Seasonal forecasts

presented by:

Willem.Landman@up.ac.za
WALandman1981@gmail.com
https://tinyurl.com/ForecastProf

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Seasonal Climate Forecasts

Seasonal Forecast Worx

Latest Update: 14 September 2023

- 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).

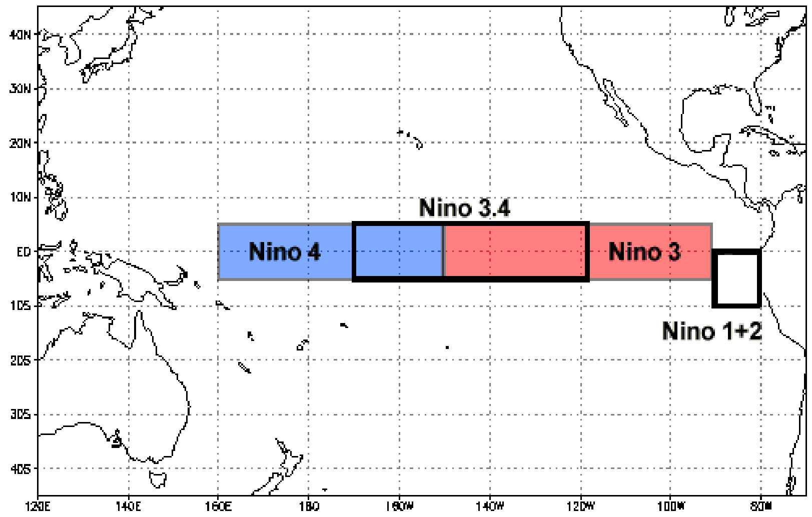
- For the official seasonal forecast for South Africa, visit the South African Weather Service website at http://www.weathersa.co.za/images/data/longrange/gfcsa/scw.pdf

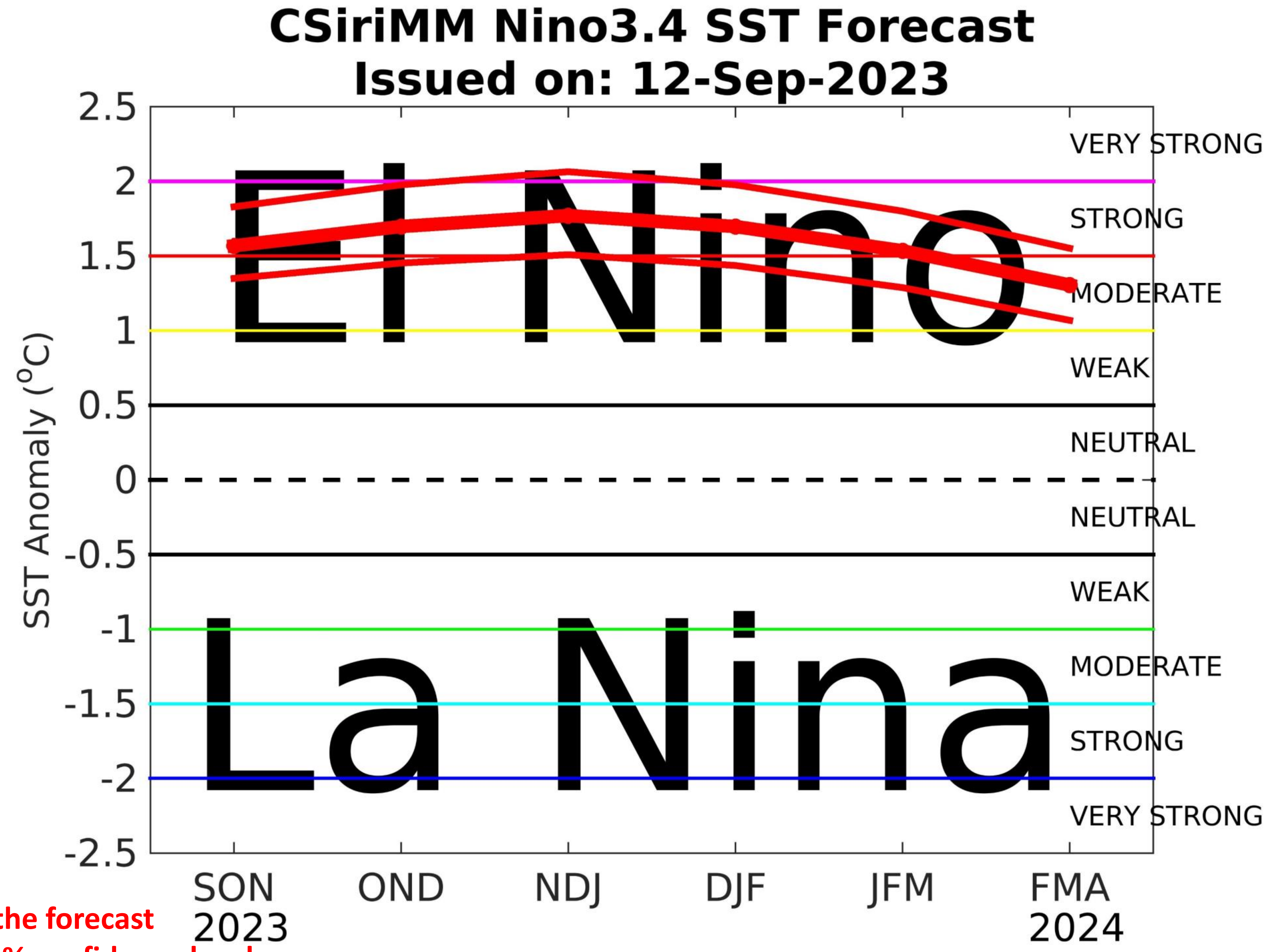
South African Weather Service

ENSO and Global SST Forecasts

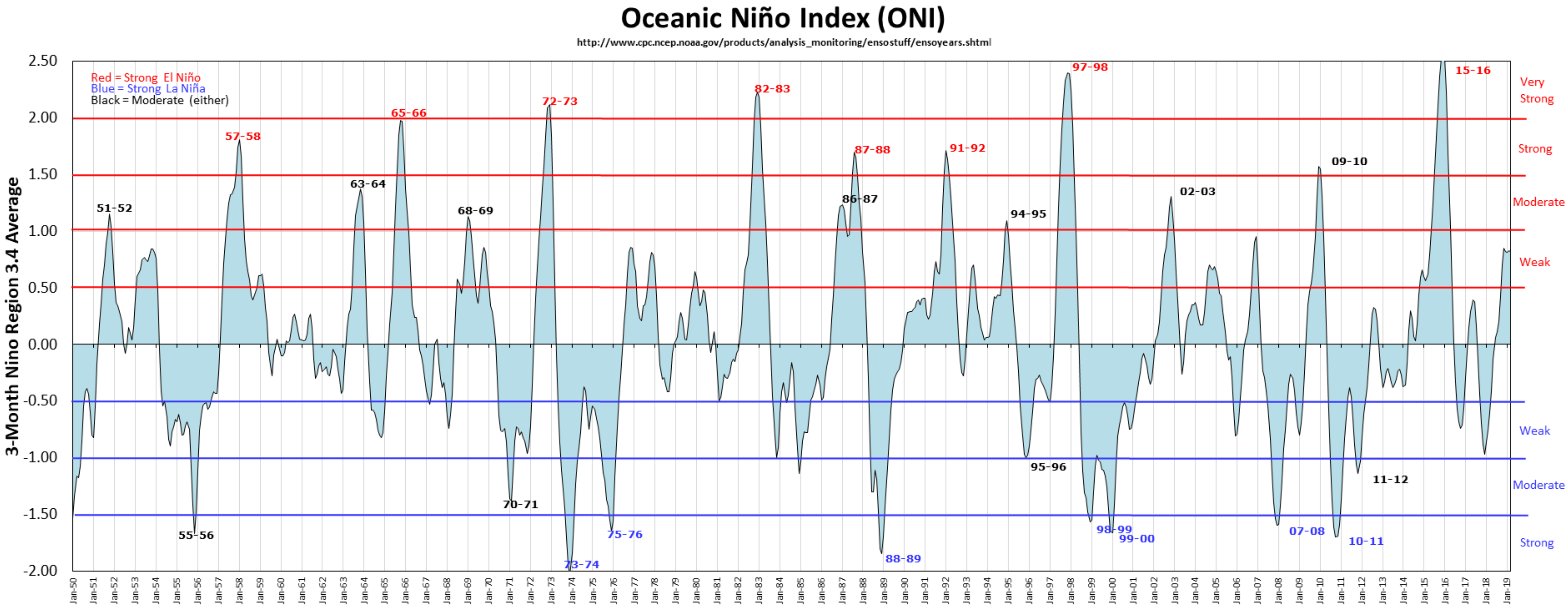
Prediction Method

- 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





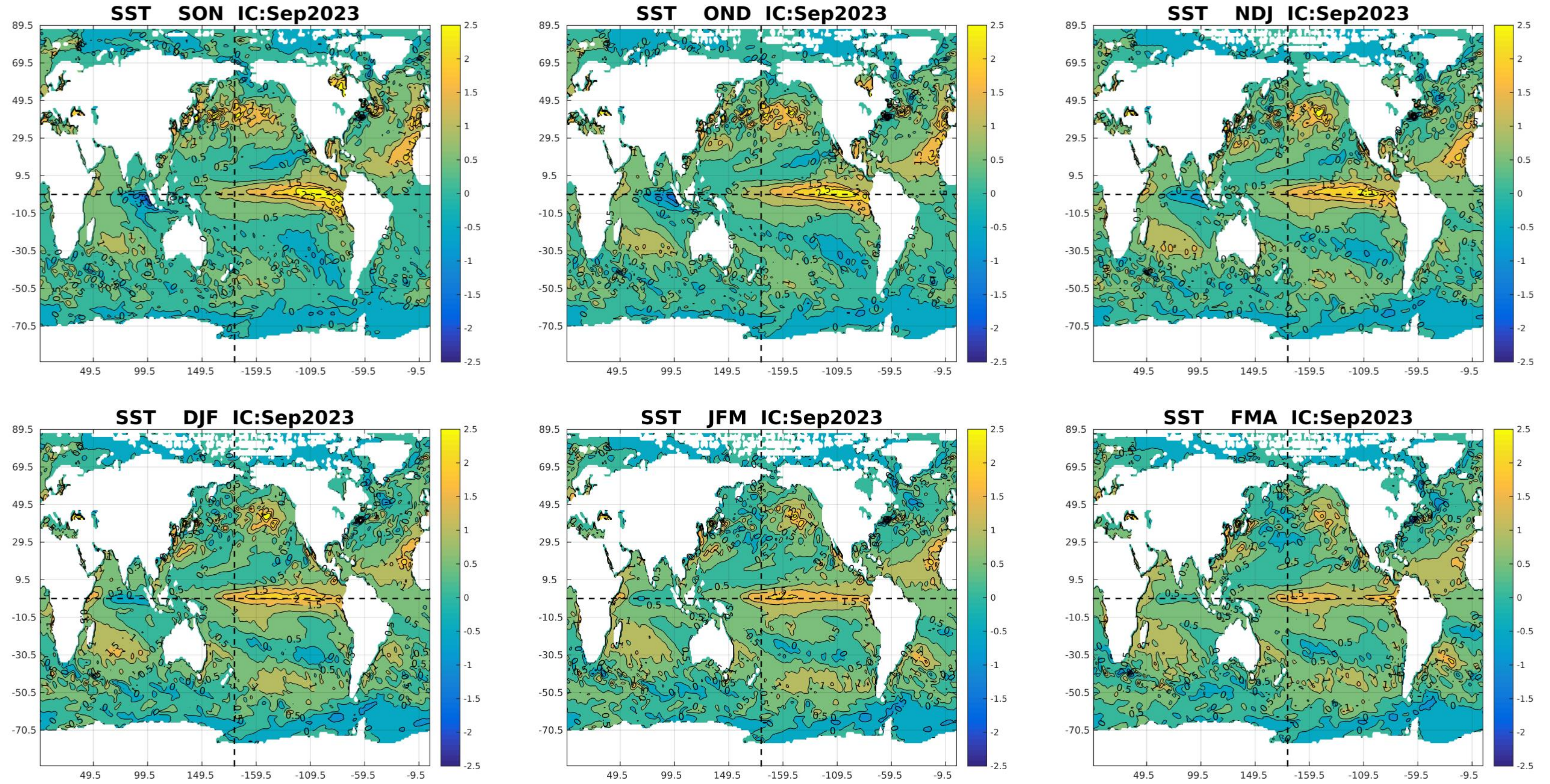
Middle red line: the forecast
Thin red lines: 25% confidence levels



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
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
95-96
97-98
98-99
99-00
02-03
07-08
09-10
10-11
11-12
15-16

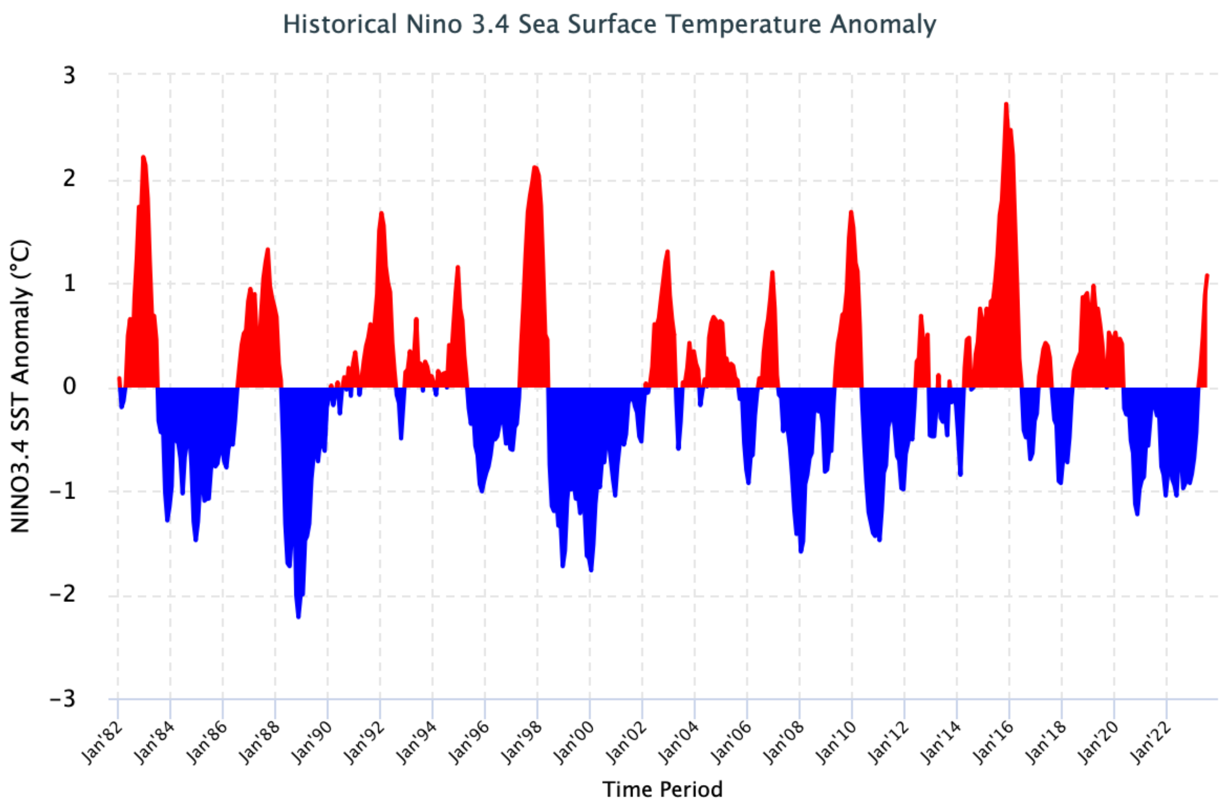
IC: the month in which the forecast was made

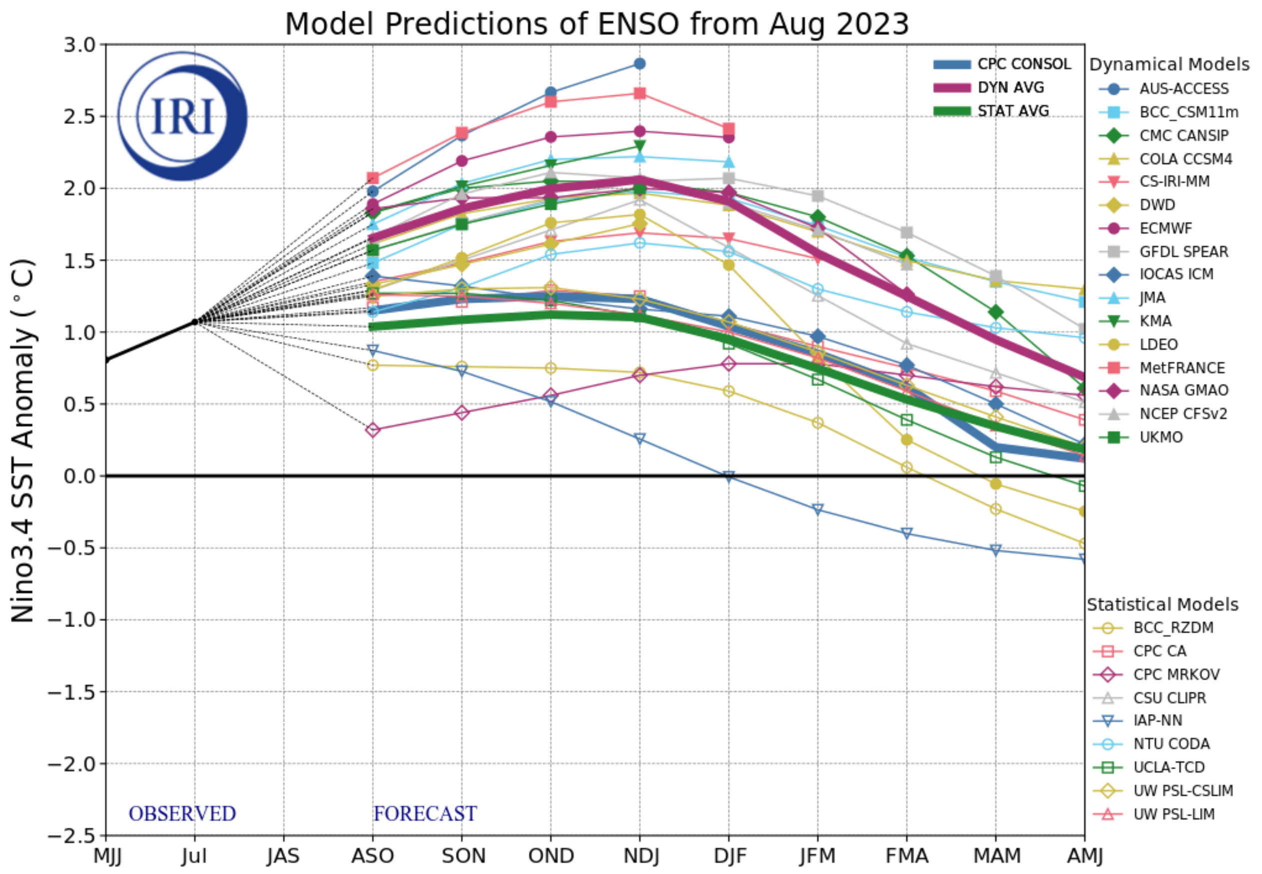
SST anomalies (in °C, where blue is cooler and orange is warmer)



Round-up: ENSO

- The UP model is predicting a strong El Niño event during the Austral mid-summer period





Africa forecasts, south of 20°N

Prediction Method

- Three-month seasons for seasonal rainfall totals and average maximum temperatures of NMME ensemble mean forecasts are recalibrated to the Climatic Research Unit (CRU; Harris et al. 2014) grids (0.5°x0.5°). 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)

NEW!!!

- Verification of forecast performance:
  - 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.
  - The white areas on the forecast maps
    - Forecasts for the near-normal category do not have skill and are therefore not shown
    - Forecasts associated with ROC values less than or equal to 0.5 (no skill) are also not shown

Forecasts are probabilistic

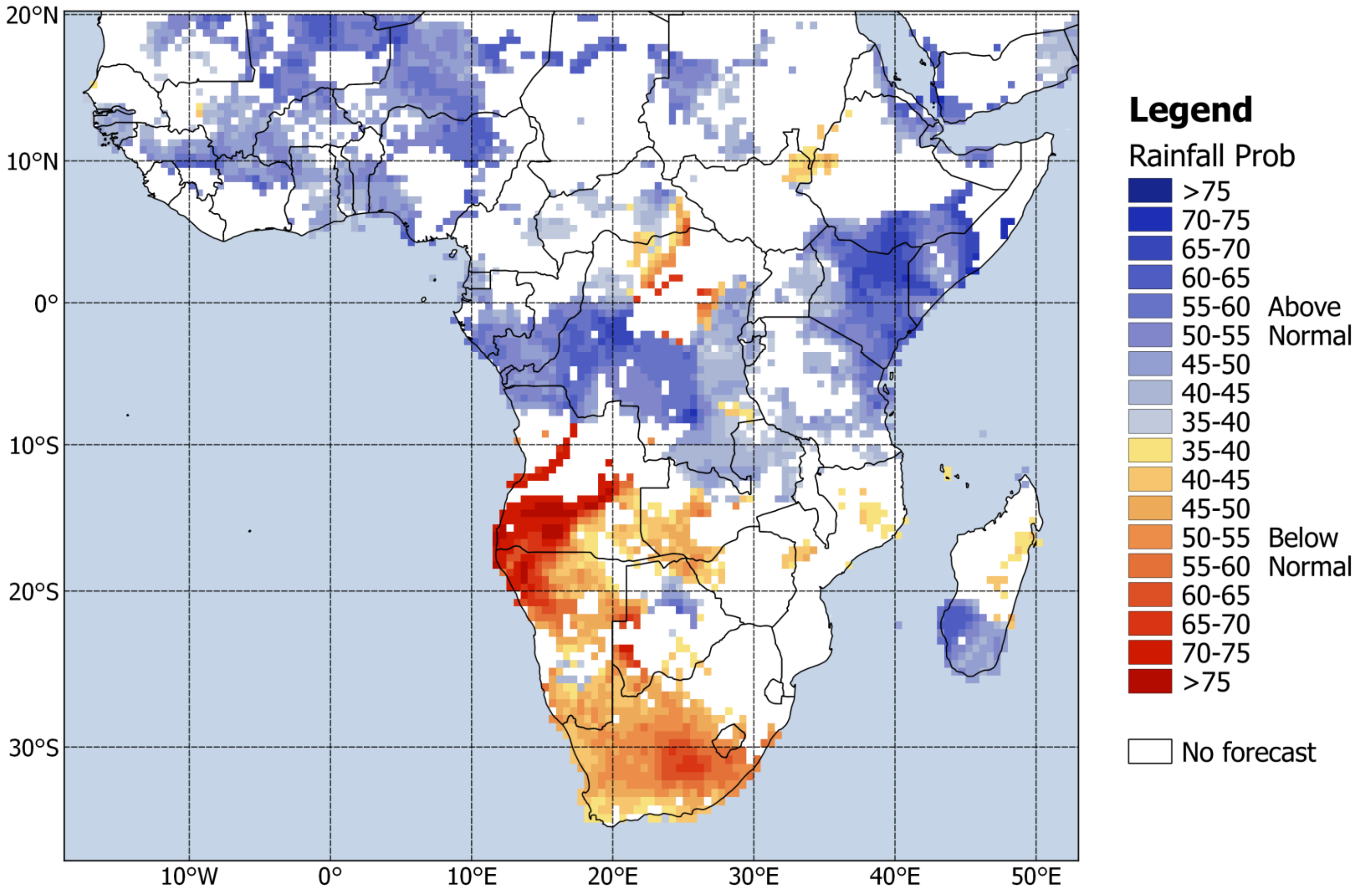
Probabilistic forecasts can help users understand risks and opportunities (forewarned is forearmed) in order to make more informed decisions.

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 ROC 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% chance 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.

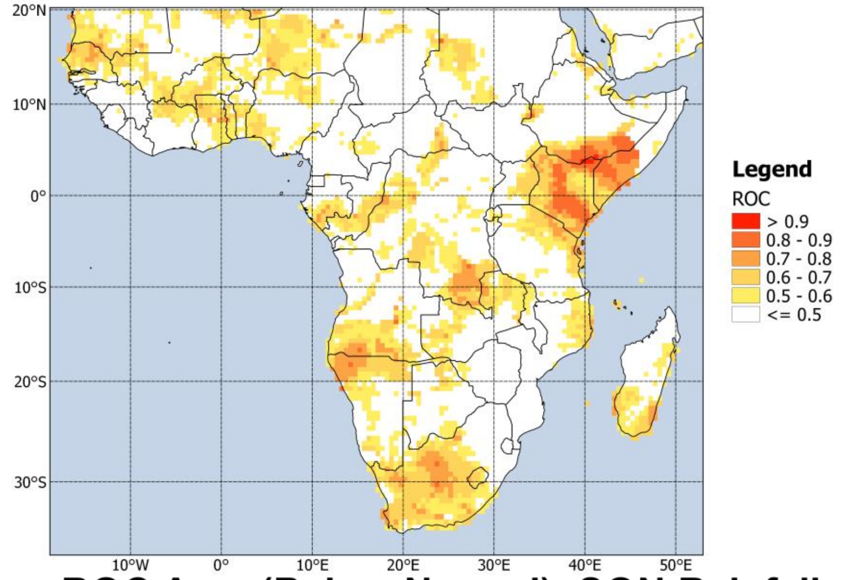
The nature of a probabilistic forecast implies that the less likely outcomes are always possible. In fact, for the probabilistic forecasts to be considered reliable, the less likely outcomes will and must occasionally occur.

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

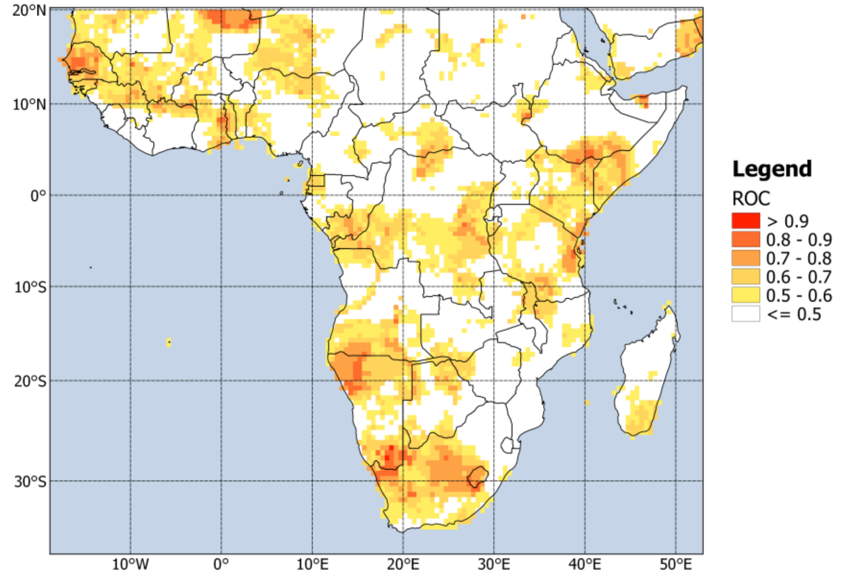
SON 2023 Rainfall; ICs: Sep

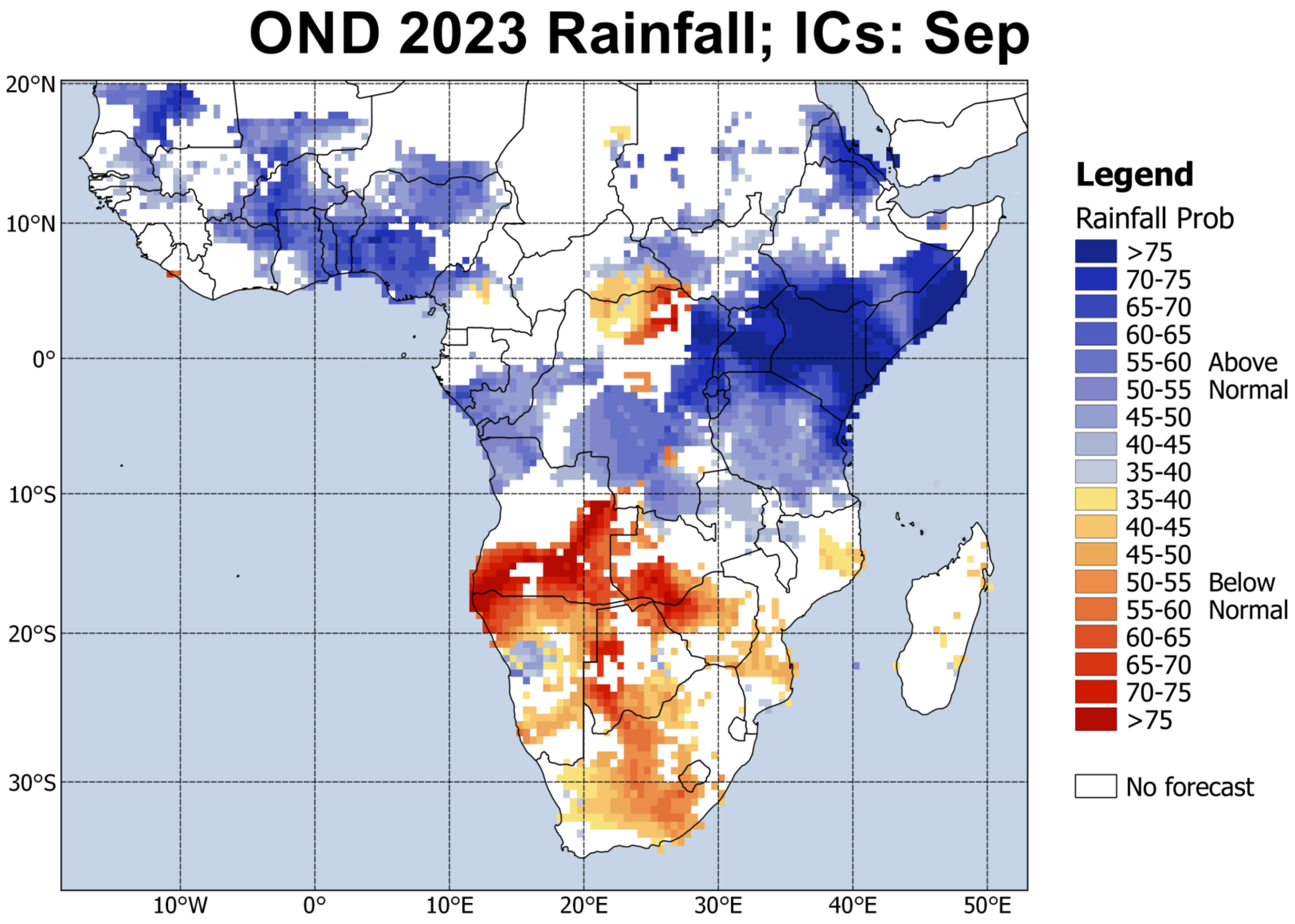


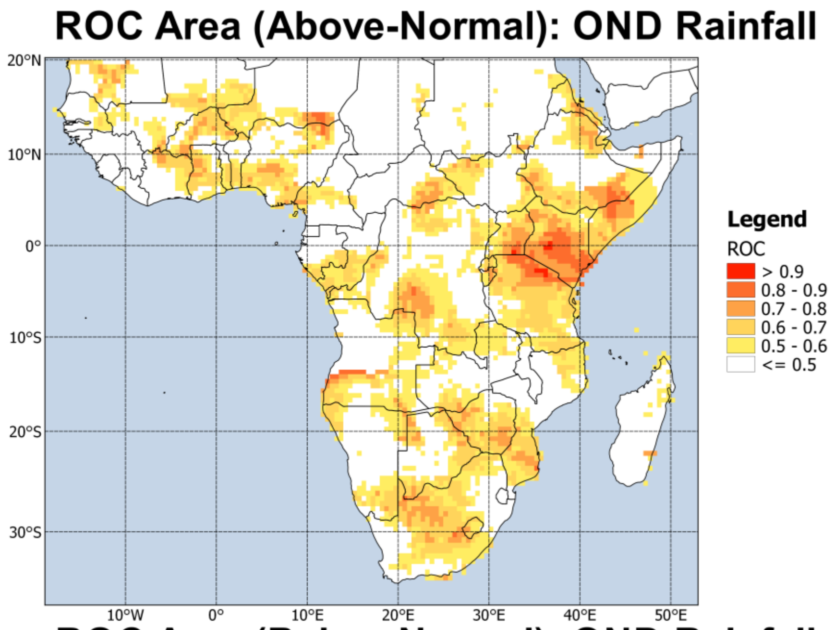
ROC Area (Above-Normal): SON Rainfall

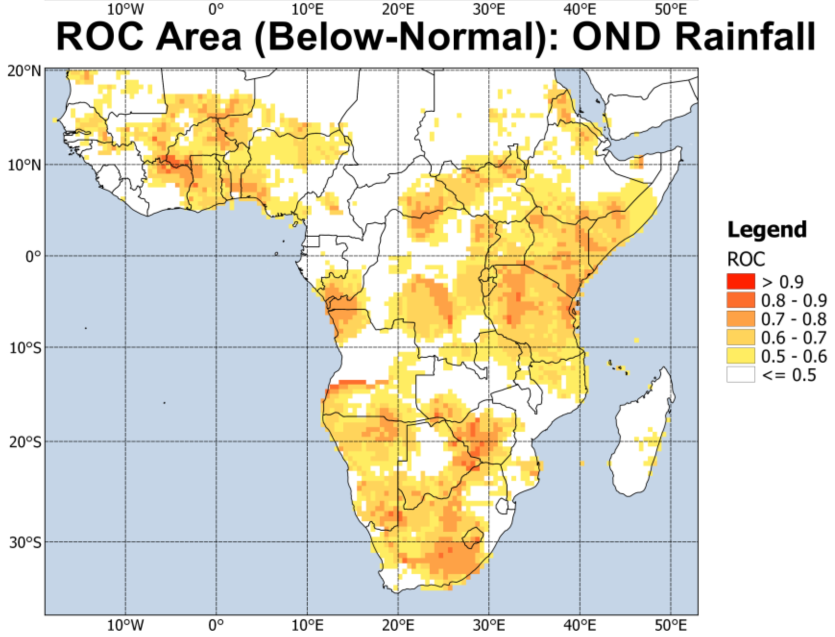


ROC Area (Below-Normal): SON Rainfall

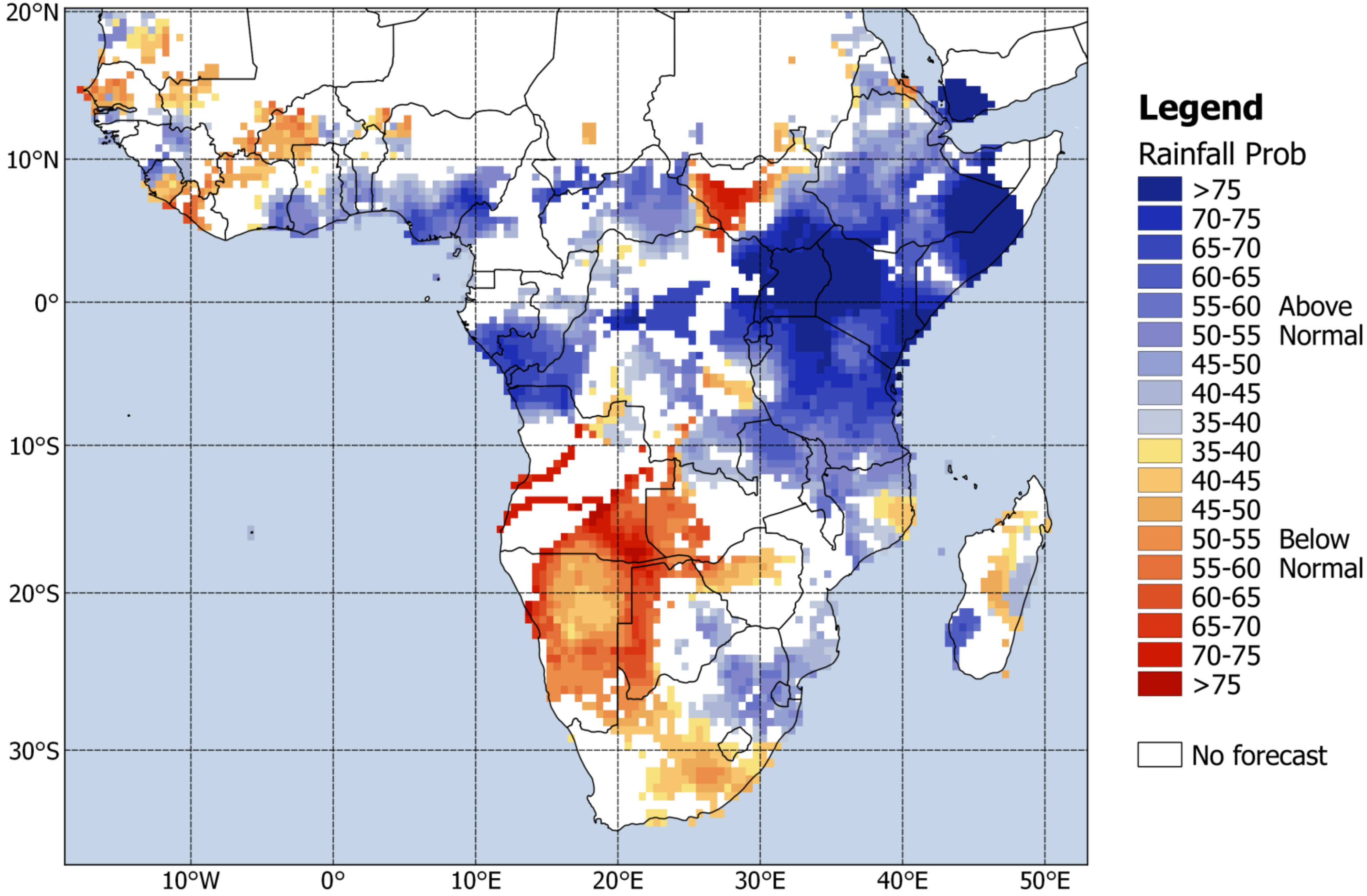



OND 2023 Rainfall; ICs: Sep
20°N
10°N
0°
10°S
20°S
30°S
10°W
0°
10°E
20°E
30°E
40°E
50°E
Legend
Rainfall Prob
>75
70-75
65-70
60-65
55-60 Above
50-55 Normal
45-50
40-45
35-40
35-40
40-45
45-50
50-55 Below
55-60 Normal
60-65
65-70
70-75
>75
No forecast

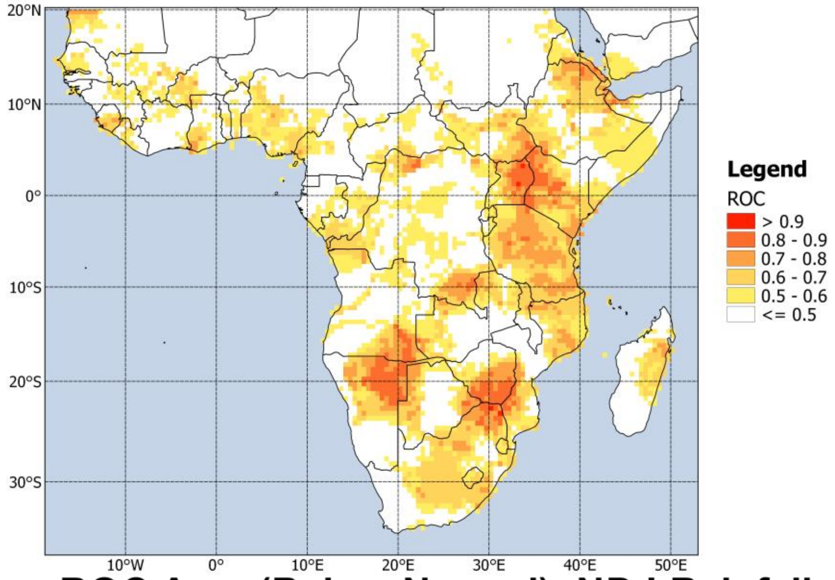

ROC Area (Above-Normal): OND Rainfall
Legend
ROC
> 0.9
0.8 - 0.9
0.7 - 0.8
0.6 - 0.7
0.5 - 0.6
<= 0.5


ROC Area (Below-Normal): OND Rainfall
Legend
ROC
> 0.9
0.8 - 0.9
0.7 - 0.8
0.6 - 0.7
0.5 - 0.6
<= 0.5

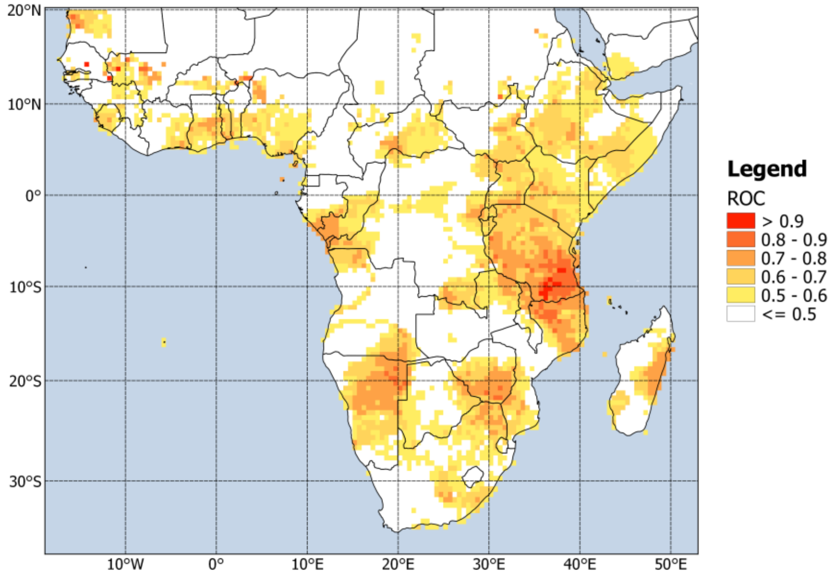
NDJ 2023/24 Rainfall; ICs: Sep



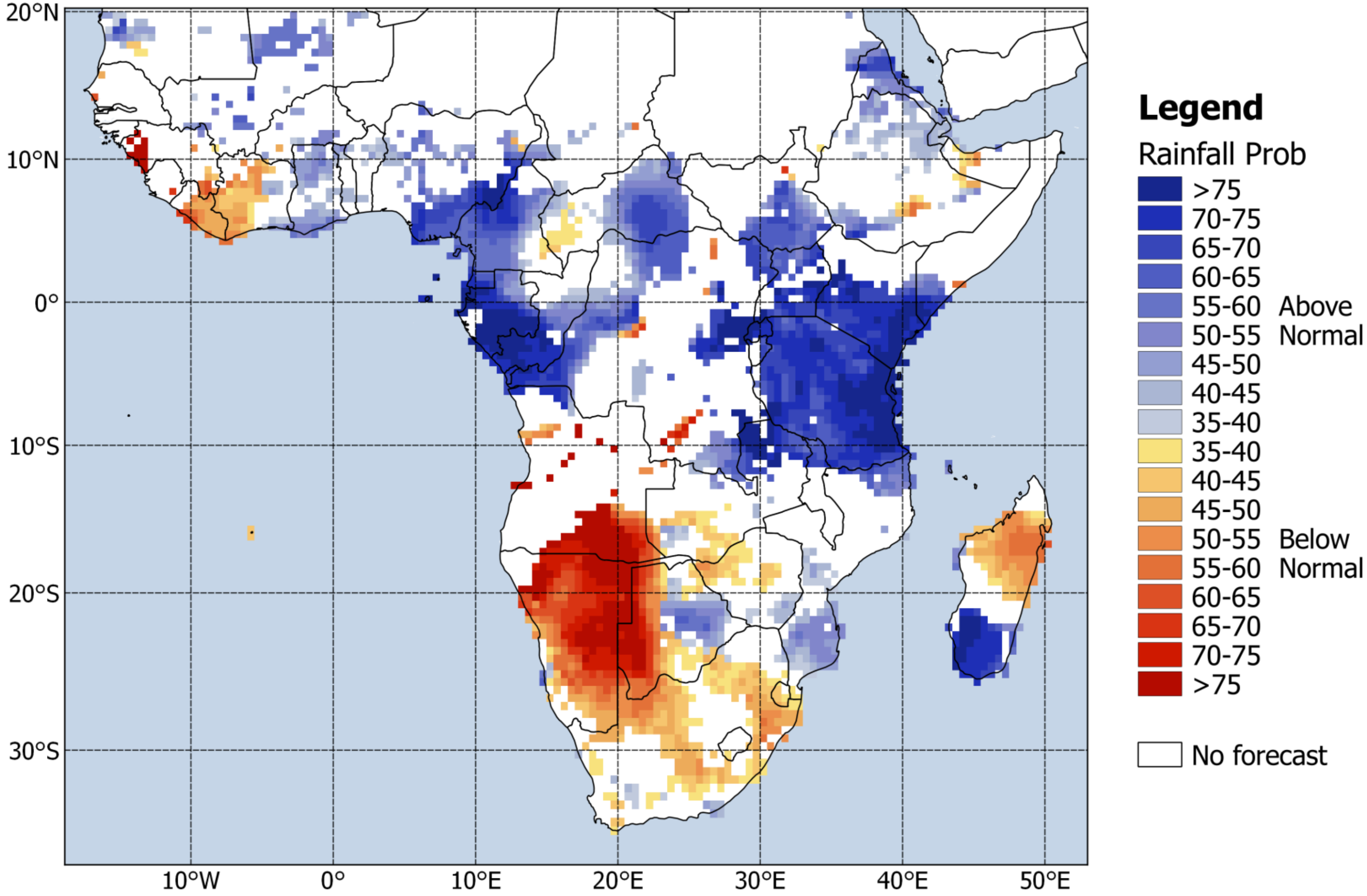
ROC Area (Above-Normal): NDJ Rainfall



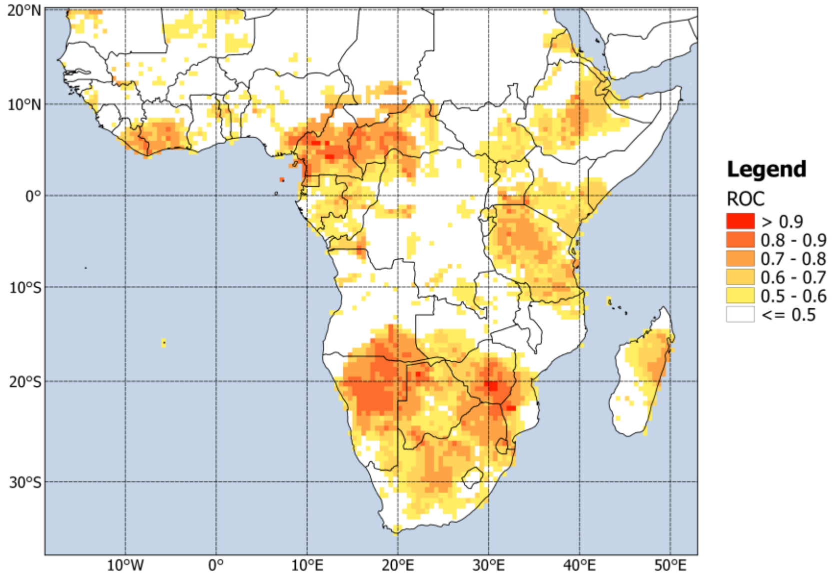
ROC Area (Below-Normal): NDJ Rainfall



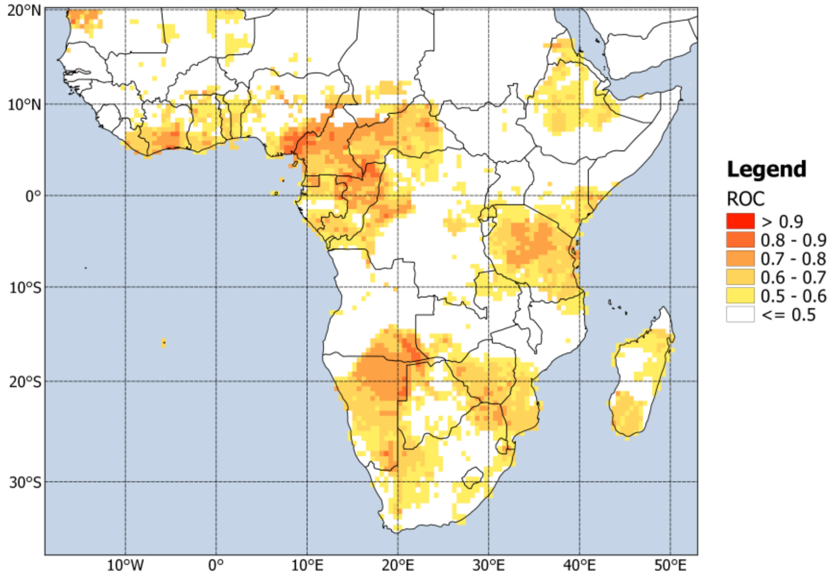
DJF 2023/24 Rainfall; ICs: Sep



ROC Area (Above-Normal): DJF Rainfall



ROC Area (Below-Normal): DJF Rainfall

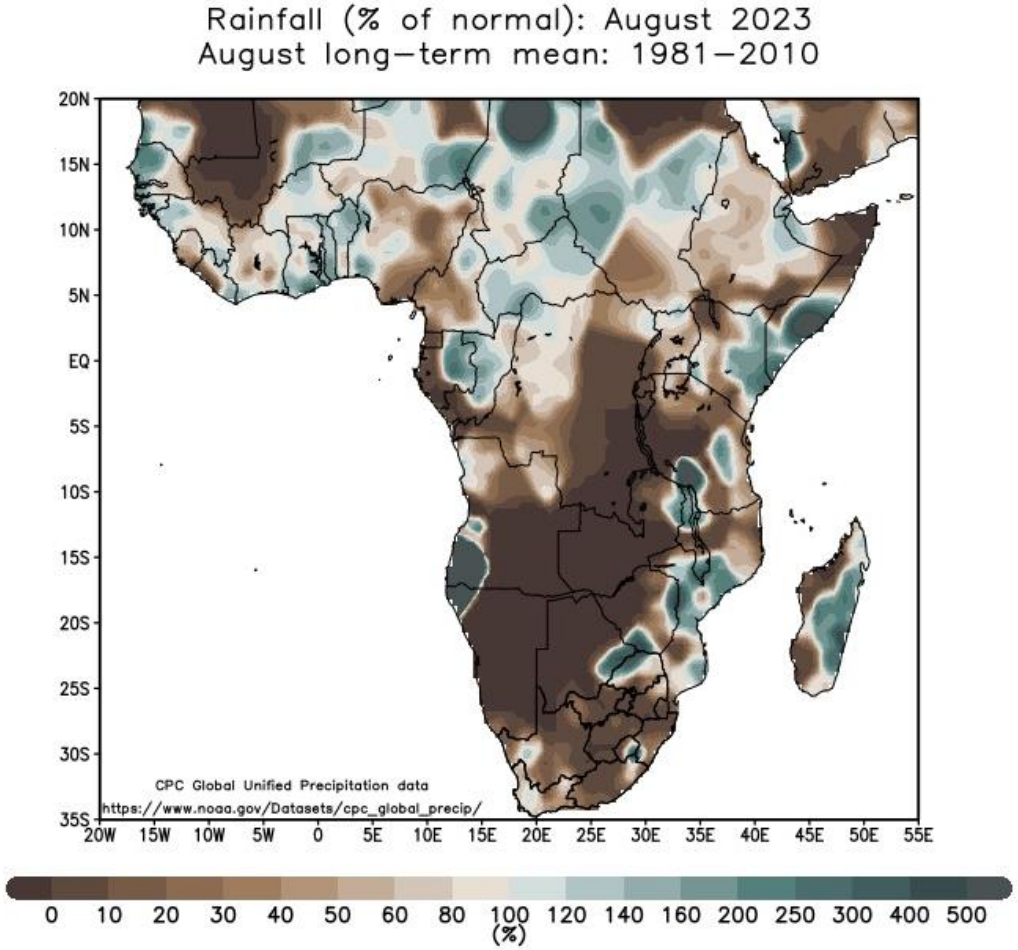


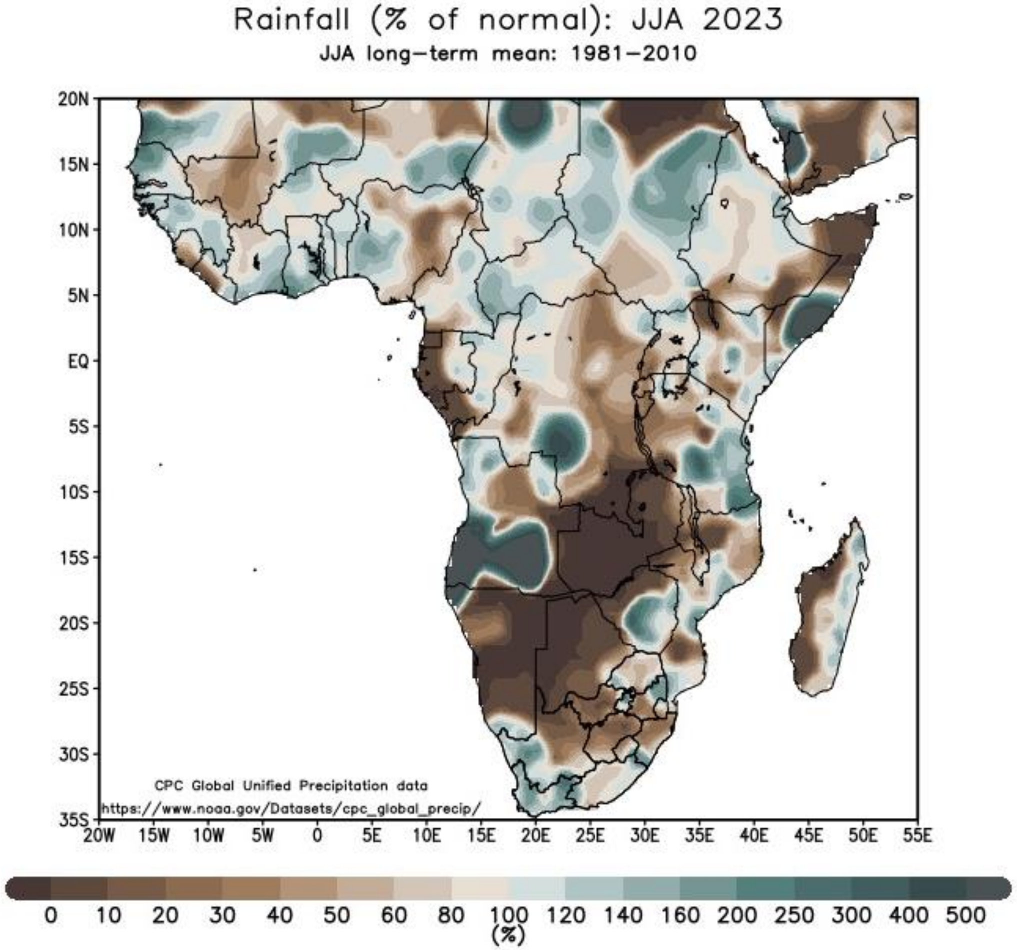
Round-up: Rainfall south of 15°S

El Nino events *(as expected this summer)* are most often associated with below-normal rainfall totals over the summer rainfall region

- At the present time, the forecasts show that the central and western parts of the region are the most strongly linked with expected below-normal rainfall conditions
- Above-normal rainfall totals are predicted over the northeastern parts when entering the New Year, which is an outcome not usually associated with El Nino seasons
- Owing to the uncertainty of the current forecasts for the larger area, it is strongly advised to closely follow forecast updates

Observed Rainfall

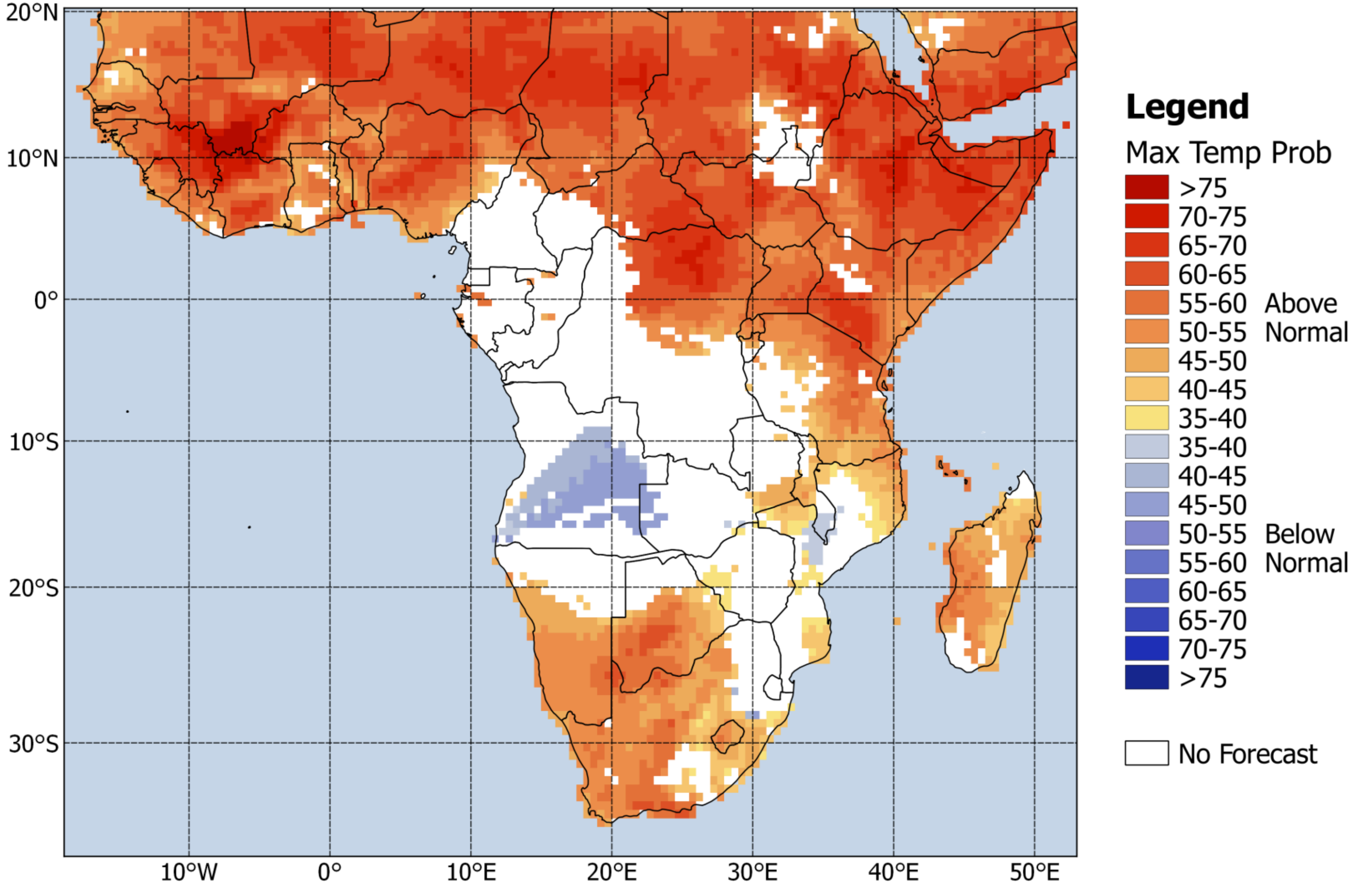




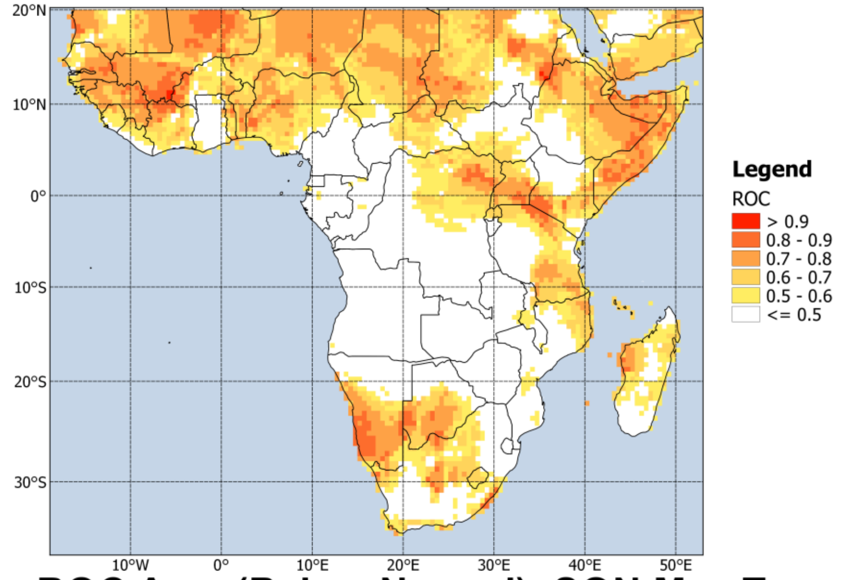
Recorded rainfall for August and the June-July-August season show below-normal rainfall over the brown areas and above-normal rainfall over the green areas

Maps prepared by Dr. Christien Engelbrecht

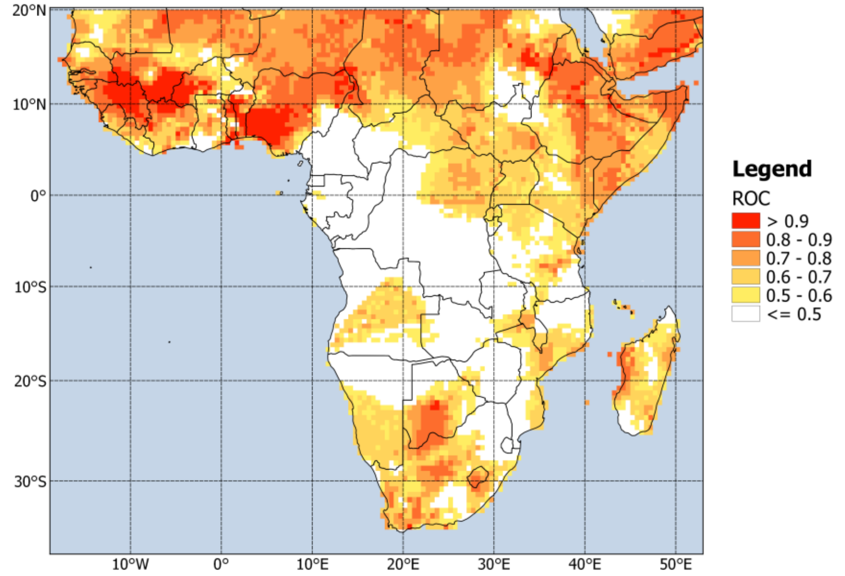
SON 2023 Max Temp; ICs: Sep



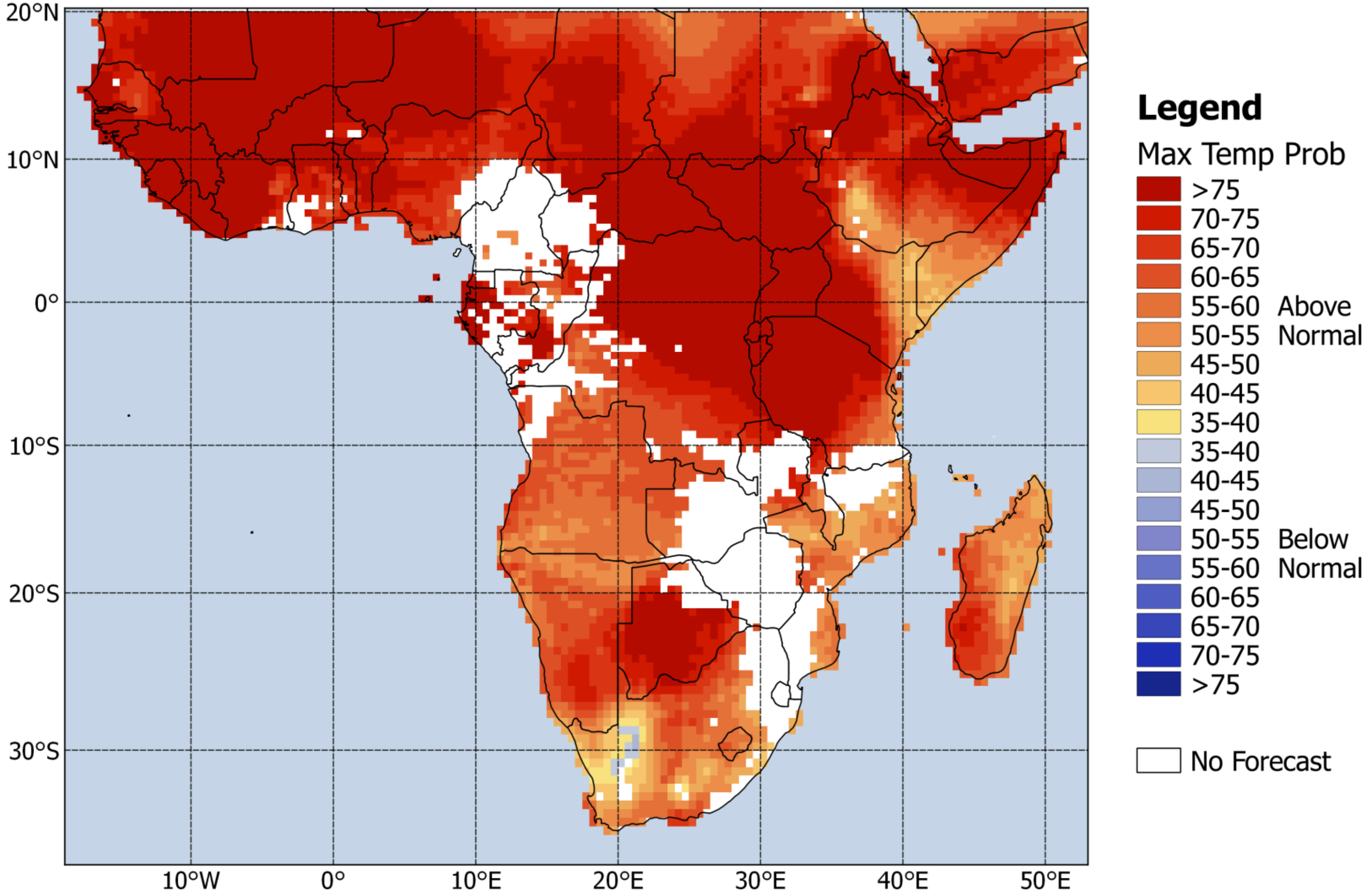
ROC Area (Above-Normal): SON Max Temp



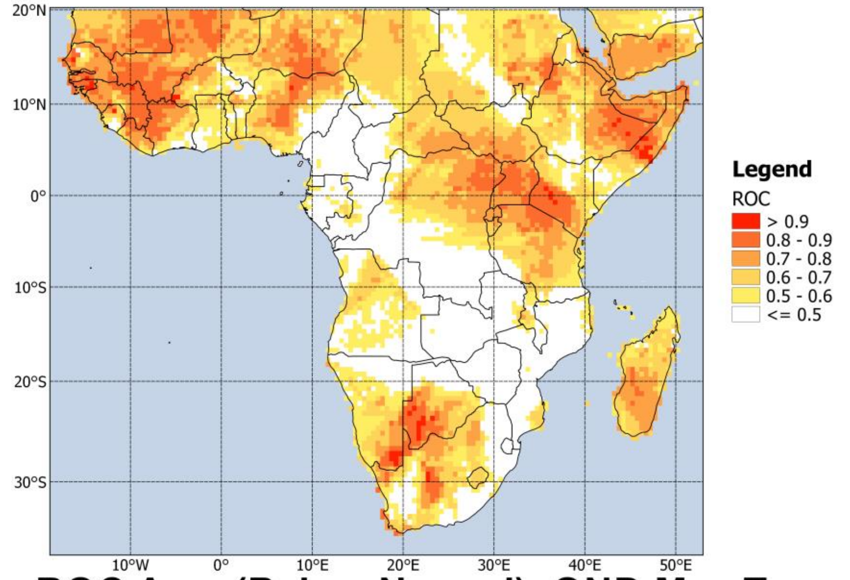
ROC Area (Below-Normal): SON Max Temp



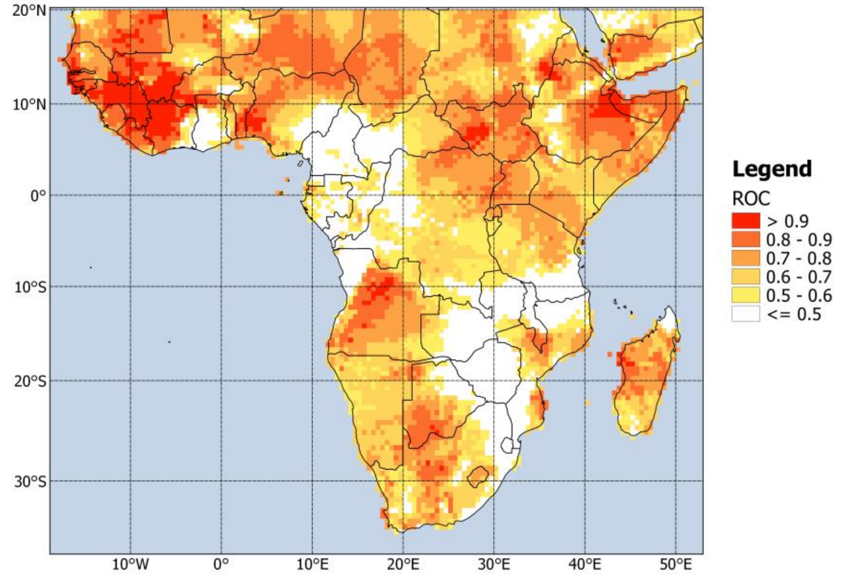
OND 2023 Max Temp; ICs: Sep



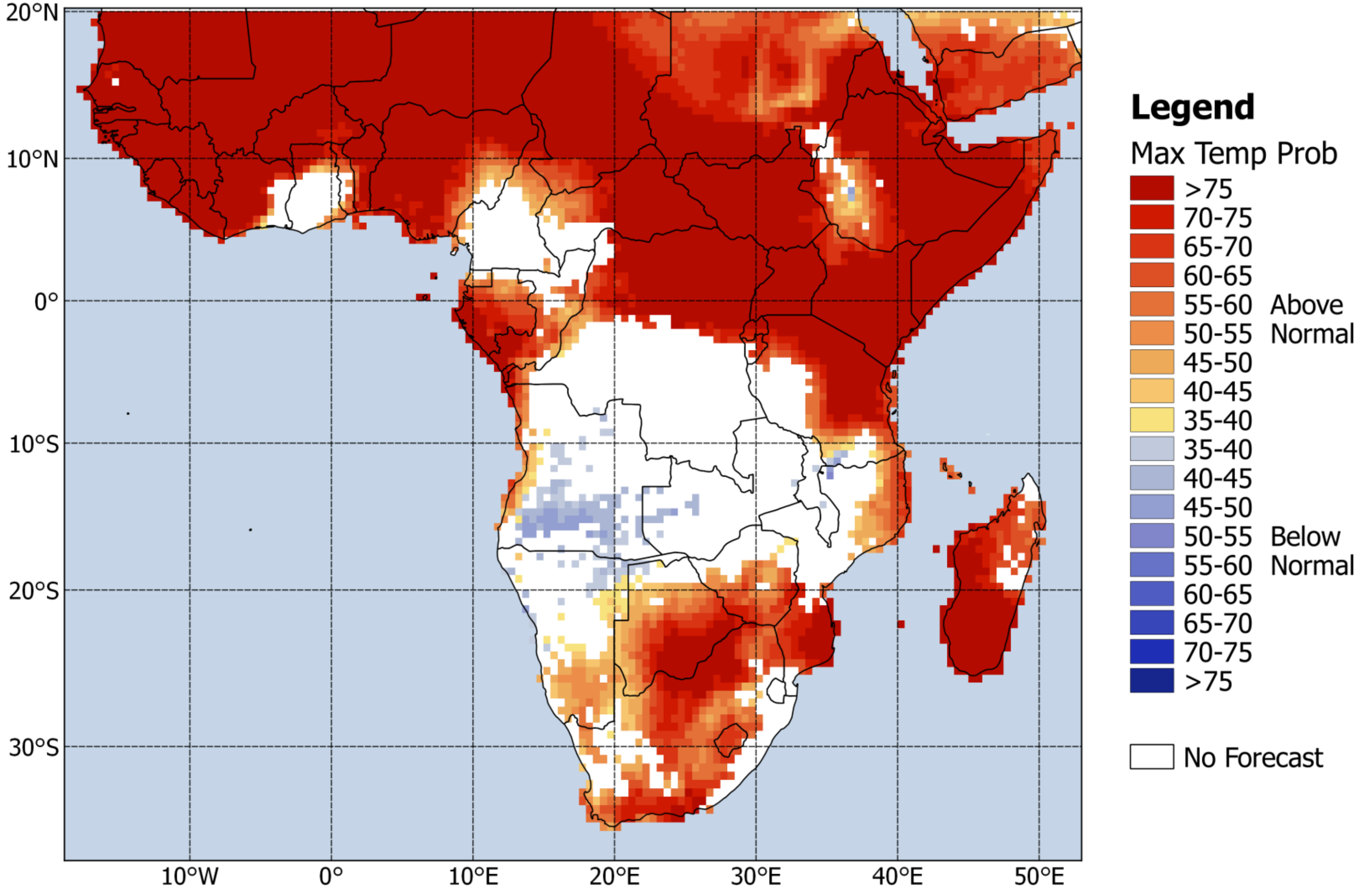
ROC Area (Above-Normal): OND Max Temp



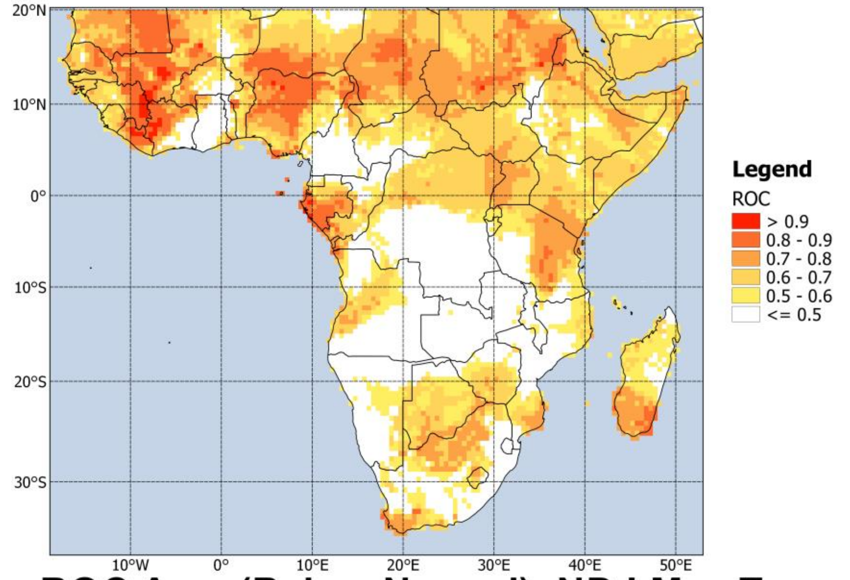
ROC Area (Below-Normal): OND Max Temp



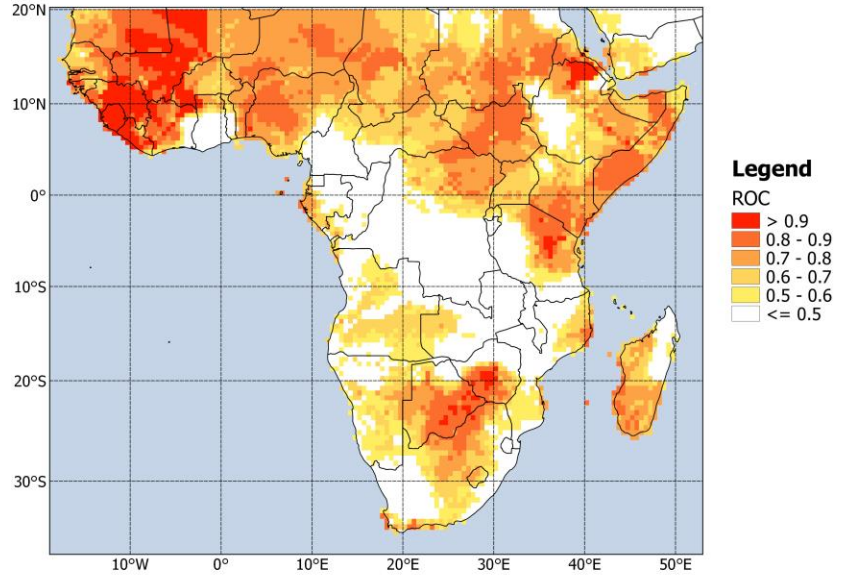
NDJ 2023/24 Max Temp; ICs: Sep



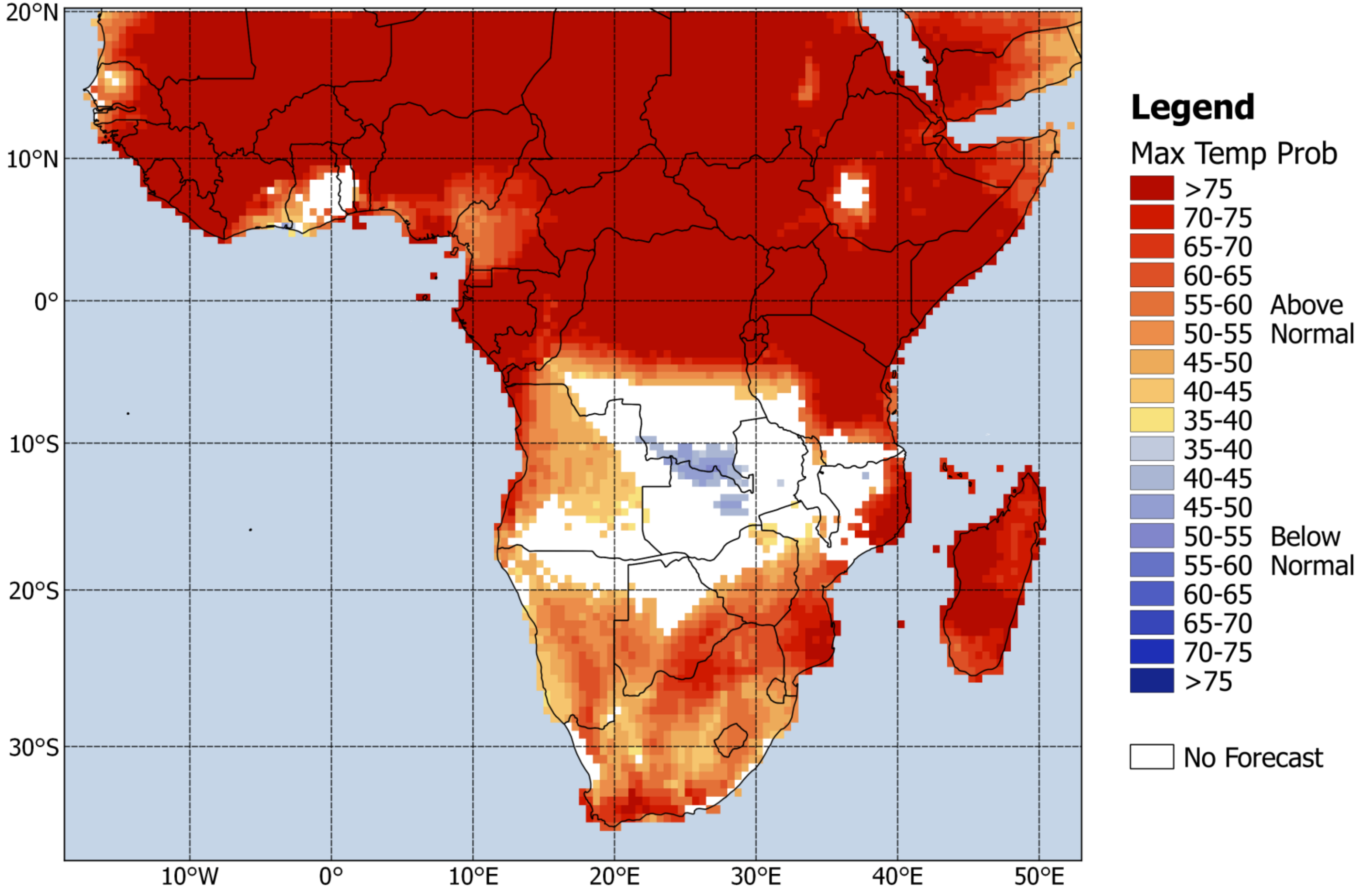
ROC Area (Above-Normal): NDJ Max Temp



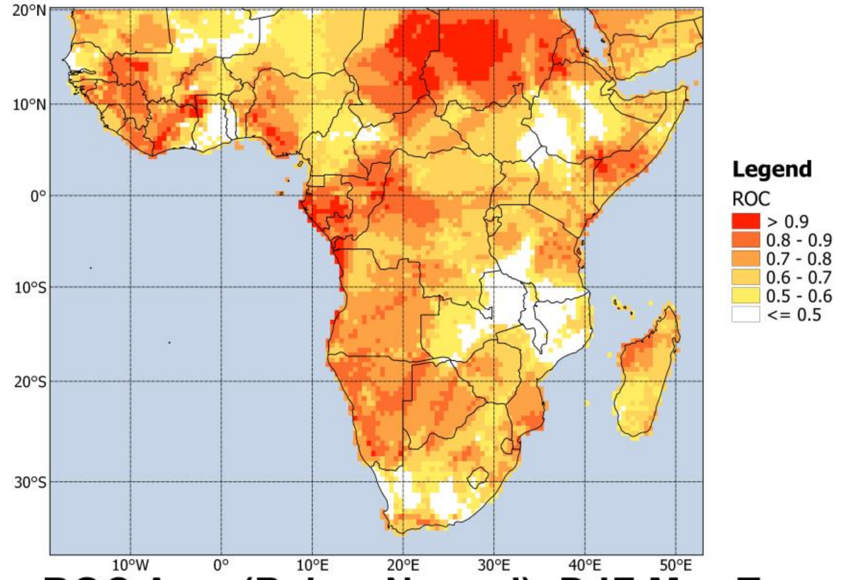
ROC Area (Below-Normal): NDJ Max Temp



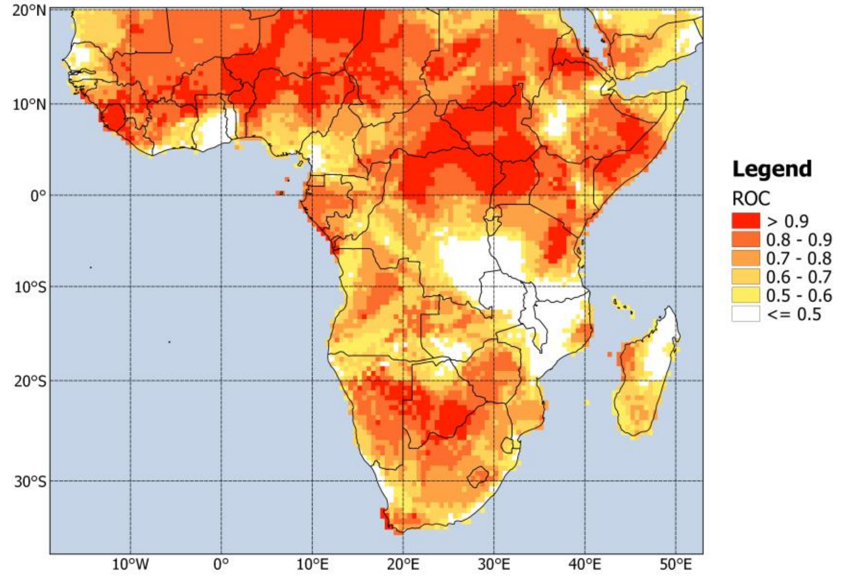
DJF 2023/24 Max Temp; ICs: Sep



ROC Area (Above-Normal): DJF Max Temp



ROC Area (Below-Normal): DJF Max Temp



Round-up: South of 15°S Max Temp

- Above-normal maximum temperatures over almost the entire region are highly likely during the forecast period

Tailored Forecasts

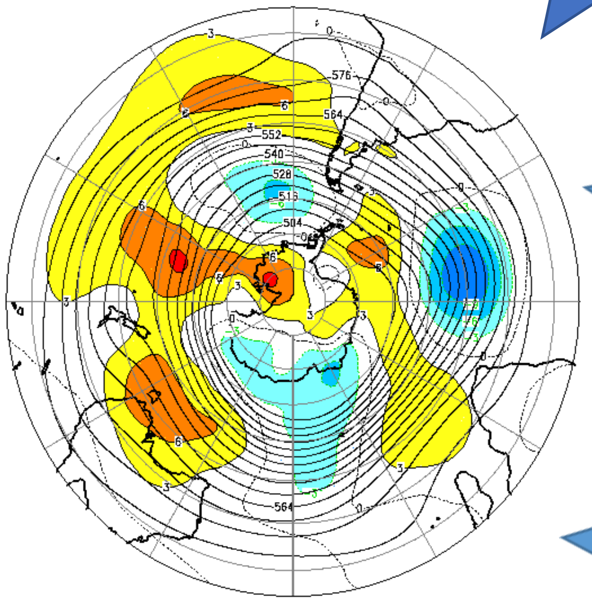
Translating forecasts into indices on a range of relevant space and time scales that can inform regional decision-making. The following forecasts are shown to indicate the potential of seasonal forecasting for real-life applications

1. **Bapsfontein end-of-season-yield three-category probabilistic forecast for 2024**
2. **Probability of exceedance Dec-Jan-Feb 2023/24 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

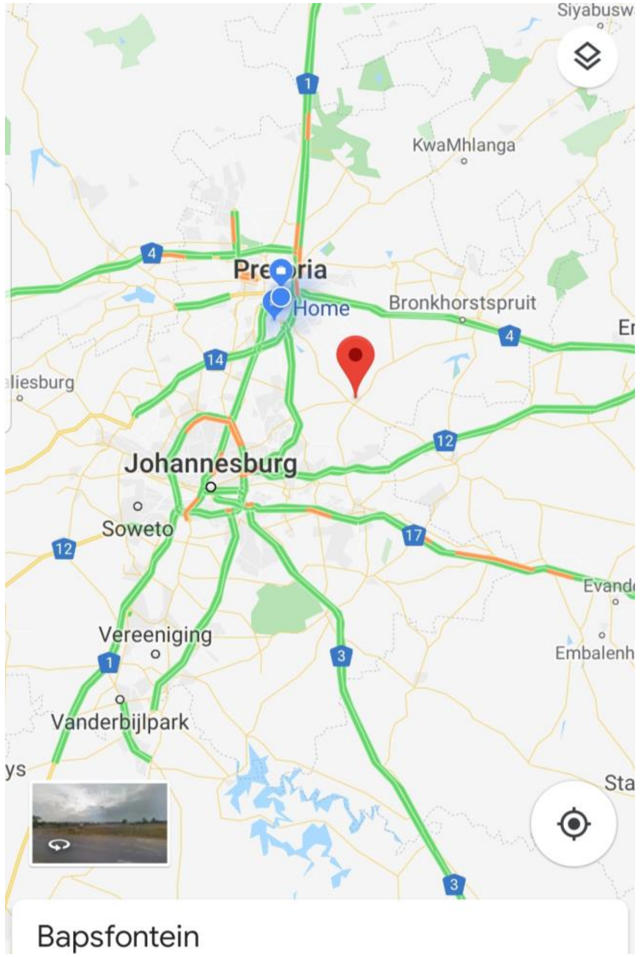
Riverflow

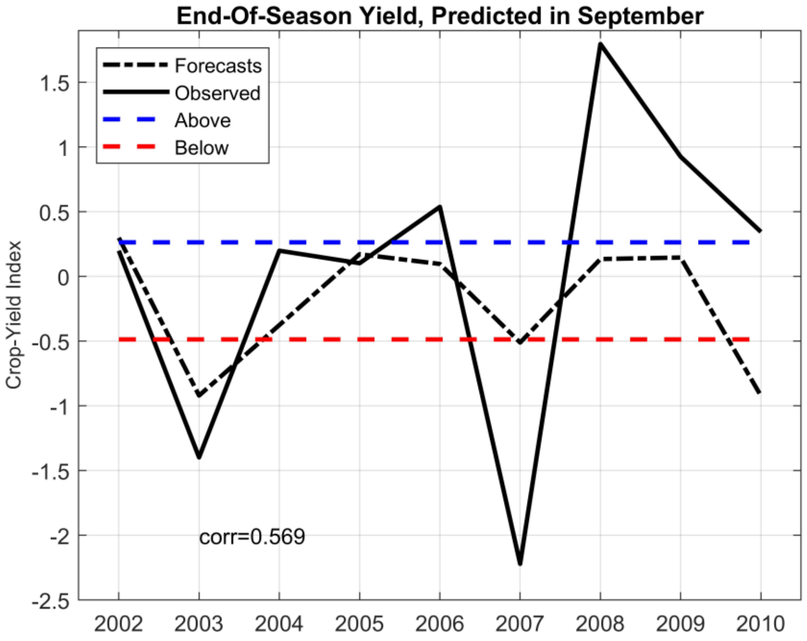
Malaria

Dry-land crop yield

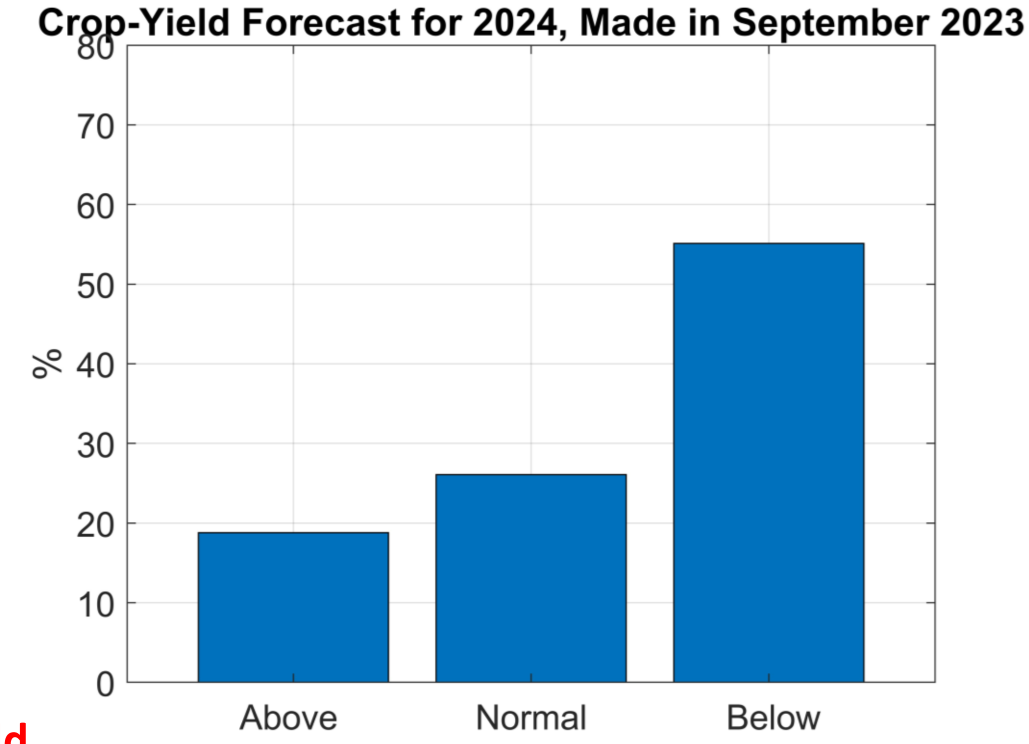
Dry-land crop-yield data and forecasts for a farm near Bapsfontein, South Africa

Landman et al. (2019)





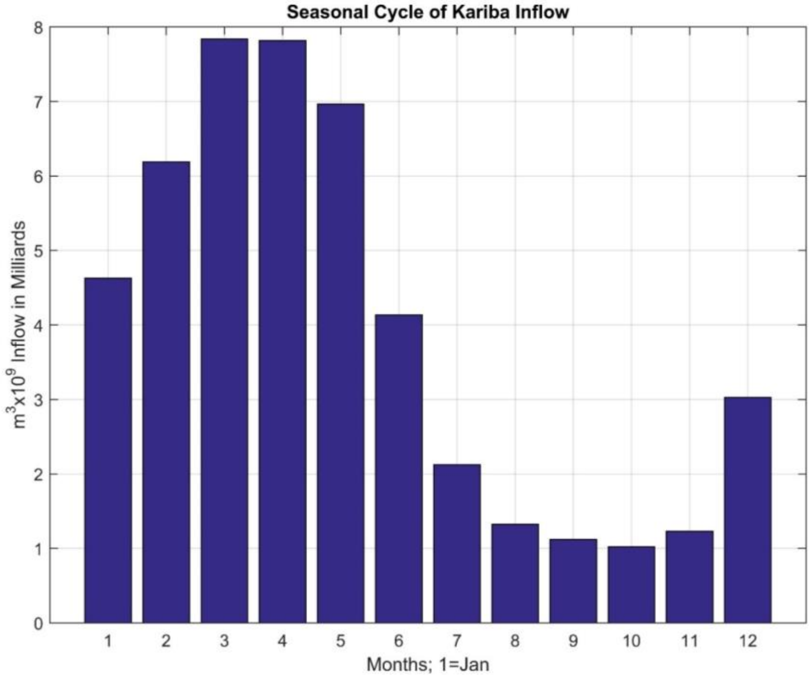
Re-forecasts for end-of-season crop yield

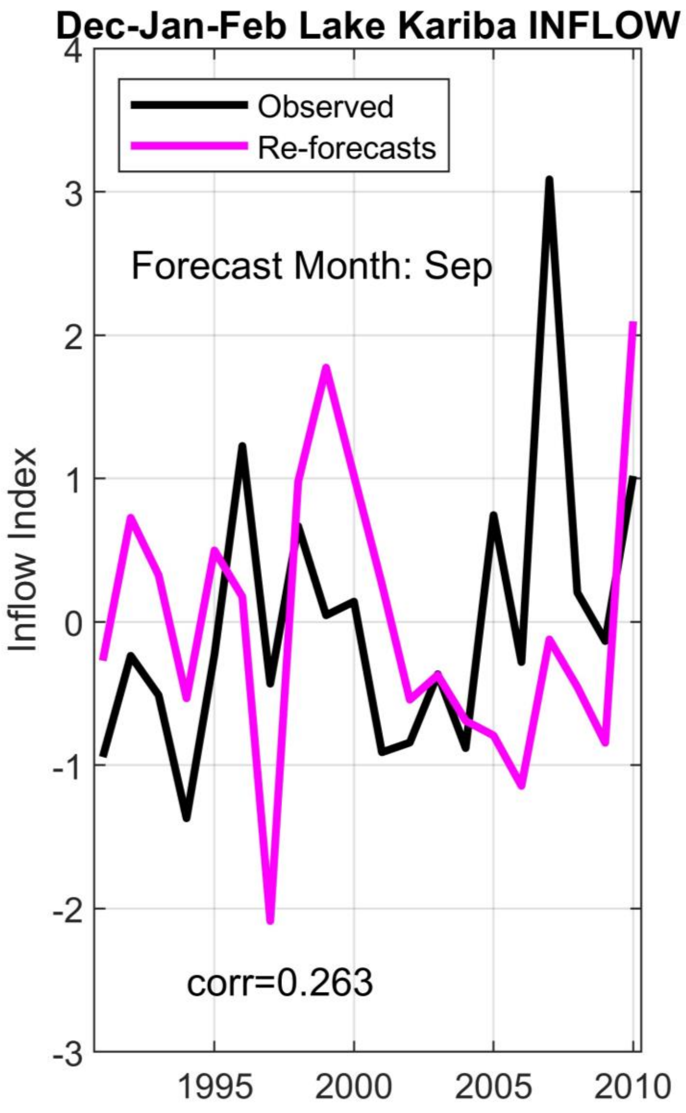


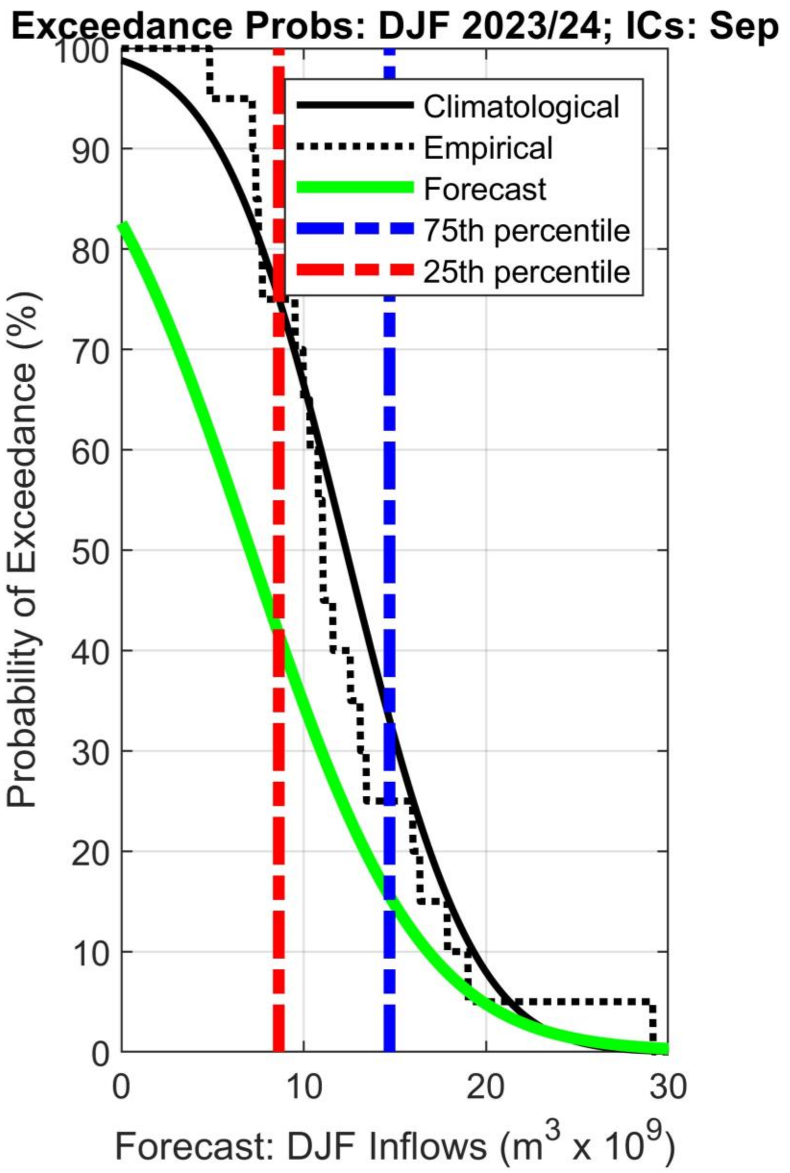
% is the probability of the respective categories to occur

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.

Round-up: Tailored products

- The yield and inflow forecasts shown are in agreement with the expected outcome during El Nino seasons – low yield and low flows

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Financial support from…

- The National Research Foundation
  - Incentive Funding for Rated Researchers (since 2017)
  - Project: Application of knowledge for the management of extreme climate events (APECX; 2022 to 2024)

- 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 2022)

National Research Foundation

access
Alliance for Collaboration on Climate and Earth Systems Science

science & technology
Department: Science and Technology
REPUBLIC OF SOUTH AFRICA

National Research Foundation

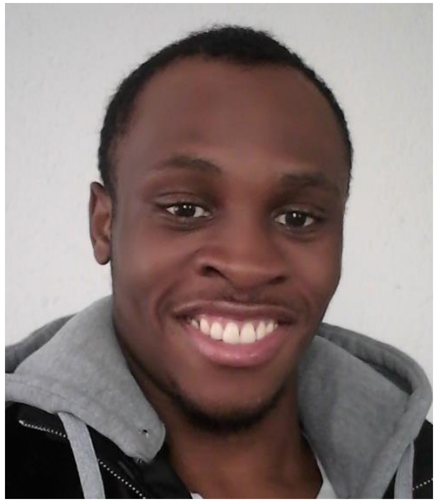
WATER RESEARCH COMMISSION

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

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

Student participation in forecast system development

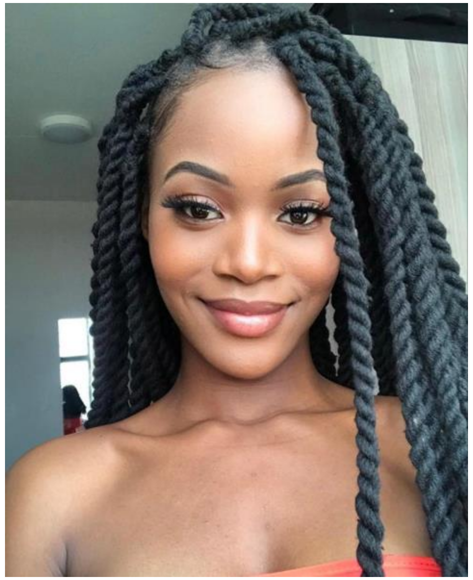
Stephanie Hinze, BSc (Honours)(Meteorology):
Statistical downscaling using large and high-resolution data sets, forecast displays for SADC rainfall and maximum temperatures, forecast verification



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.



Idani Mandiwana, BSc (Honours) (Meteorology):
Seasonal rainfall forecast verification of real-time forecasts produced by SFW over the 5-year period from 2018 to 2022. Area is SADC south of 17° South.