

Seasonal Forecasting and Climatology Analysis for Food Security

Applications in Rwanda

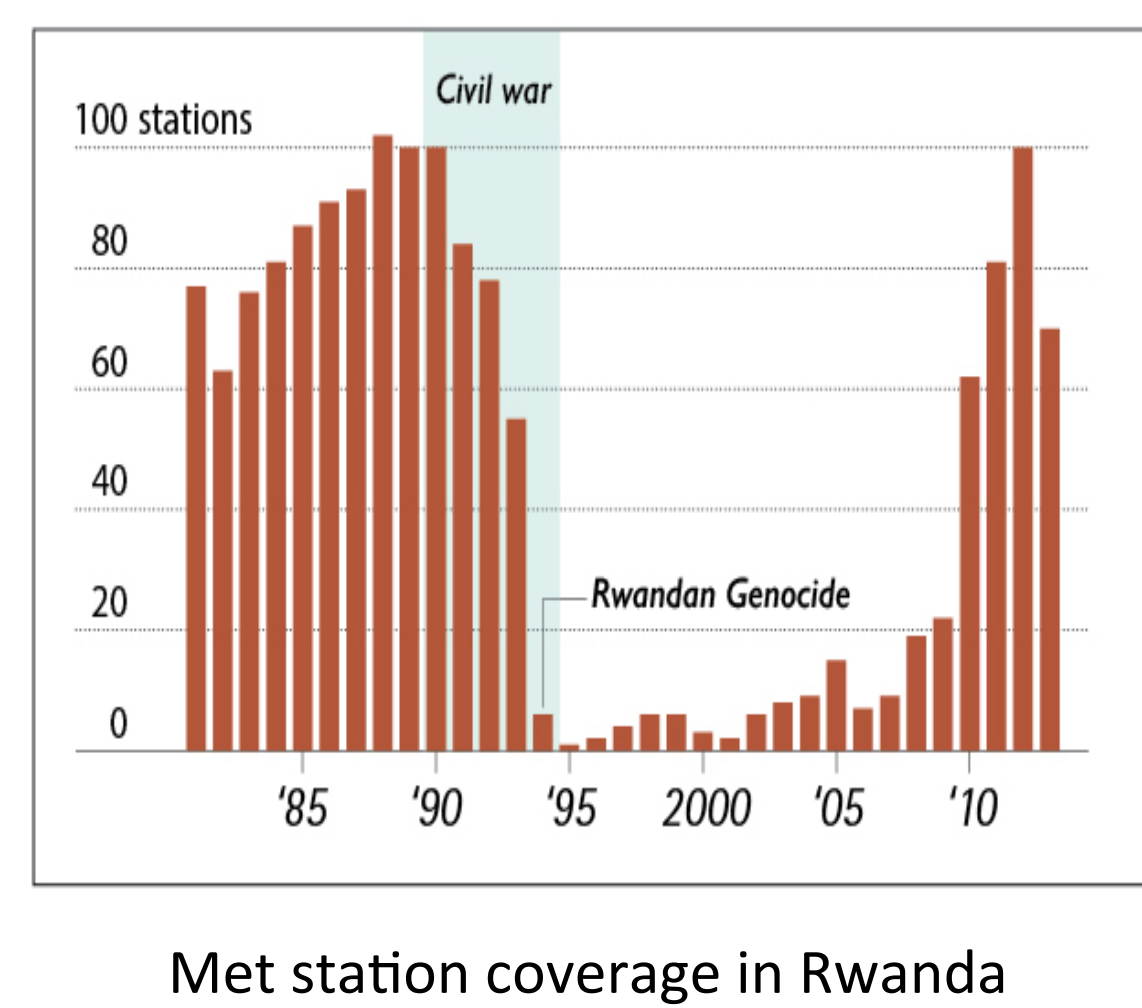
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Rutgers Climate Symposium 2016



Introduction and Overview

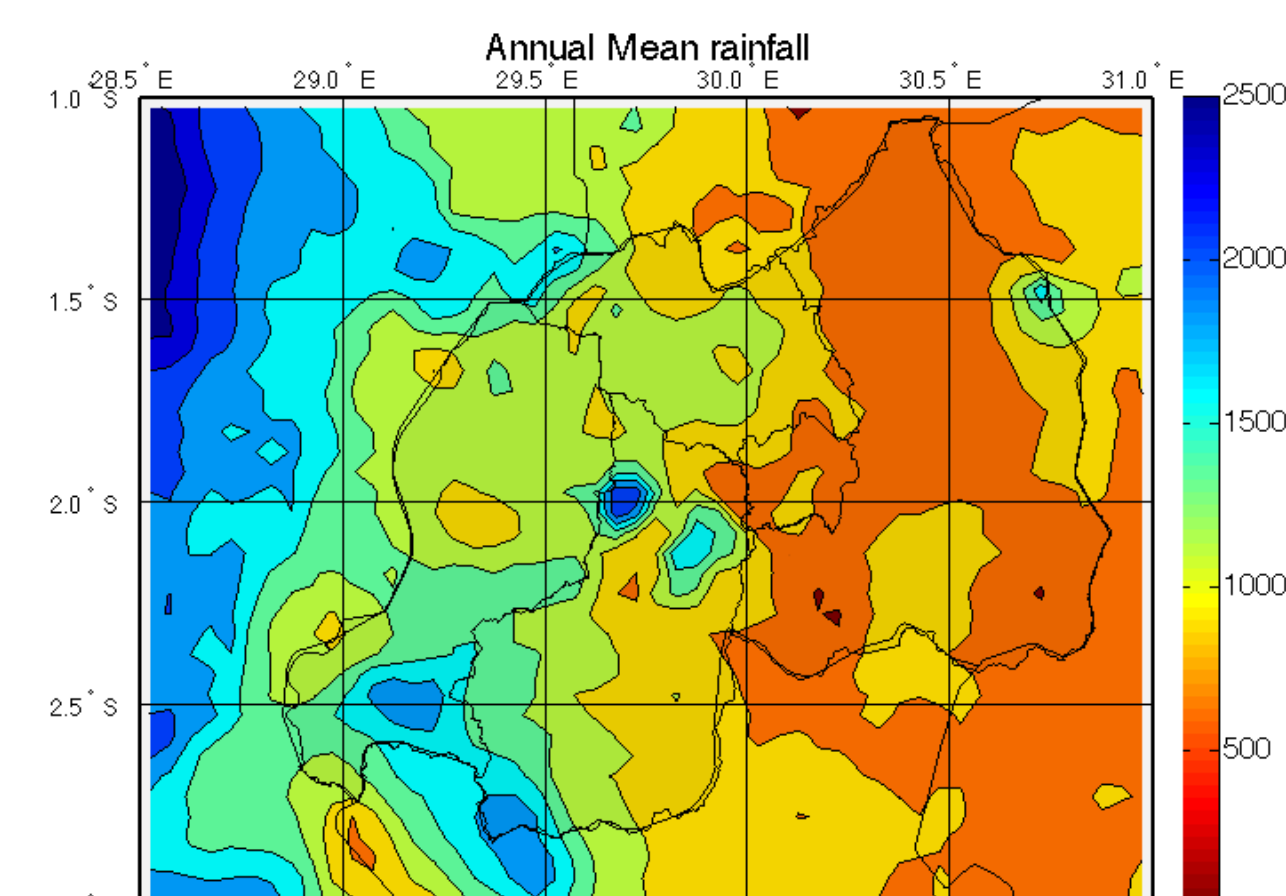
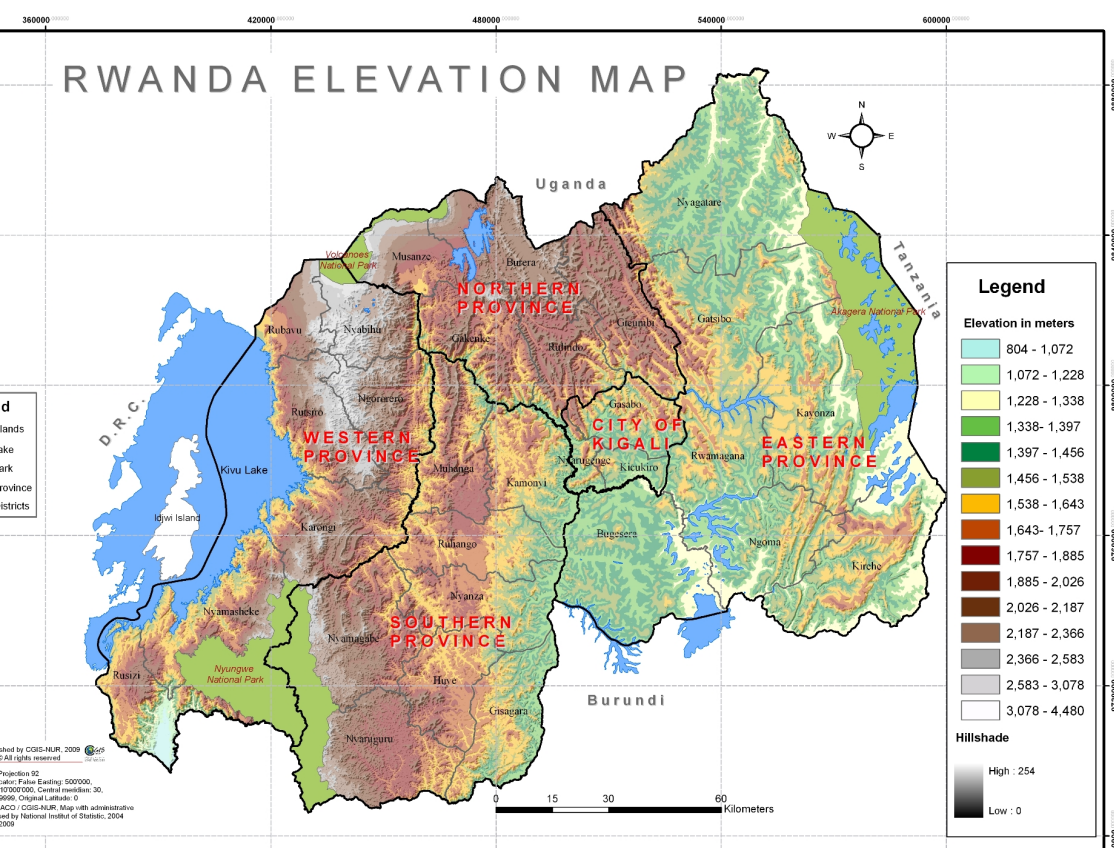
- Climate Change and Food Security (CCAFS) initiative funded by USAID through the Consultative Group on International Agricultural Research (CGIAR)
- Other Project partners include IRI, Rwanda Meteorology Agency, Rwanda Agriculture Board and CIAT (International Center for Tropical Agriculture)
- Four primary project objectives; Climate Services for Farmers, Climate Services for Governmental Planning, Climate Information Provision, National Climate Services Governance
- Over the four year life of the project, the goal is to provide over a million farmers (total population 11 million) with improved climate information, tailor the information to the specific needs of decision makers, strengthen and coordinate information sharing and institutions
- <http://iri.columbia.edu/news/new-climate-services-program-in-rwanda-aims-to-reach-one-million-farmers/>
- <https://ccafs.cgiar.org/building-climate-services-capacity-rwanda>

- Significant decline in meteorological station coverage from the mid-1990s to about 2010 due to the civil war, genocide and aftermath
- ENACTS (Enhancing NATional ClimaTe Services)
- Effort to merge station and satellite rainfall records to offer continuous record at a high resolution (0.05 degree) (led by IRI scientist Tufa Dinku)
- With ENACTS, there is daily, dekad and monthly meteorological data for the country continuously from 1981-2016
- ENACTS in many other countries in Africa; Ethiopia, Ghana, Madagascar, Mali, Tanzania, Zambia
- <http://iri.columbia.edu/resources/enacts/>



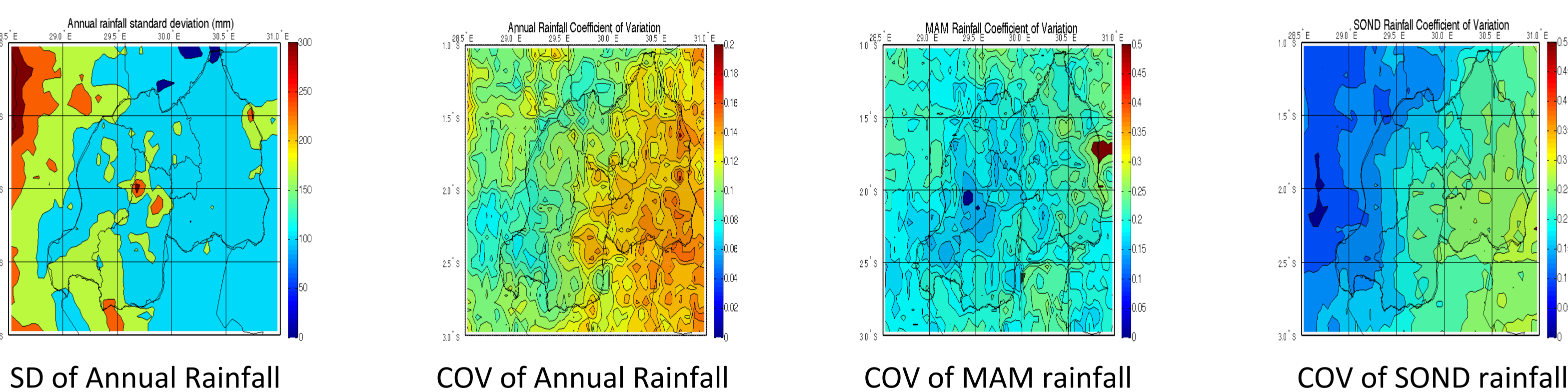
Climatology Analysis

- Highly mountainous country in the African Rift Valley – median elevation almost 5,000 ft. above sea level, highest peak almost 15,000 ft. above sea level
- Wetter west than east (orographic enhancement)
- MAM and SON/D rainy seasons
- Suppressed rainfall in JF, almost completely dry in June-August
- Meteo-Rwanda Maproom page: <http://maproom.meteorwanda.gov.rw/maproom/>



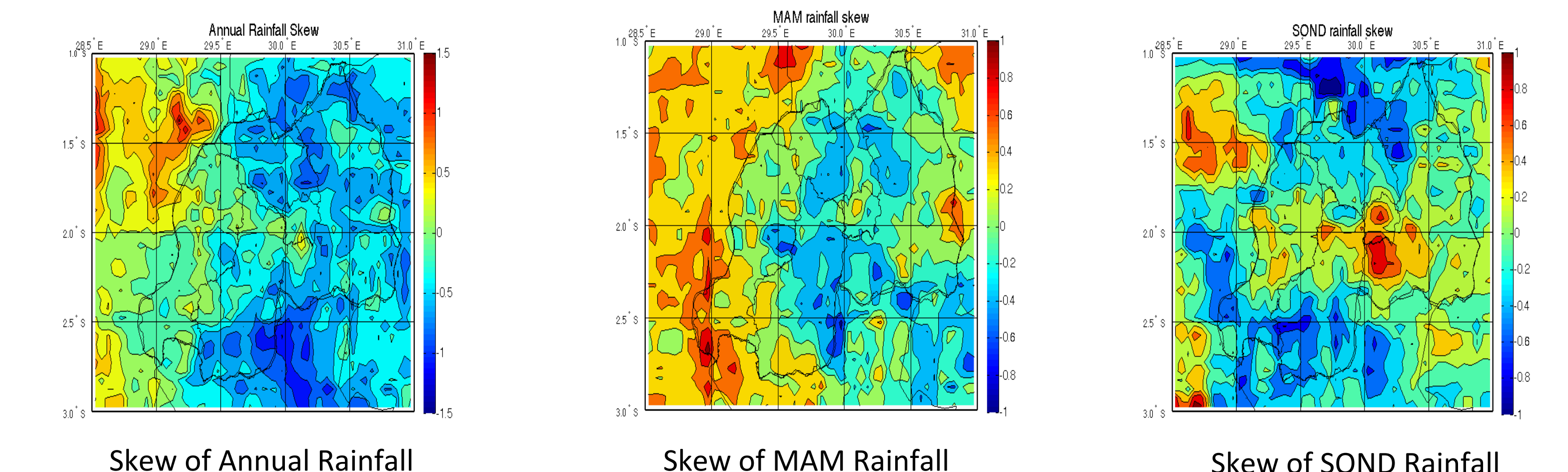
Measures of Variability

- Variability tends to follow climatological mean
- Coefficient of Variation tends to be higher in more arid areas – but there is seasonal dependence



Skew and asymmetry

- Measure of how asymmetric the distribution is – important for understanding the intertemporal distribution of extreme events
- In many places tends to be inversely correlated with rainfall; in this case, it depends on the season

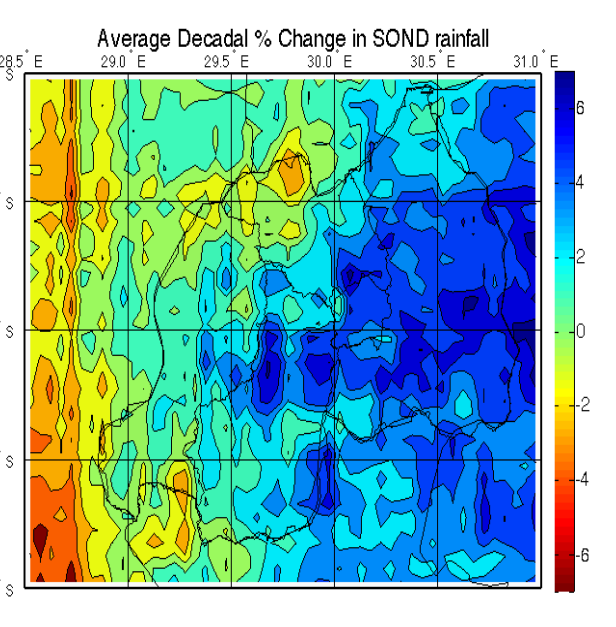
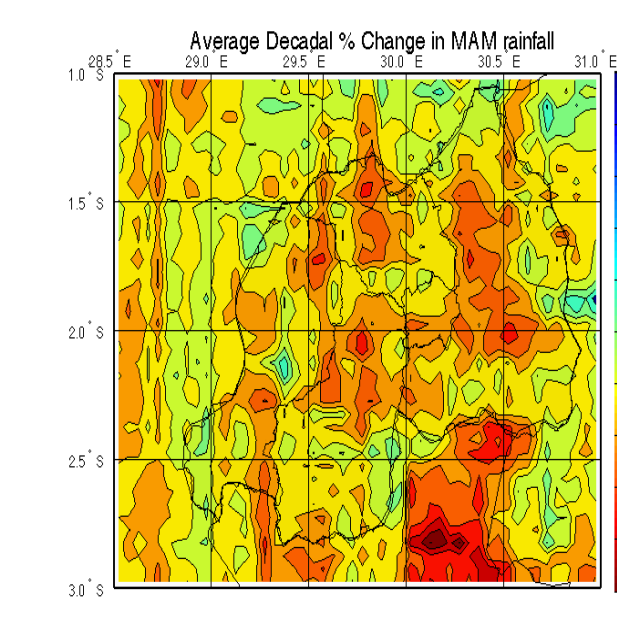
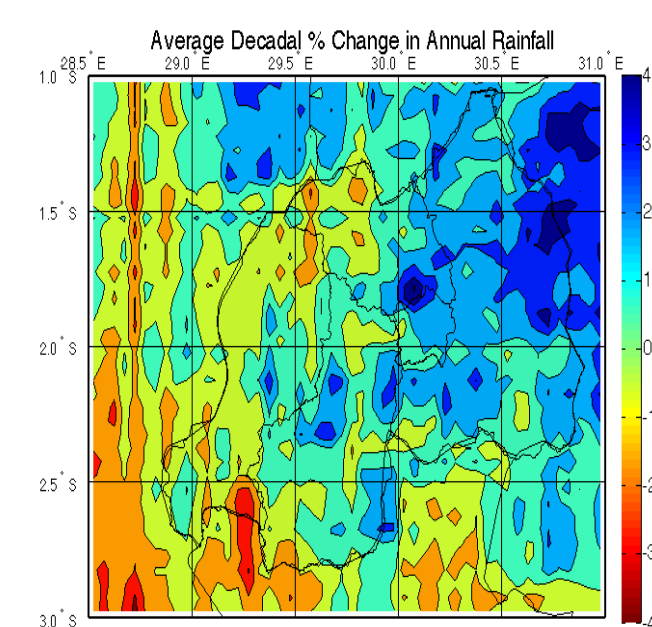


Other variables

Kurtosis, Maximum, 75th %ile, Median, 25th %ile, Minimum, Trend

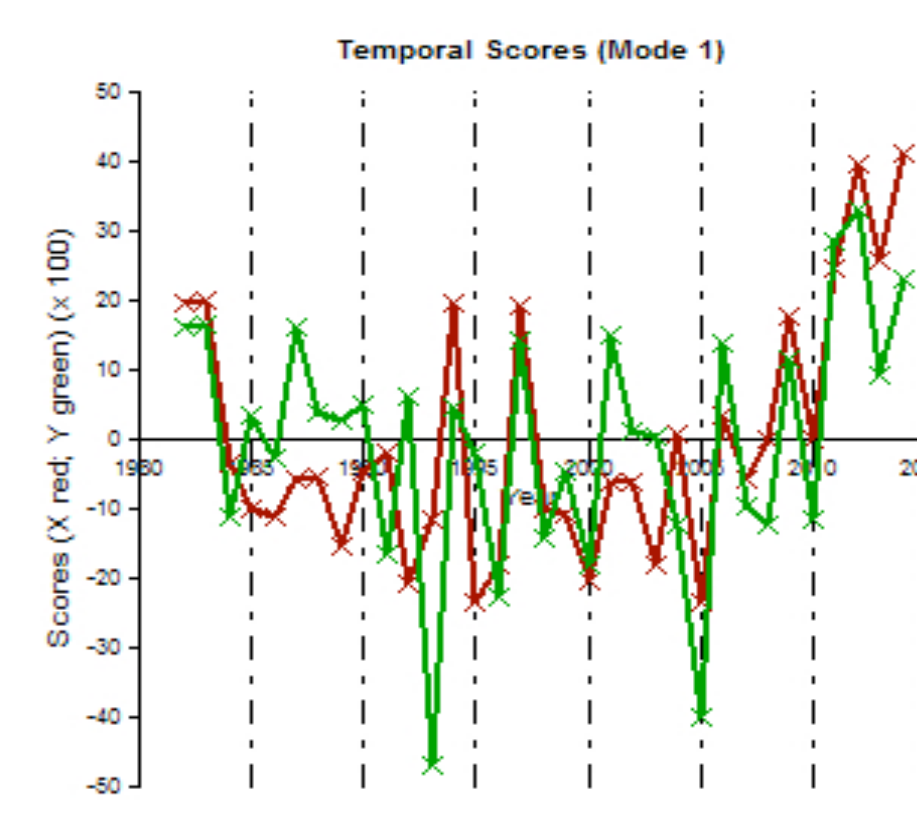
Trends in Rainfall

- In the Annual Analysis, wetting trend in the East and drying trend in the West
- MAM drying trend more prevalent
- SON/D wetting trend more prevalent

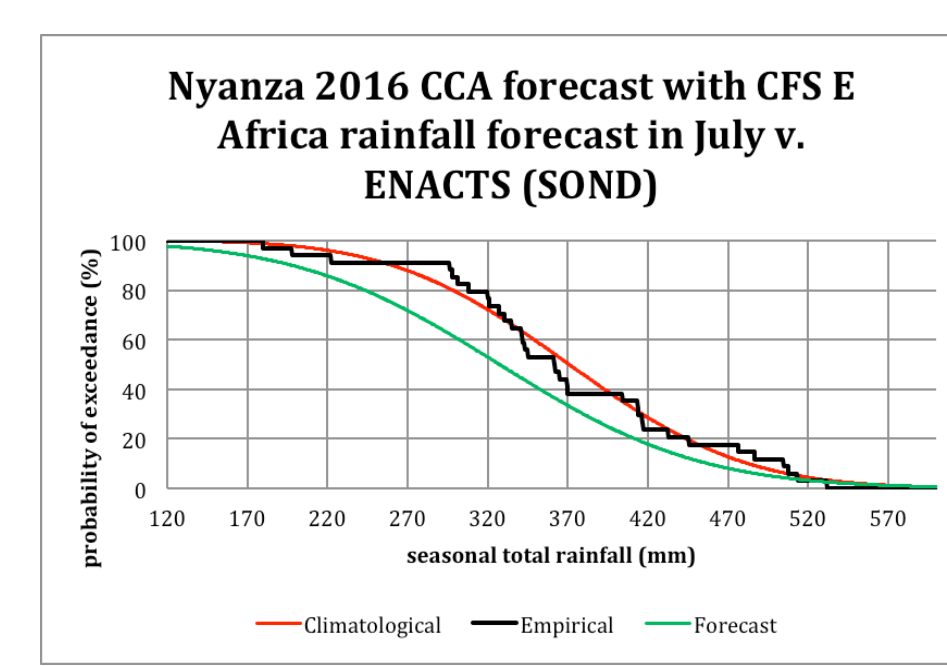
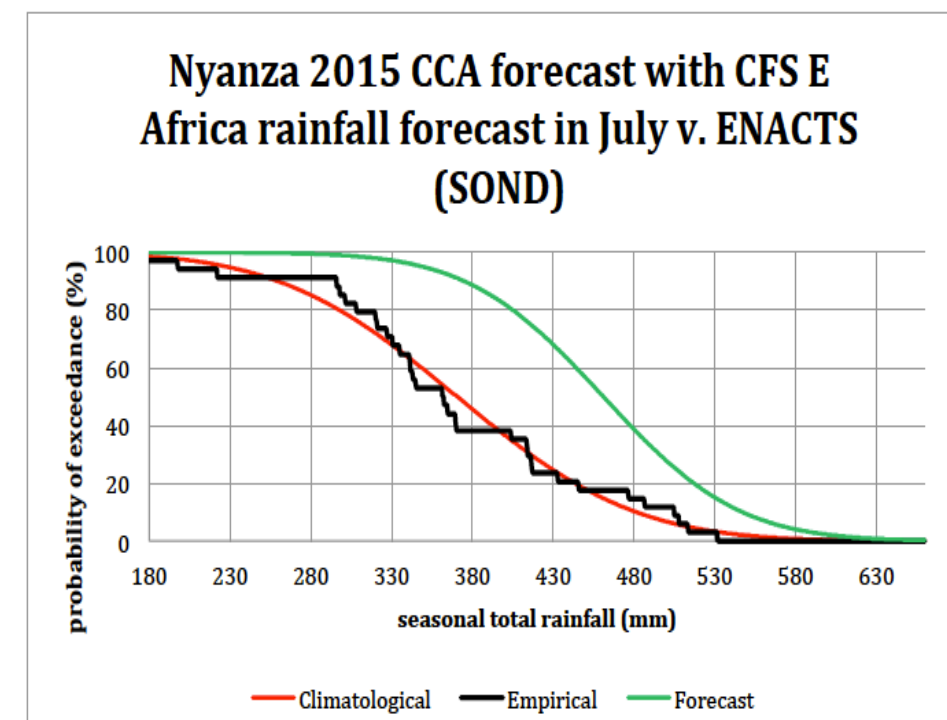
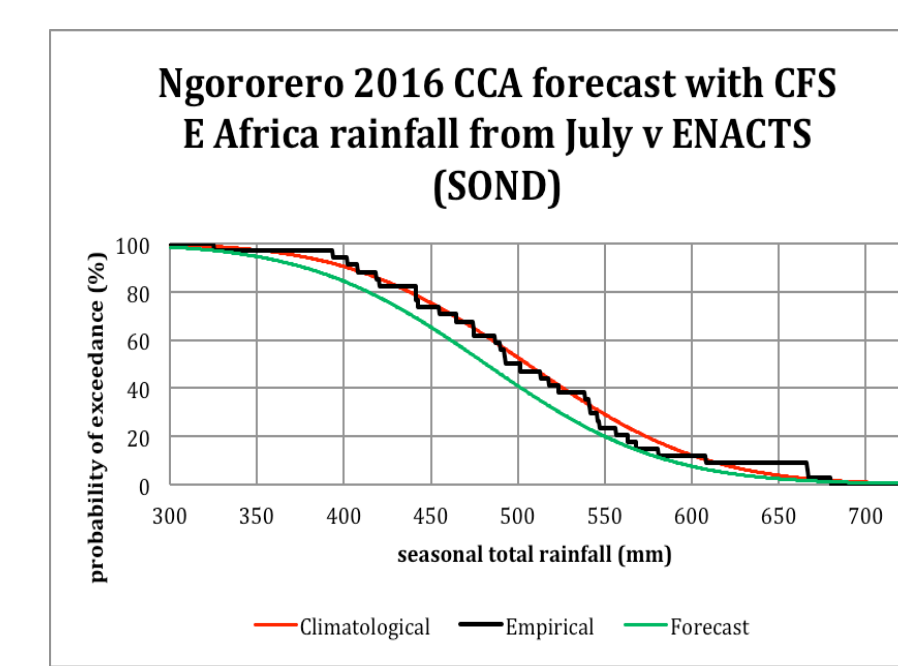
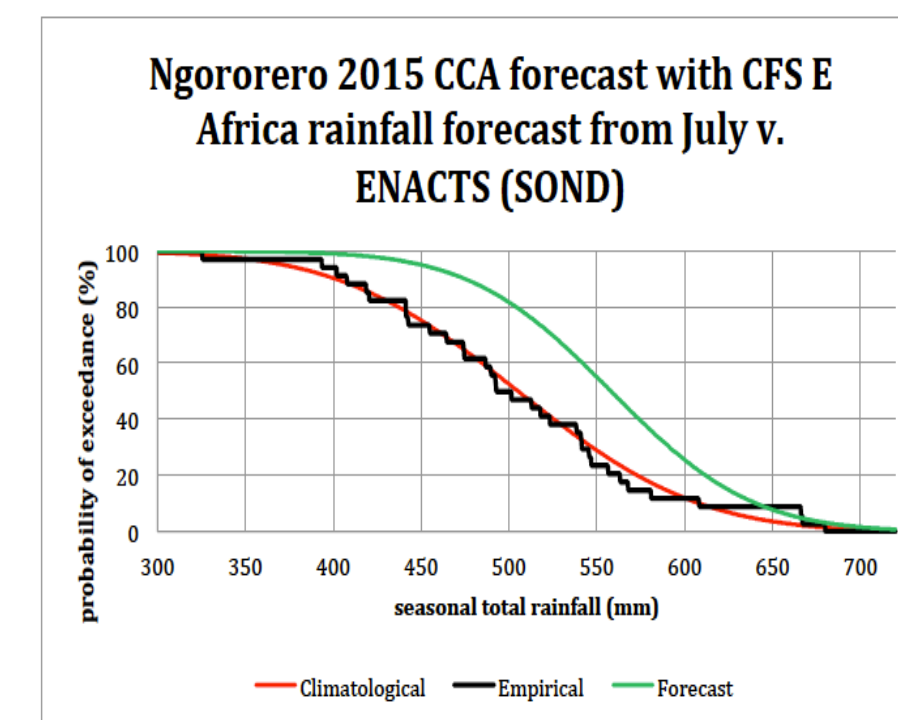
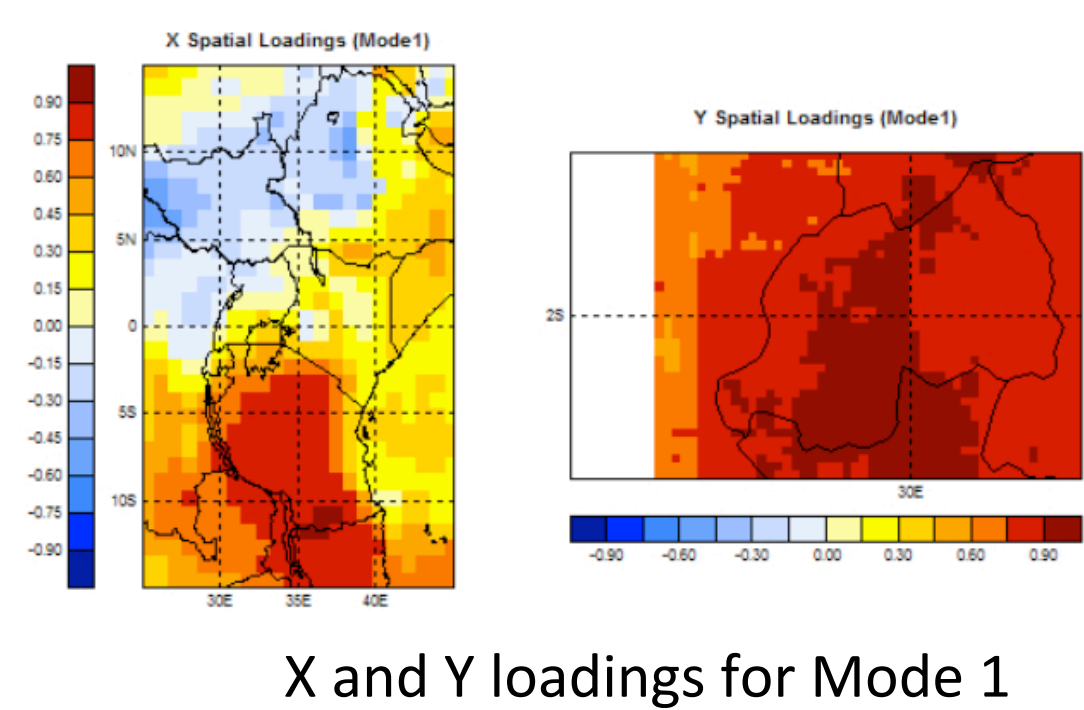
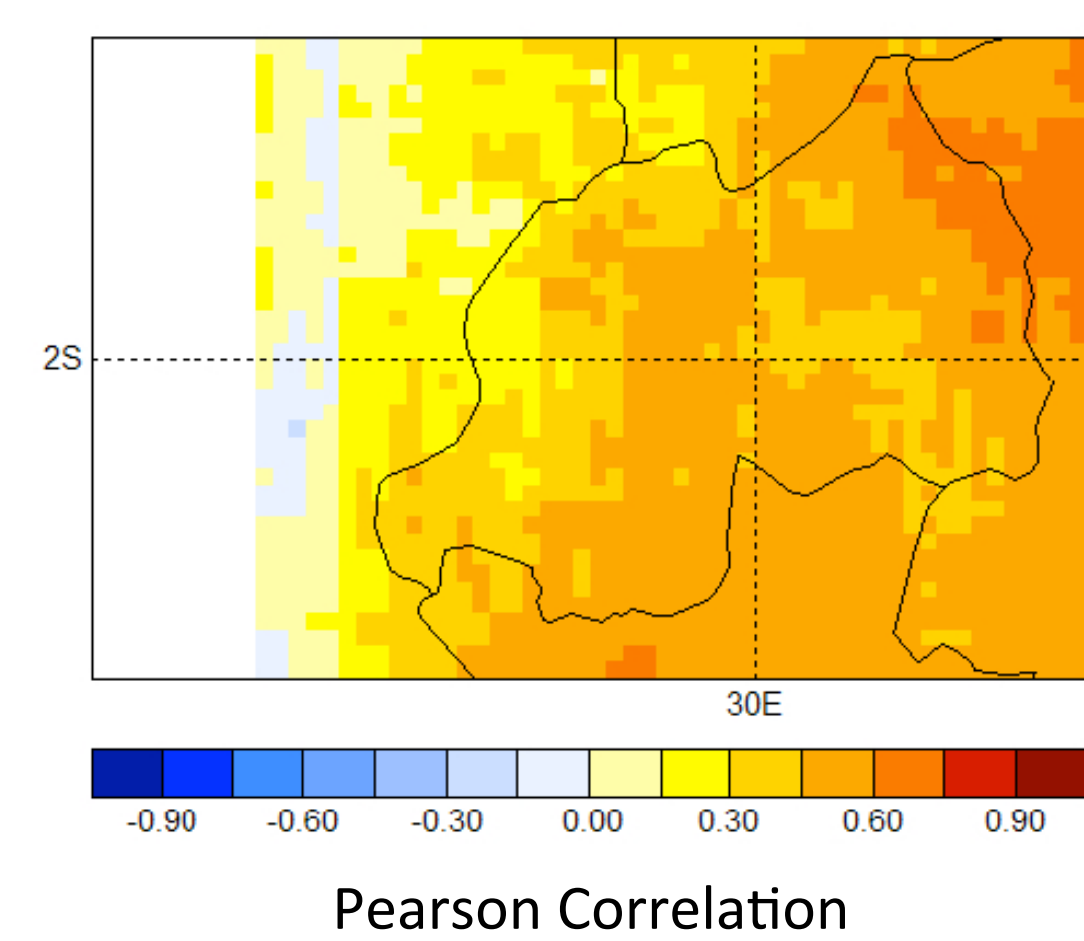


Seasonal Forecasting

- Main moisture source for most of the country is Indian Ocean
- Similar ENSO and IOD response to the rest of East Africa; warm SSTs in the Western tropical Indian Ocean tend to correspond to wetter conditions in Rwanda, Cool SSTs in the Western Tropical Indian Ocean tend to correspond to Drier conditions in Rwanda
- Some moisture advection from the Congo basin during JFMAM (especially February)



- Used Climate Predictability Tool to conduct Canonical Correlation Analysis with CFS climate model for SON/D 2016 forecast
- Mode and Skill Maps
- Mode temporal scores
- $Z_1 = \alpha_1 X_1 + \alpha_2 X_2 \dots$
- $Y = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 \dots$
- Colors in mode maps are α s
- Scores are Y values as a function of time
- Also explored other GCMs and SST predictors



- Downscaled probability of exceedance graphics for each of four districts for first year pilot phase
- Forecast for 2015 was Far above Average due to very strong El Nino
- SON/D 2015 was above average rainfall for country as a whole but below average in some regions (Eastern Province)
- Forecast for 2016 (on the basis of July model results) was for moderately below normal rainfall (very weak/ borderline La Nina)
- So far, SON/D 2016 has had a few heavy rainfall periods but has been mostly below average

Future Work

- Similar climatological work with temperature data
- Spatial bias correction
- Refine seasonal total rainfall forecasting methodology
- Develop rolling monthly forecasts
- Provide forecast information in probability of exceedance format
- Explore possibility of multi-decadal variability
- Develop forecasts for other statistics (number of rainy days, dry spell length, onset and cessation dates, etc.)
- Continue with work on climatology (peer reviewed publication, AMS poster January 2017)
- Study influence of ENSO and IOD in more detail
- Dynamical RCM modeling in conjunction with colleagues at IRI and Kenya's ICPAC
- Develop more detailed understanding of the dynamics of Rwanda's climate (wind field, moisture advection, etc.)
- Forecast verification
- Connect meteorological work with agricultural work and water balance assessment

Acknowledgements

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