Seasonal Drought in the Greater Horn of Africa and Its Recent Increase During the March–May Long Rains

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Topography and Seasonality of Climatological Rainfall

- "Short Rains"
- "Long Rains"

Maps showing annual precipitation and fraction of annual rainfall.
Climatological Surface Moist Static Energy and 850 hPa Wind (ERA-Interim)

$$\text{MSE}_{\text{sfc}} = C_p T + L_v q + \Phi$$
Climatology of East Africa

\[ \text{MSE}_{\text{sfc}} = C_p T + L_v q + \Phi \]

\[ \text{MSE}^*_{700} = C_p T + L_v q_s + \Phi \]

Monthly Climatology

Annual Average

Departure from Zonal Average

MSE_{sfc} - MSE^*_{700}

Monthly Climatology

Time


MSE/C\_p MSE^*/C\_p

Time
Regional Precipitation Time Series (1950-2010)

50% of annual variance associated with short rains (23% with long rains)
Composite Circulation Anomalies
10 Driest MAM and OND Seasons
(1950-2010)
Regional Precipitation Time Series (1950-2010)

OND, $r = 0.82$

MAM, $r = 0.23$

OND

U850 Index

SST Anom.

Correlation
Summary – Part I

- East Africa has complex topography and annual rainfall cycles. Generally, Short Rains (OND), Long Rains (MAM) and JJA max.

- OND rainfall most closely linked to SSTs in the Pacific (ENSO) and Indian (IOD) Oceans, **La Nina → Dry; El Nino → Wet.** The Pacific ENSO teleconnection operates via the Indian Ocean.

- MAM rainfall variability not closely associated with tropical SSTs on the seasonal time scale. [Some evidence for relationship with ENSO on sub-seasonal (monthly, not shown) time scale; MJO.]

- JJA rainfall variations linked modestly to ENSO, but with decadal variations in the relationship.

- For GDIS: Good predictability for OND, some for JJA, least for MAM
Part II – Increased Frequency of Drought in MAM
\[ \text{MSE}_{\text{sfc}} - \text{MSE}^*_700 \text{ East Africa} \]

\[ \text{MSE} = C_p T + L_v q + \Phi \]
\[ \text{MSE}^* = C_p T + L_v q_s + \Phi \]
Strong Linkage to Decadal SST Variability in the Pacific
200 hPa Anomalous Divergence


MAM 10-Driest 1950-2010
AMIP Models Capture the Shift...

Yang et al. 2014, J. Climate

Observed

Avg. 16 AMIP

Yang et al. 2014, J. Climate
...and Similar Relationship to Observed SSTs

Yang et al. 2014, J. Climate
The Future?

CMIP5 Models have Short and Long Rains Reversed (in current Cx)

- The *spatial patterns* of future SST changes is critical...
- Tropical Pacific more El Nino- or La Nina-ish?; Relative W vs. E warming of Indian Ocean...

Yang et al. 2014, J. Climate
Summary – Part II

- Recent decline in the Long Rains associated primarily with a decadal shift in Pacific SSTs (warm west, cool east tropical Pacific).

- Above supported by observations, AMIP and POGA model runs.

- Future projections are less certain given fundamental problems with CMIP5 models capturing annual cycle of PRCP and observed associations with SSTs…

- For GDIS:
  1) “Enhanced Pacific Gradient Events” may be a conditional forecast opportunity for MAM Long Rains in East Africa;
  2) AMIP (and NMME hindcasts) able to capture decadal shift in PRCP in East Africa (and many other locations).
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