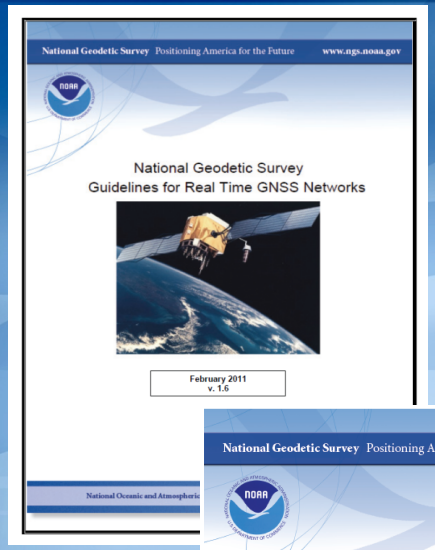
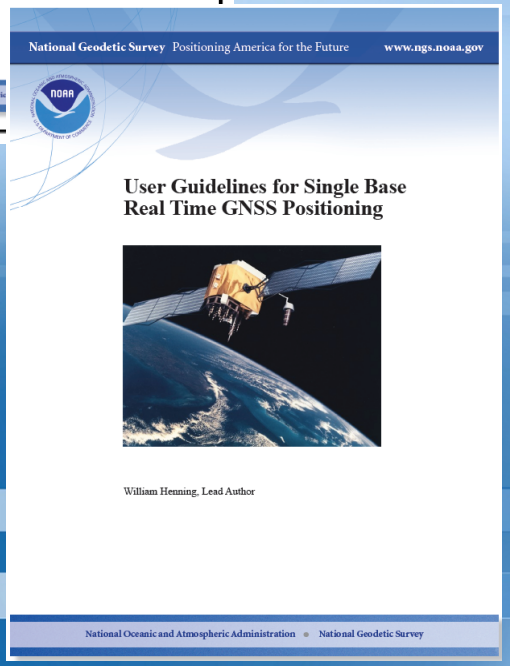
GNSS POSITIONING- STATIC & REAL-TIME SEMINAR

REAL TIME NETWORKS AND THE ROLE OF NGS





LSU LOUISIANA STATE UNIVERSITY

C⁴G Center for GeoInformatics - Louisiana State University

LSRC "Positioning Louisiana for the future"

National Oceanic and Atmospheric Administration

Bill Henning
Geodesist, PLS.

IN TEN YEARS……

- 115+ SATELLITES

- 1.5 DM AUTONOMOUS POSITIONING

- NEW GEOMETRICAL DATUM – ITRF ALIGNED GEOCENTER BUT PROBABLY FIXED ON NORTH AMERICAN PLATE. NSRS ENTIRELY REALIZED BY ACTIVE STATIONS OF THE FOUNDATION CORS

- NEW NATIONAL GEOPOTENTIAL DATUM – 1 CM GRAVIMETRIC GEOID, ORTHOMETRIC HEIGHT SITE CONTROL TO 2 CM RELATIVE TO THE NATIONAL DATUM.

- MORE REMOTE SENSING: 2 - 3 DM SATELLITE IMAGERY /MAPPING POSITIONS , Mobile Mapping Systems

- INDOOR AND UNDERGROUND POSITIONING

DATUM DEFINITIONS IN THE USA

HORIZONTAL/ GEOMETRIC:

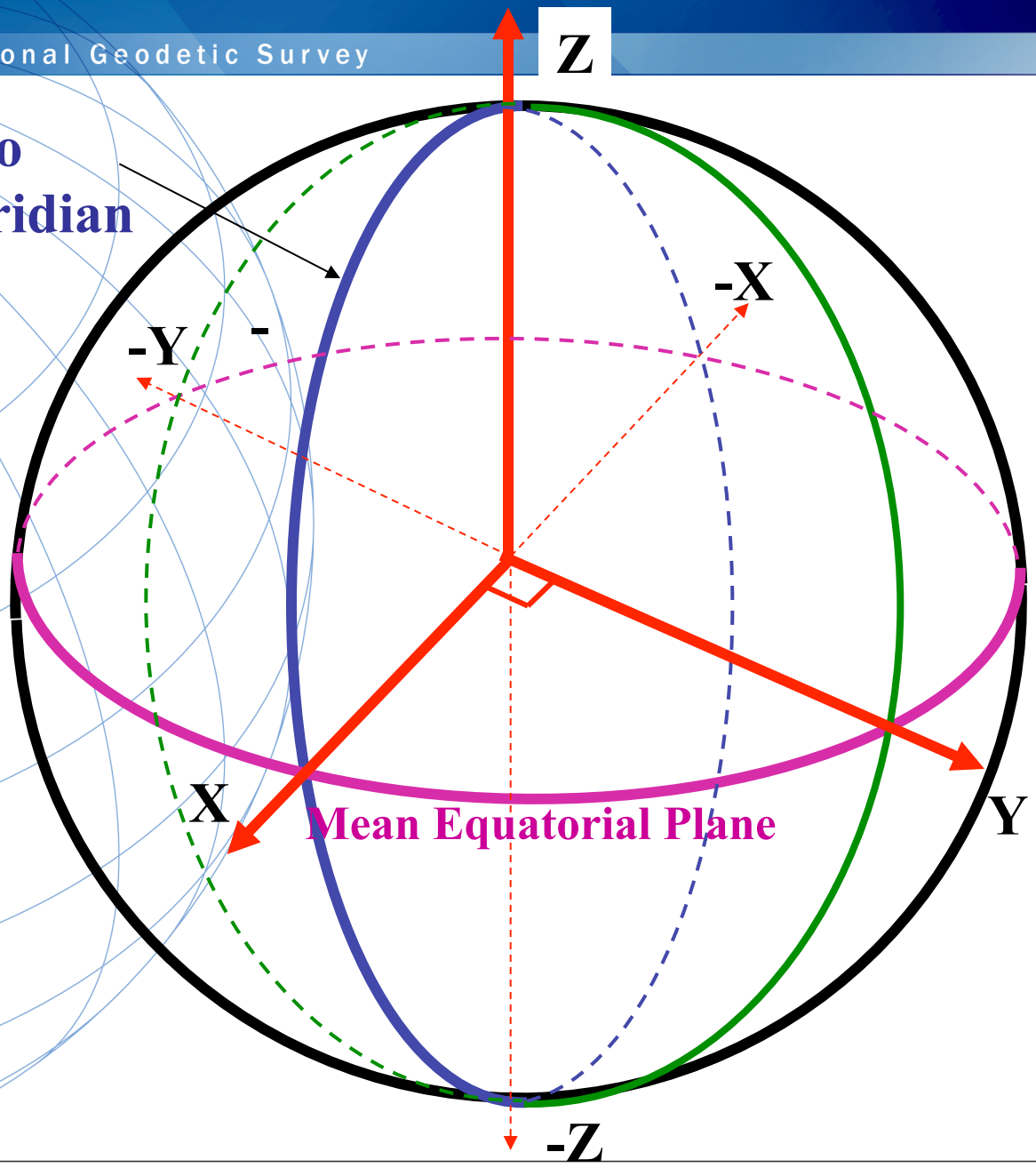
- NAD 83
- ITRS
- WGS 84
- NAD 22 (?)

VERTICAL/GEOPOTENTIAL:

- NGVD 29
- NAVD 88
- NAVD 22 (?)

PROJECTIONS FROM DATUMS:

- SPC
- UTM
- LDP

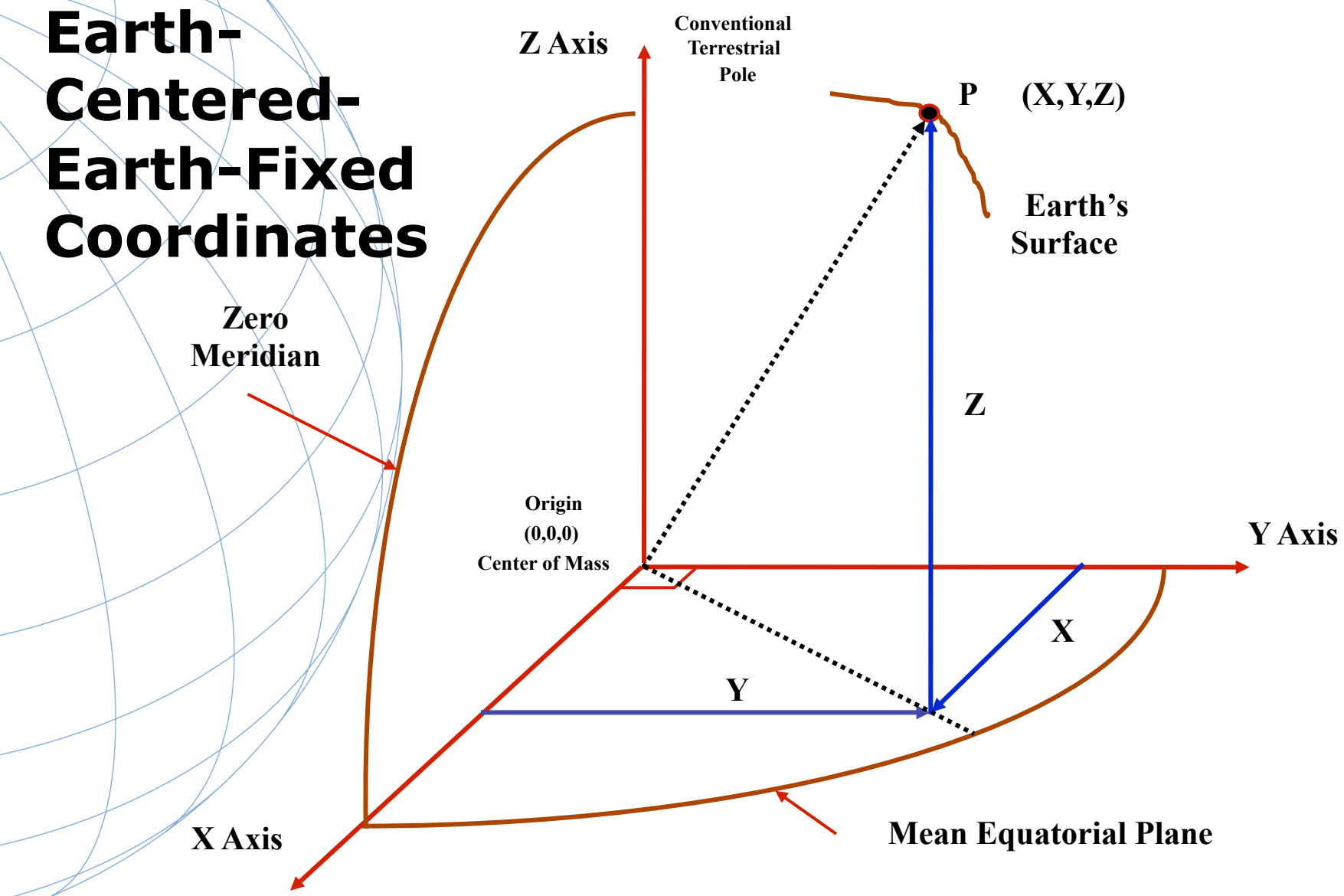


DATUM=
- ***SURFACE***
- **ORIENTATION**
- **SCALE**
- **ORIGIN**

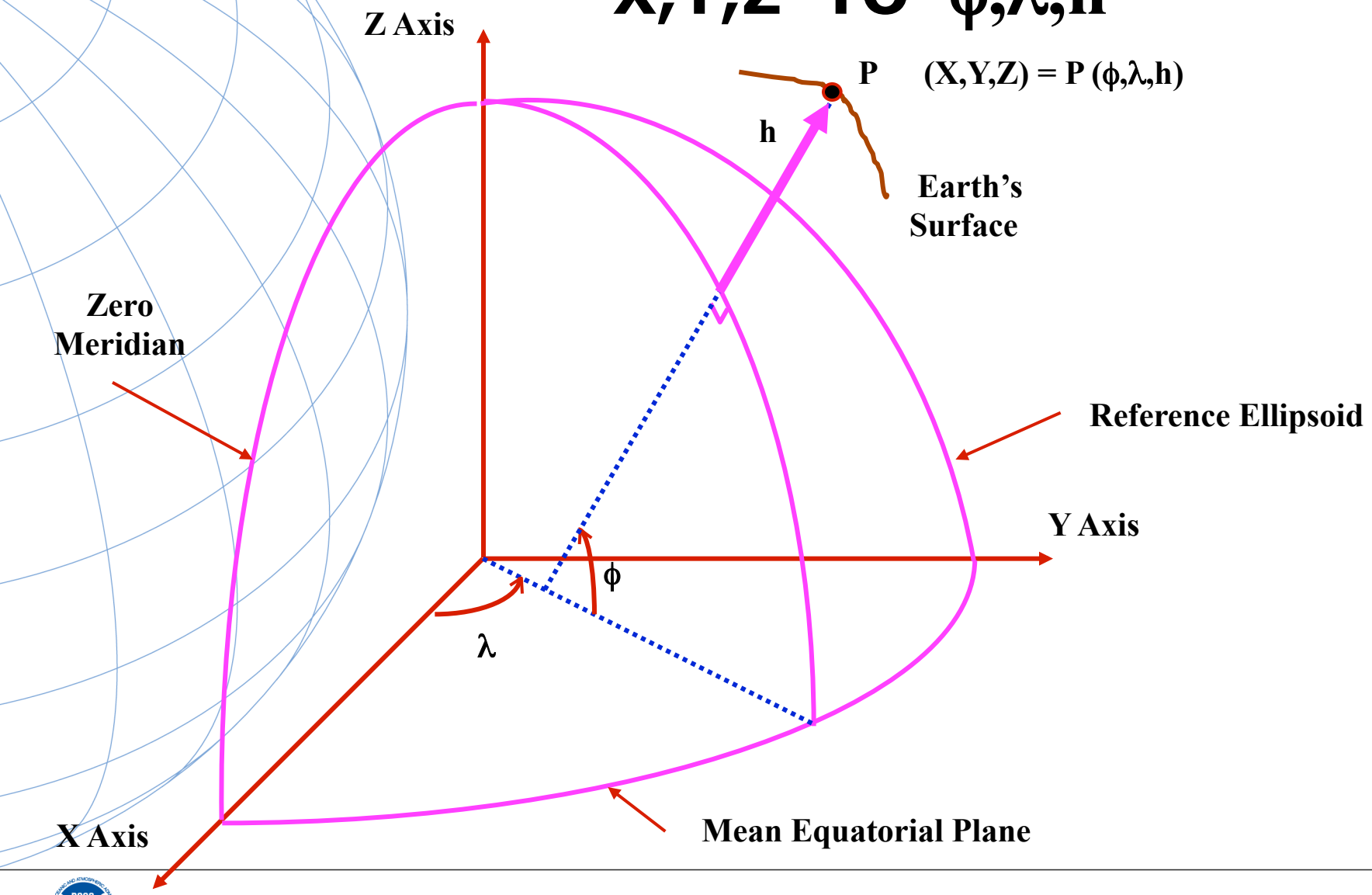
+ GRAVITY

AUTONOMOUS GNSS POSITIONS ARE ECEF, XYZ IN WGS 84 (~ITRF)

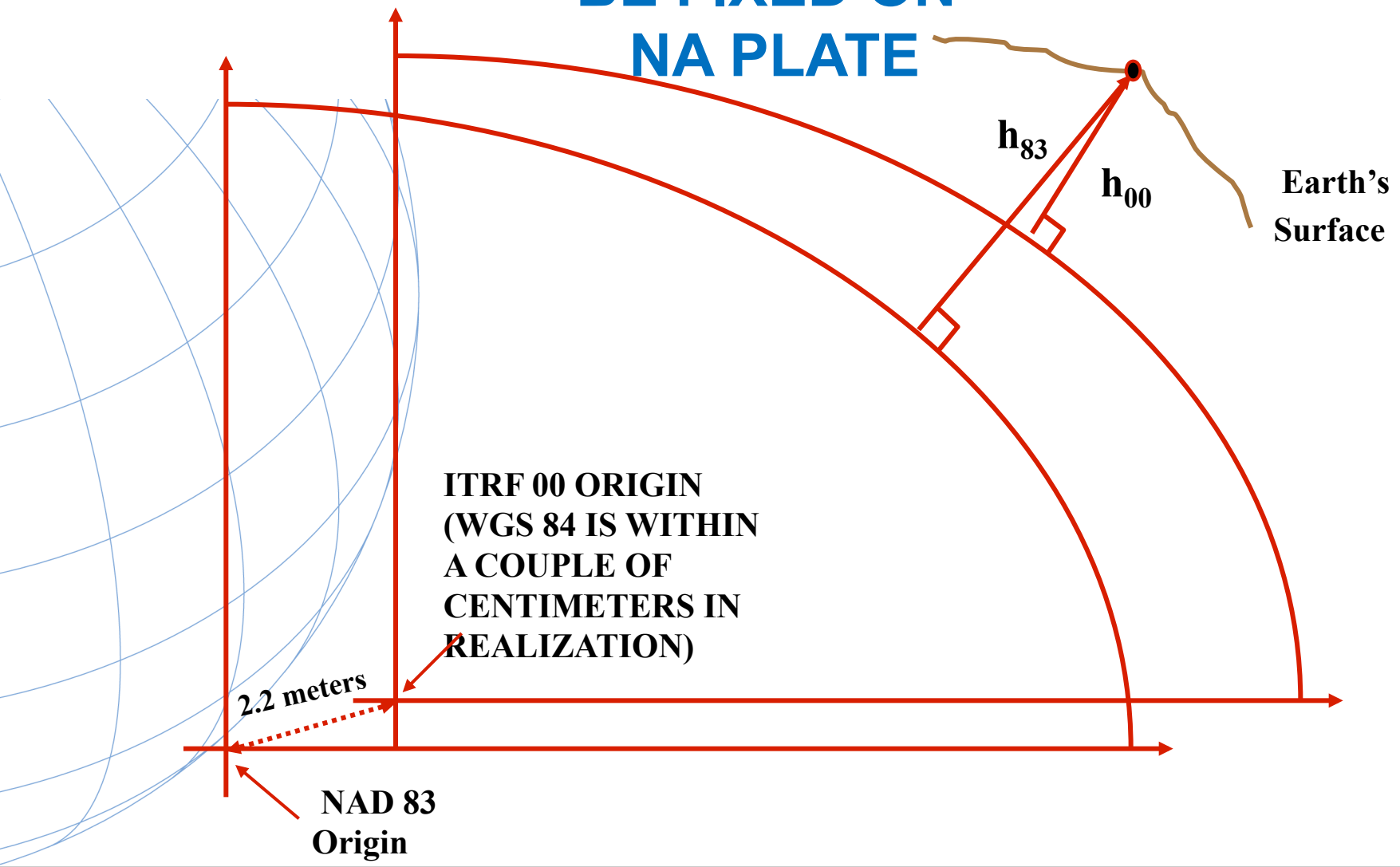
Earth-Centered-Earth-Fixed Coordinates



X,Y,Z TO ϕ,λ,h

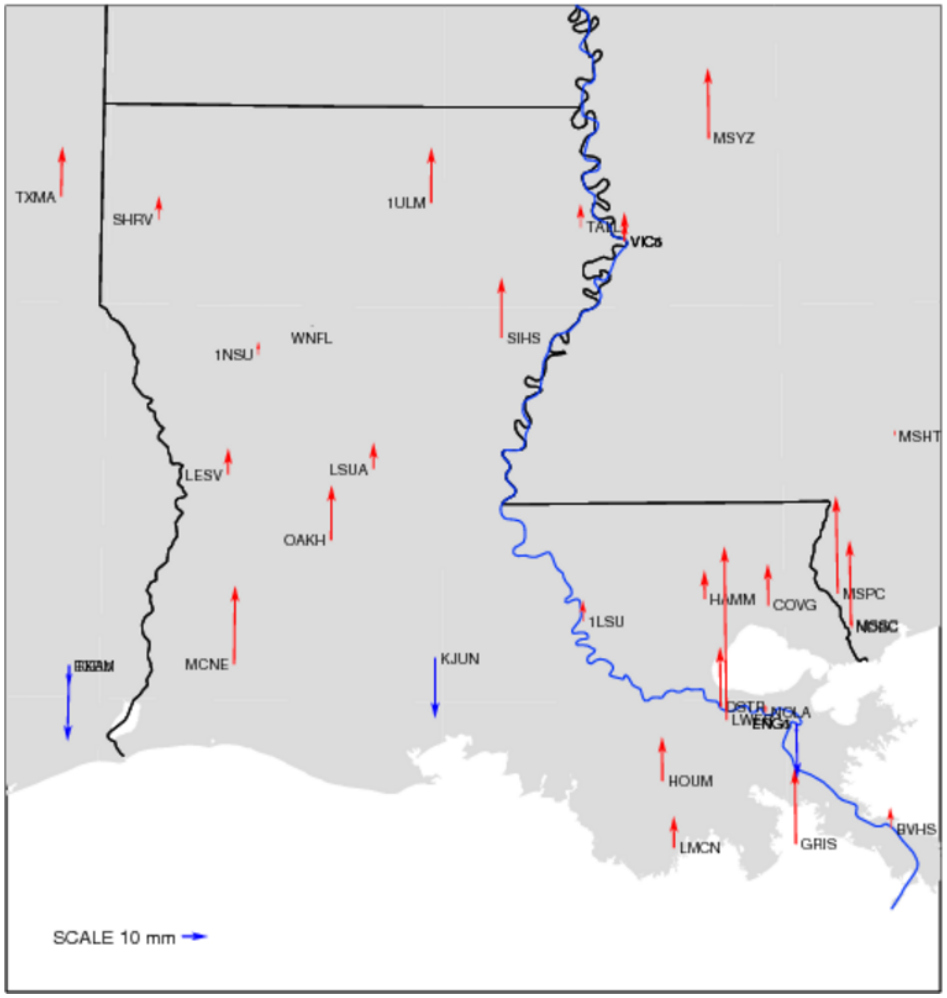

Z Axis
P
(X,Y,Z) = P (ϕ,λ,h)
h
Earth's Surface
Zero Meridian
Reference Ellipsoid
Y Axis
ϕ
λ
X Axis
Mean Equatorial Plane

NEW GEOMETRICAL DATUM WILL ALIGN TO AN EPOCH OF ITRF, BUT WILL BE PROBABLY BE FIXED ON NA PLATE



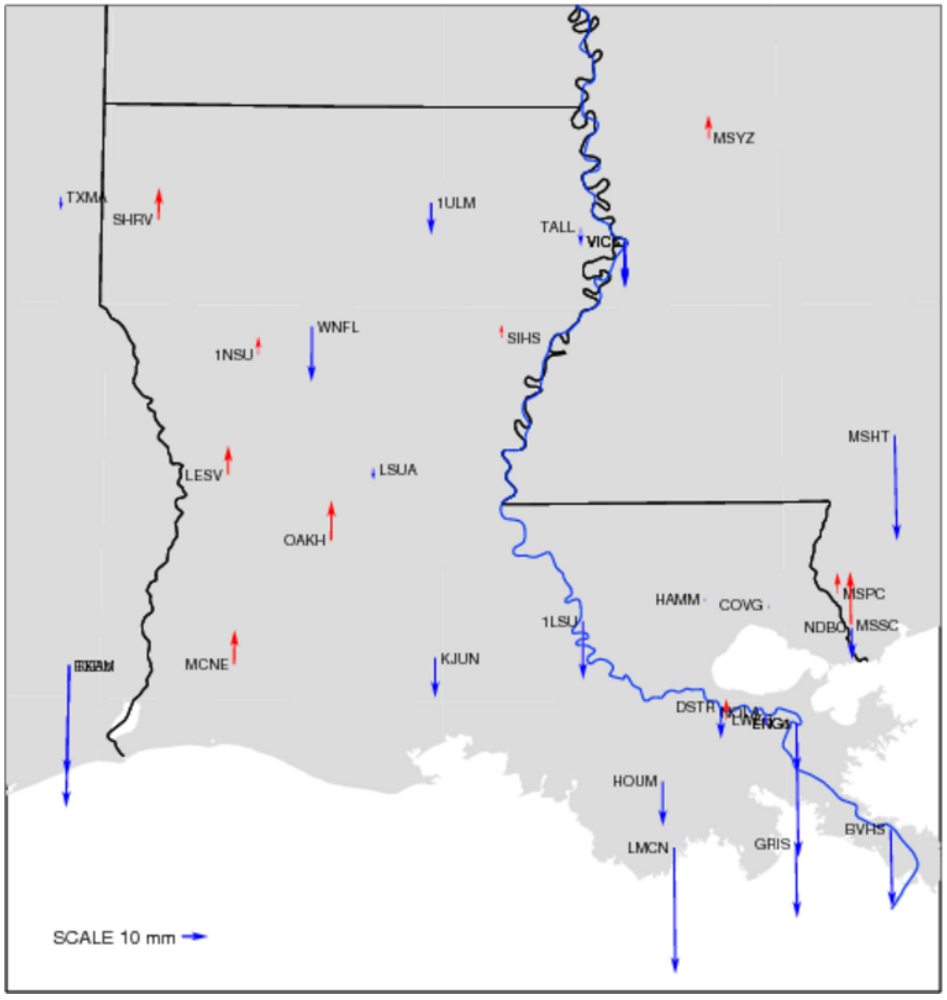
NAD 83 (2011) EPOCH 2002 MINUS NAD 83 (CORS 96) EPOCH 2002

LA Horizontal POSITIONS NAD 83(2011) 2002.00 minus NAD 83(CORS96) 2002.00 LA Vertical POSITIONS NAD 83(2011) 2002.00 minus NAD 83(CORS96) 2002.00



NAD 83 (2011) EPOCH 2010.0 MINUS NAD 83 (CORS 96) EPOCH 2002

LA Horizontal POSITIONS NAD 83(2011) 2010.00 minus NAD 83(CORS96) 2002.00 LA Vertical POSITIONS NAD 83(2011) 2010.00 minus NAD 83(CORS96) 2002.00



NEW NATIONAL VERTICAL DATUM:2022(?)
WHY ISN'T NAVD 88 GOODENOUGH ANYMORE?

NAVD 88 suffers from use of bench marks that:
Are almost never re-checked for movement
- **Disappear by the thousands every year**
- **Are not funded for replacement**
- **Are not necessarily in convenient places**
- **Don't exist in most of Alaska**
- **Weren't adopted in Canada**
- **Were determined by leveling from a single point, allowing cross-country error build up (Has been proven to be ~ 1 meter tilted across CONUS (again, based on the independently computed geoid from the GRACE satellite)**

RE-LEVELING WOULD COST 200 MILLION TO 2 BILLION $$

NEW NATIONAL VERTICAL DATUM

- A PURELY GRAVIMETRIC SURFACE
- BASED ON A HIGH RESOLUTION, 1 CM GEOID FROM GRAV-D PROGRAM

- ACCURATE TO 2 CM (ALLOWING FOR GNSS ERROR)

- ACCESSABILITY: BROUGHT TO A PROJECT SITE VIA ACTIVE REFERENCE STATIONS (NATIONAL CORS), DENSIFIED TO PROJECT ACCURACY NEEDS. (ALTERNATIVE: USE BMs PREVIOUSLY TIED TO THE DATUM-CAVEAT EMPTOR)

- ETD: 2022?

GRAVITY FOR ORTHOMETRIC HEIGHTS ("ELEVATIONS")

A HIGH ACCURACY SNAPSHOT OF THE NATION + A MOVIE OF CERTAIN AREAS

KNOW GRAVITY = KNOW HEIGHTS

GRAV-D PROGRAM
NEW VERTICAL DATUM AROUND 2018

http://www.ngs.noaa.gov/GRAV-D/pubs/GRAV-D_v2007_12_19.pdf

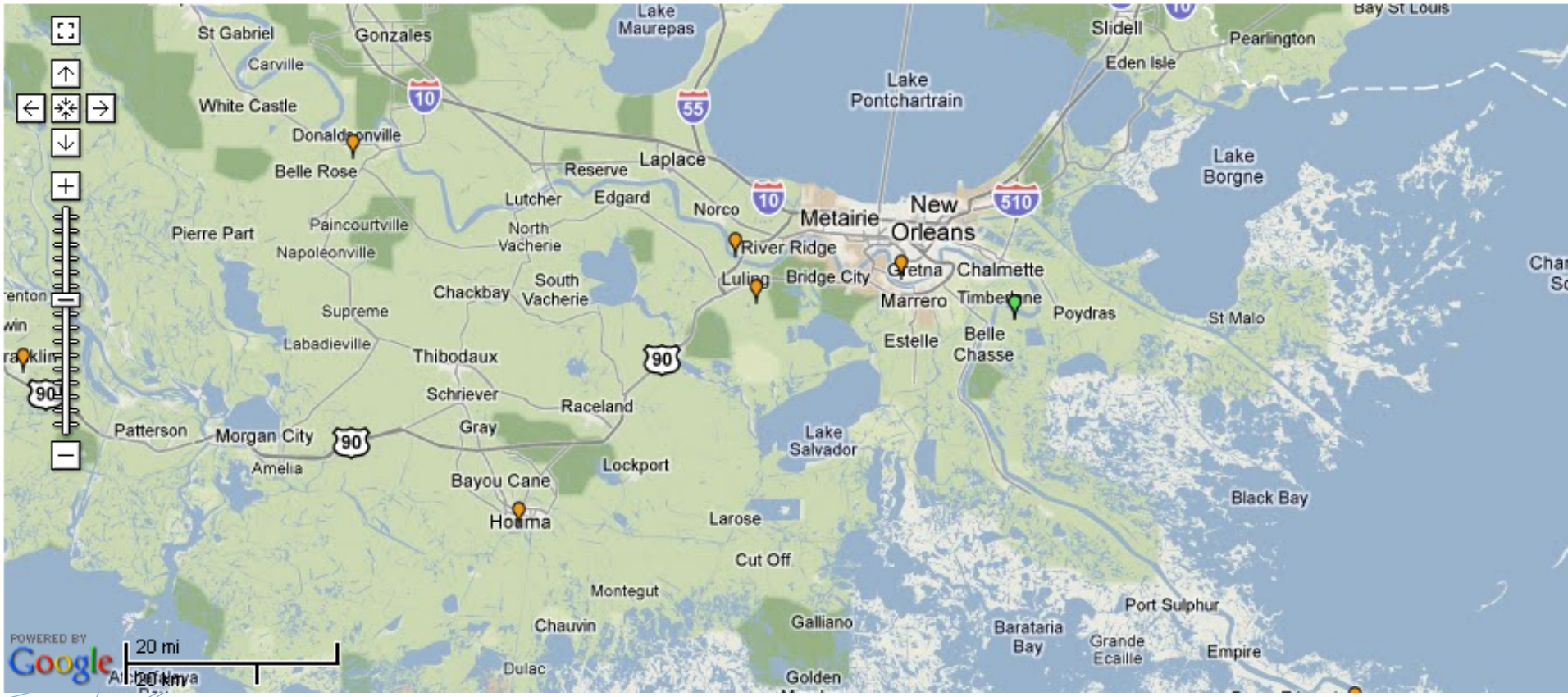
Antenna Reference Point(ARP): LOYOLA UNIVERSITY CORS ARP

PID = DH9599

H TURN 5 CORS ARP

Sampling Rate (clickable legend icons) Non-Operational 250 km radius

1 sec 5 sec 10 sec 15 sec 30 sec All Active Decom



FUTURE OF PASSIVE/ACTIVE MONUMENTATION

- **NAD 83 REALIZED THROUGH NATIONAL CORS**

- **NAVD 88 REALIZED FROM PASSIVE MARKS**

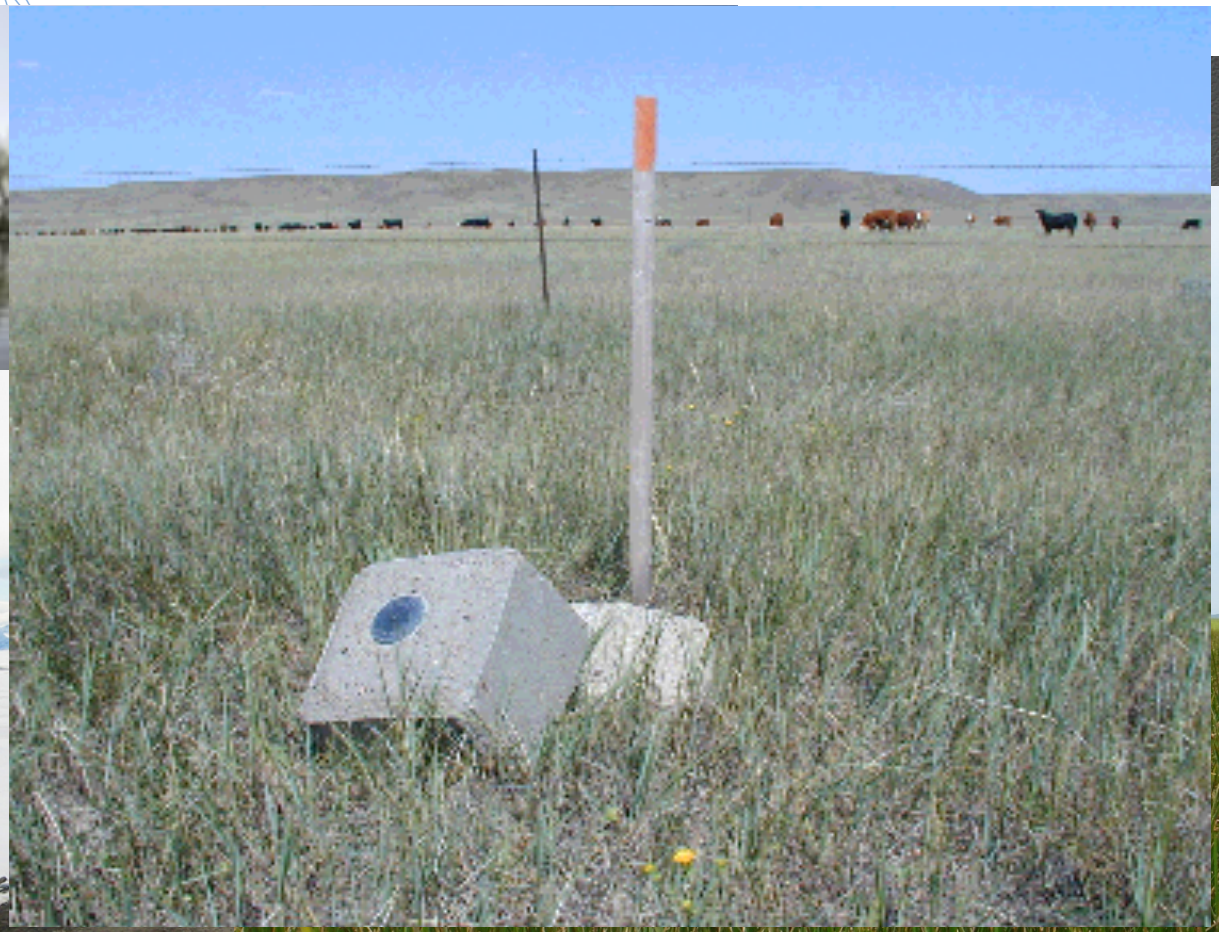
- **NGSIDB HAS 1,000,000 PASSIVE MARKS-PASSIVE MARKS IN STATES HAVE MANY CAMPAIGNS OVER MANY YEARS WITH MANY ACCURACIES IN MANY SEPARATE ADJUSTMENTS. RTN MAY NOT AGREE WITH THESE REQUIRING CONSTRAINTS TO THE MONUMENTS FOR PROJECT WORK.**

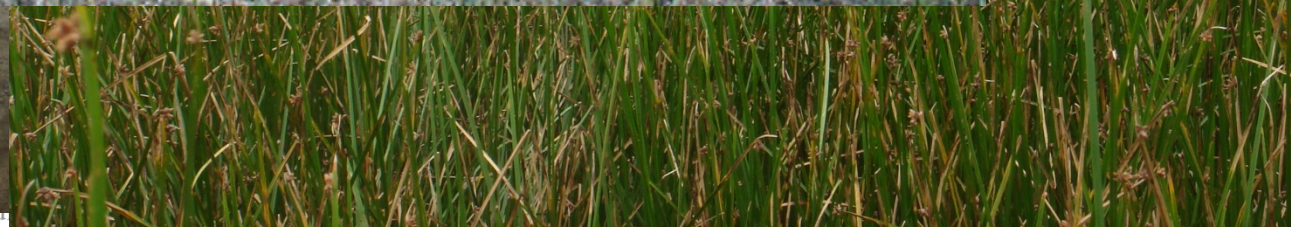
- **PASSIVE MARKS COORDINATES ARE A SNAPSHOT IN TIME AND CAN BE RELIED ON TO BE ACCURATE ONLY AT THE RECORDED OBSERVATION TIME.**

- **2022 = NEW GEOMETRIC DATUM / NEW GEOPOTENTIAL DATUM BASED ON 1 CM GRAVIMETRIC GEOID, POSITION VELOCITIES ON A GEOCENTRIC DATUM**

- **THE METHOD OF CHOICE TO ACCESS THE NSRS IS ACTIVE MONUMENTATION (CORS, OPUS, RTN)**

THE PROBLEM WITH PASSIVE MARKS….

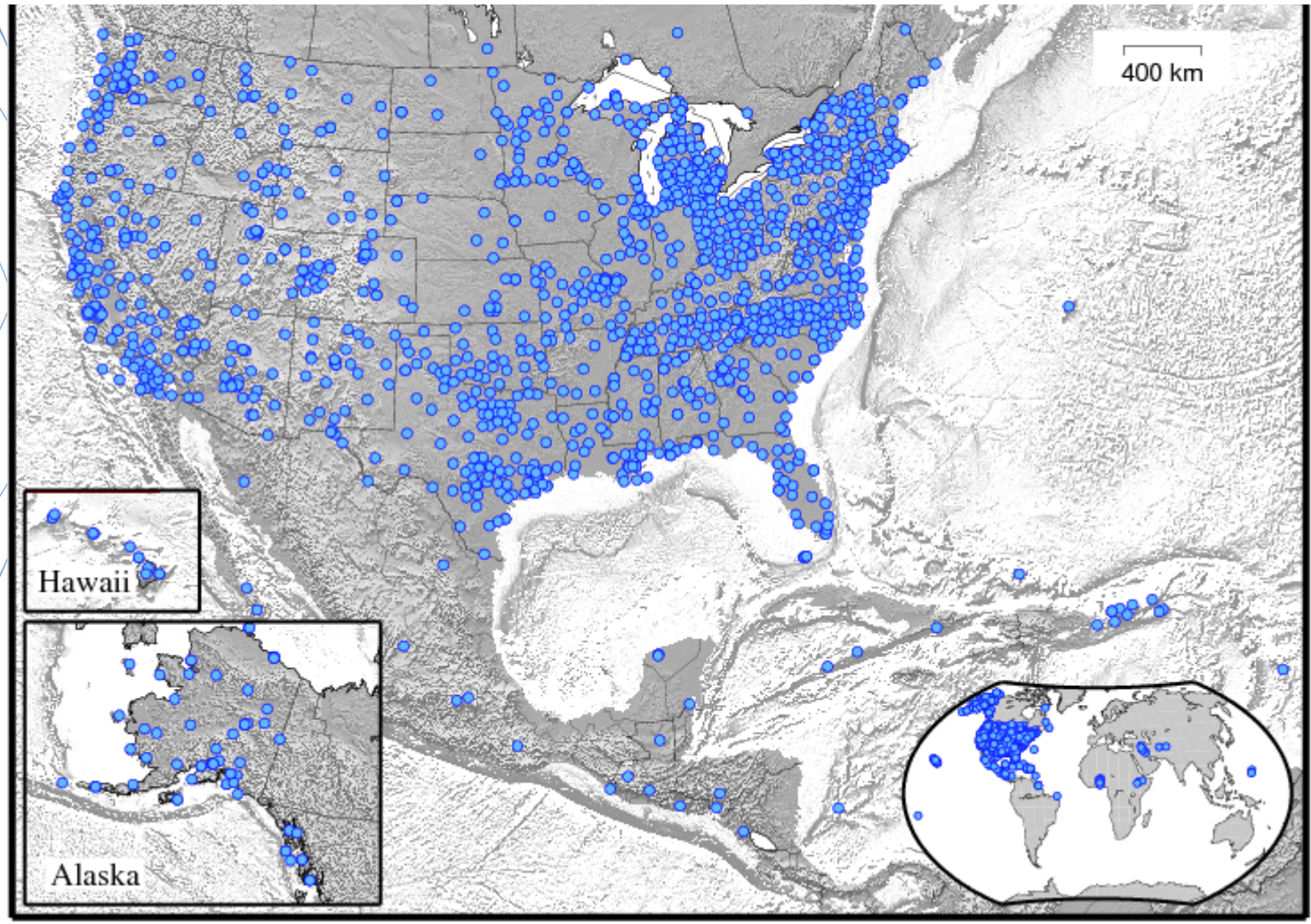




RTN AND NGS "FOUNDATION CORS" WILL BE THE PRIMARY ACCESS TO THE NSRS

CORS Network continued growth

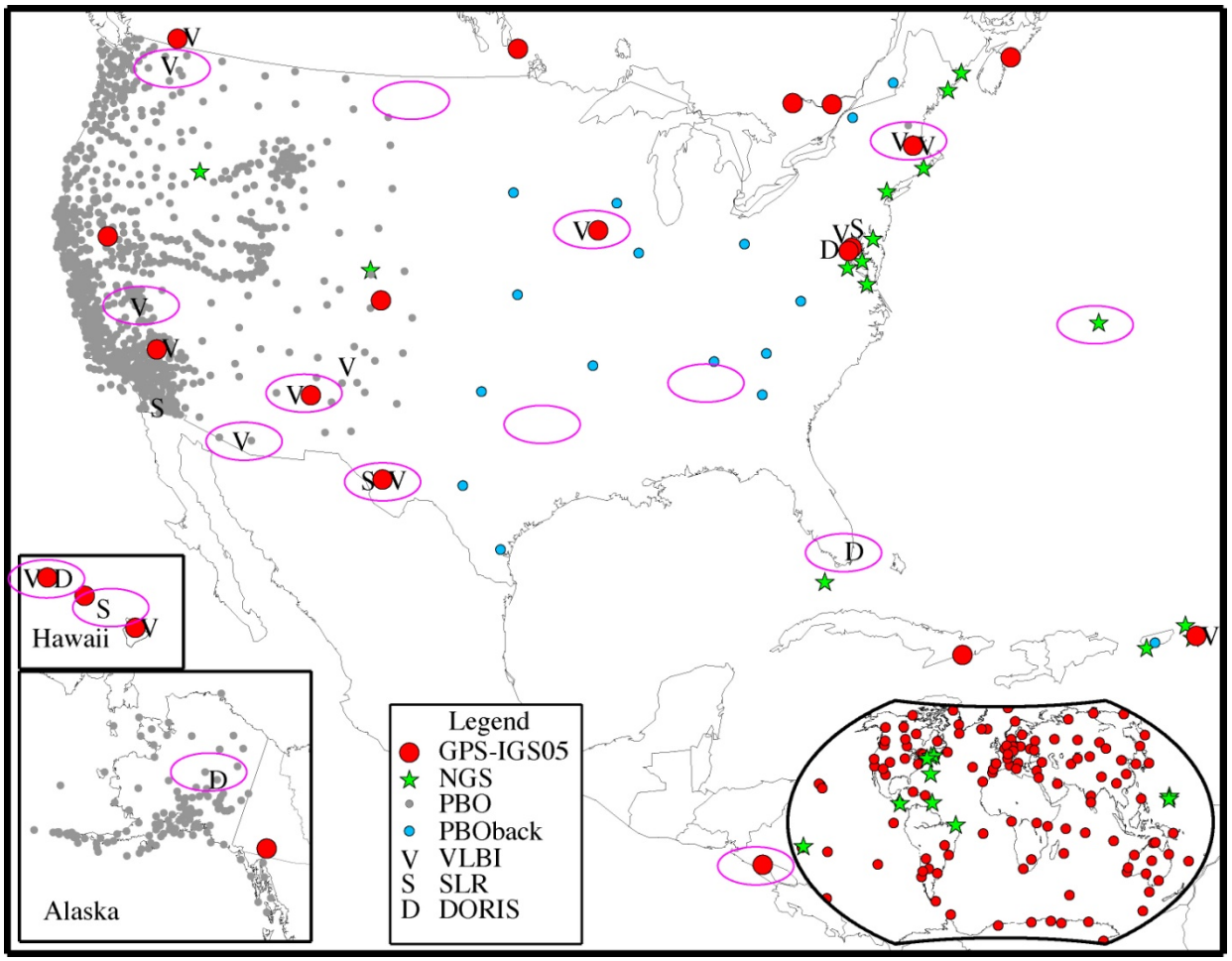
- Active sites 1750+
- 1250 used in NAD 83 (2011)



FOUNDATION CORS

- **Link to ITRF at sites co-located with VLBI, SLR, DORIS, then geographic gaps**

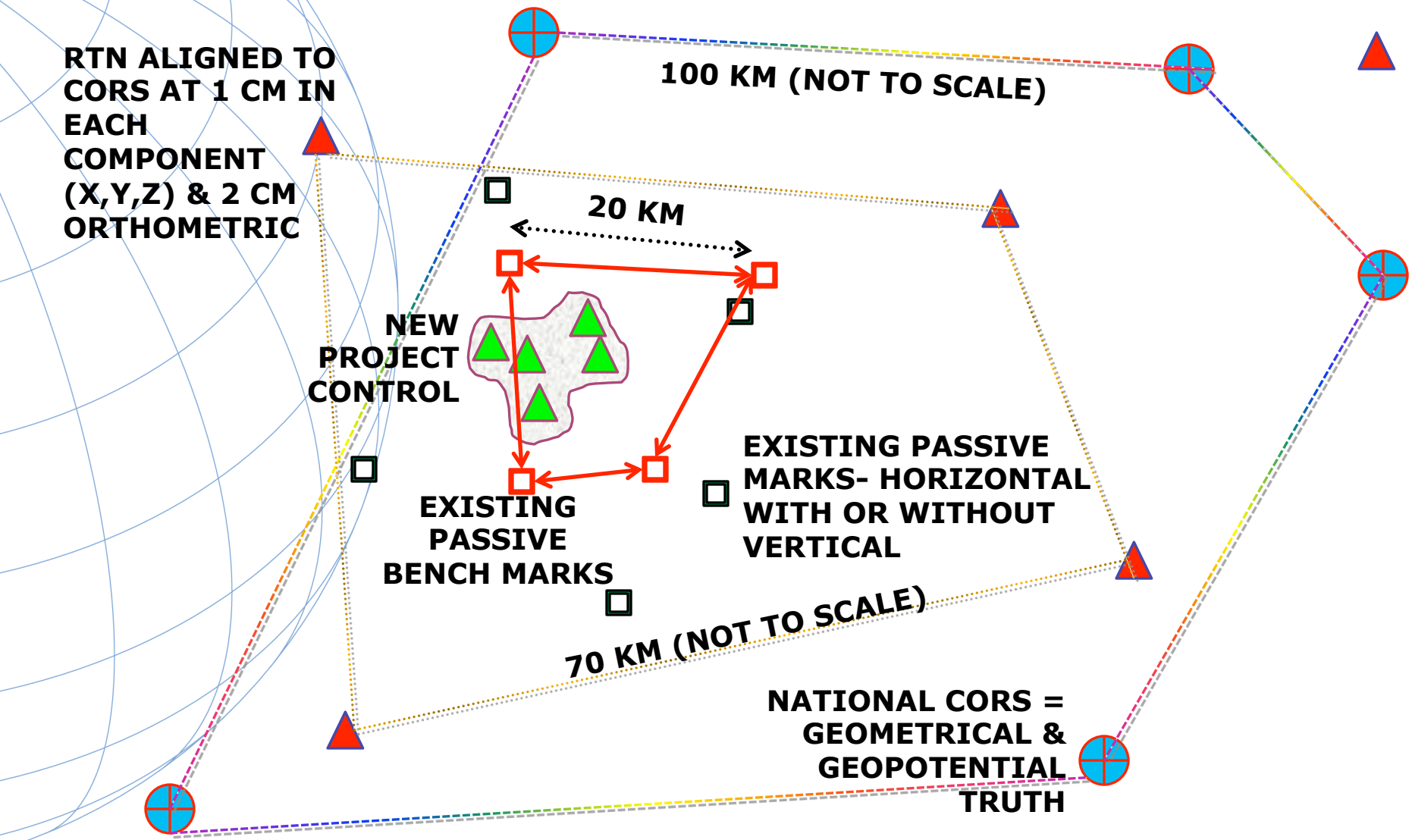
- ~10 in CONUS + AK, HW and US terr. Limited international
- Drilled braced monuments
- Time-line: ~2 sites/ year start FY10-11



Possible sites = magenta ovals

NGS WILL NOT PROVIDE CORRECTORS!

2022 NEW PROJECT CONTROL – ACCESS TO NSRS



THE ROLE OF NGS INTO THE FUTURE

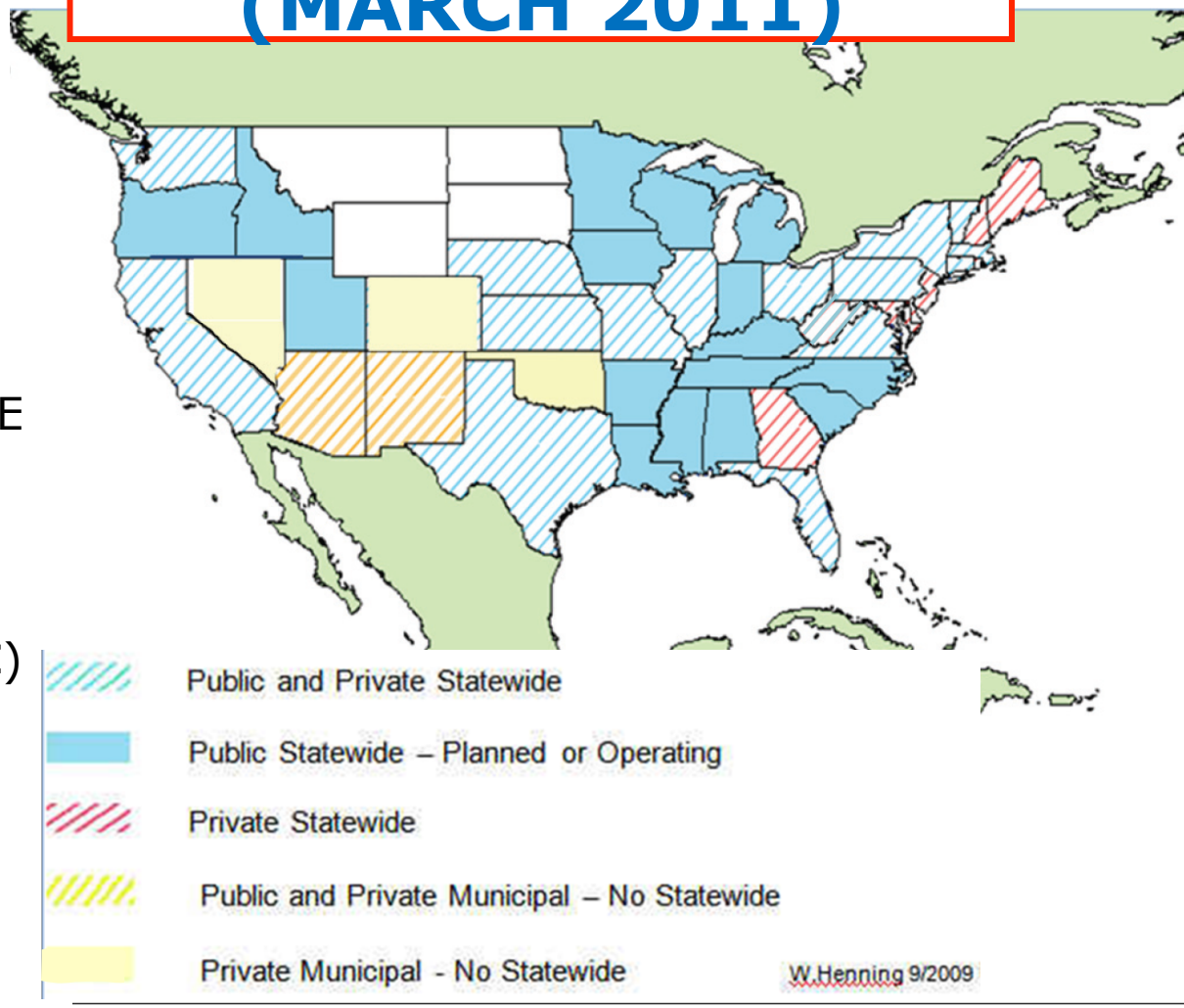
"NOAA's National Geodetic Survey provides the framework for all positioning activities in the Nation. The foundational elements – latitude, longitude, elevation, and shoreline information – contribute to informed decision making and impact a wide range of important activities including mapping and charting, flood risk determination, transportation, land use and ecosystem management. NGS' authoritative spatial data, models, and tools are vital for the protection and management of natural and manmade resources and support the economic prosperity and environmental health of the Nation."

This means that the geodetic latitude, longitude and height of points used in defining the NSRS should have an absolute accuracy of 1 millimeter at any time. Obviously, such points will be actively monitored points, not passive monuments.

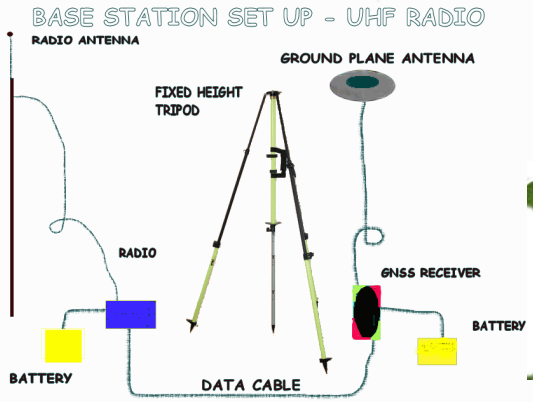
MAJOR RTN IN THE USA (MARCH 2011)

≥200 RTN WORLDWIDE
≥107 RTN USA
≥35 DOT

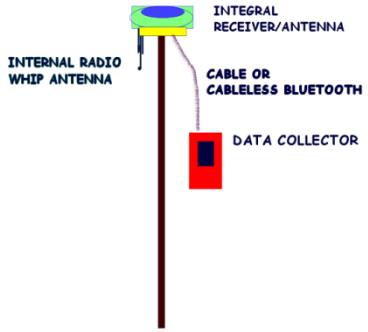
- ACADEMIC/SCIENTIFIC
- SPATIAL REFERENCE CENTERS
- VARIOUS DOTS + MACHINE GUIDANCE
- COUNTY
- CITY
- GEODETICSURVEYS(NC,SC)
- MANUFACTURERS
- VENDOR NETWORKS
- AGRICULTURE
- MA & PA NETWORKS



RTK vs. RTN



ROVER SET UP - INTERNAL RADIO

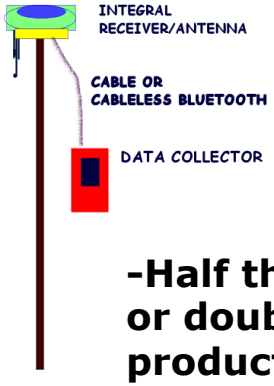


RTK

Plus:
Easy alignment to the NSRS
No ppm (1ST ORDER) ERROR
Extended range
Homogeneous Data
Easy datum updates

ROVER SET UP

Cell technology



RTN

-Half the equipment or double the production
-No monument reconnaissance/ recovery
- No set/break down time
-No base baby sitting

SO – WHAT CAN I EXPECT FROM A RTN?

MOST RTN PRODUCE "GOOD" HORIZONTAL VALUES. OUR HORIZONTAL SYSTEM IS BASED ON ACTIVE REFERENCE STATIONS (NGS CORS), AS ARE THE RTN STATIONS.

BECAUSE ORTHOMETRIC HEIGHTS ('ELEVATIONS') ARE BASED ON PASSIVE MONUMENTS (NAVD 88), THE RTN USER SHOULD, FOR THE MOST PART, CONSTRAIN THE PASSIVE MARK VALUES IN A LOCALIZATION.

CHOOSE THE RTN WITH A BUSINESS MODEL THAT BEST FITS YOUR NEEDS.

SOME RTN ADMINISTRATOR CONCERNS

- $$$$$$$$$$$$/ Business Model/ Partnerships
- Seasonal movement
- Integrity Monitoring
- Spacing
- IT set up- Communica
- OPUS vs. CORS RTN a
- Upgrade? GNSS?
- Velocity models for RTN stations (not CORS)
- Velocity for CORS-HTDP, monthly CORS or wait till tolerance exceeded?
- What formats will be provided? Orthos?
- Datum/adjustment- when should coordinates be changed?
- Supplements- weather sensors ($2K) for tropo (humidity) modeling (not upper atmosphere)

Reference Station Spacing. E.g, for a 200 Km x 200 Km area:
46 stations at 30km spacing
39 stations at 40km spacing
22 stations at 50km spacing
14 station s at 70km spacing

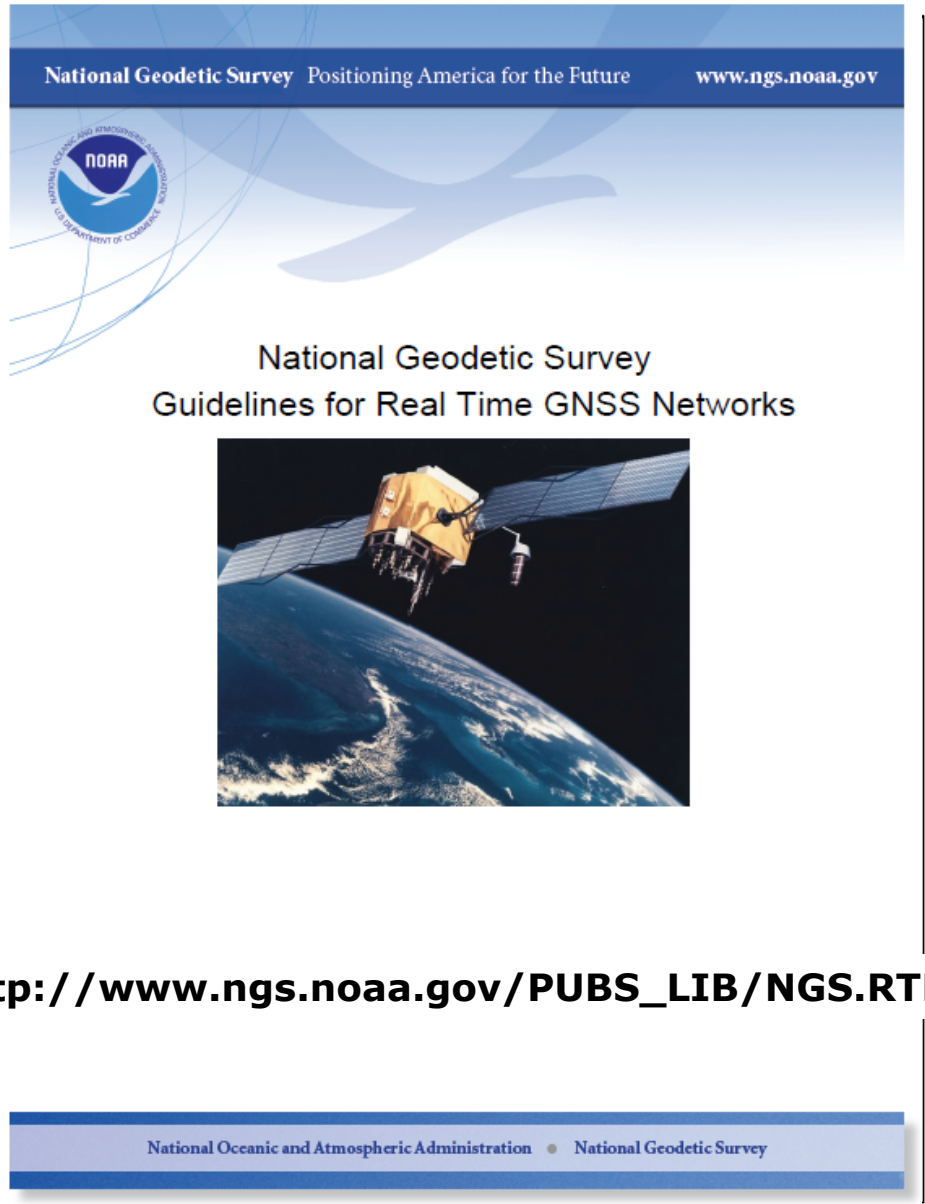
Difference could be a million dollars!

SOME RT FIELD CONSIDERATIONS

- Multipath
- Position Dilution of Precision (PDOP)
- Baseline Root Mean Square (RMS)
- Number of satellites
- Elevation mask (or cut-off angle)
- Base accuracy- datum level, local level
- Base security
- Redundancy, redundancy, redundancy
- Part(s) Per Million Error (ppm) – iono, tropo models, orbit errors
- Space weather- sunspot numbers, solar maximum
- Geoid quality
- Site calibrations (a.k.a. Localizations)
- Bubble adjustment
- Latency, update rate
-- Accuracy versus Precision
- Signal to Noise Ratio (S/N or C/N0)
- Float and Fixed Solutions
- Carrier phase precisions
- Code phase precisions
- VHF/UHF radio communication
- GSM/CDMA/SIM/Cellular TCP/IP communication
-WGS 84 versus NAD 83, or other local datums
- GPS, GLONASS, Galileo, Compass Constellations

NGS GOALS FOR RTN's

- All real-time positioning services available in the U.S. provide coordinates that are consistent with the National Spatial Reference System, and hence, with each other
- User equipment can operate with services from different RTN's to the greatest extent possible. Promote the use of NTRIP software and RTCM 3.x format
- Reference stations contained in each RTN meet prescribed criteria in terms of stability and data quality. CORS guidelines: http://www.ngs.noaa.gov/PUBS_LIB/CORS_guidelines.pdf
- Best methods for RTN users may be advanced



RTN GUIDELINES FOR GNSS POSITIONING–

WILL NOT SPECIFY OR DEFINE A STANDARD, BUT WILL HELP ADMINISTRATORS AND USERS TO BE AWARE OF ALL THE ISSUES INVOLVED WITH THIS NEW TECHNOLOGY

60+ CONTRIBUTORS:

- NGS ADVISORS
- DOT
- STATE GEODETIC SURVEYS
- GNSS MANUFACTURERS
- SRCs
- BLM, NPS

http://www.ngs.noaa.gov/PUBS_LIB/NGS.RTN.Public.v2.0.pdf

ALIGNING RTN TO THE NSRS:

#1 Include a subnetwork of the RTN into the NGS **CORS** network. This would be three stations If RTN has less than 30 stations, 10% of RTN with greater than 30 stations.

#2 Align all RTN reference stations coordinates to the CORS network at 2-cm horizontal and 4-cm vertical

#3 For each reference station in the RTN, use the some version of the Online Positioning User Service (OPUS) at http://www.ngs.noaa.gov/OPUS/ to test for the CONTINUED CONSISTENCY of its adopted positional coordinates and velocity on a daily basis, and revise the station's adopted coordinates and/or velocity if the tests reveal a need to do so. OPUS-PROJECTS looks promising

#4 NGS encourages each RTN to provide access to users of all major GNSS manufacturers' equipment

#5 NGS promotes the use of **RTCM** format data via **NTRIP** communication protocol application.

PRECISION/ACCURACY

Typical RTN *precisions* at the 95% confidence level are: horizontal 2-3 cm , vertical (ellipsoid) 3-5 cm, orthometric heights 5-7 cm (typical-using the NGS hybrid geoid model).

Exceptional RTN derived *precisions* are at the current limit of the RT technology: horizontal : ≤ 1 cm, vertical (ellipsoid) ≤ 1 cm, possible orthometric height ≤ 2 cm.

Since RTN positioning is a differential solution from a base station to a point of interest, the results are displayed in the data collector as measures of the *precision*, or repeatability, of the solution. On the other hand, the alignment of the base station to the user-selected datum (as part of the NSRS or otherwise) can be considered the level of *accuracy.*

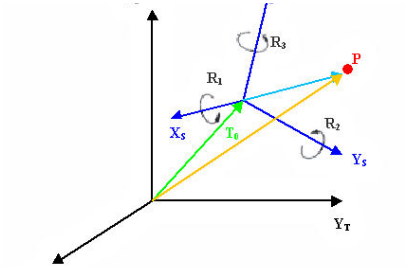
***Accuracy* is a measure of how the positions are aligned to "truth". NGS wishes to encourage all RTN to provide users with alignment to the NSRS as the representation of truth.**

OVERLAPPING RTN-NSRS?, HOMOGENEOUS?, USES ALL GNSS GEAR?

REFERENCE STATION COORDINATE DERIVATION:

ALL CORS FIXED

ALL CORS WEIGHTED



OPUS (Average of 10 days of 24 hour data sets)

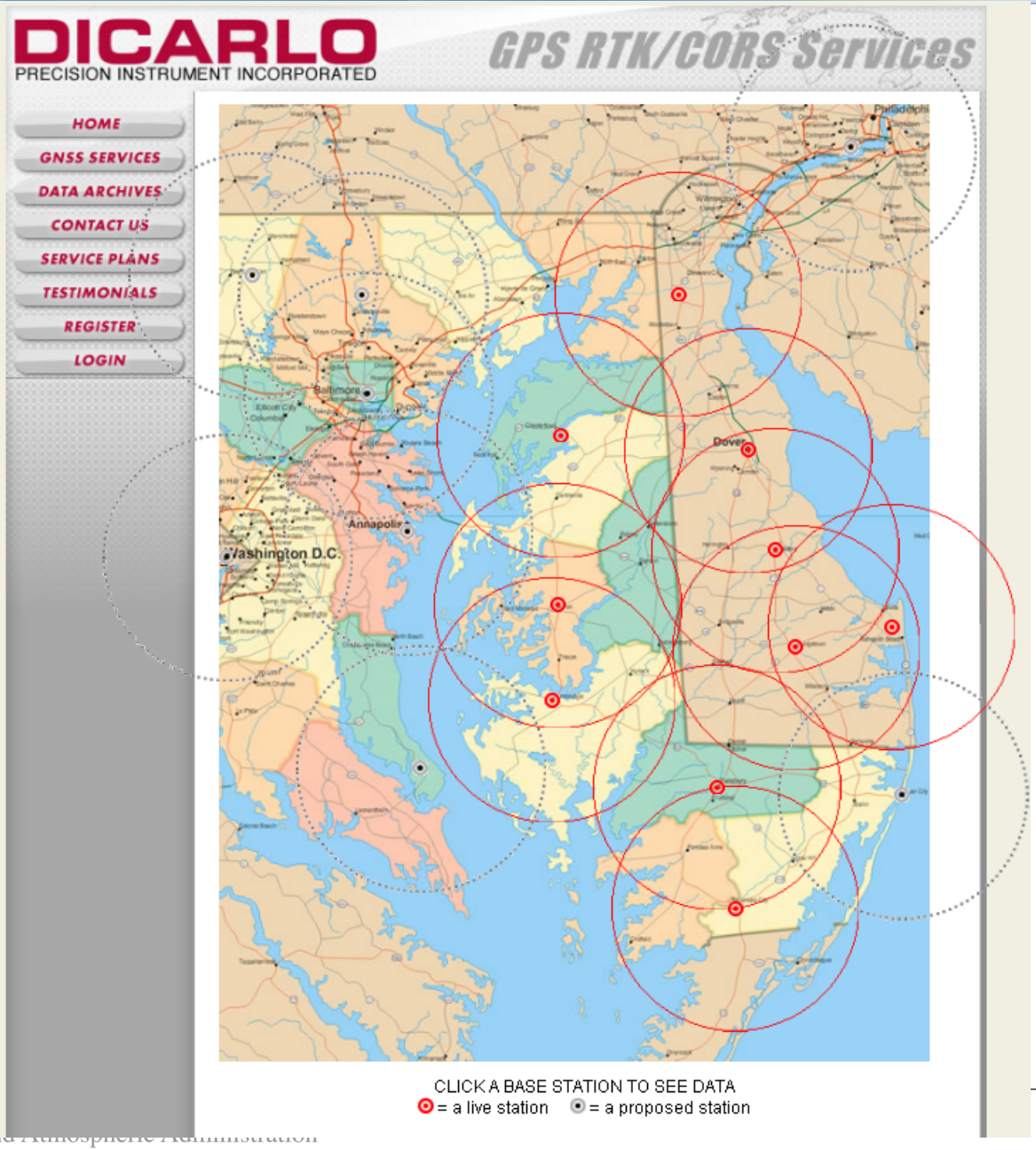
OPUS + HARN

BEST FIT TO ONE MASTER STATION

<u>THE NGS RECOMMENDATION</u>: Process at least 10 days of GPS data from all RTN stations using a simultaneous network adjustment while "constraining" several CORS coordinates with weights of 1 cm in each horizontal dimension and 2 cm in the vertical dimension. USE OF OPUS-PROJECTS?

SUGGESTIONS FOR DETERMINING VELOCITIES FOR RTN STATIONS

- **Use the HTDP (Horizontal Time-Dependent Positioning) software to predict velocities for new RTN stations. (The predicted vertical velocity will be zero.)**
- **After 3 years, use GPS data from the RTN station to produce a time series of the station's coordinates, then use this time series to estimate a velocity for the RTN station.**
- **TDP (3-D) will allow for initial vertical velocities. To be released in the near future.**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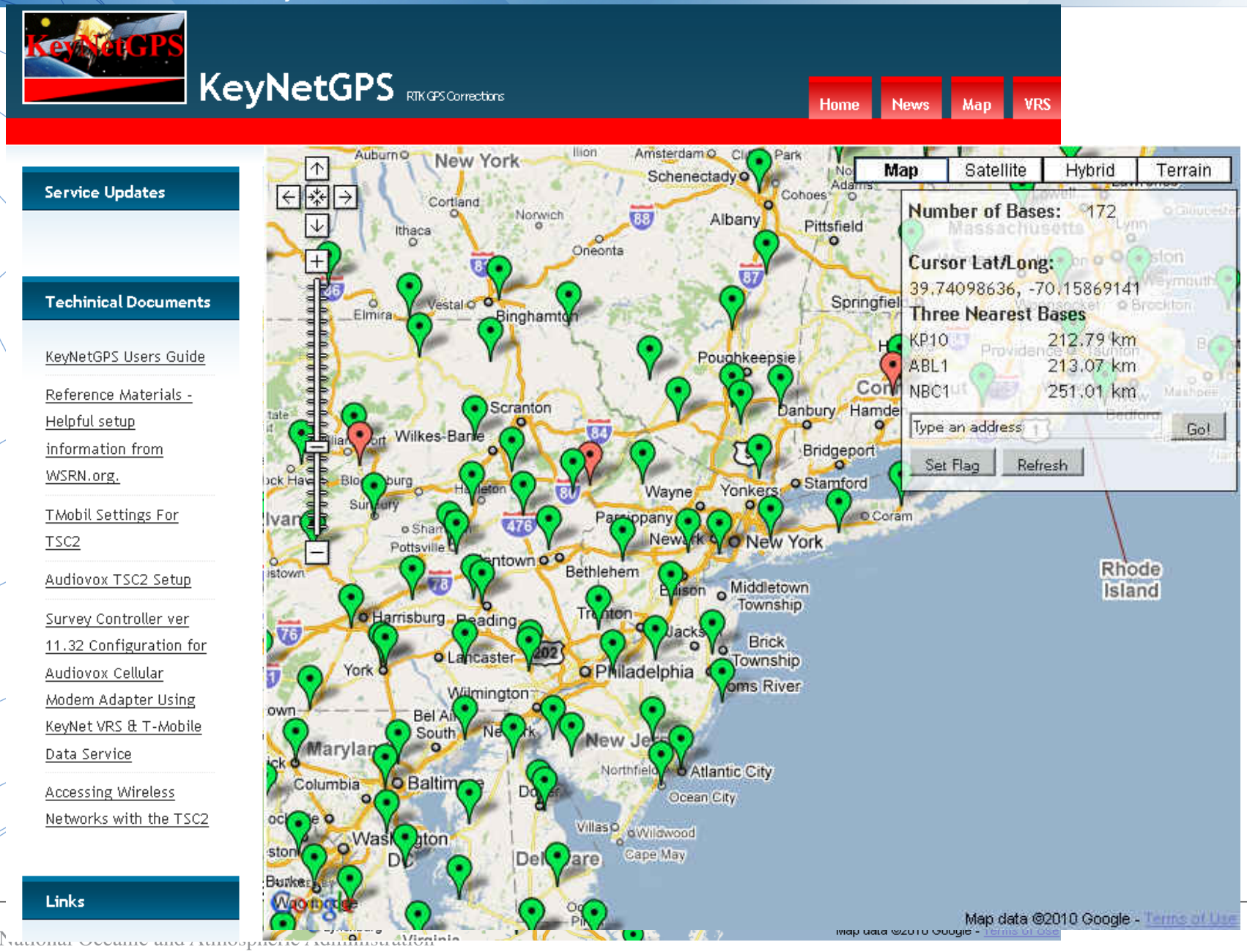
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KeyNetGPS Users Guide
Reference Materials - Helpful setup information from WSRN.org.
TMobil Settings For TSC2
Audiovox TSC2 Setup
Survey Controller ver 11.32 Configuration for Audiovox Cellular Modem Adapter Using KeyNet VRS & T-Mobile Data Service
Accessing Wireless Networks with the TSC2
Links
Map
Satellite
Hybrid
Terrain
Number of Bases: 172
Cursor Lat/Long:
39.74098636, -70.15869141
Three Nearest Bases
KP10 212.79 km
ABL1 213.07 km
NBC1 251.01 km
Type an address
Go!
Set Flag
Refresh
New York
Albany
Schenectady
Binghamton
Scranton
Wilkes-Barre
Poughkeepsie
Danbury
Bridgeport
Stamford
Yonkers
Newark
Philadelphia
Harrisburg
Reading
Lancaster
York
Wilmington
Bethlehem
Trenton
Middletown Township
Brick Township
Atlantic City
Ocean City
Cape May
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- when it has to be right

Leica Geosystems

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SmartNet & Affiliate Network Coverage

Coverage Information

You may select the type of coverage you are interested in with the drop down below.

MAX / iMAX Coverage

MAX - Master Auxiliary Concept

The only international Network RTK transmission standard and preferred format of Leica Geosystems.

iMAX - Individualized MAX

Non-Physical method of corrected data from real reference stations

Nearest Site

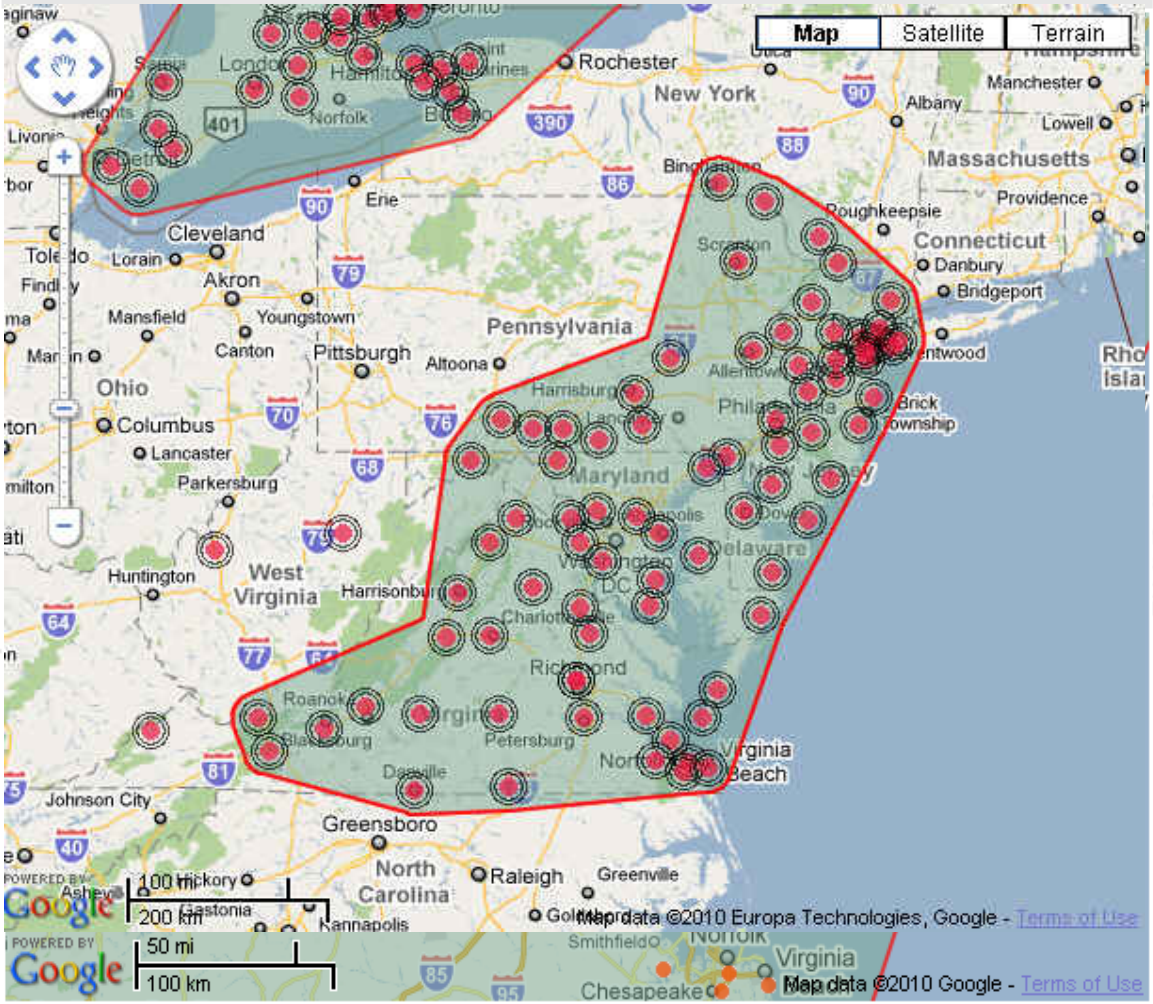
Single base corrections from the nearest reference station

SmartNet Legend

Please click on a state to find the coverage available in your area through either SmartNet or one of our SmartNet Affiliates!

SmartNet

Affiliates



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USING AN OPUS TOOL TO MONITOR RTN ANTENNAS

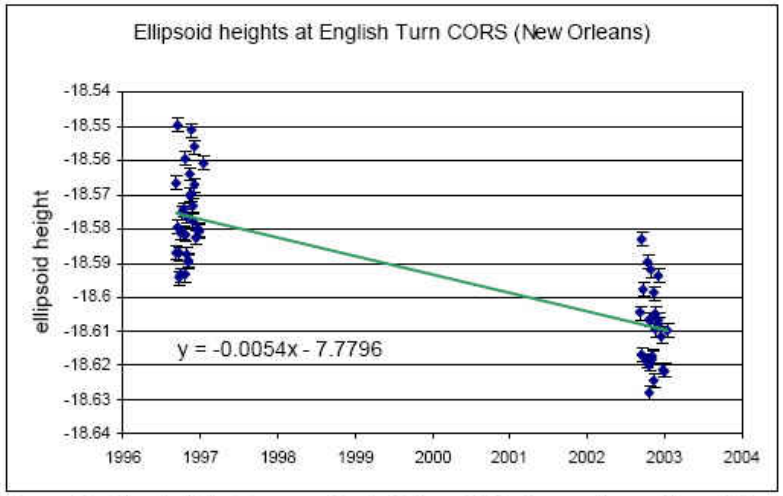
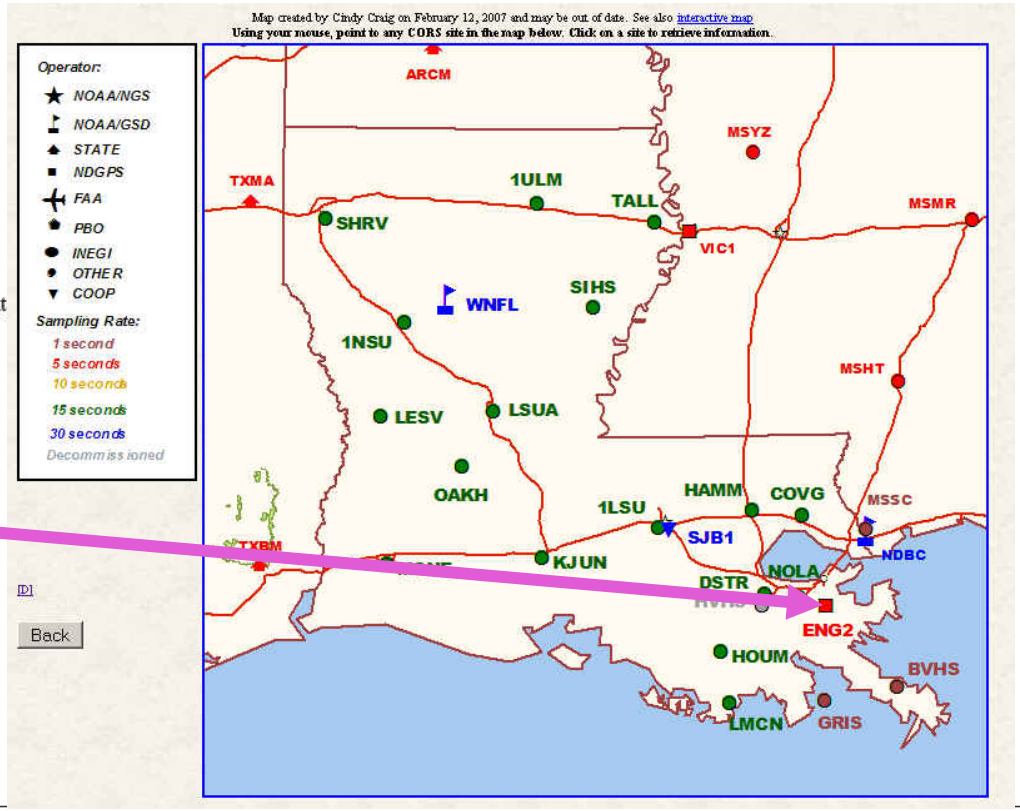


Figure 13. Vertical displacement derived from GPS observations; ellipsoid height meters.

EXAMPLE



SUBSIDENCE

≈ 6 MM / YEAR

ENGLISH TURN CORS

RTN ANTENNA MOVEMENT

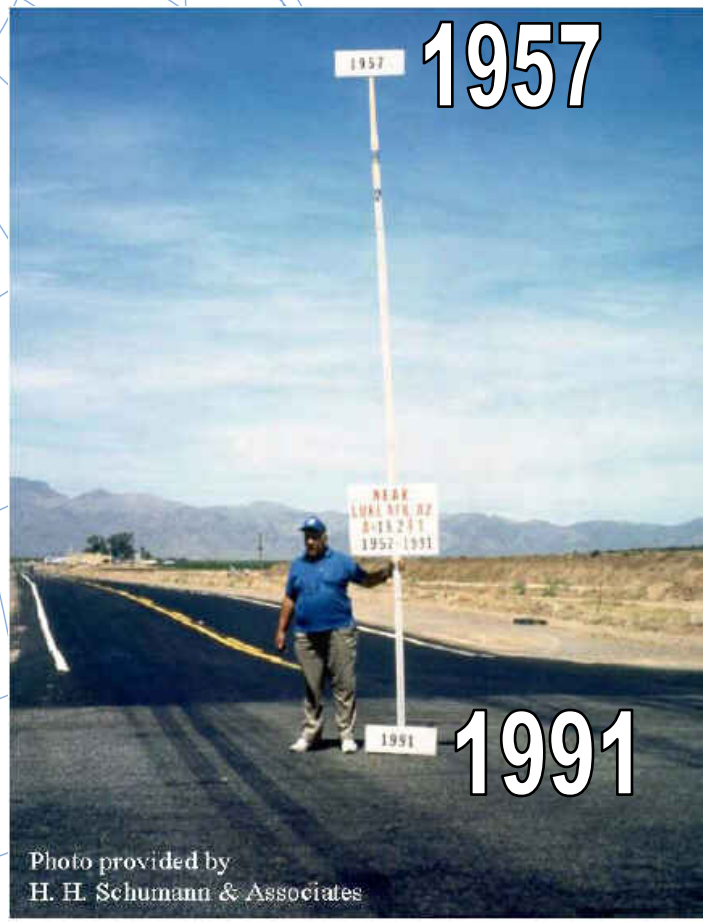
WHEN SHOULD RTN COORDINATES BE UPDATED?

VELOCITIES SHOULD BE KEPT IN THE METADATA

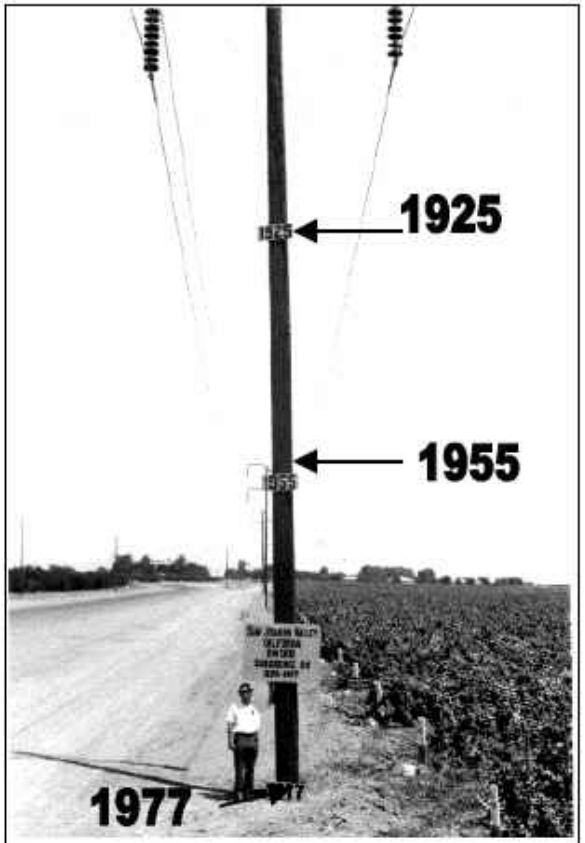
VERTICAL MOVEMENT IS MORE DYNAMIC AND NOT CURRENTLY MODELED FOR THE CORS

SOME MOTION IS NEITHER LINEAR NOR REGULARLY CYCLICAL

WHEN WAS THE PASSIVE MARK ACCESSED?



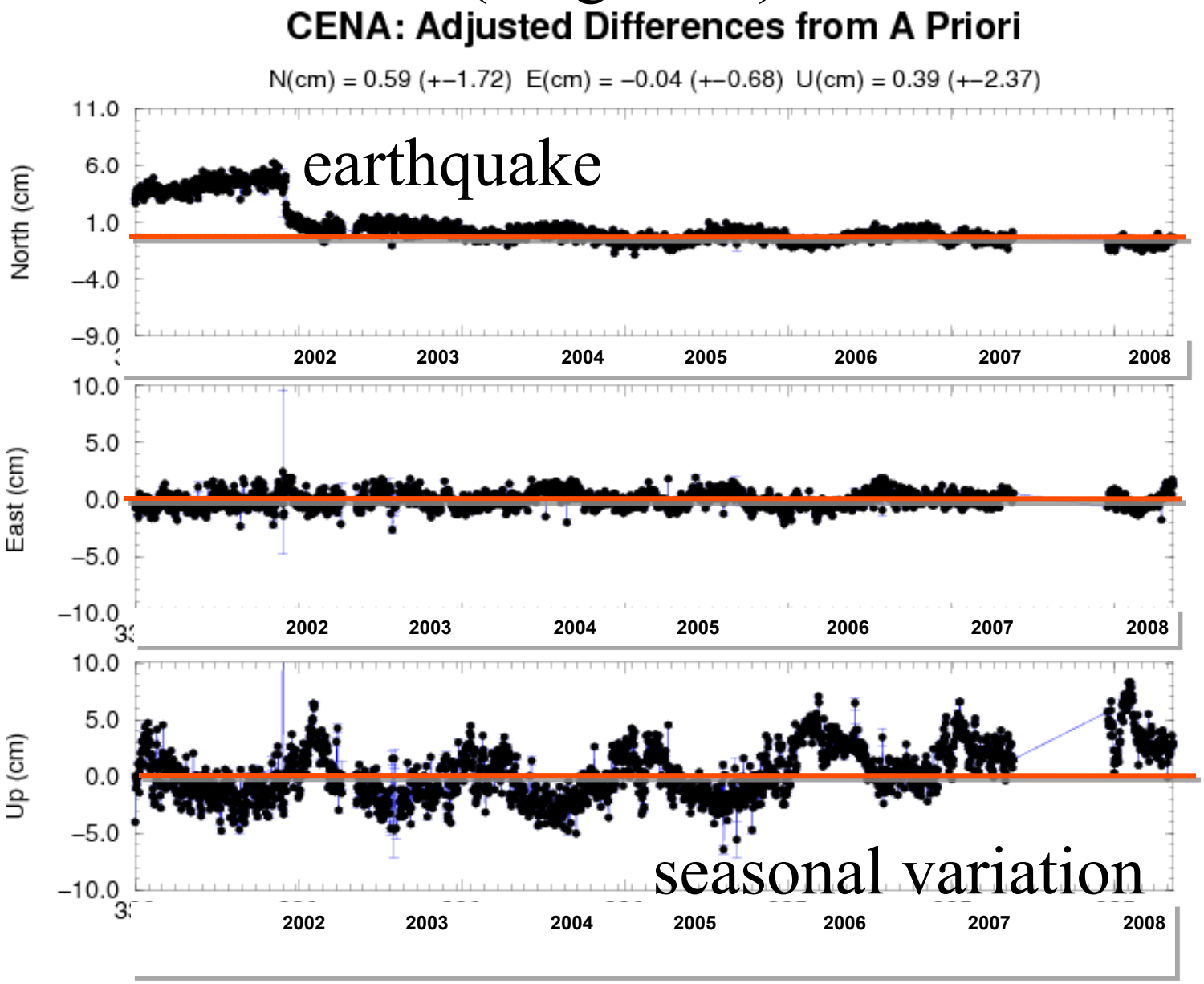
Due to land subsidence, the elevation of this spot near Luke Air Force Base in Maricopa County has dropped by more than 18 feet over a 34-year period. Knowledge of subsidence areas is a fundamental requirement for planning infrastructure such as pipelines, canals, and power plants.



Approximate levels of subsidence. The signs show the position of land surface in 1925, 1955, and 1977. Although the rate of subsidence has decreased, the continued pumping of ground water has resulted in additional subsidence in the past 20 years.

Figure 6 Subsidence in California's Central Valley

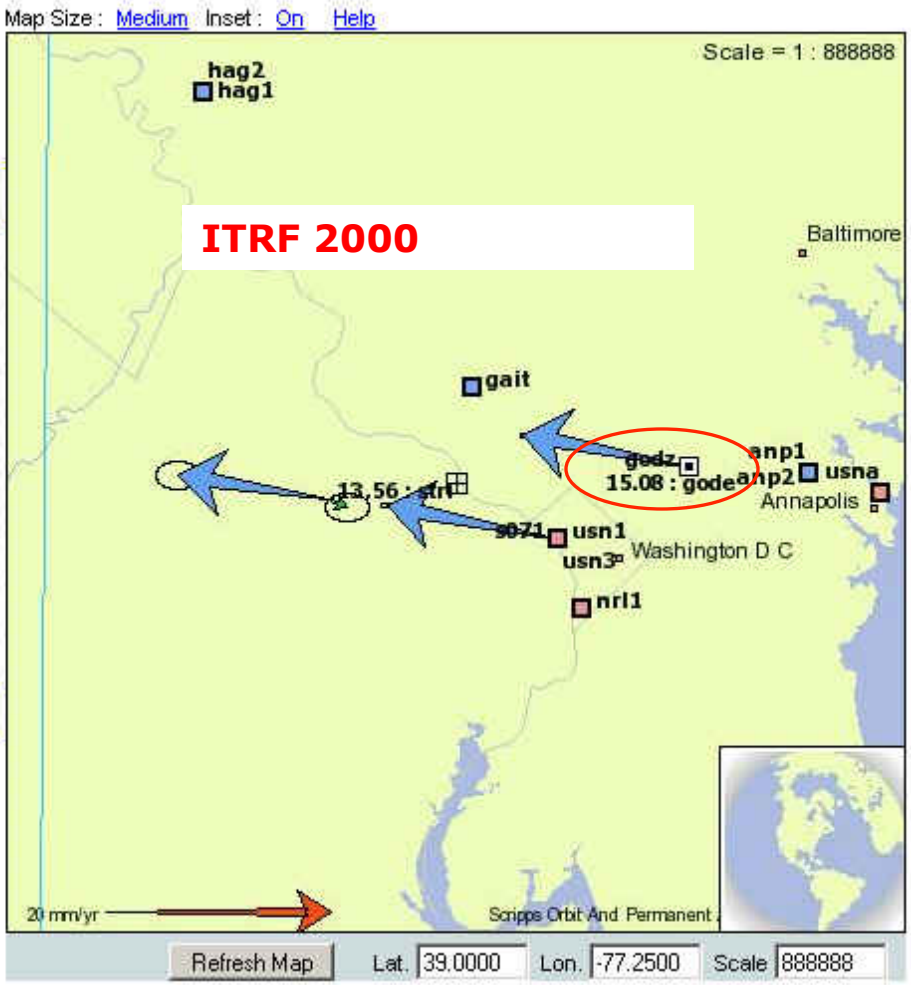
Position Time Series (long-term)

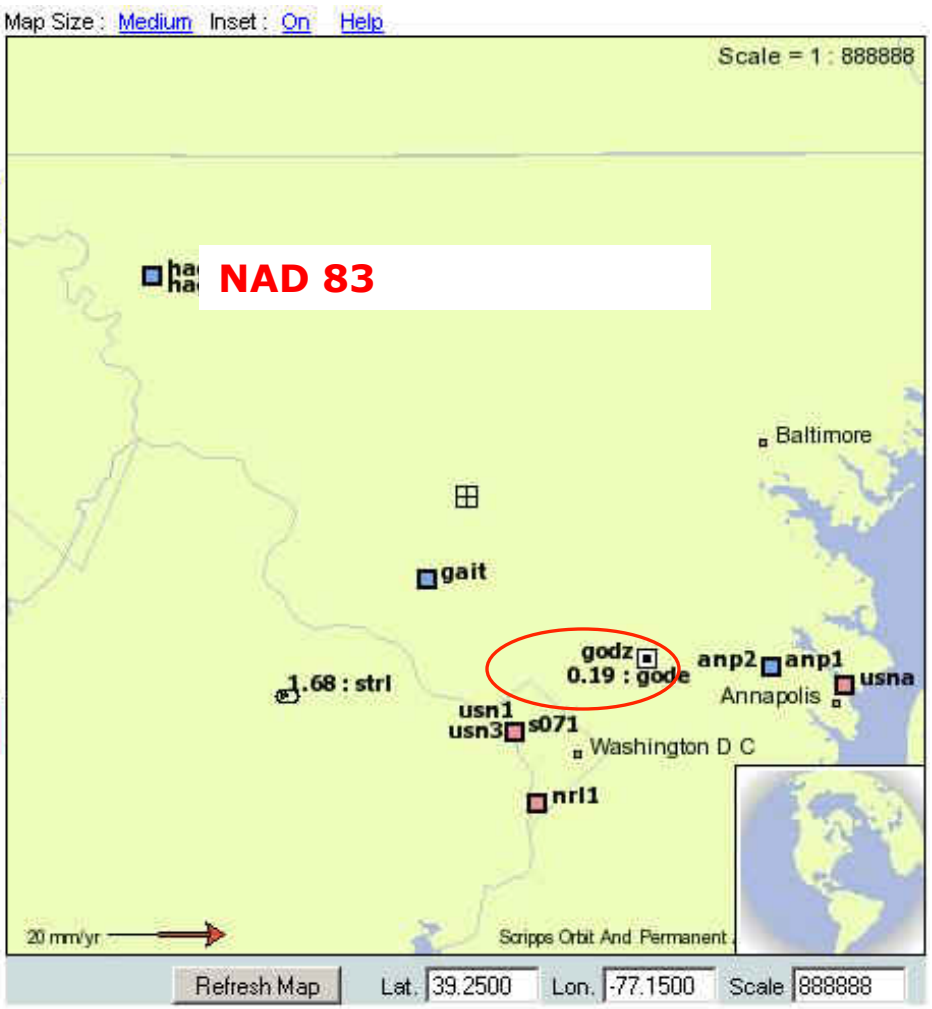


POSSIBLE REASONS FOR CYCLICAL MOVEMENT

- FLUID WITHDRAWAL/INFUSION
- OCEAN LOADING
- ATMOSPHERIC LOADING
- RECEIVERS
- PROCESSING
- IONO MODELING
- VOLCANIC "BREATHING"
- INTERMITTENT ELECTRICAL INTERFERENCE
- SNOW

SILVER SPRING, MD





SANTA CRUZ, CA

NAD 83 VELOCITIES (GOLD)

ITRF 2000 VELOCITIES (BLUE)

RTCM 3.X

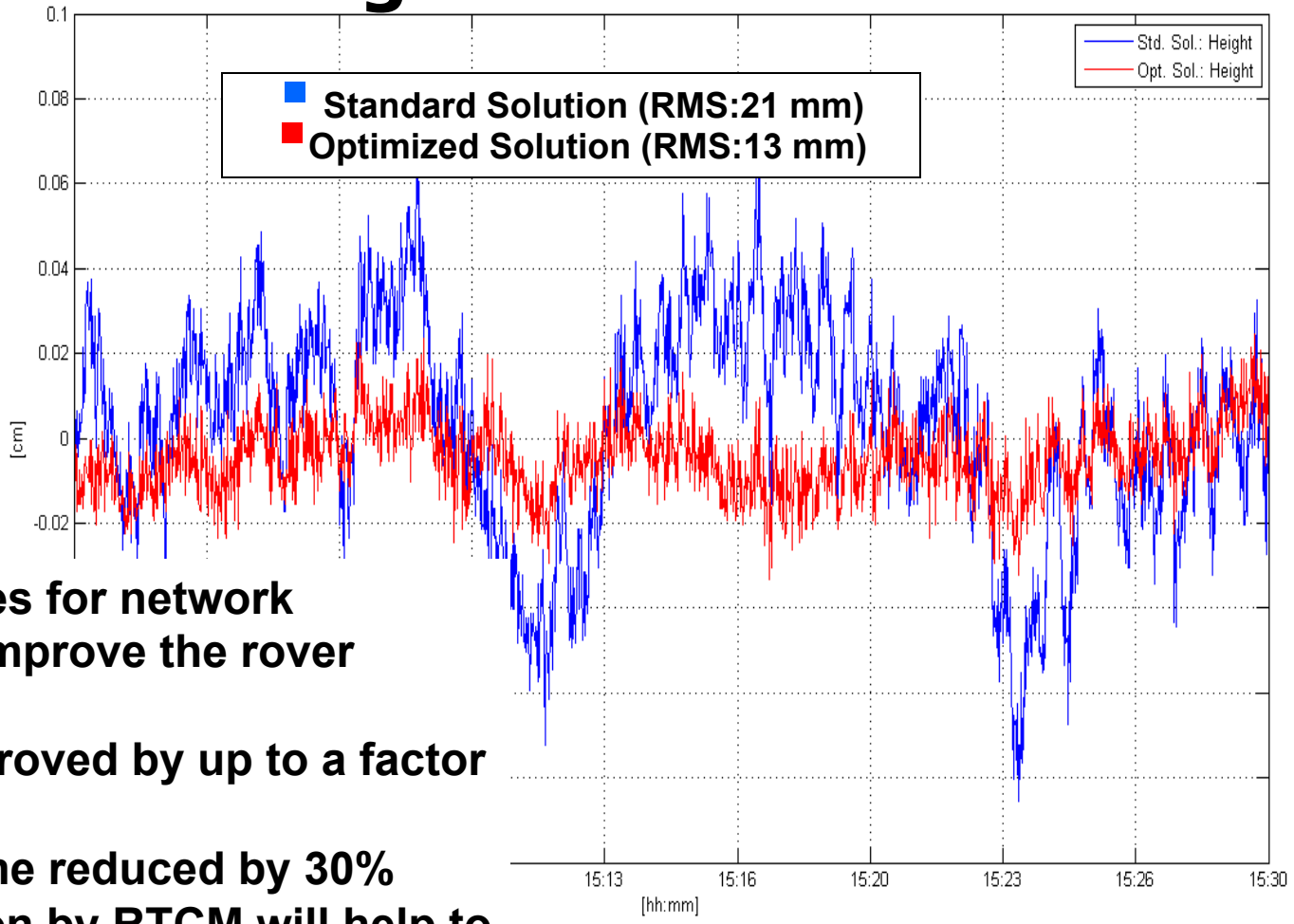
3.2 Message Type Summary

The message types shown in Table 3.2-1 support Real-Time Kinematic (RTK) individual and network broadcasts for GPS, GLONASS, .

Table 3.2-1. Message Type Table

Message Type	Message Name	No. of Bytes **	Notes
1001	L1-Only		
1002	Extende		
1003	L1&L2		
1004	Extende		
1005	Stationa		
1006	Stationa with An		
1007	Antenna		
1008	Antenna		
1009	L1-Only		
1010	Extende Observa		
1011	L1&L2		
1012	Extende Observa		
1013	System		
1014	Networl		
1015	GPS Ionospheric Correction Differences	$9+3.75*N_s$	N_s = Number of Satellites
1016	GPS Geometric Correction Differences	$9+4.5*N_s$	N_s = Number of Satellites
1017	GPS Combined Geometric and Ionospheric Correction Differences	$9+6.625*N_s$	N_s = Number of Satellites
1018	RESERVED for Alternative Ionospheric Correction Difference Message		
1019	GPS Ephemerides	62	One message per satellite
1020	GLONASS Ephemerides	45	One message per satellite
1021	Helmert / Abridged Molodenski Transformation Parameters	51.5+N+M	N = Number of characters in Source Name M = Number of characters in Target Name
1022	Molodenski-Badekas Transformation Parameters	64.625+N+M	N = Number of characters in Source Name M = Number of characters in Target Name
1023	Residuals, Ellipsoidal Grid Representation	72.25	
1024	Residuals, Plane Grid Representation	73.75	
1025	Projection Parameters, Projection Types other than Lambert Conic Conformal (2 SP) and Oblique Mercator	24.5	
1026	Projection Parameters, Projection Type LCC2SP (Lambert Conic Conformal (2 SP))	29.25	
1027	Projection Parameters, Projection Type OM (Oblique Mercator)	32.25	

Positioning Error Comparison – Height Error



- ✓Quality measures for network corrections can improve the rover performance
- ✓Positioning improved by up to a factor of 2
- ✓ Initialization time reduced by 30%
- ✓A standardization by RTCM will help to get the method implemented in existing and new RTN networks

RTCM Paper 014-2007-SC104-462

The RTN Guideline Work Group Leaders:

William Henning, team leader, editor

Dan Martin, Site Considerations group leader

Gavin Schrock, Planning and Design group leader

Gary Thompson, Administration group leader

Dr. Richard Snay, Aligning RTN to the NSRS

William Henning, Users group leader

Version History;

Draft v. 1.0, November 2009
v. 1.3 – edits from first comments from team, September, 2010
v 1.5-1.6 – reformats and edits. February 2011
v 2.0 – internal and public comment edits. March 2011

2

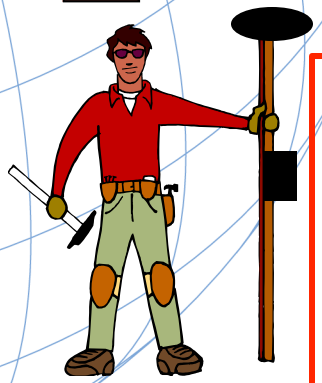
NGS IS WORKING THROUGH THE DECISION MAKING PROCESS THAT WILL RESULT IN HOW IT WILL "VALIDATE" THE ALIGNMENT OF A RTN TO THE NSRS

HOW WILL NGS VALIDATE RTN?

NGS 2011 STRATEGIC PLAN / 1.7 & 1.8:

"Develop guidelines for both the administration and use of real-time GNSS networks and especially for ensuring that these networks are compatible with the NSRS."

1. TOP DOWN: OPUS POSITIONS ON RTN REFERENCE STATIONS AT APPROPRIATE INTERVALS COULD PRODUCE GRAPHICS THAT WOULD SHOW BIASES AT A GLANCE.



2. USER UP: PHYSICAL MONUMENTATION, ESTABLISHED WITH BEST TECHNOLOGY, COULD BE USED AS FIDUCIAL STATIONS TO HELP THE USER VERIFY THAT RTN ARE PRODUCING ACCURATE COORDINATES,

ALIGNING RTN TO THE NSRS:

#1 Include a subnetwork of the RTN into the NGS **CORS** network. This would be three stations If RTN has less than 30 stations, 10% of RTN with greater than 30 stations.

#2 Align all RTN reference stations coordinates to the CORS network at 2-cm horizontal and 4-cm vertical

#3 For each reference station in the RTN, use the some version of the Online Positioning User Service (OPUS) at http://www.ngs.noaa.gov/OPUS/ to test for the CONTINUED CONSISTENCY of its adopted positional coordinates and velocity on a daily basis, and revise the station's adopted coordinates and/or velocity if the tests reveal a need to do so. OPUS-PROJECTS looks promising

#4 NGS encourages each RTN to provide access to users of all major GNSS manufacturers' equipment

#5 NGS promotes the use of **RTCM** format data via **NTRIP** communication protocol application.

FIDUCIAL PASSIVE MARKS IN A RTN

- OBSERVED WITH HIGH PRECISION GNSS FOR NAD 83
- GEODETICALLY LEVELED FOR NAVD 88
- PUBLISHED IN NGS DATABASE
- ENSURES THAT USER CAN USE ALL BRANDS OF GNSS GEAR TO COMPARE RTN AND NSRS POSITIONS.
- COULD BE USED FOR FEMA COMMUNITY BM DATA
- STUDY AREAS: LSRC (C4G), FL, OR, CT, TX

POSSIBLE METHODS OF RTN VALIDATION

- **OPUS-PROJECTS** – Ngs approved program to validate a rtn adjustment that was perhaps accomplished with gnss manufacturer's software or another program.
- **OPUS-S** – 3 or 10% of rtn are ngs cors which then generate opus-s solutions on all other rtn reference stations. These can be pushed to ngs and published as 60 day plots, or maintained on a public site at the rtn administration locale.
- **FIDUCIAL STATIONS -** High stability marks are constructed within a rtn. Gnss static provides x,y,z. Geodetic leveling provides navd 88. Stations may be blue booked. Users can then test their rovers at the marks to compare their results from the RTN with the published values. Pilot programs planned in Oregon, Florida, Connecticut and Louisiana.
- **LETTER OF CERTIFICATION** - RTN administrator sends a statement certifying that as of a particular date the rtn is aligned to the national datum at a certain level (2 cm lat/long, 4 cm h ?)
- **NGS REVIEW** - NGS does a periodical review of the RTN stations and adjustments

TEST
Internal Development Area

Real-Time Networks

National Geodetic Survey

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

for RTN users:

Guidelines:
RTK Single Base

new!
TESTING YOUR RTN

for RTN administrators:

(DRAFT)
Guidelines: RTN Admin

new!
INTEGRITY MONITORING

links

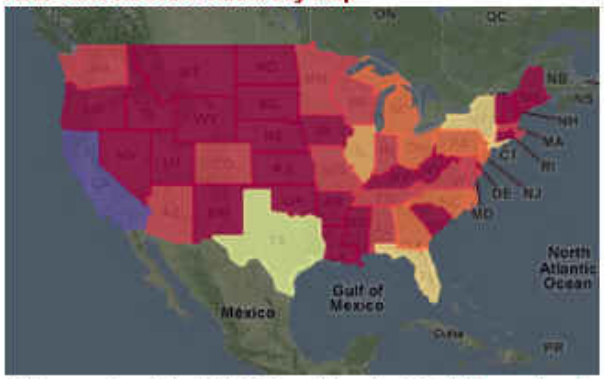
How accurate is your Real-Time Network (RTN)?

These local GNSS augmentations are great for surveying & machine guidance; fast, accurate, cheap, & internally precise, but do your results align with older maps, & with results from neighboring networks?

Promoting a consistent mapping framework

The National Spatial Reference System (NSRS) is the mapping framework for all U.S. mapping activities, & the core mission of the National Geodetic Survey. While we do not provide any direct-to-user real-time positioning service, (due to mission & budget constraints) we do what we can to help your networks align with each other. ~~(The above are paraphrased from Bill's why? how?)~~

Real-Time Network Accuracy Map



Click on a network for details. Something missing? Add my network.

Real-Time CORS Map

Click on map or list for details. Add these CORS into my network.

Website Owner: National Geodetic Survey / Last modified by ngs.realtime.gmu Apr 27 2011

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USING OPUS-PROJECTS SHOW FOR EACH RTN:

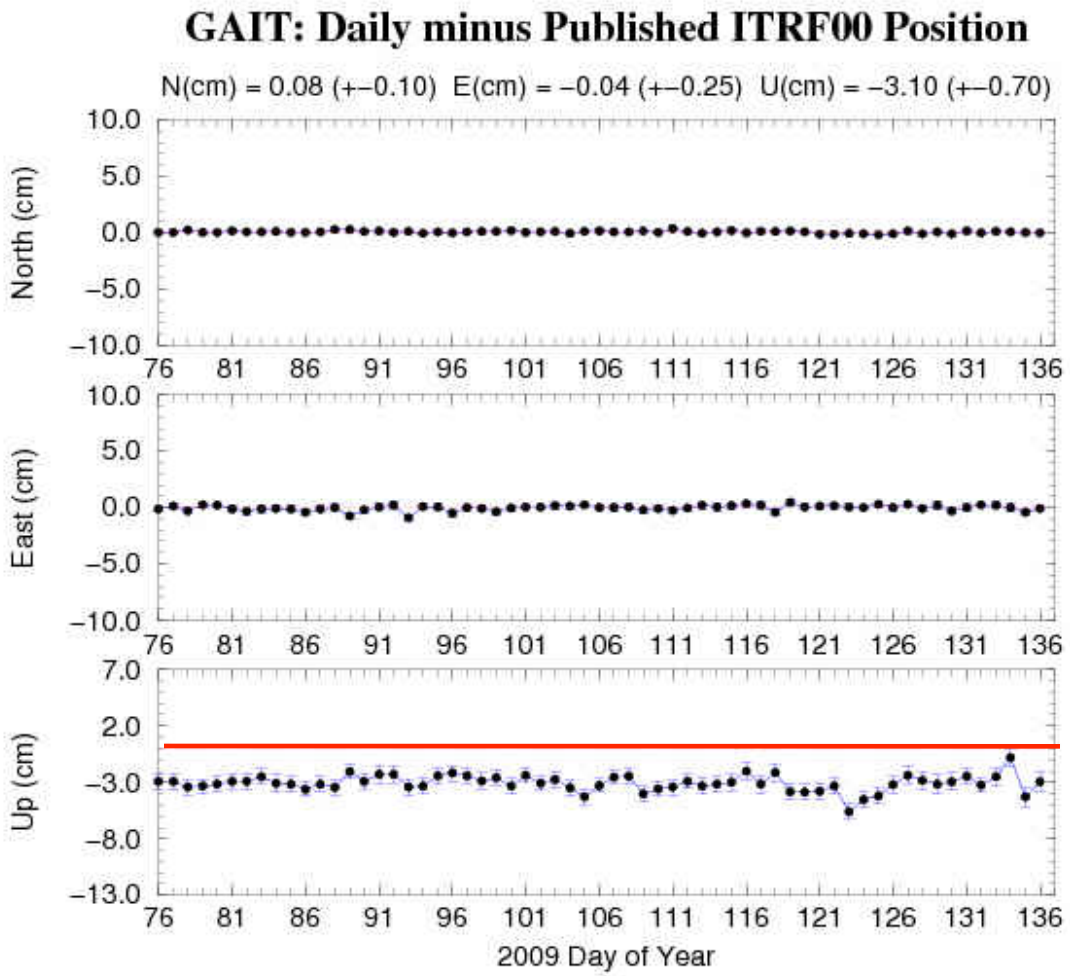
-MAX. RESIDUALS TO NSRS

-AVG. RESIDUALS

-LINK TO STATIONS 60 DAY PLOTS?


1ULM
1NSU
SIHS
LESV
LSWE
VIHS
LUCH
LMCN
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2011 Europa Technologies
US Dept of State Geographer
© 2011 Google
©2010 Google
33°31'37.56" N 95°42'41.89" W elev 0 m
Eye alt 5396.39 km

"OPUS-LIKE" GENERATED GRAPHIC OF RTN STATIONS- SIMILAR TO CORS 60-DAY PLOT



FINAL THOUGHTS

Movement from passive monumentation towards Active monumentation and from traditional positioning and traversing towards RT positioning via GNSS RTN is a movement from 3-D positioning towards 4-D Positioning in most of the conterminous USA.

The NGS data sheets with the new geometrical and geopotential datums (2022) will have 3-D velocities assigned as well as network and local accuracies.

This necessitates the recordation of metadata: source of coordinates, datum, datum epoch, alignment to the NSRS, grid/ground, date of field survey, antennas, GNSS gear, etc.

SOME PERTINENT URL'S

These ppts = ftp://ftp.ngs.noaa.gov/dist/whenning/c4g2011/

NA2011 passive mark adjustment = http://www.ngs.noaa.gov/web/news/NA2011_Project.shtml

NAD 83 (2011) = http://beta.ngs.noaa.gov/myear/

Space weather = http://www.swpc.noaa.gov/

NGS Single Base RT GNSS Guidelines = http://www.ngs.noaa.gov/PUBS_LIB/pub_GPS.shtml

NGS RTN Draft Guidelines = http://www.ngs.noaa.gov/PUBS_LIB/NGS.RTN.Public.v2.0.pdf

NGS CORS Guidelines = http://www.ngs.noaa.gov/PUBS_LIB/CORS_guidelines.pdf

GRAV-D = http://www.ngs.noaa.gov/GRAV-D/pubs/GRAV-D_v2007_12_19.pdf

CRADLE TO GRAVE GNSS!

GPS Helps Track Babies in Nurseries
Hospitals all over the world are starting to use GPS to track newborns in their nurseries as a security measure.

Instead of looking for a traditional tombstone to mark the final resting place of a loved one, friends and relatives will be able to find the location of the deceased using a GPS device or mobile phone.
"The park will look very natural, just grass and trees. There will be no headstones and instead people will be buried in the park and a GPS locator placed in the coffin," Michael McMahon chief executive of the Catholic Cemeteries Board told ABC News.