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Separating physical and biological controls on ten-year evapotranspiration fluctuations in an irrigated cropland in the North China Plain

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The North China Plain, the largest agricultural production area in China, is a water-limited region where more than 50% of the nation's wheat and 33% of its maize production is grown. Evapotranspiration (ET) is a major component of the water balance in this agricultural ecosystem. Thus, hydrological cycle is very sensitive to the seasonal and interannual variability in ET. Understanding the variability in ET at different temporal scales and identifying out the dominant factor among the climatic factors (i.e. physical factors), crop factors (i.e. biological factors), and anthropogenic factors (i.e. irrigation) regulating ET is vital for promoting the development of agro-hydrological modeling. However, little is known about how ecosystem-level ET of irrigated cropland responds to these physical and biological factors over the long term, e.g., greater than 10 years.
We have operated an eddy-covariance tower in a winter wheat-summer maize cropland for a 10-year period from 2005 through 2015, providing continuous measurements of ET and its relevant variables. The 10-year measurement period covers episodes of extremely high to low annual precipitation and higher air temperatures. The 10-year dataset provides opportunity to investigate the response of site-specific ecosystem ET to the variability of environmental factors. In this study, we reconcile an agro-hydrological model and the observations, to separate the physical and biological controls on ET fluctuations at different temporal scales. First, the model is calibrated carefully based on the observations. Second, a number of model runs are designed to disentangle the influence of climate, irrigation and biological drivers through constrained simulations. The climate drivers include precipitation, air temperature, air humidity, wind speed, and solar radiation, and the biological drivers include leaf area index and leaf-level stomatal conductance. In addition, the impacts of the variability in irrigation on ET will be studied. Last, based on the numerical runs, the dominant factor at each temporal scale (i.e. from weekly to annual) is identified.