Challenges and opportunities for seasonal prediction in the GHA

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Challenges

- Interpreting Model Differences
- Addressing Nonstationarity
- Quantifying & Communicating Uncertainty
- Identifying and Extending Prediction horizons
- Generating actionable information
- Sharing and disseminating forecasts

Opportunities

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Opportunities

- **Interpreting Model Differences**
- **Addressing Nonstationarity**
- **Quantifying & Communicating Uncertainty**
- **Identifying and Extending Prediction horizon**
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Existing Prediction Systems (partial list)

Forecast System	Approach
Ethiopian NMA (Korecha & Sorteberg 2013)	Statistical analogue, ENSO-based
KenyaMet	Regression of SST, atmospheric patterns and climate indices
RCOF	Consensus based on multiple models
ICPAC regional spectral model	Dynamical downscaling
FEWSNet Food Security Outlook	Scenarios, crop model
ENSEMBLES (Batte & Deque 2011)	GCM multimodel ensemble
African Flood & Drought Monitor (Sheffield et al. 2014)	GCM with statistical downscaling
CFSv2	Global dynamical
GEOS5	Global dynamical
IRI Global	Two-tier global dynamical

Existing Prediction Systems (partial list)

Forecast System	Approach
Nicholson 2014	Regression with atmospheric predictors
Korecha & Barnston 2007	Multivariate regression
Badr 2014	Automated Neural Network
Shukla 2014	Global dynamical + analog downscaling + hydrological model
Diro et al. 2012	RegCM3 Dynamical downscaling
Diro 2008/2011	SST regression
Gissila et al. 2004	SST regression
Segele et al. 2009	Regression with atmospheric predictors
Block & Rajagopalan 2007	Regression using surface predictors
Ntale et al. 2003	Regression using surface predictors
Hastenrath et al. 2004	Regression with atmospheric predictors
Batte and Deque 2011	Dynamical downscaling
Mwale and Gan 2005	Regression using surface predictors

And many more!

Diverse Approaches to Prediction

- Dynamical global models
- Dynamically downscaled global models
- Regression based on observed surface variables
- Regression based on observed atmospheric variables
- Hybrid dynamical-statistical
- Machine learning

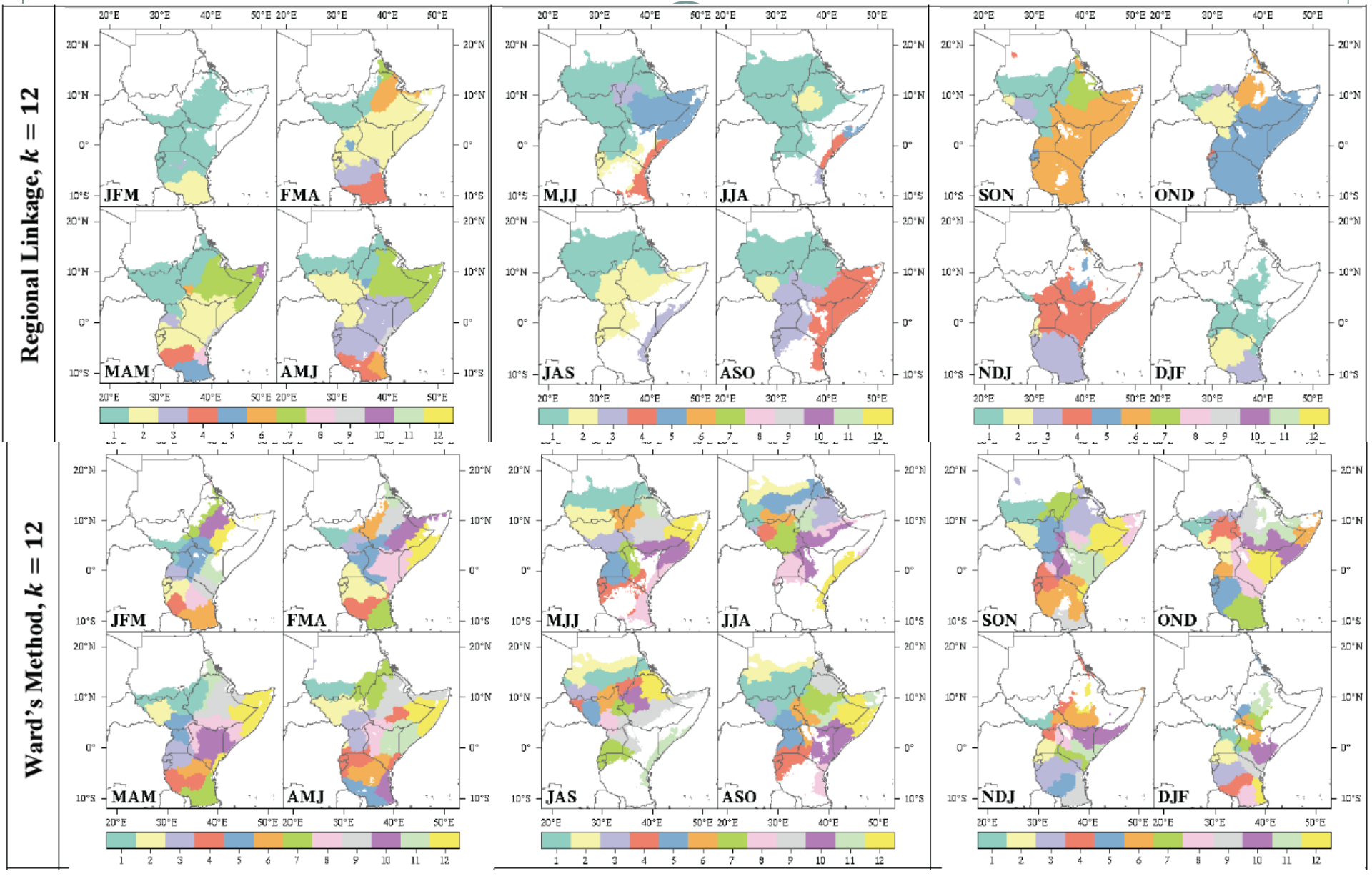
Different Prediction Targets

- Spatial Distribution
  - Gridded vs. Area Averaged (and over different areas)
- Temporal Resolution
  - Hourly →Daily→Dekad→Monthly→Seasonal
- Variables
  - Precipitation vs. Full Meteorology vs. Impacts
- Time Horizon
  - Subseasonal→Seasonal→Interannual . . . .
- Evaluation Metrics
  - Seasonal Average vs. Subseasonal Statistics
  - Deterministic vs. Probabilistic vs. Value of Information

Can we leverage information across modeling systems?

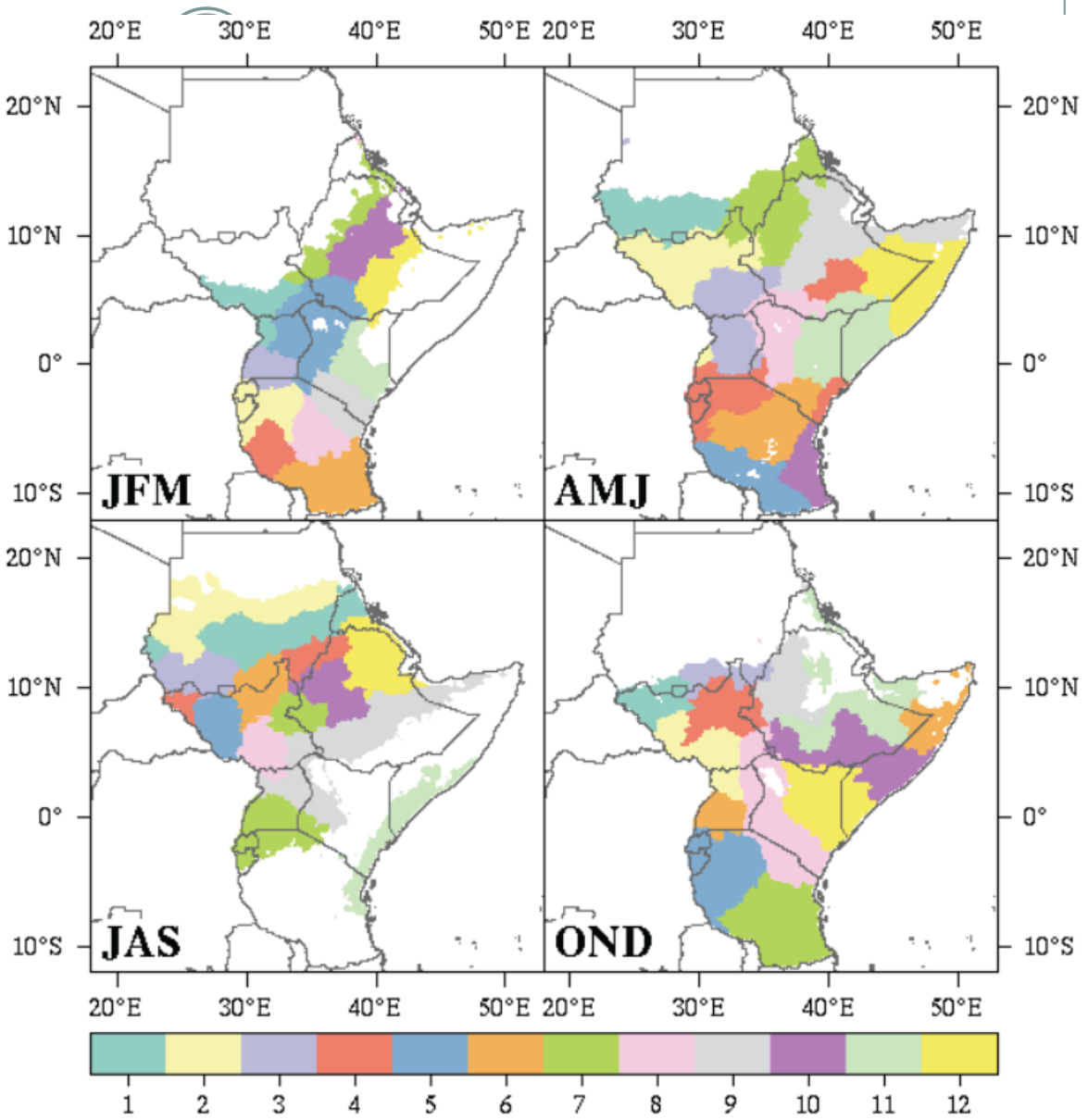
- Forecasters already learn from each other to improve their own models
- But quantitative leveraging is complicated: models differ in purpose, region, and performance
- **Can we quantify skill characteristics of different models in a common framework?**
- **Can we produce a multi-model ensemble that includes all model types?**

1st Step: Regionalization



Regionalization

- Hierarchical clustering
- Ward's method
- 12 clusters
- HiClimR for R



Metrics

- Which variables?
- Which temporal characteristics?
- Probabilistic or deterministic?
- At what predictive time horizons?

Proposed Analysis

- Quantitative comparison of forecast methods
  - Focus first on seasonal total precipitation forecasts
  - Targets are (1) springtime long-rains/belg, (2) summertime kiremt, and (3) autumn short-rains
  - Lead times of 1 and 2 months
  - Common regionalization system
- Ensemble characterization of uncertainty
  - For each time horizon, region, season, and metric, create an ensemble of high performing models
  - Study the ensemble to quantify uncertainty and to understand sources of model divergence

Period of Evaluation → Nonstationarity

- How does model performance change over time?
- Are there common “break points” across models?
- Is there any difference in the stability of predictive skill across types of models?
- Is there an optimal training period for statistical models?

Characterize Uncertainty

- What are the greatest sources of uncertainty?
  - Choice of model?
  - Input data?
  - Lack of scientific understanding?
  - Stochastic variability?
- Can we propagate uncertainty through impacts models?
  - Perhaps start with some simple economic value calculations?

Advance New Methods

- Hybrid Approaches
- Composite Forecasts
- Operational multi-method multi-model ensembles

- Is this possible?
- Is it interesting?

Thank you

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