

The National & Cooperative CORS Program

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National Geodetic Survey
National Ocean Service, NOAA

CORS Users Forum
Portland, OR
September 9, 2003



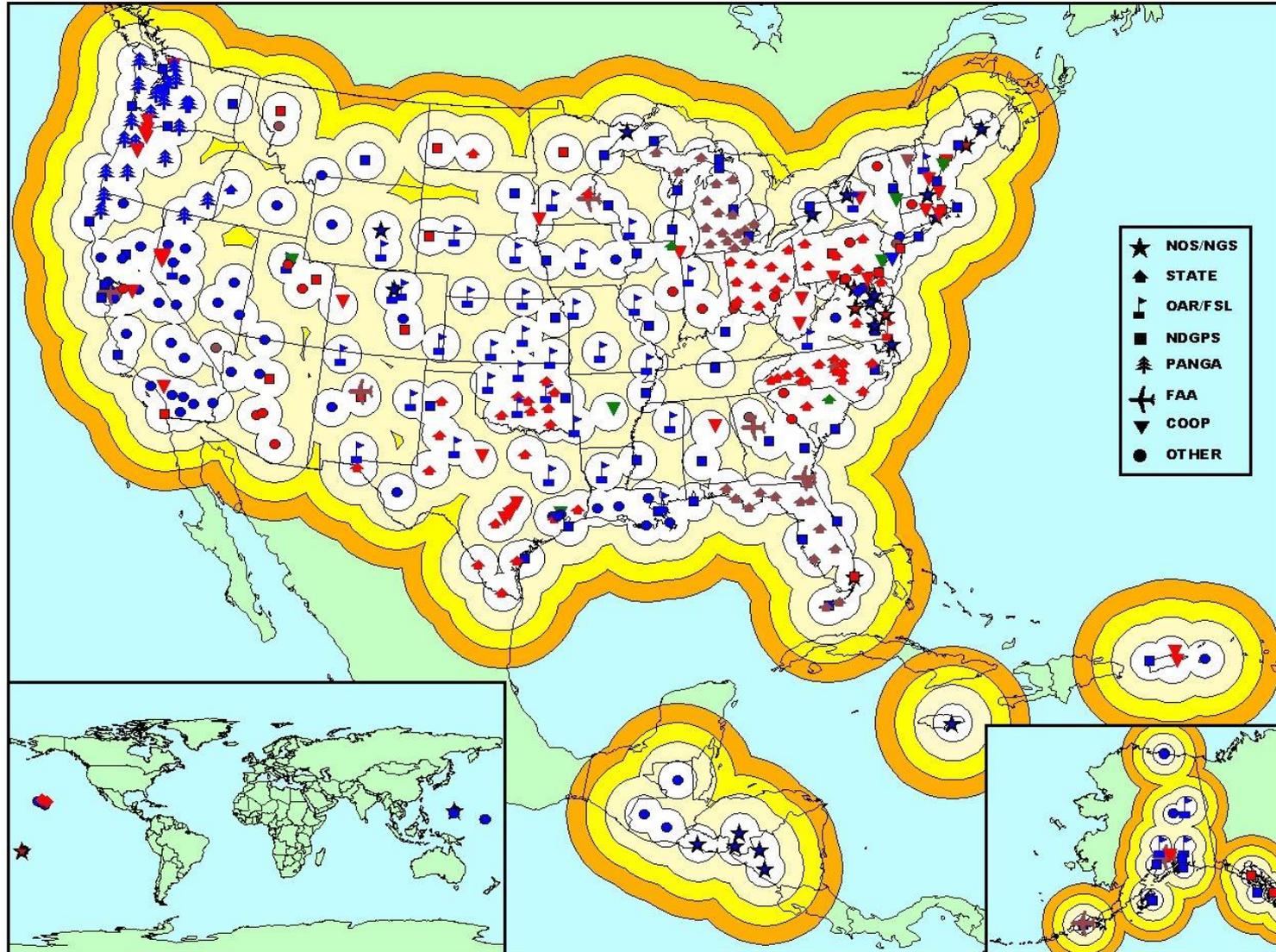
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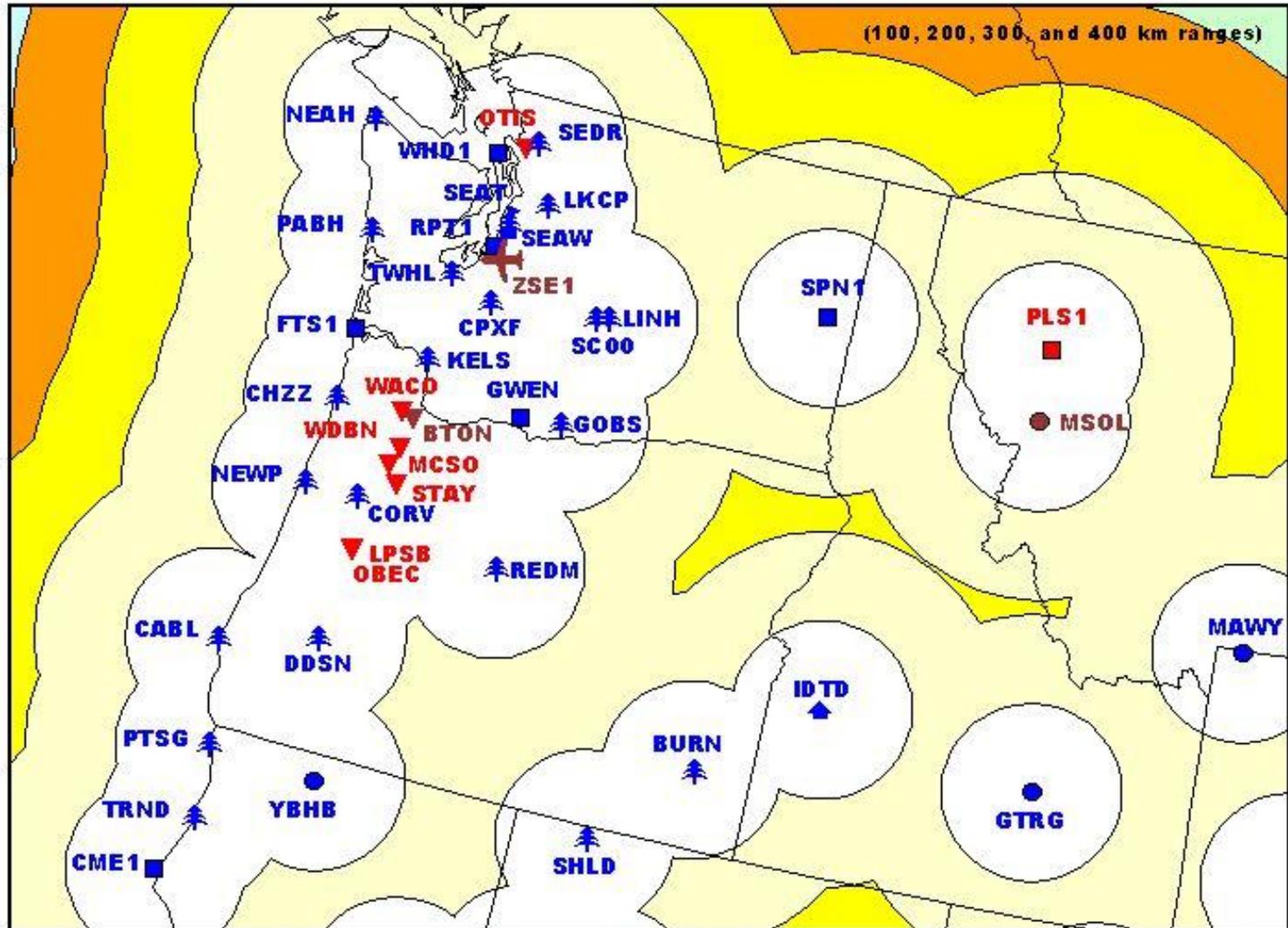
Continuously Operating Reference Stations

CORS Coverage (100, 200, 300, and 400 km radius) January 2003



Symbol color denotes sampling rates: (1 second) (5 seconds) (15 seconds) (30 seconds)

Regional CORS Coverage



Symbol color denotes sampling rates: (1 second) (5 seconds) (10 seconds) (15 seconds) (30 seconds)

Craig 5/28/03

CORS SITES



CORS SITES



CORS OVERVIEW

- Network contained 700+ sites as of August 2003
- Growing at rate of 8 sites per month
- More than 100 organizations participate in the CORS program
- Provides code range (C/A, P1, P2)
 - and carrier phase observations (L1, L2)
- Provides meteorological data at some sites



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CORS APPLICATIONS

- Postmission Static Positioning (cm-level accuracy with a few hours of data, dm-level accuracy with one minute of data)
- Postmission Kinematic Positioning (dm-level accuracy for an aircraft, a boat, or a land vehicle)
- Geophysics / Crustal Motion
- Meteorology / Water Vapor in Atmosphere
- Space Weather / Free Electrons in Ionosphere



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NATIONAL CORS NETWORK

- National CORS network contains 403 sites whose data are available directly from NOAA's National Geodetic Survey in Silver Spring, MD
- GPS and “met” data stored in RINEX format
- Data made available to public via:
 - World Wide Web
 - File transfer protocol
- Currently 9 years of CORS data are online for immediate access
- **Parallel CORS Data Site being established at NOAA's National Geophysical Data Center in Boulder, CO**



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COOPERATIVE CORS

- GPS base stations whose data are freely disseminated by cooperating organizations
- NGS provides link from its web site to that of each cooperating organization
- Site coordinates must be consistent with the National Spatial Reference System



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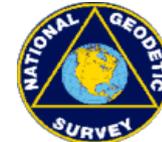
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National CORS & Cooperative CORS

| National CORS | Cooperative CORS |
|---|---|
| - Station commits to a long-term and continuous operation | - Station operates at least 8hrs/day; 5days/week |
| - Data are available online via the NGS CORS web page | - Provides a link to the participant's web page |
| - All data are permanently archived in NGS | - Minimum 7 days' data online at the participant's web site |
| - antenna position re-computed everyday | - antenna position re-computed every 30 days or less |

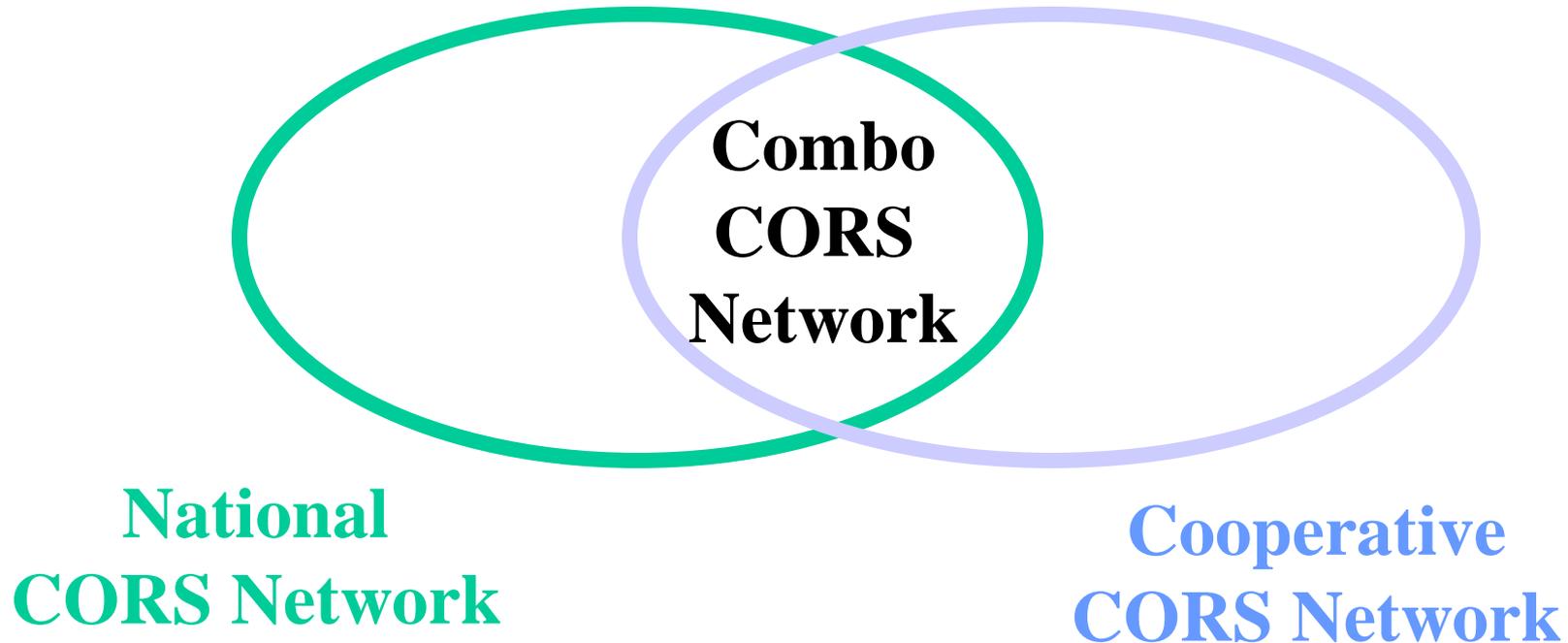


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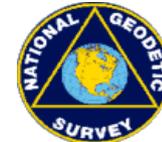


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CORS Networks



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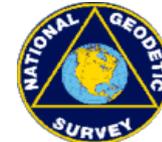
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COMBO CORS

- The term “Combo CORS” designates a station whose GPS data is distributed both by NOAA and by a cooperating organization.
- Such accessibility to CORS data is highly desirable.
- Scripps Institution of Oceanography (LaJolla, CA) distributes data for 650+ sites in the CORS network.

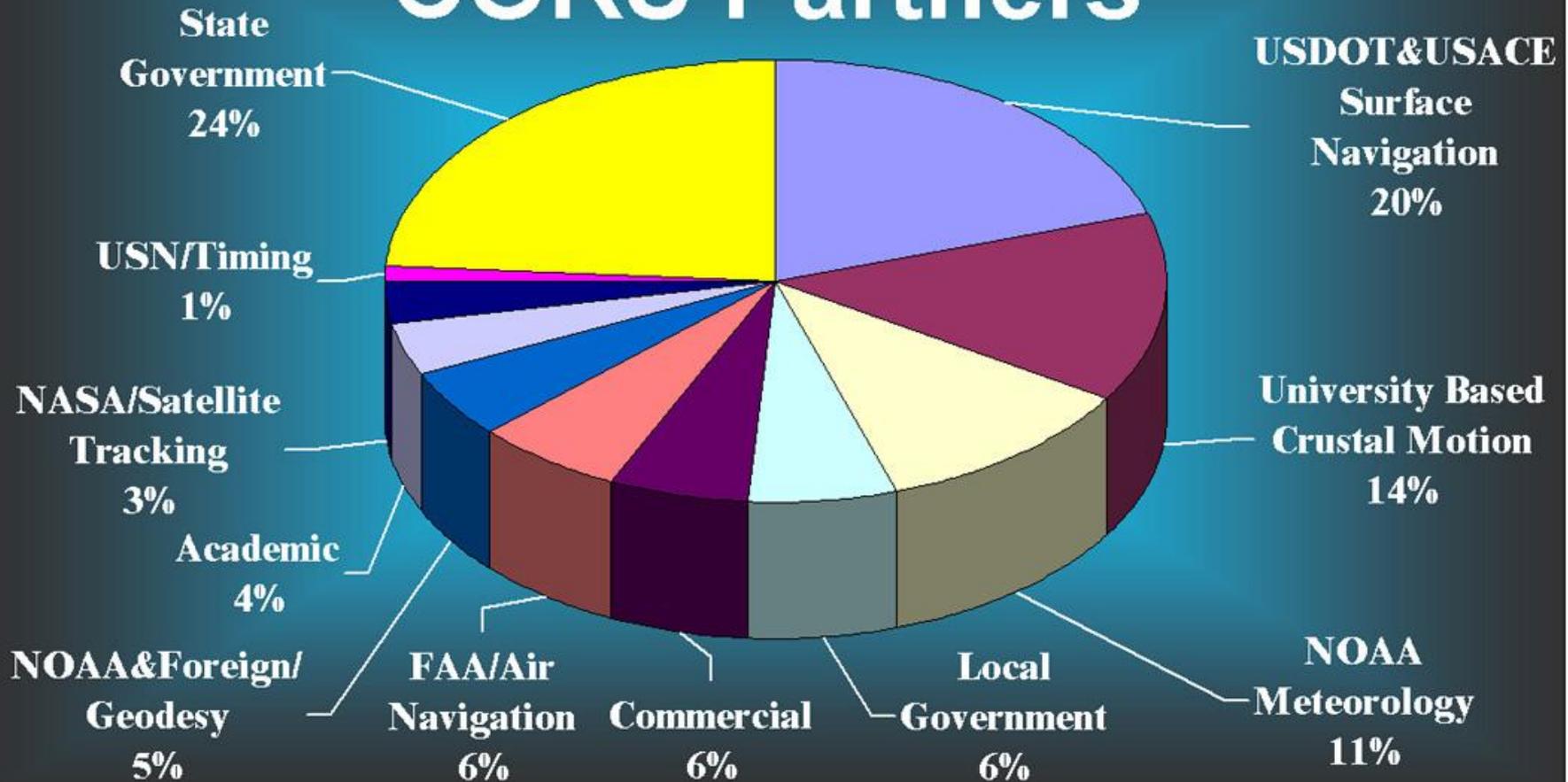


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CORS Partners

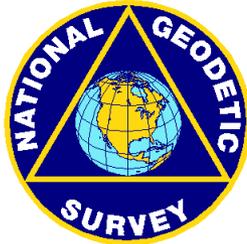


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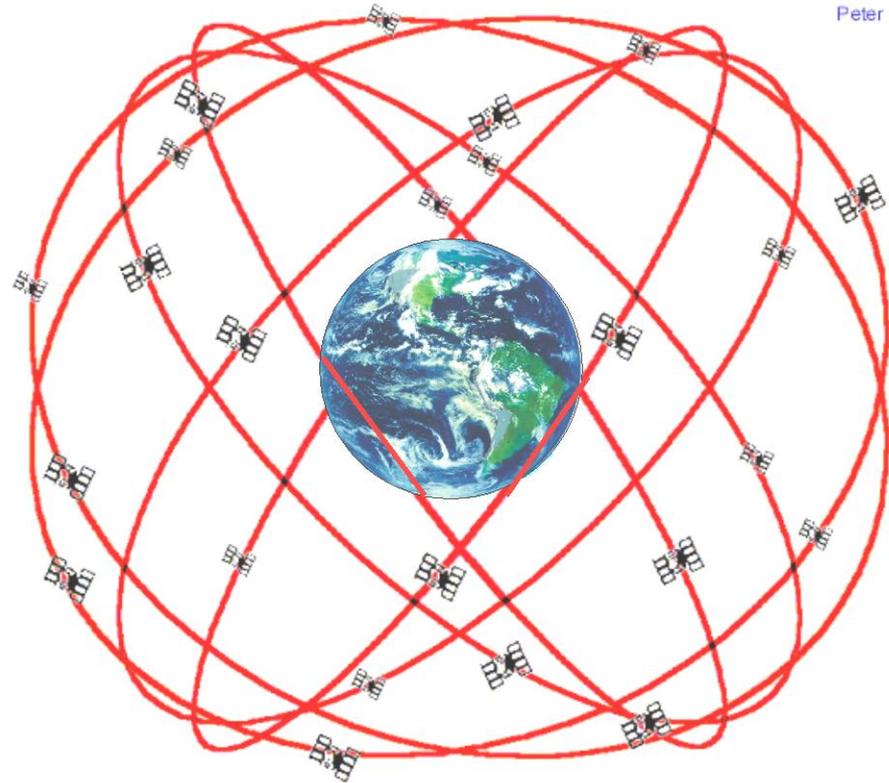
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CORS PARTNERS: FEDERAL



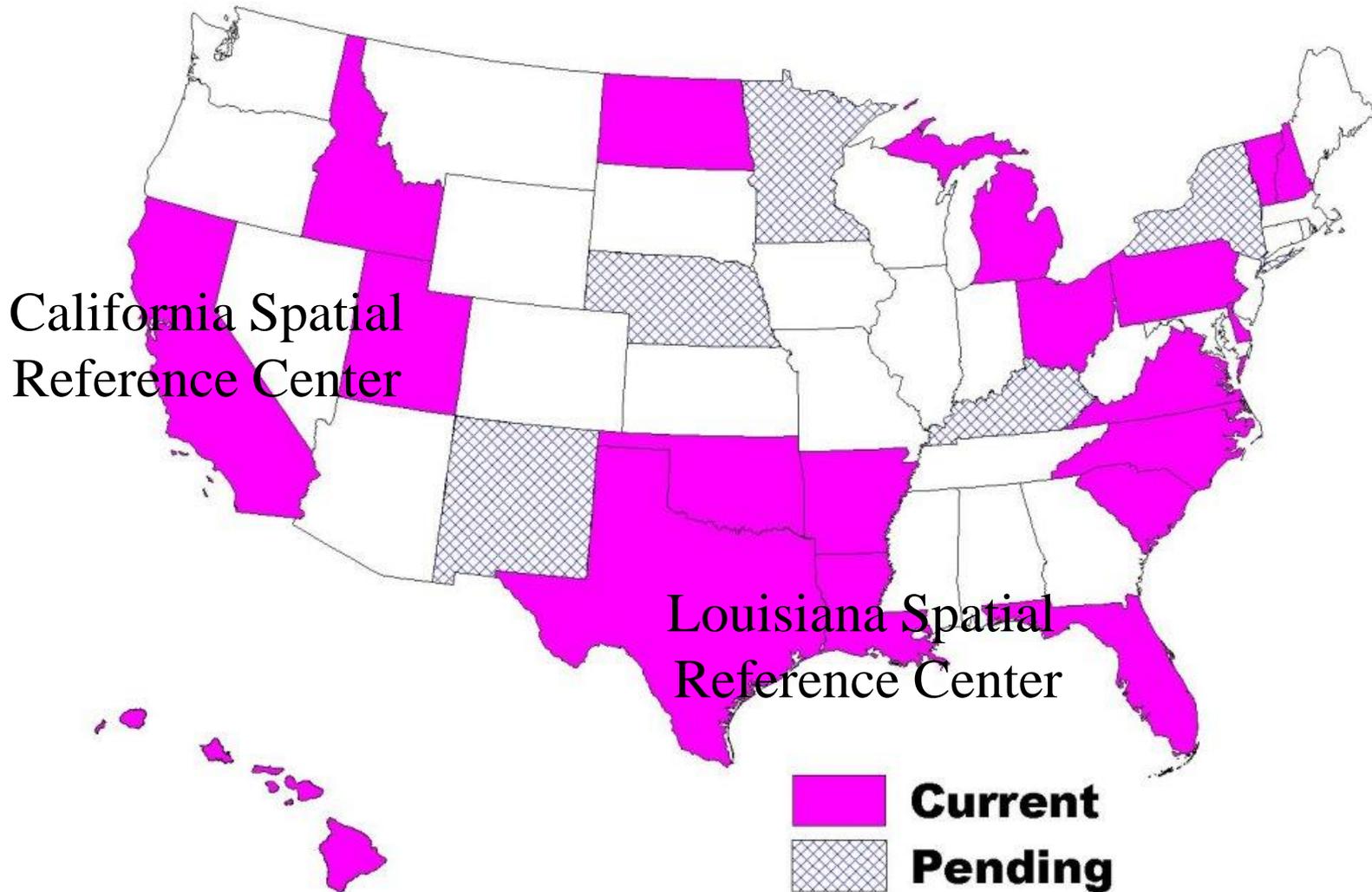
Federal Highway Administration
Federal Railway Administration
Federal Aviation Administration
Forecast Systems Laboratory
National Geophysical Data Center
NASA
US Geological Survey
US Army Corps of Engineers
US Air Force
US Naval Observatory

Peter H. Dana 9/22/98

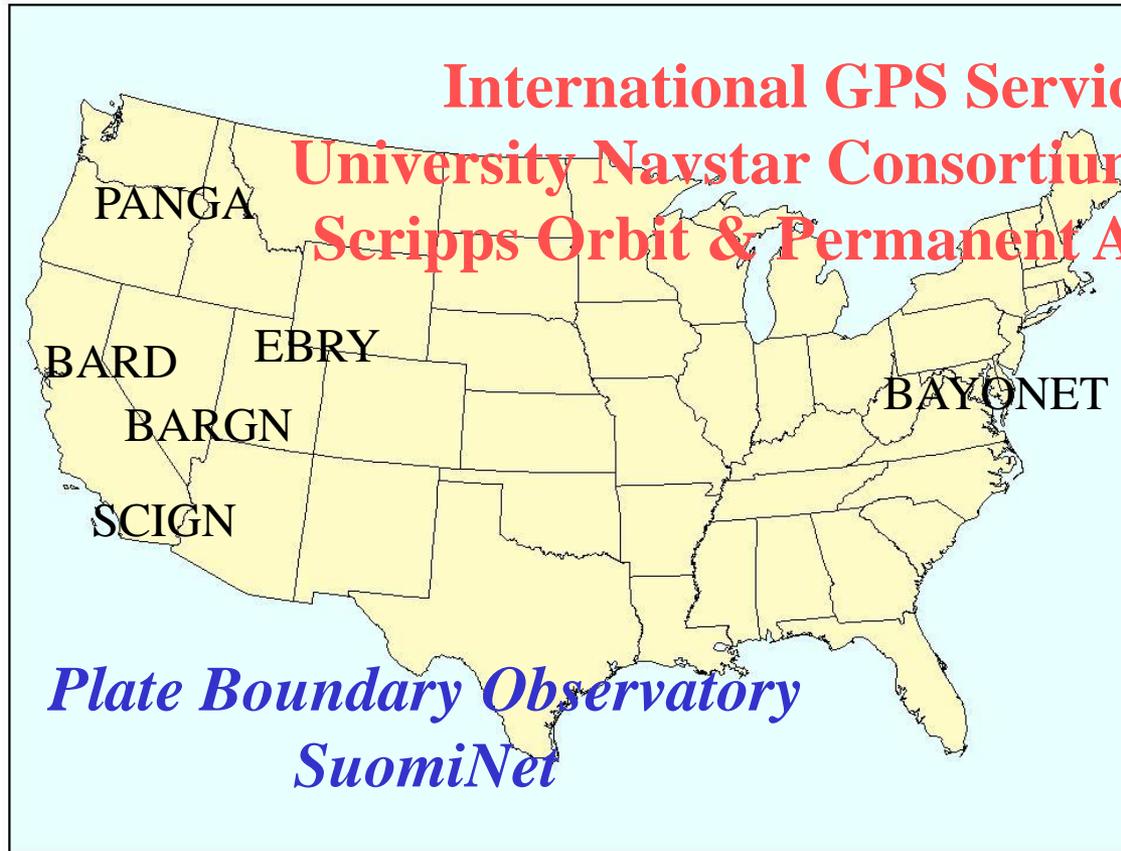


GPS Nominal Constellation
24 Satellites in 6 Orbital Planes
4 Satellites in each Plane
20,200 km Altitude, 55 Degree Inclination

CORS PARTNERS: STATES



CORS PARTNERS: SCIENTIFIC



International GPS Service (IGS)
University Navstar Consortium (UNAVCO)
Scripps Orbit & Permanent Array Center



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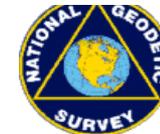


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CORS PARTNERS: INTERNATIONAL



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CORS Partners: Private Industry

“ If you want to see where GPS is going, then keep your eye on the GPS manufacturers.”

Bill Strange

Former Manager

National CORS Program

Many GPS companies have developed software that provides their customers with automatic access to CORS data for postprocessing activities.

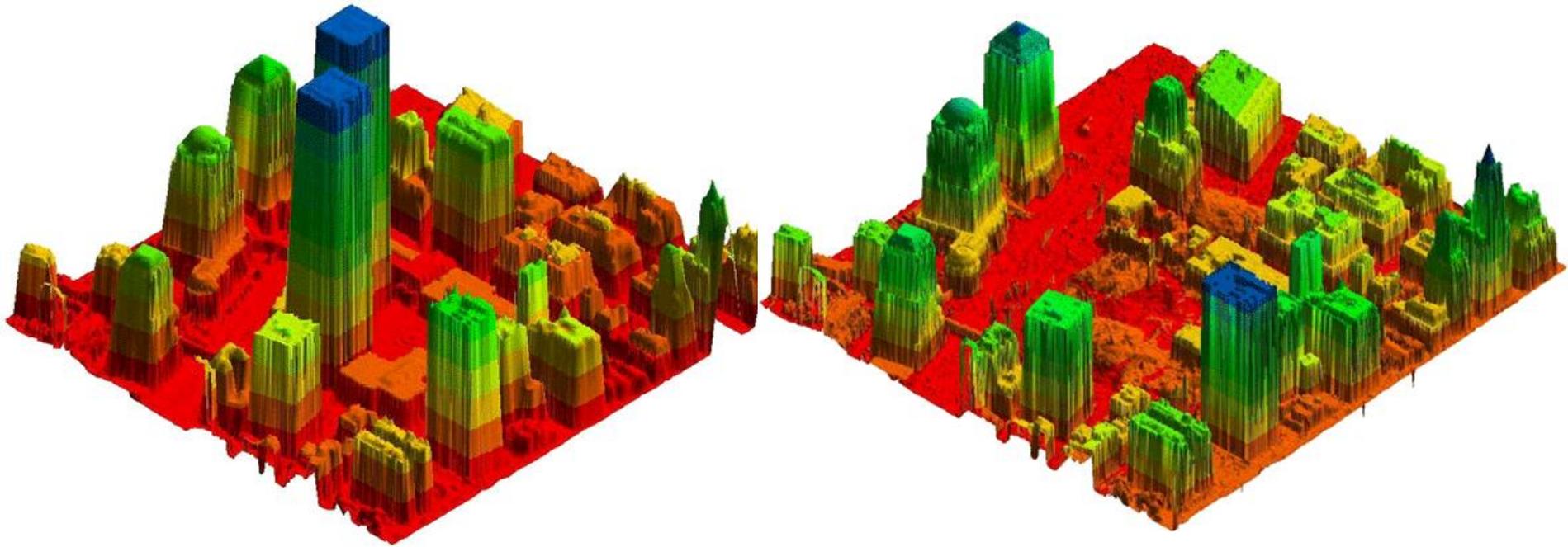


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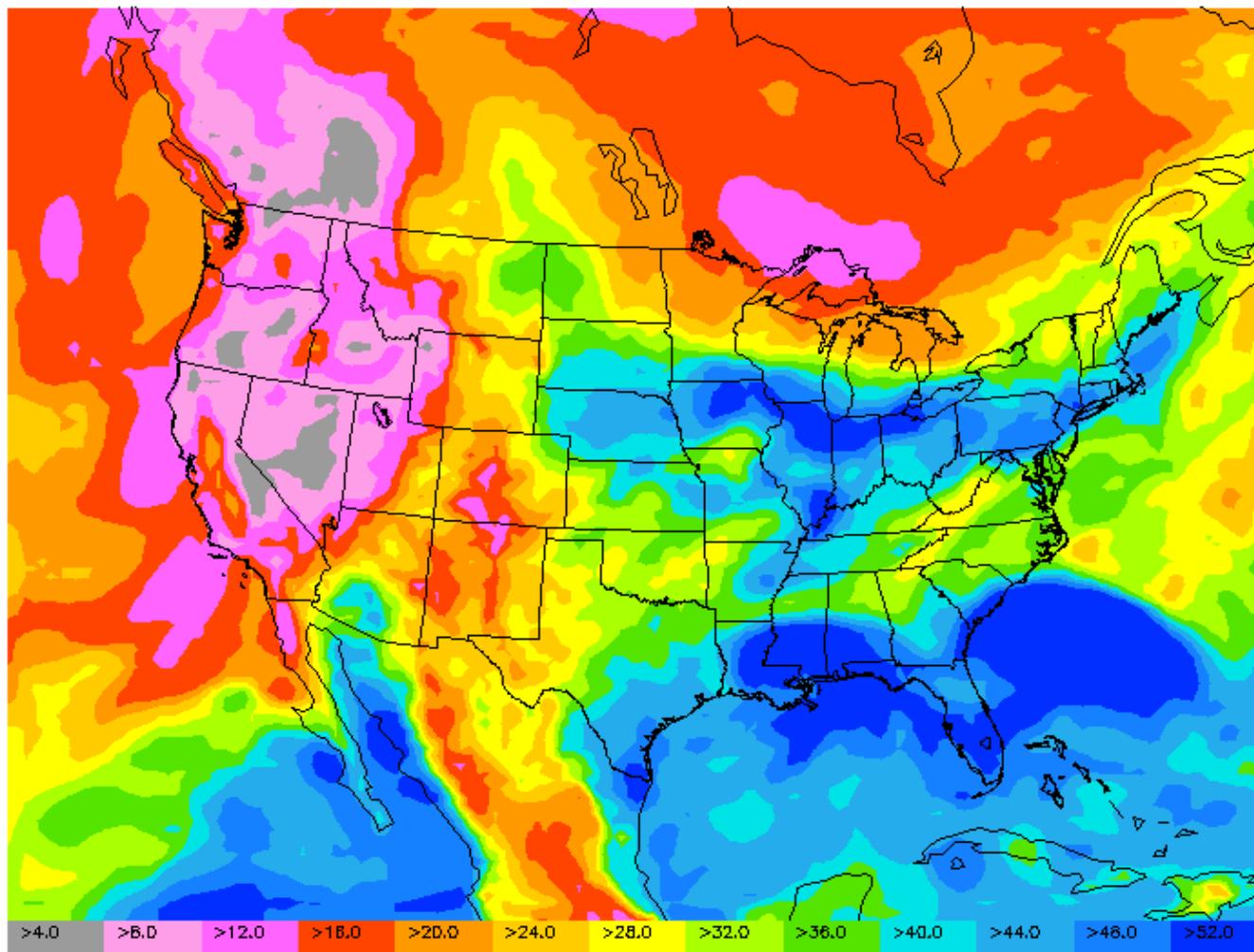
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LIDAR images of Manhattan before and after 11 SEP 2001



These images are computerized visualizations of elevation information of the World Trade Center from before (July 2000) and after (September 15, 2001) the attack. These maps were produced using an airborne LIDAR (Light Detection and Ranging) system. The LIDAR system creates detailed and highly accurate elevation information by the precise timing of thousands of laser pulses striking the ground surface. These data can be manipulated in the digital environment to create an array of maps and views of the project site and to obtain precise measurements of structures, debris fields, and other vital information. These images were generated by EarthData (www.earthdata.com), and the aircraft was positioned using CORS data from the NJI2 site which is operated by the New Jersey Institute of Technology.

Hourly Forecast of Precipitable Water

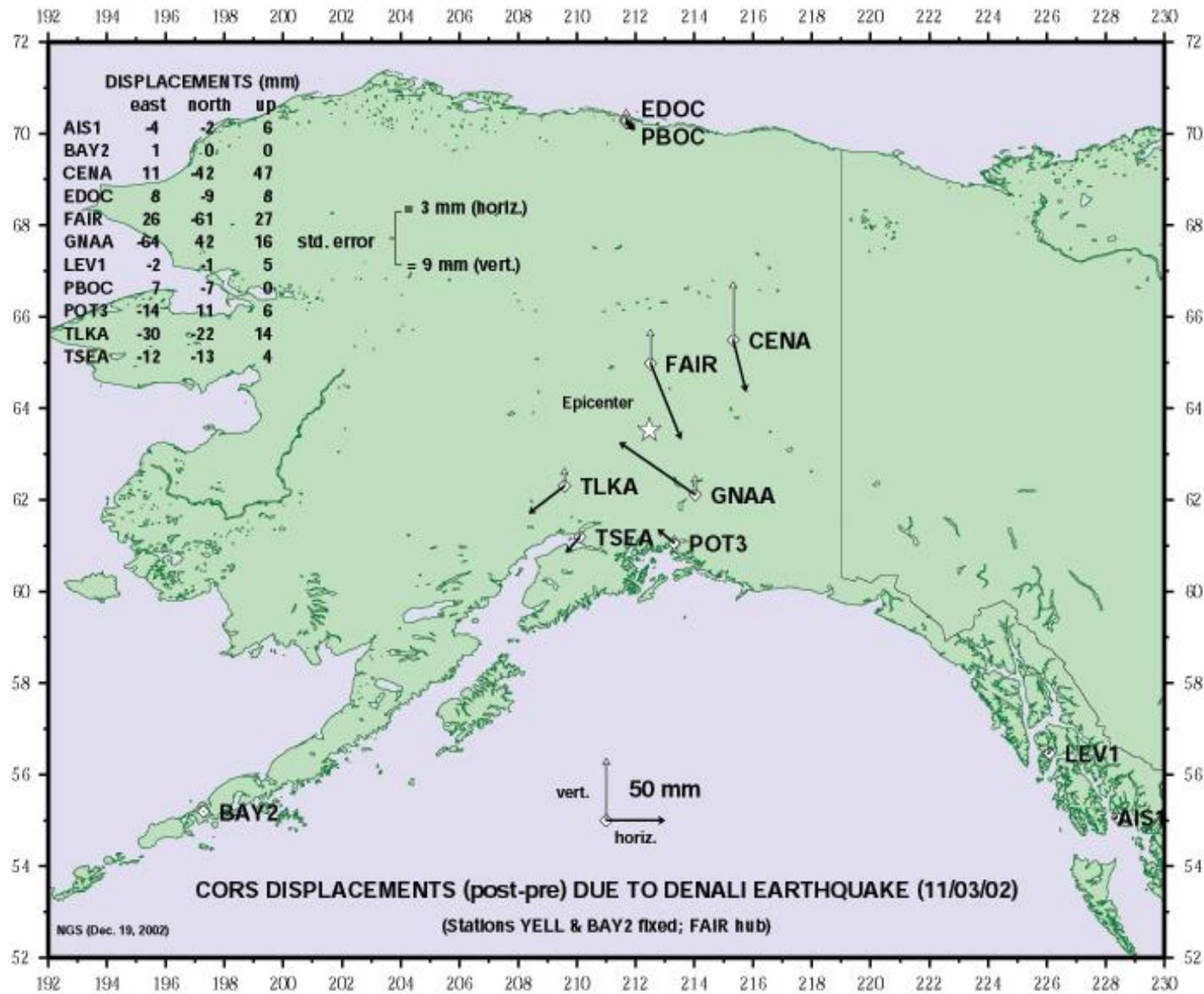


Precipitable water (mm)

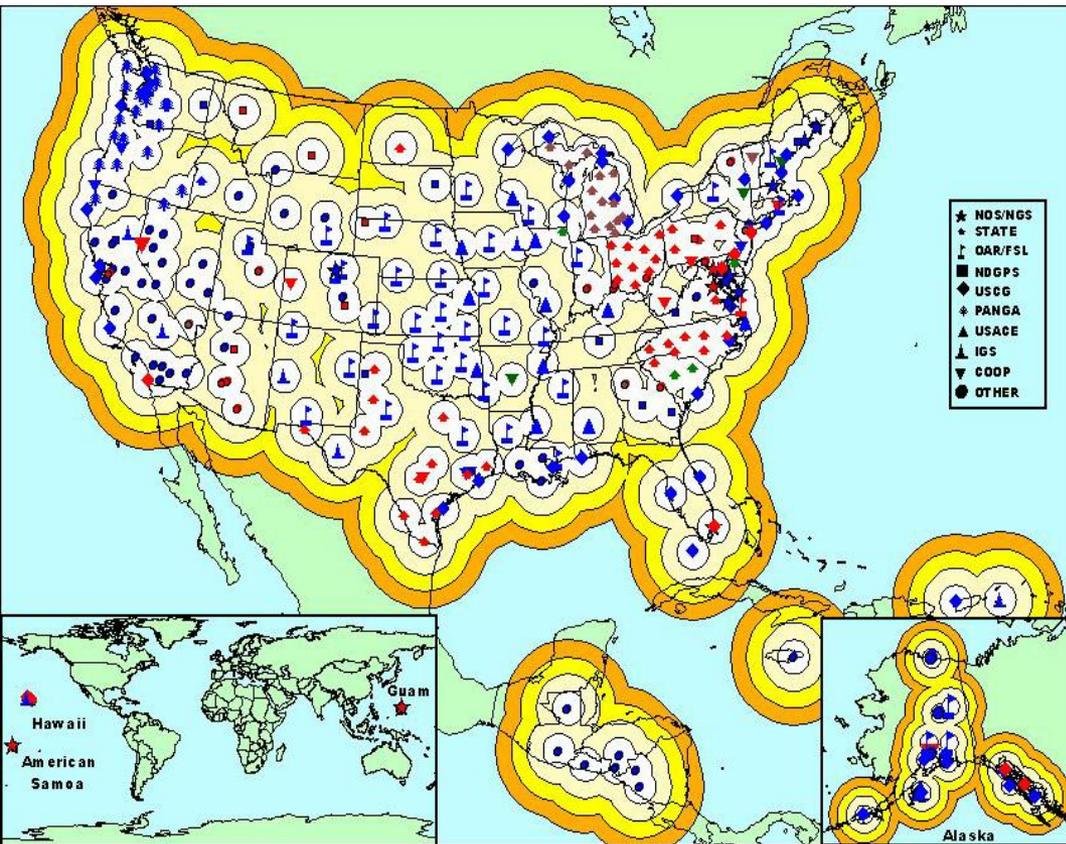
Analysis valid 05-Aug-02 16:00Z

Earthquake effects on CORS coordinates

<http://www.ngs.noaa.gov/CORS/metadata1>



WHAT IS OPUS?



- On-line Positioning User Service
- Provide GPS users faster & easier access to the National Spatial Reference System (NSRS)



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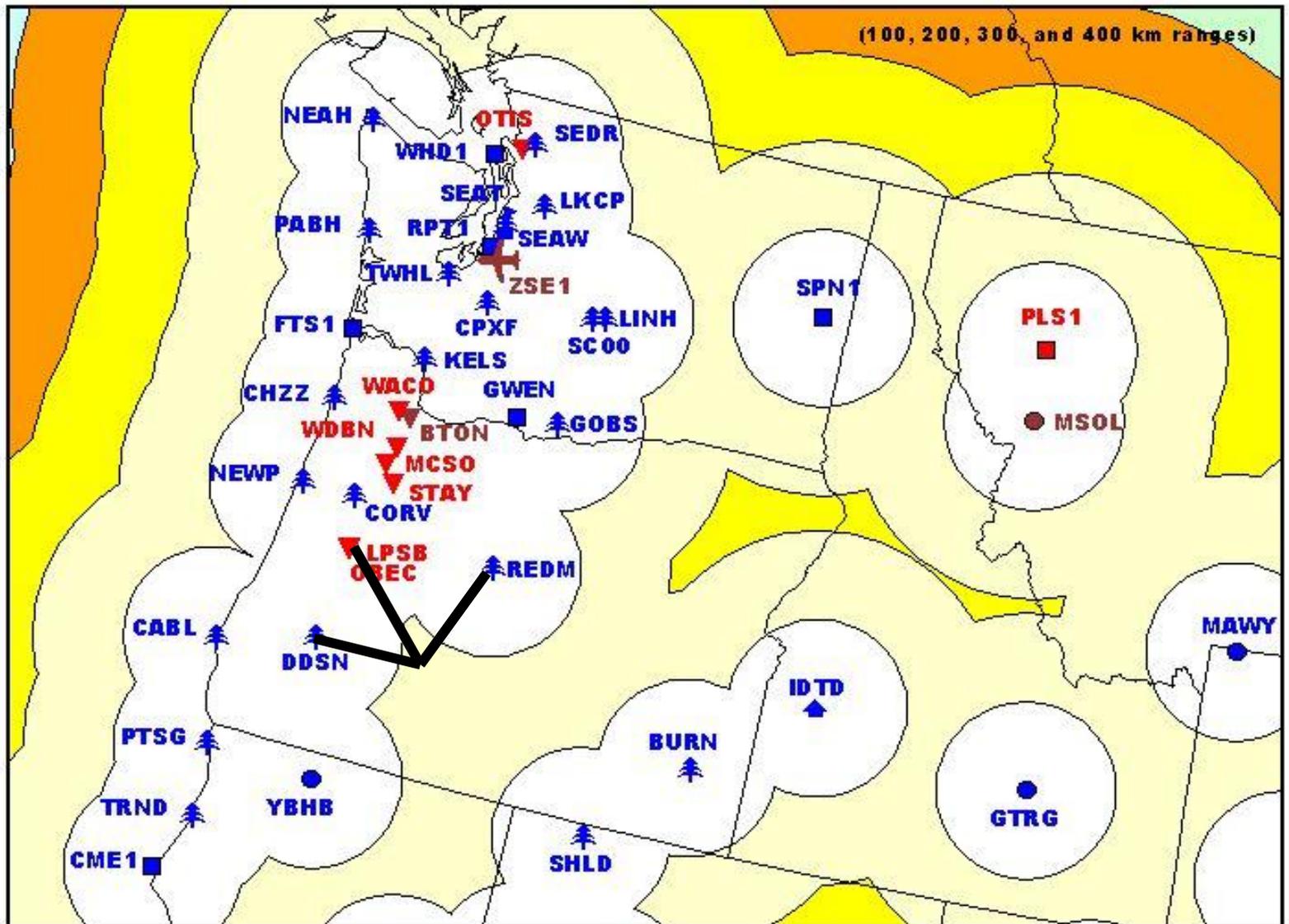


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HOW DOES OPUS WORK?

- Observe 2 or more hours of GPS data
- Submit RINEX file through NGS web page
- Processed automatically with NGS computers & software
- With respect to 3 suitable CORS
- Obtain positional coordinates via email (usually in minutes)

OPUS USES 3 CORS SITES



HOW DO I USE OPUS?

Go to OPUS web page www.ngs.noaa.gov/OPUS

- 1 - Enter your email address
- 2 - Enter/Select RINEX file
- 3 - Select antenna type from menu
- 4 - Enter antenna height in meters (defaults to ARP)
- 5 - Optional: State Plane Coordinates
- 6 - Select up to 3 base stations (optional)
- 7 - Upload File

Check your email (usually only takes a few minutes)



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OPUS

Online
Positioning
User
Service



Recent Developments

[Jan 16, 2003]
 1 addition to the list of antenna types:
 Trimble Zephyr Geodetic with Radome (TRM 41249.00 +radome)

[Jan 13, 2003]

[What is OPUS](#)

[OPUS Guidelines](#)

[GPS Height Measurements](#)

[Antenna Types](#)

[Output Description](#)

[Discussion](#)

[Expected Precisions](#)

[Recent Solutions \(plotted\)](#)

[Latest Orbits](#)

[Areas Covered](#)

OPUS

1.

Enter your email address

2.

Enter your RINEX file Now accepting compressed files (.ZIP, .zip, .Z, .gz)

3.

Select the antenna type

4. meters 5.

Enter the antenna height *Optional*: State Plane Coordinates

6.

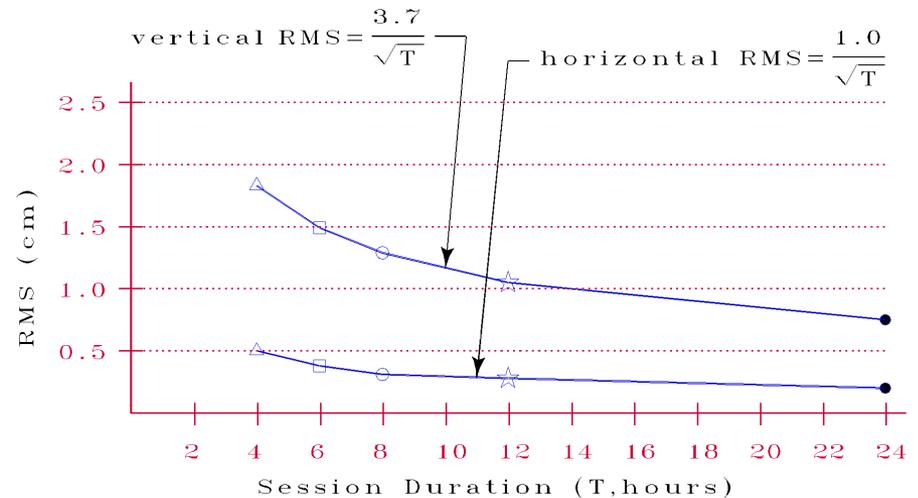
Select up to 3 base stations

7.

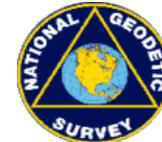
Your data must be dual frequency data (L1 and L2) and have a minimum of 2 hours of observations!

HOW CAN I IMPROVE MY RESULTS?

- The best way to get more accurate results is to observe longer sessions
- Data sets of at least four hours have been shown to produce more reliable results



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RECENT OPUS UPGRADES

- Users can submit compressed RINEX files
- OPUS can process data that is less than a day old
- Users can select one or more of the three CORS to be used as base stations by OPUS
- Users can select one or more Cooperative CORS to be used as base stations by OPUS

NGS is developing a version of OPUS that will process GPS data that has been observed simultaneously at several sites.



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What are requirements for a more effective CORS program?

- Station spacing
- Data sampling rate
- Data latency
- Environmental setting of a CORS site
- Data quality
- Hardware capabilities
- Communication capabilities
- Data formats
- Metadata
- Education / documentation

Front of room

- Reference station operation
- Weather/Ionosphere
- Cooperative CORS Network
- Coordinates/crustal motion
- Applications / outreach / technology transfer
- Data access – communications / formats/ utilities

Hatanaka/Unix vs. gzip

- GPS data for CORS now stored as compressed RINEX files using the “gzip” compression utility
- NGS is proposing to compress such RINEX files using the “Hatanaka” algorithm followed by the Unix compression utility.
- Once implemented, NGS would support both formats for about 6 months, then delete all the “gzip” files.



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IMPACT OF USING Hatanaka/Unix

- Size of Hatanaka/Unix files equals 35% the size of equivalent gzip files (saving storage and enabling faster transmission of data)
- Hatanaka/Unix format is currently used by several other organizations that store and distribute GPS data (compatibility)
- Will not affect users who obtain data via UFCORS utility
- Will affect users who obtain data via anonymous ftp (file transfer protocol)



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