

# Overview of the Transportation Secure Data Center ([www.nrel.gov/tsdc](http://www.nrel.gov/tsdc))



**March 2016**

**Jeff Gonder – Senior Engineer/Supervisor and TSDC Project Leader  
National Renewable Energy Laboratory (NREL) Transportation Center**

# Transportation Secure Data Center (TSDC) Rationale



**High-resolution survey data** (e.g., GPS travel profiles, geo-coded trip ends)

- Very valuable for research
- Misuse could violate participant privacy

Secure data center **makes data available for legitimate research while preserving privacy**

- Maximizes value from limited public funds
- Benefits data providers and users
  - Takes care of archiving and responding to data requests
  - Data accessible from a central location



\* See this 2007 National Research Council report:  
[http://books.nap.edu/openbook.php?record\\_id=11865](http://books.nap.edu/openbook.php?record_id=11865)



The TSDC has been **supported since 2009 by NREL, U.S. DOT and U.S. DOE**

- Department of Transportation, Federal Highway Administration
- Department of Energy, Vehicle Technologies Office

# NREL Transportation Data Centers

## Secure Access, Expert Analysis and Validation Support Decision-Making

### Alternative Fuels Data Center (AFDC)

*Public clearinghouse of information on the full range of advanced vehicles and fuels*

### National Fuel Cell Technology Evaluation Center (NFCTEC)

*Industry data and reports on hydrogen fuel cell technology status, progress, and challenges*

**Transportation Secure Data Center (TSDC):** *Detailed fleet data, including GPS travel profiles*

### Fleet DNA Data Collection

*Medium- and heavy-duty drive-cycle and powertrain data from advanced commercial fleets*

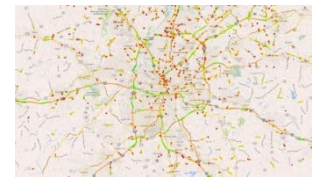
**FleetDASH:** *Business intelligence to manage Federal fleet petroleum/alternative fuel consumption*

Features	AFDC	NFCTEC	TSDC	Fleet DNA	Fleet DASH
Securely Archived Sensitive Data		Y	Y	Y	Y
Publicly Available Cleansed Composite Data	Y	Y	Y	Y	
Quality Control Processing	Y	Y	Y	Y	Y
Spatial Mapping/GIS Analysis	Y	Y	Y	Y	Y
Custom Reports		Y		Y	Y
Controlled Access via Application Process			Y		
Detailed GPS Drive-Cycle Analysis			Y	Y	

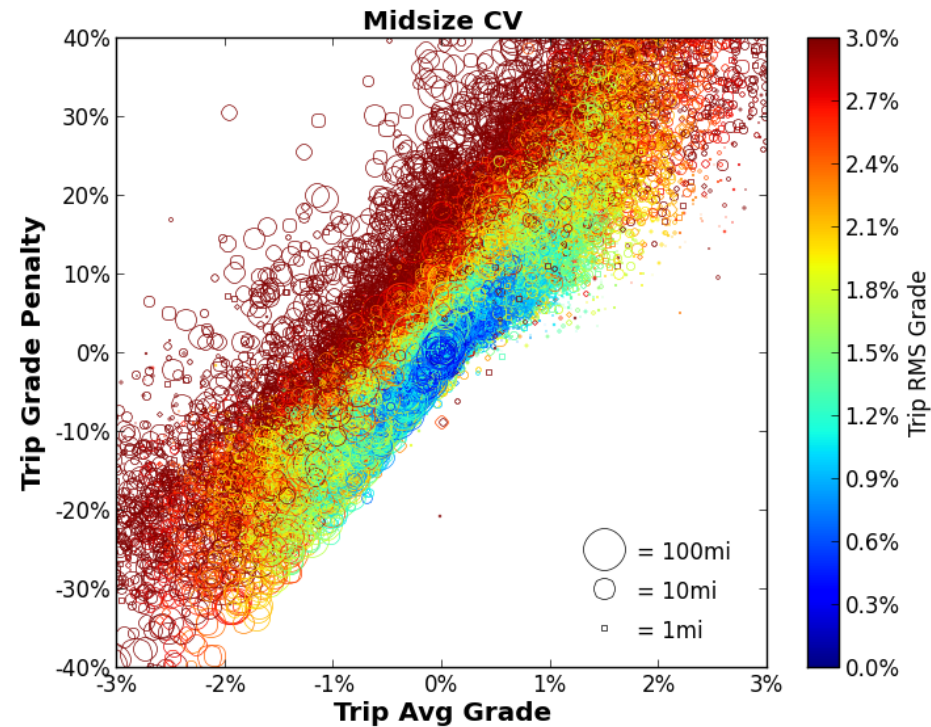
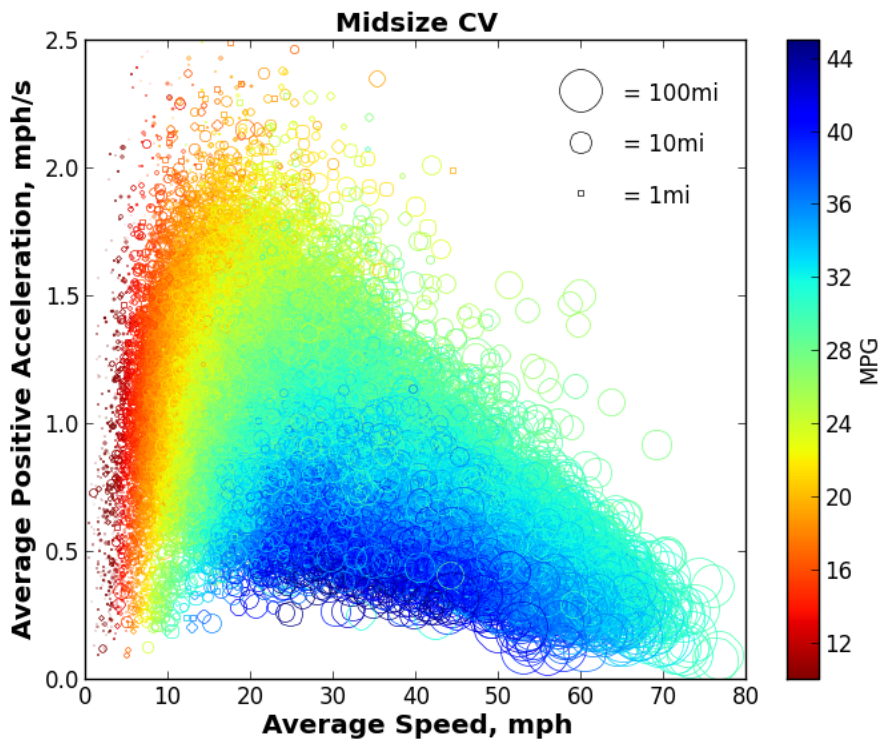
# Related Real-World Analysis Efforts Using TSDC Data

Large distribution of real-world GPS travel profiles, including speed, acceleration, distance, time of day, stop duration, etc.

E.g., previous analysis explored fuel economy sensitivity to speed/acceleration characteristics and road grade using hundreds of thousands of GPS drive cycles in NREL TSDC

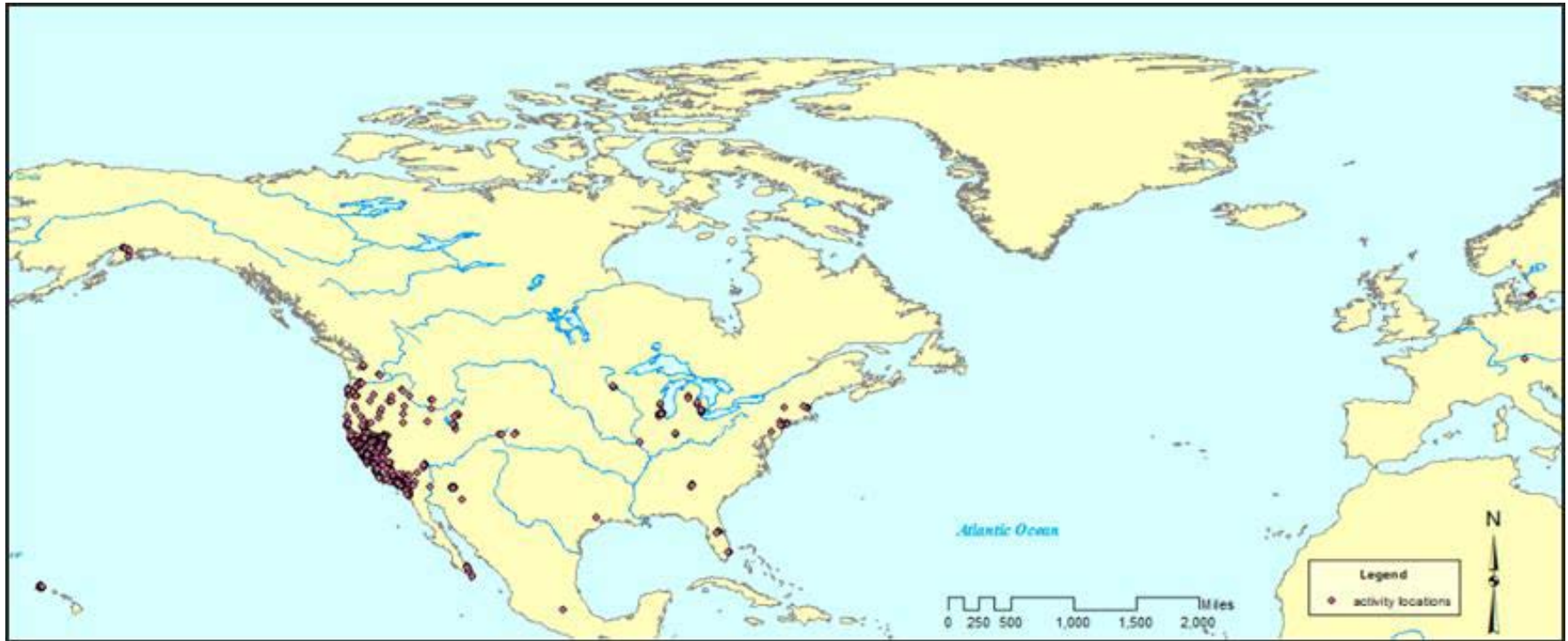


Data Visual



GPS = Global Positioning System; CV = Conventional Vehicle

# Example Travel Behavior Analysis: Day-to-Day Destination Variation for CA Bay Area Travelers



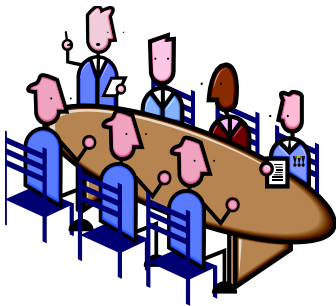
Consider short- and long-distance work commutes and leisure travel  
Able to clearly distinguish patterns of variability in terms of number of trips and type and dispersion of destinations

K. Deutsch-Burgner. "Multiday Variation in Time Use and Destination Choice in the Bay Area Using the California Household Travel Survey." Report on Multiday GPS Travel Behavior Data for Travel Analysis (2015).  
[http://www.fhwa.dot.gov/planning/tmip/publications/other\\_reports/multiday\\_gps/fhwahep15026.pdf](http://www.fhwa.dot.gov/planning/tmip/publications/other_reports/multiday_gps/fhwahep15026.pdf)

# Developing the TSDC Operating Procedures

Maintain **balanced focus** on dual priorities

- Privacy protection first and foremost
- Maximize usability (within constraints)

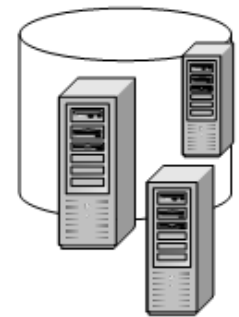


An **advisory committee** helps support oversight

- Group includes data providers and users
- Represents industry, academia and government

**Reference best practice examples**

- Experience from other NREL data centers
- And examples external to NREL (e.g., U.S. Census Research Data Center program; virtual data centers on social science<sup>1</sup> and Medicare/Medicaid data<sup>2</sup>)



1 - [www.dataenclave.org](http://www.dataenclave.org); 2 - [www.resdac.org/cms-data/request/cms-virtual-research-data-center](http://www.resdac.org/cms-data/request/cms-virtual-research-data-center)

# TSDC Data Archiving Procedures

- Establish MOU agreement with data provider
  - Receive data via mail or secure FTP
- Load onto secure raw data handling server
  - Restricted access
  - On-site security force
  - Established cyber security group
- Maintain data backups
  - Data mirrored on large storage array
  - Maintain backup in separate location for fire/disaster protection

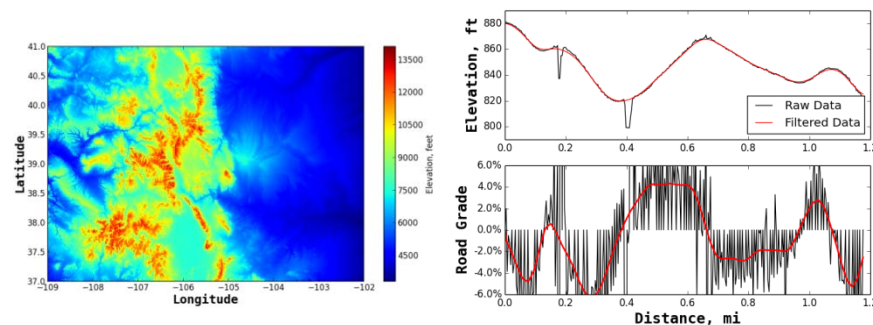
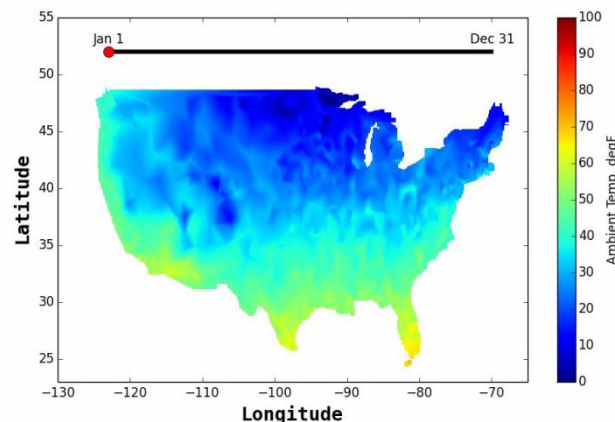
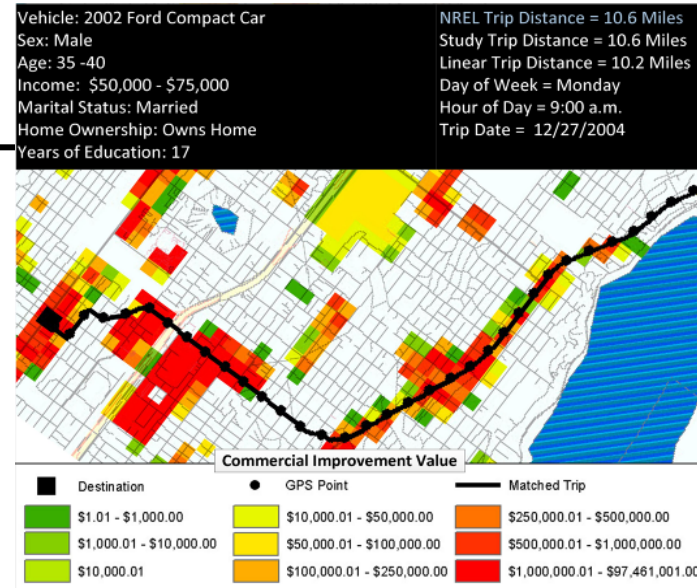


NREL Data Center  
storage arrays

MOU = memorandum of understanding; FTP = file transfer protocol

# TSDC Data Processing

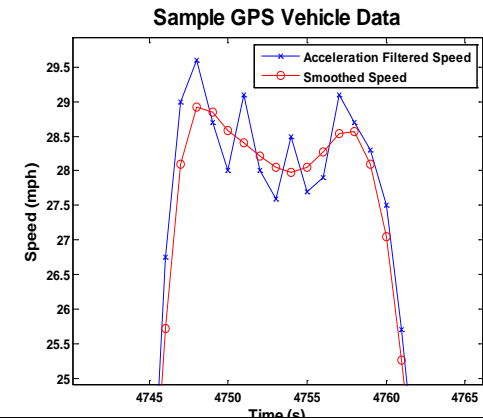
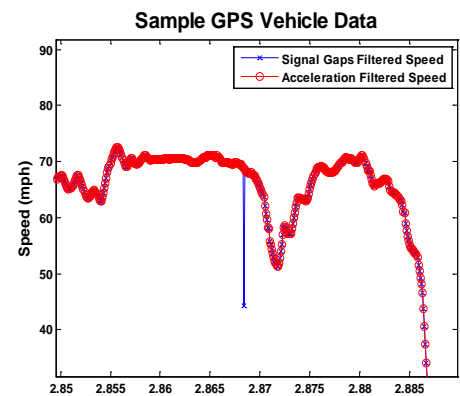
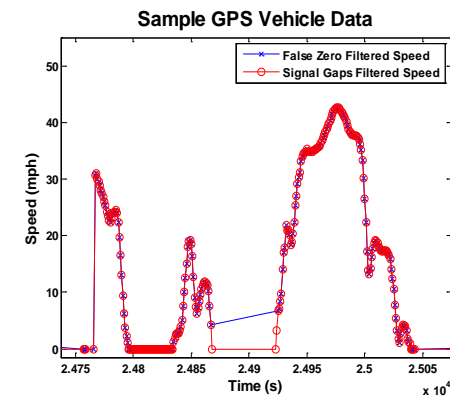
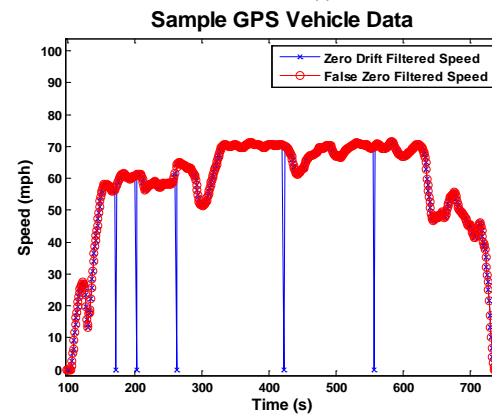
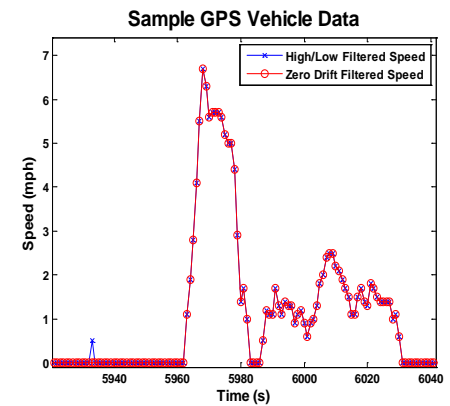
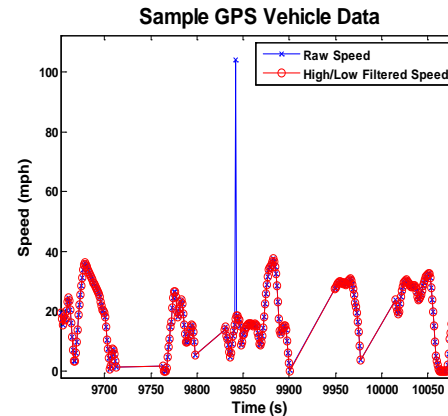
- Standardize formatting
  - Raw point lat/long, timestamp, precision
  - Trip-level distance and time summary
  - Household/vehicle demographic information
- Remove explicitly identifying information
  - Participant names, addresses, contact info
- Quality control for errant/missing GPS points
  - Remove, adjust and/or interpolate points
  - Maintain in both processed (filtered) and original (raw/uncorrected) formats
- Add/link to reference data
  - Road network, road grade, GIS layers
  - Meteorological, economic, land use data
  - Vehicle and demographic information





# Details on GPS Data Filtration

1. Remove duplicate records and data with negative values or differential time steps
2. Replace outlying high/low speed values
3. Remove zero-speed signal drift when vehicle is stopped
4. Replace false zero-speed records
5. Amend gaps in data
6. Repair outlying acceleration/deceleration values
7. Denoise and condition final signal



NREL/CP-5400-53865. Posted with permission.  
Presented at the SAE 2012 World Congress.

**SAE**International

GPS Data Filtration Method for Drive Cycle  
Analysis Applications

2012-01-0743

Published  
04/16/2012

Adam Duran and Matthew Earleywine  
National Renewable Energy Laboratory

doi:10.4271/2012-01-0743

## ABSTRACT

Global Positioning System (GPS) data acquisition devices have proven useful tools for gathering real-world driving data and statistics. The data collected by these devices provide valuable information in studying driving habits and conditions. When used jointly with vehicle simulation software, the data are invaluable in analyzing vehicle fuel use and performance, aiding in the design of more advanced and efficient vehicle technologies. However, when analyzing

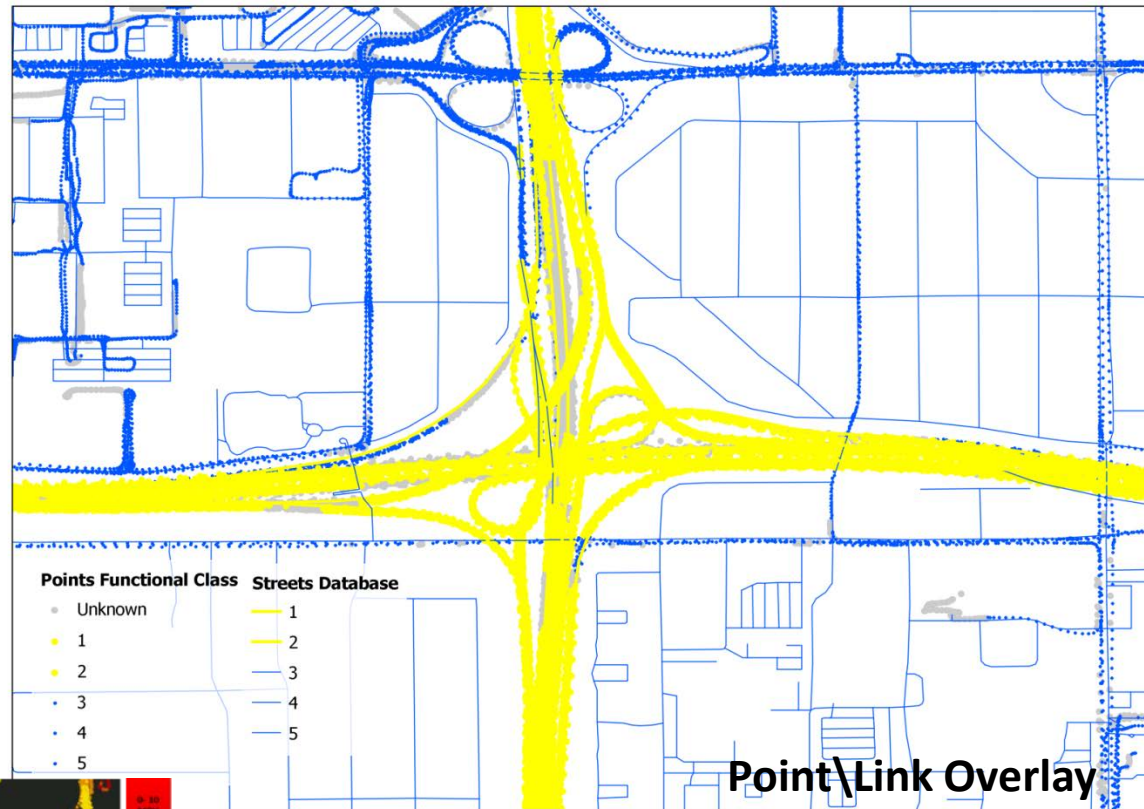
## INTRODUCTION

The cost-effective nature and ease of installation associated with GPS data acquisition systems (DASs) have aided in onboard global positioning system (GPS) data logging rapidly becoming one of the more popular methods for collecting real-world vehicle operating information [1, 2, 3, 4]. The coupled vehicle speed-time data captured by these devices are of particular interest when performing vehicle simulation and drive cycle analysis [5, 6, 7, 8, 9]. However,

# Map Matching Illustration

## Complex overpasses

- *Connectivity can become ambiguous when so many options are available*
- *Cleaned up post processing during road based analysis*



# TSDC Data Access: Established two distinct methods

- Cleansed/public download data area
  - Streamlined access for cleansed data; helps limit accounts in secure portal to those with a legitimate need to work with the detailed data
  - Excludes latitude/longitude and other potentially identifying details (e.g., vehicle model)
  - Includes useful supplemental information (e.g., distance traveled by road type)
  - Requires point-and-click user registration and usage agreement

- Secure portal for detailed/spatial data
  - Virtual access (rather than requiring travel)
  - Details on next slide



**Transportation Secure Data Center Registration**

Please fill out this short registration form to access the transportation data.

**THIS INFORMATION IS PUBLIC**

I already have a password

email address

phone number

organization name

street address

street number

password (please refer to the help page)

I accept the terms of the agreement on the right side of the page

I would like to receive periodic email updates (we can unsubscribe later)

**DATA USE DISCLOSURE POINT-AND-CLICK AGREEMENT**

**CLEANSED DATA**

These Transportation Secure Data Center data ("Data") are provided by the National Renewable Energy Laboratory ("NREL"), which is operated by the National Renewable Energy Laboratory ("NREL") for the U.S. Department of Energy ("DOE").

Access to and use of these Data shall require the following:

1. The user is required to fill out and sign the registration form, which is located on the right side of this page, and to provide the information requested in the registration form in full and accurate detail.

2. The user is required to provide a valid email address and phone number, which may be used in any advertising or public relations effort.

3. The user is required to provide a valid street address, which may be used in any advertising or public relations effort.

4. The user is required to provide a valid street number, which may be used in any advertising or public relations effort.

5. The user is required to provide a valid password, which may be used in any advertising or public relations effort.

6. The user is required to provide a valid email address, which may be used in any advertising or public relations effort.

7. The user is required to provide a valid phone number, which may be used in any advertising or public relations effort.

8. The user is required to provide a valid street address, which may be used in any advertising or public relations effort.

9. The user is required to provide a valid street number, which may be used in any advertising or public relations effort.

10. The user is required to provide a valid password, which may be used in any advertising or public relations effort.

11. The user is required to provide a valid email address, which may be used in any advertising or public relations effort.

12. The user is required to provide a valid phone number, which may be used in any advertising or public relations effort.

13. The user is required to provide a valid street address, which may be used in any advertising or public relations effort.

14. The user is required to provide a valid street number, which may be used in any advertising or public relations effort.

15. The user is required to provide a valid password, which may be used in any advertising or public relations effort.

16. The user is required to provide a valid email address, which may be used in any advertising or public relations effort.

17. The user is required to provide a valid phone number, which may be used in any advertising or public relations effort.

18. The user is required to provide a valid street address, which may be used in any advertising or public relations effort.

19. The user is required to provide a valid street number, which may be used in any advertising or public relations effort.

20. The user is required to provide a valid password, which may be used in any advertising or public relations effort.

**NREL**

Leading Clean Energy Innovation

ABOUT RESEARCH WORKING PARTNERS CAREERS

**Transportation Research**

**Transportation Secure Data Center**

The Transportation Secure Data Center ("TSDC") is a secure, web-based data center that provides access to a wide range of transportation data. The TSDC is operated by the National Renewable Energy Laboratory ("NREL") for the U.S. Department of Energy ("DOE").

The TSDC provides access to a wide range of transportation data, including:

- Vehicle location data
- Vehicle speed data
- Vehicle acceleration data
- Vehicle braking data
- Vehicle steering data
- Vehicle engine data
- Vehicle fuel data
- Vehicle emissions data
- Vehicle maintenance data
- Vehicle safety data
- Vehicle performance data
- Vehicle usage data
- Vehicle behavior data
- Vehicle interaction data
- Vehicle communication data
- Vehicle control data
- Vehicle sensor data
- Vehicle diagnostic data
- Vehicle repair data
- Vehicle insurance data
- Vehicle financing data
- Vehicle leasing data
- Vehicle rental data
- Vehicle sharing data
- Vehicle pooling data
- Vehicle carpooling data
- Vehicle carsharing data
- Vehicle bikesharing data
- Vehicle scooter sharing data
- Vehicle motorcycle sharing data
- Vehicle wheelchair accessible vehicle sharing data
- Vehicle taxi sharing data
- Vehicle ride sharing data
- Vehicle car2go data
- Vehicle Zipcar data
- Vehicle Lyft data
- Vehicle Uber data
- Vehicle LyftX data
- Vehicle UberX data
- Vehicle UberBLACK data
- Vehicle UberPOOL data
- Vehicle UberEATS data
- Vehicle UberFRISK data
- Vehicle UberMOTOCAR data
- Vehicle UberMOTOCARXL data
- Vehicle UberMOTOCARXL2 data
- Vehicle UberMOTOCARXL3 data
- Vehicle UberMOTOCARXL4 data
- Vehicle UberMOTOCARXL5 data
- Vehicle UberMOTOCARXL6 data
- Vehicle UberMOTOCARXL7 data
- Vehicle UberMOTOCARXL8 data
- Vehicle UberMOTOCARXL9 data
- Vehicle UberMOTOCARXL10 data
- Vehicle UberMOTOCARXL11 data
- Vehicle UberMOTOCARXL12 data
- Vehicle UberMOTOCARXL13 data
- Vehicle UberMOTOCARXL14 data
- Vehicle UberMOTOCARXL15 data
- Vehicle UberMOTOCARXL16 data
- Vehicle UberMOTOCARXL17 data
- Vehicle UberMOTOCARXL18 data
- Vehicle UberMOTOCARXL19 data
- Vehicle UberMOTOCARXL20 data

The TSDC is available to researchers, developers, and other interested parties. For more information, please contact the TSDC administrator at [tsdc@nrel.gov](mailto:tsdc@nrel.gov).



**DATA USE DISCLOSURE POINT-AND-CLICK AGREEMENT**

These Transportation Secure Data Center data ("Data") are provided by the National Renewable Energy Laboratory ("NREL"), which is operated by the National Renewable Energy Laboratory ("NREL") for the U.S. Department of Energy ("DOE").

Access to and use of these Data shall require the following:

1. The user is required to fill out and sign the registration form, which is located on the right side of this page, and to provide the information requested in the registration form in full and accurate detail.

2. The user is required to provide a valid email address and phone number, which may be used in any advertising or public relations effort.

3. The user is required to provide a valid street address, which may be used in any advertising or public relations effort.

4. The user is required to provide a valid street number, which may be used in any advertising or public relations effort.

5. The user is required to provide a valid password, which may be used in any advertising or public relations effort.

6. The user is required to provide a valid email address, which may be used in any advertising or public relations effort.

7. The user is required to provide a valid phone number, which may be used in any advertising or public relations effort.

8. The user is required to provide a valid street address, which may be used in any advertising or public relations effort.

9. The user is required to provide a valid street number, which may be used in any advertising or public relations effort.

10. The user is required to provide a valid password, which may be used in any advertising or public relations effort.

11. The user is required to provide a valid email address, which may be used in any advertising or public relations effort.

12. The user is required to provide a valid phone number, which may be used in any advertising or public relations effort.

13. The user is required to provide a valid street address, which may be used in any advertising or public relations effort.

14. The user is required to provide a valid street number, which may be used in any advertising or public relations effort.

15. The user is required to provide a valid password, which may be used in any advertising or public relations effort.

16. The user is required to provide a valid email address, which may be used in any advertising or public relations effort.

17. The user is required to provide a valid phone number, which may be used in any advertising or public relations effort.

18. The user is required to provide a valid street address, which may be used in any advertising or public relations effort.

19. The user is required to provide a valid street number, which may be used in any advertising or public relations effort.

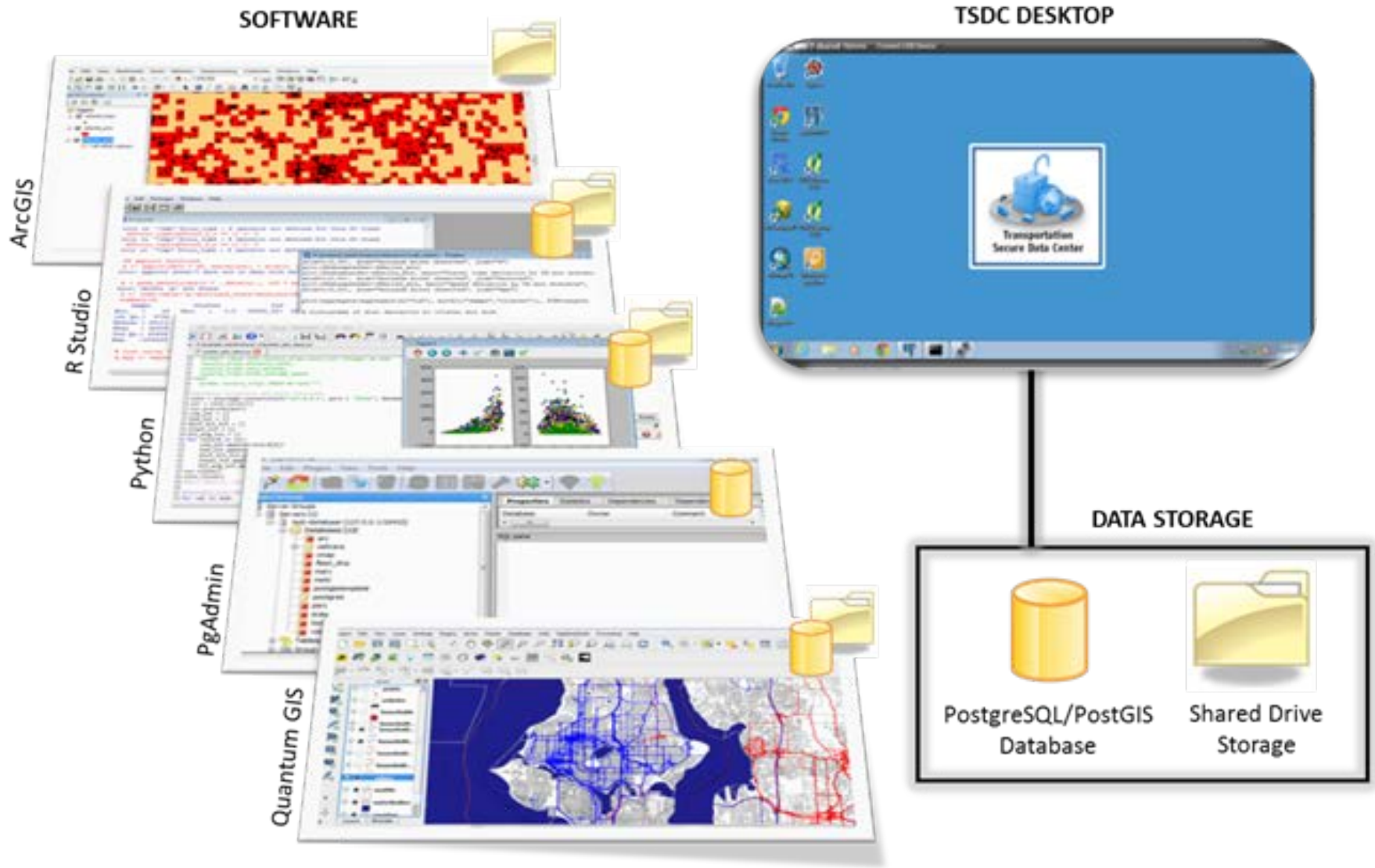
20. The user is required to provide a valid password, which may be used in any advertising or public relations effort.

# Secure Portal Environment Access Process

---

- Application packet at [www.nrel.gov/tsdc](http://www.nrel.gov/tsdc)
- Data Use Disclaimer Agreement
  - Includes confidential data protection legal language and explicit pledge not to attempt identifying individual participants
  - Required for each individual user—no data removal or account sharing
  - Requires signature from both applicant and their supervisor
- Analysis Description Document
  - Explain proposed analysis, why secure portal access needed
- Condition of Use for NREL Cyber Resources (on-line form)
- Advisory group reviews application and provides recommendation
  - Data providers included on review if desired
- Approved users only access data within the secure portal environment
  - Data transfer prohibited (clipboard sharing, local drive access, & internet disabled)
  - Use software packages provided within the environment
  - NREL audits aggregated results a user wishes to remove before providing them to the user

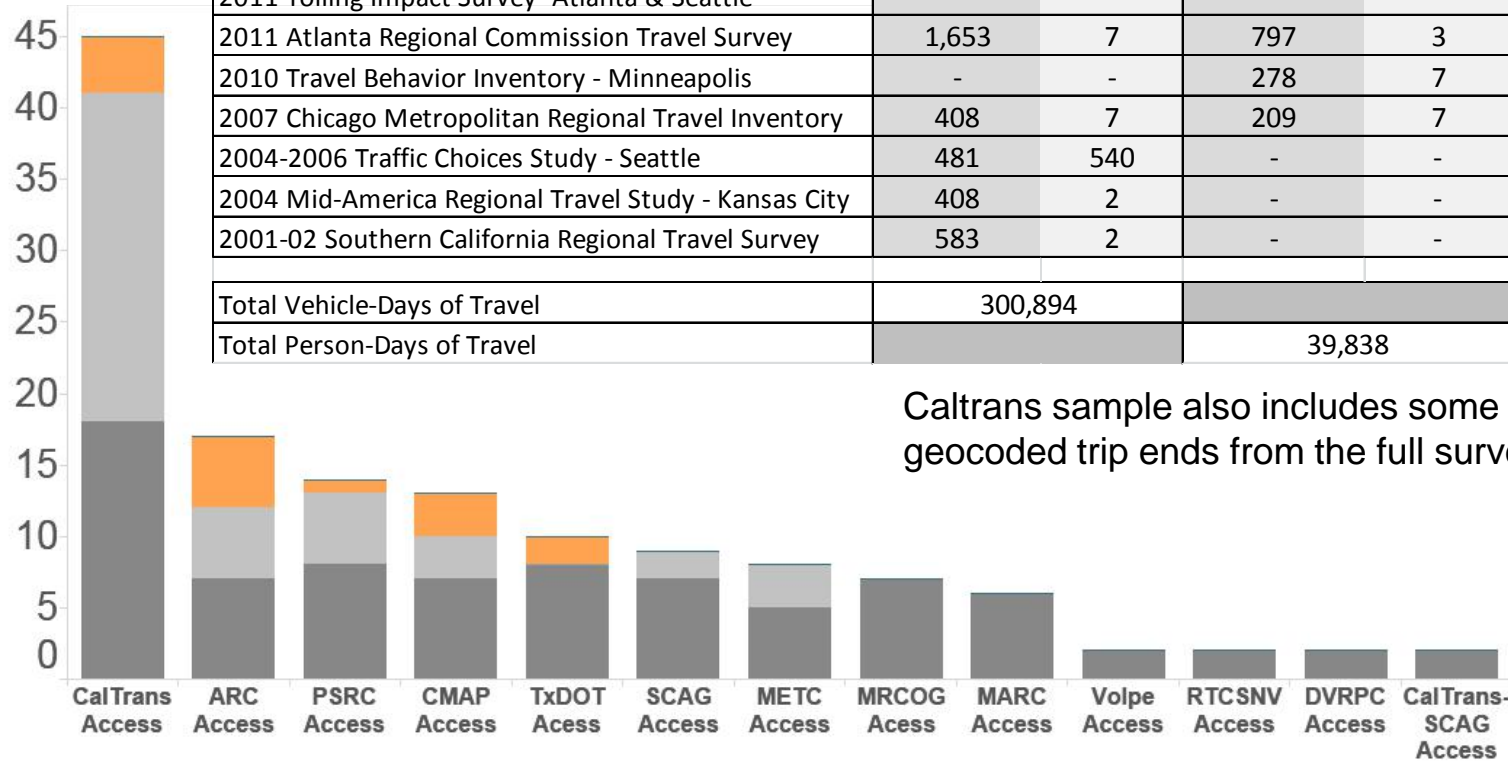
# TSDC Secure Portal Snapshot



# Included Datasets and Request Frequency

Data Set	Sec-by-Sec Veh. GPS		Sec-by-Sec Wear. GPS		Orig./Dest. Travel Diary	
	# Vehicles	# Days	# Persons	# Days	# Persons	# Days
2014 Southern Nevada Household Travel Survey	-	-	1,694	3	-	-
2002-14 Texas Regional Travel Surveys (10 total)	3,561	1	-	-	-	-
2013 Mid-Region Travel Survey - Albuquerque	-	-	1,023	3	5,522	1
2012-13 Delaware Valley Household Travel Survey	-	-	811	3	20,216	1
2010-12 California Household Travel Survey	2,910	7	7,574	3	108,778	1
2012 California Household Survey Supplement	625	7	244	3	-	-
2011 Tolling Impact Survey- Atlanta & Seattle	-	-	-	-	7,534	2
2011 Atlanta Regional Commission Travel Survey	1,653	7	797	3	25,789	1
2010 Travel Behavior Inventory - Minneapolis	-	-	278	7	18,702	1
2007 Chicago Metropolitan Regional Travel Inventory	408	7	209	7	-	-
2004-2006 Traffic Choices Study - Seattle	481	540	-	-	-	-
2004 Mid-America Regional Travel Study - Kansas City	408	2	-	-	-	-
2001-02 Southern California Regional Travel Survey	583	2	-	-	39,808	1
<b>Total Vehicle-Days of Travel</b>	<b>300,894</b>					
<b>Total Person-Days of Travel</b>			<b>39,838</b>		<b>233,883</b>	

Secure Portal Dataset Requests



Caltrans sample also includes some OBD data, and geocoded trip ends from the full survey.

Year 2012 2013 2014 2015

# Questions?

## For More Information on the TSDC...

Visit the website: [www.nrel.gov/tsdc](http://www.nrel.gov/tsdc)

- Read about the project
- View fact sheets and publications
- Download cleansed public data
- Apply for secure portal access
- Sign up to receive e-mail updates

Contact: [Jeff.Gonder@nrel.gov](mailto:Jeff.Gonder@nrel.gov) or [tsdc@nrel.gov](mailto:tsdc@nrel.gov)

- If interested in partnering on the project
- For user support
- For help answering questions



**Transportation  
Secure Data Center  
(TSDC)**

---

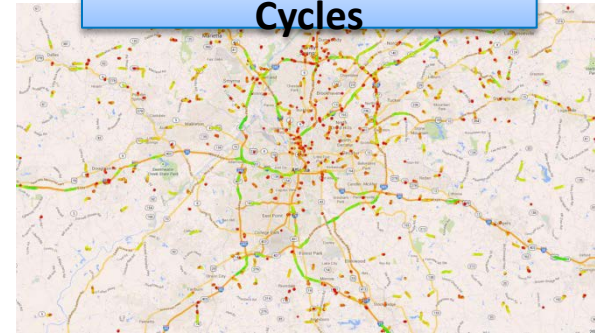
# Appendix



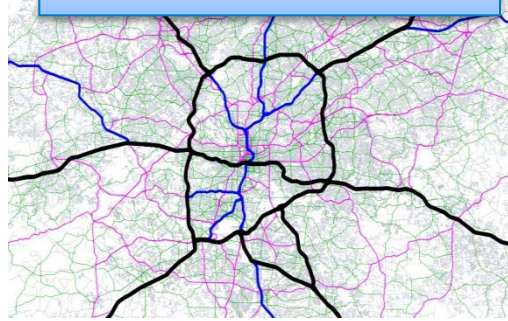


# Integration with Other Large Datasets

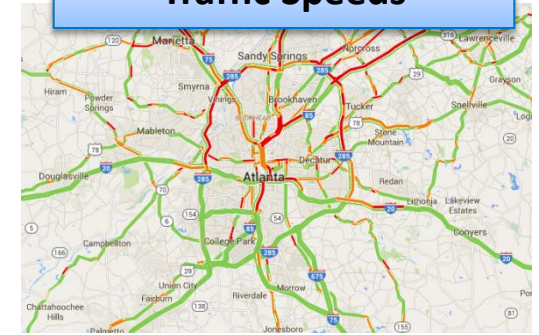
**GPS Travel/Drive Cycles**



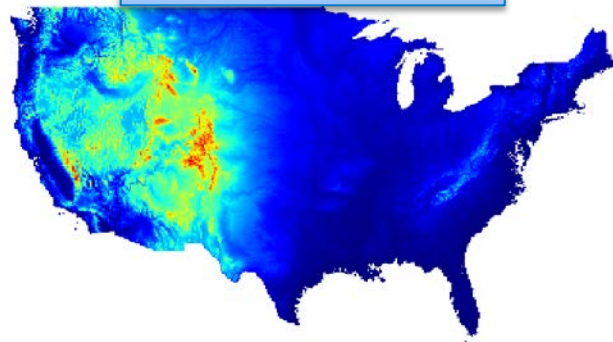
**Digital Street Maps**



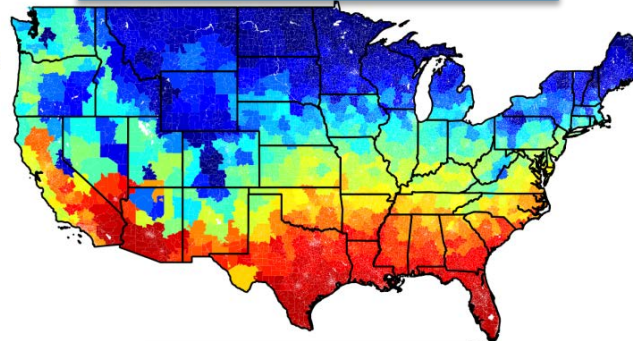
**Traffic Speeds**



**Elevation / Grade**



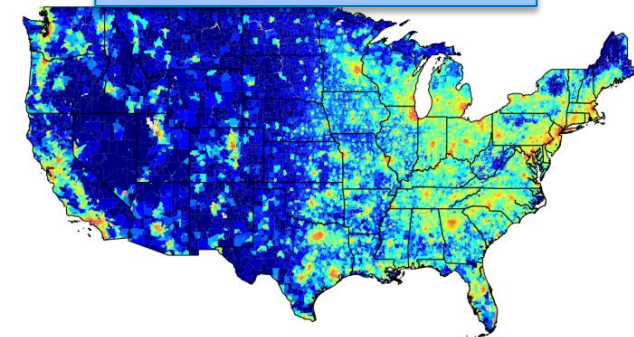
**Ambient Temperature**



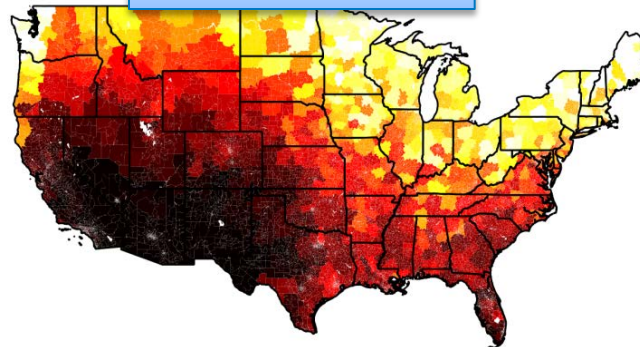
**Freight Volumes**



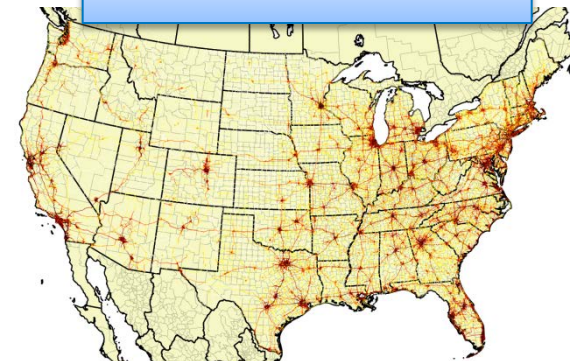
**Vehicle Registrations**



**Solar Intensity**



**Overall Road Volumes**



# Example TSDC-Enabled Studies

- Extensive NREL analyses working with large GPS datasets
  - Multi-powertrain real-world fuel economy distributions/sensitivities
  - Comparing real-world driving and standardized test profile results
  - Enabling road grade simulation and quantifying impacts
  - Synthesis with national climate data for thermal technology evaluation
  - Investigating PEV charging and alternative fuel station locations
  - Developing green routing and adaptive control algorithms
  - Assessing fuel saving opportunities from driver feedback...

