# Seasonal forecasts

## presented by:


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# Seasonal Forecast Worx

https://tinyurl.com/ybrb3a72


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NMME The North American Multi-Model Ensemble

Latest Update: 17 January 2022

- 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).

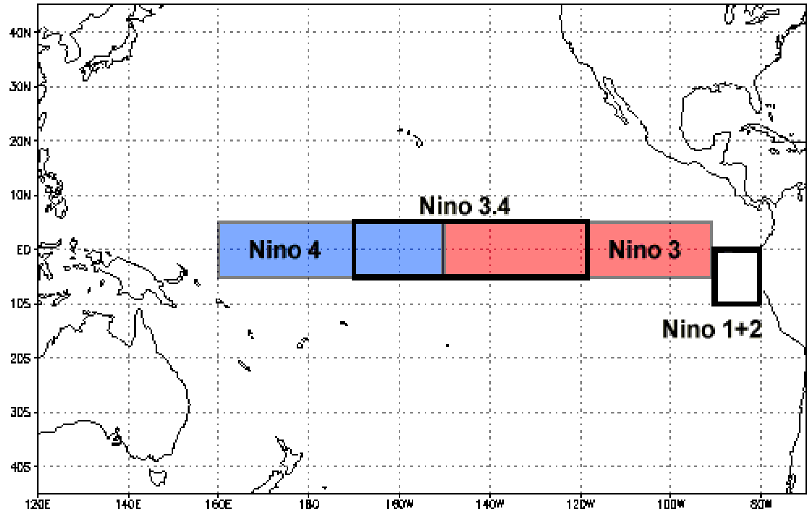
- For the official seasonal forecast for South Africa, visit the South African Weather Service website at http://www.weathersa.co.za/images/data/longrange/gfcsa/scw.pdf

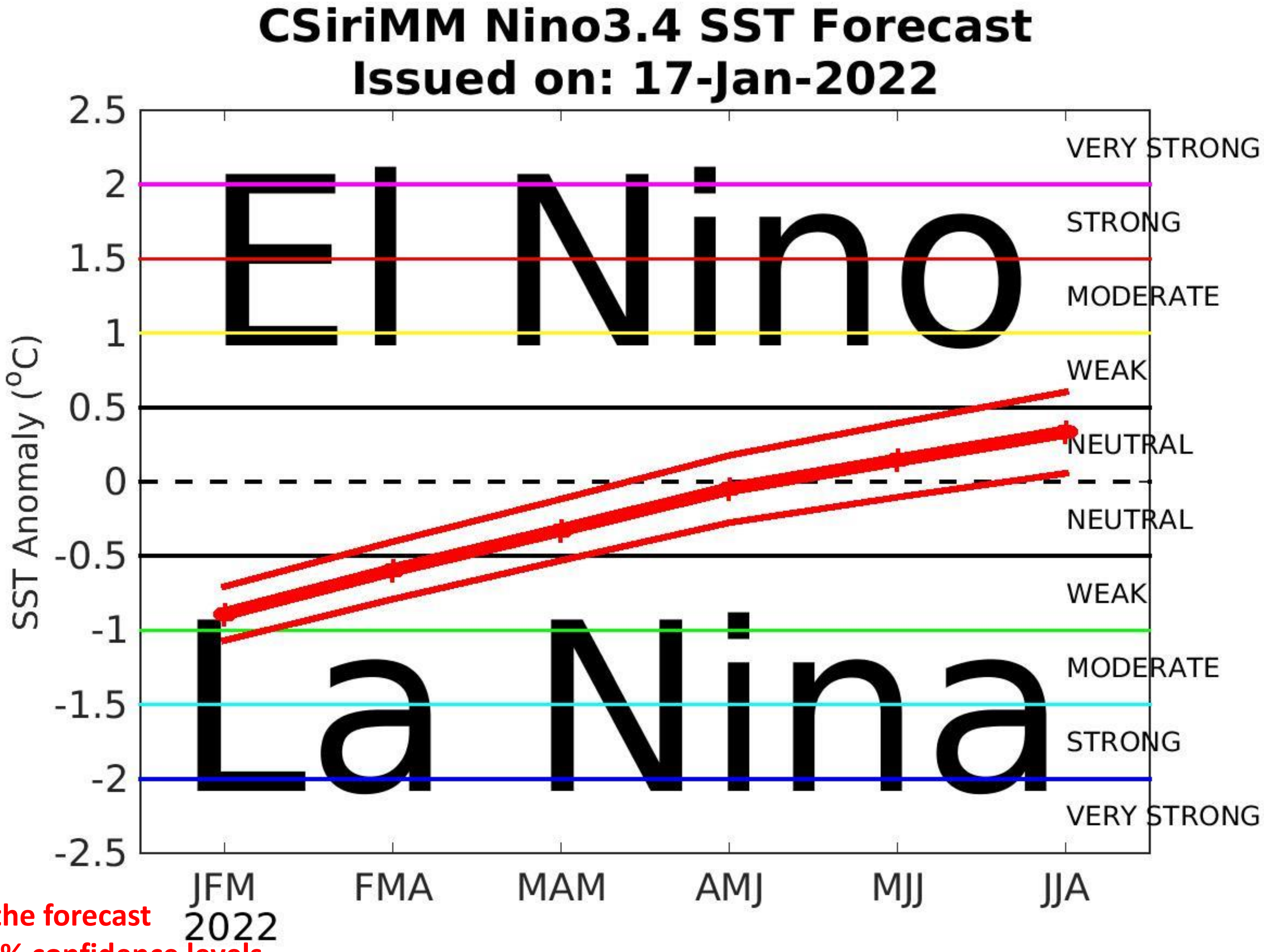
South African Weather Service

# 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

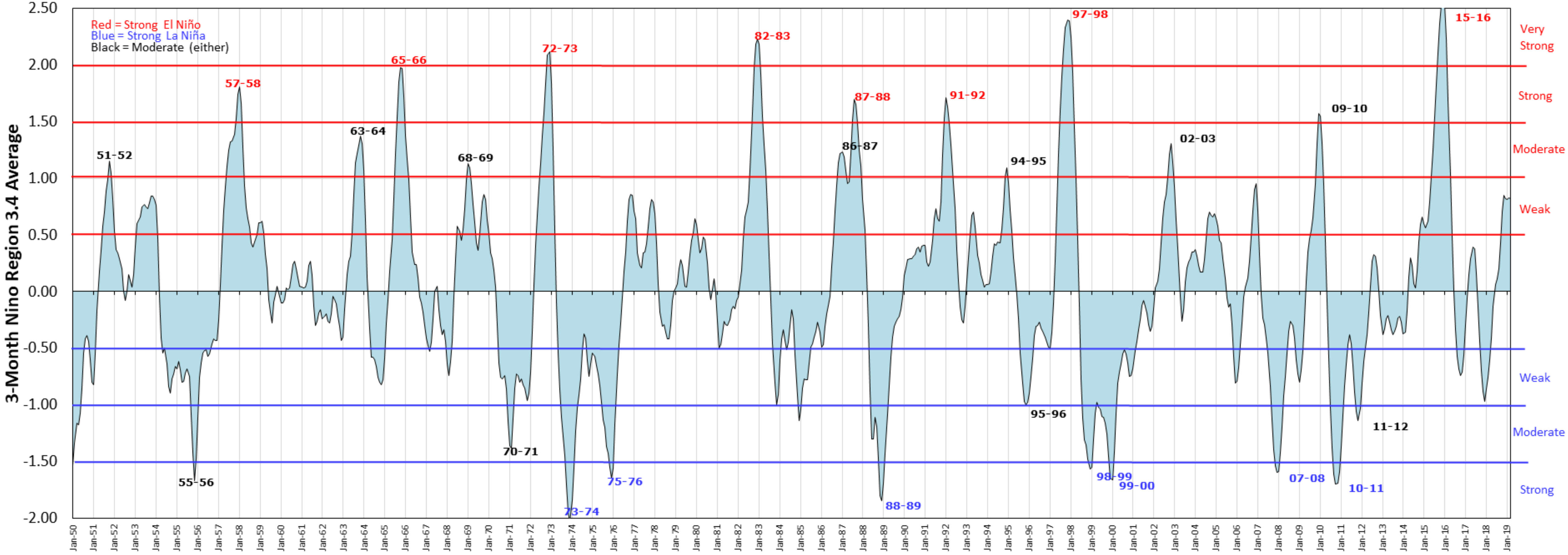





Middle red line: the forecast
Thin red lines: 25% confidence levels

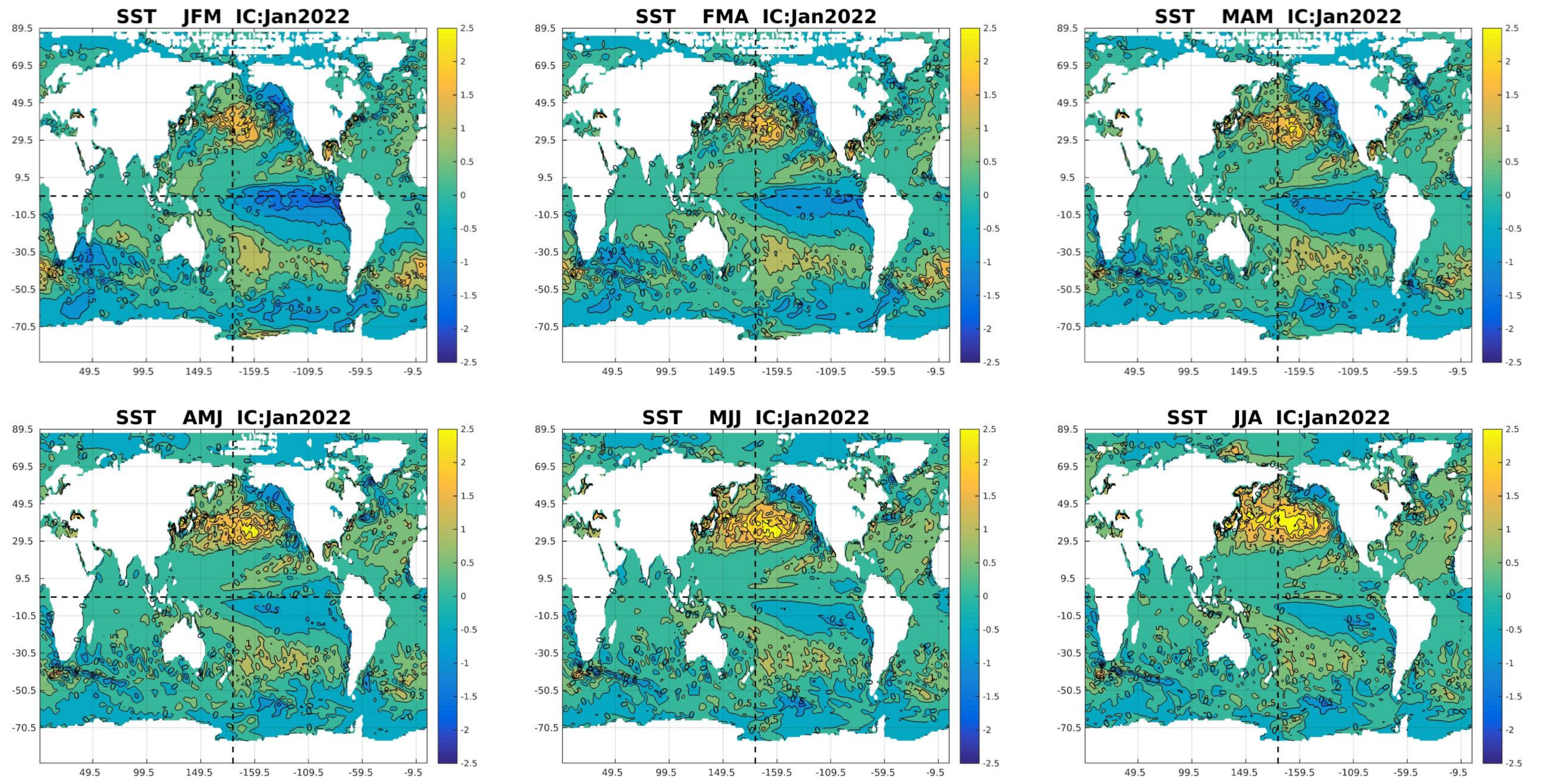
# Oceanic Niño Index (ONI)

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml



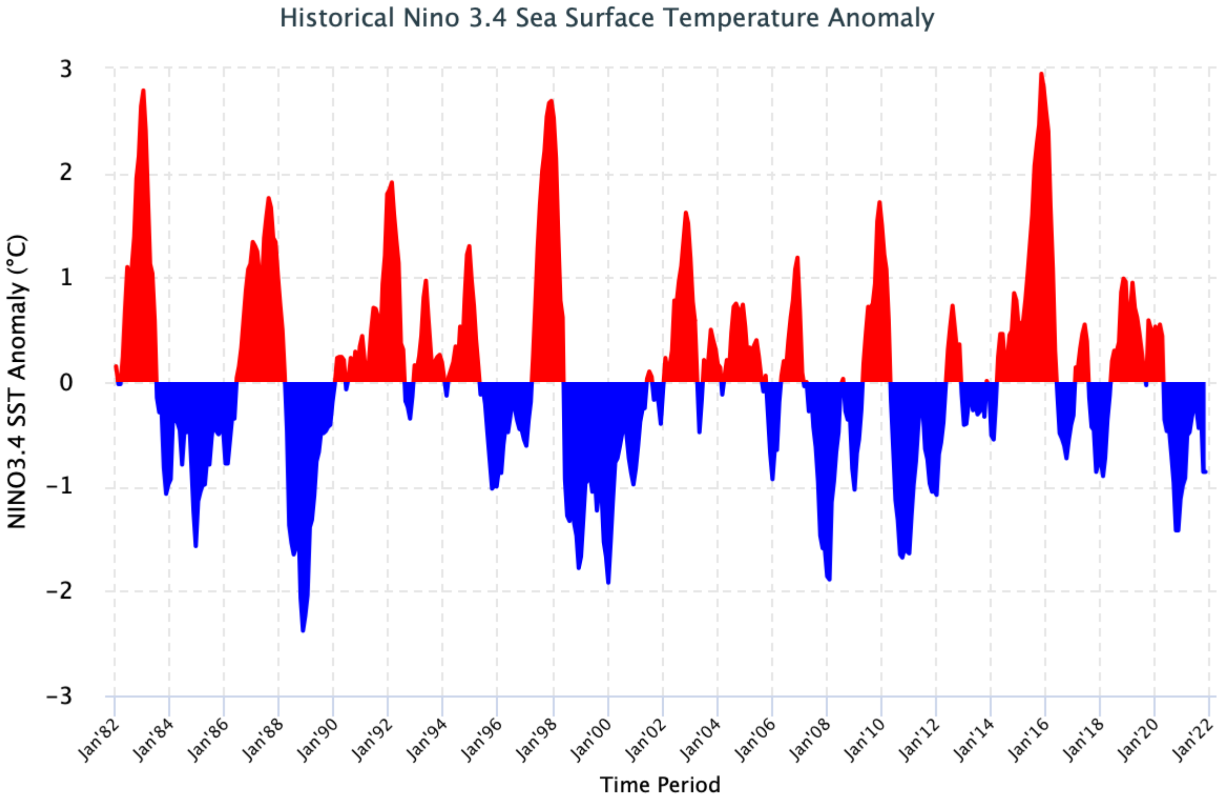
IC: the month in which the forecast was made

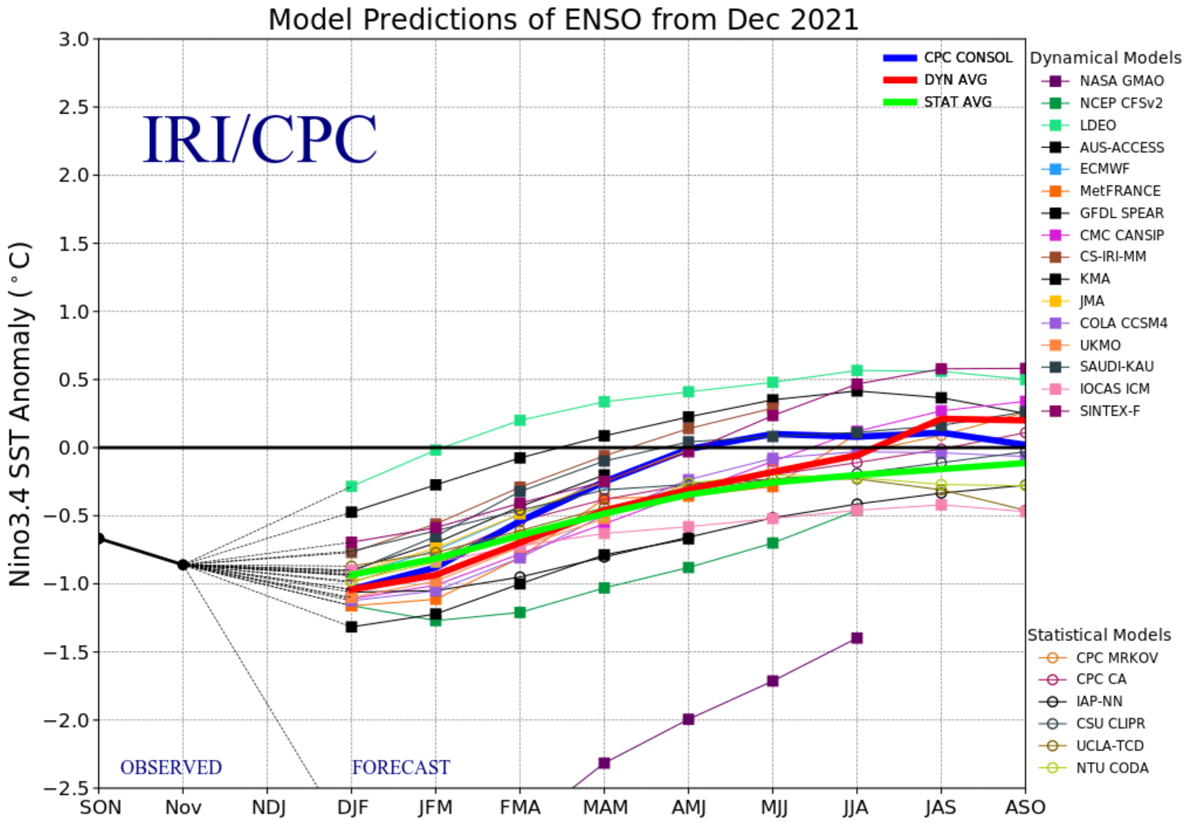
# SST anomalies (in °C, where blue is cooler and orange is warmer)



# Round-up: ENSO

- The UP model predicts weak La Niña conditions during summer; ENSO-neutral conditions develop after that – agrees with most models during summer months:



# 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

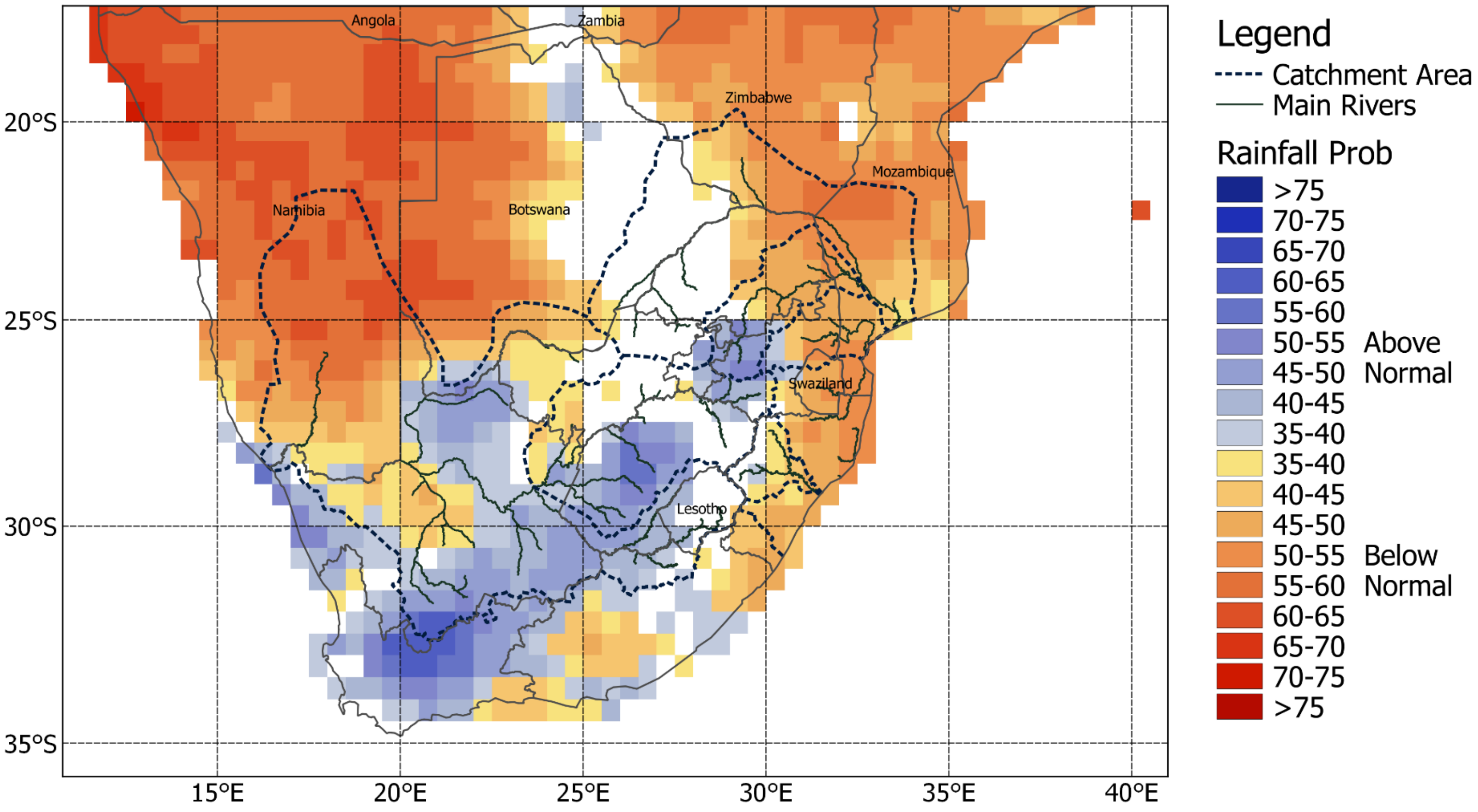
Probabilistic forecasts can help users understand risks and opportunities (forewarned is forearmed) in order to make more informed decisions.

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.

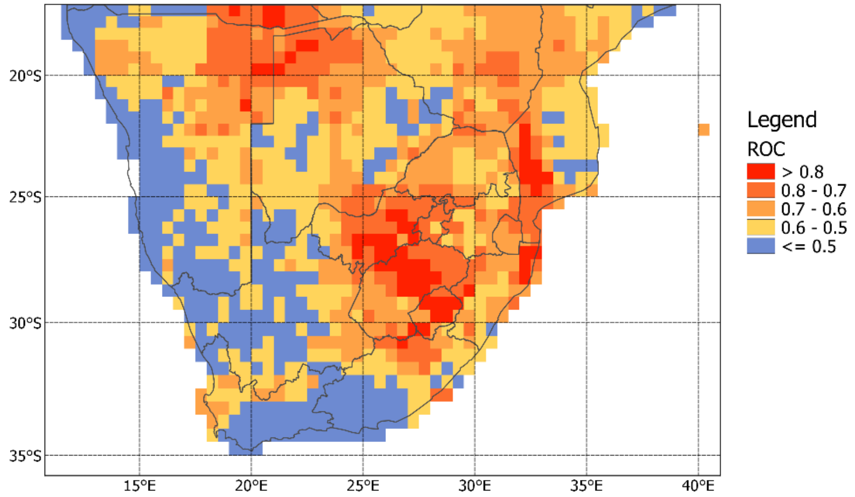
The nature of a probabilistic forecast implies that the less likely outcomes are always possible. In fact, for the probabilistic forecasts to be considered reliable, the less likely outcomes will and must occasionally occur.

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

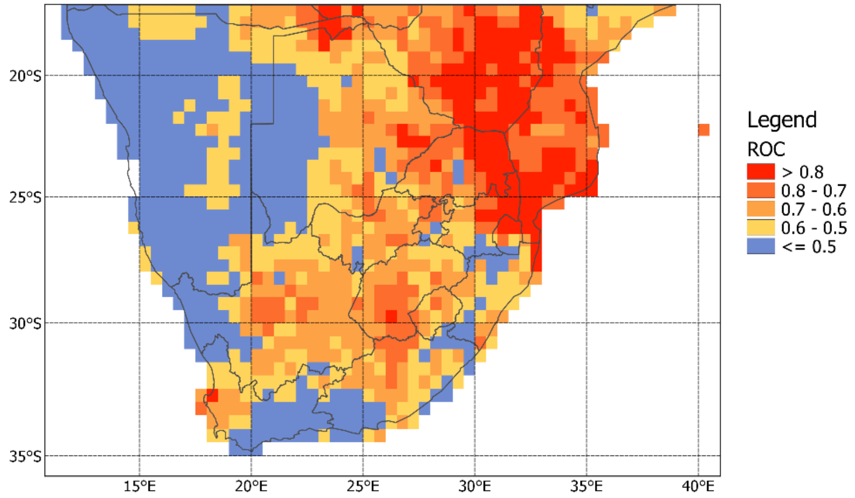
# JFM 2022 Rainfall; ICs: Jan



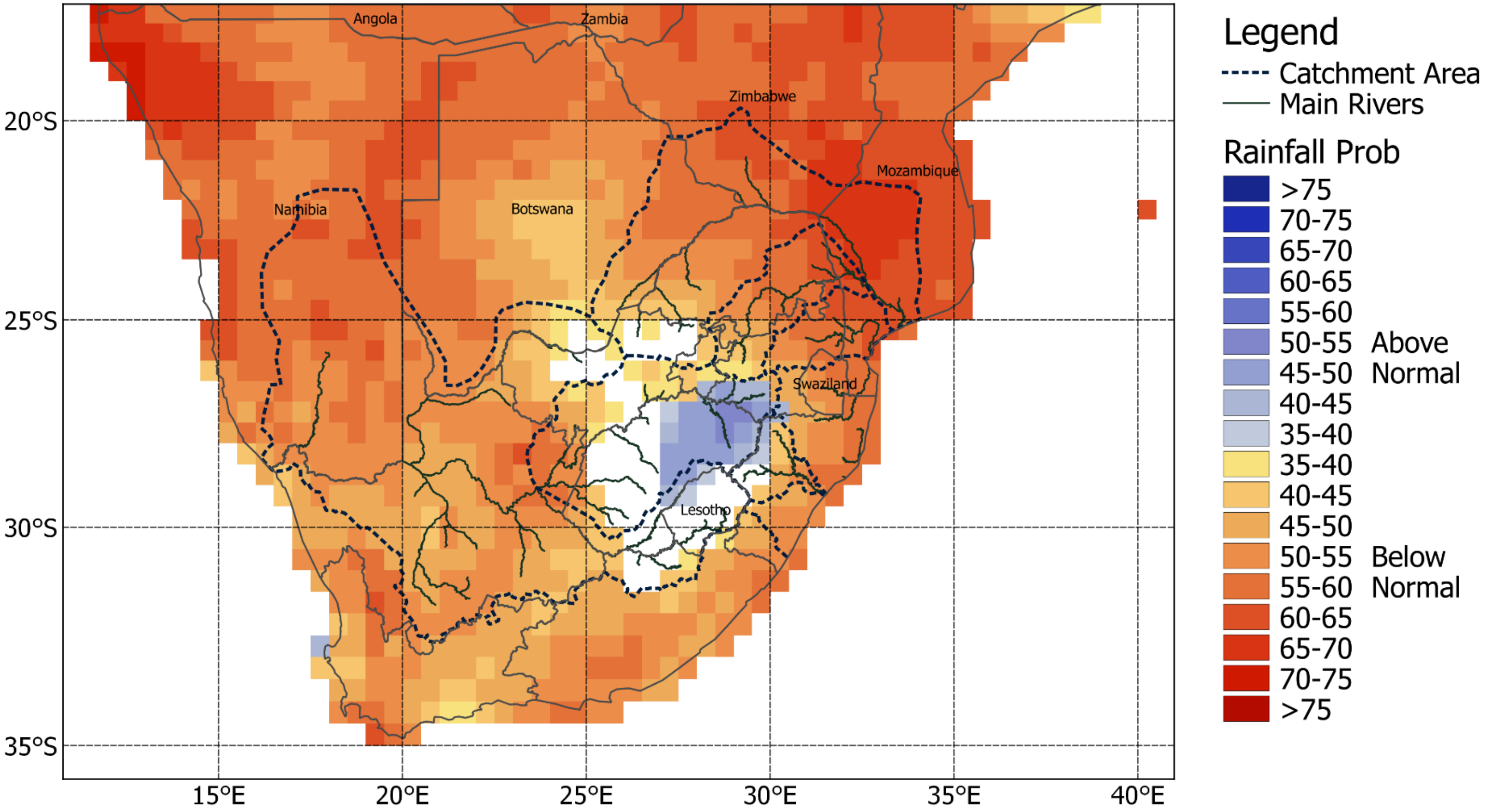

## ROC Area (Above-Normal): JFM Rainfall



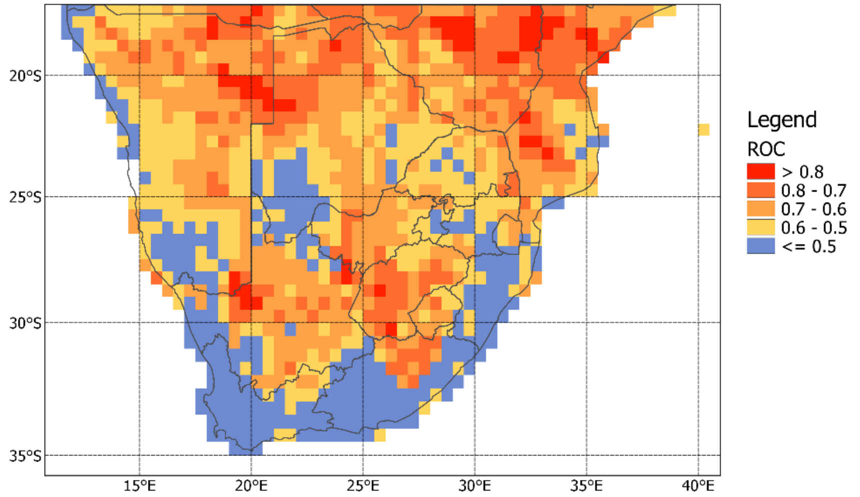

## ROC Area (Below-Normal): JFM Rainfall



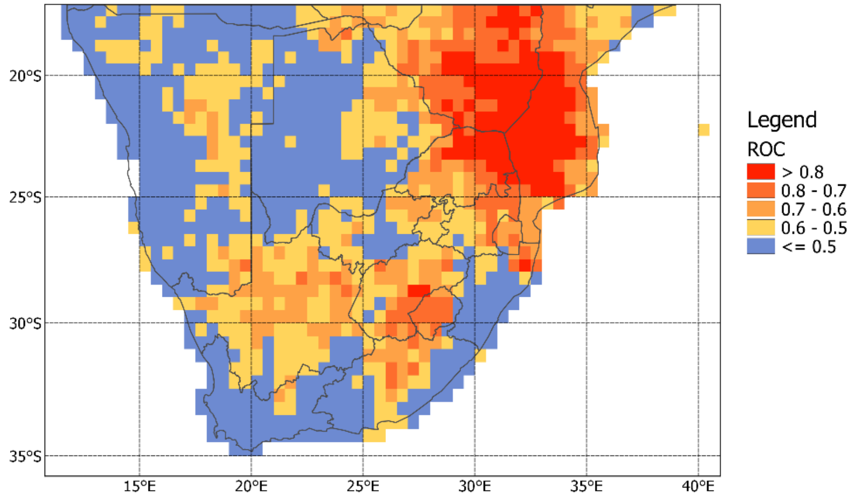
# FMA 2022 Rainfall; ICs: Jan



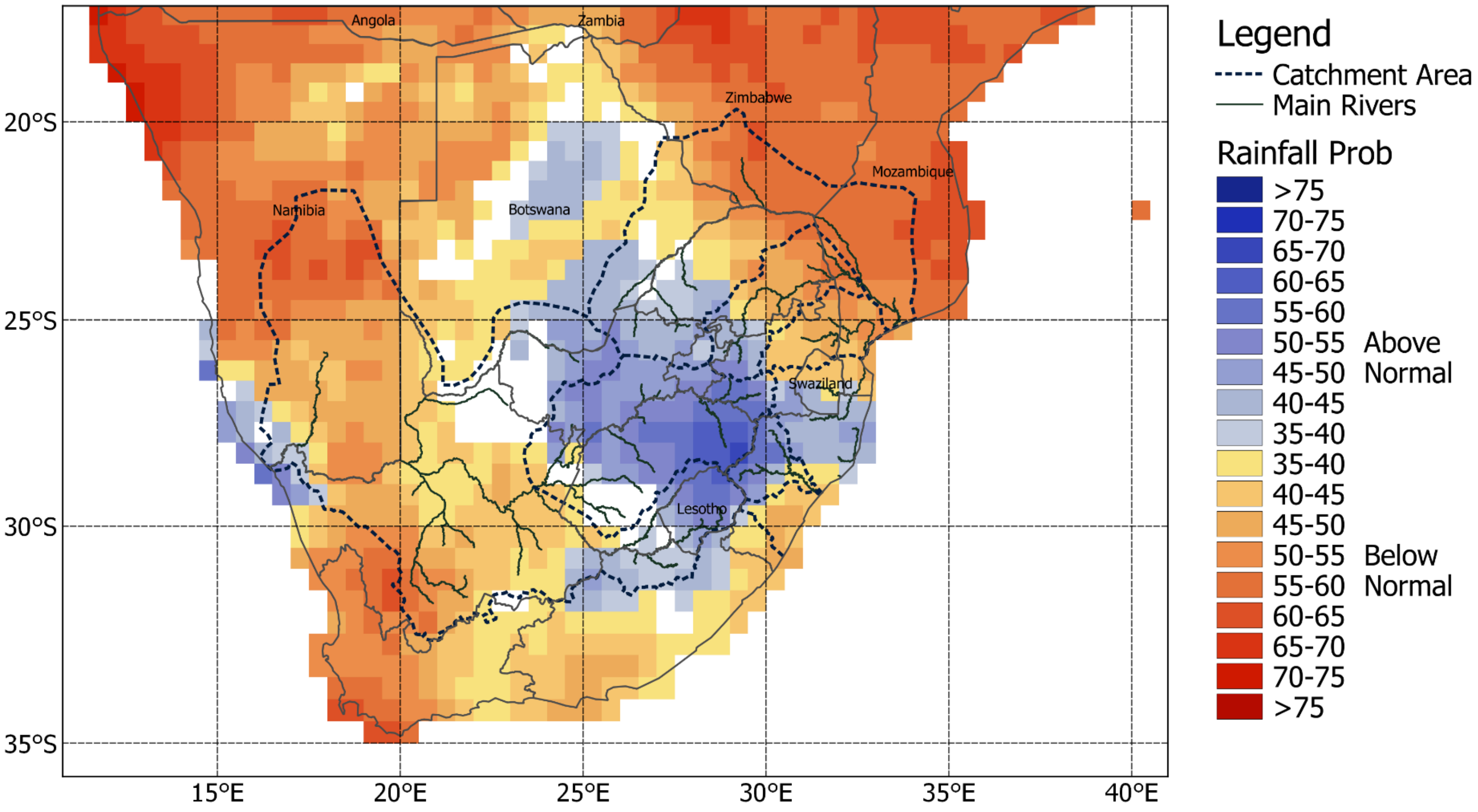

## ROC Area (Above-Normal): FMA Rainfall



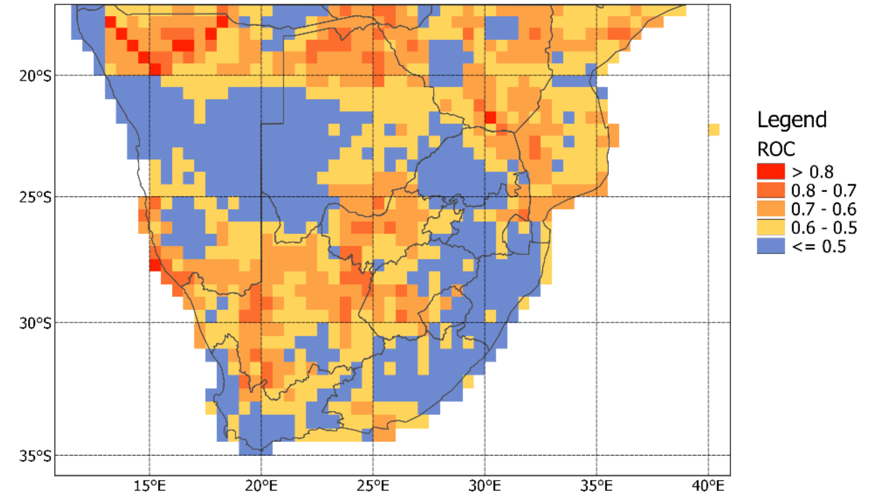

## ROC Area (Below-Normal): FMA Rainfall



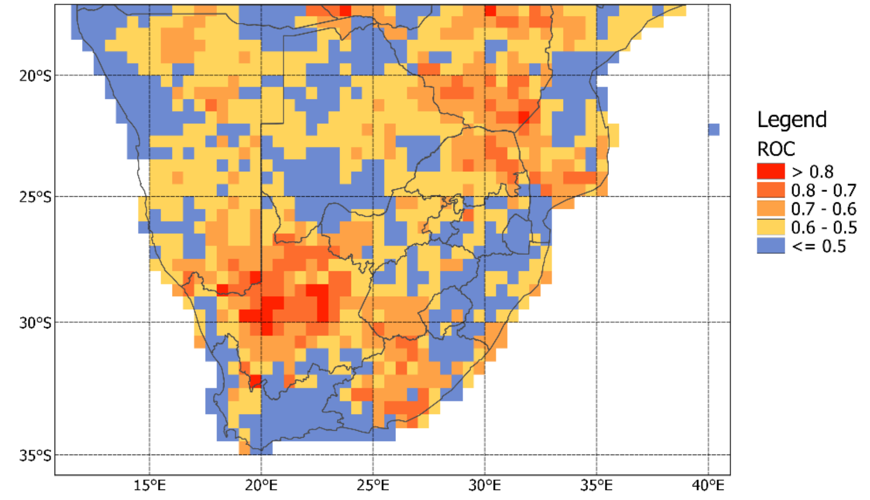
# MAM 2022 Rainfall; ICs: Jan



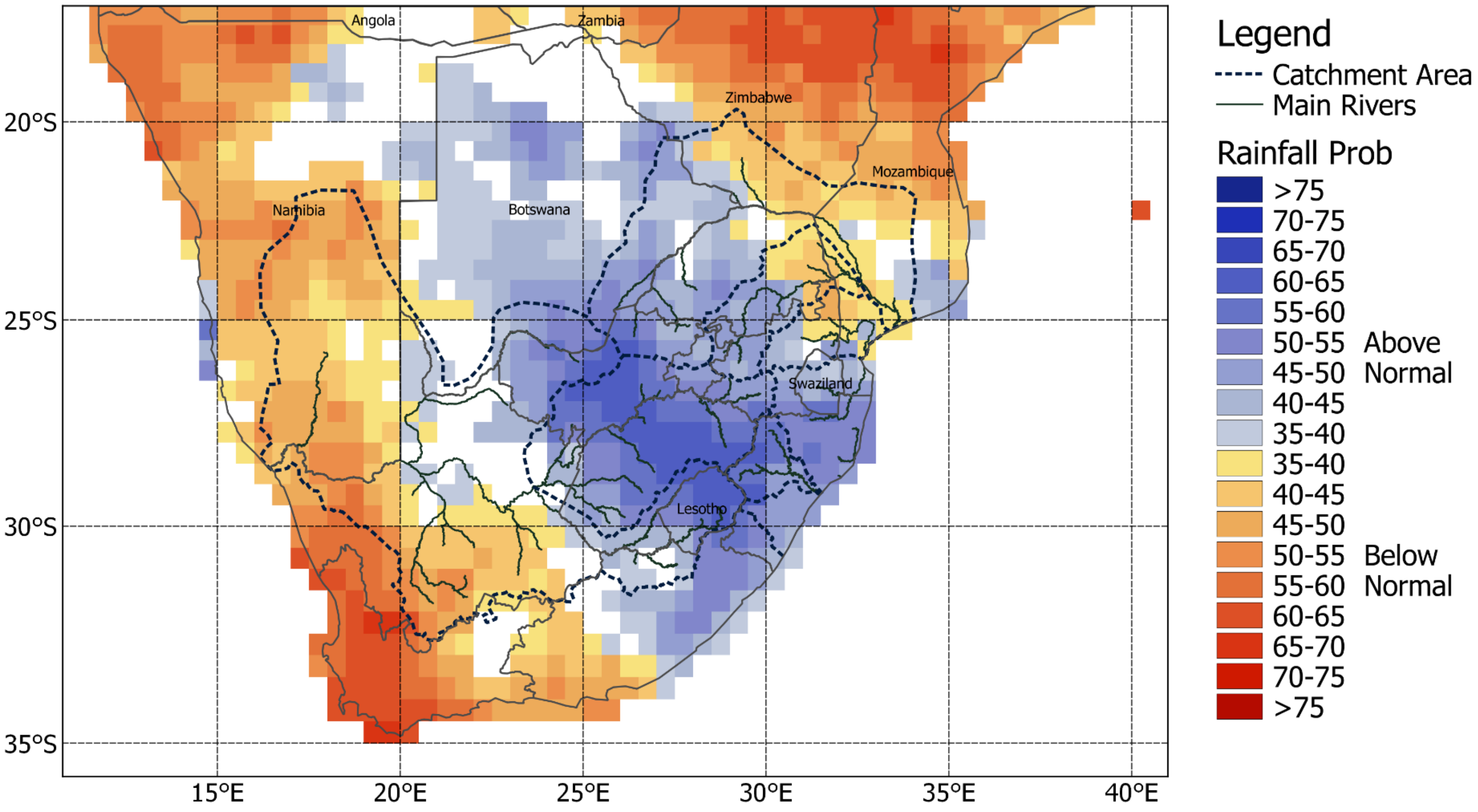

## ROC Area (Above-Normal): MAM Rainfall




## ROC Area (Below-Normal): MAM Rainfall

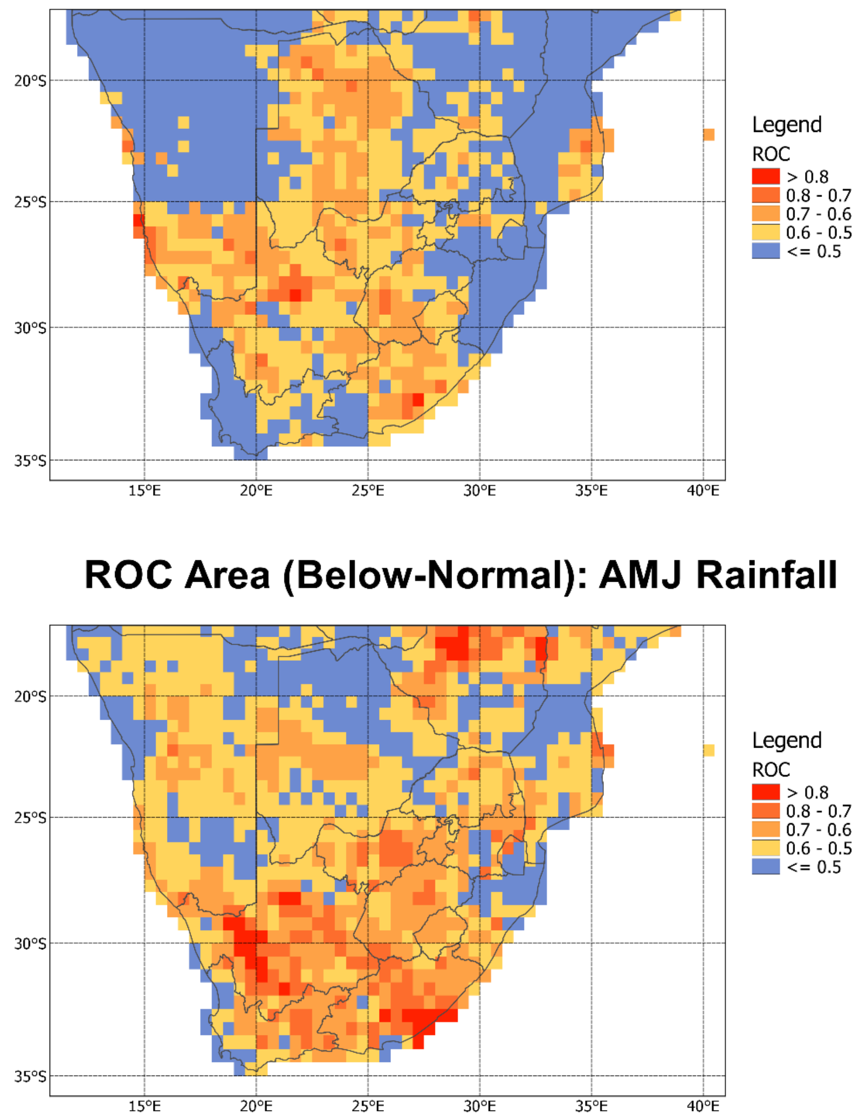


# AMJ 2022 Rainfall; ICs: Jan




## ROC Area (Above-Normal): AMJ Rainfall

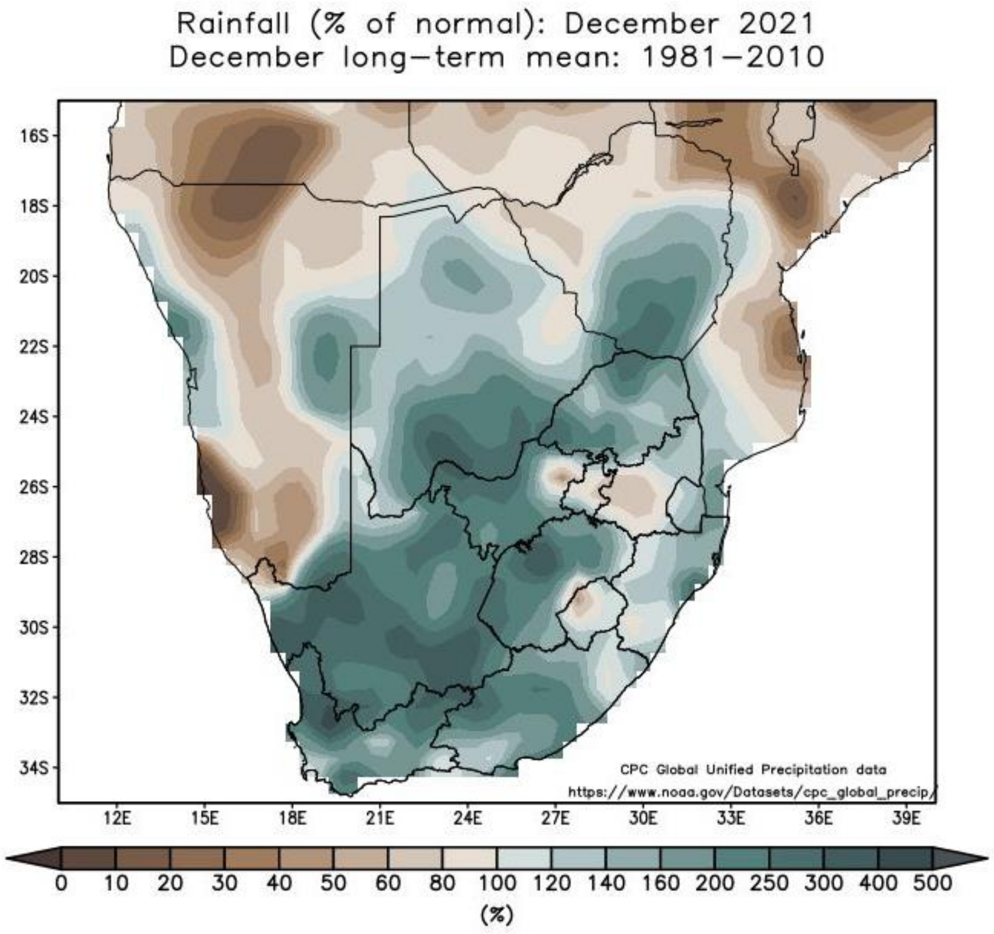
## ROC Area (Below-Normal): AMJ Rainfall

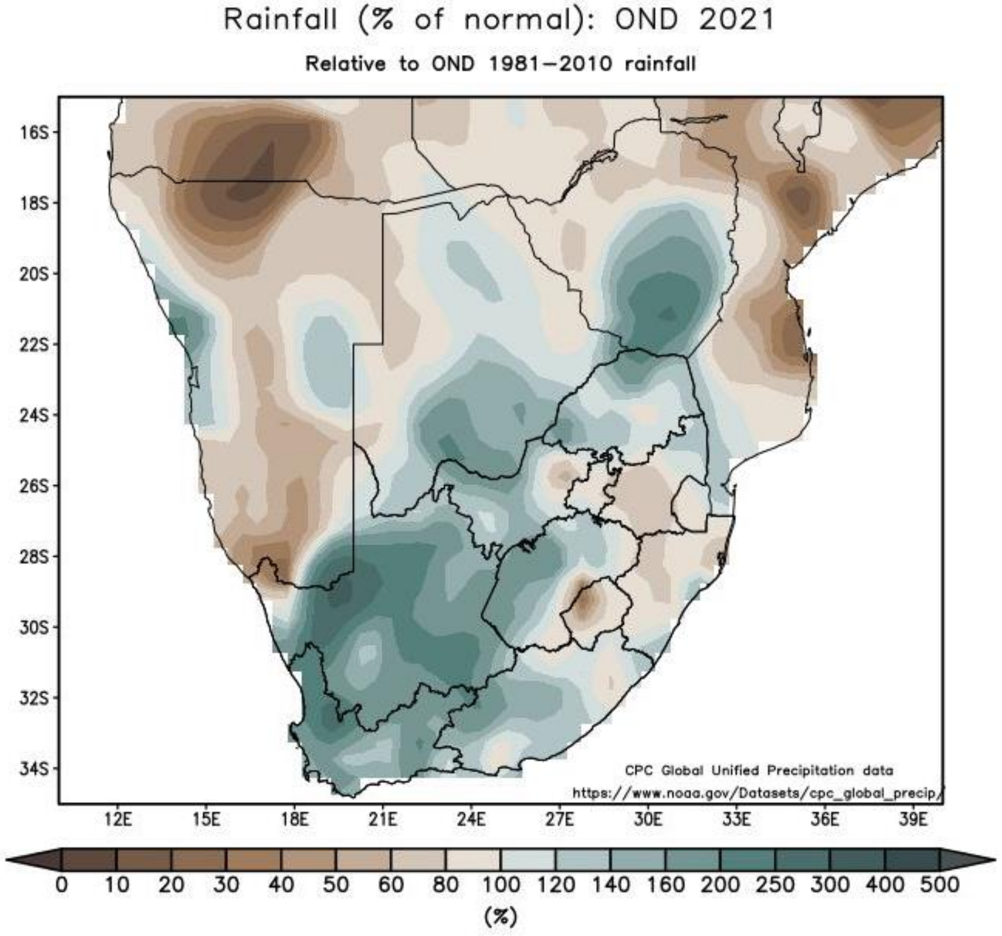


# Round-up: SADC Rainfall

- The probability of above-normal rainfall totals across the region during the second half of the summer season has decreased considerably from last month’s forecast
- Enhanced probabilities for wet conditions, however, increase again towards late autumn over the central and north-eastern parts
- The S and SW Cape, drier than normal conditions are probable in autumn and early winter

# Observed SADC Rainfall

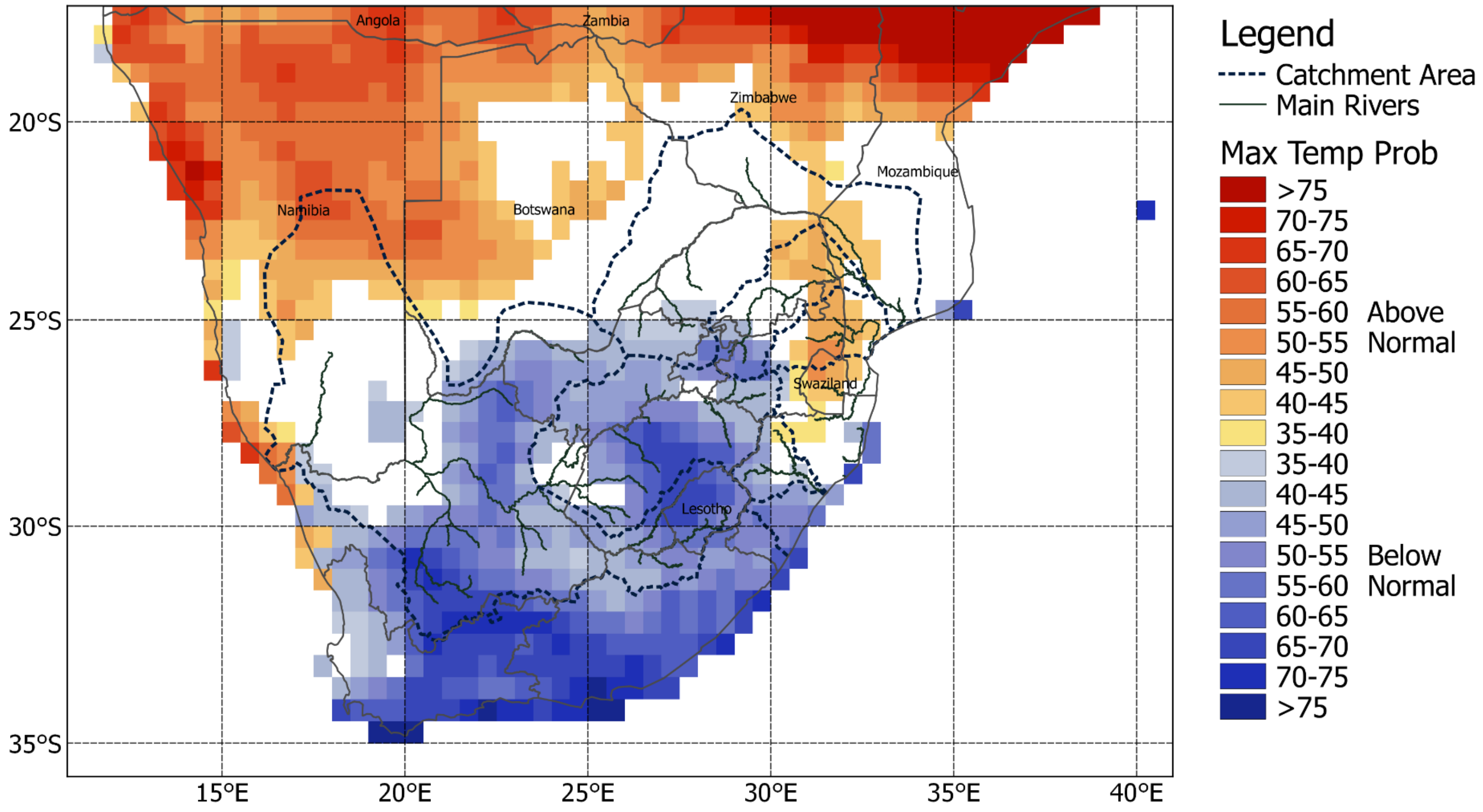


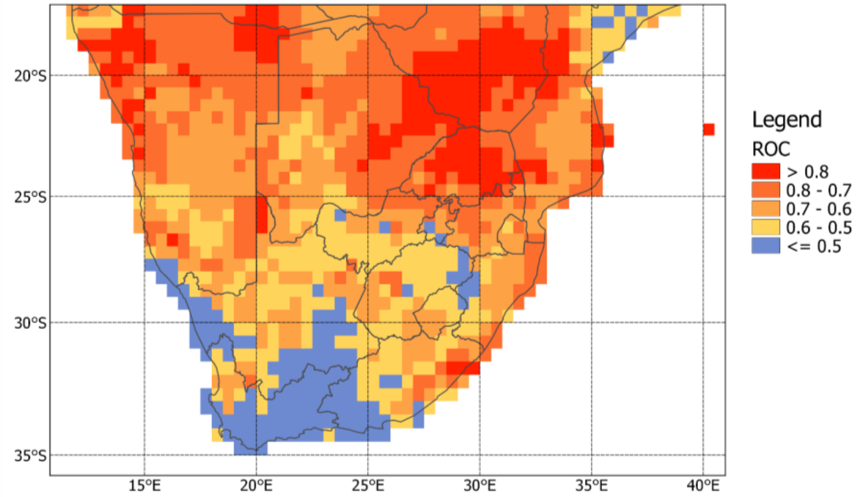

Recorded rainfall for December and the Oct-Nov-Dec season show below-normal rainfall over the brown areas and above-normal rainfall over the green areas

Maps prepared by Dr. Christien Engelbrecht

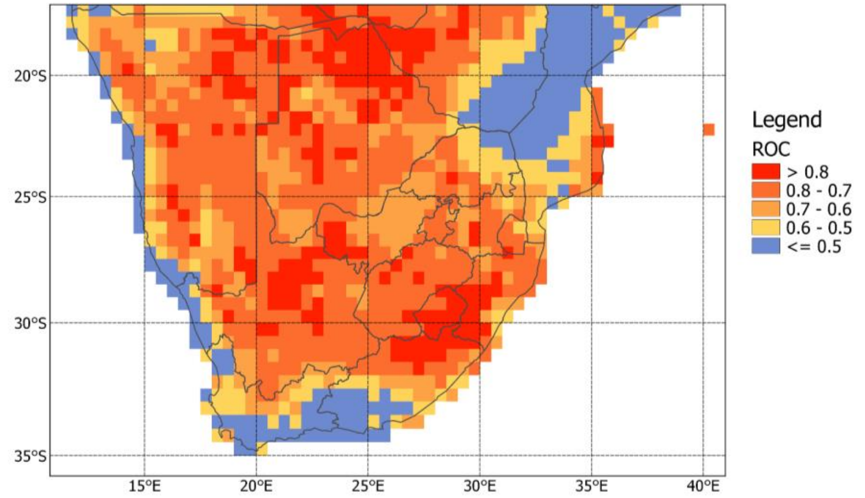
# JFM 2022 Max Temp; ICs: Jan



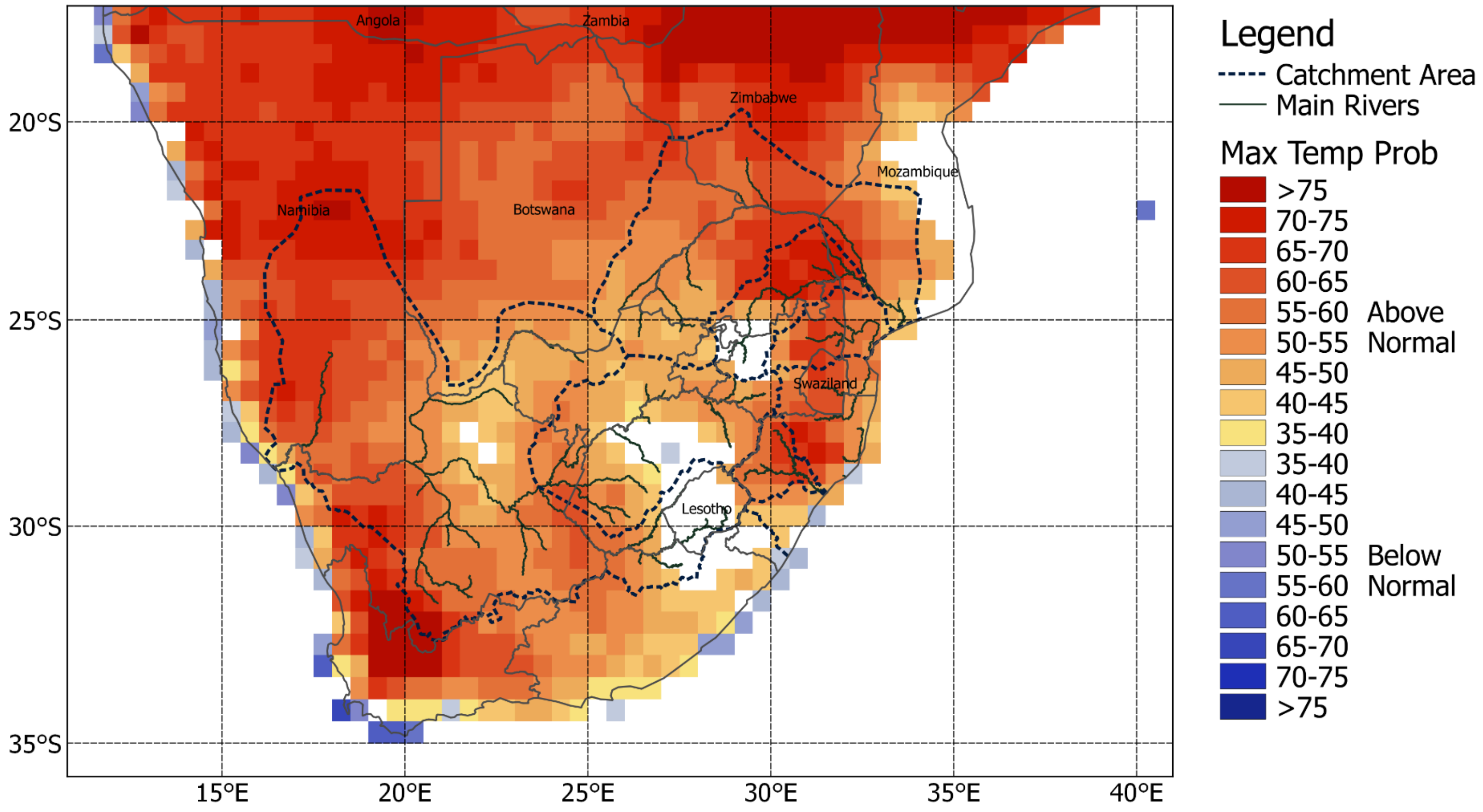

## ROC Area (Above-Normal): JFM Max Temp



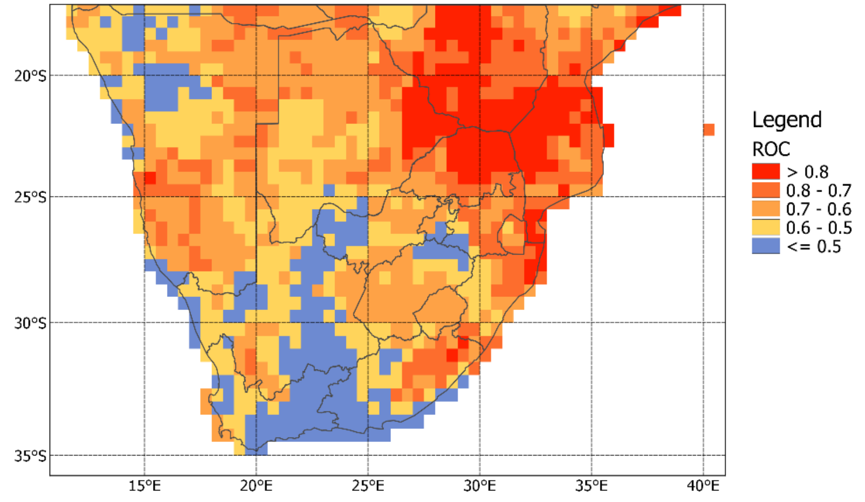

## ROC Area (Below-Normal): JFM Max Temp



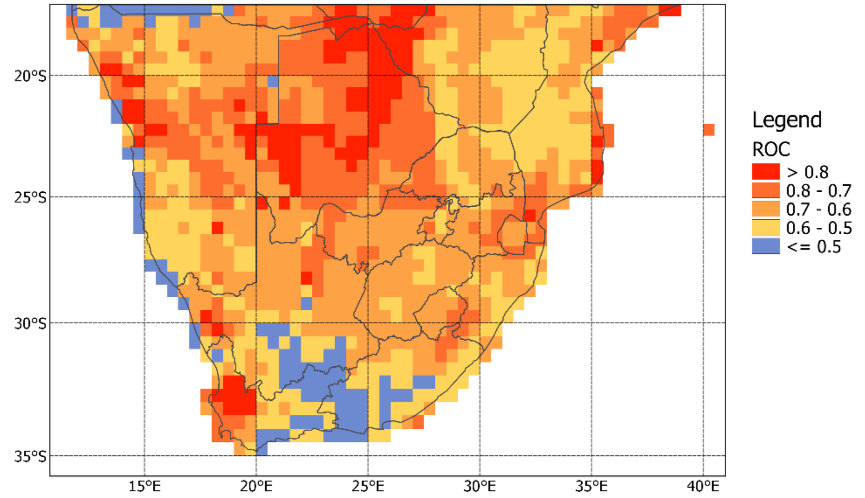
# FMA 2022 Max Temp; ICs: Jan



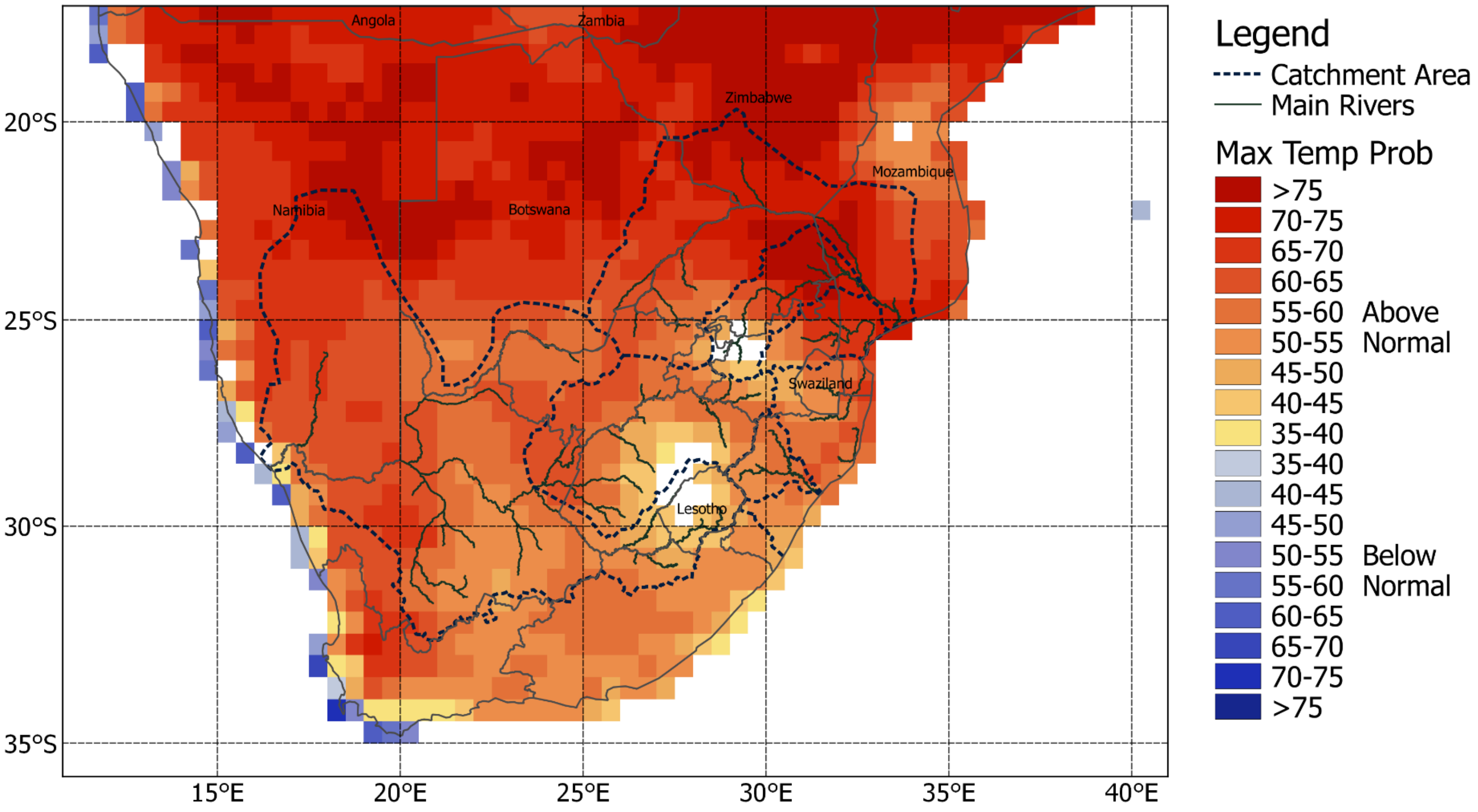

## ROC Area (Above-Normal): FMA Max Temp



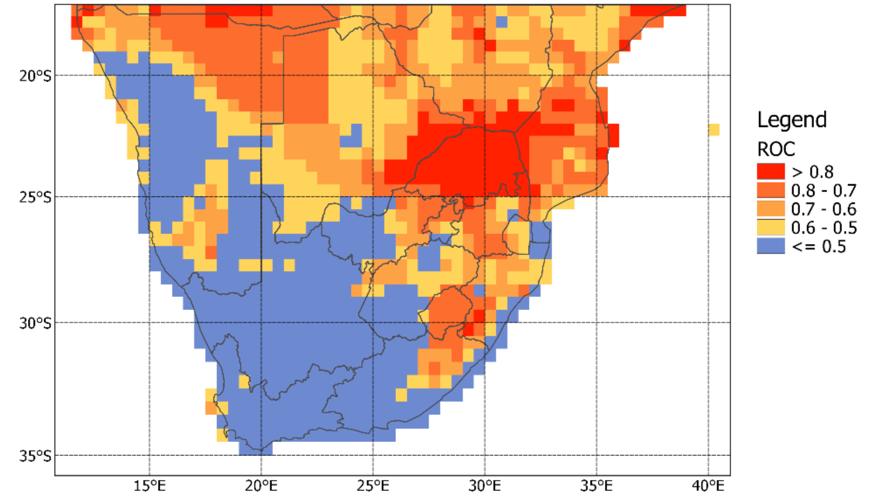

## ROC Area (Below-Normal): FMA Max Temp



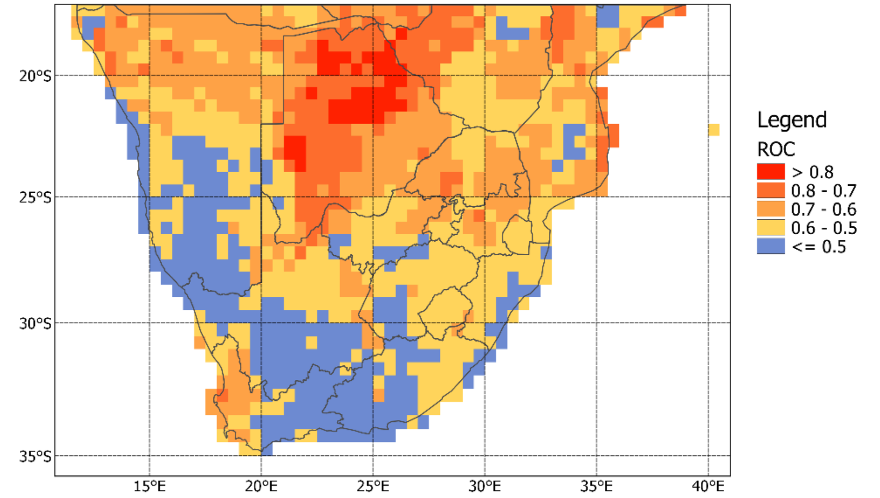
# MAM 2022 Max Temp; ICs: Jan



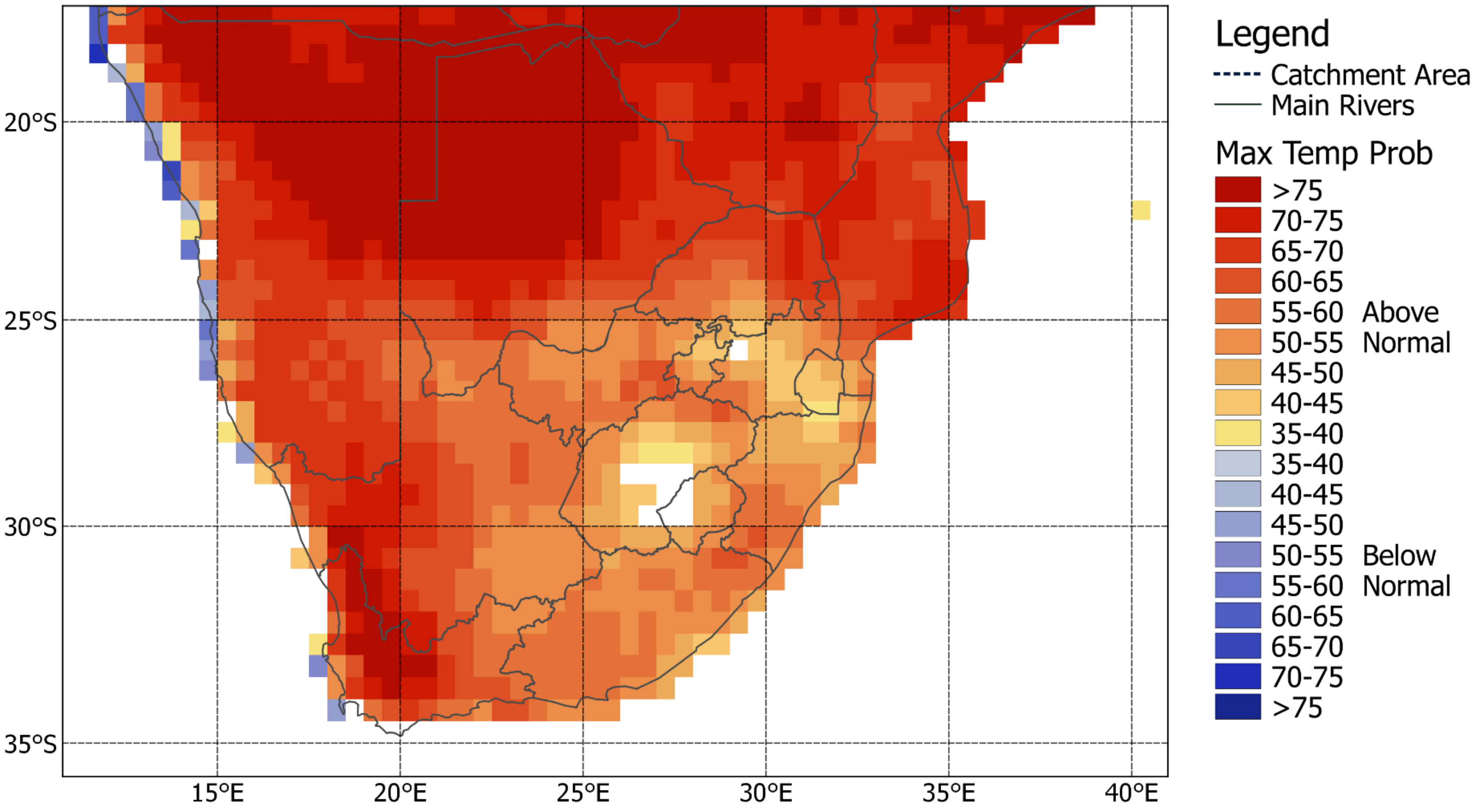

## ROC Area (Above-Normal): MAM Max Temp



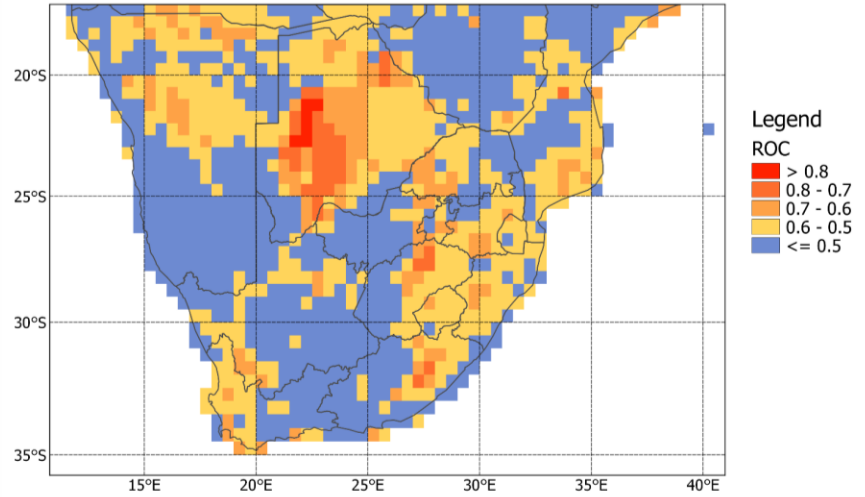

## ROC Area (Below-Normal): MAM Max Temp



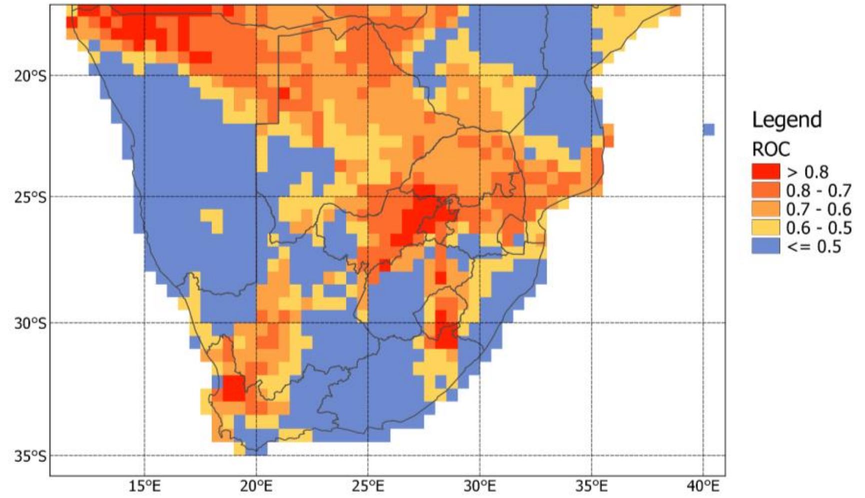
# AMJ 2022 Max Temp; ICs: Jan




## ROC Area (Above-Normal): AMJ Max Temp




## ROC Area (Below-Normal): AMJ Max Temp



# Round-up: SADC Max Temp

- Cooler and near-normal maximum temperatures are expected over the larger part of the region at first
- Warmer than average conditions are likely to set in and remain for the forecast period into early winter

# Tailored Forecasts

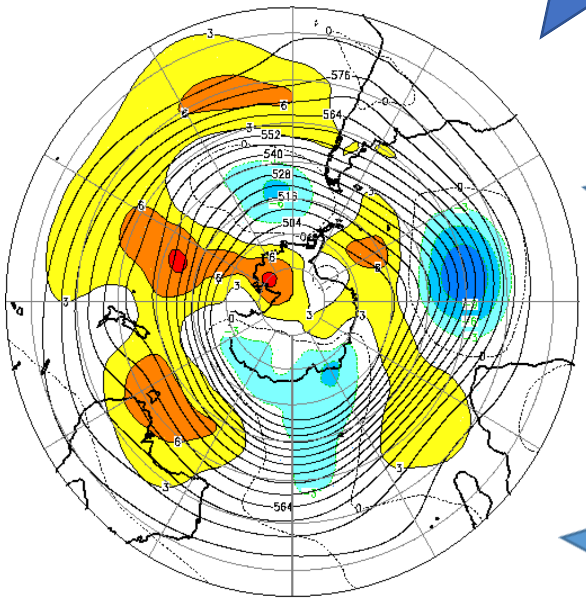
Translating forecasts into indices on a range of relevant space and time scales that can inform regional decision-making. The following forecasts are shown to indicate the potential of seasonal forecasting for real-life applications

1. **Probabilistic rainfall forecast for Jan-Feb-Mar 2022 for the farm Buschbrunnen near Grootfontein, Namibia**
2. **Probability of exceedance Jan-Feb-Mar 2022 downstream flow forecasts for Vaal Dam**
3. **Probability of exceedance Mar-Apr-May 2022 inflow forecast for Lake Kariba, Zambia/Zimbabwe**

# 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**

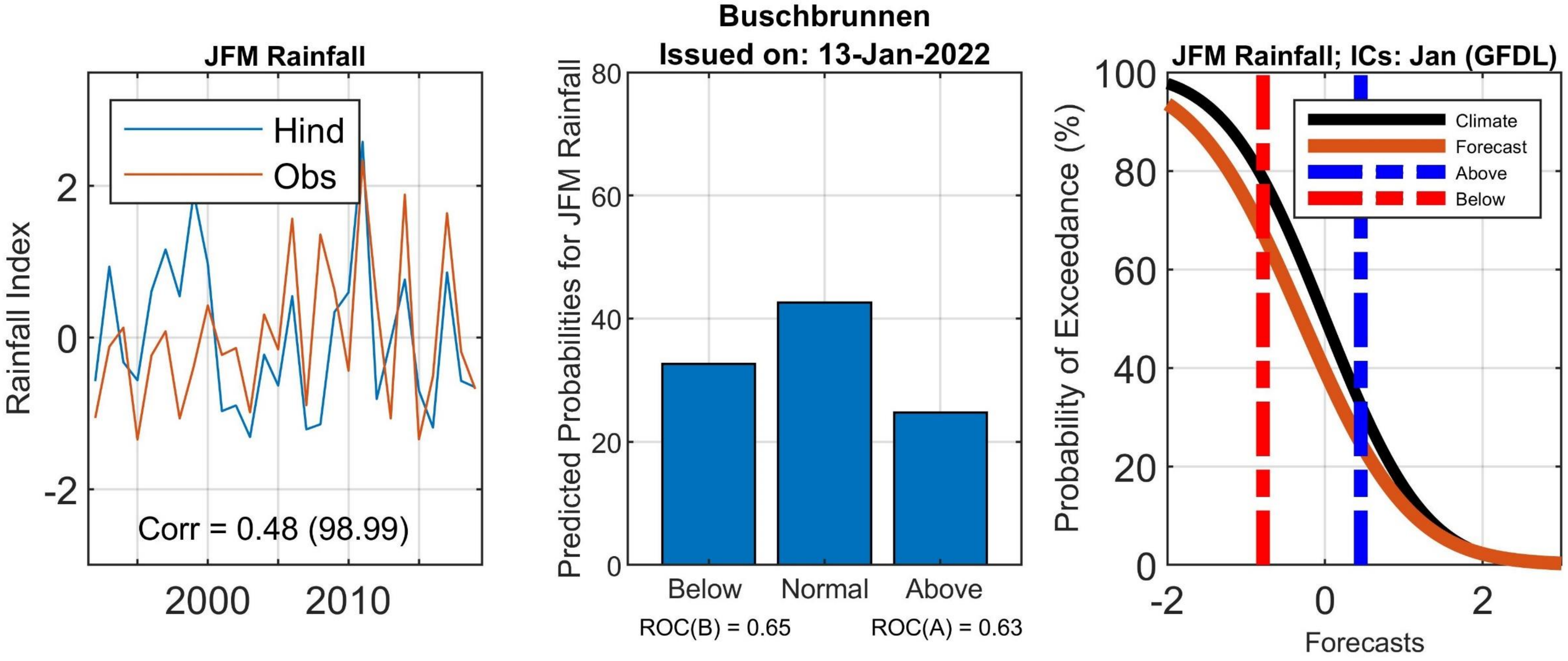
**Riverflow**

**Malaria**

**Dry-land crop yield**

# JFM rainfall forecast for the farm Buschbrunnen near Grootfontein, Namibia

Landman et al. (2016)



# Current Project, administered by the WRC: *RainSolutions*

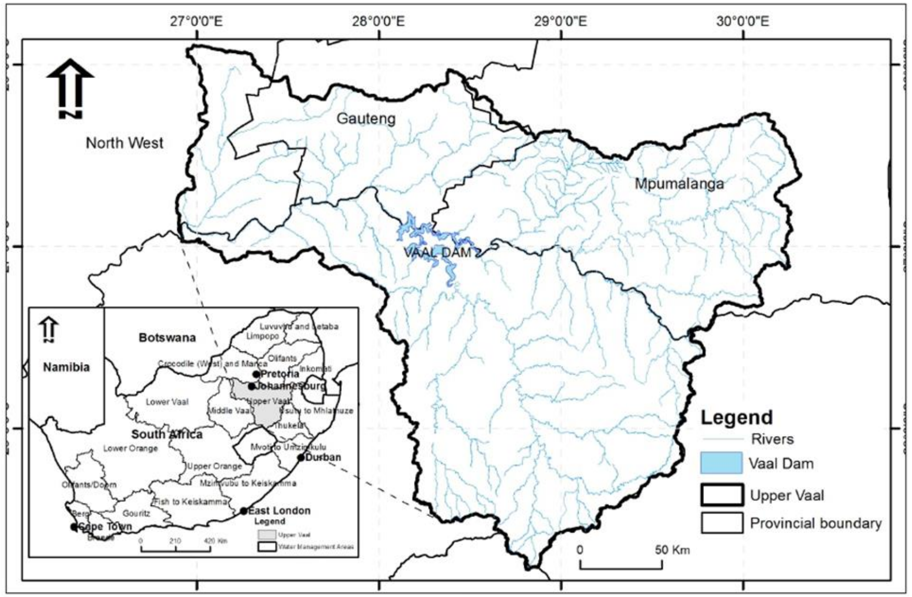
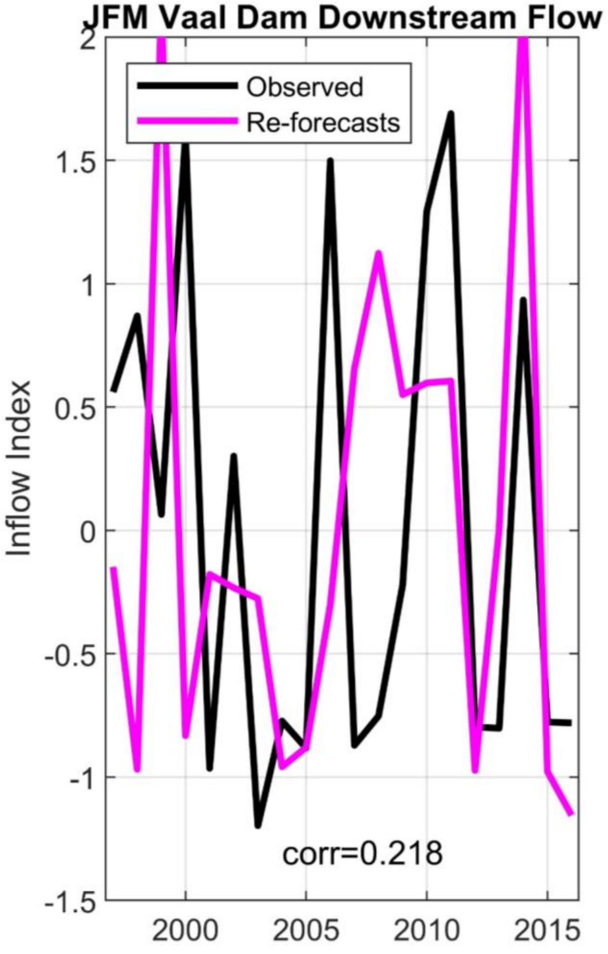
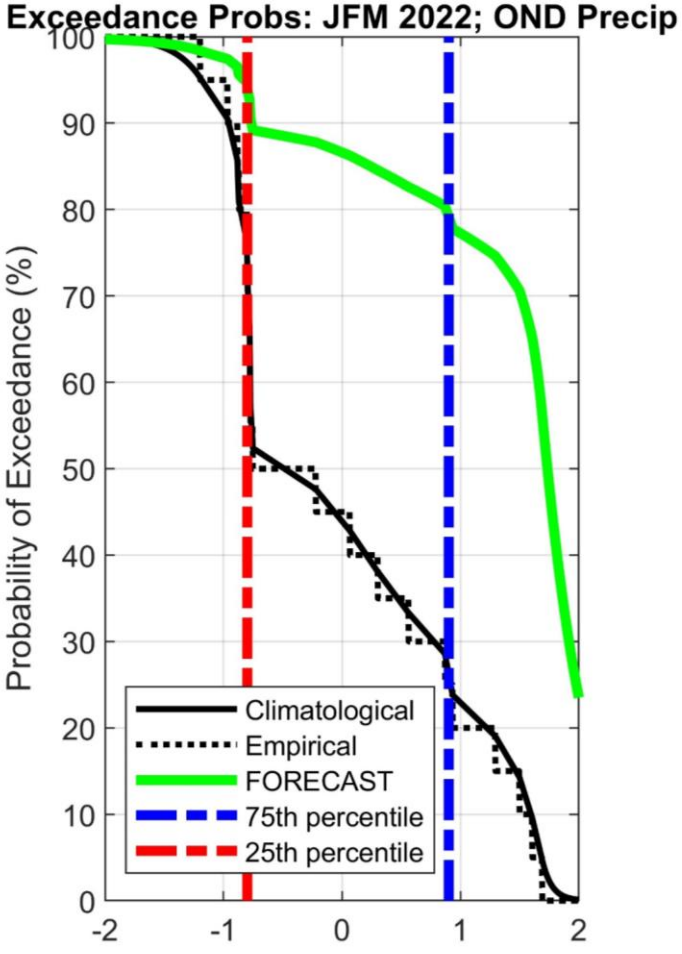



*Figure 1*

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

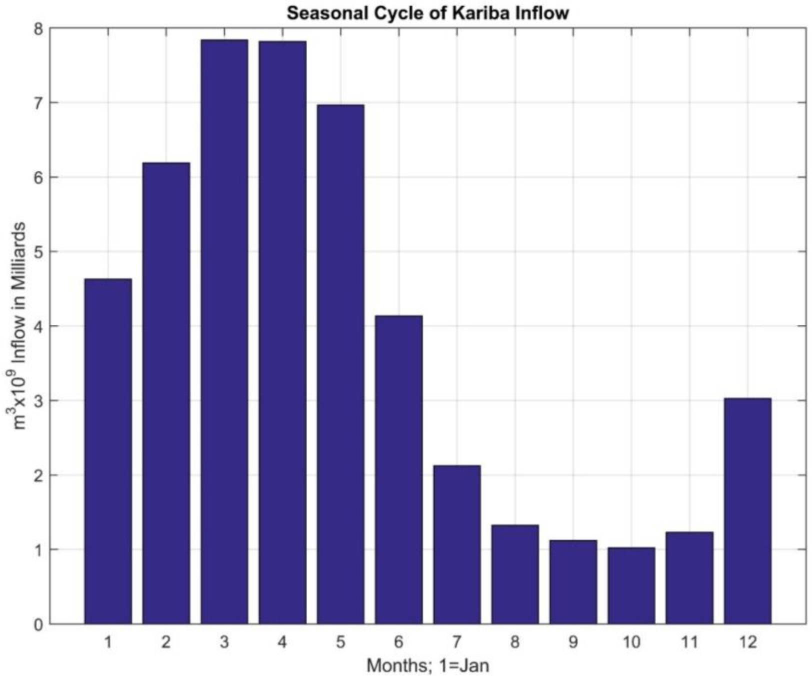


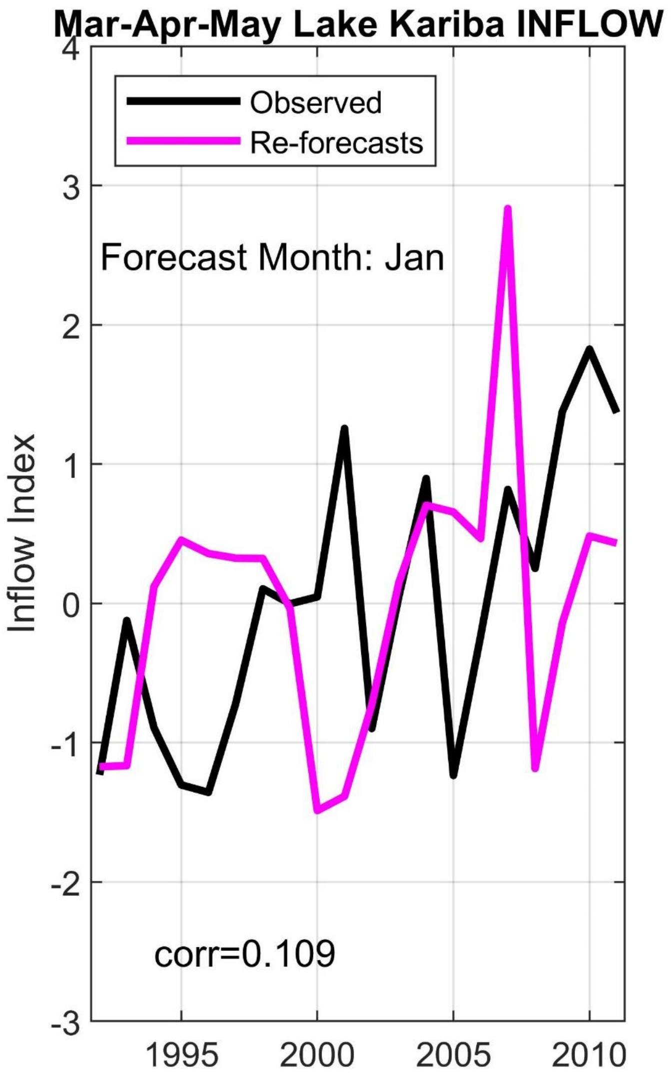



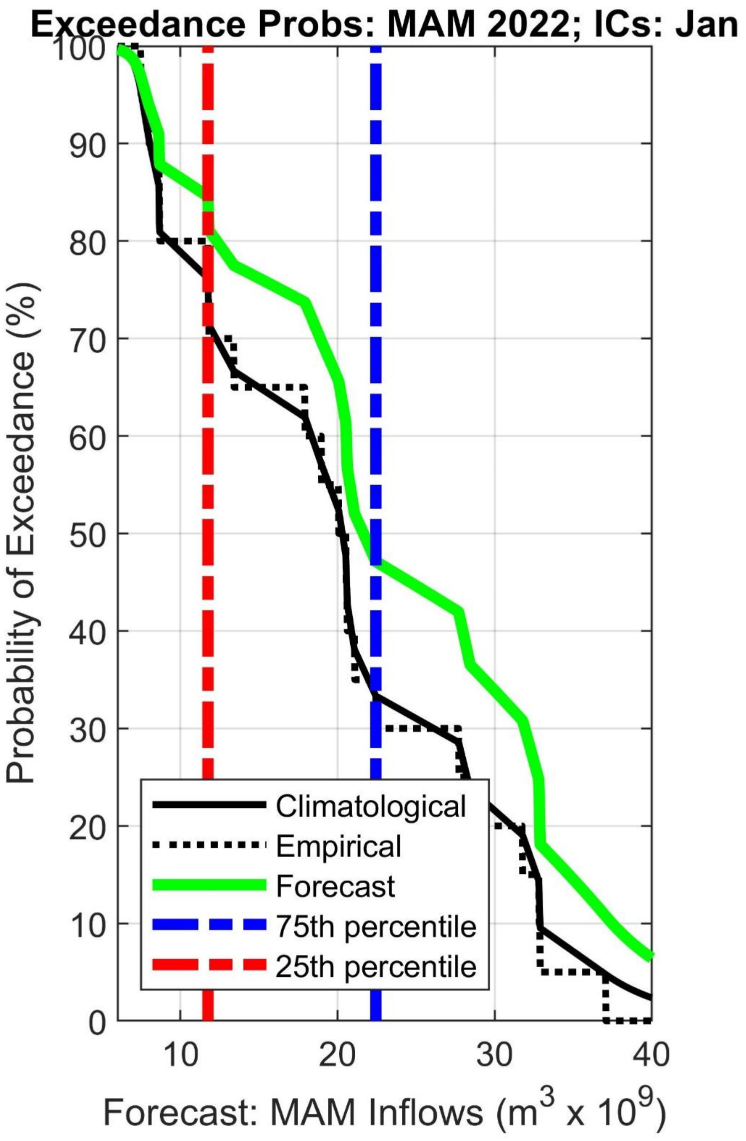

Vaal Dam Downstream Flow Predictions

# Inflow forecast for Lake Kariba: main inflow season of Mar-Apr-May

Muchuru et al. (2016)




For the forecast on the far right: The black curve represents the climatological probability distribution of MAM inflows, and the green curve represents the predicted probability distribution for the coming 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) MAM inflows.

# Round-up: Tailored products

- The tailored forecasts show
  - Namibian farm JFM rainfall forecast of an extremely wet season less likely than the forecasts issued over the last few months
  - However, increased inflow into Lake Kariba, and increased Vaal Dam downstream flow remain the most likely

# References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# Financial support from…

- The National Research Foundation through the Incentive Funding for Rated Researchers (since 2017)

- ACCESS (Alliance for Collaboration on Climate and Earth System Science) through the project "Investigating predictability of seasonal anomalies for societal benefit" (2018 to 2021)

- Water Research Commission through administering the international project "Research-based Assessment of Integrated approaches to Nature-based SOLUTIONS (RainSolutions)" (2020 to 2021)

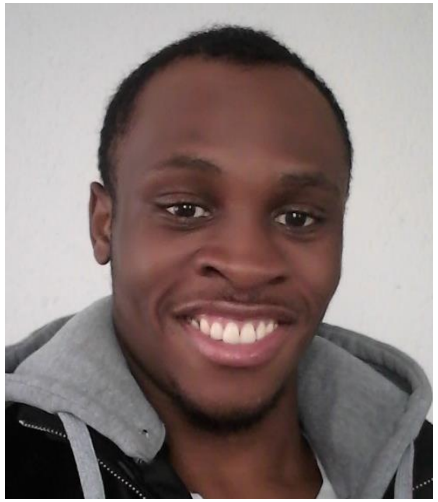
The forecast is produced by Prof Willem Landman of the University of Pretoria, South Africa, and issued on or around the 15th of each month. Please feel free to contact me at WALandman1981@gmail.com

Acknowledgments to Dr Peter Johnston of the University of Cape Town for professional comments and advice

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.