IGS DATA CENTER REPORT
1999

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Background

The IGS collects, archives, and distributes GPS observation data sets of sufficient accuracy to meet the objectives of a wide range of scientific and engineering applications and studies. During the IGS design phases, it was realized that a distributed data flow and archive scheme would be vital to the success of the IGS. Thus, the IGS has established a hierarchy of data centers to distribute data from the network of tracking stations: operational, regional, and global data centers. This scheme provides an efficient access and storage of GPS data, thus reducing traffic on the Internet, as well as a level of redundancy allowing for security of the data holdings.

Operational data centers (ODCs) are responsible for the direct interface to the GPS receiver, connecting to the remote site hourly or daily and downloading and archiving the raw receiver data. The quality of these data are validated and are then translated from raw receiver format to a common format (RINEX) and compressed. Both the daily observation and navigation files (and meteorological data, if available) are then transmitted to a regional or global data center ideally within an hour following the end of the observation day. For hourly data, files are transmitted from the operational data center within five minutes of the end of the hour.

Regional data centers (RDCs) gather data from various operational data centers and maintain an archive for users interested in stations of a particular region. Furthermore, to reduce electronic network traffic, the regional data centers are used to collect daily data from several operational data centers before transmitting them to the global data centers. Typically, data not used for global analyses are archived and available for on-line access at the RDC level. IGS regional data centers have been established in several areas, including Europe and Australia.

The IGS global data centers (GDCs) are ideally the principle GPS data source for the IGS analysis centers and the user community in general. These on-line data are utilized by the IGS analysis centers to create a range of products, which are then transmitted to the global data centers for public use. The GPS data available through the global data centers consists of observation, navigation, and meteorological files, all in RINEX format. GDCs are tasked to provide an on-line archive of at least 100 days of daily GPS data files in the common data format, including, at a minimum, the data from all global IGS sites. The GDCs also provide an archive of hourly data files for at least three days. Furthermore, the GDCs are required to provide an on-line archive of derived products, generated by the IGS analysis centers, associate analysis centers, and analysis coordinators. These data centers equalize holdings of global sites and derived products on a daily basis (at minimum). The three GDCs provide the IGS with a level of redundancy, thus preventing a single point of failure should a data center become unavailable. Users can continue to reliably access data on a daily (or hourly) basis from one of the other two data centers. Furthermore, three centers reduce the network traffic that could occur to a single

geographical location. Table 1 lists the data centers currently supporting the IGS; information on how and who to contact for these data centers are available through the IGS Central Bureau web site. Figure 1 shows the data flow from the GPS station to the Analysis Centers and the user community

Highlights for 1999 and Plans for 2000

General

In 1999, the IGS began to see an emphasis on near real-time activities that will continue in the coming year. Timeliness of the hourly data product was a growing concern thus causing all levels of service within the IGS to review existing methods of data transmission and develop new processing capabilities to ensure data would be available to users within a few minutes. During 2000, with the start of the production of rapid products by the IGS analysis centers, data centers will be further challenged to ensure the timely delivery of both data and products to the user community.

The IGS infrastructure experienced two major outages in 1999 due to a computer system failure at the CDDIS global data center. During August and late December, the CDDIS computer facility was down for several weeks because of various hardware and software problems. Since many sources of both GPS data and products deliver their files to the CDDIS, delays in data availability were felt throughout the IGS system. These problems have further emphasized the need for the IGS to develop and test backup data flow paths for all major components of the service. These problems and possible solutions will be further discussed at the next IGS Network Workshop, to be held in July 2000 in Oslo, Norway.

IGS Data

Consistent with past years, the number of stations archived by the IGS data centers increased by several percent in 1999. Over 225 sites staged completed site logs with the IGS Central Bureau Information System (CBIS). On a daily basis during the past year, over 575 stations were archived at SIO (supporting both the IGS and other global research activities), over 160 at CDDIS (supporting both the IGS and NASA activities), and over 100 at IGN. The data centers experienced increased user activity as well during 1999; the CDDIS, for example, saw over 500K GPS data and product files (nearly sixty Gbytes) per month downloaded from their system in 1999.

IGS data centers continued the routine archive of hourly, 30-second data during 1999. These data were typically available to users within 15 minutes after the hour. By late 1999, data from over 45 sites have been collected by JPL, ESOC, NRCan, and BKG and transmitted to and archived at the IGS global data centers. These hourly files are archived in compressed, compact RINEX format and are retained at the global data centers for three days. No validation or checking of data quality is performed on these data in order to provide the files in the most timely fashion to the user community. The daily observation and navigation files, containing 24 hours of data, are then transmitted through “normal” channels and archived indefinitely at the data centers. Figure 2 shows the network of GPS stations providing hourly RINEX data.

On average, the latency of the data arrival at the global data centers improved during 1999. Over fifty percent of the daily data files arrived at the global data centers within three hours and about 75 percent arrived within six hours. The timeliness of the hourly data improved greatly as the year drew to a close with data from many sites available within ten minutes after the end of the previous hour. As usual, efforts to reduce the time delay of both daily and hourly, particularly for global IGS stations, will continue during the coming months.

The IGS was a co-sponsor of a new activity to establish an international campaign for GLONASS observations during late 1998 and early 1999. The main purpose of the International GLONASS Experiment, IGEX-98, was to conduct the first global GLONASS observation campaign for geodetic and geodynamics applications. Several of the existing IGS data centers proposed to participate in IGEX-98, thereby increasing the diversity of their archives with the addition of GLONASS data and products. Although the IGEX-98 campaign officially ended in mid-April, 1999 the flow of data and products continues on a best-effort basis. The IGS Governing Board approved the follow-on program, the International GLONASS Service – Pilot Project (IGLOS-PP) in early 2000. During the coming months, the IGS and the IGLOS Pilot Project committee will investigate how to incorporate both GLONASS data and products into the existing IGS data flow.

In 2000, the data centers will begin to see one second RINEX data transmitted in hourly files. These data, from a 20 to 30 station subnetwork of IGS sites, will be utilized primarily in support of low Earth orbiter (LEO) missions such as CHAMP and GRACE. Because of the volume of the one-second data files, a new, more efficient binary data format will be utilized. Plans are to make these data available at IGS data centers in files containing hourly data only. Selected IGS data centers will become involved in the archiving of GPS flight data for some of these LEO missions as well.

IGS Products

The IGS data centers continued to archive a wide range of IGS products during 1999. These products include the weekly, standard orbit, clock, and Earth rotation parameters (ERPs) from the seven IGS Analysis Centers and the combined product from the IGS Analysis Coordinator. The accumulated IGR (rapid orbit) and IGP (predicted orbit) products were distributed and archived on a daily basis as well. IGS station coordinate and reference frame solutions were routinely provided by seven IGS Associate Analysis Centers as well as a combined solution by the IGS Reference Frame Coordinator. The IGS troposphere product, in the form of combined zenith path delay (ZPD) estimates for over 150 sites were generated by GFZ and archived on a weekly basis at the global data centers. Individual ionosphere maps of total electron content (TEC) were derived on a daily basis by five IGS Associate Analysis Centers and were also archived at the global data centers. A daily file of these data in IONEX format includes twelve two-hour snapshots of the TEC and optional corresponding RMS information.

At the 1999 LEO Workshop, it was recommended that the IGS Analysis Centers develop a new rapid analysis products, including orbits, clocks, EOP, and predictions; furthermore, these products should be made available to users through the IGS data centers with a latency of less than three hours. Plans are to begin a pilot project for this activity in 2000.

Table 1. Data Centers Supporting the IGS in 1999

Operational Data Centers	
ASI	Italian Space Agency
AUSLIG	Australian Surveying and Land Information Group
AWI	Alfred Wegener Institute for Polar and Marine Research, Germany
BKG	Bundesamt für Kartographie und Geodäsie, Germany
CNES	Centre National d'Etudes Spatiales, France
DGFI	Deutsches Geodätisches ForschungsInstitut, Germany
DSN	Deep Space Network, USA
DUT	Delft University of Technology, The Netherlands
ESOC	European Space Agency (ESA) Space Operations Center, Germany
GFZ	GeoForschungsZentrum, Germany
GSI	Geographical Survey Institute, Japan
ISR	Institute for Space Research, Austria
JPL	Jet Propulsion Laboratory, USA
KAO	Korean Astronomical Observatory
NGI	National Geography Institute, Korea
NIMA	National Imagery and Mapping Agency, USA
NMA	Norwegian Mapping Authority
NOAA	National Oceanic and Atmospheric Administration, USA
NRCan	Natural Resources of Canada
RDAAC	Regional GPS Data Acquisition and Analysis Center on Northern Eurasia, Russia
SIO	Scripps Institution of Oceanography, USA
UNAVCO	University NAVSTAR Consortium, USA
USGS	United States Geological Survey
Regional Data Centers	
AUSLIG	Australian Surveying and Land Information Group
BKG	Bundesamt für Kartographie und Geodäsie, Germany
JPL	Jet Propulsion Laboratory, USA
NOAA	National Oceanic and Atmospheric Administration, USA
NRCan	Natural Resources of Canada
Global Data Centers	
CDDIS	Crustal Dynamics Data Information System, NASA GSFC, USA
IGN	Institut Géographique National, France
SIO	Scripps Institution of Oceanography, USA

Figure 1. Internal IGS data flow from the GPS stations to the Analysis Centers

Figure 2. Subnetwork distribution of IGS stations delivering hourly RINEX data files.