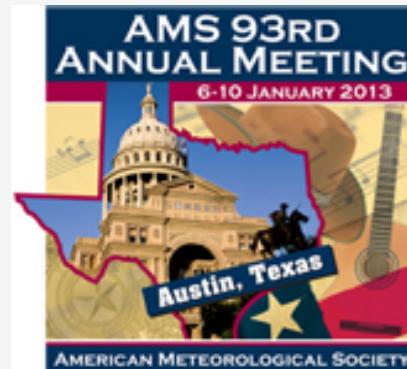




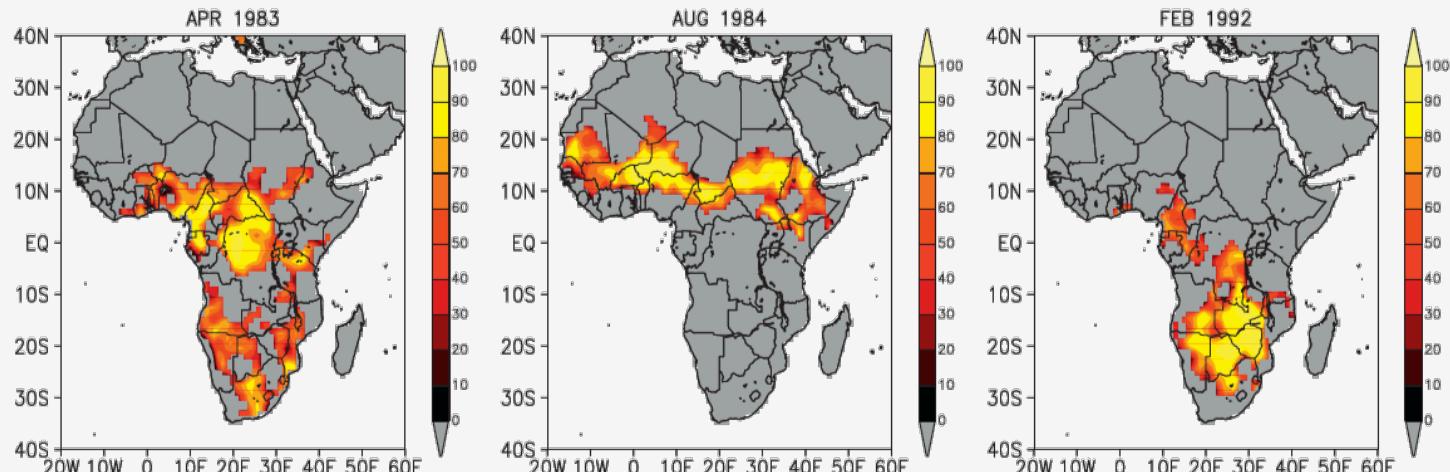
SPATIOTEMPORAL VARIABILITY OF PRECIPITATION OVER AFRICA

H. S. Badr, B. F. Zaitchik, A. K. Dezfuli
Johns Hopkins University



Motivation

- Africa is characterized by considerable variability of precipitation.
- Africa's average annual rainfall has decreased since 1968,
- There is also some evidence that natural disasters have increased in frequency and severity, particularly drought in the Sahel.

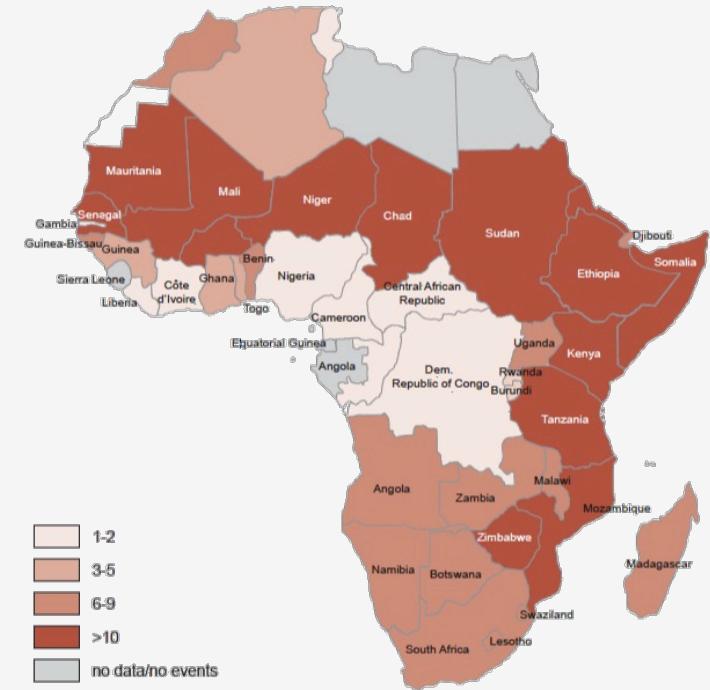
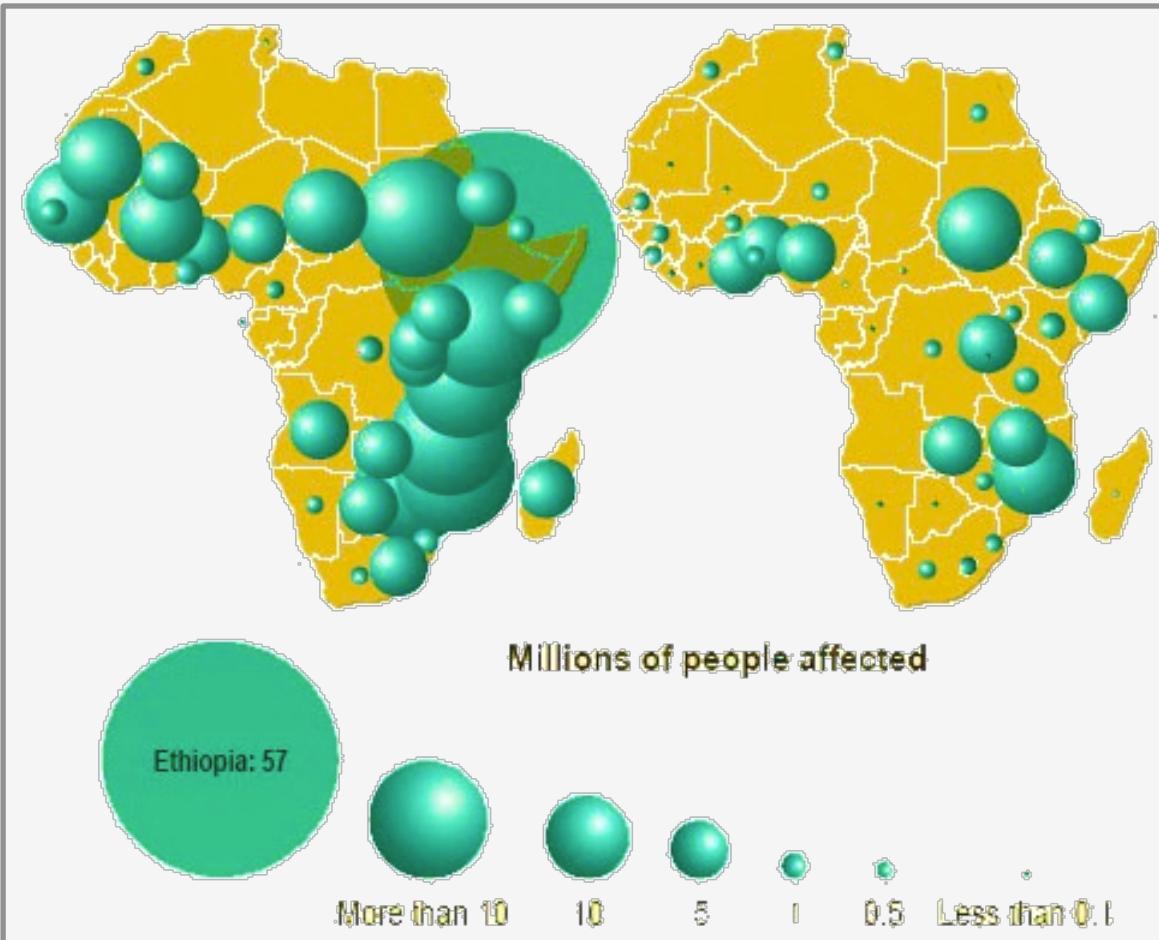


Sheffield et al. 2009

Motivation

Drought

Flood



Drought events per country from 1970 to 2004 within Sub-Saharan

Objectives

- Assessment of the interannual variability of precipitation over Africa at different temporal resolutions, using PCA.
 - Spatial patterns are temporally specific...
- Regionalization of Africa into homogeneous precipitation climates using Hierarchical Clustering Analysis (HCA).
 - Definition of seasons, as sets of months, for each region...

- Prediction of precipitation variability for each region
 - Developing and testing multiple statistical models...

- Association of precipitation variability with global patterns
 - Understanding mechanisms and representation in climate models...

■ Now

■ Presented (for Sahel)

■ In progress

Data and Methods

| Dataset / Variable | Spatial Resolution | Temporal Resolution | Type |
|--------------------|--------------------|---------------------|-----------------------|
| BADC CRU-TS 3.1 | 0.5° | Monthly (1901-2009) | ADW Interpolation |
| NASA GPCP | 2.5° | Monthly (1979-2010) | Rain Gauge, Satellite |
| NOAA/CPC CMAP | 2.5° | Monthly (1979-2009) | Rain Gauge, Satellite |
| Univ. of Delaware | 2.5° | Monthly (1900-2008) | Rain Gauge |
| NCDC GHCN | 5° | Monthly (1900-now) | Rain Gauge |
| NOAA/GFDL CM 2.1 | 2.5° | Monthly | Model |
| NOAA/GFDL CM 2.1* | 2.5° | Monthly | Model |
| NASA GISS-E2-R | 2.5° | Monthly | Model |
| Climate Indices | | Monthly | Timeseries |

Data and Methods

Pre-processing

- Data collection and preparation
- Extracting data subsets for each month
- Standardizing and/or masking the fields

PCA

- EOF preparation
- SVD-based EOF Analysis
- Rotated/Mixed/Extended EOF Analysis*

HCA

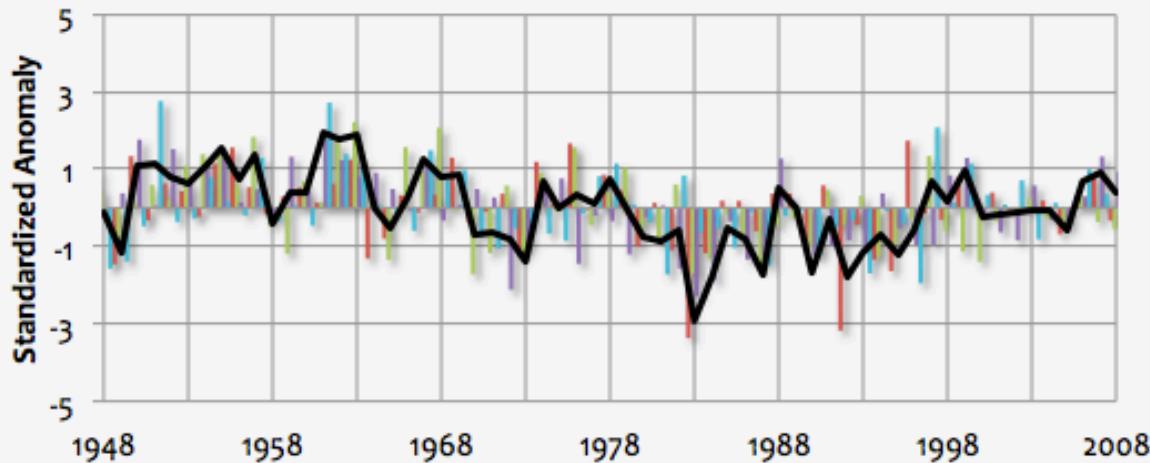
- Similarity measures
- Linkages and grouping
- Verifying the cluster tree

Post-Processing

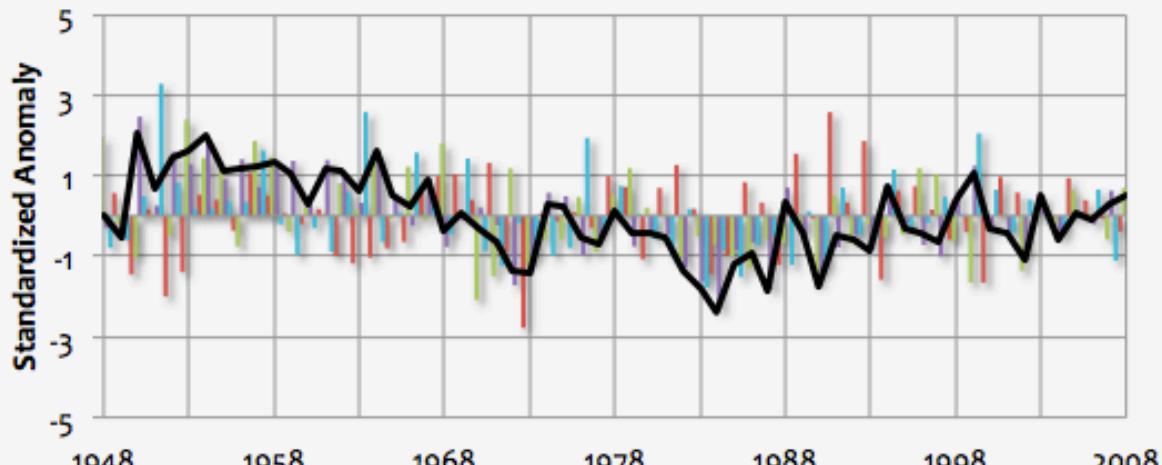
- Visualizing the results
- Sensitivity to different parameters
- Comparing different data sources

Variability of African Precipitation

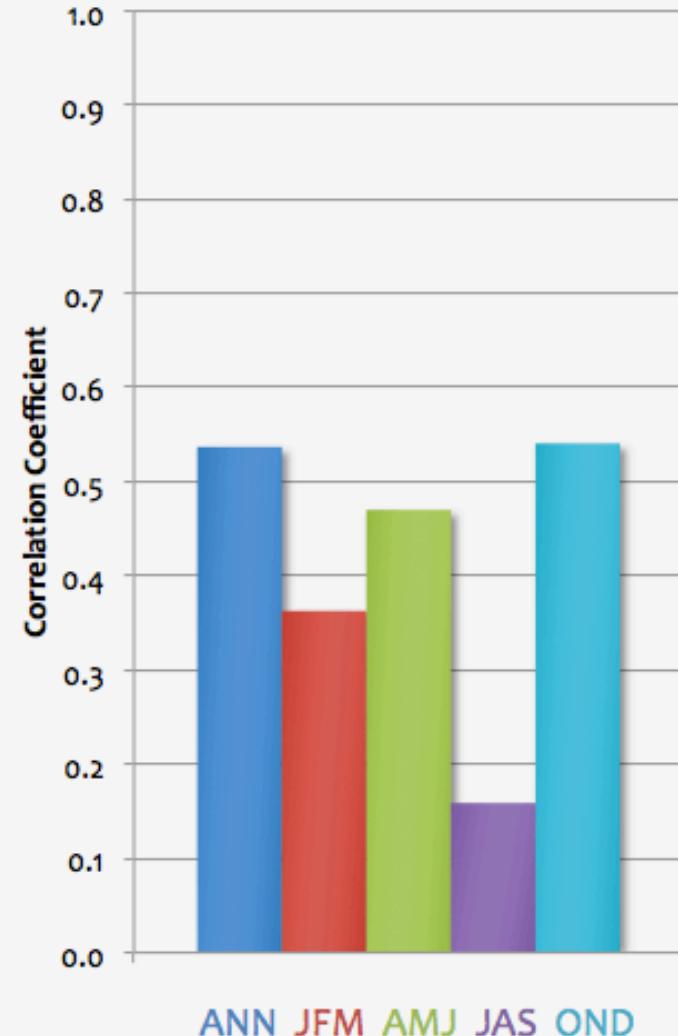
Africa



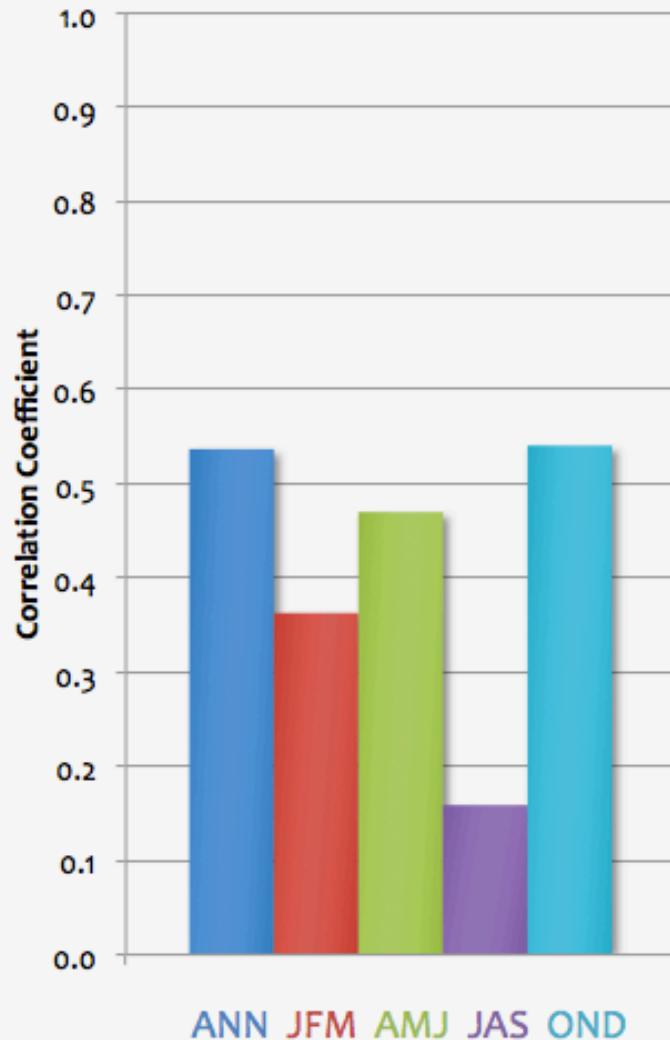
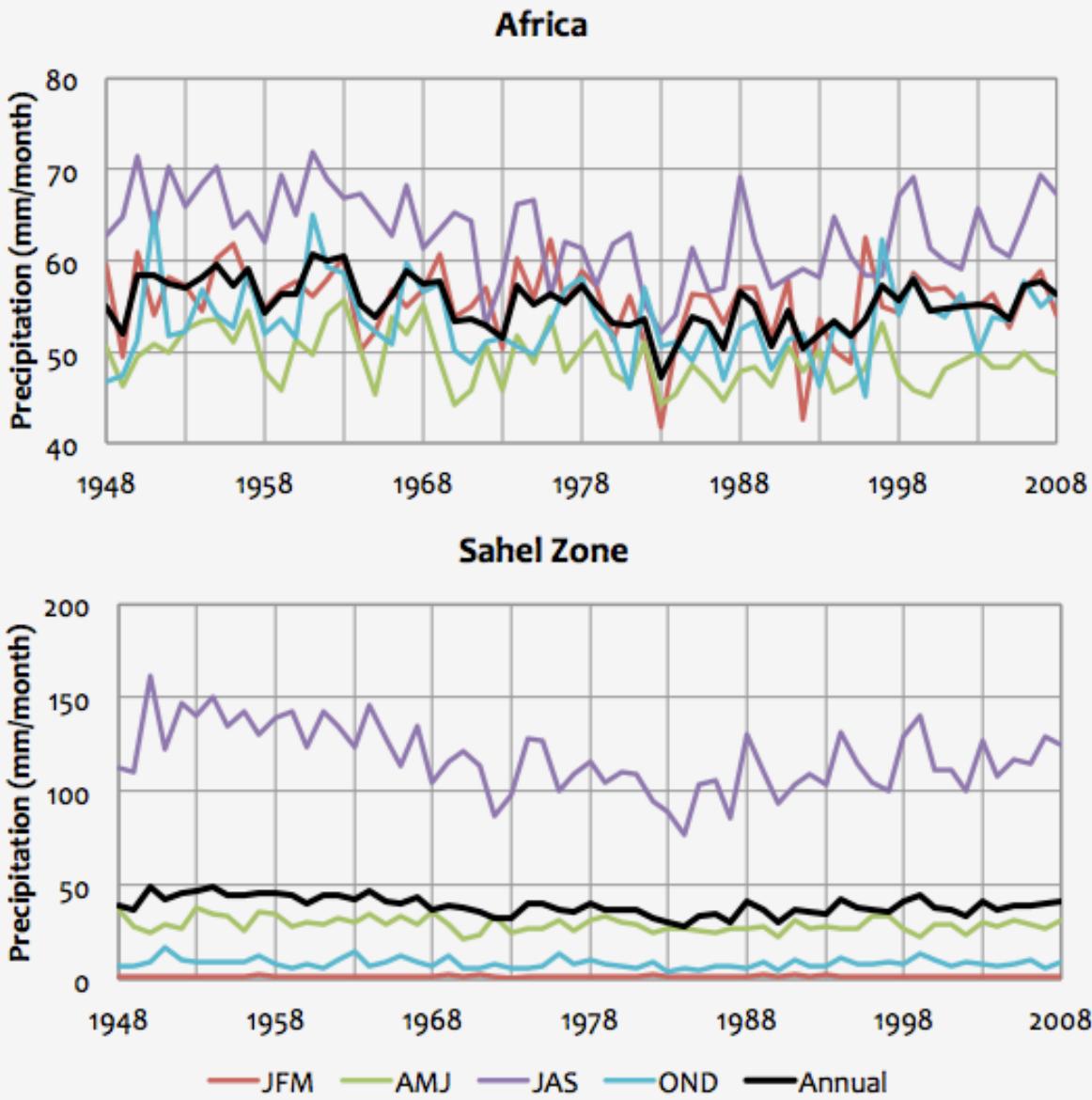
Sahel Zone



JFM AMJ JAS OND — Annual

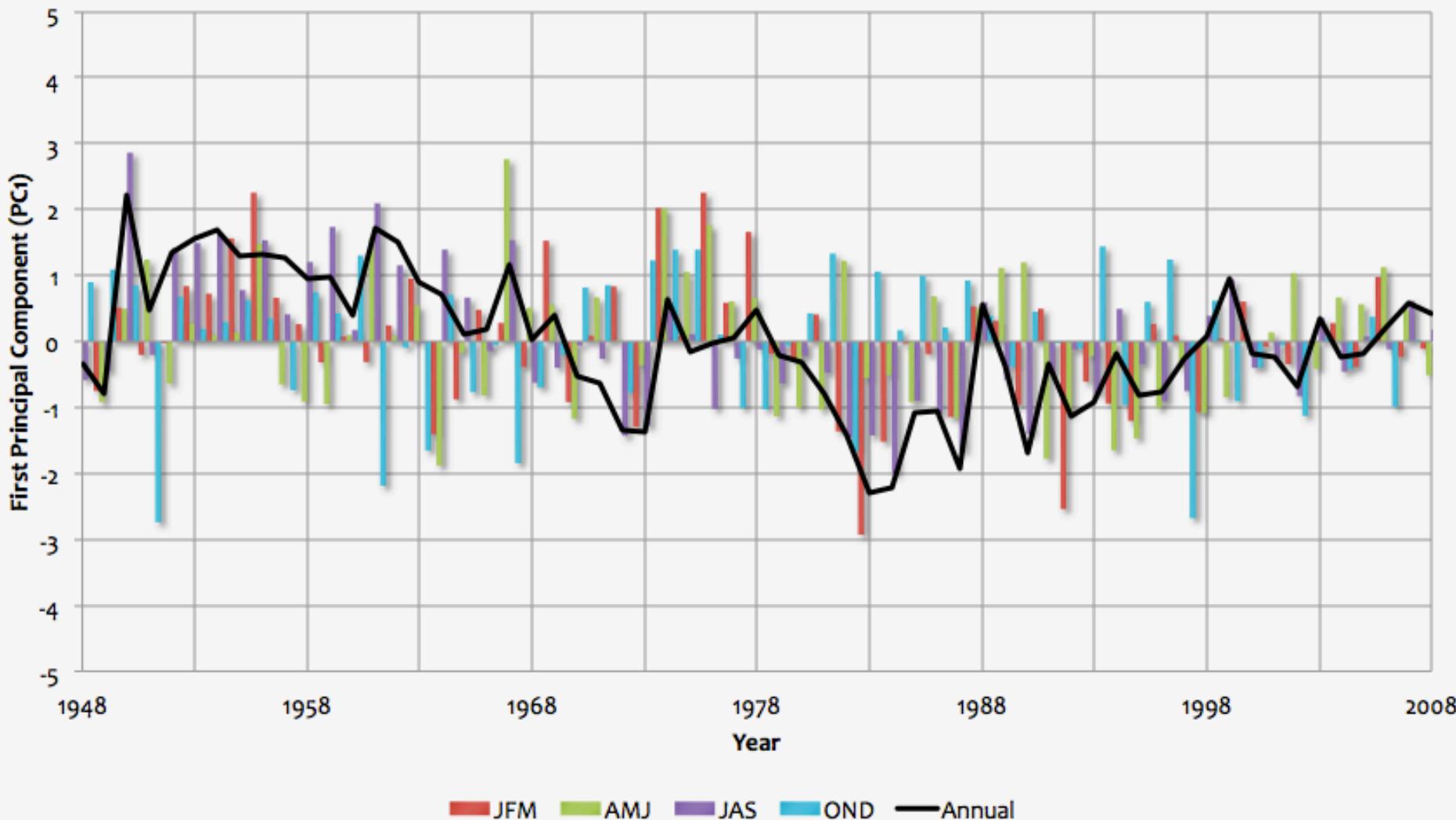


Variability of African Precipitation



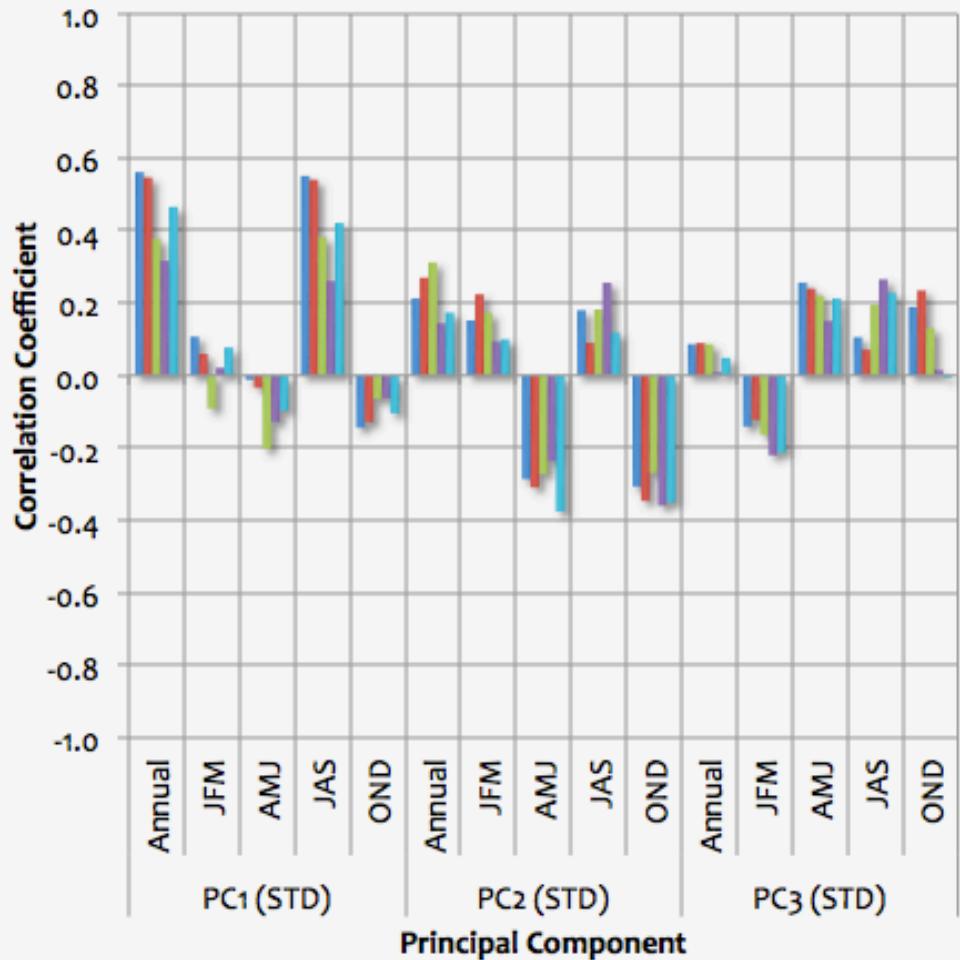
PC1 of Annual and Seasonal Precipitation

PC1 of Annual and Seasonal Precipitation Standardized Anomaly for Africa

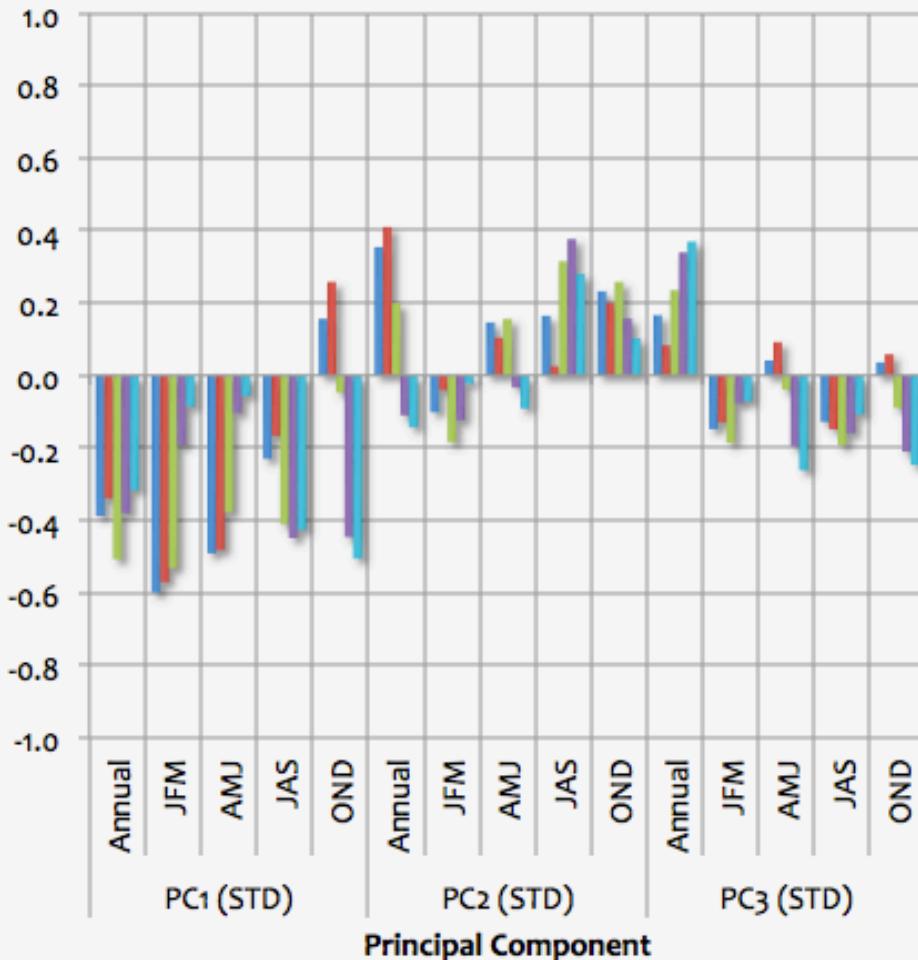


Correlation of PCs with Global Patterns

Correlation of PCs of Precipitation with AMO

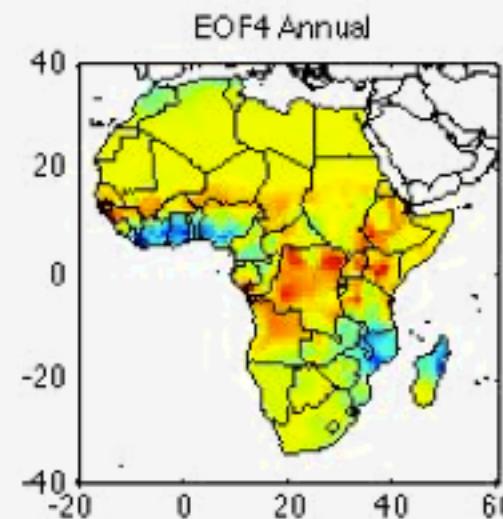
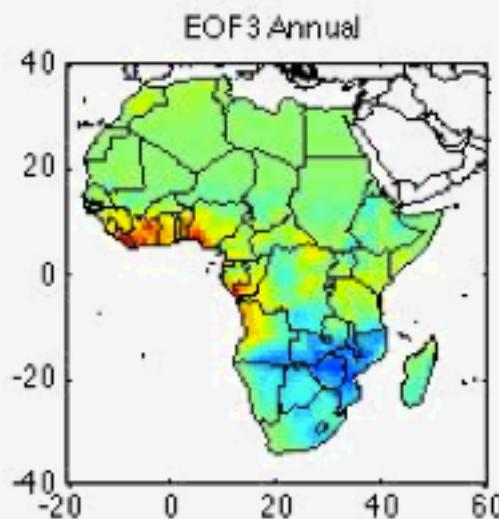
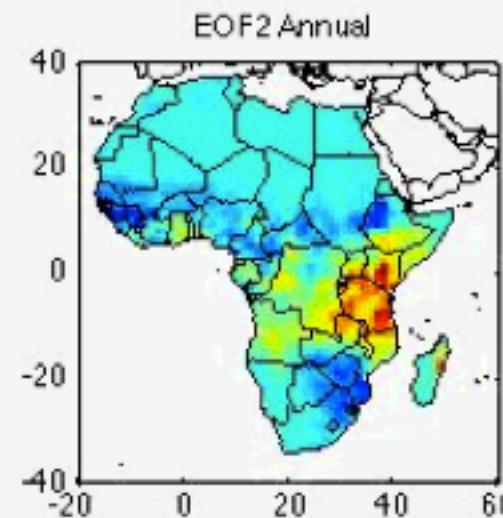
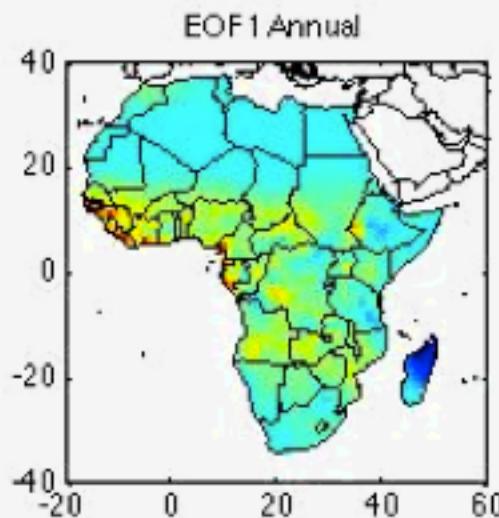


Correlation of PCs of Precipitation with MEI



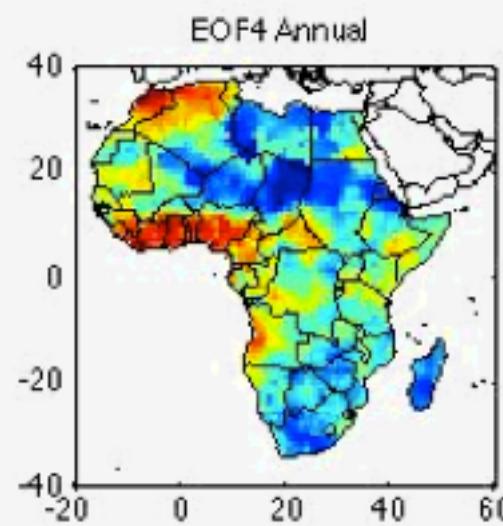
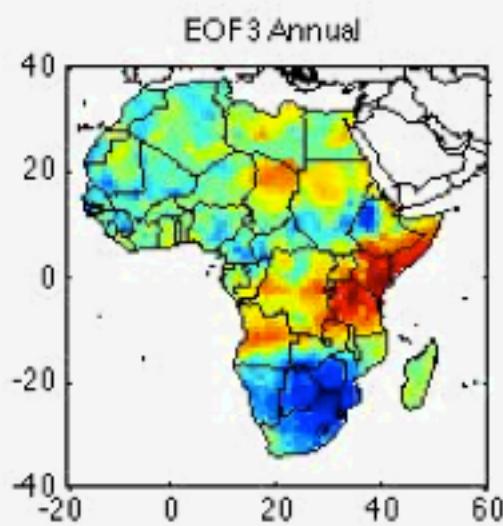
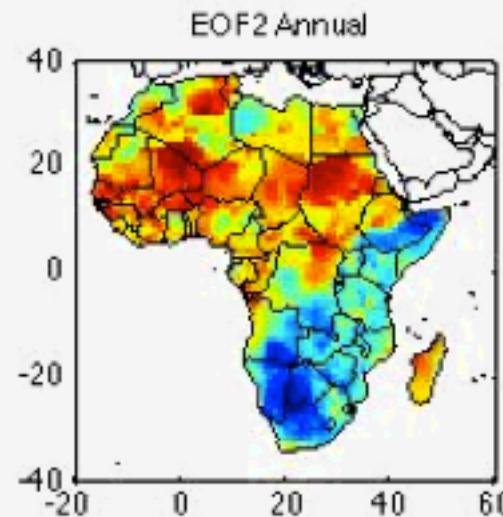
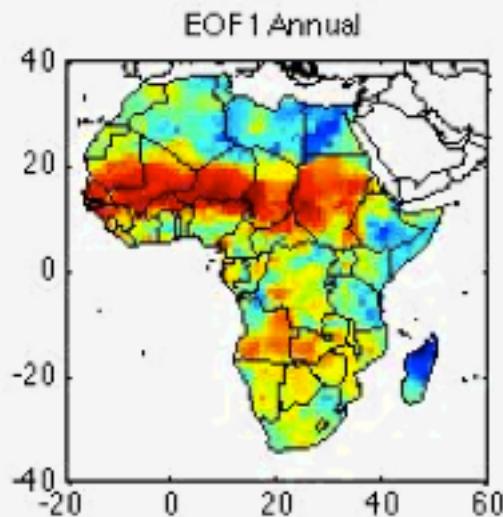
■ Annual ■ JFM ■ AMJ ■ JAS ■ OND

Spatial Patterns of Annual Precipitation



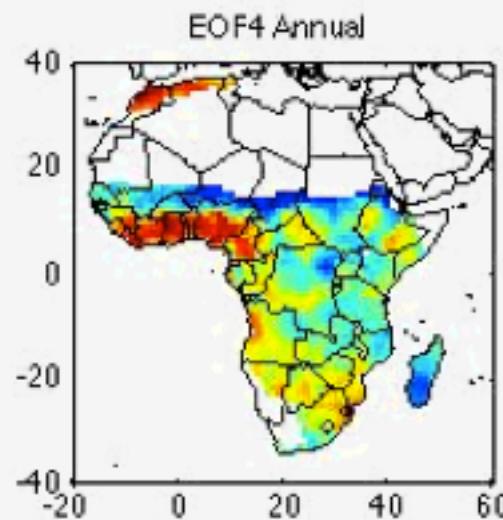
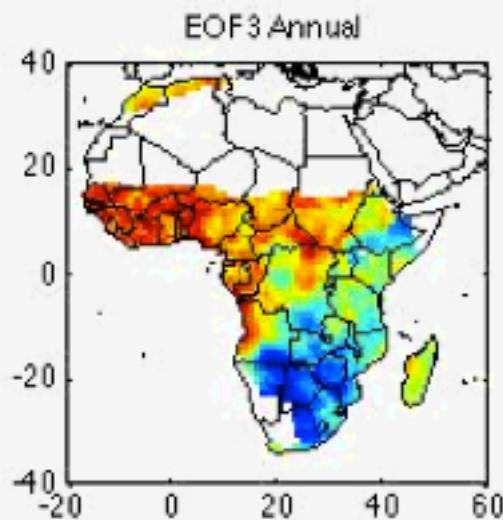
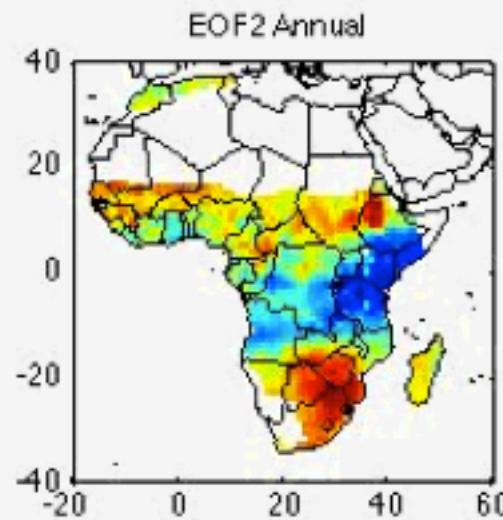
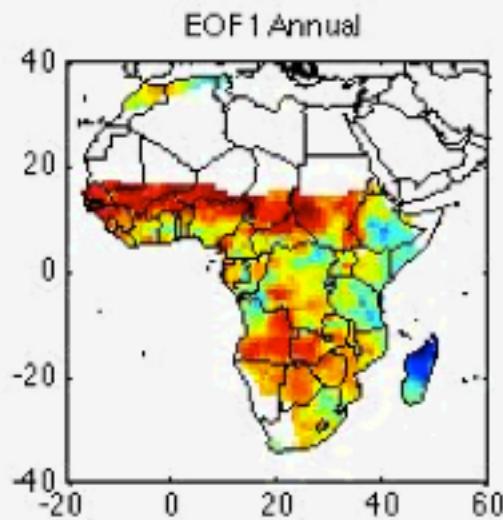
Spatial Patterns of Annual Precipitation

Standardized

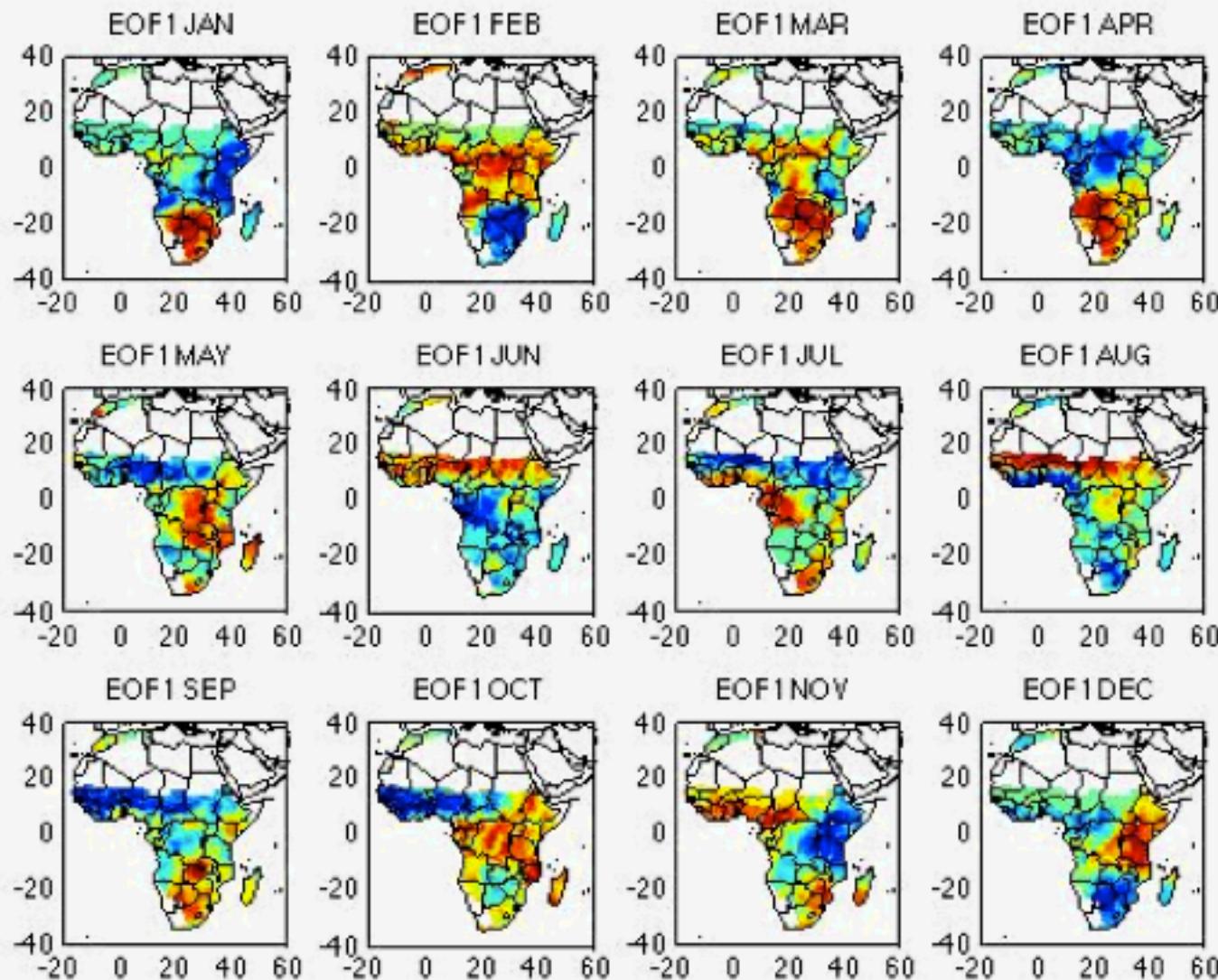


Spatial Patterns of Annual Precipitation

Standardized & Masked

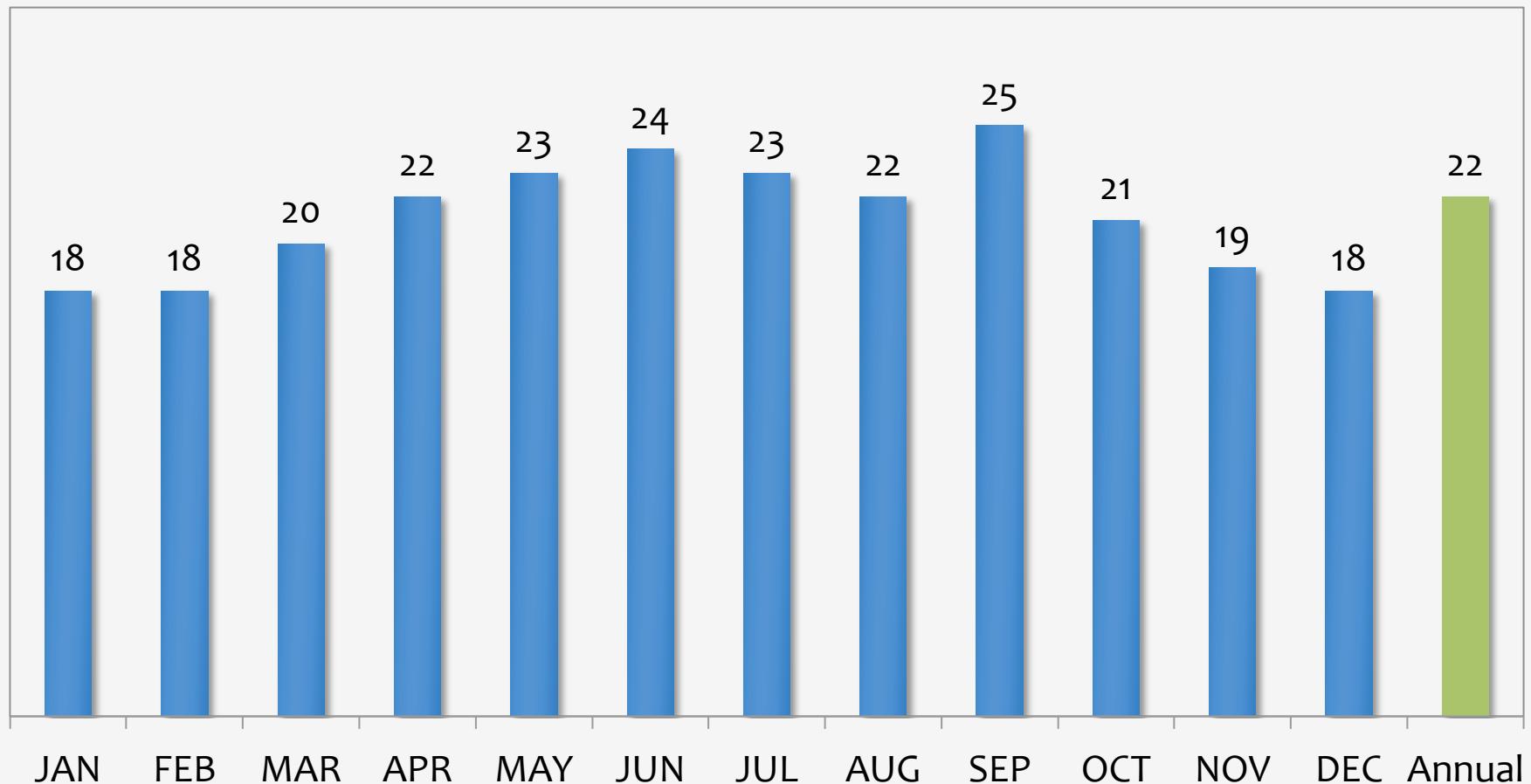


EOF1 of Monthly Precipitation



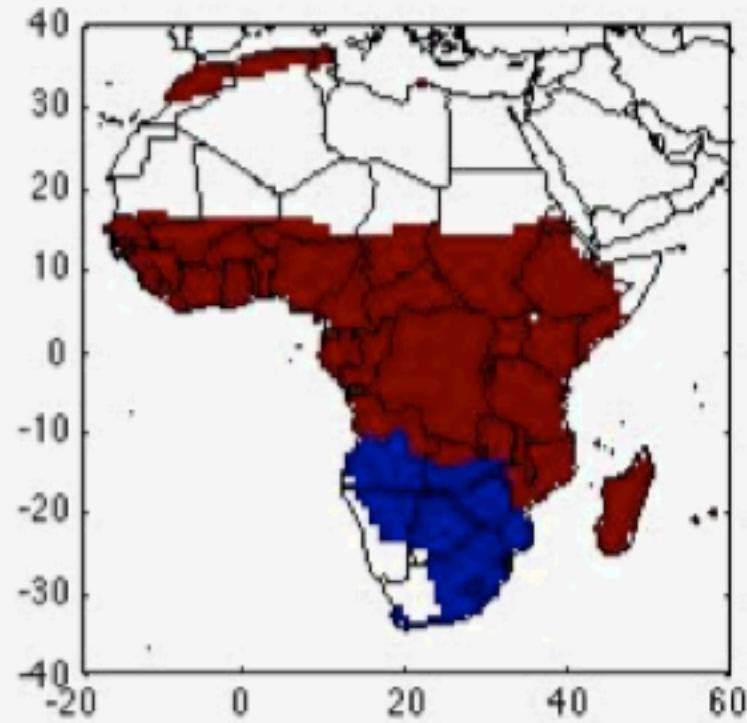
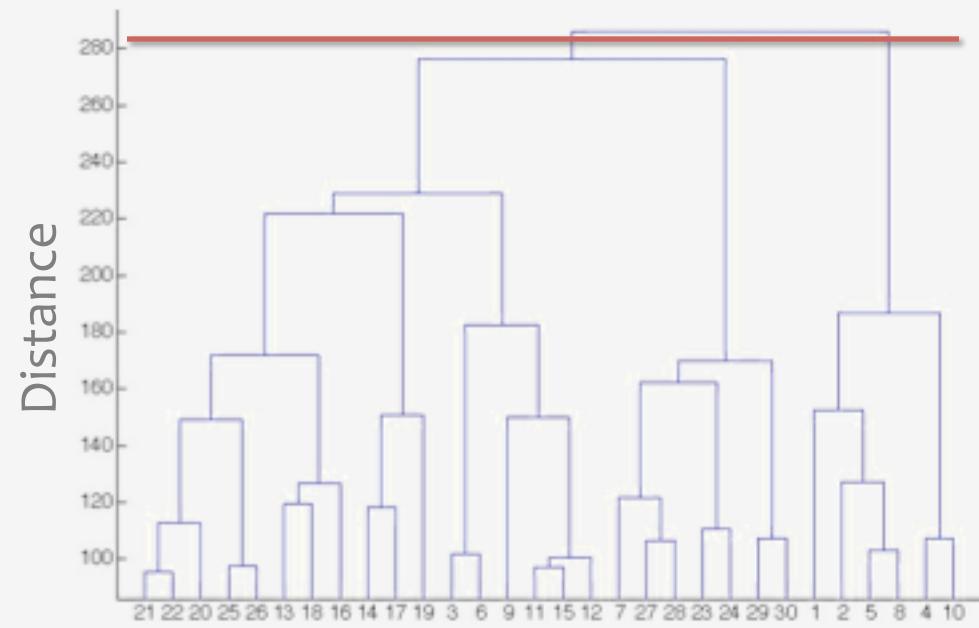
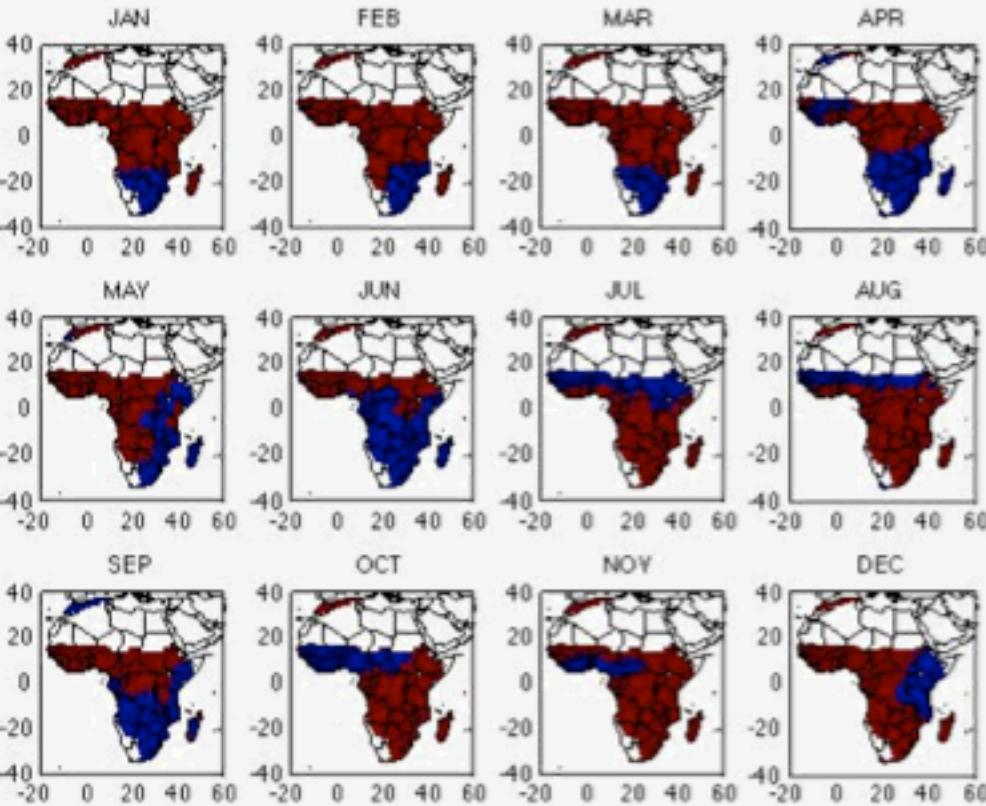
Variance Explained

Number of PCs that explain 70% of the total variance based on interannual variability for each month and annual average



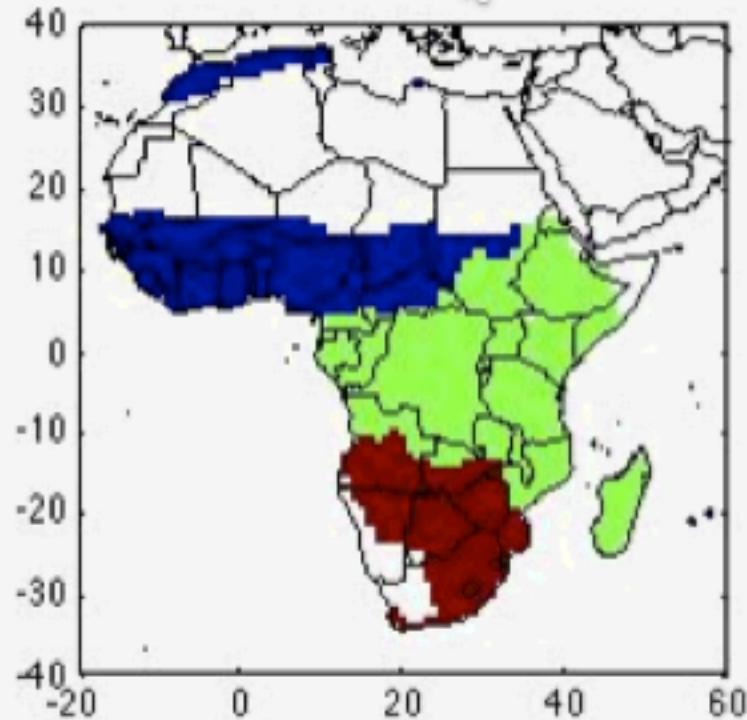
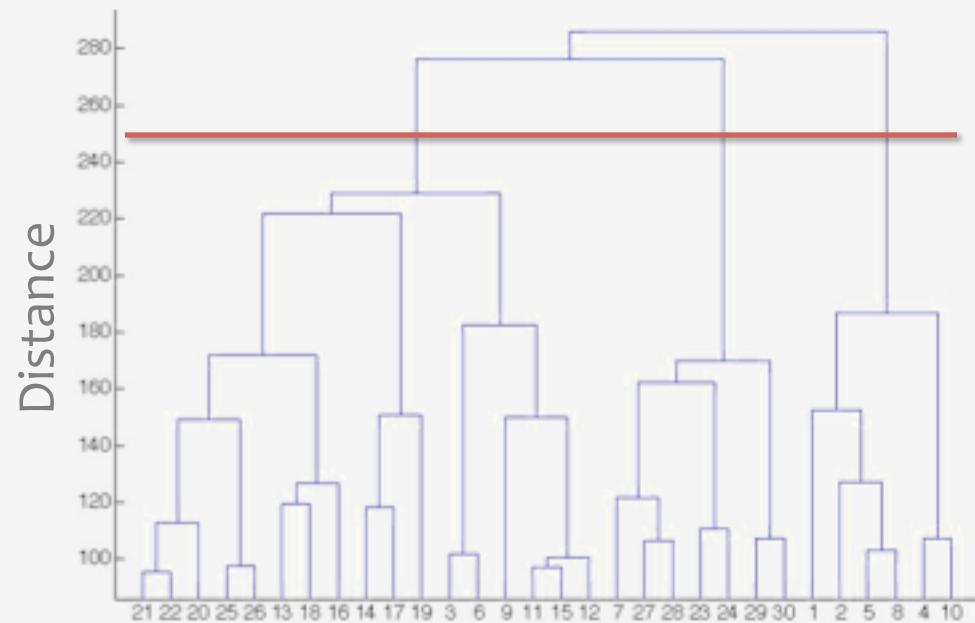
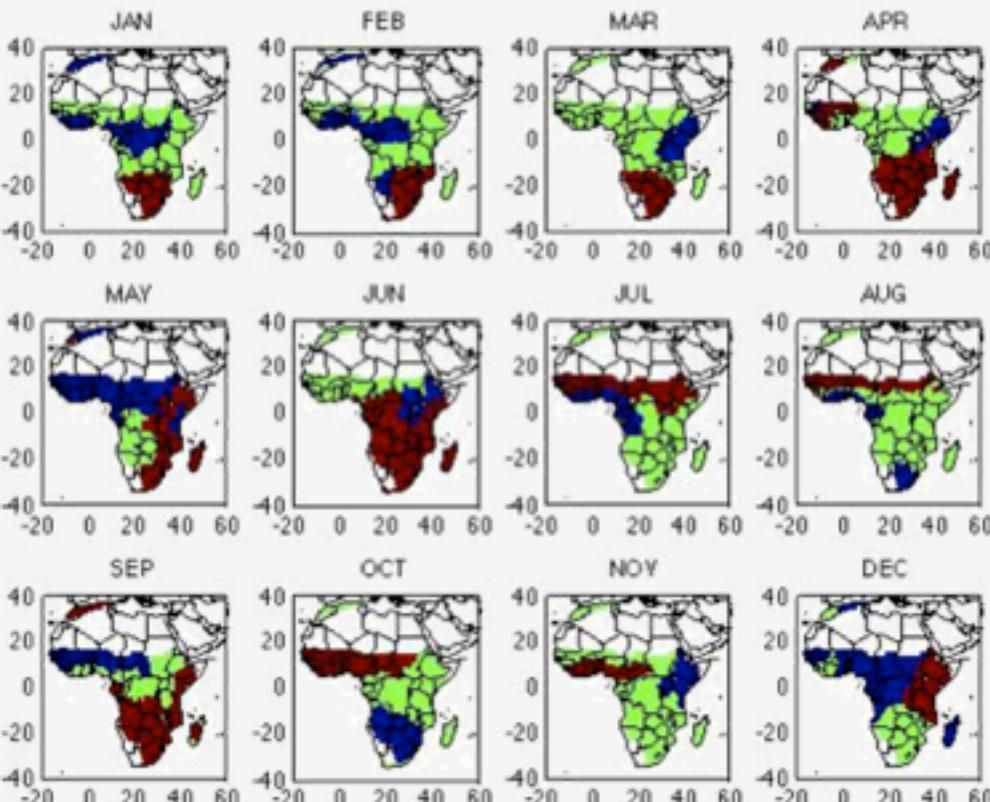
Regionalization

2 Regions



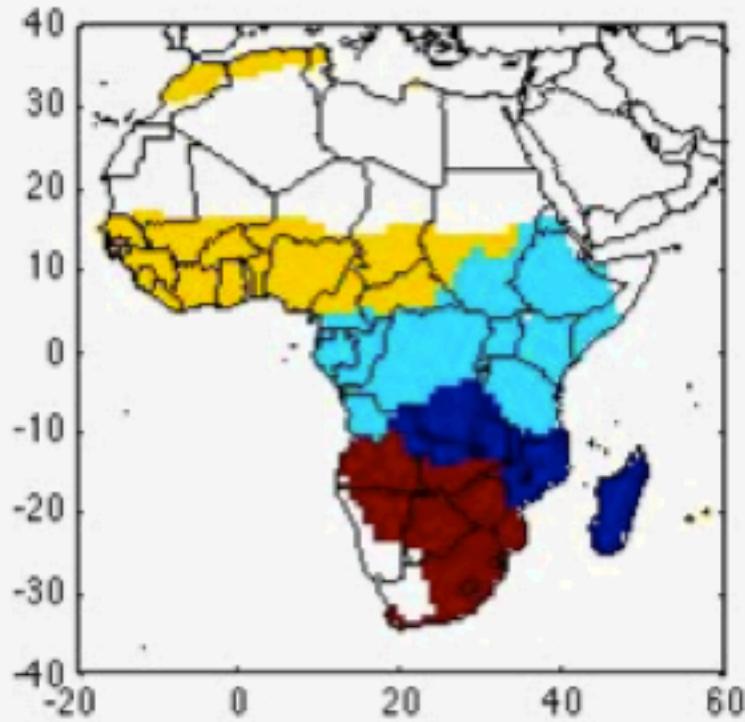
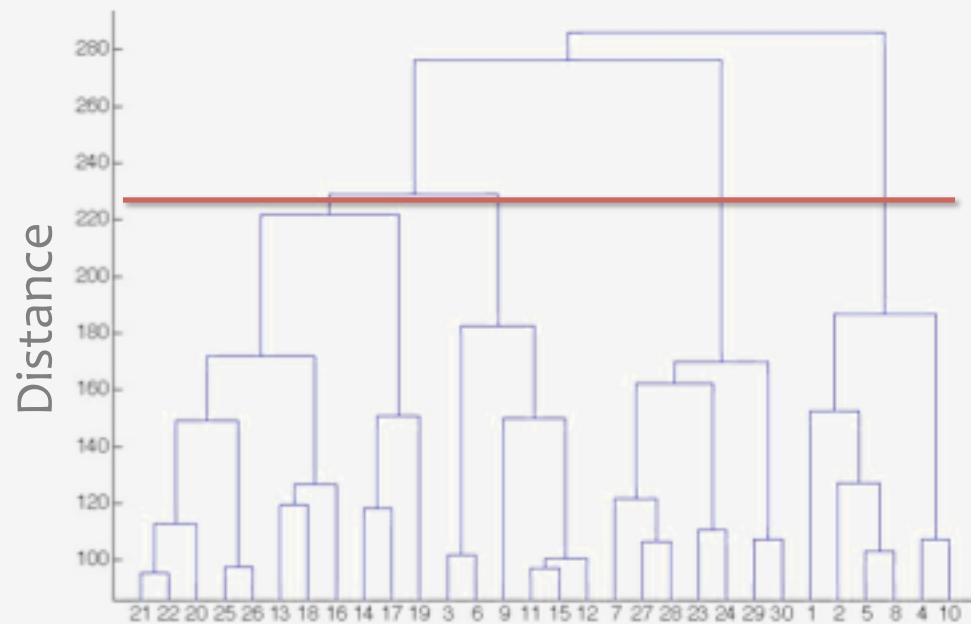
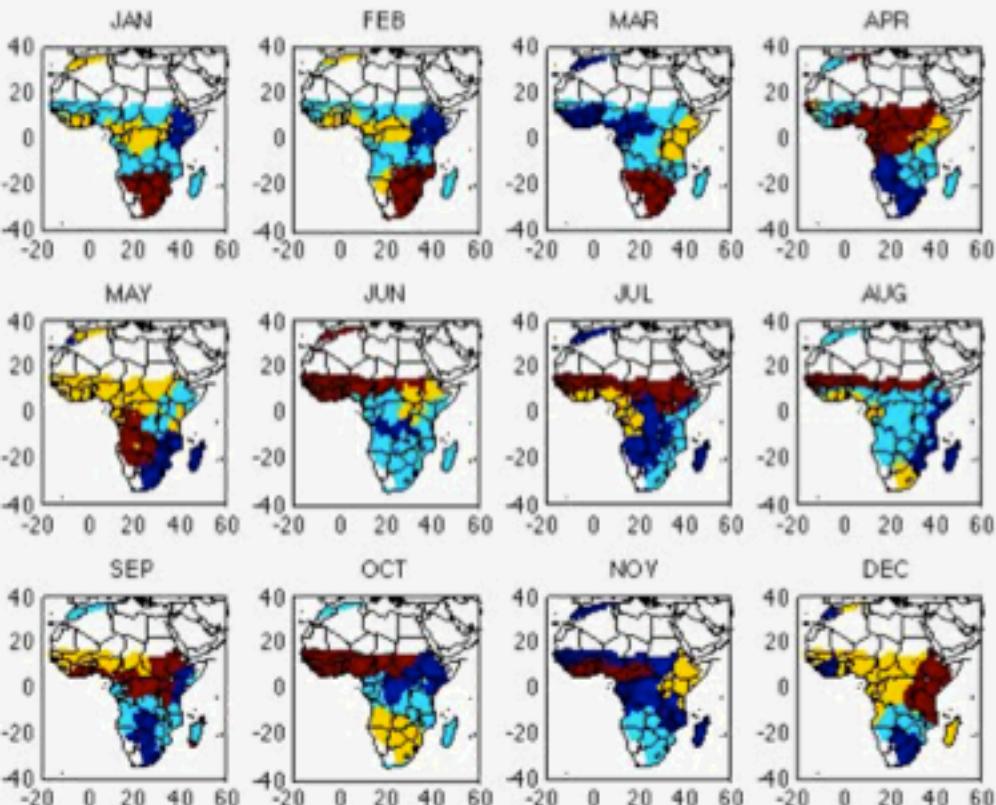
Regionalization

3 Regions



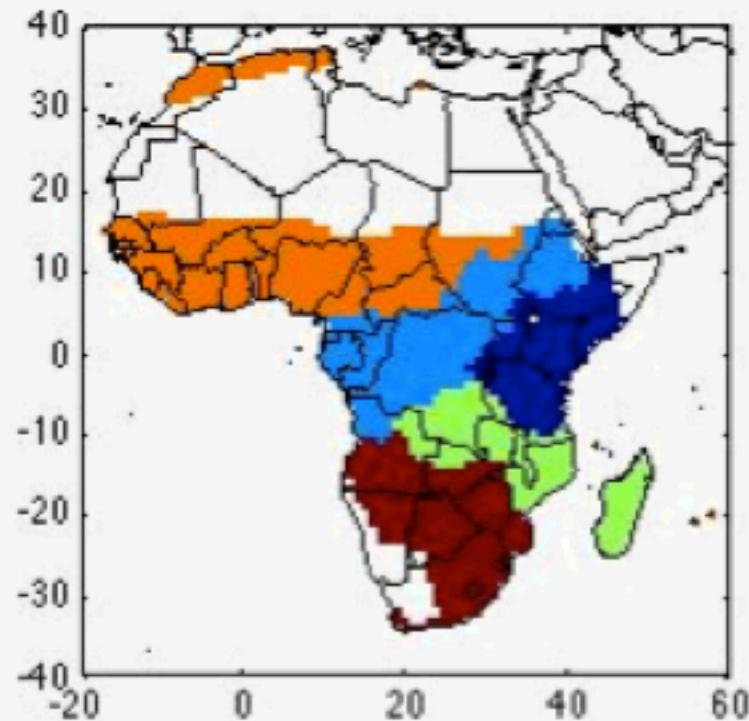
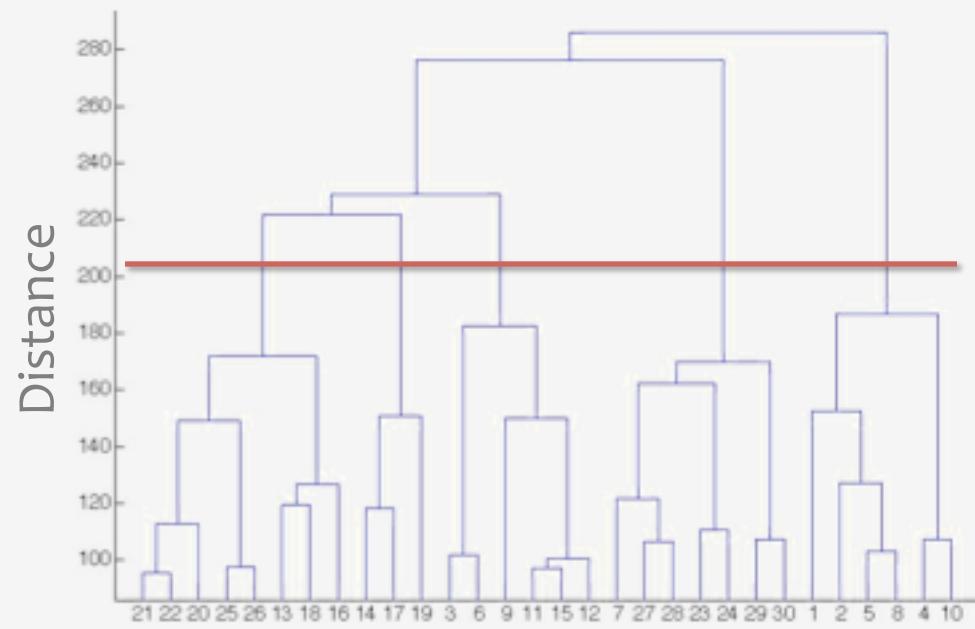
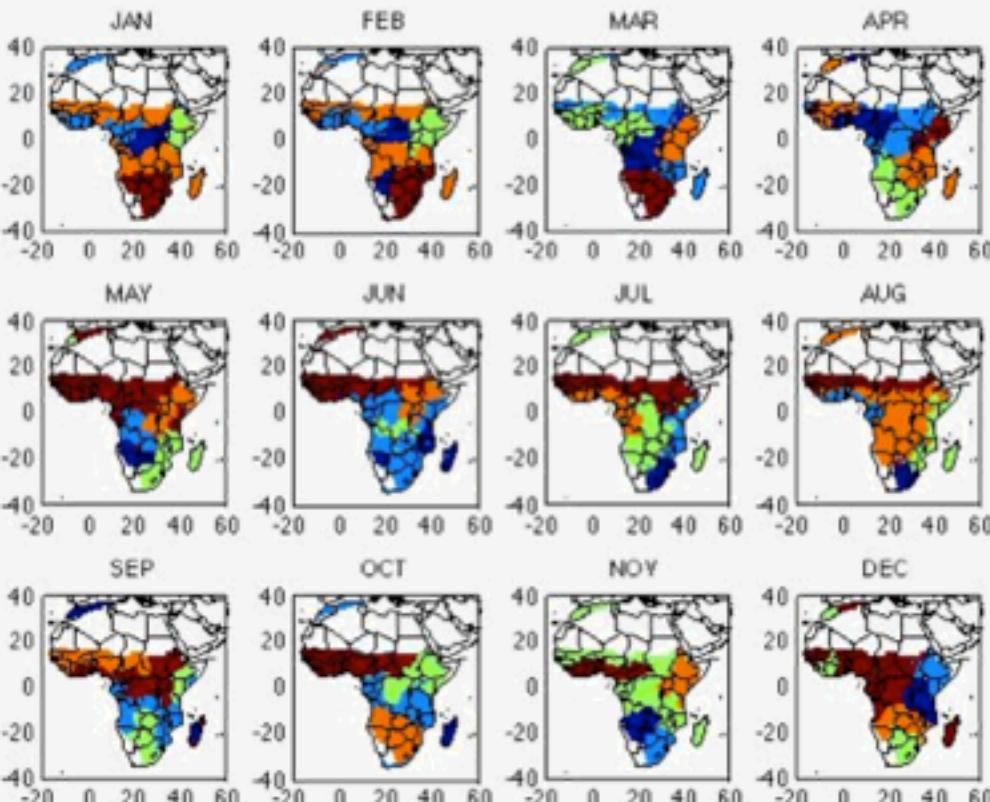
Regionalization

4 Regions



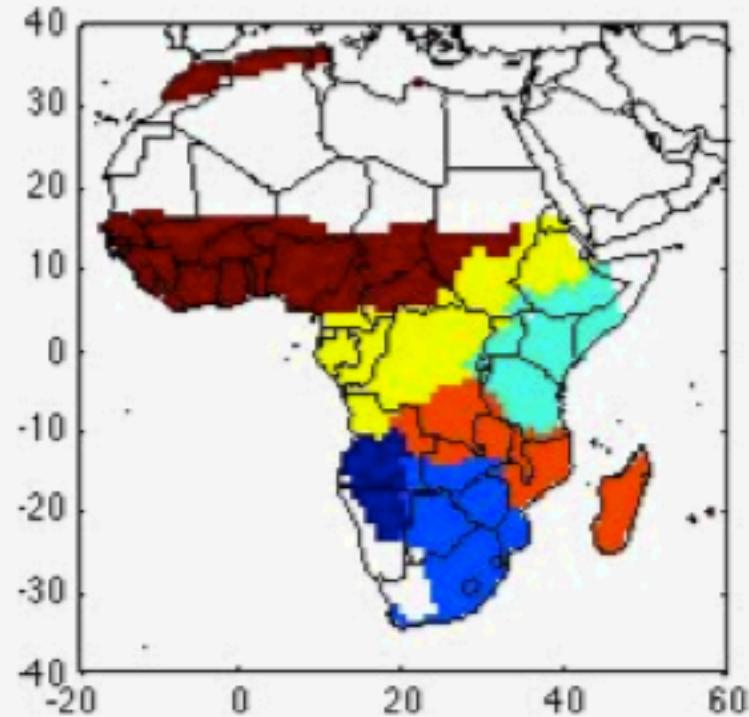
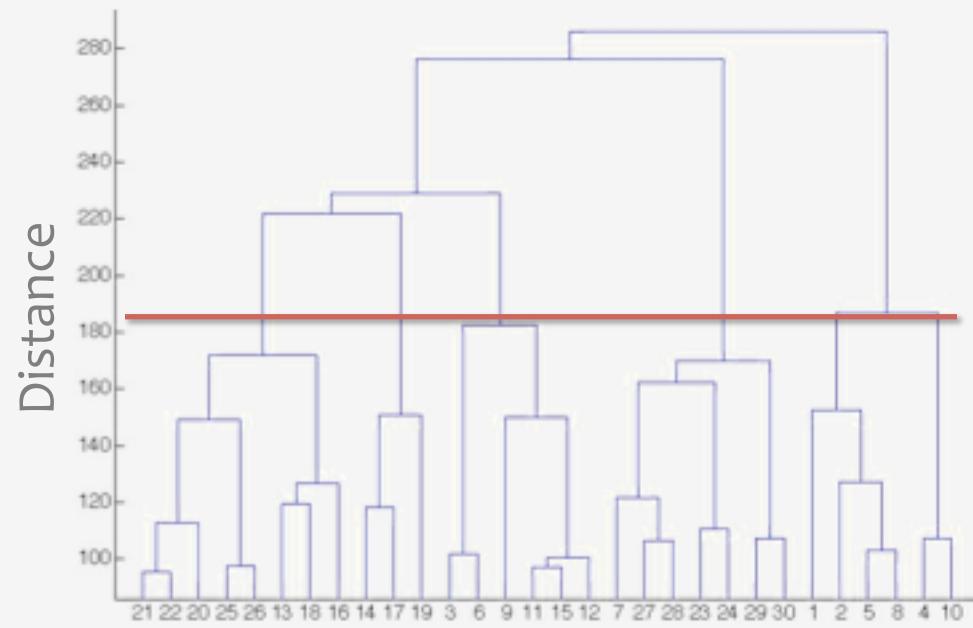
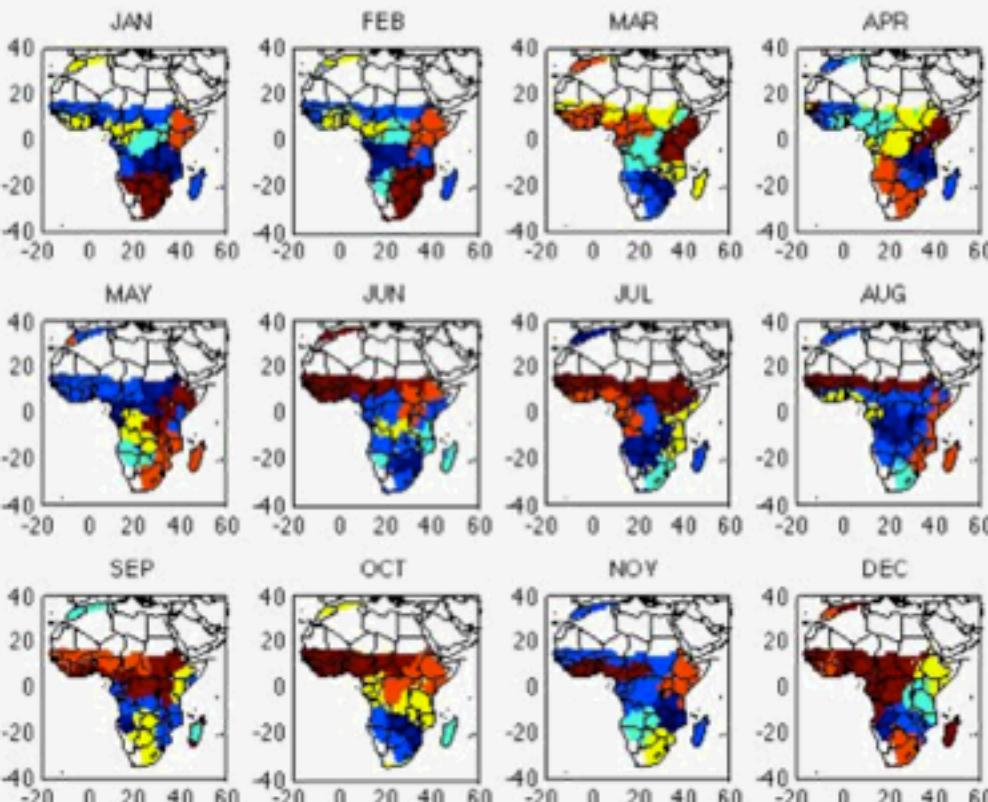
Regionalization

5 Regions



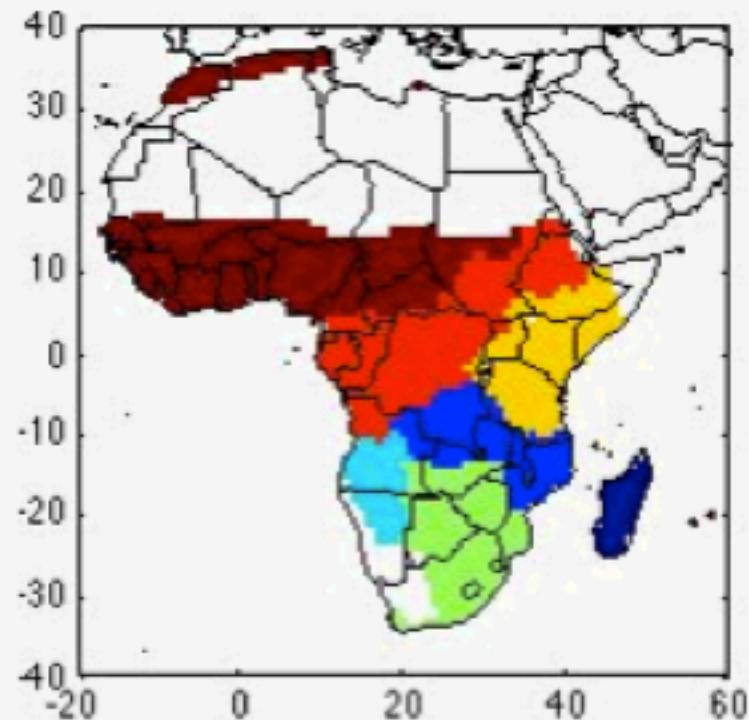
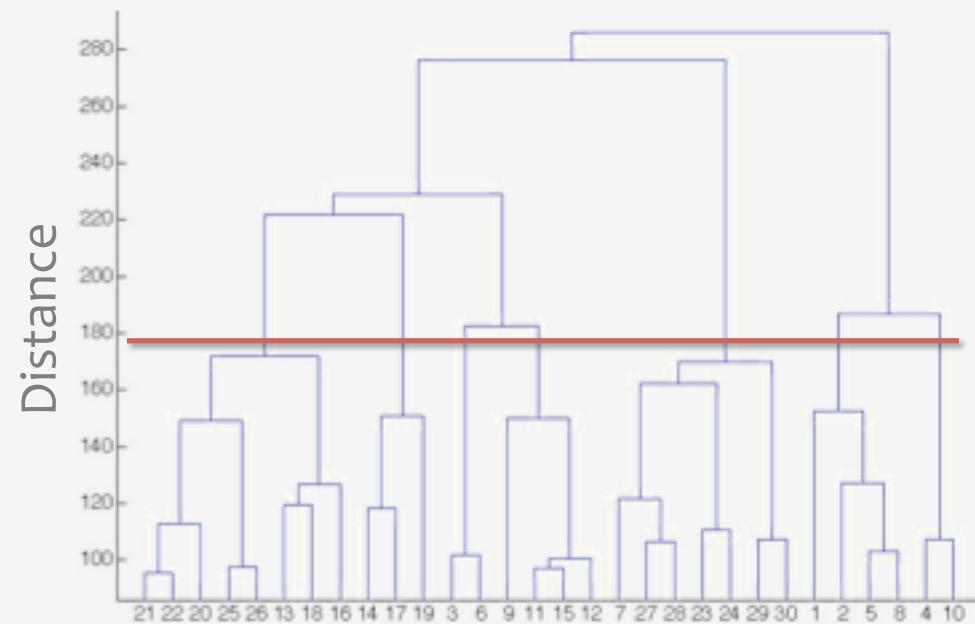
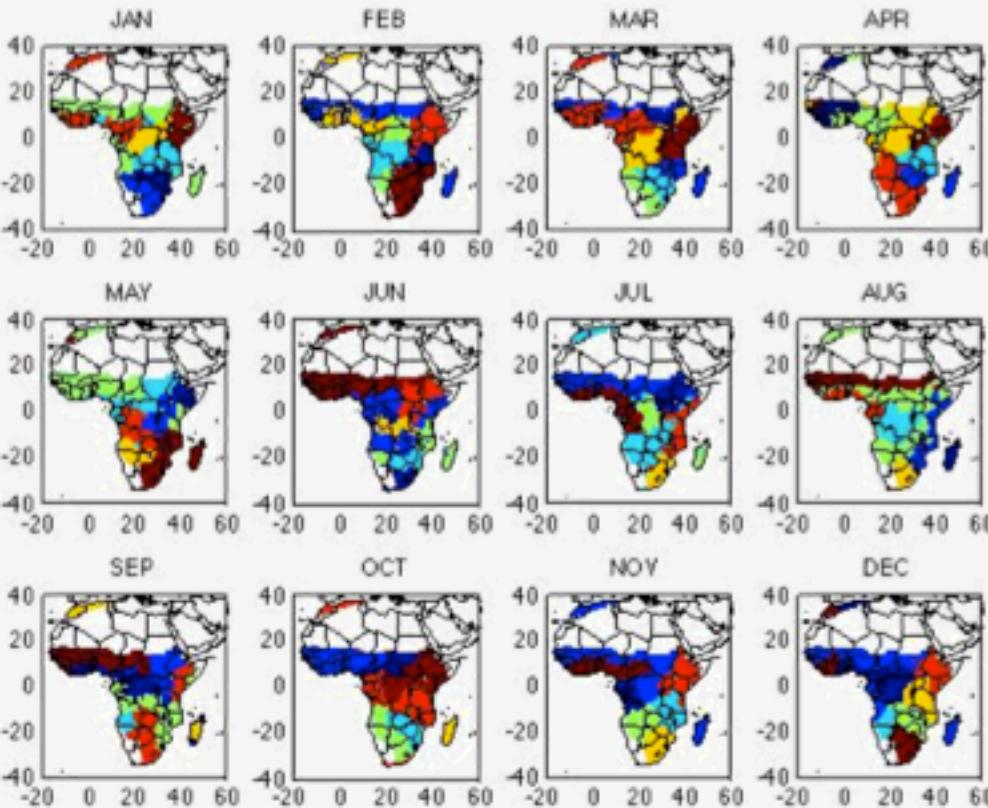
Regionalization

6 Regions



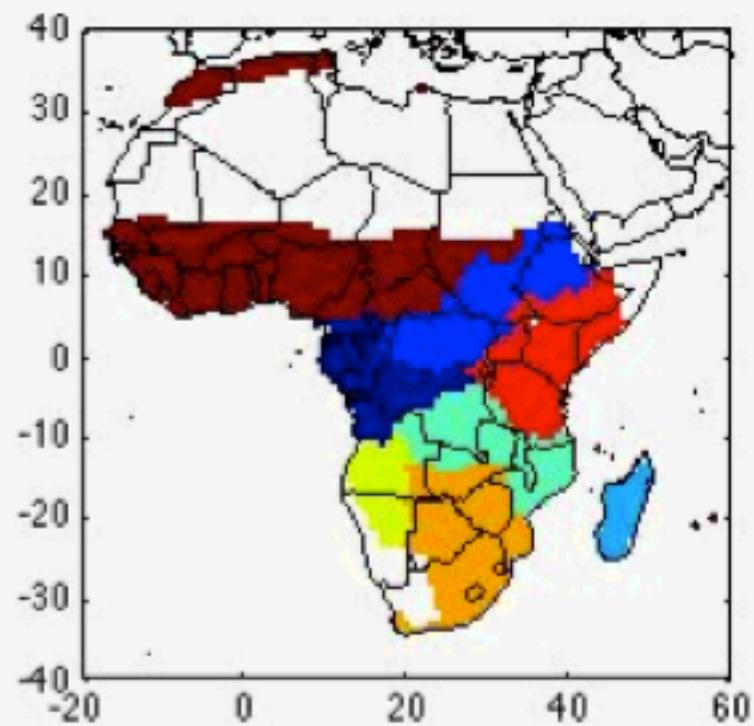
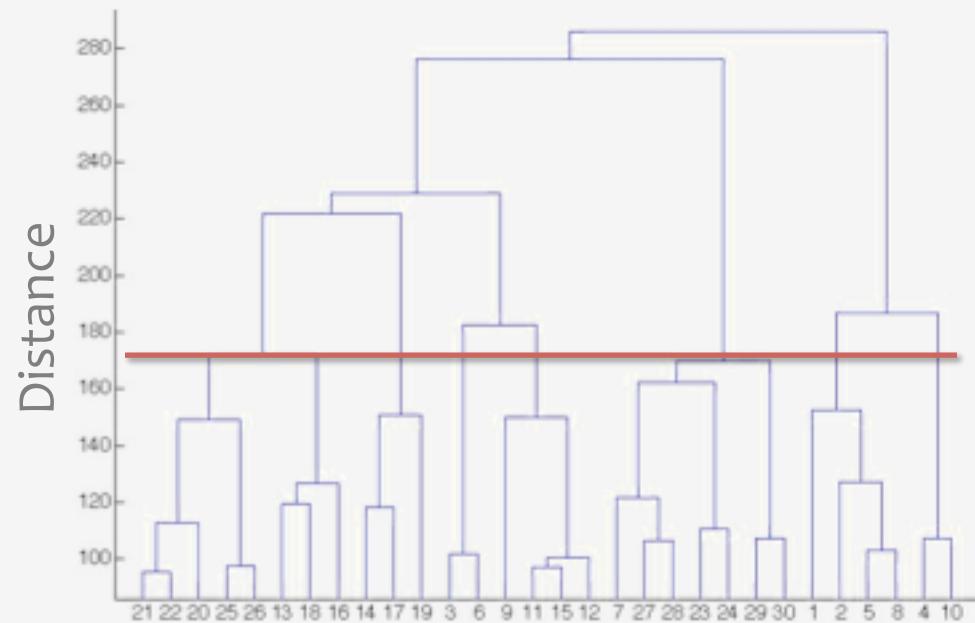
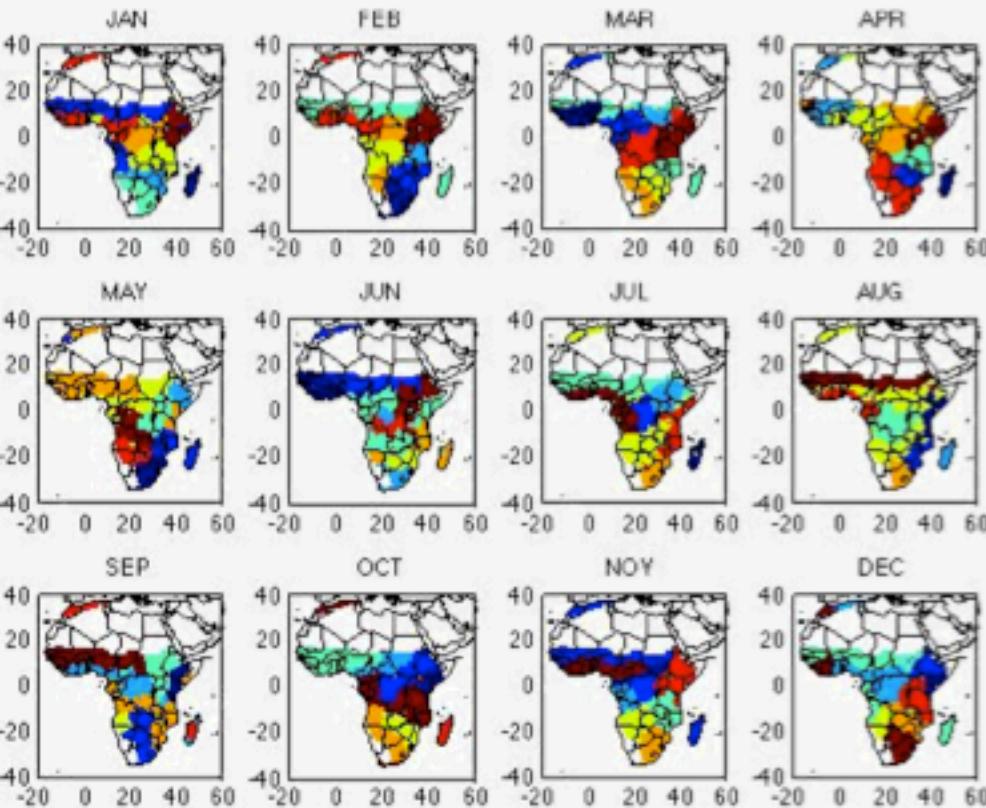
Regionalization

7 Regions



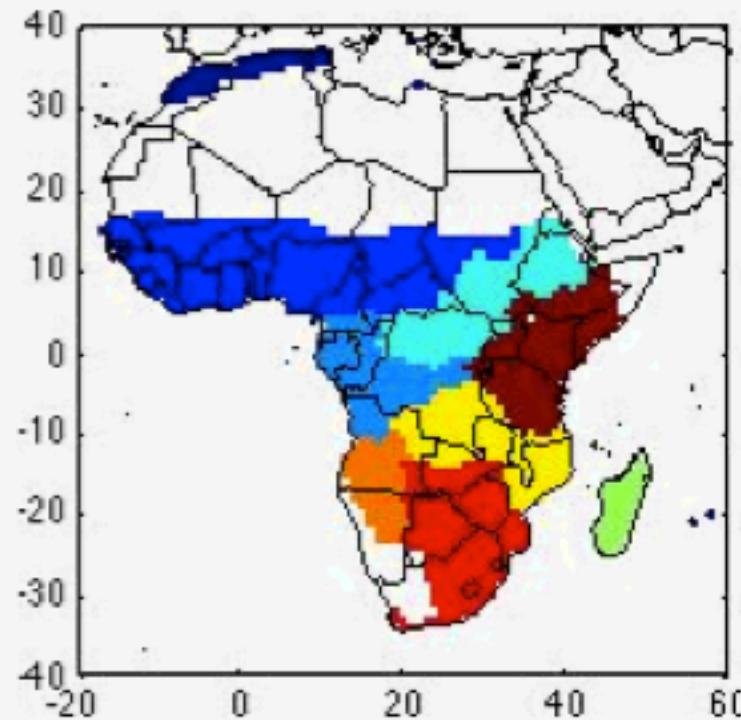
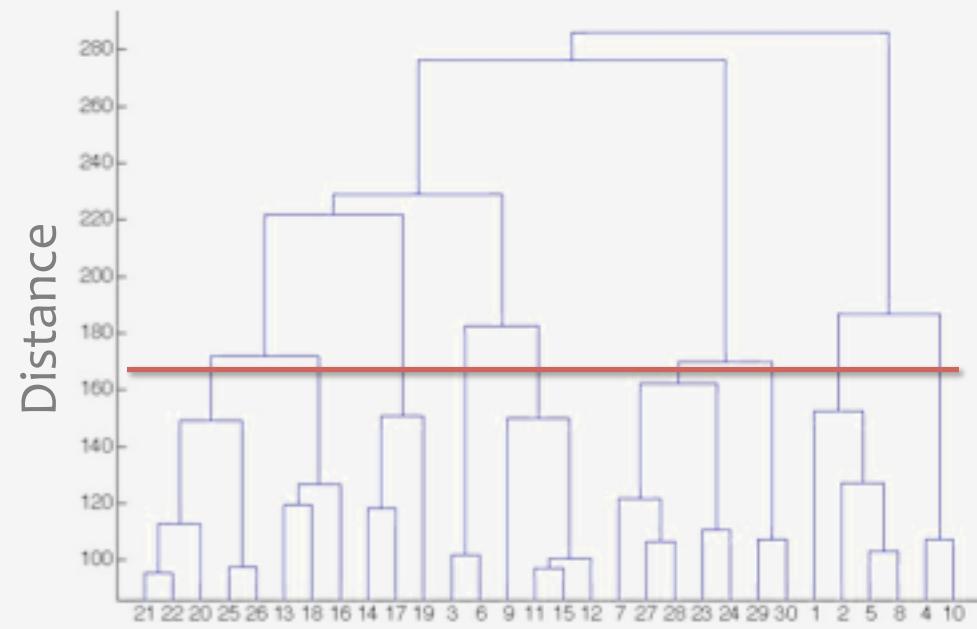
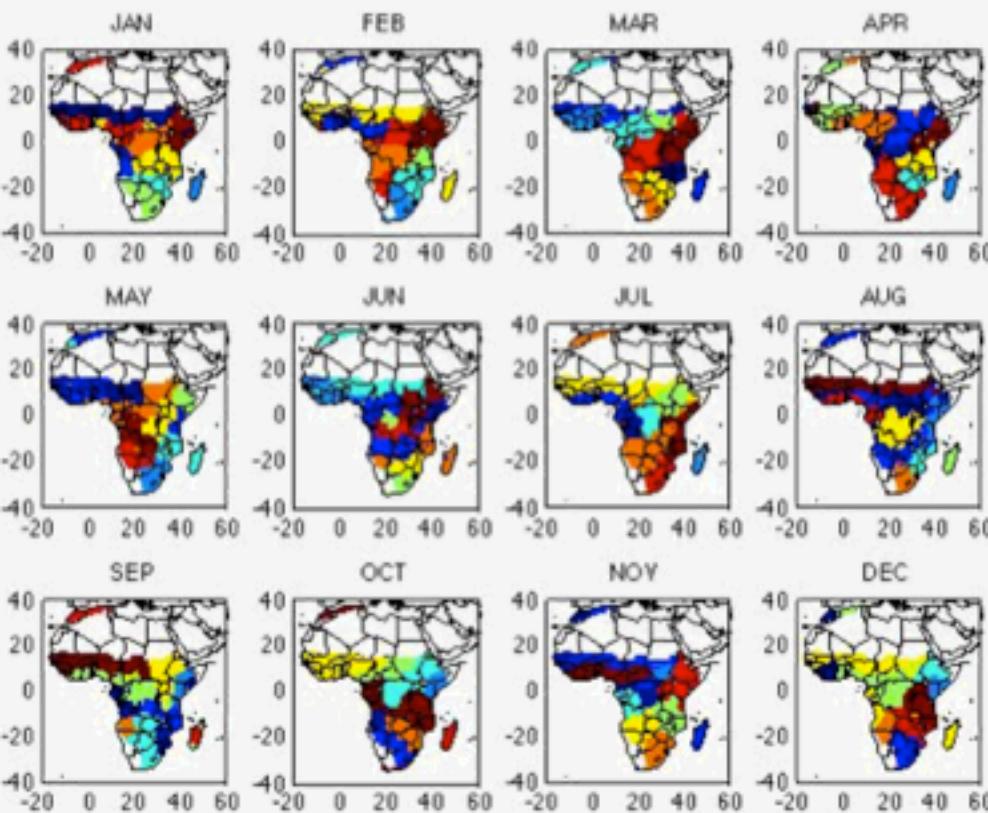
Regionalization

8 Regions



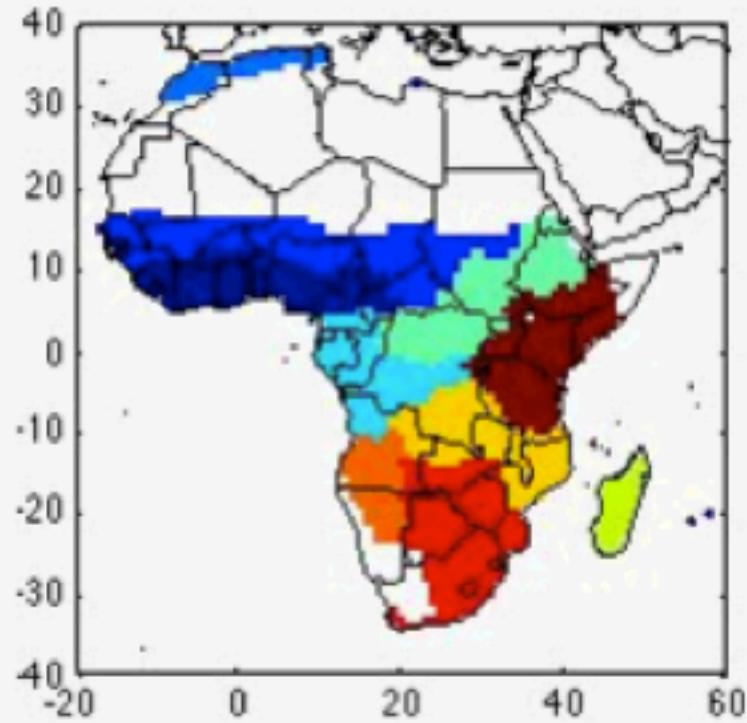
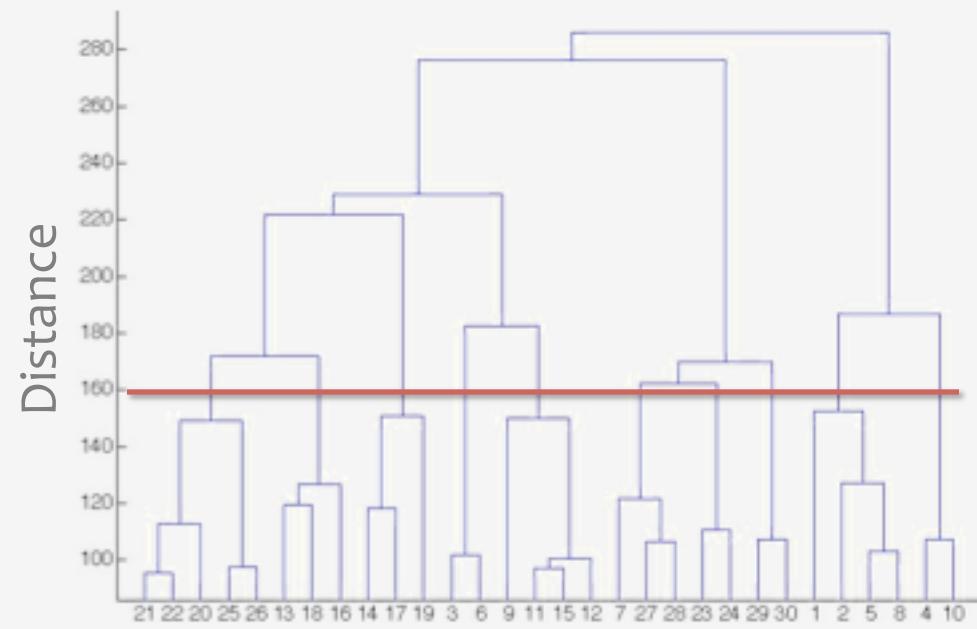
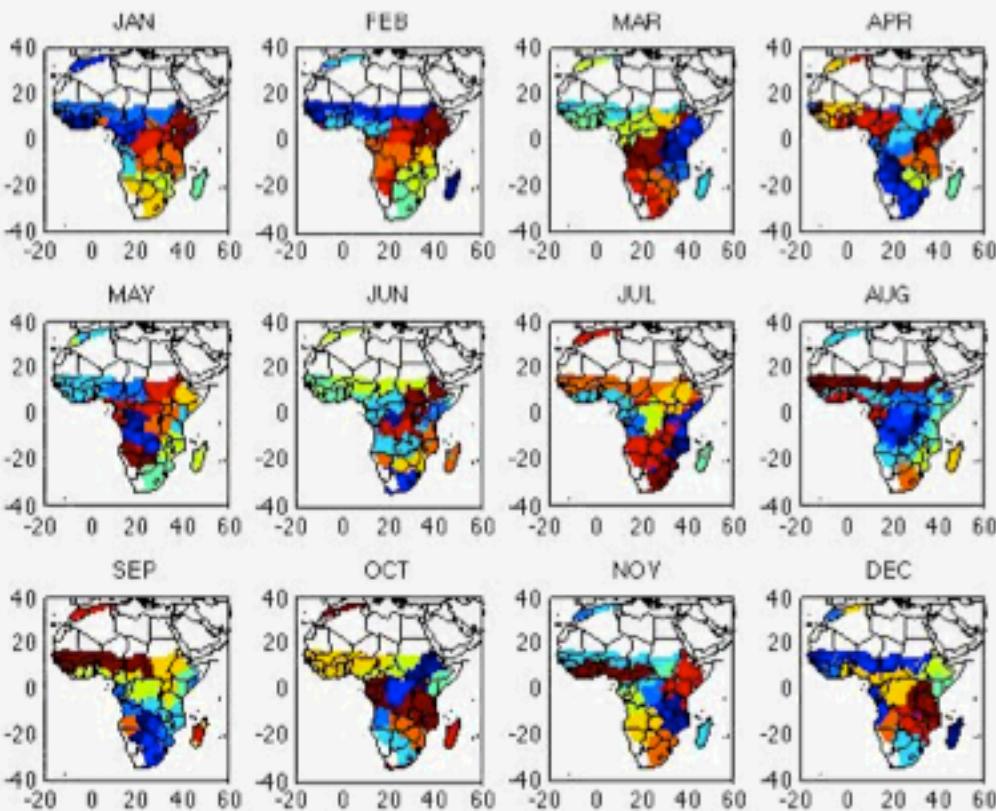
Regionalization

9 Regions



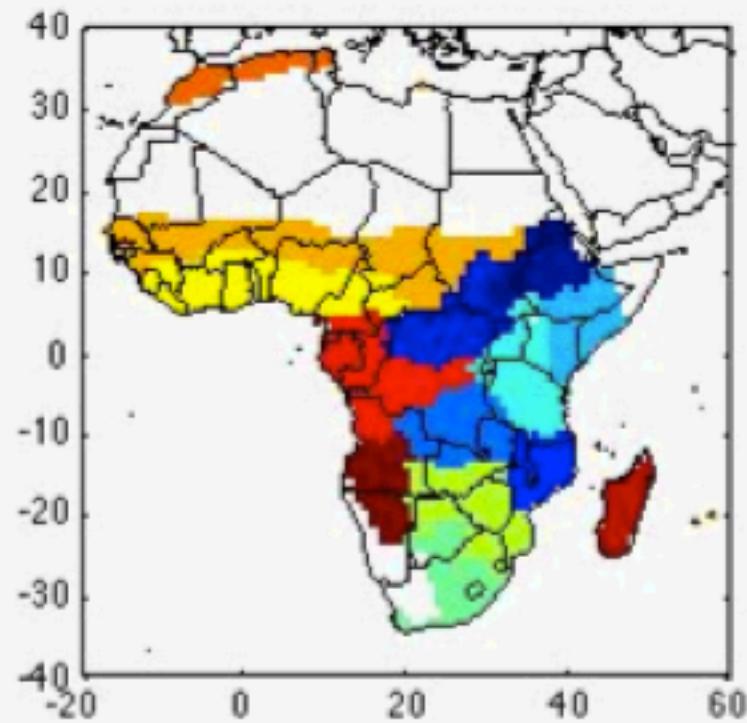
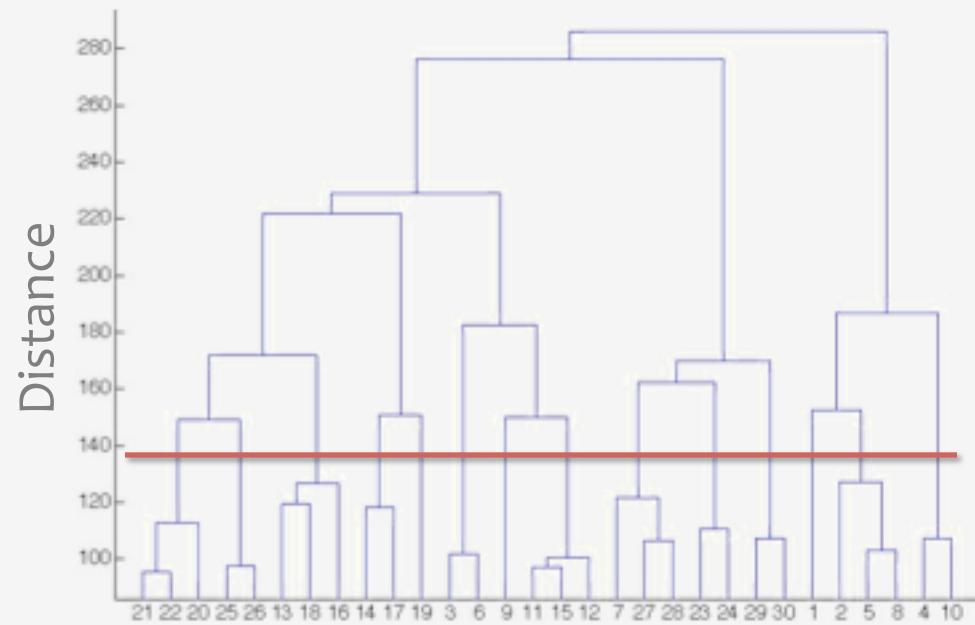
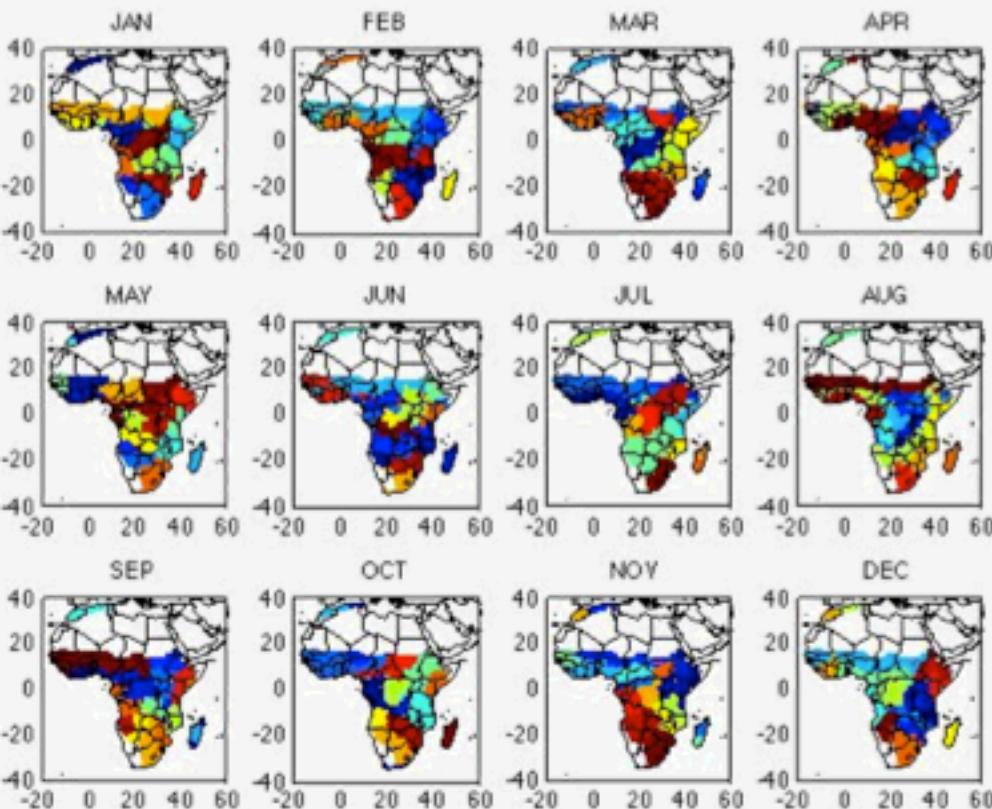
Regionalization

10 Regions



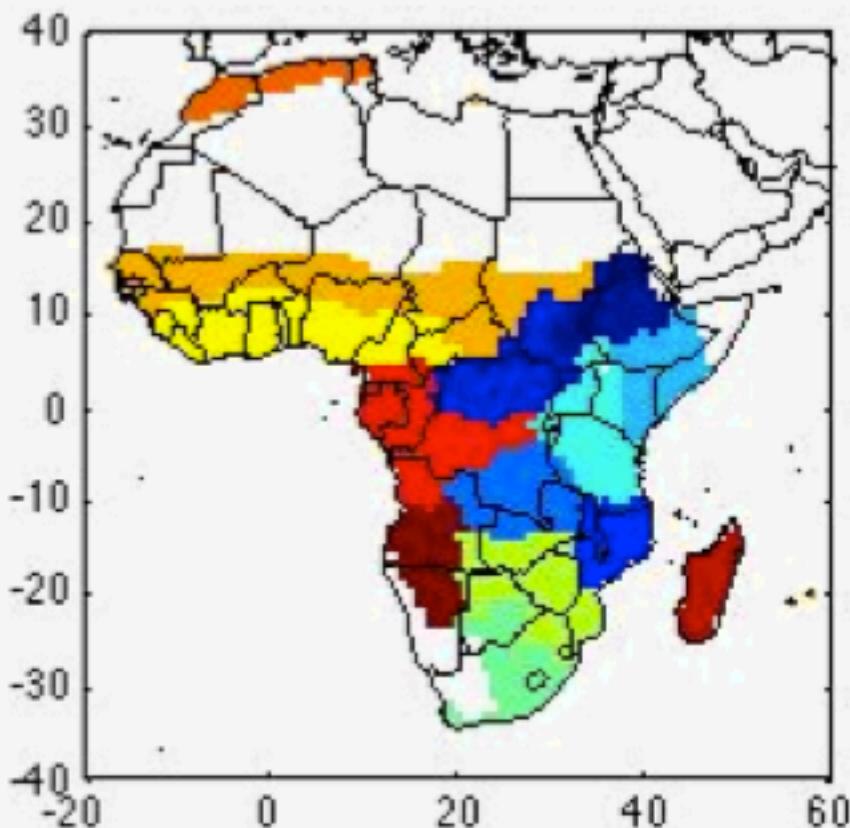
Regionalization

14 Regions

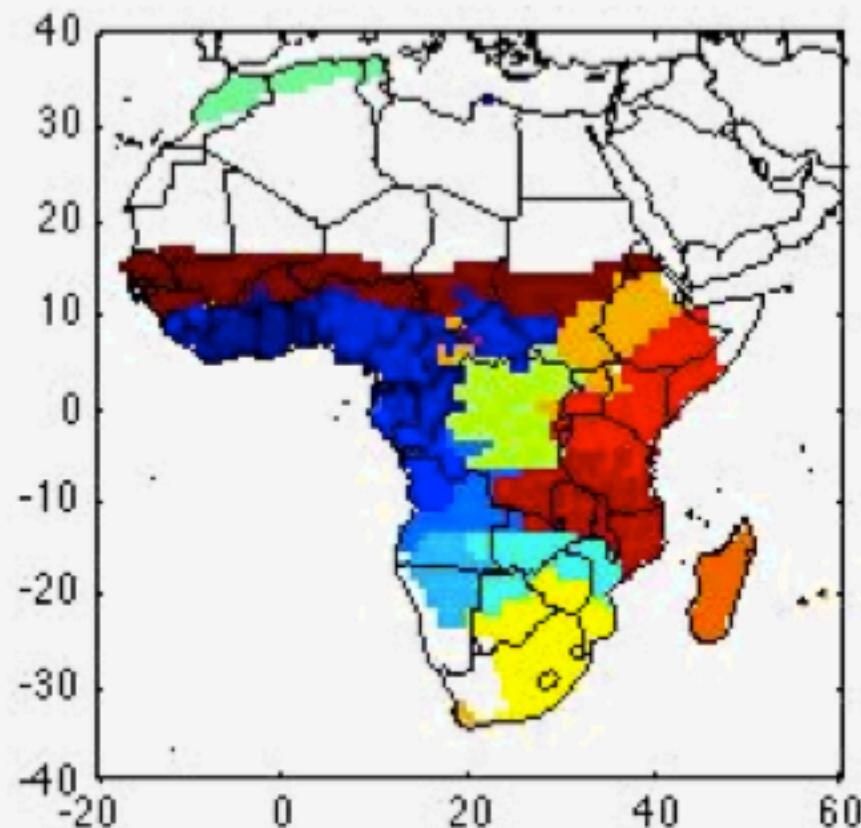


All Months vs. Annual – 14 Regions

All Months [70% of the variance]

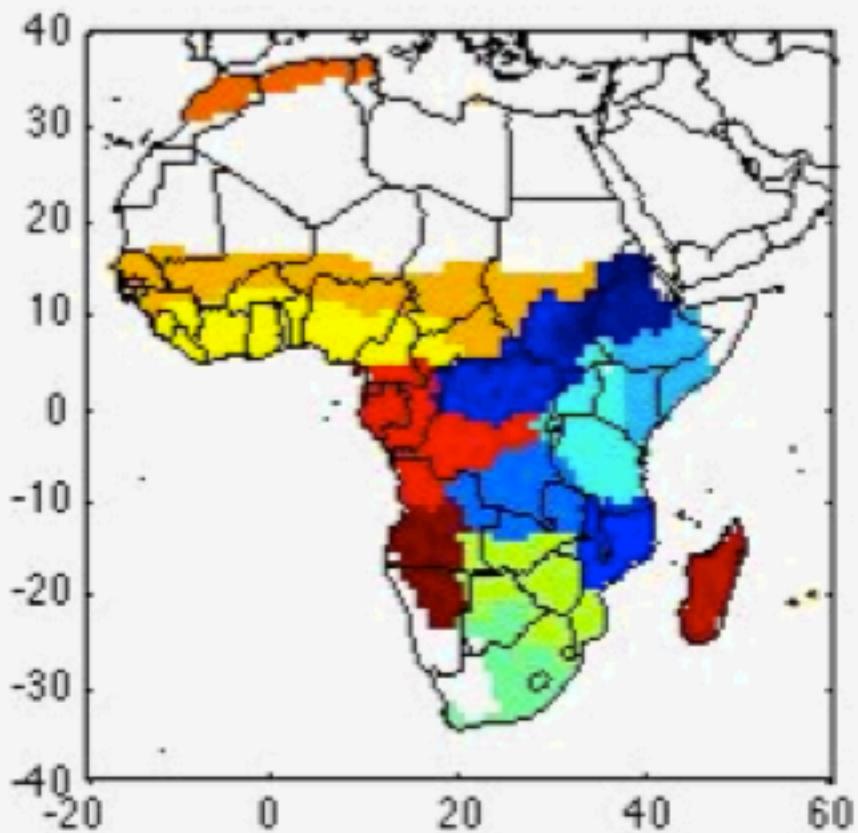


Annual [70% of the variance]

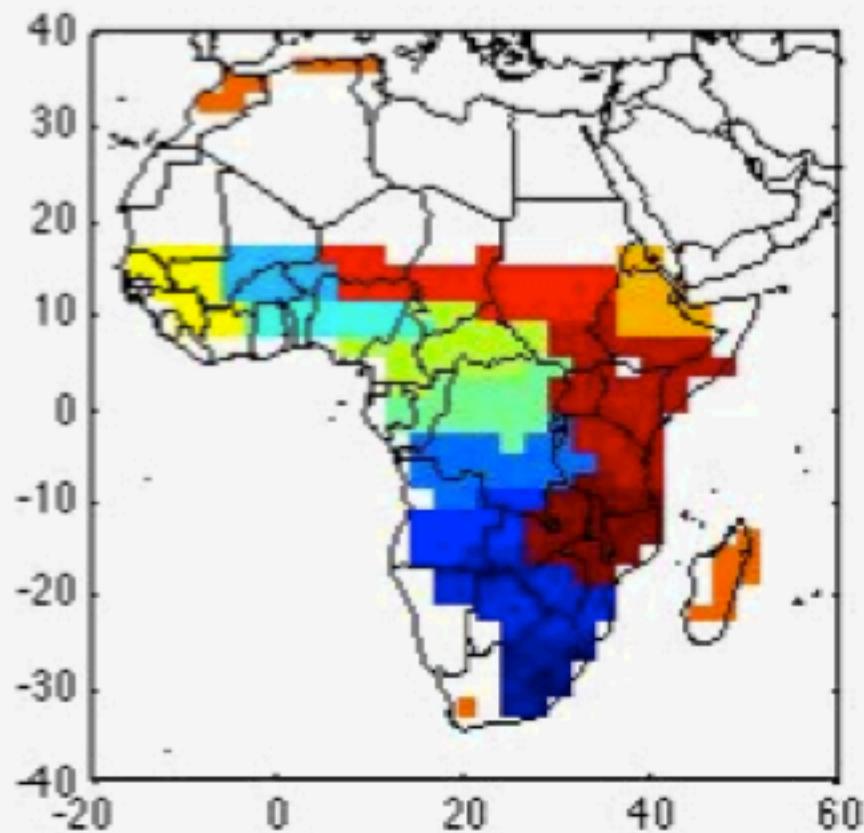


CRU TS3.1 vs. CM2.1 – 14 Regions

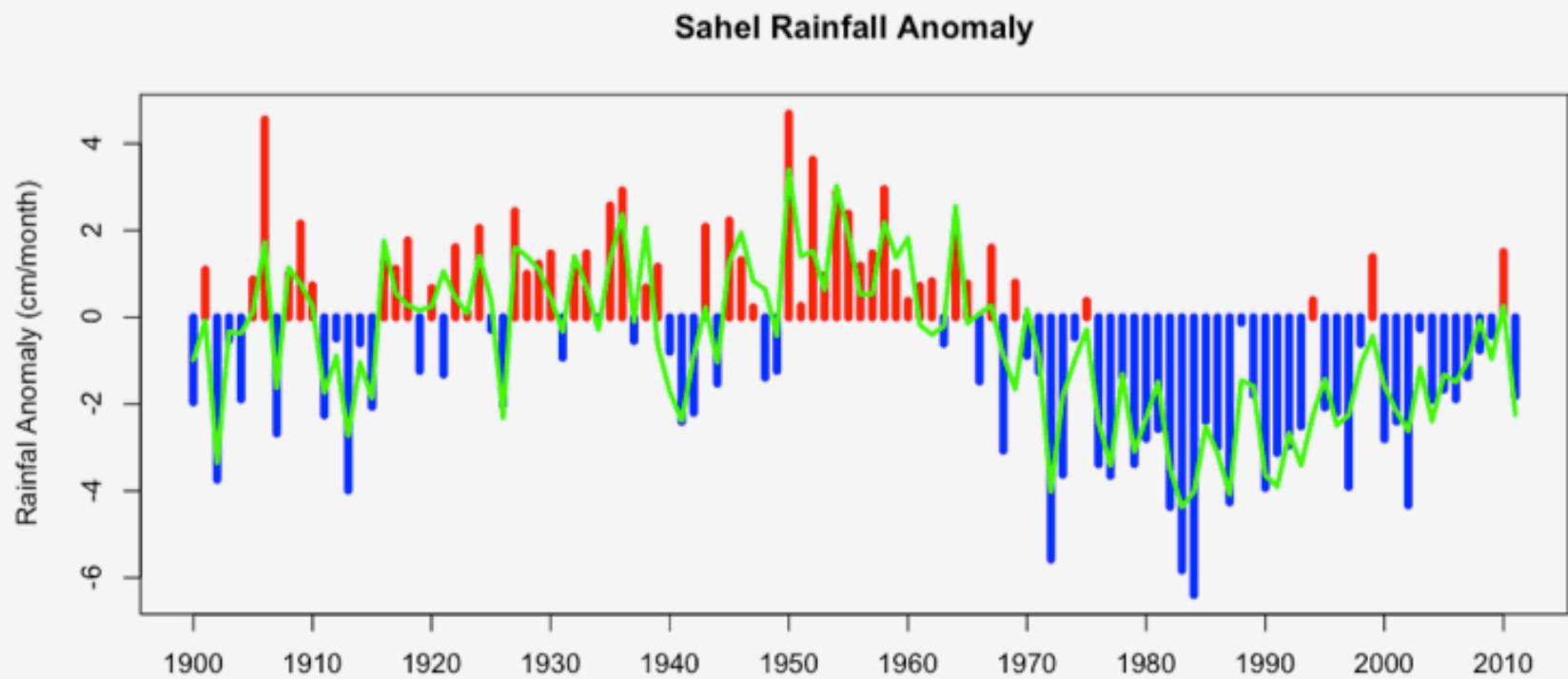
CRU TS3.1 [70% of the variance]



CM2.1 [70% of the variance]



Statistical Predictive Models for Sahel



Monday, 7 January 2013: 11:00 AM

*Statistical Predictive Models for Seasonal Rainfall Anomalies over Sahel
Room 18A (Austin Convention Center)*

Hamada S. Badr, Johns Hopkins Univ., Baltimore, MD; and B. F. Zaitchik and S. D. Guikema

Conclusions

- Spatial patterns of African precipitation are monthly specific.
- The variability of African precipitation is associated with global patterns and the relation can be identified for each region.
- Regionalization supports improved predictive modeling.
- Statistical predictive models could be developed to predict precipitation variability and understand its drivers and mechanisms.

Future Work

- Examining the representation of the variability of African precipitation in climate models
 - Histograms, Homogeneity, and contiguity tests
 - Comparing with other observational data and outputs from climate models
 - Developing and testing multiple statistical models for each region
- Evolution of regions with time (decades/centuries)
- Extension to studying the African droughts and/or floods
- Statistical vs. dynamical downscaling



QUESTIONS?

