Heat Flux response to Land Cover Uncertainty around Urumqi, China

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Abstract

Western China's drylands, particularly around Urumqi are changing due to increased grazing pressures, urban growth, and increasing population. These changes, driven by national policies of openness and economic activity, are expected to continue for the foreseeable future. The continued degradation of rangelands surrounding Urumqi can impact not only socioeconomic characteristics but also regional climate patterns. Here we show results from high-resolution regional climate simulations of the Urumqi area using the RAMS regional climate model. Under differing levels of rangeland degradation, from no degradation in fractional cover and LAI to 75% reduction a variety of impacts are found. We examine the impacts of these changes in land cover parameters via current rangeland management approaches, including influences on summertime rainfall (important for grassland production) and year-round wind patterns (which can influence air quality).

Land degradation and Urban Expansion near Urumqi:

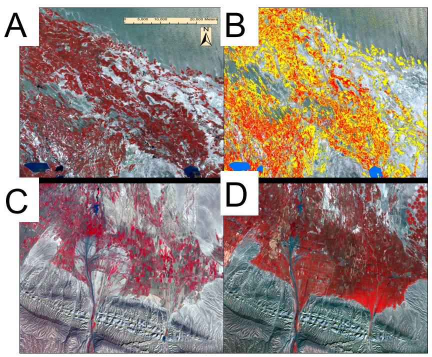

Figure 1: Fine-scale (30m) illustration of land use expansion and degradation inUrumqi, China region.
A.) False color (4:3:2) Landsat 5 TM;
B) Redshows mixed agriculture land use in 1989 and Yellow shows mixedagriculture land use expansion and intensification in 2007;
C.) Falsecolor (4:3:2) Landsat 4 TM (9/19/1989) with Red representingvegetative agriculture surfaces; and
D) False color (4:3:2) Landsat 5TM (path/row: 143/29) from 09/29/2007 with Red representing land useintensification and expansion in the form of mixed agriculture.

Land degradation around Urumqi has accelerated (Figure 1). The trend is for degraded pastures and urban expansion primarily along major roads. What consequences will this land use change have on the local climate? Will the durface energy budget be altered significantly?

Hypothesis: increased degradation of pastureland will result brighter albedos and might also impact convection locally.

Methods and Models

Land Cover Change; Urban Expansion

Trends in land cover change around Urumqi, surrounded by desert regions, have changed drastically since the economic reforms in the late 1980s. Climate models project that the region will experience higher temperatures and a correspondingly higher threat of desertification due to extended periods of drought, along with deforestation in the Tian Shan mountains. Our investigation is focusing on the impacts of these particular climate changes on urban residents, cities, and disadvantaged groups, In particular by modeling changes in land use and the corresponding climate. Higher wind speeds, for example, may better disperse pollutants and lead to relatively higher air quality.

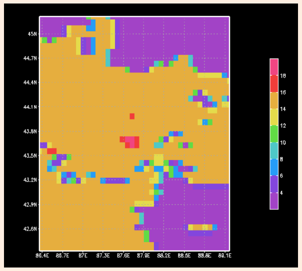

Figure 2: Urban and other land cover in the vicinity of Urumqi

RAMS 6.0 Configuration

We used RAMS (Regional Atmospheric Modeling System) 6.0, a state-of-the-art regional climate model that has been improved in numerous ways over RAMS 4.4 – perhaps most importantly Be adding NDVI and other remote sensing variables directly into the land surface model.
Figure 3 shows the innermost 2 grids (8-km and 2-km grid spacing respectively; the outermost 32-km grid is not shown).
Ultimately, we will examine historical changes in climate to identify climatic trends.
te change will be simulated under IPCC scenario A1B using RAMS driven by boundary conditions from CCSM IPCC scenarios. Again, selection of time periods will be done in such a way as to capture not only average temperature or average rainfall periods but also to capture extreme events. RAMS can be configured to have multiple nested grids with two-way communication. This feature allows RAMS to have very close landscape resolution.

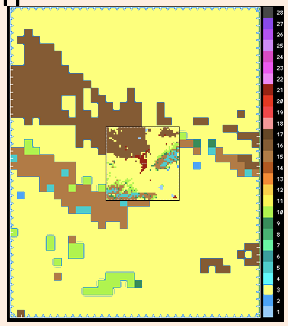

Figure 3: Land Cover classes as defined in the RAMS model.

Preliminary Results

The initial trials of four landscapes show that classification error has a significant impact on sensible heat flux (SHF) in areas where mixed pasture and farming are involved—particularly in the Karez system areas that are rapidly becoming important agriculturally. Small changes (reduced SHF) are evident in the high areas where forest misclassification occurs.

. **Figure 4** shows some examples of differences in SHF patterns due to selected error introductions.

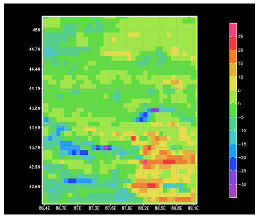

Figure 4A: SHF differences for 00111111-01011111 (W/m^2)

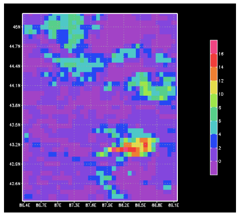

Figure 4B: SHF differences for 01011111-01101111 (W/m^2)

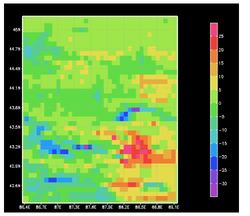

Figure 4C: SHF differences for 00111111-01101111 (W/m^2)

Potential Impacts on convection

In Xinjiang, most rainfall arrives via fronts. These fronts can be modified locally by convection. Convection can be enhanced or suppressed by land cover change: more heterogeneity can lead to stronger differences in heating, and thus in vertical motion

. **Figure 5** shows the standard deviation of vertical velocity at noon for all four cases at or around the top of the boundary layer. These perturbations show locally strong effects on atmospheric circulation that could enhance rainfall.

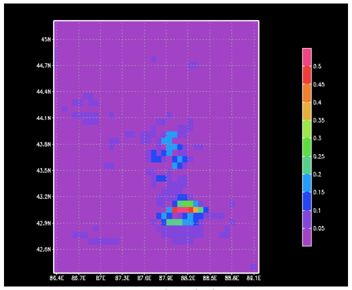

Figure 5: standard deviation of precipitation differences in convection at top of PBL