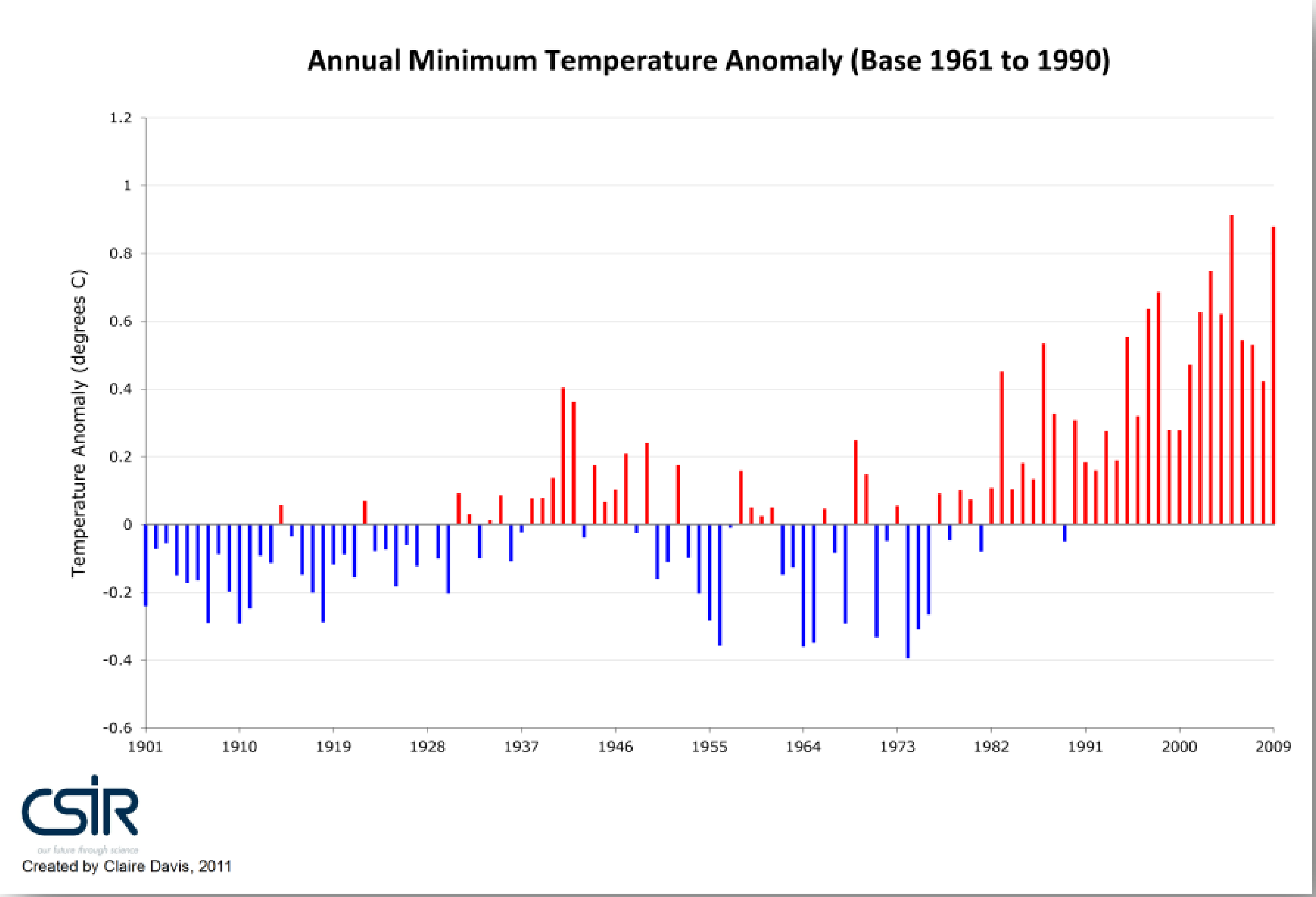
Implications of climate change for livestock in southern Africa

HOW IS TEMPERATURE AND RAINFALL CHANGING AT THE REGIONAL SCALE?

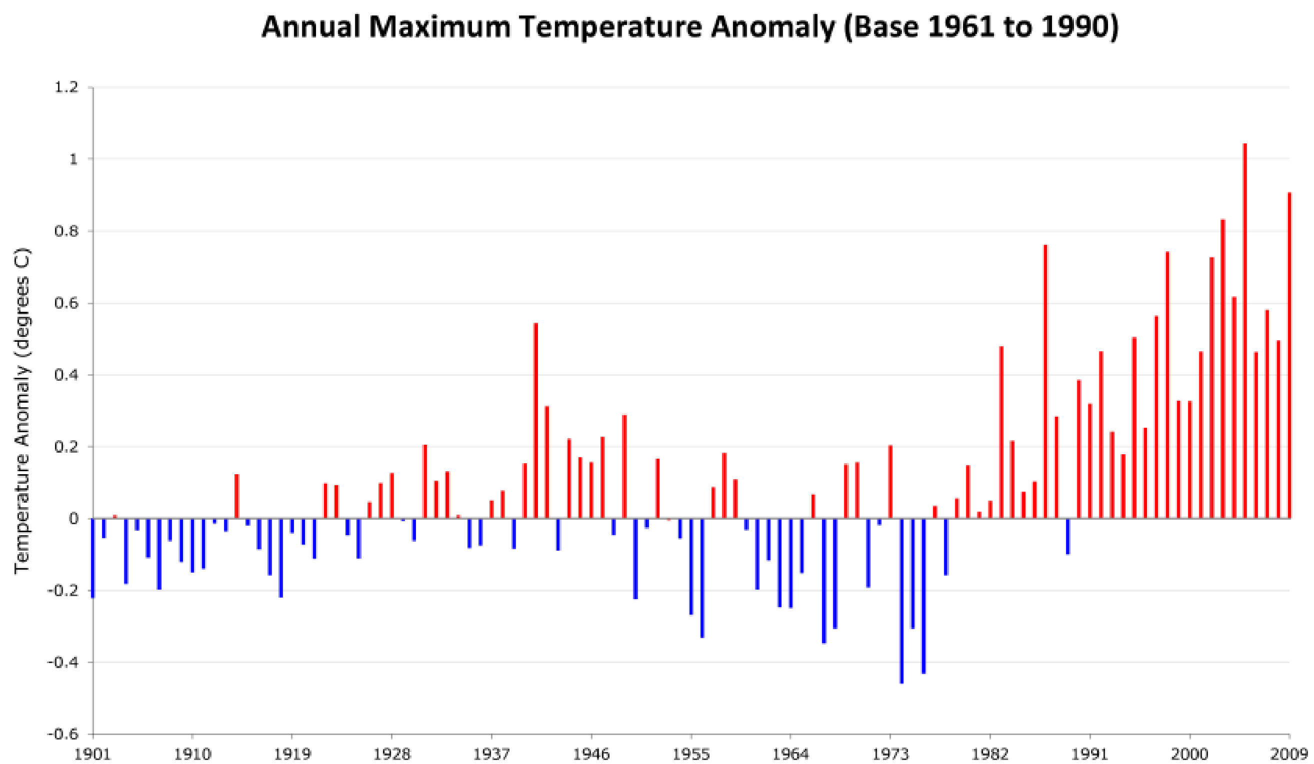
Regional temperature trends (1)

- Challenge:
    - Lack of accurate, long-term, well-maintained record of climate observations
    - Influence of local features as well as regional climate variability (such as El Nino)
- Results from a regional analysis of temperature from high-resolution gridded dataset (1901-1991); CRU TS 3.1

Regional temperature trends (2)



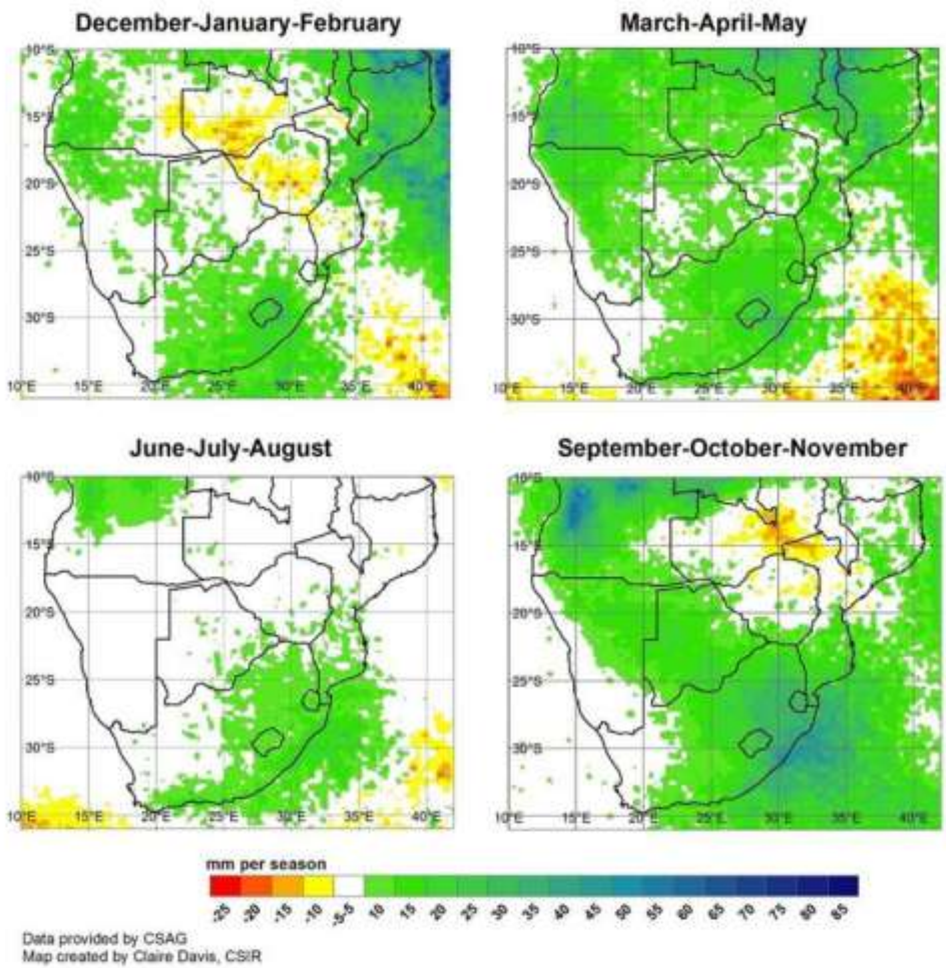
Regional temperature trends (3)



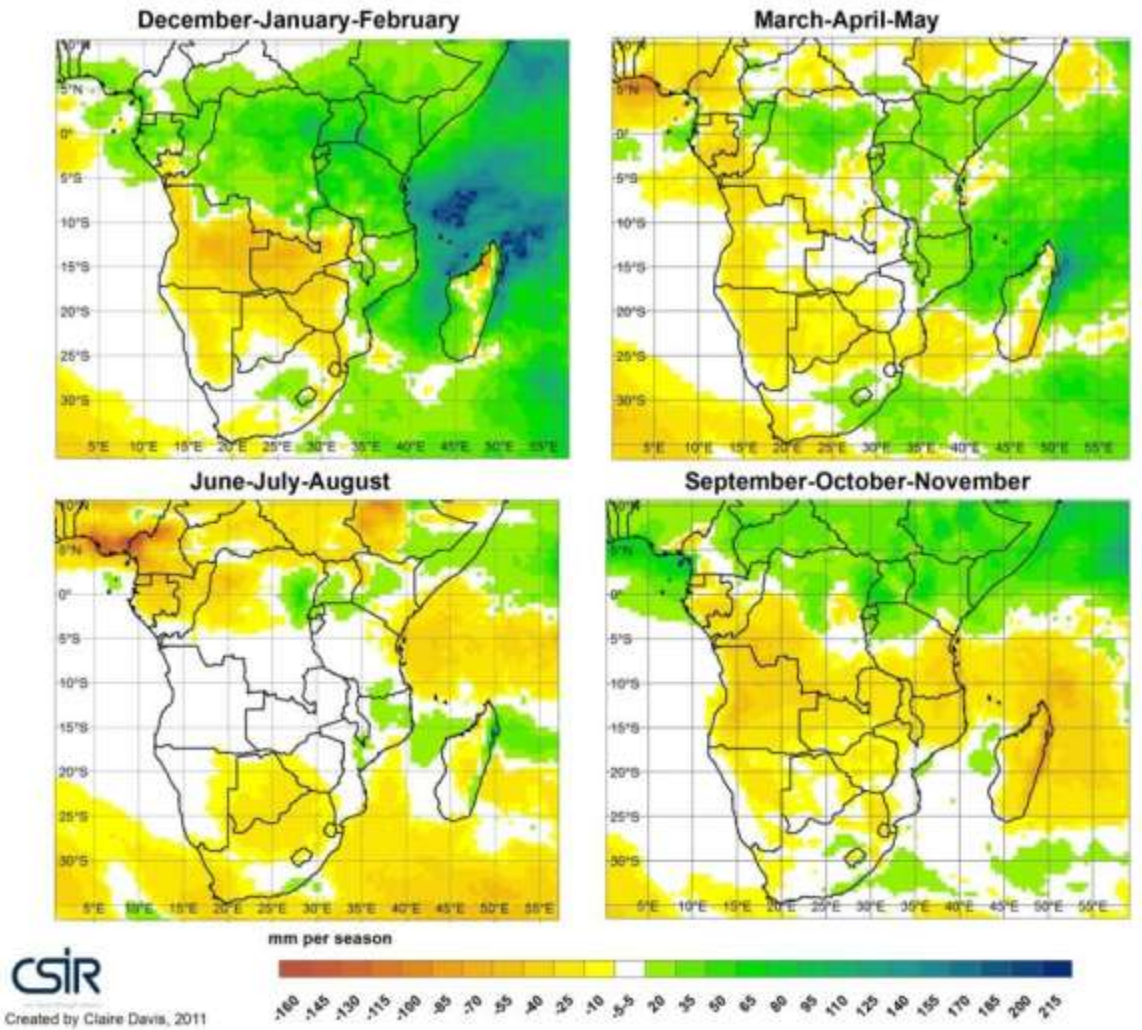
Created by Claire Davis, 2011

HOW IS CLIMATE EXPECTED TO CHANGE IN SADC?

Southern Africa predictions - statistical downscalings



Southern Africa predictions - dynamical downscalings



Areas of agreement

Box 2: Summary and comparison of climate change projections from the GCMs and the two downscaling techniques			
	GCM	Statistical Downscalings	Dynamical Downscalings
Time-scale	1960-2000 2030-2060	1961-2000 2046-2065 (A2 emissions scenario)	1961-2000 2036-2065 (A2 emission scenario)
Rainfall	Decreases over central and western southern Africa during DJF and MAM Increases further north over east Africa. Decreases over most of southern Africa during SON and southwest Africa during JJA	Increases over Angola, northern Mozambique and southeast South Africa during DJF and MAM. Decreases over Zimbabwe, Zambia and western Mozambique during DJF and SON.	Increases over East Africa and southeast South Africa, particularly during DJF and MAM Decrease in rainfall projected for rest of southern Africa, except northern Mozambique
Temperature	Increase in mean, minimum and maximum temperature		
	1 - 3˚C	0.8 - 3.6˚C	0.4 - 3.2 ˚C
Extreme weather events	Increases in very hot days and heat waves	Increases in very hot days and heat waves	More extreme rainfall events over eastern southern Africa Increase in very hot days – above 35˚C

Focus on Livestock

With contributions from DEWFORA, START, ARC collaborations

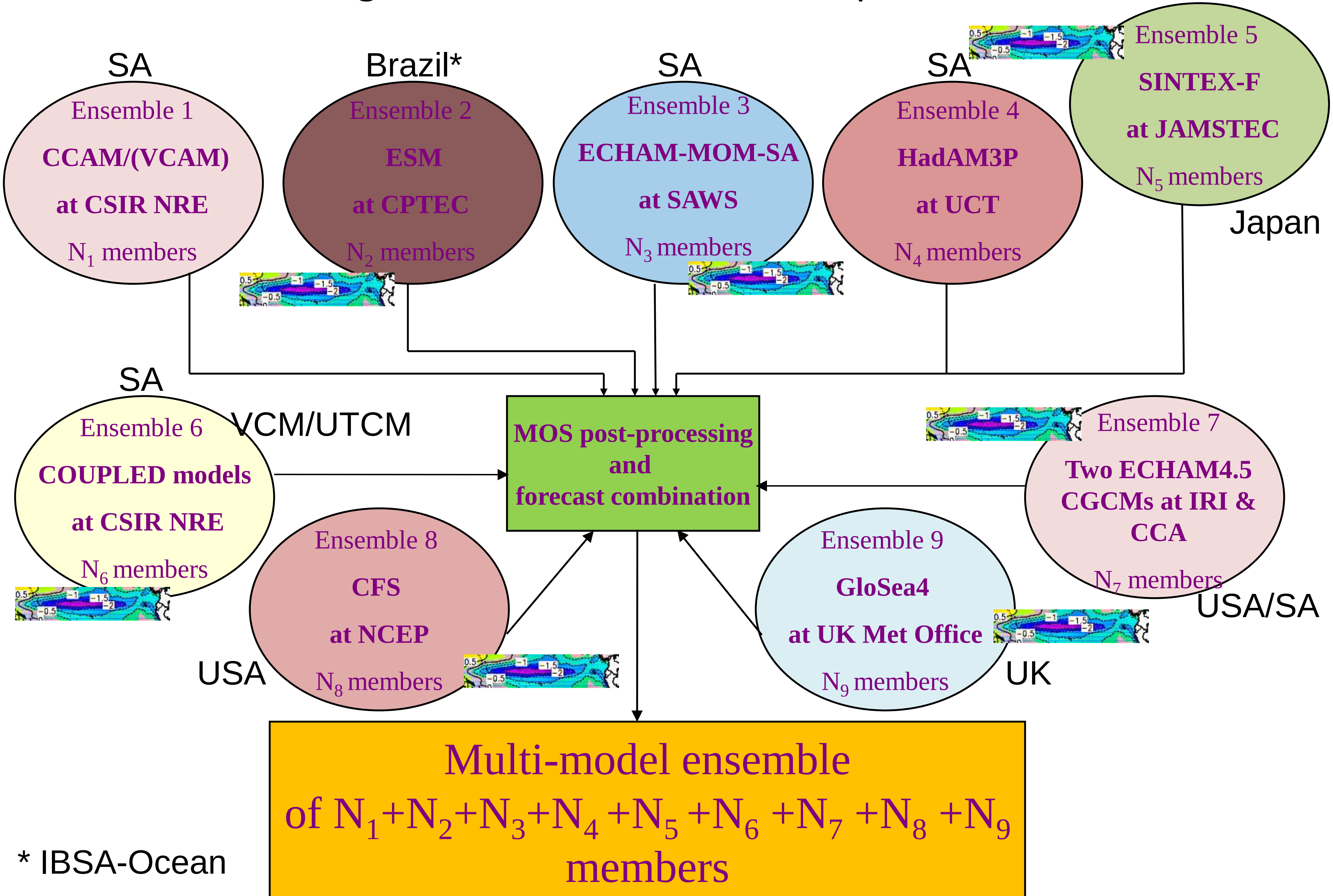
CSIR

our future through science

DEWFORA outline

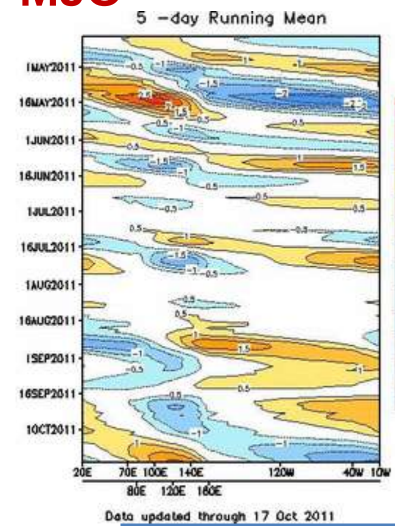
- EU FP7 project - **Improved Drought Early Warning and FORecasting to strengthen preparedness and adaptation to droughts in Africa**
- **Improved monitoring: improvement of knowledge on drought forecasting, warning** and mitigation, and advance the understanding of climate related vulnerability to drought – both in the current and in the projected future climate.
- **Prototype operational forecasting: focus on the operational implementation of** advances made, bringing these to the pre-operational stage through development of prototype systems and piloting methods in operational drought monitoring and forecasting agencies.
- **Knowledge dissemination**
- **Basin case studies – including Limpopo**

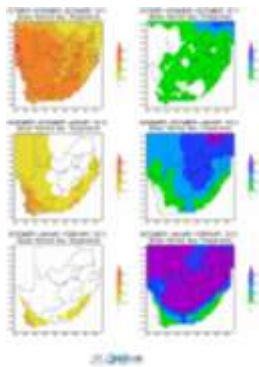
The multi-model seasonal forecasting system for SADC and for global oceans under development

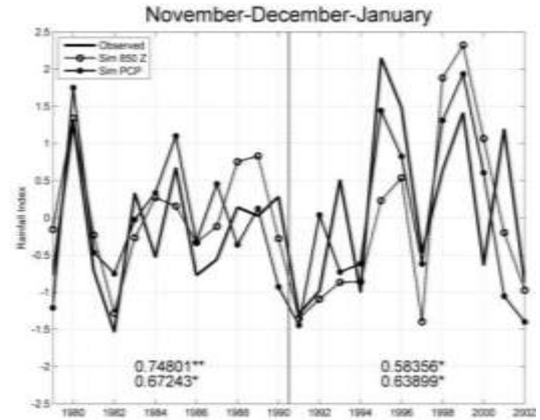


Integrated forecast system

MJO

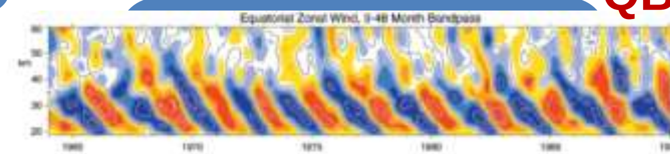






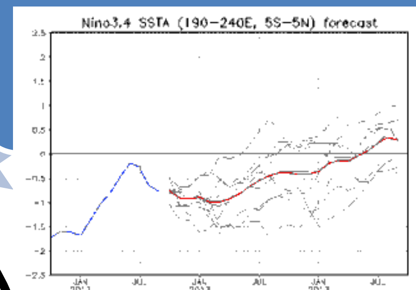
Seasonal forecast system

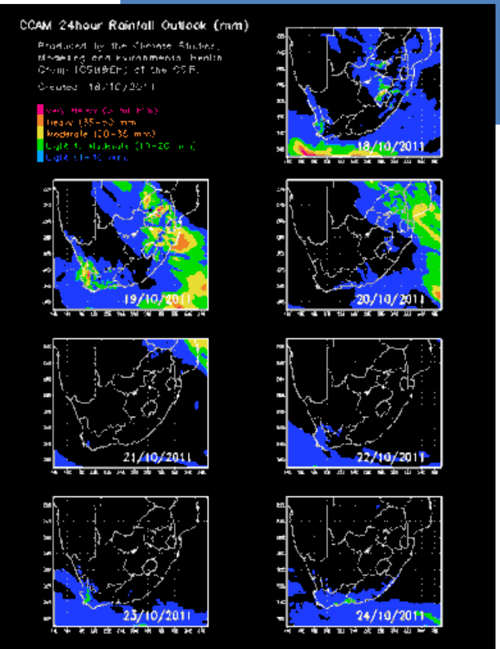
QBO



Short- to extended-range

1-3 years; decadal

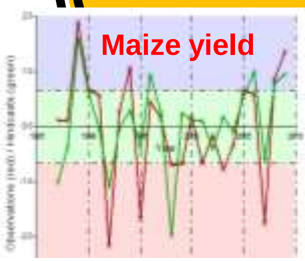




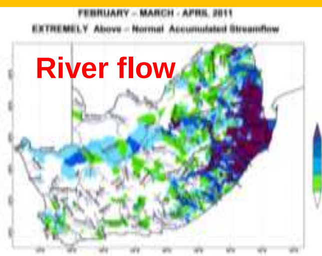
Health

APPLICATIONS

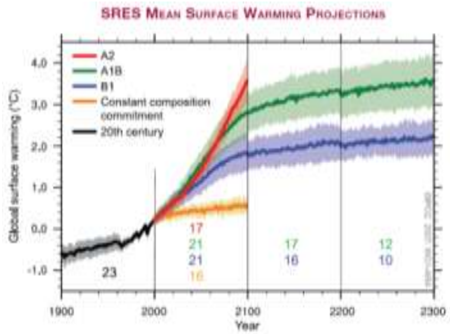
Maize yield



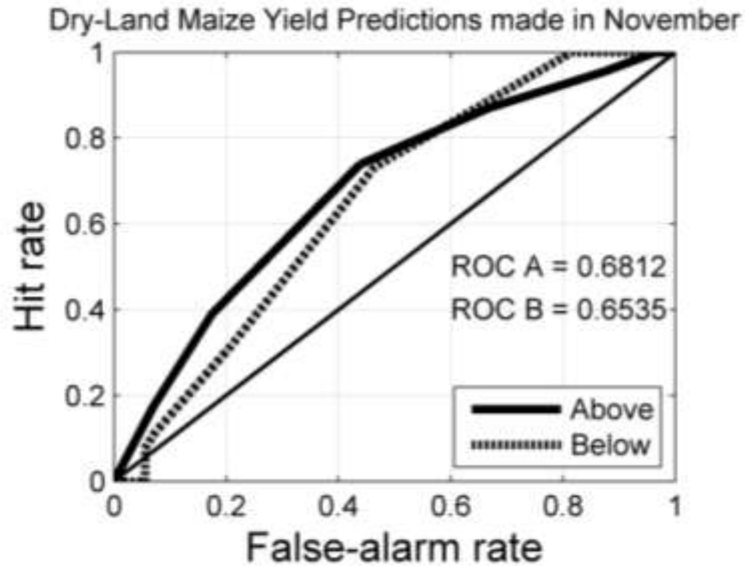
River flow

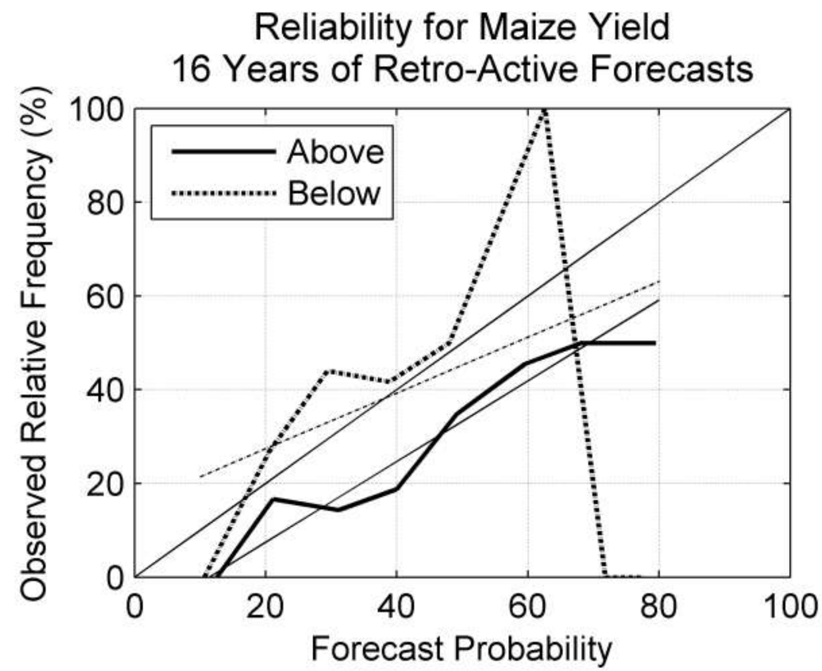


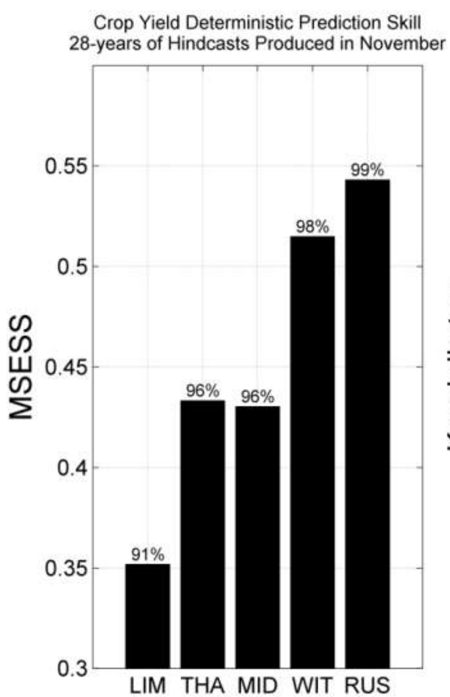
Livestock

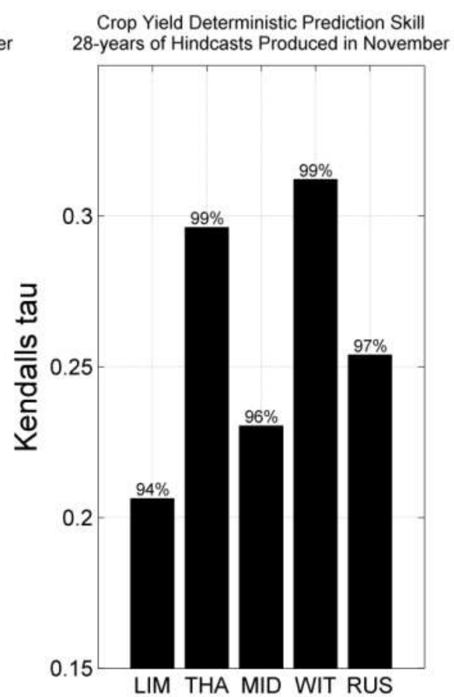


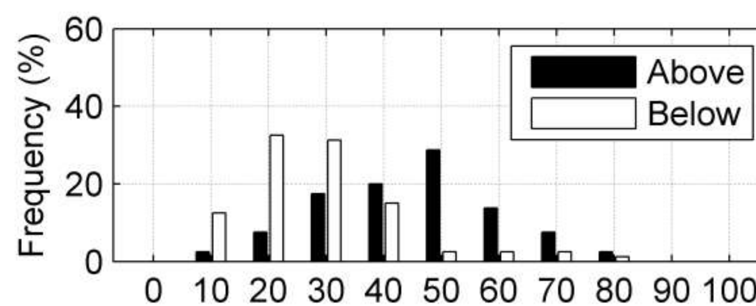
Crop predictions with coupled model











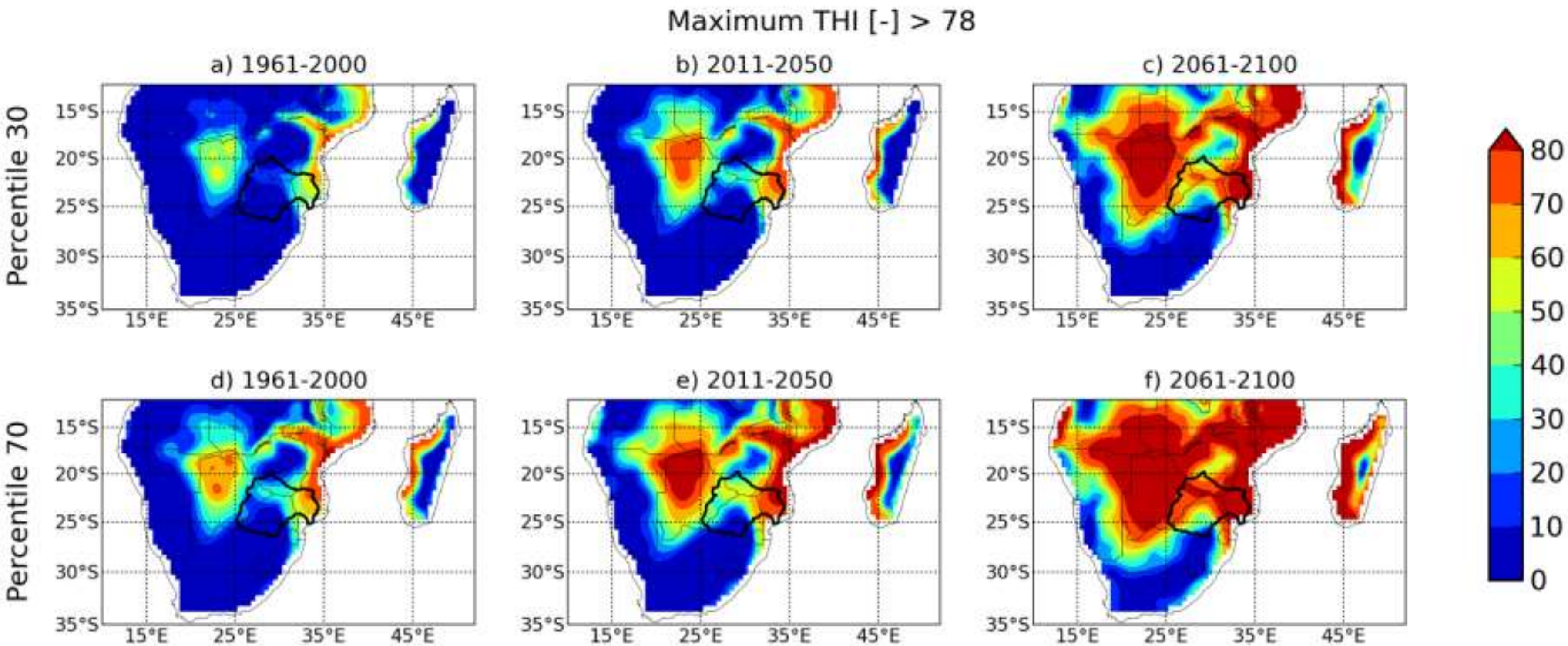
Cattle critical THI thresholds

Building further on the work of Nesamvuni et al 2012

	72 THI (22°C @ 100% humidity)	Comfort threshold for US Holsteins heat stress (Sanchez et al 2009, Ravagnolo et al., 2000; Freitas et al., 2006).	
	72 THI (22°C @ 100% humidity)	Comfort threshold for high producing dairy cows (Hernandez et al 2002, Armstrong 1994) Higher for *Bos Indicus* breeds(highly adapted to heat stress)	
	27 °C	Upper limit of comfort zone for maximum milk production in India – 2 °C higher than for temperate countries (Sirohi & Michaelowa 2007)	
	28 °C and high humidity	Heat stress begins in most breeds (Agricultural Information Centre, Government of Alberta)	
	30 °C ambient temperature	"seems to be the critical point at which both *Bos Taurus* and *Bos Indicus* begin to differ in ability to maintain near normal rectal temperatures and respiratory rates". (Hernandez et al 2002)	
	32 °C	Accepted comfort threshold for most cattle breeds	
	78 THI	Critical limit for every kind of livestock	

Results

- Using thresholds of 72 (mild stress) and 78 (severe stress)
- Estimated trends in changes in frequency of occurrence of chosen indicator and threshold combinations
- Used latest CCAM bias corrected downscalings (part of the Long Term Adaptation Scenarios full suite of downscalings; and part of the LTAS Agricultural sector report)



Changes in distribution of the DJF frequency of days with THI higher than 78

- Variability in the current climate is not very large, but the change in climatology in time due to climate change is considerable;
- Dairy cattle stress known to be severe with THI > 78 (Archer van Garderen 2012, Nesamvuni et al., 2012; Ravagnolo et al., 2000);
- These results - such conditions are now largely restricted to the lower valleys as well as the Kalahari desert, but will increase seriously in frequency towards 2100 across most countries north of South Africa (including the northern parts of South Africa itself);
- Similar increases in the frequency of occurrence of THI larger than 72 and 84. According to these results, THI above 84 now very rare across the studied region, but will occur quite frequently in the future over the Kalahari desert, as well as the lower Zambezi basin;
- THI exceedances of this type would stress most livestock, clearly a significant concern for these areas.

START – small stock critical thresholds

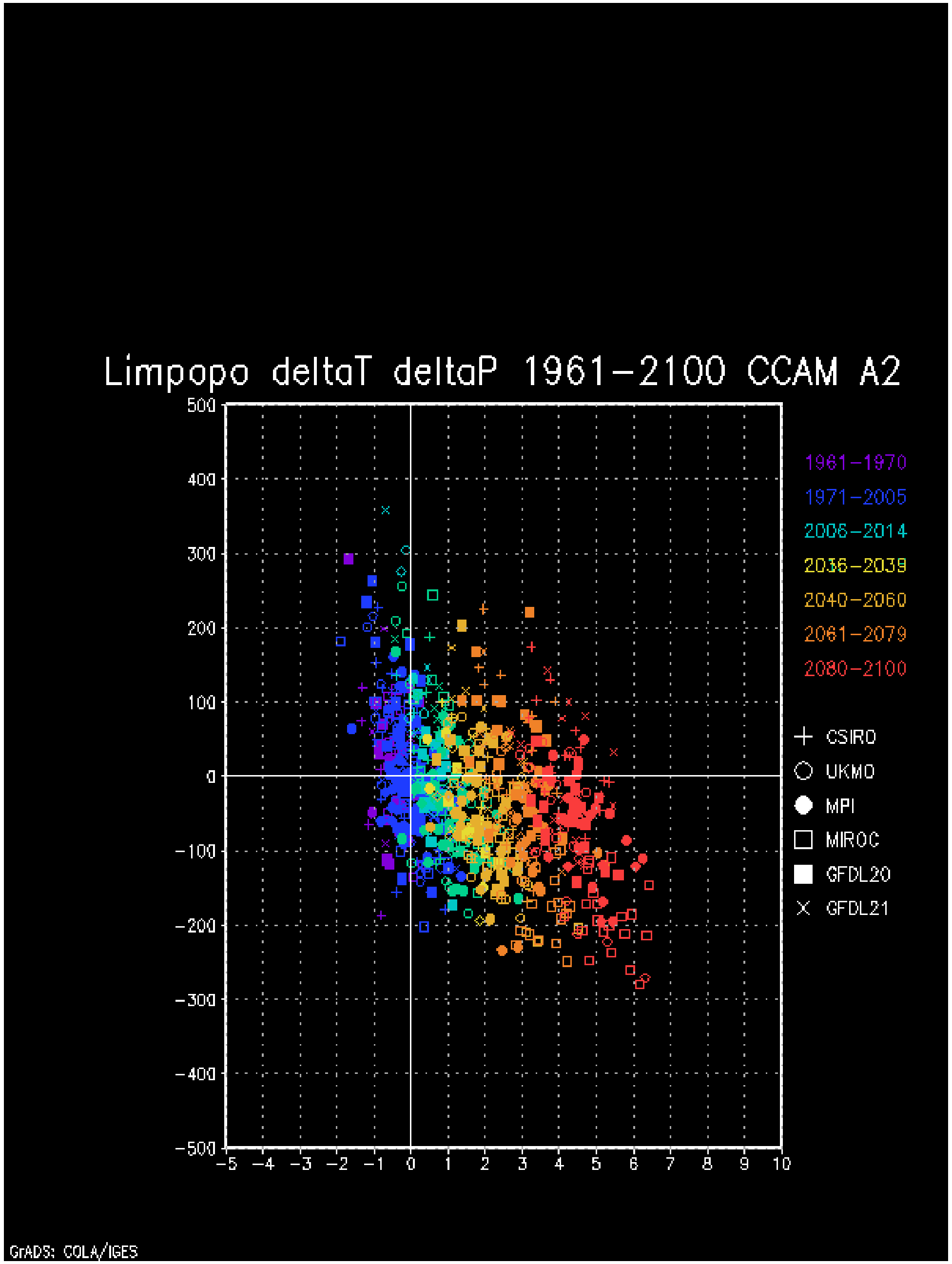
- Dorper & Damara sheep monitoring 2012-13 (Suid Bokkeveld)
- Partial funding – Volkswagen foundation & START – temperature monitoring on sheep collars; referenced to farm met stations
- Livestock parameter monitoring & liveweight monitoring
- Initial results – early 2014 (end first summer monitoring)

Forage forecasting collaboration

- With ARC ISCW; linked to AMESD-SADC
- Umlindi did include a forage forecasting capacity (Veld Info – last produced around 2009)
- AMESD will have a carrying capacity baseline; and needs to develop a predictive component
- ARC requested to undertake – partner
- Further – provide National Agromet Committee with more quantitative elements in this area

Conclusions – livestock and climate change gaps

- Predictive modelling for small stock
- Operational tailored forecasts for the livestock sector
- Detailed livestock production models
- Ease of repeated application of updated suites of downscaled climate change projections – still a challenge


Limpopo deltaT deltaP 1961-2100 CCAM A2
500
400
300
200
100
0
-100
-200
-300
-400
-500
-5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
1961-1970
1971-2005
2006-2014
2036-2039
2040-2060
2061-2079
2080-2100
CSIRO
UKMO
MPI
MIROC
GFDL20
GFDL21
GrADS: COLA/IGES