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Impacts of urban densification on neighborhood heat wave resilience

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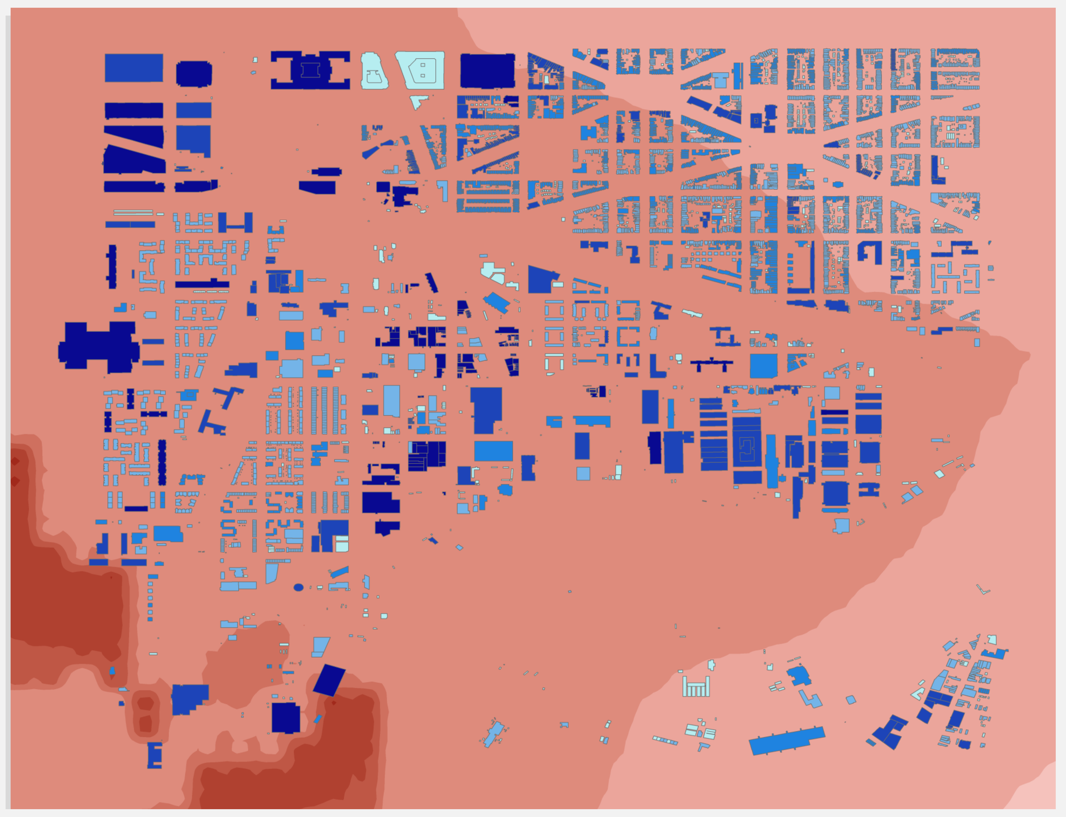
The Big Idea

The morphology of an urban neighborhood affects its local meteorology: Washington DC 1999 and 2015 Waterfront morphologies show different influence on the neighborhood's response to the 2010 heat wave.

Waterfront Neighborhood, 1999

June 30, 2pm

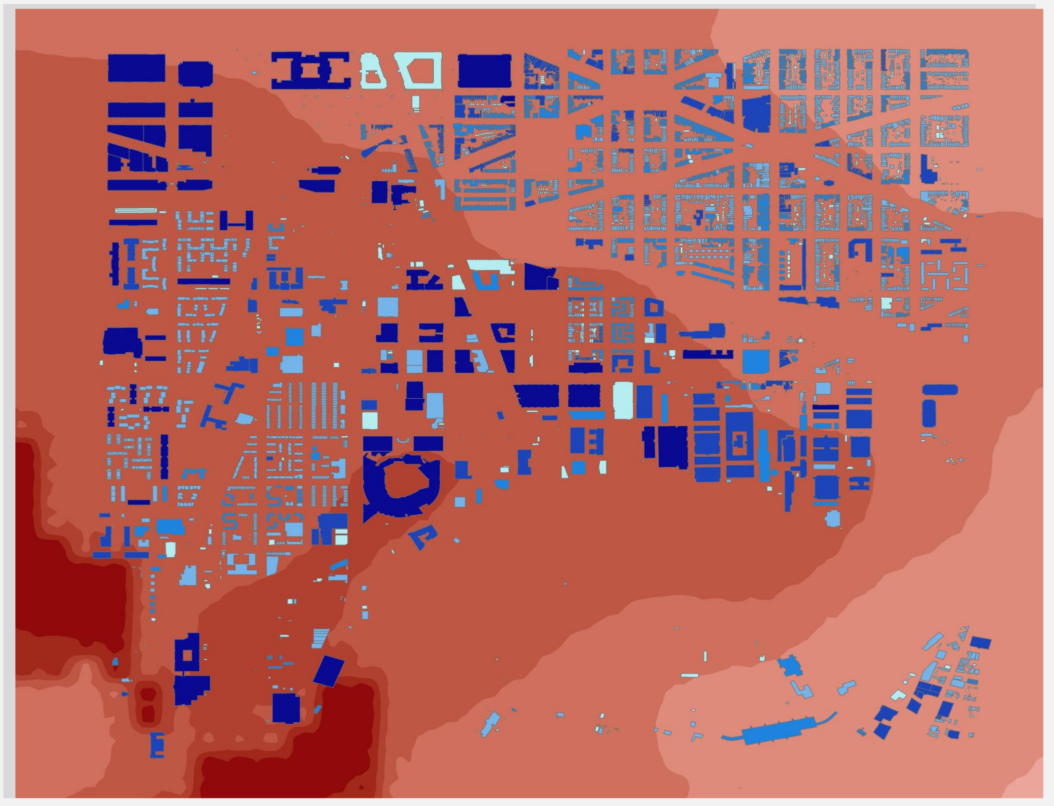
5 degree F spread (66 – 71) is shown across the waterfront area. Hottest spots are over the Potomac and Anacostia Rivers near the southwest part of the city. With the 1999 morphology, most of the area is at 69 degrees F with northeast and southeast regions at 68 degrees F.



Waterfront Neighborhood, 2015

June 30, 2pm

5 degree F spread (66 – 71) is shown across the waterfront area. Hottest spots are over the Potomac and Anacostia Rivers near the southwest part of the city. Hot spots are hotter with the 2015 morphology than with that of 1999, as is the entire waterfront neighborhood. Note the hot passageway from the river confluence to the Nationals stadium.

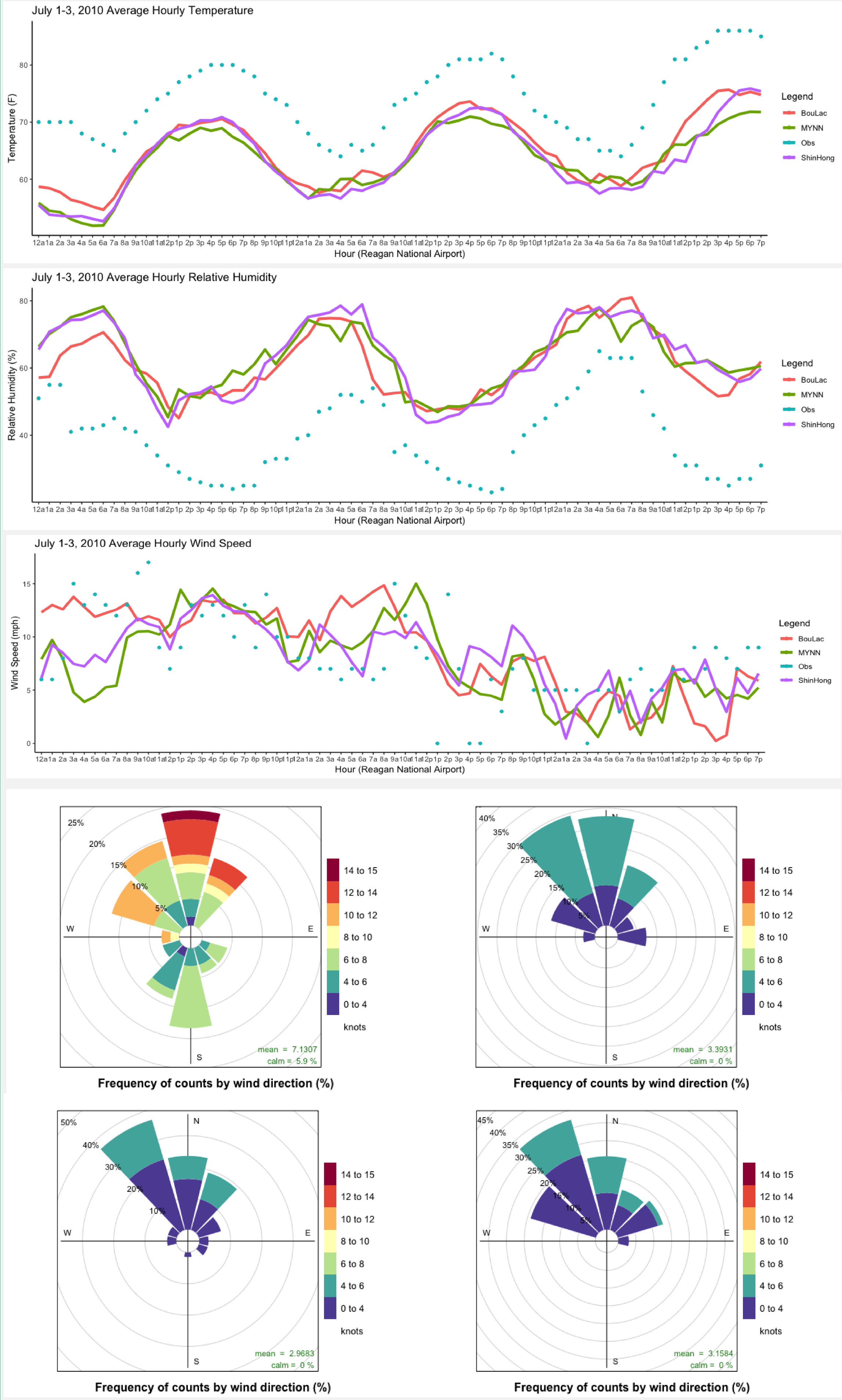


Calibration

WRF UCM 1 km Variability: PBL Schemes

Appropriate parameterization of vertical turbulent fluxes in meteorological modeling is important for correct evolution of diurnal temperature, water vapor and winds within the planetary boundary layer (PBL). Here, we compare the results of three different PBL schemes (BouLac, MYNN2 and Shin-Hong) to determine which best captures the diurnal trend measured at a specific location (Reagan National Airport) for each of these parameters over a three-day period.

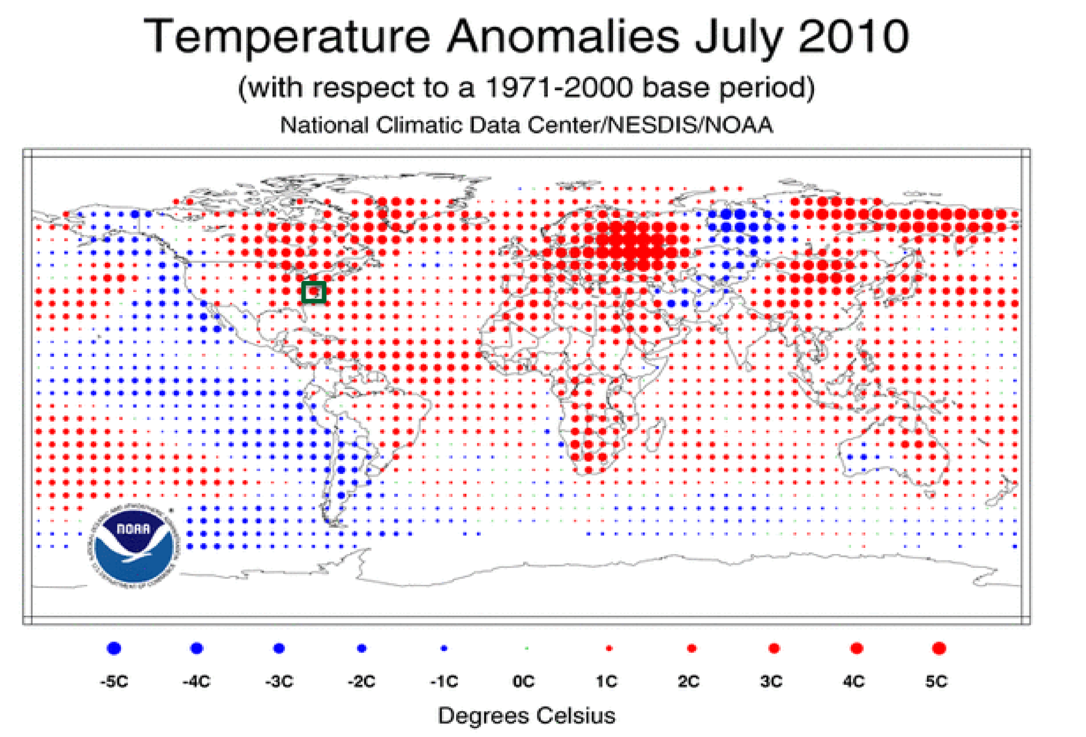
Generally, temperature and relative humidity curves of all PBL schemes plot fairly closely. All underestimate 2m temperature and overestimate 2m relative humidity. The Shin and Hong PBL scheme tracks hourly windspeed slightly better than the other two schemes, and BouLac wind directions are more consistent with the observations for the three-day period. The BouLac scheme was chosen for the higher resolution simulations for the heat wave period (July 4-10, 2010.)



Summary

Heat Waves and Heat Islands

Development of an urban heat island relies on the ways in which the urban surface exchanges fluxes with adjacent atmospheric layers, including solar and longwave radiation to and from buildings, roads, and green spaces; along with their ventilation, exhaust, moisture, energy budgets, and small-scale advection. These processes within city neighborhoods affect both the spatial variability of atmospheric characteristics and the extremes of the overall urban climate. Investigation of the impacts of the densification of the Washington, DC urban morphology from 1999 to 2015 on the Waterfront neighborhood's response to the prolonged high temperature anomaly (7 days above 95 F and earliest 100 F reading in a day, July 6) of 2010 using10m resolution neighborhood building footprints and heights as urban terrain in the Weather Research and Forecasting (WRF) model shows interesting preliminary results.



References

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