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Important drivers of October to December rainfall season in eastern Africa and relevant mechanisms

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Monsoon rainfall and year-to-year variability play an important role in Africa's energy, agriculture, and other societal sectors. Within the African continent, east African countries are affected much by higher degrees of variability in seasonal monsoon precipitation. Two large-scale climate drivers, the Indian Ocean Dipole (IOD) and El Niño Southern Oscillation (ENSO) are studied in this regard. A strong connection starting from a season ahead is identified for early austral summer (Oct-Nov-Dec, OND) monsoonal rain in eastern Africa. This has been examined using various data sources, detrending data beforehand, analysing either recent or earlier time periods - covering two decades each, and using the analyses of regression. Results of compositing also suggested a strong significant anomaly in OND rain covering that region of east Africa (named here as region A:18˚S-12˚N, 25˚E-52˚E). When IOD and ENSO are both negative in July-August-September(JAS) there is a significant deficit in OND rainfall, while an excess rain when both are positive. The Walker circulation plays a key role via altering descending and ascending branches in two circumstances. Based on this analysis, it is possible to deliver an estimation of cumulative rain in terms of median value, range and distribution, one season in advance, at a point location or average over a region. Results are further verified for recent two years of 2022 and 2023, where drivers were of same sign, either both negative (2022) or positive (2023). Classifications based on two drivers, starting from JAS, are not only modulating cumulative rain but also influencing onset dates; excess (deficit) rain and early (late) onset are associated with positive (negative) phases of both drivers. Interestingly, regions of east Africa, south of that box region show a complete reverse pattern in OND and that pattern continues till Dec-Jan-Feb. In terms of mechanisms, apart from Walker circulation, ocean also plays a key part.

Some results of compositing are confirmed for longer records (1940-2021) too and further classification of drivers, based on a threshold value (+0.4) is tested. In the recent year 2023, as both drivers were strongly positive in JAS, more analyses in such cases are presented. We note, if either of the drivers is weak positive and lies in the range of 0 to +.04, the signal in region A weakens substantially on the eastern side of the box. The strongest weakening happens when both the drivers are of low magnitude in JAS (i.e., between 0 to +0.4). Rainfall (OND) variability of region A, at intra-decadal, decadal and multi-decadal scales are studied by applying the method of centered moving averages of 5-year, 11-year and 21-year respectively. A decreasing trend is noted in all situations and major peak/trough years are identified. For multi-decadal analyses, a shift at

around 1958 is identified when the trend of OND rain is reversed and switched from increasing to decreasing. Our results have implications for future planning in optimizing energy and agricultural outputs and the livelihood of millions of east Africans will be impacted.