Climatic effects of surface condition in regional climate model over Nile Basin

By

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For the degree

Doctor of philosophy

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(Natural Resources, Meteorology)

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2015

Abstract

The climate system is a complex system by its interactions which occur between its contents such as atmosphere, biosphere, plant and hydrology, etc. the climate model is an important tool which can be used to study these interactions. Here ICTP-RegCM4 model used to study the impacts of different land surface schemes on regional climate of Nile Basin. This thesis has several objectives such as:

To study the sensitivity of regional climate model (RegCM4) for different land schemes (BATS and CLM3.5), we run the RegCM4 model twice one by RegCM4-BATS and another one by RegCM4-CLM3.5 during the period from 1995 to 2007. We divided the region into three domains, Congo Basin, East Africa and Northern Africa. From the output we found that RegCM4 model is well simulated for precipitation and temperature of three domains expect in some different in phase and magnitude after compared it by different observational dataset such as CRU, GPCP, ERA and UDEL.

We concluded that different land surface schemes have strong impact on regional climate of the region. We found that the important factor in any land surface scheme which effect on regional climate is soil moisture because it is a source for evapotranspiration which may led to precipitation.

We study the different interactions for soil moisture with evapotranspiration, precipitation and temperature. We found that RegCM4-BATS has high soil moisture content than RegCM4-CLM3.5 so the evapotranspiration is high in BATS than CLM3.5. We found here a positive feedback between soil moisture and evapotranspiration also with precipitation which follow the seasonal variation of evapotranspiration.

Also we found that RegCM4-BATS has a lower albedo value than RegCM4-CLM3.5; this due to the wetter soil of BATS than CLM3.5. So the temperature near the surface will be higher in CLM3.5 than BATS. Due to lower evapotranspiration in CLM3.5, the sensible heat will be high and latent heat will be low and vice versa for BATS.

RegCM4-BATS used to study the impact of land use change of Sudd region (wetland) which replaced by tall grass on regional climate of Nile Basin. After two simulation experiments, one is control by default wetland and the second by new land use tall grass. We found that change land use category has a local impact over Sudd region only but there is no any significant effect anywhere. Due to land use there is a decrease in soil moisture due to increase soil suction. According to this decrease in soil moisture, evapotranspiration decrease, but for precipitation there is an increase in rainy season this may be due to that the source of precipitation from outside or due to the shift of ITCZ into northward. For temperature there is a decrease which is naturally due to soil moisture decrease and increase of sensible heat and the albedo of the area will decrease.

We simulate this experiment over Sudd region only because when we increase the resolution we need a high computational power and this is not available. Sudd region with tall grass land cover with two horizontal distances 50 km and 15 km. We found that from this experiment that decreasing horizontal distance has a strong impact on local climate of Sudd region. Soil moisture increases led to increase in evapotranspiration and then precipitation (positive feedback mechanism). Temperature decreases as albedo decreases and sensible heat decreases.

Two experiment one by tall grass and another by short grass with 15 km horizontal distance. We found there is no significant difference by replacing Sudd region into tall grass or short grass, may be due to the similar physiological processes for the two land covers.

We concluded that RegCM model is an important tool which can be used in study climate (past, present and future) over the region and many applications available in the model to study chemistry, hydrology, and land use. With several tests for the RegCM model we can reach to the best configuration to reduce the bias with the observation.