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Drought in Australia

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Australian Bureau of Meteorology

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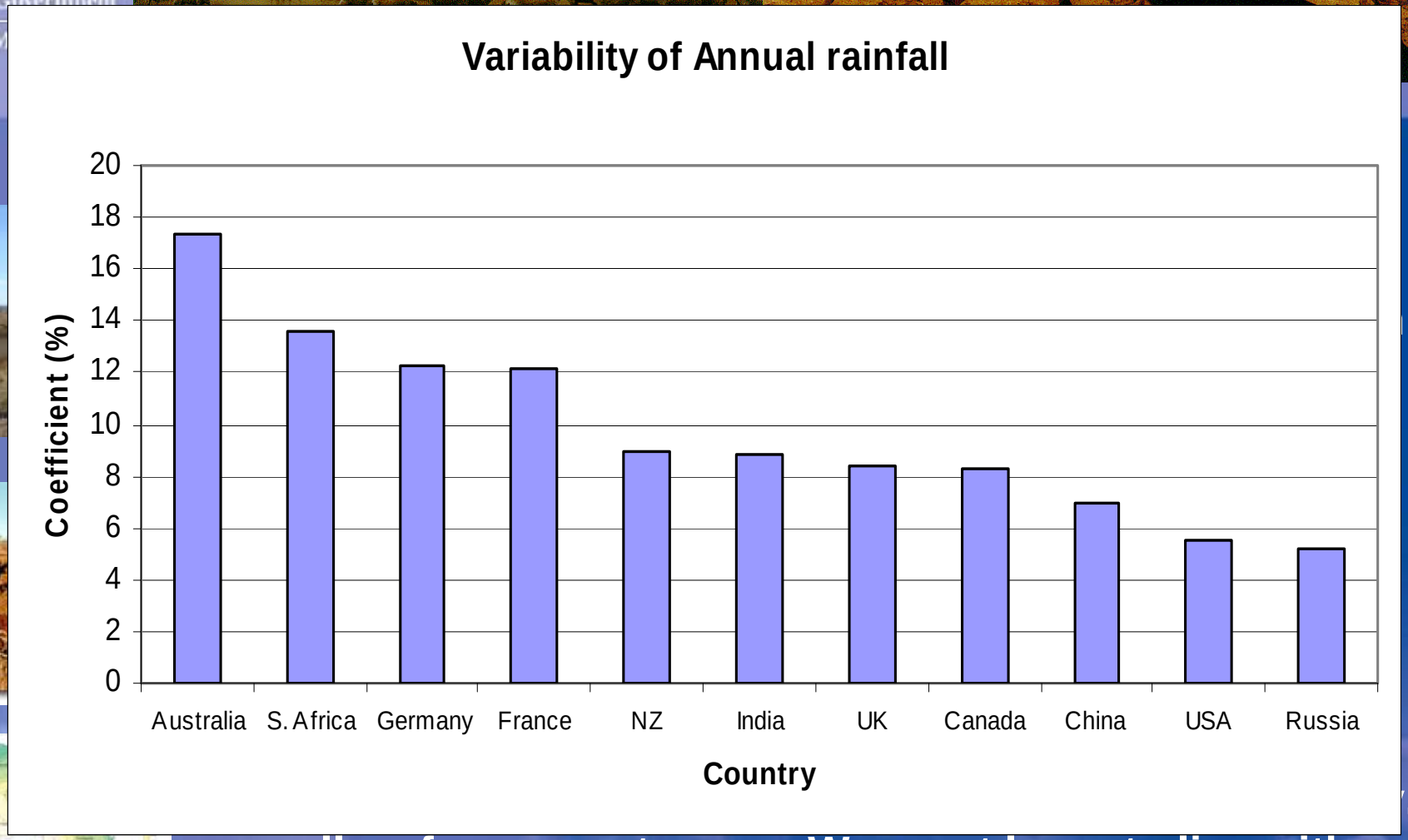
October 2008

Photograph: Mike Rayner/'The Age'



Ratio of standard deviation to mean. 100 years of data for Australia and generally also for the other countries.

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Outline

- How we monitor drought
- trends
- current situation
- future projections
- monitoring drought under climate change

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Drought – more than just (lack of) rainfall

Drought can mean many different things to different people

- Depending on:
  - their normal climate
  - their needs

- Main categories of drought are
  - meteorological
  - agricultural
  - hydrological
  - (socioeconomic)

What the Bureau currently monitors

Gibbs & Maher (1967): The availability of water depends largely on rainfall, (but) the concept of drought cannot be divorced from the use to which water is put.

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What We Mean by Drought

Need to distinguish between and monitor both the "meteorological" and "resource" aspects of drought: e.g., rainfall versus pasture growth.

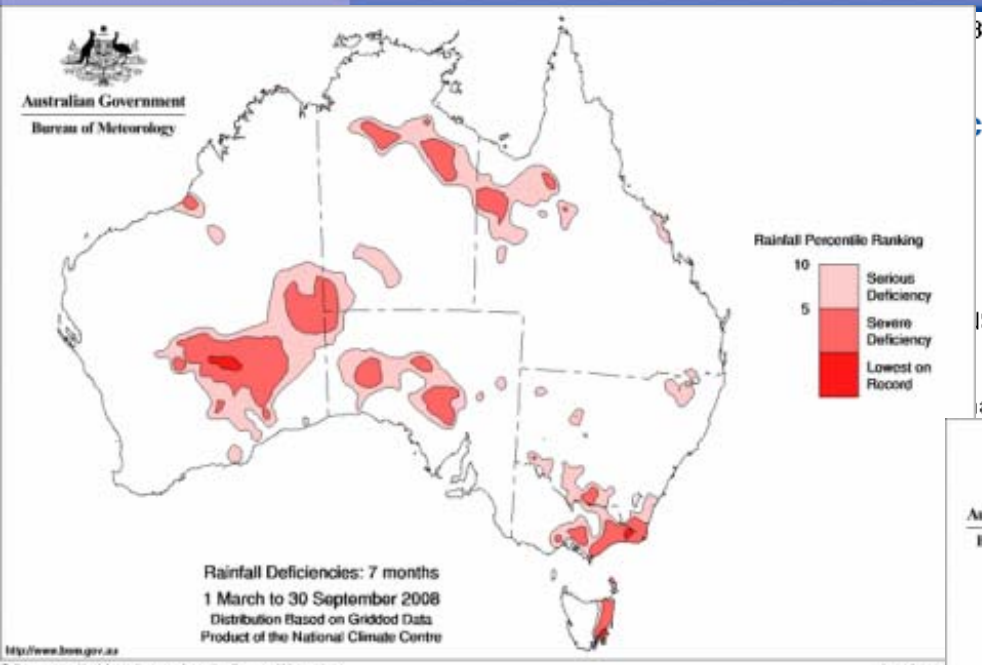
Agricultural "definition of drought" for government assistance:

- must be ***rare***, that is it must not have occurred more than once on average in every 20 to 25 years;
- must result in a ***rare*** and ***severe*** downturn (productive capacity) in farm income over a prolonged period of time (e.g. greater than 12 months);
- cannot be planned for or managed as part of farmers' normal risk management strategies; and
- must be a discrete event that is not part of long-term structural adjustment processes or of normal fluctuations in commodity prices.

(Agriculture-rainfall evaluation delivered through www.nams.gov.au)

Current drought service: Drought Statement

http://www.bom.gov.au/climate/drought/drought.shtml



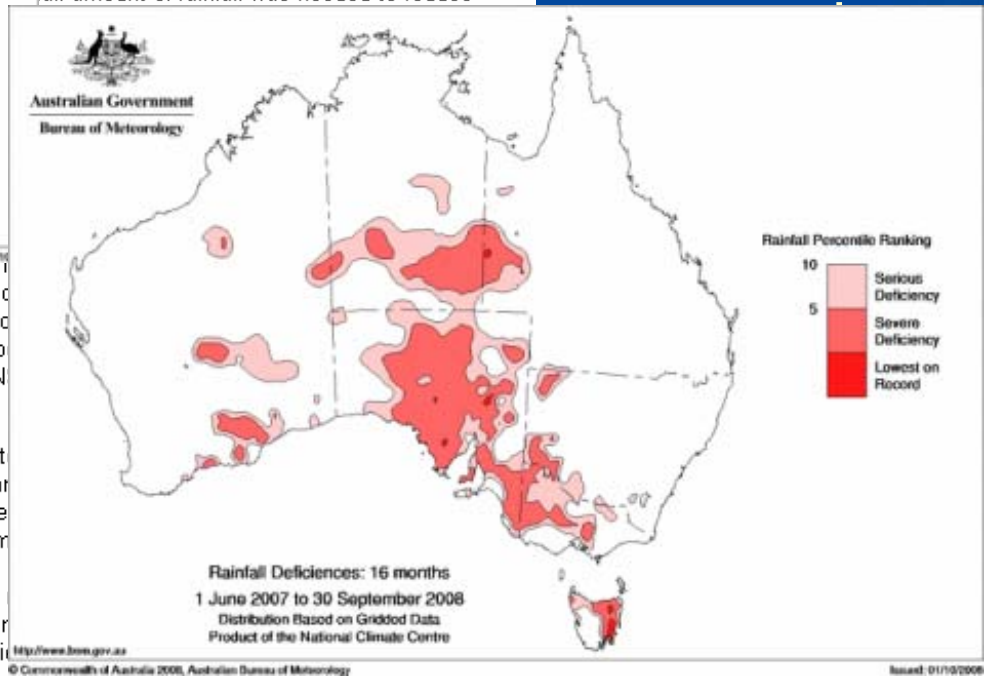
in contrast, below average September rainfall across SA, the
maintained short-term deficiencies, with some intensification
Australia, short-term deficiencies are generally a result of a po
southern Australia a drier than normal 2008 wet season has b
on record September rainfall over parts of Victoria, southern N
stress on farming activities in these regions.

Rainfall deficiencies for the **16-month** period from June 2007 t
southern NT and also in parts of southern WA, far western par
central Victoria and northern and eastern Tasmania. The large
in eastern Tasmania, north of Hobart, with only a couple of sm
anomalies are remarkable given that they partly coincide with
associated with above average rainfall rather than widespread
country saw above average rainfall between November 2007 ar
before and after this period have dominated long-term anomali

ies persist

SW, SA and the WA interior maintained short
above average September falls over much of
deficits over southwest WA, northeast NSW,
all amount of rainfall was needed to reduce

- released monthly for 1-3 chosen periods
- Highlight



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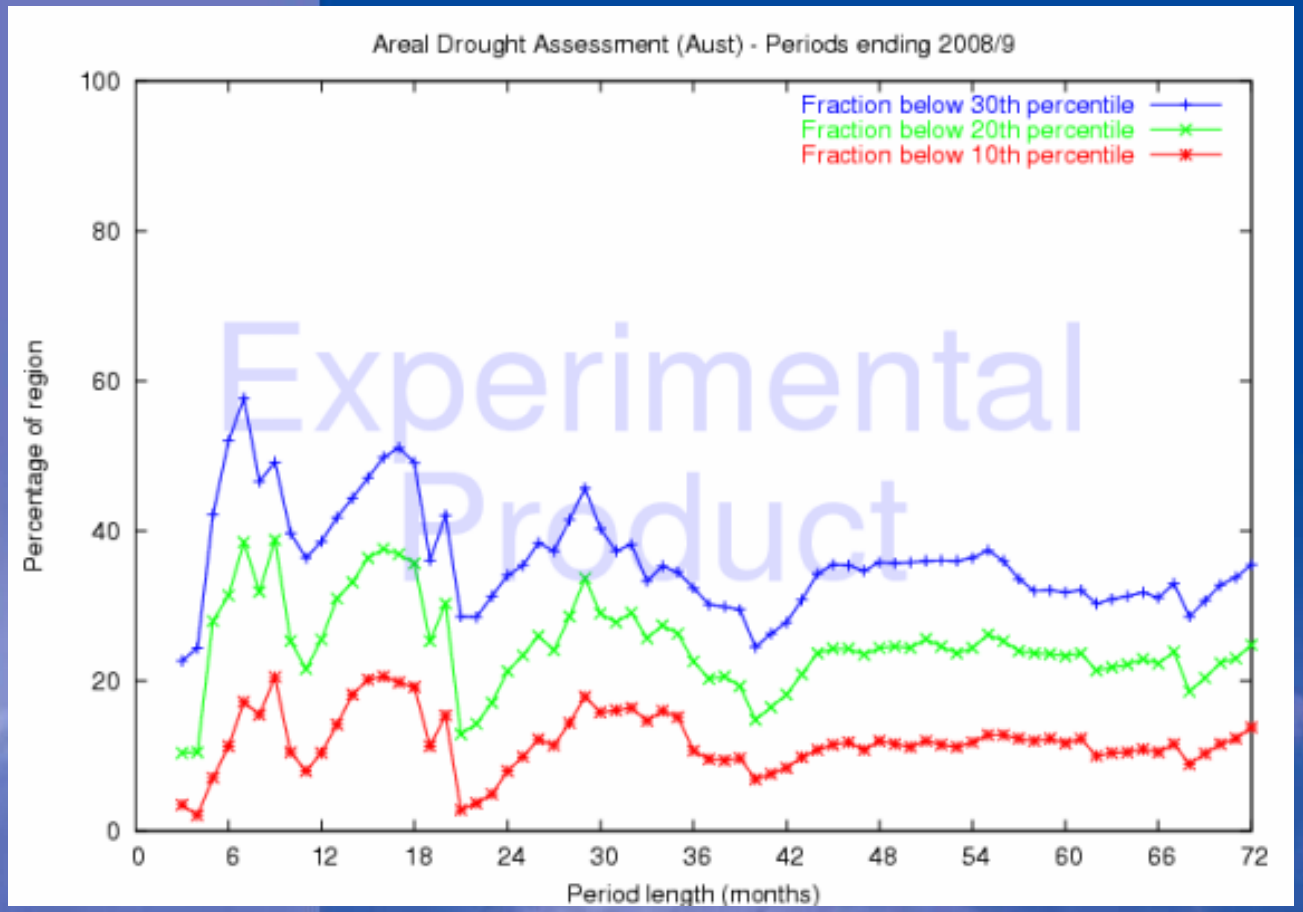
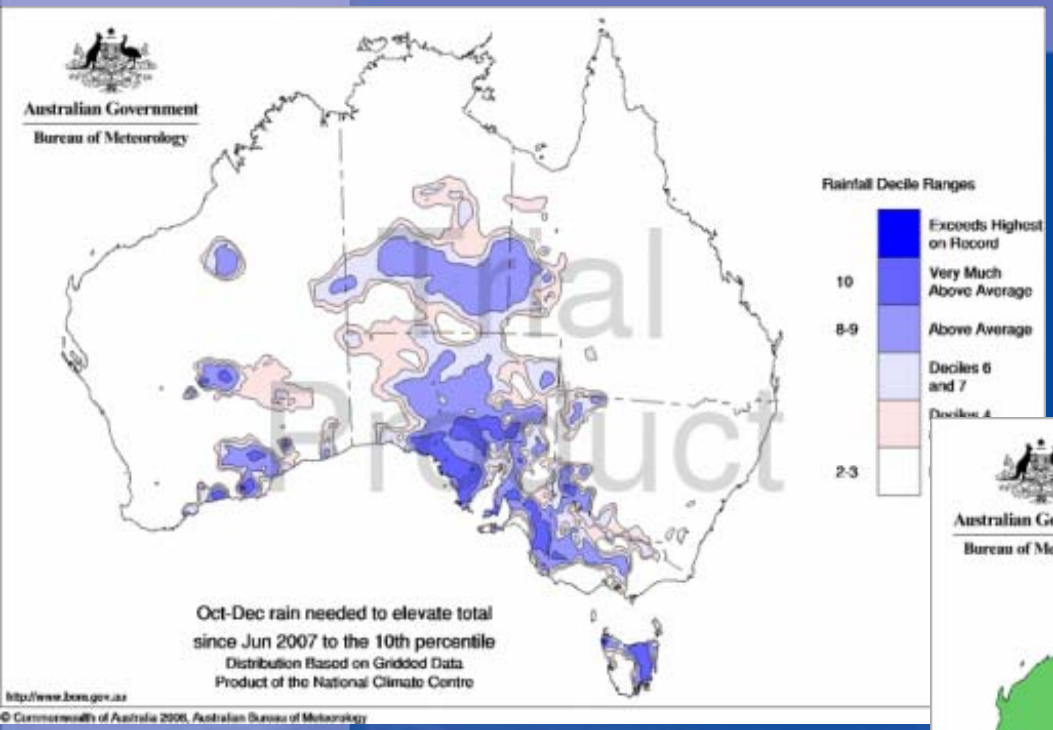
Internal products: drought period calculator

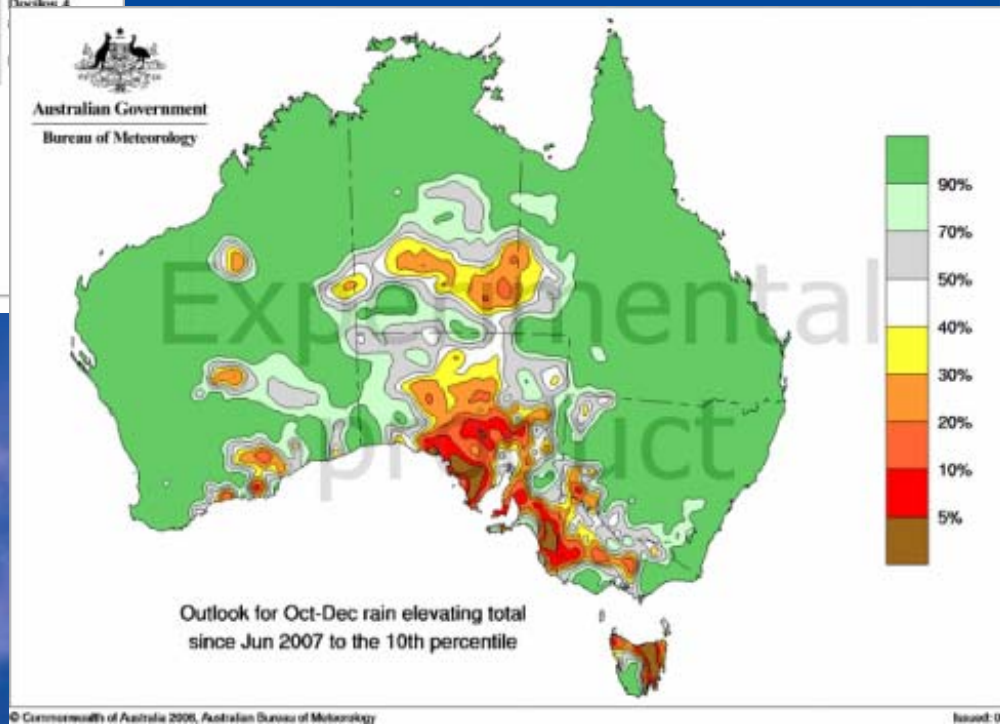


Define drought by agricultural seasons or periods of peak percentage of deficiency (below 10%) area

Internal products: drought relief

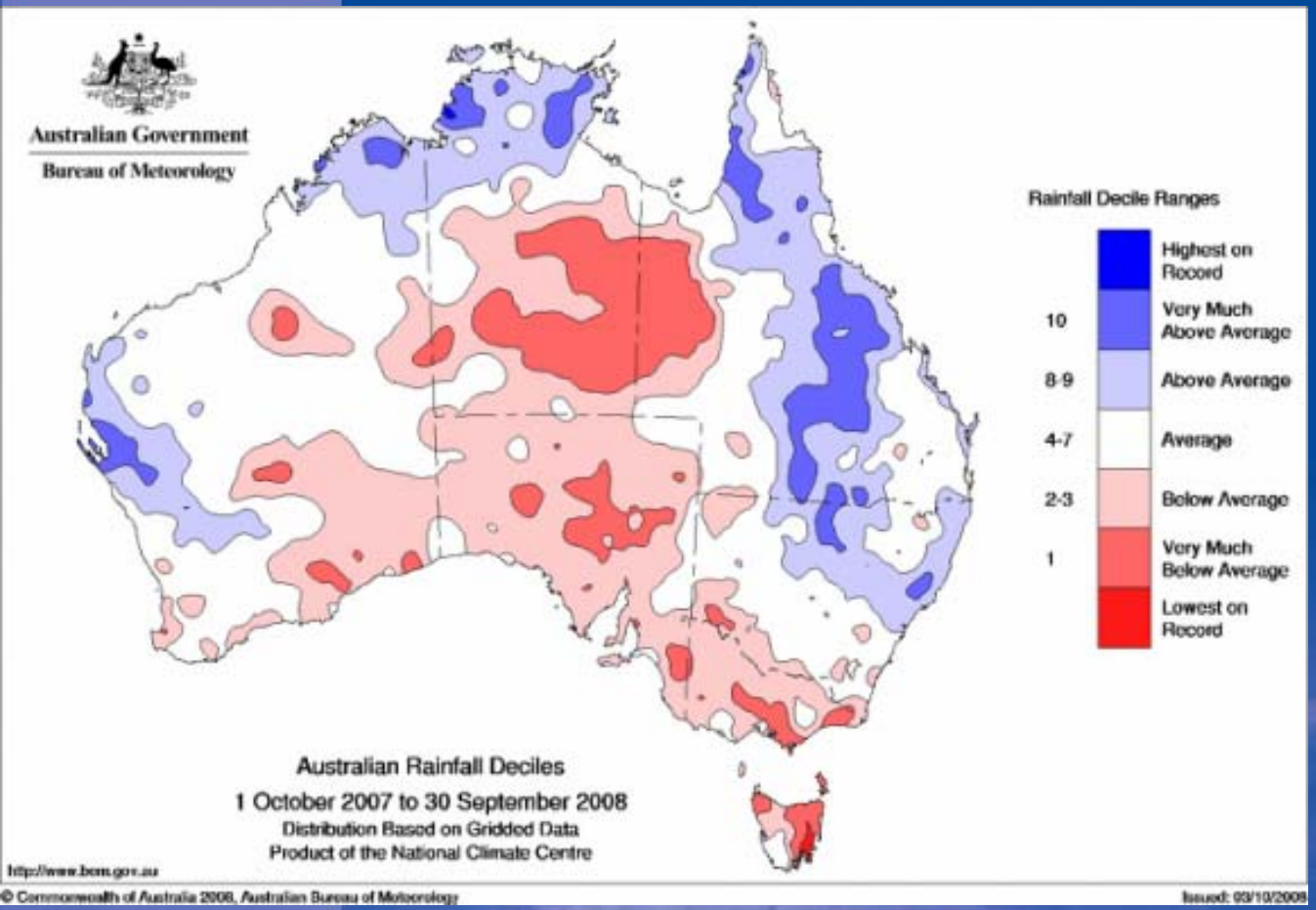


- rainfall needed to relieve rainfall deficiency
- probability of getting this rainfall



Current drought service: rainfall maps

http://www.bom.gov.au/cgi-bin/silo/rain_maps.cgi



maps of 1, 3, 6, 9, 12, 18, 24, 36 months and wet season for 'drought', deciles, percentages etc

Gibbs and Maher 1967 Rainfall deciles as drought indicators

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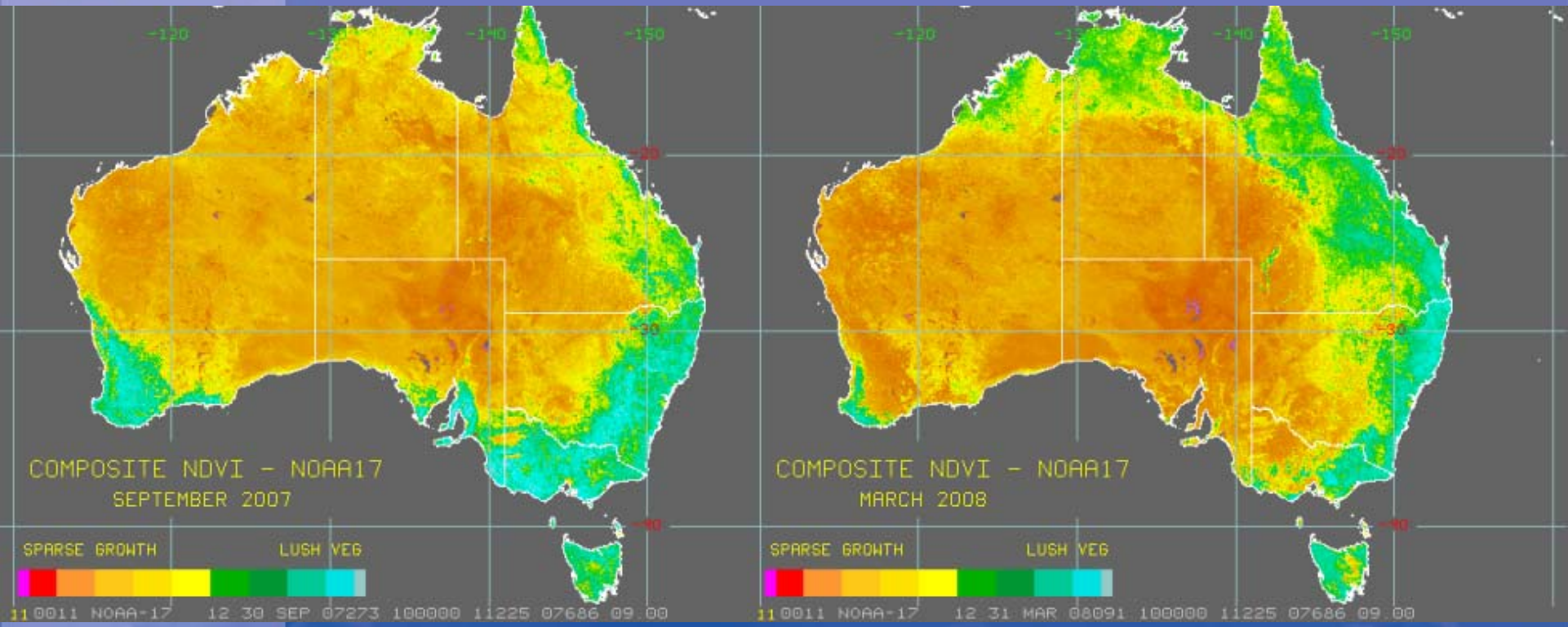
Normalised Difference Vegetation Index (NDVI)

http://www.bom.gov.au/nmoc/NDVI/index.shtml



- The Bureau interest in NDVI products is in their potential to support:
  - derivation of related curing index maps for fire weather services support
  - drought monitoring and climate services support for primary industry organisations
  - hydrological applications such as flood monitoring for inland rivers.

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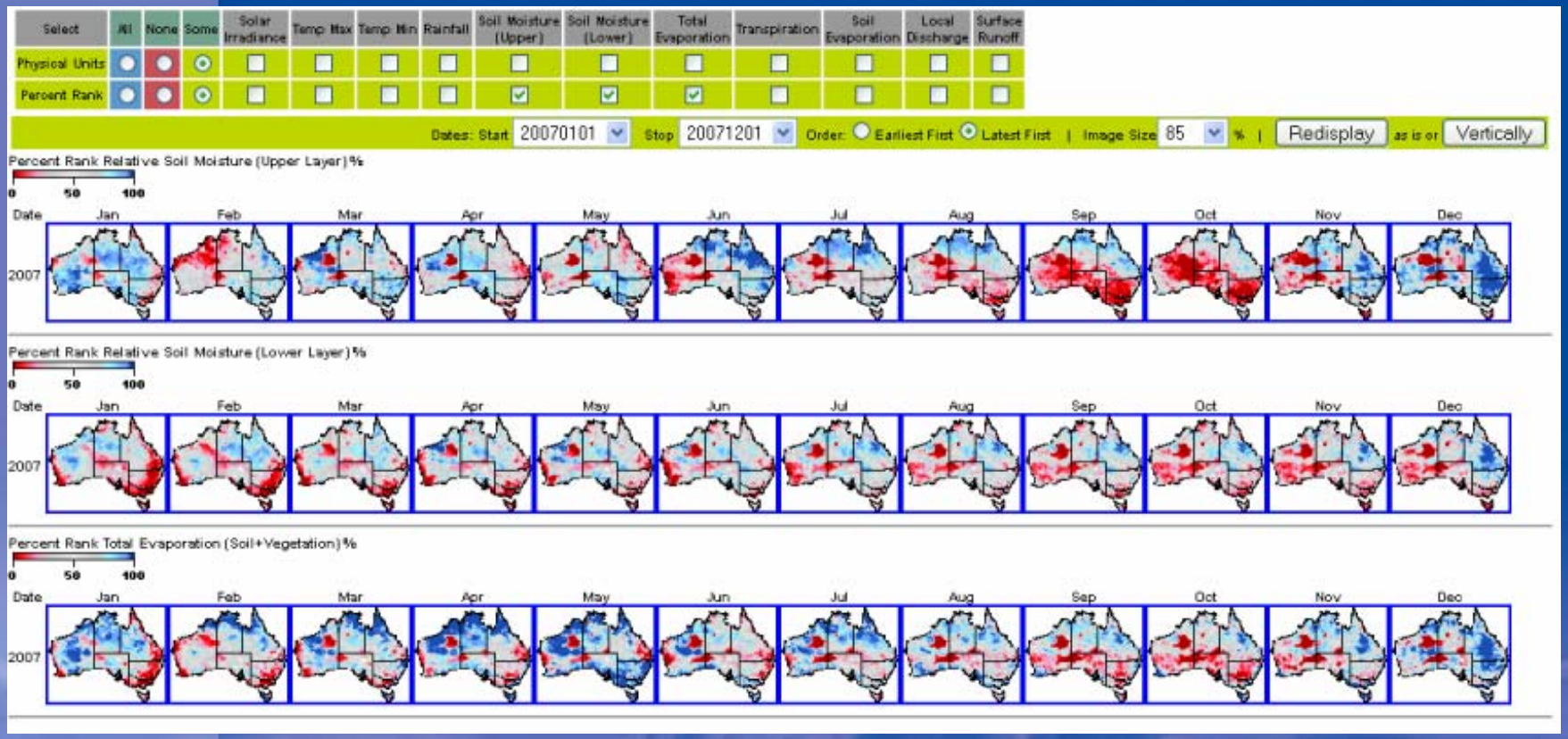
Australian Water Availability Project
http://www.eoc.csiro.au/awap/

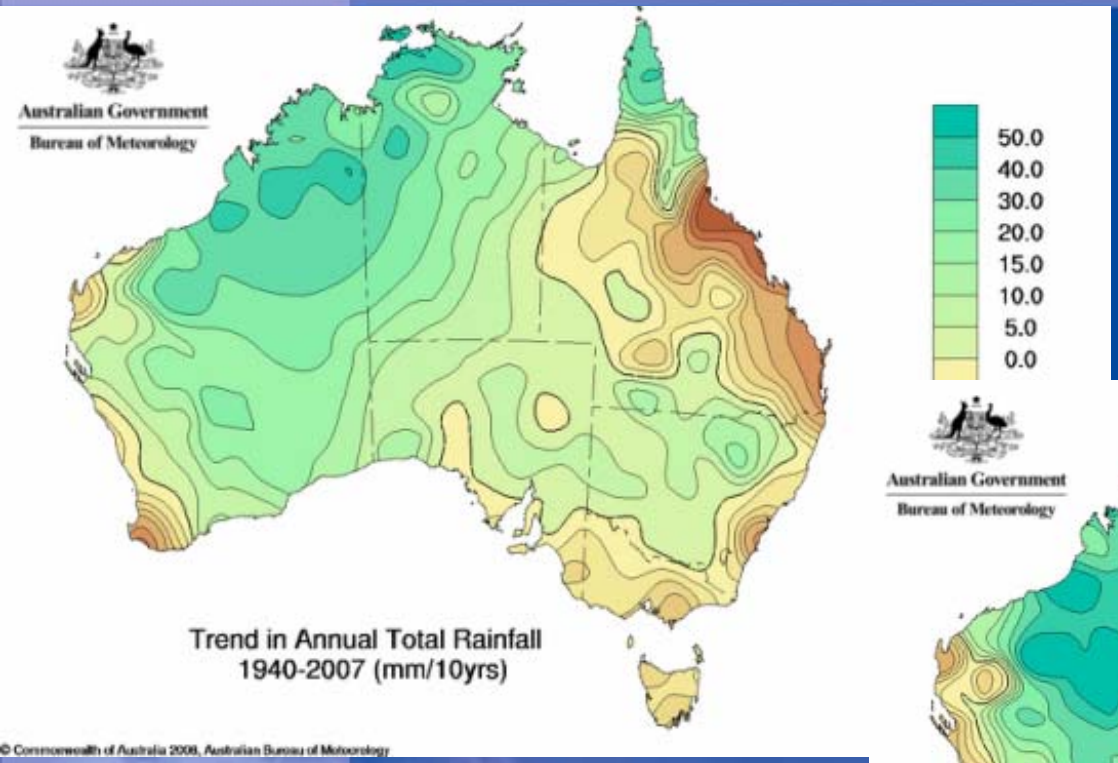


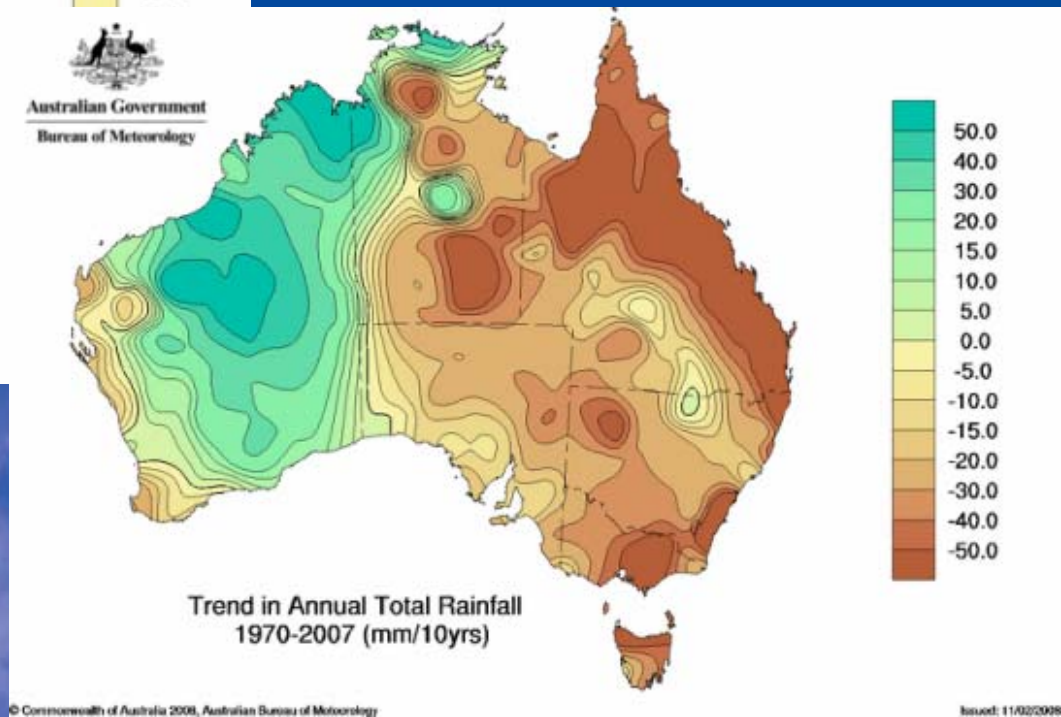
Products are produced using a physical model of the water-carbon budget constrained by in situ observations of rainfall, temperature and wind coupled with NDVI estimate of plant productive and stream-flow

Placing the current situation in climatological context:

Observing Australian Climate trends- trend maps

http://www.bom.gov.au/silo/products/cli_chg/index.shtml





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Placing the current situation in climatological context:

Observing Australian Climate trends - time series

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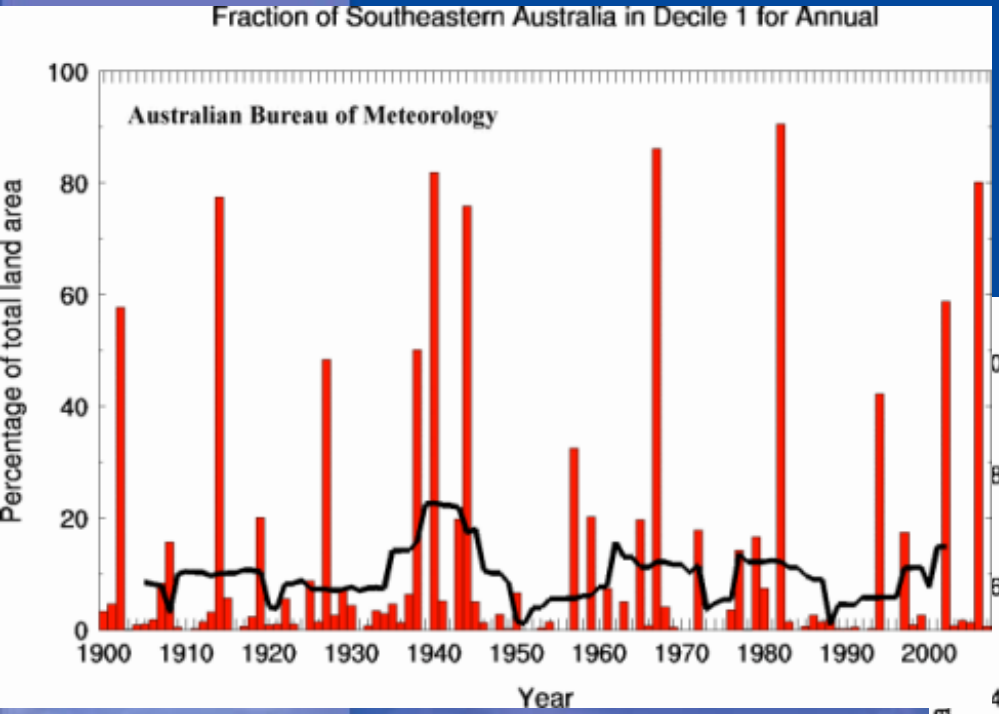

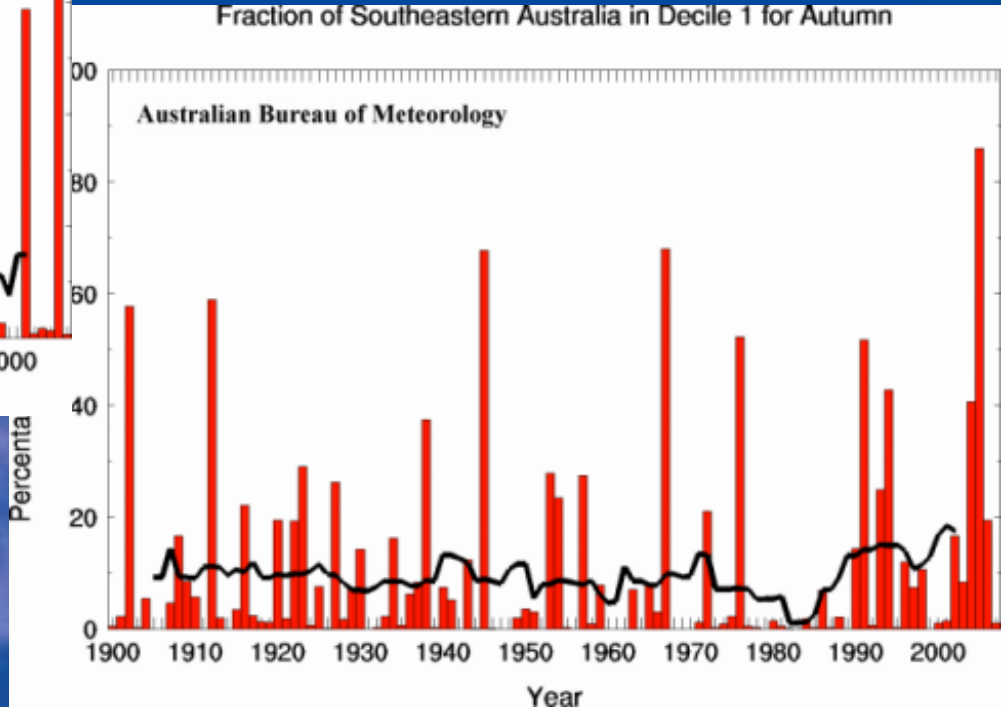

- Fraction of an area in decile 1

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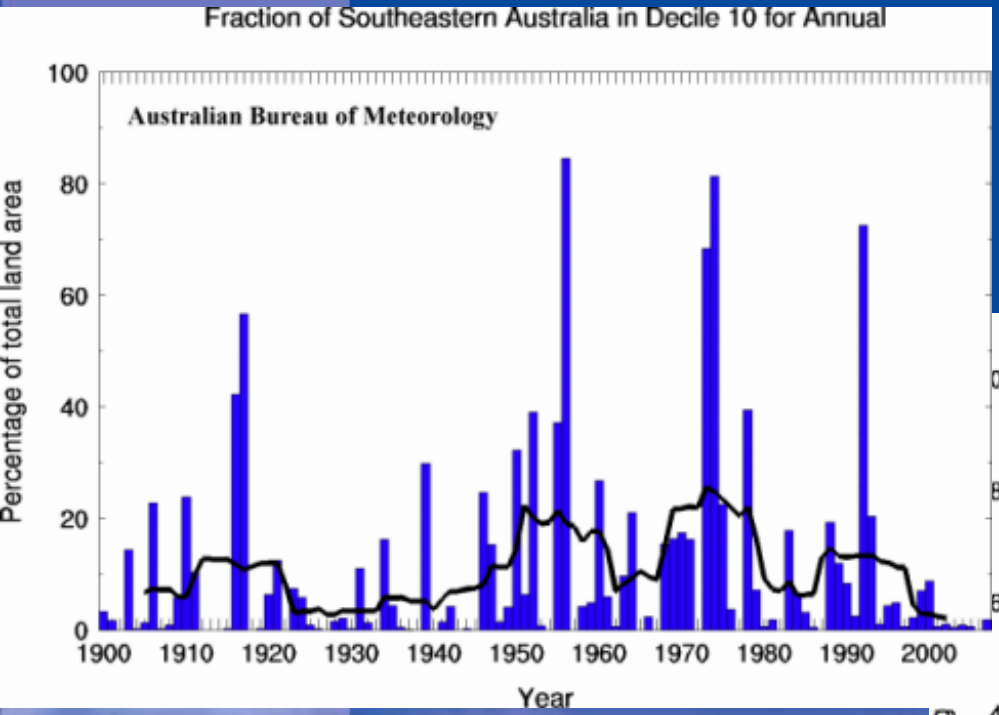
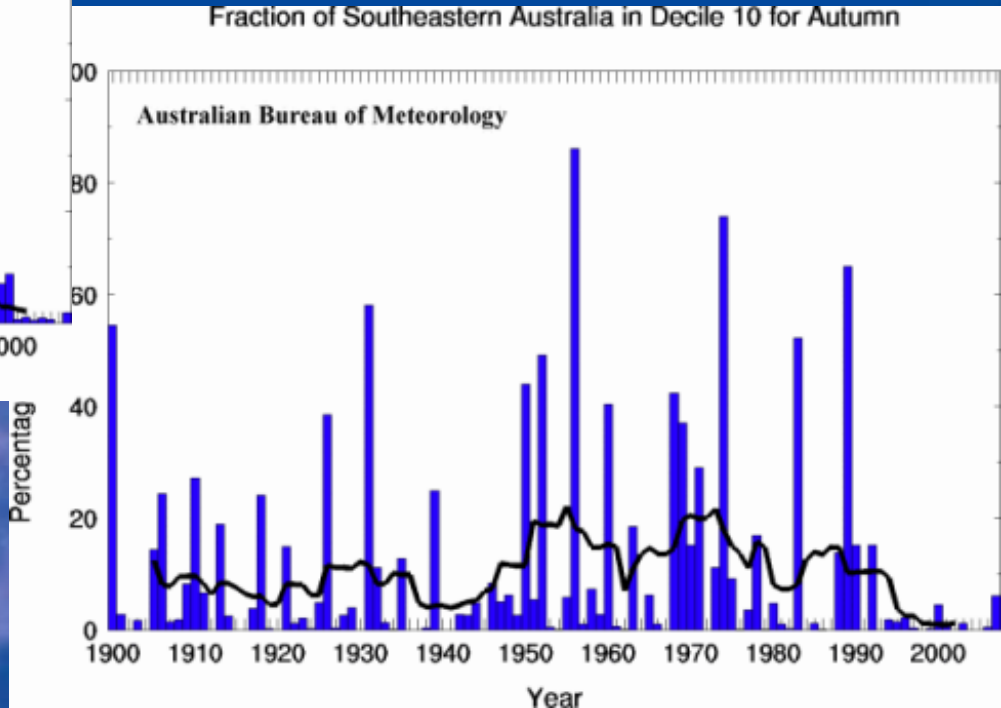
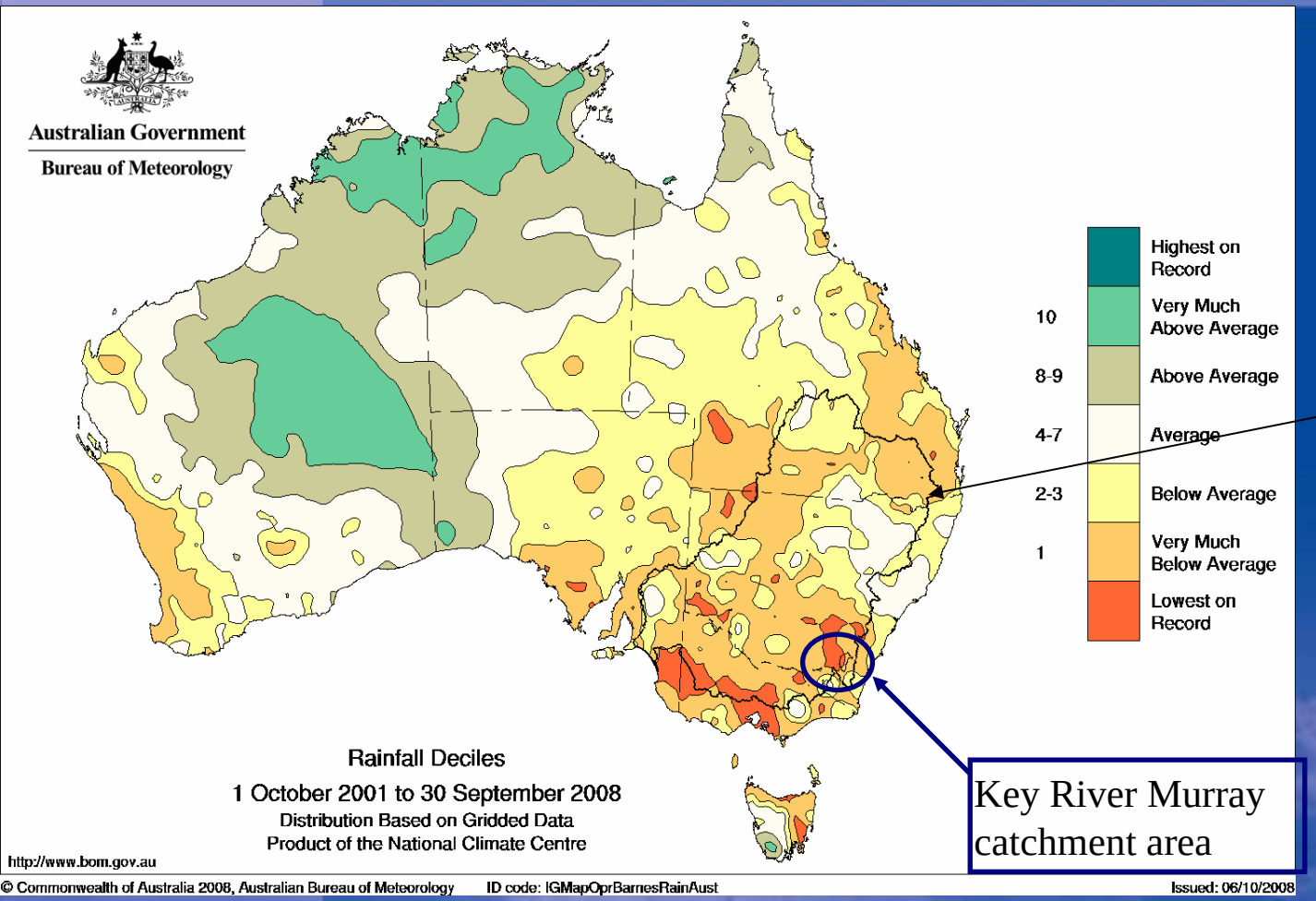




- Fraction of an area in decile 10

A Record Drought?

http://www.bom.gov.au/climate/current/special-statements.shtml



"The last year in which there was widespread above-average rainfall across much of inland eastern Australia, including most of the Murray-Darling Basin (MDB), was 2000. Since then there have been two extremely dry years, 2002 and 2006, along with a succession of years with rainfall generally near- to slightly below average. "

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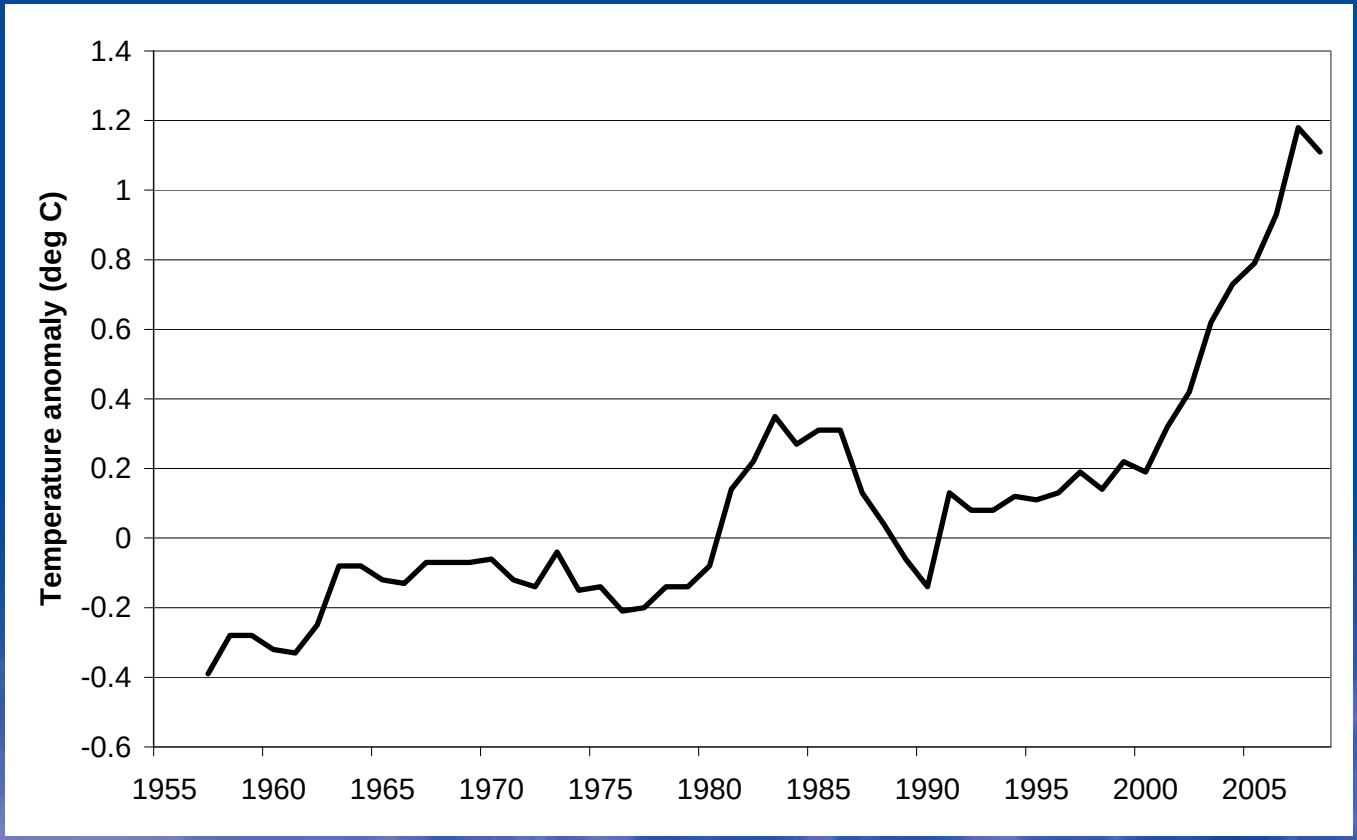
A Record Drought?

http://www.bom.gov.au/climate/current/special-statements.shtml



7-year maximum temperature anomalies (differences from 1961-90 average) for the Murray-Darling Basin.

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Nicholls 2004: The changing nature of Australian droughts

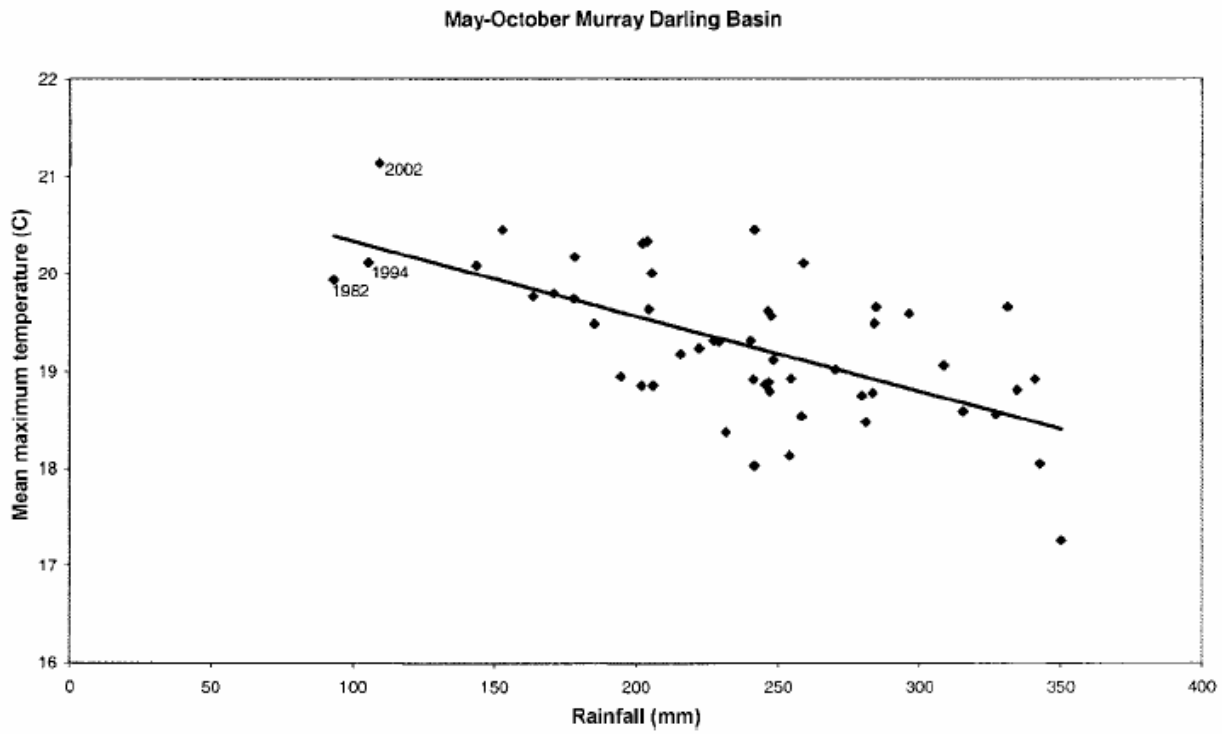

Figure 6. Scatter diagram of Murray Darling Basin May–October rainfall versus mean daily maximum temperature, 1952–2002. The three driest years are identified. Linear line of best fit is indicated.

"The possibility that the enhanced greenhouse effect is increasing the severity of Australian droughts, by raising temperatures and hence increasing evaporation, even if the rainfall does not decrease, needs to be considered".

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Cai and Cowan 2008: Evidence of impacts from rising temperature on inflows to the Murray-Darling Basin

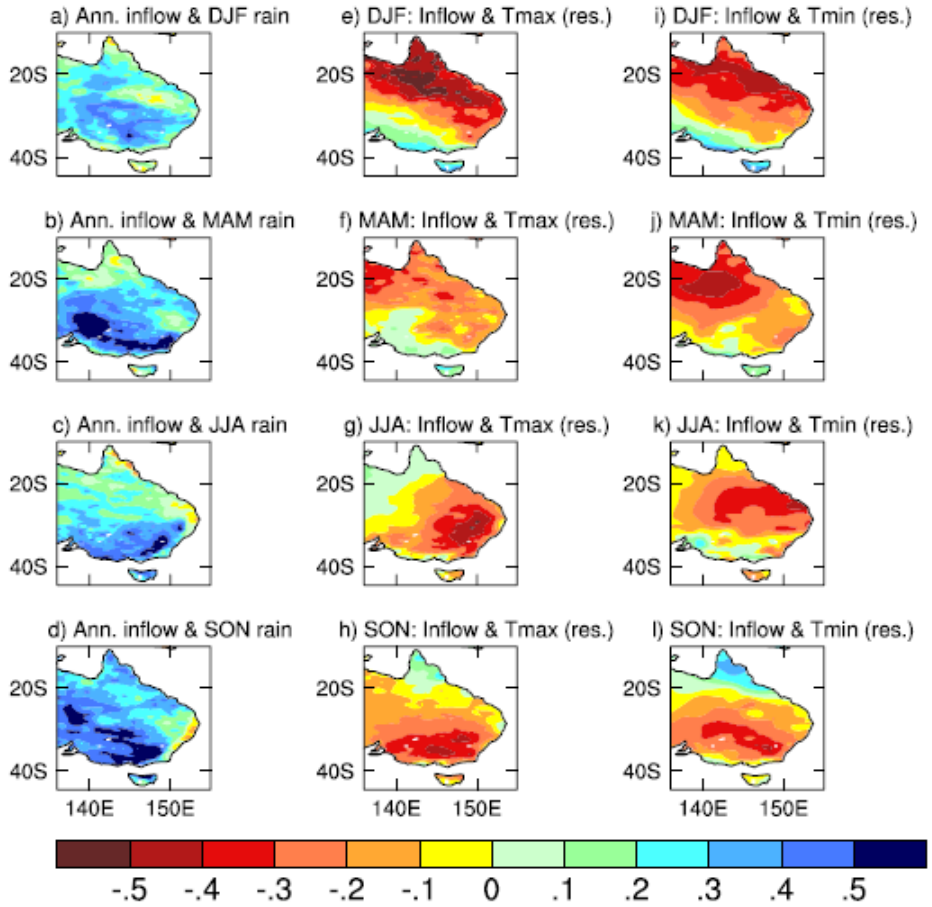

Figure 3. Maps of correlations between MDB annual-total inflow and seasonal rainfall (a–d), between residual seasonal-total inflow and residual seasonal-mean Tmax (e–h), and between residual seasonal-total inflow and residual seasonal-mean Tmin (i–l). All data are linearly detrended, and the analysis is carried out without 1956 data.

"A rise of 1ºC in temperature leads to a 15% reduction in the annual inflow, even if rainfall does not change"

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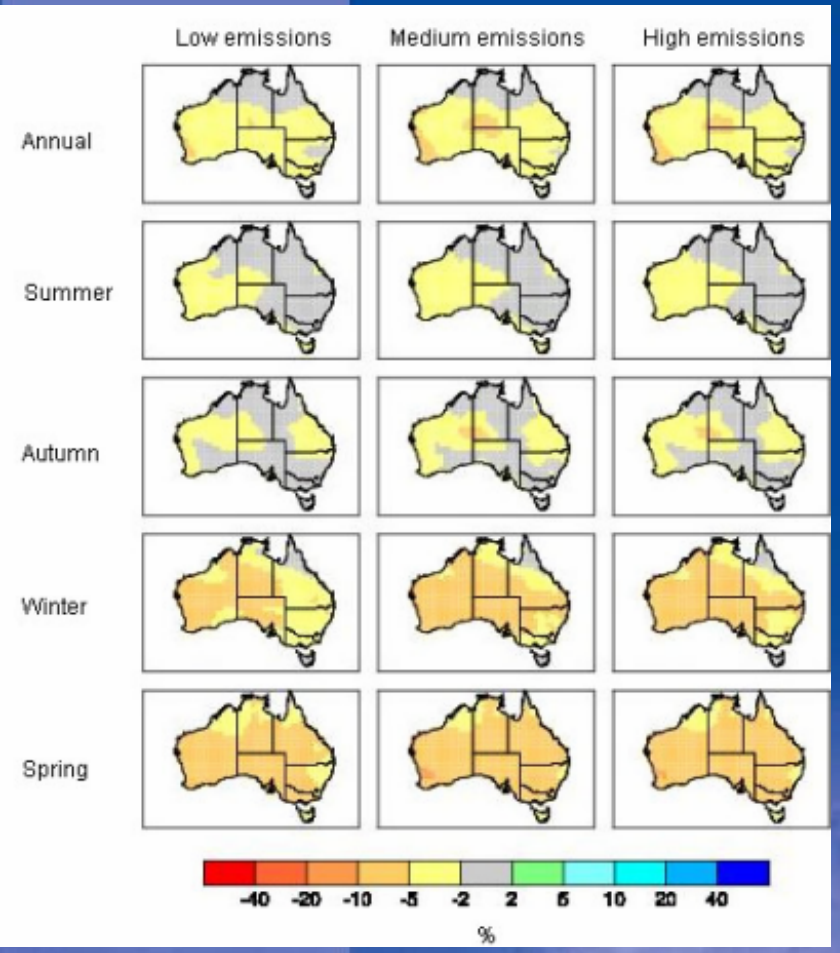
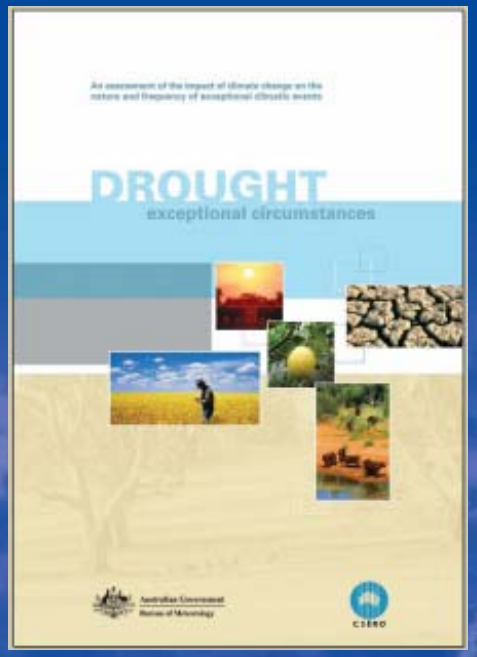
Climate change – changing the frequency and/or severity of drought



National rainfall change for 2030 – 50%ile
www.climatechangeinaustralia.gov.au

Drought as an exceptional event qualifying for assistance is currently defined by the government as something that happens every 20-25 years. The Rudd government has asked the Bureau and CSIRO to look at current thresholds under future climate scenarios.



http://www.bom.gov.au/climate/droughtec/

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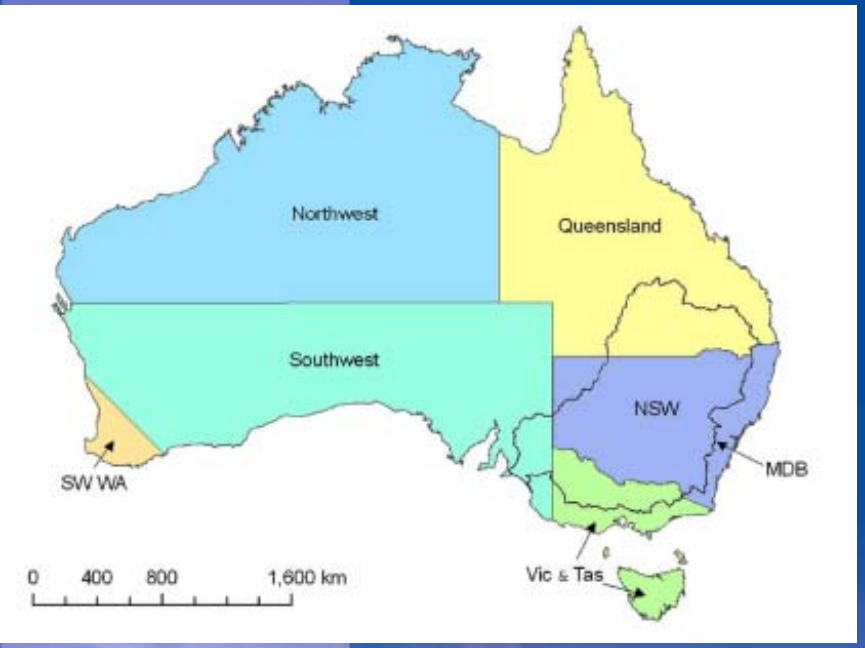
Methodology



The Study Regions

- Historical and projected changes entire period 1900-2040 in:
  - annual rainfall and temperatures
  - areas below the 5th percentile (exceptionally dry/cool) / above the 95th percentile (exceptionally wet/warm)
- Seven study regions
- 13 climate models
  - Observed GHGs/aerosols for 1900-2000
  - A1B/A2 GHG emissions scenarios for 2001-2040

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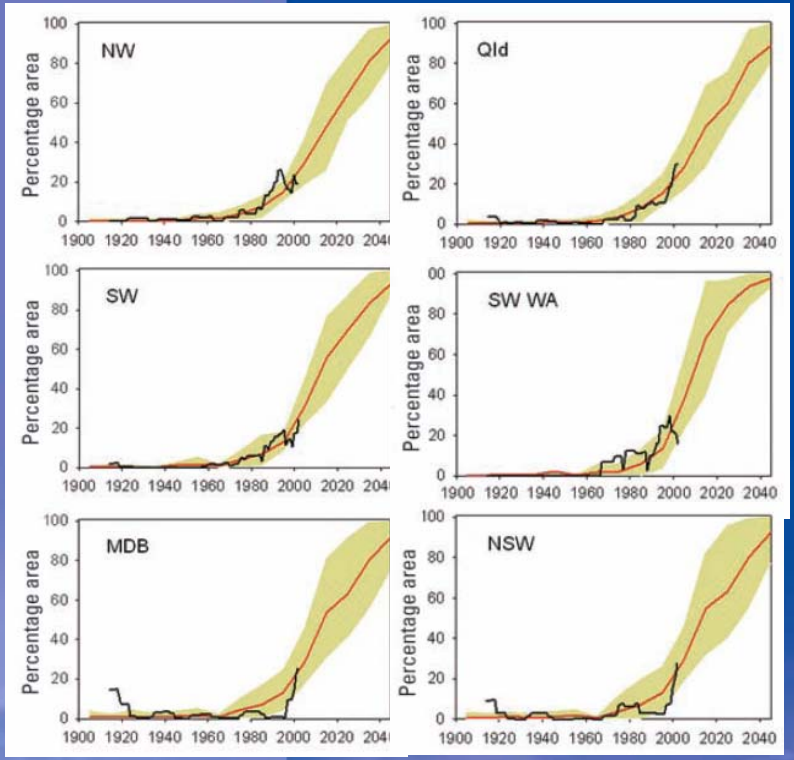
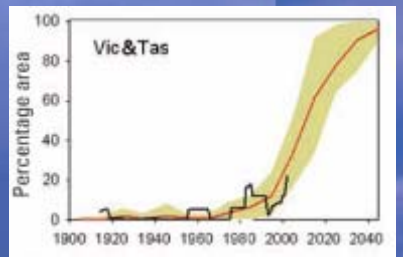
Projections – Exceptionally hot years





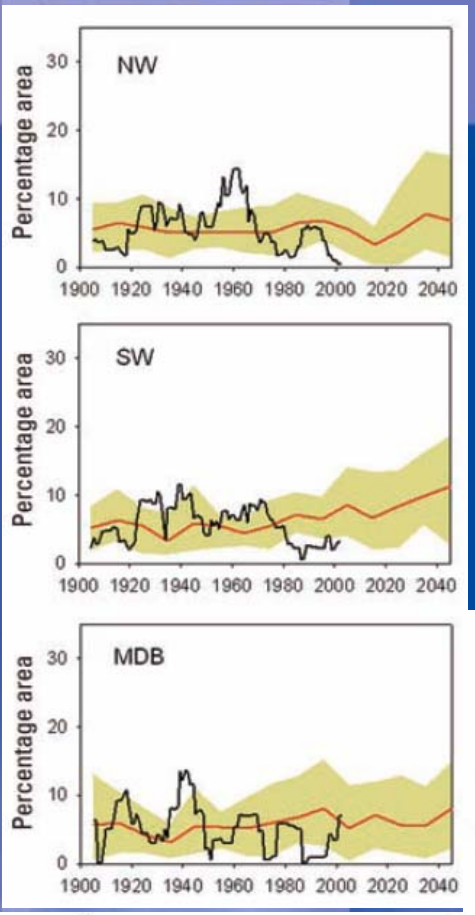
Region	1900-2007	2010-2040 low	2010-2040 mean	2010-2040 high
Qld	4.6	48.9	62.2	73.8
NSW	4.5	43.5	62.1	81.0
Vic&Tas	4.6	60.5	76.1	95.0
SW	4.6	49.1	68.4	86.3
NW	4.6	50.0	63.5	82.0
MDB	4.5	45.2	64.9	90.1
SW WA	4.6	63.1	81.9	97.1

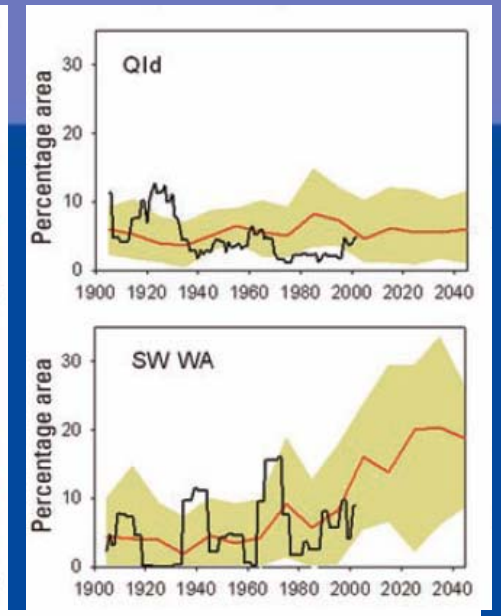
Simulated percentage area having exceptionally hot years for 1900-2007 and 2010-2040, based on 13 climate models. The low and high scenarios represent the lowest and highest 10% of the range of model results

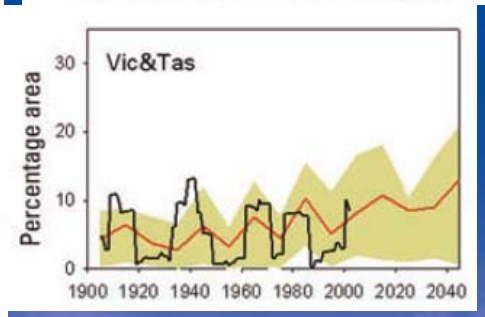
The return period is about 22 years for 1900-2007

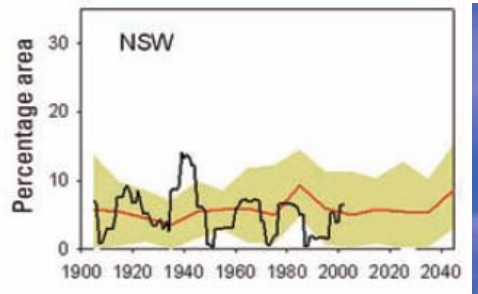
By 2010-2040, the mean return period falls to about 1.5 years in most regions

Projections – Exceptionally low Rainfall









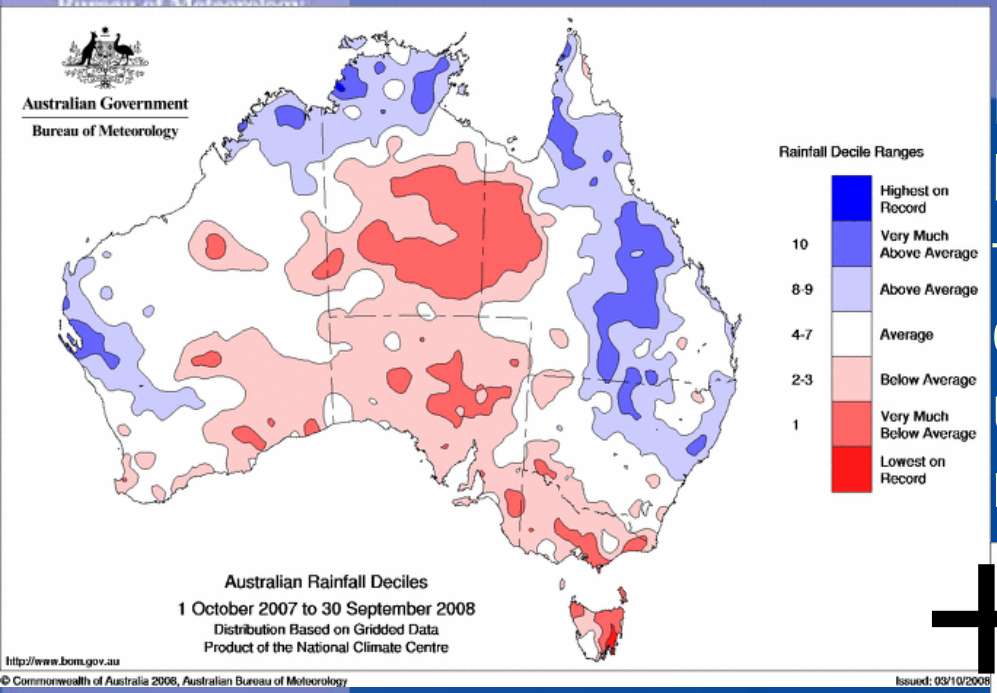
Region	1900-2007	2010-2040 low	2010-2040 mean	2010-2040 high
Qld	5.5	1.7	5.8	9.7
NSW	5.6	2.2	5.6	10.9
Vic&Tas	5.4	3.0	9.7	13.9
SW	5.6	5.0	8.4	12.1
NW	5.6	1.8	5.3	8.0
MDB	5.6	2.7	6.0	11.1
SW WA	5.5	9.0	18.4	26.5

Table 7. Simulated percentage area having exceptionally low annual rainfall for 1900-2007 and 2010-2040, based on 13 climate models. The low and high scenarios represent the lowest and highest ten per cent of the range of model results.

The return period is about 18 years for 1900-2007

By 2010-2040, the mean return period falls slightly to 16-18 years in most regions (around 13 years in SW and Vic&Tas, 6.5 years in SW WA)

A new responsibility for the Bureau?



Rainfall deficiencies alone may be less able now and in the future to quantify the severity of drought – should the Bureau be updating its drought service to reflect this?

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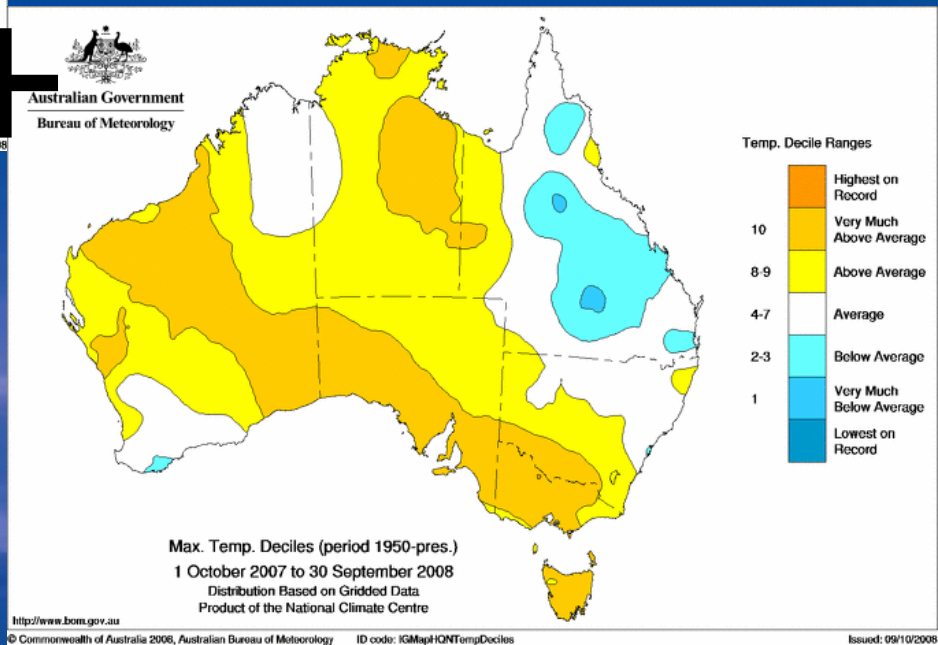
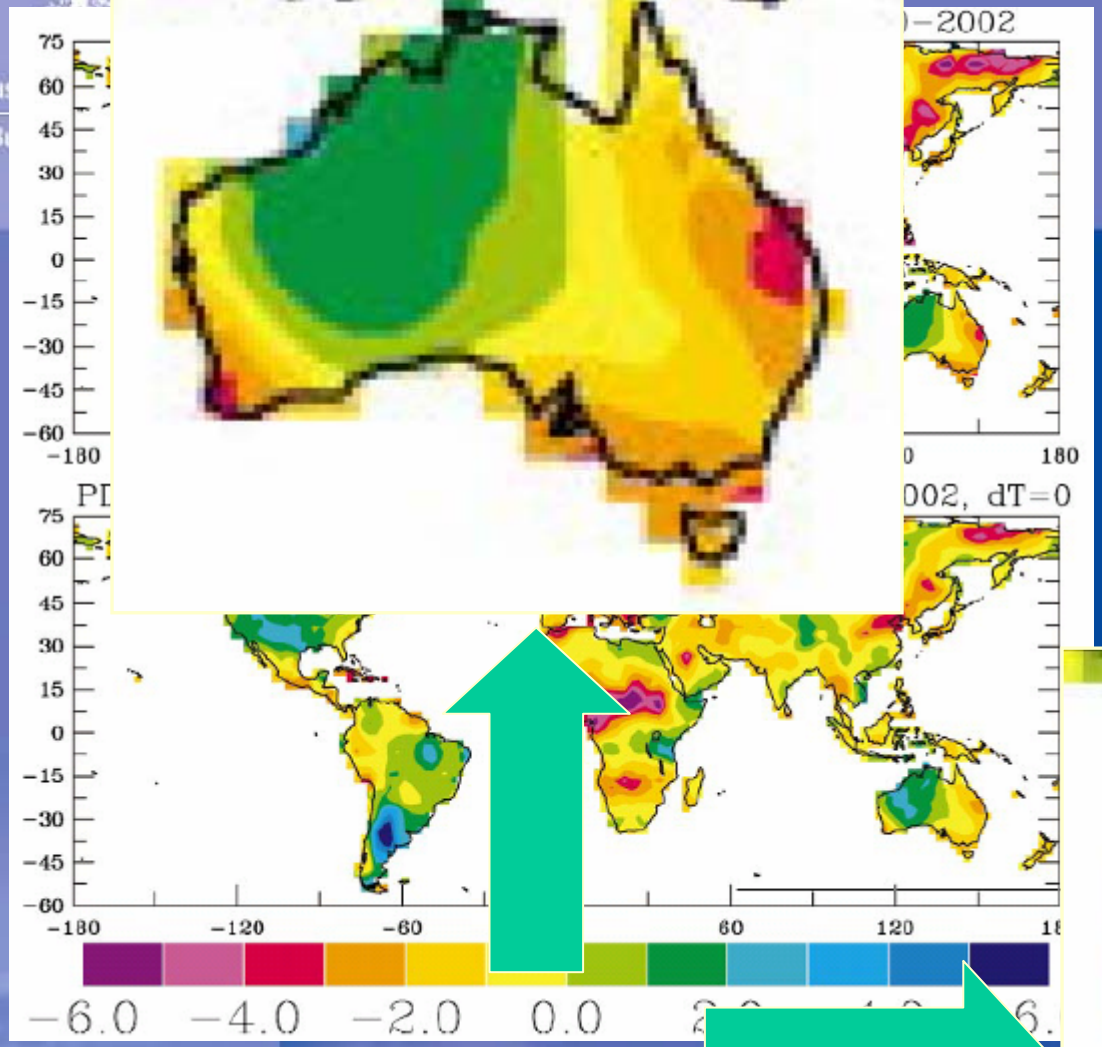
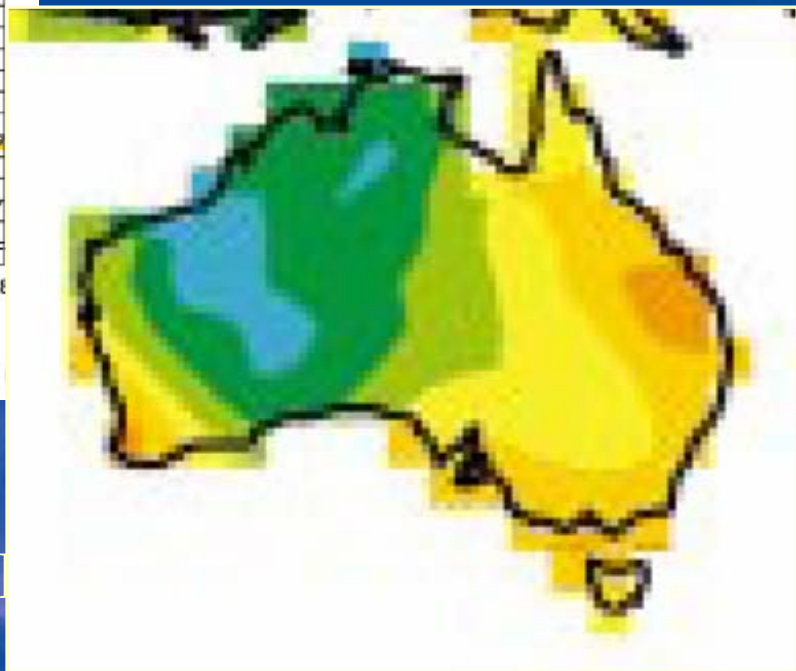


The Bureau may be best placed to give an overall picture of current Australian drought conditions – especially through awareness amongst media and the general public

Dai *et al*. 2005 Global change in Palmer Drought Severity Index (with and without temperature)

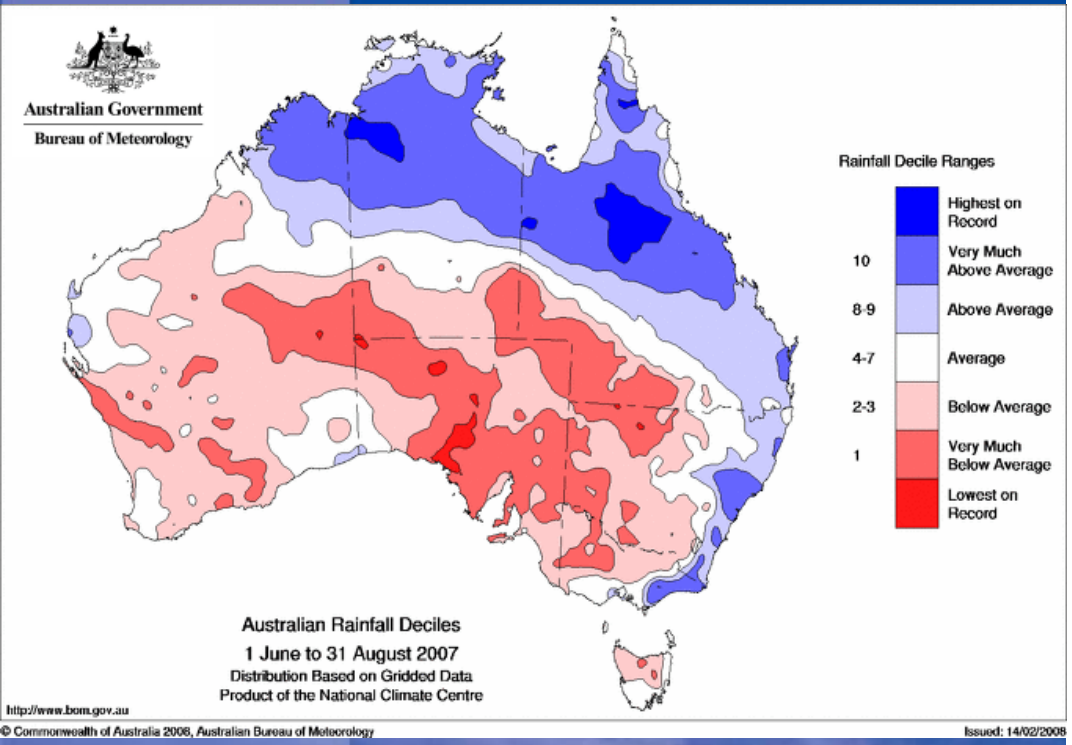


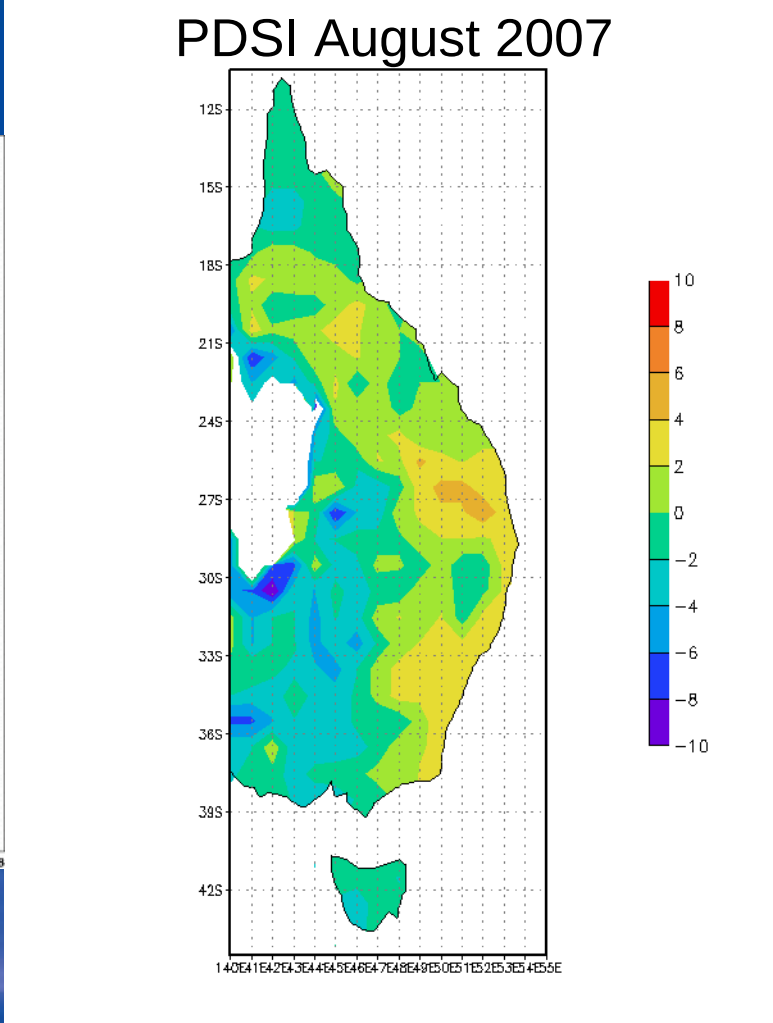


Top – global trend in PDSI

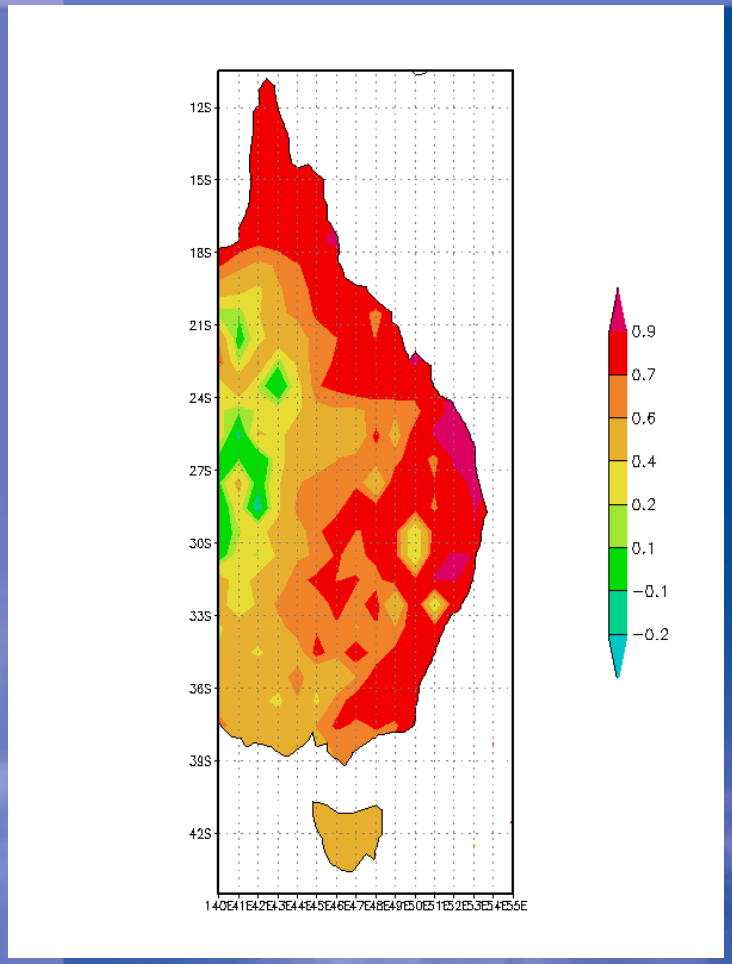
Bottom – trend with temperatures hel

Palmer index for eastern Australia versus rainfall deciles ending August 2007

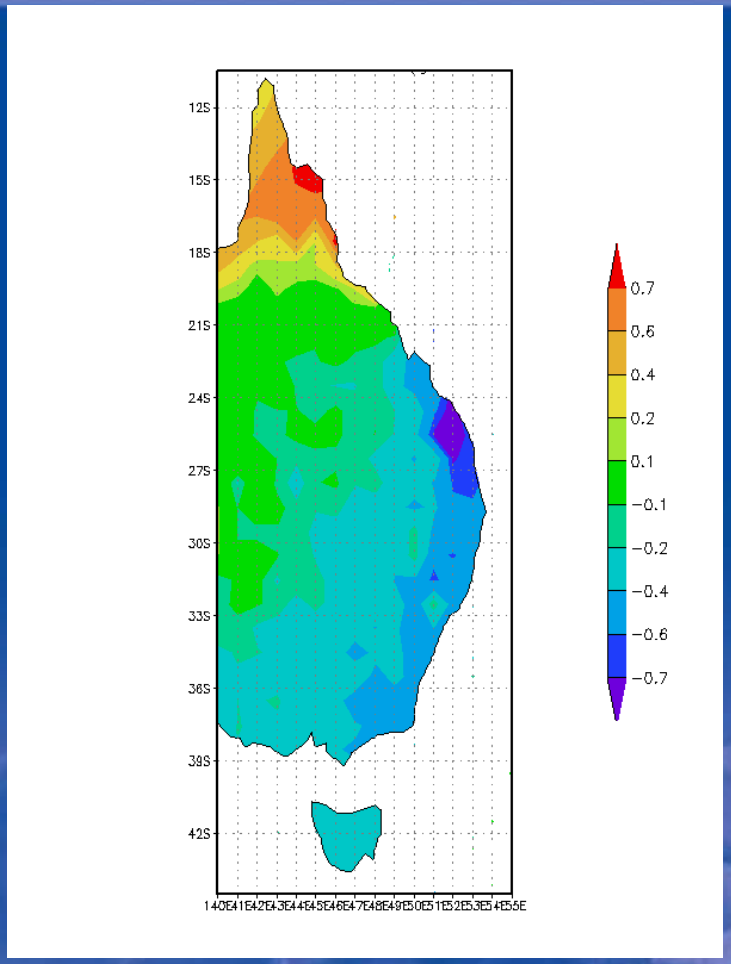




Partial correlation of Palmer Z-index with precipitation and temperature



P. Correlation with precipitation with effect of temperature removed

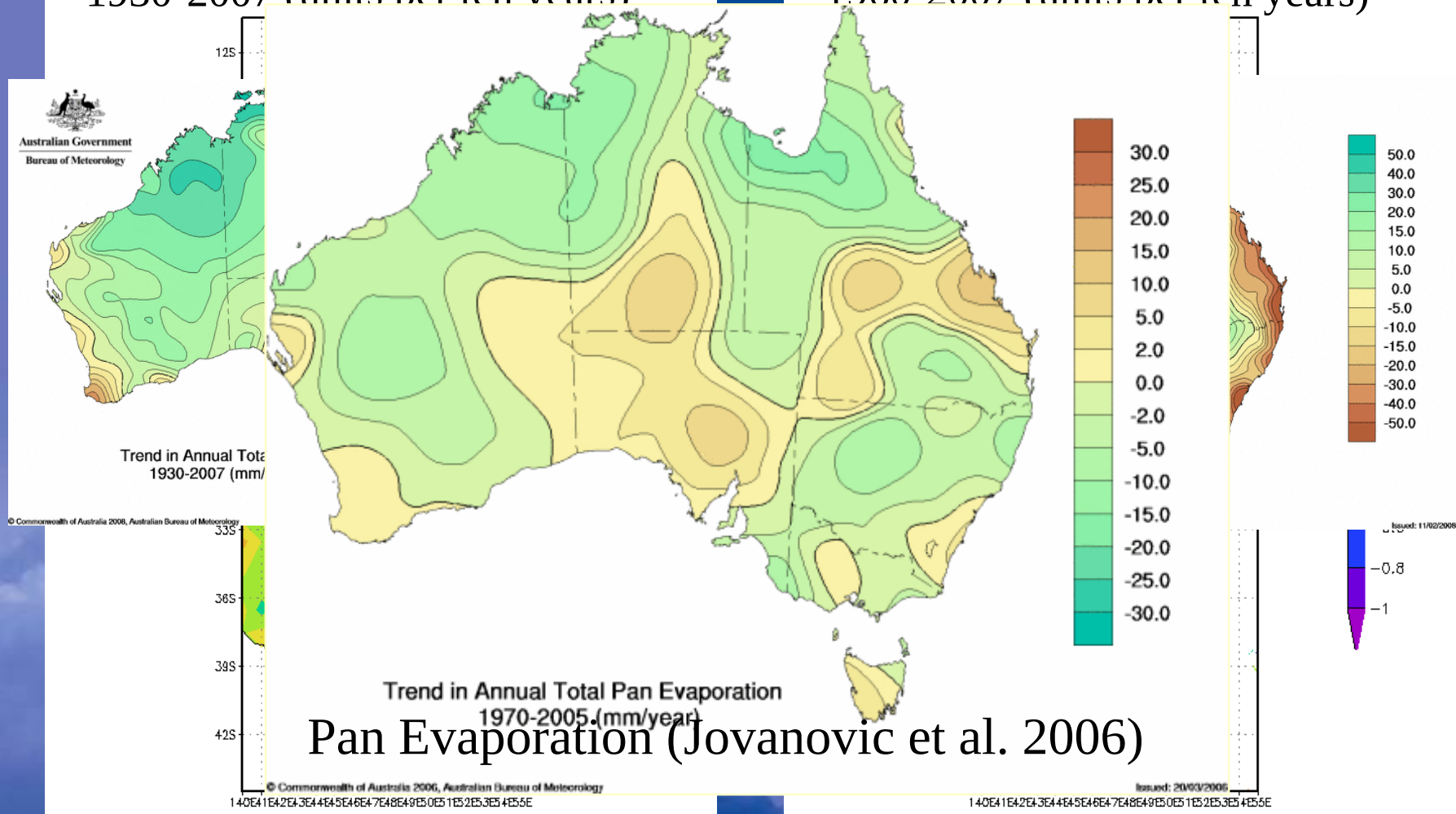


P. Correlation with temperature with effect of precipitation removed

Trend in PDSI vs trends in rainfall and evaporation

1930-2007 (units per ten years)

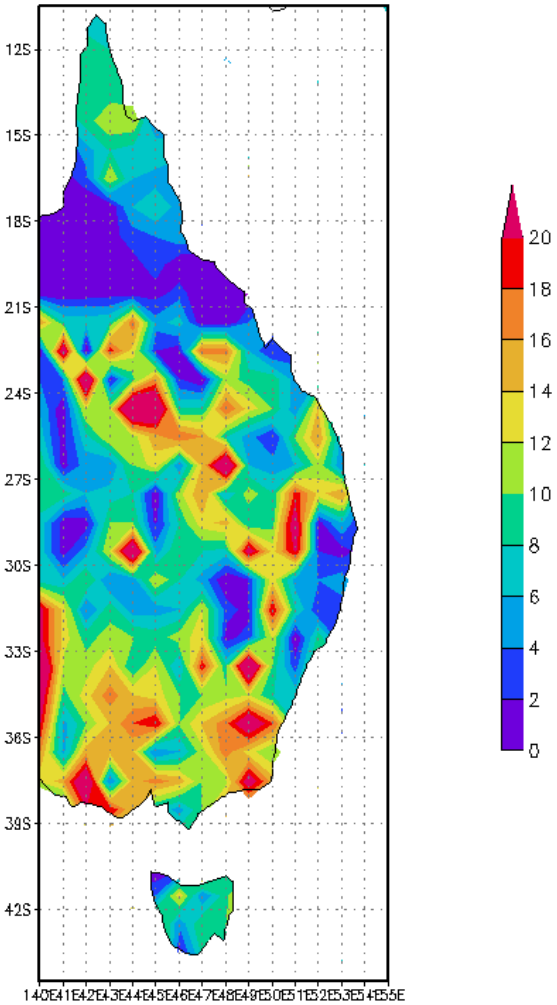
1960-2007 (units per ten years)



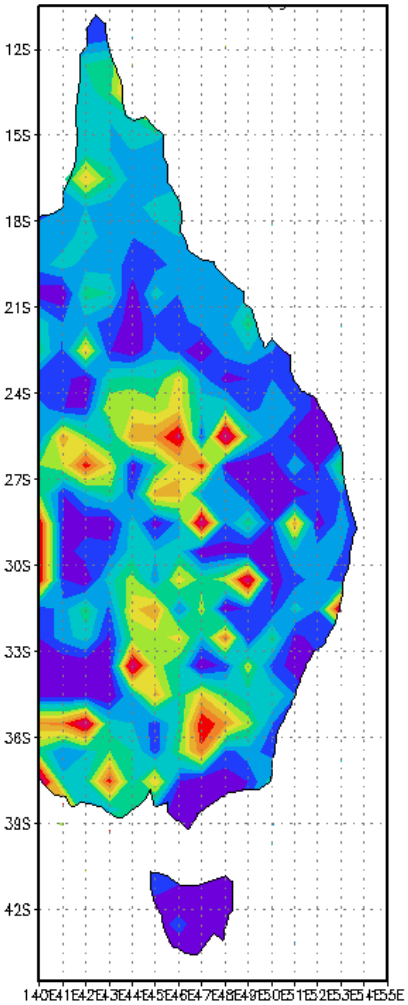
Pan Evaporation (Jovanovic et al. 2006)

A near record dry – comparison with PDSI

1939-1945: num of months in dec 1



2001-2007: num of months in dec 1



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Problem: hotter droughts and decreasing aridity require a rethink of drought.

Question: how to recast methods to reflect a non-stationary climate and an increasing role for temperatures.

Answer: ?

- Preliminary results show that the PDSI can be adapted to Australian conditions – especially in the agriculturally important southeastern Australian region. However this variability currently seems to be dominated by rainfall variability, which is easier to calculate.
- Furthermore, initial results show no strong spatial trends in this index such as might be expected from widespread increased temperatures in recent years. This agrees with recent work by Ailie Gallant (unpublished Phd thesis).
- However, recent projections of decreased rainfall and increased temperatures may make this index more important in the future.

Thus, further exploration of this index will be undertaken.