



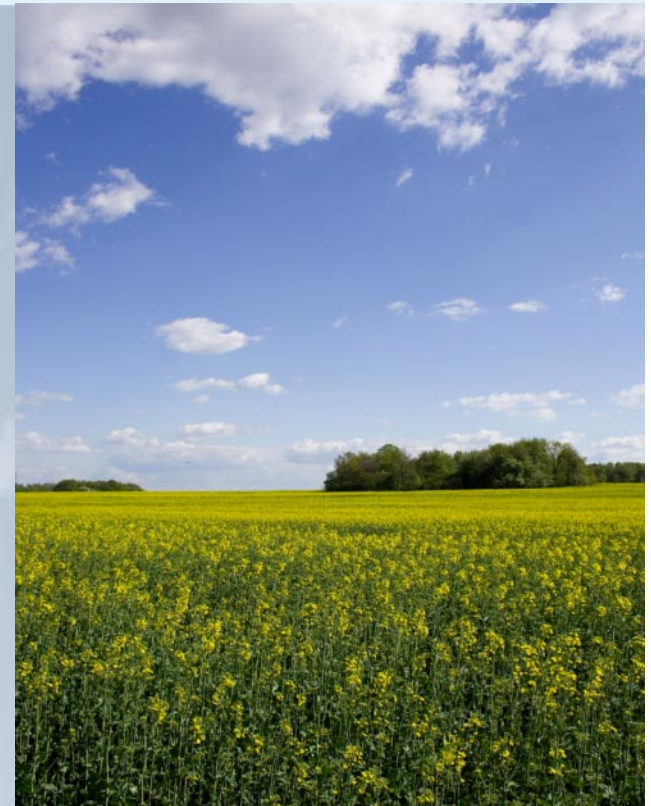
Australian Government

Bureau of Meteorology

Climate Outlook Services

What are they, how can you build one, how it takes time and effort, and why it is worth it!

Debbie Hudson and Andrew Watkins, Australian Bureau of Meteorology



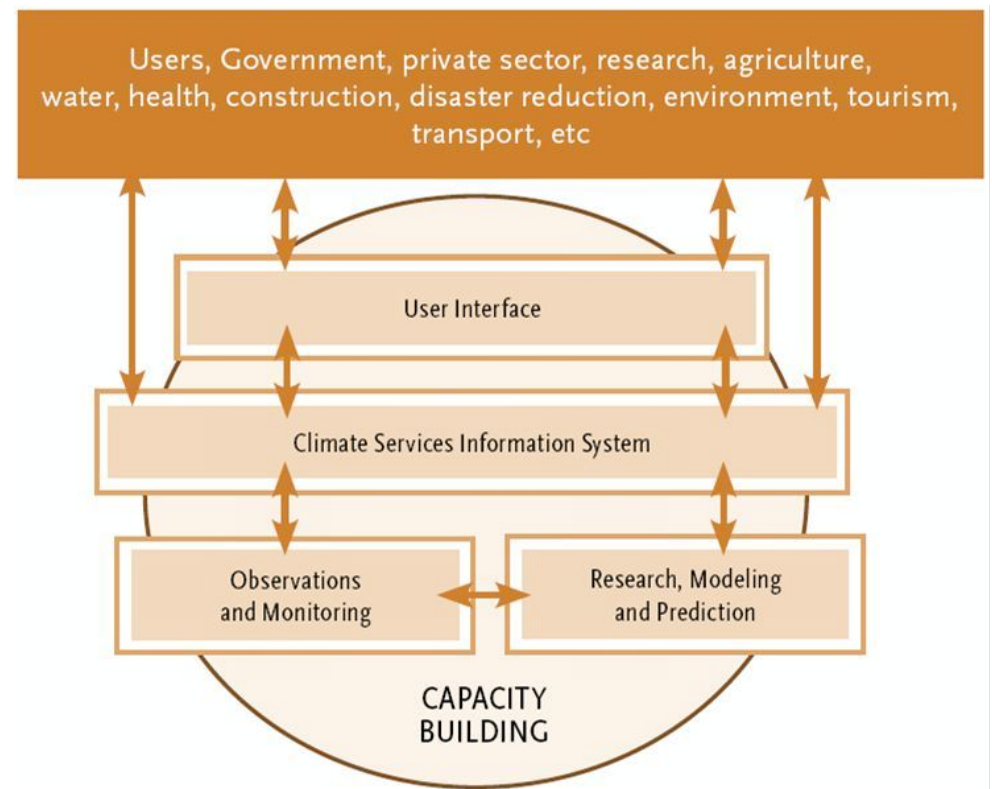
Overview

- What is a climate service?
- Why are climate services critical?
- Example of a climate service
- Engaging with users
- Example of a current research-to-operations project



What is a Climate Service?

- Climate Services assist decision making
- They require engagement and respond to user needs
- Based on high quality, reliable, supported data
- A constant two way 'conversation'
- Provide context
- May be combined with non-met data, or feed into non-met systems



Benefits of improving the service

Industry	Potential annual value of forecast
	A\$m
Construction	192
Electricity	2.3
Coal mining	68
Oil and gas	93
Transport	5
Water supply	28
Agriculture	1 567
<i>Note: All values are given in Australian dollars at 2012 prices</i>	
<i>Source: CIE estimates</i>	

- Around 5% of Australian GDP is exposed to weather and climate
- Enable sectors to better manage climate risk, making industry more profitable
- Annual value of improved forecasts to agriculture alone around A\$1.6 billion (USD 1.2b)
- Significant value also estimated for other climate sensitive industries

Why consult?

No matter how accurate a weather forecast or climate outlook is:

- If it doesn't provide information users need
- If it isn't issued when users are making their critical decisions
- If it is misinterpreted
- If it cannot help make a decision....

**The forecast has little real value*

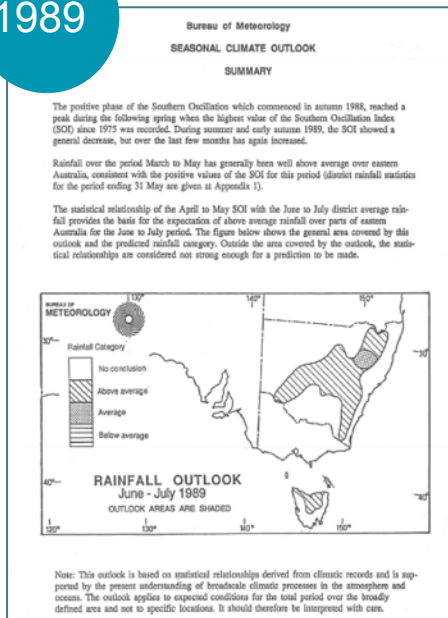




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History of Australia's climate outlook service

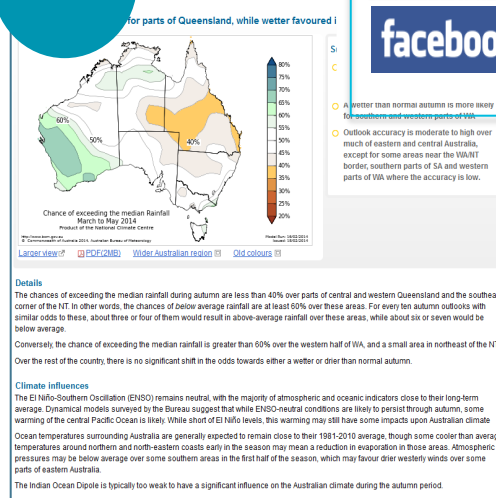
1989



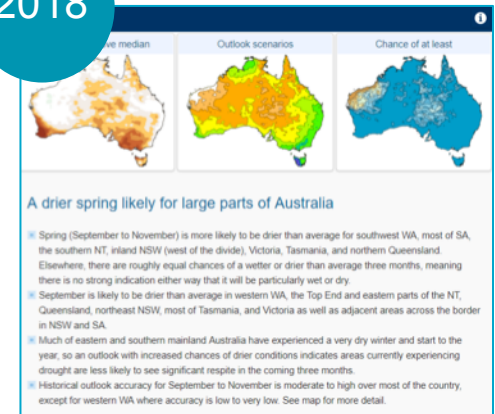
2014



2013



2018

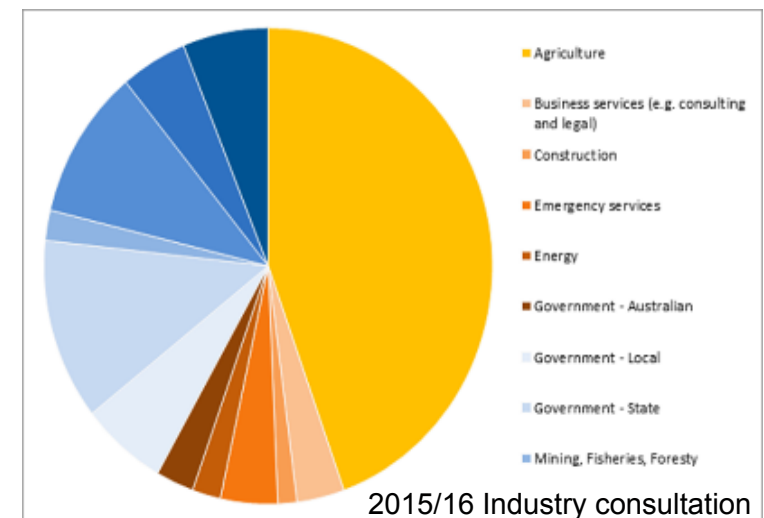


2019



Various rounds of industry stakeholder engagement at BoM

- What climate/weather sensitive decisions are made?
- When are these decisions made?
- What lead time is needed?
- What type of data is needed?
- What is the best way to supply data?
- (What's your internet speed?)
- Do people understand the information?
- Are there gaps?
- Preferences for outlook types & presentation
- Preferences for accessing climate information
- Gauge satisfaction
- Showing some 'blue sky' ideas...
- Can we come back and talk again?
- Is this what would help you?



Some key findings...

Users told us they wanted:

- Overview – simple outlook
- Advanced outlook – ability to tailor and drill into data
- Past accuracy information
- Video – climatologist explains the outlook
- Data to feed into decision-support model

2010/11 engagement facilitated modern delivery channel (2014)



"I just want a map I can glance at to get a snapshot of what's going on, then I can decide whether to drill deeper."

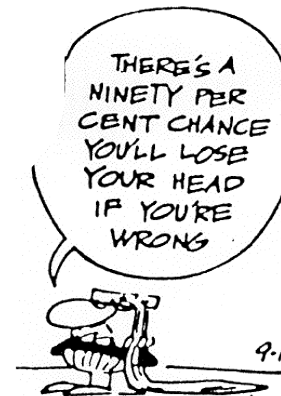
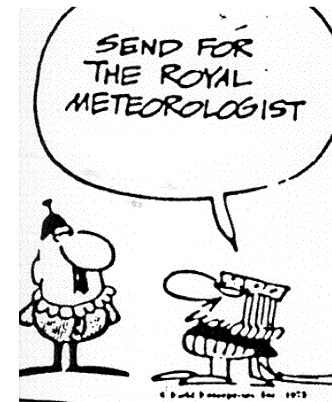
"I want climate outlook information in a form I can enter into a decision-support model."



Some key challenges...

Understanding probabilities

2015/16 engagement: **User comprehension** is linked with **user satisfaction** i.e. those that answered comprehension questions incorrectly were 3 times as likely to be dissatisfied with the service



Conveying accuracy/skill

How good is the forecast for my region?

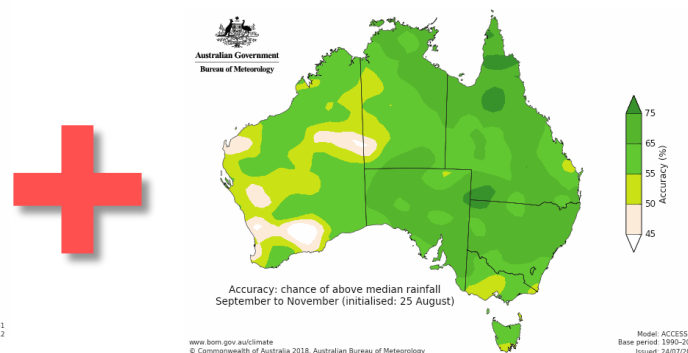
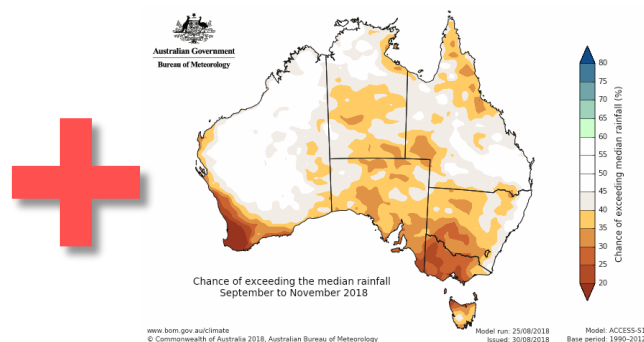
Challenges

- Ensemble verification is complicated. How best to convey?
- Forecast quality does not necessarily reflect value
- Summary skill measure – average skill over hindcasts. Does not show how skill changes over time (windows of forecast opportunity)
- Large sampling uncertainty around scores for quantities that are of most interest to the user e.g., regional rainfall
- Hindcast ensemble size (e.g., 11-members) is considerably smaller than real-time (e.g., 99-members)
- The years included in hindcast period will influence the skill
- Observational data available for data assimilation becomes more sparse as go back in time (quality of initial state influences forecast skill)

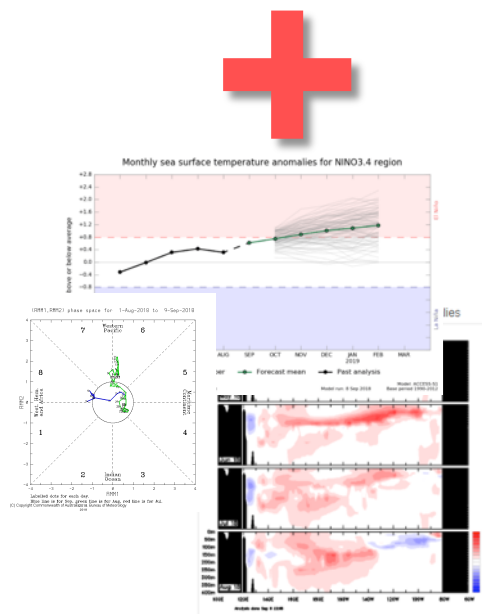
Challenge: Models becoming more computationally expensive – constraints on hindcast size – Number of years, number of start dates per year and ensemble size

What is a BoM Climate Service?

Seasonal Outlooks



- Talking with users
- Outlook probabilities
- Accuracy/skill measures
- Uses climate driver analysis
- Provided on time, every time
- Delivery via multi channels



=



Rural RnD4Profit Project: Forewarned is forearmed

Forewarned is forearmed: managing the impacts of extreme climate events

Research partners

BoM
Univ. Melbourne
Monash Univ.
Univ. S. Queensland
SARDI
DEDJTR
DAFQ
Birchip Cropping Group

USERS

Rural RDC & other partners

Meat and Livestock Australia
Grains RDC
Sugar Research Australia
Cotton RDC
Rural Industries RDC
Dairy Australia
Wine Australia
Australian Pork
Suncorp

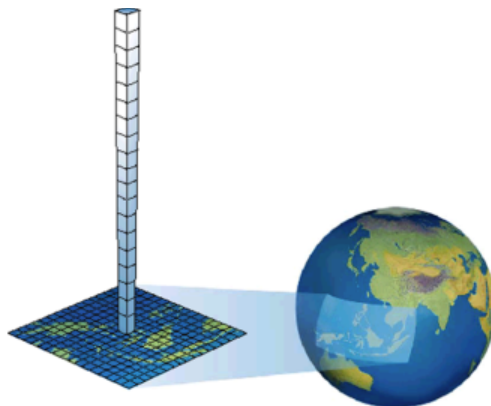
Managed by Meat and Livestock Australia; 17 collaborating partner organisations; 2017-2022

1. The foundation

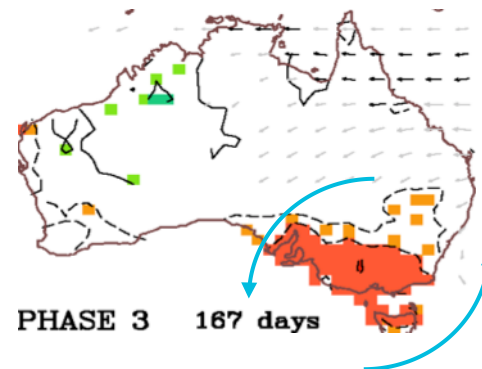
Assessing user needs



Improving the forecast system



Underpinning science



Research partners

BoM
Univ. Melbourne
Monash Univ.
Univ. S. Queensland
SARDI
DEDJTR
DAFQ
Birchip Cropping Group

Work package 1: User needs and Forecast system development

Rural RDC & other partners

Meat and Livestock Australia LTD
Grains RDC
Sugar Research Australia LTD
Cotton RDC
Rural Industries RDC
Dairy Australia LTD
Wine Australia
Australian Pork LTD
Suncorp

Assessing user needs



What kind of
extreme?

Critical times of year

Critical timescales
(weeks/months/seasons)

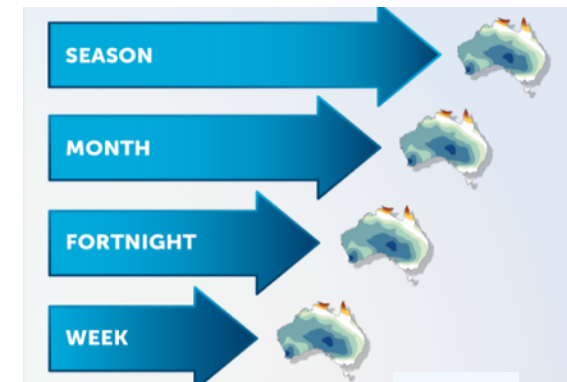
How far in
advance do you
need to know?

*A run of very hot nights in
September is bad for*

*Prolonged heavy rain in
October is..... If I knew there
were going to be more than
average extremely wet days I
could.....*

*I really need to know if Oct-Dec is
going to be a very wet season.
Ideally I need to know this by July. If
I knew, then I could make decisions
to ...*

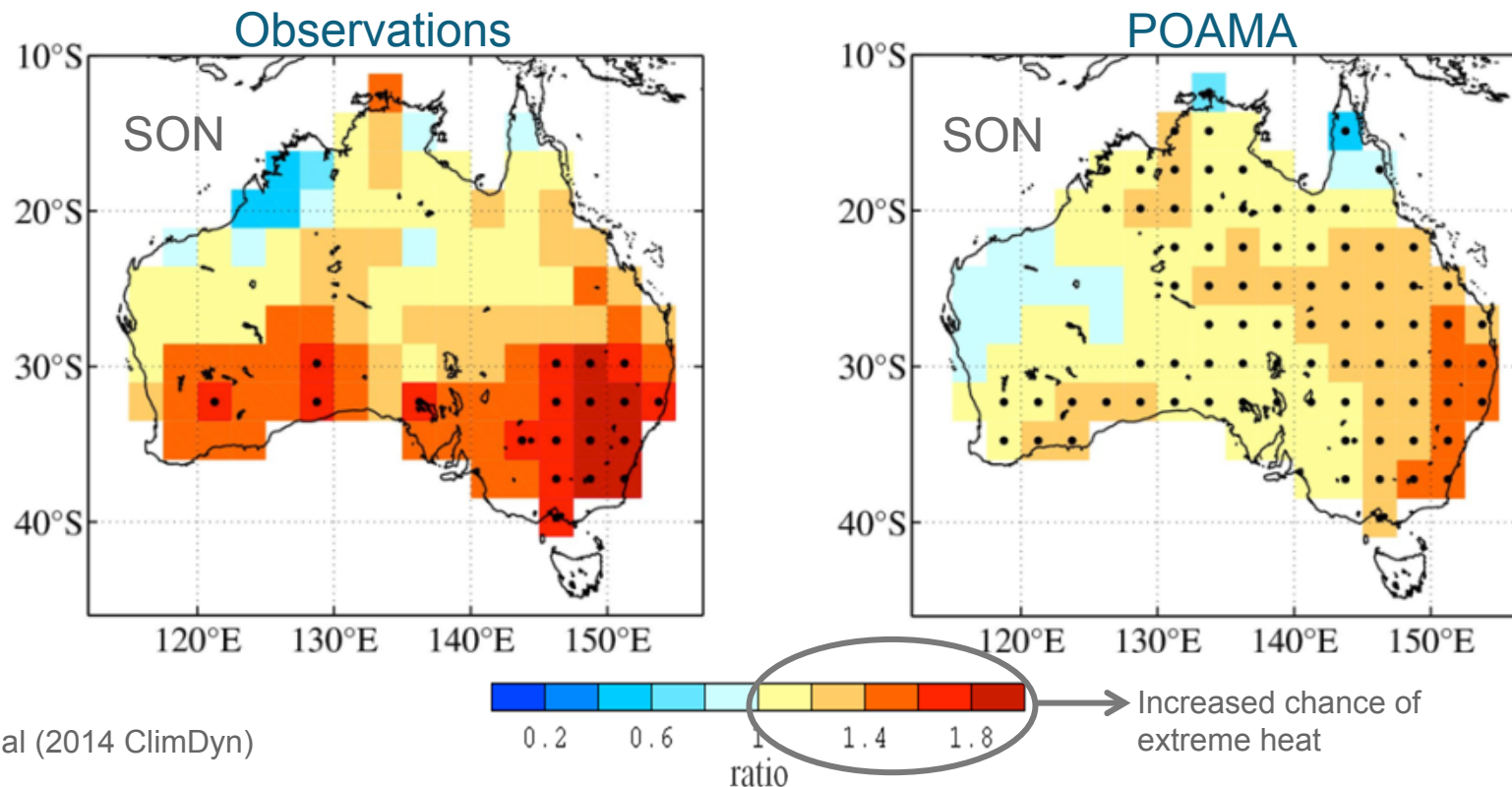
*Early frosts have a very
negative impact. If I knew
there was an increased
likelihood of a frosts more
than one week in advance, I
could....*



Underpinning science e.g. ENSO

Increased chance of heat extremes during **El Niño** especially in Spring

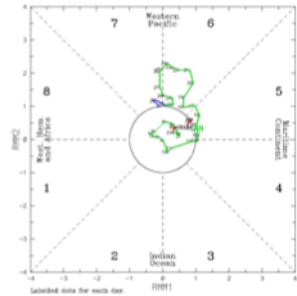
Heat extreme: weekly-mean Tmax anomaly in decile 10 (above 90th percentile)



White et al (2014 ClimDyn)

Probability of weekly mean Tmax exceeding the 90th percentile, expressed as ratio to the mean probability

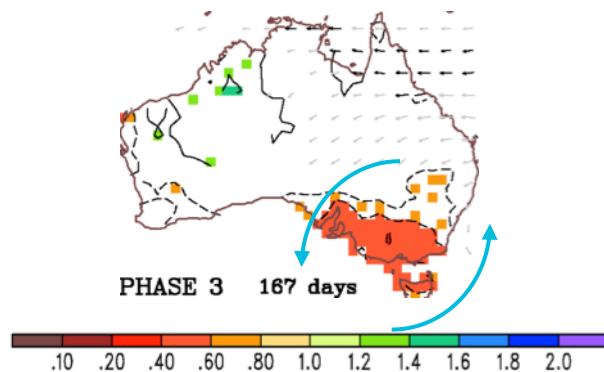
Underpinning science e.g. MJO



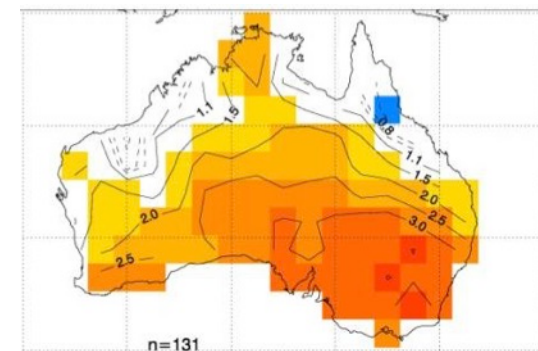
Spring season (SON) when MJO in phase 3

OBS rain prob.

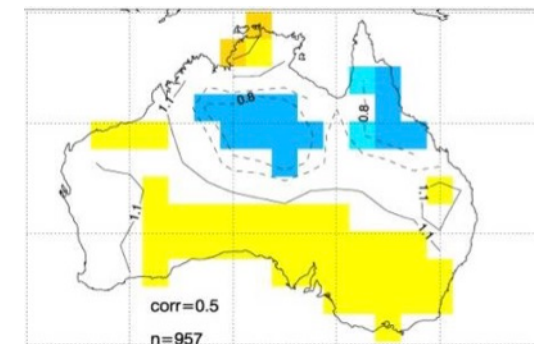
(Wheeler et al. 2009)



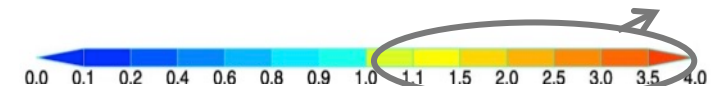
OBS
extreme
heat prob.



POAMA
extreme
heat prob.



Increased chance of
extreme heat



Probability of weekly mean T_{max} exceeding the 90th percentile, expressed as ratio to the mean probability

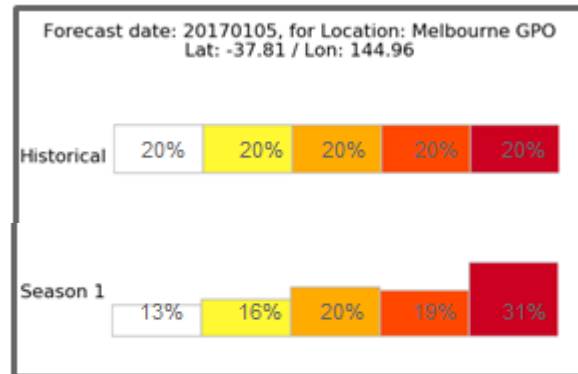
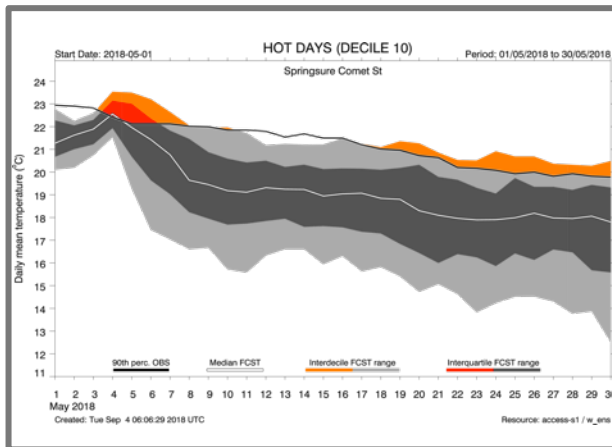


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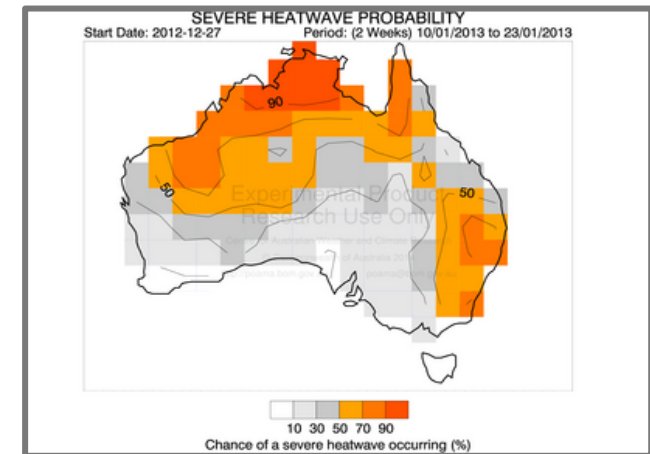
2. Developing and delivering forecasts



Australian Government
Department of Agriculture
and Water Resources



Work package 2:
Extreme forecast
products development
and delivery



- Develop a range of heat, cold and rainfall experimental extremes forecast products from ACCESS-S;
- Evaluate the accuracy and utility;
- Make experimental products available on a research web server for trial and feedback;
- Deliver operational forecasts on the BoM public webpage for a subset that have sufficient accuracy and utility.

I want to know the skill for my region!

ACCESS-S1 hindcast: 1990-2012 (23 years)

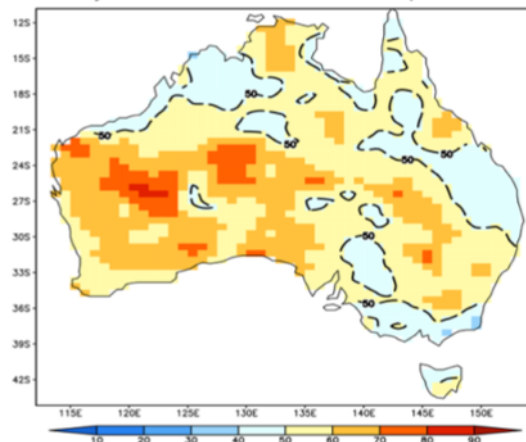
To assess skill for a particular month or season

$n=23$

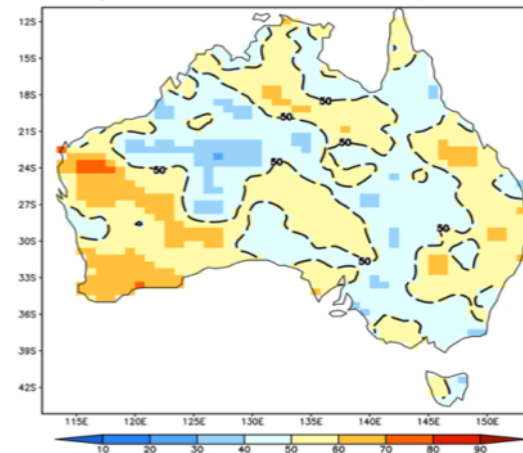
Is 23 years with 11 members enough for regional skill?

Accuracy of rainfall above median in JJA (1 month lead)

POAMA (11-member set 1)



POAMA (11-member set 2)

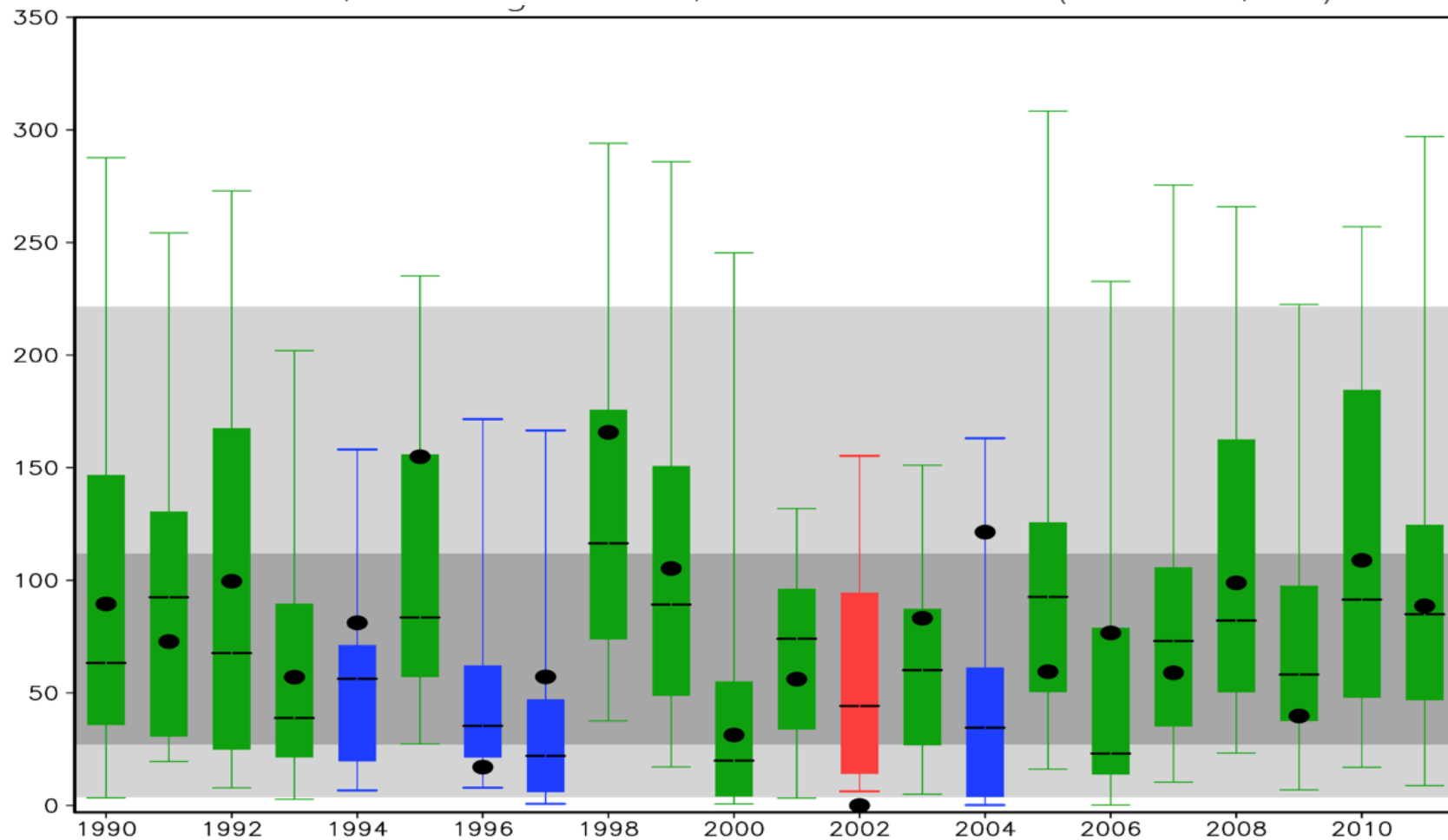




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Show past cases....

Valbona, Central Queensland, Accumulated rainfall (1 Jan start; LT0)

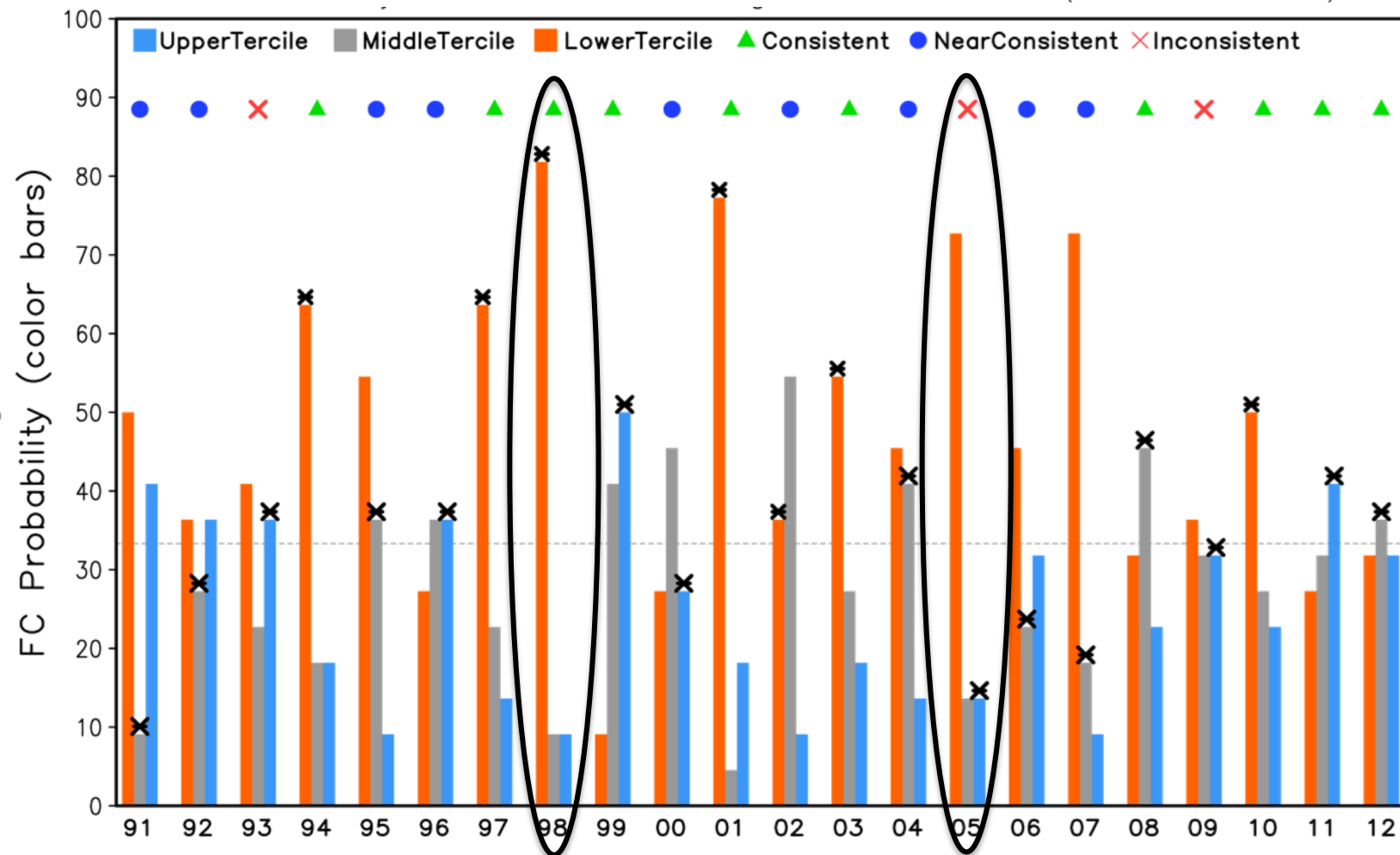




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Show past cases....

Valbona, Central Queensland, Tercile rainfall forecast (1 Jan start; LT0)



3. Linking forecasts and user decisions



Work package 3:
Interfacing to Industry
decisions



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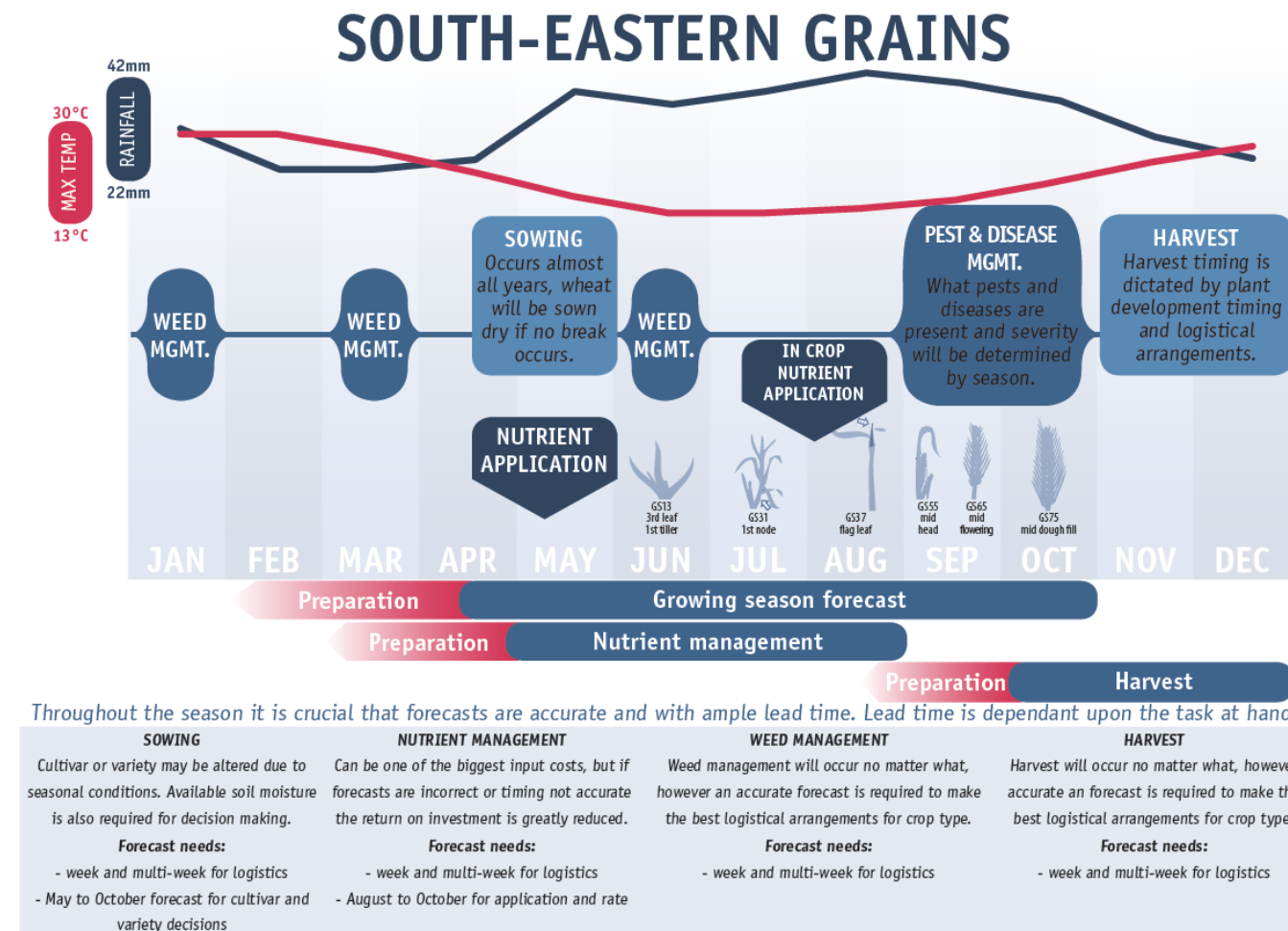


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Linking forecasts and user decisions



Australian Government
Department of Agriculture
and Water Resources



4. Extension and training

Work Package 4: Extension and training



Research partners

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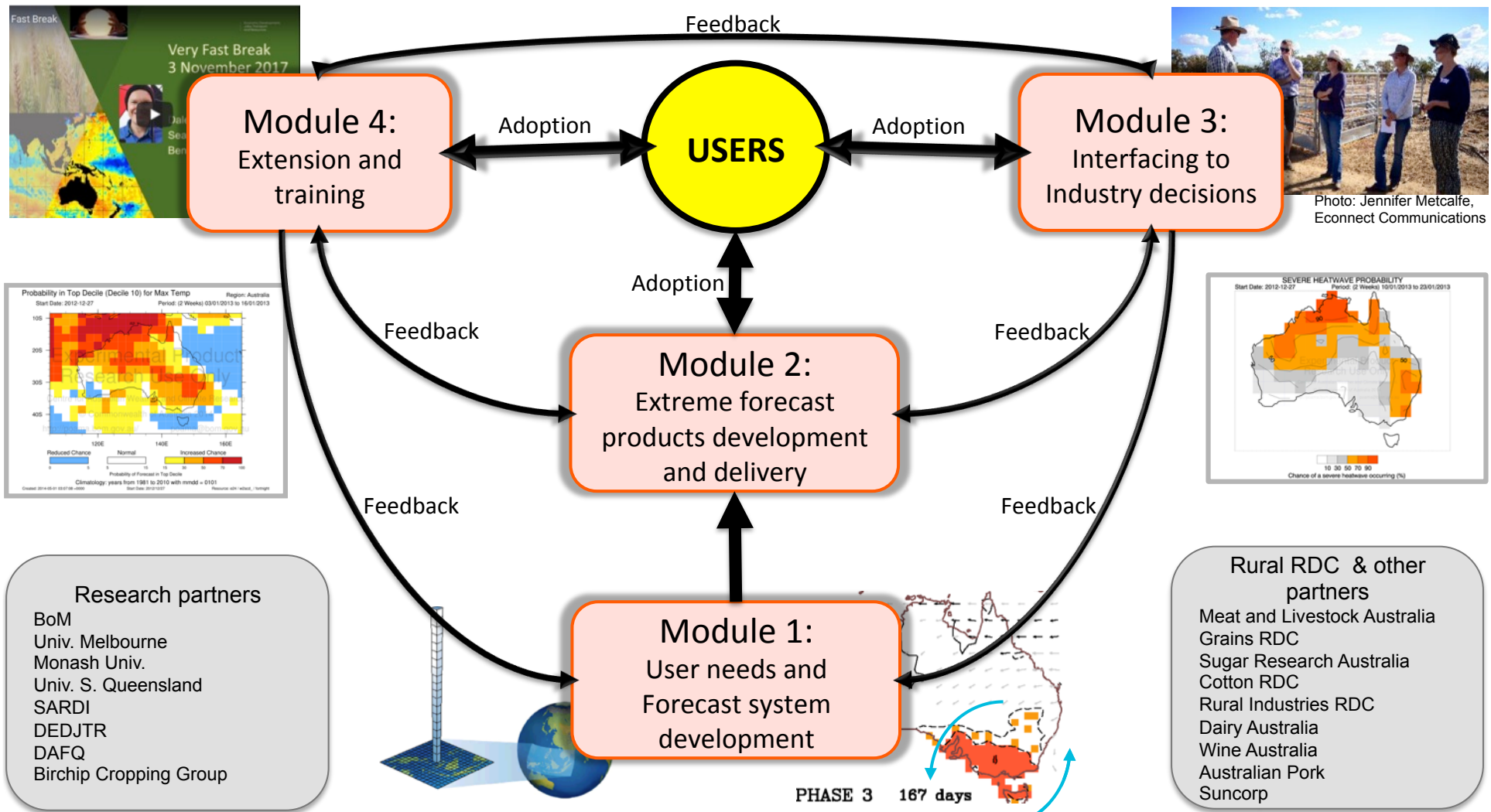


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Rural RnD4Profit Project: Forewarned is forearmed



Australian Government
Department of Agriculture
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So how can I make my research 'service ready'?

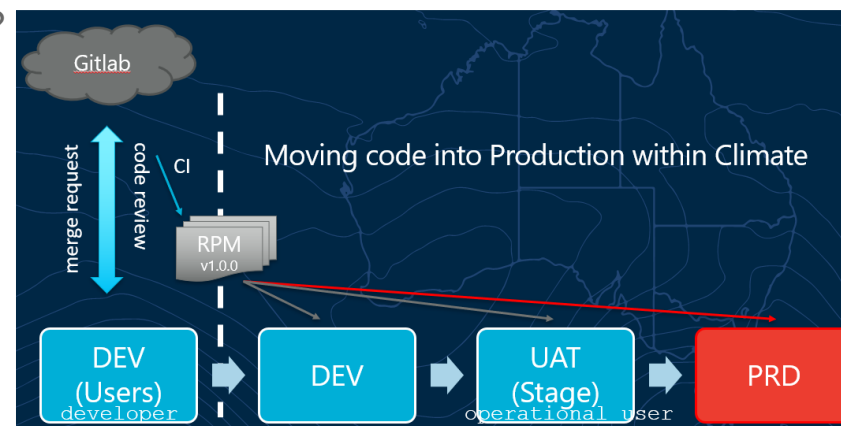
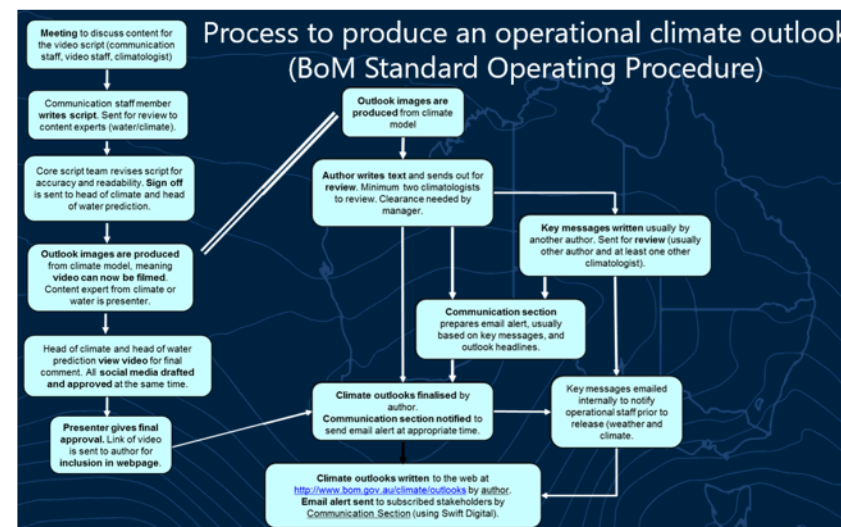


Not all research should be purely aimed at a service!

But...

Within the limitations of the science:

- Think about the **end user** – talk with them about needs
- Ensure that ultimately your work satisfies a **user 'pull'**
- How will the service **'survive' past your project?**
- Is the **code** written in a 'supported' language?
- Is the **code documented**? Archived/packaged/reviewed?
- Is the **code/system** to produce the product **transferrable**?
- Are the **outputs accessible** (e.g., WCAG2.0)?
- Can you **re-assess the outputs** with users?
- Is there a **feedback** mechanism?



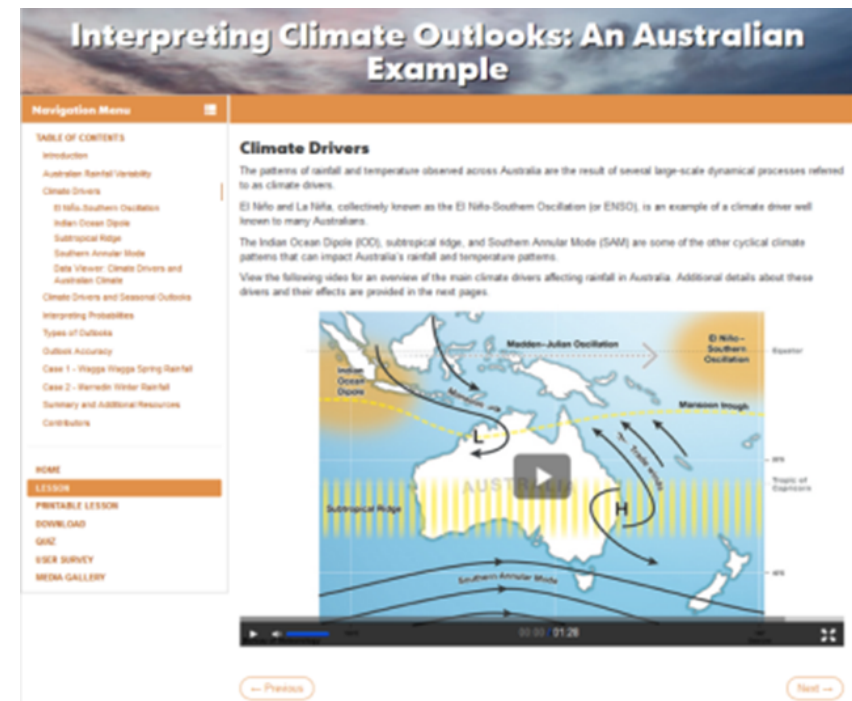


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Summary

A Climate Service

- is a step up from a climate map or climate data
- is driven by **user needs** and user decision making
- turns data into information and **intelligence**
- is **adaptable** and **transferrable**; it should be made to survive into the future without your personal assistance
- is HOW you extract **value** from climate research and products



https://www.meted.ucar.edu/training_module.php?id=1247