Climate data induced uncertainties in simulated carbon fluxes under corn and soybean systems

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NASA CMS CARBON MONITORING SYSTEM

Context and Objectives

- Process based bottom-up approaches use gridded climate datasets, which are consistently reported to have uncertainties.
- In this study, four commonly used gridded datasets in the U.S (NARR, NLDAS, Prism and Daymet) were evaluated to understand uncertainty in their daily weather variables and their impact on estimated daily Net Ecosystem Exchange (NEE) under corn and soybean cropping systems by EPIC (Environmental Policy Integrated Climate) agroecosystem model. Also studied sensitivity of the NEE to various climate variables.

Analysis

- The observational data at four flux tower cropland sites in the U.S Midwest region were used to quantify the uncertainties in the weather variables of gridded datasets.
- EPIC simulations were performed at each site using each gridded climate dataset and observed weather at flux towers, and quantify the relative uncertainties in simulated fluxes. Further, sensitivity analysis using Extended Fourier Amplitude Sensitivity Test (EFAST) was conducted.

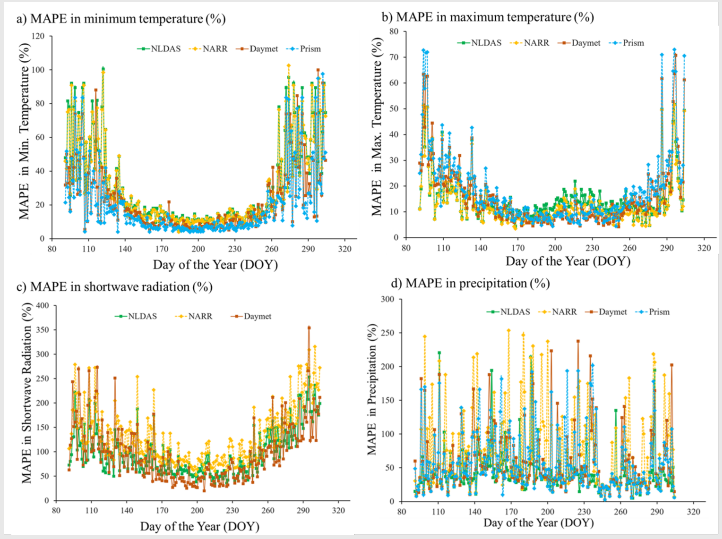

Figure 1: Comparison of Mean Absolute Percentage Error (MAPE) in daily minimum temperature (a), maximum temperature (b), shortwave radiation (c) and precipitation (d) over the growing season (April–October) from gridded climate datasets.

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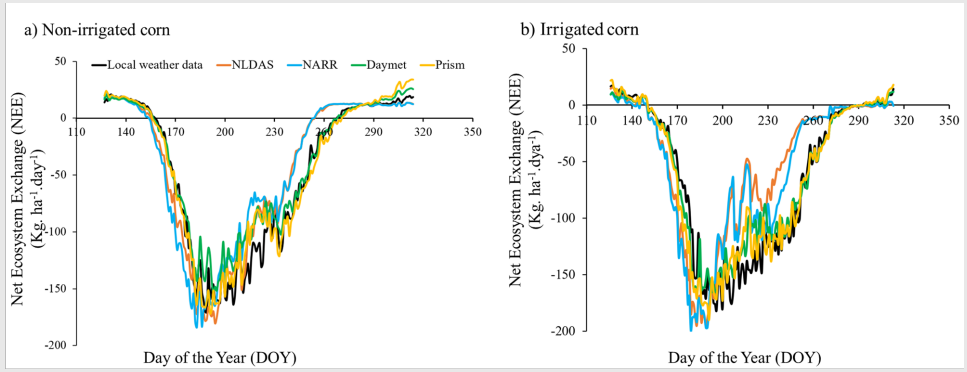

Figure 2: Average daily Net Ecosystem Exchange (NEE) estimates (averaged over sites and years) for non-irrigated (a) and irrigated corn (b) systems, simulated using various gridded datasets and measured weather data at flux tower sites.

Results/Significance

- Daily weather variables in all gridded climate datasets were shown to display uncertainties. Precipitation variable tend to have higher level of daily uncertainty with maximum Mean Absolute Percentage Error (MAPE) value of 253.89% and also exhibited more inconsistency in daily uncertainties across growing season compared to other weather variables.
- Gridded data produced based on interpolation techniques (i.e. Daymet and Prism) were shown to have less uncertainties, resulted in NEE estimates with relatively higher accuracy, likely due to their higher spatial resolution and higher dependency on meteorological station observations.
- The MAPE values of average growing season NEE estimates for Daymet, Prism, NLDAS and NARR include 22.53%, 23.45%, 62.52% and 66.18%, respectively. Further, under irrigation management, NEE are more sensitive to temperature. Conversely, under non-irrigation, precipitation is the most dominant factor influencing NEE uncertainty.

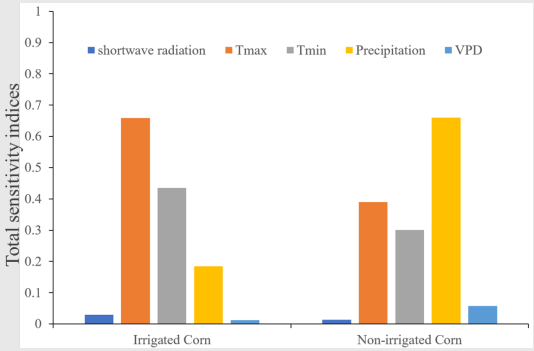

Figure 3: Total sensitivity indices for climate variables under irrigated and non-irrigated corn

- The careful consideration is necessary when selecting climate data to mitigate uncertainties in simulated NEE. Further, alternative approaches such as integration of remote sensing data products may help to improve the accuracy in the simulated CO2 fluxes.