The impact of climate change on crop irrigation requirements across the Murray-Darling Basin?

ONE BASIN CRC

A collaboration with:

Water Research AUSTRALIA

aws Australian Water School

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We acknowledge and pay respect to the Traditional Owners of the Murray–Darling Basin and their Nations.

We invite you to write in the **chat** now and acknowledge the Traditional Owners of the location you're joining from today.

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Our research programs

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Foresight and decisions

Technology and opportunity

Adaptation and innovation

Our challenges

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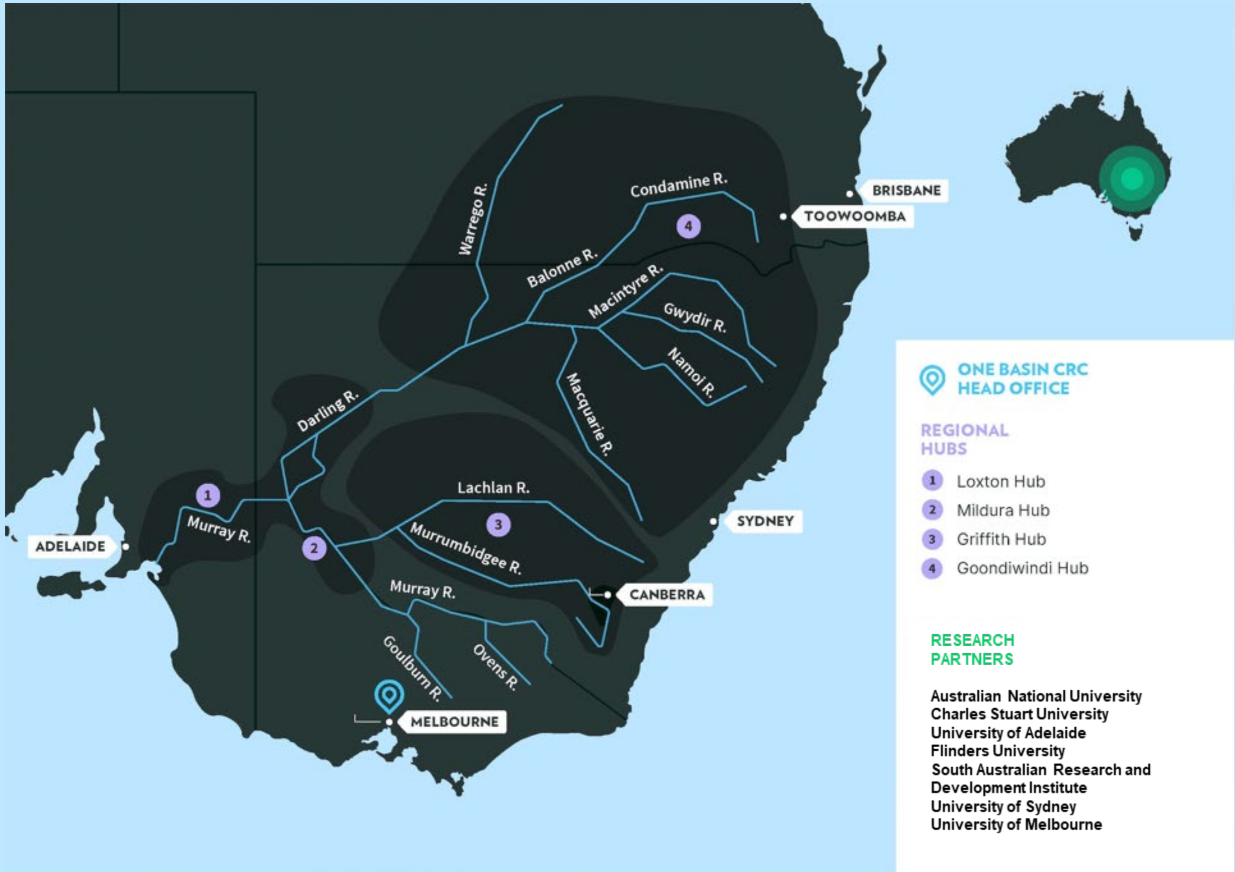
Building Capacity to Confront Climate Change Together

Creating Value from Digital Technologies to Support the Irrigated Agriculture Sector

Enhancing the Water Supply System to Deliver for Multiple Uses

Realising Value From and Within Rural Industries and Communities

Regional hubs



Housekeeping

Panel Discussion will run for approximately 60 minutes

Recording link will be emailed to you, uploaded to our website and YouTube channel

Short 1 minute survey will pop-up at the conclusion— help shape our future training

Click Q&A to:

- Ask questions and make comments
- Upvote or comment on other attendees' questions

Click Chat to:

- Talk with other attendees
- Ask AWS staff for assistance

Paul Petrie,
South Australian Research and Development Institute

Andrew Hall,
Charles Sturt University

Aims and Scope

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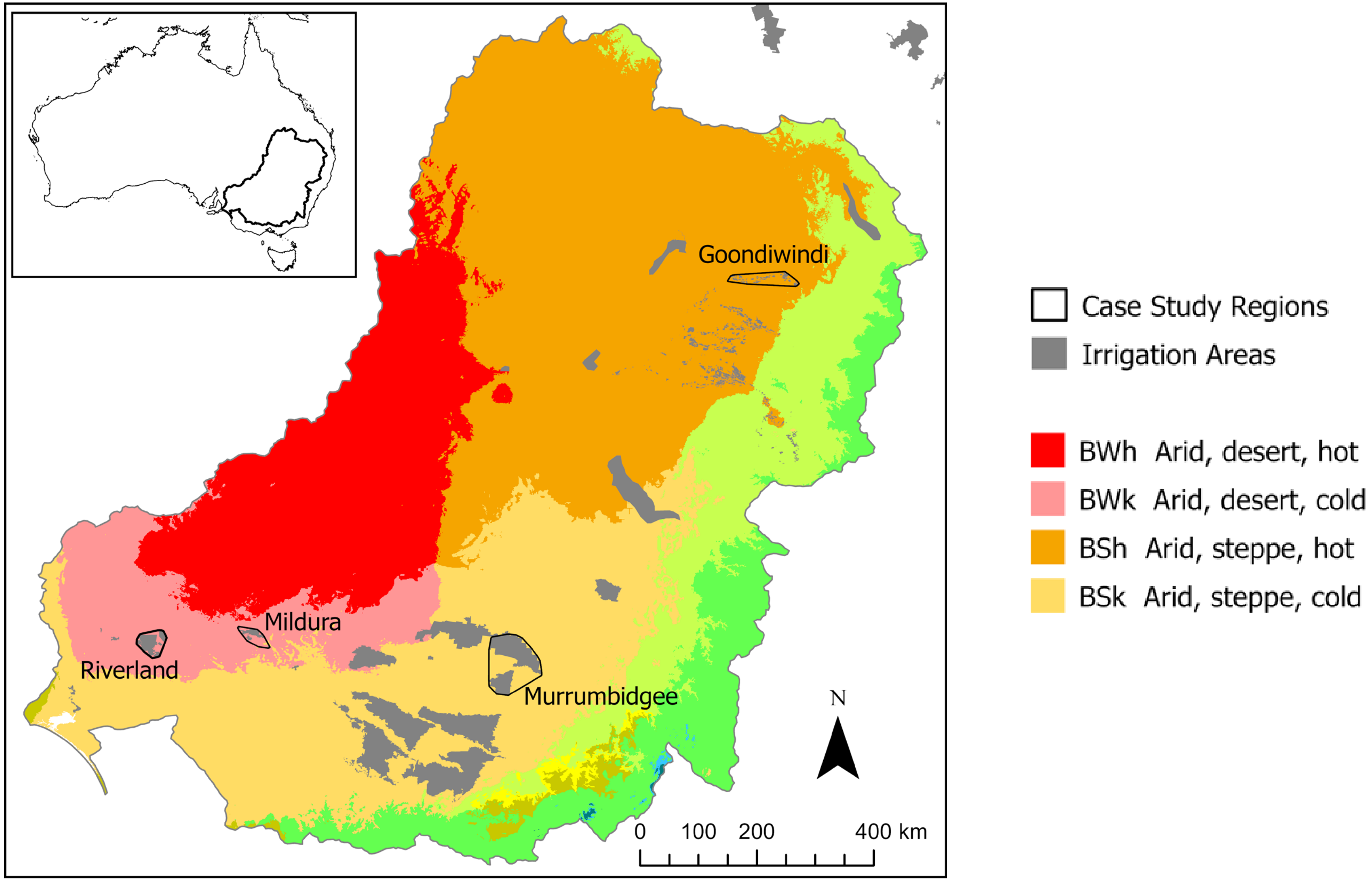
How will climate change increase demand for irrigation water across the Murray Darling Basin?

$$ET_c = K_c \times ET_0$$

Project Components

- Irrigator interviews
- ETo scenario maps
- Crop irrigation requirements

Study Area and Case Study Regions



Crops

- Wine grapes
- Almonds
- Cotton
- Rice

Irrigator interviews

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Key informants:

- Community role: “unique access” to, or experience of, the target of research interest
- Knowledge: ability to meaningfully synthesise their experiences and offer insights.
- Willingness to engage with researchers: relative ease to be recruited.
- Impartiality: biases should be minimal.

Interview questions

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1. Address why the amount of irrigation applied may differ between different areas in the same year
2. Explore the extent of year-to-year variation in amount of irrigation applied
3. Explore the past and future trend in water use
4. Explore relevance of information on evapotranspiration (ETo) in determining the amount of water applied

Almonds

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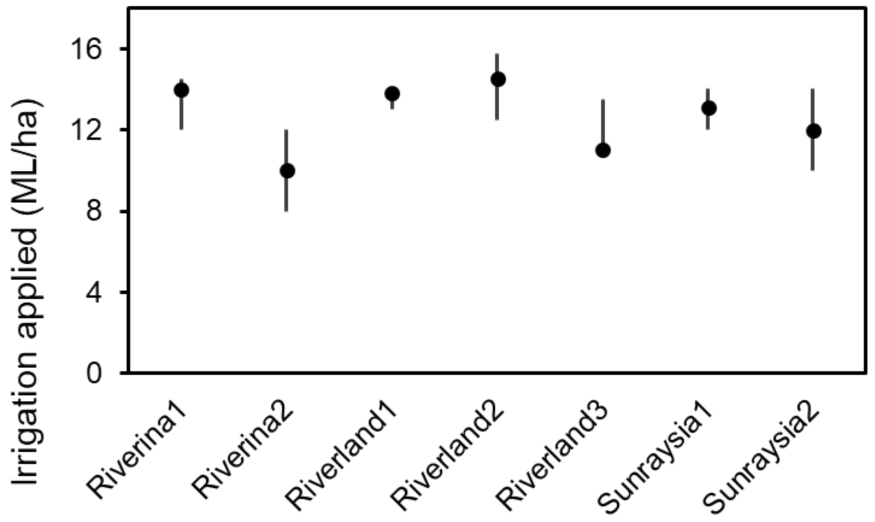
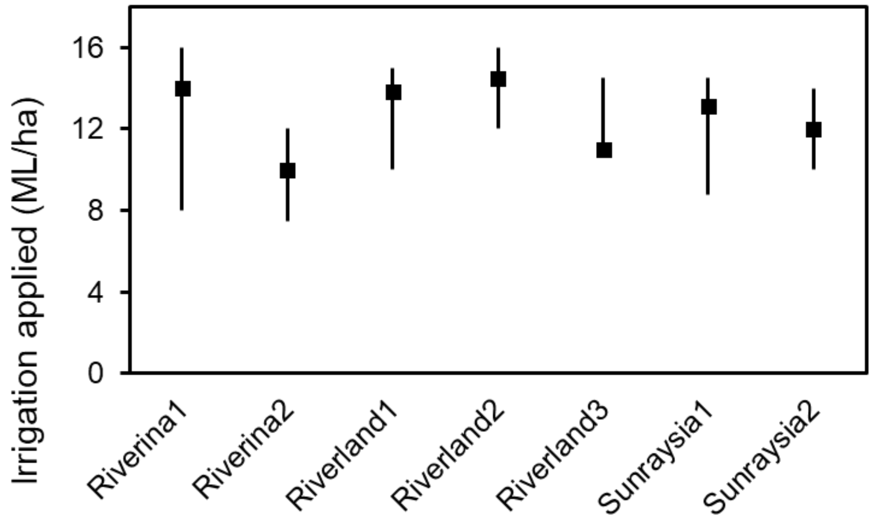
Management Variation



Seasonal Variation



Average 12.6 ML/ha (10-14.5 ML/ha)
Management 1.5-2.5 ML/ha

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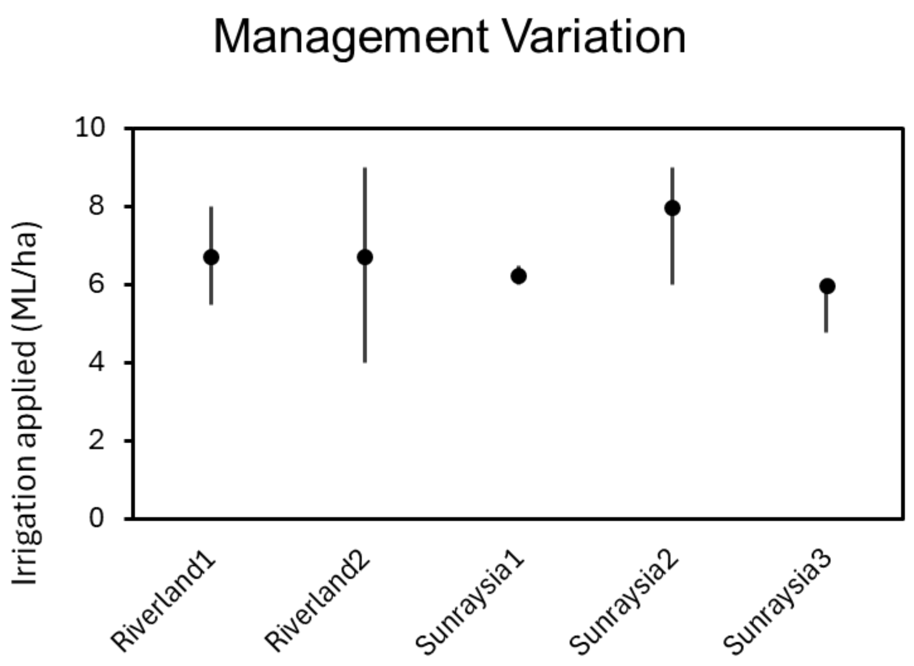
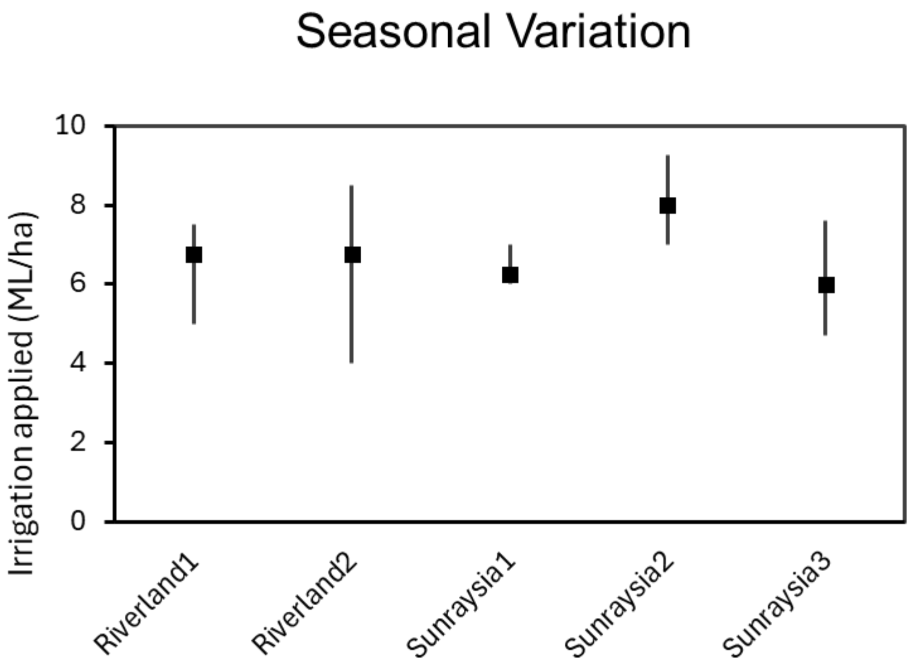
Wine Grapes





Average 6.8 ML/ha (6.25-8 ML/ha)
Management 1.5-2.75 ML/ha

Cotton

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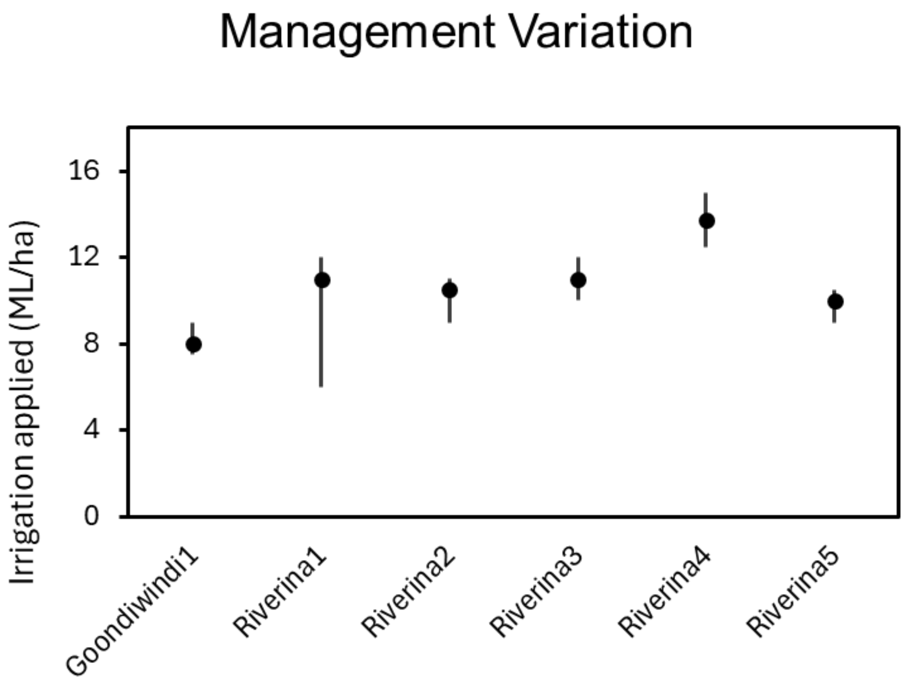
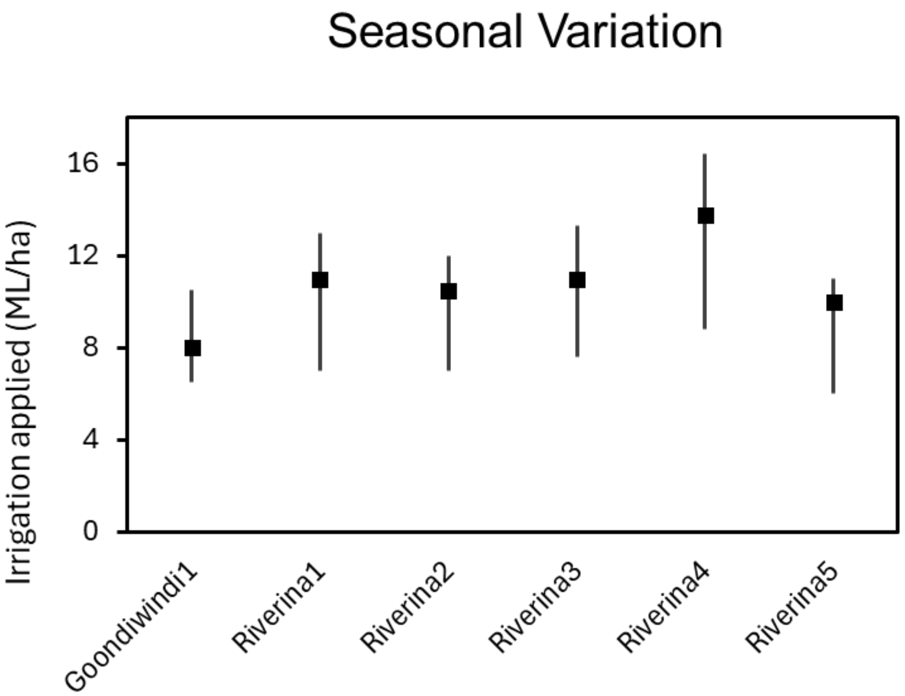
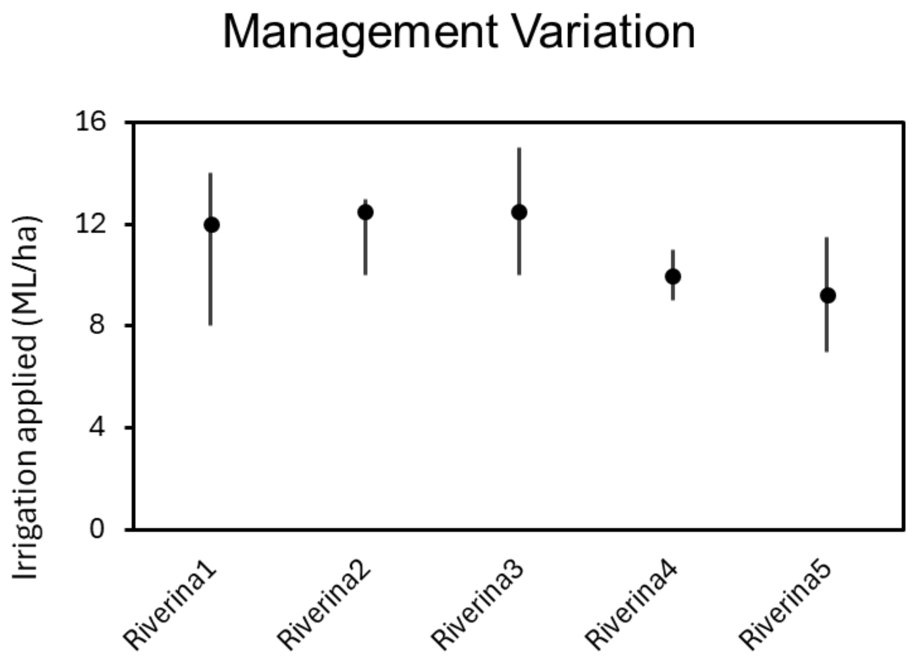
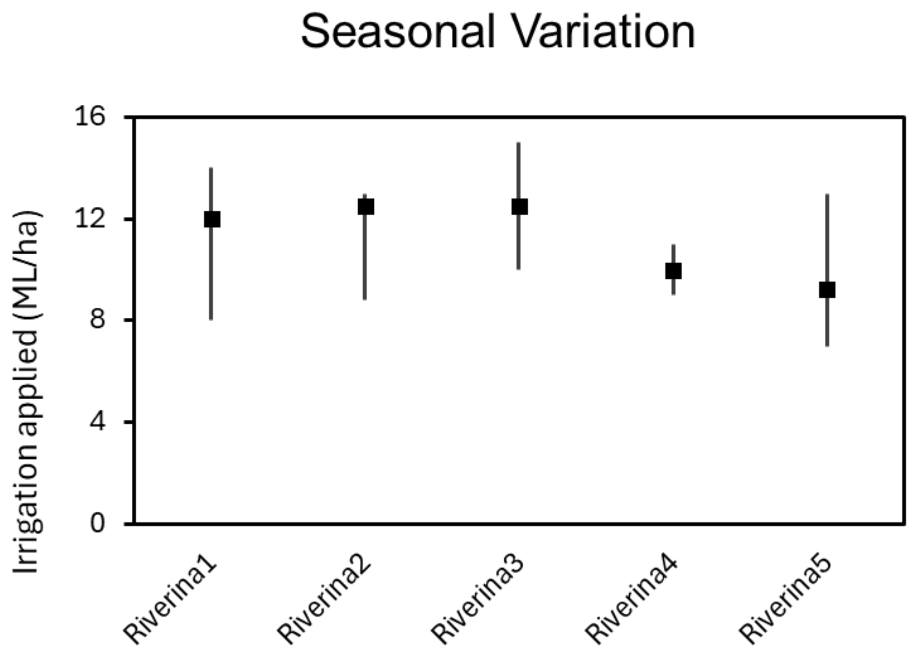




Average 10.7 ML/ha (8-13.8 ML/ha)
Management 2-5 ML/ha

Rice





Average 11.3 ML/ha (9.25-12.5 ML/ha)
Management 2.5-4 ML/ha

Interview Conclusions

- Variation in expert defined irrigation requirements
  - Between seasons
  - Sites and management
- Adaptive capacity

Study Area and Case Study Regions

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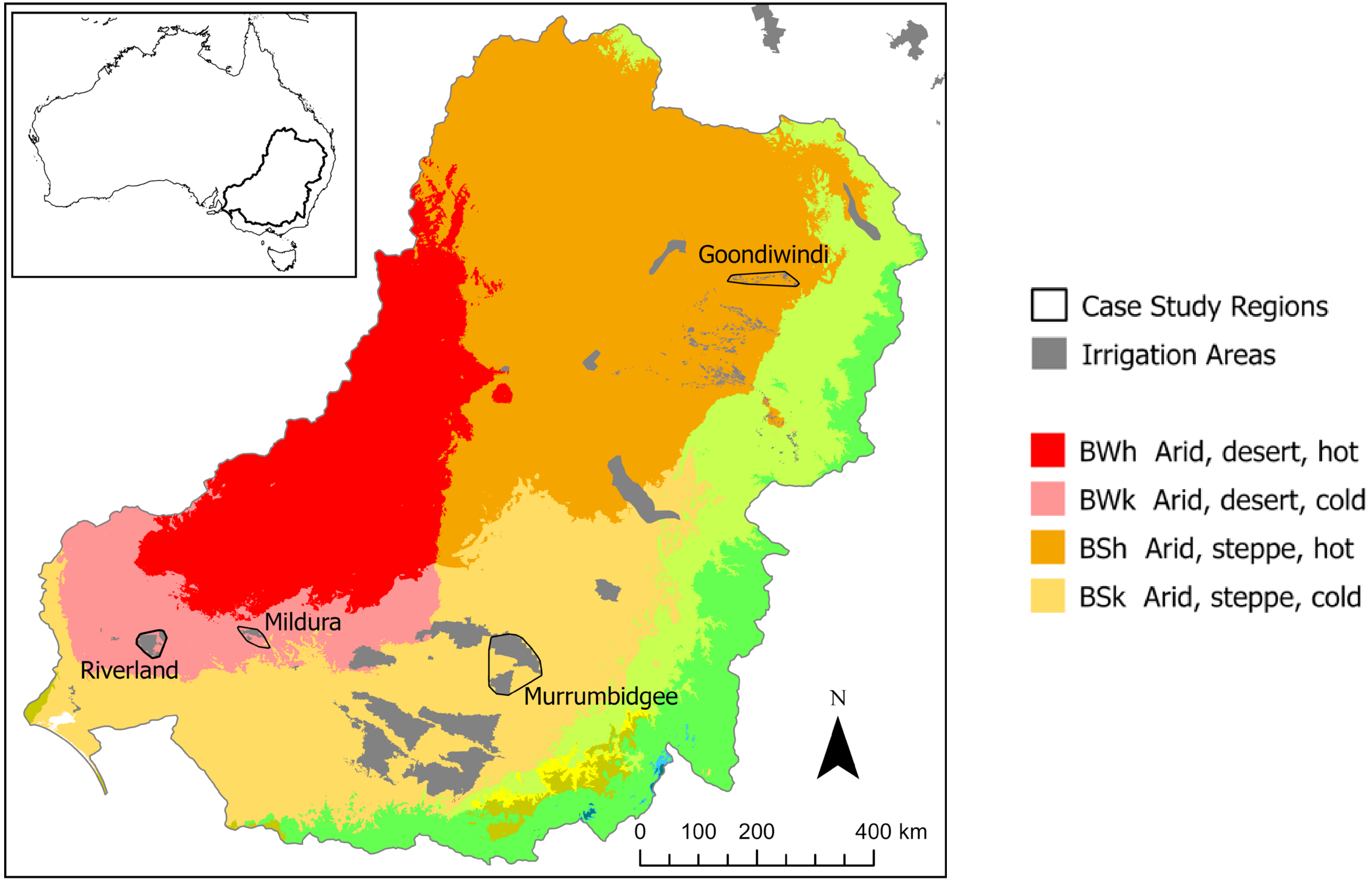
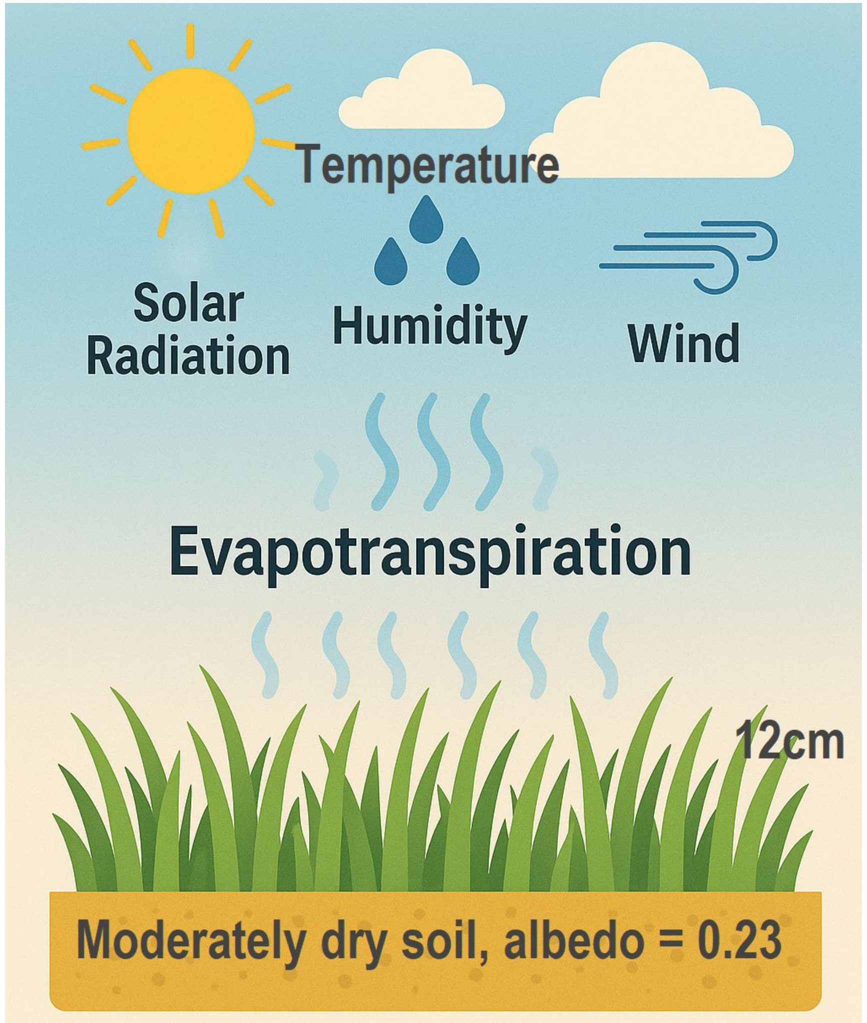
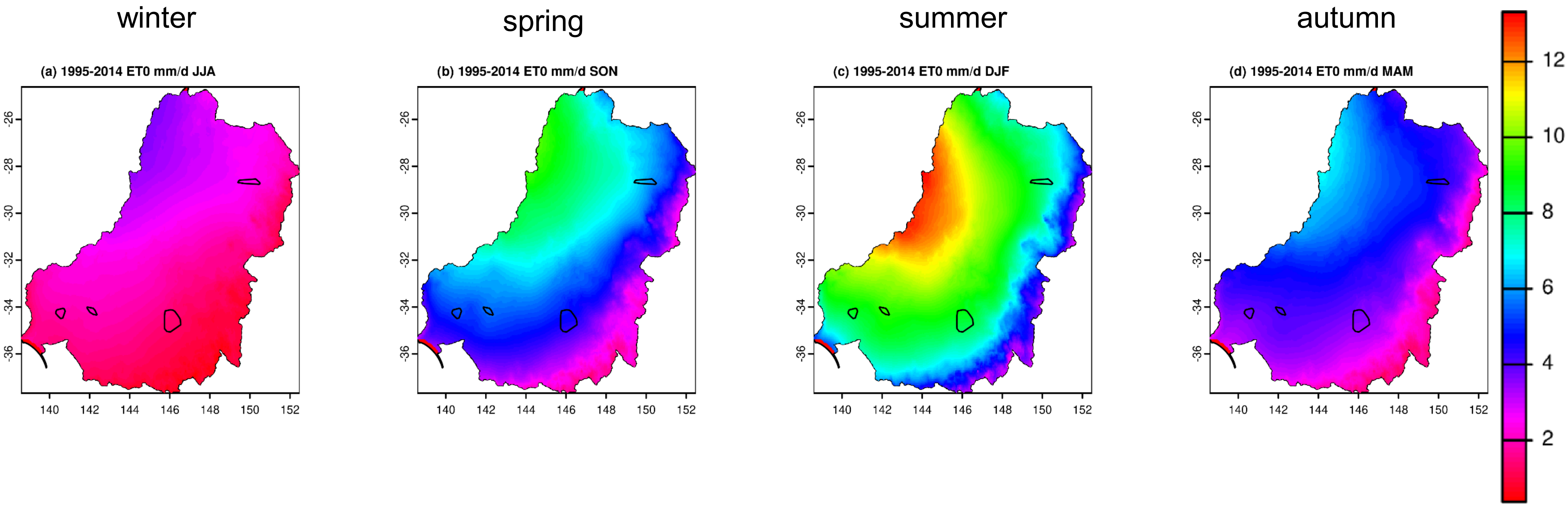


Reference Evapotranspiration

- FAO-56 Penman-Monteith
- Strong physics-based method
- Calculated monthly for reference period 1995–2014
- SILO interpolated min / max temperature, humidity, incoming shortwave radiation
- CSIRO interpolated wind speed

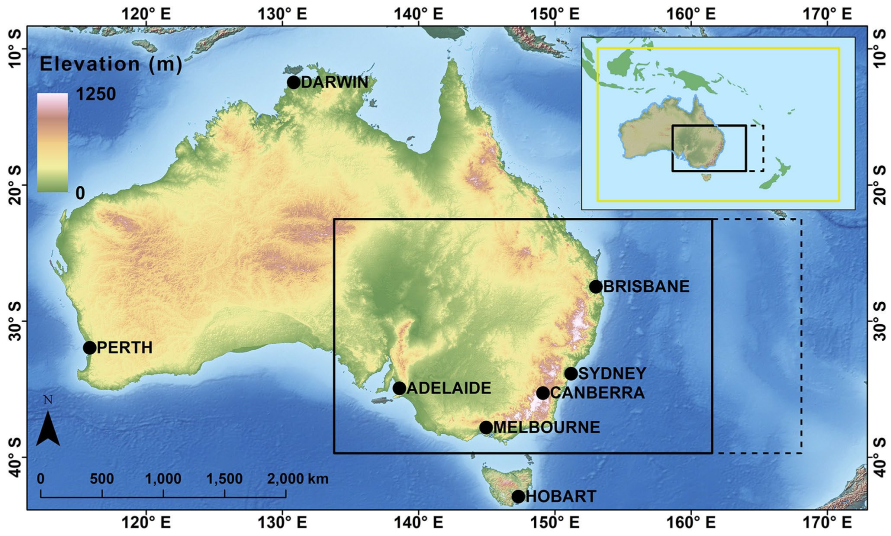


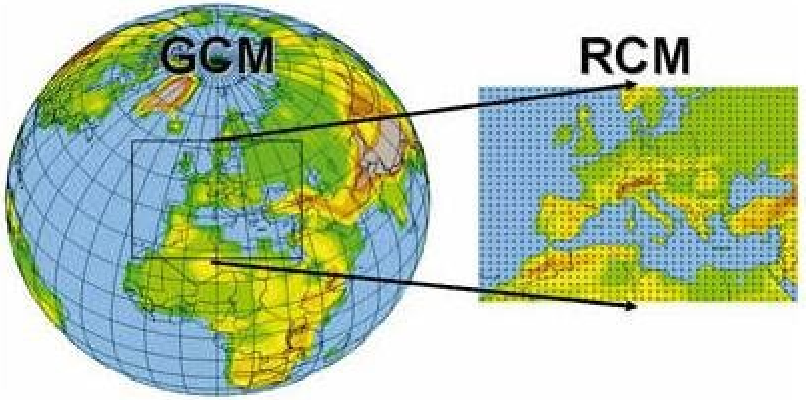
1995–2014 Observed Seasonal ET_0 (mm/day)



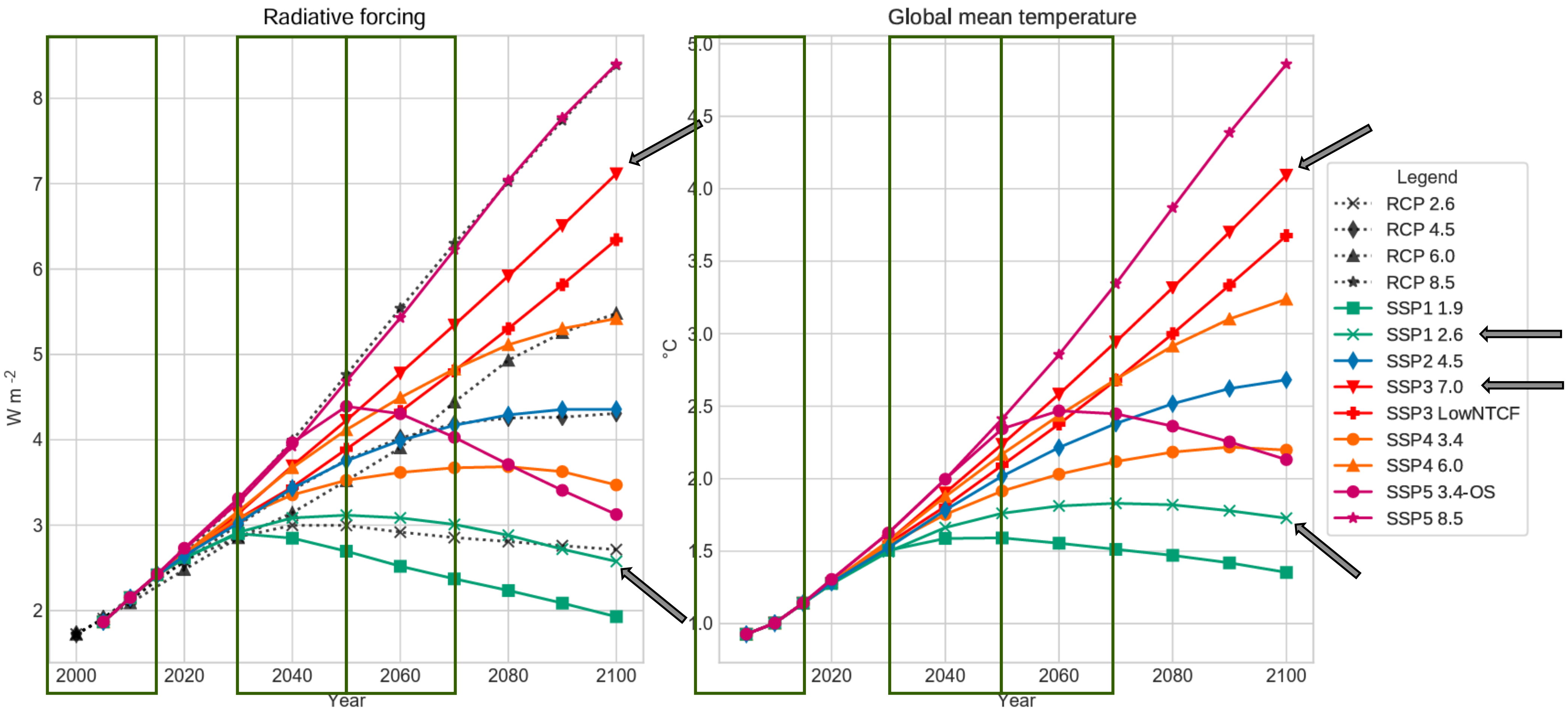
Projected Climate

- New South Wales and Australian Regional Climate Modelling Version 2.0 (NARCliM2.0)
- 5 global climate models:
  - ACCESS-ESM1-5
  - EC-Earth3-Veg
  - MPI-ESM1-2-HR
  - NorESM2-MM
  - UKESM1-0-LL
- 2 *specifically designed* regional climate model downscaling processes
  - ~1000 km grid cells to ~4 km grid cells
- 2 Shared Socioeconomic Pathways:
  - SSP1-2.6 and SSP3-7.0



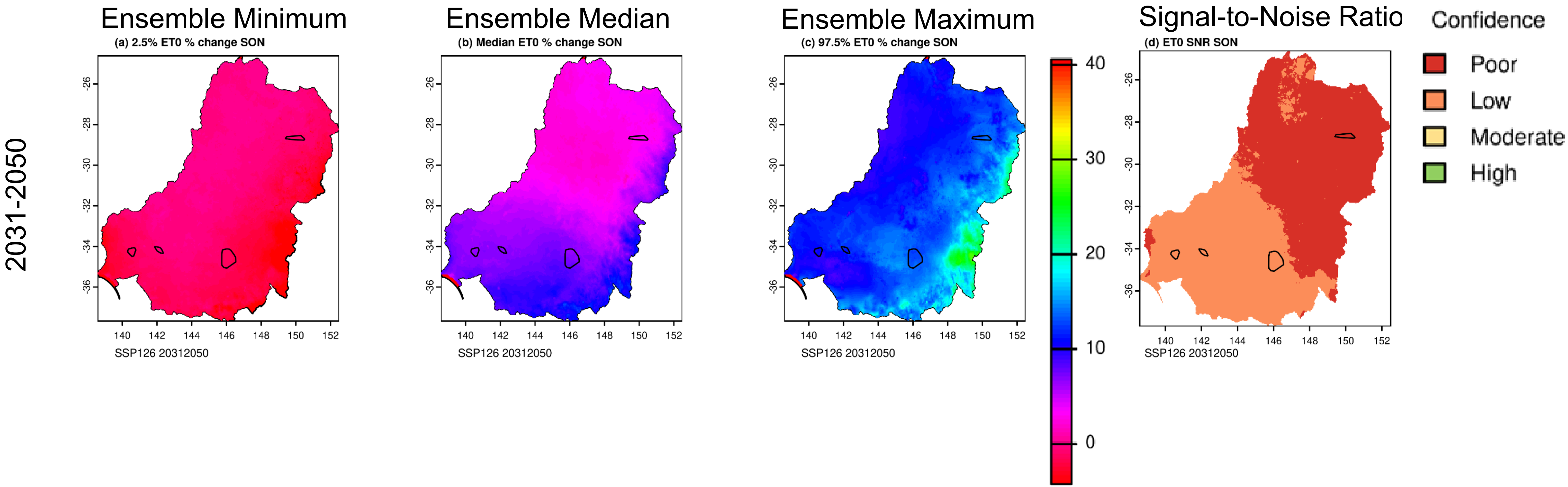


Shared Socioeconomic Pathways

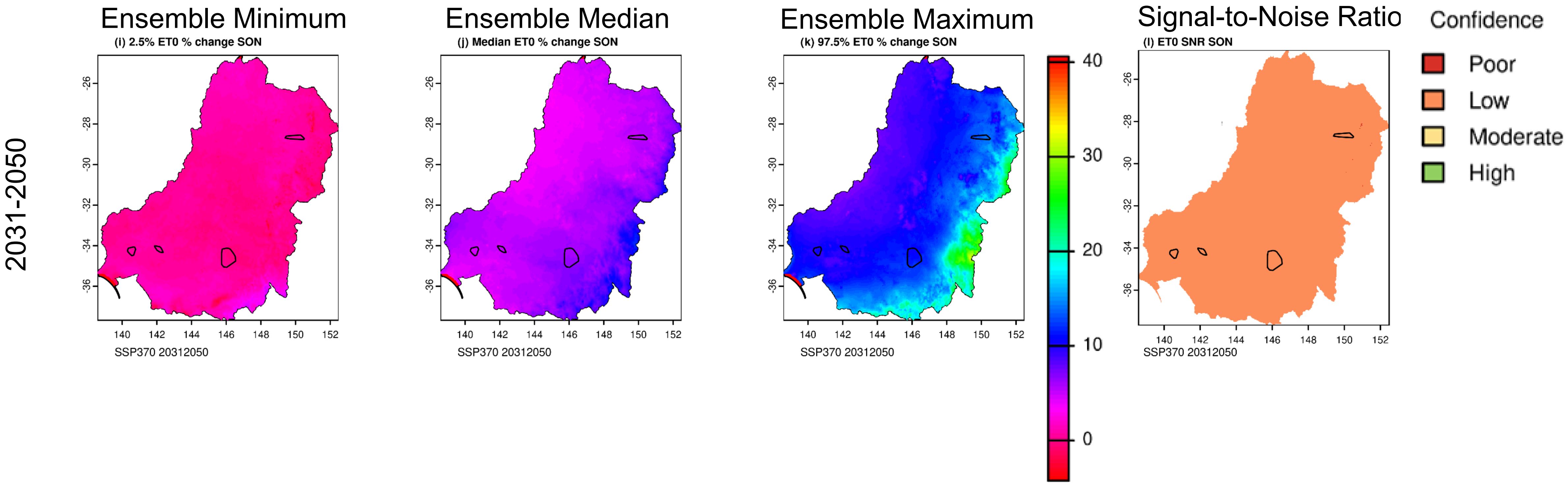


Source: Gidden, M.J., K. Riahi, et al. (2019) "Global Emissions Pathways under Different Socioeconomic Scenarios for Use in CMIP6: A Dataset of Harmonized Emissions Trajectories through the End of the Century." Geosci. Model Dev. 12, no. 4: 1443-75.

Spring ET_0 % Change – SSP1-26

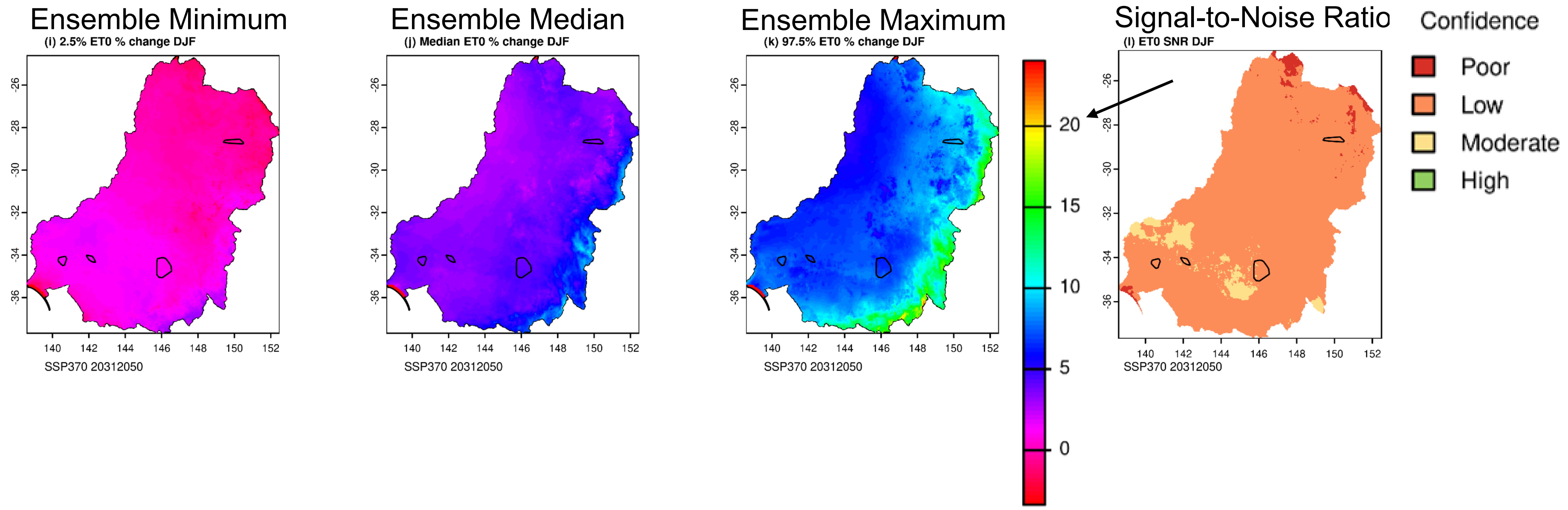


Spring ET_0 % Change – SSP3-70

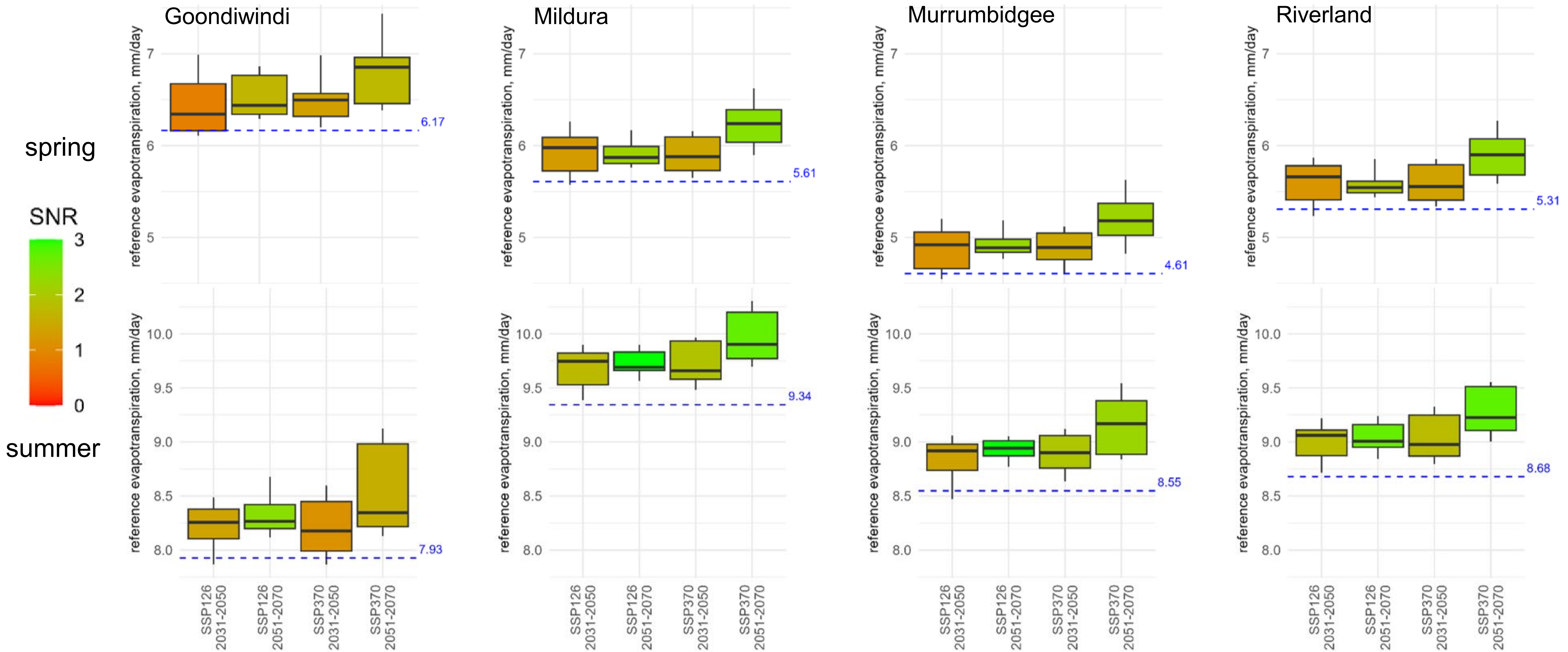


Summer ET_0 % Change – SSP3-70

2031-2050



Case Study Areas Change in ET_0 (mm/day)



Spring Precipitation Flux % Change – SSP3-70

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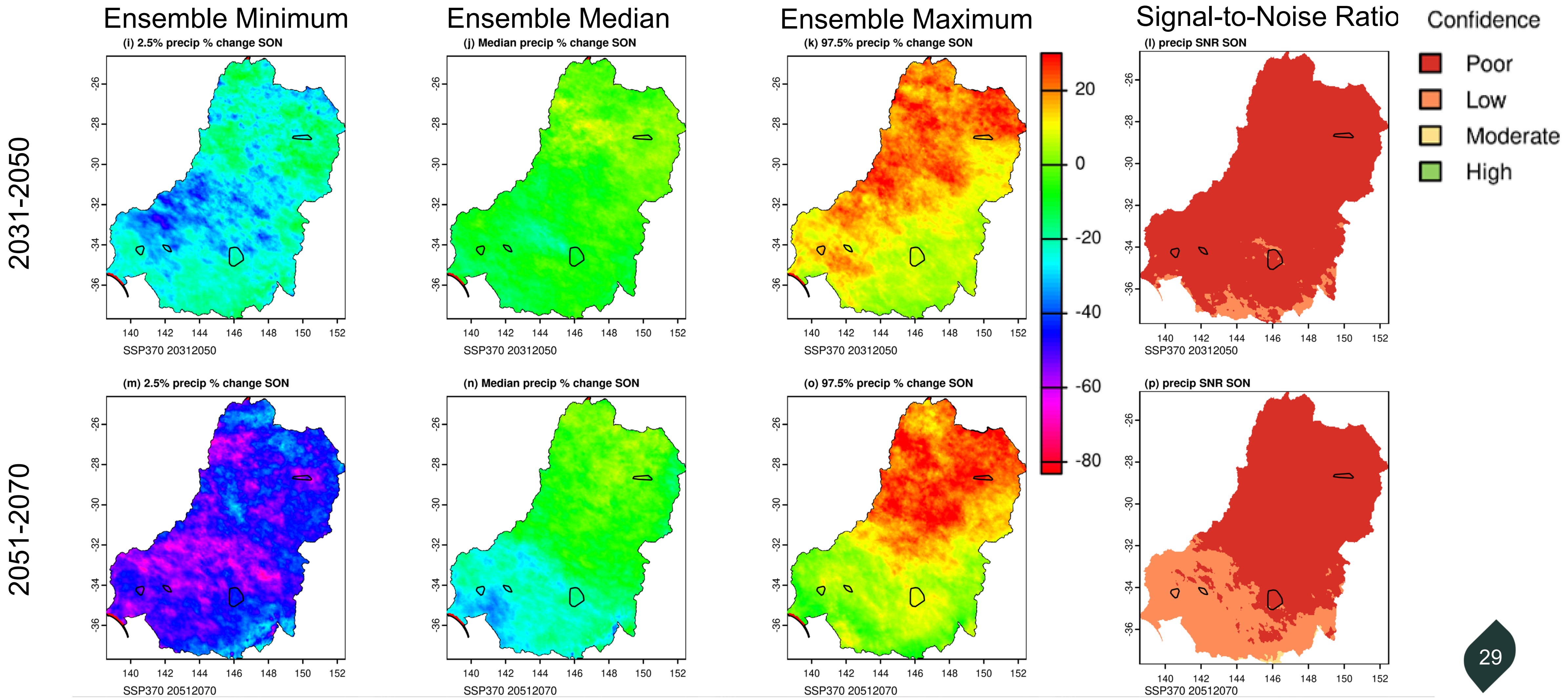
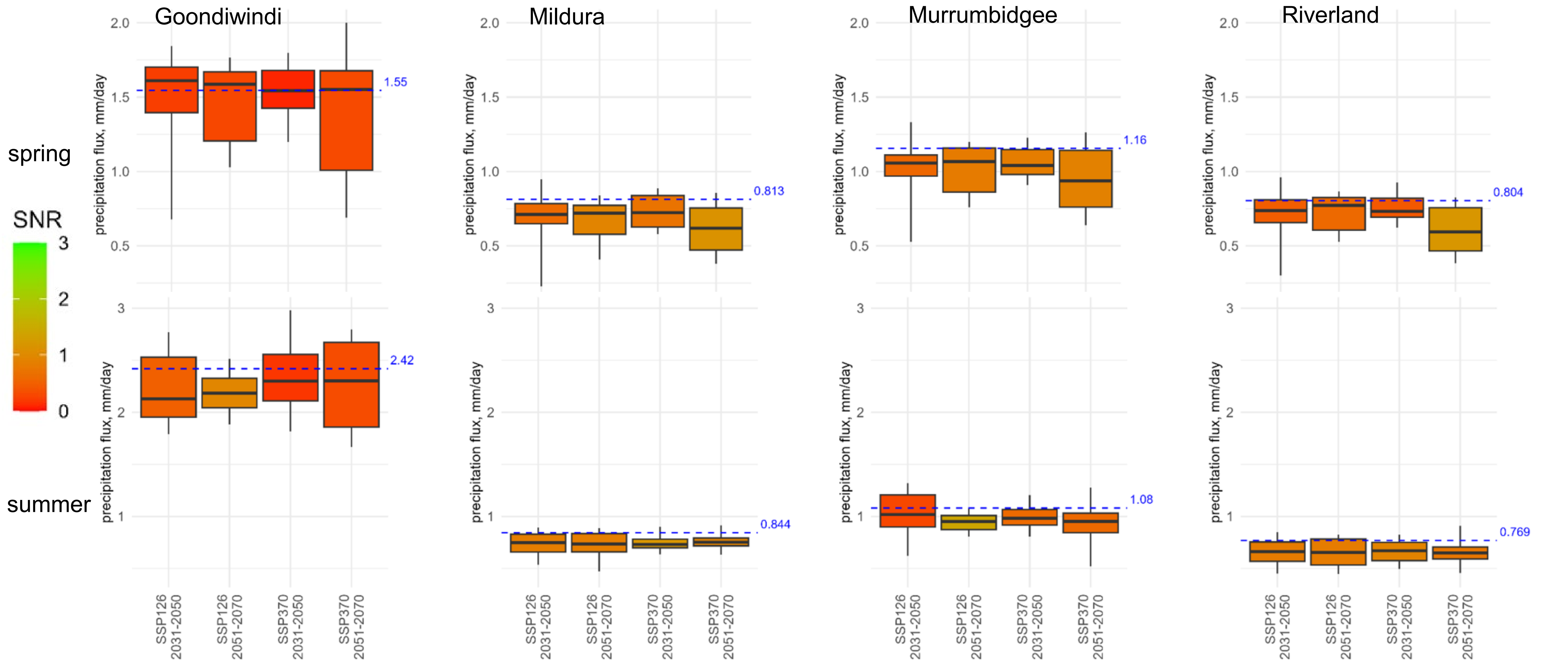


Case Study Areas Change in Precipitation Flux (mm/day)



Mildura

Projection Period	Reference ET_0 (1995 – 2014)	Ensemble Median ET_0 Change	95% Uncertainty Range	Signal-to-Noise Ratio	Ensemble Median Additional Irrigation Demand ($K_c = 1$)
spring 2031-2050	5.61 mm/day	+ 5.8%	- 0.5%, + 11.8%	1.34	0.30 ML/ha
summer 2031-2050	9.34 mm/day	+ 4.0%	+ 0.4%, + 6.9%	1.83	0.37 ML/ha
spring 2051-2070	5.61 mm/day	+ 8.1%	+ 2.9%, + 18.4%	2.30	0.41 ML/ha
summer 2051-2070	9.34 mm/day	+ 5.0%	+ 2.4%, + 10.5%	3.02	0.42 ML/ha

Riverland

Projection Period	Reference ET_0 (1995 – 2014)	Ensemble Median ET_0 Change	95% Uncertainty Range	Signal-to-Noise Ratio	Ensemble Median Additional Irrigation Demand (K_c = 1)
spring 2031-2050	5.31 mm/day	+ 5.6%	- 1.3%, + 10.9%	1.26	0.27 ML/ha
summer 2031-2050	8.68 mm/day	+ 4.1%	+ 0.5%, + 7.5%	1.78	0.37 ML/ha
spring 2051-2070	5.31 mm/day	+ 7.8%	+ 2.5%, + 18.4%	2.13	0.32 ML/ha
summer 2051-2070	8.68 mm/day	+ 5.1%	+ 2.0%, + 10.3%	2.73	0.39 ML/ha

Murrumbidgee

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Projection Period	Reference ET_0 (1995 – 2014)	Ensemble Median ET_0 Change	95% Uncertainty Range	Signal-to-Noise Ratio	Ensemble Median Additional Irrigation Demand (K_c = 1)
spring 2031-2050	4.61 mm/day	+ 6.6%	- 1.4%, + 12.9%	1.29	0.27 ML/ha
summer 2031-2050	8.55 mm/day	+ 4.2%	- 0.8%, + 6.6%	1.66	0.33 ML/ha
spring 2051-2070	4.61 mm/day	+ 9.4%	+ 3.5%, + 22.2%	2.22	0.39 ML/ha
summer 2051-2070	8.55 mm/day	+ 5.9%	+ 2.6%, + 11.6%	3.00	0.45 ML/ha

Goondiwindi

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Projection Period	Reference ET_0 (1995 – 2014)	Ensemble Median ET_0 Change	95% Uncertainty Range	Signal-to-Noise Ratio	Ensemble Median Additional Irrigation Demand (K_c = 1)
spring 2031-2050	6.17 mm/day	+ 4.1%	- 0.8%, + 13.6%	1.10	0.23 ML/ha
summer 2031-2050	7.93 mm/day	+ 4.3%	- 0.6%, + 8.7%	1.25	0.31 ML/ha
spring 2051-2070	6.17 mm/day	+ 8.2%	+ 2.2%, + 20.9%	1.70	0.46 ML/ha
summer 2051-2070	7.93 mm/day	+ 5.2%	+ 3.1%, + 15.8%	1.98	0.37 ML/ha

Preliminary Summary

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- Large uncertainty range in projected ET_0 due to emissions uncertainty and GCM/RCM differences
- Rates of projected increase in ET_0 vary spatially across the MDB, but are more consistent in arid irrigation areas
- 2031–2050 projections have similar ensemble median ET_0 increases of 4.0 – 6.6% across scenarios, but with differing uncertainty levels
- Under high emissions (SSP3) by 2051–2070, ensemble median ET_0 modelled to rise 7.8 – 9.4%, but with a chance of greater increases

Total range of modelled projected irrigation demand

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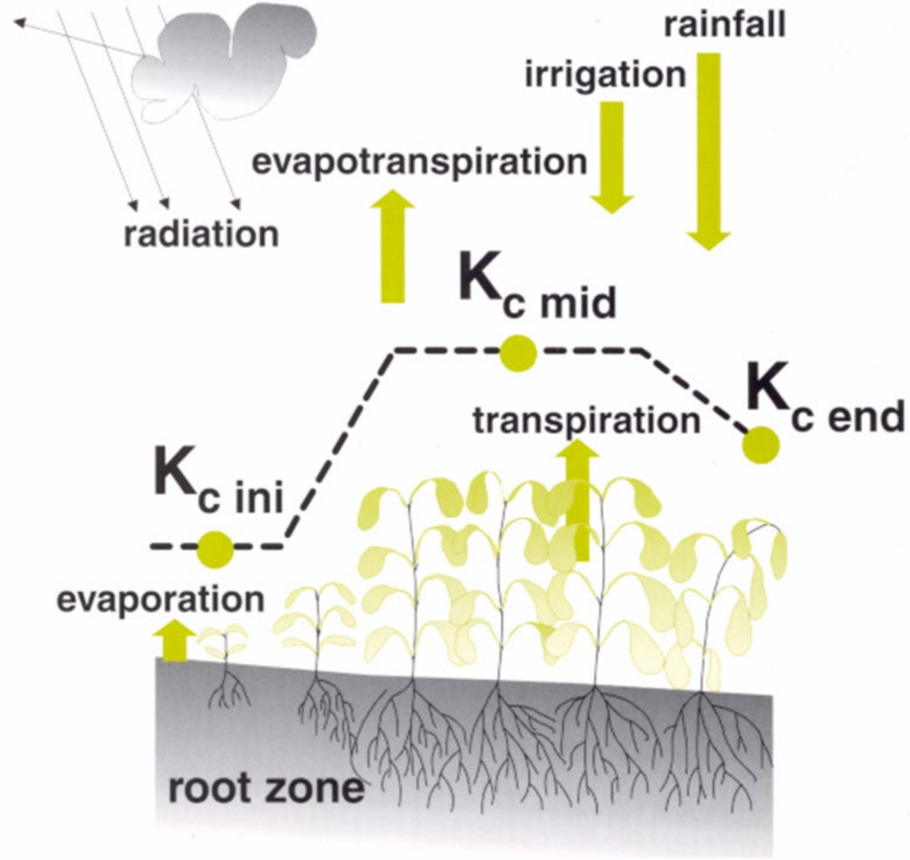
- Ensemble emissions scenarios and climate models irrigation demand across the four case study regions (K_c = 1, 1-Sep – 28-Feb) to rise by:

	2031–2050	*2051–2070*
median	0.54 – 0.63 ML/ha	0.77 – 0.85 ML/ha
minimum	-0.12 – 0.01 ML/ha	0.28 – 0.35 ML/ha
maximum	1.05 – 1.38 ML/ha	1.69 – 2.30 ML/ha

Irrigation Demand

- Penman-Monteith (FAO 56)
- Reference crop evapotranspiration (ETo)
- Canopy size (Kc)
- Rainfall
- Irrigation



Study Area and Case Study Regions

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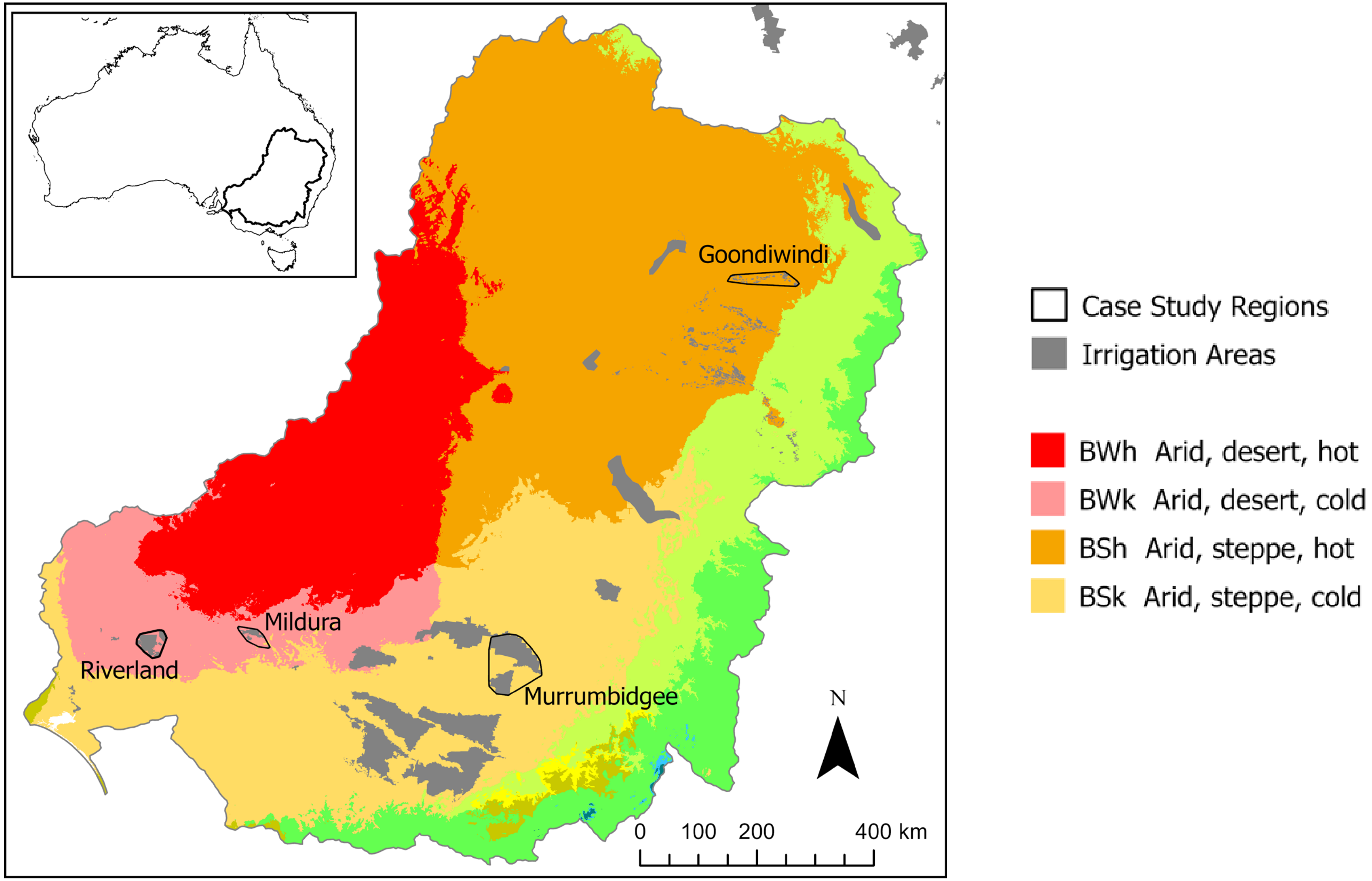
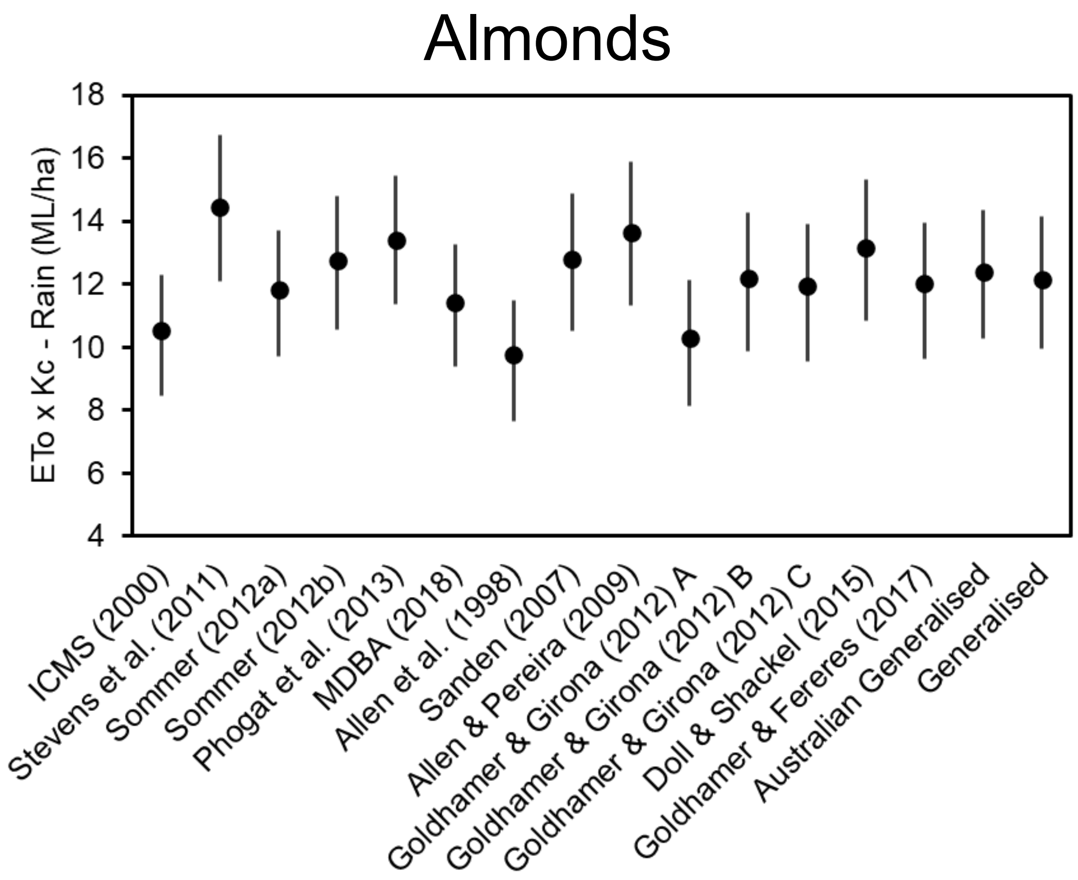
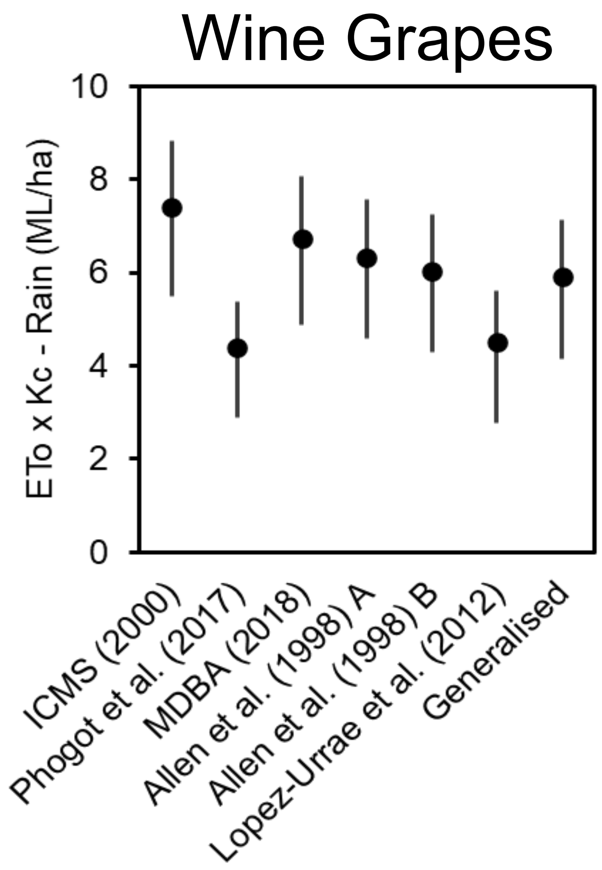


Murrumbidgee Irrigation

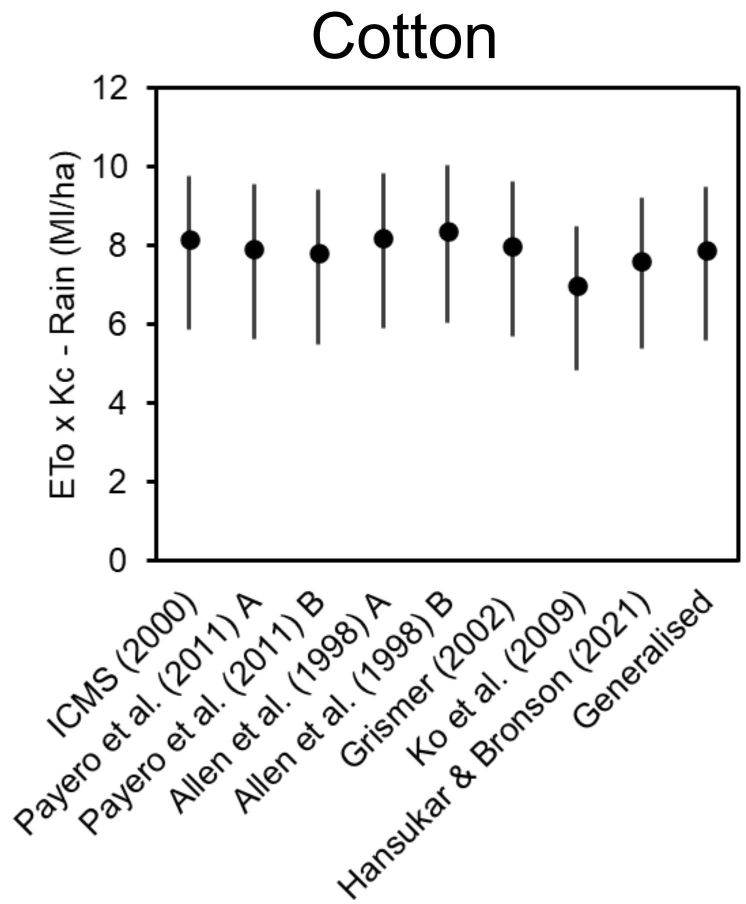


Interview average 12.6 ML/ha

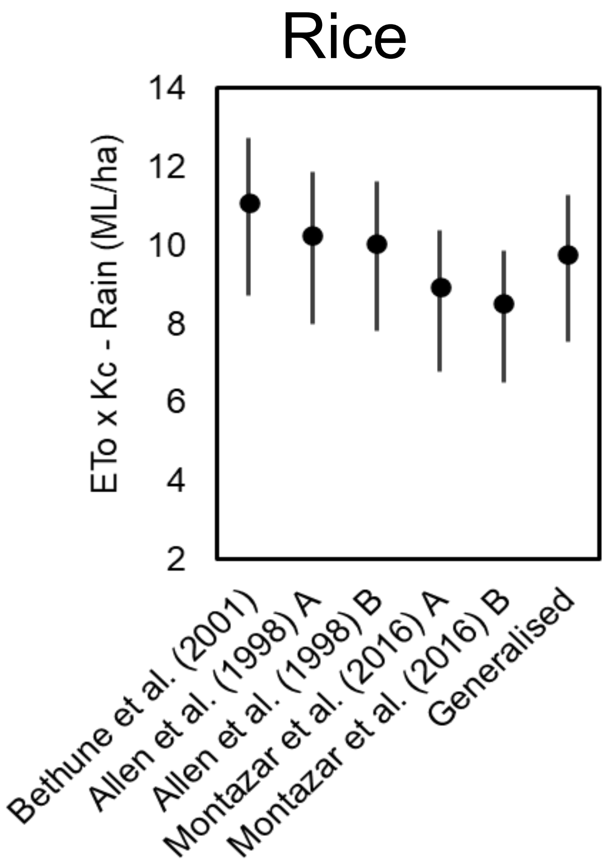


Interview average 6.8 ML/ha

Murrumbidgee Irrigation

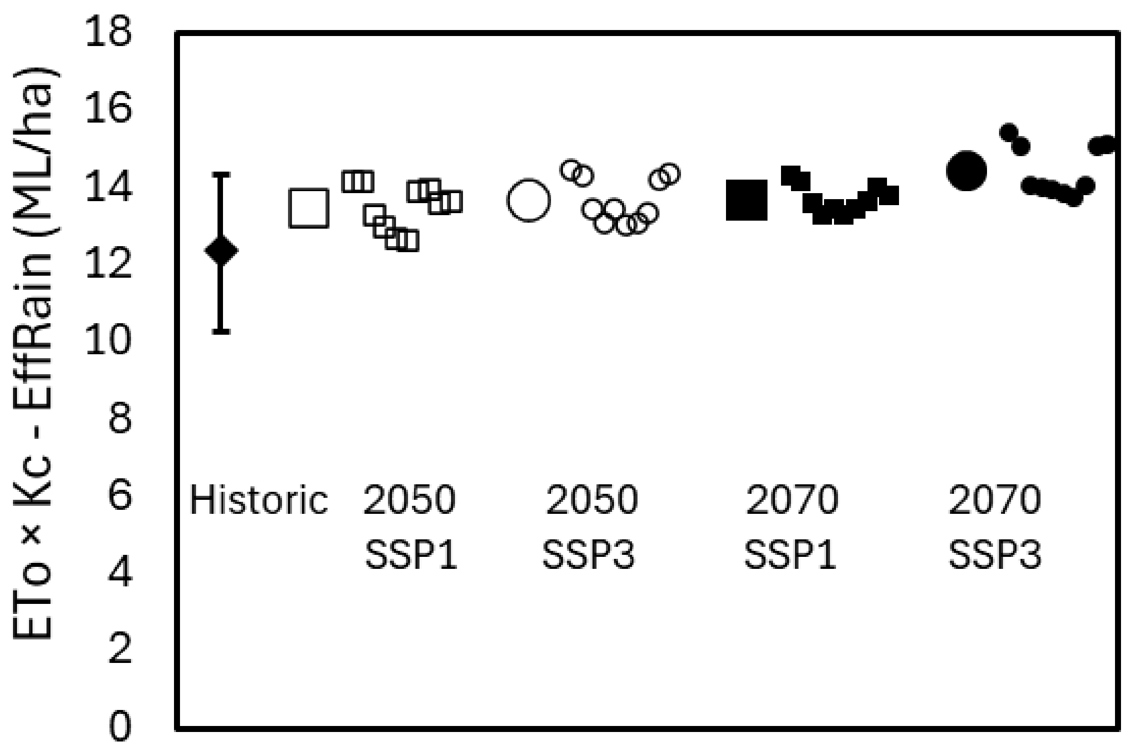


Interview average 10.7 ML/ha



Interview average 11.3 ML/ha

Almond Projections



- Murrumbidgee
- 1.1-2.1 ML/ha increase (9-17%)
- Management 1.5-2.5 ML/ha

Winegrape Projections

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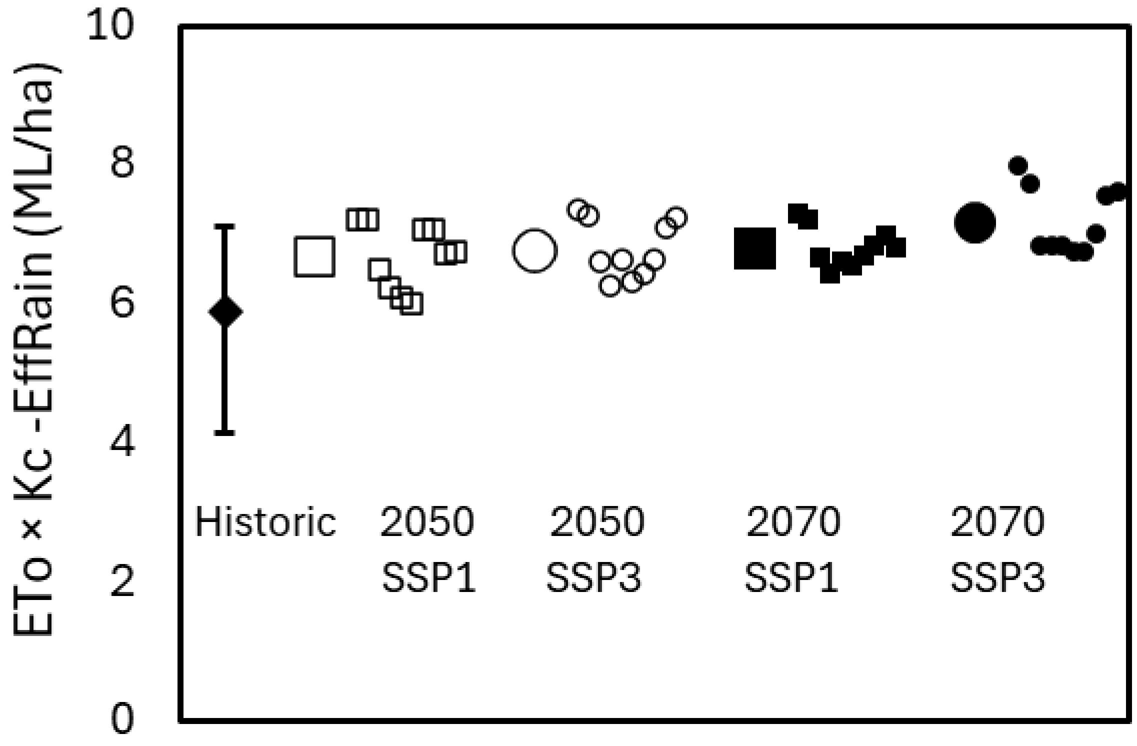
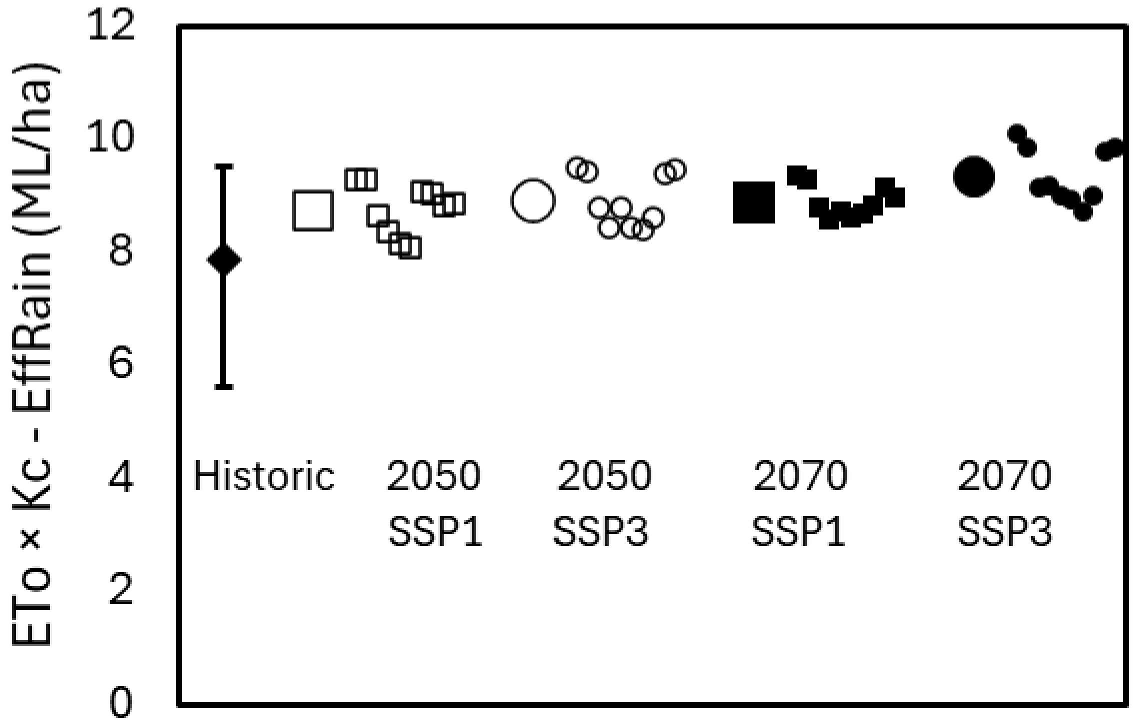


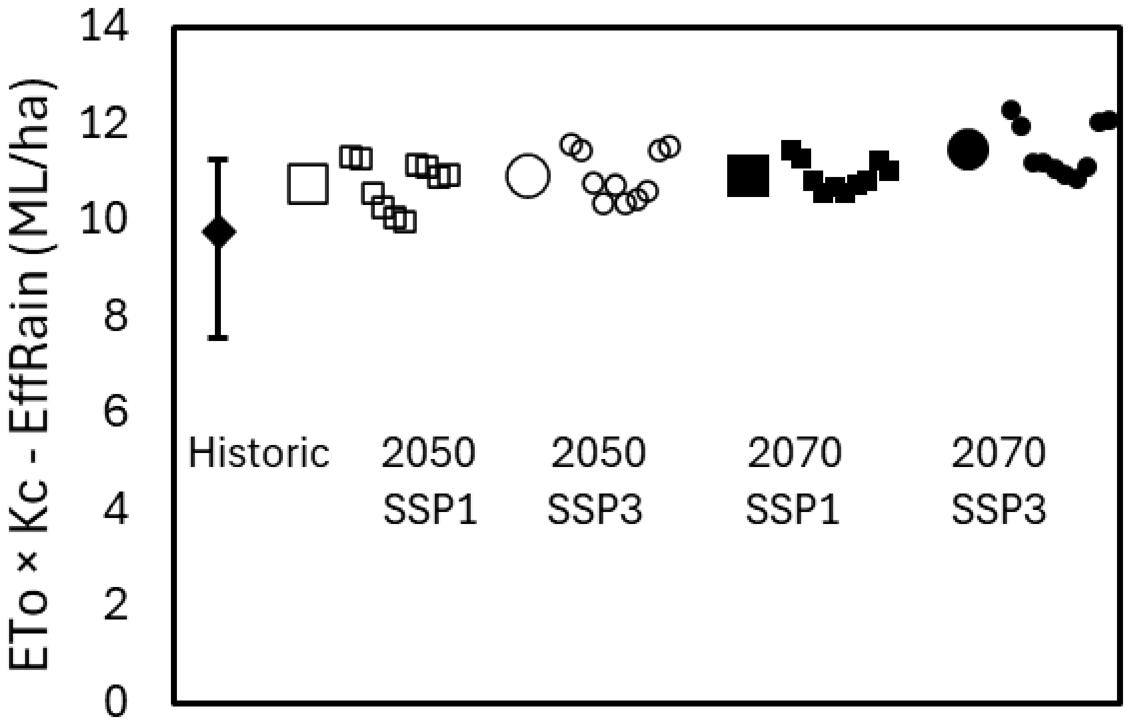
- Murrumbidgee
- 0.8-1.3 ML/ha increase (13-22%)
- Management 1.5-2.75 ML/ha

Cotton Projections



- Murrumbidgee
- 0.9-1.5 ML/ha increase (12-19%)
- Management 2-5 ML/ha

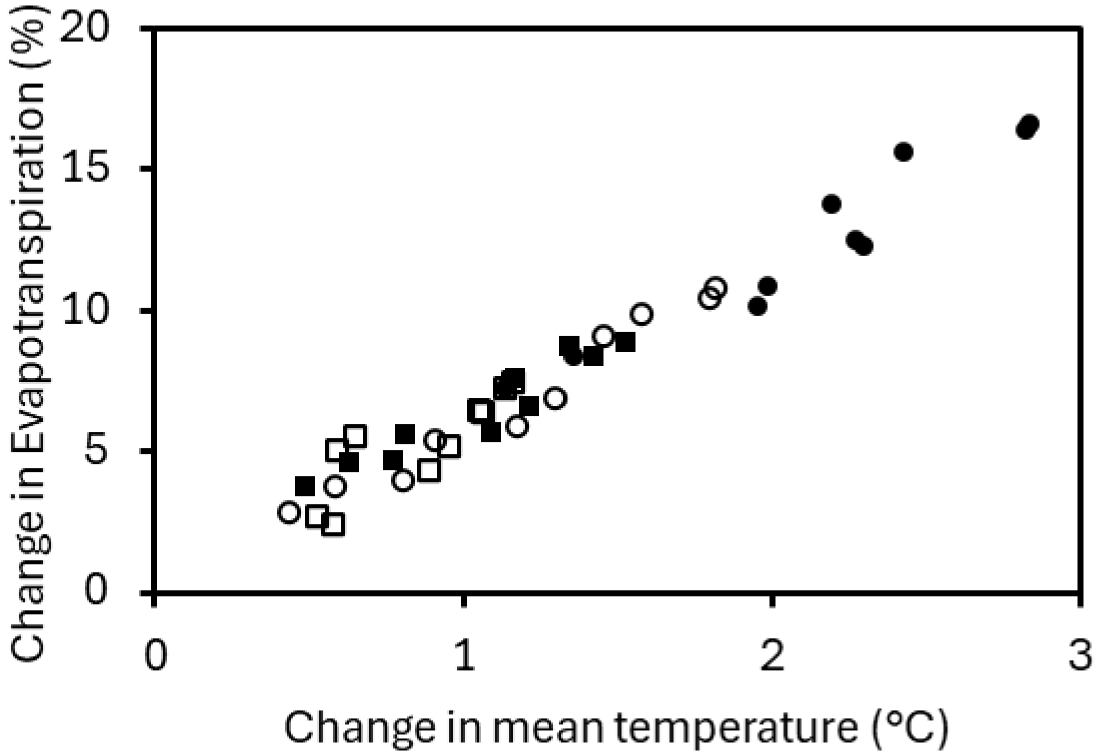
Rice Projections

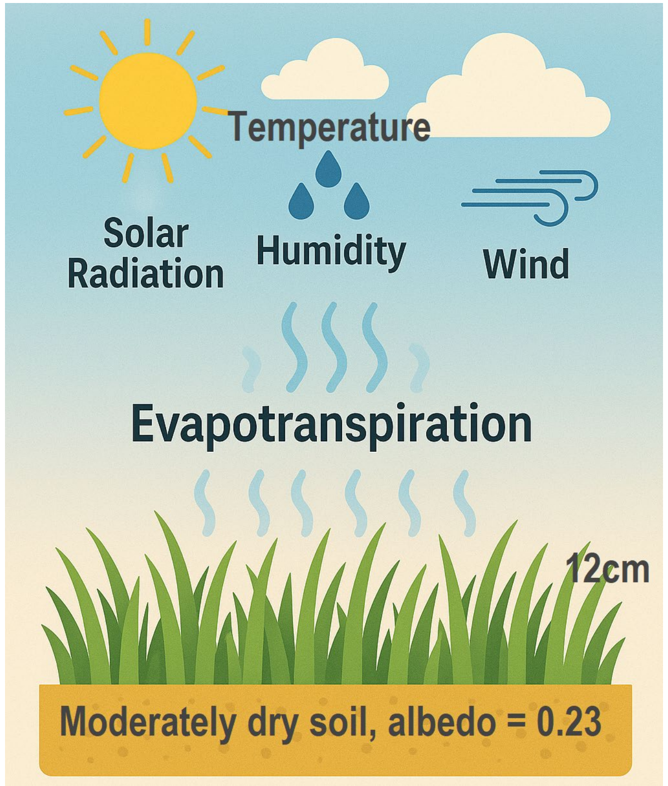


- Murrumbidgee
- 1.0-1.7 ML/ha increase (10-17%)
- Management 2.5-4 ML/ha

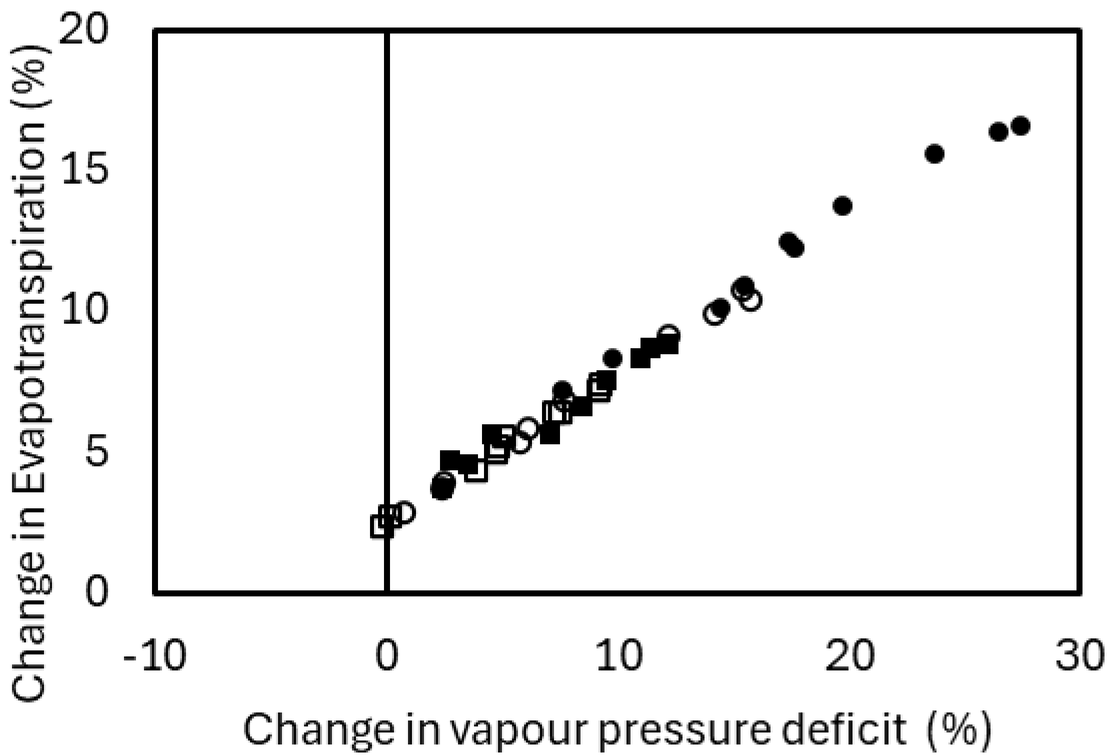
Temperature

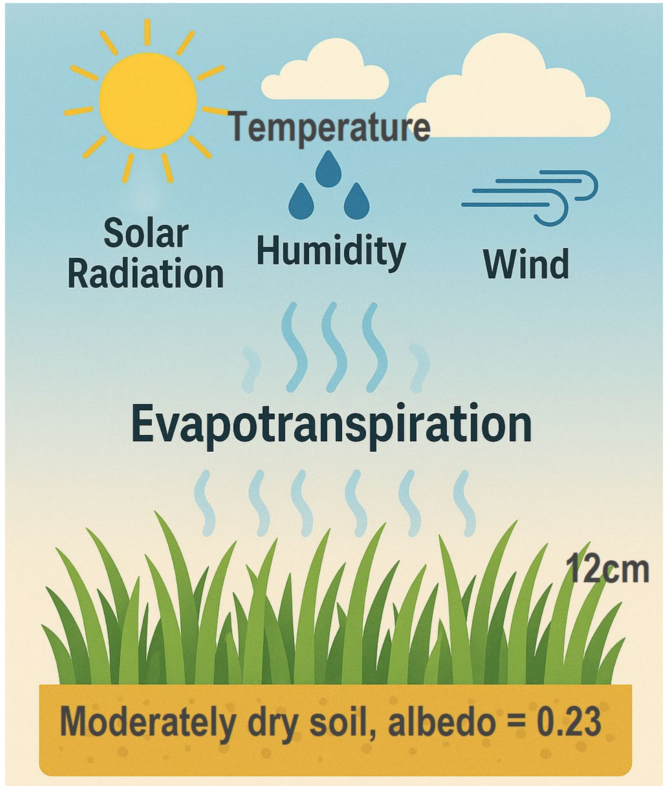
- Where the increases as much as we expected?



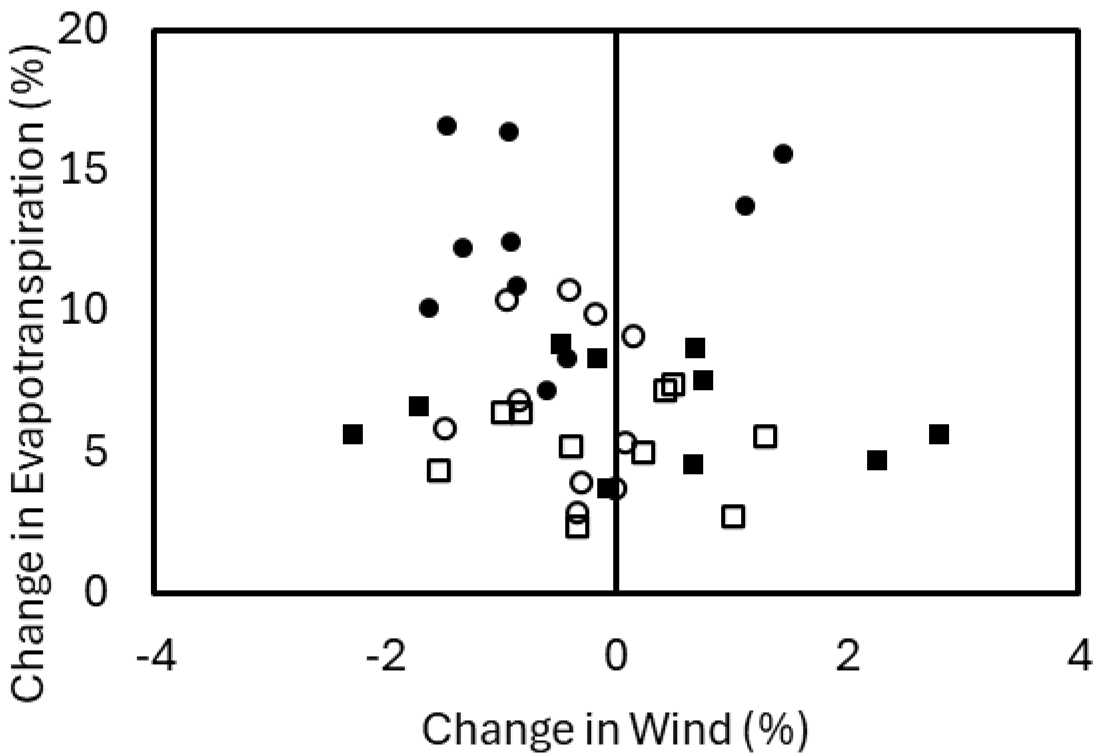


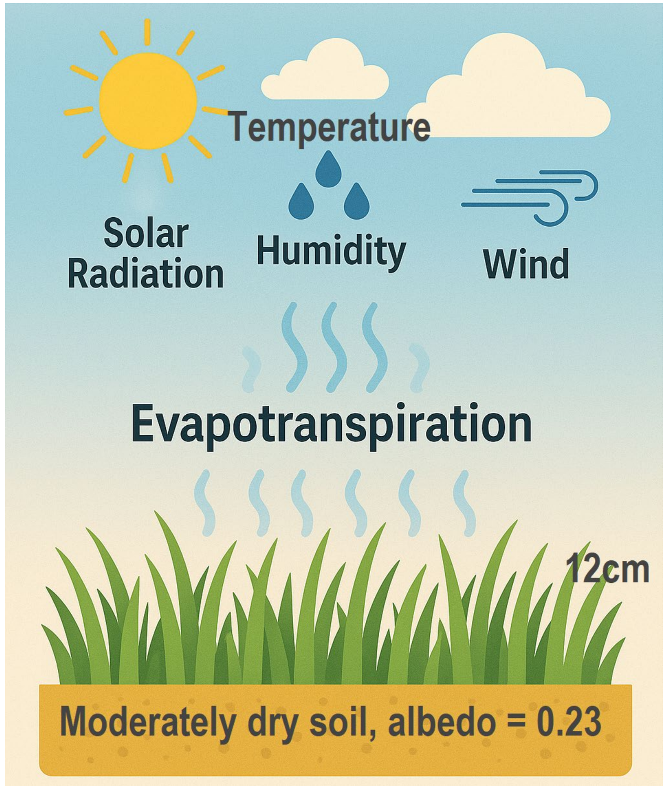
VPD


20
15
10
5
0
-10
0
10
20
30
Change in Evapotranspiration (%)
Change in vapour pressure deficit (%)

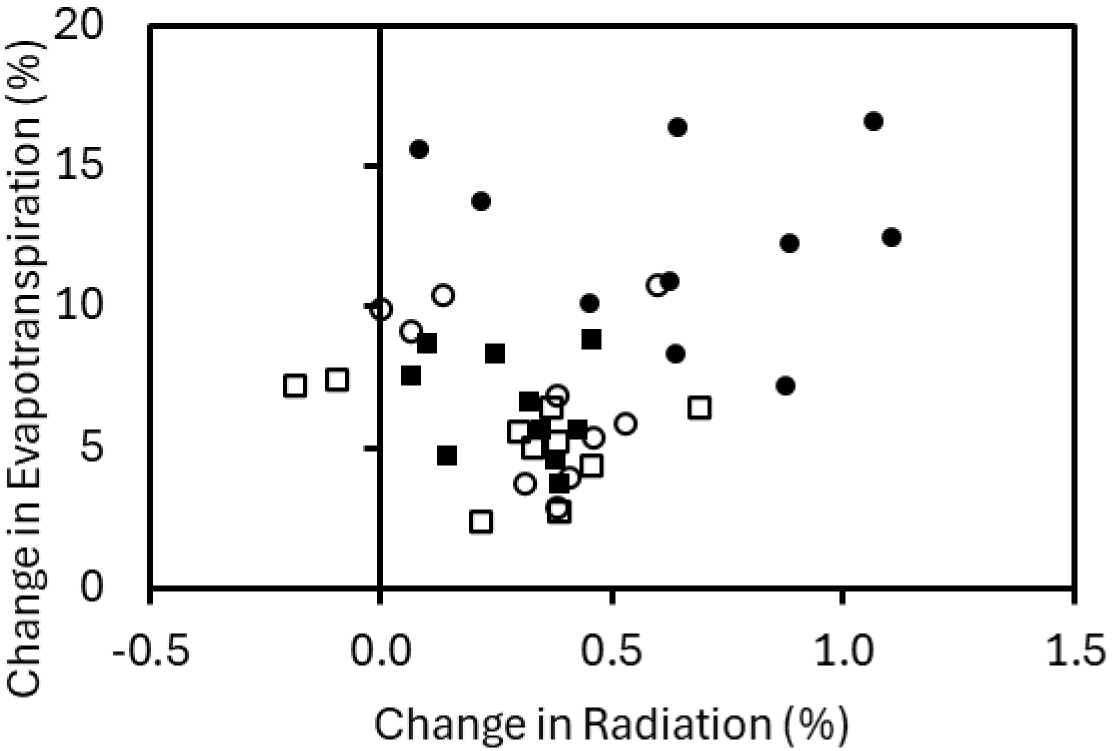

Temperature
Solar Radiation
Humidity
Wind
Evapotranspiration
12cm
Moderately dry soil, albedo = 0.23

Wind

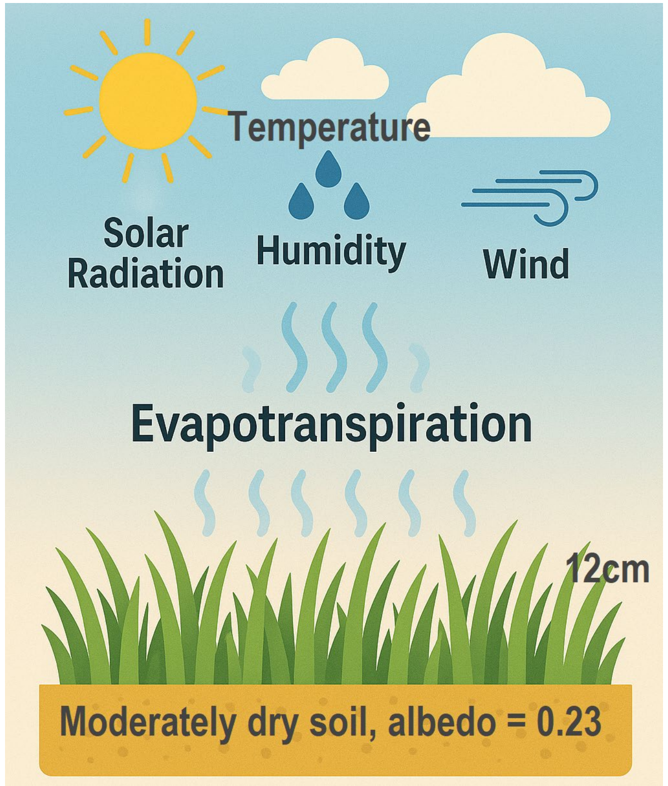

Change in Evapotranspiration (%)
20
15
10
5
0
-4
-2
0
2
4
Change in Wind (%)


Temperature
Solar Radiation
Humidity
Wind
Evapotranspiration
12cm
Moderately dry soil, albedo = 0.23

Radiation



20
15
10
5
0
-0.5
0.0
0.5
1.0
1.5
Change in Evapotranspiration (%)
Change in Radiation (%)



Temperature
Solar Radiation
Humidity
Wind
Evapotranspiration
12cm
Moderately dry soil, albedo = 0.23

Conclusions

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- Irrigation demand increased by up to 20% by 2070 at higher emissions scenarios
- Our irrigators adaptive capacity is also in this range
- Very high confidence in increasing temperatures
- Medium or lower confidence in changes to other drivers of irrigation demand
    - Rainfall, windspeed, radiation

Questions?

Thank you

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Thanks for attending

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Recording link will be emailed to you and uploaded to the AWS website and YouTube channel.

As a live attendee, you will receive a Certificate of Attendance within the next *two business days.* This may count toward your Continuing Professional Development hours.

A short 1-minute survey will pop up at the webinar's conclusion *or complete it on your phone now by scanning the QR code.*

SCAN ME

Enjoyed the webinar today?
See you at the next month's One Basin Webinar:

3rd September - details to come…

Our partners

ONE BASIN CRC

End-user organisations

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Knowledge agencies