A map of the United States showing the locations of asthma stressors. The dots are concentrated in the Northeast corridor (Boston, New York, Philadelphia), the Great Lakes region (Chicago, Detroit, Cleveland), the Midwest (Kansas City, St. Louis), the Southeast (Atlanta, Charlotte, Raleigh), and the Gulf Coast (Houston, New Orleans, Jacksonville).

Mapping Asthma Stressors: An All-Encompassing Inventory

ESRI International Users Conference, July 2015

Jeff Blossom, Center for Geographic Analysis, Harvard
University

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CENTER FOR GEOGRAPHIC ANALYSIS
HARVARD UNIVERSITY

PESBART

Effects of Physical Environment and Stress in
Blacks in relation to Asthma severity and
Response to Therapy



PESBART: an AHRP funded study run by HCRI



Agency for Healthcare Research and Quality
Advancing Excellence in Health Care

A screenshot of the Harvard Clinical Research Institute (HCRI) website. The top navigation bar is dark red with white text for 'Research', 'Services', 'About HCRI', 'Working at HCRI', and 'Social Responsibility'. The main header features the HCRI logo and the text 'HARVARD CLINICAL RESEARCH INSTITUTE'. Below this is a large banner image showing a periodic table of elements with several colorful pills (red, yellow, blue, white) scattered over it. A blue box with white text reads 'Innovative Study Design' with a 'Learn more' button. At the bottom of the banner are four dark red buttons with white text: 'Innovative Study Design', 'Clinical Trials Execution', 'Data Analysis Center', and 'Event Adjudication'.

HCRI designs and runs clinical trials with world-class academic researchers and industry sponsors. We combine the logistical capabilities of a contract research organization with world-class academic scientific leadership.

We have a proven track record in cardiology, central nervous system, and pulmonology, and our research and publications show it.



PESBART Team

HCRI – Project and Data Coordinating Center

Elliot Israel MD, Principal Investigator
Jane Lanzillotti MS, Project Mgmt
Gene Lichtman, Information Technology
Floni Bajraktari, Data Mgmt
Theo Cohen PhD, Biostatistics
Justin Booth, Project Coordination

BWH – Channing Division of Network Medicine: Environmental and Genetic Epidemiology

Francine Laden ScD, PI of BWH
Benjamin Raby MD MPH, Co-Investigator

CGA – Harvard Center for Geographic Analysis

Jeffrey Blossom MA

OMC – Asthma/Respiratory Care Research; Mgmt of PESBART ID Codes

Barbara Yawn MD MSc, Co-Investigator

Stakeholders

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Brent Coull PhD, HSPH
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BWH Partners Asthma Center

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Roslind Wright MD, MPH, Mount Sinai School of Medicine



PESBART Background

- PESBART proposes to leverage the outcome and genetic data collected in the **BELT** study which looked at asthma severity in over 1000 black patients (BELT: **B**lacks and **E**xacerbations on **L**ABA vs. **T**IO)
- The US Black population bears a disproportionate burden of asthma
- Stressors such as exposure to environmental pollution, crime, and poverty have been associated with worse asthma morbidity in patients with asthma



BELT

(parent study)

Blacks and Exacerbations on LABA vs. Tiotropium

A 4 year clinical study, 2010 - 2013

BELT Aims:

1. To determine, in a practice-based, real-world, randomized, prospective, comparative effectiveness trial, whether in self-identified Black patients with asthma, treatment with LABA/ICS is superior to use of a non-b-adrenergic bronchodilator (tiotropium) combined with ICS (TIO/ICS)
2. To conduct genetic analyses to determine whether, in the 20% of self-identified Black patients with asthma bearing Arg16Arg of ADRB2, treatment with LABA/ICS is superior to use of a non-b-adrenergic bronchodilator (tiotropium) combined with ICS



PESBART Aims

1. To expand the BELT study data infrastructure by collecting geographic information system (GIS) data from BELT subject addresses
2. To preprocess available genome-wide single nucleotide polymorphism (SNP) genotype data currently being generated on BELT patients in preparation for subsequent genetic analyses.
3. To enhance the sustainability and relevance of the dataset by involving teams of stakeholders
4. To perform a “Pilot Study” that examines the accessibility and utility of the datasets



GIS Variables for Specific Research Questions

When choosing variables to collect, consider the possible research questions related to asthma that could be answered. For example:

- ✓ Does weather play a role in the incidence or severity of asthma events? If so, what components of weather should we look at?
- ✓ What environmental allergens could be collected via GIS research?
- ✓ Do social events in a person's life influence asthma severity? For example, divorce, abuse, death in family?
- ✓ Does food/nutrient intake, sun exposure (vitamin D) effect asthma outcomes? What about exercise and physical fitness?



Summary of Specific GIS variables *Collected*

Air Quality

Distance to major road
mileage of major roads nearby
pollen severity, AQI, Ozone, SO₂, CO, NO₂,
PM_{2.5}
distance to nearest factory, factories nearby

Community Amenity Access

Distance to and densities of: Pharmacies,
hospitals, subway stations, bike paths,
libraries, supermarkets, athletic centers, day
care centers.

Crime and Chronic Stress

Alcohol consumption, homicides, rapes,
robberies, assaults, thefts, auto thefts.

Consumer Spending

Prescription drugs for asthma, Vitamin D
supplements, total medical expenditures,
groceries, fitness, pet products, vet visits.

Demographic

Educational attainment, race, age,
rural/urban, household size, tenure, multiple
family and single parent households.

Economic

Unemployment, poverty, income inequality,
median household income, community
economic growth or decline, food stamps,
delayed rent or mortgage payments.

Housing conditions

Peeling paint, water leaks, inadequate
heating, # units occupied, age of structure,
square footage, construction type, presence /
lack of heating, air conditioning, gas stoves
and heaters.

Weather/Environment

Temperature, precipitation, humidity, wind
speed, % sunshine, PBL, extreme weather
events, NDVI.

Specific GIS variables *NOT Collected*

Air Quality

Idling laws, busses with emissions controls, number of stoplights, traffic counts, advocacy to improve air quality.

Community Amenity Access

Public health programs, outreach programs, subsidized public transportation, MD's per capita, mixed use development, zoning regulations.

Crime and Chronic Stress

Abandoned or foreclosed homes, domestic abuse, calls to 911, protection orders, litter, graffiti, vandalized buildings, neighborhood disorder, divorce rate, deaths, ambulance data, domestic abuse, criminal victimization

Consumer Spending

Non-prescription drugs for asthma, Primateen mist, Metanephryn, taking medicine or receiving treatment for mental health or emotional problems.

Housing conditions

Mold, dust mites, rodent, roach, and bed bug infestations and exposers.

Social

General Social Survey, Gallup Well-Being Index, psychosocial measures, Behavioral Risk Factor Surveillance System survey.



Review of BELT Study Variables

Demographics—Baseline

Age
Sex
Co-morbidities
 HD, Ca, Stroke, DM, CRD, HIV/AIDS, HTN
Concomitant Rx (non-asthma)

Asthma Characteristics—Baseline

Age of onset, Age of Dx
Seasonality
unscheduled asthma office visits past yr
asthma ED visits yr
asthma hospitalization past yr
steroids bursts past yr
Intubation—ever
missed days due to asthma past yr
Environmental allergies
Smoking---pack yrs
Smoking environment

Outcomes

Asthma control	ACQ	Monthly
Q of L-----	AQLQ	Monthly
Symptoms		
	ASUI	0,1,6,18
	SFD	Monthly
	ACQ	Monthly
Exacerbations		Monthly
Deteriorations		Monthly
Spiro (pre/post)		0,1,6,18 (Once)

Baseline and calculated asthma

Asthma baseline Rx
Asthma severity
Change in FEV1, FVC and ratio



Genetics the Environment and Asthma Outcomes

- PESBART is supporting the development of a comprehensive genetic dataset to facilitate large-scale study of the role of genetic differences in the natural history of asthma and responsiveness to asthma medications.
- Genotyping performed on all study subjects.
 - Includes all subjects with sufficient DNA who provided informed consent for such studies
 - Genotyping on Affymetrix Amiom Biobank Array
- What questions can we ask with this genetic data?
 - What are the genetic determinants of individual response to asthma medications?
 - What are the genetic determinants of lung function and other asthma-related traits?
 - How do genes interact with environmental factors to impact asthma severity?



Geocoding results



HA

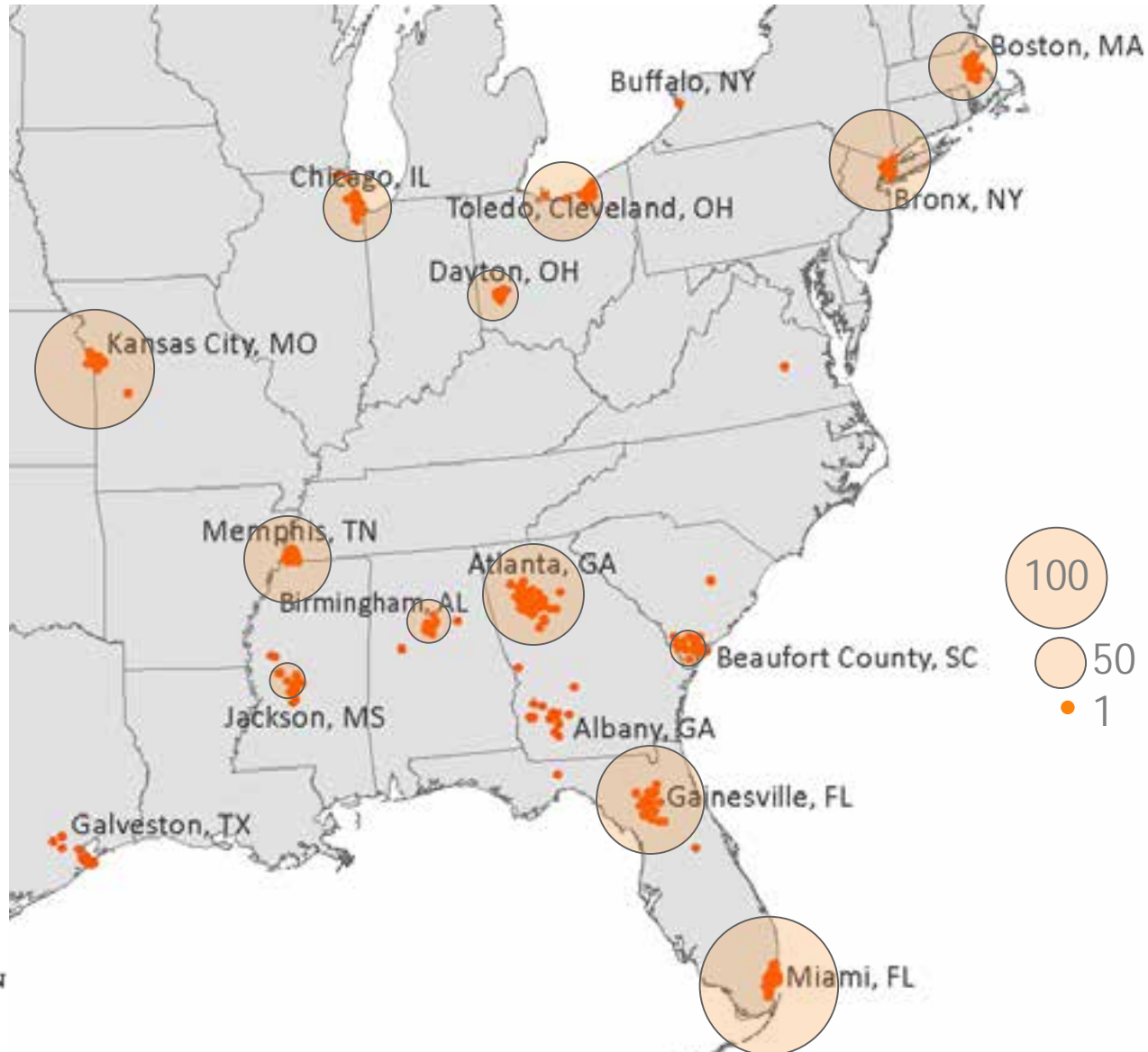
1. Geocoding Statistics

1,075 BELT subject addresses were geocoded to street address locations.
Summaries by Region listed below.

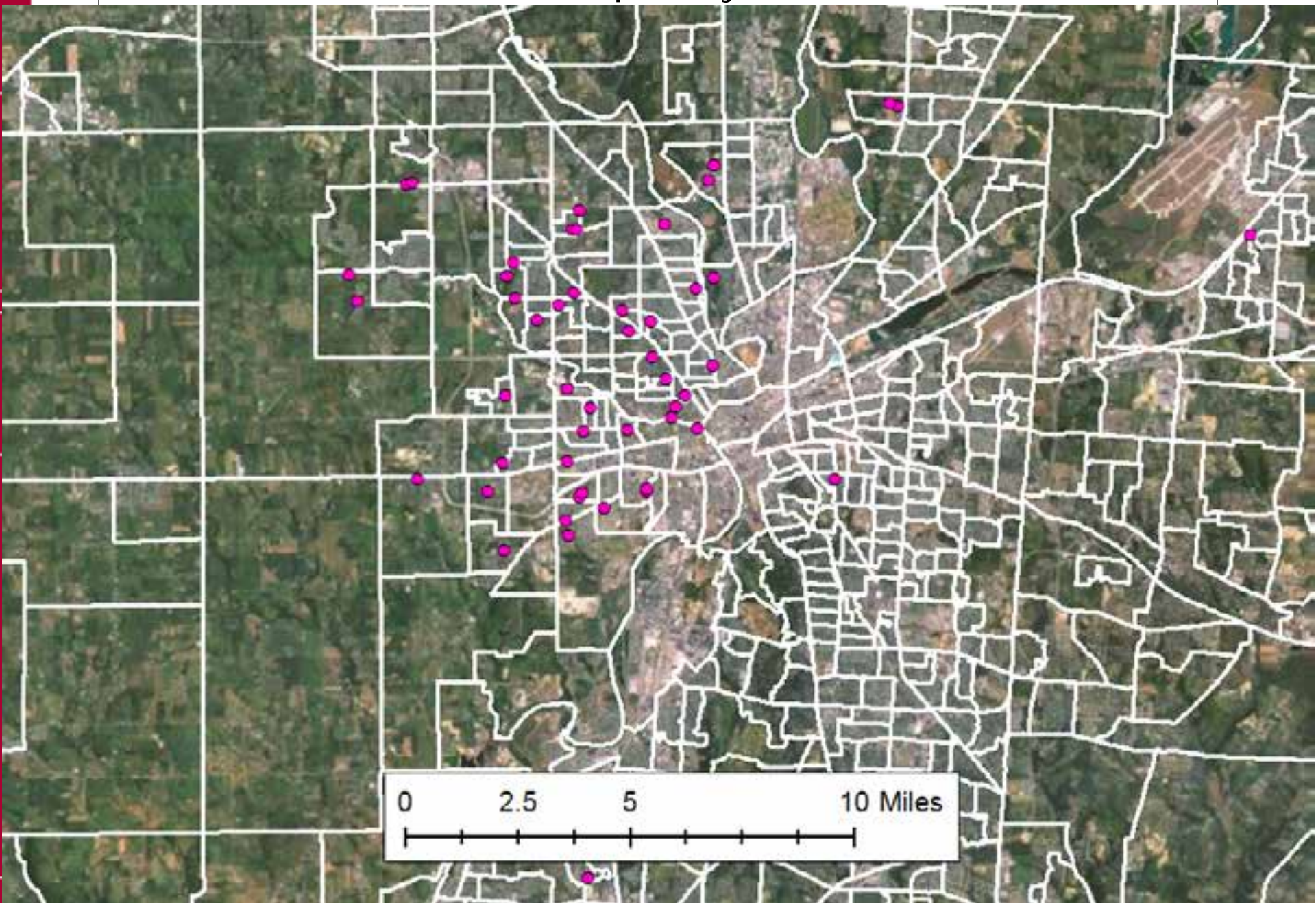
Region	Count	Region	Count
Miami, FL	162	Chicago, IL	63
Kansas City, MO	118	Dayton, OH	50
Gainesville, FL	107	Beaufort County, SC	38
New York, NY	101	Jackson, MS	35
Atlanta, GA	100	Southwest Georgia	26
Memphis, TN	86	Galveston-Houston, TX	22
Cleveland-Toledo, OH	78	Birmingham, AL	19
Boston, MA	67	Buffalo, NY	2
		Richmond, VA	1



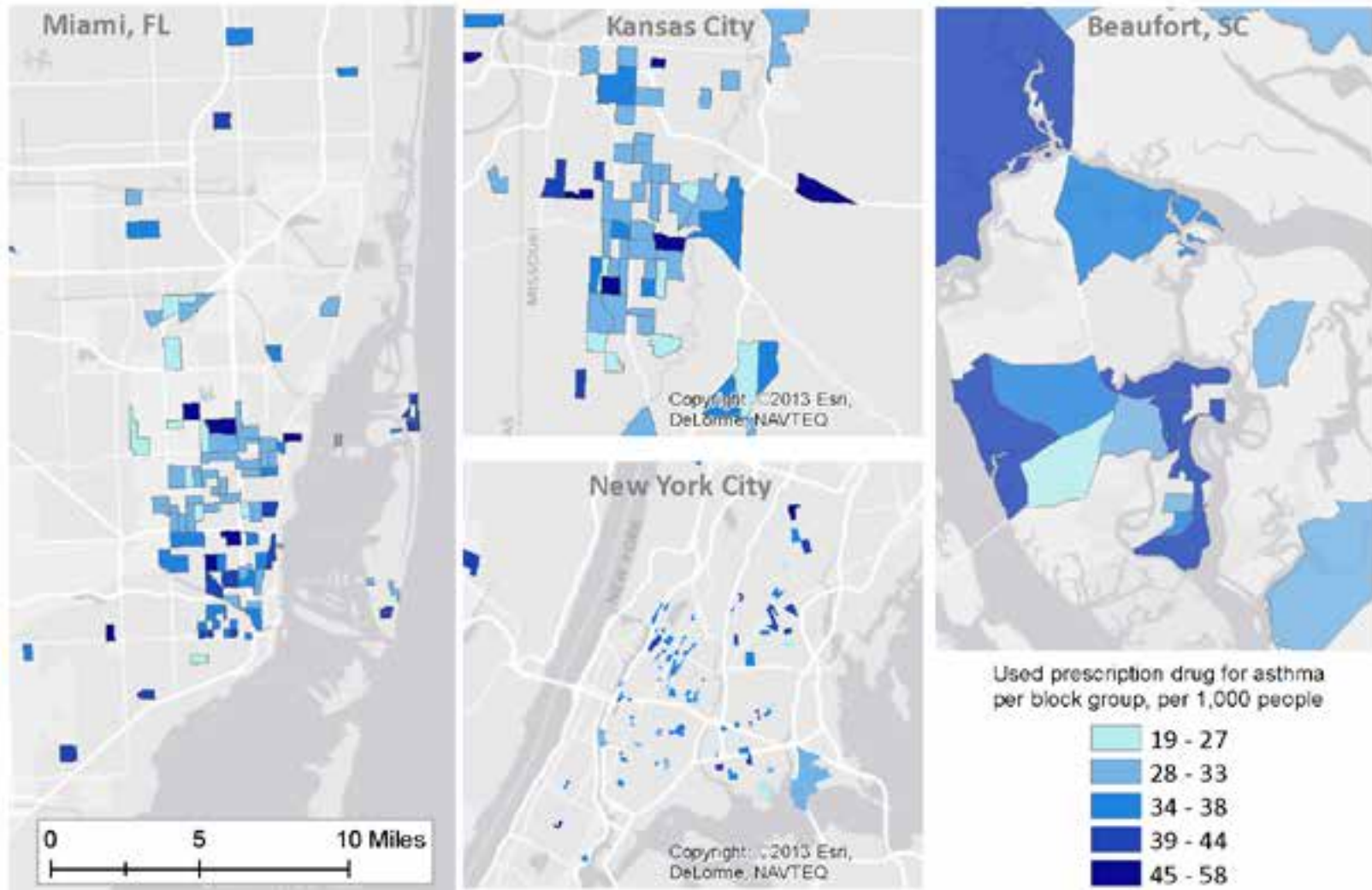
Overall Geographic Distribution of PESBART address locations (1,075)



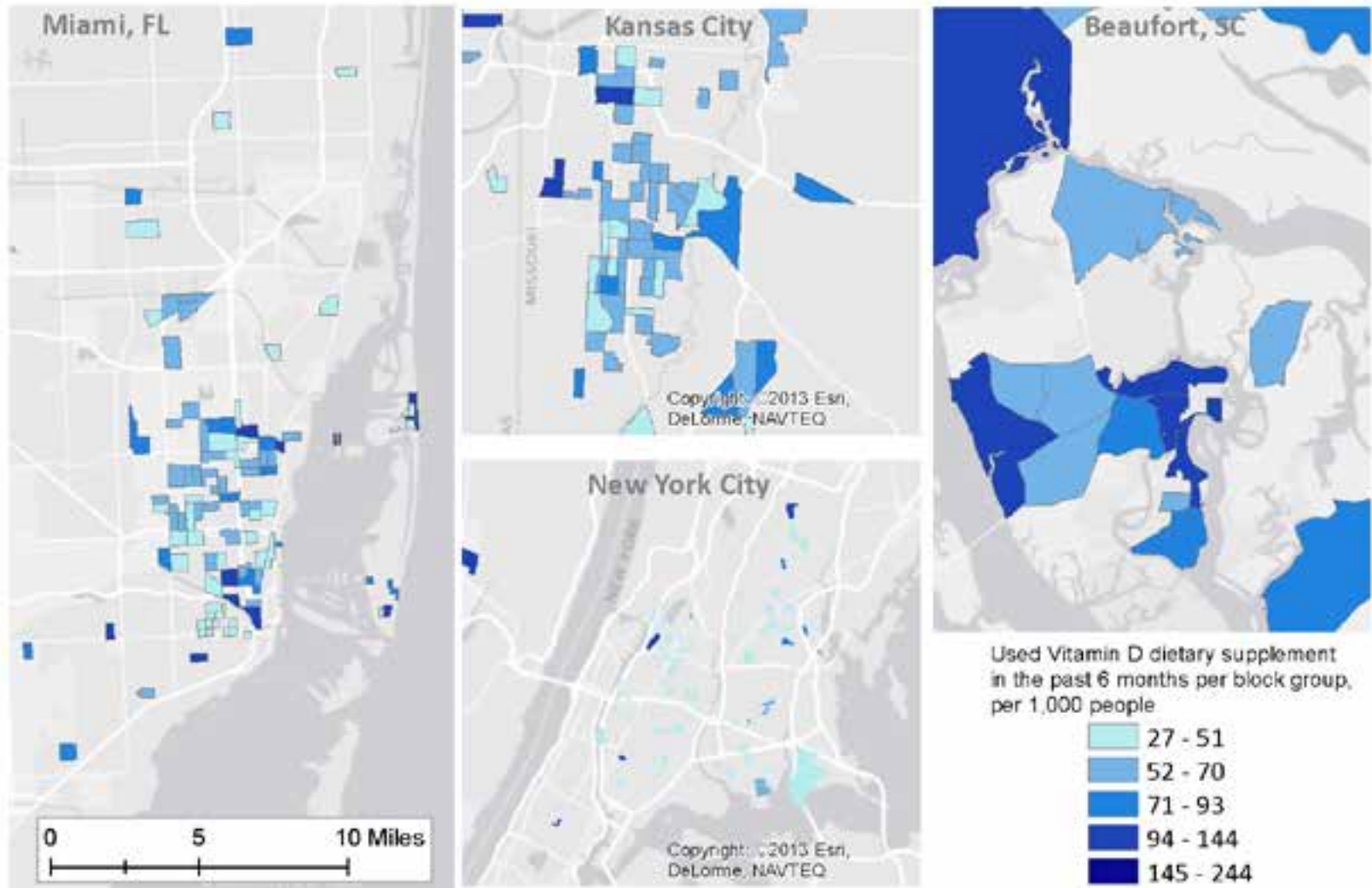
Block Groups, Dayton, Ohio



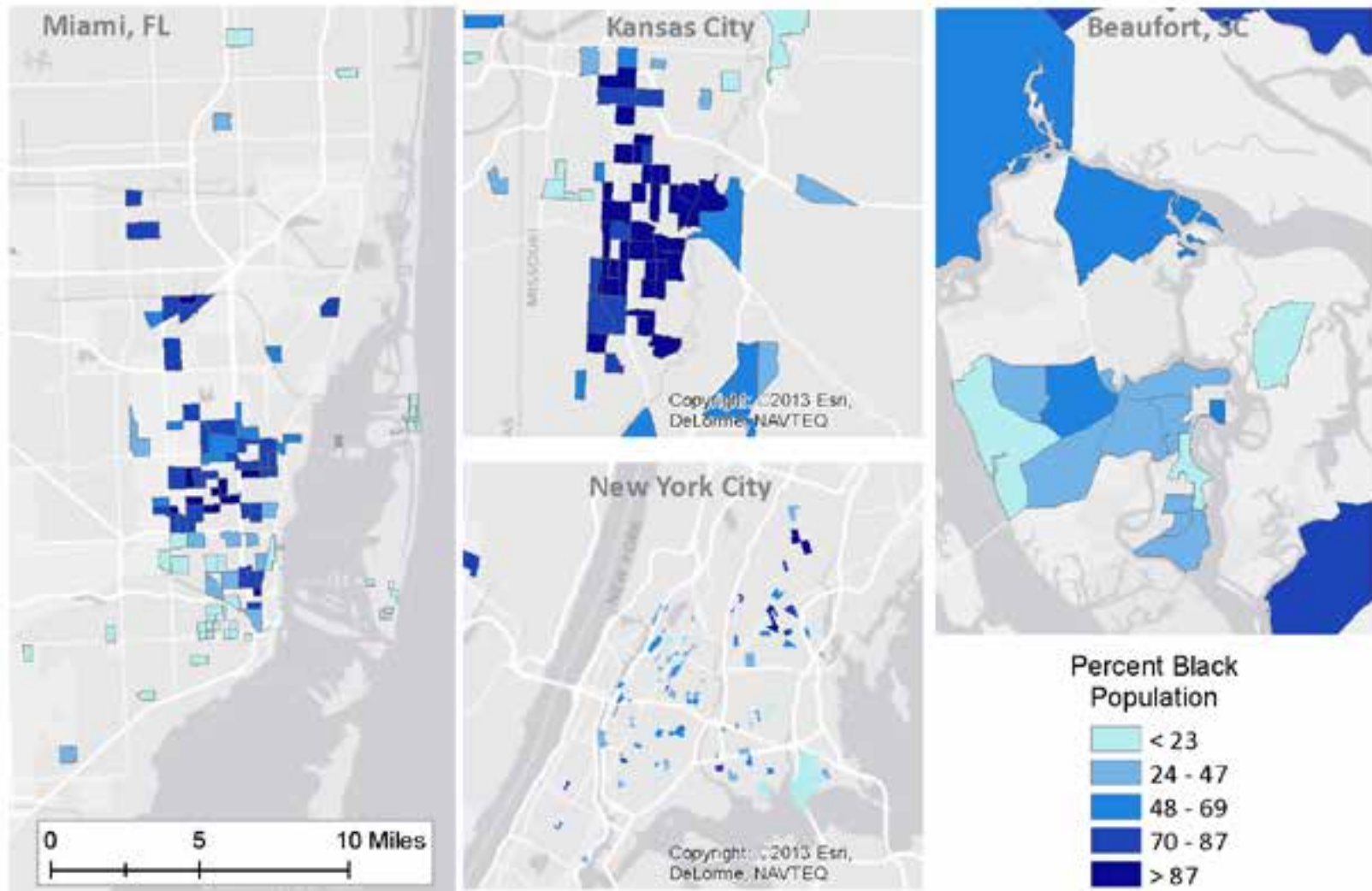
GIS Variable: Used prescription drug for asthma in 2013



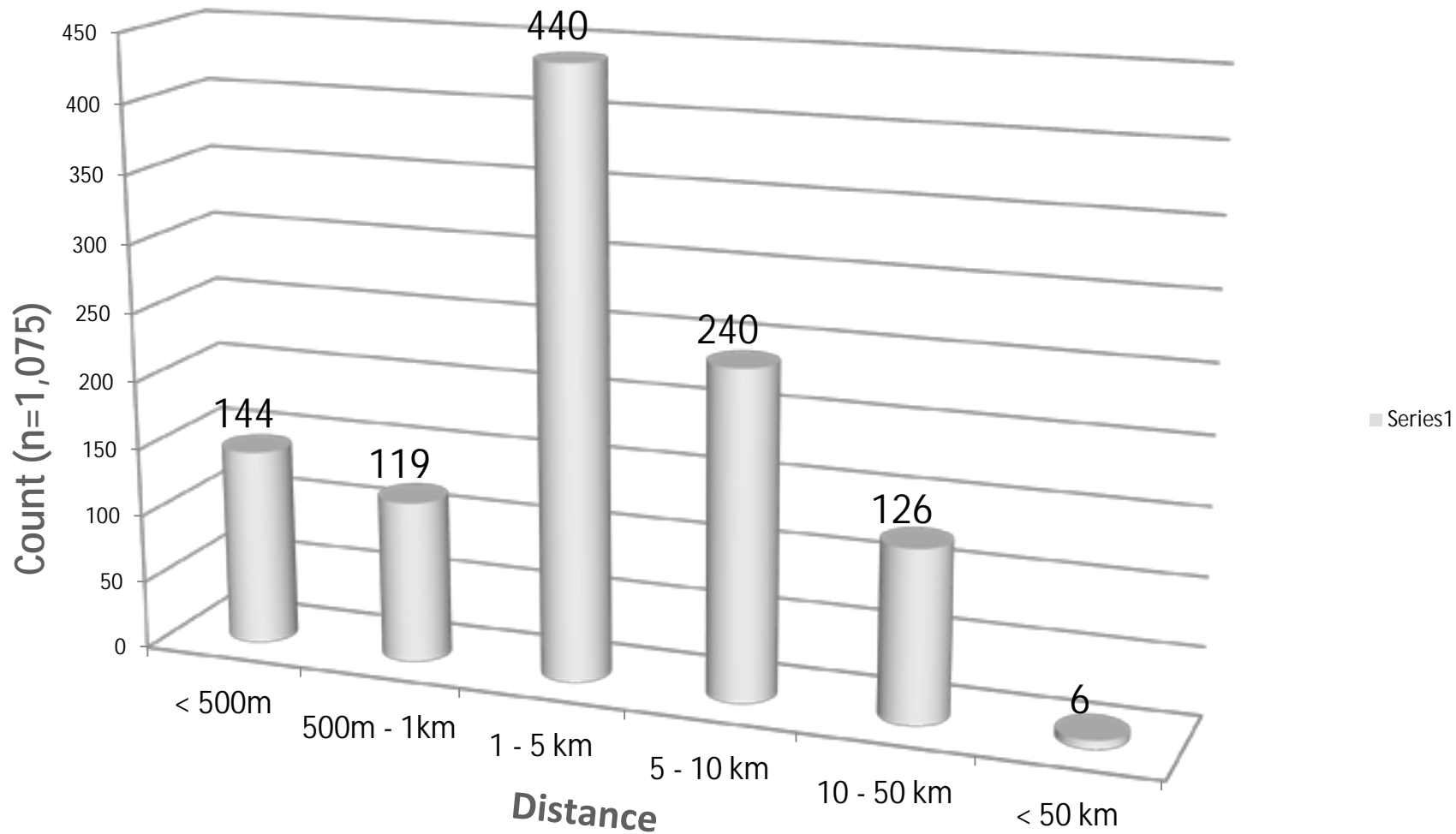
GIS Variable: Used Vitamin D supplement, past 6 months



GIS Variable: % Black Population, 2013

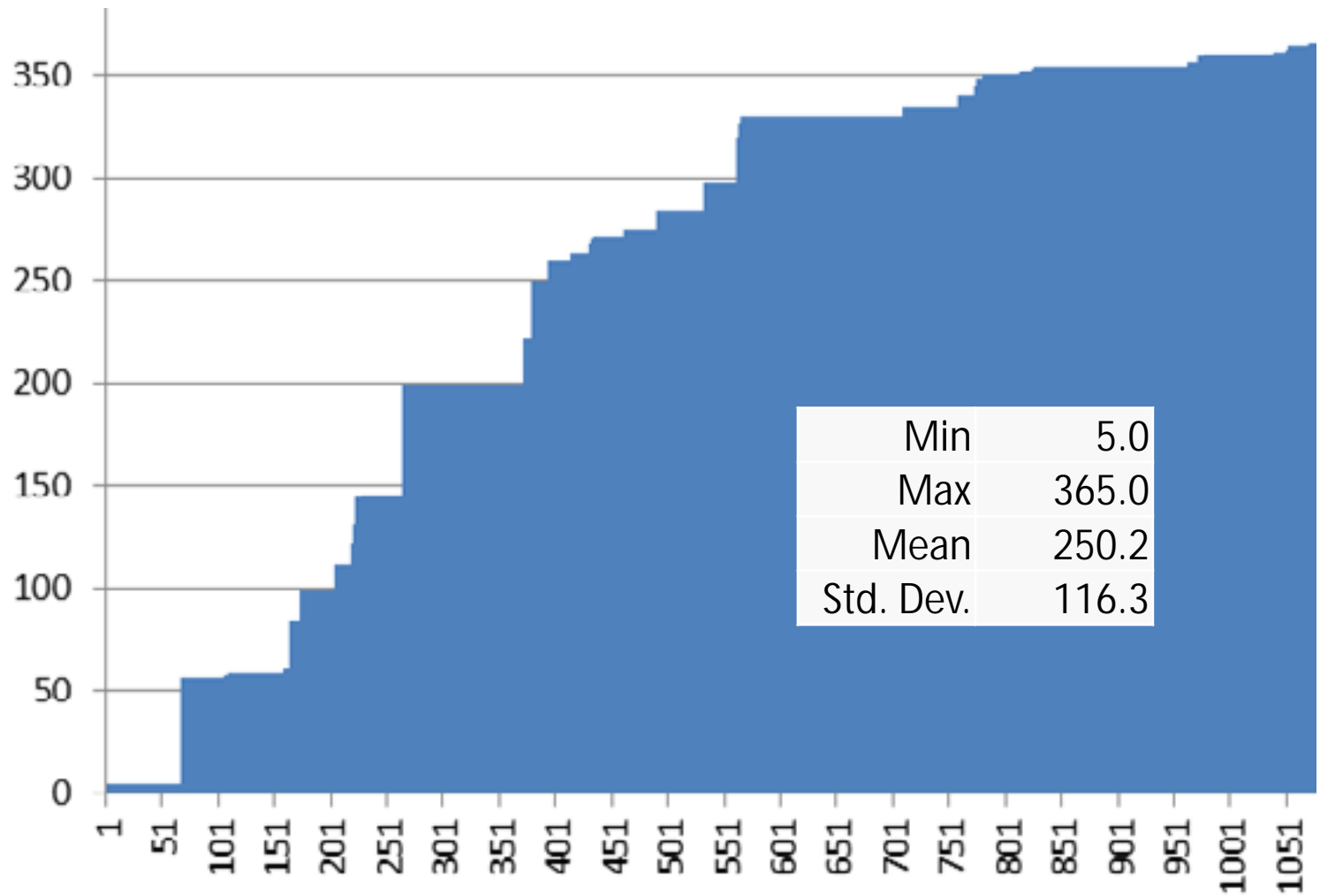


GIS Variable: Distance to nearest bus or train terminal, or subway stop



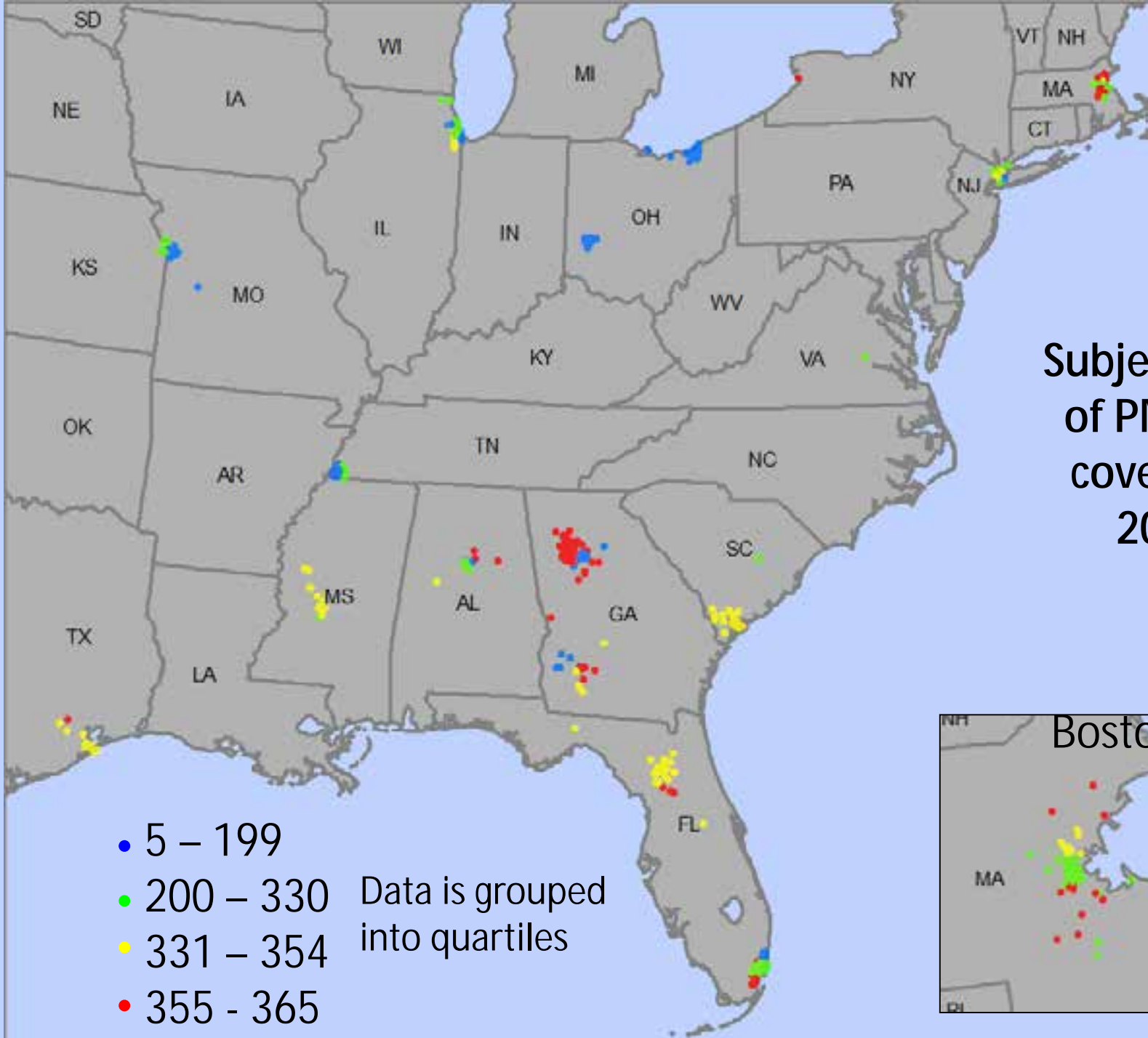
Days with PM_{2.5} data at nearest station, 2013

Days with PM 2.5, 2013

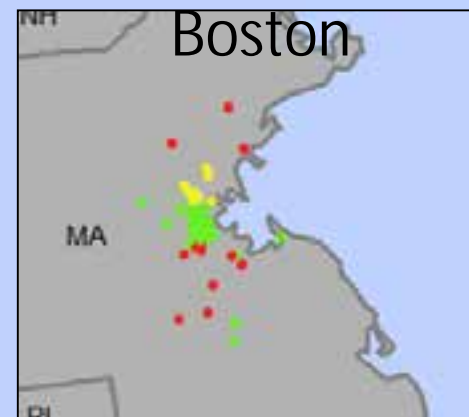


BELT subjects (1,075)



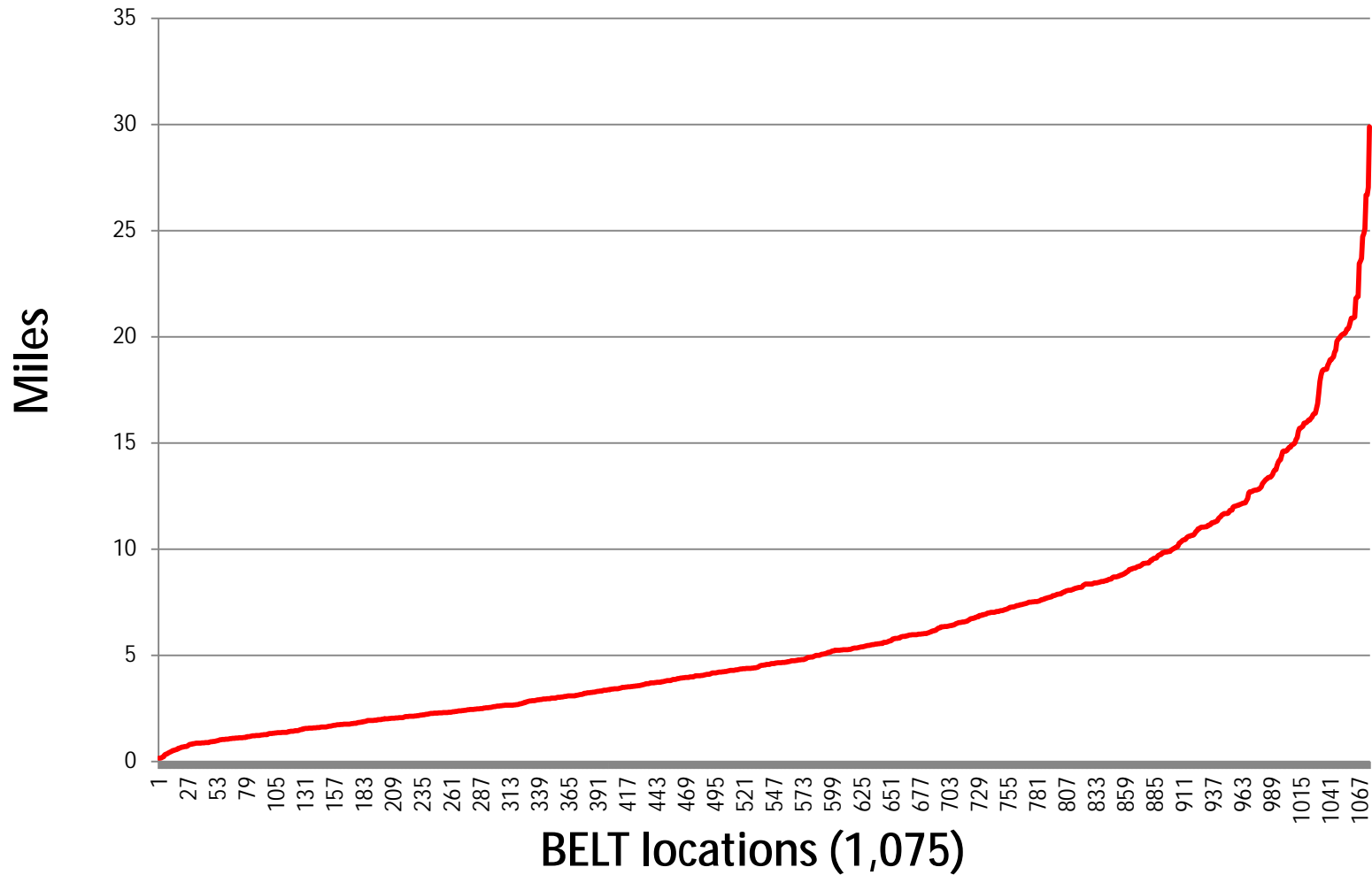


Subject days
of PM_{2.5}
coverage,
2013



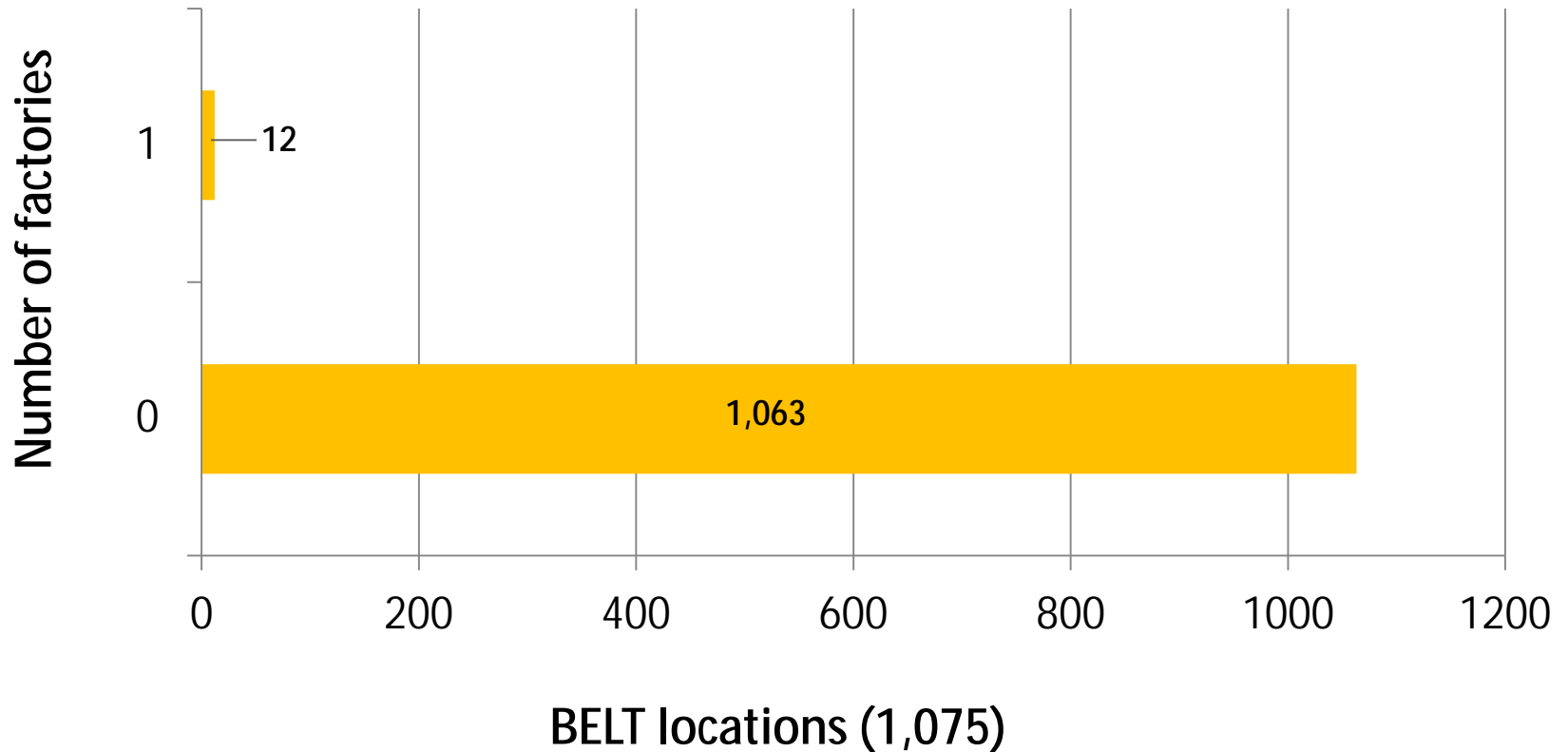
3. Overall distribution of factories

Distance to nearest factory



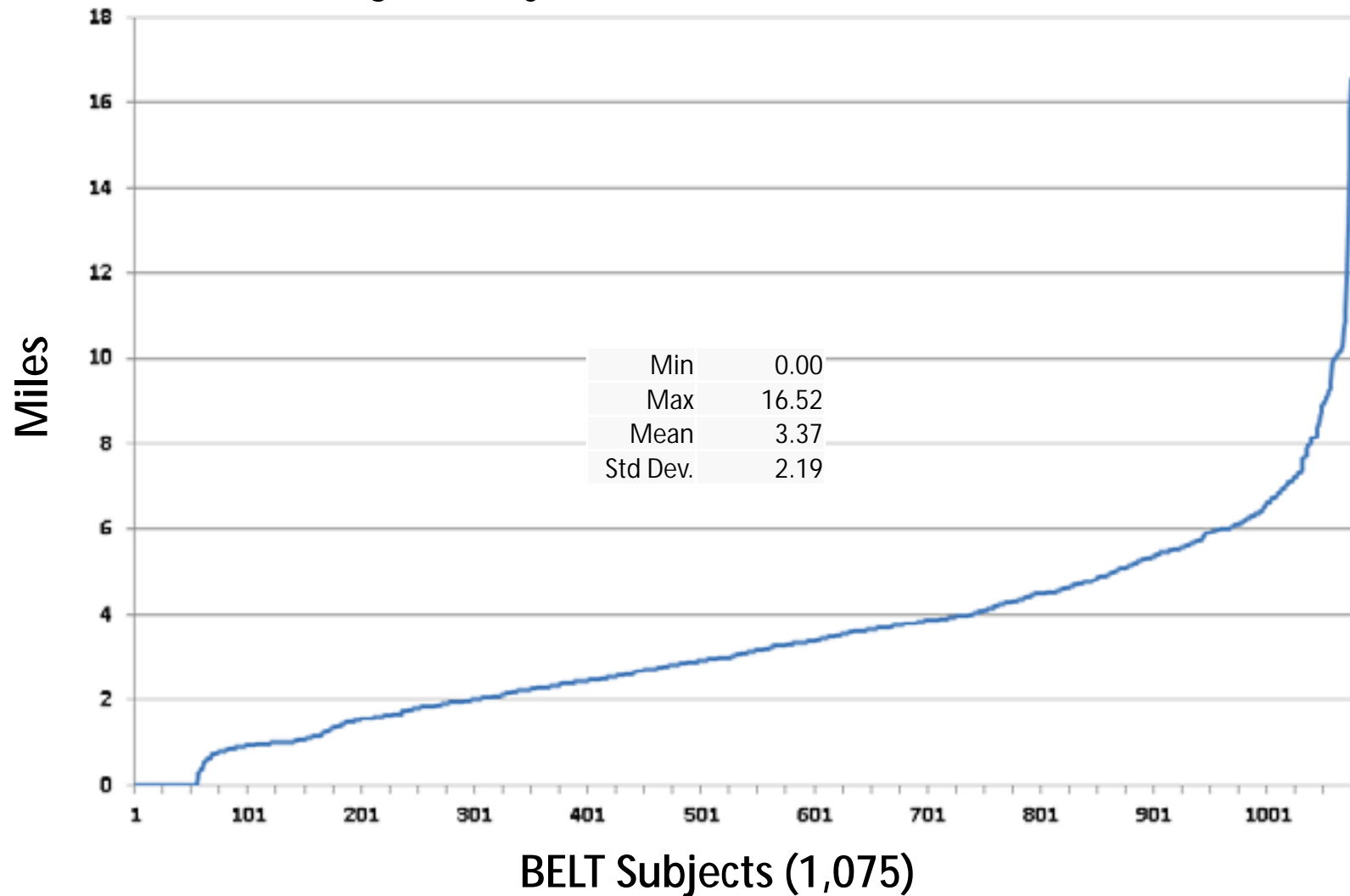
Pilot Study distribution graph

Number of factories within ½ mile



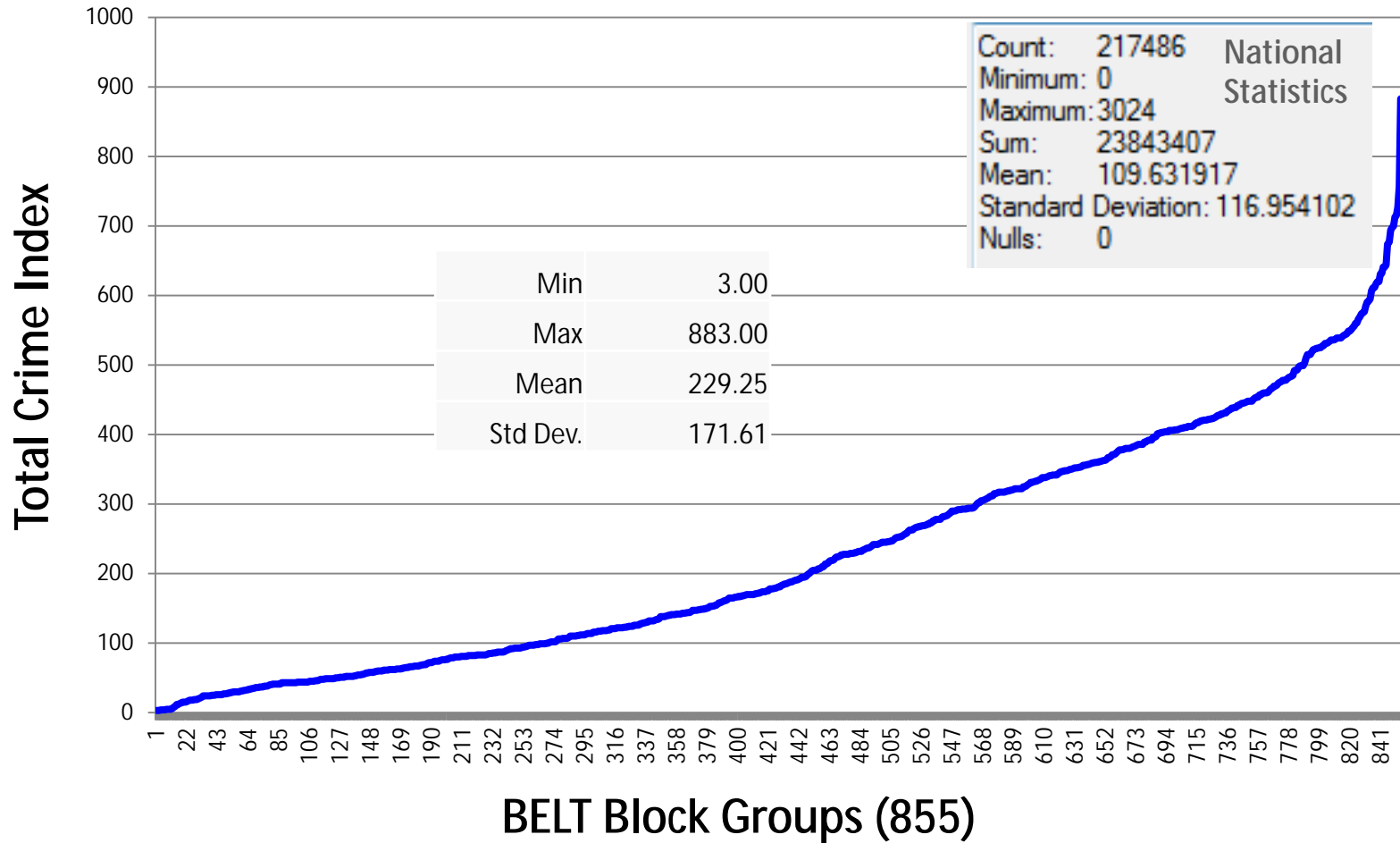
4. Overall distribution of average traffic

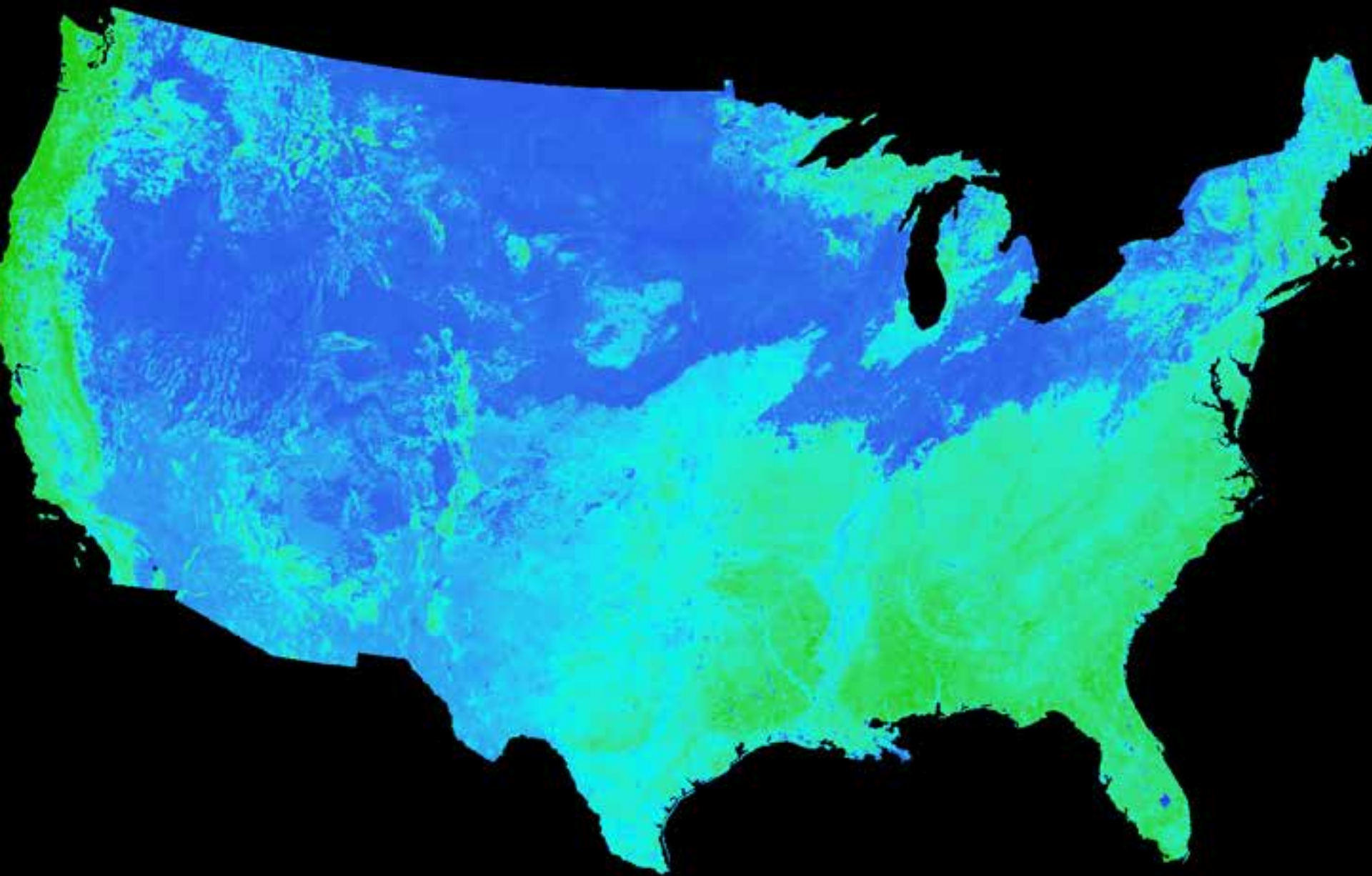
Mileage of major roads within 1/2 mile



Pilot Study Distribution Graph

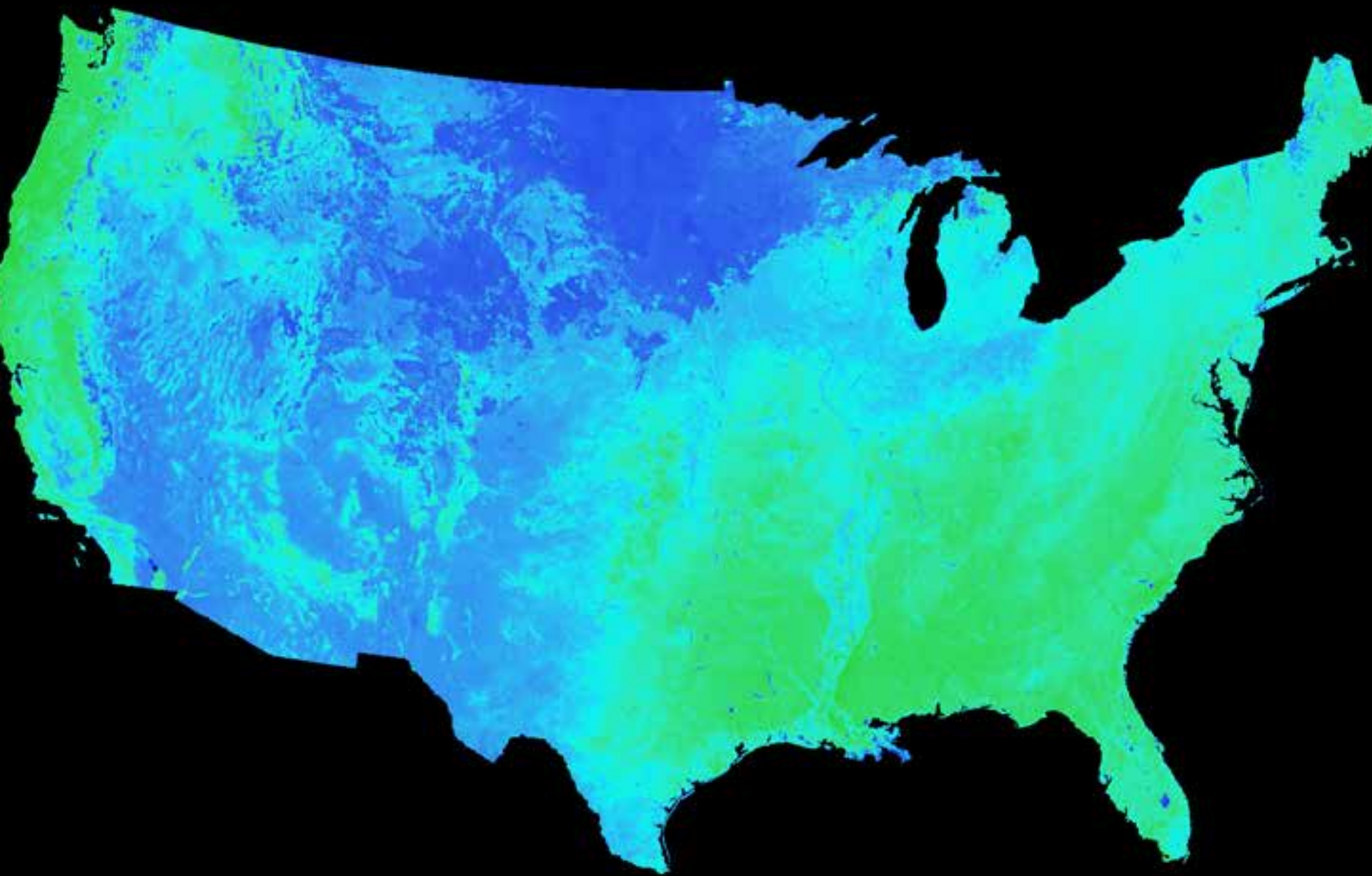
Total Crime Index per Block Group, 2013





NDVI Jan. 2013

data processed by Peter James



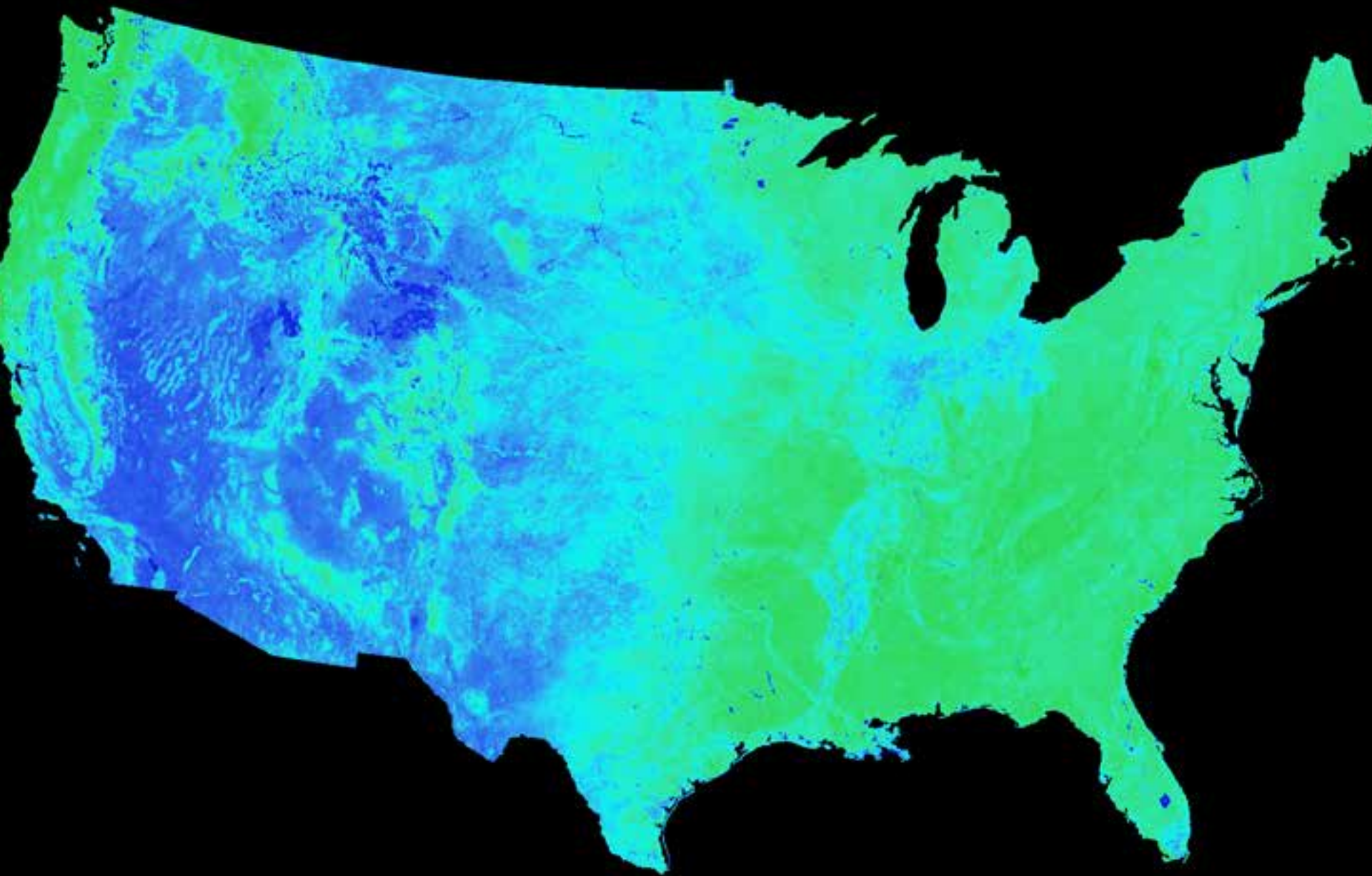
NDVI April, 2013

data processed by Peter James



NDVI July 2013

data processed by Peter James



NDVI Sept. 2013

data processed by Peter James

Daily Weather data

Clinical trial period was 1/1/2010 – 12/31/2013 (1,461 days)



Historical Weather

Find historical weather by searching for a city, zip code, or airport code. Include a date for which you would like to see weather history. You can select a range of dates in the results on the next page.

Location:

Date:

April 9 2015

Temperature, precipitation, humidity, % cloudiness, wind speed, presence of severe weather event.



Daily Weather and Air Pollution data

Clinical trial period was 1/1/2010 – 12/31/2013 (1,461 days)

Carbon Monoxide

Ozone

Sulfur Dioxide

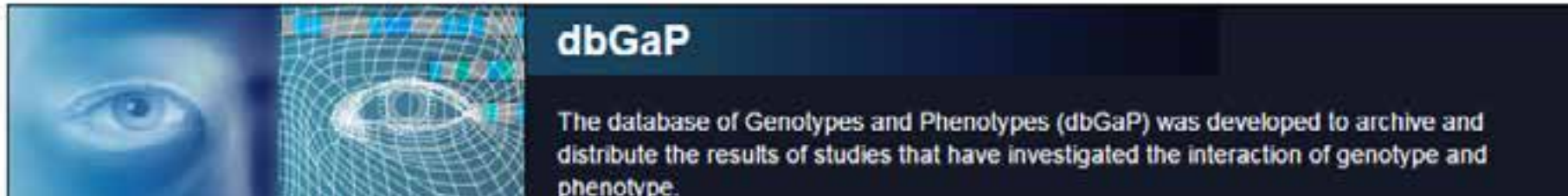
Nitrogen Oxide

The screenshot shows the EPA AirData website. The header includes the EPA logo and navigation links: LEARN THE ISSUES, SCIENCE & TECHNOLOGY, LAWS & REGULATIONS, and ABOUT EPA. The main content area is titled 'Download Daily Data' and includes a breadcrumb trail: 'You are here: EPA Home -> AirData -> Download Data -> Download Daily Data'. Below the title, there is a description: 'Download daily data for a specific location and time period. This tool queries criteria pollutants by monitor. You can get data for specific monitors or all'. The interface features four main selection steps: 1. Pollutant (CO), 2. Year (2013), 3. Geographic Area (AL - Jefferson), and 4. Monitor Site (All Sites, 010730023, 010730028, 010731003, 010736004).



Publishing

Genotype, phenotype, and **environmental data** will all be published on dbGaP ~ Sept., 2015



Table/Folder Name	Rows	Row_Description	Columns	Column_Description
PESBART.csv	1,072	Each row represents a PESBART subject	452	Each column is an subject level variable
Block_Group.csv	855	Each row represents a PESBART block group	340	Each column is a block group level variable
Tract.csv	771	Each row represents a PESBART tract	14	Each column is a tract level variable
Pollen.csv	39,648	Each row represents a pollen reading on a specific day, at one of 27 locations	2	Columns contain the "pollen area location", and pollen severity index
NDVI.csv	1,072	Each row represents a PESBART subject	32	Each column is a day, (4 per year, one in each season, 1/1/2010 to 12/31/2013)
Housing.csv	855	Each row represents a PESBART block group	4,878	Each column is a Housing variable, at the block group level
Air_pollution.csv	1,566,192	Each row represents one subject on one day from 1/1/2010 to 12/31/2013	12	Each column represents an air pollution variable
Weather.csv	1,566,192	Each row represents one subject on one day from 1/1/2010 to 12/31/2013	25	Each column represents a weather or climate variable
Total variables:		62,979,784		

Conclusions

- A laborious project (18 months, ~40 hours per month).
- A stupendously comprehensive dataset!
- Made me aware of the existence and utility of many new datasets.

CGA contributors:

Dave Strohschein, Hawk Arachy, Said Douai, Joe McGuire,
Tommy O'Connell.

HSPH contributor: Peter James



Thanks!

Questions?

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