

An Update from the National Geodetic Survey

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Outline

- NGS Personnel Changes
- SRSD Personnel Changes
- 2022 Reference Frames
 - Reference Frames \approx Datums
 - Geometric
 - CORS Updates
 - OPUS Updates
 - Vertical (Geopotential)
 - GSVS 11/14/16
 - GRAV-D
 - xGEOID14/15
- Geospatial Summit
- Outreach Efforts
- Summary and Outlook

NGS Personnel Changes

- HQ
 - Dru Smith now NSRS Implementation Manager (e.g., 2022 datums)
 - Neil Weston is now Chief Geodesist
 - Brett Howe is serving as acting Deputy Director
- Other Divisions
 - Vicki Childers is now the Chief, OAD
 - Gerry Mader has retired as Chief, GRD
 - Steve Hilla is filling in as acting Chief, GRD
 - Ross Mackay is filling in as acting Chief, GSD

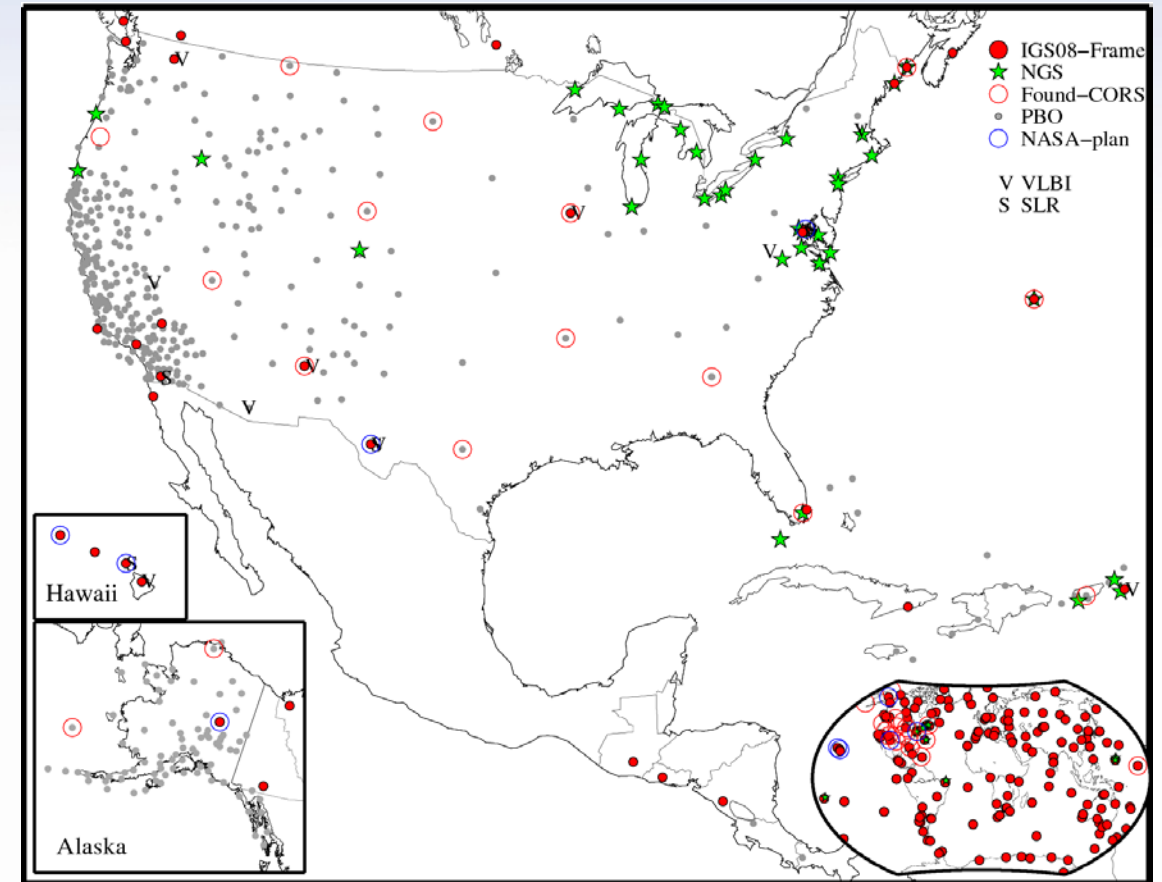
Personnel Changes in SRSD

- GSA Branch
 - Bang Le is new RTN Liaison
 - Dave Hatcher and Weibing Wang are OPUS Analyst
 - They replace Cindy Craig and Bob Siclari (01 SEP)
- CORS Branch
 - Kevin Choi is Branch Chief and will soon divest ACC duties
 - Sungpil Yoon and Jarir Saleh are Orbiteers
 - Fran Coloma and Lijuan Sun are CORS Analysts

2022 Geometric Reference Frame

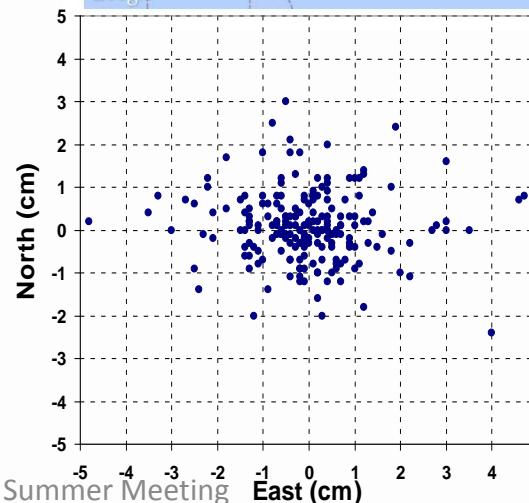
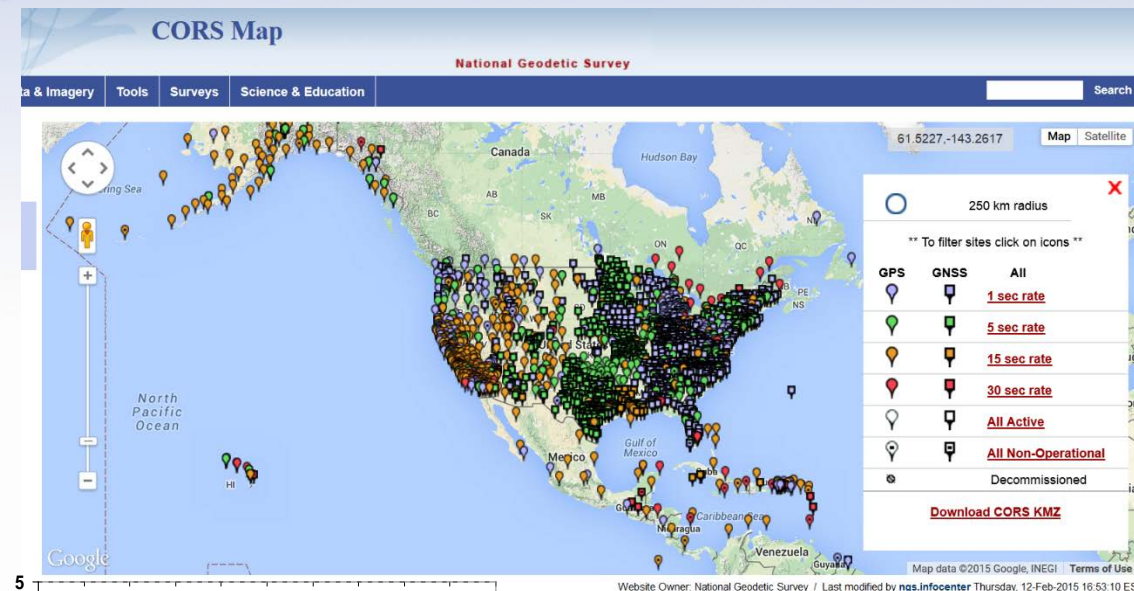
- Will be fit from global to local
- Foundation CORS will be the U.S. subset of IGS global sites
- These will adjust the CORS Sites
 - Collected/archived at ~ 2000 sites
 - Even when a site is dropped, it must be maintained in the list
- CORS Sites can then adjust RTN's
- Akin to Helmert Blocking scheme

Possible Foundation CORS



2022 Geometric Reference Frame

- The archived CORS data are used in OPUS tools
 - Currently, OPUS output is only Shared (e.g., OPUS Database)
 - Official coordinates remain those in the NGSIDB
- RTN Validator tool in DEV
 - Difference between OPUS solution and reported coordinates
 - Expedited upload – as frequent as wanted

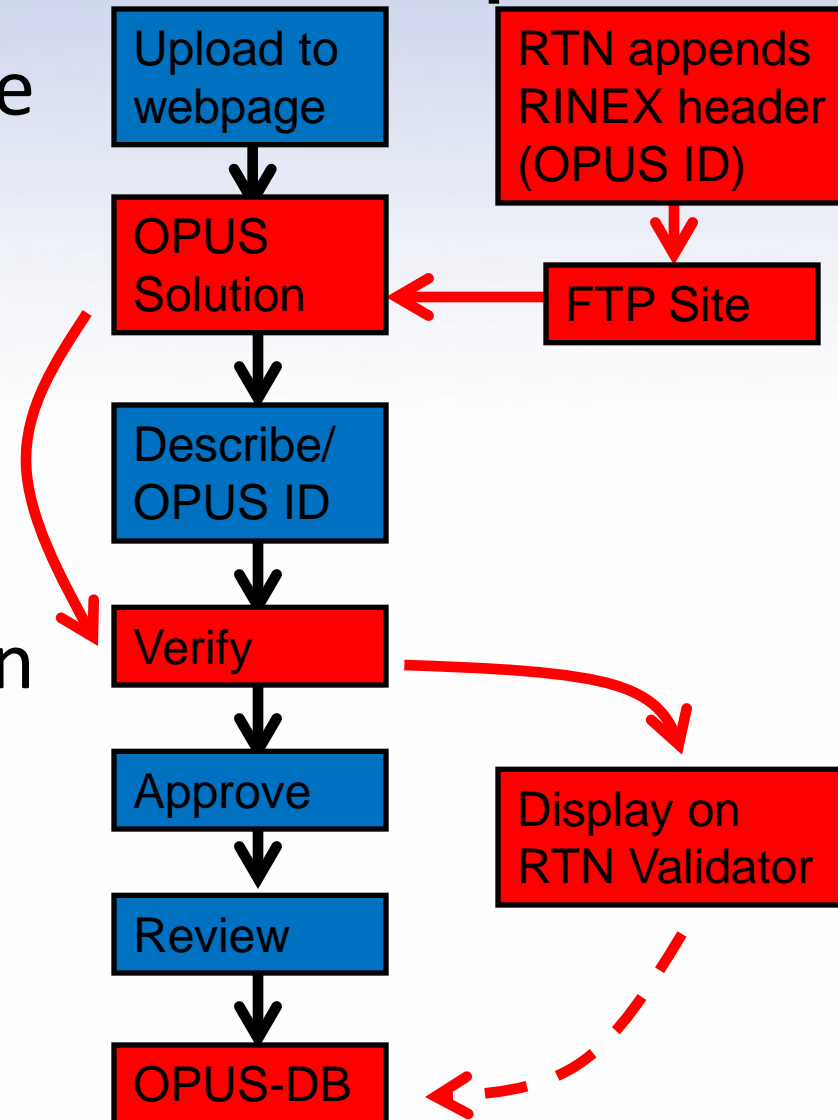


QA test of OPUS-S with 2-hour data sets at 200 CORS:
Compare output to CORS coord.

Mean: <0.1 cm
N-S RMS: 0.8 cm
E-W RMS: 1.4 cm

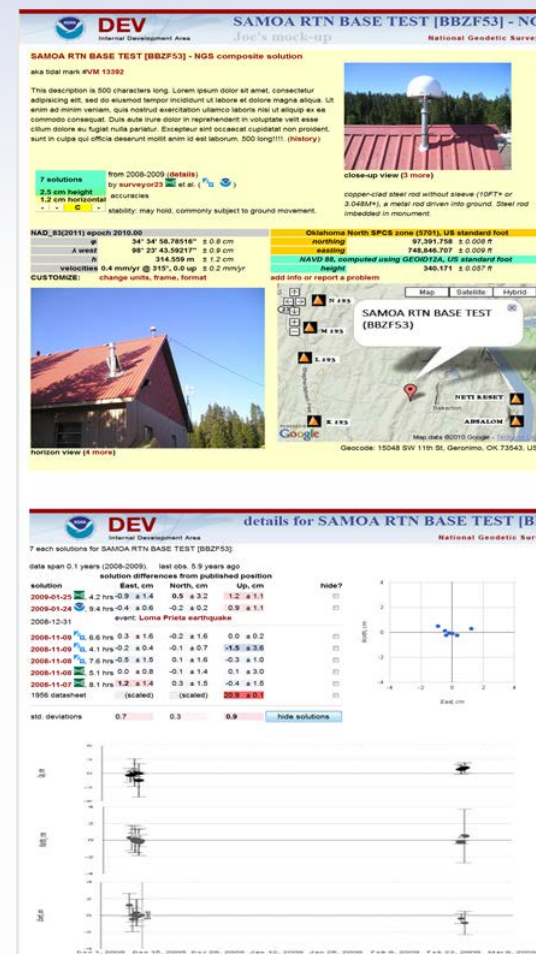
Validate RTNs with a modified OPUS process

- Major steps in OPUS are shown in left column
- Some steps can be skipped for RTN case
- Site is well established
- Operator would have an ID and appropriate header info
- Expedited upload avoids most QC checks



RTN Validator Tool for Base Station

- On a periodic (e.g., daily) basis, data are FTP'd and processed
- Top section has similar elements as in OPUS-DB
- Middle section shows available solutions
- Bottom shows a time series for X-Y-Z or lat-lon-ht
- Offset and trends are clear



RTN Validation for Users

- To evaluate the base station, the RTN operator would make that sheet available and/or publish to OPUS-DB
- Additionally, occupy established GPS bench marks listed in either the NGSIDB or OPUS-DB
 - Any systematic features observed between the established solutions and those from roving on the RTN would indicate a potential bias/offset
 - Should be located within 20 km intervals

CORS Updates

- Repro2 – better late than never
 - Reprocessing 1 (or repro1) happened as a part of IGS08/MYCS
 - After Kevin Choi turns over his IGS ACC duties (December)
 - Will reprocess all CORS data (cleaning, stacking, etc.)
 - Will bring in newer CORS sites (since 2008) and update velocities
 - Will define transformation to IGS2014
 - For CORS site coordinates, orbits, and derived positions
 - There will not be a new Realization of NAD 83
 - Since IGS2014 is expected to nearly equal IGS2008

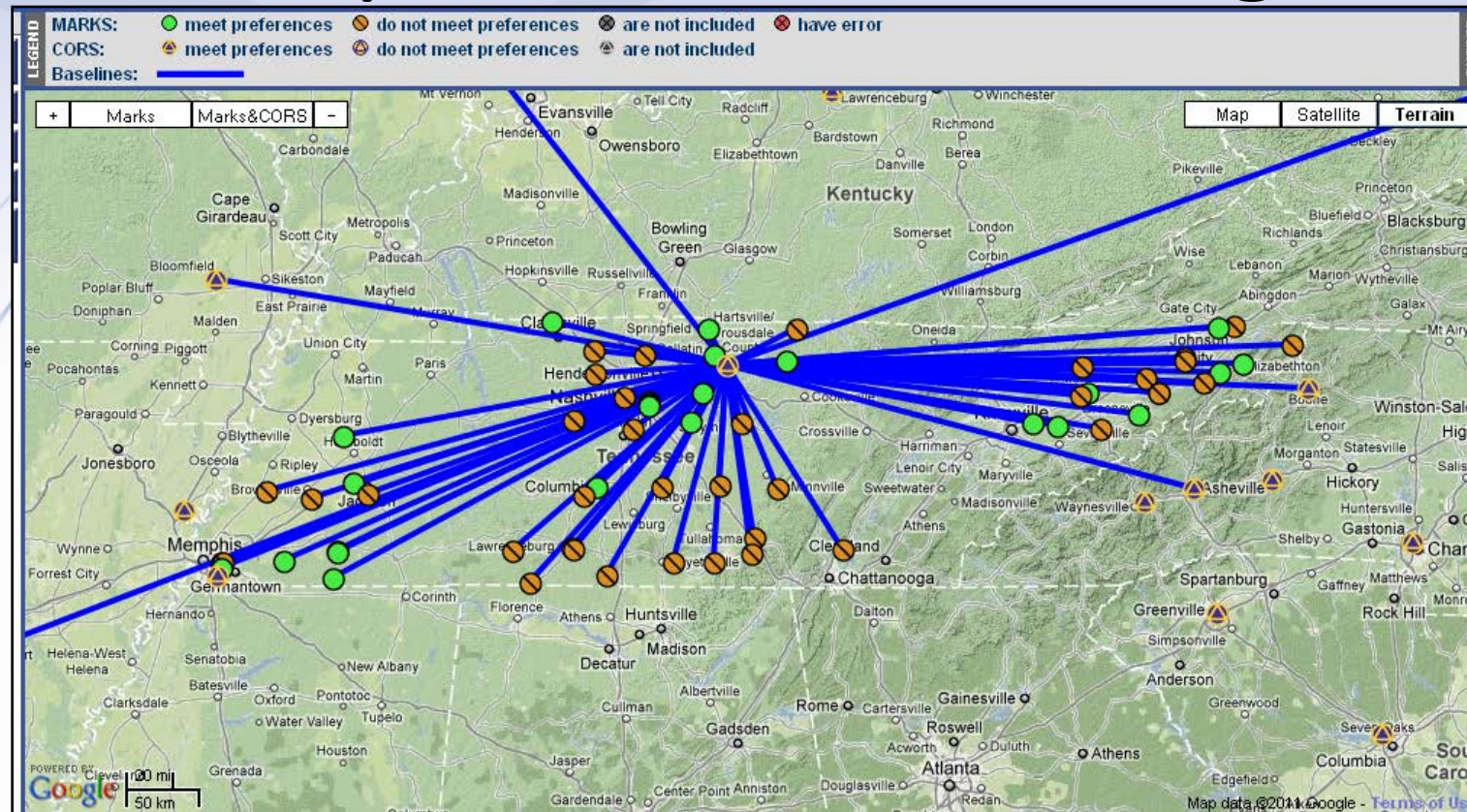
CORS Updates (continued)

- Reference Frame definition
 - Likely adopting most recent IGS model (e.g. 2014 if nothing newer)
 - Examining plate fixed vs. semi-dynamic vs. dynamic
 - Velocities could be as simple as Euler pole rotation to use of HTDP
- GNSS data collection
 - 40% of CORS sites have GNSS receivers (GLONASS)
 - Started archiving this data in January of this year
 - Not using the GNSS data in OPUSS yet but will eventually (2022 goal)

OPUS

- NOS/NGS 58/59 updates
 - HT MOD surveys still are being bluebooked
 - Goal it so have OPUS Projects (OP) replace this
 - Two separate studies: OSU vs. OSU (Ohio State U. vs. Oregon State U.)
 - Possibly reduction in collection times
 - Still aiming for Fall of 2016
- OPUS Projects
 - Multiple observations on multiple sites on multiple days
 - Uses hub and spoke design to get local control plus national ties

Simple Hub & Spoke Network Design Strategy

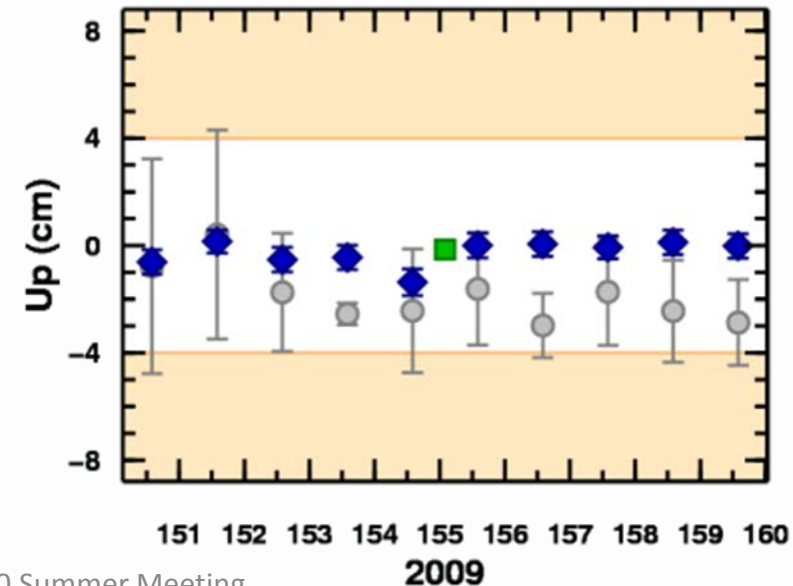
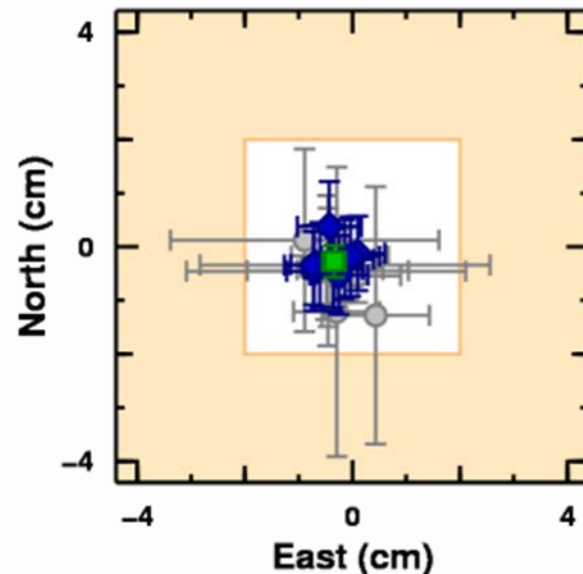


Consider a single hub site when that mark has more than 4 hrs of data:

- Include and tightly constrain CORS, loosely constrain the hub.
- Connection to CORS creates a strong connection to the ITRF.
- Provides a consistent reference for each project mark.

What's in it for me?

- **OPUS solutions** = pretty good, but each treated as independent and assumes “perfect” CORS.
- ◆ **Sessions** = simultaneously-observed marks processed together in sessions increases consistency.
- **Adjustments** = interlinking sessions through network adjustments increases accuracy.



A Possible Strategy for Use of RTN's

- Use the RTN Validator Tool to keep RTN coordinates consistent
- During a survey, use RTN stations as supplemental control
- OP permits you to weight the various observations
- Upweight the RTN and CORS and downweight the GNSS sites
- Adjusts the observations locally based on all sites plus RTN's
- Keeps regional and international control from CORS and ITRF

OPUS (continued)

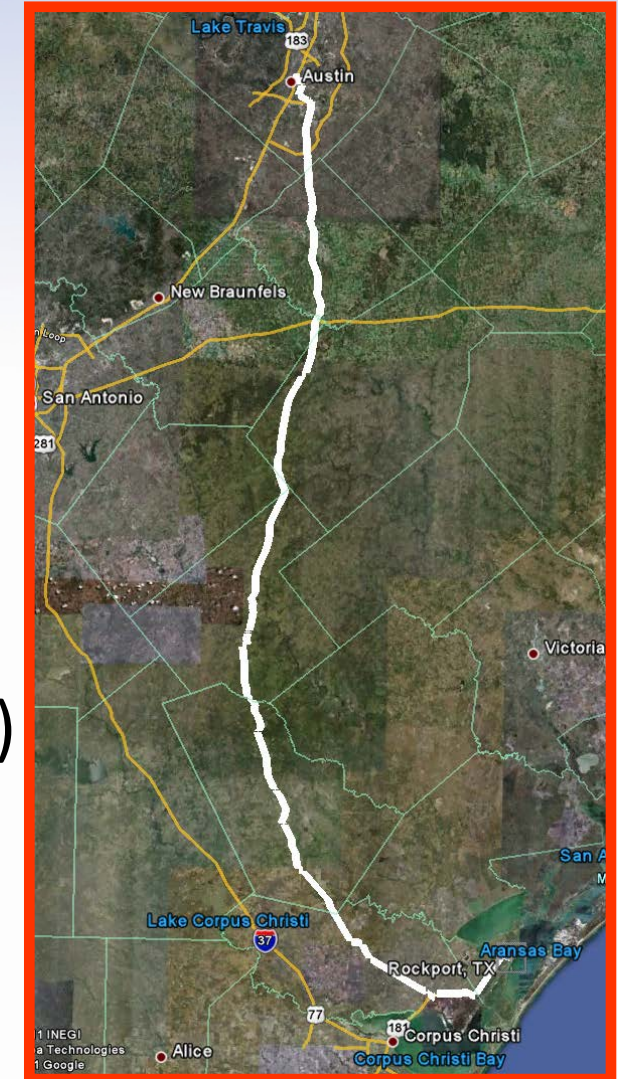
- Currently, OP outputs only to the Project
- OP output to OPUS Database
 - A project is underway to Share into OPUSDB
- OP output to NGSIDB
 - Must resolve Bluebook vs. OP results
 - Can then use OP to process and then load into NGSIDB
- OP output to NSRS DB
 - With a NSRS DB defined, OP would feed it directly (2022 goal)

2022 Vertical Reference Frame

- Defined through a geopotential model (this is a broad term)
- Current models use LSC to fill in between control points
 - Doesn't resolve underlying datum defects (1.2 m trend in NAVD 88)
 - These “hybrid” geoid models are datum conversion tools only
 - Only as reliable as the accuracy and **distribution** of the control points
- Previous studies show data grid > 1' yields significant omission
- Could use a Gravimetric Geoid model (practical method)
 - Geoid model is one arc-minute resolution
 - Converts ellipsoid height to orthometric height ($H = h - N$)
 - Conversion to other heights/functions of the gravity is difficult

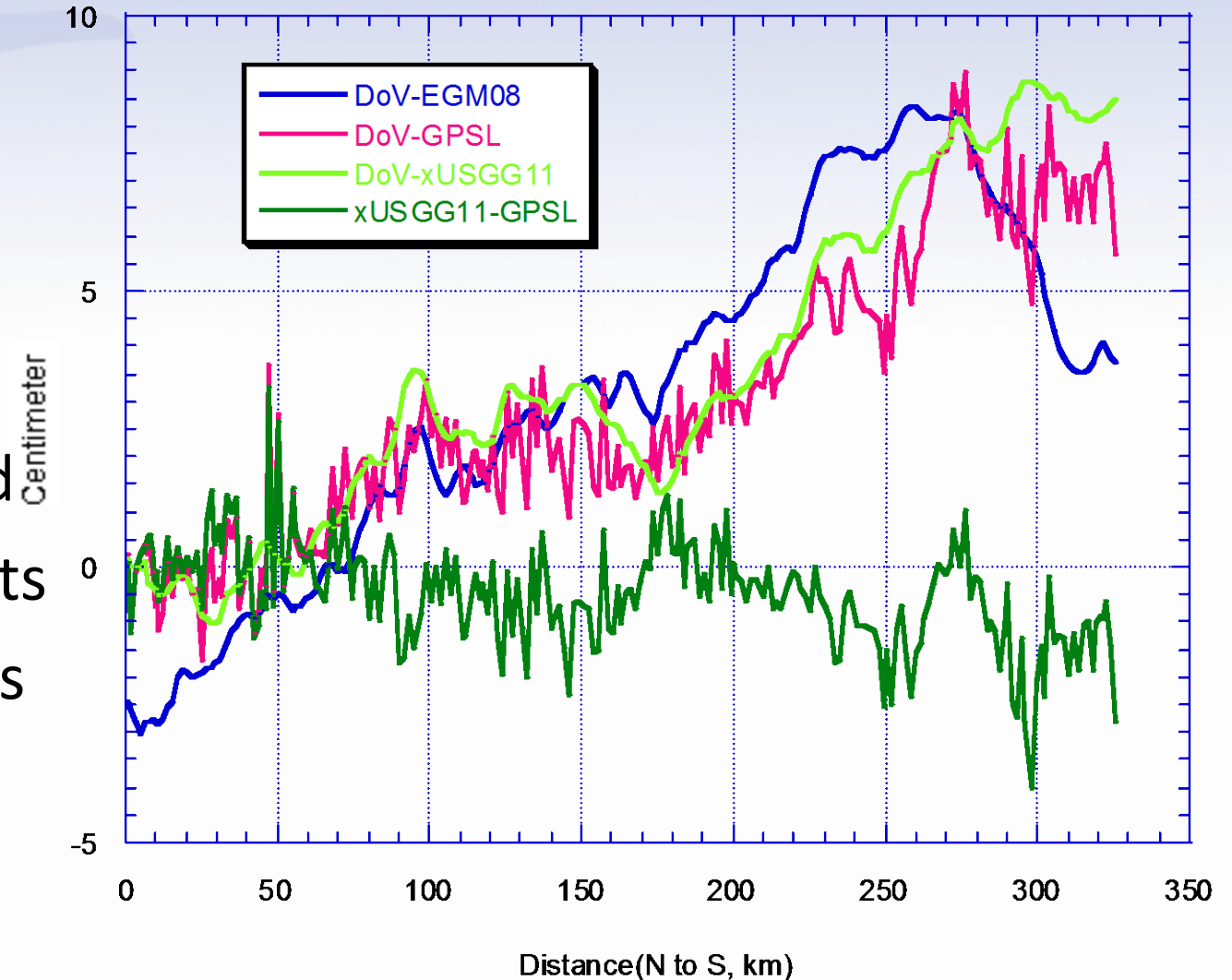
2022 Vertical Reference Frame (continued)

- Use a Geopotential model (desired method)
 - Geopotential yield any function of gravity field
 - Current models limited to degree 2160 => 5'
 - For 1' resolution, require a degree 10,800 model
 - Likely ellipsoid harmonics vs. spherical harmonics
- Geoid Slope Validation Studies (GSVS)
 - GSVS 11 – completed (presented at EGU/elsewhere)
 - GSVS 14 – completed but still being processed
 - GSVS 16 – being planned (recon IP in Colorado)
 - Will be used to check geoid models for vertical RF



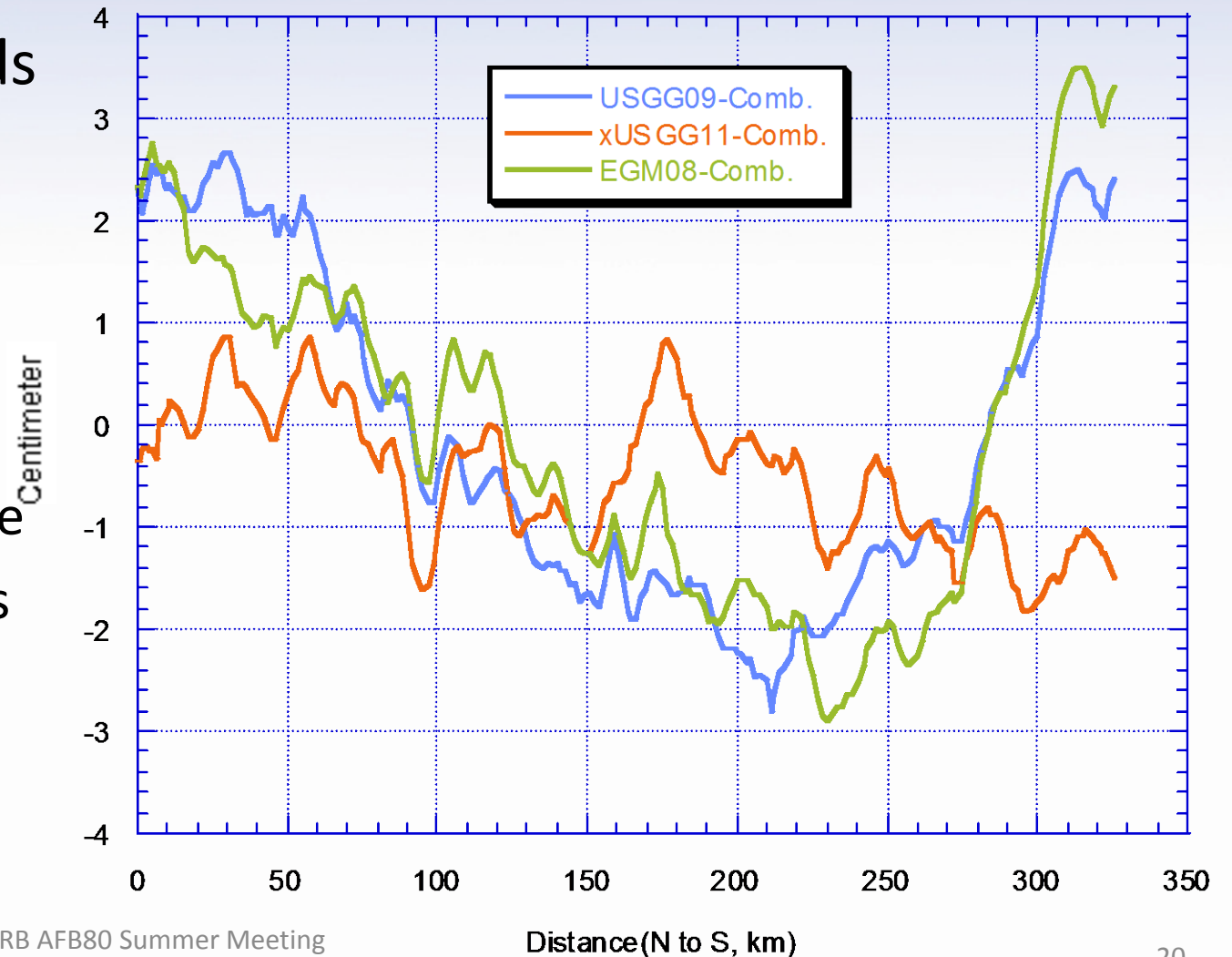
Geoid differences from GSVS 11 observations

- Data collected along the lines:
 - GPS on leveling marks (GPSL)
 - Astrogeodetic DoV's
 - Relative & absolute gravity data
- Gravity data => xUSGG11 geoid
- GPSL => pointwise geoid heights
- DoV => pointwise geoid heights



(geoid model – Comb.) along the line

- Desire is to compare vs. geoids
- Combine the DoV and GPSL
 - Long wavelength => GPSL
 - Short wavelength => DoV
- Now compare against geoids
 - xUSGG11 fits closest to zero line
 - Other models have large trends

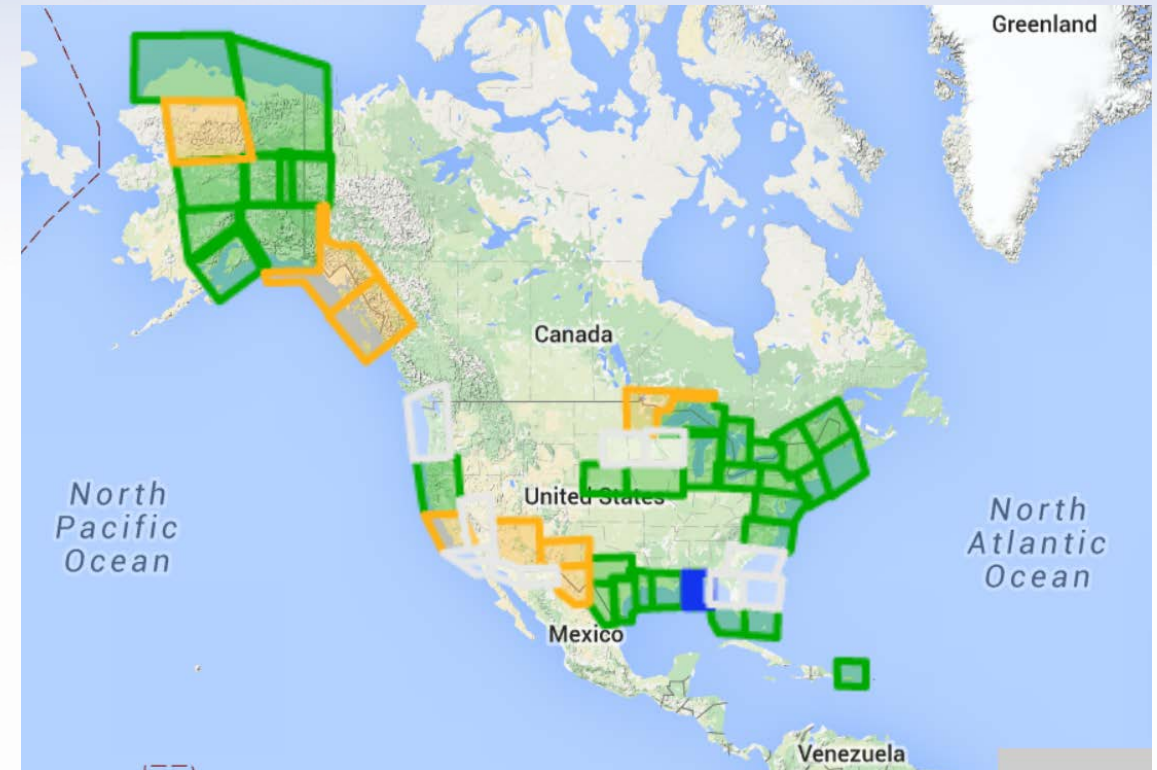


Geoid comparison (model –Comb.)

	GPSL (mm)	USGG09 (mm)	EGM08 (mm)	xUSGG11 (mm)
Mean	-0.0	-0.4	0.1	-0.5
STD	7.6	16.9	17.2	6.7
RMS	7.6	16.9	17.2	8.2
Min.	-22.2	-28.0	-29.1	-18.2
Max.	33.0	26.7	35.1	8.7

2022 Vertical Reference Frame (continued)

- GRAV-D to help define vertical RF
- Bridges spectral band between satellite and surface gravity data
- Satellite controls long wavelength (global to 500 km scales)
- Aerogravity controls intermediate wavelength (40-500 km)
- Terrestrial data and terrain models control short wavelength



Map Key - Airborne Gravity Data

Green: Available data and metadata

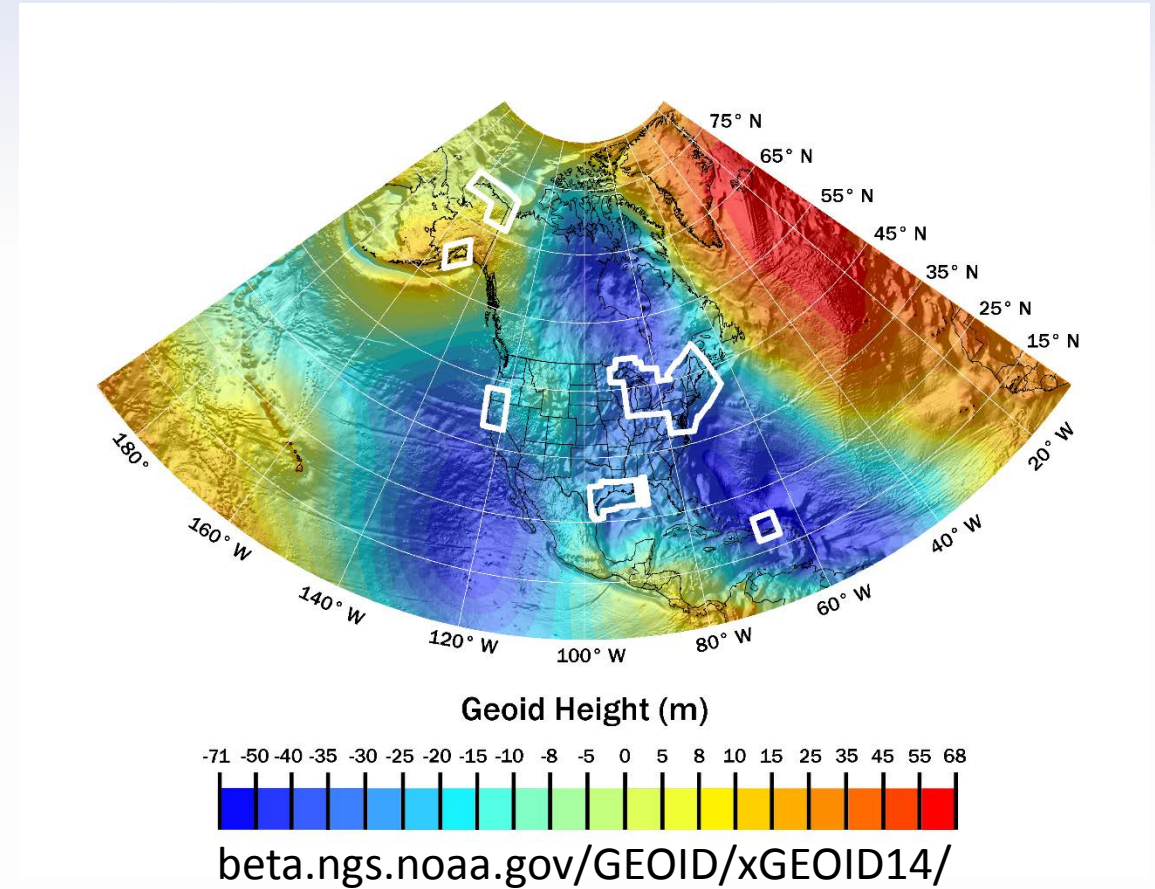
Blue: Data being processed

Orange: Data collection underway

White: Planned for data collection

xGEOID14 & xGEOID15

- These use available aerogravity
- Also use same techniques as USGG models but updated data
- xGEOID14A has no aerogravity
- xGEOID14B has data available from last year
- xGEOID15B is developed but still on Test/DEV website
- Will release to Beta in September



Geospatial Summit Survey Results

- Most were from state DOT's, were surveyors and would favor use of a new SPCS
- Desires on plate fixed was mixed
- Modeling and removing velocity important
- Most valuable NGS services are submitting data to NGS to get a coordinate and downloading data (e.g., CORS and OPUS)
- These were followed closely by transformation tools and education/outreach.

REPORT FROM THE 2015
GEOSPATIAL SUMMIT
ON IMPROVING THE NATIONAL SPATIAL
REFERENCE SYSTEM

ARLINGTON, VIRGINIA
APRIL 13-14, 2015

Geospatial Summit Survey (continued)

- Information specific to the Summit will be discussed at the monthly webinar on Thursday, September 10 at 2 pm eastern
- Register online at http://www.ngs.noaa.gov/web/science_edu/webinar_series/Webinars.shtml
- It will be recorded for anyone who is interested but cannot attend at that time
- There were some NGS Activities and Constituent Activities that seemed to be the consensus coming out of the Summit.

NGS ACTIVITIES

- **Action 1:** Adopt formal project plans and complementary communications plans to outline all activity that must occur between 2015 and the adoption of the new reference frames.
 - Deriving a valid path for OPUS-Projects to be loaded into the NGS IDB
 - Geometric Transformation Consistency
 - NAD 83(86) to NAD 83(NSRS2007) Transformation
 - Mathematical Model connecting IGSxx to NewGeRF
 - Convert all NGS GPS Software into GNSS
 - Common gravity dataset between USA and Canada
 - Organize all historic GPS files
 - Dynamic Heights from GPS
 - NSRS Database

NGS ACTIVITIES

- **Action 2:** Determine the frequency of recurring large summits. These will be supplemented by other communication efforts, including but not limited to: quarterly meetings with surveyors associations, participation in large surveyor and GIS conferences, a monthly NGS Webinar Series, continued and expanding training opportunities, and ever-growing Web resources.
- **Action 3:** Regular communication regarding policies as they are adopted by the Executive Steering Committee regarding the definition or access to the new reference frames.
- **Action 4:** Continued improvement to the Geodetic Toolkit, in anticipation of a geospatially enabled database with robust transformation tools to link NAD 83 and NAVD 88 to the new reference frames.

CONSTITUENT ACTIVITIES

- **Action 1:** Provide feedback and engage with NOAA and NGS through summits and other NGS efforts, monthly meetings, guest columns in trade publications, and through regular NGS website visits.
- **Action 2:** Engage with professional societies such as our summit co-sponsors, NSPS and MAPPS. These societies have a tremendous national and local reach, and NGS will meet with them consistently to best take advantage of their communication networks that translate to the state and local levels.

CONSTITUENT ACTIVITIES

- **Action 3:** Take ownership of this project of transitioning to the new datums, tackling how you manage your data today, change processes moving forward, and prepare for a smooth (as possible) transition.
- **Action 4:** Volunteer and share your data when the opportunities arise. There are some data-sharing options already in place, and NGS will be sure to identify opportunities that are amenable for you to engage in. Most recently NGS has encouraged the public to collect GPS observations on bench marks in conjunction with National Surveyors week, and we expect opportunities like this to recur and expand.

OUTREACH

- Will continue at future Geospatial Summits and other national and international meetings.
- Continued collaboration with IAG, FIG, and the UN-GGIM
- Continued collaboration with Canada, Mexico, and nations in Caribbean and Central America
- Will work with state surveying groups through NSPS and others to hone message for States to implement new laws

Summary and Outlook

- OPUS Projects (OP) or some derivative thereof will serve as means of determining geometric coordinates in the 2022 Geometric Reference Frame
- GNSS data will be used – not just GPS
- These coordinates will be used in some type of geopotential model to derive orthometric and other heights
- The models will be consistent with other global models and reference systems

Questions?

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