Project: Remote Geodetic Observatories

Program: GIANT, SCAR WG-GGI
Date: July 10, 2000
Venue: Tokyo, Japan
Coordinator: L. Hothem, USA

Report on Activities 1998-2000

Goal: develop a remote GPS base station capability for geoscience applications, and deploy at key remote locations.

Program Key Activities Proposed for 1998-2000:

1. Monitor and report on use of solar, wind, and other methods of power generation for data logging information at remote GPS sites
2. Monitor developments for remote retrieval of GPS data from remote sites by satellite communication techniques
3. Collaboration with non-SCAR researchers

Accomplishments and comments for 1998-2000:

1. This report is limited to establishing autonomously operating GPS (or Global Navigation Satellite System (GNSS)) observatories at sites in Antarctica remote from established science bases. These sites are accessed only by helicopter, fixed winged aircraft, ground track vehicle, or combination thereof. Thus, visits to the sites are limited to brief periods by engineers or technicians.

2. Based on available records, by July 1998, two remote and autonomous operating permanent GPS observatories had been established at sites called Mt. Coates (S77.8, E162.0) and Mt. Cox (S77.5, E162.5) that are located in the South Victoria Land region of the Transantarctic Mountains. The stations, named COAT and MTCX, were the first in a series of remotely operating GPS observatories established in support of monitoring horizontal and vertical deformation. A network of stations spanning over 1000 km is planned by the project leader, Dr. Carol Raymond, JPL/NASA.

3. During the field season of 1998-1999, permanent GPS observatories were established at remote sites located in the eastern Marie Byrd Land region of West Antarctica. This project is lead by Dr. Andrea Donnellan, JPL/NASA.

4. Since July 1998, other remote and autonomous operating GPS observatories have been established at sites in Beaver Lake and Lambert Amery regions (Tregonning, Australian National University), Borg Massif (Schwarz, Germany), and Langhovde (National Polar Research Institute, Japan).

5. The autonomous GPS observatories are powered by combination of an array of storage batteries and power generated by solar panels, wind generators, and/or use of fuel cells. The success in maintaining continuous operations has been very limited due to problems of maintaining reliable and continuous generating source for power. In the summer period when the sun is above the horizon for much of the 24-hour day, the success in meeting power needs by use of the combination of solar generating systems and batteries has been reasonably successful. Noted problems that have been reported are destruction or damage to solar panels caused by extreme high winds and/or blowing rocks.

6. Unattended power source in the winter or during darkness has been attempted by use of wind generating power systems. So far, maintaining continuous operation of wind generating systems through the winter has not been successful. In most cases, failure was due to damage caused by

extreme high winds. Also, there were reports of failure of voltage regulators that resulted in damage to batteries.

7. A potential alternative to wind generating power systems for providing power during the periods of darkness is the use of fuel cells. Deployed during the 1999-2000 field season, testing of this system is currently underway at the Beaver Lake site. Due to breakdown in the communication link for data transmitted from the Beaver Lake site, initial results of the test will not be known until the site can be accessed during the 2000-2001 field season.

8. In practice, there are three options for meeting data communication needs: 1) the communication link installed supports remote control of system operations, monitoring status (health) of the operations, and daily transmission of raw observation data to storage and processing centers; 2) the capability of the communication link installed is limited to monitoring the health status for system operations, and data are retrieved only manually during periodic and brief visits to the sites; and 3) no communication link to the sites and data are retrieved manually during periodic and brief visits to the sites. The visits to sites to retrieve data may be limited to only a couple visits during the period of the summer field season.

9. Another issue for remote GPS observatories is the method, type of media, storage capacity and reliability for on-site data storage devices or systems. Significant improvements have occurred in past two years that include: reduction in size of the storage medium while storage capacity has increased dramatically, reduced power requirements, and improved 'smart" storage devices that allow for direct SCSI interface with GPS receivers.

10. In August 1999, L. Hothem attended the Workshop on Autonomous Systems in Extreme Environments, hosted by JPL/NASA, Pasadena, California. The 3-day workshop focused primarily on developments in power generating systems, including solar, wind, and fuel cell. Presentations covered advances made in improved systems for operating in Antarctica's extreme environments. Communication systems discussed included ground-to-ground and satellite links. A critical factor in the success of power generation systems is the amount of power needed to operate the remote system and reliability of battery storage systems operating in extreme temperatures. A link to the URL for a limited report on the workshop is available at the WG-GGI website.

11. The status of developments and achievements in operation of power generating systems (wind and solar) for use at remote observatories in Antarctica are included in presentations scheduled for the IX SCALOP (Standing Committee on Antarctic Logistics and Operations) Symposium, 12 July 2000, Tokyo, Japan.

Final comments and recommendation: The efforts to successfully establish permanent GPS observatories for continuous year around operations is still in the early stages of development. Substantial progress has been made in improving power generating systems for extreme environments and in developing low power/high data rate communication systems. New power generating technologies, such as use of fuel cells, are now being tested. The power generating and communication systems should continue to mature during next couple of years with moderate success expected in maintaining continuous operations through Antarctic winters or periods of darkness.

Establishing remote and autonomous GNSS permanent observatories at rock-based will continue to be very important in meeting continent-wide needs for geophysical measurements at isolated locations. For these reasons, it is recommend this project continue as part of the 2000-2002 program for WG-GGI. Also, recommended is that the title for the project be changed to "Remote GNSS Observatories."

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