Storms, Forms, and Complexity of the Urban Canopy:

How Land Use, Settlement Patterns, and the Shapes of Cities Influence Severe Weather

Geoffrey M. Henebry[1], David J. Stensrud[2], Allison L. Steiner[3], Christopher Small[4], Laura R. Musacchio[5], Kirsten M. de Beurs[6], Kristin Calhoun[6], Jessica Walker[1], Larissa Reames[6], Stacey Kawecki[3]

[1]South Dakota State University, [2]NOAA National Severe Storms Laboratory, [3]University of Michigan, [4]Columbia University, [5]University of Minnesota, [6]University of Oklahoma

Do urban areas affect severe storm behavior?

Yes! Big urban areas affect storms.

This phenomenon has been recognized since the METROMEX field campaigns in the early 1970s (**Changnon 1979**). Recent work has included both simulation modeling and empirical analysis to probe the phenomenon (**Bornstein & Lin 2000; Shepard & Burian 2003; Niyogi *et al.* 2006; Niyogi *et al.* 2011**).

We are asking these questions:

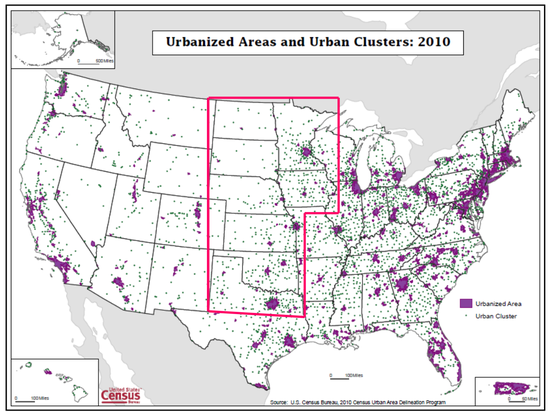
- What are the effects of smaller urban areas?
- Are there size thresholds of behavior?
- Does the shape of the city matter?
- When does the about pollution state matter?
- Which findings are relevant to urban & regional planners?

We focus on the US Great Plains because:

- Lots of relatively flat terrain
- Lots of severe storms in warm season
- Cities are embedded in agricultural land uses
- Region growing faster than US average
- Distant from maritime influences

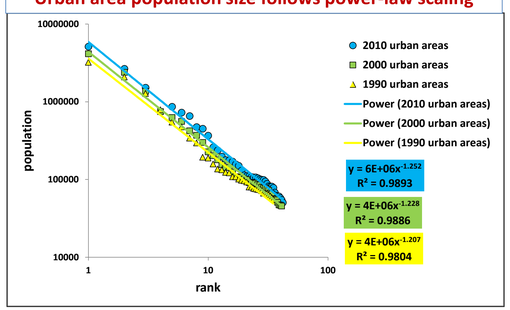
We are using these tools and data:

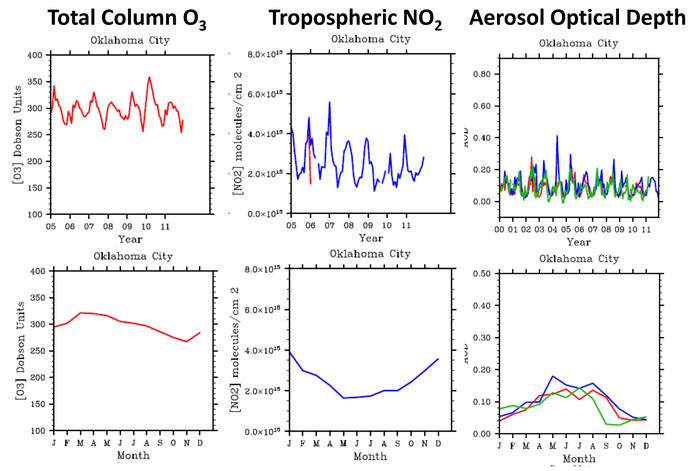
- Simulation experiments using WRF-SLUCM & WRF-CHEM
- Land surface parameterization with NLCD, Landsat, MODIS, VIIRS
- Statistical modeling of storm characteristics and behavior using NEXRAD WSR-88D time series
- Statistical modeling of (peri-)urban land surface phenologies using MODIS, Landsat, and possibly VIIRS
- Statistical analysis of urban pollution state using ground observations and remote sensing retrievals of NO_2, NH_3, AOD, BC, SO_2, O_3
- Statistical analysis of severe storm reports in SPC's SVRGIS
- Structured surveys with urban & regional planners



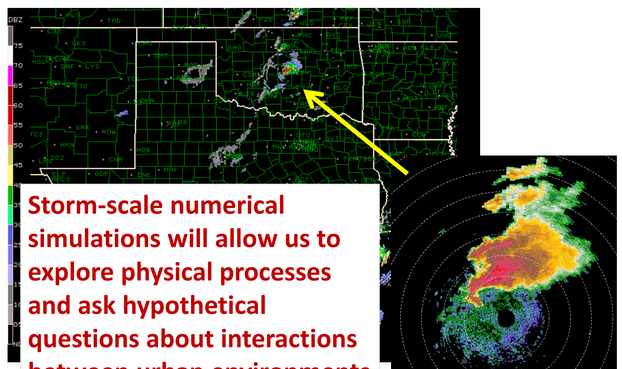
Metropolitan Statistical Area (MSA)	2010 population	2000 population	Percent change
Dallas-Ft Worth, TX	5,121,892	4,145,659	**23.6**
Minneapolis-St. Paul, MN	2,650,890	2,388,593	**11.0**
Kansas City, MO	1,519,417	1,361,744	**12.0**
Oklahoma City, OK	861,505	747,003	**15.3**
Omaha, NE	725,008	626,623	**15.7**
Tulsa, OK	655,479	558,329	**17.4**
Wichita, KS	472,870	422,301	**12.0**
Des Moines, IA	450,070	370,505	**21.4**

Urban area population size follows power-law scaling



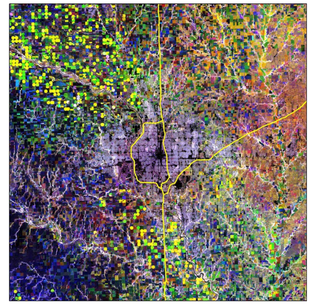


Initial Model Storm Event for Simulation Experiments with WRF: 08 MAY 2003



Storm-scale numerical simulations will allow us to explore physical processes and ask hypothetical questions about interactions between urban environments and storms.

Wichita, KS 2011
NDVI false color composite
R: 28APR G: 16JUL B: 19OCT



Wichita, KS
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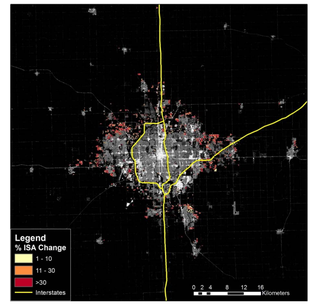
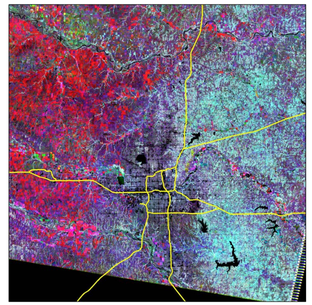


Oklahoma City, OK 2011
NDVI false color composite
R: 11APR G: 01AUG B: 19OCT



Oklahoma City, OK
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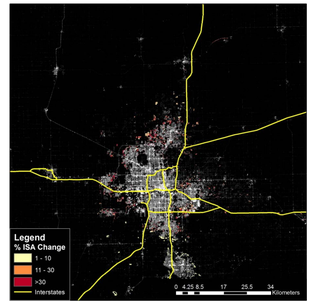
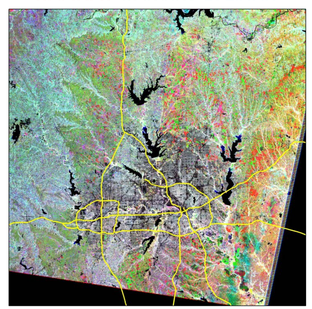


Dallas-Ft. Worth, TX 2011
NDVI false color composite
R: 04APR G: 07JUN B: 29OCT



Dallas-Ft. Worth, TX
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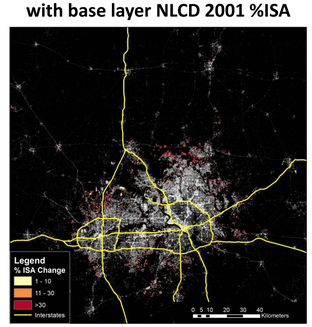
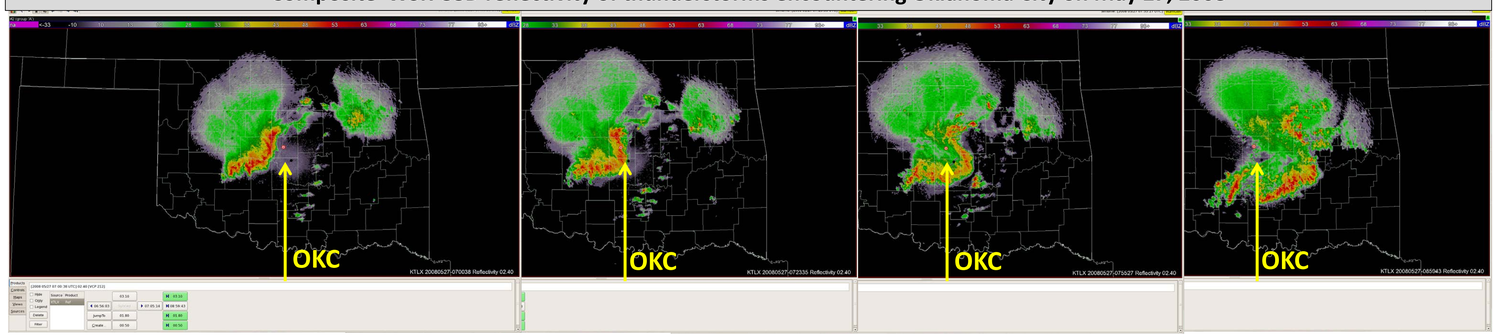


Composite WSR-88D reflectivity of thunderstorms encountering Oklahoma City on May 27, 2008



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Contact:

geoffrey.henebry@sdstate.edu

http://globalmonitoring.sdstate.edu

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