MMM SEMINAR SERIES

Investigating the Impacts of Agricultural Land Use Change on Regional Climate Processes in the Northern North American Great Plains

Gabriel Bromley
Montana State University

The northern North American Great Plains (NNAGP) of the U.S. and Canada are a global breadbasket for wheat but is prone to large-scale droughts that threaten human and natural systems. During the last century and extending to the present day, a standard agricultural practice was to utilize a wheat-summer fallow rotation schedule, in which the fields were left unsown, which results in large sensible heat fluxes from bare soil that alter atmospheric boundary layer and precipitation dynamics. Concerns over soil health and profitability have led to the systematic decline of summer fallow, and nearly 250000 km^2 of fallow that existed in the 1970s are now planted, with uncertain impacts on regional water and heat fluxes. Here we assess the regional climate impacts of this large change in land management and to see if more sustainable farming practices have led to a 'triple win' for soil health, profitability and climate.

Part I of the presentation will detail the regional climate changes in the NNAGP This observational analysis discovered that from 1970-2015, during the early warm season, the NNAGP have cooled at −0.18 °C $decade^{-1}$, nearly the same magnitude as the annual global warming rate. The near-surface atmosphere also moistened, evidenced by a decreasing vapor pressure deficit (VPD) trend, and monthly mean precipitation increased in excess of 8 mm per decade. Since 1980, the Bowen ratio during the early warm season decreased from ~2 to ~1 in the NNAGP and the increased surface moisture led to a 10% increase in convective likelihood.

Part II will discuss convection-permitting simulations designed to test whether a reduction in summer fallow in the NNAGP is responsible for these observed changes in regional climate. Two sets (4 total) of three-year simulations were driven by ERA5 data with the vegetative fraction adjusted using satellite estimated fallow amounts for 2011 and 1984. Initial results demonstrate a large change to near-surface temperature and moisture but a muted precipitation response, which contrasts studies that used simpler modeling approaches to argue that the likelihood of convective precipitation has increased.

Thursday, 25 February 2021, 3:30PM (MST)

For Zoom information, please contact Nancy Sue Kerner nskerner@ucar.edu
Seminar will also be live webcast https://operations.ucar.edu/live-mmm