IGS

NETWORK AND STATION REPORTS

IGS

GLOBAL, REGIONAL, AND
LOCAL NETWORKS

IGS Network Coordinator Report - 2002

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Network Composition Changes

The IGS network is a set of permanent, continuously-operating, dual-frequency GPS stations operated by over 100 worldwide agencies. The dataset is pooled at IGS Data Centers for routine use by IGS Analysis Centers in creating precise IGS products, as well as free access by other analysts around the world. The IGS Central Bureau hosts the IGS Network Coordinator, who assures adherence to standards and provides information regarding the IGS network via the Central Bureau Information System website at http://igscb.jpl.nasa.gov.

The IGS network of permanent dual-frequency GPS tracking stations formed by the cooperative efforts of the IGS site-operating agencies welcomed the addition of 112 stations, listed in Table 1, during 2001 and 2002.

Table 1 - Network Composition Changes During 2001-2002

Additions	
AJAC	Ajaccio, Corsica, France
ALRT	Alert, Nunavut, Canada
ANTC	Los Angeles, Chile
BAN2	Bangalore, India
BOGI	Borowa Gora, Poland
BREW	Brewster, Washington, USA
BRST	Brest, France
CAGS	Gatineau, Quebec, Canada
CAGZ	Capoterra, Italy
CFAG	Caucete, Argentina
CHPI	Cachoeira Paulista, Brazil
CHUM	Chumysh, Kazakhstan
CONZ	Concepcion, Chile
COPO	Copiapo, Chile
COYQ	Coyhaique, Chile
DARR	Darwin, Australia
DAVR	Davis, Antarctica
DLFT	Delft, the Netherlands
DREJ	Dresden, Germany
DWH1	Woodinville, Washington, USA
FALE	Faleolo, Samoa
FFMJ	Frankfurt/Main, Germany
FREE	Freeport, the Bahamas
GMAS	Mas Palomas, Gran Canaria, Spain
GUAO	Urumqi, China

Table 1 - Network composition changes during 2001-2002 (continued)

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Additions (cont'd)
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HELJ    Helgoland Island, Germany
HERP    Hailsham, England
HILO    Hilo, Hawaii, USA
HNLC    Honolulu, Hawaii, USA
HOLM    Holman, Northwest Territories, Canada
HUEG    Huegelheim, Germany
HYDE    Hyderabad, India
INVK    Inuvik, Northwest Territories, Canada
IQQE    Iquique, Chile
IRKJ    Irkutsk, Russia
JOZ2    Josefoslaw, Poland
KGN0    Koganei, Japan
KGNI    Koganei, Japan
KHAJ    Khabarovsk, Russia
KOU1    Kourou, French Guyana
KOUC    Koumac, New Caledonia
KR0G    Kiruna, Sweden
KSMV    Kashima, Japan
LAE1    Lae, Papua New Guinea
LEIJ    Leipzig, Germany
LHAZ    Lhasa, Tibet, China
LHUE    Lihue, Hawaii, USA
LIND    Ellensburg, Washington, USA
LROC    La Rochelle, France
MALD    Male, Maldives
MANZ    Manzanillo, Mexico
MARS    Marseille, France
MAT1    Matera, Italy
MAUI    Haleakala, Hawaii, USA
MBAR    Mbarara, Uganda
MDVJ    Mendeleevo, Russia
METZ    Kirkkonummi, Finland
MIKL    Mykolaiv, Ukraine
MIZU    Mizusawa, Japan
MOBN    Obninsk, Russian Federation
MORP    Morpeth, UK
MR6G    Maartsbo, Sweden
MSKU    Franceville, Gabon
MTBG    Mattersburg, Austria
MTKA    Mitaka, Japan
NAIN    Nain, Newfoundland, Canada
NNOR    New Norcia, Australia
NPLD    Teddington, UK
OBE2    Oberpfaffenhofen, Germany                      Replacing OBER
OBET    Oberpfaffenhofen, Germany
OHI2    O'Higgins, Antarctica                          Replacing OHIG
OHIZ    O'Higgins, Antarctica
OPMT    Paris, France
OS0G    Onsala, Sweden
OUS2    Dunedin, New Zealand
PADO    Padova, Italy                                  Replacing UPAD
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Table 1 - Network composition changes during 2001-2002 (continued)

Additions (cont'd)		
PARC	Puntas Arenas, Chile	
POLV	Poltava, Ukraine	
PTBB	Braunschweig, Germany	
QAQ1	Qaqortoq, Greenland	
RESO	Resolute, Nunavut, Canada	
REYZ	Reykjavik, Iceland	
SACH	Sachs Harbour, Northwest Territories, Canada	
SCUB	Santiago de Cuba, Cuba	
SIMO	Simonstown, South Africa	
STR2	Stromlo, Australia	
SULP	Lviv, Ukraine	
SUNM	Brisbane, Australia	
SUTM	Sutherland, South Africa	
SUVA	Suva, Fiji	
TCMS	Hsinchu, Taiwan, Republic of China	
TGCV	Palmeira, Republic of Cape Verde	
THU2	Thule, Greenland	
THU3	Thule, Greenland	
TITZ	Titz, Germany	
TLSE	Toulouse, France	Replacing TOUL
TNML	Hsinchu, Taiwan, Republic of China	
TWTF	Taoyuan, Taiwan, Republic of China	
ULAB	Ulaanbataar, Mongolia	
UNB1	Fredericton, New Brunswick, Canada	
USN1	Washington, D.C., USA	
VALP	Valparaiso, Chile	
VS0G	Visby, Sweden	
WROC	Wroclaw, Poland	
WTZA	Koetzting, Germany	
WTZJ	Wettzell, Germany	
WTZZ	Koetzting, Germany	
YAKT	Yakutsk, Russian Federation	
YARR	Dongara, Australia	
ZAMB	Lusaka, Zambia	
ZIMJ	Zimmerwald, Switzerland	
ZIMZ	Zimmerwald, Switzerland	
Deletions		
BARB	Bridgetown, Barbados	
IGM0	Buenos Aires, Argentina	
MATH	Lake Mathews, California, USA	
PVEP	Palos Verdes, California, USA	
TAIW	Taipei, Taiwan, Republic of China	
TEGU	Tegucigalpa, Honduras	

While this number may initially seem alarmingly higher than recent rates of station addition (and indeed, equal to the total number of IGS stations at the close of 1995!), it reflects the wholesale incorporation of an entire new class of sites: those which receive both GPS and GLONASS signals and participate in the International GLONASS Service Pilot Project (IGLOS-PP). The new sites also include some participating in other IGS Working Groups and Pilot Projects, such as timing activities and Tide Gauge Benchmarks. Notable coverage improvements came to the Arctic and southern Africa, as is evident from the large circles in Figure 1.

Six stations (also listed in Table 1) exited the IGS network in 2001-2002, due to decommissioning or other permanent unavailability of tracking data, bringing the total number of stations to 348 at the close of 2002.

Typical IGS stations contribute data sampled at 30 seconds on a daily basis; a growing and increasingly well-distributed subset contributes similar data hourly or more frequently, as shown in Figure 2.

Network-Related developments: IGLOS Site Integration

In 2001-2002, the IGS station operators and other IGS participants collaborated with the Network Coordinator to realize several improvements to the network element. An overhaul of the station logs which record the history of each site (crucial to the maintenance of the IGS realization of the International Terrestrial Reference Frame and the consistency of IGS products) started with a proposal of a form allowing the structured collection of information on more types of ancillary and geophysical data. After review and revision by a small yet representative group, final suggestions were collected from the IGS at large in typical IGS collaborative fashion. The changeover was handled at the Central Bureau, with significant and timely assistance from site operators when apparent discrepancies arose, over a period of days leading up to the actual switch on 11 Jun 2002. Care was taken to ensure that the IGS SINEX template (the authoritative compilation of station configuration history) was not adversely affected by the site log maneuvers.

This revised station metadata allowed stations participating in the International GLONASS Service Pilot Project (IGLOS-PP) to be fully integrated into the IGS network. Figure 3 shows an example of an IGLOS station co-located with a GPS-only IGS site. Combined GPS/GLONASS data and station configuration data now appear side by side with the GPS-only IGS stations. In addition to augmenting the IGS network and providing convenience for IGLOS-PP analysts, this serves as a significant demonstration of the IGS' capability to integrate data from other Global Navigation Satellite Systems (GNSS) into the IGS organization and information flow.

Notable New Web Features

Network maps

The IGS CBIS began to provide convenient clickable and downloadable maps of the IGS network and subnetworks, for the IGS community to use in preparing presentations, and to visualize the spatial distribution of the sets of sites.

Data quality plots

Detection of station anomalies has been a popular request in recent years. To that end, each station's web page at the Central Bureau was upgraded to include automatically-updated data quality plots representing the previous 45 days of daily RINEX data. The four quality figures (number of observations, cycle slips, and L1/L2 multipath) are obtained from teqc summary files (see http://www.unavco.ucar.edu/software/teqc/teqc.html for information on UNAVCO's teqc software) corresponding to each day of RINEX data. These are helpful in identifying sudden changes in data character which can identify a site disturbance or equipment failure.

The "spectrum" of all IGS stations' averages and standard deviations of these quality figures is also provided. This gives the viewer an idea how that particular station compares to the rest of the IGS network. See Figure 4 for an example of the L1 multipath graphs.

For IGS stations submitting hourly data, a graph of recent latency is also provided, alongside a graph depicting the recent latencies of all hourly data for comparison.

Network data table and access guide

Inquiries received at the CB made it clear that there was room for improvement in informing web visitors about the types of IGS data and how to acquire it. A table was developed to summarize the data types, including which Global Data Centers archive each kind. Links from the access column lead the visitor to all the needed information to acquire the data: file naming conventions, formats, and paths at the DCs. A portion of the table is shown in Figure 5. A similar access column was also added to the already-existing table of products. The complete tables are available at:
http://igscb.jpl.nasa.gov/components/data.html
http://igscb.jpl.nasa.gov/components/prods.html

Thanks to the Stations (and the People and Agencies That Make Them Possible)

These examples of network-wide improvements in themselves do not adequately reflect the complete picture of activity within the IGS network. All the while, the stations' operating agencies are planning new stations, arranging for equipment repair and upgrade, maintaining the integrity of station information, and improving communications and automation. It is this significant commitment to contribute to the global dataset that fundamentally makes the IGS possible.

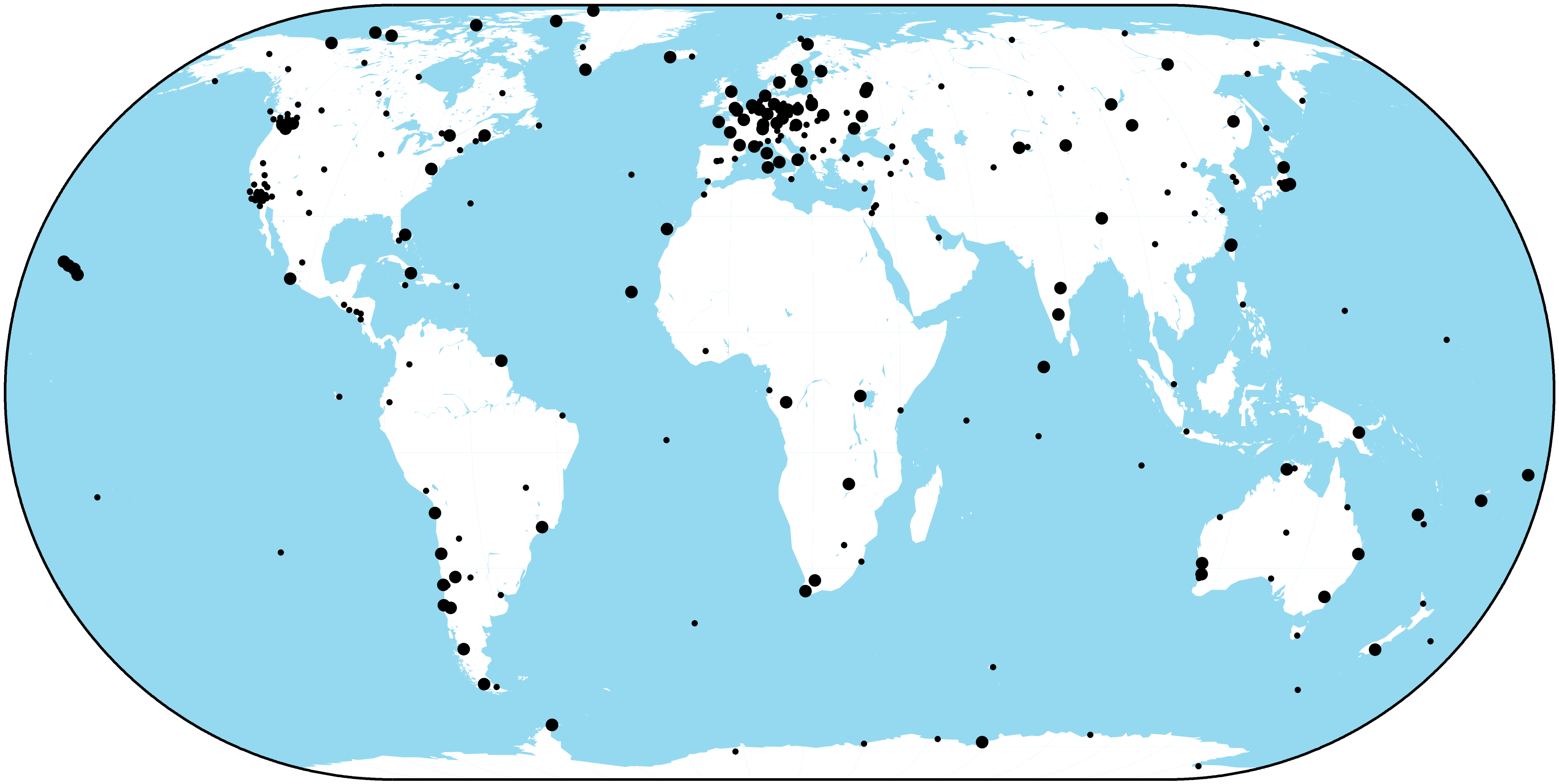


Figure 1. 112 stations (large circles) were added to the IGS network in 2001-2002, to form a total network of 242 stations (all circles).

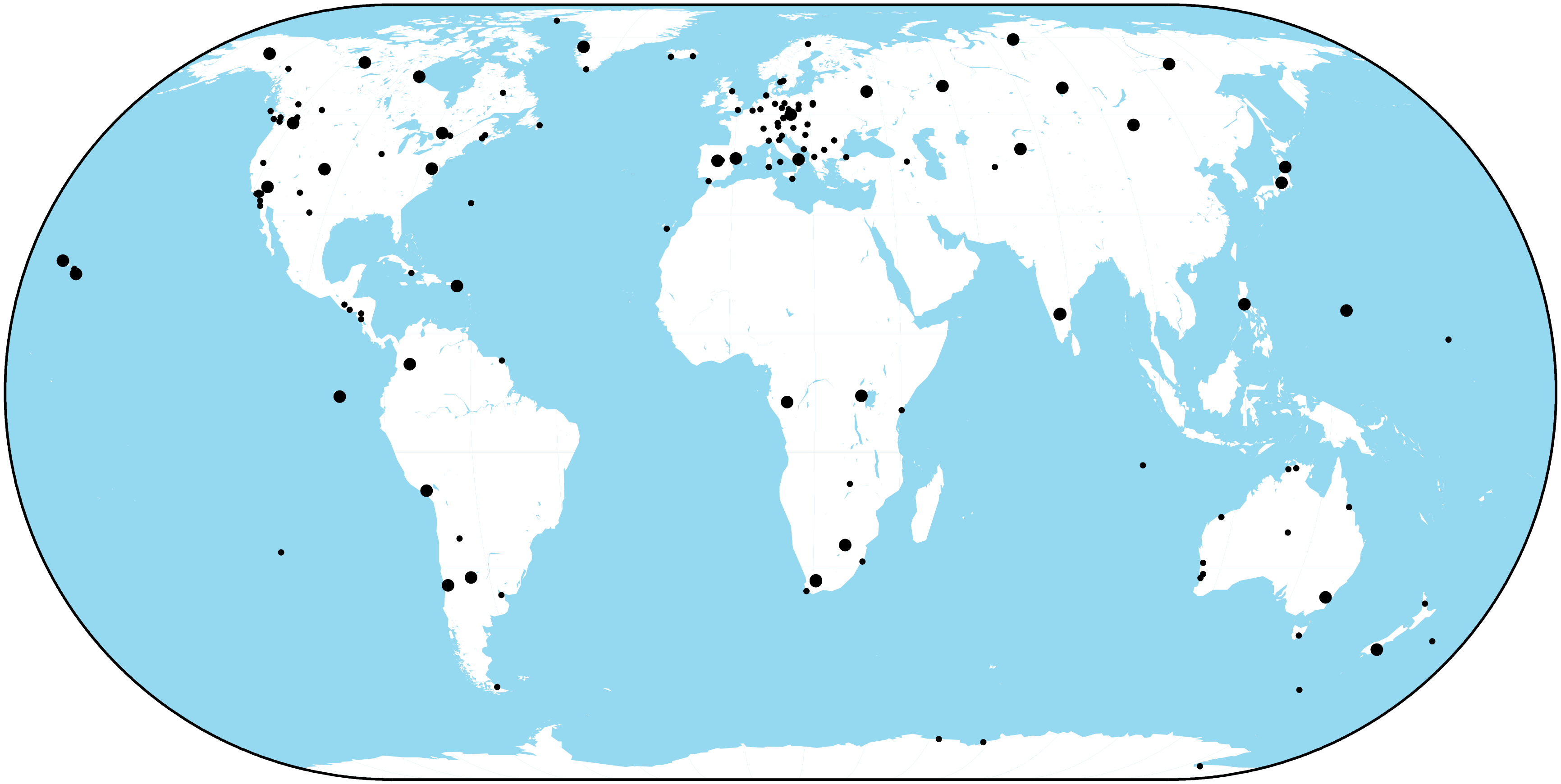


Figure 2. IGS stations contributing hourly (small circles) and sub-hourly (large circles) data during 2001-2002.

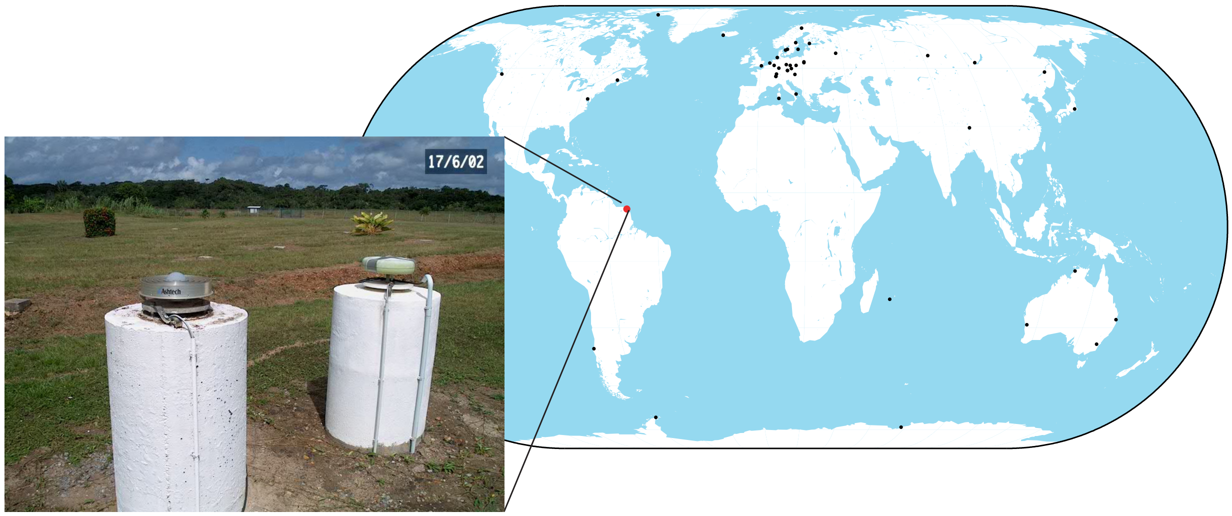


Figure 3. GPS/GLONASS tracking stations in the IGS (black circles) include the Kourou, French Guyana station, which features GPS/GLONASS tracking equipment alongside a long-standing GPS-only IGS site. Photo courtesy of ESA/ESOC.

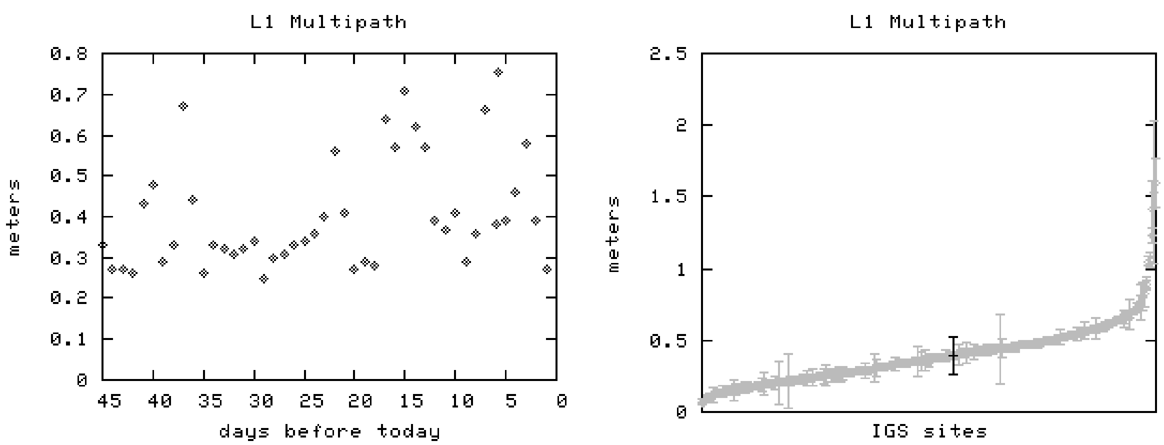
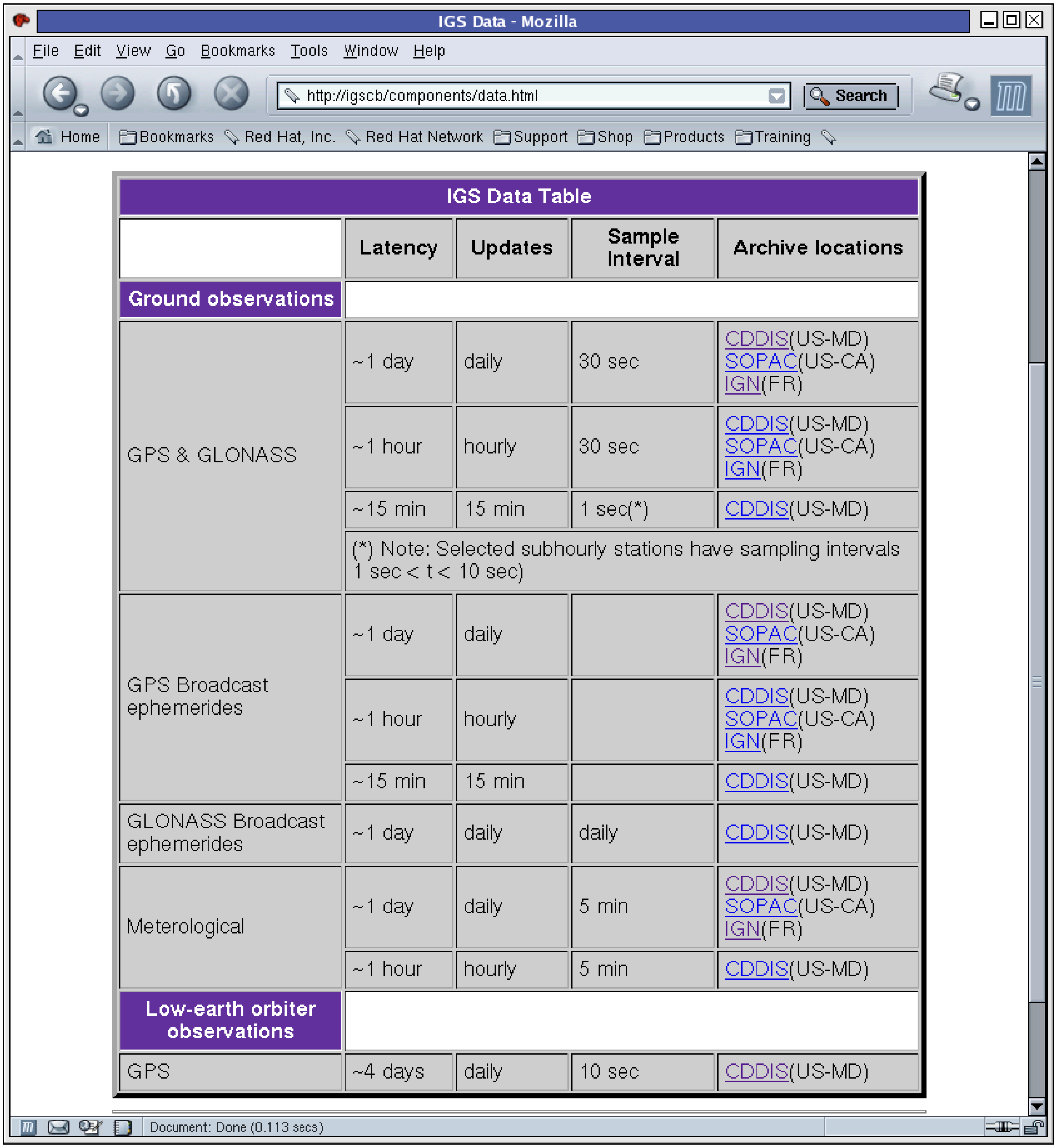


Figure 4. Graphs, updated daily at the Central Bureau website, show recent data characteristics of each sitevarying with time, and in comparison to other GPS sites.



IGS Data Table

	Latency	Updates	Sample Interval	Archive locations
Ground observations				
GPS & GLONASS	~1 day	daily	30 sec	CDDIS(US-MD) SOPAC(US-CA) IGN(FR)
	~1 hour	hourly	30 sec	CDDIS(US-MD) SOPAC(US-CA) IGN(FR)
	~15 min	15 min	1 sec(*)	CDDIS(US-MD)
	(*) Note: Selected subhourly stations have sampling intervals 1 sec < t < 10 sec)			
GPS Broadcast ephemerides	~1 day	daily		CDDIS(US-MD) SOPAC(US-CA) IGN(FR)
	~1 hour	hourly		CDDIS(US-MD) SOPAC(US-CA) IGN(FR)
	~15 min	15 min		CDDIS(US-MD)
GLONASS Broadcast ephemerides	~1 day	daily	daily	CDDIS(US-MD)
Meterological	~1 day	daily	5 min	CDDIS(US-MD) SOPAC(US-CA) IGN(FR)
	~1 hour	hourly	5 min	CDDIS(US-MD)
Low-earth orbiter observations				
GPS	~4 days	daily	10 sec	CDDIS(US-MD)

Figure 5. The data types table now available at the Central Bureau website, including access instructions for obtaining data from each Global Data Center.

NASA-Sponsored GPS Global Network Activities

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O. Ruud
University NAVstar Consortium, Boulder, CO, USA

R. Khachikyan
Raytheon Systems Company, Pasadena, CA, USA

Activities in 2002

Funding has been provided by NASA Earth Science Research (Code YS) Natural Hazards Program to JPL/Caltech and UNAVCO in support of these tasks.

NASA supported IGS sites established in 2002, and partner agencies:

AMC2 – Alternate Master Clock, Colorado, US Naval Observatory
BREW – Brewster, Washington, NRAO VLBA
GLPS – Puerto Ayora, Galapagos Island, Ecuador
GUAO – Urumqi, Xingjiang, China, Urumqi Astronomical Observatory
KELY – Kellyville, Greenland, The Sondrestrom Research Facility
SIMO – Simonstown, Hartebeesthoek RAO

NASA supported IGS sites upgraded with modern receivers:

CHPI – Cachioera Paulista, near Sao Paulo, Brazil, in collaboration with INPE
SEY1 – Seychelles, Seychelles National Oil Company, IRIS/IDA
EISL – Easter Island, Universidad de Chile, IRIS/IDA
QUIN – Quincy California, US Forest Service, Mt. Hough Ranger District
KOKB – Kokee Park, Hawaii
FAIR – Fairbanks, Alaska
AREQ – Areqipa, Peru
NSSP – Yerevan, Armenia, National Survey for Seismic Protection
SUTH – Sutherland, South Africa, Hartebeesthoek RAO

Site support emphasis is based on geographic coverage, multi-technique space geodesy instruments (SLR/VLBI) nearby, long-term site history, partnering opportunities, and IGS-related programs or pilot projects such as Ionosphere and Tide Gauge activities.

High-rate (1s sample rate) data continues to be available with global distribution. Initially installed in cooperation with GFZ as ground support for the CHAMP LEO mission, and in response to the IGS call for support of LEO missions in general, real-time GPS applications have provided the impetus to continue to expand the high-rate sub-network. In most cases, these sites are multi-function, providing 1s data with very low latency as well as the traditional hourly and daily 30 IGS RINEX file products.

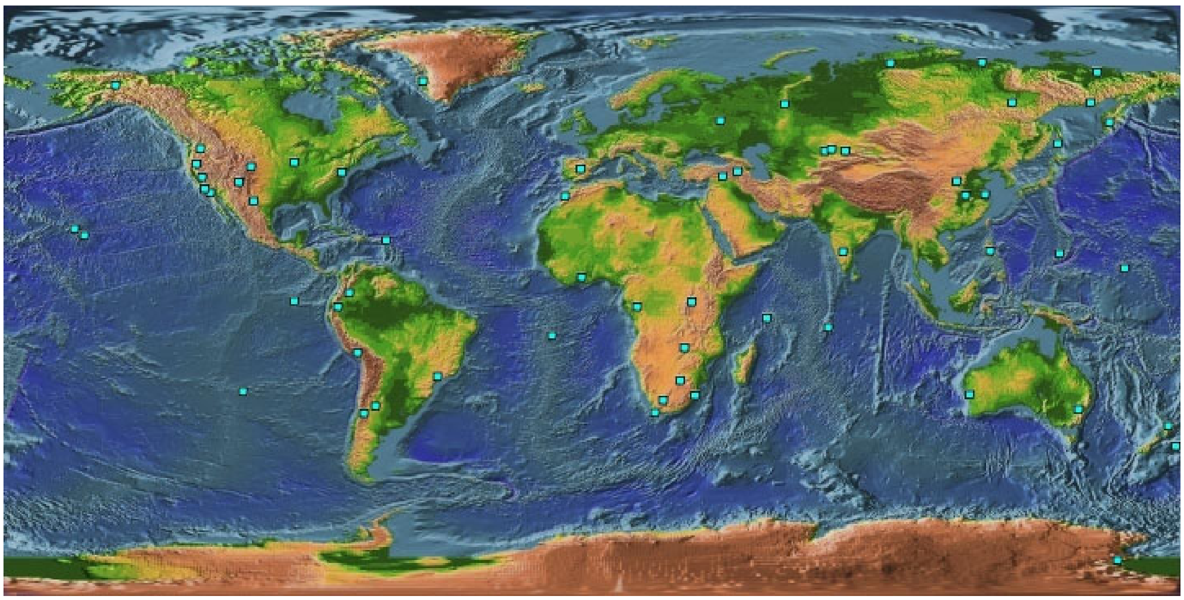

Figure 1. NASA Supported Site Distribution (non-exhaustive)

NASA Supported IGS sites (see Figure 1):

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amc2 ASHTECH Z-XII3T
aoa1 ROGUE SNR-8000
areq ASHTECH UZ-12
artu ASHTECH Z-XII3
asc1 AOA SNR-8000
auck ASHTECH Z-XII3
bili ASHTECH Z-XII3
bogt ASHTECH Z-XII3
brew ASHTECH UZ-12
casa ROGUE SNR-8000
chat ASHTECH Z-XII3
chpi ASHTECH UZ-12
chum ROGUE SNR-8000
cic1 ROGUE SNR-8000
cord ROGUE SNR-8000
cro1 ASHTECH Z-XII3
dgar AOA SNR-8000
dyr2 ROGUE SNR-8000
eisl ASHTECH UZ-12
fair ASHTECH UZ-12
glps ASHTECH Z-XII3
gode AOA SNR-8000
gol2 ROGUE SNR-12
gold ASHTECH Z-XII3
guam ASHTECH Z-XII3
guao ASHTECH UZ-12
harv AOA SNR-8000
hrao ASHTECH Z-XII3
iisc ASHTECH Z-XII3
jplm ROGUE SNR-8100
kely ASHTECH Z-XII3
kokb ASHTECH UZ-12
kunm ROGUE SNR-8000
kwj1 AOA SNR-8100
mad2 ROGUE SNR-12
madr ASHTECH Z-XII3
mag0 ASHTECH Z-XII3
mbar ASHTECH Z-XII3
mcm4 AOA SNR-12
mdo1 ROGUE SNR-8000
mkea ASHTECH Z-XII3
mobn ASHTECH Z-XII3
msku ASHTECH Z-XII3
nlib ROGUE SNR-8000
nril ASHTECH Z-XII3
nssp ASHTECH UZ-12
petp ASHTECH Z-XII3
pie1 ROGUE SNR-8000
pimo ASHTECH Z-XII3
pol2 ASHTECH Z-XII3
quin ASHTECH UZ-12
rabt ROGUE SNR-8000
rbay ROGUE SNR-8000
riop ROGUE SNR-8000
sant ASHTECH Z-XII3
sele ROGUE SNR-8000
sey1 ASHTECH UZ-12
shao ROGUE SNR-8100
simo ROGUE SNR-8000
suth ASHTECH UZ-12
*thu1 ROGUE SNR-8100
tid2 ROGUE SNR-12
tidb ASHTECH Z-XII3
tixi ASHTECH Z-XII3
usno ASHTECH Z-XII3T
usud ASHTECH Z-XII3
wes2 ROGUE SNR-8000
wuhn ASHTECH Z-XII3
xian ROGUE SNR-8100
yakt ASHTECH Z-XII3
yar1 ROGUE SNR-8100
ykro ROGUE SNR-8000
yssk ASHTECH Z-XII3
zamb ROGUE SNR-8000
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*thu1 deprecated to thu3 (an Ashtech UZ-12) and eventually turned off.

"Support" ranges from complete end-to-end equipment provision and operations, to simply supporting data flow (and just about everything in between).

New Zealand Continuous GPS Network

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Introduction

Years 2001 and 2002 have seen a major increase in the number of continuous GPS (CGPS) stations in New Zealand. This is due to a Land Information New Zealand (LINZ) project (PositioNZ) that has seen 12 new CGPS stations installed in the North Island by GNS. During 2003 and 2004, GNS will install a similar density of sites in the South Island, as well as few additional ones in the North Island.

In addition to the LINZ project, some 80 continuous sites will be installed over the next 5 years as part of the GeoNet project operated by GNS and funded primarily by the New Zealand Earthquake Commission (EQC). These stations will be sited to provide detailed measurements of tectonic deformation related to the Hikurangi subduction zone, and volcanic/tectonic deformation within the Central Volcanic Region.

For more information on the GeoNet project, see www.geonet.org.nz. For more information on the LINZ PositioNZ project, see www.linz.govt.nz/positionz.

Data Availability

Data from a subset of the New Zealand stations will be submitted to IGS from 2003, and all the New Zealand continuous data are publicly available from the GeoNet ftp site, ftp.geonet.org.nz/gps/rinex/. IGS-style site logs are stored at the same site in directory gps/docs/site_log/. Data from the PositioNZ sites are also available through the LINZ web site. Some of the New Zealand continuous data are already contributed to the Scripps Orbit and Permanent Array Center (SOPAC, garner.ucsd.edu), and we expect that all the data will become available at this site in the future.

The stations to be submitted to the IGS from 2003 are:

- AUCK and CHAT, as at present
- WGTN, HOKI and MQZG (which have been contributed for a number of years to the Asia-Pacific Regional Geodetic Project)
- NPLY

One additional South Island site (probably the new Otago University station – see below) will also be contributed to IGS after the South Island stations are installed.

Of these sites, NPLY is more-or-less on the Australian plate, MQZG and Otago University are more-or-less on the Pacific plate, and WGTN and HOKI are within the plate boundary deformation zone.

Present Status of Network

The New Zealand continuous GPS network at June 2003 is shown in the Figure 1, and the following sections provide notes on some of the stations.

AUCK and CHAT

AUCK and CHAT are the original New Zealand IGS stations, installed in 1995 in partnership between GNS, LINZ, JPL, and UNAVCO. These are the only New Zealand stations whose data are presently submitted to the IGS. Both stations were upgraded from Turborogue SNR-8000 receivers to Ashtech Z-12 CGRS receivers during 2001.

Sea Level Network

Since about 2000, GNS and Otago University have operated CGPS receivers at four of New Zealand's longest-running tide gauges. These are stations DUNT, LYTT, WGTT, and TAKL on the figure. Funding for this network is from the New Zealand Foundation for Research, Science and Technology (FRST). The data from these stations are contributed to the IGS TIGA pilot project, together with data from nearby high-quality stations OUSD, MQZG, WGTN and AUCK.

Southern Alps Network

The Southern Alps network (QUAR, KARA, WAKA, CNCL, NETT, HORN and MTJO) is primarily aimed at measuring the distribution of vertical motion across the Southern Alps in order to better understand processes of continental collision. (Note that only QUAR and MTJO are labelled on the figure.) The experiment started in February 2000 and will run at least 5 years. It is a joint project between MIT, the University of Colorado, Otago University, GNS, and UNAVCO. The funding source is an NSF grant to Peter Molnar (with U.S. co-investigators Brad Hager and Tom Herring), with the New Zealand institutions funded initially by an Otago Research Grant and now by FRST. As well as the continuous stations, a number of "semi-continuous" stations are operated for several months per year. After 3.5 years, this network has been able to measure a vertical motion profile across the Southern Alps with vertical rate uncertainties better than 1 mm/yr (1 s) from both the continuous and semi-continuous stations.

Otago University Station

OUSD is the longest-running CGPS station in New Zealand, dating from January 1995 some 8 months before AUCK and CHAT were established. This station is located on the roof of a building, and it is planned to install a new bedrock station nearby during 2003-04. The old and new sites will then be run in parallel for a considerable time period.

Acknowledgements

Paul Denys (University of Otago) and Graeme Blick (Land Information New Zealand) have also contributed to this report.

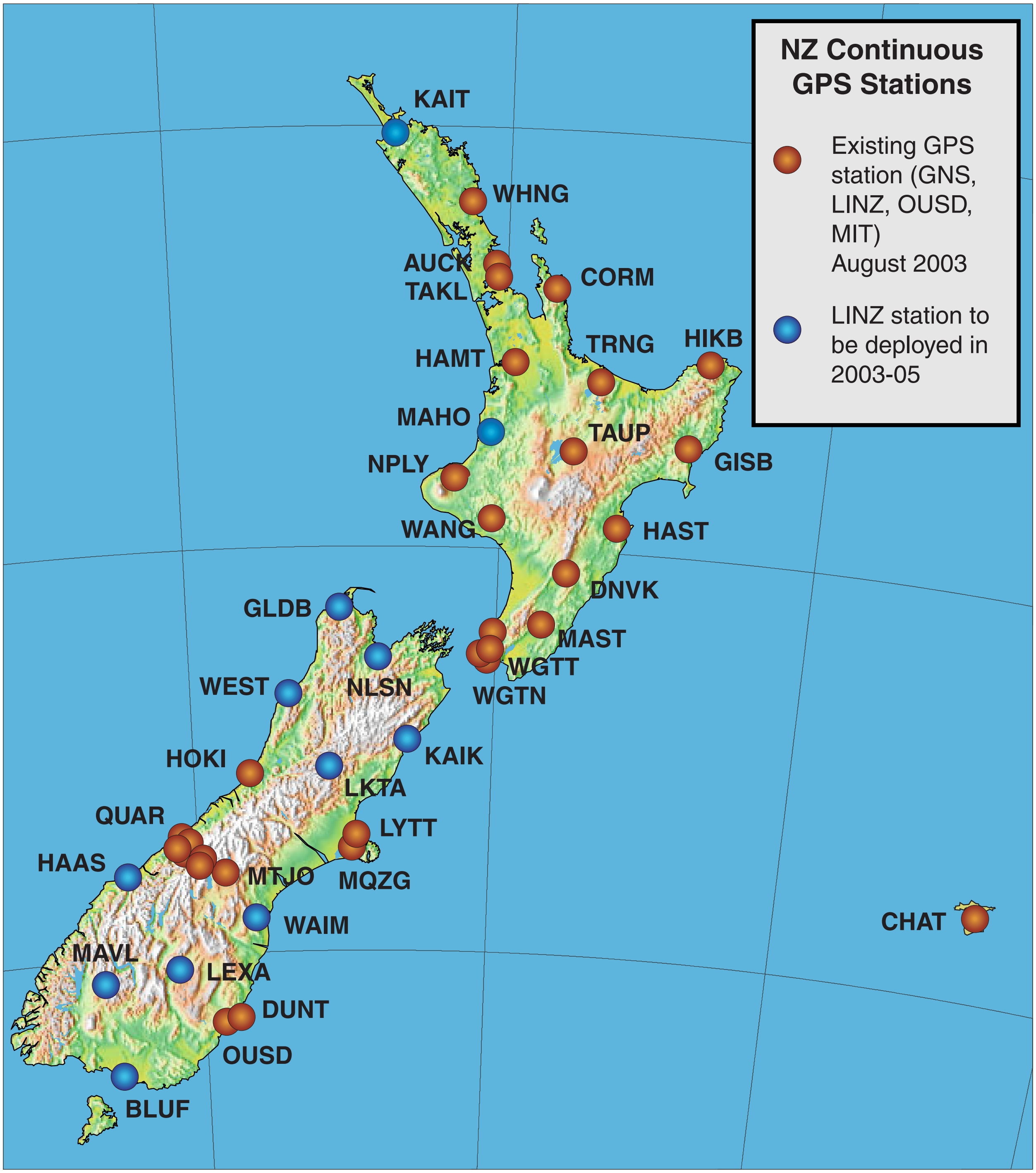

Figure 1. The New Zealand continuous GPS network at June 2003

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INDIVIDUAL STATION REPORTS

The NERC Space Geodesy Facility

Robert Sherwood and Graham Appleby

The NERC Space Geodesy Facility (NSGF) at Herstmonceux, UK, continues to manage two geodetic-quality, continuously operating, GNSS receivers; an Ashtech Z12 receiver (IGS Station HERS) and an Ashtech Z18 joint GPS/GLONASS receiver (IGS Station HERT).

During the period the Ashtech Z18, originally designated station HERP, was moved some 100m from an inferior position close to the laser ranging and radar domes and re-sited at the top of a two-storey unoccupied building, close to an SLR ground calibration target.

Figures 1 and 2 show the NSGF as seen from the HERT antenna and the antenna itself. The HERS antenna is mounted on a rigid tower above the level of the laser ranging telescope.

Figure 1. HERT antenna

Figure 2. NSGF viewed from the location of HERT

The Z18 receiver and its co-located PC are linked to the Facility LAN via a fibre-optic link The system is programmed to contribute both hourly and daily 30-second RINEX GPS/GLONASS data to IGS/IGLOSS as well as to maintain a local archive of 1-second sampled data. Judging from IGS results, this system is now working extremely well, with much reduced multi-path effects and good sky coverage.

In addition, it is planned during 2003 to use the HERT system in the EUREF-IP pilot programme to stream RTK data directly into the Internet for rapid re-broadcast for general real-time navigational applications–see
http://www.epncb.oma.be/projects/euref_IP/euref_IP.html

Local Quality Control

The quality of the data obtained by these receivers is of course monitored routinely via coordinate and orbit determination solutions by the various IGS ACs and AACs. However, every effort continues to be made on site at Herstmonceux to ensure the quality of the SGF data. Following an extended period of inferior quality data from HERS, which ended at the discovery of an antenna problem during 2001, the group has developed its own automatic QC software as a tool to maximise the probability of early detection of problems. Each day from the 30-second HERS and HERT RINEX files, local ‘sky maps’ are computed that show at a glance whether or not all GPS and GLONASS satellites were tracked continuously during the previous 24 hours. The plots are available, along with some further diagnostic results, each day from the Facility website at http://nercslr.nmt.ac.uk