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Uncovering a regime shift in Ethiopian highland summertime precipitation with implications for seasonal prediction

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Summertime (June-September) precipitation in the Ethiopian highlands, serving as the main source for the Blue Nile River, exhibits a characteristically high level of inter-annual variability. Precipitation received during this season has explicit effects on rain-fed and irrigated agriculture in addition to hydropower infrastructure, not the least of which is the massive, soon-to-be online Grand Ethiopian Renaissance Dam. Season-ahead precipitation and streamflow predictions have accordingly been developed over the past decades in an attempt to inform sectoral decision-making, including both empirical and dynamical modeling approaches. Variables describing ENSO, the Tropical Easterly Jet, Indian Ocean sea-surface temperatures, pressure systems, etc. have previously been identified as significantly correlated with summertime precipitation, and thus commonly included as predictors in empirical models. Preliminary evaluation of these models and individual teleconnections, however, illustrate very different relationships, as pre-2000 predictors correlate with summertime precipitation on the order of 0.6 on average, whereas for post-2000 this drops to 0.2. Although seasonal precipitation amounts have remained relatively stable across both periods according to many observational and reanalysis data products, nearly all predictors identified in literature show a significant decline in relationship. This change is not immediately evident in an assessment of dynamical model relationships. Further analysis reveals that this phenomenon appears to not be isolated strictly to the Ethiopian highlands, and may be connected to global circulation changes including the AMO and western Pacific warm pool circulation anomalies. This begs the question of whether this may be attributable to a regime shift, global warming, or simply within the scope of long-term, low frequency climate variability. This apparent shift in the relationship of previously identified teleconnections with Ethiopian highland precipitation warrants further investigation, as the current set of prediction models may be over-representing expected prediction skill, resulting in direct implications to societal welfare.