UNAVCO’s Network of the Americas (NOTA)

Background, Current Status, and Science Applications

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Presentation Outline

1. UNAVCO history, the GAGE Instrumentation Program

2. PBO, TLALCONet, COCONet -> Network of the Americas (NOTA)

3. Components of a typical NOTA station

4. UNAVCO data products and science applications
UNAVCO Background

- UNAVCO: a non-profit university-governed consortium, started in 1984
- Mission: Facilitate geoscience research and education using geodesy
- Comprised of 128 U.S. Academic Members
- 134 Associate Members in the U.S. and abroad in over 120 countries
- Membership has increased over 9% since 2016
GAGE Facility - Services

INFRASTRUCTURE

DATA CENTER

EDUCATION AND COMMUNITY ENGAGEMENT
GAGE Geodetic Infrastructure Program

Continuously Observing Networks
Network Of The Americas (GNSS and borehole operations)
  POLENET: GNET (Danish Contract) & ANET
  NASA Global GNSS Network (GGN)

Principal Investigator Support
NSF EAR & OPP funded PI and community projects
  RAPID Instrument Response
  Campaign and long-term GNSS deployments

Geodetic Instrumentation Testing & Support
EarthScope Background

Purpose: To study the structure and evolution of the North American continent and the processes that cause earthquakes and volcanic eruptions.

- Funded by NSF
- Project timeline 2003-2018
- Three components: geodetic, seismic, and drilling
- Total budget: $500 M over the life of the project
- Deploy thousands of GPS, seismic, and other geophysical instruments

SAFOD – Drilling Component
PBO – GPS Component
US Array – Seismic Component
EarthScope Plate Boundary Observatory (PBO)

$200 M invested by NSF over 15 years:
- Construction phase (2003-2008) – $100 M
- O+M phase 1 (2008-2013) - $54 M
- O+M phase 2 (2013-2018) - $46 M

Tectonically strategic deployment of:
- 1131 cGPS
- 78 borehole strainmeters
- 5 long baseline strainmeters
- 26 tiltmeters
- 145 meteorological instruments
TLALOCNet (Tnet) and COCONet

• Combined cGPS-Met networks in Mexico and the Caribbean Basin for the study of climate, atmospheric processes, the earthquake cycle, and tectonic processes
• COCONet 2010-2018 ~$6M
• 42 participating partners
• Build 50 new stations, upgrade 50 existing stations
• TLALOCNet 2015-2018 ~$2M
• Build 6 new stations, upgrade 18 existing stations
Network of the Americas

Federation of NSF-funded cGNSS networks across the Americas

- PBO + TLALOCNet+COCONet = NOTA
- Federated in 2018
- Funding $71.4 M until 2023
- Currently 1148 cGNSS stations distributed across 31 countries
- 789 stations are fully GNSS capable and 985 are RT capable
- 87% uptime
NOTA GNSS Station, Monuments

- Deep Drilled Braced Monument (DDBM)
- Short Drilled Braced Monument (SDBM)
- Rooftop Monument
- GNSS Antenna cross section
NOTA GNSS Station, Power

- Enclosure
- Meteorological Device
- Batteries
- GNSS Receiver
- DC Backpanel
- Cellular Modem
NOTA GNSS Station, communications

- Very Small Aperture Terminal (VSAT)
- Wireless Radio
- Broadband Global Area Network (BGAN)
- Cellular
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Position Time Series: Earthquakes

MIDA (MIDA_SCGN_CN1993) NAM08
Processed Daily Position Time Series

Sep 2004 M 6.0 Parkfield EQ
Position Time Series: Hydrogeodesy

- P056 Porterville: 850 mm in 14 years
- P565 Delano: 350 mm in 14 years
NOTA Velocity Field – Regional Tectonics

Tectonic Motion of the Western U.S.

Based on combination of JPL and IGS Orbit and Clock Products

Tectonic Motion of Alaska

Tectonic Motion of the Caribbean

Taken from UNAVCO online velocity viewer
NOTA Real Time Streams

985 STATIONS, 1-SPS STREAMS:

- **BINEX**: Primarily used by Academia, USGS
- **RTCM**: Used by commercial entities
- **PPP**: Precise Point Positioning (NMEA string)

STREAMS ACCESSED BY ALL SECTORS OF SOCIETY:

- **Government agencies**: USGS, NOAA, state level transportation departments
- **Commercial entities**: Surveyors, Construction
- **Academia**: Universities, Schools, Research Groups
- ~4,000 active connections at any given time
Shake Alert: An Earthquake Early Warning System for the West Coast of the United States

https://www.shakealert.org (9/12/22)
GNSS For Earthquake Early Warning

M 7.1, 17 Km NNE of Ridgecrest, CA, 2019-07-06

Horizontal Displacements from UNAVCO's RT Position Solutions

Predicted Magnitude vs GNSS Derived Magnitude

Displacements (mm)

Seconds After Origin Time

Hypocentral Distance (km)

PGD (cm)
Many Other Science Applications

Snow Depth
GPS provides remote snow depth measurements in hard-to-reach areas.

Ice Height
Changing ice heights indicate how much freshwater is stored by or being lost from glaciers.

Sea Level
As a tide gauge, GPS can measure local, regional, and global changes in sea level.

Vegetation
GPS can measure the onset of plant growth, plant aging, maximum vegetation growth, and the length of the growing season.

Soil Moisture
Soil moisture measured over broad regions indicates how much precipitation evaporated back into the atmosphere.

Ionosphere
The GPS satellite signal is delayed by charged particles caused by solar storms. This layer can also be displaced by tsunamis, yielding information for tsunami early warning.

Troposphere
The GPS satellite signal is delayed by water vapor that can turn into rain. This informs forecasting of flash floods and hurricanes.

Mission Cal/Val
Measuring the delay in the GPS satellite signal as it passes through the atmosphere is important for calibrating and validating satellite datasets.
National Science Foundation's Geodetic Facility
for the Advancement of Geoscience
Operated by UNAVCO