

SERVICES & FACILITIES ANNUAL REPORT - FY April 2011 to March 2012

SERVICE	FUNDING BLOCK	AGREEMENT	ESTABLISHED as S&F	TERM
BIGF		R8/H10/59	2002 (operating since 1998)	5 years

TYPE OF SERVICE PROVIDED:

BIGF is a unique and secure repository of archived, raw GNSS* data, dating back as far as 1997. All data are quality-assured, accompanied by metadata, and form the bases of in-house derived products. BIGF serves all these to the complete user-spectrum - across academia, government, and business, with impact on research and development, policy and the wider societal good. The raw data are sourced from a high density network of around 160 continuously recording GNSS stations, sited throughout the British Isles. The archive comprises 1,350 station-years of 30 second (primarily GPS) data, and 280 station-years of 1Hz (GPS+GLONASS) data. The raw data are provided to BIGF free-of-charge by a number of collaborators, including the three national Ordnance Surveys (30 second data with 30 days delay and 1Hz data with 125 days delay) and the Met Office. Users can request data and products using an online form. The service provided can be summarised in a 4-part Facility remit:



The BIGF station network

- 1.To reduce the costs of specific research, enabling a larger volume of research to be done with the same funding budget, by providing an assured repository of raw data and derived products when users bid for funding for new research, in which the costs of setting up and manning an ad-hoc observation network are reduced or eliminated, and overheads involved in deriving own products are eliminated.
- 2.To facilitate the least time delay in the examination of environmental and other minable variables, by providing extensive backward tracts of raw data and derived products, improving the rate of return on invested funds and the rate of project completion.
- 3.To provide a failsafe resource to protect researchers from the costs and delays of having to repeat failed data collection exercises, and its impact on research, and to improve the positioning quality obtained in historic or current research.
- 4.To inform and stimulate the research community across the spectrum of science using various media.

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

1. To increase the quantity of data in the archive: daily data files from around 160 CGNSS stations continued to be uploaded, at a nominal annual rate of 59k station-days. The protracted negotiations with OS Ireland (OSi) for access to their 16 stations have been successful, with historic data now archived back to 2007.
2. To improve metadata: to support users requesting data, we provide a network map, station log files and data listing by year and station. The veracity of all updated log files is monitored, assuring an accurate record of any change at each station. Over the last year we have improved the user interface, with the development of an interactive network map based on Google Maps.
3. To increase archive uptake and usage: cumulative demand to 2011/12 was 11,700 station-years of data. The number of unique projects enabled has increased from 8 in 2002/3 to 91 by 2011/12, with an average of about 78 scientific projects a year, indicating an increasing awareness of the Facility, influenced by our varied activities to promote the archive's existence and to demonstrate its utility by example. Over the last year we have also provided the first derived products to the user community, with 2 user-projects taking 1,800 station-years of derived products, and there were 24 publications, including 3 completed PhD theses.
4. To meet the 'future developments/strategic forward look' from the 2010/11 annual report:
 - a) The MoUs with all existing collaborators have been agreed in principle, to 2014.
 - b) The new website was launched with procedures to handle requests for 1Hz data and derived products.
 - c) Work is continuing on procedures to self-create RINEX data directly from the OSGB real-time data streams.
 - d) The second 'releasable' derived products, focussing on long term trends (LTT) in station coordinates and velocities, and LTT and near real-time trends in tropospheric parameters, were completed.
 - e) All 109 OSGB stations and 6 of the scientific stations are now capable of tracking Galileo, when satellites and signals become available, and plans are in place to upgrade the 9 other scientific stations at tide gauges.

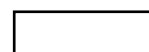
*Global Navigation Satellite Systems, including GPS, GLONASS and Galileo.

SCORES AT LAST REVIEW (each out of 5)			Date of Last Review:	2008
Need 4.5	Uniqueness 5.0	Quality of Service 4.0	Quality of Science & Training 4.5	Average 4.5

CAPACITY of HOST ENTITY FUNDED by S&F	Staff & Status	Next Review (March)	Contract Ends (31 March)
100%	Professor A Dodson, Director, 3% NERC; Dr R Bingley, Deputy Director, 22% NERC; Dr D Baker, Manager, 60% NERC; Ms D Hansen, Developer, 60% NERC	2013	2014

FINANCIAL DETAILS: CURRENT FY							
Total Resource Allocation £k 117.20		Unit Cost £k			Capital Expend £k 0	Income £k 0	Full Cash Cost £k 132.51
		Unit 1 0.000060	Unit 2 0.000060	Unit 3			
FINANCIAL COMMITMENT (by year until end of current agreement) £k							
2011-12	117.20	2012-13	118.13	2013-14	118.36	2014-2015	2015-2016

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen
NSGSC	6	1	NSGF



APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2011/12)													
	10	9	8	7	6	5	4	3	2	1	0	R*	Pilot
NERC Grant projects*													
Other academic			25	3									
Students			3	2									
TOTAL			28	5									

PROJECTS COMPLETED (current FY – 2011/12)												
	10 (α5)	9 (α4)	8 (α4)	7 (α4)	6 (α3)	5 (α2)	4 (α1)	3 (α1)	2 (β)	1 (β)	0 (Reject)	Pilot
NERC Grant projects*												
Other Academic			3	2								
Students			3									

Project Funding Type (current FY – 2011/12) (select one category for each project)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	PhD Students NERC	Other	NERC Centre	Other	NERC Grant*	PhD Students NERC	Other	NERC Centre	Other
91		1	6	5	79					

Project Funding Type (per annum average previous 3 financial years - 2008/2009, 2009/2010 & 2010/2011)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	PhD Students NERC	Other	NERC Centre	Other	NERC Grant*	PhD Student NERC	Other	NERC Centre	Other
95.67	1.00	0.67	5.00	3.00	86.00					

User type (current FY – 2011/12) (include each person named on application form)				
Academic 28	NERC Centre 5	NERC Fellows 0	PhD Students 7	Other Non-PhD students 8 Collaborators 7 Central and local Govt 16 OS user 20

User type (per annum average previous 3 financial years - 2008/2009, 2009/2010 & 2010/2011)				
Academic 29.67	NERC Centre 3.00	NERC Fellows 0.00	PhD Students 5.67	Other Non-PhD students 6.33 Collaborators 11.67 Central & local Govt 16.00 OS user 23.33

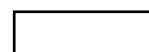
OUTPUT & PERFORMANCE MEASURES (current year)										
Publications (by science area & type) (calendar year 2011)										
SBA 0	ES 12.5	MS 0.5	AS 9	TFS 2.0	EO 0.0	Polar 0	Grand Total 24	Refereed 5	Non-Ref/ Conf Proc 16	PhD Theses 3
Distribution of Projects (by science areas) (FY 2011/12)										
Grand Total	SBA	ES	MS	AS	TFS	EO	Polar			
91	1.0	15.5	21.5	16.0	37.0	0.0	0.0			

OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)										
Publications (by science area & type) (Calendar years 2008, 2009 & 2010)										
SBA 0.17	ES 13.67	MS 1.67	AS 4	TFS 6.50	EO 0.83	Polar 0.17	Grand Total 27.00	Refereed 7.67	Non-Ref/ Conf Proc 12.00	PhD Theses 7.33
Distribution of Projects (by science areas) (FY 2008/2009, 2009/2010 & 2010/2011)										
Grand Total	SBA	ES	MS	AS	TFS	EO	Polar			
95.67	1.500	13.361	15.693	12.417	49.554	3.141	0.000			

Distribution of Projects by NERC strategic priority (current FY 2011/12)								
Grand Total	Climate System	Biodiversity	Earth System Science	Sustainable Use of Natural Resources	Natural Hazards	Environment, Pollution & Human Health	Technologies	Not classified
91	6.973	3.000	13.000	3.00	23.473	4.333	17.220	20.000

*Either Responsive Mode or Directed Programme grants

NOTE: All metrics should be presented as whole or part of whole number NOT as a %



OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2011/12):

BIGF supported not only frontline UK academic research (24% of projects), NERC centres (6%) and EU/International academic research (23%), but also the wider community in projects related to UK government and policy (25%) and industry (22%). This support impacts positively on, and benefits, the society it serves, in relation to important current issues such as conservation; coastal management; marine, air, road and rail transport and safety; renewable energy; aspects of pollution related to public health and integrated constructed wetlands; flood risk, alert and management; weather forecasting; and threats to industry and society from cyclical solar activity. BIGF has also provided advice to government, by assisting the Environment Agency in establishing a new CGNSS station, as part of a scheme to monitor the structural deformation of the Thames Barrier.

To provide this support, BIGF activities include: data archival; network, product and website development; archive access; and archive accounting.

Data archival: Daily data archival continued from around 160 CGNSS stations, comprising two data sets: 30 second, primarily GPS, with a current volume of about 1,350 station-years, with some stations operating since 1996/7; and, 1Hz GPS+GLONASS data from around 115 CGNSS stations, with a current volume of about 280 station-years, with some stations operating since August 2009.

Network development: Minor changes have taken place at many sites, but the Facility station log file monitoring system continues to enable 'clean' metadata to be stored; this is crucial to users interested in the extraction of long-term environmental signatures.

Product development: The development of derived products is well advanced, focussing initially on long term trends (LTT) in station coordinates and velocities, and LTT and near real-time (NRT) trends in tropospheric parameters. The second 'releasable' LTT products are based on time series computed from 1997-2010 data with an in-house modified version of Bernese Software version 5.0, using a global network, ITRF2008, 1st order ionosphere and VMF1G for troposphere. These have again been quality assured through comparison with parallel in-house processing using GIPSY/OASIS II.

Website development: The new website was launched in mid-2011, this both improves the user experience and includes information and access methods to high rate GPS+GLONASS data and derived products. In the interim we have continued its development with the introduction of an interactive network map based on Google Maps.

Archive access: Access to the archive is via an online request form. The request and delivery process is intentionally maintained as a personalised transaction, with capacity for verbal and e-mail dialogue on all aspects of supply, data processing and field operations, and to enable the easy gathering of user information to support NERC's reporting needs. A number of major research projects led by national and international scientists also continue to be automatically served on-going data.

Archive accounting: This is underpinned by a database designed to fulfil NERC's reporting needs, with user demand summarised in the following figures.

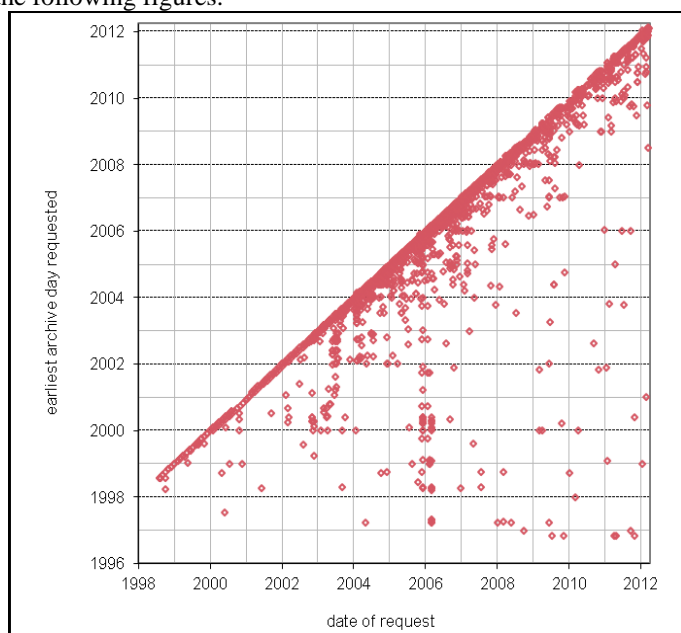


Figure 1 Archive utility across time (instantaneous)

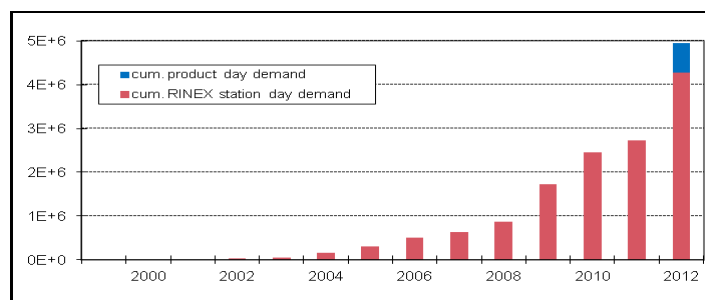


Figure 2 Cumulative raw data and product demand (FYE)

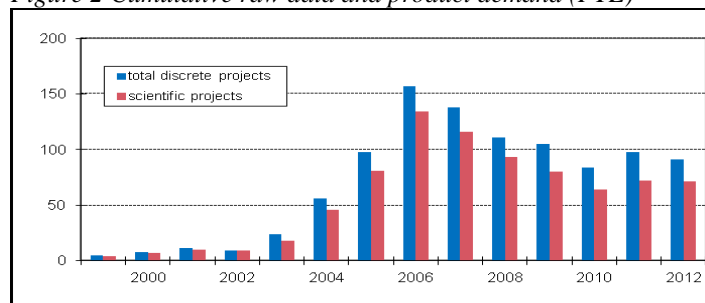


Figure 3 Project support (FYE)

Fig. 1 clearly demonstrates a continuous need for the archive through the significant number of users requiring data of several years vintage, and in a number of cases to its full temporal extent. Figs. 2 and 3 show project usage since the archive was created in 1999, and that since becoming a Facility in 2002, scientific projects have annually represented about 80% of archive workload.

SCIENCE HIGHLIGHTS:

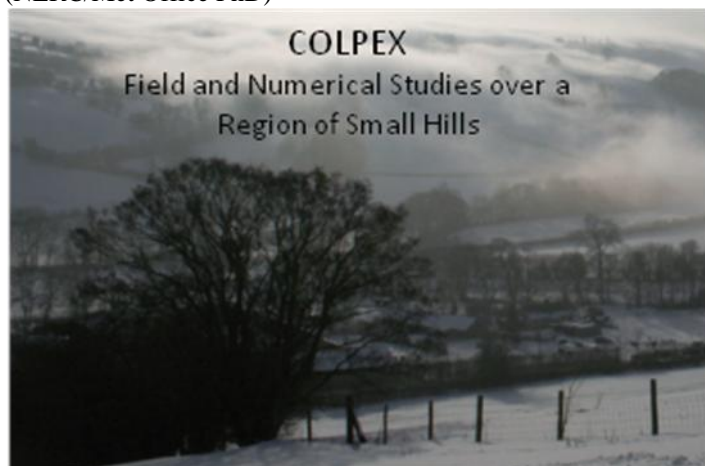
There were 71 scientific user-projects supported in 2011/12, and an output of 3 PhD theses, 5 refereed and 16 non-refereed publications, of which the 3 most significant (with their ISI 2010 JCR impact factors shown in []) were:

- Yan, J., et al. Accelerating uplift in the North Atlantic region as an indicator of ice loss. *Nature Geoscience*, Vol.3, Issue 6, DOI: 10.1038/NGEO845. [10.392].
- Price, J.D., et al. COLPEX Field and Numerical Studies over a Region of Small Hills. *Bulletin of the American Meteorological Society*, Volume: 92 Issue: 12, DOI: 10.1175/2011BAMS-D-10-3032.1. [5.078].
- Williams, S.D.P. and Penna, N.T. Non-tidal ocean loading effects on geodetic GPS heights, *Geophysical Research Letters*, DOI:10.1029/2011GL046940. [3.505].

The remainder of this section provides brief summaries of 4 significant research projects supported by BIGF in 2011/12:



Cold air pooling over complex terrain (NERC/Met Office PhD)



This project is an experimental campaign to make detailed observations of cold air pooling and fog formation in small scale valleys. Analysis of the observations along with high resolution numerical simulations will be used to improve the forecasting of such weather situations. One of the important quantities measured in the experiment is surface pressure. This has dynamical variations due to local flow features. In order to study these, the hydrostatic pressure term must first be removed. To do this requires very accurate measurements of the height of the stations, BIGF data were used in the estimation of these.

Digital Integrated Stratigraphy Project (NERC BGS)



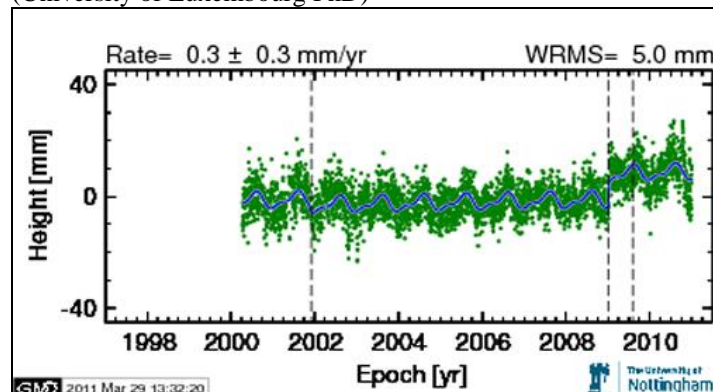
The Digital Integrated Stratigraphy Project (DISP) is a web-based, open access, digital resource for stratigraphy. It aims to eliminate stratigraphic ambiguity associated with sample position within a stratigraphic section. DISP is part of the International Geoscience Programme (IGCP) Project 591 - The Early to Middle Palaeozoic Revolution. The project uses cutting-edge surveying and visualisation technology to improve the resolution of Early to Middle Palaeozoic stratigraphic research in the UK and overseas and will lead to a much improved understanding of global change and evolution of life using evidence from the geological record. BIGF data were used to georeference and orientate laser scans.

Science, participation, and a new approach to river restoration (NERC/ESRC PhD)



This project aims to investigate the role of experiential knowledge combined with scientific knowledge in environmental decision making. The project will use a case study in which information provided by a focus group will be used in conjunction with numerical modelling to form research questions around a weir restoration problem, and determine the changes that may occur to flow and morphology on a specific stretch of river on which a weir is to be restored. BIGF reference station data will be used to position local base stations which will be used as control for data gathering to create a digital elevation model of the river bed, to be used in the modelling process.

Change detection analysis in geodetic time series (University of Luxembourg PhD)



This project aims to investigate automated analysis of time series from GPS and gravity measurements. In this analysis, outliers in the coordinates as well as discontinuities in the time series are detected and corrected for. The stochastic noise is then estimated using various methods such as Maximum Likelihood Estimation (MLE) and Monte Carlo Markov Chains (MCMC). The latter has the advantage that all parameters can be estimated simultaneously while still computing an uncertainty for the spectral index, which is not the case for the method based on MLE. Using BIGF CGPS coordinate time series products, outliers will be corrected and discontinuities detected, then various methods for estimation of stochastic noise will be compared.

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

1. To put in place procedures to self-create RINEX data directly from the OSGB real-time data streams, by 31/12/2012.
2. To develop the third 'releasable' Level 1 and Level 2 derived products, focussing on long term trends (LTT) in station coordinates, and LTT and near real-time tropospheric parameters, by 31/12/2012.
3. To consider the creation of the remaining identified Level 3 derived products, and to refine and develop the website to handle these in a variety of realisations, focussing on tropospheric parameters.
4. For the long term future, to expand data collection to include Galileo in addition to GPS and GLONASS.

Non-Mandatory Facility-specific OPMs: utilisation, allocation of capacity etc

1. Mission Statement

To provide a unique and secure repository for archived, quality-assured, raw GNSS (Global Navigation Satellite System) data, metadata and derived products dating back to 1997, from a network of continuous GNSS (CGNSS) stations sited throughout the British Isles, and to provide the interface between the archive and archive users, thereby facilitating research into the past, the present and the future, serving the complete user-spectrum - across academia, government, and business, with impact on research and development, policy and the wider societal good.

2. Steering Committee membership and Terms of Reference

Steering Committee Members:

Dr Matt King (Chair)
School of Civil Engineering and Geosciences
Newcastle University
Newcastle-upon-Tyne NE1 7RU

Dr Zhenhong Li
School of Geographical and Earth Sciences
University of Glasgow
Glasgow G12 8QQ

Mr Steve Groom
Plymouth Marine Laboratory
Prospect Place
Plymouth PL1 3DH

Dr Helen Snaith
National Oceanography Centre, Southampton
Empress Dock
Southampton SO14 3ZH

Prof Chris Hughes
National Oceanography Centre, Liverpool
Joseph Proudman Building, 6 Brownlow Street
Liverpool L3 5DA

Dr Zuheir Altamimi
Institut Geographique National, ENSG/LAREG
6-8 Avenue Blaise Pascal
77455 Champs-sur-Marne, France

Mr Matthew Wilkinson (Secretary)
NERC Space Geodesy Facility
Herstmonceux Castle, Hailsham
East Sussex BN27 1RN

Terms of Reference:

To promote awareness in the UK scientific community of activities in space geodesy by:

- reviewing multi-technique space geodesy initiatives.
- organising, in collaboration with relevant learned societies, technical meetings and appropriate review papers.

To review work proposals of NSGF and of BIGF and establish priorities, for the Heads of the two Facilities, for the allocation of resources funded from the NERC Science & Innovation Funding Directorate science budget.

To monitor the level of user satisfaction with and the quality of output from the NSGF and BIGF services and to analyse the user bases.

To give guidance to the Heads of both NSGF and BIGF on improvements of the Facilities' equipment and service functions.

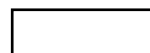
To advise Director, Science Delivery on:

- broad aspects of UK involvement in Space Geodesy.
- the level and direction of the internal R&D programmes for both NSGF and BIGF.
- anticipated changes in requirements from each of the two Facilities and the anticipated levels of future demand for each of them.
- technical developments in the precise tracking of satellites and on procurement in this area.
- technical developments in the use of networks of continuous receivers for scientific applications of GNSS satellites and on procurement in this area.

To receive annually, and comment upon, reports from both the Head of NSGF and from the Head of BIGF before they are submitted to Director, Science Delivery, and to provide advice at other times to each Facility as appropriate.

3. Equipment Inventory

a. In-kind contributions from BIGF collaborators – data from around 160 CGNSS stations, each consisting of: dual-frequency GPS (or GPS+GLONASS, or GPS+GLONASS and Galileo ready) receiver, choke ring antenna, local data storage and communications hardware, with data transfer to BIGF enabled free of charge.



b. Resources at the University of Nottingham:

- 2 Linux Network Attached Servers of 30Tb each, serving as primary and secondary archives for 30-second and 1Hz RINEX data and derived product storage (housed in the Nottingham Geospatial Building (NGB), on Jubilee Campus).
- 2 Linux Network Attached Servers of 30Tb each, serving as tertiary and quaternary archives for 30-second and 1Hz RINEX data and derived product storage (housed in the Data Centre, on King's Meadow Campus).
- 1 Linux workstation with 80Gb of longer-term data storage, serving as an ftp holding area for users given access to 30-second RINEX data.
- 1 Linux workstation acting as web server.
- 4 Linux servers, for product development.
- DVD writer – provides further backup (comprising 3 copies) of 30-second RINEX data on DVD, with one copy being held at NODC, and 2 copies held offsite in Nottingham.

4. Future Developments

The success of the Facility in 2011/12 was based on the following operational tasks:

- a) Maintain the existing archive of data from the BIGF network.
- b) Maintain the on-going memorandums of understanding with collaborators to provide new data to the archive, free of charge.
- c) Develop and maintain mechanisms for the collection of new data for the archive.
- d) Develop and maintain mechanisms to provide data to international networks on European and global scales.
- e) Carry out associated R&D to improve the Facility.
- f) Develop and maintain the website.
- g) Develop and maintain mechanisms to service user requests.
- h) Stimulate increased user demand.

During 2012/13 proposed Facility development will be focussed on enhancements to the Facility related to the above operational tasks as follows:

- a) We will maintain the four 30Tb Linux Network Attached Servers, so that each machine holds a complete copy of the archive: two machines will remain on the Jubilee Campus, and two offsite at the separate King's Meadow Campus. We will also investigate ways to create offline back-ups of 1Hz data and derived products.
- b) Under existing MOUs all collaborators continue to cooperate with BIGF in their supply of new data to the archive, with the continued understanding that 30 second data can be supplied to any user after 30 days, whereas the 1Hz data and derived products can only be supplied to approved scientific users, and in the case of 1Hz data only after 125 days. As we intend to self-create hourly RINEX files, needing direct access to the RTCM data stream from the OSGB servers, it may be that OSGB will require a service level agreement to allow this, as this data stream is even more commercially sensitive than the hourly 1Hz data.
- c) Current procedures to handle 1Hz data from OSGB with a 125 day delay follow the same procedures as for 30-second data, with OSGB creating the hourly RINEX files and BIGF downloading these by ftp on an hourly basis. The next phase will be for BIGF to self-create the hourly RINEX files using direct access to the RTCM data stream from the OSGB servers. This phase has been tested and should become operational in late 2012.
- d) We will continue to provide user-specific access to national and international scientists requesting extensive backward and/or forward tracts of data, as part of international networks on regional or global scales. We have already provided derived products to two projects, taking 24k (Atmospheric Science) and 623k (Earth Science) product days, and we will be collaborating with the University of Luxembourg as a joint IGS TIGA Analysis Centre, with the supply of BIGF derived products of long term trends in station coordinates at tide gauges in the UK, as part of this international research initiative.
- e) Through the modification of Bernese software to enable further enhanced modelling of the troposphere i.e. using GPS/GMF and VMF1G mapping functions, we have produced a range of first and second 'releasable' derived products, as: daily coordinate time series for the period 1997 to 2010, based on a global network daily processing solution; near real-time hourly tropospheric integrated water vapour, from 1st May 2009, based on a regional network daily processing solution; and 1-hourly tropospheric zenith delay time series for the period 1997 to 2010, based on a global network daily processing solution. We will develop third 'releasable' derived products through further enhanced modelling of antenna phase centre variations (I08.ATX as opposed to I05.ATX), the use of an improved reference frame (IGb08 as opposed to ITRF2008), the extension of the period beyond 2010, and the inclusion of stations in Ireland.
- f) We will continue website development, with especial regard to the presentation of sample derived products, and access to their various levels, and in particular considering the creation of the remaining identified Level 3 derived products, as: time series and maps of regional, long term trends in tropospheric zenith total delay, zenith wet delay and integrated water vapour; and contemporary time series and maps showing the temporal and spatial variations in tropospheric zenith total delay and integrated water vapour estimates for the past week.
- g) We will continue to service user requests in line with the approved peer review procedure, offer advice and support when services are requested, provide capacity to handle very large user requests, and provide regulated high level access to some users.
- h) We will continue to disseminate information to demonstrate BIGF's utility as widely as possible, at least cost to the Facility and NERC, capitalising on any free marketing opportunities, and targeting the widest range of relevant scientific workshops, fora and conferences, and identifying and targeting scientists who could potentially use BIGF derived products in enabling their research. We will be attending the NCEO Conference in September, with a particular aim to raise awareness of the change in the Facility's role from one of providing quality assured raw data to one of providing this plus derived products.



5. Summary of Performance Information

Academic (28, 23 peer-reviewed)

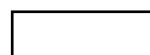
1. Archaeological assessment of Dartmoor peat; Hartley, Mr, R; University of Plymouth [TFS/SBA]
2. British Isles motion and rotation pole; Houlie, Dr, N; University of Leeds, Earth and Environment [8, ES].
3. Densification of European Permanent GNSS Network for ionospheric studies; Bergeot, Dr, N; Royal Observatory of Belgium. [8, AS].
4. Detection of storm surge loading with GPS; Penna Dr, N; Newcastle University, Geomatics. [7, ES].
5. E-GVAP near real-time atmospheric water vapour (formerly COST Action 716/CSIP); Bruyninx, Dr, C; Royal Observatory of Belgium; COST Action 716/CSIP). [8, AS].
6. E-GVAP near real-time atmospheric water vapour (formerly COST Action 716/CSIP); Dick, Dr, G; GFZ Potsdam (German Research Centre for Geosciences). [8, AS].
7. E-GVAP near real-time atmospheric water vapour (formerly COST Action 716/CSIP); Dousa, Dr, J; Geodetic Observatory Pecny. [8, AS].
8. E-GVAP near real-time atmospheric water vapour (formerly COST Action 716/CSIP); Pacione, Dr, R; Agenzia Spaziale Italiana. [8, AS].
9. E-GVAP near real-time atmospheric water vapour (formerly COST Action 716/CSIP); de Haan (KNM1), Dr, S; Royal Meteorological Institute of the Netherlands. [8, AS].
10. E-GVAP near real-time atmospheric water vapour (formerly COST Action 716/CSIP); de Haan (KNM2), Dr, S; Royal Meteorological Institute of the Netherlands. [8, AS].
11. Forensic consultancy related to stability of GPS data at specific time and location; Ince, Mr, S; University of Nottingham, NGI. [TFS].
12. GPS Signal in Space (SiS) monitoring to support aircraft navigation activities of the UK Civil Aviation authority (CAA); Ochieng, Prof, W; Imperial College London, Transport Studies. [7 TFS].
13. Impacts of climate change on navigation and waterways; Weiss, Dr, R; German Federal Institute of Hydrology. [8, ES/TFS].
14. Innovative Navigation using new GNSS Signals with Hybridised Technologies (iNsight); Funded by EPSRC; Groves, Dr, P; Imperial College London, Geomatic Engineering. [8, AS].
15. Innovative Navigation using new GNSS Signals with Hybridised Technologies (iNsight) [WP5 - Modelling of Atmospheric Effects]; Funded by EPSRC; Moore Prof T; University of Nottingham, NGI [8, AS].
16. International GNSS Service GPS tide gauge benchmark monitoring - pilot project; Schoene, Dr, T; GFZ Potsdam (German Research Centre for Geosciences); Funded by IGS. [8, ES].
17. International GNSS Service GPS tide gauge benchmark monitoring - pilot project; Woppelmann, Dr, G; University of La Rochelle; Funded by IGS. [8, ES].
18. Ionospheric research using total electron content over Europe; Tsugawa, Prof, T; National Institute of Information and Communications Technology. [8, AS].
19. Mitigation of ionospheric scintillation effects on GPS; Aquino, Dr, M; University of Nottingham, NGI. Funded by Royal Society IJP. [8, AS].
20. Reprocessing GPS+INS data for ITS research; Meng, Dr, X; University of Nottingham, NGI. [TFS].
21. Reprocessing of the TIGA GPS data set as part of the BLT TAC activities; Teferle, Prof, N; University of Luxembourg. [7, ES].
22. Sensor integration and indoor positioning; Hide, Dr, C; University of Nottingham, NGI. [TFS].
23. Supply of Newlyn to the EUREF Permanent Network; Bruyninx, Dr, C; Royal Observatory of Belgium; Funded by EC. [8, ES].
24. Supply of Newlyn to the EUREF Permanent Network; Habrich, Dr, H; Bundesamt für Kartographie und Geodäsie; funded by EC. [8, ES].
25. Supply of Newlyn to the EUREF Permanent Network; Villaverde, Dr, M; Instituto Geografico Nacional de Espana; Funded by EC. [8, ES].
26. Supply of Newlyn to the EUREF Permanent Network; Duquesnoy, Dr, T; Institut Geographique National; Funded by EC. [8, ES].
27. The physical and ecological effects of the restoration of canalised reach of the Logie Burn, Aberdeenshire; Addy, Dr, S; James Hutton Institute. [TFS].
28. Towards a global ambiguity resolved precise point solution and time series; Kreemer, Dr, C; University of Nevada, Reno; Nevada Bureau of Mines and Geology; Funded by JPL and NASA. [8, ES].

NERC centres, surveys and facilities (5, 5 peer reviewed)

1. Bathymetric survey for marine renewable energy equipment installation; Cooper, Mr, R; BGS. [8, MS].
2. Coastal Observation Project, previously CEEP; Morgan, Mr, D; NERC British Geological Survey. [8, TFS].
3. Digital Integrated Stratigraphy Project; Jones, Dr, L; BGS. [8, ES].
4. GEF Equipment Demonstration and Training; Kay, Mr C; GEF Edinburgh. [8, TFS].
5. South baseline comparison at the NERC Space Geodesy Facility, and of other baselines; Wilkinson, Mr, M; NSGF. [8, ES].

PhD (7, 5 peer-reviewed)

1. Science, participation, and a new approach to river restoration; Maynard, Ms, C; University of Durham, Geography. Funded by NERC/ESRC. PhD to be completed in 2013. [8, TFS].
2. Change detection analysis in geodetic time series; Olivares, Dr, G; University of Luxembourg, Geophysics Lab. PhD to be completed in 2014. [7, ES].
3. Gradiometry Survey of the Knowe of Swandro; Moore, Mr, J; University of the Highlands & Islands, Orkney College. PhD to



be completed in 2013. [TFS/SBA].

4. Multi-sensor fusion for driverless car technologies; Lu, Mr, L; University of Wales, Aberystwyth, Computer Science. PhD to be completed in 2015. [7, TFS].
5. Present day 3D velocity field of Europe, Buble, Mr, G; University of Arizona, Geosciences. PhD to be completed in 2012. [8, ES].
6. The accuracy of LiDAR data in urban environments; O'Neill, Mr, J; Loughborough University, Loughborough University Sustainability School. PhD to be completed in 2012. [TFS].
7. The potential of precipitable water vapour measurements from GNSS in Luxembourg; Ahmed, Mr, F; University of Luxembourg, Geophysics Lab. Funded by Luxembourg National Research Council. PhD to be completed in 2014. [8, AS].

Ongoing PhDs with no data taken in 2011/12 (5, 4 peer reviewed)

1. Channel-Scale Discrete Particle Modelling of River Channel Junctions; Tancock, Mr, M; University of Durham, Geography. Funded by NERC. PhD to be completed in 2012. [8, TFS].
2. Cold air pooling over complex terrain; Jemmett-Smith, Mr, B; University of Leeds, Earth and Environment. Funded by NERC/Met Office CASE award. PhD to be completed in 2012. [8, AS].
3. Testing the accuracy of internet-based PPP services, related to integrated flood management strategy in an un-gauged river basin; Sanyal, Ms, J; University of Durham, Geography PhD to be completed in 2012. [TFS].
4. Ionospheric scintillation effects on GNSS: monitoring and data treatment development; Romano, Mr, V; University of Nottingham, NGI. PhD to be completed in 2012. [8, AS].
5. Predicting salmonid population ecology from individual fish responses to environmental change; bridging behaviour, conservation and fishery management; Sui Chian Phang, Mr; Bournemouth University, Conservation & Ecology. PhD to be completed in 2012. [8, TFS].

Non-PhD students (8)

1. A comparison of PPP and double difference processing strategies using an episodically collected GPS time series; University of Nottingham, NGI. [ES].
2. Can GNSS 'see' the weather? Newcastle University, Civil Engineering and Geosciences. [AS].
3. Evaluating the potential use of natural flood management techniques in the Middleburn (Peebles, Scottish Borders); University of Dundee, Geography. [TFS].
4. Investigation of performance and benefits of a Doppler velocity log aided inertial positioning solution for hydrographic survey in the port environment; UCL, Geomatic Engineering. [MS].
5. Multi-beam Survey of the James Egan Layne; University of Plymouth, Marine Science and Engineering Sciences. [MS].
6. Performance assessment of four inertial navigation units; University of Plymouth, Marine Science and Engineering Sciences. [MS].
7. The stability analysis of GPS receivers' monuments using double differenced short baselines; Newcastle University, Civil Engineering and Geosciences. [TFS].
8. Un-modelled residual errors in GNSS NRTK in the presence of adverse space weather conditions; University of Nottingham, NGI. [AS].

Collaborators (7)

1. De-siltation Investigation on the River Cam and associated Cam Lodes; Waggott, Mr, S; Environment Agency.
2. East Anglia coastal erosion monitoring; Williamson, Mr, S; Environment Agency.
3. Geoid model test observations; Greaves, Mr, M; Ordnance Survey of Great Britain.
4. Re-levelling or levelling in new flood warning gauging station benchmarks; Coward, Mr, M; Environment Agency.
5. Monitoring the effect of Thames bridge works on shoaling/erosion; Morgan, Ms, H; Environment Agency.
6. Near real-time atmospheric water vapour for numeric weather prediction in the UK; Jones, Dr, J; Met Office.
7. Thames Barrier Automated Monitoring System: Study of diurnal movements at Barking Barrier during Spring tides; Groome, Mr, R; Environment Agency.

Government / .org (16)

1. Anglesey and Llyn fens LIFE Project: Action A4; Guest, Mrs, J; Countryside Council for Wales.
2. Charting of Loch Linnhe, Firth of Lorne, Sound of Mull, Passage of Tiree; Arfaras, Mr, F; Maritime and Coastguard Agency.
3. Enhancing the accuracy of base station measurements for an RTK solution; Treffny, Dr, R; Local Council.
4. Geo-video capture and street furniture/highway assets database creation and maintenance; Martindale, Mr, J; Various Local Councils.
5. Georeferencing of multibeam sonar data; Eve, Mr, D; Port of London Authority.
6. IHO Special Order Survey; Malone, Lt RN, R; RN HMS Drake.
7. Lighting asset survey; Colclough, Mr, J; Various Local Councils.
8. Locating precision approach path indicator units and establishing runway levels; Thomas, Mr, J; RAF Hythe.
9. Maritime and Coastguard Agency routine re-survey project; Robertson, Mr, P; Maritime and Coastguard Agency.
10. Monitoring of habitats; Lloyd, Dr, D; Countryside Council for Wales.
11. SAC (special area of conservation) features monitoring and condition assessment; Lloyd, Dr, D; Countryside Council for Wales.
12. South-west strategic regional coastal monitoring programme; Mills, Mr, P; Teignbridge District Council.
13. Survey of 60km of scenic public amenity path by network GPS; Lumley, Mr, J; East Ayrshire Council.
14. Training on POSOAC using an old MBES & POS(MV); Malone, Lt RN, R; RN HMS Drake.

15. Updating navigational products; Worth, Mr, G; United Kingdom Hydrographic Office.
16. Validate the location of a Maritime and Coastguard Agency tide gauge; Ferris, Ms, K; Maritime and Coastguard Agency.

Ordnance Survey user (20)

1. Benchmark verification; Williams, Mr, P; Sumo Services.
2. Checking condition and verticality of electricity towers; Verth, Mr, S; National Grid.
3. Control point coordination; Hester, Mr, K; Ascot Environmental.
4. Control station check survey, Athletes Village, Olympic Park, London; Montero, Mr, R; Site Engineering Survey.
5. Evaluation of L1 GPS Receivers for use in sonar buoys; Hall, Mr, J; Sonardyne.
6. Folkestone Warren Cliff stabilisation and movement monitoring; Reynolds, Mr, R; Network Rail.
7. GPS performance analysis; Pattinson, Dr, M; Nottingham Scientific.
8. Improve flight capacity and maintain safety record at Heathrow runways; Hall, Mr, C; British Airports Authority.
9. Instrument calibration prior to hydrographic survey; Skinner, Mr, H; Forth Ports.
10. London Array Wind Farm Project; Andersen, Mr, K; London Array.
11. London GPS network (Rail); Noble, Mr, T; Network Rail.
12. Orthorectifying imagery of Sellafield site; Hails, Mr, T; Sellafield Ltd.
13. Ship tracking in a delimited area; Mayne, Mr, C; Forsberg Services/Novatel.
14. Site investigation works; Cunningham, Mr, G; Latitude Surveys.
15. Solway Firth Water Quality Monitoring Survey; Nelson, Mr, G; United Utilities.
16. The effect of the solar maximum on GNSS performance in the UK; Faragher, Dr, R; BAE Systems.
17. Topographic survey control; Pearshouse, Mr, S; RWE npower.
18. Verification of onboard marine navigation systems; Ferris, Ms, K; Gardline Geosurvey.
19. Verifying real time positioning; Allen, Mr, M; Marcus Allen.
20. Wylfa Oceanographic Study; Hayes, Ms, K; Titan Environmental Surveys.

6. Publication details for the calendar year (2011)

Refereed (5, with their ISI 2010 JCR impact factors shown in [])

1. Price, J.D., Vosper, S., Brown, A., Ross, A., Clark, P., Davies, F., Horlacher, V., Claxton, B., McGregor, J.R., Hoare, J.S., Jemmett-Smith, B., Sheridan, P. COLPEX Field and Numerical Studies over a Region of Small Hills. Bulletin of the American Meteorological Society, Volume: 92 Issue: 12 Pages: 1636-+ DOI: 10.1175/2011BAMS-D-10-3032.1; December 2011. [5.078].
2. Santamaria-Gomez, A., M-N, Bouin., Collilieux, X., Wöppelmann, G. Correlated Errors in GPS Position Time Series: Implications for Velocity Estimates. Journal of Geophysical Research, 116, B01405, doi:10.1029/2010JB007701., 2011. [3.303].
3. Sun, X., Shiono, K., Rameshwaran, P., et al. Modelling vegetation effects in irregular meandering river. Journal of Hydraulic Research, Volume:48, Issue:6, PP.775-783. 2010. [1.005].
4. Williams, S.D.P., Penna, N.T. Non-tidal ocean loading effects on geodetic GPS heights, Geophysical Research Letters, doi:10.1029/2011GL046940., 2011. [3.505].
5. Yan, J., Dixon, T.H., Wdowinski, S. Accelerating uplift in the North Atlantic region as an indicator of ice loss. Nature Geoscience, Vol.3, Issue 6, pp.404-407, DOI: 10.1038/NGEO845, 2010. [10.392].

Non-Refereed/Conference Proceedings (16)

1. Bingley, R., Hansen, D.N., Leighton, J., Teferle, F. N., Baker, D.F. Results from an initial re-processing of the British Isles continuous GNSS Facility (BIGF) archive of CGPS data for 1997 to 2010; American Geophysical Union, Fall Meeting 2010, abstract #G23B-0823.
2. Bradshaw, E. UK tide gauge status report - National contribution to GLOSS; GLOSS Group of Experts 12th Meeting, November 2011.
3. Dayoub N., Moore P., Edwards S.J., Penna N.T. The Geoid Geopotential Value for Unification of Vertical Datums. FIG Working Week 2011, Bridging the Gap between Cultures, Marrakech, Morocco, 18-22, May 2011.
4. Dayoub, N., Moore, P., Penna, N.T., Edwards, S.J. Evaluation of EGM2008 Within Geopotential Space from GPS, Tide Gauges and Altimetry, Geodesy for Planet Earth International Association of Geodesy Symposia 136, 321-329, DOI10.1007/978-3-642-20338-1_39.
5. Dousa, J. Global near real-time GNSS troposphere product. Geophysical Research Abstracts V.13, EGU2011-4871, 2011, EGU General Assembly 2011.
6. Greaves, M., Fane, C., Cruddace, P., Bingley, R., Baker, D.F., Hansen, D., Appleby, G., Sherwood, R., Clarke, P., King, M., Penna, N., Bingham, R., Edwards, S., Moore, P. National Report of Great Britain 2011, Report on the Symposium of the IAG Sub-Commission for the European Reference Frame (EUREF), Moldova, 2011.
7. Hansen, D.N., Teferle, F.N., Bingley, R.M., Williams, S.D.P. New Maps of UK Vertical Land Movements based on Continuous GPS and Absolute Gravity. Oceans 2025 Science of the Blue Planet Meeting, London, 13 December 2011.
8. Jemmett-Smith, B., Ross, A., Sheridan, P. Investigating cold air pools; a case study from COLPEX. International Conference on Alpine Meteorology, Aviemore, May 2011.
9. Jemmett-Smith, B. COLPEX; cold air pooling over complex terrain, 14th Conference on Mountain Meteorology, Lake Tahoe, USA, September 2010.
10. Kealy, A., Toth, C., Brzezinska, D., Roberts, G., Retscher, G., Gikas, V. A New Paradigm for Developing and Delivering Ubiquitous Positioning Capabilities. FIG Working Week 2011, Bridging the Gap between Cultures Marrakech, Morocco, 18-22, May 2011.
11. Otsuka, Y., Nakagawa, S., Nishioka, M., Shiokawa, K., and Tsugawa, T. GPS Observations of Medium-Scale Travelling



Ionospheric Disturbances over Europe. American Geophysical Union, Fall Meeting 2011, abstract #SA41A-1837.

12. Penna, N.T., Williams, S.D.P. Non-tidal ocean loading effects on GPS height time series, XXV IUGG General Assembly, Melbourne, Australia, July 2011.
13. Santamaria-Gomez, A., Bouin, M-N., Wöppelmann, G. Improved GPS data analysis strategy for tide gauge benchmark monitoring. IAG Symposia 136, Geodesy for Planet Earth, pp. 11-18, doi:10.1007/978-3-642-20338-1_2, 2011.
14. Santamaria-Gomez, A., Bouin, M-N., Collilieux, X., Wöppelmann, G. Time-correlated GPS noise dependency on data time period. Proceedings of IAG Symposium on Reference Frames for Applications in Geosciences (REFAG2010), Marne-la-Vallée, 2011.
15. Tsugawa T., Ishibashi H., Kato H., Nishioka M., Otsuka Y., Saito A., Nagatsuma T., and Murata K.T. High-resolution Total Electron Content Observations of Severe Ionospheric Disturbances Using Dense GPS Receiver Networks, Jan. 27-28, 2011, SEALION International Symposium 2011, Bangkok, Thailand.
16. Yuichi O., Nakagawa S., Shiokawa K., Tsugawa T. Observations of total electron content variations using GPS networks in Europe, May 22-27, 2011, Japan Geoscience Union Meeting 2011, Chiba, Japan.

PhD Theses (3)

1. Upscaling of peatland methane emission estimates from small to large scales; Mohammed, Mr, A; University of Edinburgh. Funded by NERC/Royal Society/Dorothy Hodgkin. [8, AS].
2. Application of the ionospheric tomographic inversion method MIDAS to radio astronomy; Katamzi, Ms, Z; University of Bath. Funded by University of Bath [8, AS].
3. Towards centimetre level real-time kinematic GNSS single point precise positioning; Martin, Mr, I; Newcastle University [8, ES/MS].

Appendix 2: Optional Annexes

1. Projects completed

Academic (5)

1. Digital Integrated Stratigraphy Project; Jones, Dr, L; NERC BGS. [8, ES].
2. Bathymetric survey for marine renewable energy equipment installation; Cooper, Mr, R; NERC BGS. [8, MS].
3. GPS Signal in Space (SiS) monitoring to support aircraft navigation activities of the UK Civil Aviation authority (CAA); Ochieng, Prof, W; Imperial [7, TFS].
4. Innovative Navigation using new GNSS Signals with Hybridised Technologies (iNsight); Groves, Dr, P; UCL [7, AS].
5. British Isles motion and rotation pole; Houlie, Dr, N; University of Leeds [8, ES].

PhD (3)

1. Upscaling of peatland methane emission estimates from small to large scales; Mohammed, Mr, A; University of Edinburgh. Funded by NERC/Royal Society/Dorothy Hodgkin. [8, AS].
2. Application of the ionospheric tomographic inversion method MIDAS to radio astronomy; Katamzi, Ms, Z; University of Bath. Funded by University of Bath [8, AS].
3. Towards centimetre level real-time kinematic GNSS single point precise positioning; Martin, Mr, I; Newcastle University [8, ES/MS].

7. Targets and Milestones

No further comments to add to the information given in the ANNUAL TARGETS AND PROGRESS TOWARDS THEM section of the main report.

8. Finance

Spend	£132,510
Revenue	£0
Unit cost	£0.060
Planned capital spend	£0

9. Service Management

Dr Richard Bingley, Head of Facility
Dr David Baker, Manager
Ms Dionne Hansen, Developer

