Seasonal forecasts

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https://tinyurl.com/ybrb3a72

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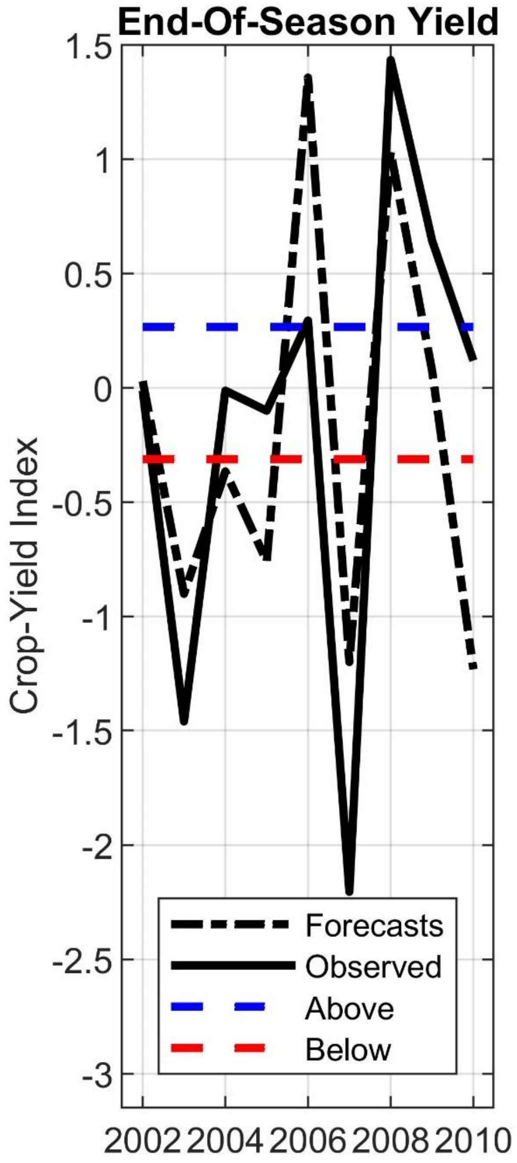
NMME The North American Multi-Model Ensemble

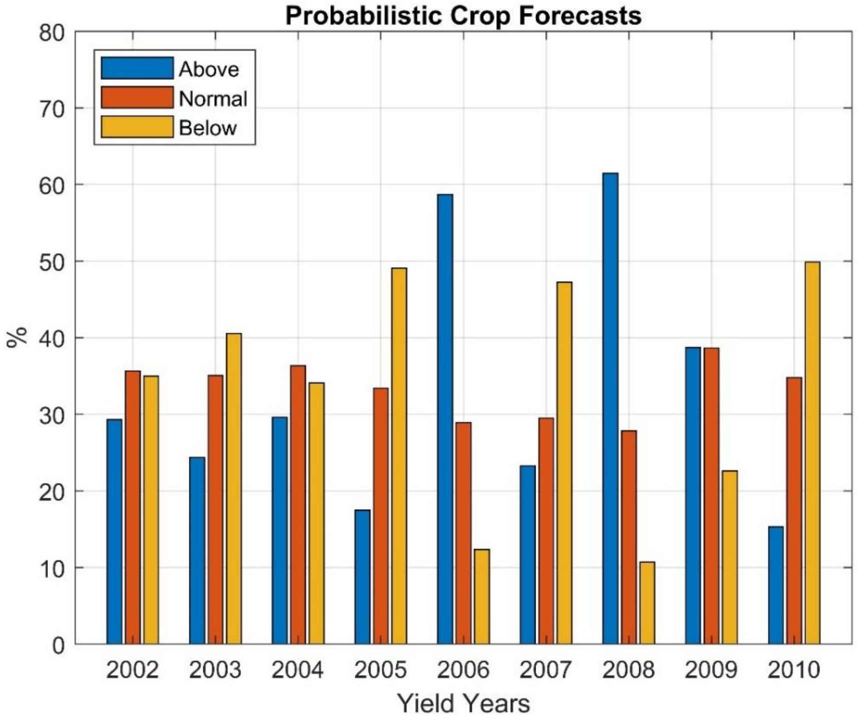
Seasonal Forecast Worx

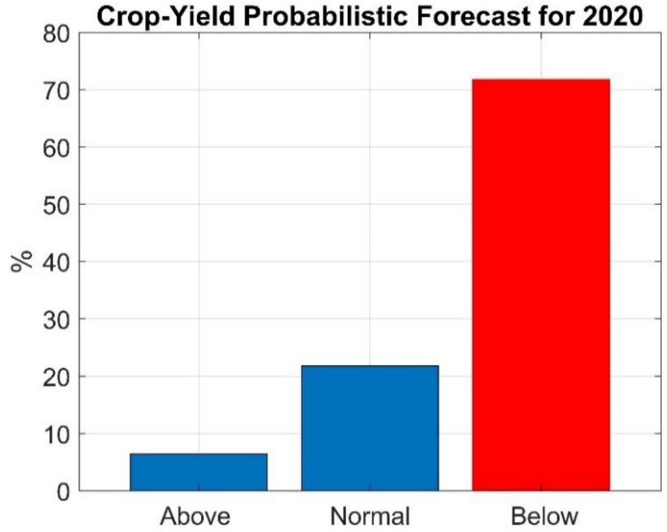
Latest Update: 18 February 2021

Are you a farmer who wants to make use of science-based seasonal predictions for your farm? If you are interested to be part of an initiative at the University of Pretoria that involves the development of seasonal forecast systems for farms, specifically tailored to farmers' needs, please send an email to WALandman1981@gmail.com



Have a look at this example of end-of-season crop yield forecasts for a farm near Bapsfontein. The farmer provided several decades of crop-yield data and these data were subsequently used to create a crop forecast model specific to the farm





Above is the crop-yield forecast for the coming season. The forecast is for enhanced probabilities of below-normal (low) crop yield for the farm. The farmer may be able with support to use this forecast information to plan for the coming season

On the left are time series of forecast and observed crop yields at the time of harvest for the years indicated. Next to the time series are probabilistic forecasts over the same 9-years for below- (low yields), near- (about average) and above-normal (high yields). For example, in 2008 the forecast and observed index values are high and positive (figure on the left), and the highest predicted probability is for above-normal yield (figure in the middle).

Share your data and become part of this initiative

- 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).

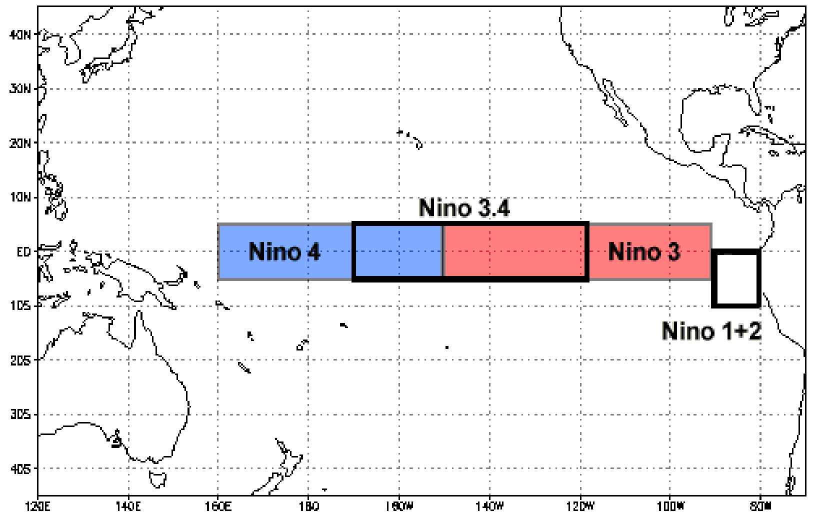
- For the official seasonal forecast for South Africa, visit the South African Weather Service website at http://www.weathersa.co.za/images/data/longrange/gfcsa/scw.pdf

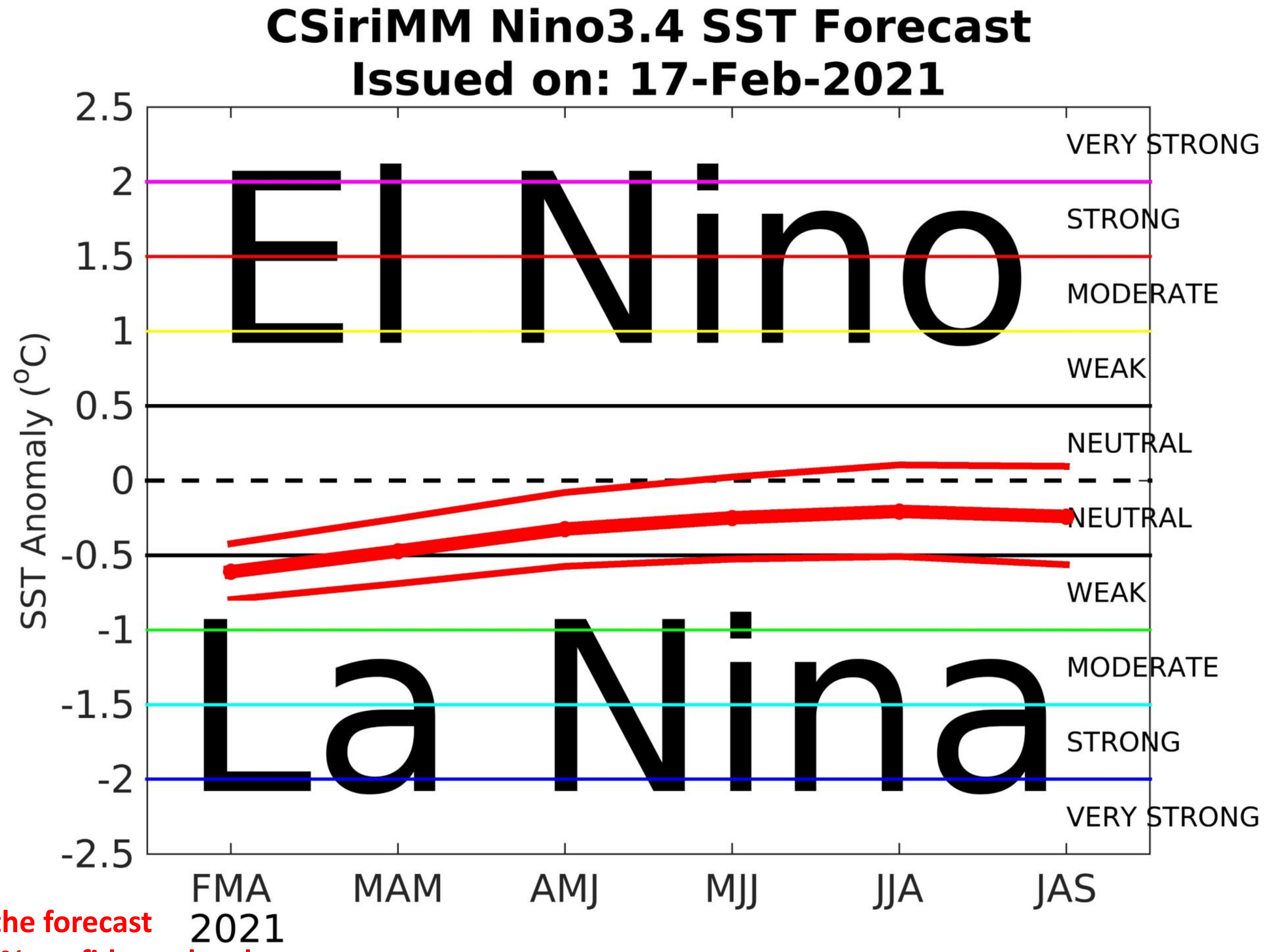
South African Weather Service

ENSO and Global SST Forecasts

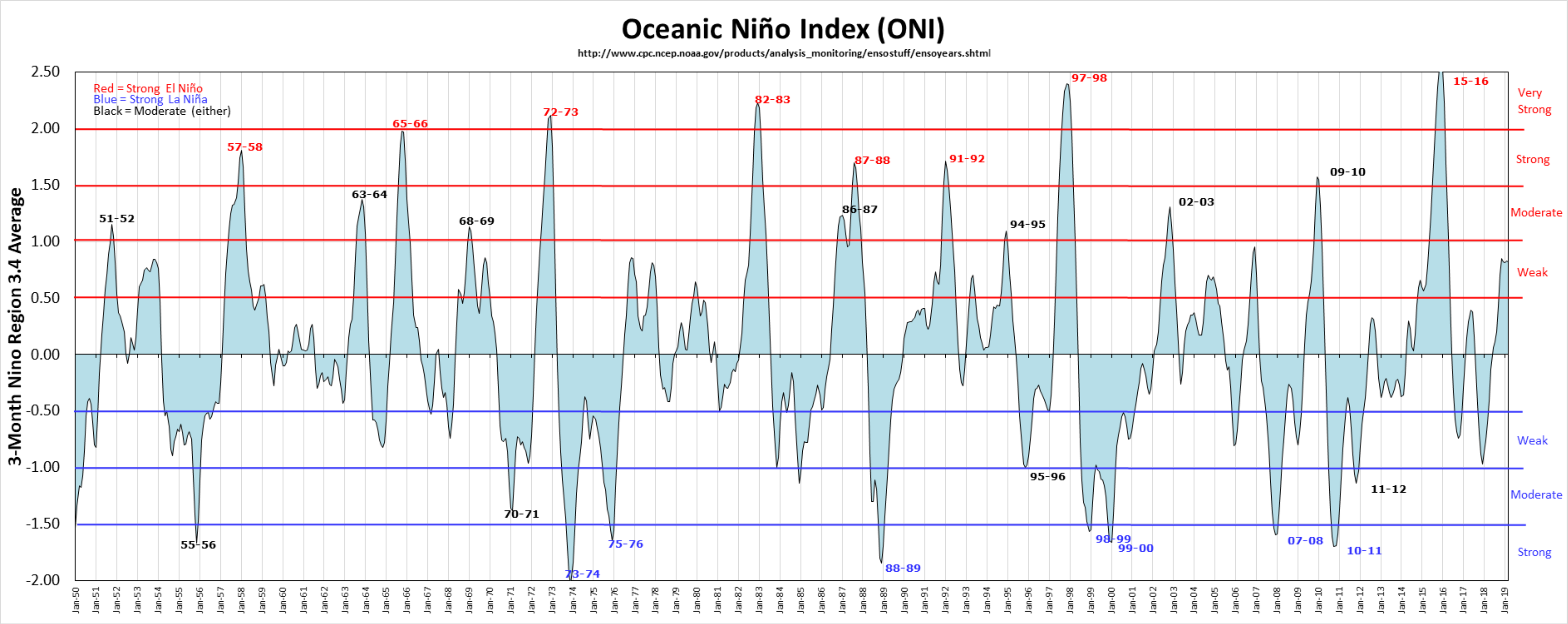
Prediction Method

- 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
57-58
63-64
65-66
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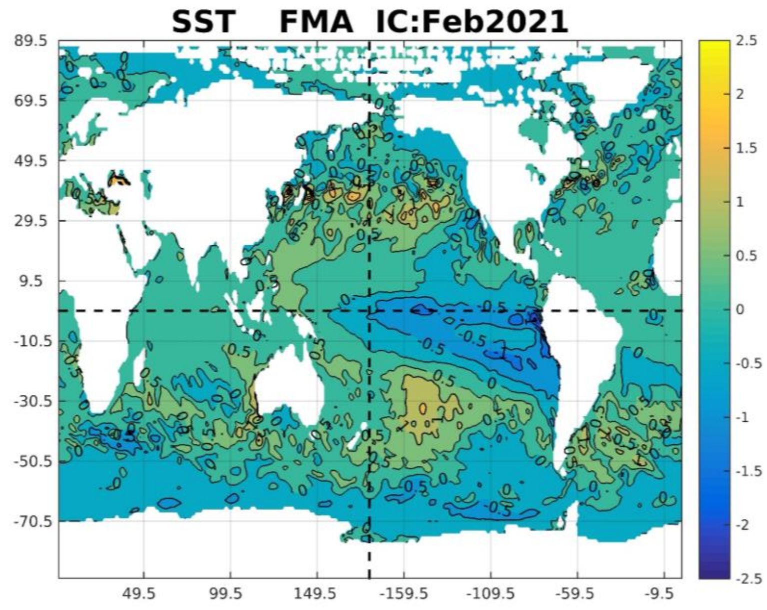
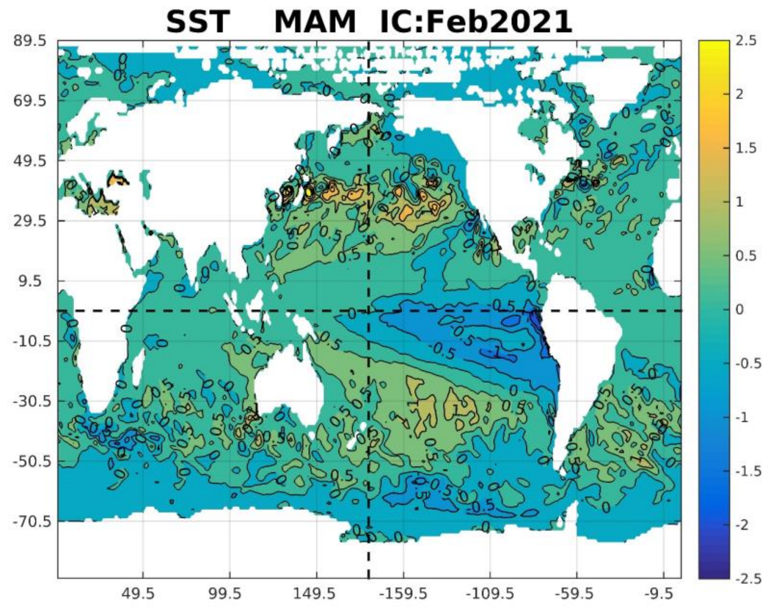
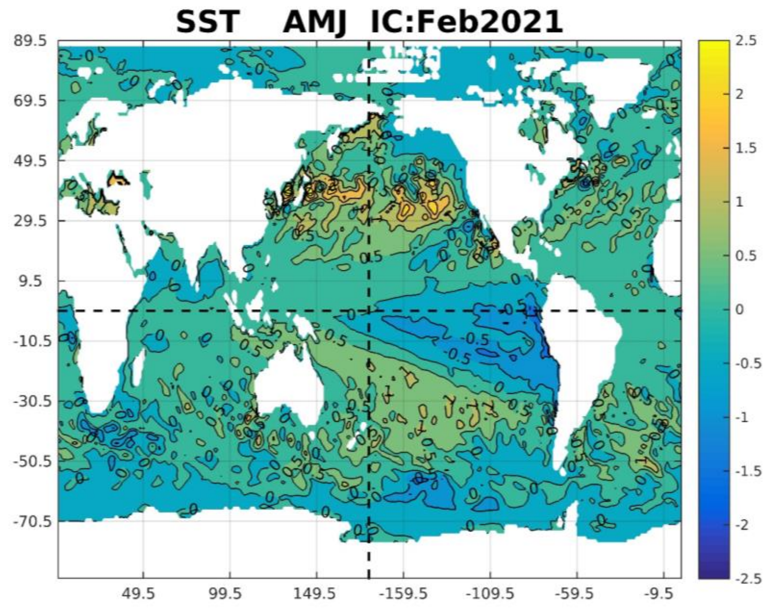
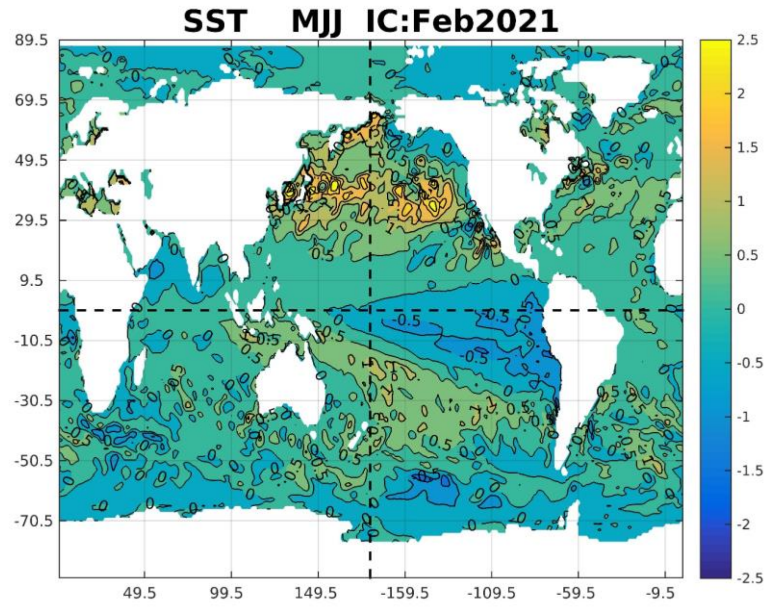
IC: the month in which the forecast was made

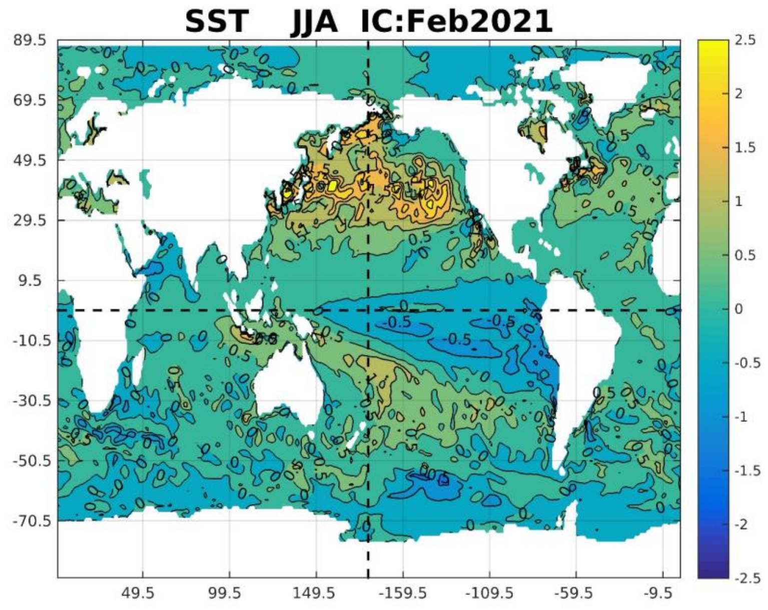
SST anomalies

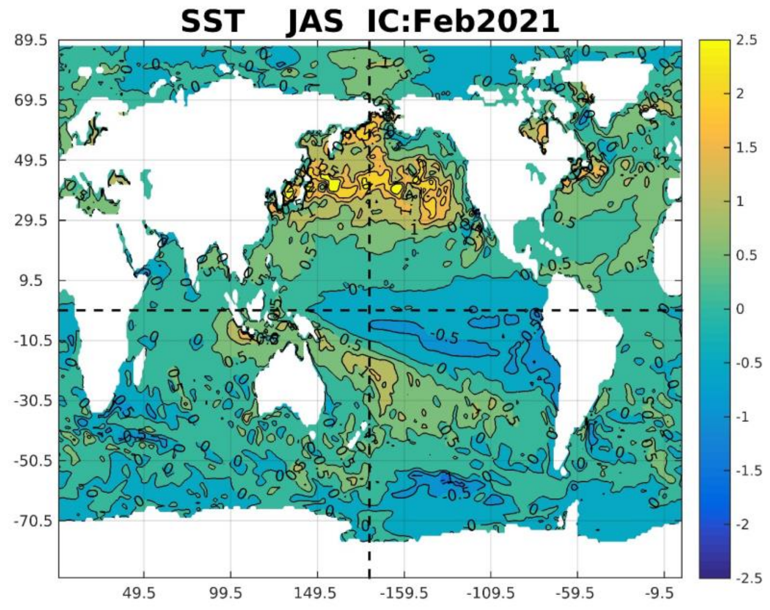






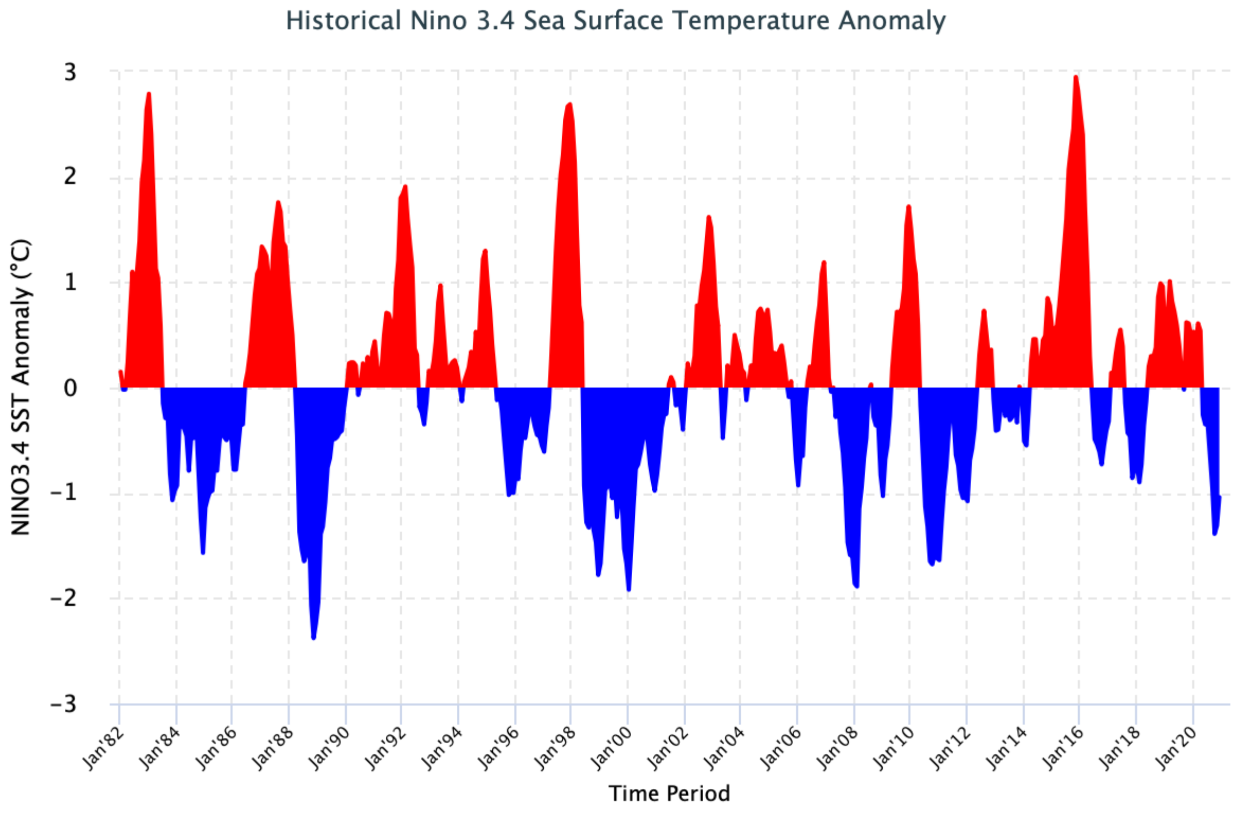


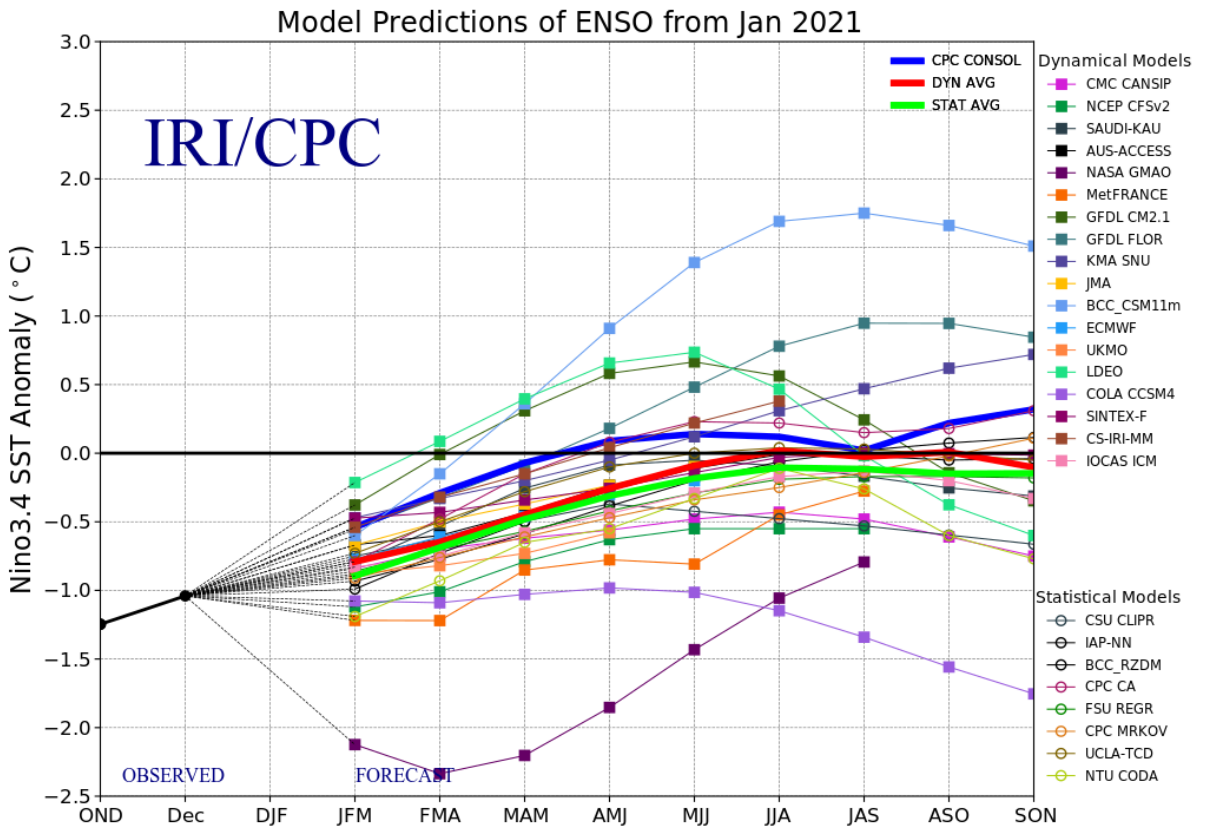




Round-up: ENSO

- The UP model predicts ENSO-neutral conditions to occur during winter





Southern Africa Forecasts

Prediction Method

- Three-month seasons for seasonal rainfall totals and average maximum temperatures of NMME ensemble mean forecasts are interpolated to 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:
  - ROC Area (Below-Normal) – The forecast system's ability to discriminate dry or cool seasons from the rest of the seasons over a 32-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 32-year test period. ROC values should be higher than 0.5 for a forecast system to be considered skilful.

Forecasts are probabilistic

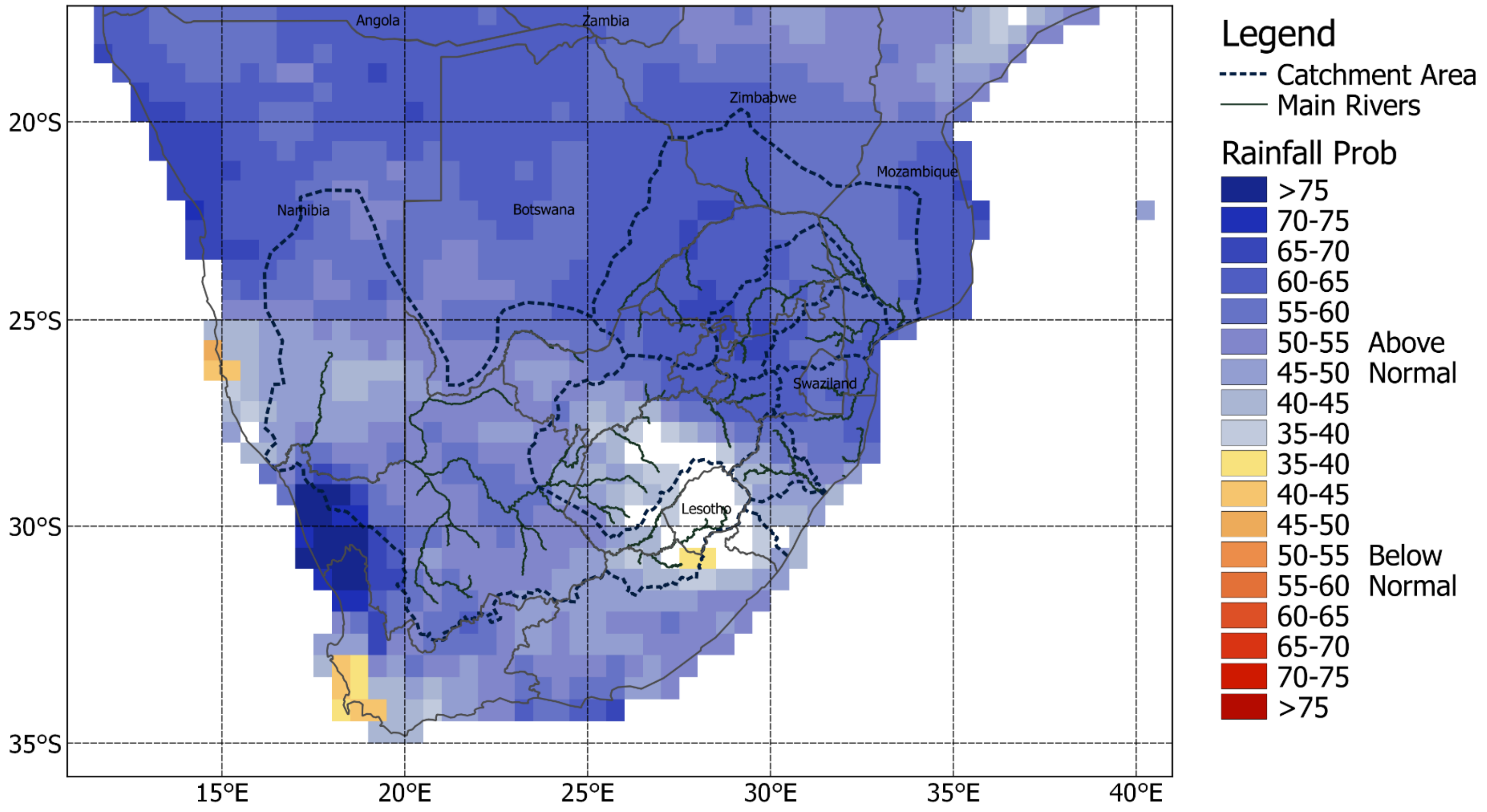
Probabilistic forecasts can help users understand risks and opportunities (forewarned is forearmed) in order to make more informed decisions.

The seasonal rainfall and maximum temperature forecast 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 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.

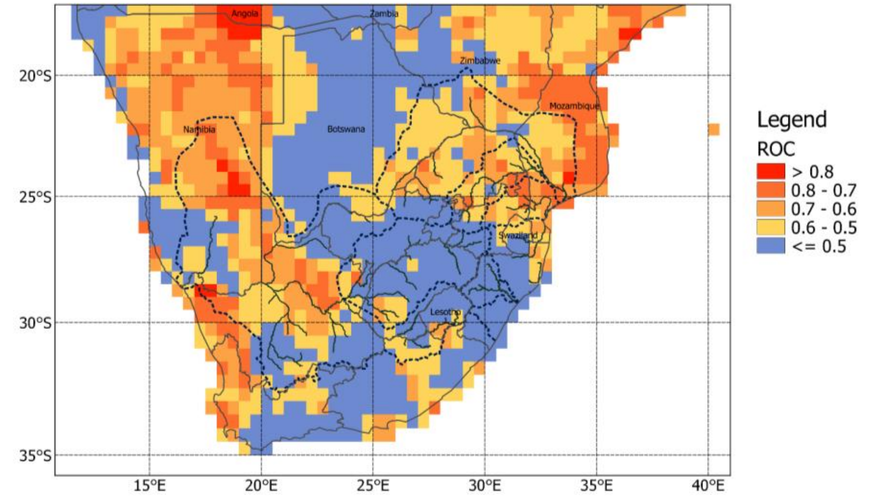
The nature of a probabilistic forecast implies that the less likely outcomes are always possible. In fact, for the probabilistic forecasts to be considered reliable, the less likely outcomes will and must occasionally occur.

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

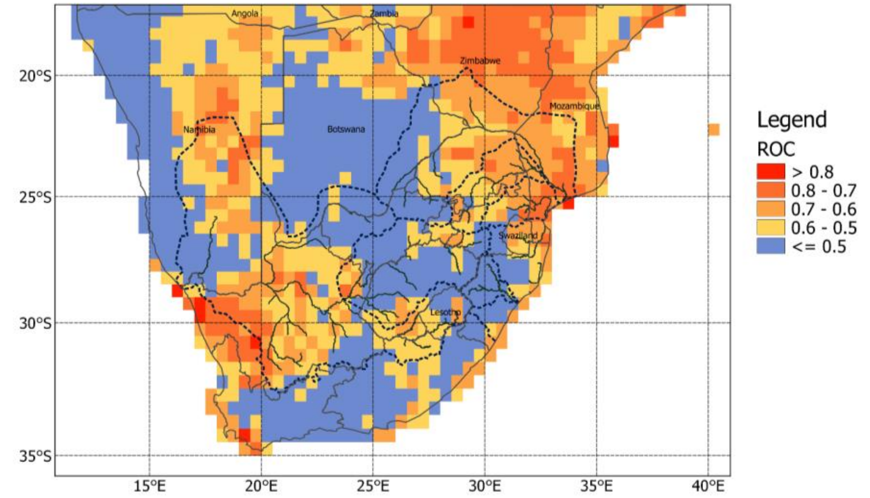
FMA 2021 Rainfall; ICs: Feb



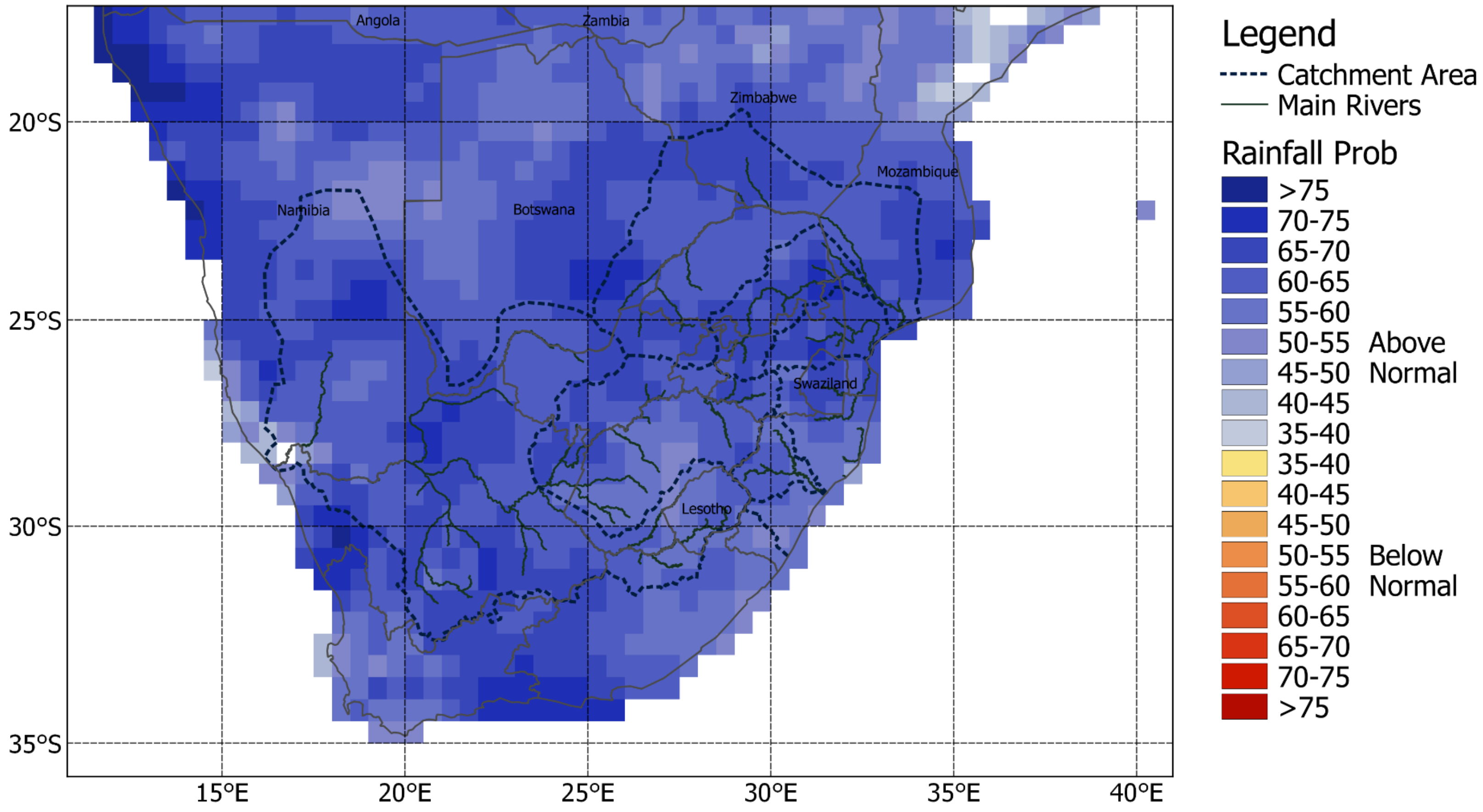
ROC Area (Above-Normal): FMA Rainfall



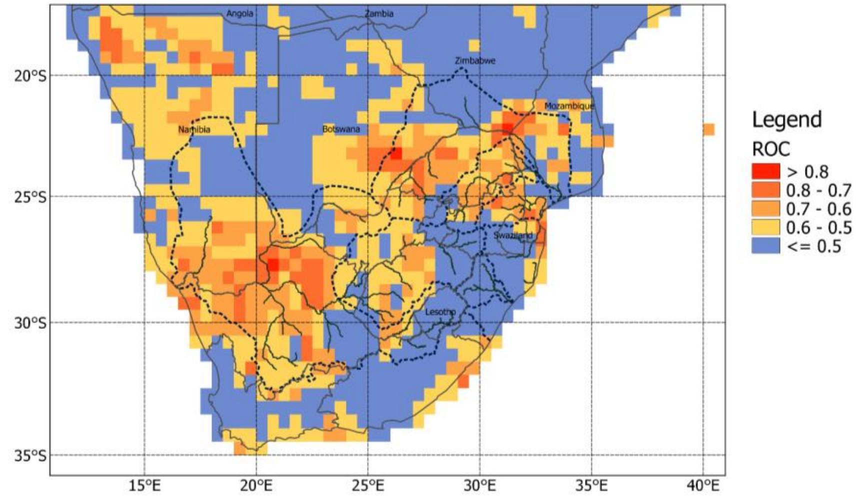
ROC Area (Below-Normal): FMA Rainfall



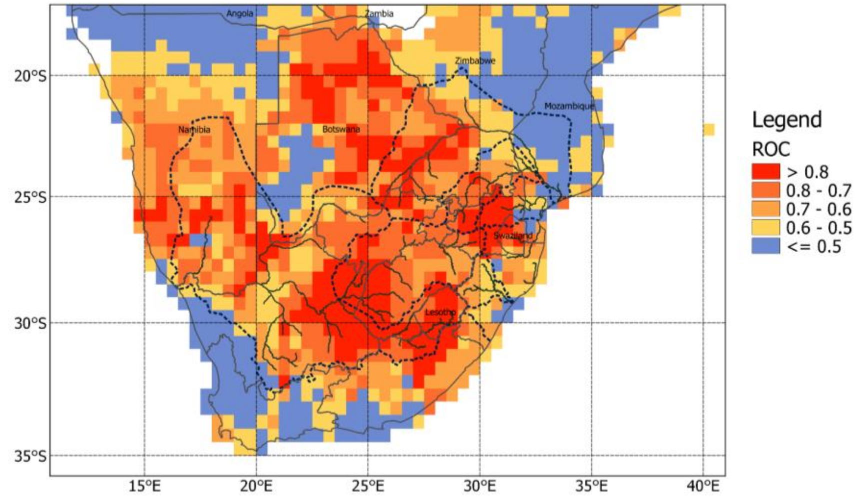
MAM 2021 Rainfall; ICs: Feb



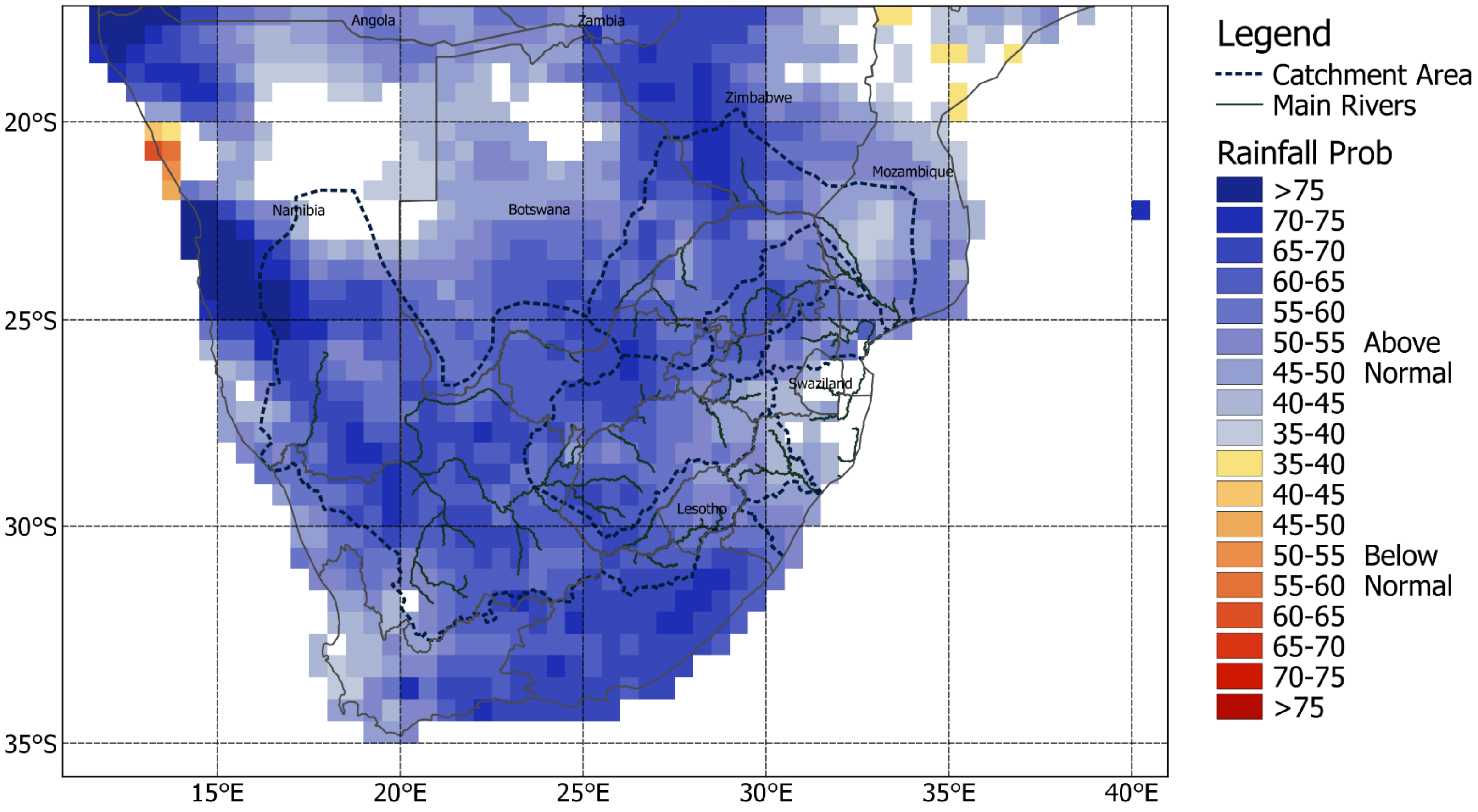
ROC Area (Above-Normal): MAM Rainfall



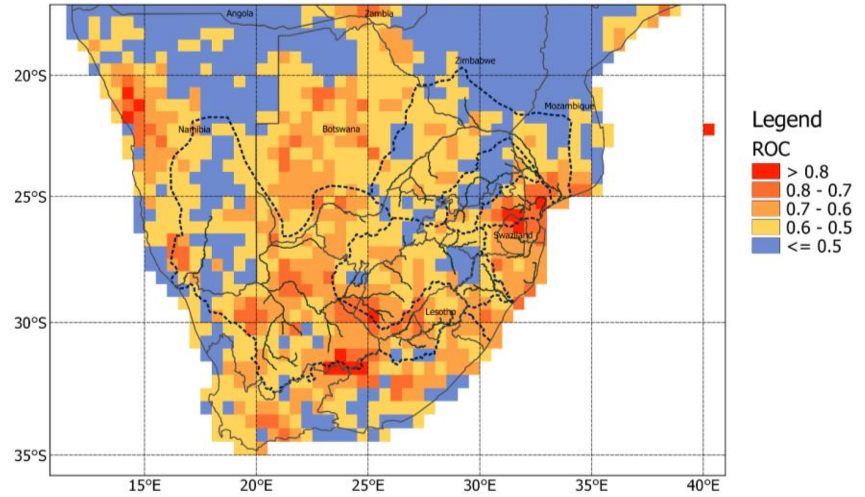
ROC Area (Below-Normal): MAM Rainfall



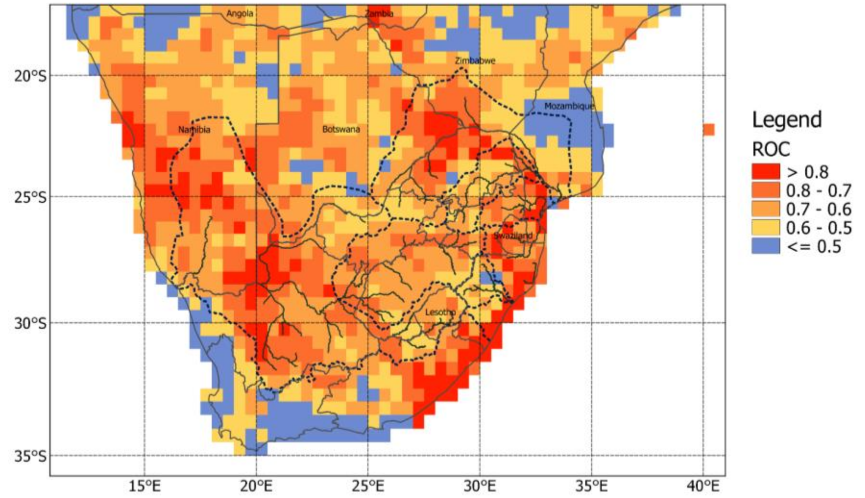
AMJ 2021 Rainfall; ICs: Feb



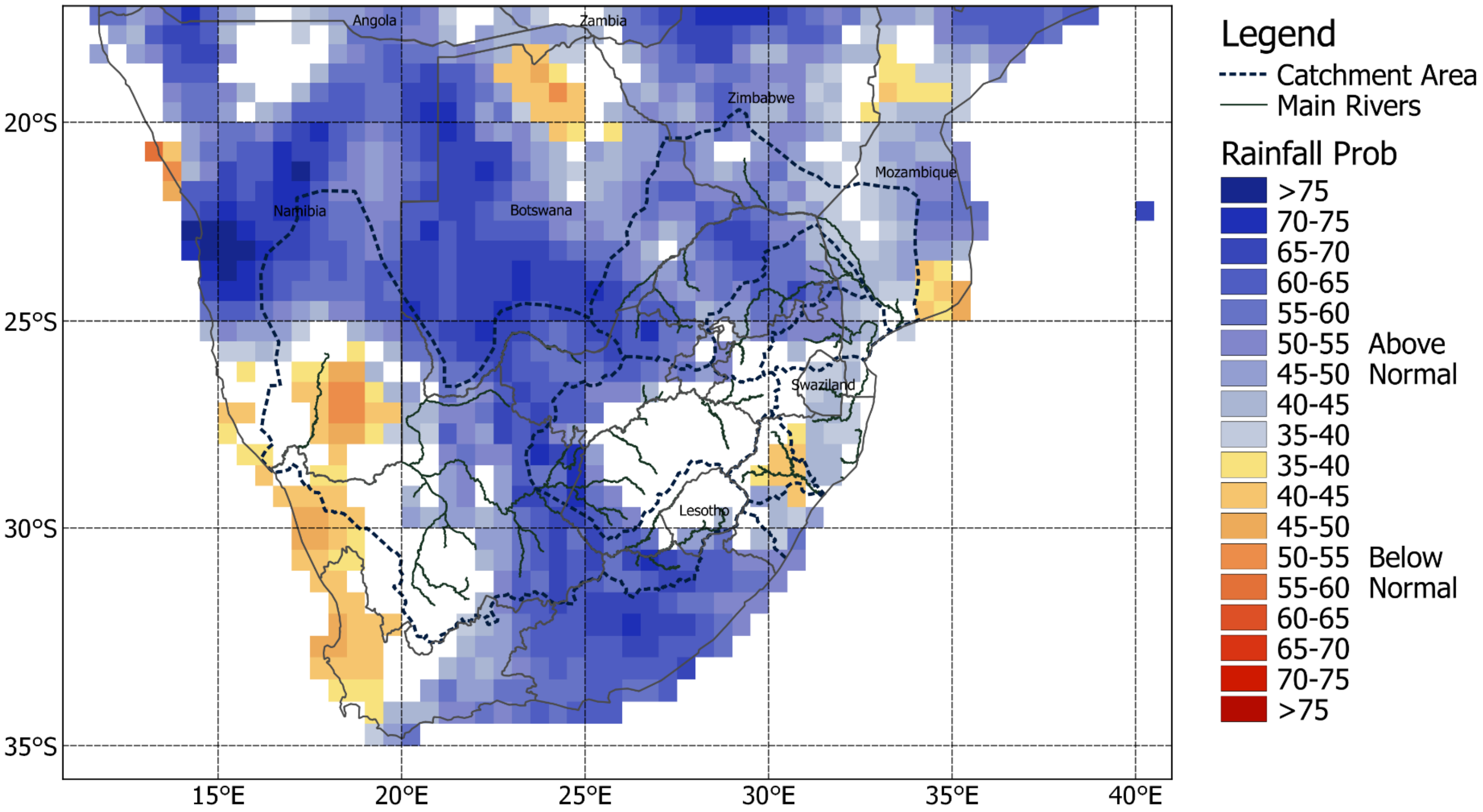
ROC Area (Above-Normal): AMJ Rainfall



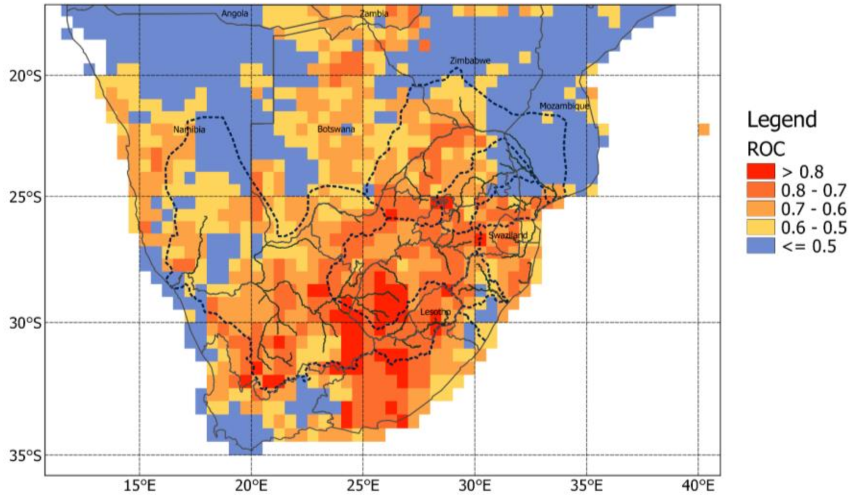
ROC Area (Below-Normal): AMJ Rainfall



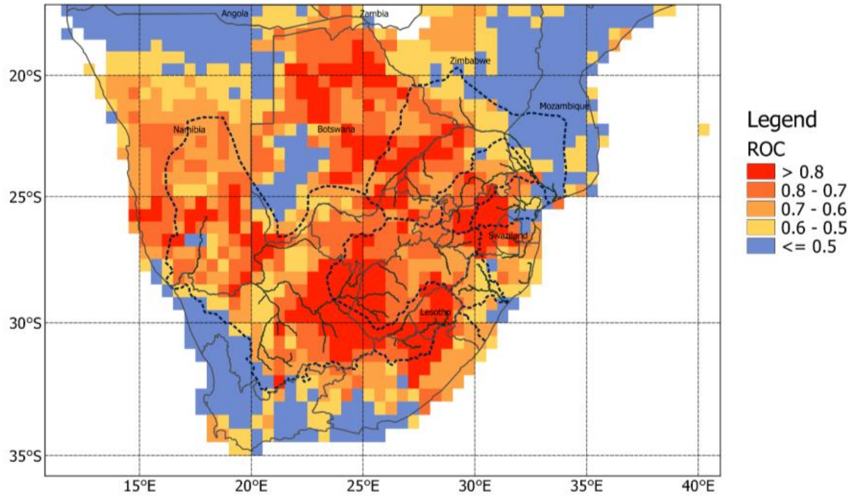
MJJ 2021 Rainfall; ICs: Feb



ROC Area (Above-Normal): MJJ Rainfall



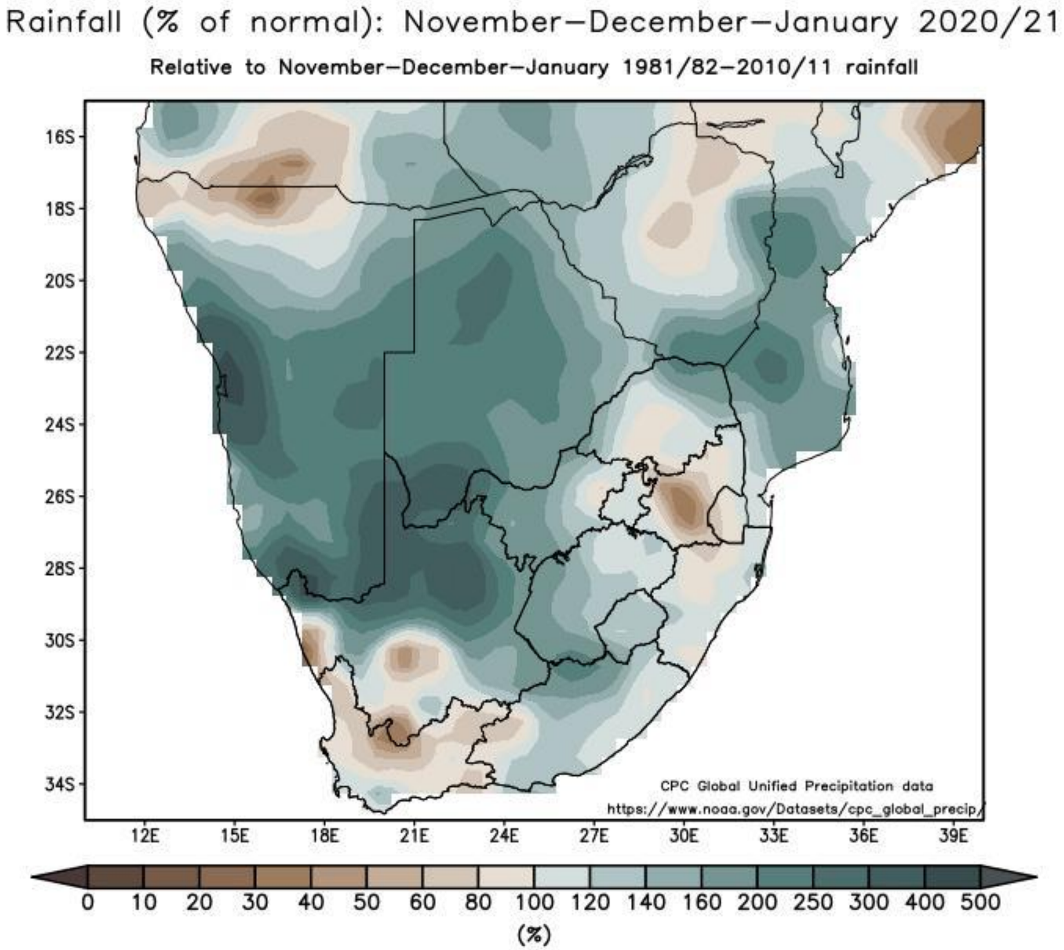
ROC Area (Below-Normal): MJJ Rainfall

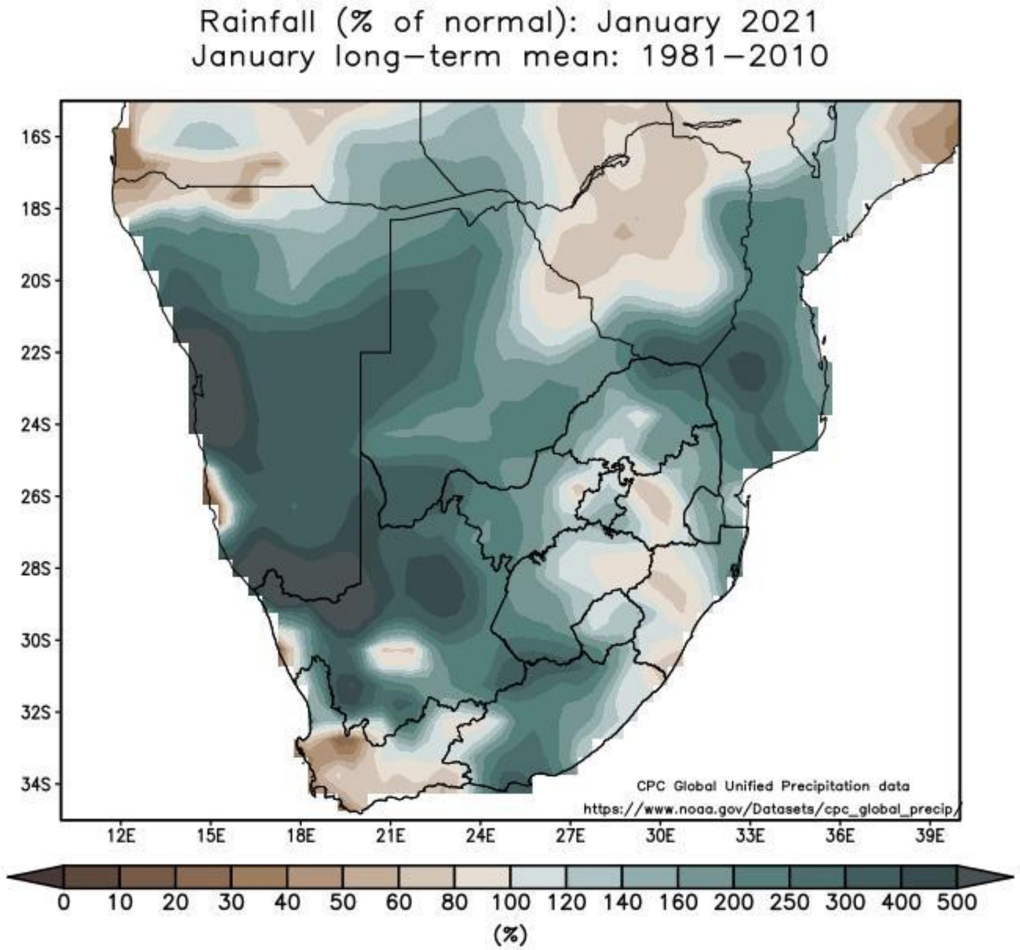


Round-up: SADC Rainfall

- Above-normal rainfall outcomes are expected over the larger part of the forecast region during late summer

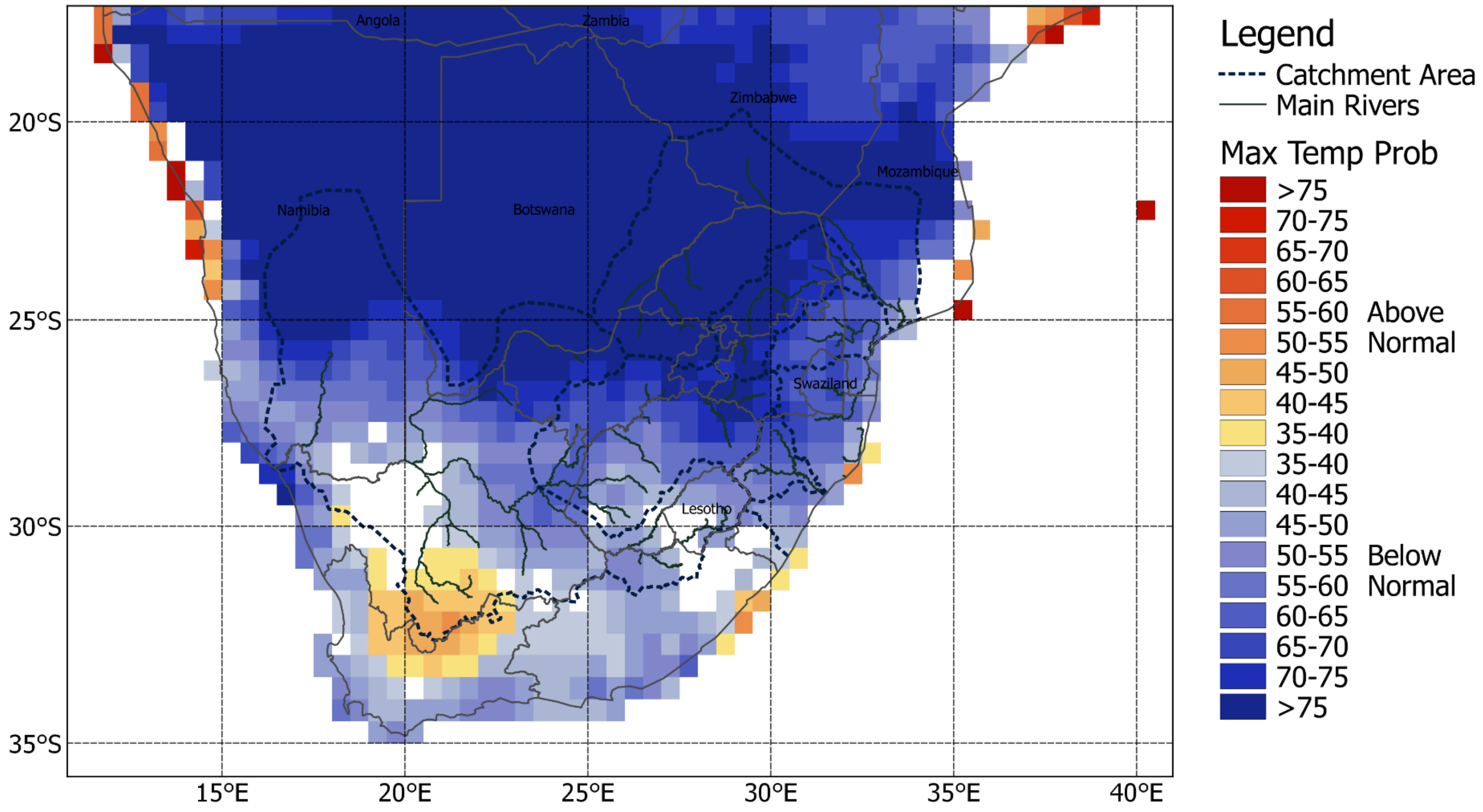
Observed SADC Rainfall



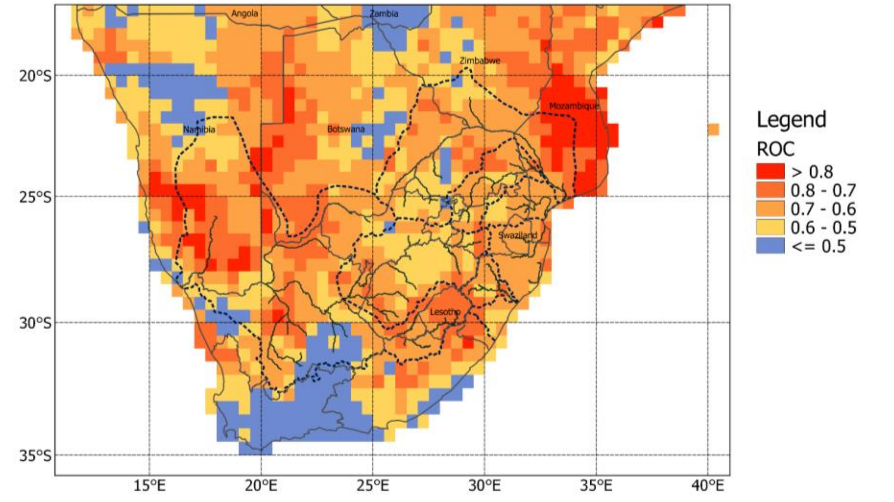


Maps prepared by Dr. Christien Engelbrecht

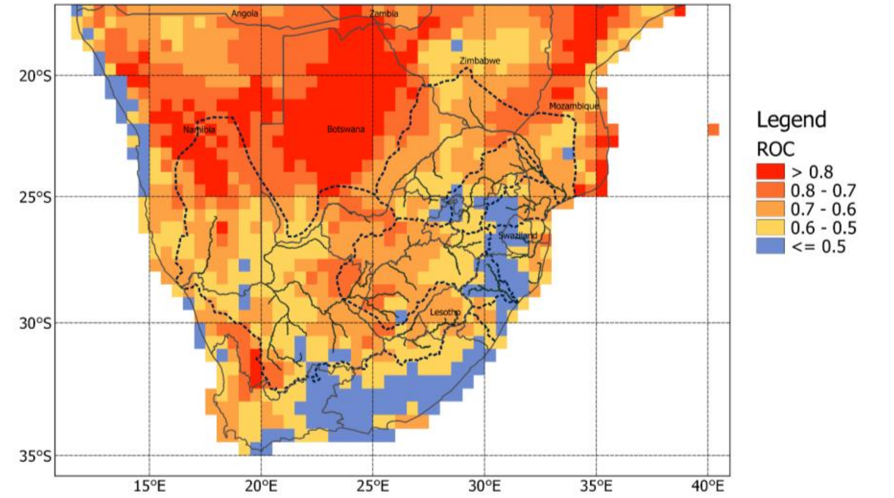
FMA 2021 Max Temp; ICs: Feb



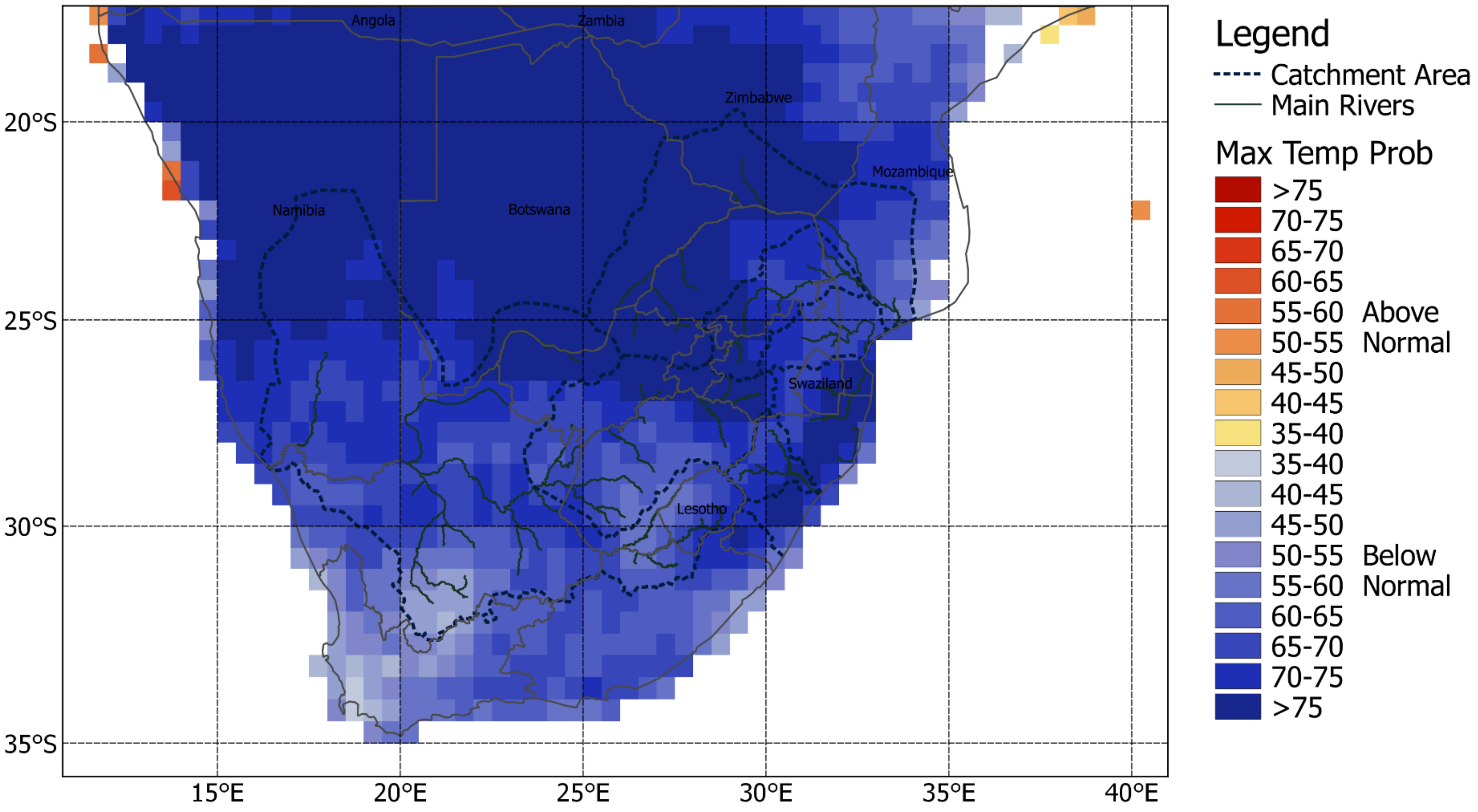
ROC Area (Above-Normal): FMA Max Temp



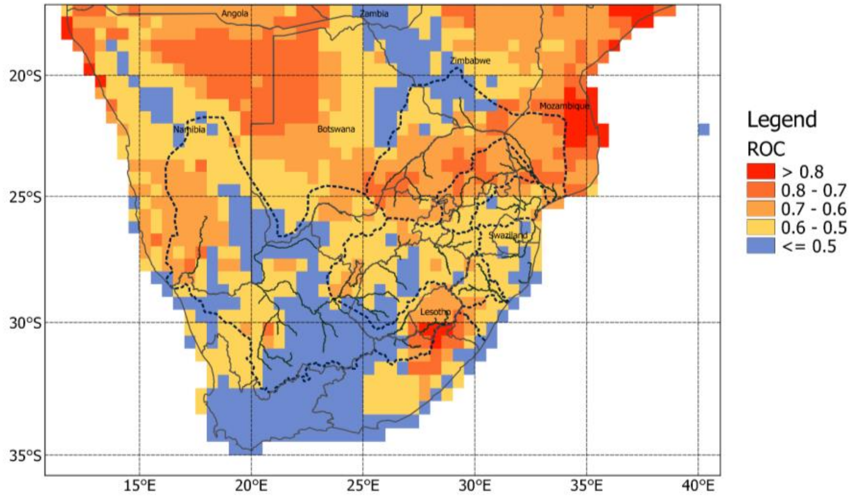
ROC Area (Below-Normal): FMA Max Temp



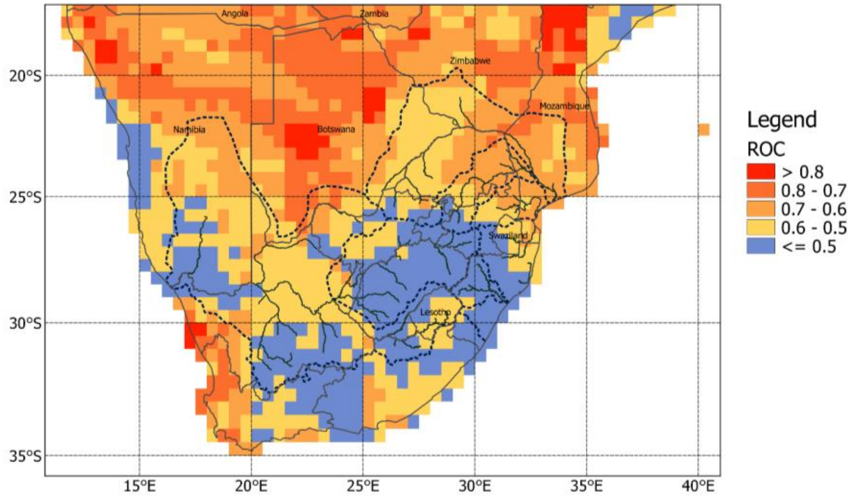
MAM 2021 Max Temp; ICs: Feb



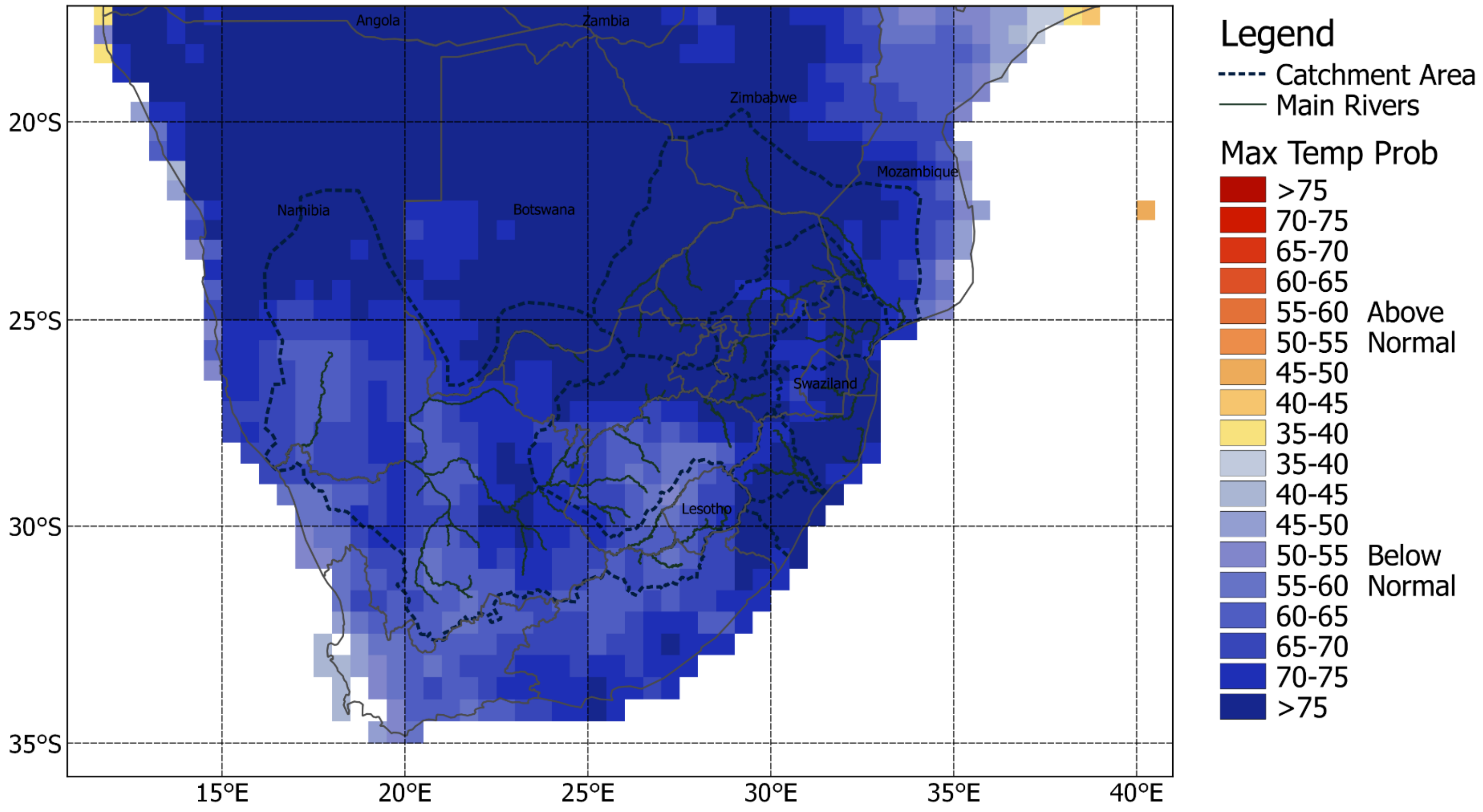
ROC Area (Above-Normal): MAM Max Temp



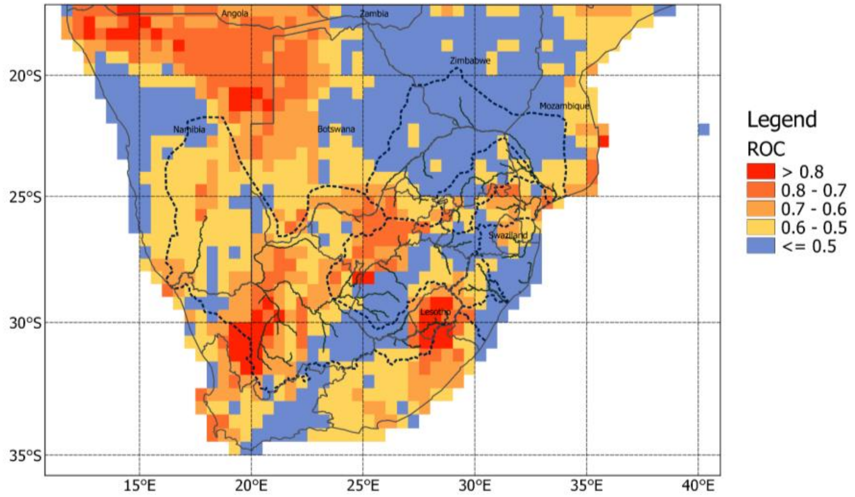
ROC Area (Below-Normal): MAM Max Temp



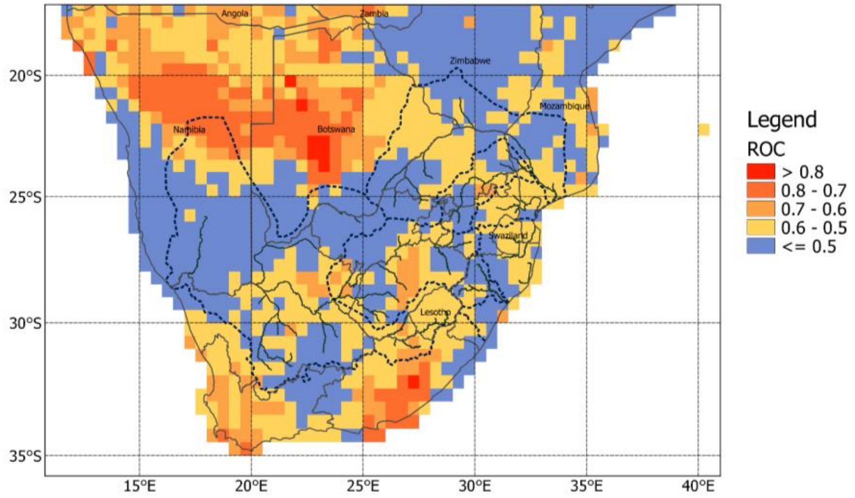
AMJ 2021 Max Temp; ICs: Feb



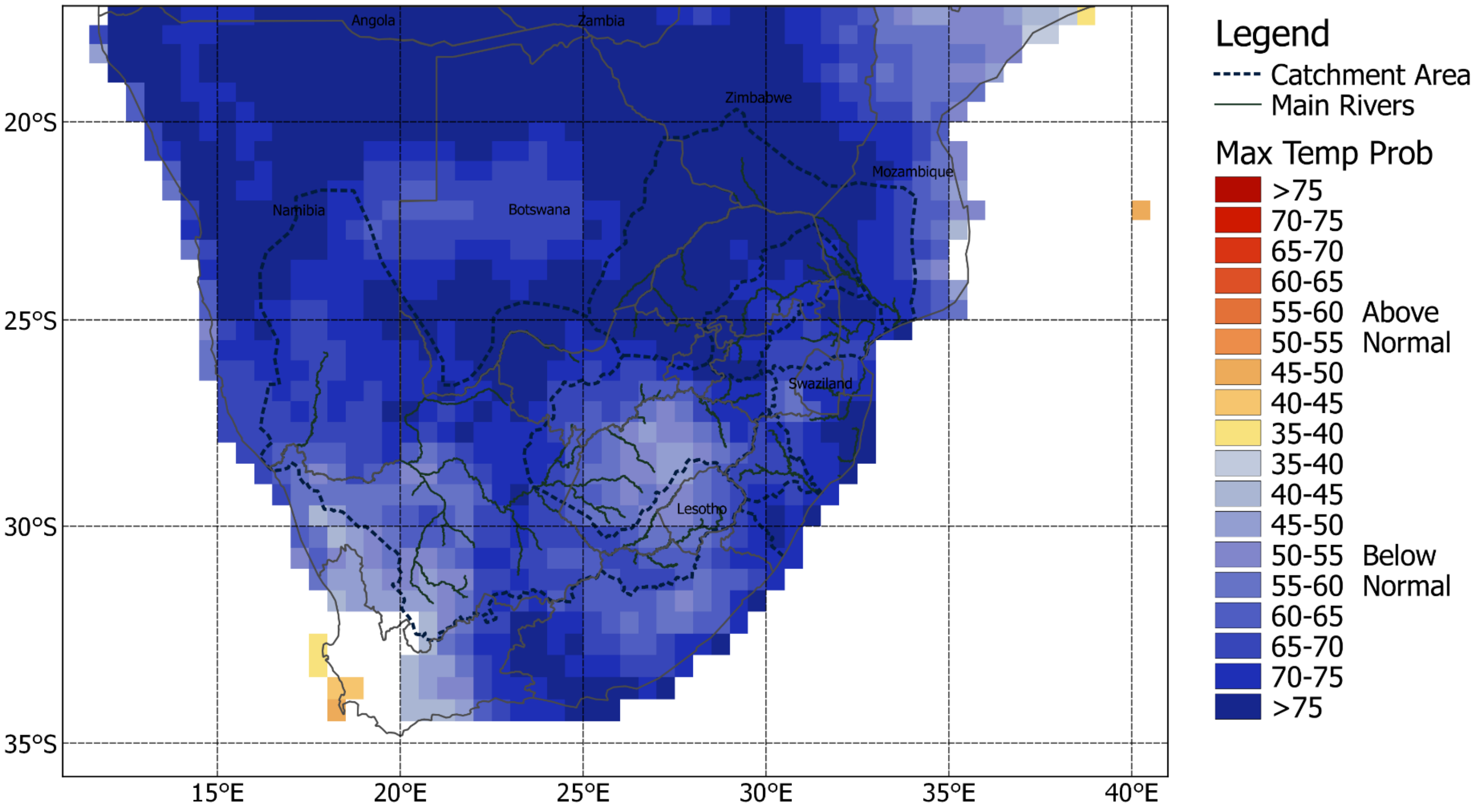
ROC Area (Above-Normal): AMJ Max Temp



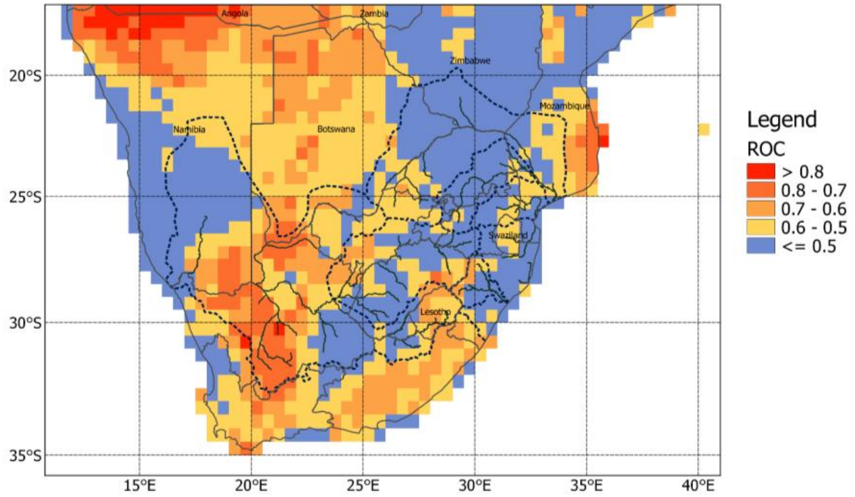
ROC Area (Below-Normal): AMJ Max Temp



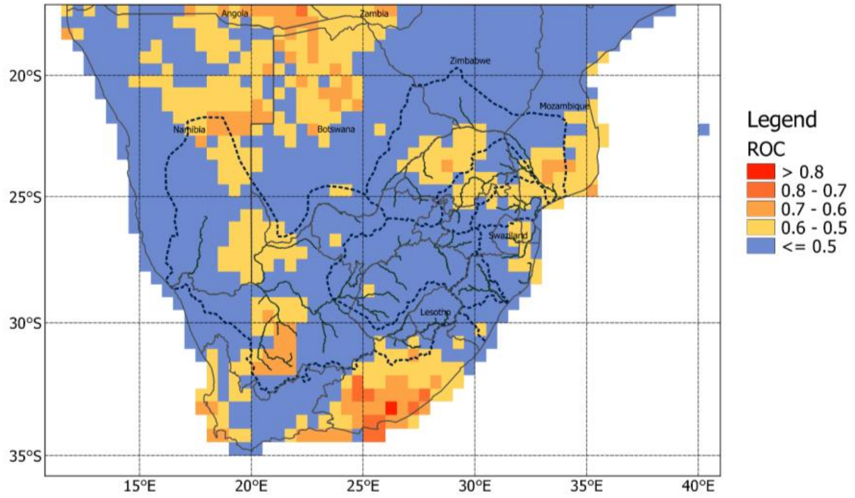
MJJ 2021 Max Temp; ICs: Feb



ROC Area (Above-Normal): MJJ Max Temp



ROC Area (Below-Normal): MJJ Max Temp



Round-up: SADC Max Temp

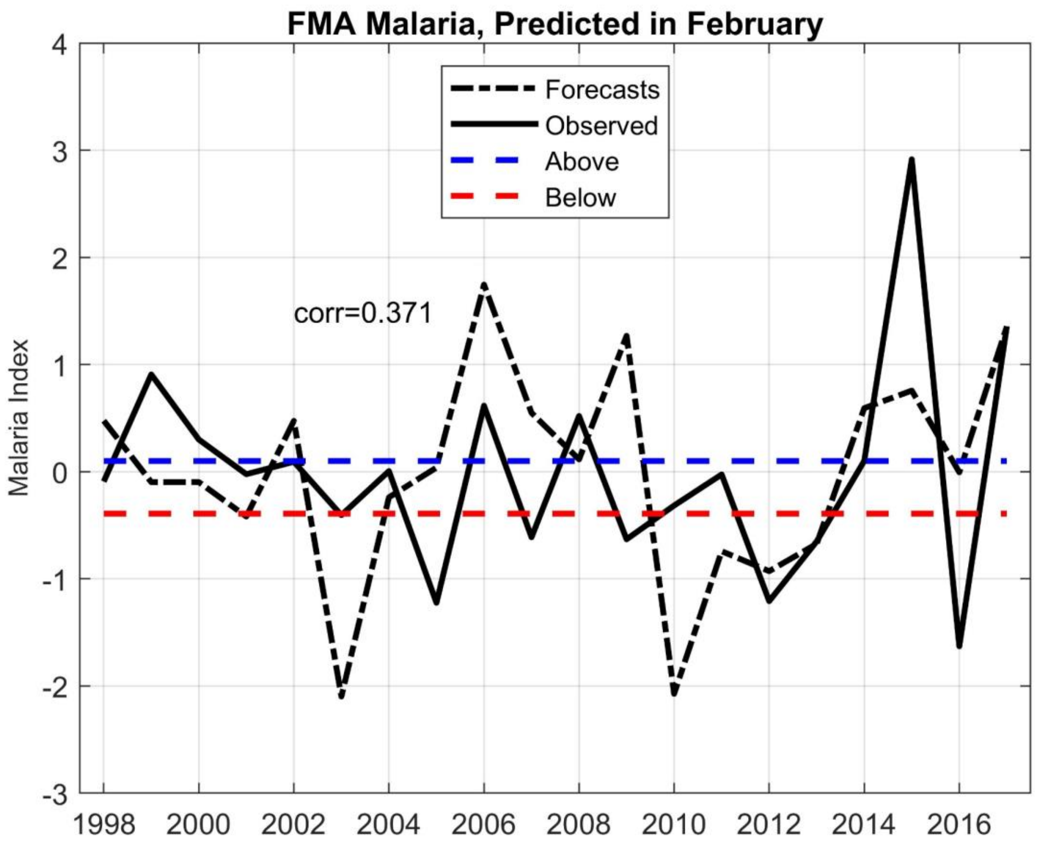
- Cooler maximum temperatures, in association with the increased likelihood of a wet late summer season, are likely over the region
- Cold start to winter likely

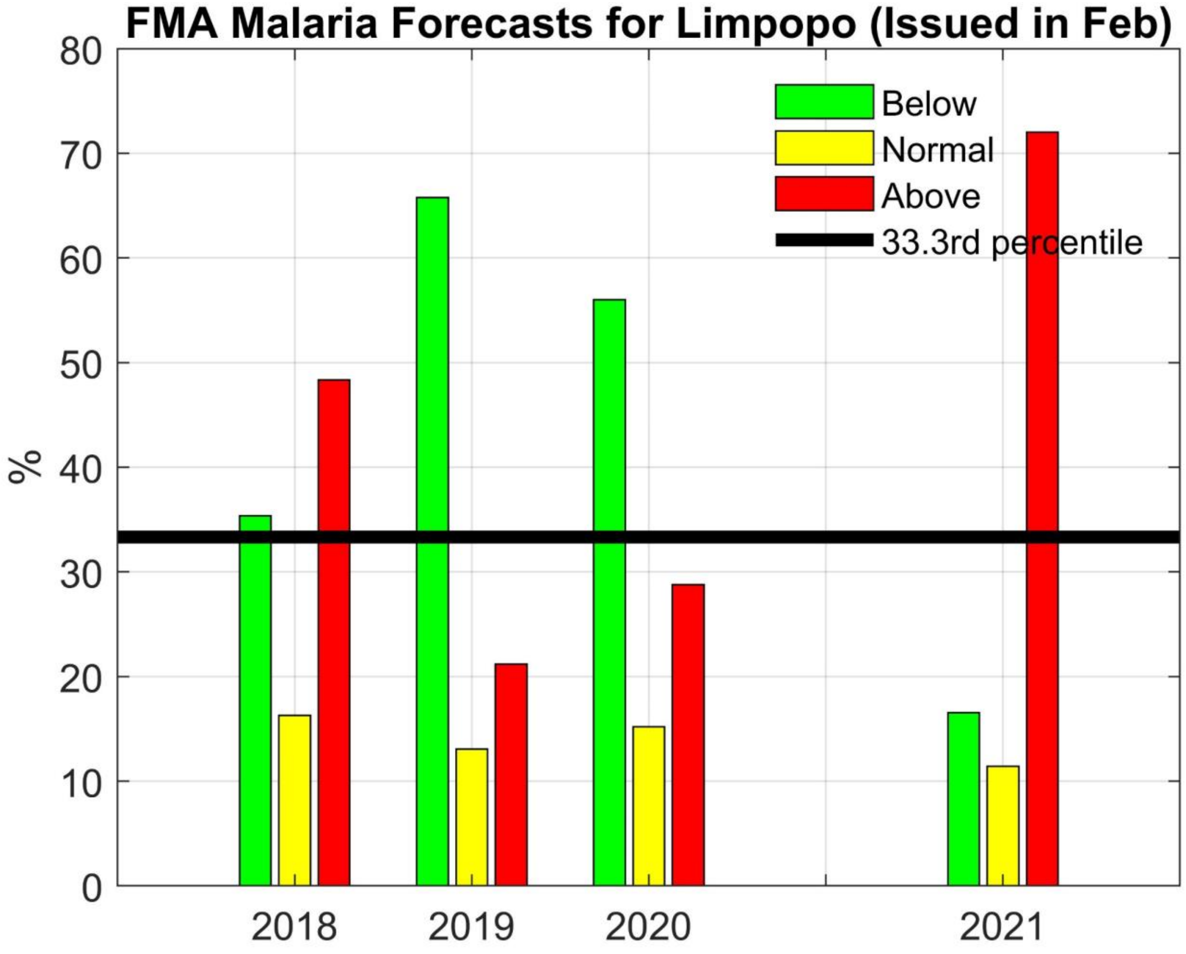
Tailored Forecasts

1. **Probabilistic three-category malaria forecast for Limpopo for Feb-Mar-Apr 2021**
2. **Probability of exceedance Mar-Apr-May 2021 inflow forecast for Lake Kariba, Zambia/Zimbabwe**
3. **Probability of exceedance Feb-Mar-Apr 2021 downstream flow forecasts for Vaal Dam**

Note: These products have been created from data received from the forecast users at each site, and are specifically tailored towards a sector for optimal decision making

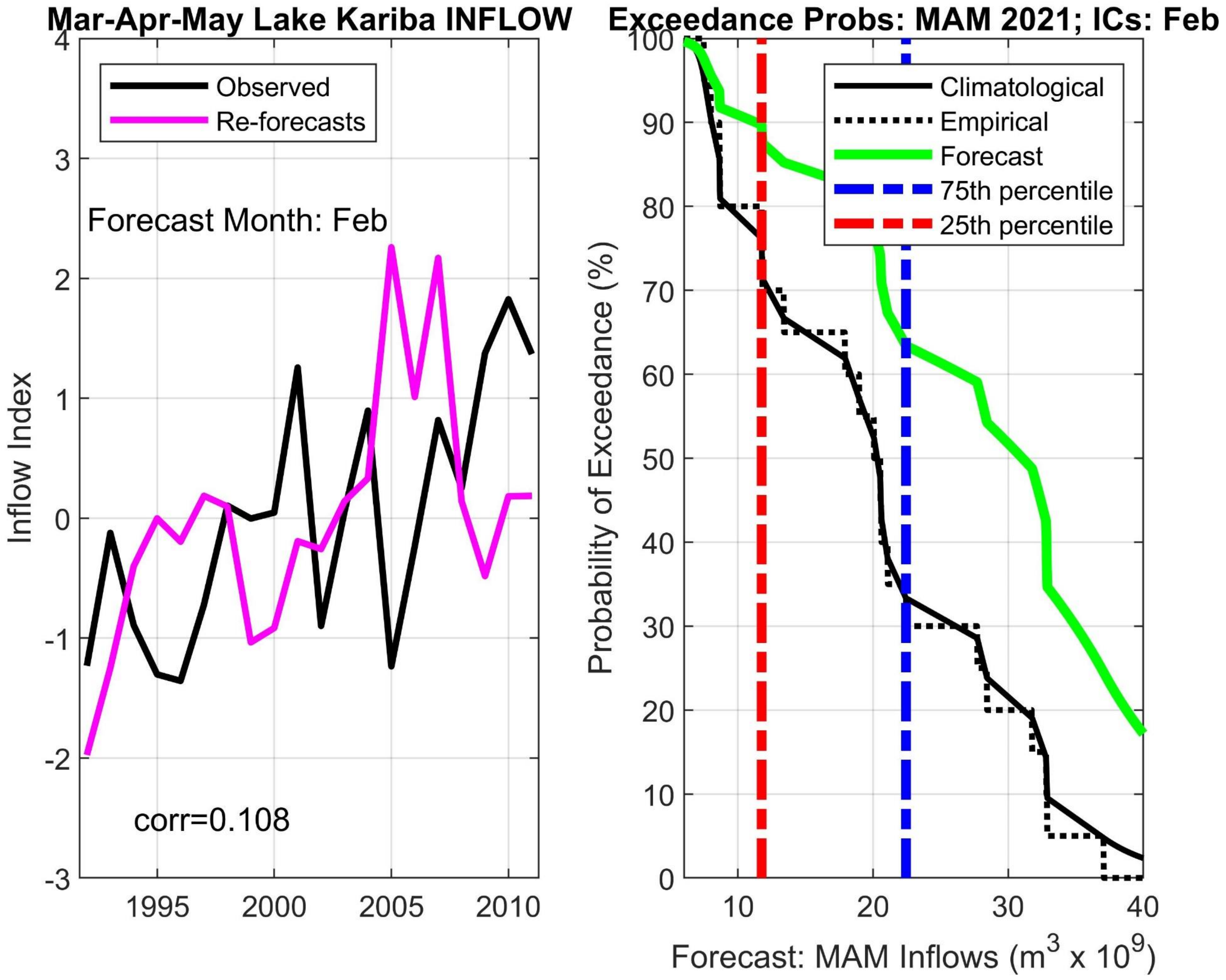
Malaria forecast
Landman et al. (2020b)



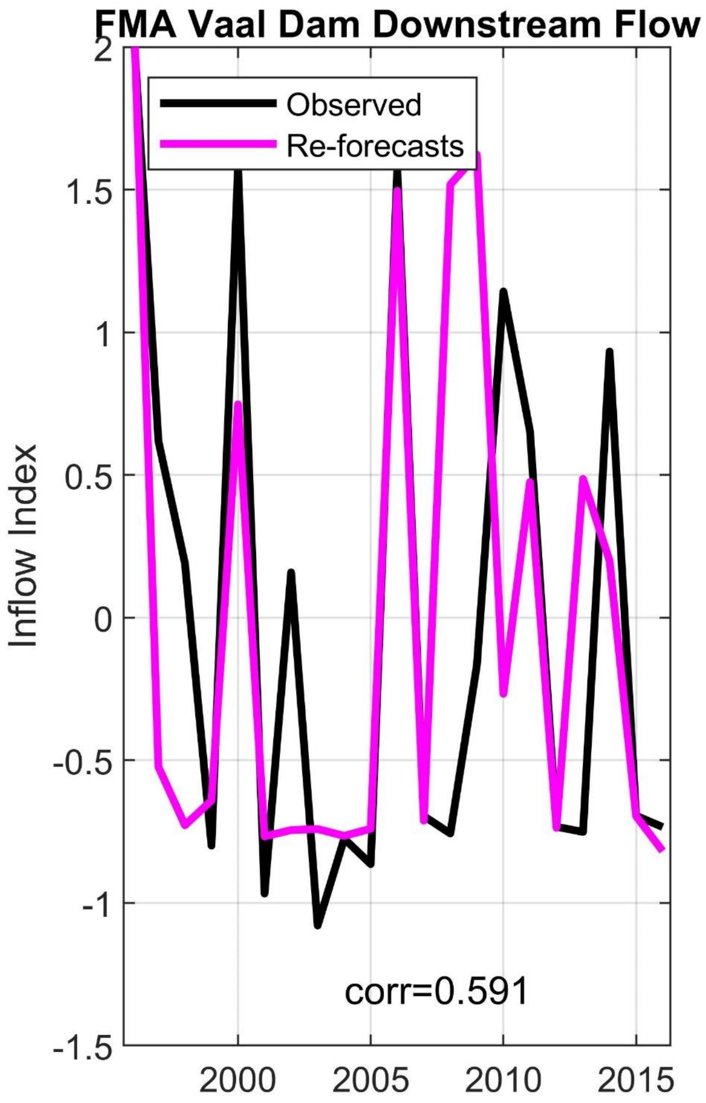


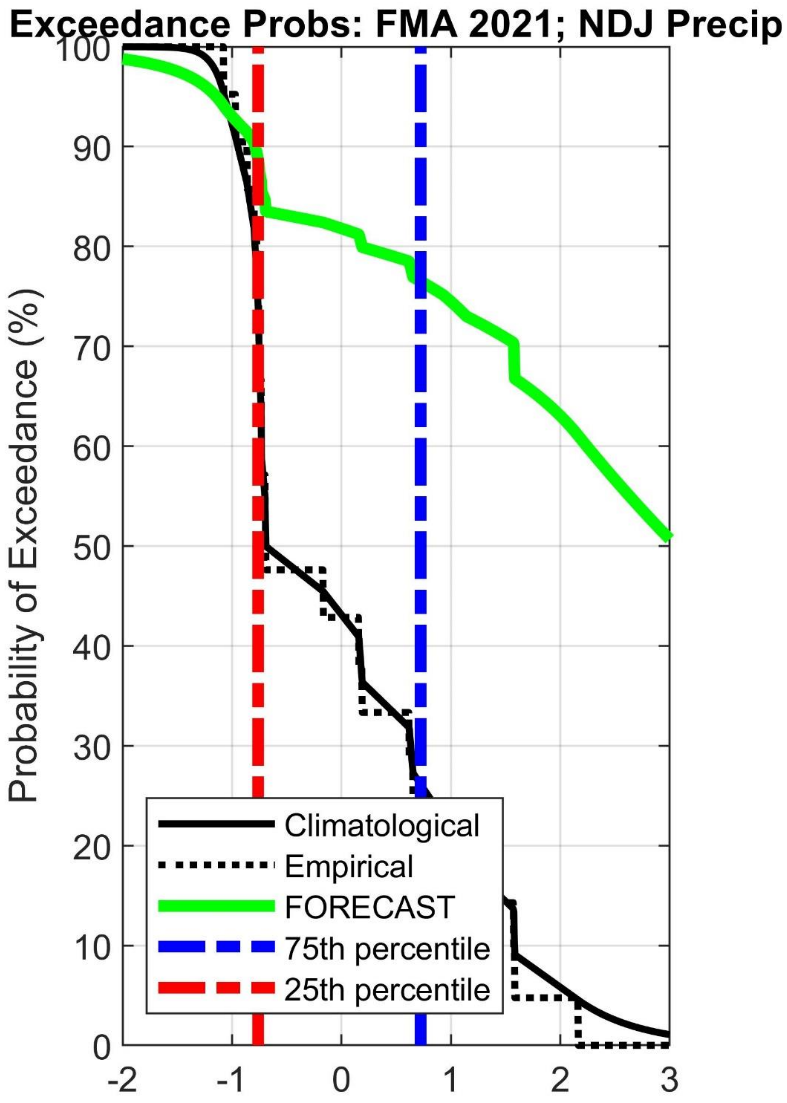
Inflow forecast for Lake Kariba: MAM (main)

Muchuru et al. (2016)



Current Project, administered by the WRC: *RainSolutions*





Vaal Dam Downstream Flow Predictions

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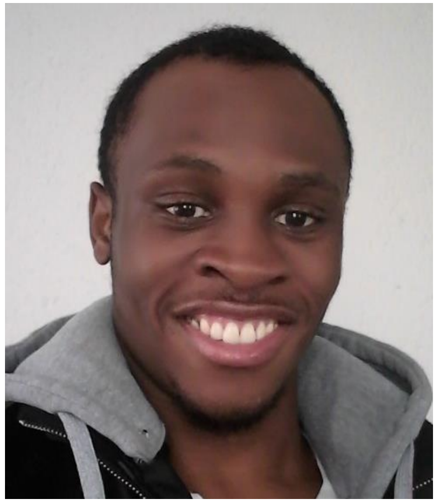
Student participation in forecast system development

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.