On the application of lidar and in-situ based observations and numerical simulations to examine the spatiotemporal variability in urban heat island and urban heat advection

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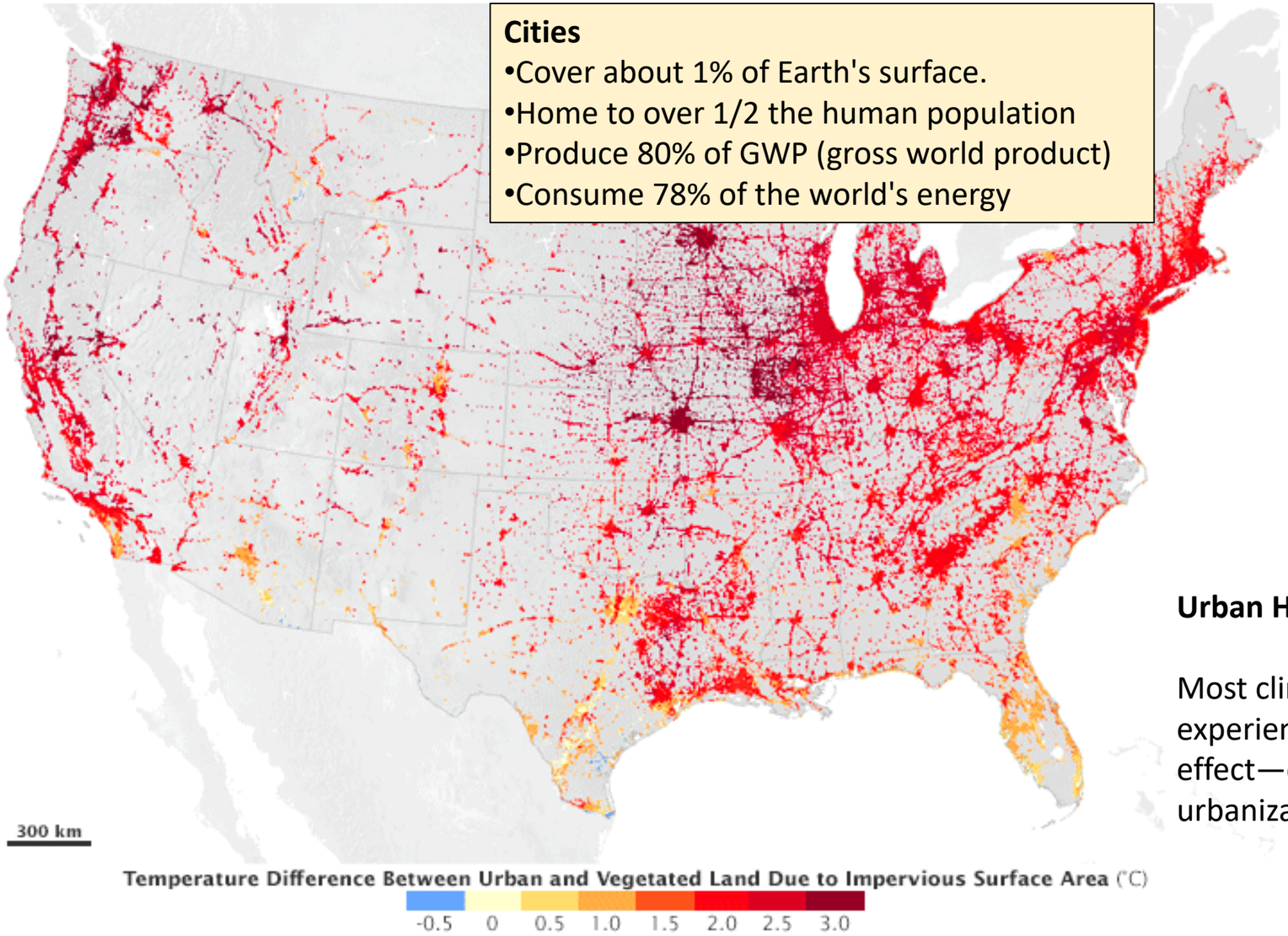
08- Atmospheric boundary layer processes

Urban Heat Island Effect: Need for a better definition for heat advection

Cities
- Cover about 1% of Earth's surface.
- Home to over 1/2 the human population
- Produce 80% of GWP (gross world product)
- Consume 78% of the world's energy



Between 1950-2015

- 27% of cities and 65% of urban population warmed more than the world average

- 60% of that urban population experienced warming twice as large as the world (about 0.6 C)

- This effect could add 2 C to warming for the most populated cities by 2050

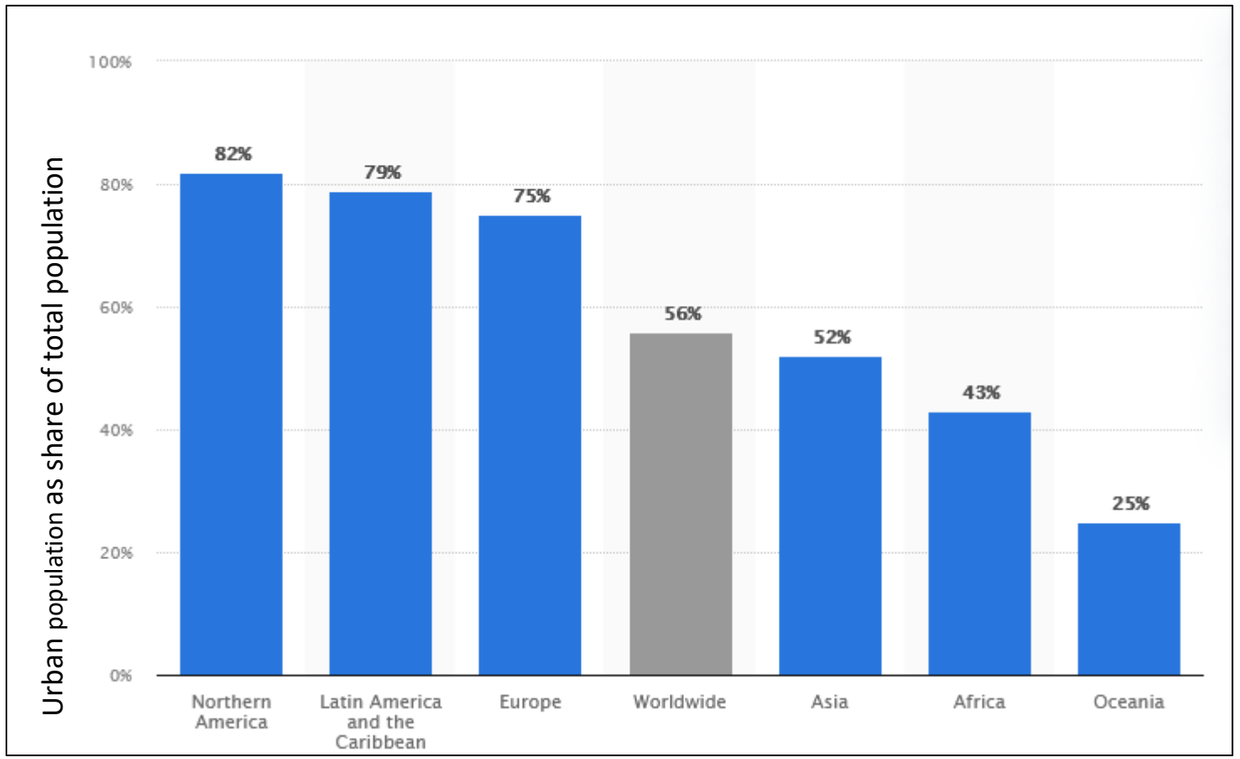
Urban Heat Island Effect

Most climate change impact don't take into account that cities will experience additional warming due to the urban heat island effect—defined as the change of local climate patterns caused by urbanization.

Nature Climate Change 7, 403-406 (2017)

UHI and Urbanization

Share of urban population worldwide in 2021, by continent



Small cities matter [Few Megacities compared to a huge number of small-sized cities in the US and around the world]

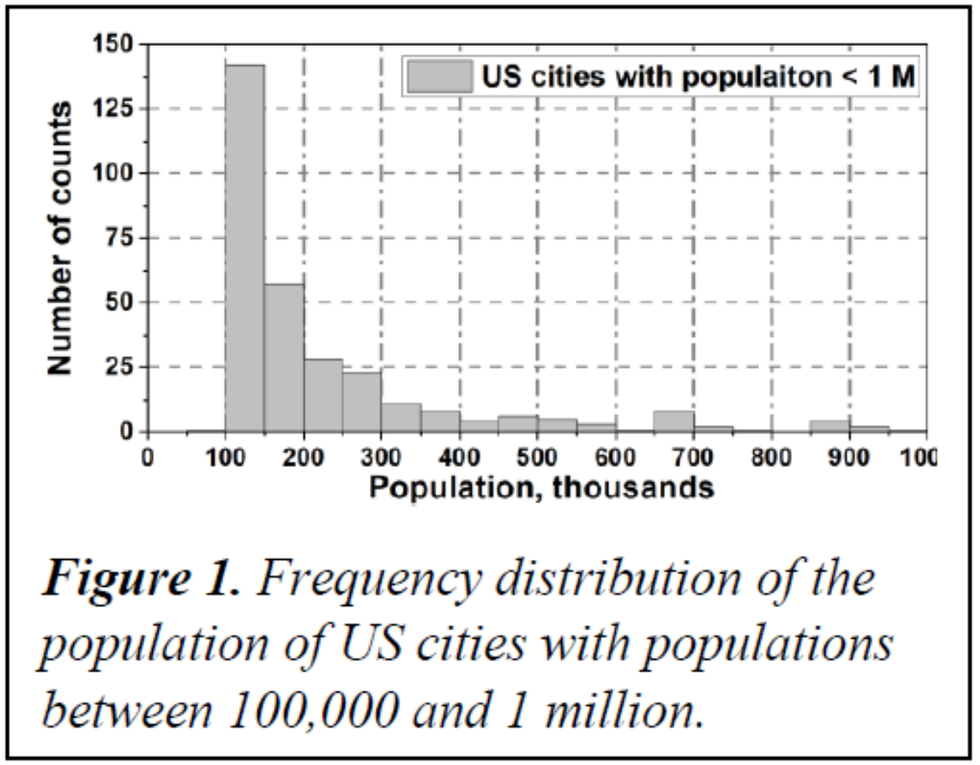


Figure 1. *Frequency distribution of the population of US cities with populations between 100,000 and 1 million.*

By 2050, almost 70% global population will live in cities [Rapid Urbanization]

>90% studies on UHI focuses on metropolitan areas [Megacities]

UHI and Urbanization

Toward operations:

- Establish the quantitative aspects of the UHI for different wind patterns which have not been considered yet in UHI forecasts.

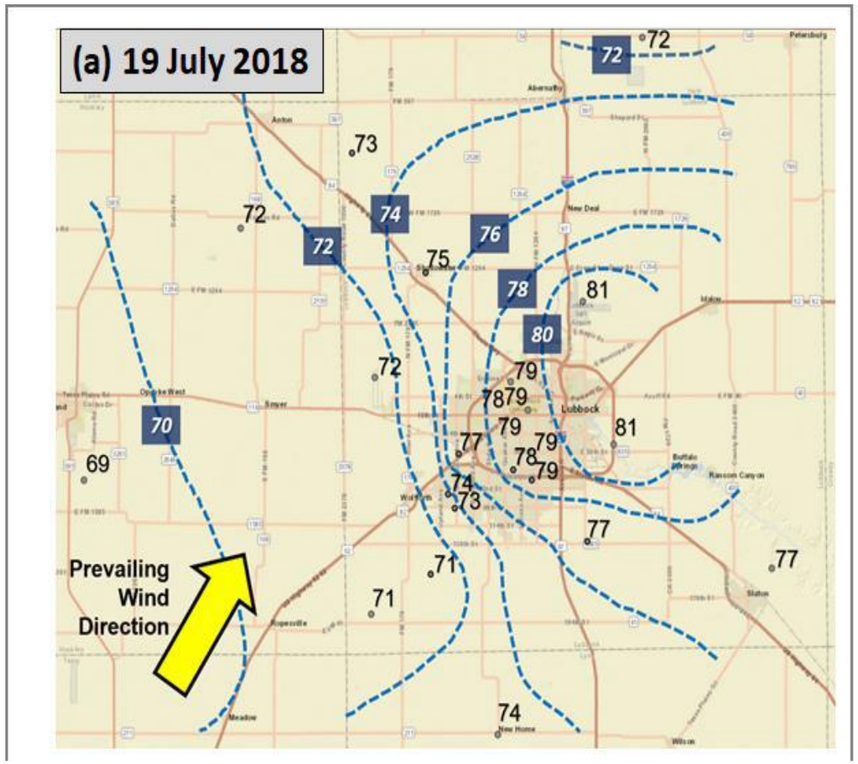
- In collaboration with local Weather Forecast Office in Lubbock, this work will facilitate better forecasts for heat extremes and provide important information for planning outdoor events (e.g., school playgrounds, neighborhood parks, outdoor sports, recreation)

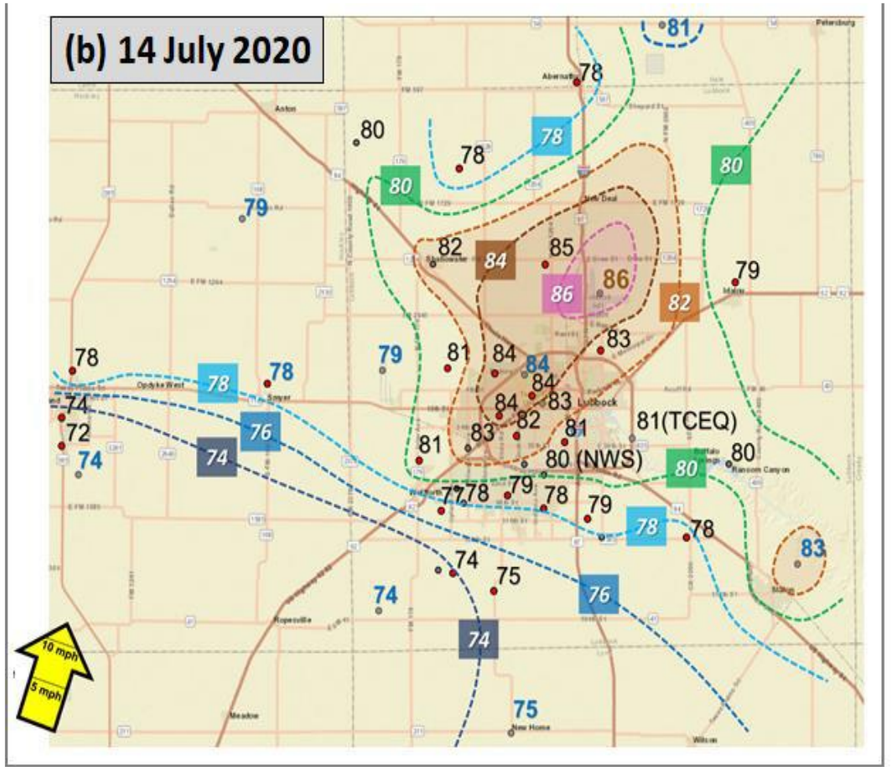
- Will help the public avoid excessive heat-related hazards.

- Will provide new observations that will help improve operational forecasts of urban heat

- Establish the fact that “small cities” also require better urban planning and risk management than is currently present.

The Urban Heat Island and Lubbock's Warmest Night

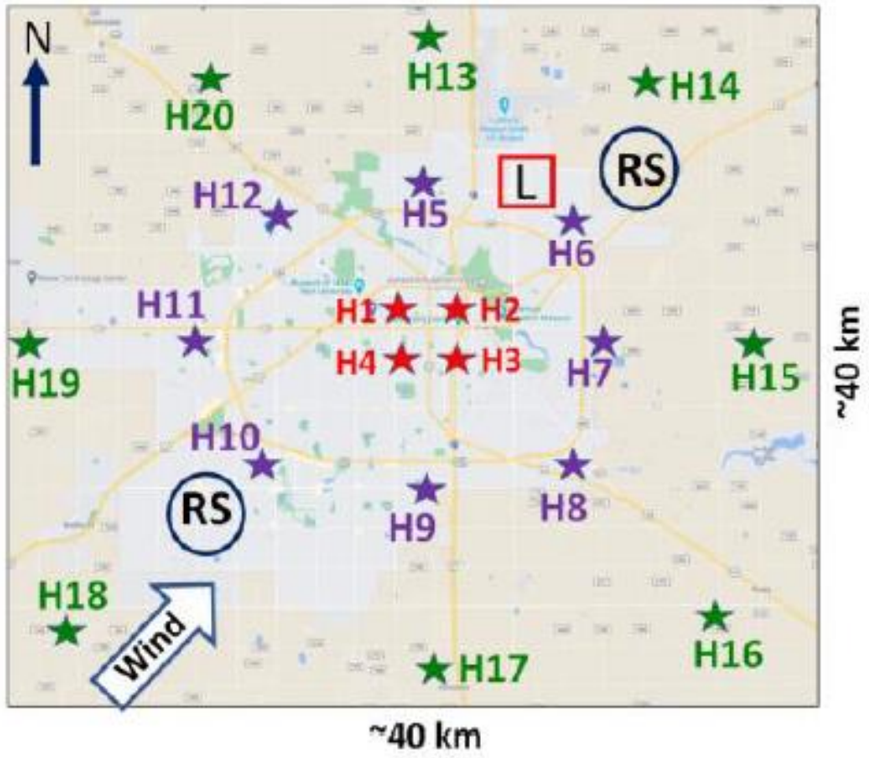




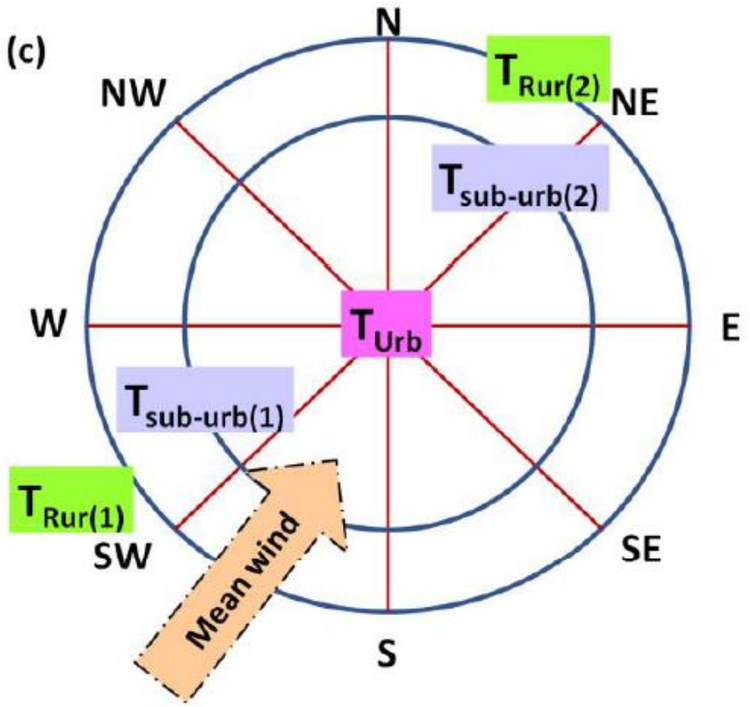
The Warmest Nights on Record at the Lubbock Airport:

1: 81 degrees on 19 July 2018
2: 80 degrees on 8 August 2019
3t: 79 degrees on 7 August 2019
3t: 79 degrees on 13 July 2016
3t: 79 degrees on 8 August 2011
3t: 79 degrees on 27 July 2011
3t: 79 degrees on 28 July 1966
4t: 78 degrees on 24 June 2018,
and 14 other times in previous years

Instrument deployments for both routine and field campaign measurements



H: locations of HOBOs in city (red starts), suburban sites (violet), rural (green); RS: radiosondes, and L: lidar during field campaigns).



Estimate the impact of UHA under southwesterly flow. T: Temperature, Urb, Sub-urb and Rur represents sites over urban, suburban and rural sites

Take home messages (Summary)

The key deliverables of this work include:

- Basically, to save people from heat-related mortality and heat-stress via comprehensive monitoring and forecasts of extreme heat events
- Details on UHII for a small city (i.e. Lubbock) for a year-long period under diverse weather conditions with particular emphasis on summer and spring-time extreme UHI events;
- Better forecast of heat index and heat stress
- Assessment of UHA for varying wind regimes over the region;
- Identification of weather conditions yielding excessive heat-related hazards in the urban and suburban regions and over the adjacent rural regions under strong UHA, in particular at night;