National Aeronautics and
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Using Satellite Data to Enhance Evidence Based Public Health Efforts at the Local Level

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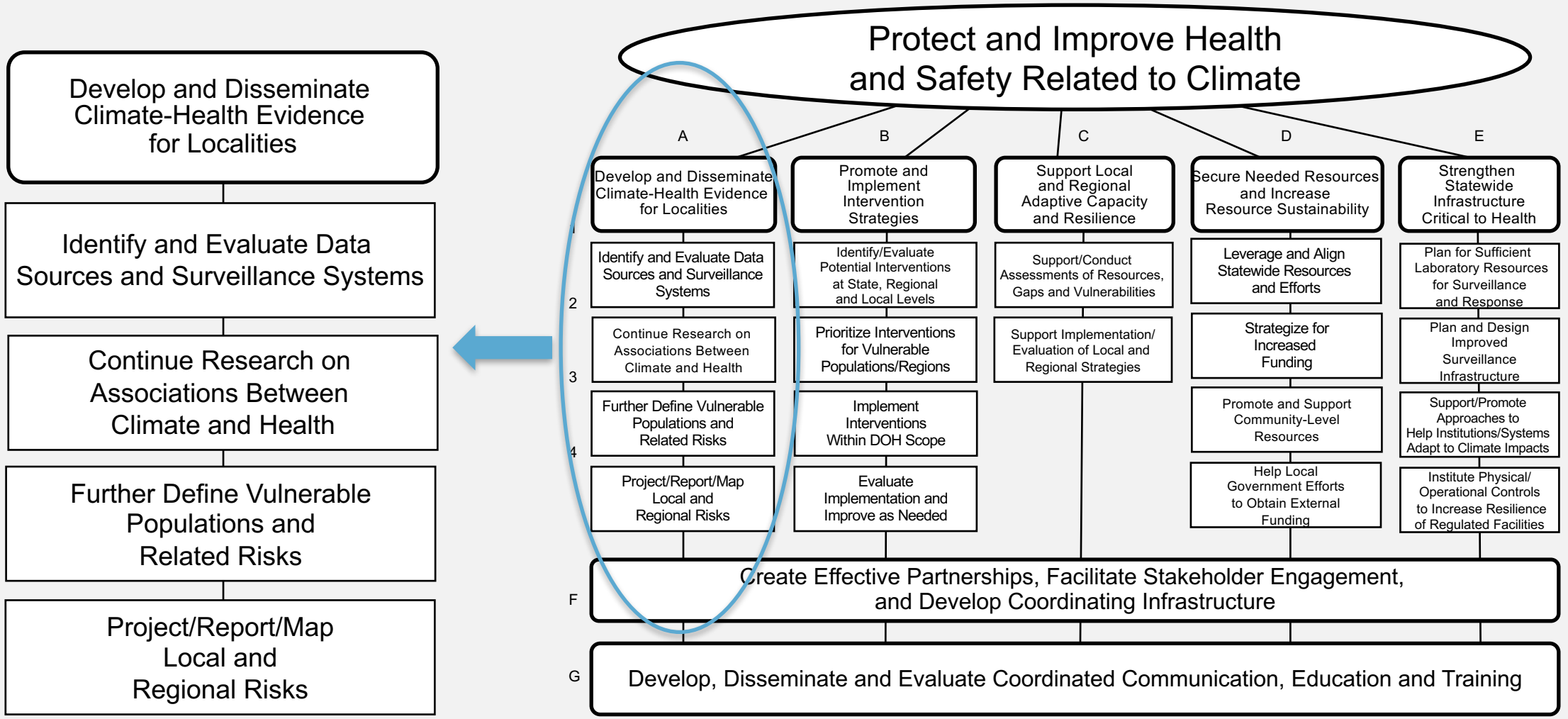
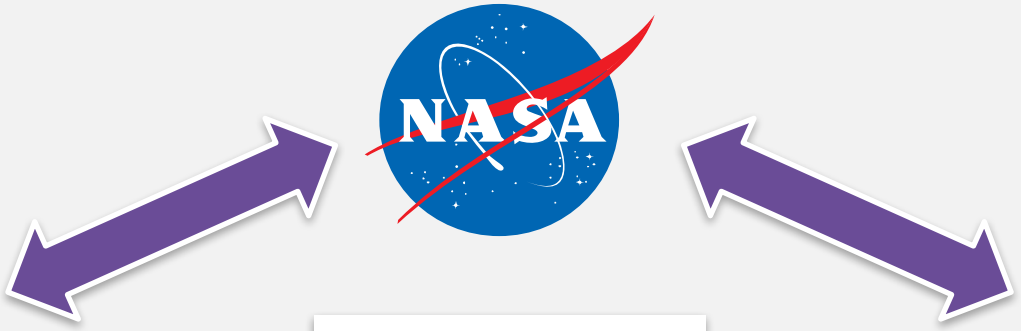
Integration of Satellite Data in State and Local Public Health Efforts

New York State Department of Health

Climate Adaptation and Mitigation Strategic Map: 2016-2021





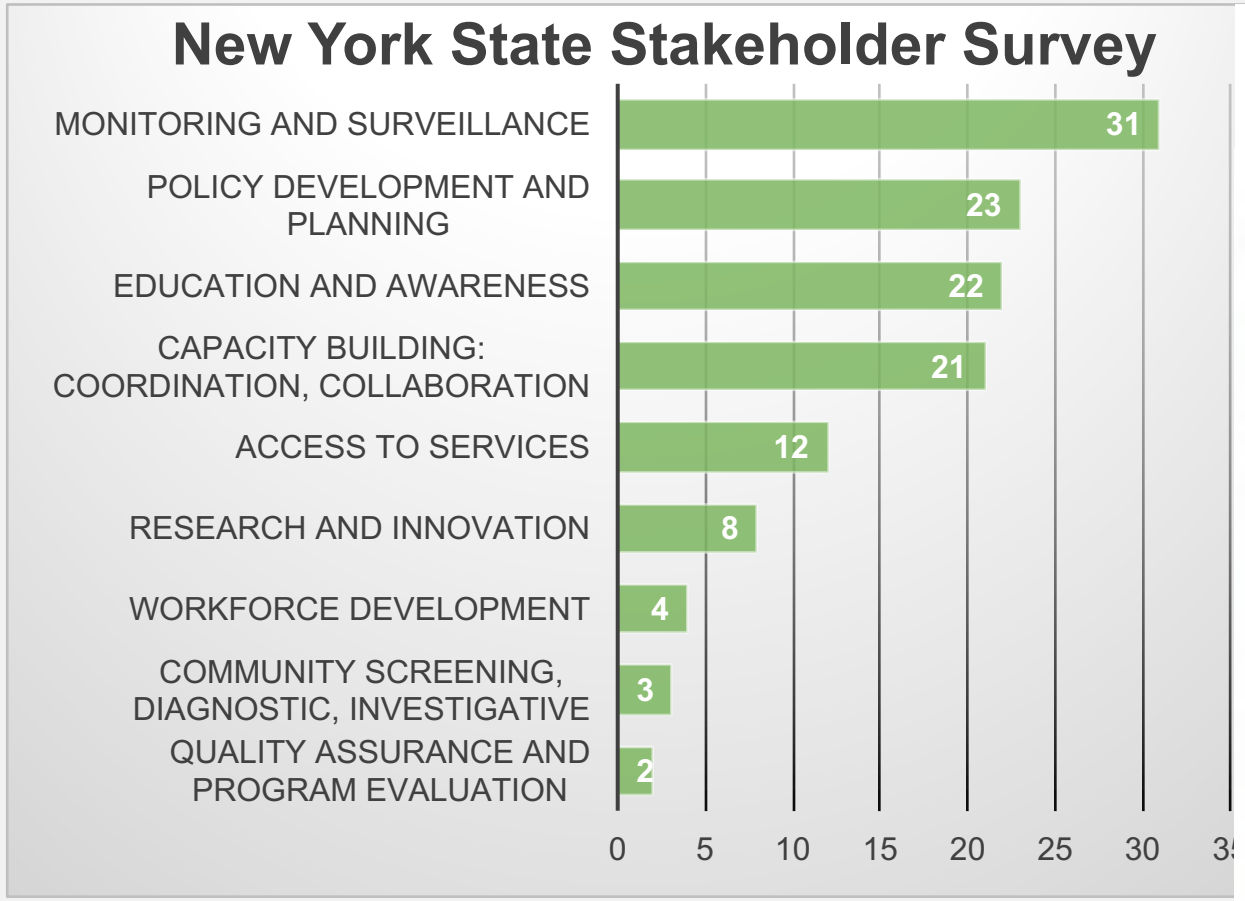
Local Health Departments

Climate Ready States and Cities Initiative

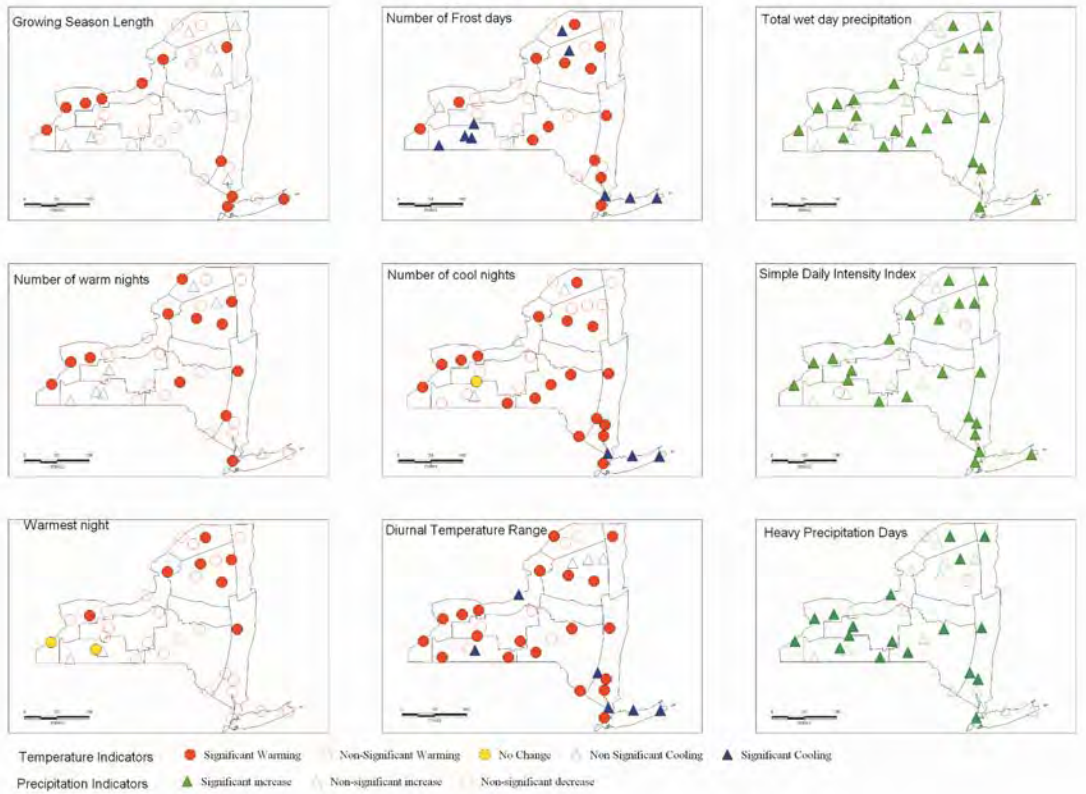
NYS Environmental Public Health Tracking Decision-Support Tool

	Features	Access	Purpose
Tier 1	• Individual level data • Statistical tools • Mapping tools	Researchers and project staff in Center for Environmental Health	Research and Surveillance
Tier 2	• Finer geographic resolution at sub-county level • Data query tools • Query based data displays including map and charts	Role based access to public health professionals Access determined by program areas/data owners	Surveillance
Tier 3	• County level data and display • Simple data queries, maps, charts, and tables • Public health message	Open access	Outreach

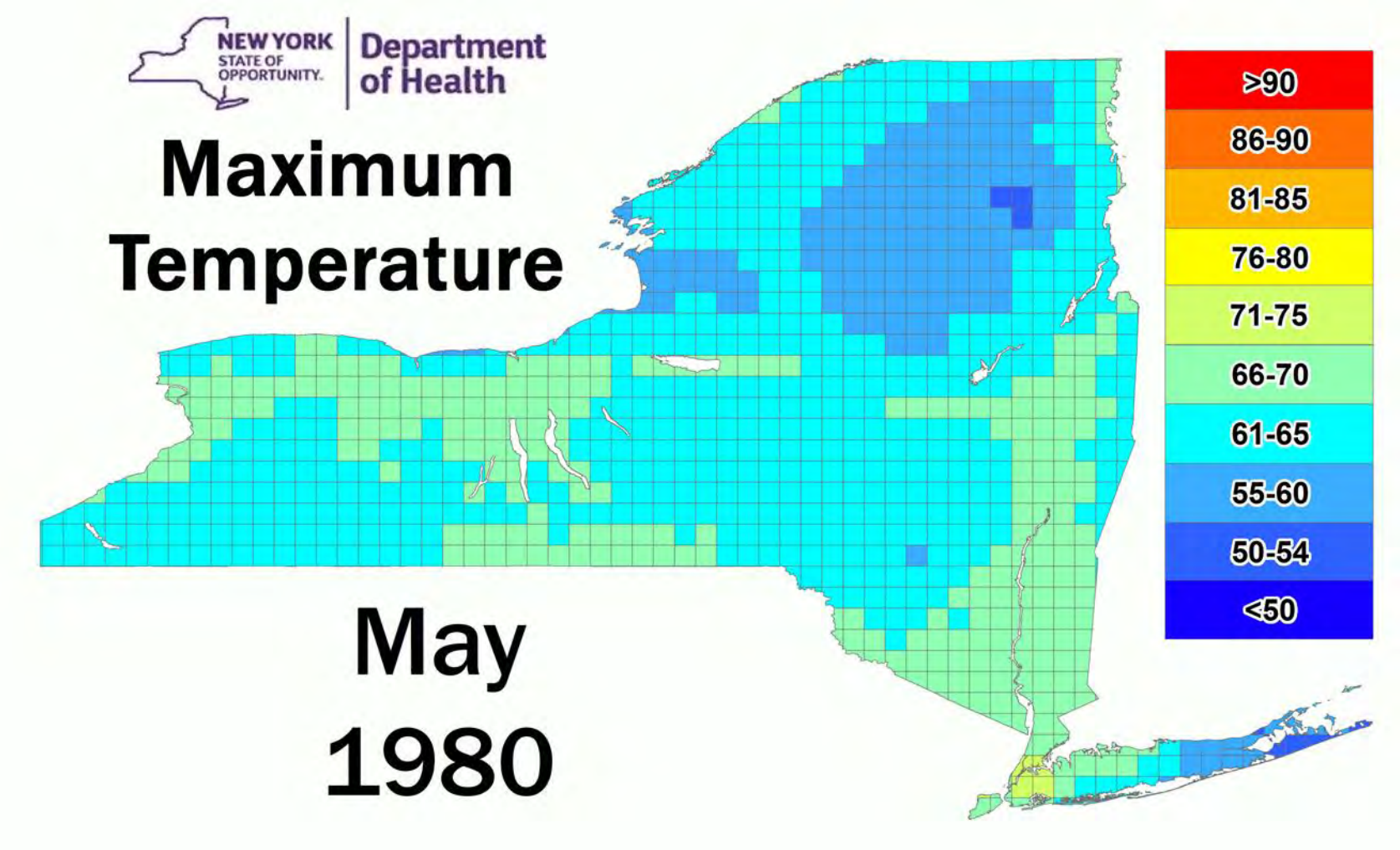
Establishing a Baseline



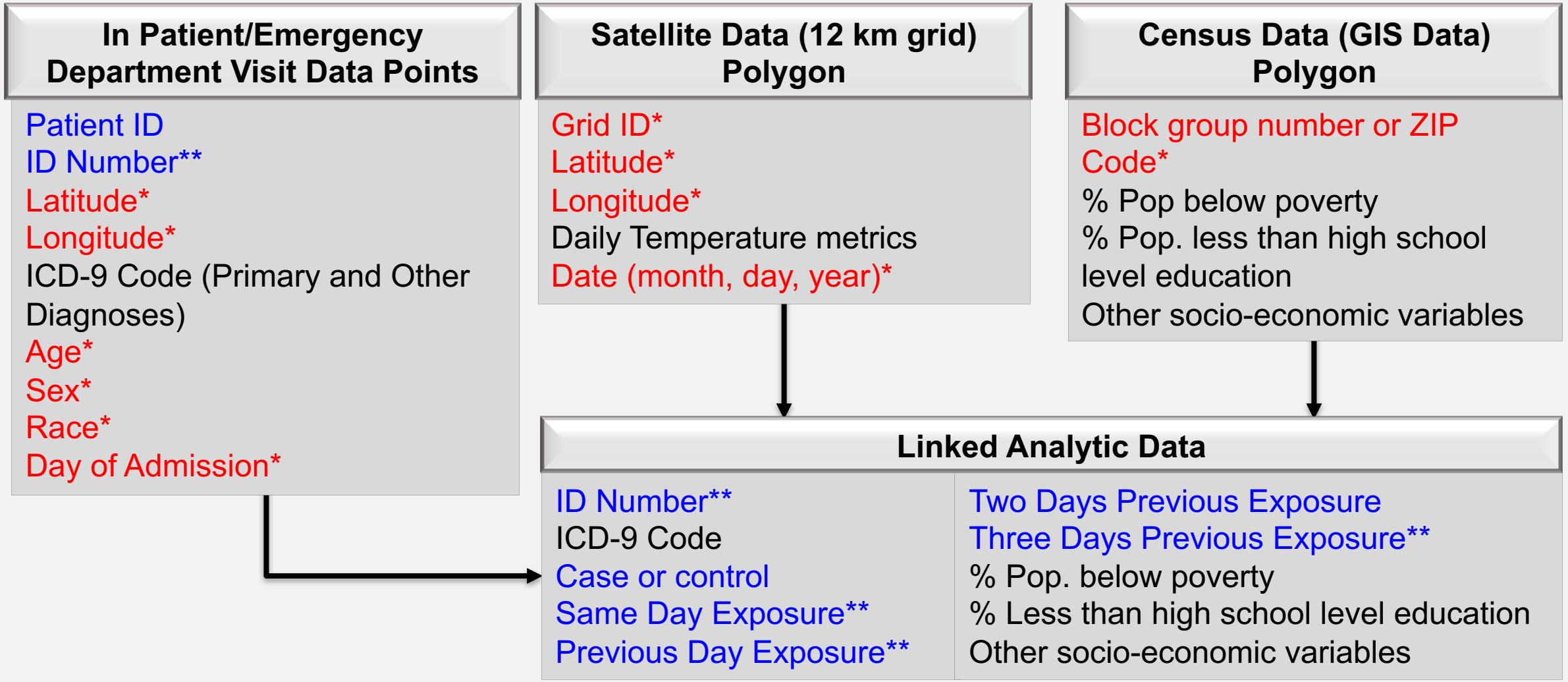
Climate trends in indices for temperature and precipitation across New York State, 1948–2008
-Insaf et al. 2013



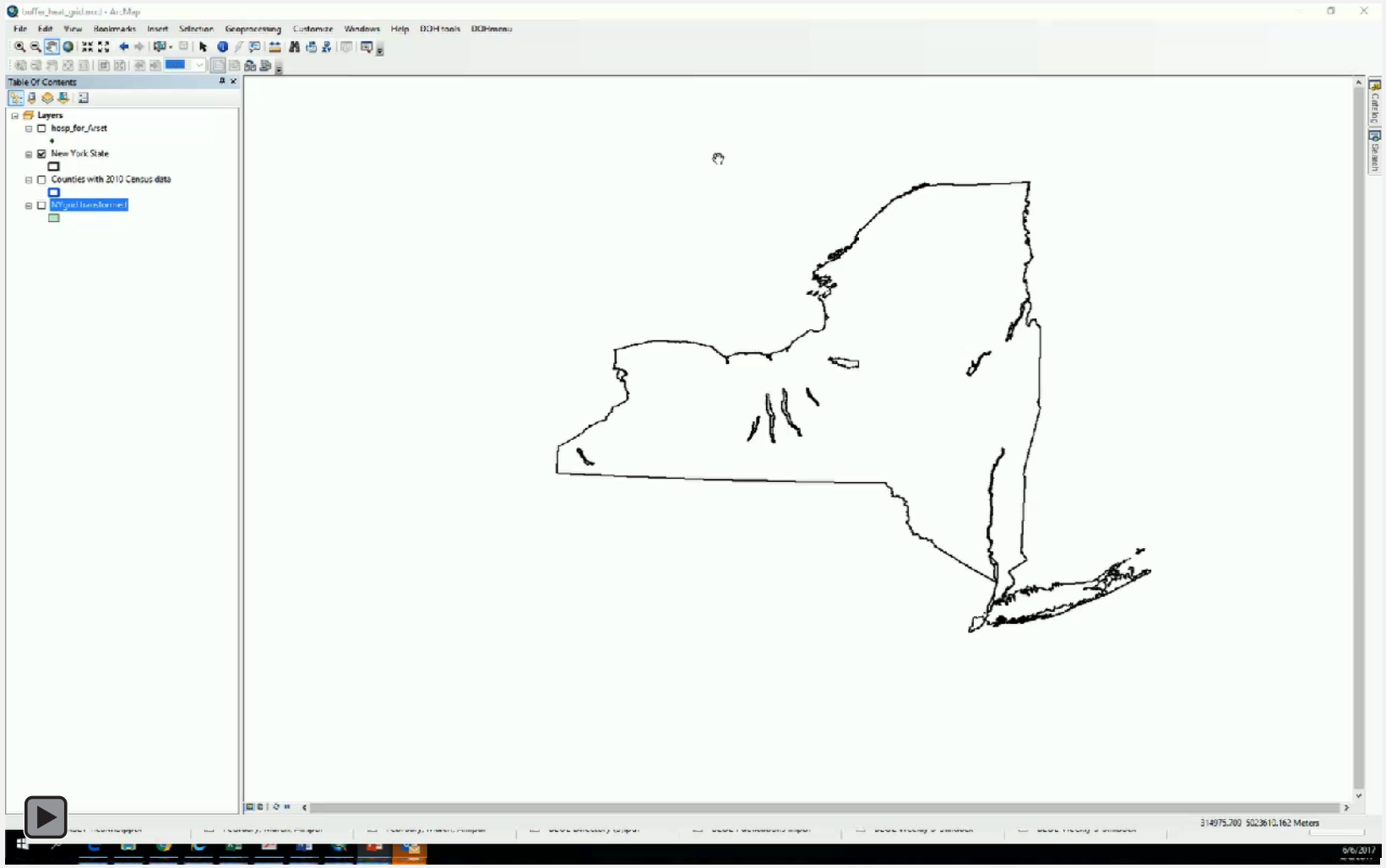
Using Satellite Data for Public Health: NLDAS 12 km Grid



Schema for Linkage of Analytic Datasets



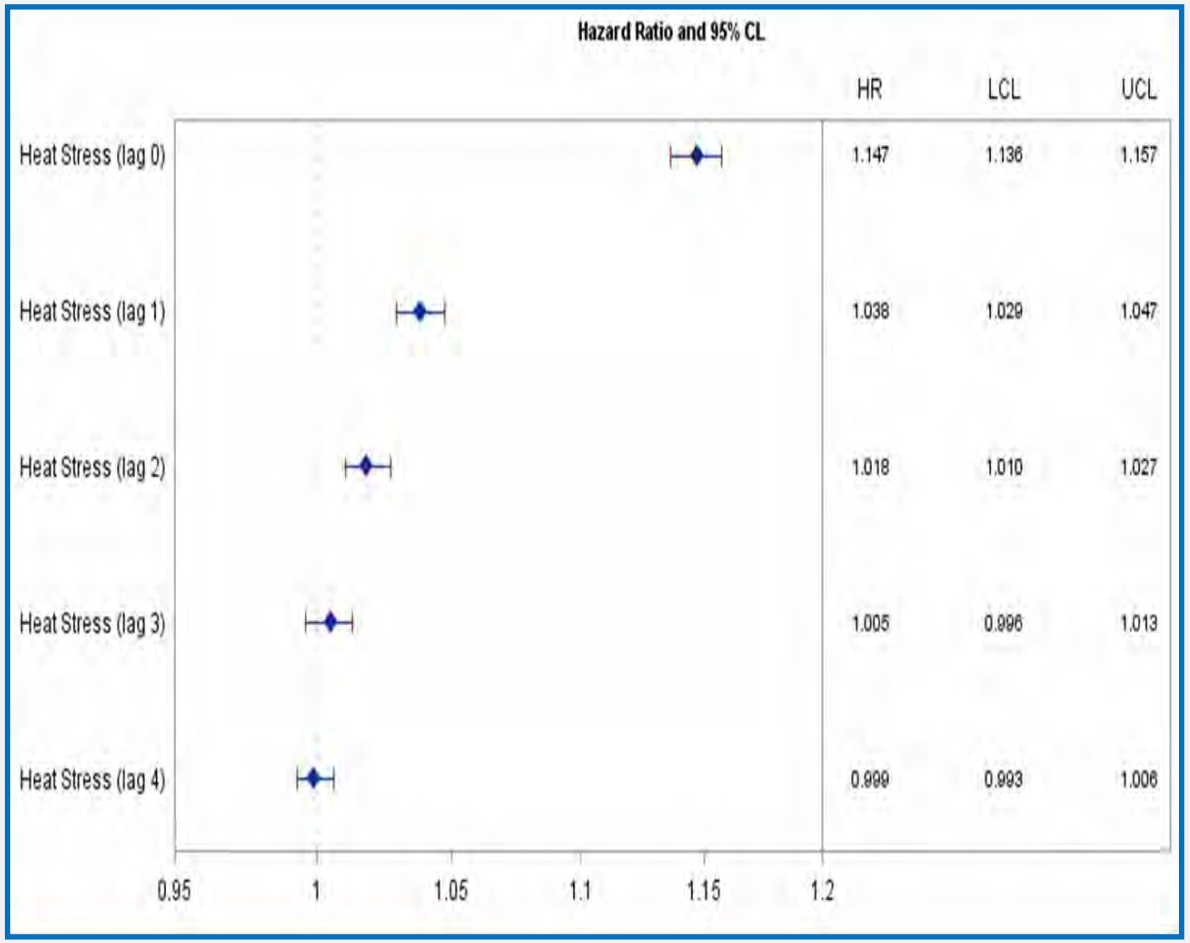
Linking Health and Environmental Data in ArcMap

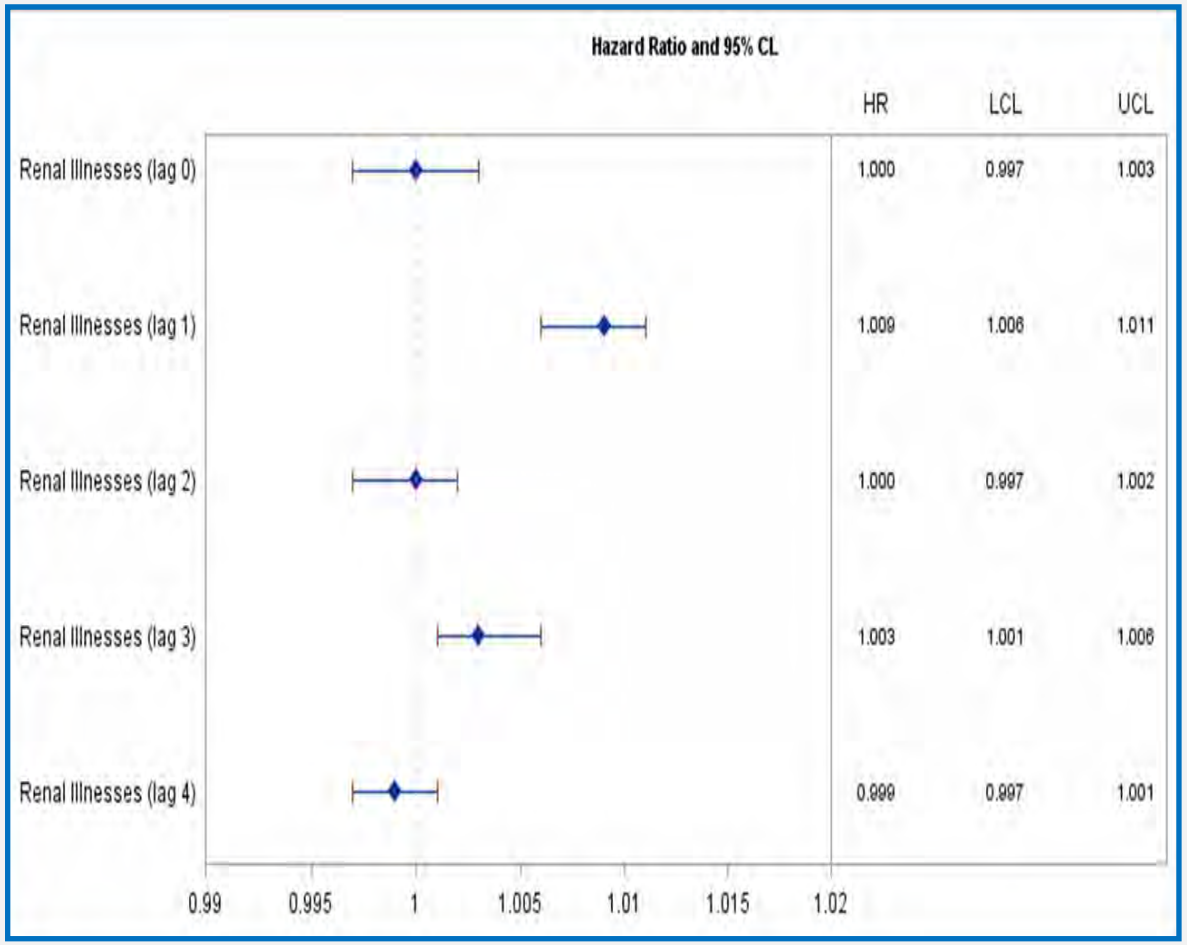


Case-Crossover Study

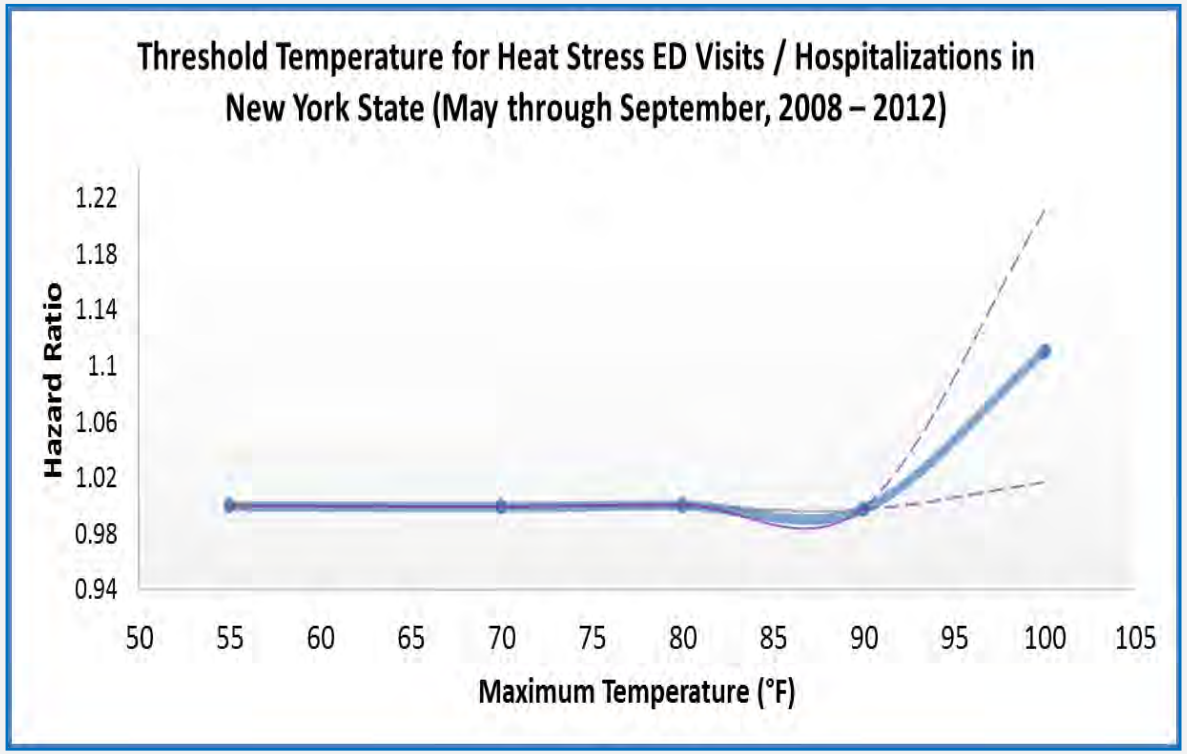
- Study of “triggers” within an individual
- “Case” and “control” component, but information of both components will come from the same individual
- “Case component” = hazard period which is the time period right before the disease or event onset
- “Control component” = control period which is a specified time interval other than the hazard period

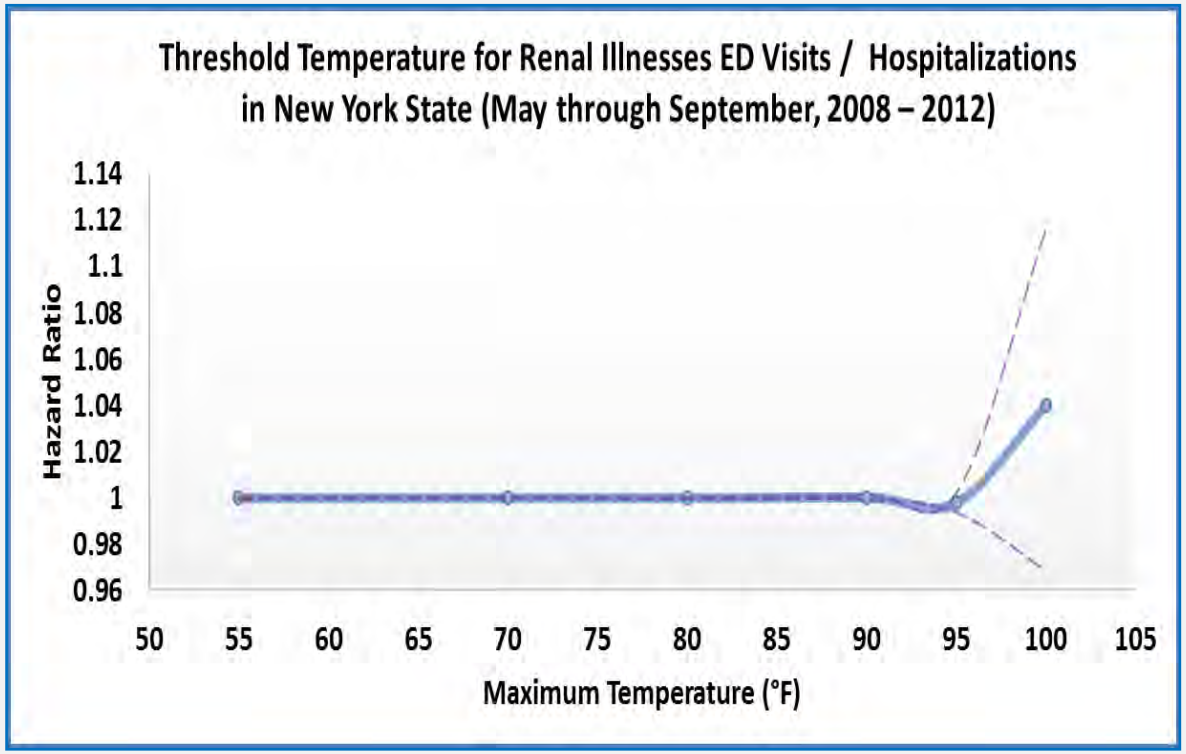
Association Between Heat Stress, Renal Illness, and Temperature





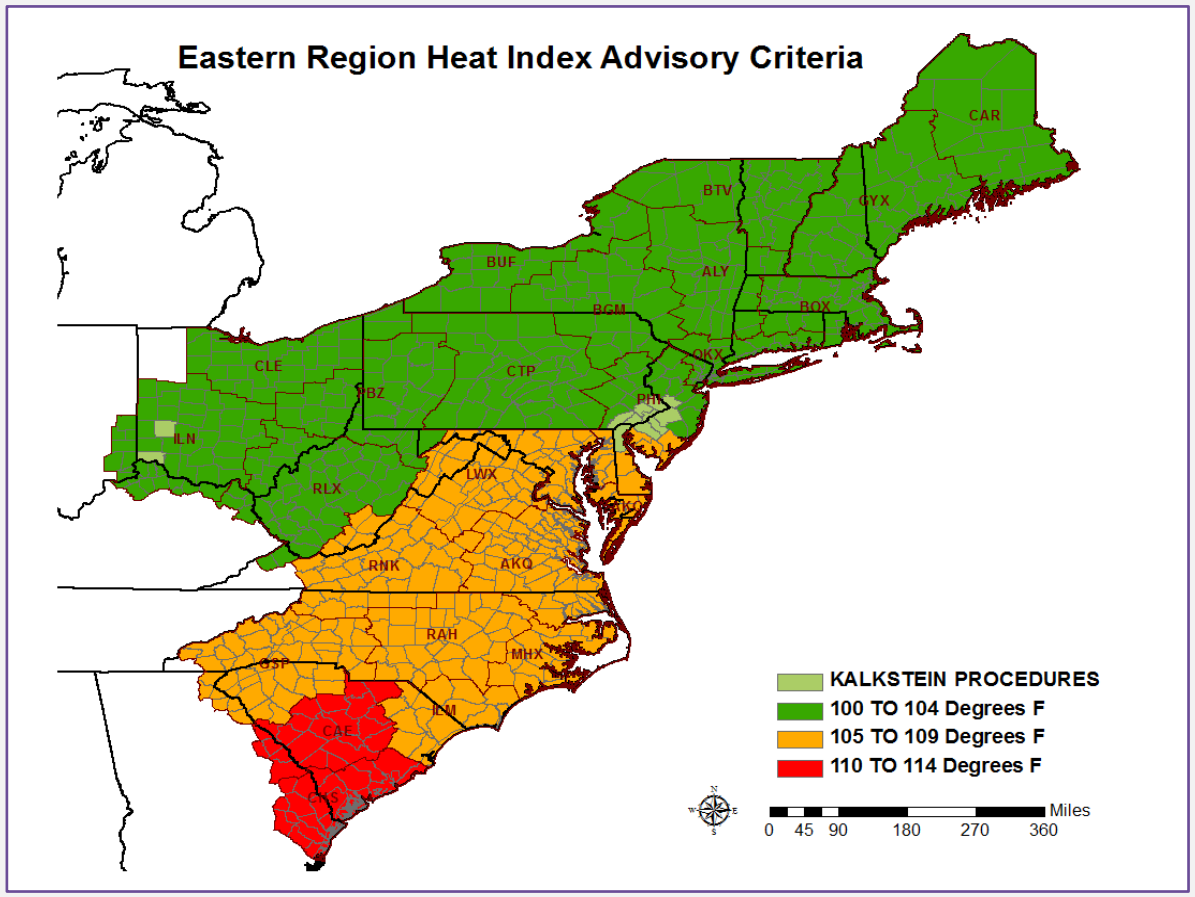
Threshold Analysis for Health Effects of Heat Events

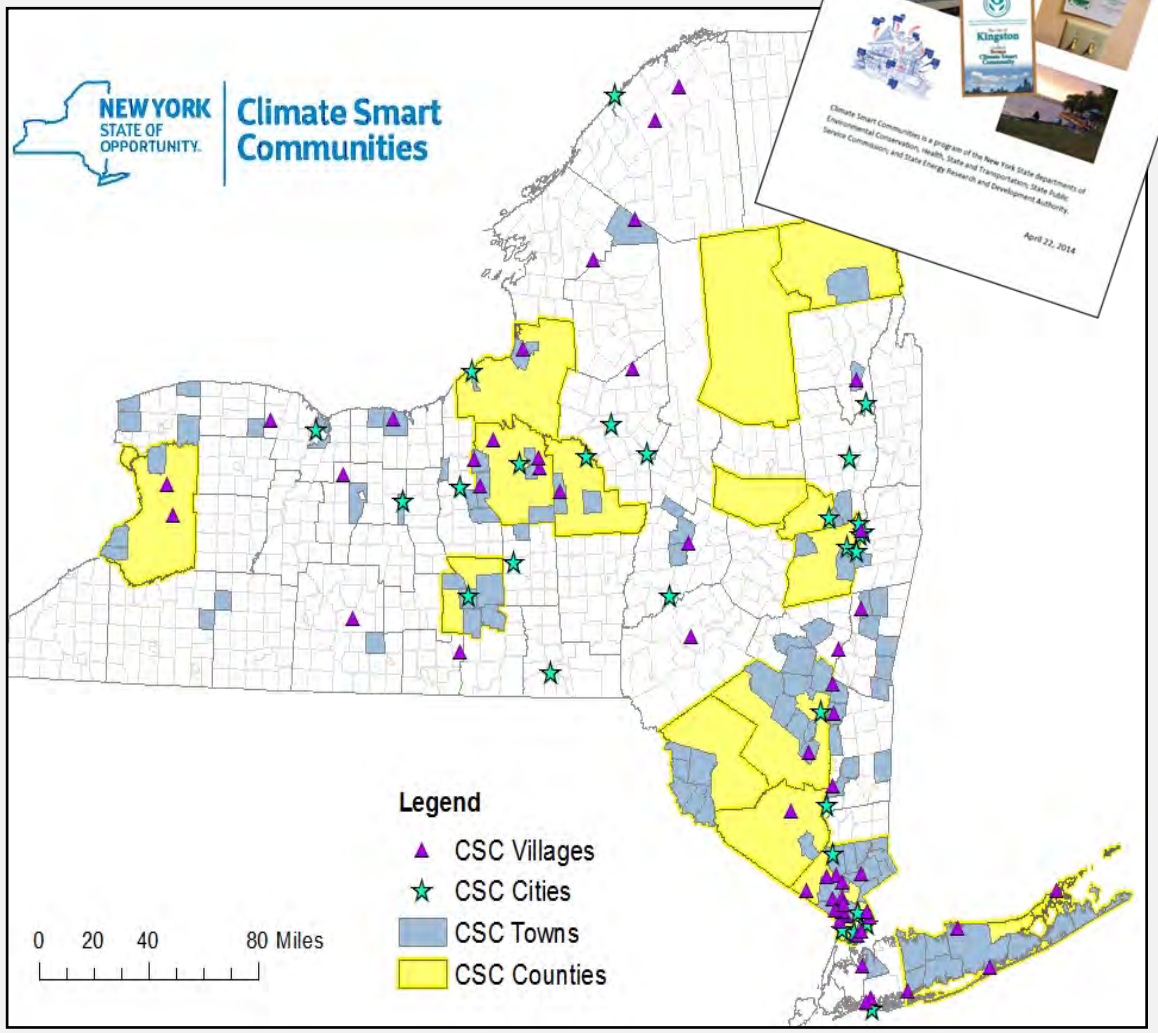


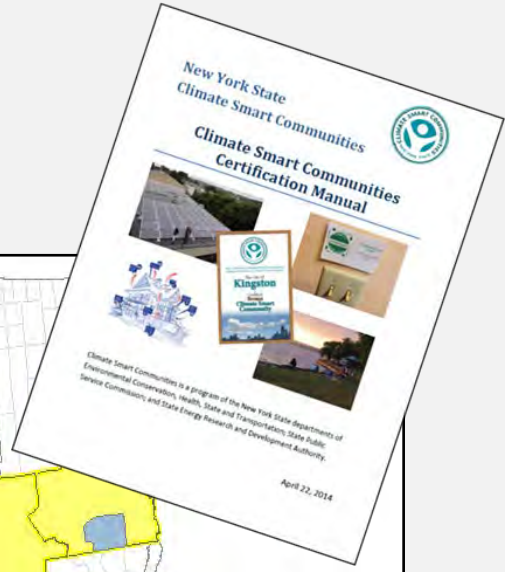


Engaging Stakeholders

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

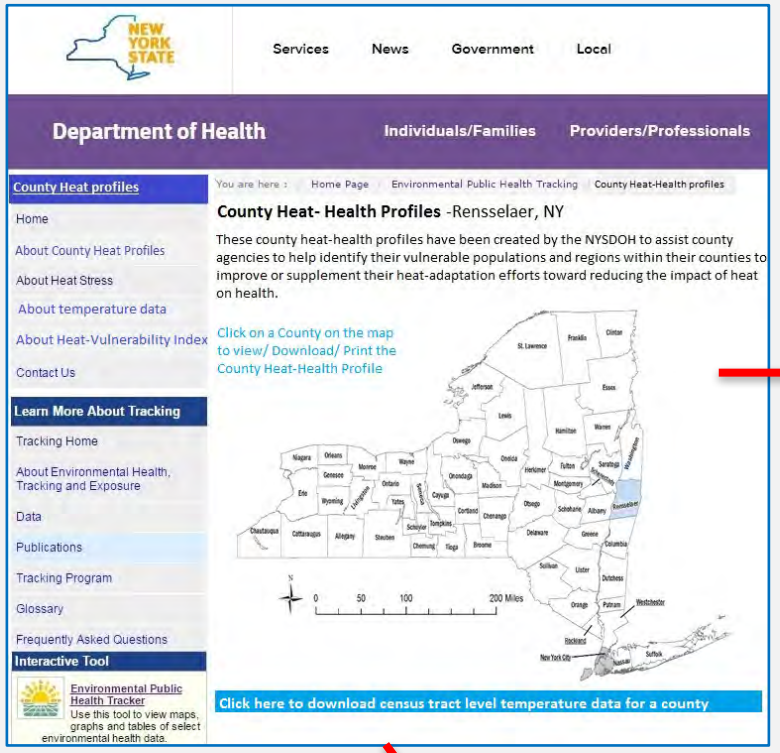


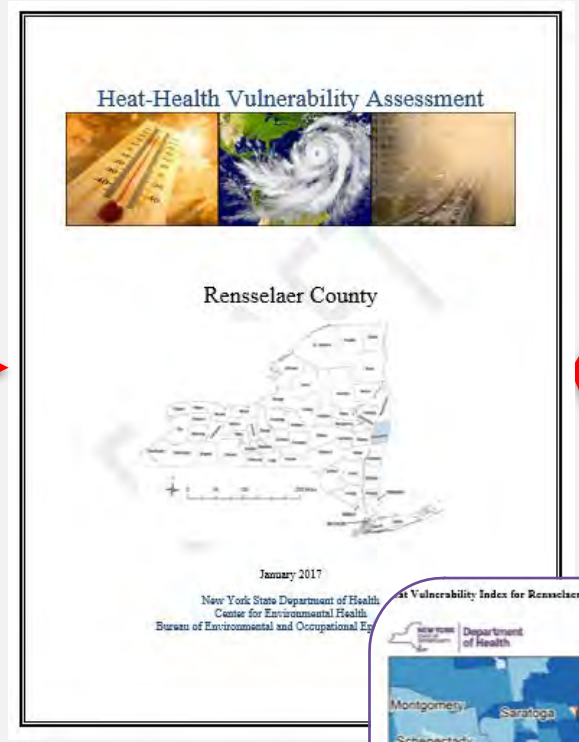


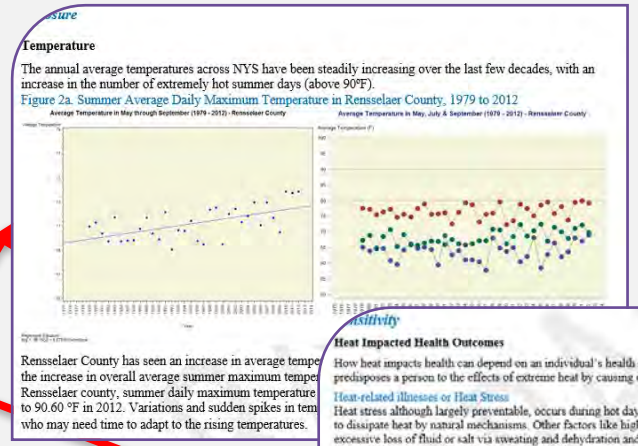


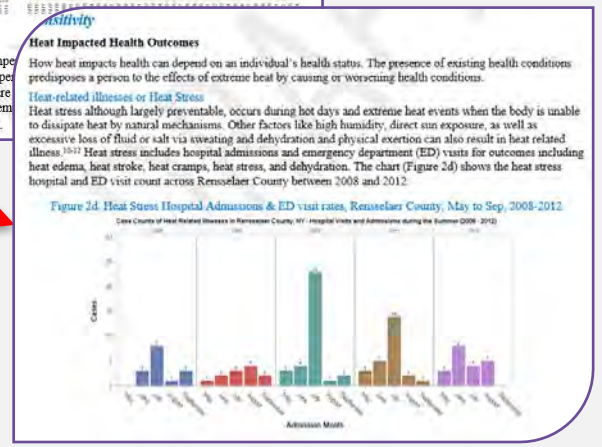
NYSDOH County-Heat Health Profiles

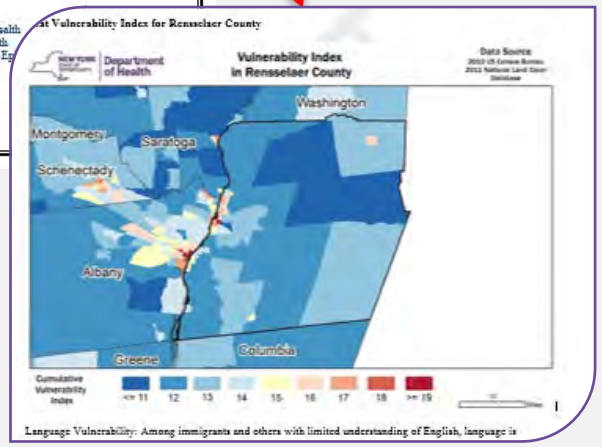
http://www.health.ny.gov/environmental/public_health_tracking/

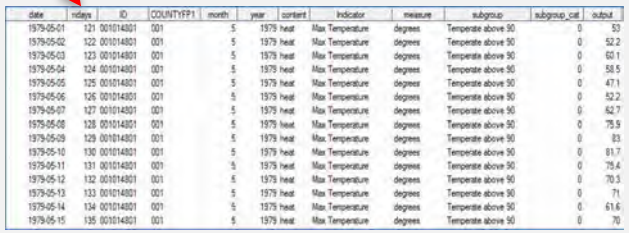








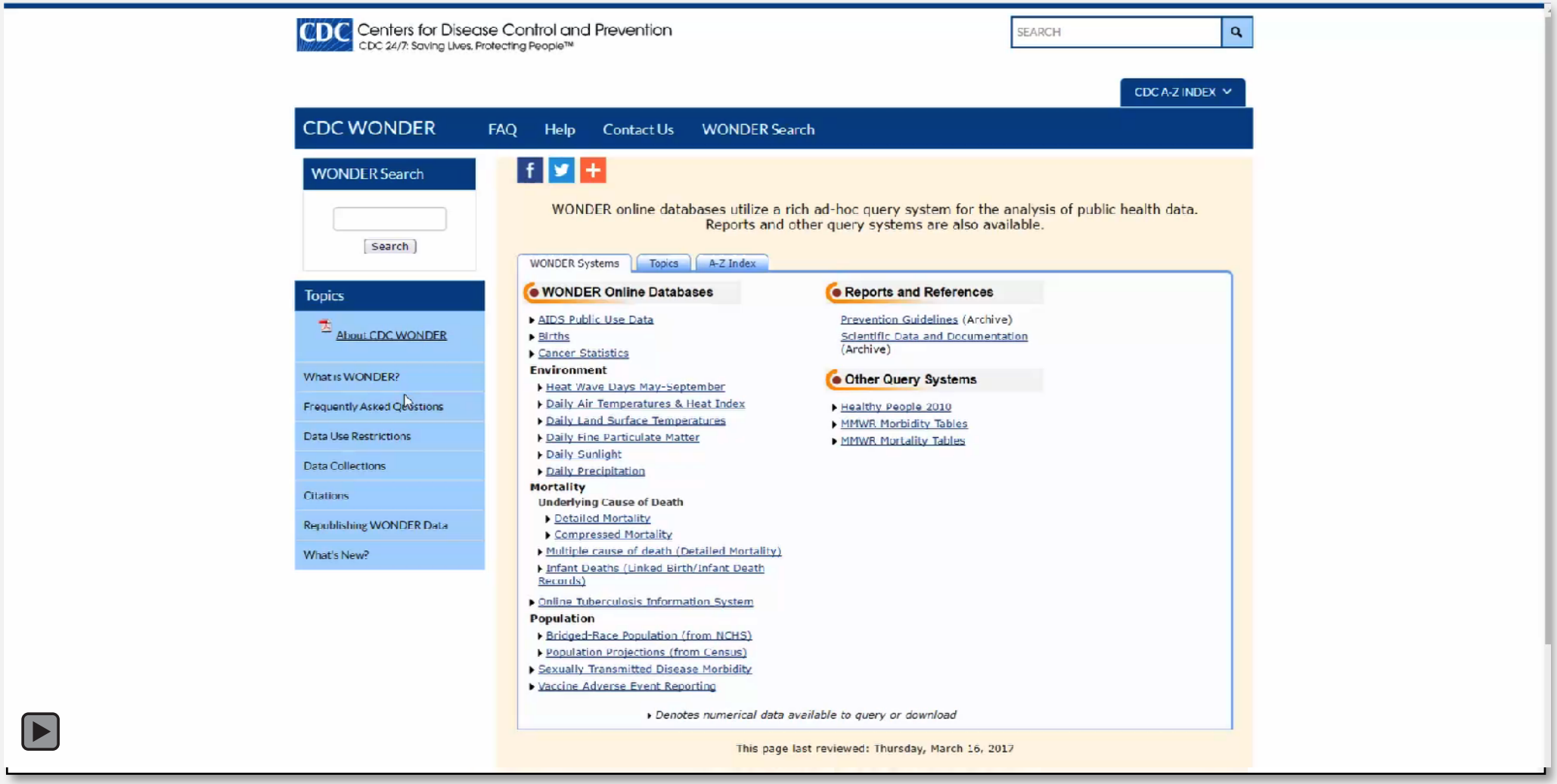




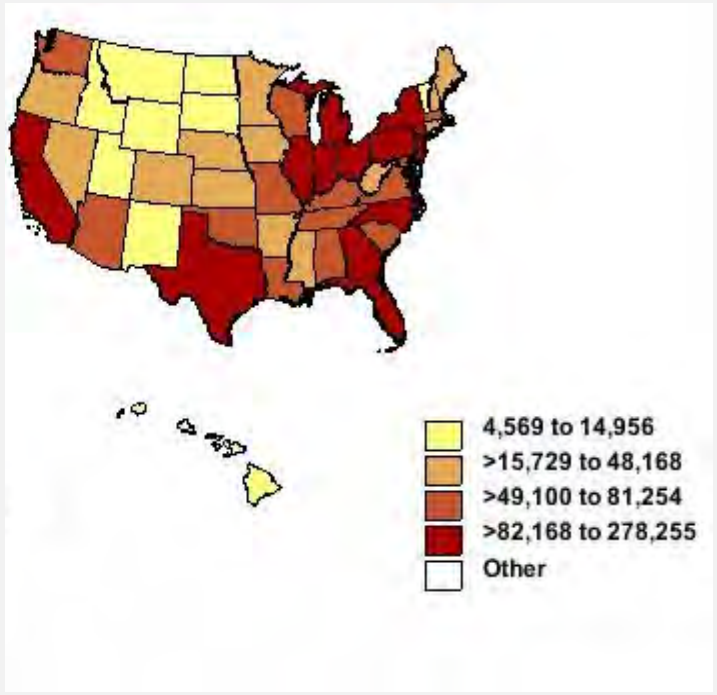
Downloadable data at census tract level

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

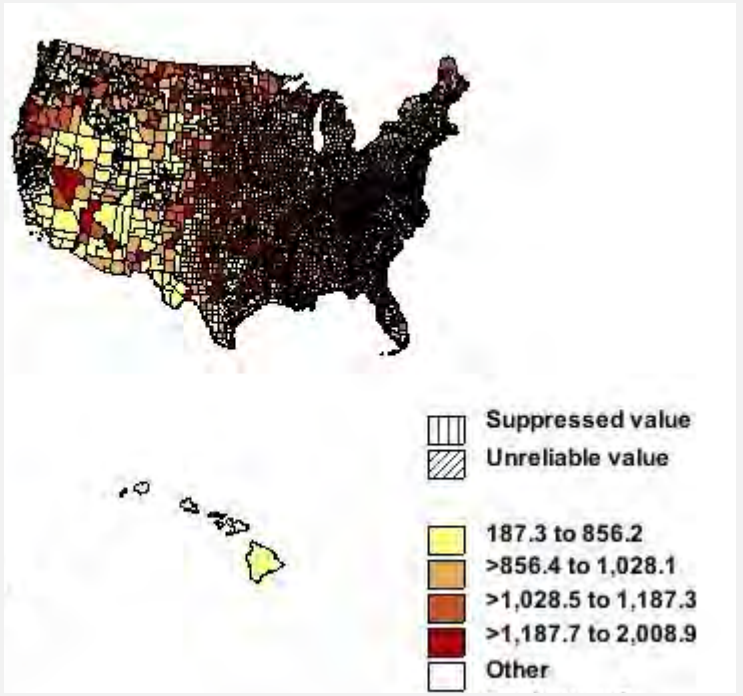
CDC WONDER: http://wonder.cdc.gov/



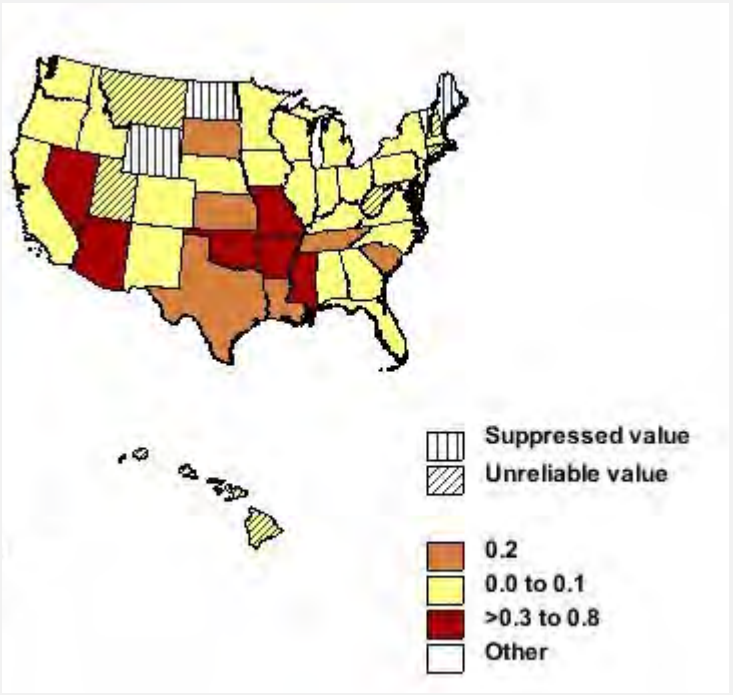
Health Outcome Datasets Available Through CDC WONDER



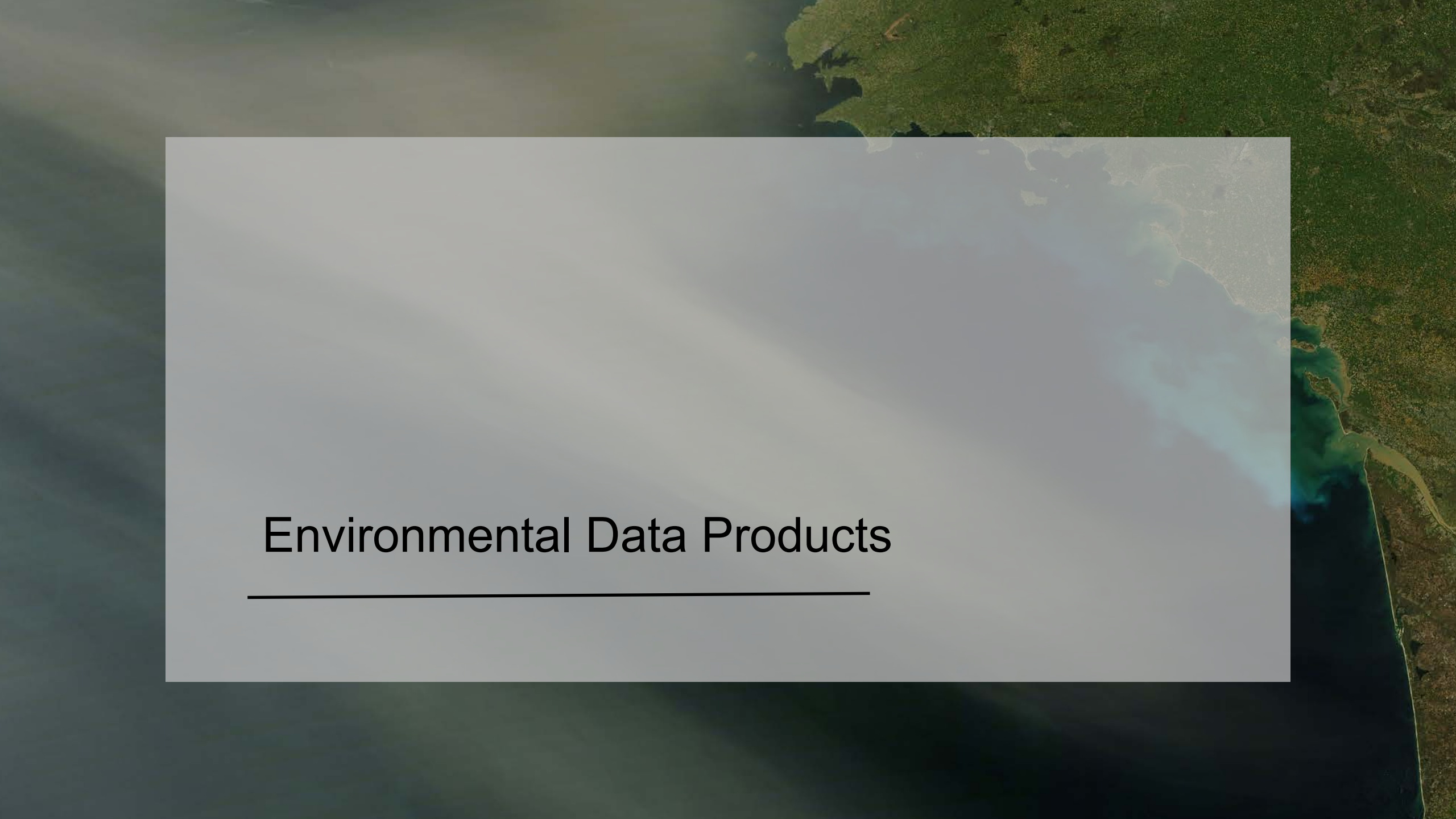
Respiratory Cancers
by State
1999-2013



All Causes Mortality
by County
1999-2015



Heat-Related Mortality
by State
1999-2015



Environmental Data Products

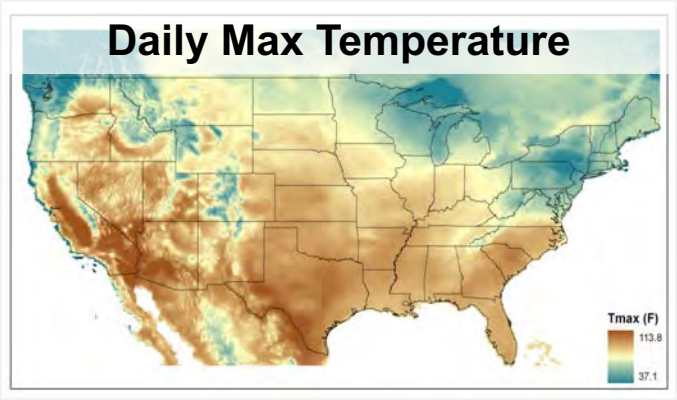
Introduction to NLDAS

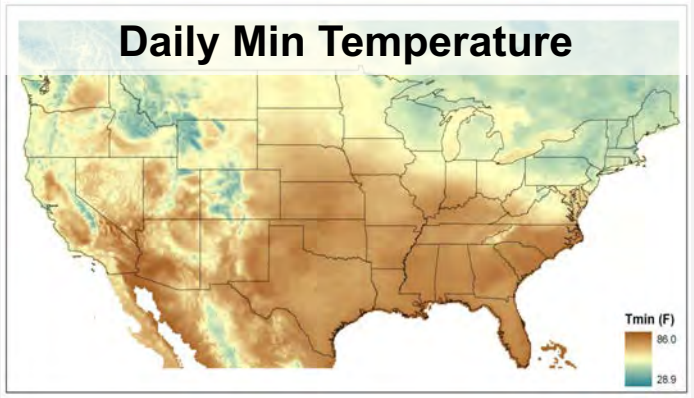
- North American Land Data Assimilation System (NLDAS) provides gridded meteorological data for the contiguous United States and parts of Mexico & Canada.
  - Combines three types of data:
    - Ground observations (National Weather Service stations)
    - Numerical weather model output
    - Satellite observations (GOES shortwave radiation) and radar/rain gauge rainfall
  - 1/8th degree latitude/longitude spatial grid (about 12 km)
  - NLDAS data are interpolated spatially and temporally from the North American Regional Reanalysis (NARR), which are at a 32 km spatial resolution and 3-hourly temporal frequency.
  - In creating NLDAS from NARR, air temperature, specific humidity and surface air pressure are adjusted to account for terrain height.
  - Hourly data are available from 1979-present.
- NLDAS data are available from http://www.emc.ncep.noaa.gov/mmb/nldas/

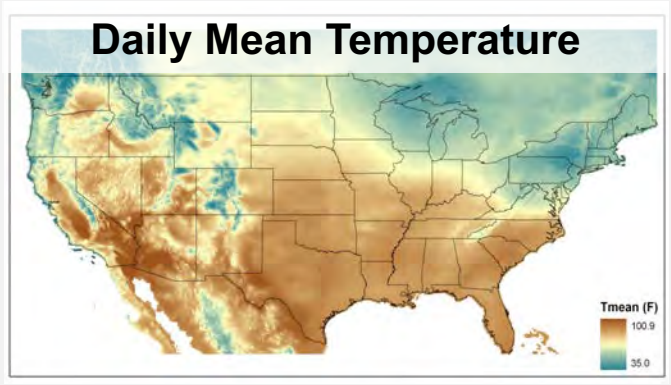
NLDAS-Derived Heat Metrics

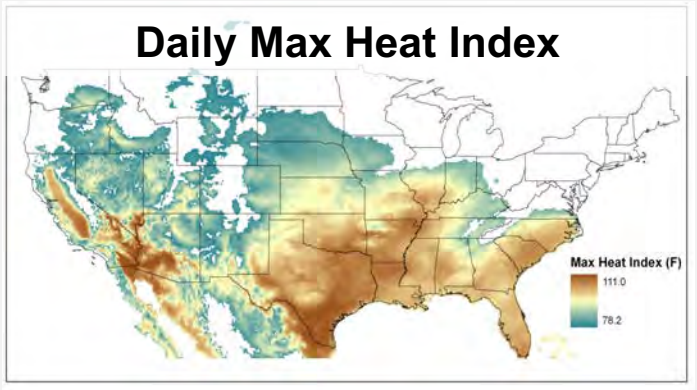
From hourly NLDAS data, we developed a set of daily heat metrics: daily maximum, minimum, and mean air temperature, daily maximum Heat Index (a measure of the combined effect of heat and humidity), and a newly-defined measure called Net Daily Heat Stress (NDHS).

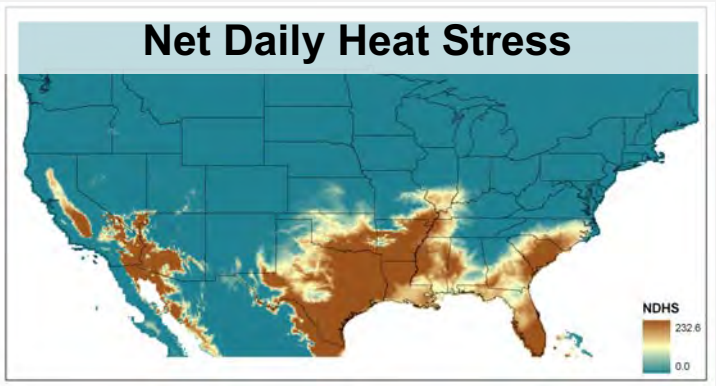
Examples of meteorological products derived from NLDAS
July 1, 1986











Downscaling (‘Disaggregating’) Air Temperatures

- Rationale:
  - The NLDAS meteorological re-analysis provides hourly air temperature and other variables on a ~12 km CONUS grid. The resolution is in fact coarser since NLDAS is derived via spatial interpolation from the 32 km NARR. At this resolution, small-scale features such as the Urban Heat Island and near-coastal temperature gradients are not captured.
  - 1 km MODIS Land Surface Temperature (LST) data can be used to down-scale NLDAS daily maximum and minimum air temperatures.
  - Our approach is to use long-term means of MODIS Aqua LST (1:30 PM/AM local time) to capture the fine-scale (1 km) spatial pattern of daily maximum/minimum air temperature, and impose this pattern on 12 km NLDAS daily maximum/minimum air temperatures.

Downscaling Assumptions

- Except in cases of the passage of a warm or cold front, air temperature is driven primarily by the temperature of the surface, thus the spatial patterns of air temperature mimic the patterns of LST in a relative sense (although the magnitude of air temperature spatial variability is much lower than that of LST).
- Spatial patterns of air temperature at the sub-NLDAS scale (< 12 km) are nearly constant from day to day within the respective season, as these patterns are driven mostly by land use.
- Daily maximum (minimum) air temperatures occur during the early-mid afternoon (early morning), aligning well with the PM (AM) Aqua overpass.

These assumptions are met much more frequently during the warm season.

Downscaling Algorithm

1. Calculate standardized LST departures, Z_{HR}, from recent MODIS 8-day composite LST grids, in which the spatial means and standard deviations are calculated within a local neighborhood or ‘moving window’, the size of which can be varied. The standardized departures are calculated according to:

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

where 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 the neighborhood.

- ZHR is calculated separately for daytime maximum and nighttime minimum temperatures.

Downscaling Algorithm

2. Compute the down-scaled daily maximum (or minimum) air temperatures for each day, T_{DIS}, based on the standardized MODIS daytime (or nighttime) LST departures:

$$T_{DIS} = T_{LR} + Z_{HR} \bullet \sigma_{LR} = T_{LR} + (T_{HR} - T_{HR,mean}) \bullet (\sigma_{LR} / \sigma_{HR})$$

where T_{LR} and σ_{LR} are the mean and standard deviation, respectively, of low-resolution (NLDAS) daily air temperatures over the neighborhood.

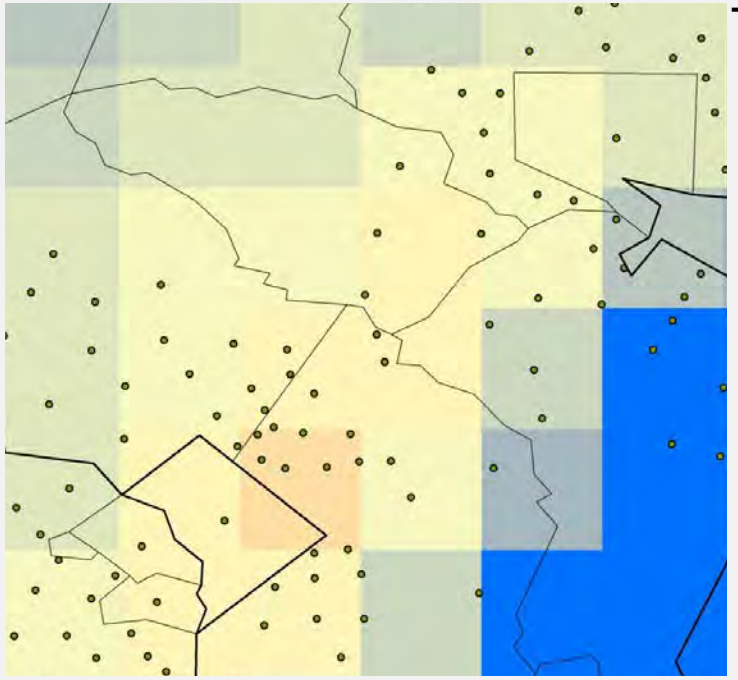
Downscaled Air Temperature

Results from application of the downscaling algorithm are illustrated below, which shows NLDAS daily maximum air temperatures, downscaled to a 1 km grid using MODIS LST data, for the Washington-Baltimore metropolitan area. Urban areas, which are not apparent warm anomalies in the NLDAS temperature image, are evident in the downscaled temperature image.

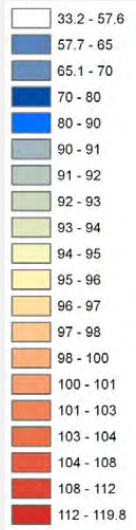
Daily Maximum Air Temperature from NLDAS, and downscaled to 1 km using MODIS LST for the Washington-Baltimore Metropolitan Area

Green circles indicate urban centers

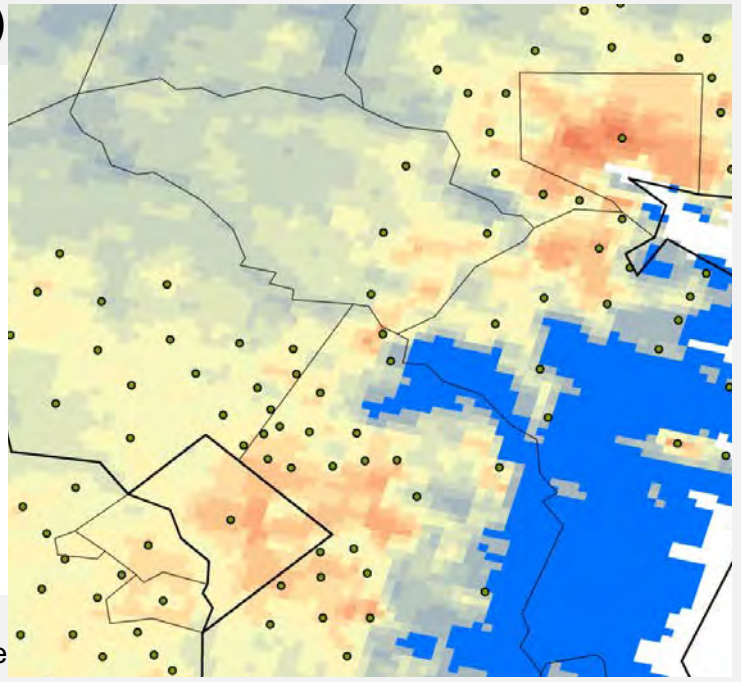
NLDAS 12 km



T_{max} (°F)



Downscaled to 1 km

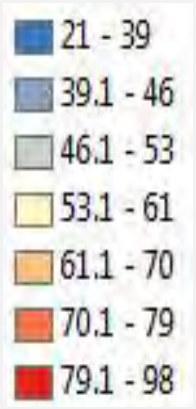


Applie

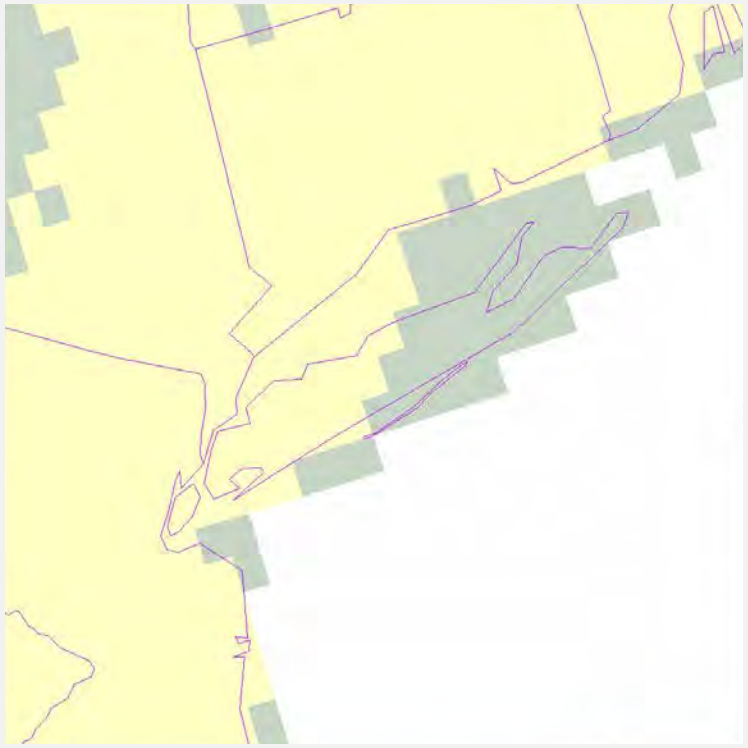
Downscaled Air Temperature

Daily Maximum Air Temperature from NLDAS, and downscaled to 1 km using MODIS LST for the New York City Metropolitan Area for May 2, 2005

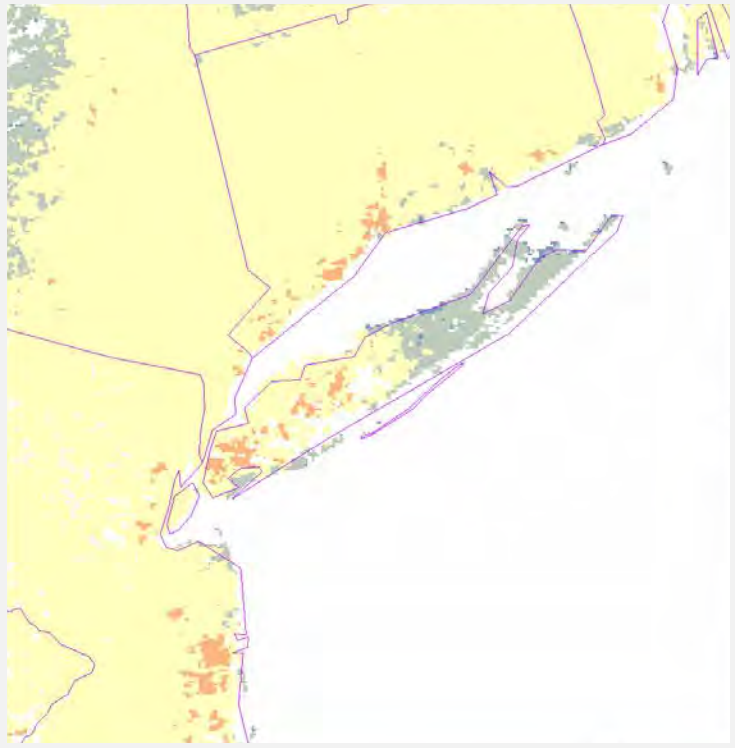
T_{max} (°F)
May 2, 2005



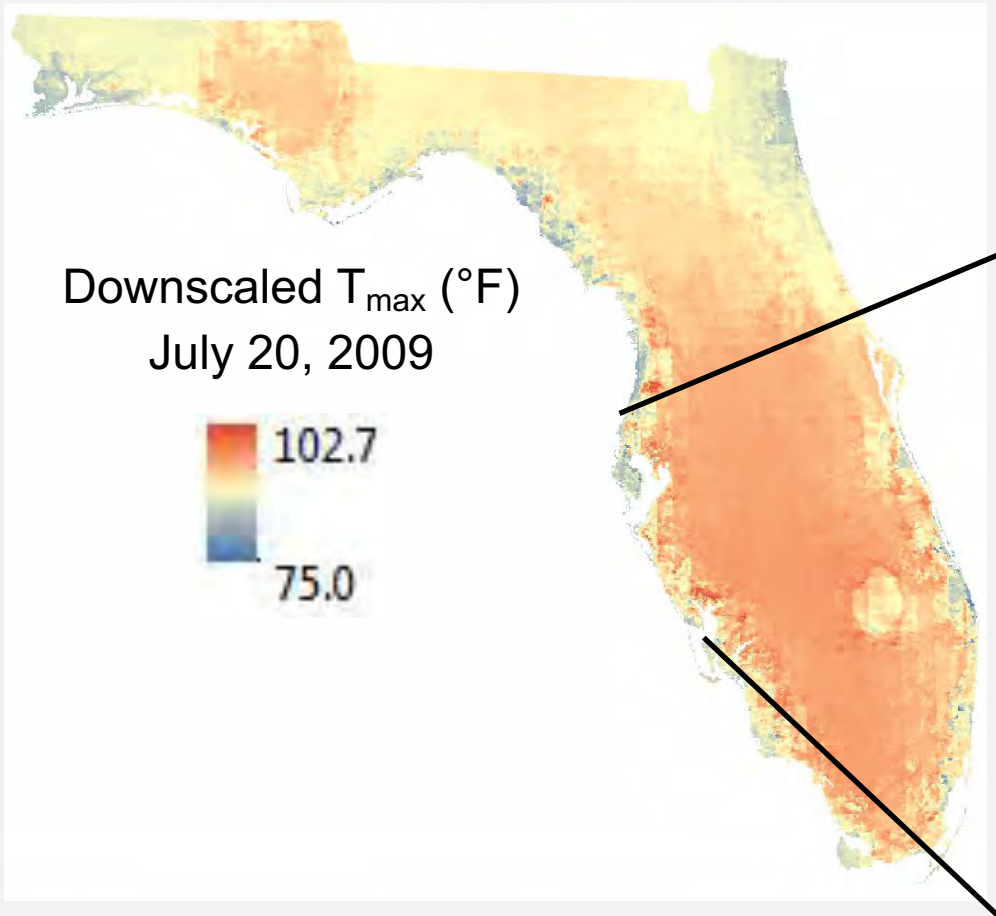
NLDAS 12 km



Downscaled to 1 km



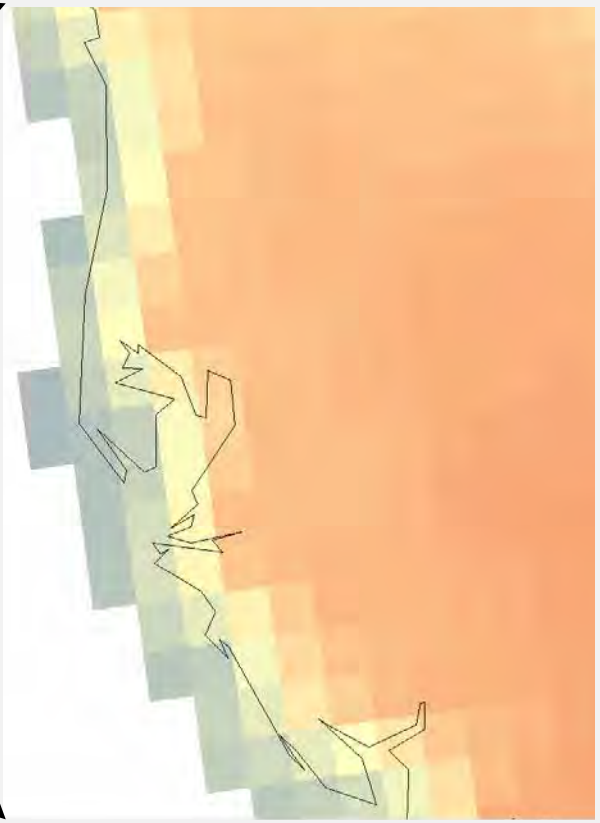
Florida Results



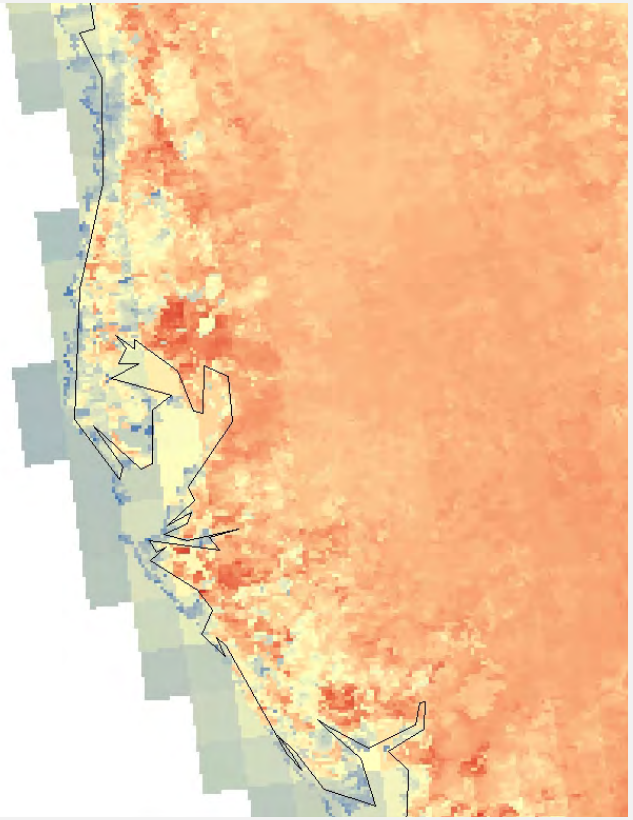
Tampa Bay Area

T_{max} - July 12, 2009

NLDAS 12 km



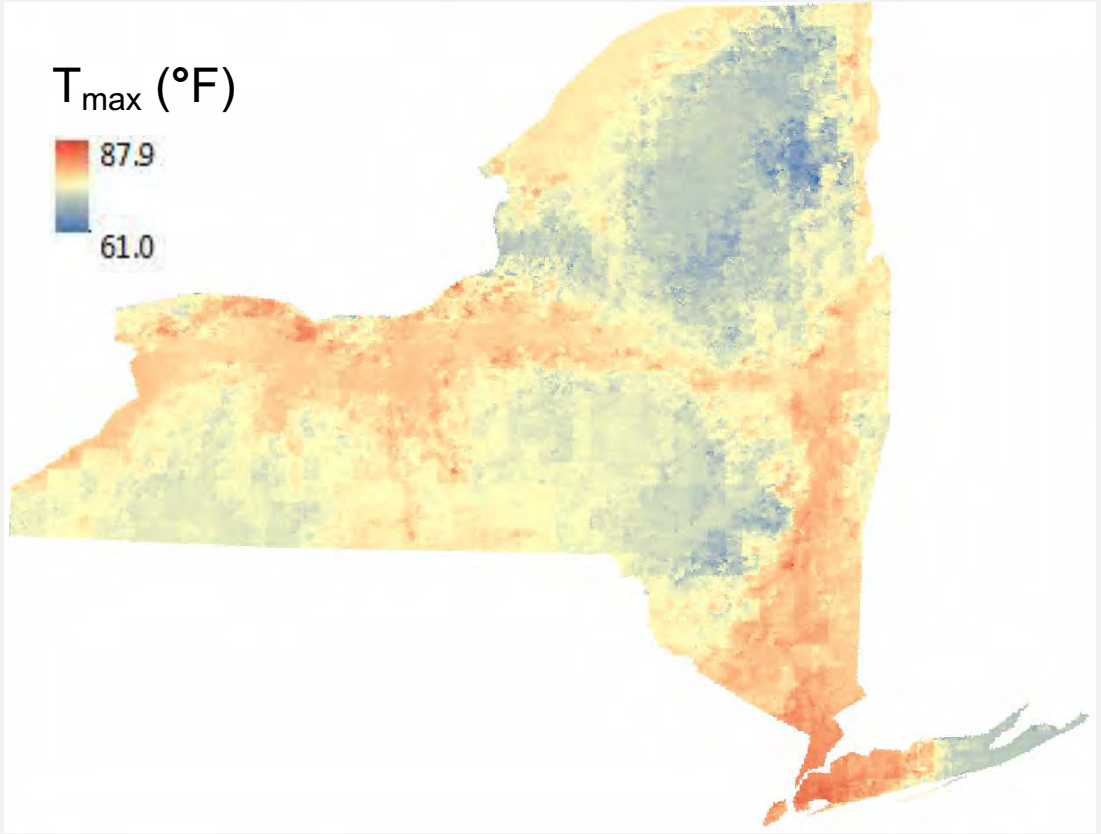
Downscaled to 1 km

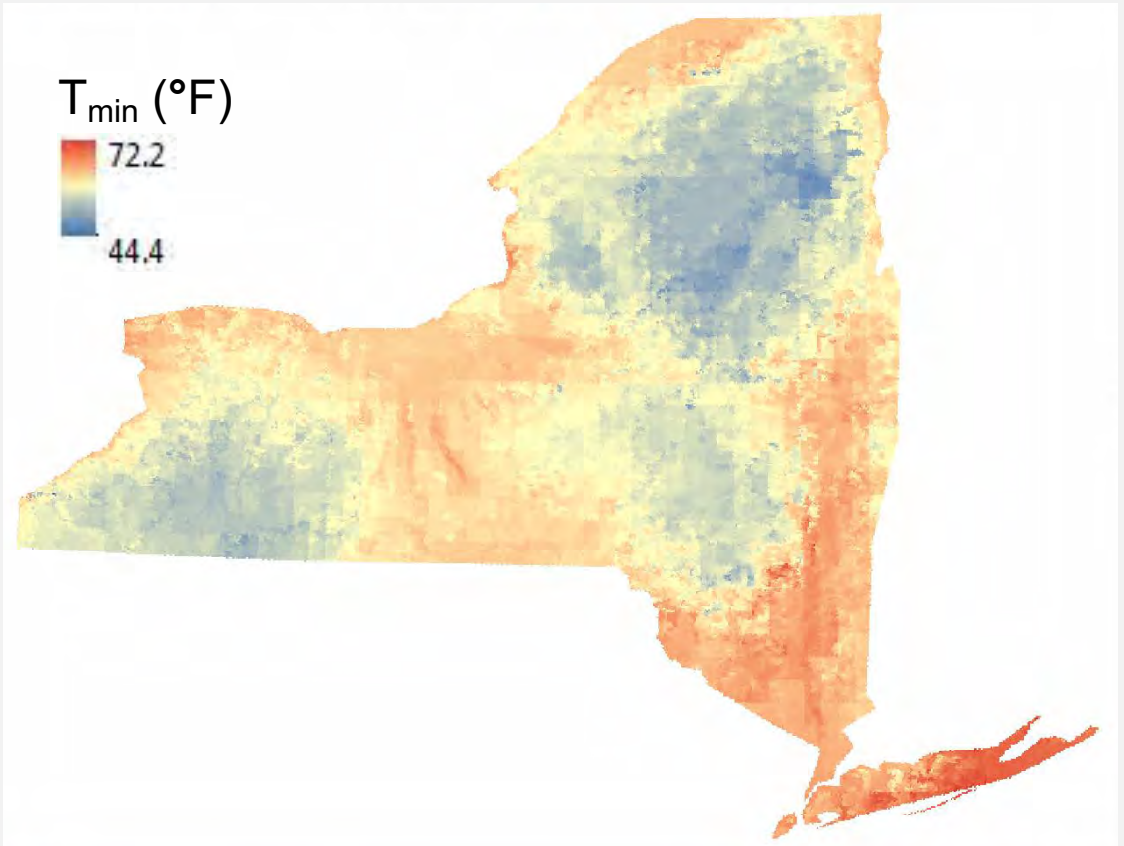


New York State Results

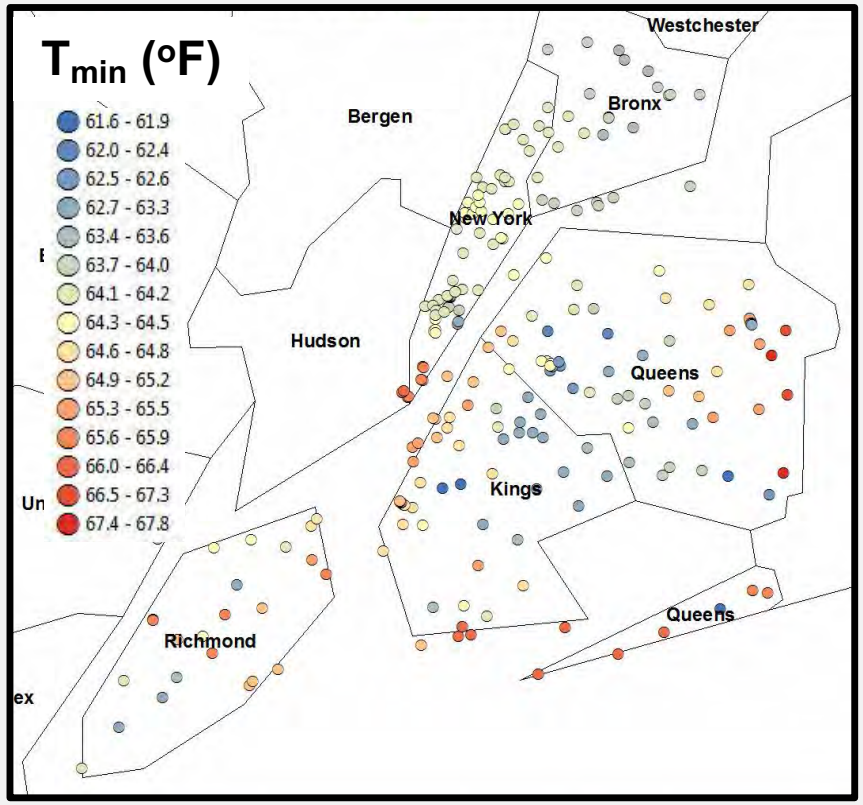
Downscaled T_{max}, T_{min}

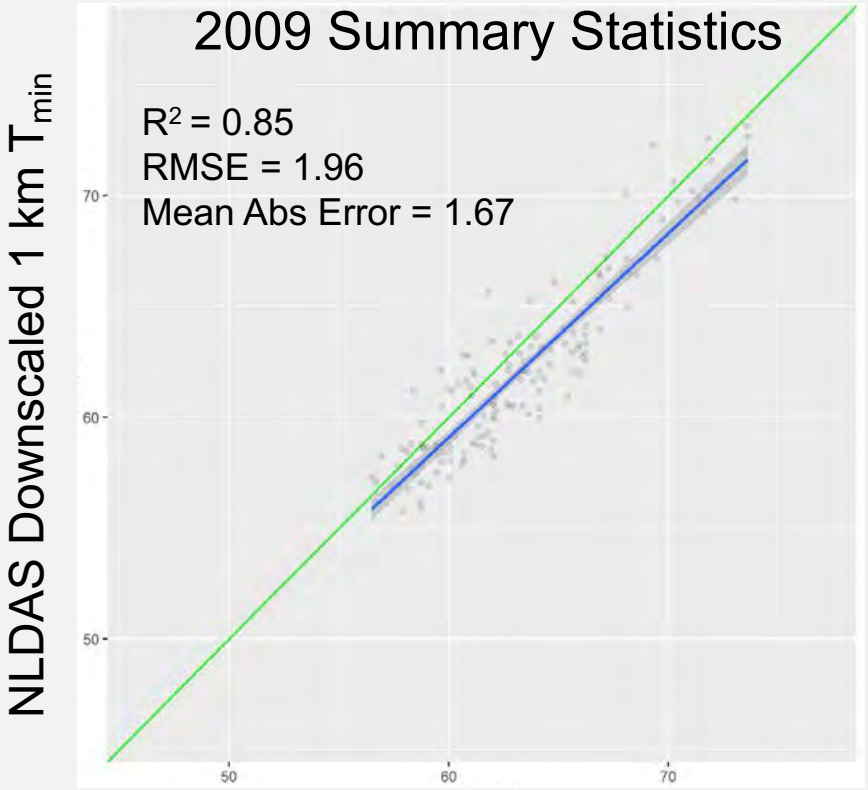
July 20, 2009





New York City Validation



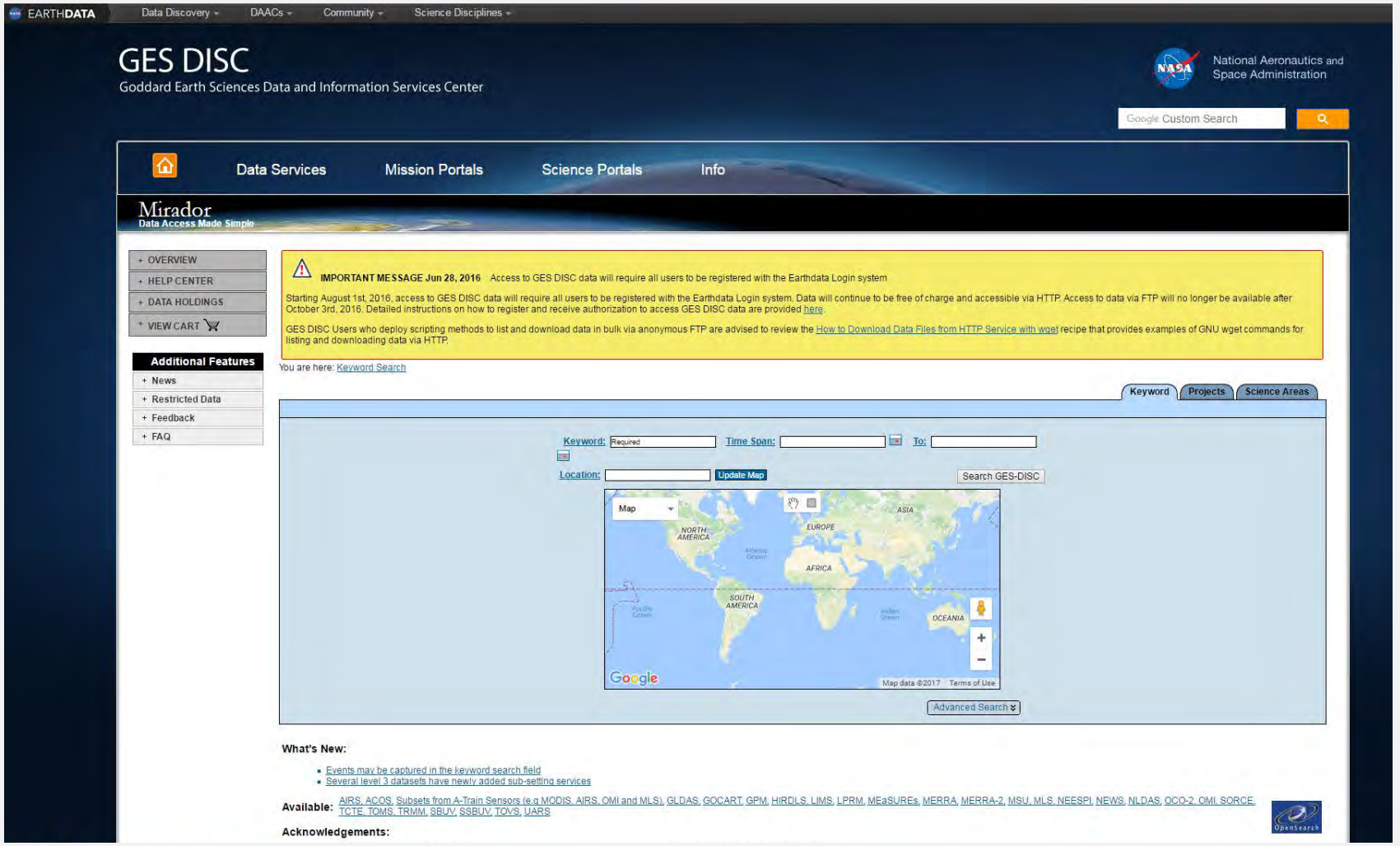


Downscaled Daily Minimum Temperatures have been linked to the locations of ground-based measurements made through the NYCCAS (New York City Community Air Survey).

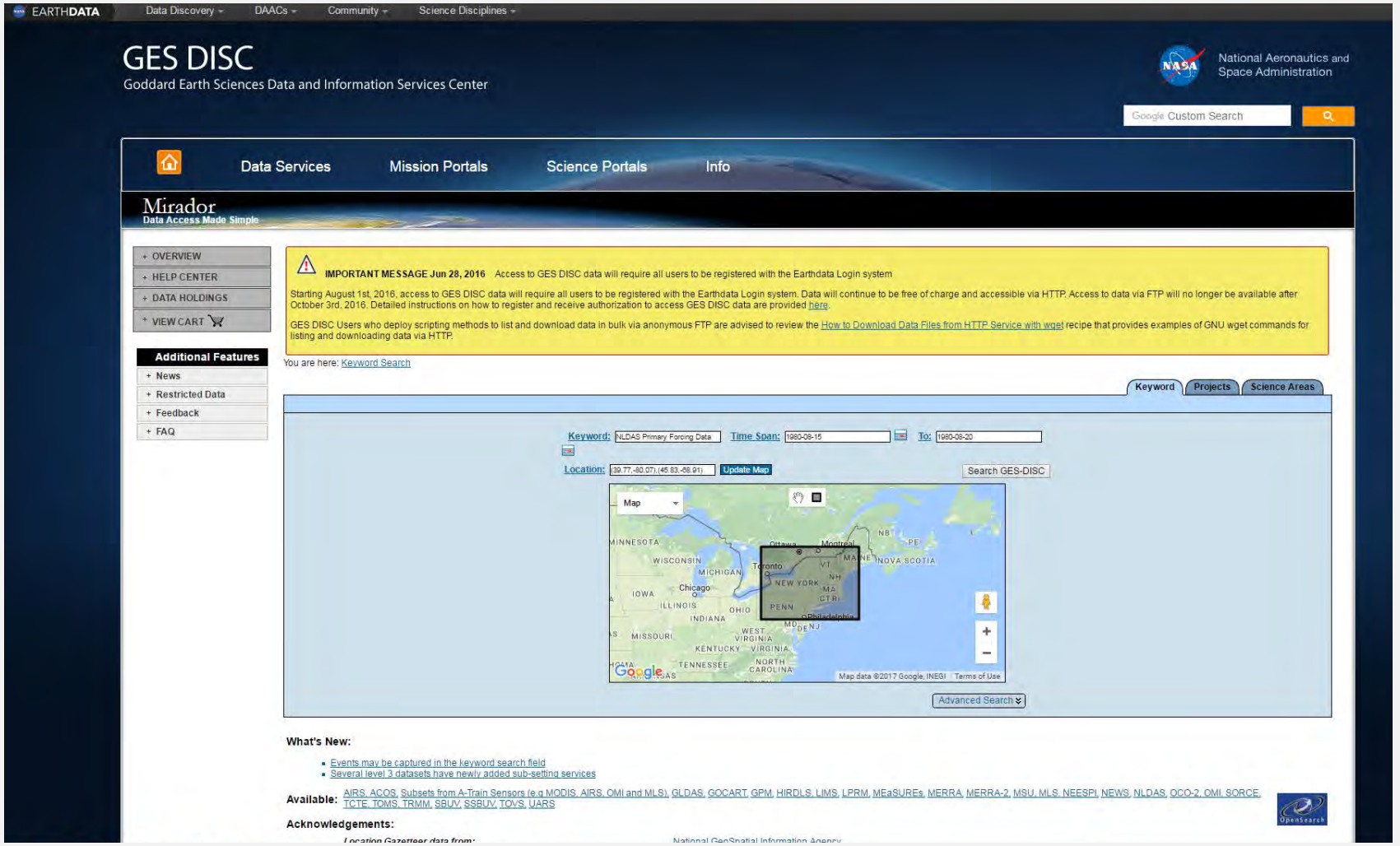
There is excellent agreement between the downscaled temperatures and ground-based measurements.

Downloading and Processing NLDAS Data

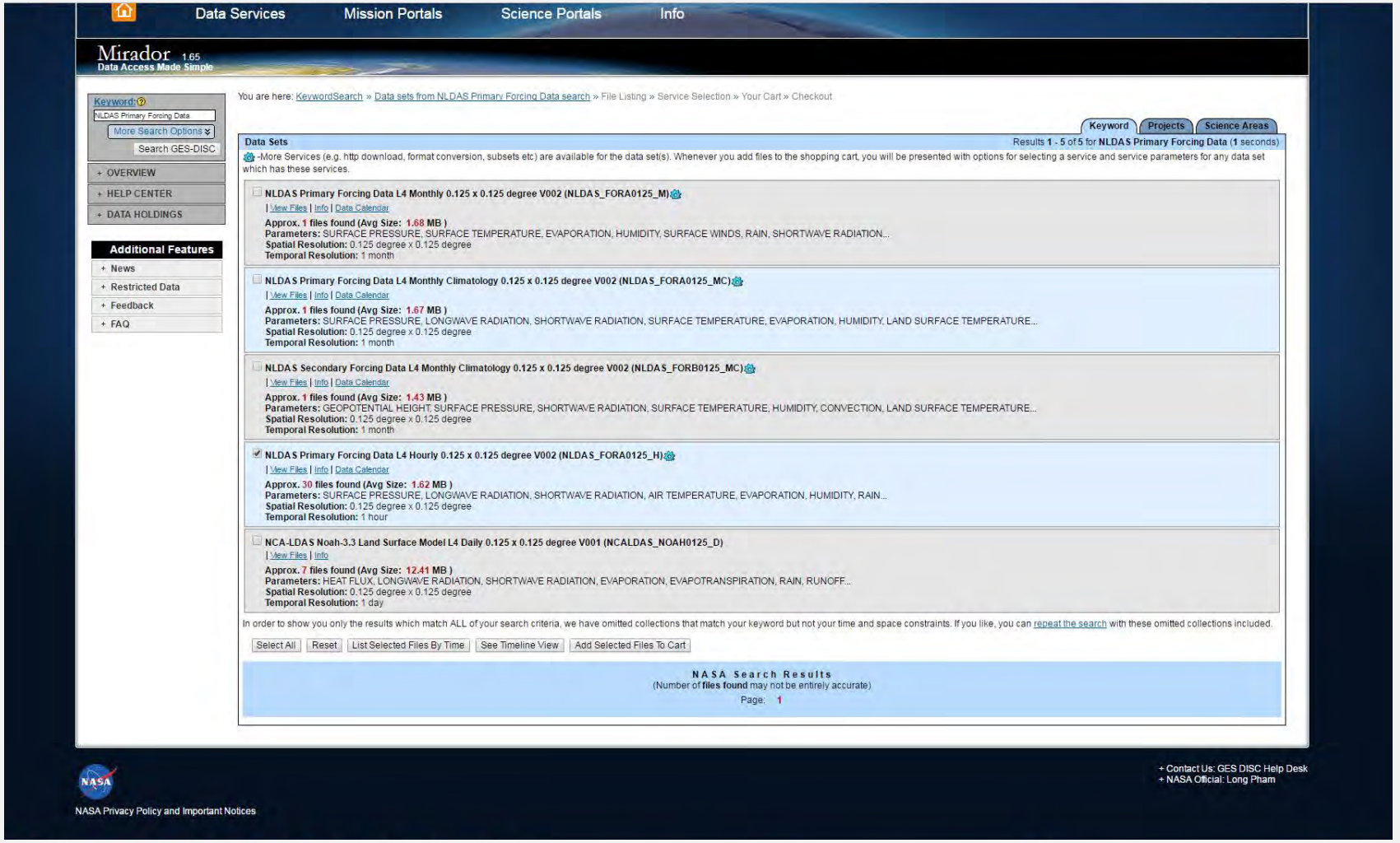
Downloading Data from Mirador: http://mirador.gsfc.nasa.gov/



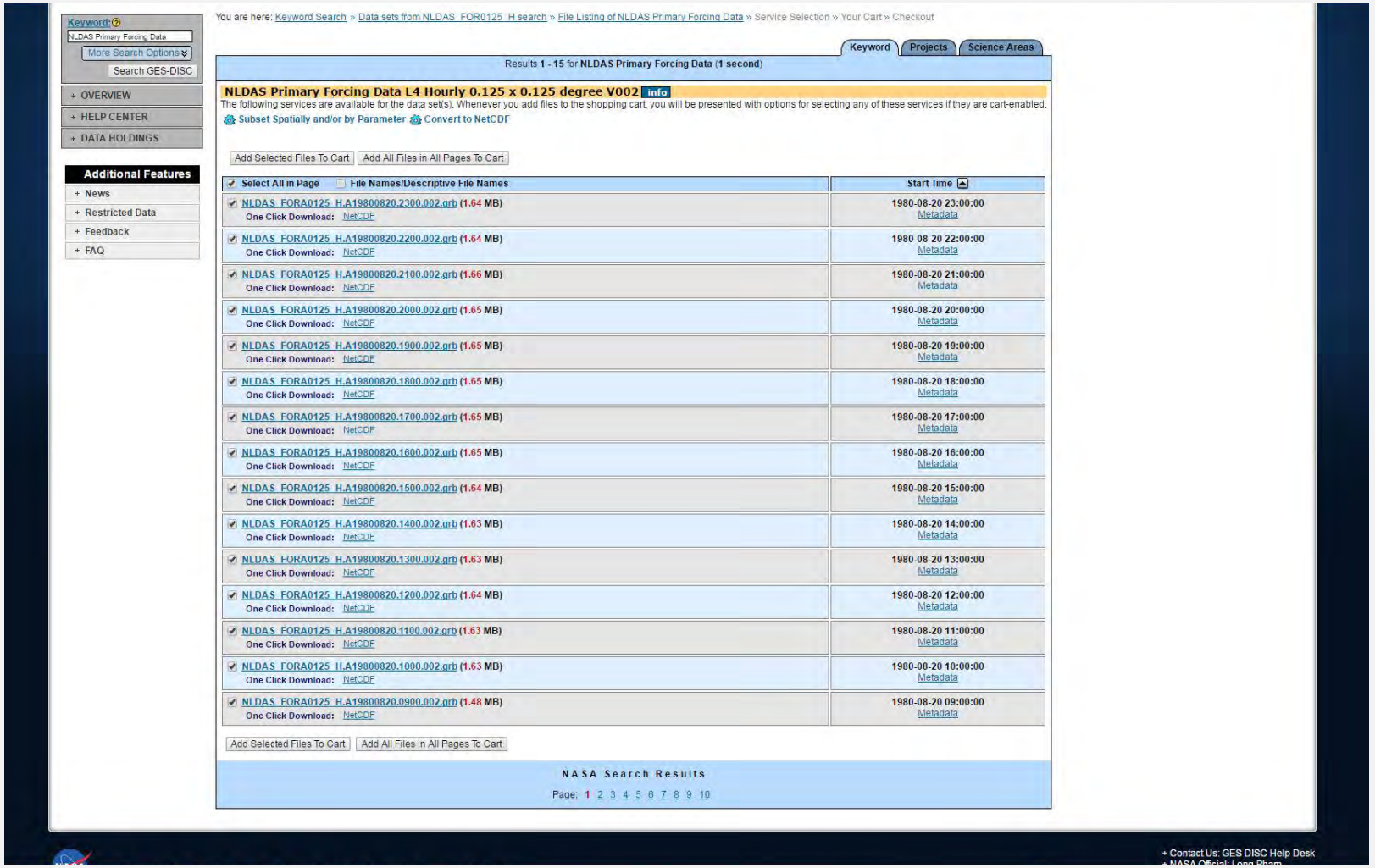
Select Dataset, Period, Location



Selecting Exact Dataset of Interest



Add to Cart


Keyword:
NLDAS Primary Forcing Data
More Search Options
Search GES-DISC
+ OVERVIEW
+ HELP CENTER
+ DATA HOLDINGS
Additional Features
+ News
+ Restricted Data
+ Feedback
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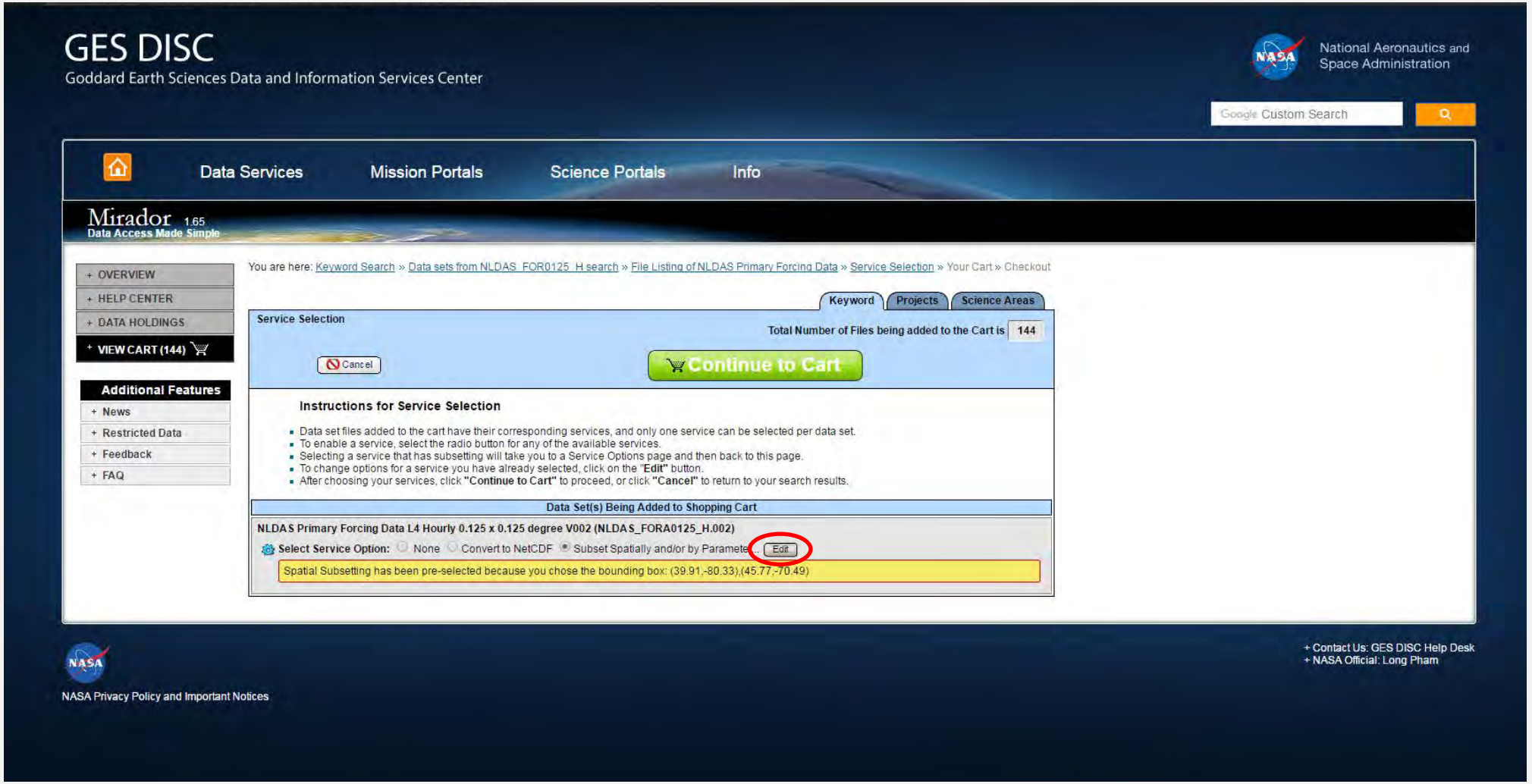

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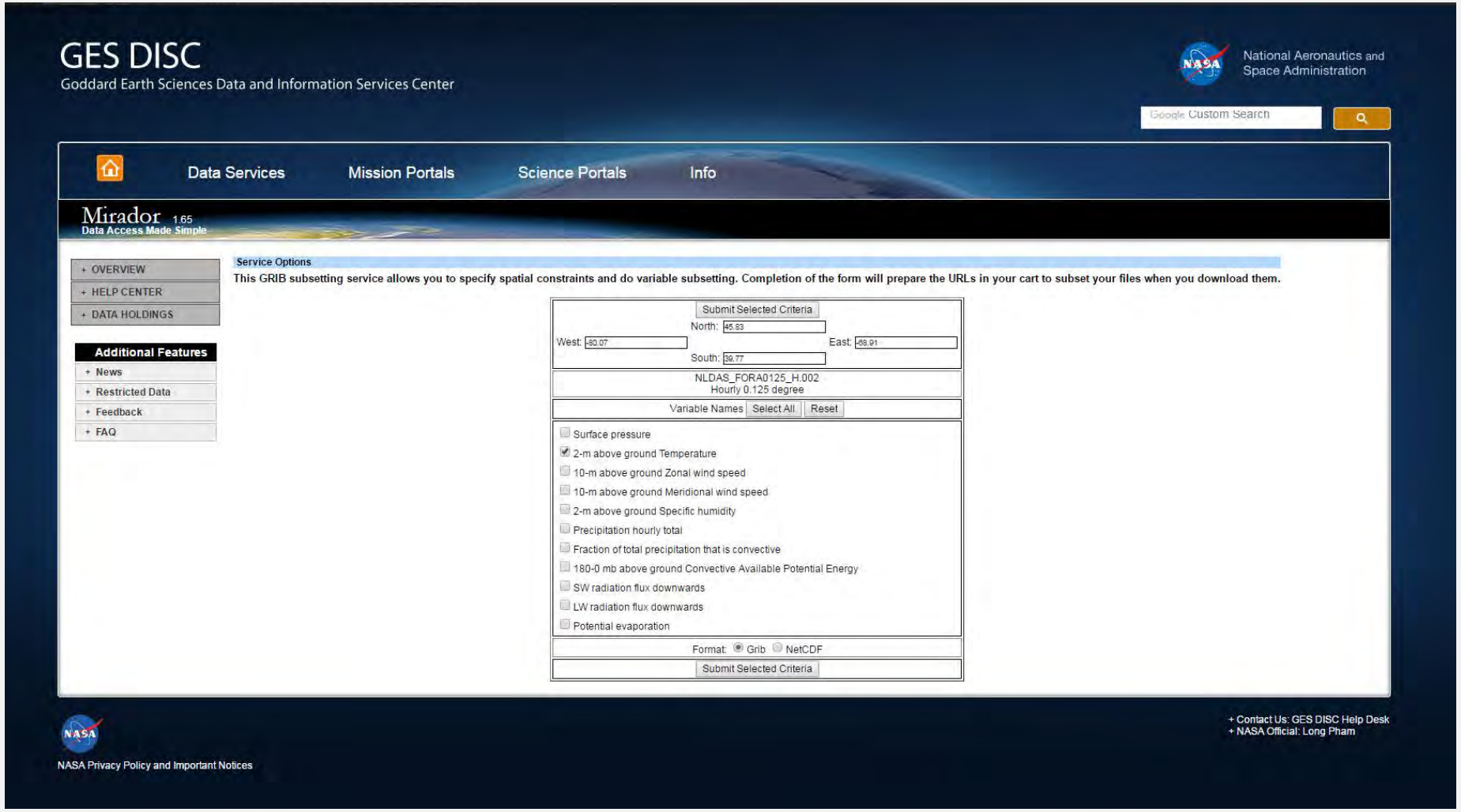

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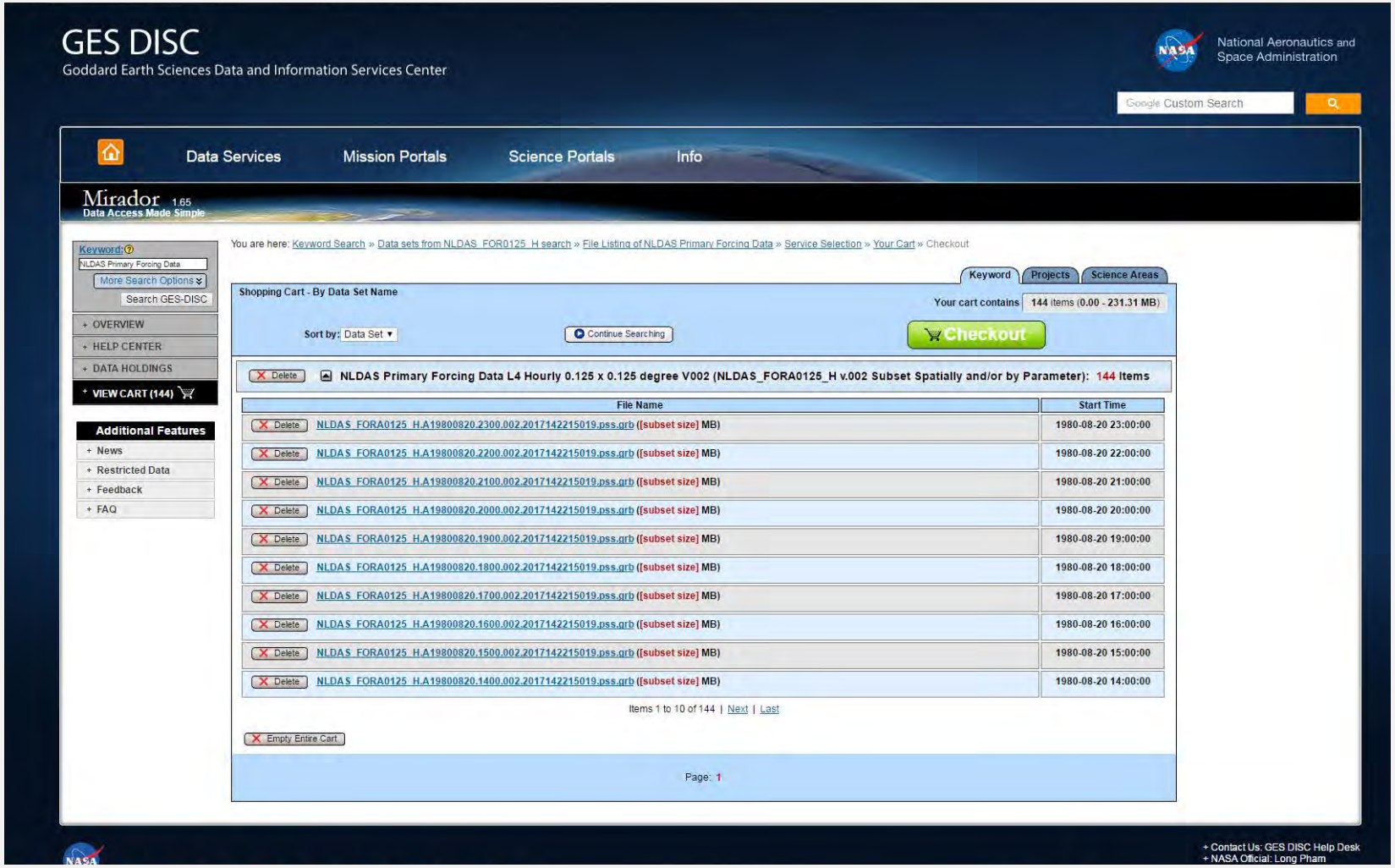
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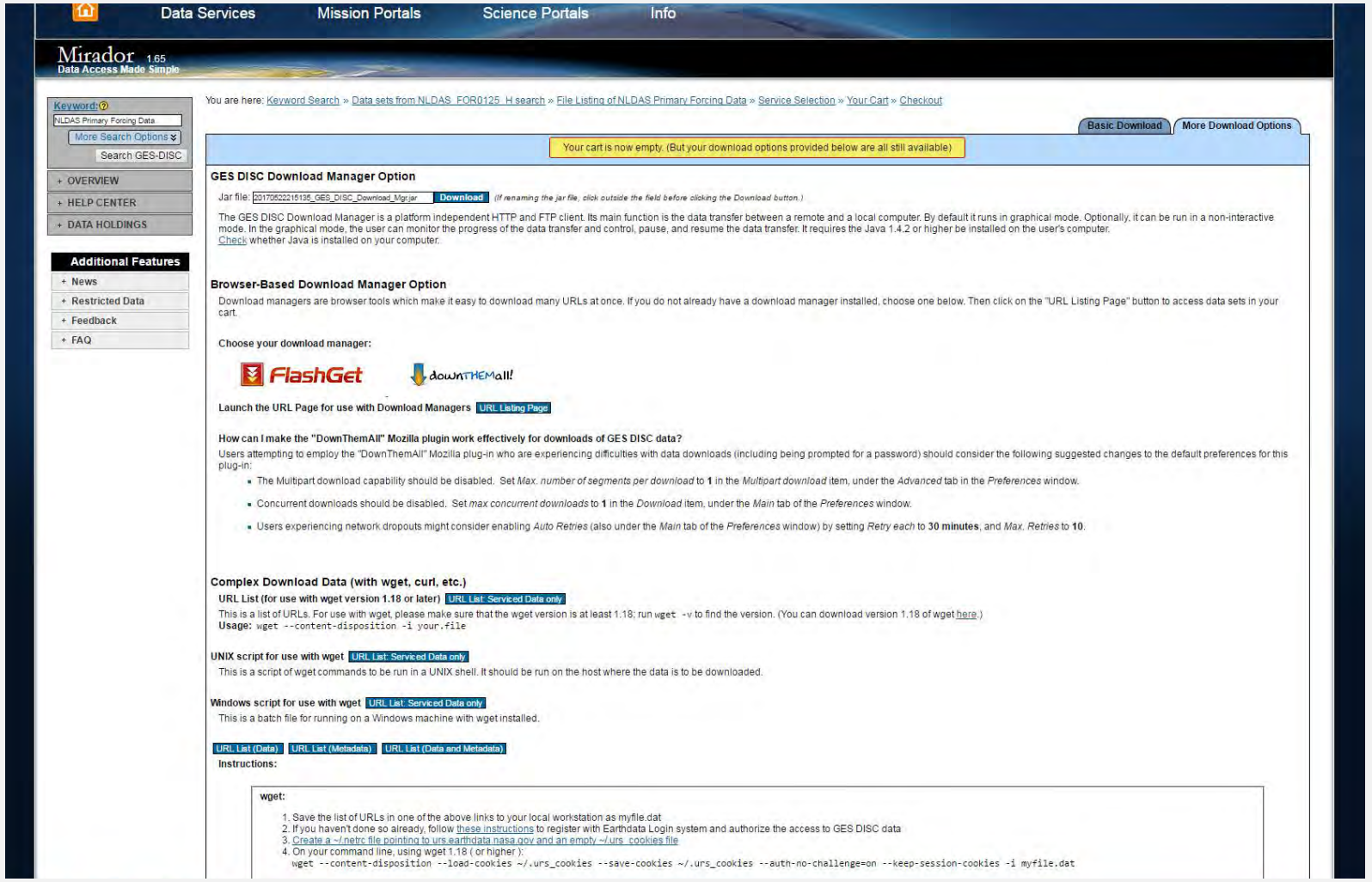
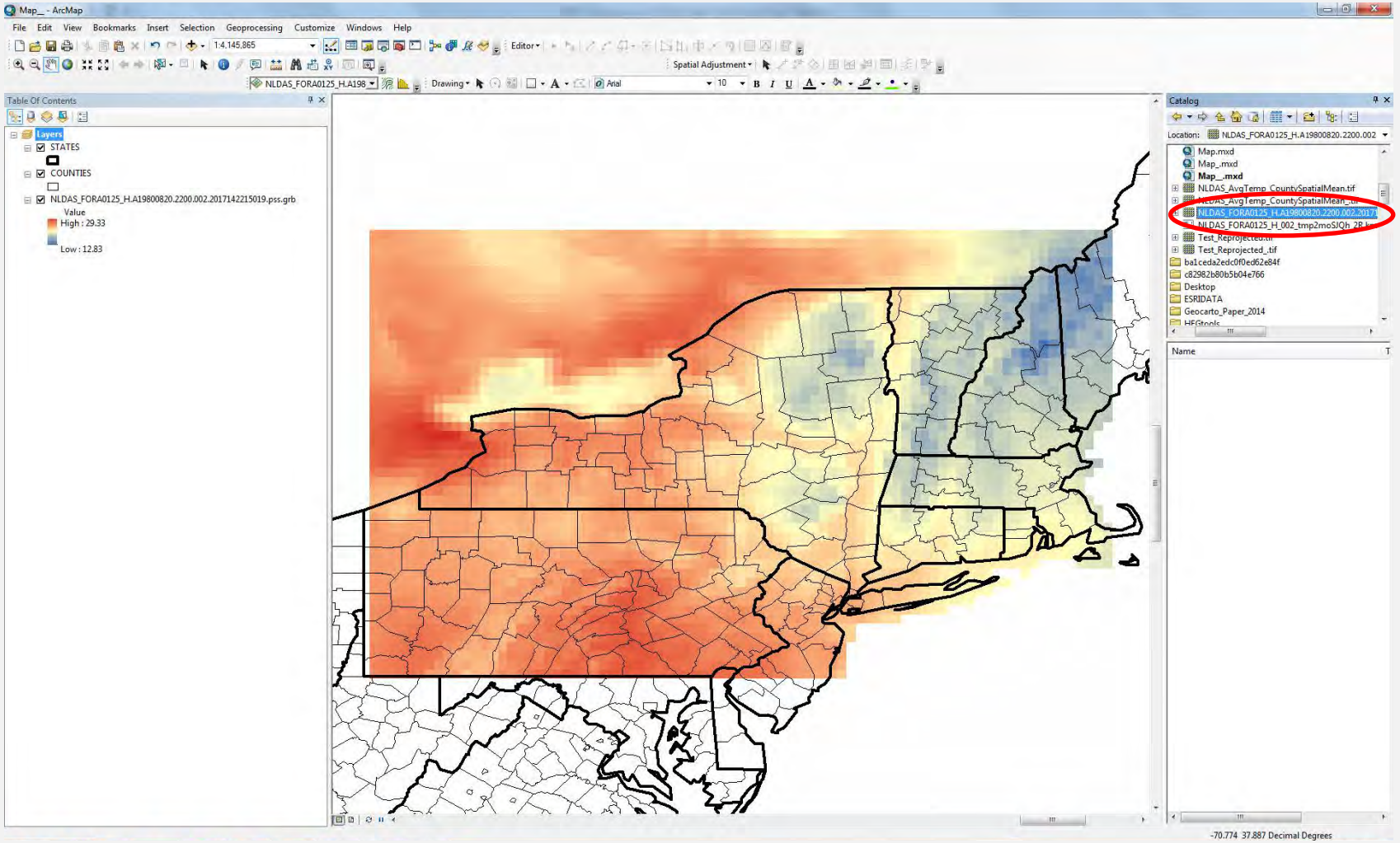
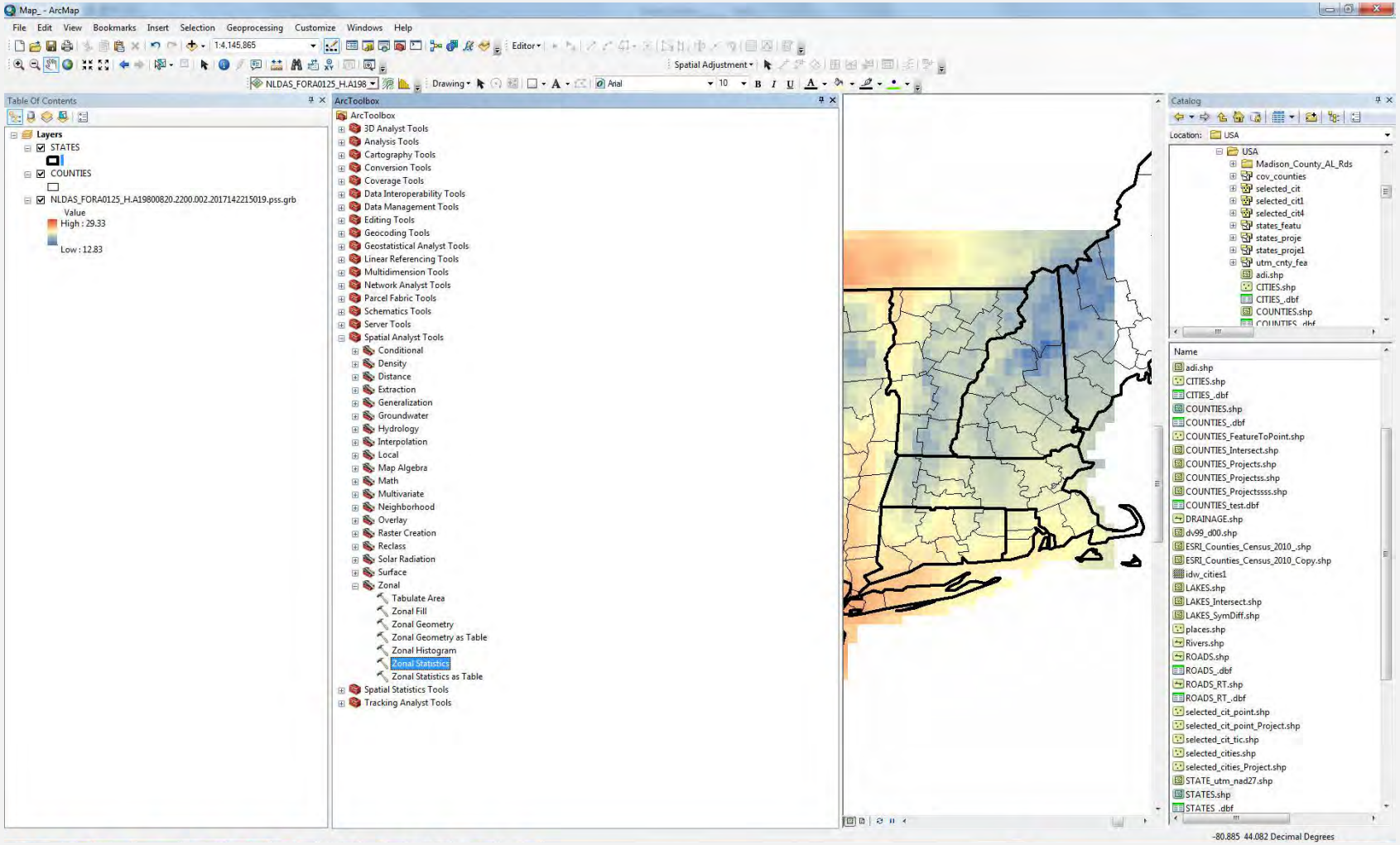


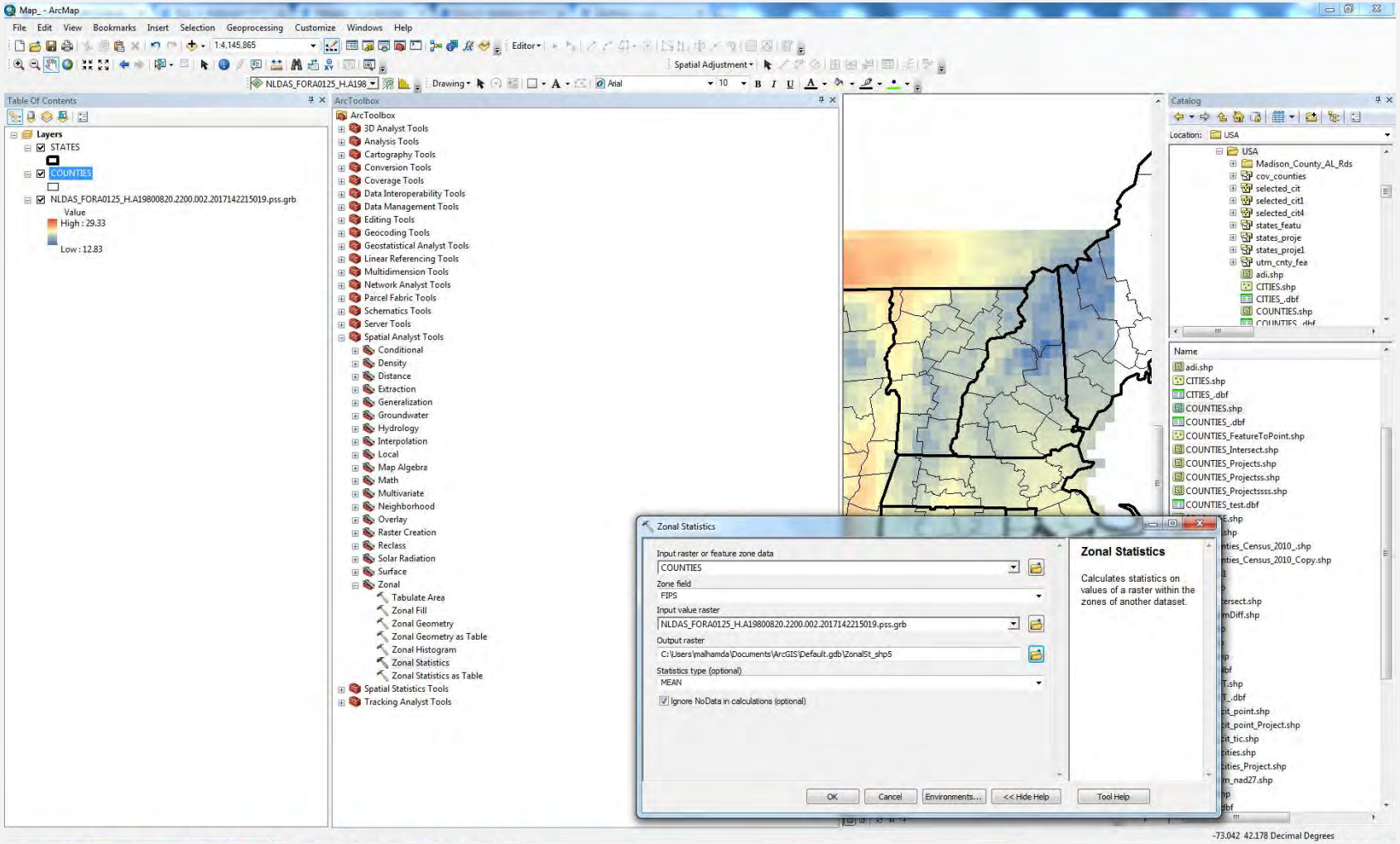
Import into GIS (ArcGIS used below)



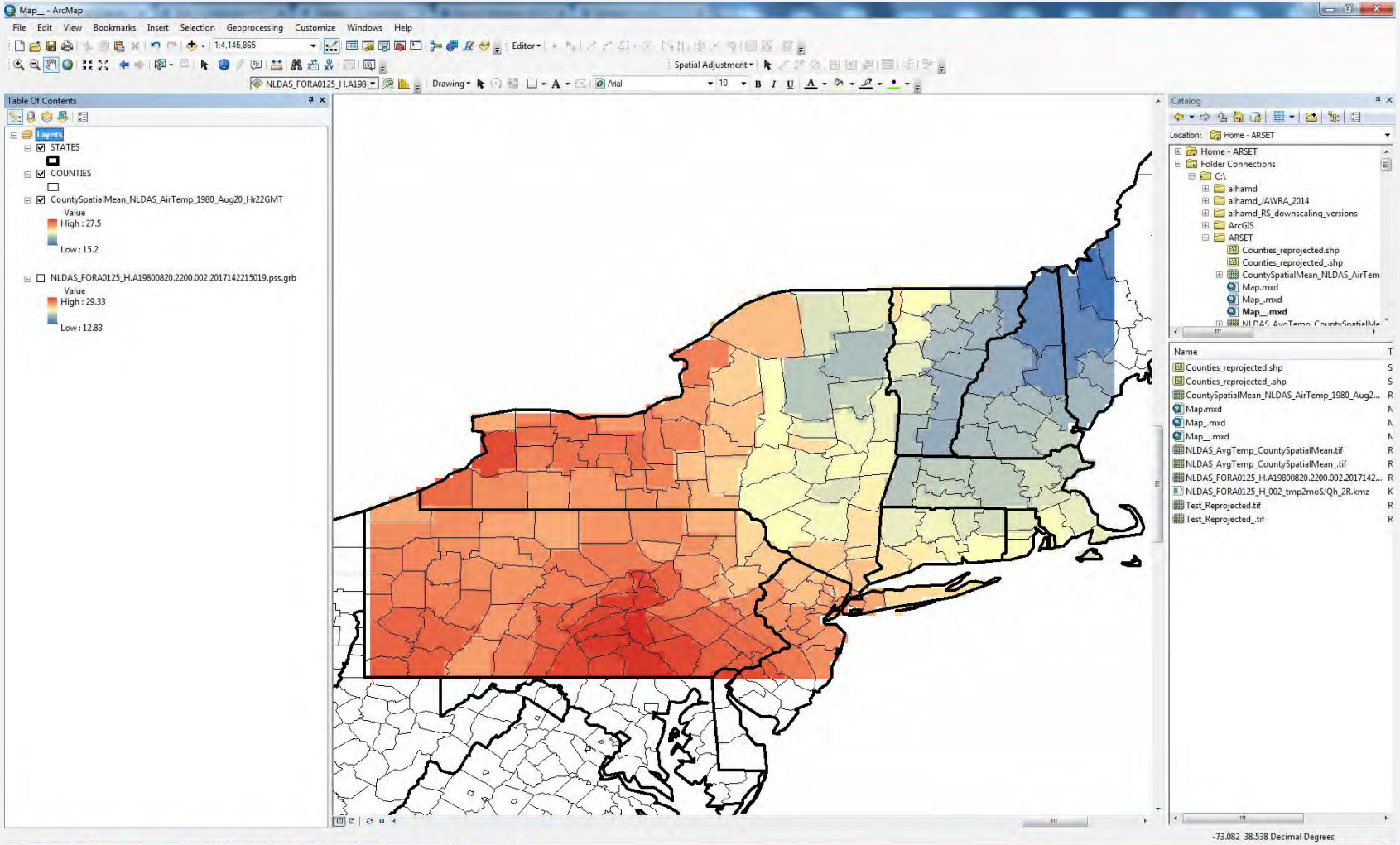
Aggregating Gridded Data to County-Level in ArcGIS



Aggregating Gridded Data to County-Level in ArcGIS

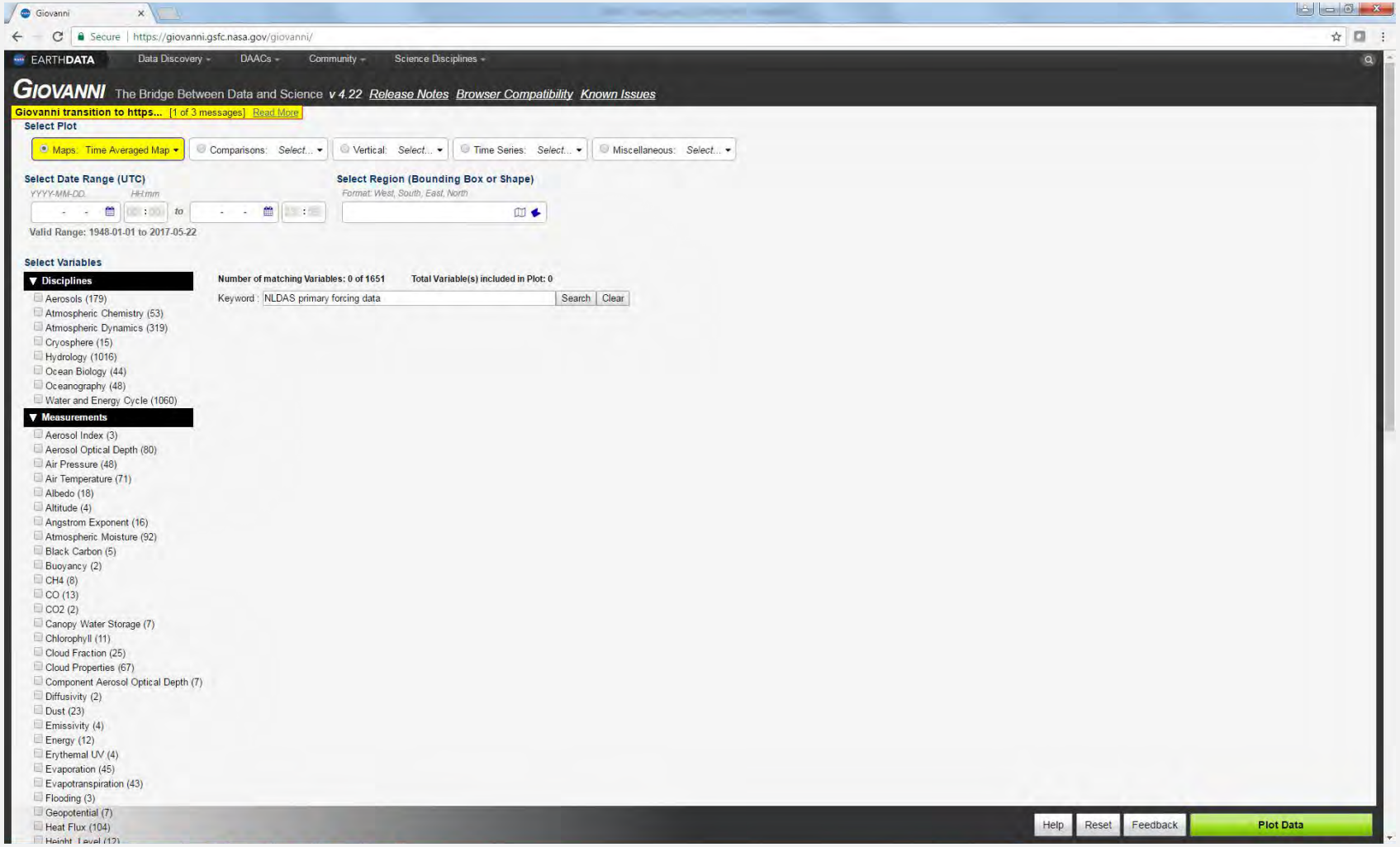


Aggregating Gridded Data to County-Level in ArcGIS (County Mean)

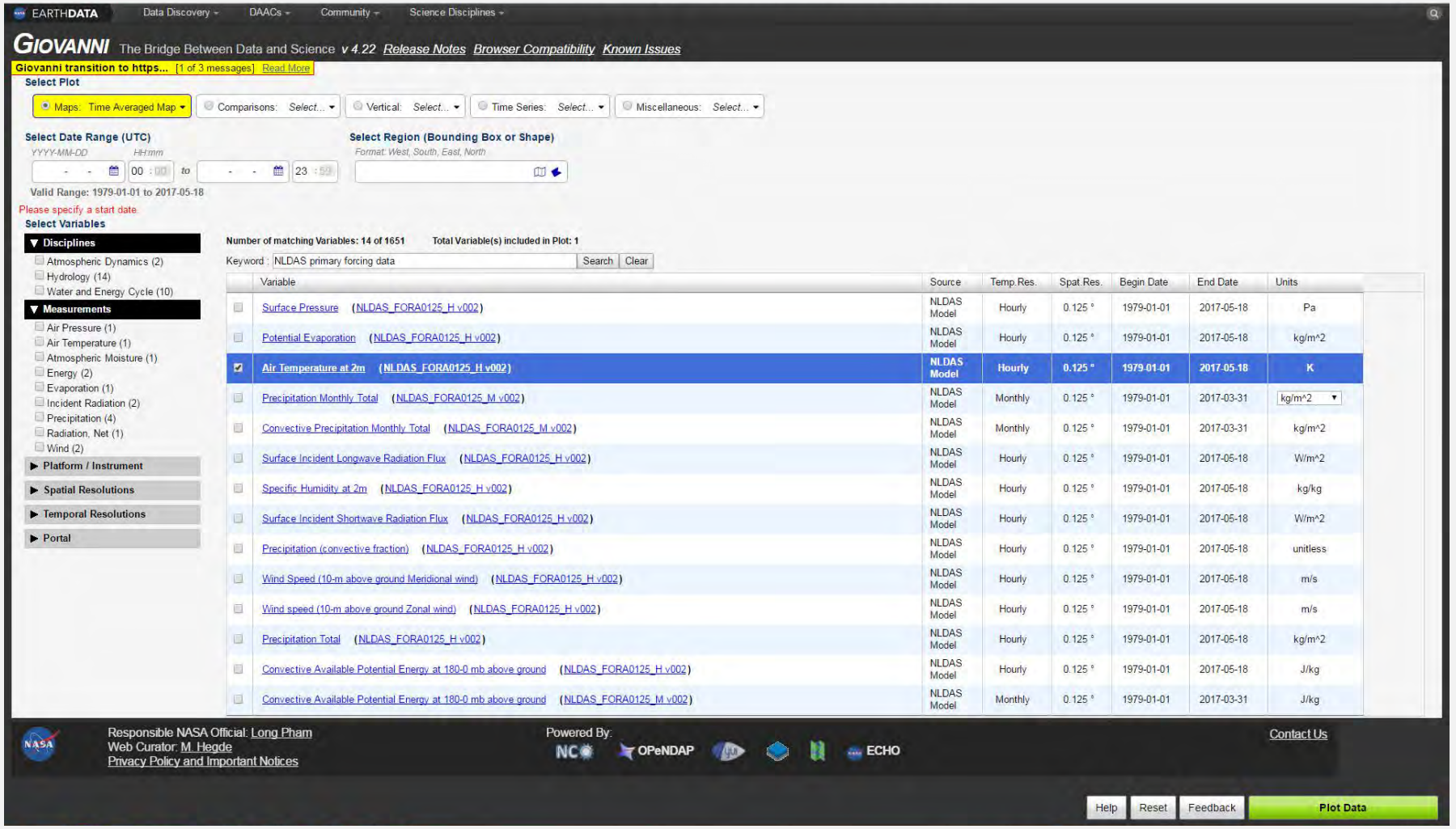


Plotting and Analyzing Gridded Data into Giovanni

http://giovanni.gsfc.nasa.gov/giovanni/



Selecting Dataset, Period, and Location



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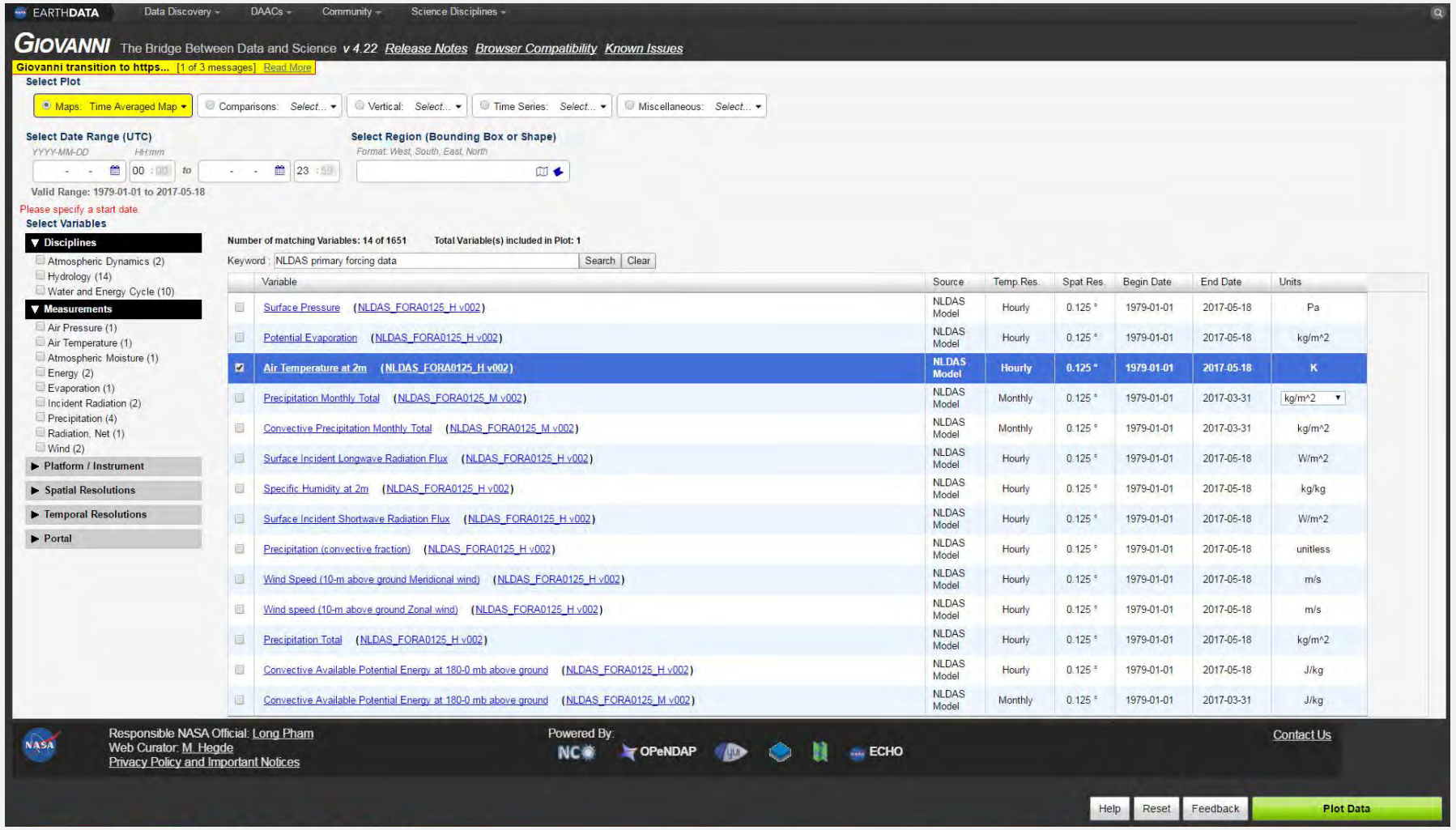
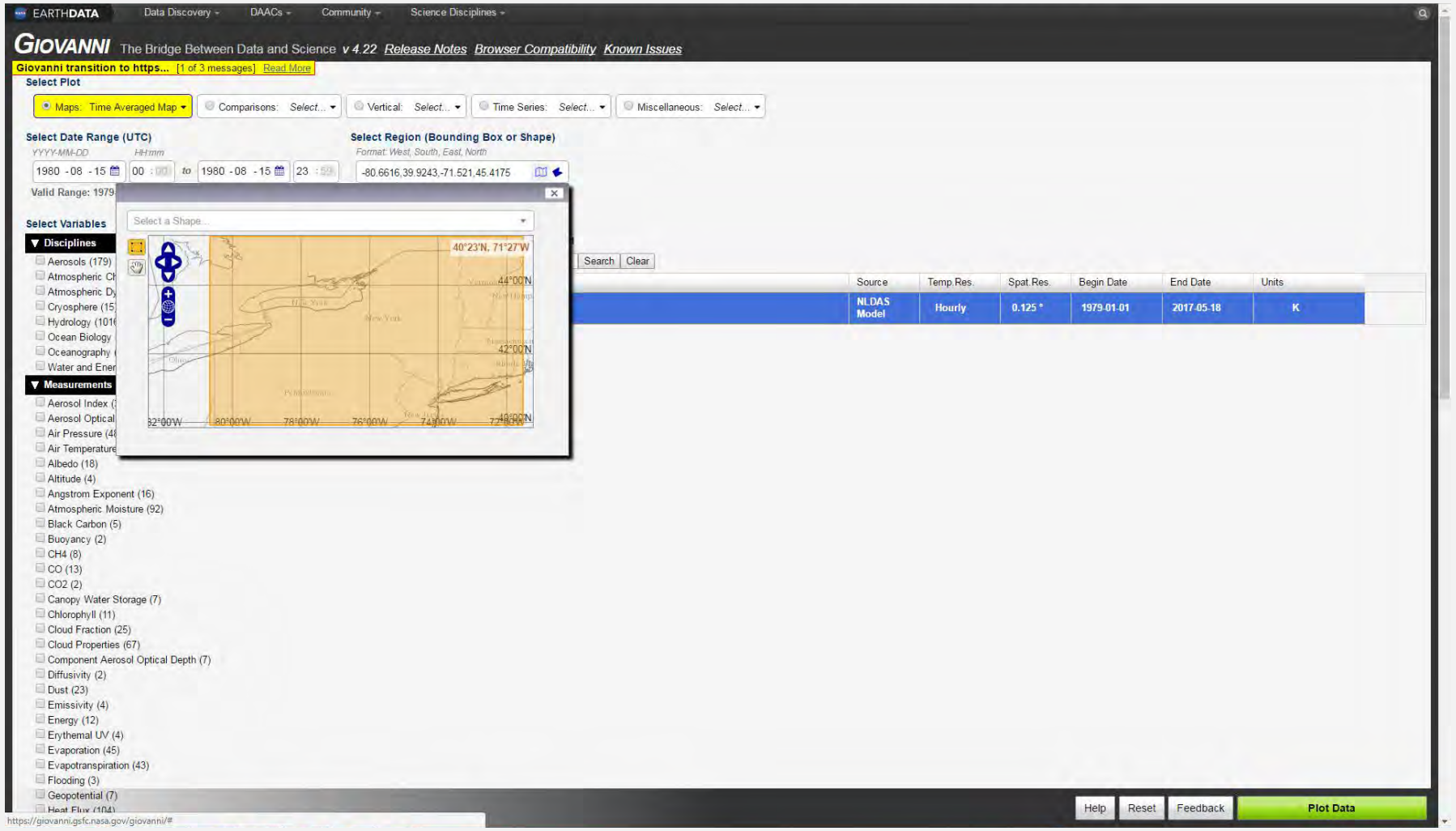


Selecting Period and Location



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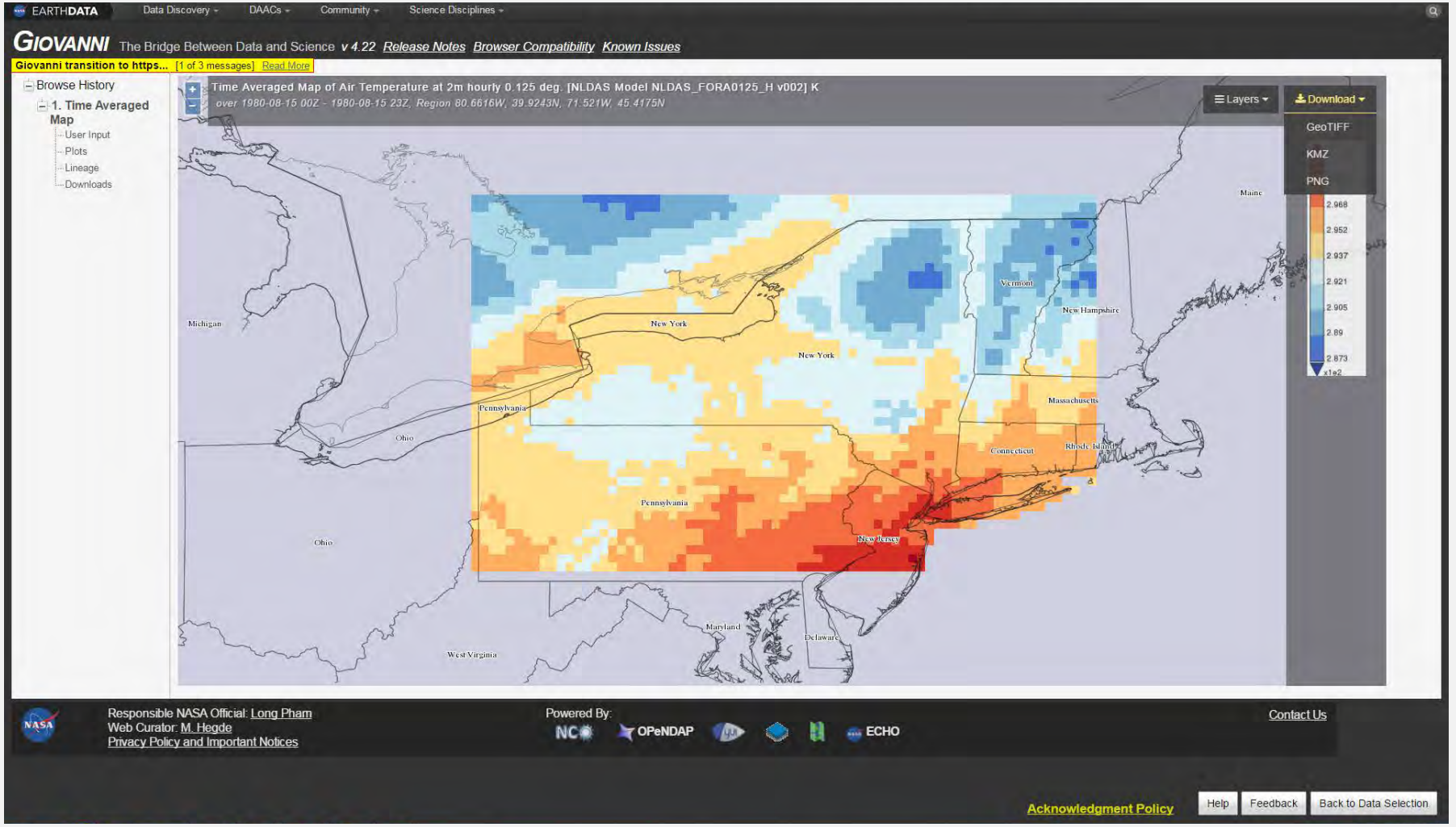

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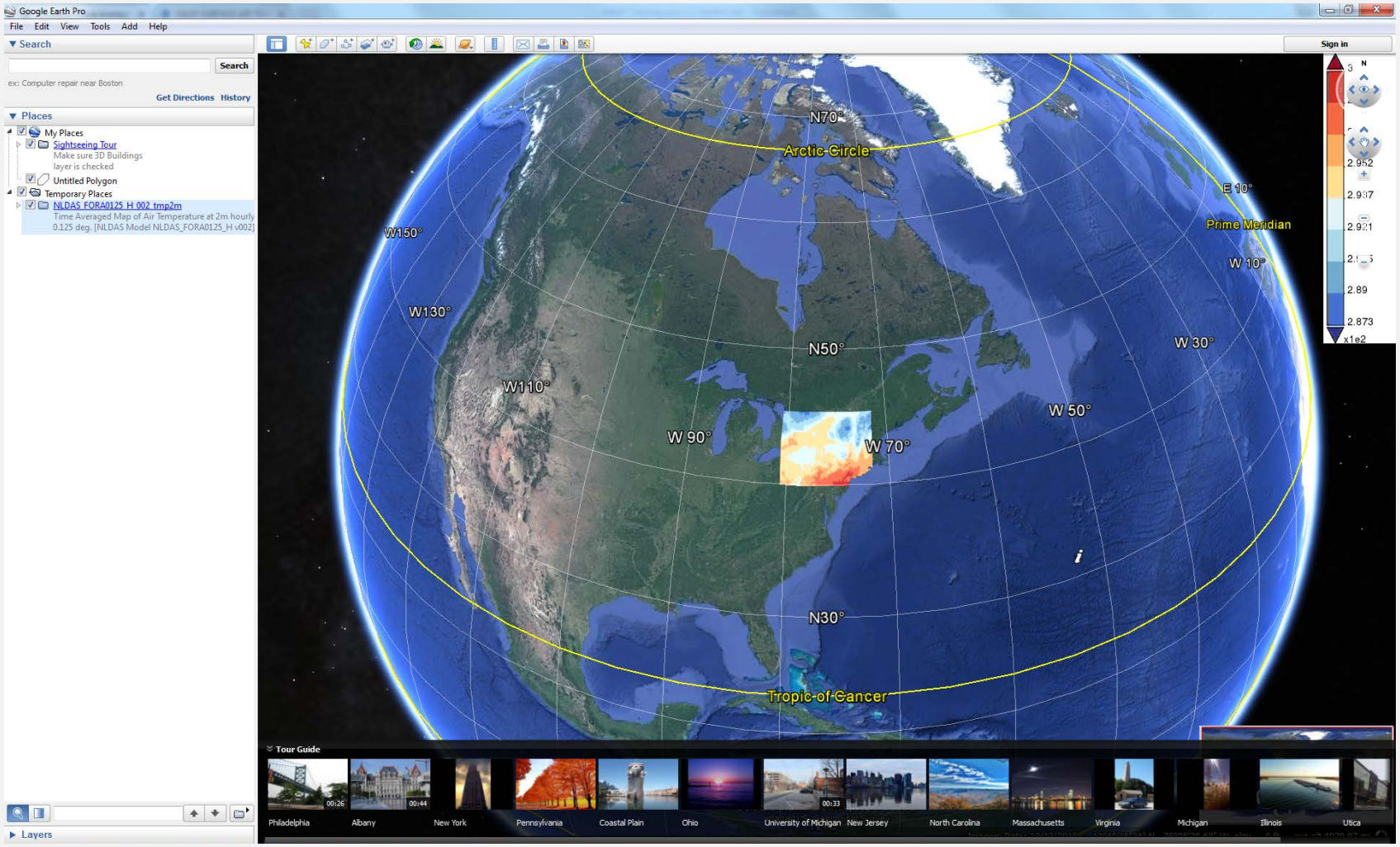
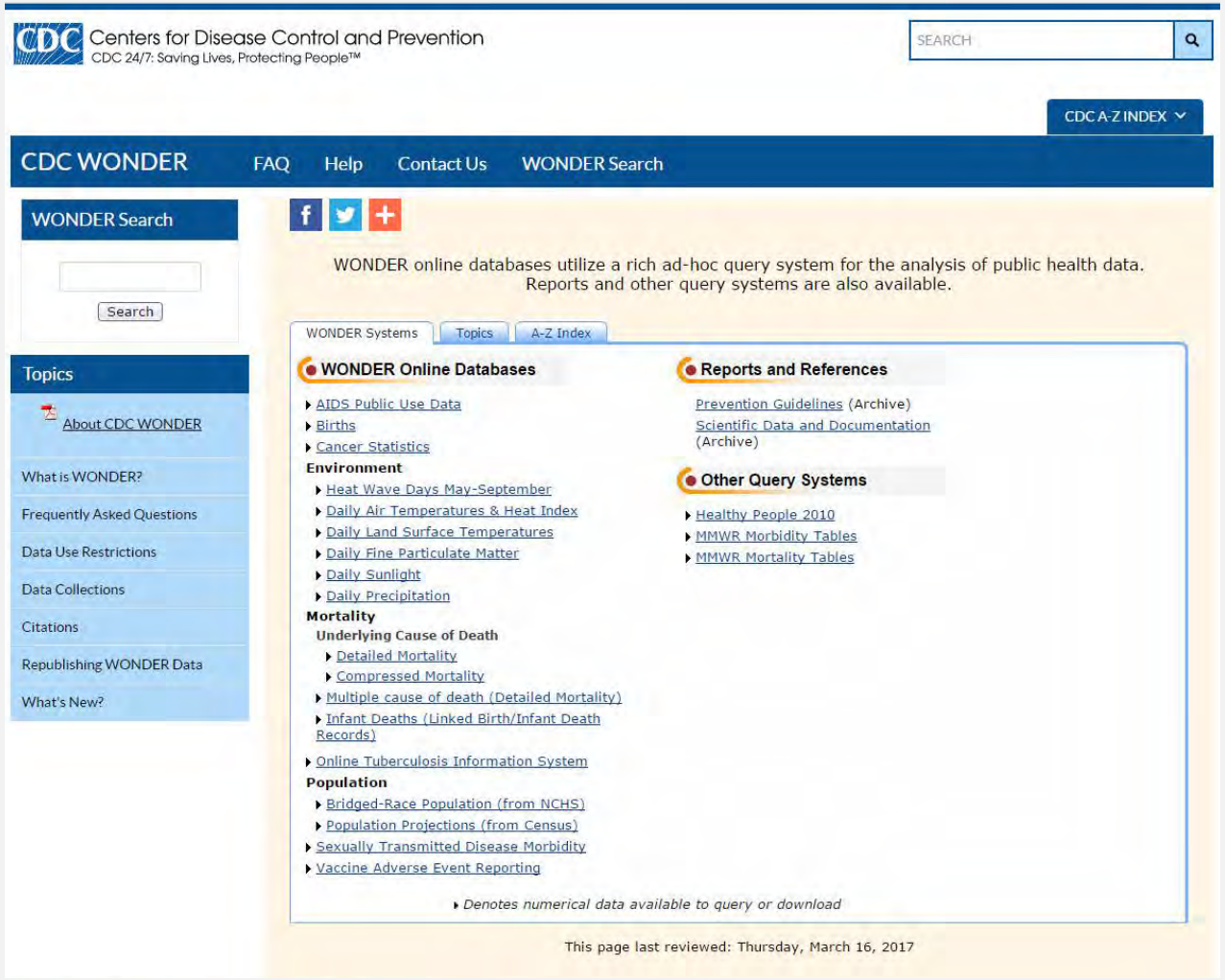


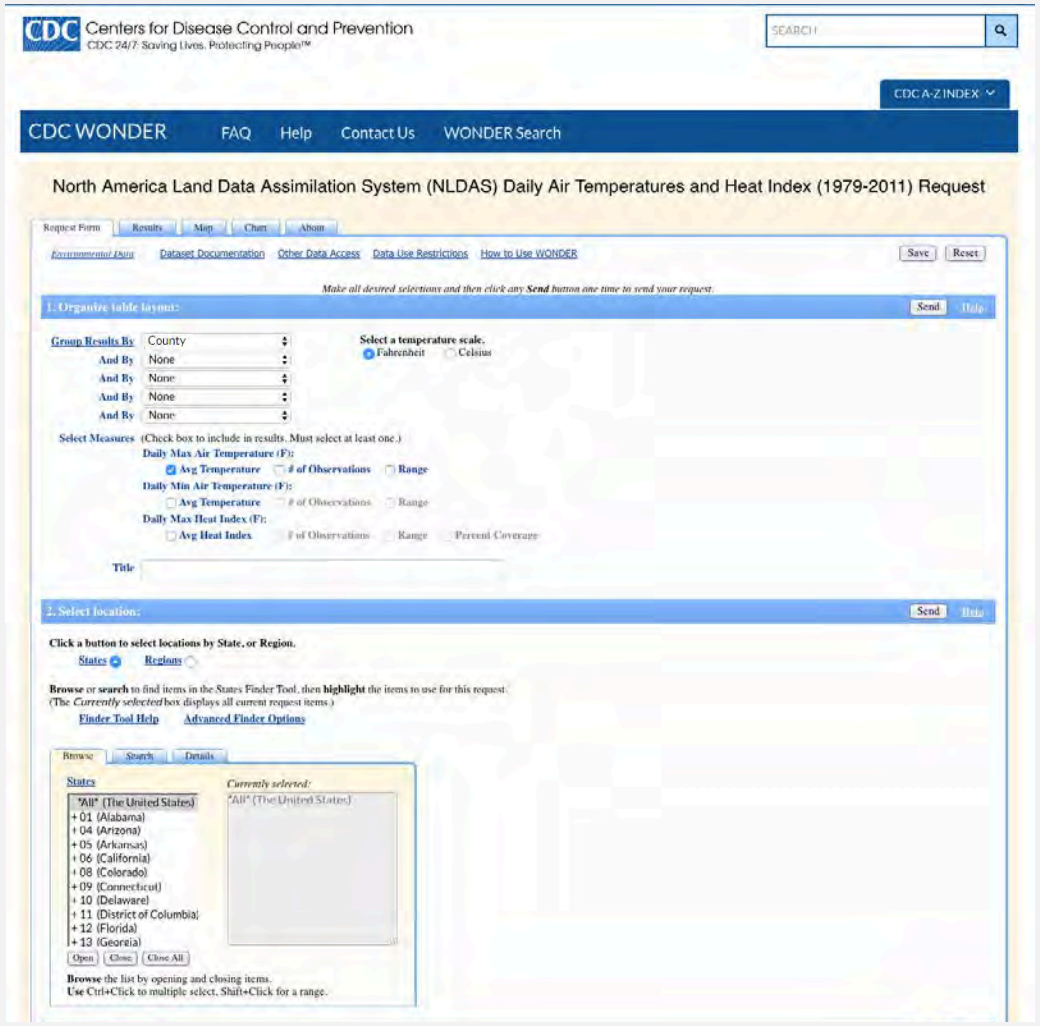
CDC WONDER Main Website

http://wonder.cdc.gov/



NLDAS-Derived Heat-Related Products on CDC Wonder

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



CDC WONDER Tabular Results

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

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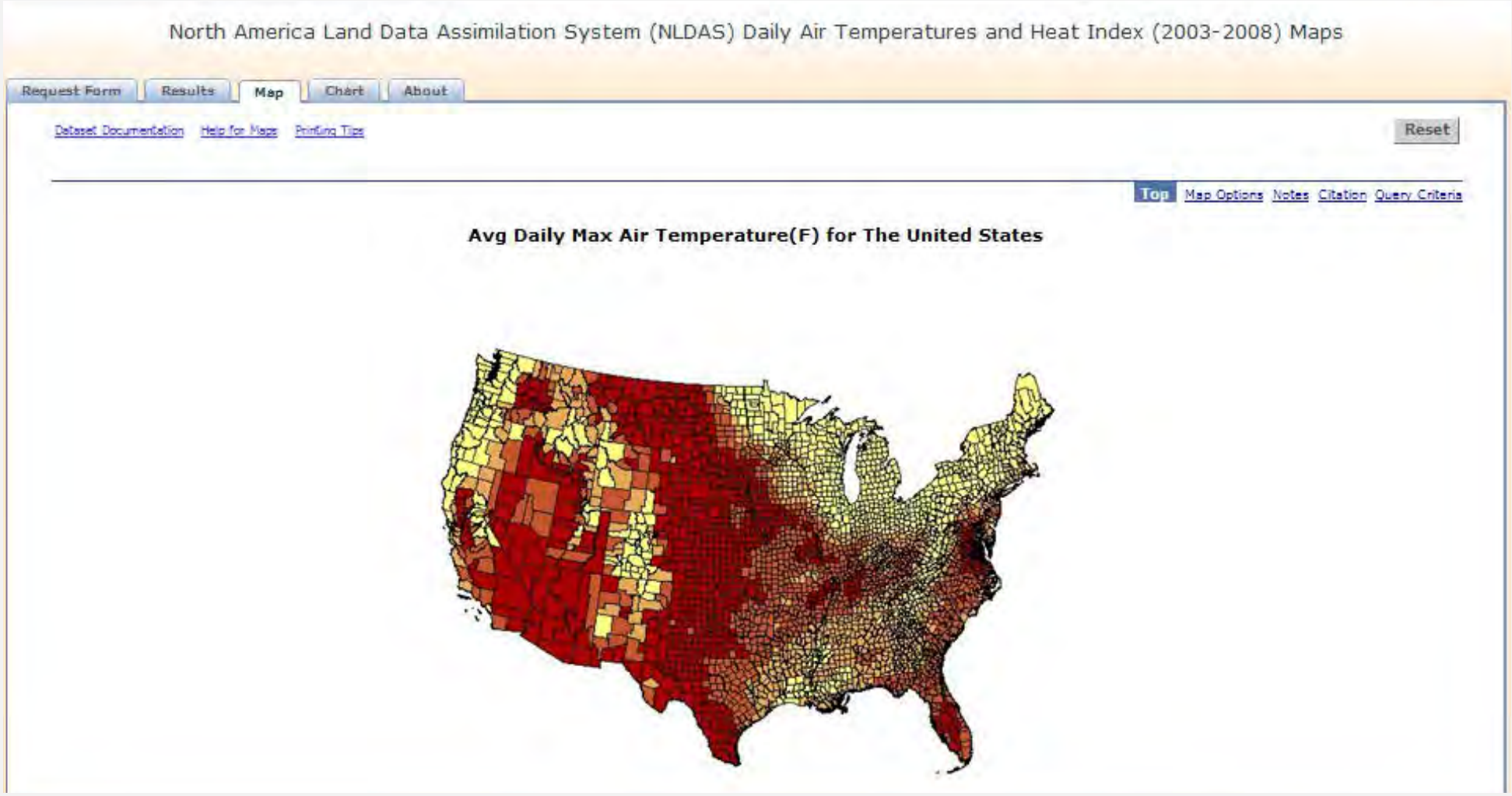
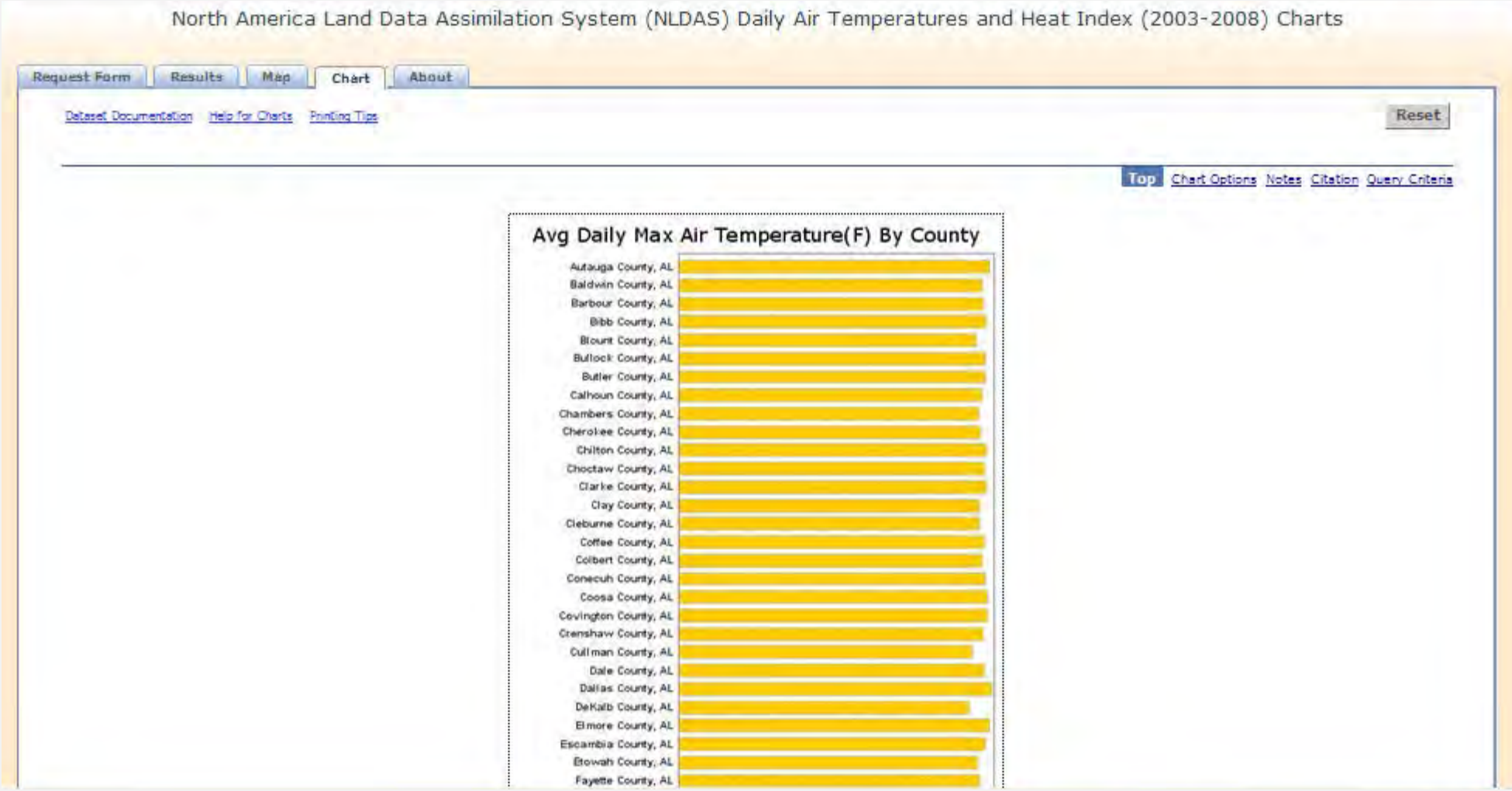
County	Avg Daily Max Air Temperature(F) # of Observations Range Standard Deviation
Autauga County, AL (01001)	87.85 11 (87.20 to 88.40) 0.43
Baldwin County, AL (01003)	85.82 26 (84.30 to 87.20) 0.61
Barbour County, AL (01005)	86.04 14 (85.50 to 86.60) 0.37
Bibb County, AL (01007)	86.92 9 (86.40 to 87.50)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



CDC WONDER Chart Results

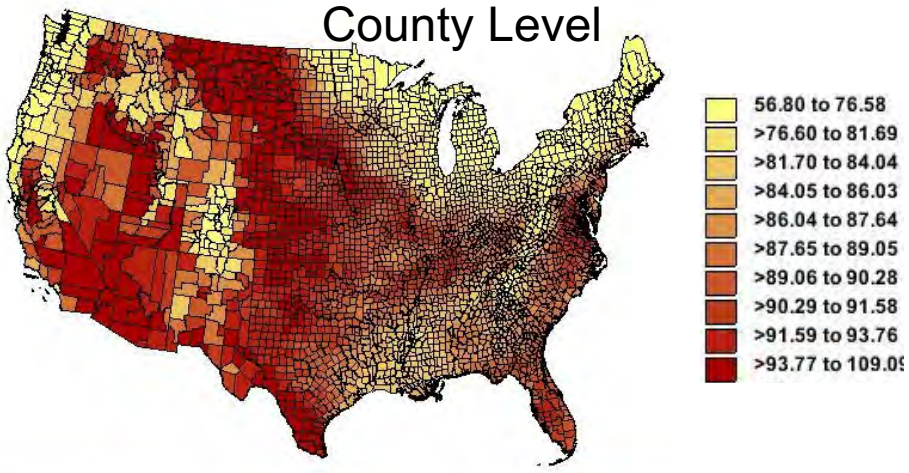


CDC WONDER Spatial Aggregation

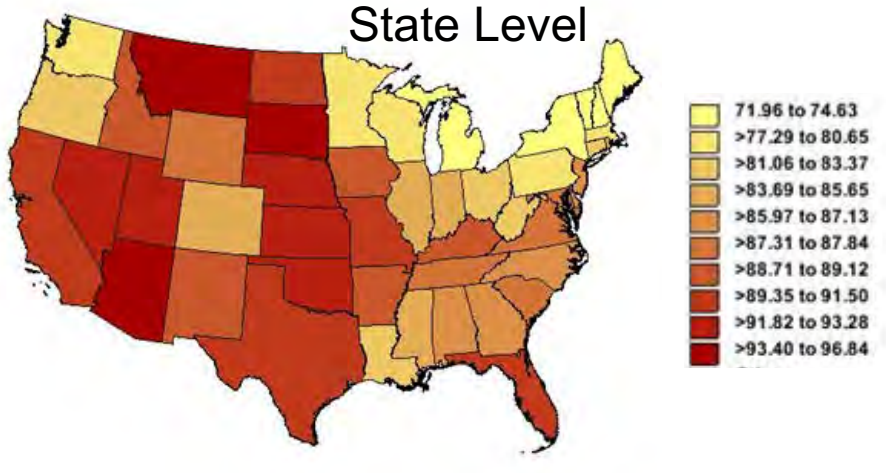
Average Daily Max Temperature (°F) for the United States

July 15, 2007

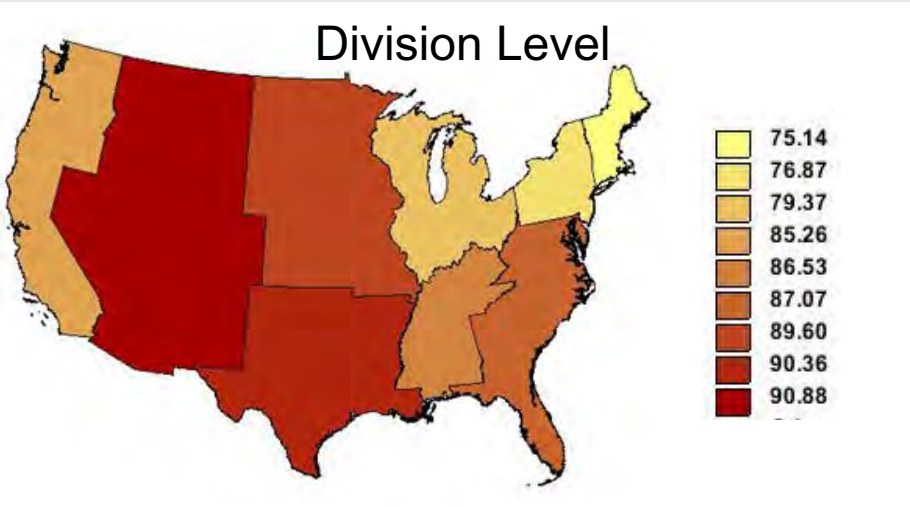
County Level



State Level



Division Level

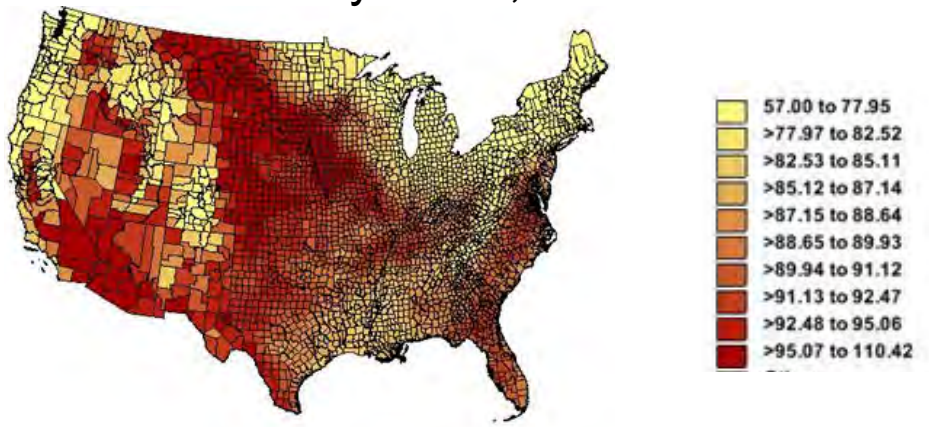


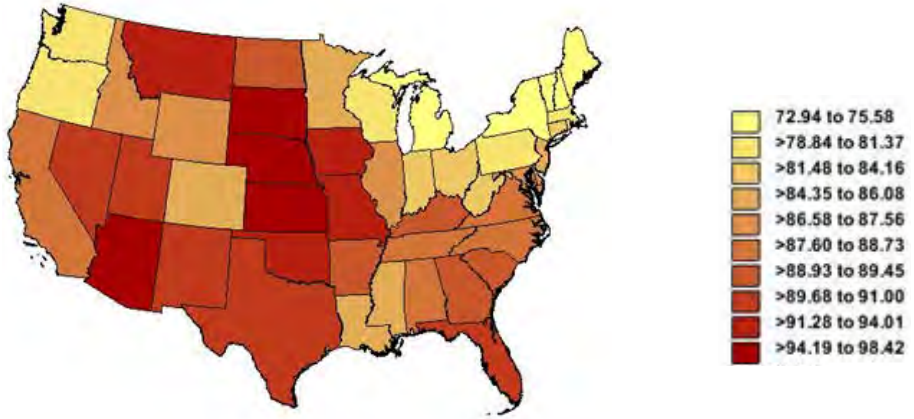
Region Level

CDC WONDER Spatial/Temporal Aggregation

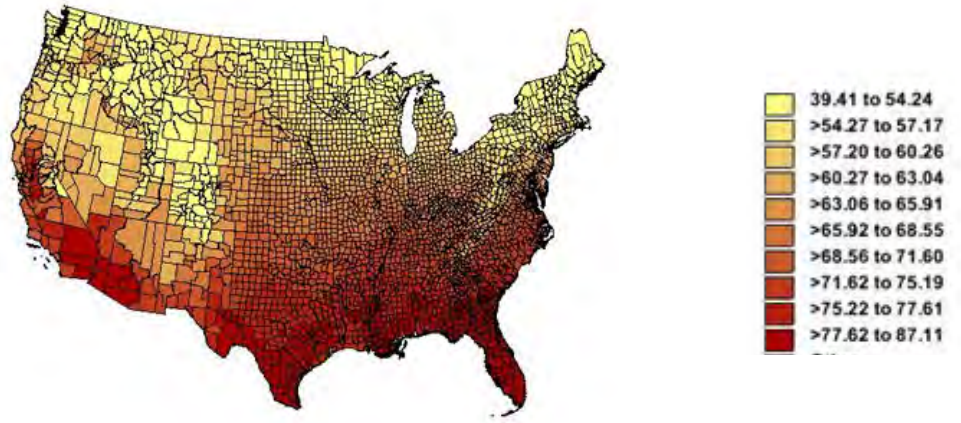
Average Daily Max Temperature (F) for the United States

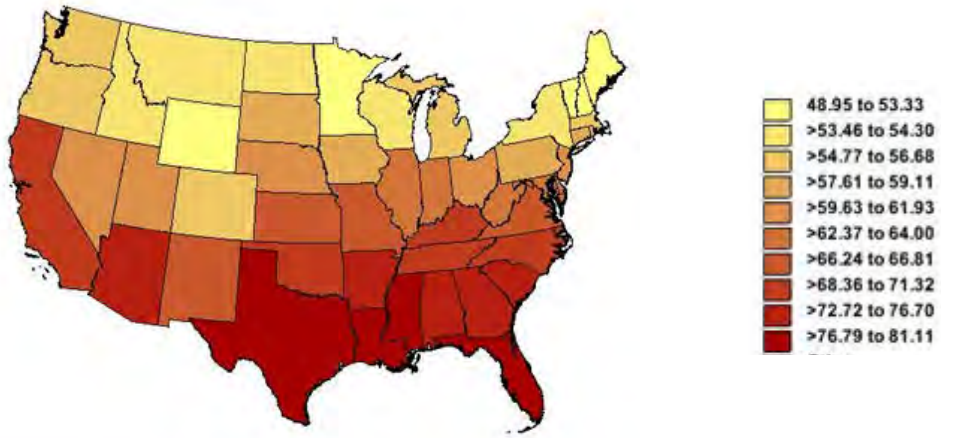
July 15-17, 2017





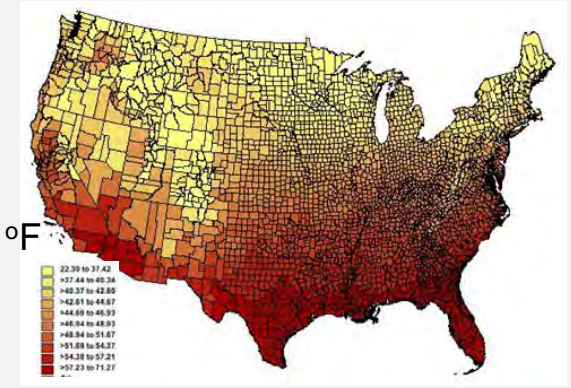
Jan 1 – Dec 31, 2017



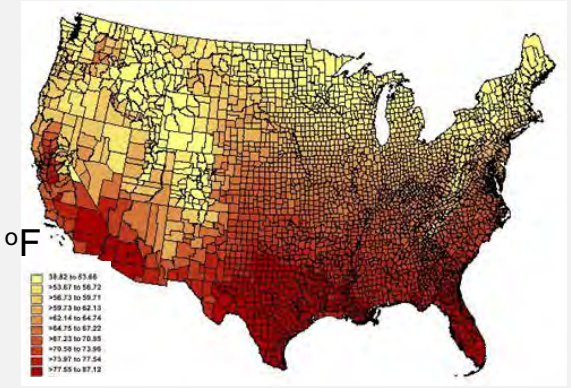


CDC WONDER Environmental Datasets Status

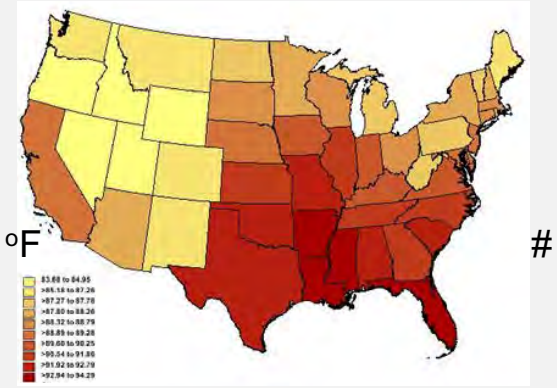
Avg Daily Min Air Temp



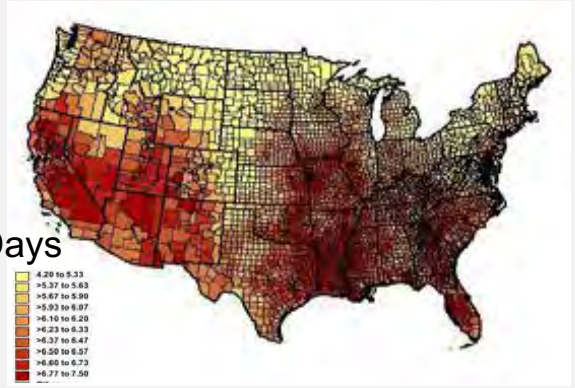
Avg Daily Max Air Temp



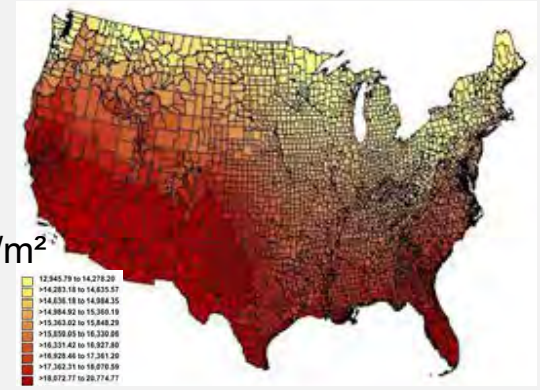
Avg Daily Max Heat Index



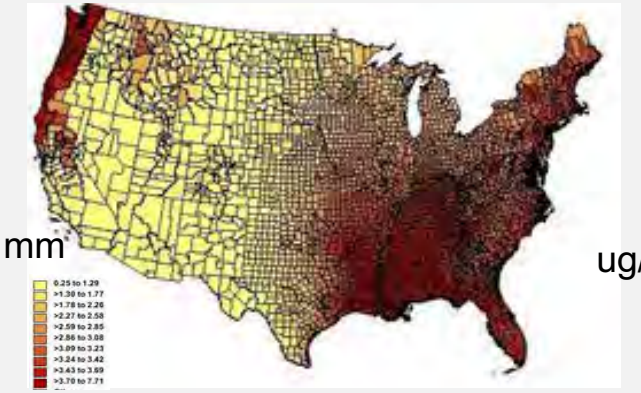
Avg Heat Wave Days Based on Daily Max. Temp.



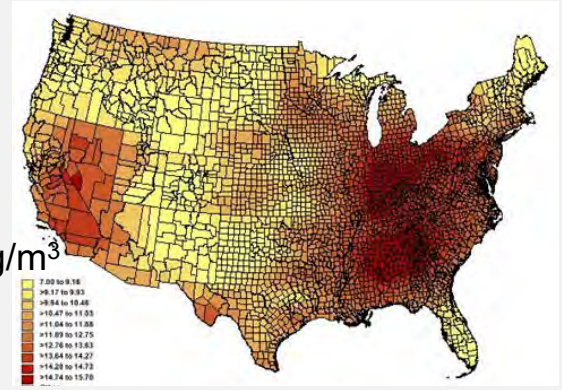
Avg Daily Sunlight



Avg Daily Precipitation



Avg Fine Particulate Matter ($PM_{2.5}$)



Avg Day MODIS LST