1. SUMMARY

A Non-Homogeneous hidden Markov Model (NHMM) is developed using a 60-years record (1950-2010) of daily rainfall at eleven stations in Tanzania and re-analyses atmospheric fields of Temperature (T) at 1000 hPa, Geo Potential Height (GH) at 1000 hPa, Meridional Winds (M1) and Zonal Winds (M2) at 850 hPa, and Zonal Winds at the Equator (DGF) from 10 to 100 hPa. The NHMM is then used to predict future rainfall patterns under a global warming scenario (RCPS 8.5) using predictors from the CMCC-CMS simulations from 1950-2010. The model directly takes into account potential non-linearities through changes in the driving variables that address the question of how future changes in seasonal precipitation can be modeled. The future downscaled simulations from NHMM, with predictors derived from the simulations of the CMCC-CMS CGI, are the recent conditions of global warming as simulated by NHMM for scenarios, indicating that Tanzania may be subjected to a reduction of total annual rainfall; this reduction is concentrated in the wet seasons, OND, mainly as a consequence of decreasing of seasonal number of wet days. Frequency and intensity of extreme events don’t show any evident trend during the 21st century.

2. DATA & METHODS

NHMM is applied to relate hidden states to daily large scale predictors extracted from the NCAR re-analysis project. Using seasonality identified by the NHMM, the full year without seasonality assumptions is then applied to the daily data for the full year without seasonality assumptions. “Seasonality” is identified by the NHMM for the conditional simulation of the NHMM. These fields were obtained from NCPS/NCAR reanalysis data (http://iri.columbia.edu/reanalysis/).

3. HIDDEN STATES OF DAILY RAINFALL OCCURRENCE AND AMOUNT

In order to use NHMM to predict future rainfall patterns for Tanzania using 21st century global warming scenarios, the following steps are taken:

1. Selection criteria to choose between different GCMs from CMIP5 (Coupled Model Inter-comparison Project Phase 5) (Kim et al., 2003), Criteria: comparison of basic statistics (seasonal mean, variance, skew, variance and serial correlation) and the spatial pattern for the PCs from the two candidate GCMs for each variable in the NHMM developed with re-analyses atmospheric fields.

2. Comparison of the PCs for the best GCM to match the scales of the corresponding PCs for the observations.


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The NHMM for the conditional simulation of the NHMM for the 21st century is tied to the movement of the Inter-tropical Convergence Zone (ITCZ) which moves north and south during the year. (Chris Jack, 2008). Rossby waves in the Extratropical region, which moves polewards and is tied to the movement of moisture along the Indian Ocean. (N. H. Saji, B. N. Goswami, P. N. Vinayachandran & T. Yamagata, 1999). The El Niño/Southern Oscillation (ENSO) is tied to the movement of moisture along the Indian Ocean. (N. H. Saji, B. N. Goswami, P. N. Vinayachandran & T. Yamagata, 1999). The El Niño/Southern Oscillation (ENSO) is tied to the movement of moisture along the Indian Ocean. (N. H. Saji, B. N. Goswami, P. N. Vinayachandran & T. Yamagata, 1999).

4. 60 YEARS RAINFALL OCCURRENCE AND AMOUNT

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5. HMM & NHMM VALIDATION

The calibration (1950-2010) and validation (2011-2030) tests, for different predictor combinations, revealed the effectiveness of the NHMM for the conditional simulation of the seasonal occurrence and amount statistics including the extreme values.

6. PROJECTING CHANGES IN TANZANIA RAINFALL FOR THE 21ST CENTURY

The Inter-tropical Convergence Zone (ITCZ), together with Indian Ocean Dipole (IOD) have been identified as the most important circulation factors affecting the Tanzania hydro-climatic. Rainfall in Tanzania is tied to the movement of the Inter-tropical Convergence Zone (ITCZ) which moves north and south during the year. (Chris Jack, 2008). The IOD contributes to the movement of moisture along the Indian Ocean. (N. H. Saji, B. N. Goswami, P. N. Vinayachandran & T. Yamagata, 1999). The El Niño/Southern Oscillation (ENSO) is tied to the movement of moisture along the Indian Ocean. (N. H. Saji, B. N. Goswami, P. N. Vinayachandran & T. Yamagata, 1999). The El Niño/Southern Oscillation (ENSO) is tied to the movement of moisture along the Indian Ocean. (N. H. Saji, B. N. Goswami, P. N. Vinayachandran & T. Yamagata, 1999). The El Niño/Southern Oscillation (ENSO) is tied to the movement of moisture along the Indian Ocean. (N. H. Saji, B. N. Goswami, P. N. Vinayachandran & T. Yamagata, 1999). The El Niño/Southern Oscillation (ENSO) is tied to the movement of moisture along the Indian Ocean. (N. H. Saji, B. N. Goswami, P. N. Vinayachandran & T. Yamagata, 1999). The El Niño/Southern Oscillation (ENSO) is tied to the movement of moisture along the Indian Ocean. (N. H. Saji, B. N. Goswami, P. N. Vinayachandran & T. Yamagata, 1999). The El Niño/Southern Oscillation (ENSO) is tied to the movement of moisture along the Indian Ocean. (N. H. Saji, B. N. Goswami, P. N. Vinayachandran & T. Yamagata, 1999).