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Monitoring drought occurrences using MODIS evapotranspiration data: Direct impacts on agricultural productivity in Southern Brazil

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Evapotranspiration (ET), including water loss from plant transpiration and land evaporation, is of vital importance for understanding hydrological processes and climate dynamics and remote sensing is considered as the most important tool for estimate ET over large areas. The Moderate Resolution Imaging Spectroradiometer (MODIS) offers an interesting opportunity to evaluate ET with spatial resolution of 1 km. The MODIS global evapotranspiration algorithm (MOD16) considers both surface energy fluxes and climatic constraints on ET (water or temperature stress) to predict plant transpiration and soil evaporation based on Penman-Monteith equation. The algorithm is driven by remotely sensed and reanalysis meteorological data. In this study, MOD16 algorithm was applied to Southern Brazil to evaluate drought occurrences and its impacts over the agricultural production. Drought is a chronic potential natural disaster characterized by an extended period of time in which less water is available than expected, typically classified as meteorological, agricultural, hydrological and socioeconomic. With human-induced climate change, increases in the frequency, duration and severity of droughts are expected, leading to negative impacts in several sectors, such as agriculture, energy, transportation, urban water supply, among others. The current drought indicators are primarily based on precipitation, however only a few indicators incorporate ET and soil moisture components. ET and soil moisture play an important role in the assessment of drought severity as sensitive indicators of land drought status. To evaluate the drought occurrences in Southern Brazil from 2000 to 2012, we used the Evaporative Stress Index (ESI). The ESI, defined as 1 (one) minus the ratio of actual ET to potential ET, is one of the most important indices denoting ET and soil moisture responses to surface dryness with effects over natural ecosystems and agricultural areas. Results showed that ESI captured major regional droughts (2005, 2010 and 2012) occurred in Southern Brazil, with similar wetting and drying patterns based on the Standardized Precipitation Index (SPI) and strong correlation with agricultural productivity. Overall, the MODIS remotely sensed drought indices reveal the efficacy and effectiveness for near-real time monitor land surface drought events. Furthermore, understanding and predicting the consequences of drought events on agricultural productivity is emerging as one of the greatest challenges currently due to the increasing global demand for food.
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