Study of the Urban Heat Island and its Effect on the Planetary Boundary Layer for the El Paso – Juarez Airshed

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Introduction

The Urban Heat Island (UHI) is a metropolitan area which is significantly warmer than its surrounding rural area. The El Paso-Juarez metropolitan area, with a combined population of ~1.972 million (in 2010) and growing infrastructure, can be a good example of an UHI. The Earth's surface is the bottom boundary of the atmosphere. The portion of the atmosphere most affected by that boundary is called the Planetary Boundary Layer (PBL). It is directly influenced by the earth's surface and responds to heat transfer, pollutant emission and other surface forces. It is a key component of air pollution transport studies. The overall objective of the project is to contribute to a better understanding of the PBL structure and the effect the UHI has for the El Paso-Juarez airshed.

Methodology

1 - Satellite images and data from NASA's 'WORLDVIEW' are used to study the surface land and air temperature for day and night hours (worldview.earthdata.nasa.gov).

2 - The Vaisala Ceilometer CL-31 situated at the UTEP campus, measures the cloud height, vertical visibility and mixing height using the aerosol backscatter profile data. BL-view software is used to analyze the mixing height using the ceilometer data.

3 - Weather Research Forecast (WRF) simulations are used for studying PBL in the El Paso-Juarez Airshed and neighboring regions.

Results

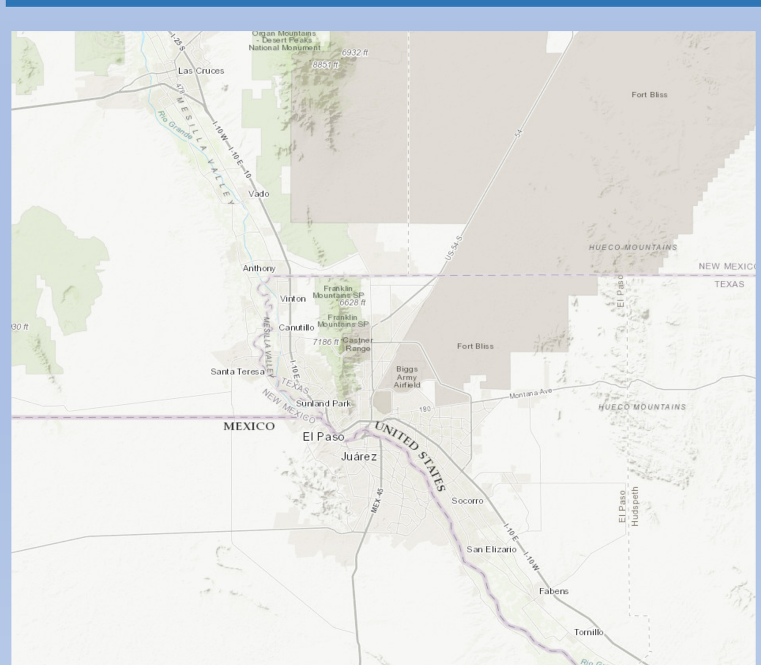

Fig.1 El Paso City and neighboring rural areas

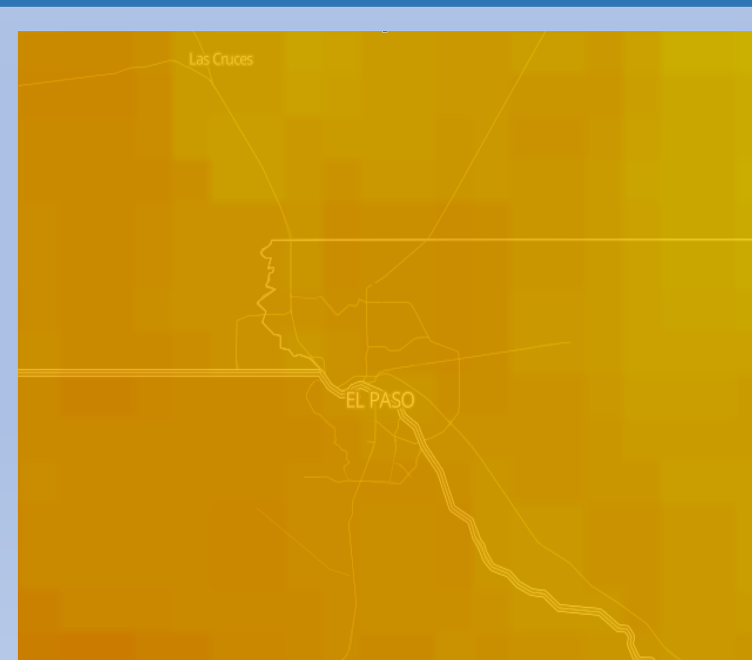

Fig.2 Surface Soil Temperature 9 Km (L4, 12z Instantaneous) SMAP / Model Value Added

Surface Urban Heat Island (SUHI) intensity = $\Delta T_{Urban - Rural}$

($\Delta T_{Urban - Rural}$) Summer ≈ 4 - 5 ^{o}C

($\Delta T_{Urban - Rural}$) Winter ≈ 2 - 3 ^{o}C

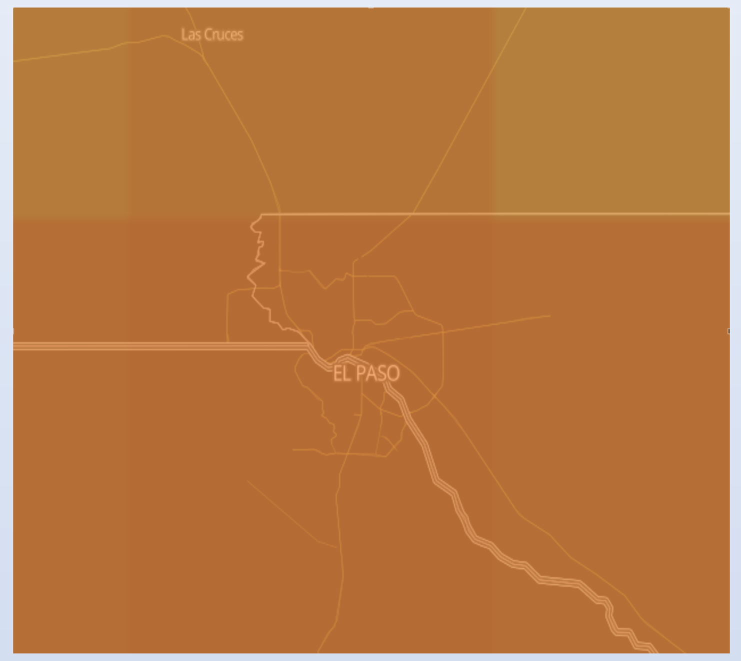

Fig.3 Surface Air Temperature (Night, Monthly) Aqua/AIRS

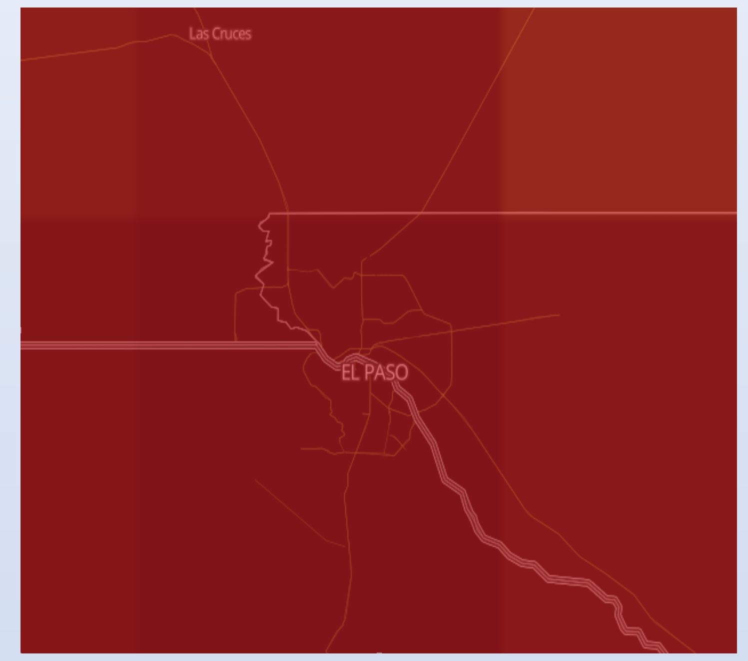

Fig.4 Surface Air Temperature (Day, Monthly) Aqua / AIRS

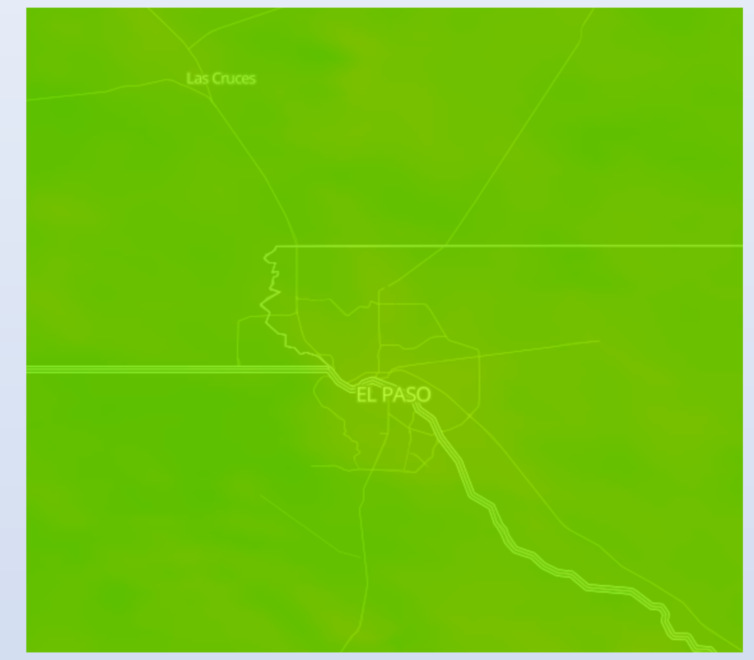

Fig.5 Land Surface Temperature (Night) Aqua / MODIS

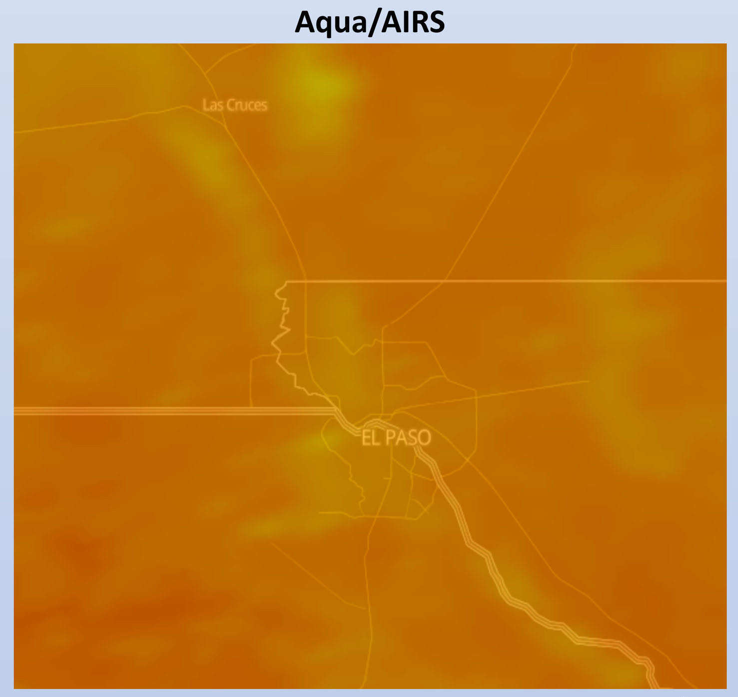

Fig.6 Land Surface Temperature (Day) Aqua / MODIS

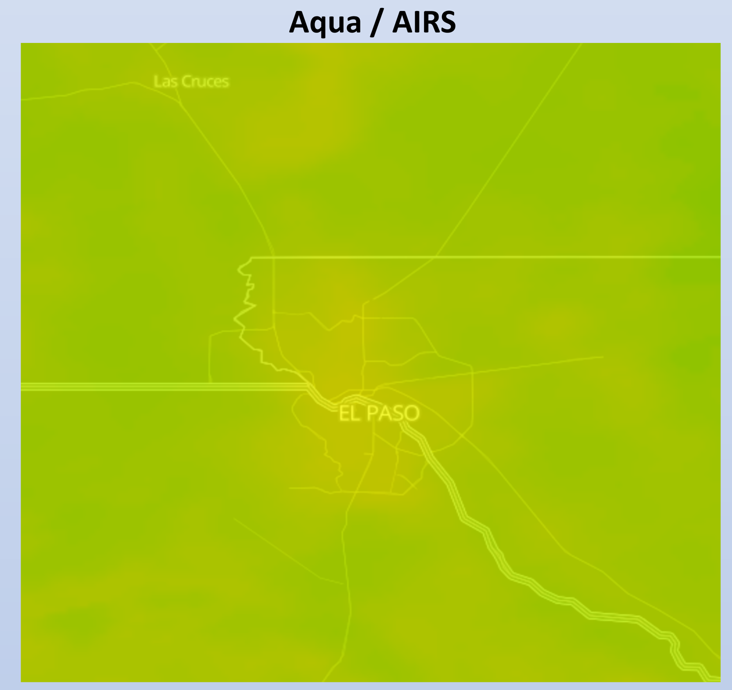

Fig.7 Land Surface Temperature (Night) Terra / MODIS

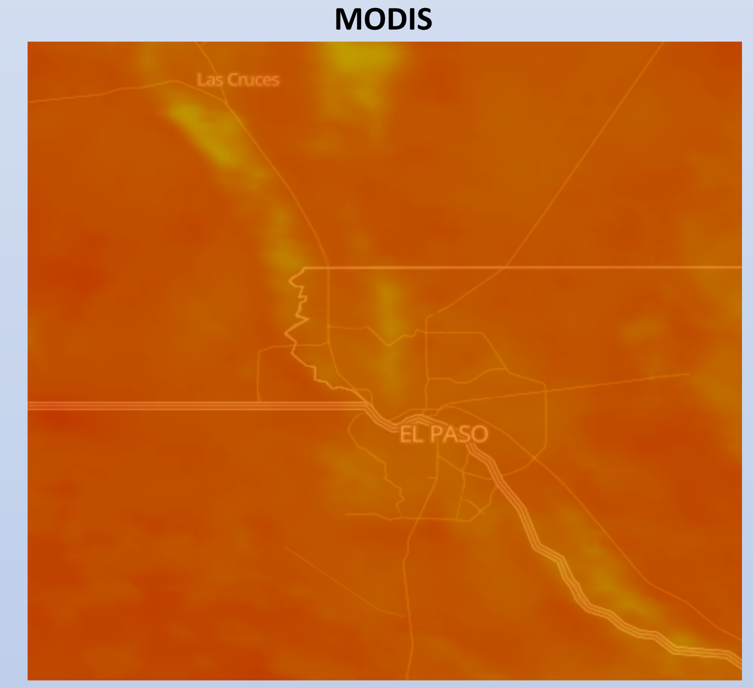

Fig.8 Land Surface Temperature (Day) Terra / MODIS

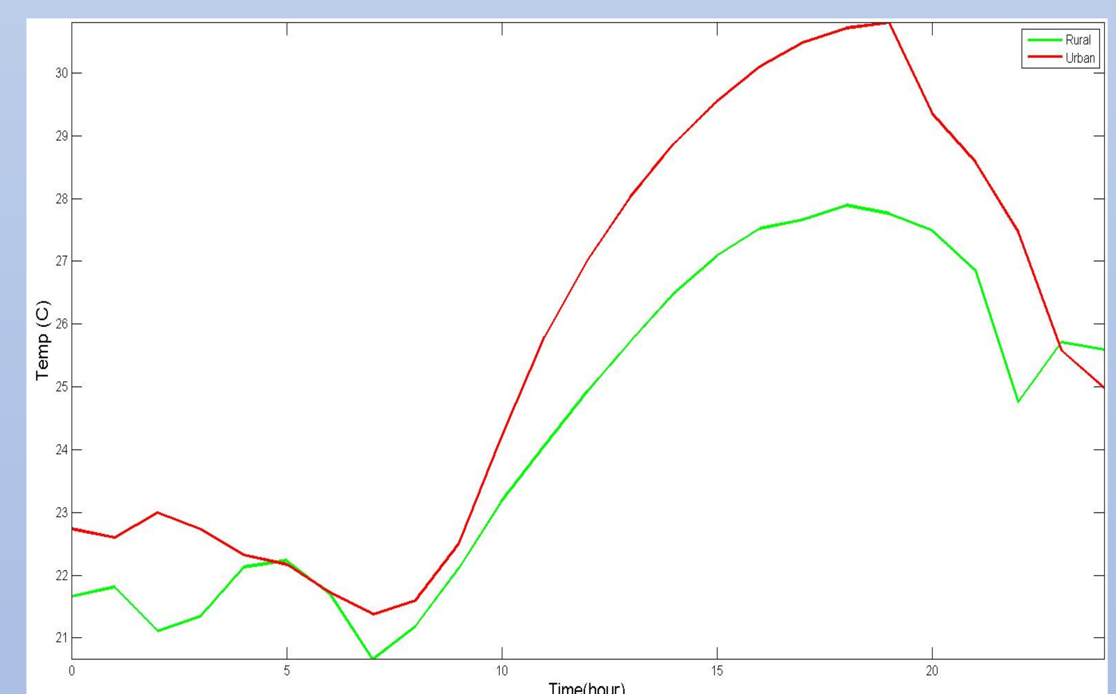

Fig.9 Temperature comparison for Urban and Rural region

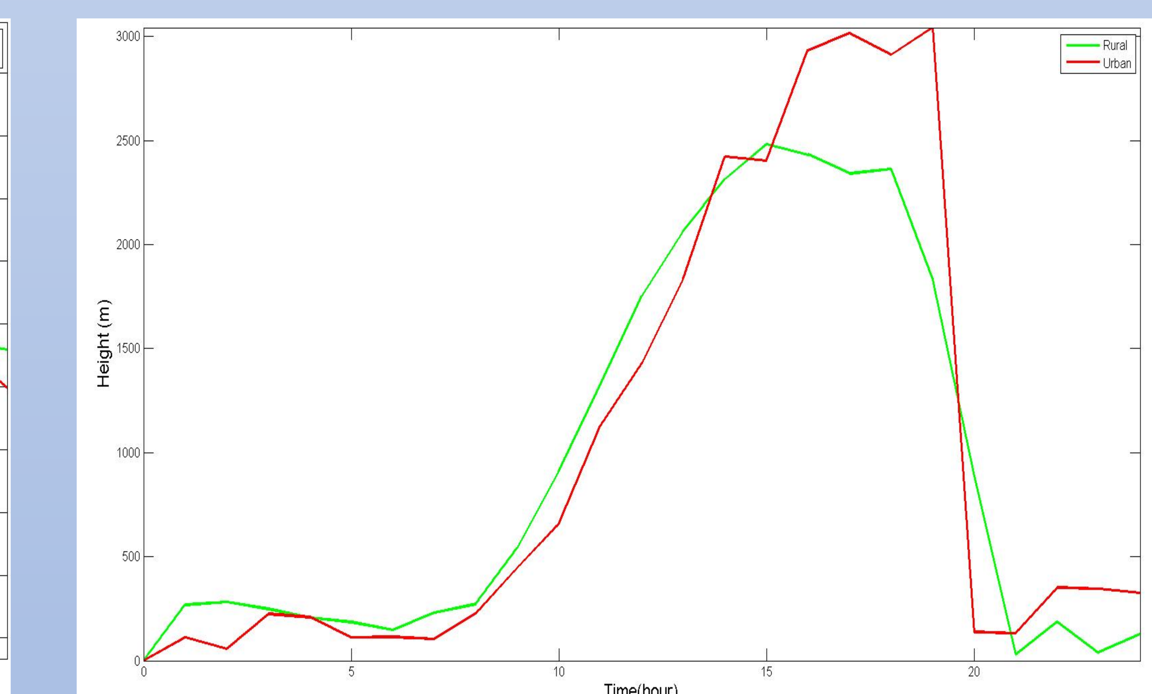

Fig.10 PBLH comparison for Rural and Urban region

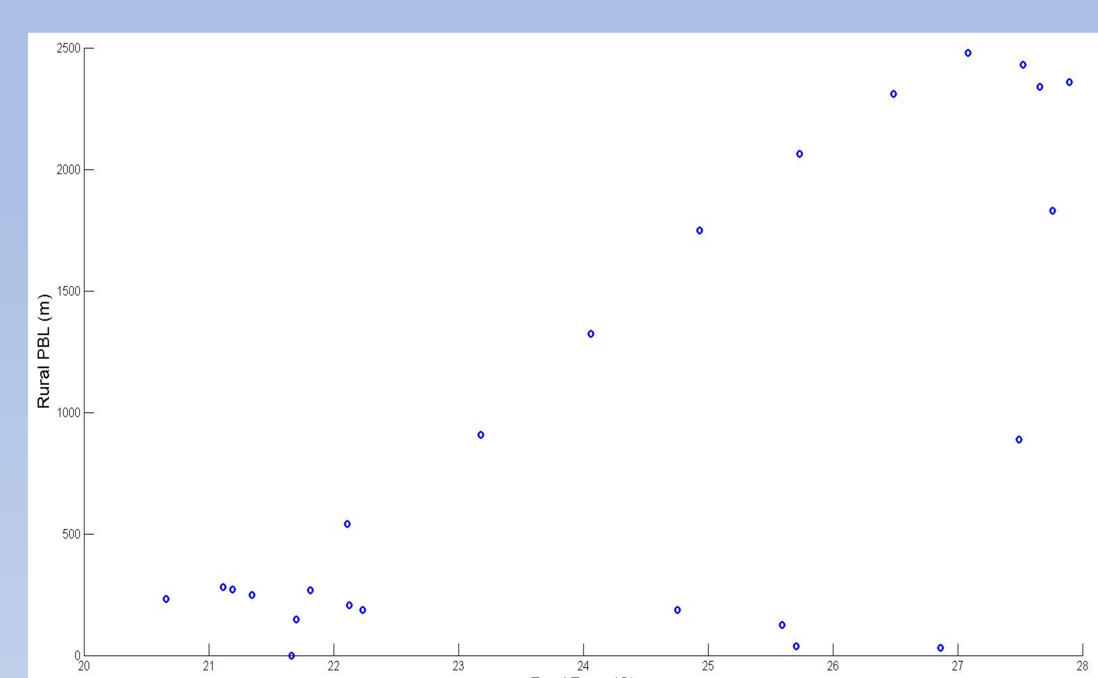

Fig.11 Correlation coefficient of Rural PBL and Temperature (0.7038)

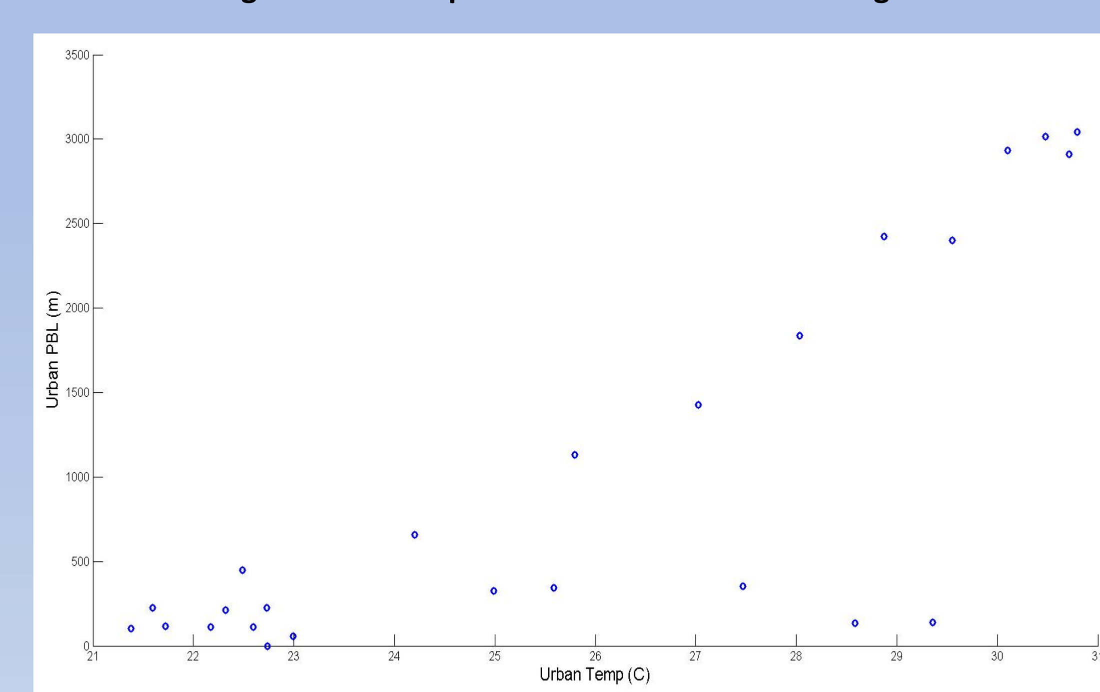

Fig.12 Correlation coefficient of Urban PBL and Temperature (0.8051)

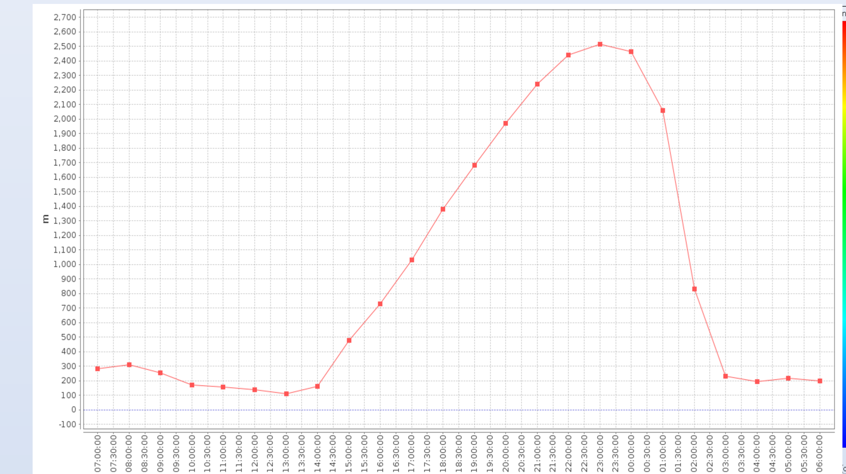

Fig.13 PBL in El Paso-Juarez region, 06/07/2017 using the (WRF) Simulations

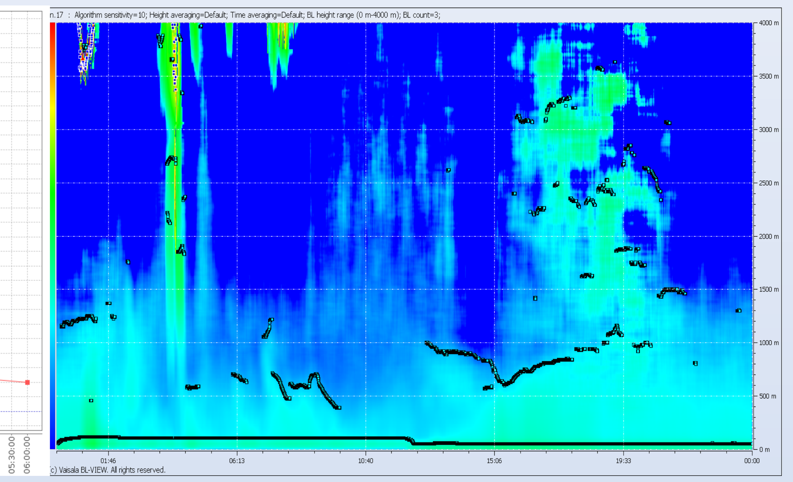

Fig.14 BL-view mixing layer height plot in El Paso-Juarez region, 06/07/2017 using the data from ceilometer CL-31

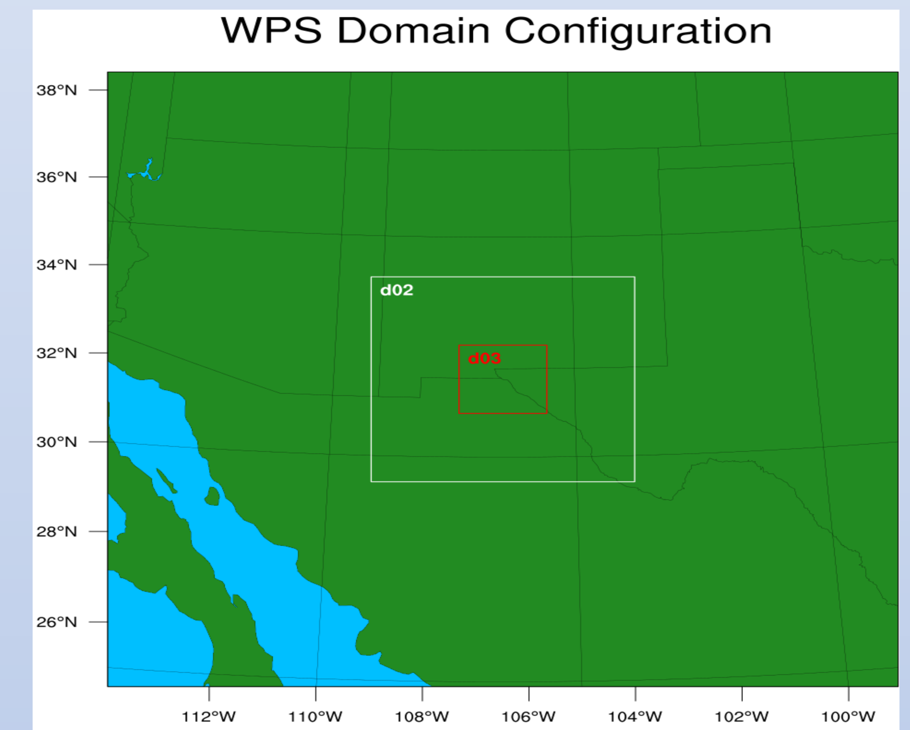

Fig. 15 WRF Simulations domain configuration

Fig. 16 Vaisala Ceilometer CL-31 @ UTEP

Conclusion

- Remote sensing data confirms that El Paso-Juarez airshed is warmer (≈ 4 - 5 ^{o}C) during summer and (≈ 2 - 3^{o}C) during winter than its surrounding rural region.
- High average wind speed especially during the summer, may contribute to lower surface urban heat island intensity.
- PBL and mixing heights are studied for the first time for El Paso-Juarez region. It is observed that both heights follow the expected diurnal cycle.
- PBL heights varies between 75 – 2700 meters. Its higher for the urban region compared to the surrounding rural regions.
- Urban correlation coefficient (0.8051) is higher than rural correlation coefficient (0.7038).

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