Geophysical Research Abstracts
Vol. 20, EGU2018-2578-1, 2018
EGU General Assembly 2018


# Variability of interannual-to-decadal teleconnections observed over the Greater Horn of Africa in the 20th century

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In this study, observational datasets from 1901 to 2013 were used to revisit the interannual to decadal teleconnections during three major rainy seasons over the Greater Horn of Africa (GHA) region. The strengths and their multidecadal changes in the linear statistical relationships between Sea Surface Temperature (SST)-based remote indices of climate variability and rainfall indices were examined and some physical explanations were explored. Consistent with recent studies, the post-1998 March-May (MAM) "long rains" decline is strongly associated with decadal variability in the Pacific Ocean (PO). The results reveal that both the Pacific Decadal Oscillation (PDO) and Interdecadal Pacific Oscillation (IPO) show a positive and significant correlation to long rains. The percent variance explained (PVE) ranges from 25 to 64% and the association stems from low-frequency variability (>8 years) for both PDO and IPO. The Eastern Mediterranean SSTs (EMS) are found to be significantly related to long rains on the interannual time scale with PVEs between 10 and 36% in the early 20th-century, but this teleconnection disappeared in the recent decades. October-December (OND) "short rains" interannual variability is dominantly influenced by the SST anomalies in the Indian Ocean (Indian Ocean Dipole, IOD), particularly in recent years, with PVEs increasing to 80%. In the pre-1951 period, there was no significant linear link between the IOD and the short rains for a time series window of fewer than 20 years. However, abrupt shifts in correlation are observed for starting years near 1918, 1951, 1987 and another strong shift in correlation occurred recently. These abrupt changes have been identified by previous studies and confirmed as times when real shifts occurred in the Indian Ocean. El Niño-Southern Oscillation (ENSO) is also associated with the short rains interannual variability, yet the ENSO influence is mediated by the warming in the western IO. This has been extracted by partial correlation analysis. On the other hand, decadal variations of short rains are mostly explained by SST anomalies in the PO, as it is demonstrated by significant correlations to the low-pass filtered time series of ENSO and IPO indices. ENSO is also strongly associated with June-September (JJAS) "Kiremt rains" over the Ethiopian Highland. This correlation is significant, stable with PVEs larger than 50%, and mainly based on high-frequency variability (<8 years). However, the correlation between Kiremt rains and Atlantic Niño 3 (ATL3) changed from significantly negative to positive after the 1960s. Corresponding to decadal regime shift of the relation between the Atlantic Niño and the West African monsoon (WAM).

In summary, the present study revealed both stable and variable teleconnections over GHA during the 20th-century. Three novel findings are worthy of note. On interannual timescales, (A) an early 20th-century impact of the EMS on long rains has been discovered and (B) a regime shift within the WAM system might have simultaneously changed the influence of the Atlantic Niño on Kiremt rains. Lastly (C), the study sheds more light on the link between decadal variability of the long rains and Pacific decadal variability.