Simulating the 2012 High Plains drought using three single column models (SCM)

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Abstract. The impact of changes in the frequency and severity of drought on fresh water sustainability is a great concern for many regions of the world. One such location is the High Plains, where the local economy is primarily driven by fresh water withdrawals from the Ogallala Aquifer, which accounts for approximately 30% of total irrigation withdrawals from all U.S. aquifers combined. Modeling studies that focus on the feedback mechanisms that control the climate and eco-hydrology during times of drought are limited, and have used conventional General Circulation Models (GCMs) with grid length scales ranging from one hundred to several hundred kilometers. Additionally, these models utilize crude statistical parameterizations of cloud processes for estimating sub-grid fluxes of heat and moisture and have a poor representation of land surface heterogeneity. For this research, we focus on the 2012 High Plains drought and perform numerical simulations using three single column model (SCM) versions of BUGS5 (Colorado State University (CSU) GCM coupled to the Simple Biosphere Model (SiB3)). In the first version of BUGS5, the model is used in its standard bulk setting (single atmospheric column coupled to a single instance of SiB3), secondly, the Super-Parameterized Community Atmospheric Model (SP-CAM), a cloud resolving model (CRM) (CRM consists of 32 atmospheric columns), replaces the single CSU GCM atmospheric parameterization and is coupled to a single instance of SiB3, and for the third version of BUGS5, an instance of SiB3 is coupled to each CRM column of the SP-CAM (32 CRM columns coupled to 32 instances of SiB3). To assess the physical realism of the land-atmosphere feedbacks simulated by all three versions of BUGS5, differences in simulated energy and moisture fluxes are computed between the 2011 and 2012 period and are compared to those calculated using observational data from the AmeriFlux Tower Network for the same period. This research will provide a better understanding of model deficiencies in reproducing and predicting droughts in the future, which is essential to the economic, ecologic and social well being of the High Plains.