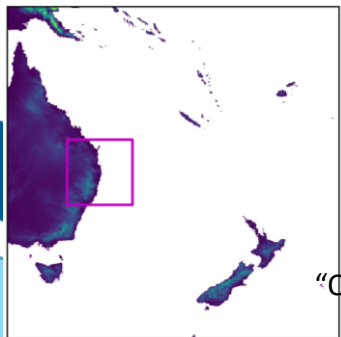


20220226T130000

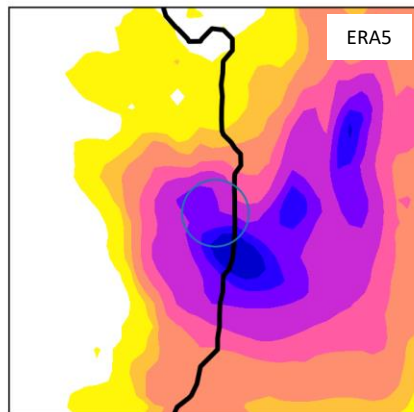


RAL3P2 nest from GAL9 120 sec timestep radiation ts (1800, 600). ERA5+ERA5-land + OSTIA varying.

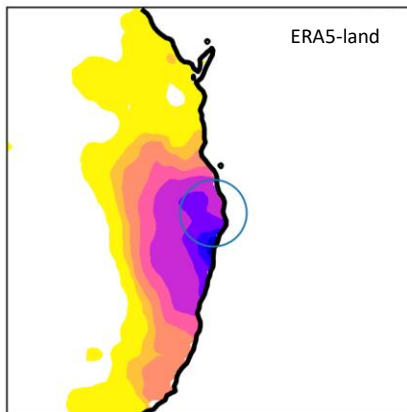
stratiform rainfall [ $kgm^{-2}$ ]  
20220227T0000 to 20220228T0000



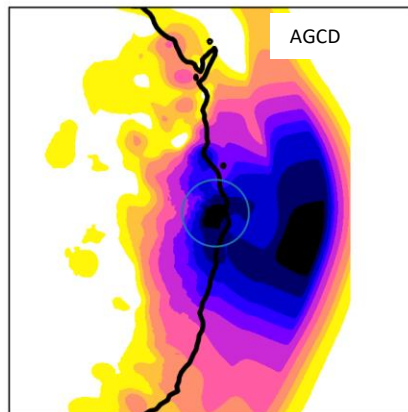
“Observations”



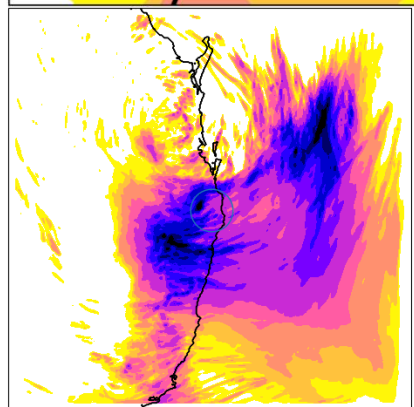
ERA5



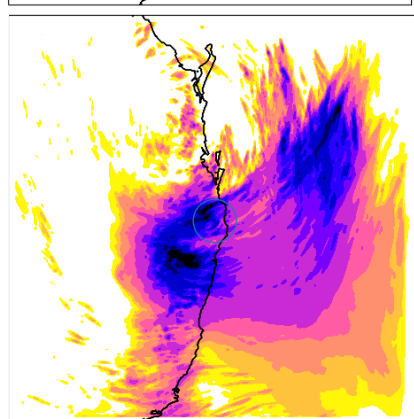
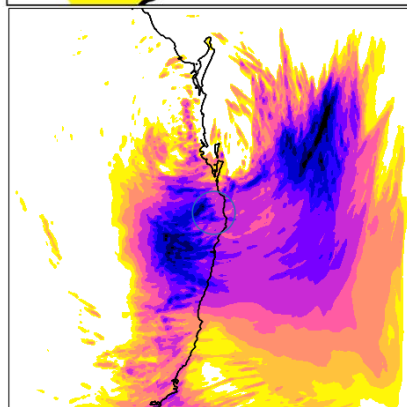
ERA5-land



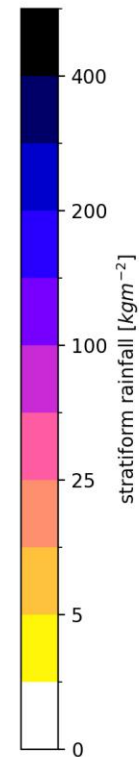
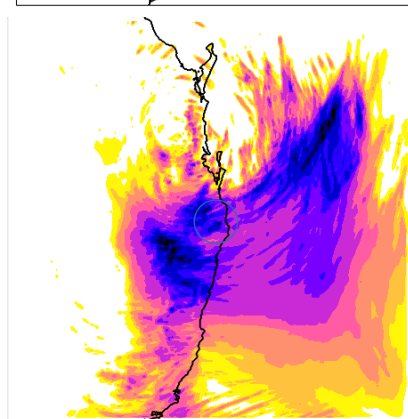
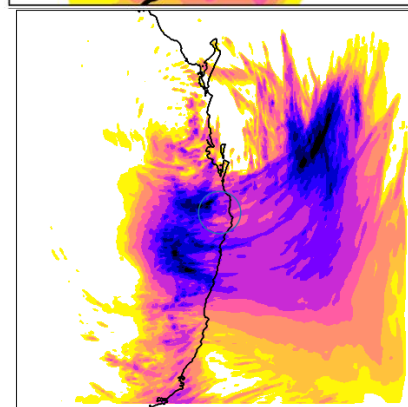
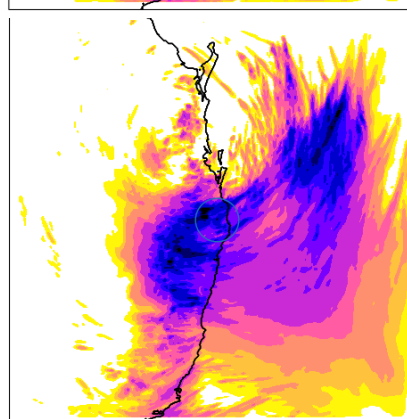
AGCD



Static  
ERA5 SST



Daily varying  
OSTIA SST



Atmosphere: ERA5  
Varied land-surface

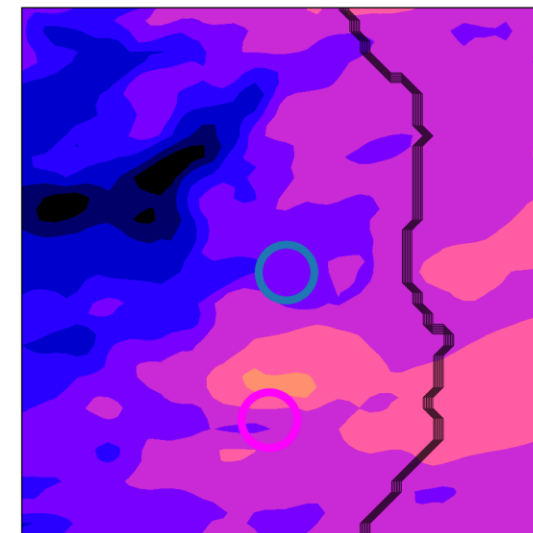
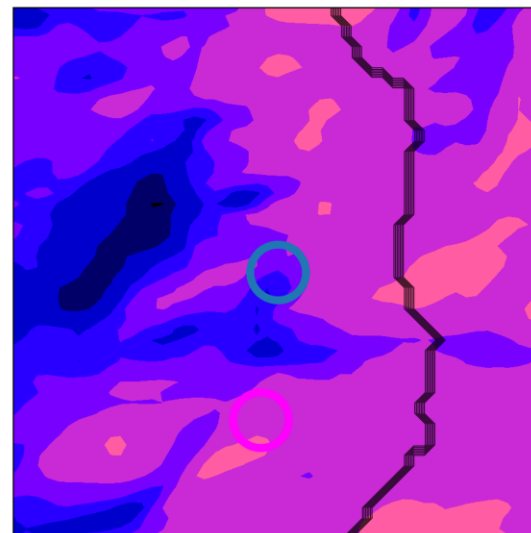
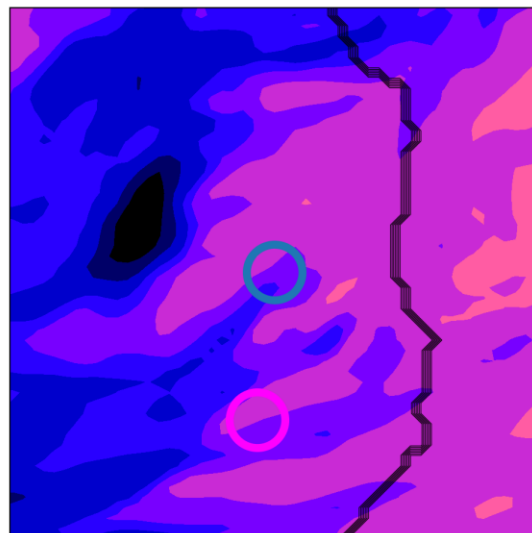
stratiform rainfall [ $\text{kgm}^{-2}$ ]  
20220227T0000 to 20220228T0000

LS = ERA5

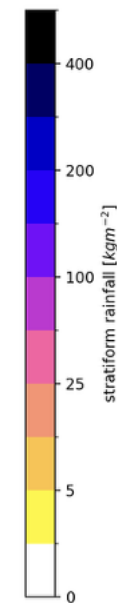
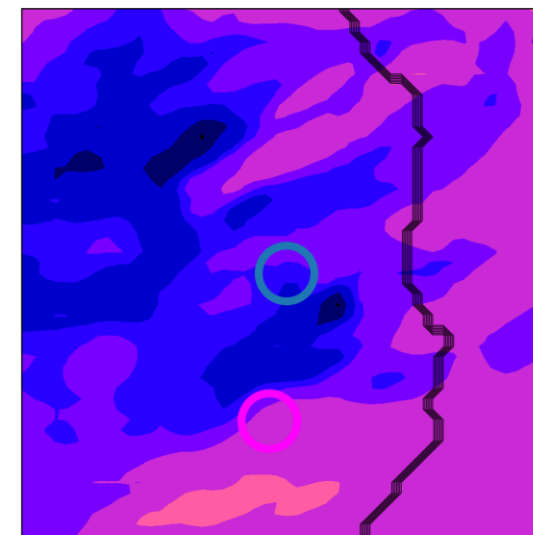
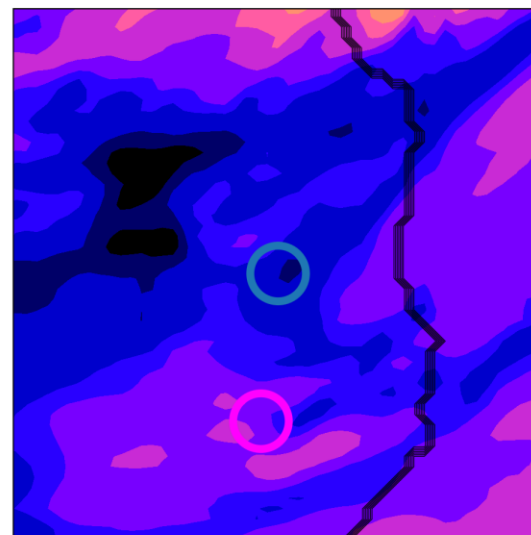
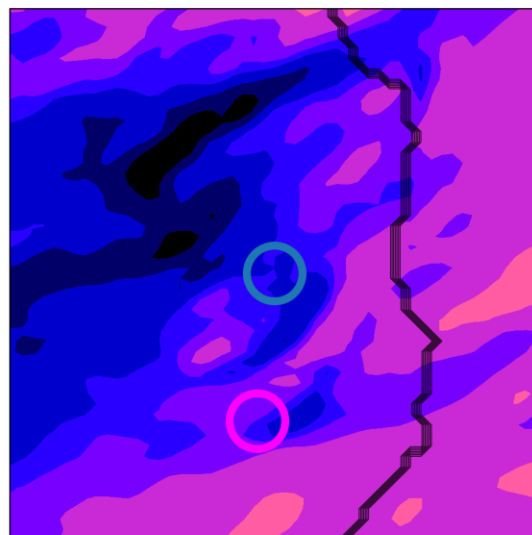
LS = ERA5-land

LS = BARRA-R2

Static  
ERA5 SST



Daily varying  
OSTIA SST



 DOON DOON

 LISMORE



# Future Work

Making the OSTIA option widely available

Add Global Climate Model data as a driving model

Support scientists who want to modify physics

Questions/feedback?

