National Aeronautics and Space Administration

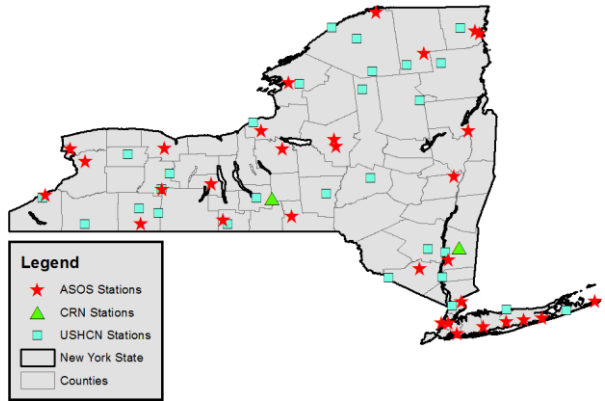# Utilizing Satellite Data for Extreme Heat Surveillance Efforts

Tabassum Insaf – New York State Department of Health
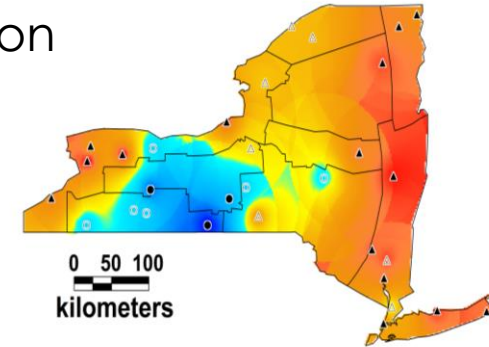
Outline

- Enhanced Exposure Assessment with Satellite Data

- Policy Relevant Public Health Research

- Outreach and Communication

Enhanced Exposure Assessment with Satellite Data

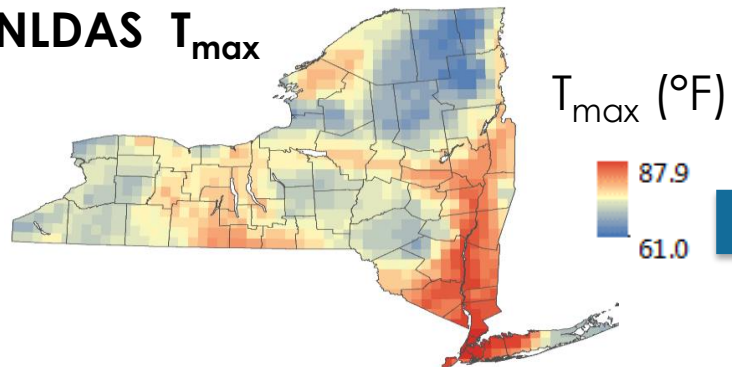Monitoring stations in New York State are sparse

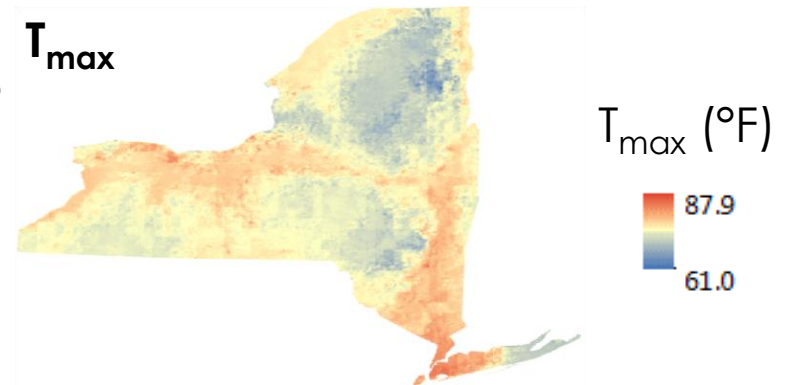Spatial extrapolation from monitor data can result in misclassification

North American Land Data Assimilation System provides uniform exposure surface for health studies

**12 Km Native NLDAS T_{max}
July 21, 2010**

T_{max} (°F)

Downscaling to a 1KM using MODIS land surface temperature improves identification of local effects

**Downscaled T_{max}
July 20, 2009**

T_{max} (°F)

Extreme Heat in New York State (NYS)

- Annual average temperatures have increased by over 2°F since 1970

- Over the next century, average summertime (June-August) temperatures in NYS are projected to increase between 3.6 to 10.8°F

- A 5°F increase in daily maximum summer temperature could double the risk of heat-related illnesses in New Yorkers

1980

Temperature Anomalies (°F)

6

-3
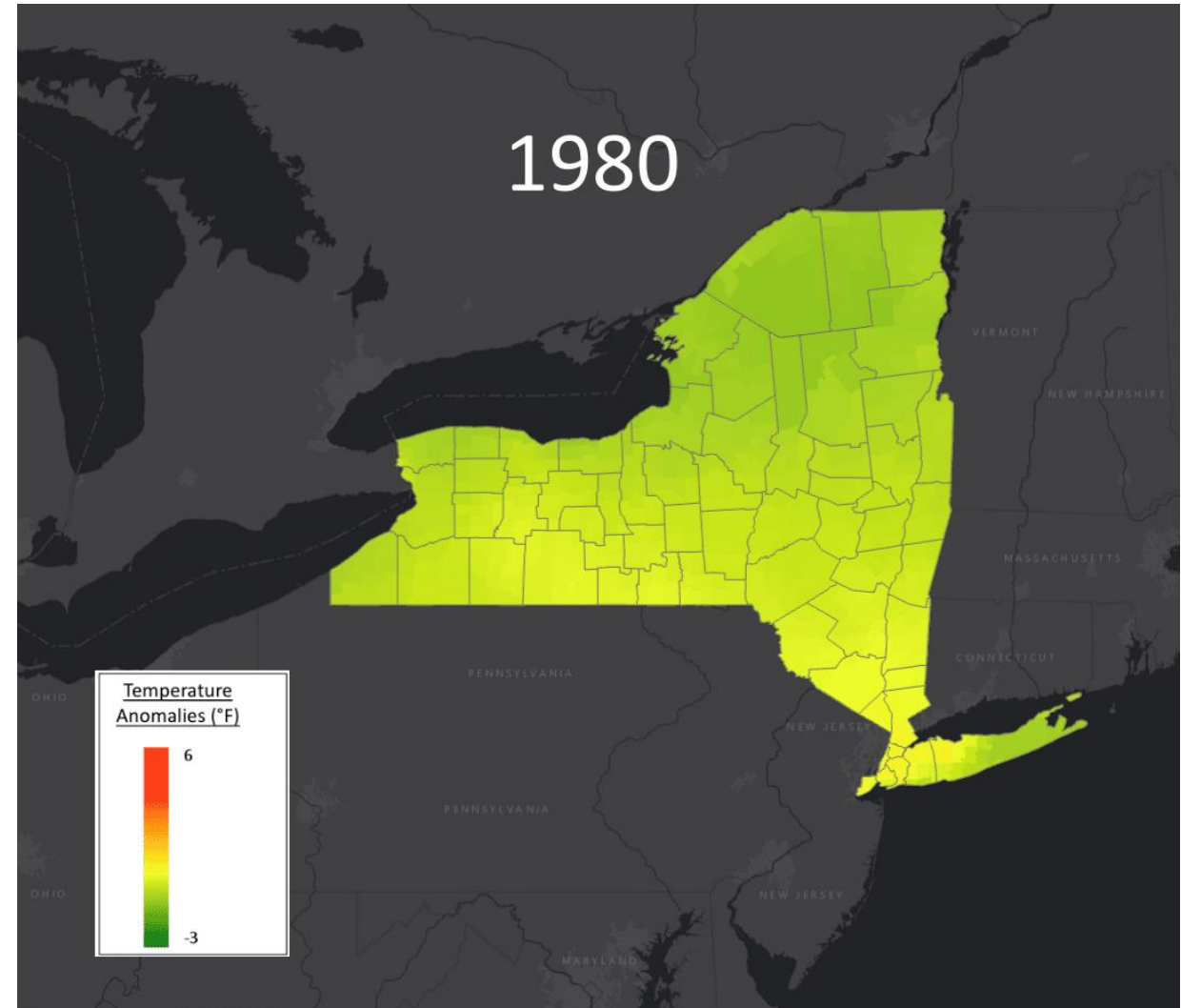
Down-Scaling NLDAS Air Temperature to MODIS Scale

Rationale

- NLDAS is a meteorological re-analysis providing hourly air temperature and other variables on a 1/8 degree (~12 km) CONUS grid for 1979-present

- The resolution is in fact coarser since NLDAS is interpolated interpolation from the 32 km North American Regional Reanalysis (NARR)

- At this resolution, small-scale features such as the Urban Heat Island and near-coastal temperature gradients are not captured

Down-Scaling NLDAS Air Temperature to MODIS Scale

Approach

- Use long-term means of MODIS Aqua LST (1:30 PM/AM local time) to capture the spatial pattern of daily max/min temperatures, and impose that spatial pattern onto NLDAS 12 km max/min air temperatures

The disaggregated daily Tmax or Tmin is given by:

$$TDIS = TLR + ZHR * \sigma LR$$

where ZHR is the standardized LST departure, given by:

$$ZHR = (THR - THR[mean])/\sigma HR$$

- THR = high-resolution (MODIS) LST, THR[mean] and σHR are the mean and standard deviation, respectively, of high-resolution (MODIS) LST over a spatial neighborhood, here set to one NLDAS grid cell (~12 km)

Improved Resolution Over New York City Using MODIS LST for Downscaling

**NLDAS native resolution temperatures in deg. C**

- < 23.1
- 23.3
- 23.4
- 23.5 - 23.7
- > 23.7
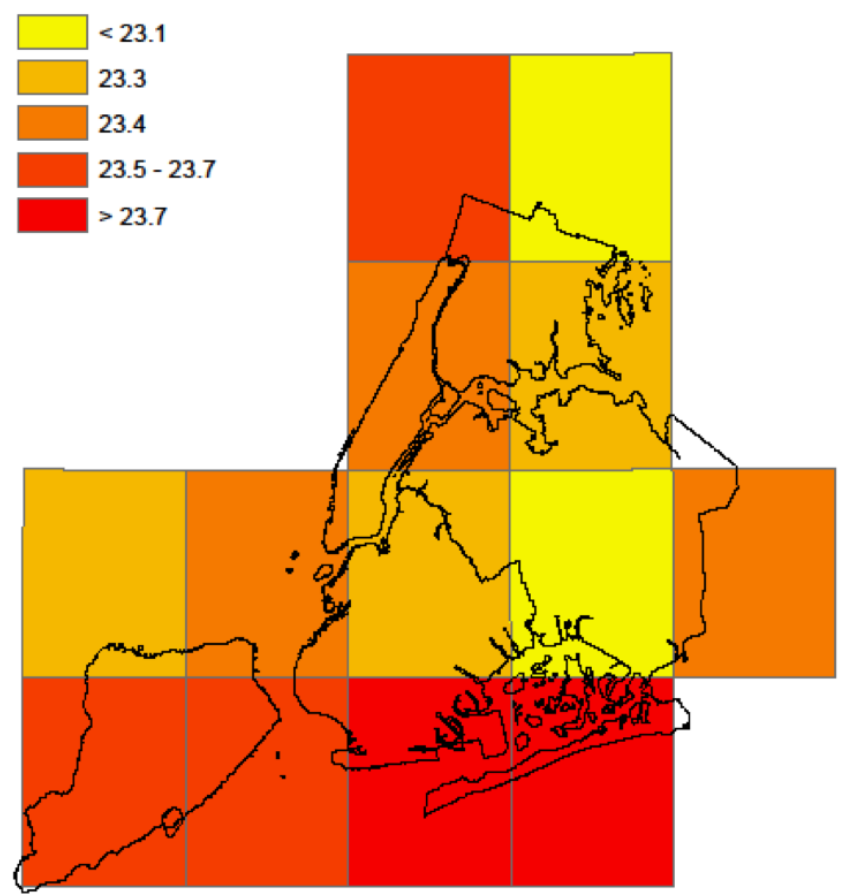
1-km downscaled NLDAS temperatures in deg. C
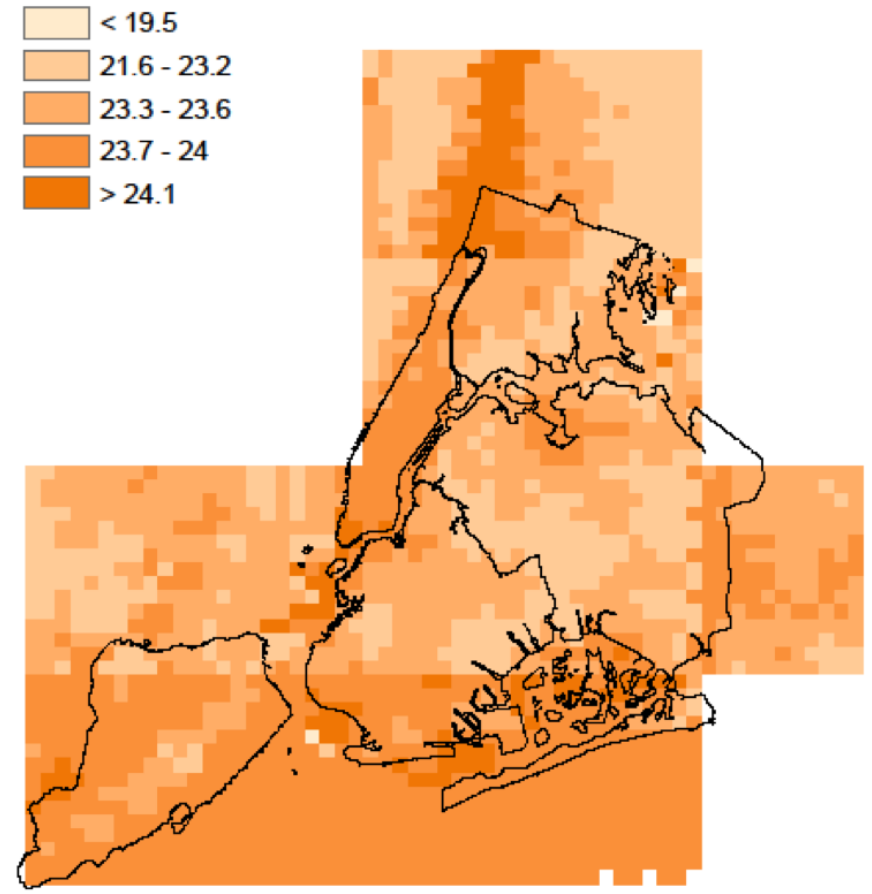
- < 19.5
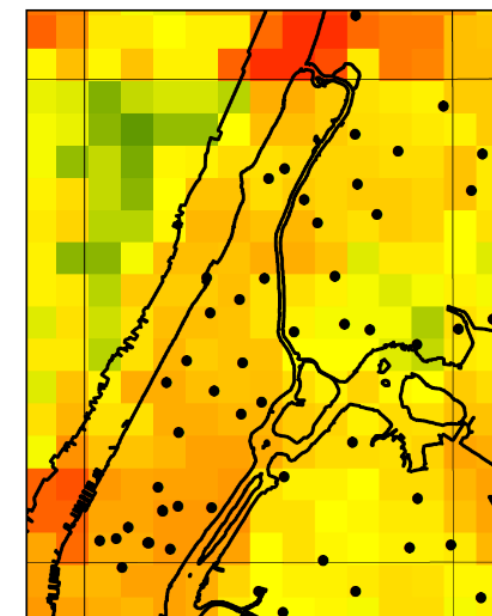- 21.6 - 23.2
- 23.3 - 23.6
- 23.7 - 24
- > 24.1

Eleizer H, Johnson S, Crosson, WL, Al-Hamdan MZ, Insaf TZ. Ground-truth of a 1 km downscaled NLDAS air temperature product using the New York City Community Air Survey. Journal of Applied Remote Sensing 13(2), 024516 (2019) https://doi.org/10.1117/1.JRS.13.024516

New York City Validation
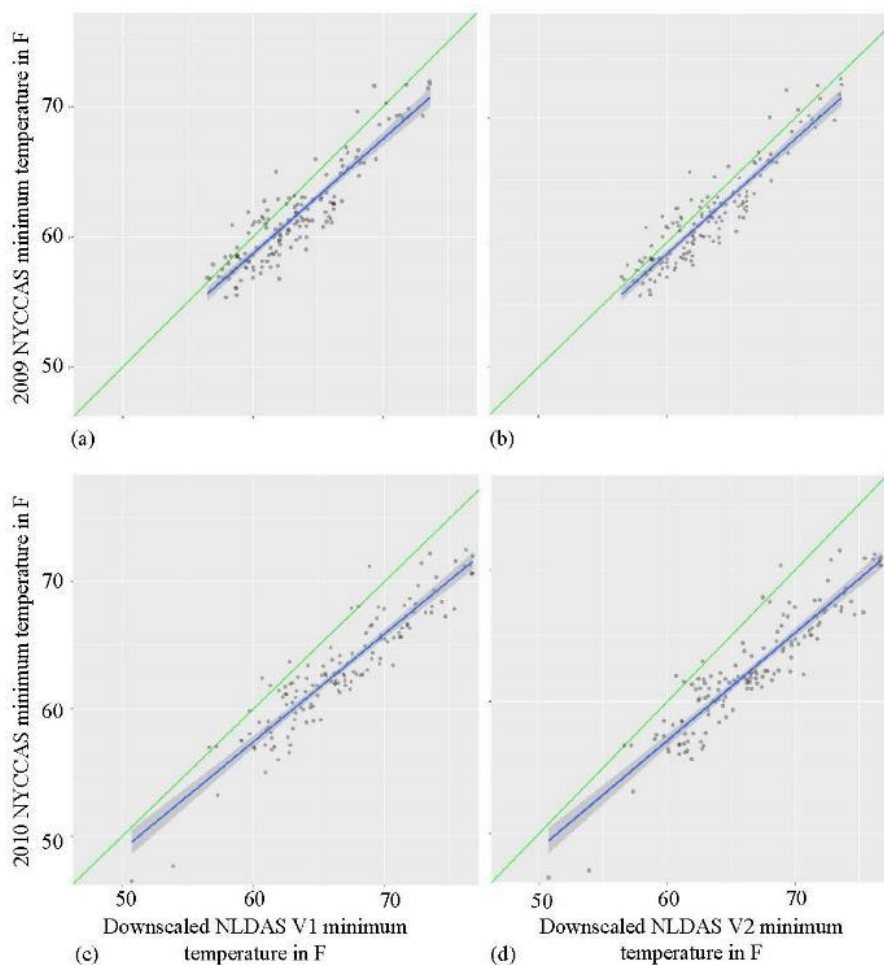
Scatterplots of (a) 2009 NYCCAS vs NLDAS down-scaled 1 km averaged values for the Version 1 model (3x3 kernel), and (b) the same for Version 2 (5x5 kernel)

Plots (c) and (d) are the same scatterplots for Versions 1 and 2 respectively for 2010. The blue line shows values fitted to a linear model; gray shading show the 95% confidence interval limits. The green line shows a 1:1 fit.


Down-scaled 1 km grid
- High temperature
- Low temperature

- NYCCAS Ground Stations
- ~12 km NLDAS grid cell
- New York City boundaries

Eleizer H, Johnson S, Crosson, WL, Al-Hamdan MZ, Insaf TZ. Ground-truth of a 1 km downscaled NLDAS air temperature product using the New York City Community Air Survey. Journal of Applied Remote Sensing 13(2), 024516 (2019) https://doi.org/10.1117/1.JRS.13.024516

Improved Resolution Over Florida's Tampa Bay Area Using MODIS LST for Downscaling

Native NLDAS

1 km Downscaled Product

°C

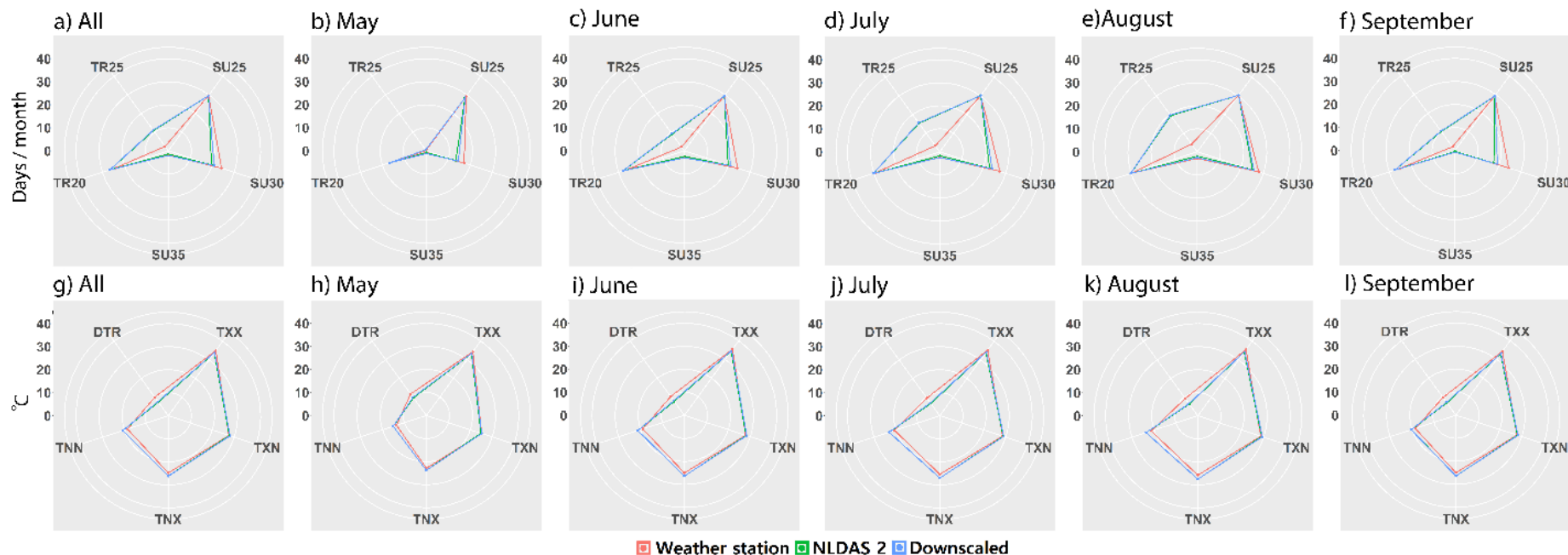|	
	24-25
	25-26
	26-27
	27-28
	28-29
	29-30
	30-31
	31-32
	32-33
	33-34
	34-35
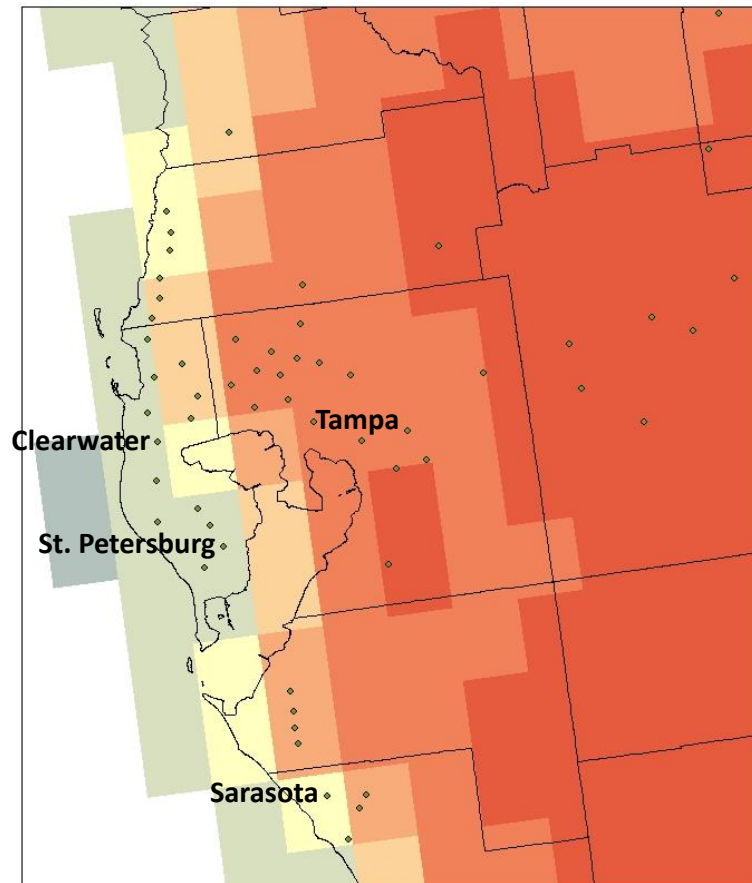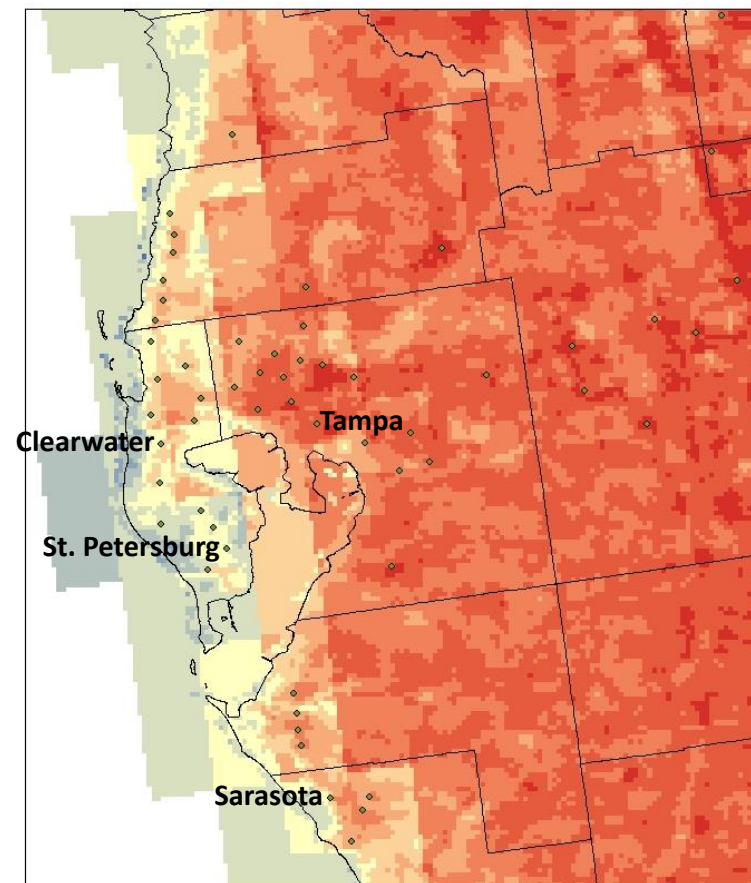
Image Credit: Bill Crosson : Universities Space Research Association

Florida Validation

Ten Indices to Compare Monthly Extremes

Image Credit: JiHoon Jung Florida State University

SU25 (30, 35): monthly count of days when maximum temperature > 25°C (30°C, 35°C); **TR20 (25)**: monthly count of days when minimum temperature > 20°C (25°C); **TXX**: monthly maximum value of daily maximum air temperature; **TXN**: Monthly minimum value of daily maximum air temperature; **TNX**: Monthly maximum value of daily minimum air temperature; **TNN**: Monthly minimum value of daily minimum air temperature; **DTR**: Daily air temperature range: monthly mean difference (TX – TN).

Policy Relevant Public Health Research

Schema for Linkage of Analytic Datasets

In Patient/Emergency Department Visit Data Points

Patient ID
ID Number**
Latitude*
Longitude*
ICD-9 Code (Primary and Other Diagnoses)
Age*
Sex*
Race*
Day of Admission*

Satellite Data (12 km grid) Polygon

Grid ID*
Latitude*
Longitude*
Daily Temperature metrics
Date (month, day, year)*

Census Data (GIS Data) Polygon

Block group number or ZIP Code*
% Pop below poverty
% Pop. less than high school level education
Other socio-economic variables

Linked Analytic Data

ID Number**
ICD-9 Code
Case or control
Same Day Exposure**
Previous Day Exposure**

Two Days Previous Exposure
Three Days Previous Exposure**
% Pop. below poverty
% Less than high school level education
Other socio-economic variables

Risk of Hospitalizations/Emergency Department Visits in NYS 2008-2012
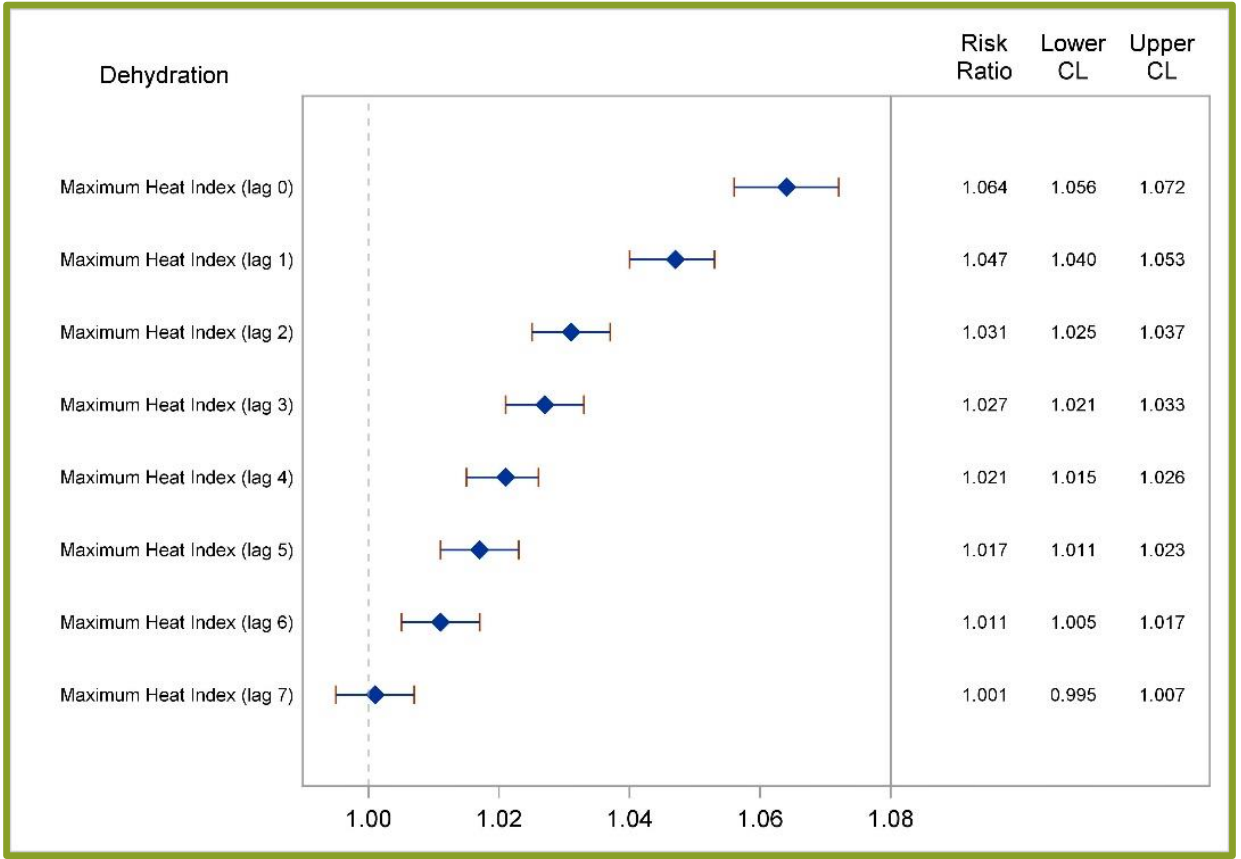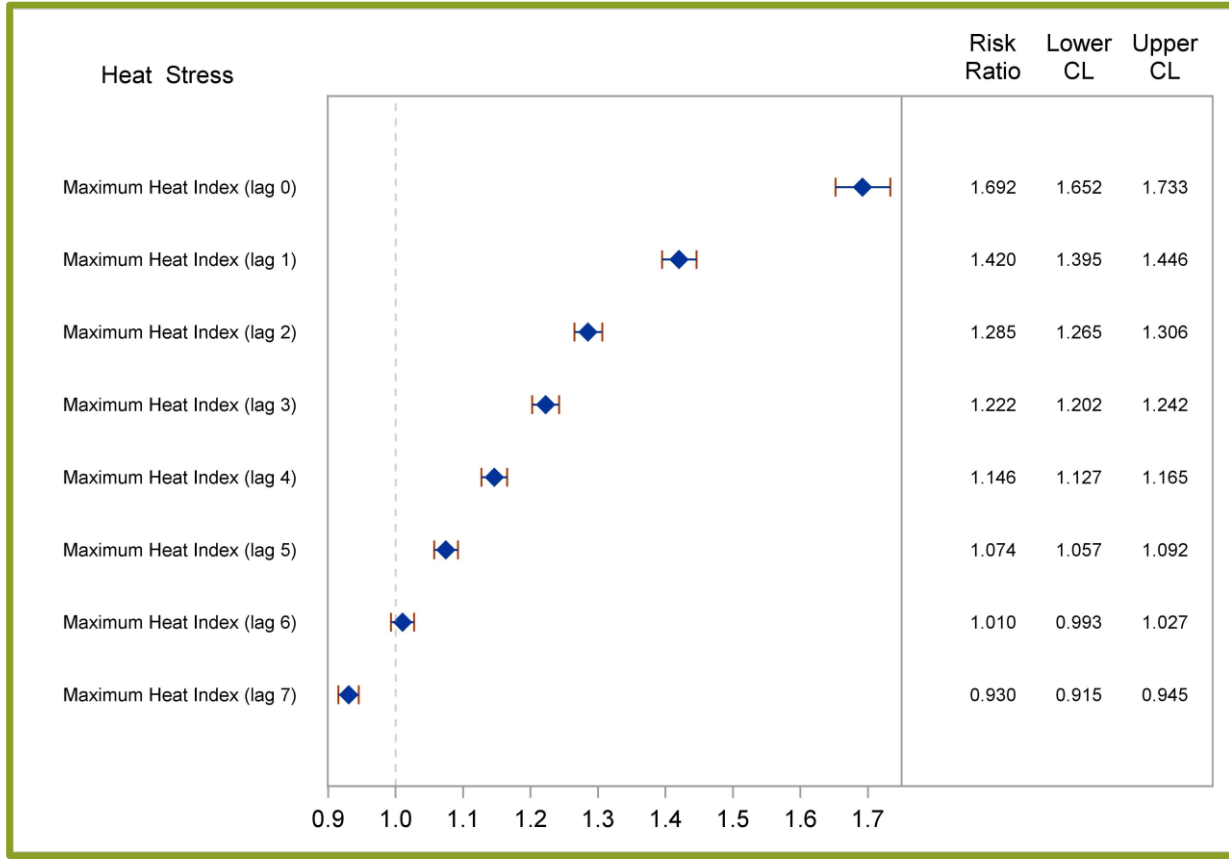
Image Credit: Adeyeye T, Insaf TZ**, Al-Hamdan M, Nayak S, Stuart N, Dirienzo S, Crossson W. Estimating policy relevant health effects of ambient heat exposures using spatially contiguous remote sensing reanalysis data –Environmental Health 2019 18:35 https://doi.org/10.1186/s12940-019-0467-5

New York City (NYC), rural & urban New York State (NYS)

Same Day Exposure and Risk of Heat Stress Hospitalization/ED Visits in New York State
(Risk Ratio and 95% CL)

	Risk Ratio	Lower CL	Upper CL
Heat Stress (NYC only)	2.38	2.23	2.55
Heat Stress (rural NYS)	2.36	1.99	2.80
Heat Stress (urban NYS)	2.34	2.22	2.47

Same Day Exposure and Risk of Dehydration Hospitalization/ED Visits in New York State
(Risk Ratio and 95% CL)

	Risk Ratio	Lower CL	Upper CL
Dehydration (NYC only)	1.09	1.07	1.11
Dehydration (rural NYS)	1.07	1.02	1.12
Dehydration (urban NYS)	1.05	1.04	1.07

National Weather Service Heat Advisory

- Regional NWS forecast offices issue excessive heat alerts (advisories, watches, and warnings) based on the maximum heat index forecasts over 24–72 hours

- Current temperature thresholds for heat advisories and warnings in upstate NYS were established over 20 years ago and were not based on heat-health associations

- The NLDAS reanalysis dataset provides the opportunity to conduct heat-health analysis for all regions of NYS and reassess the criteria for heat advisories, so they are more relevant to temperatures experienced in NYS during the summer

Image Credit: NWS offices, Albany

Eastern Region Heat Index Advisory Criteria
2016

KALKSTEIN PROCEDURES
100 TO 104 Degrees F
105 TO 109 Degrees F
110 TO 114 Degrees F
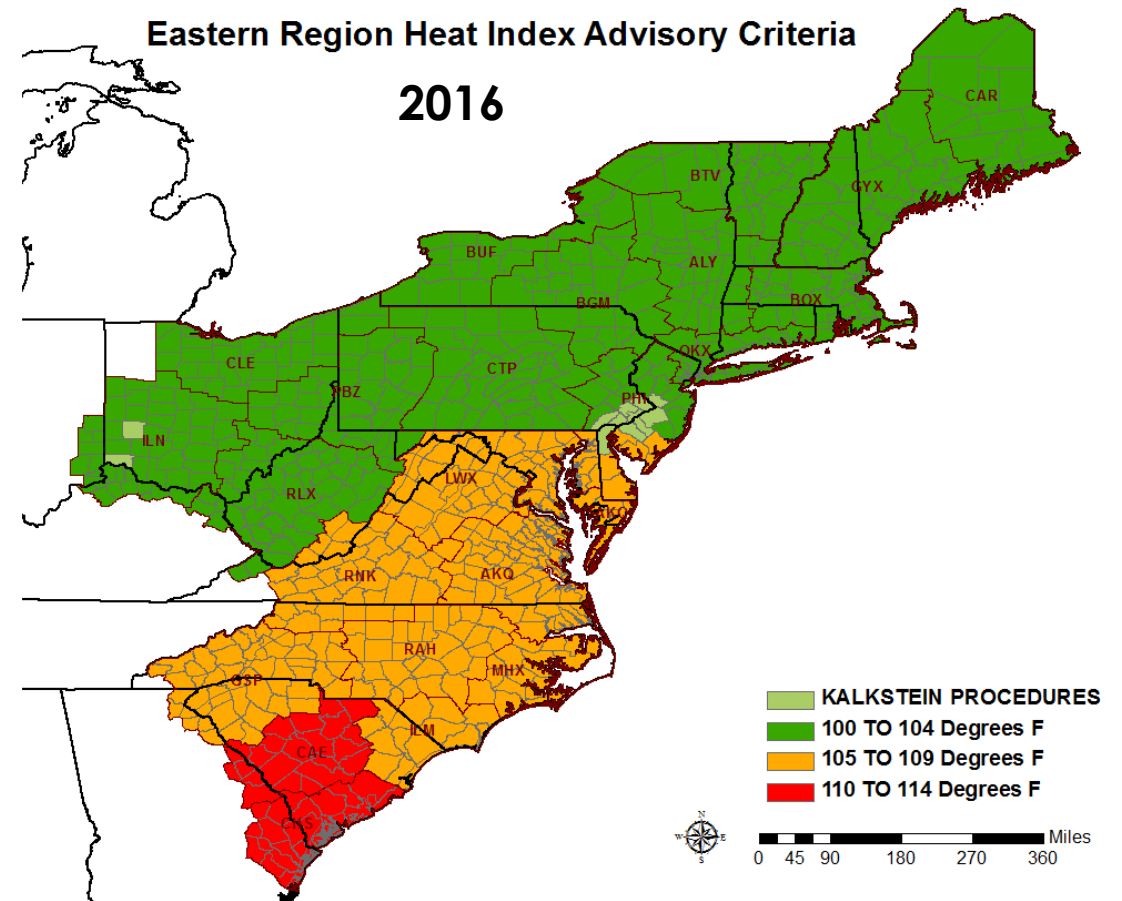
Threshold Analysis
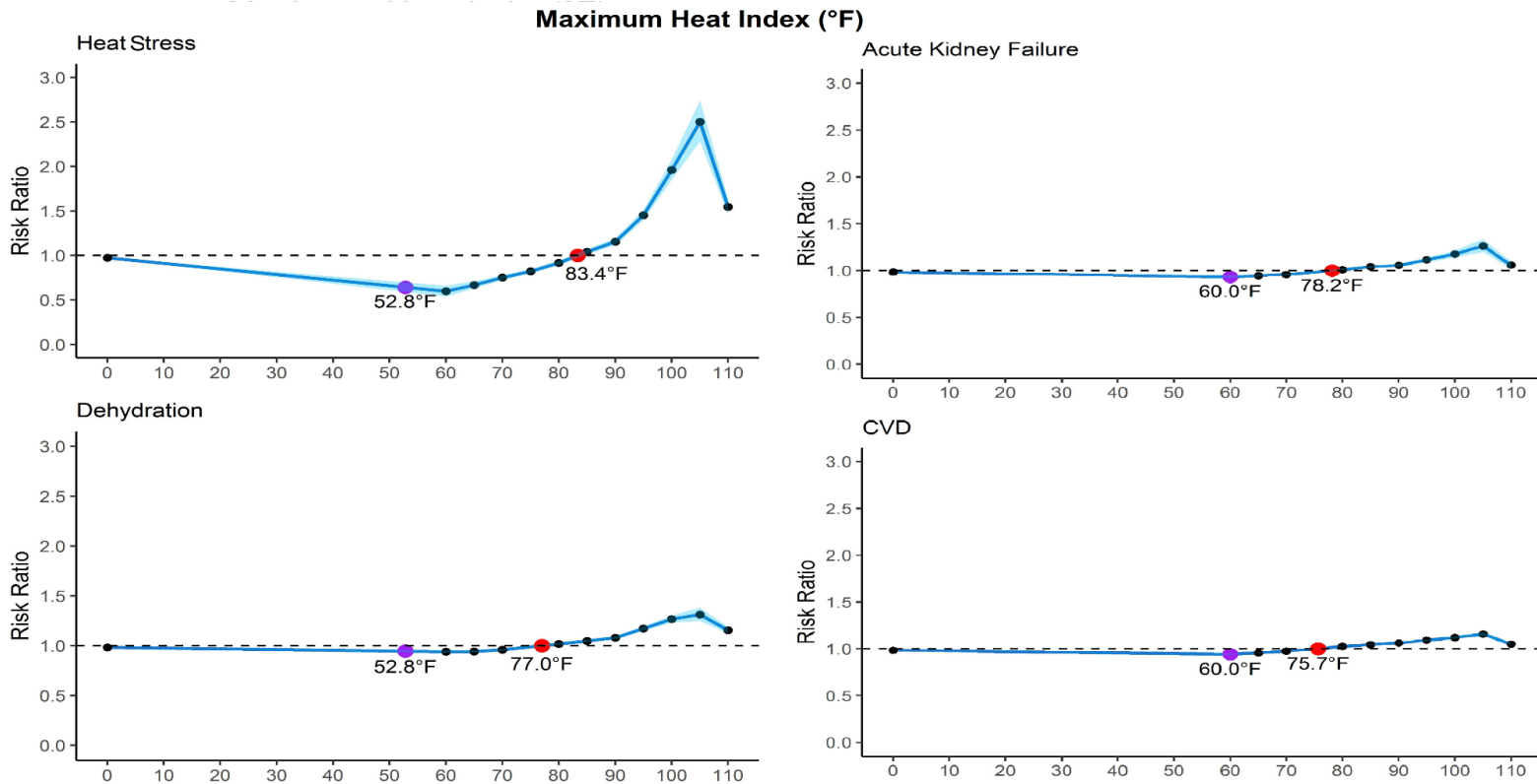
- The excess risk temperature (ERT) was defined as the lowest temperature at which the lower bound of the 95% confidence interval of relative risk of a particular health outcome was greater than 1.

- For heat stress, the ERT was defined at 83.8 °F while the ERTs were between 75.2–78.8 °F for all other health outcomes.

Threshold Analysis

Maximum Heat Index (°F)
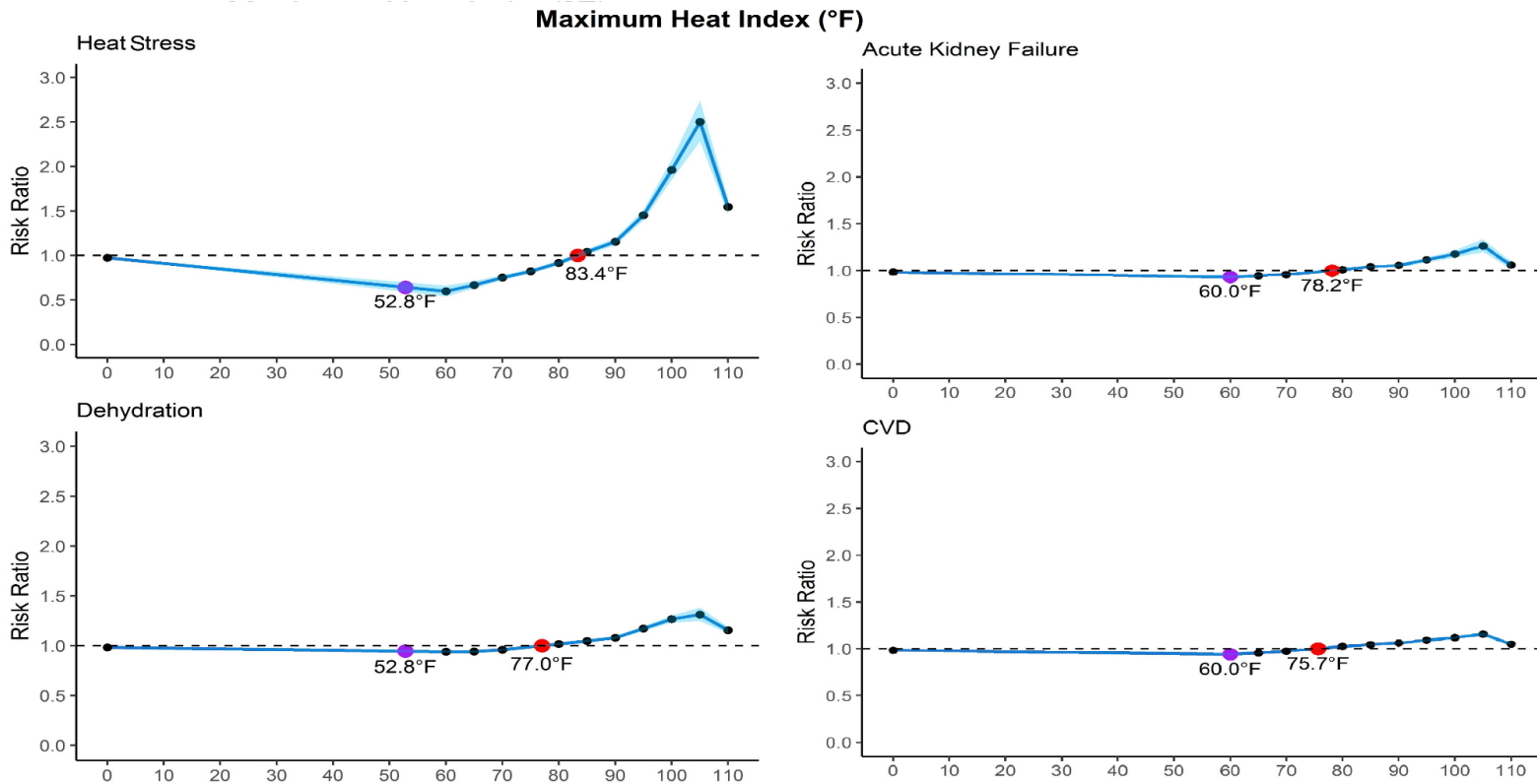
- At the pre-existing NWS threshold of 100 °F, the risk ratio for heat stress was 3.727 while the risk ratio for other health outcomes ranged from 1.727 for dehydration, 1.534 for AKF and 1.412 for CVD

- In contrast, at a reduced heat advisory criterion of 95 °F, the risk ratio for heat stress is 1.927 and ranges from 1.436 for dehydration, 1.329 for AKF and 1.290 for CVD

National Weather Service Heat Advisory

- Recognizing that the Excessive Heat Warning / Heat Advisory criteria should be based on regional climate variability and the effect of excessive heat on the local population, the NWS encourages regional offices to work with health departments and develop criteria based on scientific evidence derived from local data

- We recommended that a conservative heat advisory threshold of 35 °C (95 °F) be considered for the general public

Eastern Region Heat Index Advisory Criteria
Effective June 2018

KALKSTEIN PROCEDURES
95-99 F for 2 consecutive days or 100-104 F for any duration
100 F or more for 2 consecutive hours
105 F or more for 2 consecutive hours
110 F or more for 2 consecutive hours
95 F or more for 2 consecutive hours
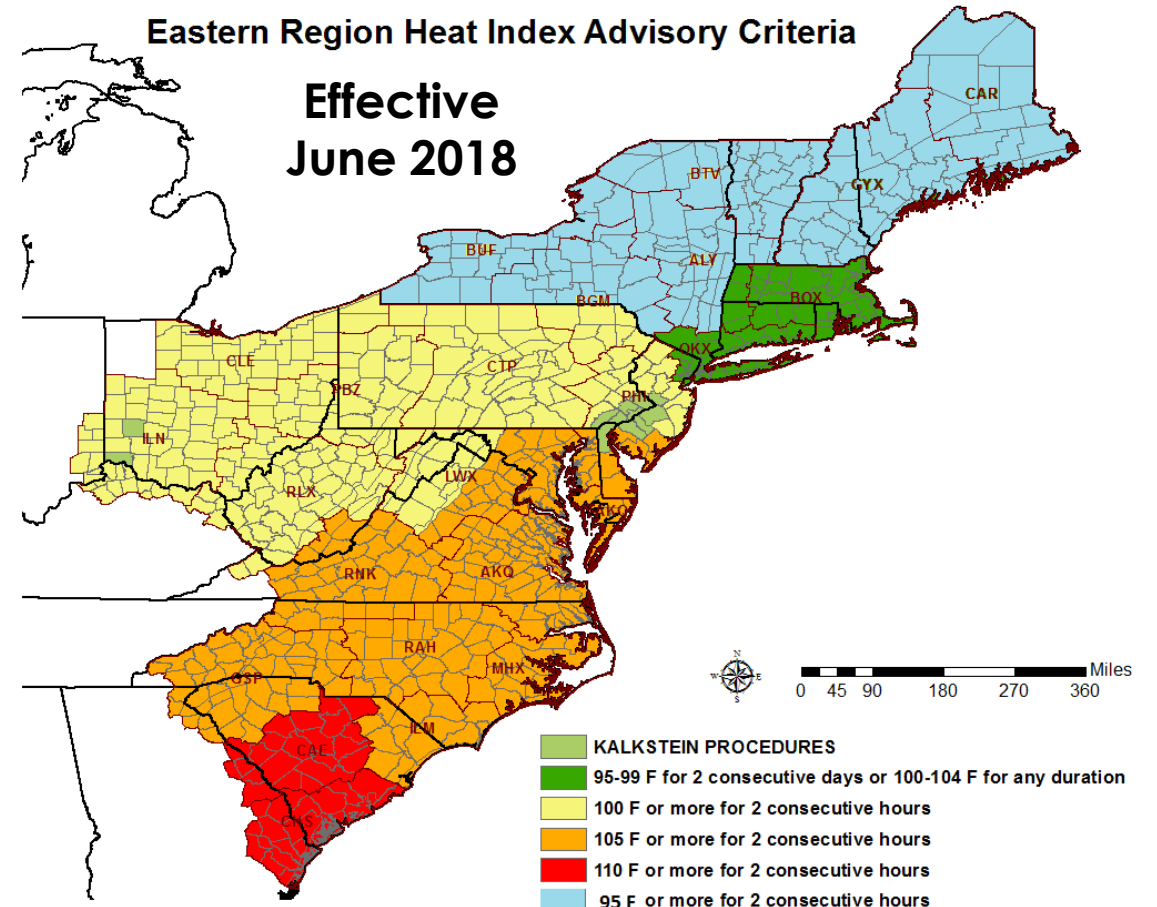
Image Credit: NWS offices, Albany

National Weather Service Heat Advisory

- This would capture a high proportion of heat events likely to result in significant morbidity, while avoiding warning fatigue if frequent advisories were issued at lower temperatures

- Based on research findings and recommendations, four NWS offices (Albany, NY; Binghamton, NY; Buffalo, NY; and Burlington, VT) changed their heat advisory criteria for New York, effective on or about June 1st, 2018 to 35 °C (95 °F) or more for two consecutive hours

Image Credit: NWS offices, Albany

Eastern Region Heat Index Advisory Criteria
Effective June 2018

KALKSTEIN PROCEDURES
95-99 F for 2 consecutive days or 100-104 F for any duration
100 F or more for 2 consecutive hours
105 F or more for 2 consecutive hours
110 F or more for 2 consecutive hours
95 F or more for 2 consecutive hours
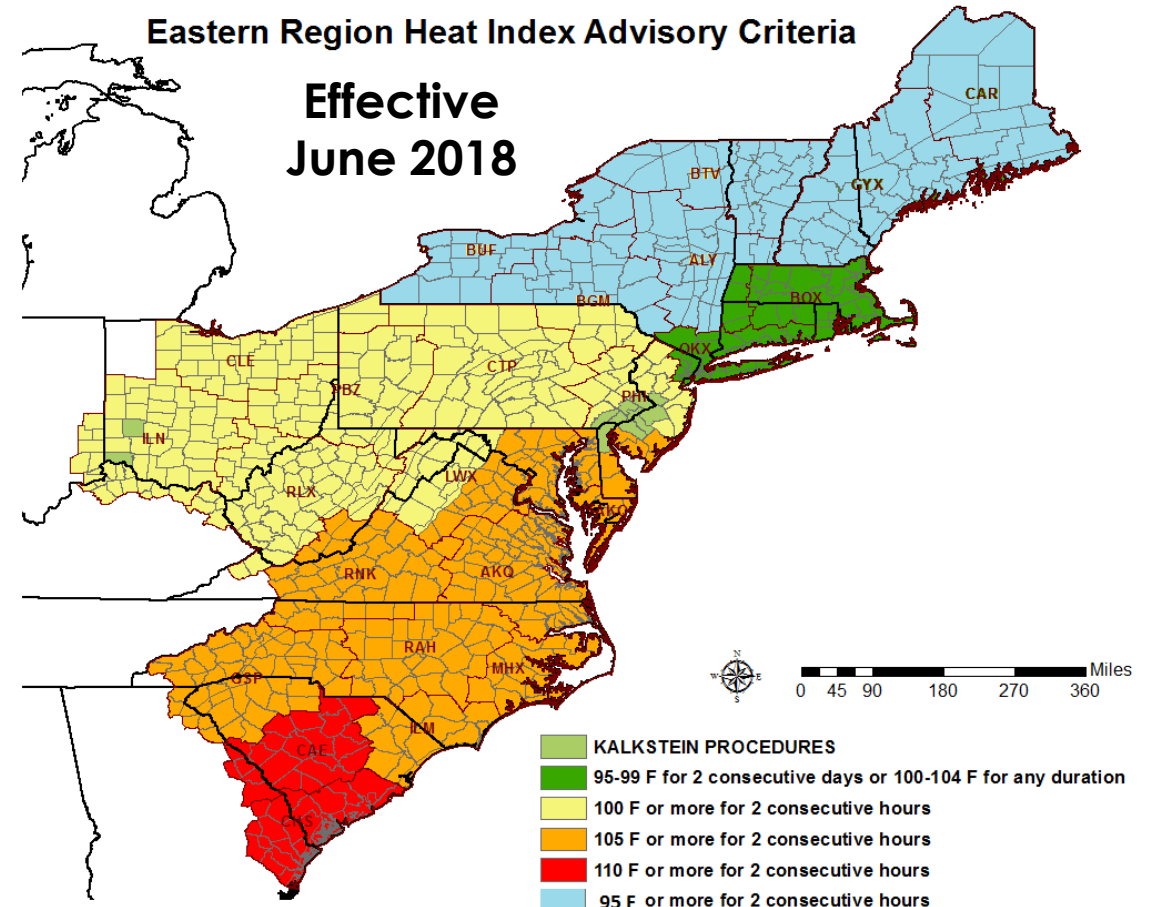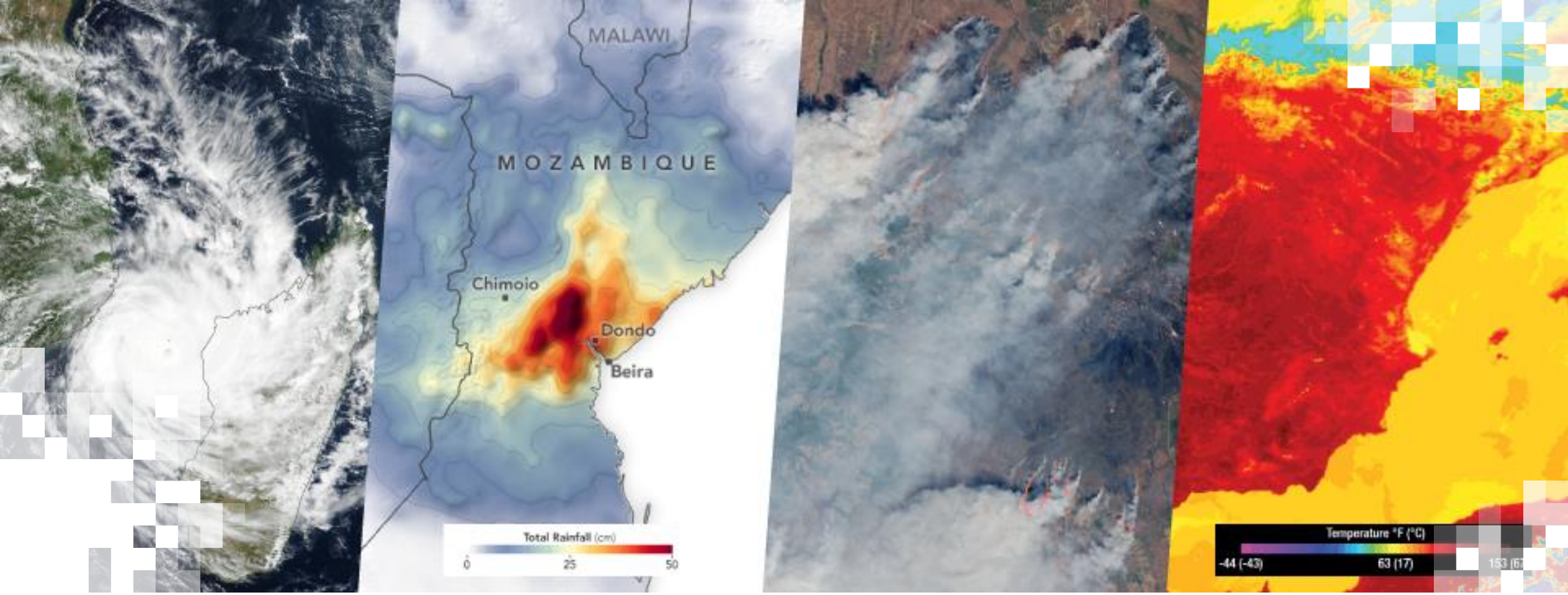
Outreach and Communication

New York State Heat & Health Infographic

https://www.health.ny.gov/publications/6636.pdf

County Heat and Health Profiles

https://www.health.ny.gov/environmental/weather/profiles/

County Heat and Health Profiles

Exposure: Heat

Sensitivity: Health

Figure 1b. Summer Temperature Anomalies in Cortland County, 1979 to 2016

A temperature anomaly is a departure from a reference value or long-term average. Reference value used is a 30-year norm (1980 - 2010). A positive anomaly indicates that the observed temperature was warmer than the reference value, while a negative anomaly indicates that the observed temperature was cooler than the reference value

Figure 2a. Heat Related Illness Hospitalizations & ED Visit rates, Cortland County, May to Sep, 2008-2016

Satellite data allows NYS DOH to provide climate reports for each county in NYS

EPHT Portal

https://www.health.ny.gov/environmental/public_health_tracking/

- New York's Environmental Public Health Tracking (EPHT) Program focuses on tracking environmental and health patterns and trends

- Environmental Public Health Tracking is a national program led by the Centers for Disease Control and Prevention (CDC)

- It is intended to improve access to environmental health information and support research, programs and policies that may help protect our communities

EPHT Subcounty Portal
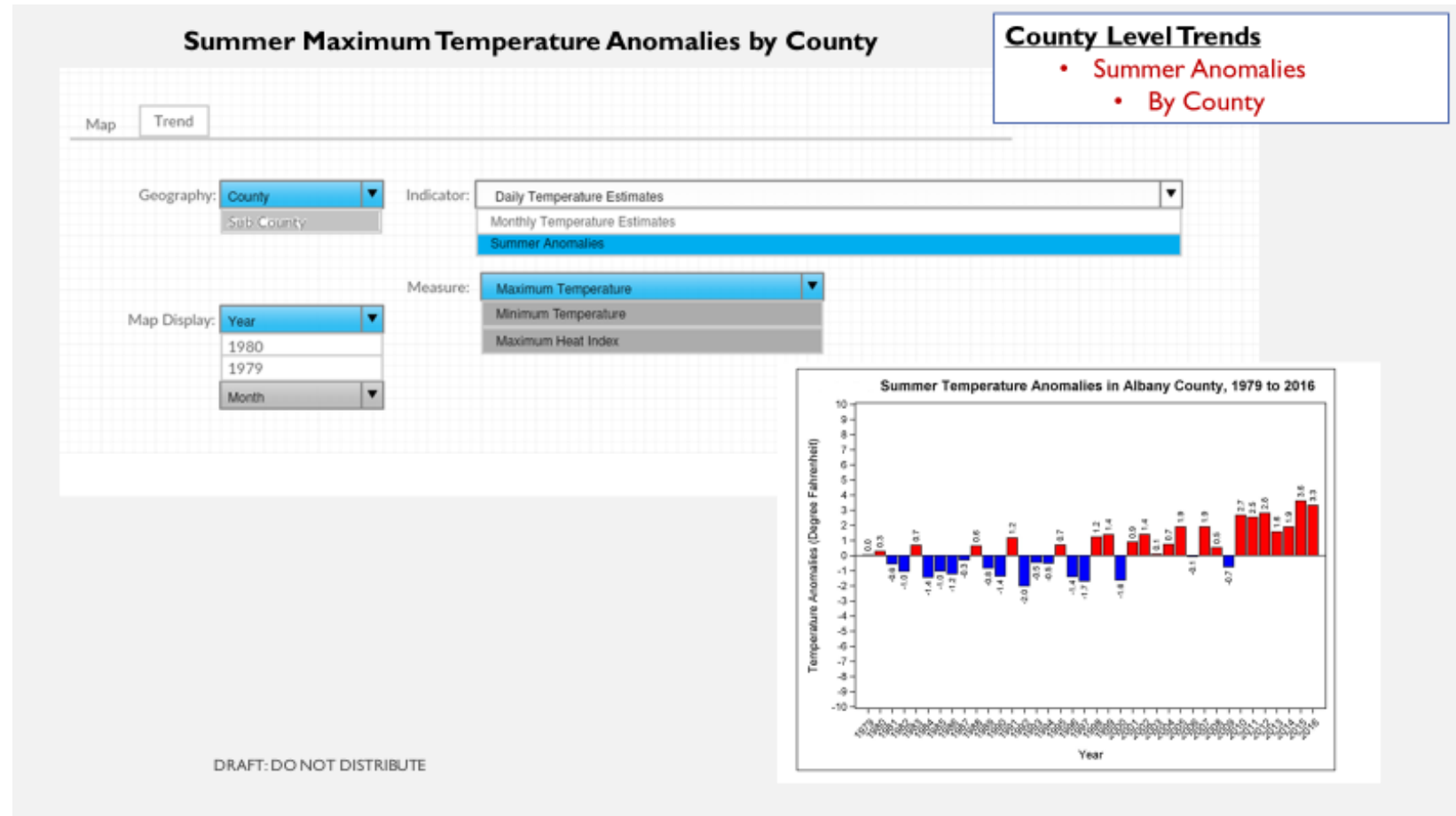
- Currently under development
- Satellite/Reanalysis data allows development of region specific climate indicators
- Indicators include:
 - Daily Temperature Estimates (by month and year)-derived from 12 km NLDAS
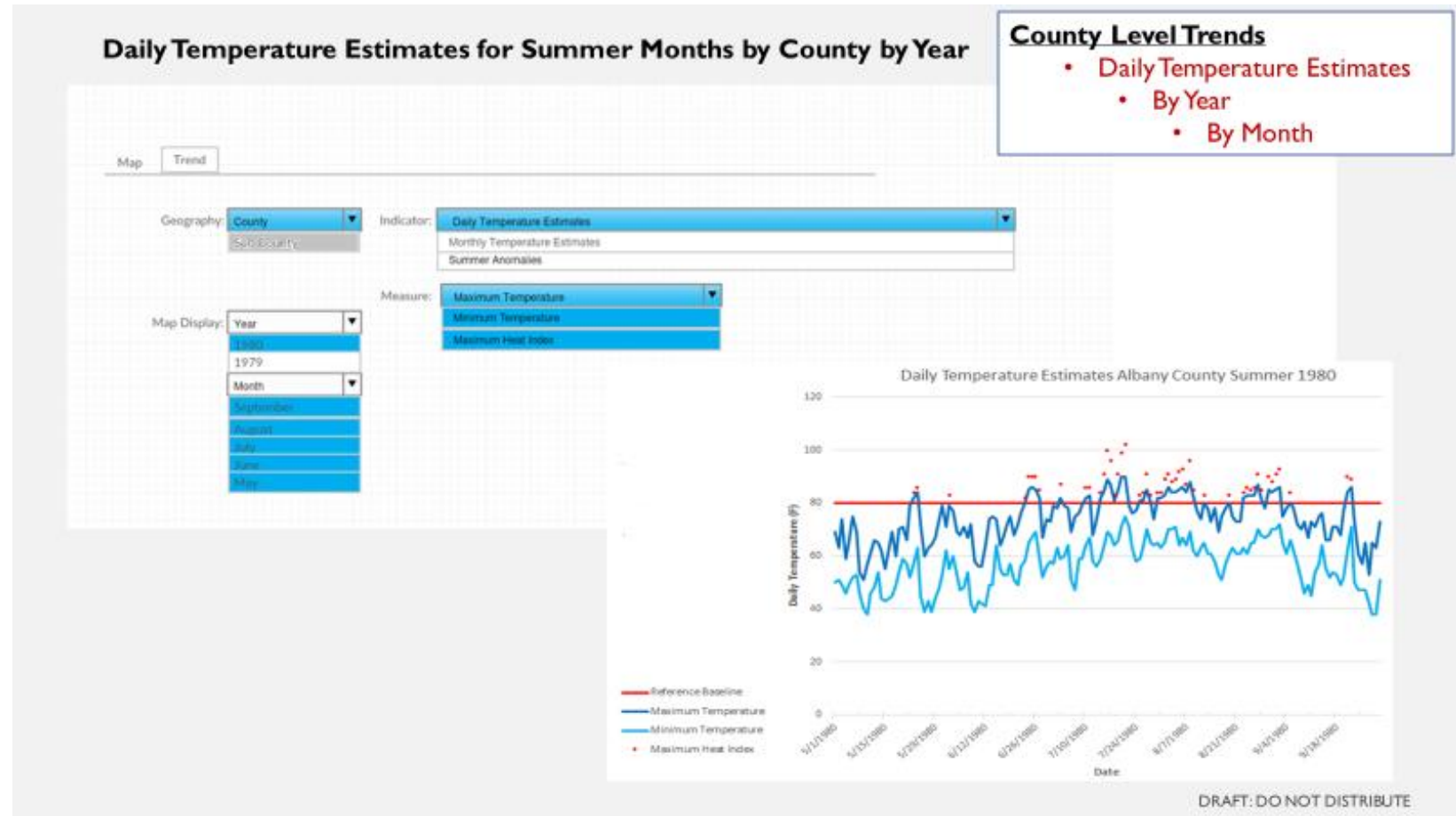
EPHT Subcounty Portal

- Currently under development

- Indicators include:
  - Summer Anomalies (May through September)-derived from county level estimates of 12 km NLDAS

EPHT Subcounty Portal

- Currently under development

- Indicators include:
  - Average Temperature (by month and year)
  - census tract estimates derived from 12 km NLDAS
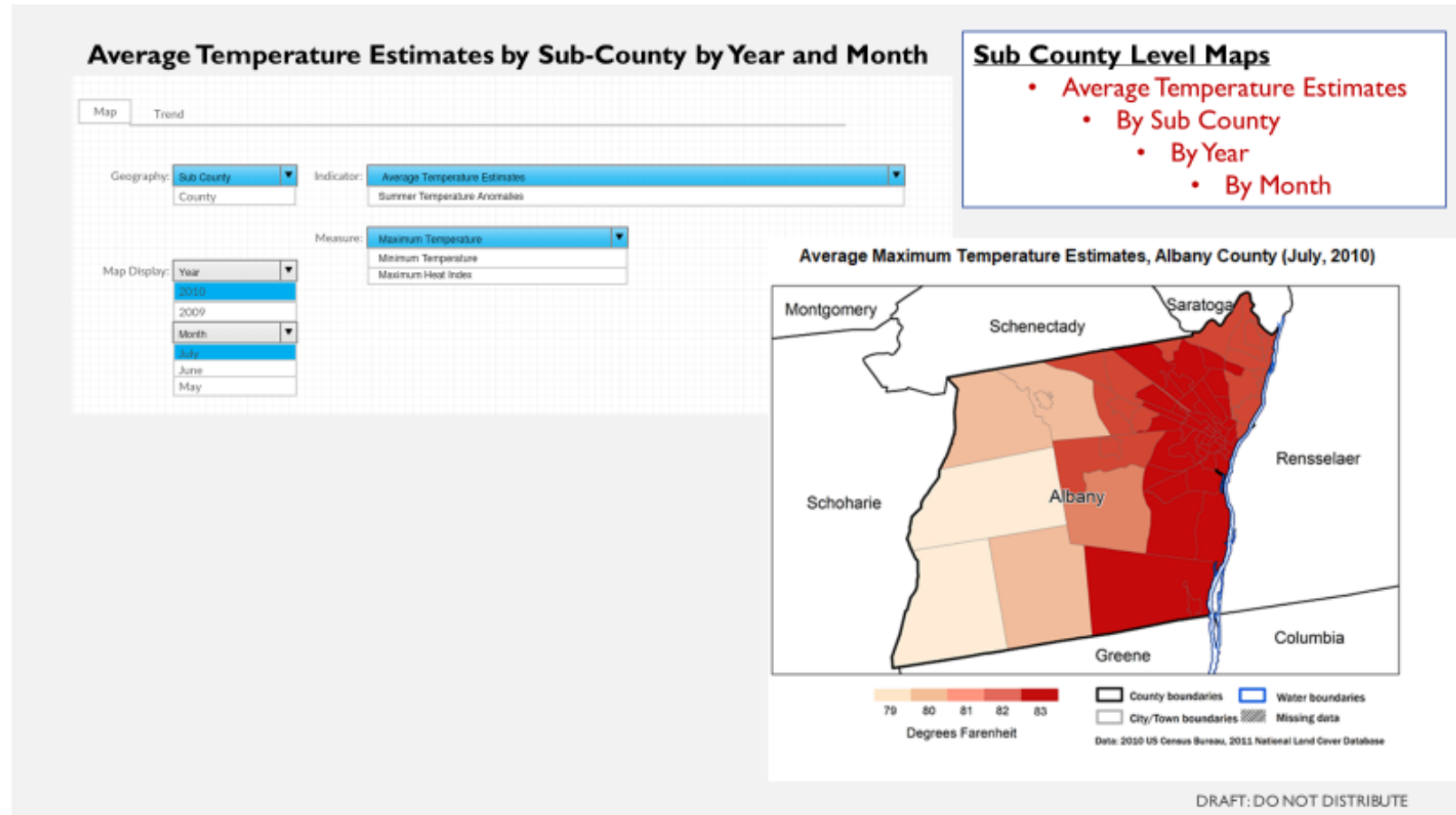
Apply for Heating and Cooling Assistance (HEAP)

Need help paying your energy bill? Low-income New Yorkers can apply for heating and cooling assistance under the Home Energy Assistance Program, or HEAP.

Apply for HEAP

Vendor Information

You may be eligible for a Cooling Assistance HEAP benefit if:

- Your household's gross monthly income is at or below the current income guidelines for your household size as posted in the following table, or
- You receive Supplemental Nutrition Assistance Program (SNAP) benefits, or
- You receive Temporary Assistance (TA), or
- You receive Code A Supplemental Security Income (SSI Living Alone), and
- You and your household members are United States Citizens or qualified aliens, and
- Includes an individual with a documented medical condition that is exacerbated by heat, and
- You received a Regular benefit greater than $21 in the current program year, and
- You currently do not have a working air conditioner or the air conditioner you have is five years old or older, and
- You did not receive a HEAP funded air conditioner within the past ten years.

Your household eligibility requirements include filing an application with your local department of social services, providing all necessary documentation, and the household must reside in an eligible living situation.
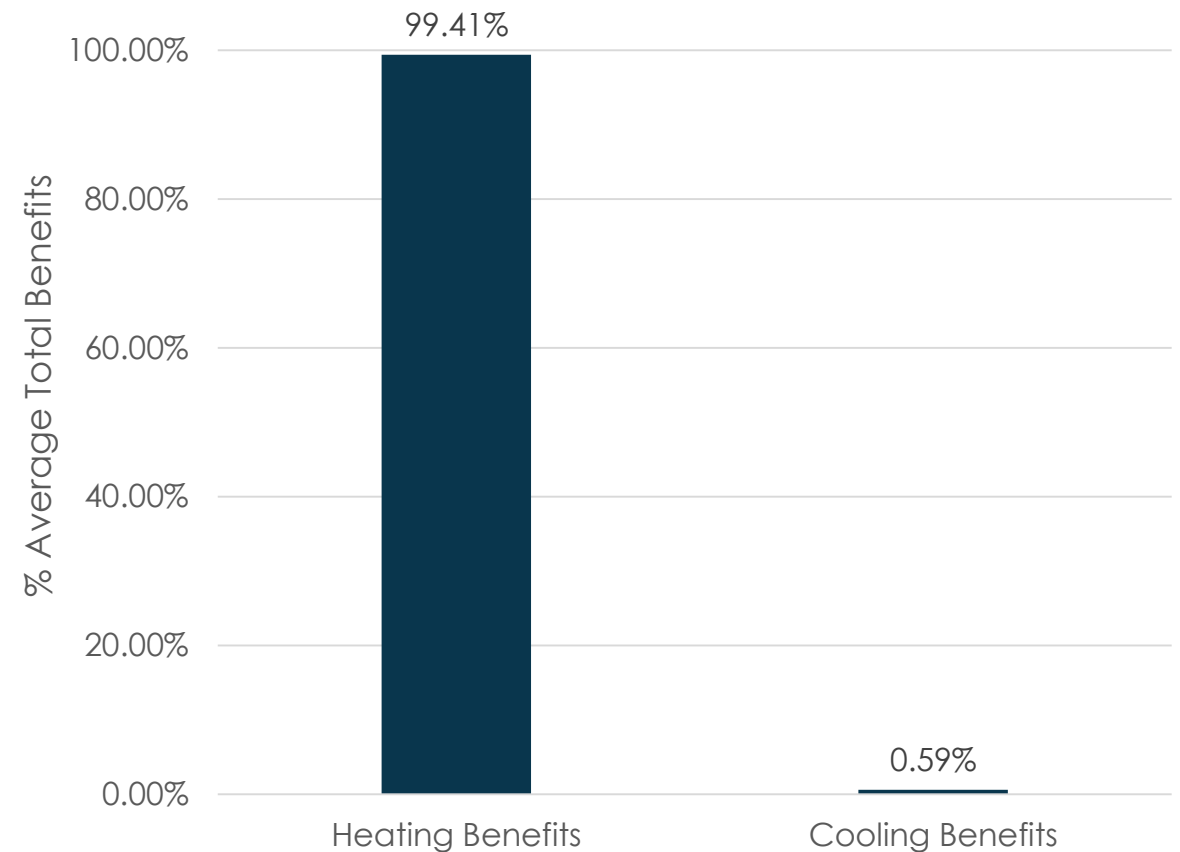
Office of Temporary Disability Assistance – Home Energy Assistance Program
Distribution of HEAP Benefits and Illness

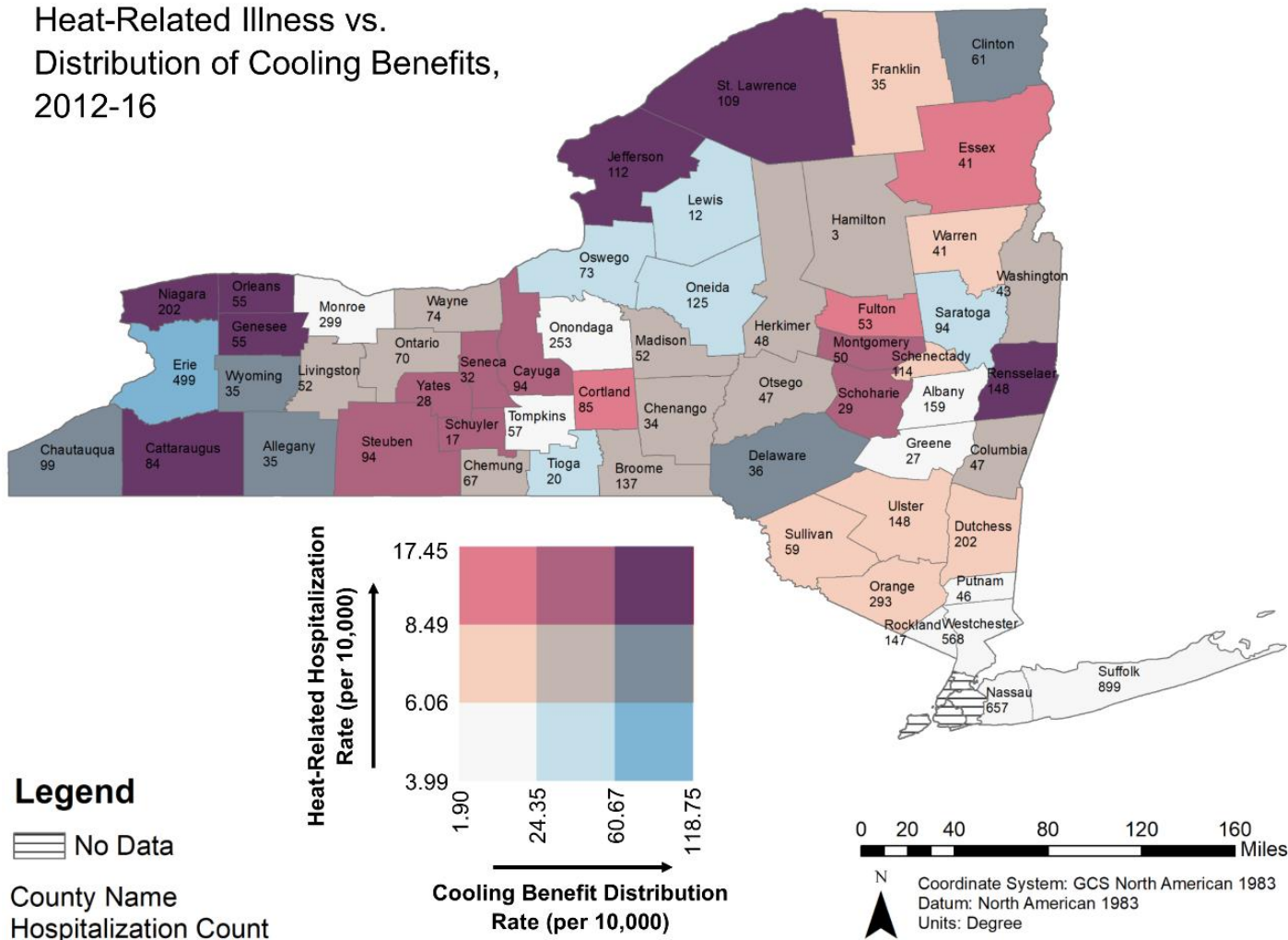NYS Cold vs. Heat-Related Hospitalizations, 2012-2016
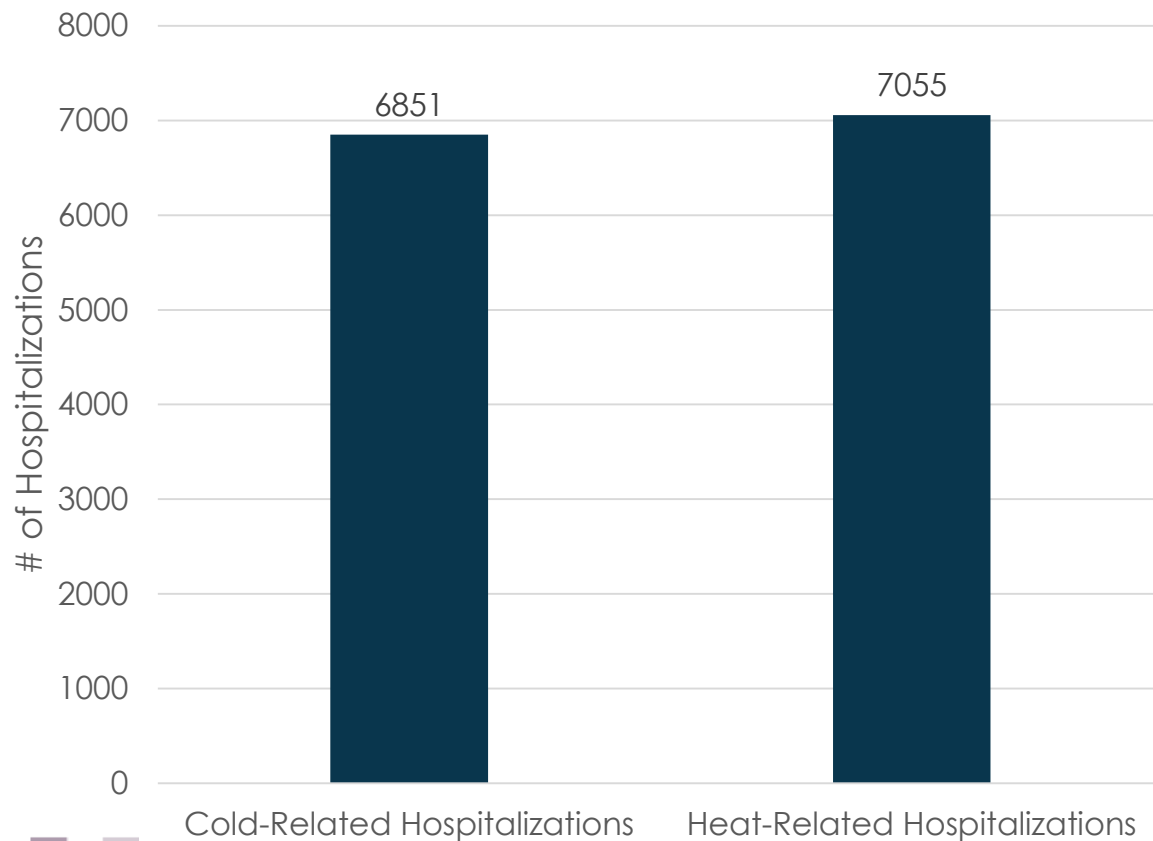
% Average Total Benefits, 2015-2016

Heat-Related Illness vs. Distribution of Cooling Benefits

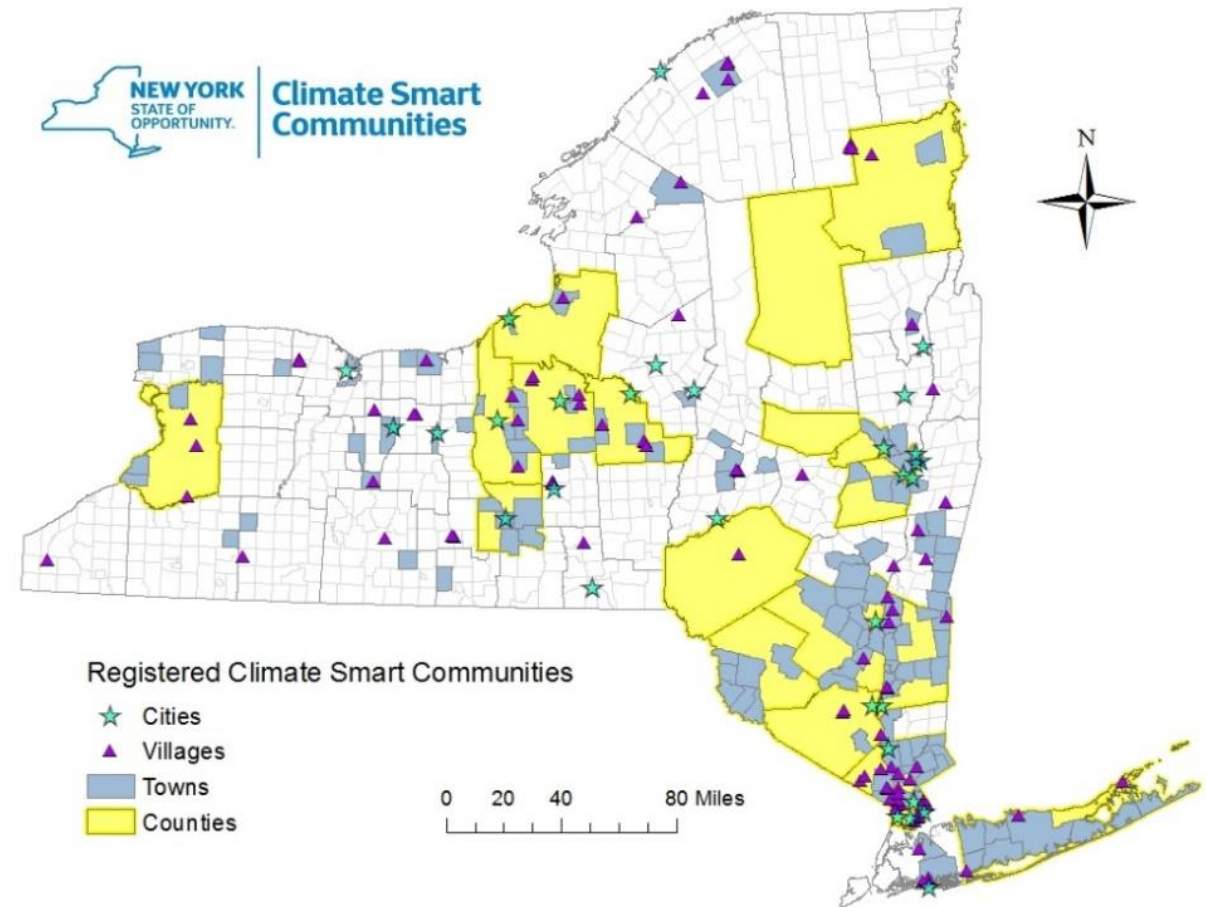Heat-Related Illness vs. Distribution of Cooling Benefits, 2012-16

An additional **$3.5 million** was allocated to the cooling budget after analysis of funding trends and projected utilization

Climate Smart Communities

https://climatesmart.ny.gov/

- Climate Smart Communities (CSC) is a New York State program that helps local governments take action to reduce greenhouse gas emissions and adapt to a changing climate. Benefits include leadership recognition, free technical assistance, and access to grants.

- Satellite data can be used to estimate local climate trends, health benefits of climate change mitigation and assess local areas of high vulnerabilities

NEW YORK STATE OF OPPORTUNITY. | Climate Smart Communities

Registered Climate Smart Communities

★ Cities
▲ Villages
◼ Towns
◼ Counties

0 20 40 80 Miles

Avenues for Outreach

Climate Change and Health in New York State

Focus: Extreme Heat and Human Health

A Story Map

Thank You

Tabassum Insaf PhD, MPH, MBBS

Research Director

Bureau of Environmental and Occupational Epidemiology

New York State Department of Health

tabassum.insaf@health.ny.gov