IBPSA USA SimBuild

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Weather forecast uncertainty

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R2M RESEARCH TO MARKET SOLUTION

Objective

Develop a **weather forecast uncertainty emulator** to be implemented as part of BOPTEST.

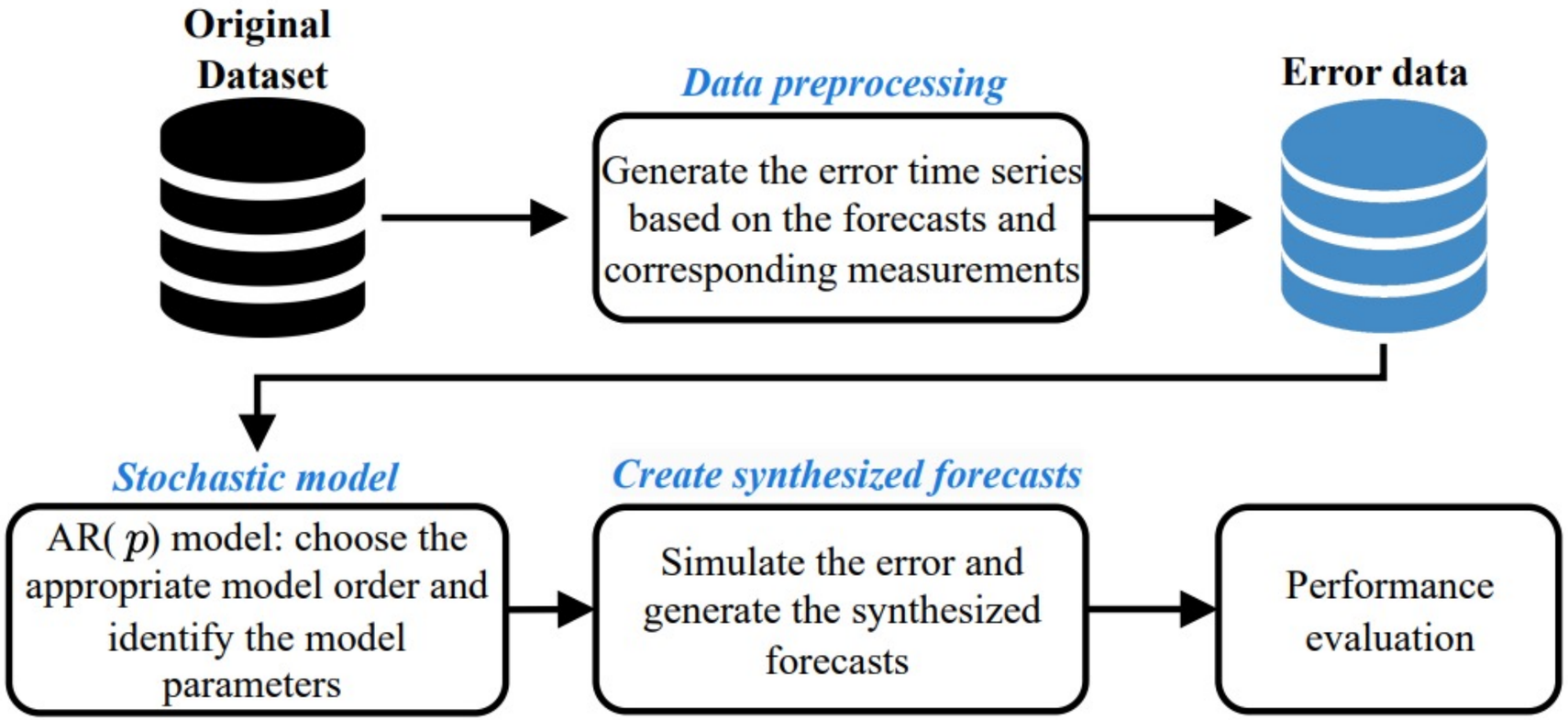
BOPTEST test cases → real weather data (TMY data) → add an error to emulate real forecasts for weather variables.

Focus: outdoor temperature and solar radiation.

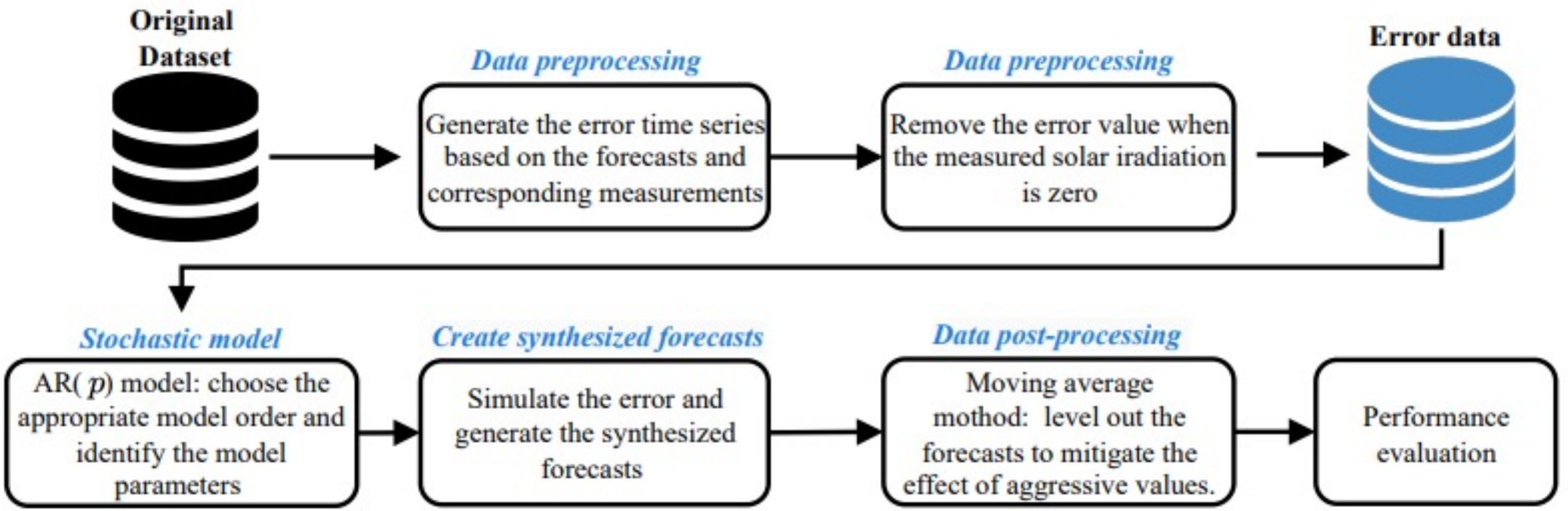
Weather dataset analysis

- **Berkeley (USA)** from LBNL. Predictions updated every hour, and 48h forecast. Forecast data is obtained from the DarkSky API. The historic data is collected from a weather station on LBNL's campus (MESOWEST STATION INTERFACE (utah.edu)). •
- **Oslo (Norway)** – provided by SINTEF. Predictions updated every hour, and 60h forecast. Data available at the site of Norwegian Meteorological Institute. Historic predictions: http://thredds.met.no/thredds/metno.html. Real measurements: Frost API (met.no).
- **Leuven (Belgium)** – provided by KU Leuven. Predictions updated every 6 hours, and 48h predictions. Climatic data were collected at the Vliet Building in Leuven operated by the Building Physics Section of the KU Leuven. Forecasts purchased at OpenWeather service (https://openweathermap.org/).
- **Berlin (Germany)** – provided by RWTH Aachen. Predictions updated every hour, and 48h predictions.
- **Milan (Italy)** – provided by Politecnico de Milano. Predictions updated once a day, and 72h forecast. Provided by the regional office of weather data. Data for four different locations, and in some of them two different prediction models are used, so we have a total of 7 combinations.

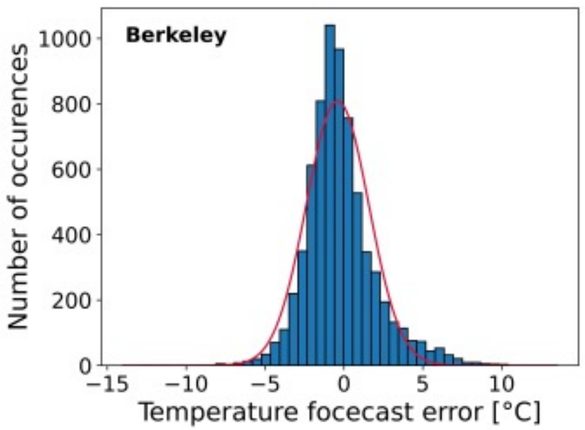
Workflow: outdoor temperature

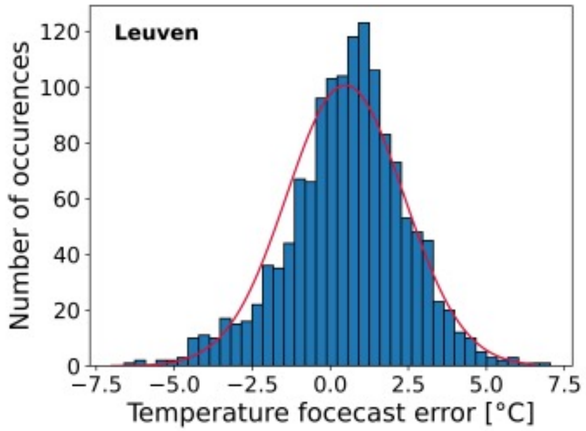


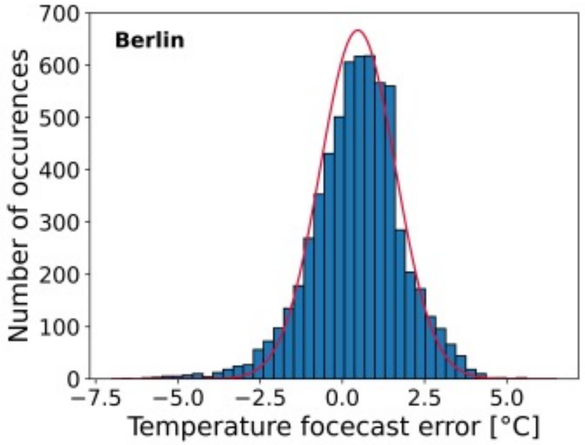
Workflow: solar radiation

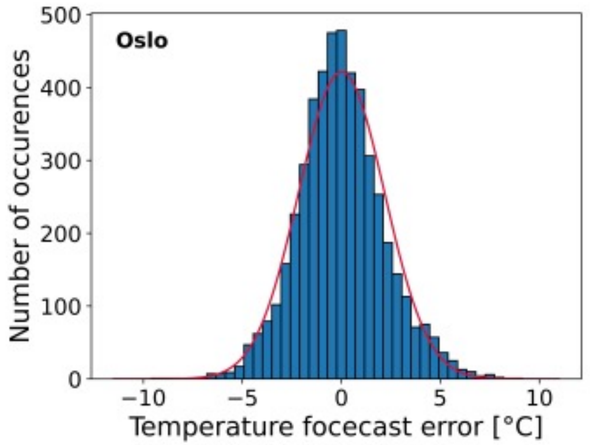


Outdoor temperature error: histograms



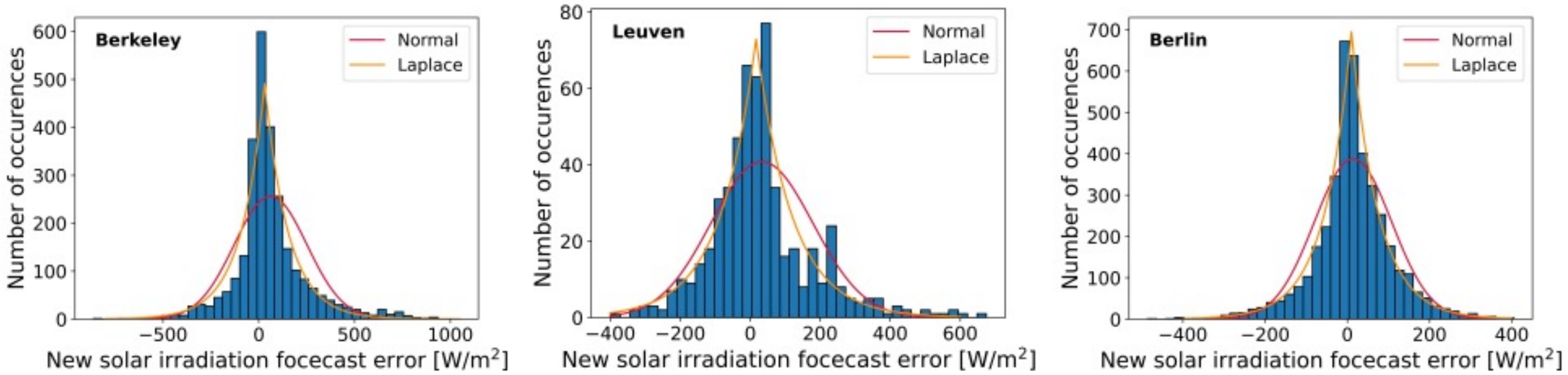






The error in the temperature matches a **normal distribution**

Solar radiation error: histograms



The error in the solar radiation matches a
Laplace distribution

Temperature error model

The absolute error in the temperature is

$$e_k = X_k - \widetilde{X_k}$$

X_k: historical data

$\widetilde{X_k}$: prediction

	Proposed model
Model	$e_{k+1} = F e_k + K w_k$
Parameters	$\boldsymbol{F}$
	$\mathbf{K}$
Variance	$w_k \sim \mathrm{N}(0,1)$

- The initial error is defined by a normal distribution

$$e_1 = \boldsymbol{F_0} + \boldsymbol{K_0} w_k$$

Solar radiation error model

The absolute error in the temperature is

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X_k: historical data

$\widetilde{X_k}$: prediction

	Proposed model
Model	$e_{k+1} = F e_k + K w_k$
Parameters	$\boldsymbol{F}$
	$\mathbf{K}$
Variance	$w_k \sim \mathcal{L}(0,1)$

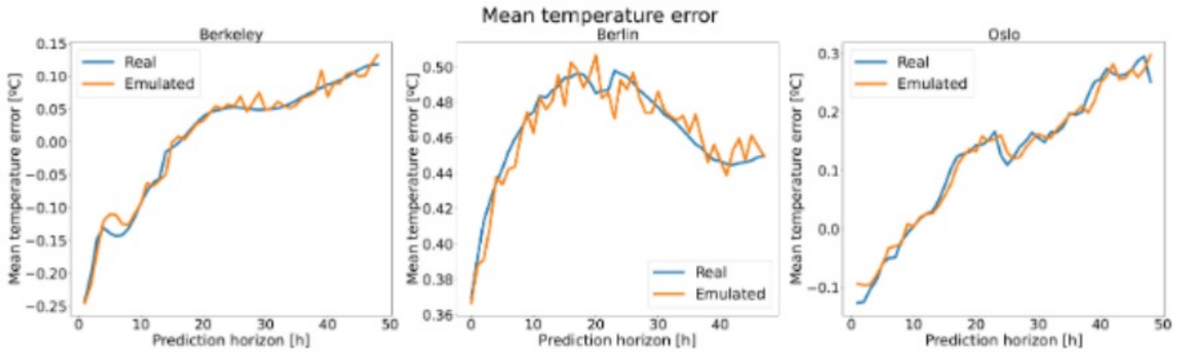
- The initial error is defined by a Laplace distribution

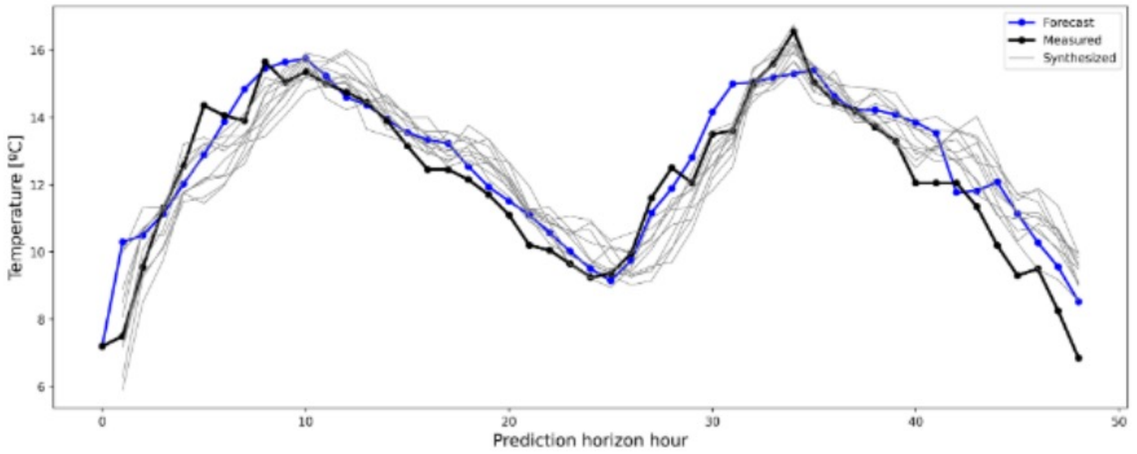
$$e_1 = \boldsymbol{F_0} + \boldsymbol{K_0} w_k$$

Validation of the models

Comparison between the synthetic generated forecast and the historic forecasts based on statistical parameters.

Publication sent to Journal.





Uncertainty scenarios definition

4 scenarios of uncertainty are considered for the test cases:

- No uncertainty
- Low uncertainty
- Medium uncertainty
- High uncertainty

The scenarios' parameters defined based on available data.

Integration into BOPTEST

Review process ongoing.

Questions:

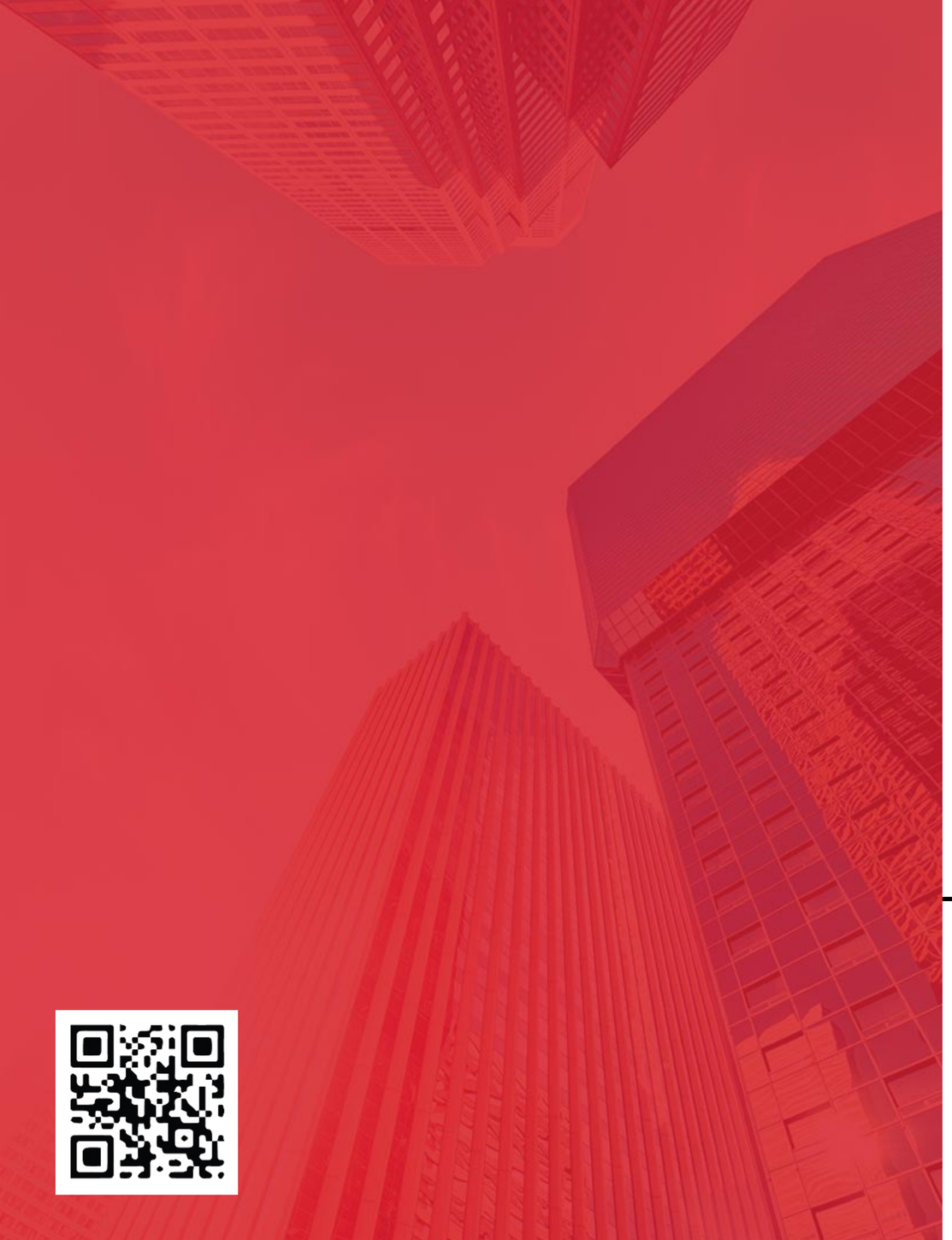
- Solar radiation is limited (not just to avoid negative values) → should we include something similar for temperatura?

Next steps

Other uncertainty sources will be considered (occupancy, measurements)

Validate with new data → any source?

Suggestions for improvement, new functionalities



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