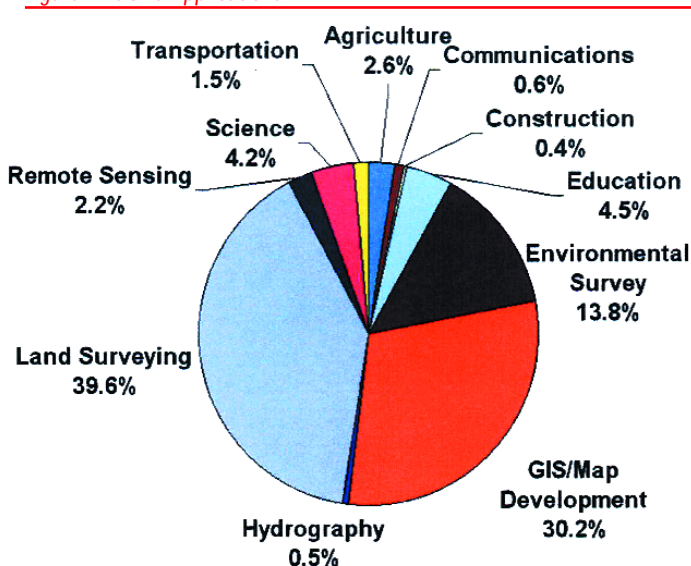# The Cooperative CORS Program

Julie Prusky

The National CORS system is comprised of a network of permanent GPS stations for precise 3D positioning in the United States. People use National CORS data for land surveying, GIS/LIS development, environmental surveys, education, science, agriculture, remote sensing, transportation, communications, hydrography, and construction. The 180+ sites in the National CORS system, however, provide relatively sparse coverage across the contiguous United States. With GPS equipment being so affordable today, many organizations are establishing other CORS to meet their own local needs. State and local governments, as well as private companies, are operating these sites. Academic institutions are also establishing CORS to enhance their educational programs while supporting their local communities.

As part of my job, I surf the Internet looking for CORS that are not part of a "formal" CORS network. When I come upon sites posting coordinates, I always wonder how consistent these positions are with their National CORS counterparts. If both National and local CORS are used in post-processing, what error may be introduced due to using coordinates belonging to different reference frames? Also, how were the positional coordinates computed, and do they correspond to the monument, the L1 phase center, or the antenna reference point? And since most of the time it isn't easy finding these websites, I also wonder if local surveyors and others know that these valuable resources exist in their area and are literally right at their finger tips?

Introducing the Cooperative CORS

This program was designed as an extension of the National CORS to provide access to more CORS data and to encourage the use of positional coordinates consistent with the National Spatial Reference System (NSRS). People can now feel

Figure 1 CORS Applications

confident about coordinates posted by cooperating organizations and know that the corresponding GPS base stations meet certain standards.

An old saying declares that one should be sure to compare apples to apples. Cooperative CORS ensures just that. It is unwise to mix coordinates expressed in different reference frames. The positional coordinates of sites in Cooperative CORS will be computed using the Web-based utility called The GPS On-line Processing User Service (OPUS), which is being developed by NGS. OPUS will enable easy computations of ITRF97 and NAD83 coordinates that are consistent with the NSRS.

Additionally, the NGS' Cooperative CORS Website provides direct links to the participating organization's Web page, where their data is posted and each link will be represented on the National CORS map.

Some Differences between the National and Cooperative CORS

On a daily basis, NGS collects data from each site in the National CORS network and performs a quality assurance check. NGS converts the GPS data into Receiver Independent Exchange (RINEX) format and posts it on the Internet for a minimum of two years. The data is also archived for permanent storage. In the Cooperative CORS program, it is the participating organization's responsibility to process their own data and post it on the Internet for at least seven days. Since NGS will not be posting positional coordinates for each site, a link from the NGS Web page will take users directly to the member's website where data and coordinates can be obtained.

Another difference is the operation time required; the National CORS program requires continuous operation of its GPS receivers for 24 hours/day, seven days/week; Cooperative CORS need only be operated eight hours/day, five days/week (they should really be called Frequently Operating Reference Stations). Though 24-hour operation is preferable, local needs may not justify continuous operation. As previously mentioned, NGS performs a daily coordinate quality check for each National CORS site. If the results of these daily solutions indicate a change in the current position of more than 2cm horizontally, or 4cm vertically, the posted coordinates for the site in error will be revised. Recomputation of cooperative stations will be performed at least every 90 days, and positions will be reposted after each computation regardless of the amount of change, though consideration is being given to set a tolerance for Cooperative CORS much like that of National CORS.

Requirements (Details) of the Provider

A comprehensive Web page explaining the minimum requirements for Cooperative CORS is located under "Details" at: *www.ngs.noaa.gov/CORS/Coop*

To summarize this Web page:

- First and foremost, the GPS data are freely available to the public.

- The cooperating organization supports both an FTP server and World Wide Web server for distributing their GPS data.
- The organization's Website will contain a link to the NGS Cooperative CORS Website.
- The GPS receiver/antenna is dual-frequency.
- The GPS receiver/antenna provides both carrier phase and code range measurements.
- The GPS base station operates a minimum of eight hours per day, five days per week.
- The cooperating Website will post positional coordinates computed with NGS software.
- The GPS data should be posted within 10 days of collection.
- The data will remain online for at least seven days (prefer ably 30 days).
- The antenna mount is stable with less than 1-cm short-term variability. (NGS has calibrated and tested various antennas and their mounts. For details see: *www.grdl.noaa.gov/GRD/GPS/Projects*)
- The antenna's view to the horizon should be relatively clear of obstructions.
- The receiver can track at least eight GPS satellites simultaneously.
- The posted GPS data corresponds to a sampling rate of 30 seconds or less.

For those hinking of purchasing a base station, some options to consider are:

- Choke-ring antennas to reduce multipathing effects
- Software packages that convert GPS data into the RINEX format
- A system that has ample disk space

Refer to "Getting Started" on the Cooperative CORS Web page for more information.

User Benefits

Cooperative CORS provides one-stop shopping. People will be able to use the Cooperative CORS in much the same way as the National CORS. When planning your survey, visits to both the National CORS and Cooperative CORS websites are recommended in order to select appropriate stations for control. A Cooperative CORS may be closer to your survey and therefore more beneficial than the nearest National site, thereby enabling you to position points more accurately and/or with shorter occupation time. In addition, with closer control, one-person surveys may be feasible; that is, a survey with only one roving receiver. Using CORS for control will eliminate the need to allocate GPS receivers and personnel to occupy control points.

Considerations

The Cooperative CORS program is still in its infancy. There are some issues where the pros and cons are still being weighed:

- NGS is considering the publication of positional coordinates for Cooperative CORS by including them in the NGS Integrated Data Base (NGSIDB), as some states do not allow their licensed surveyors to use any control points whose coordinates are not published in the NGSIDB.
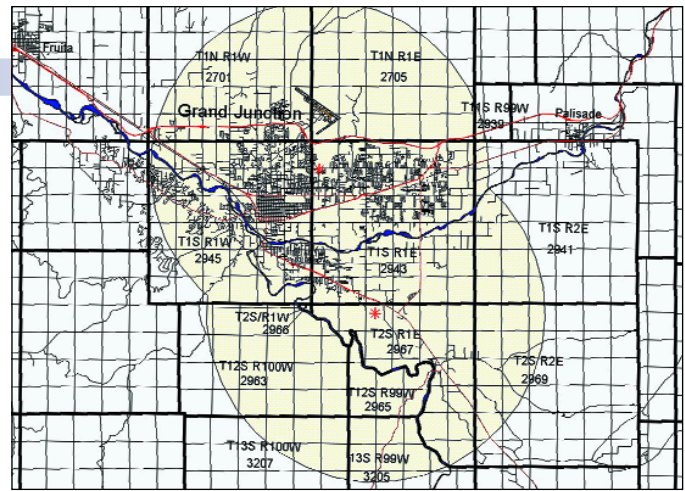

Figure 2 Broadcast RTK Signal for Mesa County, Colorado Cooperative CORS site. The following disclaimer is posted with this map: This map depicts the suggested range (10km) of the RTK. Although the broadcast can be used outside this range, it probably will not comply with published RTK Survey Performances. This is due to the fact that RTK only uses the L1 frequency after start-up Initialization even if you have dual-frequency receivers and OTF. This means that there is no correction for errors such as Ionospheric effects. The purpose of showing this range is a reminder of this situation and should not be taken as the absolute range. All GPS performance criteria is a function of the number of satellites visible, obstructions, baseline length, multipath, environmental effects, availability of L1/L2 signals, occupation times, and observation conditions.

- Another consideration is quality classifications. Some agencies have stated a preference for the recomputation of coordinates more frequently than every 90 days. Although the computation date would surely be on the coordinate page, a quality classification may be desirable. Other quality issues could be occupation time, down time, how many days of data were used in computing the positional coordinate, etc.
- To compute coordinates for new points, OPUS is being designed to use the three closest National CORS as controls. NGS is considering whether or not to allow OPUS to include existing Cooperative CORS as control, either by default or by option.
- Once the Cooperative CORS is well established, NGS anticipates a possible interest in establishing a Cooperative "CORS light" program, which would extend its membership to single-frequency GPS base stations.

NGS is interested in your ideas. Please e-mail your thoughts to: *julie.prusky@noaa.gov;* please enter the words "Coop CORS" in the subject line.

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