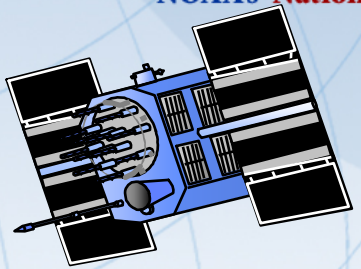
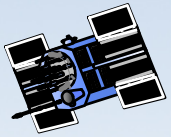




The **Online Positioning User Service**: An Overview & Update

William (Bill) Stone
Southwest Region (AZ, NM, UT) Geodetic Advisor
NOAA's National Geodetic Survey
william.stone@noaa.gov

UESI Surveying & Geomatics Conference
April 23, 2018
Cal Poly Pomona

UESI UTILITY ENGINEERING & SURVEYING INSTITUTE

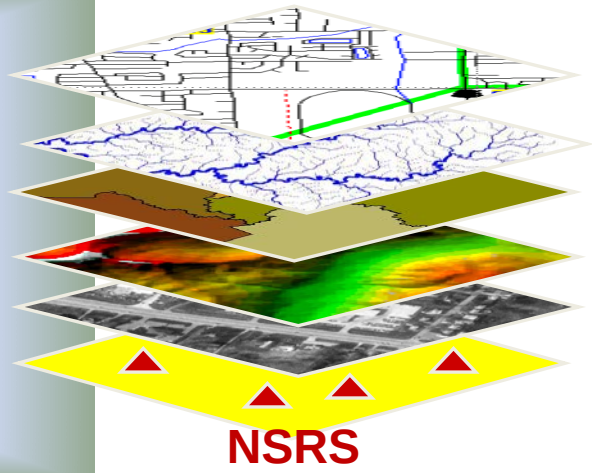
U.S. Department of Commerce
National Oceanic & Atmospheric Administration (NOAA)
National Geodetic Survey (NGS)

Mission: To define, maintain & ***provide access*** to the ***National Spatial Reference System (NSRS)*** to meet our Nation's economic, social & environmental needs

NSRS

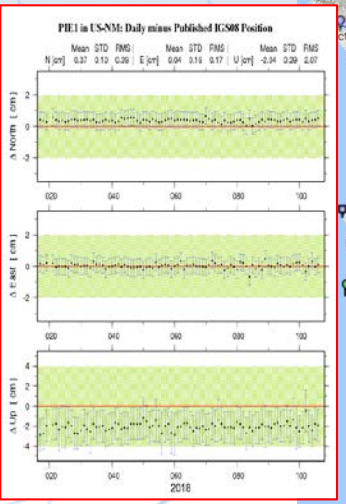
- Latitude
- Longitude
- Height
- Scale
- Gravity
- Orientation

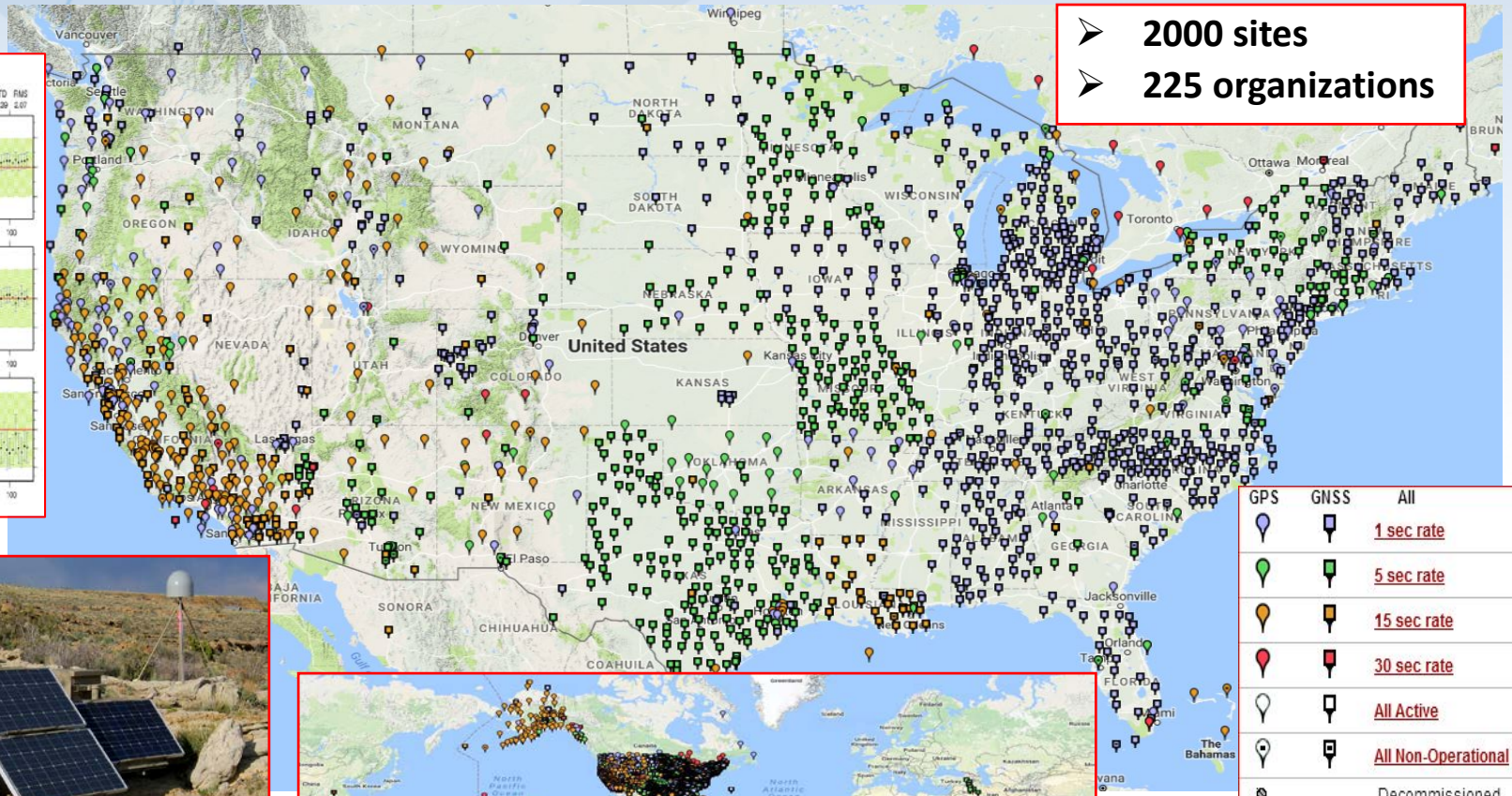
& their time variations



Continuously Operating Reference Station (CORS) Network

- 2000 sites
- 225 organizations

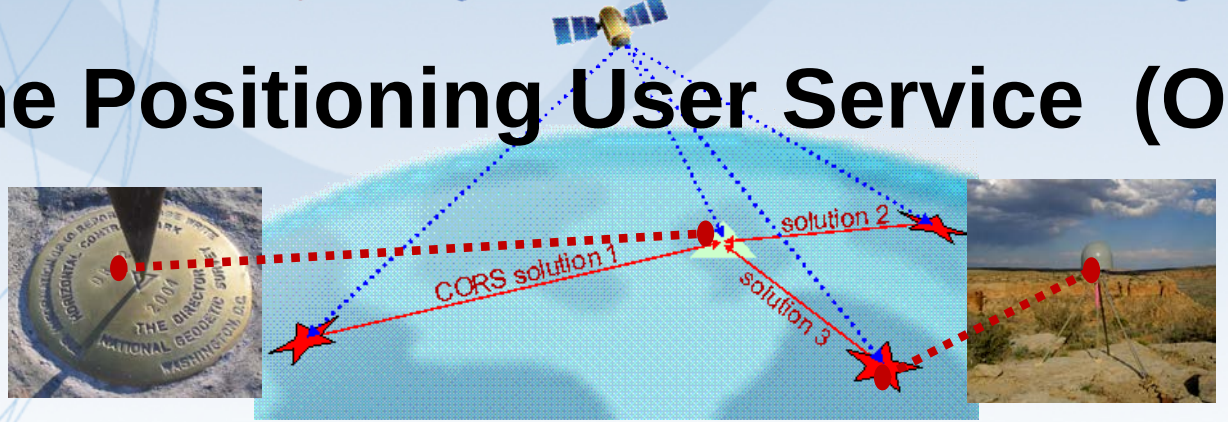




GPS	GNSS	All
		1 sec rate
		5 sec rate
		15 sec rate
		30 sec rate
		All Active
		All Non-Operational
		Decommissioned

Online Positioning User Service (OPUS)

✓ your static L1/L2 GPS data



✓ NGS CORS data

✓ plus NGS processing software & geodetic models

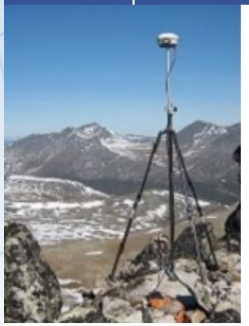
- OPUS-RS (Rapid Static) --- 15 min to 2 hr (per CORS availability)
- OPUS-S (Static) --- 2 to 48 hr (anywhere)
- OPUS-Share --- sharing of results (> 4 hr occupation)
- OPUS-Projects --- adjusted network of multi-stations / occupations

OPUS >>> fast, easy, consistent access to NSRS

OPUS: Online Positioning User Service

National Geodetic Survey

NGS Home | About NGS | Data & Imagery | Tools | Surveys | Science & Education | Search

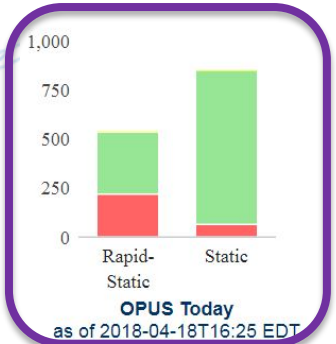


OPUS menu

home / upload
about OPUS

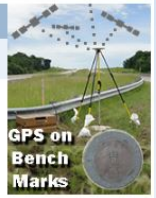
projects
shared solutions

support / feedback



Is your data from an NGS bench mark?

use Options Yes, Share for **GPS on Bench Mark campaign**. (*about sharing*)



Upload your data file.

Solve your GPS position & tie it to the National Spatial Reference System.

What is OPUS? **FAQs**

Choose File 4COR1881.110

* **data file** of dual-frequency GPS observations. **sample**

sample solutions

observation file

ASH701975.01AGP NONE

GEODETIC IV, REV A WITH GROUNDPLANE

antenna - choosing wrong may degrade your accuracy.

antenna

2.000 *meters above your mark.*

antenna height of your antenna's reference point.

antenna height (ARP, true vertical, meters)

william.stone@noaa.gov

* **email address** - your solution will be sent here. **Privacy Act Statement**

e-mail

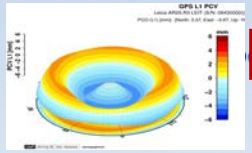
Options to **customize** your solution.

options

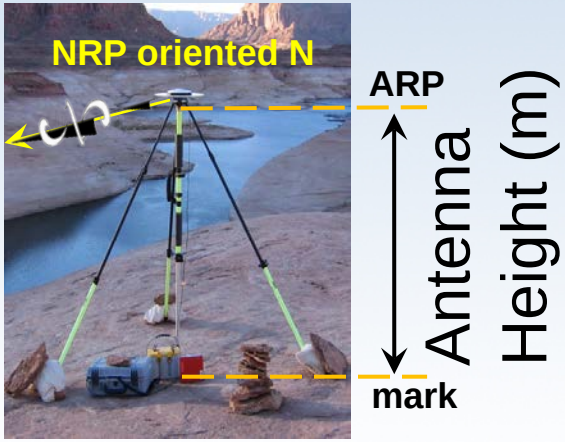
Upload to Rapid-Static
for data 15 min. - 2 hrs.

Upload to Static
for data 2 hrs. - 48 hrs

select your processor



geodesy.noaa.gov/ANTCAL/



Options to **customize** your solution.

geodesy.noaa.gov

formats extended ▼ **formats explained**

report format

base stations

Use: **Exclude:**

ORS2
IANA
MIAR

identify any CORS you wish to explicitly include or exclude from your solution by typing in 4-char site IDs separated with line break

-- sample

-- find site IDs

use/exclude CORS

state plane let OPUS choose ▼ your **SPCS zone**

SPCS zone

project identifier enter the id provided by your project manager

project ID

my profile ▼ customize OPUS defaults for future solutions

profile

share my solution No, don't share ▼ **sharing explained**

share

```
                        NGS OPUS SOLUTION REPORT
                        ========================

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy

      USER: william.stone@noaa.gov                DATE: April 17, 2018
RINEX FILE: 4cor188c.11o                          TIME: 23:33:33 UTC


  SOFTWARE: page5  1603.24 master91.pl 160321      START: 2011/07/07  02:16:00
 EPHEMERIS: igs16434.eph [precise]                  STOP: 2011/07/07  13:01:00
  NAV FILE: brdc1880.11n                       OBS USED: 26042 / 27220    :  96%
  ANT NAME: ASH701975.01AGP NONE            # FIXED AMB:   134 /   139    :  96%
ARP HEIGHT: 2.000                           OVERALL RMS: 0.015(m)

  REF FRAME: NAD_83(2011)(EPOCH:2010.0000)          IGS08 (EPOCH:2011.5132)

         X:     -1664599.636(m)   0.005(m)          -1664600.413(m)   0.005(m)
         Y:     -4821995.065(m)   0.004(m)          -4821993.735(m)   0.004(m)
         Z:      3818181.566(m)   0.007(m)           3818181.471(m)   0.007(m)

       LAT:   36 59 56.31590      0.006(m)        36 59 56.33304      0.006(m)
     E LON:  250 57 17.37943      0.003(m)       250 57 17.33216      0.003(m)
     W LON:  109  2 42.62057      0.003(m)       109  2 42.66784      0.003(m)
    EL HGT:         1460.794(m)   0.005(m)              1459.935(m)   0.005(m)
 ORTHO HGT:         1481.549(m)   0.027(m) [NAVD88 (Computed using GEOID12B)]
```

solution metadata & summary statistics

NAD83 & IGS08 coordinates/uncertainties

	UTM COORDINATES UTM (Zone 12)	STATE PLANE COORDINATES SPC (3003 NM W)
Northing (Y) [meters]	4096544.989	666054.149
Easting (X) [meters]	673944.595	722137.486
Convergence [degrees]	1.17671172	-0.72935592
Point Scale	0.99997275	1.00005994
Combined Factor	0.99974356	0.99983073

US NATIONAL GRID DESIGNATOR: 12SXF7394496544(NAD 83)

UTM, SPCS, USNG coordinates, etc.

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DI2245	P011 SPIDERROCKAZ2005 CORS ARP	N360859.363	W1093109.175	103366.8
DH6916	MC04 MESA CNTY 04 COOP CORS ARP	N384102.975	W1085825.823	187185.1
DL3642	MC09 NUCLA CORS ARP	N381435.614	W1083329.283	144670.7

CORS used

NEAREST NGS PUBLISHED CONTROL POINT

GO0510	BOUNDARY MI COR 330 CO NM	N365956.309	W1090235.673	171.8

nearest IDB mark

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

Preparing for Tomorrow & North American-Pacific Geopotential Datum of 2022 (NAPGD2022)

********** New Reference Frame Preview **********

We are replacing the nation's NAD 83 and NAVD 88 datums, to improve access and accuracy of the National Spatial Reference System. More at https://geodesy.noaa.gov/datums/newdatums/

Below are approximate coordinates for this solution in the new frames:

APPROX ORTHO HGT: 1480.951 (m)

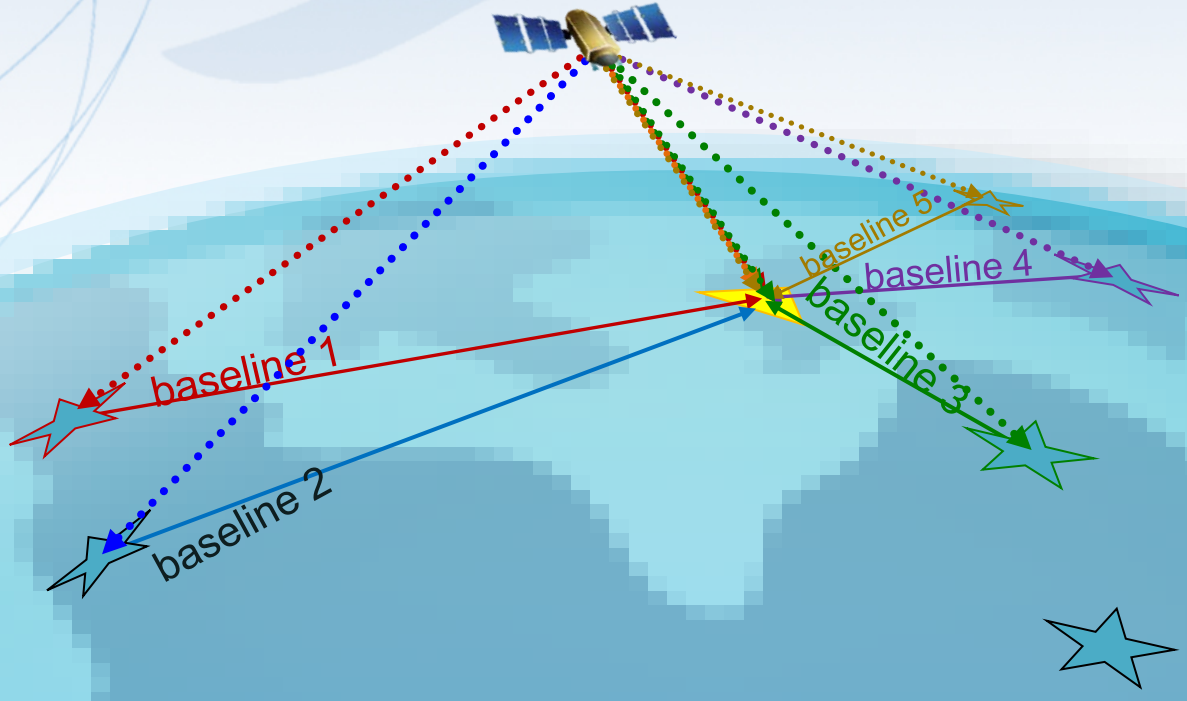
(NAVD88: 1481.549 m)

[PROTOTYPE (Computed using xGeoid17B,GRS80,IGS08)]

(Extracted from OPUS Extended Output)

OPUS-Static

1. single-baseline differential static ties to 5 CORS
2. your position is the mean of the "best" 3 (of the 5)



NOAA's National Geodetic Survey

OPUS-Share (aka OPUS-DB)

❑ Sharing Criteria:

- **> 4 hour data span**
- **quality solution**
- **brief description**
- **2 photos (mark/horizon)**
- **calibrated antenna**

❑ Uses:

- **NGS GPSBM campaign**
- **NGS transformation tools**
- **data archive/sharing**
- **for fun!**

PID: GT0228
Designation: F 72
Stamping: F 72 1928
Stability: Most reliable; expected to hold position well
Setting: In rock outcrop or ledge
Mark Condition: G
Description: The station is located 6.2 miles along the Mount Whitney Trail from the trailhead at the Whitney Portal, west of Lone Pine. It is located at Trail Camp, about 250 feet south of the south shore of a lake and about 50 feet south of the trail, opposite a 10-feet-tall boulder that sits directly along the north side of the trail. The station is a USCGS bench mark disk set flush in the top of a granite outcrop measuring about 75 feet by 25 feet and standing about 10 feet above the level of the trail.
Observed: 2010-08-17T16:53:00Z
Source: OPUS - page5 1209.04
See Also 1928

Close-up View

REF_FRAME: NAD_83(2011)	EPOCH: 2010.0000	SOURCE: NAVD88 (Computed using GEOID12A)	UNITS: m	SET PROFILE	DETAILS

LAT:	36° 33' 46.36644"	± 0.006 m
LON:	-118° 16' 46.29502"	± 0.003 m
ELL HT:	3645.963	± 0.013 m
X:	-2431390.178	± 0.006 m
Y:	-4519449.679	± 0.013 m
Z:	3780713.238	± 0.002 m
ORTHO HT:	3671.261	± 0.031 m

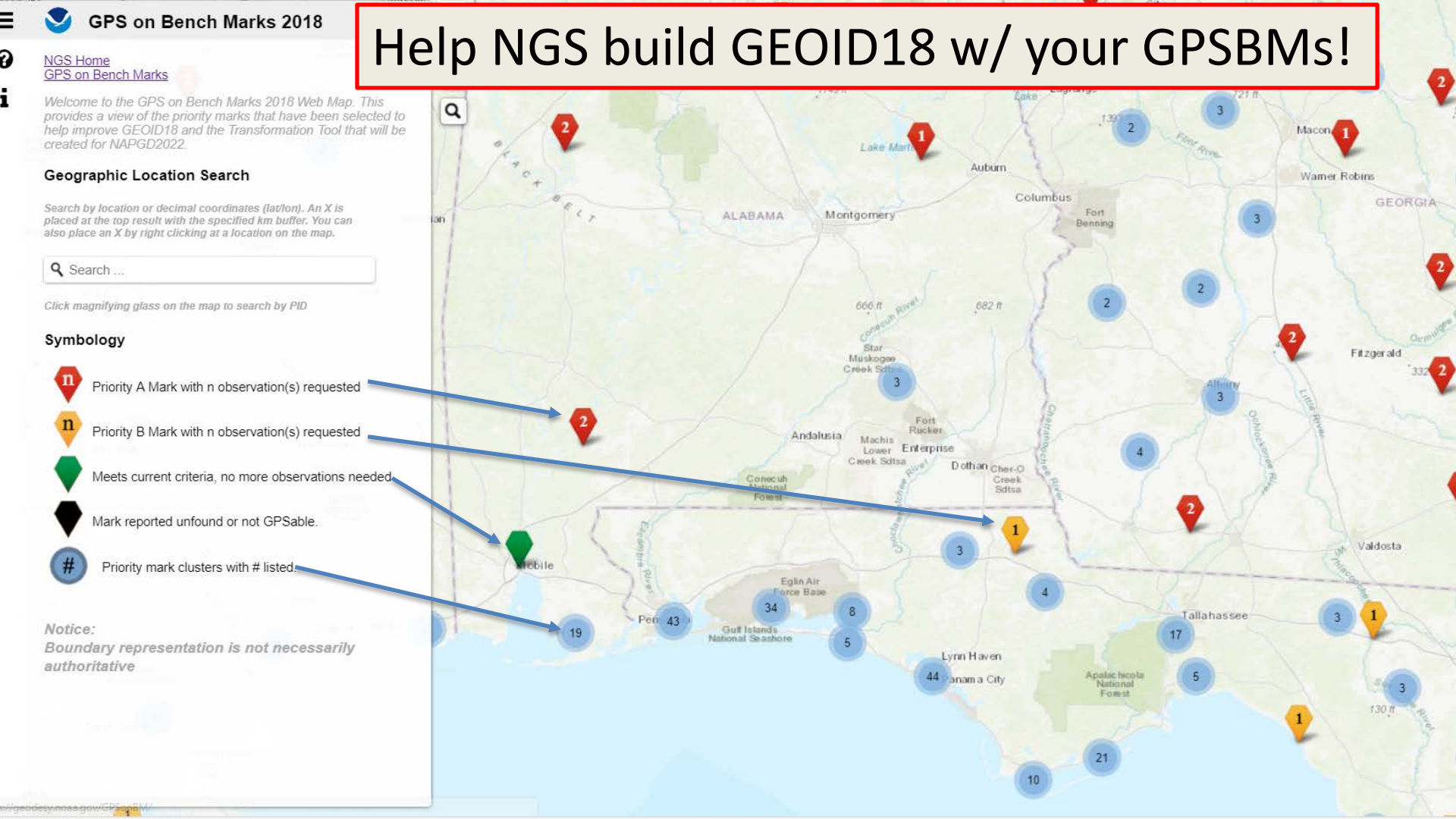
	UTM 11	SPC 404(CA 4)
NORTHING:	4047144.640m	636673.937m
EASTING:	385501.607m	2064491.407m
CONVERGENCE:	-0.76230261°	0.42982529°
POINT SCALE:	0.99976152	0.99994136
COMBINED FACTOR:	0.99918979	0.99936952

CONTRIBUTED BY
william.stone
National Geodetic Survey


Horizon View

OPUS-Share Solutions

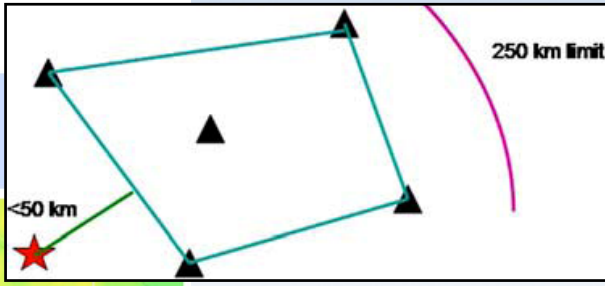
Help NGS build GEOID18 w/ your GPSBMs!



OPUS-RS Estimated Precision (1-sigma)

N-S or E-W coordinates with 15 minutes of data

geodesy.noaa.gov



OPUS-RS

- 3-9 CORS
- <250 km

HELP:
ABOUT THIS MAP

OPUS-RS Estimated Precision and Availability

Version: 0.85

OPTIONS:

Choose Map:
NS or EW 15-min Data

CORS Sites:
Show Hide

Predicted Precision:
Latitude : 36.98500309285
Longitude: -109.0597102046
Retrieve Accuracy

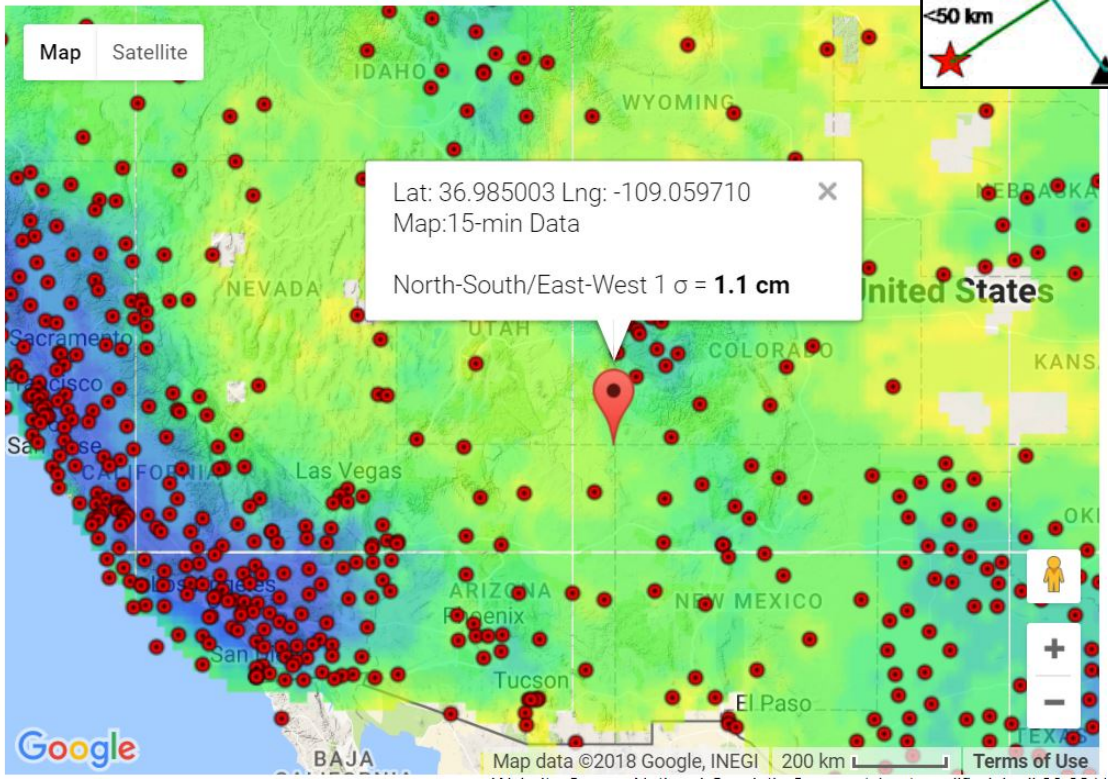
Overlay Opacity:
60%

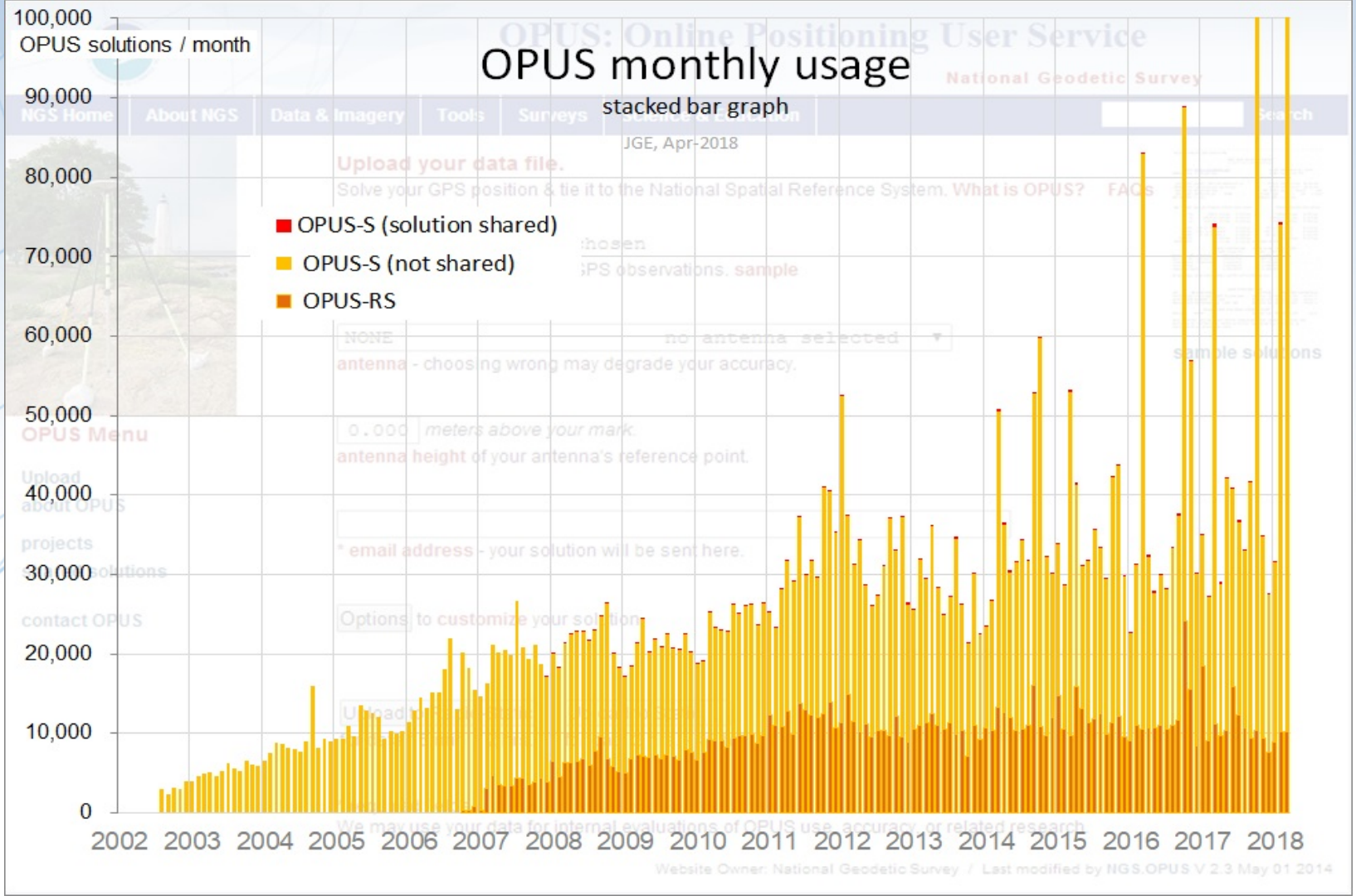
LEGEND:

Horizontal 1 SD (cm)

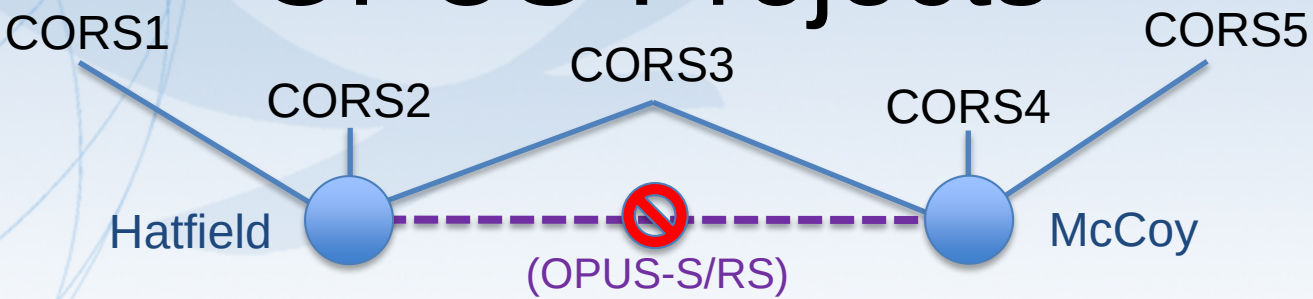
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0+

Data as of Apr 12 2018




OPUS monthly usage
stacked bar graph
JGE, Apr-2018
OPUS solutions / month
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
OPUS-S (solution shared)
OPUS-S (not shared)
OPUS-RS
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

OPUS-Projects



- combine simultaneous, repeated, networked observations
- harvest data from multiple observers, sessions, stations, days
- constrain adjustments to CORS, local control, elevation control
- publish results to NGS database (optional) (Try Beta **OP2IDB)**
- OPUS-Projects 1.5-day workshops

Controls

Preferences | Design | Serfil | Solutions | Show File | Send Email | Set up Adjustment | Review and Publish | Delete Project

LEGEND
MARKS: meet preferences | do not meet preferences | are not included | have error
CORS: meet preferences | do not meet preferences | are not included
Baselines:

Marks | Marks&CORS | Map | Satellite | Terrain

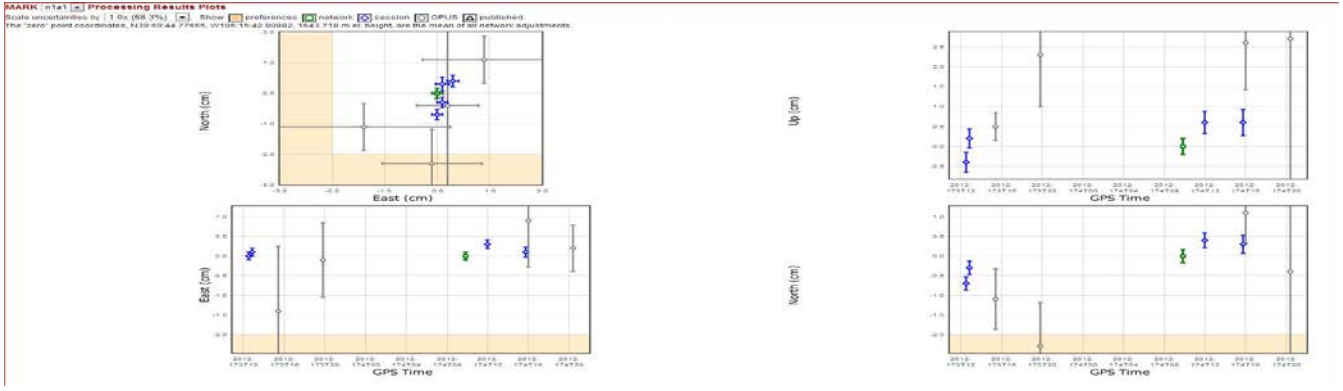
MARKS: n1a1, n1a2, n1a3, n3a1, nis2, nis4, nis5
Add MARKS

CORS: ctmc, dsrc, p041, pltc, tmgo, zdv1
Add CORS

Imagery ©2013 DigitalBoge, GeoEye, U.S. Geological Survey, USDA Farm Service Agency - Terms of Use

Sessions & Solutions

MARKS	2012-170-A	2012-170-B	2012-171-A	2012-171-B	2012-172-A	2012-172-B	2012-173-A	2012-173-B	2012-174-A	2012-174-B	2012-175-A	2012-175-B	2012-176-A	2012-176-B	network-Final Adjustment	network-TEST 1	network-Test 2	MARKS
n1a1							⊗	⊗	⊗	⊗					●	⊗	⊗	n1a1
n1a2								⊗	⊗	⊗	⊗				●	⊗	⊗	n1a2
n1a3											⊗	⊗	⊗	⊗	●	⊗	⊗	n1a3
n3a1			⊗	⊗	⊗	⊗									●	⊗	⊗	n3a1
nis2					⊗	⊗	⊗								●	⊗	⊗	nis2



OPUS Miscellanea

- accepts raw or RINEX (ver 2.x / 3.x) observation file
- accepts zipped files (same antenna type / height)
- processes 30-sec data
- processes with 10-deg elevation mask
- 2-hr observation can go to -Static OR –RapidStatic
- signal environment issues – sky visibility, multipath
- antenna issues – type, height, plumb, N-orient, stability
- quick submission failure? > wait a day or so & try again

OPUS Future Plans

- implement International GNSS Service 2014 (IGS14) global reference frame (following CORS adoption)
- ingest RTK/RTN GNSS vectors into OPUS-Projects
- beta OPUS-Projects (OP2IDB) >> production product for direct bluebooking from OPUS-Projects

- OPUS-Projects for Leveling
- ongoing tweaks / improvements
- and … your ideas, please!

OPUS-Projects of the future?

www.ngs.noaa.gov/OPUS-cgi/OPUS-Projects/OpusProjects.prl

OPUS Projects - Manage "Washington Monument 2013"

National Geodetic Survey

NGS Home | About NGS | Data & Imagery | Tools | Surveys | Science & Education

GNSS | Leveling | Gravity | DoV | Traverse

Results From: network-2013-ADJ-X01

Controls: Preferences | Project List | Design | Serifl | Solutions | Show File | Send Email | Set up Adjustment | Review and Share | Delete Project

MARKS: meet preferences | do not meet preferences | are not included | have error

CORS: meet preferences | do not meet preferences | are not included

Baselines:

Marks | Marks&CORS

MARKS: 000a, jeff, meri, usfs, wash, wmso, wmwe, zero — Add MARKS

CORS: gode, godz, hnpt, loyb, loyk, nrl1 — Add CORS

Sessions & Solutions

National Geodetic Survey

Positioning America for the Future

geodesy.noaa.gov

NGS Home | About NGS | Data & Imagery | Tools | Surveys | Science & Education | Search

Quick Links

- OPUS
- CORS
- Survey Mark Datasheets
- NGS Data Explorer
- OPUS Projects
- Geodetic Tool Kit
- State Plane Coordinates
- Antenna Calibration
- UFCORS
- GEOID
- GPS on Bench Marks
- Geodetic Advisors
- Storm Imagery
- Publications
- 2017 Geospatial Summit
- FAQs
- Contact Us
- **Subscribe for email notifications**

Coming in 2022: **New Datums!** Learn more...

NOAA's National Geodetic Survey (NGS) provides the framework for all positioning activities in the Nation. The foundational elements of latitude, longitude, elevation, shoreline information impact a wide range of important activities.

Learn more about:

- Data and tools we provide
- Activities in your area
- Applications of geodesy

GNSS & GPS Data

Get coordinate information and the tools you need to work independently.

Learn More

Remote Sensing

Download data and critical information into nautical charts.

Learn More

Land Surveying

View guidelines and get tools to support land surveyors.

Learn More

Geodesy

NGS works closely with the global researchers advancing geodetic science.

Learn More

Training & Education

Classes and educational resources on scientific topics relating to geodesy.

Learn More

Datums & Transformations

NGS defines datums to help align data and tools to transform coordinates.

Learn More

Looking for Bench Marks?

Notices

Live Release: NGS Coordinate Conversion and Transformation Tool (NCAT)

In the News

04/06/2018 - NGS Participates in Inaugural Global Surveyors' Day

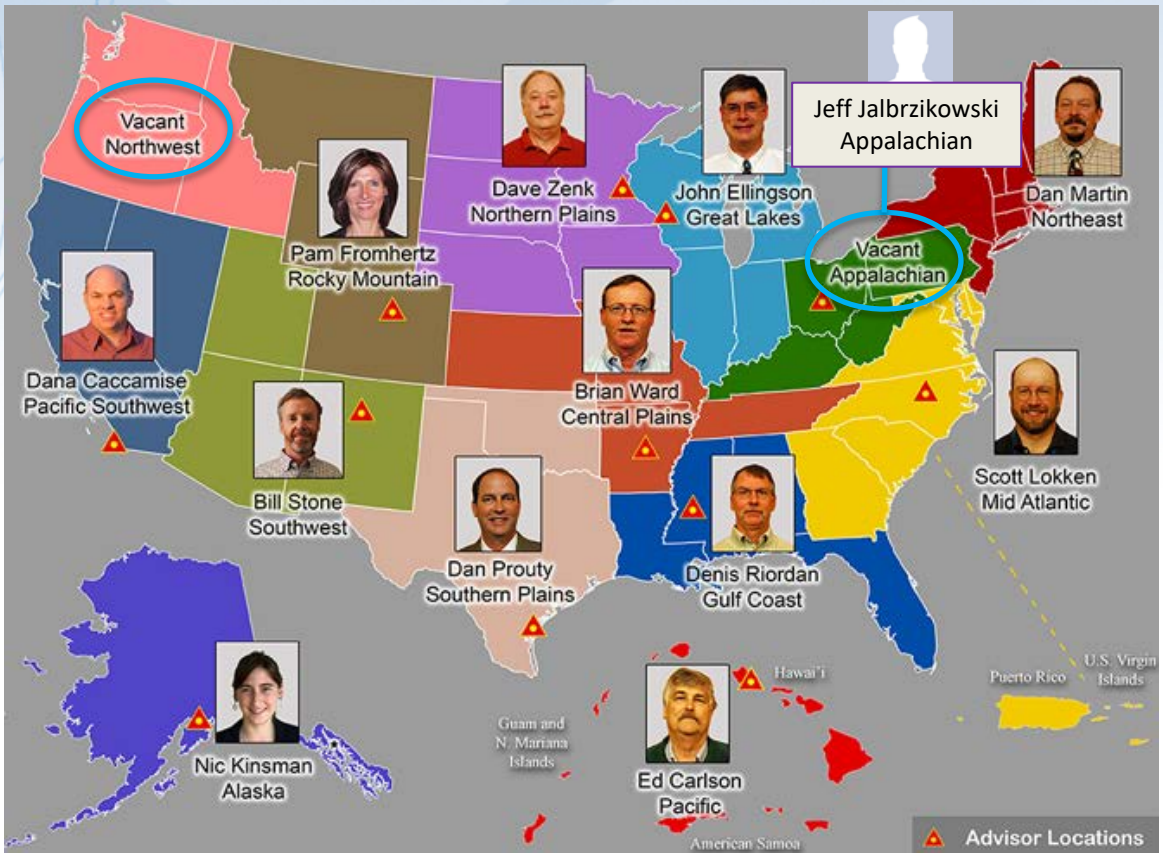
03/29/2018 - NGS and Canadian Counterparts Foster Lidar Integration

03/22/2018 - State Plane Coordinate System Report and Training Materials are Available

Previous News Stories

geodesy.noaa.gov

National Geodetic Survey - Regional Geodetic Advisors

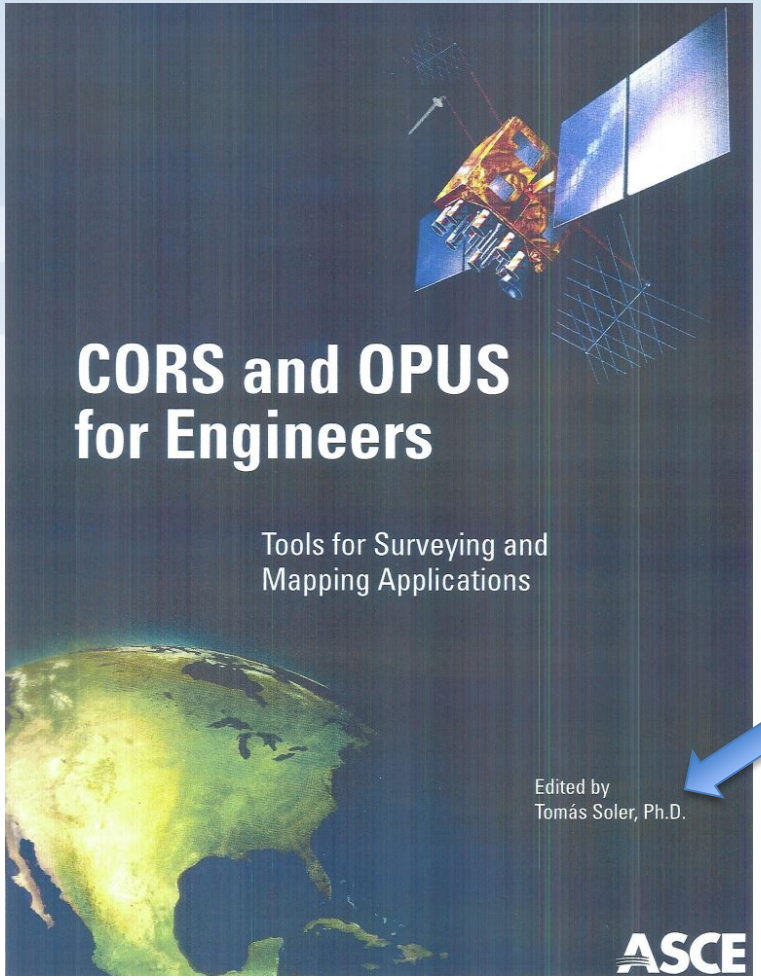


https://geodesy.noaa.gov/ADVISORS/index.shtml

Always sandbag your tripod! …

… and Happy **OPUS**-ing!

William Stone - william.stone@noaa.gov - geodesy.noaa.gov


CORS and OPUS
for Engineers
Tools for Surveying and
Mapping Applications
Edited by
Tomás Soler, Ph.D.
ASCE