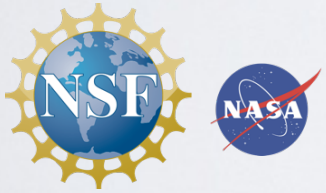
UNAVCO

UNAVCO'S ROLE IN NATURAL HAZARDS PREPAREDNESS, RESPONSE AND MITIGATION



Linda R. Rowan, UNAVCO; Adrian Borsa, Scripps;
Brendan Crowell, University of Washington;
John LaBrecque, IUGG Georisk; John Braun, UCAR;
& Rodney Viereck, NOAA Space Weather Prediction Center

GEODETIC FACILITY AND DATA CENTER FOR RESEARCH

- UNAVCO, a non-profit university-governed consortium, facilitates geoscience research and education using geodesy.

- Our consortium has 100+ academic Members and 100+ Associate Members.

SERVICES FOR RESEARCH

GPS equipment for field campaigns

Permanent GPS station installations, O&M

Meteorological instruments, tide gauges, accelerometers

Terrestrial laser scanning (TLS) equipment

Borehole station installations, O&M

Communications and power systems

Proposal planning, project logistics, and support letters

Field engineering support

Data acquisition, quality control, transfer, management, & archiving

Collection & archiving airborne LiDAR & SAR satellite imagery

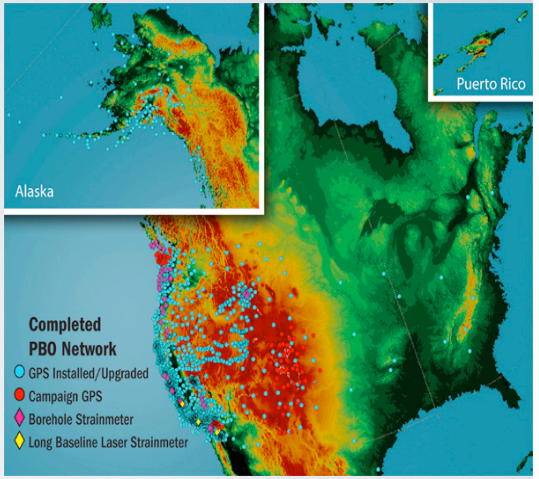
Training and advice for instrumentation and data

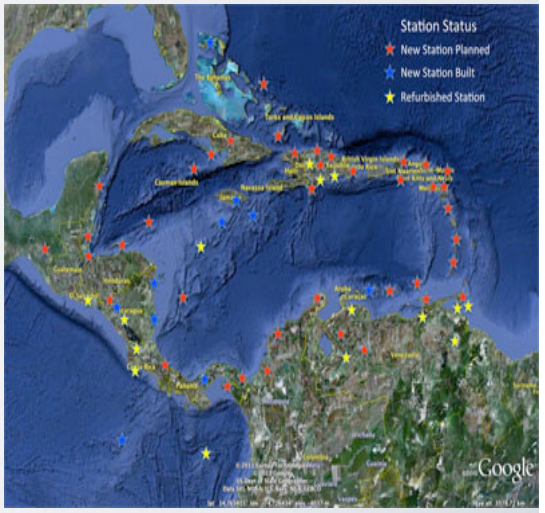
GEODETIC-BASED RESEARCH

- Geodesy is the study of Earth's shape, gravity field, and rotation
- Define terrestrial reference frame
- Quantify changes in Earth's surface and subsurface (e.g. earthquakes, volcanoes, landslides, subsidence/uplift, snow depth, & soil moisture)
- Quantify changes in ice sheets (Greenland and Antarctica) and glaciers
- Quantify changes in oceans and the atmosphere (e.g. ocean tides, sea level changes, water vapor in the atmosphere, and ion density in the ionosphere)

PERMANENT GEODETIC NETWORKS

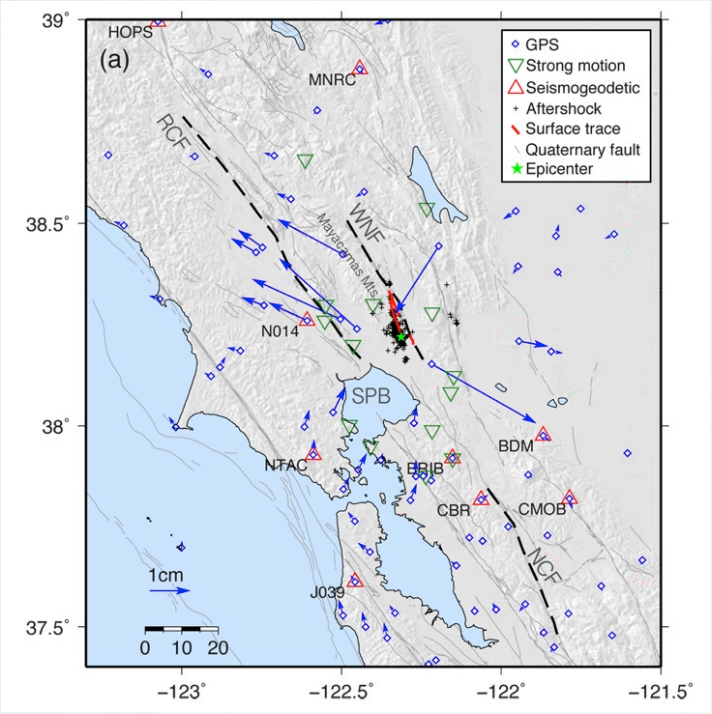
- Plate Boundary Observatory (PBO) covering the U.S.
- Continuously Operating Caribbean GPS Observational Network (COCONET) in the Caribbean and Americas
- TLALOCNET in Mexico
- Polar Earth Observing Network (POLENET) in the Arctic and Antarctica
- Part of the Global Geodetic Network (GGN) to define the International Terrestrial Reference Frame (ITRF)
- Africa Array, Nepal Array and other regional networks

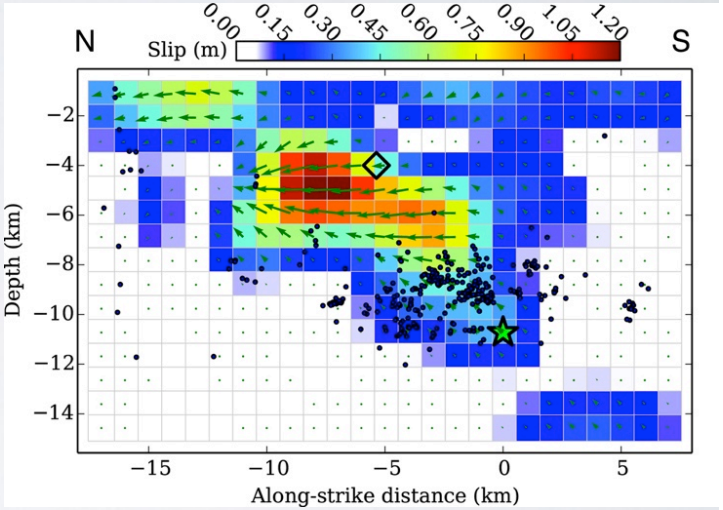




EARTHQUAKE EARLY WARNING

Combining seismic and geodetic data yields faster estimates of earthquake characteristics, enhancing earthquake and tsunami early warning; coined a new term, seismogeodesy





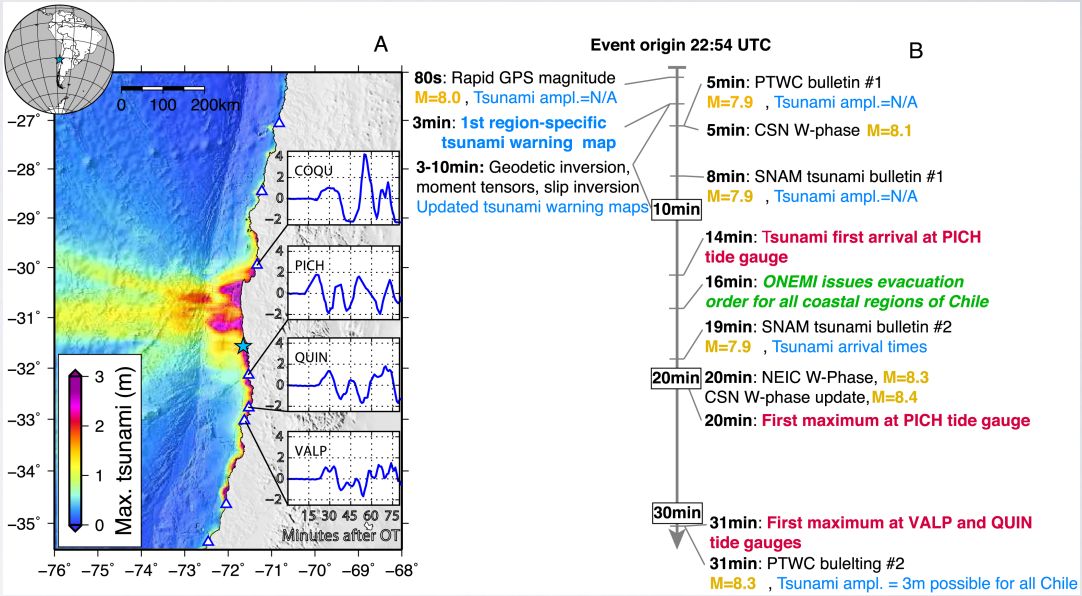
Melgar, D., J. Geng, B. W. Crowell, J. S. Haase, Y. Bock, W. C. Hammond, and R. M. Allen (2015), Seismogeodesy of the 2014 Mw6.1 Napa earthquake, California: Rapid response and modeling of fast rupture on a dipping strike-slip fault, J. Geophys. Res. Solid Earth, 120, doi:10.1002/2015JB01192.

TEW & EEW IMPLEMENTATION

Tsunami early warning from GPS analysis of tectonic event

Maximum tsunami amplitude and timeline of events for the 2015 M_w8.3 Illapel earthquake.

Melgar, D., et al. (2016), Local tsunami warnings: Perspectives from recent large events, Geophys. Res. Lett., 43, 1109–1117, doi: 10.1002/2015GL067100.

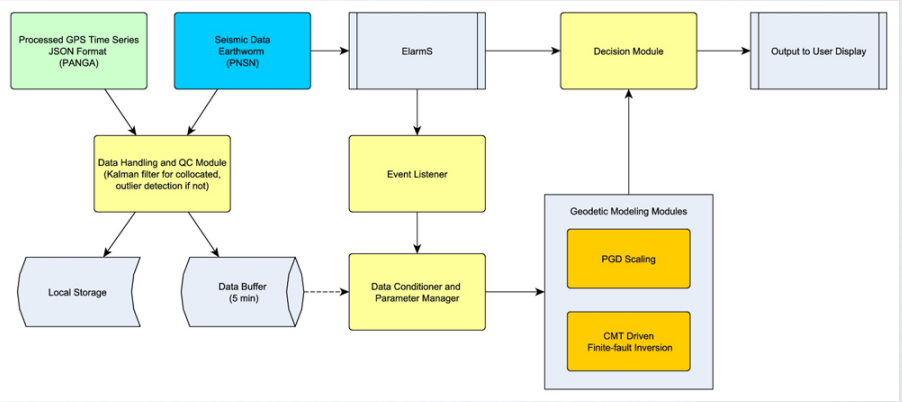


Adding geodetic data to the Pacific Northwest Seismic Network

Geodetic First Approximation of Size and Time (G-FAST)

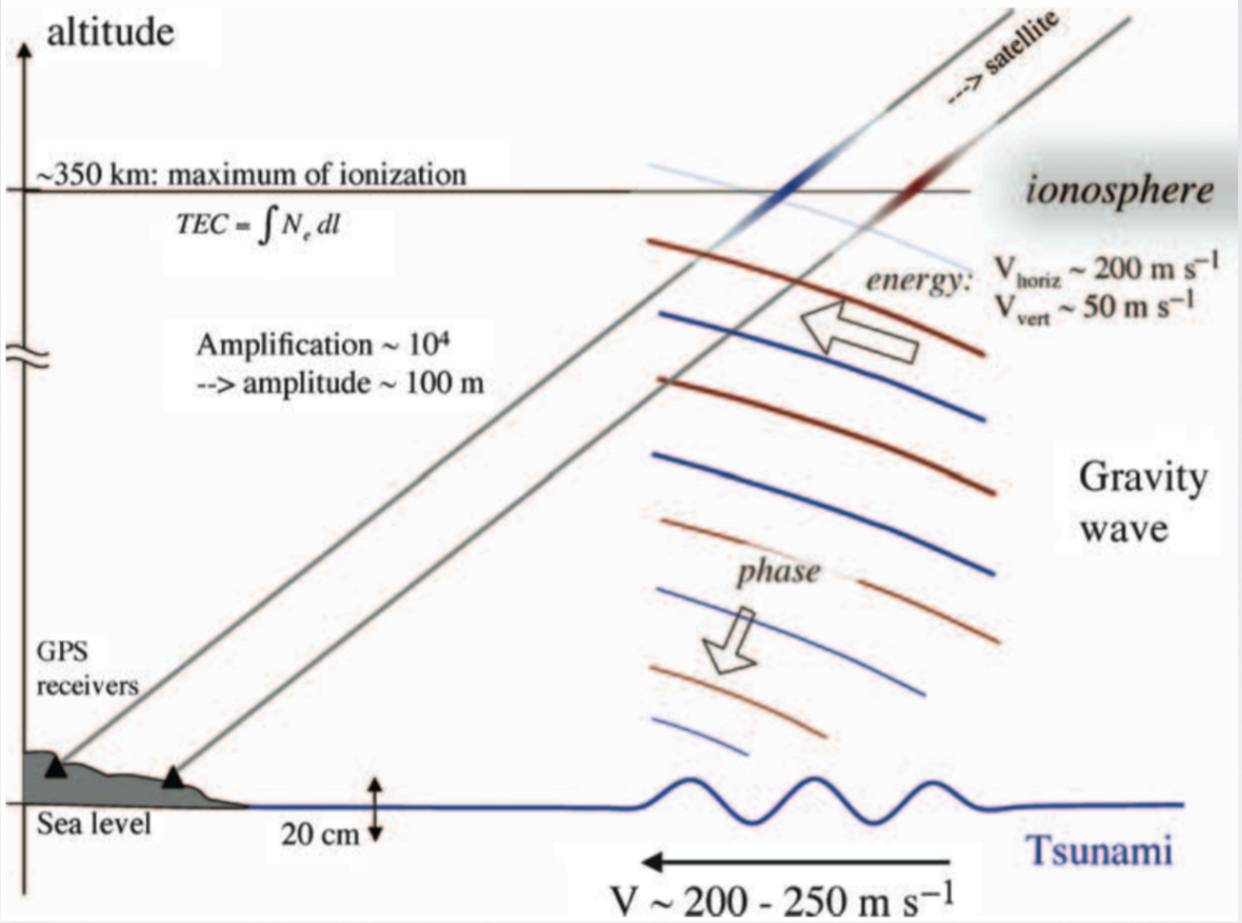
Geodetic data provides estimates of peak ground displacement (PGD) about 17 seconds after the Nisqually Earthquake

6 seconds before shaking reaches Seattle



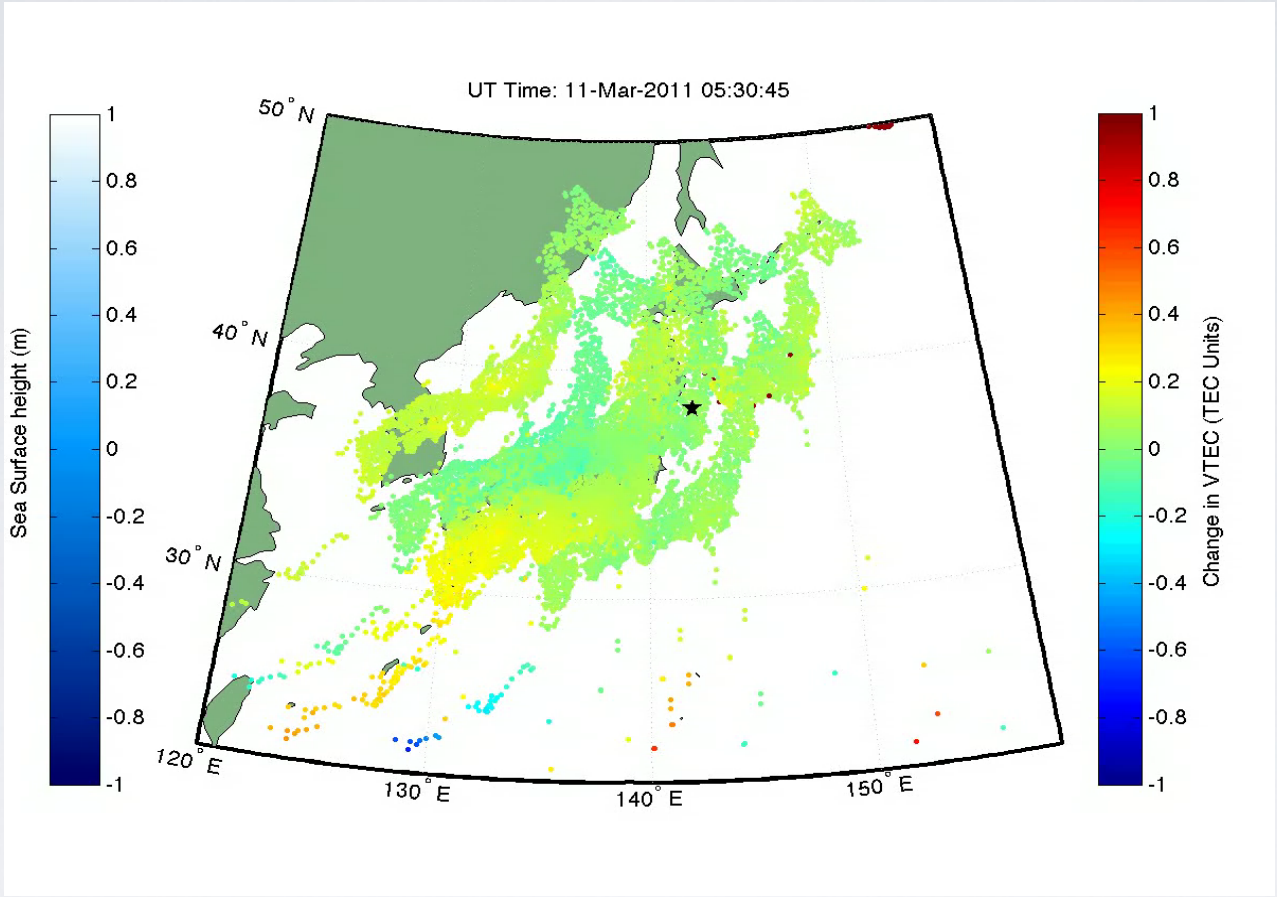
Demonstration of the Cascadia G-FAST Geodetic Earthquake Early Warning System for the Nisqually, Washington, Earthquake, Brendan W. Crowell, David A. Schmidt, Paul Bodin, John E. Vidale, Joan Gomberg, J. Renate Hartog, Victor C. Kress, Timothy I. Melbourne, Marcelo Santillan, Sarah E. Minson, Dylan G. Jamison, Seismological Research Letters, v. 87, no. 4 (2016), doi:10.1785/0220150255.

TSUNAMI TRACKING FROM IONOSPHERE



Juliette Artru, Vesna Ducic, Hiroo Kanamori, Philippe Lognonné, and Makoto Murakami, Ionospheric detection of gravity waves induced by tsunamis Geophys. J. Int. (2005) 160 (3): 840-848 doi:10.1111/j.1365-246X.2005.02552.x

Japan's GEONET Captured the Ionospheric Coupled Waves and Imaged the Tsunami Generation and Propagation



Ionospheric Response to Mw9.0 Tohoku Earthquake and Tsunami in Japan on March 11, 2011,
A.Komjathy, D.A.Galvan, M.P Hickey, P.Stephens, Mark Butala, and A.Mannucci,
(http://visibleearth.nasa.gov/view.php?id=77377)

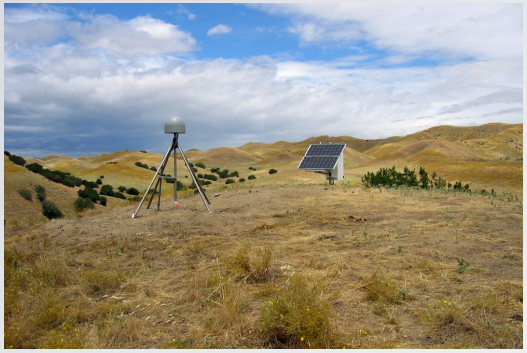
TSUNAMI TRACKING: GEODETIC DATA AUGMENTATION

Global Geodetic Observing System (GGOS) in support of the United Nations General Assembly and International Union of Geodesy and Geophysics resolutions has posted a call for participation for GNSS augmentation to tsunami early warning.

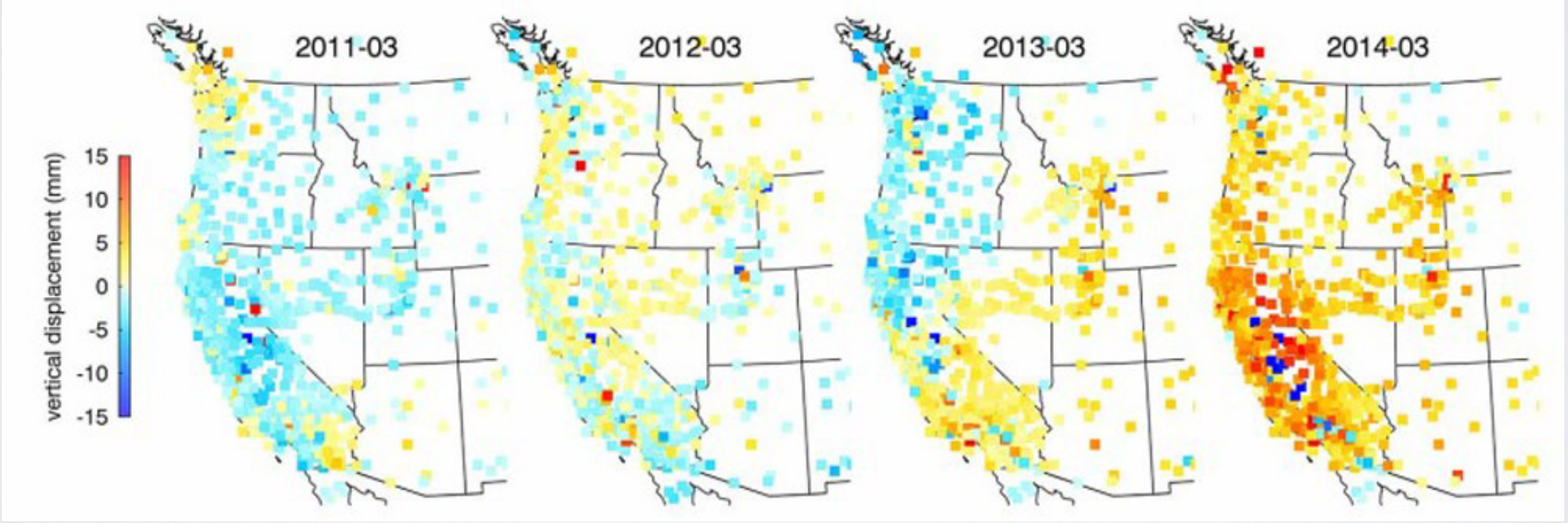
Dr. John LaBrecque, vice chair for IUGG GeoRisk Commission and lead for GGOS Geohazards Monitoring Focus Area, is coordinating this call.

International Union of Geodesy and Geophysics:
Resolution 4: July 2015
Considering:
•That large populations may be impacted by tsunamis generated by megathrust earthquakes
• Among existing global real-time observational infrastructure, the Global Navigation Satellite Systems (GNSS) can enhance the existing tsunami early warning systems;
Urges:
•Operational agencies to exploit fully the real time GNSS capability to augment and improve the accuracy and timeliness of their early warning systems,
•That the GNSS real-time infrastructure be strengthened,
•That appropriate agreements be established for the sharing of real-time GNSS data within the tsunami early warning systems,
•Continued support for analysis and production of operational warning products,
Resolves:
•To engage with IUGG member states to promote a GNSS augmentation to the existing tsunami early warning systems.
•Initially to focus upon the Pacific region because the high frequency of tsunami events constitutes a large risk to the region's large populations and economies, by developing a prototype system, together with stakeholders, including scientific, operational, and emergency responders.

HYDROLOGICAL/DROUGHT MONITOR



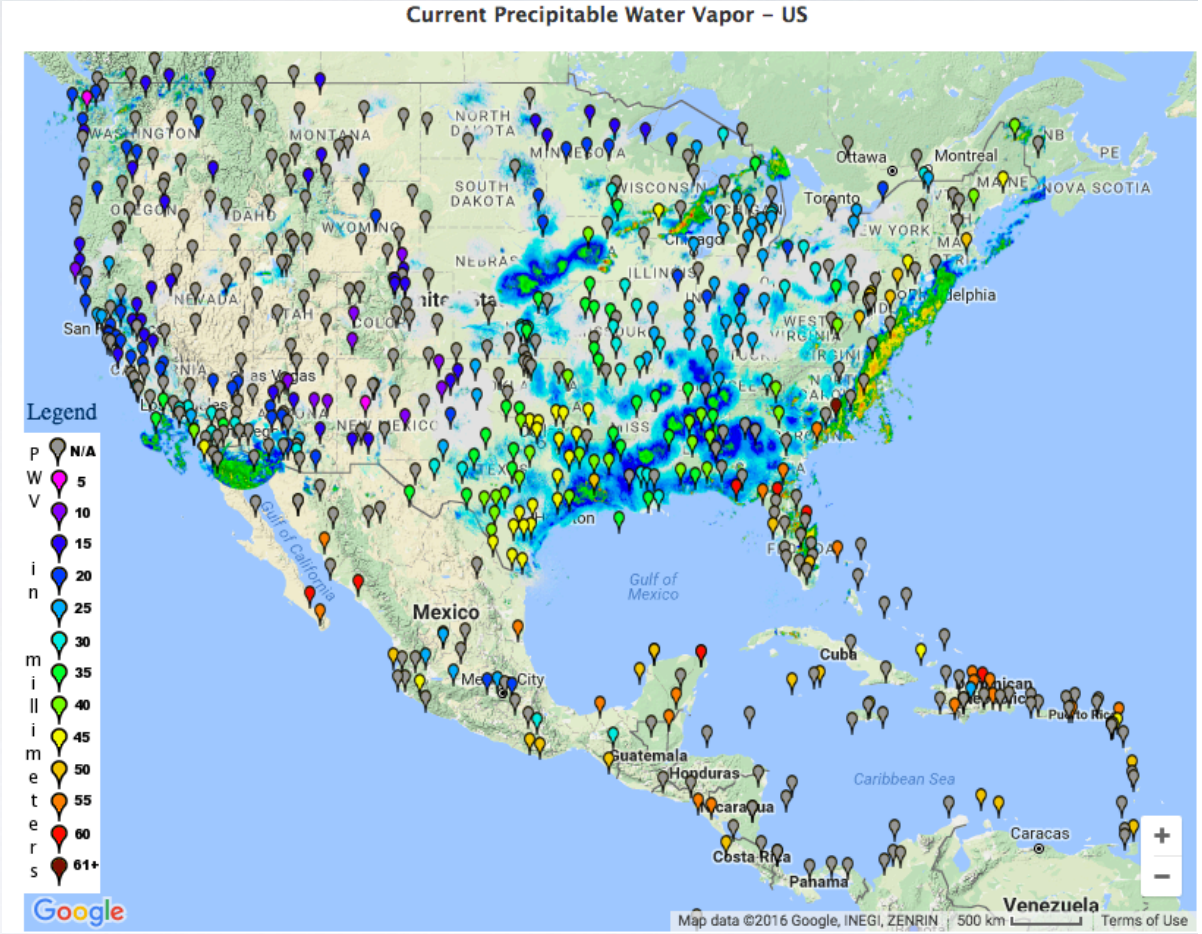
- Long term GPS observations provide improved vertical motion measurements
- Can separate tectonic from hydrologic factors
- Use years worth of data to improve precision and decipher multiple causes for position changes
- During 2 years of drought, 240 gigatons of water load lost



Adrian Antal Borsa, Duncan Carr Agnew, Daniel R. Cayan (2014), Ongoing drought-induced uplift in the western United States, Science, doi:10.1126/science.1260279

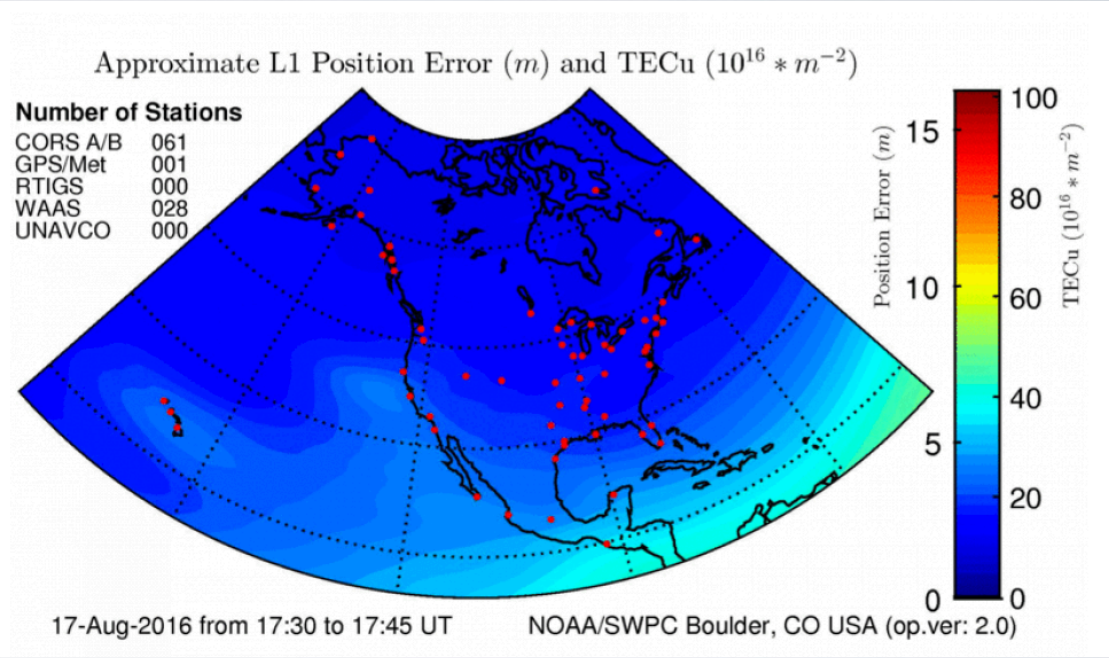
SEVERE WEATHER TRACKING

- University Corporation for Atmospheric Research (UCAR), suominet.ucar.edu
- Water vapor in troposphere is variable and can be used to track severe weather
- GPS senses water vapor
- Measure water vapor in one hour segments from GPS stations
- Can also measure water vapor in near real time when needed for weather forecasts



SPACE WEATHER PREDICTIONS

- NOAA's National Space Weather Prediction Center, swpc.noaa.gov
- Total electron content (TEC) in the ionosphere is variable and can be used to track incoming space weather
- GPS senses TEC in the ionosphere
- Measure TEC in 15 minute intervals from GPS stations



CONCLUDING REMARKS

- Geodetic data valuable for many natural hazards and open access to data is essential

- Real-time data should be integrated into the appropriate early warning systems

- Infrastructure providing data should be hardened ensuring communications and power systems are reliable 24/7

- Long-term data has foundational and high precision value; data management and archiving should be supported

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Thank you

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