



**Presented at the FIG Working Week 2023,  
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## NGS Field Operations Modernizing in Many Ways

FIG Working Week 2023  
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# Standard Work

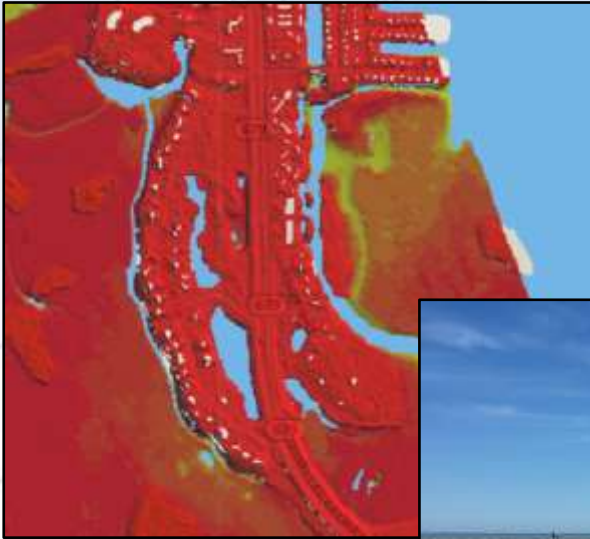
Responsible for the collection and processing of surveying data for various NOAA missions.

- Coastal Mapping Program ground support
- GNSS observations for to support VDATUM
- FAA/NGS Aeronautical Survey Program (ASP)
- Campaign Surveys (GSVS, IGLD, ChesBay, GeMS)
- Grav-D and NOAA Vessel Support
- IERS & Foundation CORS local tie surveys
- Support of technical manuals and survey protocols



# Existing Products

- NGS utilizes real-time GNSS for QA/QC on collection of remotely sensed data





# Transformation Tools

- Thousands of marks at tidal stations have been recovered and shared

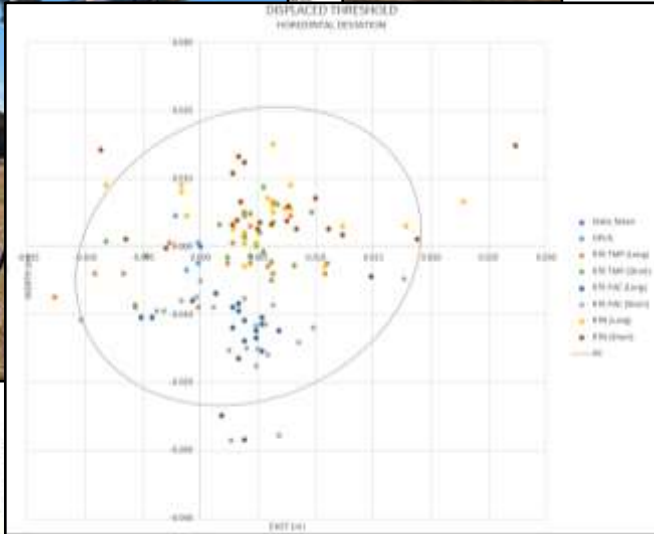


U.S. Department of Transportation  
Federal Aviation Administration

## Advisory Circular

Subject: General Order for Aeronautical Survey Geodetic Control and National Geodetic System (NGS)

1. Purpose. This advisory order on or new Geodetic System (NGS)



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# ASP

Updating specs/processes with FAA

- OPUS Projects implementation
- Use of modern technology
- Reporting on database thresholds
- Advising on development of real-time protocols

**Naming Convention**

NGS, in cooperation with the Canadian Geodetic Survey, has finalized certain key decisions in the replacement of the three NAD 83 reference frames, and in the replacement of the various vertical datums of the NSRS.

**Four Terrestrial Reference Frames**

Replacing the three existing NAD 83 reference frames will be four plate-fixed terrestrial reference frames. The tectonic plate for each frame may be inferred from their names, which are:

- North American Terrestrial Reference Frame of 2022 (NATRF2022)
- Pacific Terrestrial Reference Frame of 2022 (PATRF2022)
- Mariana Terrestrial Reference Frame of 2022 (MATRF2022)
- Caribbean Terrestrial Reference Frame of 2022 (CATRF2022)

**Relationship to the International GNSS Service (IGS) frame**

Each of the four frames will be identical to the latest IGS reference frame (as available in 2022) at an epoch to be determined. Away from that epoch, the four frames will relate to the IGS frame through the definition of an Euler Pole rotation specific to that plate. All CORS velocities which deviate from the rotation of a rigid plate will be captured in a residual 3-D velocity model.

**Heights and Other Physical Coordinates**

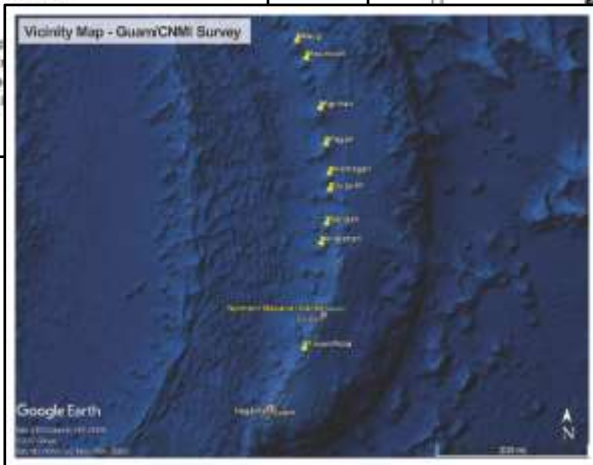
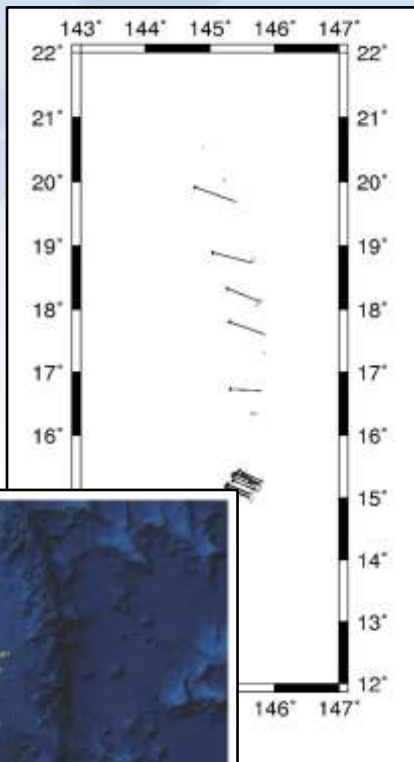
A geopotential datum will be created which will contain all of the necessary information to provide mutually consistent orthometric heights, geoid undulations, gravity anomalies, deflections of the vertical and all other geodetic coordinates related to the gravity field. This geopotential datum will be called:

- North American-Pacific Geopotential Datum of 2022 (NAPGD2022)

**Geoid Model**

Within NAPGD2022, a variety of products will exist. The most dependent model of the geoid, provided in three regions (the United States, Alaska, Greenland and the Caribbean, the second covering Hawaii and the Commonwealth of the Mariana Islands, and the third covering Guam and the Commonwealth of the Mariana Islands).

- GEOID2022



# Campaigns

- GNSS comparisons helped determine a new plate rotation model for MATRF2022



# Campaigns

- GNSS static survey on mainland and individual islands accessed via two weeks of remote marine charter

# Campaigns

- Other Modernization projects include the Geoid Slope Validation Survey (GSVS) and Geoid Monitoring (GeMS)
- Projects with specific products include IGLD2022 and Chesapeake Bay VLM
- Continual improvement of technology used, logistics, data collection, QA/QC
- Upcoming survey in America Samoa for Foundation CORS recon and GNSS collection







# Tech Work

- Sensor surveys
- Leveling
- Real-time
- Leveraging GIS
- Apps for Ops
  
- These activities support Modernization products, hydrographic mapping, and scientific partners.
  
- In addition they hone skills, equipment use, and protocols for high-precision work

# Emerging

- RTK/N for control
  - Deflection of Vertical
  - Astrogeodetic azimuths
  - CORS/FCORS
  - Tie surveys
- 
- New data exchange formats will be key to layered data
  - These projects inform Modernization standards, field test new tools in place, help establish new protocols



# Tie Surveys & Co-location

- History of NGS local tie surveys:
  - Supporting mobile VLBI and SLR programs, evolving into
  - Supporting IERS by completing annual surveys at co-location sites
- ITRF realizations are the combination of the four space geodetic techniques
  - VLBI, SLR, DORIS, GNSS
  - Co-locating these techniques allows for their combination
  - Individual techniques are asking for millimeter precision



**No matter how accurate the individual techniques are, a ground survey ties them together.**

# IERS/ITRF Work

- Using passive marks as our fabric, we measure ties with terrestrial observations and align with GNSS.....for now
- Data goes through rigorous analysis and processing and is submitted to IERS via a SINEX file for incorporation in ITRF development



# IERS/ITRF Work

- **Recent Activities**
  - Maui, HI (GNSS/SLR)
  - Westford, MA (GNSS/VLBI)
  - Stafford, VA (GNSS/SLR)
  - Table Mountain, CO (GNSS/Gravity)
  - Mauna Kea, HI (VLBI/GNSS)
  - Greenbelt/Goddard (All)
  - Kokee (VLBI/GNSS)
- There was an increase in tie surveys vectors from GNSS to DORIS, SLR, VLBI between 2014 to 2020 (Altamimi 2022)
  - Total vectors from 212 to 253
  - Vectors with discrepancy <5mm from 64 to 96



# Need for Co-location

- Enhanced partnerships due to Foundation CORS development has increased need and number of partners
- Growing interest in water levels and coastal resilience has increased the desire and need for tie surveys and layered data
- Researchers and scientists are striving for (and reporting in) mm's, so the continued need for robust field surveying protocols is only growing



# Co-location research

- On-going development in field protocols and research topics are development based on field discoveries, operator requests, and site-specific challenges
- Current topics are VLBI antenna deformation, automated site monitoring, and the inclusion of additional sensors (InSAR, water levels, etc.)
- The value of these surveys to the overall community is immense and co-locating of sensors continues to be a growing area of expertise



# NGS Field Support

- Surveying
  - Conduct or provide input on campaign surveys utilizing long-duration static GNSS
  - Measure local ties at co-location sites (observatories, water level stations, VLM)
- Training
  - Videos or job aids available from various projects that describe tripod calibration, receiver configuration, and best practices
  - Established training courses available
  - Lessons learned in the field
- Geodetic Expertise
  - We will answer questions, provide feedback on survey plans, or potentially operationalize for those that have challenges requiring field work
- Equipment
  - Consistently working with CORSs, GNSS, robotic total stations, leveling procedures, etc. to determine best course forward for geodetic-quality work



# Thank You



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