Using Climate Models to generate Crop yield forecasts in Southeast USA

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One of the major achievement in climate related studies in the last decade is the improved performance of AGCMS and CGCMS in simulating climate with respect to annual and seasonal averages. How these simulations can be used to study the local and regional impact analysis is one of the most challenging problem for the meteorologists and oceanographers. Traditionally, agricultural applications of climate forecasts have used statistical analysis of historical climate and ENSO information to arrive at climate scenarios for adaptive management. Seasonal forecasts from the state-of-the-art climate models can provide better inputs and hence can be directly linked to various application models such as crop, hydrology, ecology etc.

Since the GCMs simulations are carried out at a larger grid interval (∼200kms), downscaling the parameters for a particular station may result in inaccurate results. The regional climate models (RCMs) which is usually run at very high resolutions (∼20kms) using the boundary conditions provided by the GCM allow more accurate representation of the station data. We have used FSU Regional Spectral model (Cocke and LaRow, 2000) to generate crop yield forecasts in S.E USA. To be precise, an attempt was made to integrate outputs from the FSU regional climate Model with agricultural models to forecast maize yield in SE USA using the CERES-maize crop model.

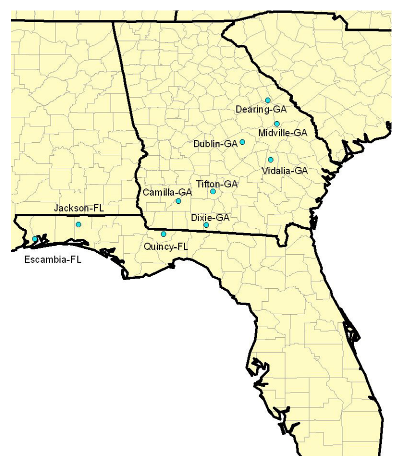

Figure 1: : Study sites

Methodology

Seasonal integrations (March-August) of the FSU global coupled spectral model and the FSU regional spectral model has been carried out for a period of 13 years (1987-1999) using two different convection schemes. The regional model was centered over southeast U.S and run at 20km resolution, roughly resolving the county scale. Model outputs of max/min surface temperature, precipitation and shortwave radiation at the surface are used as inputs into the crop model to determine crop yields.

Comparison of regional model outputs with station observations in Florida and Georgia show that minimum surface temperatures are well simulated for the 180 day period starting from first May. The maximum temperatures show a cold bias of around 10 degrees. The model shows a wet bias in the precipitation field. Surface solar radiation shows reasonable agreement with the few stations which report that observation. The crop model is presently being run for 10 stations in south Georgia and north Florida (see Fig.1) using both the global and regional model as forcing. These stations are selected depending on the availability of crop yield data. Moreover these stations have recorded a fairly continuous record of observed surface

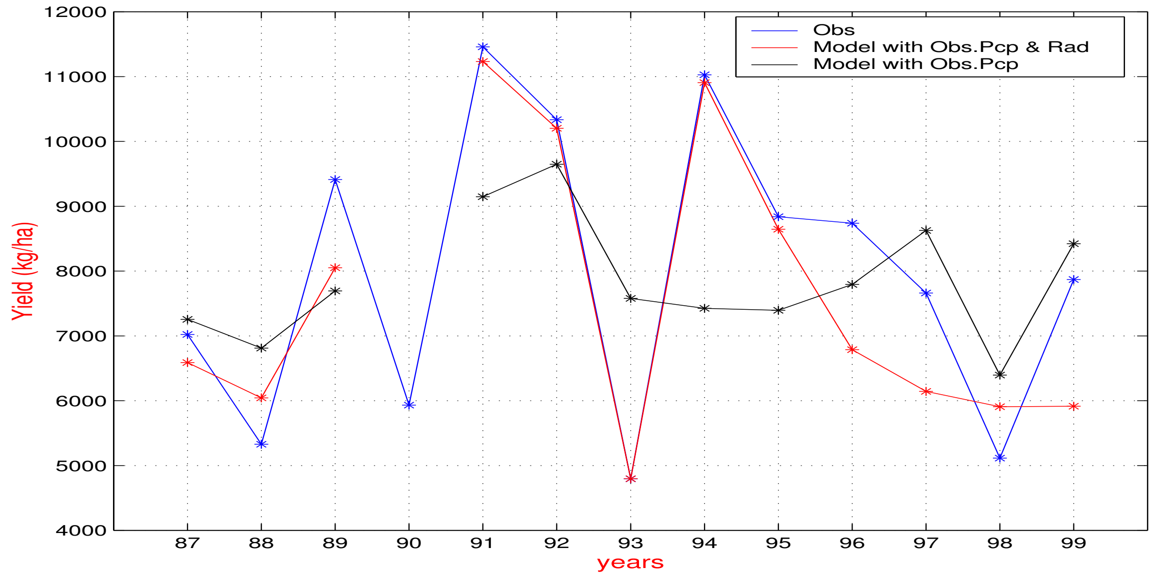

Figure 2 : Maize Yield simulated by the Crop Model using observed data and climate model data at Dublin,GA.

solar radiation. Max/Min surface temperature outputs from the model are bias corrected with respect to 13-year climatology of the observed station data. Fig.2 shows the maize yield generated by the crop model for the 13-year period with two different scenarios at a particular station in Georgia (Dublin). Blue line indicates the yield generated by the crop model using the observed station data and climatological surface radiation values were used for periods before 1995. Red line denotes the first scenario where the yield is generated using the regional model bias corrected surface temperatures and using the observed precipitation and radiation. The black line denotes the yields generated using the model bias corrected surface temperatures and radiation and using the observed precipitation. For the first case, the model performs reasonably well before 1995, but the skill is reduced after 1995. The second case performance is not good as the first case. The results indicate the need for bias correction for the precipitation field. The fact that, only by bias correcting surface temperature produces a reasonable result is promising, though a conclusive statement cannot be made at this stage of the study. Future work involves finding methods to correct the model precipitation and to see how the crop model performs in the other selected stations.

We plan on generating ten member ensembles of the regional model using different initial conditions for the entire 13-year period. These will be the used to make a probability forecast of the crop yield. We hope to correct much of the temperature and precipitation biases by using the latest version of FSUGSM which incorporates a new state-of-the-art land surface scheme and has been shown to provide better surface temperature and precipitation fields.

References

S.Cocke and T.E LaRow, Seasonal predictions using a Regional Spectral Model embedded within a Coupled Ocean-Atmosphere Model, **128**, *Mon.Wea.Rev*, 689-708, 2000.

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