Enhanced Access to High-Resolution LiDAR Topography through Cyberinfrastructure-Based Data Distribution and Processing

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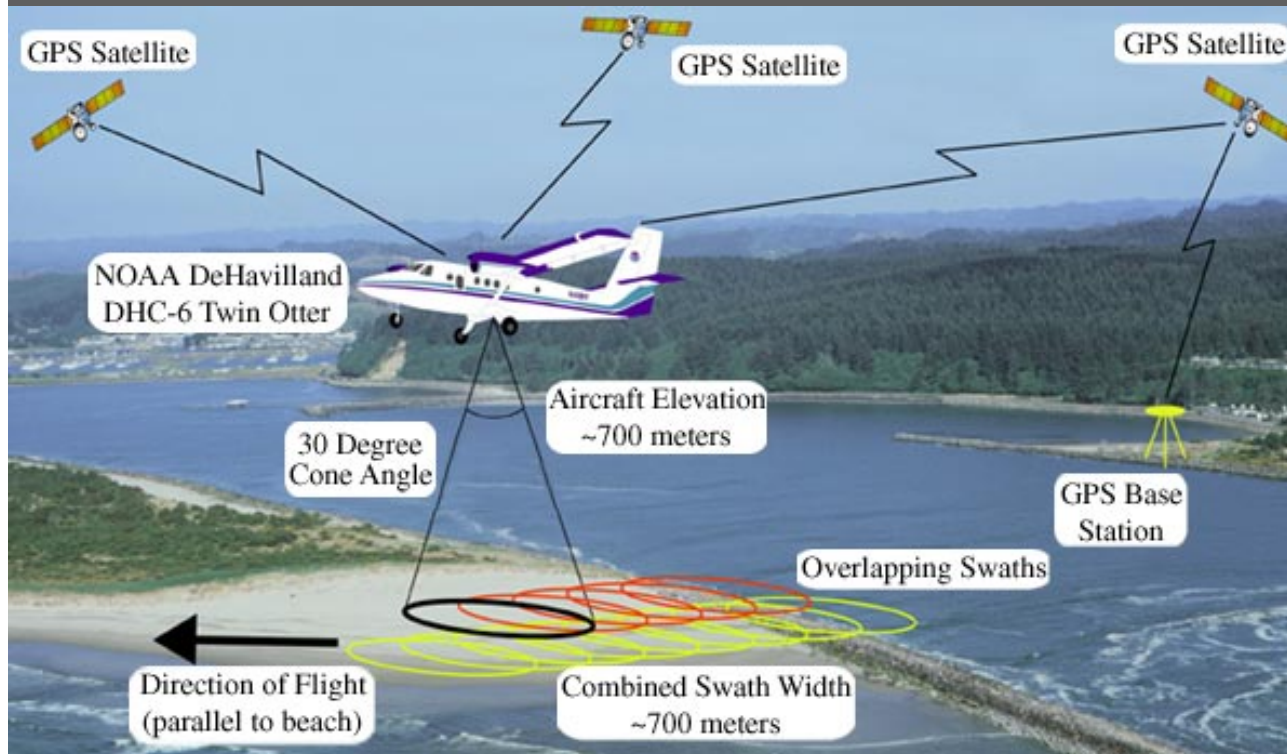Ashraf Memon, Chaitan Baru

Han S. Kim

ASU | GEON CYBERINFRASTRUCTURE RESEARCH FOR THE GEOSCIENCES
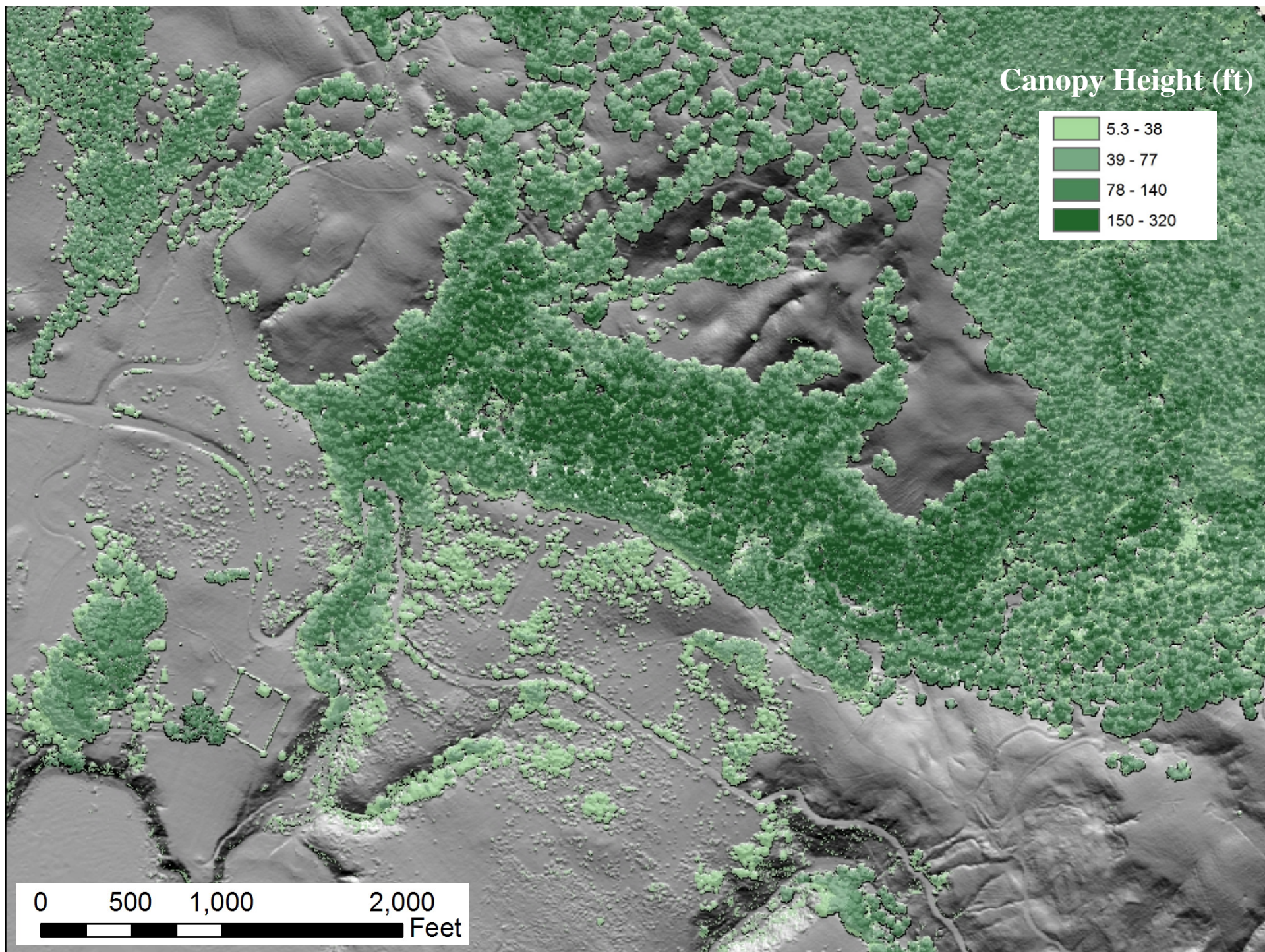www.geongrid.org

Enabling Scientific Discoveries and Improving Education in the Geosciences Through Information Technology Research
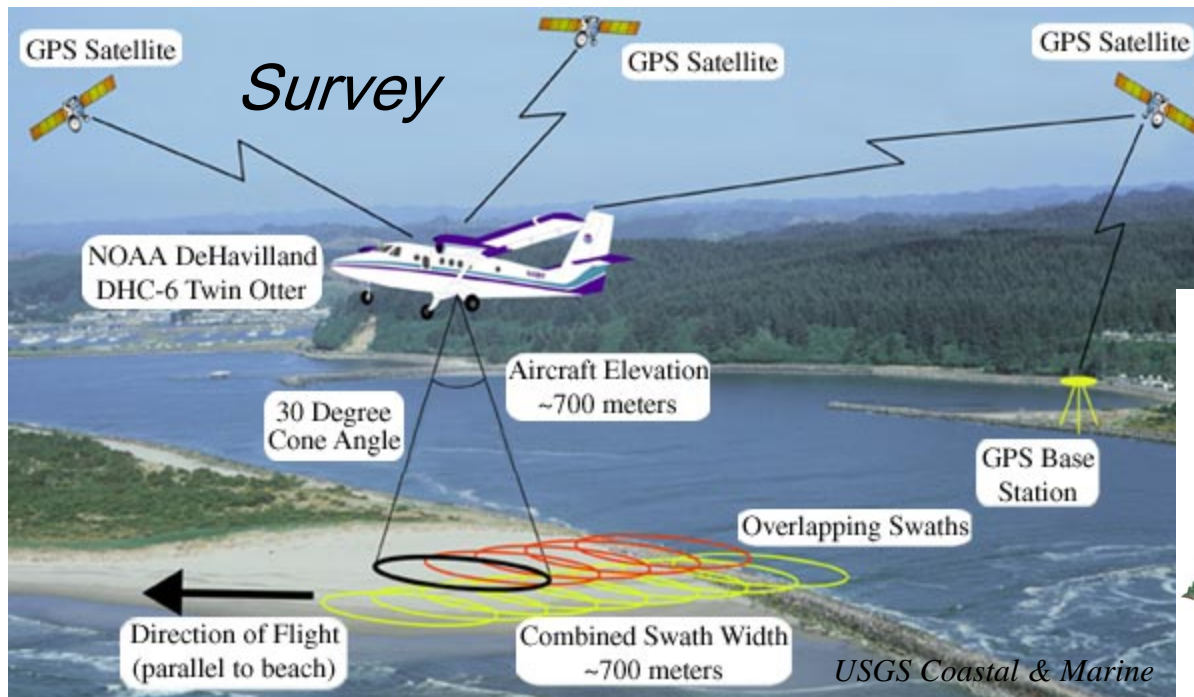
LiDAR (LIght Detection And Ranging)
a.k.a ALSM (Airborne Laser Swath Mapping)

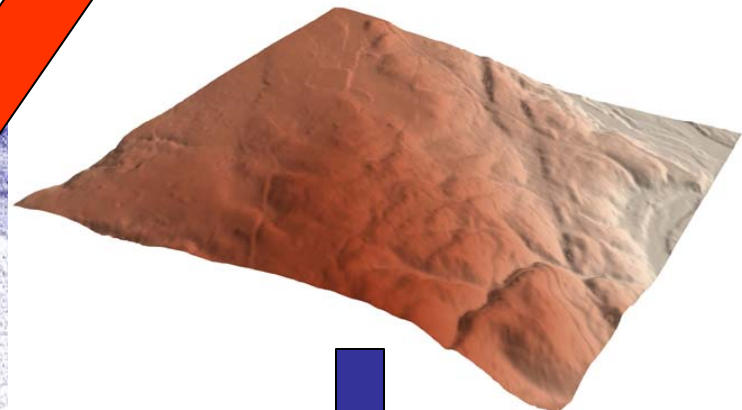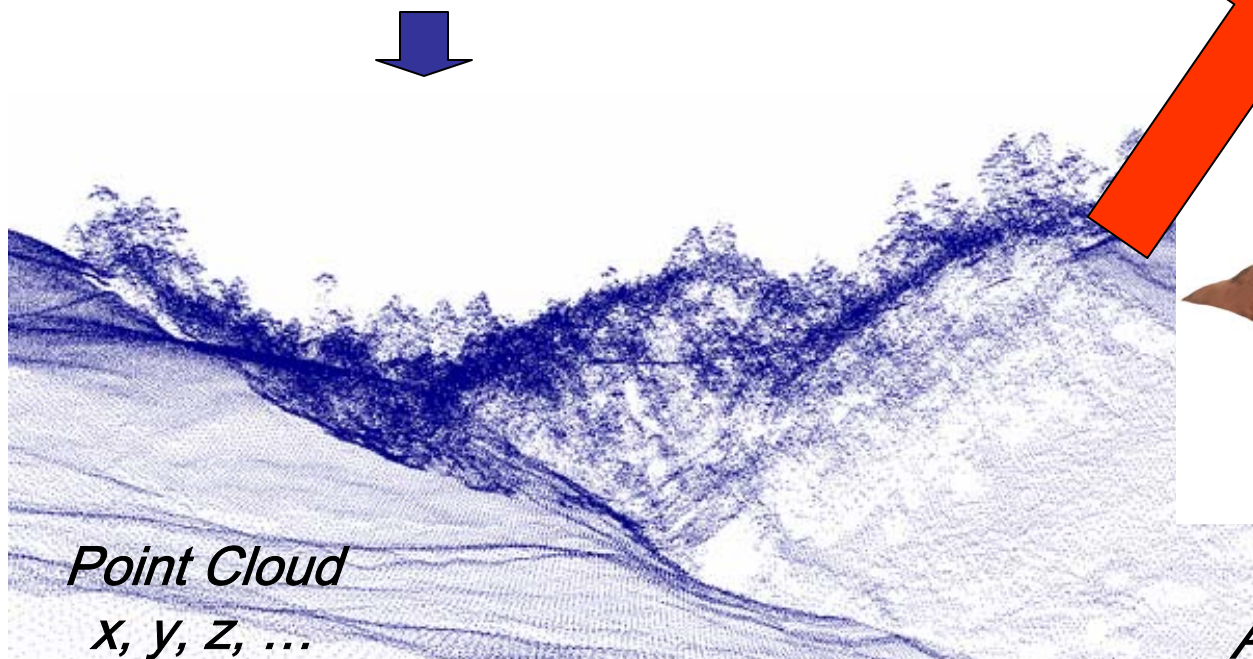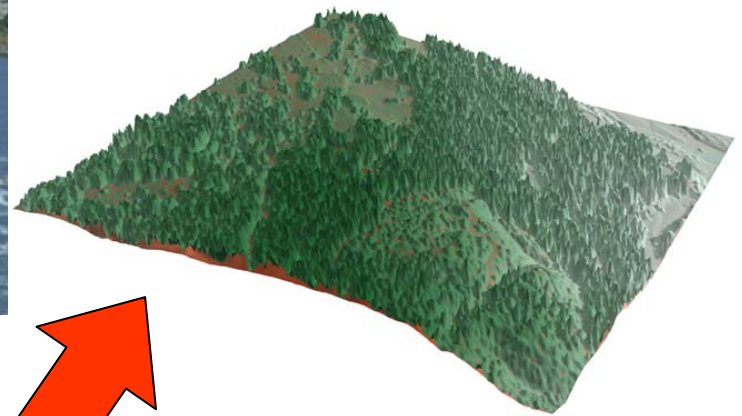*http://coastal.er.usgs.gov/hurricanes/mappingchange/*

- Airborne pulsed laser scanning system + differential GPS + inertial measurement unit (IMU)

- > 30,000 points/second

- Ground sampled at multiple points/sq. meter

- ~ 15 cm vertical accuracy

- ~$300 - $500 per sq. km acquisition cost

Canopy Height (ft)

	5.3 - 38
	39 - 77
	78 - 140
	150 - 320

0   500   1,000   2,000
Feet

Complete LiDAR Workflow

Survey

Interpolate / Grid

GPS Satellite

GPS Satellite

GPS Satellite

NOAA DeHavilland
DHC-6 Twin Otter

30 Degree
Cone Angle

Aircraft Elevation
~700 meters

GPS Base
Station

Overlapping Swaths

Direction of Flight
(parallel to beach)

Combined Swath Width
~700 meters

USGS Coastal & Marine

*Point Cloud
x, y, z, ...*

Analyze / "Do Science"

The Flood of Data

B4

NCALM
The National Center for Airborne Laser Mapping

LiDAR coverage of the southern San Andreas and San Jacinto faults

SAF SEGMENT 11
SAF SEGMENT 10
SAF SEGMENT 9
SAF SEGMENT 8
SAF SEGMENT 7
SAF SEGMENT 6
SAF SEGMENT 5
BANNING SEGMENTS
SAF SEGMENT 4
SAF SEGMENT 3
SAF SEGMENT 2
SAF SEGMENT 1
SJF SEGMENT 7
SJF SEGMENT 6
SJF SEGMENT 5
SJF SEGMENT 4
SJF SEGMENT 3
SJF SEGMENT 2
SJF SEGMENT 1
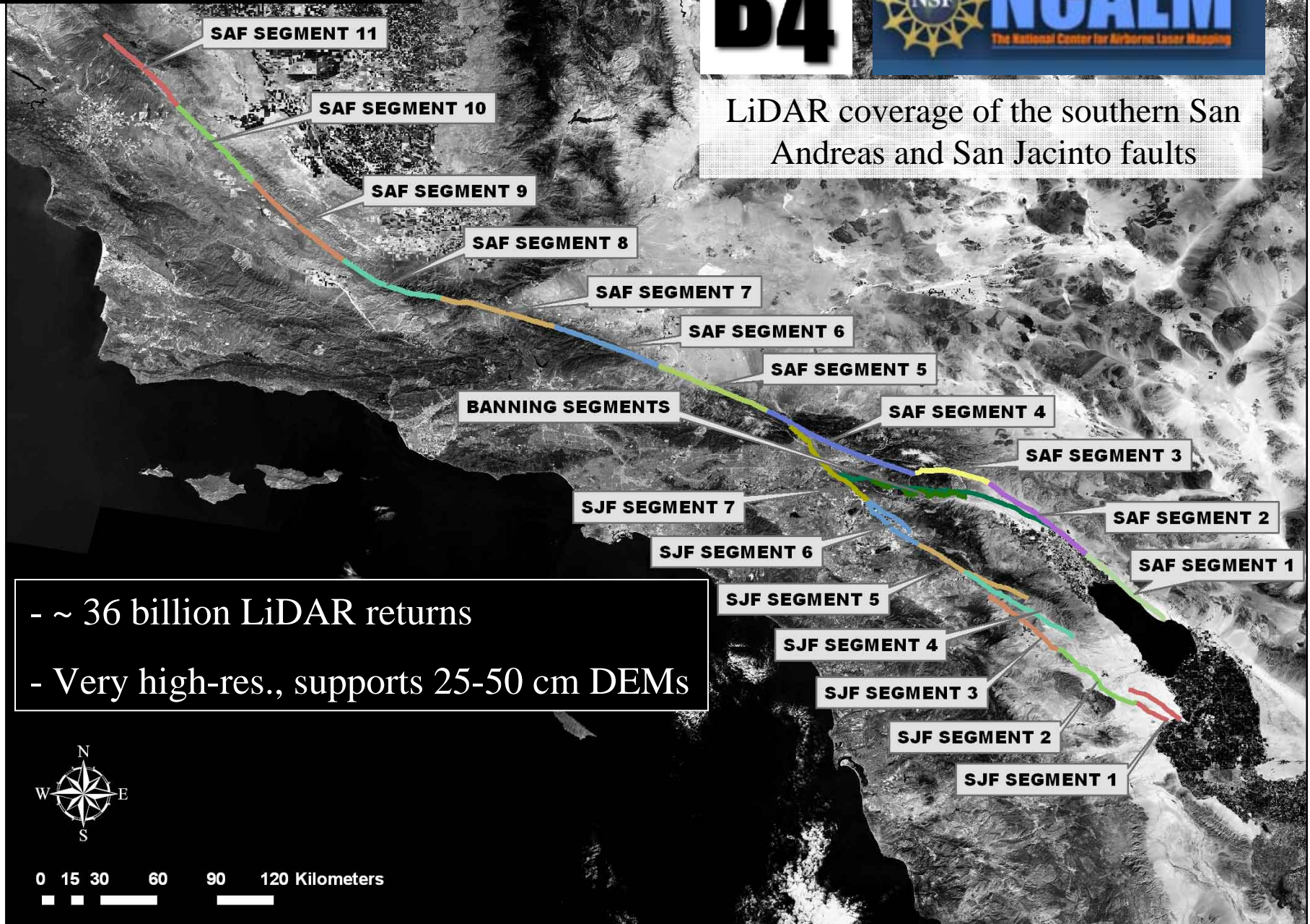
- ~ 36 billion LiDAR returns

- Very high-res., supports 25-50 cm DEMs

N
W   E
S

0 15 30   60   90   120 Kilometers

- Multi-institution collaboration between IT and Earth Science researchers
- Funded by NSF "large" ITR program

- GEON Cyberinfrastructure provides:
  - Authenticated access to data and Web services   - Scientific workflow environment
  - Registration of data sets and tools, with metadata   - Data and map integration capability
  - Search for data, tools, and services, using ontologies - Visualization and GIS mapping

- "GEON was designed as an equal collaboration between Information Technology (IT) and Geoscience researchers, with the goal of developing an enabling IT platform to facilitate the next generation of Geoscience research."
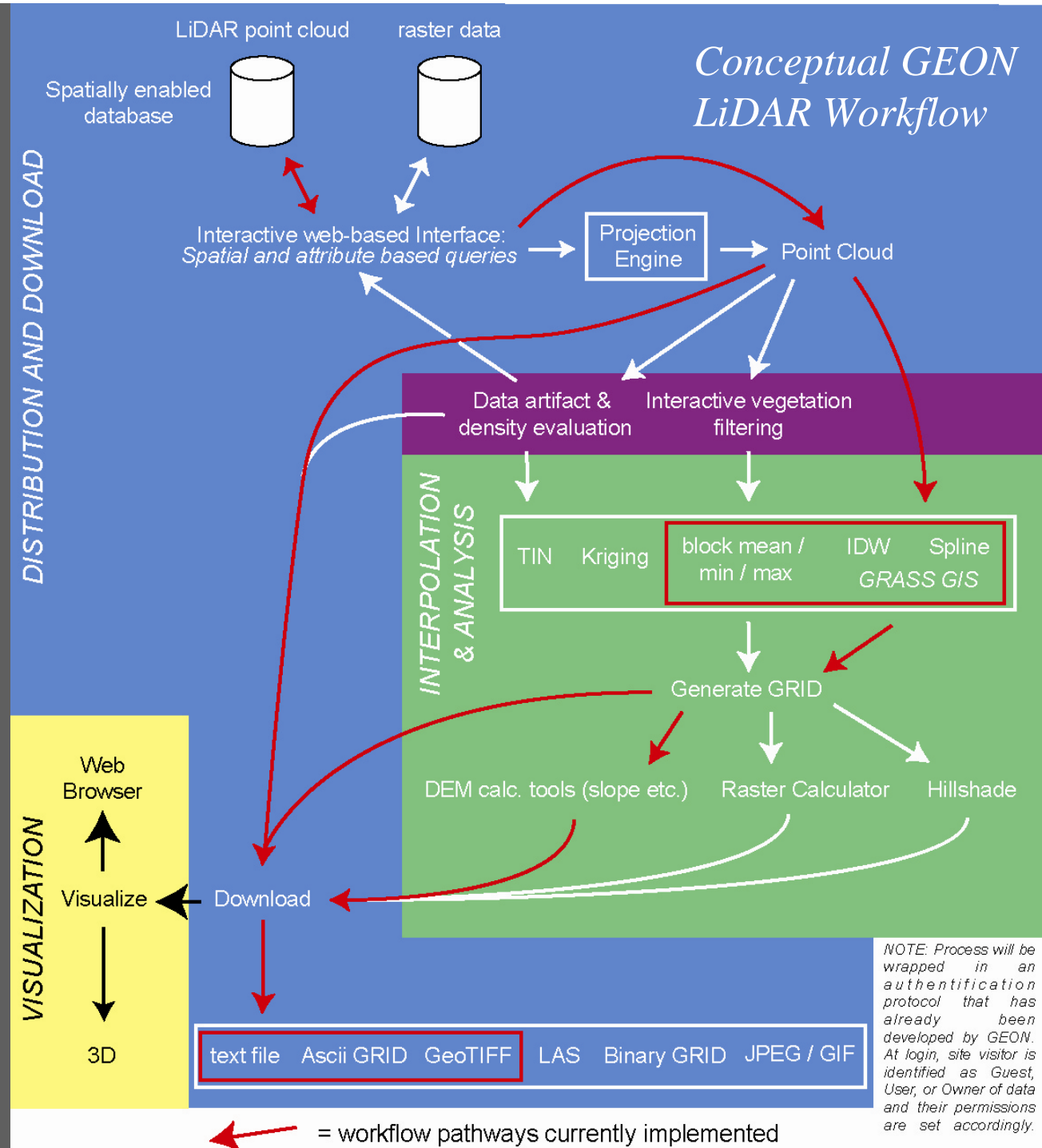
Distributed Network
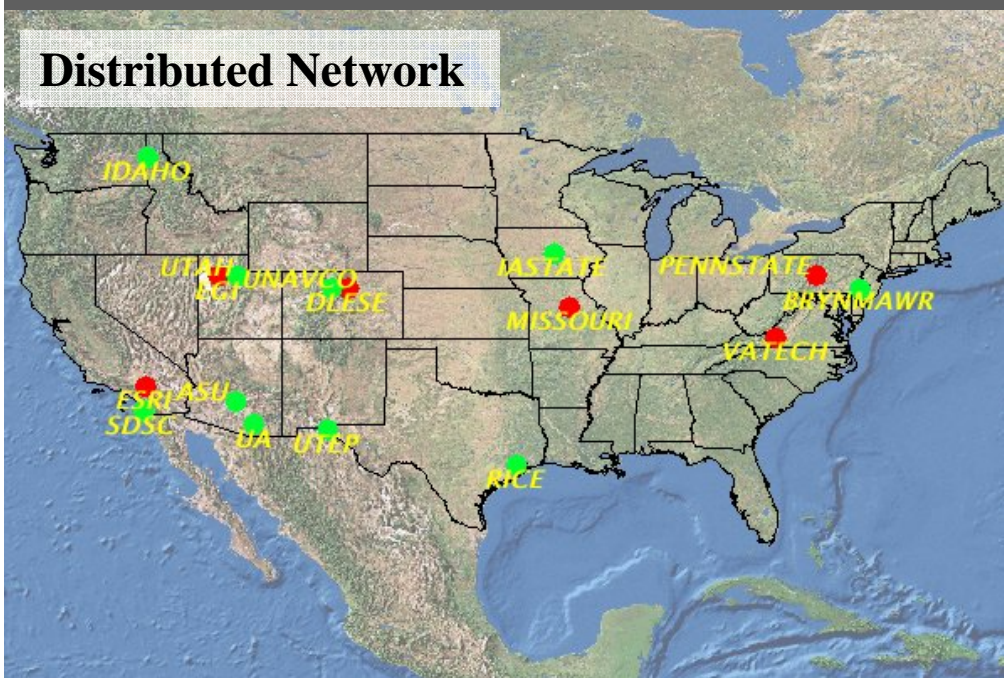
GEON /
ASU node
"Agassiz":

The Vision:

- Utilize cyberinfrastructure developed by GEON to offer online data distribution, DEM generation, and analysis of large LiDAR datasets.

- Completely internet-based workflow:
  - **Point cloud to visualization**

- Utilize modular web services to complete a variety of processing and analysis tasks.

- Offer users control of processing and analysis parameters.

Conceptual GEON LiDAR Workflow

LiDAR point cloud   raster data

Spatially enabled database

DISTRIBUTION AND DOWNLOAD

Interactive web-based Interface: *Spatial and attribute based queries*

Projection Engine

Point Cloud

Data artifact & density evaluation   Interactive vegetation filtering

INTERPOLATION & ANALYSIS

TIN   Kriging   block mean / min / max   IDW   Spline
GRASS GIS

Generate GRID

DEM calc. tools (slope etc.)   Raster Calculator   Hillshade

VISUALIZATION

Web Browser

Visualize

3D

Download

text file   Ascii GRID   GeoTIFF   LAS   Binary GRID   JPEG / GIF

NOTE: Process will be wrapped in an authentification protocol that has already been developed by GEON. At login, site visitor is identified as Guest, User, or Owner of data and their permissions are set accordingly.

= workflow pathways currently implemented

Current GLW features:

- Interactive polygon data selection via WMS map

- Attribute selection (ground returns, vegetation returns)

- Rapid estimate of points within selection area

- Point cloud download

- DEM generation via two pathways:

    - local binning algorithm (*see G53C-0921*)

    - Spline interpolation algorithm (GRASS GIS web service)

- User defined grid resolution and processing parameters

- Products produced in multiple, user-defined, file formats

- User provided job title and description

- Dynamically generated and customized metadata file

- Email notification

G53C-0921 – An efficient implementation of a local binning algorithm for digital elevation model generation... Kim et al.

Implementation Overview:

The GLW utilizes advanced spatial databases (IBM DB2), GRASS Open Source GIS, custom DEM generation code, Kepler Workflow manager and web service technology to distribute, interpolate, and analyze LiDAR data.
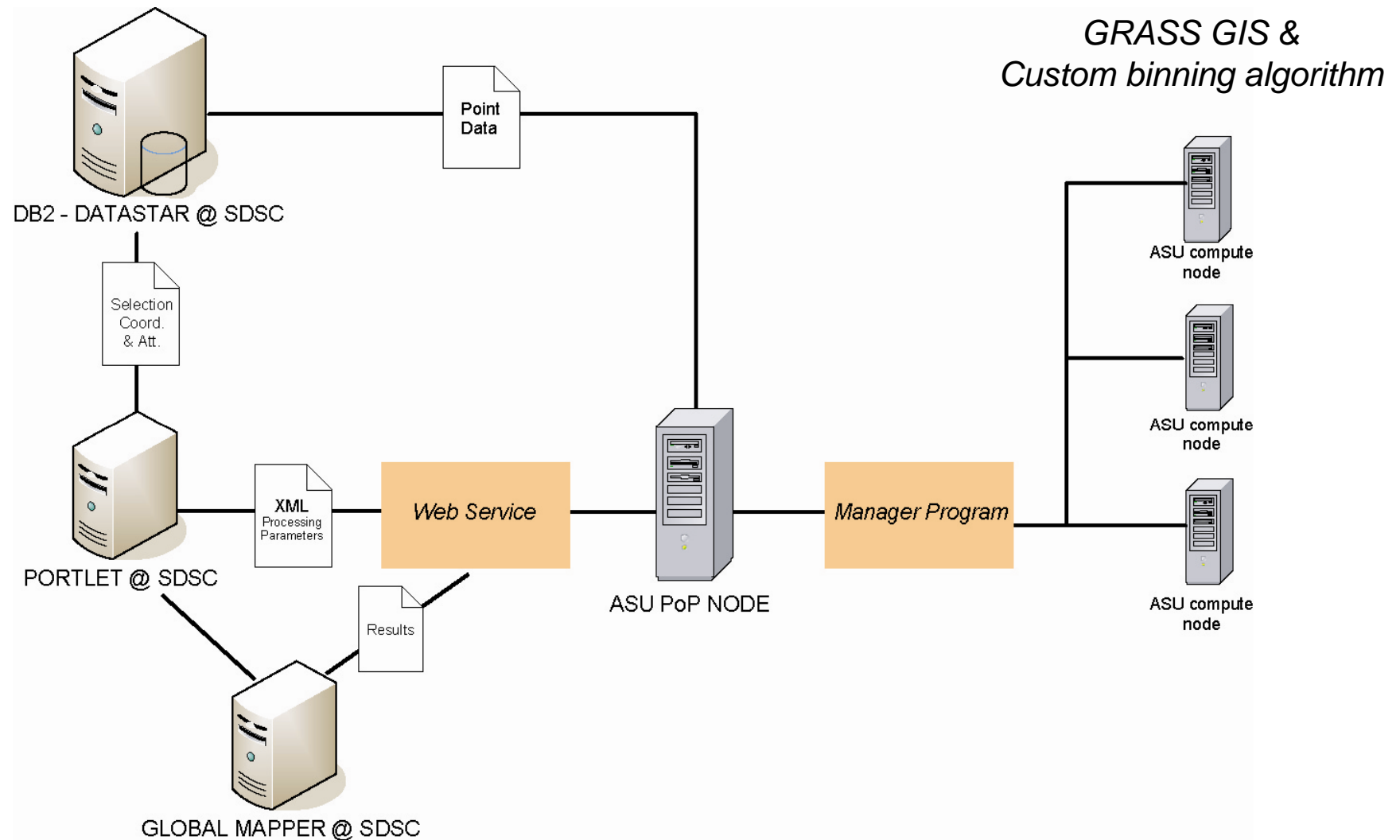
Current GLW Status

Datasets online:

1. Northern San Andreas Fault
2. West Rainier Seismic Zone
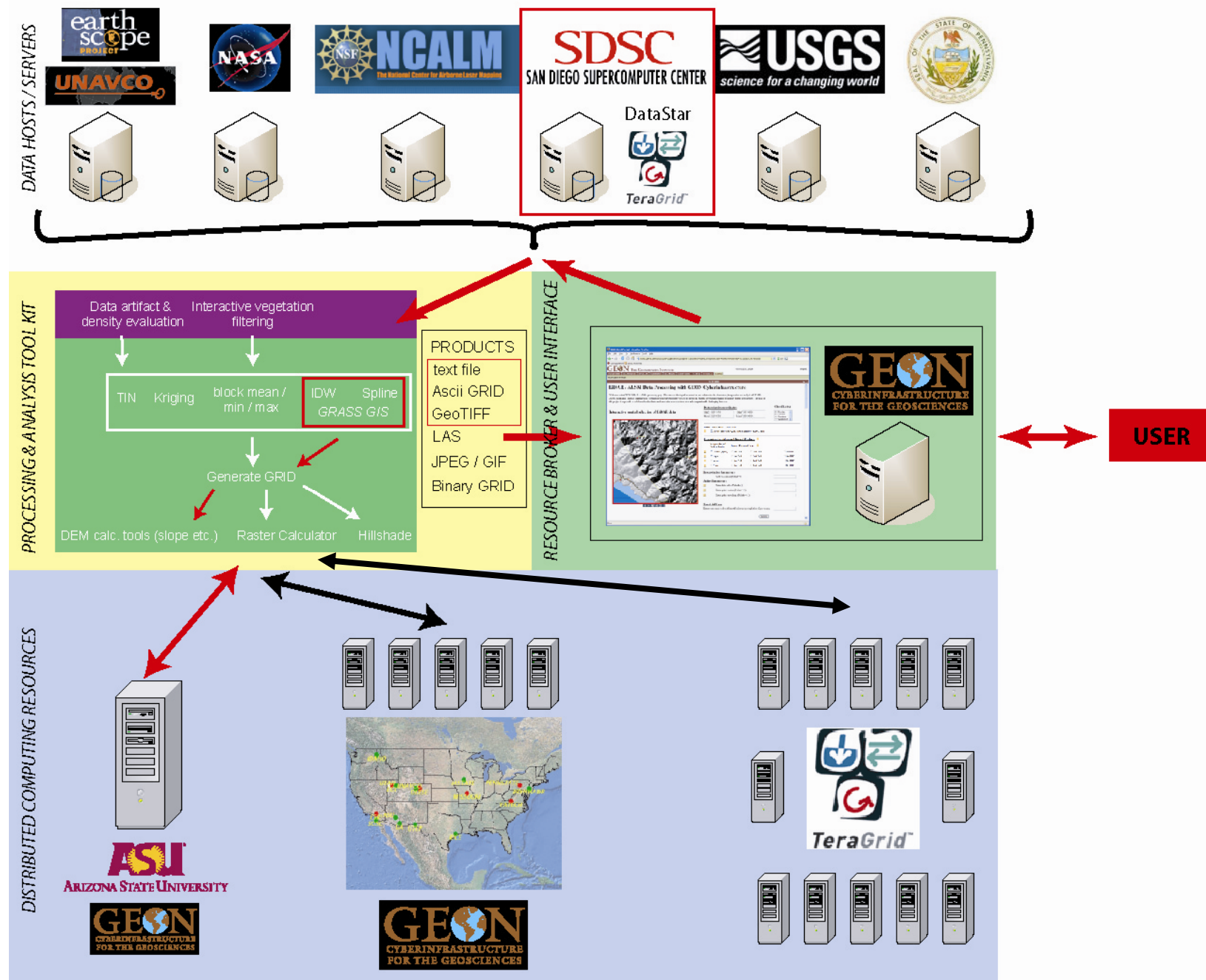
3. Eastern California Shear Zone

(Mike Oskin PI)

4. Full B4 Dataset (Southern SAF and SJF)

Total of ~38 billion LiDAR returns available via GLW

A cyberinfrastructure-based model for managing the flood of community LiDAR datasets

Implications

- GLW is a proof of concept for utilization of cyberinfrastructure to democratize access to the next generation of community geoscience datasets and processing tools.
  - Generic and scaleable GEON architecture applicable to numerous (geo) science datasets.

- GLW proposed as distribution pathway for forthcoming GeoEarthscope LiDAR datasets:
  - 5 more B4 style data acquisitions in next 2 years.

- Discussions underway with USGS EROS Data Center to expose their LiDAR archive (CLICK) via the GLW.

GEON LiDAR Workflow Access Instructions:

http://www.geongrid.org/science/lidar.html

<u>More information on the GLW</u>:

Efrat Jaeger-Frank, Christopher J. Crosby, Ashraf Memon, Viswanath Nandigam, J. Ramon Arrowsmith, Jeffery Conner, Ilkay Altintas, Chaitan Baru, **A Three Tier Architecture for LiDAR Interpolation and Analysis**, *Lecture Notes in Computer Science*, Volume 3993, Apr 2006, Pages 920-927, DOI: 10.1007/11758532_123.

Crosby, C.J. et al., **A geoinformatics-based approach to LiDAR data distribution and processing** *in preparation*.

<u>Abstracts, posters & presentations</u>:

http://lidar.asu.edu/