



# Urban Signatures in Planetary Boundary-Layer Heights: Evidence from High-Resolution Rawinsonde Observations

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## ABSTRACT

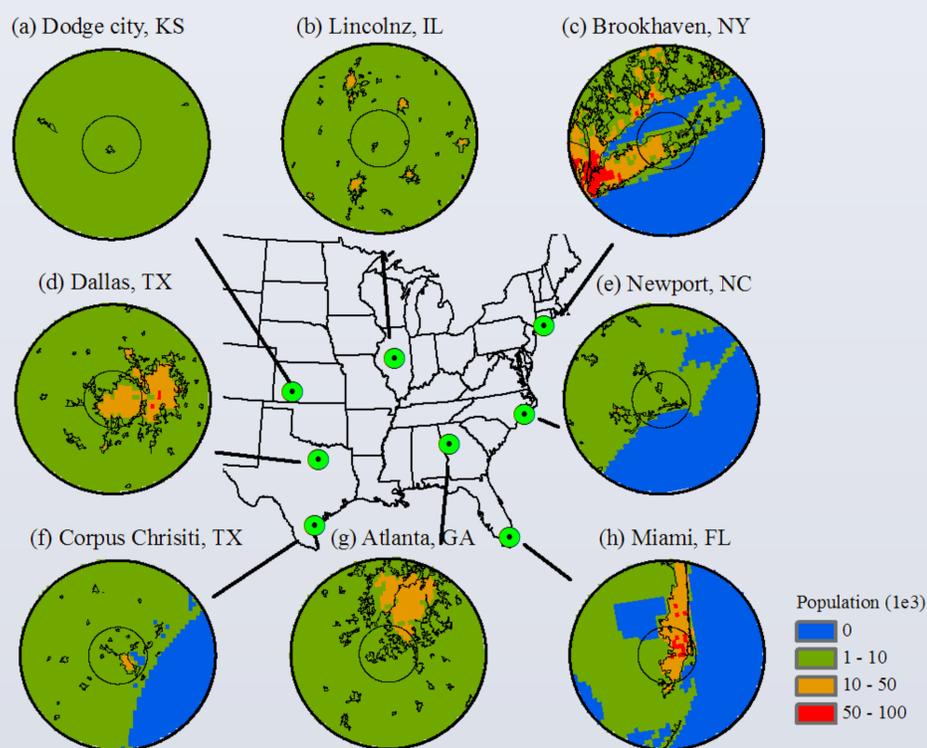
**Objective:** Detect urban impacts on the ambient environment from the perspective of planetary boundary layer (PBL) heights;

**Data & Methods:** Two different methods were used to determine seasonal behaviors of PBL heights based on a long-term (about 10 years), high-resolution (vertical interval of 20-30 m) rawinsonde observations over select representative sites (urban/rural, coastal/inland) over US;

**Conclusion:** Contrast behaviors of seasonal PBL heights among select sites were detected. Land surface induced thermodynamic heterogeneity is a detectable first-order feedback in assessing the climatic impacts due to urbanization.

## SITE DETERMINATION & METHODOLOGY

Eight rawinsonde sites were chosen over the continental US with different representative geographical attributes (coastal and inland) and land surface properties (urban and rural). Each site was classified as either "urban" or "rural" based on population density. See the figure below for details of the sites.

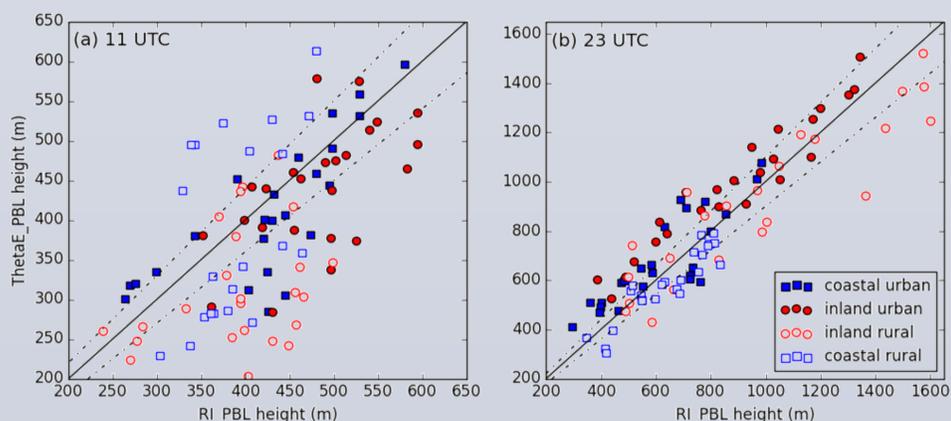


Two methods were used for determining climatological PBL heights:

**Method 1:** The bulk Richardson method (abbreviated as "RI"): we chose the lowest height at which bulk Richardson number exceeds 0.25 as the PBL height;

**Method 2:** An automated statistical method (abbreviated as "ThetaV", see Schmid and Niyogi, 2012 JAOT): we utilize the statistical variance and kurtosis of virtual potential temperature and dew point with height to locate the inversion associated with the PBL height;

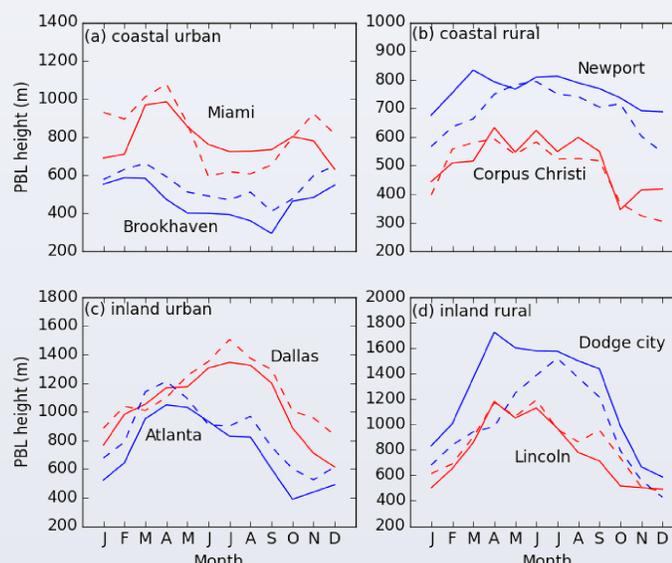
Comparative results between two methods are shown below:



## SEASONALITY OF PBL HEIGHTS

Seasonality of afternoon PBL heights are shown below for eight sites:

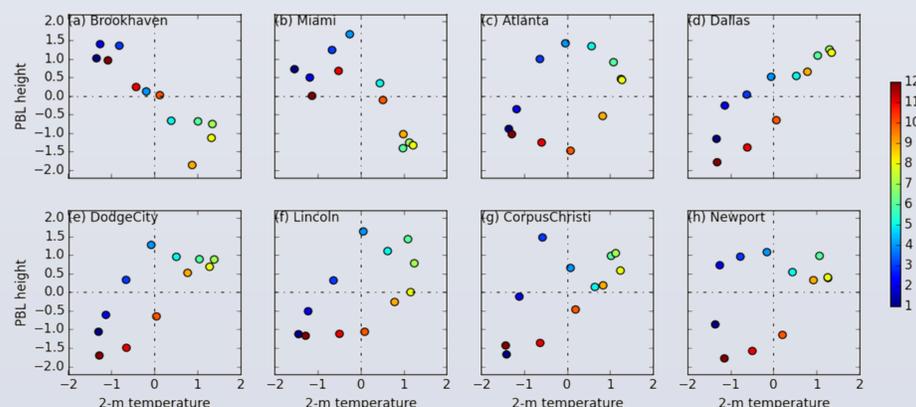
- 1) Coastal urban sites: bi-modal pattern, PBL heights are relatively lower in summer than other months;
- 2) Inland sites and coastal rural sites: unimodal pattern, peak PBL heights occur during spring or summer months;



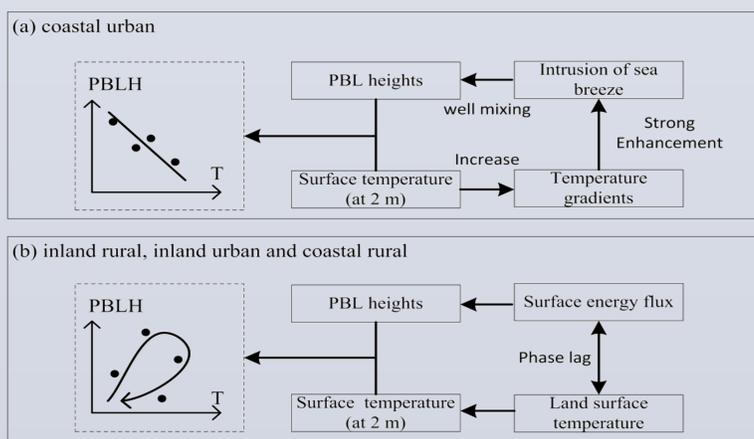
## CORRELATION BETWEEN PBL HEIGHTS AND 2-M AIR TEMPERATURE

Contrast correlations between seasonality of PBL heights and air temperature among sites are shown below:

- 1) Coastal urban sites: Negative, anti-clockwise correlation.
- 2) Inland sites and coastal rural sites: Positive, clockwise correlations indicating a phase lag.



## ATTRIBUTIONS OF SEASONAL BEHAVIORS IN PBL HEIGHTS



- 1) Coastal urban sites: thermal contrast between land and water enhances vertical mixing and reduces the height of the marine inversion;
- 2) Inland urban sites: partitioning of surface energy fluxes due to soil moisture anomalies play dominant role;

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