

National Elevation Dataset (NED)
Gayla Evans
OCM Inventory Workshop
January 12-13, 2011

EROS: Earth Resources Observation and Science Center



The EROS Mission:

Science:

To promote and conduct applications, use, and knowledge of land information to better understand our planet

Data Access:

To ensure that scientists, researchers, businesses, decision makers, and the public have ready access to land information

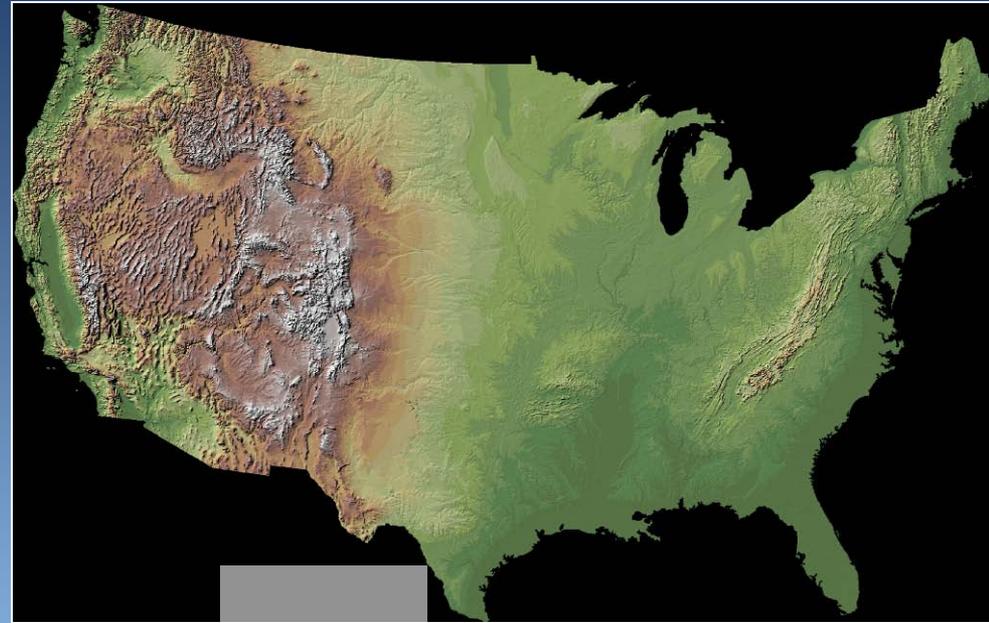
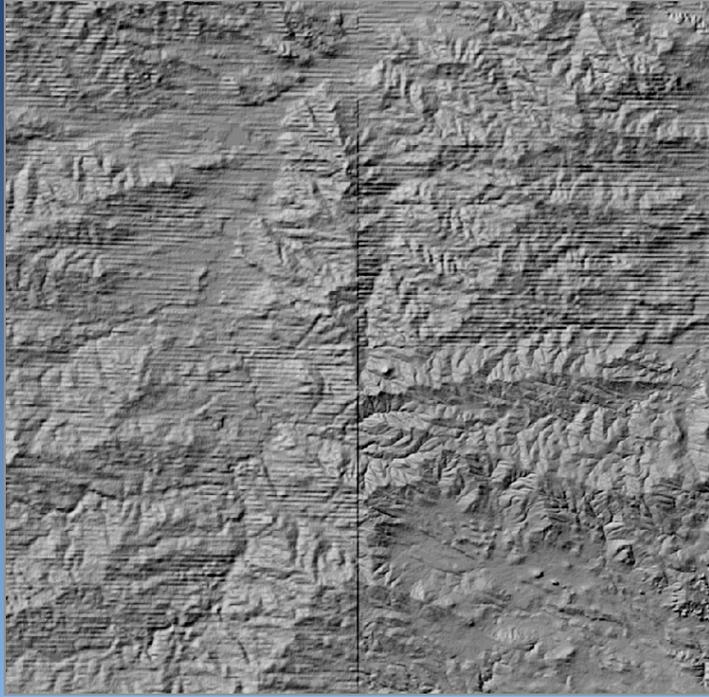
Data Archives:

To safeguard and expand the national archive of remotely sensed land data

The National Elevation Dataset (NED)

- Seamless national coverage of “best available” raster elevation data
 - Geographic “projection”
 - 1-arc-second (30-meter), 1/3-arc-second (10-meter), and 1/9-arc-second (3-meter) grid spacing
 - Alaska: 2-arc-second grid spacing
 - Datum: NAD 83 horizontal; NAVD 88 vertical
 - Elevation units: decimal meters
 - Updated bi-monthly to incorporate all new USGS DEM production and other newly available source data
- NED is the elevation layer of *The National Map*

Large-Area Elevation Data Coverage



7.5-minute quadrangle tiled database

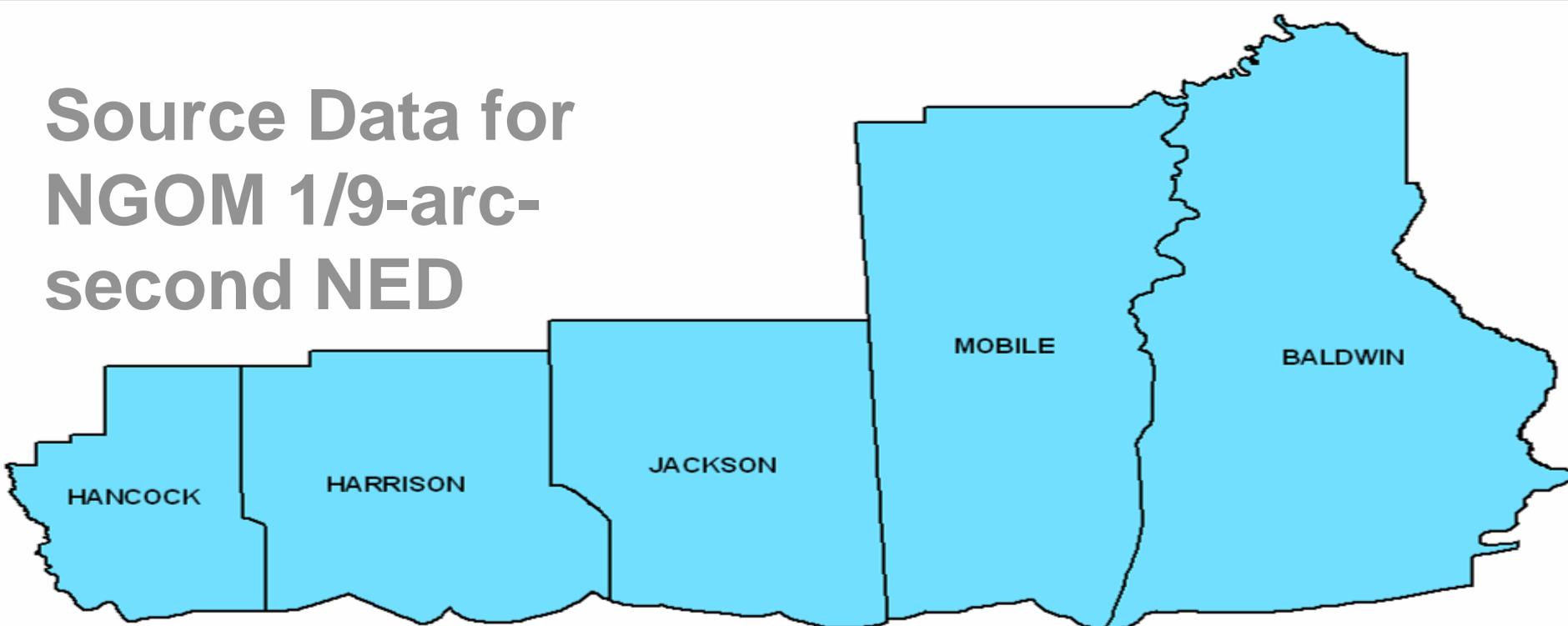
- Nearly 54,000 quad-based DEMs
- Projected in 10 different UTM zones
- Production artifacts (stripes), slivers of missing data, elevation value mismatches along quad boundaries
- Metadata in individual files



The National Elevation Dataset (NED)

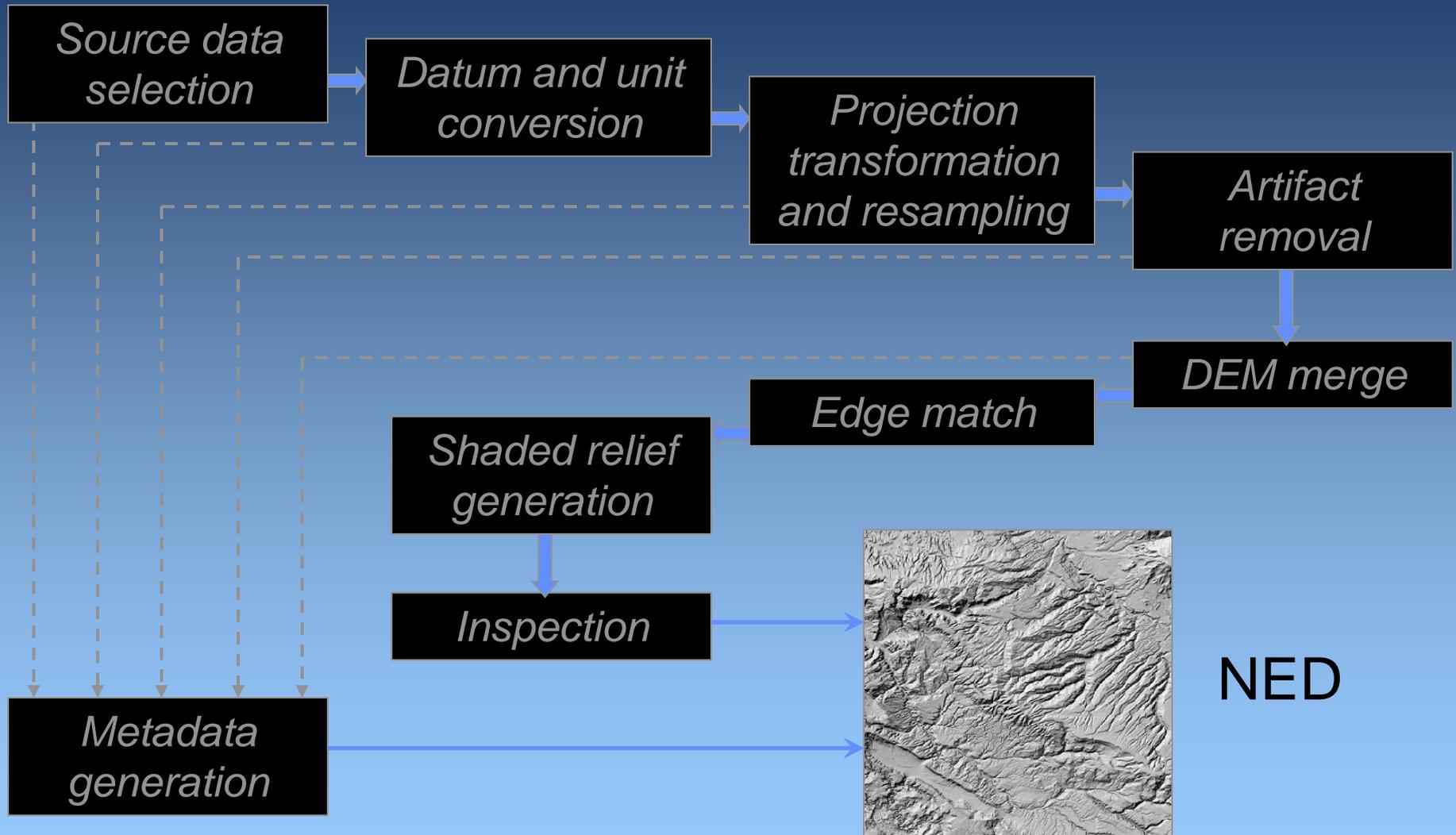
- Seamless raster mosaic
- Consistent national coordinate system
- Standardized datums and units
- Filtered and edge-matched, where necessary
- Spatially referenced metadata

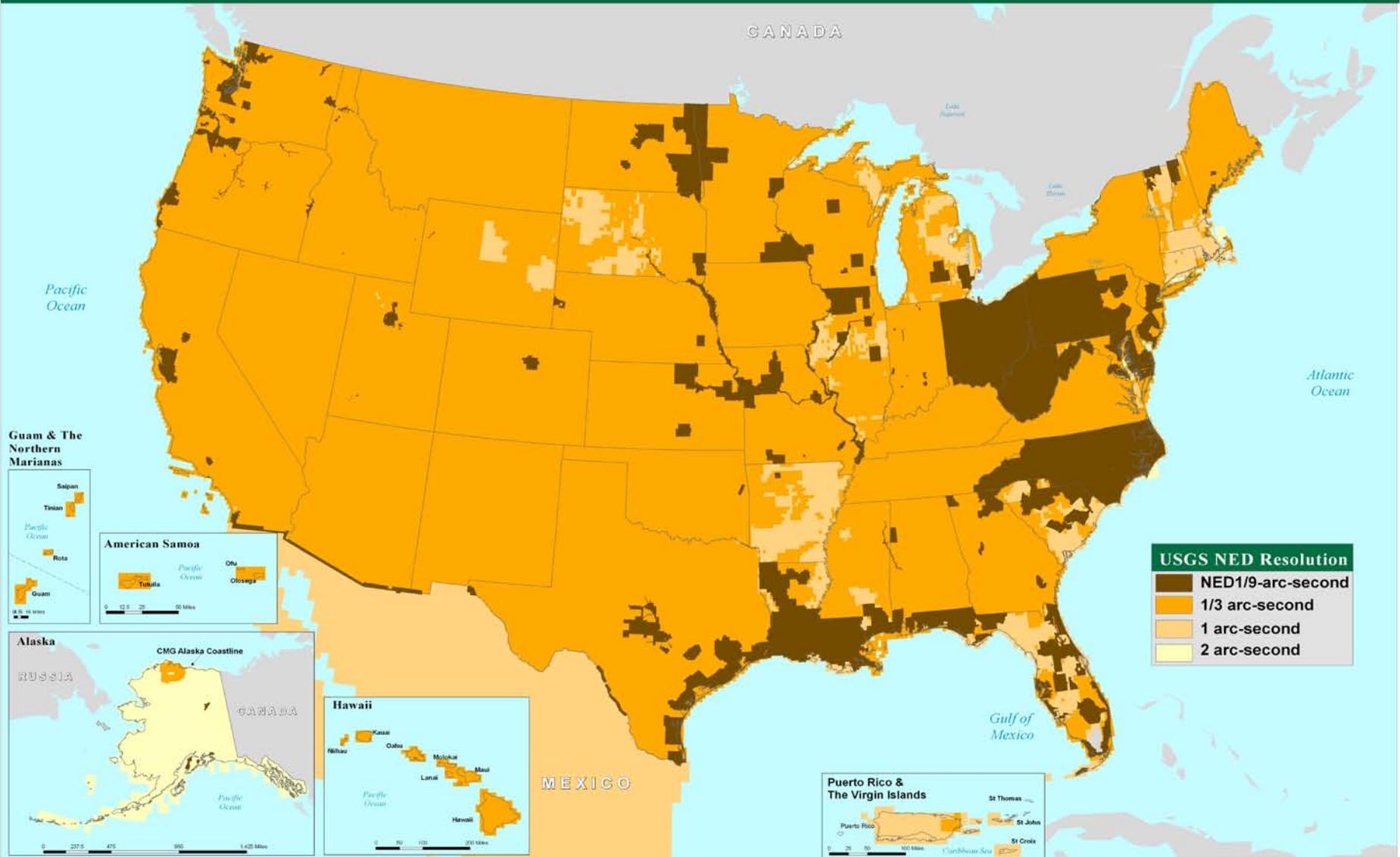
Source Data for NGOM 1/9-arc- second NED

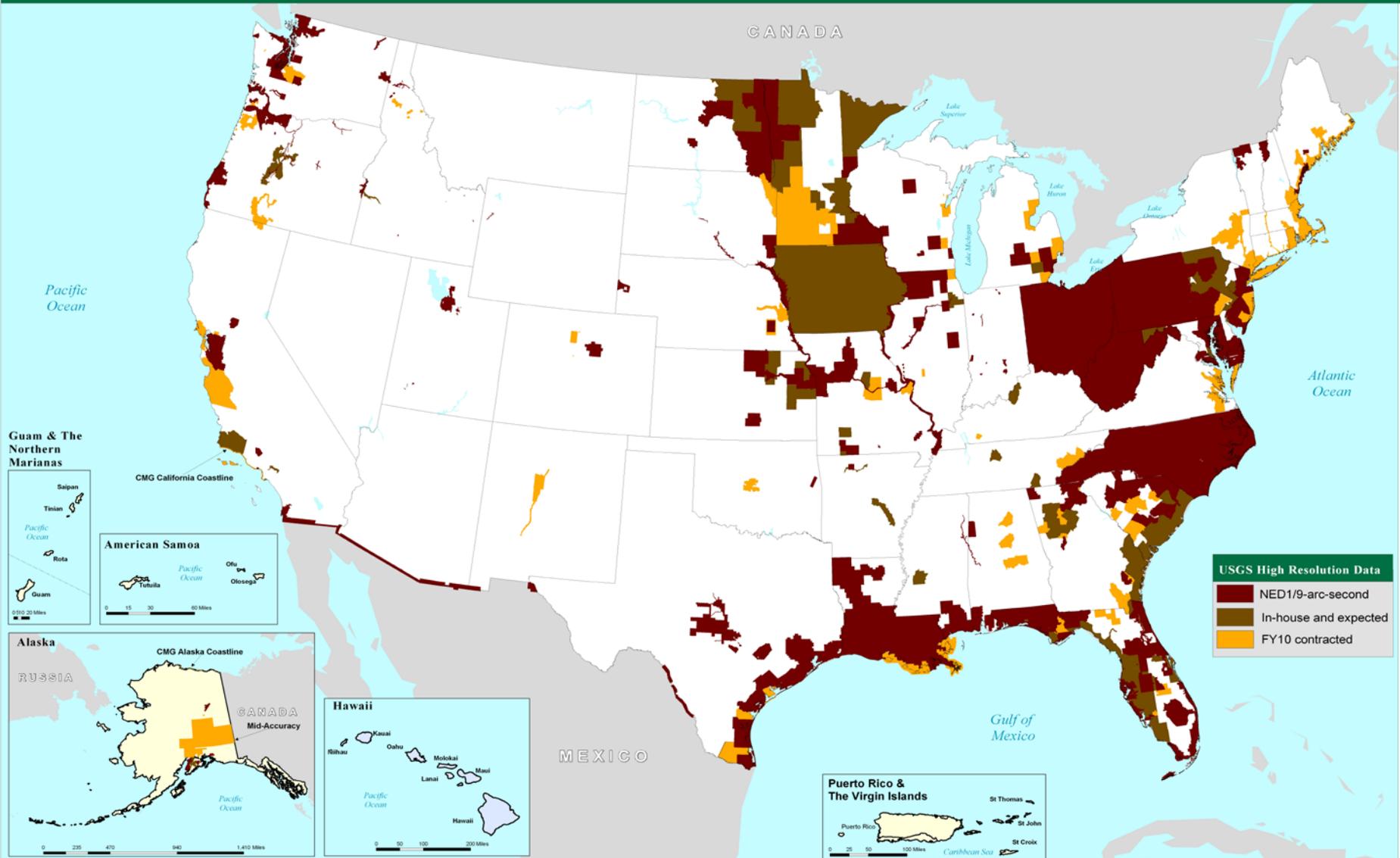


Area	Format	Projection	Elevation Units	Metadata?
Louisiana	5-m DEM (raster)	UTM	Feet	Yes
Hancock Co., Mississippi	LAS binary (points)	MS State Plane (m)	Feet	Yes
Harrison Co., Mississippi	ASCII XYZ (points)	MS State Plane (ft)	Meters	No
Jackson Co., Mississippi	LAS binary (points)	MS State Plane (m)	Feet	Yes
Mobile Co., Alabama	LAS binary (points)	AL State Plane (ft)	Feet	Partial
Baldwin Co., Alabama	Shapefile (MPBL)	AL State Plane (ft)	Meters	Partial

NED Production







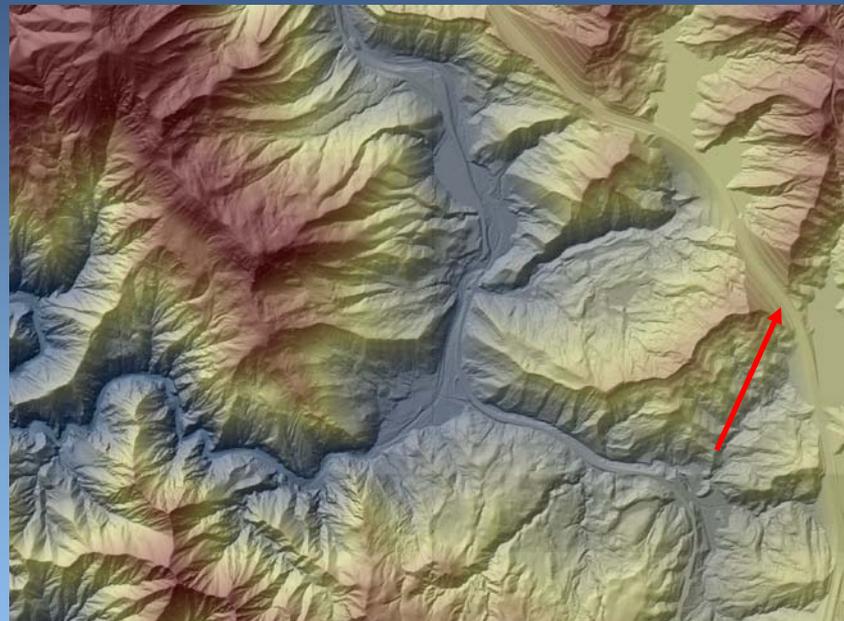
USGS High Resolution Data

- NED1/9-arc-second
- In-house and expected
- FY10 contracted

Importance of improved elevation 10-meter vs 1-meter lidar

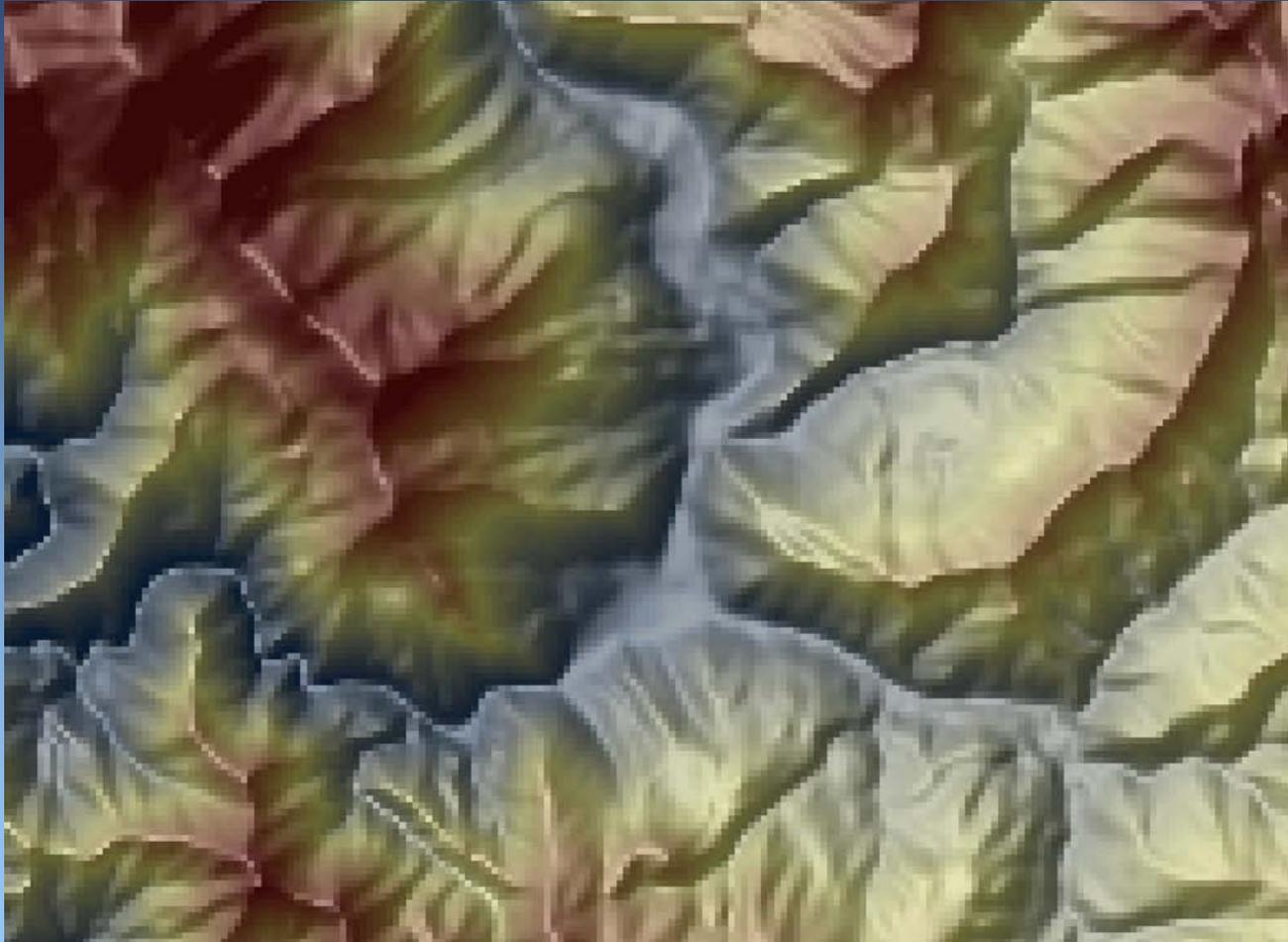


10 meter elevation data

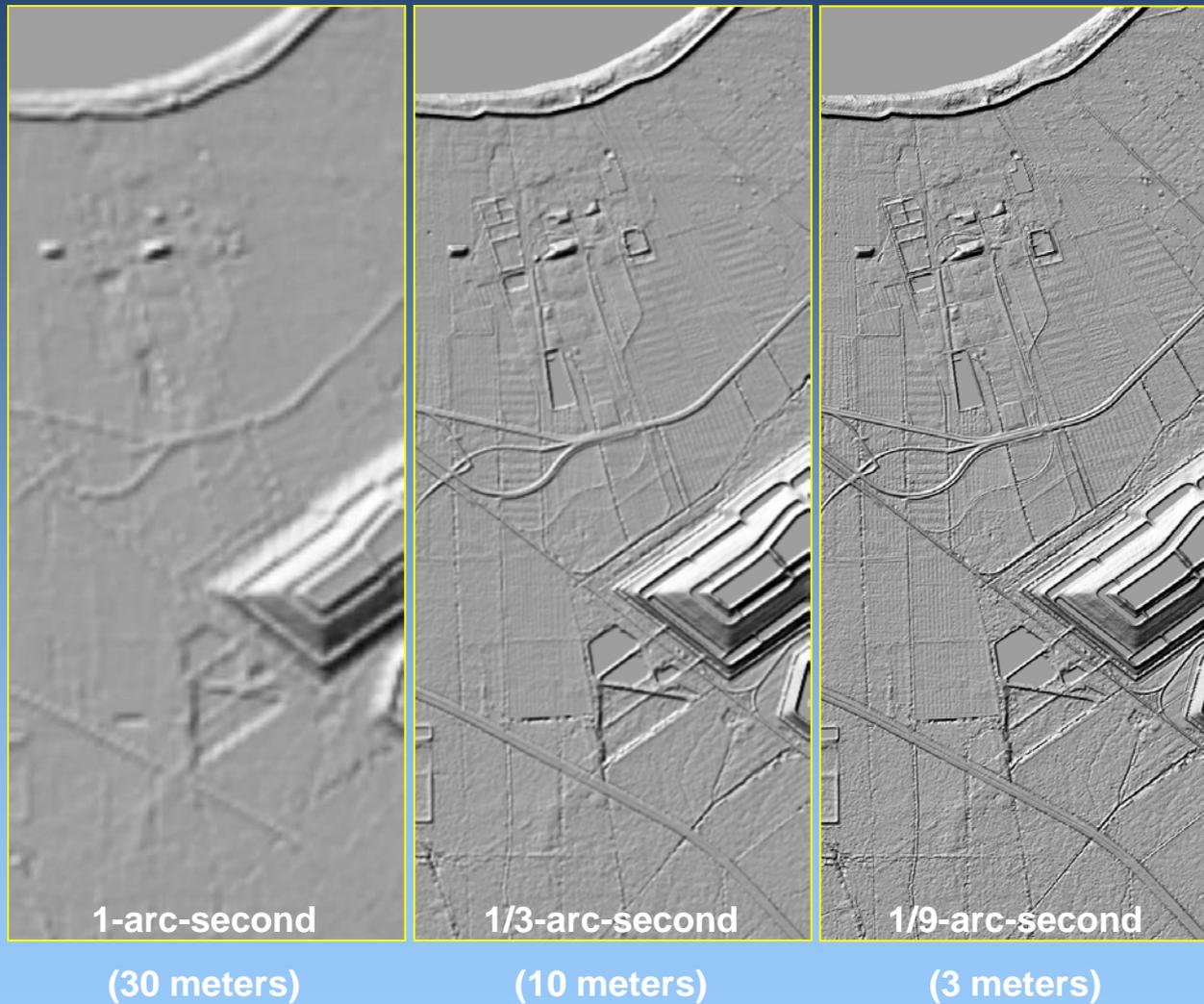


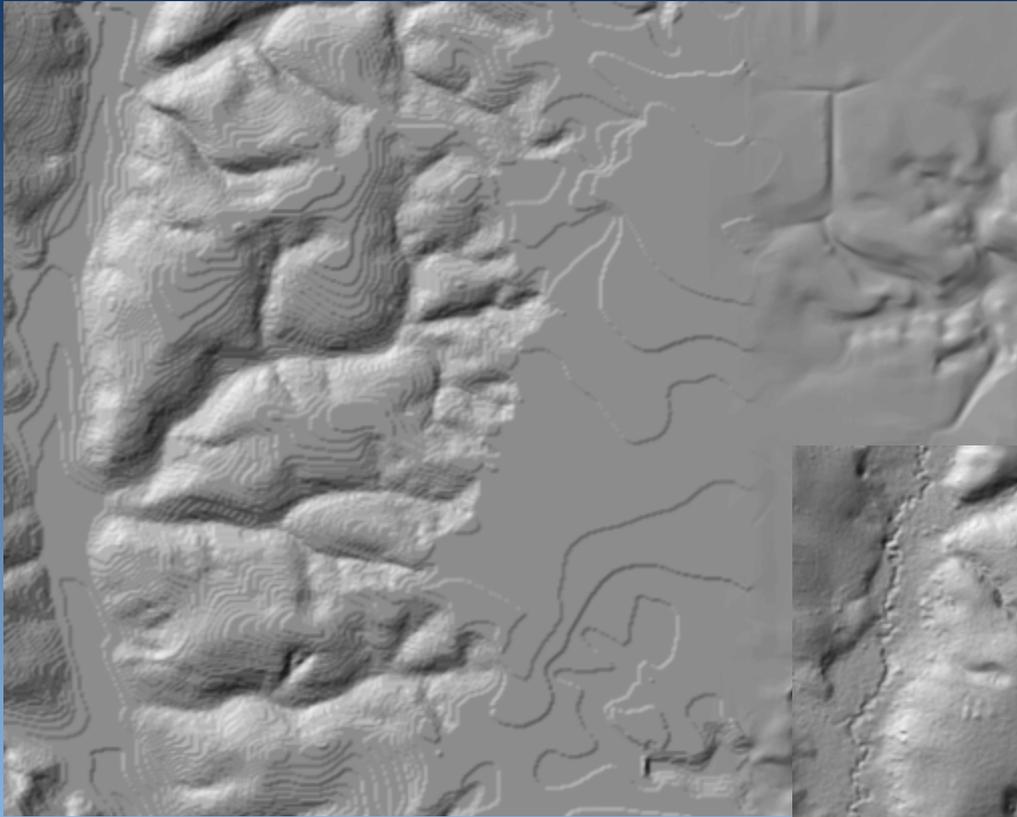
1 meter elevation data
derived from lidar

Elevation – 30m, 10m, & 1m

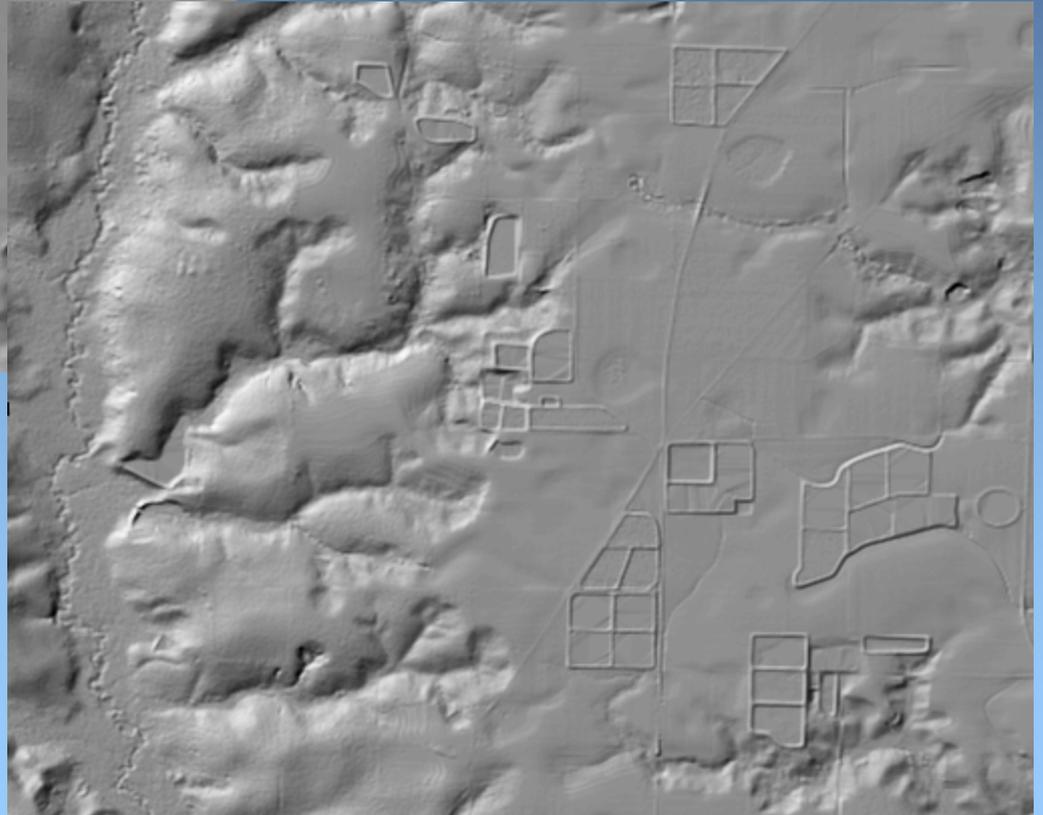


Higher resolution source migration





NED 1/3 10M source
prior to 3M source
migration



Present NED 1/3 with
3M source



Migration of the NED Source Data

- Resampling higher resolution data and merging it into the lower resolution datasets
- This has been an automatic process as the 10 meter source has been included into the NED replacing the 30 meter source
- The NED 1 and 1/3 datasets are kept in sync having identical source data used to prepare them

Migration Continued:

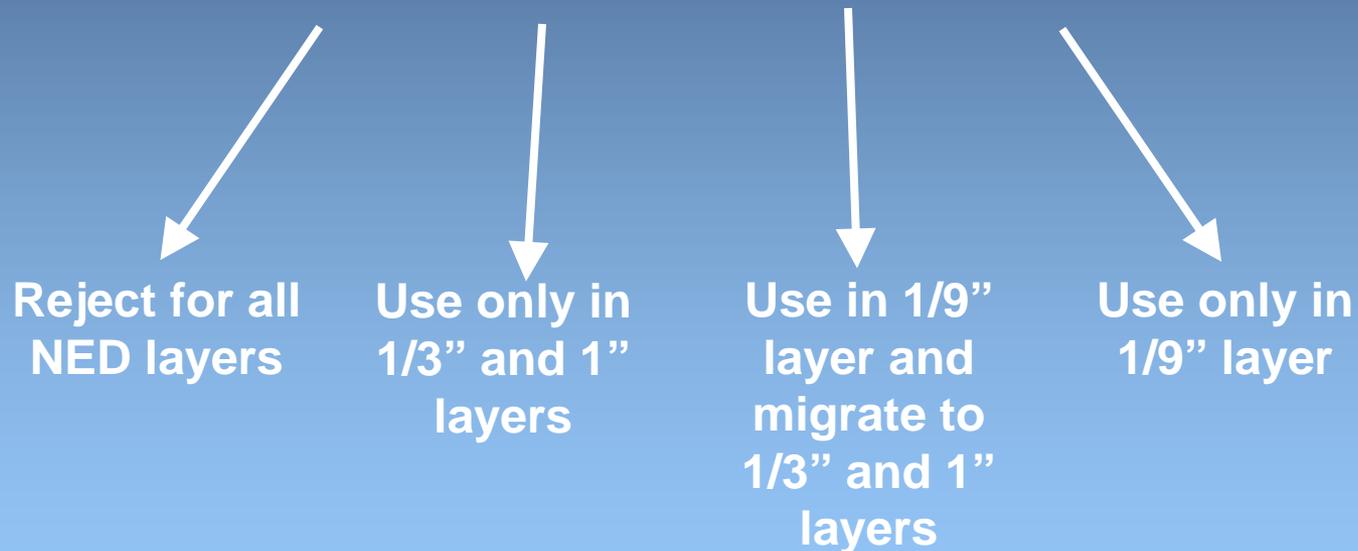
- Originally there was a similar assumption for the inclusion of the higher resolution source data
- Unfortunately, the consistency of the high resolution datasets has not stabilized
- Many of the high resolution datasets received are very useful for specific applications
- However, the dataset may not meet the NED criteria to which the 1 and 1/3 layers are held to
 - Flattened water bodies
 - Properly bare-earthed surface
 - Good resampling and minimal seam lines
 - Minimal TIN artifacts

Migration Continued:

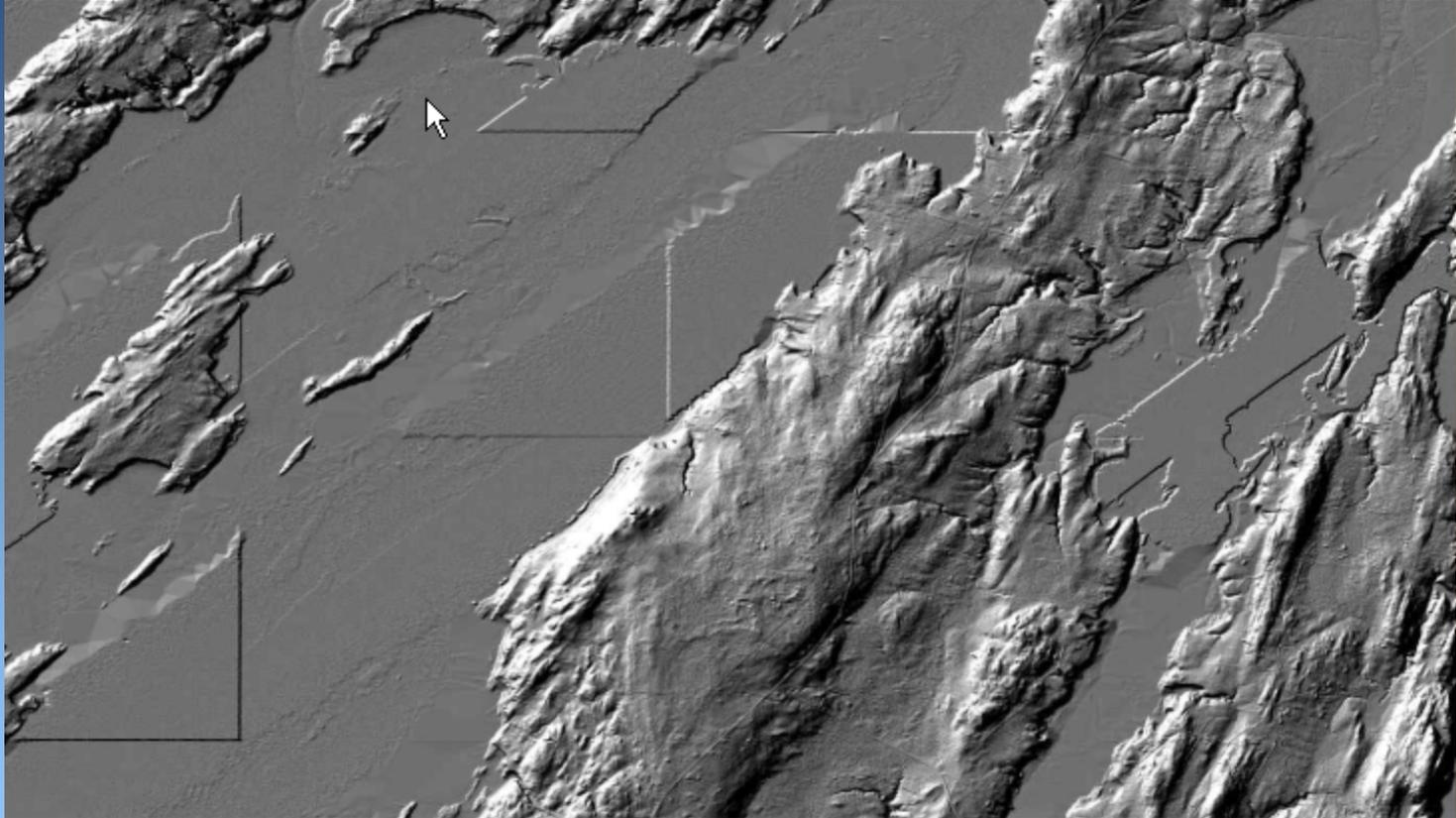
- **The National Elevation Team through the weekly telecons altered the migration policy**
 - **Higher resolution source datasets which do not meet the criteria of the NED 1 and 1/3 layers but support the NED 1/9 resolution and are the best available for that resolution will be accepted into the NED 1/9 layer**
 - **Datasets not meeting the criteria the of NED 1 and 1/3 layers will not be migrated**
 - **Reasons for migration rejection of a dataset and example graphics of the issues are captured for future reference**
 - **New spatial metadata fields have been developed to support this change**

“Best Available”

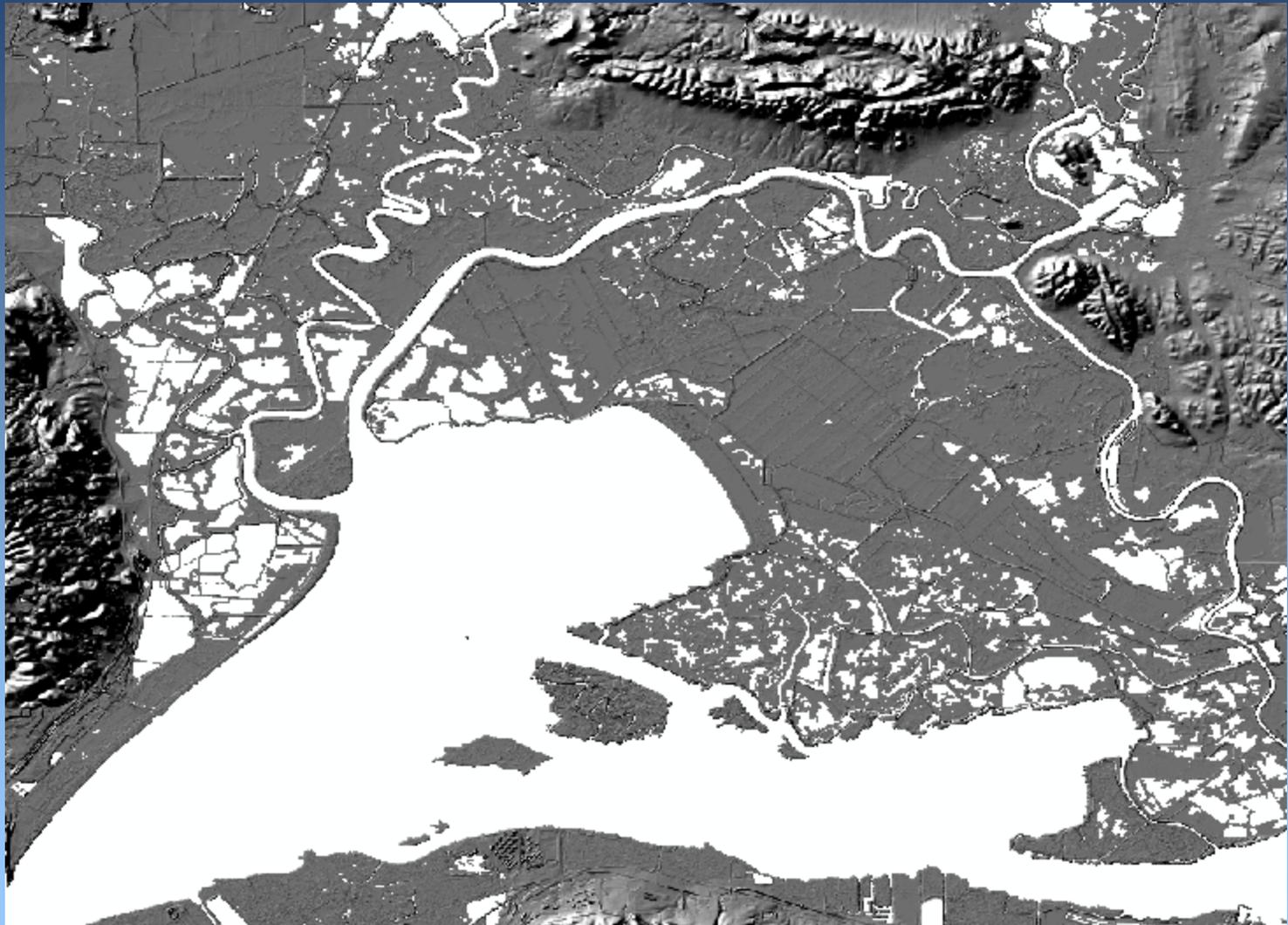
NED “best available” source data – decision rules



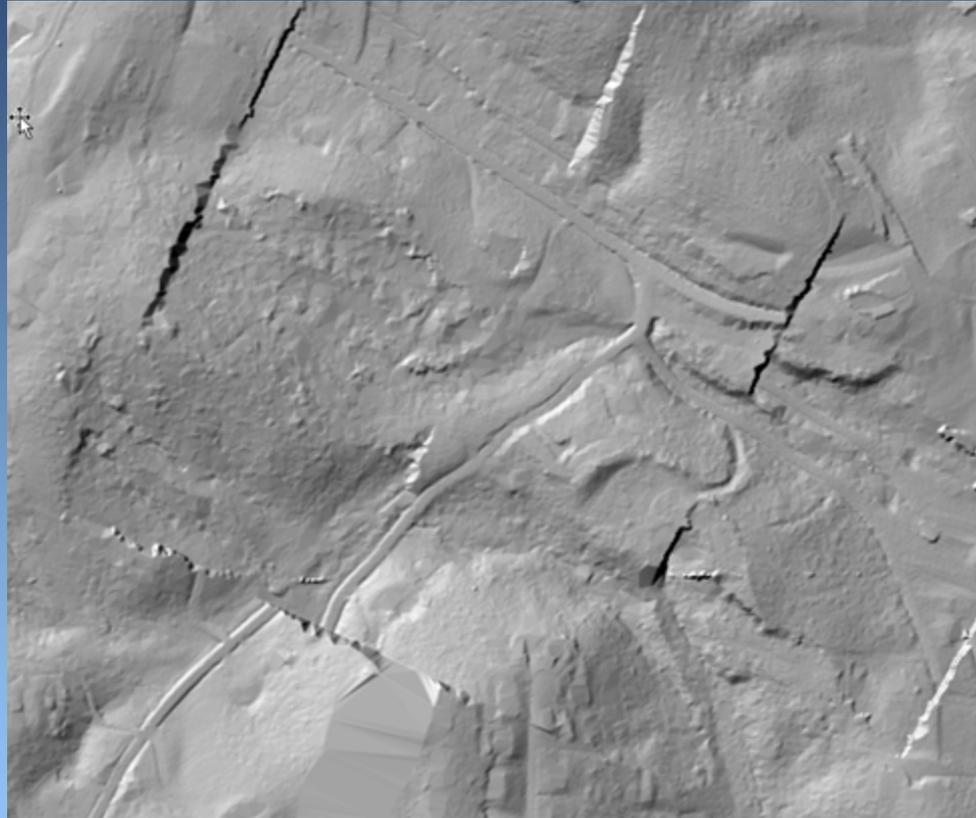
Water bodies higher than land



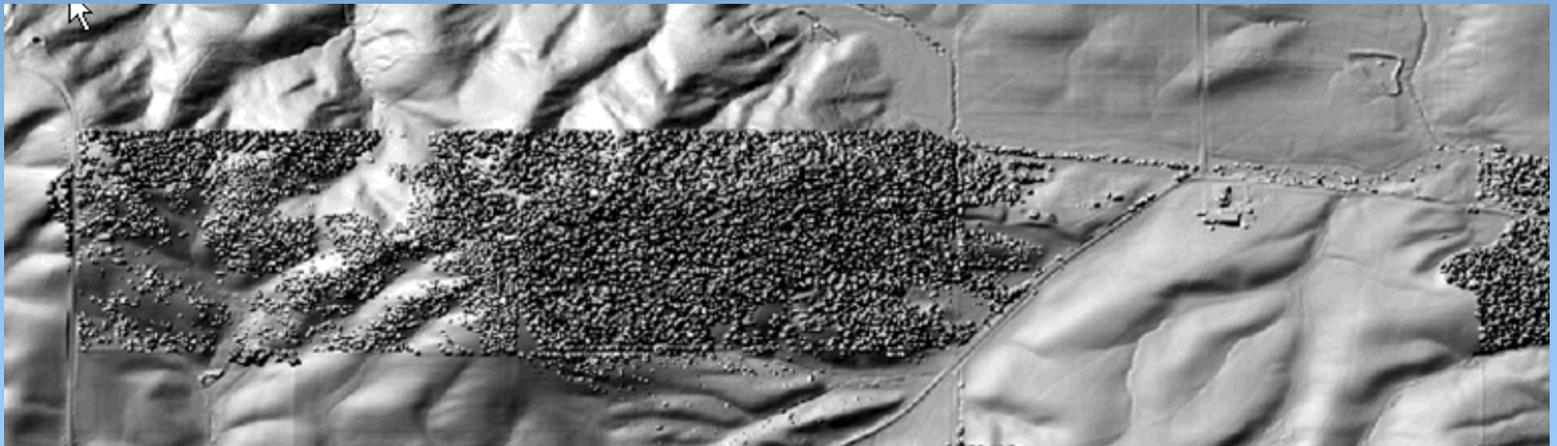
Large number of data voids



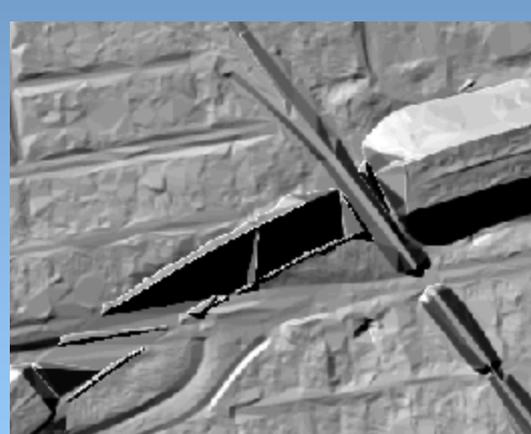
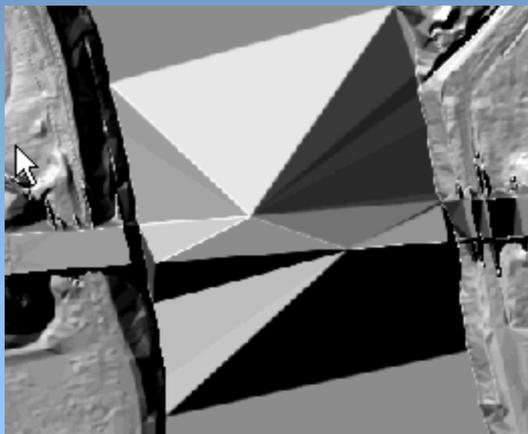
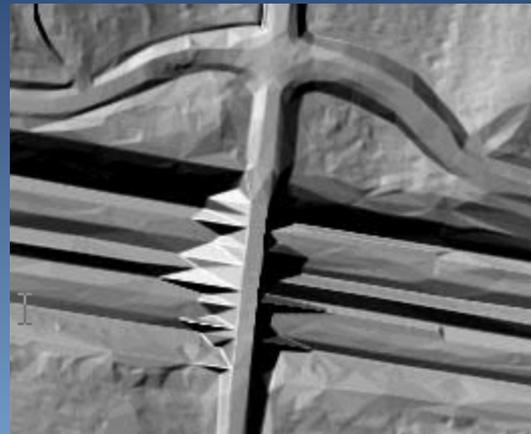
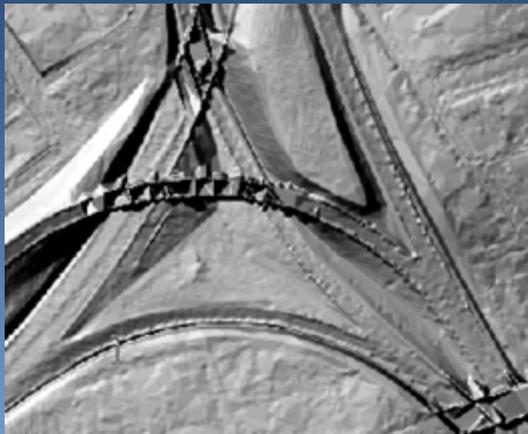
Misalignment of data



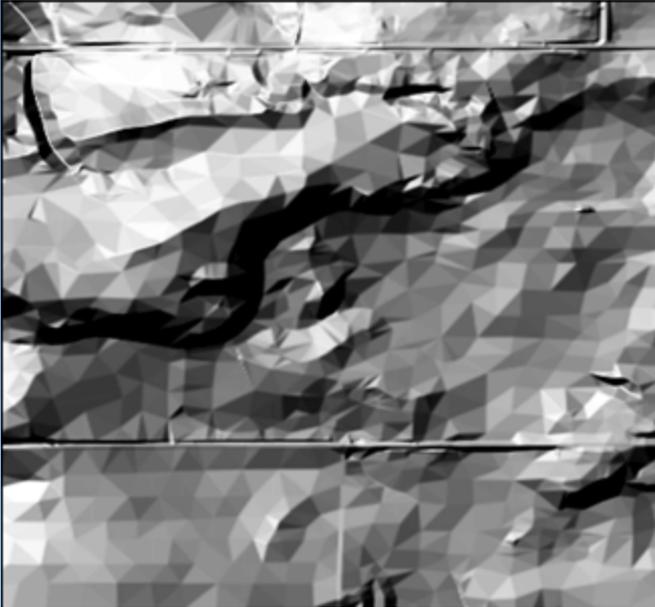
Poor bare earth process



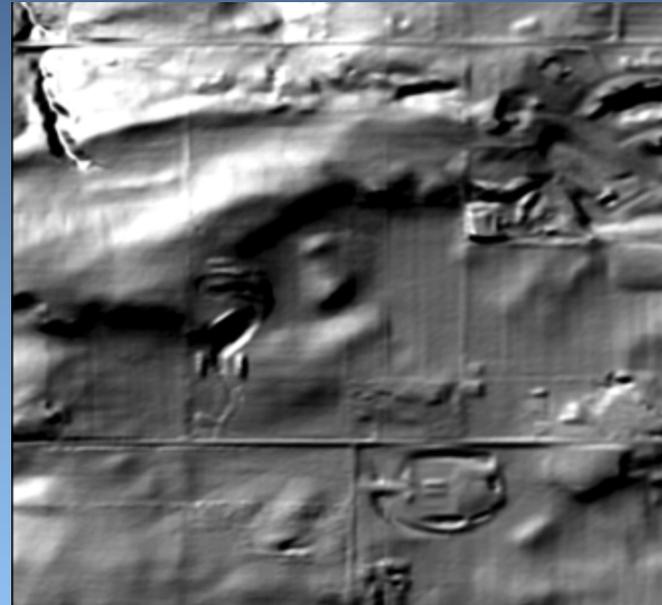
Improper handling of overpasses



Excessive tinning



Excessive Tinning



Expected surface

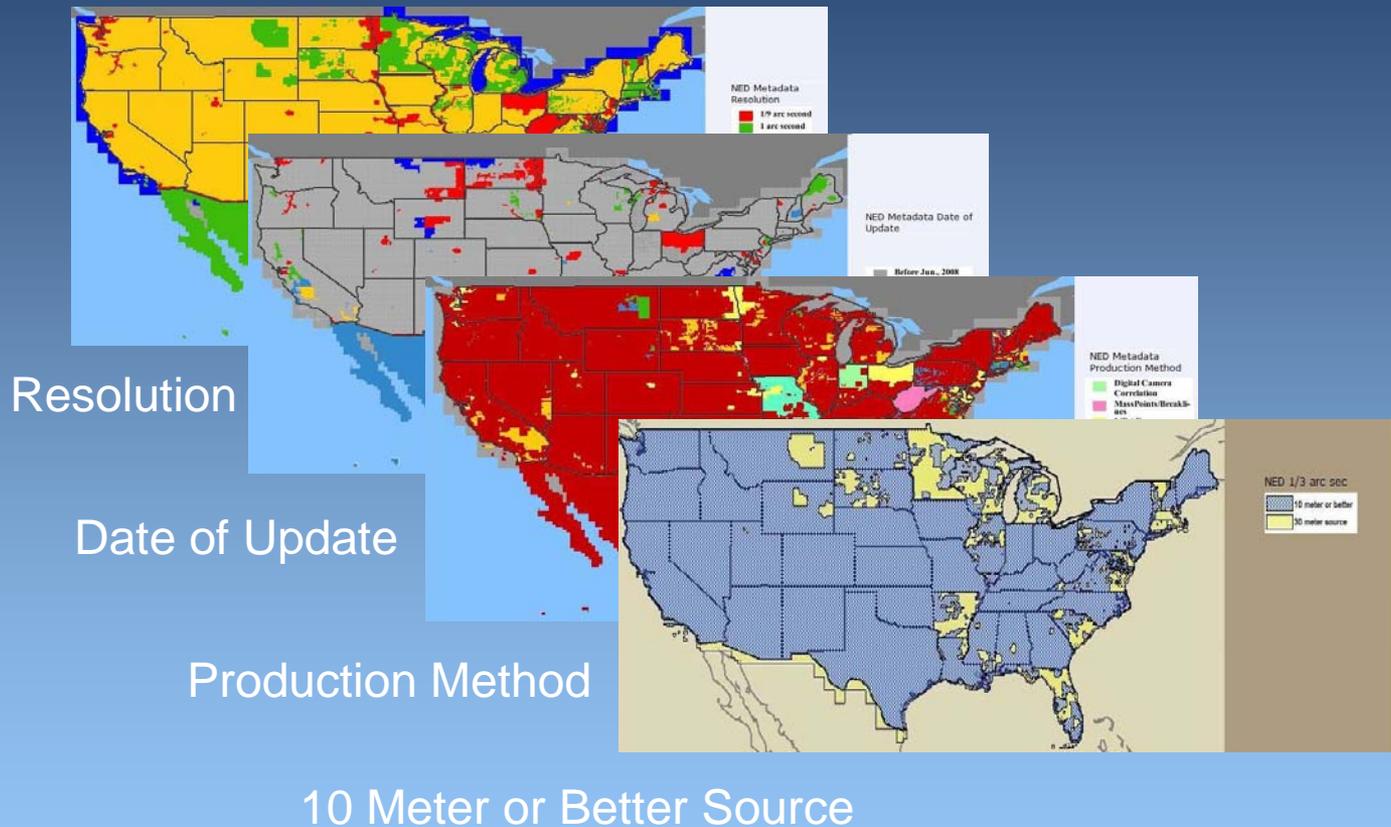
USGS-NGP Base Lidar Specification

- Prompted by ARRA funding for lidar to support the NED
 - Clarify USGS **minimum** requirements for NED usage
 - Include optional buy-up options
 - **Initially viewed as a one-pager**
- Wide variety of lidar issues caused expansion of scope
 - Improve consistency across lidar deliveries to the USGS
 - Allow waivers for flexibility (previous collections; science)
 - Better reflect the goals of the earlier Draft Standard
- Addresses both point cloud data and derived products
 - Assures delivery of bare-earth DEMs suitable for use in the NED
 - Assures delivery of consistent point cloud data for use in other scientific and mapping applications
- Specs to be durable beyond ARRA projects

Status of the Base Specification

- Intended only to apply to NGP projects, and still in draft form, the Spec has already been tentatively embraced by numerous other Federal agencies, data and software vendors, and professional groups:
 - FEMA, NRCS, NGA
 - Dewberry, Merrick, URS
 - ASPRS, MAPPS
- Expectation that a broader “Federal” Lidar Spec will be developed
 - Common body dealing with point clouds and practices
 - Appendices specific to individual agencies/projects
 - Collection specifics
 - Derived product requirements

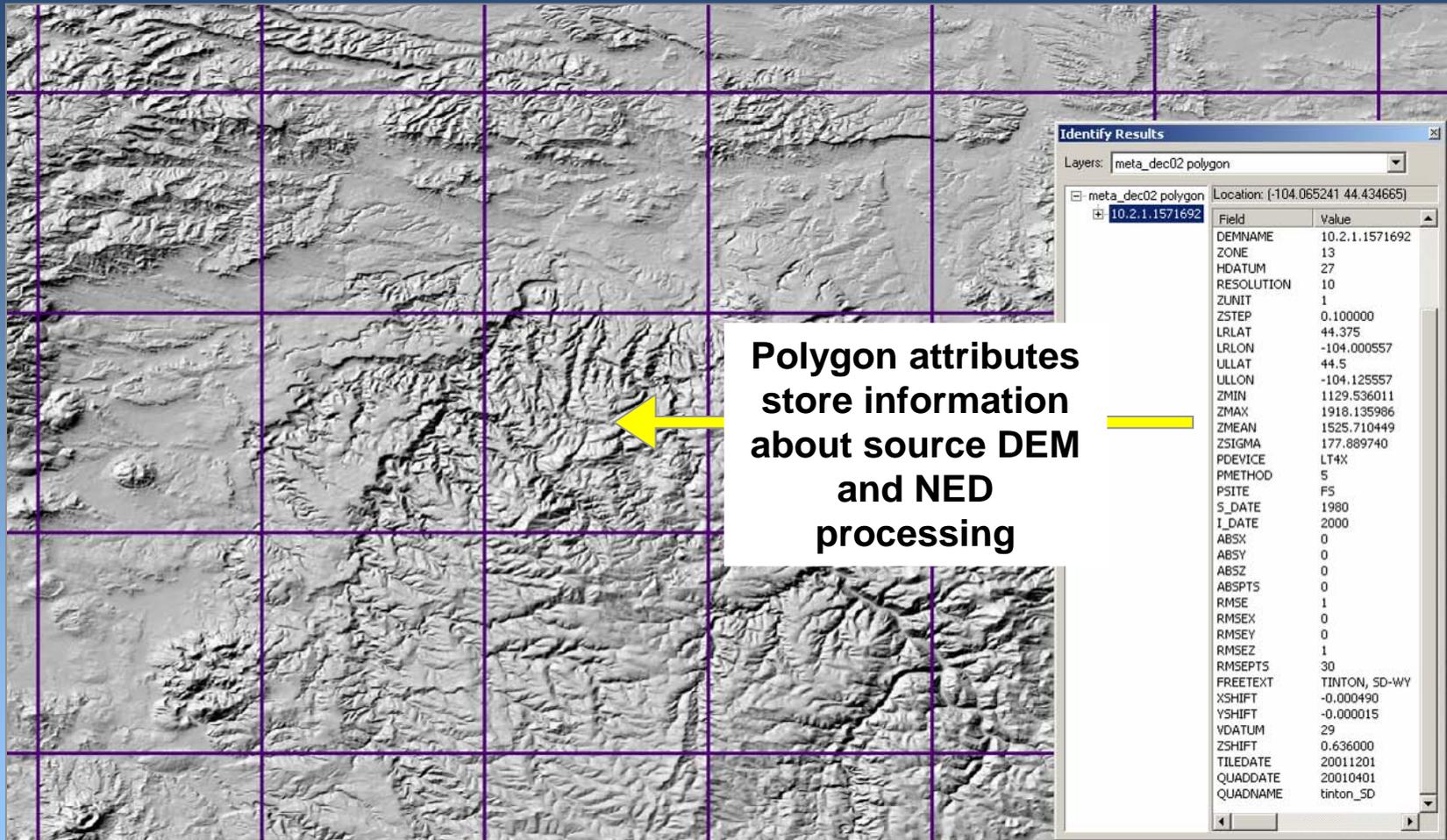
NED Spatial Metadata



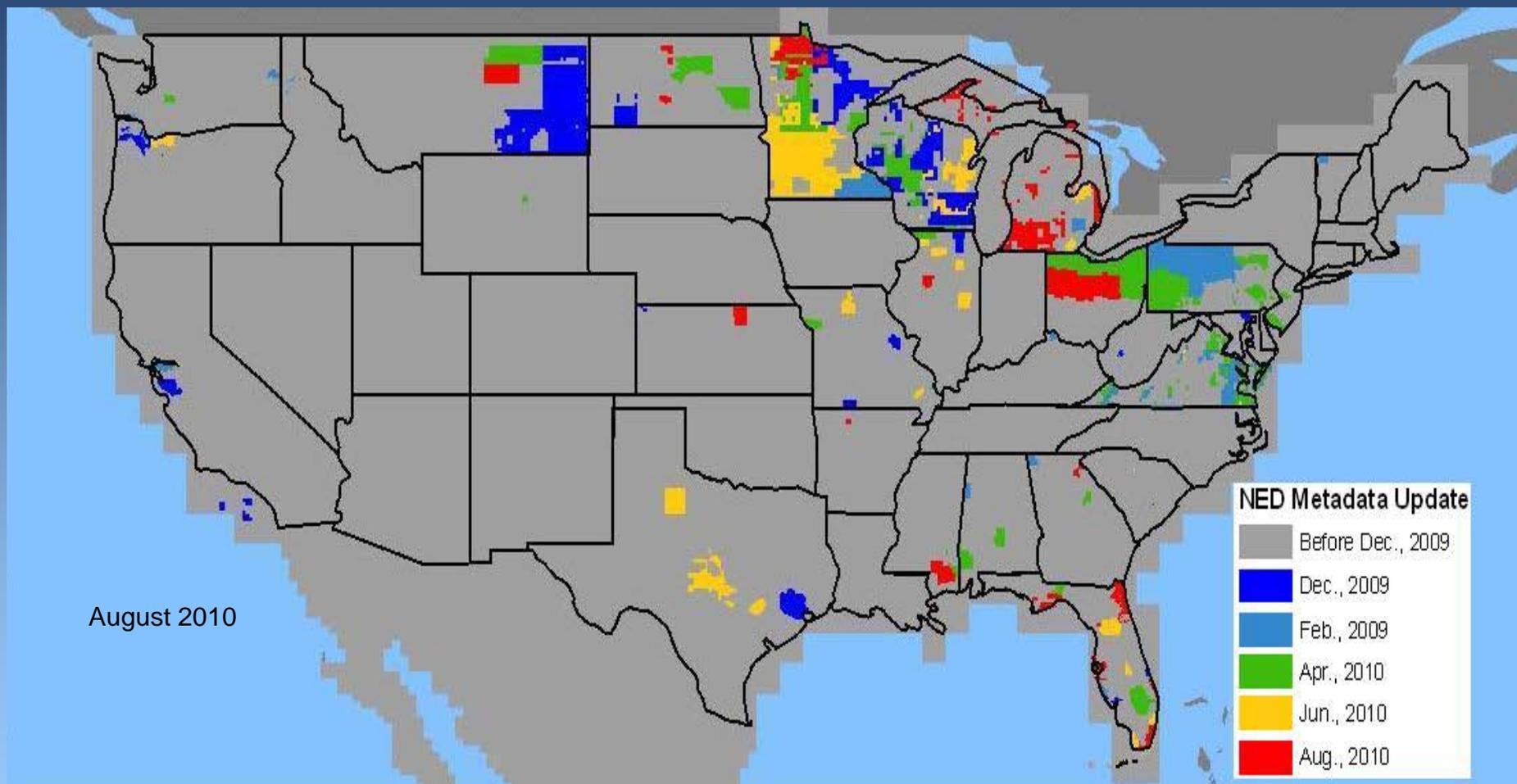
Over 30 metadata items are recorded for each DEM

- File name and quadrangle name
- Geographic location
- Horizontal and vertical resolution
- Summary statistics (min, max, mean, std dev)
- Horizontal and vertical datum, and adjustments
- Production site, method, and instrument
- Accuracy (C-record)
- Free text
- Source date and production date
- Date of addition to the NED (for status graphics)
- Contour interval of source map
- Others used internally during NED processing

Spatial Metadata

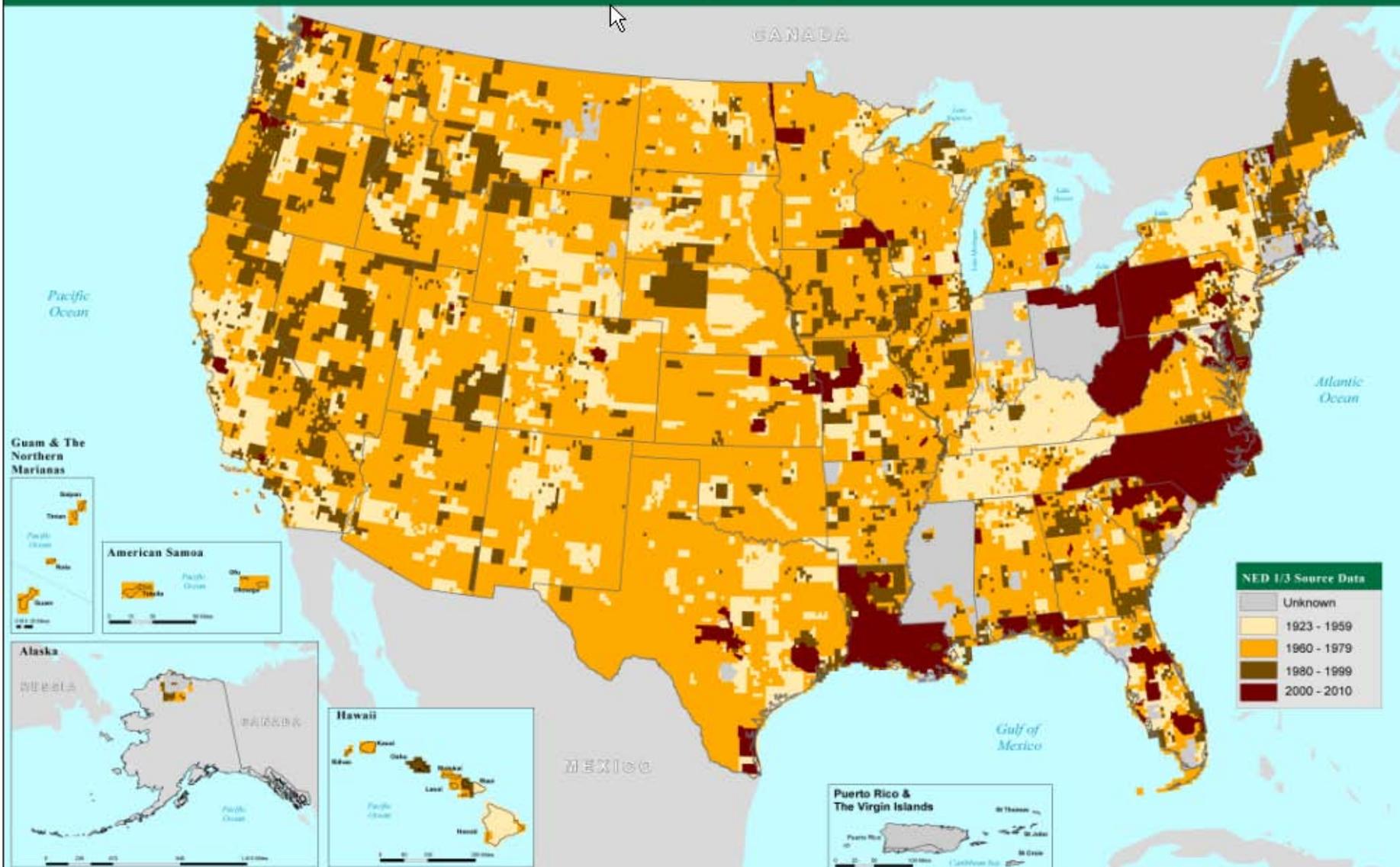


NED Update Areas by Release Date



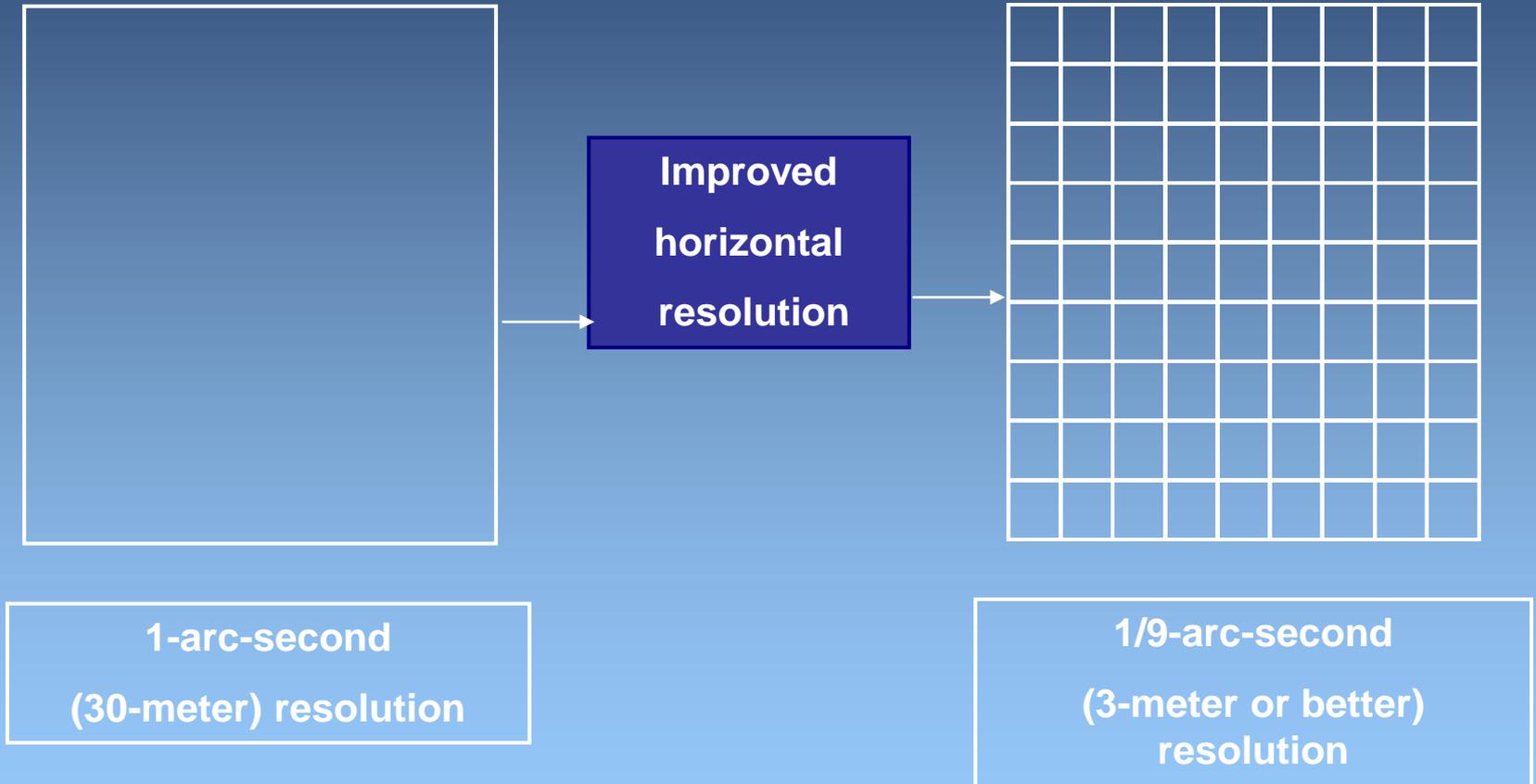
National Elevation Dataset (NED) by Year Acquired

Projected as of August 2010

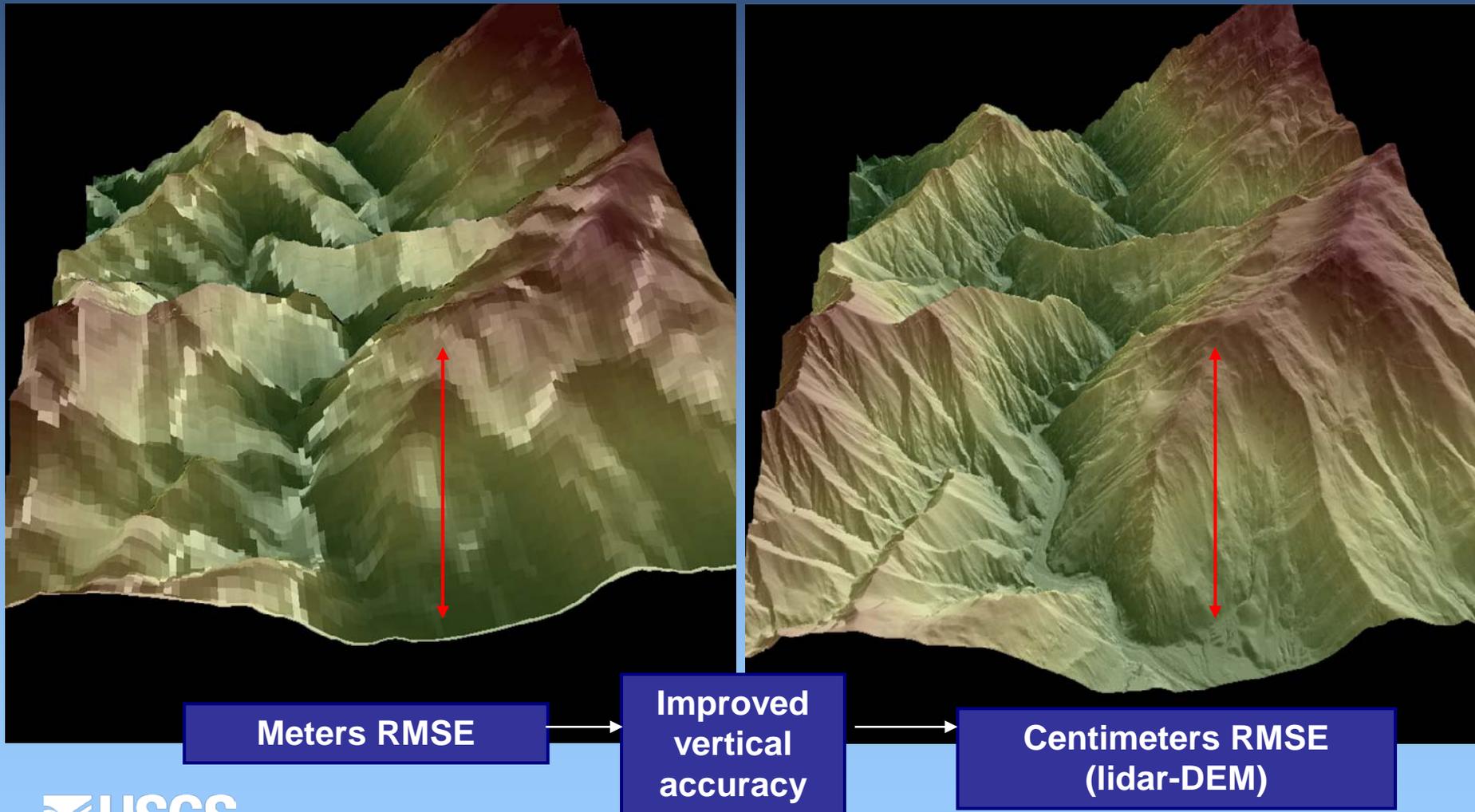


NED 1/3 Source Data	
Grey	Unknown
Light Yellow	1923 - 1959
Orange	1960 - 1979
Dark Brown	1980 - 1999
Dark Red	2000 - 2010

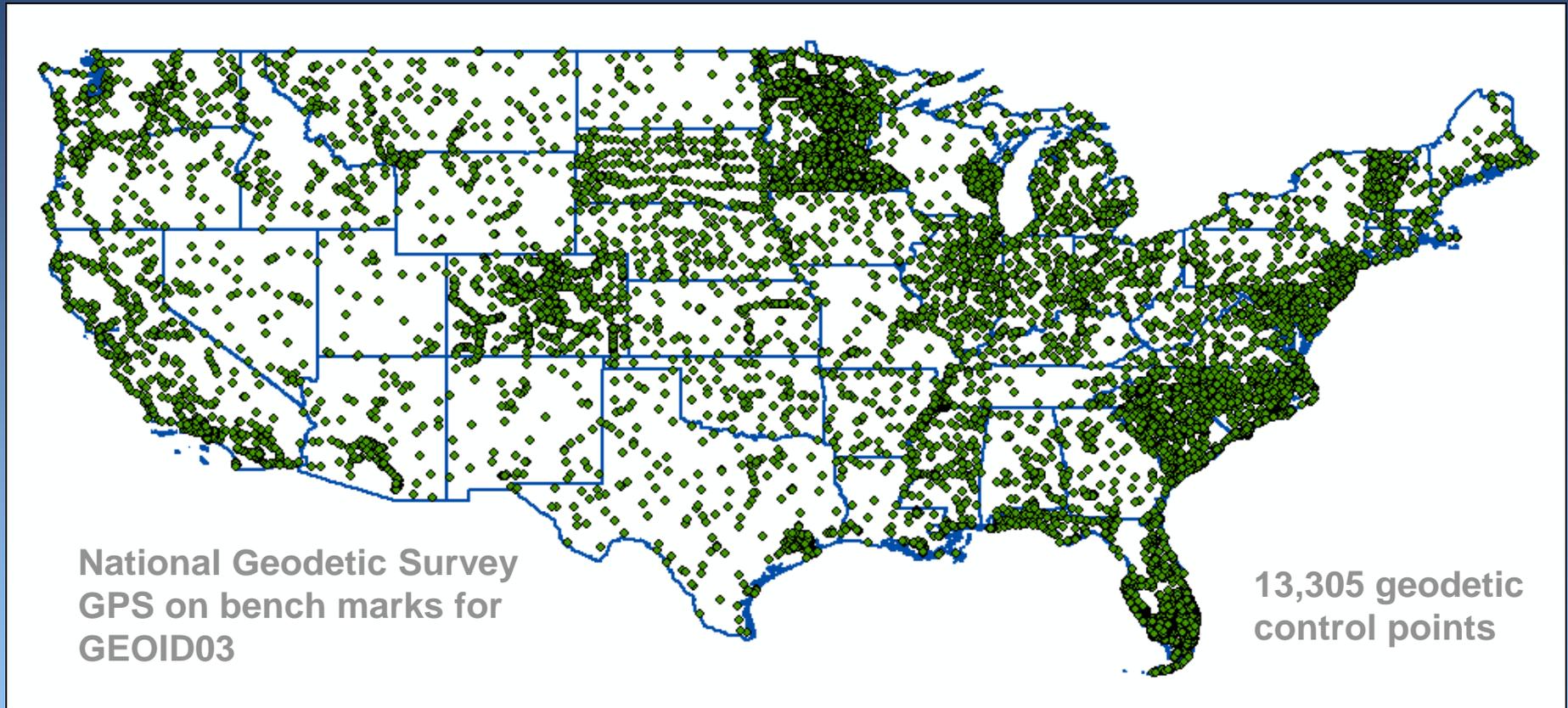
Elevation data derived from lidar has not only improved in horizontal resolution, but also.....



Elevation data derived from lidar has improved in vertical accuracy



NED Accuracy Assessment



Reference data set for absolute vertical accuracy tests

Absolute Vertical Accuracy

Statistics of Errors (meters) vs. NGS GPS Benchmarks

Version Date of the NED	RMSE	NMAS (90%)	NSSDA (95%)
September 1999	3.74	6.15	7.34
October 2001	3.13	5.15	6.14
October 2002	2.70	4.44	5.29
June 2003	2.44	3.99	4.75
December 2005	2.34	3.81	4.54
February 2009	2.09	3.44	4.54
August 2010	1.89	3.12	3.70

NED Updates of NED 1 and 1/3 layers

■ Bi-monthly Updates

- NED updates are tentatively scheduled for the first Monday of Feb, Apr, June, Aug, Oct, and Dec
- All standard 10m DEMs which reside in the GDA database 1 month prior to the release date are processed
- Migration of NED 1/9 data which were released during the previous update

NED Updates of NED 1/9

- Presently, we are coordinating the 1/9 releases with the NED 1 and 1/3
 - Due to the project-based processing it is possible to do out-of-cycle updates if a critical need arises
- NED 1/9 dataset are prioritized
 - Critical need such as hurricane or potential flood area
 - NGP priorities such as contour generation
 - Size of the dataset: bigger is better
 - Area is near other dataset which are in progress
 - USGS collaboration prior to over the fence data

NED Updates Continued:

- Other components of the NED Release
 - NED Release Notes generated, distributed to email list and posted for download
 - <http://ned.usgs.gov/download>
 - Spatial metadata for all three resolutions are zipped and posted for download
 - <http://ned.usgs.gov/download>
 - State liaisons are notified of NED 1/9 areas within their state which have been updated in the release

NED Delivery

- **Seamless Server (<http://seamless.usgs.gov>)**
 - Available for NED 1-, 1/3- and 1/9-arc-second
 - User defined area
 - ESRI ArcGrid, Float, GeoTIFF, BIL
 - Spatial and text metadata, current Release Notes and Data Dictionary are included in downloads
 - Customer selects size download packages
 - Method is good for small area
- **Bulk Data Delivery**
 - Available for NED 1-, 1/3- and 1/9-arc-second
 - Provide a hard drive or return a USGS drive
 - Delivered by resolution layer in 1 degree blocks
 - ESRI ArcGrid or Float
 - Spatial and text metadata, current Release Notes and Data Dictionary are included in downloads
 - Best method for large areas, however turn around can be up to 8 week depending on the demand

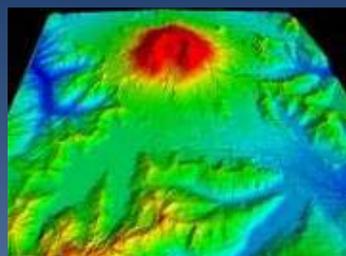
NED Delivery

- **Pre-packaged Tile Download**

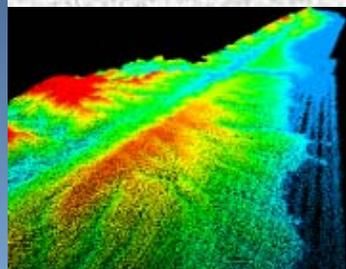
(<http://gisdata.usgs.gov/webappcontent/neddownloadtool/NEDDownloadToolDMS.html>)

- Available for NED 1- and 1/3-arc-second
- Delivered in canned 1 degree tiles
- ESRI ArcGrid format
- Spatial and text metadata, Data Dictionary are included in downloads
- Viewer displays 1 degree blocks by state, county or user defined area
- Downloads can start immediately
- Method is good for large areas need immediately
- However it requires a good connection and large band width

Range of National Applications



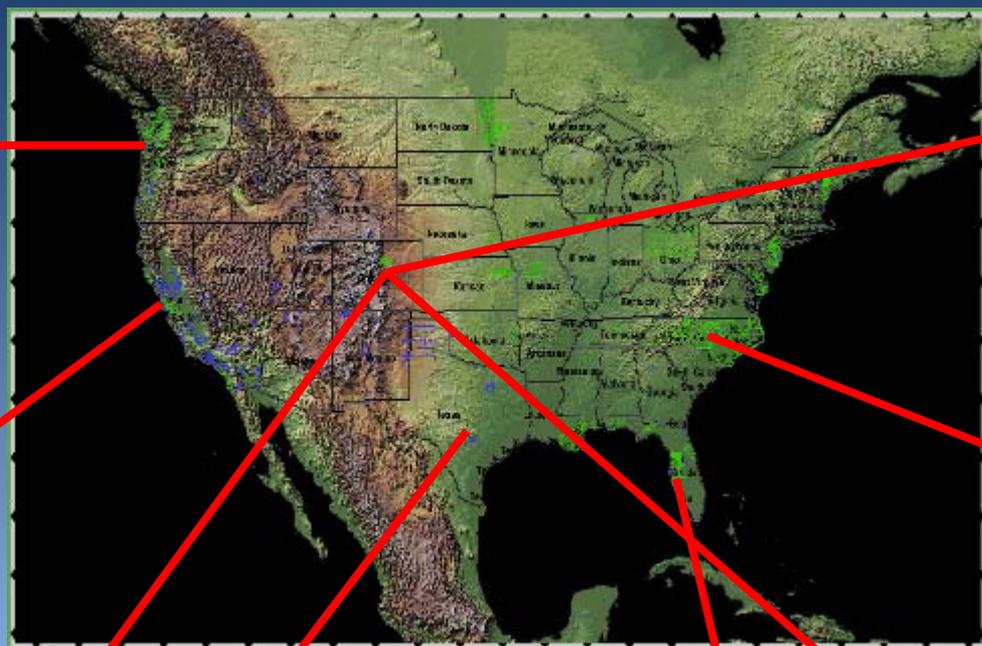
Volcano Monitoring



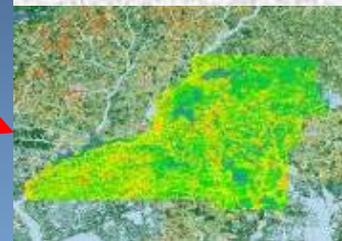
Earthquake Faults



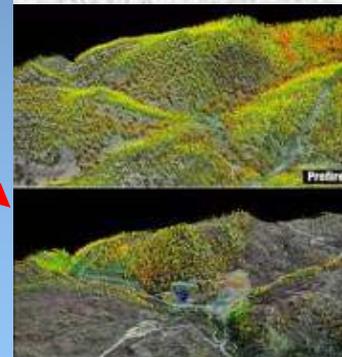
Hydrologic Studies



Vegetation/Biomass



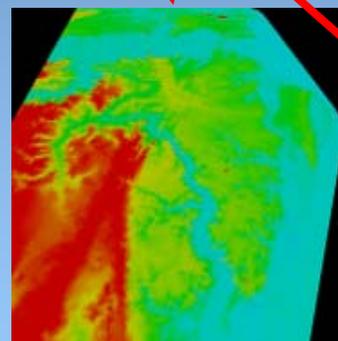
Land Cover



Carbon / Disturbance



Urban / Suburban Response



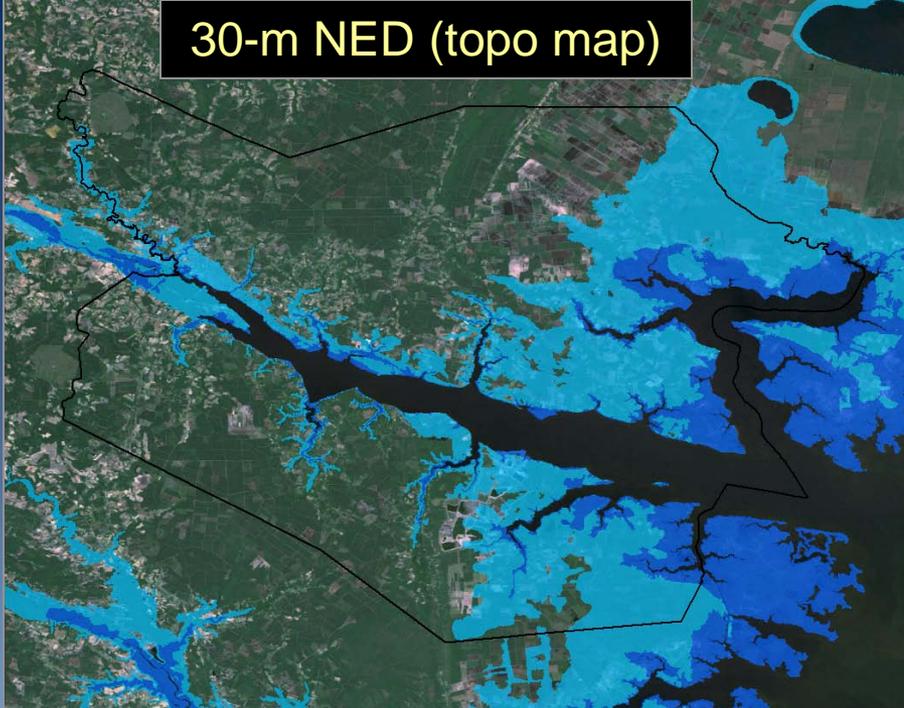
Coastal Studies

Sea-Level Rise

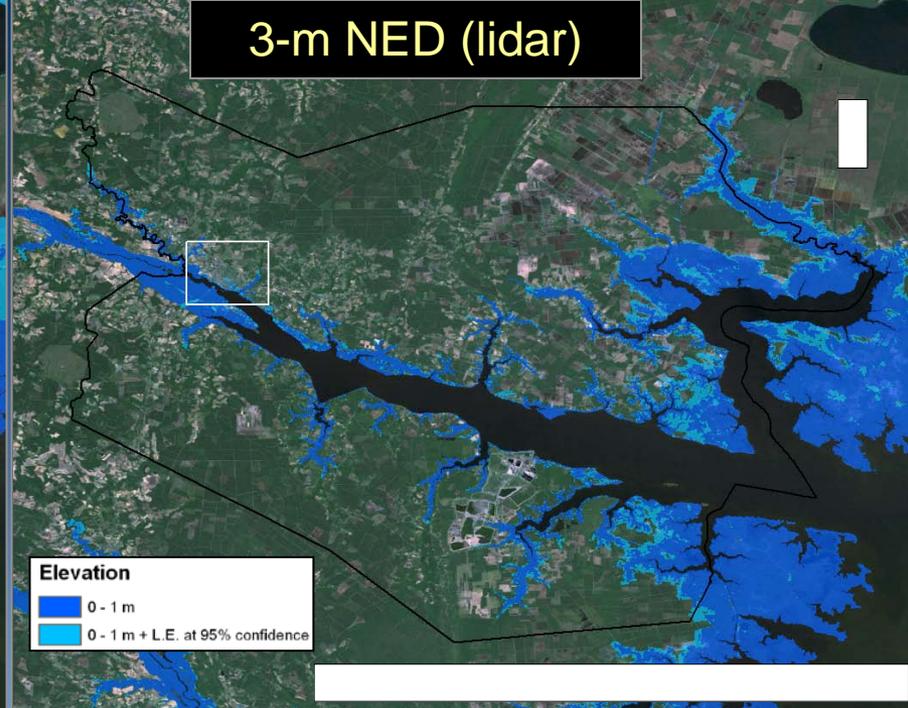
Climate and environment

Natural disasters and national security

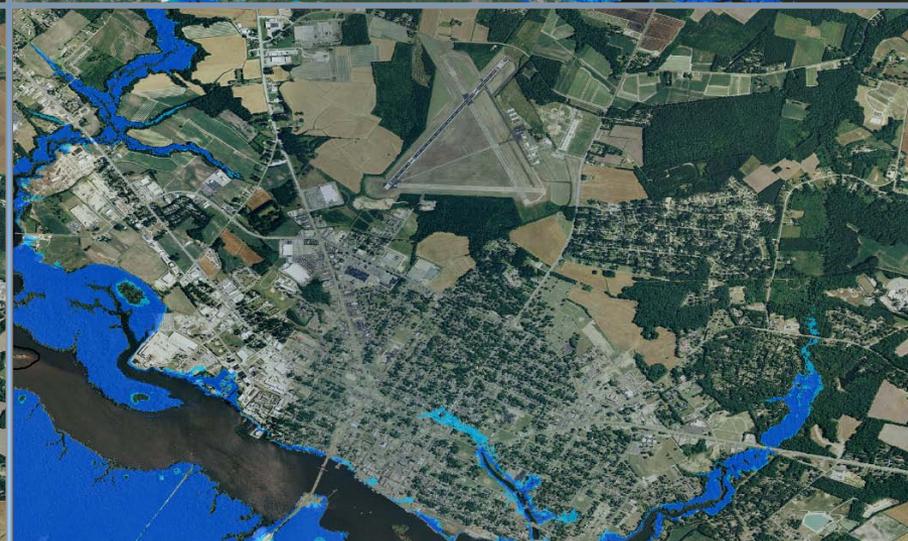
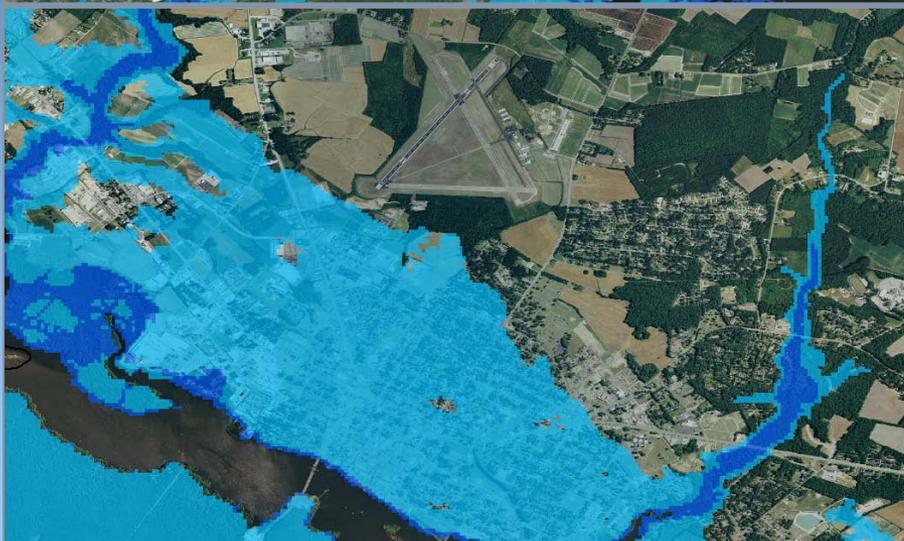
30-m NED (topo map)



3-m NED (lidar)



Elevation
0 - 1 m
0 - 1 m + L.E. at 95% confidence



Maps of lands vulnerable to sea-level rise, derived from 1-arc second NED (USGS 30 meter DEM source) and 1/9 arc-second NED (lidar source). (North Carolina coast)

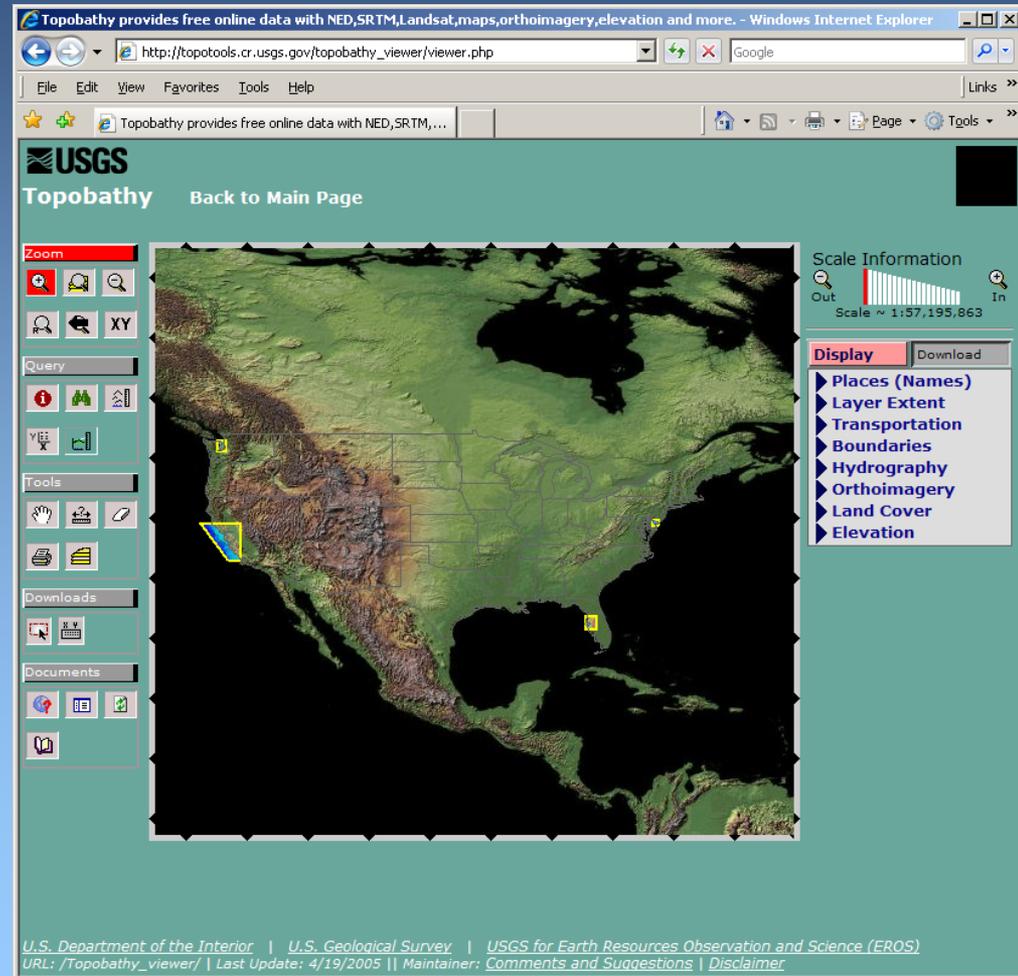
Data Integration

Natural disasters and national security

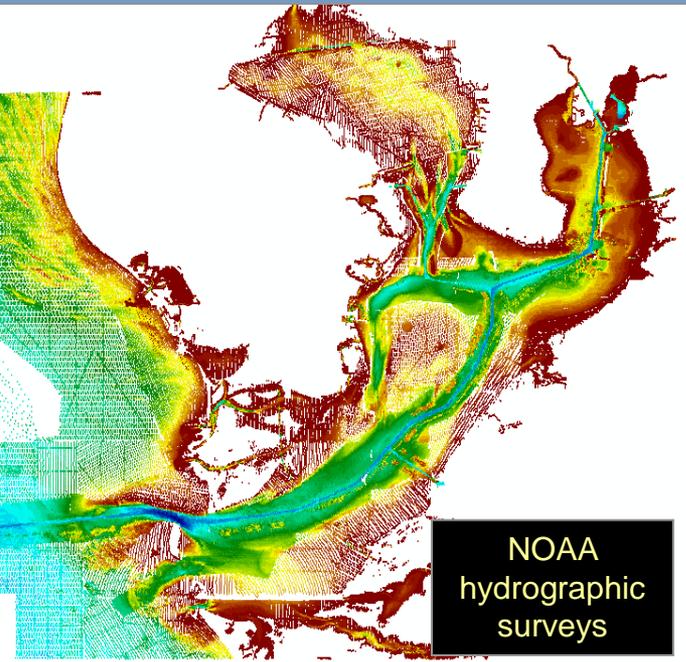
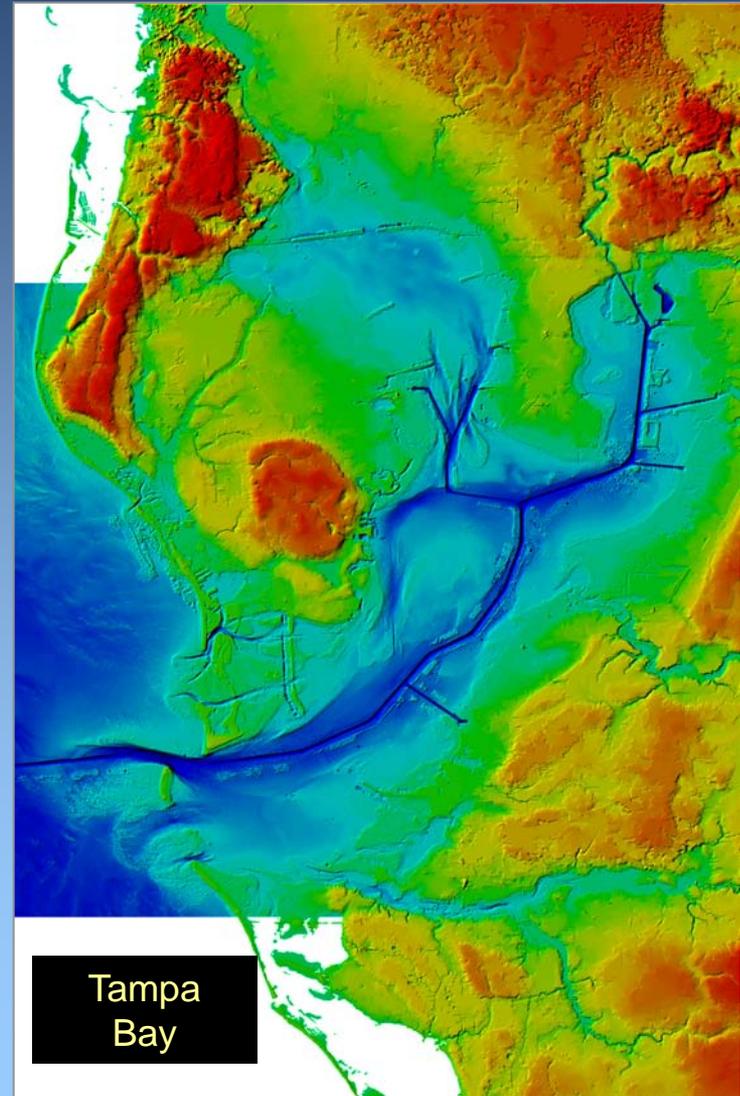
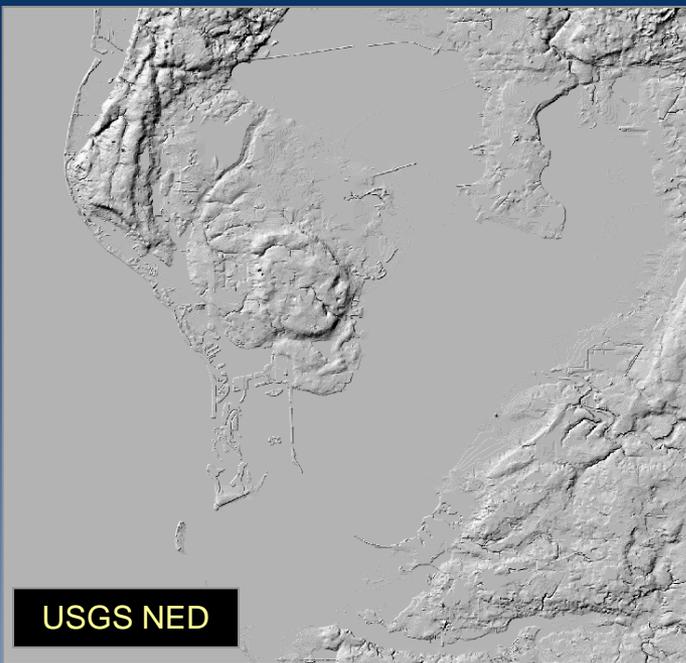
Topographic / Bathymetric Data Integration Natural Disasters and National Security

- Topographic-Bathymetric data, also known as topobathy data, are a merged rendering of topography (land elevation) and bathymetry (water depth).

http://topotools.cr.usgs.gov/topobathy_viewer/viewer.php



Topographic / Bathymetric Data Integration



Chandeleur Barrier Island - Topobathy

- DEM Characteristics:

- Resolution: 1/9th Arc-Second
- Horizontal Datum: NAD83
- Vertical Datum: NAVD88
- Pixel Depth: 32 Bit (Floating Pt)
- Data Format: IMG File

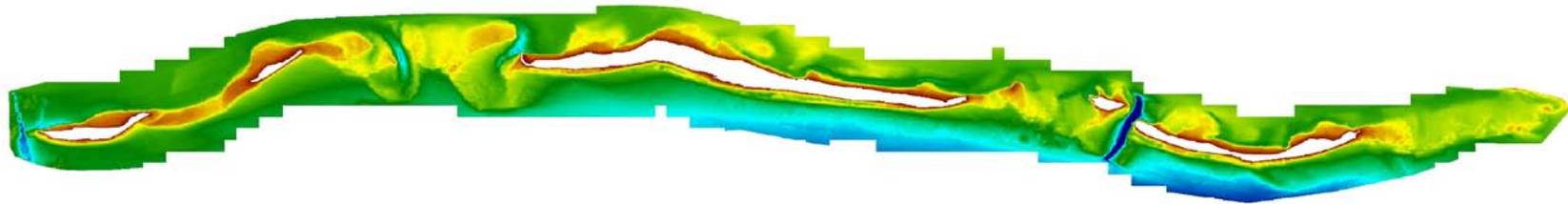
- DEM Statistics:

- Maximum Elevation: 2.21 m
- Minimum Elevation: -15.80 m

- Input Data Sources:

- EAARL – 2010
- Single beam and swath bathymetry
(Dr. Michael Miner)
 - 2006 – North Chandeleur
 - 2007 – South Chandeleur

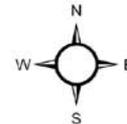
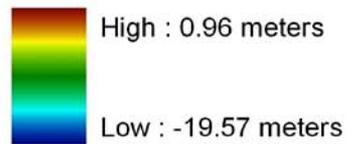
Mississippi Barrier Island - Bathymetry



Legend

Mississippi Barrier

Elevation Value



• DEM Characteristics:

- Resolution: 1/9th Arc-Second
- Horizontal Datum: NAD83
- Vertical Datum: NAVD88
- Pixel Depth: 32 Bit (Floating Pt)
- Data Format: IMG File

• Input Data Sources:

- Single beam bathymetry (Dr. David Twichell)
- 2007 – Gulf Island National Seashore (07CCT01)

• DEM Statistics:

- Maximum Elevation: 0.96 m
- Minimum Elevation: -19.57 m

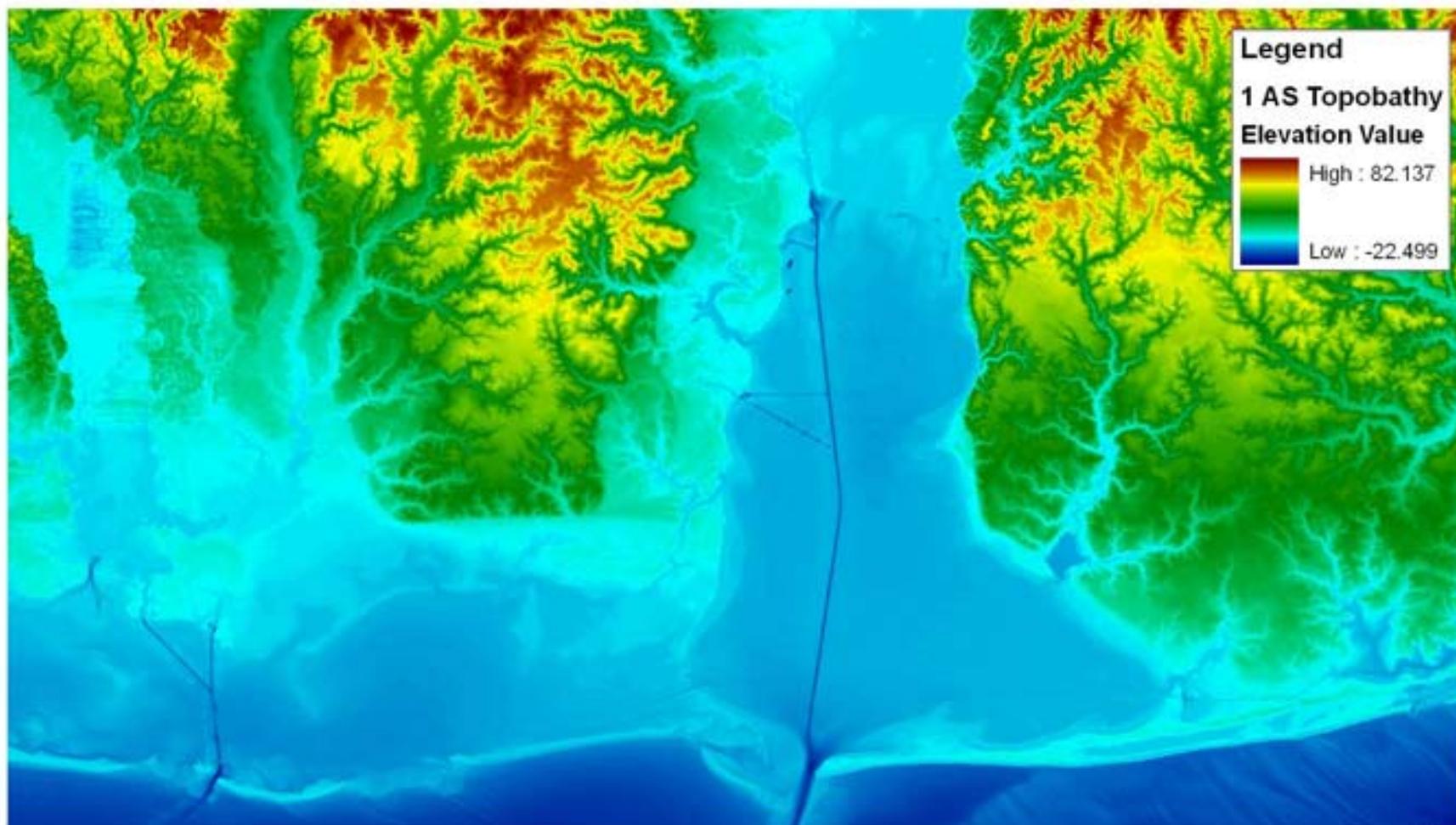


Mobile Bay Pilot Area

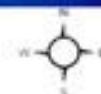
Preliminary 1 Arc-Second Topobathymetric Merge

Sources:

- 1) 1 AS NED: Includes All 1/9th NED Lidar; Does not include any CHARTS or new EAARL Data
- 2) 1 AS NOAA Bathymetry; Does not include newer NOAA high-resolution bathymetry from Tim Osborne.



0 3.75 7.5 15 22.5 30
Kilometers

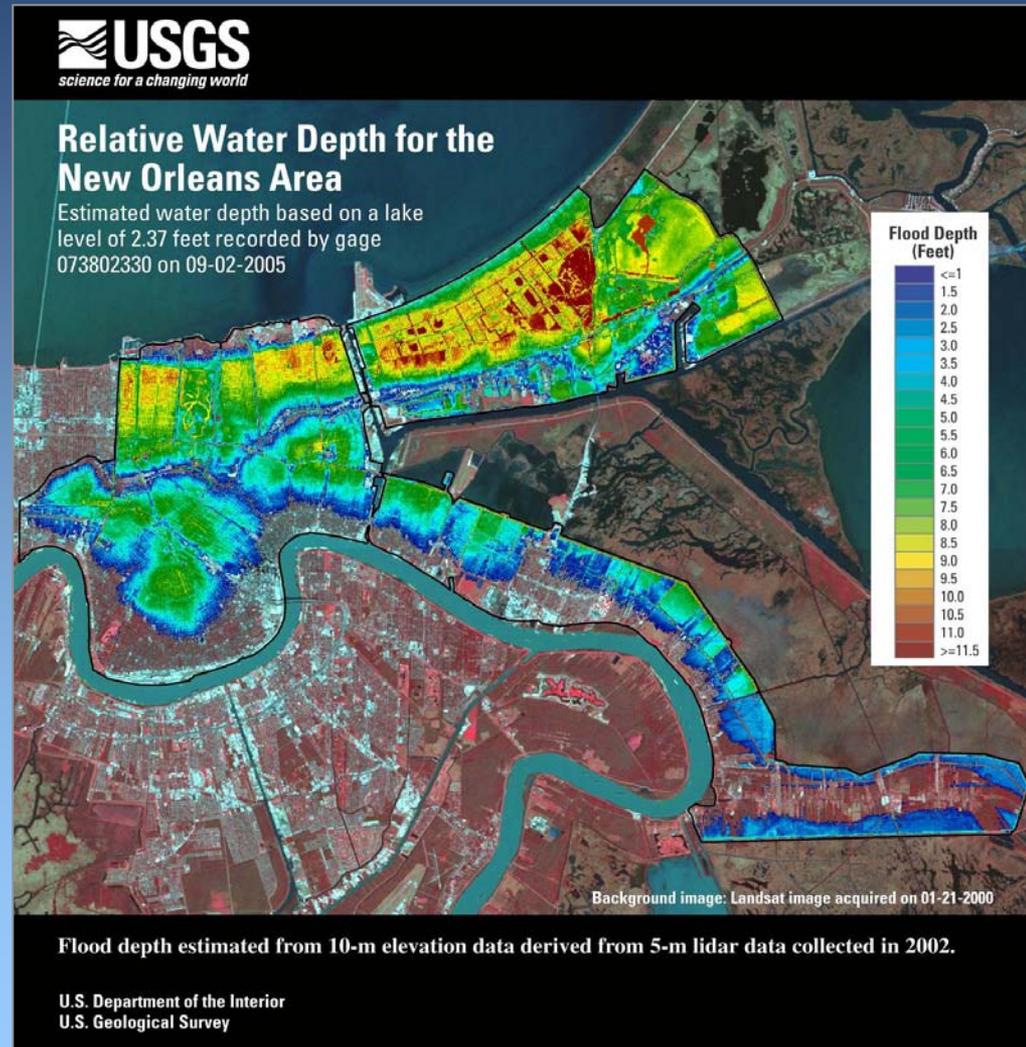


Applications

Natural disasters and national security

Natural Disasters and National Security

- Flood depth estimates were derived from these data in New Orleans after Hurricane Katrina.



Changes in the United States

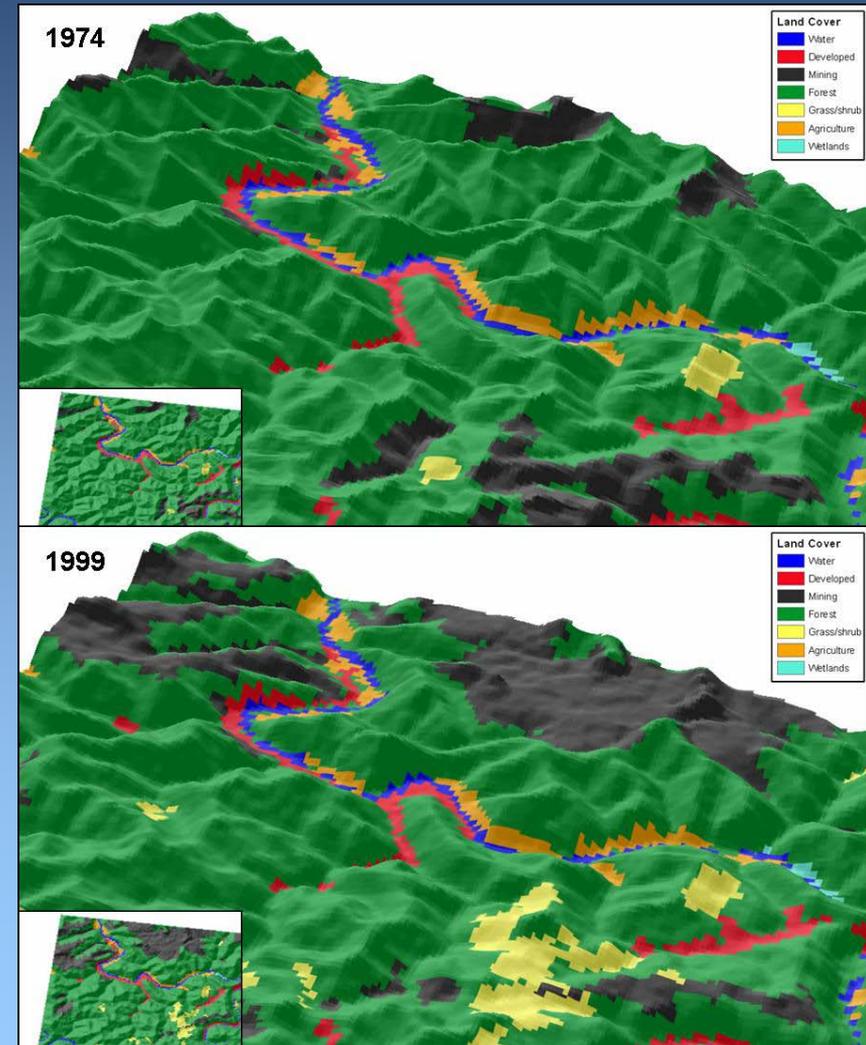
Resource management

Energy development and utilization

Human Services and infrastructure development

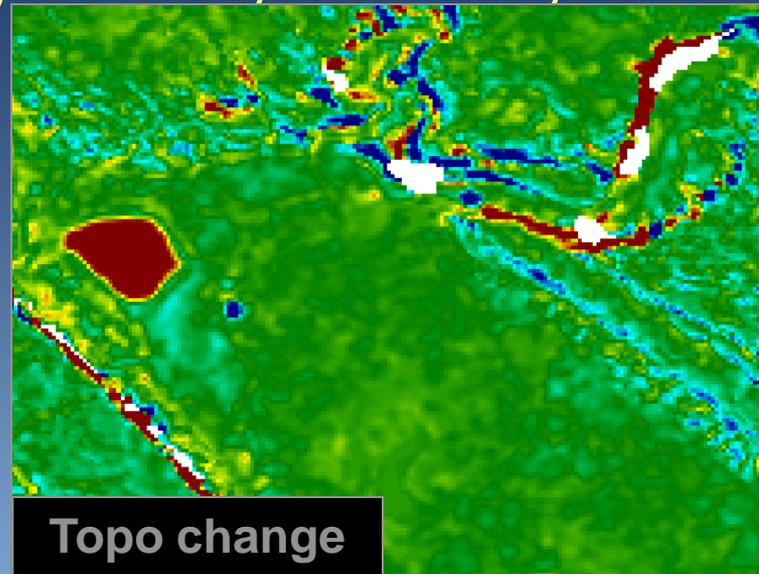
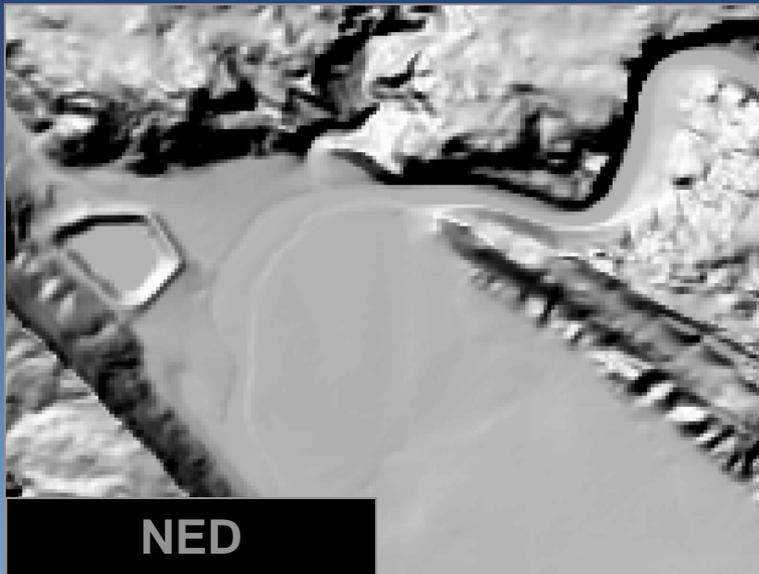
Significant Topographic Changes in the United States

- Direct anthropogenic processes create several types of landform modifications that remain as a distinct imprint on the topographic landscape.
- The types of topographic change from human activity include: (see following slides for examples)
 - Mining - **Resource management**
 - Dam construction - **Energy development and utilization**
 - Urban development, road construction, or landfills - **Human services and infrastructure development**
- <http://topochange.cr.usgs.gov/index.php>

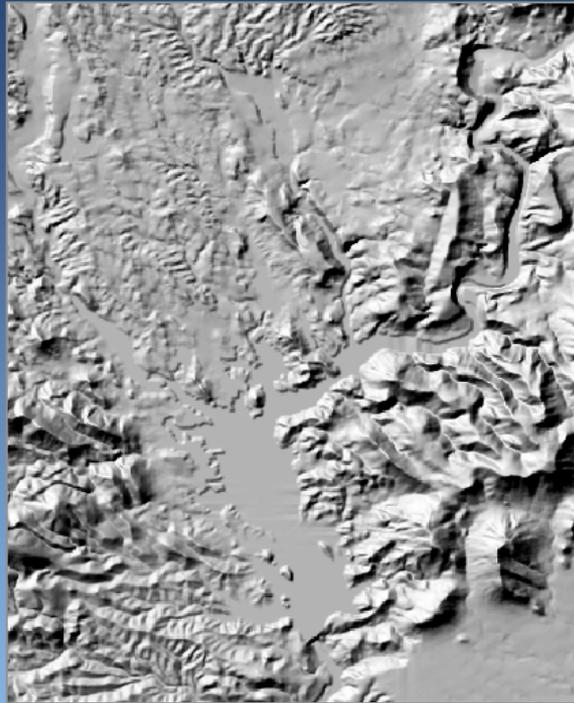


Resource Management

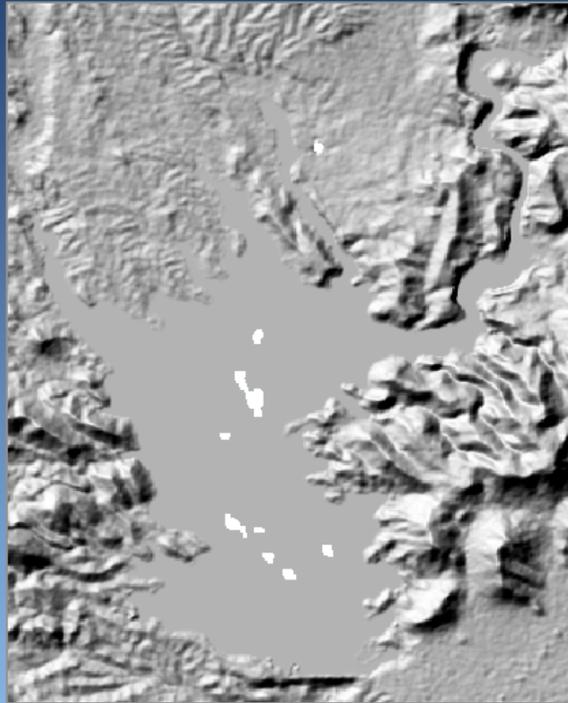
Uranium Mill Tailings Pile, Moab, UT



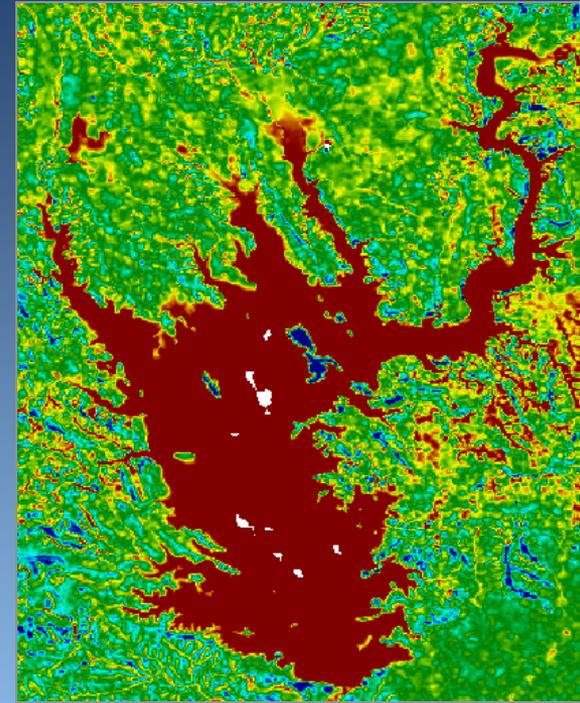
Energy Development and Utilization Lake Pleasant, Phoenix, AZ



NED



SRTM



Topo change

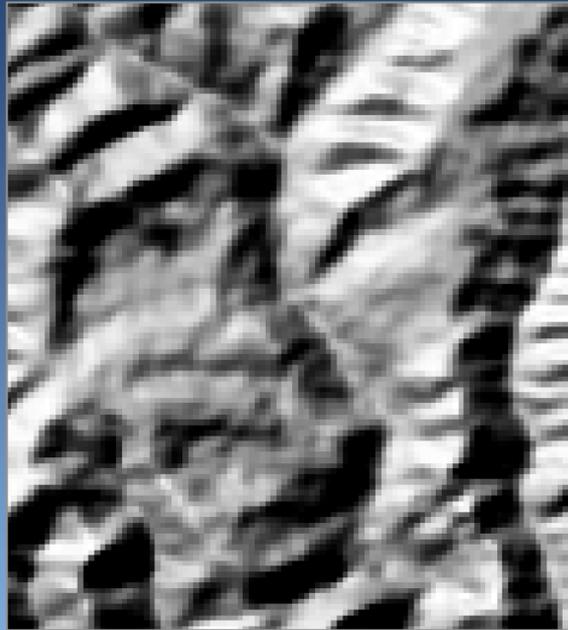


Human Services & Infrastructure Development

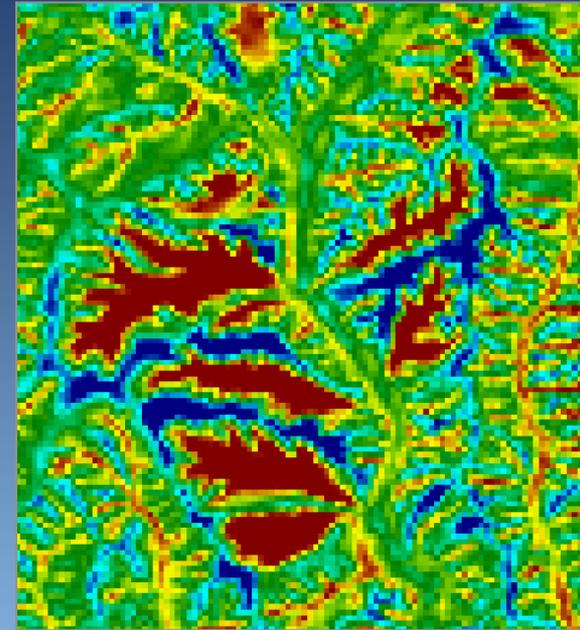
Golf Course Development, Los Angeles



DOQQ



SRTM

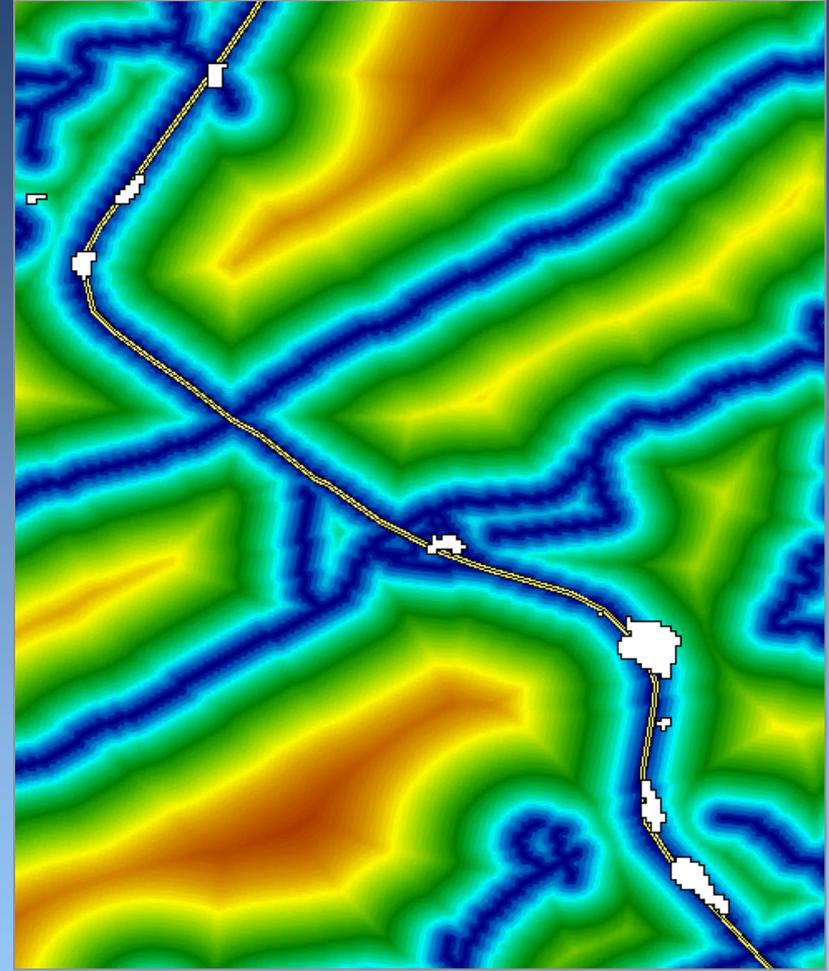
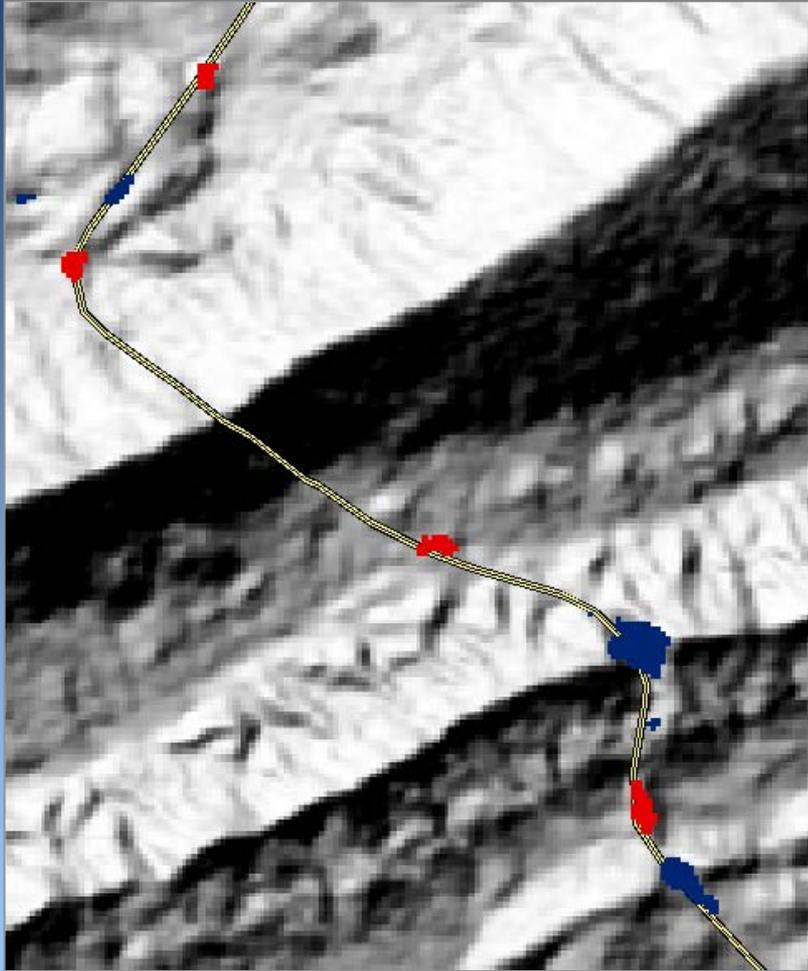


Topo change



Human Services & Infrastructure Development

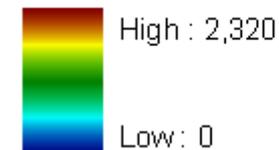
Virginia I-77 Road Cuts and Fills



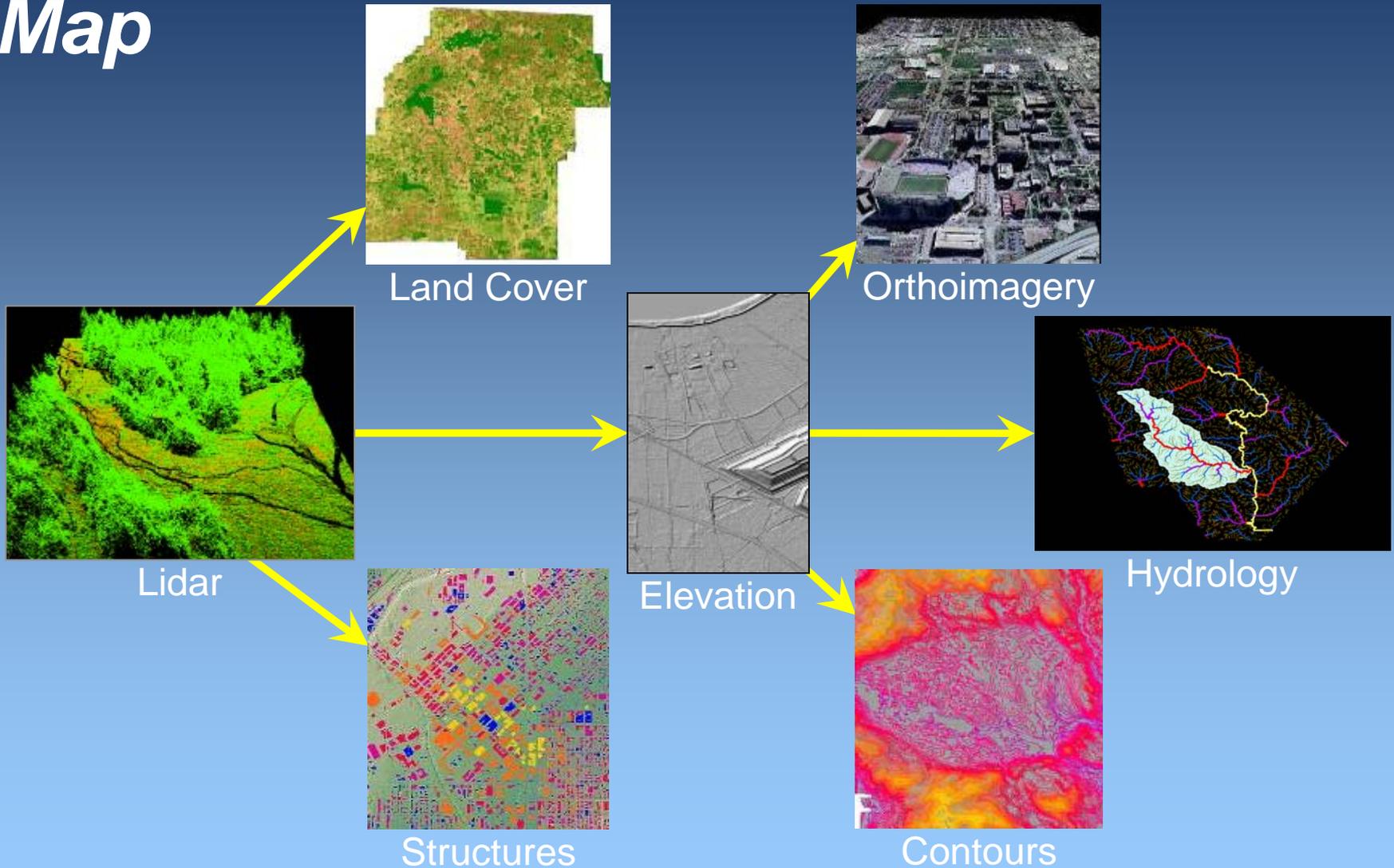
Blue = decreased elevation (cut)

Red = increased elevation (fill)

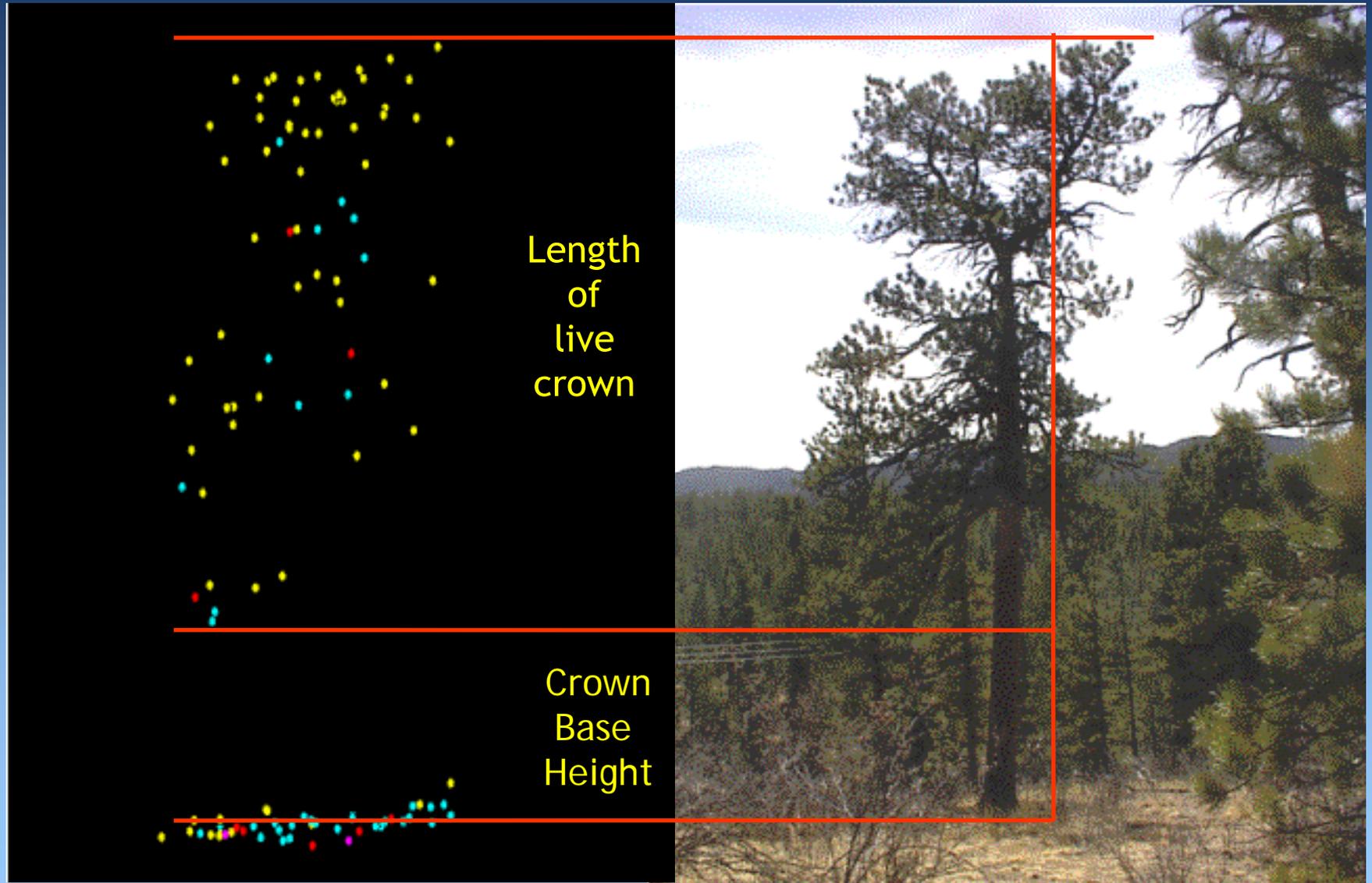
Distance to Road (meters)



Lidar Applications for *The National Map*



Lidar Research Topics: Forestry



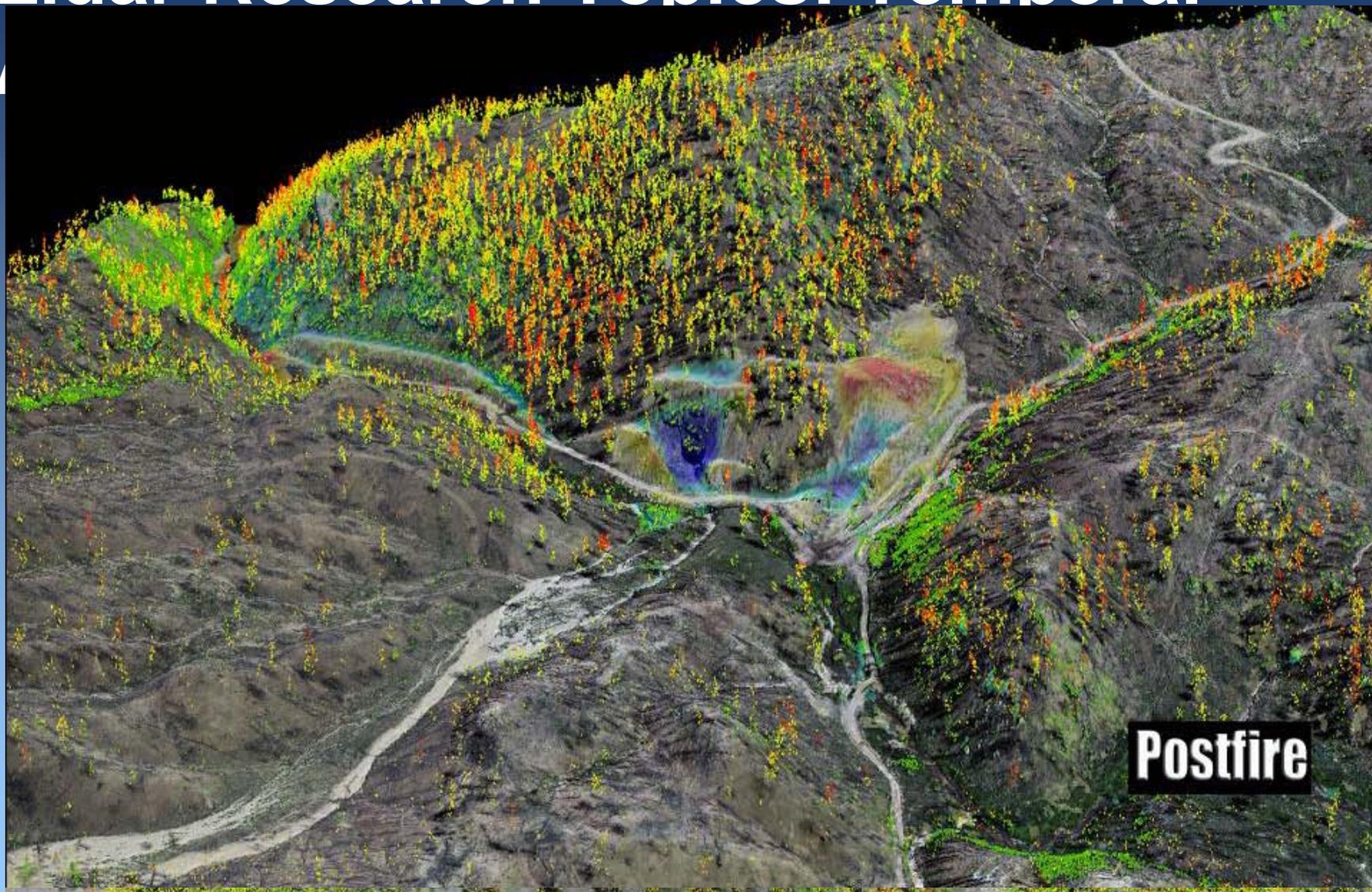
Lidar Research Topics: Fire Science

Crown Base Height

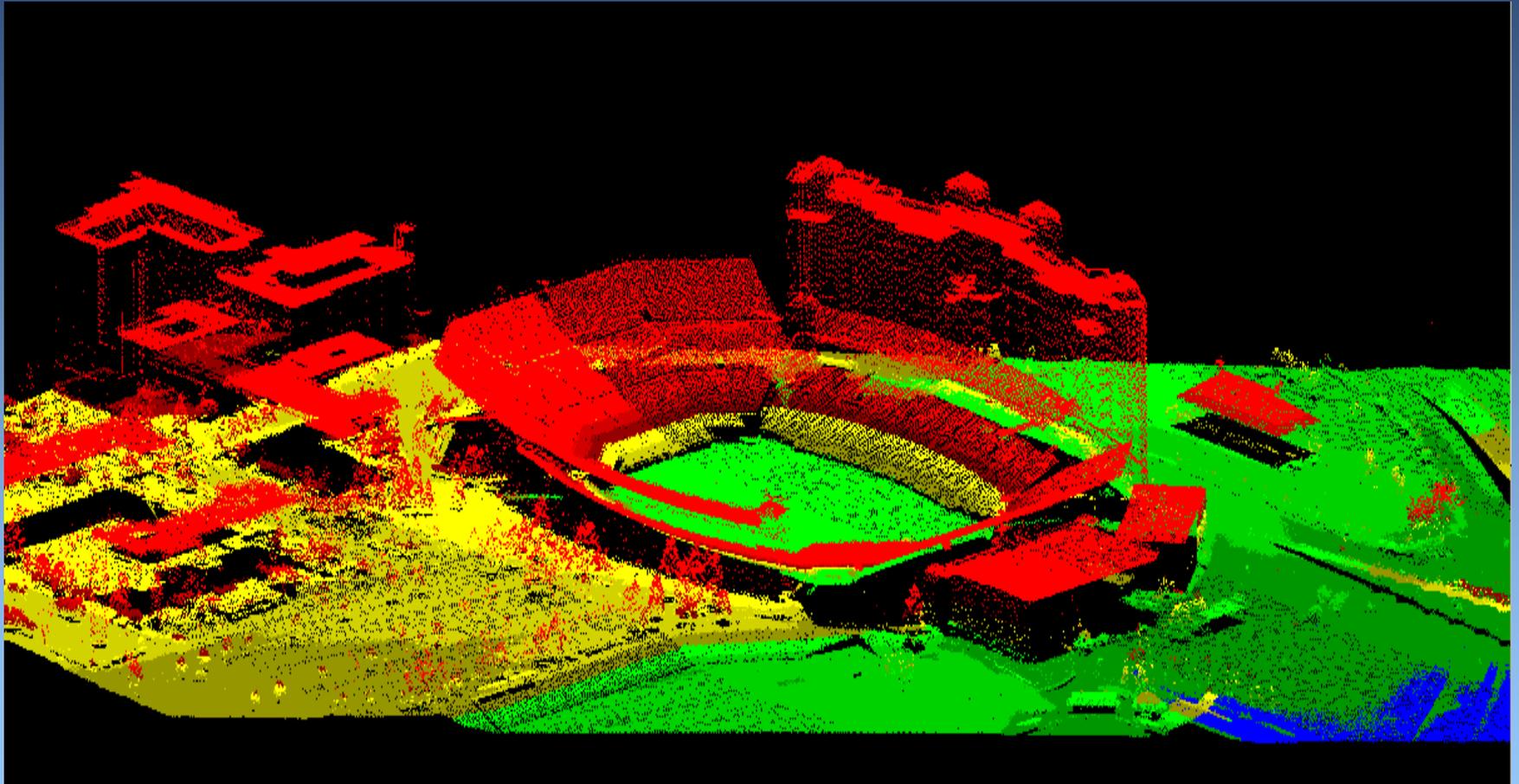
- ☀ Distance from the ground to the lowest needle-bearing branch
- ☀ Important in fire modeling
- ☀ Helps determine potential for surface fire vs. crown fire



Lidar Research Topics: Temporal



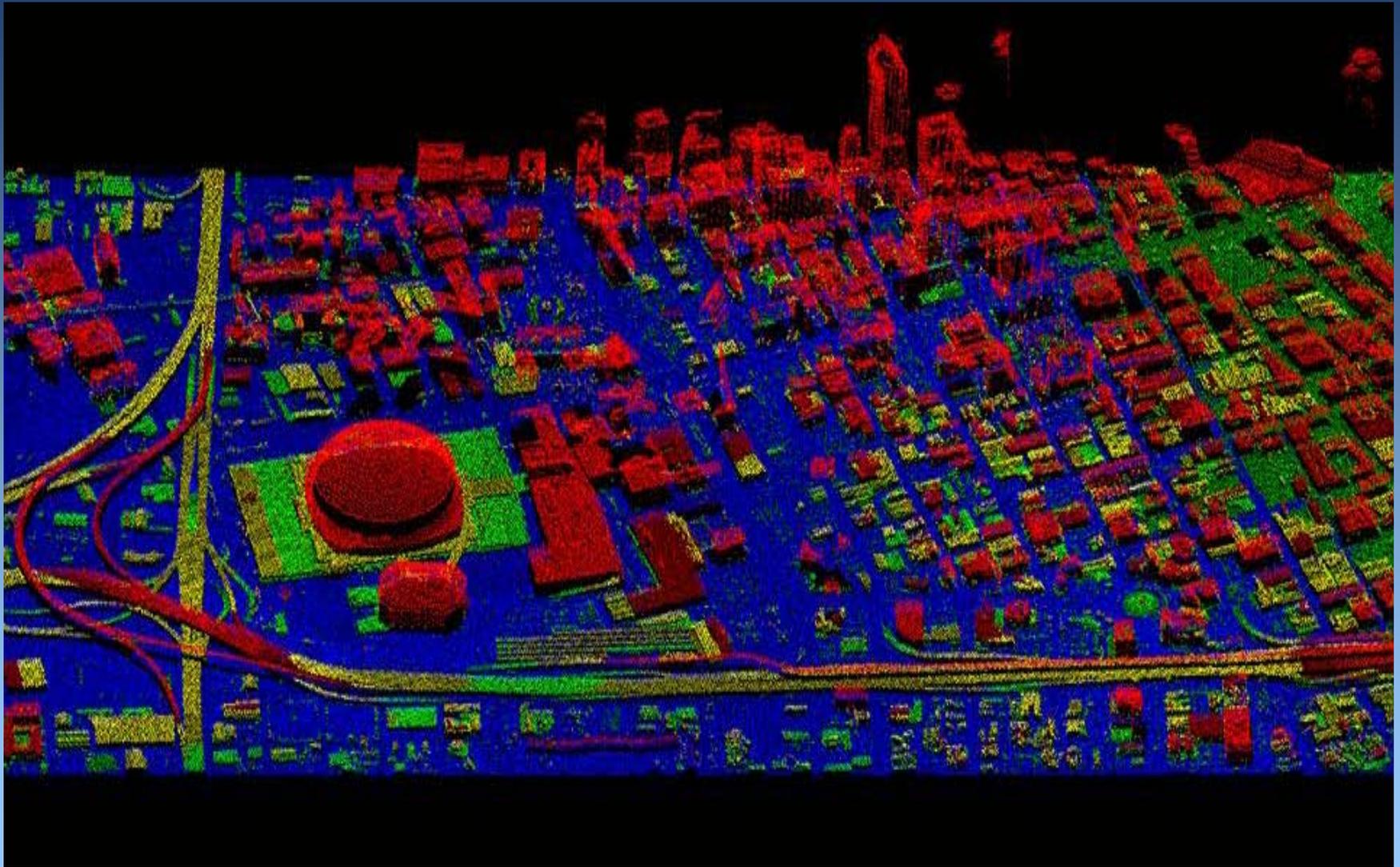
Other Lidar Uses: Structure Analysis



Other Lidar Uses: Feature Extraction



Other Lidar Uses: Urban Modeling



Questions?