Intraseasonal Variability of the Belg Rains in Ethiopia

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Overview

The February to May rainfall season over Ethiopia, locally known as Belg, contributes to up to 40% of the annual rainfall over Northeast, whereas its contribution exceeds 50% over South and Southeast Ethiopia. Interactions between mid-latitude and tropical systems across the Red Sea play a major role in modulating the rainfall pattern during this season. In this poster, we show how intraseasonal modes of variability, such as the Northern Atlantic Oscillation (NAO) and the Madden–Julian oscillation lead to Belg rainfall anomalies. Also presented here are dominant features of the regional circulation patterns that lead to intraseasonal variability.

Data and Methodology

- Data used in in this study include, daily rainfall data covering 117 Stations of the National Meteorological Agency of Ethiopia for the 1980 to 2010 period, daily NAO index data , Daily Real-time Multivariate MJO series 1 (RMM1) and 2 (RMM2) data, and daily NCEP/CDAS analysis data.
- Daily areal average rainfall over Ethiopia is used to identify days that fall into the lower tercile (dry Belg) and upper tercile (wet Belg) categories.
- Positive (negative) NAO events are defined as days that are within the upper (lower) quartile, calculated from 1980 – 2010 daily NAO index, and the RMM index is used for MJO classification following the method used by the NOAA/CPC's online MJO information.

NAO Influences

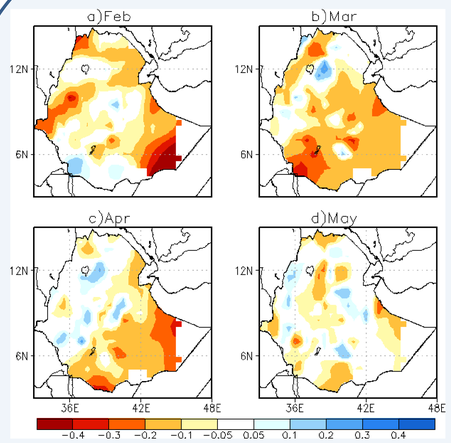


Figure 1: Correlation between dekadal average NAO indices and dekadal average standardized rainfall anomalies .

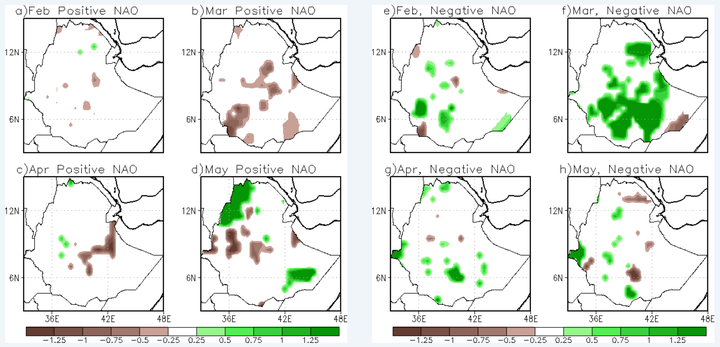
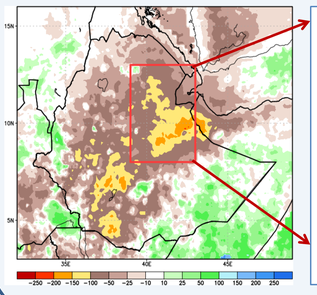


Figure 2: Composites of daily rainfall anomalies averaged over months of the Belg season for NAO positive (left) and NAO negative (right) events, significant at the 95% confidence level (student's t-test).

- **The Belg rainfall is negatively correlated with NAO over much of the Belg rainfall benefiting areas, with the higher correlation values focusing over eastern and southern Ethiopia (Figures 1a-d and 2a-h).**

A Case of Belg 2015



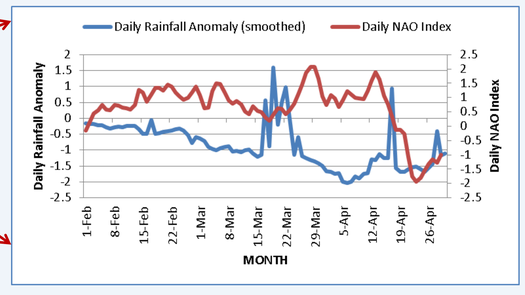


Figure 3: FMA 2015 CPC/ARC2 rainfall anomaly (left), and time Series of daily FMA 2015 rainfall anomaly and NAO Index over the Belg Areas - Areal Average over 39E to 43E & 8N to 13N (right)

- **The NAO positive phase may have contributed to the observed severe dryness across northeastern and eastern Ethiopia during Belg 2015.**

MJO Influences

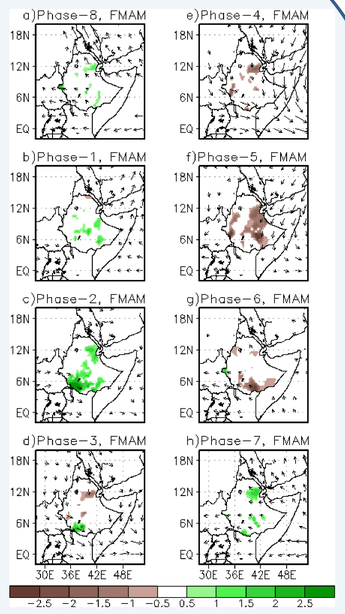


Figure 4: Composites of daily rainfall and 850 hPa wind anomalies averaged over the FMAM season for MJO phases, significant at the 95% confidence level (student's t-test).

- **MJO phases 1 and 2 (Figure 4b-c) tend to enhance the Belg rainfall, whereas the Belg rainfall tends to be suppressed during the MJO phases of 5 and 6 (Figure 4f-g).**

Anomalous Circulation Patterns

Dry Belg

Wet Belg

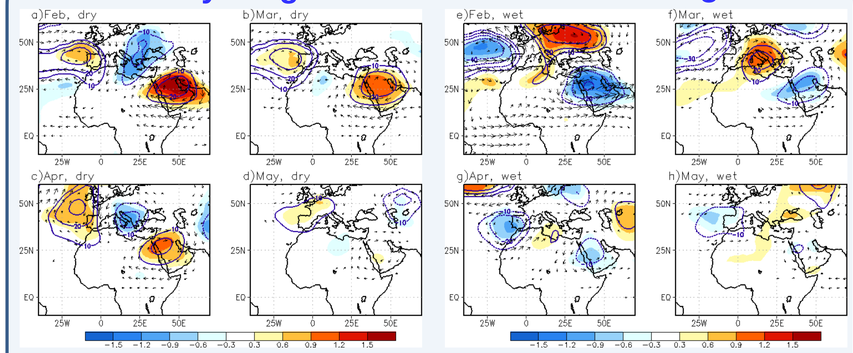


Figure 5: Composites of daily 500hPa temperature anomalies (shaded), geo-potential height anomalies (contour) and wind anomalies (vector) for dry Belg (left) and wet Belg (right), significant at the 95% confidence level (student's t-test).

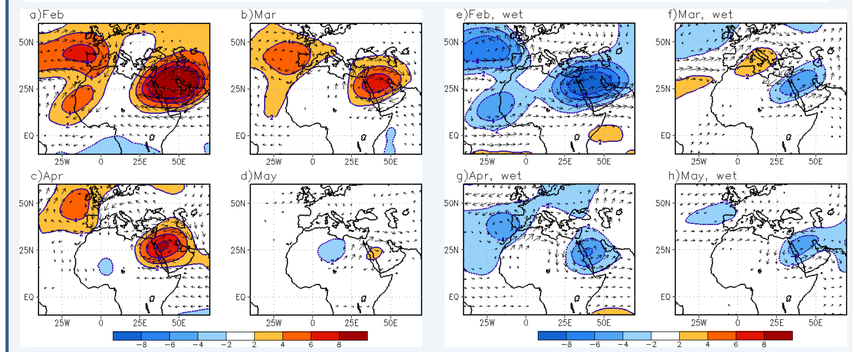


Figure 6: Composites of daily 200hPa stream function and wind anomalies for dry (left) and wet (right) , significant at the 95% confidence level (student's t-test).

- **A shortwave tripole structure with two anomalous mid-upper level warm anti-cyclones and one cold cyclonic trough in the region between the Northeast Atlantic and the Arabian Peninsula tends to suppress the Belg rainfall by way of weakening the interactions between the mid-latitude and tropical systems (Figures 5a-d and 6a-d).**
- **In contrast, a tripole structure with two anomalous mid-upper level cold cyclonic, and one warm anti-cyclonic trough tends to enhance rainfall in the Belg season of Ethiopia (Figure 5e-h and 6e-h).**