Modernizing Water Level Vertical Control through cGNSS

GNSS for Vertical Control at NOAA’s National Water Level Observation Network (NWLOM) Station

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National Water Level Observation Network (NWLOON)

A network of 210 continuously operating water level stations throughout the United States.

NWLOON data supports:

- Tide predictions, real-time data, and nowcast/forecast models that aid safe navigation and response to storms and oil spills
- The nation’s water level reference framework (tidal datums)
- Production of nautical charts, shoreline and marine boundary determination
- Understanding global/local sea level trends, nuisance flooding, and extreme water levels
- Enhanced tsunami and storm surge warning systems
- Restoration and coastal management projects
Vertical Control Of Sensor & Datum

Over a 19-year NTDE:

- Vertical movement of the water level sensor relative to the local Station Datum must be <1.2 cm.
- Vertical position of the Station Datum relative to geodetic control must be <0.9 cm.
Bench Mark Network
Primary Means of Vertical Control

Galveston, TX

Berwick, Atchafalaya River, LA
Vertical Control

Today

- Establish station datum
- Tidal bench mark network installation
- Periodic leveling surveys to tidal bench mark network in accordance with Federal Geodetic Data Committee (FGDC) standards to measure sensor elevation relative to land
- Connection to National Spatial Reference System (NSRS) wherever possible
  - Differential surveying
  - Campaign GPS observation ties
    - Each station has one GPS bench mark
    - One 4 hour observation every five years (annual w/ high RSL trends)

Initial incorporation of GNSS
“All GLOSS sites must be equipped with Continuous GNSS antennas located as close to the gauge as possible, or connected to the gauge with a regularly maintained geodetic tie. CGNSS records support studies of vertical land movement and satellite altimeter calibration.”

UNESCO\IOC Manual on Sea Level Measurement and Interpretation, Vol V (2016)
CO-OPS Strategic Vision for GNSS-Based Vertical Control

Leading the world in Earth system observation
Global leader in water level observations
Team

CO-OPS GNSS Working Group
- Developed Strategic Vision
- Held NOAA cGNSS Workshop with National Geodetic Survey (NGS), Office of Coast Survey and Office of Climate
- Developed draft implementation plan
- Is expanding it NGS membership
- Guiding path forward
Priority 1: Sensor Vertical Position

Monitoring & accounting for vertical movement of water level sensors

Goal 1.1: Implement GNSS as a means of measuring sensor stability for various timescales and in a range of environments.

Goal 1.2: Realize station datum by referencing the ellipsoid using GNSS.

Goal 1.3: Reduce check leveling at stations wherever possible.
Priority 2: Reference Framework Connection

*Linking water level stations to national & global reference systems*

**Goal 2.1:** Improve GNSS-based connections between water level datums and NSRS at all stations.

**Goal 2.2:** Increase spatial and temporal VDatum coverage and reduce VDatum transformation errors.

**Goal 2.3:** Increase stakeholder access to water level datums through improved connectivity across existing and new databases.
Priority 3: Vertical Land Motion Component of Relative Sea Level Trends

**Understanding the movement of land near water level stations**

Goal 3.1: Support determination of the land and ocean components of relative sea level change at long-term NWLON stations using GNSS.

Goal 3.2: Investigate the resolution of regional and local variability in absolute sea level change.

Goal 3.3: Enhance utility of CO-OPS' suite of sea level products for stakeholders.
What’s Next?

01 Continue Installations
Continue working with Global Sea Level System (GLOSS) to co-locate cGNSS sensors at NWLON stations.

02 Collaborate with NGS
Strengthen partnership with NGS to align strategies and detail joint initiatives to move vision forward.

03 Detail Implementation Plan
With close consultation with NGS, CO-OPS seeks to complete a detailed five-year implementation plan by the end of 2018.
Vertical Control Future?

- Continuous monitoring of NWLON configuration stability
- Connections to the National Spatial Reference System (NSRS) everywhere:
  - Connections via cGNSS, where possible
  -Connections via static/campaign GNSS will be more comprehensive, systematic, & utilize longer occupations
- Targeted prioritization of geodetic leveling surveys
- Solutions for vertical control in offshore or unstable areas
- Increased participation in international collaboration on observing global sea level trends
Thank You