GPS Data, Analysis Methods and Products from the EarthScope Plate Boundary Observatory and Other Regional Networks: Spanning the Geodetic Temporal Spectrum from Decadal Time Series and Velocity Fields to Real-Time Data Streams

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We present an overview of 1) GPS data, analysis methods, and derived products from the EarthScope Plate Boundary Observatory (PBO) and other large scale regional networks including decadal position time series, velocities, and other parameters for 2000+ continuously operating GPS stations distributed throughout a quadrant of Earth’ s surface encompassing the high Arctic, North America, and Caribbean, and 2) high-rate real-time GPS/GNSS data streams available from 700+ stations operated by UNAVCO. All 2000+ station data are freely and publicly available as RINEX files. This continent-spanning distribution represents an essential contribution to the current high-precision global geodetic coverage, with a rich data set collected over more than a decade.

The Geodesy Advancing Geosciences and EarthScope (GAGE) Facility, operated by UNAVCO, provides a diverse suite of geodetic data, derived products and cyberinfrastructure services to support community Earth science research and education. GPS derived products are generated by two Analysis Centers, at Central Washington University (CWU) and the New Mexico Institute of Mining and Technology (NMT), and an Analysis Center Coordinator at the Massachusetts of Institute of Technology (MIT). GAGE GPS data analysis involves formal merging within a Kalman filter of two independent, loosely constrained solutions: one is based on precise point positioning using GIPSY/OASIS (v6.x) software at CWU and the other is based on a network solution from double-differencing produced with the GAMIT (v10.60) software at NMT. The primary data products are station position time series that show motions relative to a North America reference frame called NAM08 (IGb08 rotated to a fixed North America Plate), and secular motions of the stations represented in the velocity field. The position time series contain a multitude of signals in addition to the secular motions. Examples of time series displacements due to geophysical phenomena such as coseismic and postseismic signals, as well as seasonal signals associated with hydrologic processes, are presented. Examples of displacements resulting from anthropogenic phenomena and site maintenance events are also shown.

Position time series, and the signals they contain, are inherently dependent upon analysis parameters, such as network scaling and reference frame realization. The estimation of scale changes (a common practice) has large impacts on vertical motion estimates. Reference frames and realizations evolve through time, and on 29 January 2017 (GPS week 1934 day 0), the IGS switched its operational products to use the IGS14 system, replacing the current IGb08 system. For GAGE, our plan is to reprocess all data from all 2000+ stations and release a full set of time series in NAM14 and IGS14 reference frames when the reprocessing is complete.

UNAVCO also provides high-rate (1 Hz), low-latency (<2s) data streams from 700+ GPS/GNSS stations

from the PBO, COCONet (circum-Caribbean), and TLALOCNet (Mexico) networks as well as networks in Nepal and Tanzania funded by the U.S. National Science Foundation. Some of these stations have been augmented with accelerometers to facilitate studies of broadband waveforms. Beyond increasing uses for science and engineering, real-time GPS/GNSS data streams have the potential to significantly enhance Hazard Early Warning applications.

Keywords: Geodesy, GPS/GNSS Networks, GPS/GNSS Data Analysis, Hazard Early Warning, Plate Tectonics, Deformation

