National Report of Great Britain, 2002

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1. Introduction

The main focus of development within national geodesy during the past year has been in both the consolidation and development of the GPS and geodetic reference frame and utilities in the country. The Ordnance Survey's (Great Britain's national mapping agency) National GPS Network is the infrastructure which gives access to the national plan and height coordinate systems in Great Britain.

The major developments in national geodetic infrastructure, that will be outlined below are; the densification of the Continuously Operating Reference Station (CORS) network, the computation of new transformation and geoid models, the establishment and completion of a EUREF station network and the development of a prototype RTK network.

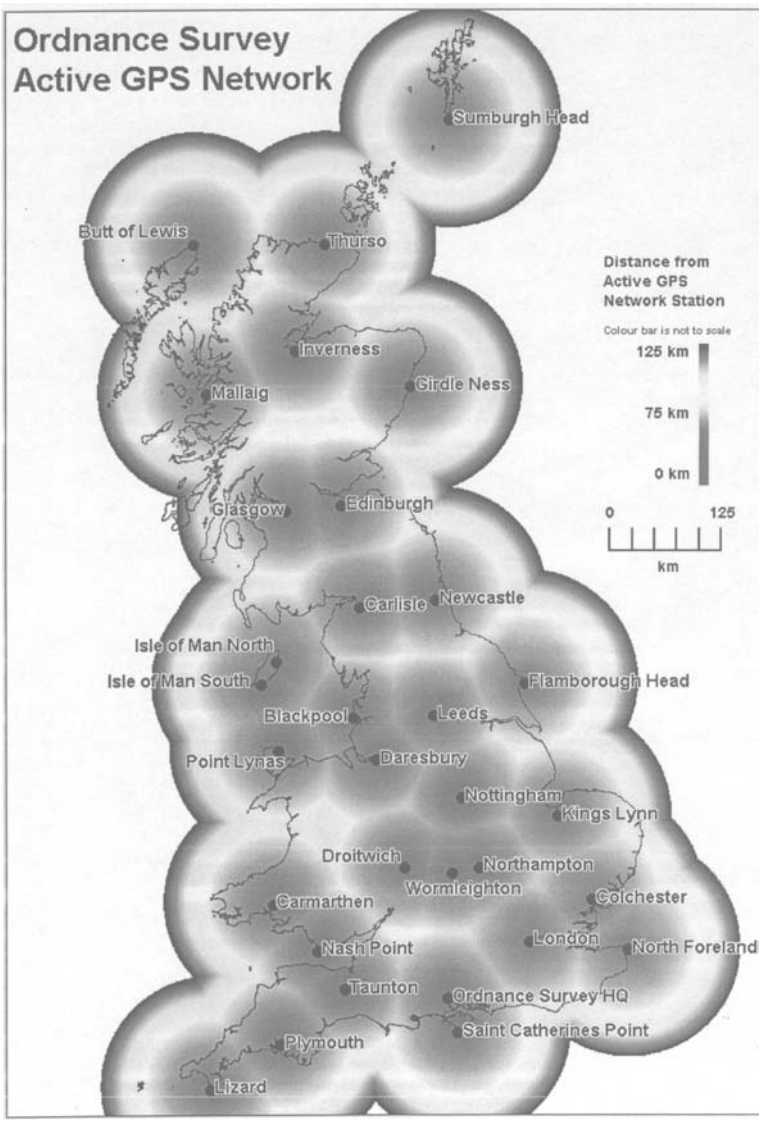

Figure 1. Distribution of Ordnance Survey's CORS's

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2. CORS network

The Ordnance Survey CORS network was densified during 2001 and currently consists of 32 permanently installed geodetic quality GPS receivers throughout Great Britain, figure 1 shows their distribution. Two of these stations are actually owned and operated by the Isle of Man Government and a further nine by the General Lighthouse Authority. All of the active stations record dual-frequency GPS data and one-hour packets of data from each CORS are sent via ISDN line every hour for internal and external access approximately 18 minutes after the end of each hourly period.

Daily positions of the CORS's are computed using the Bernese software and this is used to monitor the positions of the stations.

The raw RINEX data is freely available through; *www.gps.gov.uk.*

3. OSTN02 & OSGM02

The plan transformation model (OSTN97) and geoid model (OSGM91) which have provided the linkage between ETRS89 coordinates and OSGB36 and the height datums in Great Britain have been updated in early 2002 to OSTN02 and OSGM02 respectively.

The main aim of OSTN02 is to improve the accuracy of the existing transformation to 0.1 m rmse. This has been achieved by significantly increasing the point density of the transformation computation data set. Many more OSGB36 points are being coordinated in ETRS89, using GPS observations and the CORS network. The observation campaign started in October 1999 and was completed in late 2001. 3293 points have been coordinated with GPS and all areas of Great Britain, no matter how small or remote, now contain transformation points occupied with GPS. A grid look-up table combined with bilinear interpolation is used to define the transformation parameter for a point.

Apart from providing a more accurate ETRS89 to OSGB36 transformation, OSTN02 will also herald a fundamental change in the definition of Great Britain's mapping coordinate system. For this reason OSTN02 will also be known as the *Definitive Transformation*.

In the past, despite having a CORS network and transformation (OSTN97), the mapping system of Great Britain (OSGB36) is still defined by the National Grid positions of the original triangulation points. Now that the Definitive Transformation (OSTN02) is complete, it will be used to *define* the National Grid in conjunction with the ETRS89 positions of the National GPS Network stations. This change means that, for example, the National Grid coordinates of an existing OSGB36 triangulation pillar, refixed using GPS from the National GPS Network and the Definitive Transformation will be the correct ones. The original archived OSGB36 National Grid coordinates of the pillar will be wrong, by definition, but the two coordinates (new and archived) will agree on average to better than 0.1 m. This is a subtle change in definition only and will not mean that existing OSGB36 coordinates need to be changed in any way.

OSGM02 is a new geoid model which covers the land areas and inshore waters of the United Kingdom, the Republic of Ireland and the Isle of Man and allows ETRS89 to local height datum conversion. The model was produced by a consortium consisting of KMS – Denmark (R FORSBERG & G STRYKOWSKI), UCL – UK (P CROSS, M ZIEBART & J ILIFFE) and the University of Copenhagen (C Tscherning). A gravimetric geoid model was computed from a 100m spaced DEM and gravity at an approximate spacing of 1.5 km. The model was computed by remove-restore techniques, using spherical FFT and RTM prism integration, using EGM96 as a reference field. The gravimetric geoid was computed rigorously as a quasi-geoid, then converted to a classical geoid consistent with the use of Helmert orthometric heights. The model was then related to the relevant local height datums. The new model was completed in early 2002 and has an overall error of 2cm rms in the UK, 4cm in other areas.

4. EUREF Campaign

2001 saw the establishment of a new network of EUREF stations across Great Britain: EUREF GB 2001, figure 2. This campaign and the resultant network is described more fully in a paper within this volume 'The British EUREF GB 2001 GPS Campaign'. Great Britain has an existing network of EUREF (European Reference Frame) stations – EUREF GB 92 [DENYS et al 1995]. This network consists of 26 ground marked stations and includes two fiducial stations from the original EUREF89 network – Solar Pillar, Herstmonceaux (an eccentric station to the current International GPS Service station HERS on the same site) and Buddon, a temporary VLBI site.

Over the past 2 years Ordnance Survey have developed a nation-wide network of 32 CORS's. The coordinates of the stations in the Active GPS Network are computed in the European Terrestrial Reference System 1989 (ETRS89) and are therefore compatible with other EUREF stations. However, at present the "official" EUREF network for Great Britain was still EUREF GB 92.

The purpose of the EUREF GB 2001 campaign was to compute new ETRS89 coordinates for all of the stations in the Active GPS Network.

The coordinates are of the highest possible quality and have been computed following the latest recommended methods of the EUREF Technical Working Group (TWG).

The EUREF GB 2001 GPS Campaign is based on observations at the 30 permanent GPS stations which comprise the Ordnance Survey Active Network, four additional stations and six IGS stations in Europe. In all, data from 40 stations were processed, of which 20 are proposed to become official EUREF stations. Figure 2 shows a map with their distribution.

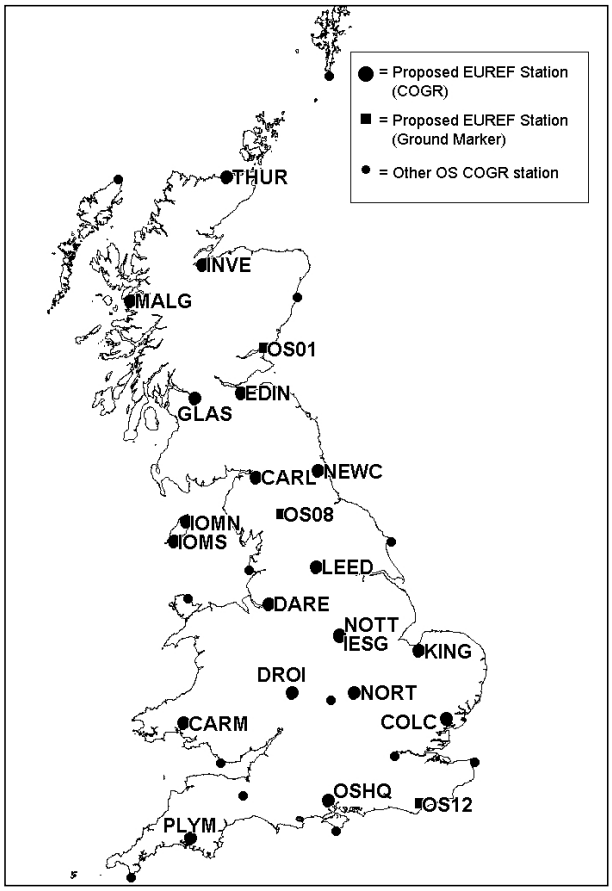

Fig. 2: The EUREF GB 2001 Map of Stations

Summary of results

- The results from the unconstrained solution show the high level of internal quality of the solution to be generally better than 3 mm in North and East and 7 mm in height.
- The coordinate recoveries of the IGS fiducial stations show that the ITRF is being realised at the 10 mm level.
- The differences between the unconstrained and the constrained solutions show the high level of internal consistency between the IGS stations.
- Comparison with previous campaigns has shown that the ETRS89, coordinates agree with previous (recent) campaigns to generally 10 mm or better. This is despite some larger than expected differences that are explained. Comparison to older campaigns up to 1995 (and up to ITRF93) generally agree to around 20 to 30 mm.

5. GPS – Levelling in Great Britain

Great Britain has a extensive network of 188 primary orthometric levelling points fundamental benchmark network (FBM), all of which have been observed with GPS and are available for scientific study, figure 3.

The Ordnance Survey Fundamental Bench Mark (FBM) project (1999-2000) involved the precise coordination of 188 FBM's distributed throughout the British mainland based on the use of a single GPS receiver and a network of Continuously Operating GPS Stations (COGR's). Two four hour sessions at each of the FBM stations were observed by GPS, with the antenna height altered and re-measured between sessions to enable the resulting height quality to be assessed and blunders detected. The data were processed and analysed by IESSG at the University of Nottingham using their in-house GPS Analysis Software (GAS). The coordinates of the COGR network were computed in the ITRS96 e1999.00 and then transformed to ETRS89 e1989.00. The ETRS89 e1989.00 coordinates of the FBM's were then computed relative to the COGR network. The techniques were employed to ensure that the computed ETRS89 coordinates of the FBM stations are as precise and reliable as possible, especially with regard to the height component. The resulting ellipsoidal heights have a precision and accuracy of about 1.5cm.

It is difficult to compare this with the Fundamental levelling network in the UK which is based on the Third Geodetic Levelling of Great Britain completed in 1958. This had an estimated observing error of ±1.2mm/Ökm but is considered by definition to be 'error free'.

Data resulting from this project is available for scientific and academic purposes.

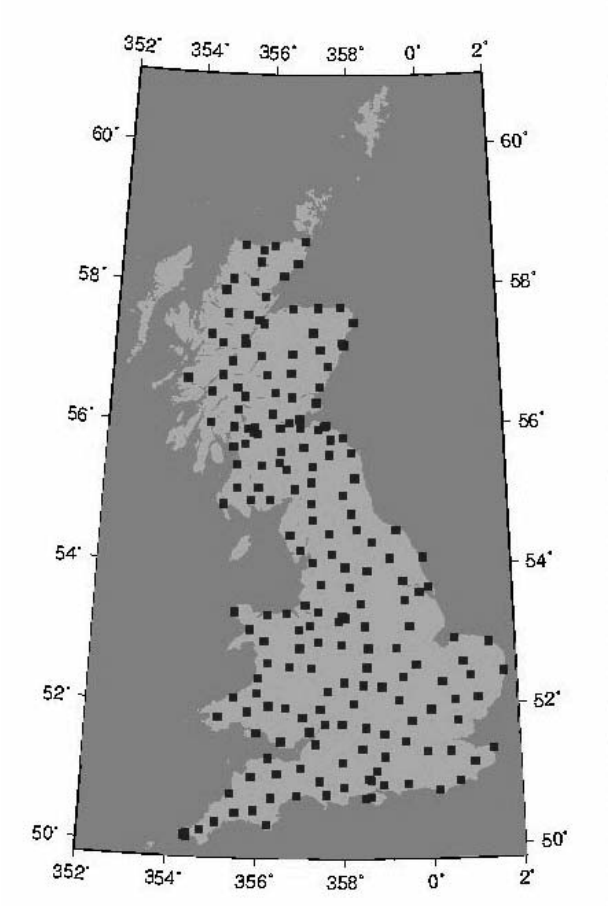

Figure 3. Collocated Fundamental Benchmark and GPS observations in Great Britain

6. Network RTK Development

The Ordnance Survey has established a test network in the north of England to investigate the network RTK concept. 24 CORS are sited and send data in real-time down to the processing centre in Southampton. Software from the

company Geo++ is used to generate the network RTK corrections and to control the network. The correction is then delivered to the user via either GSM or VHF transmission. An example installation is shown in figure 4.

The network was established in 2001 and testing will continue until September 2002 when a decision will be made whether to role-out the solution nationwide.

Figure 4. Typical network RTK installation