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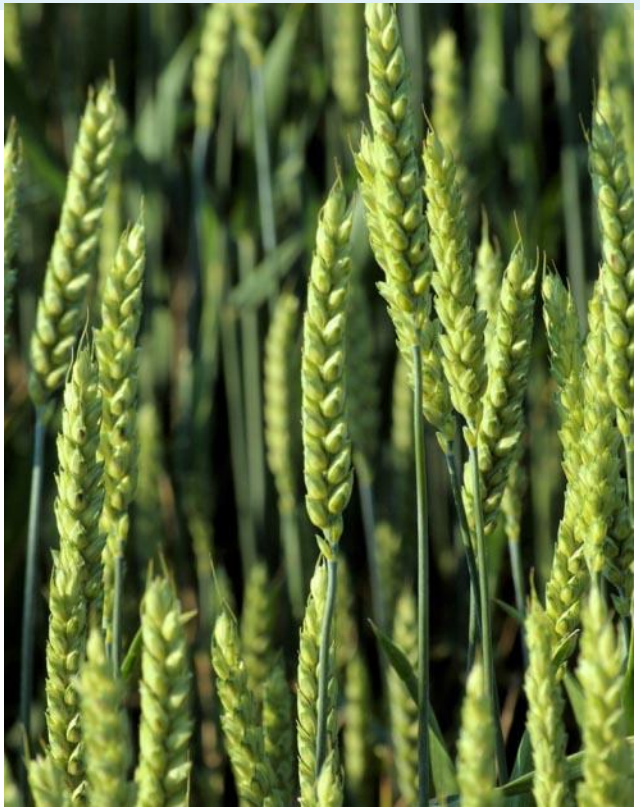
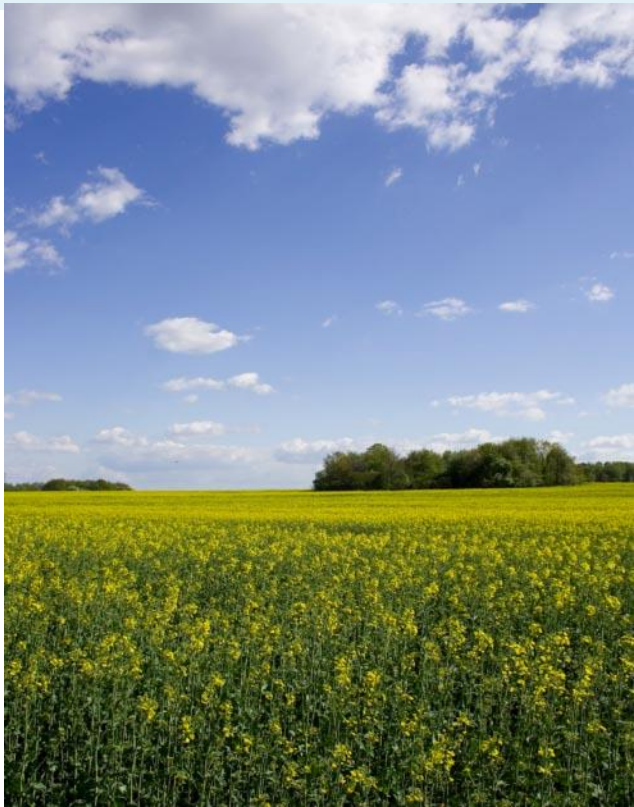
Towards sub-seasonal predictions of extreme heat

Debbie Hudson, Andrew Marshall, Oscar Alves, Li Shi, Griffith Young

Research and Development Branch, Bureau of Meteorology

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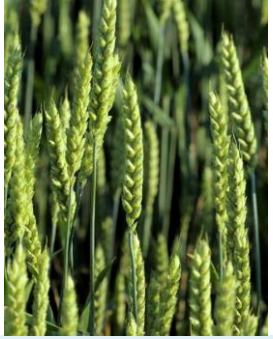
Motivation


- Increasing demand for extended range forecast guidance in Australia

MANAGING CLIMATE VARIABILITY R&D PROGRAM

GRDC Grains Research & Development Corporation

mla MEAT & LIVESTOCK AUSTRALIA

Australian Government
Department of Agriculture, Fisheries and Forestry
Rural Industries Research and Development Corporation
Sugar Research and Development Corporation


CliMag

Multi-week forecasts will help bridge the gap

In this issue

MANAGING CLIMATE VARIABILITY R&D PROGRAM


Researchers blazing a trail on extreme heat predictions

by Alison Bevan

- Large-scale impacts of heat extremes e.g. health, agriculture, infrastructure
- Trend towards more frequent and intense heat waves is projected to continue
- Recent record-breaking Australian heat waves

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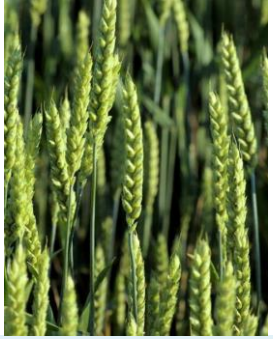
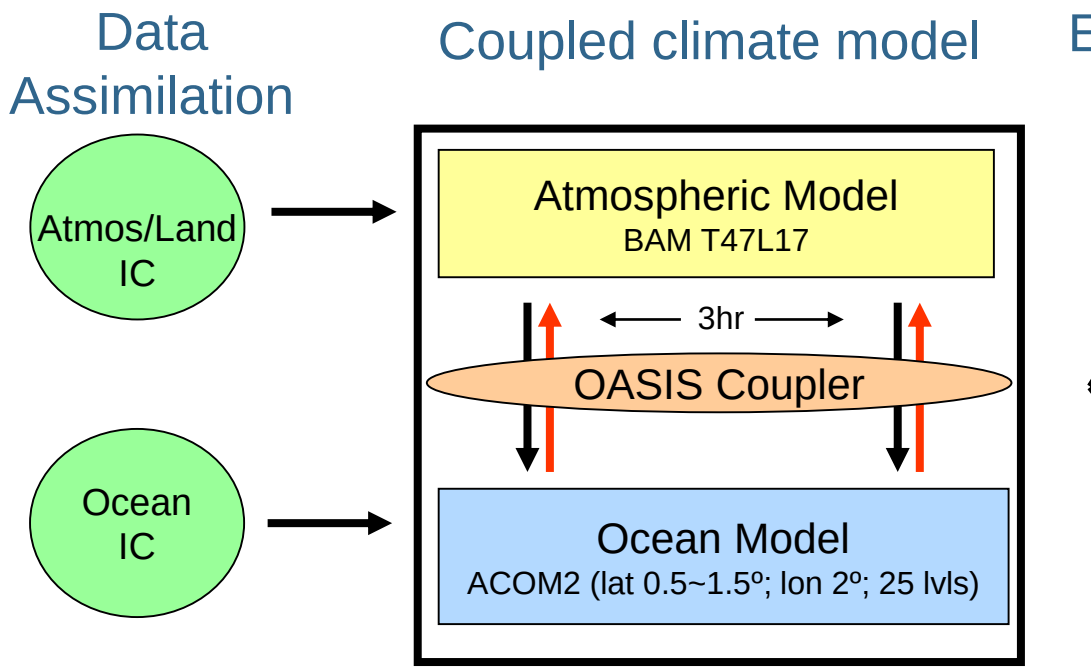
POAMA

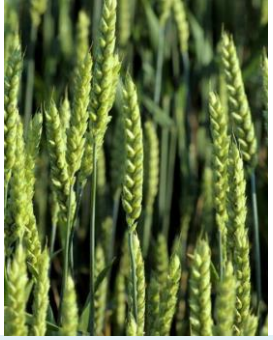



Real-time: ensemble of 33 forecasts updated twice-weekly

Hindcast set:

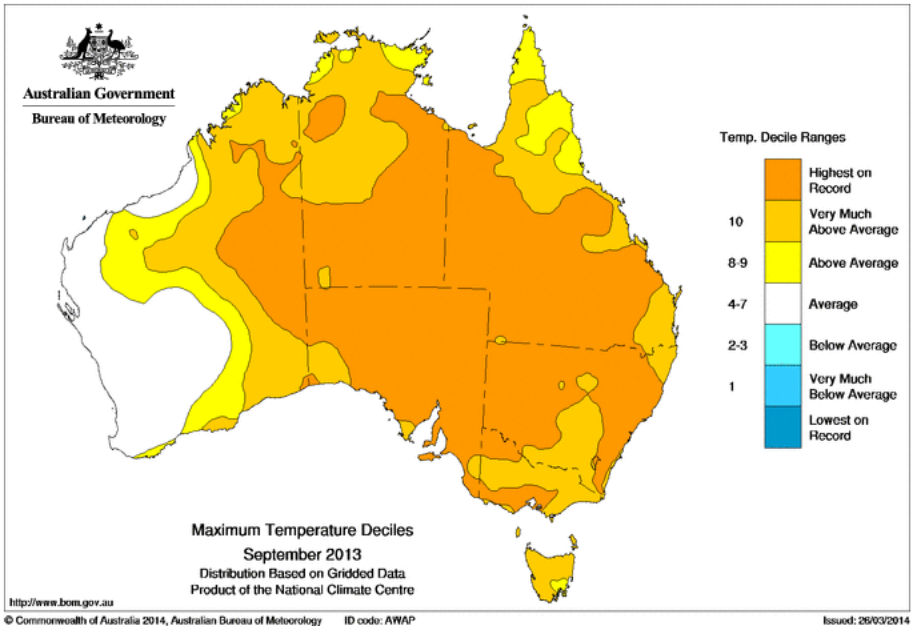
- 1981-2010
- Ensemble (n=33) 6x every month
- Forecasts out to 9-months

Definition of extreme?


- Threshold of extreme will be region (e.g. Northern Australia vs. Tasmania) and user/purpose-specific (e.g. human health, agriculture)
- We have typically used a percentile threshold approach, usually defining extreme as exceeding the 90th percentile (i.e. in decile 10)

Example of an extreme month for much of Australia: *Observed Tmax deciles for Sept 2013*



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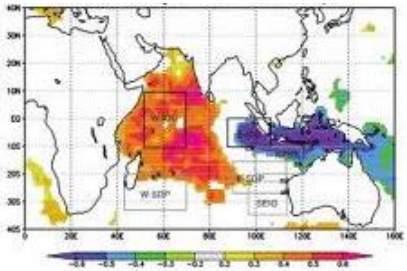
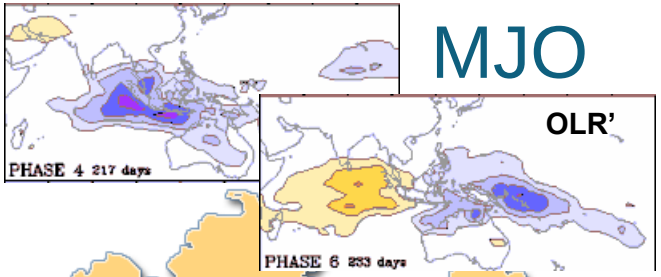
Capturing the link between the large-scale drivers and heat extremes

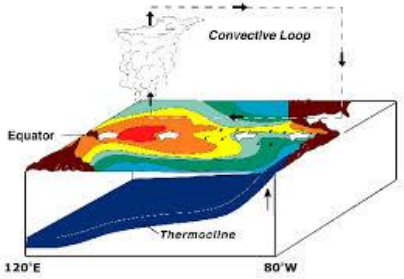
IOD

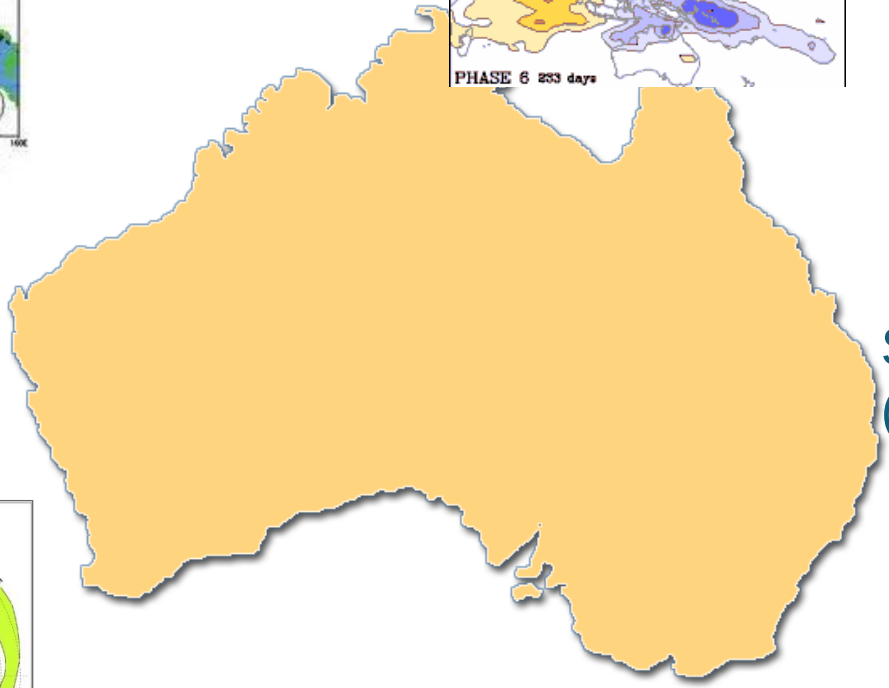


MJO

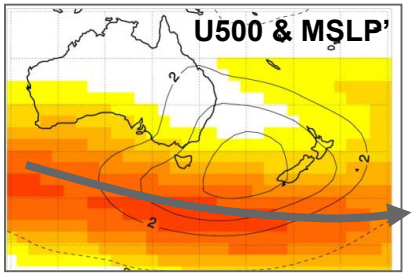


ENSO

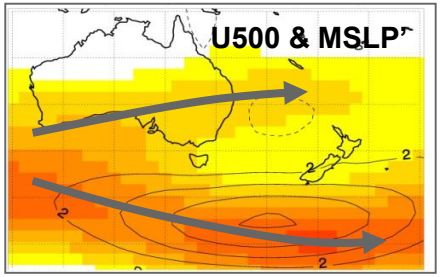




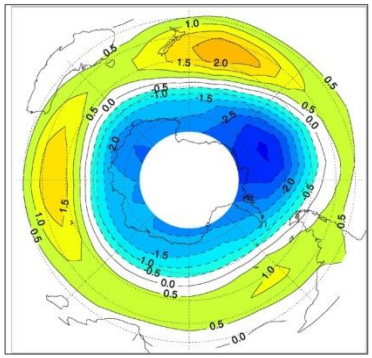
STR high (Tasman)



Blocking (split-flow)



MSLP EOF1

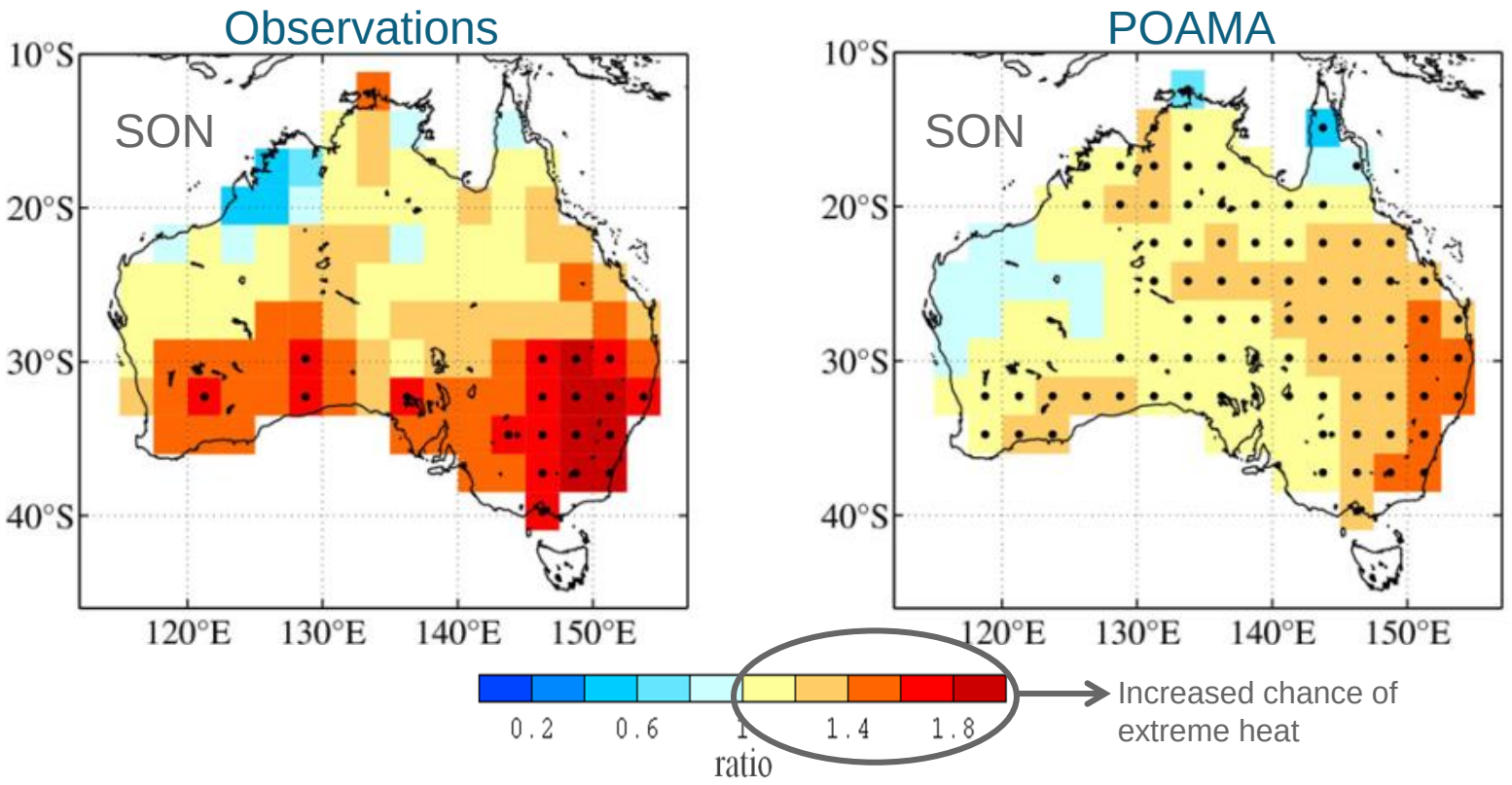


SAM

Capturing the link 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)



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

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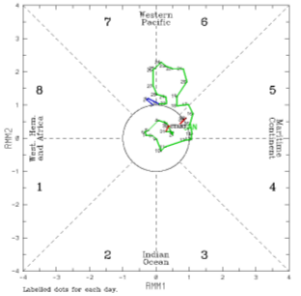
Capturing the link e.g. MJO



Examples:

OBS rain prob.

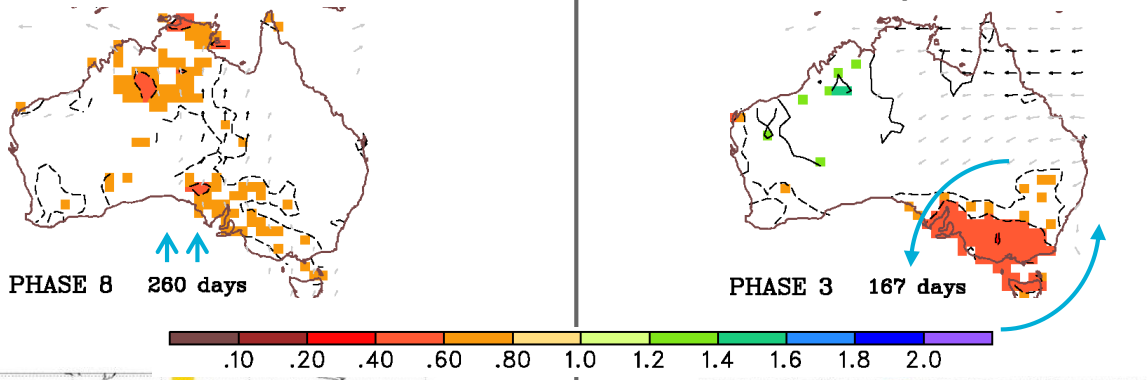
(Wheeler et al. 2009)

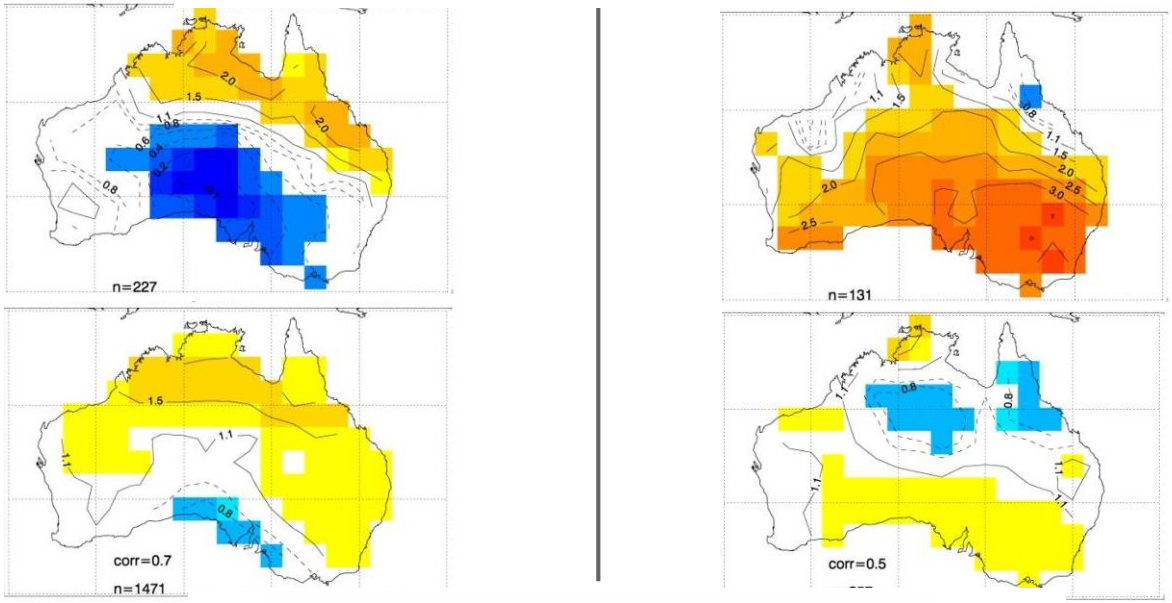
OBS extreme heat prob.

POAMA extreme heat prob.

DJF, phase 8

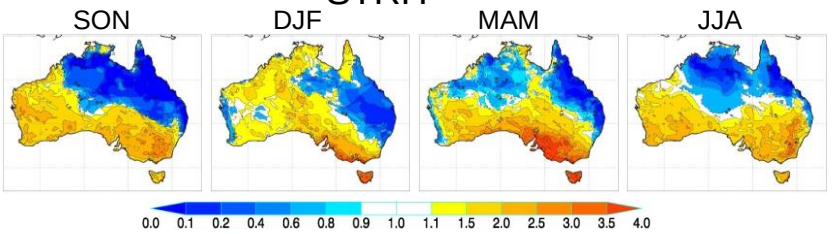
SON, phase 3



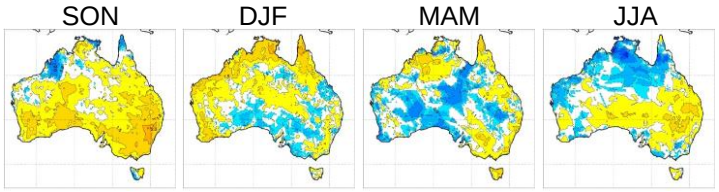


Capturing the link: lots of composites…..

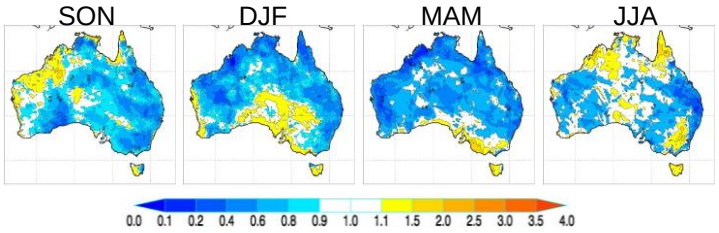
STRH



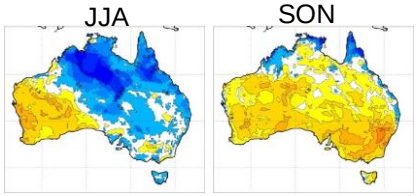
El Niño



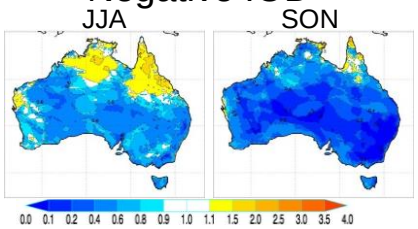
La Niña



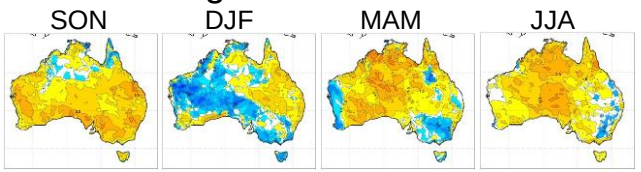
Positive IOD



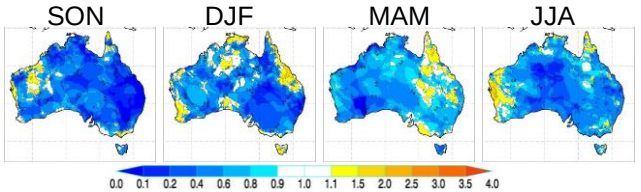
Negative IOD



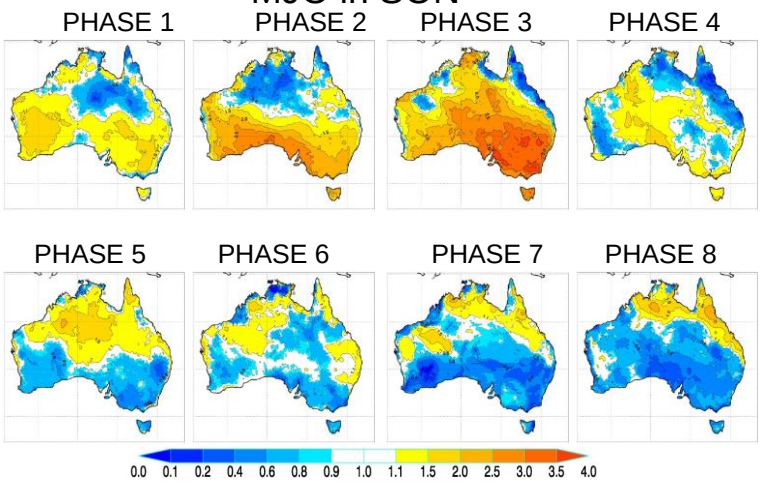
Negative SAM



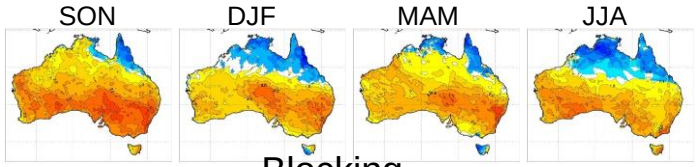
Positive SAM



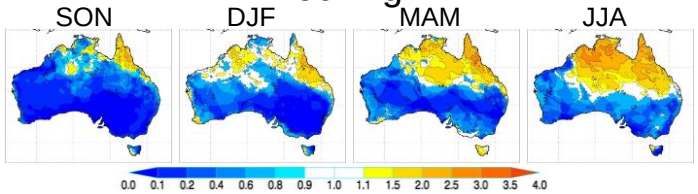
MJO in SON



Low Block (enhanced zonal midlatitude flow)



Blocking



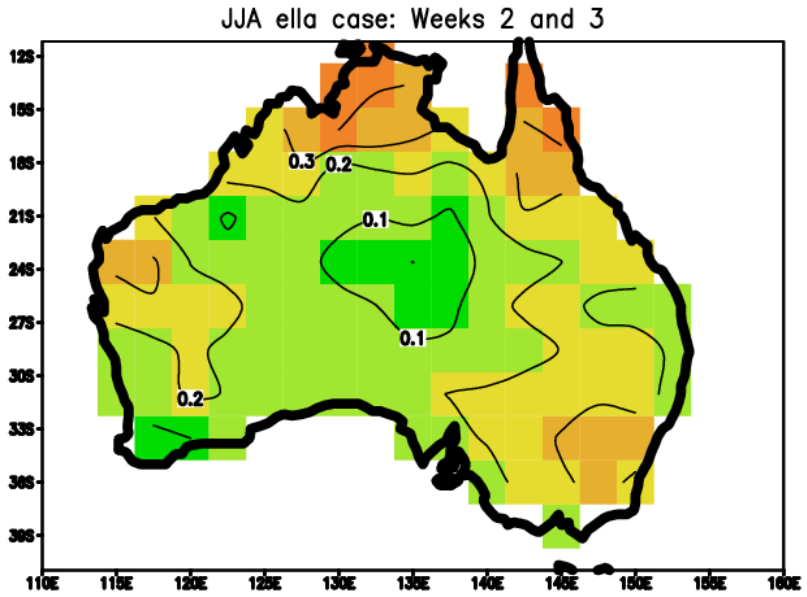
Forecast skill: Windows of forecast opportunity

Example: ENSO

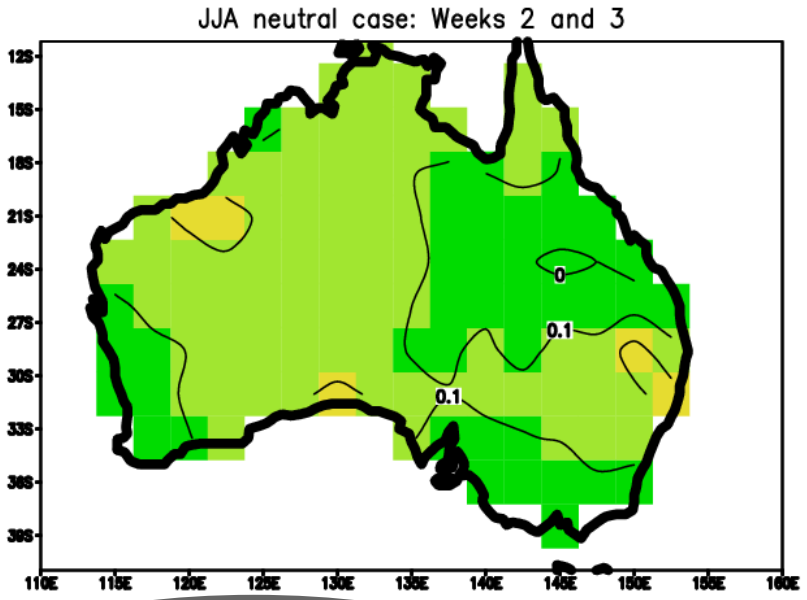
Skill for forecasting extreme heat

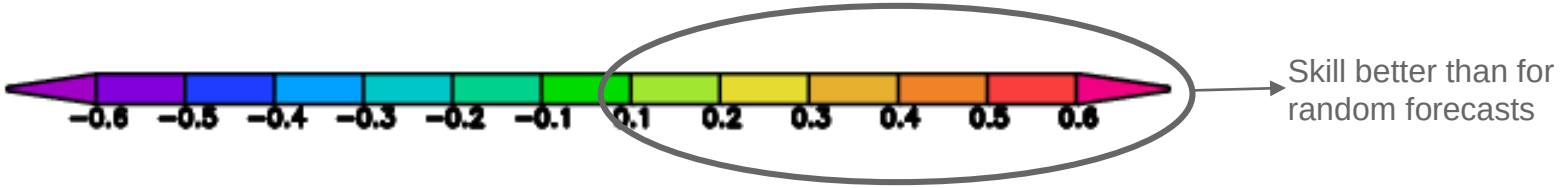
Decile 10 Tmax in JJA in weeks 2 and 3 of the forecast

Skill when ENSO is strong



Skill when ENSO is weak/neutral





Skill better than for random forecasts

Symmetric Extremal Dependence Index (SEDI; Ferro and Stephenson, 2011)

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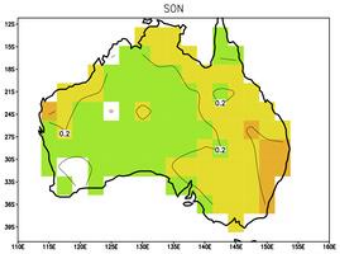
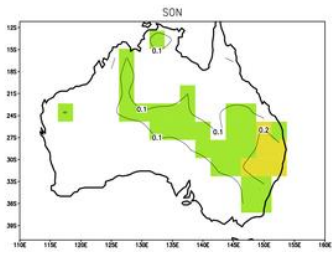
POAMA's skill at forecasting extreme heat

Example: Skill of forecasting decile 10 Tmax conditions for spring time of year

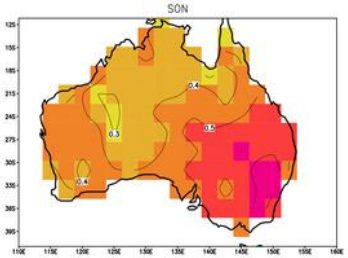
Week 2 (during SON)



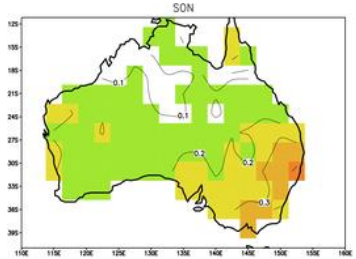
Week 3 (during SON)



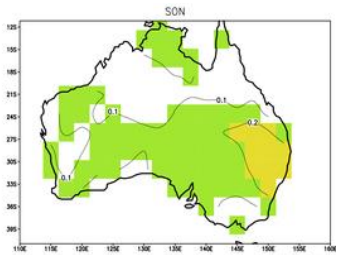
Fortnight 1 (weeks1 and 2) (during SON)



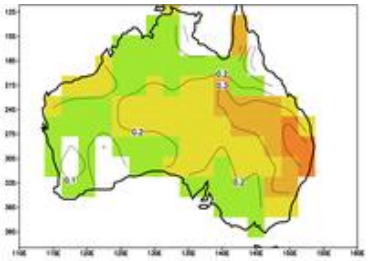
Fortnight 1.5 (weeks 2 and 3) (during SON)



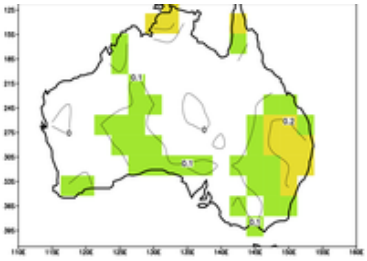
Fortnight 2 (weeks 3 and 4) (during SON)



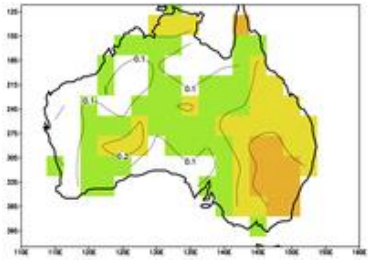
Forecasts of October at 0-10days lead



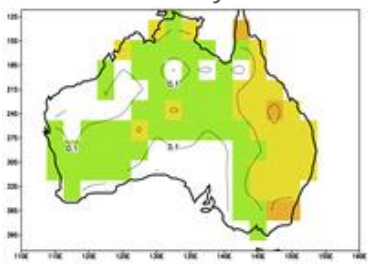
Forecasts of October at 20-30days lead

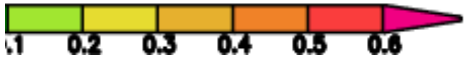


Forecasts of SON at 0-10days lead



Forecasts of SON at 20-30days lead





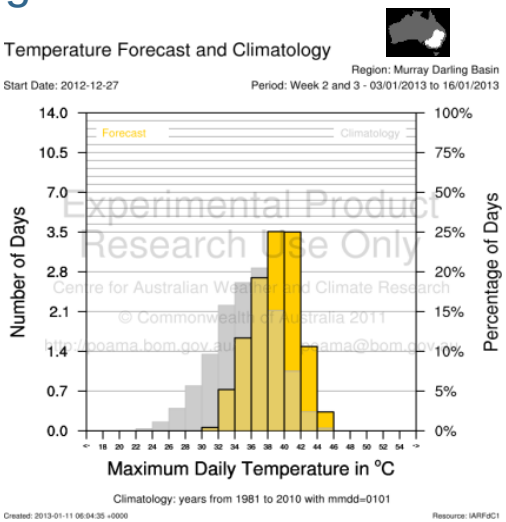
Values >0 indicate skill is better than for random guessing

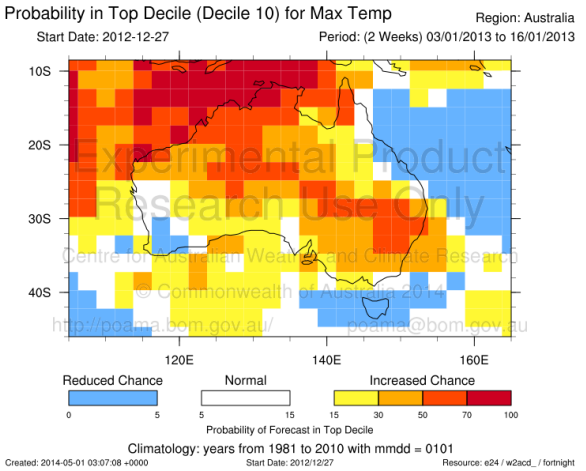
Symmetric Extremal Dependence Index Score (SEDI; Ferro and Stephenson, 2011)

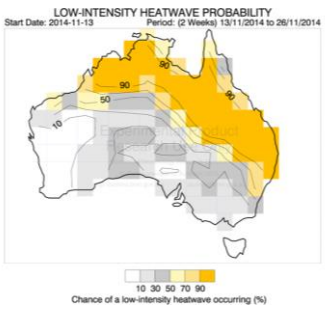
Experimental forecast products

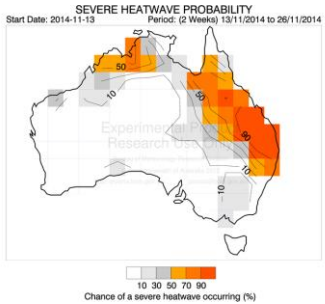
- Extreme Temperature: probability top quintile/decile
- Temperature Histograms for regions/stations
- Extreme Heat Days
- Heatwaves

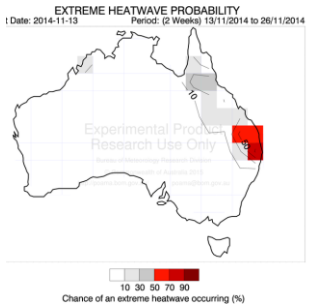
http://poama.bom.gov.au

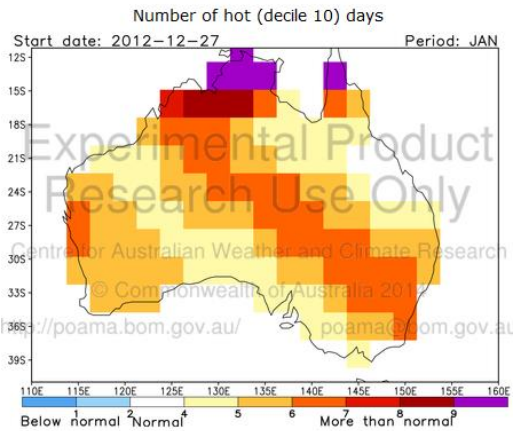








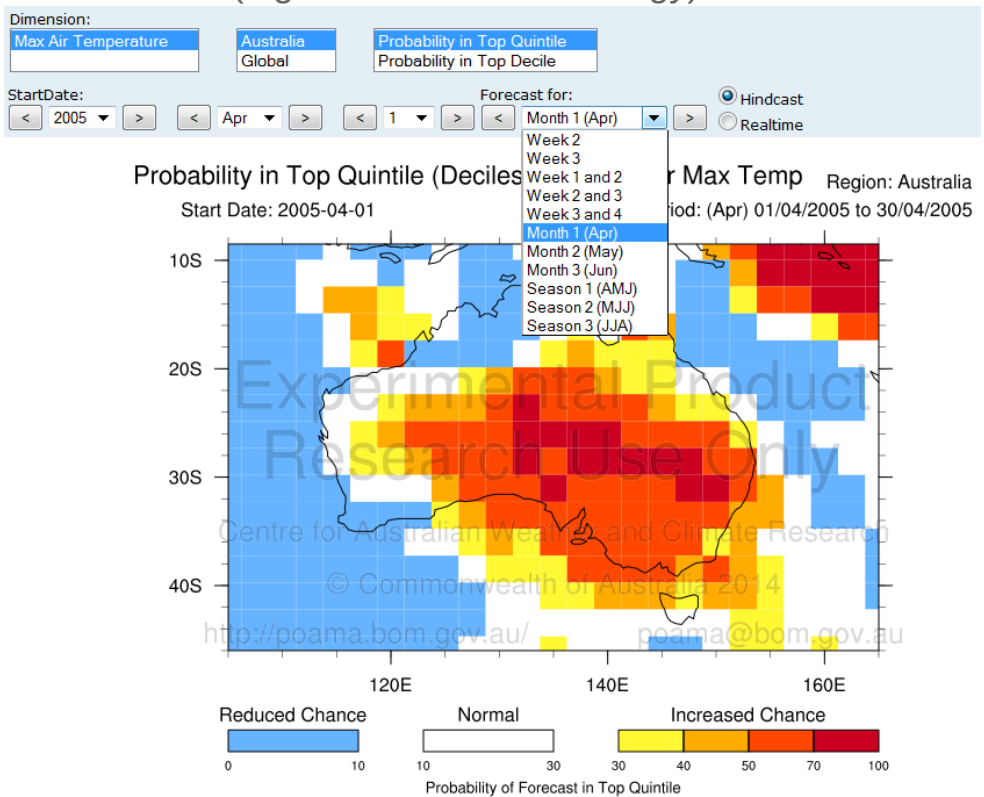




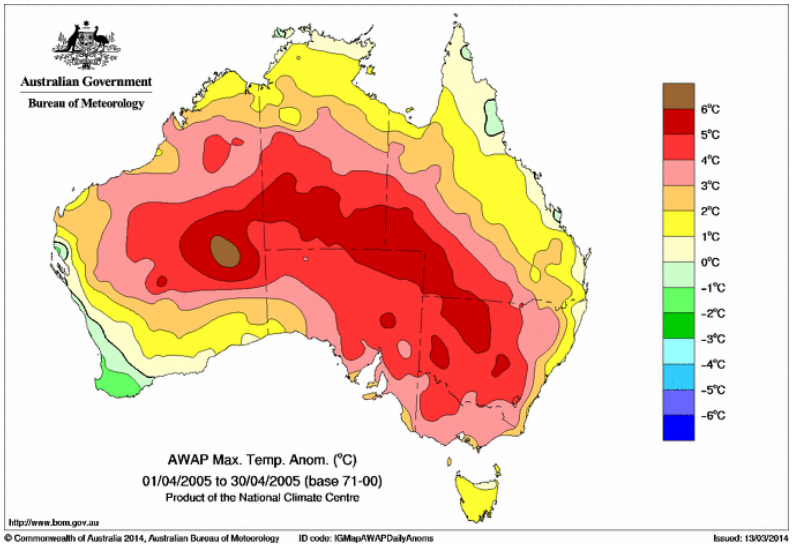
Probability top quintile/decile

The chance that the upcoming weeks/fortnights/months/season will be in the top decile (i.e. decile 10) or top quintile (i.e. deciles 9 and 10) of usual events.

Chance of having a top quintile (decile 9 and 10) event (highest 20% of climatology)

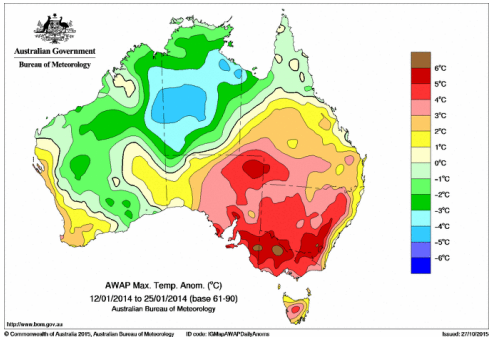


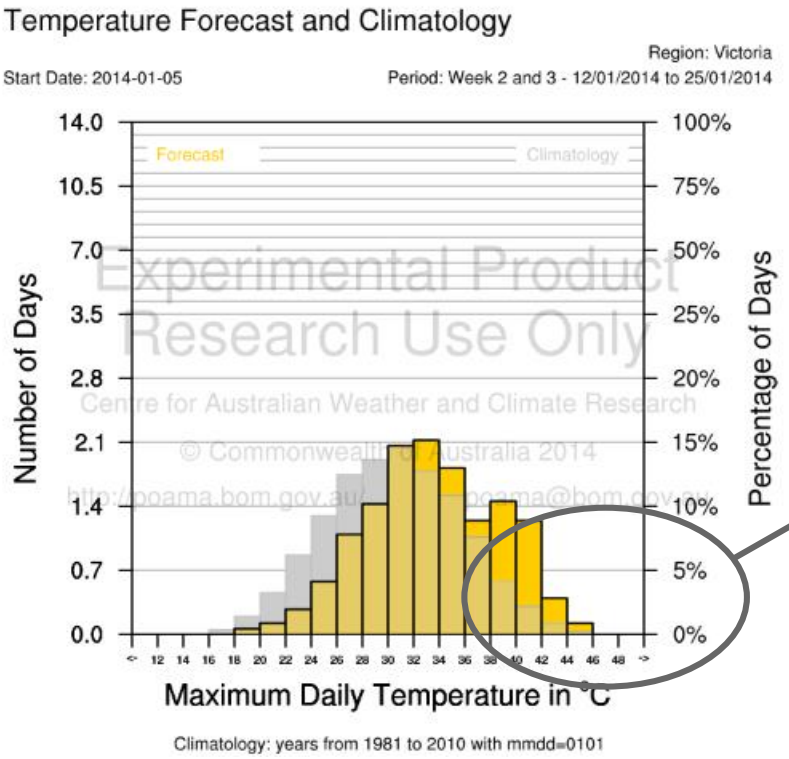
Example: April 2005



Histograms

Example: January 2014 for Victoria





Shifts in the tails of the distribution provides indications of changes in extremes

Grey: Climatological (1981-2010) temperature distribution for this time of year
Yellow: Temperature distribution for this forecast

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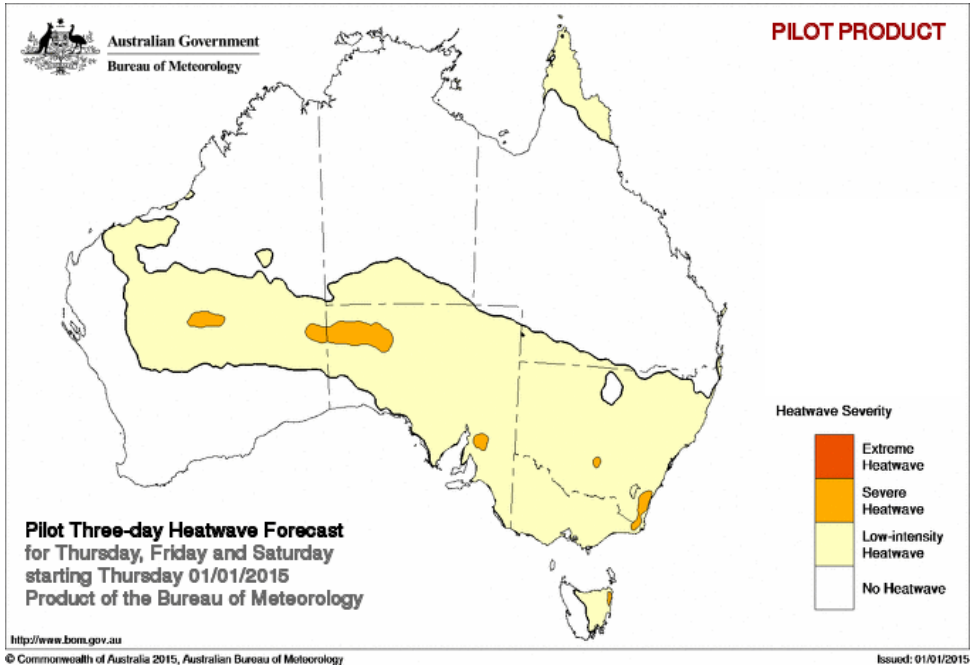
BoM's new weather forecast pilot heatwave service

http://www.bom.gov.au/australia/heatwave/index.shtml

Definition: A 'heatwave' is 3 or more days of high maximum and minimum temperatures relative to the past 30 days as well as to a climatological 95th percentile threshold (from annual daily data).

NOTE: this definition will only pick up heatwaves in the summer half of the year



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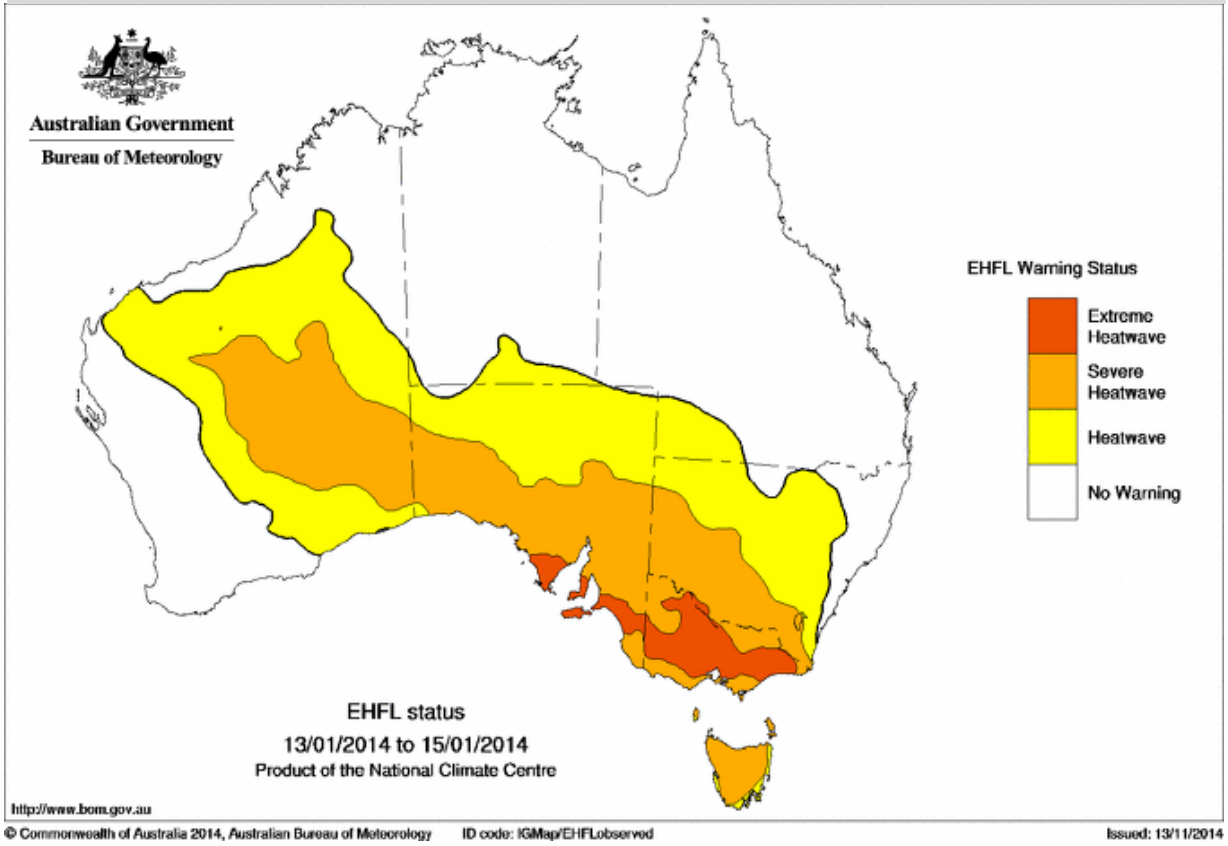
Heatwave forecasts: from weather to multi-week

Example: January 2014

One of the most significant multi-day heatwaves on record affected southeast Australia over the period from 13 to 18 January 2014

Observations for 13-15 January 2014



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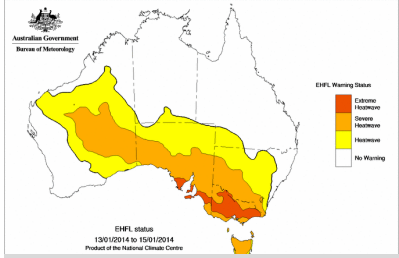
Heatwave forecasts: from NWP to multi-week

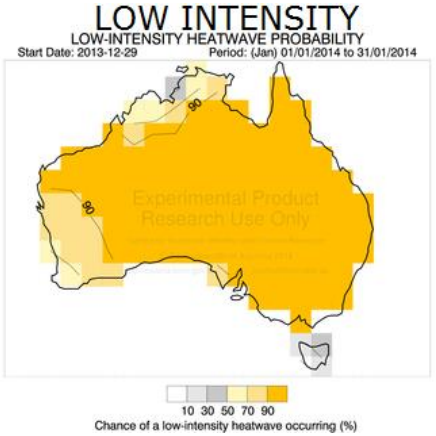


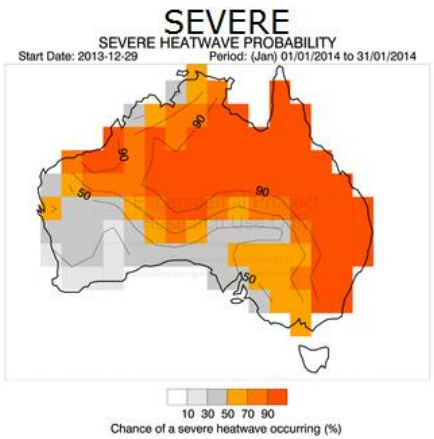
Observed heatwave: 13-15 January 2014

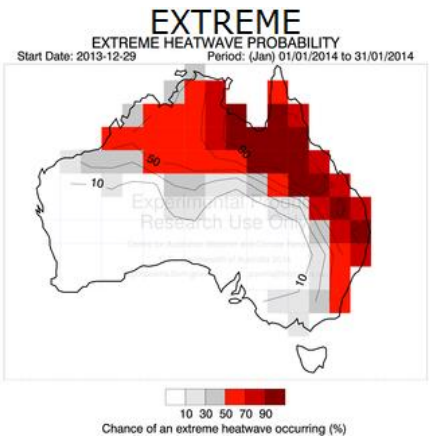
POAMA Forecasts (chance of a heatwave occurring in the period)

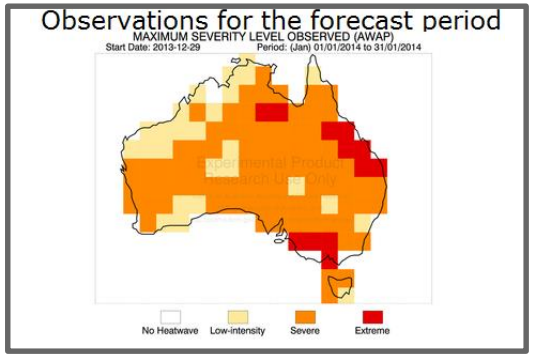
Forecast start date on ***29 December*** 2013 for the month of ***January 2014***

READY

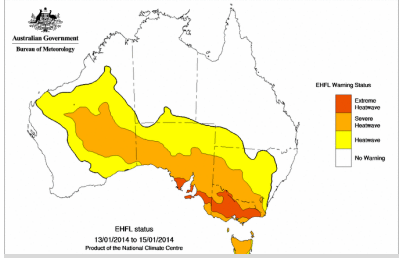








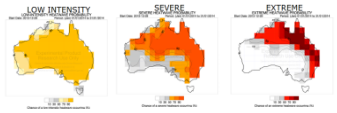
Heatwave forecasts: from NWP to multi-week



Observed heatwave: 13-15 January 2014

POAMA Forecasts (chance of a heatwave occurring in the period)

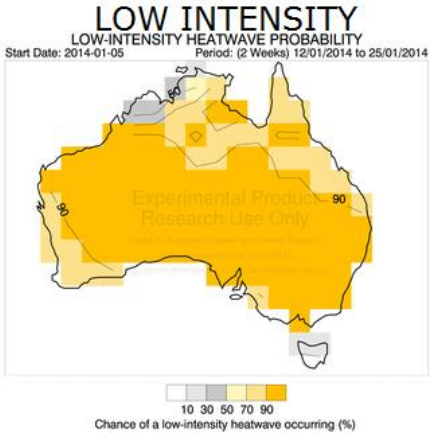
READY

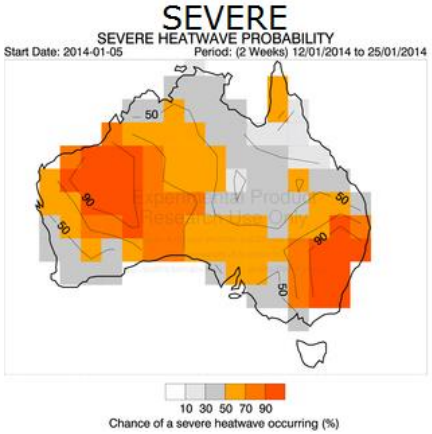


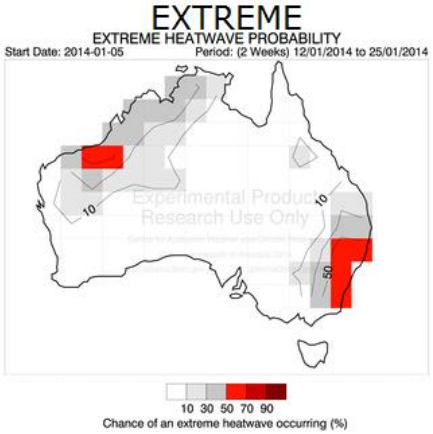
Forecast start date on ***29 December*** 2013 for the month of ***January 2014***

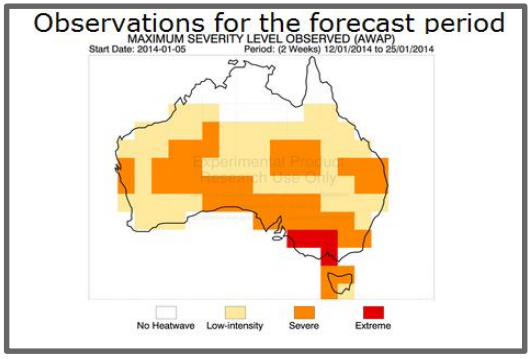
Forecast start date ***5 January*** 2014 for ***12 to 25 January*** (i.e. weeks 2 & 3)

SET

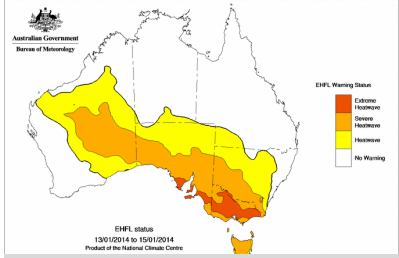








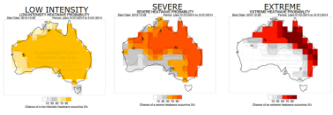
Heatwave forecasts: from NWP to multi-week



Observed heatwave: 13-15 January 2014

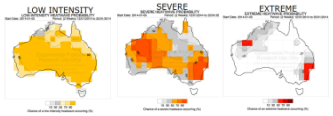
POAMA Forecasts (chance of a heatwave occurring in the period)

READY



Forecast start date on ***29 December*** 2013 for the month of ***January 2014***

SET

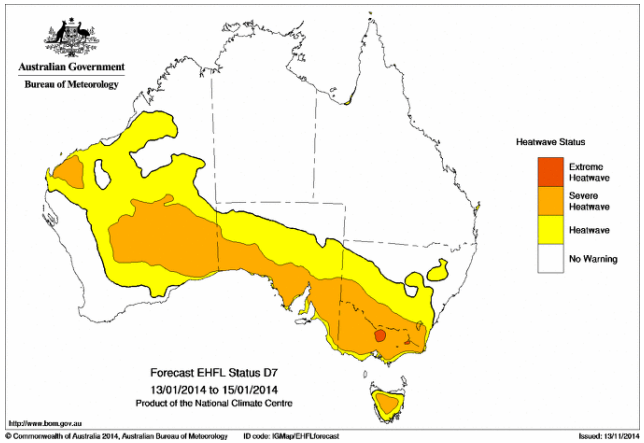


Forecast start date ***5 January*** 2014 for ***12 to 25 January*** (i.e. weeks 2 & 3)

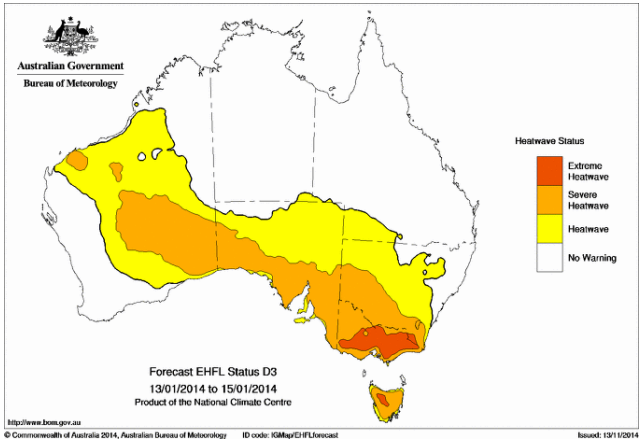
*Weather (NWP) Forecasts for **13 to 15 January***

GO

Forecast start date
***8 January** 2014*



Forecast start date
***12 January** 2014*



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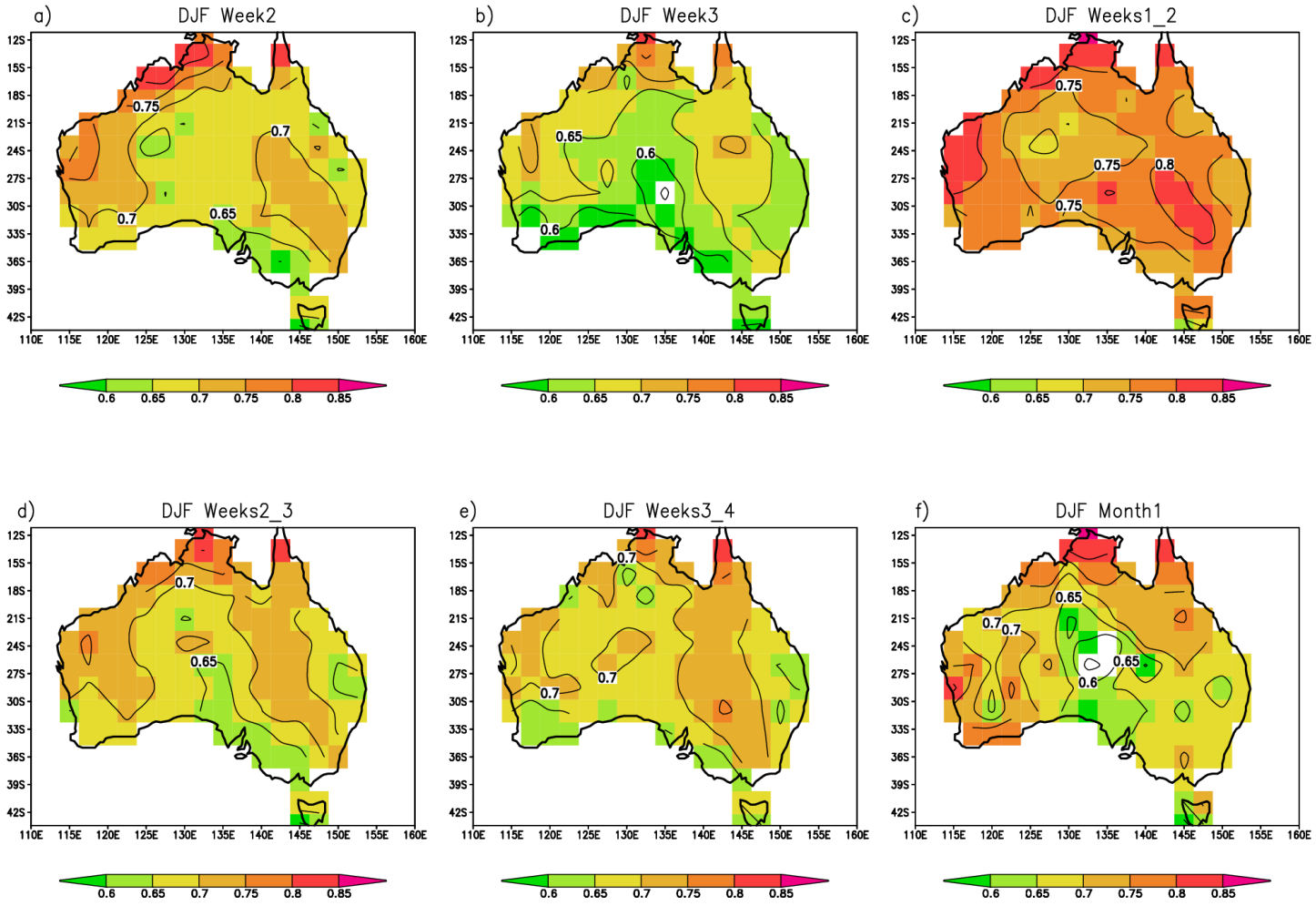
Skill for forecasting heatwaves

ROC area for the probability of the occurrence of a low-intensity heatwave



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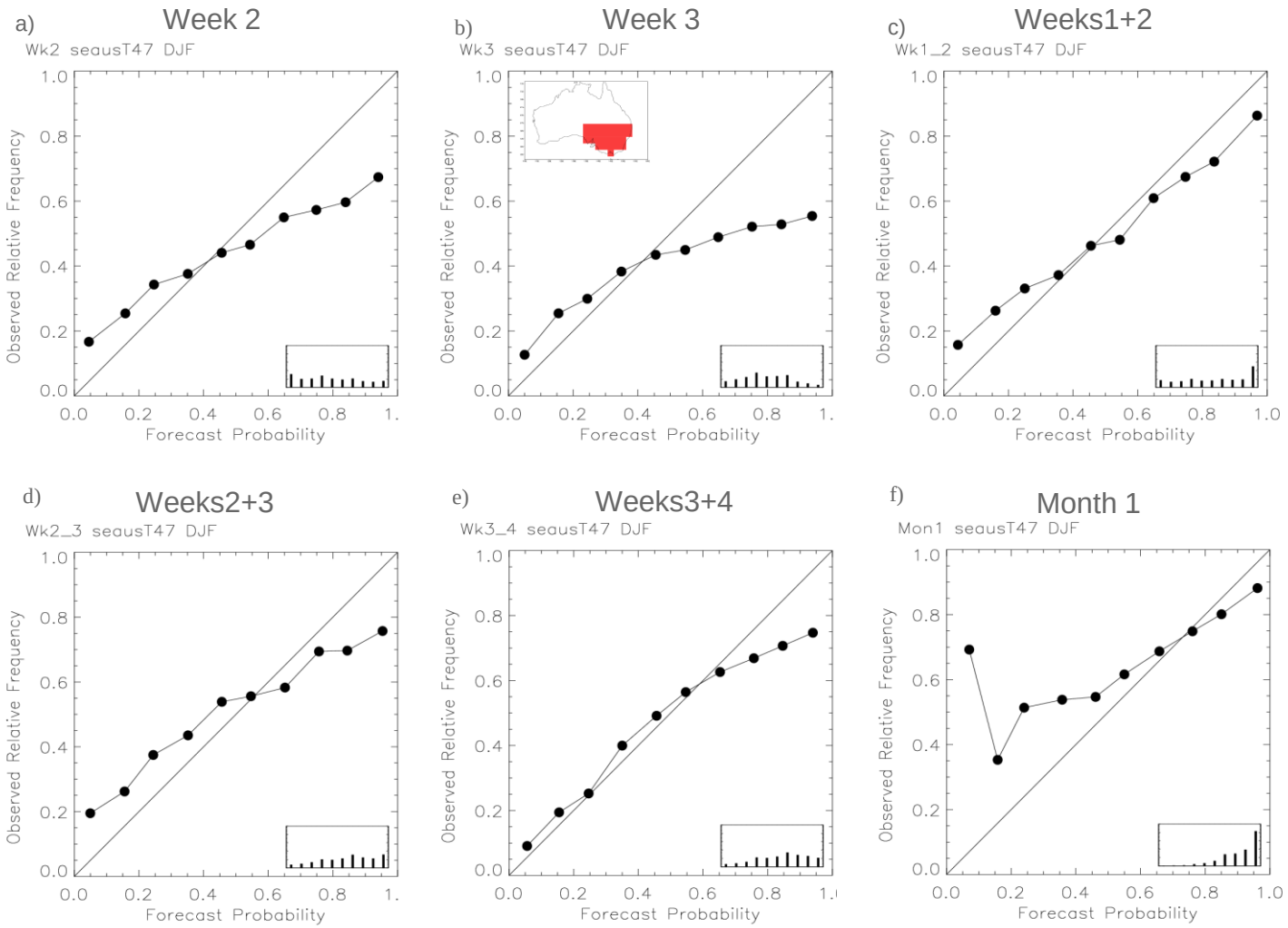
Skill for forecasting heatwaves

Reliability (low-intensity heatwave)

SE Australia



Australian Government
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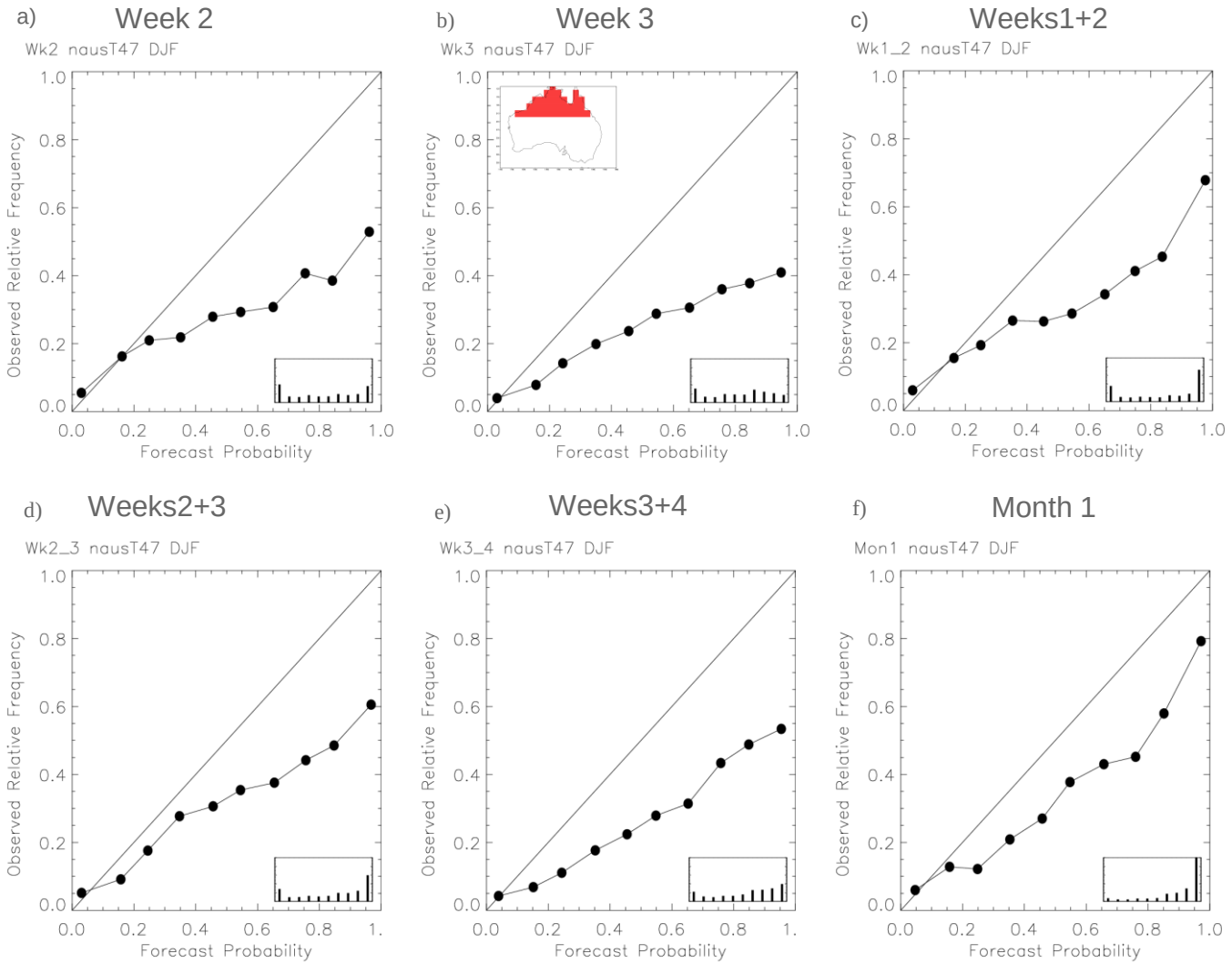
Skill for forecasting heatwaves

Reliability (low-intensity heatwave)

N Australia



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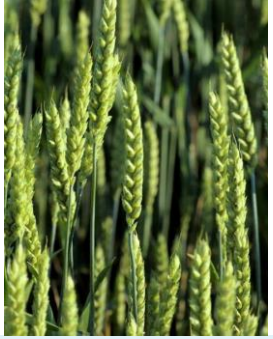
Conclusions


- There is significant potential to extend traditional weather forecasts and warnings for extreme events to include longer lead probabilistic guidance
- POAMA has promising skill and scientists now have an improved understanding of the climate drivers that lead to extreme heat
- The experimental products and acquired knowledge are invaluable for realising the ultimate goal of operational forecasts of extreme heat for farmers

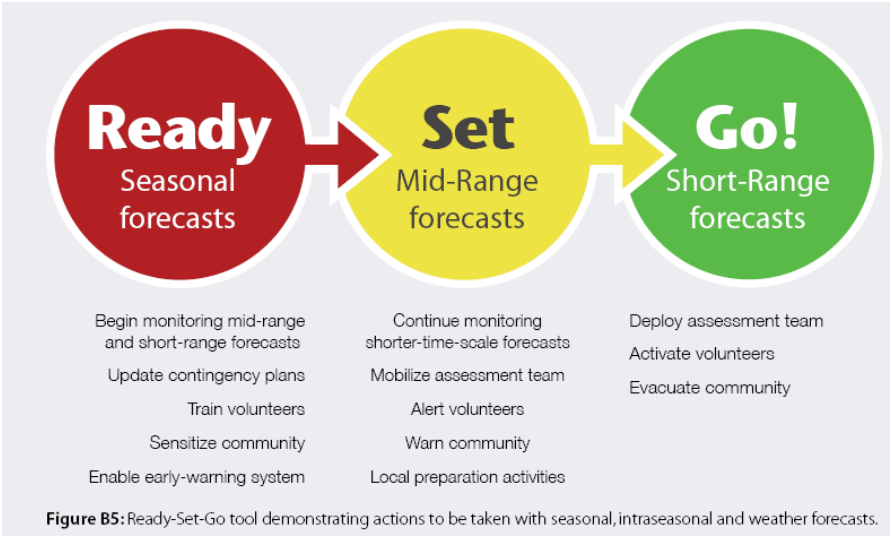


Figure B5: Ready-Set-Go tool demonstrating actions to be taken with seasonal, intraseasonal and weather forecasts.

From: iri.columbia.edu/csp/issue3/download