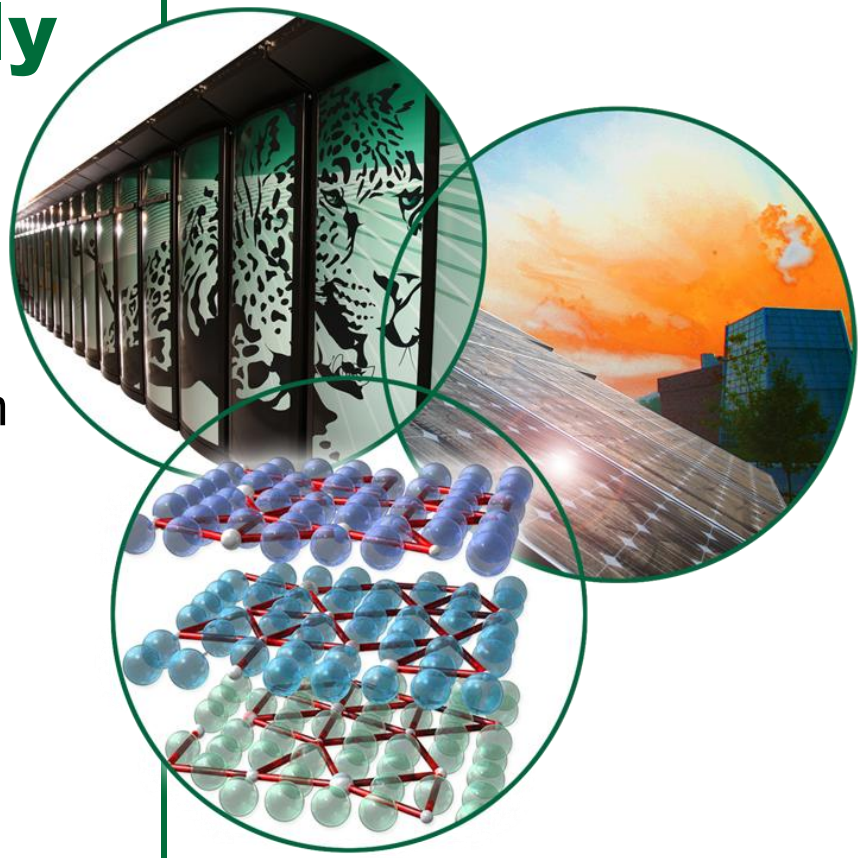
Visualizing Energy Resources Dynamically on Earth



Arjun Shankar[1], PhD

John Stovall[2], Steve Fernandez[1], Rangan Sukumar[1], Alex Sorokine[1], and Femi Omitaomu[1]

[1]Computational Sciences; [2]Energy Sciences

Oak Ridge National Laboratory
Contact: shankarm@ornl.gov

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U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
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Outline

- Background
- Application and use
  - Information layers for energy status awareness
  - Mash-ups to enable decision support
- Data layers: sources, sharing, and analysis
  - Spatio-temporal data-sharing
  - Analysis

Background

Lesson learned from August 14th, 2003 Blackout and Hurricane Katrina

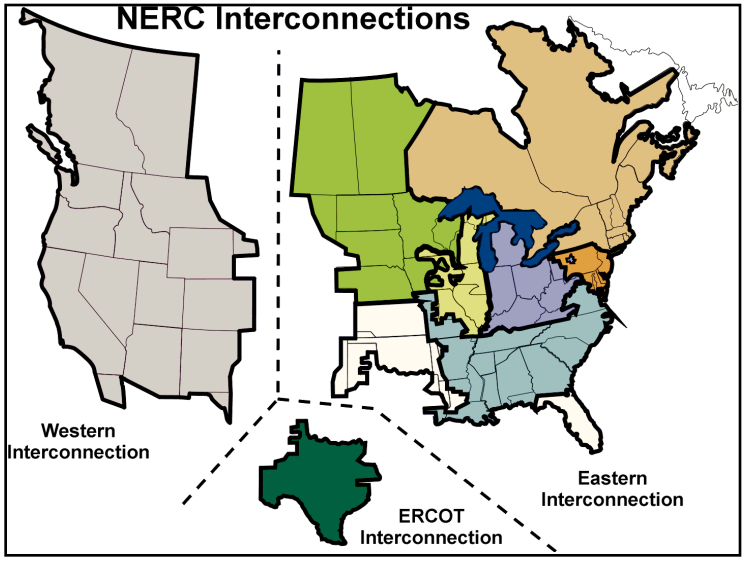
- A key missing ingredient was a high level view of the system
- Even though SCADA measurements were available somewhere, PJM, IMO, NYISO, ISONE, MISO, etc. did not have a good all-encompassing view of what was happening on the grid, particularly outside of their areas of control/oversight

Electric Grid and Energy Infrastructure Situational Awareness

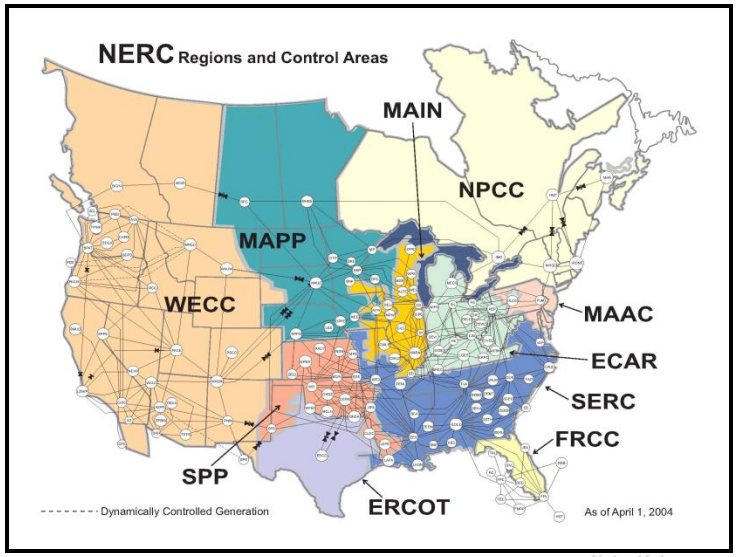
- U.S. DOE Office of Electricity Delivery and Energy Reliability sponsored effort
- Coordinate federal response to natural disasters or major events
- ORNL, in partnership with TVA, developed situational awareness visualization tool
- Initially assess status of transmission lines in the Southeast

Not Exactly a Clean Slate

- Electric Grid is a 20th century marvel but still a legacy system
  - Much works well
  - Significant data collection infrastructure exists
  - Crucial to understand the existing system interactions before we can improve them



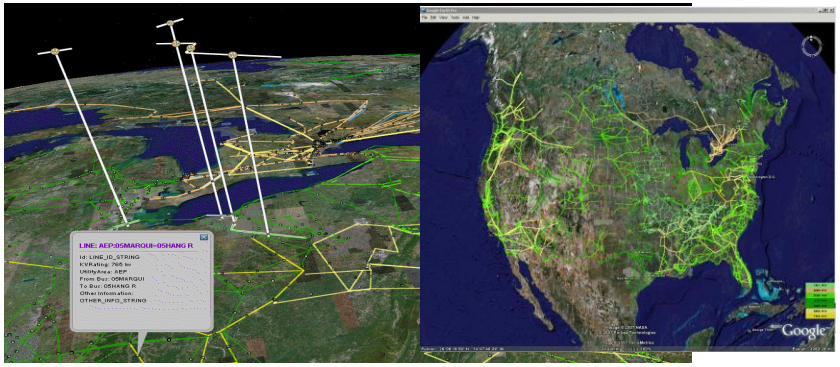
Moving to a scale beyond anything currently avaiable



3 Interconnections, 139 Control Areas (105 in the East), 18 Reliability Coordinators, & 10 Regions

VERDE: Visualizing Energy Resources Dynamically on Earth

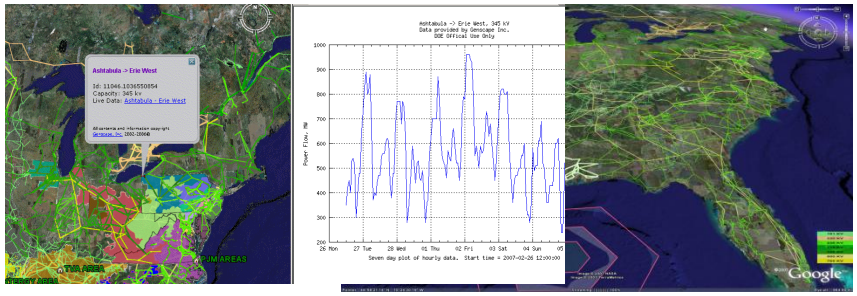
- Platform provides wide area visualization capability
- Situational awareness of transmission in partnership with TVA
- Real-time weather overlays
- Predictive impact models & Animated replay
- Data analysis
- Energy infrastructure interdependencies:
  - Coal delivery and rail lines
  - Refinery and oil wells
  - Natural gas pipelines
  - Transportation and evacuation routes
  - Population impacts - LandScan

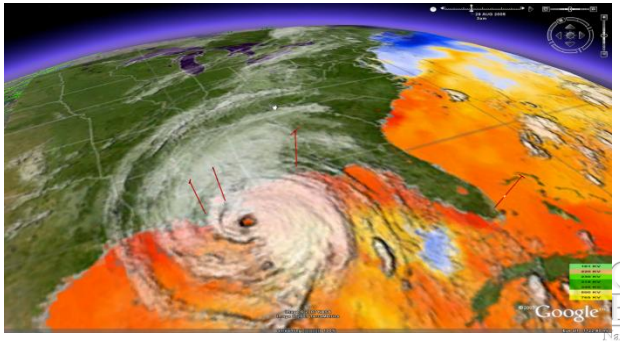


Wide-Area Power Grid Situational Awareness

Streaming Analysis

Impact Models

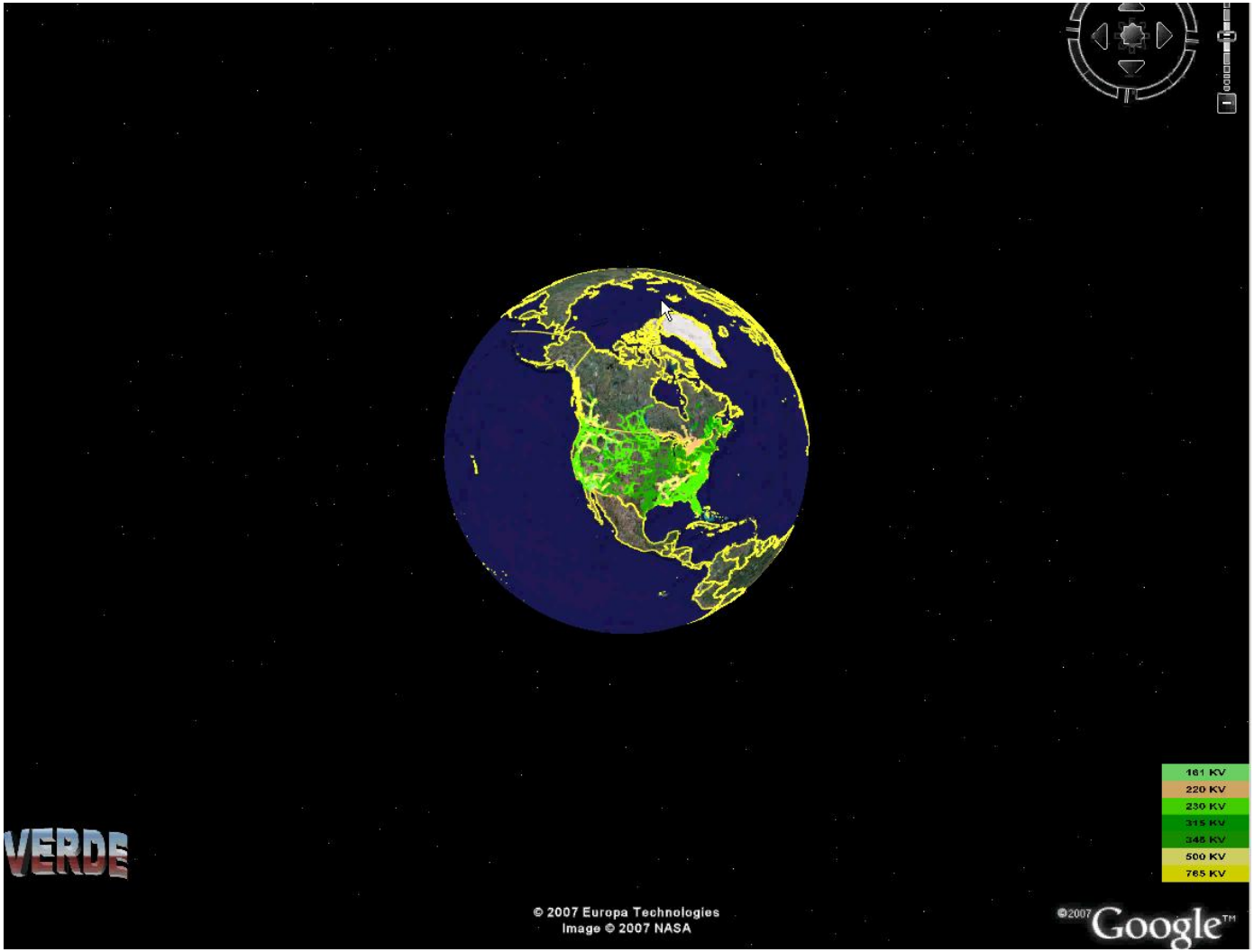




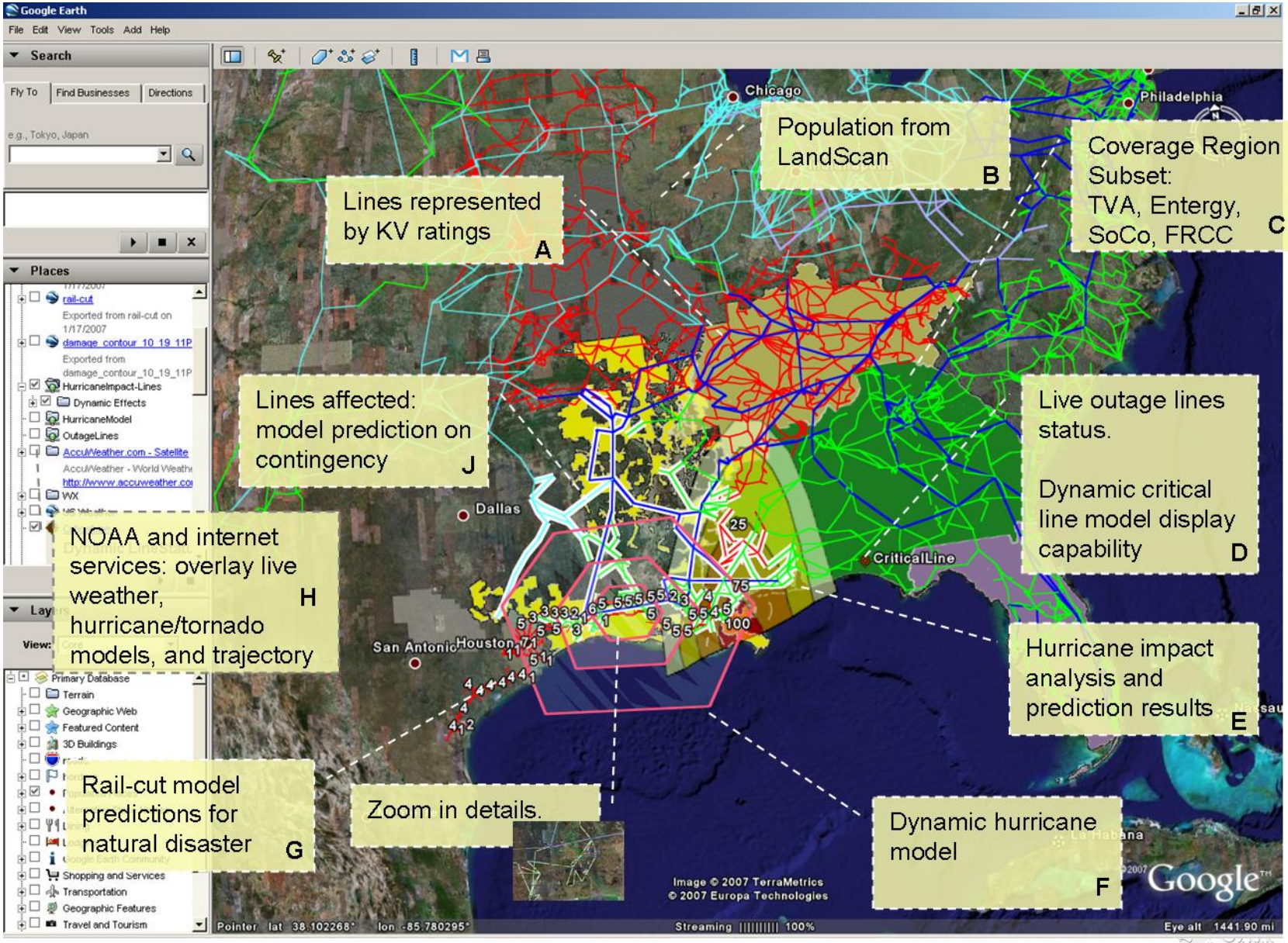
Real-time Weather Overlays

Uses and Mashups of Data-Layers for Energy Awareness

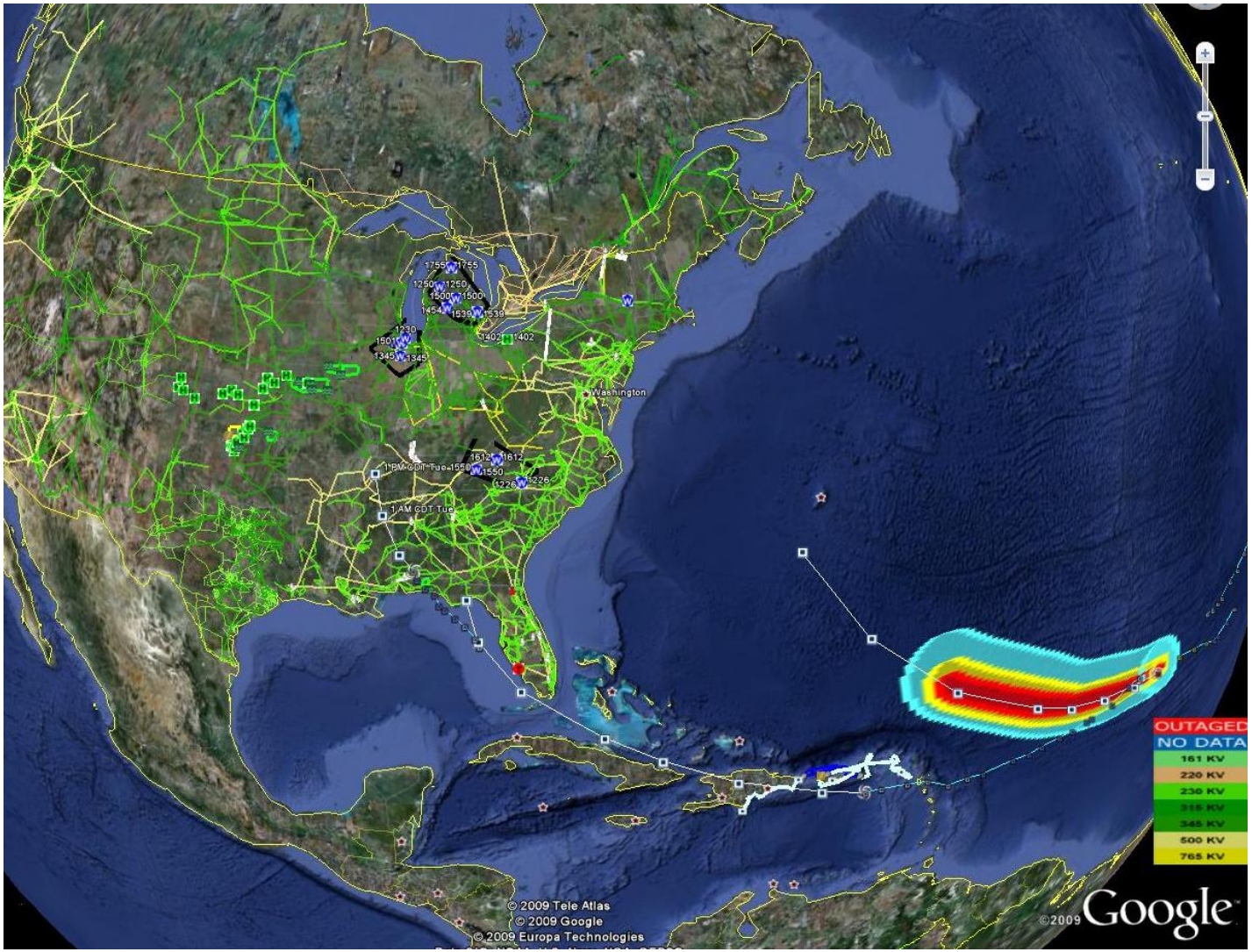
Wide-Area Views (Video)



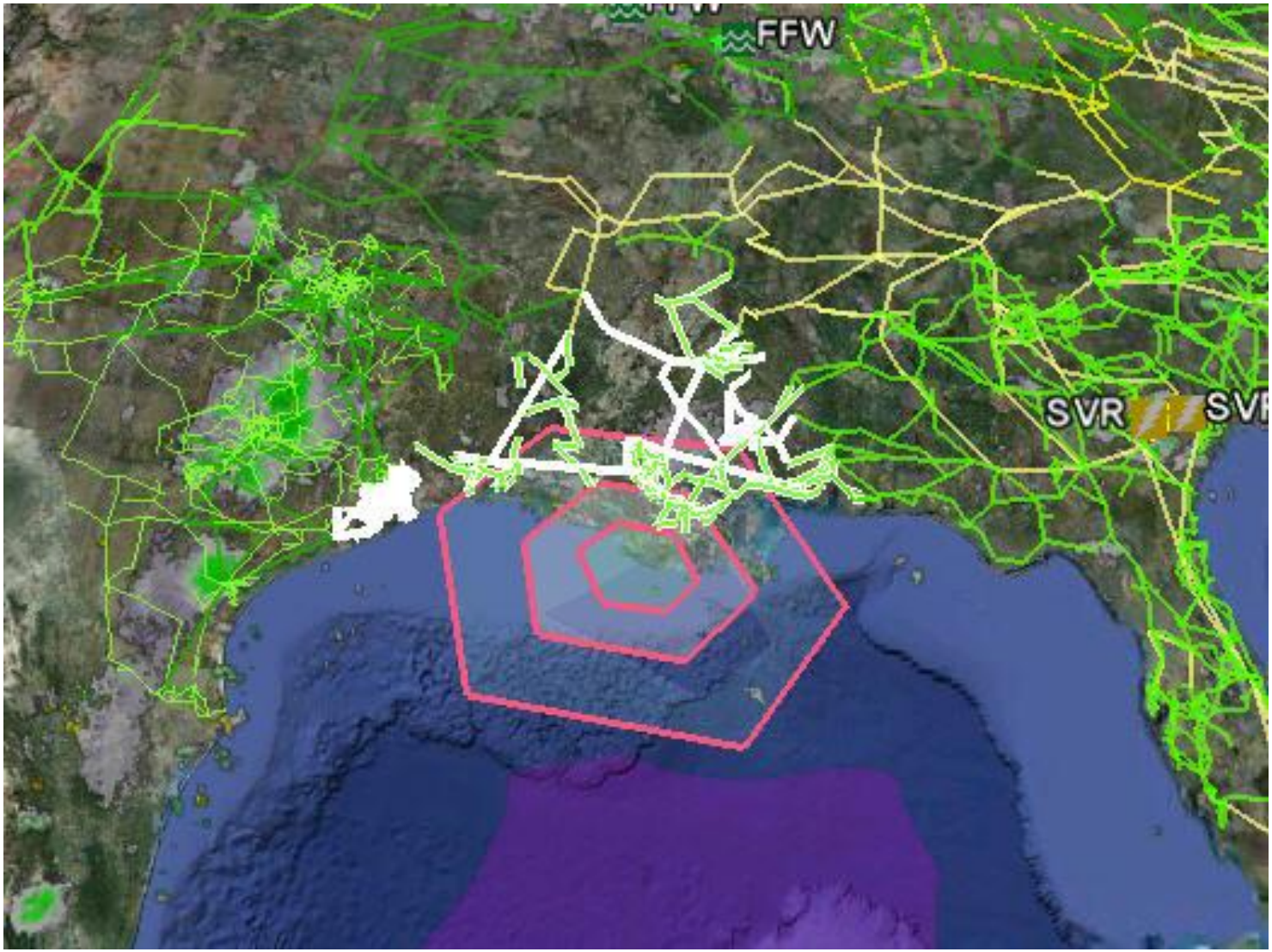
Wide-Area Views (Capability Layers)



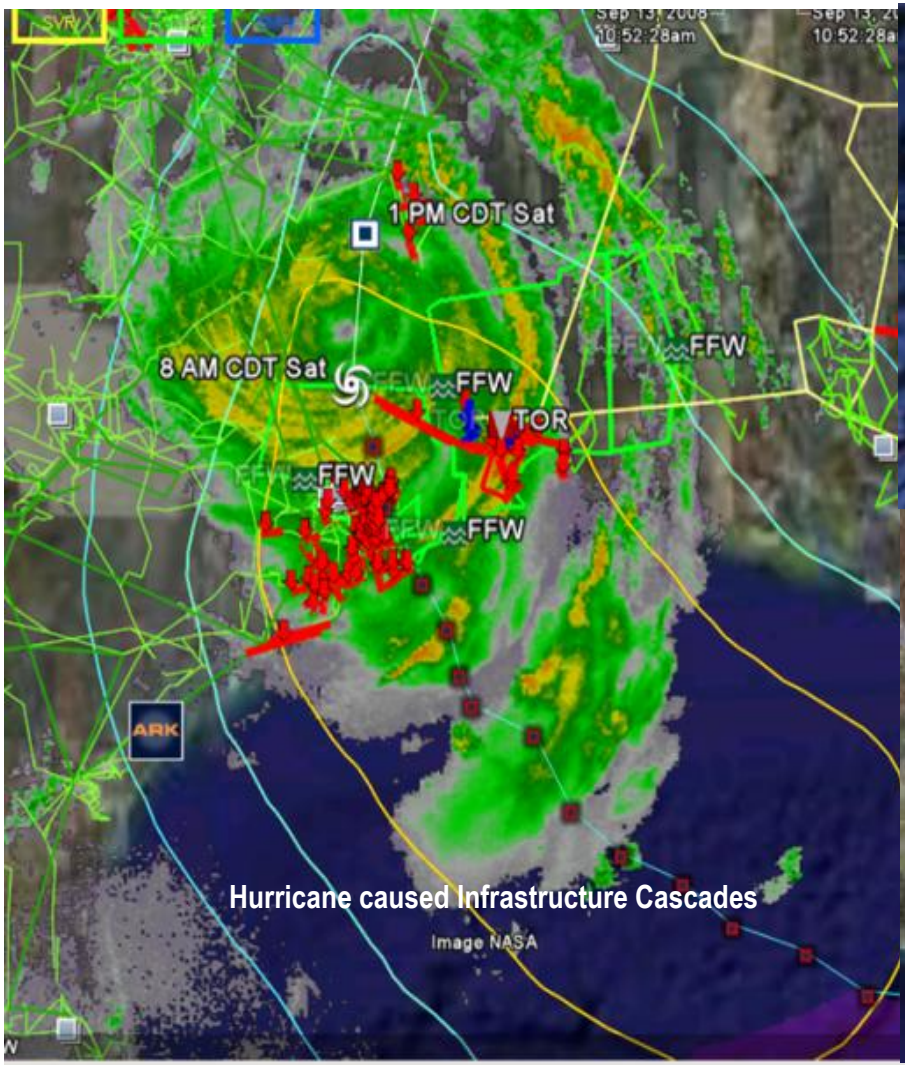
Example Impacts and Causes

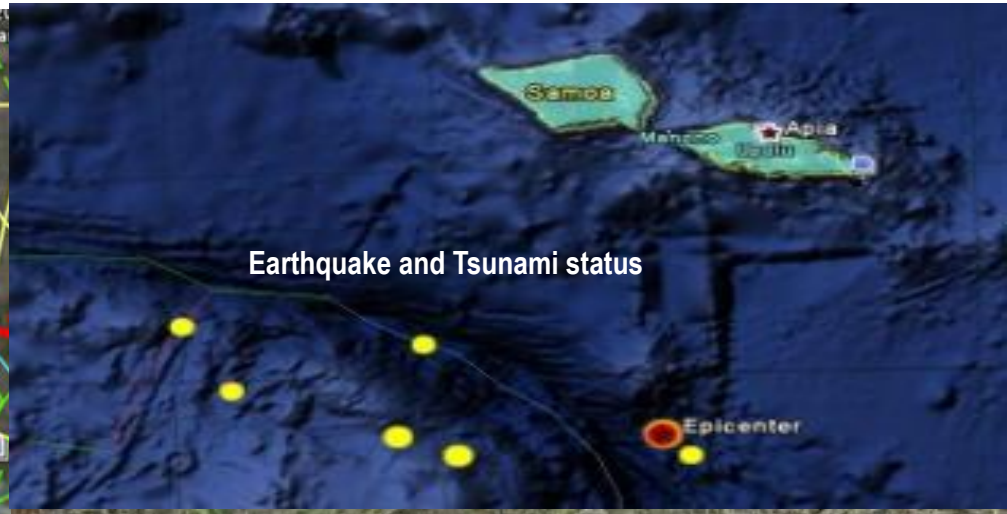


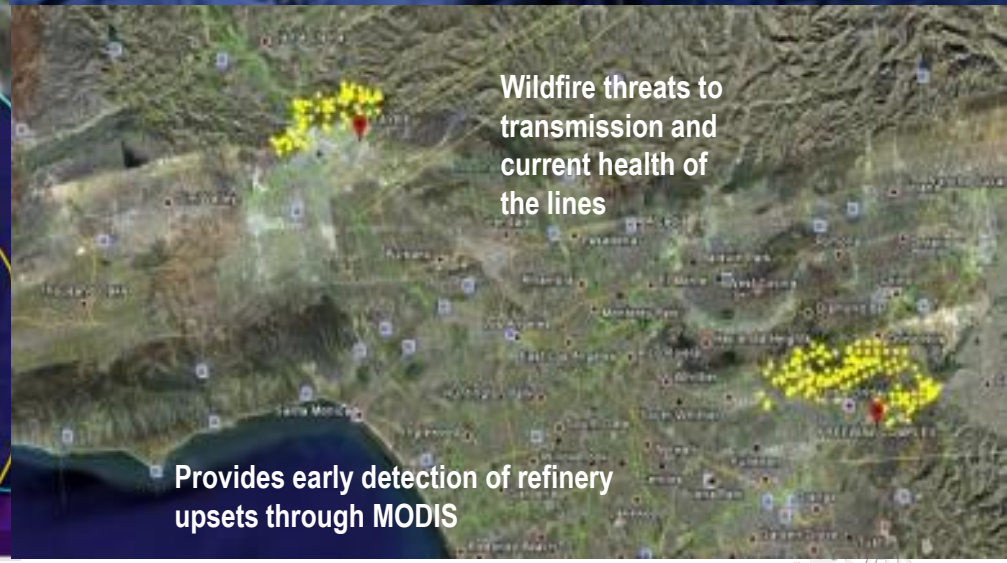
Predictive Capabilities



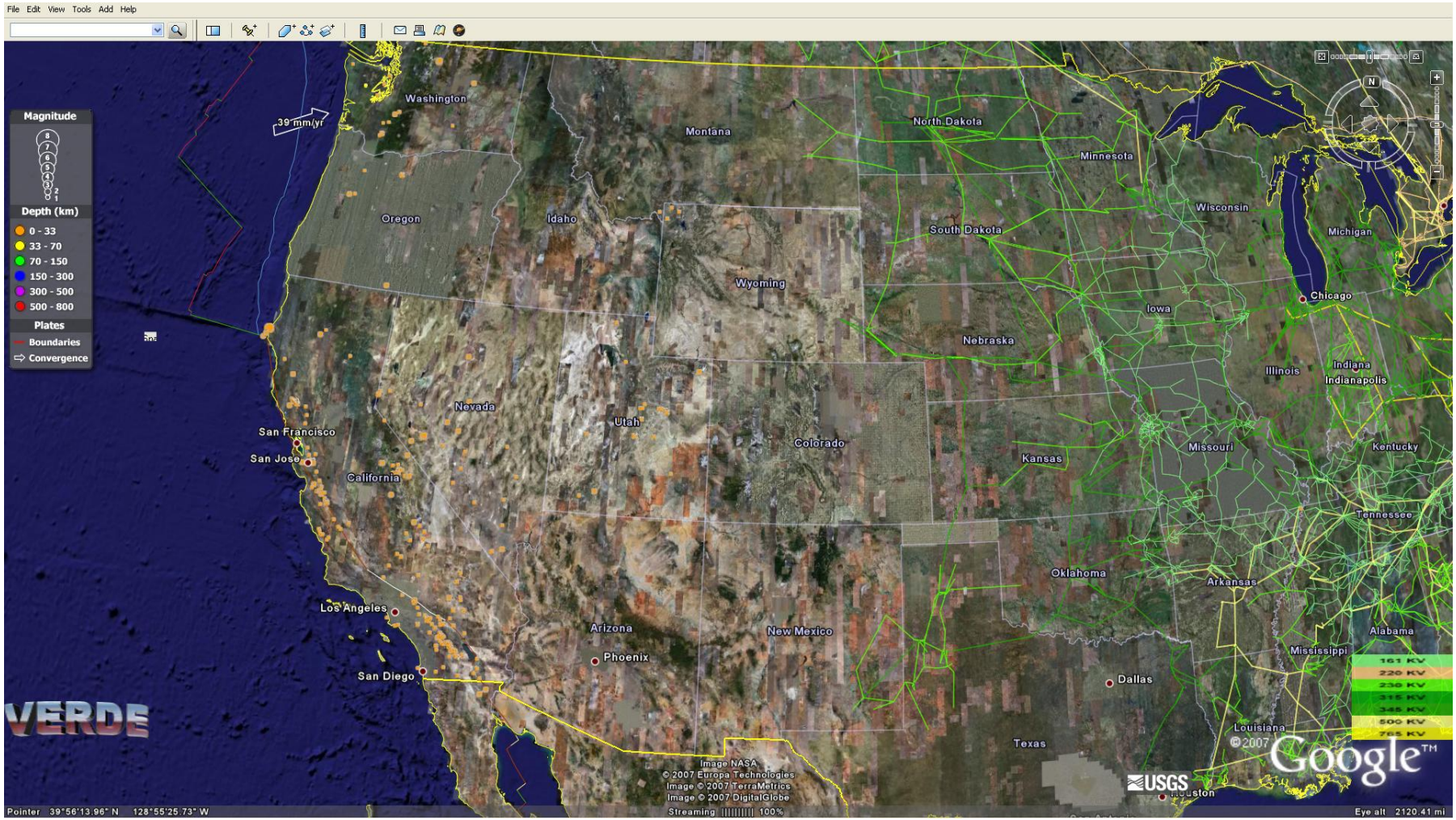
All Hazard Damage Forecast





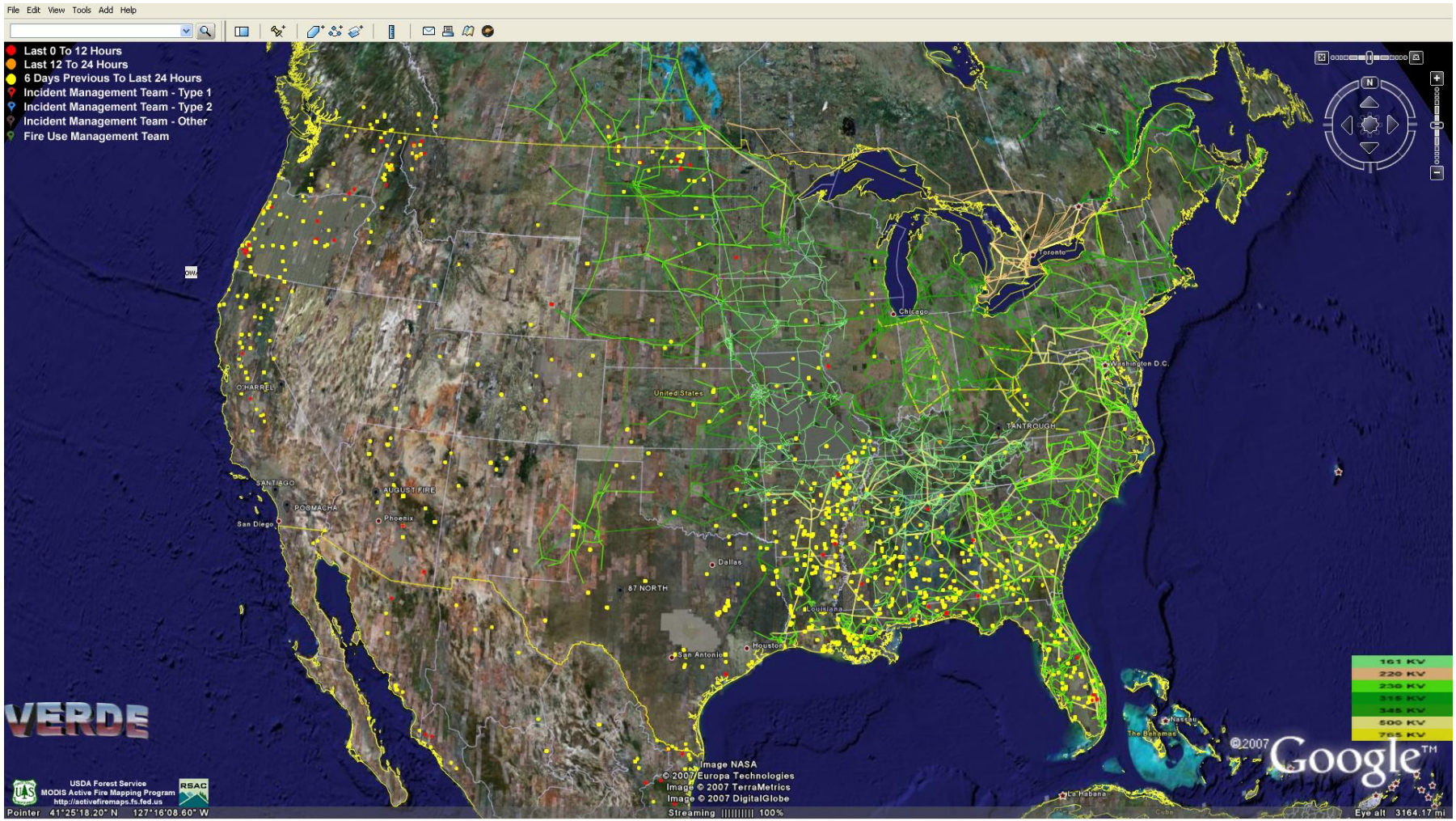


Earthquake Data (from USGS)



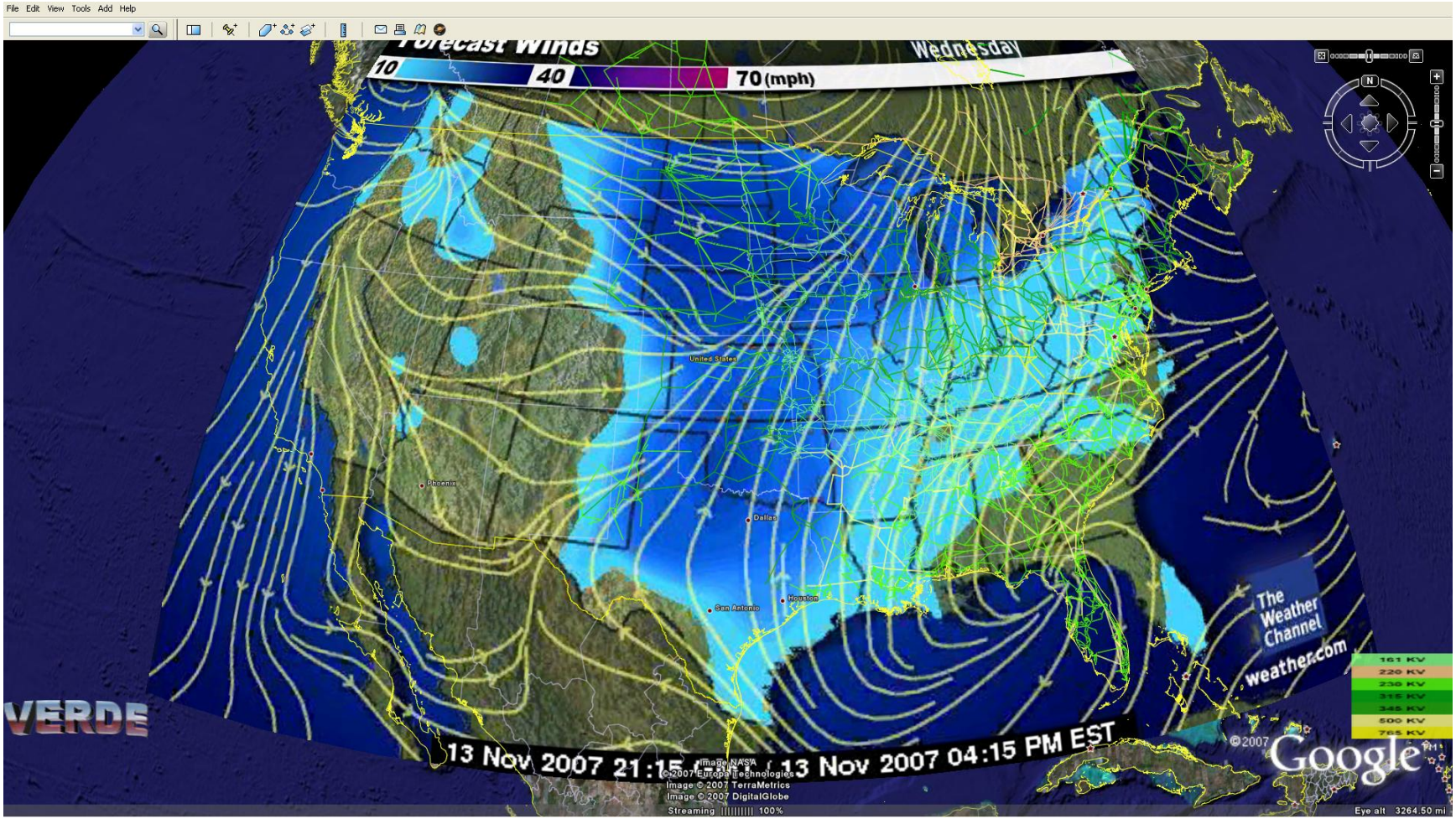
Sources: VERDE, USGS

Forest Fires (from USGS)



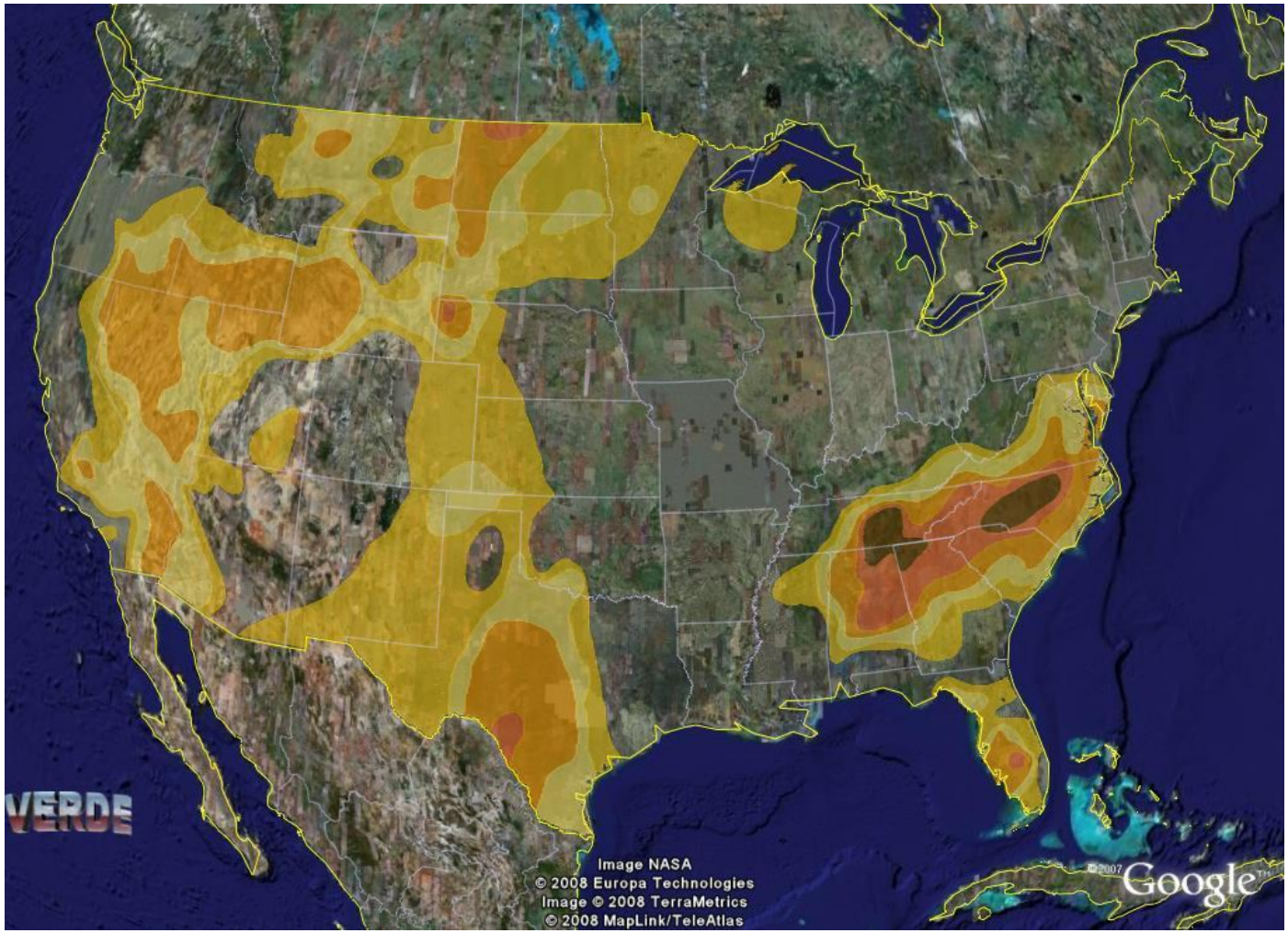
Sources: VERDE, USDA Forest Service

Wind Data



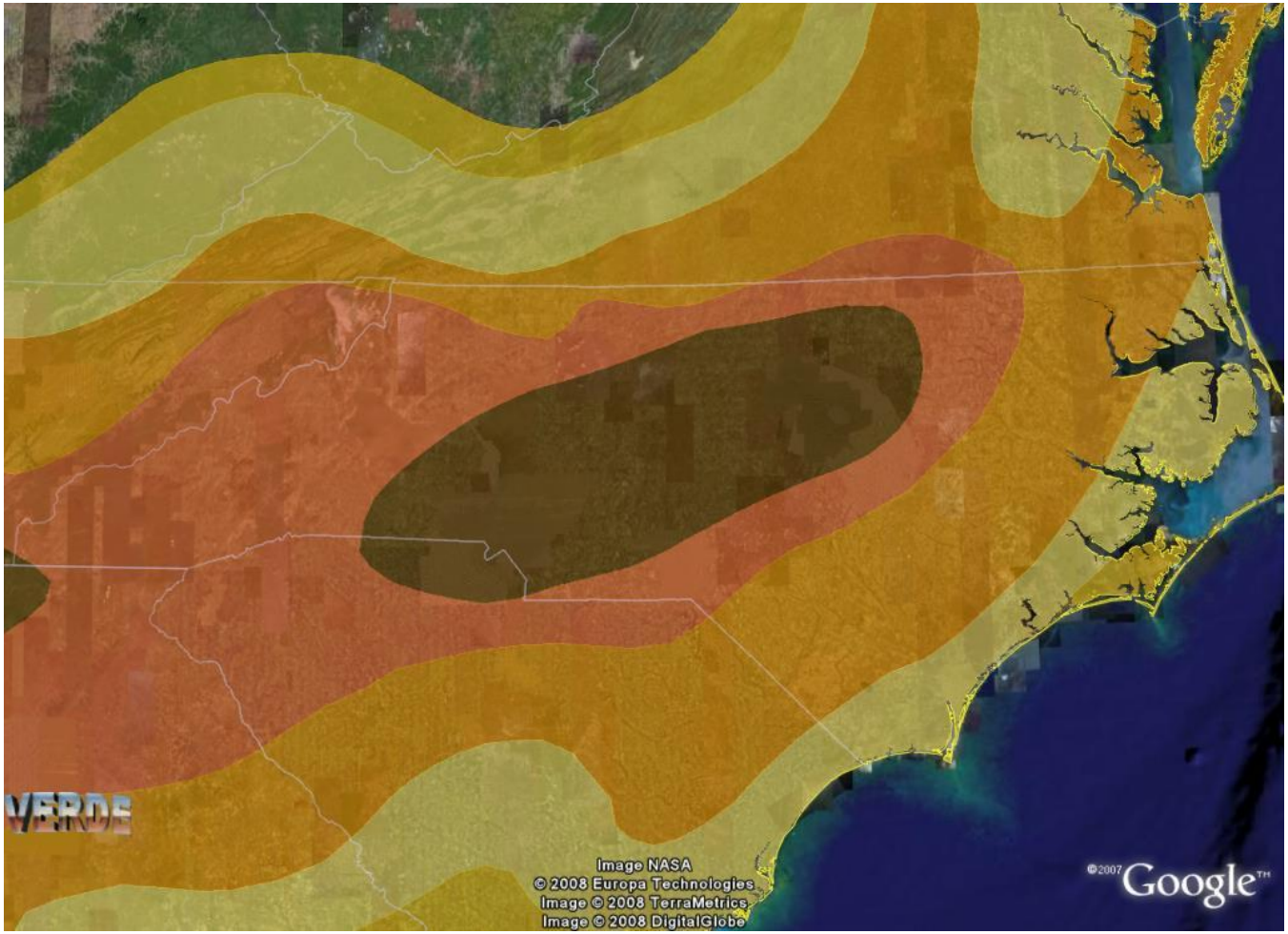
Sources: VERDE, The Weather Channel

U.S. Drought Monitor

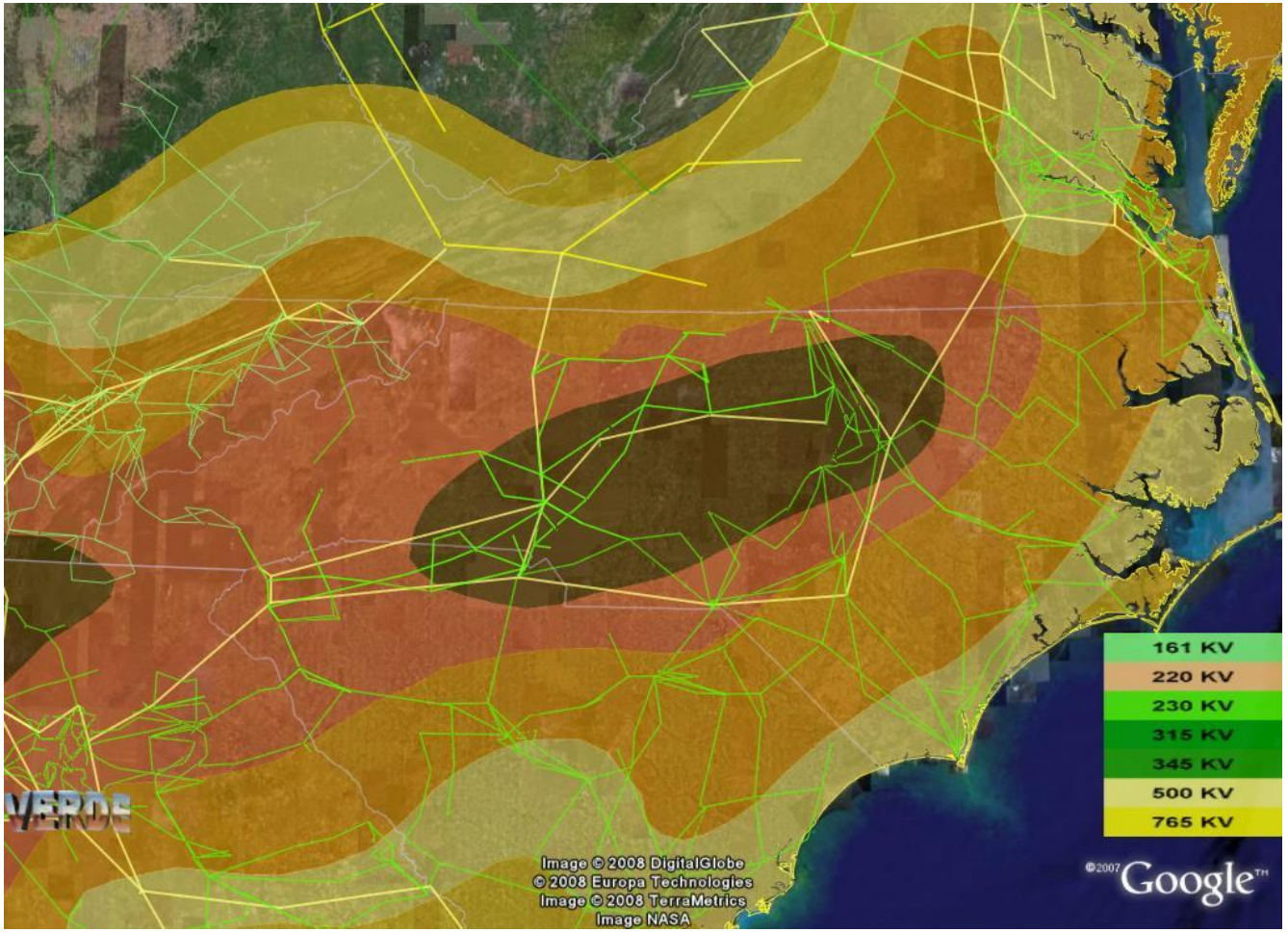


http://www.drought.unl.edu/dm/monitor.html

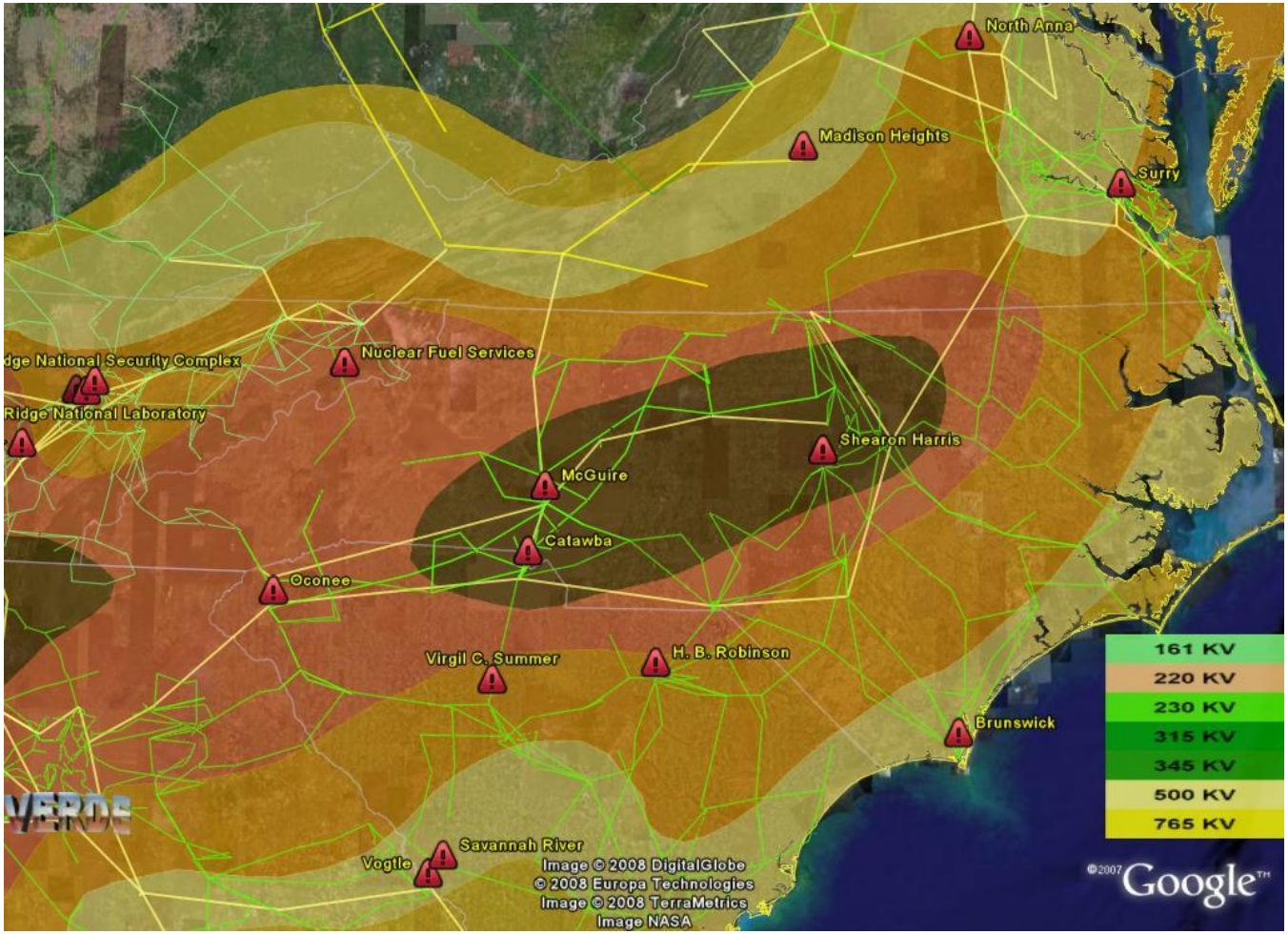
Zoom to North Carolina Drought Conditions



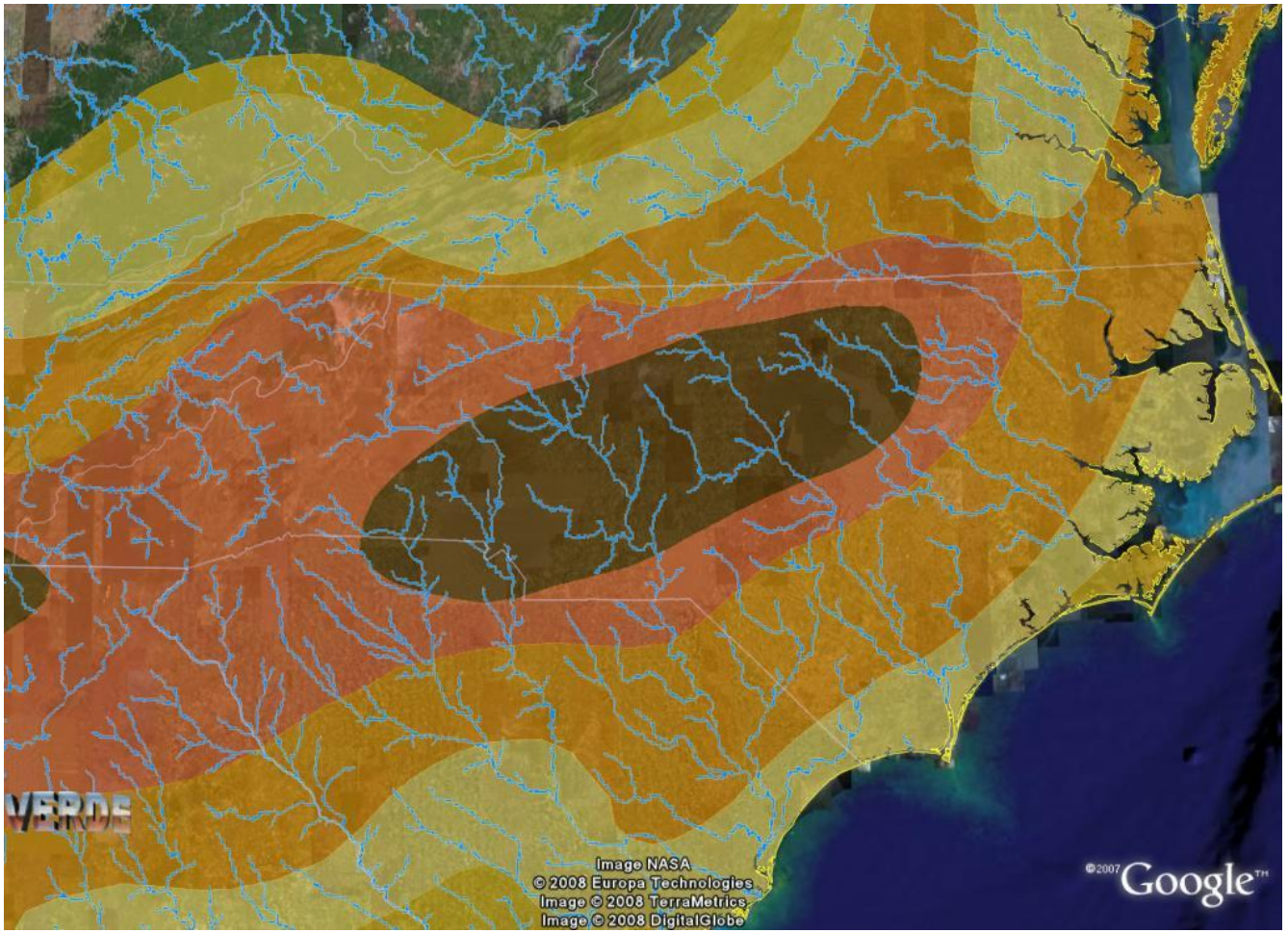
Transmission Lines in NC



Overlay Nuclear Facilities

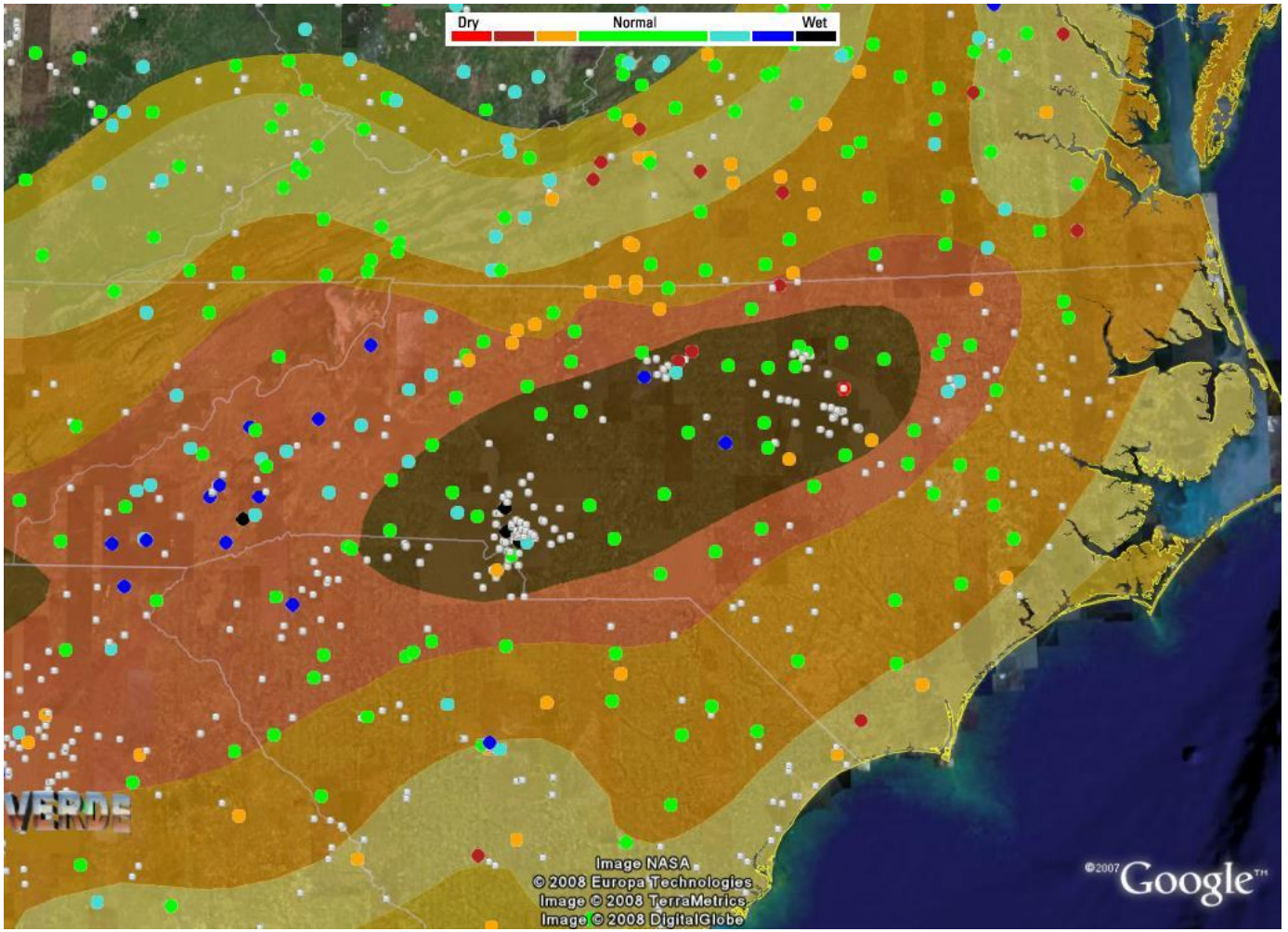


USGS - National Hydrography Dataset

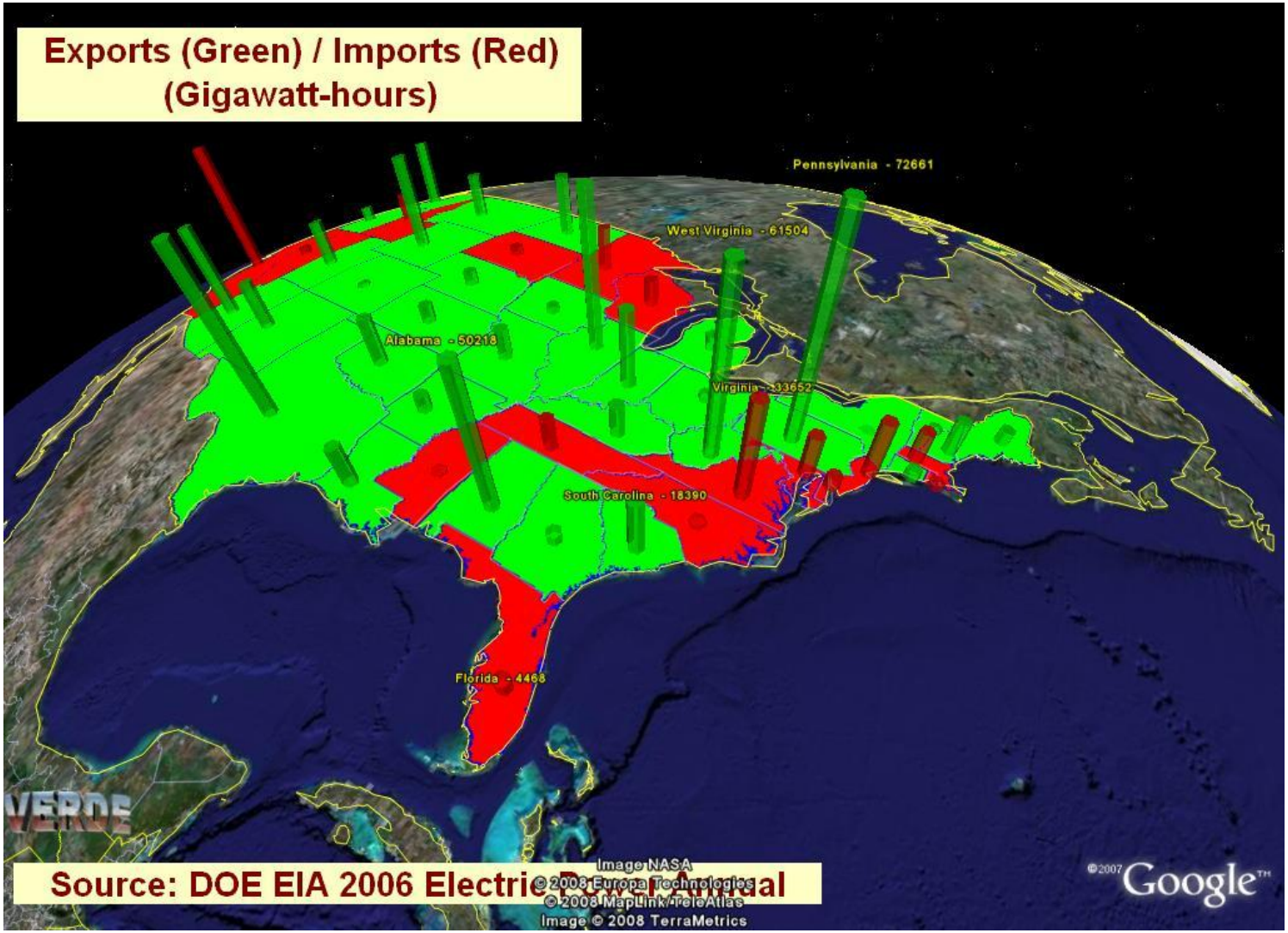


http://nhd.usgs.gov/

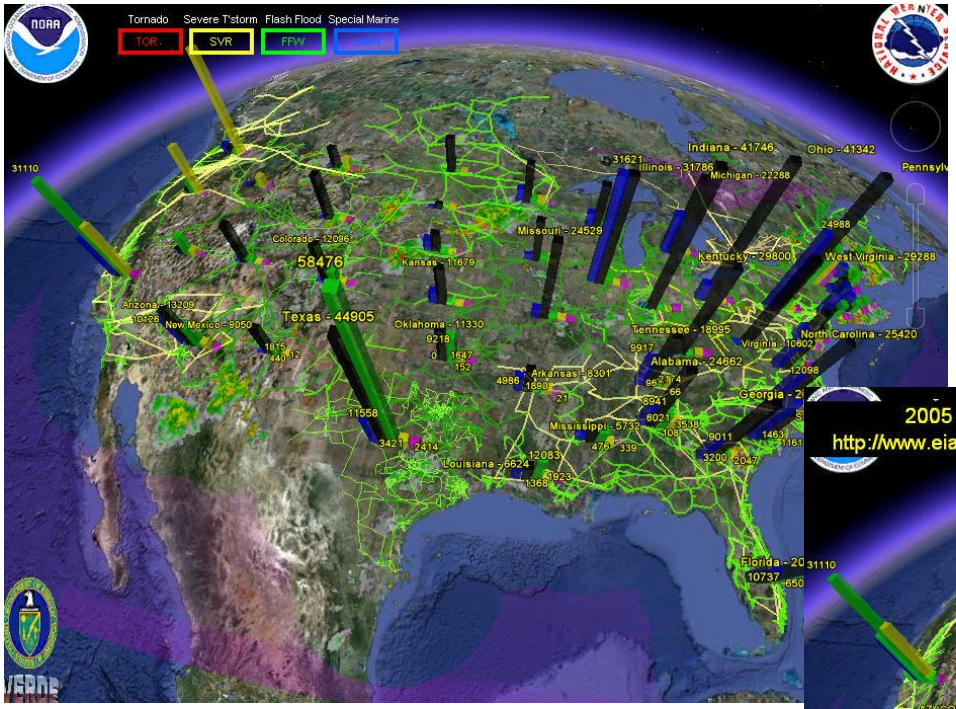
Stream Gauges

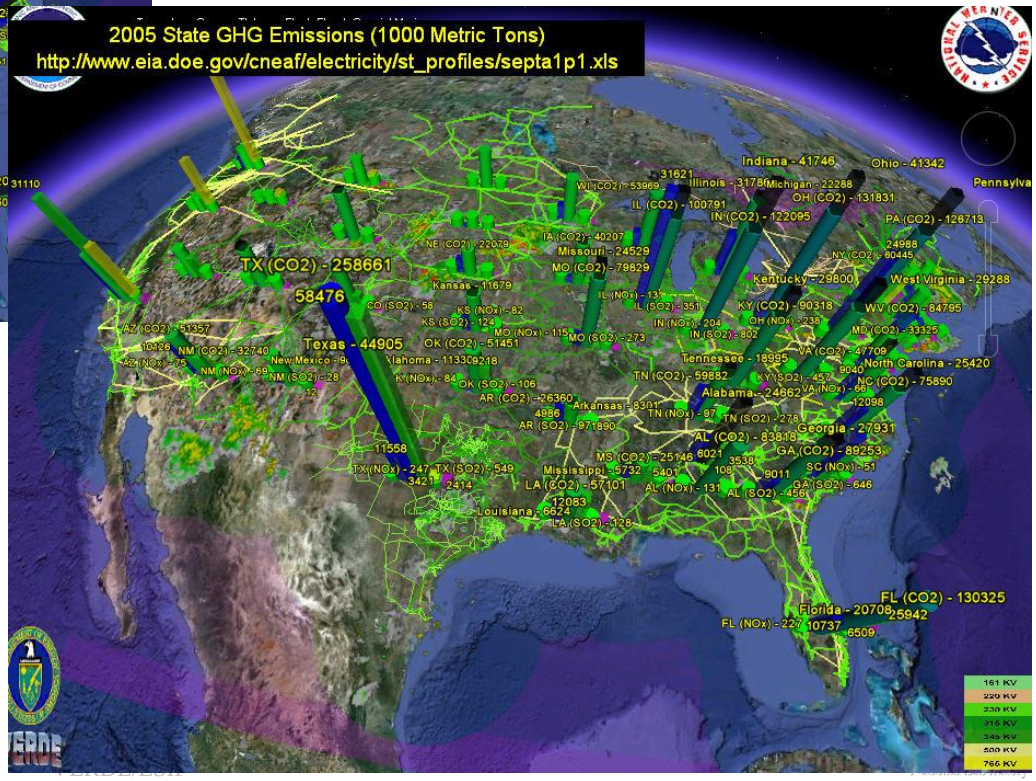


State Energy Imports and Exports



State Energy Generation and GHG Emissions





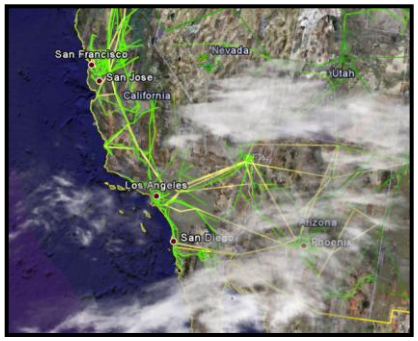
Data-Layers: Sources, Sharing, and Analysis

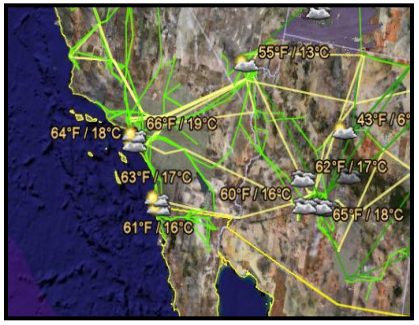
Open and Proprietary Data

- Open Data Examples
  - For transparency in trading and status. Example: PJM's OASIS (Open Access Same-time Information System).
  - Aggregate status for customers. Example: Customer outages.
  - Innovative non-utility data: UTK/VT Frequency Data Recorders
- Proprietary Data Examples
  - Intranet data. Example: SCADA data.
  - Extranet data. Example: NERC-net ICCP (Inter-Control-Center Protocol).
  - Innovative non-utility data: Genscape standoff recorders.

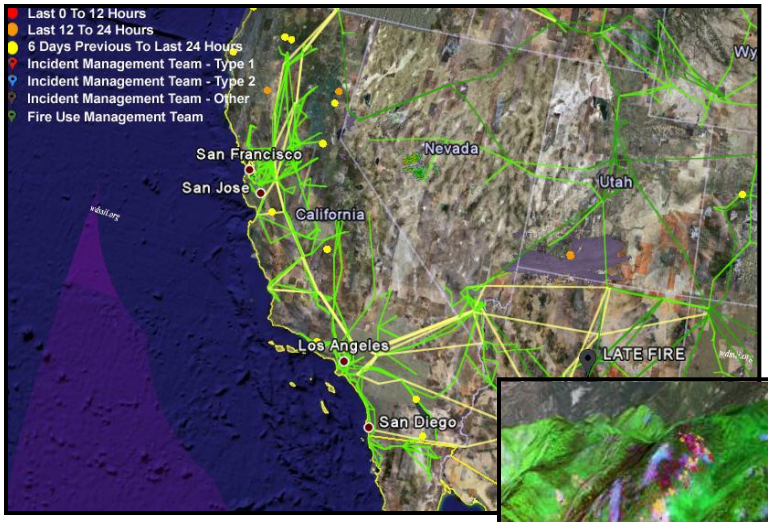
VERDE flow example: Evaluation of forest fire hazard

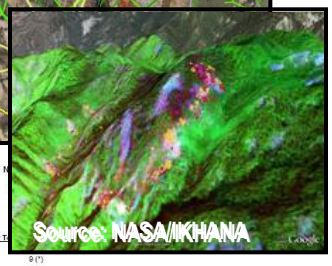
VERDE Data Feeds ➡ ***Model Inputs*** ➡ **Model Outputs**

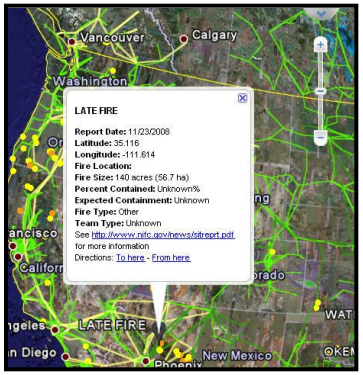


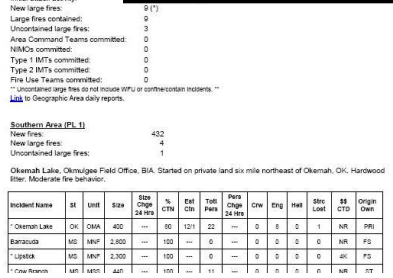


- Sample inputs
  - Wind
  - Temp./R.H.

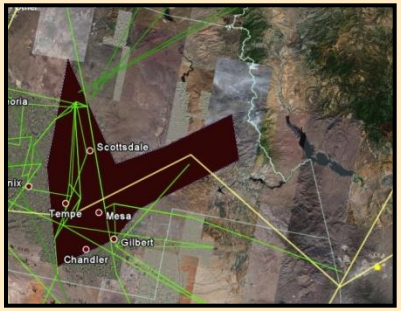






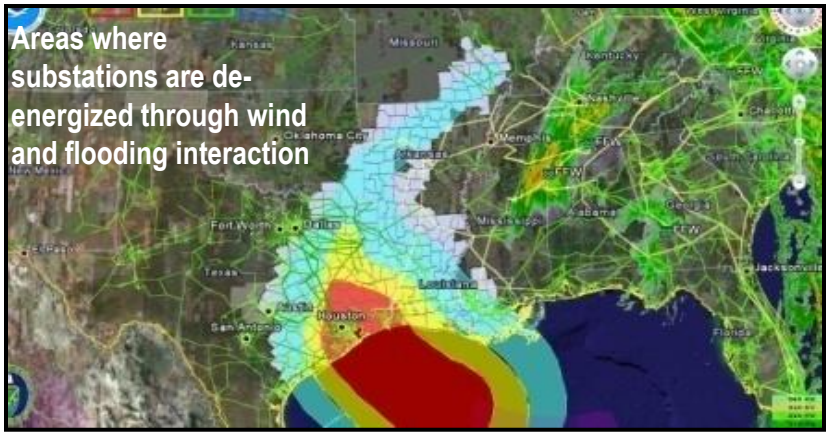


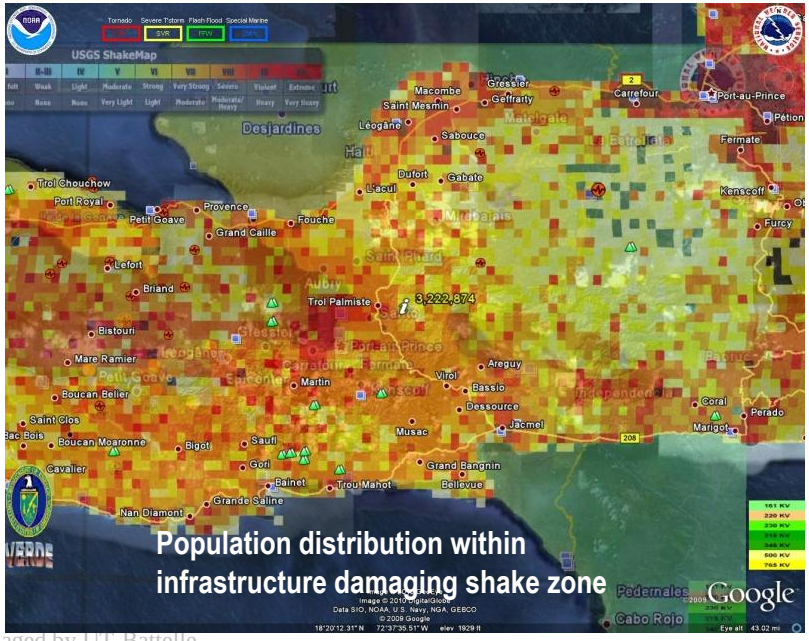
- **Status and infrastructure overlays**
- **NICC outputs**



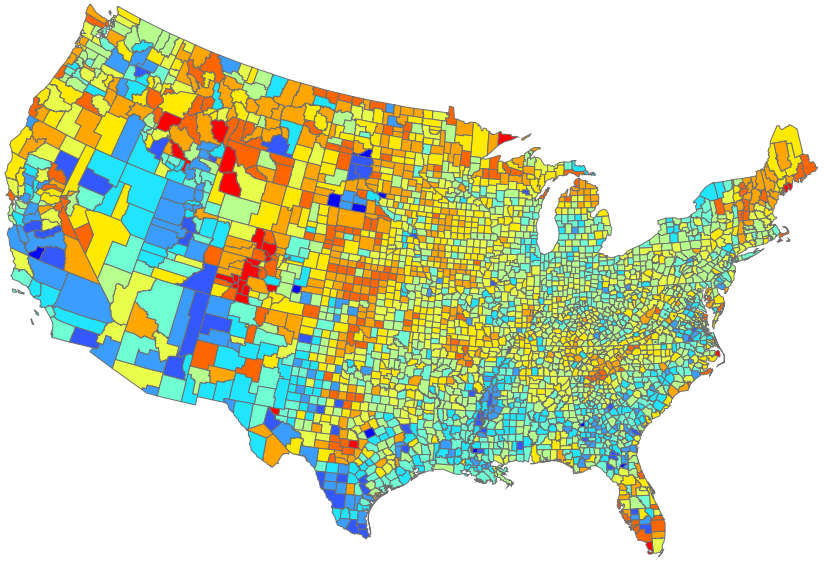
- **Impact estimate**
- **Contingency alerting**

Estimates of Power Customers and Population at Risk





Value by County of the Population to Power Customer Conversion Factor



Policy Module

Policy landscape for renewable energy

Renewable Technology

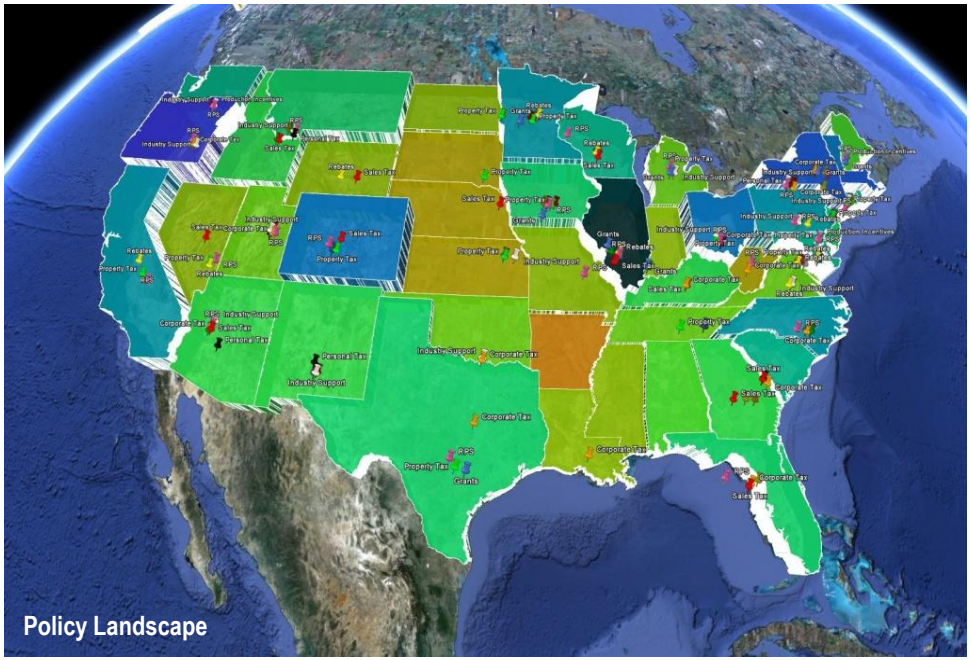
Solar

Bio-energy

Wind

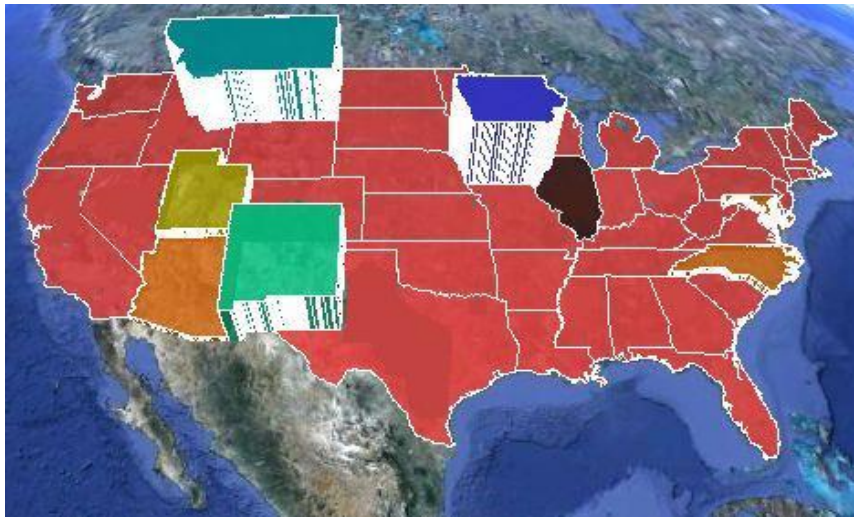
Other

- Policy Incentives
  - Production Incentive
  - Grants
  - Industry Support
  - Rebates
  - Corporate tax credit
  - Personal tax credit
  - Sales tax credit
  - Property tax credit

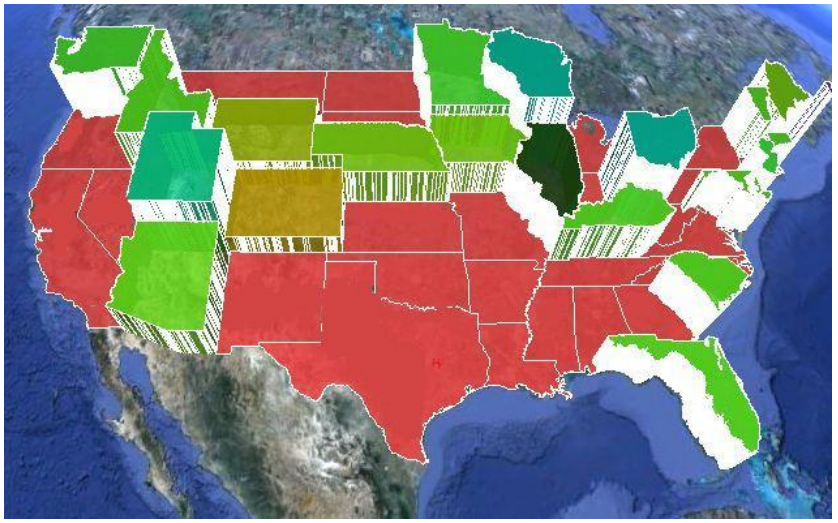


Policy module : Results and Analysis

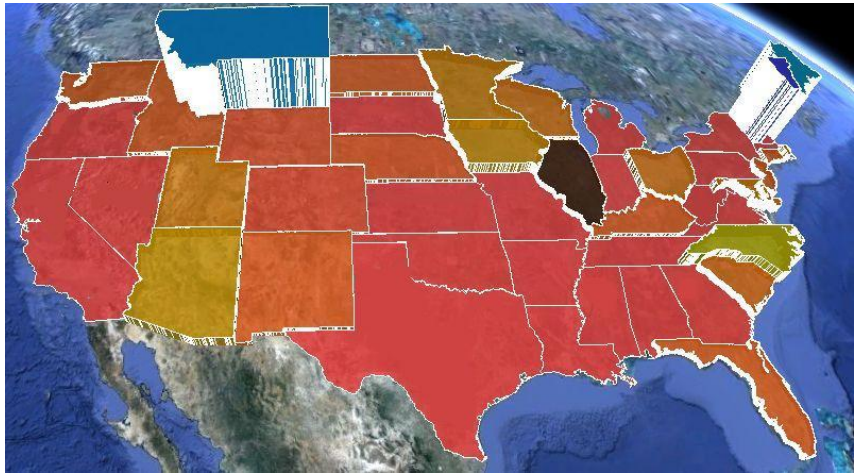
Personal Tax incentives for $5M investment

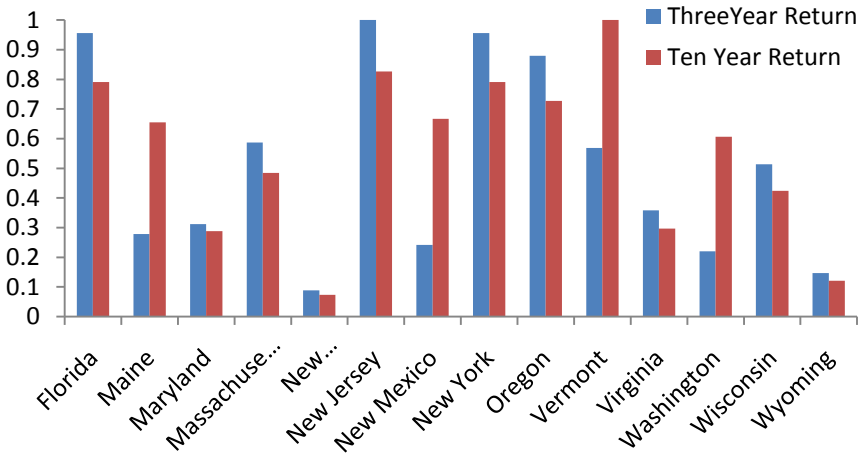


Sales Tax incentives for $5M investment



Incentives for 50MW of generated power





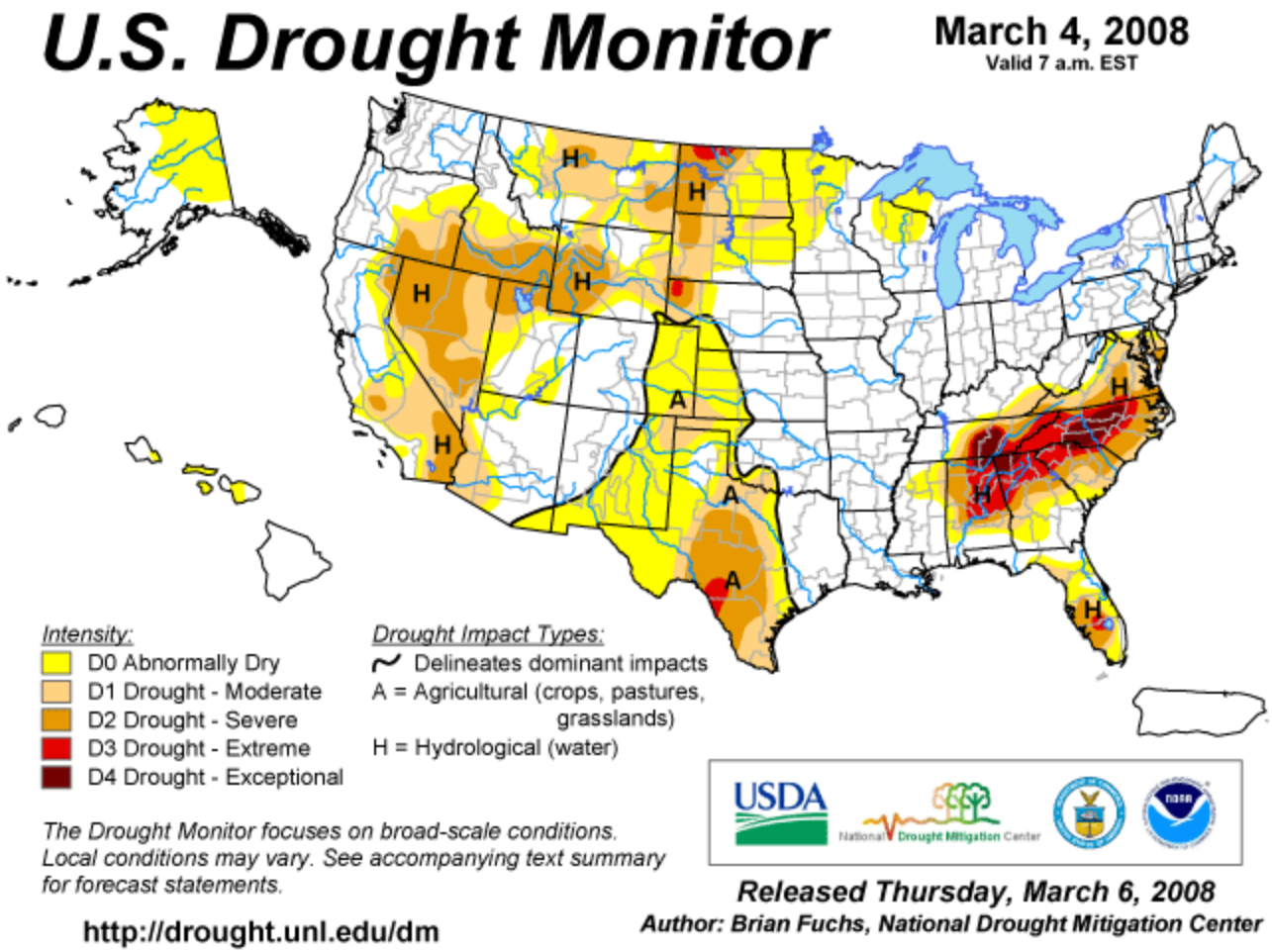
Analysis performed using source data from dsireusa.org

Summary

- **Situational-awareness energy data landscape:**
  - **Actionable information is increasingly available: visualizing data-layers - a useful first step.**
  - **Multiple streams of data (mashups) fill in the composite picture of the interdependent system.**
  - **Live spatio-temporal information is critical for decision/policy-makers context**
- **Energy data analysis:**
  - **Source data layers are value-added with analysis layers**
  - **Toolkits must be informed by diverse constituent components because of cross-cutting socio-infrastructural dimensions**

Thank You! Questions?

The Palmer Drought Severity Index



http://www.drought.unl.edu/whatis/indices.htm#pdsi