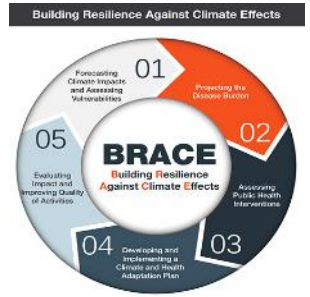
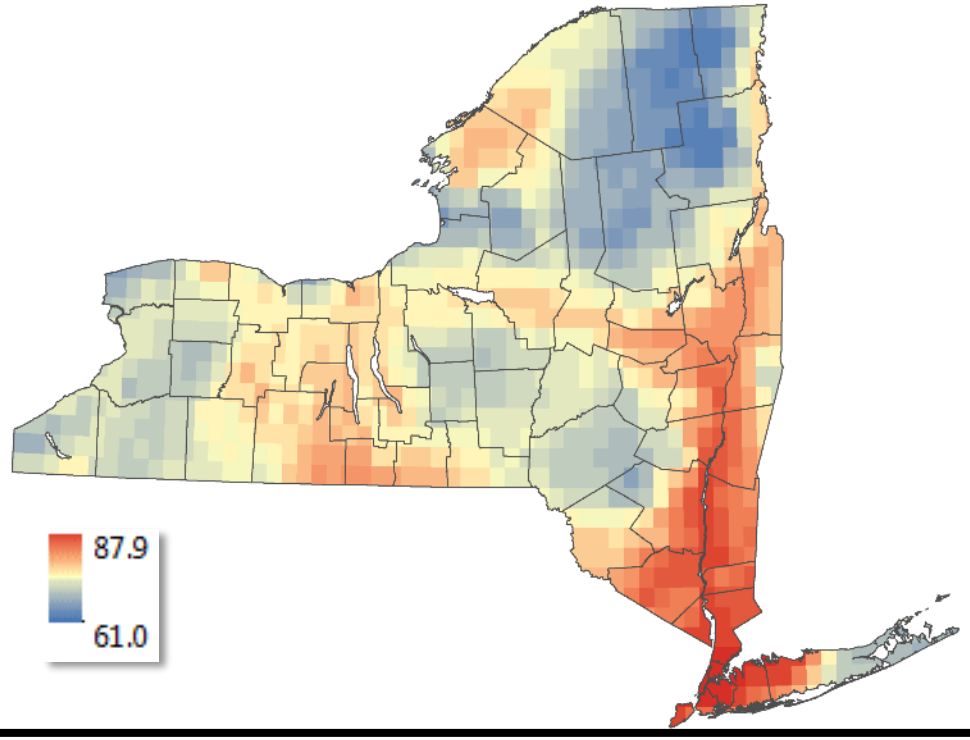
Utilizing Satellite Data in Climate Health Surveillance and Mitigation

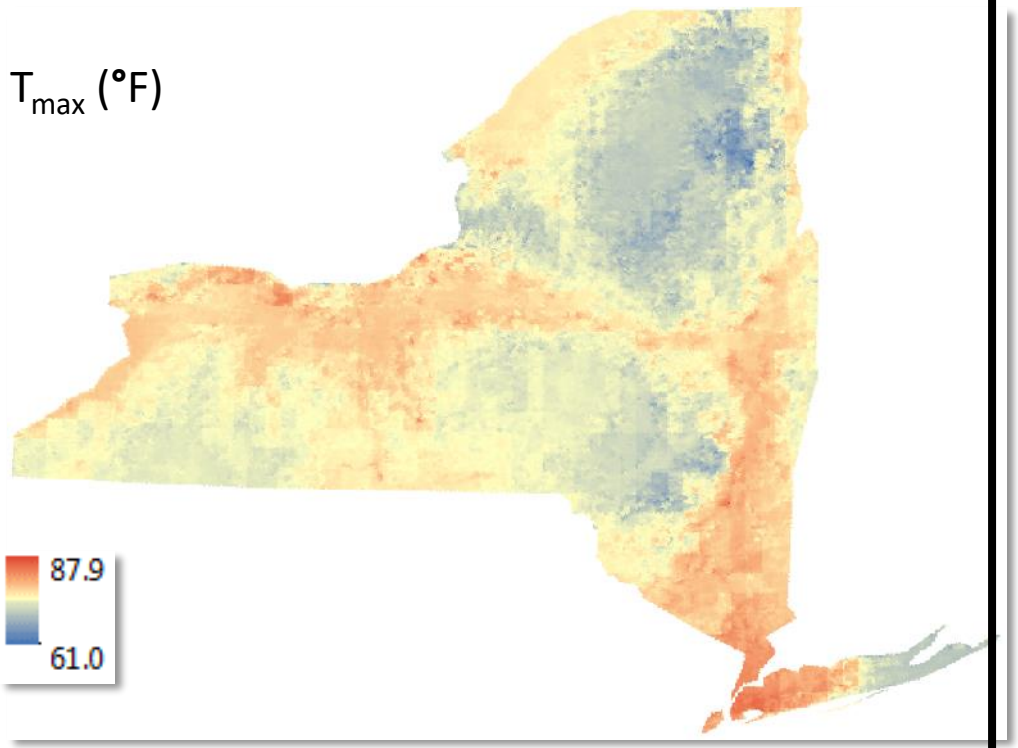


NLDAS Datasets for New York

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



Downscaled T_{max}July 20, 2009



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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^{o} (~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.**
- **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 T_{max} or T_{min} is given by:

$$T_{DIS} = T_{LR} + Z_{HR} \cdot \sigma_{LR}$$

where Z_{HR} is the standardized LST departure, given by:

$$Z_{HR} = (T_{HR} - T_{HR,mean})/\sigma_{HR}$$

and T_{HR} = high-resolution (MODIS) LST, and $T_{HR,mean}$ and σ_{HR} 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).

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12km NLDAS Maximum Temperature Product

2006

Station	*r*	r^2
Dansville	0.93	0.86
Indian Lake	0.92	0.85
Ithaca	0.92	0.85
Tupper	0.91	0.84
Cooperstown	0.89	0.79
Elmira	0.86	0.74
Norwich	0.85	0.73
Oswego	0.85	0.72
Fredonia	0.85	0.72
Dannemora	0.84	0.71
Canton	0.82	0.68
Mohonk Lake	0.80	0.65
Lake Placid	0.80	0.63
Hemlock	0.78	0.61
Poughkeepsie	0.77	0.60
NYC Park	**0.76**	**0.59**
Batavia	0.76	0.58
Dobbs Ferry	0.76	0.58
WestPoint	0.75	0.56
Port Jarvis	0.75	0.56
Albany	**0.75**	**0.56**
Rochester	**0.74**	**0.54**
Lawrenceville	0.73	0.53
Binghampton	**0.72**	**0.52**
Syracuse	**0.72**	**0.51**
Buffalo	**0.66**	**0.44**
Angelica	0.62	0.39
Alred	0.59	0.35
Avg.	0.79	

2009

Station	*r*	r^2
Hemlock	0.91	0.8
Syracuse	0.89	0.8
Rochester	0.88	0.8
Oswego	0.88	0.8
Albany	0.85	0.7
Lake Placid	0.85	0.7
Binghampton	0.84	0.7
Fredonia	0.84	0.7
Cooperstown	0.84	0.7
Poughkeepsie	0.75	0.6
Batavia	0.74	0.6
Buffalo	0.74	0.6
Indian Lake	0.73	0.5
Ithaca	0.73	0.5
Ogdensburg	0.70	0.5
Dannemora	0.69	0.5
Stillwater	0.69	0.5
Mohonk Lake	0.66	0.4
Canton	0.66	0.4
Dansville	0.64	0.4
Dobbs Ferry	0.64	0.4
Port Jarvis	0.63	0.4
Angelica	0.62	0.4
NYC Park	0.62	0.4
Elmira	0.58	0.3
Norwich	0.58	0.3
Alred	0.57	0.3
Watertown	0.57	0.3
Wanakena	0.56	0.3
Tupper	0.52	0.3
WestPoint	0.48	0.2
Avg.	0.71	

2010

Station	*r*	r^2
Binghampton	0.92	0.85
Syracuse	0.92	0.84
Rochester	0.92	0.84
Hemlock	0.91	0.83
Oswego	0.90	0.81
Cooperstown	0.90	0.81
Fredonia	0.89	0.80
Lake Placid	0.88	0.77
Albany	0.84	0.71
Poughkeepsie	0.84	0.70
Batavia	0.84	0.70
Buffalo	0.82	0.67
Mohonk Lake	0.79	0.62
Angelica	0.79	0.62
Watertown	0.78	0.61
NYC Park	0.77	0.59
Ithaca	0.76	0.58
Dannemora	0.76	0.58
Dobbs Ferry	0.74	0.55
Wanakena	0.72	0.52
Tupper	0.71	0.50
Indian Lake	0.71	0.50
Ogdensburg	0.68	0.46
Elmira	0.65	0.42
Norwich	0.64	0.41
Port Jarvis	0.62	0.39
Stillwater	0.62	0.38
WestPoint	0.58	0.34
Avg.	0.78	

Note: Bold is ASOS station

1km Downscaled Maximum Temperature Product

2006

Station	*r*	r^2
Rochester	**0.97**	**0.93**
Albany	**0.95**	**0.91**
Syracuse	**0.95**	**0.91**
NYC Park	**0.95**	**0.90**
Dobbs Ferry	0.94	0.89
Binghampton	**0.94**	**0.89**
Poughkeepsie	0.94	0.88
Hemlock	0.94	0.88
Oswego	0.94	0.88
Angelica	0.93	0.86
Buffalo	**0.93**	**0.86**
Lawrenceville	0.92	0.86
Port Jarvis	0.92	0.84
Lake Placid	0.92	0.84
Alred	0.91	0.82
Fredonia	0.91	0.82
Batavia	0.90	0.81
Dannemora	0.90	0.81
Mohonk Lake	0.89	0.80
Cooperstown	0.82	0.67
WestPoint	0.82	0.67
Dansville	0.80	0.65
Ithaca	0.80	0.64
Elmira	0.80	0.64
Indian Lake	0.79	0.63
Norwich	0.79	0.62
Tupper	0.74	0.55
Canton	0.73	0.53
Avg.	0.88	

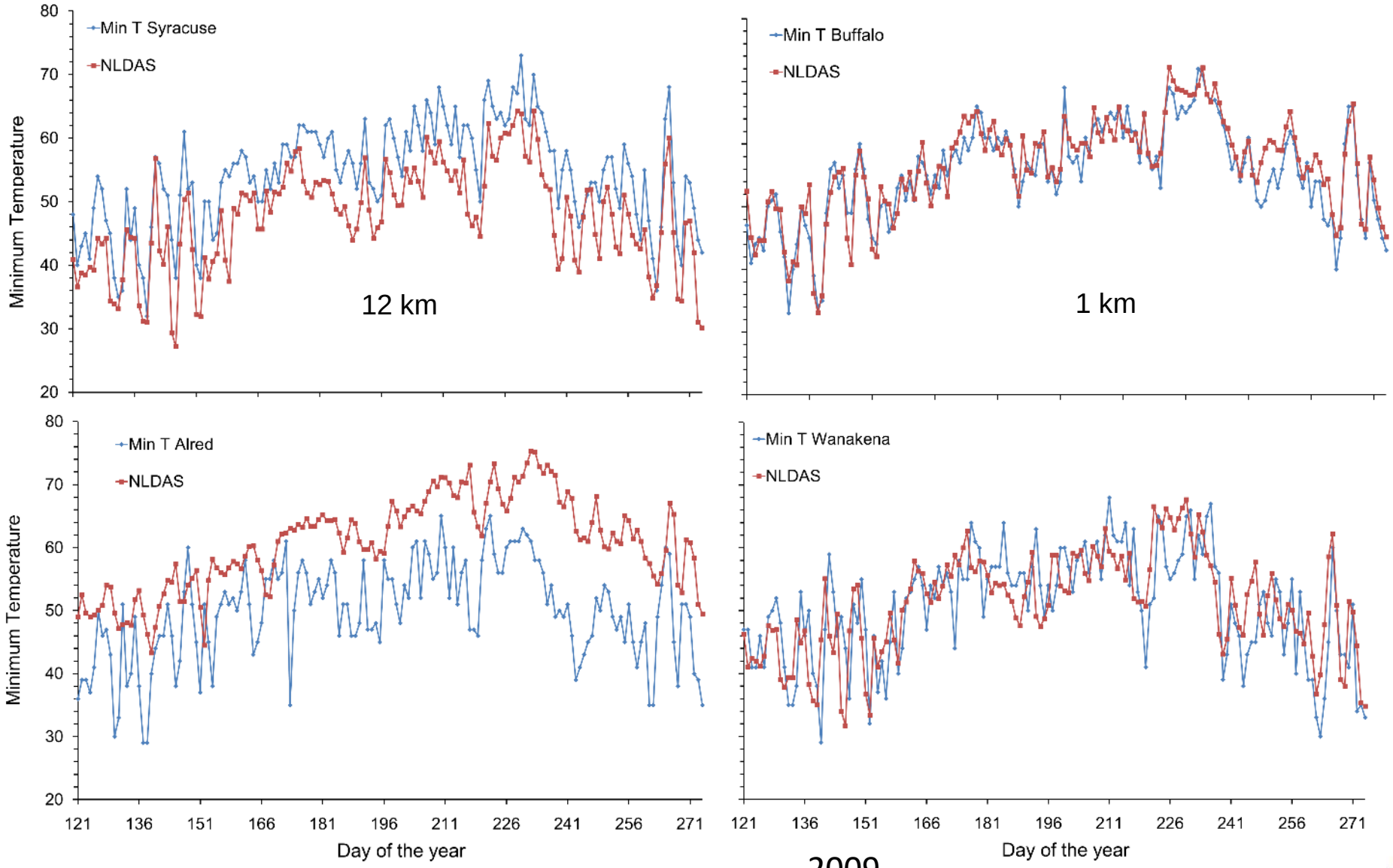
2009

Station	*r*	r^2
Syracuse	**0.94**	**0.89**
Rochester	**0.94**	**0.89**
NYC Park	**0.93**	**0.87**
Buffalo	**0.93**	**0.86**
Binghampton	**0.92**	**0.85**
Albany	**0.92**	**0.84**
Poughkeepsie	0.91	0.84
Hemlock	0.91	0.82
Batavia	0.90	0.81
Oswego	0.89	0.79
Alred	0.89	0.79
Dobbs Ferry	0.88	0.77
Dannemora	0.87	0.76
Angelica	0.87	0.75
Lake Placid	0.86	0.74
Cooperstown	0.86	0.74
Fredonia	0.86	0.74
Mohonk Lake	0.83	0.69
Port Jarvis	0.82	0.67
Watertown	0.76	0.57
Indian Lake	0.74	0.55
Canton	0.73	0.54
Ogdensburg	0.73	0.53
Tupper	0.73	0.53
Ithaca	0.71	0.51
Stillwater	0.67	0.45
Norwich	0.67	0.45
Elmira	0.67	0.45
Dansville	0.64	0.41
WestPoint	0.64	0.41
Wanakena	0.57	0.33
Avg.	0.81	

2010

Name	*r*	r^2
Albany	0.96	0.93
Syracuse	0.96	0.92
Binghampton	0.96	0.92
Buffalo	0.96	0.92
NYC Park	0.95	0.91
Rochester	0.95	0.91
Cooperstown	0.94	0.89
Poughkeepsie	0.94	0.89
Batavia	0.94	0.88
Hemlock	0.92	0.84
Fredonia	0.91	0.83
Lake Placid	0.90	0.82
Oswego	0.90	0.81
Dobbs Ferry	0.89	0.80
Dannemora	0.88	0.78
Mohonk Lake	0.87	0.76
Angelica	0.86	0.75
Watertown	0.75	0.57
Indian Lake	0.75	0.57
Wanakena	0.74	0.55
Ogdensburg	0.73	0.53
Tupper	0.72	0.51
WestPoint	0.71	0.51
Norwich	0.71	0.50
Ithaca	0.71	0.50
Port Jarvis	0.70	0.50
Elmira	0.68	0.46
Stillwater	0.64	0.41
Avg.	0.84	

NEW YORK STATE OF OPPORTUNITY. Department of Health



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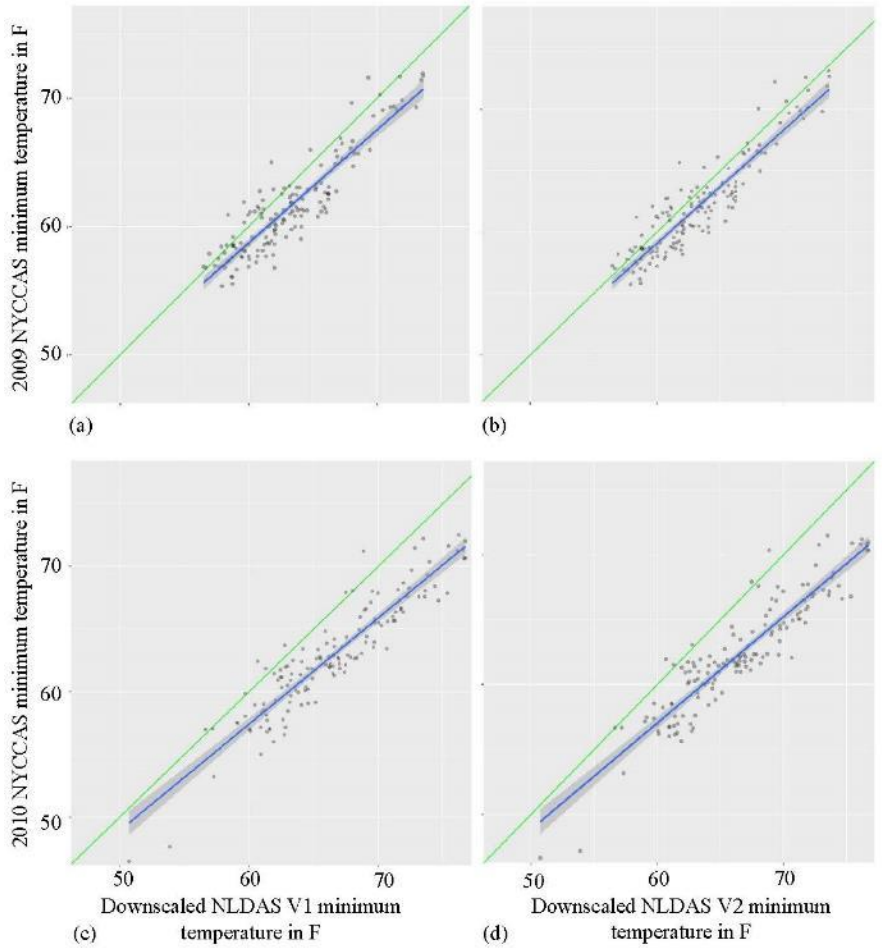
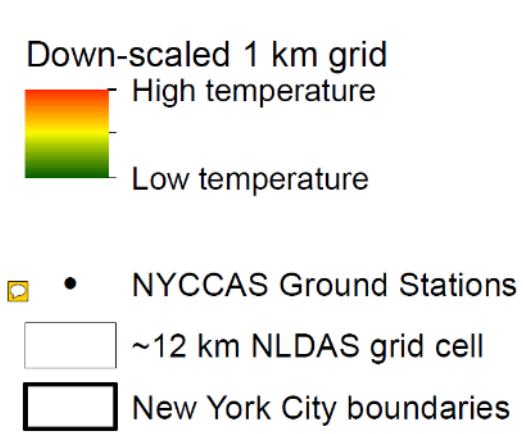
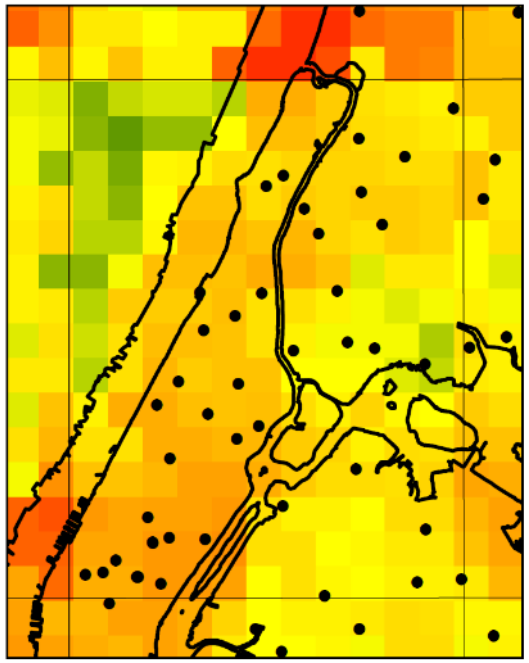
New York City Validation







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.

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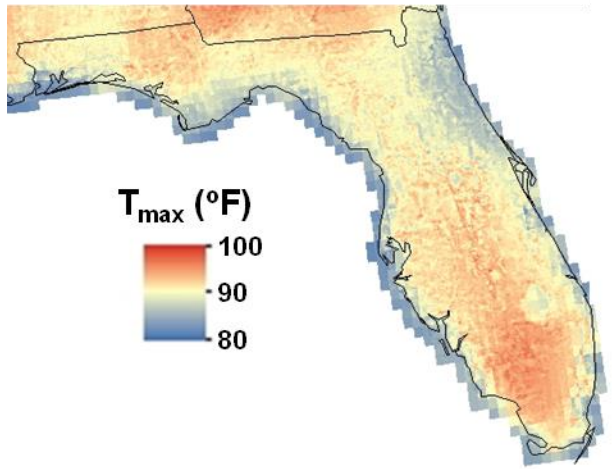

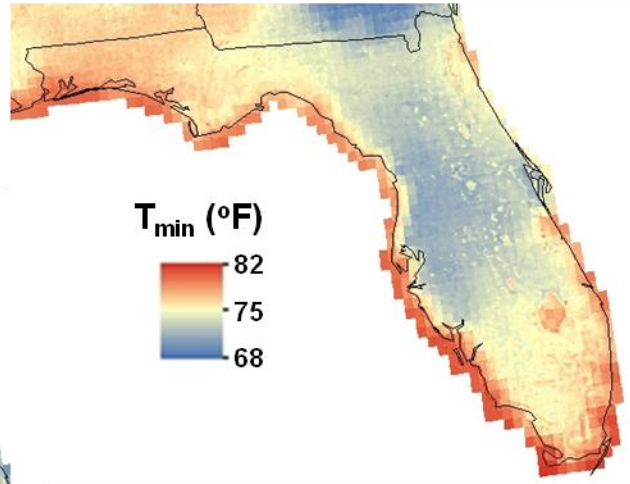

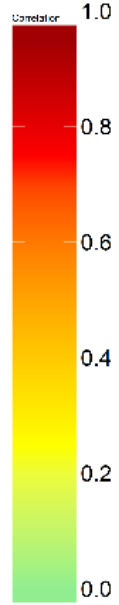

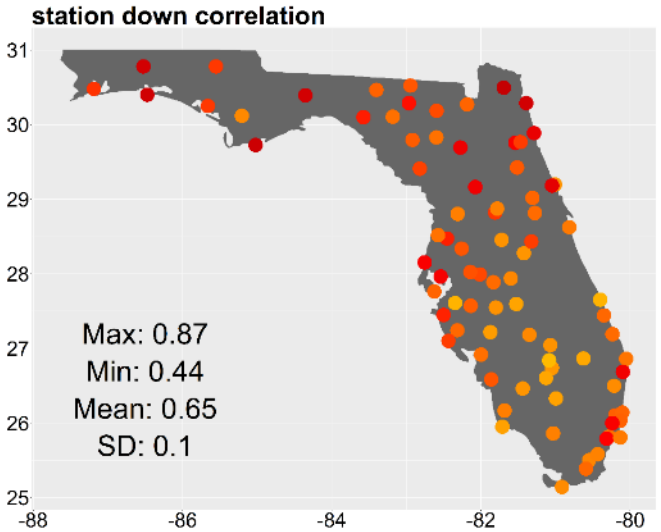

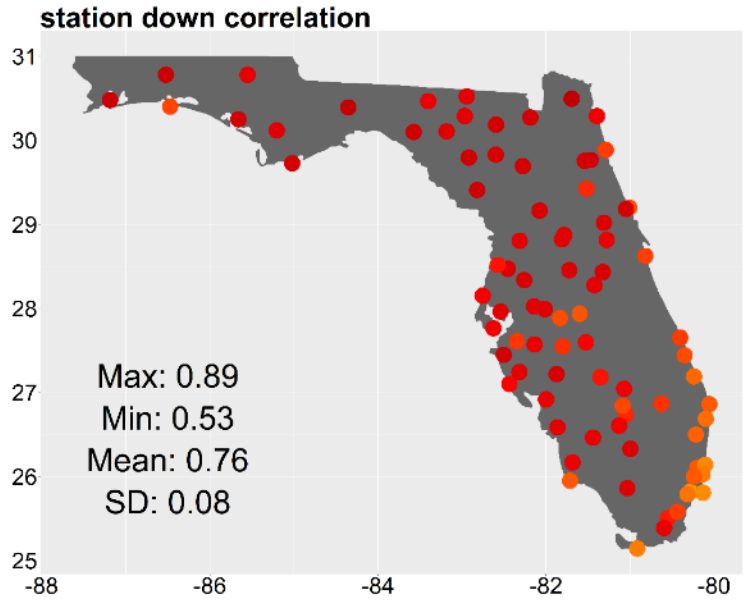

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Health- Analysis
Case-Crossover Design

- Outcomes:
  - May through September hospital admissions & ED visits 2008 – 2012 (SPARCS)
    - Heat Stress, Dehydration, Acute Kidney Failure, Cardiovascular Diseases
- Exposure:
  - Daily maximum temperature (Tmax) & Daily maximum heat index
- Stratum Window: 28 days
- Exposure lags: 1 – 4 days
- Cumulative exposure: 1 – 4 days

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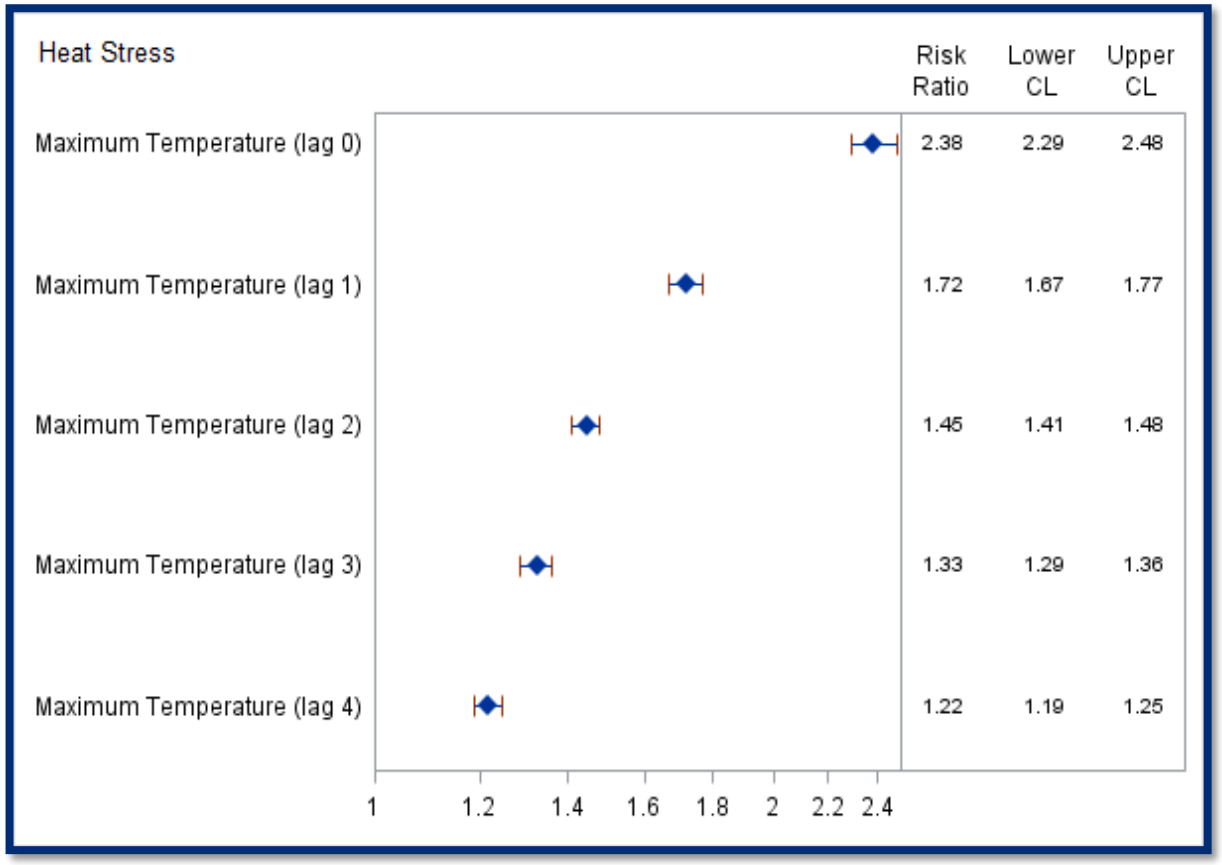
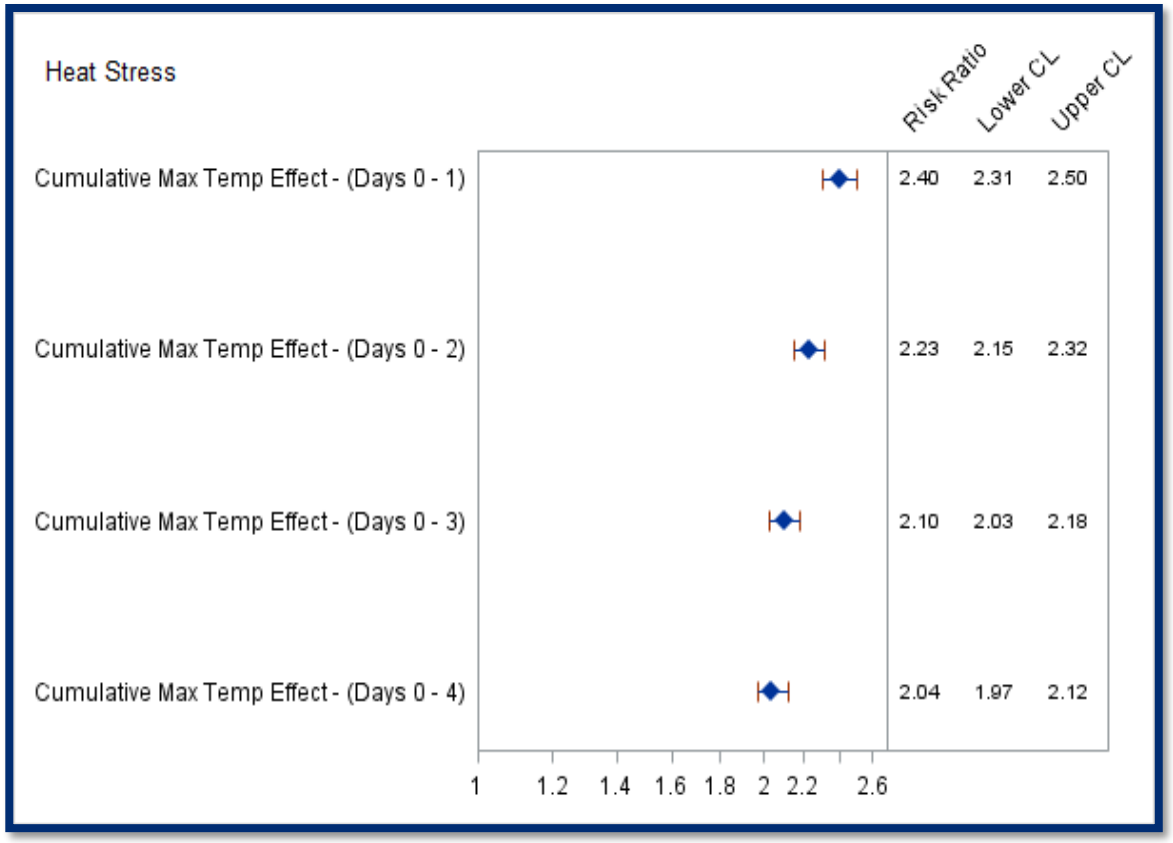
Heat Stress (Lag Effects)





ΨFor every 5F change in temperature
Adjusted for ozone & PM2.5

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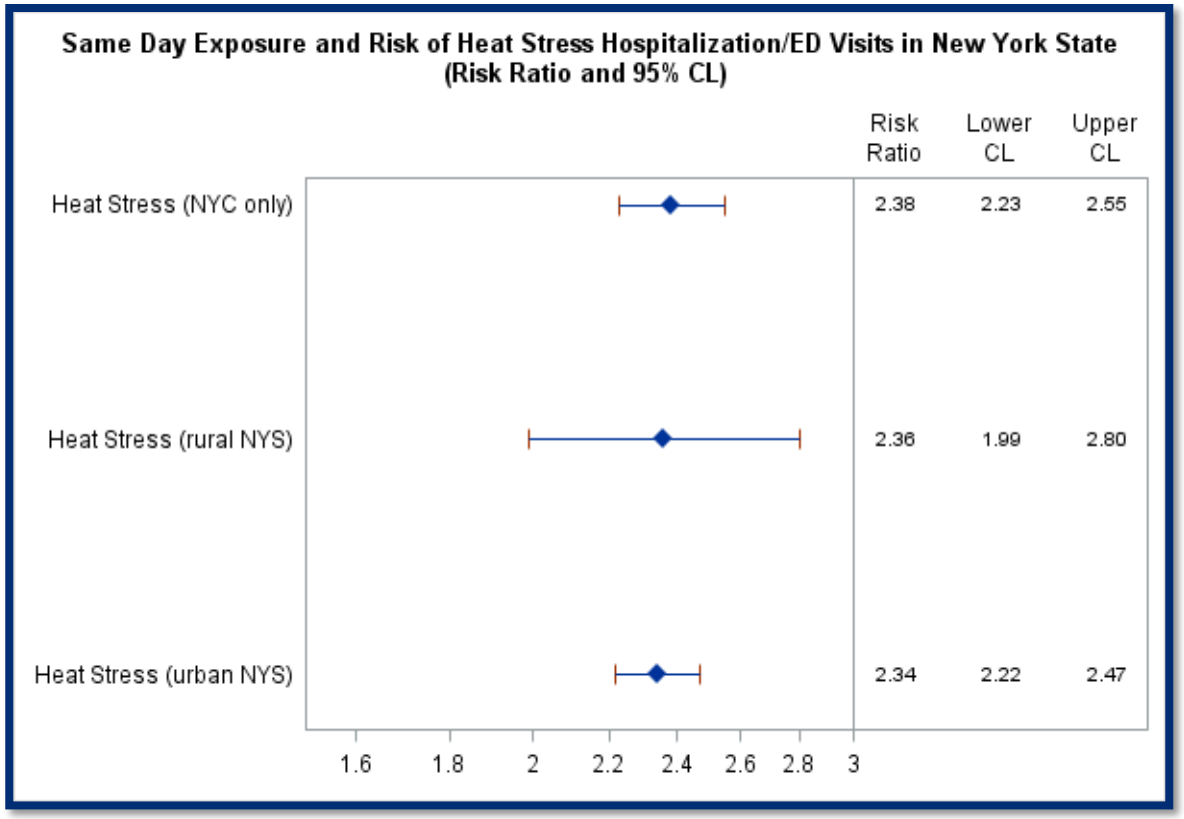
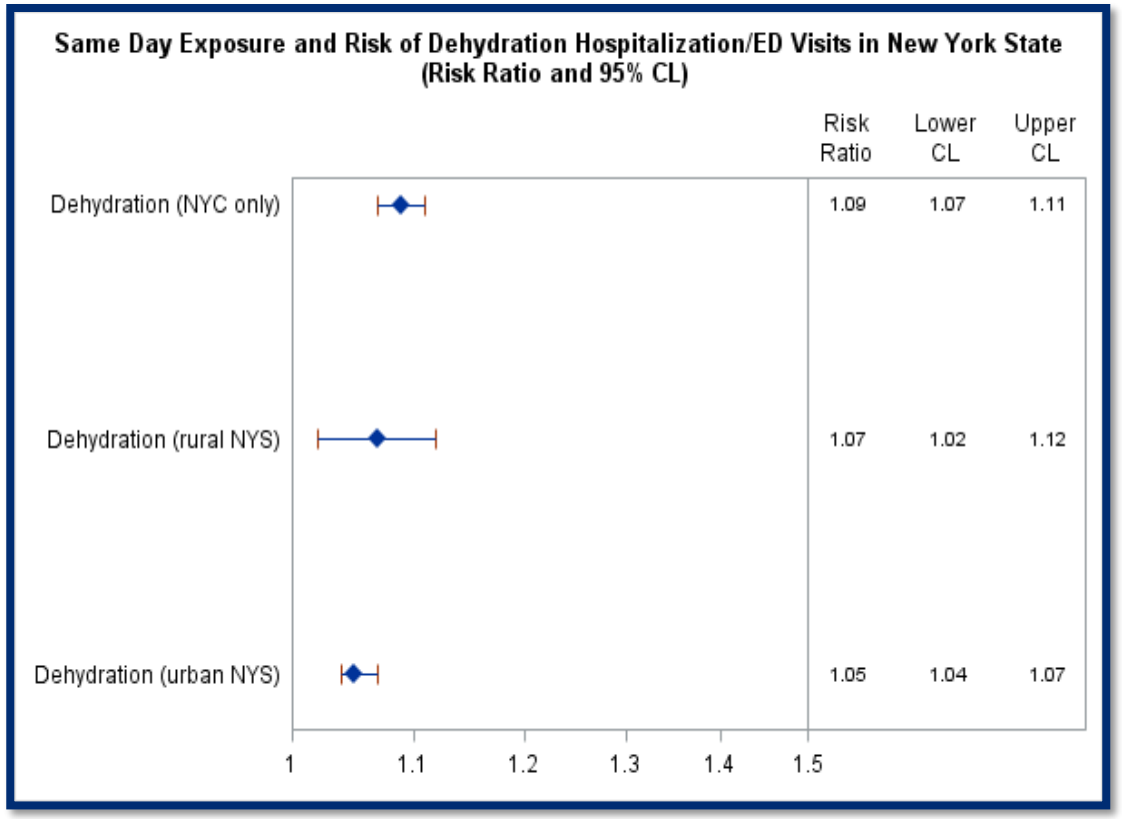
NYC, rural NYS & urban NYS





ΨFor every 5F change in temperature
Adjusted for ozone & PM2.5

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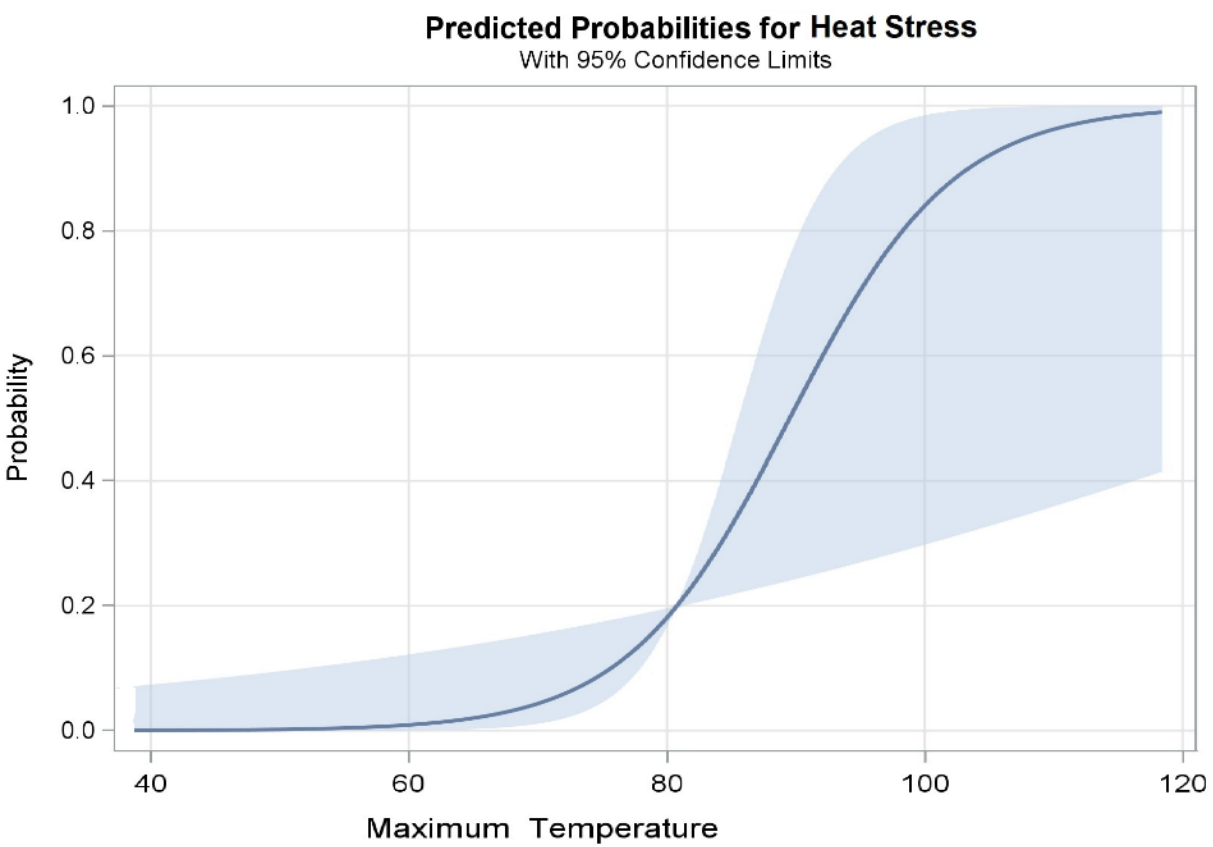
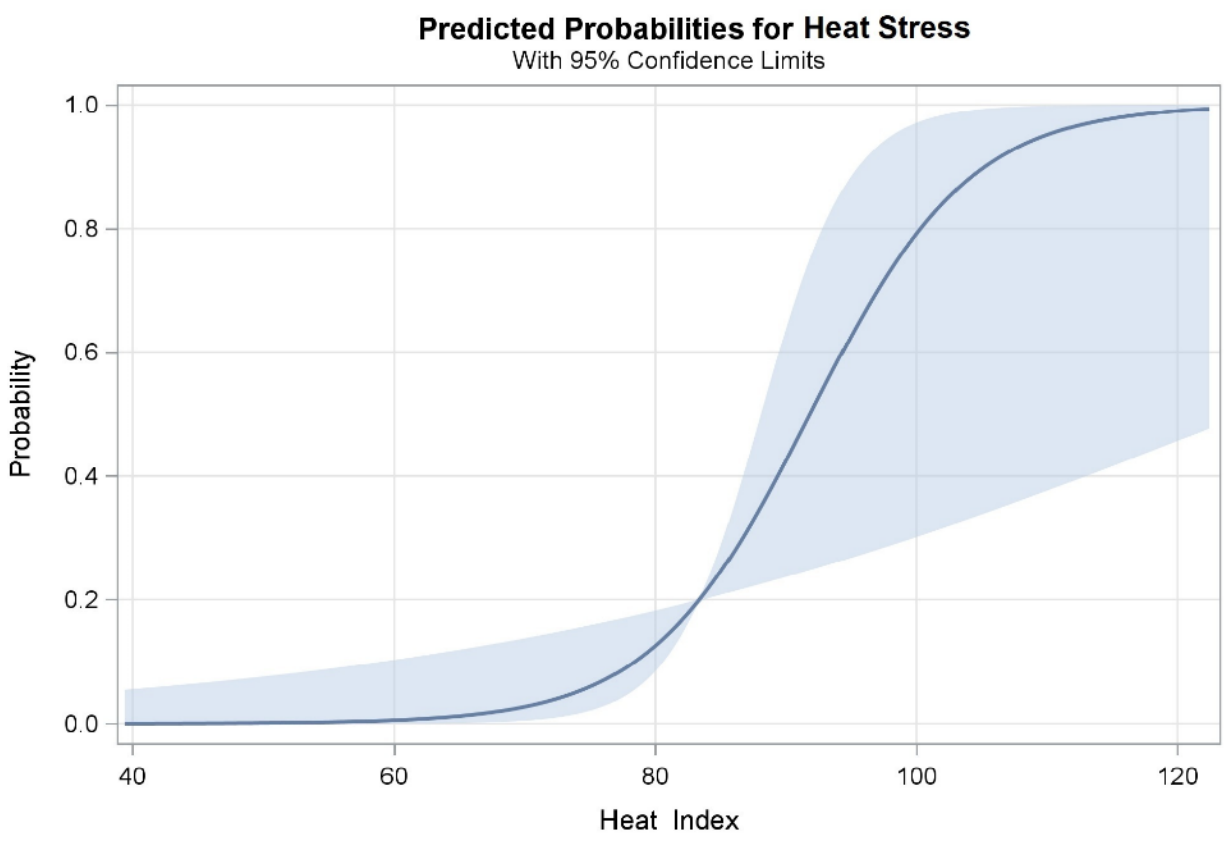
Heat Stress – *Threshold Analysis*





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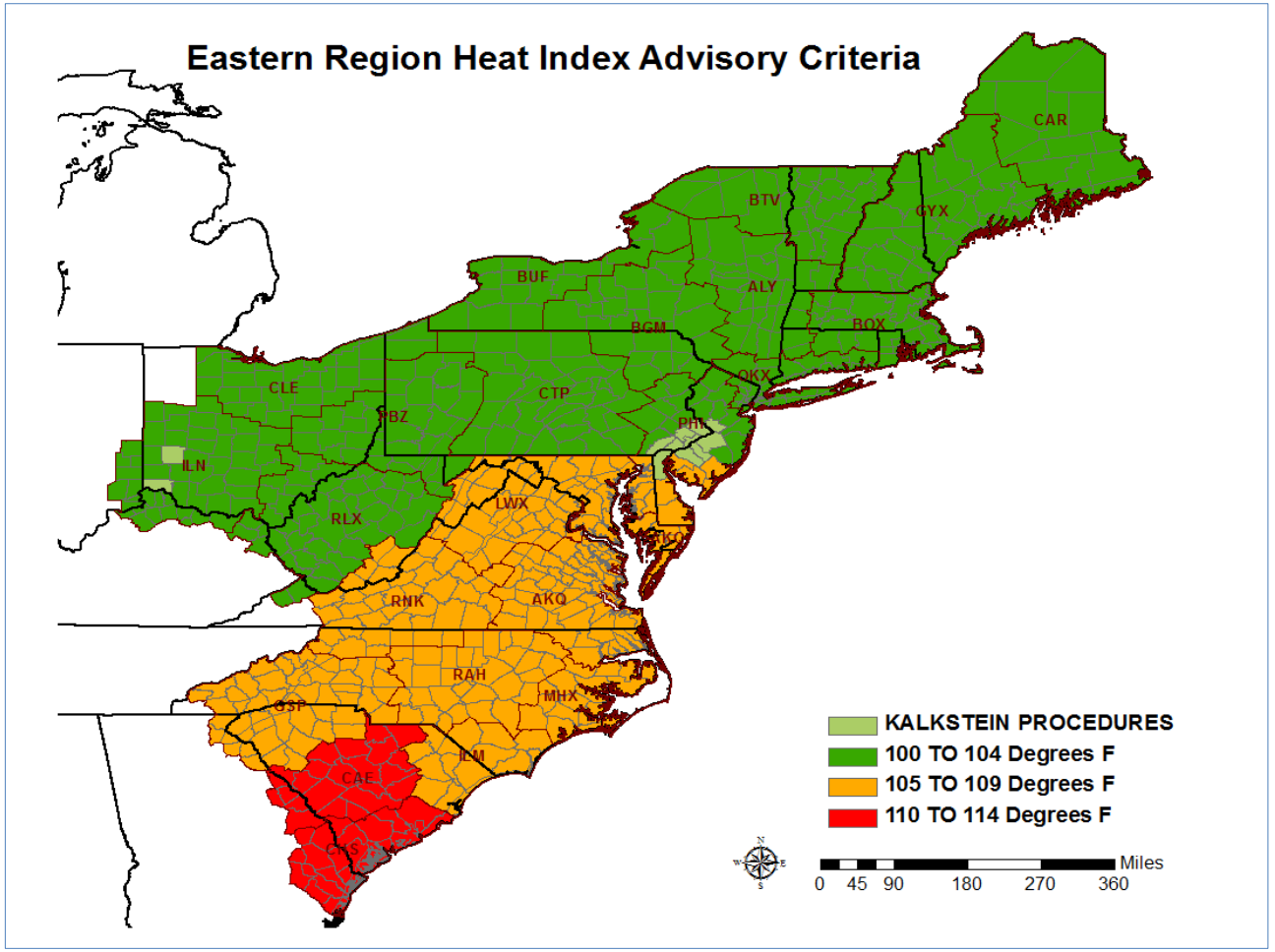
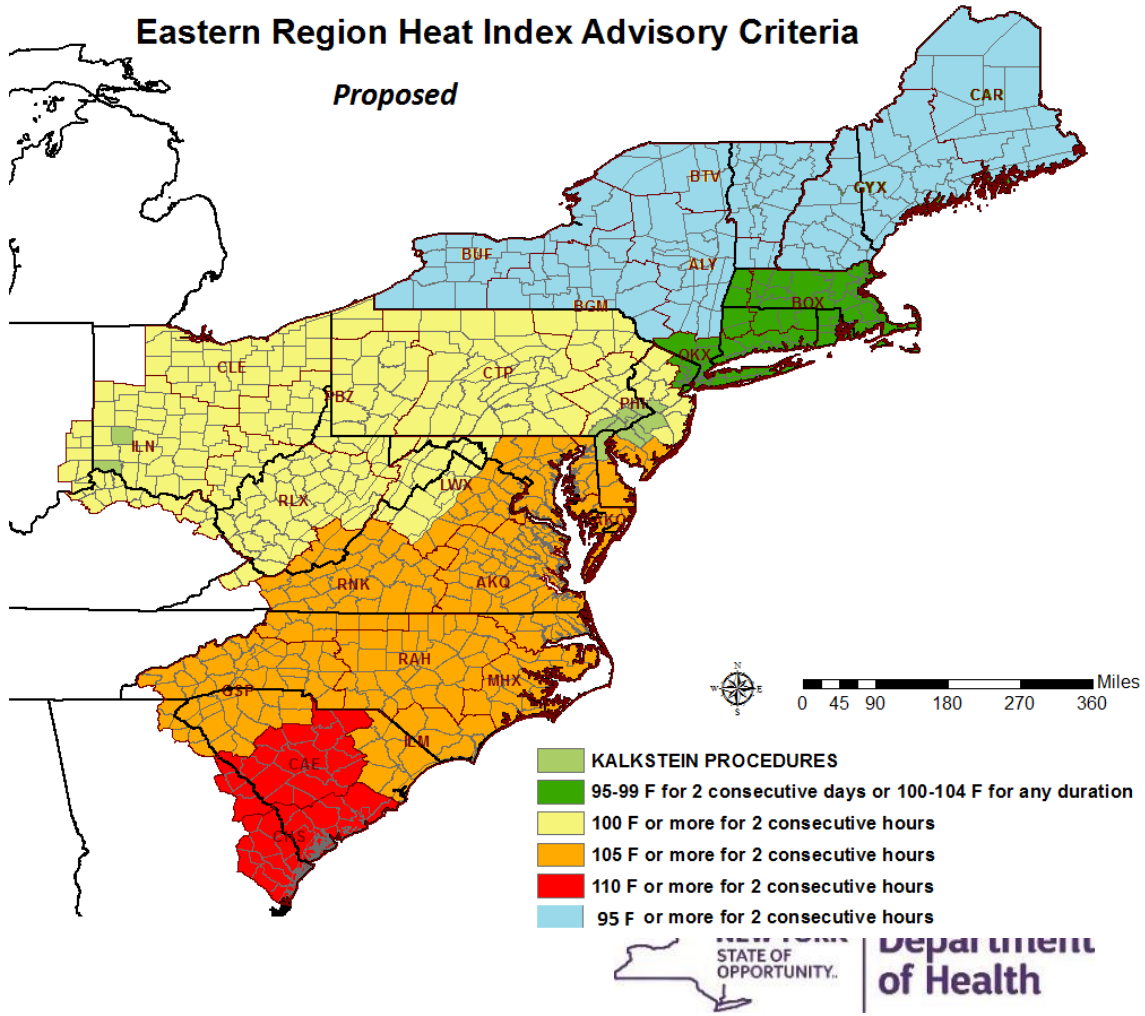
NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION





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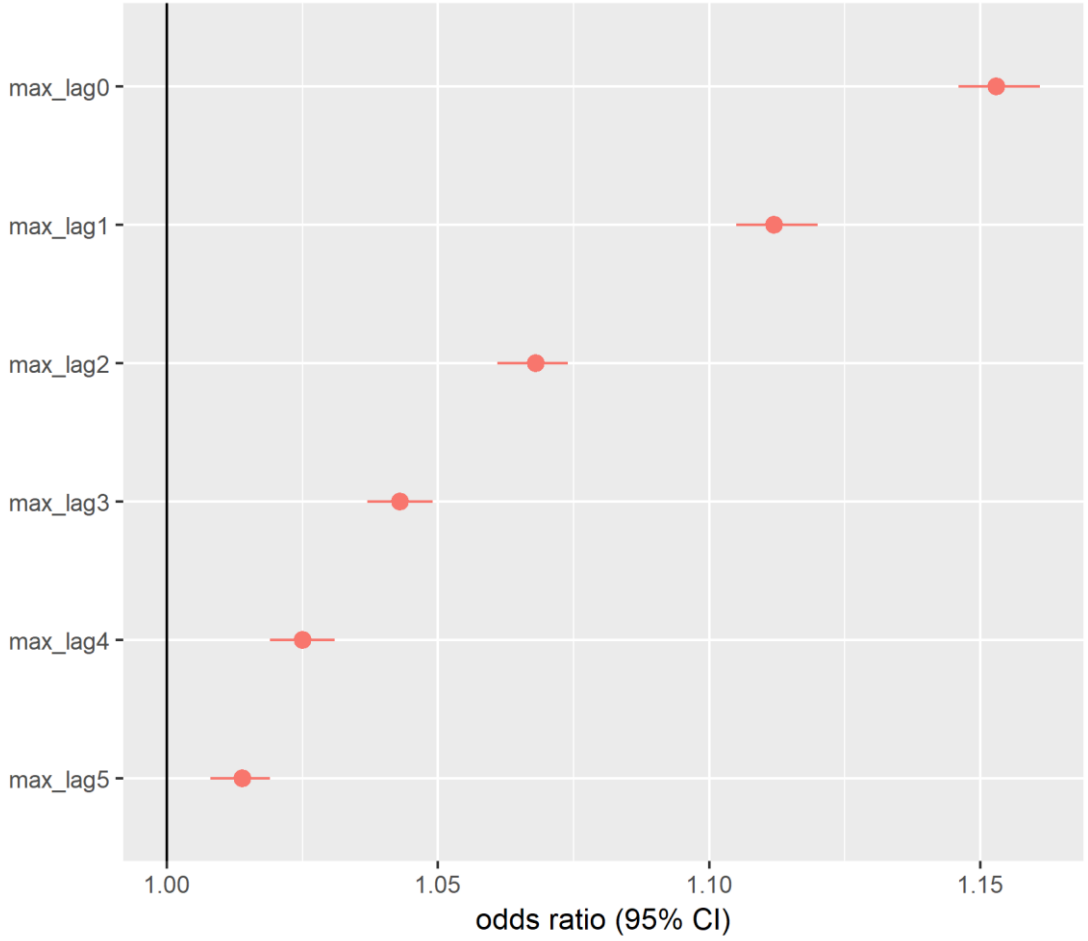
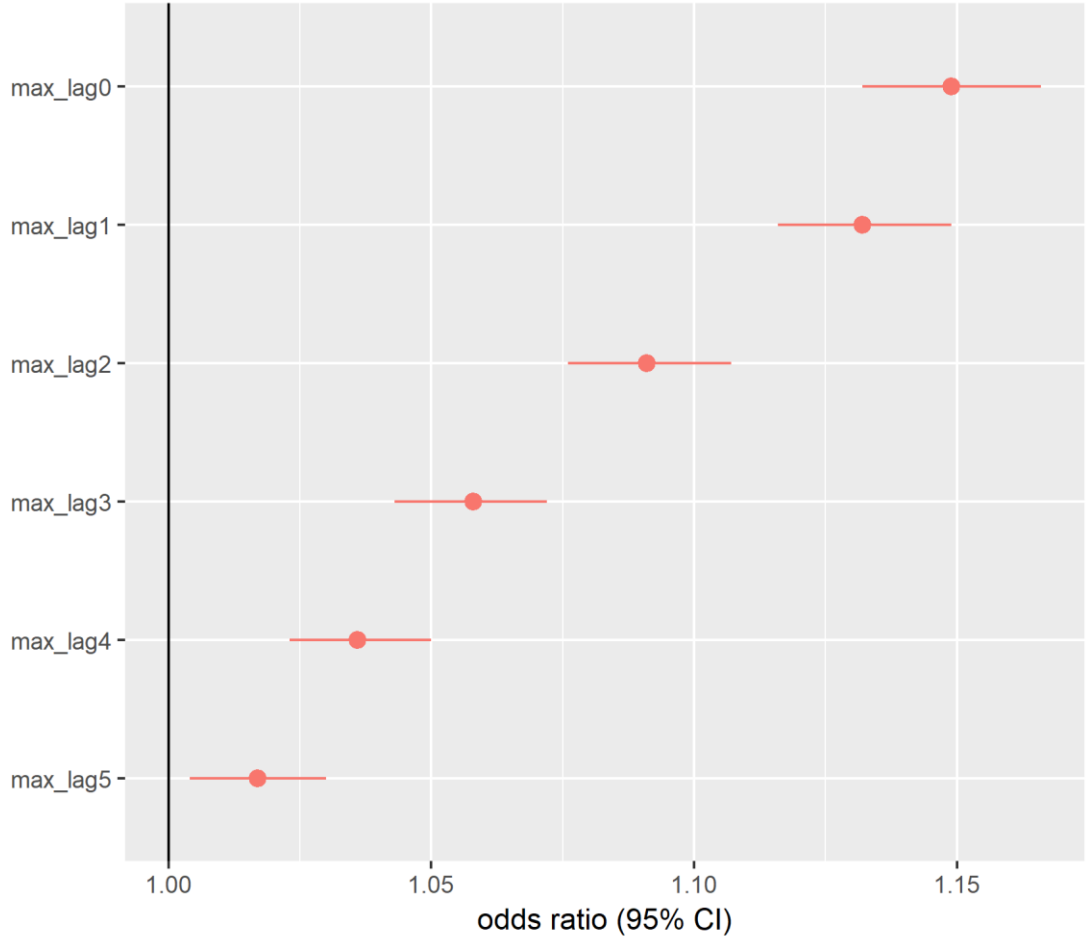
Florida Heat-related (left: ED, right: HSP)





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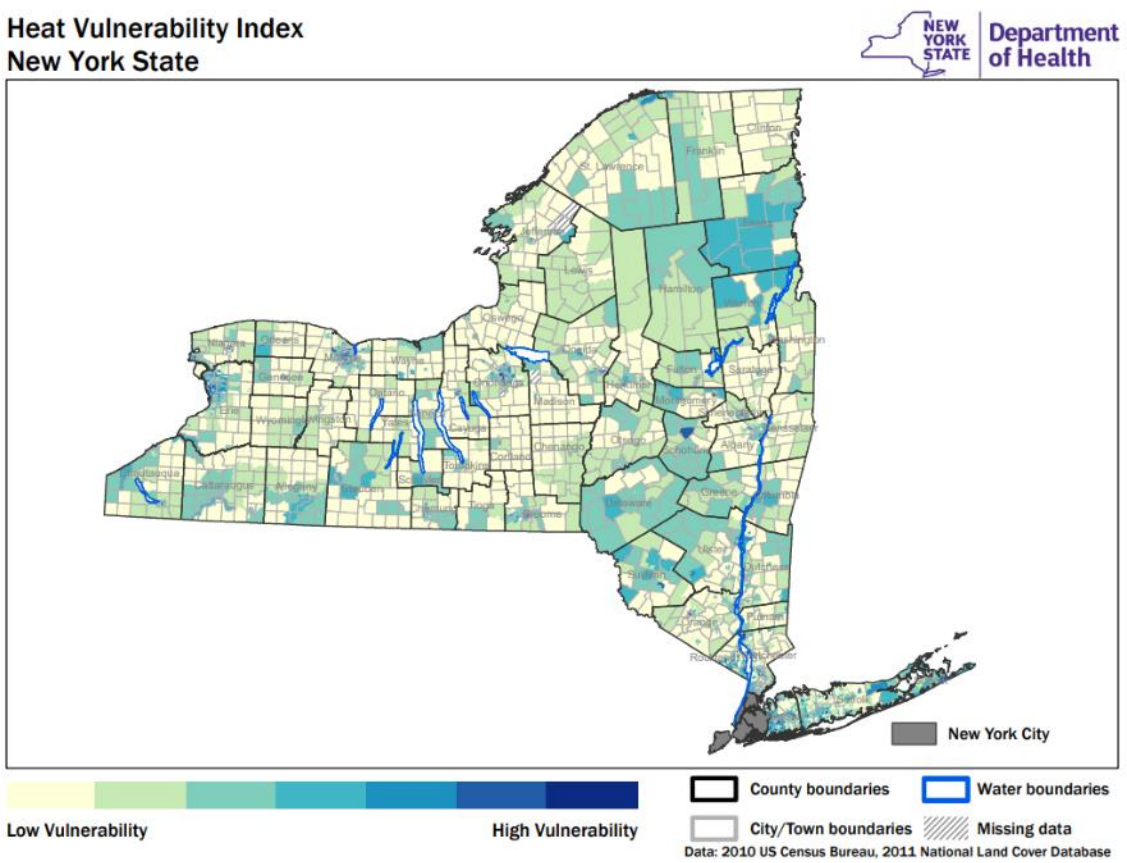
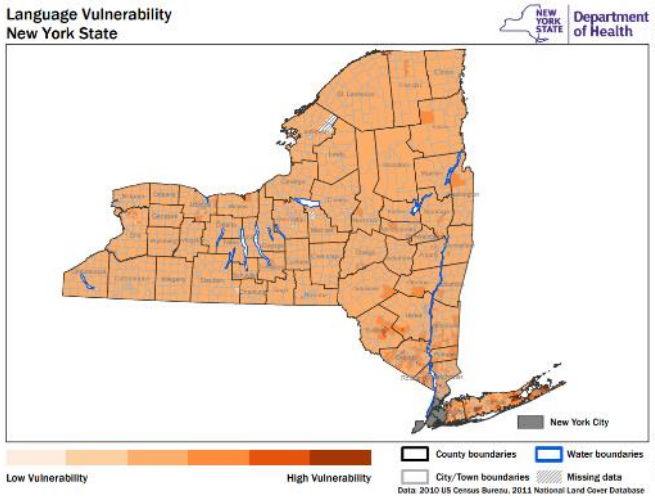
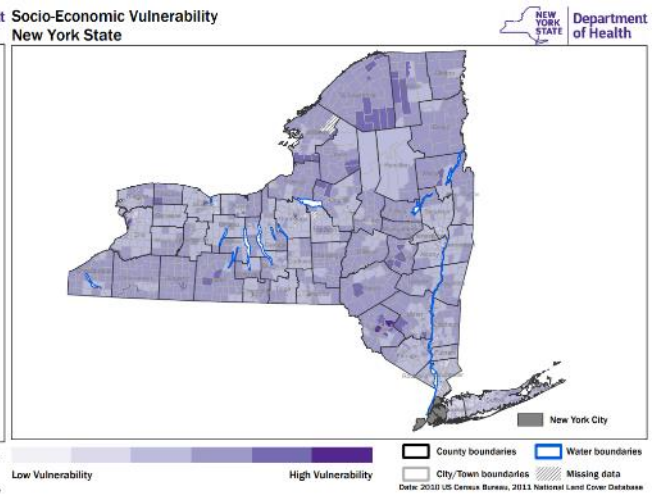
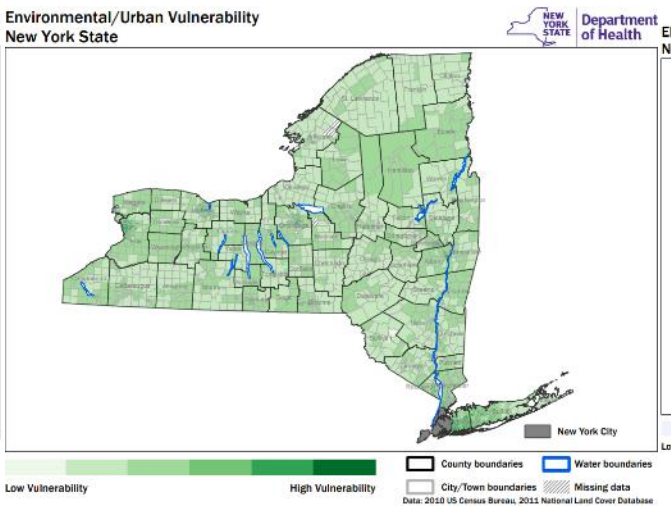


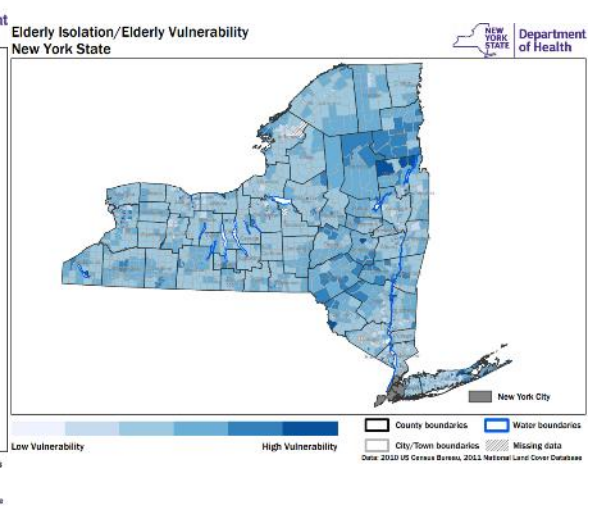
Heat Vulnerability	Vulnerability Category	Heat Vulnerability Factors (Variables)
	Language Vulnerability	Percent population that is Hispanic Percent population that is foreign born Percent population who speak English 'less than very well'
	Socio-economic Vulnerability	Percentage population with income below poverty level Percentage population that is Black Percentage population (18–64 years) that has a disability Percentage population (18–64 years) that are unemployed
	Environmental/Urban Vulnerability	Percentage houses built before 1980 Density of housing units per square mile Percentage land with highly developed areas Percentage land that consists of open undeveloped areas
	Elderly Isolation and Vulnerability	Percentage population 65 years of age and over Percentage population 65 years of age and over and living alone

https://www.health.ny.gov/environmental/weather/vulnerability_index/index.htm

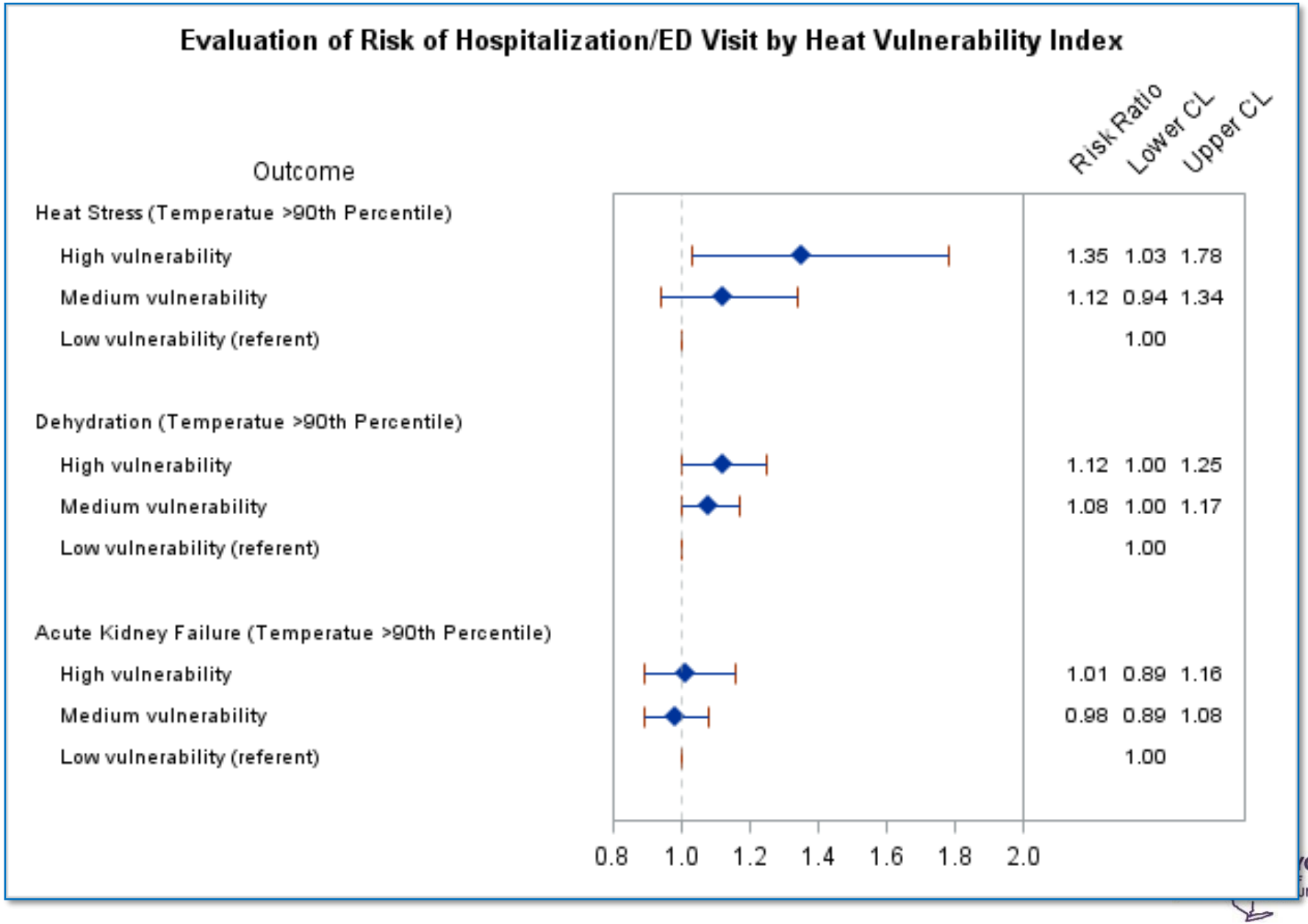








Evaluation of Risk of Hospitalization/ED Visit by Heat Vulnerability Index



Department of Health

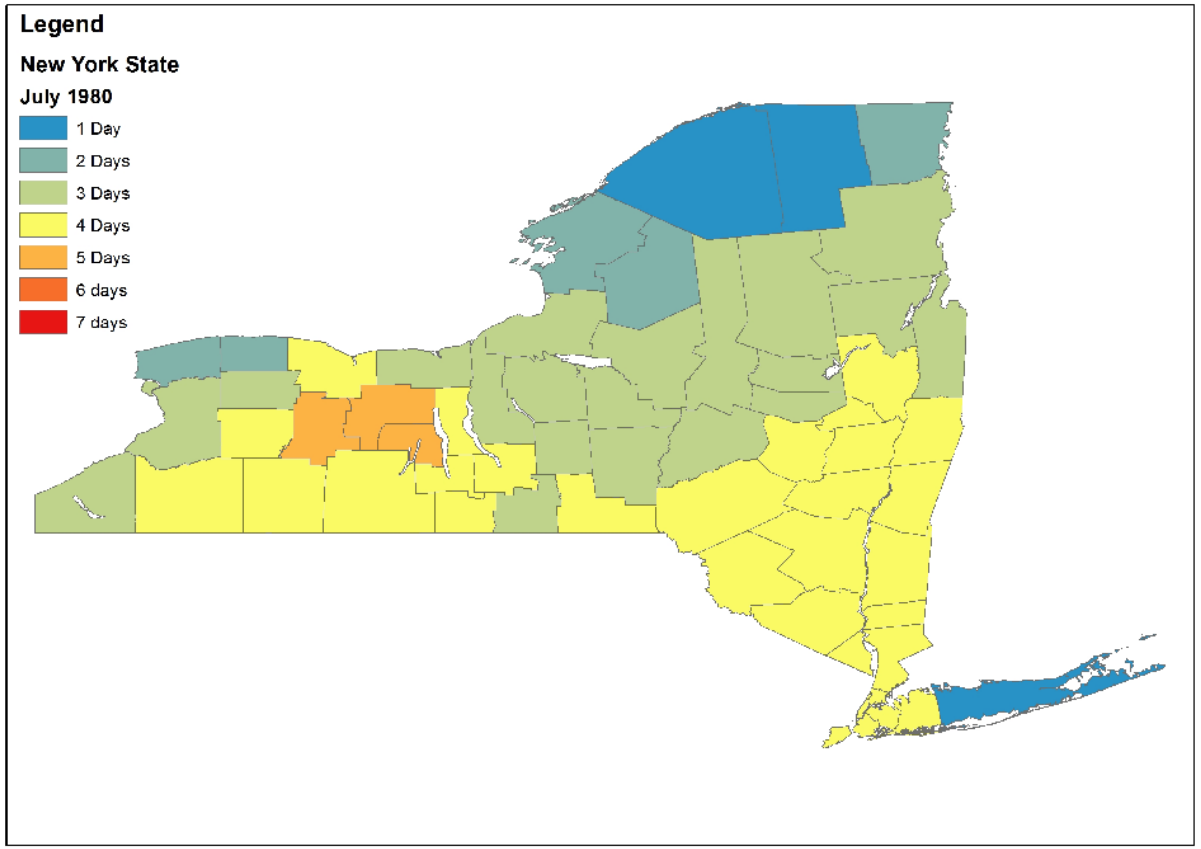
NYS EPHT/ CDC EPHT

DATA DISSEMINATION AND INDICATORS

***Relative Thresholds calculated based on the temperature distribution of the NLDAS grids within the entire county, by month, over the 1980-2010 baseline period.**

Temperature
Relative Threshold 90th %
Maximum Temperature
1980
July
Export Data

Relative Threshold Days Above 90th Percentile Maximum Temperature July 1980



County Level Maps

- Number of Extreme Heat Days
  - By Year
    - By Month

- Absolute Threshold: 90 degrees F
  - Daily Maximum Temperature
  - Daily Maximum Heat Index
- Absolute Threshold: 95 degrees F
  - Daily Maximum Temperature
  - Daily Maximum Heat Index
- Absolute Threshold: 100 degrees F
  - Daily Maximum Temperature
  - Daily Maximum Heat Index
- Relative Threshold*: 90th percentile
  - Daily Maximum Temperature
  - Daily Maximum Heat Index
- Relative Threshold*: 95th percentile
  - Daily Maximum Temperature
  - Daily Maximum Heat Index
- Relative Threshold*: 99th percentile
  - Daily Maximum Temperature
  - Daily Maximum Heat Index

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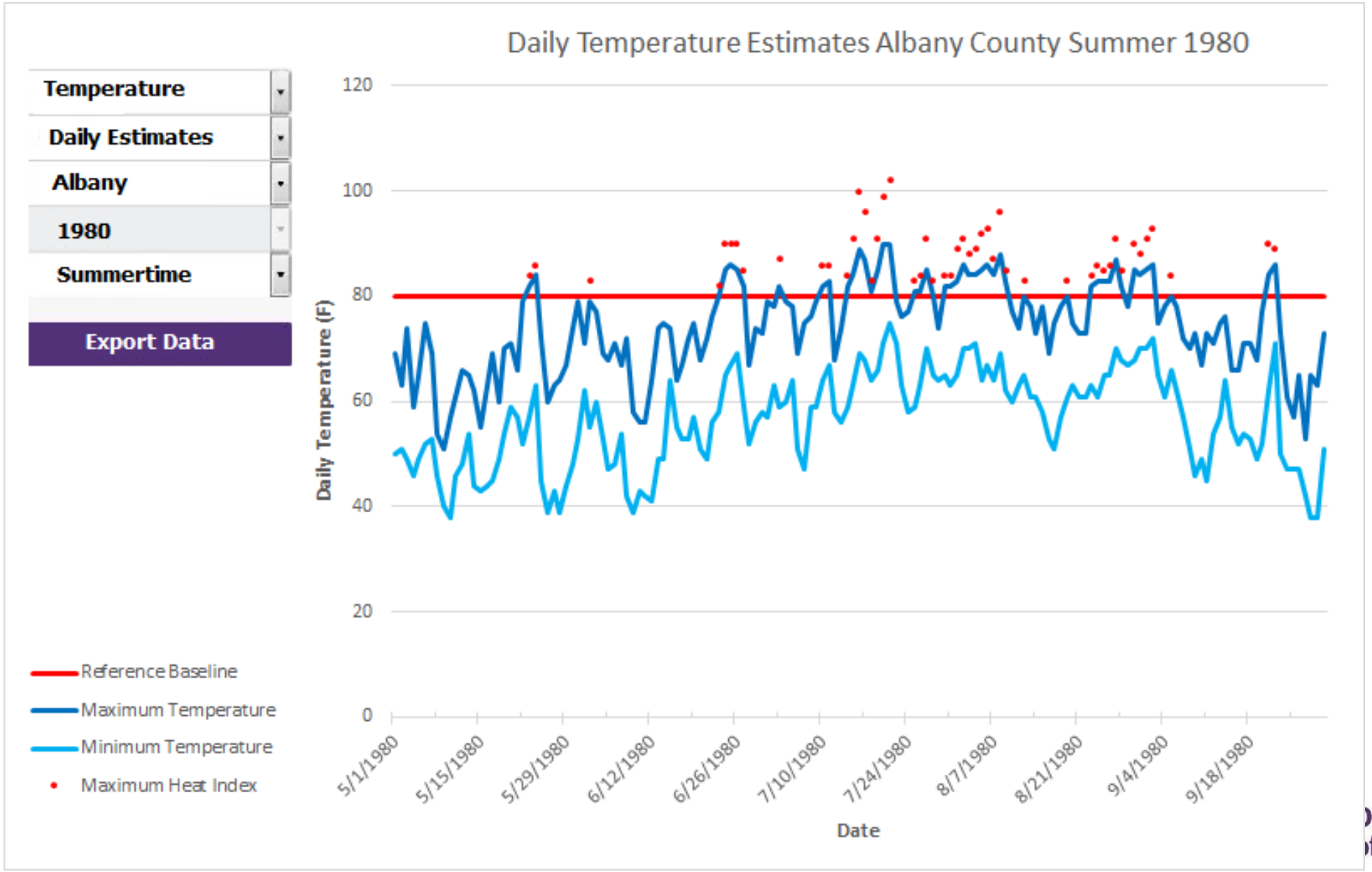
Daily Temperature Estimates for Summer Months by County by Year



Department of Health

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Temperature

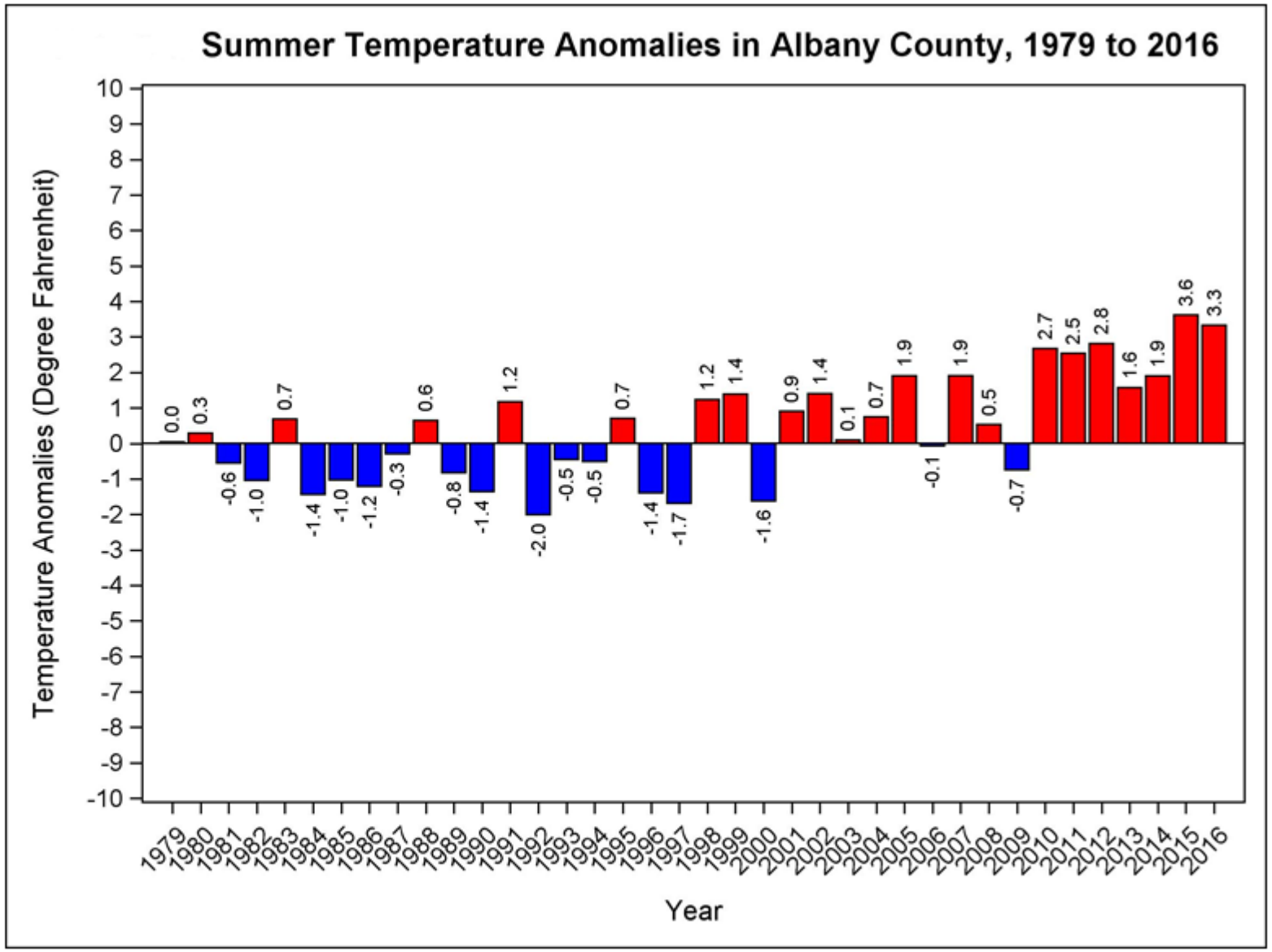
Anomalies

Albany

Summer

Yearly

Export Data



*Temperature anomalies were calculated based on the deviation of the average summer temperature in each county from the 30-year baseline/norm (1980 – 2010) for each county (0 represents the 30 year norm for each county)

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Temperature

Maximum Temperature

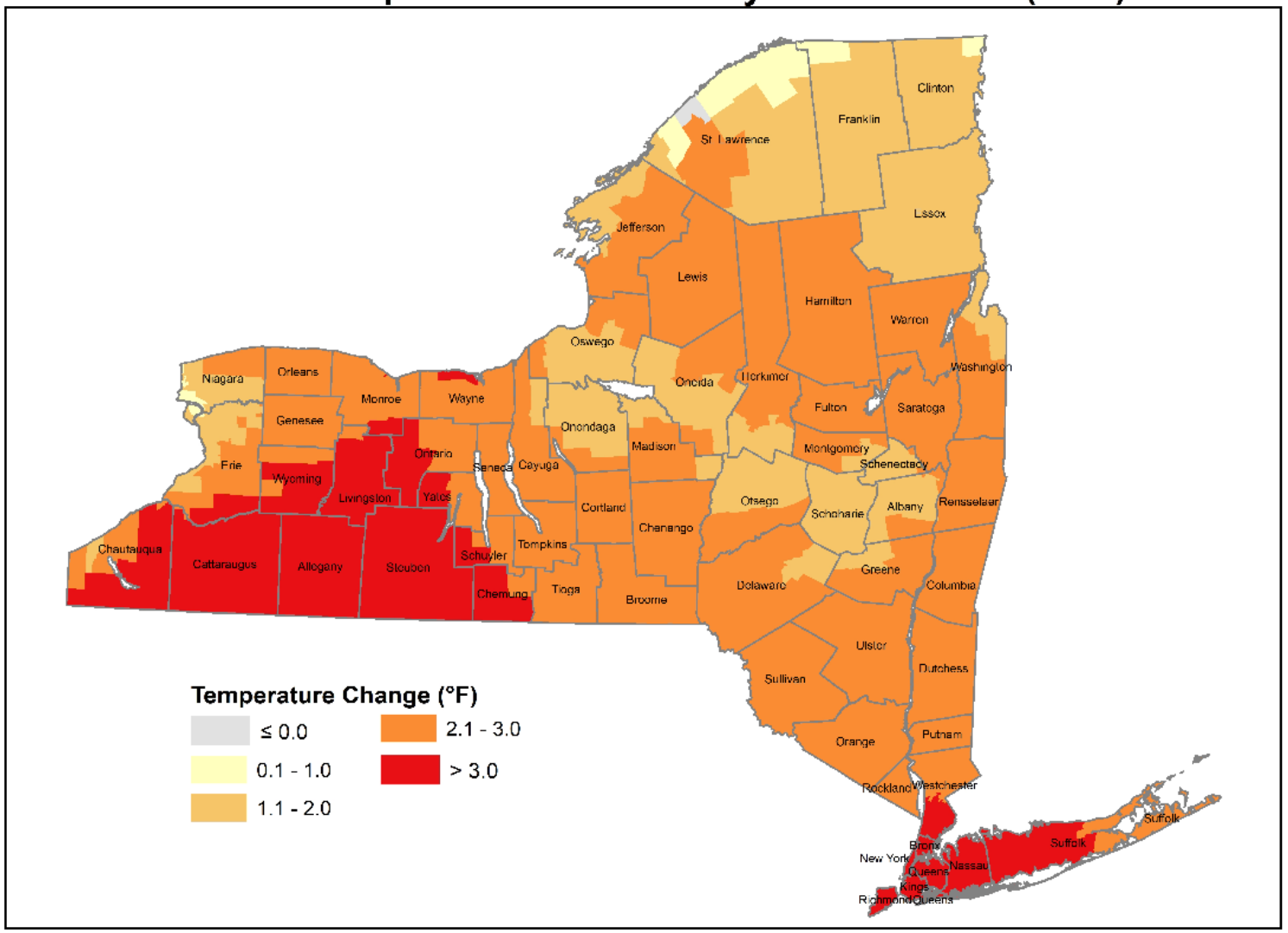
2010

Summer

Anomalies

Export Data

Summer Temperature Anomalies by Census Tracts (2010)

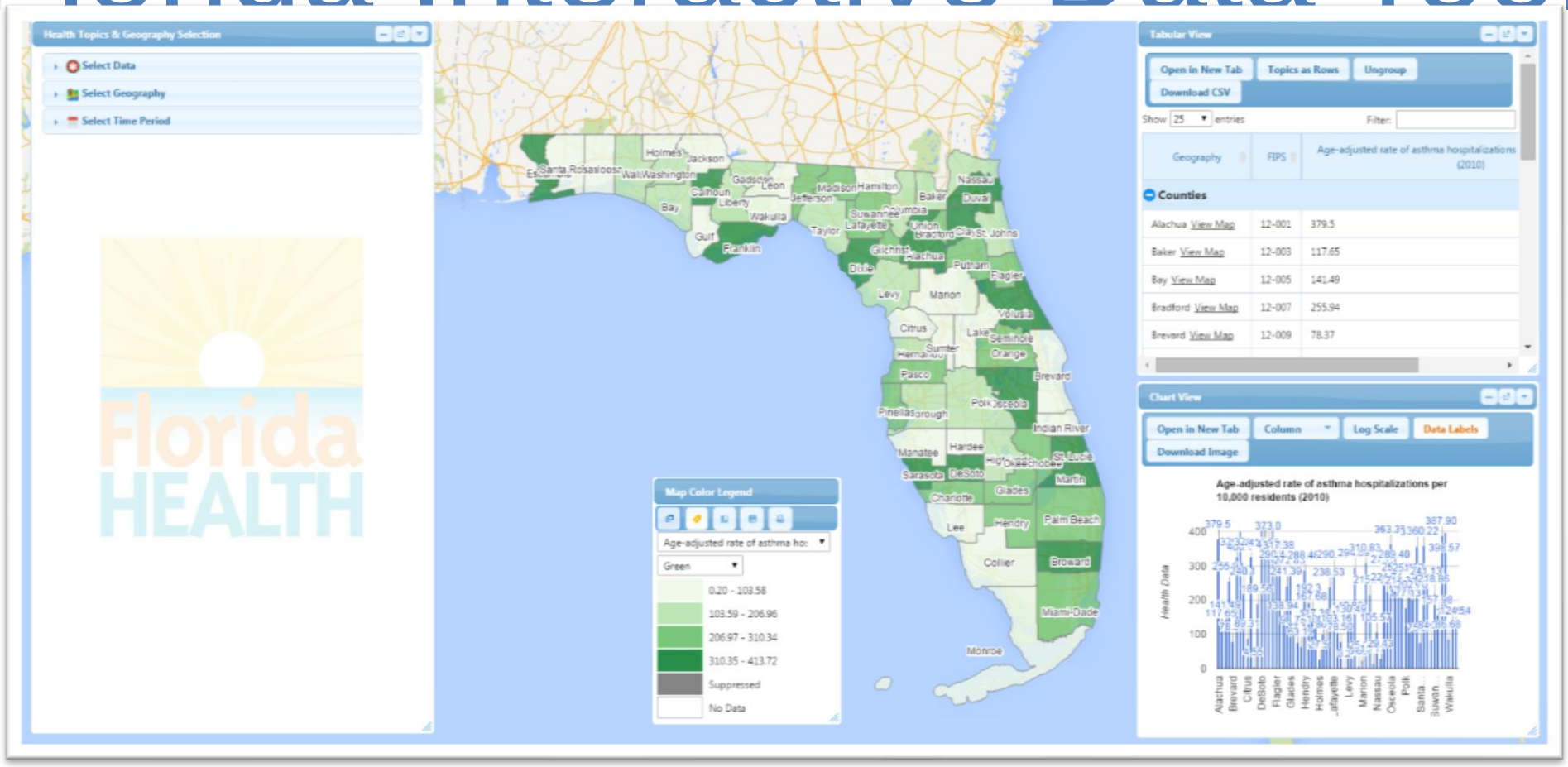


***Temperature anomalies were calculated based on the deviation of the average summer temperature in each census tract from the 30-year baseline/norm (1980 – 2010) for each census tract (0 represents the 30 year norm for each census tract)**

artment
lealth

DRAFT: DO NOT DISTRIBUTE

Florida Interactive Data Tool



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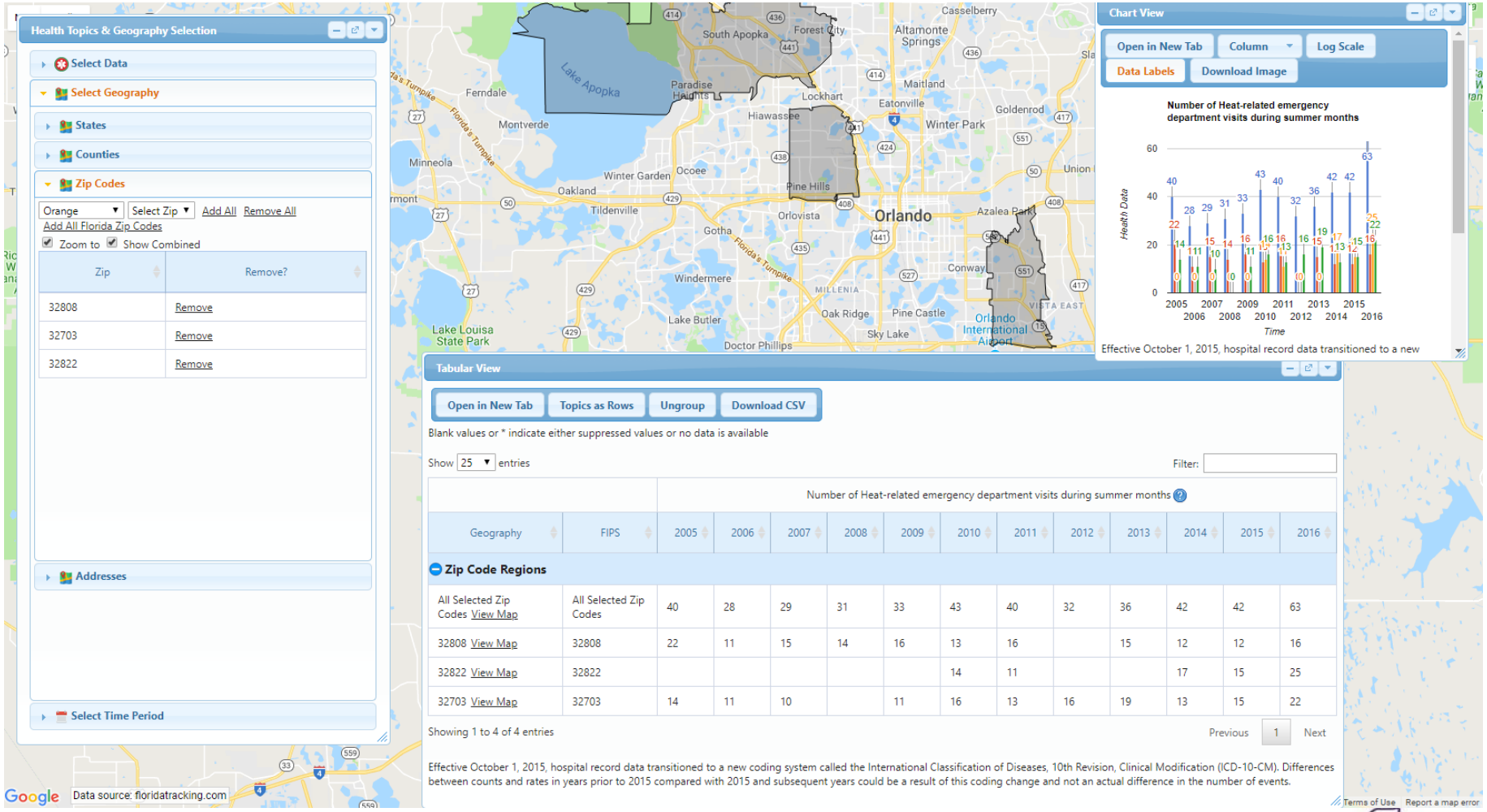
ZIP Code Level Heat Data (ED Visits)



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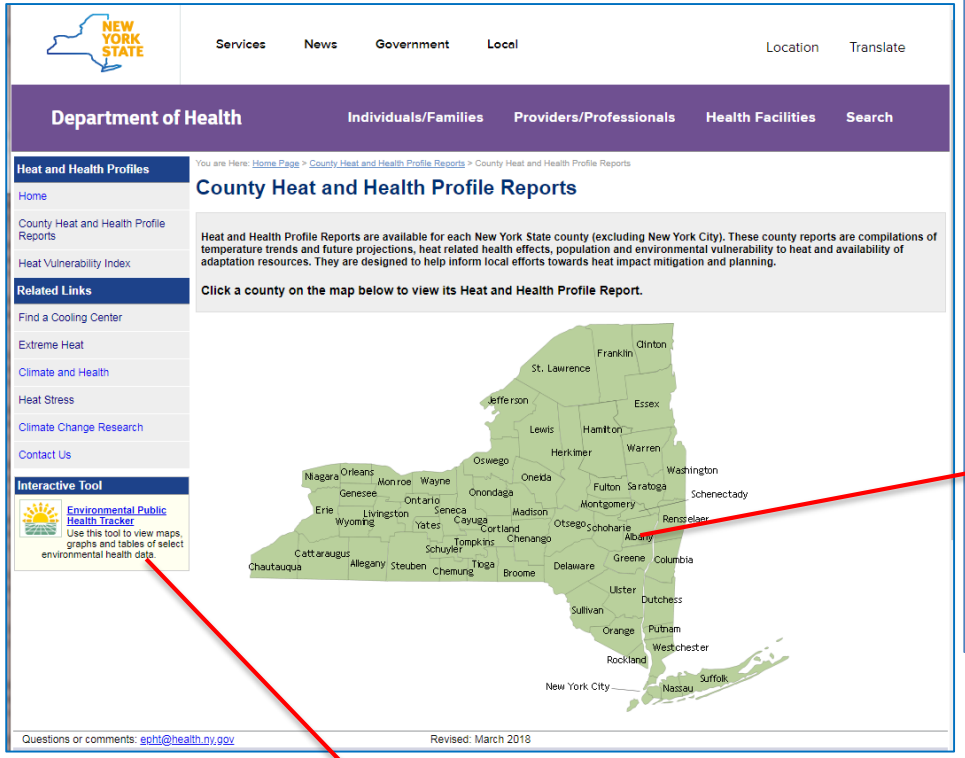
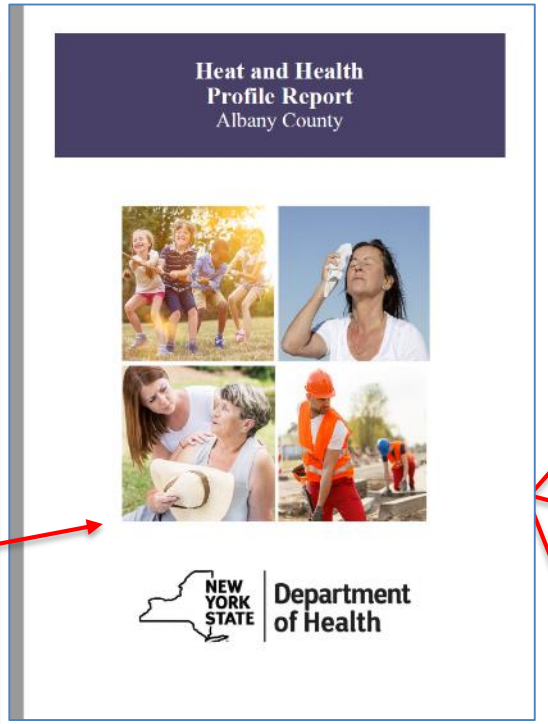
OUTREACH EFFORTS

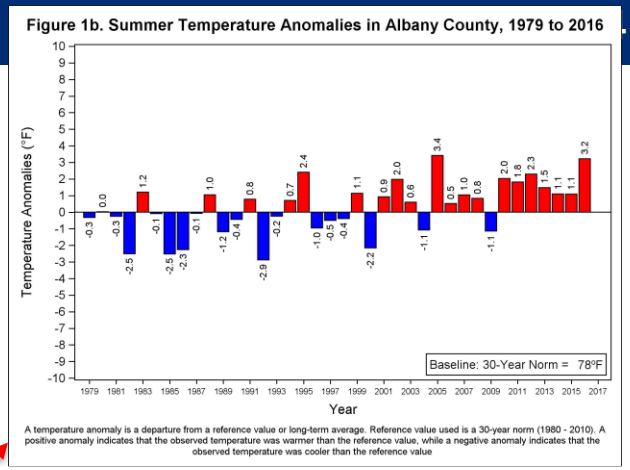
Public Affairs Group, CEH-Outreach and Education, NYS EPHT, NYS CRSCI, NYSERDA

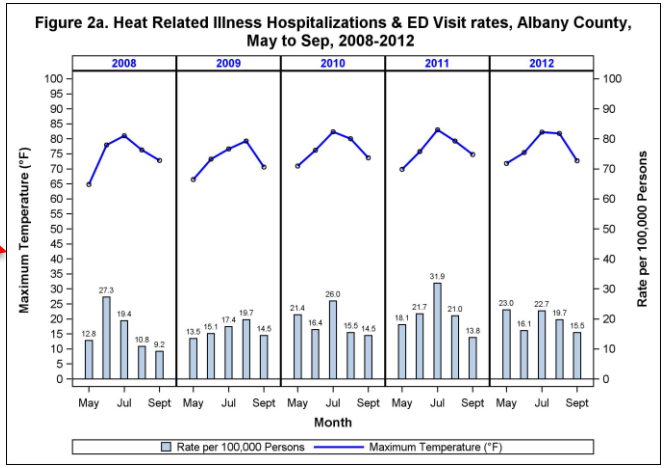
NEW YORK STATE OF OPPORTUNITY. Department of Health

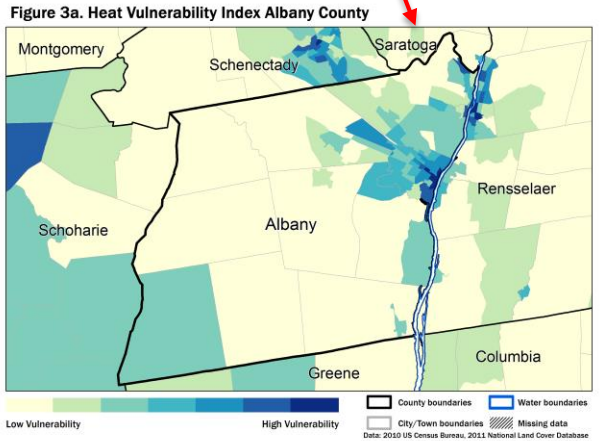
NYSDOH County-Heat Health Profiles



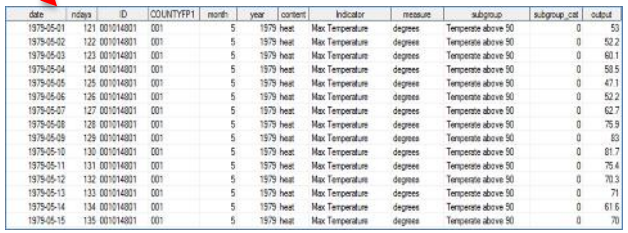








Downloadable data at census tract level



Includes information on temperature exposure, heat impacted health and heat vulnerability in each county

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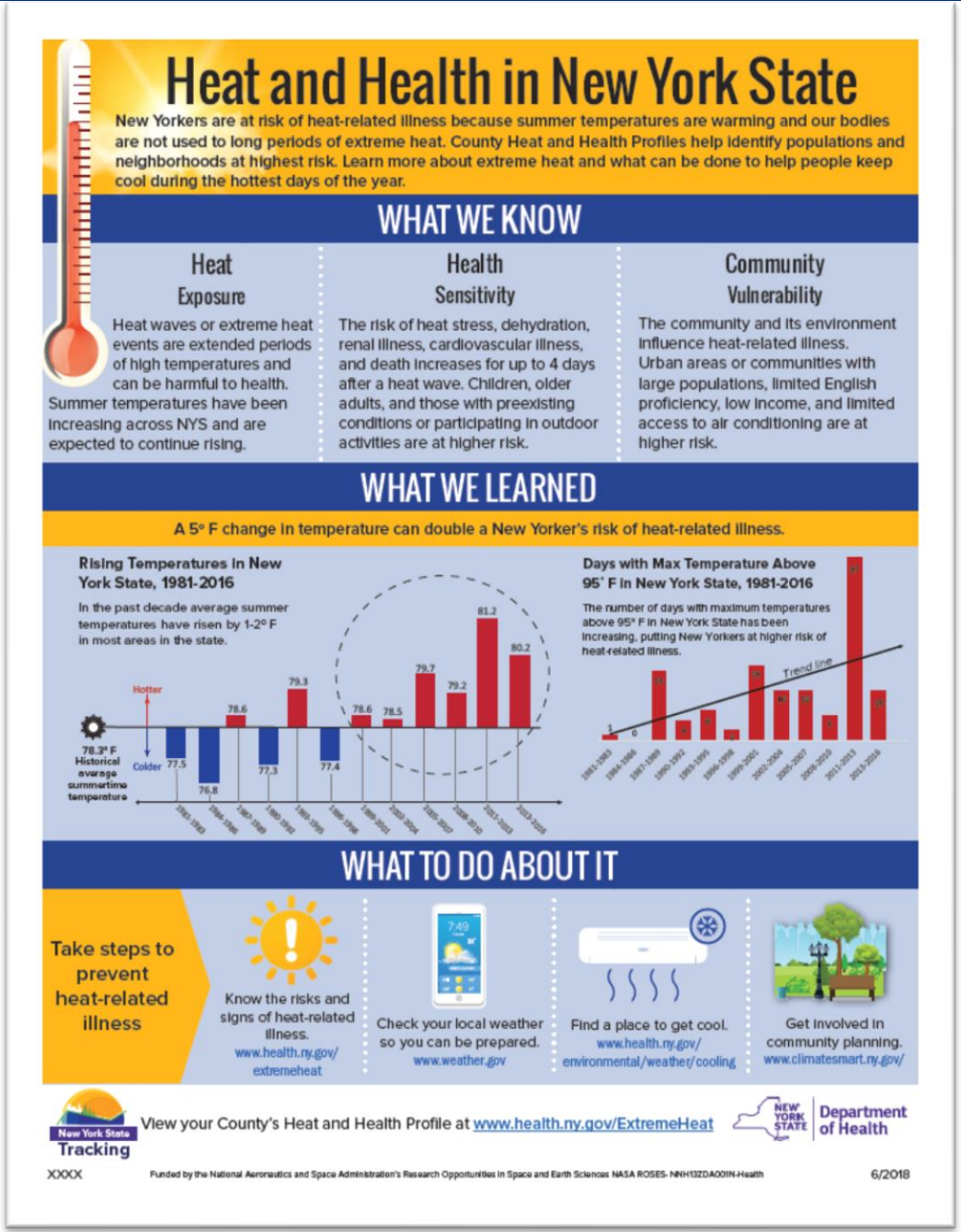
http://www.health.ny.gov/environmental/public_health_tracking/

twitter



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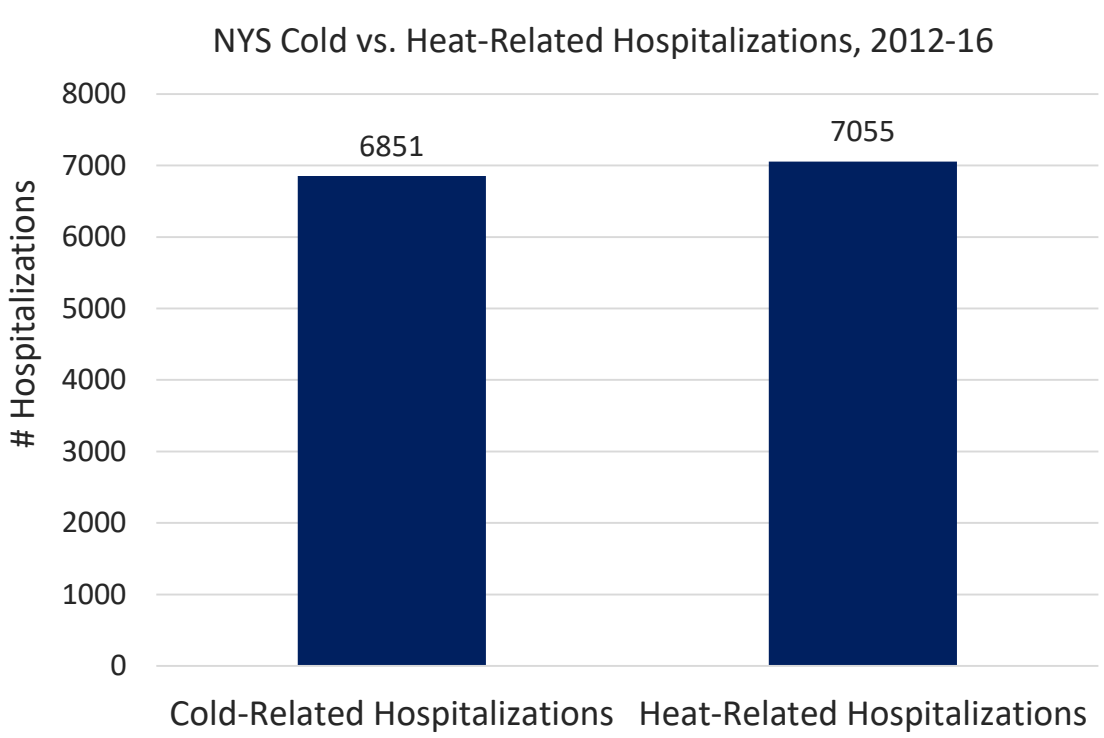
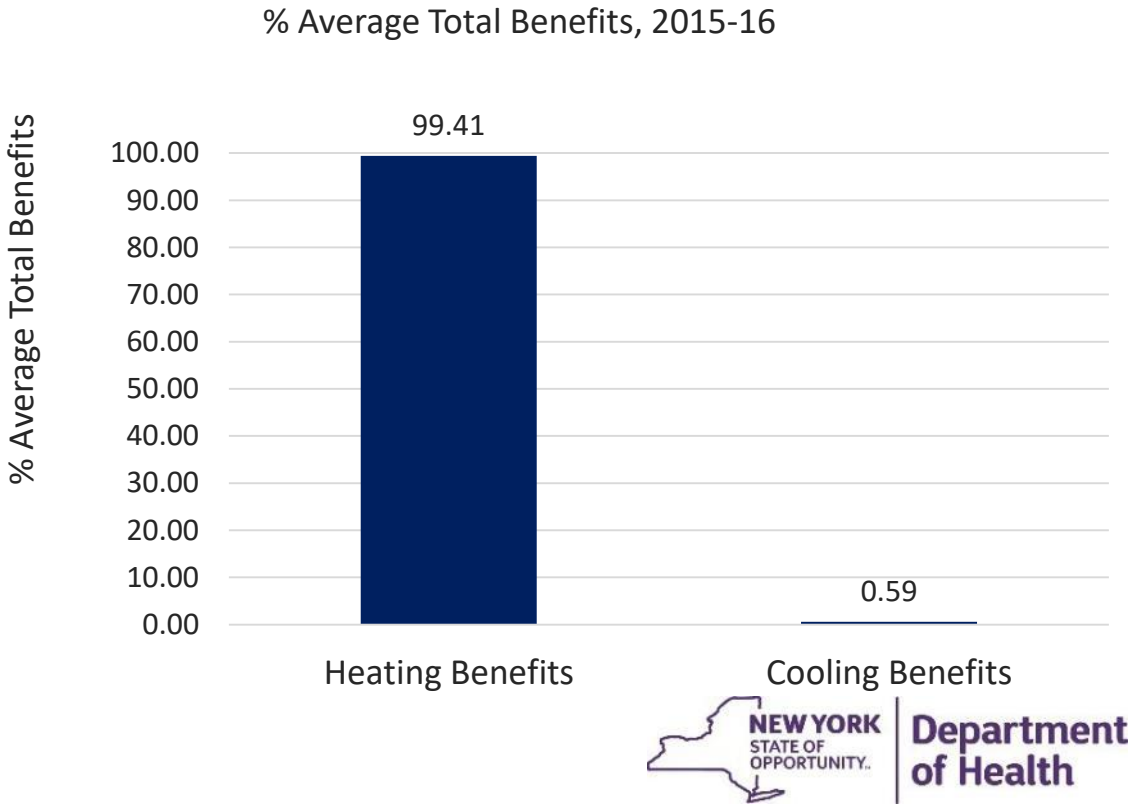
Office of Temporary and Disability Assistance- Home Energy Assistance Program

Distribution of HEAP Benefits and Illness





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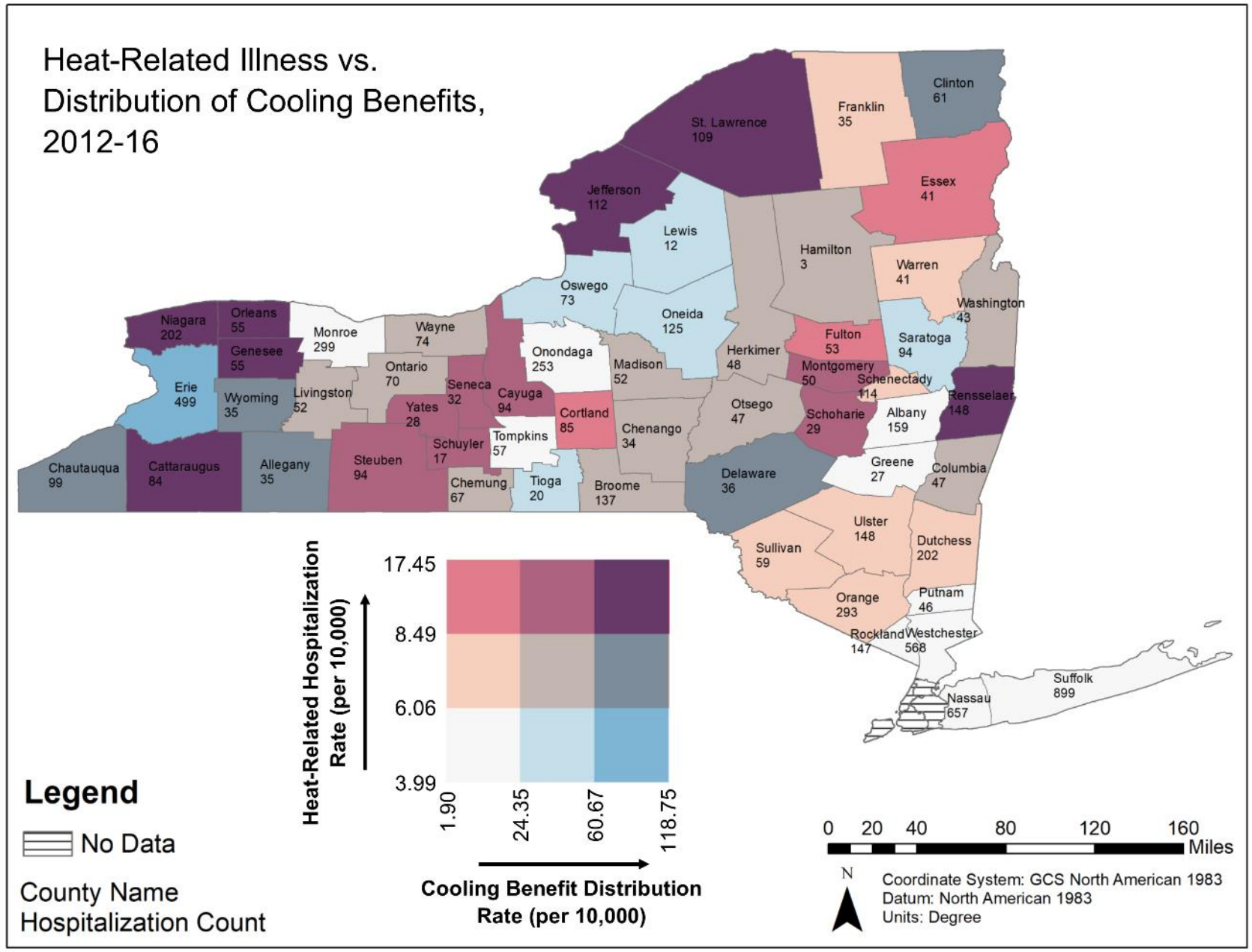

Department of Health

Past and Upcoming

PRESENTATIONS AND TRAINING

APHA

AMERICAN PUBLIC HEALTH ASSOCIATION

For science. For action. For health.

NASA ARSET

Applied Remote Sensing Training

AGU

American Geophysical Union

ser Society for Epidemiologic Research

NYSACC

NEW YORK STATE ASSOCIATION OF CONSERVATION COMMISSIONS

2017 Conference on the Environment

November 17-18, 2017 | Kingston, NY

AMS

American Meteorological Society

CHART the Course

CLIMATE AND HEALTH ● HEALTH STUDIES ● AIR POLLUTION AND RESPIRATORY HEALTH ● RADIATION STUDIES ● TRACKING

2016 Summit on Environmental Hazards and Health Effects

Manuscripts**(In review/planned):**

- **Ground-truth of a 1 km downscaled NLDAS air temperature product using the New York City Community Air Survey**" Under 2nd review at the Journal of Applied Meteorology and Climatology

- **Estimating policy relevant health effects of ambient heat exposures using spatially contiguous remote sensing reanalysis data –** Under review at Environmental Health

- **Downscaling NLDAS Air Temperature Using MODIS Land Surface Temperatures-** Being readied for submission at Remote Sensing

Manuscripts (planned)

- NYS Downscaling Validation manuscript
- NYS Vulnerability manuscript
- Florida Validation manuscript
- Florida Health manuscript

Thank You

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