Posted on 21 Nov 2022 — The copyright holder is the author/funder. All rights reserved. No reuse without permission. — https://doi.org/10.1002/essoar.10504989.1 — This a preprint and has not been peer reviewed. Data may be preliminary.

A Next Generation (NextGen) Approach to Improve the Seasonal Prediction System in East Africa

Nachiketa Acharya[1], Tufa Dinku[1], and Kyle Joseph Chen Hall[2]

[1]International Research Institute for Climate and Society (IRI), The Earth Institute at Columbia University, Palisades NY, U.S.A.
[2]International Research Institute for Climate and Society, Earth Institute at Columbia University, Palisades, NY, USA

November 21, 2022

Abstract

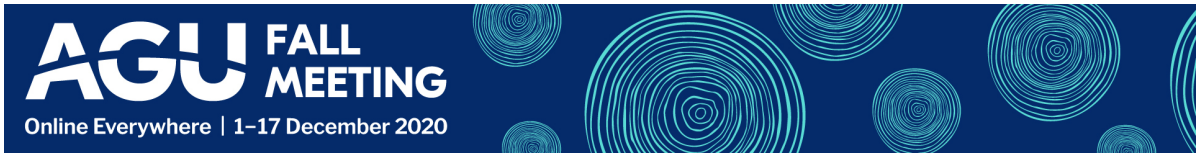
The use of an objective seasonal forecast procedure, defined as a traceable, reproducible, and well-documented set of steps that allows the quantification of forecast quality, are preferred and recommended by the World Meteorological Organization in their recent seasonal forecast guidance. However, National Meteorological Services (NMS) in African countries have been issuing seasonal rainfall forecasts using a subjective consensus process, which is based on meteorologists' experiences using Global Producing Center's (GPCs) outputs and other available information. A systematic general objective approach named as NextGen (Next Generation) forecasting system is being developed for some East African countries as part of implementing or strengthening ENACTS (Enhancing National Climate Services; https://iri.columbia.edu/resources/enacts/) initiative as well implementing Columbia University's World Project "Adapting Agriculture to Climate Today, for Tomorrow" (ACToday; https://iri.columbia.edu/actoday/) project. This new forecast system is based on a calibrated multi-model ensemble (CMME) process using state-of-the-art general circulation models (GCM) from the North American Multi-Model Ensemble project. A canonical-correlation-analysis-based regression is used to calibrate the raw outputs from the GCMs; then the individually-calibrated GCMs are combined with equal weight to make a final CMME prediction. In addition to traditional tercile probability forecasts, NextGen also provides a more flexible format that enables users to extract information for those parts of the forecast distribution of the greatest interest to them in the decision-making process. Therefore, NextGen enables NMS to generate and deliver targeted climate information products relevant to the needs of decision-makers at multiple levels. The NextGen forecast system has so far been implemented in Ethiopia, Rwanda, Zambia, Malawi and Tanzania, and planned to be implemented in more countries in the near future. In this study, we describe the co-design, co-development, and skill assessment of this NextGen system.

A Next Generation (NextGen) Approach to Improve the Seasonal Prediction System in East Africa

Nachiketa Acharya, Tufa Dinku and Kyle Joseph Chen Hall

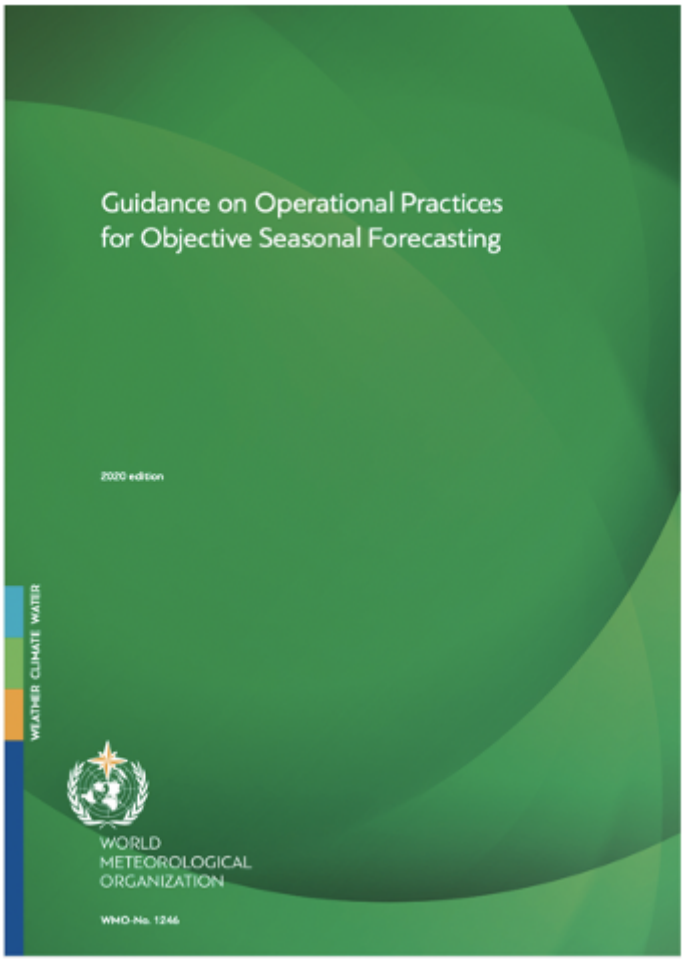
International Research Institute for Climate and Society, Earth Institute at Columbia University, Palisades, NY, USA

PRESENTED AT:



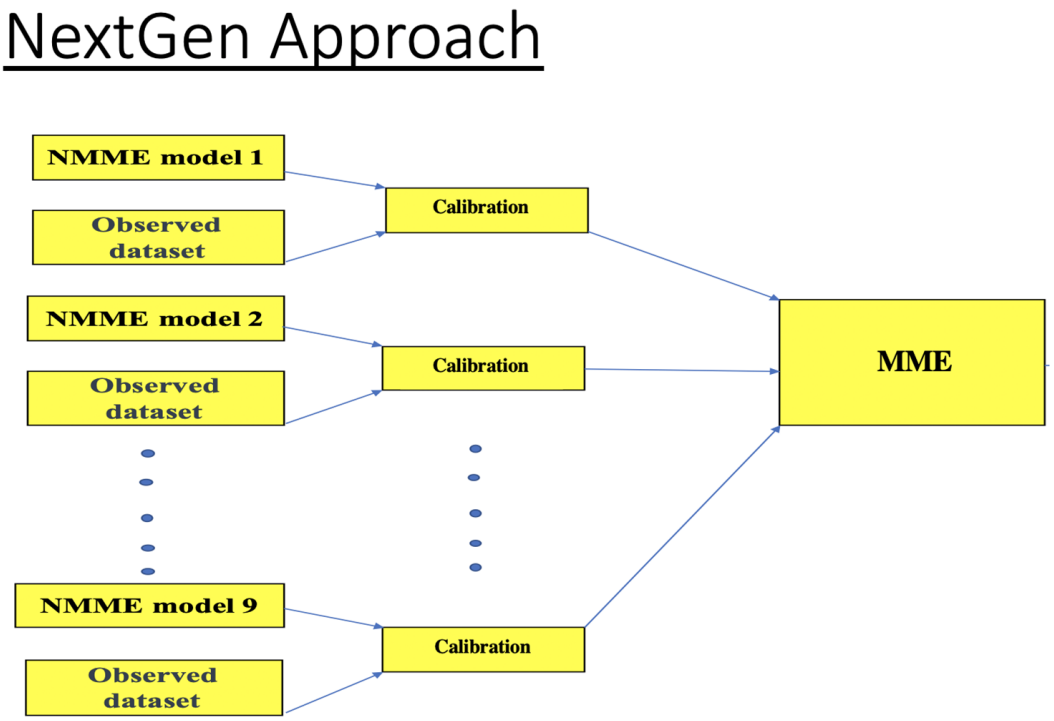
1. MOTIVATIONS & GOAL

- National Meteorological Services (NMS) in African countries have been issuing seasonal rainfall forecasts using a subjective consensus process, which is based on meteorologists' experiences, some globaly available forecast and tools.
- The use of an objective seasonal forecast procedure which is defined as a traceable, reproducible, and well-documented set of steps that allows the quantification of forecast quality, are preferred and recommended by the World Meteorological Organization in their recent seasonal forecast guidance.



- The Next Generation **(NextGen)** seasonal forecast system is a systematic and objective approach. It enables calibration, combination, and verification of objective climate forecasts from the state-of-the-art general circulation models (GCM) of the North American Multi-Model Ensemble project.
- NextGen is being adopted for some East African countries with close collaboration with NMSs in each country.

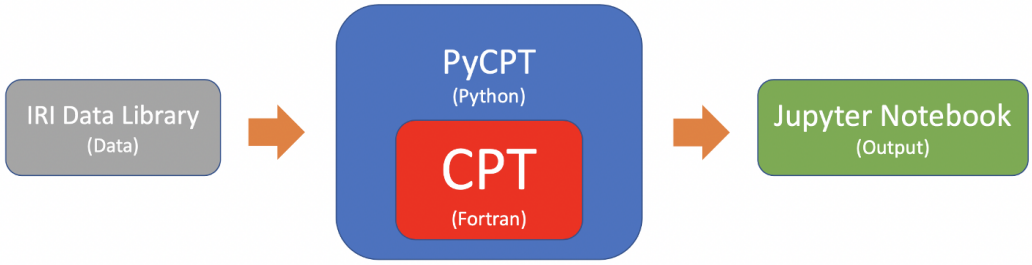
2. THE NEXT GENERATION (NEXTGEN) SEASONAL PREDICTION APPROACH



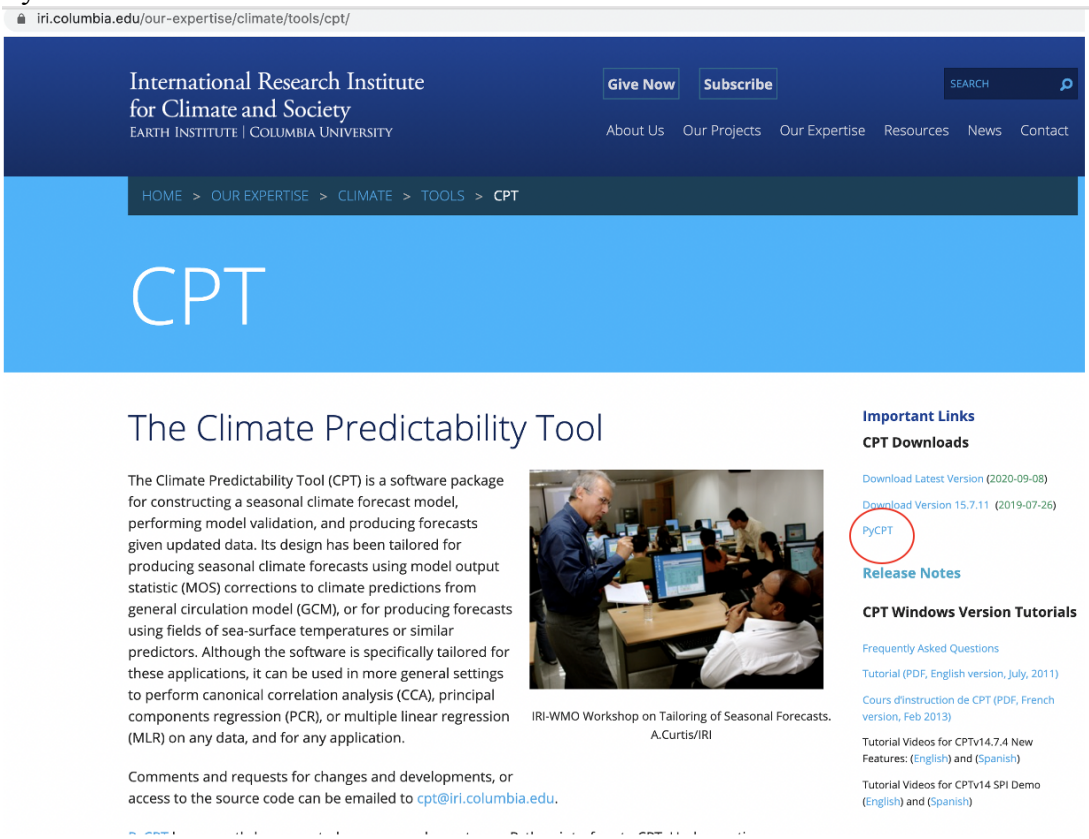
- A canonical-correlation-analysis-based regression is used to calibrate the raw outputs from the GCMs; then the individually-calibrated GCMs are combined with equal weight to make a final calibrated multi-model ensemble (CMME) prediction.
- In addition to traditional tercile probability forecasts, NextGen also provides a more flexible format that enables users to extract information for those parts of the forecast distribution of the greatest interest to them in the decision-making process.

3.TOOL FOR NEXTGEN:PYCPT

- PyCPT is a Python library that provides an interface and extra functionalities to IRI's Climate Predictability Tool (CPT), a widely used research and application Model Output Statistics/Prediction toolbox.
- PyCPT Layout



- PyCPT Website

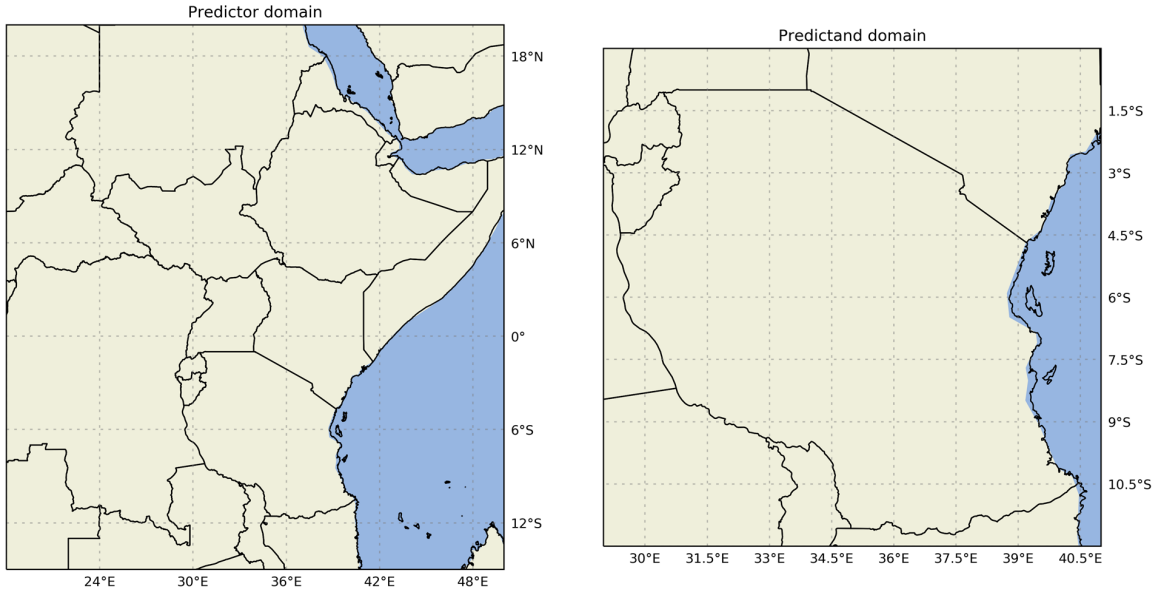


- PyCPT wiki

- Download

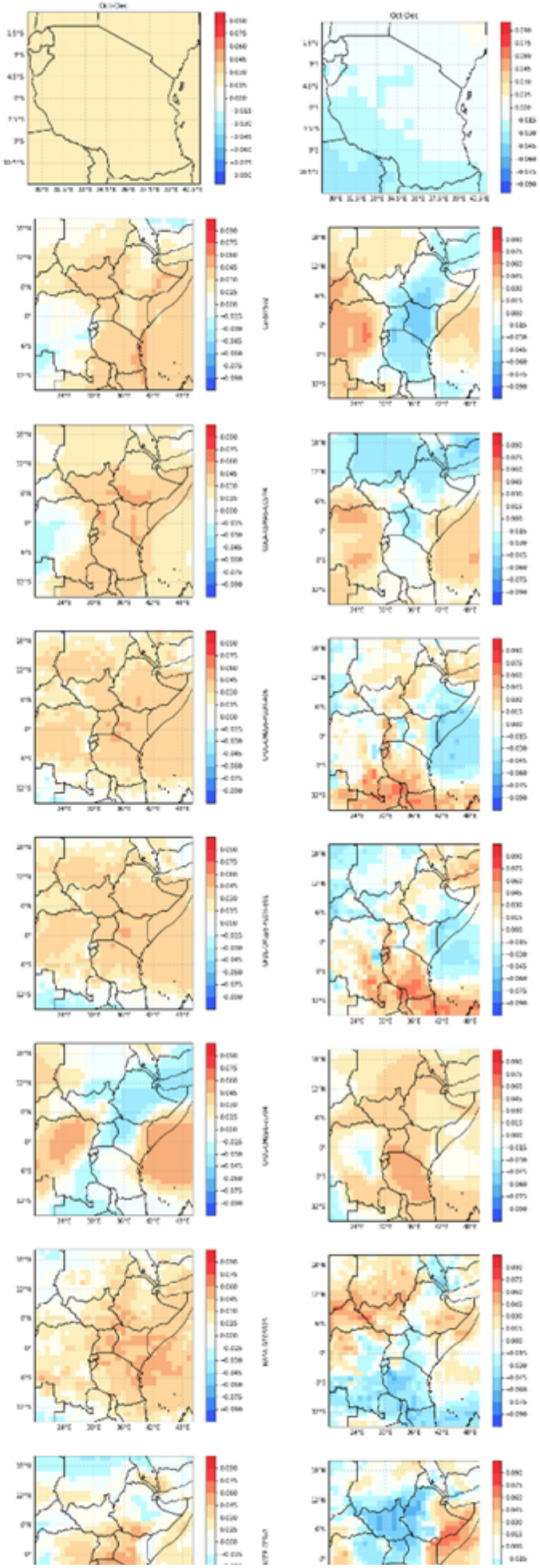
Plots generated by PyCPT to develop a NextGen system: Example for Tanzania

Domain for CCA

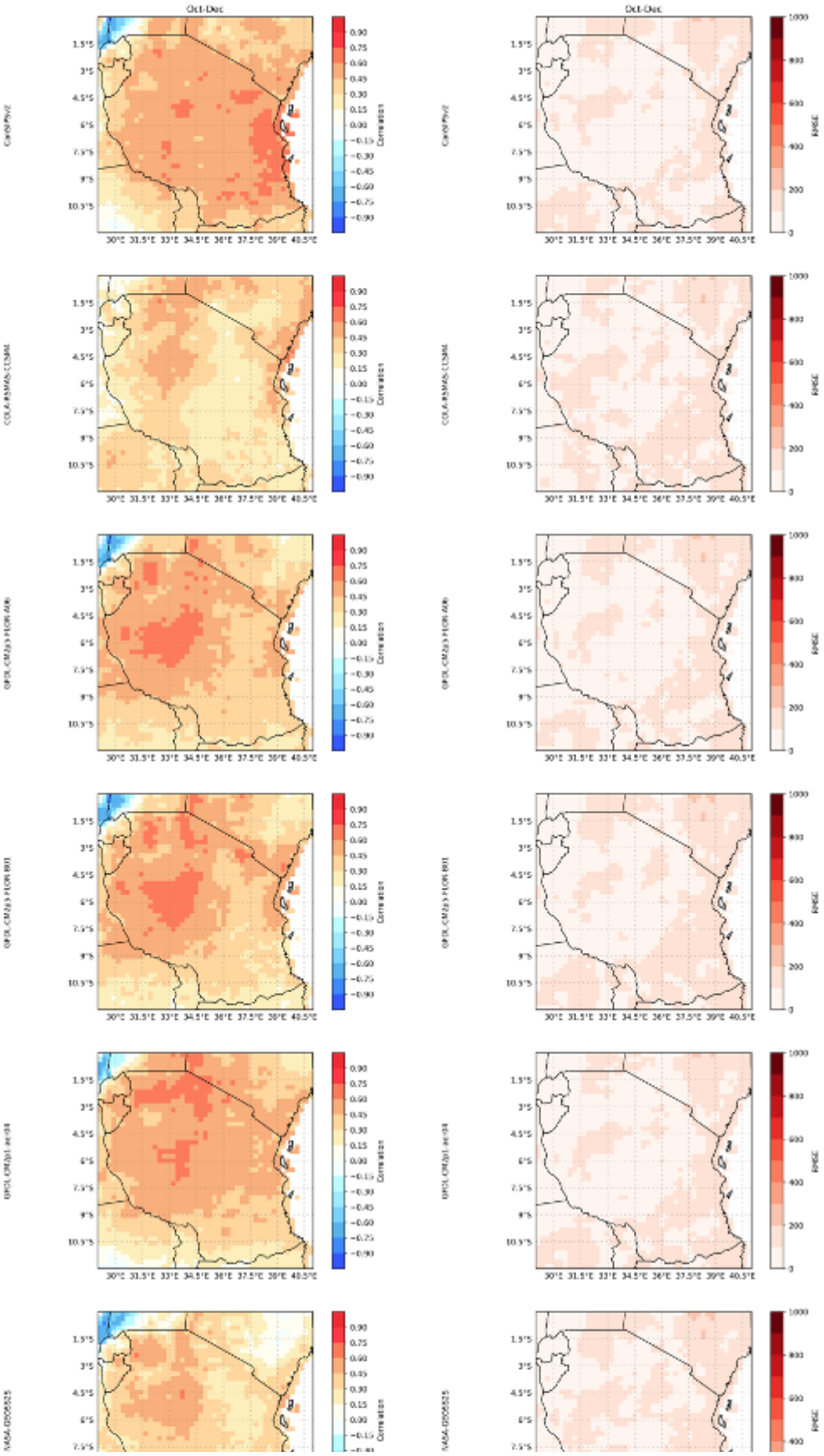


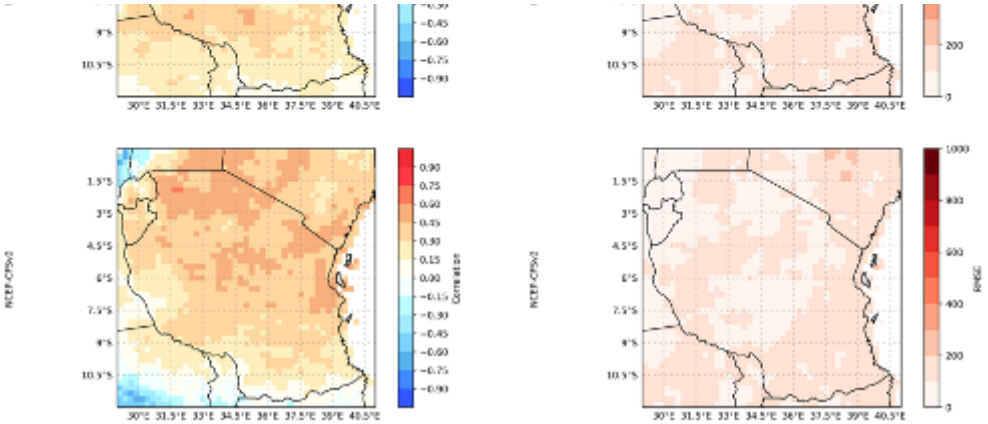
EOF maps of observation and each GCMs

EOF1 EOF2

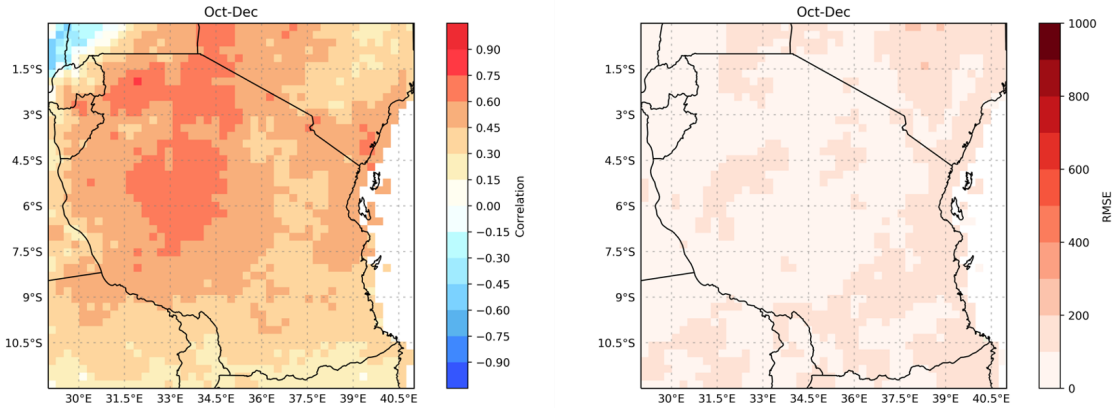


Spearman's correlation and RMSE maps of each calibrated GCMs





Spearman's correlation and RMSE maps of NextGen (calibrated MME)



4.CAPACITY BUILDING OF THE NEXTGEN SYSTEM

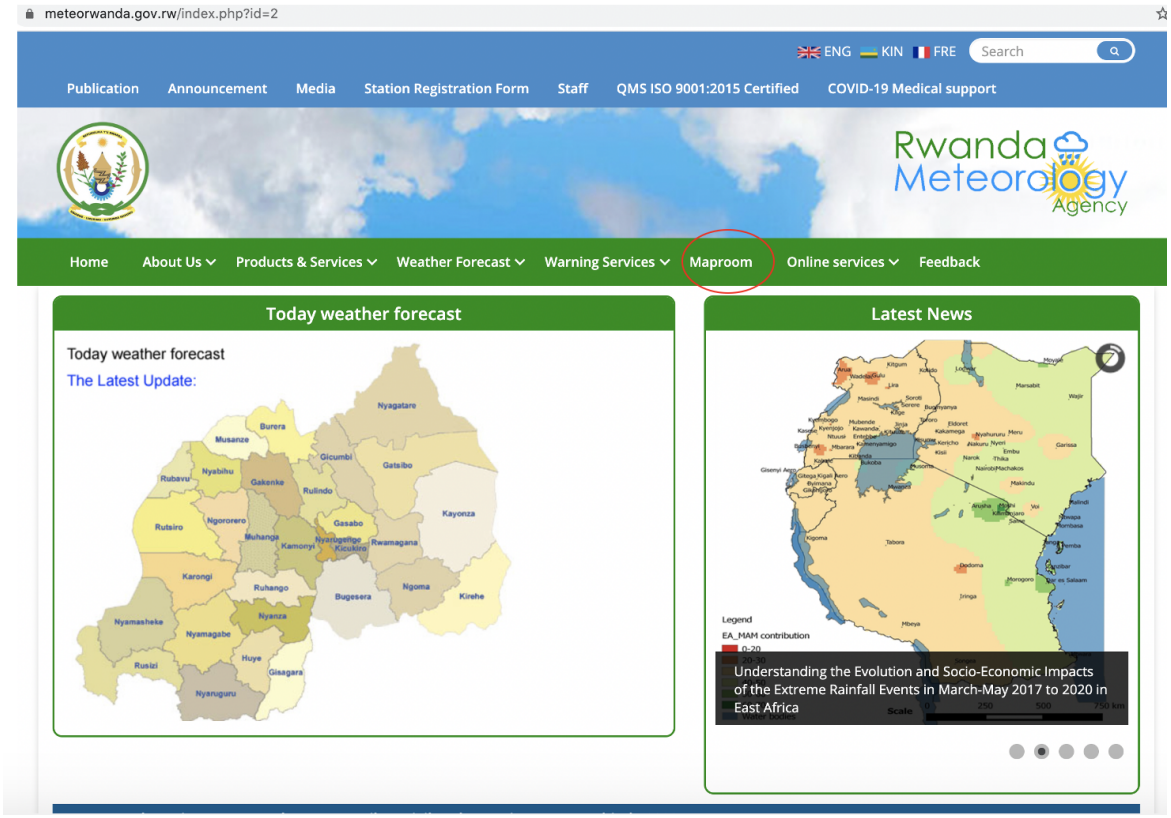
- The NextGen approach is being implimented in **Ethiopia, Rwanda, Zambia, Malawi, and Tanzania** as a part of IRI's Enhancing National Climate Services (ENACTS) initiative.
- Part of this implimention is capacity devlopemnt for the NMS.Several training activities were conducted by the IRI.

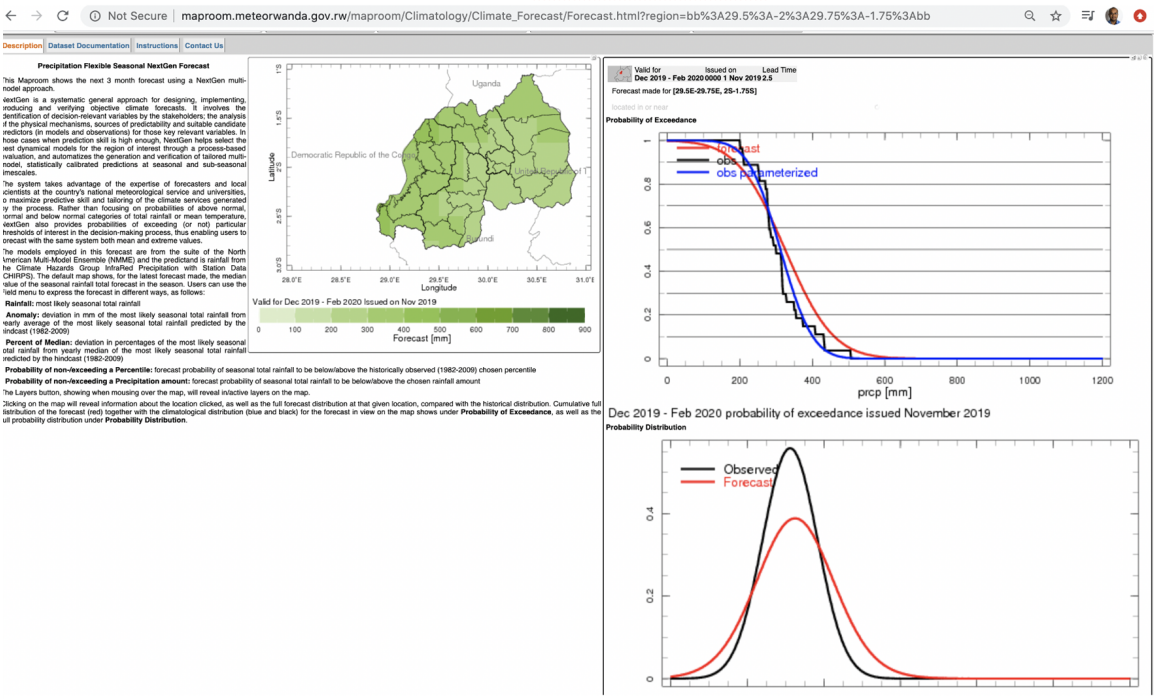
Training at National Meteorological Agency of Ethiopia.

Training at Meteo Rwanda.

Online training with Zambia Meteorological Department.

5. EXAMPLE OF REAL-TIME FORECAST MAPROOM BY METEO RWANDA





http://maproom.meteorwanda.gov.rw/maproom/Climatology/Climate_Forecast/Forecast.html (http://maproom.meteorwanda.gov.rw/maproom/Climatology/Climate_Forecast/Forecast.html)

6. CONCLUSIONS AND ACKNOWLEDGEMENTS

- NextGen is being implemented for some East African countries (Ethiopia, Rwanda, Zambia, Malawi, and Tanzania) with close collaboration with NMSs in each country.
- Building the capacities for the NextGen system of NMSs through several training activities.
- It is planned to implement the NextGen system in more African countries in the near future.

Acknowledgements:

- National Meteorological Agency of Ethiopia.
- Meteo Rwanda.
- Department of Climate Change and Meteorological Services of Malawi.
- Tanzania Meteorological Agency.
- Zambia Meteorological Department.
- PyCPT development team and Maproom development team at IRI.

AUTHOR INFORMATION

Nachiketa Acharya

Nachiketa Acharya
iri.columbia.edu

Email for correspondes: nachiketa@iri.columbia.edu

ABSTRACT

The use of an objective seasonal forecast procedure, defined as a traceable, reproducible, and well-documented set of steps that allows the quantification of forecast quality, are preferred and recommended by the World Meteorological Organization in their recent seasonal forecast guidance. However, National Meteorological Services (NMS) in African countries have been issuing seasonal rainfall forecasts using a subjective consensus process, which is based on meteorologists' experiences using Global Producing Center's (GPCs) outputs and other available information. A systematic general objective approach named as NextGen (Next Generation) forecasting system is being developed for some East African countries as part of implementing or strengthening ENACTS (Enhancing National Climate Services; https://iri.columbia.edu/resources/enacts/) initiative as well implementing Columbia University's World Project "Adapting Agriculture to Climate Today, for Tomorrow" (ACToday; https://iri.columbia.edu/actoday/) project. This new forecast system is based on a calibrated multi-model ensemble (CMME) process using state-of-the-art general circulation models (GCM) from the North American Multi-Model Ensemble project. A canonical-correlation-analysis-based regression is used to calibrate the raw outputs from the GCMs; then the individually-calibrated GCMs are combined with equal weight to make a final CMME prediction. In addition to traditional tercile probability forecasts, NextGen also provides a more flexible format that enables users to extract information for those parts of the forecast distribution of the greatest interest to them in the decision-making process. Therefore, NextGen enables NMS to generate and deliver targeted climate information products relevant to the needs of decision-makers at multiple levels. The NextGen forecast system has so far been implemented in Ethiopia, Rwanda, Zambia, Malawi and Tanzania, and planned to be implemented in more countries in the near future. In this study, we describe the co-design, co-development, and skill assessment of this NextGen system.