Assessing Climate Impacts of Projected Continental U.S. Urban Expansion

Danielle Lorenz[1,2], M. Georgescu[1], A. Brazel[1]

SCHOOL OF Geographical Sciences & Urban Planning
ARIZONA STATE UNIVERSITY

[1] School of Geographical Sciences and Urban Planning, Arizona State University, PO Box 875302, Tempe AZ 85287-5302

[2]Barrett Honors College, Arizona State University, PO Box 871612, Tempe, AZ 85287 [dlorenz@asu.edu]

Central Arizona-Phoenix Long-Term Ecological Research
CAP LTER

Introduction

Today, roughly half of the world's population lives in urban areas and, according to the United Nations, the share of global urban dwellers is expected to surpass 60% by 2050. Potentially adverse effects of urbanization on climate have already been shown for Arizona's rapidly expanding Sun Corridor[1], highlighting the importance of assessing regional-scale impacts of extensive urbanization over larger spatial domains. This research will assess potential climate impacts of projected urban growth through 2100 over the contiguous United States.

Methods

Continental-scale modeling was carried out using the WRF modeling system following the methodology of Georgescu et al. [1]. Multi-year simulations (2001-2008) were conducted with both a contemporary and projected urban growth scenario anticipated through 2100. Analysis was performed to illustrate seasonal average impacts and year to year variability. Impacts of future urban expansion (UrbExp) are based on national housing and impervious land cover assessment conducted by US EPA, which were compared to a baseline modern day (i.e., 2006) urban representation (Control) [2].

Results: Differences in Mean Temperature

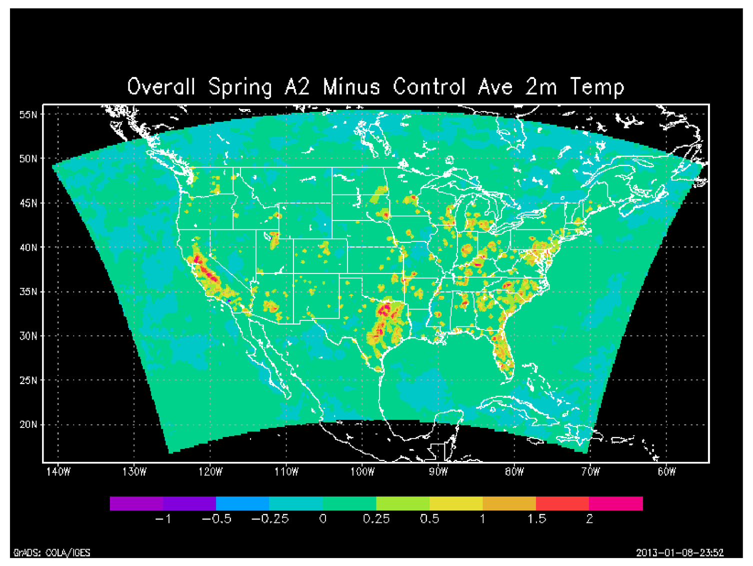

Fig. 1: Mean (2001-2008) MAM near surface temperature difference (UrbExp – Control) [°C].

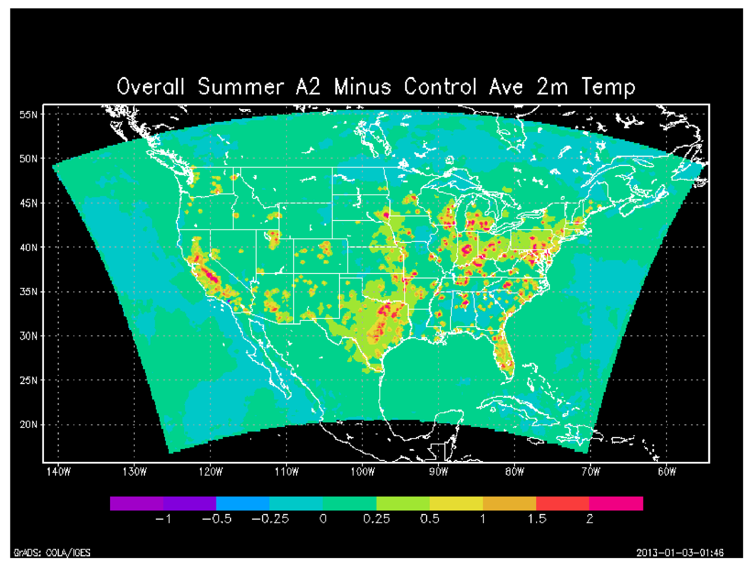

Fig. 2: As Fig. 1 but for JJA.

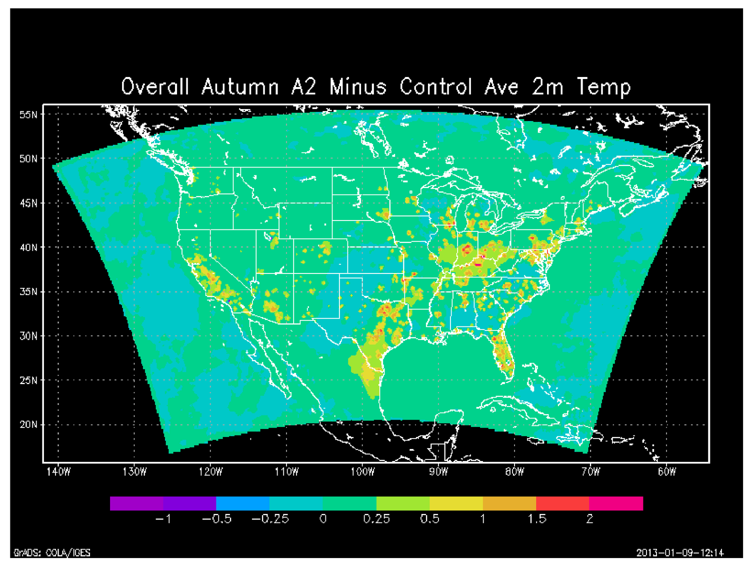

Fig. 3: As Fig. 1 but for SON.

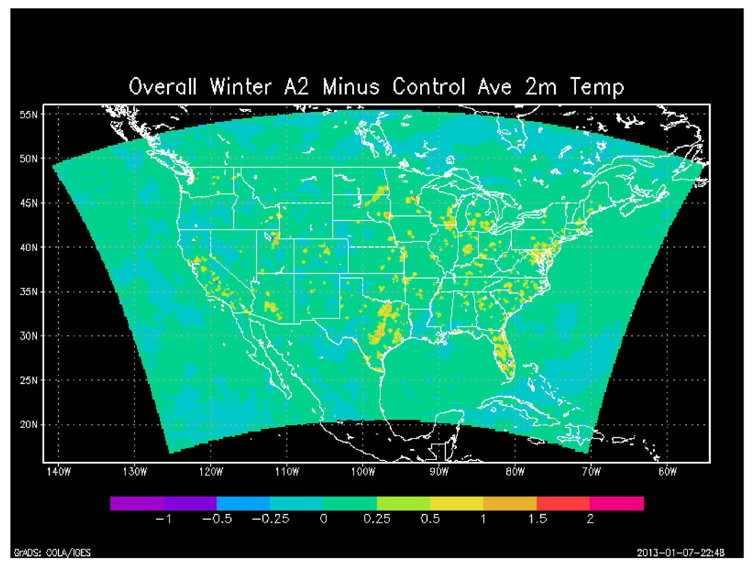

Fig. 4:As Fig. 1 but for DJF.

Results: Inter-annual Variability

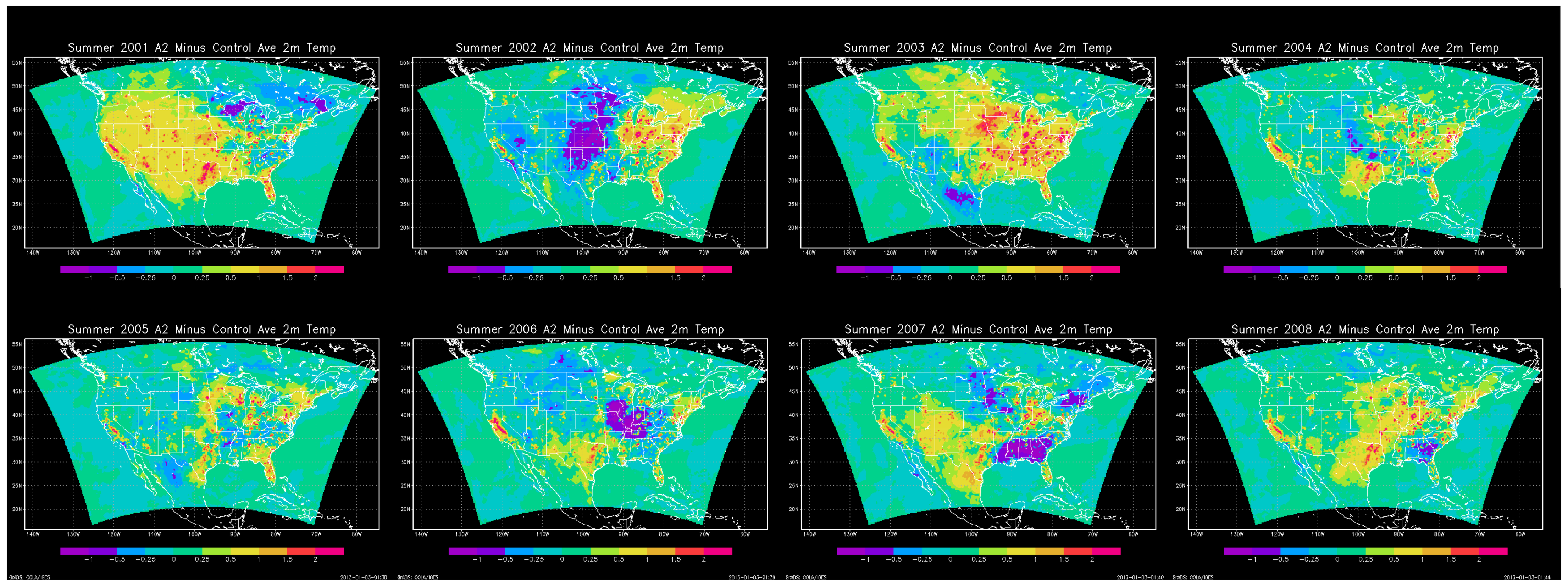

Fig. 5: Mean JJA near surface temperature difference (UrbExp – Control) [°C] for 2001 (top left panel), proceeding left-right for each successive year, through 2008 (bottom right panel).

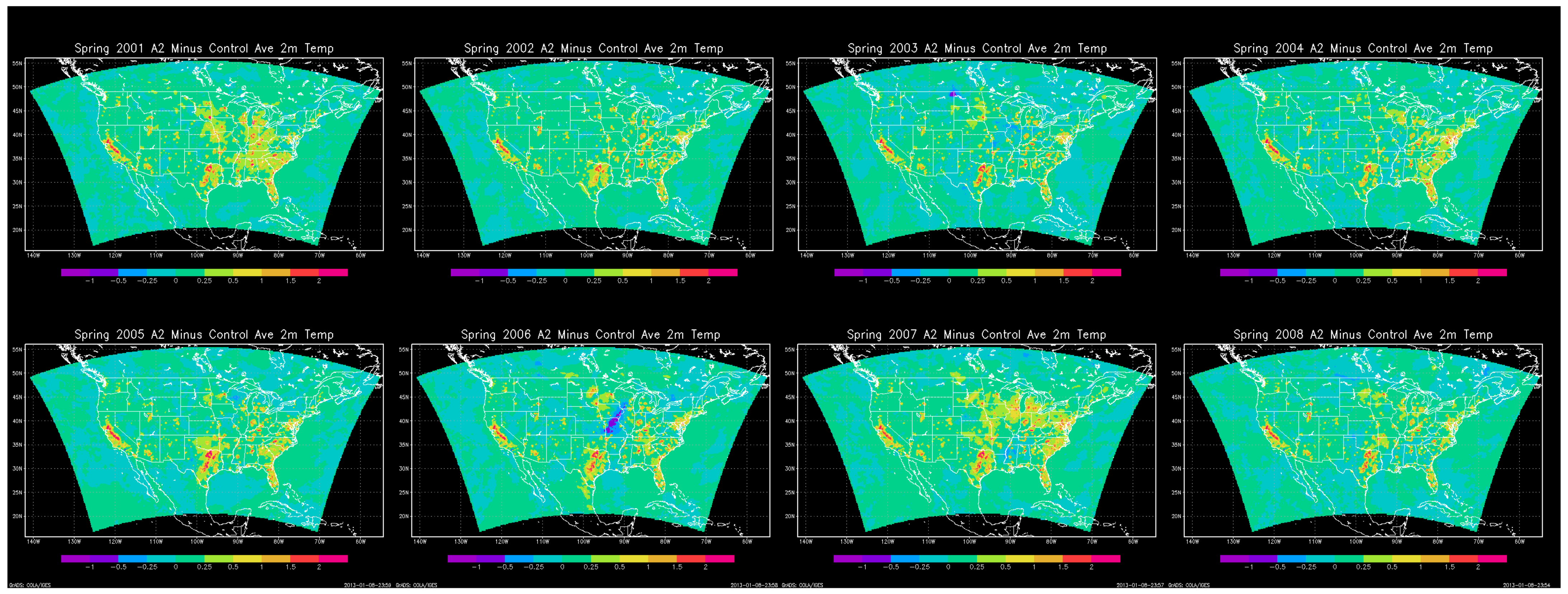

Fig. 6: Mean MAM near surface temperature difference (UrbExp – Control) [°C] for 2001 (top left panel), proceeding left-right for each successive year, through 2008 (bottom right panel).

Summary

- Summer-time average near surface temperature differences between the A2 urban growth scenario and baseline (Control) scenario are greatest among all seasons but also show the most inter-annual variability.
- Winter-time average near surface temperature differences appear to be least. However, impacts during the winter display the least inter-annual variability of all seasons.
- The significant inter-annual variability illustrated during the summer and fall (not shown) seasons indicate additional simulations are required to test the robustness of simulated results during the time of year when convective precipitation is dominant.
- The impact of future urbanization during the spring season is similar to that of the summer but with less variability from year to year.
- Maximum warming owing to the A2 urban growth scenario consistently exceeds 2°C for select regions across the U.S., including California's Central Valley and the Texas Triangle megapolitan area.

References

[1] Georgescu, M. *et al*. Summer-time climate impacts of projected megapolitan expansion in Arizona, *Nature Climate Change,* DOI: 10.1038/NCLIMATE1656. (2012).

[2] Bierwagen, B. G. et al., National housing and impervious surface scenarios for integrated climate impact assessments, *PNAS*, DOI: 10.1073/pnas.1002096107 (2010).