

# Seasonal forecasts

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<https://tinyurl.com/ybrb3a72>



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# Seasonal Forecast Worx

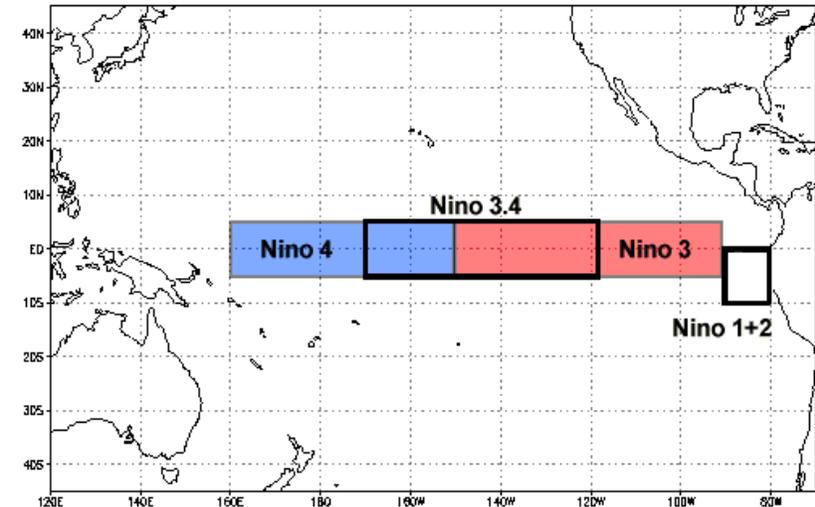
Latest Update: 16 March 2021

- 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>

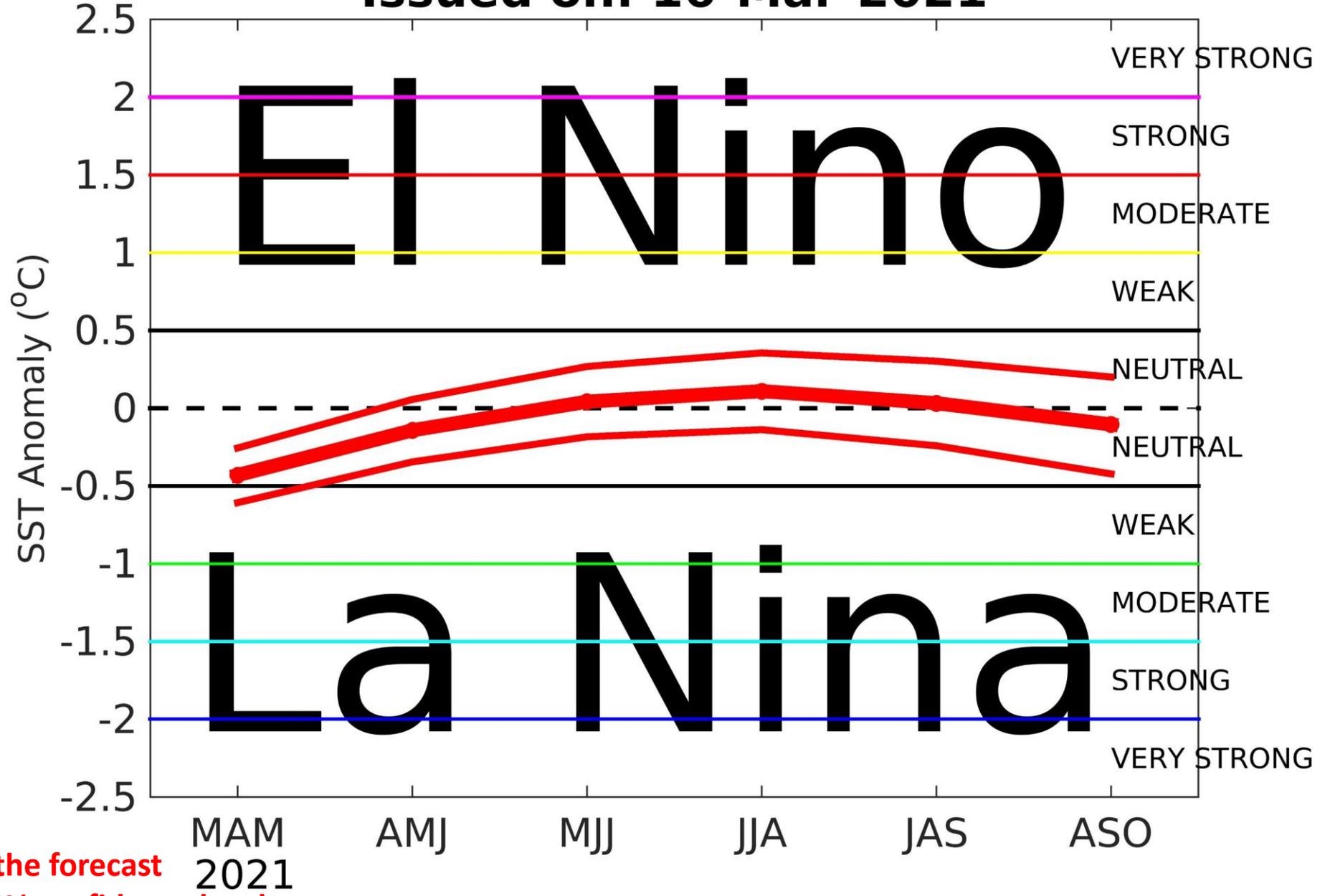
# ENSO and Global SST Forecasts

# 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



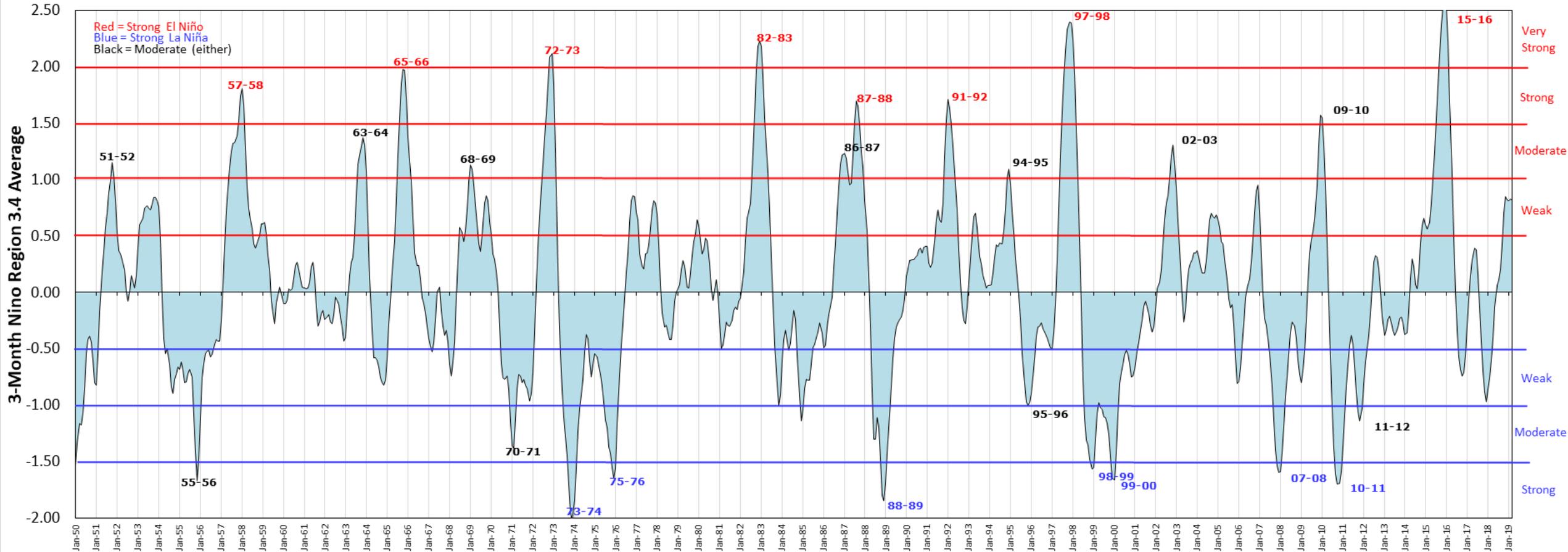
# CSiriMM Nino3.4 SST Forecast Issued on: 16-Mar-2021



Middle red line: the forecast 2021  
Thin red lines: 25% confidence levels

# Oceanic Niño Index (ONI)

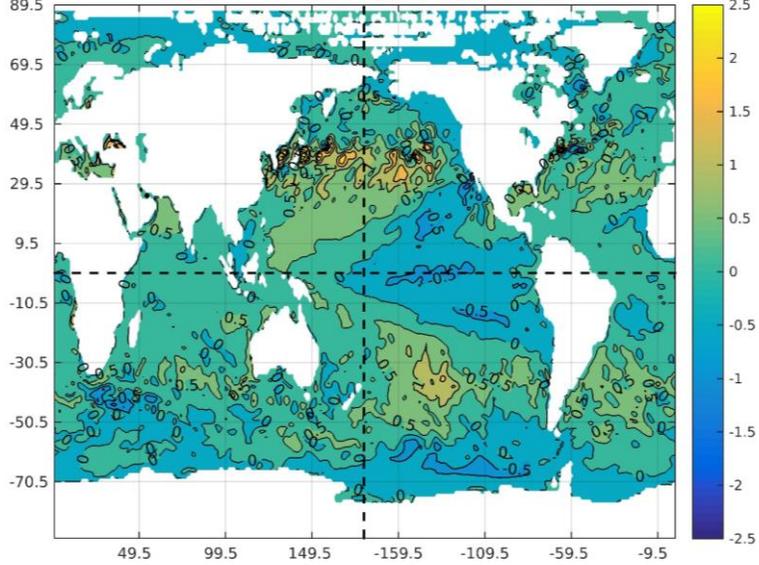
[http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/ensostuff/ensoyears.shtml](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml)



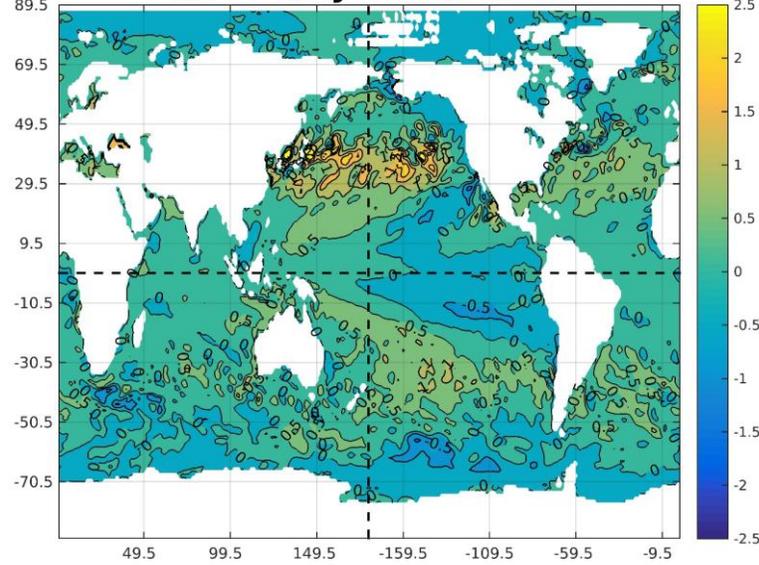
IC: the month in which the forecast was made

# SST anomalies

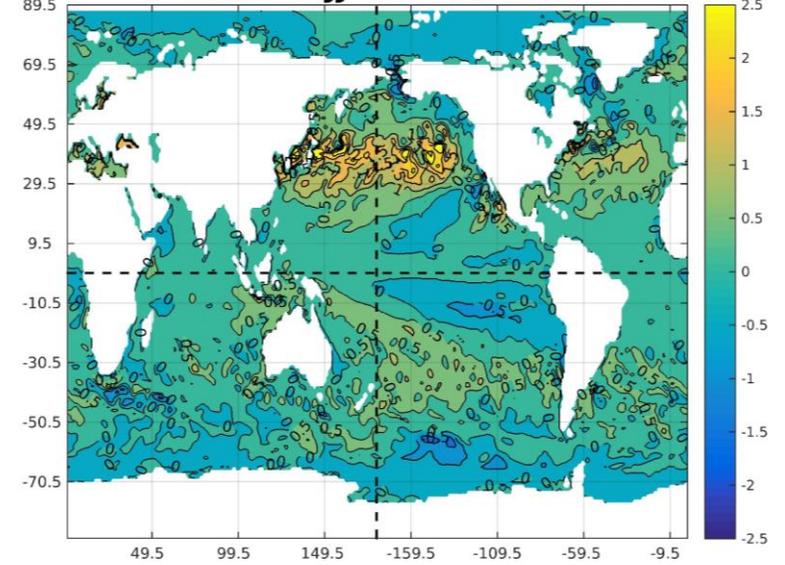
SST MAM IC:Mar2021



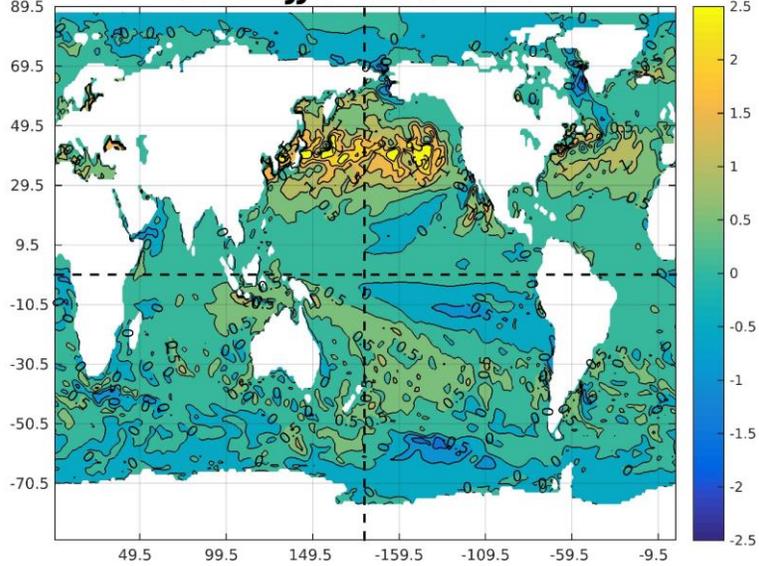
SST AMJ IC:Mar2021



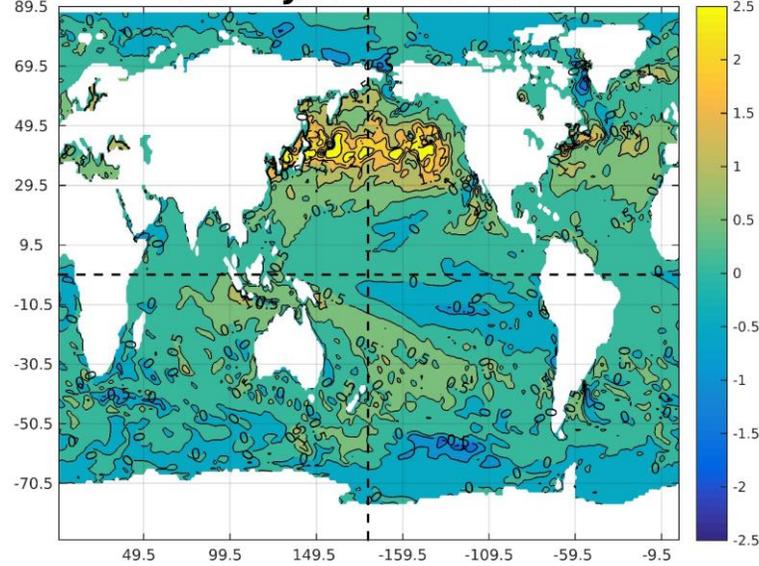
SST MJJ IC:Mar2021



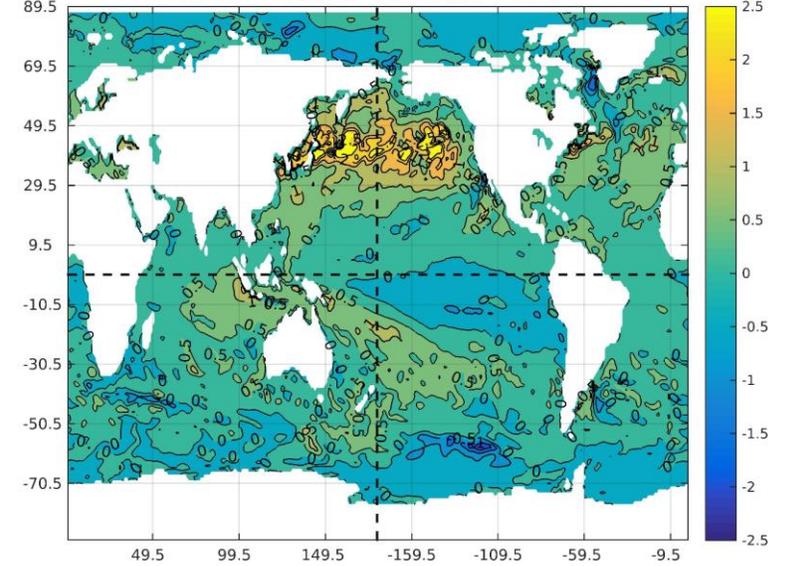
SST JJA IC:Mar2021



SST JAS IC:Mar2021

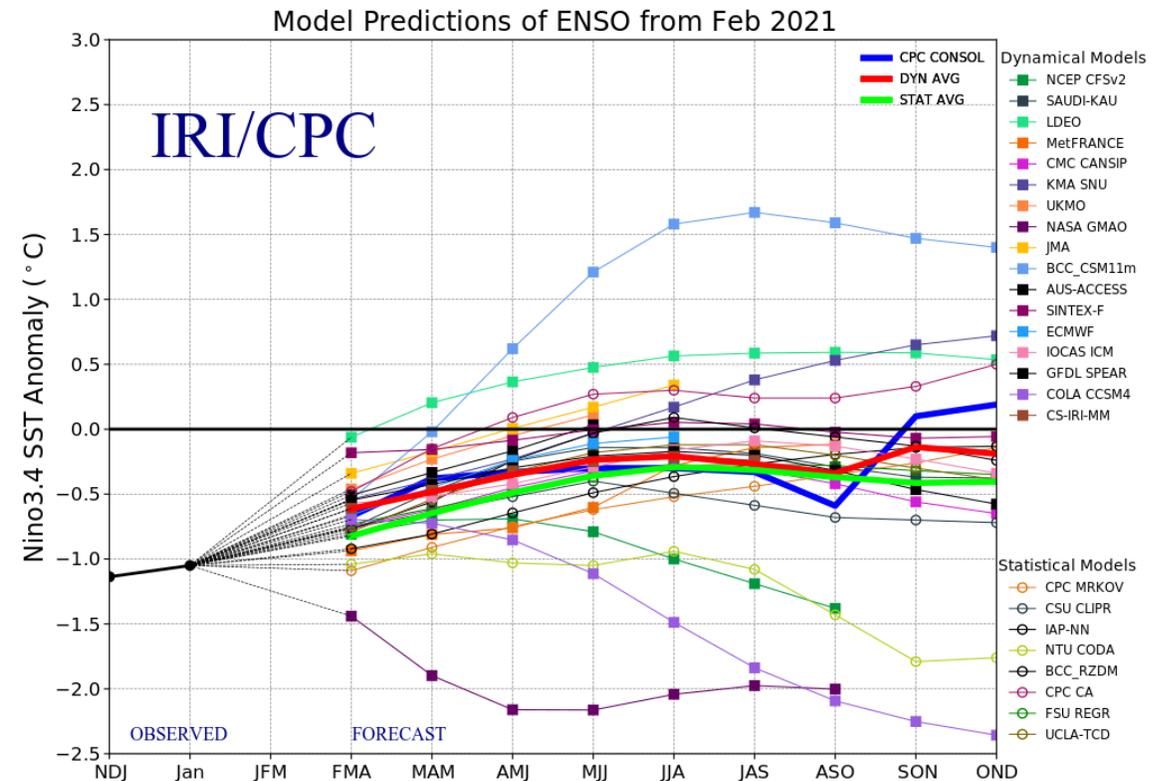
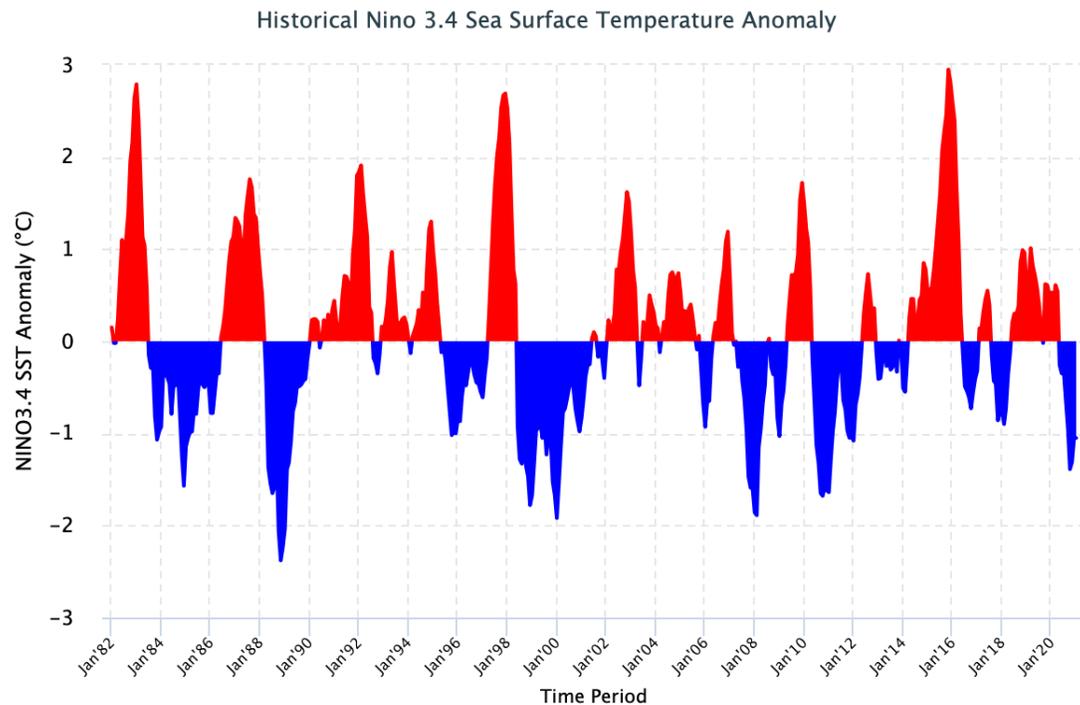


SST ASO IC:Mar2021



# Round-up: ENSO

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



# 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 ( $0.5^{\circ} \times 0.5^{\circ}$ ), 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 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

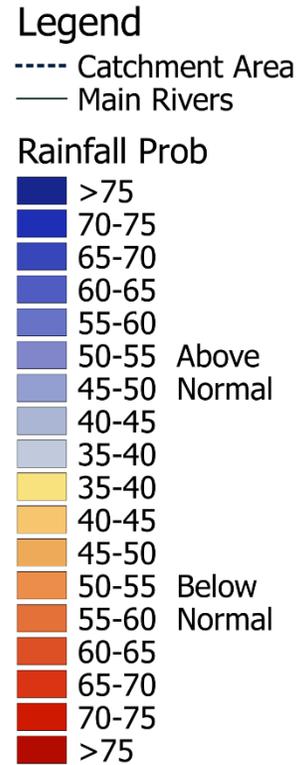
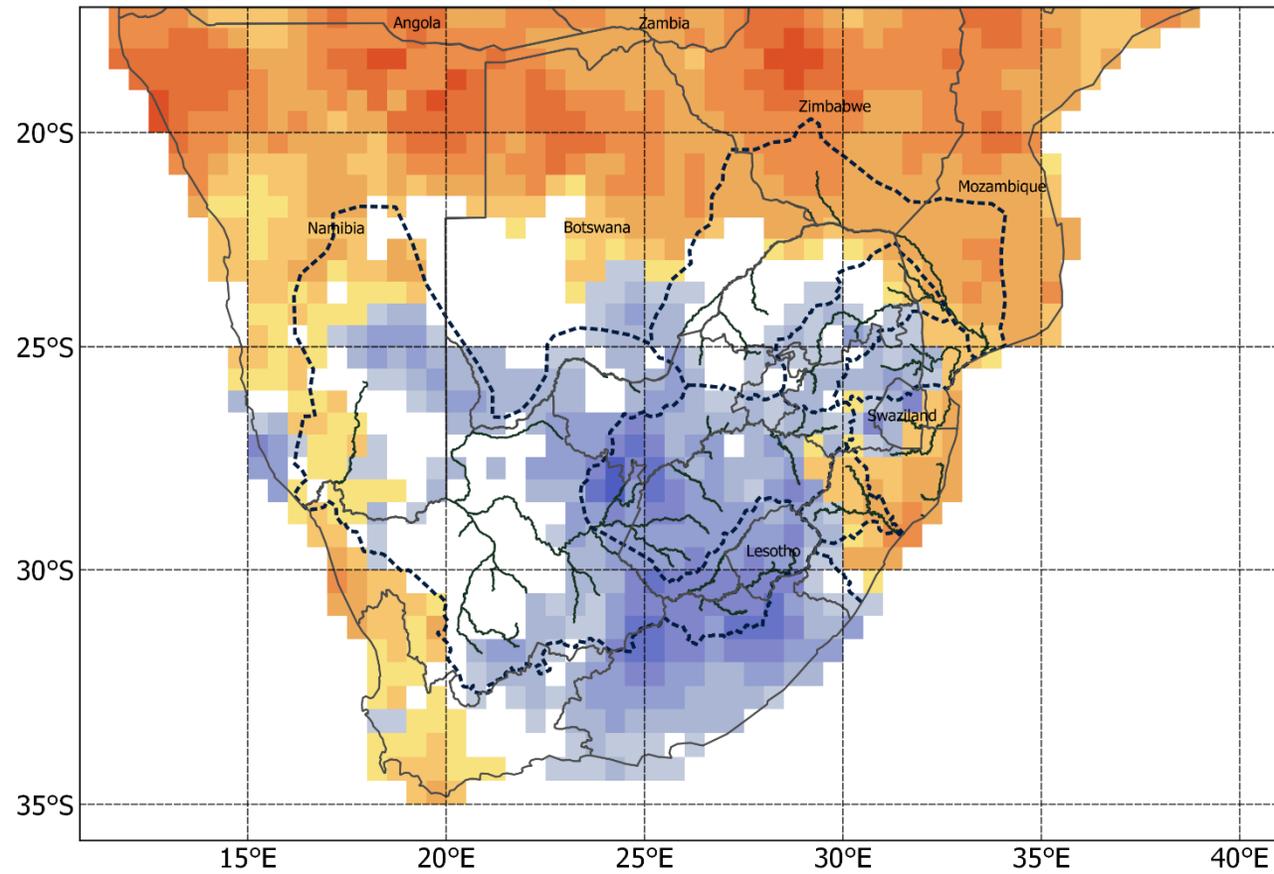
Probabilistic forecasts can help users understand risks and opportunities (forewarned is forearmed) in order to make more informed decisions.

The seasonal rainfall and maximum temperature 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.

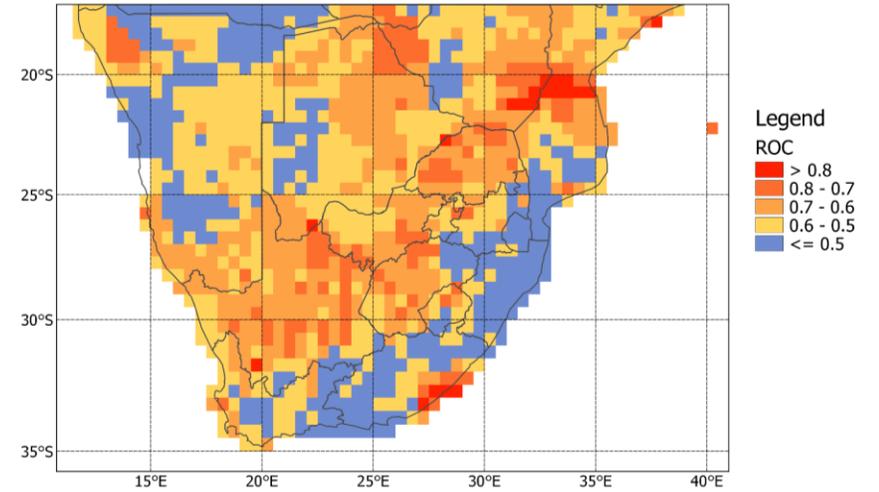
The nature of a probabilistic forecast implies that the less likely outcomes are always possible. In fact, for the probabilistic forecasts to be considered reliable, the less likely outcomes will and must occasionally occur.

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

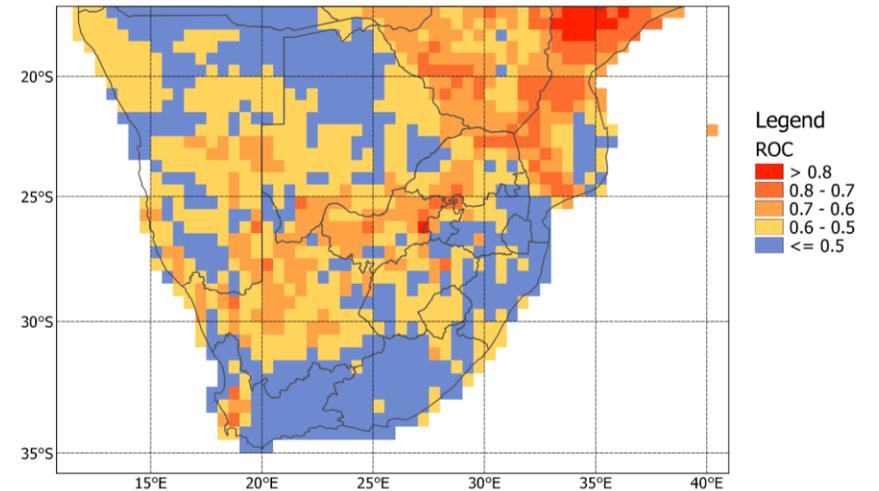
# MAM 2021 Rainfall; ICs: Mar



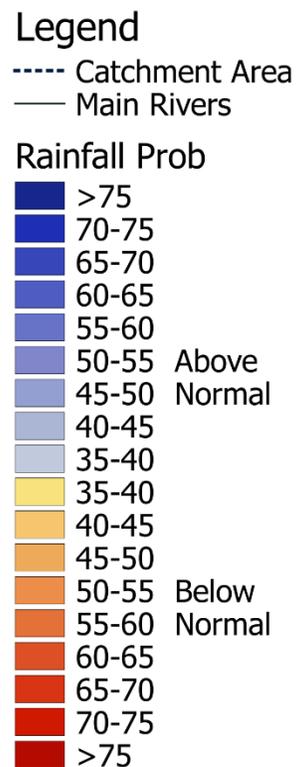
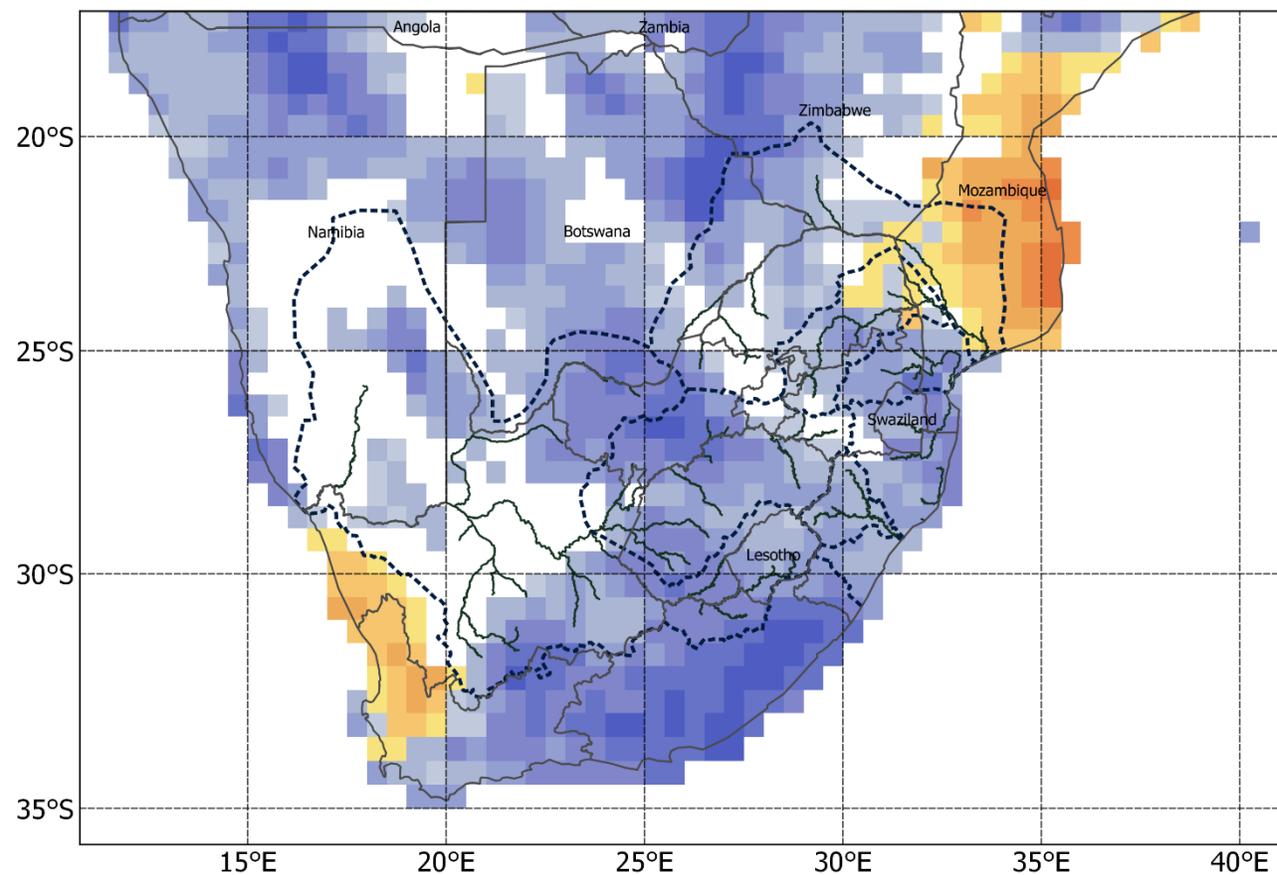
## ROC Area (Above-Normal): MAM Rainfall



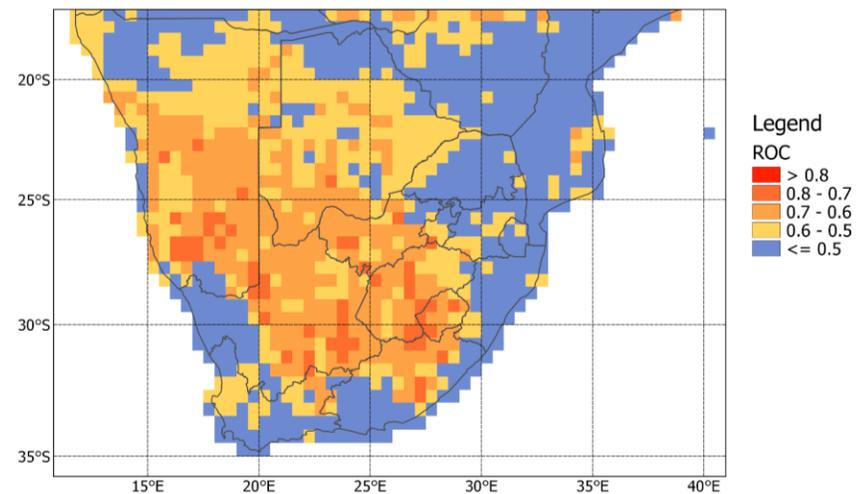
## ROC Area (Below-Normal): MAM Rainfall



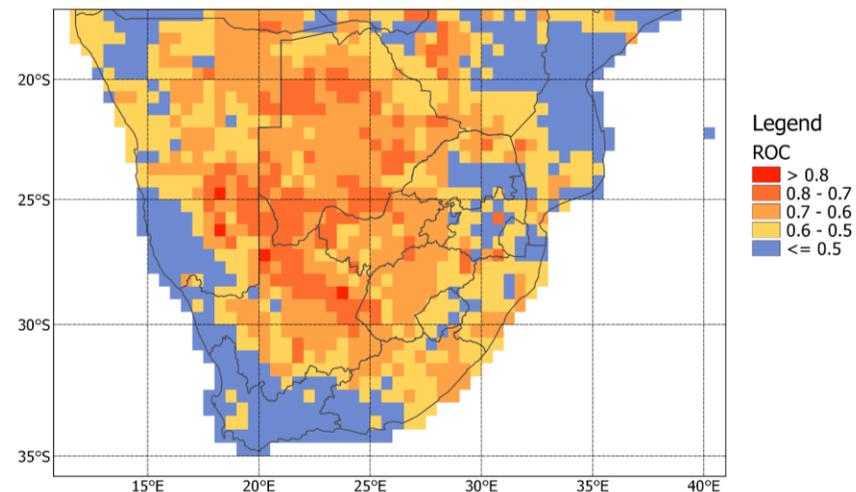
# AMJ 2021 Rainfall; ICs: Mar



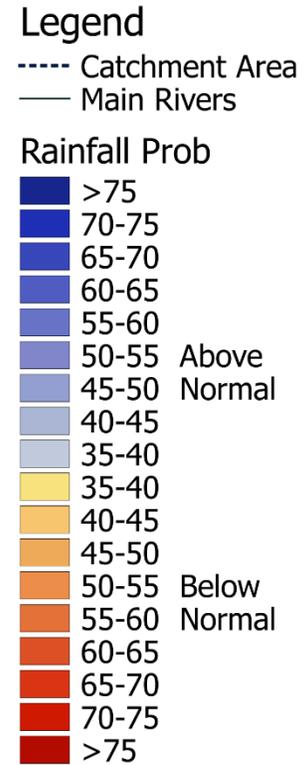
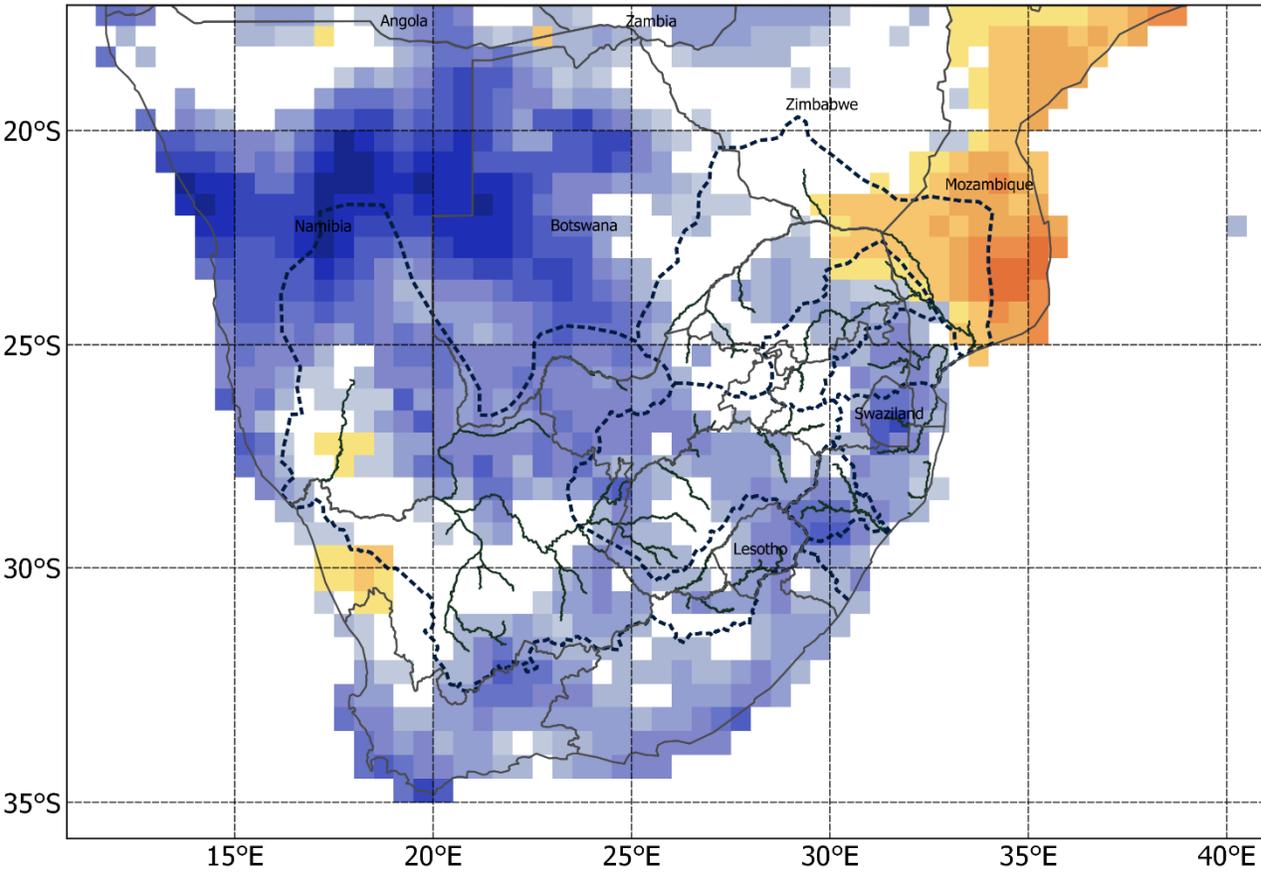
## ROC Area (Above-Normal): AMJ Rainfall



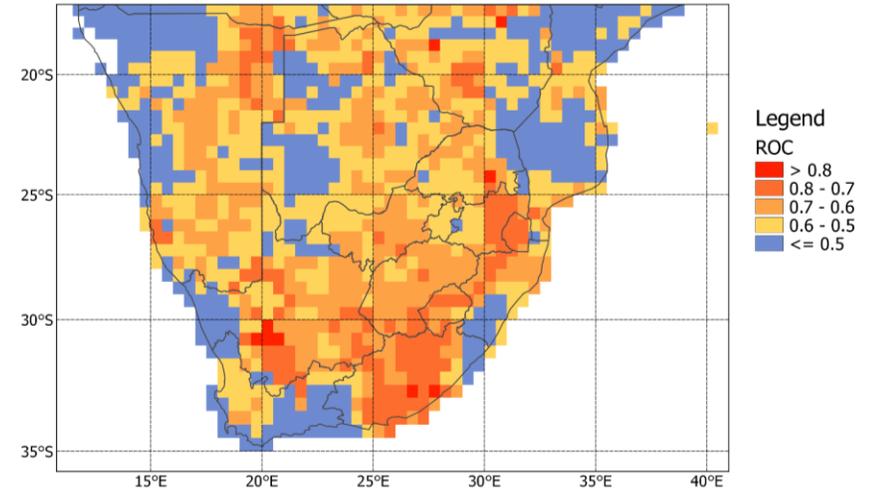
## ROC Area (Below-Normal): AMJ Rainfall



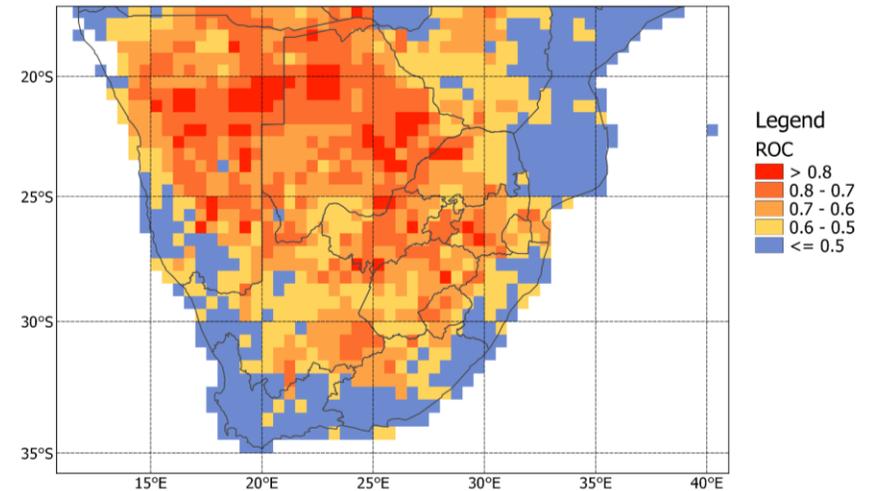
# MJJ 2021 Rainfall; ICs: Mar



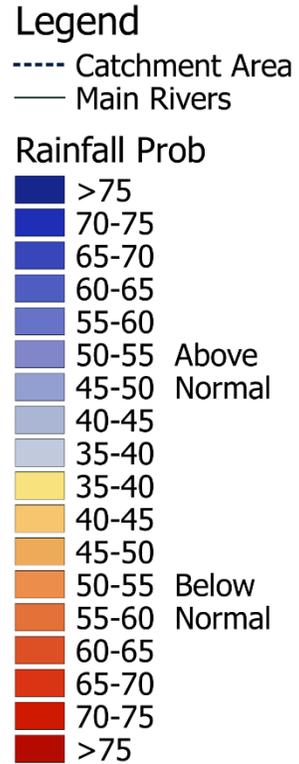
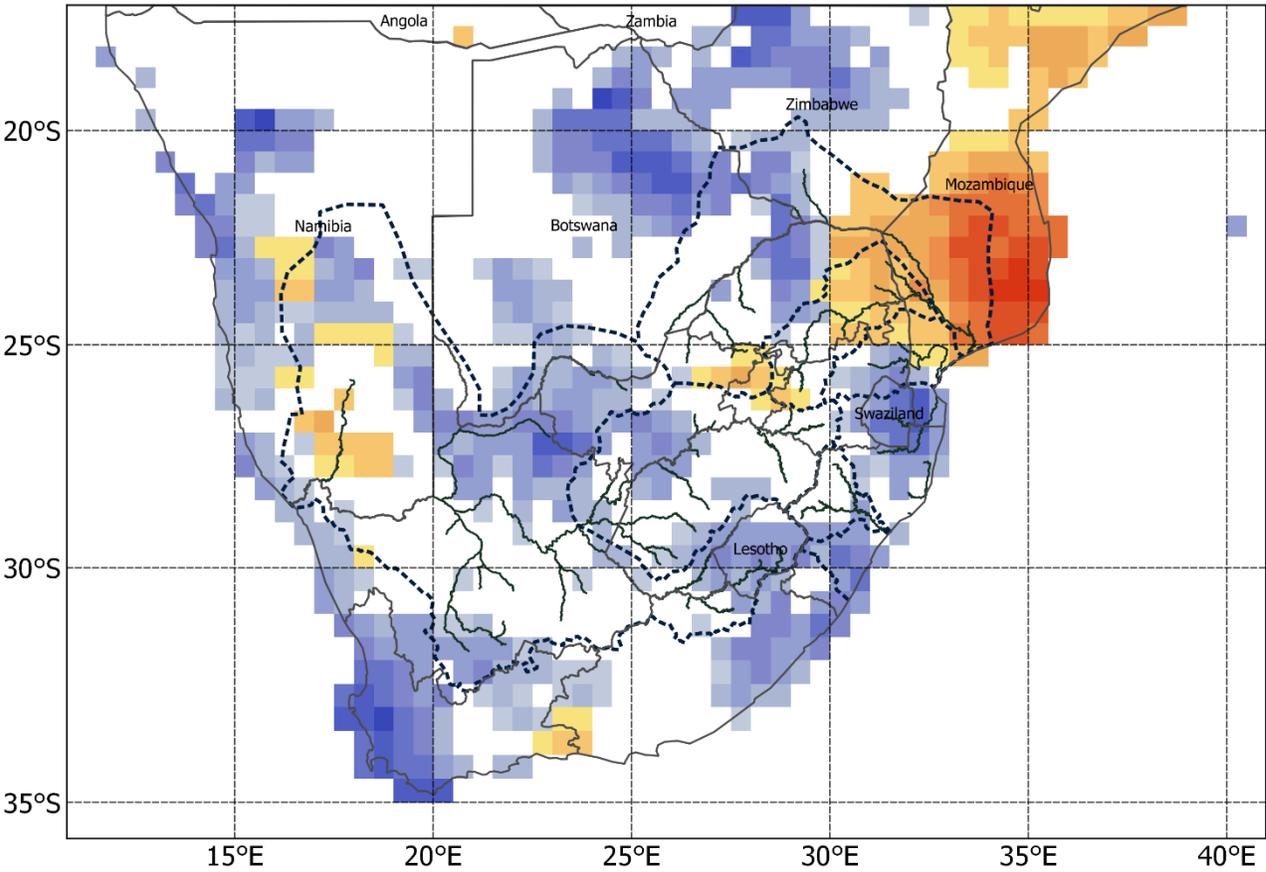
## ROC Area (Above-Normal): MJJ Rainfall



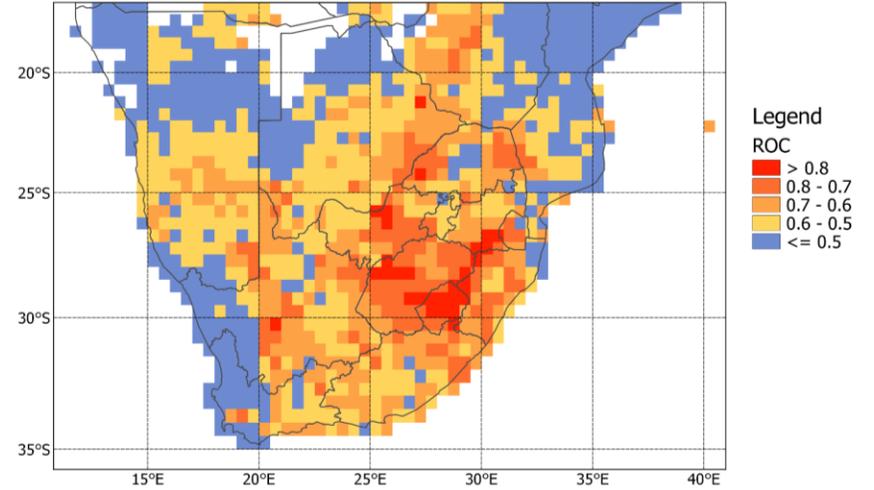
## ROC Area (Below-Normal): MJJ Rainfall



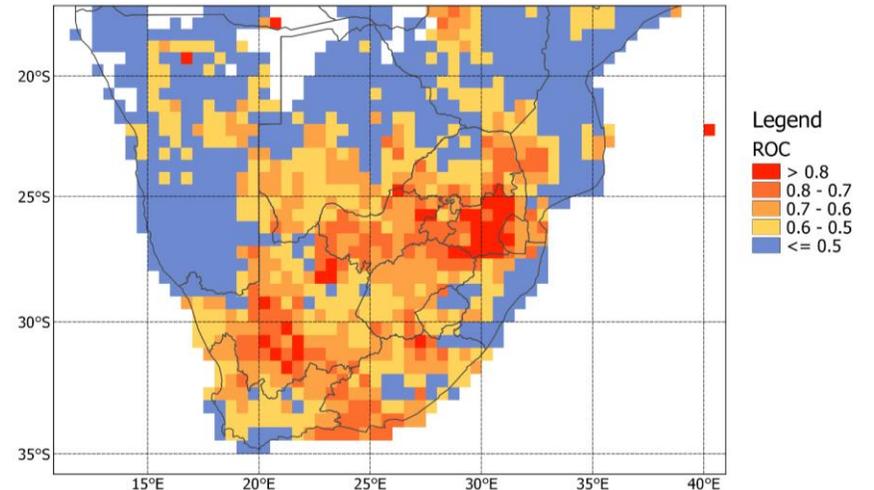
# JJA 2021 Rainfall; ICs: Mar



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



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



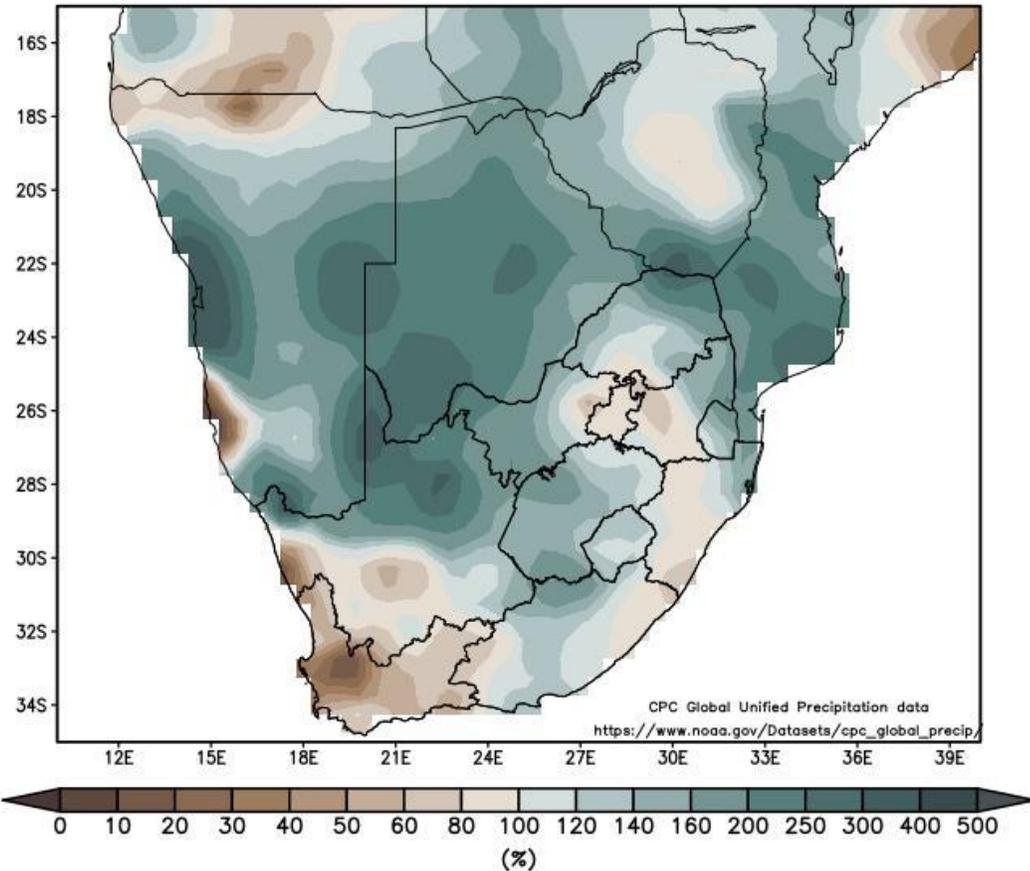
# Round-up: SADC Rainfall

- Parts of the central areas are expected to receive above-normal rainfall totals during late summer
- There is a chance that the southwestern Cape may be wet during winter

# Observed SADC Rainfall

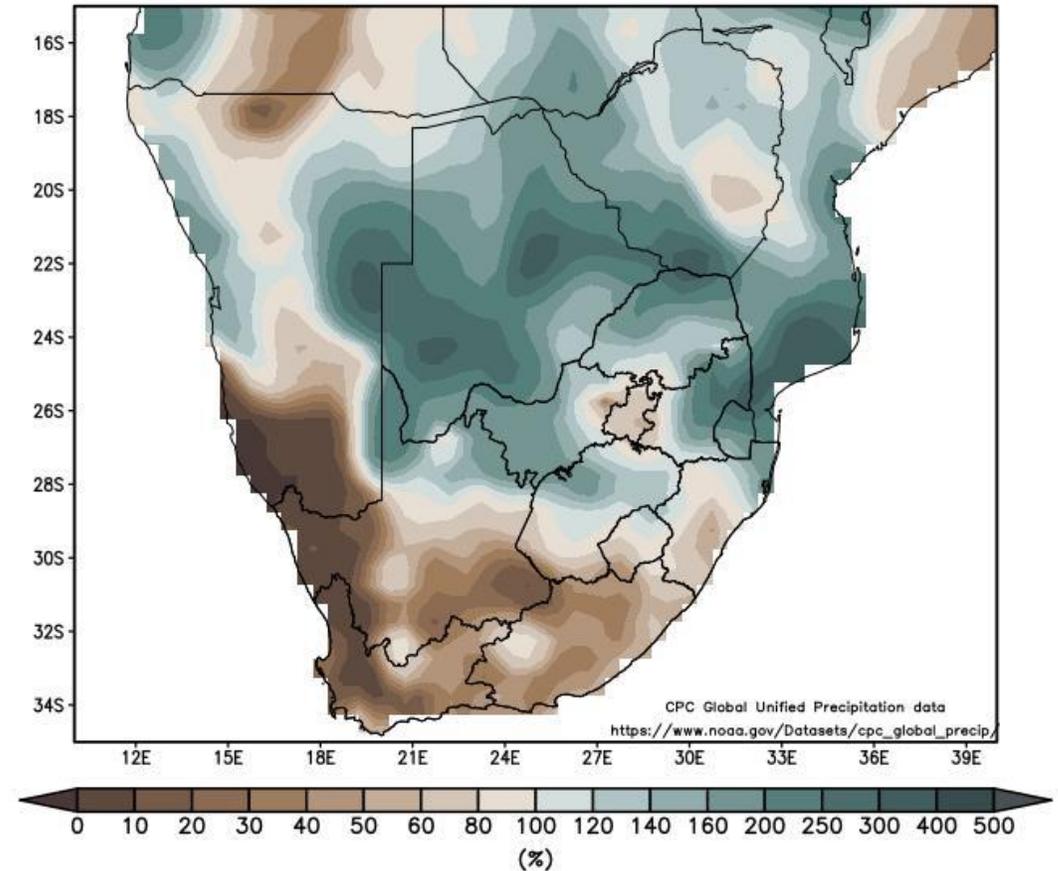
Rainfall (% of normal): December–January–February 2020/21

Relative to December–January–February 1981/82–2010/11 rainfall



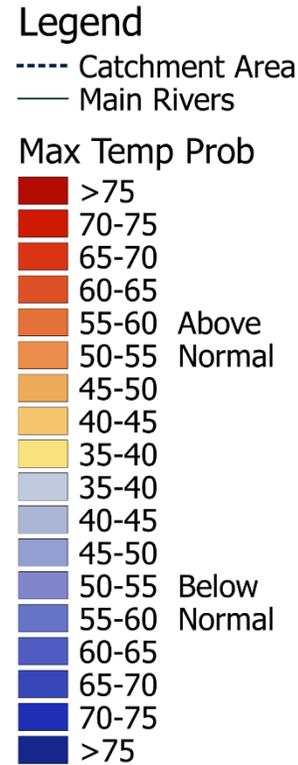
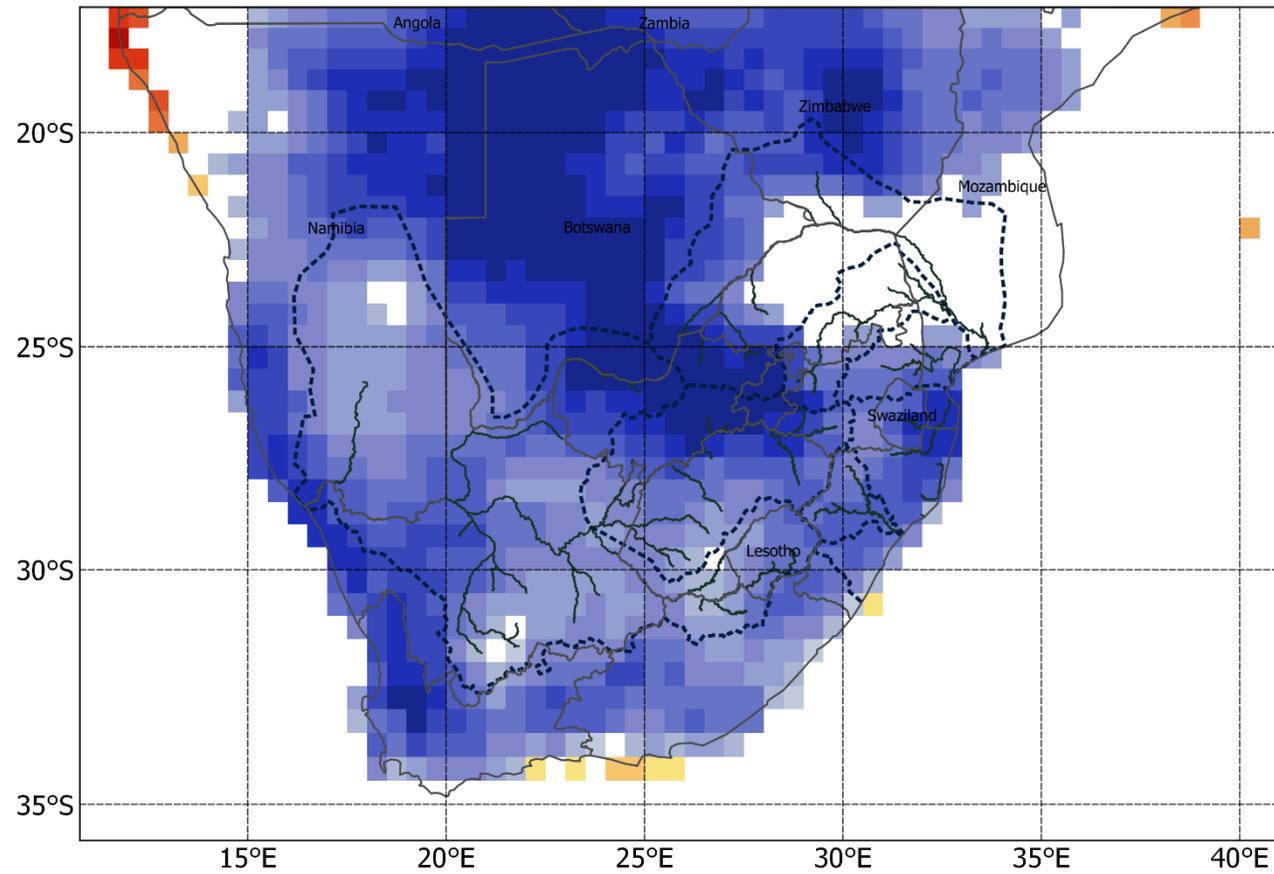
Rainfall (% of normal): February 2021

February long-term mean: 1981–2010

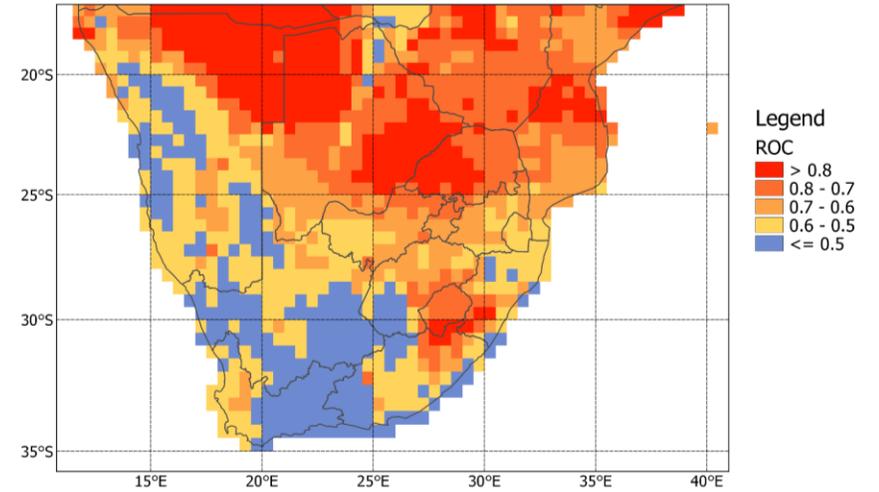


Maps prepared by Dr. Christien Engelbrecht

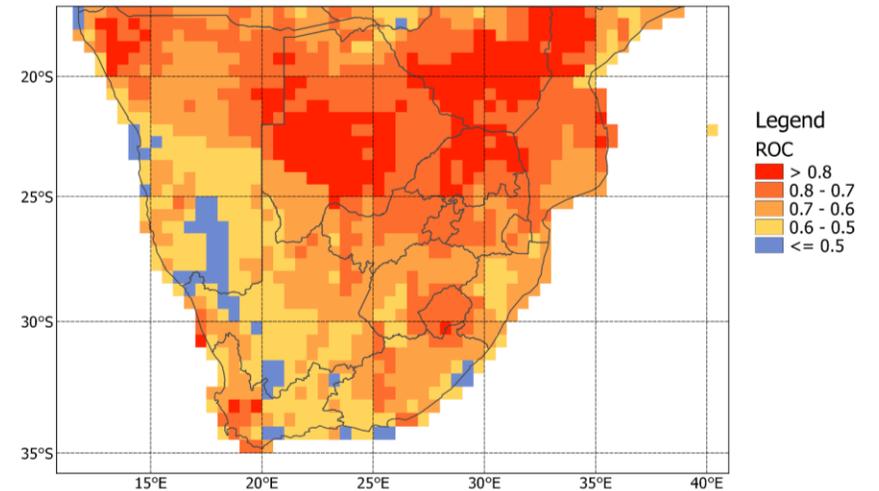
# MAM 2021 Max Temp; ICs:Mar



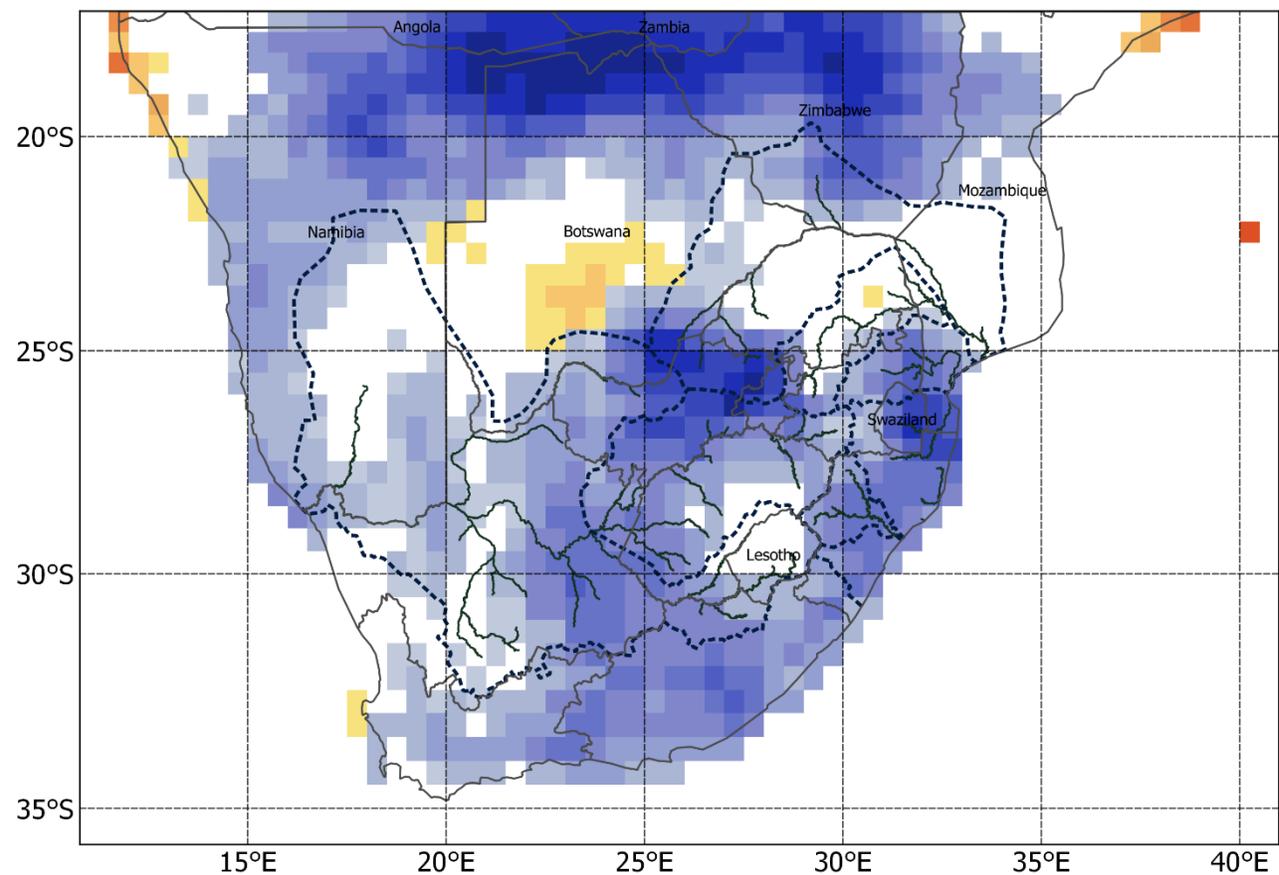
## ROC Area (Above-Normal): MAM Max Temp



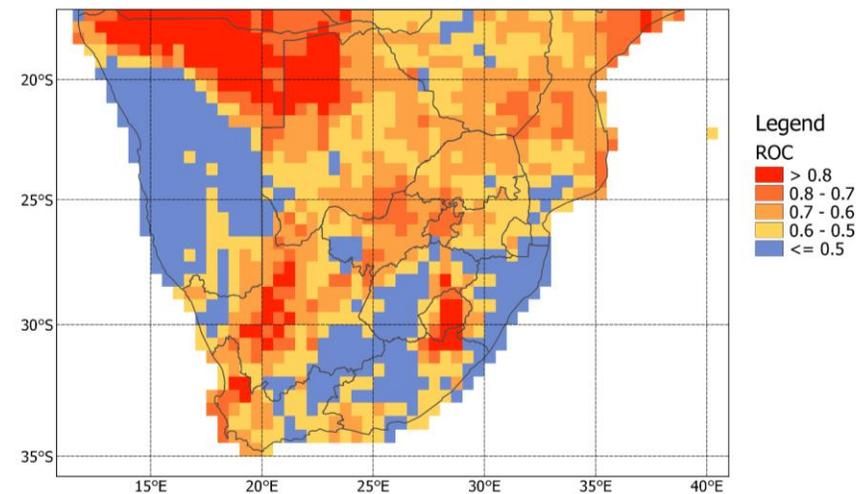
## ROC Area (Below-Normal): MAM Max Temp



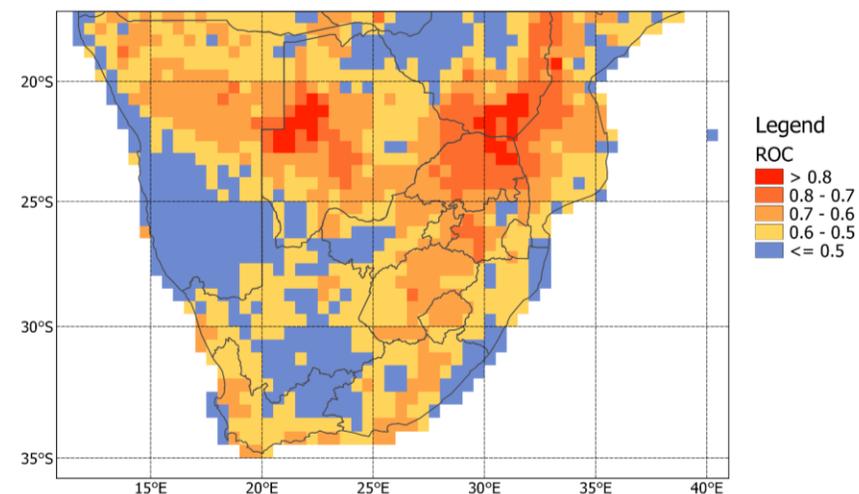
# AMJ 2021 Max Temp; ICs:Mar



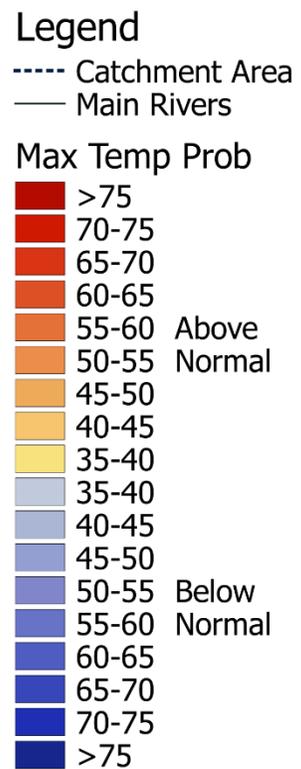
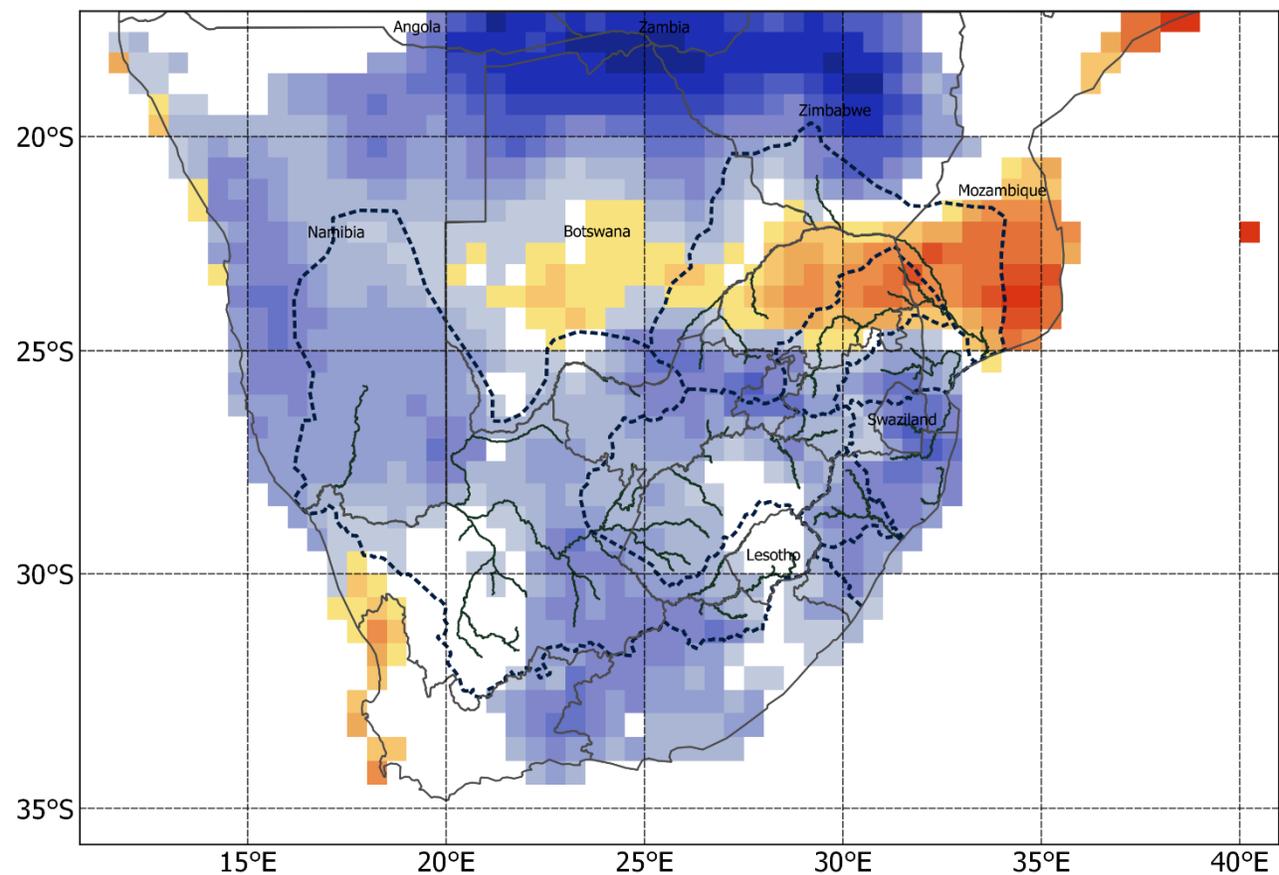
## ROC Area (Above-Normal): AMJ Max Temp



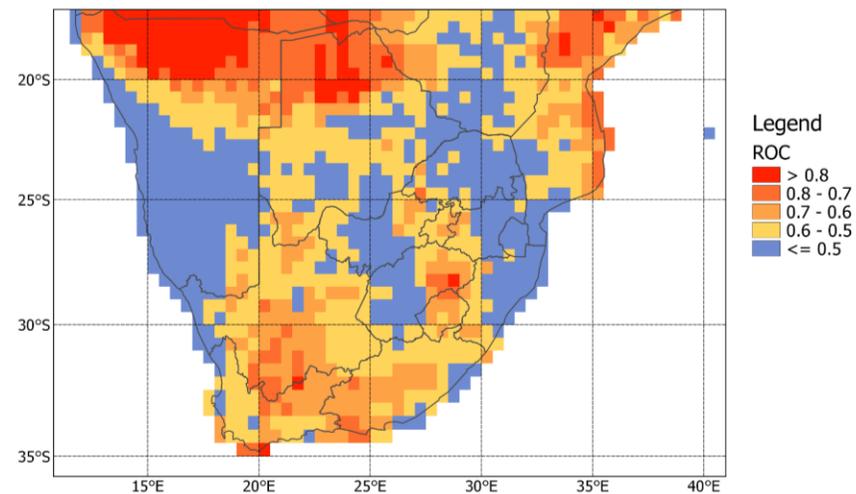
## ROC Area (Below-Normal): AMJ Max Temp



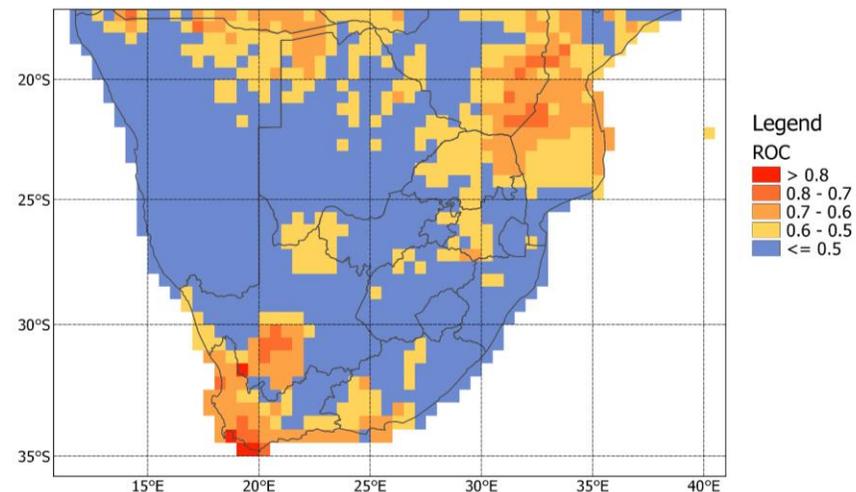
# MJJ 2021 Max Temp; ICs:Mar



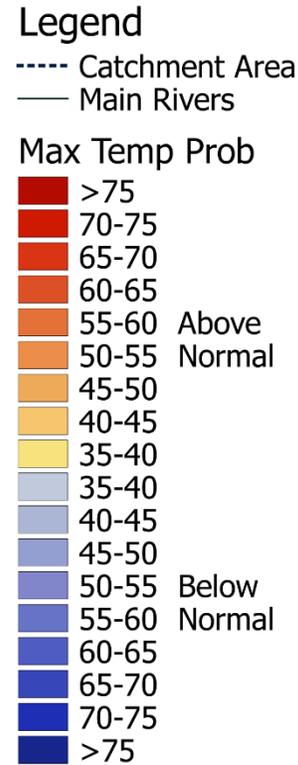
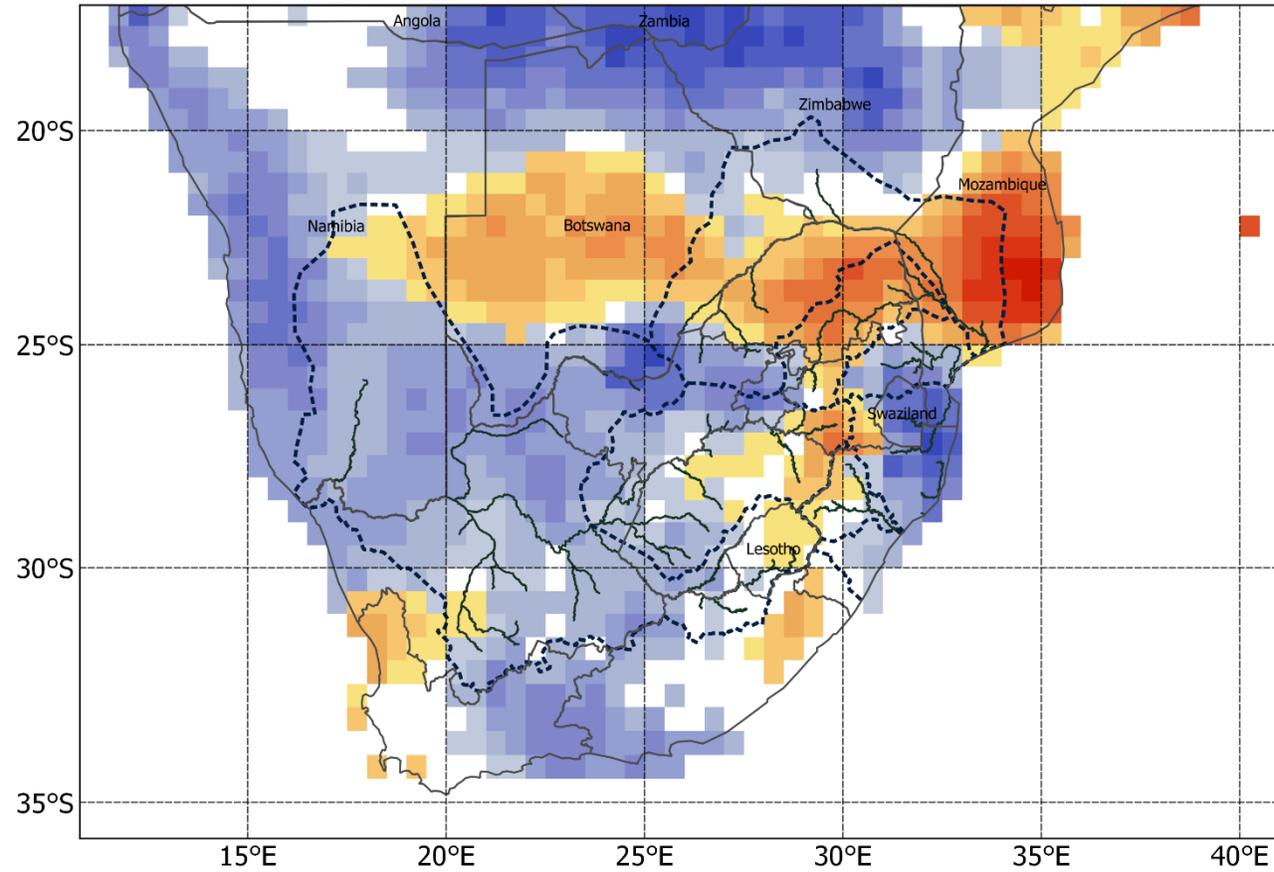
## ROC Area (Above-Normal): MJJ Max Temp



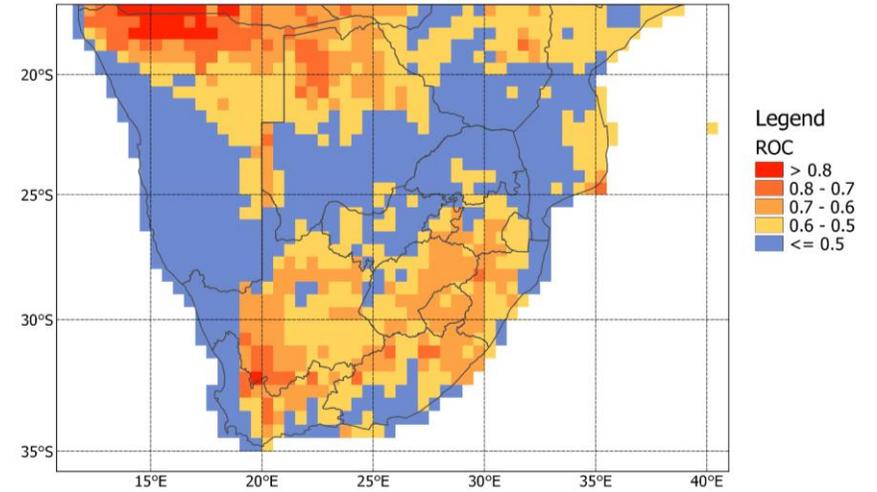
## ROC Area (Below-Normal): MJJ Max Temp



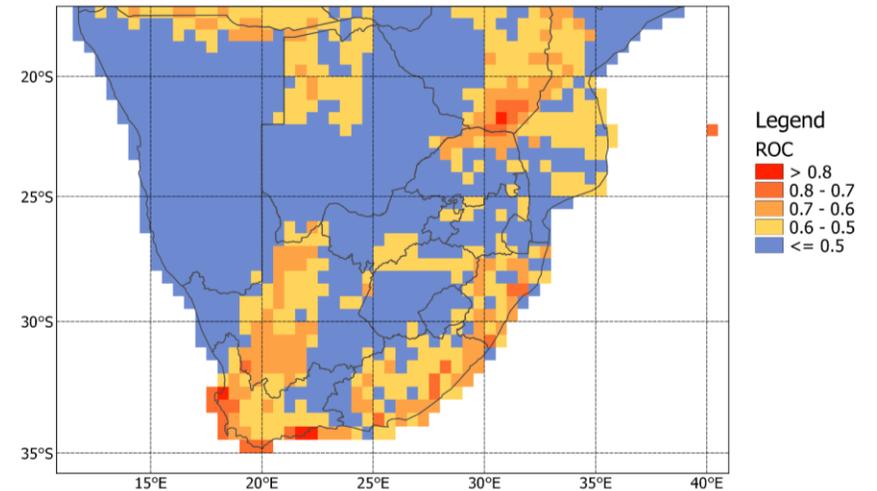
# JJA 2021 Max Temp; ICs:Mar



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



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



# Round-up: SADC Max Temp

- Cooler maximum temperatures during autumn likely
- Cold start to winter likely, except for the Limpopo province and adjacent regions

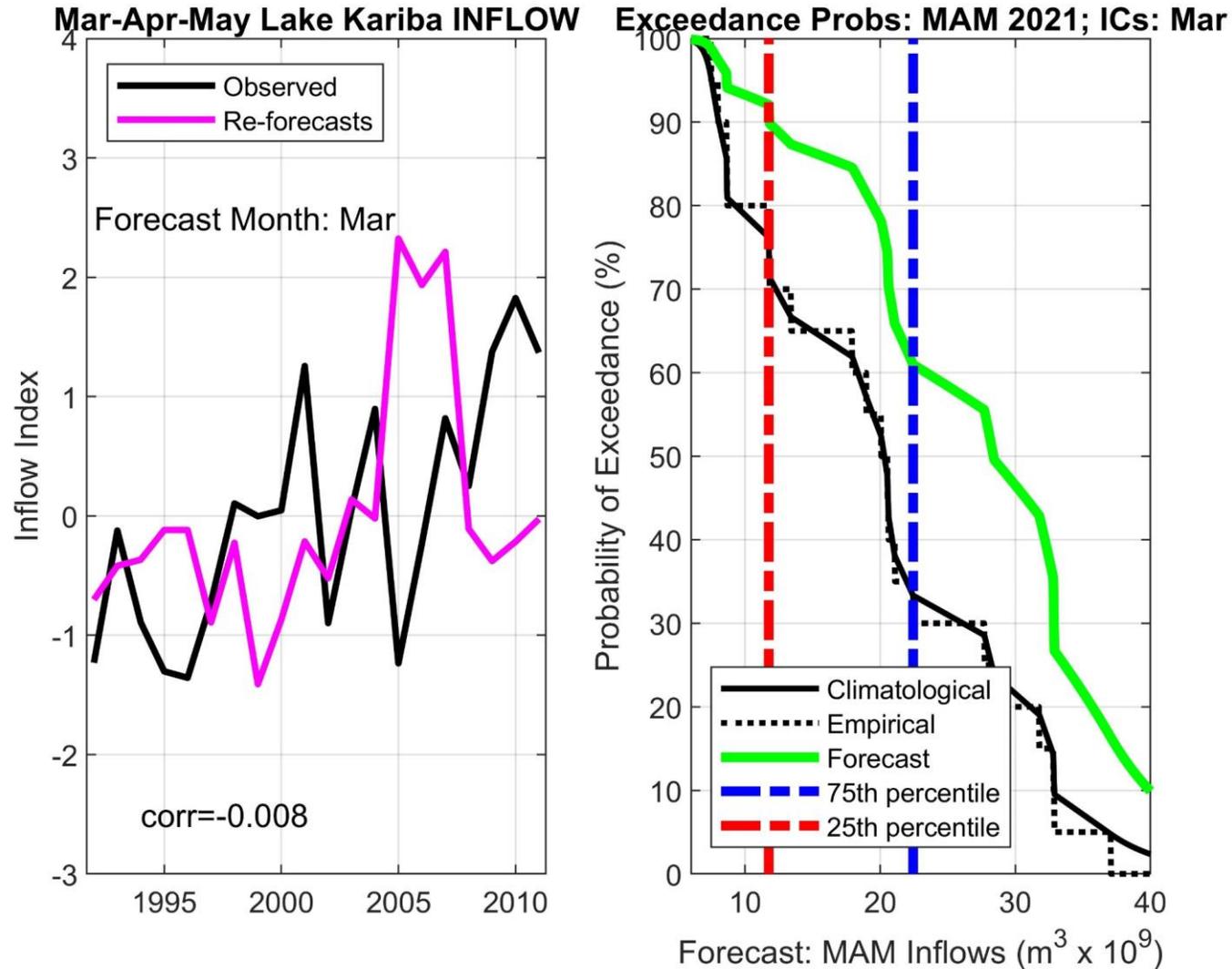
# Tailored Forecasts

1. Probability of exceedance Mar-Apr-May 2021 inflow forecast for Lake Kariba, Zambia/Zimbabwe
2. Probability of exceedance Mar-Apr-May 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

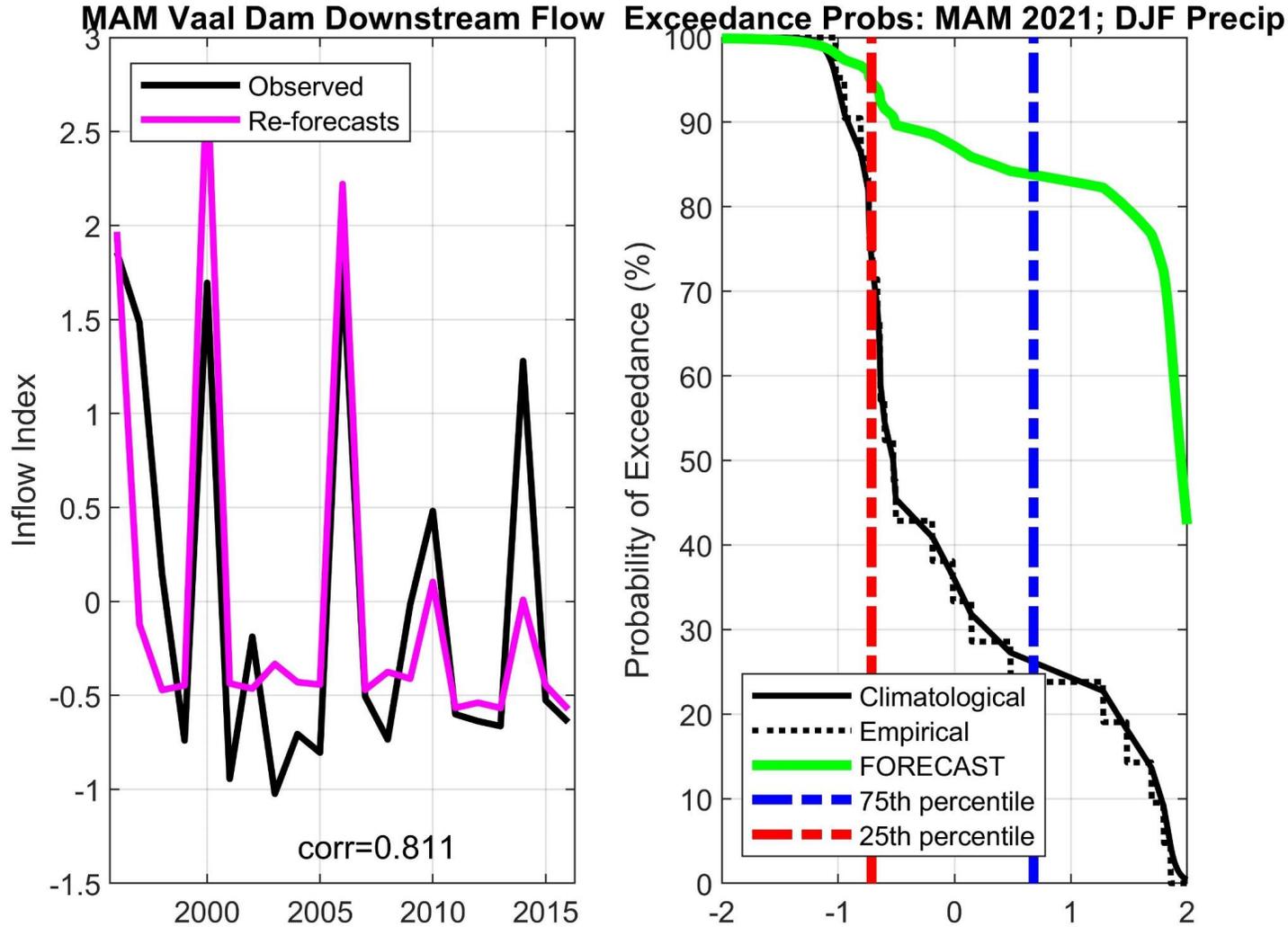
# Inflow forecast for Lake Kariba: MAM (main)

Muchuru et al. (2016)



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

## Vaal Dam Downstream Flow Predictions



# References

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- Troccoli, A., Harrison, M., Anderson, D.L.T. and Mason, S.J., 2008: *Seasonal Climate: Forecasting and Managing Risk*. NATO Science Series on Earth and Environmental Sciences, Vol. 82, Springer, 467 pp.

# Financial support from...

- The National Research Foundation through the Incentive Funding for Rated Researchers
- ACCESS (Alliance for Collaboration on Climate and Earth System Science) through the project “Investigating predictability of seasonal anomalies for societal benefit”
- Water Research Commission through administering the international project “Research-based Assessment of Integrated approaches to Nature-based SOLUTIONS (RainSolutions)”



# 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 Gosiambe, 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.