Seasonal forecasts

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Seasonal Climate Forecasts

Seasonal Forecast Worx

Latest Update: 17 May 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).

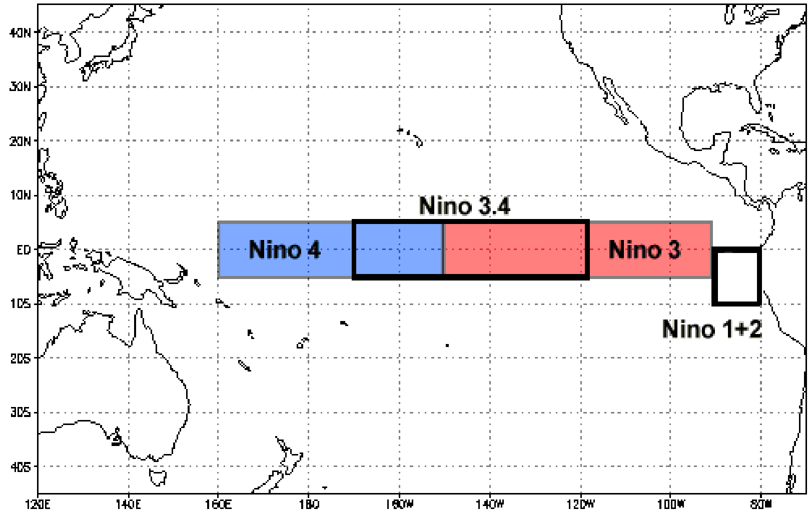
- For the official seasonal forecast for South Africa, visit the South African Weather Service website at http://www.weathersa.co.za/images/data/longrange/gfcsa/scw.pdf

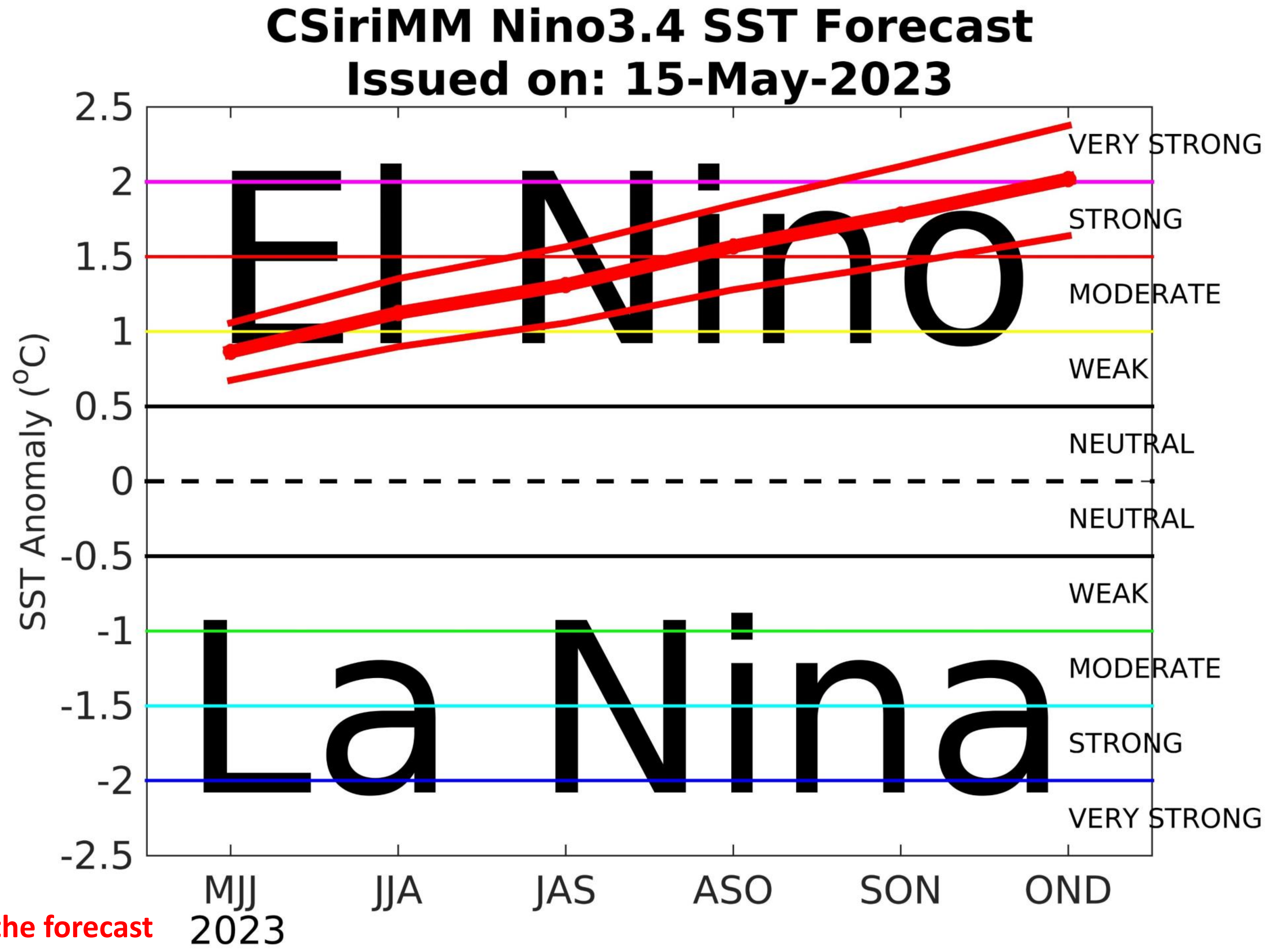
South African Weather Service

ENSO and Global SST Forecasts

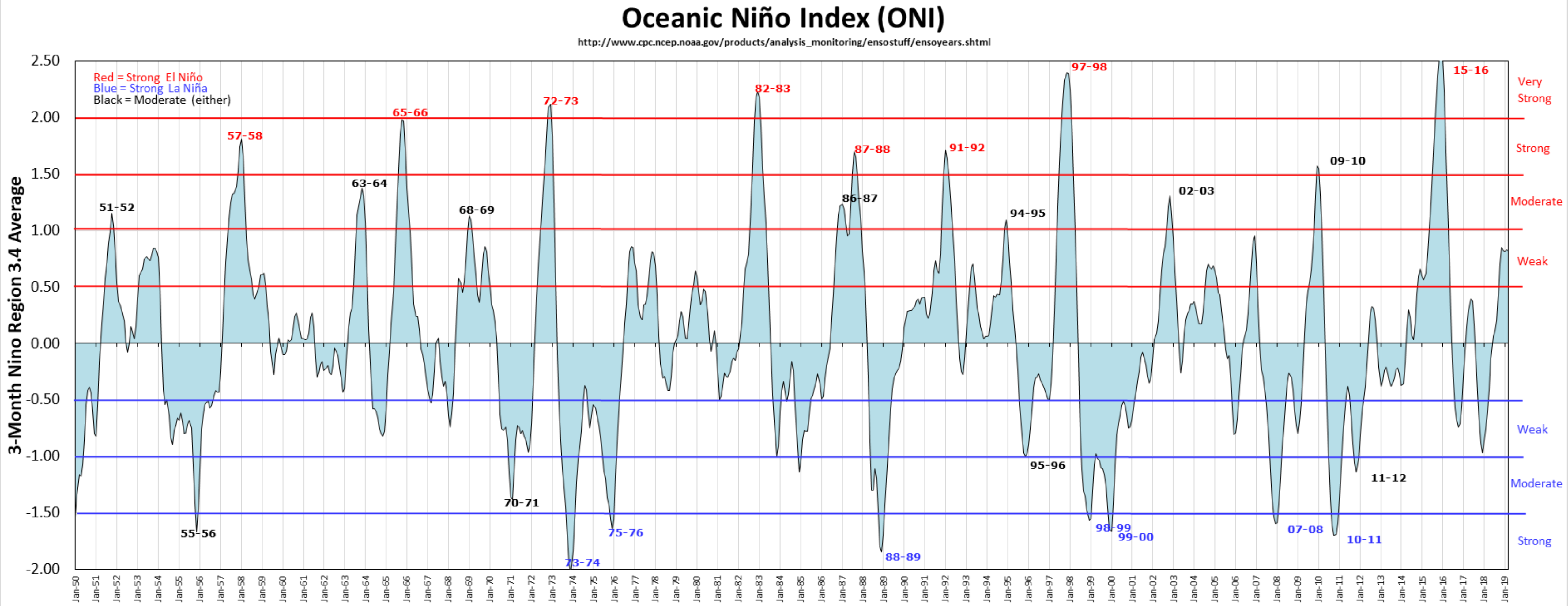
Prediction Method

- 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





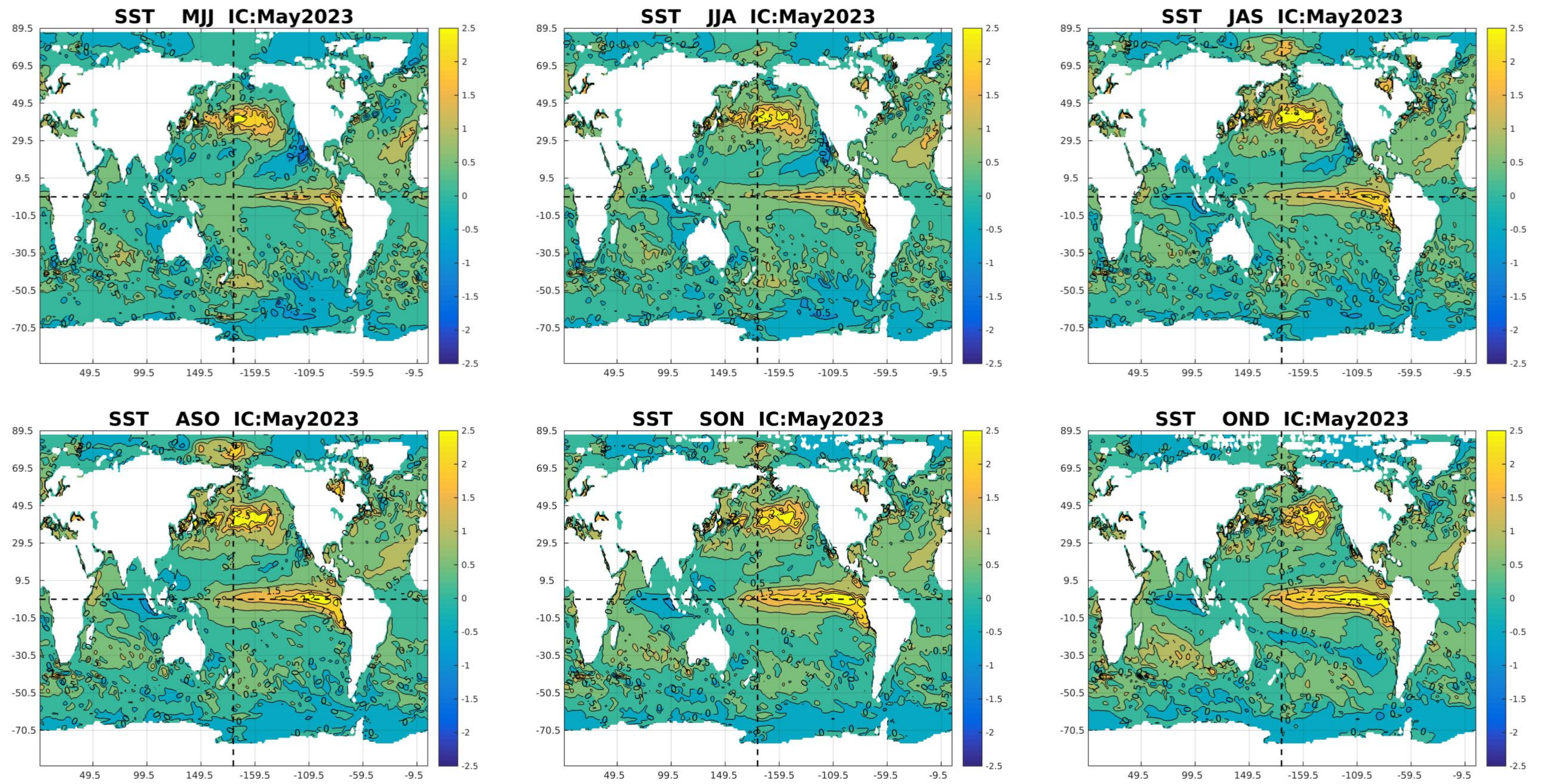
Middle red line: the forecast
Thin red lines: 25% confidence levels



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

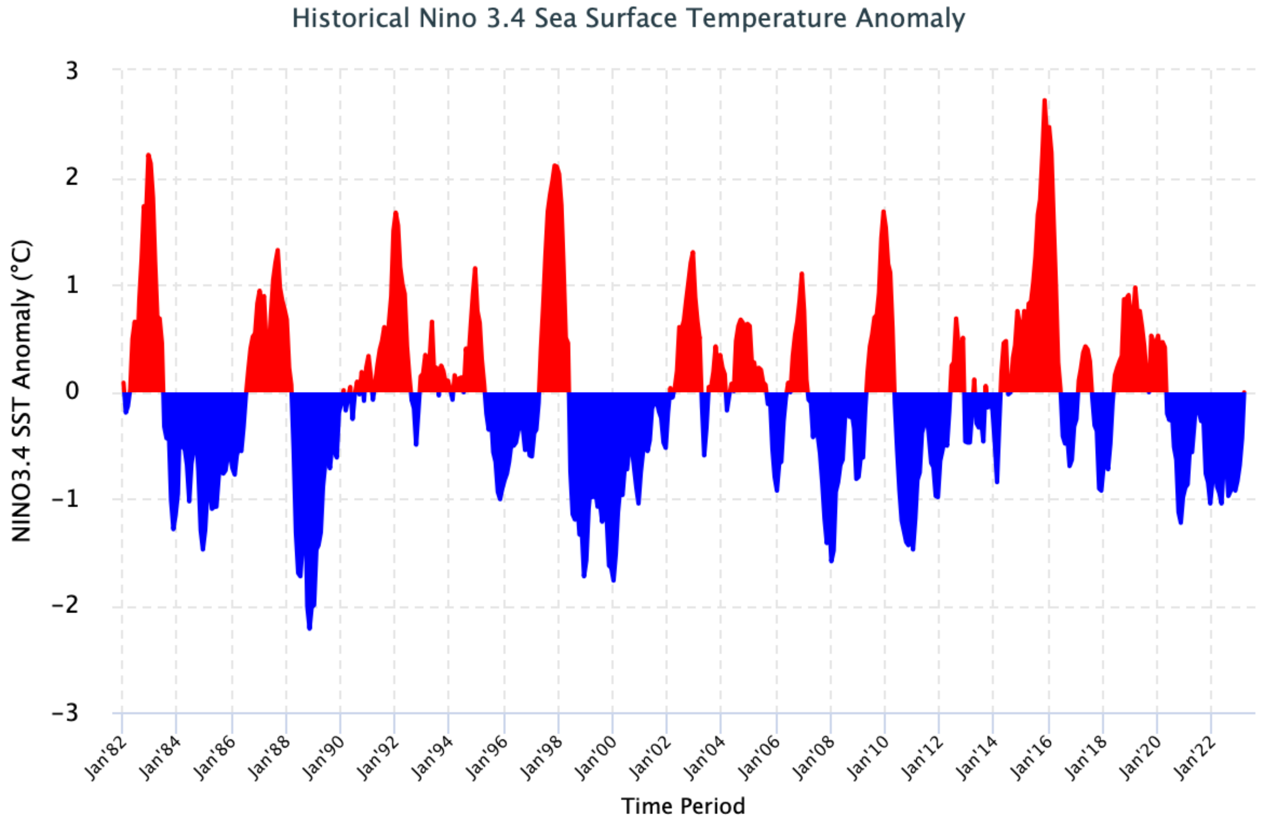
IC: the month in which the forecast was made

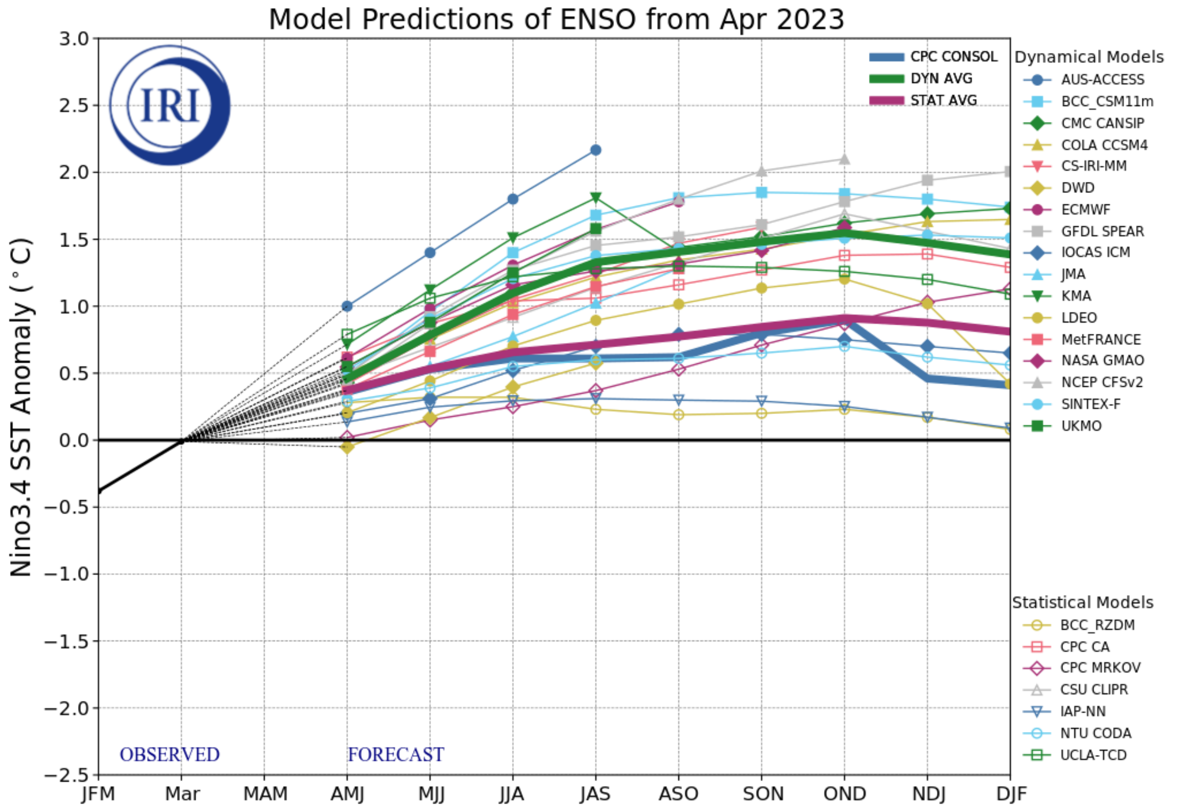
SST anomalies (in °C, where blue is cooler and orange is warmer)



Round-up: ENSO

- The UP model predicts a strong El Niño event during the Austral summer





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 interpolated to the 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 of forecast skill:
  - 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

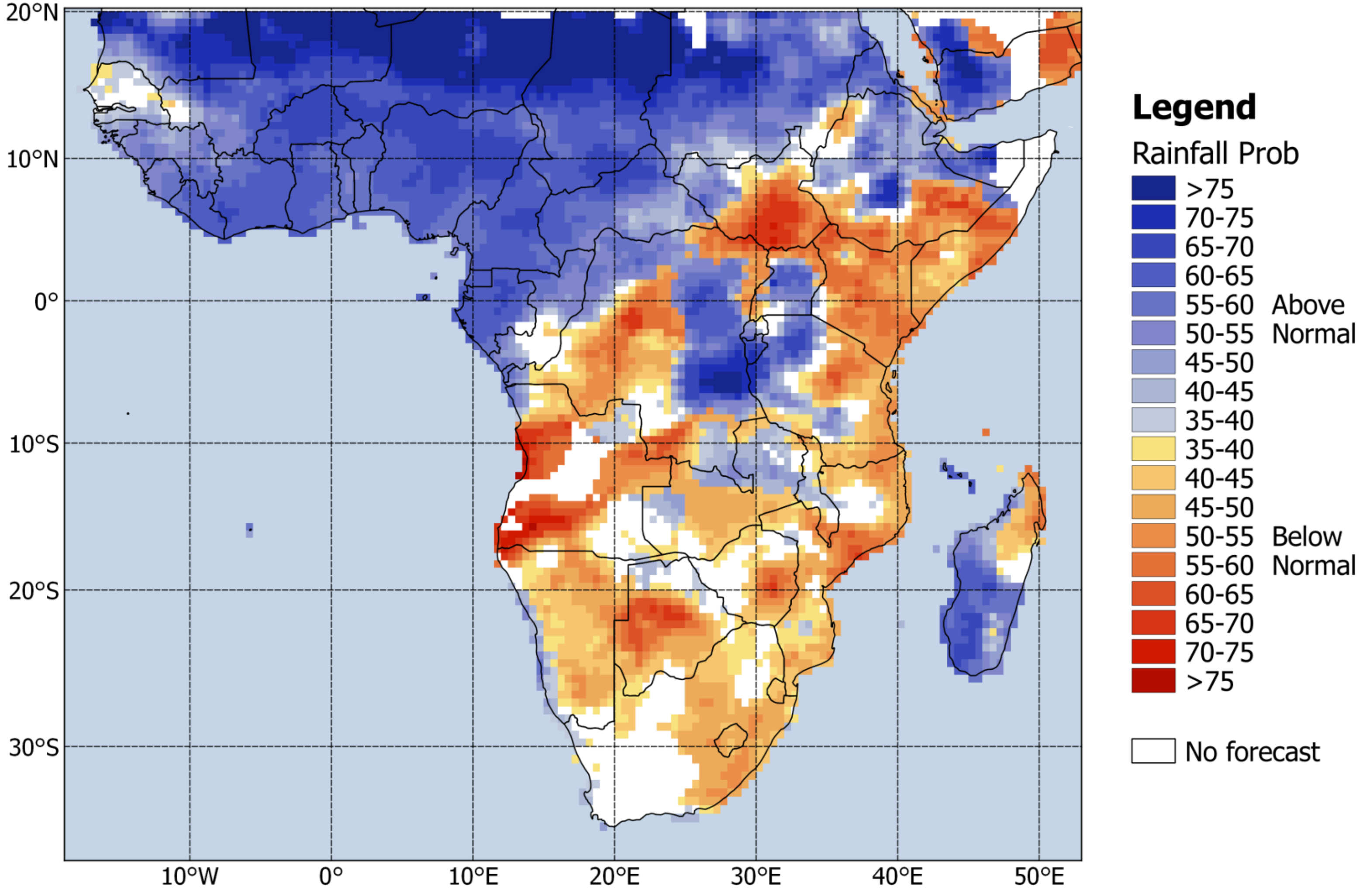
Probabilistic forecasts can help users understand risks and opportunities (forewarned is forearmed) in order to make more informed decisions.

The seasonal rainfall and maximum temperature 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 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.

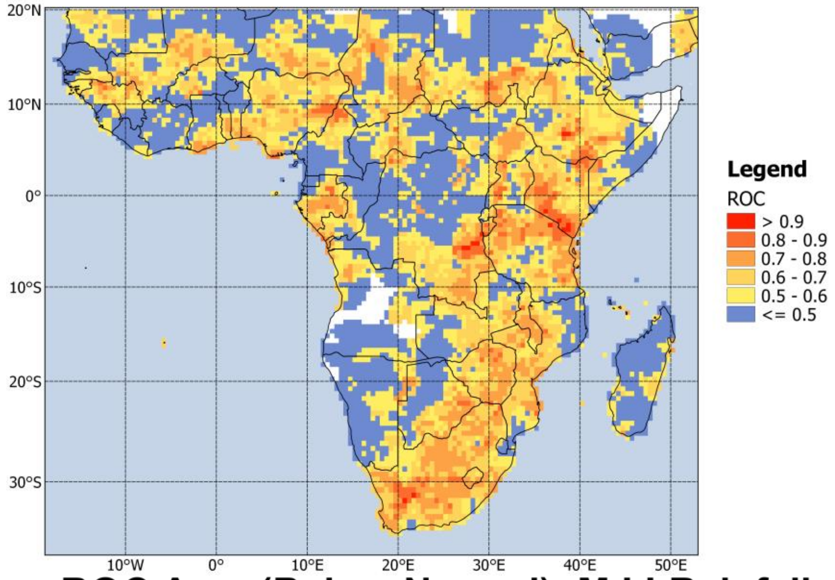
The nature of a probabilistic forecast implies that the less likely outcomes are always possible. In fact, for the probabilistic forecasts to be considered reliable, the less likely outcomes will and must occasionally occur.

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

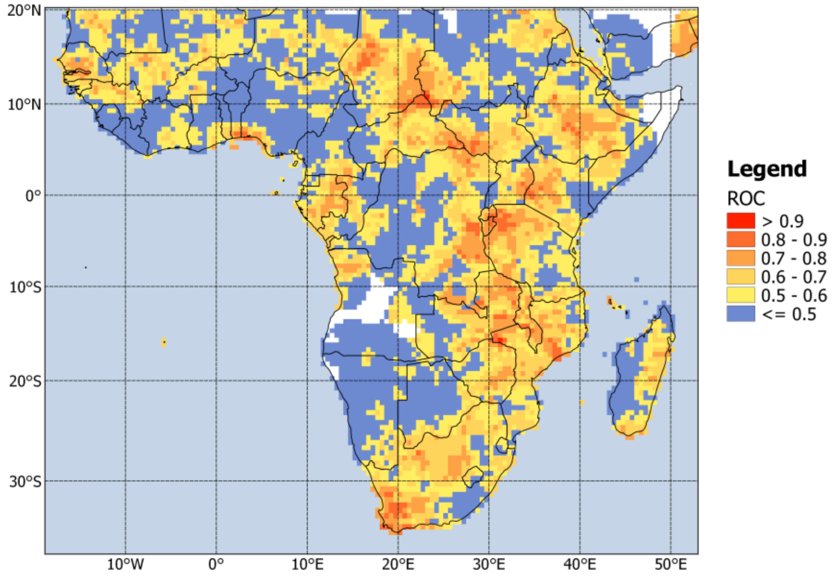
MJJ 2023 Rainfall; ICs: May



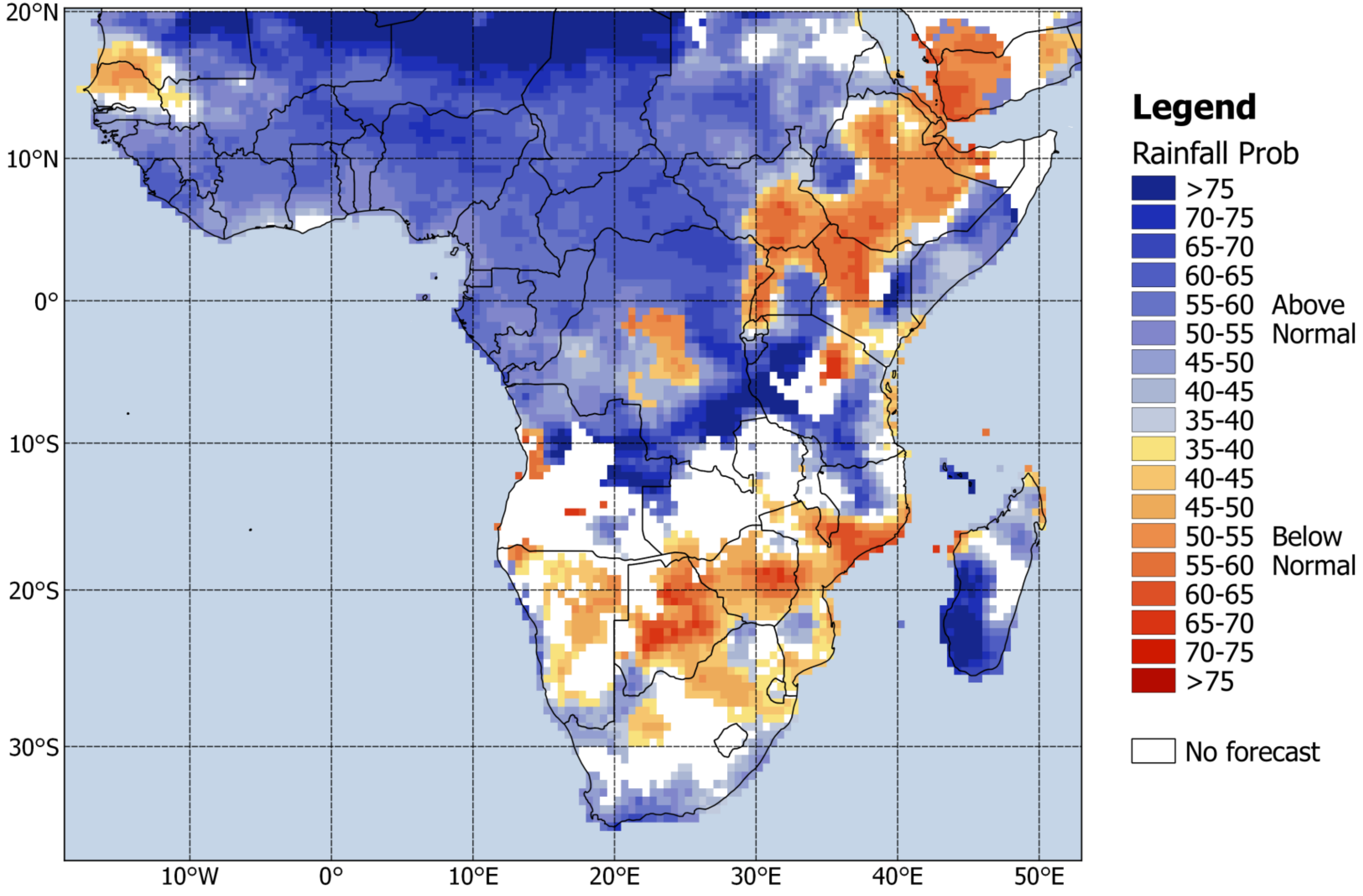
ROC Area (Above-Normal): MJJ Rainfall



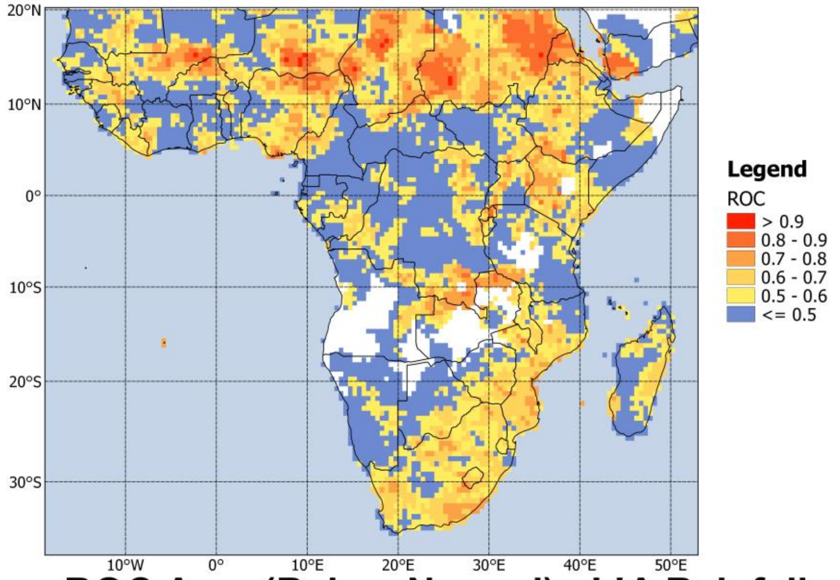
ROC Area (Below-Normal): MJJ Rainfall



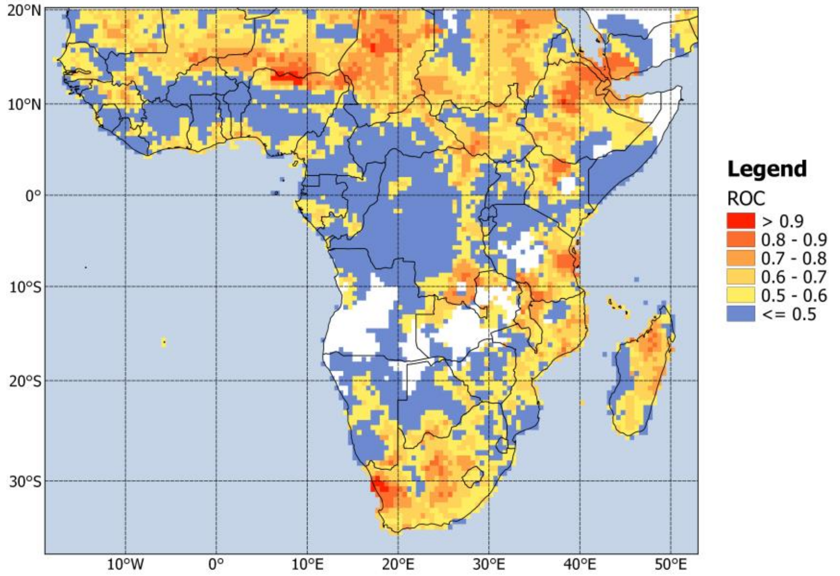
JJA 2023 Rainfall; ICs: May



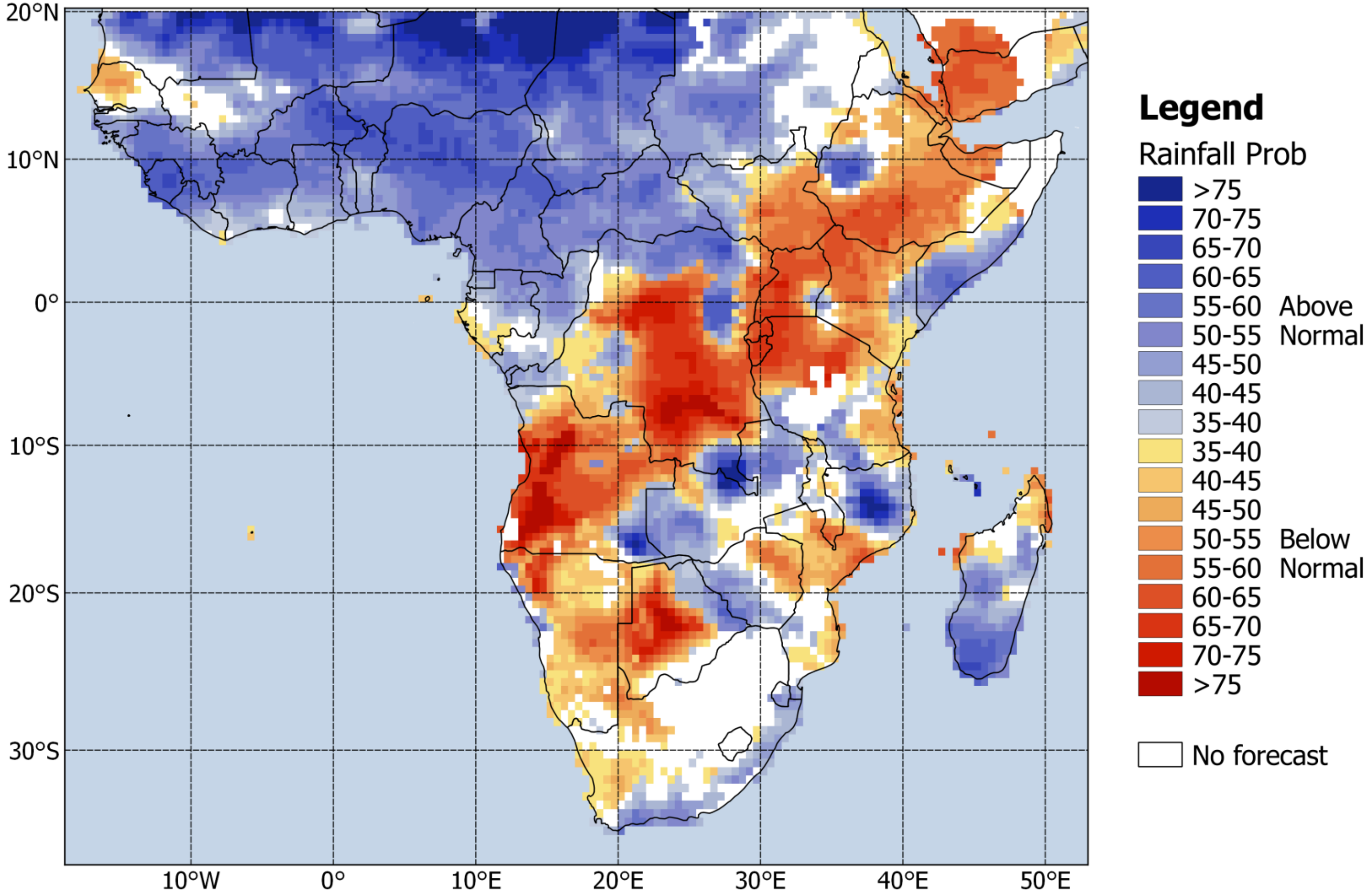
ROC Area (Above-Normal): JJA Rainfall



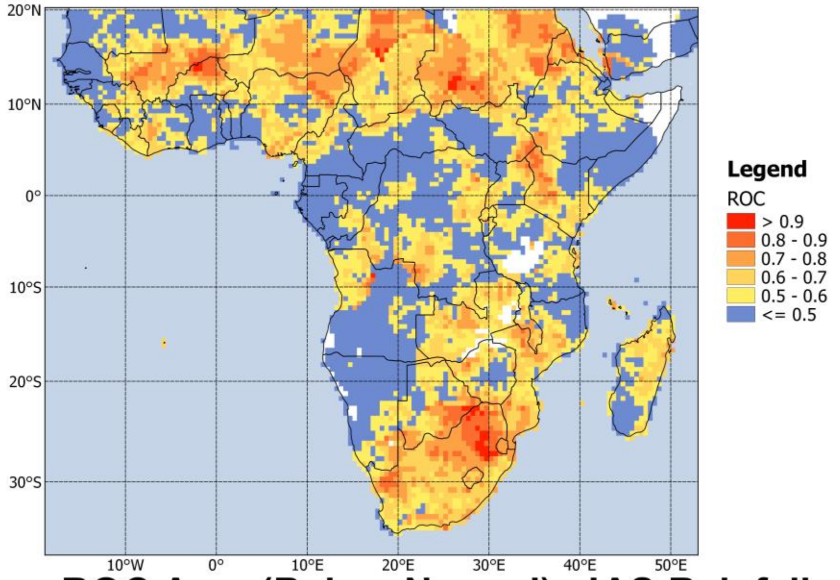
ROC Area (Below-Normal): JJA Rainfall



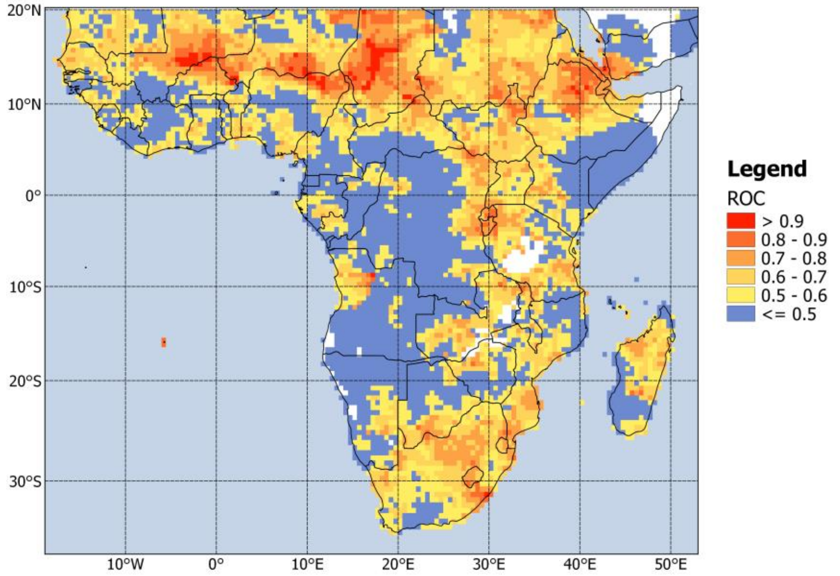
JAS 2023 Rainfall; ICs: May



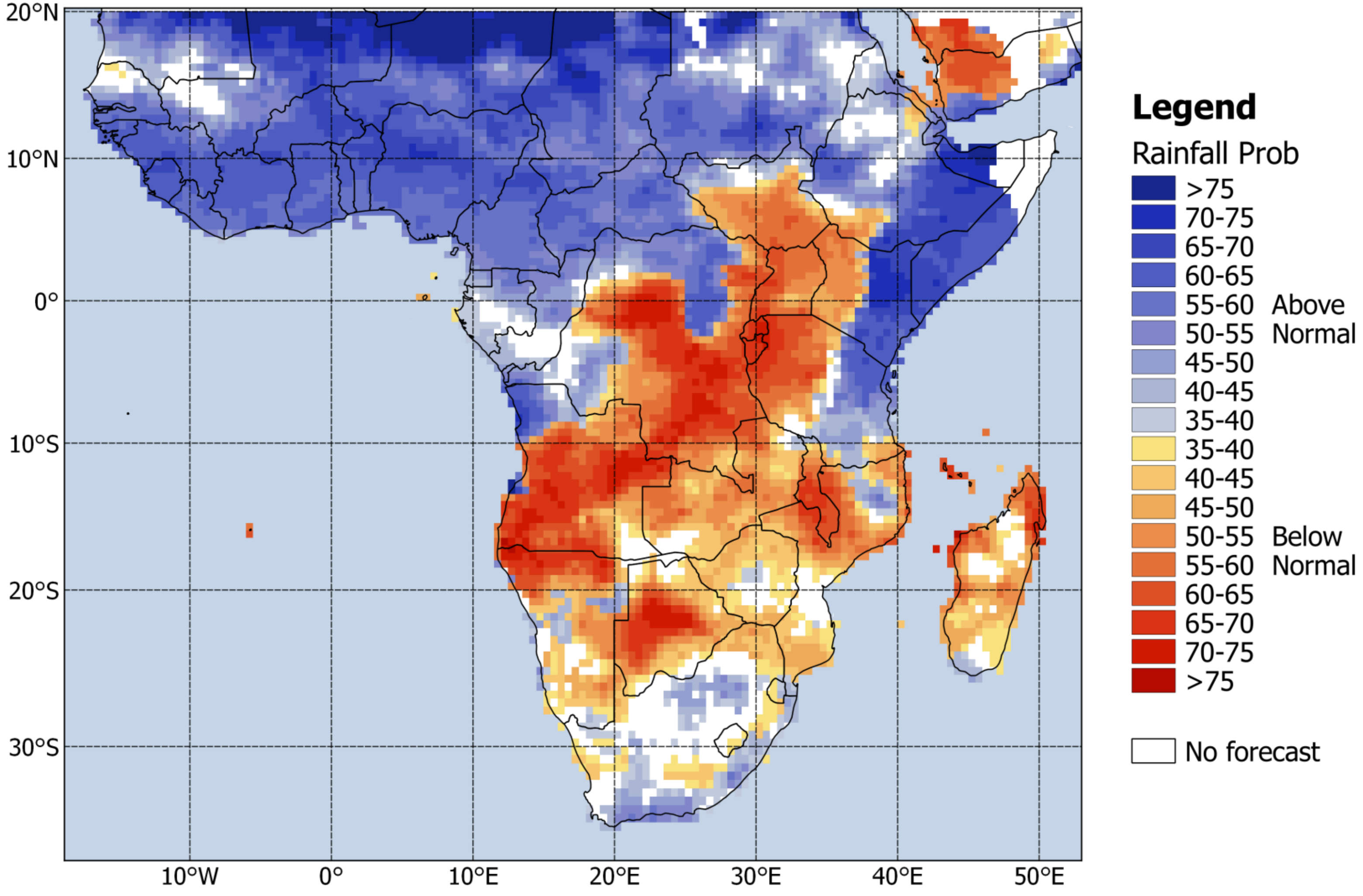
ROC Area (Above-Normal): JAS Rainfall



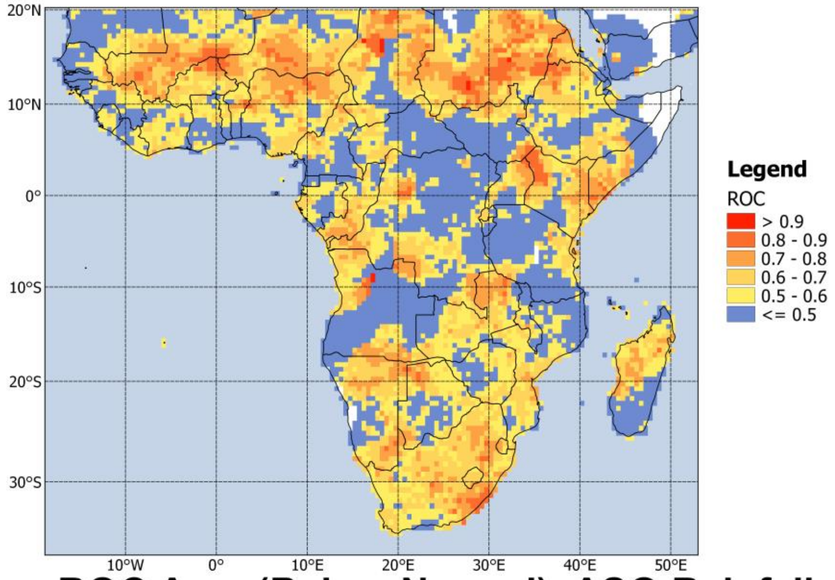
ROC Area (Below-Normal): JAS Rainfall



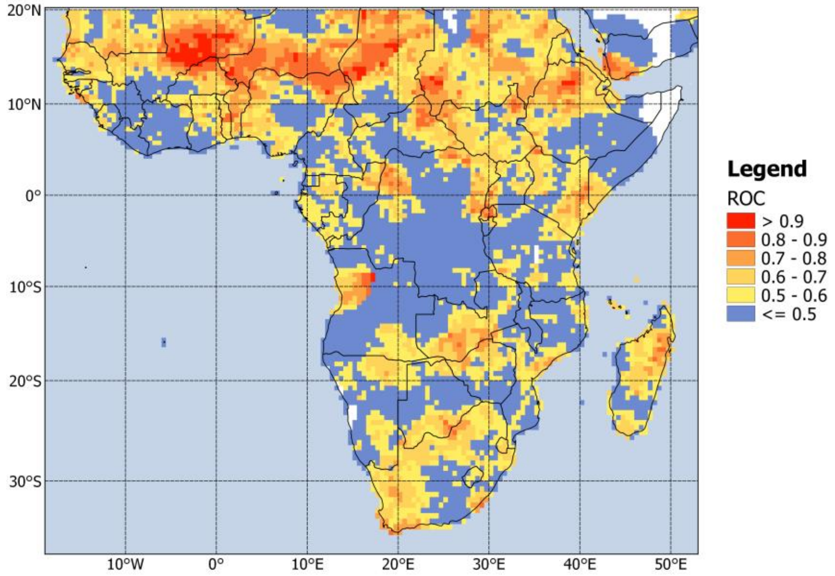
ASO 2023 Rainfall; ICs: May



ROC Area (Above-Normal): ASO Rainfall



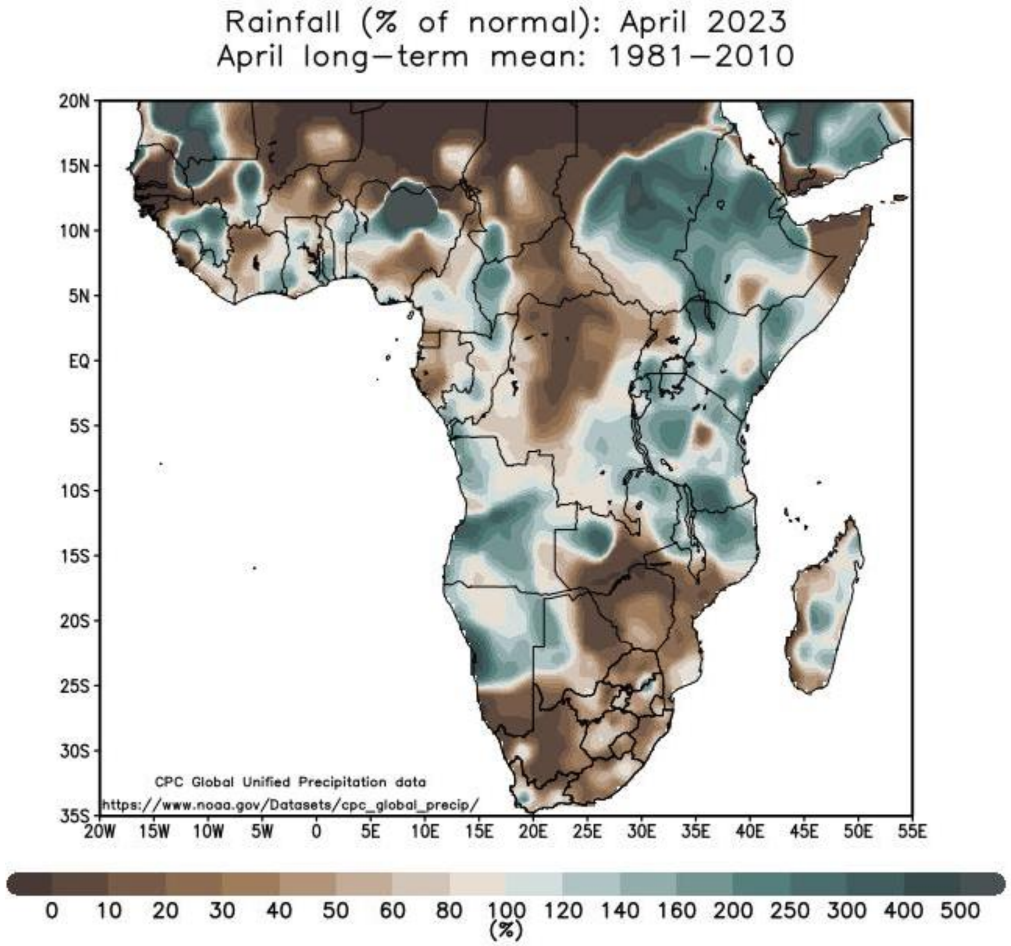
ROC Area (Below-Normal): ASO Rainfall

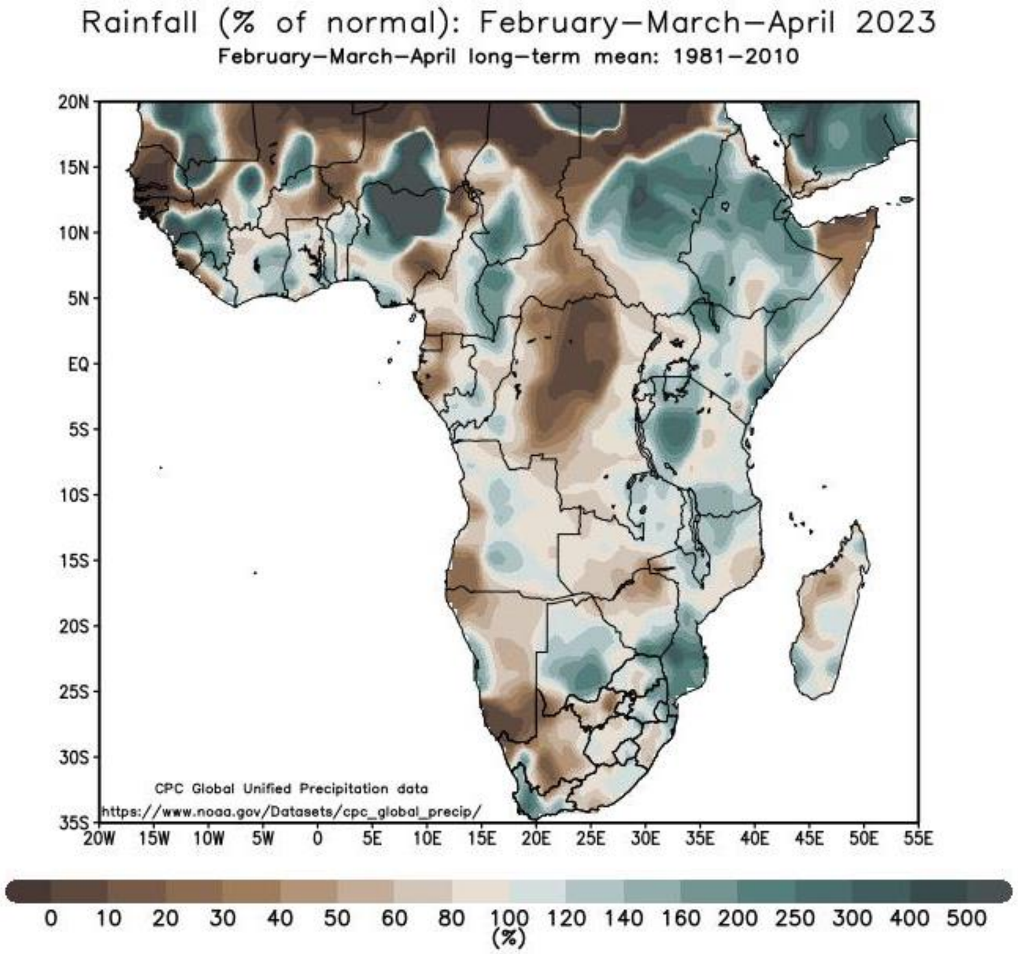


Round-up: Rainfall south of 15°S

- Mostly below-normal rainfall is expected during late autumn
- Parts of the summer rainfall area may expect above-normal winter rain
- Above-normal mid-winter rainfall is expected over the western winter rainfall region, and the southern and south-eastern regions. The latter areas may expect above-normal rainfall during spring
- Below-normal rainfall is expected over the larger winter rainfall region during late winter/early spring

Observed Rainfall

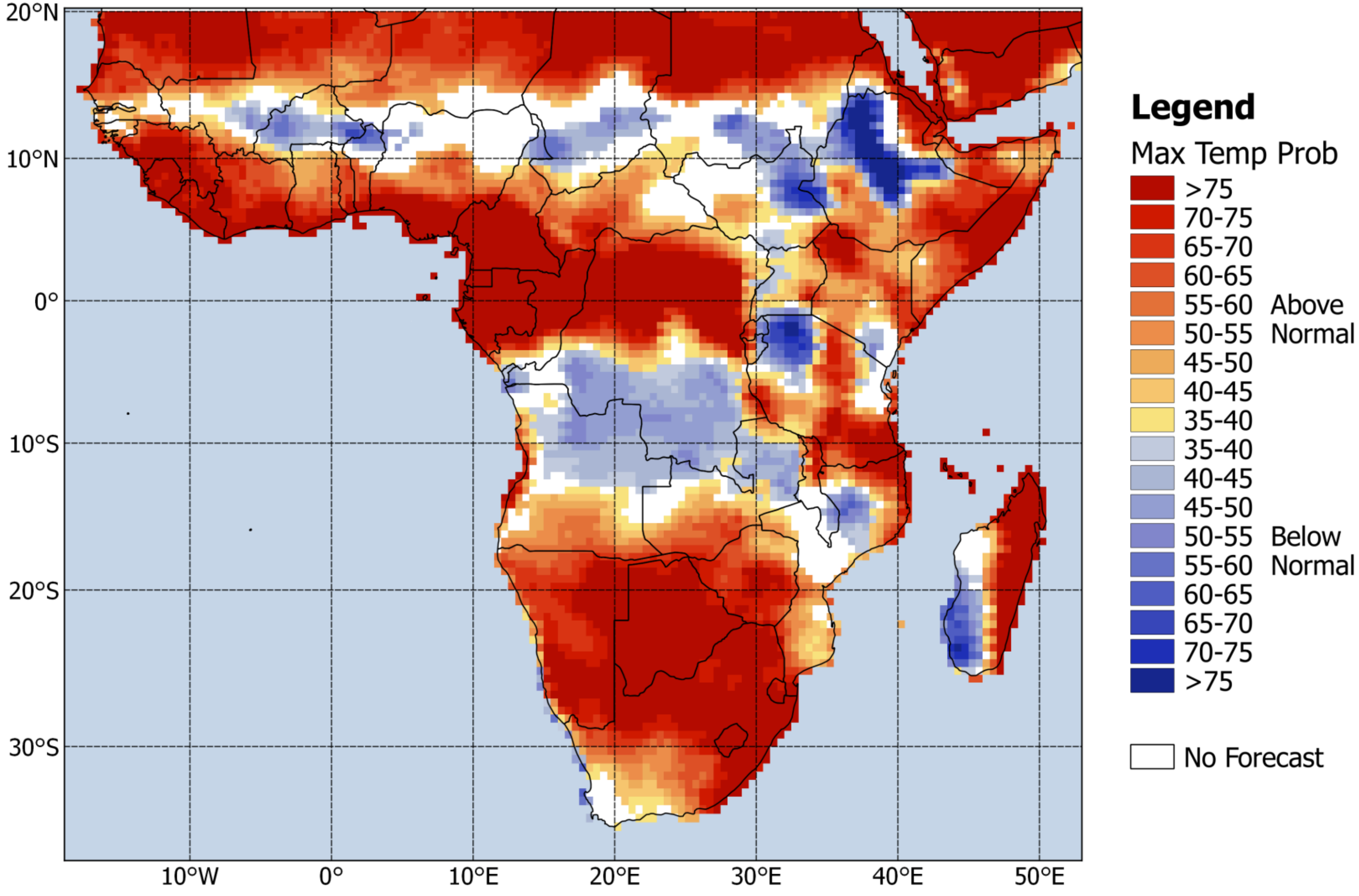




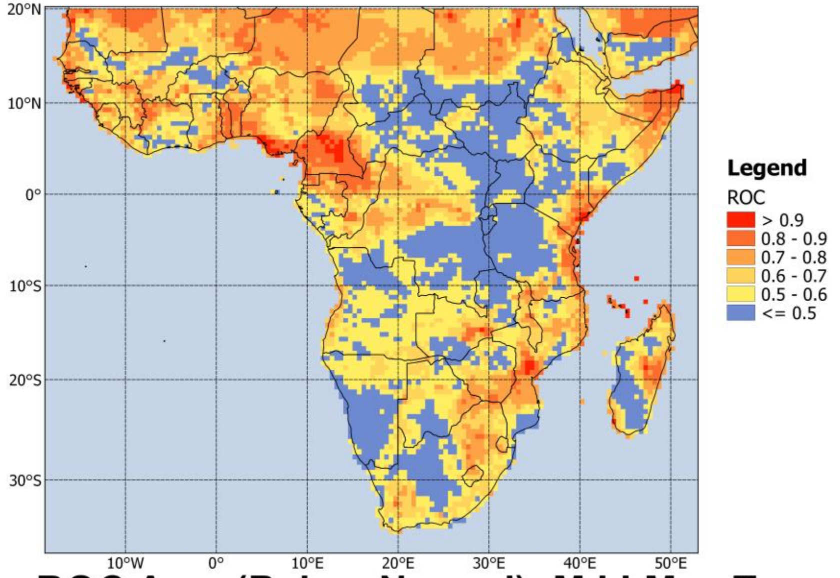
Recorded rainfall for April and the February-March-April season show below-normal rainfall over the brown areas and above-normal rainfall over the green areas

Maps prepared by Dr. Christien Engelbrecht

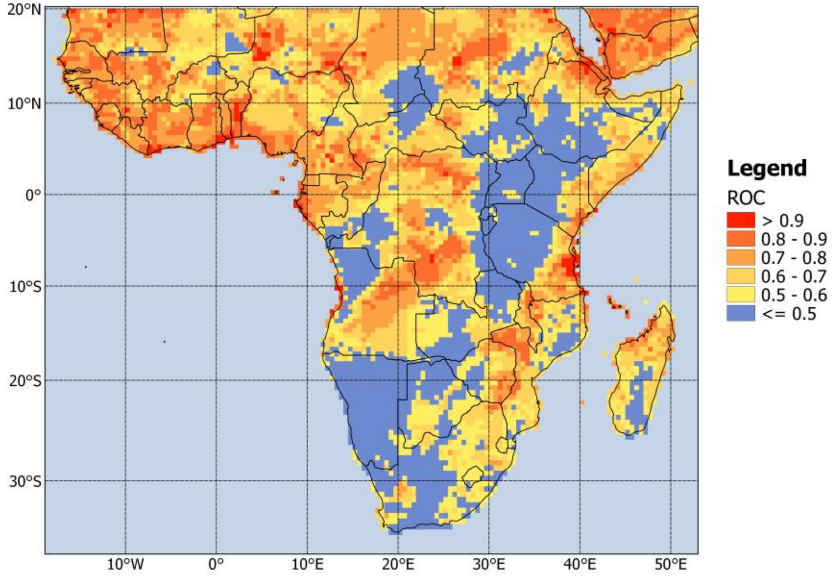
MJJ 2023 Max Temp; ICs: May



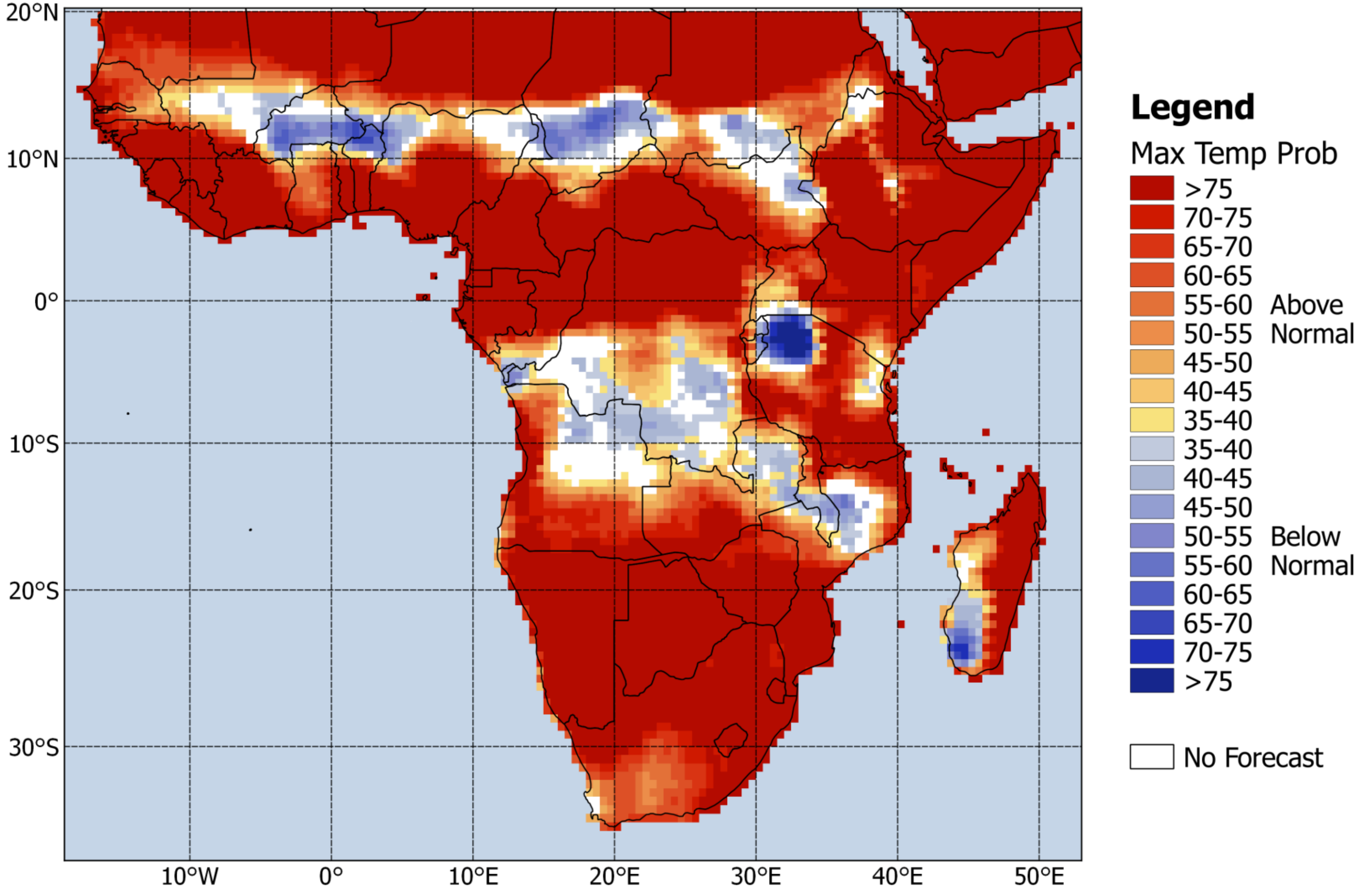
ROC Area (Above-Normal): MJJ Max Temp



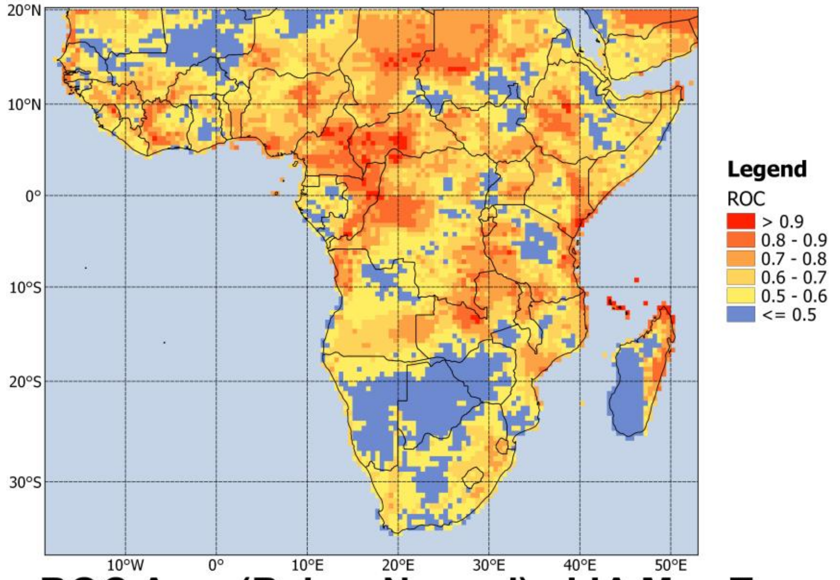
ROC Area (Below-Normal): MJJ Max Temp



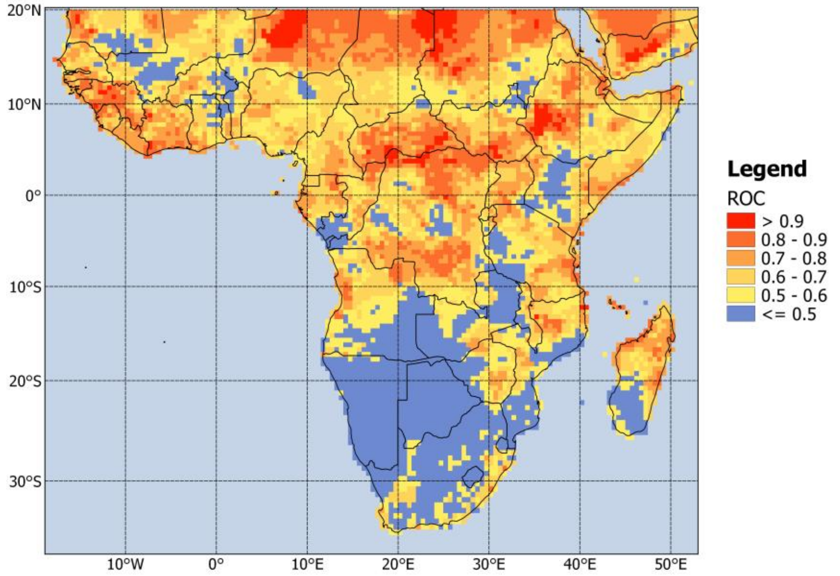
JJA 2023 Max Temp; ICs: May

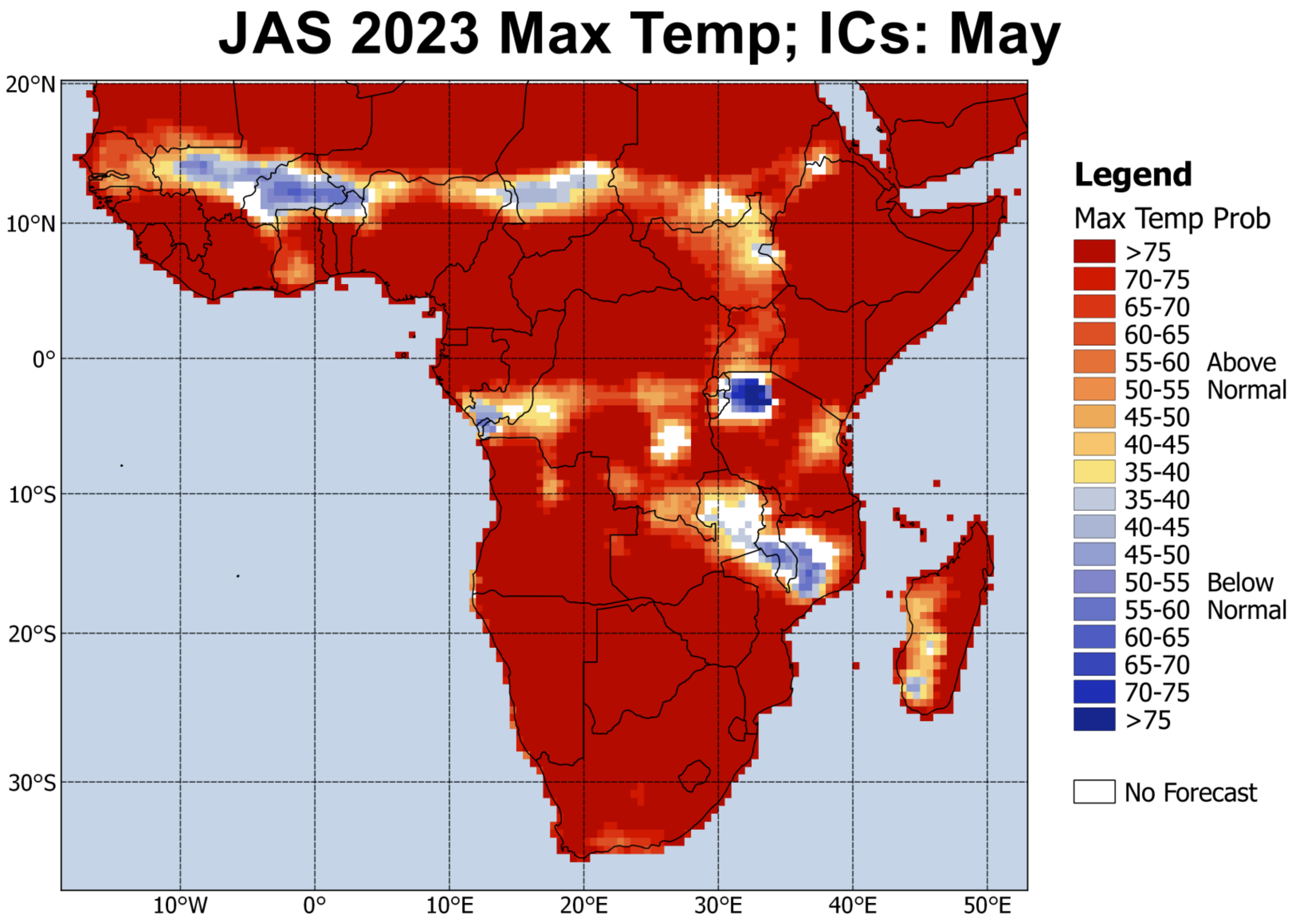


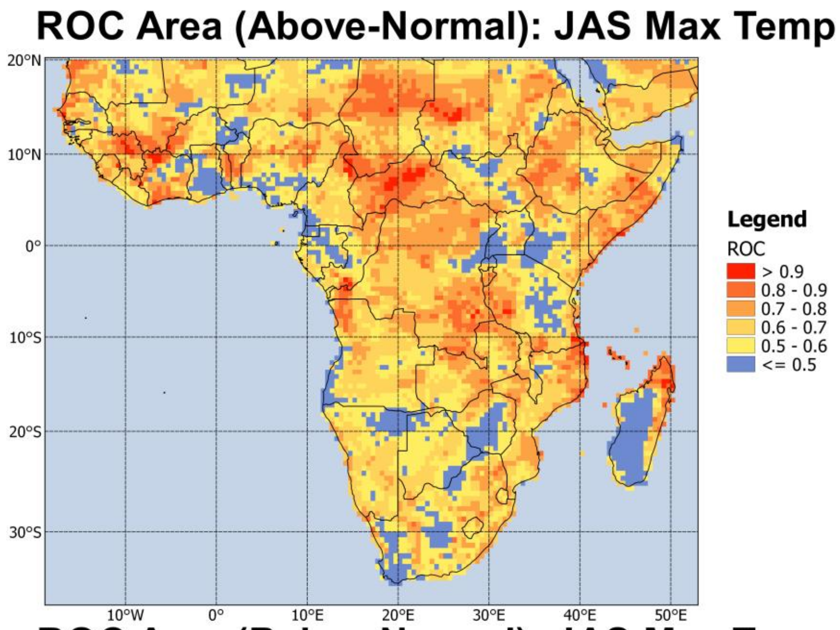
ROC Area (Above-Normal): JJA Max Temp

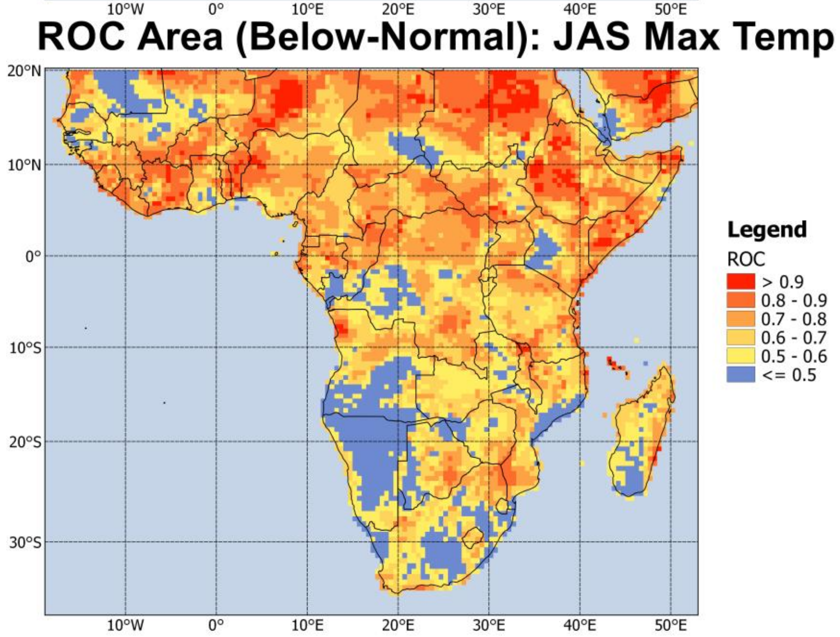


ROC Area (Below-Normal): JJA Max Temp

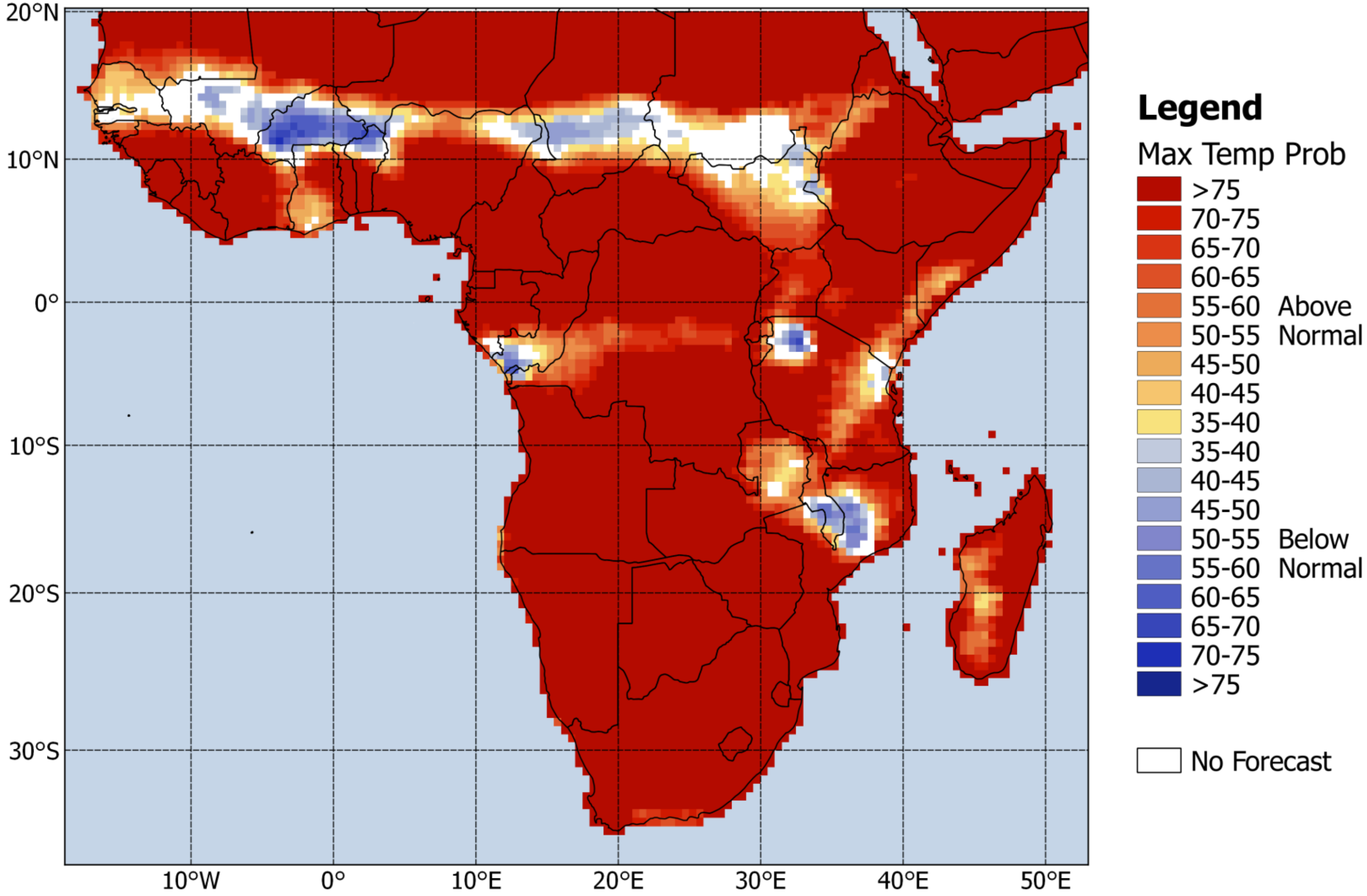



JAS 2023 Max Temp; ICs: May
20°N
10°N
0°
10°S
20°S
30°S
10°W
0°
10°E
20°E
30°E
40°E
50°E
Legend
Max Temp Prob
>75
70-75
65-70
60-65
55-60 Above
50-55 Normal
45-50
40-45
35-40
35-40
40-45
45-50
50-55 Below
55-60 Normal
60-65
65-70
70-75
>75
No Forecast

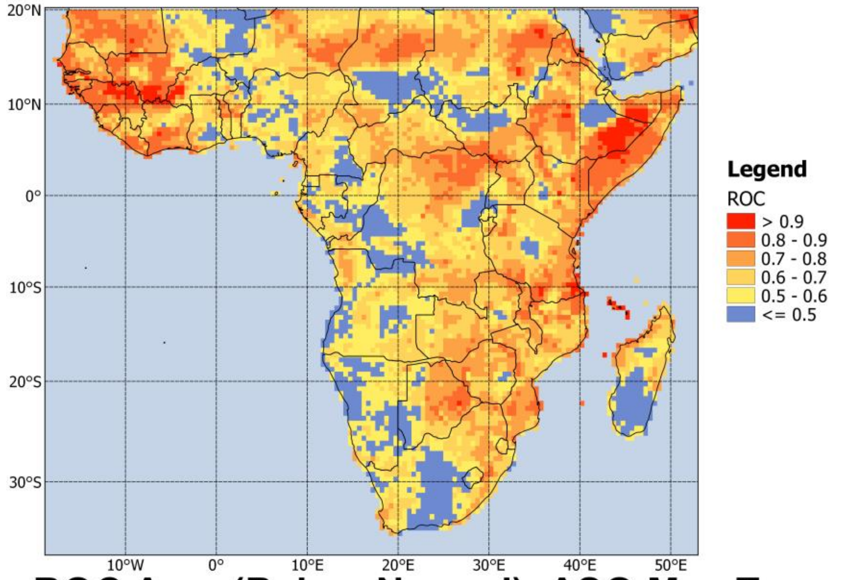

ROC Area (Above-Normal): JAS Max Temp
Legend
ROC
> 0.9
0.8 - 0.9
0.7 - 0.8
0.6 - 0.7
0.5 - 0.6
<= 0.5


ROC Area (Below-Normal): JAS Max Temp
Legend
ROC
> 0.9
0.8 - 0.9
0.7 - 0.8
0.6 - 0.7
0.5 - 0.6
<= 0.5

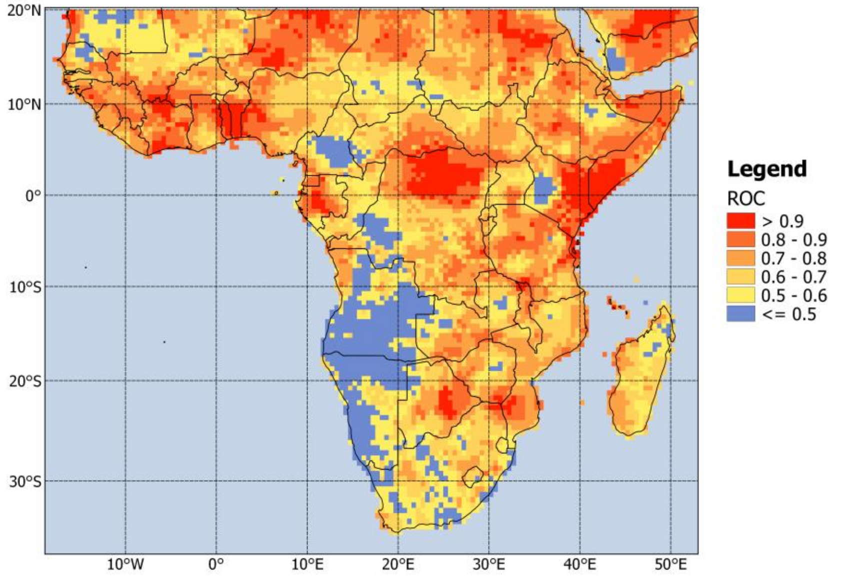
ASO 2023 Max Temp; ICs: May



ROC Area (Above-Normal): ASO Max Temp



ROC Area (Below-Normal): ASO Max Temp



Round-up: South of 15°S Max Temp

- Enhanced likelihoods of above-normal maximum temperatures over the entire region are expected during the forecast period

References

- Barnston, A.G. and Tippett, M.K., 2017: Do statistical pattern corrections improve seasonal climate predictions in the North American Multimodel Ensemble models? Journal of Climate, 30: 8335-8355. doi: 10.1175/JCLI-D-17-0054.1
- Harris, I., Jones, P. D., Osborn, T. J., and Lister, D. H., 2014: Updated high-resolution grids of monthly climatic observations - the CRU TS3.10 Dataset. International Journal of Climatology, 34: 623-642. doi: 10.1002/joc.3711
- Kirtman, B. P. and Co-authors 2014: The North American Multimodel Ensemble: Phase-1 seasonal-to-interannual prediction; Phase-2 toward developing intraseasonal prediction. Bulletin of the American Meteorological Society. 95, 585–601. doi: http://dx.doi.org/10.1175/BAMS-D-12-00050.1
- Landman, W.A., and Beraki, A., 2012: Multi-model forecast skill for midsummer rainfall over southern Africa. International Journal of Climatology, 32: 303-314. doi: 10.1002/joc.2273.
- Landman, W.A., Archer, E. and Tadross, M., 2016: Decision-relevant information on seasonal time scales – the case of a farm in northern Namibia. Conference Proceedings of the 32nd Annual Conference of the South African Society for Atmospheric Science, Cape Town, 31 October to 1 November 2016, pp 69-72. ISBN 978-0-620-72974-1.
- Landman, W.A., Archer, E. and Tadross, M. (2019): How costly are poor seasonal forecasts? Peer reviewed abstracts, 35th Annual conference of the South African Society for Atmospheric Science, Vanderbijlpark, 8 to 9 October 2019, pp 60-63. ISBN 978-0-6398442-0-6.
- Landman, W.A., Archer, E.R.M and Tadross, M.A (2020a). Citizen science for the prediction of climate extremes in South Africa and Namibia. Frontiers in Climate, 2:5, doi: 10.3389/fclim.2020.00005
- Landman, W.A., DeWitt, D., and Lee, D.-E., 2011: The high-resolution global SST forecast set of the CSIR. Conference Proceedings of the 27th Annual Conference of South African Society for Atmospheric Sciences, 22-23 September 2011, Hartbeespoort, North-West Province, South Africa. ISBN 978-0-620-50849-0
- Landman, W.A., Sweijd, N., Masedi, N. Minakawa, N. (2020b). The development and prudent application of climate-based forecasts of seasonal malaria in the Limpopo province in South Africa. Environmental Development, 35, 100522, doi: 10.1016/j.envdev.2020.100522.
- Landman, W.A., DeWitt, D. Lee, D.-E., Beraki, A. and Lötter, D., 2012: Seasonal rainfall prediction skill over South Africa: 1- vs. 2-tiered forecasting systems. Weather and Forecasting, 27: 489-501. DOI: 10.1175/WAF-D-11-00078.1
- Muchuru, S., Landman, W.A. and DeWitt, D., 2016: Prediction of inflows into Lake Kariba using a combination of physical and empirical models. International Journal of Climatology, 36: 2570–2581, DOI: 10.1002/joc.4513.
- 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.

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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)

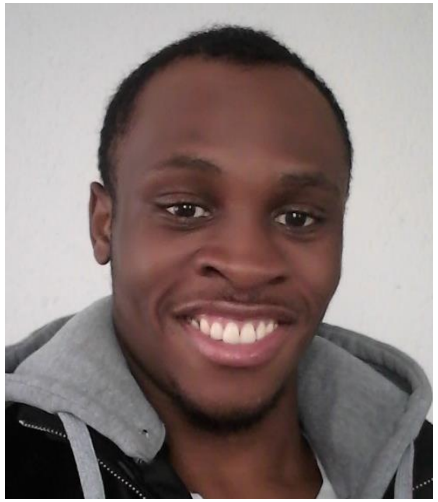
- Water Research Commission through administering the international project "Research-based Assessment of Integrated approaches to Nature-based SOLUTIONS (RainSolutions)" (2020 to 2022)

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

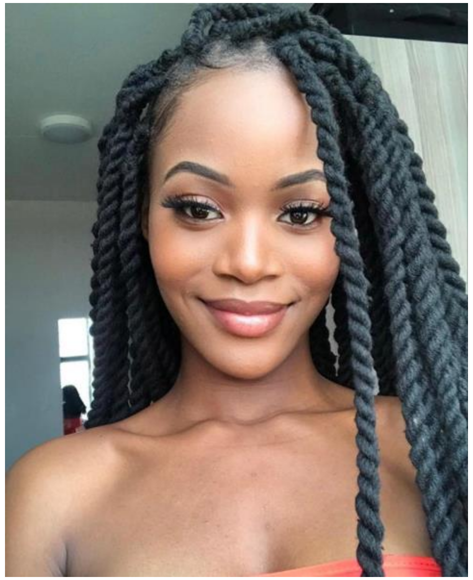
Stephanie Hinze, BSc (Honours)(Meteorology):
Statistical downscaling using large and high-resolution data sets, forecast displays for SADC rainfall and maximum temperatures, forecast verification



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.