Geophysical Research Abstracts
Vol. 20, EGU2018-19604, 2018
EGU General Assembly 2018

The correlation between sea surface temperature anomalies and grassland plant production across the United States Great Plains

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Previous studies have shown that precipitation in the Great Plains is well correlated to interdecadal variation pattern of sea surface temperature anomalies (SSTAs, such as Pacific Decadal Oscillation (PDO) and El Niño–Southern Oscillation (ENSO or NINO-3)). Previous studies have also shown that annual precipitation is one of the major factors controlling grassland production in semiarid regions. In this study, we quantified the impact of these SSTAs on growing season actual evapotranspiration (iAET) and aboveground net plant production (ANPP) in the Great Plain. The biogeochemical model, DayCent, was used to calculate AET values from the daily precipitation and temperature data.

At the test site in Colorado, we found that during cold-phase PDOs, mean ANPP are lower, and frequency of low ANPP years (drought years) is much higher, compared to warm-phase PDO years. ANPP and iAET are highly variable during the cold-phase PDOs. When NINO-3 values are negative, there is a higher frequency of droughts and lower frequency of wet years regardless of the PDO phase. The two SSTAs (i.e. PDO and NINO-3) reinforce each other resulting in a high frequency of above-normal iAET (52%) and low frequency of drought (20%) when both SSTAs are positive and the opposite pattern when both SSTAs are negative (24% frequency of above normal and 48% frequency of drought). Precipitation variability and subsequent ANPP dynamics in the grassland are dampened when the two SSTAs have opposing signs.

At the regional scale, we found that the northern Great Plains has lower ANPP and iAET during the warm-phase PDOs than during the cold-phase PDOs. The southern Great Plains shows the opposite pattern. Variability of ANPP and iAET is much higher in central Great Plains especially during the cold-phase PDOs. Similar to the test site, we found that for the Southern Great Plains (including Colorado) ANPP and iAET are above normal when the two SSTAs are both positive and they are lower than normal when the two SSTAs are both negative. Unlike the test site, ANPP and iAET are not well connected to the April SSTAs for the northern Great Plains.

In addition to grasslands, we also investigated the correlation between winter wheat yields and patterns of the two SSTAs in the northern and central Great Plains, since plant production and SSTAs are both connected to April-June iAET.

The findings of this study will help ranchers understand whether the mean and variability of forage production in the Great Plain will differ in a decadal time scale and give them sufficient time for planning, decision-making, and adaptive management.