

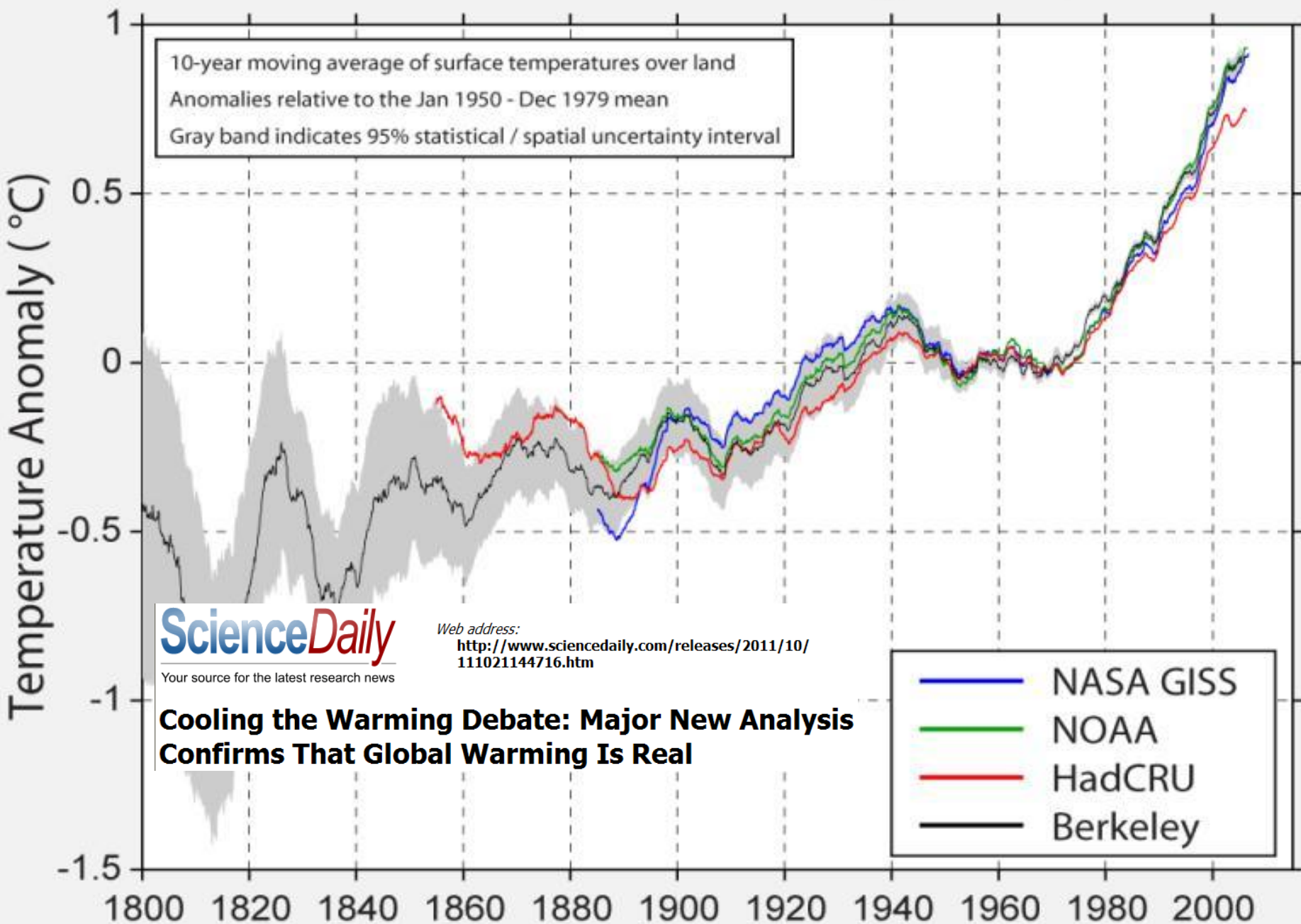
# In a warming climate, just how predictable are temperature extremes at weather and seasonal time scales?

Willem A. Landman  
Estelle Marx  
Ruth Park  
Stephanie Landman  
Melissa Lazenby

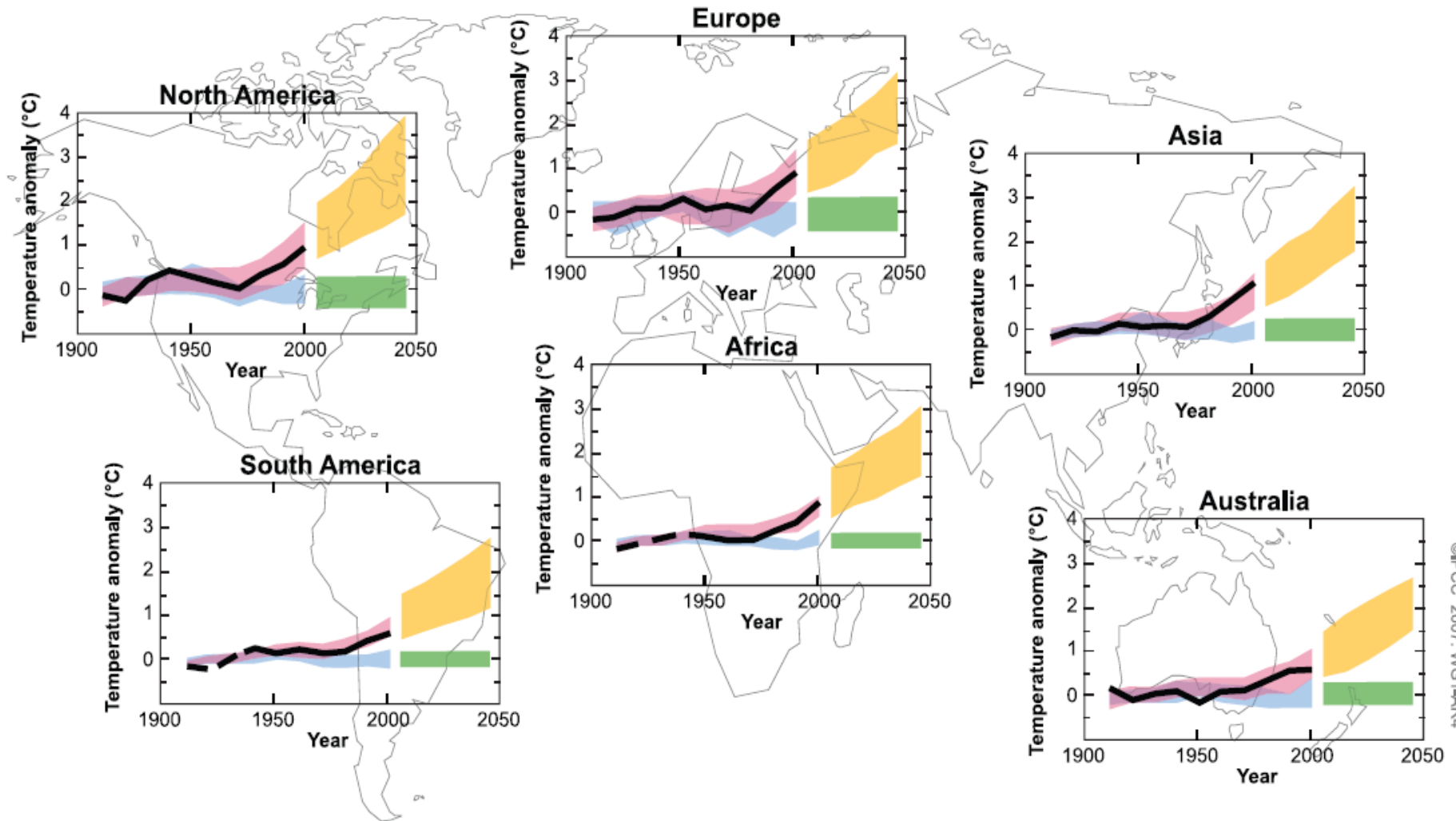


UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

# Decadal Land-Surface Average Temperature



# Climate change projections

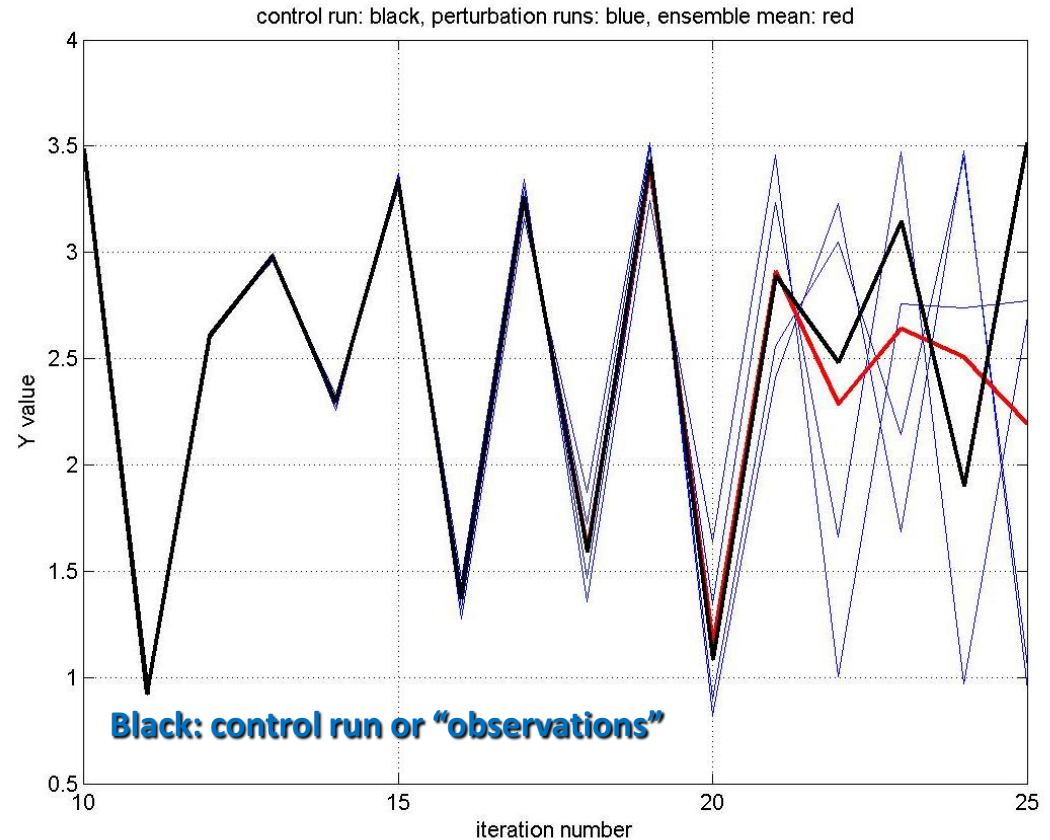


# First-order quadratic difference equation

- **Lorenz** illustrated the general problem of predictability by considering the first-order quadratic difference equations:

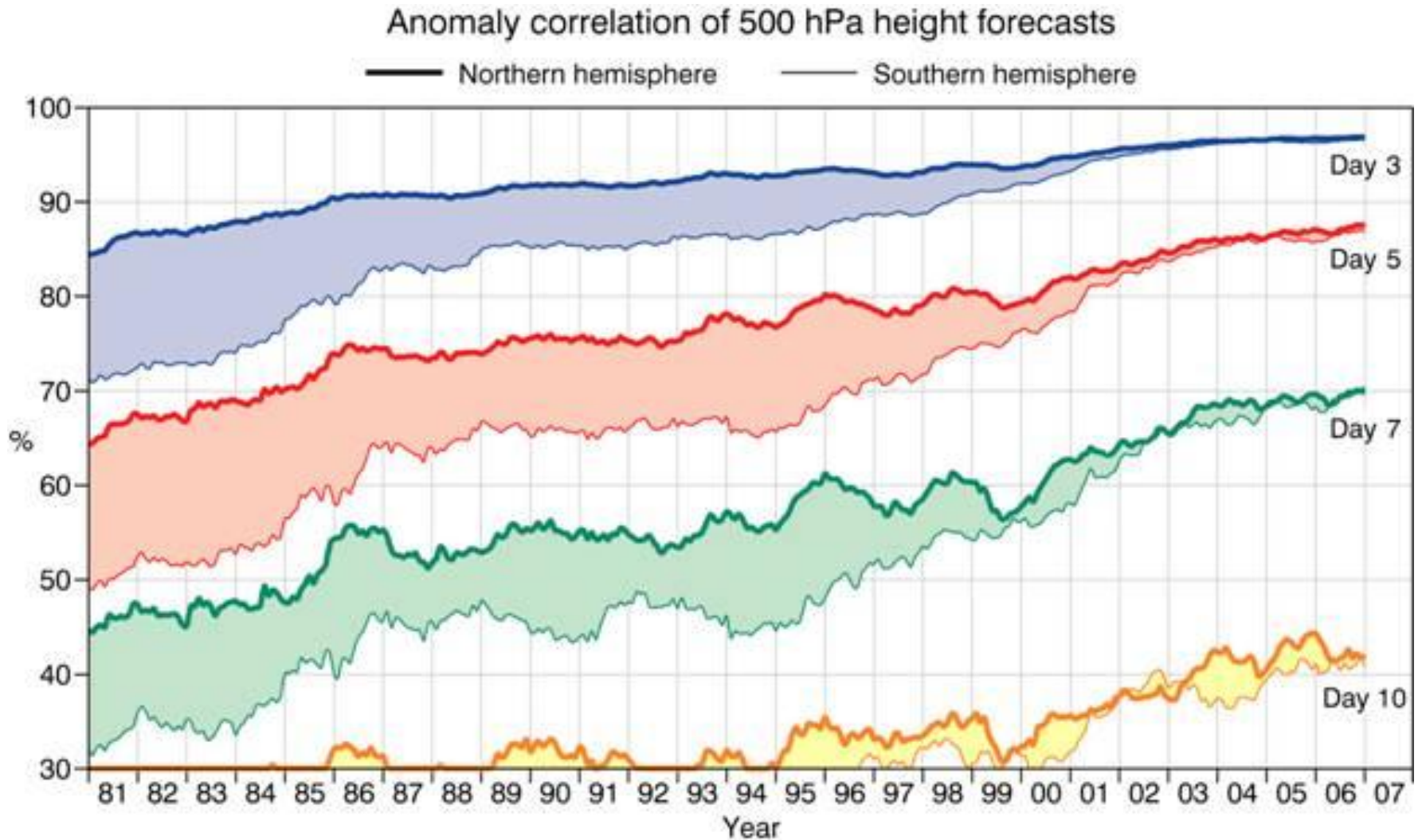
$$Y_{s+1} = aY_s - Y_s^2$$

- Figure is for  $Y(0) = 1.5$ ;  $a = 3.75$



Initial value perturbed by 0.001

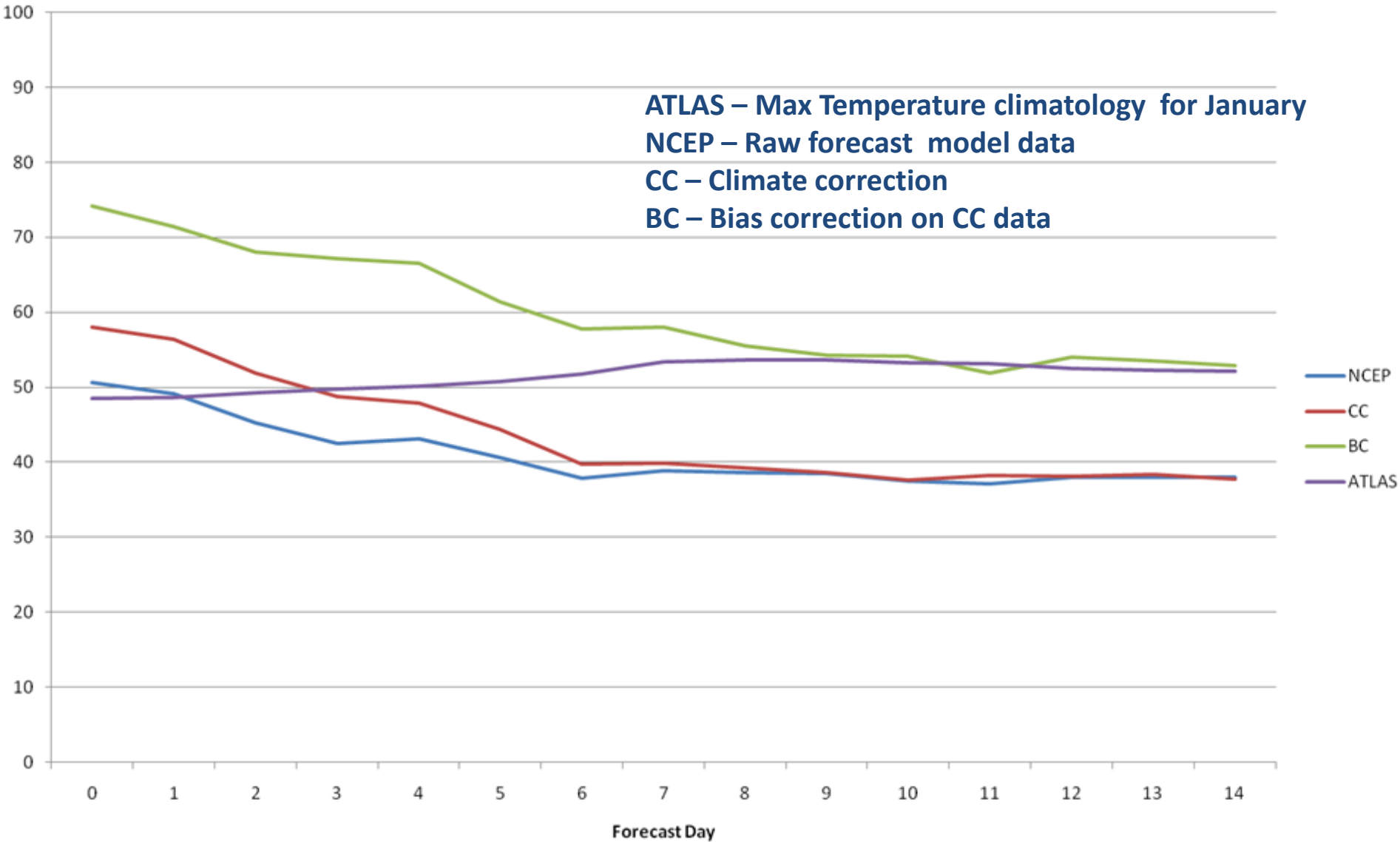
# Typical weather forecast skill





# Tx - Average Percentage Correct within 2deg - Jan2011

ATLAS – Max Temperature climatology for January  
NCEP – Raw forecast model data  
CC – Climate correction  
BC – Bias correction on CC data



# Spearman Correlation - Maximum Temperature

2011

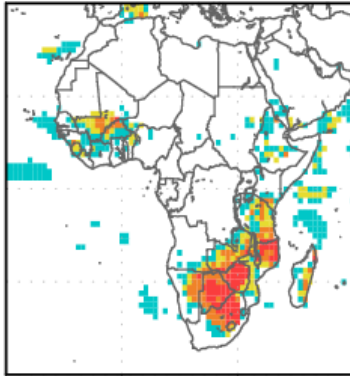


# The recent heat wave (1)

Occurrence probability of extreme warm T2m  
Initial: 2011.10.21.12UTC, Valid: 2011.10.24.12UTC

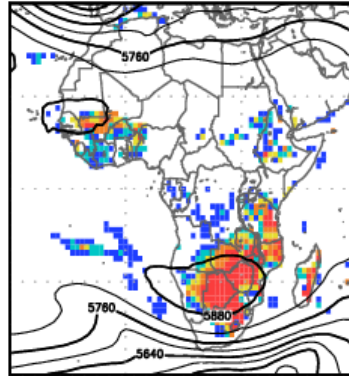
**Multi-Centre Grand Ensemble**

MCGE

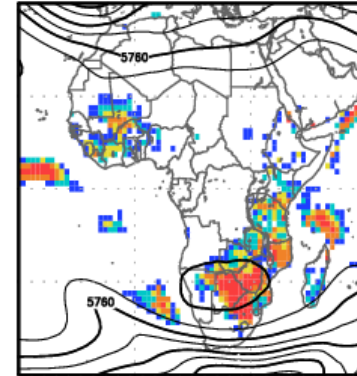


1 2 3 4  
number of centers  
with > 50% probability

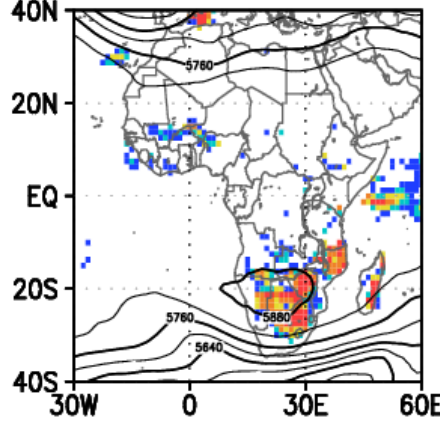
ECMWF



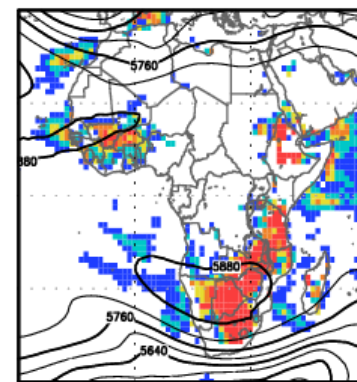
JMA



NCEP



UKMO



contour: control Z500



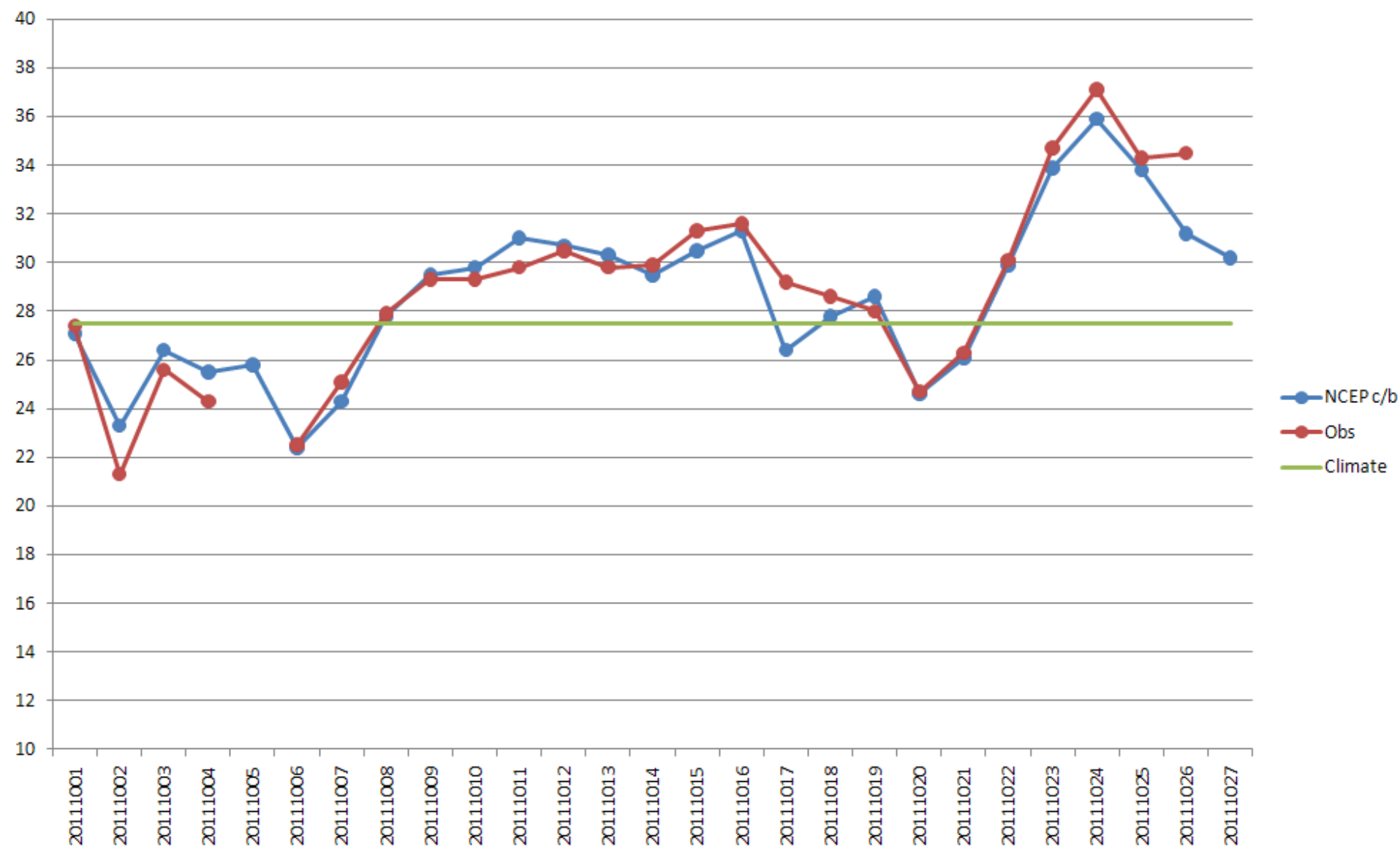
In South Africa

- 1) Unified Model
- 2) NCEP
- 3) WRF
- 4) CCAM



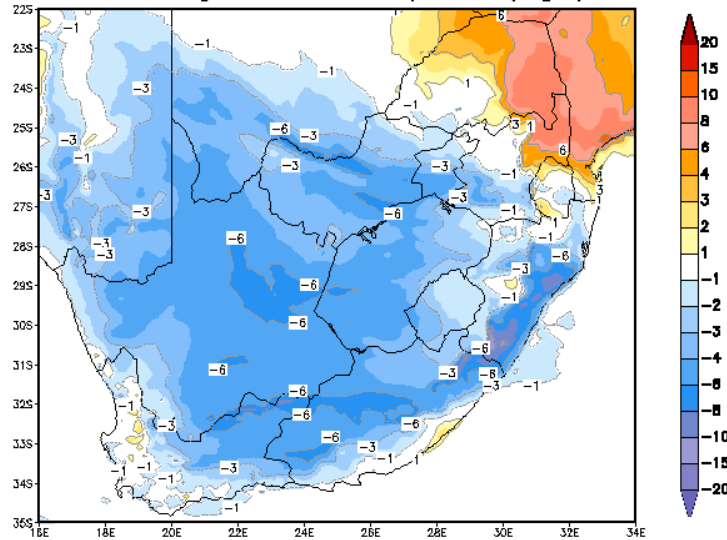
# The recent heat wave (2)

Tmax : Pretoria (68262) : October 2011



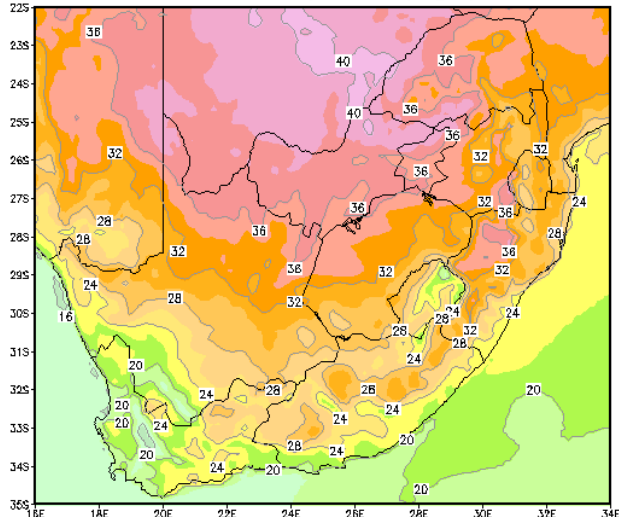
# The recent heat wave (3)

UM 12km horizontal resolution – xaant Run:  
24Hr Change in Maximum Temperature (deg C)



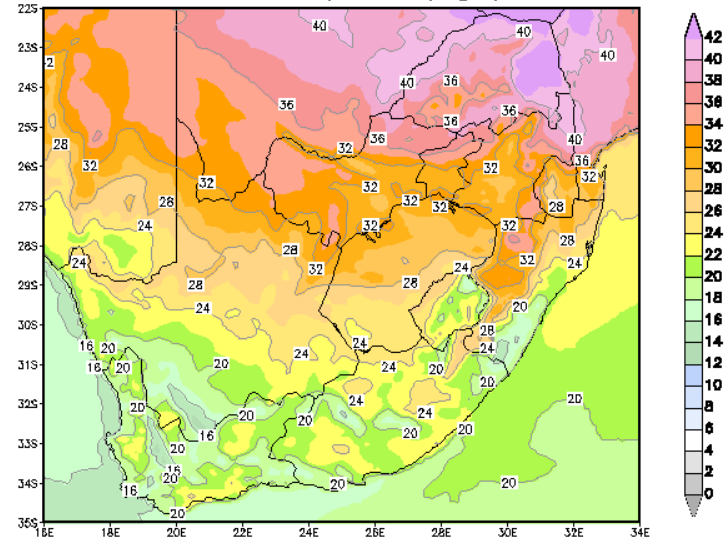
Forecast from 00Z 24 OCT 2011: for 24 OCT 2011 – 25 OCT 2011

UM 12km horizontal resolution – xaant Run:  
Maximum Temperature (deg C)



Forecast from 00Z 24 OCT 2011 – for 00Z 24 OCT to 00Z 25 OCT

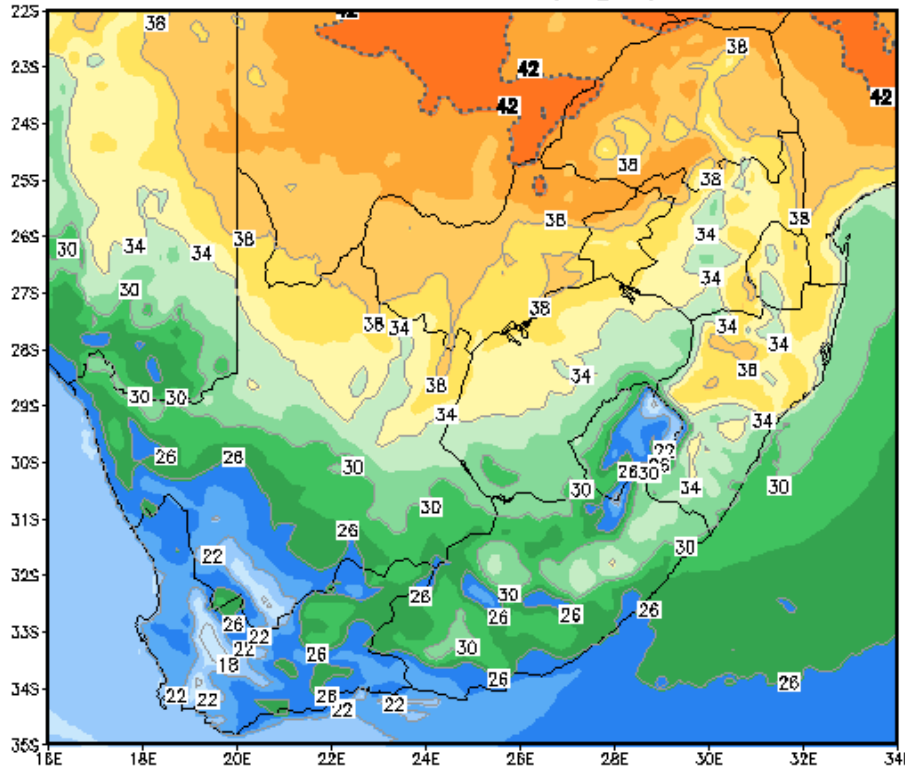
UM 12km horizontal resolution – xaant Run:  
Maximum Temperature (deg C)



Forecast from 00Z 24 OCT 2011 – for 00Z 25 OCT to 00Z 26 OCT

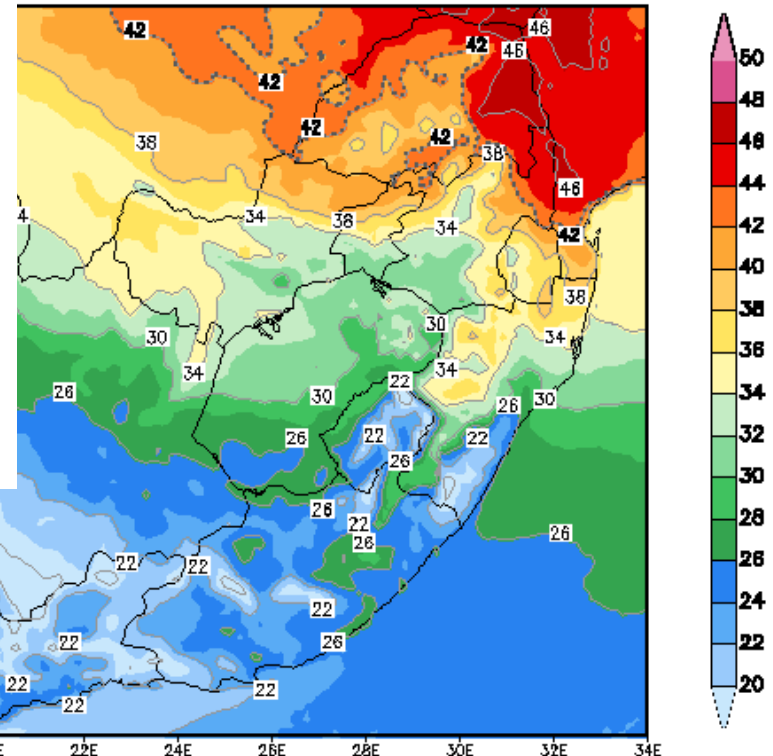
# The recent heat wave (4)

UM 12km horizontal resolution – xaant Run:  
Discomfort index (deg C)



12hr Forecast from 12Z 24 OCT 2011 – for 12Z 24 OCT 2011

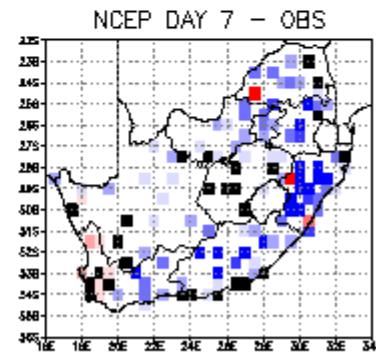
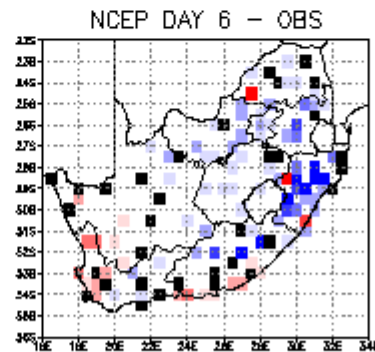
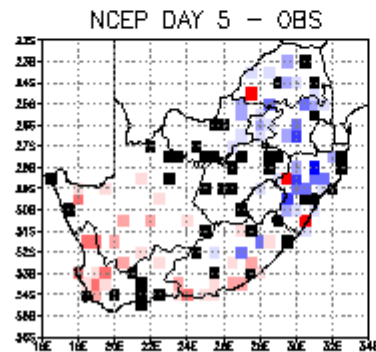
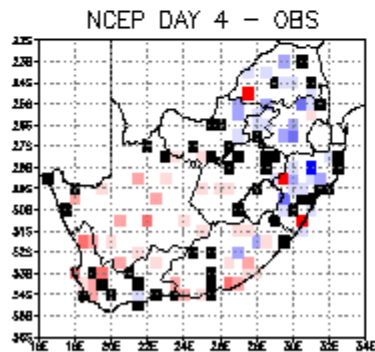
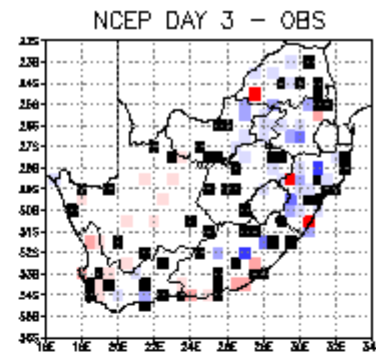
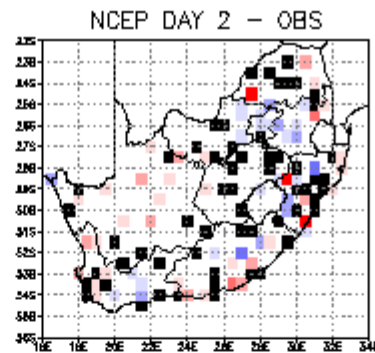
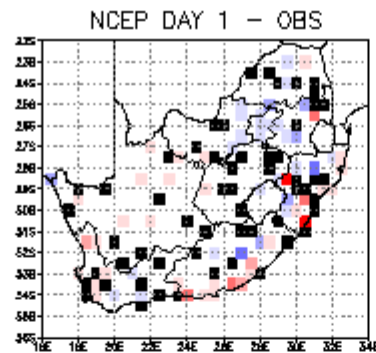
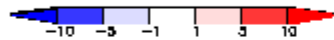
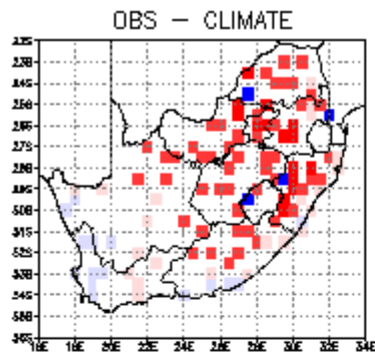
horizontal resolution – xaant Run:  
Discomfort index (deg C)



36hr Forecast from 12Z 24 OCT 2011 – for 12Z 25 OCT 2011

# The recent heat wave (5)

## 24/10/2011



# The recent heat wave (6)

CCAM Maximum Temperature (C)



Produced by the Climate

Modelling and Environmental  
Group (CSM&EH) of the C

CCAM Maximum Temperature (C)



Produced by the Climate St

Modelling and Environmental  
Group (CSM&EH) of the CSI

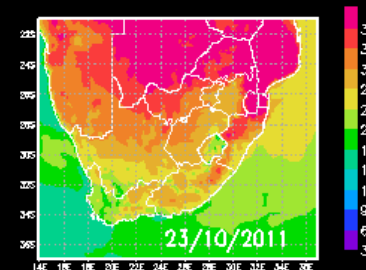
CCAM Maximum Temperature (C)



Produced by the Climate

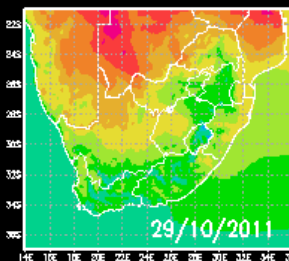
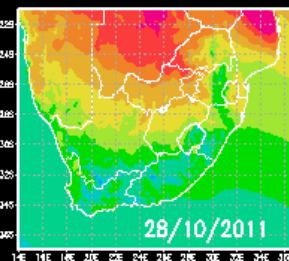
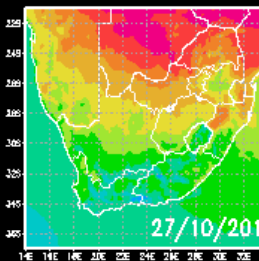
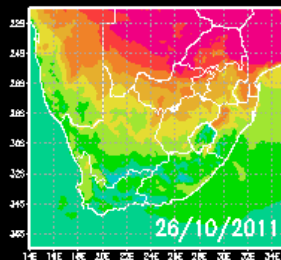
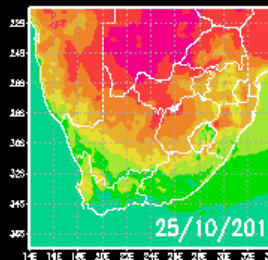
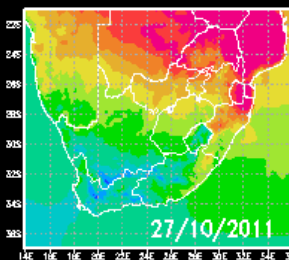
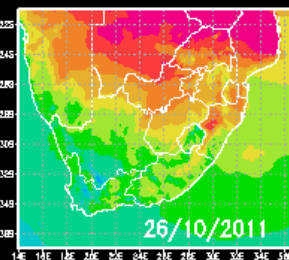
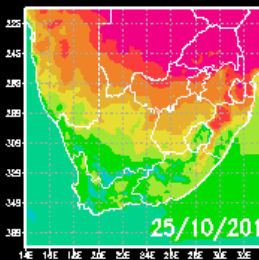
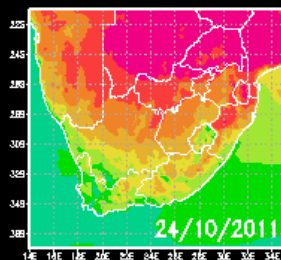
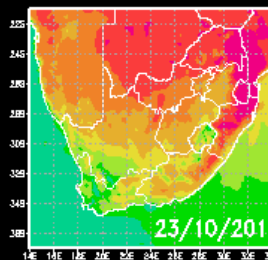
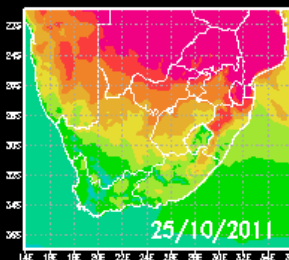
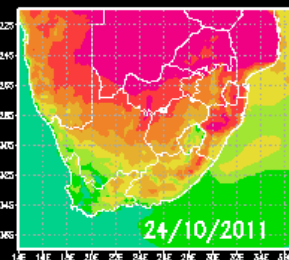
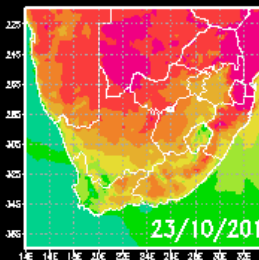
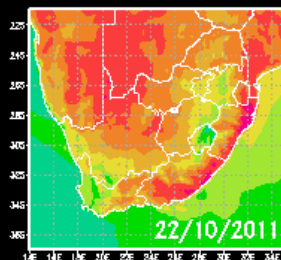
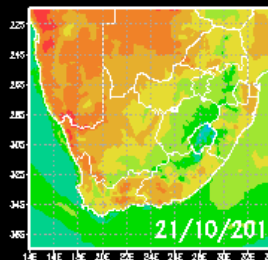
Modelling and Environmental  
Group (CSM&EH) of the C

CCAM Maximum Temperature (C)



Produced by the Climate Studies,

Modelling and Environmental Health  
Group (CSM&EH) of the CSIR.





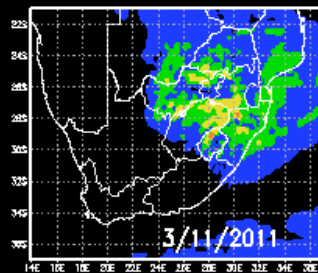
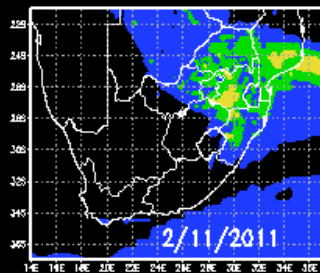
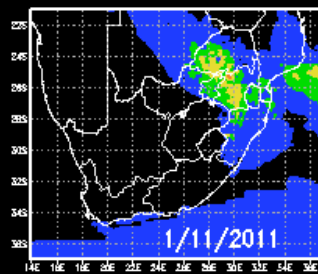
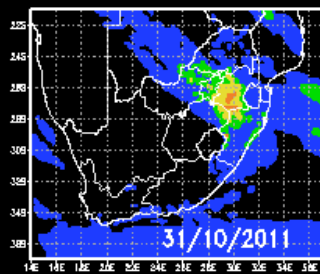
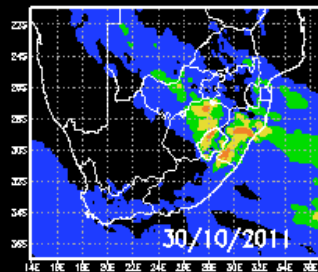
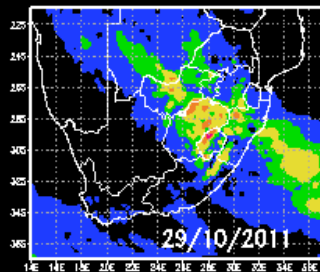
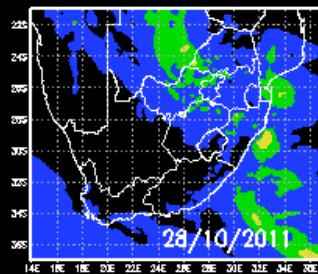
# Today's forecast

## CCAM 24hour Rainfall Outlook (mm)

Produced by the Climate Studies, Modelling and Environmental Health Group (CSM&EH) of the CSIR.

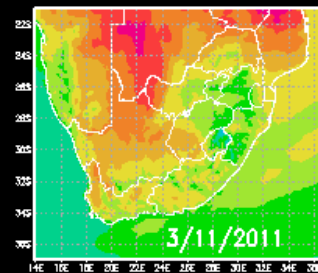
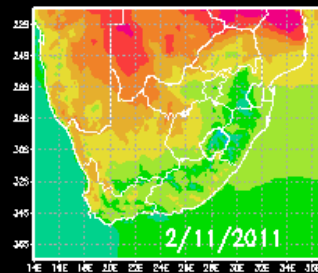
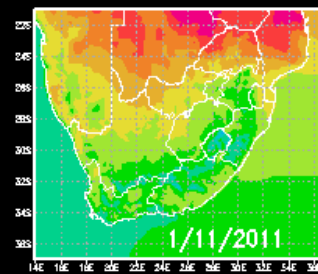
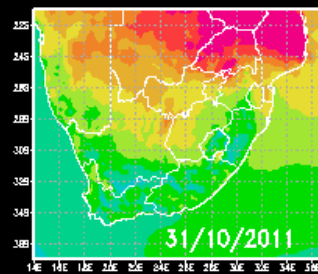
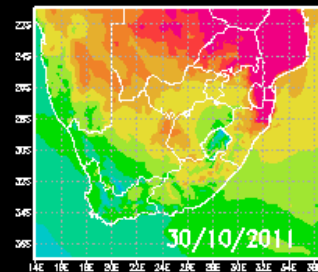
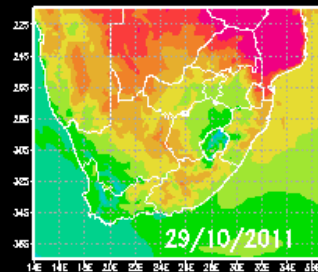
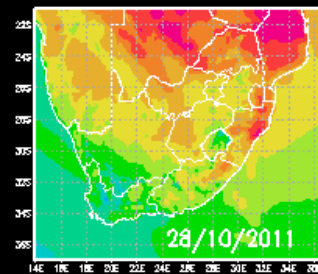
Created: 28/10/2011

■ Very Heavy (> 50 mm)  
■ Heavy (35-50 mm)  
■ Moderate (20-35 mm)  
■ Light to Moderate (10-20 mm)  
■ Light (1-10 mm)



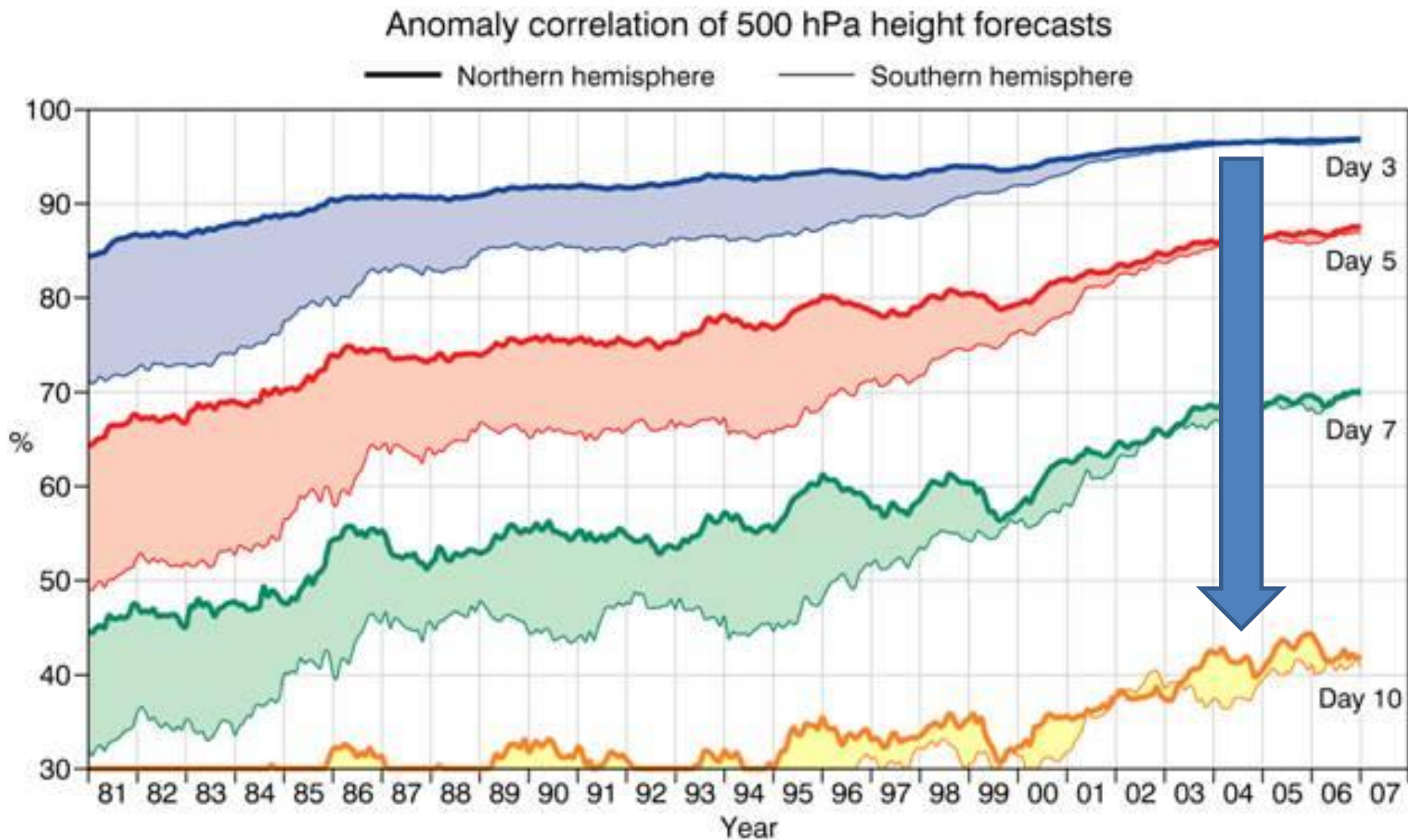
## CCAM Maximum Temperature (C)

Produced by the Climate Studies, Modelling and Environmental Health Group (CSM&EH) of the CSIR.



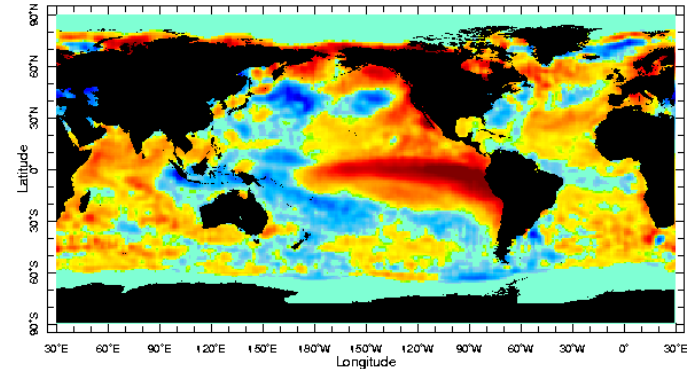


# Typical weather forecast skill



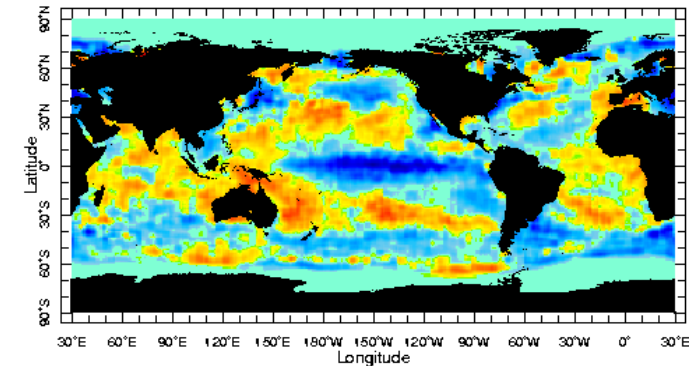
# How is it possible to predict *seasonal climate anomalies*?

Predictions of rainfall, frontal passages, etc. for a particular day at a certain location several months ahead has no usable skill. However, there is some skill in predicting anomalies in the **seasonal average** of the weather. The predictability of seasonal climate anomalies results primarily from the influence of **slowly evolving boundary conditions**, and most notably SSTs (i.e., El Niño and La Niña), on the atmospheric circulation.



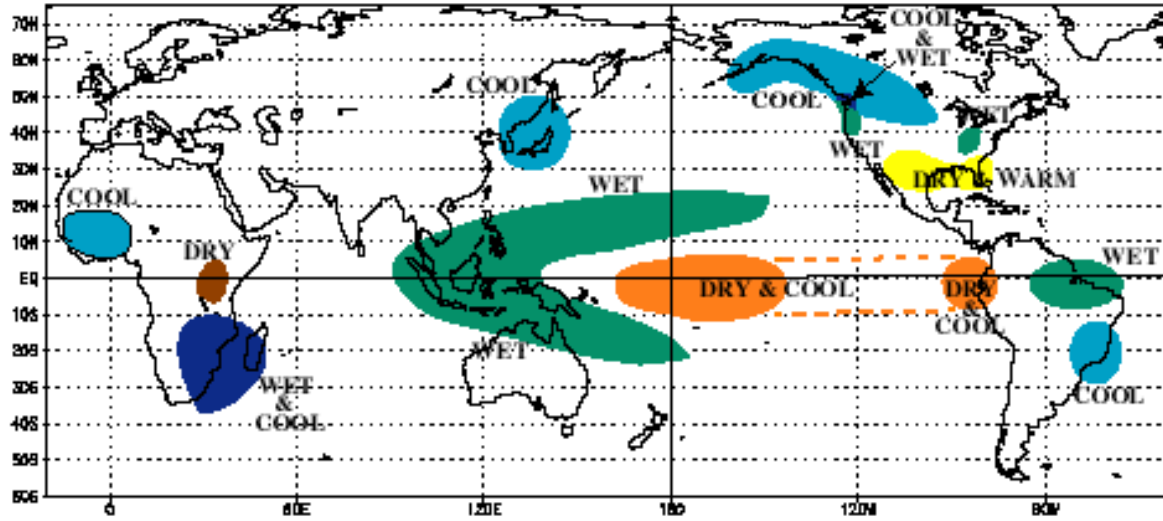
Sea-surface temperature (SST) anomalies of September 1997 (El Niño of 1997/98)

**Anomaly: departure from the mean or average**



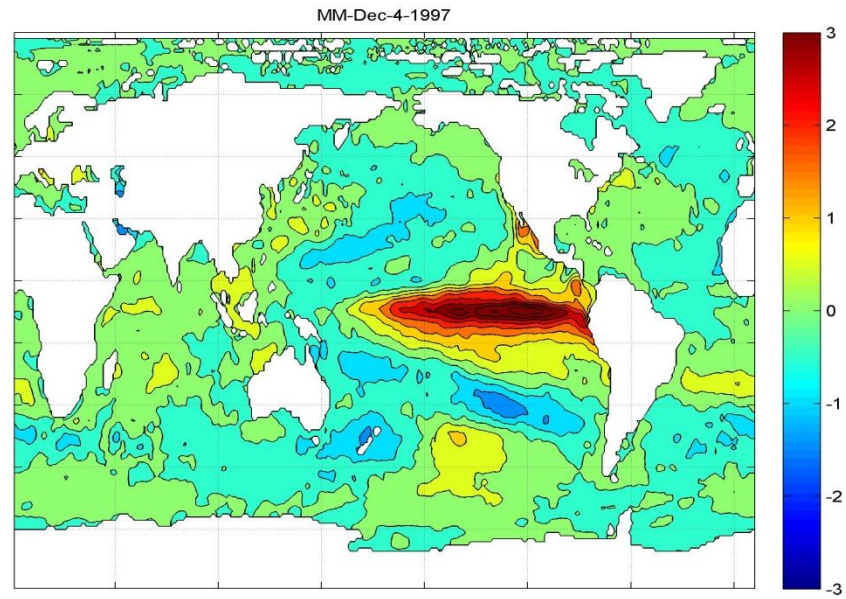
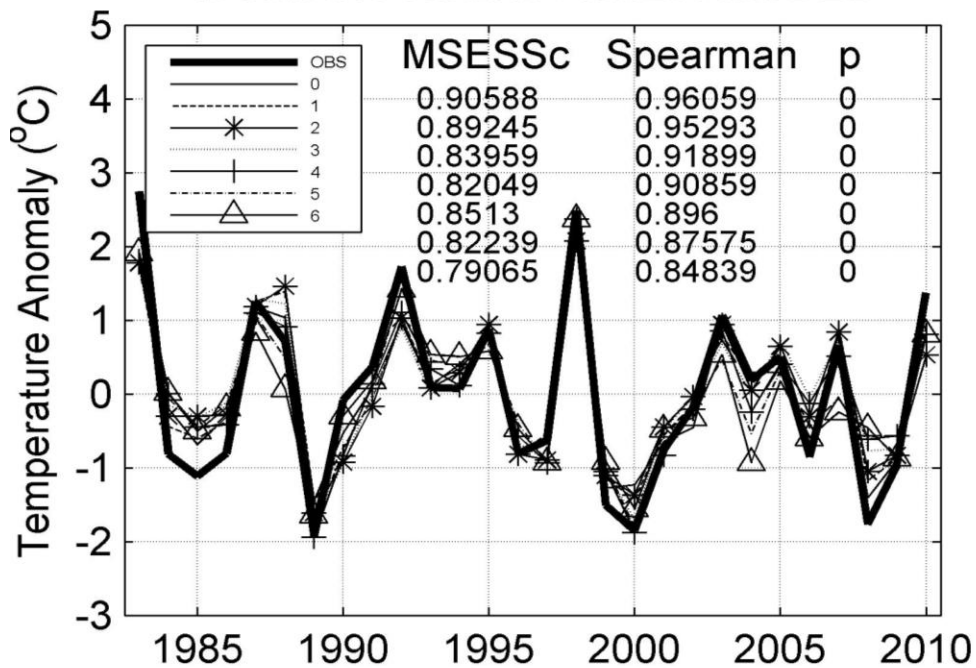
Sea-surface temperature (SST) anomalies of November 1988 (La Niña of 1988/89)

# COLD EPISODE RELATIONSHIPS DECEMBER - FEBRUARY

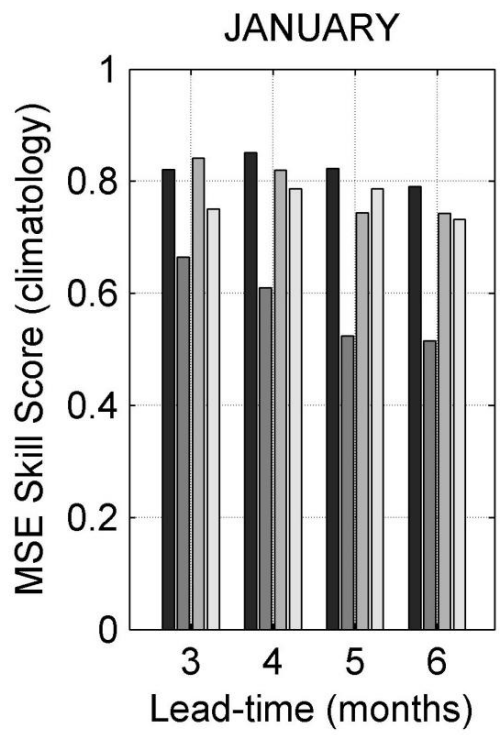
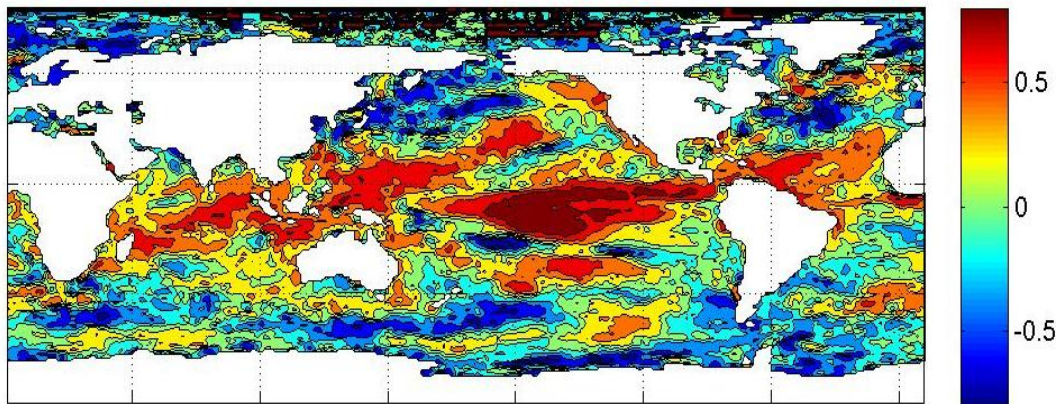




# JANUARY NINO3.4 MULTI-MODEL



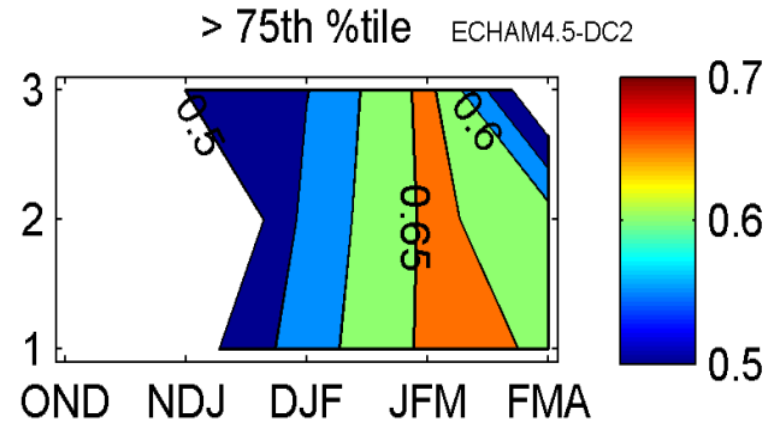
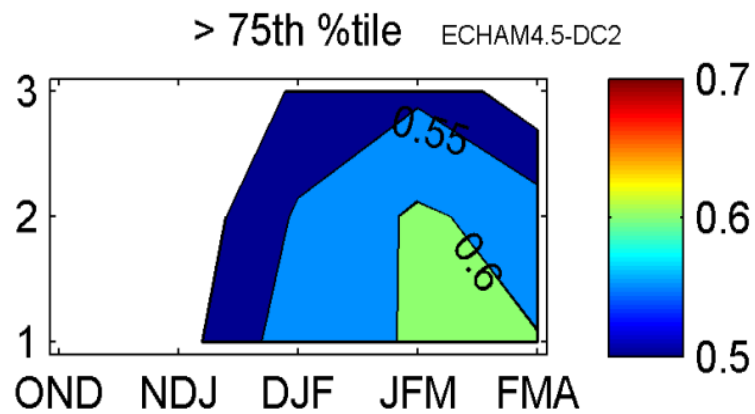
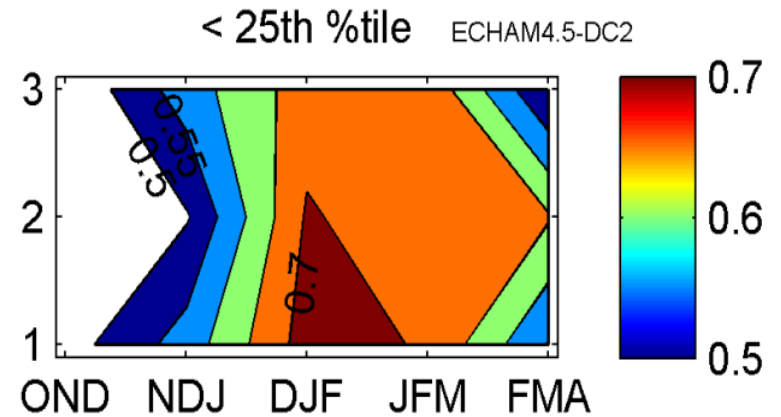
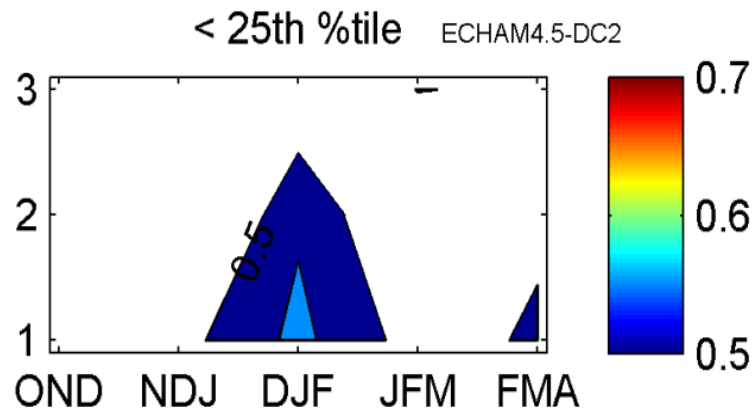
Spearman Rank Correlations (1983-2010) Multi-Model Feb-3



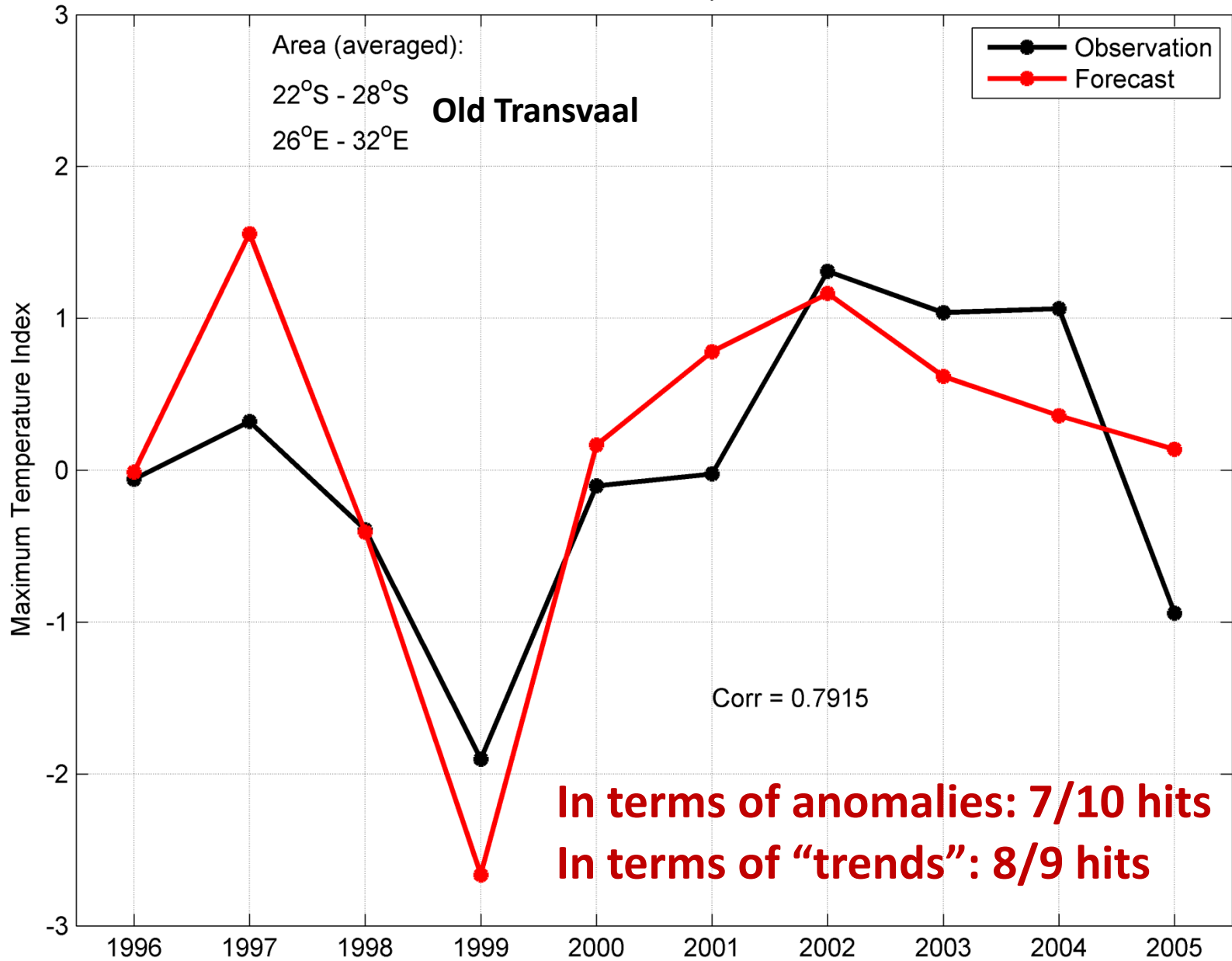
### Minimum temperatures

### ROC Scores

### Maximum temperatures



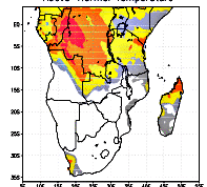
Global Model Hindcasts: End of September for Dec-Jan-Feb



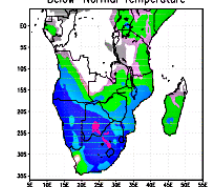


# Seasonal forecast examples: *Issued Nov 2010*

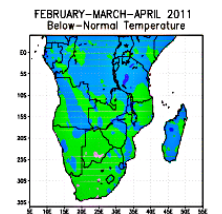
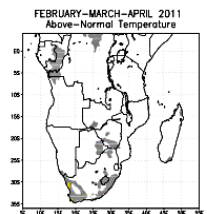
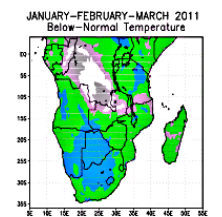
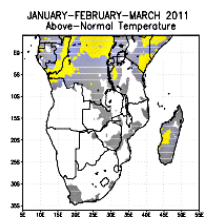
DECEMBER–JANUARY–FEBRUARY 2010/11  
Above-Normal Temperature



DECEMBER–JANUARY–FEBRUARY 2010/11  
Below-Normal Temperature

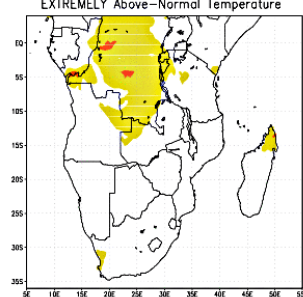


Mean  
temperatures

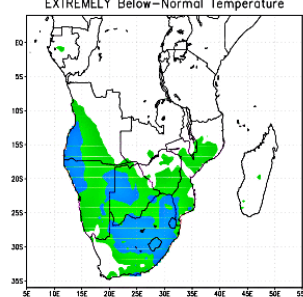


Contributing Agencies:  
CSIR, IRI

DECEMBER–JANUARY–FEBRUARY 2010/11  
EXTREMELY Above-Normal Temperature

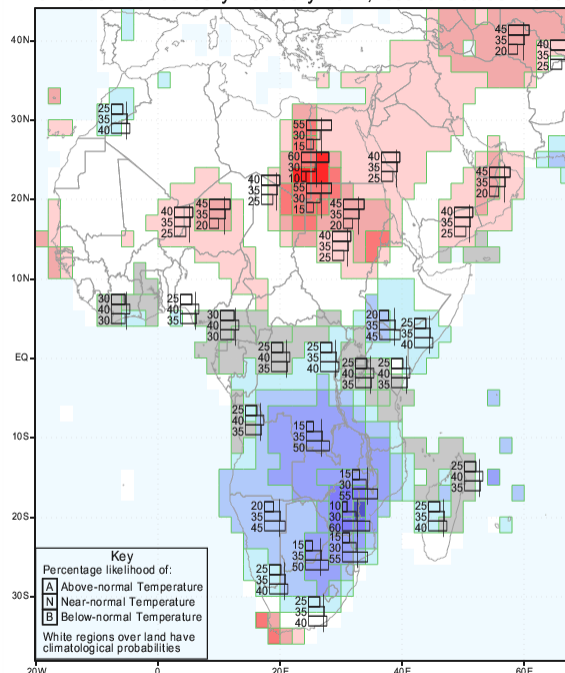


DECEMBER–JANUARY–FEBRUARY 2010/11  
EXTREMELY Below-Normal Temperature



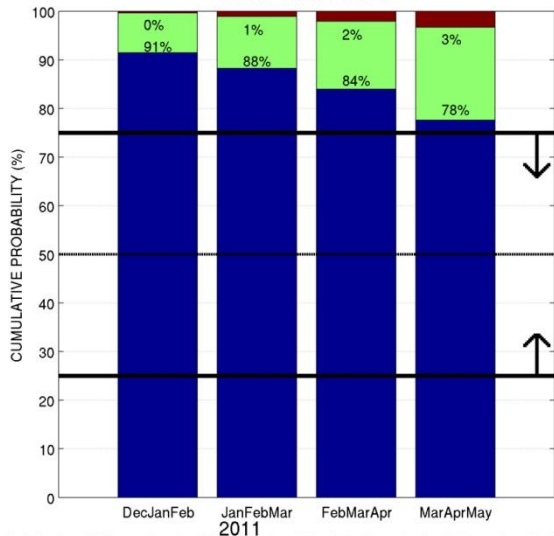
Contributing Agencies:  
CSIR, IRI

IRI Multi-Model Probability Forecast for Temperature  
for December-January-February 2011, Issued October 2010



MULTI-MODEL PROBABILISTIC ENSO FORECASTS (NINO3.4 SST)

ISSUED ON: 09-Nov-2010



CSIR NRE

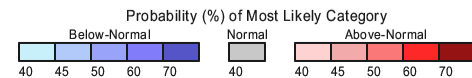
our future through science

Climate Studies & Modelling

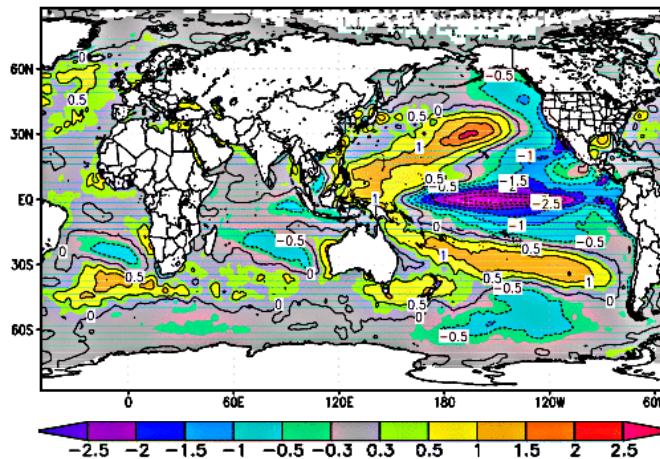
El Nino  
more likely than usual

La Nina  
more likely than usual

Contributing Agency:  
International Research Institute  
for Climate and Society



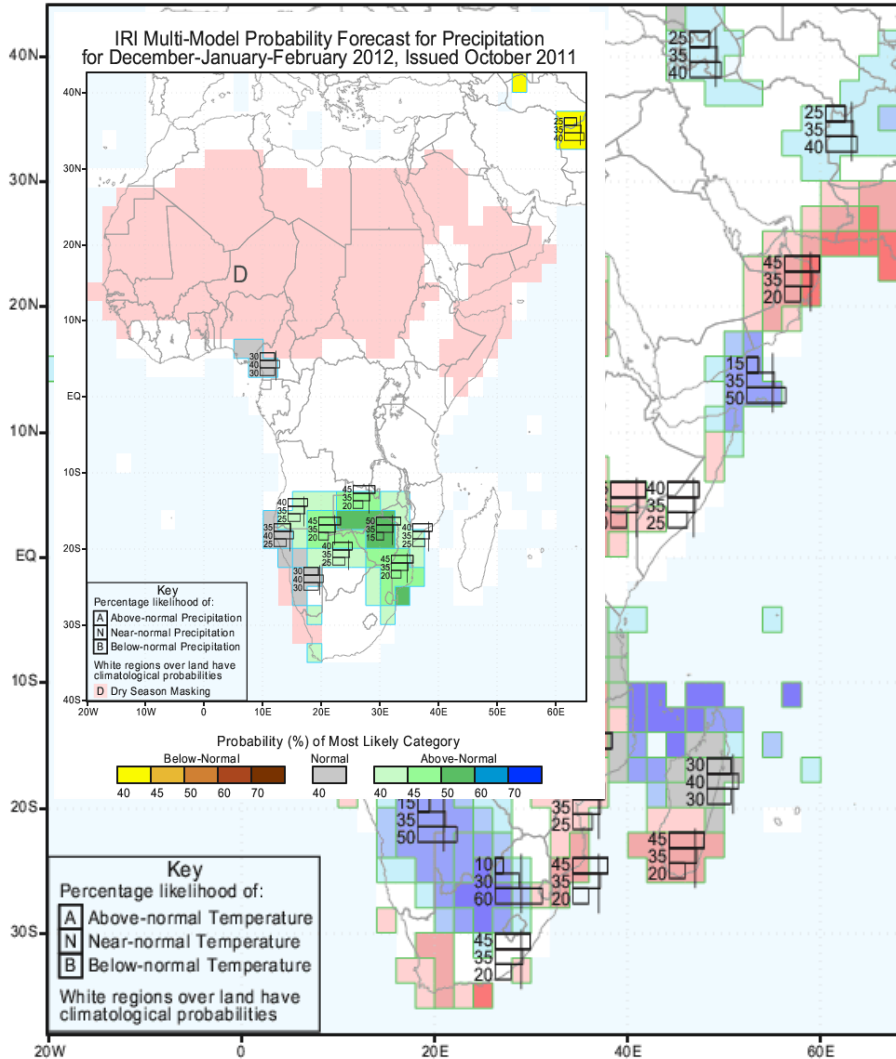
JANUARY–FEBRUARY–MARCH 2011



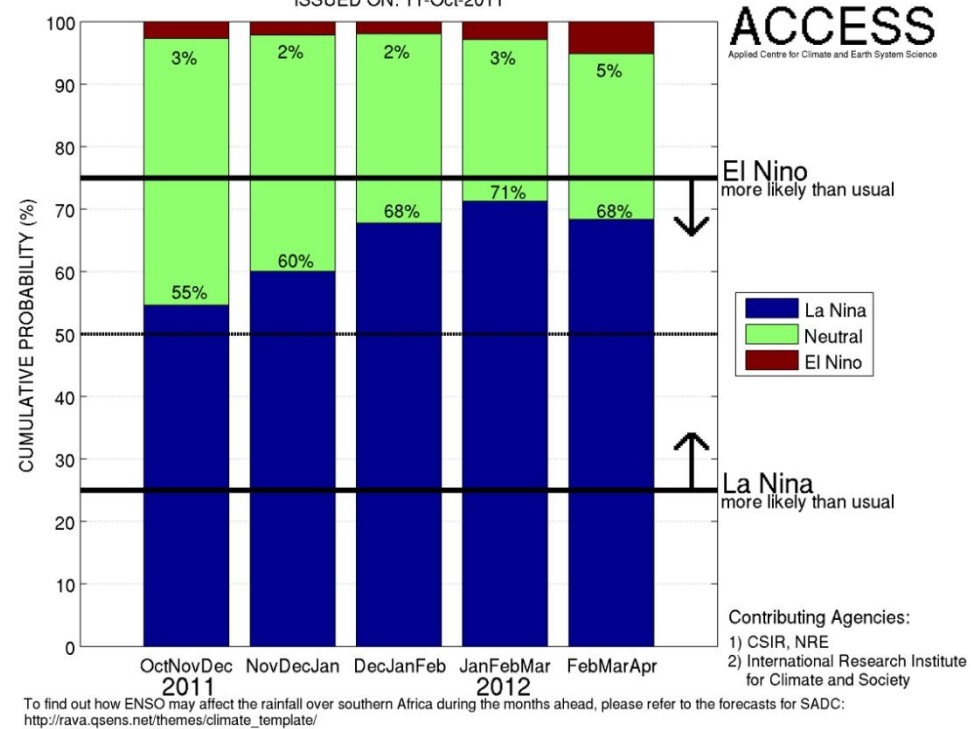
To find out how ENSO may affect the rainfall over southern Africa during the months ahead, please refer to the forecasts for SADC:  
[http://rava.qsensis.net/themes/climate\\_template/](http://rava.qsensis.net/themes/climate_template/)

# Latest seasonal forecasts

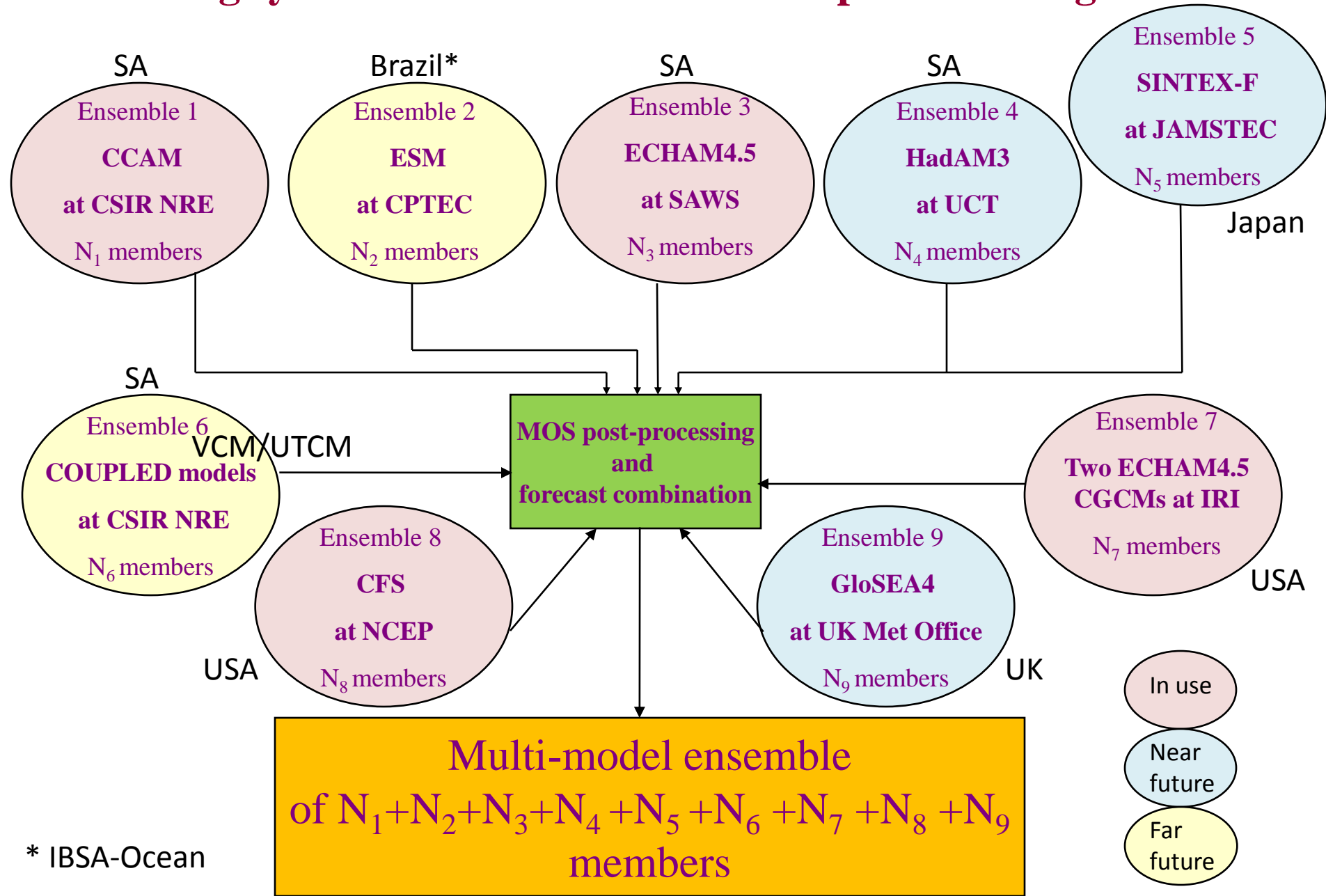
IRI Multi-Model Probability Forecast for Temperature for December-January-February 2012, Issued October 2011



MULTI-MODEL PROBABILISTIC ENSO FORECASTS (NINO3.4 SST)  
ISSUED ON: 11-Oct-2011



# The multi-model seasonal rainfall and surface temperature forecasting system for SADC under development through ACCESS





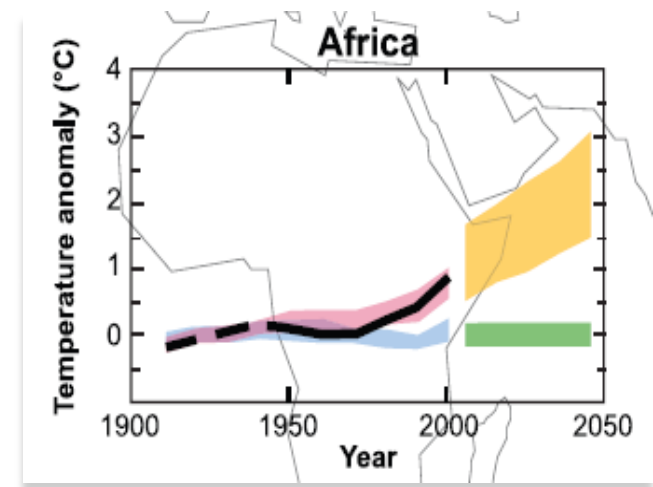
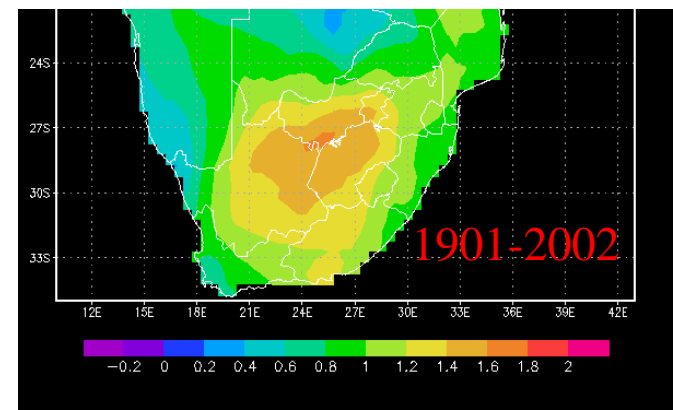
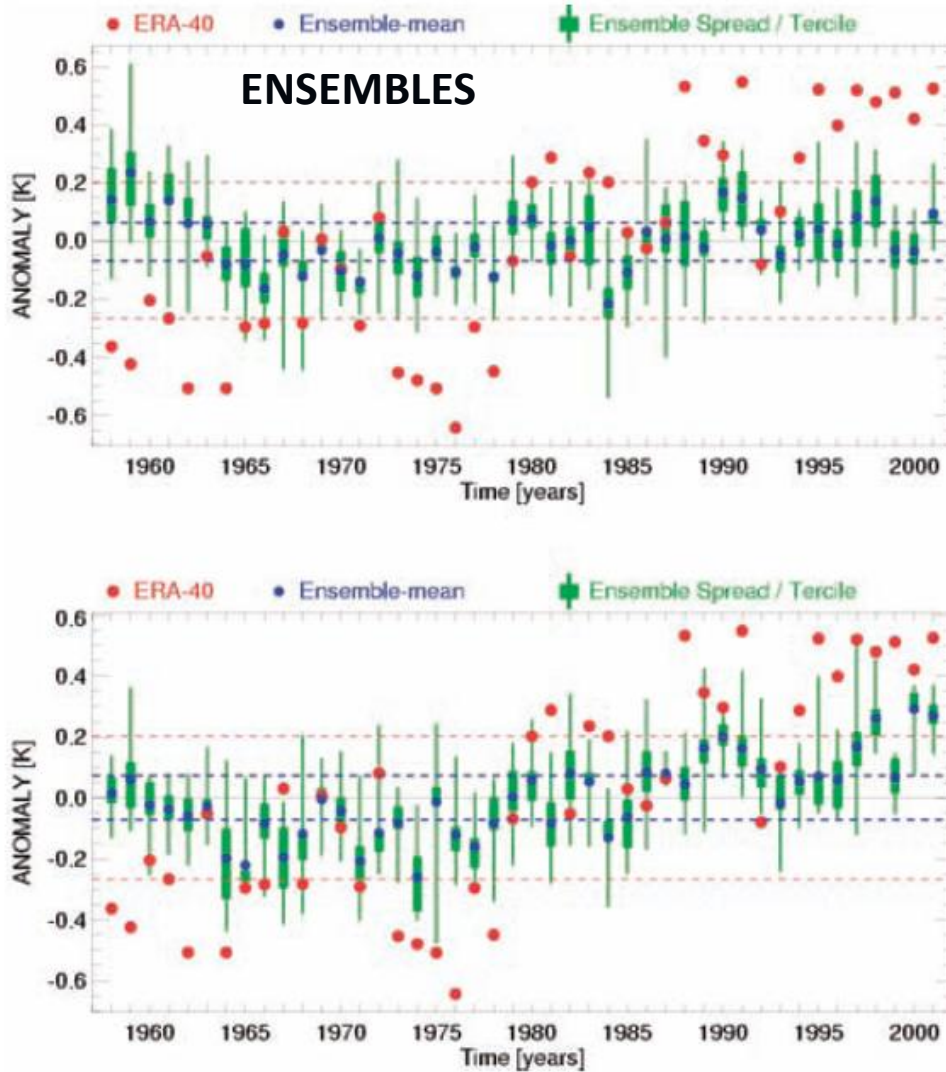


Figure 7.17: ECMWF 3-month lead time hindcasts of global 2 m temperature for August–October without (upper panel) and with (lower panel) time-varying anthropogenic greenhouse gases (GHG). In the upper panel the correlation between the ensemble mean and the observations is only 0.29, whereas this increases to 0.68 with variable GHGs, indicating that including variable greenhouse gas concentrations improves the seasonal forecast/hindcast skill of global mean surface air temperature (after Doblas-Reyes et al., 2006).

Strong anthropogenically forced warming trends have been observed over southern Africa and are projected to continue to rise, consequently justifying the investigation into how the annual update of greenhouse gas (GHG) concentrations in a global model may affect seasonal forecast performance over the region.

# Summary

- South African modellers have developed the capacity to predict temperatures and their extremes for weather and for seasonal time scales
  - The recent heat wave was captured successfully by forecast models
  - Last summer season's cool temperatures too
- Seasonal forecasts are only really useful for summer months, while weather forecasts are skilful throughout the year
- More modelling work is required to further improve on forecast performance (including lead-time and skill)