Long Range Forecasting of the Nile River Flows Using Climatic Forcing

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Abstract. Forecasting the Nile River flows is of vital interest for many African nations such as Sudan and Egypt. Any improvement in the forecast accuracy and/or the prediction horizon will have a significant influence on improving the water management in these nations. The idea of this research stems from previous studies that have identified that certain large scale climatic oscillations, such as the El Niño Southern Oscillation (ENSO), as being important factors in long-range hydro-climatic forecasting. The mechanism by which the Pacific ENSO is transmitted to the Nile basin hydrology is not fully understood, although its effects on the flow have been identified. In addition, other large-scale oceanic-atmospheric systems, such as those related to the Atlantic and the Indian Oceans, may exert a significant influence on the climate of the Nile basin. Thus, other predictors need to be identified to find signals that may contribute to explaining the variability of the Nile River flows. The aim of this study is to further identify Oceanic regions and hydro-climatic variables of strong connection with the Nile Basin hydrology, particularly Nile River streamflows. The study will also focus on extending the prediction horizon beyond the previously used time scales.

Multivariate statistical techniques are used to relate the sea surface temperatures (SSTs), Guinea precipitation (Western Africa), and streamflows. SSTs at different lead-time are averaged over 51 oceanic regions to construct several potential predictors for the river flows. Lead-lag correlation maps identified some SST regions of high correlation and longer lead-time with the Nile River flows other than the known ENSO region. 20 regions with serially independent SST series and high correlations with the Nile are selected. A multivariate regression model fitted based on data from these 20 regions, plus previous year (-1) precipitation data from Guinea explains 49% to 74% of the variability of the Blue Nile flood for the lead seasons (March-June) MAMJ(-1) through MAMJ(0), respectively. In addition, an empirical orthogonal function (EOF) analysis was applied to the seasonal mean data sets to reduce the number of potential predictors to be included in the multiple regression procedure. The principal component (PCA) multivariate model explains 54% to 71% of the variability of the Blue Nile flood for the lead seasons (November-February), NDJF(-2) through MAMJ(0), respectively. The model is capable of forecasting the flow fluctuations reasonably well. Further improvements are under way.