GPS at CTO: Geodetic Arrays and Data Processing

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CTO operates 4 medium- to long-term GPS geodetic arrays at or near plate boundaries. Two arrays are located near prominent subduction zones, a third monitors deformation at a continental collision setting, and a forth measures displacement at an intraplate extensional setting. The 27-station Sumatra GPS Array (SuGAr) occupies the Sumatran forearc from Enggano in the South to the Alor Strait in the North. The 11-station Central Andean GPS Array (CAGA) spans northern Chile from the Peruvian border to Antofagasta (Figure 1). Since 2004, data from 5 CTO stations in Nepal (Figure 2) add substantially increased spatial resolution to measurements from the 5-year existing permanent sites in the area. The 7-station Borneo and Island Geodetic Network (BANBAN) has been a collaboration project between Caltech and Harvard since 1996. Recent CTO efforts focus on a 31-station subset of BARGEN (Figure 3). CTO also contributed locations to a terminally important bathymetric survey of the Central Range to the Taiwan GPS Network.

Site Design

Basic station design is similar for all networks (Figures 4 and 5). A tripod, formed by welded stainless steel tubing resting on an 8-kVA, is anchored in the subsoil by epoxy and supports the radome-equipped GPS choke-ring antenna. A 10-m coaxial cable connects this broadband satellite signal to the preamplifier (located at the base of the antenna to the GPS receiver). The receiver is housed in a steel equipment box together with auxiliary electronics and electrical equipment. Solar panels and a deep-cycle, 70-100 Ah-rated gel cell. Where feasible, communications with the receiver is facilitated by radio links.

Future Development

Site Augmentation

A major addition of new sites is scheduled for all CTO run networks. For SuGAr, a density- in-citation to key areas (Figure 1) will help to account for research activities related to the different stages of the seismic cycle for different parts of the west Pacific forearc. For SuGAr, a density-in-citation to key areas (Figure 1) will help to account for research activities related to the different stages of the seismic cycle for different parts of the west Pacific forearc. For CAGA, targeted new sites near the coast and the Andean foothills will provide important contributions to natural hazards early warning systems. Three CTO sites (JRGN, MCLA, P105) currently have internet links. Link to other additional sites (JGSC, JGTA) have been tested successfully. Near real-time data links to SuGAr have been explored earlier this year at the central facility of the satellite communications provider (ACS) in Japan. Using existing line bandwidth, remote geodetic networks with sampling interval of about 5 s were forwarded to CTO with a latency of several seconds. Employing a higher bandwidth satellite Ethernet radio bridge, pilot subsurface transects for data streams of 1 or 2 Hz. Efforts to expand real-time connectivity are underway for all CTO networks.

Data Processing

The displayed time series of station positions (Figures 7 and 8) show a long-term, approximately linear trend that reflects crustal motion. This trend is further separated into noise from a variety of sources. Depending on their origin, these are temporally correlated aperiodic and periodic components with annual, semiannual, or diurnal contributions. Local (multipathing), regional-, and reference frame-induced errors produce additional, spatially correlated noise. Eliminating or moderating these contributions with the help of suitable models and filters will be a major area of future work. With an increasing number of on-line data streams, it will also become necessary to develop proper tools for near real time data processing and analysis.

Figure 1. Map of existing and future SuGAr sites in Sumatra.

Figure 2. Map of existing and future CAGA sites in northern Chile.

Figure 3. CAGA station ATJN in northern Chile. Equipment box, solar panels, and ethernet link radio antenna in the foreground. GPS tripod and antenna in the background.

Figure 4. CTO subnetwork of BARGEN.

Figure 5. Equipment box for station PCCL. Solar panel control unit and ethernet radio located above battery. GPS receiver below.

Figure 6. CAGA station ATJN.

Figure 7. Interior of equipment box for station PCCL.