

Linking NASA Environmental Data with a National Public Health Cohort Study and a CDC on-line System to Enhance Public Health Decision Making

**Mohammad Al-Hamdan, William Crosson, Maury Estes, Sue Estes,
Sarah Hemmings, Dale Quattrochi, Gina Wade**
NSSTC at NASA Marshall Space Flight Center, Huntsville, AL

Leslie McClure, Shia Kent
School of Public Health, University of Alabama at Birmingham, Alabama

Sigrid Economou, Mark Puckett
*National Center for Public Health Informatics, Centers for Disease Control and Prevention,
Atlanta, Georgia*

ONE step...BEYOND Workshop
*European Space Agency/European Space Research Institute
Frascati, Italy, October 15-16, 2015*

Goals and Objectives

- **This project has dual goals in decision-making activities**
 - Providing information to decision makers about associations between environmental exposures and health conditions in a large national cohort study
 - Enriching the CDC Wide-ranging Online Data for Epidemiologic Research (WONDER) system by integrating environmental exposure data
- **Develop daily high-quality spatial data sets of environmental variables for the conterminous U.S. for the years 2003-2008 utilizing NASA data (Objective 1)**
 - Fine Particulates (PM_{2.5}) (NASA MODIS and EPA AQS)
 - Land Surface Temperature (NASA MODIS)
 - Solar Insolation and Heat-related Products (Reanalysis Data)
- **Link these environmental variables with public health data from a national cohort study and examine environmental health relationships (Objective 2)**
 - Cognitive Function
 - Hypertension
- **Make the environmental datasets available to public health professionals, researchers and the general public via the CDC WONDER system (Objective 3)**

Environmental Health Implications

➤ **Fine Particulates (PM2.5)**

- Human observation studies show that exposure to general pollution containing PM2.5 could cause inflammation, degradation, and oxidation in the brain when inhaled and could lead to altered regulation of biomarkers involved in cognitive function
- Possible risk factor for cardiovascular and respiratory diseases

➤ **Solar Insolation**

- Some research suggests that a relationship between sunlight exposure and cognition exists by affecting brain blood flow

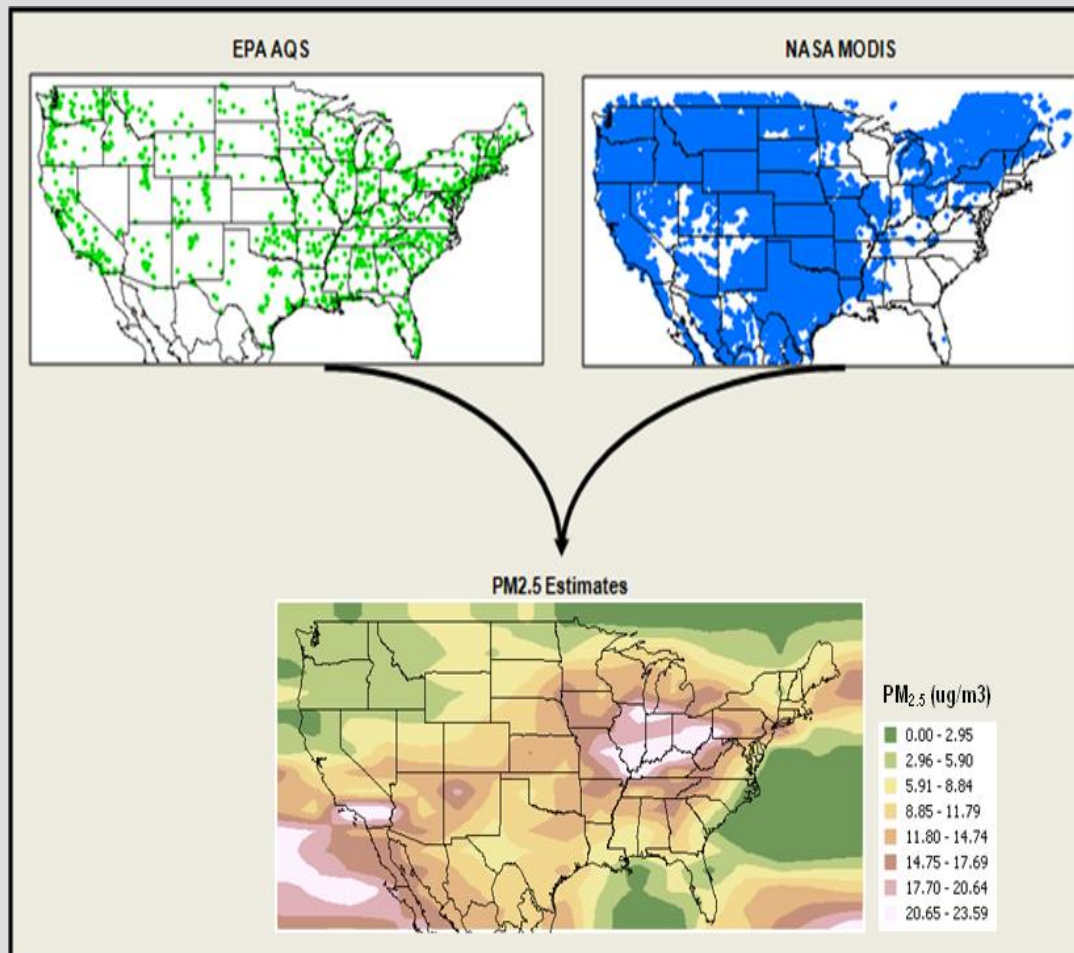
➤ **Heat Exposure**

- Some research suggests that a relationship between heat exposure and hypertension exists by affecting stress level

National Environmental Datasets (Objective 1)

Fine Particulate Matter (PM_{2.5})

- Estimated ground-level PM_{2.5} from MODIS AOD using published regression equations per EPA region per season (Zhang et al., JAWMA 2009)
- Combined with EPA PM_{2.5} data from the AQS for 2003-2008
- Modified and ran MSFC Surfacing Algorithm (Al-Hamdan et al., JAWMA 2009) to produce continuous spatial surfaces of daily PM_{2.5} for the contiguous US for 2003-2008

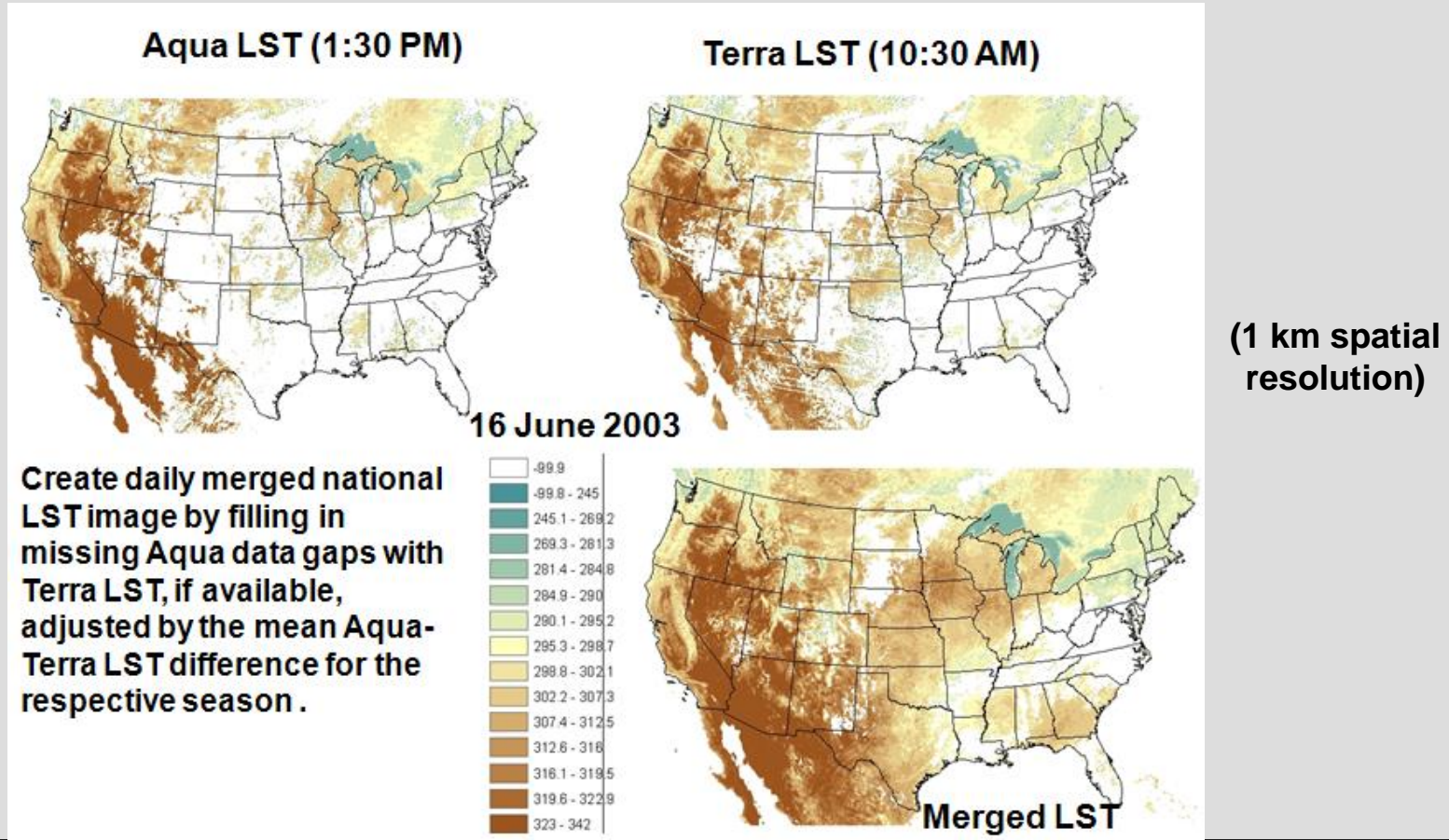


PM_{2.5} on July 14, 2003

(10 km spatial resolution)

Land Surface Temperature (LST)

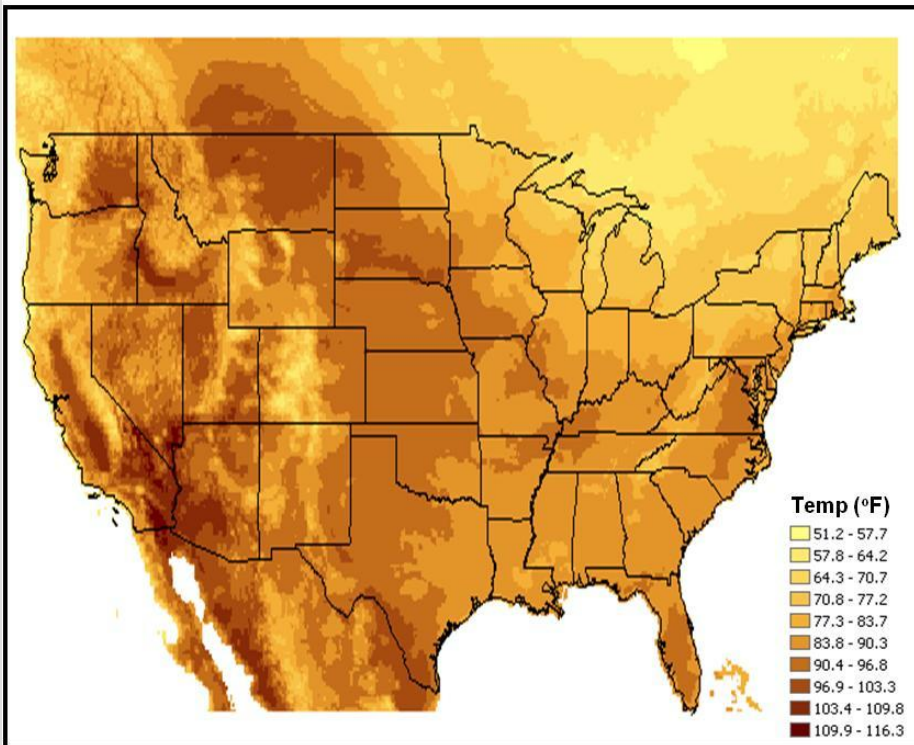
- Aqua and Terra daytime & nighttime data for 2003-2008 were processed
- Aqua-Terra differences were computed by season for 2003-2008
- Aqua data gaps were filled with Terra-adjusted LST (if available) by mean seasonal difference
- National merged Aqua-Terra daily LST dataset were generated for 2003-2008 for day & night (Crosson et al., RSE, 2012)
- Coverage improvement by 25% and 30% for daytime and nighttime overpasses, respectively



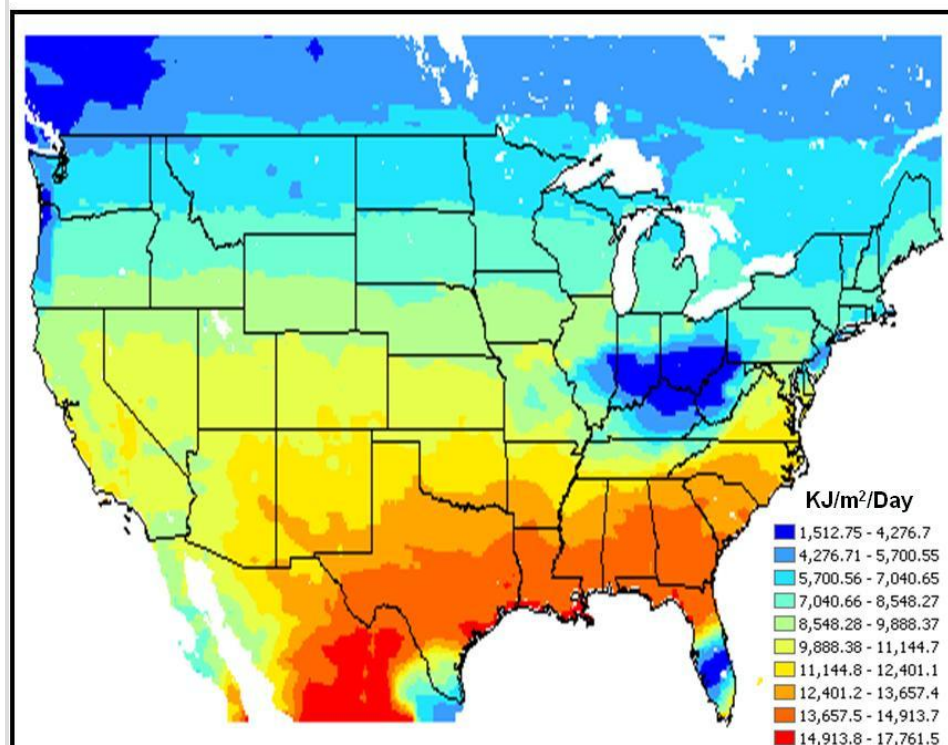
Heat and Solar Insolation

- NLDAS hourly forcing data (air temperature, solar radiation, specific humidity, atmospheric pressure) for the 2003-2008 period were processed
- Daily statistics of Maximum Air Temperature, Minimum Air Temperature, Maximum Heat Index, and Total Solar Insolation were computed for 2003-2008

NLDAS Max Air Temperature on July 15, 2008



NLDAS Solar Insolation on January 1, 2008

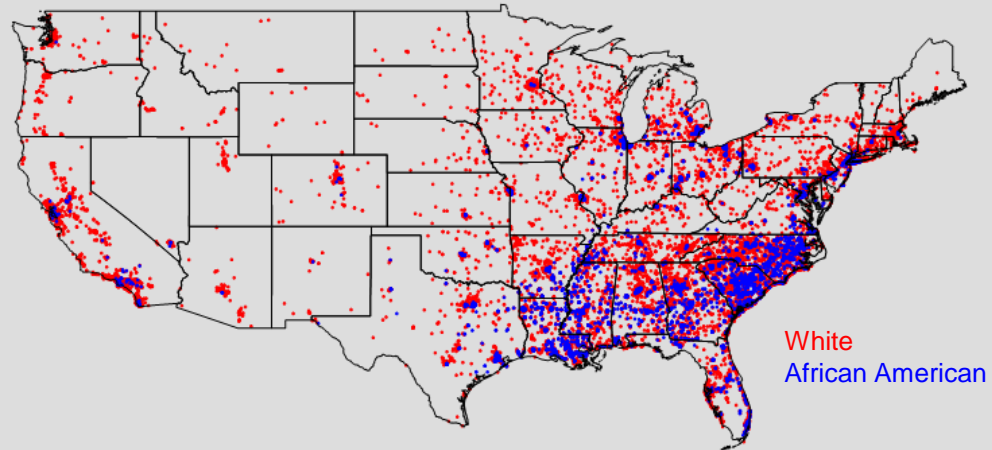


(~14 km spatial resolution)

Environmental Health Data Linkage (Objective 2)

REasons for Geographic And Racial Differences in Stroke (REGARDS) Study Population

- Longitudinal population-based cohort of over 30,000 volunteers age 45 and older
- Racial representation
 - 50% African American
 - 50% white
- Sex representation
 - 50% male
 - 50% female
- Geographic representation
 - 20% from the buckle of the stroke belt
 - 30% from the stroke belt
 - 50% from the rest of the contiguous US
- Successfully transferred from UAB to NASA/MSFC
 - BAA as per HIPPA Regulations
 - Data Encryption



Data Linkage for Biostatistical Analyses

- Link in a GIS the estimates of the PM_{2.5}, Solar Insolation, and Air Temperature with health data from all participants in the REGARDS study on the individual level at the geographic coordinates of their residences
- Sort the environmental data by participant ID, and merge in with the corresponding health data from the REGARDS database
- Determine whether exposures to these environmental risk factors are related to cognitive decline and other health outcomes such as hypertension, inflammation, and stroke

Participant ID	Lat	Lon	Day1 Solar Insolation (KJ/m ² /Day)	Day2 Solar Insolation (KJ/m ² /Day)	Day3 Solar Insolation (KJ/m ² /Day)	Day365 Solar Insolation (KJ/m ² /Day)
1	99.045	-87.105	7950	8941	8945		7850
2	99.055	-89.036	7401	8501	8412		7501
3	99.065	-86.212	8001	7015	8251		8401
.							
.							
.							
.							
.							
30200	99.075	-87.855	15650	11402	15650		10750

Simulated example of the linked data set consisting of participant ID and the associated NLDAS solar insolation

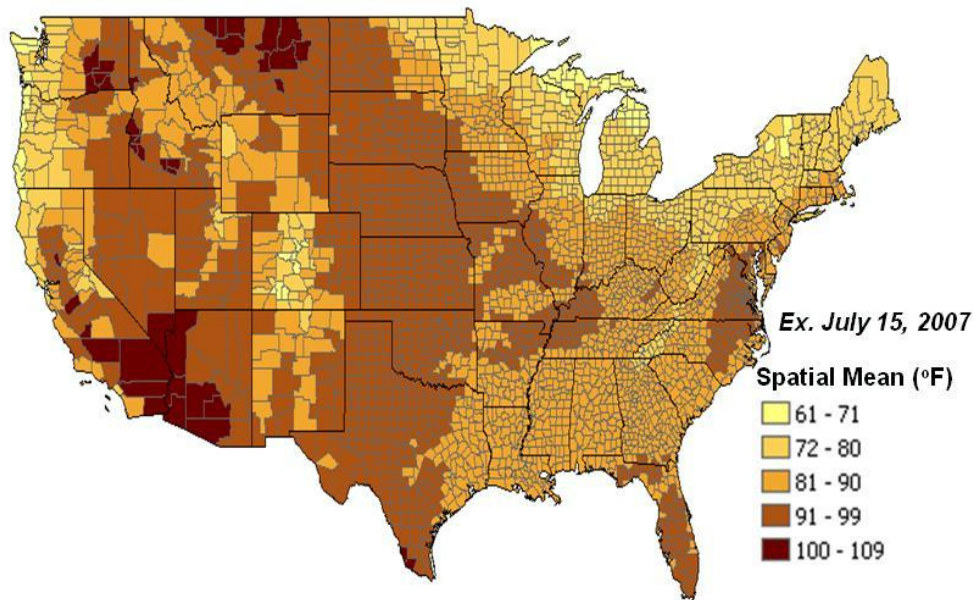
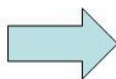
**Data Dissemination via CDC WONDER
(Objective 3)**

Data Dissemination via CDC WONDER

Examples of County-level Spatial and Temporal Statistics (Map and Chart) as provided by CDC-WONDER real-time data queries

Tabular Grid-level Daily Data

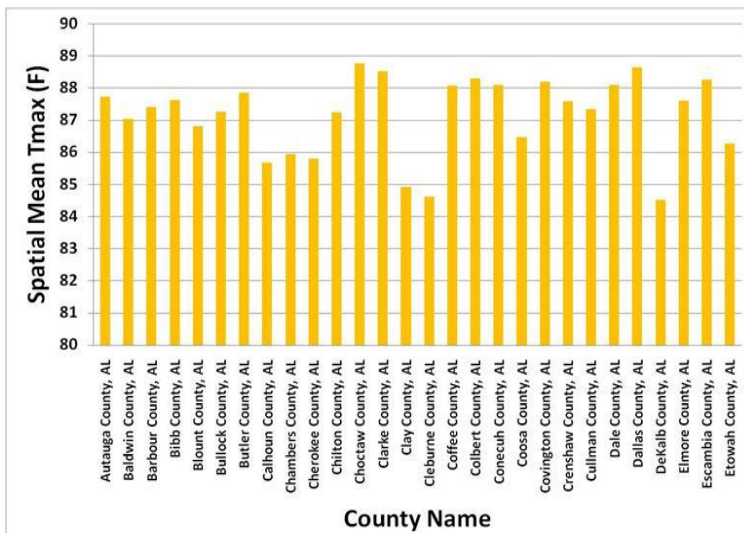
Grid Cell ID	County, State	FIPS	Day1 Tmax (°F)	Day2 Tmax (°F)	Day3 Tmax (°F)	Day365 Tmax (°F)
1	Kern, CA	06029	71	74	66		70
2	Kern, CA	06029	70	72	67		69
3	Kern, CA	06029	72	73	66		72
.							
.							
.							
.							
103936	Aroostook, ME	23003	35	31	32		34



➤ Environmental exposure datasets will be made available to public health professionals, researchers and the general public via WONDER, where they can be aggregated to the county-level or higher as per users' need

➤ Users are able to spatially and temporally query datasets and create county- and higher-level maps and downloadable statistical tables and charts of data across the contiguous U.S.

➤ Enabling easy linkage of the environmental exposure data with other health data available via CDC WONDER



County	Avg Daily Max Air Temperature (F) # of Observations Range Standard Deviation
Autauga County, AL (01001)	87.85 11 (87.20 to 88.40) 0.43
Baldwin County, AL (01003)	85.82 26 (84.30 to 87.20) 0.61
Barbour County, AL (01005)	86.04 14 (85.50 to 86.60) 0.37
Bibb County, AL (01007)	86.92 9 (86.40 to 87.50) 0.31

CDC WONDER Main Web Page

<http://wonder.cdc.gov/>

CDC WONDER

WONDER Home FAQ Help Contact Us Search

WONDER online databases utilize a rich ad-hoc query system for the analysis of public health data. Reports and other query systems are also available.

WONDER Systems Topics A-Z Index

- **WONDER Online Databases**
 - ▶ [AIDS Public Use Data](#)
 - ▶ [Births](#)
 - ▶ [Cancer Statistics](#)
 - Environment**
 - ▶ [Daily Air Temperatures & Heat Index](#)
 - ▶ [Daily Land Surface Temperatures](#)
 - ▶ [Daily Fine Particulate Matter](#)
 - ▶ [Daily Sunlight](#)
 - ▶ [Daily Precipitation](#)
 - Mortality**
 - Underlying Cause of Death
 - ▶ [Detailed Mortality](#)
 - ▶ [Compressed Mortality](#)
 - ▶ [Multiple cause of death \(Detailed Mortality\)](#)
 - ▶ [Infant Deaths \(Linked Birth/Infant Death Records\)](#)
 - ▶ [Online Tuberculosis Information System](#)
 - Population**
 - ▶ [Bridged-Race Population \(from NCHS\)](#)
 - ▶ [Population \(from Census\)](#)
 - ▶ [Sexually Transmitted Disease Morbidity](#)
 - ▶ [Vaccine Adverse Event Reporting](#)

- **Reports and References**
 - [Prevention Guidelines \(archive\)](#)
 - [Scientific Data and Documentation](#)

- **Other Query Systems**
 - ▶ [Healthy People 2010](#)
 - ▶ [MMWR Morbidity Tables](#)
 - ▶ [MMWR Mortality Tables](#)

▶ Denotes numerical data available to query or download

CDC
SAFER • HEALTHIER • PEOPLE™

Search

[What is WONDER?](#)

[Frequently Asked Questions](#)

[Data Use Restrictions](#)

[Data Collections](#)

[Citations](#)

[Republishing WONDER Data](#)

[What's New?](#)

CDC Home Search Health Topics A-Z

NLDAS-derived Heat-related Products on CDC WONDER

Now Available at <http://wonder.cdc.gov/nasa-nldas.html>



[CDC Home](#) [Search](#) [Health Topics A-Z](#)

CDC WONDER

[WONDER Home](#) [FAQ](#) [Help](#) [Contact Us](#) [Search](#)

North America Land Data Assimilation System (NLDAS) Daily Air Temperatures and Heat Index (2003-2008) Request

[Request Form](#) [Results](#) [Map](#) [Chart](#) [About](#)

[Dataset Documentation](#) [Data Use Restrictions](#) [How to Use WONDER](#)

[Reset](#)

*Make all desired selections and then click any **Send** button one time to send your request.*

1. Organize table layout:

[Send](#) [Help](#)

Group Results By

Select a temperature scale.

Fahrenheit Celsius

And By

And By

And By

And By

Select Measures (Check box to include in results. Must select at least one.)

Daily Max Air Temperature (F):

Avg Temperature # of Observations Range Standard Deviation

Daily Min Air Temperature (F):

Avg Temperature # of Observations Range Standard Deviation

Daily Max Heat Index (F):

Avg Heat Index # of Observations Range Standard Deviation

Title

2. Select location:

[Send](#) [Help](#)

CDC WONDER Tabular Results

North America Land Data Assimilation System (NLDAS) Daily Air Temperatures and Heat Index (2003-2008) Results

Request Form Results Map Chart About

[Dataset Documentation](#) [Help for Results](#) [Printing Tips](#) [Help with Exports](#)

Export Reset

Quick Options

More Options

Top [Notes](#) [Citation](#) [Query Criteria](#)

County ↓	Avg Daily Max Air Temperature(F) # of Observations Range Standard Deviation
Autauga County, AL (01001)	87.85 11 (87.20 to 88.40) 0.43
Baldwin County, AL (01003)	85.82 26 (84.30 to 87.20) 0.61
Barbour County, AL (01005)	86.04 14 (85.50 to 86.60) 0.37
Bibb County, AL (01007)	86.92 9 (86.40 to 87.50) 0.31
Blount County, AL (01009)	84.20 10 (83.60 to 84.90) 0.43
Bullock County, AL (01011)	86.57 10 (86.10 to 87.30) 0.44

CDC WONDER Map Results

North America Land Data Assimilation System (NLDAS) Daily Air Temperatures and Heat Index (2003-2008) Maps

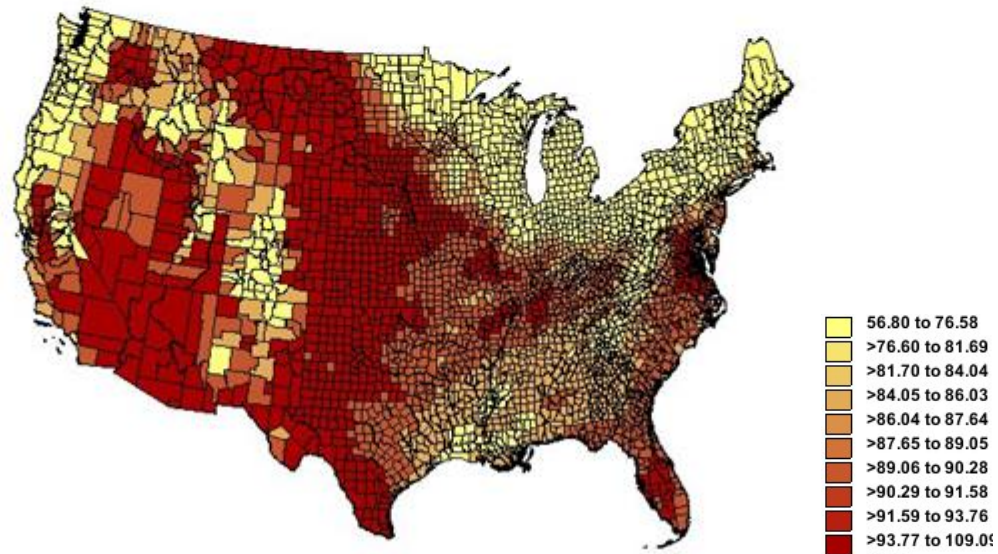
[Request Form](#) [Results](#) [Map](#) [Chart](#) [About](#)

[Dataset Documentation](#) [Help for Maps](#) [Printing Tips](#)

[Reset](#)

[Top](#) [Map Options](#) [Notes](#) [Citation](#) [Query Criteria](#)

Avg Daily Max Air Temperature(F) for The United States



CDC WONDER Chart Results

North America Land Data Assimilation System (NLDAS) Daily Air Temperatures and Heat Index (2003-2008) Charts

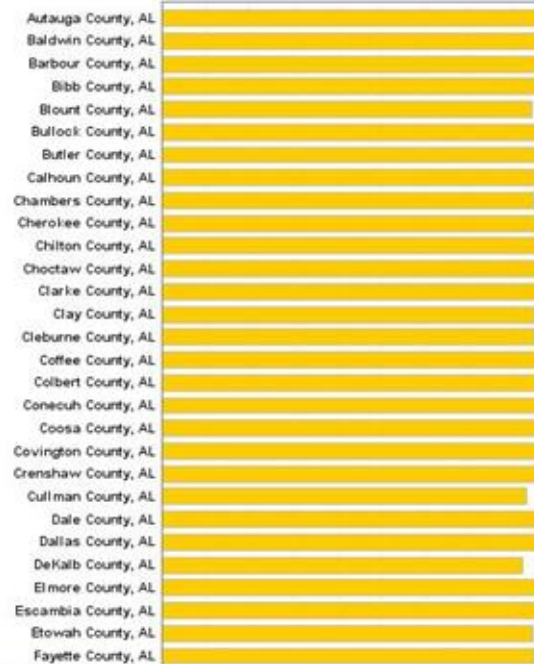
[Request Form](#) [Results](#) [Map](#) [Chart](#) [About](#)

[Dataset Documentation](#) [Help for Charts](#) [Printing Tips](#)

[Reset](#)

[Top](#) [Chart Options](#) [Notes](#) [Citation](#) [Query Criteria](#)

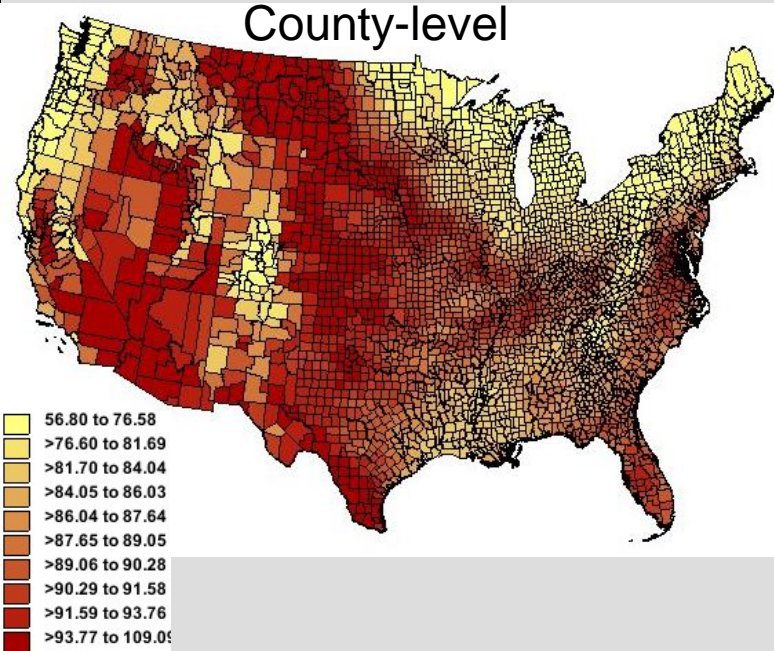
Avg Daily Max Air Temperature(F) By County



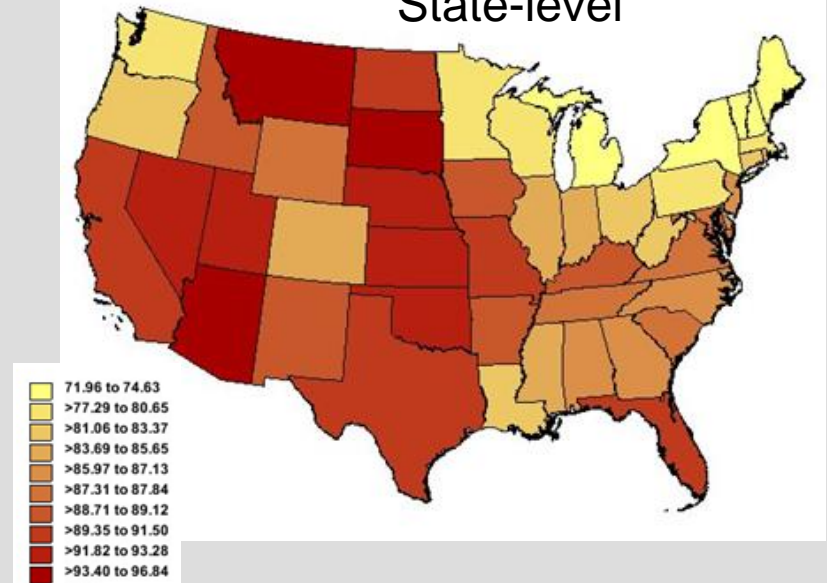
CDC WONDER Spatial Aggregation

Avg Daily Max Air Temperature(F) for The United States

County-level

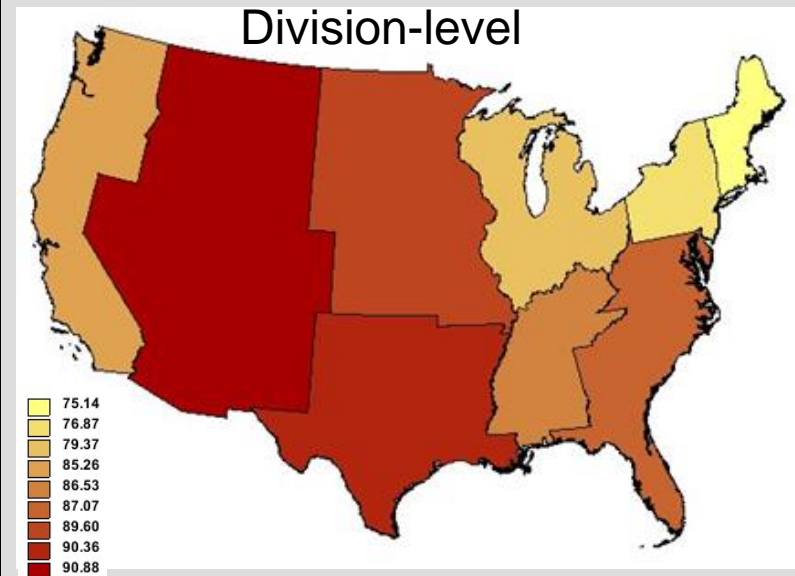


State-level

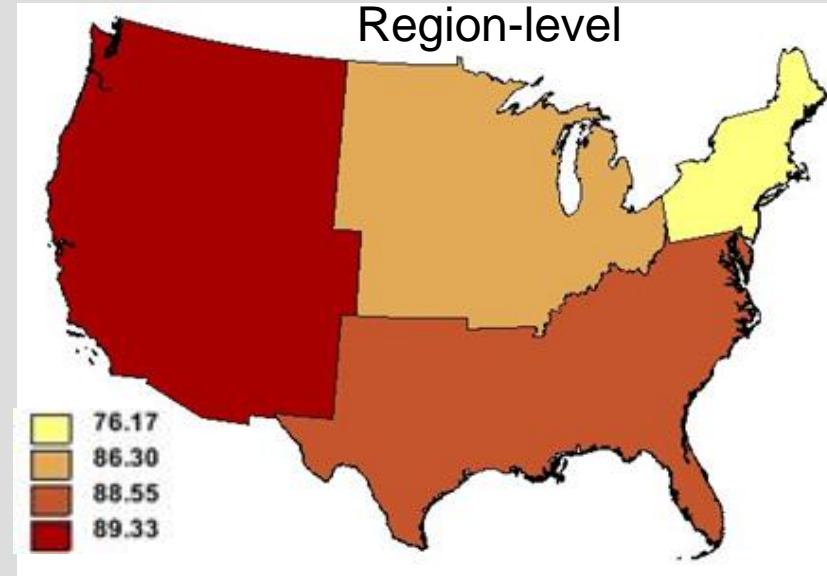


July 15, 2007

Division-level



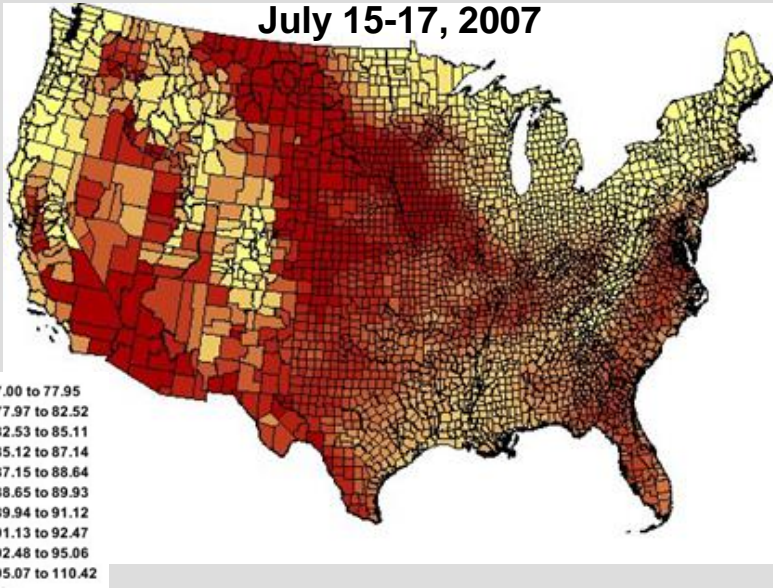
Region-level



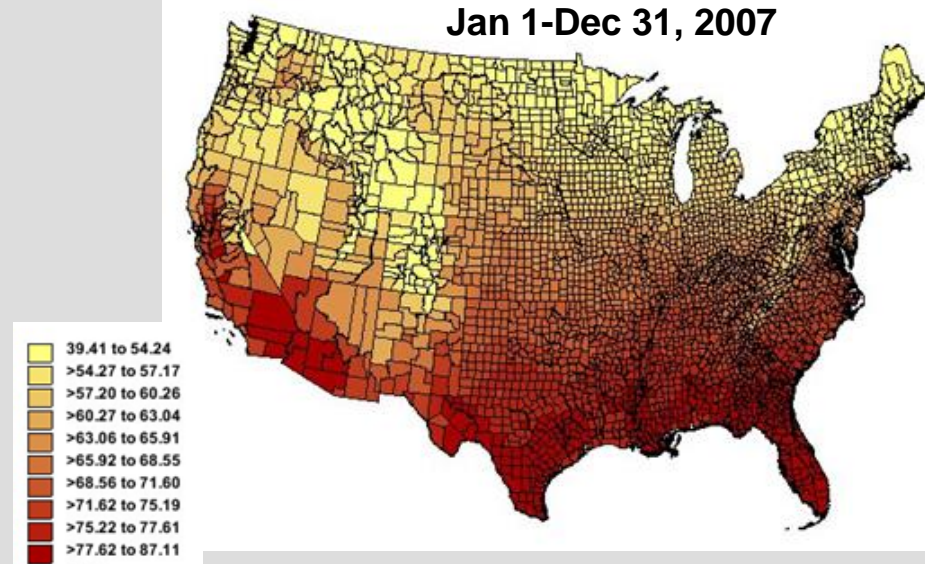
CDC WONDER Spatial/Temporal Aggregation

Avg Daily Max Air Temperature(F) for The United States

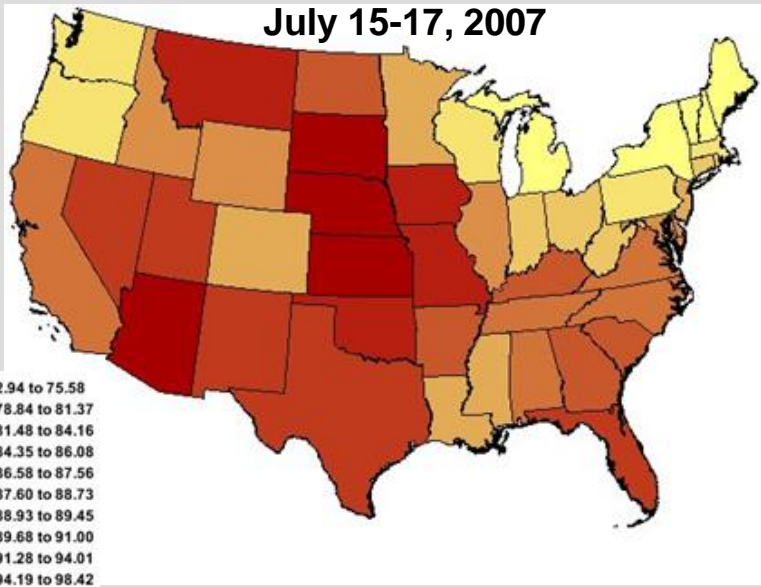
July 15-17, 2007



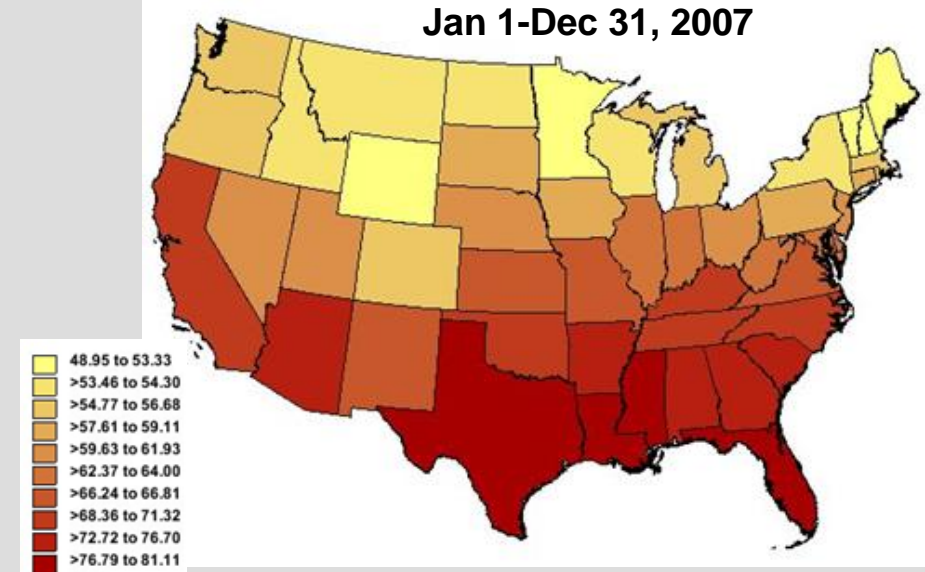
Jan 1-Dec 31, 2007



July 15-17, 2007

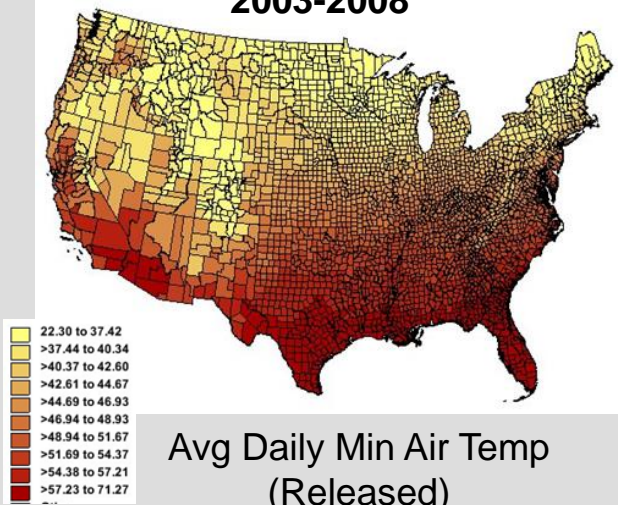


Jan 1-Dec 31, 2007



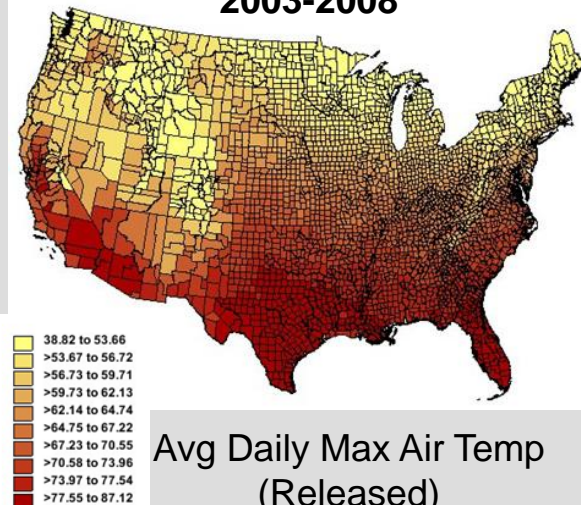
CDC WONDER Environmental Datasets Status

2003-2008



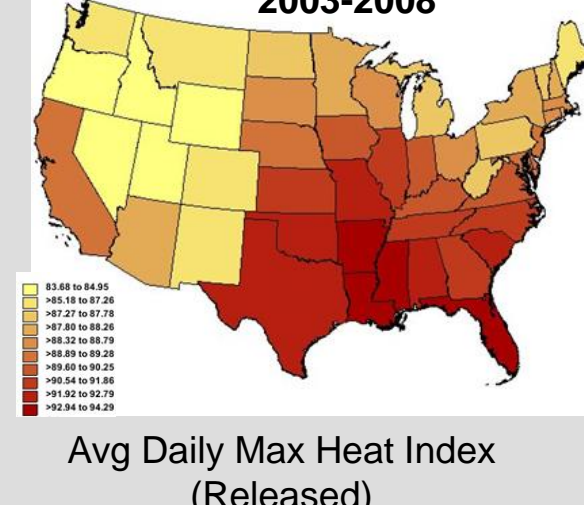
Avg Daily Min Air Temp
(Released)

2003-2008



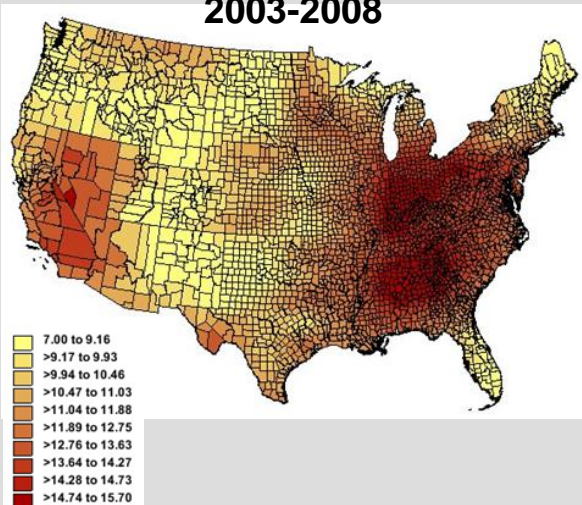
Avg Daily Max Air Temp
(Released)

2003-2008



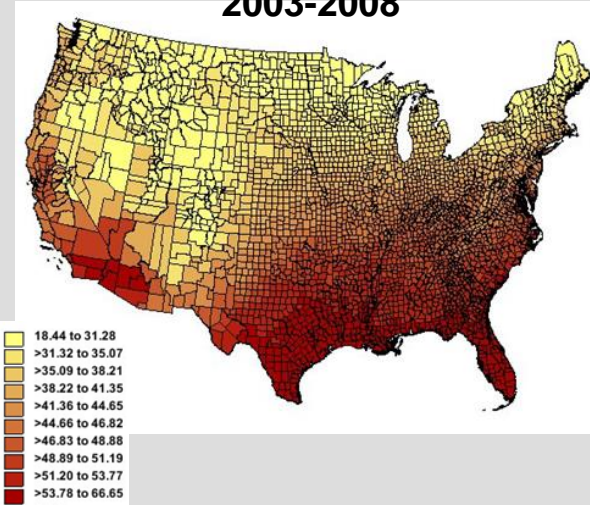
Avg Daily Max Heat Index
(Released)

2003-2008



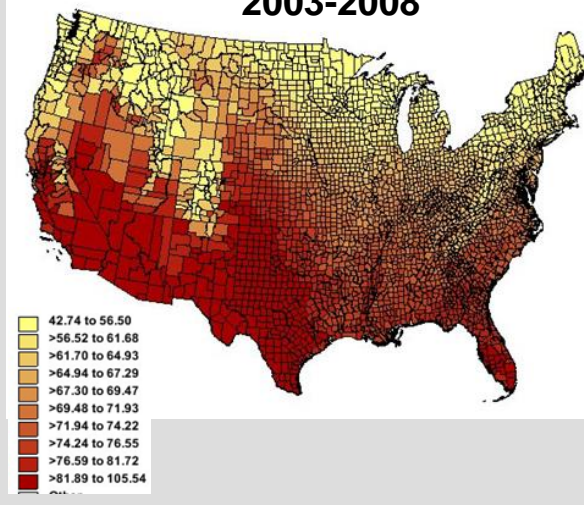
Avg PM2.5
(Released)

2003-2008



Avg Night MODIS LST
(Released)

2003-2008



Avg Day MODIS LST
(Released)

Summary

- Development of national daily products of PM_{2.5}, LST, maximum and minimum air temperature, maximum heat index, and solar insolation for 2003-2008
- Linkages of these data with public health data from the REGARDS national cohort study for environmental health correlation studies
- Dissemination of these environmental datasets to public health professionals, researchers and the general public via the CDC WONDER online system
 - Maximum and minimum air temperature and maximum heat index datasets, PM_{2.5}, LST, and solar insolation ***have been released at*** <http://wonder.cdc.gov/nasa-nldas.html>
- Providing a useful addition to CDC WONDER, allowing public health researchers and policy makers to better include environmental exposure data in the context of other health data available in CDC WONDER online system
- Substantially expanding public access to these NASA environmental datasets, making their use by a wide range of decision makers more feasible

Thanks!

Presenter's Contact Information:

Mohammad Z. Al-Hamdan, PhD

mohammad.alhamdan@nasa.gov