High-Performance Visualization of Geographic Data

Presented by

Budhendra Bhaduri
Alexandre Sorokine
Cheng Liu

Geographic Information Science
and Technology
Computational Sciences and Engineering

OAK RIDGE National Laboratory

Geographic information systems: A short introduction

- **GIS = geographic information system**
  - Information system to manage geographic data
- **Uses**
  - Data integration, analysis, modeling, and visualization
- **Example applications**
  - Government
  - Homeland security
  - Resource management
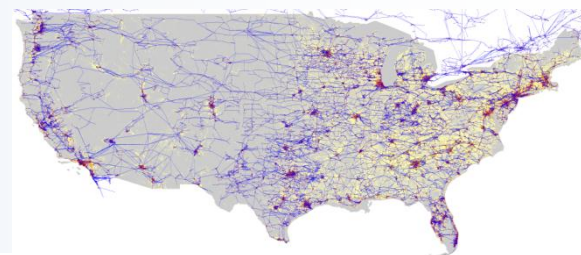 - Environmental management
  - ...
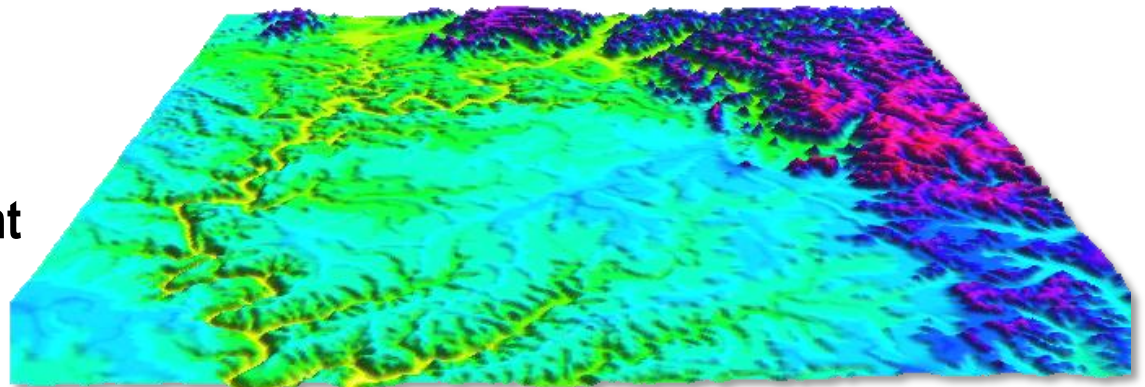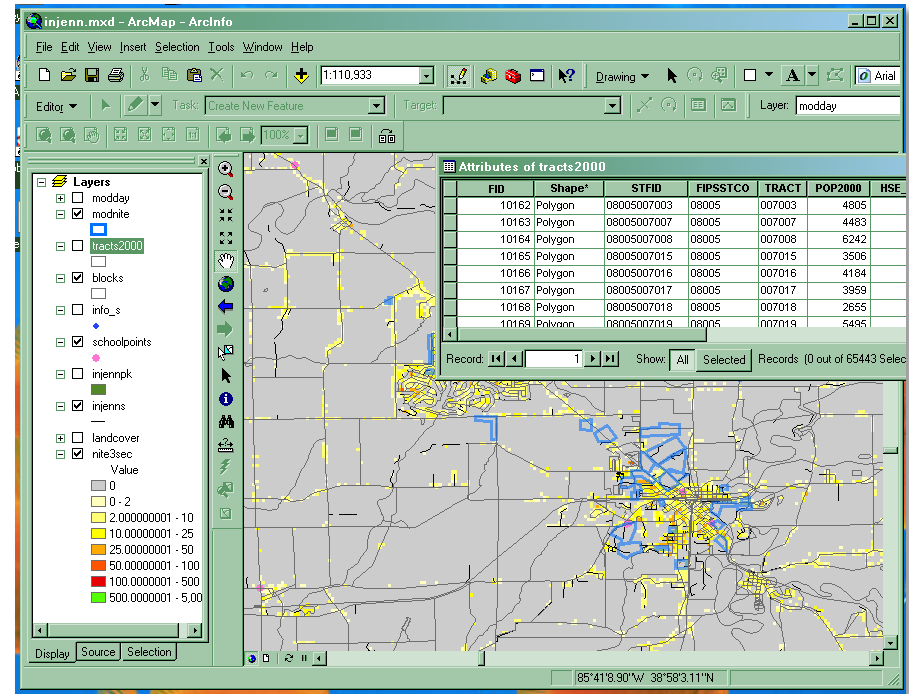
# GIS and high-performance computing: Incentives for convergence

- **Growing size of geographic databases (TB per day)**
  - Hi-res satellite imagery
  - Sensor networks
  - LIDAR, SAR, MODIS, and other sensor platforms
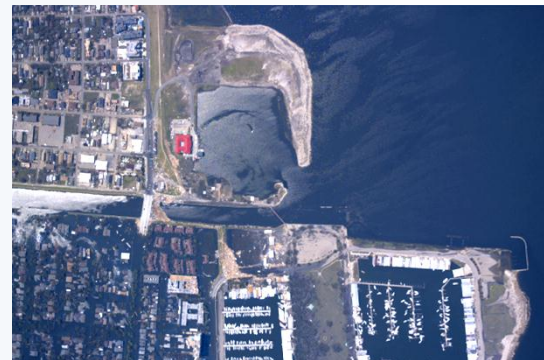
- **Integration of multiple data sources**
  - In Internet applications
  - Using OpenGIS standards

- **New technologies for scientific computing**
  - Dynamic data analysis
  - Data mining and visual exploratory methods
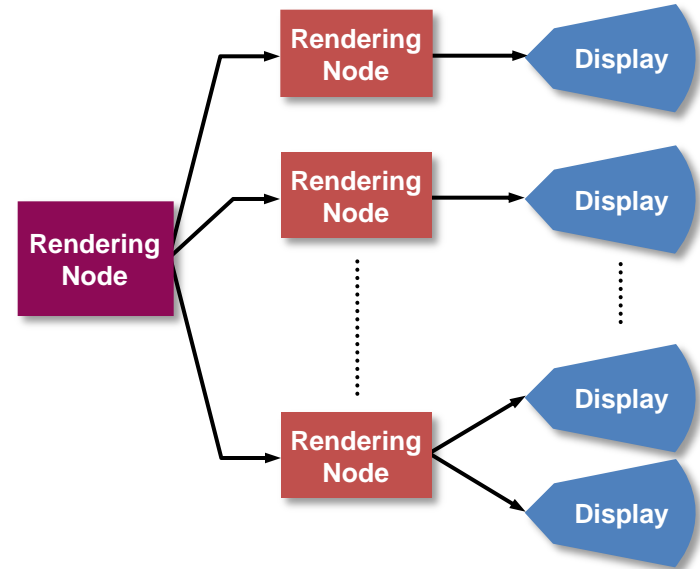 - Simulation models
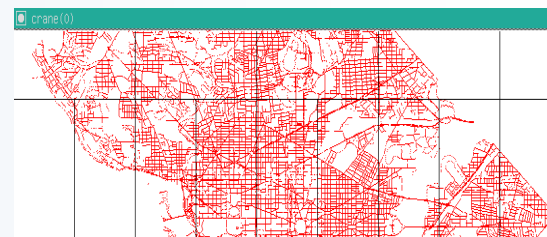
High-performance visualization architecture for GIS

- **EVEREST visualization cluster**
  - **30 × 8 foot viewing area**
  - **11,530 × 3,072 pixel array (35 MP)**
  - **27 digital light projectors**
  - **15 rendering nodes**

- **Software**
  - **OS Scientific Linux**
 - **Xdmx distributed X server**
  - **GRASS graphic information system**

OAK RIDGE National Laboratory

pd-GRASS: Parallel display for GRASS GIS

- **GRASS GIS**
  - **Free GIS package**
  - **No license fees**
 - **Works on Linux**

- **pd-GRASS**
  - **GRASS module for parallel visualization**
  - **Full parallelization**
  - **Tested with data sets of up to 40 GB**
  - **Full GRASS GIS functionality**
  - **Available under GPL from http://www.ornl.gov/gist/software/grass/**
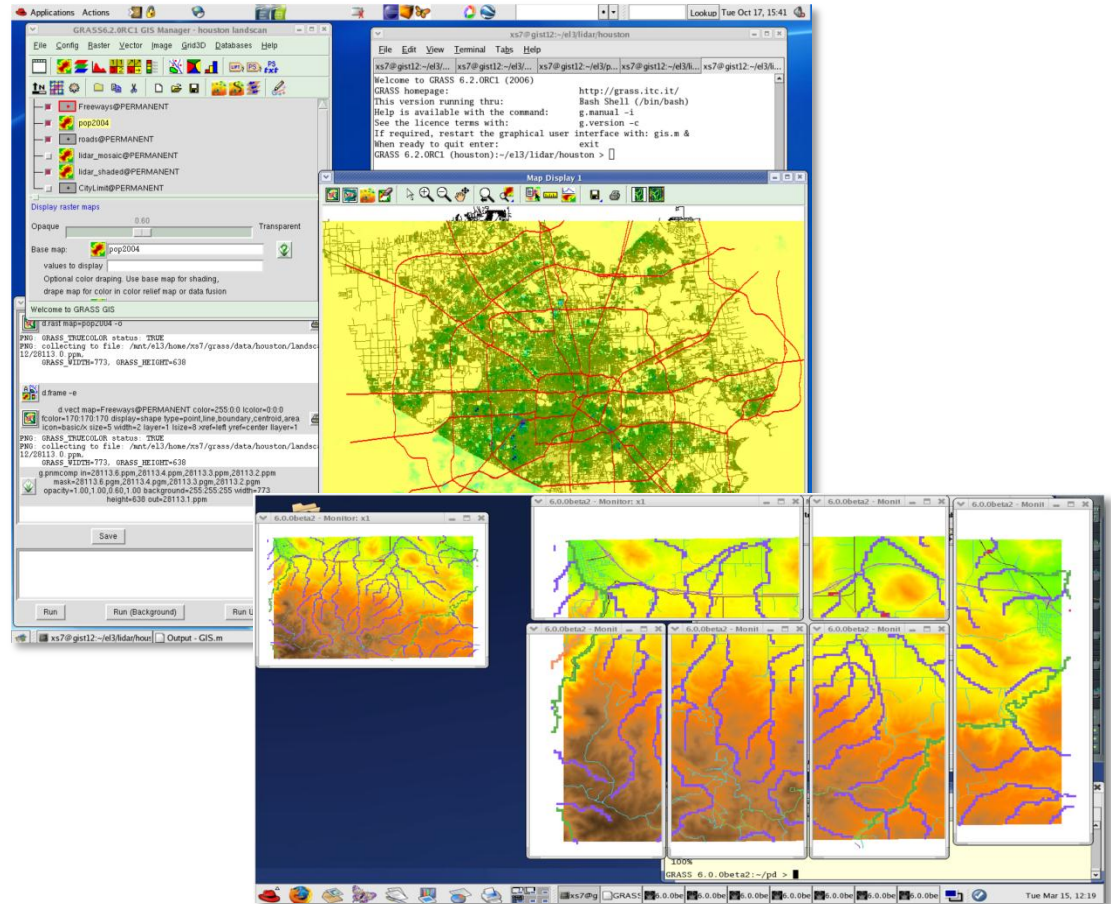
pd-GRASS visualization example: Beyond desktop capabilities

Shuttle Radar Topography Mission (SRTM) dataset

- 90 m cell size

- About 3×10^9 pixel

- Approximately 7 GB

OAK RIDGE
National Laboratory
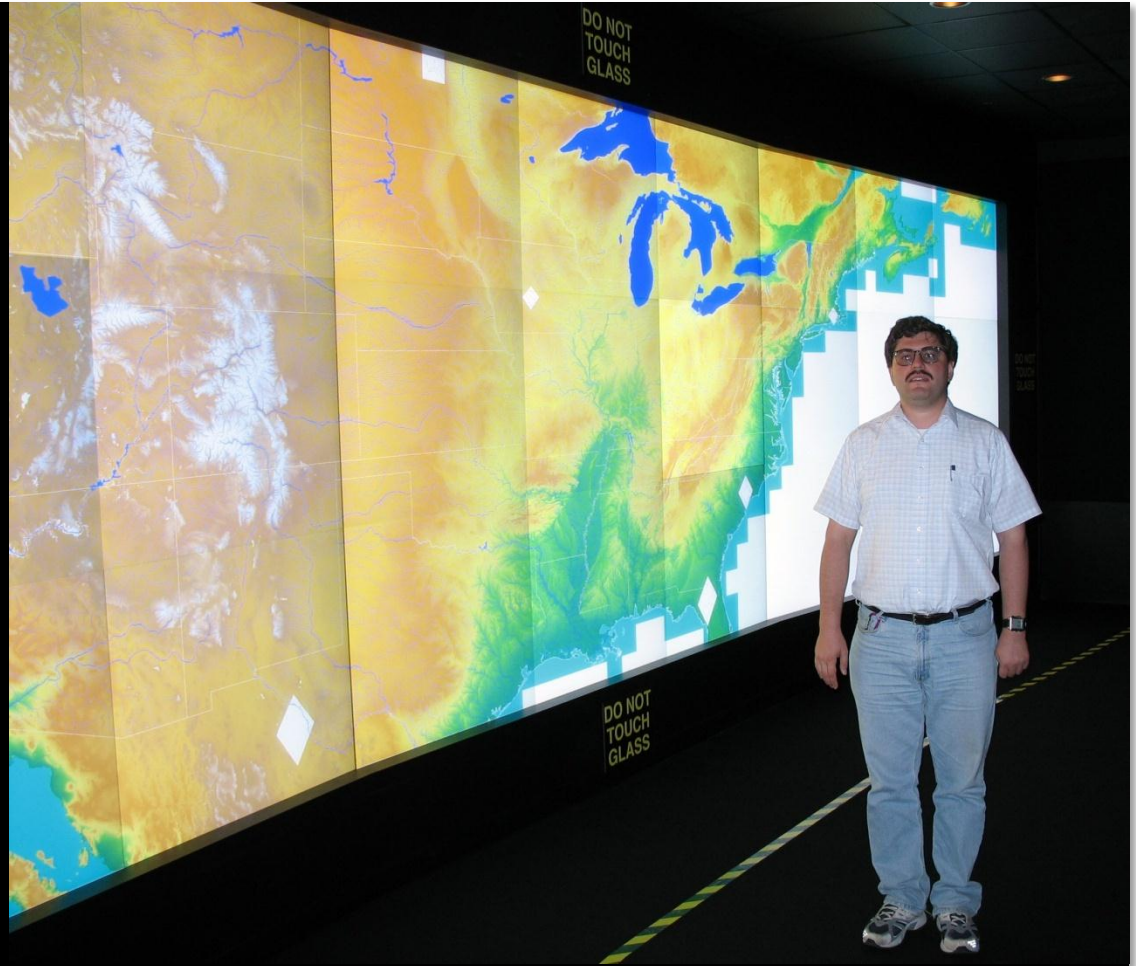
High-resolution 3D view of LIDAR data: Beyond desktop capabilities

## LIDAR data set for the city of Houston

- Resolution: 3 cm horizontal, 1 cm vertical
- 10^8 cells
- Approximately 4 GB

Data courtesy of Center for Space Research, UT–Austin

Parallel geospatial computing

- **Uses**
  - Processing of large data sets
  - Visual analytics of dynamic data
  - Rendering of scientific animations
- **Tools**
  - GRASS+SLURM
    - GRASS = free Linux-based GIS
    - SLURM = Simple Linux Utility for Resource Management (LLNL)
- **Computational domain decomposition**
  - By data layer
  - By function
  - By geographic region
- **Application example**
  - Decluttering of a map of the southeastern United States electric grid

OAK RIDGE
National Laboratory
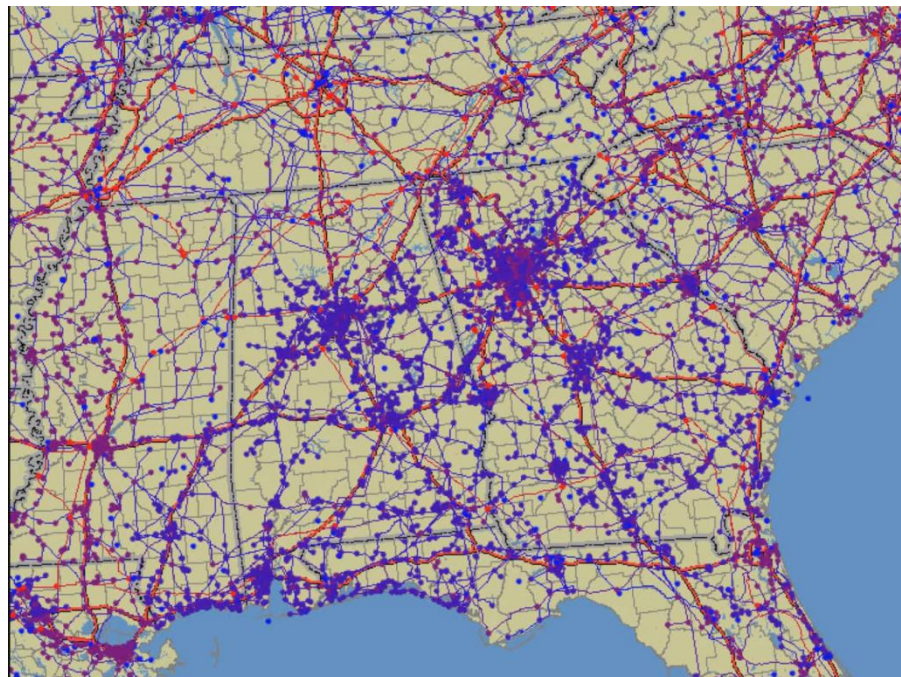
High-performance visualization of agent-based transportation models

- Meso- and macro-scale models
- Testing evacuation scenarios
- Up to a million links
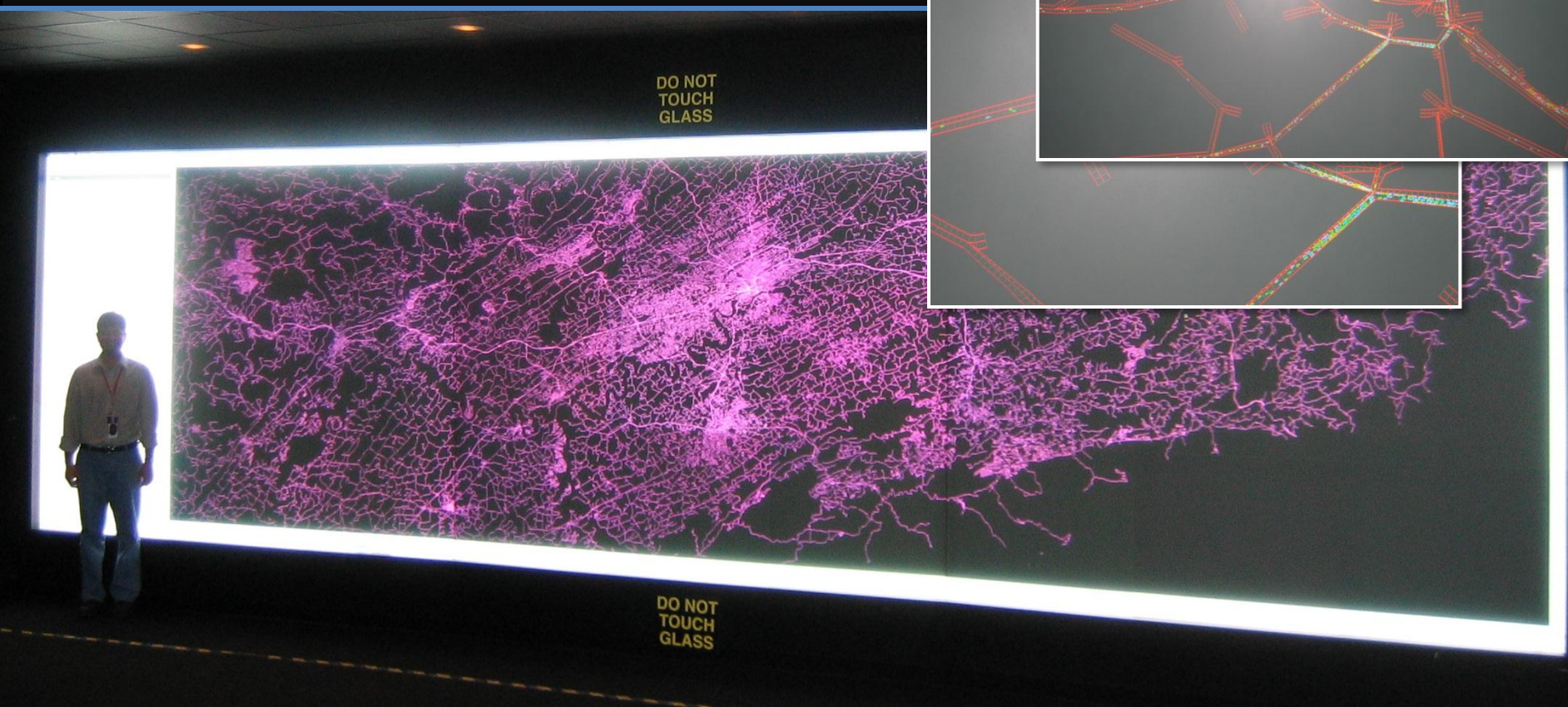
# Animations of high-resolution remote sensing data

Normalized Difference Vegetation Index (NDVI) calculated from MODIS (Moderate Resolution Imaging Spectroradiometer) imagery shows the condition of the vegetated areas at spatial resolution of 250 m and 16 day time intervals

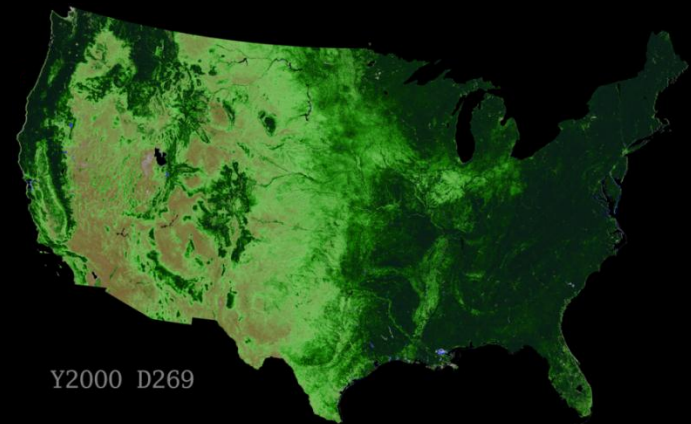NDVI can be compared with temperature and precipitation from preceding period to vegetation growth
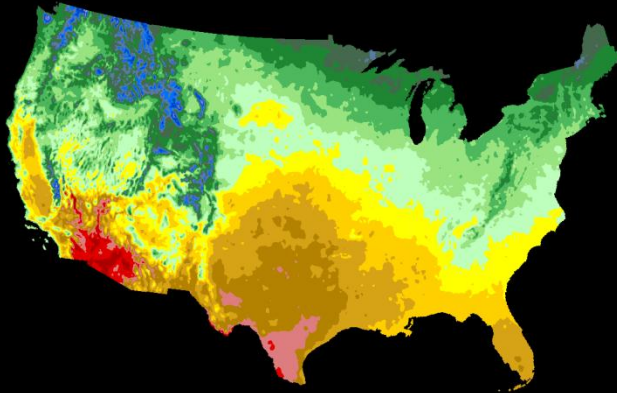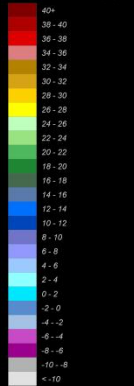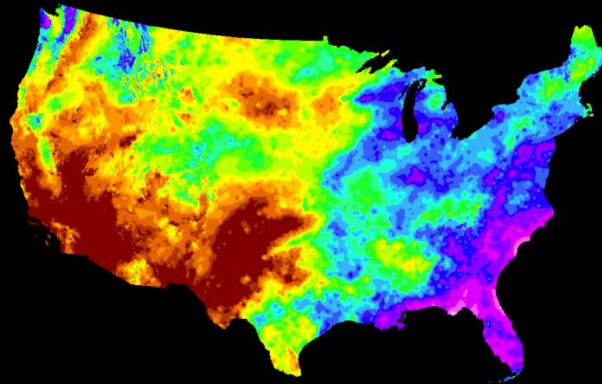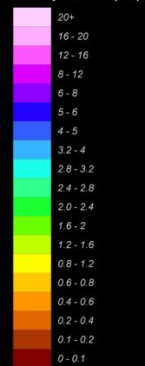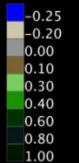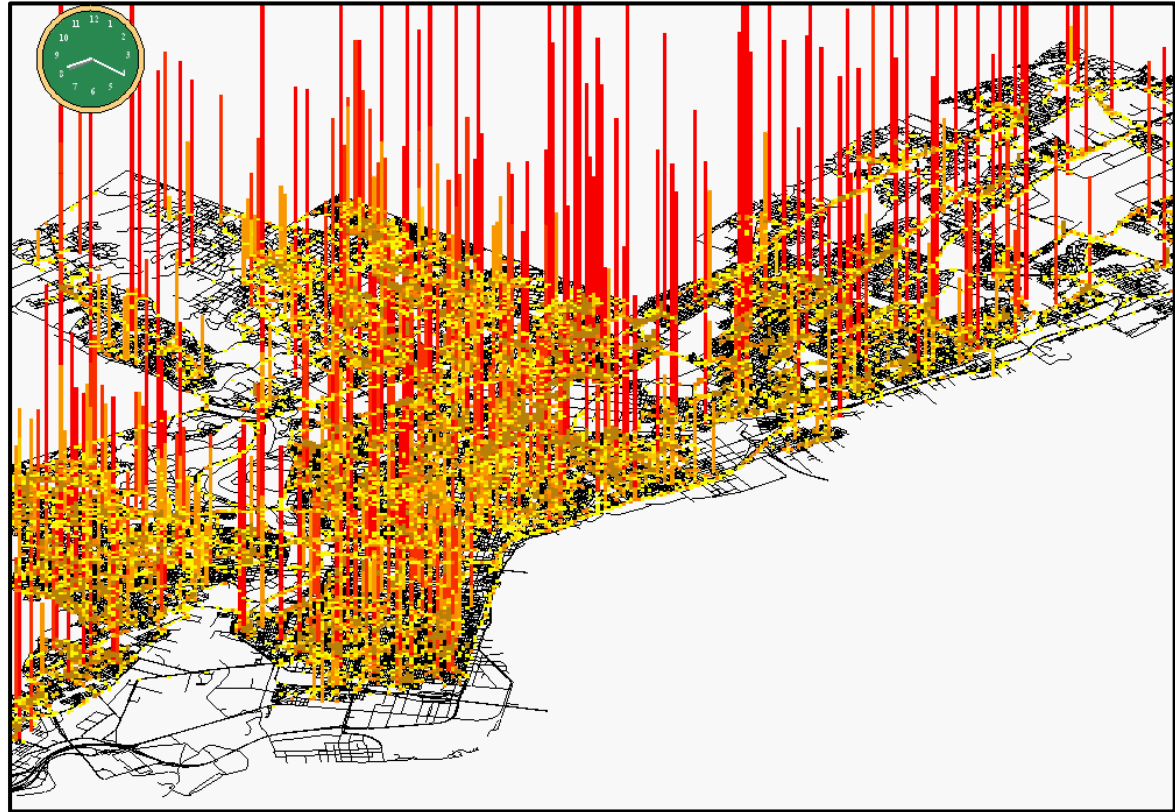
High-performance visualization of transportation models

- **Movement of school students in Philadelphia County**

- **270,000 high school, middle school, and elementary school students**

- **50,000 links on street network**

Visualization of nationwide transportation networks

- **GDT Street network (38M links, 30M nodes) for Continental U.S. (CONUS)**
- **>160 million pixels**

OAK RIDGE
National Laboratory
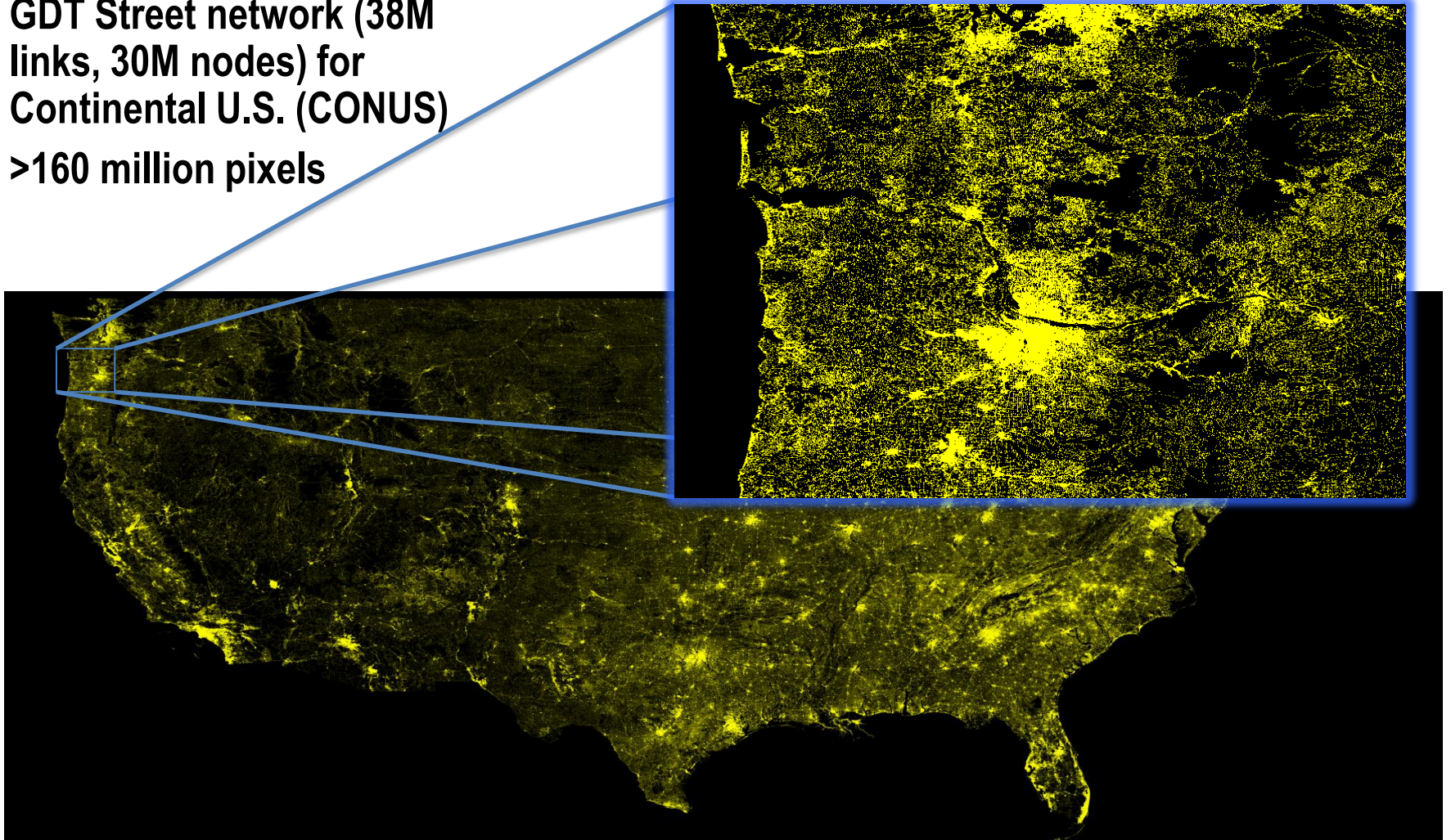
TIGER 2009 Street Map and LandScan USA

- **Image Size**
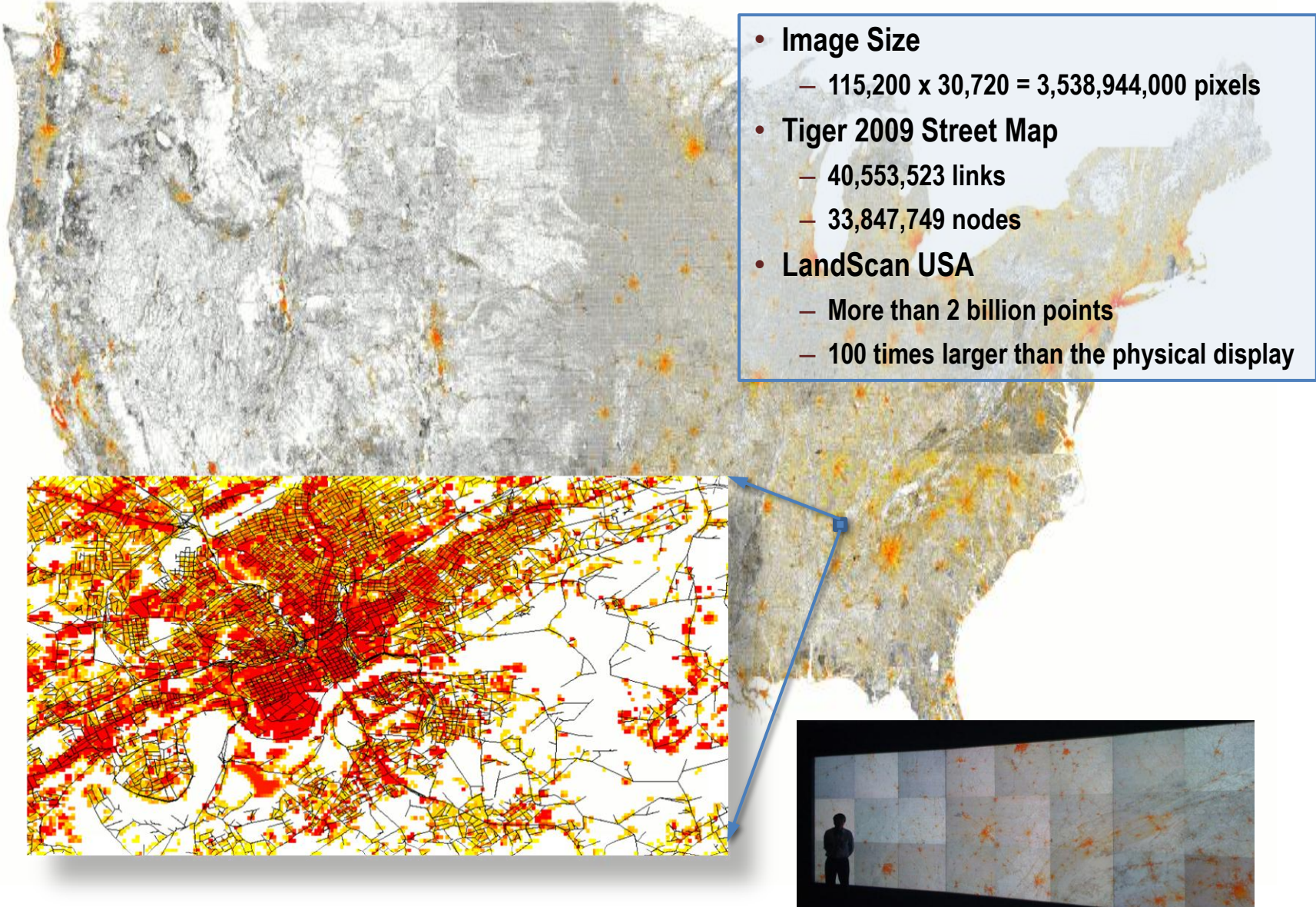 - 115,200 x 30,720 = 3,538,944,000 pixels
- **Tiger 2009 Street Map**
  - 40,553,523 links
  - 33,847,749 nodes
- **LandScan USA**
  - More than 2 billion points
  - 100 times larger than the physical display

OAK
RIDGE
National Laboratory

Contacts

Budhendra Bhaduri

Geographic Information Science and Technology
Computational Sciences and Engineering
(865) 241-9272
bhaduribl@ornl.gov

Alexandre Sorokine

Geographic Information Science and Technology
Computational Sciences and Engineering
(865) 576-7597
sorokina@ornl.gov