Quantify uncertainty in soil water storage modelling with a Bayesian linear regression.

Introduction

A gridded product of daily soil moisture at 250-meter spatial resolution was created by integrating in situ soil moisture from the Kansas Mesonet and a simple soil water storage model as part of my research. The model represented temporal soil moisture dynamics using the following equation:

$$S_t = \begin{cases} (S_{t-1} - S_{LL})\,\lambda_t + S_{LL} + P_t, & S_t \leq S_{UL} \\ S_{UL}, & S_t > S_{UL} \end{cases} \quad (1)$$

Where S_t represent the soil water storage in the rootzone at day t, λ_t is a recursive parameter representing the fraction of remaining water storage after the daily storage loss due to the different processes of the water dynamics in soil. S_{LL} is the lowest limit the soil can reach after it is dry, and S_{UL} is the maximum amount of water the soil can store, S_{t-1}, represent the previous state of soil water storage. Finally, P_t represent the precipitation events. In the current model λ_t is implemented as a function of vapor pressure deficit (VPD).

Significance of the study

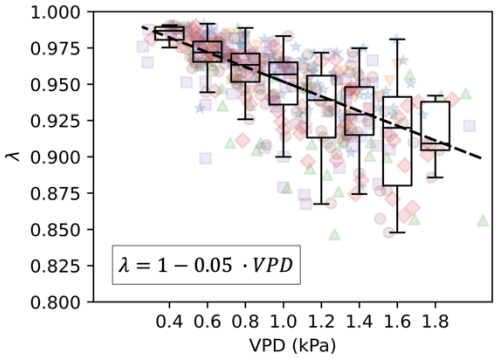

Figure 1. λ as a function of VPD, different markers show different.

Figure 1 shows a correlation between VPD and λ;, however, the proposed equation does not account for all the possible values that are not represented by the linear regression. Using a Bayesian approach for this problem can lead to more accurate and reliable predictions or inferences by incorporating prior knowledge and will represent the uncertainty.

Methodology

Using the Bayesian framework, this project aims to quantify the uncertainty during the inference of the soil water storage dry-down in each location by adjusting a Bayesian linear regression model, which will provide a more accurate and reliable prediction of soil moisture dynamics by accounting for all possible values that are not represented by the linear regression equation currently used.

Data Dissemination

The findings of this research will be published as part of my research in a poster at the 2023 ASA-CSA-SSSA annual meeting and a scientific article in the Vadoze Zone Journal. Moreover, the outcomes of this research will be used to develop a Mesoscale Soil Moisture Monitoring tool as one of the Rainfed Agriculture Innovation Network project objectives.