Ground-truth of a 1-km downscaled NLDAS air temperature product using the York City Community Air Survey

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Motivation

- The frequency of extreme heat days has risen with the increase of anthropogenic global warming.
- Public health decision making and messaging depend on reliable air temperature data.
- In an urban public health context currently available data lack sufficient spatial resolution.
- Prior ground-truthing has not been done for a downscaled NLDAS (North American Land Data Assimilation System) dataset or for air temperature in a highly variable urban landscape such as NYC.

Data sources

The New York City Community Air Survey (NYCCAS): Air temperature records

NYCCAS has the most comprehensive geographic coverage of any urban air monitoring network in the U.S. with 150 monitors in a 790 square kilometer area (Matte et al., 2013).

NLDAS meteorological re-analysis 1x1 km² downscaled temperature data

- Historical NLDAS land-surface model temperature data derived from the National Centers for Environmental Prediction (NCEP) NARR (Al-Hamdan et al., 2014; Mesinger, 2006; NOAA/ U.S., 2005, Cosgrove et al., 2003).

- 12x12 km² NLDAS dataset (Al-Hamdan et al., 2014) downscaled to 1x1 km² daily maximum/ minimum air temperature using 1 km Moderate Resolution Imaging Spectroradiometer (MODIS) Land Surface Temperature (LST) (Crosson and Al-Hamdan, 2014).

    - LST grids created previous 8-day composite MODIS LST products
    - Calculated NLDAS air temperature standard deviation for geographic 'neighborhood'
    - Normalized departure for 3x3 grid cells in Version 1, 5x5 in Version 2

- Version 2 improved the slope slightly and decreased the error for 2009 and 2010 comparisons.
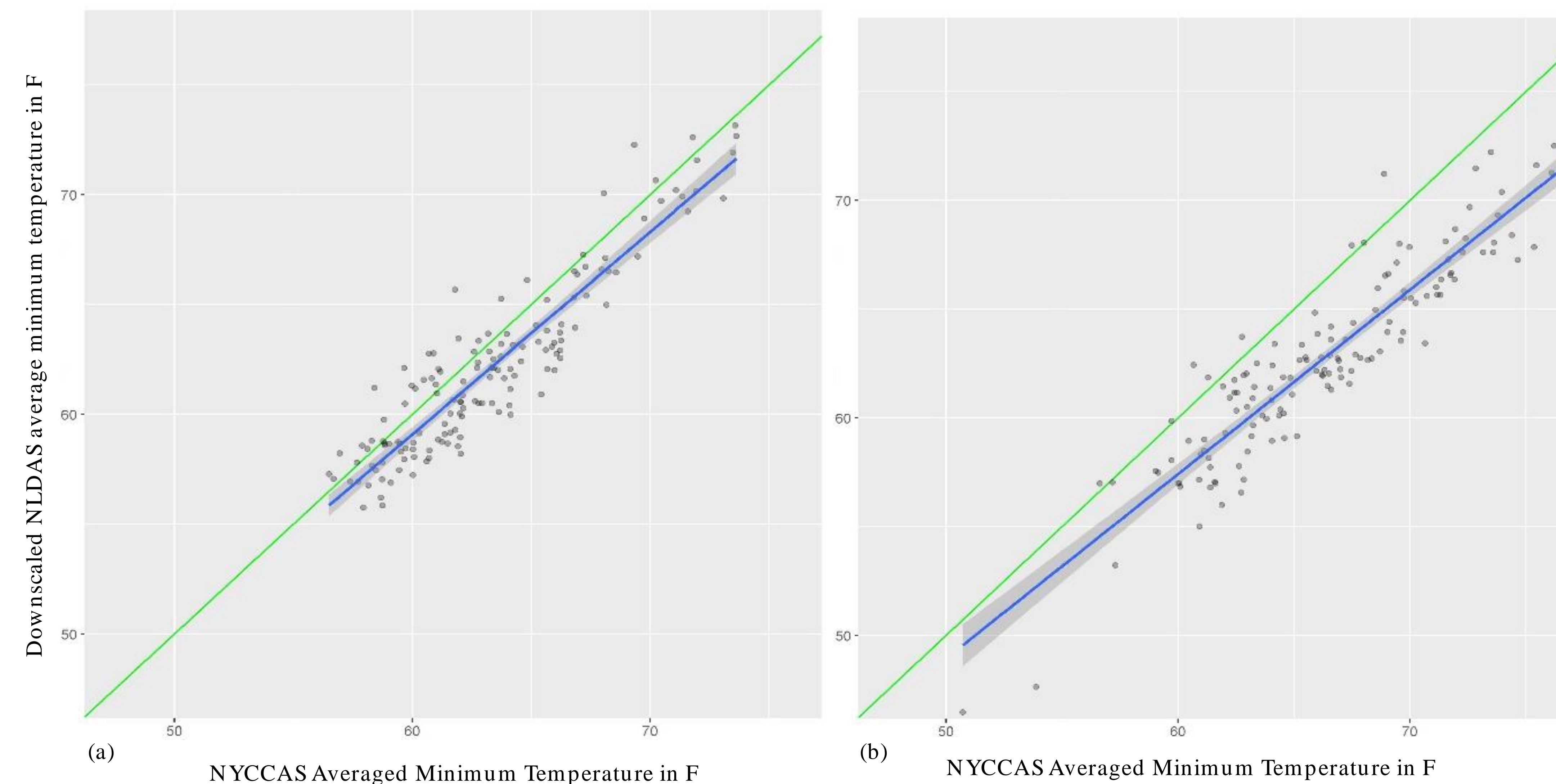
Downscaled NLDAS-NYCCAS minimum temperature comparisons

(a)   NYCCAS Averaged Minimum Temperature in F
(b)   NYCCAS Averaged Minimum Temperature in F

Fig. 1. Scatterplots of (a) 2009 NYCCAS vs NLDAS downscaled 1-km averaged daily minimum values for Version 2 (5x5 kernel) and (b) for 2010. The blue line shows values fitted to a linear model; gray shading show the 95% confidence interval limits.

- NYCCAS measured warmer temperatures on average than downscaled NLDAS
- Best agreement at lower temperatures

(a)   Longitude
(b)   Longitude

Fig.2. NYCCAS-NLDAS 1-km downscaled average minimum temperature differences for the Version 2 (5x5 kernel) for 2009 (a) and 2010 (b)

- NYCCAS measured warmer temperatures on average than downscaled NLDAS

Average Temperature Differences in °F

Fig. 3. Surface Normalized Difference Vegetation Index, NYC borders added. (NASA EOSDIS, 2017) (a). Scatterplot of NYCCAS-downscaled NLDAS temperature difference and NDVI, averaged within a 300 meter buffer (b). The blue line shows values fitted to a linear model; gray shading show the 95% confidence interval limits.

- Inverse relationship between temperature differences and NDVI

Summary statistics

	Version	r	R2	RMSE	Mean Abs Error	Slope
2009	1	0.91	0.83	2.37	2.02	0.88
2009	2	0.92	0.85	1.96	1.67	0.92
2010	1	0.92	0.85	4.57	4.18	0.82
2010	2	0.92	0.85	4.04	3.65	0.85
2009 12-km		0.22	0.05	1.93	1.75	-0.11
2010 12-km		0.12	0.01	3.92	3.5	0.06

Table 1. Summary statistics showing correlation coefficients, coefficient of determination, root-mean square error, mean absolute error, and slope for daily minimum comparisons. All numbers are for the 1 km downscaled model averaged centroids except for those labeled 12 km.
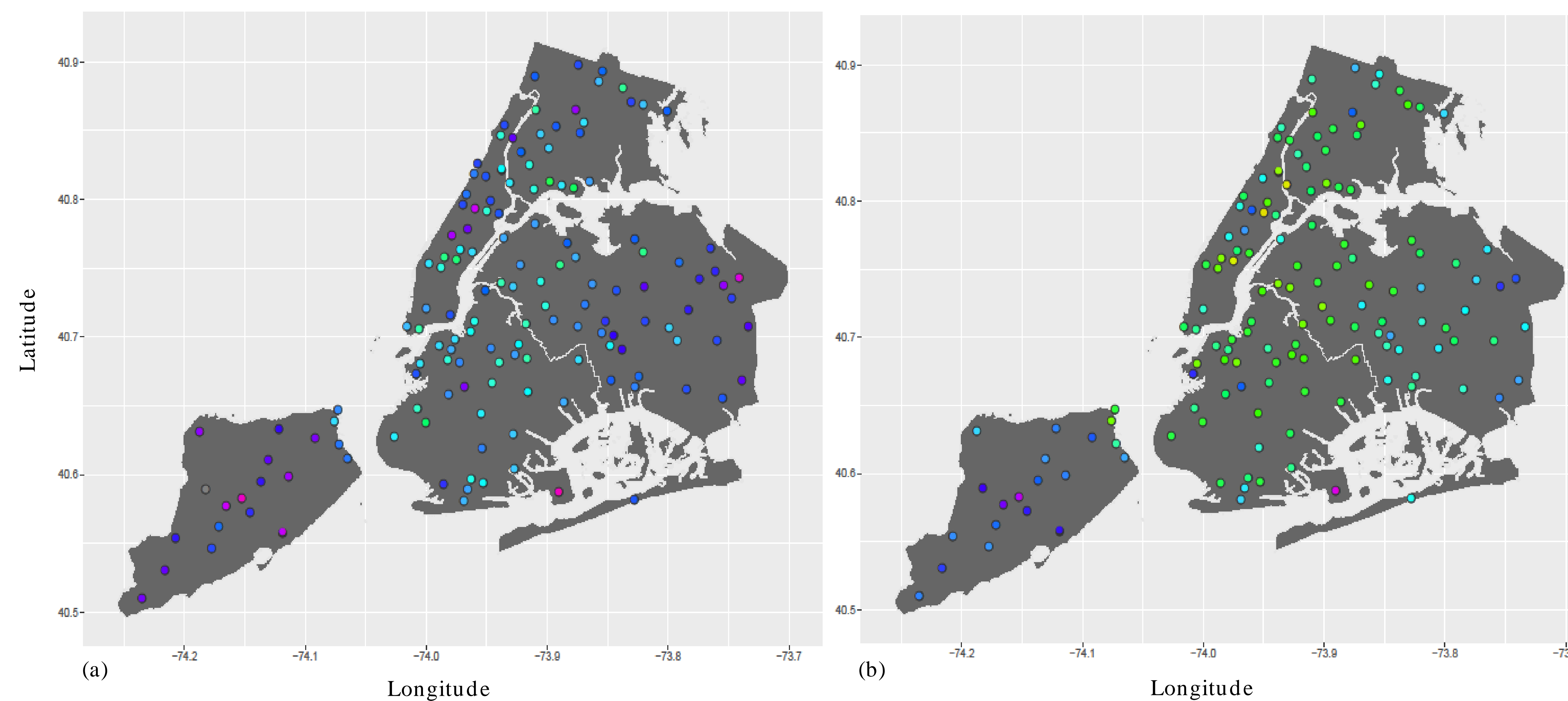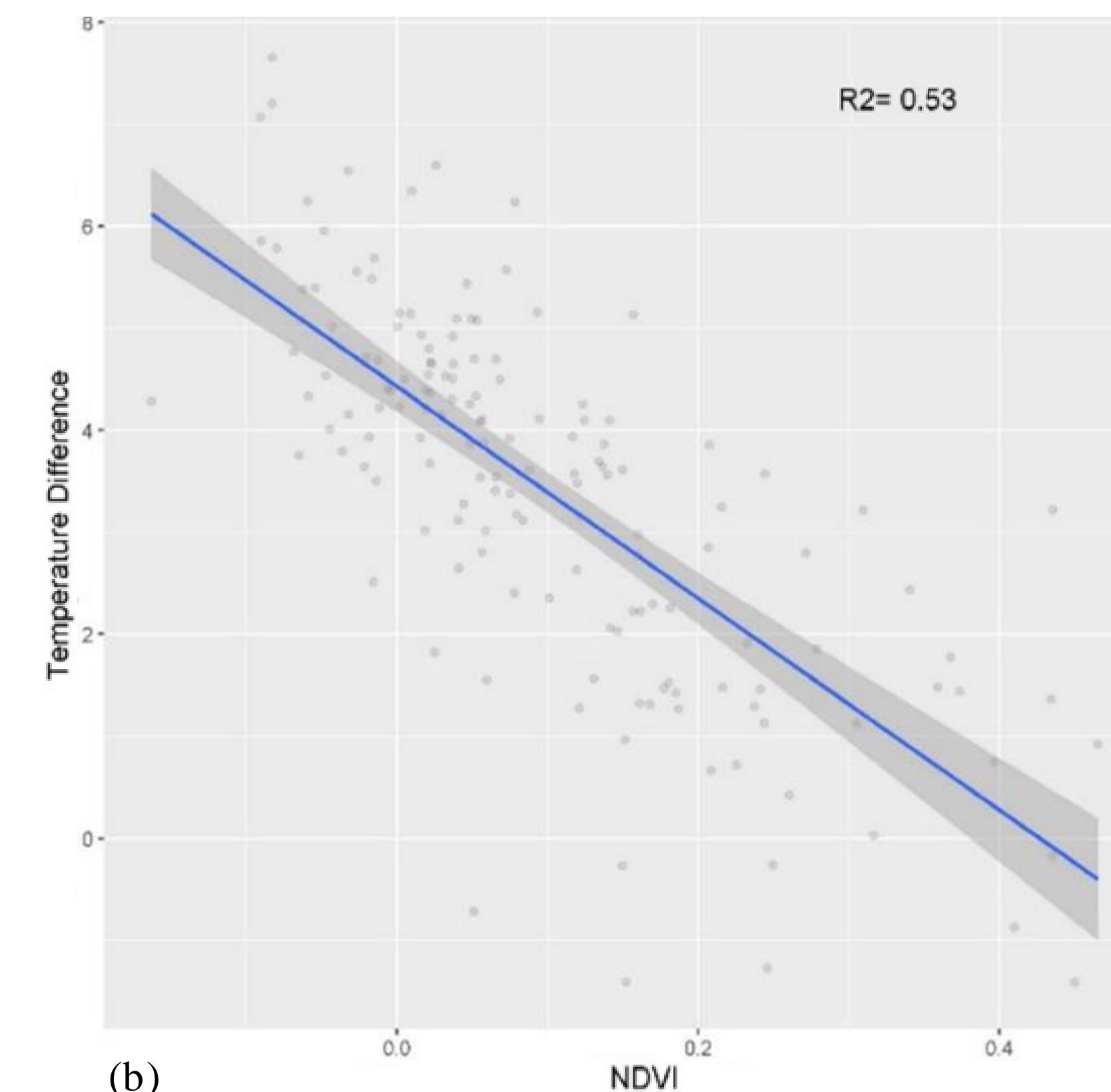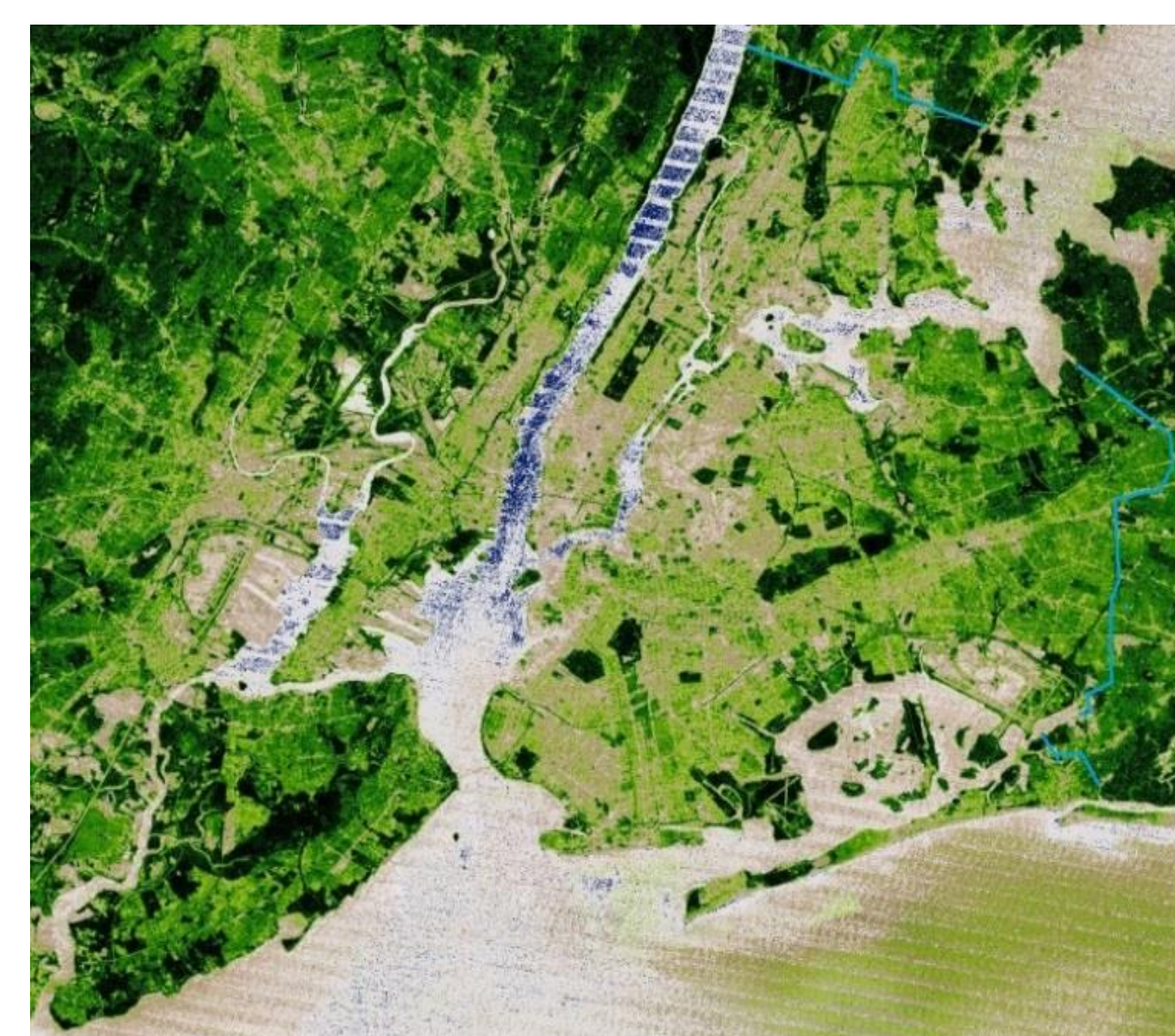
Summary and conclusions

- Strong improvement of the downscaled NLDAS model in capturing the spatial variability of temperature across NYC neighborhoods over the native 12 km resolution.
- Very good overall agreement between downscaled NLDAS modeled minimum temperatures with NYCCAS ground station measurements.
- NYCCAS measured warmer temperatures on average than the downscaled NLDAS temperatures, with the best agreement in cases of lower average minimum temperatures and lower vegetative cover.
- The higher resolution is needed for coastal urban applications
- Allows for discernment of neighborhood level differences in temperature and areas with heterogeneous land cover.
- The nationwide dataset will be available at the Centers for Disease Control and Prevention (CDC) Environmental Public Health Tracking Network.

Acknowledgements and references

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