# Forecasting Seasonal Rainfall Characteristics in Rwanda Using the NextGen Python-Based Climate Predictability Tool

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## Introduction

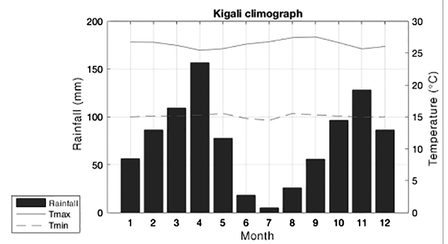

- IRI is developing a new tool for forecast generation, calibration, ensembling and verification and integrating its use into an existing project in Rwanda supported by the USAID funded Climate Change Agriculture and Food Security (CCAFS) project of the Consultative Group for International Agricultural Research (CGIAR).
- The main tool in this effort is a Python-based approach to running the Climate Predictability Tool (CPT).

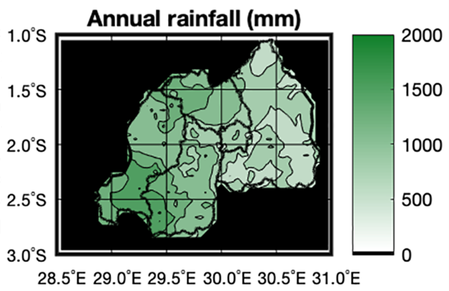
- Rwanda has enjoyed significant growth, but still relies heavily on the agricultural sector and most farming in the country is rain-fed.
- The project in Rwanda has been multi-year collaboration between IRI scientists, social scientists and data experts, CIAT-Rwanda (International Center for Tropical Agriculture) and Rwanda's Meteorological Agency (MeteoRwanda).
- This project has improved the quality of meteorological data by merging high resolution satellite data with station observations to form a spatially and temporally complete rainfall and temperature dataset from the early 1980s to the present called ENACTS (Enhancing NAtional ClimaTe Services)
- This project has also been very involved in disseminating forecast information to agricultural extension services throughout the country through a participatory process known as PICSA (Participatory Integrated Climate Services for Agriculture). Over the course of the last several years (2016-2019), this project has reached about 1 million of Rwanda's 12 million population and has won the 2018 Africa Climate Services Project of the Year Inaugural Award.

## Rwanda Climatology

Rwanda is located slightly to the south of the equator in East Africa and has a bimodal annual rainfall distribution. The rainy seasons are September-December (Umuhindo) and March-May (Ituba). The January-February season (Urugaryi) is somewhat dry and the June-August season (Impeshyi) is very dry.

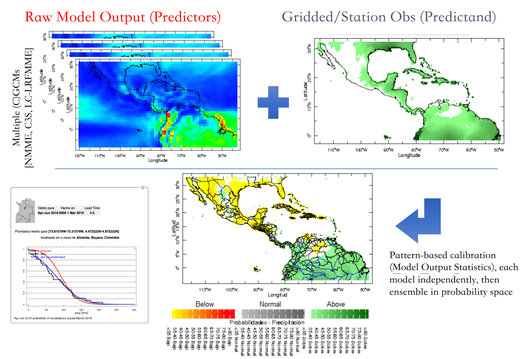
Rainfall is more abundant in the higher elevations in southwest and northwest Rwanda and lower in the lowlands of Eastern Rwanda. Moisture sources for Rwanda include the Indian Ocean, Lake Victoria and the Congo Airmass. Seasonality is closely associated with the seasonal migration of the ITCZ.



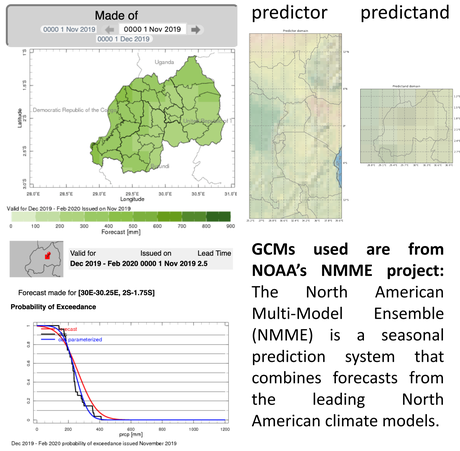

## NextGen & PyCPT Interface

- NextGen forecasting efforts at IRI strive to make systematic, objective forecasts of rainfall and other critical variables at the national and regional level, primarily using publicly accessible GCM data as predictors.
- The goal is to implement WMO guidelines to encourage and enable NMHS to implement objective forecasts based on dynamical model output and user-tailored predictands
- NextGen efforts can also provide flexible forecasts in digital maproom format.
- PyCPT is the main tool in this effort and it is a set of Python function files and executables that can call the program Climate Predictability Tool (CPT) to conduct GCM validation, canonical correlation analysis (CCA), principal component regression (PCR) or extended logistic regression (ELR) with chosen pairings and specified domains of predictors and predictands.




## Seasonal Rainfall Forecast

- NextGen forecasts are being mainstreamed into the operation of MeteoRwanda in the form of rolling forecasts, an example of which is shown below for the DJF 19/20 period forecast in November 2019.
- http://maproom.meteorwanda.gov.rw/maproom/Climatology/Climate_Forecast/Forecast.html

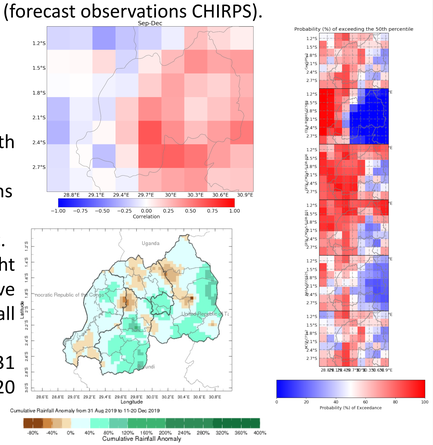



predictor predictand

**GCMs used are from NOAA's NMME project:** The North American Multi-Model Ensemble (NMME) is a seasonal prediction system that combines forecasts from the leading North American climate models.

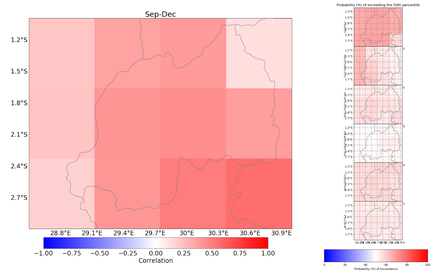
- NextGen forecasts can be evaluated for different seasons, with different combinations of models and for different lags
- Multiple skill metrics are shown and probability of exceeding a threshold percentile is also shown
- Here we show the Spearman correlation for the MME forecast for SOND 2019 initiated in August and the probability of exceeding the 50th %ile rainfall total among the models (forecast observations CHIRPS).

Forecast agrees relatively well with monitoring observations shown below right. Map at right is cumulative % rainfall anomaly from Aug 31 to Dec 20 2019.




## Rainy Day Frequency Forecast

- Forecast using rainy day frequency as predictand for SOND 2019 shows increased skill and increased confidence of above average conditions.
- Rainy day frequency may be a more critical variable for some applications.




## Conclusions

- The DJF 2019/2020 forecast for Rwanda rainfall leaned towards above average rainfall
- The SOND 2019 forecasts for Rwanda rainfall total and rainy day frequency and total rainfall leaned towards above average conditions
- NextGen forecasting can enable rolling seasonal forecasts in an objective framework that is skill dependent
- Flexible forecast format can more specifically inform user needs
- Different predictand variables can be chosen on the basis of forecast skill and user needs

## Next Steps

- Refine ENACTS product and make forecasts with ENACTS
- Explore the potential of developing 2-4 week lead sub-seasonal forecasts
- Integrate forecasts of dry spell frequency, wet spell frequency and onset date using dynamic IRIDL function definitions
- Explore linkages with Madden Julian Oscillation (MJO)
- Adapt NextGen forecasts to other user defined variables through user engagement

## Acknowledgments

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