Forecasting Cotton Yields over the Southeastern US using NOAA/NCEP Climate Forecast System

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Justification

During the summertime there is only weak predictability associated with ENSO in the southeastern USA, making it difficult to forecast seasonal climate and yields to improve agricultural practices. The use of forecasted meteorological variables directly from Global Circulation Models (GCMs) are a viable alternative to categorical ENSO-phase predictions.

Objective

To apply the NOAA/NCEP Climate Forecast System (CFS) forecasts to forecast cotton lint yields at a county scale in the southeastern USA.

Data (1970-2006)

Cotton yields:

- De-trended data from 57 Counties in Alabama and Georgia (USDA/NASS)

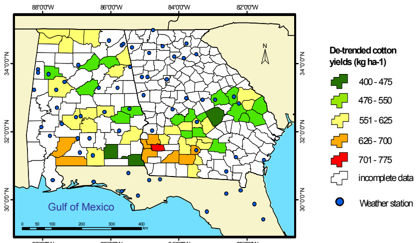

Fig. 1: Location of the 62 weather stations and the 57 counties with the average de-trended cotton yields used in this study

Atmospheric conditions:

- April-May-June total rainfall from 62 weather stations (NCDC)
- July-August-September 2m temperatures (NCEP/NCAR CDAS Reanalysis)
- June 0.5 – 2.5 2m temperature forecasts (NOAA/NCEP CFS)

Methods

- Calculate the first Principal Component (PC1) of the de-trended cotton yields.
- Average of the 62 weather stations April-May-June total rainfall.
- Extract PC1 of 2m temperatures from Reanalysis in the geographical domain of the southeastern United States.
- Extract PC1 of 2m temperatures from CFS in the same geographical domain.
- Correct Reanalysis and CFS PC1s in years where rainfall average were lower than 250mm.
- Predict cotton yields PC1 (1987 – 2006) using corrected 2m temperatures Reanalysis' PC1 using retroactive validation.
- Hindcast cotton yields PC1 (1987 – 2006) using corrected 2m temperatures CFS PC1 using retroactive CR§ validation.

Results and Discussion

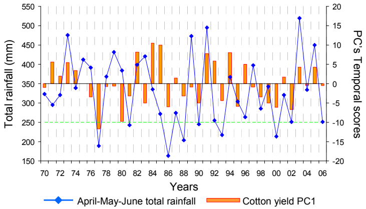

Fig. 2: Comparison between observed April-May-June total rainfall and PC1 of de-trended cotton yields

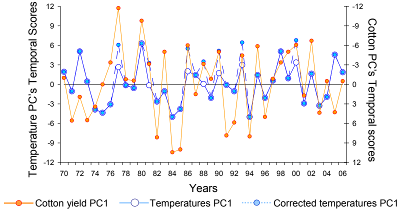

Fig. 3: Raw and corrected 2m temperature PC1s versus cotton yield PC1

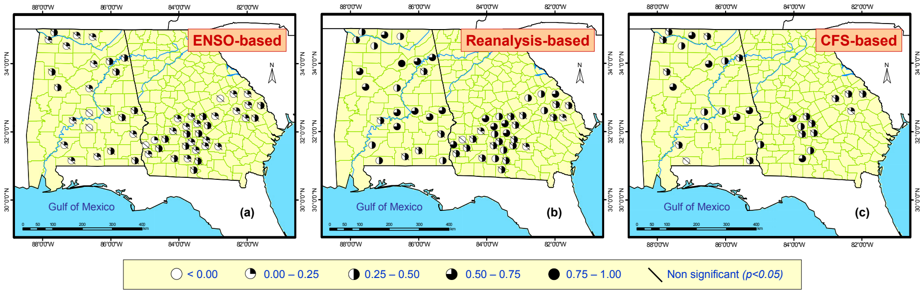

Fig. 4: Spatial distribution of the retroactive validated Pearson's correlations between observed de-trended cotton yields and (a) ENSO-based hindcast, (b) Reanalysis-based prediction, and (c) CFS-based hindcast

Correcting 2m temperature PCs

Cumulative rainfall below 250 mm during the growing phenological phase (April-May-June) negatively affects cotton yields (Fig. 2). Consequently, PC1's temporal scores during those years received a penalty proportional to the driest year. The penalty was assessed by relating the rainfall deficit and the threshold ratios. The method of Mean Squares was used to fit the new temporal scores (Fig. 3).

Predicting cotton yields

The PC1 extracted from Reanalysis of 2m temperatures, corrected by observed April-May-June rainfall, significantly predicted cotton yields in 31 counties (Fig. 4b). This increased the cotton yield predictability in the southeastern USA in comparison to the ENSO-based hindcasts (Fig. 4a). After applying a retroactive validation, the Goodness-of-Fit Index (GFI) was 0.5274.

Hindcasting cotton yields

The use of CFS's hindcasts significantly hindcasted cotton yields in 48% of the counties predicted using Reanalysis (Fig. 4c). For those counties, the GFI was 0.5247 and the RMSE ranged between 13.6% and 28.2% after applying a retroactive 'coral reef' (CR) validation.

§ In this new method, Reanalysis data from a continuous sub-period of years was used for training the model whereas the CFS hindcast of the following year was used to hindcast the cotton yield. The process was performed successively by increasing one year to the initial sub-period until reaching the last year of available data.

Conclusions

- Cotton lint yields in some counties of the southeastern USA can be significantly forecasted three months before harvesting using June 0.5 – 2.5 forecasts of 2m temperatures from the NOAA/NCEP CFS and observed total rainfall during the cotton growing phenological phase (April-May-June).

Reference

- Baigorria, GA, JW Hansen, N Ward, JW Jones, JJ O'Brien. 2008. Assessing predictability of cotton yields in the southeastern USA based on regional atmospheric circulation and surface temperatures. J. App. Met. Climatol., 47(1): 76-91.
- Saha, S, S Nadiga, C Thiaw, J Wang, W Wang, et al., 2006. The NCEP Climate Forecast System. J. Climate, 19: 3483-3517

Acknowledgments

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