Better long-lead seasonal and crop forecasts for southern Australia

July 2003 – June 2007

MANAGING CLIMATE VARIABILITY R&D PROGRAM

Location: Southern Australian grain belt

Principal investigator

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The need

Most forecasting systems only deliver seasonal outlooks for the next three months and do not show much skill until the end of the predictability barrier at the end of autumn i.e. early June/July. However, by then most of the major management decisions related to the winter crop have been made, i.e. area of crop, crop type, forward contracts of fertiliser, herbicides etc. Farmers have also found the probabilistic presentation of existing forecasts difficult to use and through consultation prefer to be warned of extremes (below average, above average) in rainfall. Clearly, there is a need for more concise forecasts that show skill with more lead-time, and crop forecasts that integrate soil moisture and improved rainfall outlooks at a regional scale.

How this project fits with MCV objectives

This project directly addresses the MCV objective to invest in research that delivers more accurate agricultural seasonal forecasts with longer lead times.

Project objectives

1. Understanding of how major climate anomalies develop and what longer-term climate change is taking place in the southern mid-latitudes in the Australian region
2. Long-lead climate forecasting system that indentifies the development of major El Niño-Southern Oscillation (ENSO) events and climate extremes
3. National and regional crop yield forecasts that integrate real-time rainfall, seasonal forecasts and average rainfall

Methods

Phase 1 – Long-lead ENSO forecasting

We mapped the sequence of atmospheric (pressure, winds) and oceanographic variables (sea surface temperatures) leading into ENSO events. This includes the transitions to strong and weak El Niño, from El Niño to neutral, and from El Niño to La Niña. From this work, we have determined new indices to track changes in ENSO State, i.e. an El Niño Prediction Index (EPI), ENSO Transition Index (ETI) and a more broad-scale measure of the Southern Oscillation (MeanSOI).

Through the improved understanding of the dynamics of ENSO, we have combined these indices into an analogue year selection system, which chooses the five most similar analogue years (to the present year) from the historical record. The analogue system enables the prediction of the developing ENSO state by the end of the year, and importantly, by using the median rainfall ranking of the five years, to spatially map Australia's future expected rainfall. We use the Gerrity Skill Score to test the skill of the system at predicting rainfall.

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Phase 2 – Understanding regional factors that contribute to climate extremes

Spatially averaged rainfall for the south-western and south-eastern Australian grain belt has been correlated spatially with gridded atmospheric pressure and sea surface temperature data from the region around Australia. In future months, we will combine these factors to see if a regionally-based forecasting system can improve on the broad-brush global-scale ENSO Sequence System described above.

Desired outcomes

- An improved capacity to warn of climate extremes and transitions between ENSO states
- A significant increase in the number of farmers that understand and follow the factors that contribute to local climate extremes, and employ better crop management practices
- A national mapping capacity that is able to integrate soil moisture supplies and expected rainfall from broad-scale indicators

Achievements to date

- We found that atmospheric pressure changes in the mid-latitudes precede the development of ENSO events and determine the strength of Pacific warming. This challenges the commonly held perception that ENSO events are driven by air-sea interactions along the equator. In October 2005, we submitted a paper demonstrating this to the Journal of Climate[1].
- An experimental ENSO sequence system (ESS) has been found to skilfully forecast eastern Pacific sea surface temperatures a year in advance, and skilfully predict May-October rainfall for much of the country with 4-6 months lead-time. These forecasts have the potential to revolutionise farming and risk management practices across Australia and in other regions of the world where weather is affected by El Niño and La Niña events.
- The largest decline in the MeanSOI between October (year -1) and May is a clear indicator of whether an El Niño event will develop, and is a strong indicator of major drought years in the Australian grain belt.

What is left to do?

The process of directly predicting Australian wheat belt rainfall with a combination of ENSO and local factors will be the focus of research to be undertaken in 2006/2007.

A number of manuscripts will be submitted for publication. This includes:

- The ENSO transition sequence mapping
- New climate indices of the Southern Oscillation (EPI, ETI, MeanSOI)
- Climate change in the southern hemisphere[2]
- Long wave trough positioning in El Niño events
- The ENSO Sequence System

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[1] Stephens, D.J, M. J. Meuleners, N.P. Telcik, H. van Loon, and M.H. Lamond (2006). The differences in atmospheric circulation between the development of weak and strong warm events in the southern oscillation. J. Climate, submitted.

[2] Van Loon, H., D.J. Stephens, and M.H. Lamond (2006). Southern Hemisphere aspects of the global circulation change in the late 1970s (submitted for comment to Indian Ocean Climate Initiative, IOCI, in prep. for publ.).

MCV is a collaborative program between the Grains, Rural Industries and Sugar Research and Development Corporations; the Australian Government Natural Heritage Trust and Department of Agriculture, Fisheries and Forestry; Dairy Australia; Meat & Livestock Australia; and Land & Water Australia. The National Farmers Federation and Australian Wool Innovation Limited are associate partners.

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