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Linkages between global sea surface temperatures and decadal rainfall variability over East Africa

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The overall objective of this study was to investigate the dominant spatial and temporal decadal rainfall variability modes and their teleconnection with decadal variability modes of the specific global oceans. Knowledge derived from this teleconnection was used to examine the predictability potentials of decadal rainfall variability over East Africa. The data sets used in the study included monthly-observed rainfall (1920-2010) over East Africa and global sea surface temperature covering the period 1950 to 2010. The observed rainfall and sea surface temperature data used in the study were smoothed using a nine-point binomial coefficient filter to remove all fluctuations equal less than 9 years. The methods used include trend spectral analyses to investigate the dominant patterns of the existing decadal rainfall variability. Principal Component Analysis (PCA) was used to delineate the region into homogenous decadal rainfall zones while Cannonical Correlation Analysis (CCA) and Singular Value Decomposition (SVD) techniques were used to investigate teleconnection amongst decadal rainfall with Sea Surface Temperature (SST) modes over various parts of the global oceans. The predictability potentials of the regional decadal rainfall variability patterns were assessed using correlation and Multiple Linear Regression (MLR) methods. The patterns of decadal varaibility showed wet and dry decades recurring and sometimes extend over large areas while there were very few decades when floods or drought covered the whole of East Africa region. Results from spectral density analysis of rainfall time series showed dominance of ten years period that were significant at 95% confidence level. The Principal Component Analysis results for decadal rainfall records yielded seven and nine homogeneous decadal rainfall zones for October-December (OND) and March-May (MAM) seasons respectively. The results obtained from analyses of teleconnection between the regional decadal rainfall variability patterns and the global sea surface temperatures using Singular Value Decomposition (SVD) analysis showed high values of Square Covariance Fractions (SCF) explained by the first three modes of the global oceans. The results for the first SVD modes for Indian, Atlantic and Pacific oceans, respectively, contributed to 50%, 43% and 38% of the total square covariance for March - May, 65%, 48% and 40% for September - December rainfall seasons. It was very evident that the El Niño modes were prominent over the Pacific Ocean, while Indian Ocean dipole was a key feature over the Indian Ocean basin. An inter-hemispheric dipole mode that is common during ENSO was a prominent feature in the Atlantic Ocean. In general, the results from the SVD highlighted the significant roles of all the global oceans in the observed decadal rainfall variability modes over the region. Results from Multiple Linear Regression (MLR) method showed substantial variation of the model prediction skill of the decadal rainfall variability modes within various homogenous zones and seasons. The results of this study, therefore, have provided some very useful insights, tools, methods and products that can be broadly used to inform short to long term planning and management of all rainfall dependent activities in the region. In particular, the outcomes of this study will be useful milestone in mainstreaming decadal climate variability information into the regional economic development strategies. The results can be integrated in the development of new climate risk management tools to aid in coping with current climate variability and adaptation to future climate changes in East Africa.