Modeling soil-water and heat transport of rain-fed soybean fields under different hydroclimatic settings throughout Japan

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Monitoring field water balance conditions continuously is a critical issue for crops cultivated under rain-fed conditions, such as soybean fields in Japan. Numerical hydrological models are applied to account for water and heat fluxes rather than expensive and time-consuming direct field measurements. This study is designed to characterize the soil-water and heat transport dynamics explicitly during the soybean crop growing period under different hydroclimatic conditions in Japan using HYDRUS-1D, which is accepted unanimously as the state-of-the-art of the physical-based hydrological models, and can simulate the transport process of water, heat, and solutes in the vadose zone simultaneously. In addition, HYDRUS-1D is able to simulate crops' water uptake from the different soil layers. Therefore, it can provide a better understanding of the soil-water-atmospheric interactions during crop growing seasons. To understand the actual field conditions during the soybean crop growing period, soil water content and temperature were measured in a number of soybean fields throughout Japan during the last crop growing period. Further, meteorological stations were installed to measure meteorological variables near the soybean fields and soil samples were collected and analyzed. The meteorological and soil data gathered were fed into the HYDRUS-1D to simulate temporal changes in soil water contents and temperature during the soybean growing period. They were compared with the same variables observed in the field to ensure model performance. In addition, a sensitivity analysis was performed to reduce the uncertainty of the model's predicted variables. The outcomes of this study will be fed into the soybean crop models later to develop a coupled crop-hydrological model that will provide the mechanistic details of the soybean crops cultivated in Japan.

Keywords: Soil-water model, Heat transport, Soybean, HYDRUS-1D, Japan

