Successfully Integrating NASA Data Into an On-going Public Health Study and Linking NASA Environmental Data with a National Public Health Cohort Study to Enhance Public Health Decision Making

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Outline

• VERY Brief introduction to REGARDS
• Objectives of current funding
• Progress to date
• Remaining goals
Why REGARDS?
Racial Disparities

Race/Ethnic Relative Risk
White Reference (1997)
Why REGARDS?
Regional Disparities
Why REGARDS?
Regional Disparity

Unlikely Causes

- Proportion of AA
- SES Differences
- Quality of Health Care

Case Fatality

Prevalence of CVD Risk Factors

Environmental Exposures

Lifestyle Choices

Genetic Factors

Uninvestigated Causes

Infection Rates
REGARDS

Study Population

• Longitudinal population-based cohort of 30,229 volunteers aged 45 and older, with a goal of determining why there are racial and region differences in stroke mortality rates

• Simple random sampling with geographic representation
  – 21% from the buckle of the stroke belt (goal was 20%)
  – 35% from the stroke belt (goal was 30%)
  – 44% from the rest of the contiguous US (goal 50%)

• Racial representation: 42% African American / 58% white (goal was 50/50%)

• Sex representation: 45% male / 55% female (goal was 50/50%)
REGARDS
Study Population

N = 30,229
Overarching Goals of this Research

• Characterize PM$_{2.5}$, solar insolation, and land surface temperature using NASA satellite observations, EPA ground level data, and other national datasets
• Link these data with data from REGARDS, in order to assess whether these factors impact cognitive decline and secondary outcomes
• Disseminate the dataset to end-users for decision making through CDC WONDER
Objectives of the Current Project

We have 7 objectives through which we hope to accomplish our overarching goals

1. Produce daily gridded estimates of PM$_{2.5}$ for the conterminous US for the years 2003-2008 from MODIS Aqua data
2. Produce daily gridded solar insolation (SI) maps for the conterminous US during the same period using data from the NARR
3. Produce daily gridded and surface temperature (LST) maps over the conterminous US during the same period using data from MODIS
Objectives of the Current Project

• We have 7 objectives through which we hope to accomplish our overarching goals

4. Link the estimates of PM$_{2.5}$, SI and LST with data from the more than 30,000 participants from the REGARDS study.

5. Determine whether exposure to PM$_{2.5}$ or SI is related to the rate of cognitive decline among participants in the REGARDS study, independent of other known risk factors for cognitive decline.

6. Examine the relationship between the estimated PM$_{2.5}$ and SI and other health-related conditions among REGARDS participants, including diminished kidney function, hypercholesterolemia, hypertension, and inflammation (CRP)
Objectives of the Current Project

• We have 7 objectives through which we hope to accomplish our overarching goals

7. Deliver daily gridded environmental data sets (PM$_{2.5}$, SI and LST) to CDC-WONDER for the 2003-08 period
Year 3 Status

1. Produce daily gridded estimates of PM$_{2.5}$ for the conterminous US for the years 2003-2008 from MODIS Aqua data

2. Produce daily gridded solar insolation (SI) maps for the conterminous US during the same period using data from the NARR

3. Produce daily gridded and surface temperature (LST) maps over the conterminous US during the same period using data from MODIS

All datasets have been produced, and transferred to UAB!
4. Link the estimates of PM$_{2.5}$, SI and LST with data from the more than 30,000 participants from the REGARDS study.

All datasets have been linked to the REGARDS participants!
5. Determine whether exposure to PM$_{2.5}$ or SI is related to the rate of cognitive decline among participants in the REGARDS study, independent of other known risk factors for cognitive decline

- SI analyses completed for cognitive decline, results reported last year (using six-item screener)
  - Paper under review at *International Journal of Biometeorology*
  - Secondary analyses of more sensitive cognitive measures planned
PM$_{2.5}$ Analyses (ICD)

- Assessed association between PM$_{2.5}$ and incident cognitive decline (ICD)
  - Primary exposure: average PM$_{2.5}$ exposure during the two-week period prior to baseline interview
  - Primary outcome: ICD based on impairment on the six-item screener at the most recent follow-up visit
PM$_{2.5}$ Analyses (ICD)

- Fit incremental logistic regression models to assess association
  - Model 1: PM2.5, temperature, season, incident stroke
  - Model 2: M1+age, race, sex, education, income
  - Model 3: M2+smoking, exercise, alcohol use, obesity
  - Model 4: M3+depression, dyslipidemia, diabetes, hypertension

- Also, examined the impact of urban/rural residence on relationship between PM$_{2.5}$ and ICD
PM$_{2.5}$ Analyses (ICD)

• Results:
  Model 1: 1.15 (1.01, 1.31)
  Model 2: 1.12 (0.98, 1.28)
  Model 3: 1.12 (0.97, 1.28)
  Model 4: 1.13 (0.97, 1.30)

• Thus, there is an association between PM$_{2.5}$ and ICD, but after adjustment for a variety of factors, it is no longer statistically significant
  – For each increase of 10 $\mu$g/m$^3$ in PM$_{2.5}$, the odds of ICD increase by approximately 15%
  – The association does not differ depending on whether participants are rural or urban residents
PM$_{2.5}$ Analyses (ICD)

- Manuscript currently under review at *Environmental Health Perspectives*
- Plans to assess the relationship between PM$_{2.5}$ and more sensitive measures of cognitive function are in the works
6. Examine the relationship between the estimated PM$_{2.5}$ and SI and other health-related conditions among REGARDS participants, including diminished kidney function, hypercholesterolemia, hypertension, and inflammation (CRP)

- Analyses of SI and secondary outcomes completed, manuscript in progress
- Analyses of PM$_{2.5}$ and stroke completed
- Analyses of PM$_{2.5}$ and MI proposed
- Analyses of PM$_{2.5}$ and CRP under development
SI and Secondary Outcomes

- Analysis of SI and secondary outcomes (CRP, cholesterol, systolic blood pressure (SBP) and chronic kidney disease) largely hypothesis generating
  - Use a split sample methodology, in which we randomly divided the sample in two
    - First half used as “exploratory sample” in which all analyses conducted
    - Second half used as “confirmatory sample” in which significant associations from the exploratory sample were confirmed
SI and Secondary Outcomes

• Primary exposure: average insolation for the year prior to the baseline assessment, categorized into above or below the median exposure (i.e. high and low levels of exposure)

• Primary outcomes:
  – C-reactive protein (CRP)
  – High density lipoprotein (HDL)
  – Low density lipoprotein (LDL)
  – Total cholesterol
  – SBP
  – Estimated glomular filtration rate (eGFR)
SI and Secondary Outcomes

• Results
  – From the exploratory sample, we found that SI was associated with SBP and HDL after multivariable adjustment
    • The association between SPB and SI differed by race (p=0.02)
    – For blacks, exposure to SI below the median was associated with an increase in SBP of 1.6 mmHg (95% CI: 0.4, 2.8)
    • Exposure to SI below the median was associated with HDL levels 1.6 mg/dL lower than those exposed above the median (95% CI: 0.5, 2.4)
• Results
  – Only the association between HDL and SI was confirmed in the confirmatory sample
    • In the multivariable model, SI exposure below the median was associated with HDL levels 2.1 mg/dL lower than for those exposed above the median (95% CI: 1.2, 3.1)
7. Deliver daily gridded environmental data sets (PM$_{2.5}$, SI and LST) to CDC-WONDER for the 2003-08 period

- All data have been transferred to CDC WONDER
  - MODIS LST, NLDAS Daily Sunlight Data to go live ANY DAY NOW!
  - Daily PM$_{2.5}$ data are live
  - Daily temperature data are live

- We’re very excited about the feedback we’ve received
  - User feedback to improve the portal
  - Interest from Google Public Data Explorer
  - Interest from Temboo Library (App developer)
Planned Activities – No Cost Extension

• Complete the secondary analyses of both the SI and PM$_{2.5}$ data
  – SI manuscript in progress
  – PM$_{2.5}$ manuscripts in development
    • Stroke analyses completed
    • MI, CRP in discussion
• Complete additional analyses of ICD and each of: SI and PM$_{2.5}$ using more sensitive measures of cognition
• Continue to work with CDC to refine the NASA data available on the WONDER portal
  – Performance measures, describing user access needed
• Develop ideas for and submit additional grants that continue and further our current work
Major Deliverables & Time Schedule

• We experienced some delay in meeting our time schedule this year, with a backlog of analyses that are on-going
  – We hope to complete these during our no-cost extension period
<table>
<thead>
<tr>
<th>Task</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
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<tr>
<td>6</td>
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<td></td>
</tr>
</tbody>
</table>

1a Production of LST data set
1b Production of solar insolation data set
1c Production of PM$_{2.5}$ data set
2a Linkage of LST and cognitive decline data sets
2b Linkage of insolation and cognitive decline data sets
2c Linkage of PM$_{2.5}$ and cognitive decline data sets
3a Analysis of insolation and cognitive decline
3b Analysis of PM$_{2.5}$ and cognitive decline
4a Analysis of insolation and secondary outcomes
4b Analysis of PM$_{2.5}$ and secondary outcomes
5 Transition to end-users through CDC WONDER
6 Final research report

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Financial Status

Figure describing the financial status of our project – money received vs. money spent

Total dollars received: $801,3996
Total dollars spent: $573,298
Collaborators

**UAB**
Shia Kent
George Howard
Matthew Loop

**NASA**
Dale Quattrochi
Douglas Rickman

**CDC**
Sigrid Economou
Mark Puckett

**USRA**
Mohammad Al-Hamdan (co-PI)
William Crosson
Maury Estes
Sue Estes
Gina Wade
Sarah Hemmings
Choose how to group results
Choose a temperature scale
Region
State
Fahrenheit

Select a temperature scale.
- Fahrenheit Scale
- Celsius Scale
Select Measures (Check box to include in results. Must select at least one.)

- Record Count for Min/Max Daily Air Temperature
- Record Count for Daily Max Heat Index

Daily Max Air Temperature (F) measurements:

- Avg Temperature
- Record Count
- Min Max Range
- Standard Deviation

2. Select location:

Click a button to select locations by State, Region, or Grid ID.

- States
- Regions

Browse or search to find items in the States Finder Tool, then highlight to select. (The Currently selected box displays all current request items.)

Finder Tool Help  Advanced Finder Options

**States**

<table>
<thead>
<tr>
<th>States</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>All</em> (The United States)</td>
</tr>
<tr>
<td>01 (Alabama)</td>
</tr>
<tr>
<td>04 (Arizona)</td>
</tr>
<tr>
<td>05 (Arkansas)</td>
</tr>
<tr>
<td>06 (California)</td>
</tr>
<tr>
<td>08 (Colorado)</td>
</tr>
<tr>
<td>09 (Connecticut)</td>
</tr>
<tr>
<td>10 (Delaware)</td>
</tr>
<tr>
<td>11 (District of Columbia)</td>
</tr>
<tr>
<td>12 (Florida)</td>
</tr>
</tbody>
</table>

Currently selected:

*All* (The United States)
3. Select year, month, day:

Click a button to choose dates by individual date fields or by aggregate date fields.

- **Individual Date Fields**
- **Aggregate Date**

**Year**
- All Years
- 2003

**Month**
- All Months
- January
- February
- March
- April
- May
- June

**Day of Month**
- All Days
- 1
- 2
- 3
- 4
- 5
- 6

**Hint**: Use Ctrl + Click for multiple selections, or Shift + Click for a range.

3. Select temperature:

- **Daily Max Air Temperature (F)**
  - All Temperatures
  - -11
  - -10
  - -9
  - -8
  - -7
  - -6
  - -5
  - -4
  - -3

- **Daily Min Air Temperature (F)**
  - All Temperatures
  - -30
  - -29
  - -28
  - -27
  - -26
  - -25
  - -24
  - -23
  - -22

- **Daily Max Heat Index (F)**
  - All Temperatures
  - 78
  - 79
  - 80
  - 81
  - 82
  - 83
  - 84
  - 85
  - 86
### 5. Other options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export Results</td>
<td>☐ (unchecked)</td>
<td>(Check box to download results to a file)</td>
</tr>
<tr>
<td>Show Totals</td>
<td>☑ (checked)</td>
<td></td>
</tr>
<tr>
<td>Show Zero Values</td>
<td>☐ (unchecked)</td>
<td></td>
</tr>
<tr>
<td>Precision</td>
<td>2 decimal places</td>
<td></td>
</tr>
<tr>
<td>Data Access Timeout</td>
<td>3 minutes</td>
<td></td>
</tr>
</tbody>
</table>

Hit “Send” – there are “Send” buttons located throughout the page
### Several Levels of Output

Export the Data

Region and State Level Results

<table>
<thead>
<tr>
<th>Region</th>
<th>State</th>
<th>Avg Daily Max Air Temperature°F</th>
<th>Avg Daily Min Air Temperature°F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Valid Dates)</td>
<td>(Valid Dates)</td>
</tr>
<tr>
<td>Connecticut (09)</td>
<td></td>
<td>57.65 (6.23 to 94.41)</td>
<td>44.17 (-9.00 to 78.02)</td>
</tr>
<tr>
<td>Maine (23)</td>
<td></td>
<td>51.31 (-15.34 to 89.66)</td>
<td>38.03 (-23.53 to 76.70)</td>
</tr>
<tr>
<td>Massachusetts (25)</td>
<td></td>
<td>55.94 (0.47 to 97.38)</td>
<td>43.36 (-11.65 to 78.00)</td>
</tr>
<tr>
<td>New Hampshire (33)</td>
<td></td>
<td>52.87 (-16.71 to 91.44)</td>
<td>39.51 (-20.98 to 77.43)</td>
</tr>
<tr>
<td>Rhode Island (44)</td>
<td></td>
<td>57.91 (6.20 to 96.23)</td>
<td>44.16 (-5.98 to 77.66)</td>
</tr>
<tr>
<td>Vermont (50)</td>
<td></td>
<td>51.15 (-15.77 to 92.63)</td>
<td>38.03 (-20.87 to 77.93)</td>
</tr>
</tbody>
</table>

Census Region 1: Northeast (CEN5-R1)
<table>
<thead>
<tr>
<th>Census Region 4: West (CENS-R4)</th>
<th>( \text{Regional Total and Overall Total} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Mexico (35)</td>
<td>68.35 (15.64 to 104.77)</td>
</tr>
<tr>
<td>Utah (49)</td>
<td>57.89 (5.84 to 102.55)</td>
</tr>
<tr>
<td>Wyoming (56)</td>
<td>55.54 (-5.03 to 116.10)</td>
</tr>
<tr>
<td>California (06)</td>
<td>49.05 (-4.65 to 95.52)</td>
</tr>
<tr>
<td>Oregon (41)</td>
<td>42.52 (-7.86 to 84.11)</td>
</tr>
<tr>
<td>Washington (53)</td>
<td>42.58 (-15.18 to 84.27)</td>
</tr>
<tr>
<td>Total</td>
<td>60.36 (17.86 to 120.07)</td>
</tr>
<tr>
<td>Total</td>
<td>66.05 (-18.42 to 120.07)</td>
</tr>
</tbody>
</table>

**Notes:**


Query Date: Sep 12, 2011 11:11:12 PM

**Suggested Citation:**
1. Select map(s) to create:

Pick one or more items from each list. A map will be made for each combination of items selected.

Locations
- The United States
- Census Region 1: Northeast
- Census Region 2: Midwest
- Census Region 3: South
- Census Region 4: West
- Division 1: New England
- Division 2: Middle Atlantic
- Division 3: East North Central

Measures
- Avg Daily Max Air Temperature°F
- Min Temp for Daily Max Air Temp°F
- Max Temp for Daily Max Air Temp°F
- Avg Daily Min Air Temperature°F
- Min Temp for Daily Min Air Temp°F
- Max Temp for Daily Min Air Temp°F

Other By-Variables: None

2. Control map appearance:

- Height in Pixels: 250
- Labels:
- Zoom in to smallest extent
- Show Interstates
- Show Rivers:
- Map Title:
- New Page Each Map

Color Scheme: Dark Red to Yellow
- Geography Year: 2000
- Precision: 2

3. Control category breaks:

Click the button for the type of category break desired, and make selections.