Seasonal forecasts

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https://tinyurl.com/ybrb3a72

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NMME The North American Multi-Model Ensemble

Seasonal Forecast Worx

Latest Update: 12 October 2021

- The seasonal forecasts presented here by **Seasonal Forecast Worx** are based on forecast output of the coupled ocean-atmosphere models administered through the North American Multi-Model Ensemble (NMME) prediction experiment (http://www.cpc.ncep.noaa.gov/products/NMME/; Kirtman et al. 2014). NMME real-time seasonal forecast and hindcast (re-forecast) data are obtained from the data library (http://iridl.ldeo.columbia.edu/) of the International Research Institute for Climate and Society (IRI; http://iri.columbia.edu/).
- NMME forecasts are routinely produced and are statistically improved and tailored for southern Africa and for global sea-surface temperatures by employees and post-graduate students in the Department of Geography, Geoinformatics and Meteorology at the University of Pretoria (http://www.up.ac.za/en/geography-geoinformatics-and-meteorology/). Statistical post-processing is performed with the CPT software (http://iri.columbia.edu/our-expertise/climate/tools/cpt/).
- Why do we apply statistical methods to climate model forecasts?

  "…statistical correction methods treating individual locations (e.g. multiple regression or principal component regression) may be recommended for today's coupled climate model forecasts". (Barnston and Tippett, 2017).
- Why do we not use just a single model in our forecasts?

  "…multi-model forecasts outperform the single model forecasts…" (Landman and Beraki, 2012).

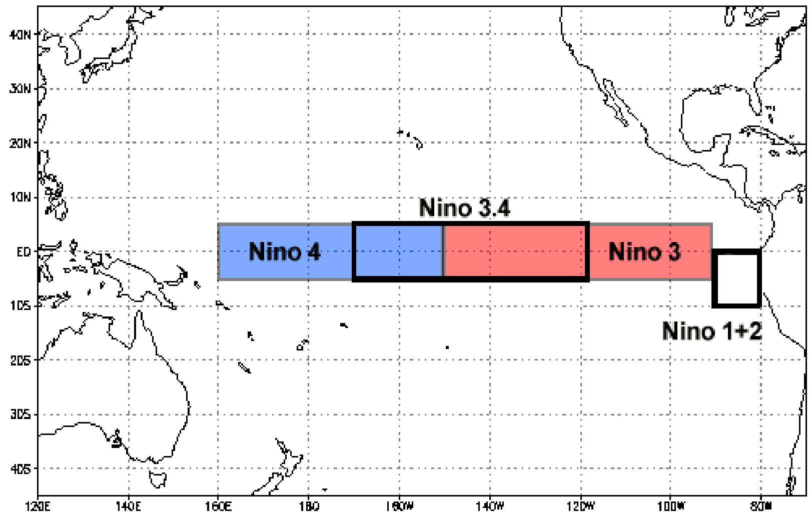
- For the official seasonal forecast for South Africa, visit the South African Weather Service website at http://www.weathersa.co.za/images/data/longrange/gfcsa/scw.pdf

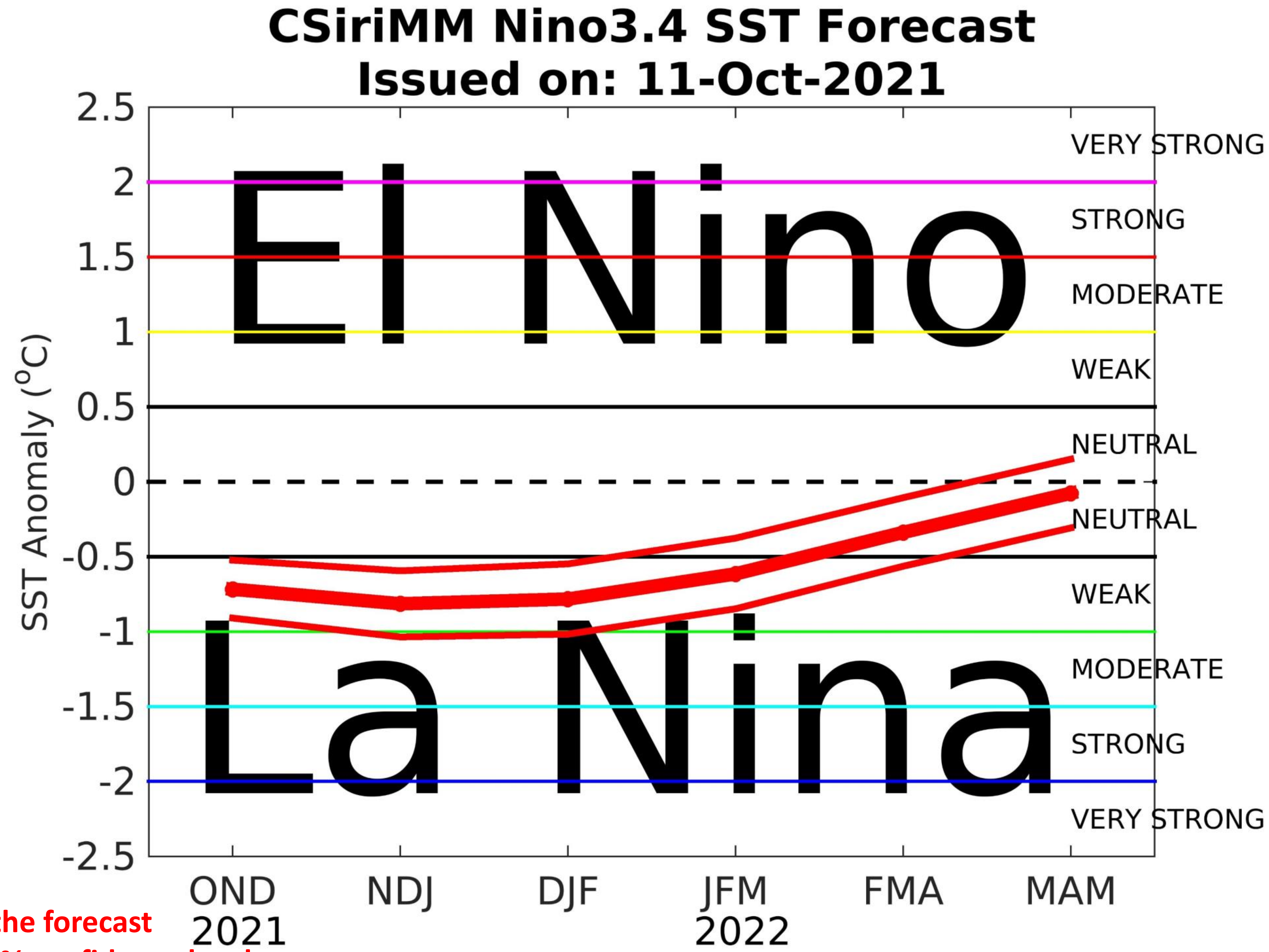
South African Weather Service

ENSO and Global SST Forecasts

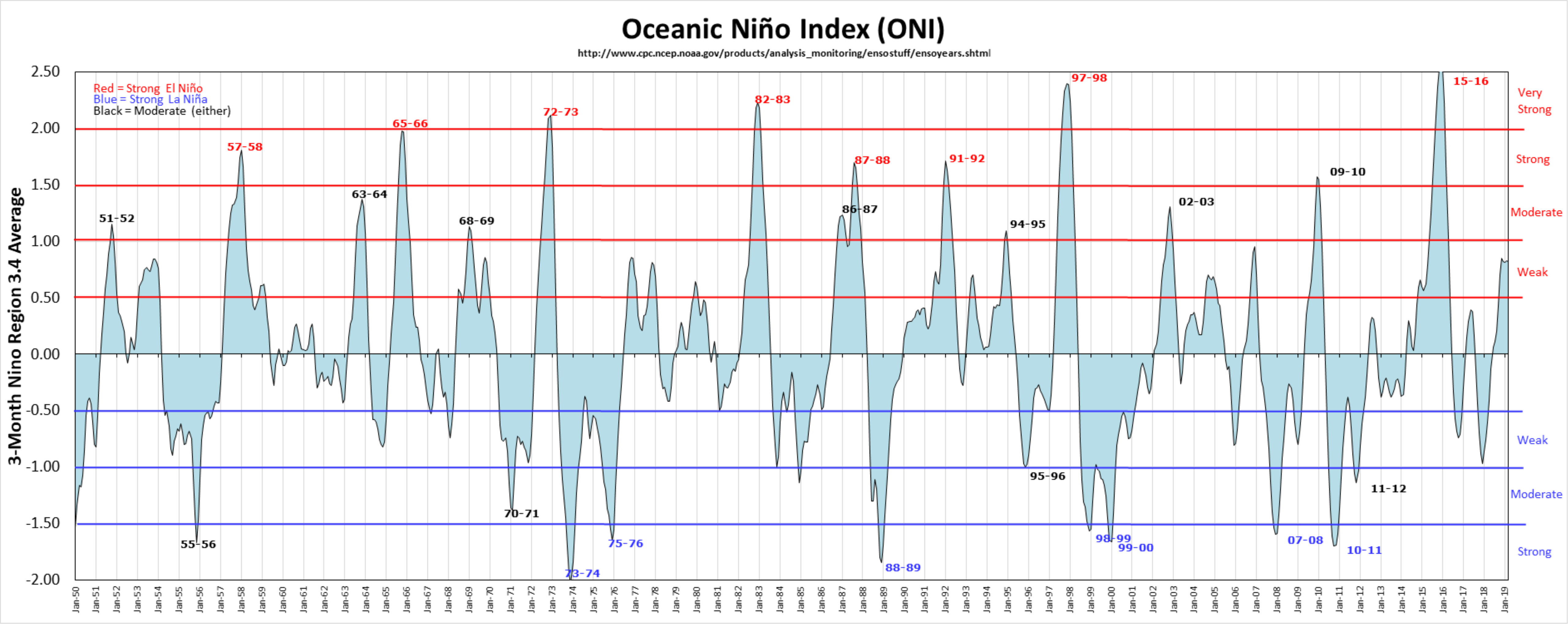
Prediction Method

- Forecasts for global sea-surface temperature (SST) fields are obtained through a combination of NMME models and a linear statistical model, that uses antecedent SST as a predictor (Landman et al. 2011). Forecasts for the Niño3.4 area (see insert) are derived from the global forecasts.
- SST forecasts from the NMME models are variance and bias corrected.
- Three-month Niño3.4 SST forecasts are produced for three categories:
  - **El Niño:** SST above the 75th percentile
  - **La Niña:** SST below the 25th percentile
  - **Neutral:** Neither El Niño nor La Niña





Middle red line: the forecast
Thin red lines: 25% confidence levels


Oceanic Niño Index (ONI)
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml
Red = Strong El Niño
Blue = Strong La Niña
Black = Moderate (either)
3-Month Nino Region 3.4 Average
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
Very Strong
Strong
Moderate
Weak
Weak
Moderate
Strong
51-52
55-56
57-58
63-64
65-66
68-69
70-71
72-73
73-74
75-76
82-83
86-87
87-88
88-89
91-92
94-95
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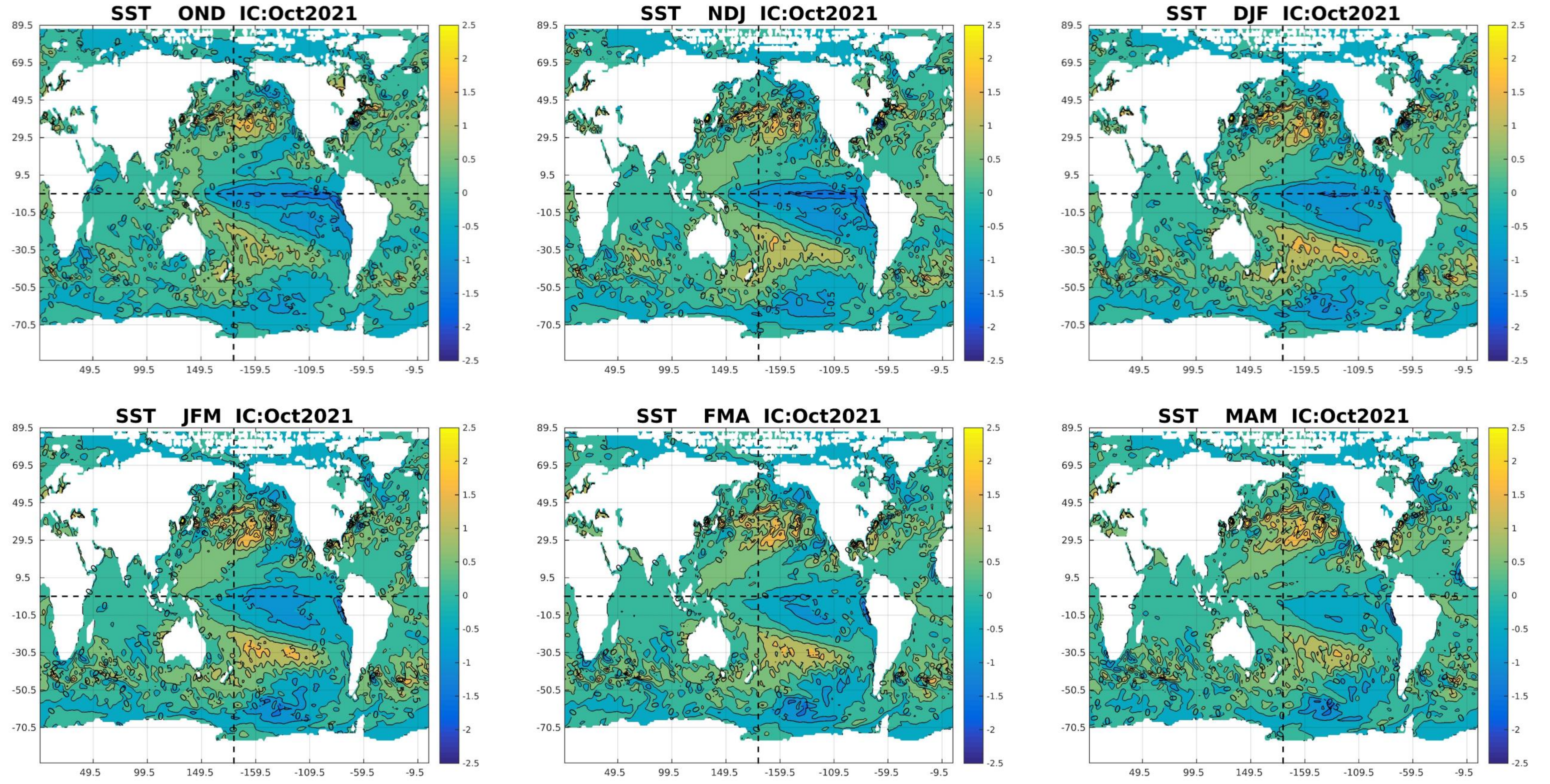
Jan-19

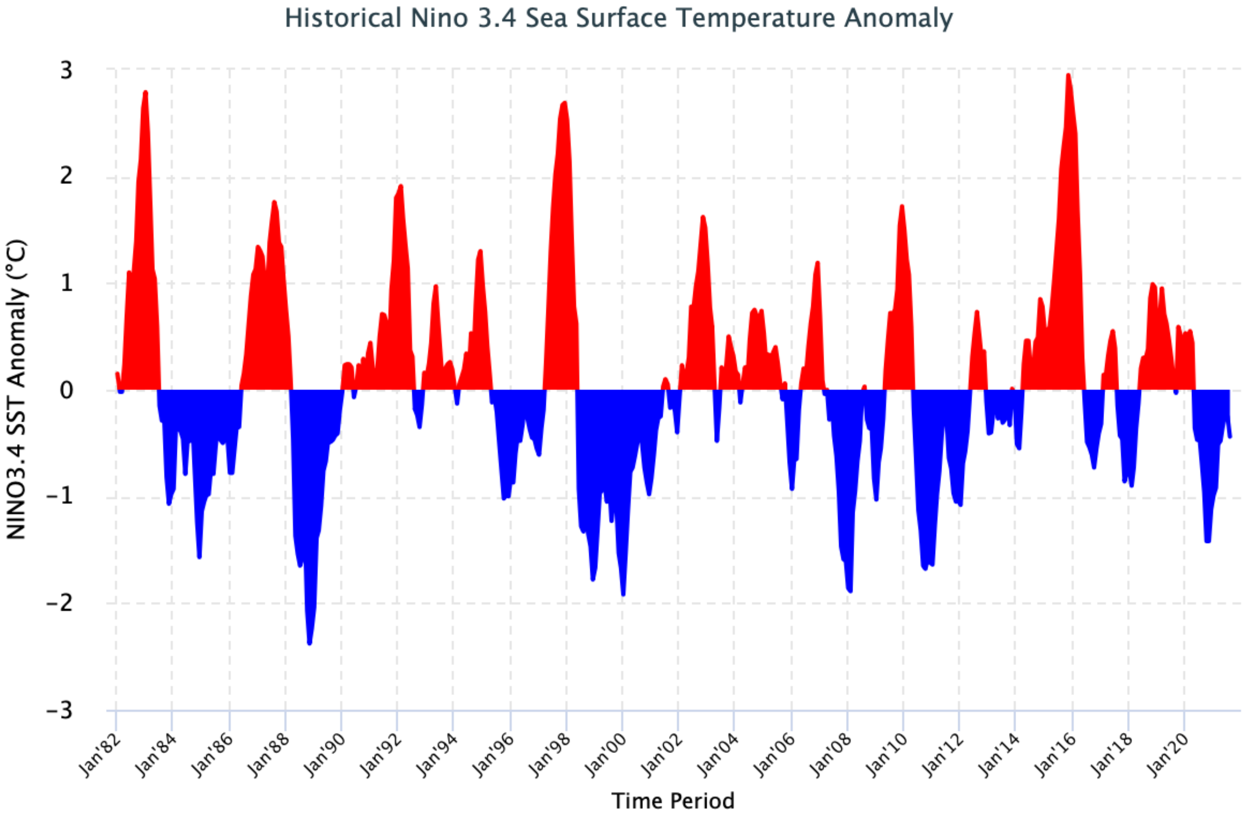
IC: the month in which the forecast was made

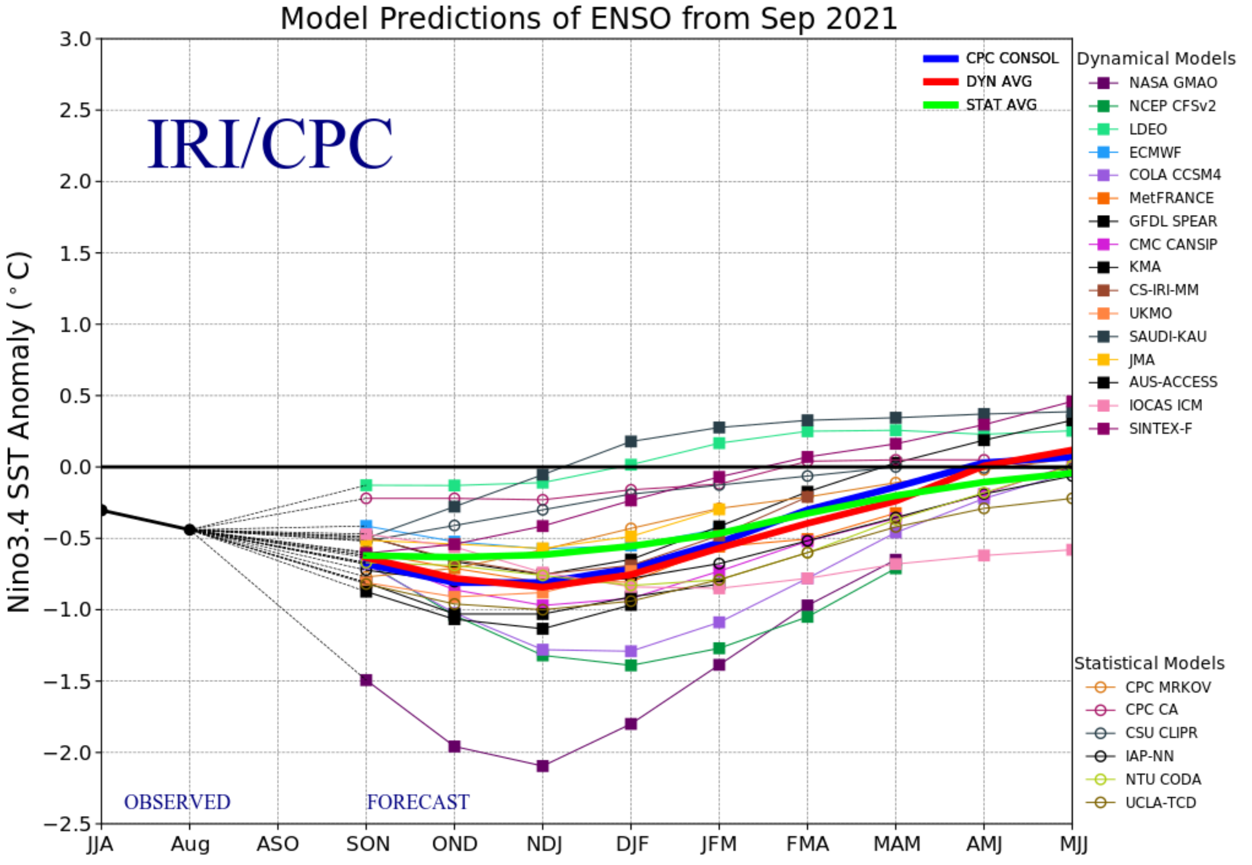
SST anomalies (in °C, where blue is cooler and orange is warmer)



Round-up: ENSO

- The UP model predicts weak La Niña conditions to persist throughout most of the 2021/22 summer season – supported by the plume of forecasts below





Southern Africa Forecasts

Prediction Method

- Three-month seasons for seasonal rainfall totals and average maximum temperatures of NMME ensemble mean forecasts are interpolated to the Climatic Research Unit (CRU; Harris et al. 2014) grids (0.5°x0.5°), by correcting the mean and variance biases of the NMME forecasts. Probabilistic forecasts are subsequently produced from the error variance obtained from a 5-year-out cross-validation process (Troccoli et al. 2008). Forecasts cover a 6-month period.
- Forecasts are produced for three categories:
  - **Above:** Above-normal ("wet" rainfall totals / "hot" maximum temperatures higher than the 75th percentile of the climatological record)
  - **Below:** Below-normal ("dry" rainfall totals / "cool" maximum temperatures lower than the 25th percentile of the climatological record)
  - **Normal:** Near-normal ("average" season)
- Verification of forecast skill:
  - ROC Area (Below-Normal) – The forecast system's ability to discriminate dry or cool seasons from the rest of the seasons over a 23-year test period. ROC values should be higher than 0.5 for a forecast system to be considered skilful.
  - ROC Area (Above-Normal) – The forecast system's ability to discriminate wet or hot seasons from the rest of the seasons over a 23-year test period. ROC values should be higher than 0.5 for a forecast system to be considered skilful.

Forecasts are probabilistic

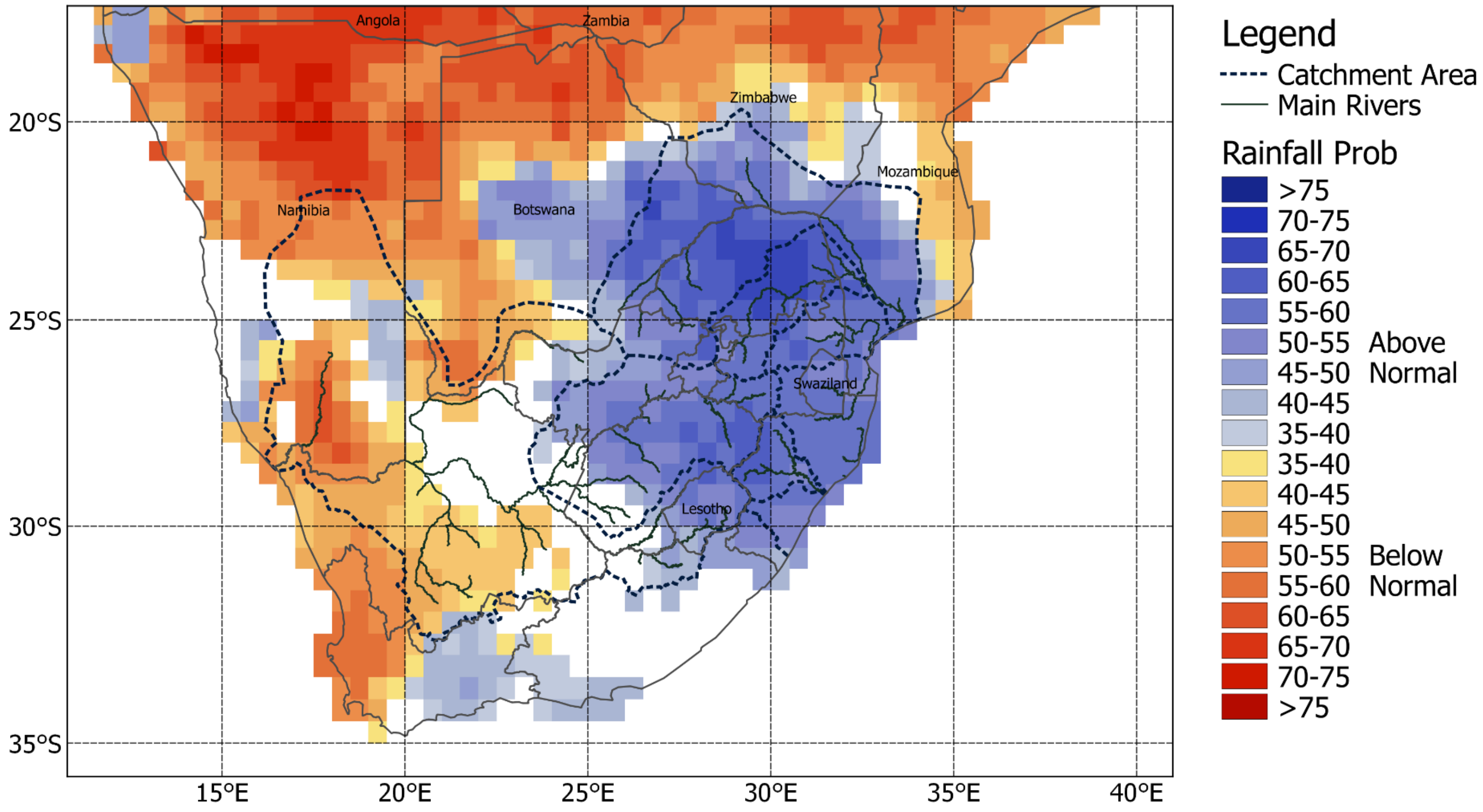
Probabilistic forecasts can help users understand risks and opportunities (forewarned is forearmed) in order to make more informed decisions.

The seasonal rainfall and maximum temperature forecasts to follow are expressed in probabilities, shown as the % chance of the most likely outcome of 3 categories. The colour of the scale reflects the most likely category and the % shows the probability of that outcome. Only ONE of the ROC area skill assessment maps should be consulted, depending on the category shown on the forecast map (Above- or Below-Normal), and the higher the value, the more skilful the forecast for that pixel is. The probabilities shown are always less than 100% - so there is no absolute certainty that the less favoured outcome will not occur. For example, if the forecast claims a 75% of below-normal rainfall totals for a season (i.e. drought), it means that 1 out of 4 times it will **not** develop into a drought.

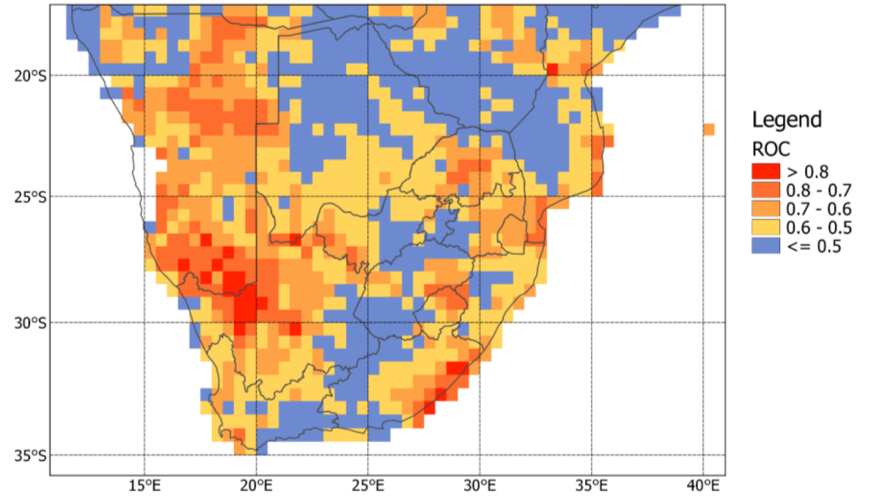
The nature of a probabilistic forecast implies that the less likely outcomes are always possible. In fact, for the probabilistic forecasts to be considered reliable, the less likely outcomes will and must occasionally occur.

Note: Probabilistic forecasts are considered reliable when the forecast probability is an accurate estimation of the relative frequency of the predicted outcome. In other words, forecasts are reliable if the observation falls within the category (Below-, Near- or Above-Normal) as frequently as the forecast implies

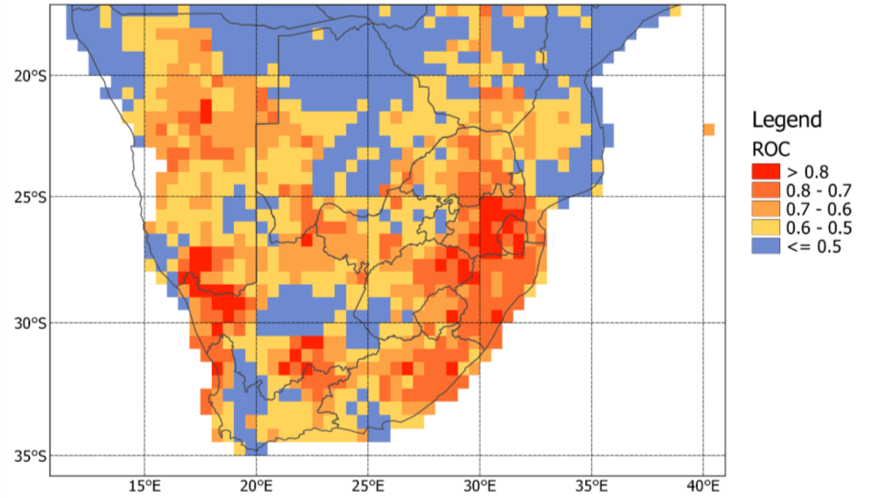
OND 2021 Rainfall; ICs: Oct



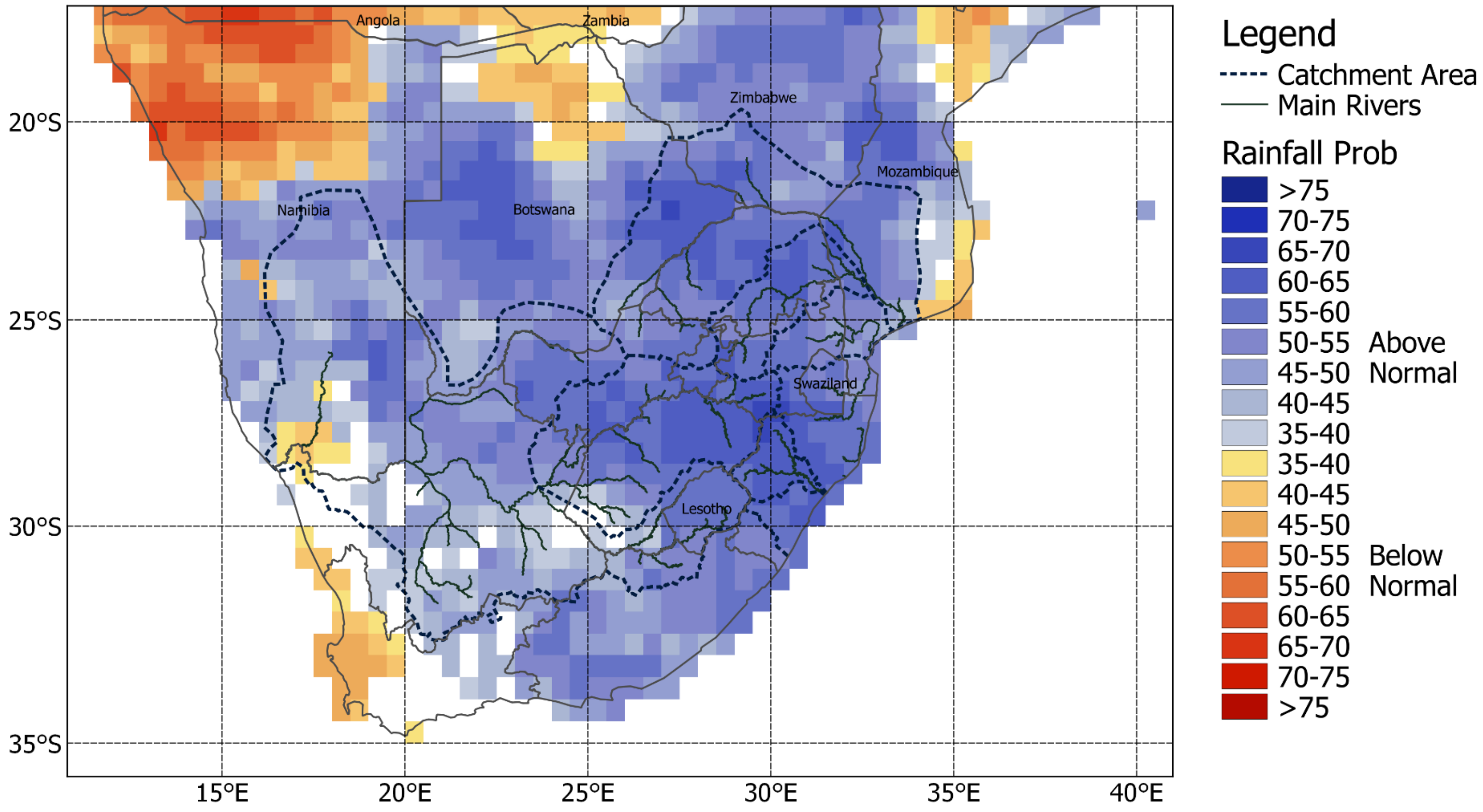
ROC Area (Above-Normal): OND Rainfall



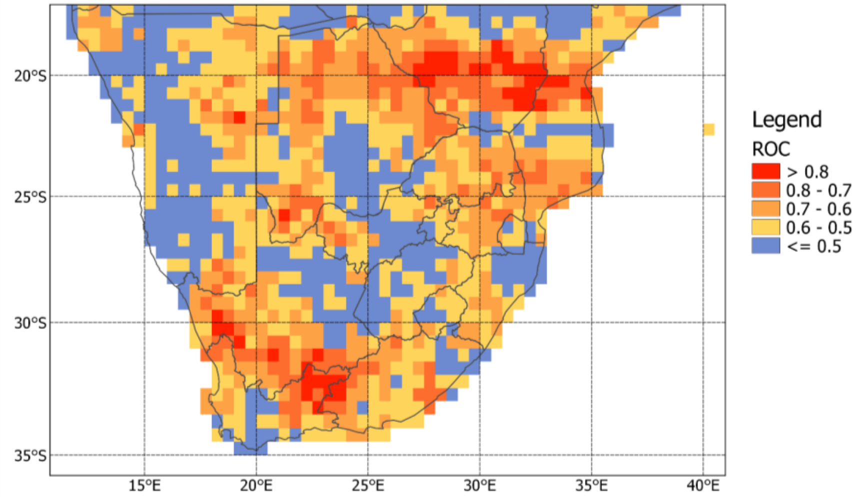
ROC Area (Below-Normal): OND Rainfall



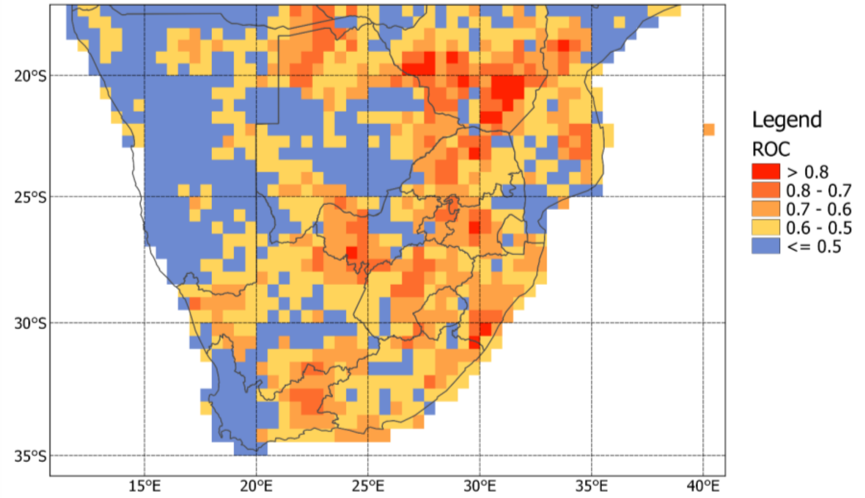
NDJ 2021/22 Rainfall; ICs: Oct



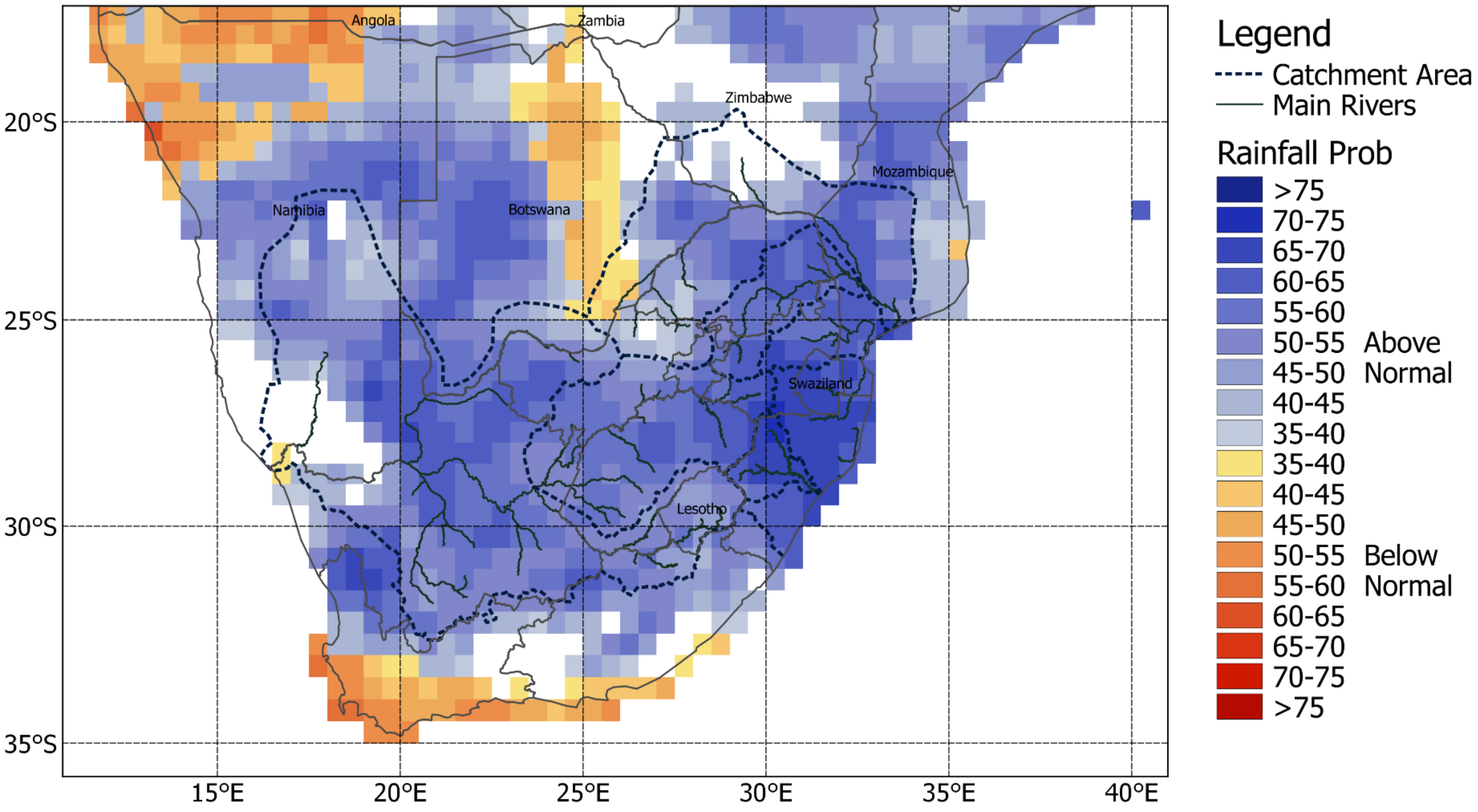
ROC Area (Above-Normal): NDJ Rainfall



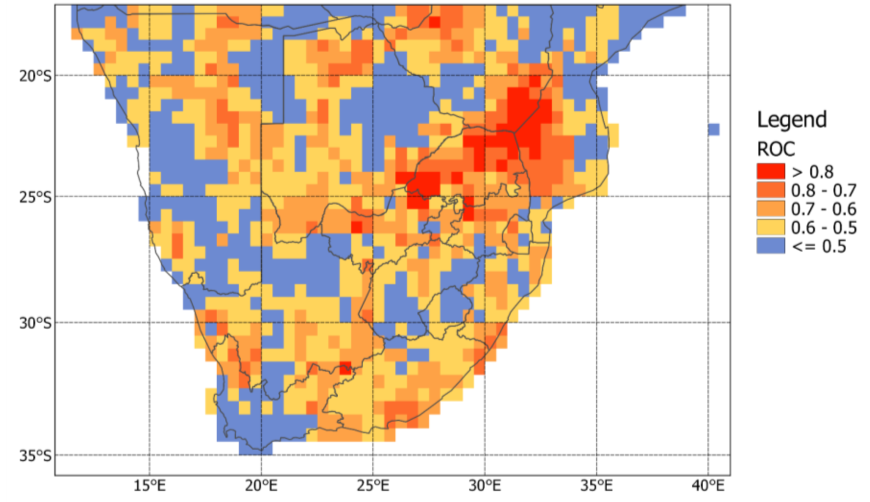
ROC Area (Below-Normal): NDJ Rainfall



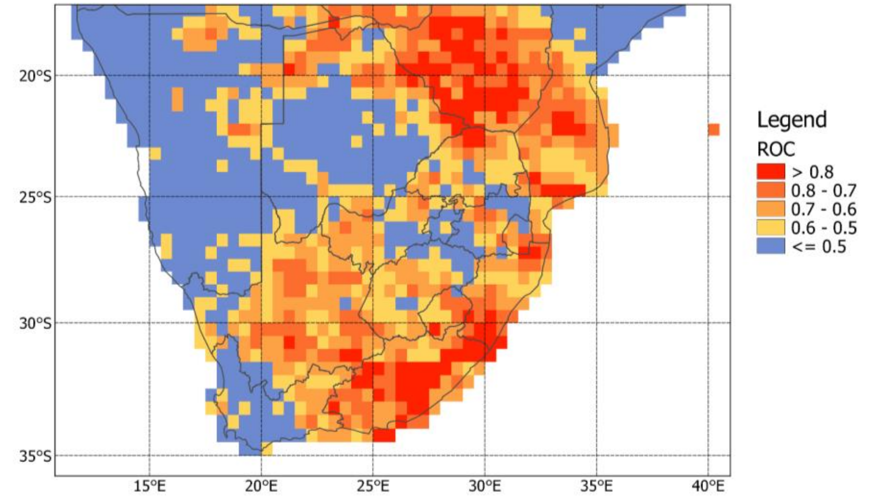
DJF 2021/22 Rainfall; ICs: Oct



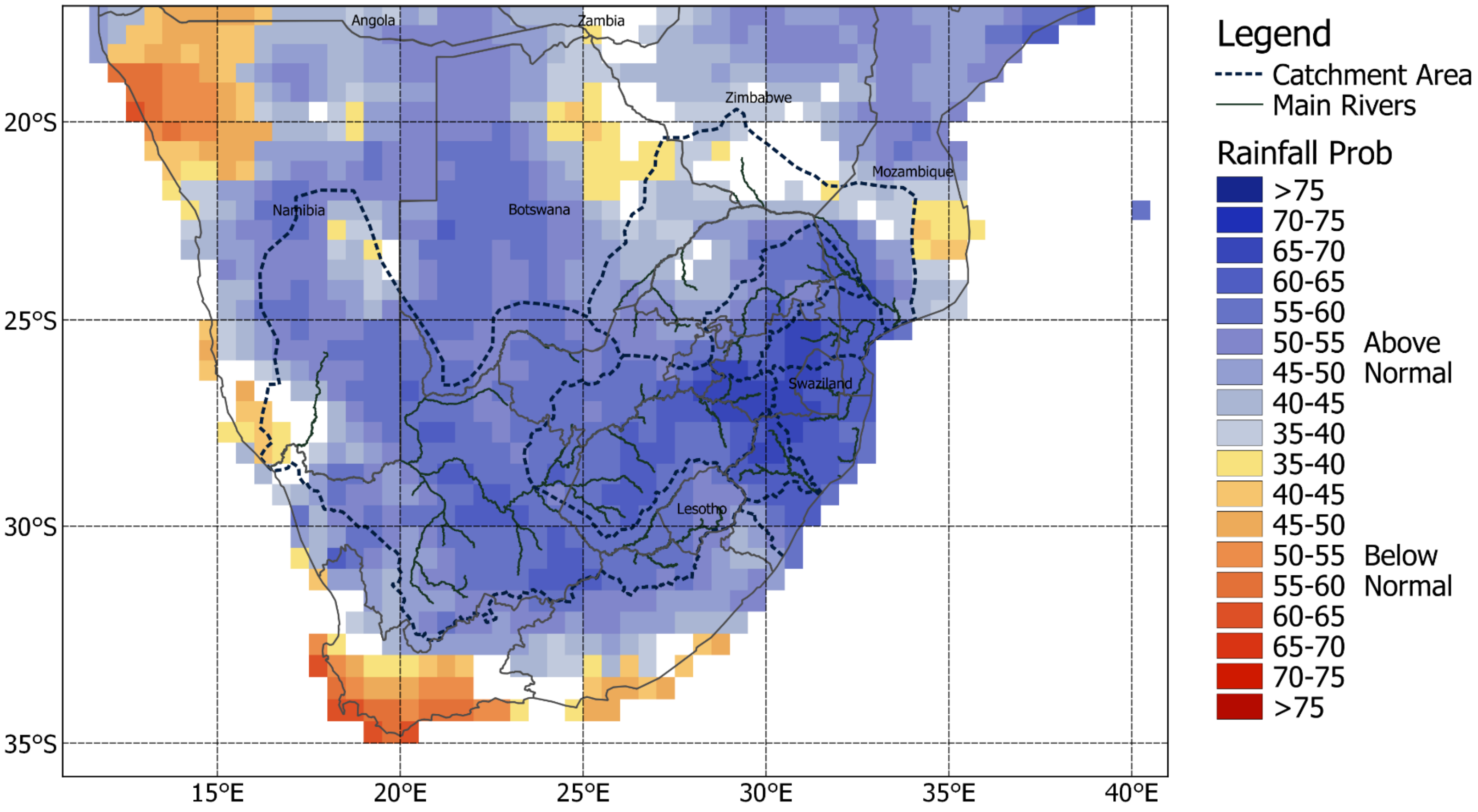
ROC Area (Above-Normal): DJF Rainfall



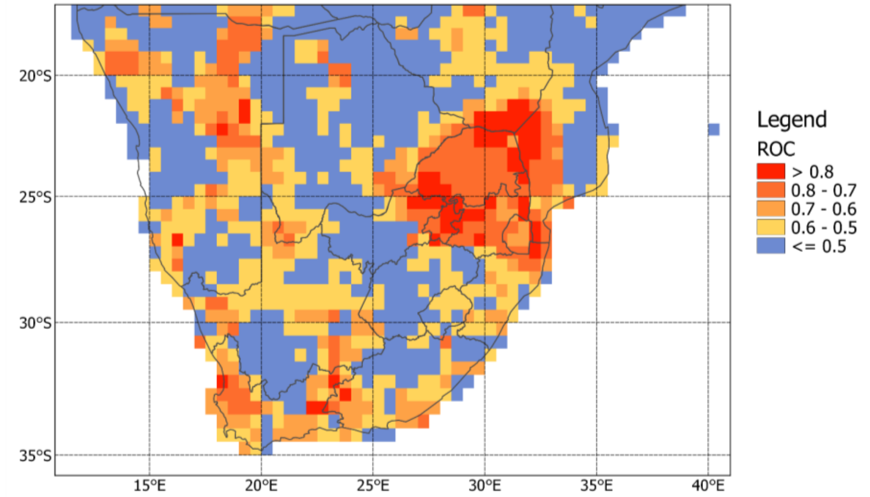
ROC Area (Below-Normal): DJF Rainfall



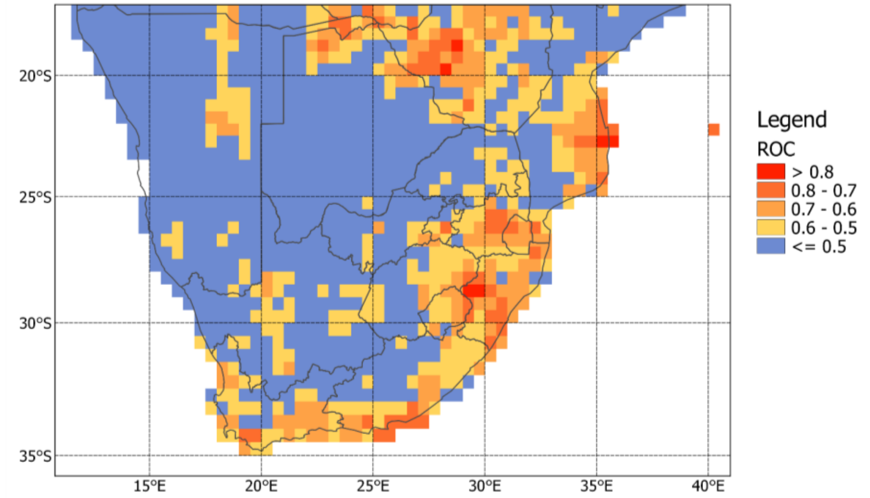
JFM 2022 Rainfall; ICs: Oct



ROC Area (Above-Normal): JFM Rainfall



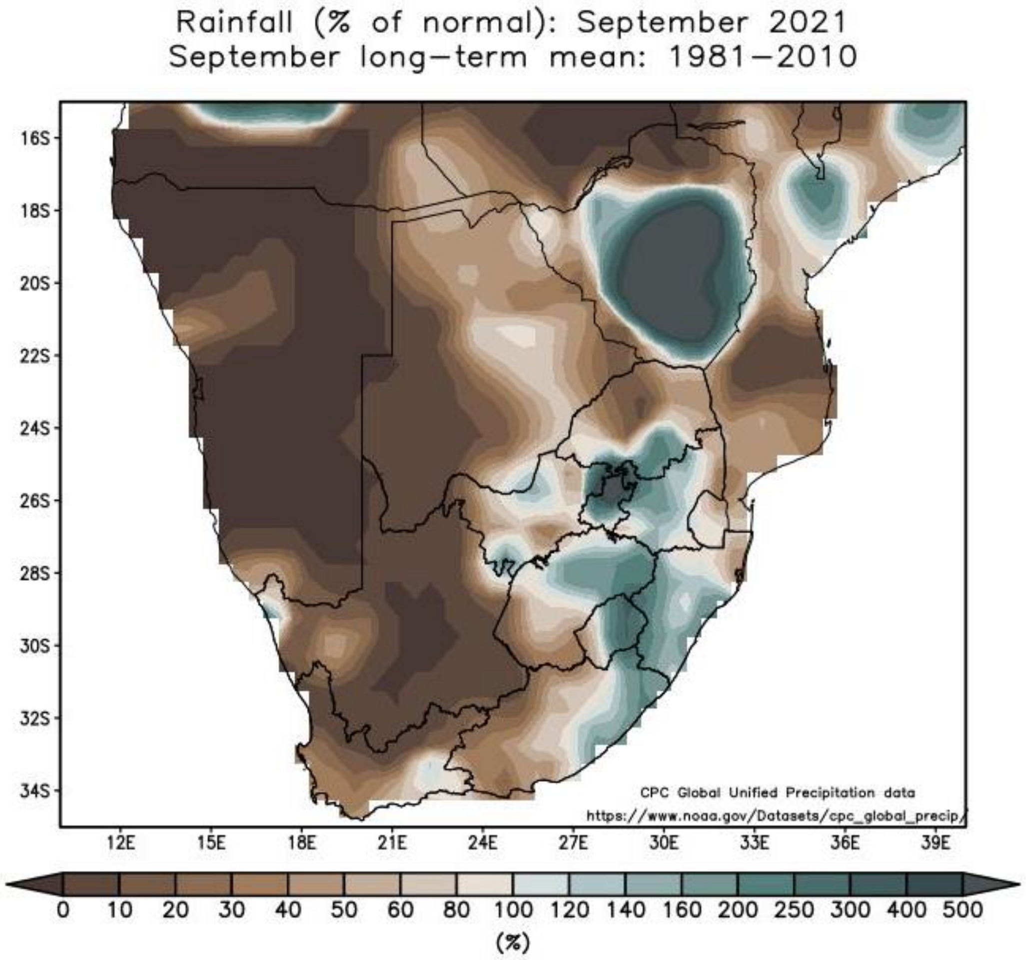
ROC Area (Below-Normal): JFM Rainfall

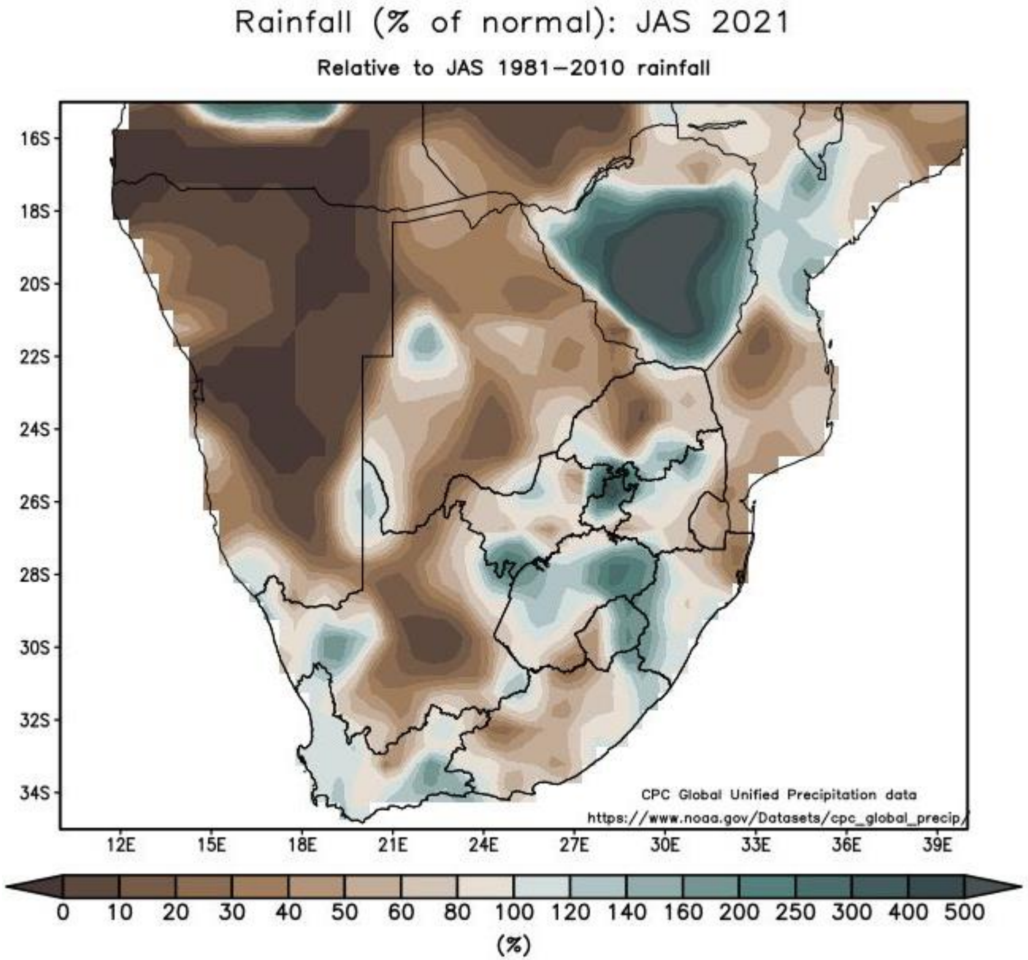


Round-up: SADC Rainfall

- Favourable rains are expected at the start of the rainfall season, especially in the northeastern parts
- With the exception of the Southwestern and Southern Cape, and the northwest of the SADC region, the whole area is likely to experience an above-normal rainfall season

Observed SADC Rainfall

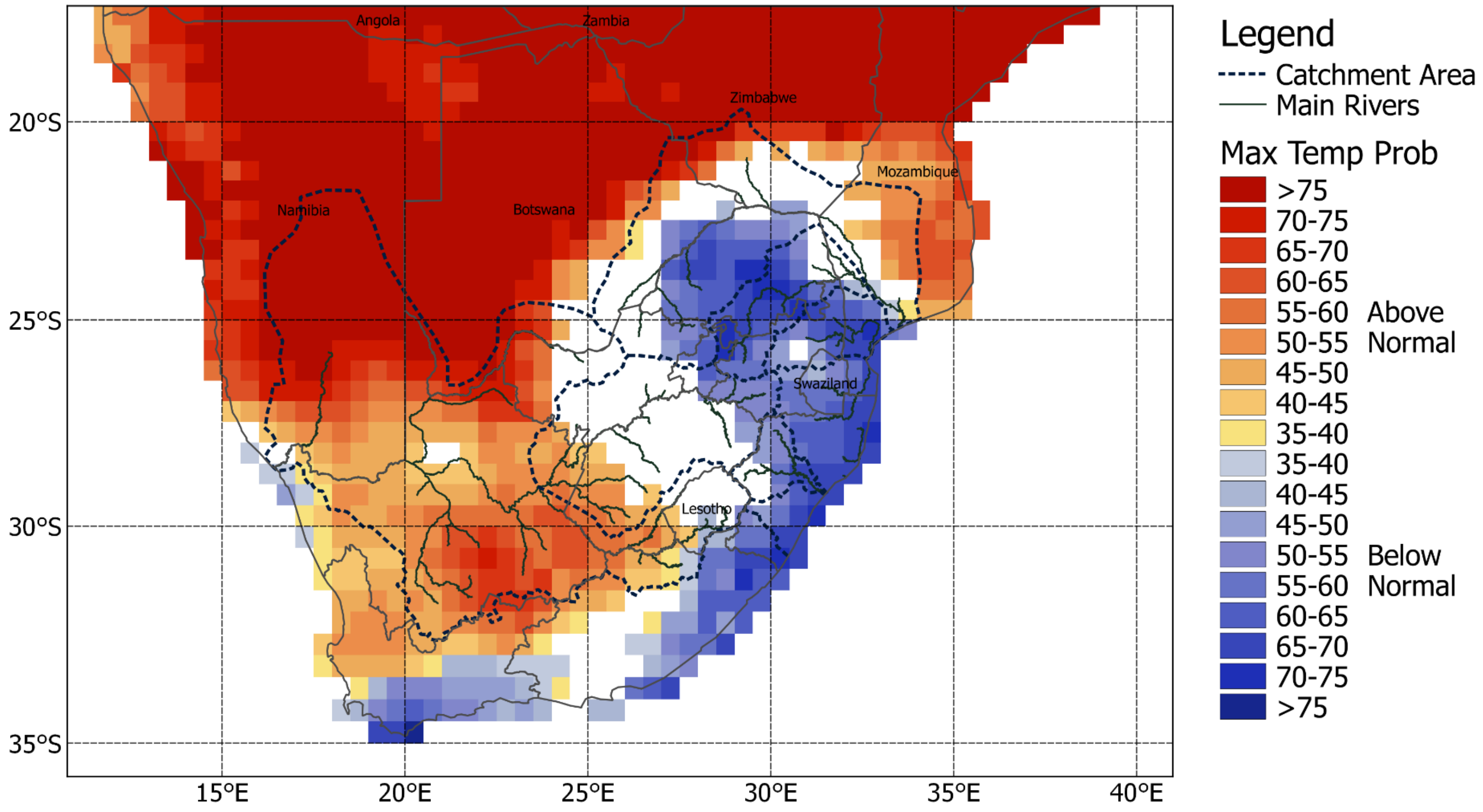




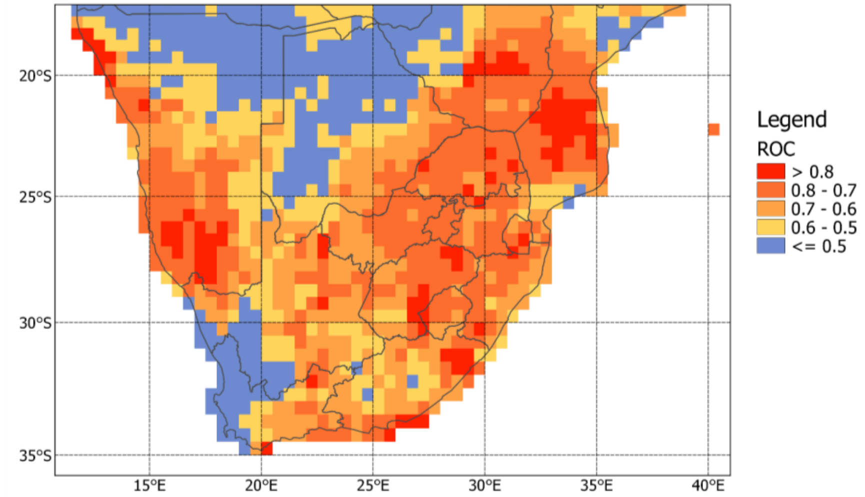
Recorded rainfall for September and the Jul-Aug-Sep season show below-normal rainfall for most of the central and northern regions, with normal- to above-normal rainfall in the southeast and over Zimbabwe

Maps prepared by Dr. Christien Engelbrecht

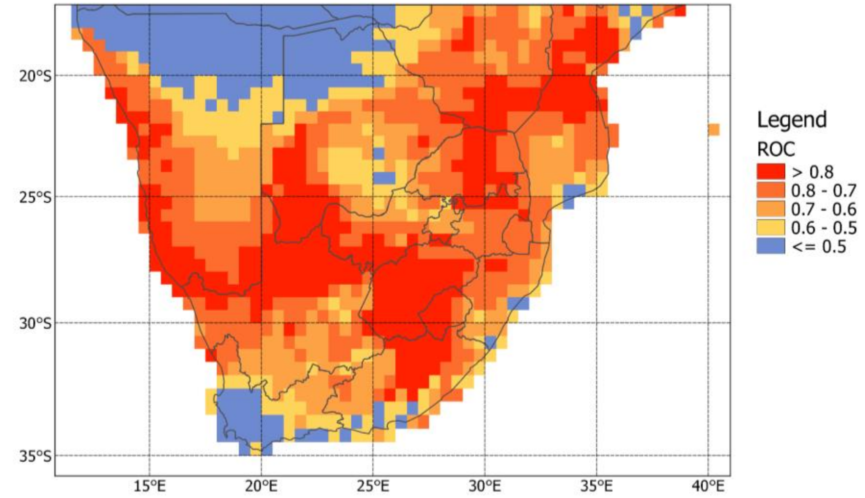
OND 2021 Max Temp; ICs: Oct



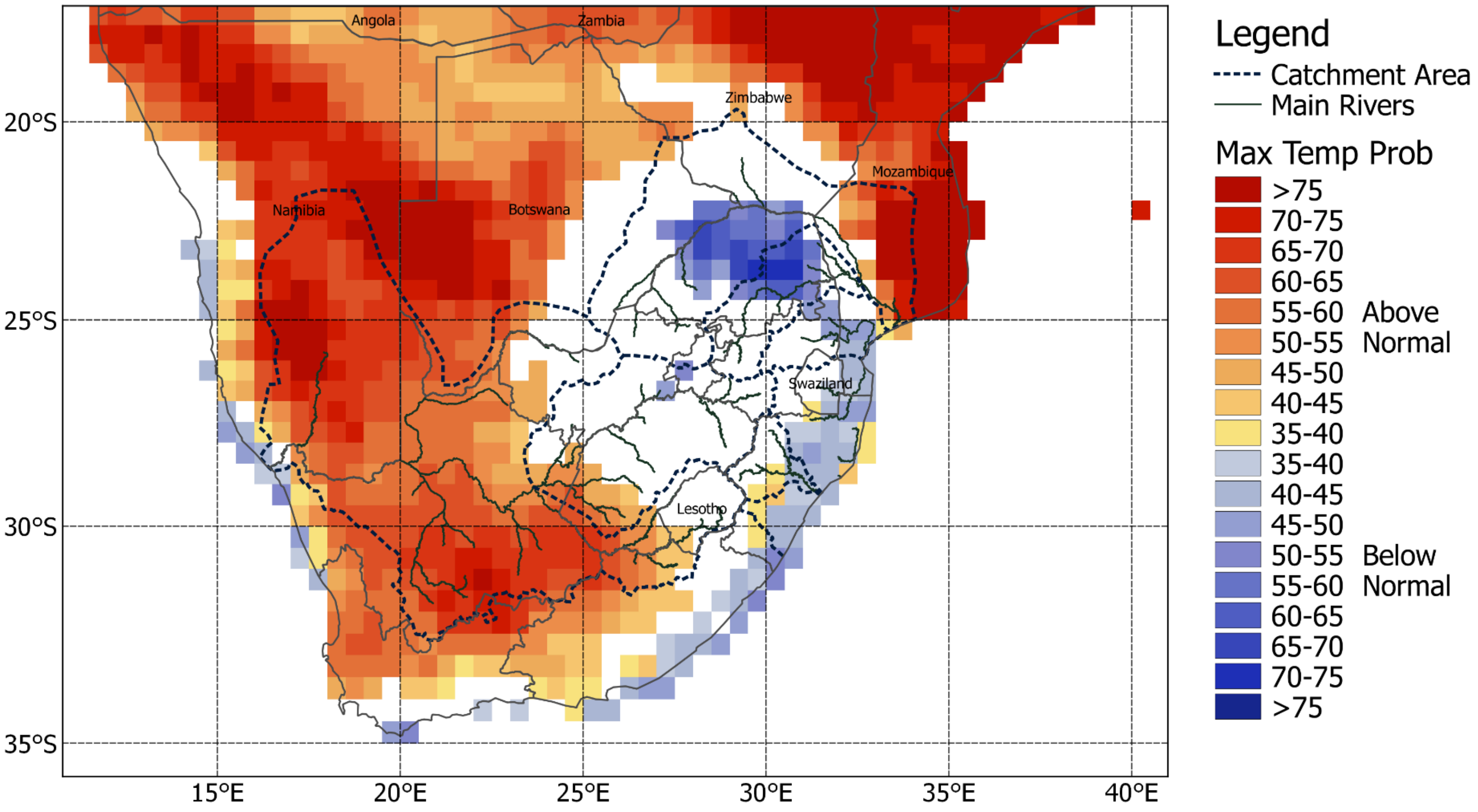
ROC Area (Above-Normal): OND Max Temp



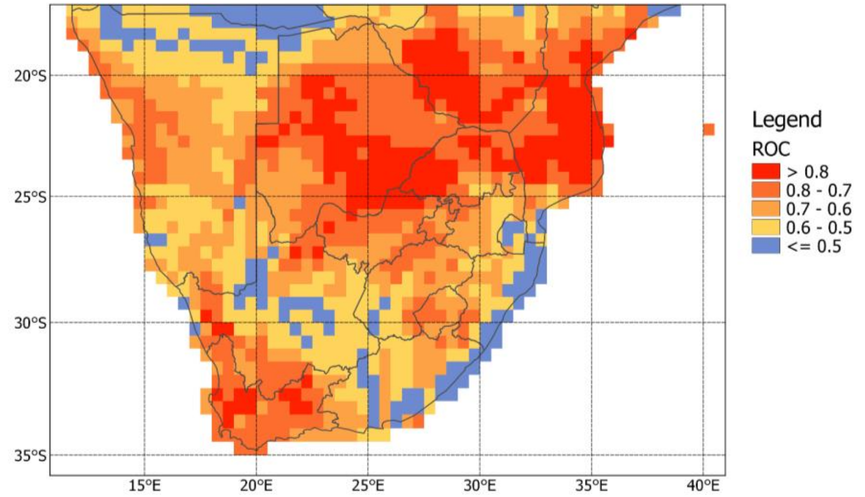
ROC Area (Below-Normal): OND Max Temp



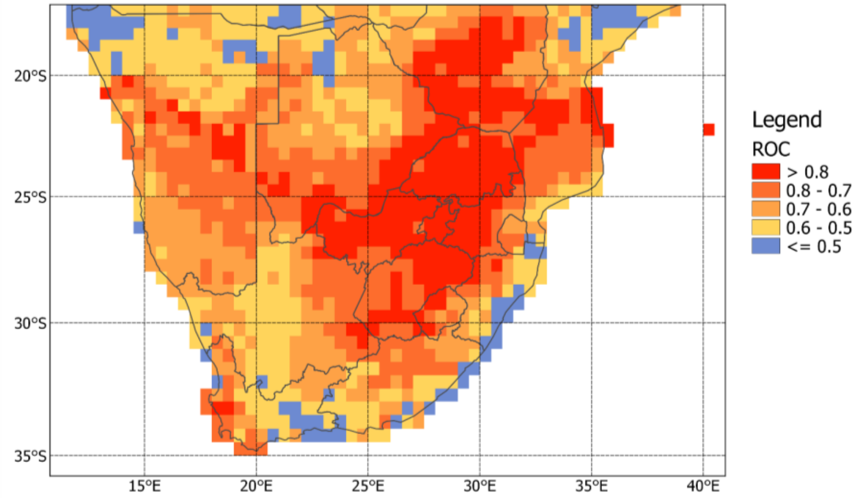
NDJ 2021/22 Max Temp; ICs: Oct



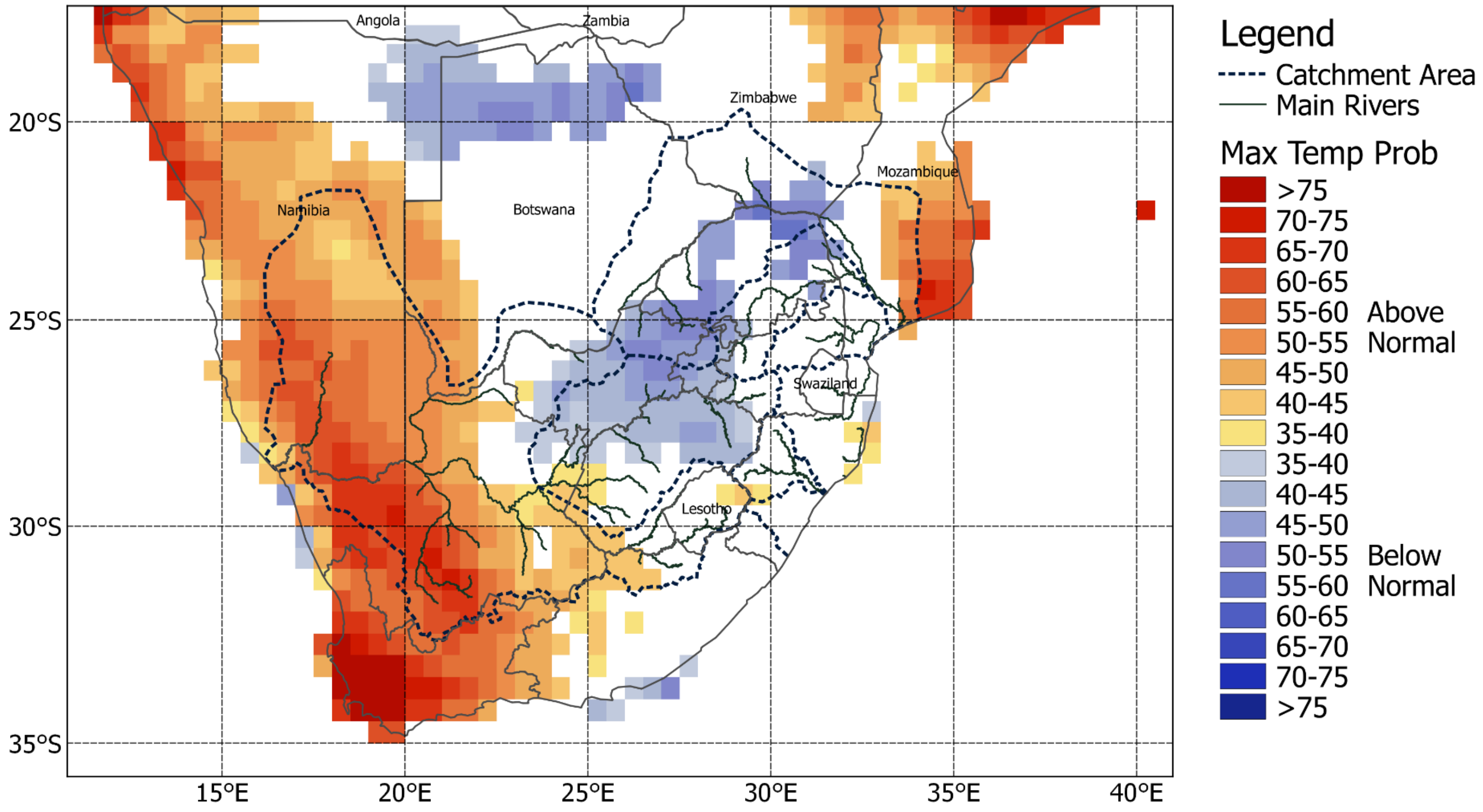
ROC Area (Above-Normal): NDJ Max Temp



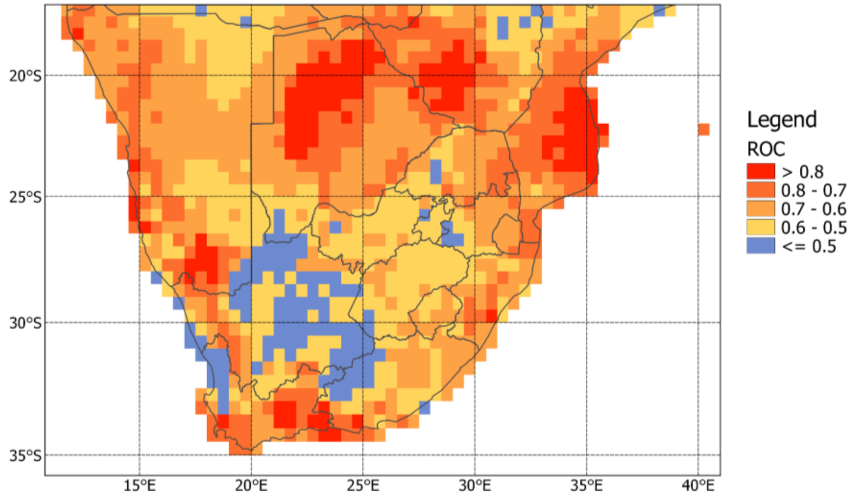
ROC Area (Below-Normal): NDJ Max Temp



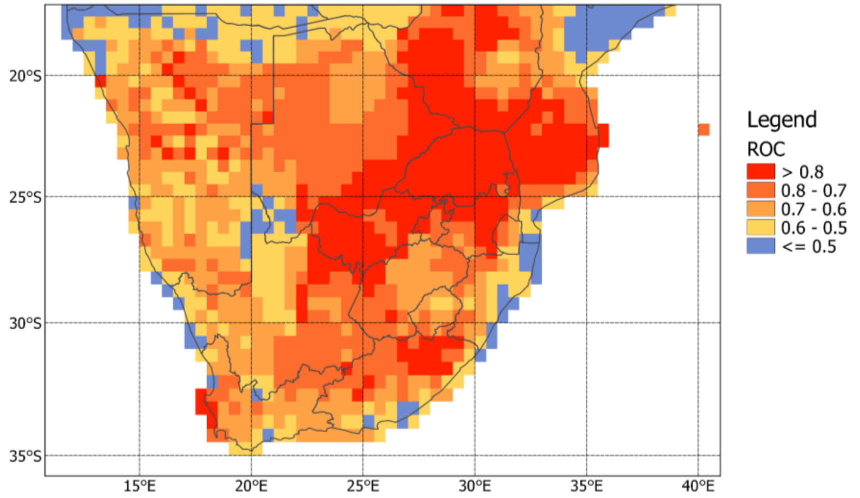
DJF 2021/22 Max Temp; ICs: Oct



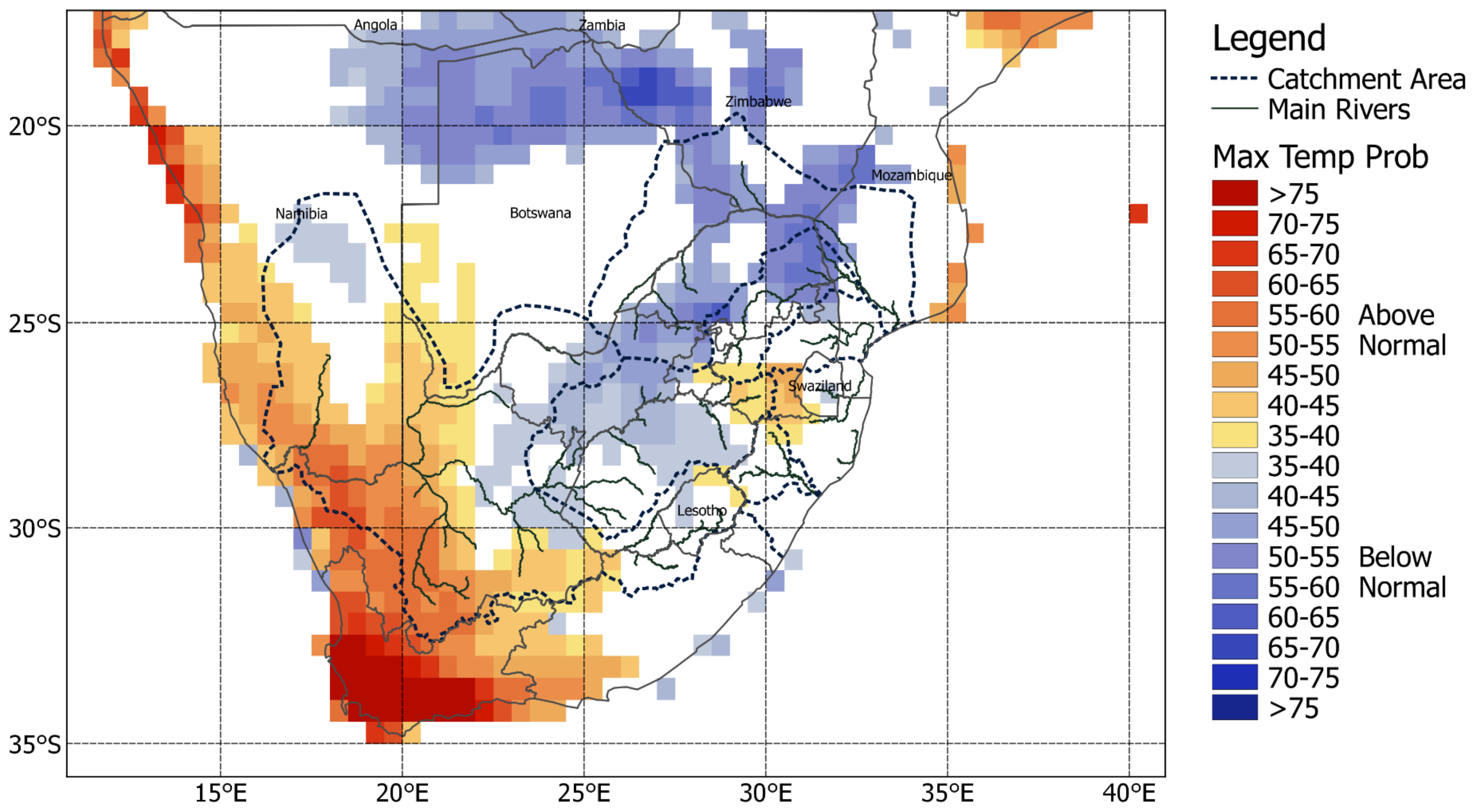
ROC Area (Above-Normal): DJF Max Temp



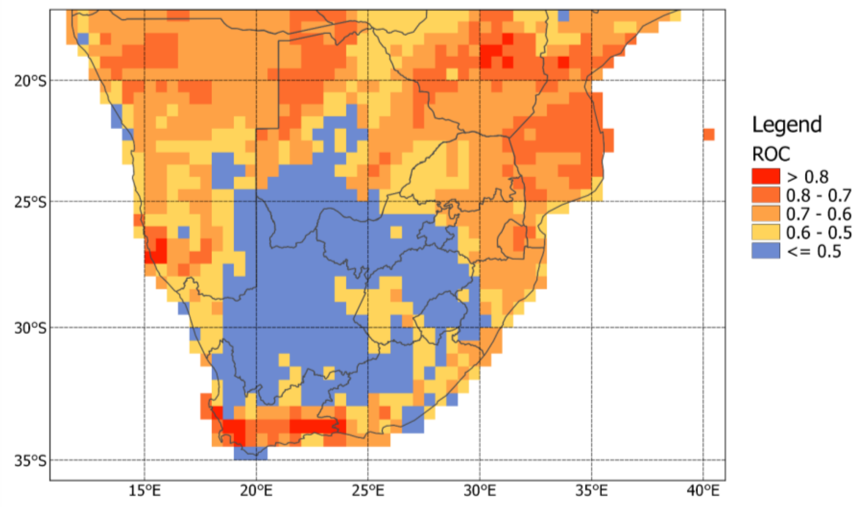
ROC Area (Below-Normal): DJF Max Temp



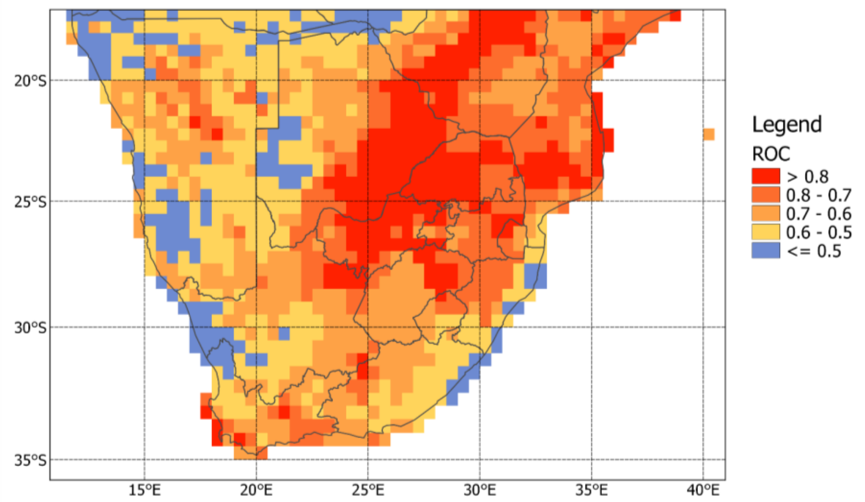
JFM 2021 Max Temp; ICs: Oct



ROC Area (Above-Normal): JFM Max Temp



ROC Area (Below-Normal): JFM Max Temp



Round-up: SADC Max Temp

- Cooler than normal maximum temperatures are expected over the northeastern interior and eastern and southern coastal areas early in the season, spreading further west and north as the season progresses
- Higher than normal maximum are expected over the western parts, including the SW Cape

Tailored Forecasts

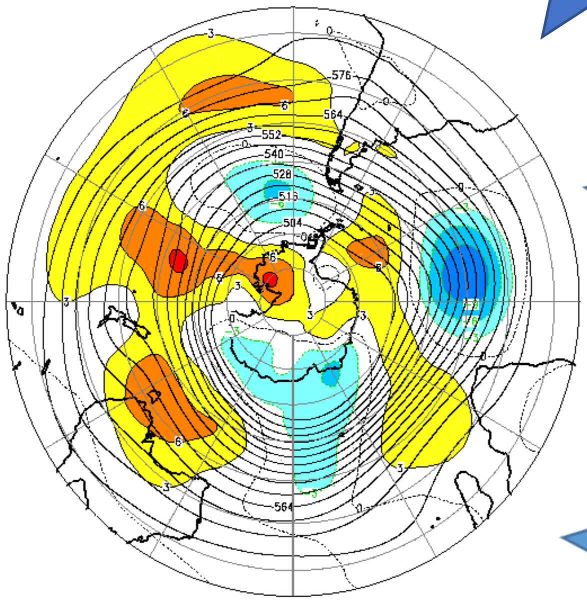
Translating forecasts into indices on a range of relevant space and time scales that can inform regional decision-making. The following forecasts are shown to indicate the potential of seasonal forecasting for real-life applications

1. **Bapsfontein end-of-season-yield three-category probabilistic forecast for 2022**
2. **Probabilistic three-category rainfall forecast for the farm of Robbie Kingsley for Dec-Jan-Feb 2021/22**
3. **Probabilistic three-category malaria forecast for Limpopo for Dec-Jan-Feb 2021/22**
4. **Probability of exceedance Dec-Jan-Feb 2021/22 inflow forecast for Lake Kariba, Zambia/Zimbabwe**
5. **Probabilistic rainfall forecast for Jan-Feb-Mar 2022 for the farm Buschbrunnen near Grootfontein, Namibia**
6. **Probability of exceedance Jan-Feb-Mar 2022 downstream flow forecasts for Vaal Dam**

The prediction scheme

1. Phenomena to be predicted should contain a climate signal (e.g. ENSO) in the data; 2. Observed and model time series must be over sufficiently long enough periods so that robust statistical relationship can be developed; 3. and some form of quality control of the observed data had taken place.

Climate models of the NMME



Seasonal forecast of the climate models, statistically linked to observed values

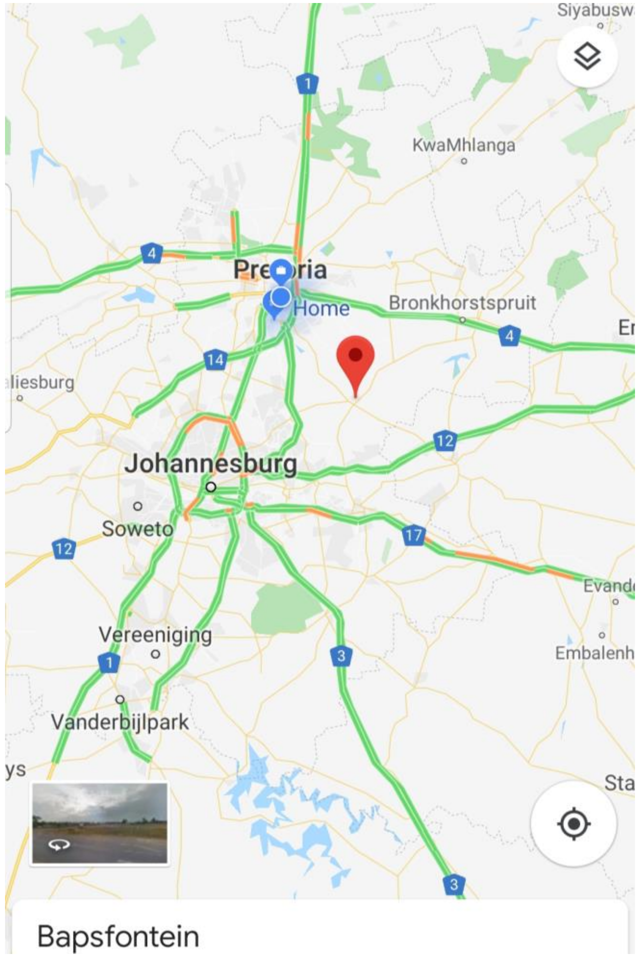
Riverflow

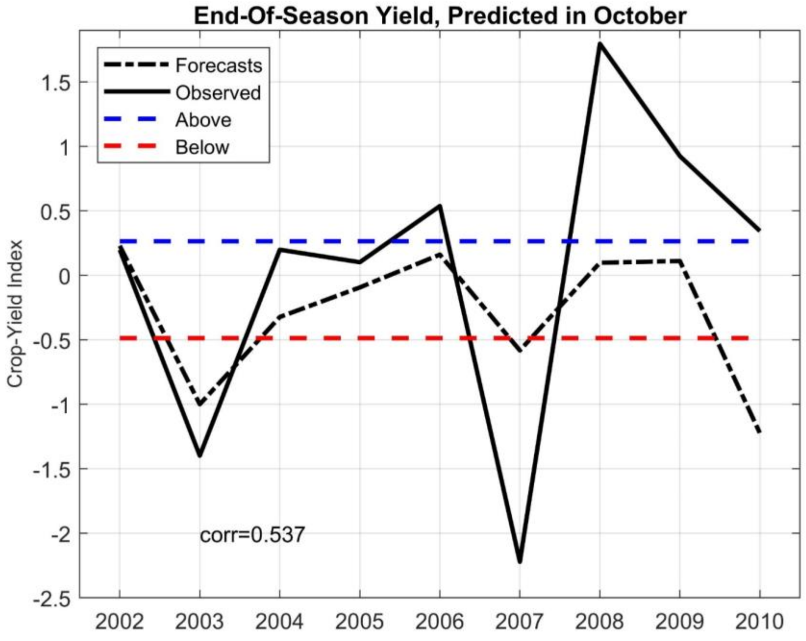
Malaria

Dry-land crop yield

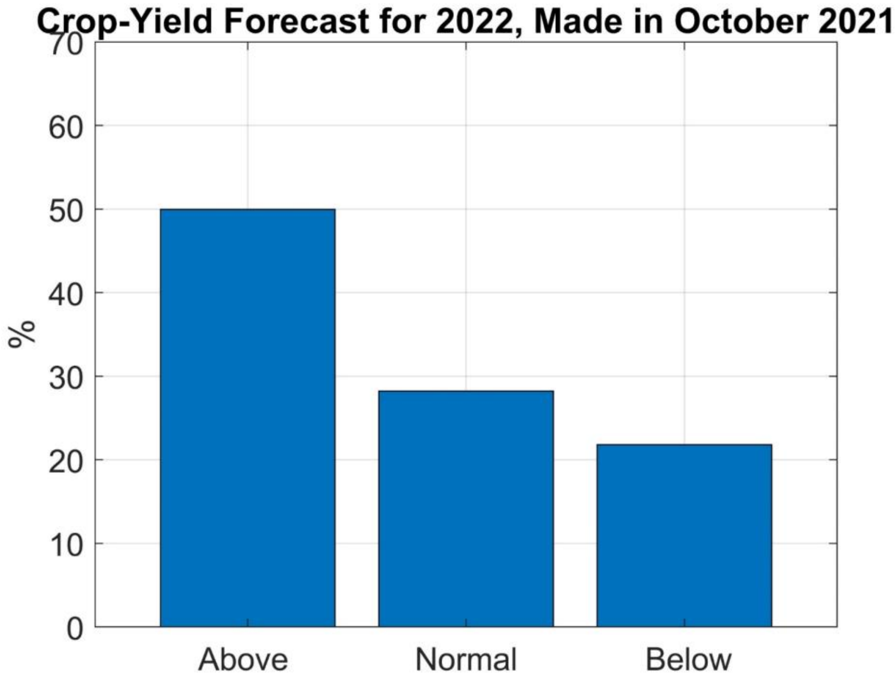
Dry-land crop-yield data and forecasts for a farm near Bapsfontein, South Africa

Landman et al. (2019)



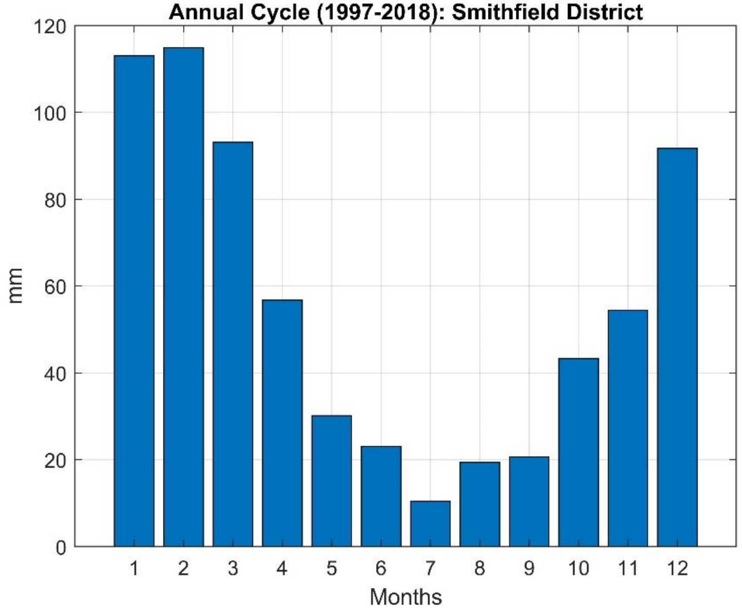


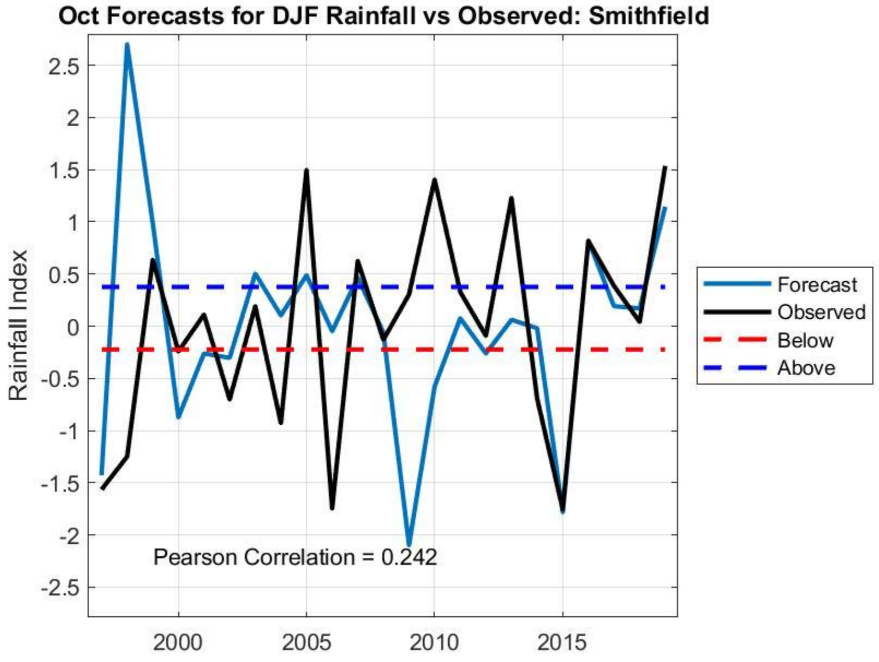
Re-forecasts for end-of-season crop yields

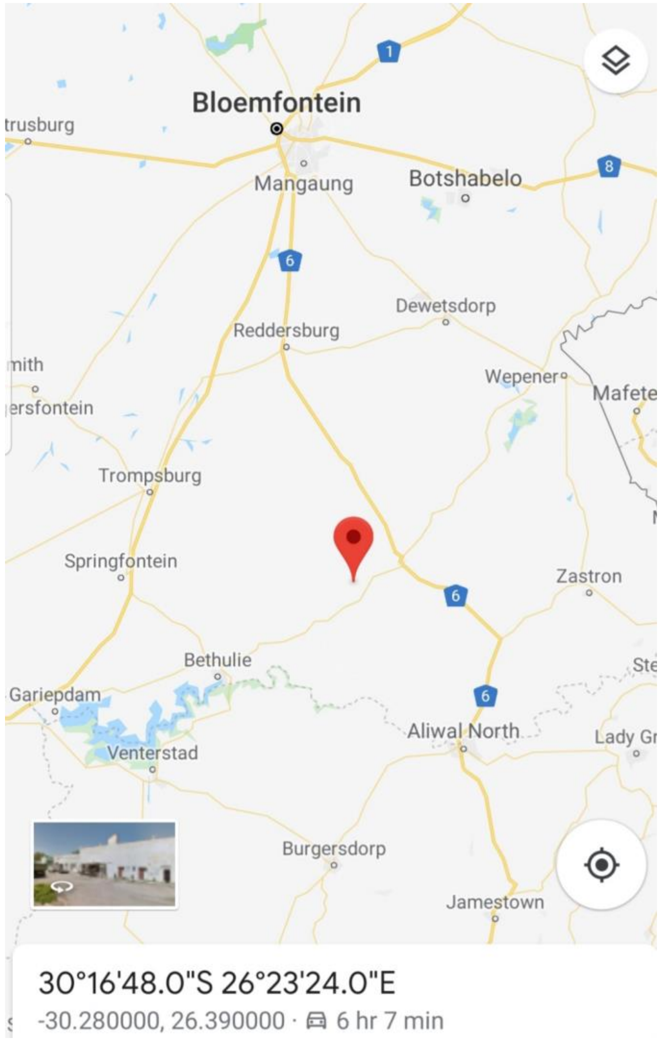


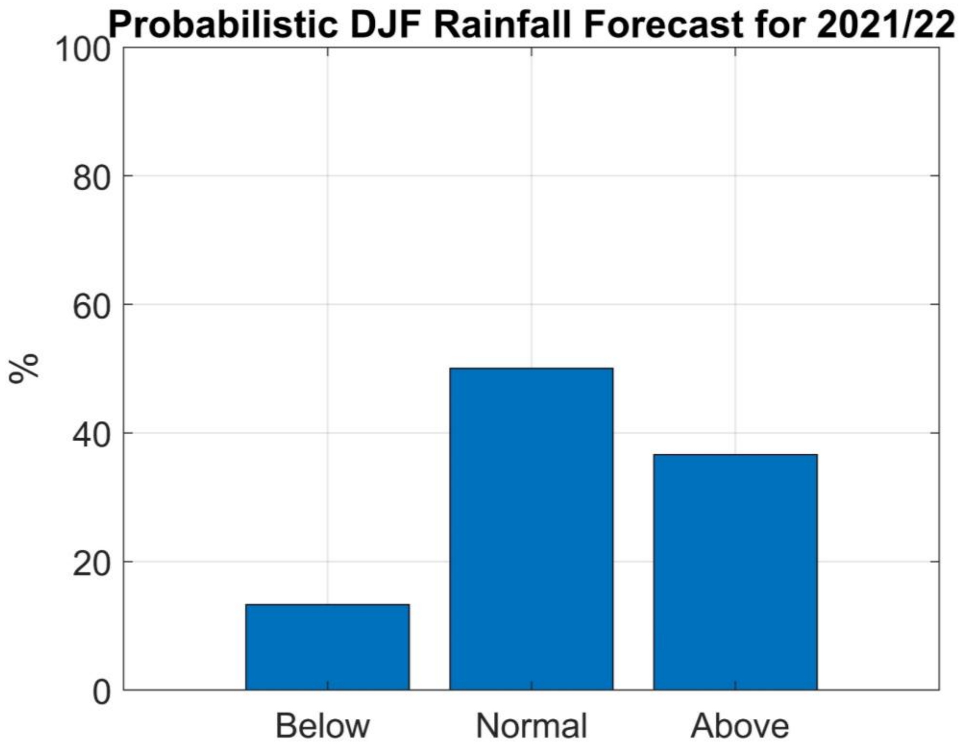
Dec-Jan-Feb 2021/22 rainfall forecast for farm in the Smithfield district (see map). Rainfall data provided by the farmer, Mr. Robbie Kingsley

Landman et al. (2020a)



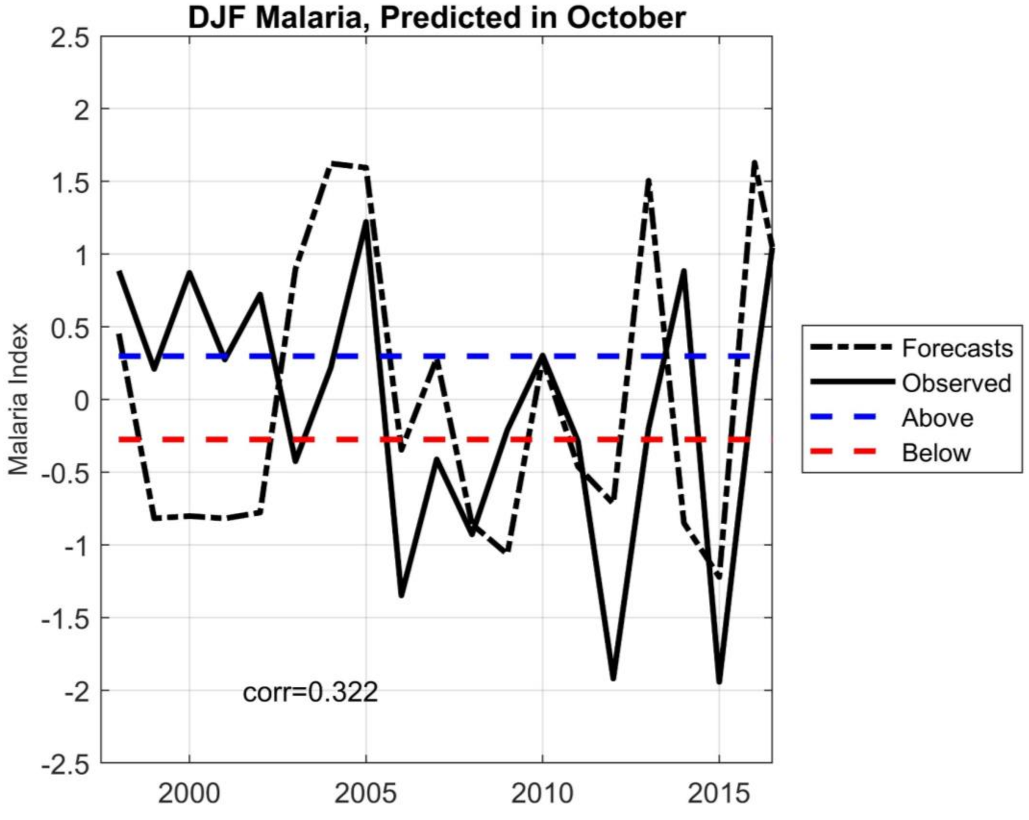


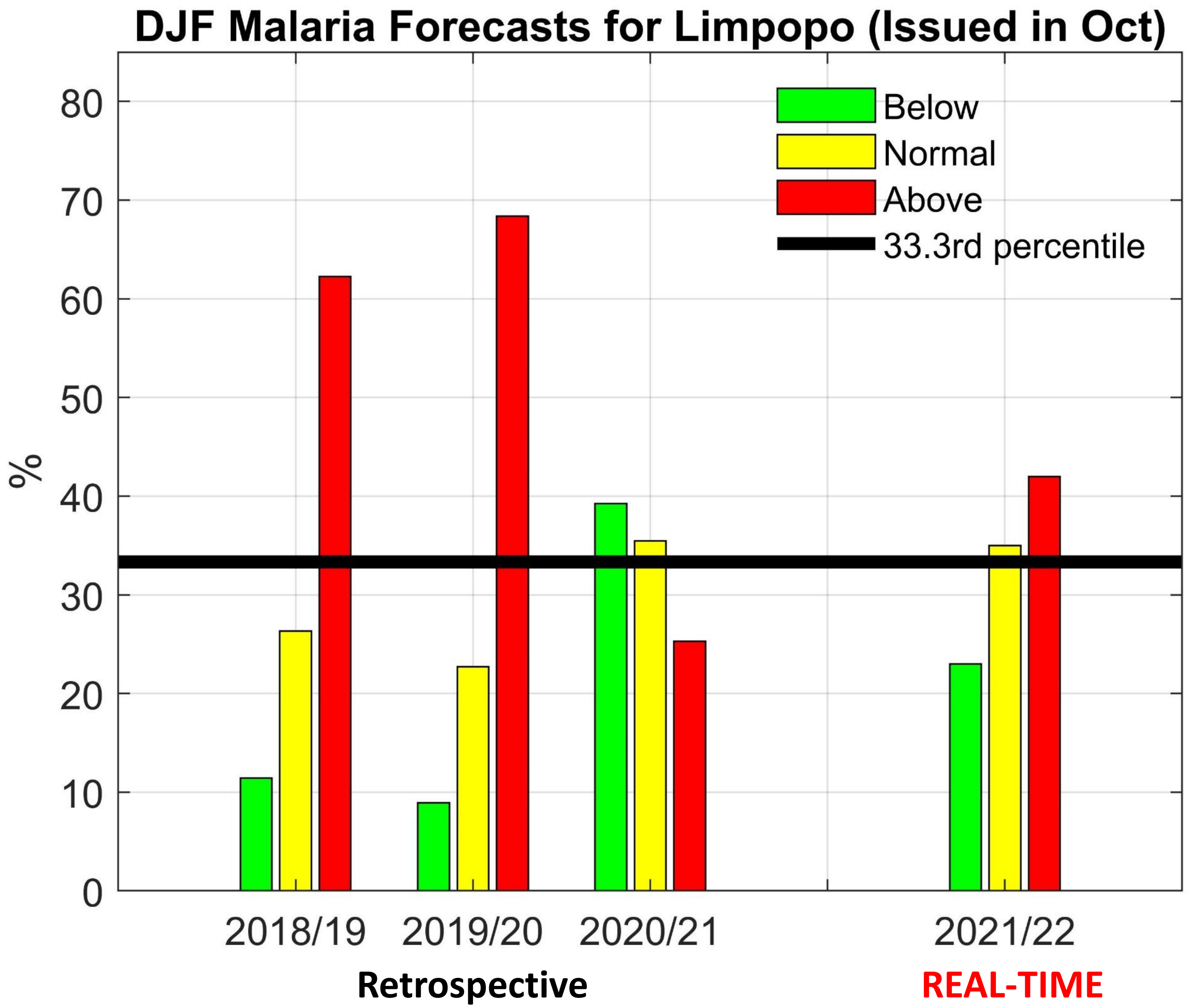




Malaria forecast
Landman et al. (2020b)

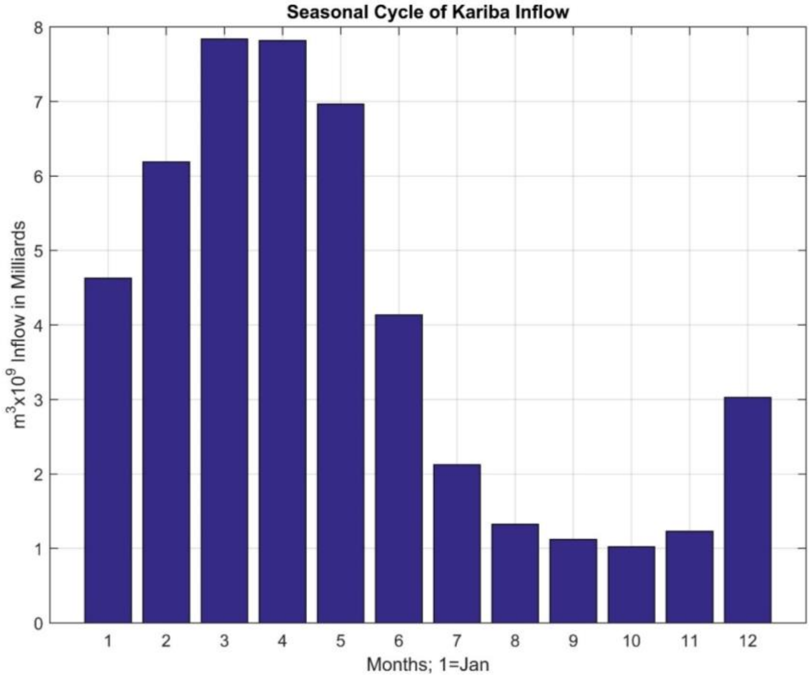
Hindcasts

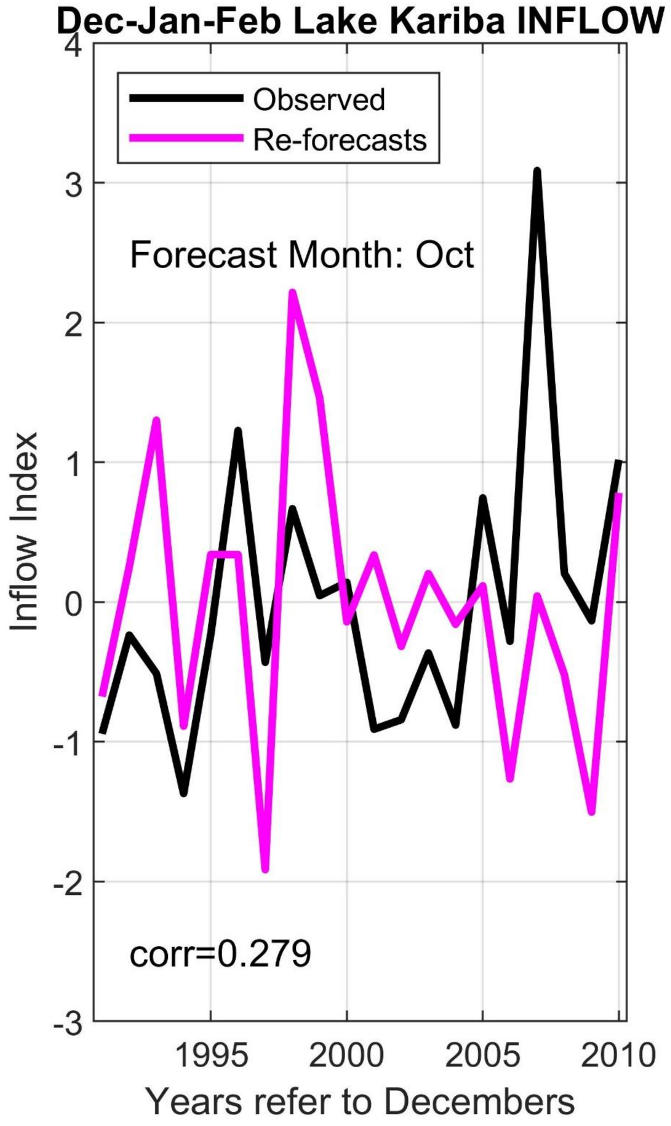


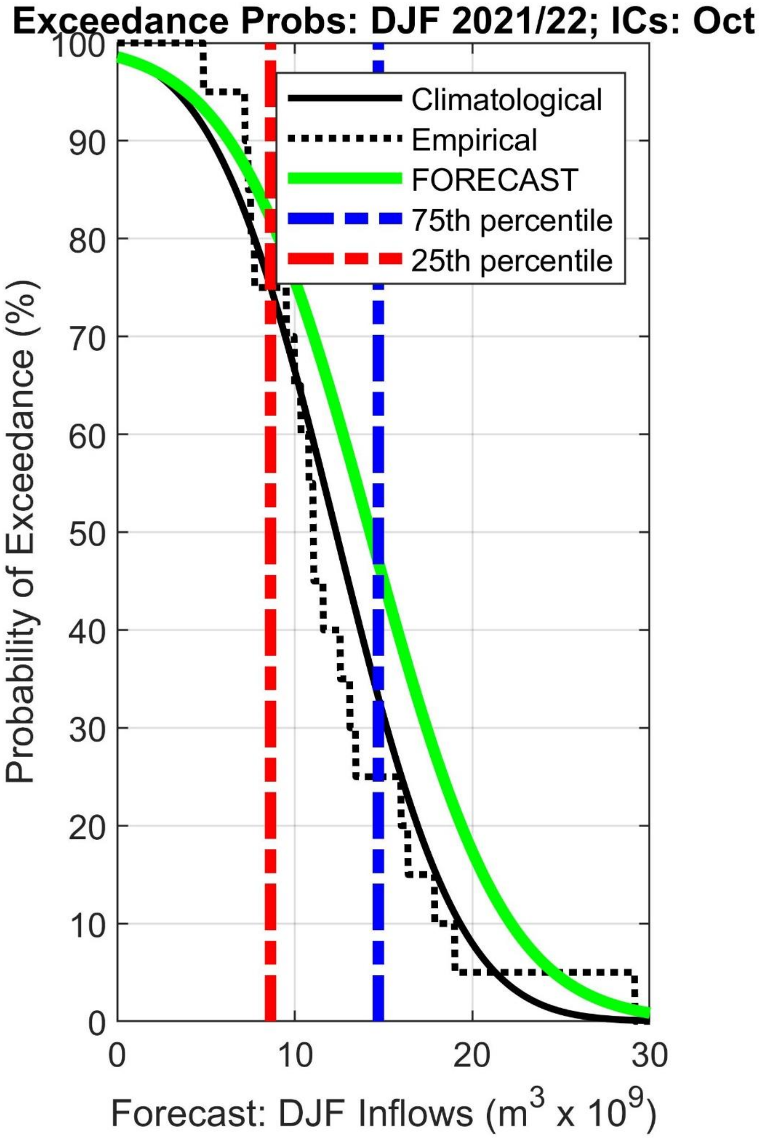


Inflow forecast for Lake Kariba: onset season of DJF

Muchuru et al. (2016)



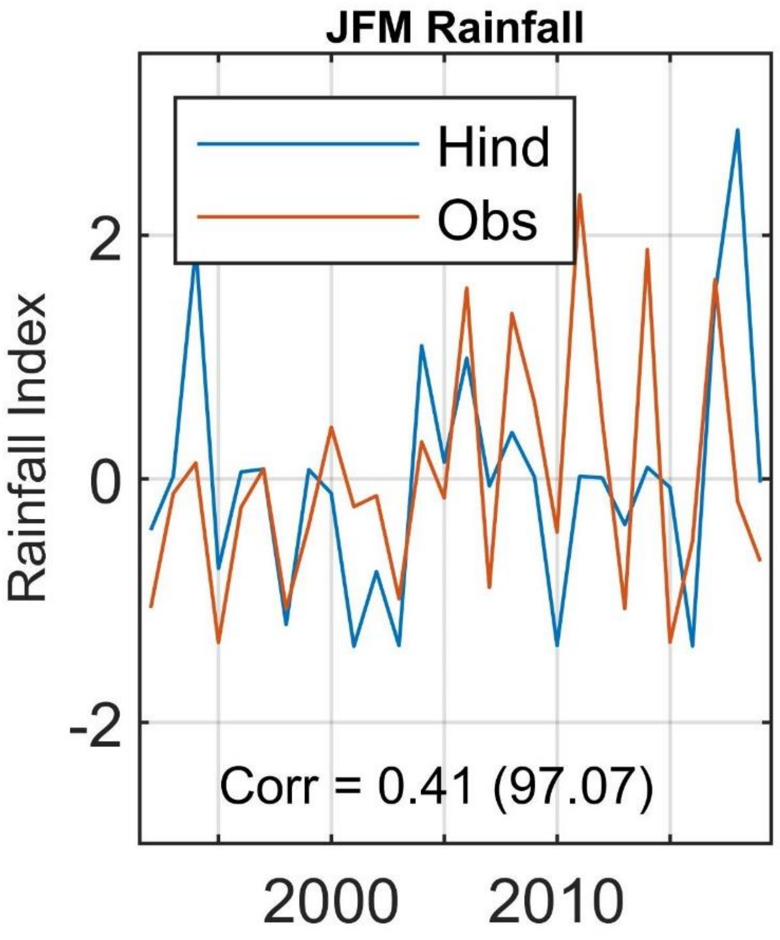


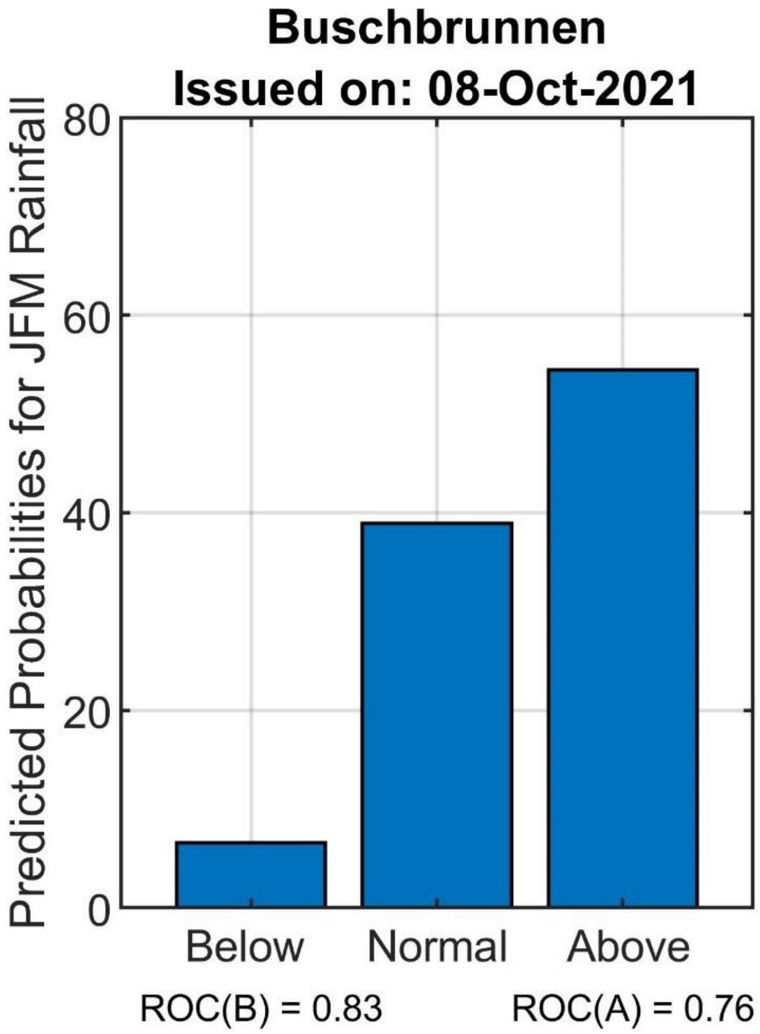


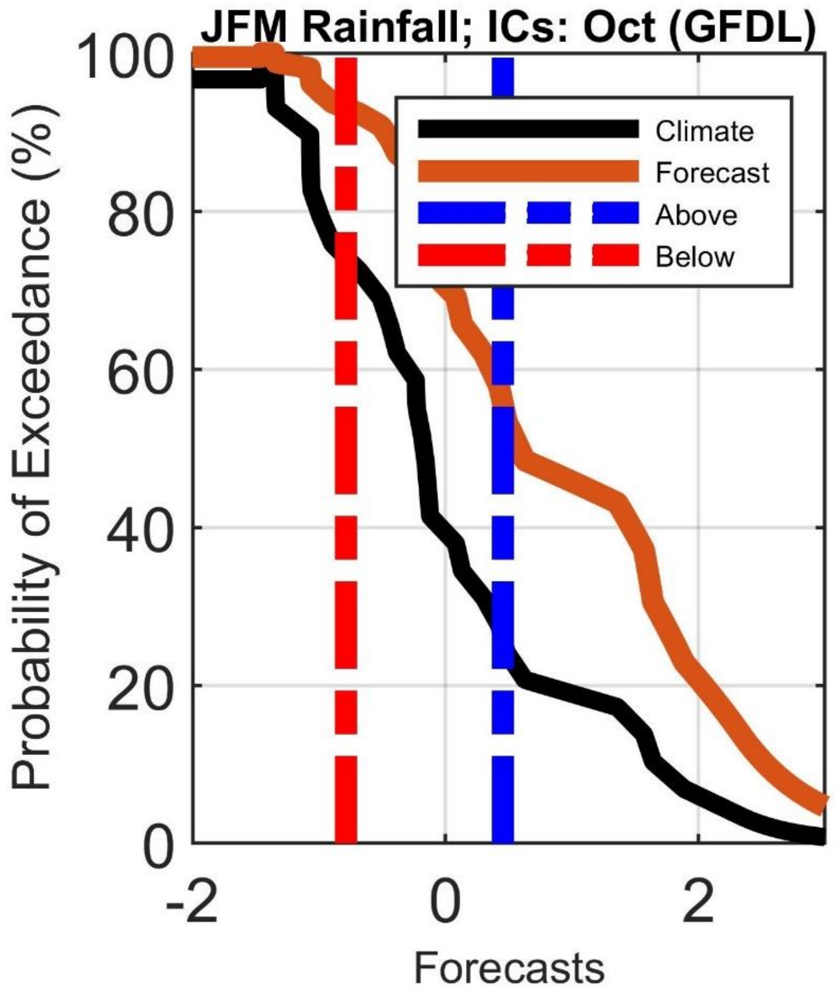
For the forecast on the far right: The black curve represents the climatological probability distribution of DJF inflows, and the green curve represents the predicted probability distribution for the coming DJF season. The vertical dashed lines represent the category thresholds. The easiest way to interpret the green forecast curve would be to consider a curve above (below) the thick black curve to be probabilistic forecasts for anomalously high (low) DJF inflows.

JFM rainfall forecast for the farm Buschbrunnen near Grootfontein, Namibia

Landman et al. (2016)







Current Project, administered by the WRC: *RainSolutions*

Vaal Dam Downstream Flow Predictions

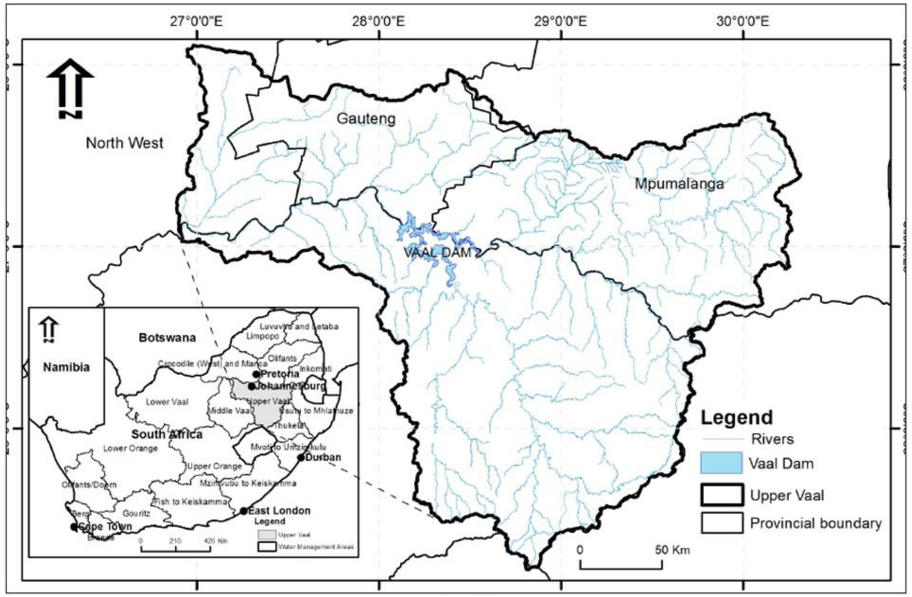
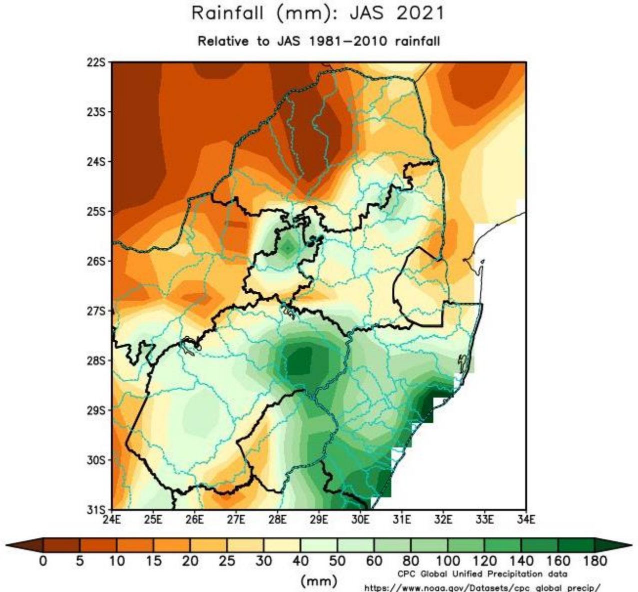
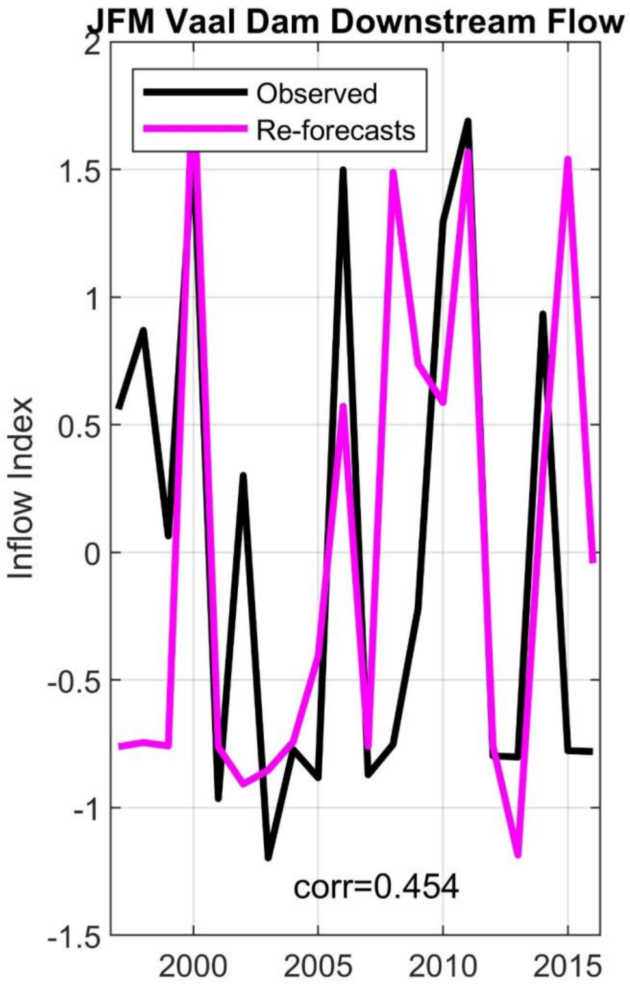
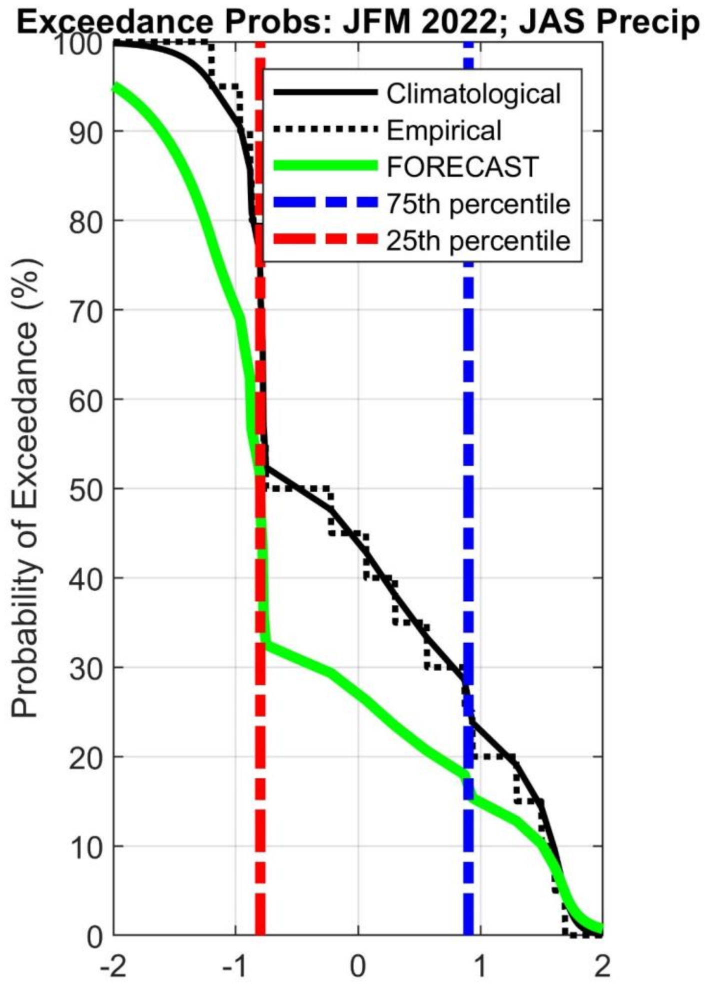


Figure 1
Location of Vaal Dam in Upper Vaal Water Management Area in South Africa (Modified from DWA, 2010)







Round-up: Tailored products

- The tailored forecasts shown are in agreement with the rainfall forecasts for Southern Africa
  - Increased farm rainfall and crop yield
  - Increased malaria occurrence over Limpopo
  - Increased inflow into Lake Kariba
- The low Vaal Dam downstream flow forecast may be a result of the relatively dry spring season in central and western parts of the catchment

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WATER RESEARCH COMMISSION

The forecast is produced by Prof Willem Landman of the University of Pretoria, South Africa, and issued on or around the 15th of each month. Please feel free to contact me at WALandman1981@gmail.com

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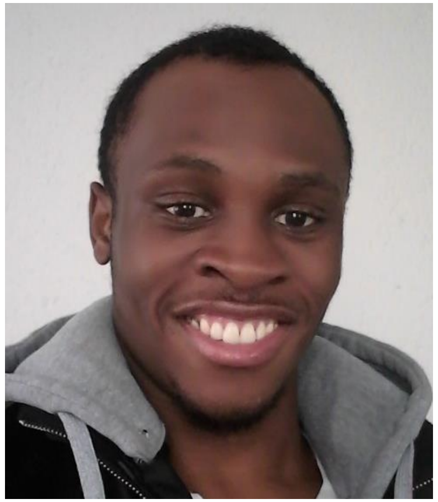
Disclaimer: The author has compiled this forecast guidance as a service to users for application in appropriate sectors, but cannot be held responsible for inaccuracies contained therein

Student participation in forecast system development

Stephanie Hinze, BSc (Honours)(Meteorology):
Statistical downscaling using large and high-resolution data sets, forecast displays for SADC rainfall and maximum temperatures, forecast verification



Surprise Mhlongo, BSc (Honours)(Meteorology):
Improving on SST forecast system through pattern correction, correlation vs covariance approaches, forecast output combination (multi-model approaches), mean and bias correction, and correct for skill

Shepherd Muchuru, PhD (Meteorology):
Statistical modelling to relate large-scale features to seasonal inflows into Lake Kariba in southern Africa. Two predictions systems: 1) using antecedent seasonal rainfall totals over the upper Zambezi catchment as predictor in a baseline model, and 2) using predicted low-level atmospheric circulation of a coupled ocean–atmosphere general circulation model as predictor.

Pearl Gosiame, BSc (Honours)(Meteorology):
Development of hydro-climate predictions models for dam levels and downstream flows of the Vaal Dam. Predictors considered include historical rainfall over the catchment, SST and output from global climate models.