Climate Smart Communities Webinar

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Welcome

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Climate Smart Communities Webinar

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Explore a New Environmental Area: Climate Factors / Change and Under-Studied Health Risks

Feb 14, 2013

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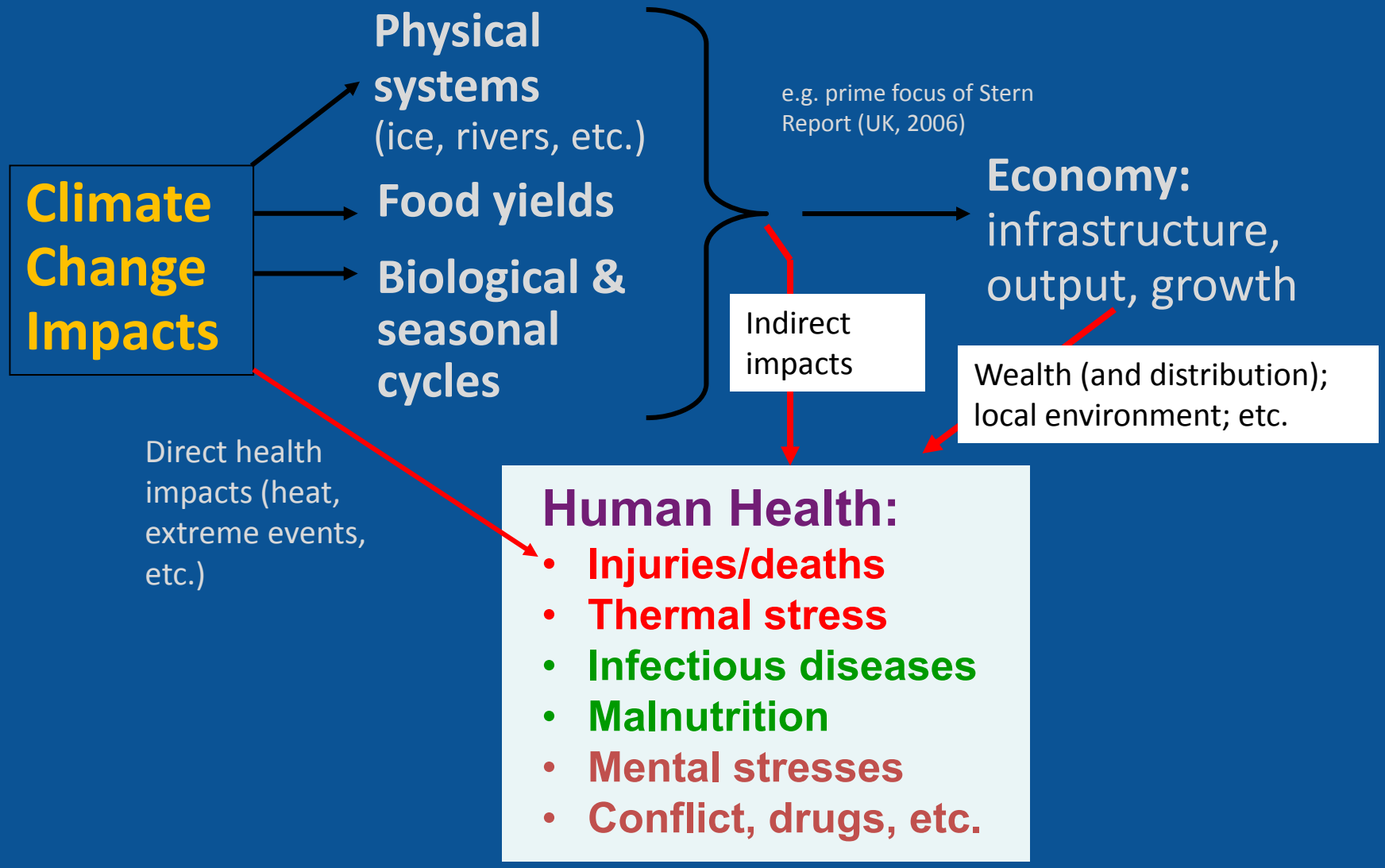
NYS Department of Health
Bureau of Environmental & Occupational Epidemiology

Climate Change & Health



HEALTH EFFECTS OF CLIMATE CHANGE

CLIMATE CHANGE

Temperature Rise [1]
Sea level Rise [2]
Hydrologic Extremes

1. 3°C by yr. 2100
2. 40 cm " "

IPCC estimates

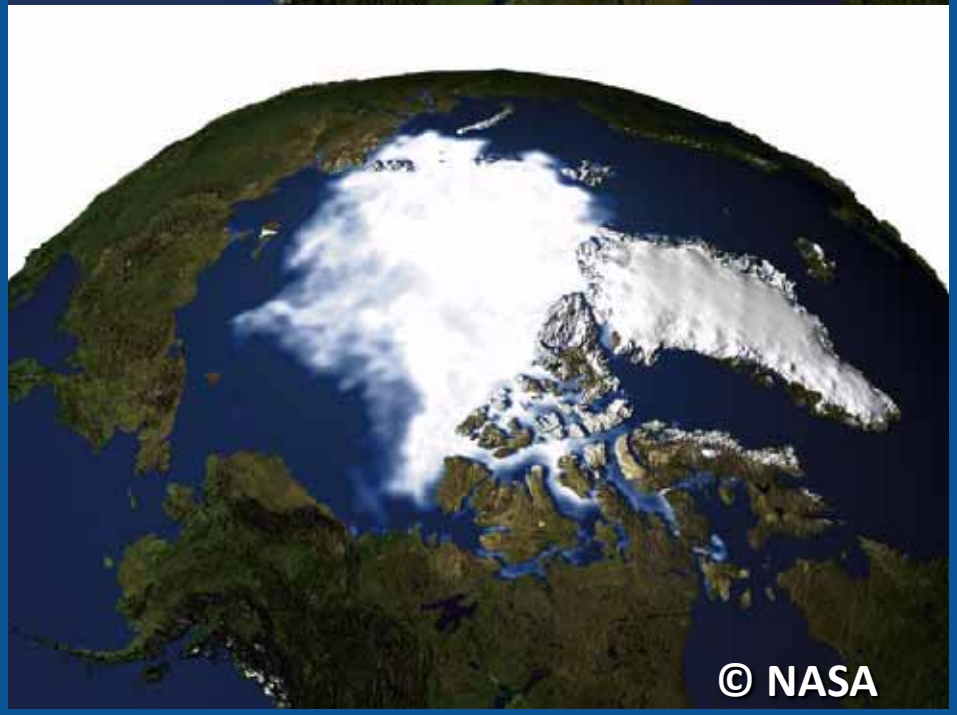
Patz, 1998

Urban Heat Island Effect	Heat Stress Cardiorespiratory failure
Air Pollution & Aeroallergens	Respiratory diseases, e.g., COPD & Asthma
Vector-borne Diseases	Malaria Dengue Encephalitis Hantavirus Rift Valley Fever
Water-borne Diseases	Cholera Cyclospora Cryptosporidiosis Campylobacter Leptospirosis
Water resources & food supply	Malnutrition Diarrhea Toxic Red Tides
Mental Health & Environmental Refugees	Forced Migration Overcrowding Infectious diseases Human Conflicts

Observed Sea Ice

September, 1979

September, 2003



Composite satellite reconstruction © NASA

Source: ACIA, 2004

- "The severity and duration of summertime regional air pollution episodes are projected to increase in the Northeast and Midwest US by 2045-2052 due to climate-change-induced decreases in the frequency of surface cyclones." (IPCC, 2007)

- By 2050, warming alone may increase by 68% the number of Red Ozone Alert days across the Eastern US. (IPCC, 2007 -Bell et al, 2006)

Why should public health engage in climate action planning?

- ✓ Climate change happening now
  - Faster than expected
  - Upper end of IPCC scenarios
  - Risk of tipping points
- ✓ Impacts health in many ways, directly & indirectly
  - Heat, extreme weather, floods, drought, wildfires, water &food-borne disease, vector-borne disease
  - Affects life systems on which we depend
  - Air, water, food, shelter, security
- ✓ Climate gap
  - Vulnerable communities most at risk
- ✓ If we act urgently and aggressively we can
  - Prevent the most catastrophic climate scenarios
  - Promote mitigation and adaptation strategies with health co-benefits
  - Build resilient communities to adapt better
- ✓ Public health matters

Climate Variability / Change and the Risks for Under-Studied Adverse Health Outcomes

U01EH000396 Grant (CDC)
Sep. 2009 – Sep. 2012

NYSDOH, Center for Environmental Health
NYSDOH, Center for Community Health
NYS Dept. of Environmental Conservation
Kent State University
Columbia University
University at Albany
USEPA

Primary Objective:

Evaluate independent and joint effects of meteorological factors on important, under-studied health endpoints.

Research gaps:

- Prior work studied heat rather than cold effects;
- Main outcome was mortality but not morbidity;
- Few studies on vector-borne diseases or adverse birth outcomes (biologically plausible);
- Focused on a single-weather factor (temperature), other weather factors and joint effects rarely studied;
- Few on special events (blackouts or major snowstorms);
- No translational studies to use regional findings as guide to develop public health education / intervention.

Specific Aims

Specific Aim 1: To identify specific diseases related to various individual weather factors and their public health impacts

- To evaluate health effects of extreme weather, climate variability, and season-modifying effect;
- To estimate public health impact (costs/ absences);
- To evaluate interactive effects between weather factors and air pollutants on health outcomes;
- To assess whether potentially vulnerable groups are at disproportionately higher risks.

Specific Aim 2: To evaluate health effects of weather pattern using a composite weather indicator to analyze multiple weather variables jointly.

Specific Aims (cont.)

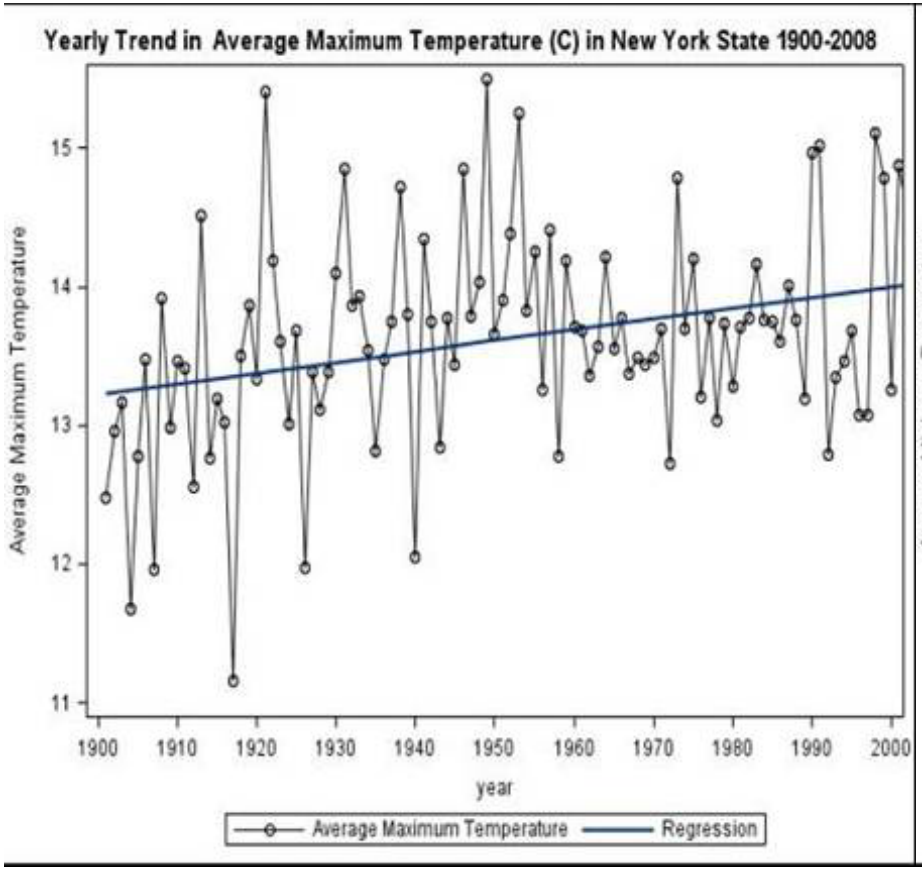
- **Specific Aim 3:** To establish a climate-health tracking system and develop appropriate public communication or education strategies based on findings:

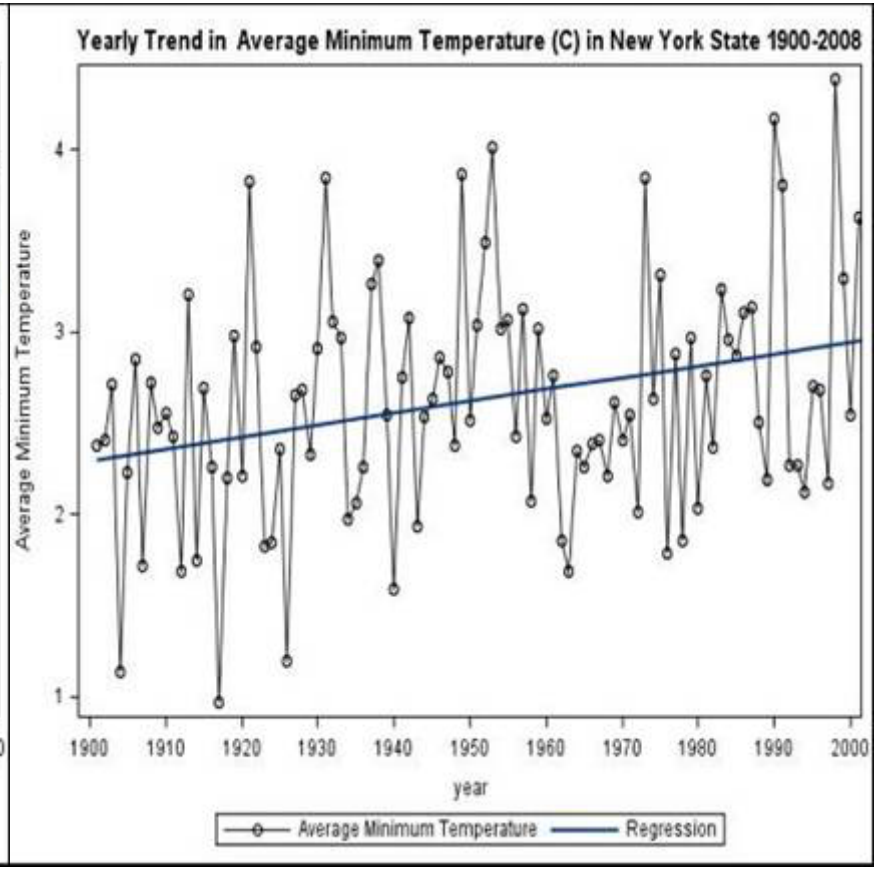
  - To create a climate-health tracking system for long-term surveillance, preparedness, and public health response by incorporating both climate and health data into our ongoing EPHT program and developing a NYS climate-vulnerability map for targeting high-risk areas

  - To provide evidence-based findings from the proposed project to NYSDEC and NYS Department of Health (NYSDOH) for developing public communication and education strategies.

Trends in extreme climate indicators in New York State 1900-2008

Yearly Trends in Average Temperature

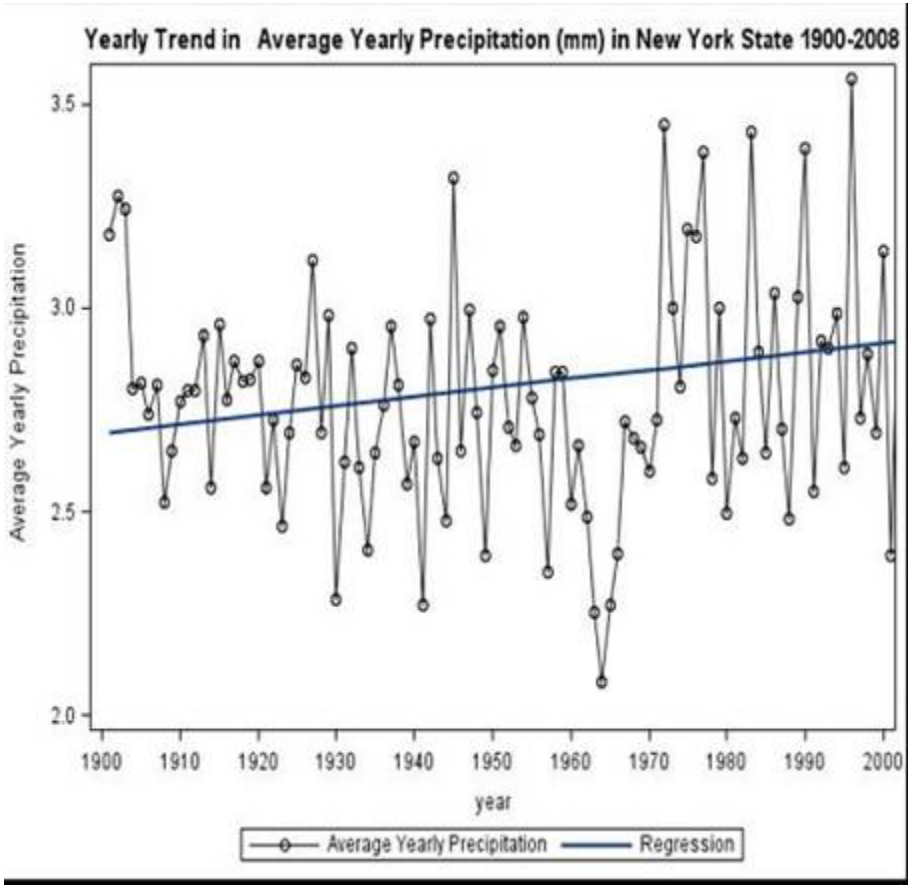




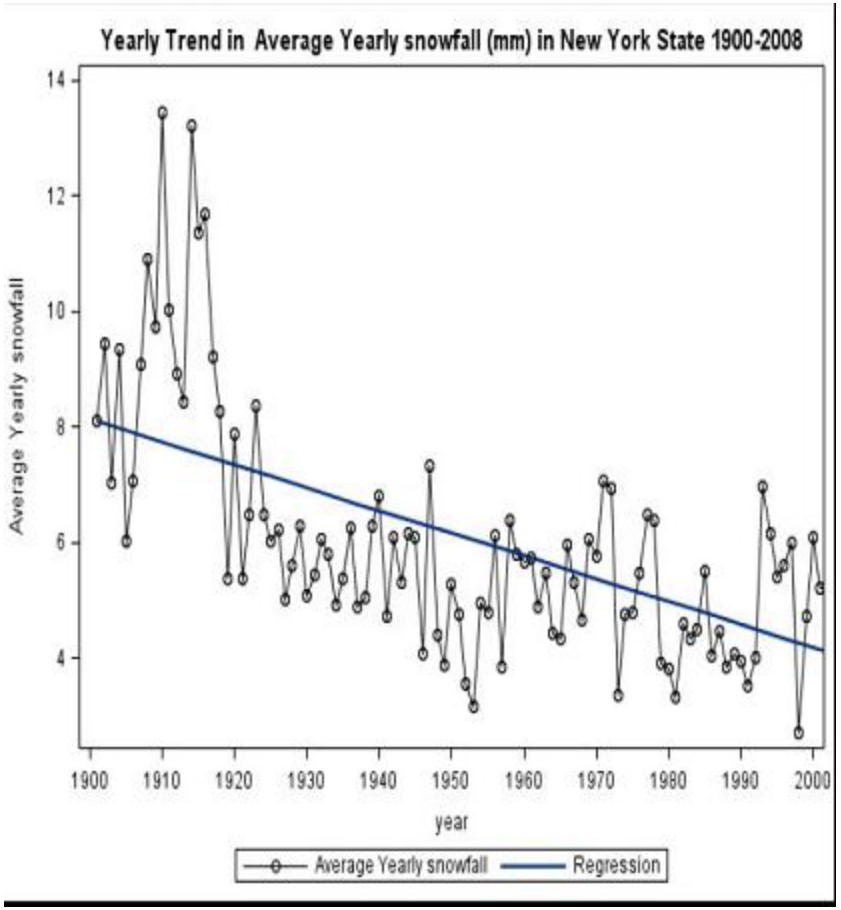
Maximum Temperature

Minimum Temperature

Yearly Trends in Average Rainfall and Snowfall



Precipitation



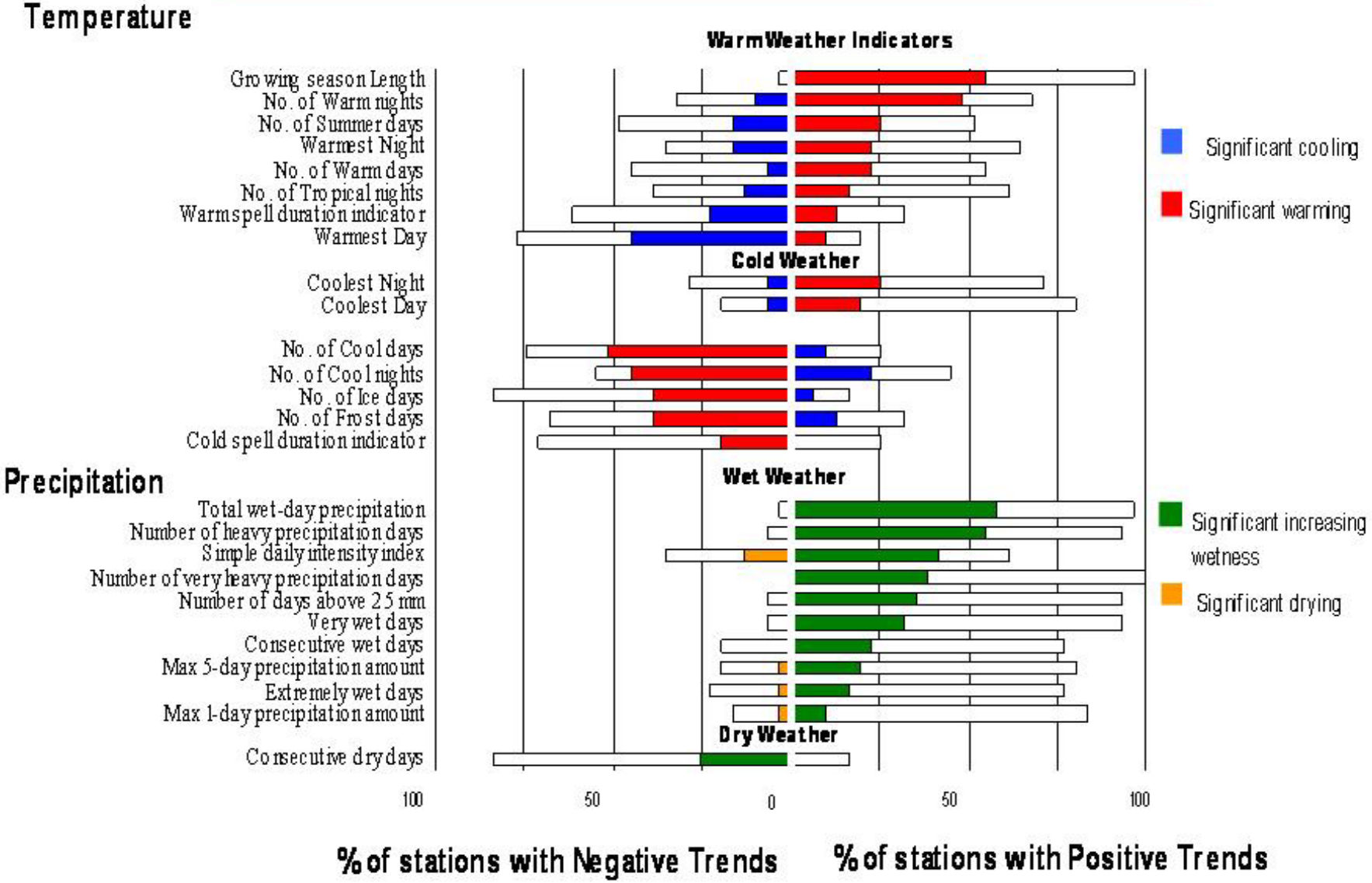
Snowfall

Temperature Indicators	Definition	Type	Average trend in New York State/ decade		
Percentile Indicators					
Warm days	Tmax>90th percentile	Warm weather	**0.23**	*	%
Warm nights	Tmin>90th percentile	Warm weather	**0.22**	*	%
Cool days	Tmax<10th percentile	Cold weather	**-0.62**	**	%
Cool nights	Tmin<10th percentile	Cold Weather	**-0.45**	**	%
Threshold Indicators					
Summer days	Tmax>25°C	Warm weather	0.73		days
Tropical nights	Tmin>20°C	Warm weather	0.06		days
Ice days	Tmax<0°C	Cold weather	**-1.01**	**	days
Frost days	Tmin<0°C	Cold Weather	**-0.93**	**	days
Absolute indicators					
Warmest day	Monthly maximum value of daily Tmax	Warm weather	**-0.11**	*	°C
Warmest night	Monthly maximum value of daily Tmin	Warm weather	**0.17**	*	°C
Coldest day	Monthly minimum value of daily Tmax	Cold Weather	0.02		°C
Coldest Night	Monthly minimum value of daily Tmin	Cold weather	**0.24**	*	°C
Duration Indicators					
Growing season Length	first span of at least 6 days with T avg>5°C and first span after July 1 of 6 days with T avg<5°C	Mild Weather	**1.22**	*	days
Warm spell duration indicator	at least 6 consecutive days when Tmax>90th percentile	Warm weather	0.33		days
Cold spell duration indicator	at least 6 consecutive days when Tmin<10th percentile	Cold weather	-0.18		days

Note: TX= Maximum Temperature, Note: TX= Maximum Temperature, TN=Minimum Temperature

Precipitation Indicators	Definition	Average Trend in New York State/decade		
Percentile Indicators				
Very wet days	PRCP>95th percentile	3.93		mm
Extremely wet days	PRCP>99th percentile	1.45		mm
Threshold Indicators				
Number of heavy precipitation days	PRCP>=10mm	**0.4**	*	days
Number of very heavy precipitation days	PRCP>=20mm	0.05		days
Number of days above 25 mm	PRCP>=25 mm	0.06		days
Absolute indicators				
Max 1-day precipitation amount	Monthly maximum 1-day precipitation	-0.12		mm
Max 5-day precipitation amount	Monthly maximum consecutive 5-day precipitation	0.41		mm
Duration Indicators				
Consecutive wet days	Maximum number of consecutive days with PRCP>=1mm	**0.33**	**	days
Consecutive dry days	Maximum number of consecutive days with PRCP<1mm	-0.12		days
Other Indicators				
Annual total wet-day precipitation	Annual total PRCP in wet days (PRCP>=1mm)	**11.03**	**	mm
Simple daily intensity index	Annual total precipitation divided by the number of wet days (defined as PRCP>=1.0mm) in the year	0.01		mm/day

Trends in extreme weather indicators in weather stations in New York State



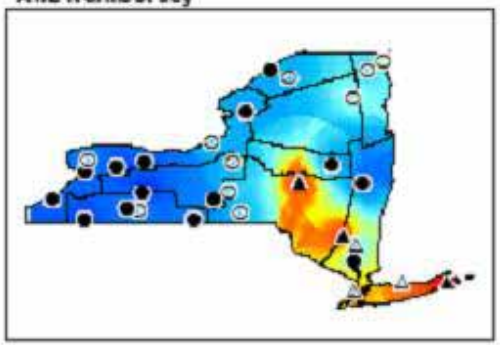
New York State Maps showing Significant Historical trends in Extreme Weather Indicators

A1. Temperature-Warming Indicators

A1.1 Growing Season Length

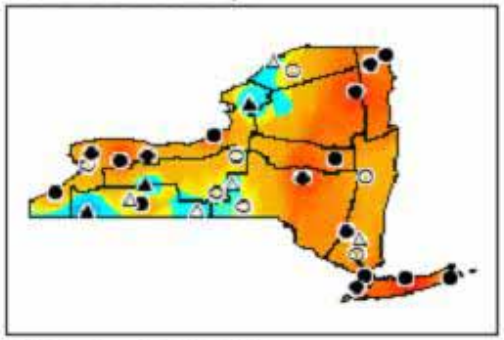
A1.3 Number of Warm Nights

A1.2 Warmest day

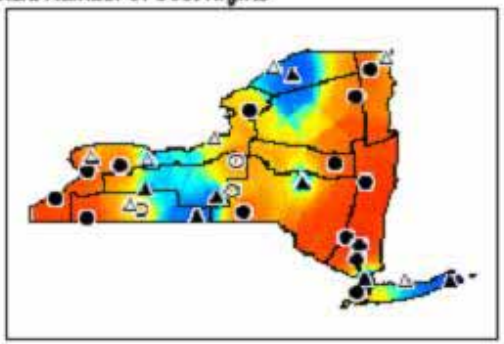


A2. Temperature-Cooling Trends

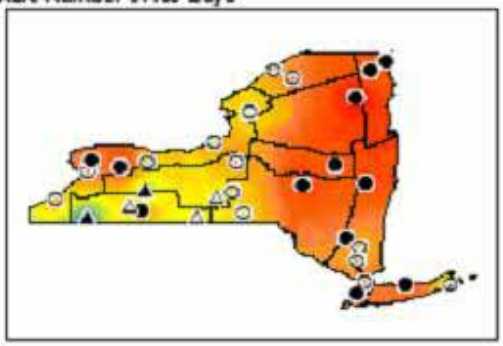
A2.1 Number of Cool Days



A2.2 Number of Cool Nights

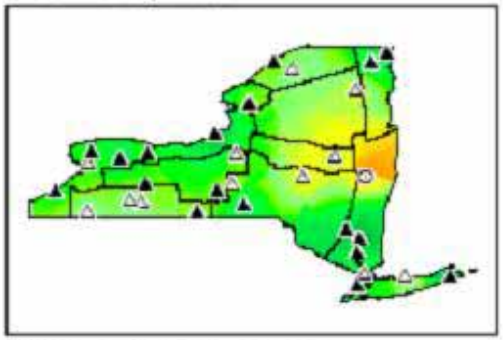


A2.3 Number of Ice Days

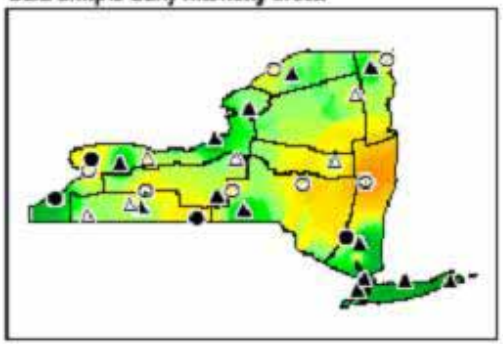


B. Precipitation Indicators

B1. Total Precipitation



B2.2 Simple Daily Intensity Index



B3. Number of Heavy Precipitation Days

Legend

▲ Significant Positive △ Non-Significant Positive ○ Non-Significant Negative ● Significant Negative

Scale: 1 inch = 147 miles

High Temperature and Hospital Admissions in New York City

NYS Department of Health
Bureau of Environmental & Occupational Epidemiology

Objective

- Assess potential impact of high temperature, humidity & apparent temperature on hospitalizations for respiratory and cardiovascular diseases in NYC during 1991-2004;
- Identify thresholds of high temperature on hospitalizations;
- Evaluate possible interactions between meteorological conditions and socio-demographic factors or sub-disease groups.

Study Population & Data Sources

- Population
  - NYC residents
  - Hospital admissions (1991-2004)
- Health Outcome data
  - SPARCS (Statewide Planning and Research Cooperative System) discharge data for respiratory and cardio-vascular outcomes
- Meteorological condition
  - National Climate Data Center
- Ambient air Ozone
  - NYS Department of Environmental Conservation ambient monitoring data (1991 - 2004)
- Socio-demographic variables
  - SPARCS (age, gender, race/ethnicity) and Census (income from census block group)

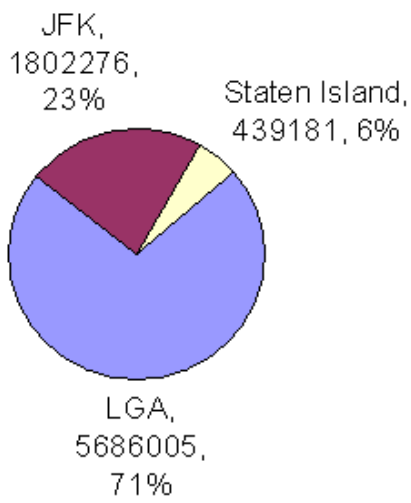
Health Outcomes

Disease Compositions for Cardiovascular/ Respiratory Hospital Admissions by Principal Diagnosis, NYC, 1991-2004

Disease	ICD-9	Cases	Percentage
Cardiovascular Diseases	393 – 438	392,734	100%
Chronic rheumatic heart disease	393-398	2,334	1%
Hypertensive Disease	401-405	33,557	9%
Ischemic heart disease	410-414	160,751	41%
Cardiac dysrhythmias	427	51,567	13%
Heart failure	428	87,058	22%
Cerebrovascular disease	430-434, 436-438	57,467	15%
Respiratory Diseases	491-493, 496, 490*, 466*	108,445	100%
Acute bronchitis and bronchiolitis	466*	7,710	7%
Bronchitis, not specified as acute or chronic	490*	693	1%
Chronic bronchitis	491	17,366	16%
Emphysema	492	3,259	3%
Asthma	493	70,727	65%
Chronic airway obstruction, not elsewhere classified	496	8,690	8%

* for age<5

Climate Regions for NYC



Population in 3 buffers

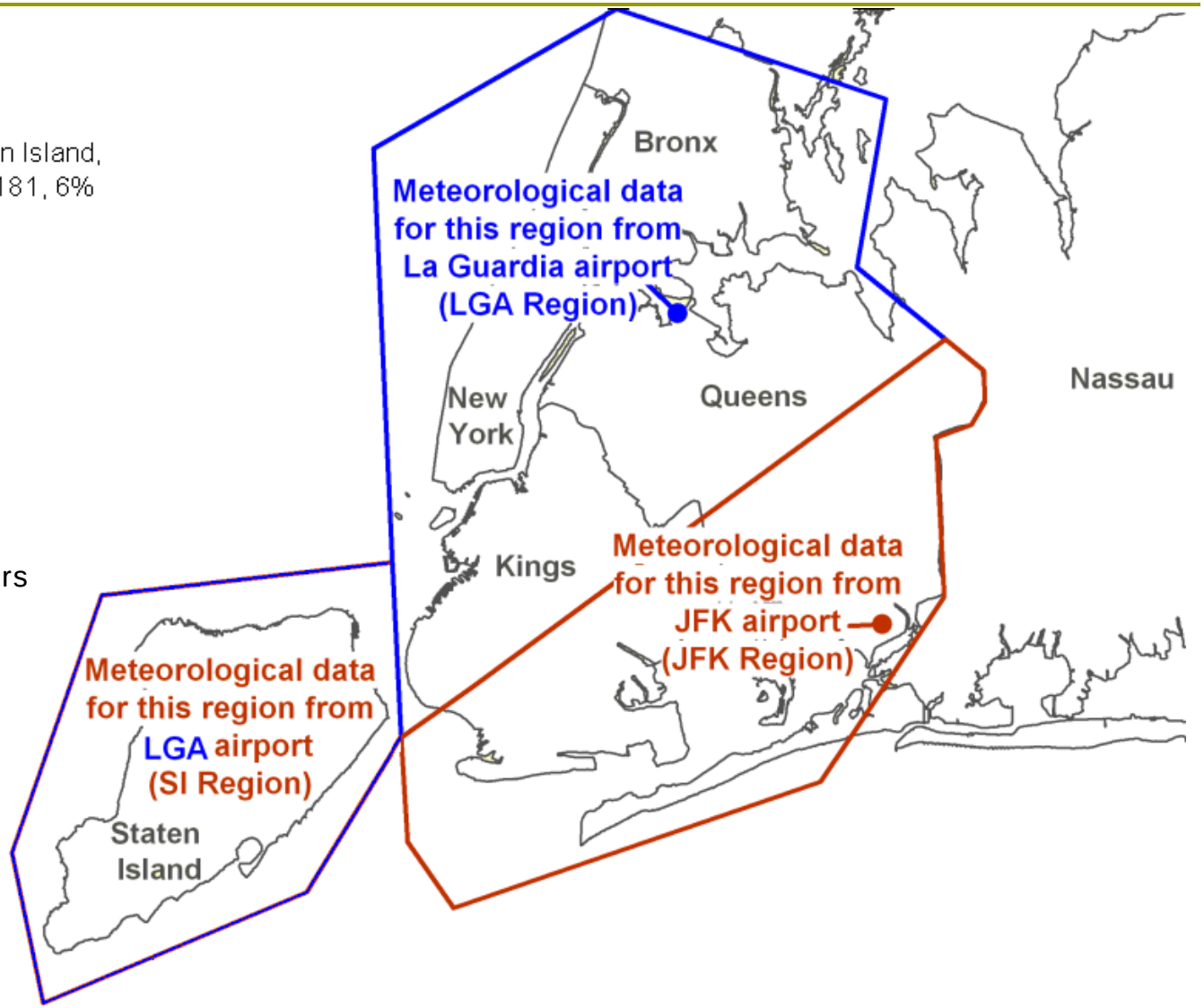


Table 1. Summary Statistics of Daily Weather Conditions, Ozone Concentrations, Daily Hospital Admission Rates in New York City*, 1991-2004

	Mean	SD	Min	P(25)	Median	P(75)	Max
Mean Temperature (°F)							
Staten Island, LGA	75.15	6.07	55.17	71.56	75.38	79.19	93.63
JFK	73.02	5.58	54.71	69.79	73.42	76.62	91.83
Mean Apparent Temperature (°F)							
Staten Island, LGA	78.05	8.42	53.76	72.67	78.36	84.15	104.59
JFK	76.45	8.08	51.05	71.37	76.77	82.27	101.68
Mean Relative Humidity (%)							
Staten Island, LGA	64.51	0.135	32.94	53.86	63.55	74.79	99.28
JFK	71.55	0.138	31.34	61.90	72.75	82.78	99.71
Ozone Daily 8hr Max (ppm)							
JFK, LGA	0.0574	0.0246	0.0020	0.0396	0.0545	0.0720	0.1550
Staten Island**	0.0650	0.0253	0.0050	0.0466	0.0625	0.0802	0.1780
Daily Admission Rate for Respiratory Diseases* **							
LGA	10.18	3.31	2.46	8.27	10.20	12.14	20.75
JFK	12.42	7.98	2.22	7.77	9.99	13.87	98.21
Staten Island	8.99	5.05	0.00	4.55	9.11	11.38	34.15
Daily Admission Rate for Cardiovascular Diseases* **							
LGA	36.48	7.93	18.99	28.32	38.16	42.74	53.11
JFK	43.37	10.79	17.76	34.40	43.83	51.60	71.02
Staten Island	43.95	13.86	11.38	34.15	43.26	54.65	88.80

*** Time period for this table is June to August, 1991-2004, 1288 days.**

** Only 1130 day records due to missing.

*** For per million people.

Table 2. Percent Change in Daily Morbidity per Degree Fahrenheit Over Threshold, NYC, 1991-2004

Disease outcome	Threshold (°F)	Lag in days	Risk change(95% CI) : % per °F over threshold				
		0	*1.50*	*(*	*0.70*	*,*	*2.31*	*)*
Respiratory diseases temperature	84	1	0.53	(	-1.85	,	2.97	)
		2	-0.15	(	-0.95	,	0.66	)
		3	0.01	(	-2.07	,	2.13	)
		4	0.28	(	-0.53	,	1.09	)
		0	-0.17	(	-0.74	,	0.40	)
Cardiovascular diseases temperature	85	1	0.35	(	-0.20	,	0.92	)
		2	0.33	(	-0.22	,	0.88	)
		3	*2.00*	*(*	*0.18*	*,*	*3.86*	)
		4	0.39	(	-0.86	,	1.66	)
		0	*1.17*	*(*	*0.63*	*,*	*1.72*	)
Respiratory diseases apparent temperature	89	*1*	*0.77*	*(*	*0.22*	*,*	*1.31*	)
		2	0.16	(	-0.37	,	0.70	)
		3	-0.20	(	-1.73	,	1.35	)
		4	0.51	(	-0.04	,	1.05	)
		0	0.08	(	-2.18	,	2.40	)
Cardiovascular diseases apparent temperature	96	*1*	*1.37*	*(*	*0.34*	*,*	*2.42*	*)*
		2	*1.19*	*(*	*0.25*	*,*	*2.14*	*)*
		3	*2.00*	*(*	*1.06*	*,*	*2.96*	*)*
		4	0.75	(	-0.24	,	1.75	)

Note: Controlled for long-term trend, seasonality, Ozone, holidays, the blackout event of Aug. 2003.

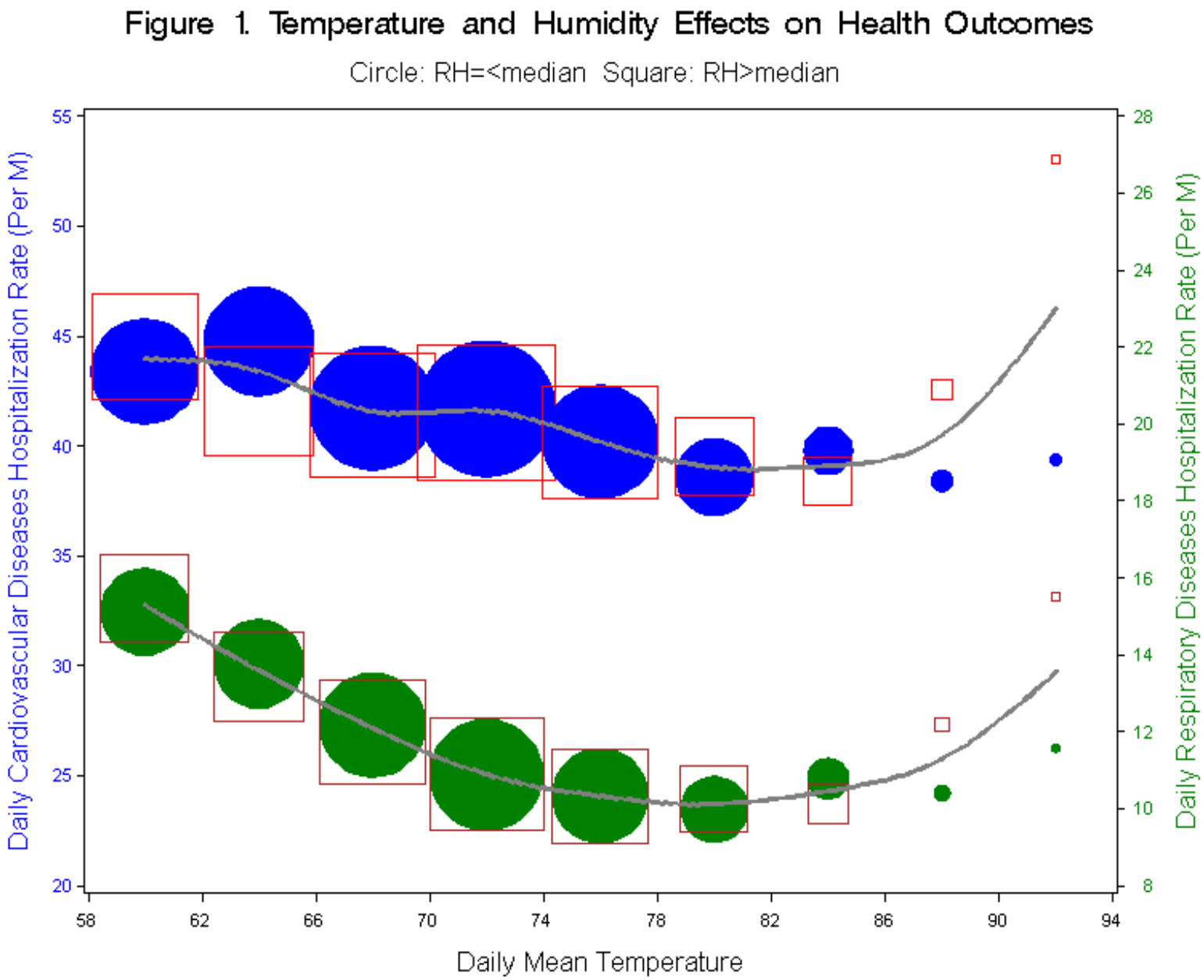
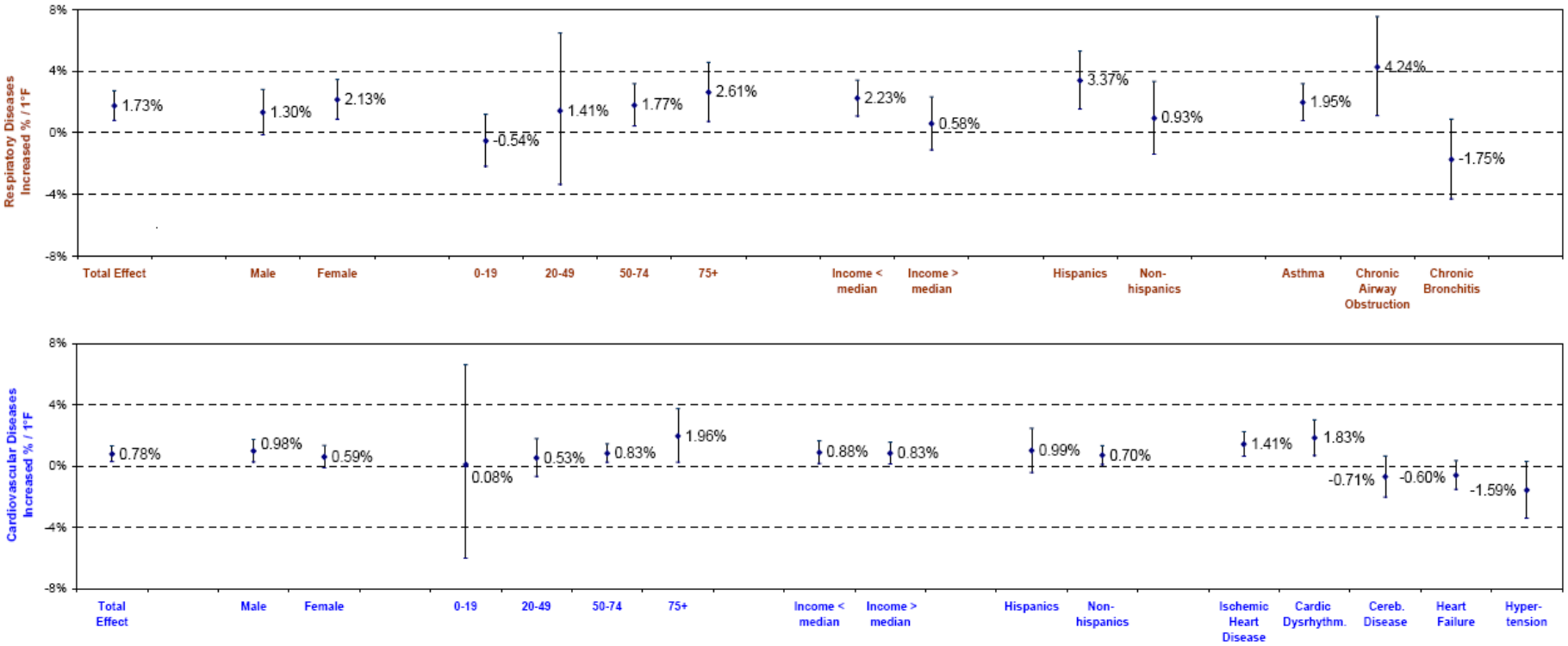


Figure 1. Temperature and Humidity Effects on Health Outcomes
Circle: RH=<median Square: RH>median
Daily Cardiovascular Diseases Hospitalization Rate (Per M)
Daily Respiratory Diseases Hospitalization Rate (Per M)
Daily Mean Temperature
55
50
45
40
35
30
25
20
28
26
24
22
20
18
16
14
12
10
8
58
62
66
70
74
78
82
86
90
94

Figure 1. Stratified Analyses of Apparent Temperature (3-day moving average) on Respiratory and Cardiovascular diseases, NYC, 1991-2004



Note:
1. Threshold is 90°F for each stratification group.
2. For respiratory diseases, exposure is the mean of apparent temperatures in current day, yesterday, and the day before yesterday.
3. For cardiovascular diseases, exposure is the mean of apparent temperatures in yesterday, the day before yesterday, and 3 days before current day.

Conclusions and Implication

- High temperature >threshold points were associated with increases in respiratory admissions on the same day and CVD with delayed effect in NYC.

- We detected a heat-health threshold effect (84°F for respiratory diseases and 85°F for CVD) with temperatures less than HW standard (90°F for 3 days). Compared to California health effects in NYC tended to be higher, suggesting acclimatization.

- The interactions identified between high temperature and humidity, socio-demographics, and sub-disease groups on health effect can help target vulnerable population and conduct effective prevention.

The Health Impact in New York City during the Northeastern (US) Blackout of 2003

- Largest blackout, began on August 14, 2003 at 4 PM, lasted 31 hours Without power …

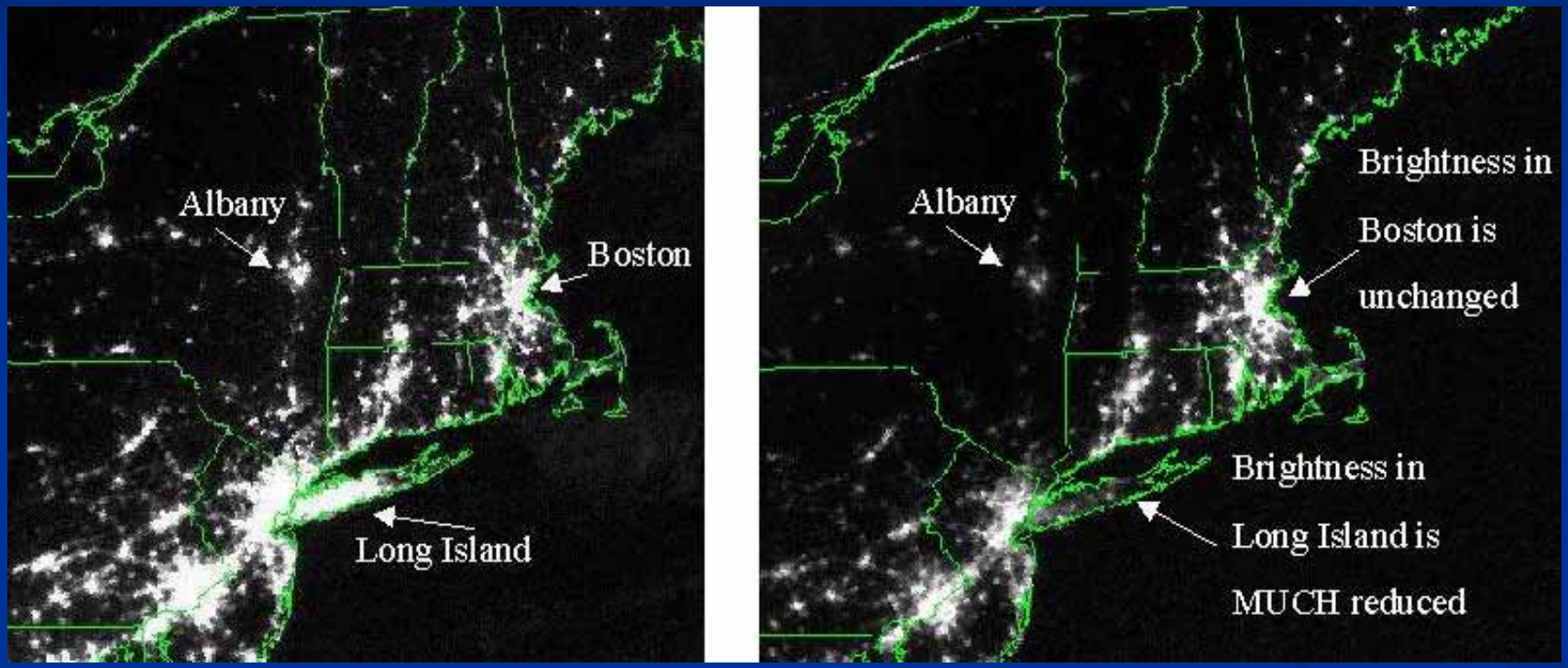
… the only lights came from cars

Widespread, affected 50 million people in NE, Midwest and Canada

NYC especially hard hit, occurred during rush hour

Times Square

Night Light: New York Downstate



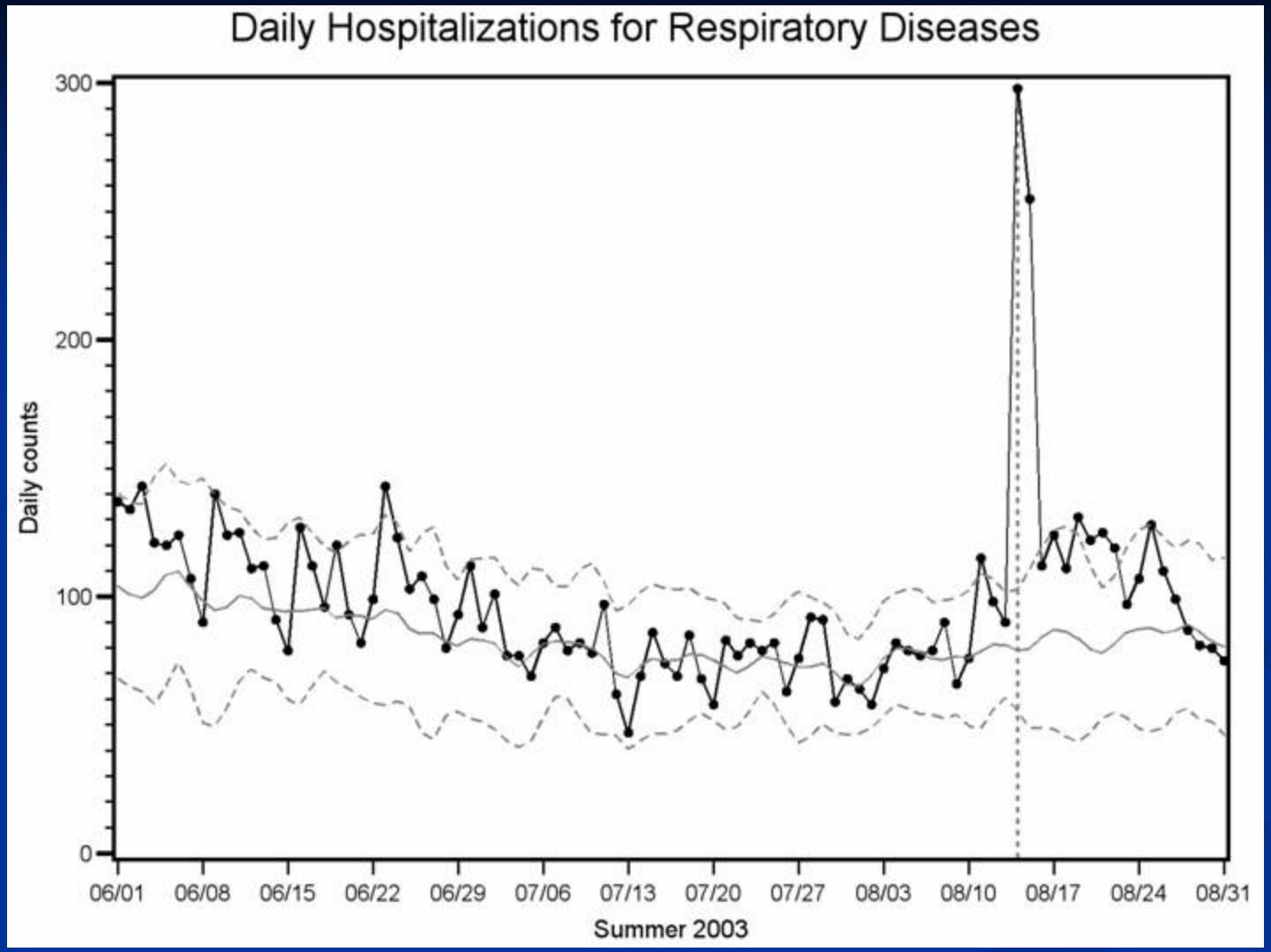
20 hours before blackout

Aug. 13, 2003, at 9:21 p.m. EDT

7 hours after blackout

Aug. 14, 2003, at 9:03 p.m. EDT

NASA Satellite Image



Respiratory hospitalization and total mortality, but neither cardiovascular nor renal admissions were affected by conditions during the blackout.

Table 3. Comparisons of demographic characteristics of patients admitted to hospitals with respiratory diagnoses during the 2003 blackout, comparably hot days and normal summer days.

Demographic Groups	Hospital Admissions						OR [a] (95% CI)	
	Blackout days (n=2)		Comparably hot [b] days (n=110)		Normal days [c] (n=703)		Blackout vs. normal	Comparably hot vs. normal
	n	Percent	n	Percent	n	Percent		
White	218	42.00	3085	35.28	19360	34.71	**1.36 (1.14–1.62)**	1.02 (0.98–1.07)
Black	180	34.68	3105	35.51	20086	36.01	0.94 (0.79–1.13)	0.98 (0.93–1.03)
Other Race	121	23.31	2555	29.22	16330	29.28	**0.73 (0.60–0.90)**	1.00 (0.95–1.05)
Hispanic [d]	95	18.77	2140	27.50	13072	26.40	**0.64 (0.52–0.81)**	1.06 (1.00–1.12)
Non-Hispanic [d]	411	81.23	5643	72.50	36444	73.60	**1.55 (1.24–1.94)**	0.95 (0.90–1.00)
High Income Area	217	39.38	3050	34.19	19722	34.62	**1.23 (1.03–1.46)**	0.98 (0.94–1.03)
Low Income Area	334	60.62	5871	65.81	37243	65.38	**0.82 (0.69–0.97)**	1.02 (0.97–1.07)
Female	333	60.22	6045	56.27	32486	55.93	**1.19 (1.01–1.41)**	1.01 (0.97–1.06)
Male	220	39.78	4754	43.73	25595	44.07	**0.84 (0.71–0.99)**	0.98 (0.94–1.03)
<20	109	19.71	2295	25.20	14772	25.43	**0.72 (0.58–0.89)**	0.98 (0.94–1.04)
20-49	63	11.39	2275	24.98	14545	25.04	**0.38 (0.30–0.50)**	1.00 (0.95–1.05)
50-74	196	35.44	3016	33.12	19309	33.24	1.10 (0.93–1.31)	0.99 (0.95–1.04)
75+	185	33.45	1520	16.69	9455	16.28	**2.58 (2.16–3.09)**	1.03 (0.97–1.09)

Bolded values are significant at $p < 0.05$.

[a] Odds ratios are based on comparing the selected stratum to all other strata.

[b] Comparably hot days are days with maximum temperatures between 89 and 91°F (the maximum temperatures on August 14 and 15, 2003).

[c] Normal days are days with maximum temperatures between 78 and 87°F (the 25th and 75th percentile of the distribution of maximum temperature in NYC) from June 1 through August 31, 1991 to 2004, excluding blackout days.

[d] Missing values are approximately 8% for blackout days, 15% for comparably hot days, and 15% for normal days.

Conclusion: 1) Elderly and women had higher risks than others;

2) Demographic patterns of susceptibility during the blackout were different than those during hot days: white, non-Hispanic, higher income affected more.

Discussion: Air conditioner's effect?

People walking on the street …

… sleeping on the sidewalk

Proportion of admissions for high socioeconomic status (SES) group significantly increased during the blackout, which was different from heat wave days when proportion of admissions for low SES group increased.

The Effects of Summer Temperatures on Hospital Admissions for Renal Diseases in New York State:

Case-Crossover Study

Background

- High ambient temperatures are associated with increases in hospitalizations for many disorders

- Very few studies have examined the effect of temperature on admissions due to renal and urinary disorders

- Biological plausibility: the kidney and urinary system both affect and are affected by the body's fluid balance which can be compromised by exposure to high temperatures. Acute renal failure, for instance, can be a consequence of heat stroke.

Methods

- Study population: N=147,885 hospitalizations due to renal diseases in NYS, July-August, 1991-2004 (12,370 acute renal failure (ARF))

- Study design and analysis
  - Time-stratified case-crossover/conditional logistic regression

- Exposure indicators
  - Actual temperature: minimum, maximum, average
  - Apparent temperature: minimum, maximum, average
  - Same day exposure, lagged exposure

- Confounders/effect modifiers
  - Daily average atmospheric pressure and relative humidity
  - Age, race, ethnicity, socioeconomic status, geographic region

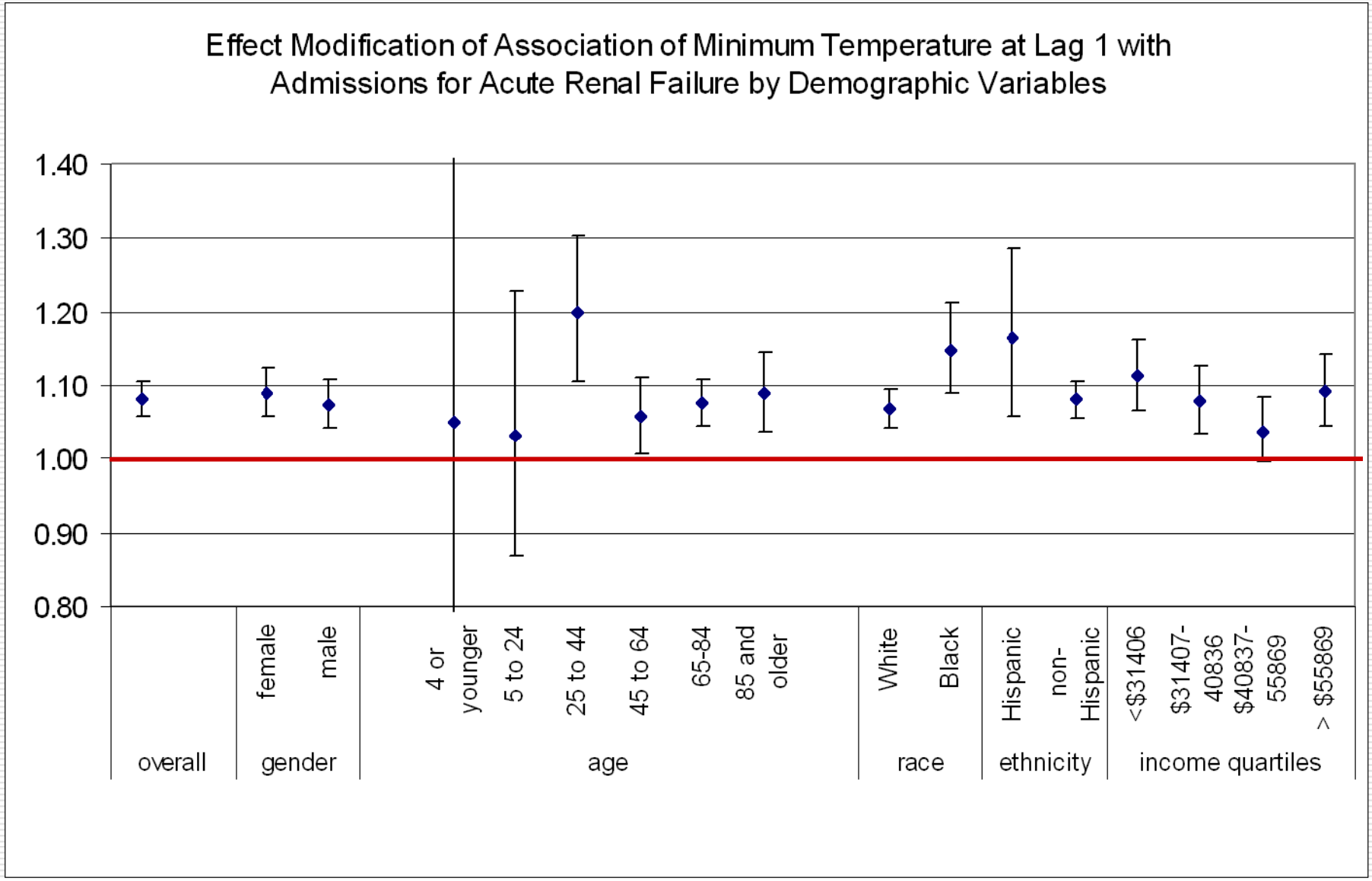
Results

Table 2. Odds Ratios for the Associations Between a 5°F (2.78°C) Change in Lagged Minimum, Maximum, Actual and Apparent Temperature and Hospital Admissions for Acute Renal Failure in New York State, July-August, 1991-2004, Adjusted for Relative Humidity and Barometric Pressure.

	Actual Temperature						Apparent Temperature					
	Minimum			Maximum			Minimum			Maximum		
Lag	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
0	**1.06***	(1.04,	1.09)	**1.04***	(1.02,	1.06)	**1.04***	(1.02,	1.05)	**1.04***	(1.02,	1.05)
1	**1.08***	(1.06,	1.11)	**1.07***	(1.05,	1.09)	**1.05***	(1.03,	1.07)	**1.05***	(1.03,	1.07)
2	**1.05***	(1.02,	1.07)	**1.04***	(1.02,	1.06)	**1.04***	(1.02,	1.05)	**1.04***	(1.02,	1.05)
3	1.02	(1.00,	1.04)	1.01	(1.00,	1.03)	1.01	(1.00,	1.03)	1.01	(1.00,	1.02)
4	1.01	(1.00,	1.03)	1.01	(1.00,	1.02)	1.00	(1.00,	1.01)	1.00	(1.00,	1.01)
5	1.01	(1.00,	1.03)	1.02	(1.00,	1.04)	1.00	(1.00,	1.02)	1.01	(1.00,	1.03)

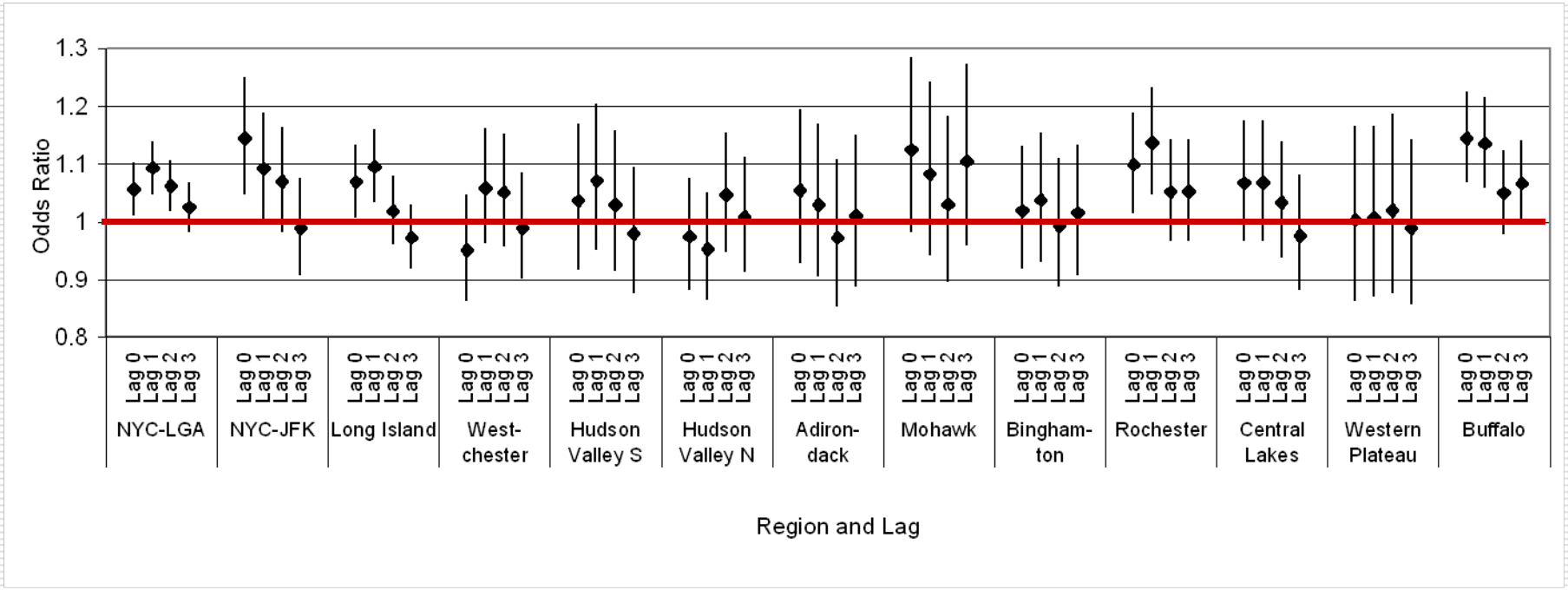
*$P < 0.05$

CI: confidence interval; OR: Odds Ratio


Effect Modification of Association of Minimum Temperature at Lag 1 with Admissions for Acute Renal Failure by Demographic Variables
1.40
1.30
1.20
1.10
1.00
0.90
0.80
overall
gender
female
male
age
4 or younger
5 to 24
25 to 44
45 to 64
65-84
85 and older
race
White
Black
ethnicity
Hispanic
non-Hispanic
income quartiles
<$31406
$31407-40836
$40837-55869
> $55869

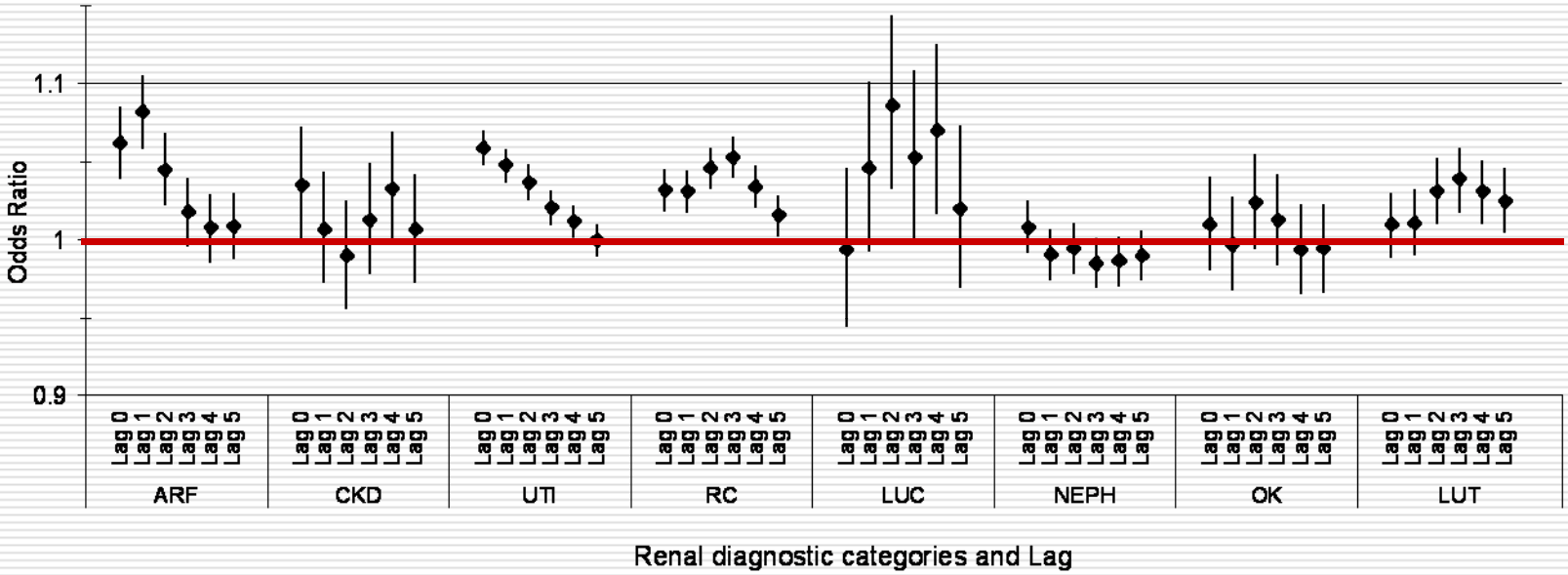
Results

Figure 2. Odds ratios with 95% confidence intervals for the association between a 5°F (2.78°C) change in lagged minimum temperature and hospital admissions for acute renal failure in New York State, July-August, 1991-2004, by geographic region. All models were adjusted for relative humidity and barometric pressure.



Results

Figure 3. Odds ratios with 95% confidence intervals for the associations between a 5°F (2.78°C) change in lagged minimum temperature and hospital admissions in New York State, July-August, 1991-2004, for 8 renal diagnostic categories. All models were adjusted for relative humidity and barometric pressure.



Abbreviations: ARF: acute renal failure, CKD: chronic kidney disease, UTI: urinary tract infection, RC: renal calculi, LUC: lower urinary calculi, NEPH: nephritis and nephrosis, OK: other kidney disorders, LUT: lower urinary tract disorders.

Conclusions

- Minimum actual temperature more sensitive than maximum or apparent
- Lag 1 temperature most strongly associated with hospitalization for ARF
- Most vulnerable for ARF: 25-44 year olds, Blacks, Hispanics
- Significant associations found only in regions with large cities within them (NYC, Buffalo, Rochester)
- Effects found for other renal categories: UTI, upper and lower tract stones, lower urinary tract disorders.
- Next steps:
  - Cumulative effects
  - Extreme high temperatures
  - Temperature variability

Associations between Composite Weather Factors and Water/ Foodborne Disease in summer in NYS from 1991 to 2004

NYS Department of Health
Bureau of Environmental & Occupational Epidemiology

Method

Study Population and Health Outcomes

- New York State Residents; June-August; 1991 to 2004.
- WFBD hospitalizations: Bacterial infections, protozoal infections, viral enteritis and unspecified WFBD.

Data Sources and Exposures

- Health Outcomes: SPARCS hospital discharge database.
- Spatial Synoptic Classification (SSC) Data: Daily composite weather air mass data for each SSC region Kent State University.
- SSC Weather Exposures: 7 types of air masses:

Dry Moderate (DM)	Dry Polar (DP	Dry Tropical (DT)
Moist Moderate (MM)	Moist Polar (MP)	Moist Tropical (MT)
Transition (TR)		

Study Design and Analysis

Spike-day ratio (SPKDR) analysis:

- Investigating SSC's impact on spikes in WFBD

- Spike-day (SPKD): defined as any day with a SD value of WFBD distribution >1.5 in each SSC region for each SSC air mass.

- Expected Spike-day (ESPKD) for any SSC air mass in each region is calculated as the product of the number of days with certain air mass and the percentage of total SPKDs in the study period.

- Spike-day ratio:

$$SPKDR_{Dry\ Tropical} = \frac{SPKD_{Dry\ Tropical}}{EXPKD_{Dry\ Tropical}} = \frac{SPKD_{Dry\ Tropical}}{\frac{SPKD_{Total}}{\#\ Total\ days} \times \#\ Dry\ Tropical\ days}$$

Figure 1. Overall Spatial Hospital Admissions (A) and Stratified Profile (B) for WFBD in NYS in Summer (June - August) from 1991-2004

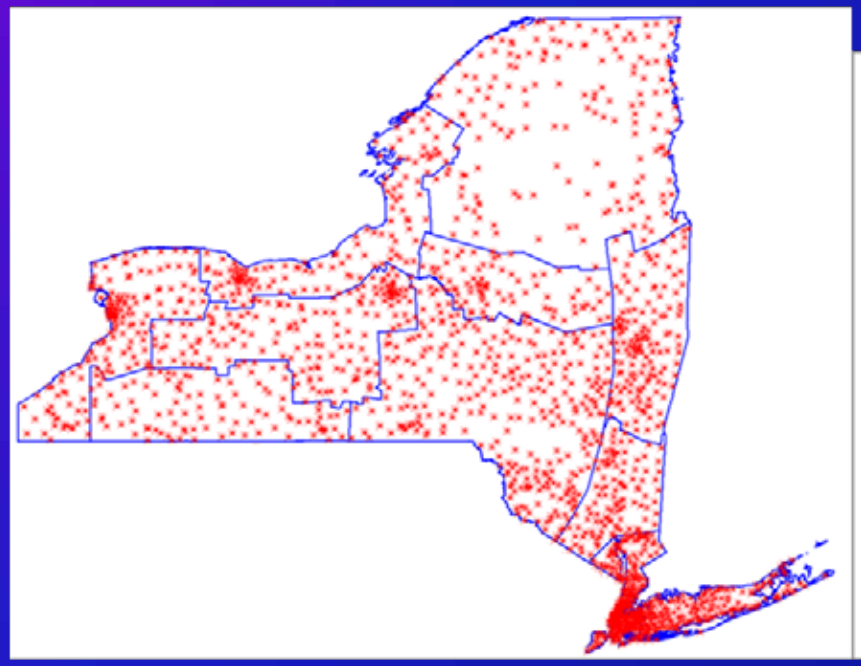


Figure 1A

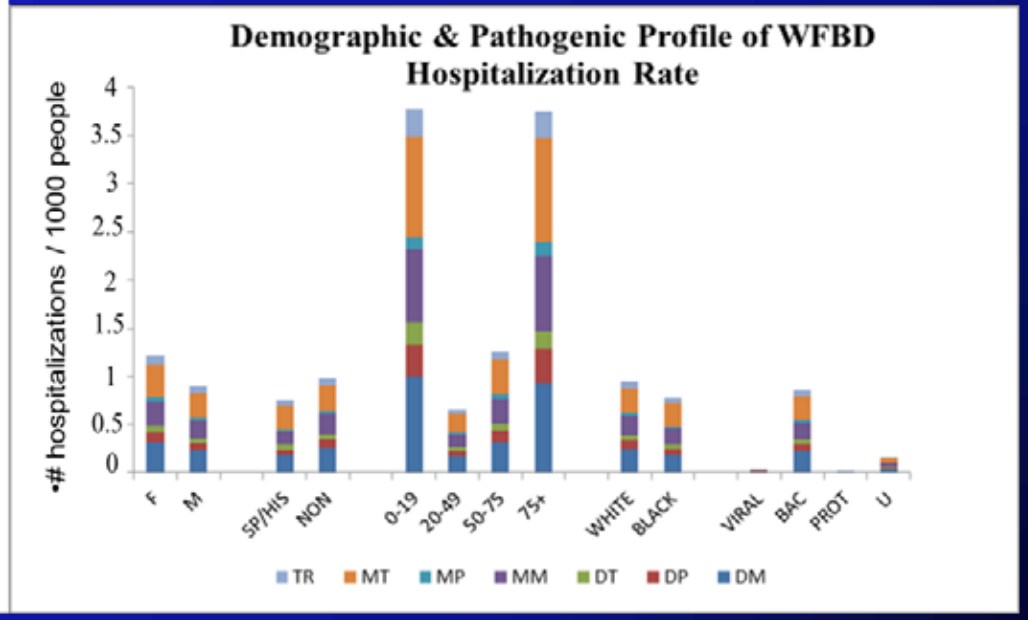


Figure 1B

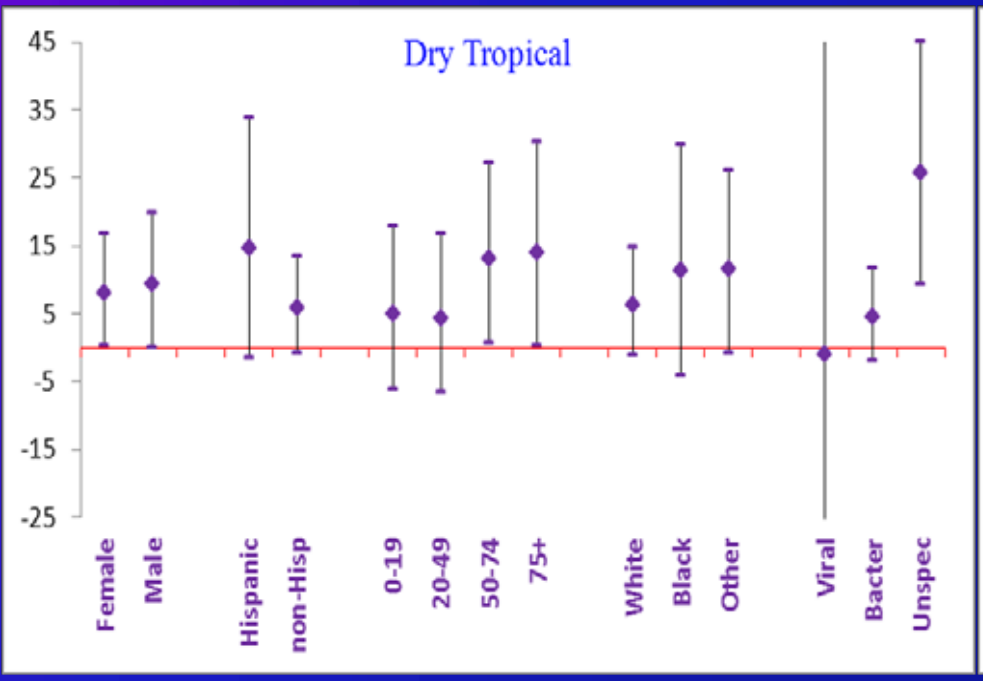
Table 1. Percentage changes in health risk of SSC Air Mass on WFBD hospitalizations by lag day in NYS Summer (June - August) from 1991 to 2004*

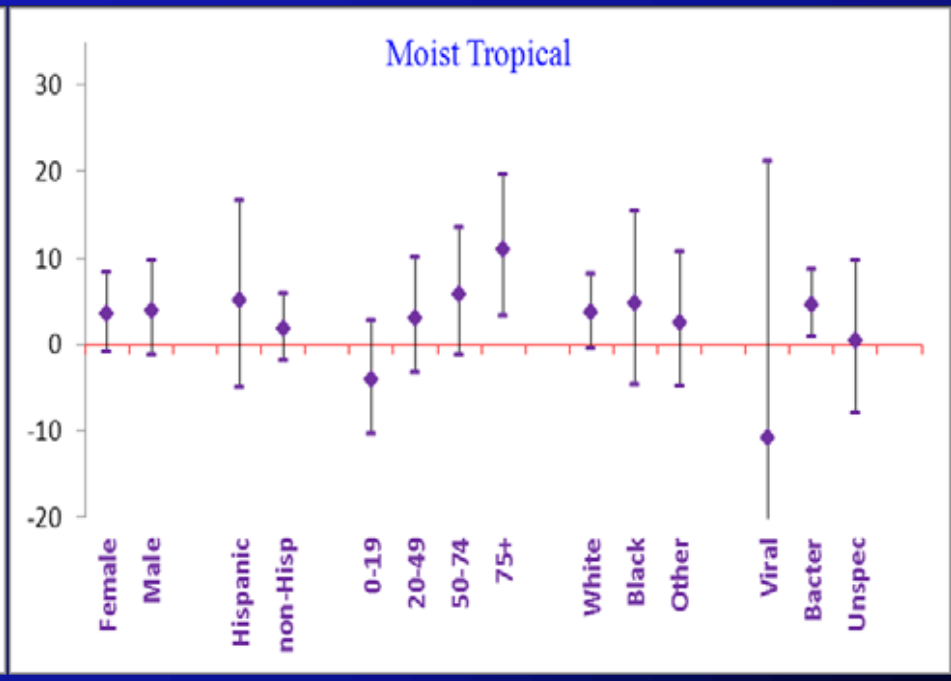
LAG	Dry Polar	Dry Tropical	Moist Moderate	Moist Polar	Moist Tropical	Transition
0	-1.51 (-6.12, 3.33)	**8.48 (2.35, 14.98)**	2.14 (-1.49, 5.9)	0.34 (-6.42, 7.59)	**3.71 (0.28, 7.26)**	**5.78 (0.45, 11.39)**
1	-3.21 (-7.75, 1.55)	**6.31 (0.27, 12.71)**	1.91 (-1.7, 5.65)	-7.2 (-13.6, -0.31)	**4.06 (0.63, 7.6)**	0.94 (-4.2, 6.37)
2	-1.46 (-6.02, 3.33)	1.77 (-4.1, 8)	0.88 (-2.68, 4.56)	-6.59 (-12.95, 0.23)	0.28 (-3.03, 3.7)	1.68 (-3.45, 7.08)
3	-2.47 (-6.99, 2.26)	1.42 (-4.45, 7.64)	-0.7 (-4.22, 2.94)	1.7 (-5, 8.86)	0.91 (-2.42, 4.36)	0.06 (-5.01, 5.4)
4	-1.6 (-6.12, 3.15)	1.14 (-4.66, 7.29)	-1.56 (-5.04, 2.05)	3.53 (-3.24, 10.77)	-0.21 (-3.51, 3.2)	-0.59 (-5.65, 4.75)
5	1.23 (-3.4, 6.07)	-5.95 (-11.46, -0.1)	-0.47 (-3.97, 3.16)	1.36 (-5.32, 8.51)	-2.2 (-5.43, 1.13)	-1.71 (-6.72, 3.56)
6	4.28 (-0.48, 9.27)	-0.17 (-5.94, 5.95)	0.06 (-3.5, 3.75)	6.19 (-0.76, 13.62)	0.81 (-2.54, 4.27)	1.9 (-3.28, 7.37)

* Dry Moderate is reference air mass;

Values in bold: $p \leq 0.05$

Figure 2. Demographic Analysis of Association between WFBD Hospitalizations and Tropical SSC Weather Type in NYS in Summer (June - August) from 1991 to 2004*





* Dry Moderate is reference air mass

Table 2. Percentage changes in SPKDR of WFBD Hospitalizations by Lag Day and Weather Type in NYS in Summer (June - August) from 1991 to 2004 *

LAG	DPR♦	DTR♦	MMR♦	MPR♦	MTR♦	TRR♦
0	- 6.1(-24.9, 12.6)	**40.1(8.4, 71.8)**	**20.6(2.5, 38.9)**	17.1(-12.1, 46.2)	15.1(-6.4, 36.6)	17.6(-2, 37.4)
1	6.6(-16.2, 29.2)	-1.6(-19.8, 16.5)	8(-5.8, 21.7)	5.3(-27.3, 37.8)	-4.3(-20.6, 11.9)	-15.6(-33.9, 2.8)
2	-4.3(-20.4, 11.8)	8(-29.2, -45.2)	-0.2(-10, 9.5)	13.6(-16.3, 43.4)	8.7(-2.7, 20)	-8.3(-36.1, 19.5)
3	6.1(-16.4, 28.6)	4.8(-22.4, 32)	27(-1.2, 54.1)	15.3(-5.3, 36)	14.2(-4.1, 32.5)	24(-3.3, 51.3)
4	-7.8(-20, 4.1)	15(-33.3, 63.4)	-5.5(-22, 11.1)	-21.5(-53, 10.1)	-6.3(-22.2, 9.4)	-12.9(-29.4, 3.4)
5	-14.1(-35.6, 7.5)	3.7(-27.2, 34.6)	-6.8(-14.9, 1.4)	-26.3(-48.2, 4.5)	-20.0(-34.9, 5.5)	-13.3(-35.3, 8.8)
6	6.3(-13.7, 26.3)	21.4(-13, 55.4)	4.5(-16.9, 25.8)	-8.2(-34.1, 17.8)	2.7(-15, 20.4)	1.3(-26.2, 28.9)

* Dry Moderate is reference air mass;

♦ SPKDR corresponding to each SSC weather air mass;

Values in bold: $p \leq 0.05$

Discussion

- Risk effect of Dry Tropical (DT) is greater than that of Moist Tropical (MT), consistent with our findings that impact of extreme heat and temperature is stronger than that of precipitation.

- Bacterial infection hospitalizations were significantly elevated under MT, but not DT, suggesting that moist weather facilitates WFBD.

Continued…

Discussion

- DT and Moist Moderate (MM) air mass were more important in explaining the spikes in WFBD hospitalizations.

- These findings:
  - Help identify sub-populations vulnerable to climate change
  - Can be used to inform public health preparedness.

- Further studies needed to identify unspecified pathogen-related hospital admissions for WFBD.

Climate change and respiratory hospitalizations in New York State: Estimating the future health burden of increasing temperature

Epidemiologic Studies & Evaluation Section

Bureau of Environmental & Occupational Epidemiology
New York State Department of Health

Data Sources and Exposure Indicators

- Study population: Hospital admissions among NYS residents respiratory disease (1991-2004) from SPARCS.
- Historical Meteorological Data – Hourly temperature, dew point and pressure from 1991-2004 were obtain from NCAR.
- Heat Threshold Index
  - Apparent Temperature (AT) Threshold (based on our previous work)
  - 90th Percentile AT
  - Heat Index 90°F AT

Projection

Future daily apparent temperature distributions were estimated for each climate scenario:

- High Emission: A2 assumes a very heterogeneous world with high population growth, slow economic development and slow technological change.

- Mid Emission: A1B assumes a world of very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technologies with a balance across all energy sources.

- Low Emission: B1 assumes a convergent world, with the same growth population as A1B, but with more rapid changes in economic structures toward a service and information economy (IPCC, 2007).

FIGURE 1—NYS projected apparent temperature for various times and scenarios

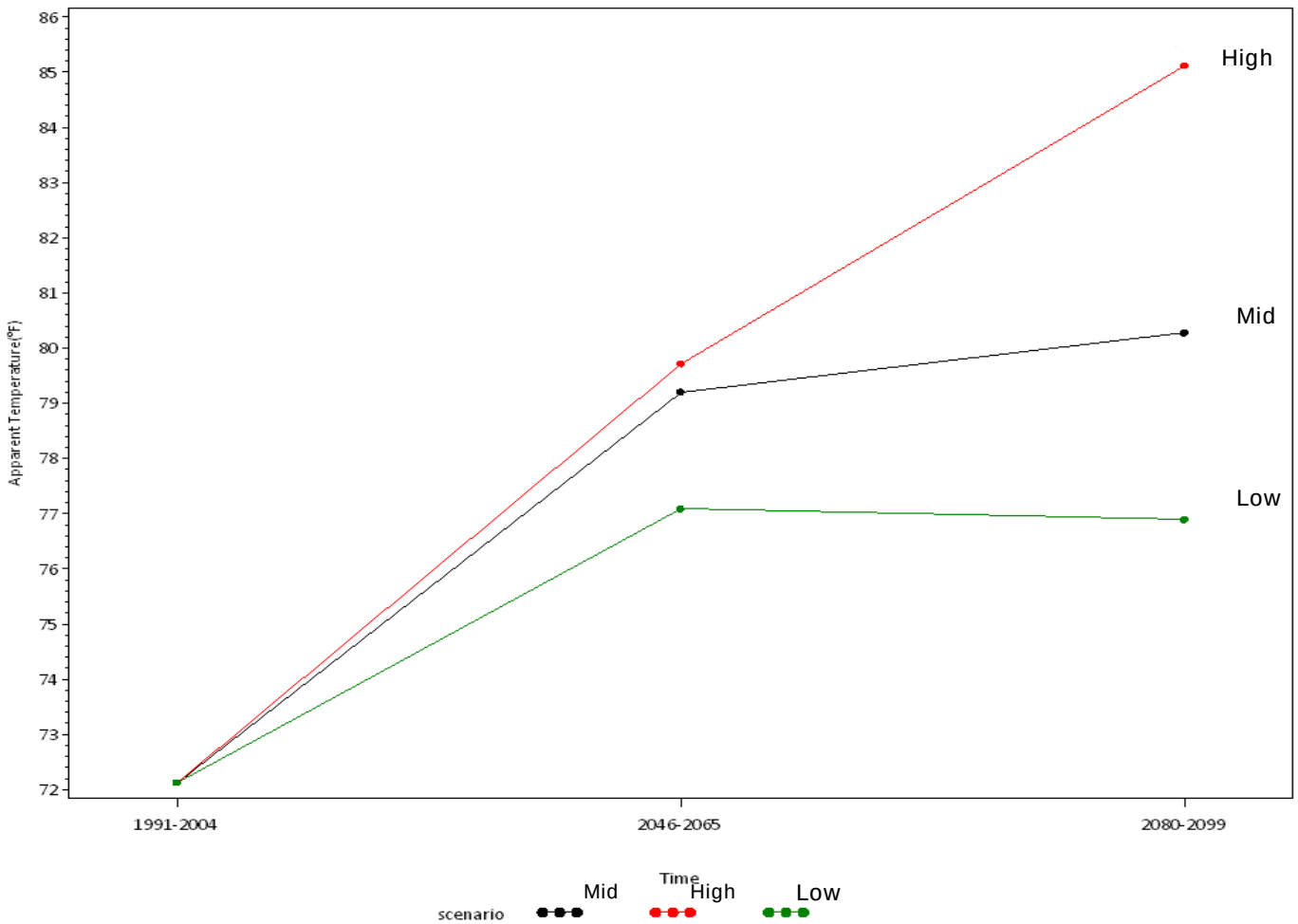


TABLE 2—Effects of extreme high apparent temperature* in summer on respiratory hospital admissions, cost and lost workdays by region

Time, Scenario	1991-2004			2046-2065 Mid**			2080-2099 Mid**		
Region	Increased Admissions per Year	Increased Cost per Year	Increased Lost Workdays per Year	Increased Admissions per Year	Increased Cost per Year	Increased Lost Workdays per Year	Increased Admissions per Year	Increased Cost per Year	Increased Lost Workdays per Year
LGA	**32**	**$362,815**	**179**	**131**	**$1,480,369**	**729**	**159**	**$1,786,289**	**879**
JFK	8	$90,358	47	39	$455,717	235	48	$559,802	288
Staten Island	2	$21,026	12	9	$89,910	50	10	$110,664	61
Long Island	6	$75,369	40	30	$393,206	208	37	$477,200	253
White Plains	8	$94,533	59	19	$227,741	143	21	$256,091	161
Hudson Valley South	**6**	**$78,651**	**43**	**25**	**$299,411**	**162**	**30**	**$361,013**	**196**
Hudson Valley North	-1	-$3,731	-3	-7	-$49,681	-42	-9	-$63,761	-54
Adirondack & North	-4	-$22,046	-21	-17	-$100,919	-97	-19	-$113,875	-109
Mohawk Valley	2	$15,950	14	9	$62,587	53	10	$72,386	62
Binghamton	**4**	**$28,894**	**23**	**27**	**$194,620**	**158**	**33**	**$243,918**	**198**
Great Lakes-Rochester	10	$68,798	60	35	$233,207	204	39	$257,949	225
Central Lakes	4	$27,764	25	14	$96,334	86	17	$111,390	100
Western Plateau	4	$23,820	22	11	$66,840	62	12	$75,004	70
Great Lakes - Buffalo	2	$16,116	13	13	$96,211	80	16	$117,702	98

*Threshold index is AT threshold.

*The mid scenario is A1B.

TABLE 3—Effects of extreme high apparent temperature* in summer on respiratory hospital admissions, cost and lost workdays by subgroup, 1991-2004

		1991-2004		
	Outcome	Increased Admission per Year	Increased Cost per Year	Increased Lost Workdays per Year
	All	**99**	**$1,032,460**	**616**
Gender	**Female**	**82**	**$892,343**	**532**
	Male	17	$170,675	102
Age	0-15	-6	-$31,899	-18
	16-64	40	$383,170	218
	64-74	24	$319,118	195
	75 and above	27	$381,884	237
Disease	Asthma	26	$207,052	116
	Bronchitis	41	$497,732	287
	Other	23	$347,211	241
Income	**Low**	**68**	**$660,941**	**398**
	High	61	$679,314	401

*Threshold index is AT threshold.

Current and Ongoing Climate-Health Projects

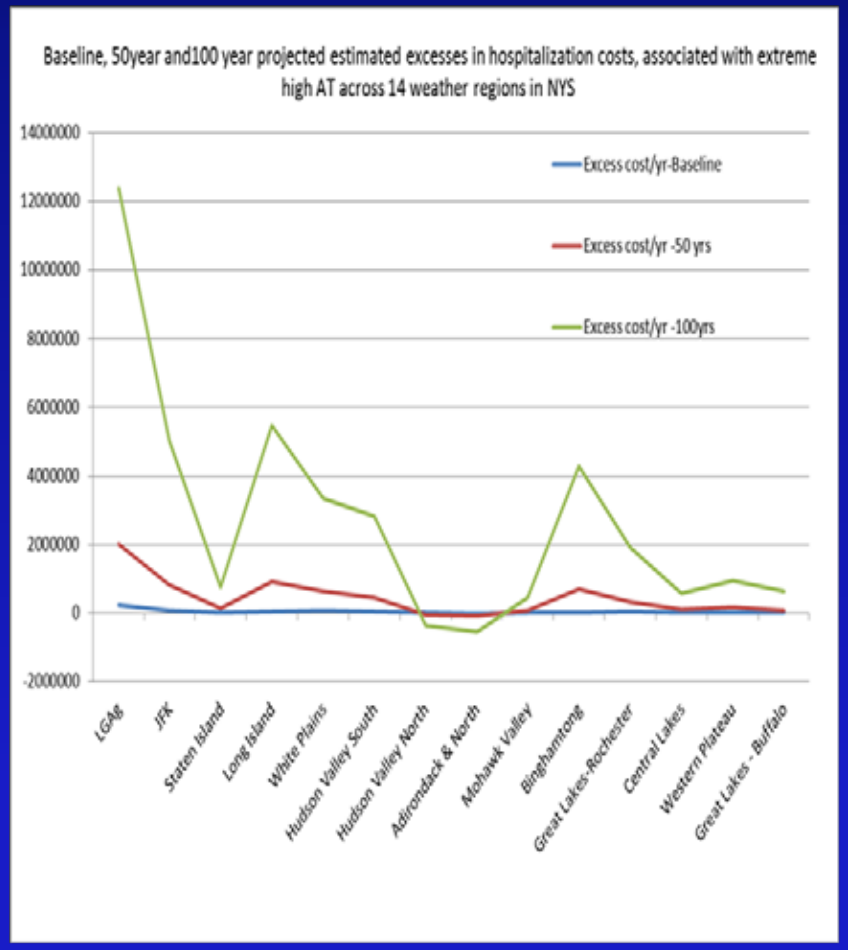
NYS Department of Health
Bureau of Environmental & Occupational Epidemiology

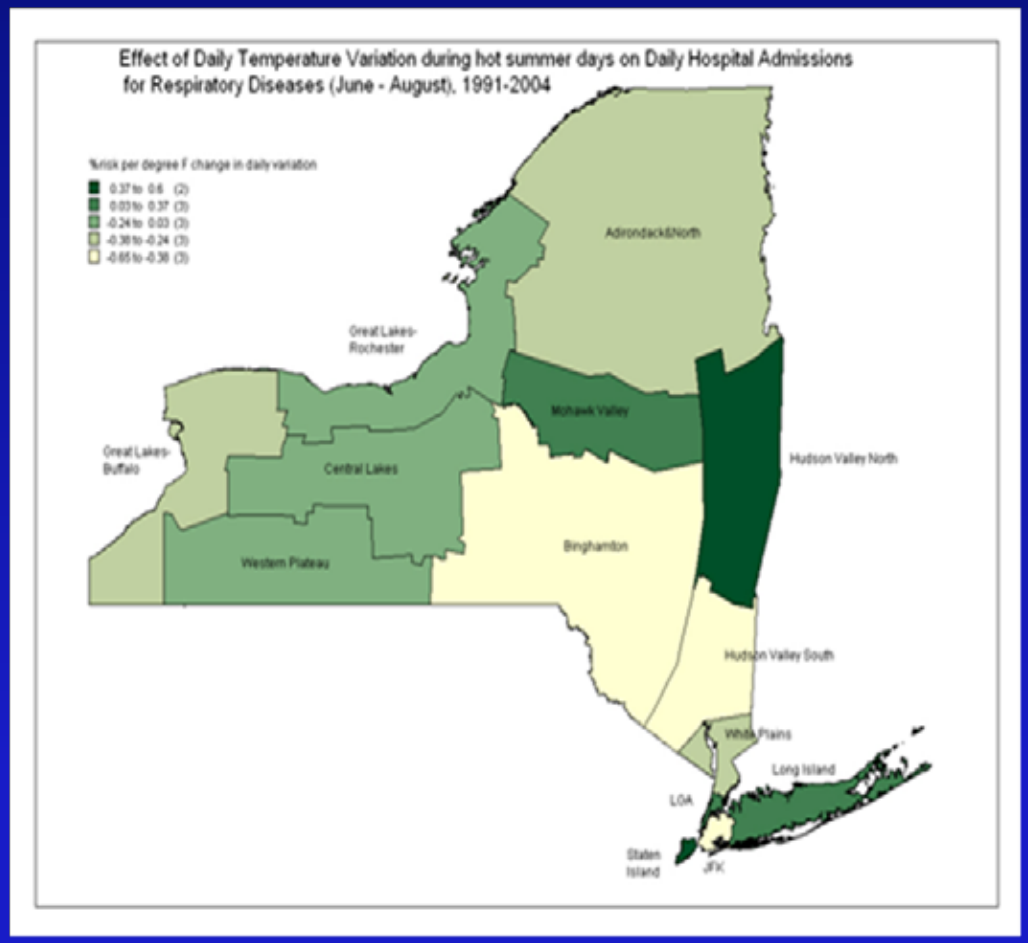
Ongoing Climate-Health Projects

- Climate Variability/Change & the Risks for Understudied Health Outcomes *(funded by CDC, 2009-2013)*
  - Evaluate independent & joint effects of meteorological factors on respiratory, cardiovascular, water/foodborne, & Lyme diseases, birth defects, & LBW, & translate research to practice
- Climate Change & Adverse Birth Outcomes: Assessing the Vulnerability of Pregnancy *(funded by NIH, 2012-2014)*
  - Evaluate exposures to extreme weather conditions & different climate patterns during pregnancy on selected birth defects, preterm birth, & LBW, & project their future burdens
- Identify Population Vulnerability to Climate Change in NYS & Plan Adaptation Strategies *(funded by NYSERDA, 2013-2015)*
  - Identify & map vulnerabilities to heat exposure, related health risks, individual sensitivity & community characteristics, & access to cooling centers & develop a heat vulnerability index & appropriate climate adaptation strategies

Putting Science to Practice

- Findings displayed by factsheets, maps, tables, & charts on the EPHT public portal (http://www.health.ny.gov/environmental/public_health_tracking/)
- Incorporated both climate & health data into the ongoing NYS EPHT program http://www.health.ny.gov/statistics/environmental/Public health_tracking/environmental/)





Translating Science to Practice

- Plan to establish a new climate-health tracking system for long-term surveillance & public response
- On behalf of NYS, the PI has participated in & assisted 3 national climate-related workgroups (SEHIC Climate Work Group, EPHT Climate Contact Work Group, & Pollen Sub-team)
- Assist SEHIC Climate Group to develop climate indicators, such as daily diurnal temperature range & assist with pilot testing of different definitions of heat-related conditions
- Collaborate with the SEHIC & the Pollen Sub-team in preparing two whitepapers, one for climate indicators for US Congress, & another for pollen indicator for the US EPHT
- Estimate & project current & future public health burden related to climate change in NYS for planning & intervention

(EHP http://ehp.niehs.nih.gov/wp-content/uploads/2012/10/ehp.1104728.pdf)

Thank you

Any Questions?