



## **The EarthScope Plate Boundary Observatory and allied networks, the makings of nascent Earthquake and Tsunami Early Warning System in Western North America.**

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The NSF-funded GAGE Facility, managed by UNAVCO, operates approximately ~1300 GNSS stations distributed across North and Central America and in the circum-Caribbean. Following community input starting in 2011 from several workshops and associated reports, UNAVCO has been exploring ways to increase the capability and utility of the geodetic resources under its management to improve our understanding in diverse areas of geophysics including properties of seismic, volcanic, magmatic and tsunami deformation sources. Networks operated by UNAVCO for the NSF have the potential to profoundly transform our ability to rapidly characterize events, provide rapid characterization and warning, as well as improve hazard mitigation and response. Specific applications currently under development include earthquake early warning, tsunami early warning, and tropospheric modeling with university, commercial, non-profit and government partners on national and international scales. In the case of tsunami early warning, for example, an RT-GNSS network can provide multiple inputs in an operational system starting with rapid assessment of earthquake sources and associated deformation, which leads to the initial model of ocean forcing and tsunami generation. In addition, terrestrial GNSS can provide direct measurements of the tsunami through the associated traveling ionospheric disturbance from several 100's of km away as they approach the shoreline, which can be used to refine tsunami inundation models. Any operational system like this has multiple communities that rely on a pan-Pacific real-time open data set. Other scientific and operational applications for high-rate GPS include glacier and ice sheet motions, tropospheric modeling, and better constraints on the dynamics of space weather.

Combining existing data sets and user communities, for example seismic data and tide gauge observations, with GNSS and Met data products has proven complicated because of issues related to metadata, appropriate data formats, data quality assessment in real-time and other issues related to using these products operational forecasting. While progress has been made toward more open and free data access across national borders and toward more cooperation among cognizant government sanctioned "early warning" agencies, some impediments remain making a truly operational system a work in progress.

Accordingly, UNAVCO has embarked on significant improvements and improvement goals to the original infrastructure and scope of the PBO. We anticipate that PBO and related networks will form a backbone for these disparate efforts providing high quality, low latency raw and processed GNSS data. This requires substantial upgrades to the entire system from the basic GNSS receiver, through robust data collection, archiving and open distribution mechanisms, to efficient data-processing strategies. UNAVCO is currently in a partnership with the commercial and scientific stakeholders to define, develop and deploy all segments of this improved geodetic network. We present the overarching goals, and current and planned future state of this international resource.