TRANSLATING CLIMATE PROJECTIONS FOR USE IN HEAT AND HEALTH STUDIES

Keith W. Dixon

Q3: How can GFDL research and modeling be further utilized to meet NOAA stakeholder needs and enhance research partnerships to ensure GFDL's success?

NOAA GEOPHYSICAL FLUID DYNAMICS LABORATORY

Background: The GFDL Empirical Downscaling Team

- Part of GFDL's Marine Ecosystems & Downscaling Division
- Evaluate the performance characteristics of commonly used methods for refining climate predictions & projections
- Connecting to downscaling developers, applied researchers, and other stakeholders.

Background: Our Projections for Heat & Health Project

www.gfdl.noaa.gov/heat-and-health-downscaling

- Genesis at NOAA's 2019 Climate Connections meeting
- Collaborating with NOAA/CPO/NIHHIS & NOAA/NCEI/Eastern Regional Climate Services launched in 2022 (R2S)
- Co-production involving Philadelphia Office of Sustainability & Department of Health.

Source: www.climate.gov

Heat Health Emergency Declarations in Philadelphia

The Philadelphia Dept of Public Health defines Heat Health Emergencies (HHE) based on daily maximum heat index thresholds at PHL airport, the duration of the exceedance of these seasonally varying thresholds, and 10 years of hospital data.

A HHE activates a media blitz and the city's multi-faceted emergency heat programs

The Heat Index is a function of temperature and humidity. It aims to represent what the temperature feels like to the human body, assuming shady conditions with a light wind.

`e.g., T=86F (30C) & RH=72% ... Heat Index = 96.0F (35.6C)`

Stakeholder-relevant Research Questions

- How might the frequency and duration of Heat Health Emergency declarations in Philadelphia change in coming decades?
  (assuming constant criteria)

- What sorts of uncertainties exist in the heat index projections used in studies of this type?

	Timeframe	Heat Health Emergency
Short Duration Threshold (2 days)	**May 1 - June 30**	**2** consecutive days **101°F & above (≥38.5°C)**
	July 1 – Sept 30	**2** consecutive days **106°F & above (≥41°C)**
Long Duration Threshold (3+ days)	**May 1 - June 30**	**3 or more** consecutive days **98°F & above (≥36.5°C)**
	July 1 – Sept 30	**3 or more** consecutive days **103°F & above (≥39.5°C)**

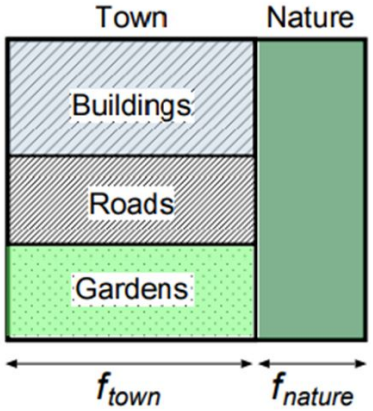
SURFEX simulations of Philadelphia

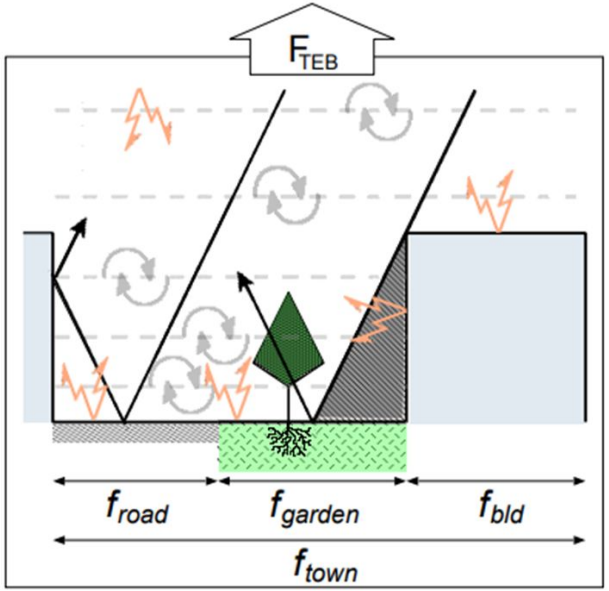
We ran simulations with the SURFEX-TEB land surface and urban canopy models.

The model has 400m horizontal resolution.

It is forced by ERA5 atmospheric data for 1991-2020.

Four 2021–2085 simulations are run using forcings developed from four CMIP6 global climate models.



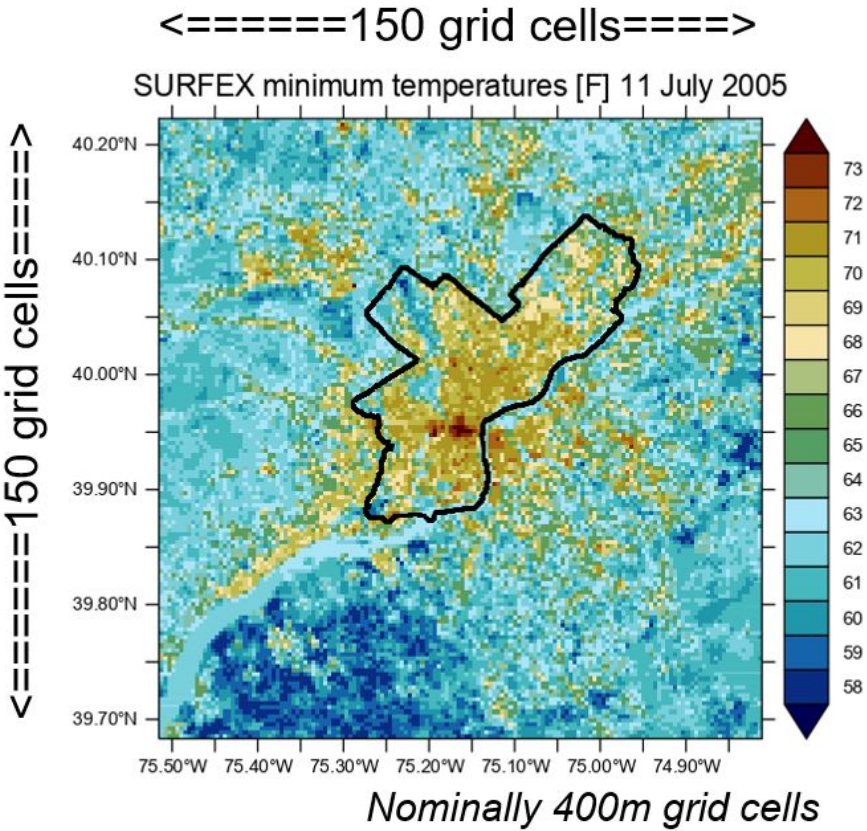


Le Roy, B., K. W. Dixon, and D. Adams-Smith, 2024: High-resolution urban climate simulations for heat and health applications in Philadelphia. *Urban Climate*.

SURFEX Model Evaluation: 1991-2020

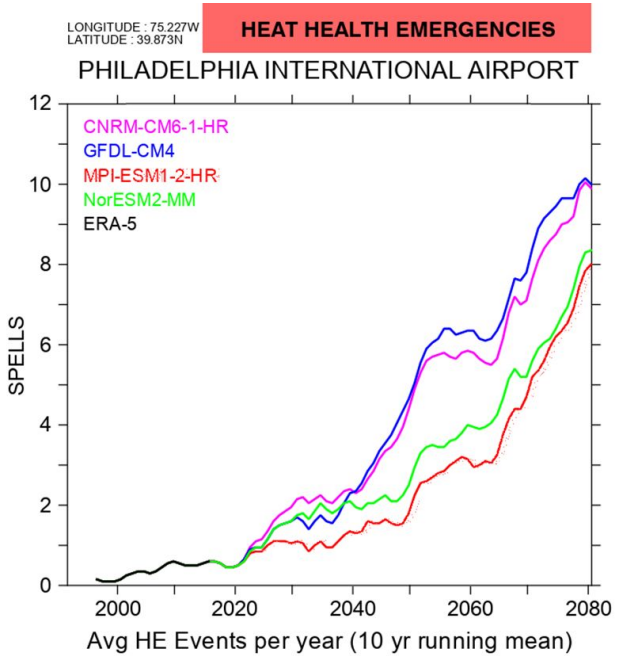
Average summer biases of only -1.0°C for daily minimum and and +0.8°C for maximum temperatures outside the city, and near zero mean bias in the city.

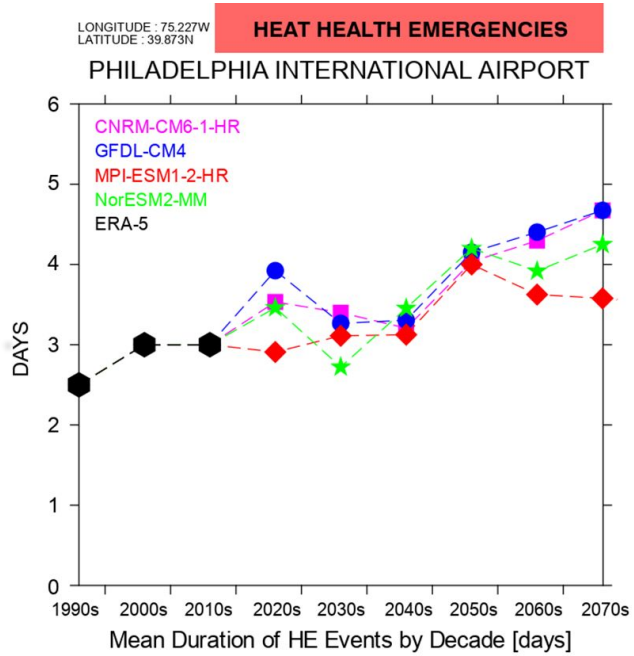
Summer daily maximum heat index values are overestimated at the airport station grid cell by ~0.6 °C, but that is well-addressed by the QDM bias correction method.



Future ssp585 Scenarios

Current avg of <1 Heat Health Emergency per year increases to ~1.5 to 2.5 by 2040 & to ~3.0 to 6.5 by 2060 in this small ensemble.





The increase in the number of Heat Emergency events is substantial.
The increase in the average length of events is more modest.

Examining other heat index projection uncertainties

The SURFEX and observed PHL airport data was available at hourly time resolution, allowing straightforward calculations of daily maximum heat index values. However, for other studies, the frequency of temperature and humidity data can be a challenge. Many models archive only daily minima and maxima.

Several published studies estimate the daily maximum heat index as

$$f(\text{tasmax}, \text{hursmin})$$

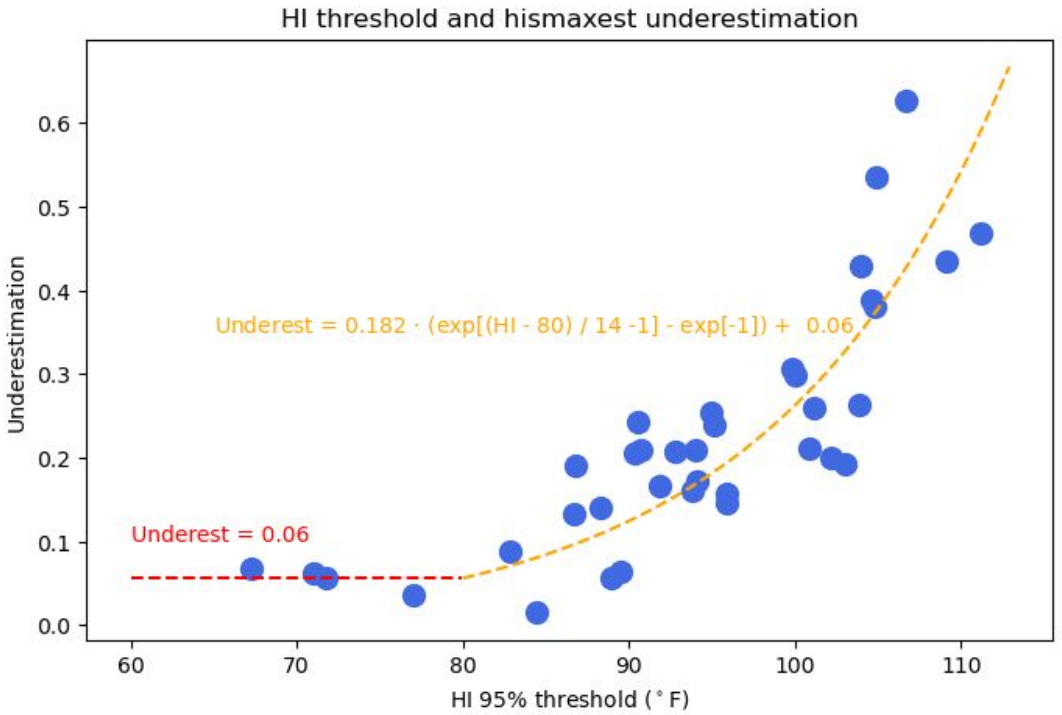
(tasmax = daily maximum temperature,
hursmin = daily minimum relative humidity)
…assuming that coincides with the afternoon maximum heat index.
The estimation can be exact or it can underestimate.

Source: www.cdc.gov/niosh/heat-stress

Uncertainties linked to estimating dailly max heat index as f (tasmax, hursmin)

Using the count of days exceeding the the 95th percentile of JJA max heat index as a diagnostic -and- Hourly observations from ~35 CONUS stations…

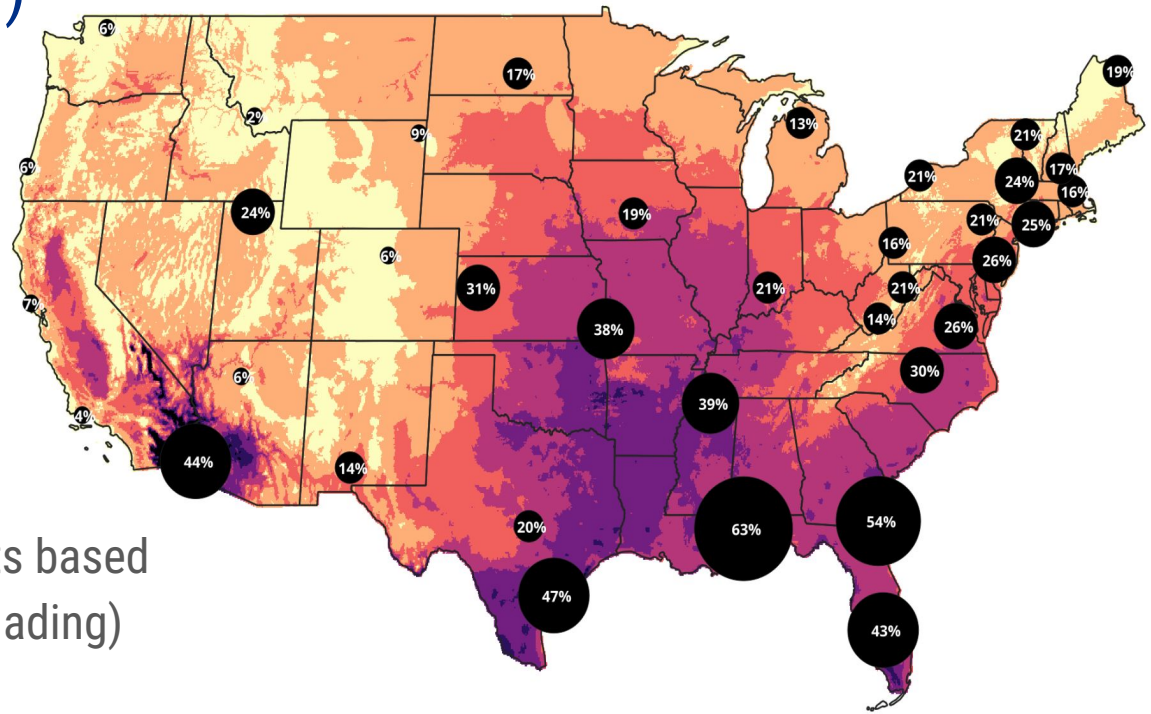
The estimation approach has larger undercounts (some >50%) at sites with higher summer heat index values.



Uncertainties linked to estimating dailly max heat index as f (tasmax, hursmin)

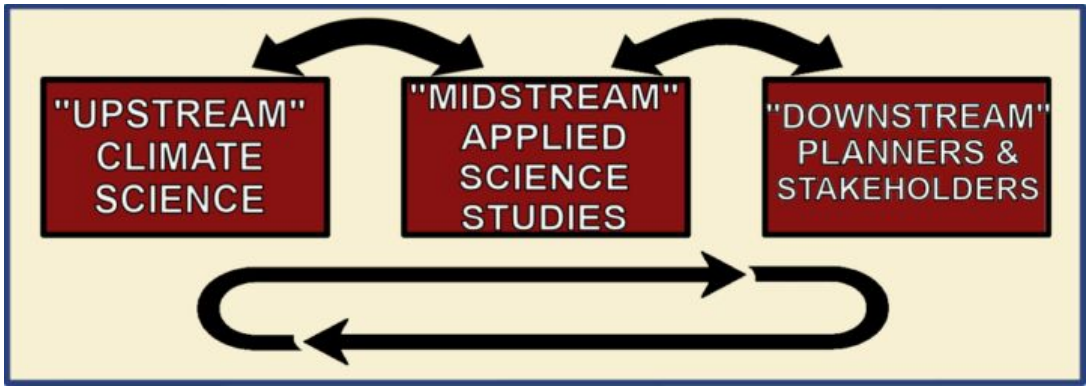
Map version of [a] station undercount info presented on previous slide (circles)

[b] estimates of undercounts based on gridMET gridded obs (shading)



Connecting GFDL Research to Enhance Research Partnerships and Address Stakeholder Needs

GFDL ESD Team efforts, including our Heat & Health work, seek to help strengthen the link between more foundational climate research results and those who use refined versions of climate model predictions and projections as input to their applied research studies.



Co-production of actionable science efforts have been facilitated by intra-NOAA collaborations & coordination. (working across silos)