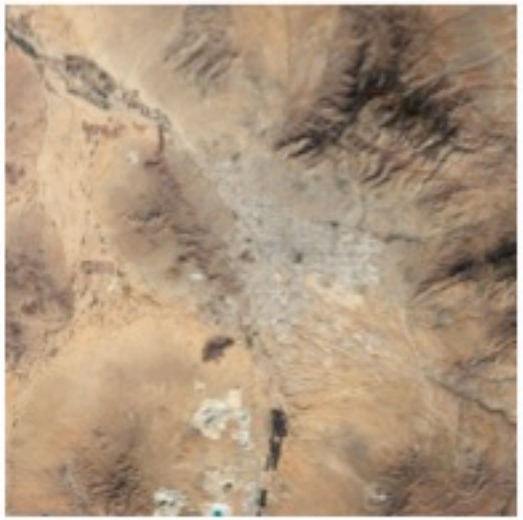
Progress Report WP1

Relative effect of Land Use - Land Cover change and Climate Change on Extreme precipitation events in the Tucson-Phoenix urban corridor and associated Watersheds

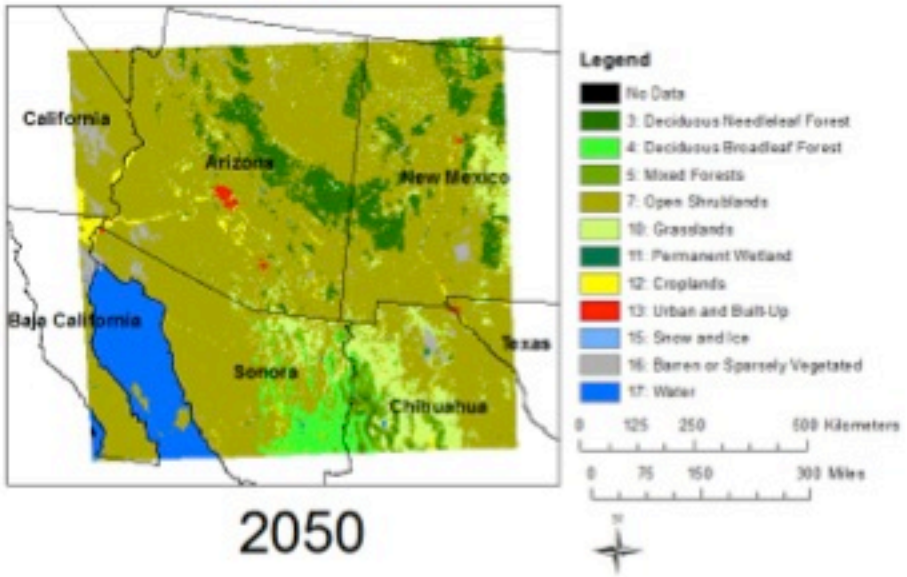
SWAN meeting
Seville, June 2014

Satellite image of Tucson, Arizona in 1965 (Source http://eoimages.gsfc.nasa.gov/)

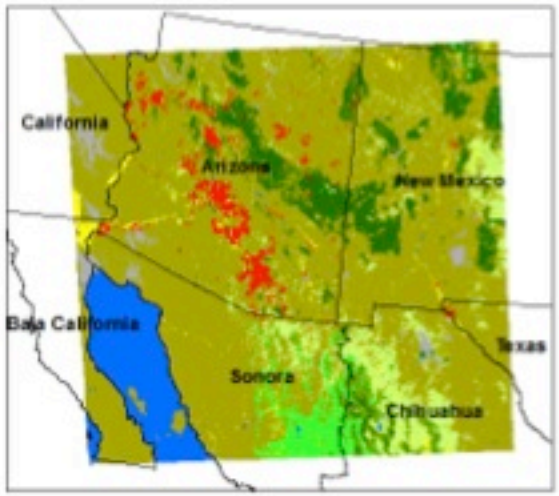


Satellite image of Tucson, Arizona in 2011 (Source http://eoimages.gsfc.nasa.gov/)

2005

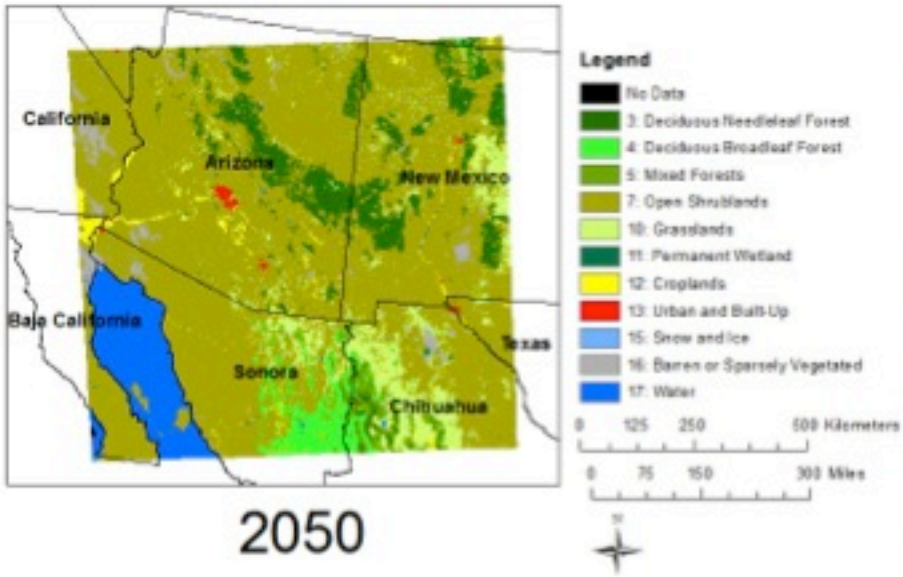


2050

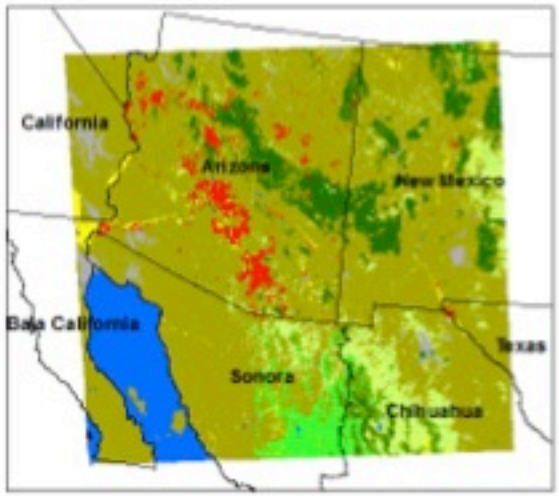


The cities of Phoenix and Tucson are projected to become one urbanized corridor by the year 2050

2005



2050



The projections of urbanized regions are based on the SLEUTH model.

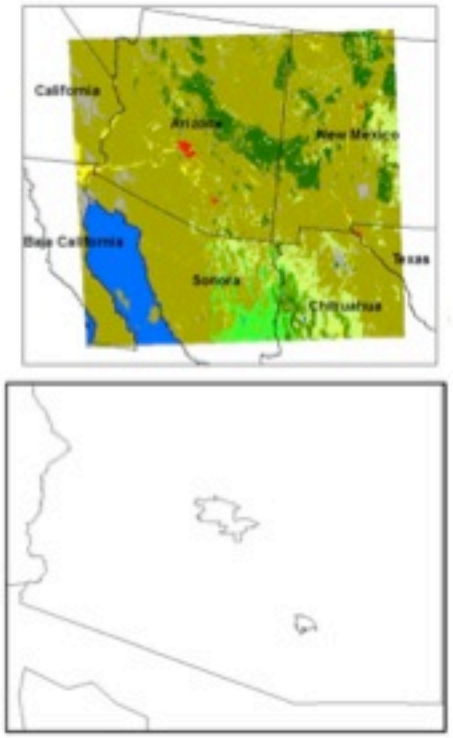
Slope, Land use, Exclusion, Urban extent, Transportation, and Hillshade data.

Which projects potential future urban growth and landuse change

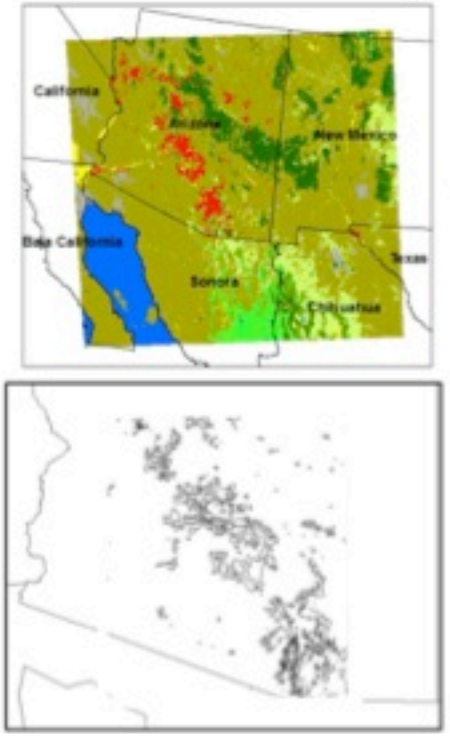
Clarke et al., 1997
Norman (USGS)

Our goal with this project has been to understand how urban expansion affects climate in the region.

Phoenix and Tucson - 2005



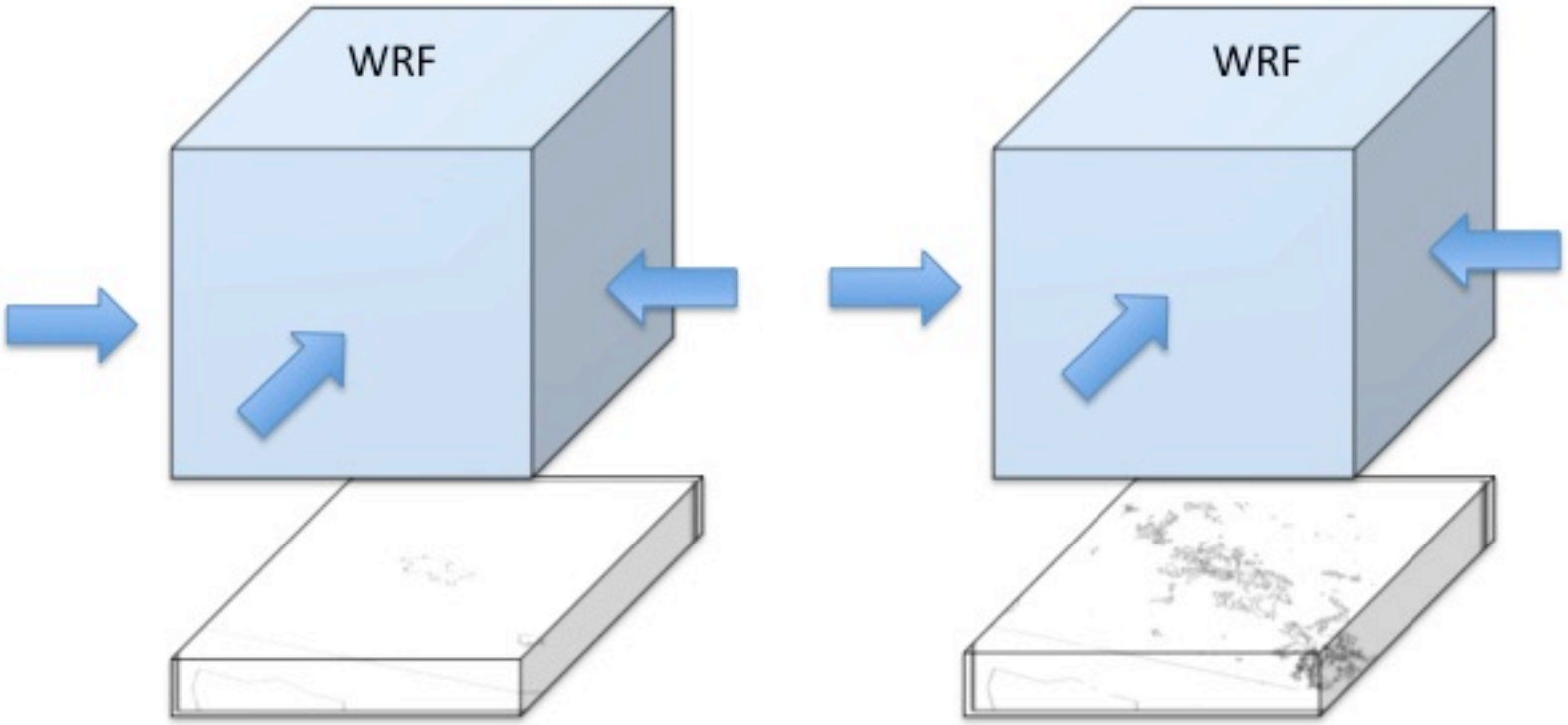
Phoenix-Tucson Corridor - 2050



Future climate projections had to be modified to be ingested into WRF.

To tackle this question we use the projected land use changes and the WRF regional climate model.

We analyzed 10 years (1991 to 2000) and used historical atmospheric data with current and future land use.



Phoenix and Tucson - 2005

Phoenix-Tucson Corridor - 2050

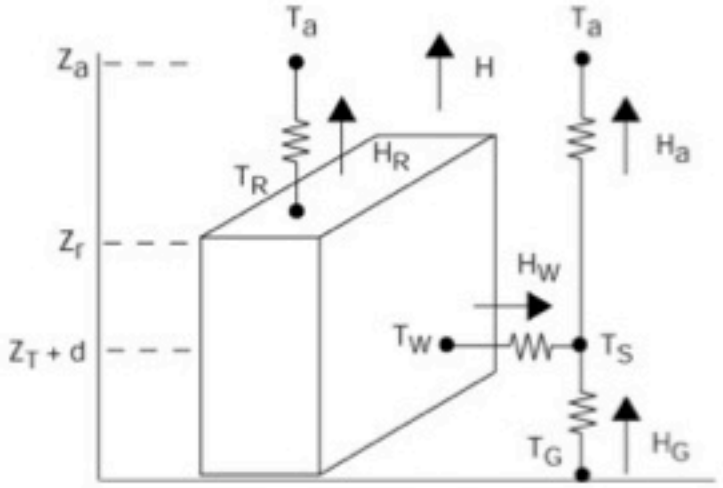
We only analyzed the summer Monsoon period (July and August) when surface forcing is more important.

We use a more realistic representation of urban regions within the WRF model

Traditional approach (bulk parameterization):

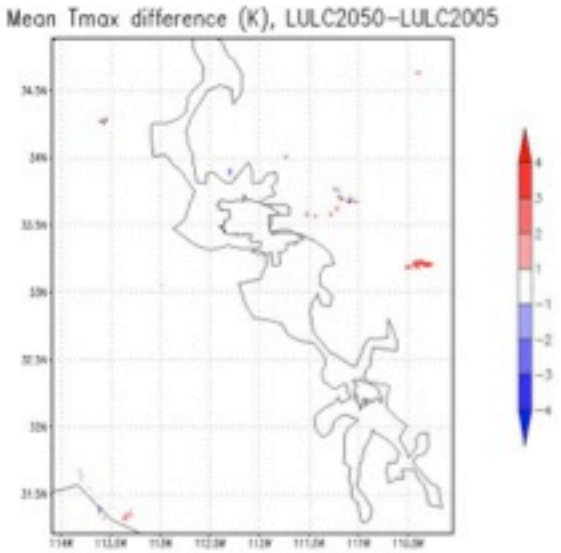
modifying the values of albedo, roughness length, soil thermal properties, and evaporation for urban landuse in the Noah-LSM model (Liu et al., 2004)

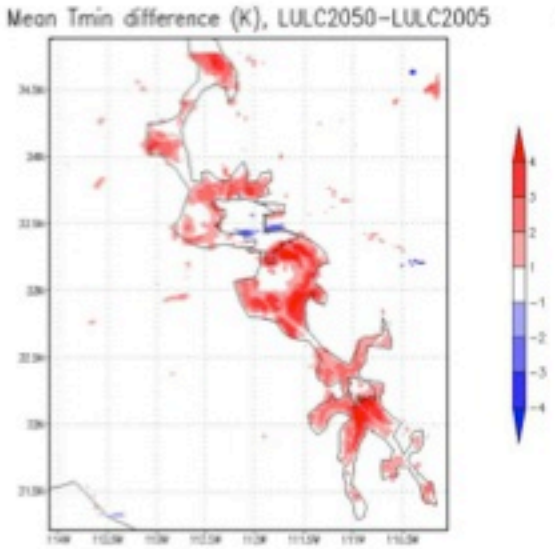
Single layer urban canopy model in WRF/NOAH

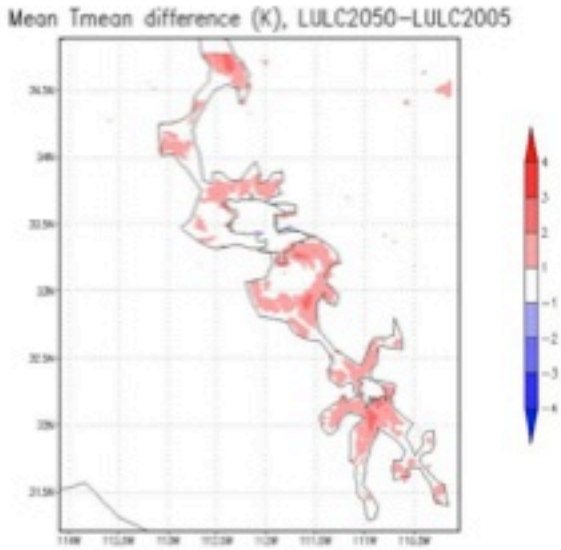


From Chen et al., 2004

We find that the urbanized regions have a statistically significant increase in minimum and mean temperatures.

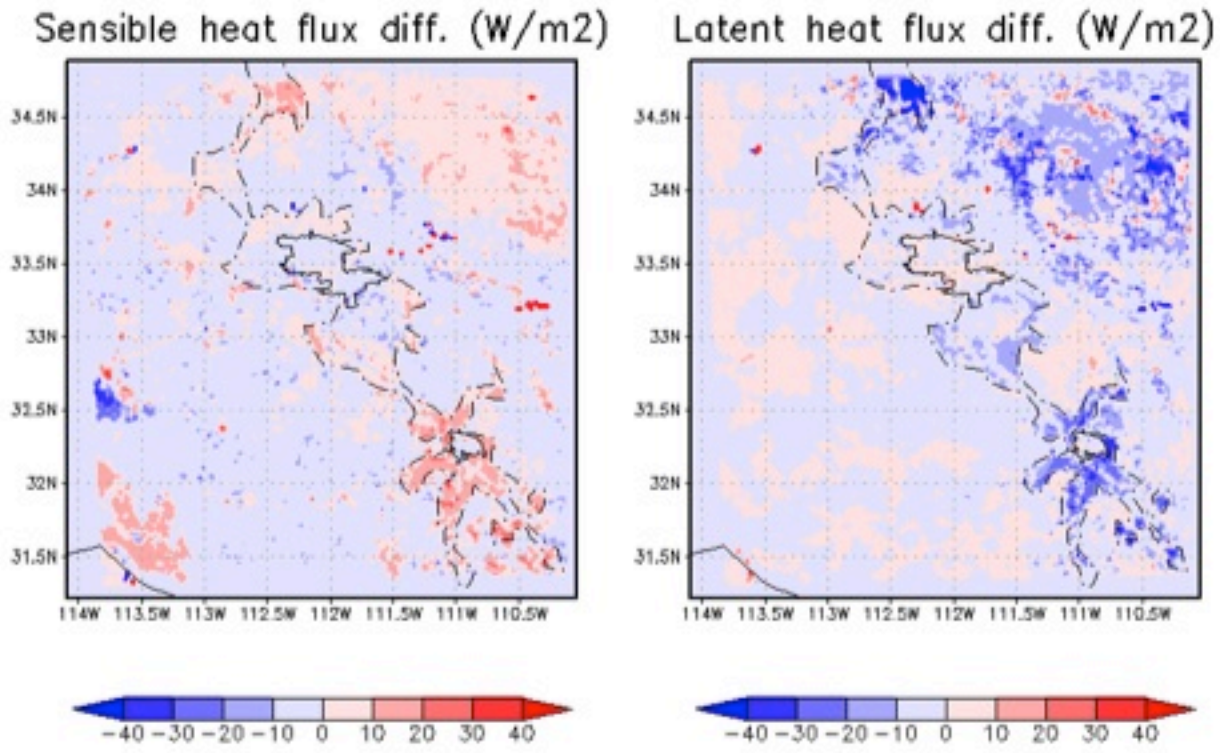






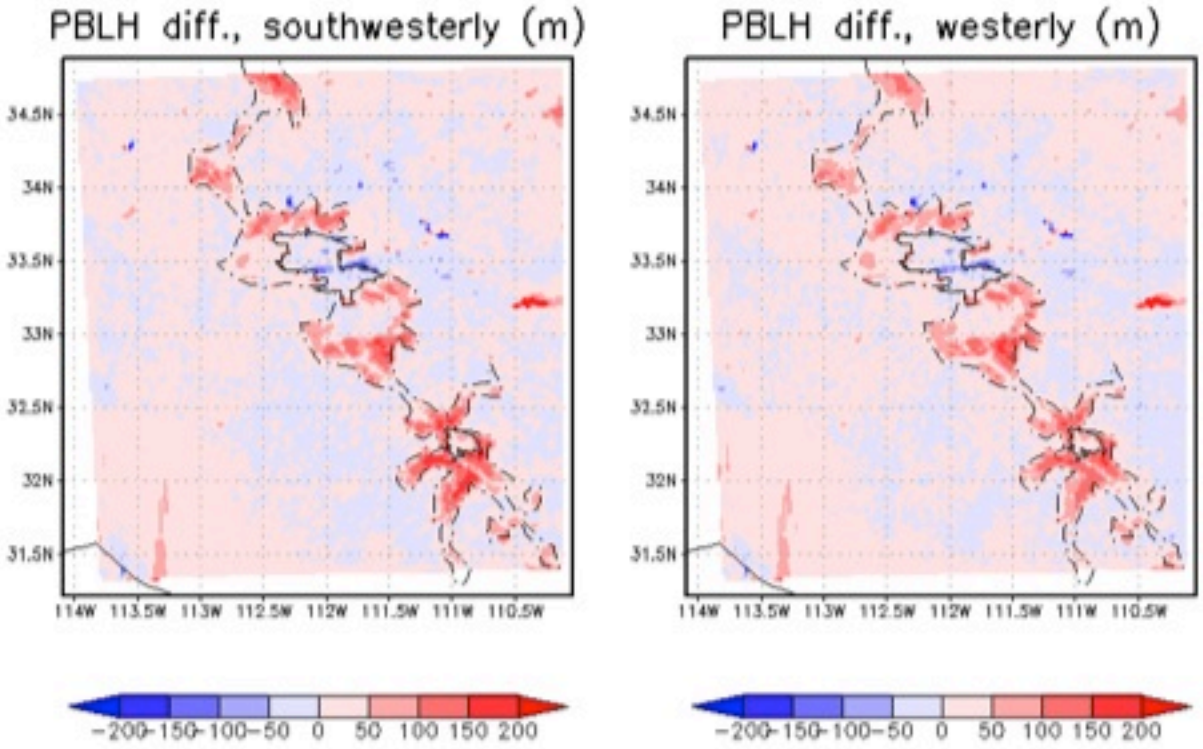
Maximum temperature shows no change.

Sensible heat increases, and latent heat decreases throughout the new urbanized regions.



The city is generating more heat and less moisture than natural vegetation.

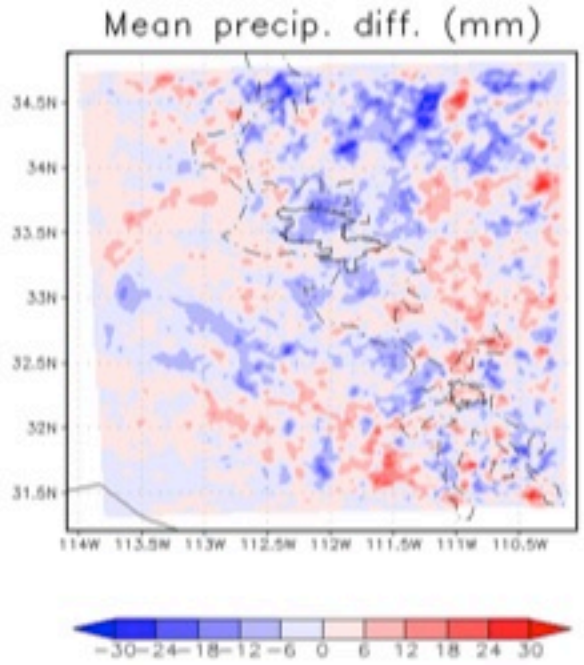
The planetary boundary layer height increases (because there are higher temperatures).

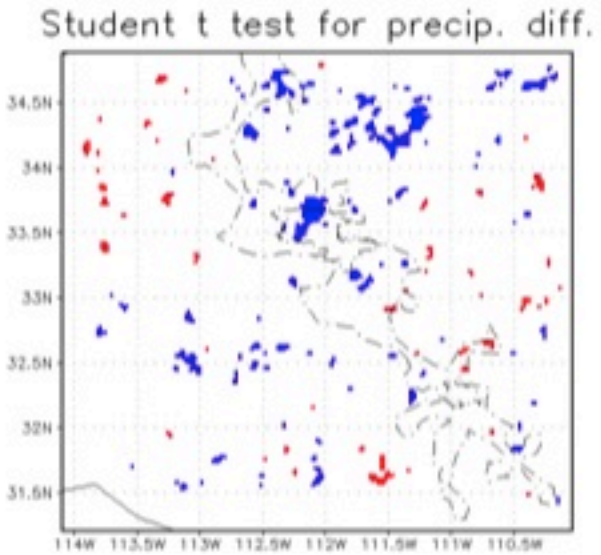


There is a fundamental modification of the atmosphere above the city.

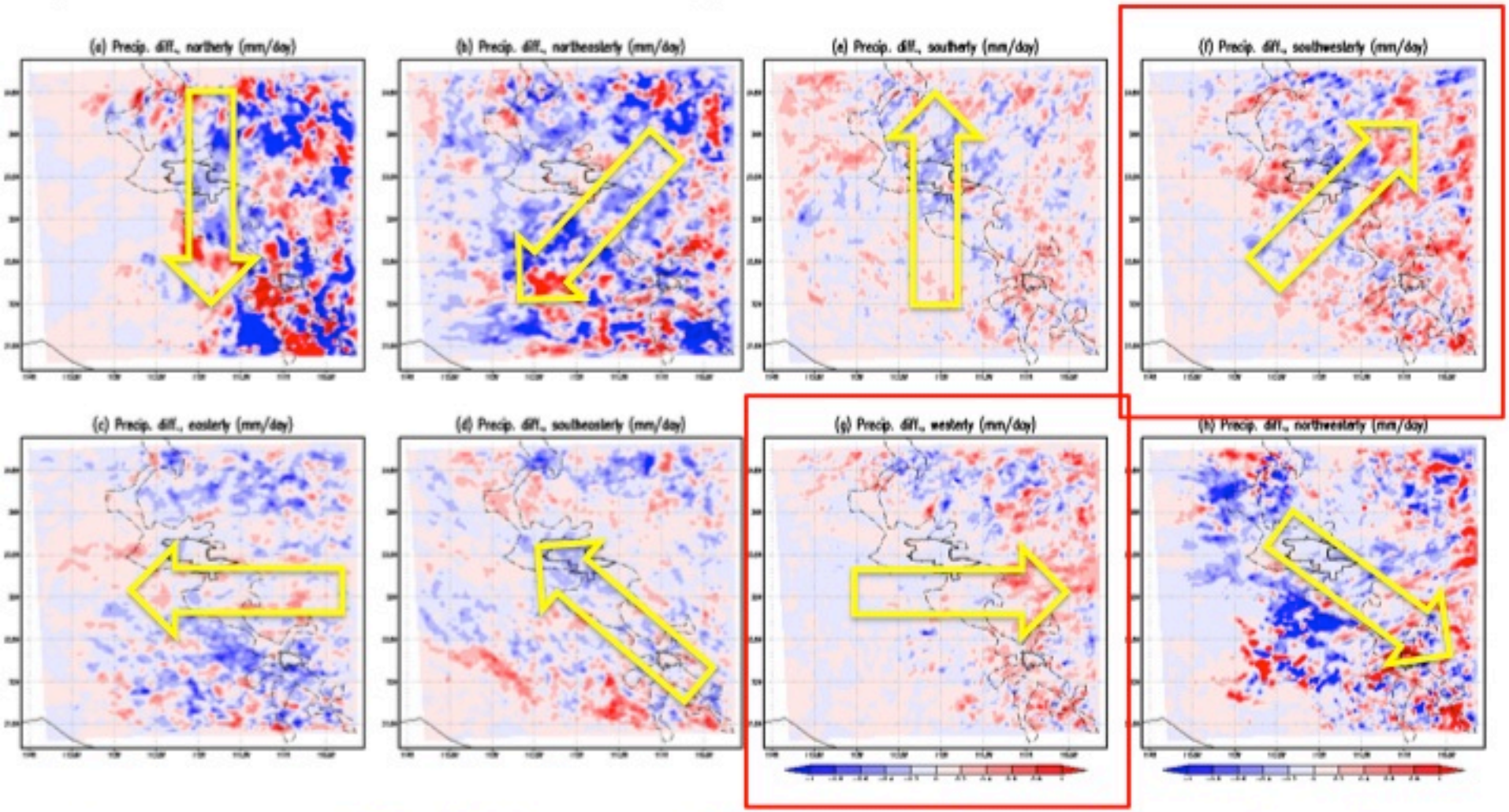
Our hypothesis was that the extension of the urban region would increase precipitation downwind of the city.

However, mean precipitation shows no significant change.





We separated the days between those that had predominant winds coming from different directions



We were particularly interested in days with southwesterly and westerly winds-most important during monsoon storms.

We found no consistent changes in precipitation.

We were not able to prove the hypothesis of modification of precipitation.

Where do we go from here?
We need your input!

Idea # 1: Continue with initial research focus.

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Problem: because there is no change in precipitation with land use, we already know the result – it will be hotter and drier.

Idea # 2: Modify our focus to irrigation.

Based on our results, and those of other students in ATMO, we believe that irrigation in urban areas dramatically affects the effects on the atmosphere.

Also, there is a more direct link with water use – how sustainable is growth of urban corridor with irrigation?