Seasonal forecasts

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Seasonal Climate Forecasts

Seasonal Forecast Worx

Latest Update: 11 December 2024

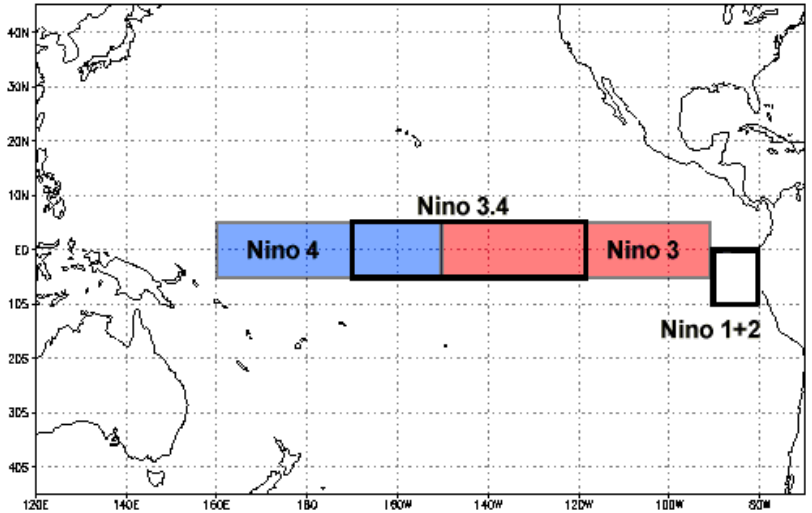
- The seasonal forecasts presented here by **Seasonal Forecast Worx** are based on forecast output of the coupled ocean-atmosphere models administered through the North American Multi-Model Ensemble (NMME) prediction experiment (http://www.cpc.ncep.noaa.gov/products/NMME/; Kirtman et al. 2014). NMME 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: https://www.weathersa.co.za/home/seasonalclimate

South African Weather Service

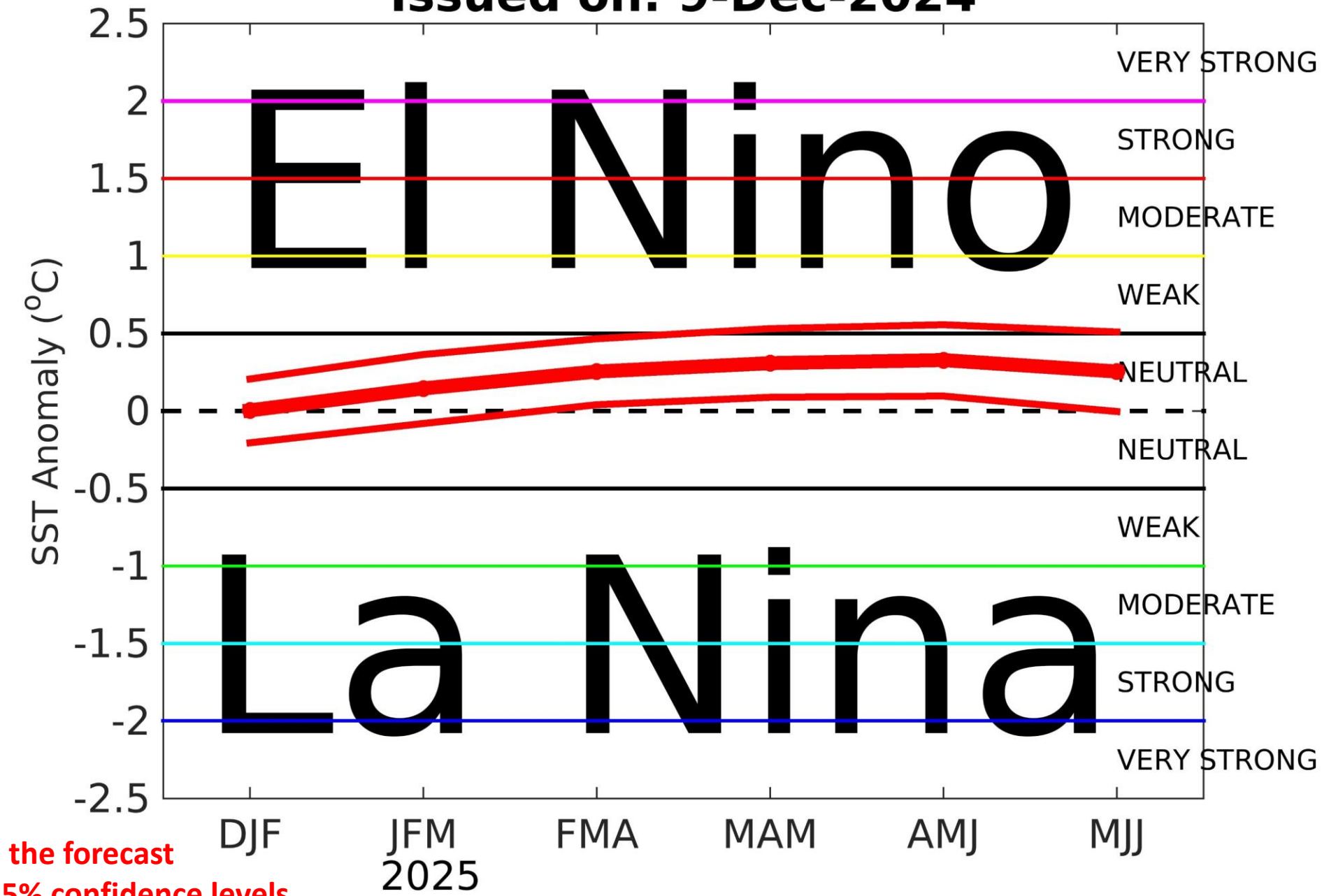
ENSO and Global SST Forecasts

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: 9-Dec-2024

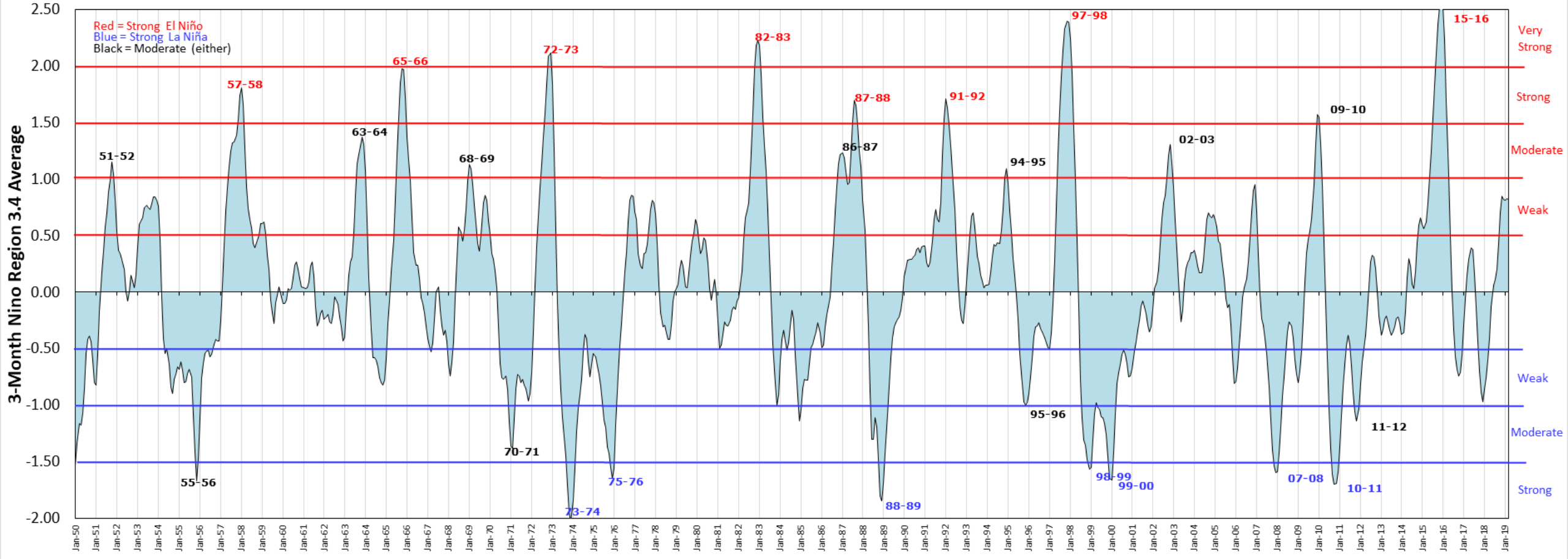


Middle red line: the forecast

Thin red lines: 25% confidence levels

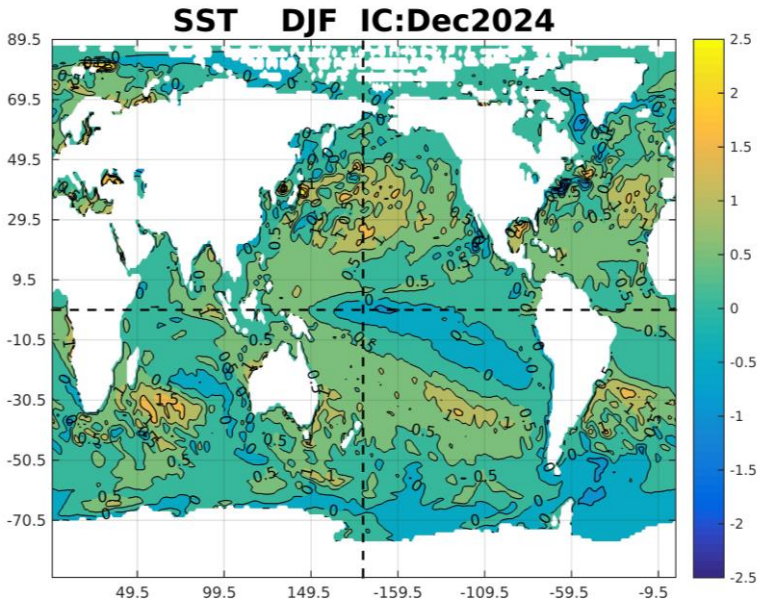
Oceanic Niño Index (ONI)

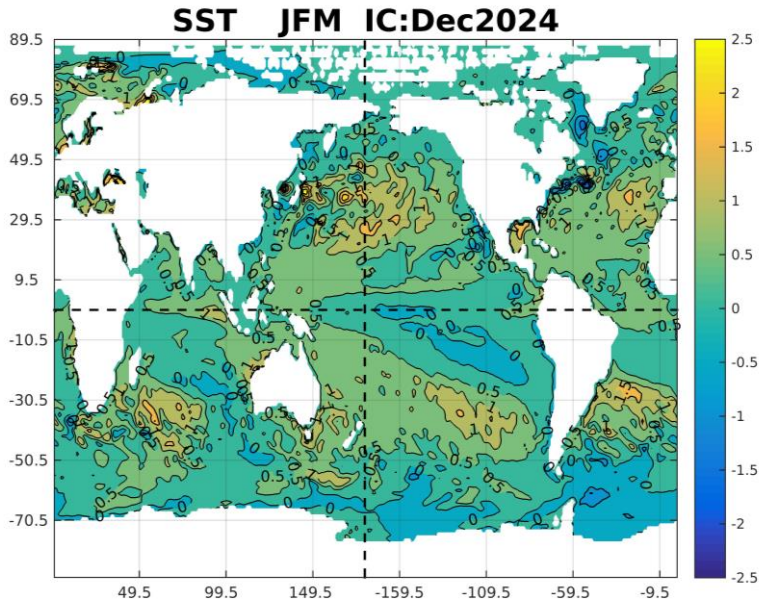
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

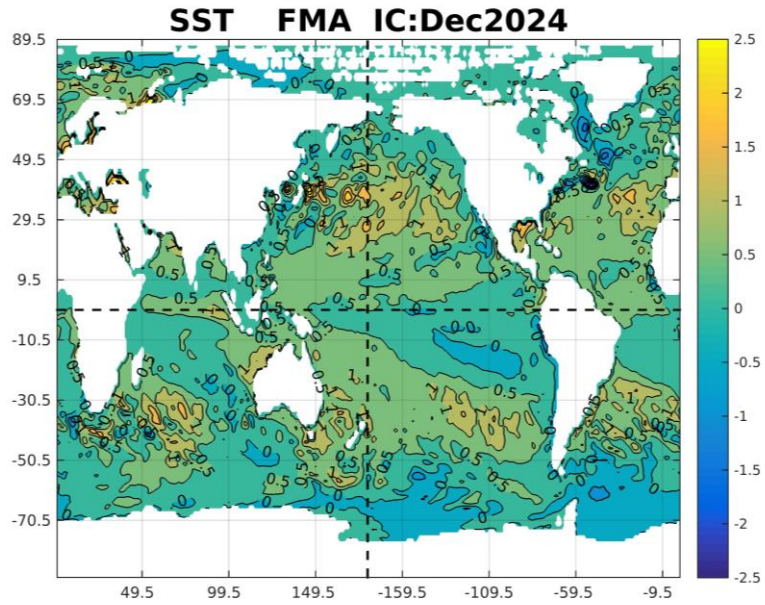


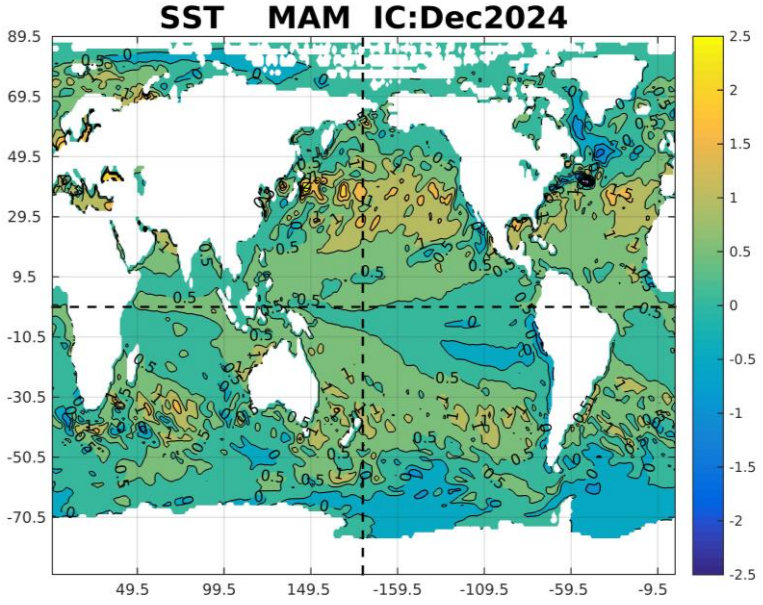
IC: the month in which the forecast was made

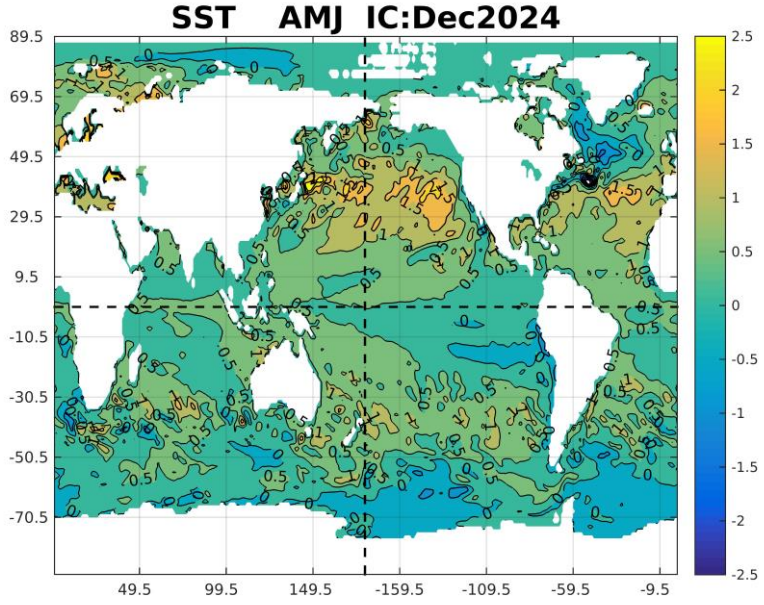
SST anomalies (in °C, where blue is cooler and orange is warmer)

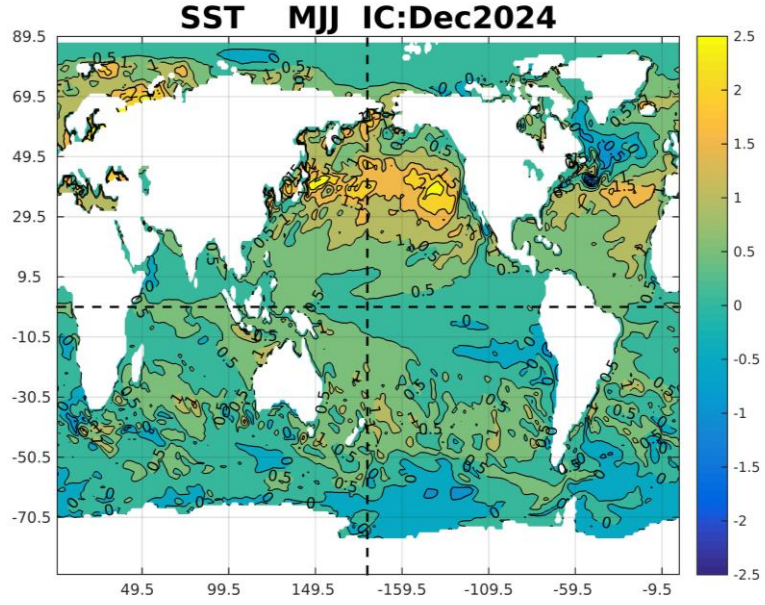






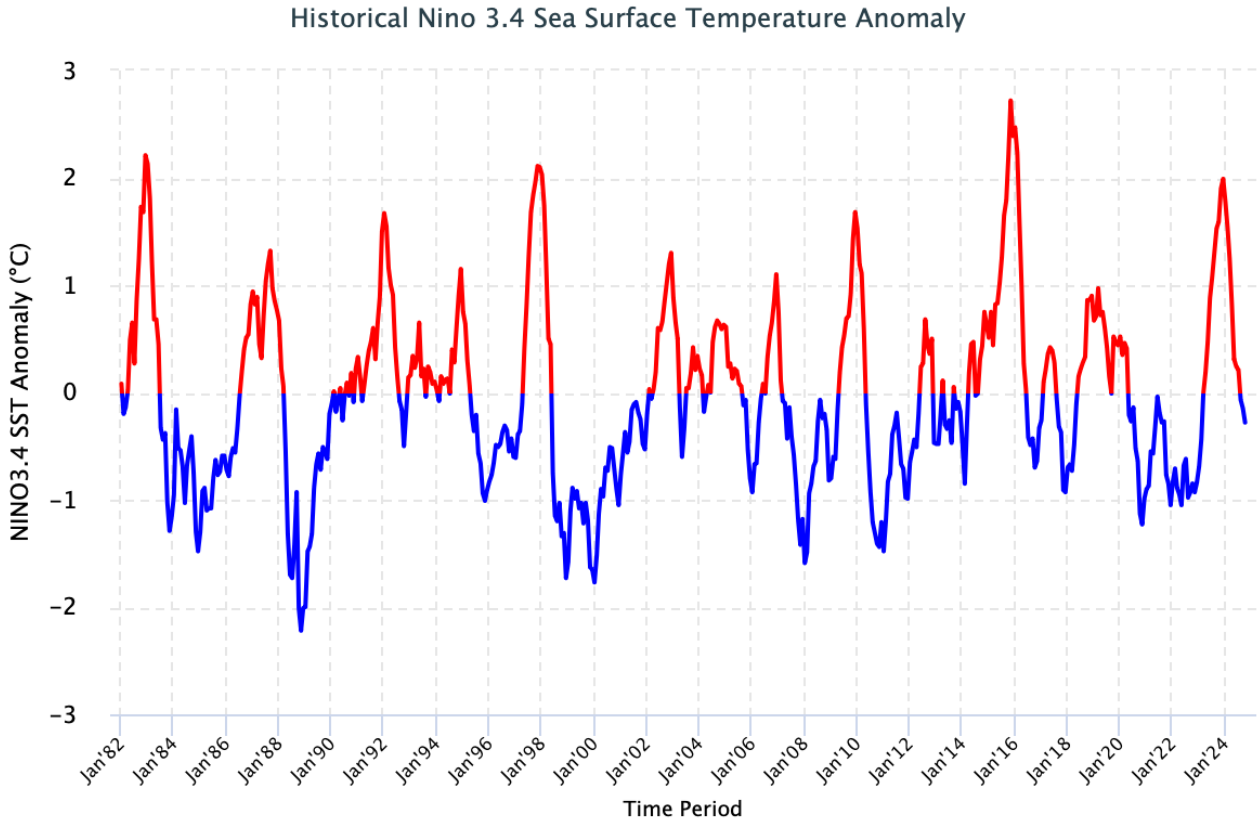


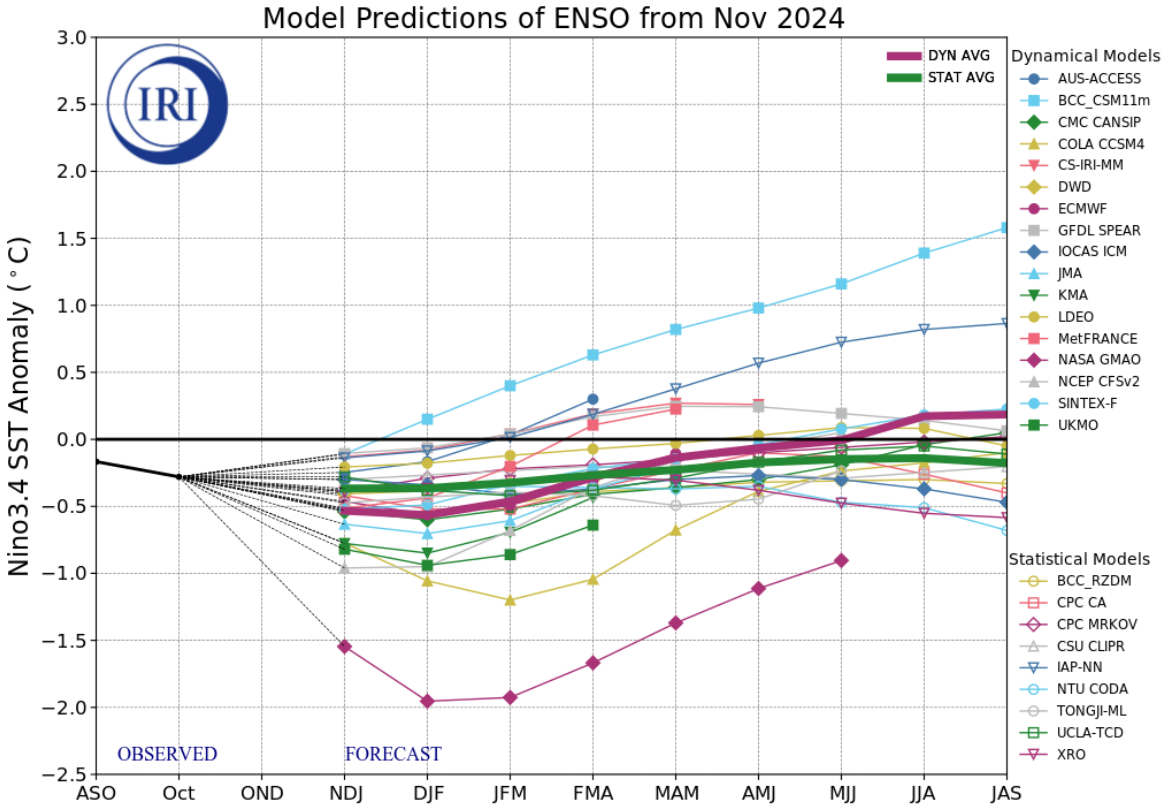




Round-up: ENSO

- The UP model (on previous pages) is predicting the likely development of ENSO-neutral conditions, although some international forecasts are showing a weak La Niña event; cooler than average SST is observed





The UP model forms part of this plume, and is marked as "CS-IRI-MM"

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)

- 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
    - No forecast - forecasts for the near-normal category do not have skill and are therefore not shown

Forecasts are probabilistic

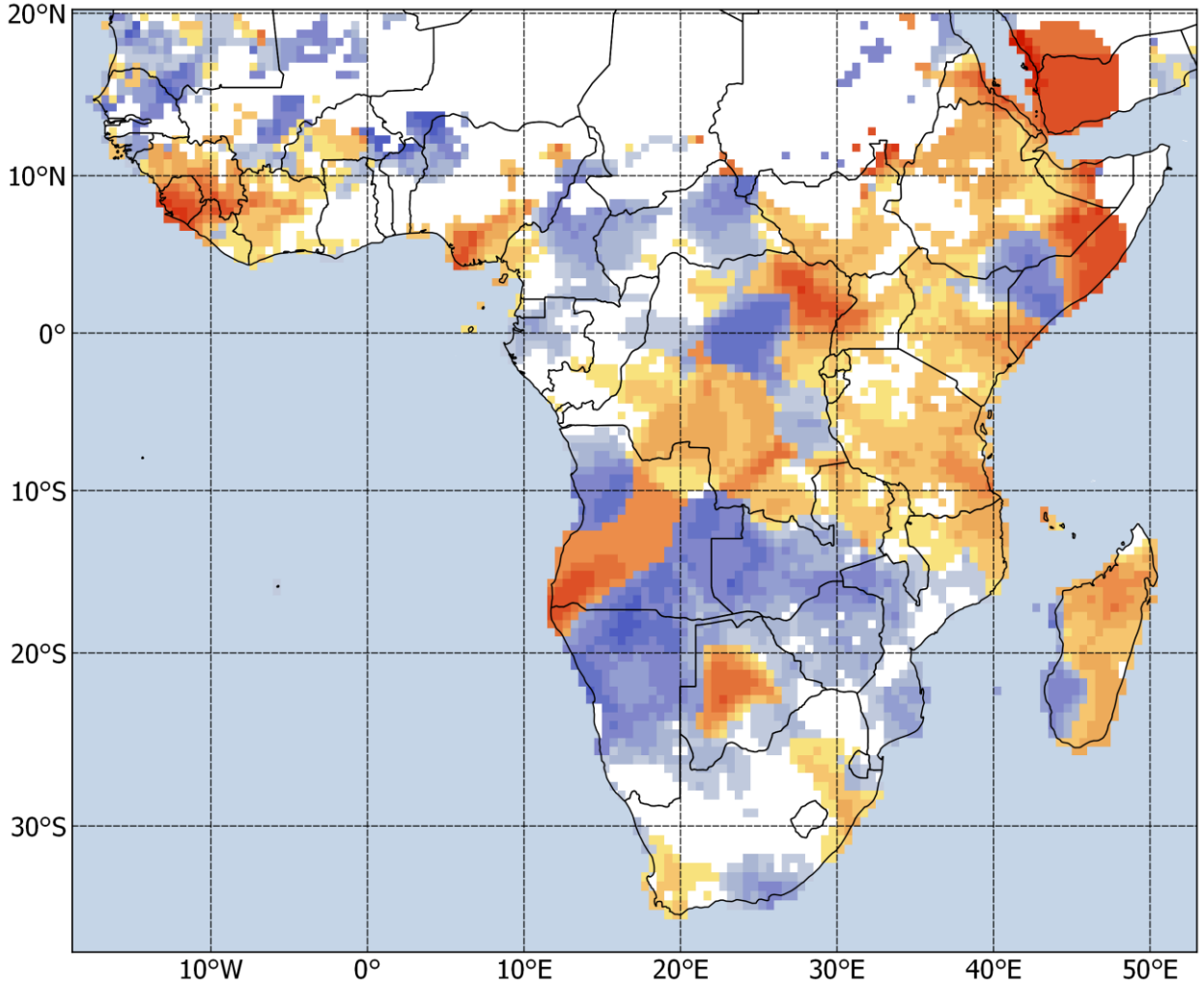
Probabilistic forecasts can help users understand risks and opportunities (forewarned is forearmed) in order to make more informed decisions.

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

DJF 2024/25 Rainfall; ICs: Dec



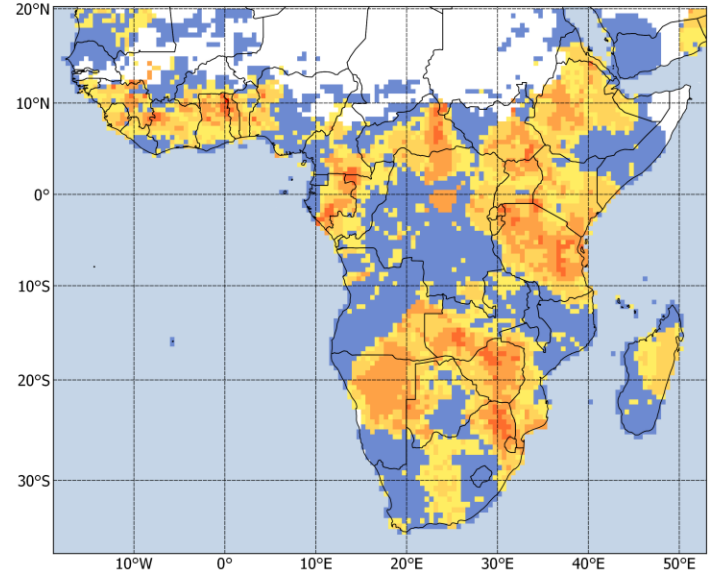
Legend

Rainfall Prob

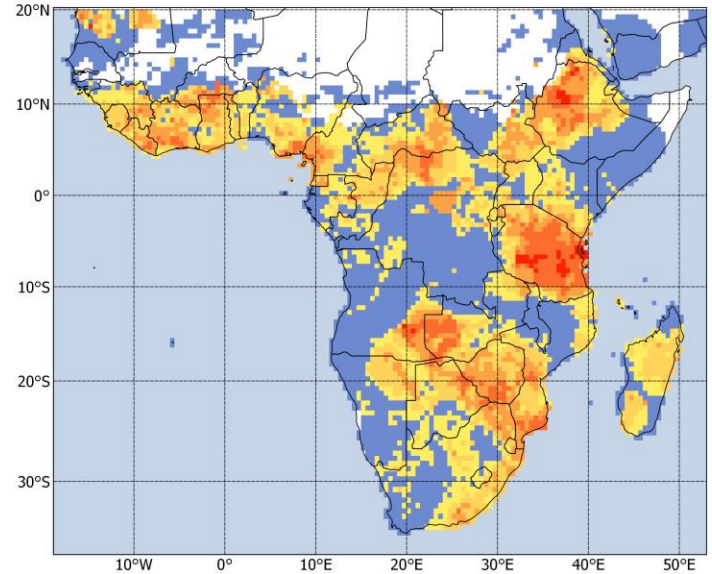
>75	
70-75	
65-70	
60-65	
55-60	Above
50-55	Normal
45-50	
40-45	
35-40	
35-40	
40-45	
45-50	
50-55	Below
55-60	Normal
60-65	
65-70	
70-75	
>75	

No forecast

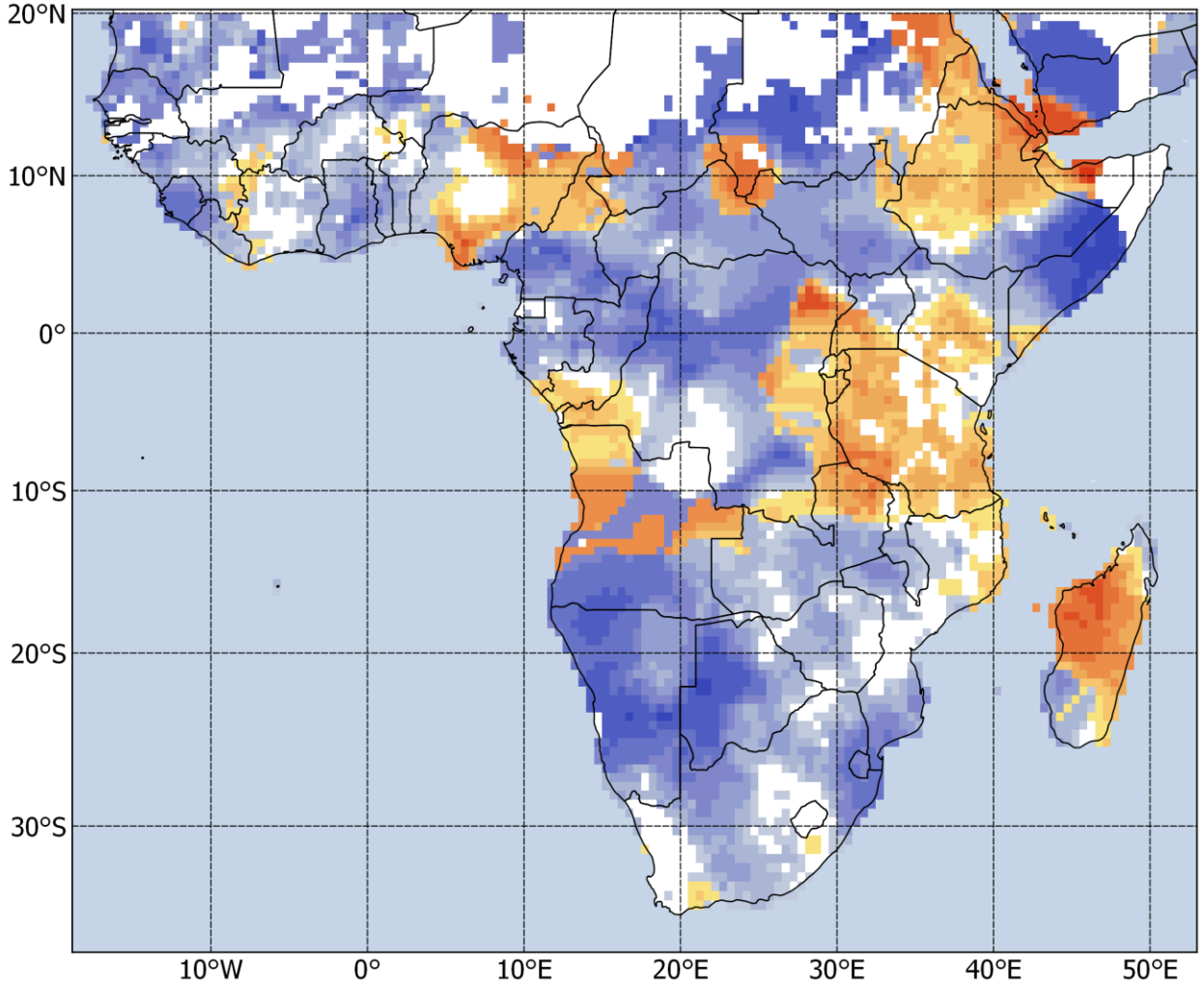
ROC Area (Above-Normal): DJF Rainfall



ROC Area (Below-Normal): DJF Rainfall



JFM 2025 Rainfall; ICs: Dec



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	
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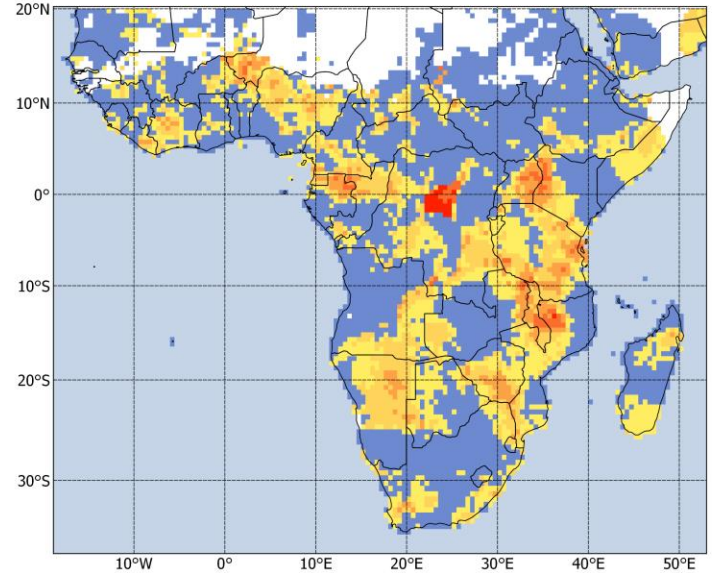
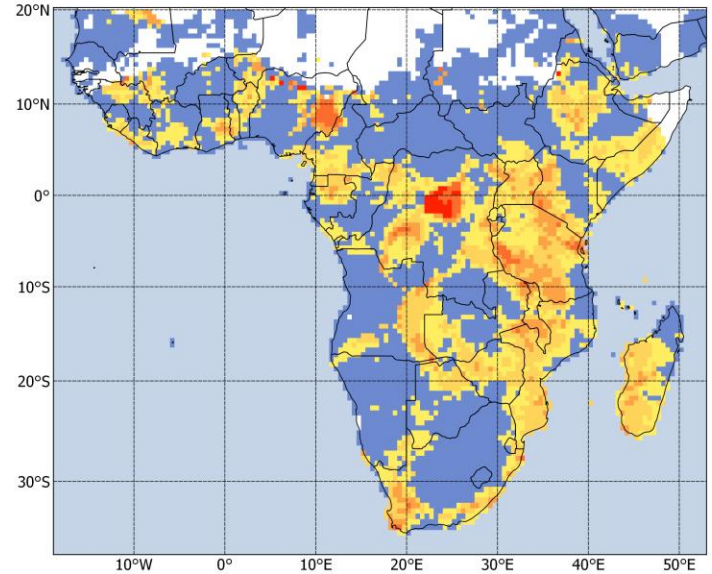
55-60	Normal
60-65	
65-70	
70-75	
>75	

No forecast

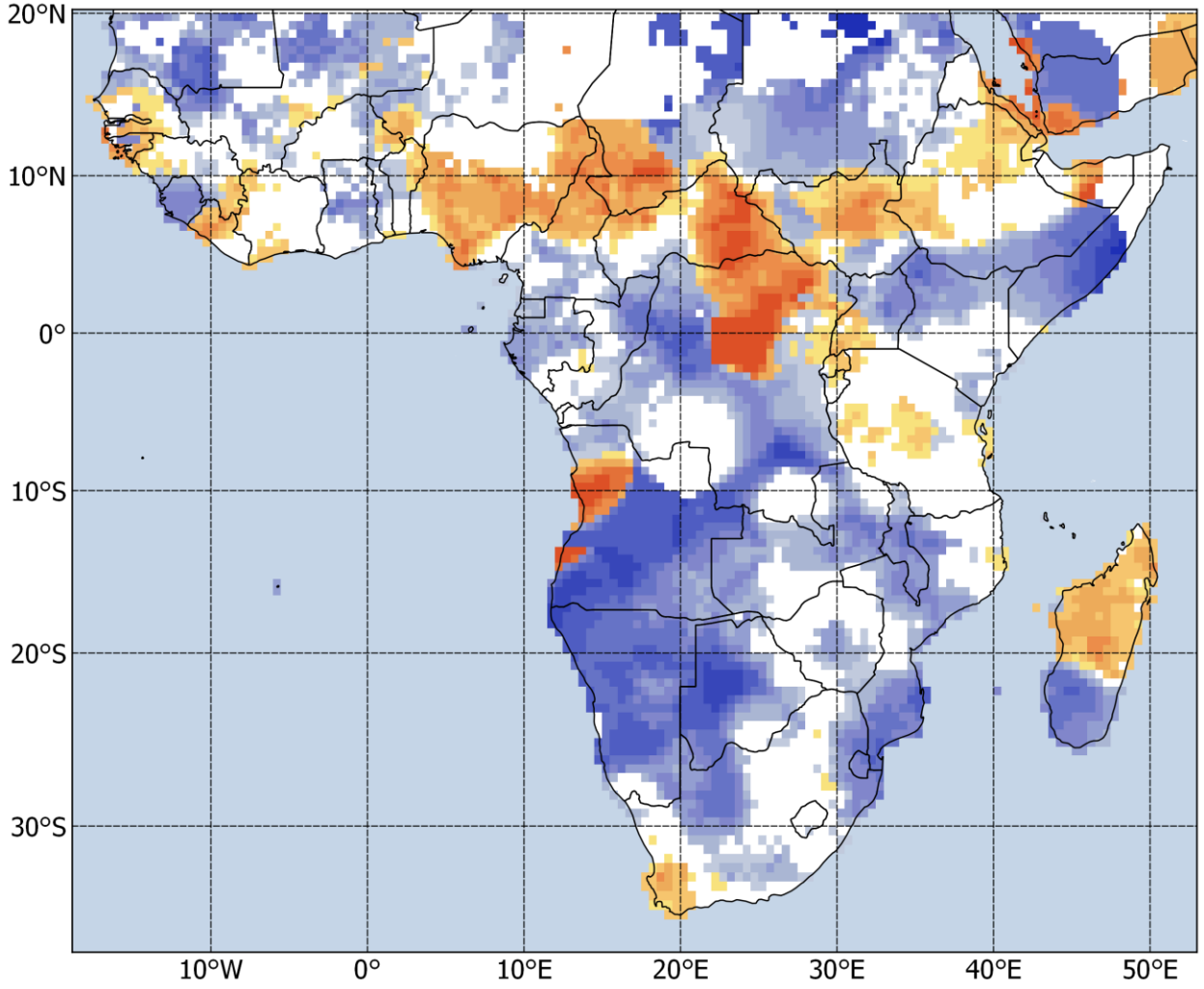
ROC Area (Above-Normal): JFM Rainfall



ROC Area (Below-Normal): JFM Rainfall



FMA 2025 Rainfall; ICs: Dec



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	
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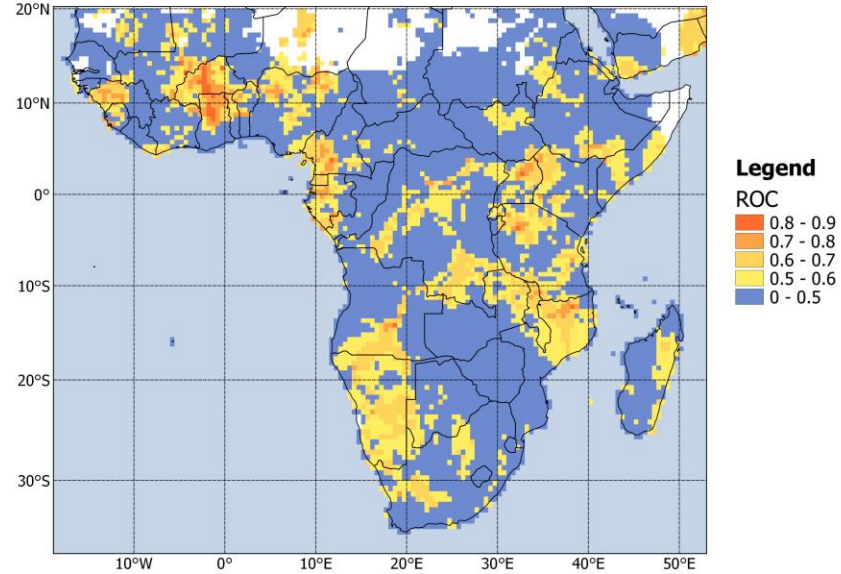
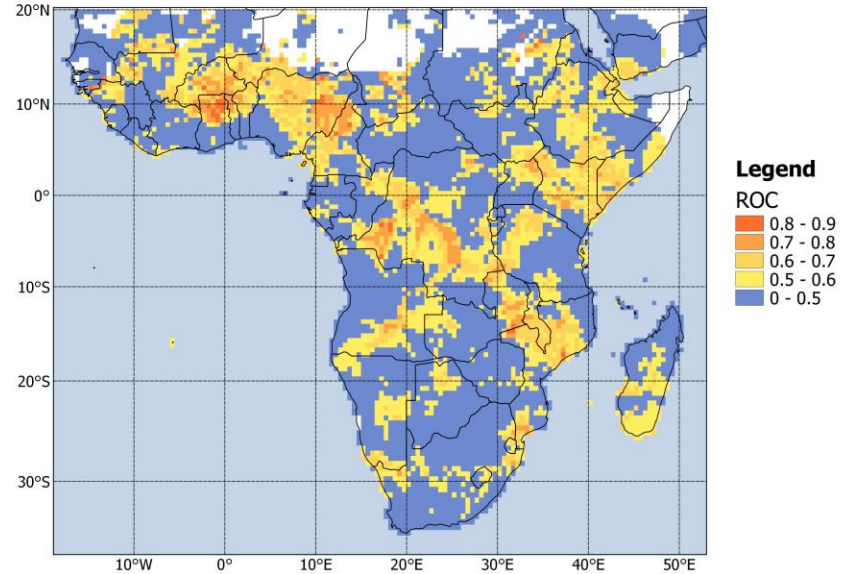
55-60	Normal
60-65	
65-70	
70-75	
>75	

No forecast

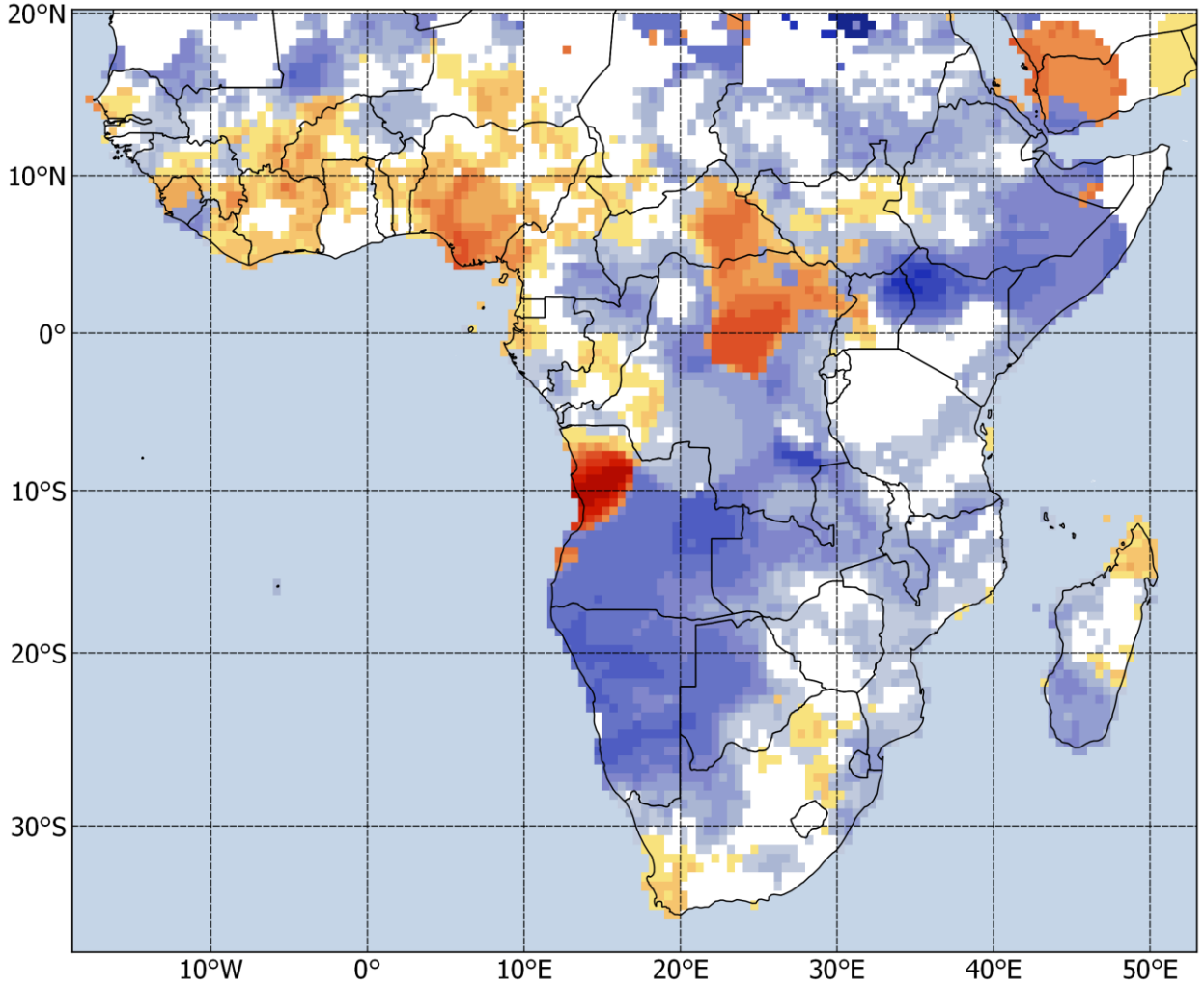
ROC Area (Above-Normal): FMA Rainfall



ROC Area (Below-Normal): FMA Rainfall



MAM 2025 Rainfall; ICs: Dec



Legend

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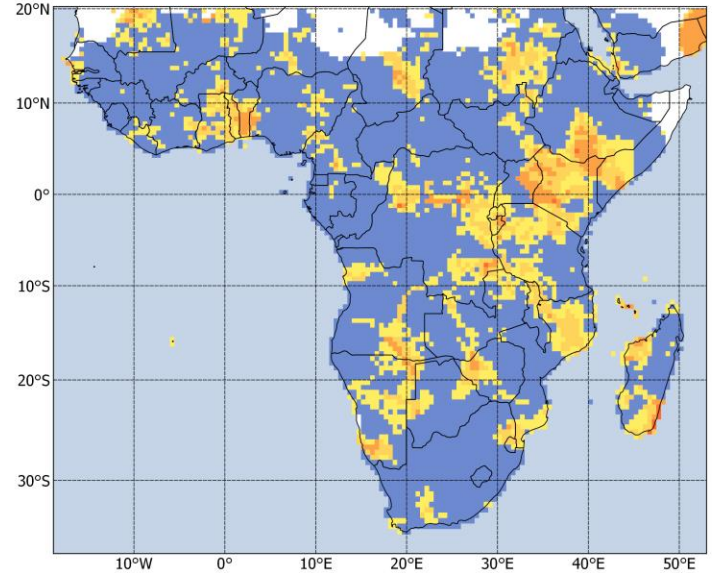
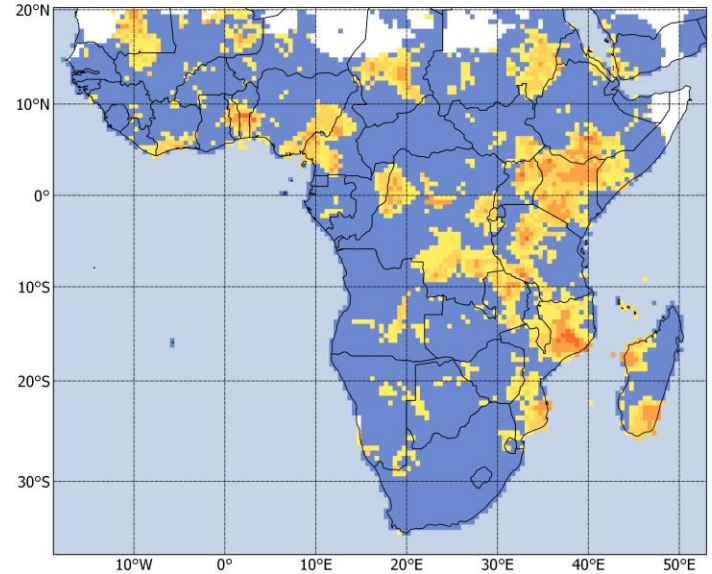
No forecast

ROC Area (Above-Normal): MAM Rainfall



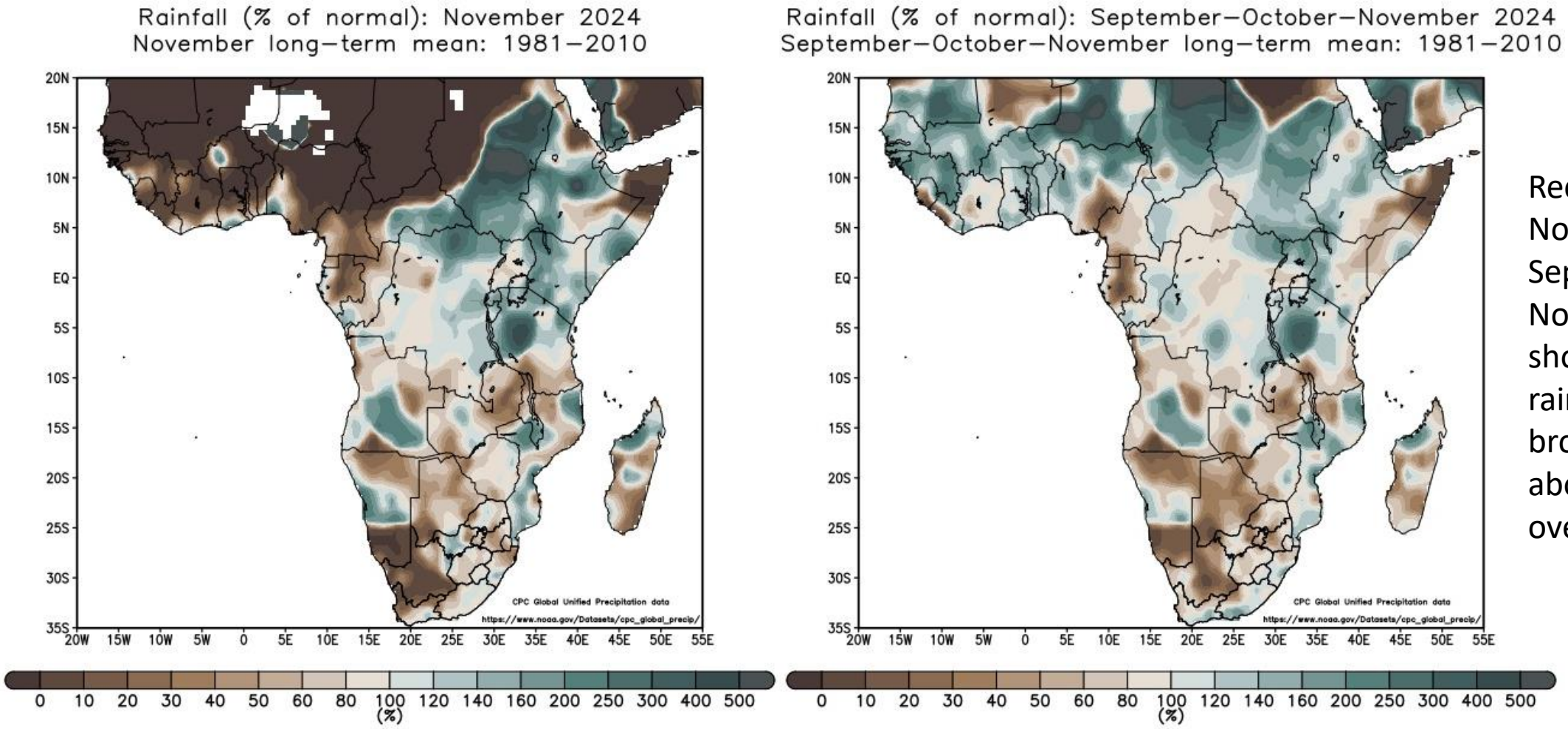
ROC Area (Below-Normal): MAM Rainfall



Round-up: Rainfall south of 15°S

- The 2024/25 La Niña event is expected to be WEAK
  - In the absence of a strong “signal” from the Pacific Ocean predicted probabilities of above-normal rainfall totals over the summer rainfall region, normally associated with La Niña events, are not very high
  - Some areas may even experience below-normal rainfall totals
- The winter rainfall region may experience drier than normal conditions for the remainder of the 2024/25 summer season

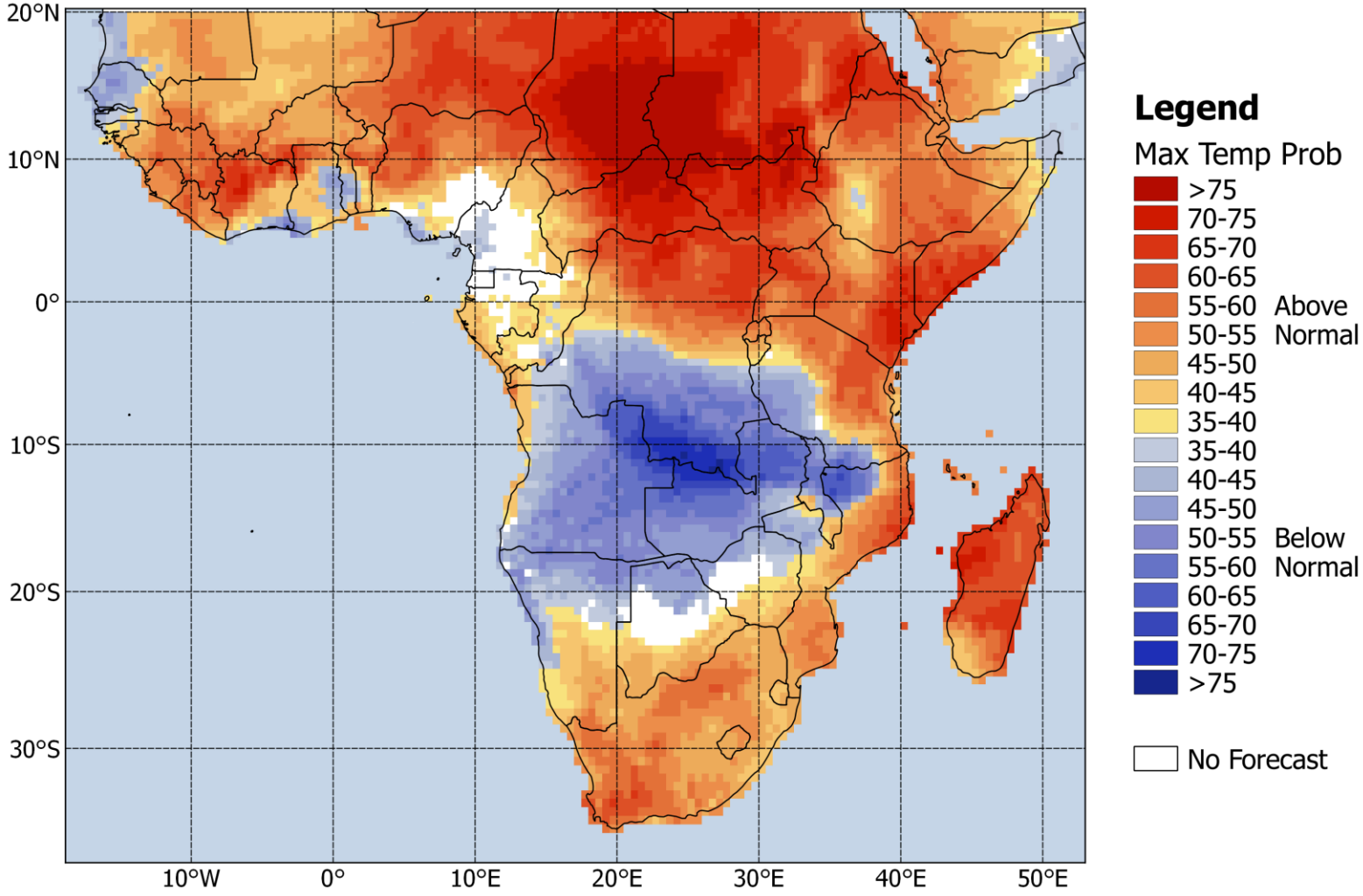
Observed Rainfall



Recorded rainfall for November and the September-October-November season show below-normal rainfall over the brown areas and above-normal rainfall over the green areas

Maps prepared by Dr. Christien Engelbrecht

DJF 2024/25 Max Temp; ICs: Dec



Legend

Max Temp Prob

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35-40	
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55-60	Normal
60-65	
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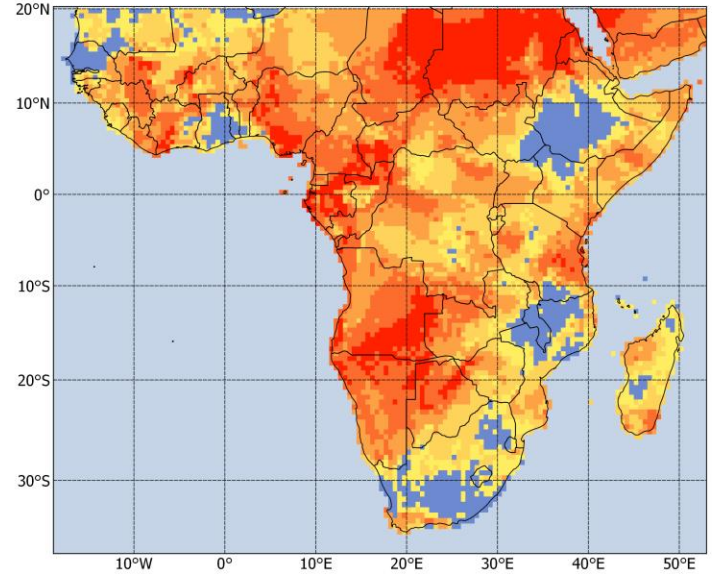
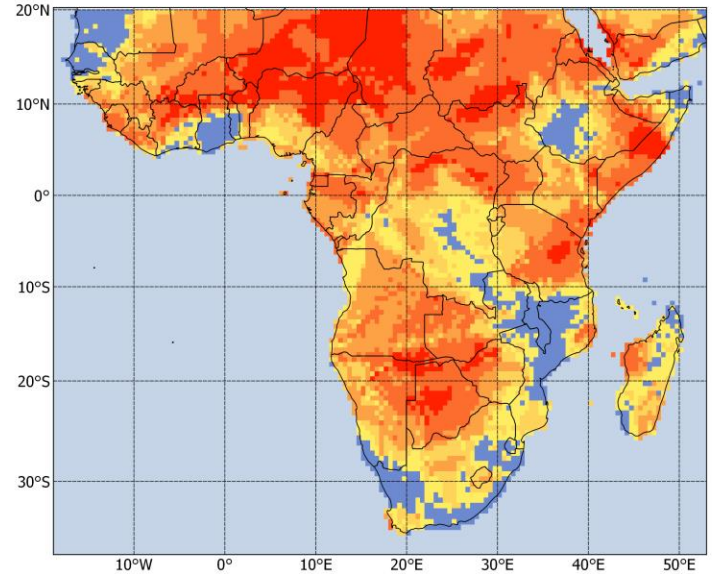
70-75	
>75	

No Forecast

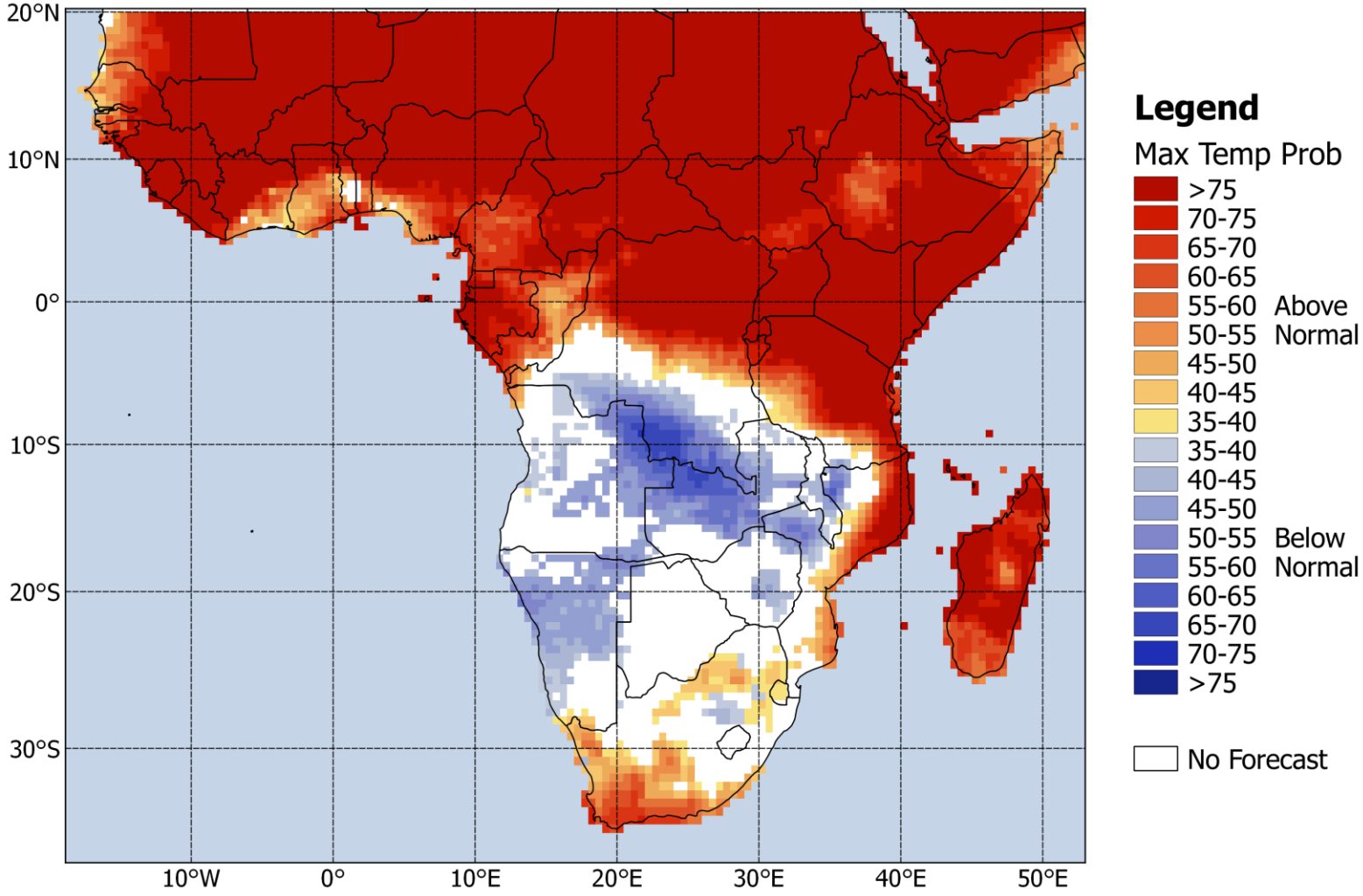
ROC Area (Above-Normal): DJF Max Temp



ROC Area (Below-Normal): DJF Max Temp



JFM 2025 Max Temp; ICs: Dec



Legend

Max Temp Prob

- >75
- 70-75
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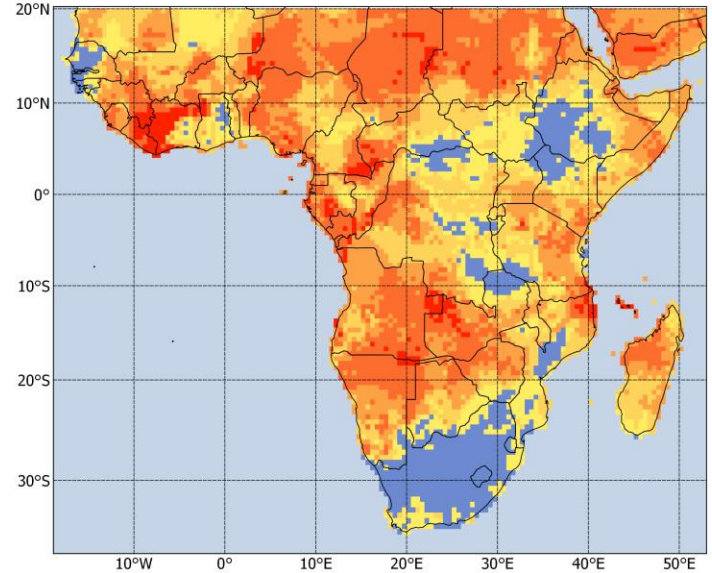
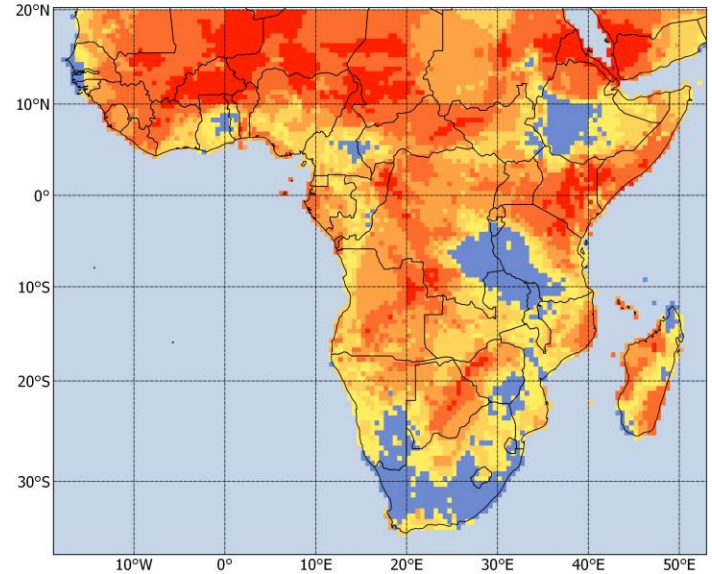
- 35-40
- 35-40
- 40-45
- 45-50
- 50-55 Below
- 55-60 Normal
- 60-65
- 65-70
- 70-75
- >75

No Forecast

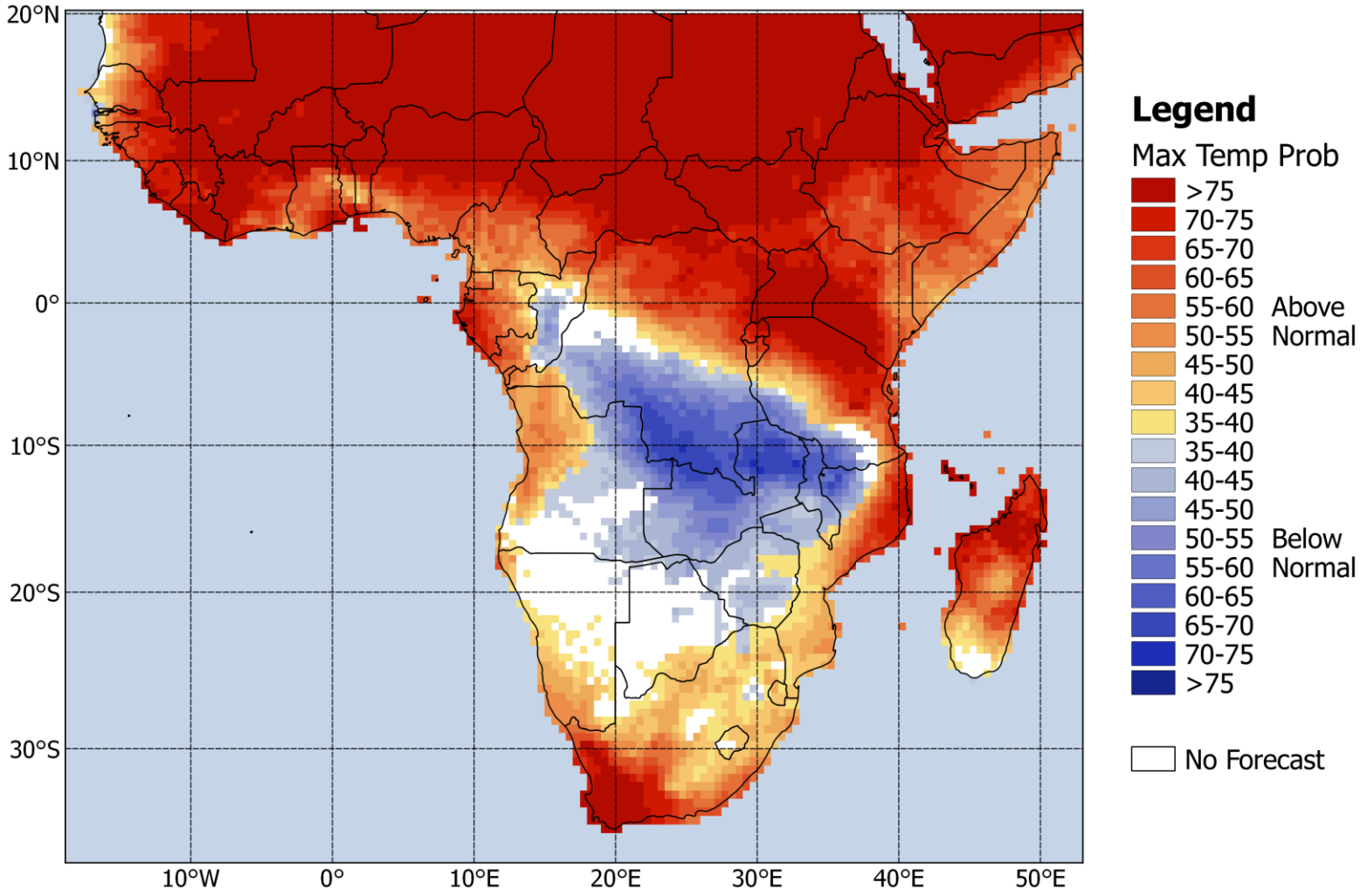
ROC Area (Above-Normal): JFM Max Temp



ROC Area (Below-Normal): JFM Max Temp



FMA 2025 Max Temp; ICs: Dec



Legend

Max Temp Prob

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- 35-40
- 35-40
- 40-45
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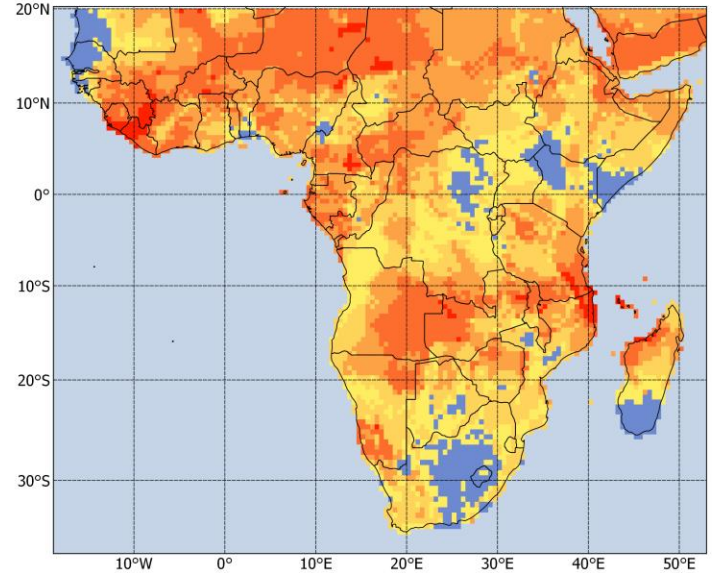
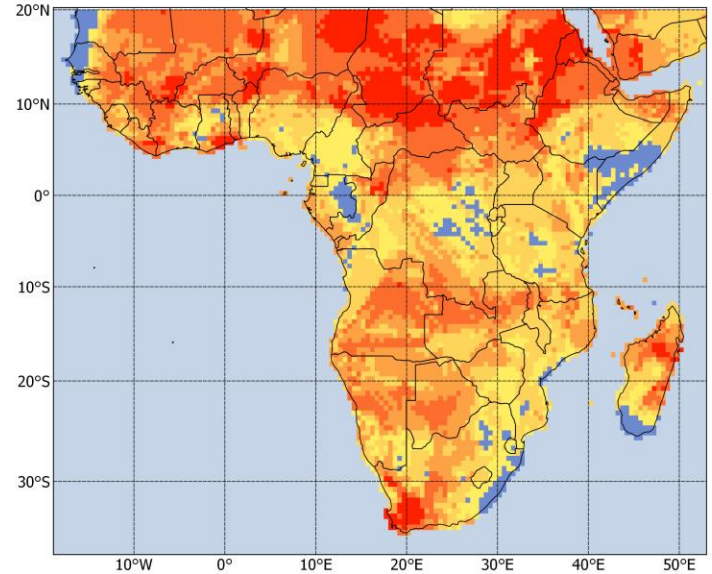
- 55-60 Normal
- 60-65
- 65-70
- 70-75
- >75

No Forecast

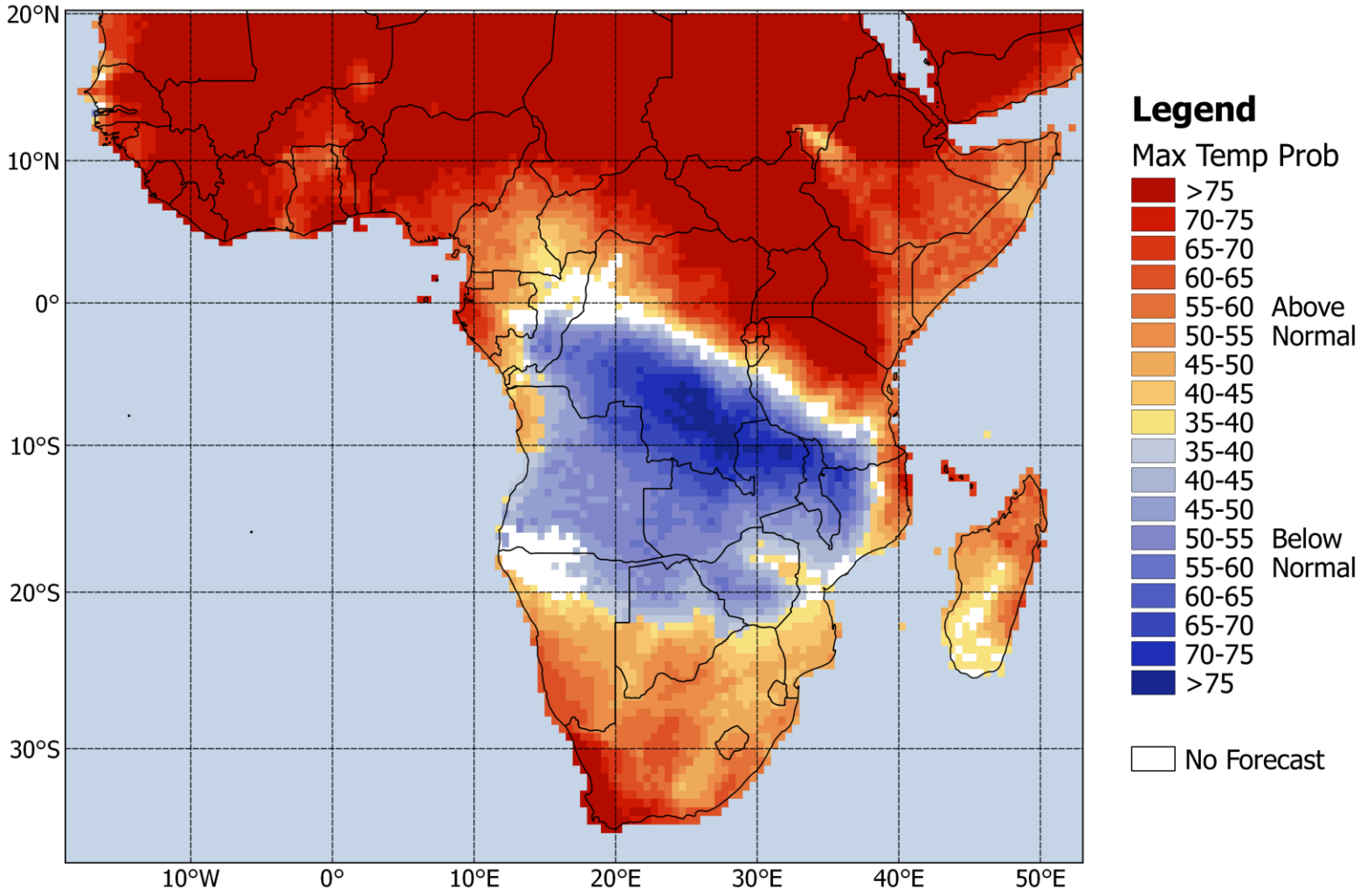
ROC Area (Above-Normal): FMA Max Temp



ROC Area (Below-Normal): FMA Max Temp



MAM 2025 Max Temp; ICs: Dec



Legend

Max Temp Prob

>75	
70-75	
65-70	
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55-60	Above
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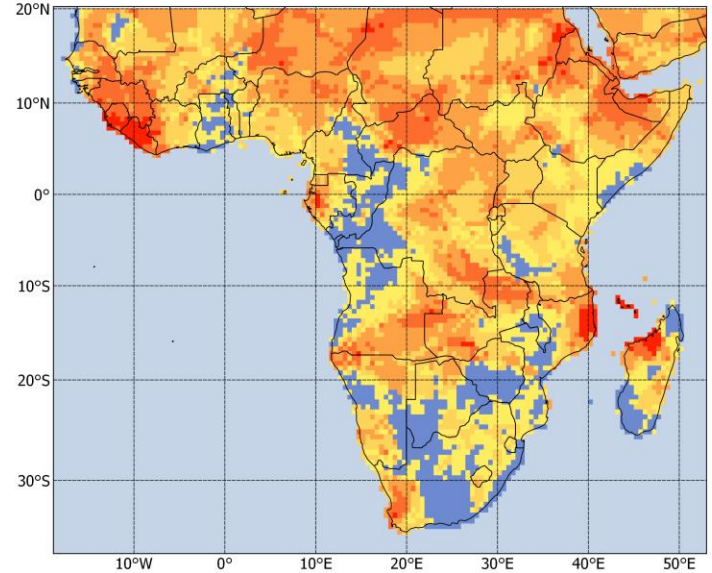
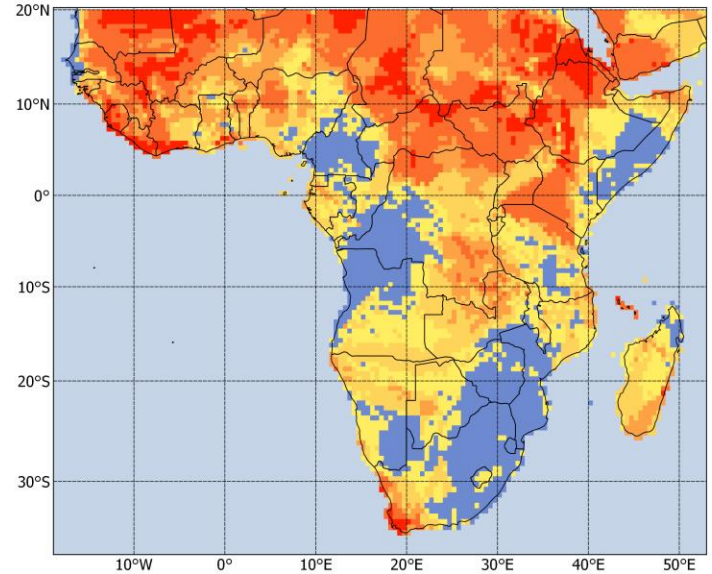
45-50	
40-45	
35-40	
35-40	
40-45	
45-50	
50-55	Below
55-60	Normal
60-65	
65-70	
70-75	
>75	

No Forecast

ROC Area (Above-Normal): MAM Max Temp



ROC Area (Below-Normal): MAM Max Temp



Round-up: South of 15°S Max Temp

- Below-normal maximum temperatures over parts of the region are predicted
- Above-normal maximum temperatures are predicted further south, expanding northwards during the second half of summer going into autumn

Tailored Forecasts

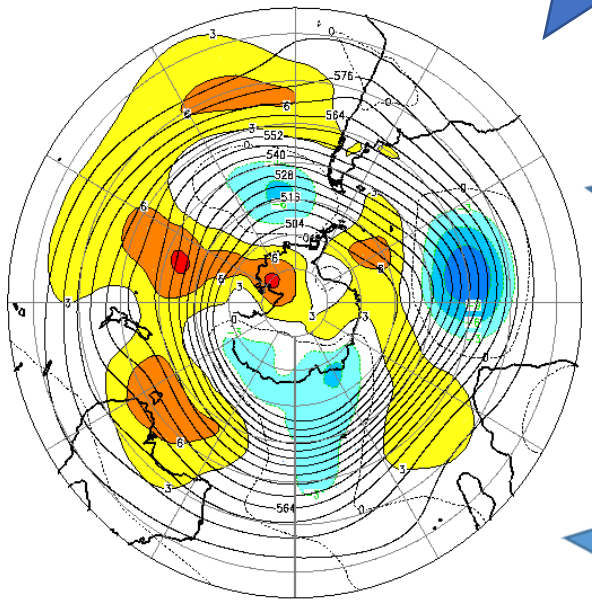
Translating forecasts into indices on a range of relevant space and time scales that can inform regional decision-making. The following forecasts are shown to indicate the potential of seasonal forecasting for real-life applications

1. **Bapsfontein end-of-season-yield three-category probabilistic forecast for 2025**
2. **Probabilistic three-category rainfall forecast for the farm of Robbie Kingsley for Dec-Jan-Feb 2024/25**
3. **Probability of exceedance Dec-Jan-Feb 2024/25 inflow forecast for Lake Kariba, Zambia/Zimbabwe**
4. **Probabilistic rainfall forecast for Jan-Feb-Mar 2025 for the farm Buschbrunnen near Grootfontein, Namibia**

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

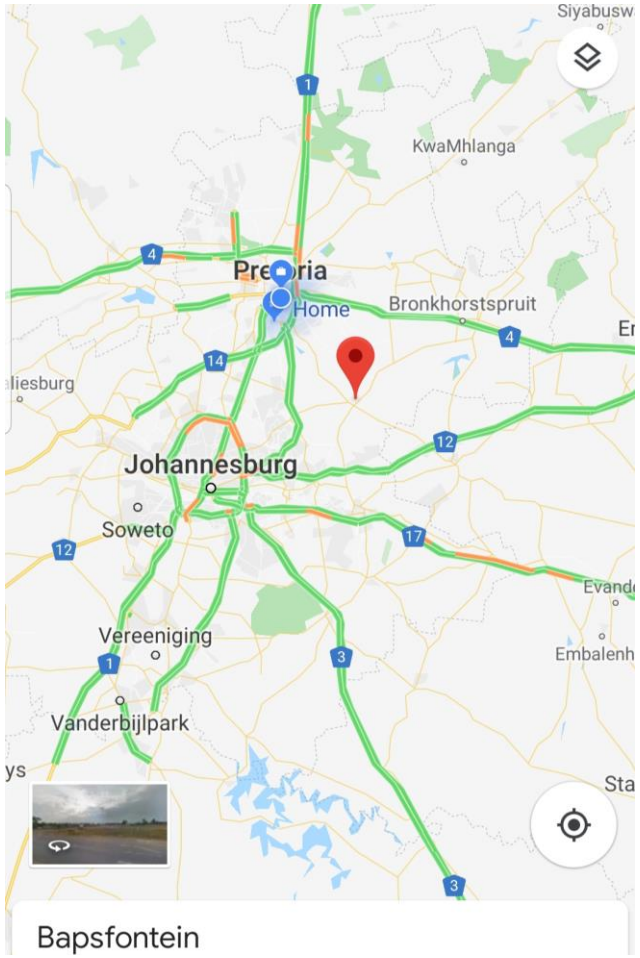
Riverflow

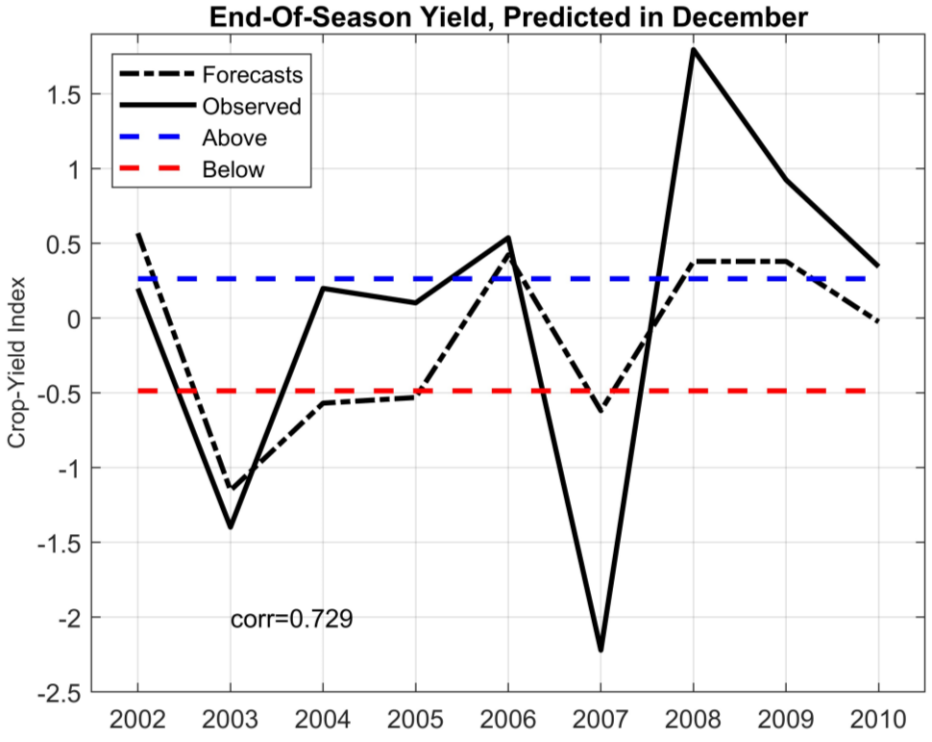
Malaria

Dry-land crop yield

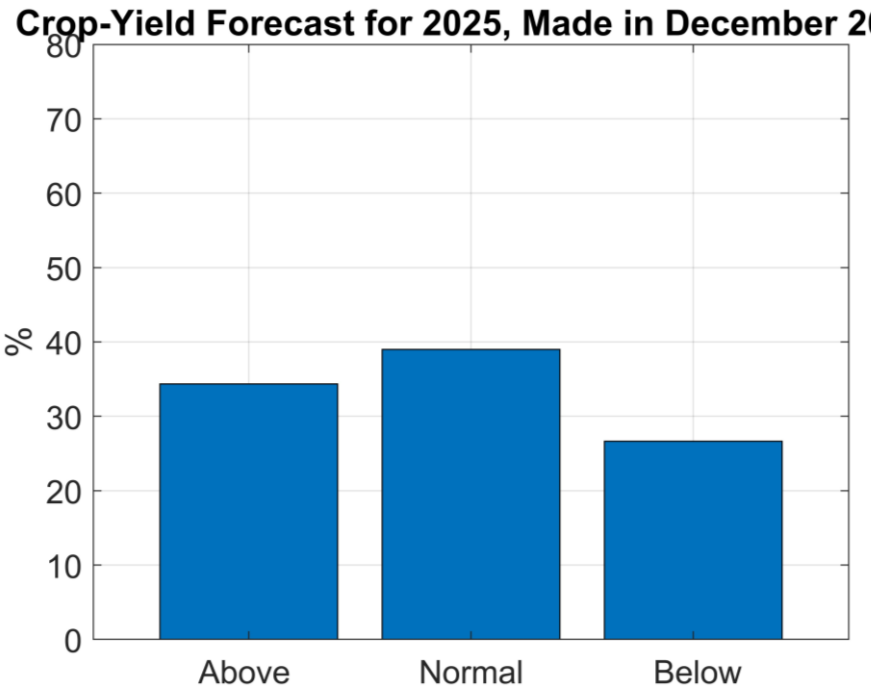
Dry-land crop-yield data and forecasts for a farm near Bapsfontein, South Africa

Landman et al. (2019)





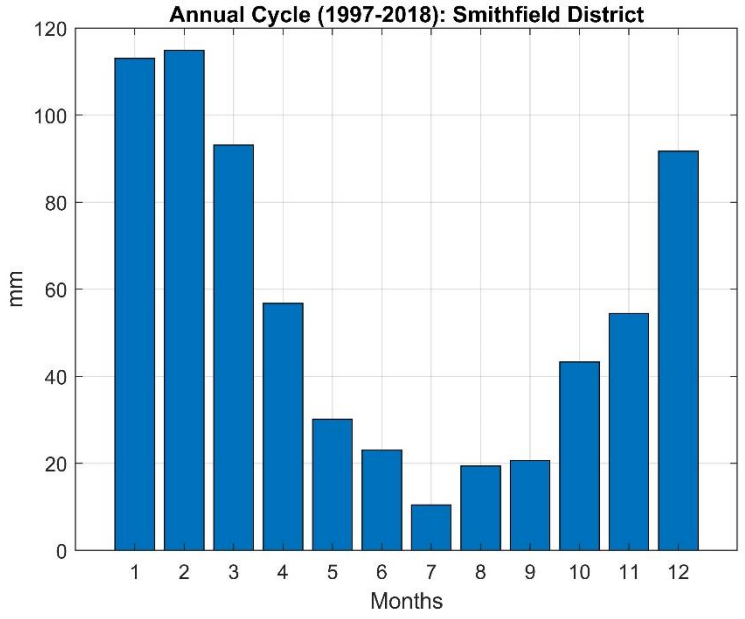
Re-forecasts for end-of-season crop yields

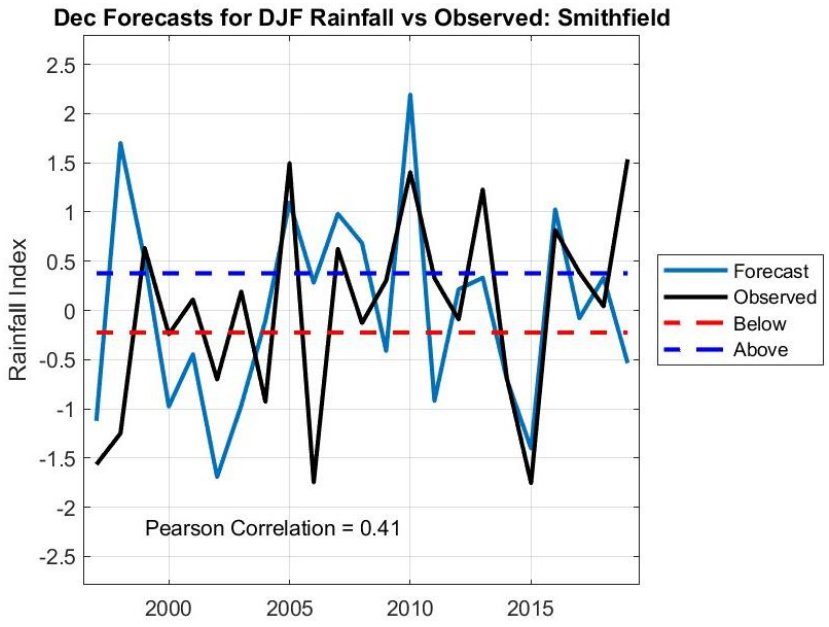


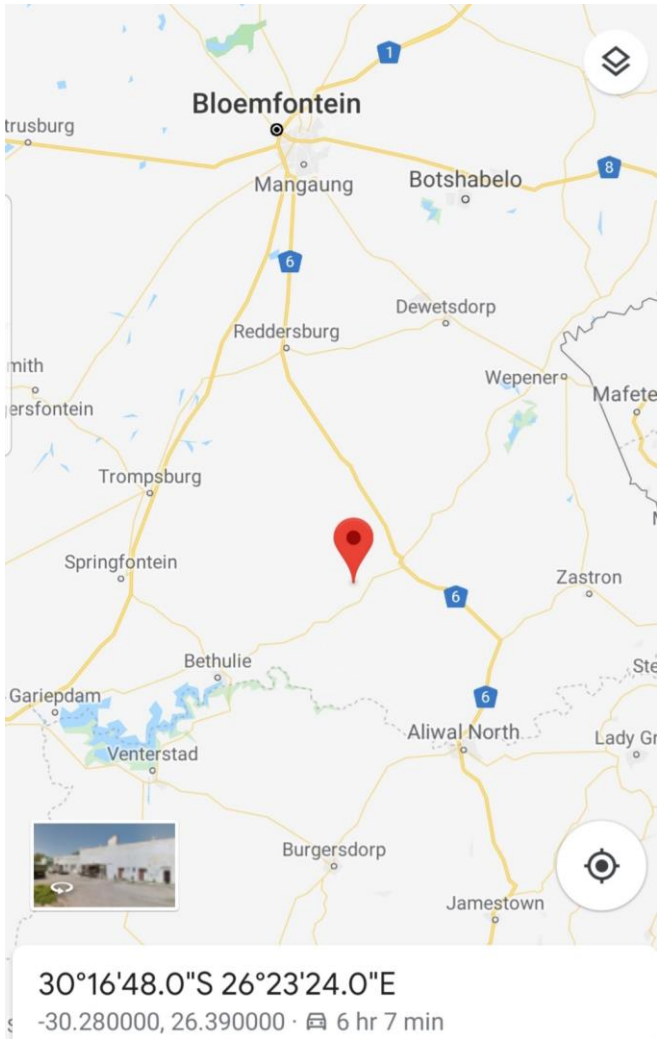
% is the probability of the respective categories to occur

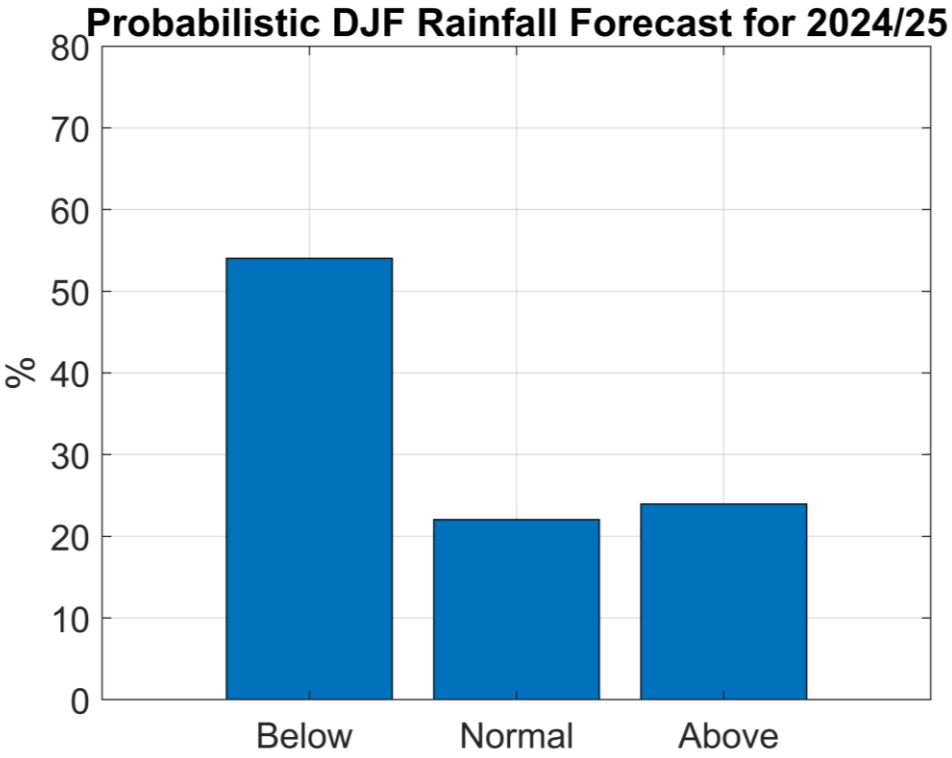
Dec-Jan-Feb 2024/25 rainfall forecast for farm in the Smithfield district (see map). Rainfall data provided by the farmer, Mr. Robbie Kingsley

Landman et al. (2020a)



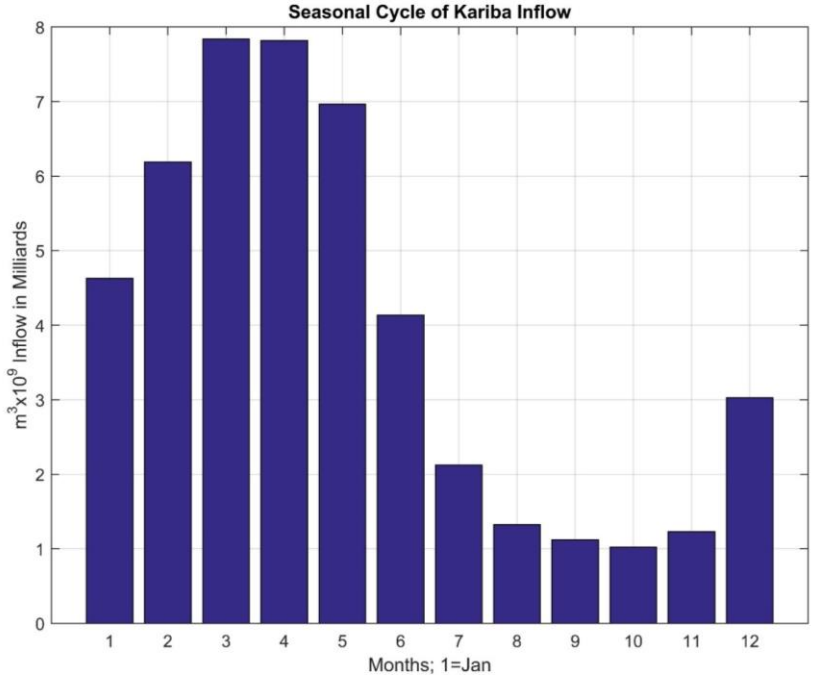




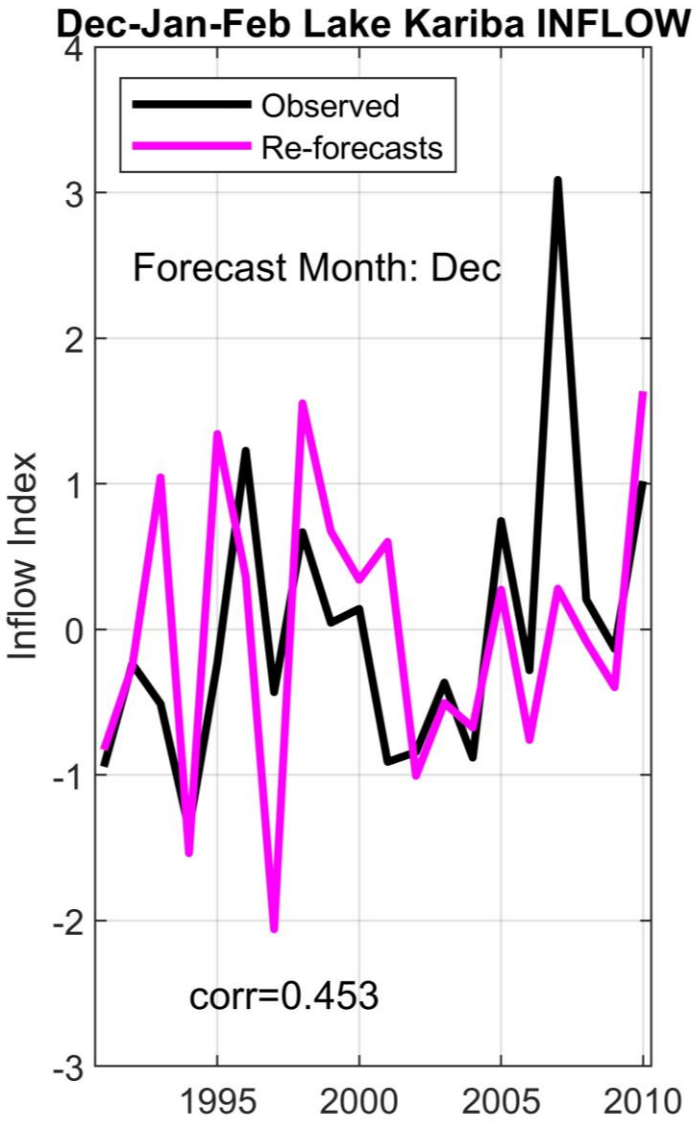


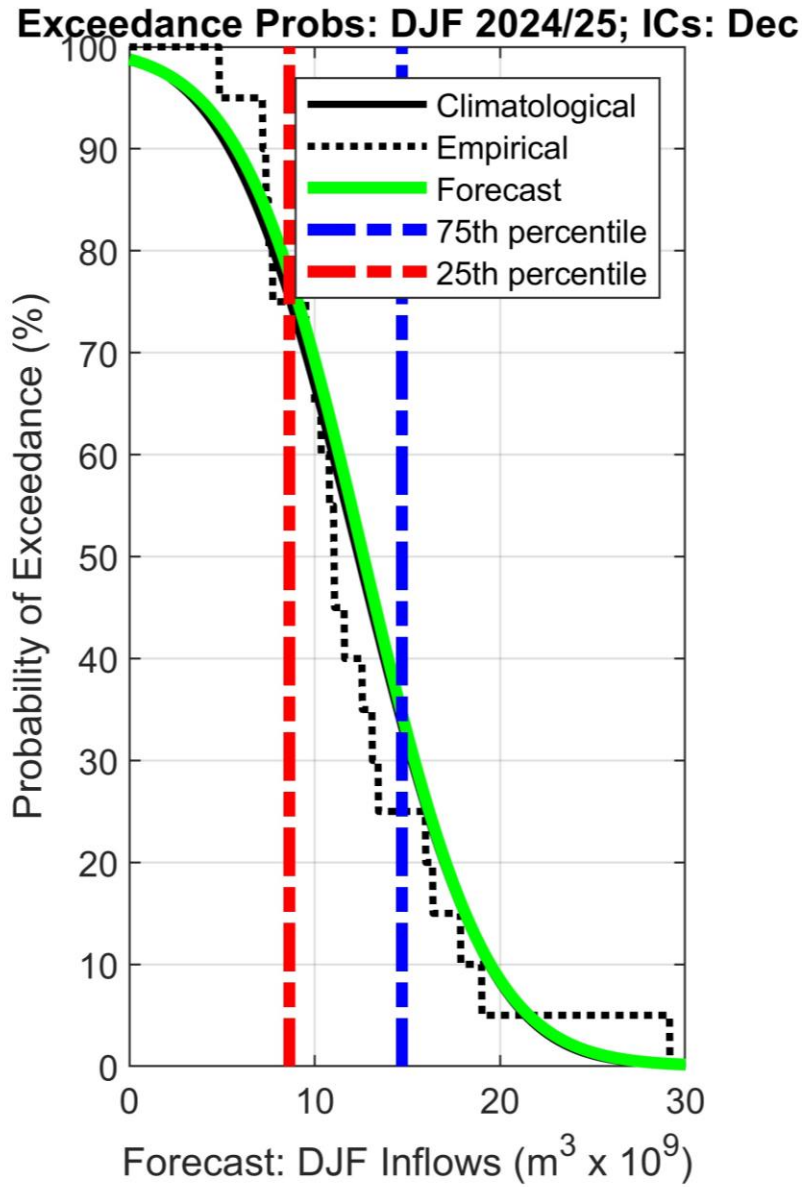
Inflow forecast for Lake Kariba: onset season of DJF

Muchuru et al. (2016)



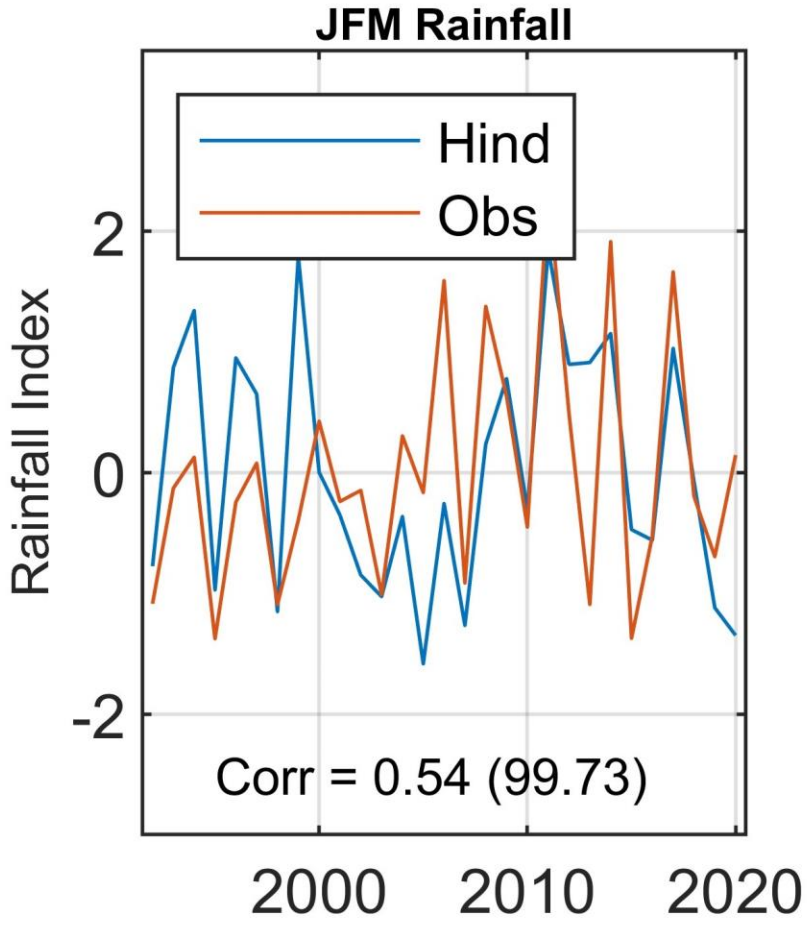
For the forecast on the far right: The black curve represents the climatological probability distribution of DJF inflows, and the green curve represents the predicted probability distribution for the coming DJF season. The vertical dashed lines represent the category thresholds. The easiest way to interpret 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.

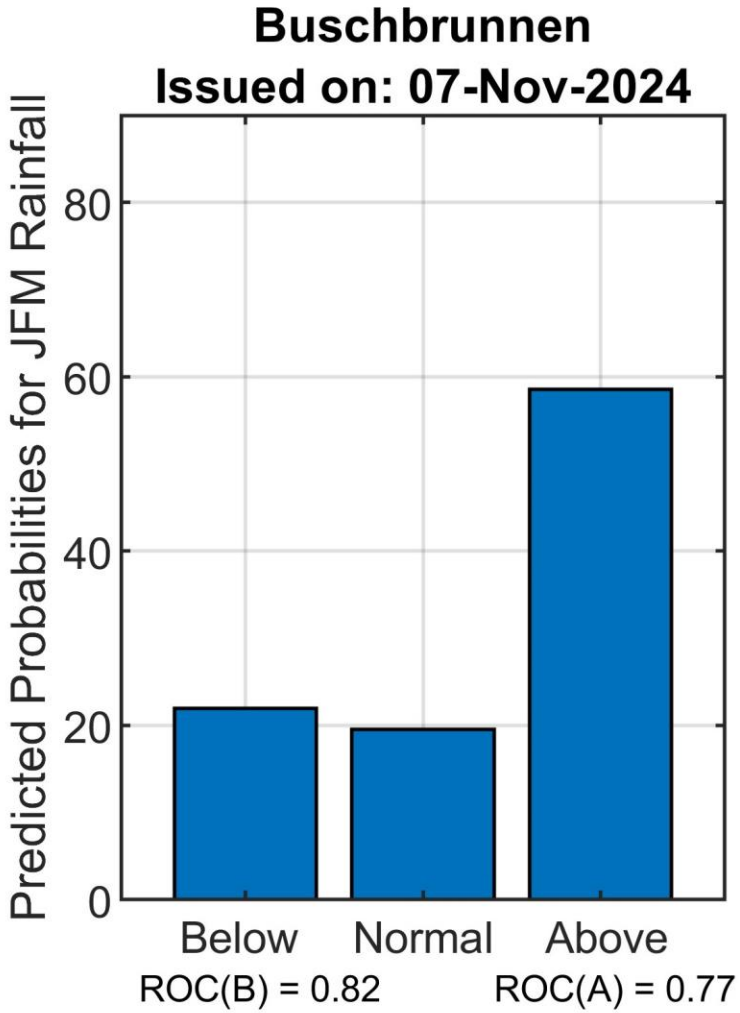


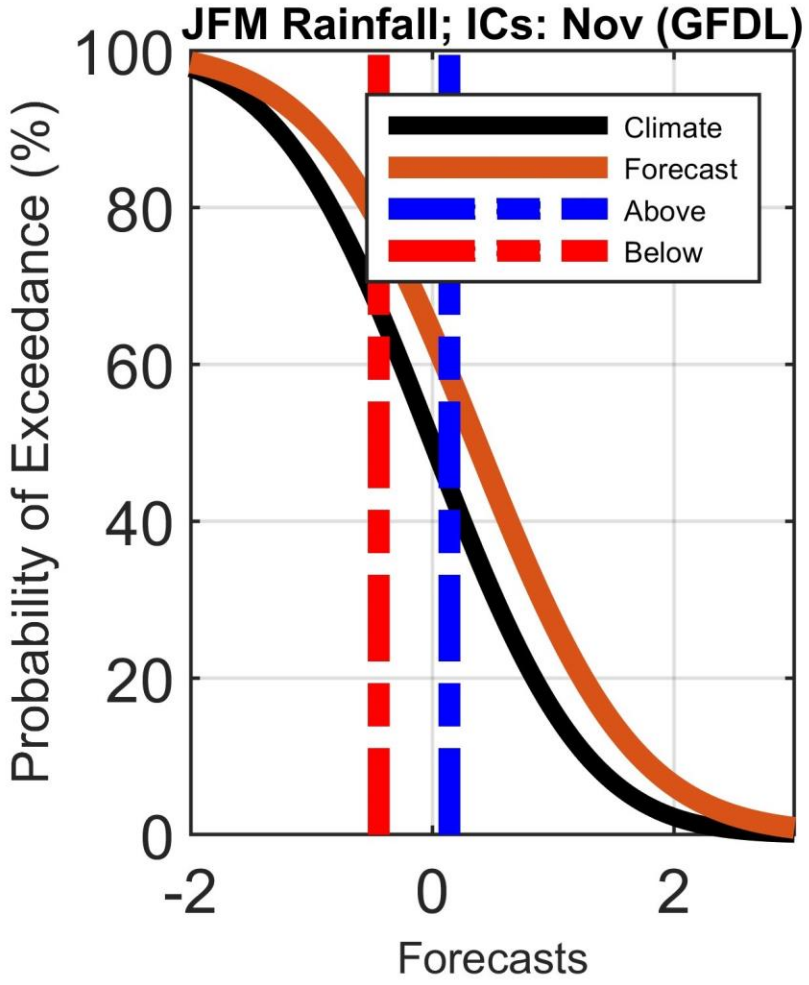


JFM rainfall forecast for the farm Buschbrunnen near Grootfontein, Namibia

Landman et al. (2016)







Round-up: Tailored products

- The tailored forecasts present a mixed outcome
  - Near-normal yield for highveld farm
  - Close to normal inflow into Lake Kariba
  - Below-normal rainfall for central interior farm
  - Above-normal rainfall for northern Namibia farm

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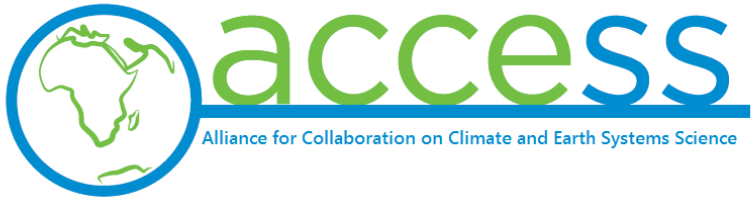
- The National Research Foundation
  - Incentive Funding for Rated Researchers (since 2017)
  - Project: Application of knowledge for the management of extreme climate events (APECX; 2022 to 2024)

- 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)

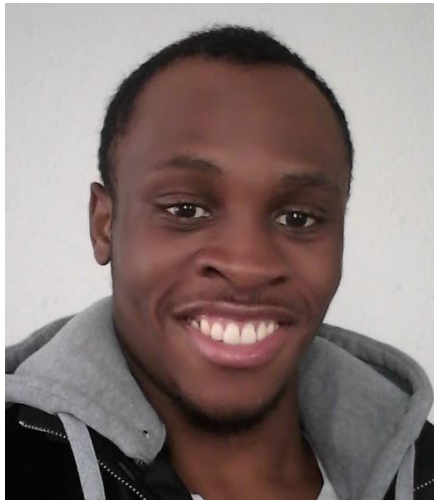


The forecast is produced by Prof Willem Landman of the University of Pretoria, South Africa, and issued on or around the 15th of each month. Please feel free to contact me at WALandman1981@gmail.com

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.