# Modernizing Geodetic Control at National Water Level Observation Network (NWLON) Stations

Peter Stone, Technical Director
Center for Operational Oceanographic Products and Services (CO-OPS)

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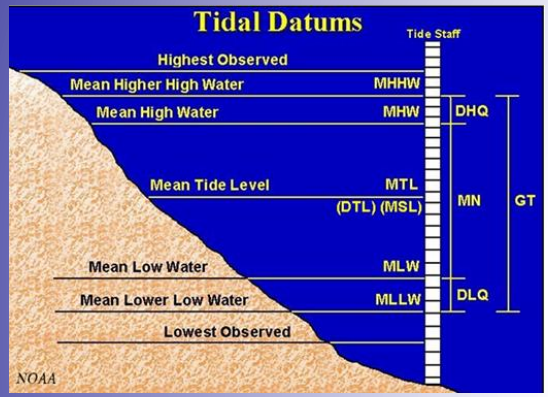
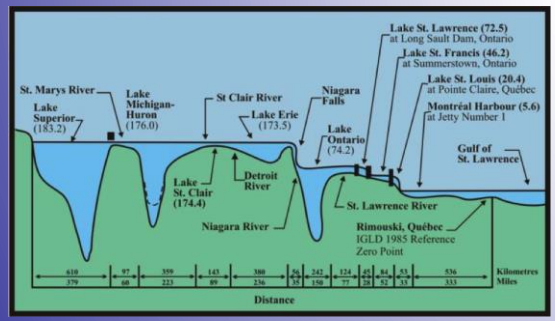
# National Water Level Observation Network (NWLON)





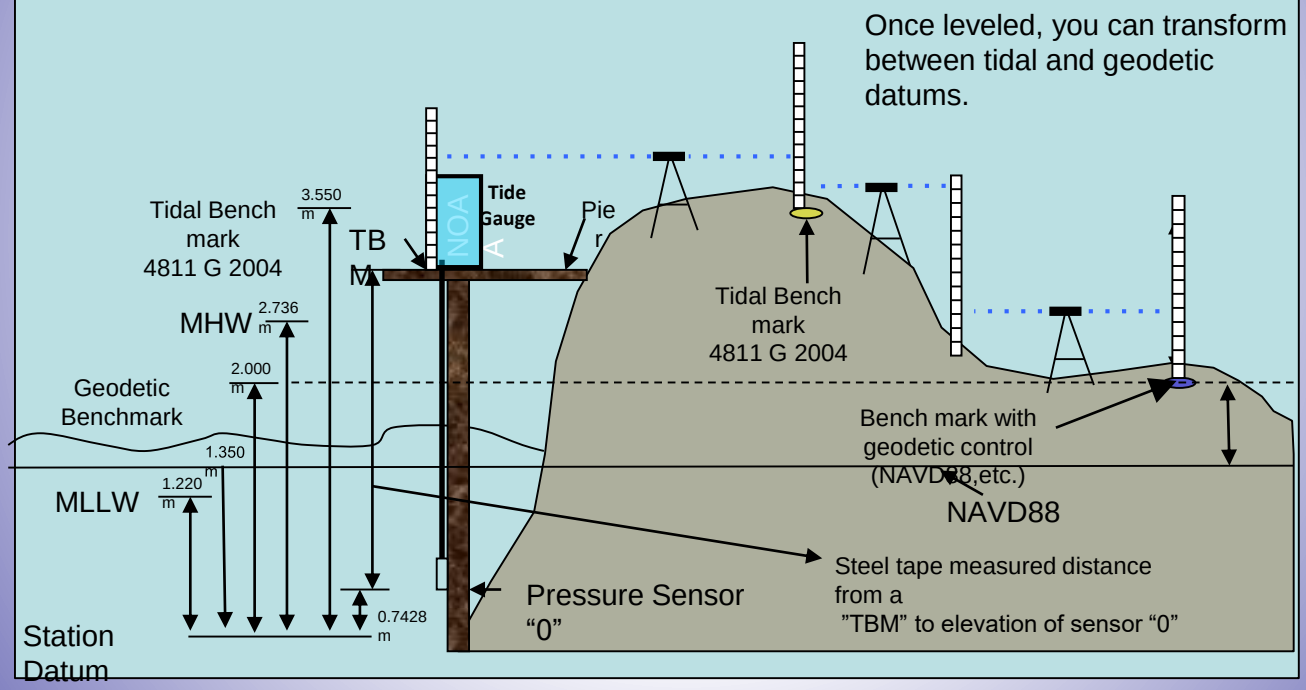



**National Tidal Datum Epoch (1983-2001)**

**International Great Lake Datum (1985)**

# Present capability

## Leveling surveys determine relationships between benchmarks and water level sensors



# CO-OPS Global Navigation Satellite System (GNSS) Vision

Leverage evolving GNSS technology to:

- Continuously monitor water level sensor stability and realize potential efficiencies in bench mark maintenance protocols
- Strengthen station datum connections to NSRS (ellipsoid)
- Improve ability to determine land motion.

Future: Use as potential water level sensor

# Static Global Positioning System (GPS) Observations at NWLON Benchmarks

- GPS replaced line of sight connections to NGS First Order bench mark networks used to achieve NSRS connections
- Each station has a designated GPS mark - observations done annually or every five years depending on sea level rate of change
- Documentation and data submitted to NGS
- Track and compare solutions over time

# Land Motion through NWLON/CORS Collocation

***Global Sea Level Observing System Group (GLOSS) requirement****

***Risk reduction requirement for other NWLON stations***

Crescent City, CA

Newport, RI

Alpena, MI

# Challenges

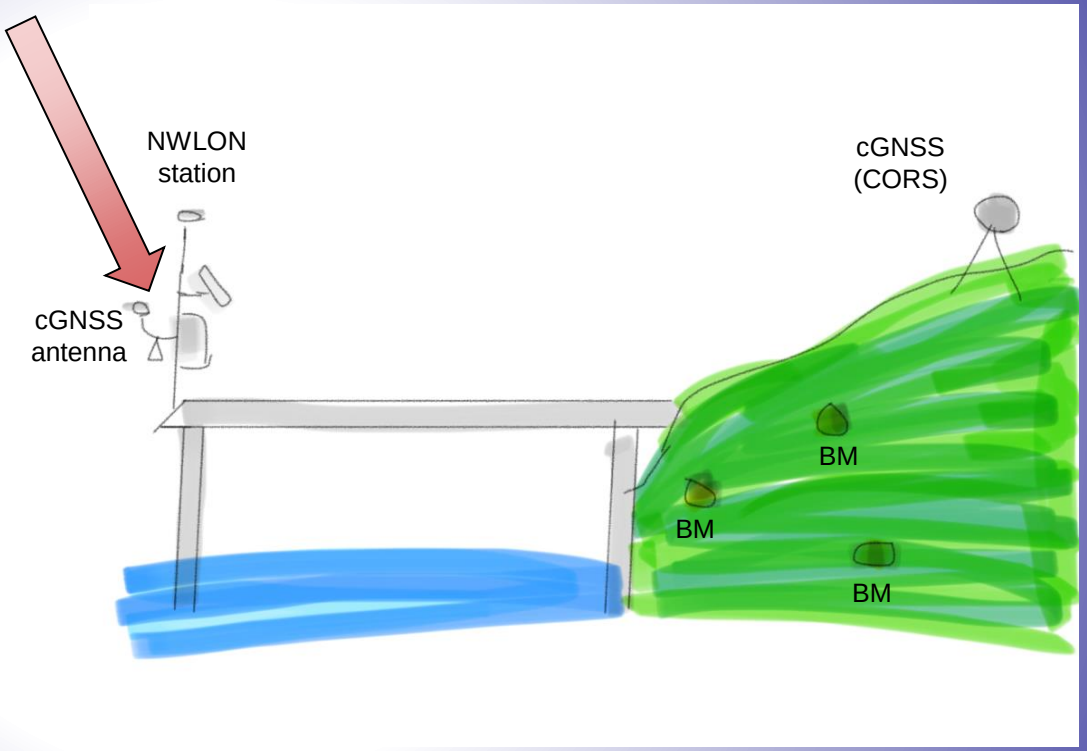
- Legacy Observation Networks
- International Requirements
- Data Management
- Identification of new geophysical processes
- Reference Framework Continuity
- Resources & Expertise

# GNSS-Based Future

- GNSS antenna on the sensor

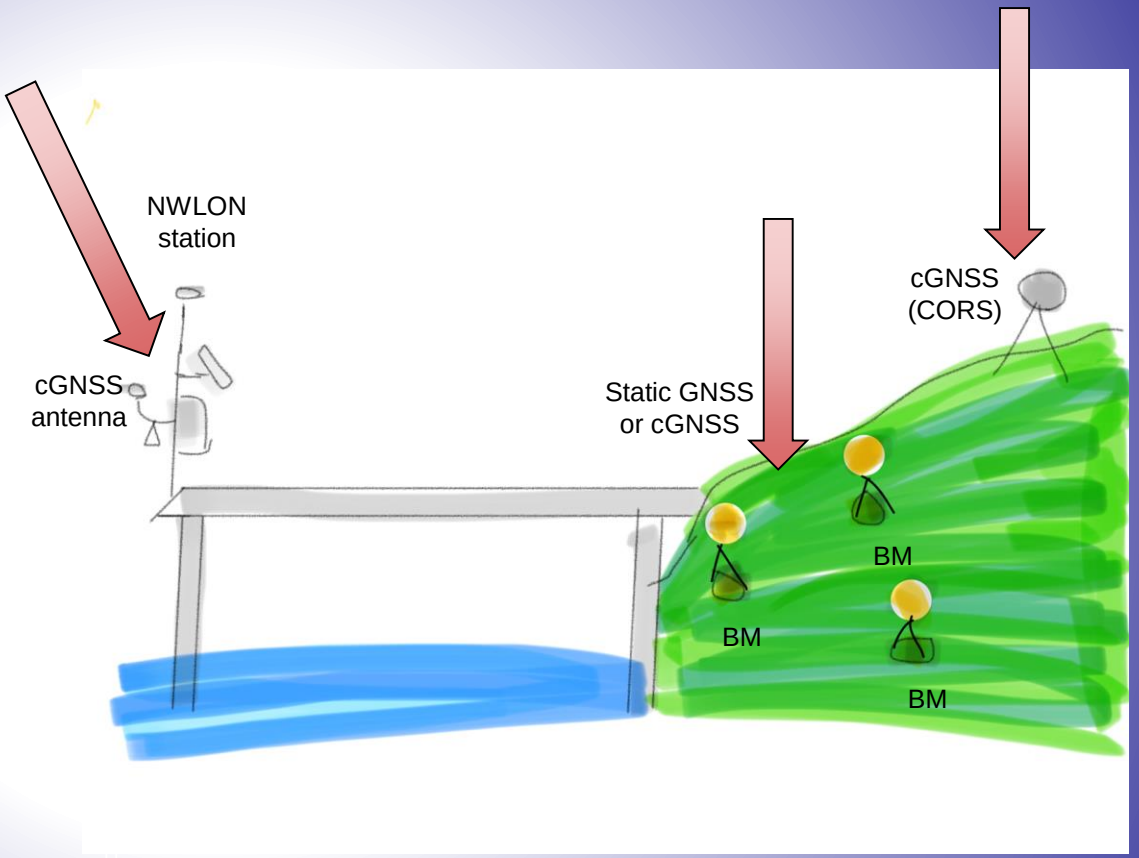
or

- GNSS near sensor on same platform w/ known offset
- Use to continuously monitor sensor stability



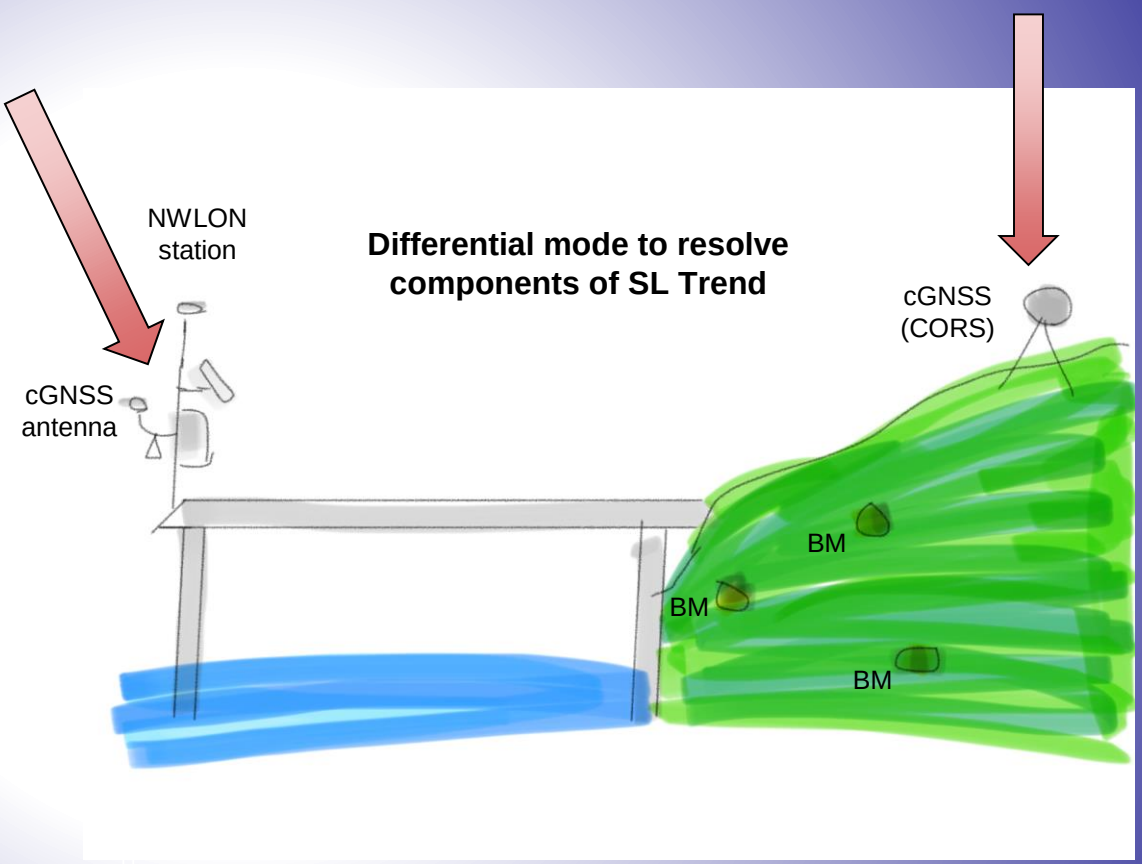
# GNSS-Based Future

- Use nearby CORS or CORS-like cGNSS, or
- Combine static observations with continuous observations
  - Gain efficiencies in leveling procedures
    - Reduce benchmarks?
    - Reduce leveling frequency?
  - Better connection to other reference frames



# GNSS-Based Future

- Multiple cGNSS signals used to understand land component of relative sea level trends
- Absolute sea level measured to the ellipsoid



# Progress to Date

PLANNING

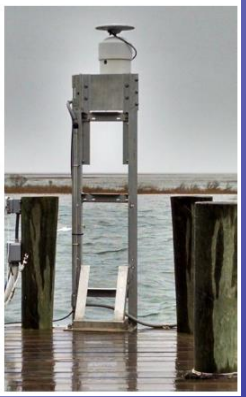
- Formed CO-OPS cGNSS working group and collaborated with NGS and other partners;
- Held GNSS Workshop
- Published GNSS strategy (NGS assistance)

TECHNOLOGY & DATA MANAGEMENT

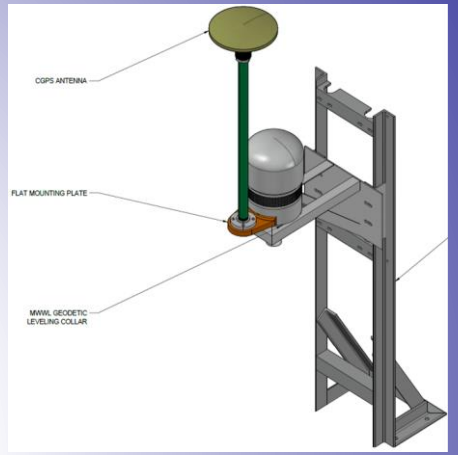
- Performed system, configuration, installation, operations & maintenance familiarization
- Conducted data logging, processing and analysis options (with NGS assistance)
- Established two long-term test platforms

FIELD OPERATIONS

- Installed four long-term GNSS systems on NWLON stations in collaboration with Old Dominion Univerisity
- Developed sensor GNSS antenna mounting design options



# Planned Efforts in FY 18




PLANNING

- Finalize CO-OPS GNSS implementation plan

TECHNOLOGY & DATA MANAGEMENT

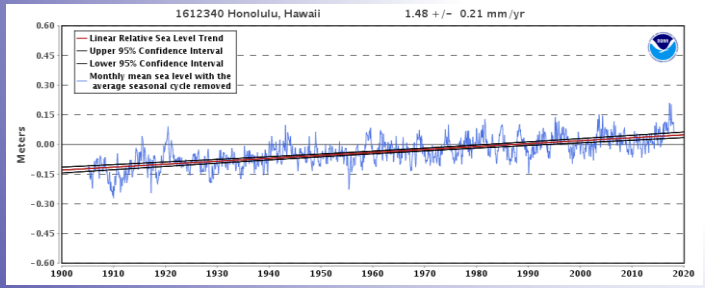
- Develop new methods for installing cGNSS systems collocated with NWLON
- Explore data processing tools, methodologies and analysis for various water level applications (with NGS assistance)

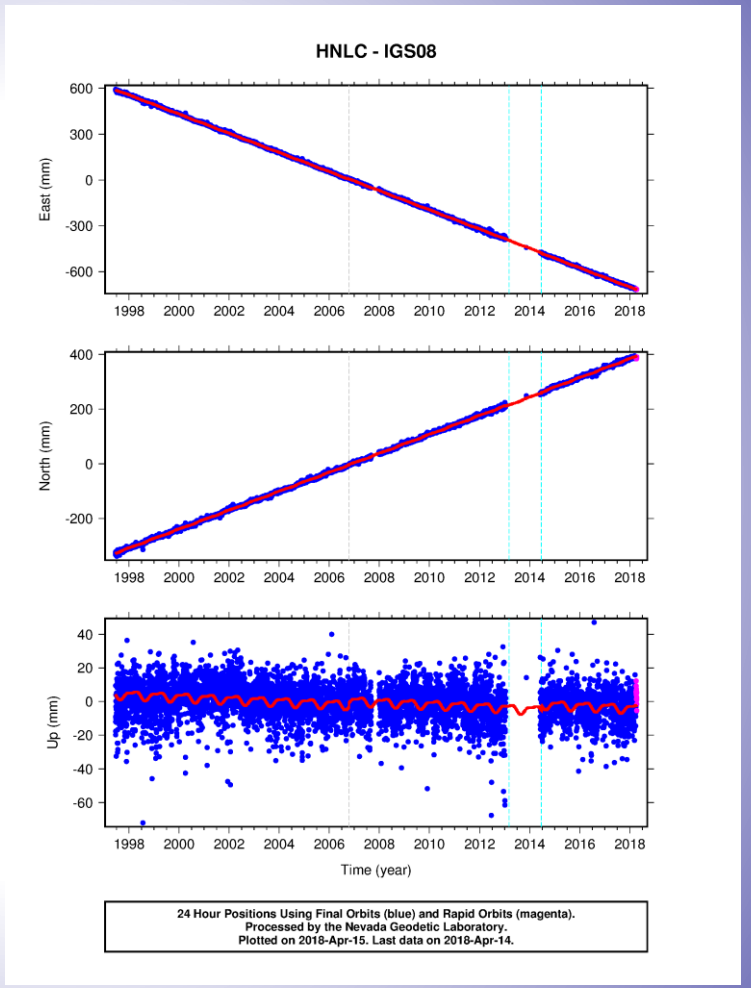
FIELD OPERATIONS

- Install “on sensor” cGNSS systems at four NWLON stations Virginia Key FL and Galveston Pier 21 TX (GLOSS), and Newport, RI, Dahlgren, VA

Galveston Pier 21, TX

# Honolulu, Hawaii
# Water Levels & GNSS



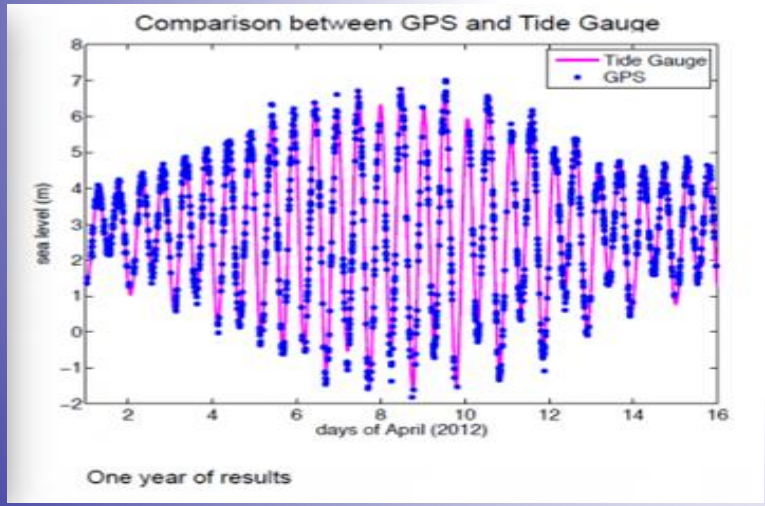



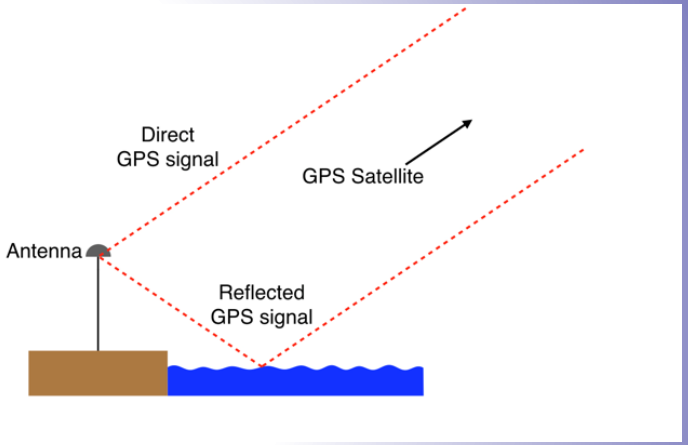
# FY19 and Beyond

- Evaluate and implement lessons learned from FY18 cGNSS sensor installations for sensor stability
- Evaluate and implement alternative surveying procedures
- Explore other techniques such as rapid, short, dynamic GNSS observations for validity or quick check
- Collaborate with NGS on databases and data processing
- Explore the options for processing using differential cGNSS mode to resolve land and water level components

# Future: Real-Time Water Level Observing Using GPS Reflectometry

- This developing method uses reflected satellite GPS signals to determine the water level.
- Research organizations and regional associations are further testing this technology.




"The Accidental Tide Gauge: A GPS Reflection Case Study From Kachemak Bay, Alaska", Kristine M. Larson, Richard D. Ray, Felipe G. Nievinski, and Jeffrey T. Freymueller, IEEE GEOSCIENCE AND REMOTE SENSING LETTERS, VOL. 10, NO. 5, SEPTEMBER 2013

# Questions