Seasonal forecasts

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Seasonal Forecast Worx

https://tinyurl.com/ybrb3a72

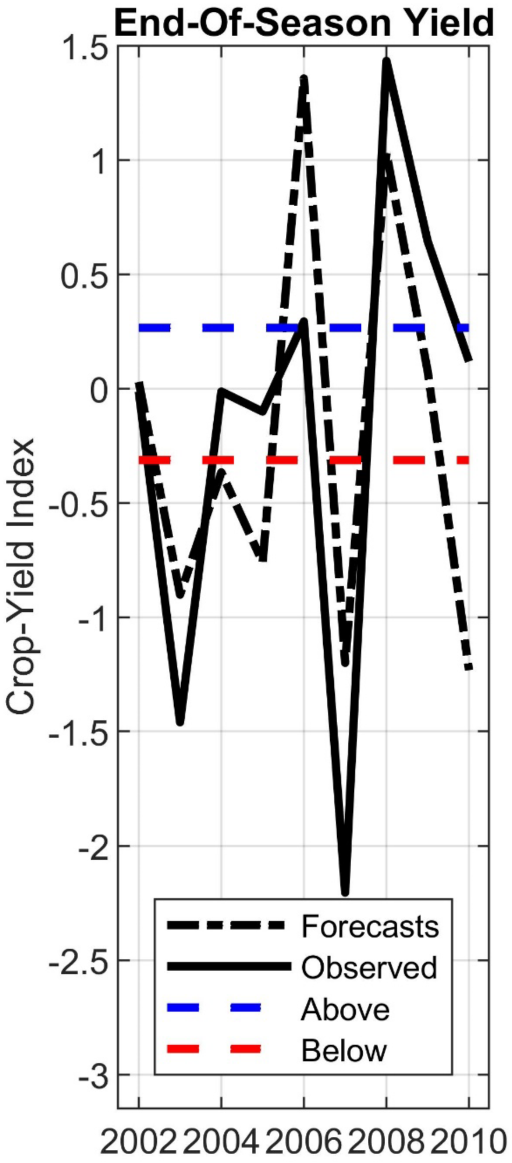
UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

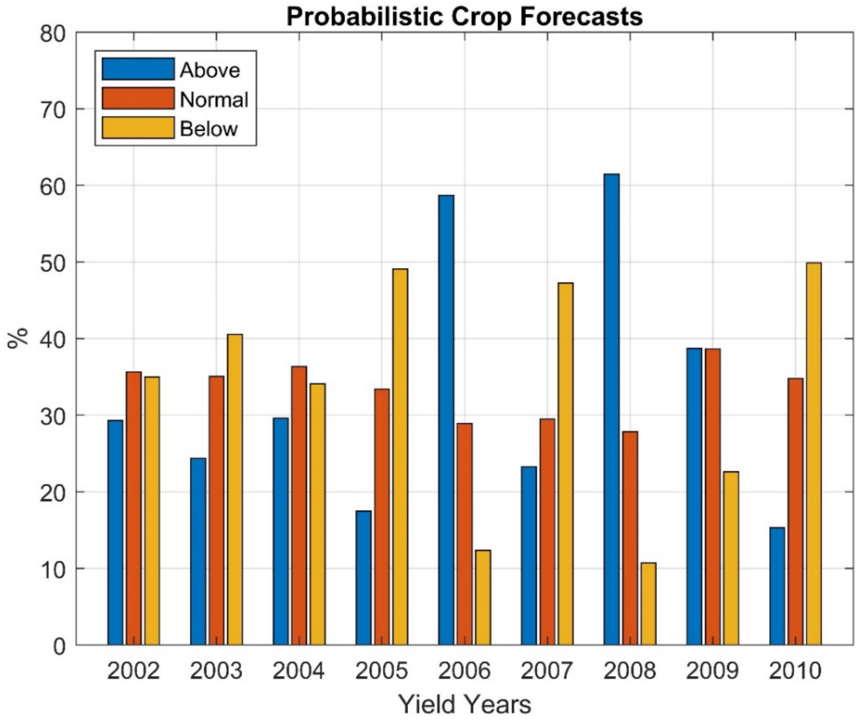
NMME The North American Multi-Model Ensemble

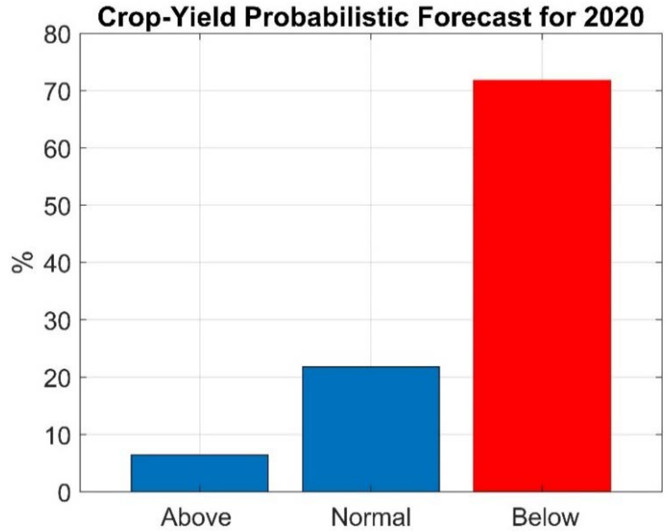
Latest Update: 9 October 2020

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).

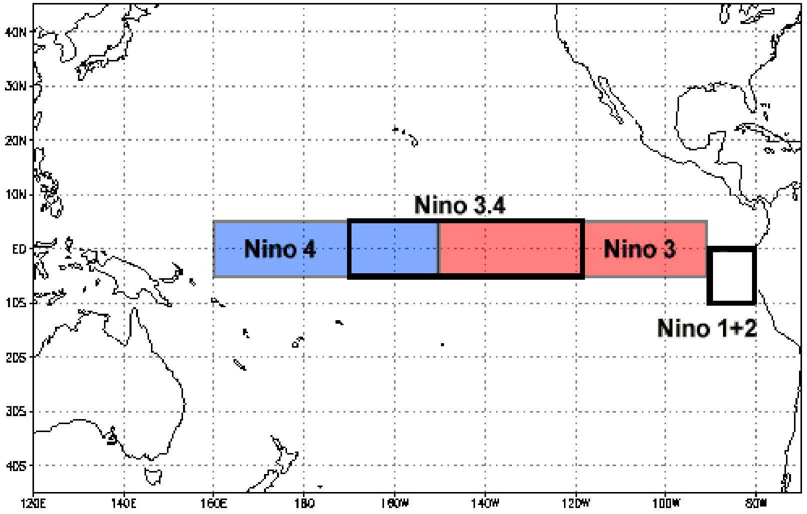
- For the official seasonal forecast for South Africa, visit the South African Weather Service website at http://www.weathersa.co.za/images/data/longrange/gfcsa/scw.pdf

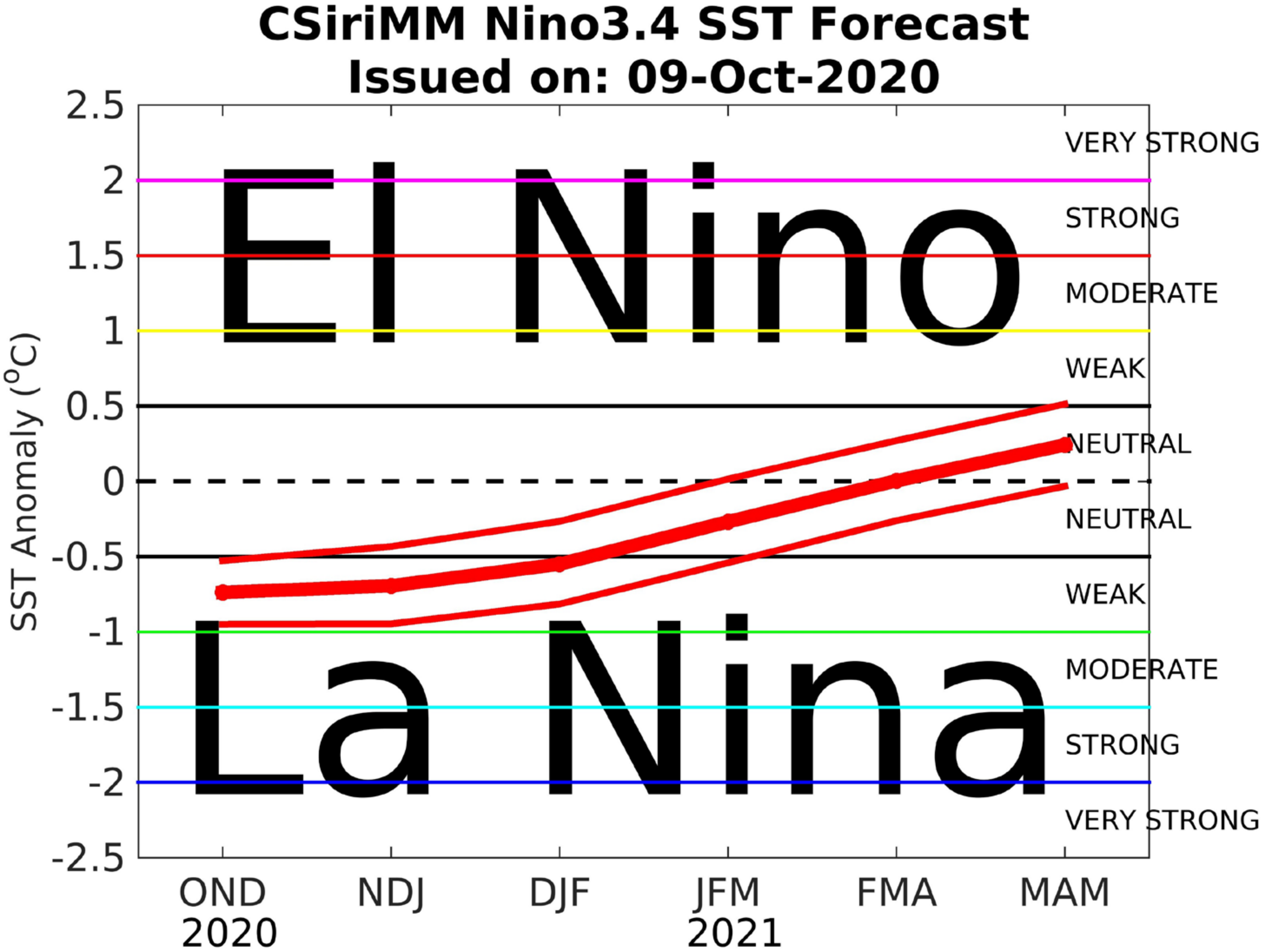
South African Weather Service

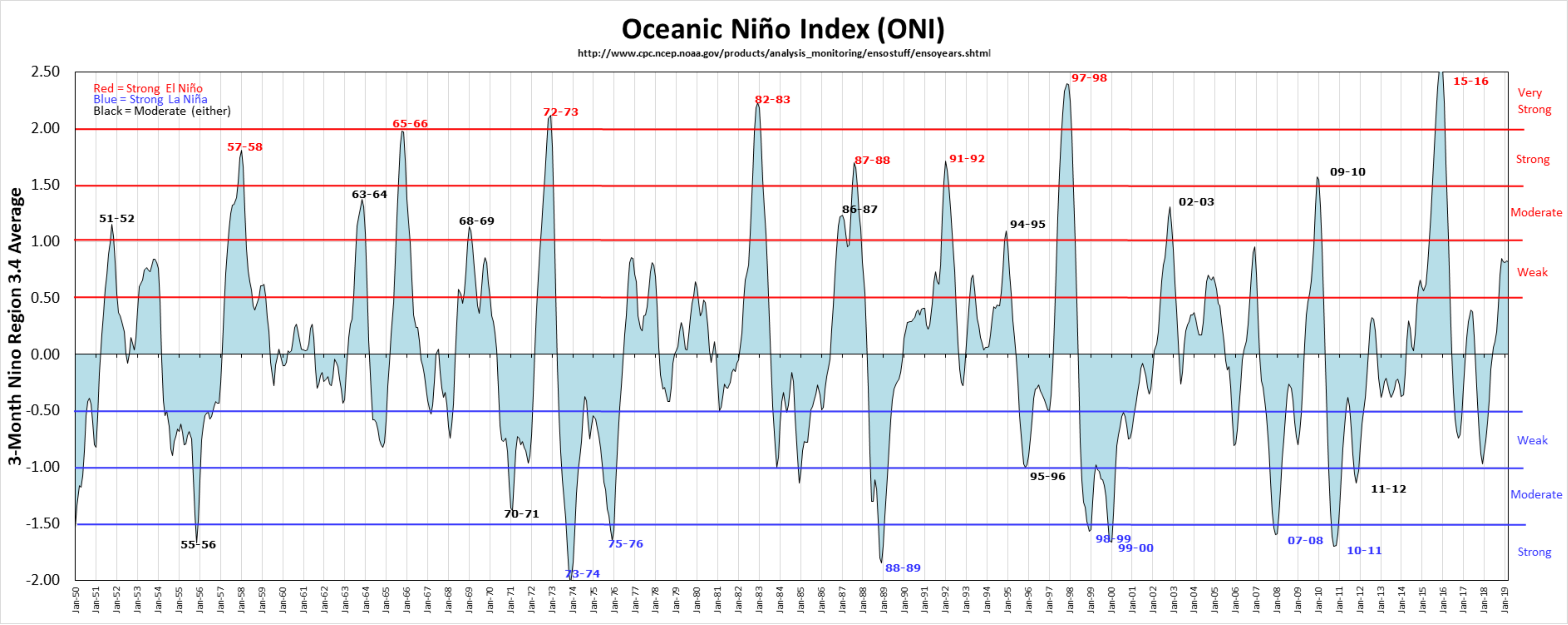
ENSO and Global SST Forecasts

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




CSiriMM Nino3.4 SST Forecast
Issued on: 09-Oct-2020
SST Anomaly (°C)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
El Nino
La Nina
VERY STRONG
STRONG
MODERATE
WEAK
NEUTRAL
NEUTRAL
WEAK
MODERATE
STRONG
VERY STRONG
OND
NDJ
DJF
JFM
FMA
MAM
2020
2021



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
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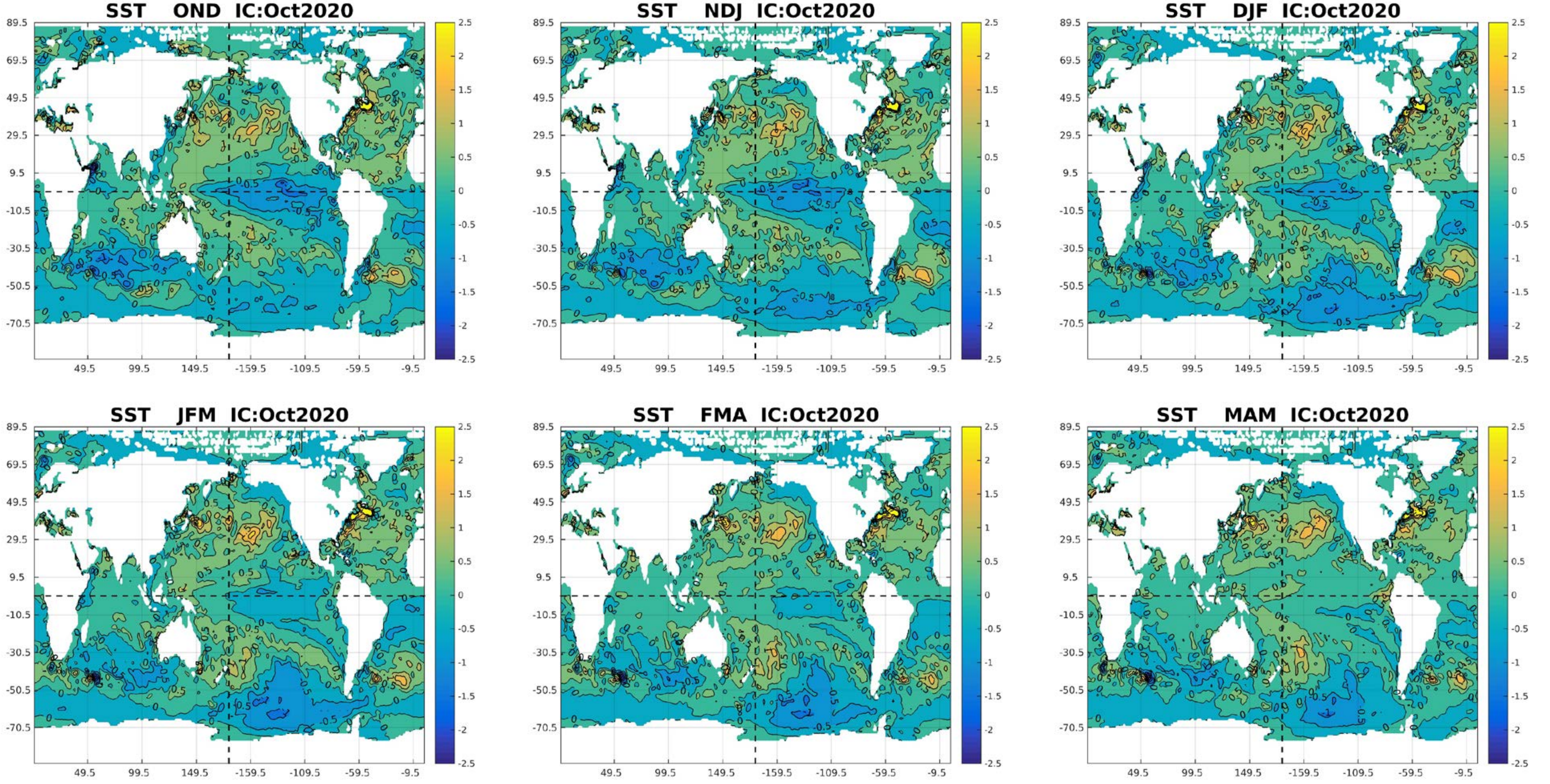
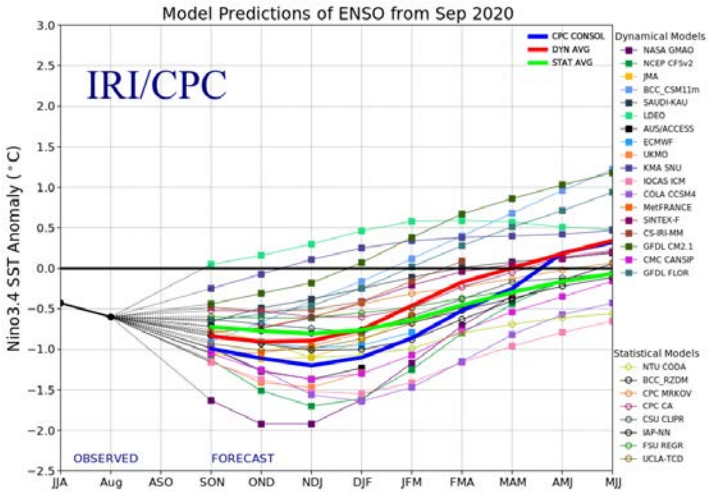
Jan-19

SST anomalies



Round-up: ENSO

- The UP model predicts weak La Niña conditions for spring and mid-summer, but ENSO-neutral conditions during the second half of summer
- Most forecast models continue to be for colder SST, with just a few warmer than the UP model (CS-IRI-MM)



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" / "hot", rainfall totals / maximum temperatures higher than the 75th percentile of the climatological record)
  - **Below:** Below-normal ("dry" / "cool", rainfall totals / 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

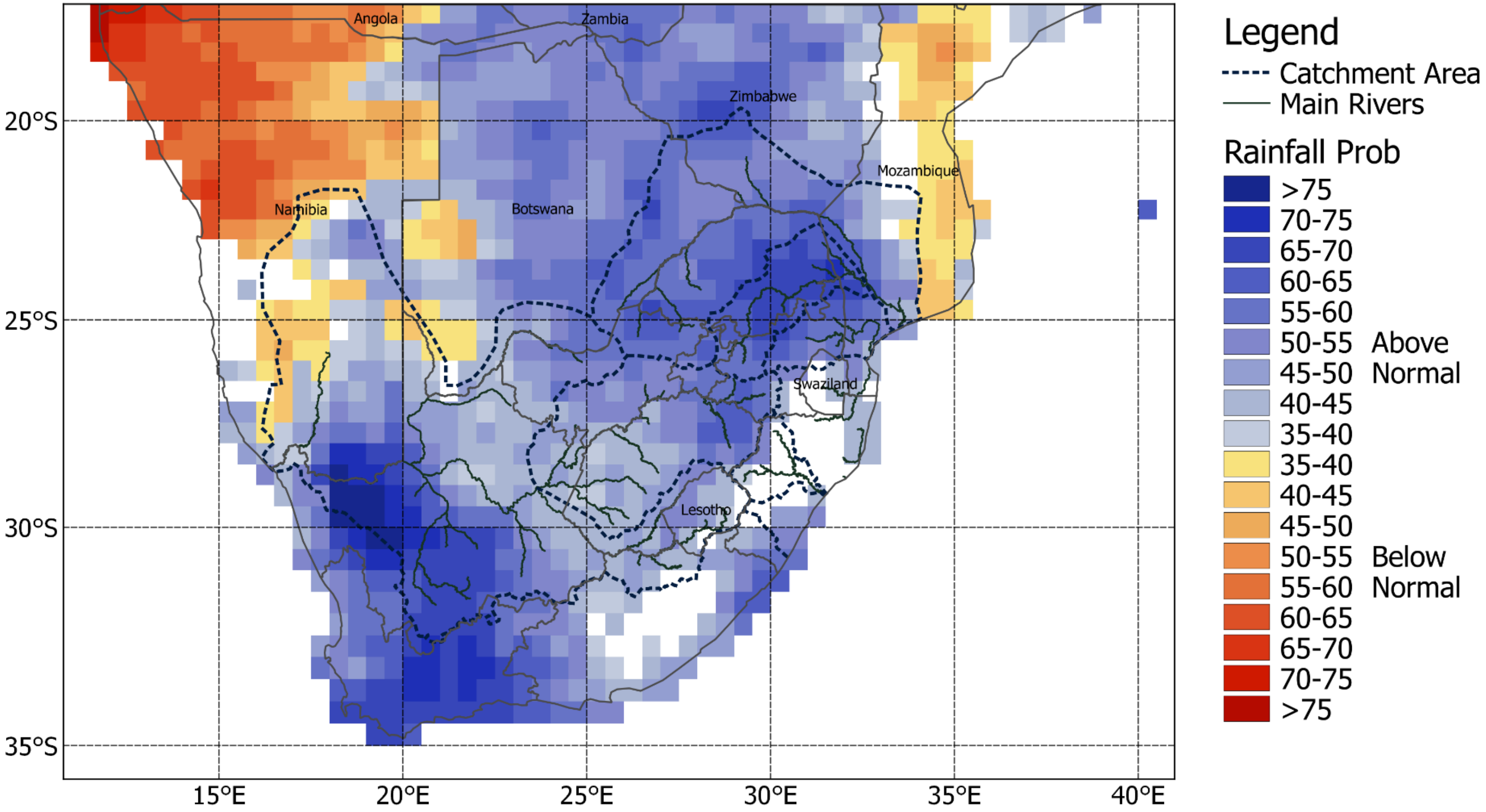
Probabilistic forecasts can help users understand risks and opportunities (forewarned is forearmed) in order to make more informed decisions.

The seasonal rainfall and maximum temperature forecast to follow are probabilities (% chance) of only the most likely outcome for below-, near-, or above-normal (B, N or A). 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.

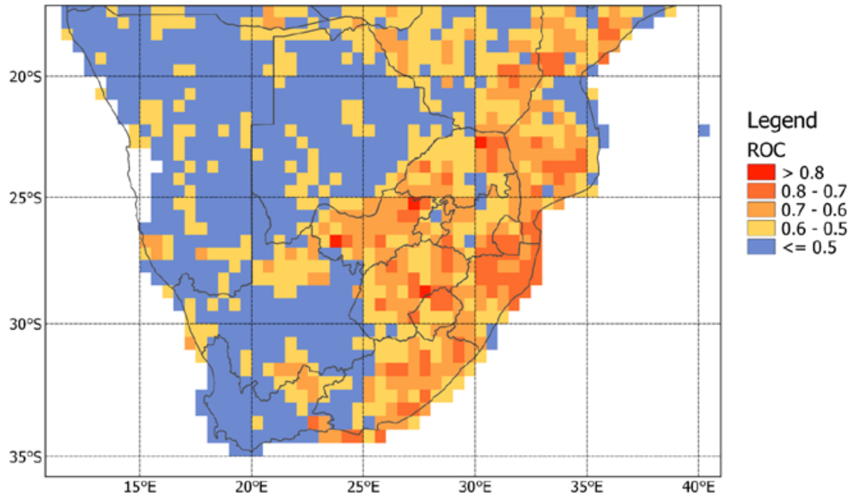
The nature of a probabilistic forecast implies that the less likely outcomes are always possible. In fact, for the probabilistic forecasts to be considered reliable, the less likely outcomes will and must occasionally occur.

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 (B, N or A) as frequently as the forecast implies

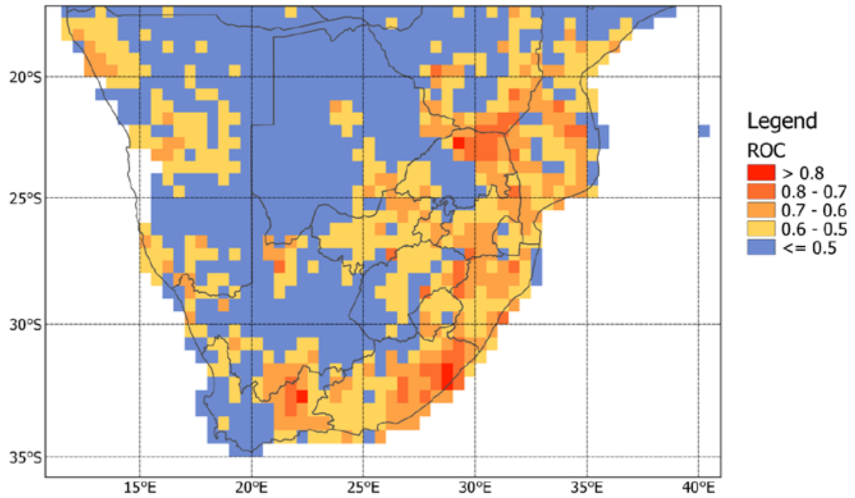
OND 2020 Rainfall; ICs: Oct



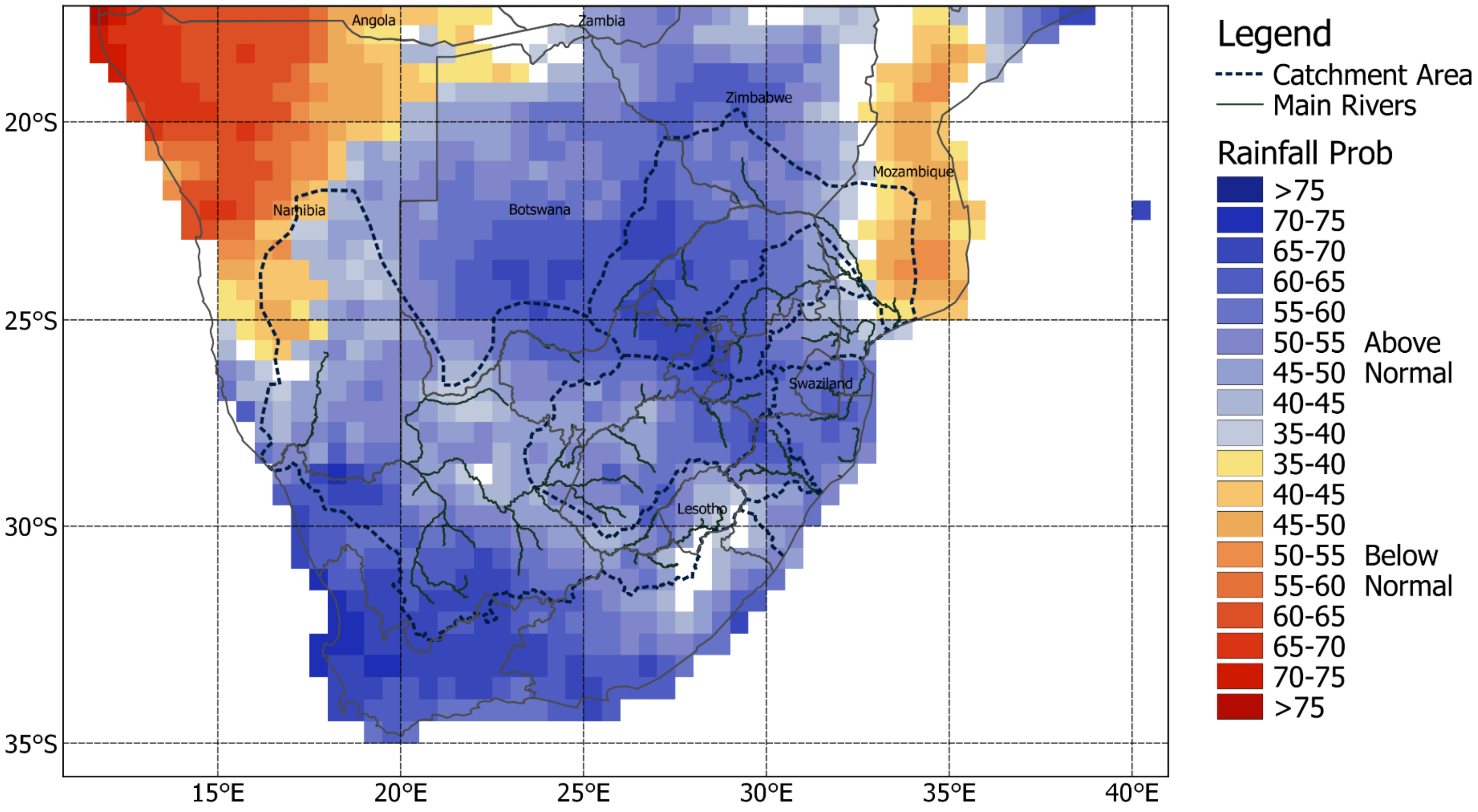
ROC Area (Above-Normal): OND Rainfall



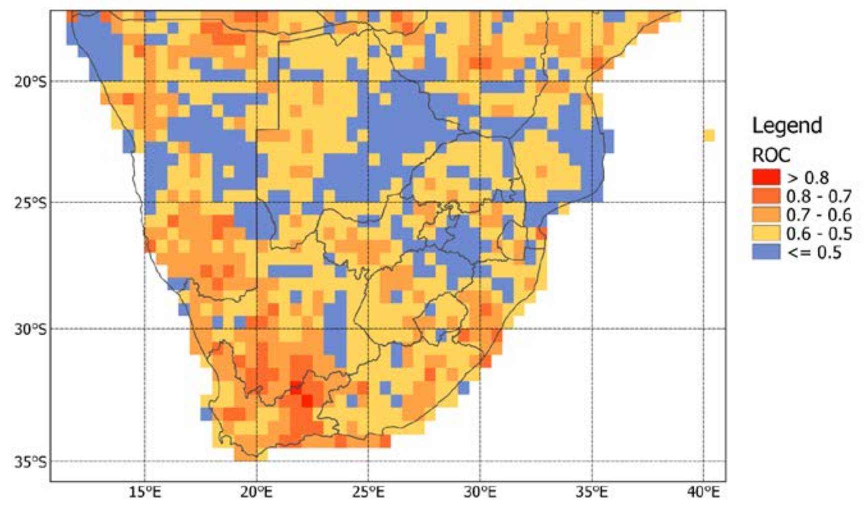
ROC Area (Below-Normal): OND Rainfall



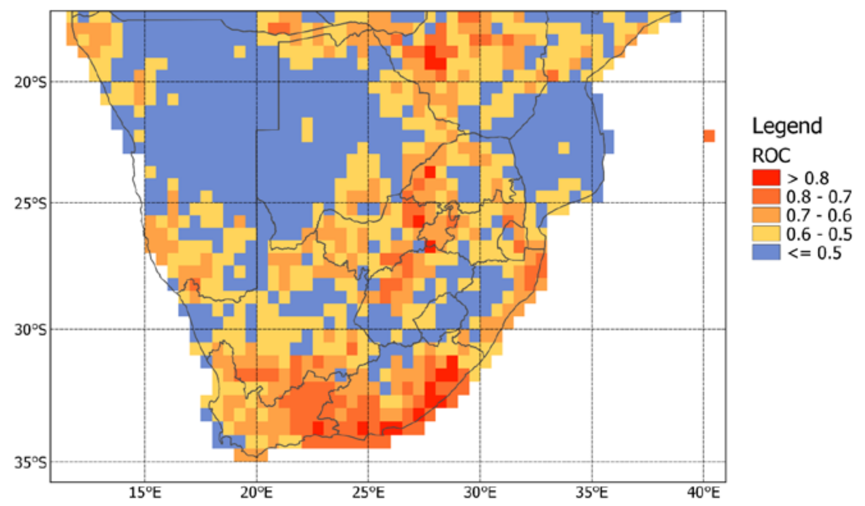
NDJ 2020-21 Rainfall; ICs: Oct



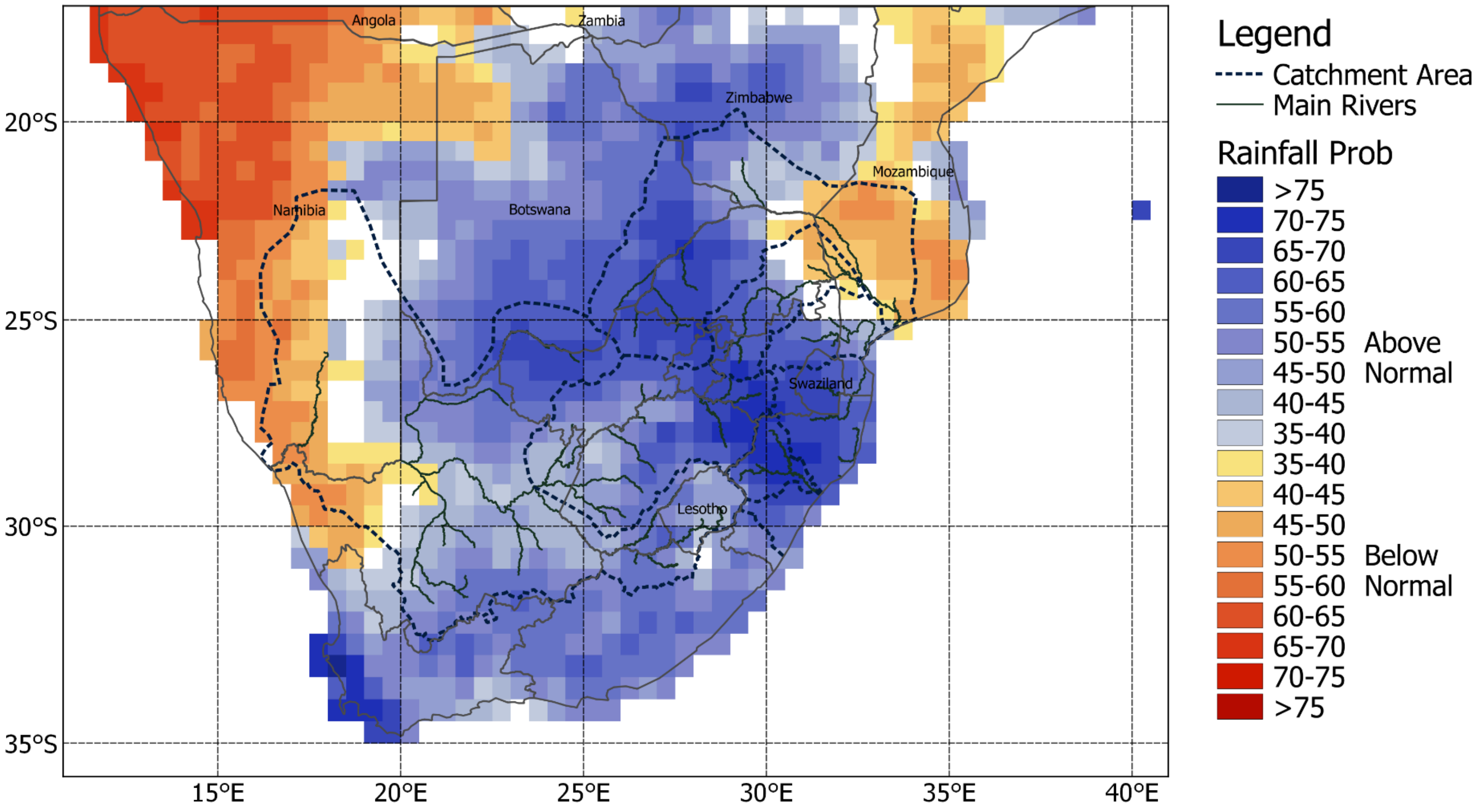
ROC Area (Above-Normal): NDJ Rainfall

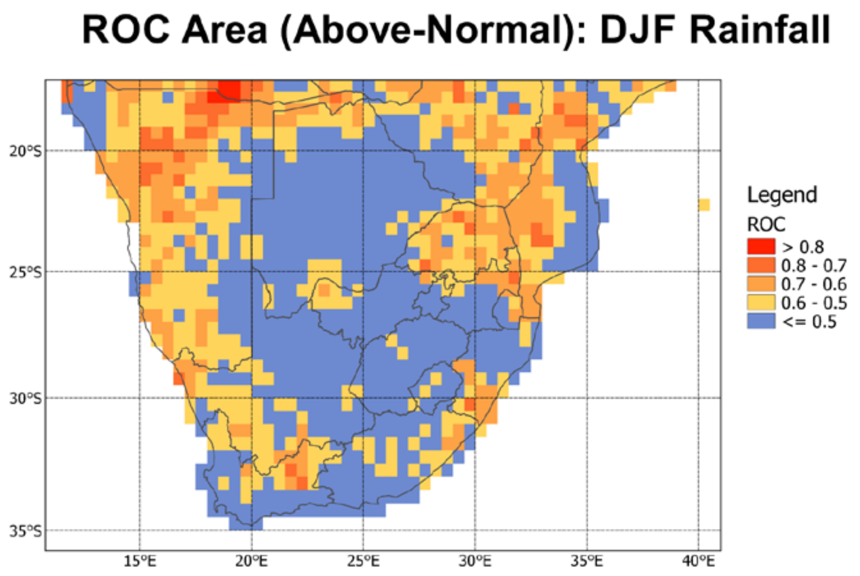


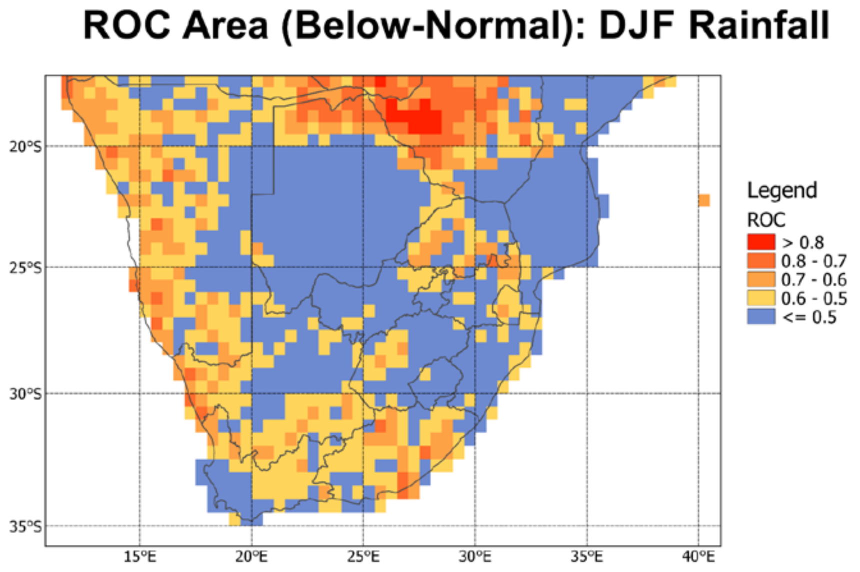
ROC Area (Below-Normal): NDJ Rainfall



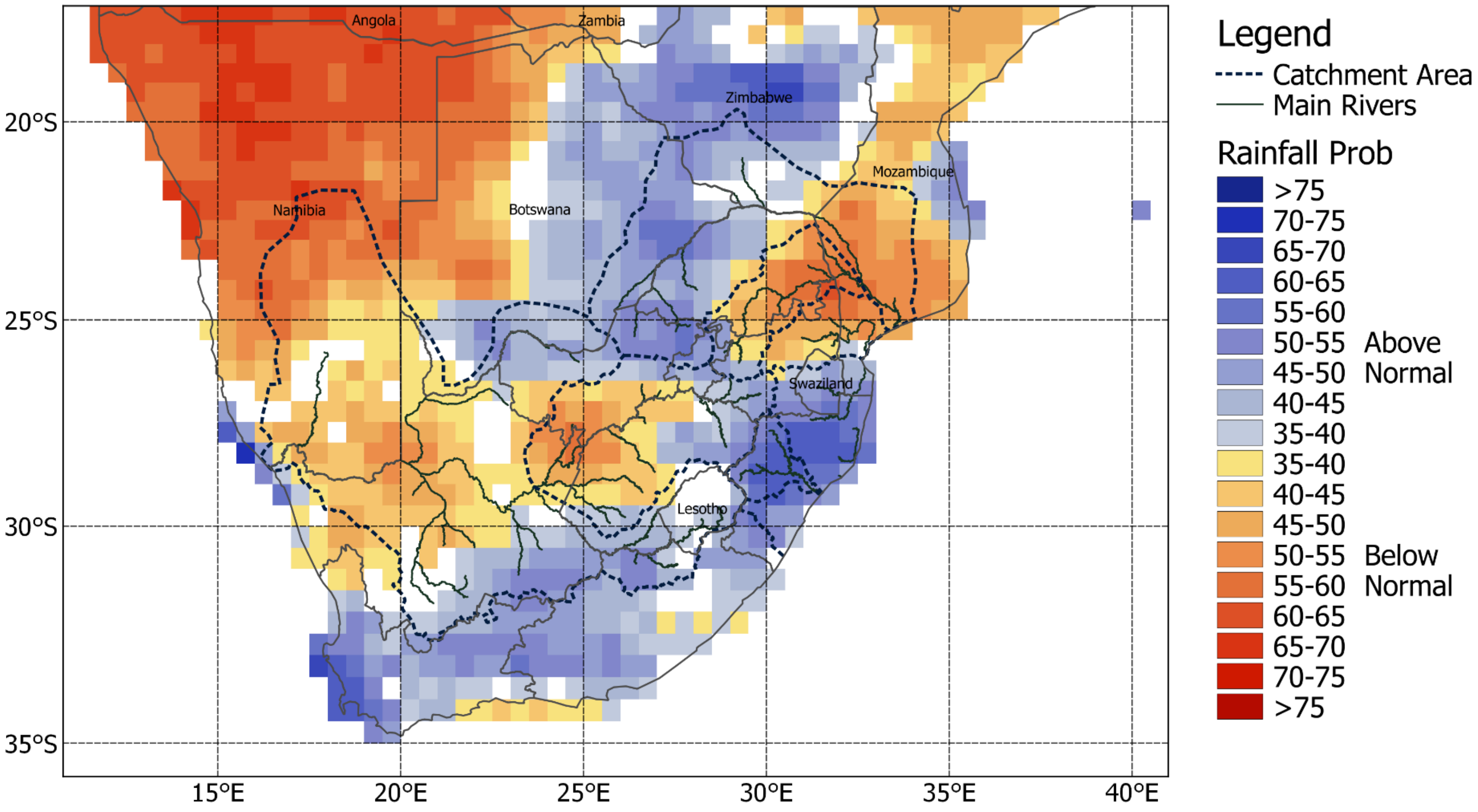
DJF 2020-21 Rainfall; ICs: Oct



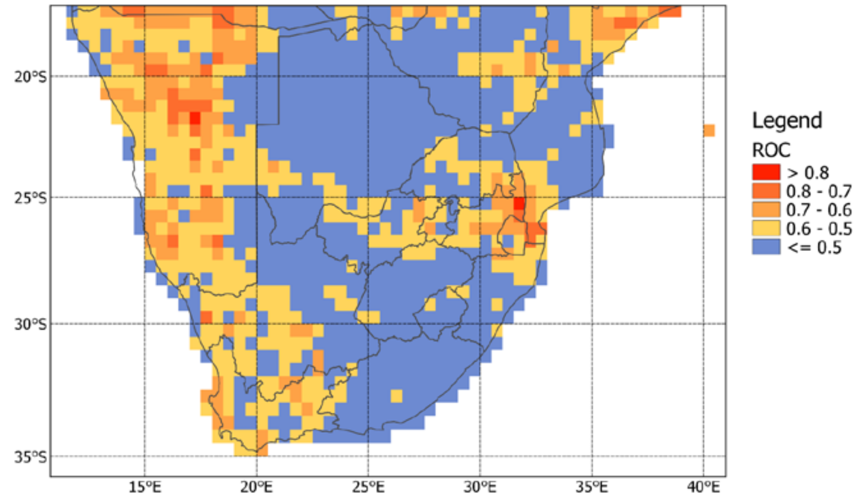




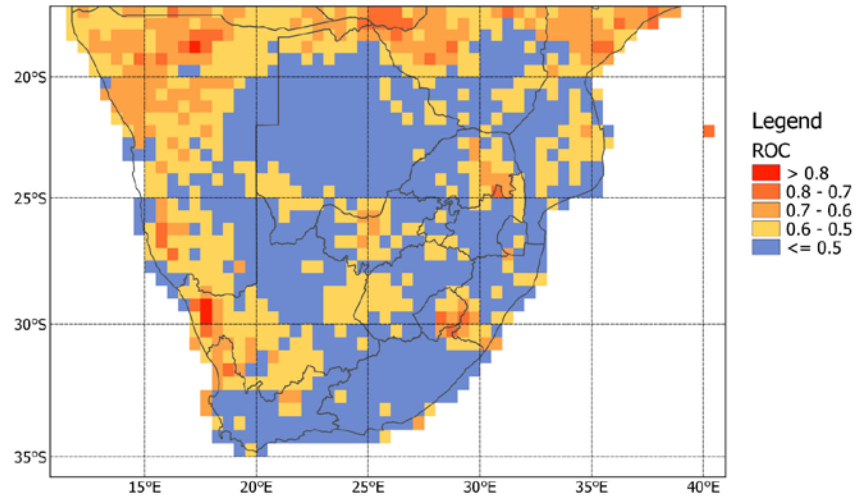
JFM 2021 Rainfall; ICs: Oct



ROC Area (Above-Normal): JFM Rainfall



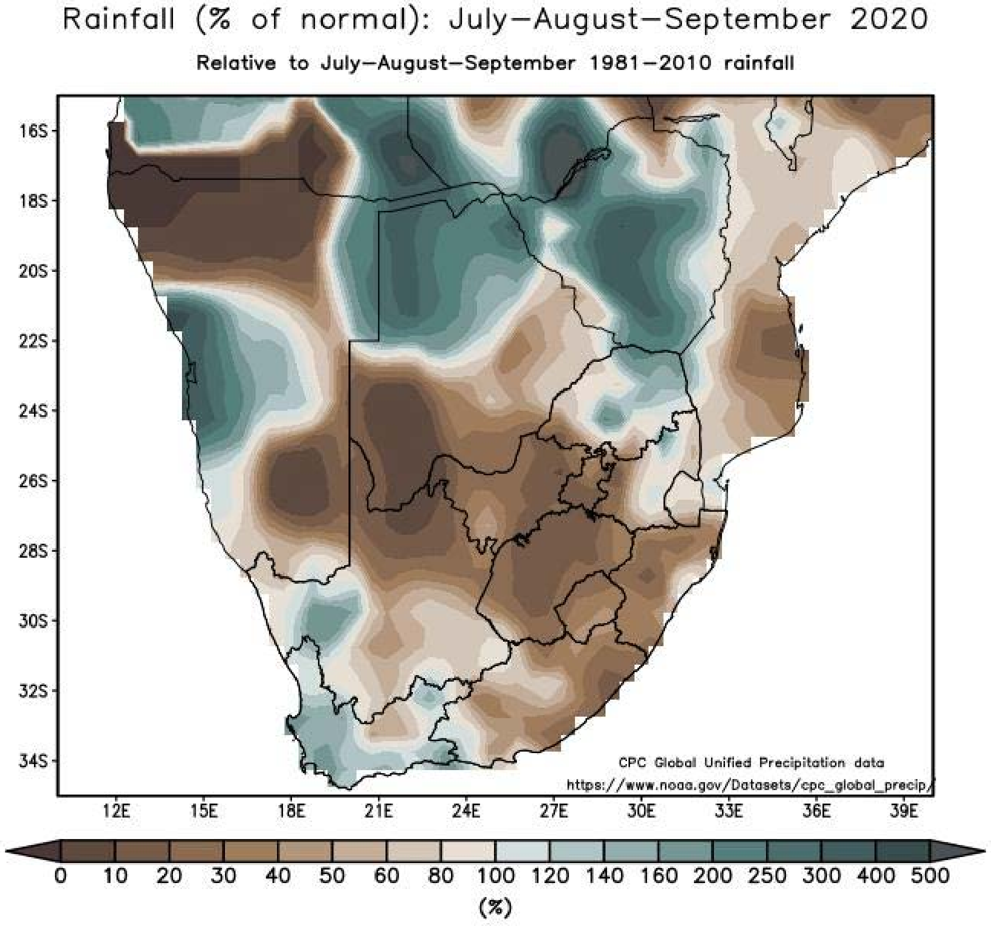
ROC Area (Below-Normal): JFM Rainfall

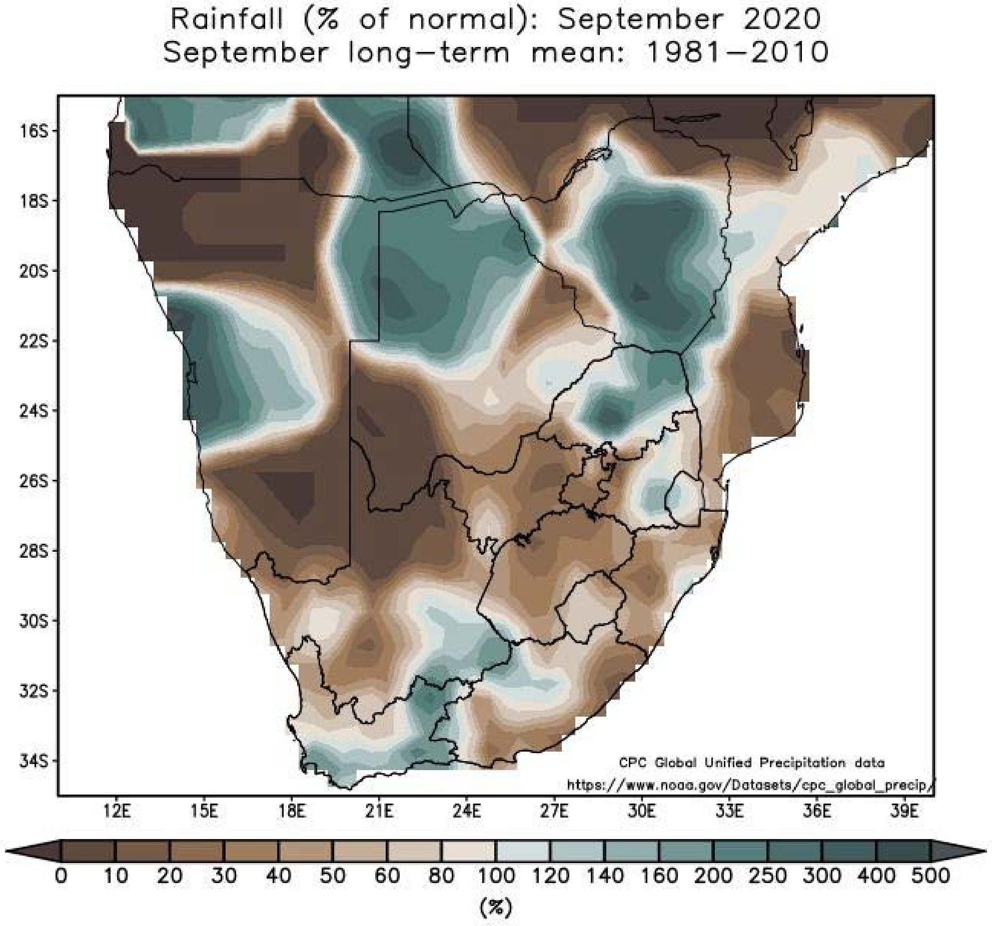


Round-up: SADC Rainfall

- Favourable rainfall outcomes are expected over the larger part of the forecast region during spring and summer, except over parts of Namibia and Mozambique

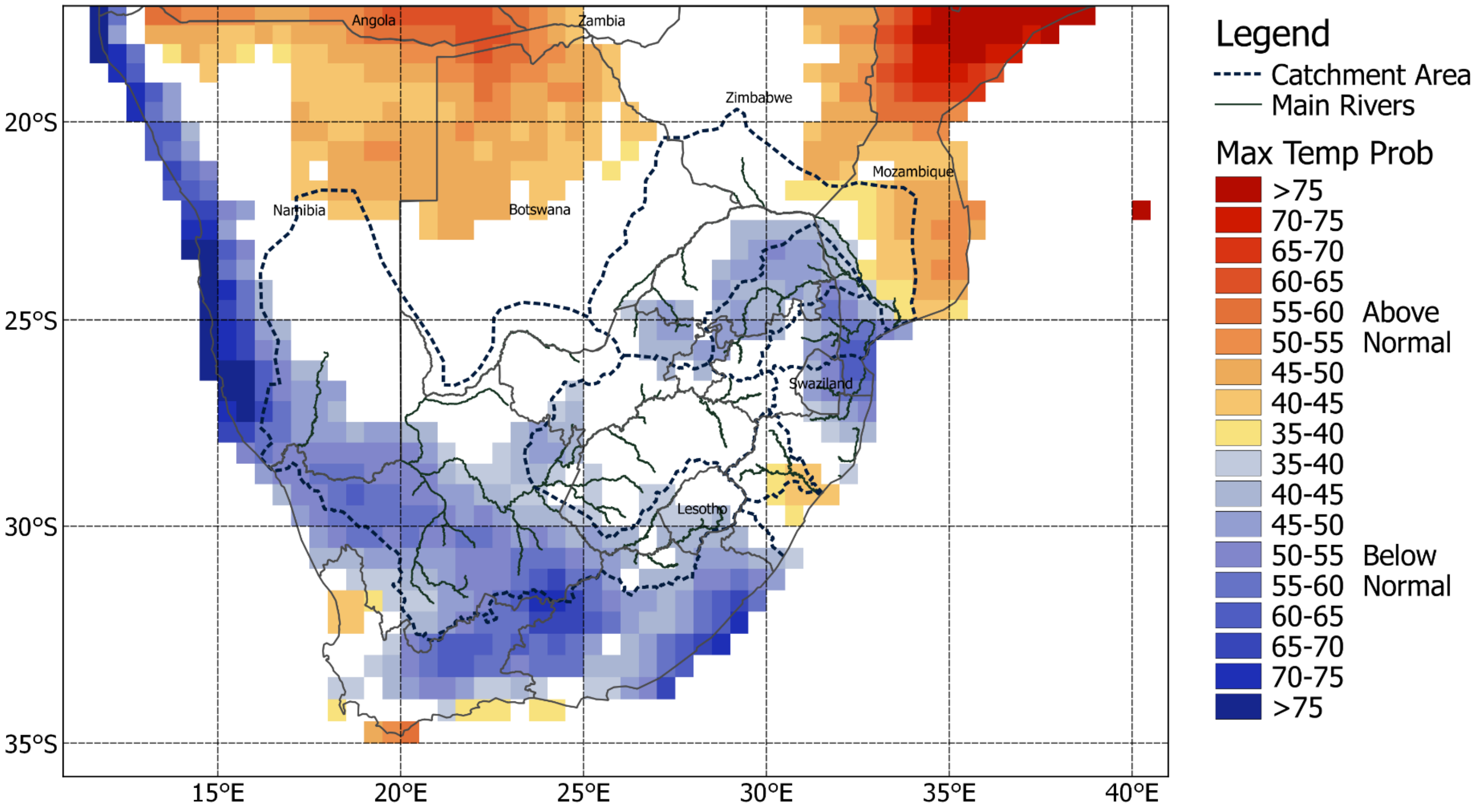
Observed SADC Rainfall



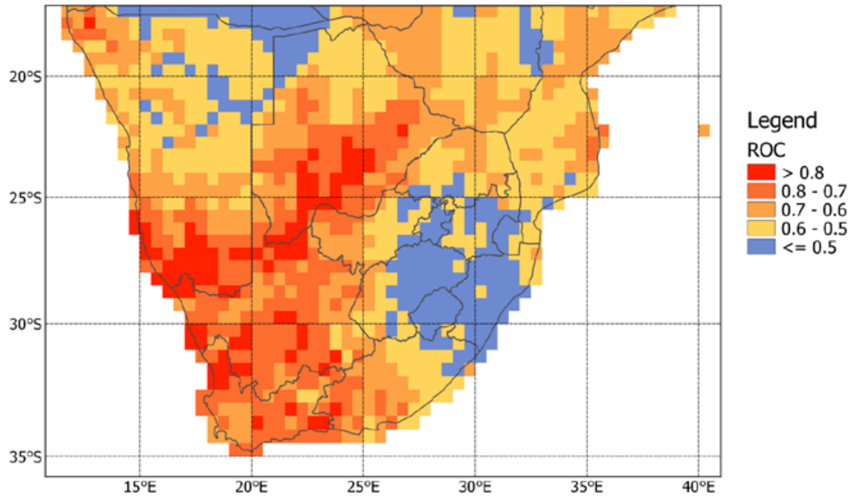


Maps prepared by Dr. Christien Engelbrecht

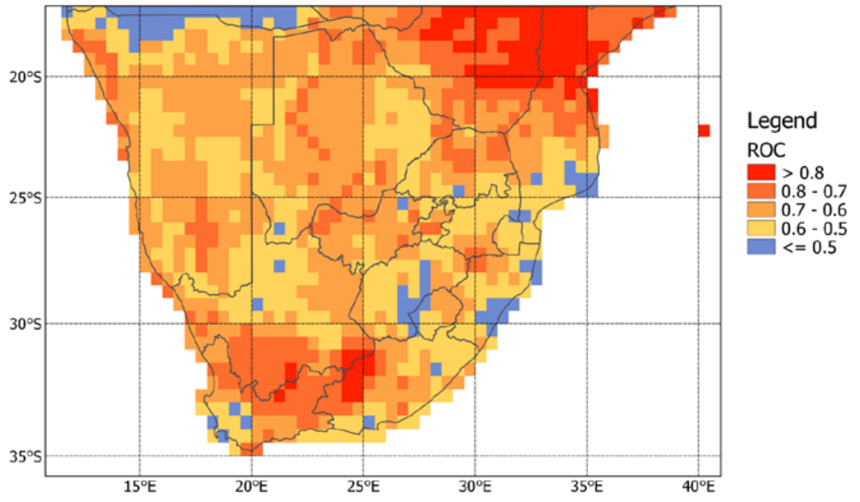
OND 2020 Max Temp; ICs: Oct



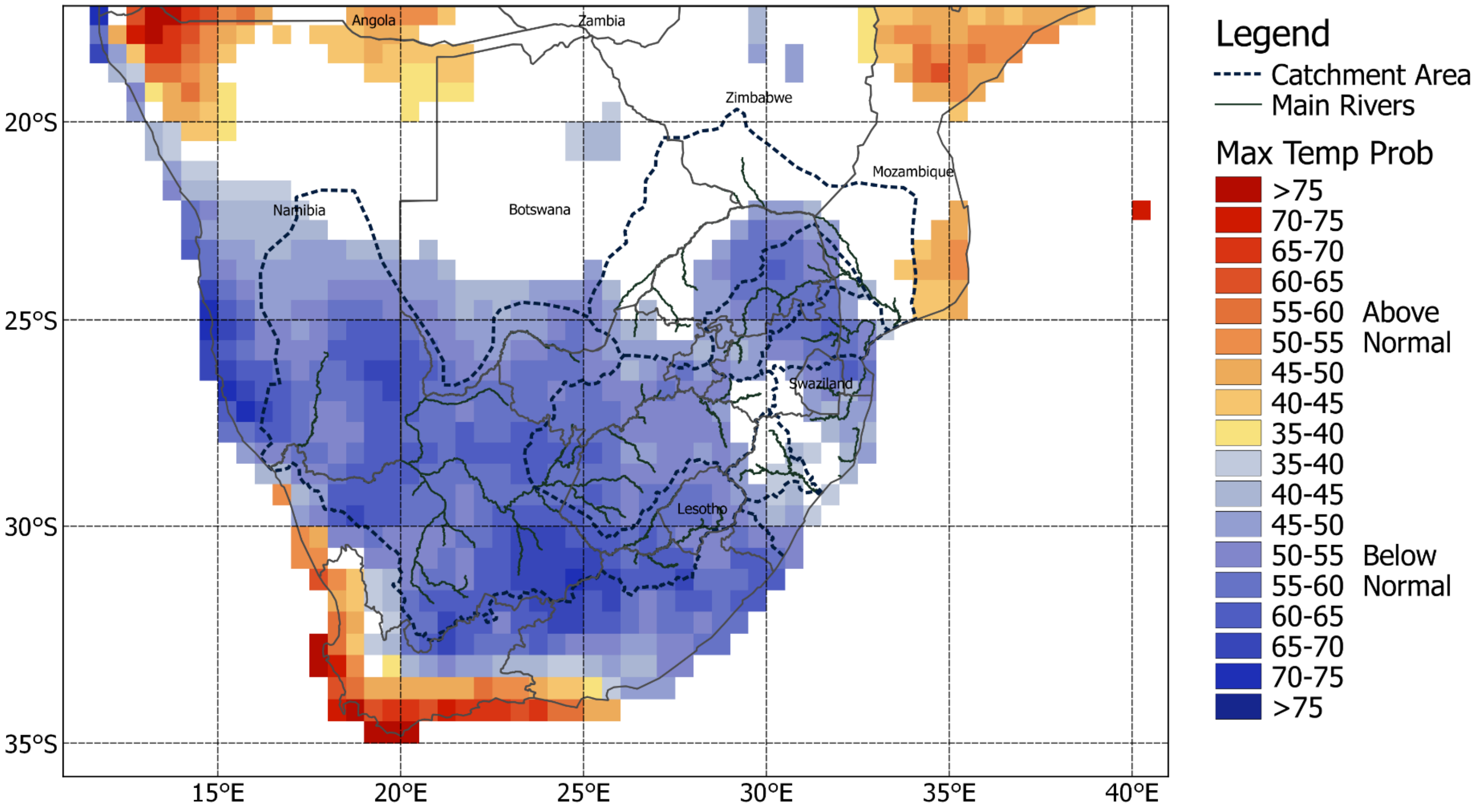
ROC Area (Above-Normal): OND Max Temp



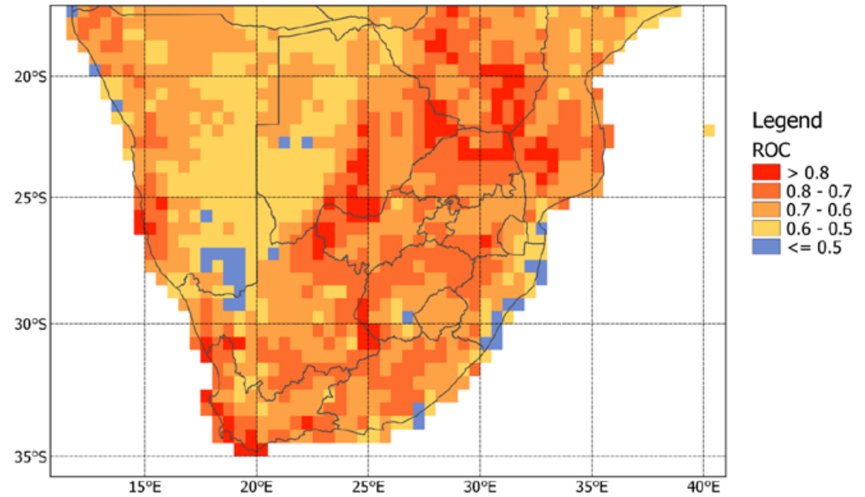
ROC Area (Below-Normal): OND Max Temp



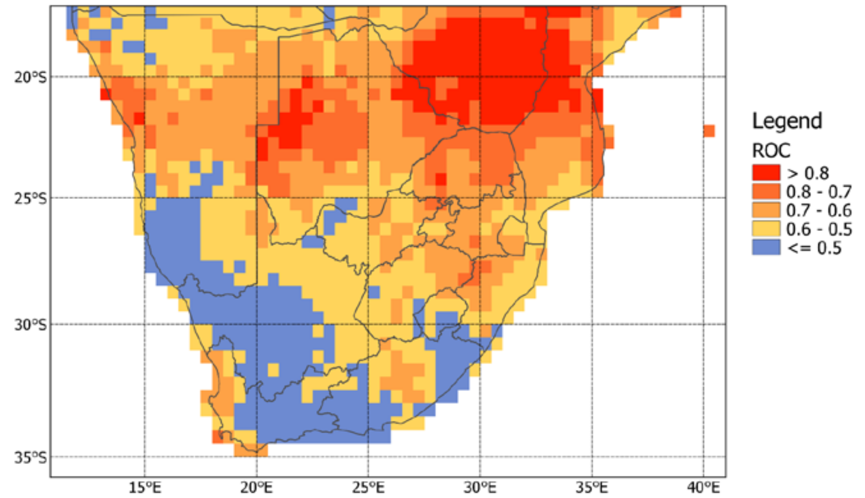
NDJ 2020-21 Max Temp; ICs: Oct



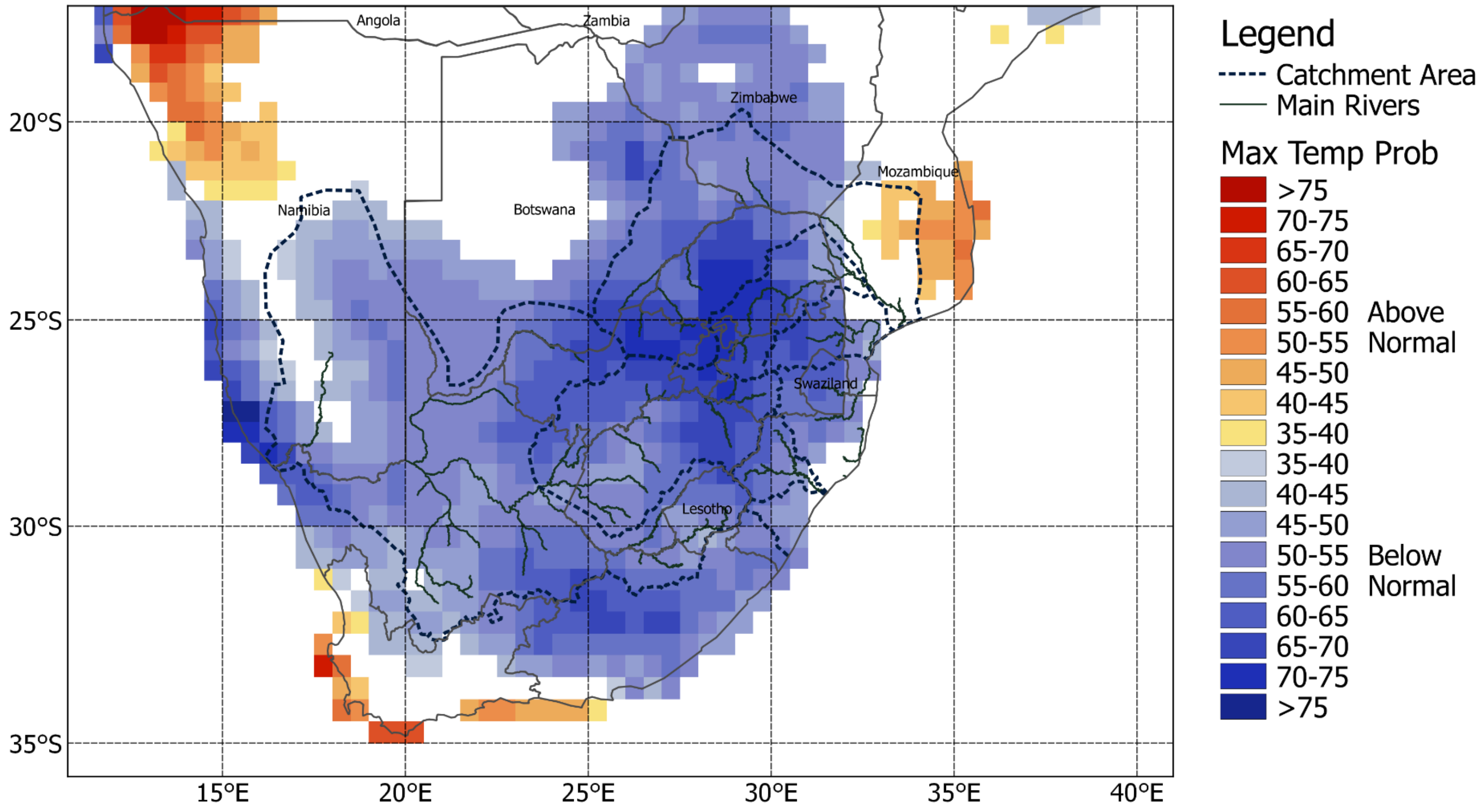
ROC Area (Above-Normal): NDJ Max Temp



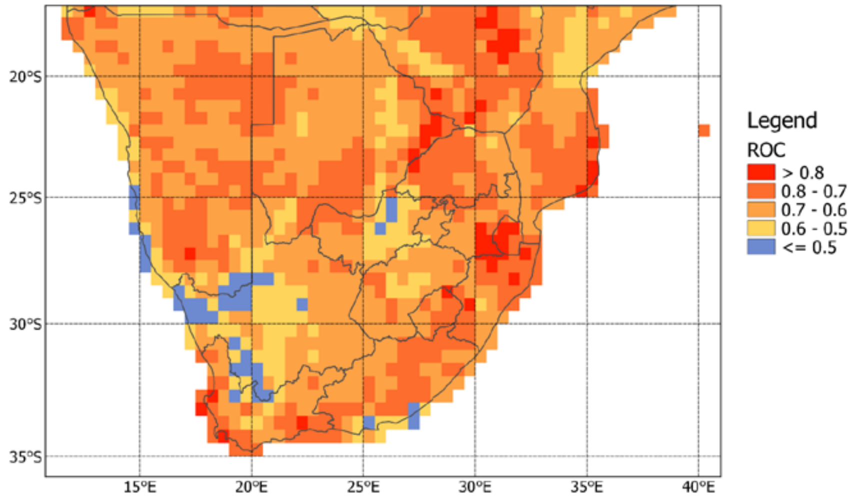
ROC Area (Below-Normal): NDJ Max Temp



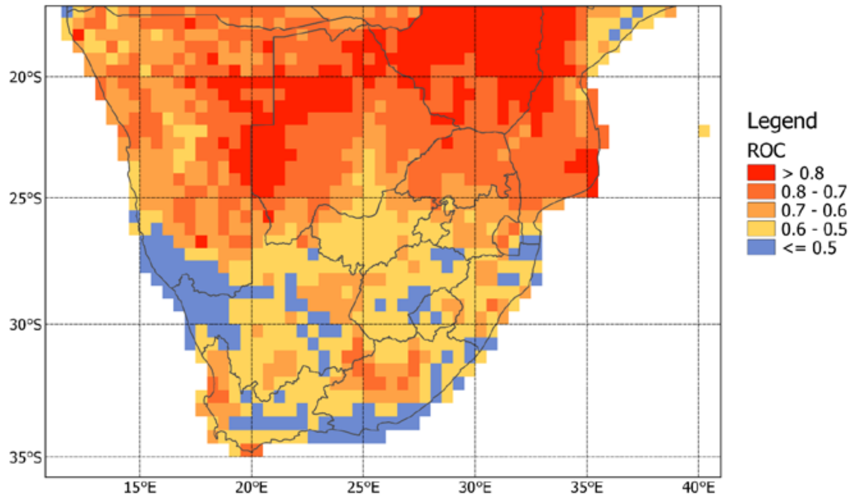
DJF 2020-21 Max Temp; ICs: Oct



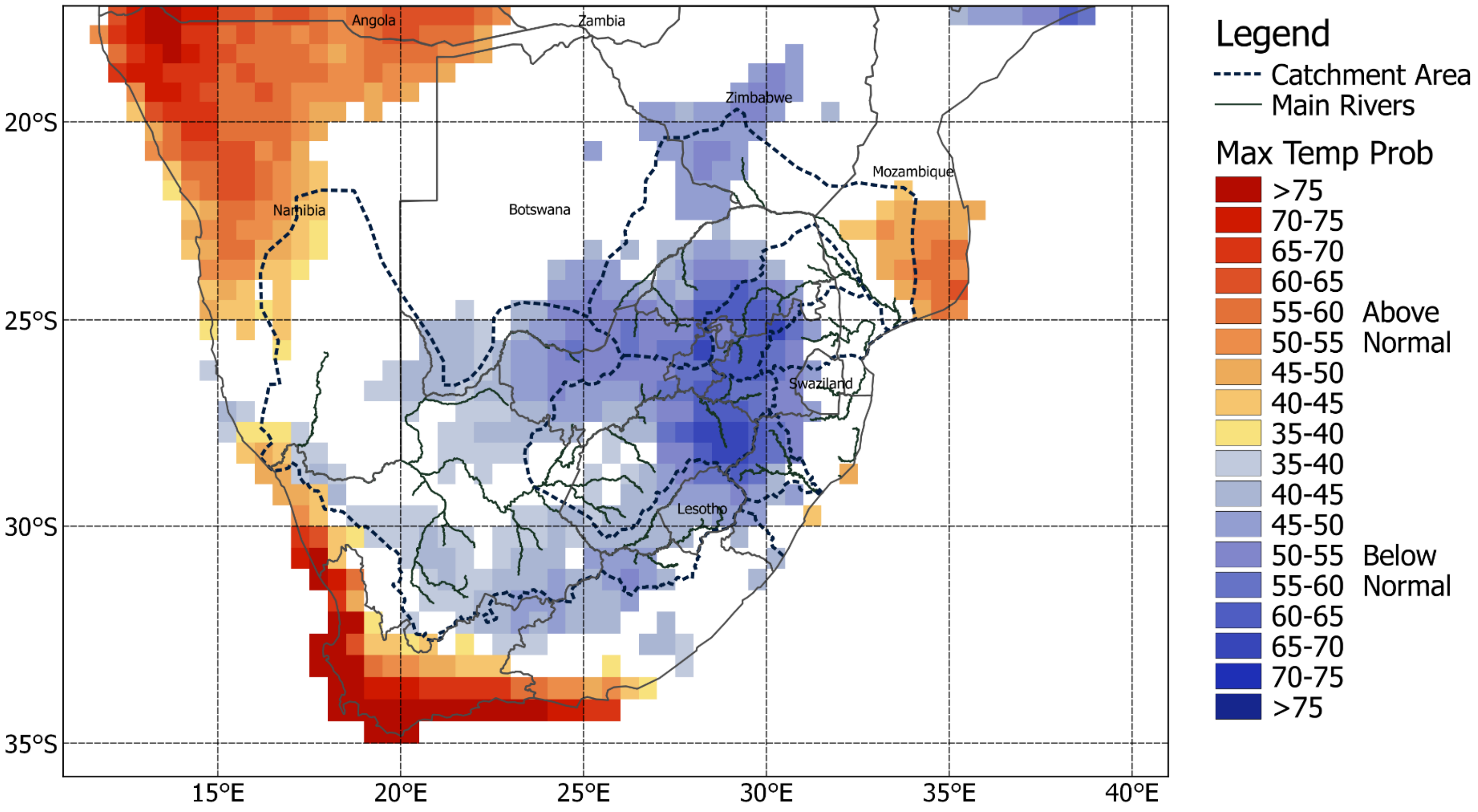
ROC Area (Above-Normal): DJF Max Temp



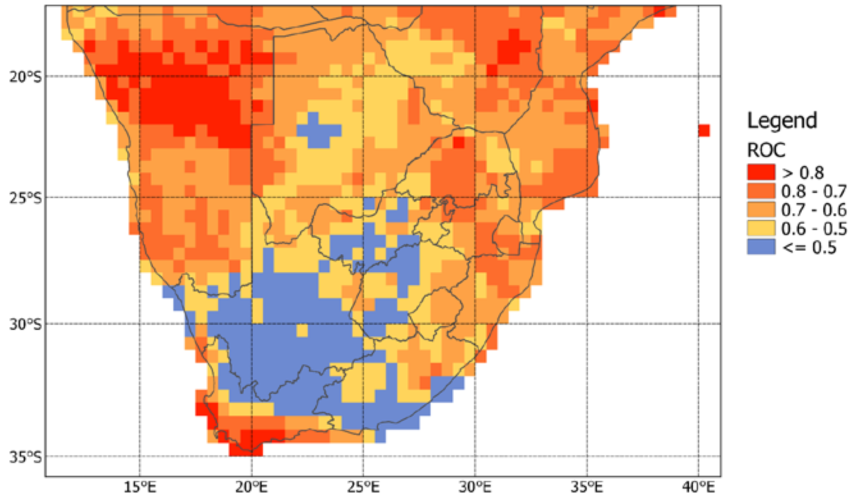
ROC Area (Below-Normal): DJF Max Temp



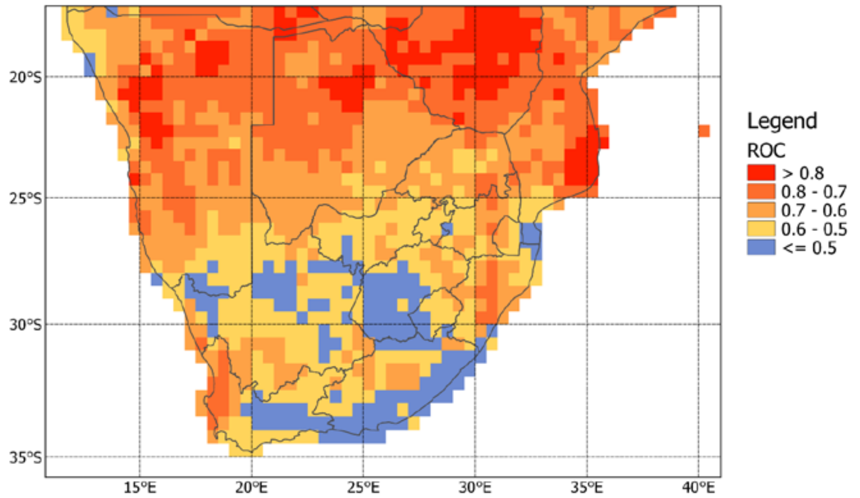
JFM 2021 Max Temp; ICs: Oct



ROC Area (Above-Normal): JFM Max Temp



ROC Area (Below-Normal): JFM Max Temp



Round-up: SADC Max Temp

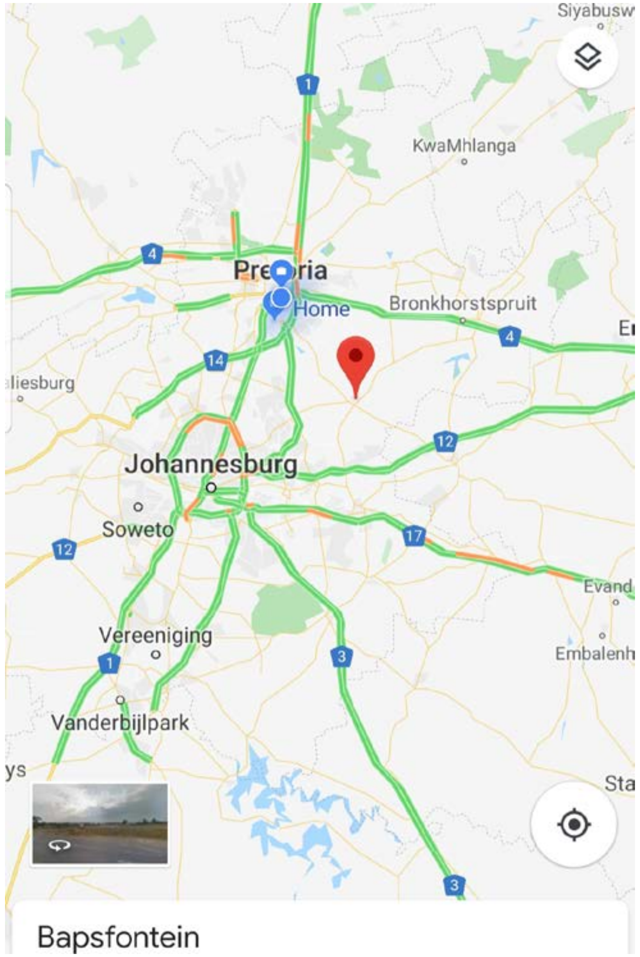
- Cooler maximum temperatures are likely in association with the increased likelihood of a wet summer season over parts of the region

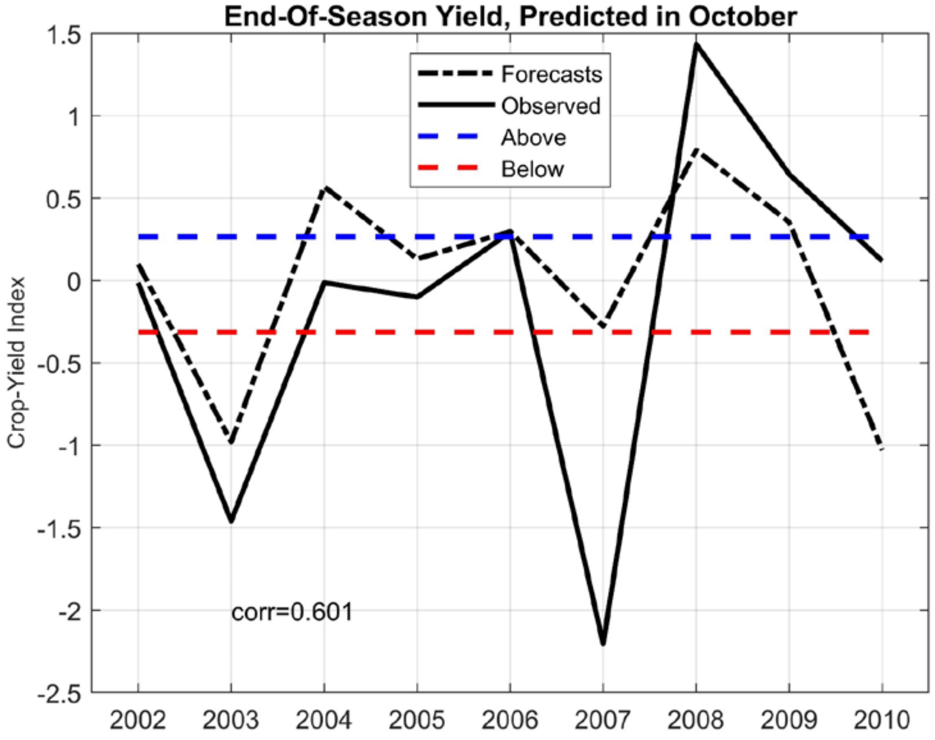
Tailored Forecasts

1. **Bapsfontein end-of-season-yield three-category probabilistic forecast for 2021**
2. **Probabilistic three-category rainfall forecast for the farm of Robbie Kingsley for Dec-Jan-Feb 2020/21**
3. **Probabilistic three-category malaria forecast for Limpopo for Dec-Jan-Feb 2020/21**
4. **Probability of exceedance Dec-Jan-Feb 2020/21 inflow forecast for Lake Kariba, Zambia/Zimbabwe**
5. **Probabilistic rainfall forecast for Jan-Feb-Mar 2021 for the farm Buschbrunnen near Grootfontein, Namibia**

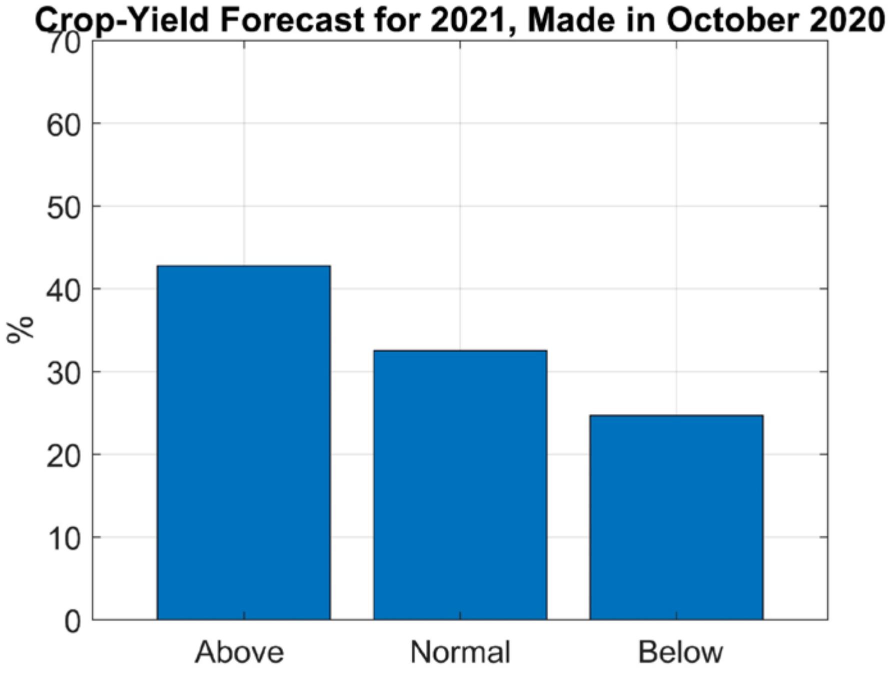
Crop-yield data and forecasts for a farm near Bapsfontein, South Africa

Landman et al. (2019)



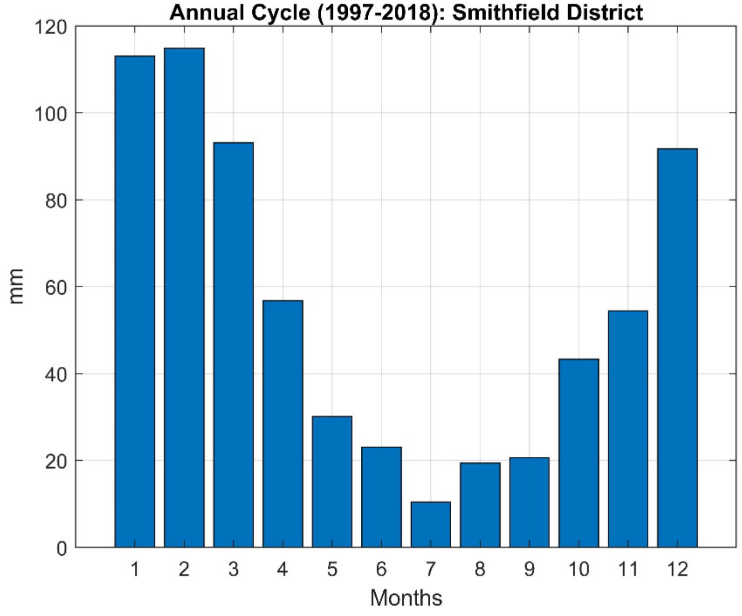


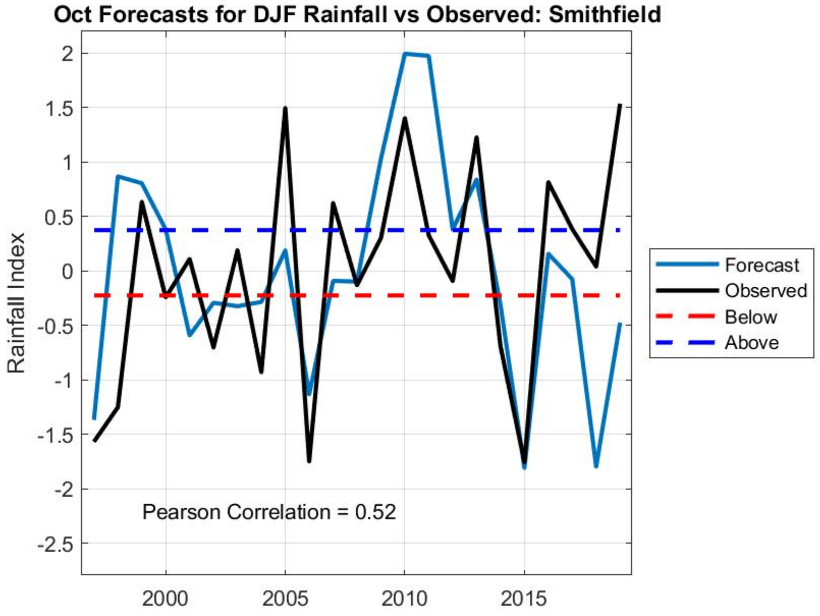
Re-forecasts for end-of-season crop yields

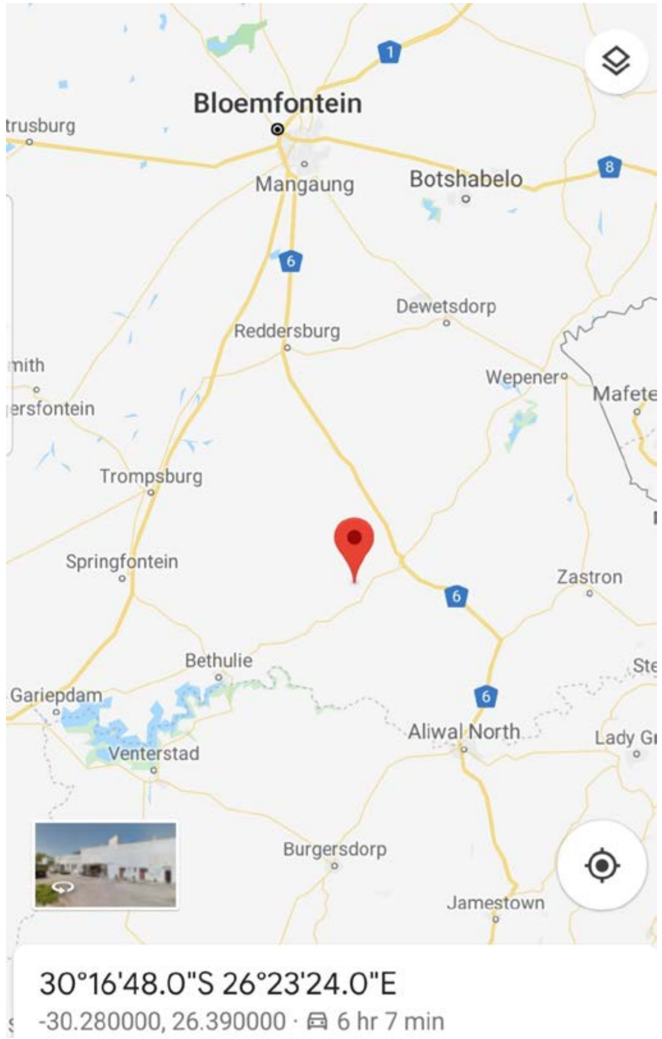


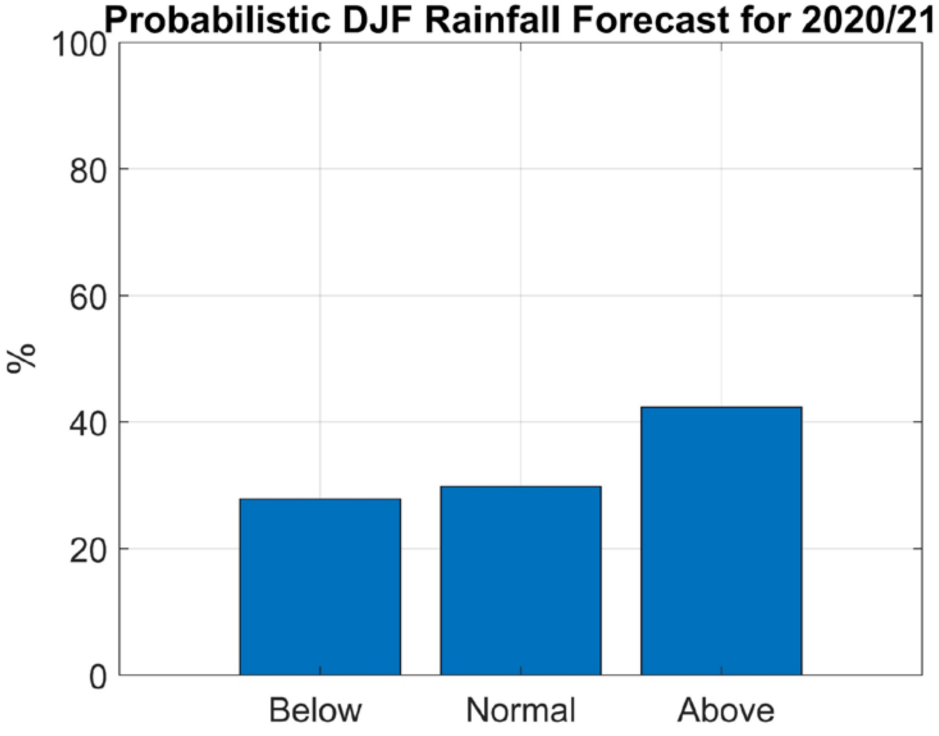
Dec-Jan-Feb 2020/21 rainfall forecast for farm in the Smithfield district (see map). Rainfall data provided by the farmer, Mr. Robbie Kingsley

Landman et al. (2020a)



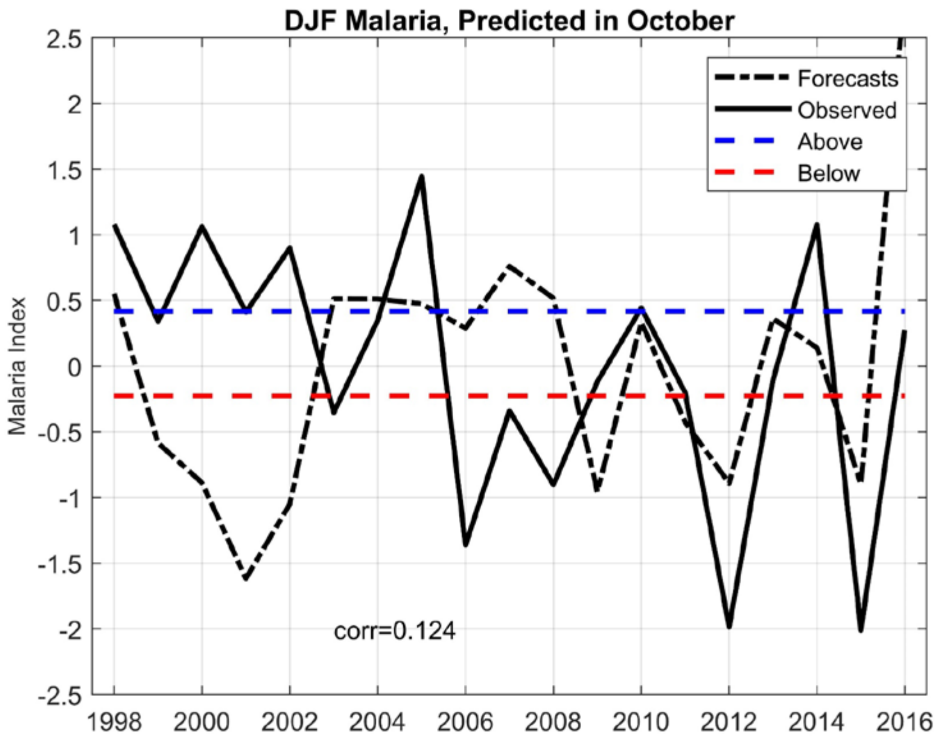


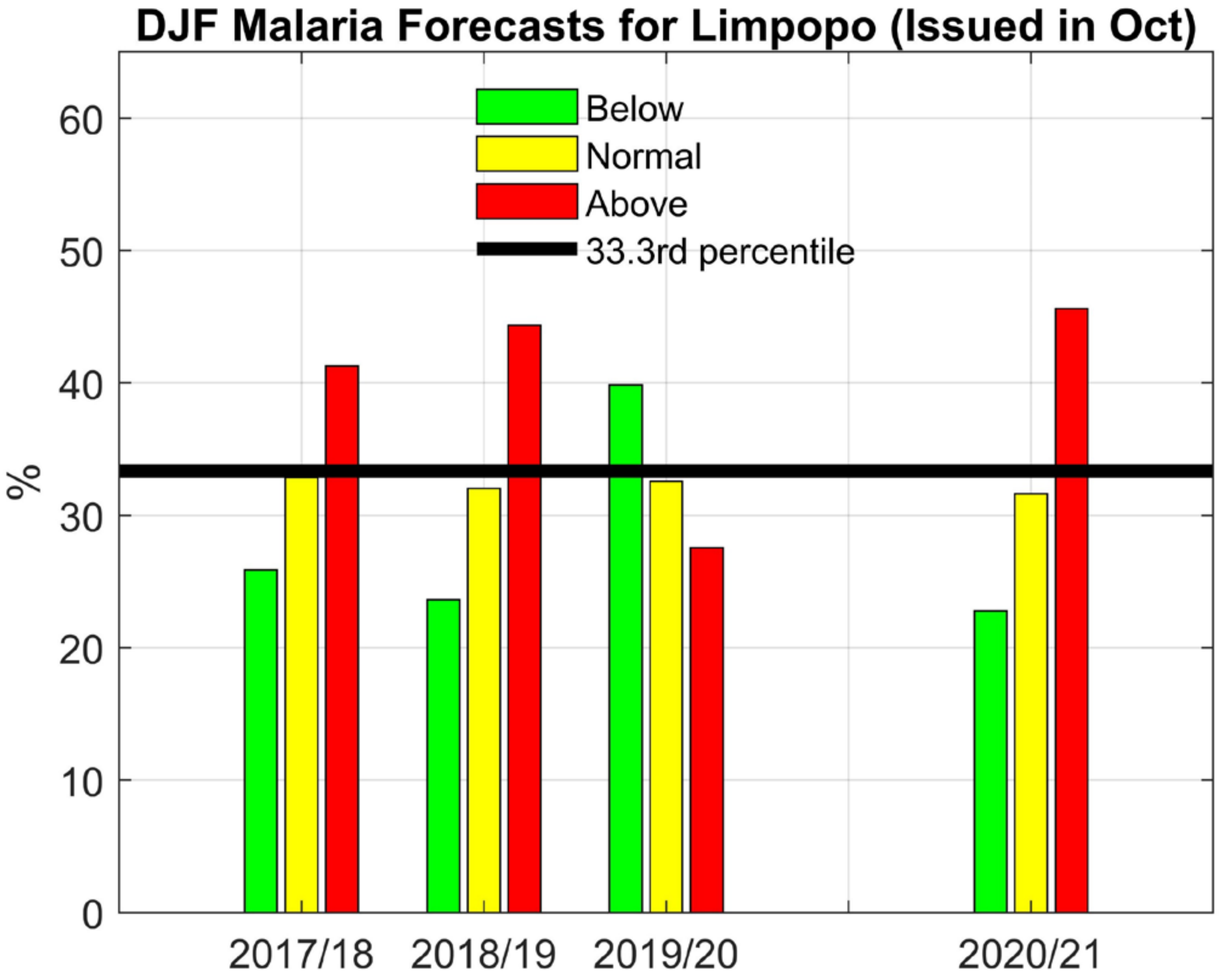




Malaria forecast
Landman et al. (2020b)

Hindcasts



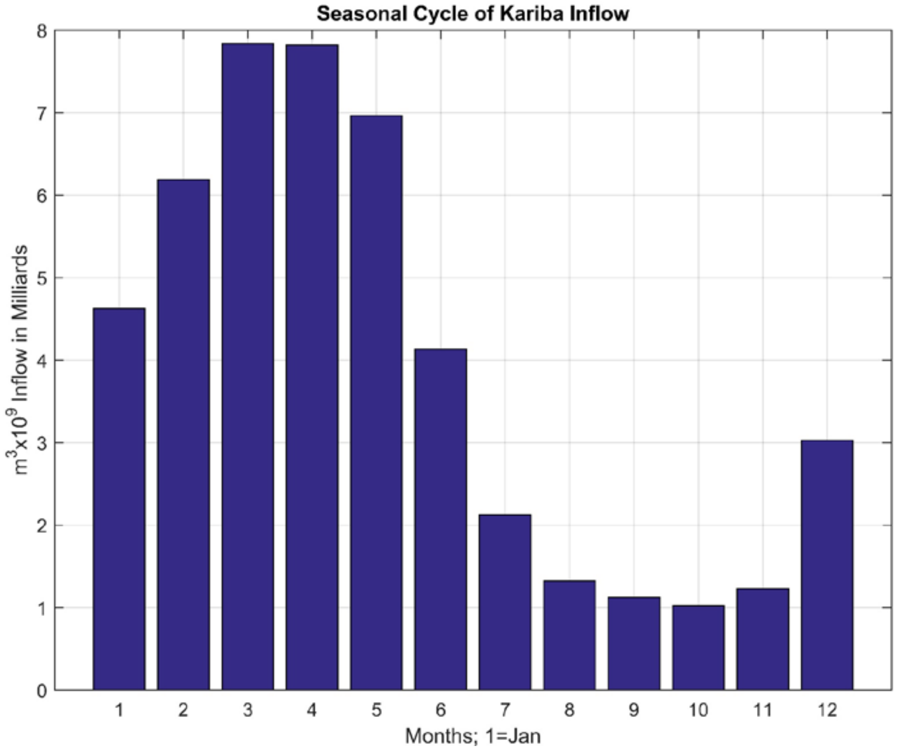


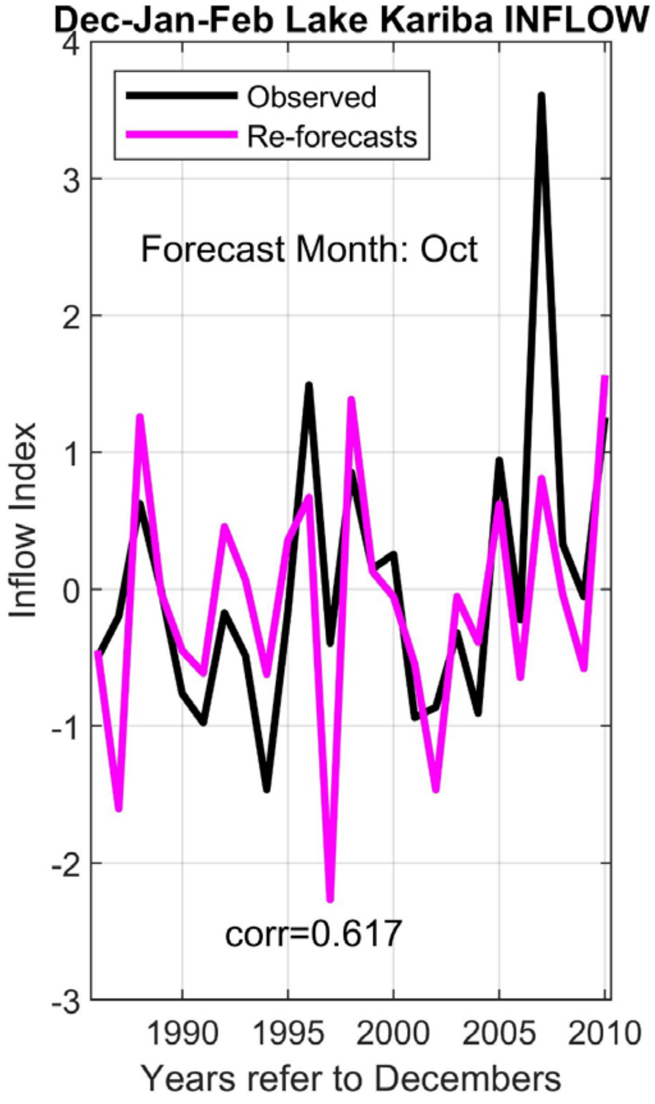
Retrospective

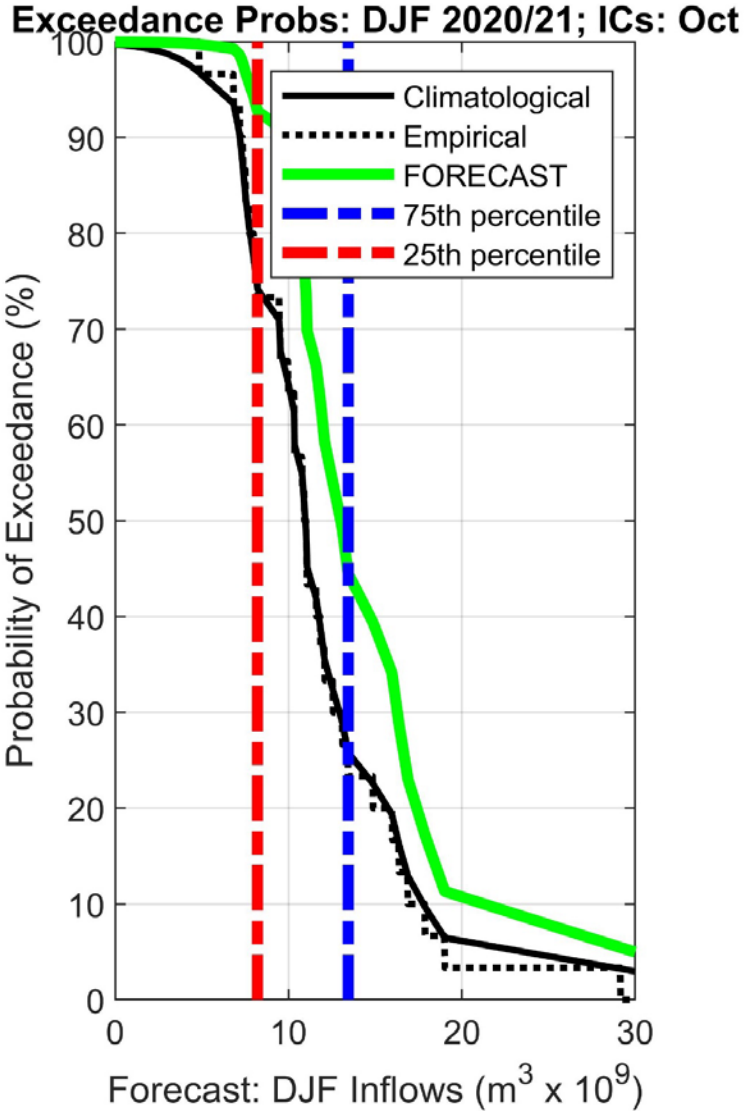
REAL-TIME

Inflow forecast for Lake Kariba: onset season of DJF

Muchuru et al. (2016)

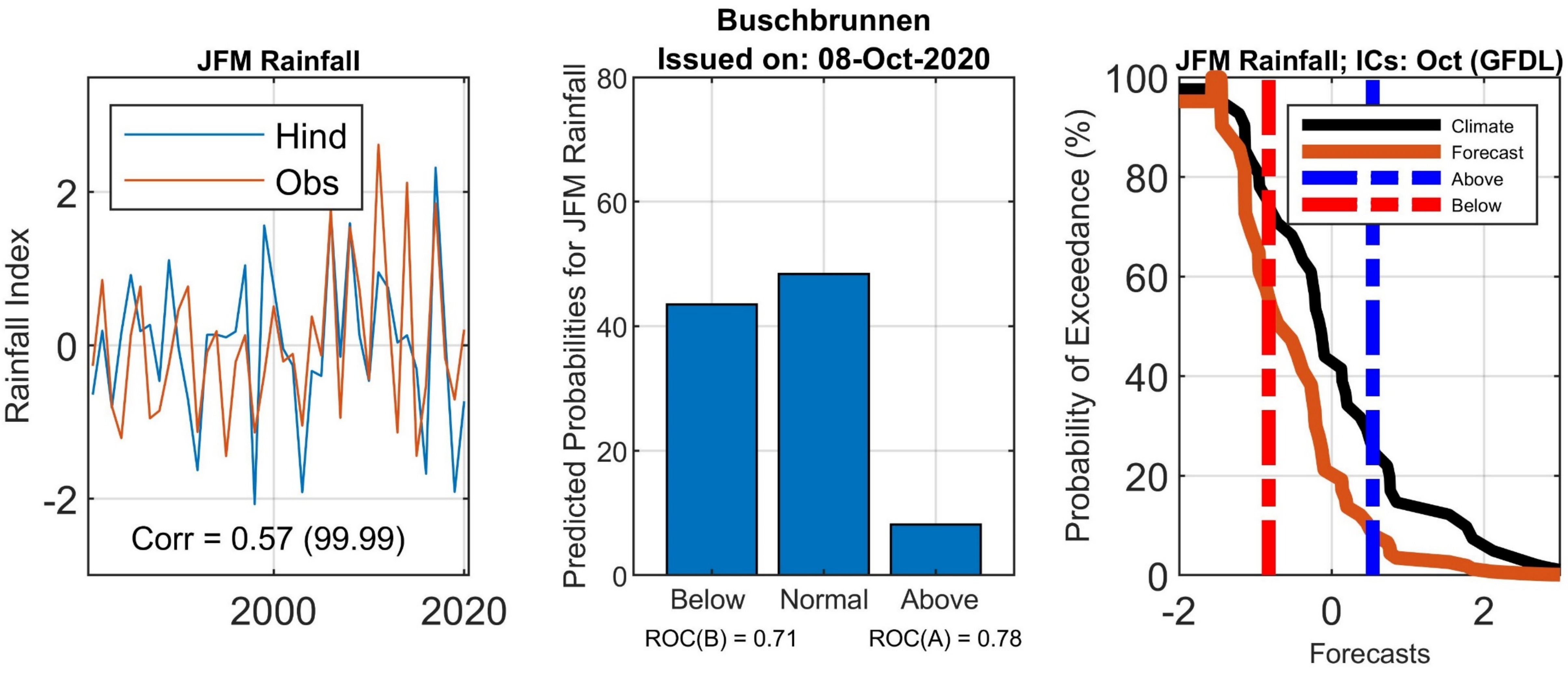






JFM rainfall forecast for the farm Buschbrunnen near Grootfontein, Namibia

Landman et al. (2016)



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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"

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