Severe Weather Forecasting Demonstration Project: Seasonal Forecasting: Using Global Climate Models

South African Weather Service:
Long-Range Forecasting Group

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Introduction

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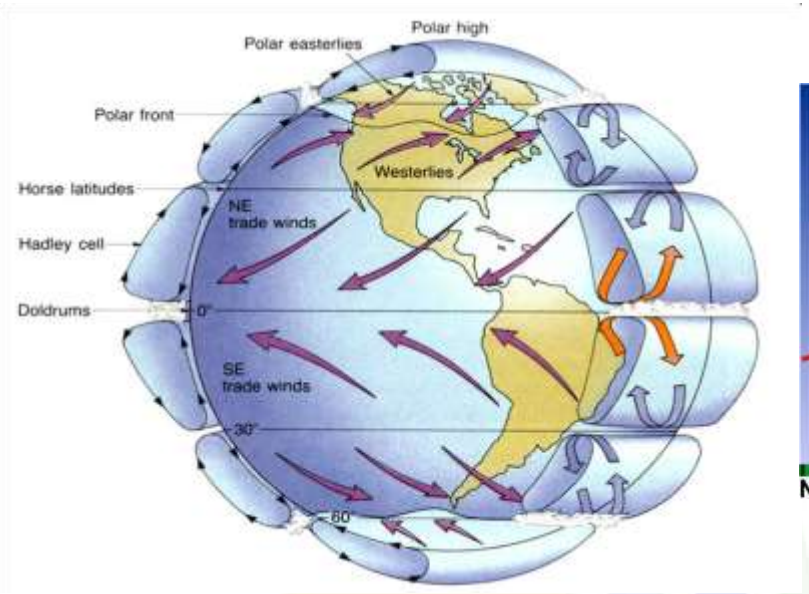
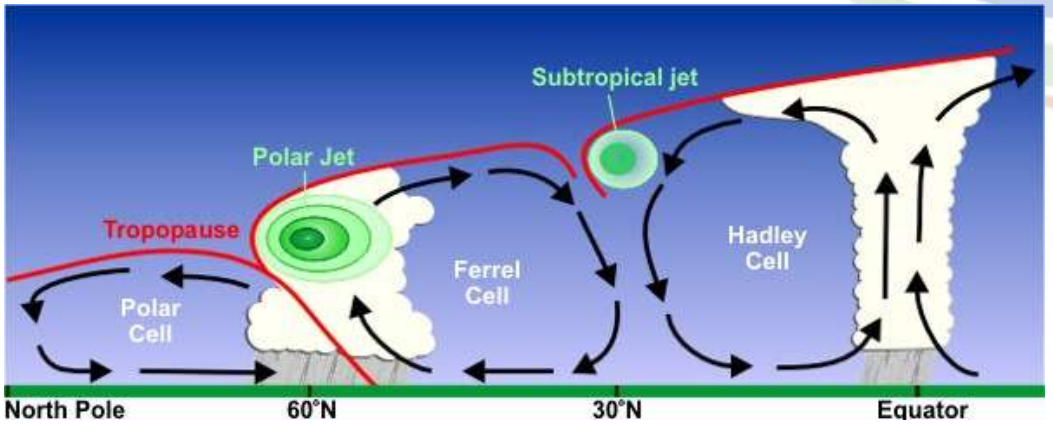
Introduction: Atmospheric General Circulation Model





Atmospheric Circulation is large-scale movement of mass and energy and triggered by thermal gradient
Hadley cell: circular motion of air masses toward poles at tropopause (trough; ITCZ) and toward equator at the surface (trade winds) characterized by rising unstable warm and moist air and subsiding dry air (ridge).
Ferrell cell: eddy-driven mid-latitude circulation though not closed cell (causes upper and low level westerlies) with no strong source heat, cold sink . The course of westerlies is easily overridden by moving weather system
Polar cell: circular motion driven by thermal gradient; Polar easterlies are the result of this cell and Corolis effect.

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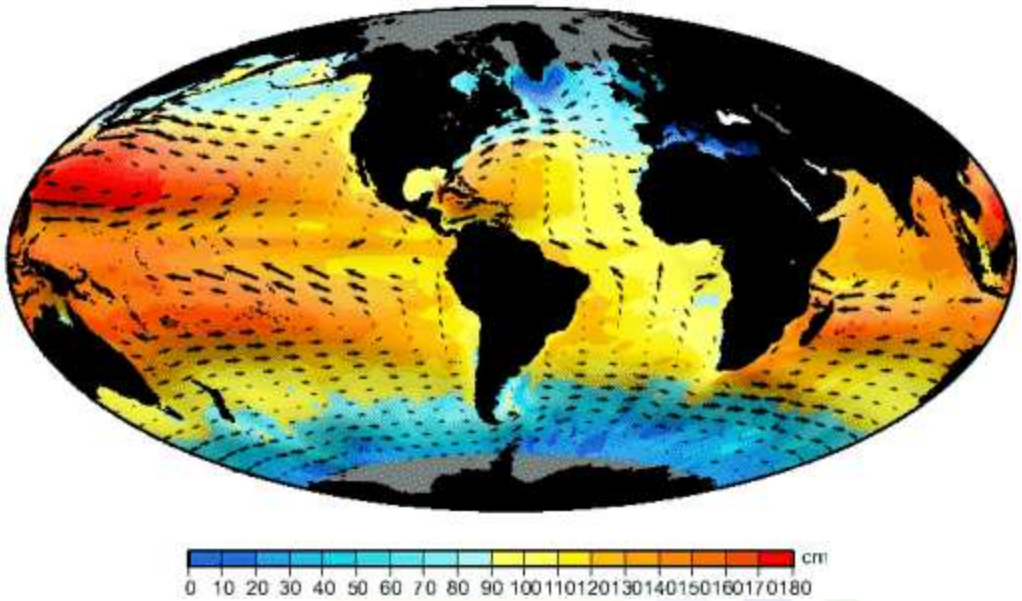
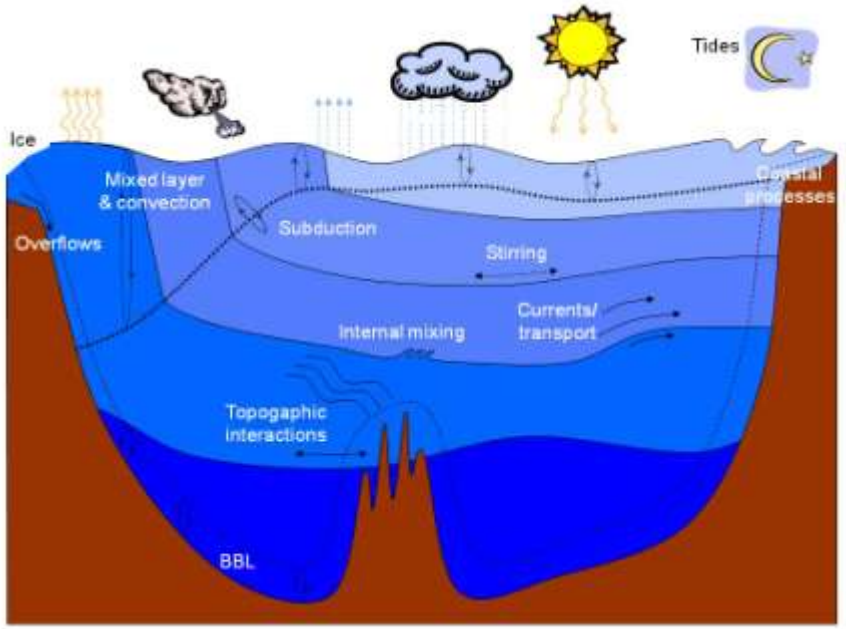
Introduction: Oceanic General Circulation Model





Numerical ocean models approximate the real ocean by dividing the global ocean into finite sized grid boxes, and representing the exchange of ocean tracers and momentum between these boxes using the equations for fluid flow on a rotating sphere

While ocean models start with the same continuous equations, the discrete equations possess important distinctions that play a role in the simulation features. Different parts of the ocean are most naturally represented using different coordinate systems. Level-coordinate models consider each box is at the same level. These models are relatively easy to code and have been the basis for ocean climate modeling since the 1960s. Such models may also have particular advantages in representing the transition between the poorly stratified mixed layer and the interior ocean where flow is predominantly along density surfaces. In contrast, isopycnal models handle the interior ocean more naturally.

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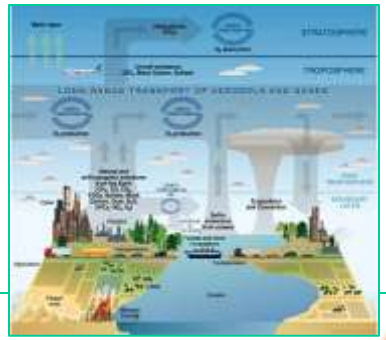
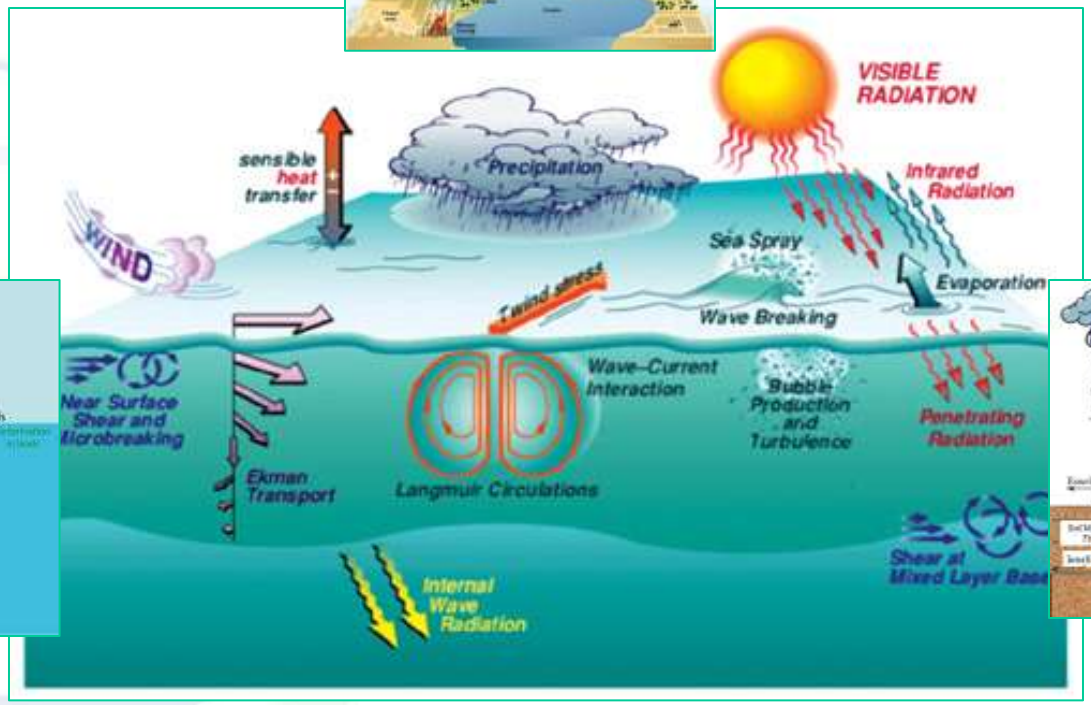
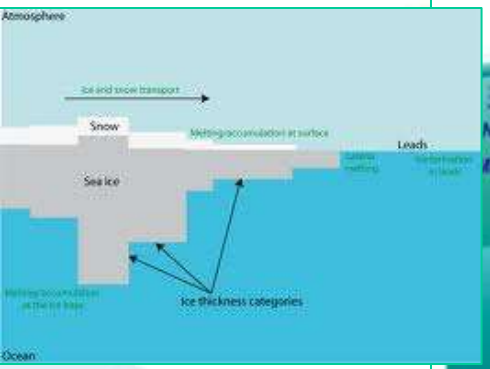
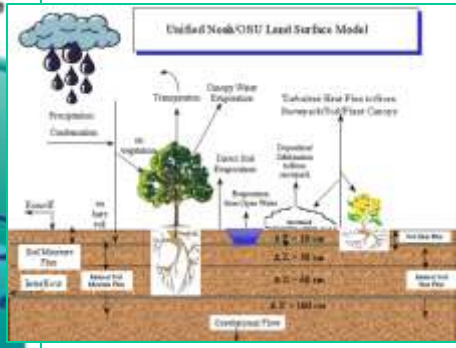
Introduction: Coupled General Circulation Model









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Products and Interpretation

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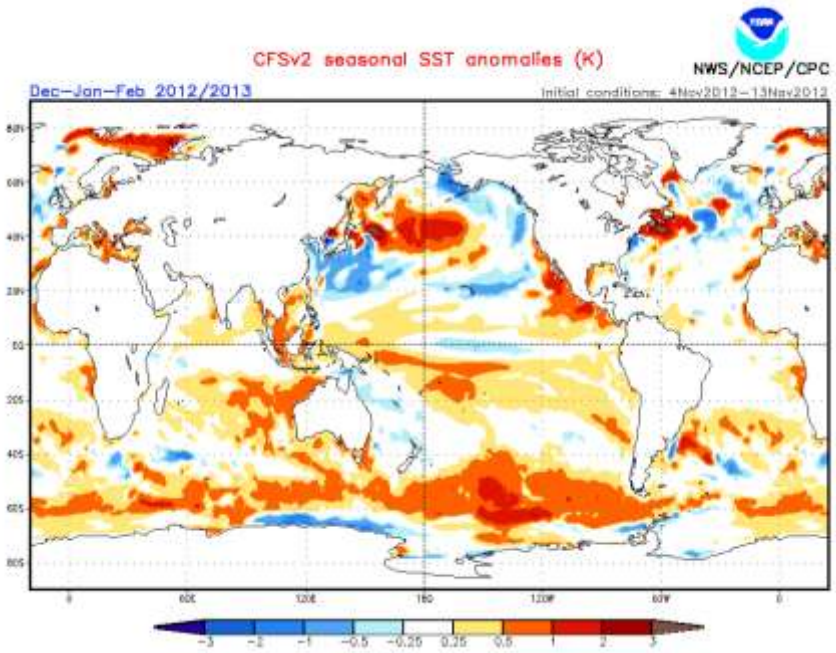
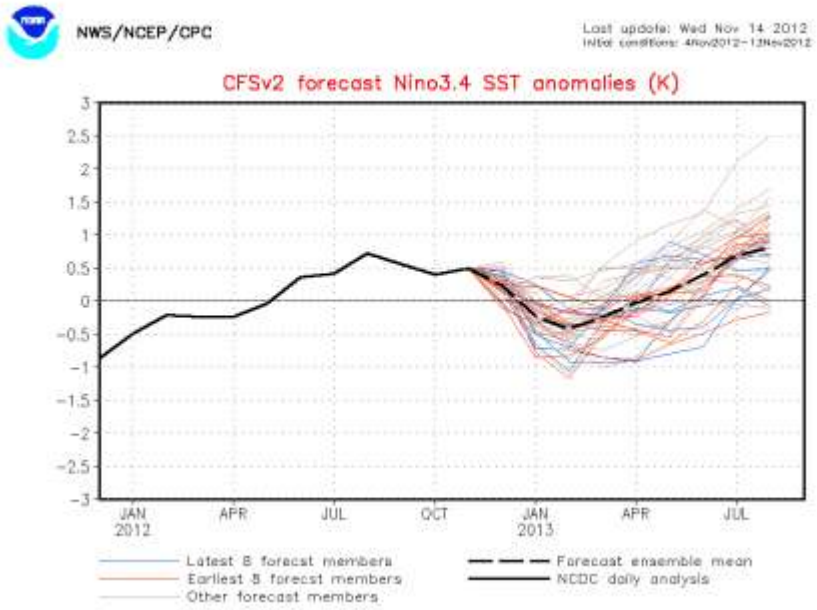
Products and Interpretation: Sea Surface Temperature





SST' are generally given in Anomaly forecasts for the globe as well as specific basins of interest for example the Nino3.4 region in the equatorial pacific. SST's are generally very predictable at seasonal time scales even deterministically (anomalies).

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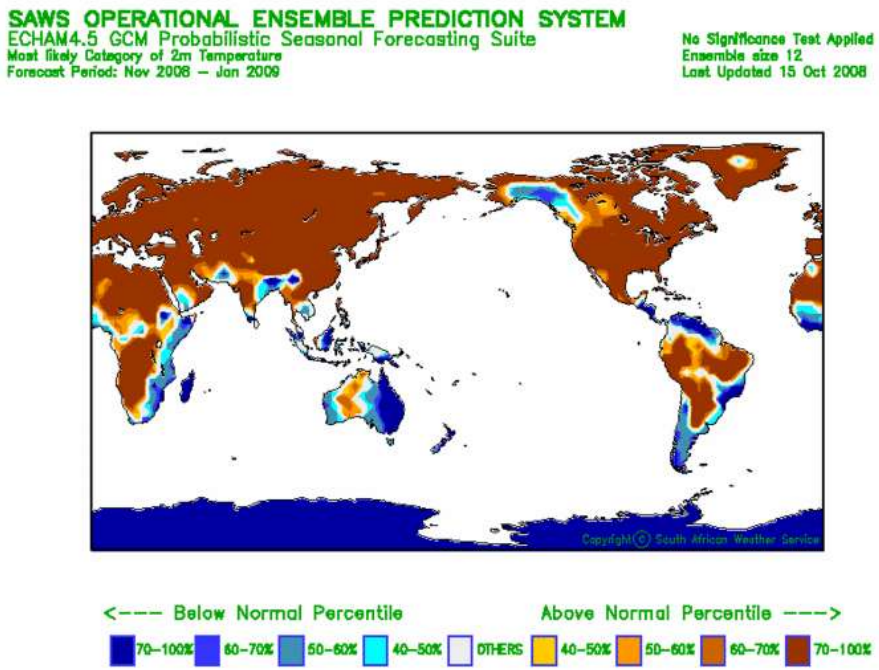
Products and Interpretation: 2m Temperature



2m Average Seasonal Temperature is usually presented as probabilistic forecasts due to relatively large uncertainties as a result of large variability in the climate system

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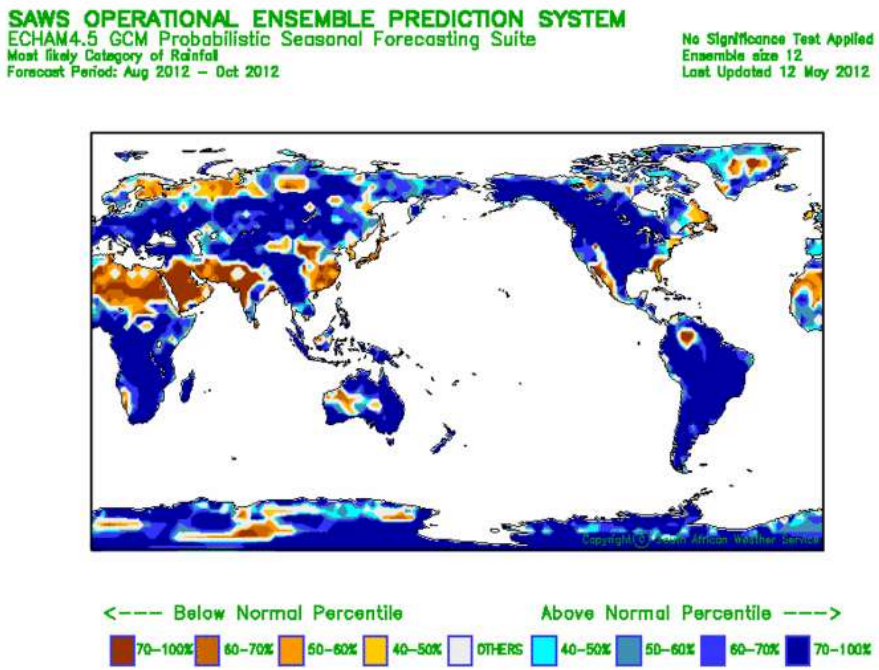
Products and Interpretation: Precipitation



Precipitation products is generally also given as probabilistic forecasts as there is also generally a massive uncertainty envelope (more than temperature) and its complex nature.

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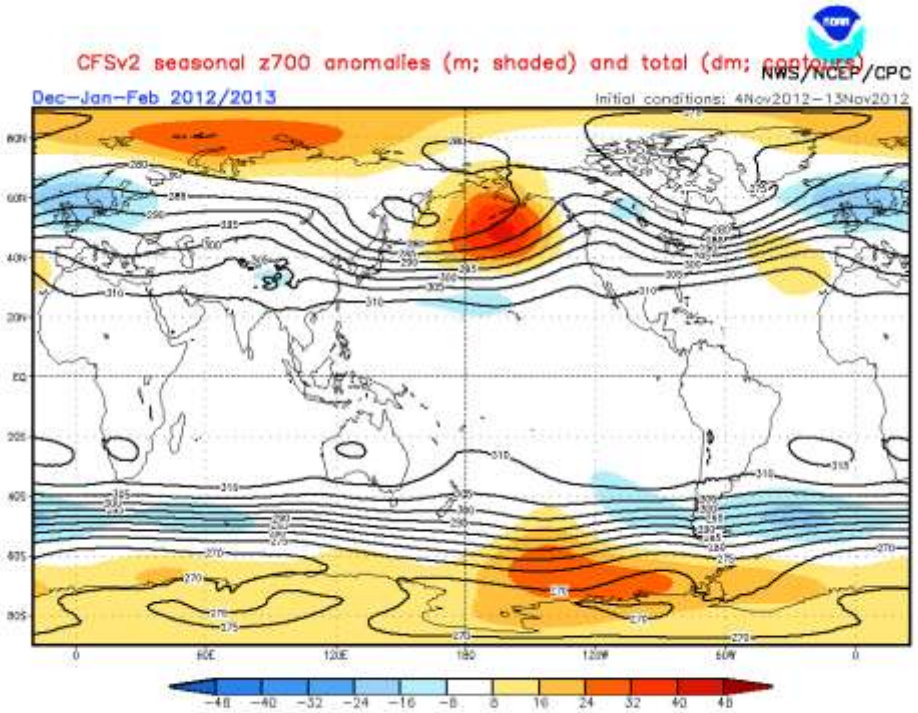
Products and Interpretation: Upper Air Circulation



Upper air variables are generally used for more specialized applications such as additional information for confidence in precipitation and temperature forecasts and for input to various downscaling techniques. Upper air variables are also more predictable than surface variables.

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Performance

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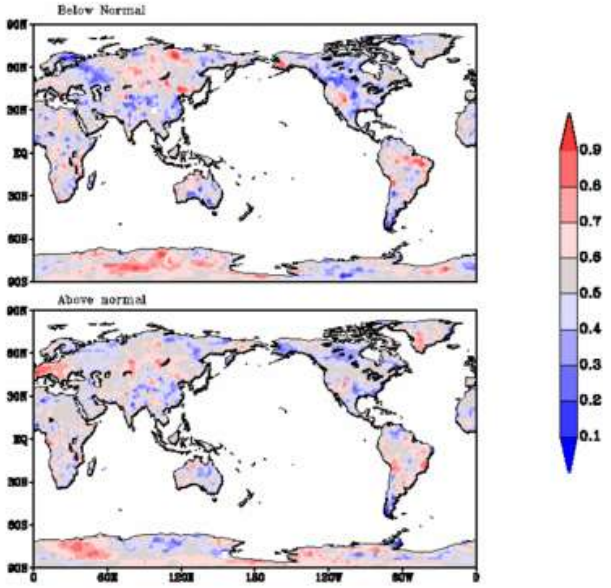
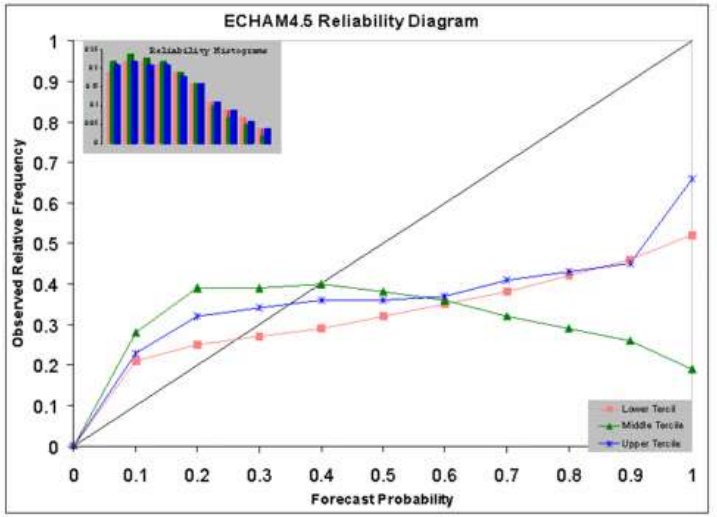
Performance: Atmospheric General Circulation Model





Two Main verification methods are used for Long-Range Forecasting namely, Relative Operating Characteristic (ROC) and the Reliability Diagrams. There is however a large variety of skill scores that would each indicate something unique about the performance of the forecasting system.

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Downscaling

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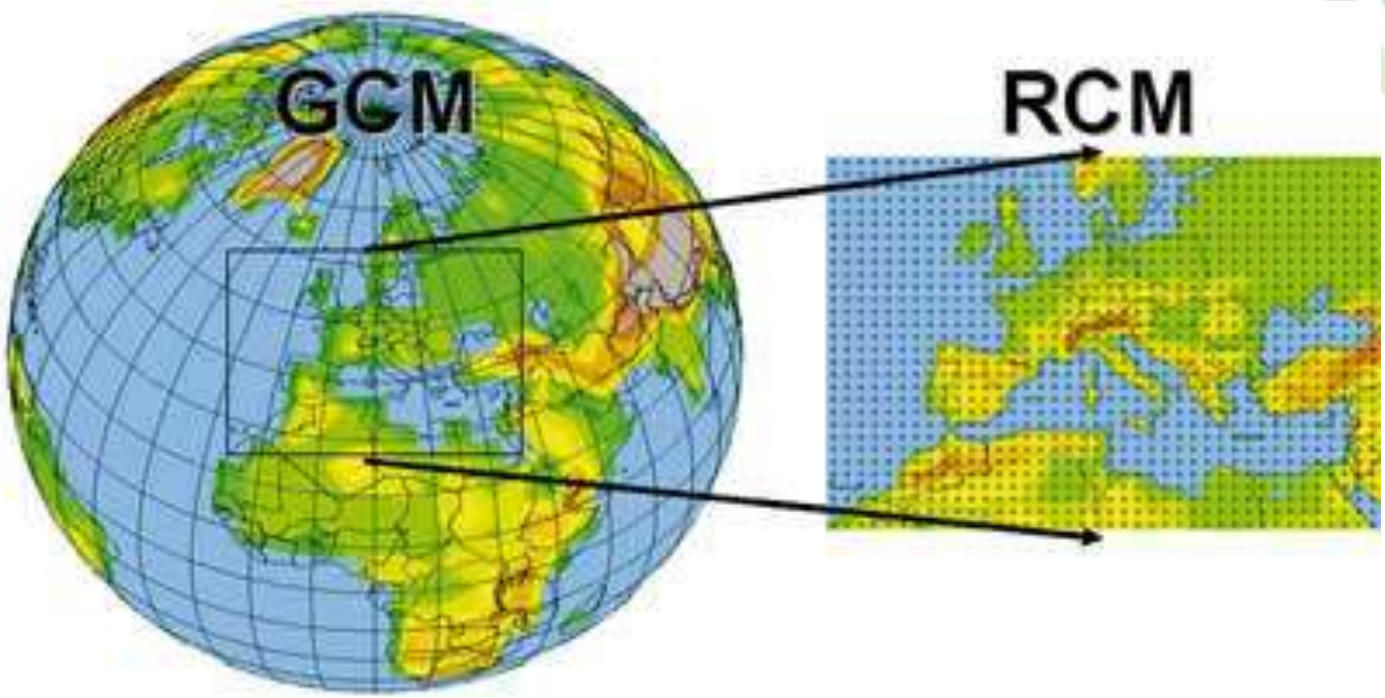
Downscaling: Dynamical



GCM data is provided at a course resolution to the Regional model, where most of the dynamics is again applied in the regional model with higher resolution terrain, land use, etc.

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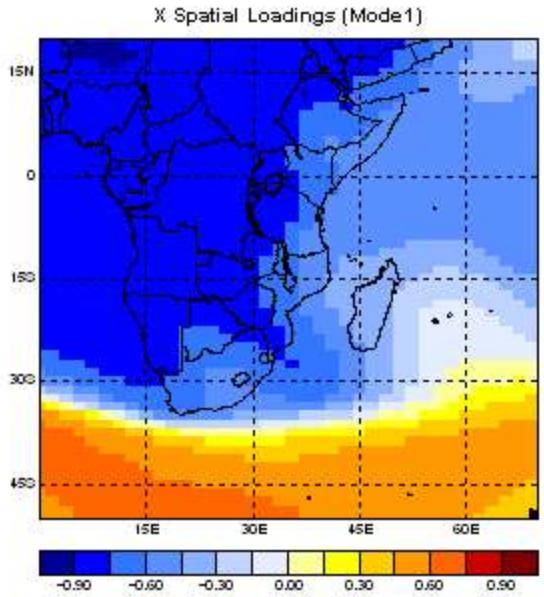
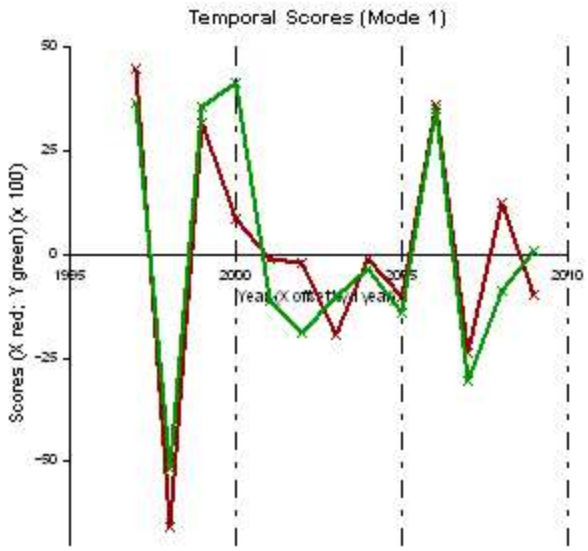
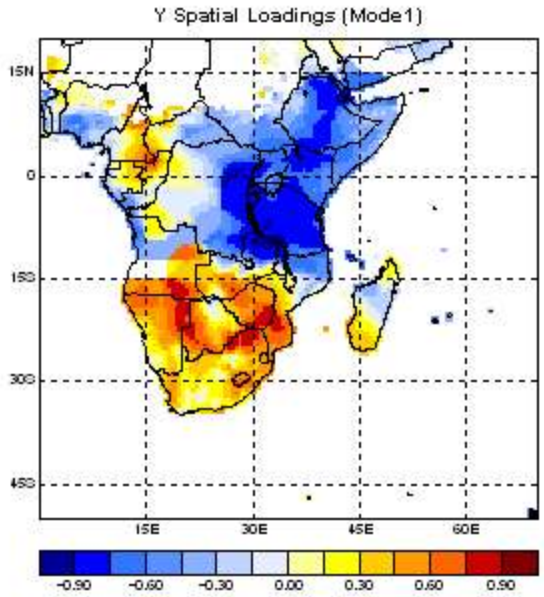
Downscaling: Statistical – Methods (1)







GCM data is used to statistically determine the relationship between the predictor (GCM data) and the predictand (Observed Rainfall/Temperature), through a Canonical Correlation Analysis (CCA)

Important note for downscaling is that the verification of the GCM does not apply to the downscaled results. A new set of verification statistics needs to be calculated for the new system.

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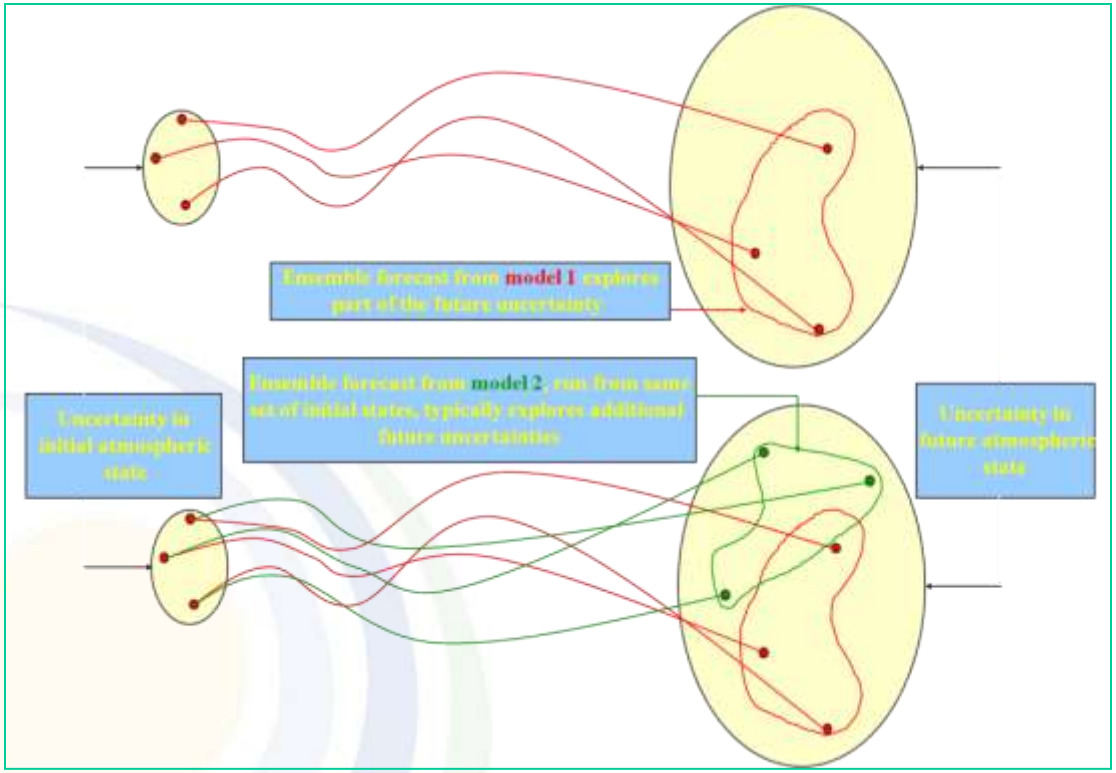
Downscaling: Statistical – Methods (2)



Due to the uncertainties from any one model simulation, it is necessary to have multiple model realizations in order to fully capture the possible outcomes for a specific forecast period

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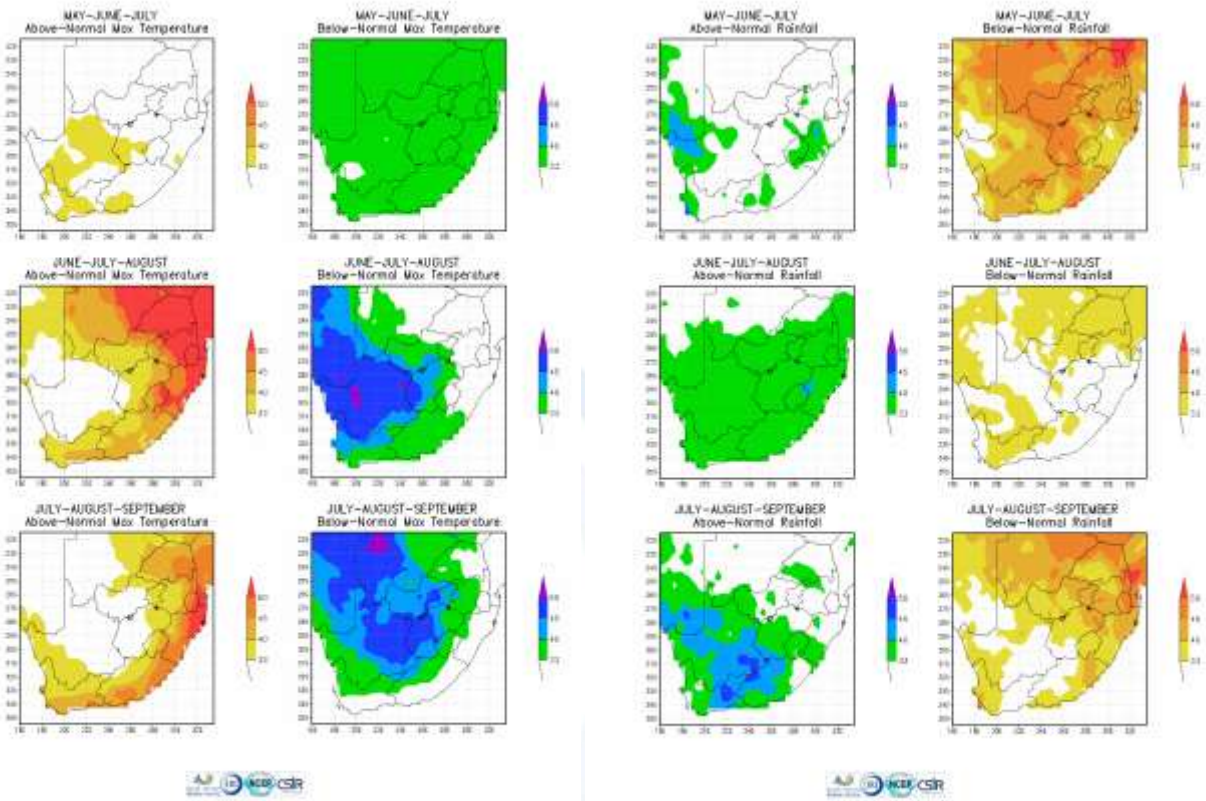
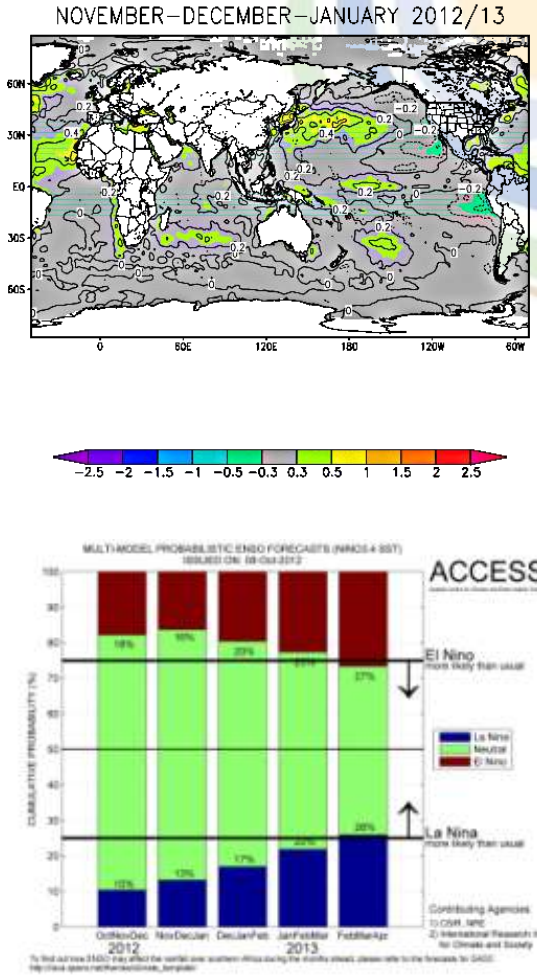
Downscaling: Statistical – MMS Products





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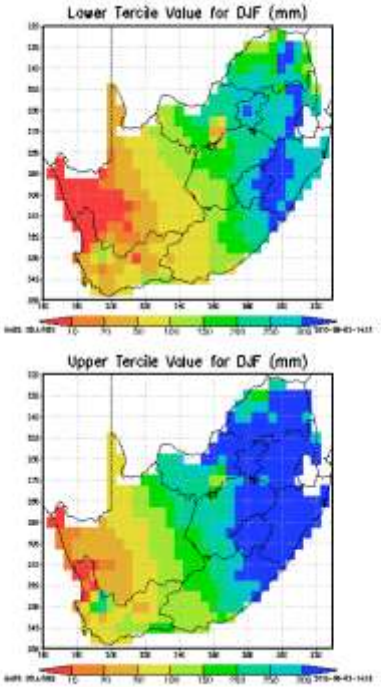
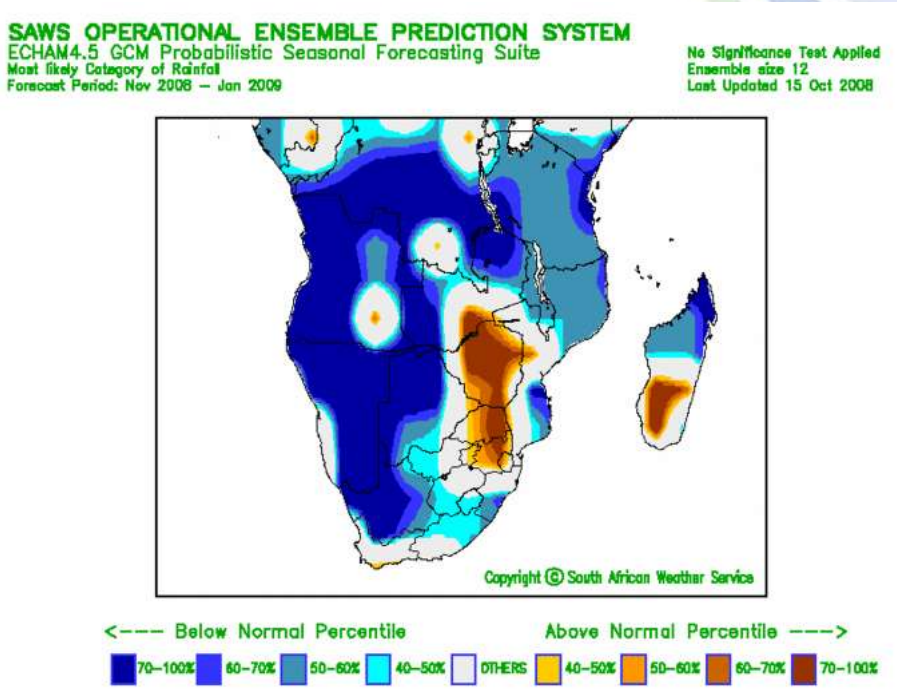
Downscaling: Statistical - Interpretation

Observed and Forecast Categories





Seasonal Forecasting mainly forecasts the departure from the climate conditions in three equi-probable categories. This implies that to use the forecast effectively one needs to know what is meant by the Below-, Near- and Above-normal categories.

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International Global Seasonal Forecasts

SAWS and GPC Pretoria

Climate Forecast System (CFS) – NCEP

International Research Institute (IRI)

EUROSIP – ECMWF/UK Met Office/Meteo France

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