The 100th Meridian Climate Divide & Its Present and Future Impact on the Human Geography of the American Great Plains

[1]J. Feldman, [2]N. Lis, [3]R. Seager, [3]M. Ting

[1]Columbia University, [2]Pennsylvania State University, [3]Lamont-Doherty Earth Observatory of Columbia University

The 100th Meridian has been viewed historically as a boundary between the more arid western Plains in the midwestern United States, and the more humid eastern half of the country. The purpose of this project is to evaluate the true climatic characteristics of this divide, and to determine its implications for landscape and land use, with a focus on agriculture. An aridity index is first defined as precipitation divided by the potential evapotranspiration, P/PET, where PET is calculated with the Penman-Monteith equation using data from the North American Land Data Assimilation System Phase 2 (NLDAS-2) for the period 1979-2015. The NLDAS-2 is a compilation of observed climate data and output from three land surface models: NOAH, VIC, and MOSAIC. The three models agreed on a clear west-east gradient in aridity, with a boundary between semi-humid and dry-land at approximately the 100th Meridian. The sharp west-east aridity gradient is also seen in soil moisture in the three land surface models. Using USDA data from the 2012 census, the longitudinal distribution of agricultural variables, such as farm size, percent cropland, percent corn, percent wheat etc. were examined. Clear differences were observed in these variables across the aridity boundary, especially in the Northern Plains. We performed regressions between these variables and the aridity index, and found a close relationship between the aridity index and the percent of corn and wheat grown, as well as farm size. To project the potential future changes in agricultural practices due to changes in aridity, we used CMIP5 projections of the change in aridity index over the Plains in the period 2040-2060 and the regression relation to predict that the percent corn may decrease by as much as 20% at all longitudes, as corn requires a more humid environment, and may not even be feasible to grow west of the 100th Meridian. Corn is generally more profitable than wheat, thus the farm economy will be impacted by the shifting aridity gradient due to climate change in the coming century.