Agricultural Productivity Forecasts for Improved Drought Monitoring

Ashutosh Limaye, Richard McNider, Donald Moss and Mohammad Alhamdan
National Space Science Technology Center (NSSTC)
320 Sparkman Dr., Huntsville, AL 35805

Introduction

Water stresses on agricultural crops during critical phases of crop phenology (such as grain filling) has higher impact on the eventual yield than at other times of crop growth [1]. Therefore farmers are more concerned about water stresses in the context of crop phenology than the meteorological droughts. However the drought estimates currently produced do not account for the crop phenology. US Department of Agriculture (USDA) and National Oceanic and Atmospheric Administration (NOAA) have developed a drought monitoring decision support tool: The U.S. Drought Monitor, which currently uses meteorological droughts to delineate and categorize drought severity. Output from the Drought Monitor is used by the States to make disaster declarations. More importantly, USDA uses the Drought Monitor to make estimates of crop yield to help the commodities market. Accurate estimation of corn yield is especially critical given the recent trend towards diversion of corn to produce ethanol. Ethanol is fast becoming a standard 10% ethanol additive to petroleum products, the largest traded commodity. Thus the impact of large-scale drought will have dramatic impact on the petroleum prices as well as on food prices.

USDA's World Agricultural Outlook Board (WAOB) serves as a focal point for economic intelligence and the commodity outlook for U.S. WAOB depends on Drought Monitor and has emphatically stated that accurate and timely data are needed in operational agrometeorological services to generate reliable projections for agricultural decision makers [2]. Thus, improvements in the prediction of drought will reflect in early and accurate assessment of crop yields, which in turn will improve commodity projections.

We have developed a drought assessment tool, which accounts for the water stress in the context of crop phenology. The crop modeling component is done using various crop modules within Decision Support System for Agrotechnology Transfer (DSSAT [3]). DSSAT is an agricultural crop simulation system, which integrates the effects of soil, crop phenotype, weather, and management options. It has been in use for more than 15 years by researchers, growers and has become a de-facto standard in crop modeling communities spanning over 100 countries. The meteorological forcings to DSSAT are provided by NASA's National Land Data Assimilation System (NLDAS) datasets. NLDAS is a framework that incorporates atmospheric forcing and land parameter values along with land surface models to diagnose and predict the state of the land surface [4].

Approach

Our methodology for drought characterization is intended to be used in conjunction with the Drought Monitor to better assess the agricultural drought, which are produced on a spatial grid. Agricultural crop estimates require modeling crop growth, which traditionally are done on a sporadic agricultural research stations. Instead, we model the crop yields on a spatial grid for a hypothetical farm in each grid cell growing the given crop.

We have used DSSAT crop modules to estimate crop yields in Alabama, where we have successfully generated model runs for corn for the summer of 2009. The daily weather datasets are comprised of temperature, precipitation and solar radiation, which are be derived using NLDAS datasets. The spatial resolution of NLDAS is 12 km, the same spatial resolution used for the crop modeling. For each day of the crop-growing season, we performed a model run for each grid point, with the NLDAS data available for the season to that day and the remainder of the season substituted with climatology. Thus the crop model output at the beginning of the crop year was entirely climatology and as the year progressed, the climatological data was substituted with actual observations. The model output is validated using crop yield measurements from data at agricultural research stations.

In the presentation, we will show our results from our Alabama corn yield estimates throughout the growing season and comparisons with the observational data. We will also compare our modeled estimates with the data compiled by USDA National Agricultural Statistical Service.

References

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