CARBON, WATER AND LAND USE IN THE WESTERN GREAT PLAINS: MANAGEMENT IMPACTS ON LOCAL AND REGIONAL BIOSPHERE-ATMOSPHERE INTERACTIONS

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"So the Dust Bowl had taught us another lesson; namely, that bare ground exposed to the sun will transform warm breezes into fiery blasts. The hot wind seemed to rob all vegetation of its vitality." (Svobida, 1986, *Farming the Dust Bowl*, Kansas University Press).

ABSTRACT
This research investigates how land use in the shortgrass steppe of eastern Colorado impacts short and long-term water, carbon and energy dynamics. A large and homogeneous area of Conservation Reserve Program (CRP) grassland near Briggsdale, Colorado, was selected for this experiment and divided into three 40 hectare plots. An open-path eddy flux system was established in each plot and measurements made during a baseline comparison prior to land use transformation. The three treatments include an un-grazed grassland (control), a moderate intensity grazing treatment, and a dry-land agricultural rotation (winter wheat-hay millet; considered optimal for this low rainfall area of Colorado). We report on the trajectories of carbon, water and energy fluxes in theses three land use systems and analyze how altered carbon storage and water use efficiency may impact short-term land surface-atmosphere interactions, as well as long-term source-sink relationships, water conservation, productivity and sustainability.

INTRODUCTION
Agricultural practices in the Great Plains have the potential to produce rapid changes in land-use across the region. The USDA Conservation Reserve Program (CRP) program is a prime example: the program pays farmers to return cropland to natural or semi-natural grassland, and currently has active contracts on more than 2 million acres in the shortgrass prairie region of eastern Colorado alone. As contracts come to an end, or if the CRP program is discontinued, land owners will likely decide on future usage depending on the economic returns available in alternative management, particularly grazing or return to dry-land agriculture. The resulting changes in management will alter vegetation structure and phenology in ways that impact the timing and intensity of short- and long-term carbon, water and energy exchange. Changes in surface energy and water balance also impact atmospheric boundary layer processes with consequent effects on weather and feedback on vegetation growth and biogeochemistry.

The Curtis Ranch is located on the shortgrass steppe approximately 8 km north of Briggsdale and 60 km east of Fort Collins, Colorado. The site is centered at 40.7ºN 104.3ºW at an elevation of approximately 1525 m. The average frost-free period is 133 days, and average annual precipitation is 325 mm, of which 50-80% occurs during the summer. Three eddy covariance towers have been established in adjacent large (40 hectare) parcels of CRP that had been in the program for approximately 17 years. After an initial comparison period to establish similarity of the three parcels, one was opened to cattle grazing at moderate intensity, while the second was converted to the first stages of a minimum-till wheat-hay millet rotation. The third parcel remained in CRP as a control. Fluxes of carbon, water and energy have been made in the three plots for two years, including baseline comparison and post-manipulation periods. Ancillary measurements include incoming and outgoing shortwave and longwave radiation, incoming

PAR, near-surface temperature, humidity and wind speed profiles, soil heat flux, soil moisture and soil temperature, leaf area and above ground biomass measurements. We are also exploring treatment effects on different soil carbon pools, and on labile and total nitrogen, through extensive soil collection and resin bag sampling.

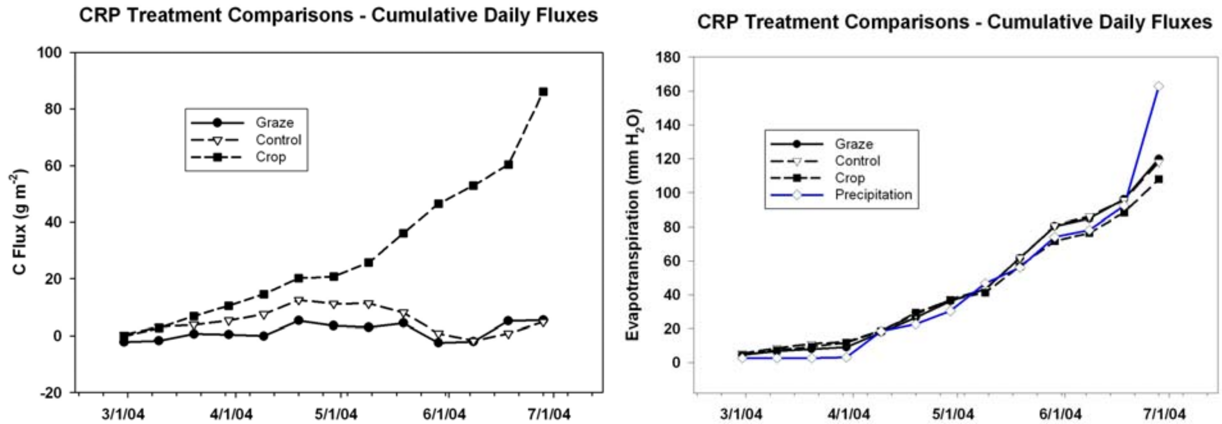

Fig. 1. Cumulative fluxes of carbon and water measured above three contrasting land use treatments in Spring 2004. Cumulative precipitation is also shown for comparison with the water fluxes.

RESULTS

Cumulative carbon and water fluxes in the three CRP plots with varying treatment for part of 2004 are shown in Figs. 1 and 2. Cumulative rainfall is shown in Fig. 2 for comparison. The first crop treatment (removal of grass cover) was not applied until mid-April although differences with respect to the control site appear before then (perhaps related to local differences in rainfall). Following grass removal, the fallow crop site becomes a source of carbon dioxide release to the atmosphere. The graze site had greater uptake of carbon in the spring, perhaps related to reduced moribund plant material and resulting increased photosynthetic uptake. Following further grazing and LAI reductions in mid-May, the graze treatment uptake was reduced to values similar to the control site. Water loss from the ungrazed and grazed sites appears similar, but a small amount of water is being conserved in the fallow crop site ready for the winter wheat seeding in September.

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