High-Resolution WRF-Urban Simulations of Metropolitan Tel-Aviv

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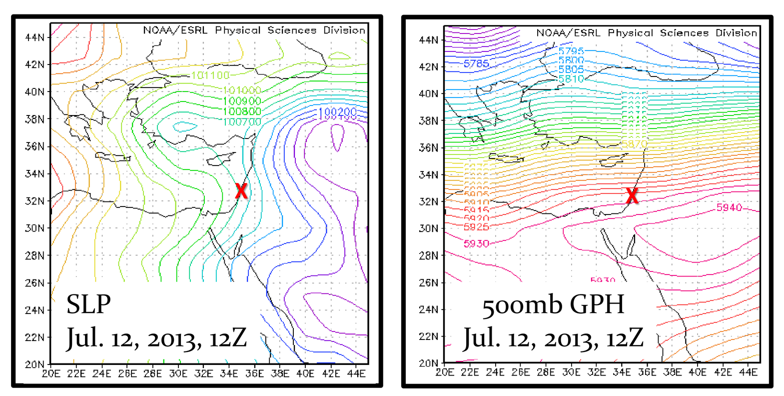
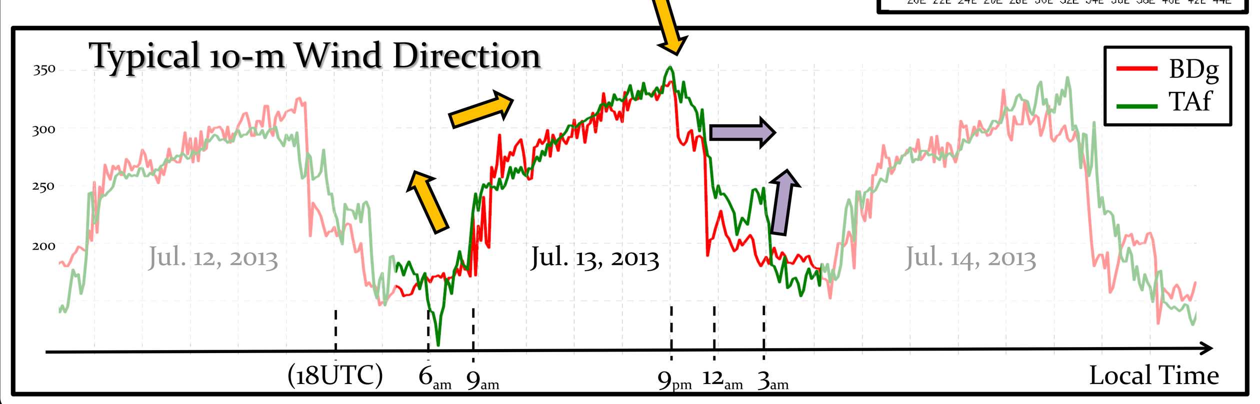
Introduction

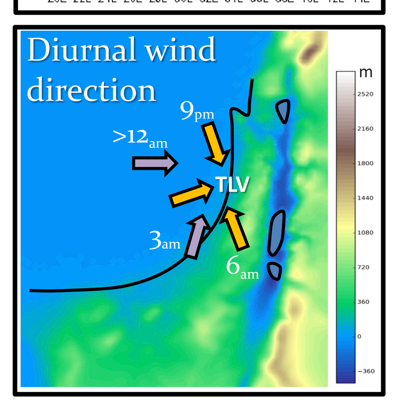
Urbanization affects local and regional meteorological conditions which, in turn, affect air quality and human health and comfort. Our aim is to study the influence of metropolitan Tel-Aviv (TLV, ~2 million people) on local meteorological conditions. For that purpose, we conduct WRF-urban simulations with updated high-resolution gridded map of TLV. We vary urban parameters and surface characteristics to test their impact on the simulated near-surface fields, which are compared to observations.

Synoptic Scenario

We study a typical summer-day dominated by upper-level *subtropical ridge* and sea-level *Persian trough*. As the land heats, sea-breeze develops and rotates clockwise. Following sunset, the wind rotates anti-clockwise and land-breeze develops before dawn.





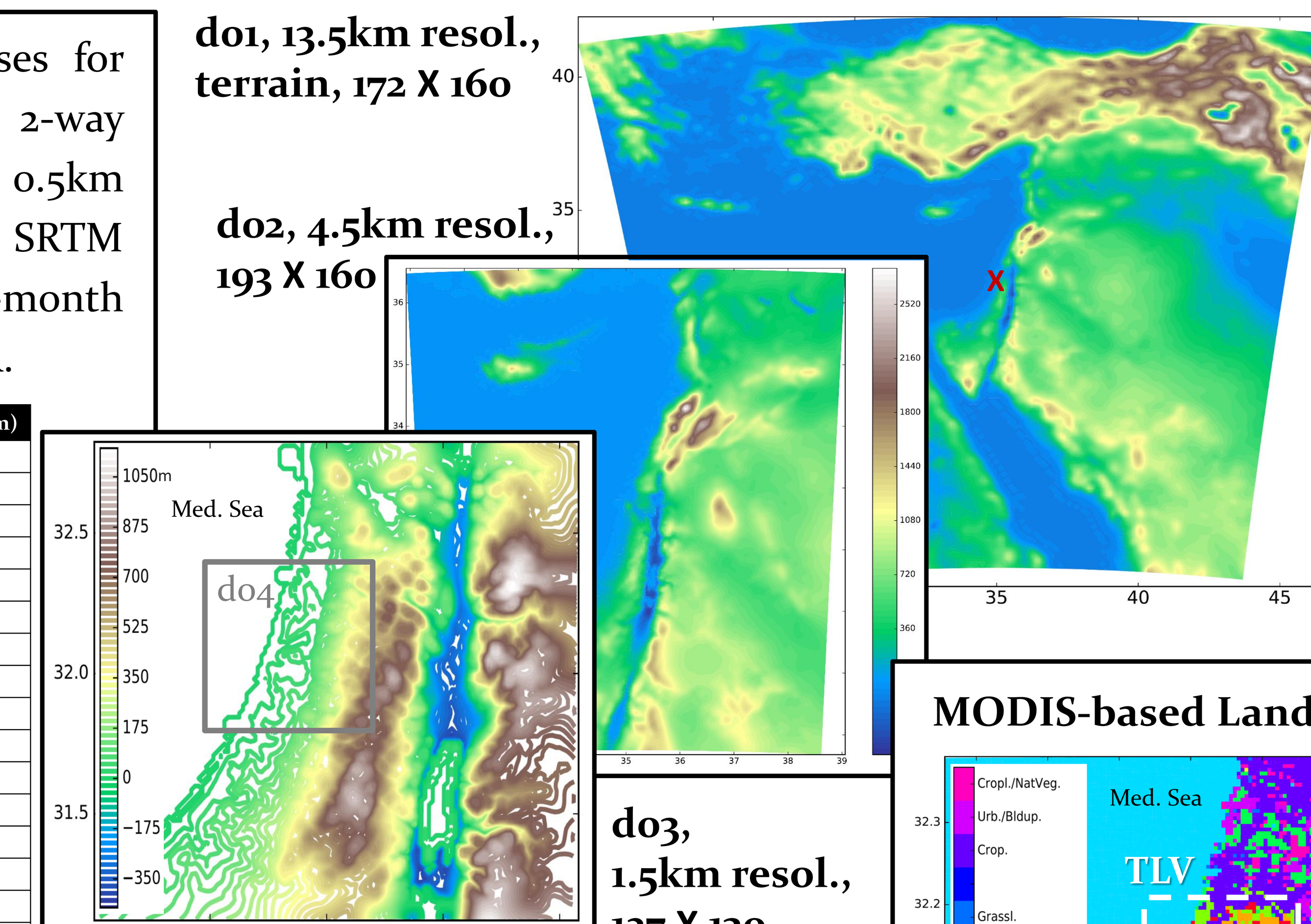


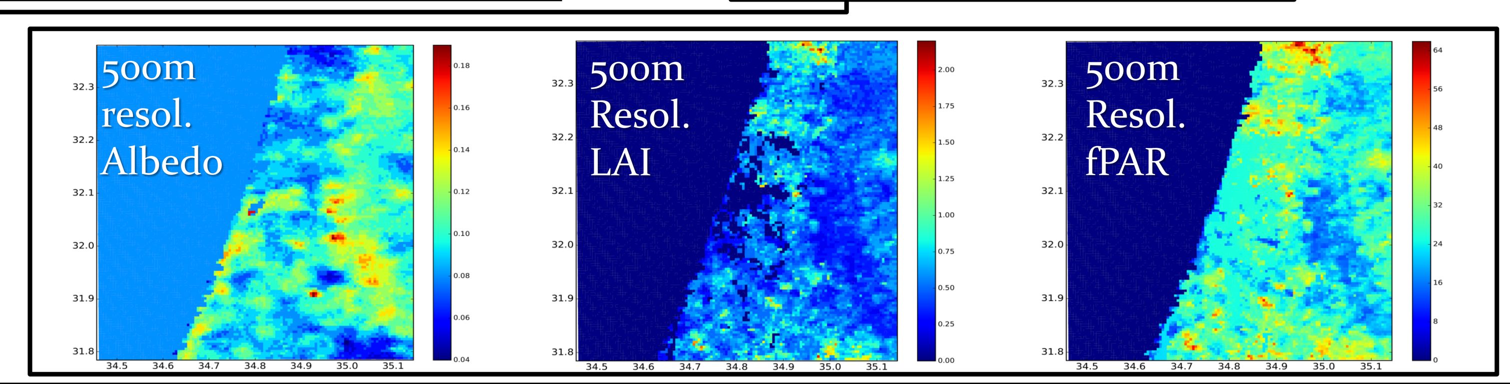
Model Configuration

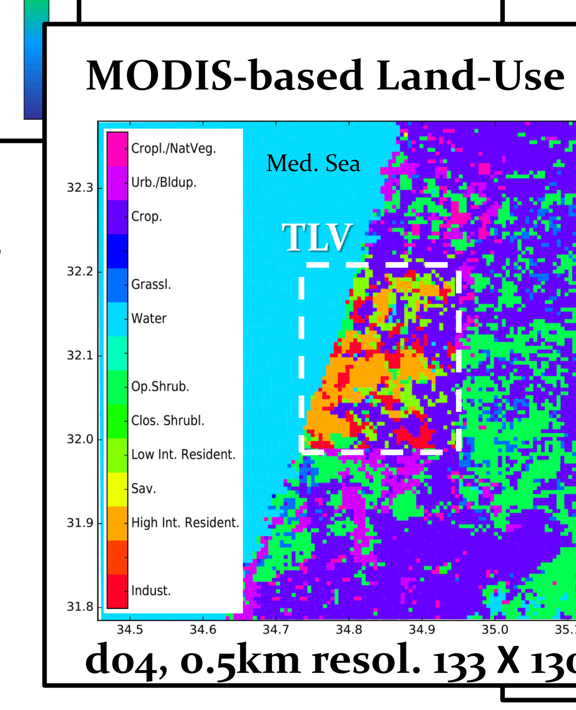
GEOGRID: We use GFS 0.5° analyses for initial (18UTC) and L.B. conditions, 2-way nested domains (13.5, 4.5, 1.5, 0.5km resolution), 50 vertical levels, 90m SRTM terrain, and test MODIS updated 3-month averaged gridded albedo, LAI and fPAR.

Physics schemes	
Microphys.	WRF SM6
Longwave rad.	RRTM
Shortwave rad.	Dudhia
Surface layer	Revised MM5
Land surface	Noah
Urban surface	SLUCM
Planetary BL	Yonsei Univ.
Cumulus(d01)	Kain-Fritsch

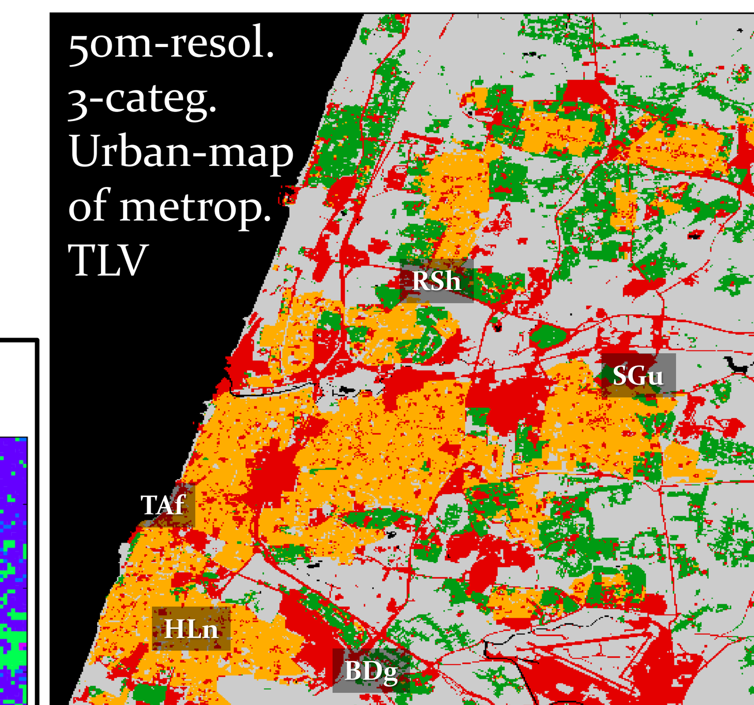
Vrt. Lvl. (m)
38.1
46.6
67.8
84.9
110.5
144.7
204.8
256.7
325.9
395.7
483.5
572.0
679.2
796.8
925.1
1111.6







URBAN: We built a 3-category 50m-resolution gridded map of ***LOW***- and ***HIGH***-intensity residential, and ***INDUSTRIAL*** areas, based on GIS database. Characteristic morphological parameters were derived.

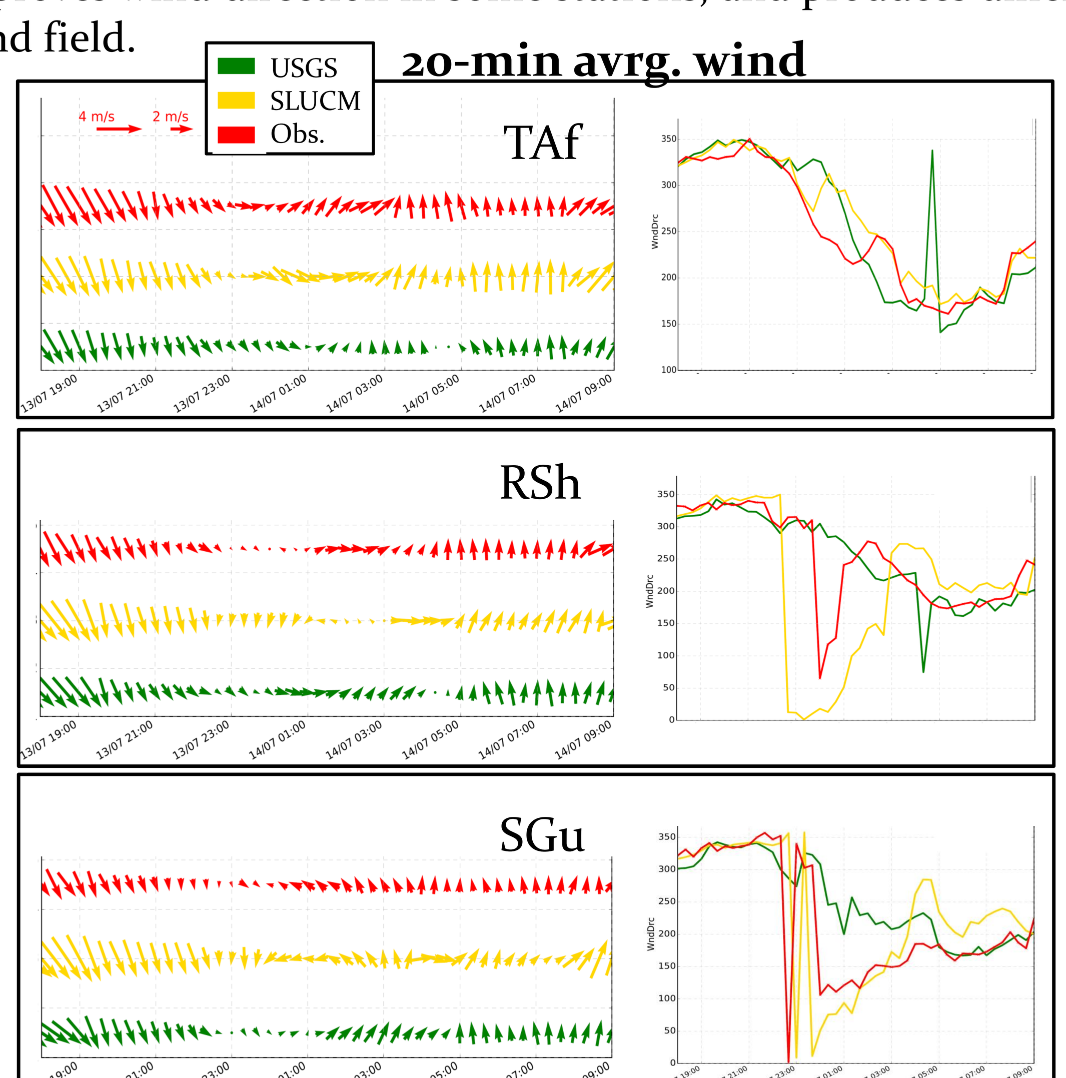


	LOW	HIGH	INDUSTRIAL
Bldg. H. (m)	5.3	10.8	8.6
Urb. Frac. (%)	29	40	83
AH(W/m²)	30	60	100
Albedo	0.15	0.17	0.18

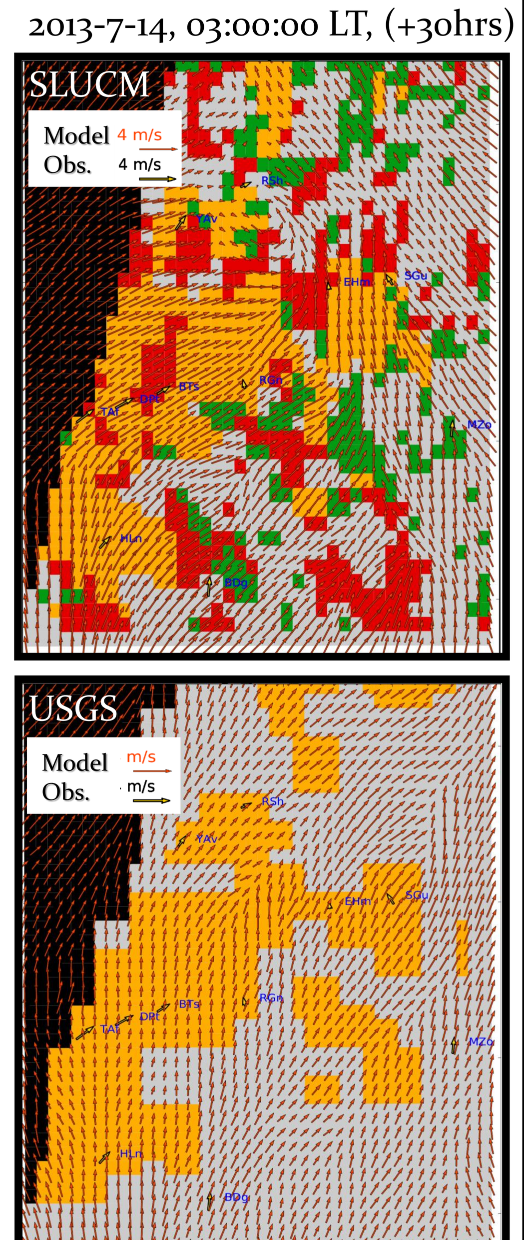
Results

MODIS-based SLUCM vs USGS-based Bulk Urban Parameterization (BUP) 10-m Wind Vectors: We are interested in night-time hours, after the sea-breeze forcing ceases. SLUCM improves wind direction in some stations, and produces different wind field.

20-min avrg. wind



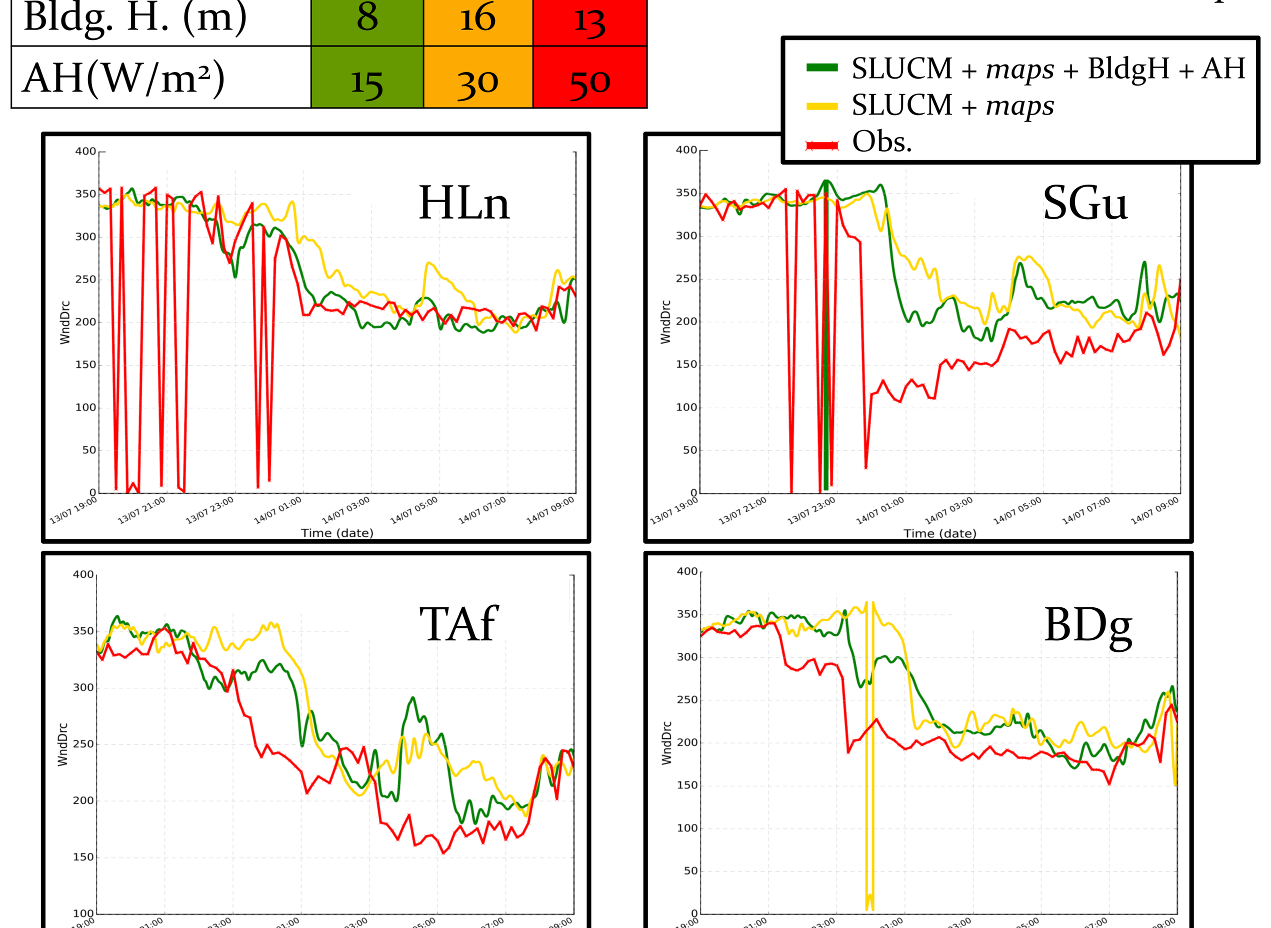
2013-7-14, 03:00:00 LT, (+30hrs)



Rotating the wind anti-clockwise: We hypothesize that *higher buildings* (i.e., larger friction) and *lower AH* (i.e., less vertical mixing) should cause an anti-clockwise rotation of the 10-m wind at night, and make it fit better to observations. The model simulations show such a combined positive effect.

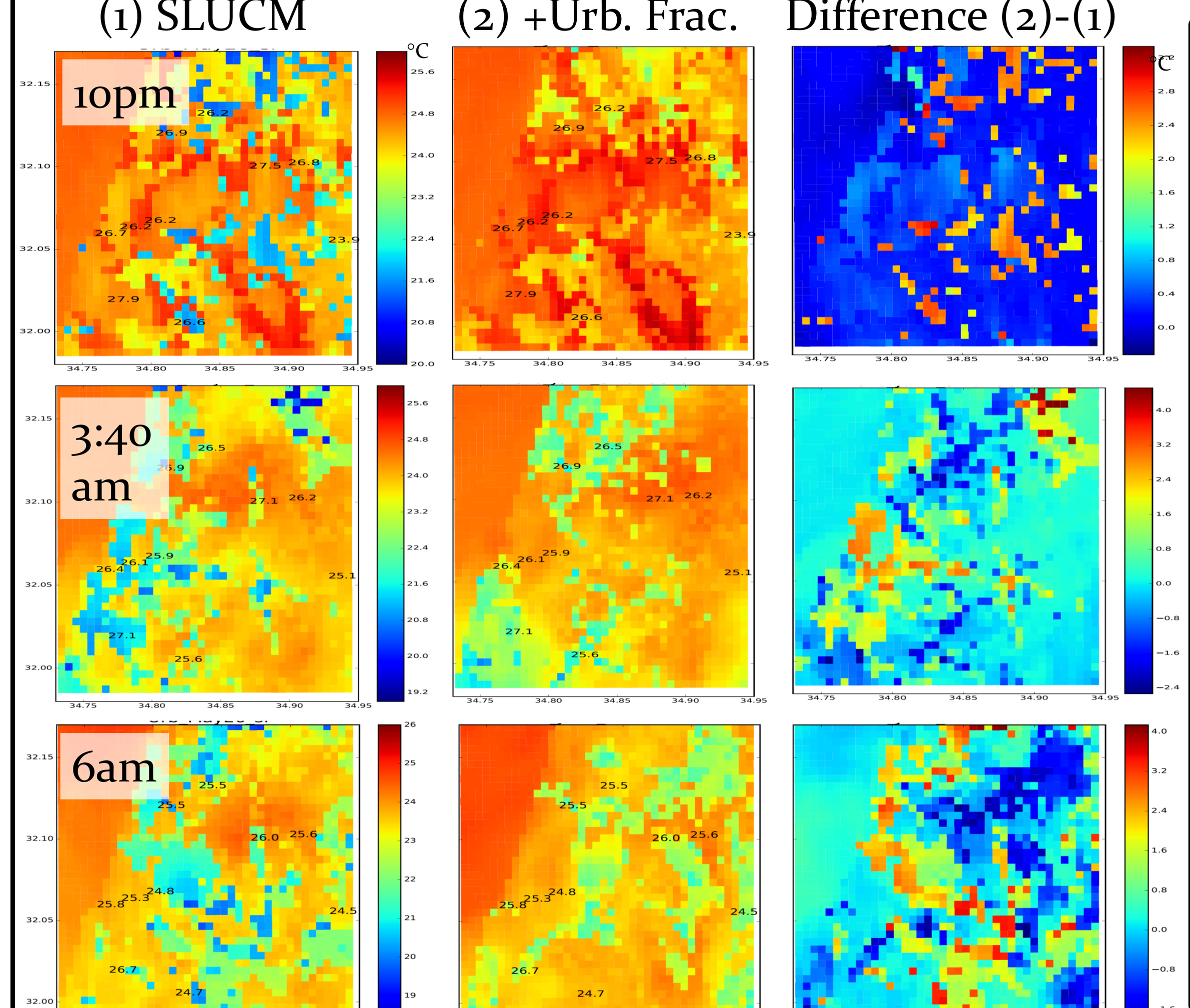
Modified urban parameters			
Bldg. H. (m)	8	16	13
AH(W/m²)	15	30	50

* Note that we use the albedo, LAI and fPAR *maps*.



Temperature: The SLUCM reproduces 2-m temperature with a bias of ~2–3 °C. Increasing the urban fractions cause a significant increase in 2-m temperature of urban-cells, at night.

Modified urban parameters			
Urb. Frac(%)	50	60	95



Concluding Remarks

1. MODIS-based 3-category SLUCM improves wind patterns relative to USGS-based BUP.
2. BEP and SLUC+MYJ-PBL produce extremely fluctuating patterns of wind direction.
3. Generally, 2-m temperatures show biases (~2–3 °C) and strong fluctuations. The bias reduces with increasing urban fraction.
4. Increasing AH affects 2-m temperatures only very moderately.