CNH-L: The coupled relationship between regional climate and land management in the North American northern Great Plains

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Overview Human activities have changed global climate in ways that place many staple crops at risk. Countering the global warming trend is observed summertime cooling in the Canadian Prairie Provinces. Maximum summer temperatures in the Prairies have decreased by nearly 2 C since 1970, summer precipitation has increased by 10 mm/decade, and summer radiative forcing has decreased by up to a remarkable 6 W m^{-2}, resulting in increased crop yields. Initial work shows that this cooling trend extends to the U.S. Northern Great Plains. Observations and conceptual models suggest that these changes to regional climate are due in part to a 23 Mha decline in the area of land held in summer fallow across the region, an area nearly the size of the United Kingdom. Shifting from fallow to crops increases the amount of water and decreases the amount of sensible heat entering the atmosphere, which results in a moister, cooler atmospheric boundary layer with an increased likelihood of cloud formation and precipitation. Fallow is used to bank soil water for the next growing season, so the annual decision to plant or fallow is intimately linked to climate and perceptions of water availability. The trend away from fallow also improves soil conservation and usually increases aggregate yields, and may lead to a unique 'win-win-win' scenario for climate, conservation, and the economy. It is unclear if climate benefits will persist into the future and the degree to which changes in land management have impacted climate to date, in part because we lack a fundamental understanding of human management decisions that impact climate and the degree to which climate impacts these decisions.

Intellectual Merit We will couple process-based models of human decision-making and climate to study the dynamics of the coupled natural – human system in the North American northern Great Plains, a system where observed cooling and moistening trends during summer are consistent with regional-scale declines in the practice of fallow. Our **goal** is to transform models of climate and human behavior by formally coupling the two, which to our understanding has not happened to date. To explore the coupled natural-human system in the U.S. Northern Great Plains we will perform coupled and uncoupled runs of a state-of-the-art general circulation model (the Ocean Land Atmosphere Model, OLAM), an ecosystem function model (the Ecosystem Demography model v.2, ED2, which has been coupled to OLAM), and a land management decision-making model developed using multi-attribute utility theory (MAUT) that will be parameterized using interviews and surveys and designed to enhance social science and decision-making theory. We will explore hypotheses designed to better-understand the human and natural components of this system and their interactions, and hope to contribute to sustainability science by understanding the mechanisms that underlie what may be a beneficial climate-human interaction.

Broader Impacts efforts at Montana State University (MSU) will continue existing efforts by the project team to recruit and train talented Native American students from Montana. Students advised by the project team to date have presented at the national SACNAS (Society of Chicanos and Native Americans in Science) conference and proceeded to win competitive scholarships. We seek to recruit Native American students from the northeastern and north-central MT intensive project study areas to begin and to continue graduate work at MSU. To emphasize climate literacy and communication – and to buck the trend of declining meteorological stations in Montana – we will deploy climate stations in cooperation with land managers and contribute to the forthcoming Montana Climate Assessment Report. Northern State University is a primarily undergraduate institution and a talented undergraduate scholar will be trained in GIS and remote sensing techniques during each project year. Broader Impacts at Notre Dame seeks

to improve K-12 education by using Data Nuggets (www.datanuggets.org) for data interpretation and scientific inquiry.