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Modelling Regional Evapotranspiration in the Volta Basin, West Africa: A Test of Complementarity Relationship Hypothesis

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Abstract

Engineers, water managers, agriculturists and hydrologists continue the search for simple but robust or novel methods to estimate evapotranspiration rates, for proper managements of water resource at both local and regional scales, using only standard meteorological parameters obtainable from synoptic weather stations. Models based on Bouchet's complementarity relationship hypothesis are examples of such models that could bypass or incorporate the complex feedback mechanisms existing in the soil-plant-atmosphere system, and are hence useful in that respect. The complementarity relationship hypothesis was, therefore, tested in the Volta Basin using the Advection-Aridity (AA) approach. This model is based on conceptual symmetry between actual (ETa) and potential (ETp) evapotranspiration over a large area of regional extent. The AA model was reformulated to make it suitably applicable in the Volta Basin. Recalibration of wet environment ET (ETw) and reparameterisation of wind function yielded a marked improvement of the AA model performance. Seasonal surfaces of ETp and ETw follow the gradients of available energy and moisture, respectively. The monsoon (convective) clouds and harmattan play significant roles in attenuating solar radiation which, coupled with seasonal changes in surface albedo, influence evapotranspiration processes in the Basin. The good performance of the improved AA model compared to ETa output from a regional circulation model (MM5) indicates the utility of models based on Bouchet's complementarity relationship hypothesis in regional ET studies for providing independent estimates of actual evapotranspiration. Modelling of evapotranspiration investigated in this research provide relevant information that can be integrated with other data for sustainable agricultural water management, eco-hydrological modelling, and in the study of climate effects of land use/land-cover change in West Africa.

Keywords: Advection-Aridity model, complementarity relationship hypothesis, regional evapotranspiration

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