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The regional climate effects of irrigation and urbanization in the western United States

B. C. Weare and H. Du

Department of Land, Air and Water Resources, University of California, Davis (bcweare@ucdavis.edu)

Anthropogenic land use changes have substantially modified the earth's surface, potentially altering regional climates. Past land use changes in the semi-arid western United States suggest potential climate impacts from the conversion of natural vegetation to irrigated agriculture and urban areas. Here, we report the results of a suite of regional climate model (RCM) runs for the western United States. We prescribed two land cover distributions, a pre-development vegetation land cover and a modern land cover that includes irrigated agriculture and urban areas. In addition to better understand the uncertainties in the model and to establish the statistical significance, different assumptions concerning model rainfall and boundary layer parameterizations were used to create a small ensemble of model runs.

The control RCM replicates well the variations of observed surface temperature and precipitation in the region. The perturbation results show that irrigation in summer leads to decreases in mean surface temperatures by up to about 2.5C and increases in surface humidity of up to about 1g/kg. Nearly all of the temperature change is associated with the daily maxium, rather than minimum temperature. These changes are accompanied by increases of surface latent heat fluxes and decreases of surface sensible heat fluxes of up to 100W/m2. The comparable changes in other seasons are generally of the same sign, but smaller and less significant. In spring irrigation is associated with an increase in precipitation over much of the irrigated region. At the same time there are increases in snow water over the northern Sierra Nevada mountains and decreases in snow water over the southern Sierra Nevada. Observed temperature trends over the past century for California are reinterpreted in the light of these results.