IGS DATA CENTER REPORT
1998

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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 daily and downloading and archiving the raw receiver data. The quality of these data are validated by checking the number of observations, number of observed satellites, date and time of the first and last record in the file. The data are then translated from raw receiver format to a common format (RINEX) and compressed. Both the observation and navigation files (and sometimes meteorological data) are then transmitted to a regional or global data center ideally within an hour following the end of the observation day.

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 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 RDCs. 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 general user community. These on-line data are employed 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 observation data available through the global data centers consists of observation, navigation, and sometimes meteorological files, all in RINEX format. GDCs are tasked to provide an on-line archive of at least 100 days of GPS data in the common data format, including, at a minimum, the data from all global IGS sites. The GDCs are also required to provide an on-line archive of derived products, generated by the IGS analysis centers and associate analysis centers. 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 basis from one of the other two data centers. Furthermore, three centers reduce the network traffic that could occur to a single geographical location. The table below lists the data centers currently supporting the IGS; information on how and who to contact for these data centers is available through the IGS web site.

Highlights for 1998 and Plans for 1999

General

In November 1998, NASA GSFC, through the CDDIS, an IGS Global Data Center, in conjunction with the IGS Central Bureau, hosted the IGS Network Systems Workshop for three and one half days in Annapolis, Maryland. The goals of the workshop focused on developing a closer community and strengthening communications within the IGS infrastructure, improving the performance of the network as well as developing a shared vision of the future network, and preparing a proceedings targeted along the lines of an "IGS Network Operations Plan" that would document the network operations of the IGS and future plans. The workshop provided a venue for the various network components of the IGS to meet and discuss current configurations, problems and their resolutions, how to incorporate the many future requirements into the existing infrastructure, and what new technologies are available that could be incorporated into various levels of the service. The proceedings are nearing completion and will be made available via the IGS web site and in limited hardcopy distribution by mid-1999.

IGS Data

Consistent with past years, the number of stations archived by the IGS data centers increased by approximately fifteen percent in 1998. Nearly 200 sites staged completed site logs with the IGS Central Bureau Information System (CBIS). On a daily basis during the past year, nearly 350 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 1998; the CDDIS, for example, saw over 7K GPS data and product files per day (nearly five Gbytes) downloaded from their new UNIX computer system toward the end of 1998.

The Hatanaka compression scheme was adopted in 1998 and is now considered the operational method for transmitting data within the IGS itself. All data centers used this software to create smaller data files for exchange with other data centers and analysis centers. However, as a service to the general user community, many data centers continue to provide data in both compressed RINEX format and compressed, compact RINEX.

IGS data centers began the routine and rapid transmission and archive of hourly, 30-second data during 1998. These data were typically available to users within 25 minutes after the hour. By late 1998, data from over thirty sites have been collected by JPL, ESOC, 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.

On average, the latency of the data arrival at the global data centers improved during 1998. Approximately forty percent of the daily data files arrived at the global data centers within one hour, 65 percent within three hours, and 75 percent within six hours. As usual, efforts to reduce the time delay of both daily and hourly, particularly for global IGS stations, will continue during 1999.

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 IGEX-98 was schedule to complete in mid-April 1999, this activity will continue indefinitely, perhaps becoming a permanent component of the IGS itself.

In 1999, 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 primarily be utilized 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 data format, probably binary, will be developed in the near term. Plans are to have these data available at IGS data centers in files containing hourly data only. IGS data centers may also become involved in the archiving of GPS flight data for some of these LEO missions.

IGS Products

The IGS Analysis Coordinator began generating two new products in early 1998, accumulated IGR (rapid orbit) and IGS (final orbit) ERP files on a daily and weekly basis, respectively. The files, igs96p02.erp (to be used with IGS rapid orbits) and igs95p02.erp (to be used with IGS final orbits) are available through the GDCs and the CBIS. Also in 1998, the IGS Analysis Center Coordinator activities transitioned from Jan Kouba at NRCan to Tim Springer at AIUB. Following this move, both the rapid and predicted products were made available to the user community sooner, at 17:00 UTC and 23:30 UTC respectively.

At the February 1998 IGS Analysis Workshop in Darmstadt Germany, the IGS Governing Board recommended that the pilot phase of the experiment on the combination of troposphere estimates be terminated and that the combined zenith path delay (ZPD) estimates generated by GFZ become an official product of the IGS. Using a sampling rate of two hours, the ZPD estimates generated by the IGS analysis centers are combined by GFZ to form weekly ZPD files for nearly 150 IGS sites. The troposphere products are now available at all IGS global data centers.

Also at the 1998 IGS Analysis Workshop, it was decided to start a coordinated, routine processing and a combination of IGS ionosphere products. The IGS Ionosphere Working Group was formally established by the IGS Governing Board at its meeting in May. An official format for the exchange of ionosphere maps, called IONEX, was developed and approved thereafter for exchange of these data. In mid-1998, five IGS Analysis Centers began supplying daily, global ionosphere maps of total electron content (TEC) in the form of IONEX files. These products are available from the IGS Global Data Centers. A (daily) IONEX file includes twelve two-hour snapshots of the TEC and optionally 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 the summer of 1999.

Table. Data Centers Supporting the IGS in 1998

Operational Data Centers	
ASI	Italian Space Agency
AUSLIG	Australian Surveying and Land Information Group
AWI	Alfred Wegener Institute for Polar and Marine Research, Germany
CNES	Centre National d'Etudes Spatiales, France
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 Image and Mapping Agency, USA
NMA	Norwegian Mapping Authority

NOAA	National Oceanic and Atmospheric Administration, USA
NRCan	Natural Resources of Canada
RDAAC	Russian Data Analysis and Archive Center
SIO	Scripps Institution of Oceanography, USA
UNAVCO	University NAVSTAR Consortium
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