CROPLIFE AUSTRALIA PERSPECTIVES CONFERENCE

28 NOVEMBER 2006

Presentation by Dr Roger Stone

Science Leader, Climate and Systems Technologies,

Queensland Department of Primary Industries and Fisheries and

University of Southern Queensland

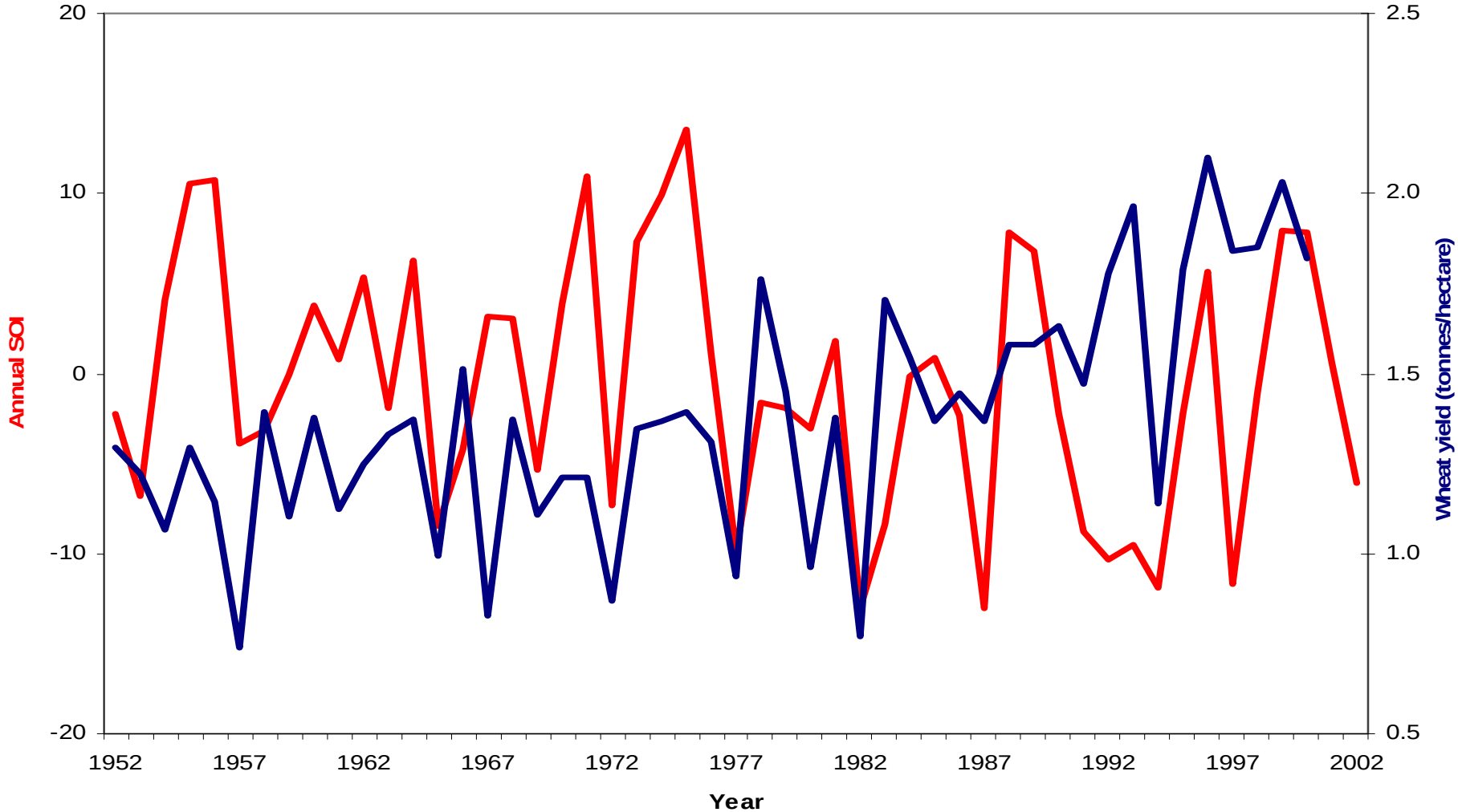
Short and long term weather prospects – recent breakthroughs in the understanding of climate patterns and climate change and their impacts on crop yields : Roger Stone.

Climate and Systems Technologies, Dept of Primary Industries and Fisheries; University of Southern Queensland.

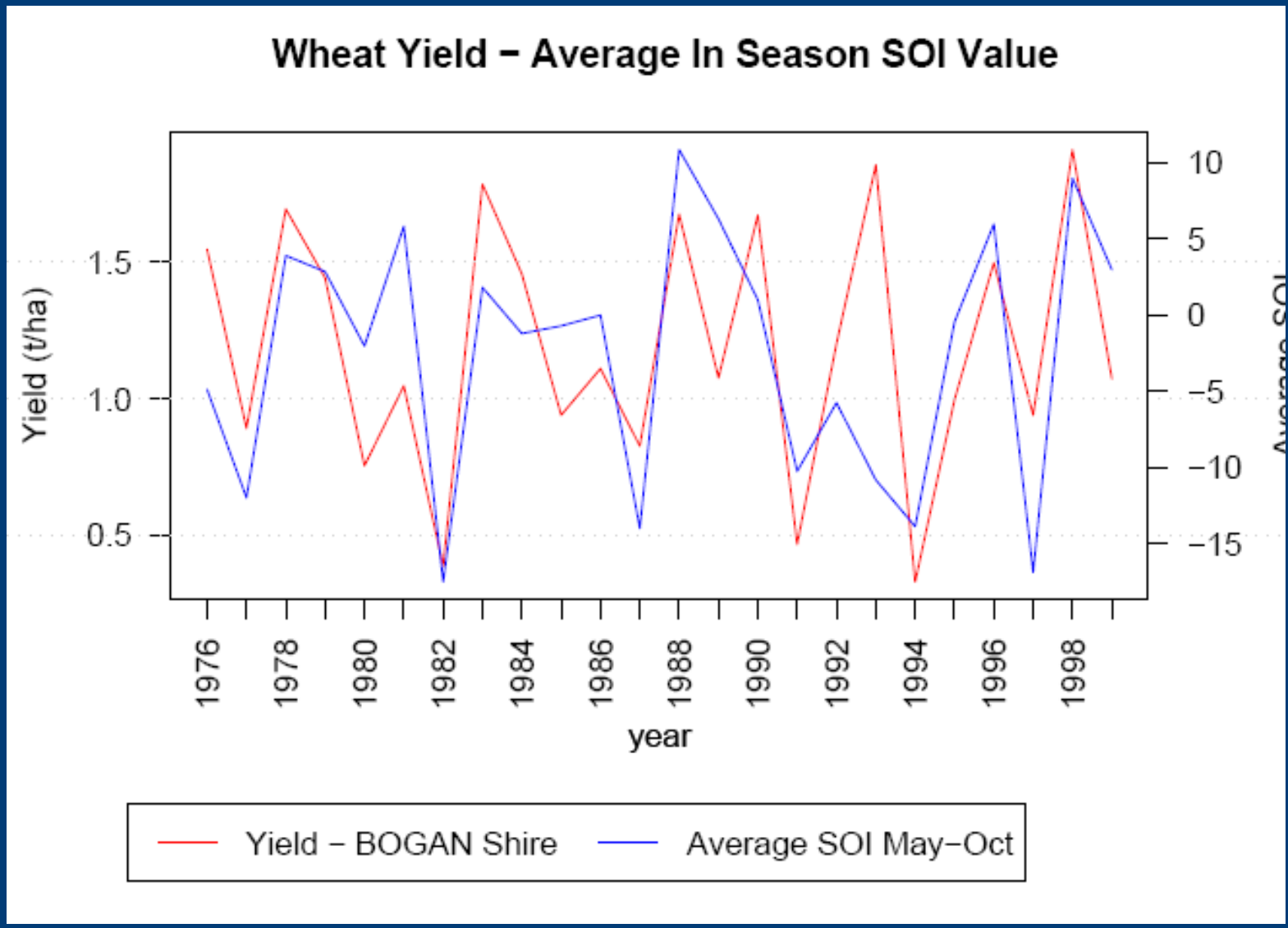
CropLife Perspectives Conference. (Thanks to GRDC, MCVP).

Outline today: “examining current and emerging trends and issues”

- Recap on what we have available now in climate science: includes world climate perspectives, forecast probability distributions.
- The importance of linking to management decisions.
- The importance of linking climate models to crop models.
- Regional commodity forecasting.
- Some additional applications (hail, frost, etc).
- A few words about climate change.
- Conclusions.



Climate impacts: relationship between annual variation in the SOI and annual Australian wheat yield (N Nicholls). Need to modify actions ahead of likely impacts.

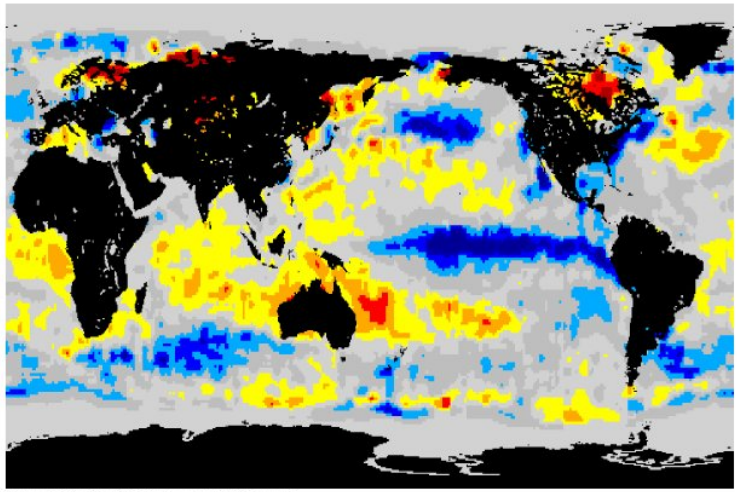

Wheat Yield – Average In Season SOI Value
Yield (t/ha)
1.5
1.0
0.5
10
5
0
−5
−10
−15
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
year
Yield – BOGAN Shire
Average SOI May–Oct

Agricultural Systems, Climate Variability, and Management Decisions

Decision Type (eg. only)	*Frequency (years)*
Logistics (eg. scheduling of planting / harvest operations)	Intraseasonal (> 0.2)
Tactical crop management (eg. fertiliser / pesticide use)	Intraseasonal (0.2 – 0.5)
Crop type (eg. wheat or chickpeas)	Seasonal (0.5 – 1.0)
Crop sequence (eg. long or short fallows)	Interannual (0.5 – 2.0)
Crop rotations (eg. winter or summer crops)	Annual / biennial (1 – 2)
Crop industry (eg. grain or cotton, phase farming)	Decadal (~ 10)
Agricultural industry (eg. crops or pastures)	Interdecadal (10 – 20)
Landuse (eg. agriculture or natural systems)	Multidecadal (20 +)
Landuse and adaptation of current systems	Climate change

SST Anomaly (degrees C)
October 1988

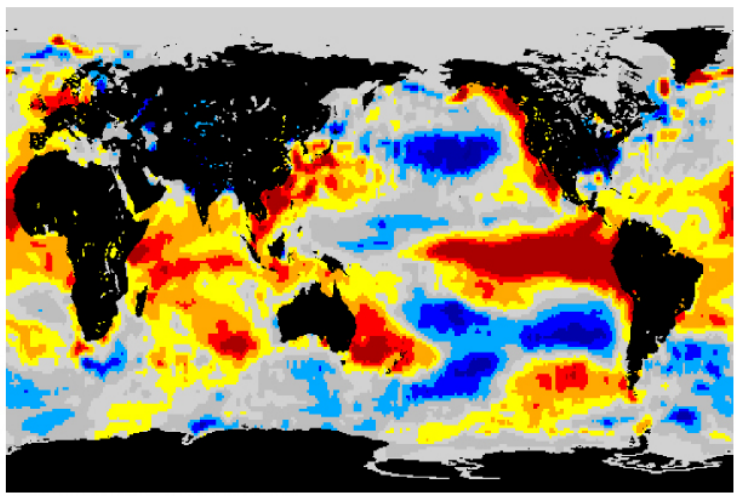
Less than -2.0
-2.0 to -1.5
-1.5 to -1.0
-1.0 to -0.5
-0.5 to 0.0
0.0 to 0.5
0.5 to 1.0
1.0 to 1.5
1.5 to 2.0
Greater than 2.0



Produced by Roger Stone & Torben Marcussen, QDPI, Toowoomba
Data courtesy of National Oceanographic and Atmospheric Administration, USA

SST Anomaly (degrees C)
February 1998

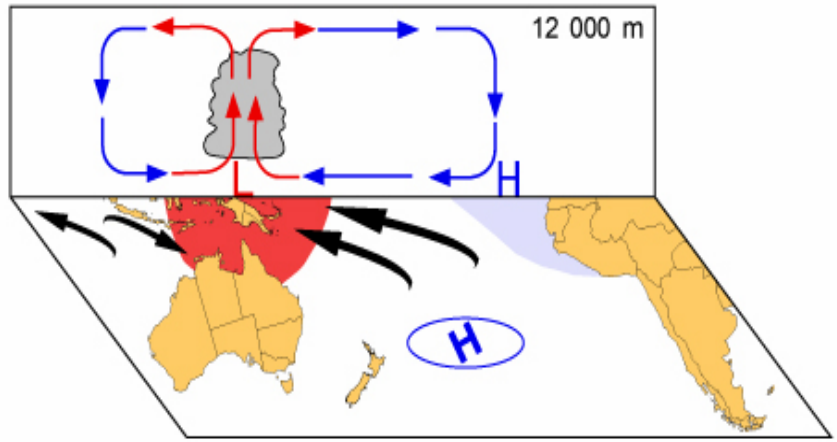
Less than -2.0
-2.0 to -1.5
-1.5 to -1.0
-1.0 to -0.5
-0.5 to 0.0
0.0 to 0.5
0.5 to 1.0
1.0 to 1.5
1.5 to 2.0
Greater than 2.0



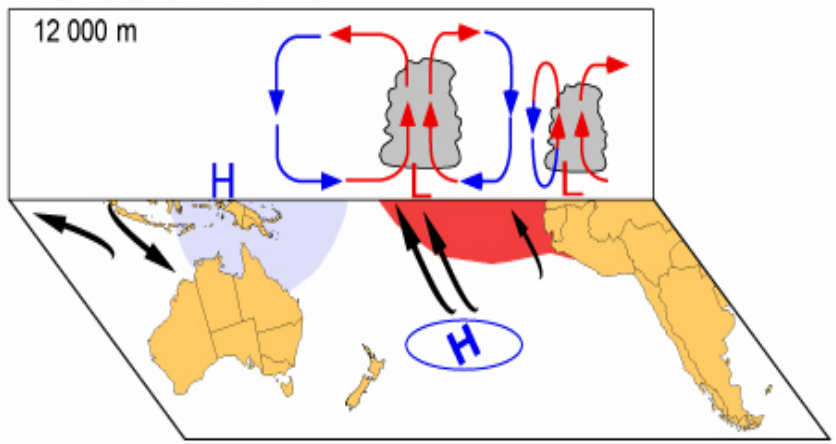
Produced by Roger Stone & Torben Marcussen, QDPI, Toowoomba
Data courtesy of National Oceanographic and Atmospheric Administration, USA

THE WALKER CIRCULATION

Positive SOI - La Niña



Negative SOI - El Niño



Sea temperatures

Warmer

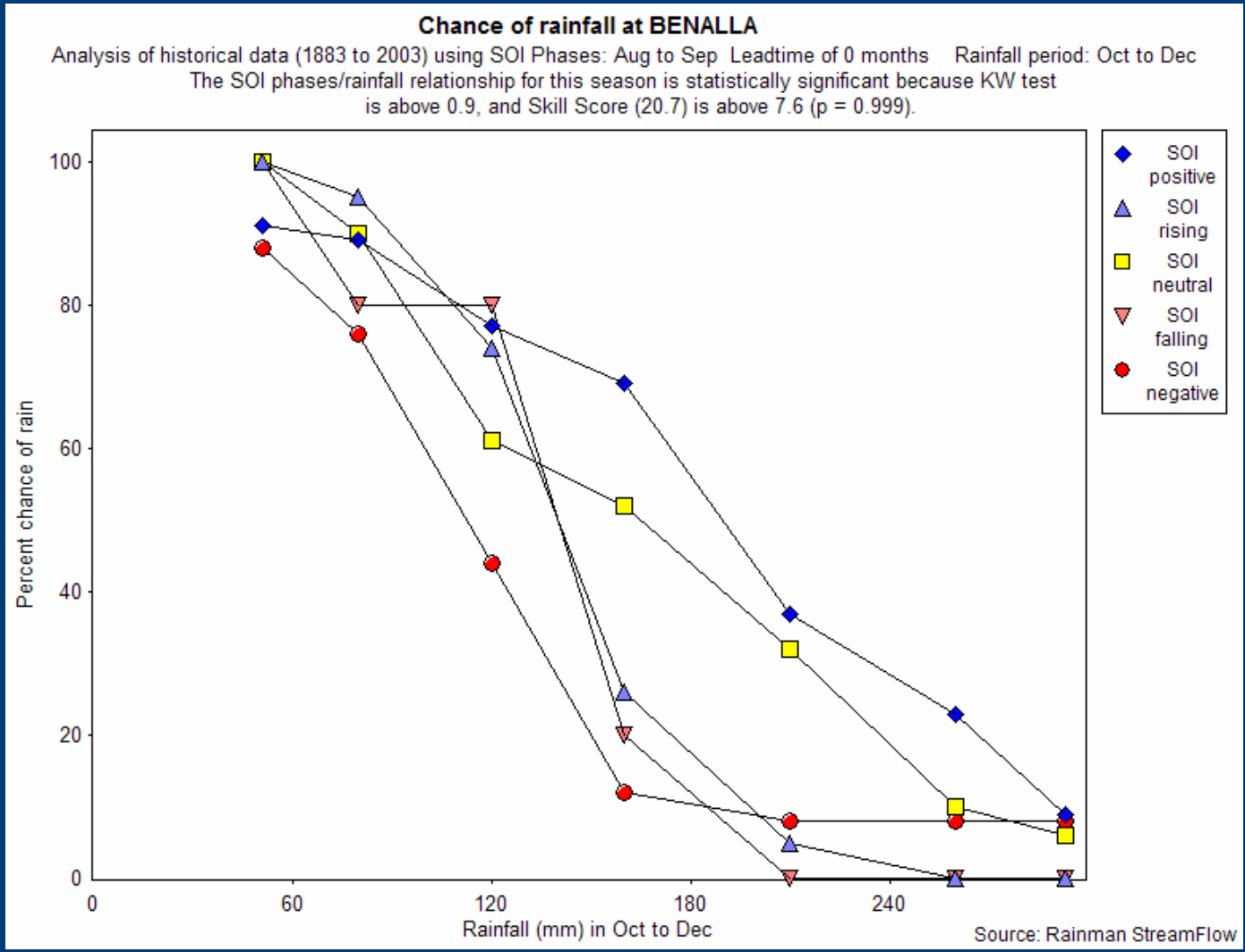
Cooler

Air pressure

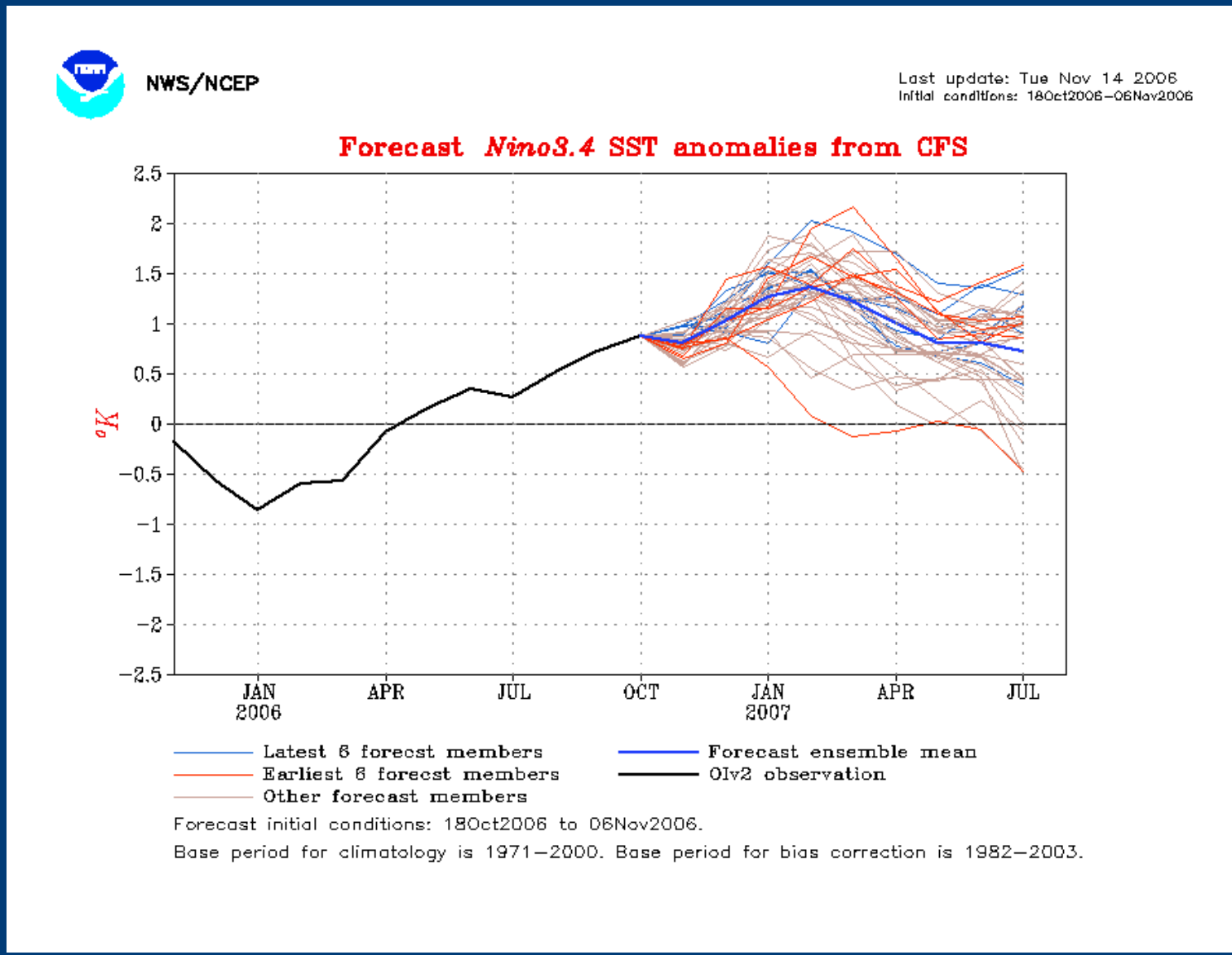
L Lower

H Higher

Surface winds



General climate forecast outputs….



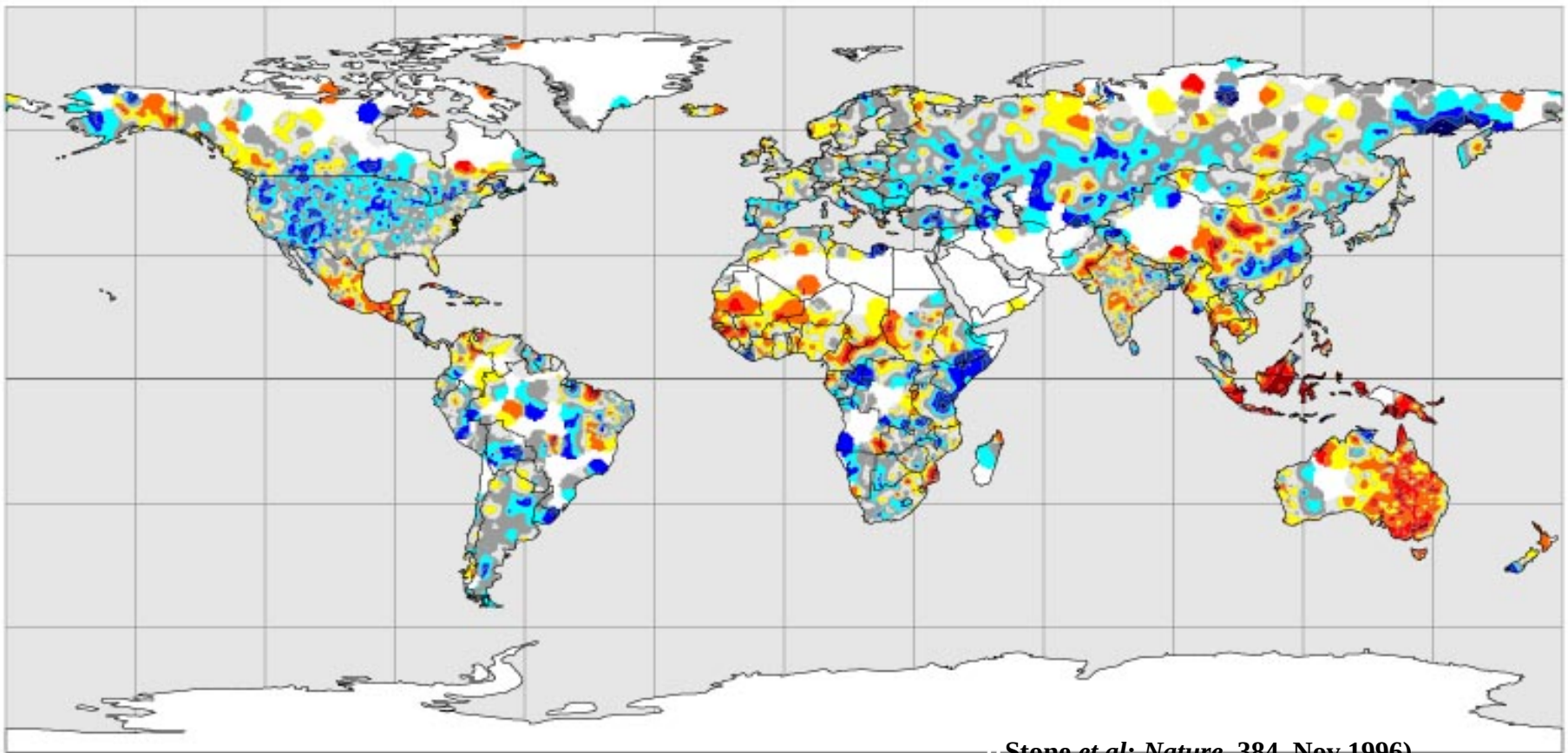
General climate forecast outputs…

Probability of exceeding Median Rainfall

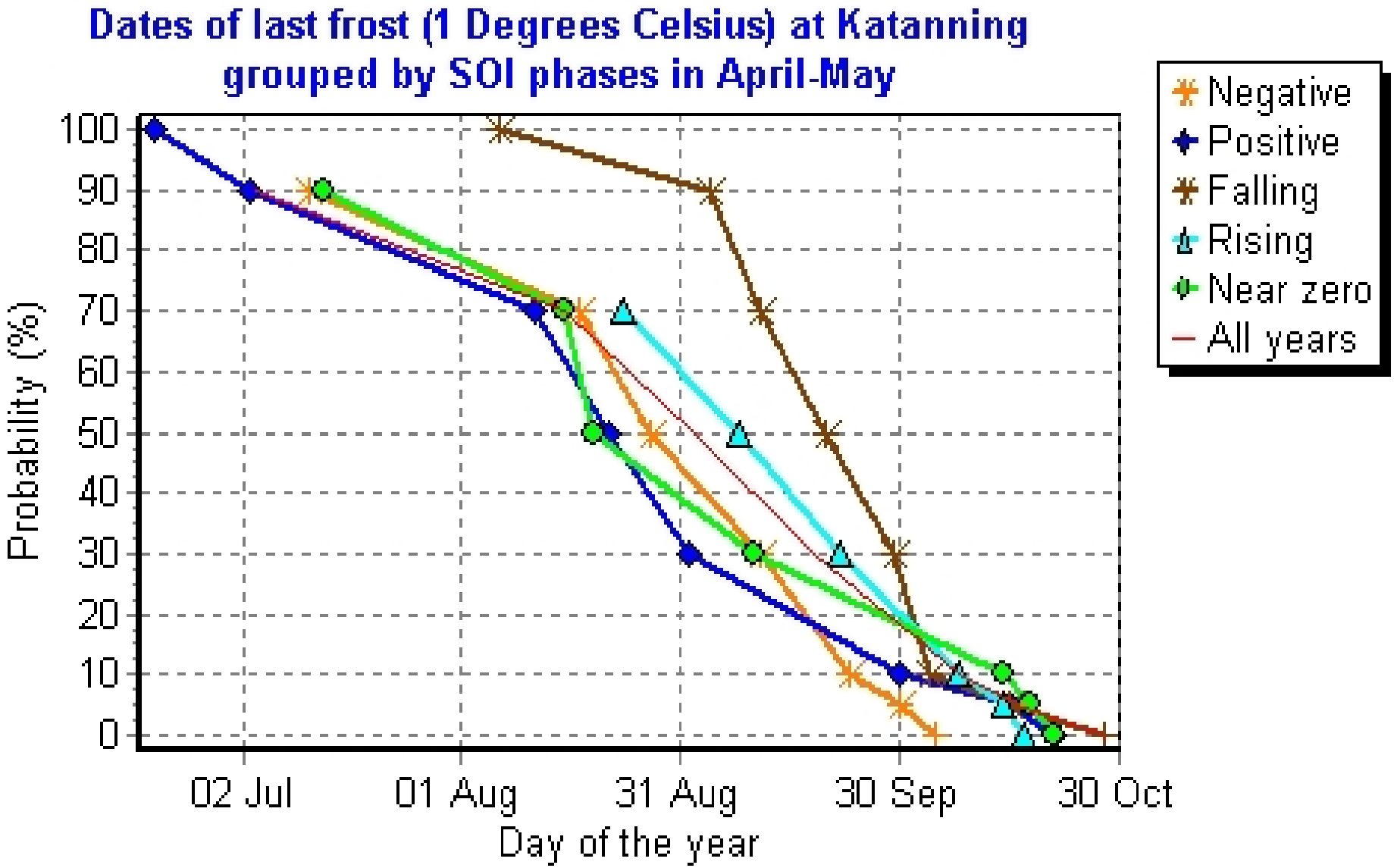
for August / October
based on consistently negative phase
during June / July

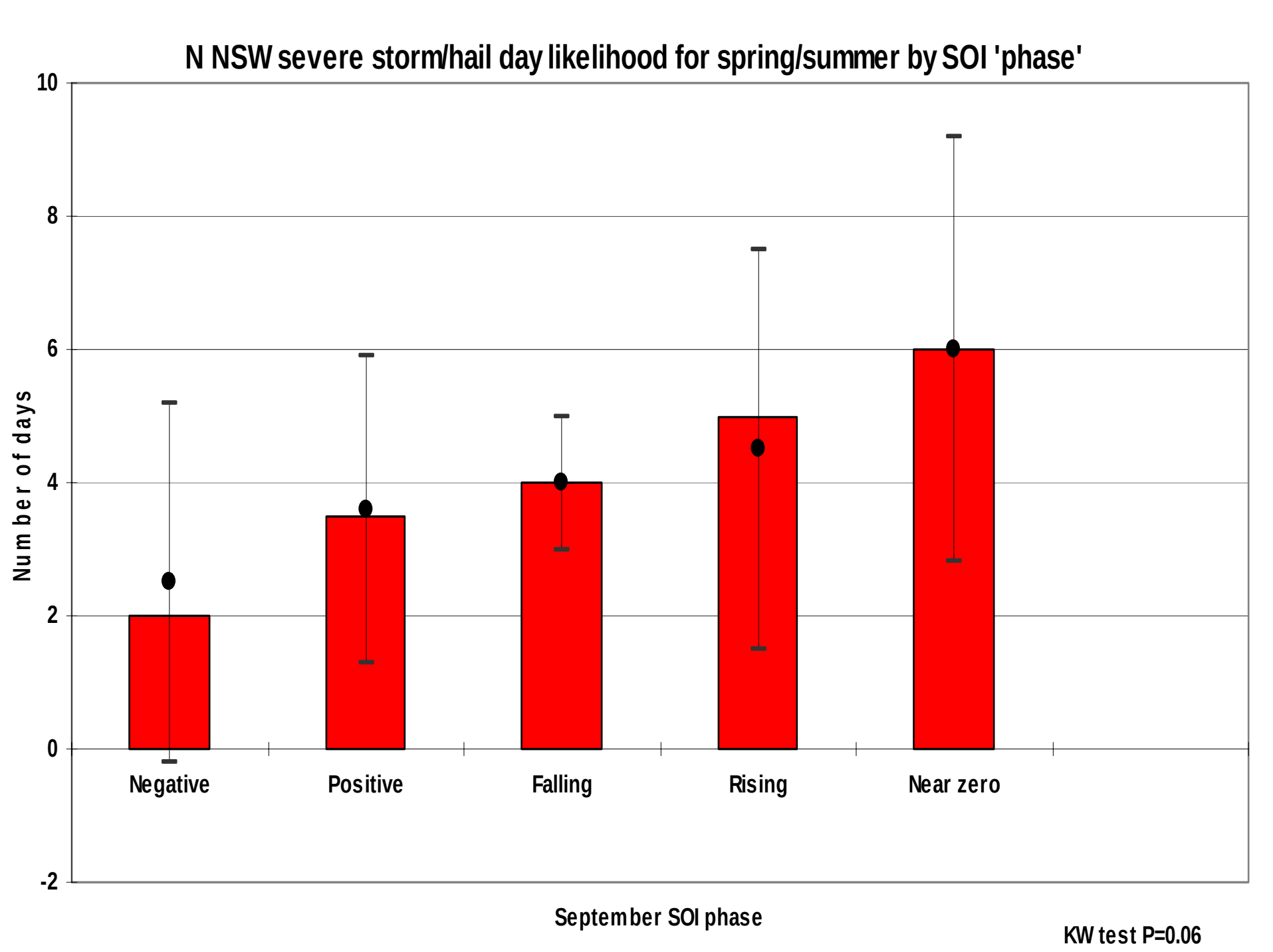
Queensland Government
Department of Primary Industries

90 - 100%
80 - 90%
70 - 80%
60 - 70%
50 - 60%
40 - 50%
30 - 40%
20 - 30%
10 - 20%
0 - 10%
No nearby stations or seasonally dry



Stone *et al*; *Nature* 384, Nov 1996)


Dates of last frost (1 Degrees Celsius) at Katanning
grouped by SOI phases in April-May
Negative
Positive
Falling
Rising
Near zero
All years
Probability (%)
100
90
80
70
60
50
40
30
20
10
0
02 Jul
01 Aug
31 Aug
30 Sep
30 Oct
Day of the year

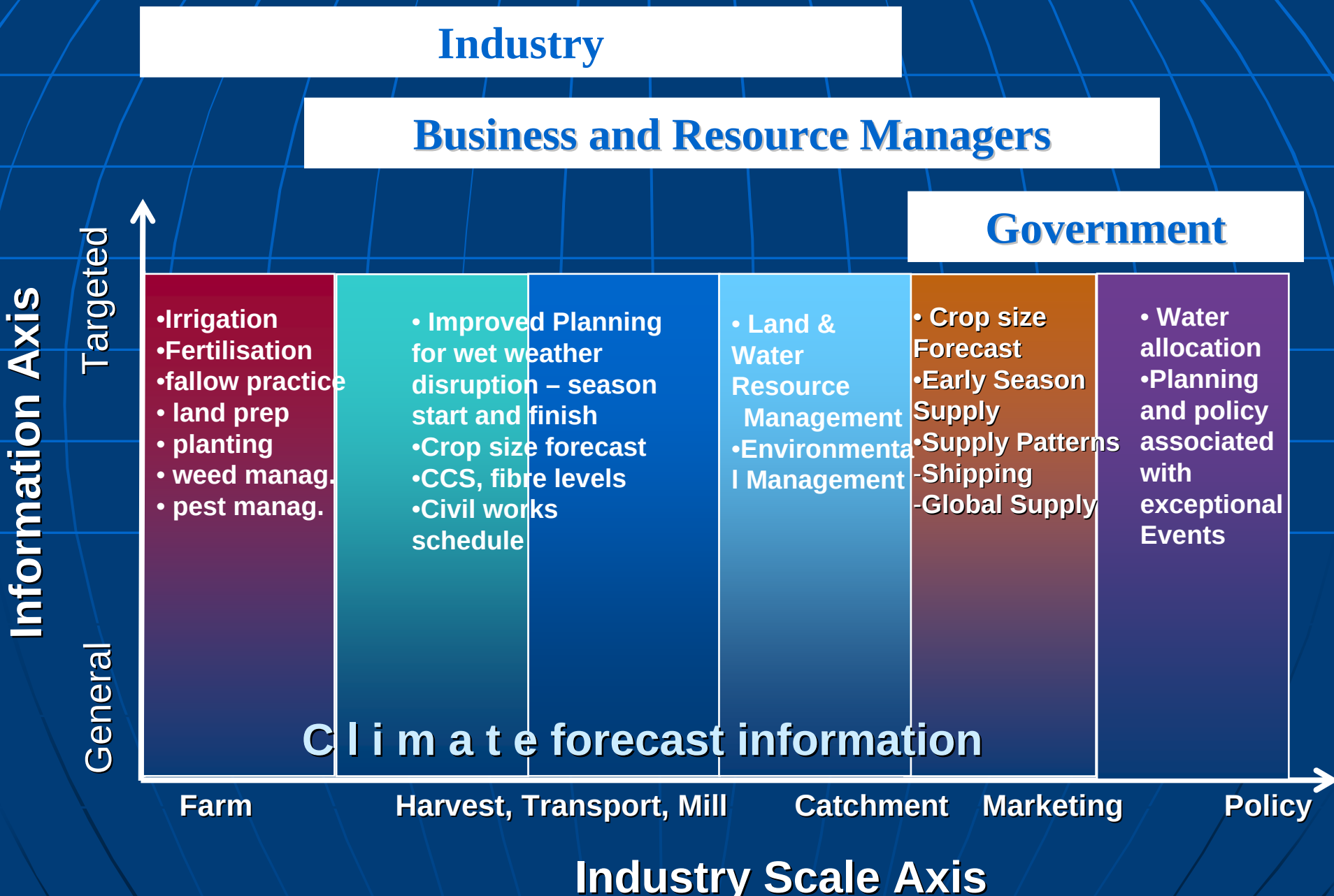

N NSW severe storm/hail day likelihood for spring/summer by SOI 'phase'
10
8
6
4
2
0
-2
Number of days
Negative
Positive
Falling
Rising
Near zero
September SOI phase
KW test P=0.06

Seasonal forecasting has no value unless it changes a management decision

How much Nitrogen to apply given current low soil moisture levels and low probability of sufficient in-crop rainfall?

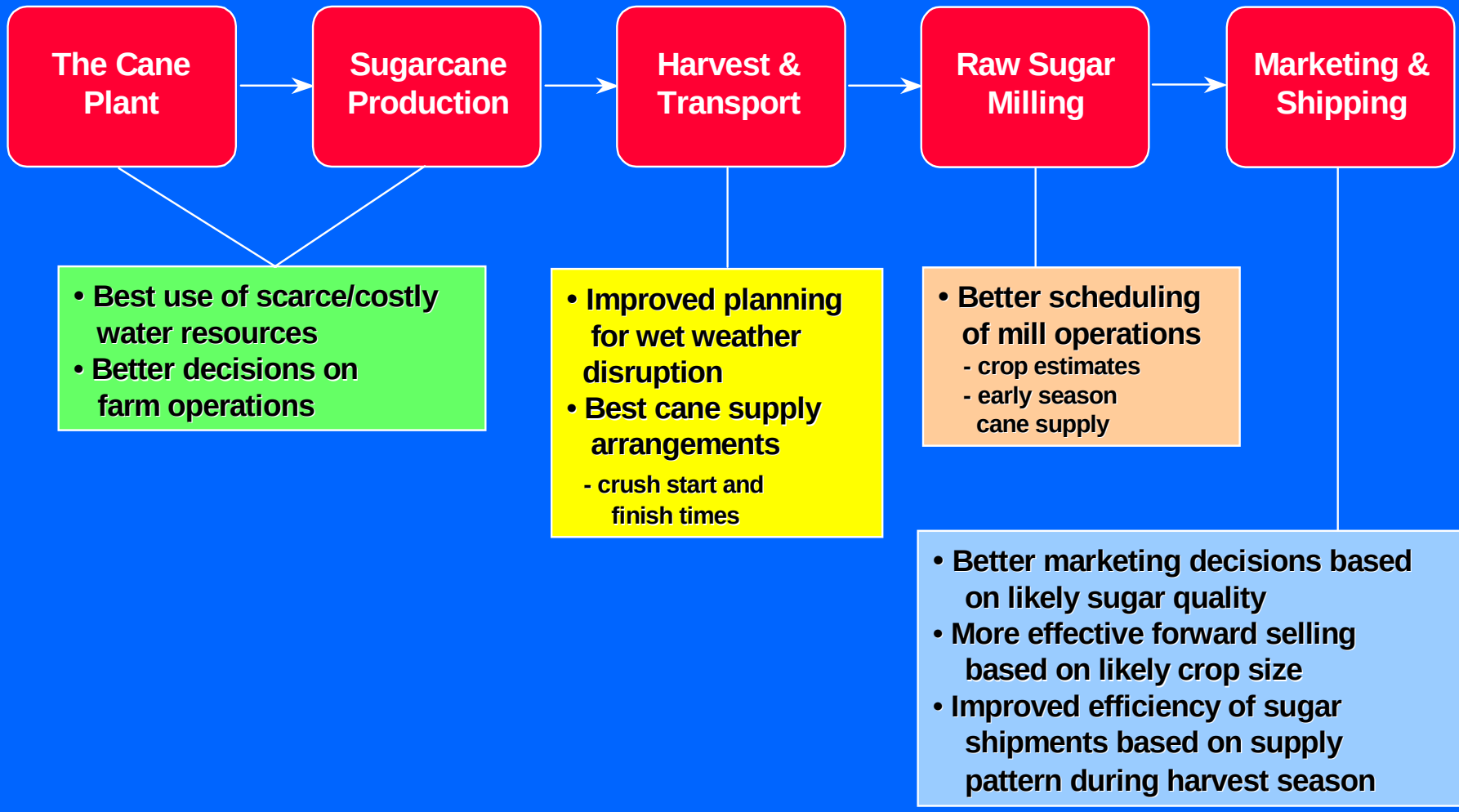
Which variety to plant given low rainfall probability values and high risk of damaging frost and anthesis?

Scale issues: Seasonal forecasting and decision making, sugar industry



Need to consider the whole value chain

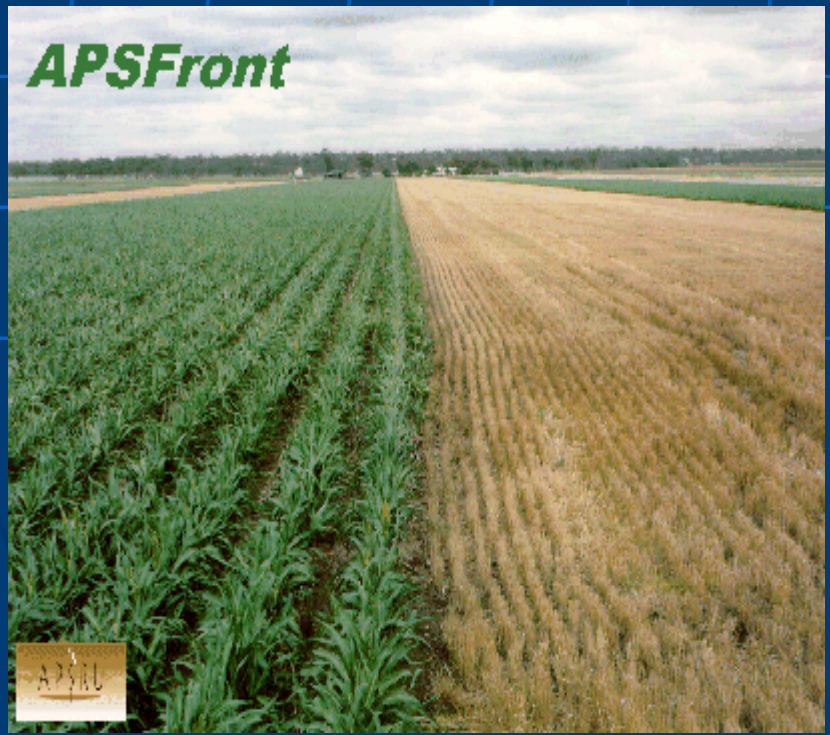
Understanding issues across the whole value chain



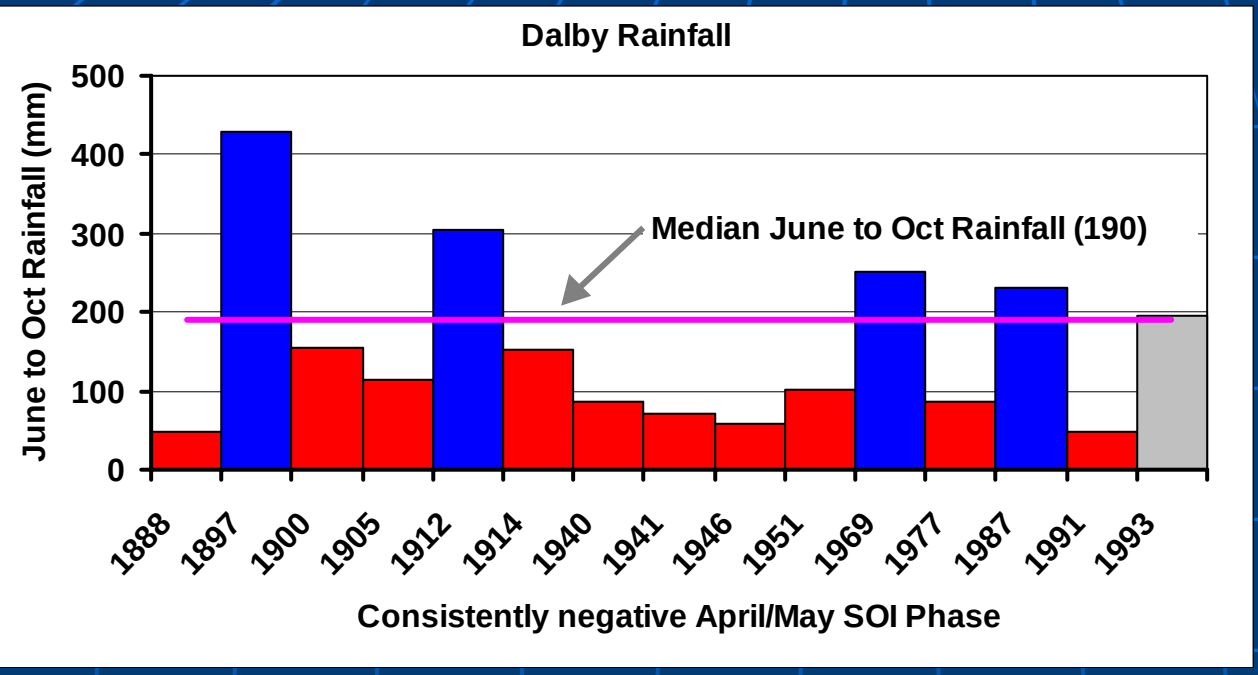
Key Linking Role of Modelling

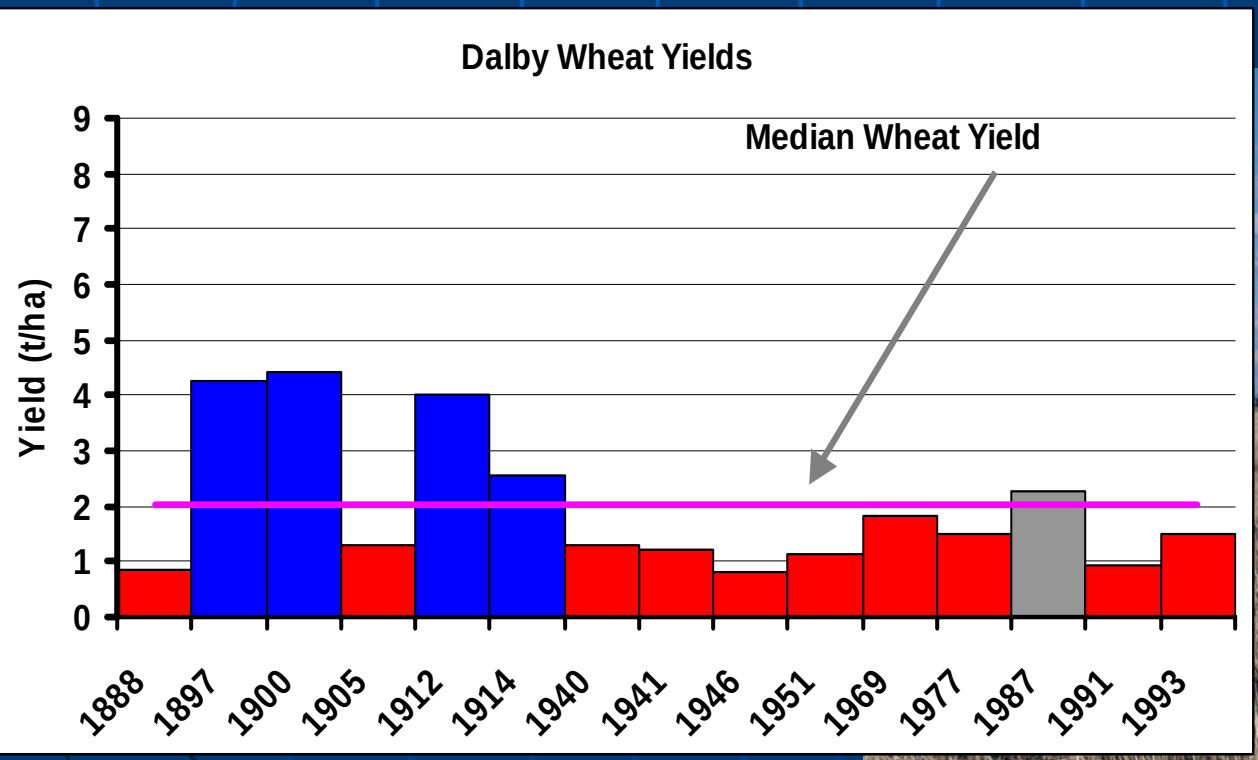
- Simulate management scenarios using analogue years
- Evaluate outcomes/risks relevant to decisions

Agricultural Production Systems Simulator (APSIM) simulates



- yield of crops and pastures
- key soil processes (water, N, carbon)
- surface residue dynamics & erosion
- range of management options
- crop rotations + fallowing
- short or long term effects

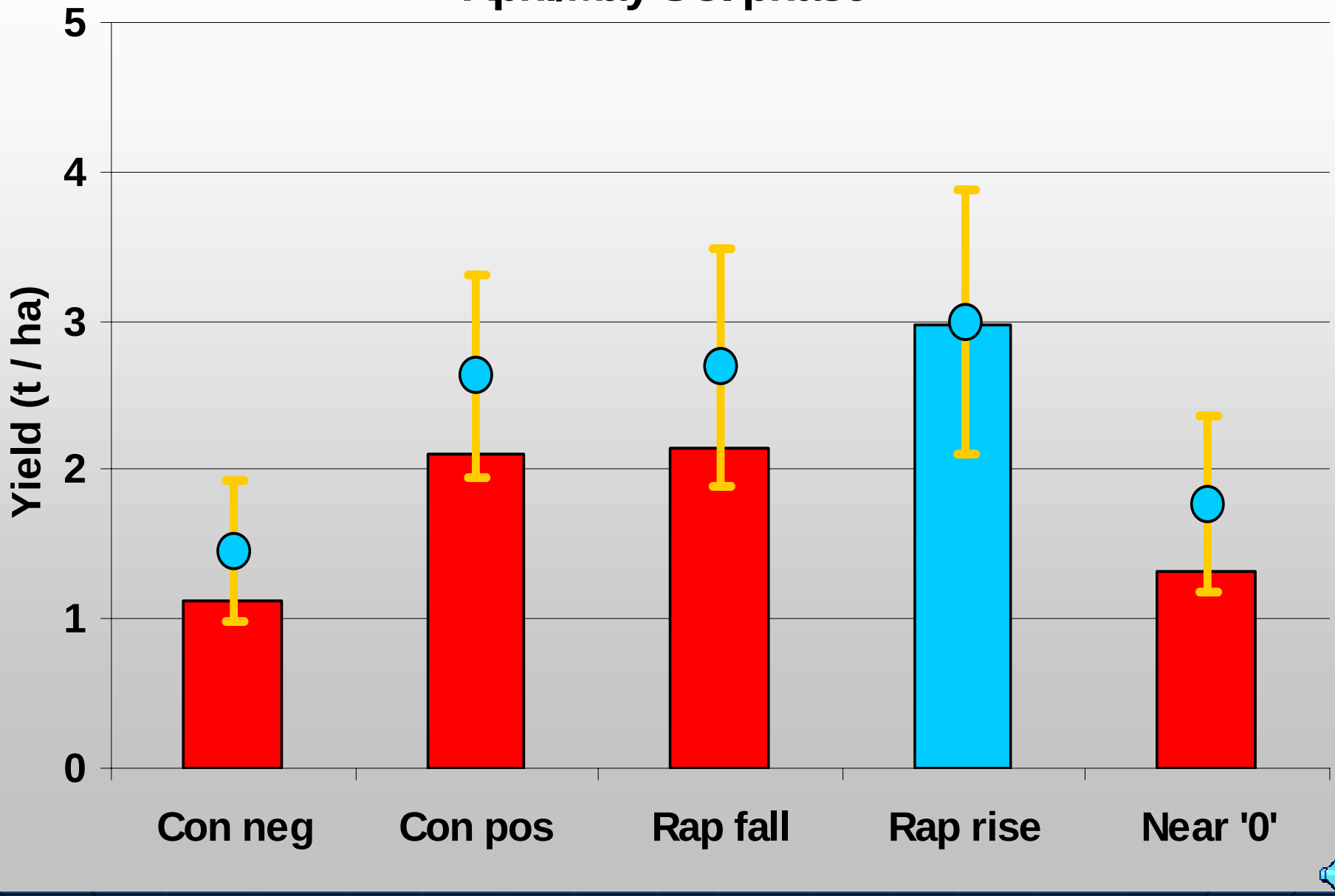


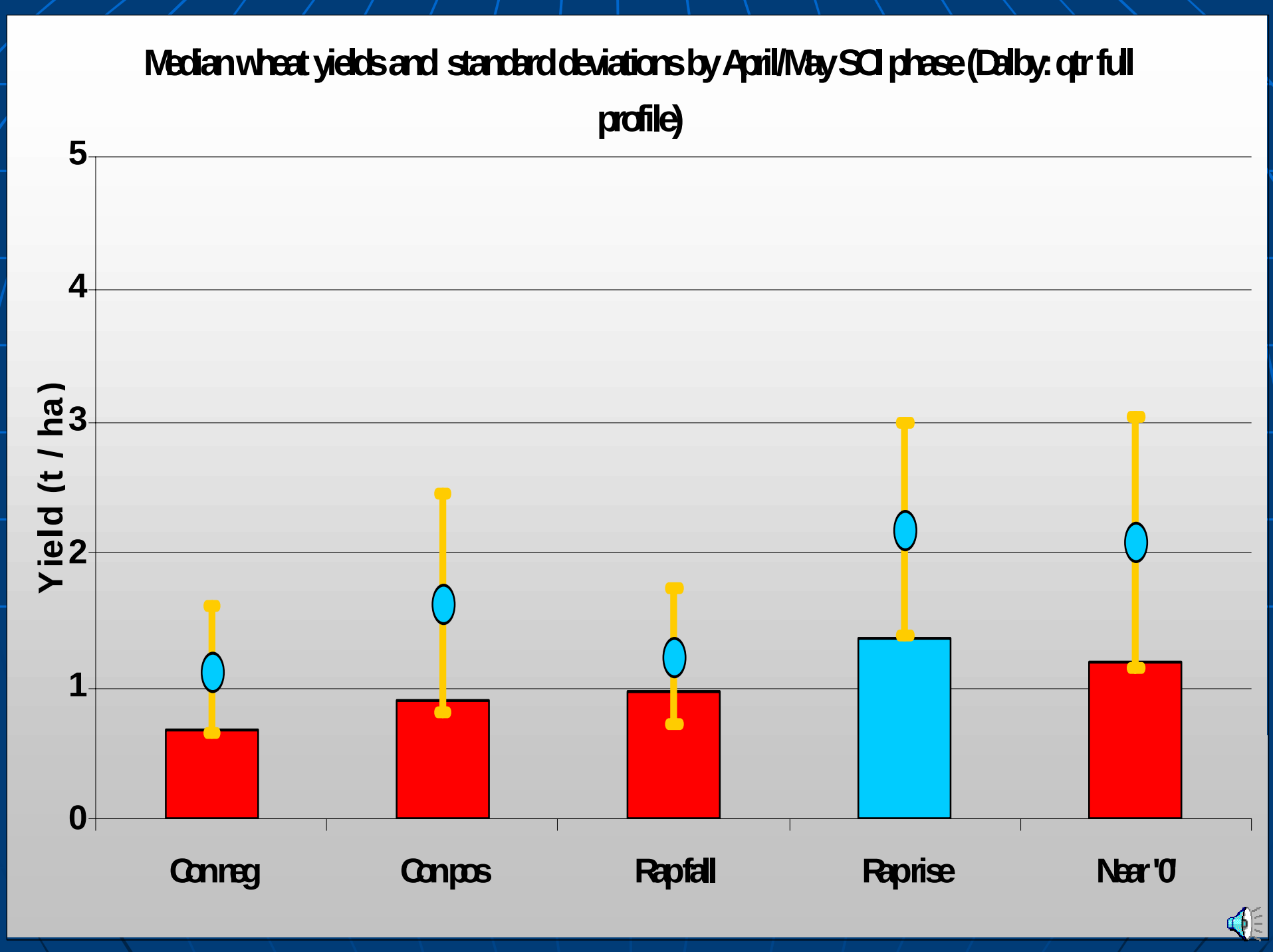


The key integrating role of modelling.

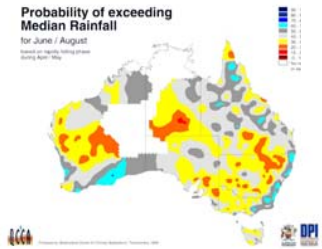
Integrated climate /crop simulation forecast systems applied to decision making (N levels, variety choice).

Median wheat yields and standard deviations by April/May SOI phase

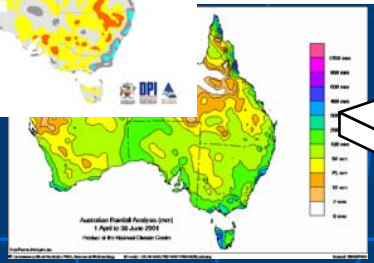


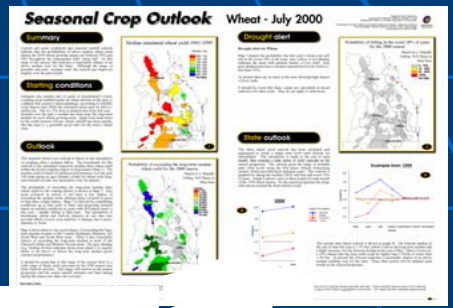

Median wheat yields and standard deviations by April/May SOI phase (Dalby: otr full profile)
Yield (t / ha)
5
4
3
2
1
0
Conneg
Conpos
Rapfall
Raprise
Near '0'

Forecasting the Australian Grain Crop; example of a fully integrated agrometeorological system

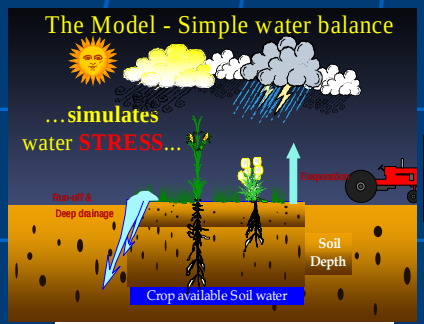


Rainfall up to date and Climate Forecast



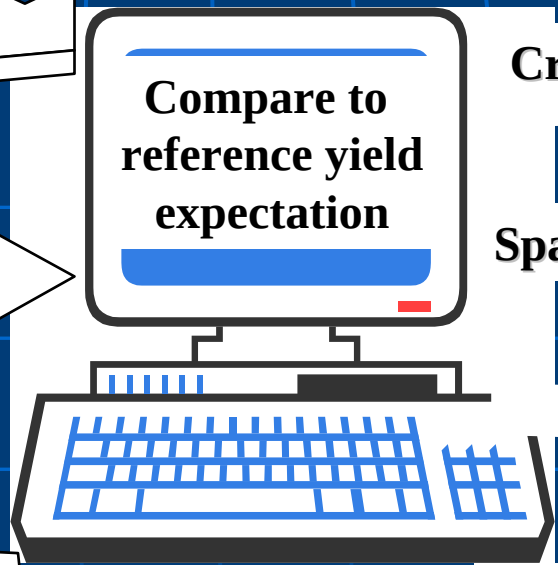


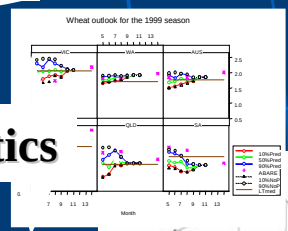
Crop Outlook



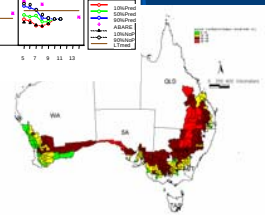
Simple Agro-climatic model

Compare to reference yield expectation

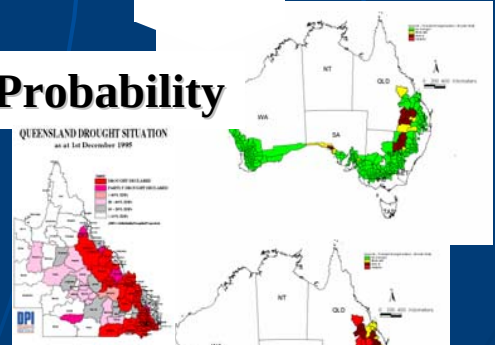


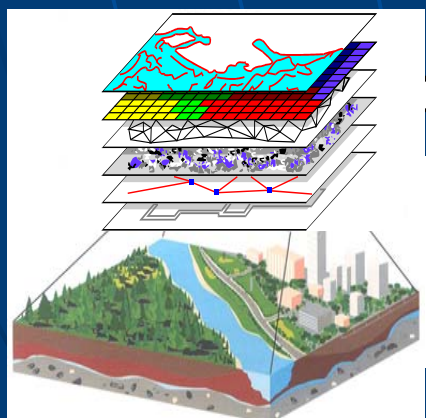


Spatial Statistics



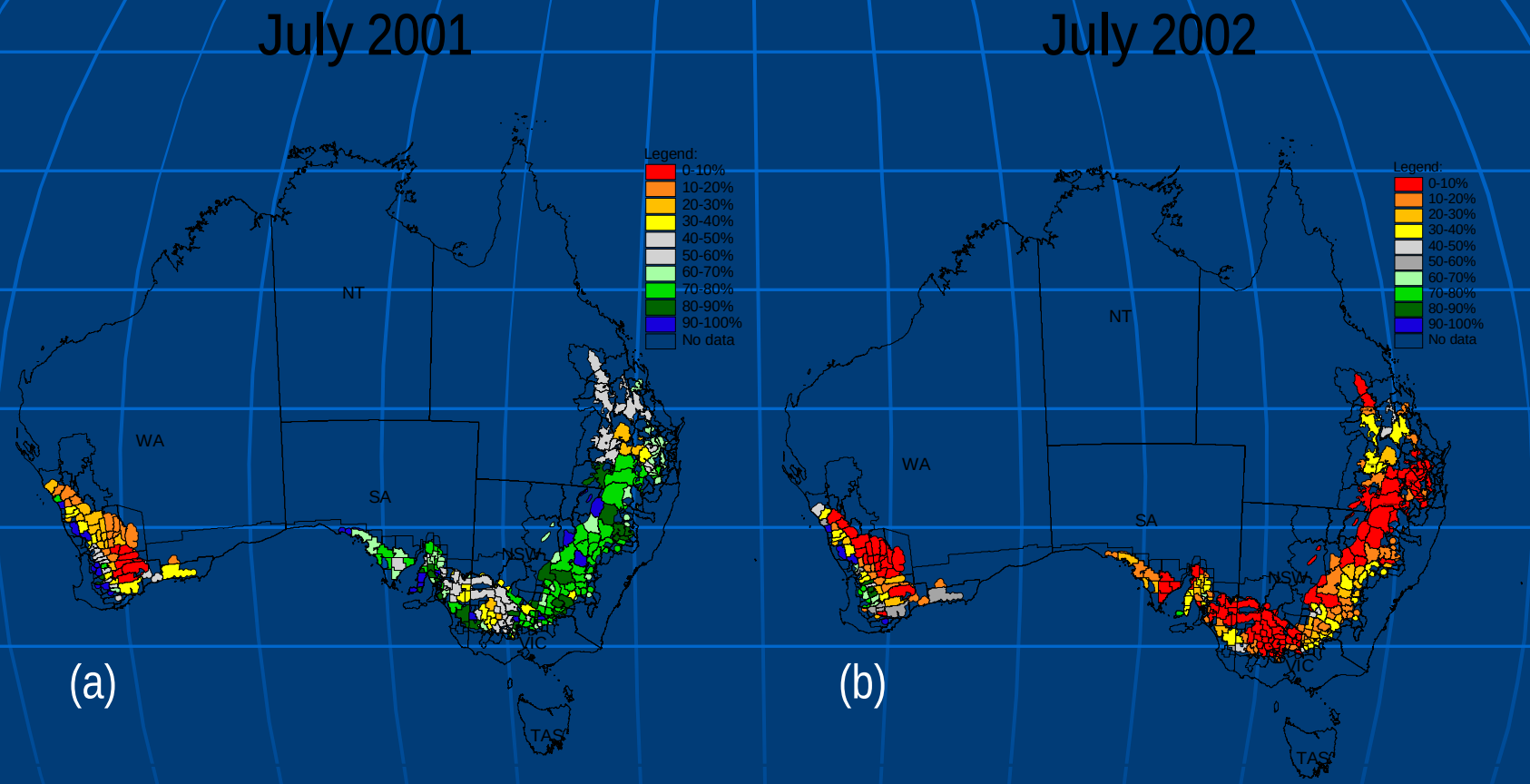
Drought Probability



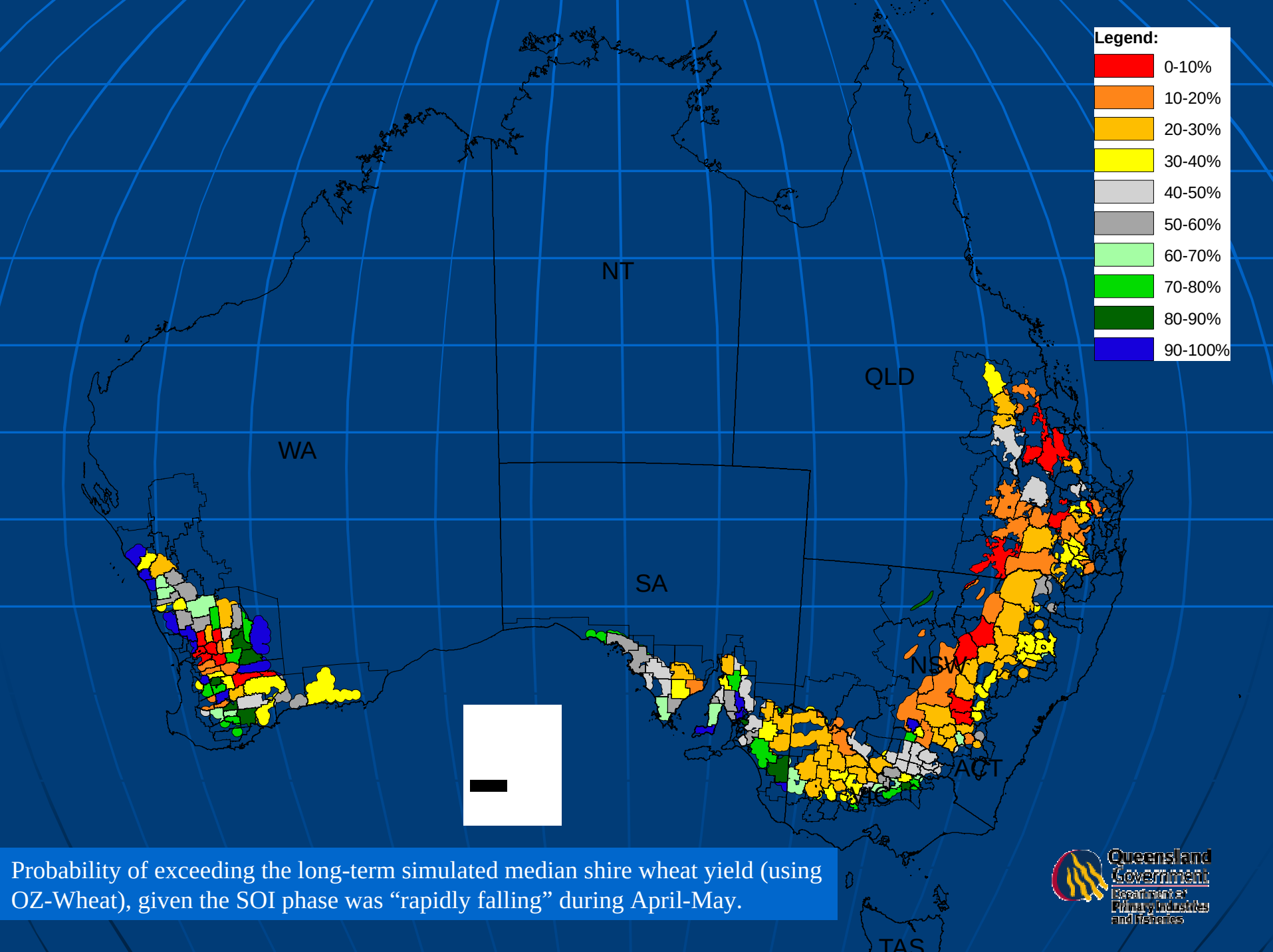


Geographical Information System

(Potgieter, 2003)

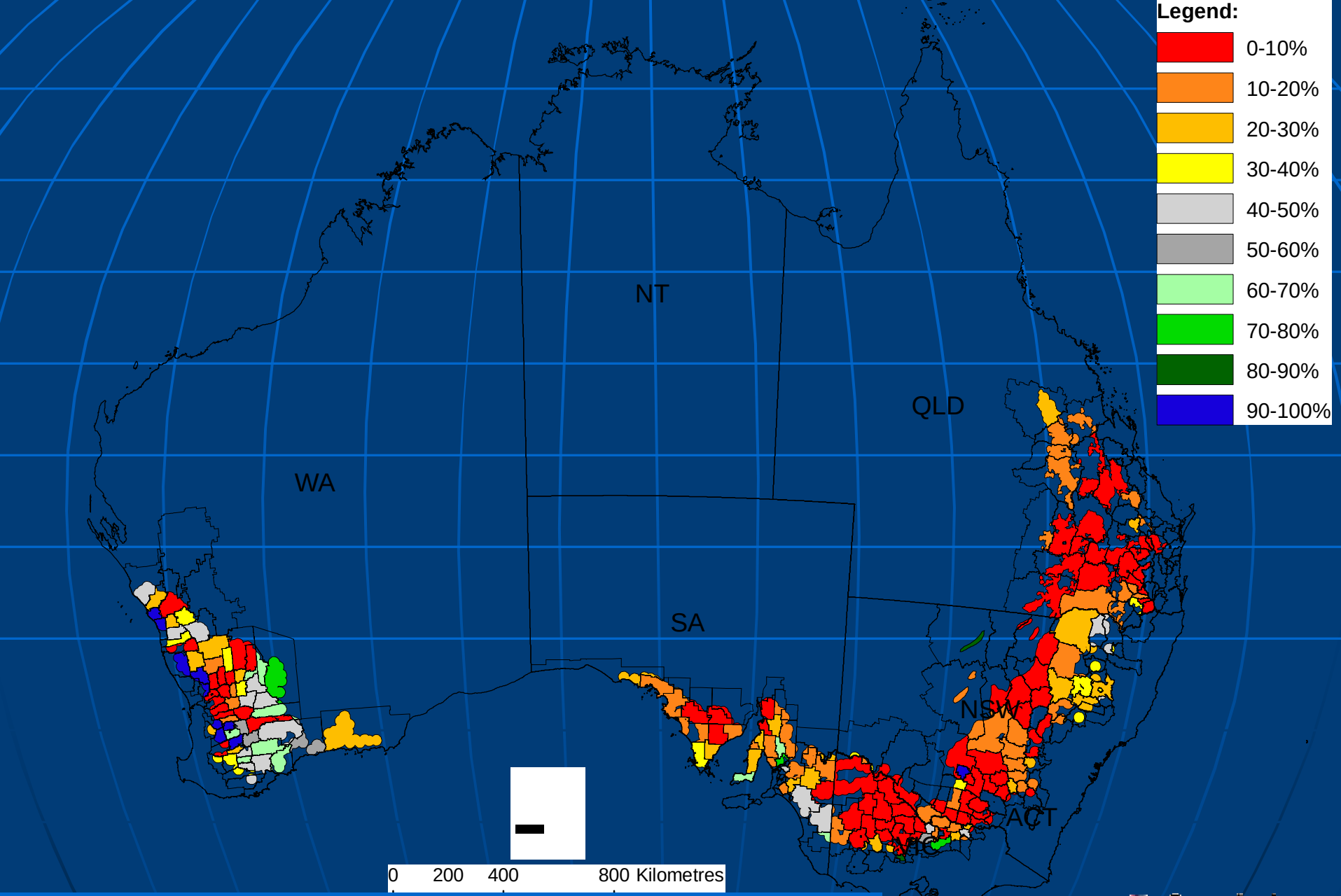


Forecasting agricultural commodities: Probabilities of exceeding long-term median wheat yields for every wheat producing shire (= district) in Australia issued in July 2001 and July 2002, respectively. (Grain trading issues).



Probability of exceeding the long-term simulated median shire wheat yield (using OZ-Wheat), given the SOI phase was “rapidly falling” during April-May.

Queensland Government
Department of Primary Industries and Fisheries

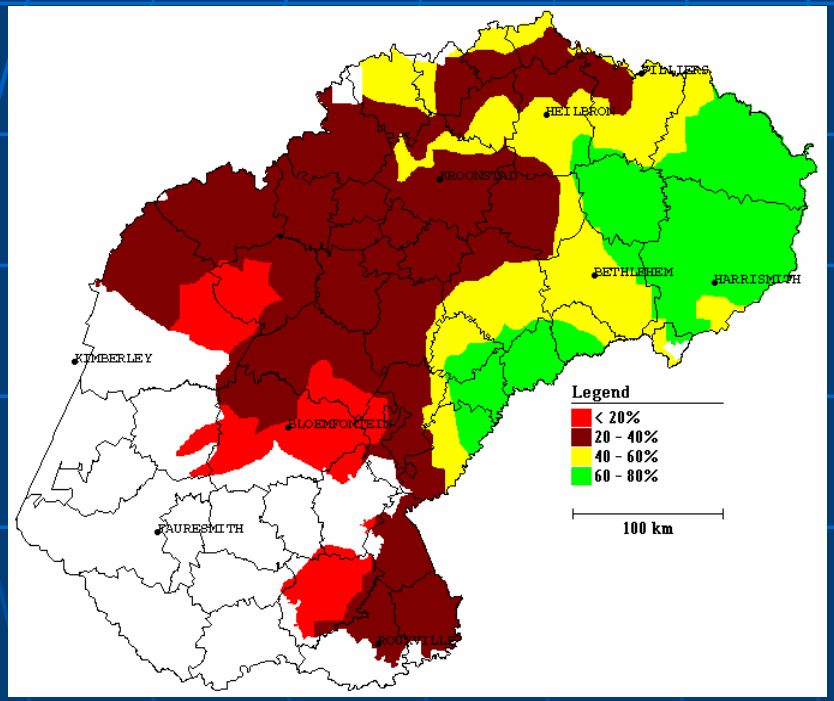


Probability of exceeding the long-term simulated median shire wheat yield (using OZ-Wheat), given the SOI phase was “consistently negatively” during May-June.

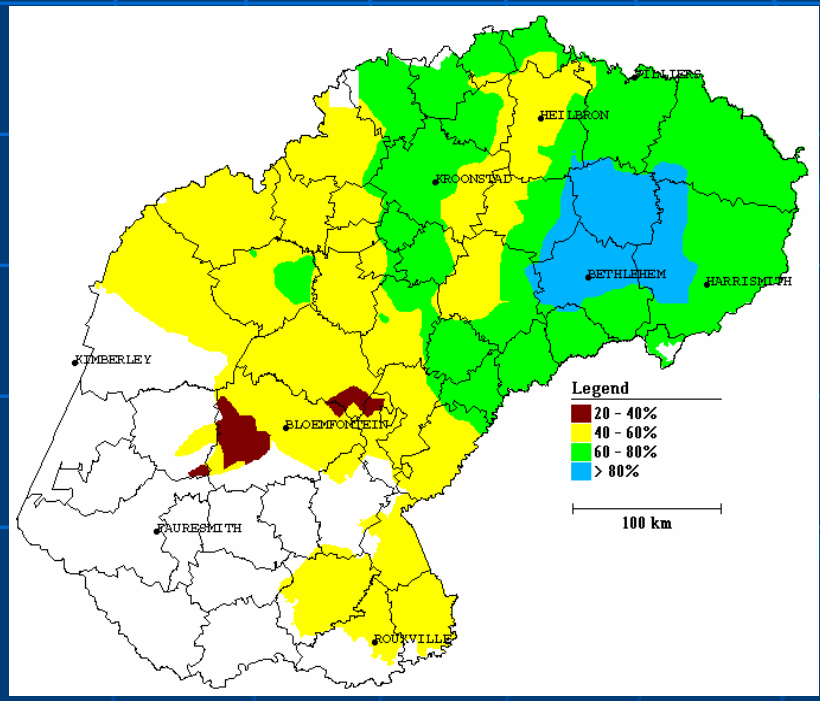
Queensland Government
Department of Primary Industries and Fisheries

Case study example from RSA: An integrated climate-farming/cropping systems forecast

Probability (%) of exceeding maize yields of 2.5 t/ha

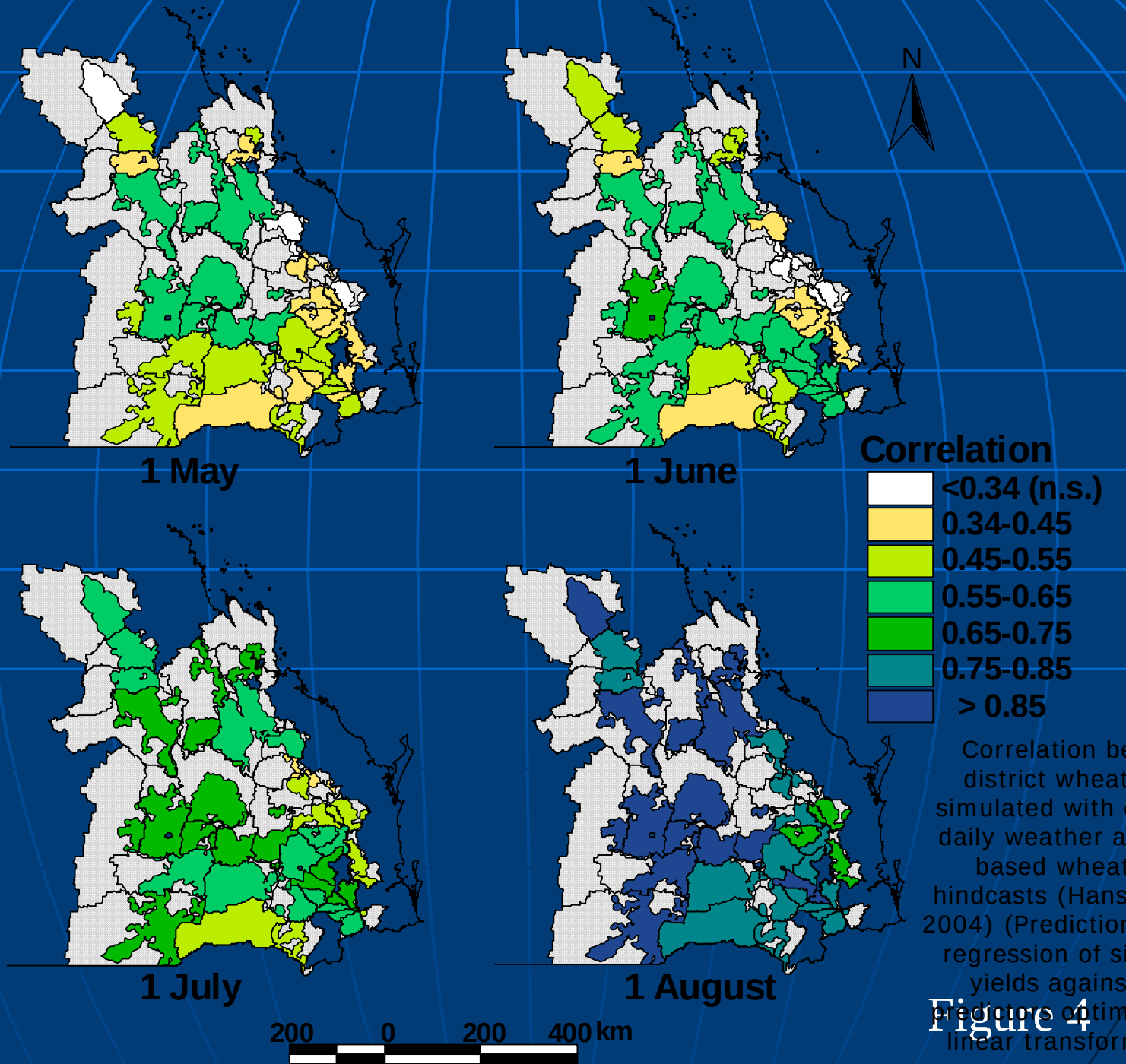


Planting date: 1 November
(Cons –ve SOI phase)



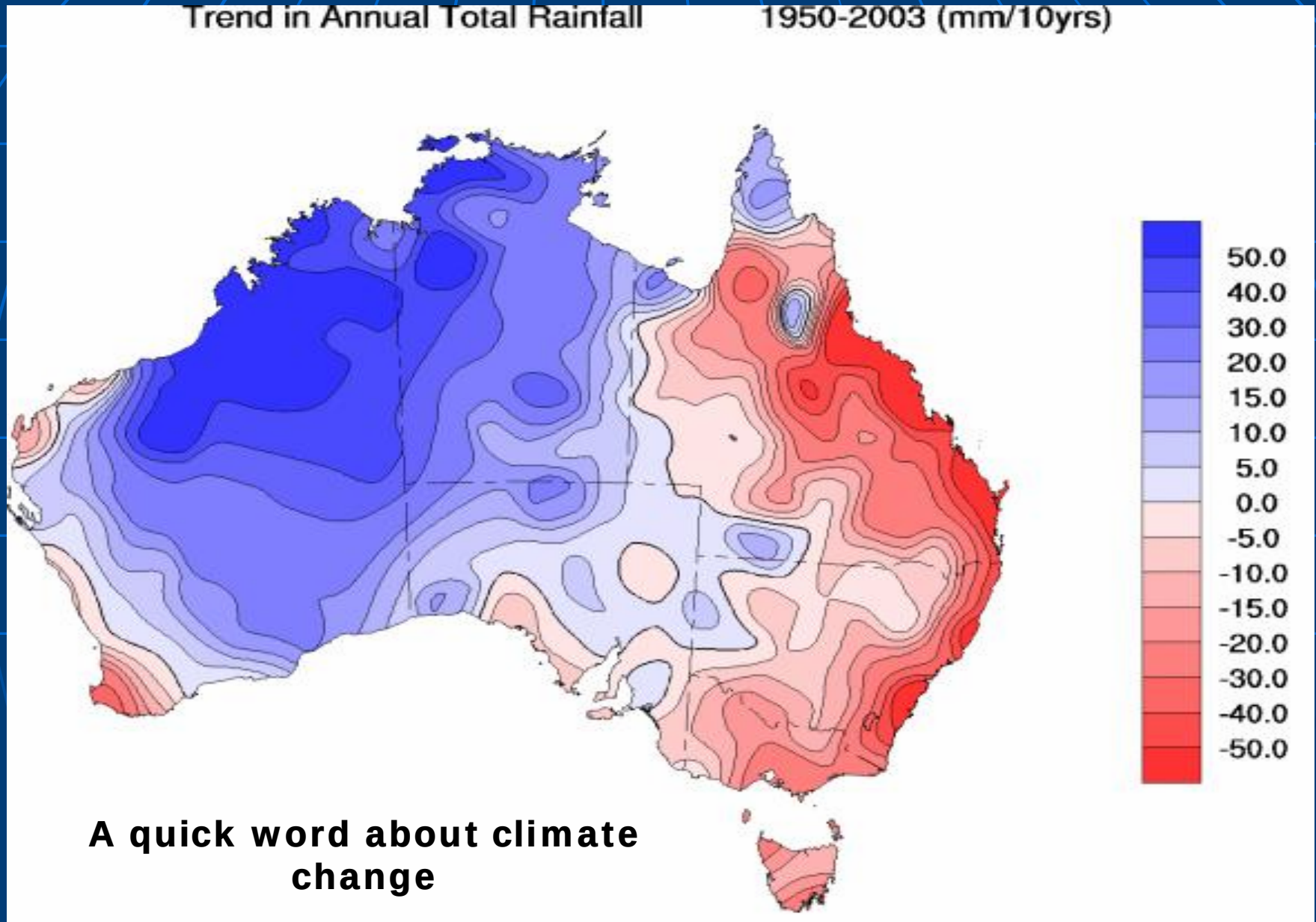
Planting date: 1 November
(Cons +ve SOI phase)

(Potgieter, 1999)

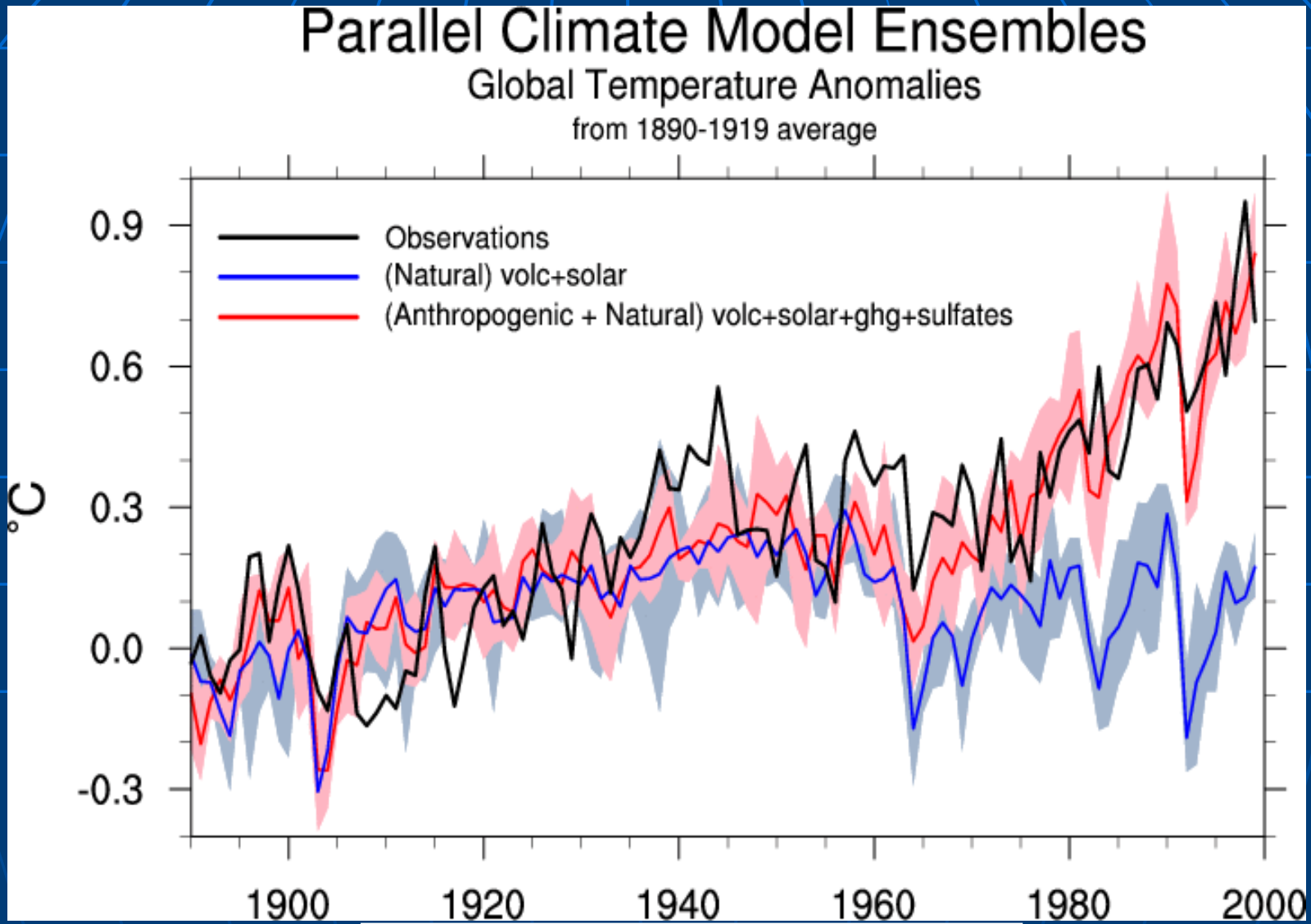


Correlation between district wheat yields simulated with observed daily weather and GCM-based wheat yield hindcasts (Hansen *et al.*, 2004) (Prediction by linear regression of simulated yields against GCM predictors optimized by a linear transformation).

Figure 4

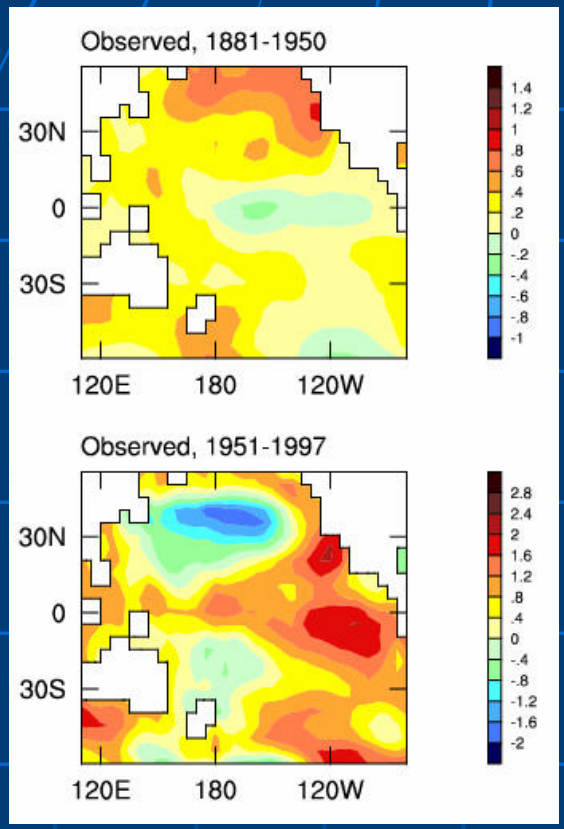


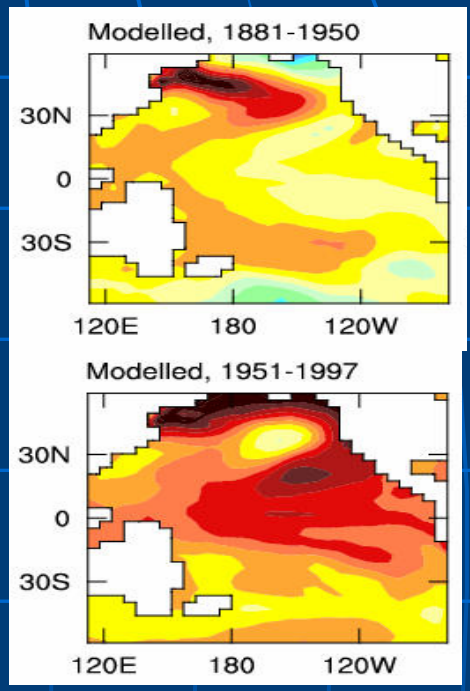
Rainfall shifts in mm/decade 1950-2003 (BoM and DPI&F).

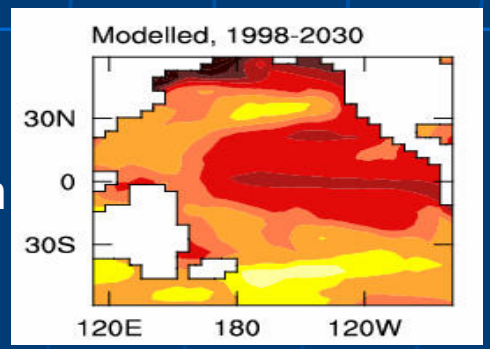


Courtesy: J Arblaster (NCAR/BMRC)

Potential Future Changes in El Niño



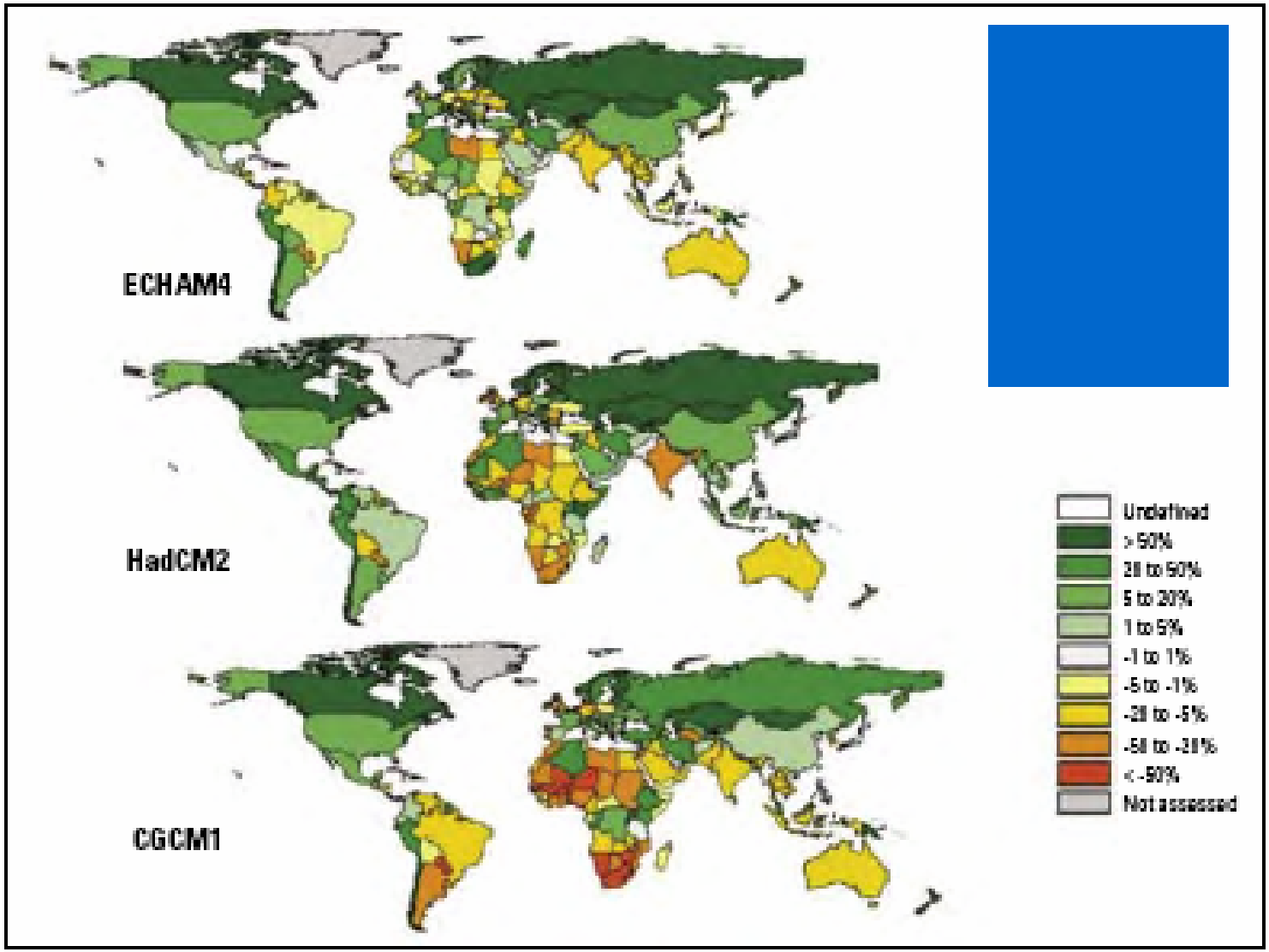




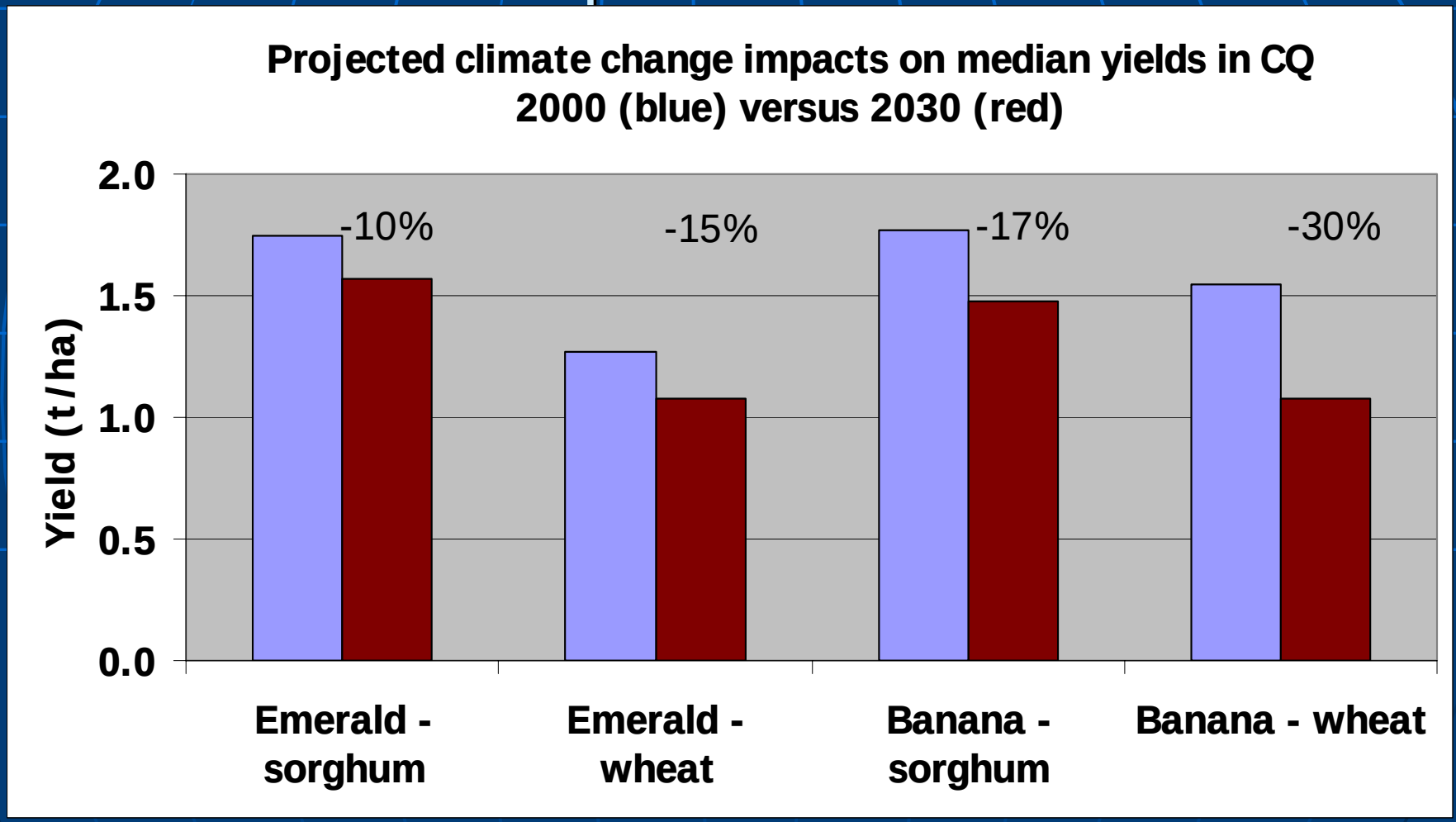
Source: CSIRO DAR

Simulated Pattern of Pacific Ocean warming consistent with observation although stronger

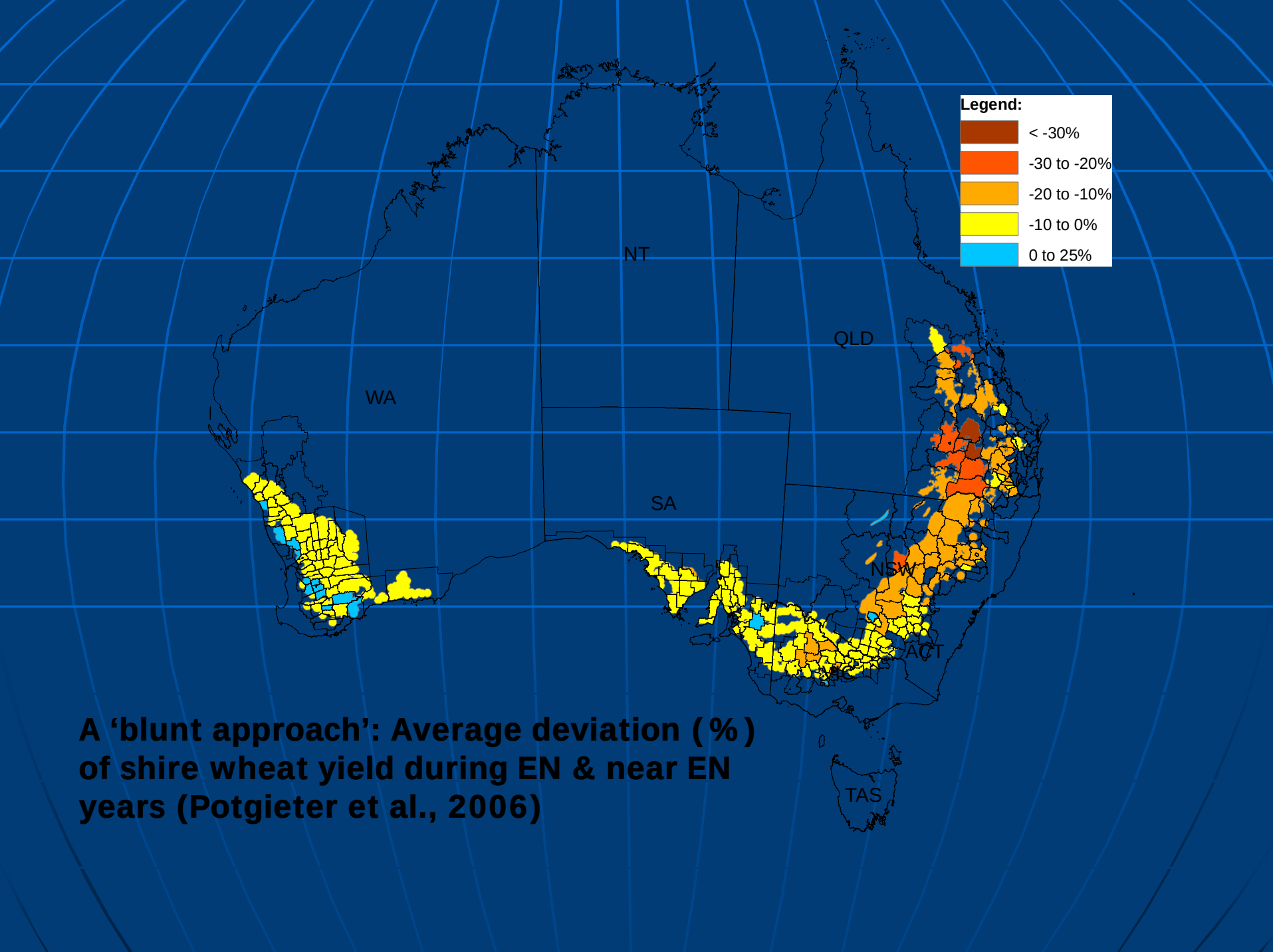
Climate change impacts on cereal production potential by 2050



Likely climate change impacts on grain production



Meinke and Howden (2001)



A ‘blunt approach’: Average deviation (%) of shire wheat yield during EN & near EN years (Potgieter et al., 2006)

Conclusions

- Reasonable capability from current climate forecast systems.
- Increased capability when linked to crop growth models.
- Increased capability when additional variables included (hail, frost, international aspects).
- Climate change major issue – note that analyses conducted on current varieties.
- Need to increase targeted application into horticulture, insurance, financial risk areas and to address issues across the whole value chain.


CANADA
NORTH
UNITED STATES
AMERICA
MEXICO
Tropic of Cancer
MARSHALL
ISLANDS
KIRIBATI
International Date Line
PACIFIC OCEAN
COOK
ISLANDS
(NZ)
FRENCH POLYNESIA
(FR)
Tropic of Capricorn
AUSTRALIA
Antarctic Circle

Thank you