

An Evaluation of the 2015 “Belg” Rains in Ethiopia

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Background

Climate Prediction Center (CPC)’s monitoring of short-term climate is an integral part of Famine Early Warning System Network (FEWS Net) and their support to food security in developing countries, especially in Africa. The February-May or “Belg” rains in Ethiopia constitute the crucial cereal grain growing season for this part of the world and also impact pastoral activities. The majority of the 2015 season performed poorly, among the worst in the climatology through April (**Fig. 1**). Major crop and livestock losses were felt throughout central and northeastern Ethiopia causing serious tangible impact to food security in the region.

Figure 1. 5 lowest years areal avg. Feb-Apr rainfall

Rank	Year	Area Avg. Rainfall
1	2008	2.8
2	2000	4.4
3	2012	8.16
4	1984	12.06
5	2015	12.34

Data and Methods

This case study uses much of the same data utilized in weekly operations for CPC’s support of FEWS Net.

- NCAR/NCEP Reanalysis data, in part downloaded from ESRL
- NOAA/CPC ARC2 daily rainfall (with 1983-2014 climatology)
- Wheeler and Hendon’s real-time multivariate MJO index

The study period spans February-May 2015.

Area average rainfall totals are computed over a box from 38E-43E and 7N-13N

The study period is broken up into “wet” and “dry” periods for analysis.

- Wet periods: 7 or more consecutive days of ≥ 1 mm area averaged rainfall
- Dry periods: 7 or more consecutive days of < 1 mm area averaged rainfall

Seasonal Evolution

The “Belg” rains evolved unusually over the “Belg”-producing areas of Central Ethiopia, characterized by a late start, followed initially by below-average rainfall (**Fig. 2**). By May, there was a transition to heavy, above-average rainfall, despite rains climatologically peaking in April. Areas south and east observed the opposite trend. May rain reduced seasonal deficits in the study area markedly, but the entire

season still finished with a 14.2mm area averaged deficit. Many regions along the highest elevations received nearly no rain during March and less than 50% of normal rainfall during April. The season contained 4 distinct dry periods during Feb-Apr. and 2 wet periods during May (**Fig. 3**).

Figure 3. Feb-May 2015 “Belg” region daily

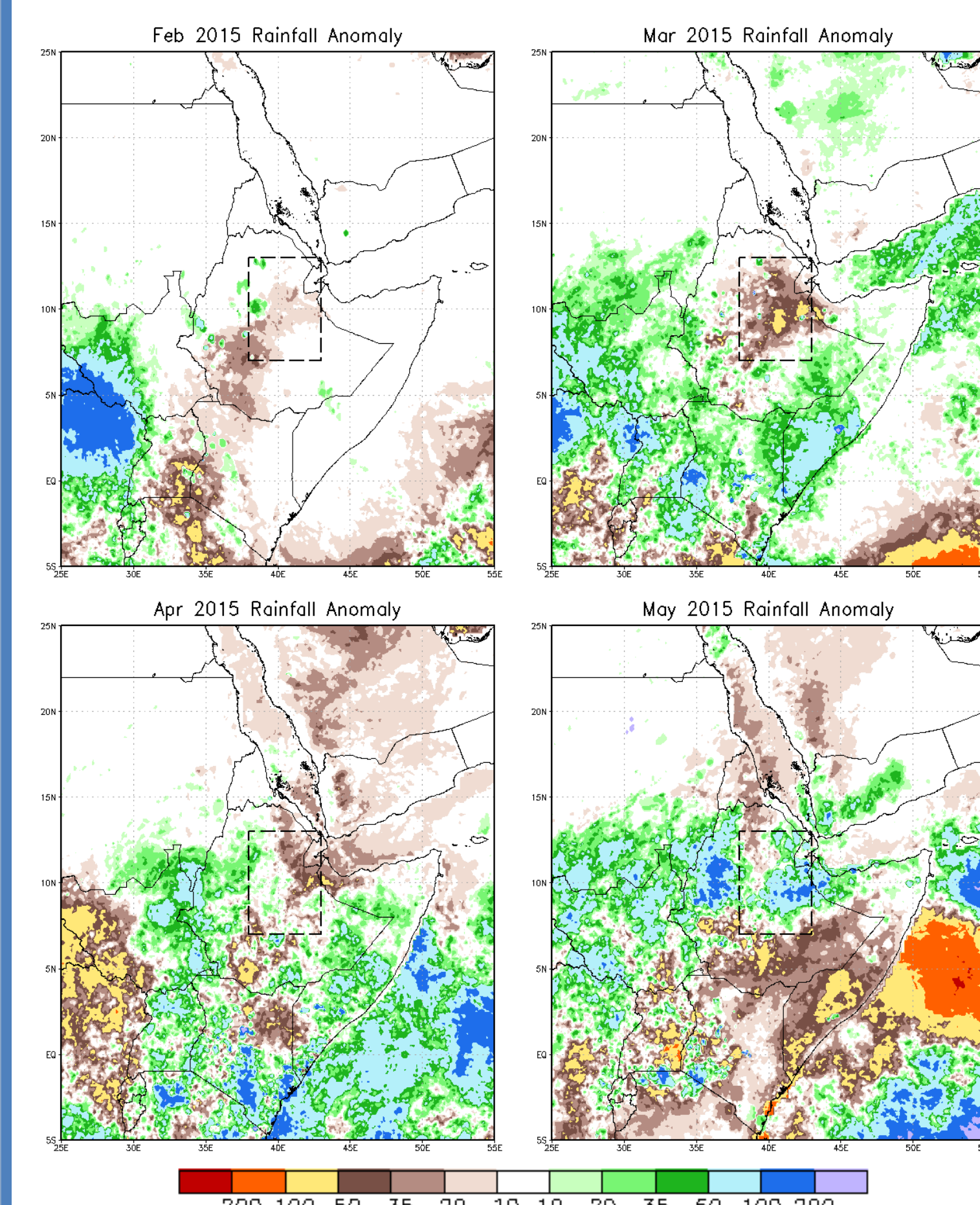
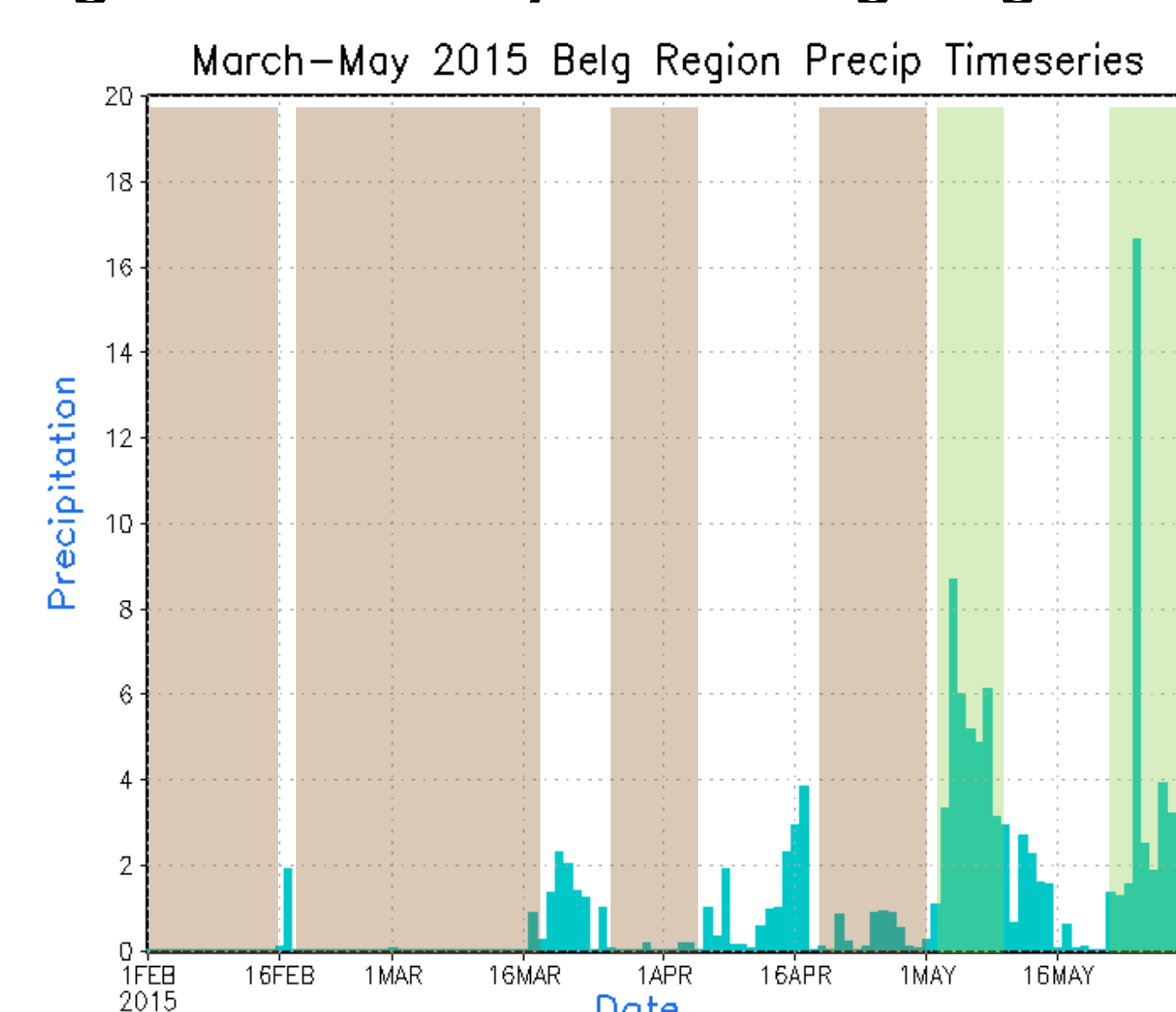
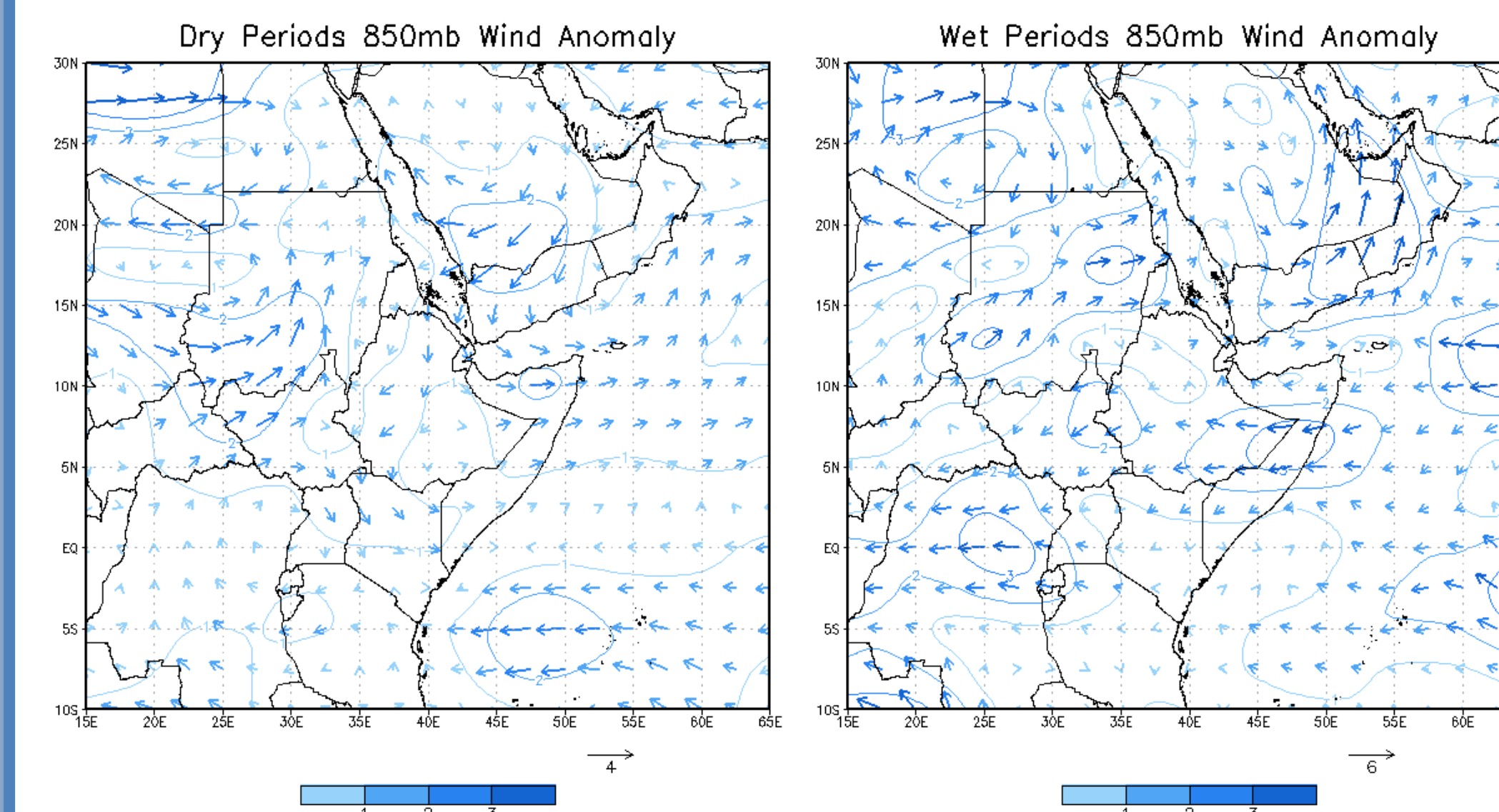


Figure 2. ARC2 monthly rainfall anomaly

Local-Scale Pattern

At low levels (**Fig. 4**), during wet periods, there was an anomalous easterly onshore jet into the Horn of Africa originating over the Indian Ocean. During dry periods, there was anomalously northerly flow into Ethiopia originating over the Arabian peninsula. Diffluence was also evident in the wind field over the “belg”-producing regions in the dry composite, making an unfavorable environment for precipitation.

Figure 4. 850mb Composite Wind Anomaly



Vertically integrated moisture flux and convergence (**Fig. 5**) is used to examine moisture transport by the low-level flow. Weaker moisture flux from the northeast was observed during dry periods. The shift in wind direction allowed for strong flux from the moisture rich equatorial Indian ocean region during wet periods. At the same time, the strongest moisture convergence became concentrated directly over the “belg”-producing regions leading to higher levels of specific humidity there.

Figure 5. 850-700mb vertically integrated moisture divergence (shading), flux (vectors), and specific humidity (contours)

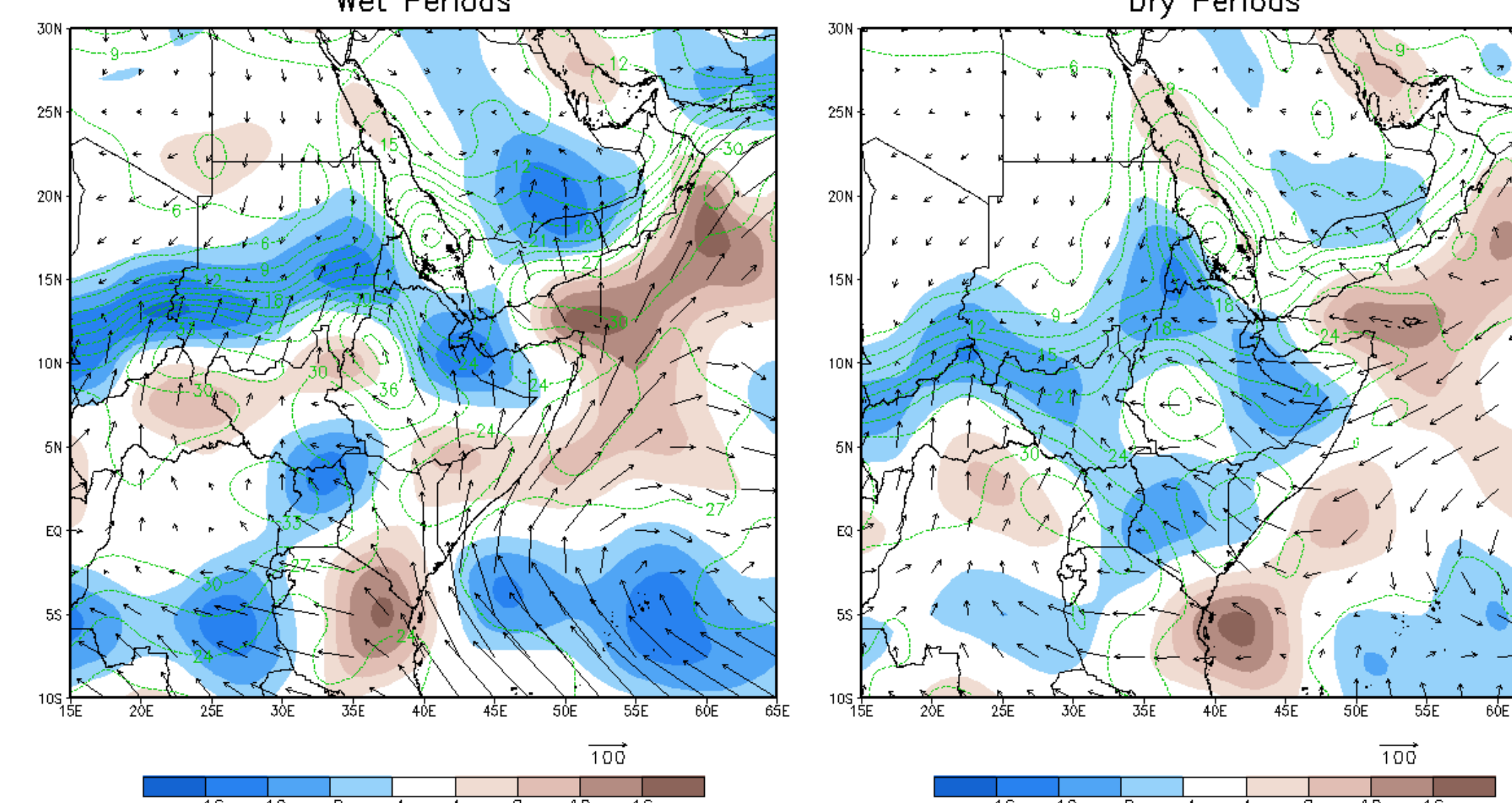
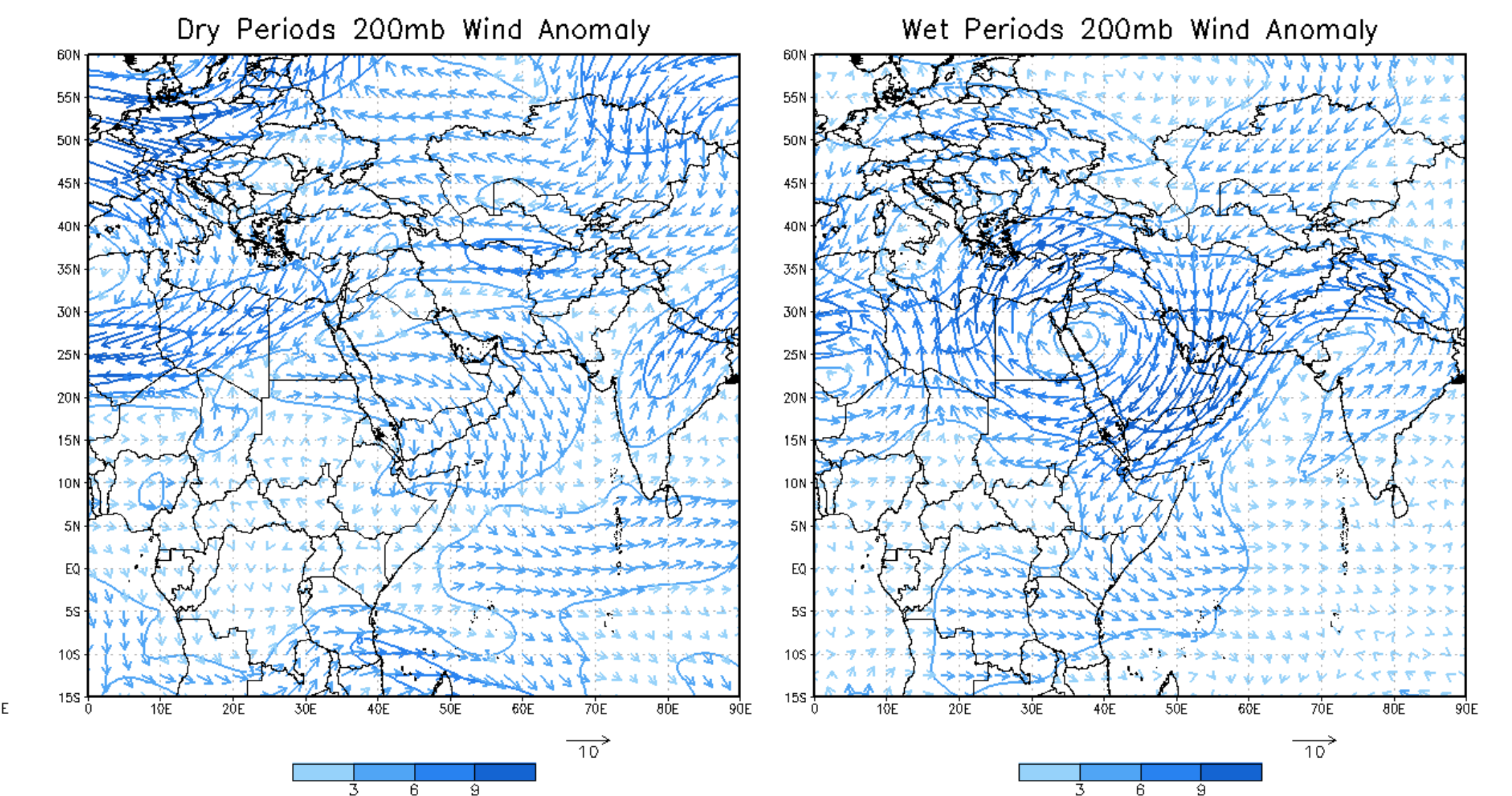


Figure 6. 200mb Composite Wind Anomaly



Large-Scale Pattern

Northern hemisphere flow was stronger and more amplified during dry periods than wet periods (**Fig. 7**). Week ridging was present over northeastern Africa and the Arabian peninsula. During wet periods, northern hemisphere flow was less amplified and coherent. The ridge over northeastern Africa broke down during these periods. Such a pattern likely facilitated more intrusion of mid-latitude systems into the horn of Africa region, enhancing precipitation.

A strong MJO event occurred throughout March and into early April with a peak intensity in RMM phases 6-8 during mid-March (**Fig. 8**). MJO related circulation during these phases have been found to correlate with northerly flow and suppressed rainfall in eastern Africa, which are observed during this time.

The negative mode of the Indian ocean dipole is associated with dry conditions over East Africa and the positive mode with wet. The dipole mode index climbed from strongly negative in February to strongly positive by May (**Fig 9**).

Figure 9. Dipole Mode Index (DMI)

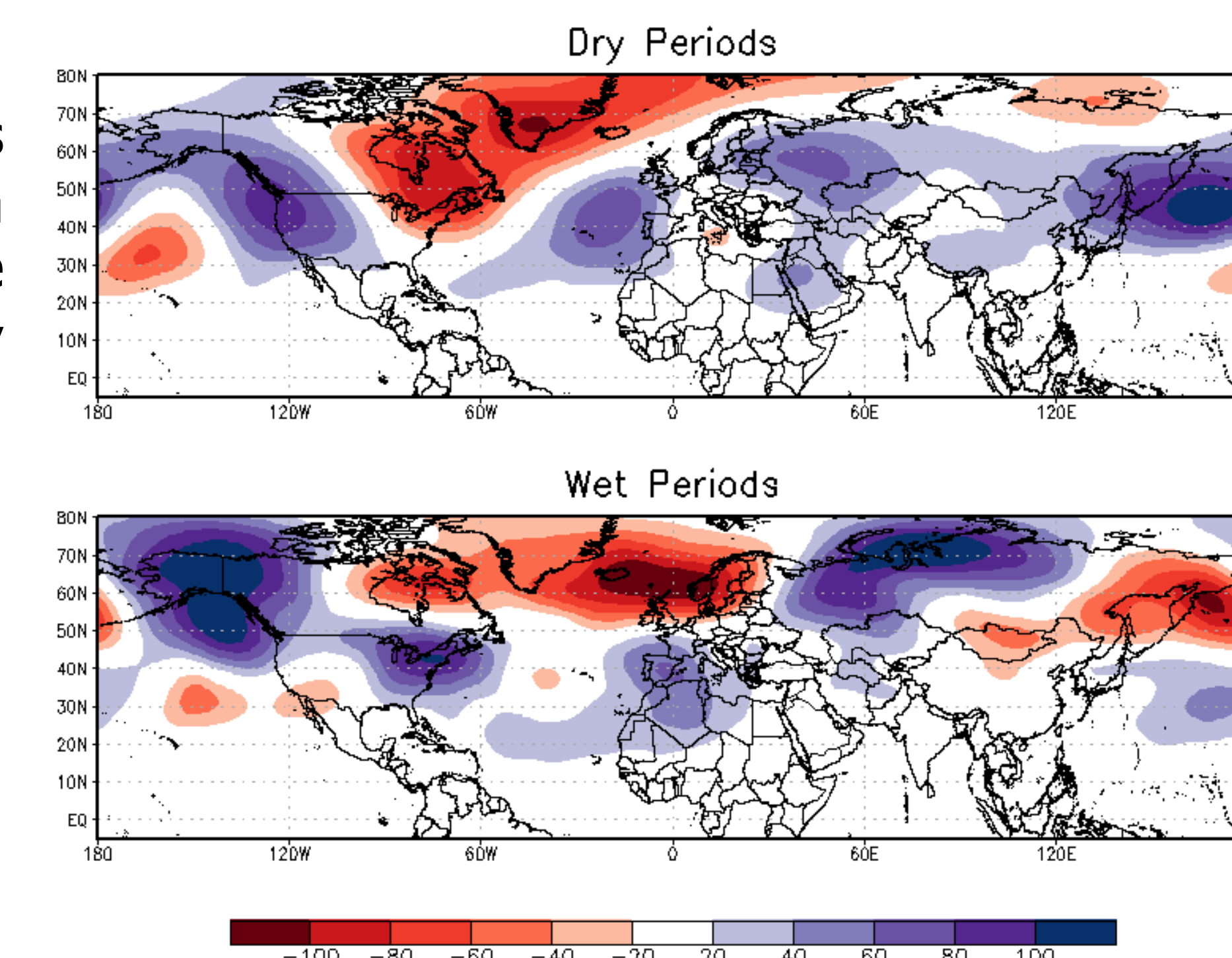
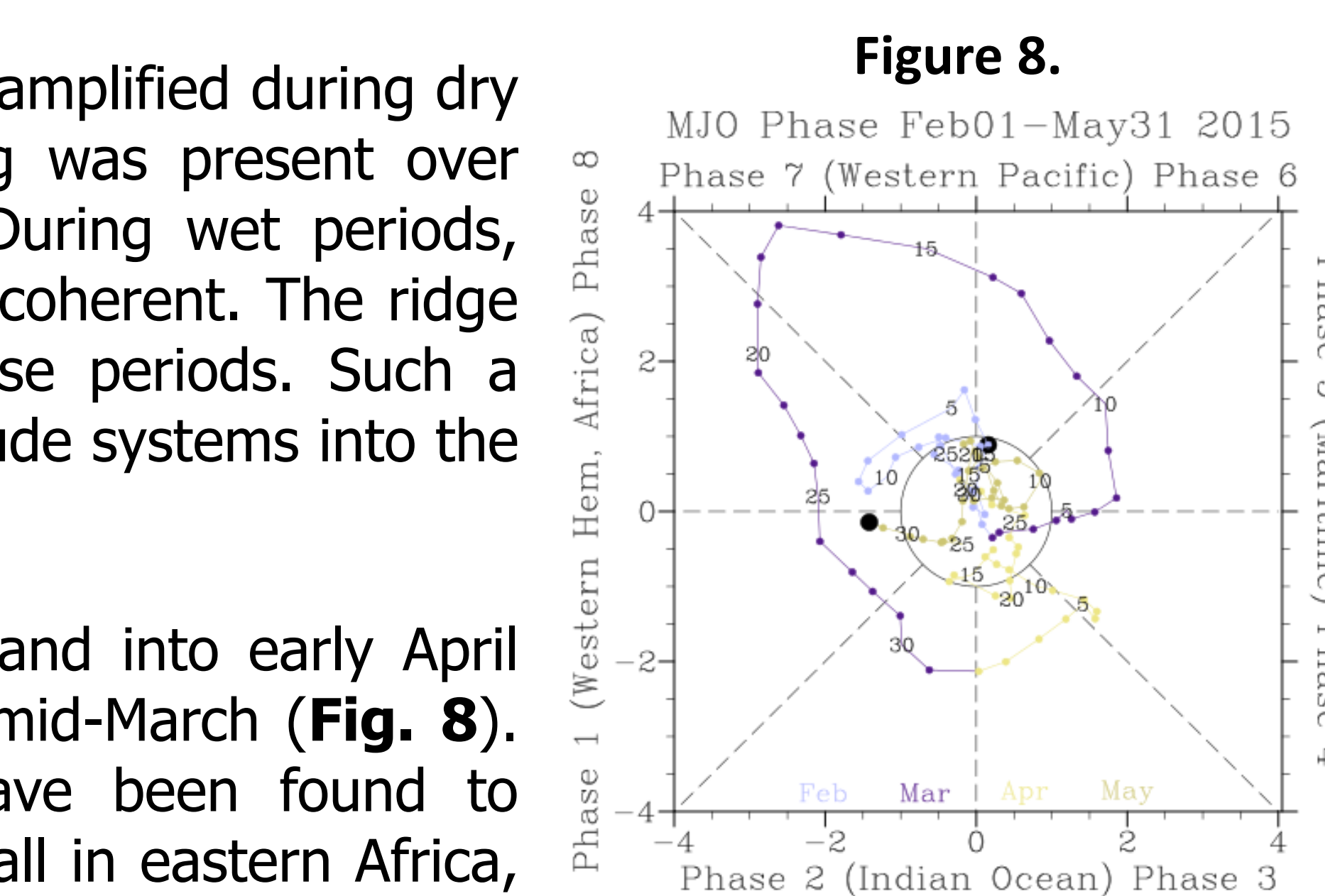
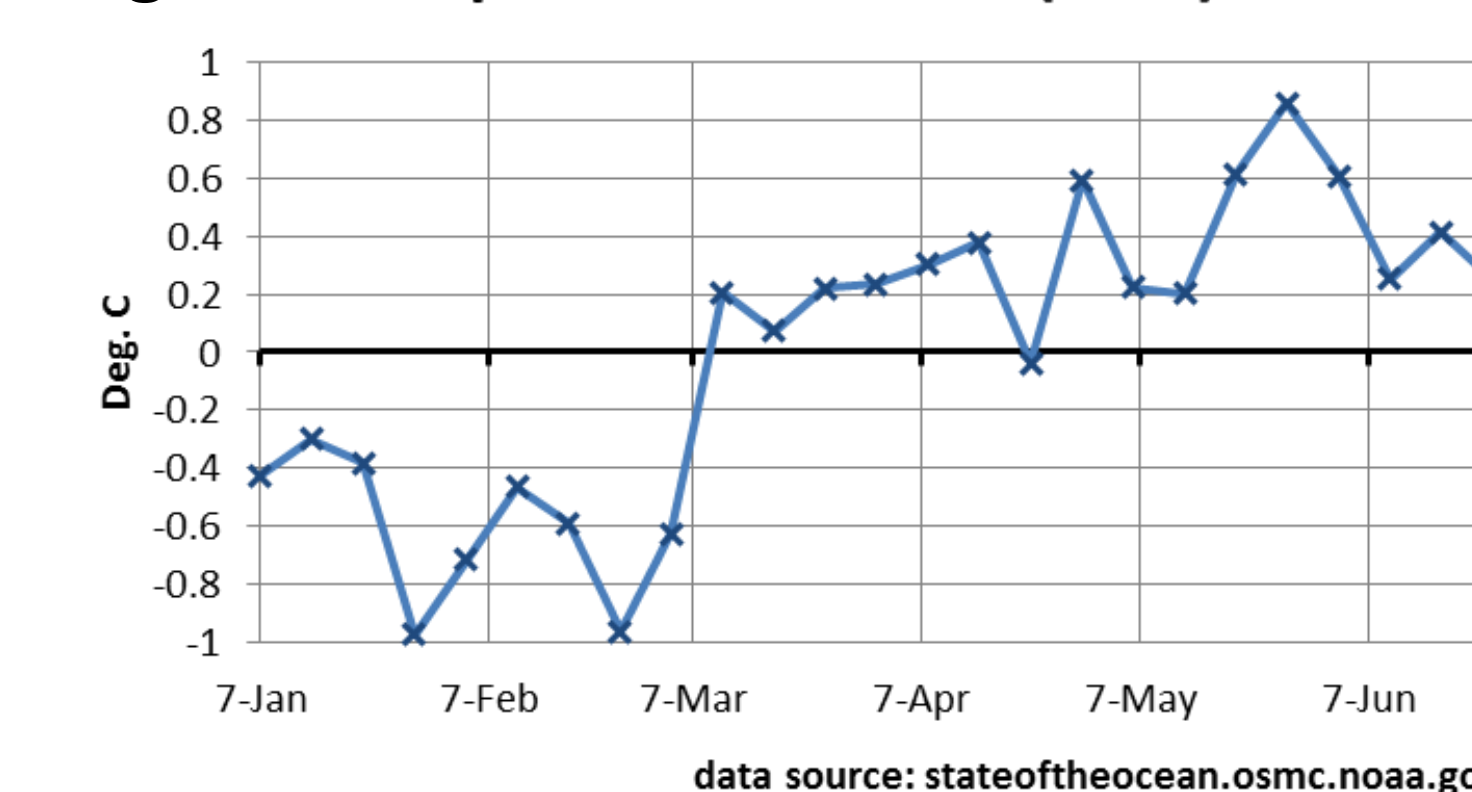


Figure 7. 500mb Geopotential Height Anomaly

Synopses & Conclusions

After a delayed start, the “belg” rain season initially produced light, insufficient precipitation through April. Though May was significantly wetter, exhibiting above-normal rainfall, relief was too late for some livestock and many crops, which had already failed. By the end of the season, conditions led to CPC issuing a drought hazard for much of central Ethiopia (**Fig. 10**).

The following factors were found to likely be largely responsible for the “belg” rain season’s abnormal evolution:

- Strong MJO event in March led to anomalous northerly flow
- presence of upper-level ridge just north of the region diminished mid-latitude influence
- Anomalous upper-level diffuence in the exit region of a jet streak enabled enhanced convection during May.
- Northerly low-level flow from the Arabian desert switched to southeasterly flow causing strong transport of maritime tropical air.
- Indian ocean dipole flipped from negative to positive phase

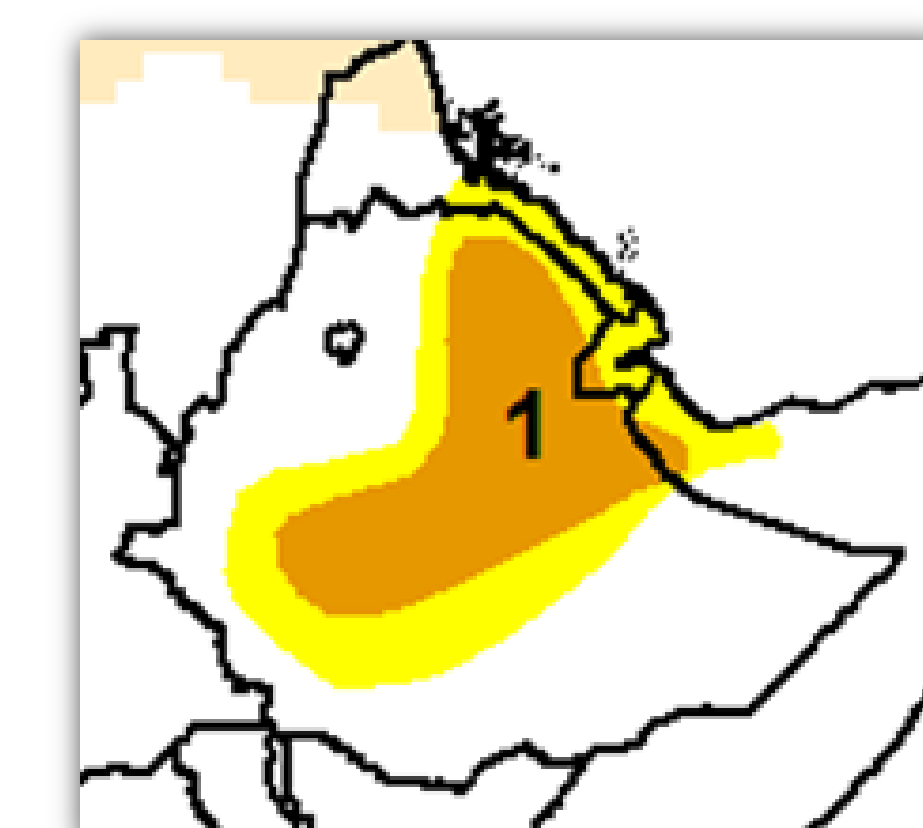


Figure 10. CPC hazards 5/3/15



Source: FEWS NET Apr-Sep, 2015 Ethiopia Food Security Outlook.