Simulation of Crop Yield in the Amhara Region Using a Large Area Crop Model as Driven by Outputs from RegCM-4

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Objectives
The general objective of this study is to assess the capability of RegCM-4 output together with a large area crop model to simulate wheat yield.

The specific objectives of the study are:
- Evaluate the RegCM4 performance in representing the climatology, seasonal variability of precipitation to use for crop model
- Asses the ability of RegCM-4 simulation to capture summer season rainfall over Ethiopia and,
- Use RCM output to drive crop model and asses the accuracy of simulated yield prediction for the projection work 2013-2050.

Data and Methodology
The General Large Area Model (GLAM) for Annual Crop(Charllinor,2004; Li,2008) and 2010 version of ICTP’s Regional Climate Model (RegCM-4) are used in this thesis.

- The daily GPCP rainfall and Observed yield datasets are used for validation.
- GPCP rainfall data sets are provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at http://www.esrl.noaa.gov/psd.
- Daily gridded Tmin, Tmax, rainfall and radiation data sets are taken from the simulated RegCM-4 output using the following configuration:
  - 60km horizontal resolution, 18 vertical ζ-levels and model top at 50hpa.
  - The domain covers 96 grid points in the y-direction and 224 grid points in the x-direction.
  - SST is derived from the OI-Weakly.
  - Surface parameters (topography, land use, vegetation, soil type etc) are determined from a 10-min archive.
  - Meteorological ICBC’s are taken from ERA-Interim data.
- Soil hydrological properties were drove from FAO/UNESCO (1974) soil map of the world and data are averaged to our model grid
- Yearly zonal-level wheat yield for the summer season for the period 1995-2008 have been compiled by CSA, Addis Ababa, Ethiopia.

Fig 1: Geographical features Amhara Regional states and locations of GLAM gridcell inside Amhara region, and also in the right side the RegCM-4 domain to simulated climate variability.

The performance of GLAM and RegCM-4 models are evaluated quantitatively by analyzing
- Correlation coefficient
- Bias
- RMSE

Mean Rainfall climatology over Ethiopia

Mean and STDV difference of rainfall over Amhara Region

Summer Seasonal Seasonal Cycle

Summer (JJAS) Rainfall Variability

Fig 4 Comparison of modeled Coefficient of variation of rainfall (%) with the observed data in Ethiopia during the period 1995 - 2008.

Fig 5: The difference between RegCM-4 and GPCP data in (a) mean and (b) Standard deviation of JJAS rainfall(mm/day) (c) Spatial Correlation between the two datasets.

RegCM-4 Results

Modeling Approach

Assessment of GLAM internal consistency

Model skill at 0.5° Spatial Scale

Conclusions
- RegCM-4 has the ability to downscale and simulate rainfall distribution and it’s interannual variability over Ethiopia.
- Downscaled climate data can be use to explore sources of uncertainty in yield simulation.
- The internal cosistancy checks that are used to ensure the performance of the crop model proves that GLAM performs magnificently.
- Correlations between simulated yields and whether agrees with the observed.
- Evaluation of 14-yrs simulated yield revealed that GLAM-Wheat model combined with RegCM-4 whether data has simulated over study area with high correlation. This support the hypothesis that GLAM-Wheat can reasonably simulated the variability of wheat yield over Amhara region.