Heat risk assessment using surrogate model for meso-scale surface temperature

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NEURAL INFORMATION PROCESSING SYSTEMS

Why is forecasting temperature important?

Extreme heat is a risk for urban areas

Surface temperature has remarkable influence on:

- Human health
- Energy consumption
- Water resource
- Lost productivity

Cities are vulnerable places to extreme temperature because of:

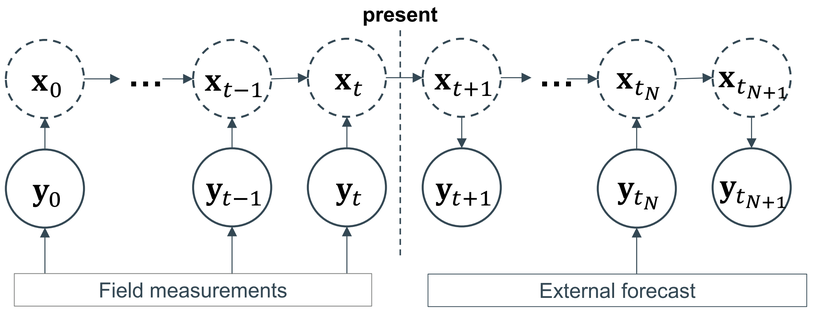
- High population
- Urban heat island (UHI)
- Climate change

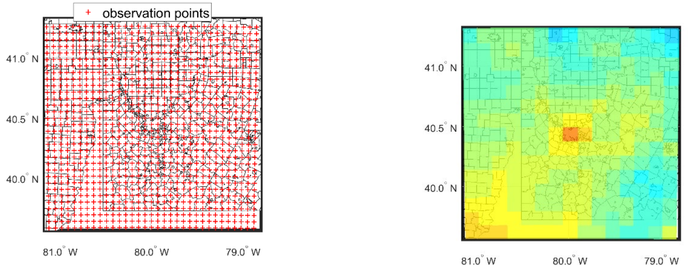
Spatio-temporal surrogate model for meso-scale surface temperature

Surrogate model infers surface temperature

We propose a surrogate model to forecast the meso-scale surface temperature in an urban area at a relatively low computational cost, as an alternative to widely-utilized but computationally intensive Numerical Weather Prediction (NWP) models.

Having hierarchical structure, the proposed model forecasts surface temperature field as a probabilistic inference from the given inputs: field measurement and external forecasting system.

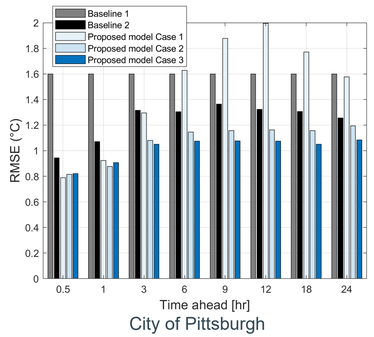




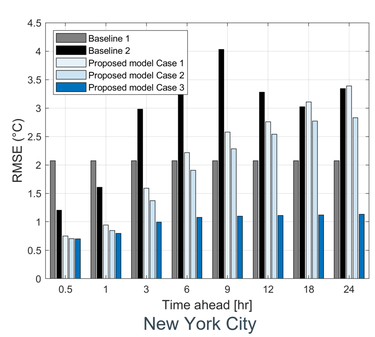
Temperature forecast using the surrogate model

Surrogate model enables convenient risk assessment

Model validation

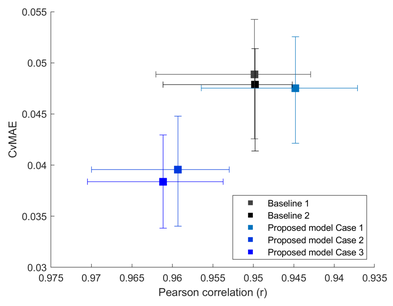


City of Pittsburgh

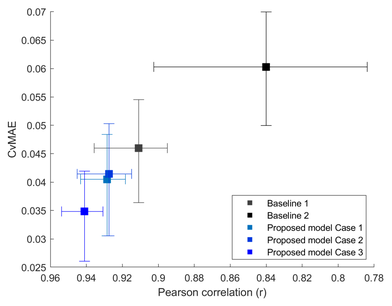


New York City

After calibrating the model with data from two urban areas, New York City and City of Pittsburgh, we validate the model by assessing the model's prediction performance under various model-use cases. The model assessment is conducted using three error metrics: root-mean squared error (RMSE), the coefficient of variation in the mean absolute error (CvMAE), and Pearson correlation coefficient (r).



City of Pittsburgh

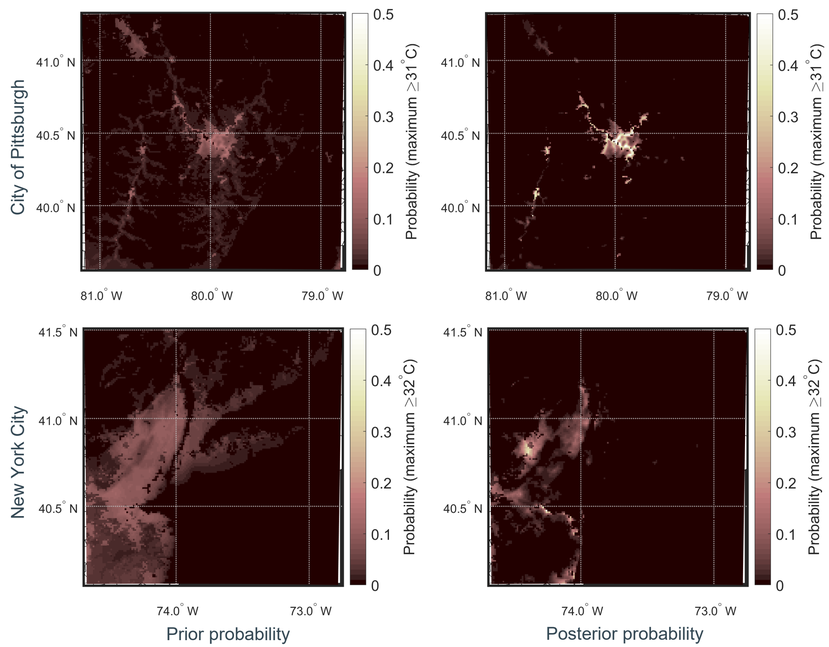


New York City

Summary of model-use cases

	Field measurement		External forecast	
	Grid spacing	Time interval	Zonal scale	Time interval
Case 1	6km	30min	-	-
Case 2	6km	30min	Domain size	6hourly
Case 3	6km	30min	12km×12km	6hourly
Baseline 1	12km×12km	6hourly	12km×12km	6hourly
Baseline 2	6km (<10km)	Up to 24hours	12km×12km	6hourly

Test period: Aug 02-03, 2020

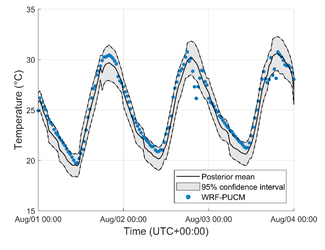


Prior probability

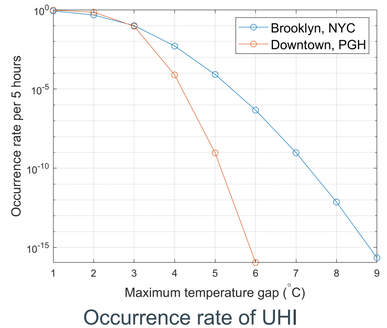
Posterior probability

Heat-risk assessment

we integrate the developed model into a probabilistic risk analysis framework to estimate extreme temperature distribution around these cities. In doing so, we expand the model's applicability, providing insights on the future risk and enabling various other statistical inferences.



3hrs-ahead prediction (Pittsburgh)



Occurrence rate of UHI

References

Malings,C., Pozzi,M., Klima,K., Bou-Zeid,E., Ramamurthy,P., Bergés,M. "Surface Heat Assessment for Developed Environments: Probabilistic Urban Temperature Modeling", Computers, Environment and Urban Systems 66:53-64., Elsevier, 2017

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