CARE-C

Climate and Atmosphere Research Center

How are air and land temperatures affected by the horizontal resolution and the bulk urban parametrisation in the WRF model simulations over the eastern Mediterranean and the Middle East?

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Weather Research and Forecasting (WRF) model

Nested simulation:

horizontal resolution: - 16 km – Middle East and North Africa (MENA) domain
- 4 km – eastern Mediterranean and the Middle East (EMME) domain

period: 2000-2002

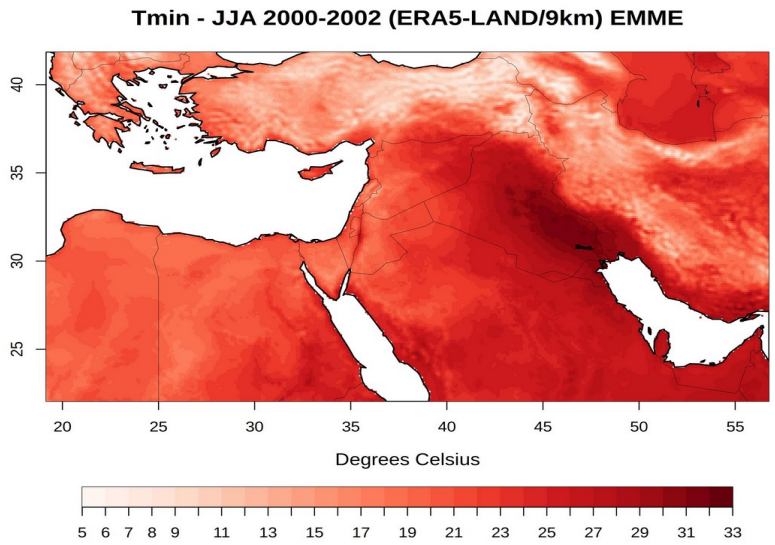
Land surface scheme: NoahMP (dynamical vegetation option = ON)

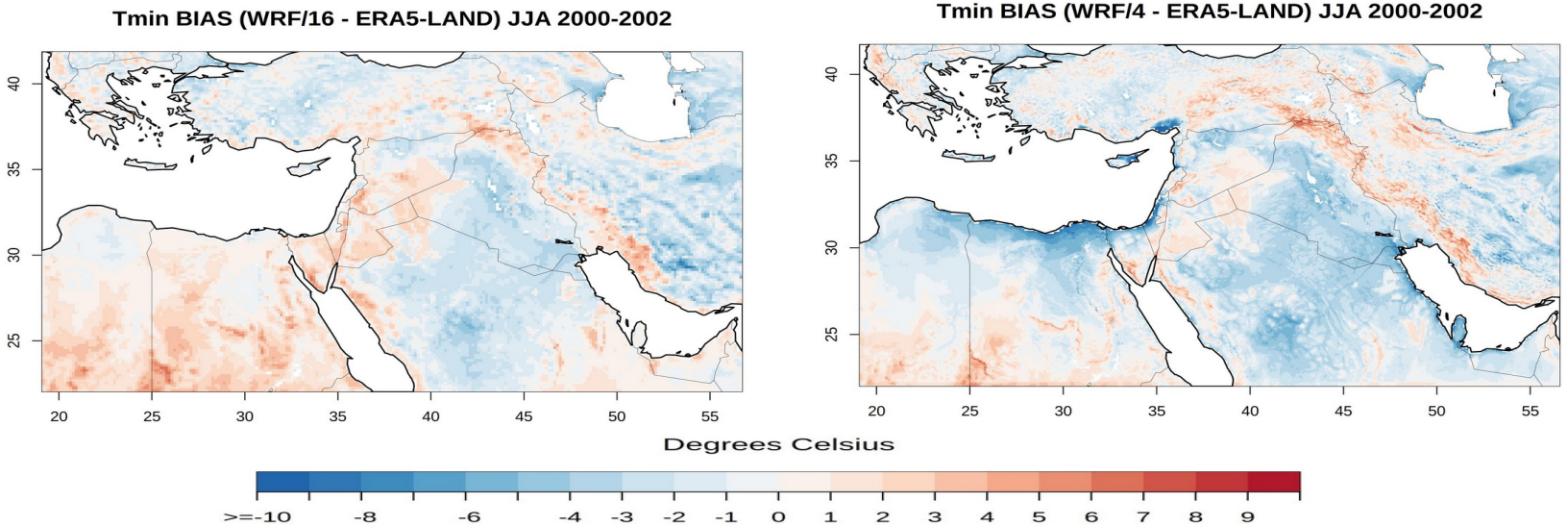
Urban parameterization scheme: Bulk

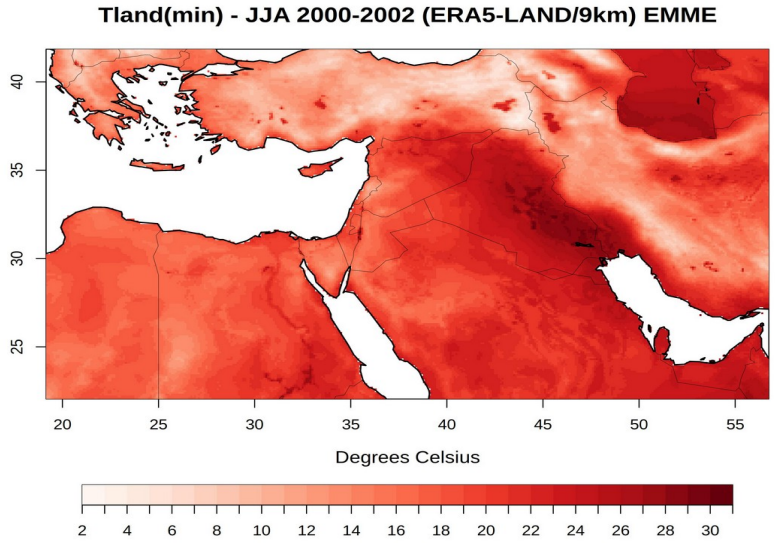
Assigned land parameters over urban grid boxes:

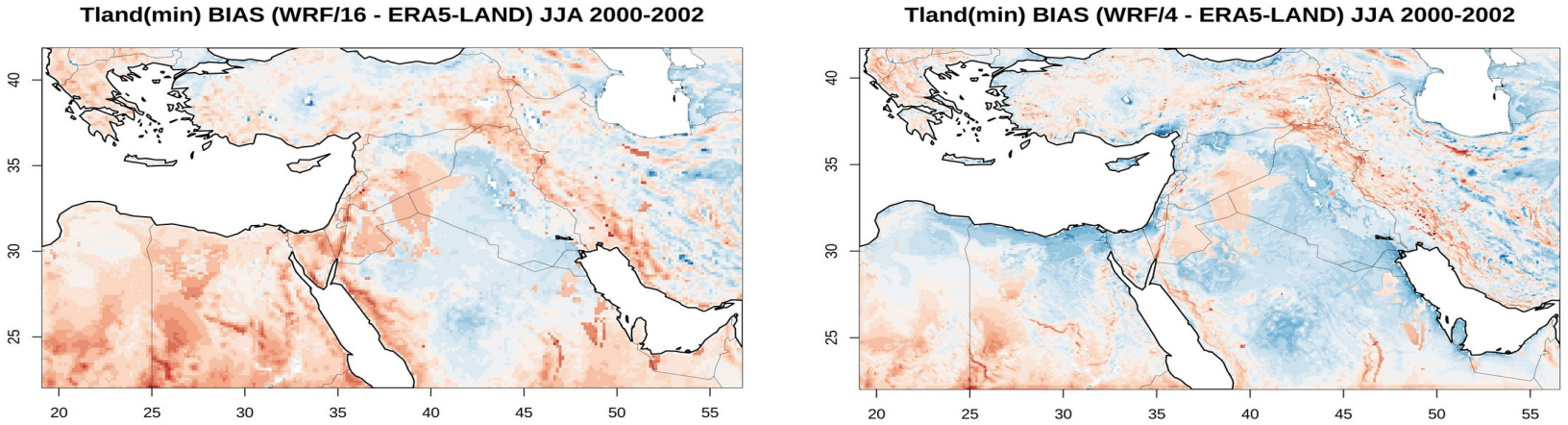
- roughness length = 0.8 m to represent turbulence generated by roughness elements and drag due to building
- surface albedo = 0.15 to represent shortwave radiation trapping in urban canyons
- volumetric heat capacity = 3.0 J m−3K−1 for urban surfaces (walls, roofs, and roads), assumed as concrete or asphalt
- soil thermal conductivity = 3.24 W m−1K−1 to represent the large heat storage in urban buildings and roads
- green-vegetation fraction = 0.1 reduced over urban areas to decrease evaporation

Comparison of air and land Tmin of WRF (16km & 4km) with ERA5-Land for June-July-August (JJA) 2000-2002

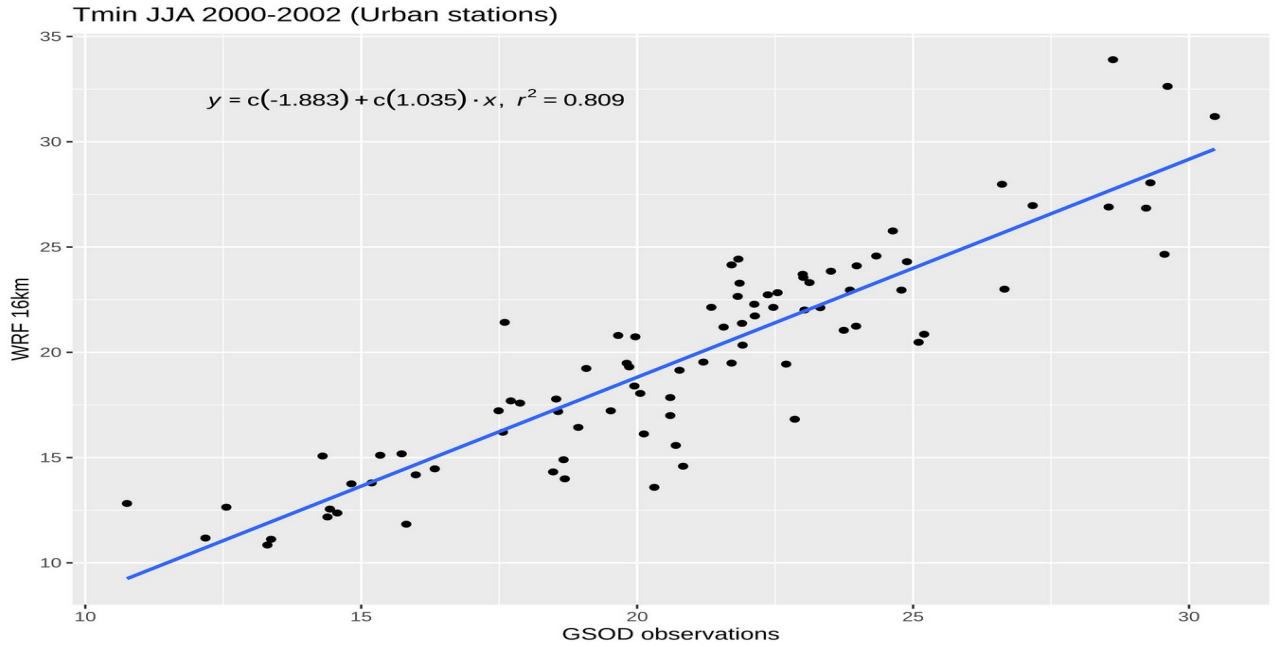


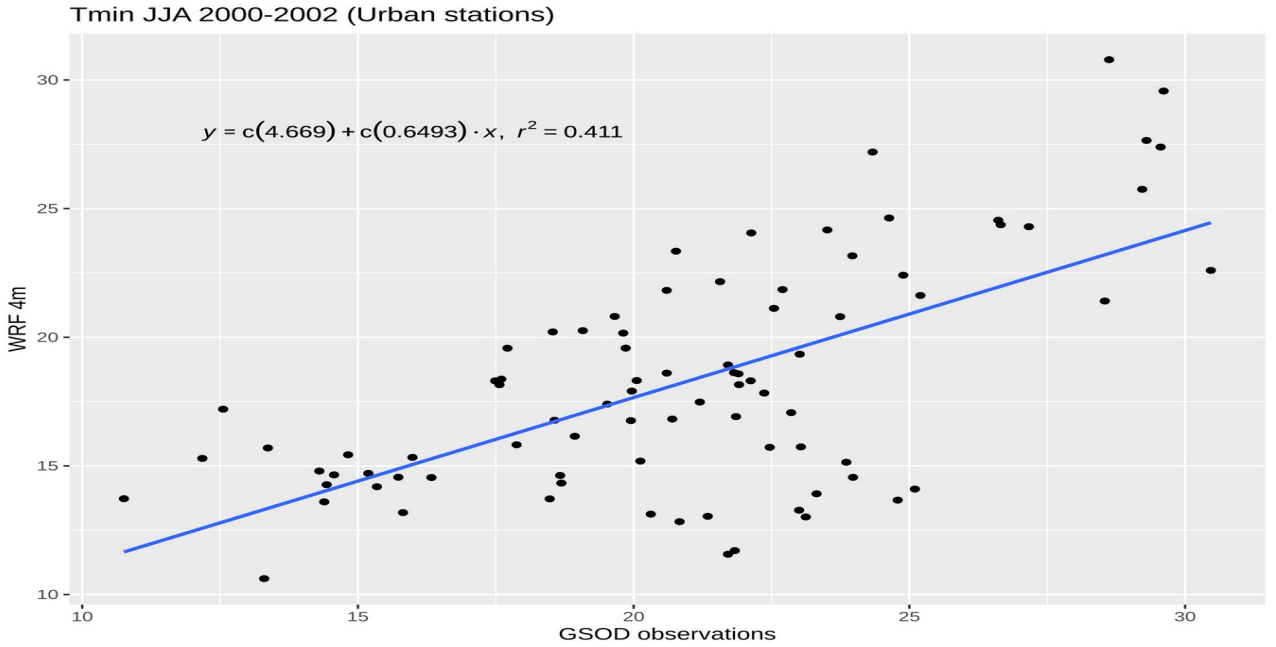


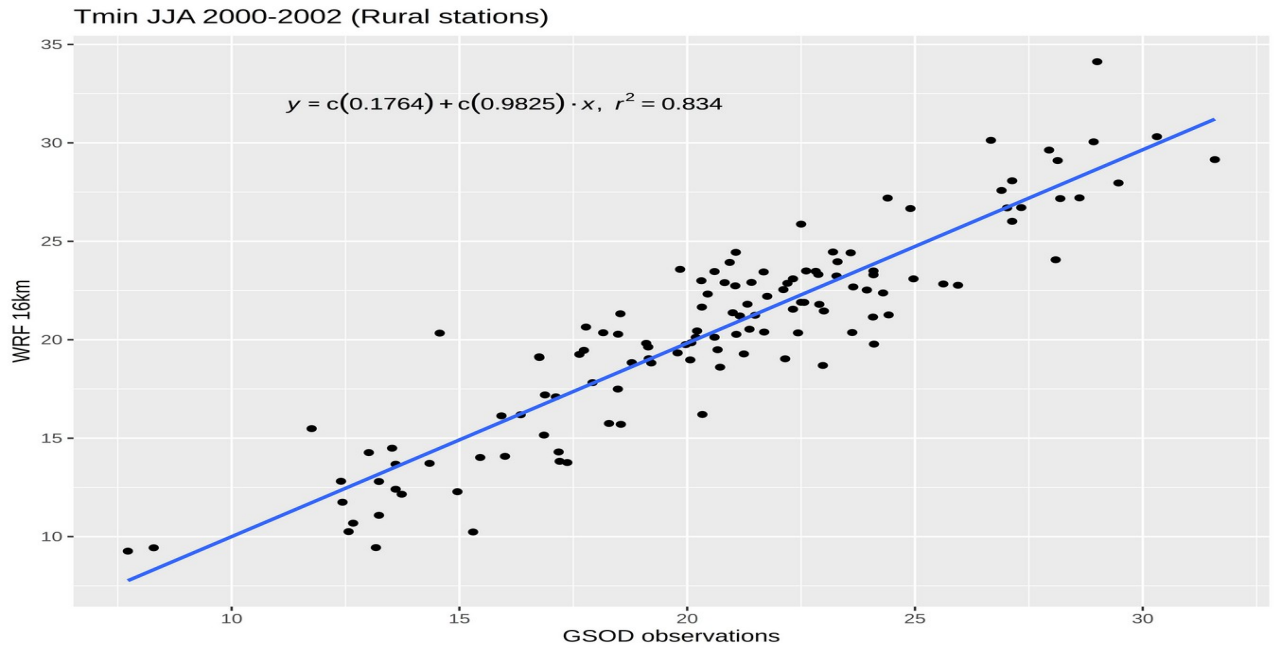


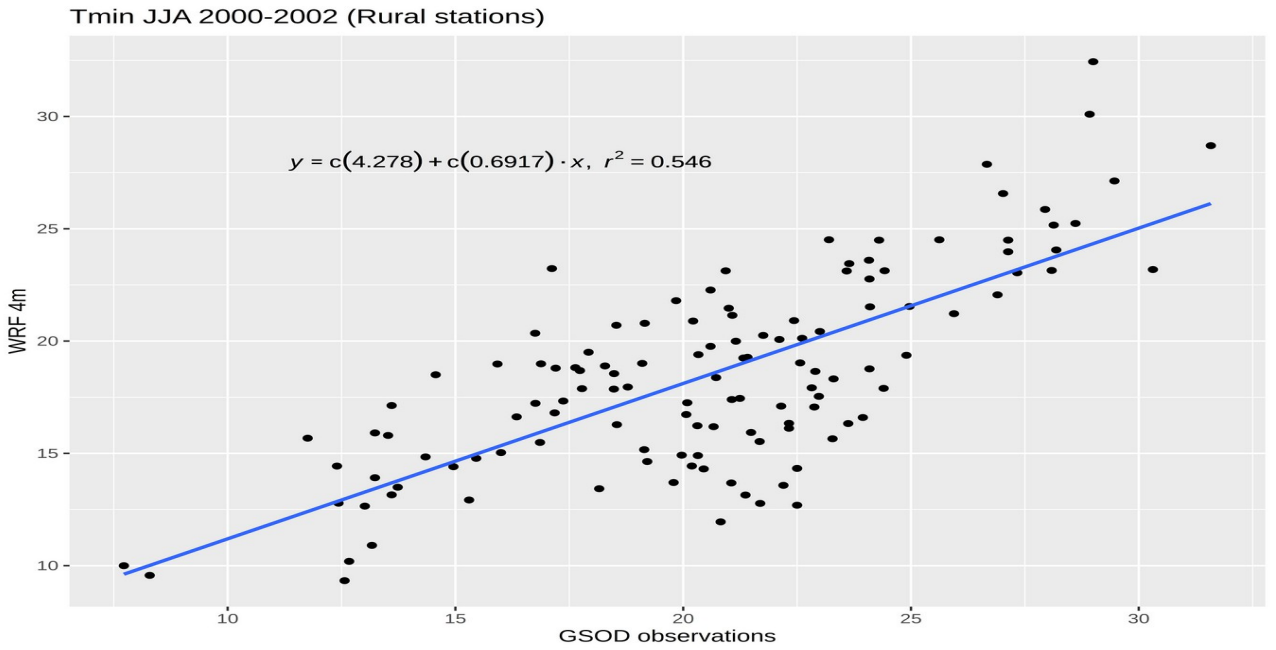


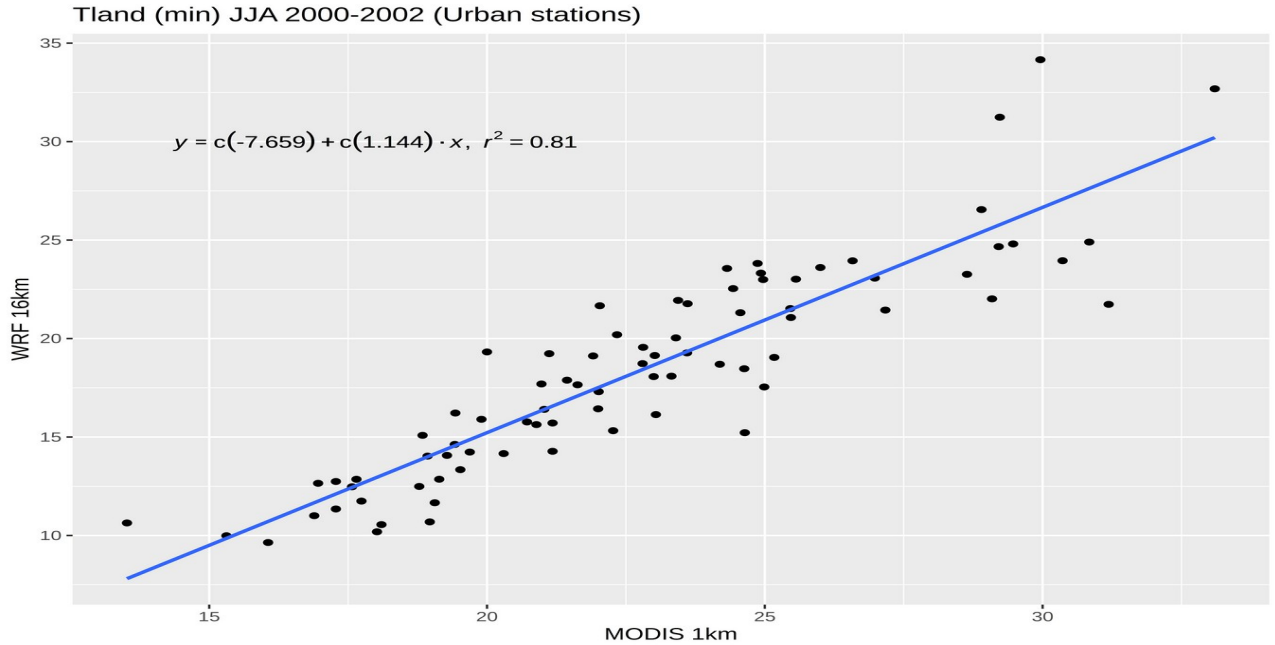
WRF/4km underestimates both air and land minimum temperatures across the coastal areas

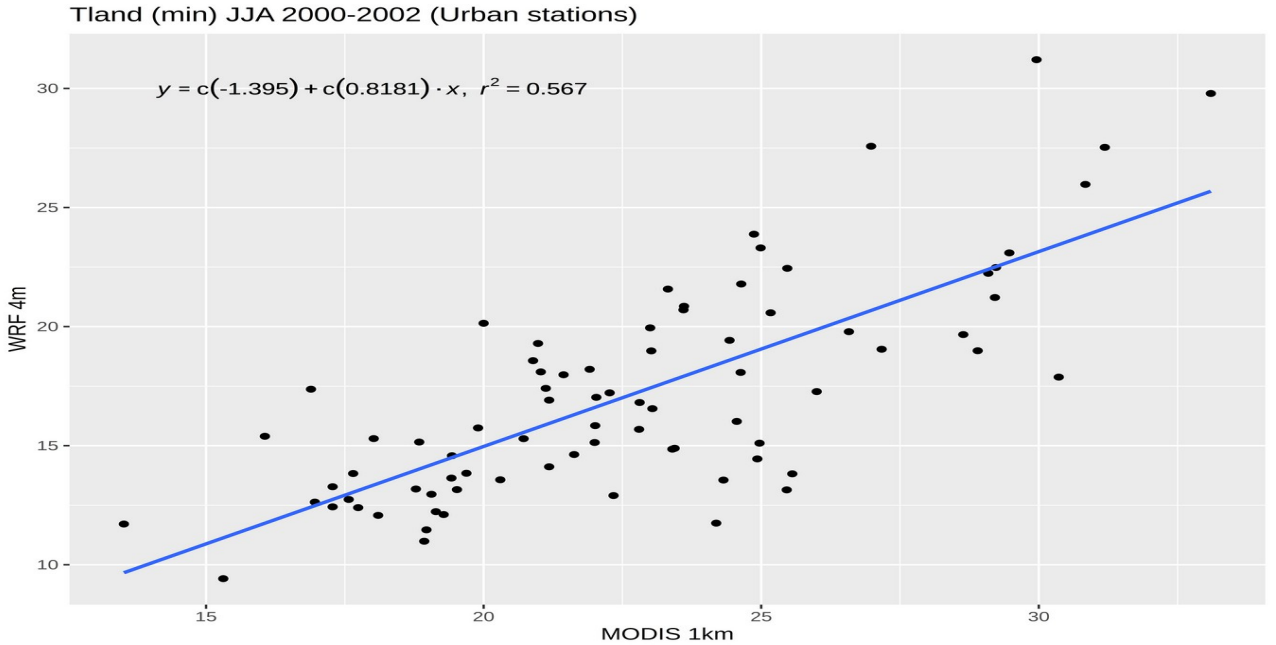

Tmin JJA 2000-2002 (Urban stations)
$y = c(-1.883) + c(1.035) \cdot x,\ r^2 = 0.809$
WRF 16km
GSOD observations

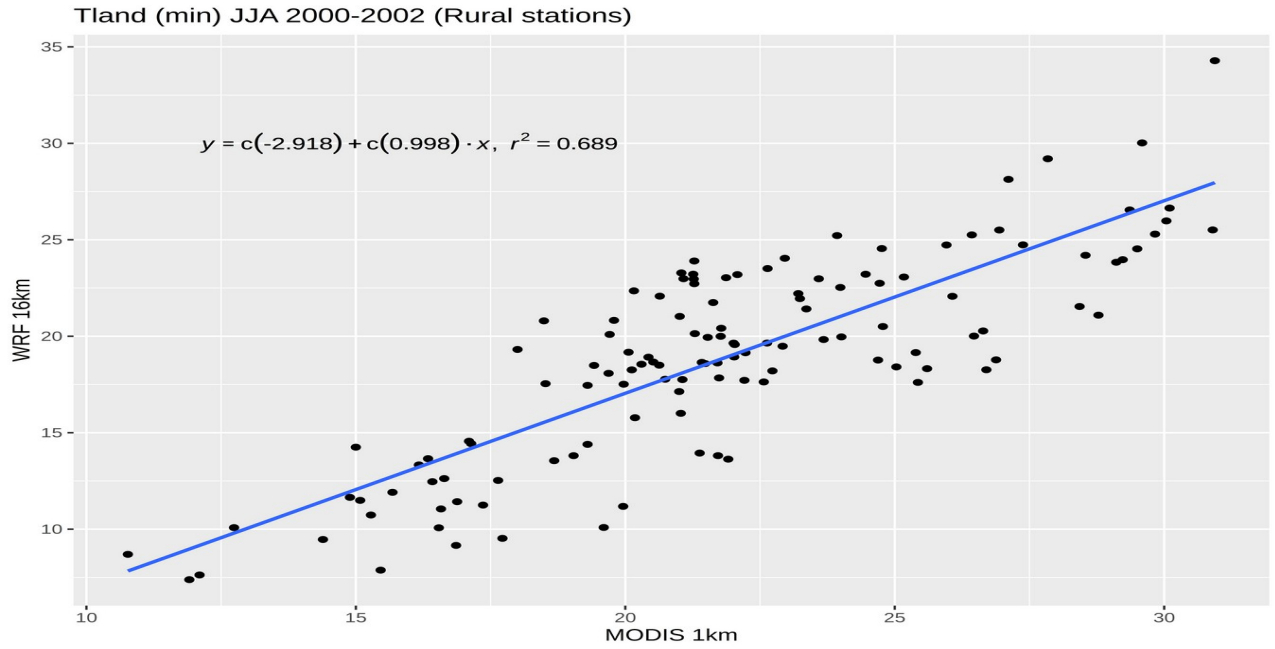

Tmin JJA 2000-2002 (Urban stations)
$y = c(4.669) + c(0.6493) \cdot x,\ r^2 = 0.411$
WRF 4m
GSOD observations

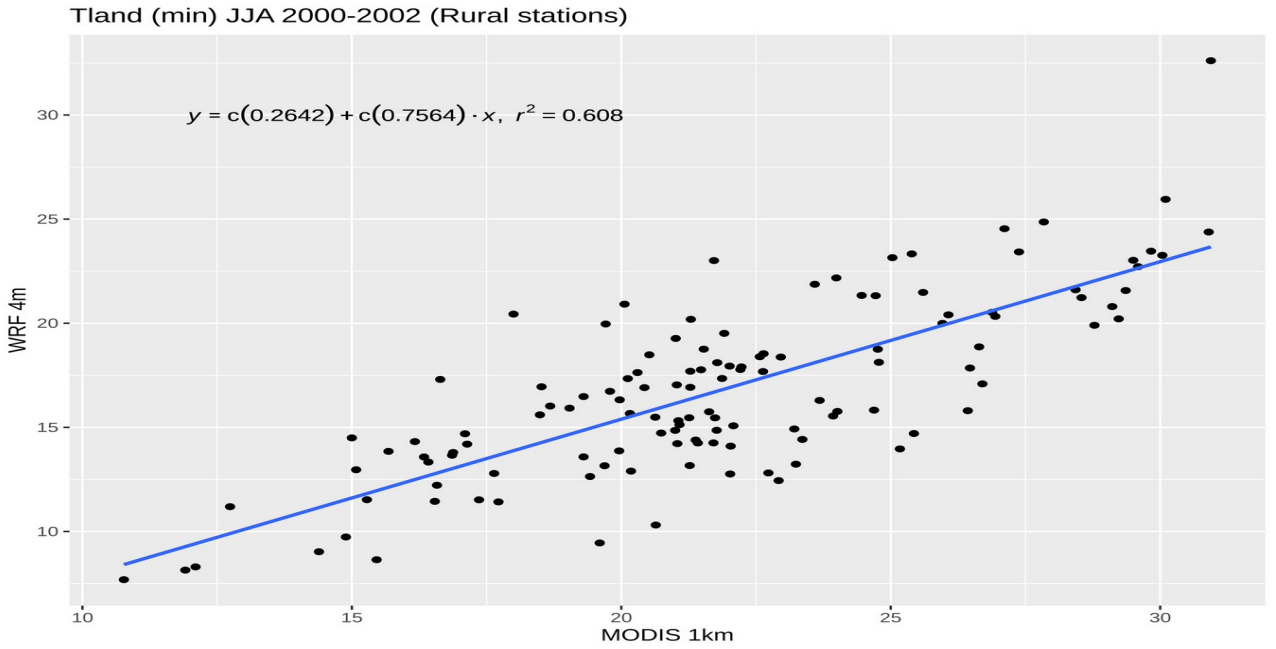

Tmin JJA 2000-2002 (Rural stations)
$y = c(0.1764) + c(0.9825) \cdot x,\ r^2 = 0.834$
WRF 16km
GSOD observations


Tmin JJA 2000-2002 (Rural stations)
$y = c(4.278) + c(0.6917) \cdot x,\ r^2 = 0.546$
WRF 4m
GSOD observations

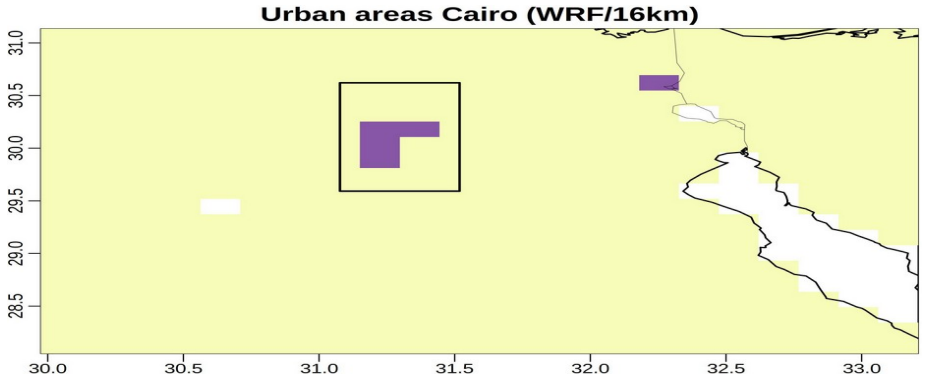

Tland (min) JJA 2000-2002 (Urban stations)
y = c(-7.659) + c(1.144) · x, r² = 0.81
WRF 16km
MODIS 1km

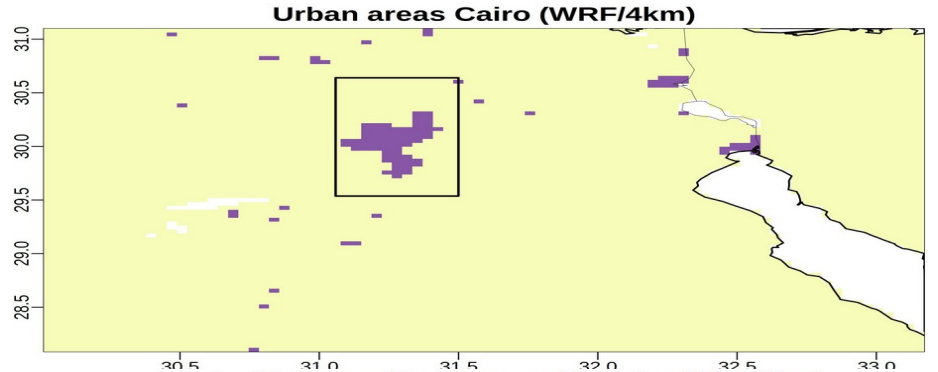

Tland (min) JJA 2000-2002 (Urban stations)
y = c(-1.395) + c(0.8181) · x, r² = 0.567
WRF 4m
MODIS 1km

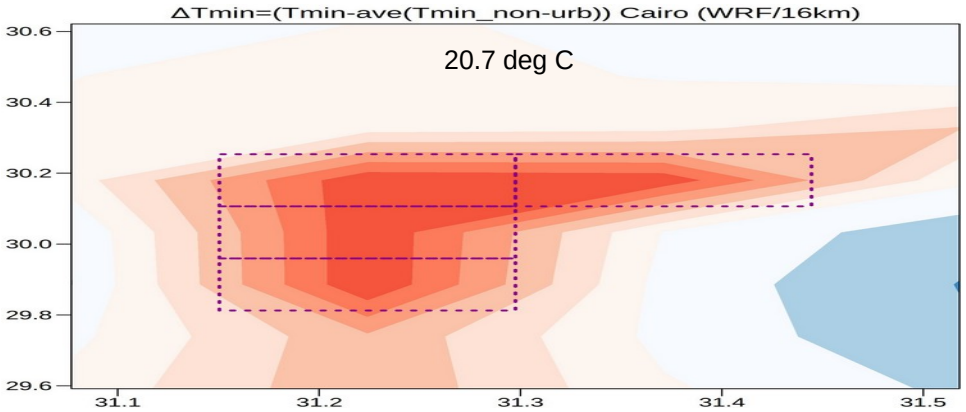

Tland (min) JJA 2000-2002 (Rural stations)
y = c(-2.918) + c(0.998) · x, r² = 0.689
WRF 16km
MODIS 1km

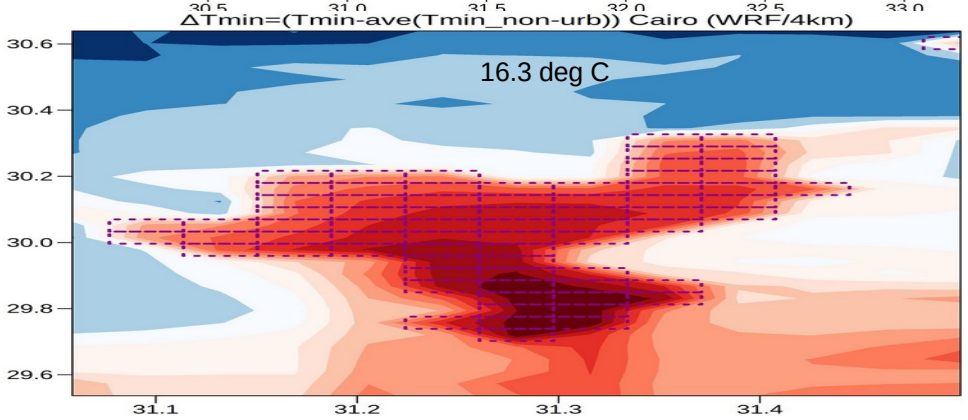

Tland (min) JJA 2000-2002 (Rural stations)
y = c(0.2642) + c(0.7564) · x, r² = 0.608
WRF 4m
MODIS 1km

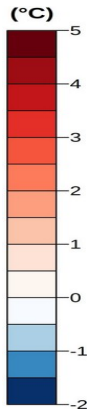
Temperature differences between urban and non-urban areas for June-July-August (JJA) 2000-2002

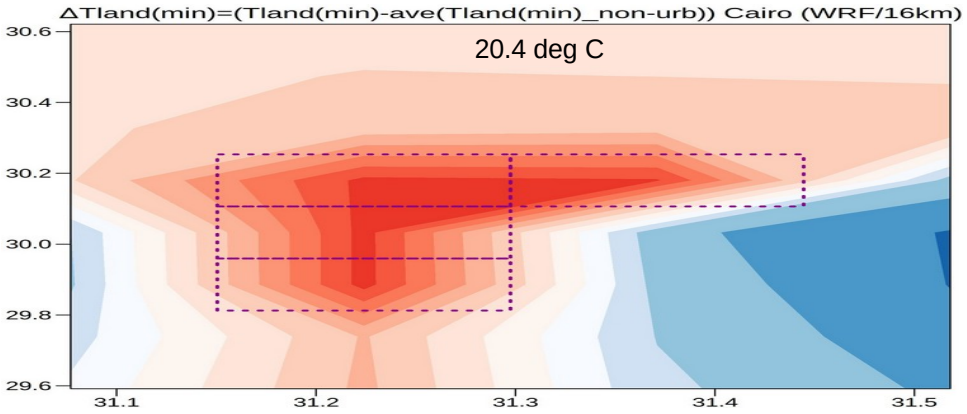


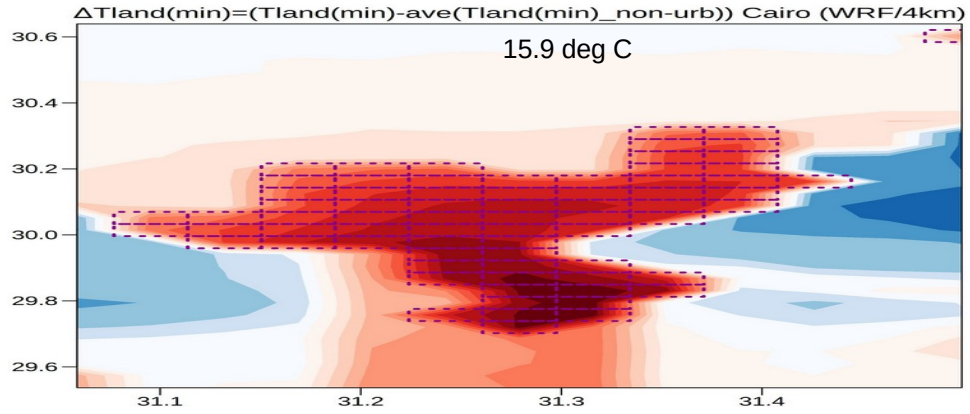


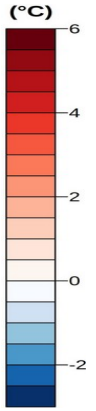












	Tair (min)		Tland (min)	
	UHI=urban-rural		UHI=urban-rural	
	WRF/16km	WRF/4km	WRF/16km	WRF/4km
Cairo	2.9	3.3	3.6	4.2
Damascus	3.1	3.8	5.6	6.3
Athens	1.8	2.6	3.1	3.8
Istanbul	2.1	2.4	2.7	3
Bursa	2.8	4.4	4.4	6.2
Baghdad	4.5	4.3	6.6	6.7
Tehran	4.5	5.2	7.1	8.2
Isfahan	3.9	3.6	7.4	7.5
Kuwait	4.8	3.9	7.8	7.2
Riyadh	3.5	3.1	7	7.4
Medina	2.6	3	4.8	6.2

Generally for all 11 cities:

- Both air and land Tmin have a positive calaculated UHI

- UHI calculated using Tland (min) gets higher values than UHI(Tair(min))

UHI = Urban Heat Island

Summary & Conclusions

- The effect of horizontal resolution and bulk urban parametrization on simulated air and land temperature over the EMME region and specifically over 11 cities of the region is studied.

- Comparison of the simulated minimum Tair and Tland (WRF/16 and WRF/4) is performed for summer averages (2000-2002) against ERA5-Land reanalysis, GSOD stations and MODIS/1km satellite observations.
- ==> Higher resolution simulation under estimates both minimum air and land temperatures over coastal areas independently of the urban and rural characterization

- The urban signature is more obvious when looking at the higher resolution results over different cities of the domain

- Both air and land Tmin have a positive calculated UHI

- Tland(min) get higher values of UHI than Tair(min)

Thank you
for your attention!!

CELSIUS

Projecting temperature extremes

CELSIUS is funded by the European Regional Development Fund
and the Republic of Cyprus through the Research Innovation Foundation
(RIF, Project: EXCELLENCE/1216/0039)

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This project has received funding
from the European Union's Horizon 2020 research
and innovation programme under grant agreement
No. 856612 and the Cyprus Government

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