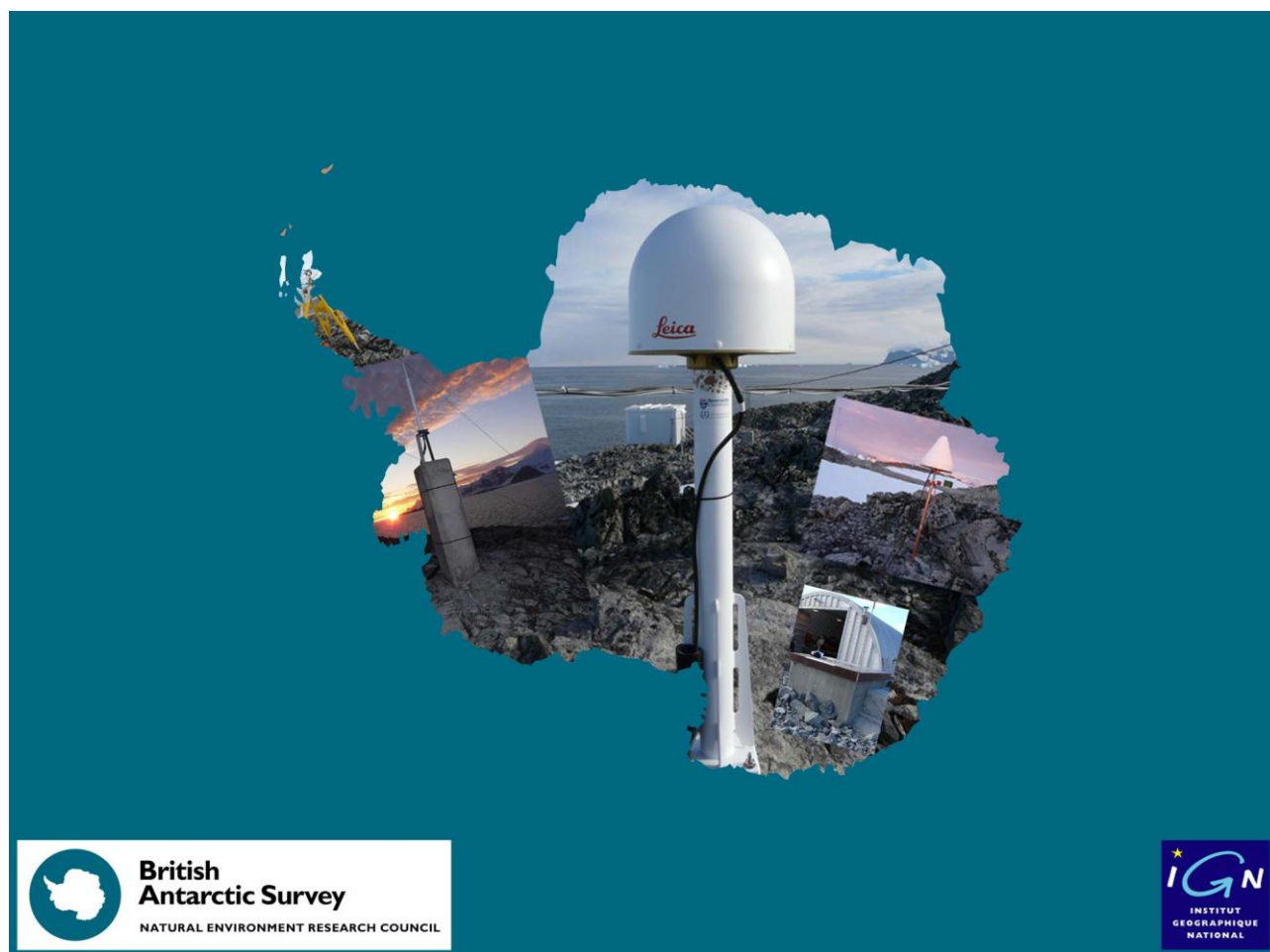


**J-C. Poyard**

## Rattachement ITRF à Rothera



**British  
Antarctic Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL



## Rothera ITRF co-location survey

**DIFFUSION OUVERTE**

RT/G 117

N° archive 28337

Date de création 26/05/2011

N° de version 1

---

### Mots-clé

---

Rattachement, ITRF, DORIS, GNSS, British Antarctic Survey, BAS, Rothera, Antarctique

---

### Résumé

---

L'ITRF2008 (dernière réalisation de l'International Terrestrial Reference System) menée par le Laboratoire de Recherche en Géodésie (LAREG) de l'IGN est le résultat de la combinaison des référentiels terrestres issus des quatre techniques de géodésie spatiale (c'est à dire GNSS, SLR, DORIS et VLBI). Un moyen d'améliorer les réalisations consiste à ajouter dans la combinaison les résultats de rattachement sur des sites co-localisés. Le site de Rothera (Antarctique) disposant d'une station DORIS et d'une station GNSS permanente, intégrée récemment dans le réseau de l'IGS, a été identifié comme prioritaire dans la programmation des opérations de rattachement.

---

### Matériel

---

#### Système d'exploitation

Mac OS X

---

#### Logiciel

Word 2008 pour Mac version 12.2.3

---

### Validation

---

	<b>Fonction</b>	<b>Nom</b>	<b>Visa</b>
Commanditaire	Chef de l'unité RSI	Bruno Garayt	30/06/2011 – signé
Rédacteur principal	Responsable de production	Jean-Claude Poyard	30/06/2011 – signé
Correcteur	Chef de l'unité RSI	Bruno Garayt	23/08/2011 – signé
Correcteur	Responsable SIRS	Jérôme Saunier	19/08/2011 – signé
Approbateur	Chef de Service	Alain Harmel	29/08/2011 – signé
Vérificateur	Responsable Qualité	Thierry Person	01/09/2011 – signé

---

**Diffusion**

<b>Organisme, service</b>	<b>Nom</b>	<b>Numérique</b>	<b>Papier</b>
IGN / DPR	Alain Perret	oui	-
IGN / MODSP	François Becirspahic	oui	-
IGN / SG / SDOG / CDOC	Richard Grimm	oui	-
IGN / DT / SR / LAREG	Olivier Jamet	oui	-
IGN / ENSG / DPTS	Serge Botton	oui	-
IGN / DPR / SGN	Alain Harmel	oui	-
IGN / DPR / SGN	RQ / Thierry Person	oui	-
IGN / DPR / SGN / PMC	Resp.Doc / Xavier della Chiesa	non	3
IGN / DPR / SGN / PMT	François L'Ecu	oui	-
IGN / DPR / SGN	Chefs de départements	oui	-
IGN / DT / SR / LAREG	Zuheir Altamimi	non	1
IGN / DT / SR / LAREG	Xavier Collilieux	oui	-
British Antarctic Survey	Archives BAS	non	1
British Antarctic Survey	Ellen Bazeley-White	oui	-
British Antarctic Survey	Edward C. King	oui	-
Université de Newcastle	Matt King	oui	-
Université de La Rochelle	Guy Wöppelmann	oui	-
IGN / DPR / SGN	Jérôme Saunier	oui	-
IGN / DPR / SGN	Jean-Claude Poyard	non	1

---

**Sommaire**

---

Introduction .....	5
Acknowledgements.....	5
1 CO-LOCATION SITE DESCRIPTION.....	6
2 CO-LOCATED POINTS .....	7
2.1 DORIS station.....	7
2.2 GNSS stations.....	8
2.2.1 ROTH permanent station.....	8
2.2.2 BAS GNSS station .....	8
2.3 ROT1.....	9
2.4 Other points of interest.....	9
2.4.1 Tide gauge .....	9
2.4.2 Geodetic point CELINA.....	10
2.4.3 Gravimetric Point .....	10
3 SURVEY DESCRIPTION.....	11
3.1 Organization .....	11
3.2 Equipment (Instruments).....	11
3.3 Rothera observations polygon .....	11
3.4 Survey method.....	12
3.4.1 Permanent GNSS stations reference point.....	12
3.4.2 Verticality check and centring equation .....	12
3.4.3 Levelling.....	12
3.4.4 GPS observations .....	13
4 COMPUTATIONS.....	13
4.1 On-site validation.....	13
4.2 GPS network.....	13
4.3 Global Adjustment .....	13
5 RESULTS .....	14
5.1 Station name translation table.....	14
5.2 Adjusted coordinates and confidence regions .....	14
6 APPENDIXES .....	17

## INTRODUCTION

The International Terrestrial Reference Frame (ITRF) is the result of a combination of different terrestrial reference frames provided by the four space geodetic techniques (ie. GNSS, SLR, DORIS and VLBI). To perform this combination between independent reference frames, it is necessary to have some co-location sites where the various techniques are operating, from which tie vectors between their reference points have been surveyed in three dimensions. During the last ITRS realization (ITRF2008), scientists from LAREG (Geodesy Research Laboratory) at IGN (French National Geographic Institut) identified some inconsistencies on a few places where several space geodesy techniques are co-located.

Waiting for launches of satellites equipped with the four space geodetic techniques, one way to improve the ITRS realization consists in adding some co-location sites in the combination or, with the advent of new instruments, in surveying sites where ties are inconsistent. Within this context, Rothera co-location site was identified as a matter of interest.

This document presents the Rothera (Antarctica) local tie survey which took place in February 2011, from the observations on site to the computation, with as many details as necessary to fully understand what the resulting SINEX file means.

## ACKNOWLEDGEMENTS

I would like to acknowledge not only the British Antarctic Survey team, but also all the Rothera team without whom nothing would have been possible! With a special thank to Geese and Tom (field assistants) who helped me in this survey work.

Finally, I'm thankful to Tamsin Gray, Edward King and Matt King, for their precious help in various problems at Rothera or for equipment shipment.

## 1 CO-LOCATION SITE DESCRIPTION

Rothera - one of the five research stations in Antarctica managed by BAS - is located by 68° S & 68° W in the south-east coast of Adelaide Island. This 140 km long island is located in the middle west part of the Antarctic Peninsula.

There's an airstrip allowing the access by plane during the austral summer from the Falkland Islands or Punta Arenas (Chile) within 4 or 5 hours on board of a Dash-7 belonging to BAS. Rothera is also served by the vessels RRS Ernest Shackleton and RRS James Clark Ross. Air and sea links usually operate from October to April.

Last season the population rose to around 95 during December and January with brief peaks to 115 but the winter 2011 team is number 20.

What else ? Rothera is an exciting place to be and a really great experience.

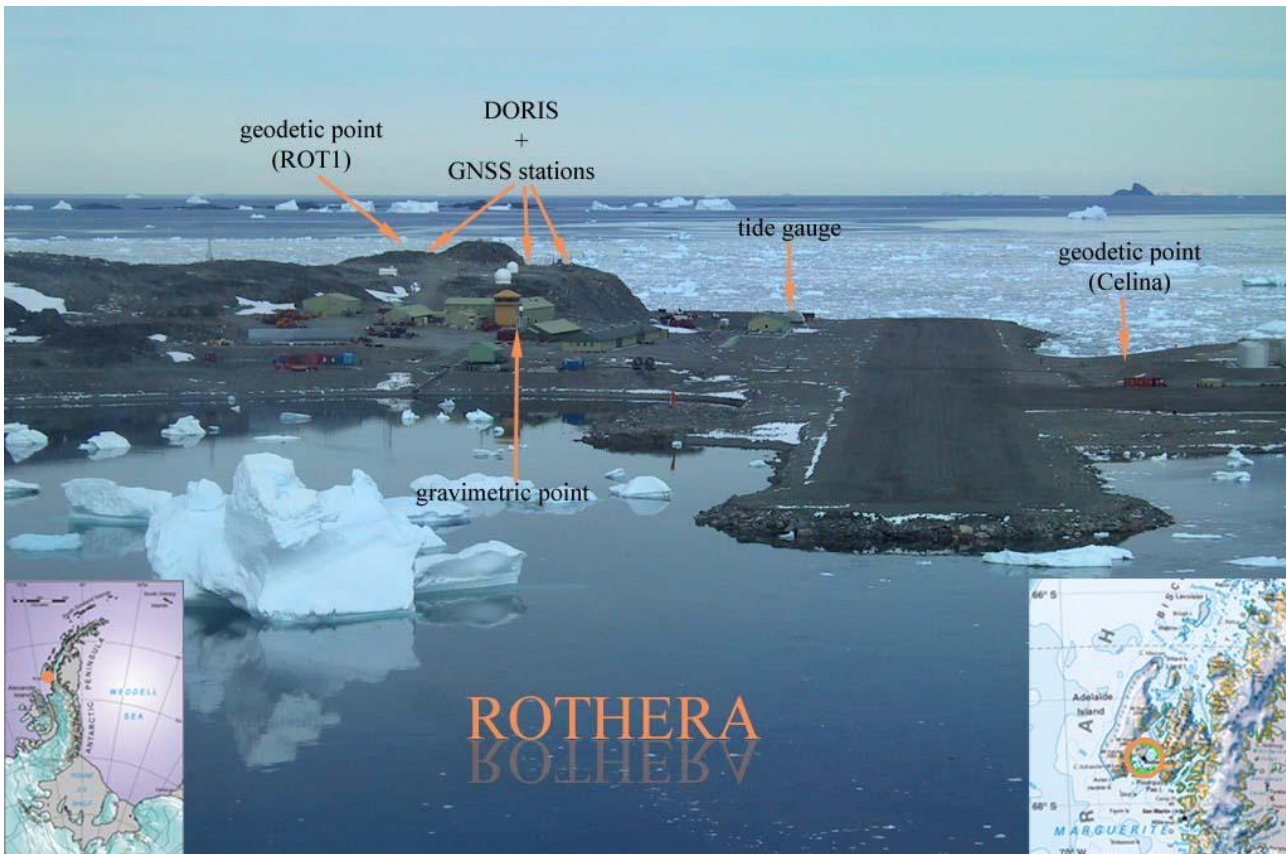
On a geodetic point of view, Rothera site possesses references from two space geodetic techniques; indeed there are :

- two GNSS stations "ROTH" (part of the IGS network since march 2010) and "BAS".
- one DORIS station.

Furthermore, Rothera is equipped with :

- a tide gauge.
- relative gravimetry points.
- geodetic points.

The co-location area is situated to the south of the base, on a small hill near memorials.



## 2 CO-LOCATED POINTS


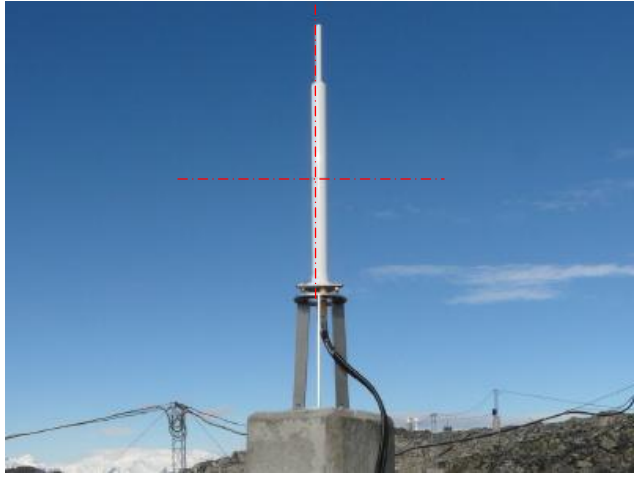
### 2.1 DORIS station

The first DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) station was initially set up in november 1991 by Peter Foden (Proudman Oceanographic Laboratory - POL) on the side wall of a timbered laboratory and the data acquisition started on February 3<sup>rd</sup>, 1992. In March 2005, the DORIS station moved to memorial hill and the antenna set up on a concrete pillar. Then gradual improvements have been carried out to the DORIS antenna support.

The different positions of the antennas reference points have been associated with distinct acronym and DOMES number as summarized in the following table :

Acronym	DOMES number	Antenna / Support	Period
ROTA	66007S001	Alcatel / side wall	from Nov. 1991 to Feb. 2005
ROTB	66007S002	Starec / concrete pillar	from March 2005 to Oct. 2007
ROUB	66007S003	Starec / concrete pillar + 6 stainless steel rods (15 cm long)	from Oct. 2007 to Jan. 2011
ROVB	66007S004	Starec / concrete pillar + stainless tripod	from Feb. 2011 till now

NB: on the pillar, the antennas reference points were accurately surveyed (precise DORIS internal local ties between the different positions) with respect to the DORIS marker (DOMES number : 66007M002). An extract of the site log appears in appendix 6.1.



Acronym : ROVB	DOMES number : 66007S004
 <p>Global view</p>	 <p>Detail view (reference point)</p>
Description : DORIS antenna reference point.	



## 2.2 GNSS stations



### 2.2.1 ROTH permanent station

This GNSS station installed in December 2009 (thanks to British Antarctic Survey and Newcastle University) is part of the IGS network since March 2010 (see appendix 6.2)

Acronym : ROTH	DOMES number : 66007M003
 <p data-bbox="389 1066 539 1093">Global view</p>	 <p data-bbox="940 1066 1316 1093">Close-up view (reference point)</p>
<p data-bbox="145 1099 1171 1128">Description : axis and base of a 5/8 inch thread on top of a tech2000 mast (UNAVCO).</p> <p data-bbox="145 1131 469 1162">Antenna height is <b><u>0.000 m</u></b>.</p>	

### 2.2.2 BAS GNSS station



This GNSS station is not part of the IGS network. The tie with the DORIS antenna has already been surveyed by H. Fagard in March 2005 (cf. report IGN/SGN n°28122 «Rénovation de la station DORIS de Rothera»).

Acronym : BAS	no DOMES number
 <p data-bbox="389 1962 539 1989">Global view</p>	 <p data-bbox="940 1962 1316 1989">Close-up view (reference point)</p>
<p data-bbox="145 1984 951 2016">Description : marker embedded in the rock and carved "GAP 1998".</p> <p data-bbox="145 2018 715 2054">The reference point is <b><u>1.157 m below the ARP.</u></b></p>	



## 2.3 ROT1



This point has been observed by GPS during the Geodetic Antarctic Project (GAP) : the name of a compound project within the Scientific Committee on Antarctic Research (SCAR) Epoch Campaigns.

Acronym : ROT1	DOMES number : 66007M001
 <p data-bbox="391 936 539 963">Global view</p>	 <p data-bbox="938 936 1316 963">Close-up view (reference point)</p>
<p>Description : marker embedded in the rock and carved "GAP 1995" (axis and top of screw).</p>	

## 2.4 Other points of interest

### 2.4.1 Tide gauge



Since 1992 a tide gauge, part of the UK South Atlantic & Antarctic network, is operating at Rothera. The ACCLAIM (Antarctic Circumpolar Current Levels by Altimetry and Island Measurements) programme in the South Atlantic and Southern Oceans consists of measurements from coastal tide gauges and bottom pressure stations, together with an ongoing research programme in satellite altimetry. This network spread out by the National Oceanographic Centre (NOC) was his main contribution to the World Ocean Circulation Experiment (WOCE) and now provides data to the Climate Variability and Predictability Programme (CLIVAR), Global Sea Level Observing System (GLOSS) and the Permanent Service for Mean Sea Level (PSMSL).

Tide gauge	WOCE n° 9100
 <p data-bbox="391 1982 539 2009">Global view</p>	 <p data-bbox="981 1982 1268 2009">Close-up view (brassout)</p>
<p>Description : the reference level is the top of the brassout upon the sea water well.</p>	

*On a DORIS request, it has been tied by BAS to the GNSS "BAS" station on Feb. 2007 using GPS technique.*



### 2.4.2 Geodetic point CELINA

This point is regularly used for different topographic works (*for example, as a GPS base for studying the impact of the Rothera base and airstrip on the nearby glaciers*).

Acronym : CELINA	Geodetic point
 <p data-bbox="389 994 539 1025">Global view</p>	 <p data-bbox="938 994 1315 1025">Close-up view (reference point)</p>
<p>Description : axis and top of an embedded rod in concrete.</p>	

### 2.4.3 Gravimetric Point

This point carved “GEOLOGICAL SURVEY POSITION / ROTHERA GRAV 1975-1976” is near the control tower. During my stay at Rothera it has been surveyed across a gravimetry traverse; As it was on the way between DORIS and the tide gauge, I also included this point in my spirit levelling observations.

Gravimetric point	
 <p data-bbox="370 1928 520 1960">Global view</p>	 <p data-bbox="890 1951 1267 1982">Close-up view (reference point)</p>
<p>Description : marker embedded in concrete (centre and top). (<i>gravimetric value is 982481,7 mGal ±24,3 mGal in K. Lindner Feb. 1995 report</i>)</p>	



### 3 SURVEY DESCRIPTION

#### 3.1 Organization

I carried out the local ties survey from the 31<sup>th</sup> January to the 3<sup>rd</sup> of February 2011, with the friendly cooperation of either Tom or Geese (field assistants).

All the topometric survey instruments and equipments belong to IGN and were sent by vessel (by BAS) for the purpose of the survey.

#### 3.2 Equipment (Instruments)

A Leica tacheometer (TC2002) was used for this work. This instrument, which is regularly calibrated by IGN's equipment control unit, was associated with two Leica accurate prisms. It has a standard deviation of 0.15 mgon for horizontal and vertical angles and 1 mm + 1 ppm for distances. The altimetric observations were performed with a Leica electronic level (NA3003) linked with invar bar code levelling rods. This equipment, also regularly calibrated, has a resolution of 0.01 mm. Finally, the GPS observations were performed with a Leica SR530 receiver and an ASHTECH choke ring antenna (701945-01 without radome). Concerning the permanent GNSS station ROTH, the current antenna is a Leica AR25 with radome LEIT.

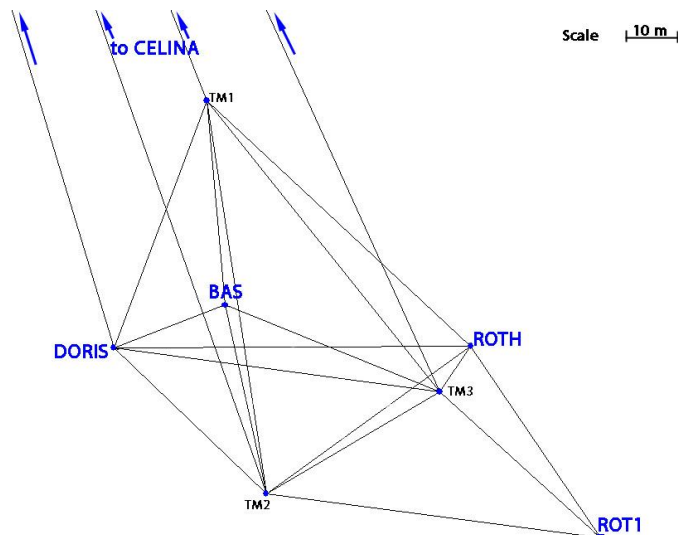
All these instruments allowed the observations to be recorded electronically on memory cards or storage devices and were then downloaded to a laptop PC for checkings and processing.

In order to ensure the stability of temporary stations, we also used «heavy tripods».



#### 3.3 Rothera observations polygon

All the survey was conducted in order to provide the highest accuracy in the determination of the 3D vectors between the observing instruments. During the survey, I wasn't faced with any particular difficulty. I just added two temporary stations to deal with the small hills between ROT1 and the other points.



### 3.4 Survey method

All the visible lines of sight were observed with the tacheometer. Horizontal directions and zenith angles were observed in data sets, each set consisting in one reading in both direct and reverse theodolite positions. Distance measurements were observed at least once over each line. Meteorological data (atmospheric pressure and temperature) used to correct the distances, were recorded at the beginning of each station occupation.

As far as direct levelling is concerned, forward and backward runs were observed between each benchmark. At the beginning of the spirit levelling, the instrument collimation was checked. The electronic level instrument was set to perform two readings on a bar code staff and measurements were repeated if the difference between the two readings was inconsistent. In the same way, we checked the difference between two runs. A third run has to be measured if the difference between the forward and the backward run was greater than  $0,15 \text{ mm} \times \sqrt{n}$  ( $n$  = number of traverse legs).

The strategy has been to mix GPS and conventional observations (ie GPS observations are used to get the polygon's bearing).

#### 3.4.1 Permanent GNSS stations reference point

As we could not remove ROTH and BAS GNSS antennas, their reference point had to be determined indirectly.

For the planimetric position :

From each survey station aiming at the antennas, the right and left sides of the choke ring theoretically centred on the phase centre of the antenna were observed. This element was chosen so that it is optically well defined for the operator, and in the adjustment, horizontal angle observations were simply averaged to get its planimetric position.

For the altimetric position :

These points have been surveyed by spirit levelling. Moreover, vertical angles have been measured on a well defined element of the antenna. Then, the resulting position has been reduced to the reference point using the manufacturer values and included in the adjustment as a check.

#### 3.4.2 Verticality check and centring equation

Using a theodolite the verticality of the « theoretical » DORIS reference points were measured with respect to the DORIS marker. The results of this eccentricity combined with the height above the marker are the centring equations. The DORIS positions ROTB and ROVB were exactly above the marker ; but the new stainless tripod is slightly beside the marker.

In the same way, the BAS ARP position was checked with respect to the GAP 1998 marker. The result of our observations is a position 1,5 cm to the north and 4 mm to the west. The height coming from the levelling is 1,154 m above the marker.

#### 3.4.3 Levelling

Double-run spirit levelling operations were carried out on these main points described in paragraph 2.

About the GNSS antennas, the ARP were levelled with a 0,5 m rod in reverse position.

The DORIS reference points have been deducted from the heights above the DORIS marker.

We patiently did the slope to the tide gauge with the 2 m height rod the day before leaving.

### 3.4.4 GPS observations

GPS observations have been carried out in order to orientate the survey. For ROTH, we used the IGS data and the two other points were observed with our GPS equipment (ie. Leica SR530 receiver with Ashtech choke ring antenna).

The following table sums up the GPS observations.

Point	Start (UT)	End (UT)	Ant. Height (m)	Ant. Type
ROTH	Daily RINEX file DOY 033		0,000	LEIAR25
ROVB	DOY 033 16 : 03	DOY 033 19 : 09	-0,376	ASH701945E_M
CELINA	DOY 033 19 : 18	DOY 033 20 : 57	0,825	ASH701945E_M

All antenna heights are related to the antenna reference point. Only ROTH was equipped with LEIT radome.

## 4 COMPUTATIONS

### 4.1 On-site validation

The theodolite observations were checked on site in order to point out any problem in the observations. The levelling observations were also checked on site and validated by a global adjustment.

### 4.2 GPS network

Back to the office, the GPS baselines were processed with LEICA Geo Office V 6.0 Software using IGS05 precise ephemeris and the original set of “absolute” GNSS antenna calibrations (igs05.atx). ROTH coordinates come from the station position in IGS05 at epoch 2011:033 of the corresponding IGS RF weekly solution (i.e. file igs11P1621.ssc).

The corresponding LGO report file is given in appendix 6.3.

### 4.3 Global Adjustment

The final computation has been carried out by a 3D Least Squares Adjustment with the Microsearch GeoLab 2001 version 2001.9.20.0 software. The input file (see appendix 6.4) comes from :

- Theodolite observations : horizontal and zenith angles, distances
- Spirit levelling : height differences between points
- Centring equations : relative position between points.
- An azimuth issued from the GPS baselines process.
- ROTH coordinates have been constrained at 1 mm to its IGS05 (epoch 2011:033) values.

The a priori standard deviations used for the different observations with tacheometers are :

- 0.8 mgon for horizontal and vertical angles
- 1mm for distances on prism
- 0.1 mm x  $\sqrt{n}$  (n = number of traverse legs) for the height differences

(These are the values used for most of the targets in our Microsearch GeoLab computation input file).

This adjustment provided coordinates and a covariance matrix of our survey work (appendix 6.5).

## 5 RESULTS

### 5.1 Station name translation table

The following list sums up the most interesting points used in the Microsearch GeoLab input file. In bold, the main points, description, used name or code and computation name.

Point Description	Used name or code	Computation name
<b>Former DORIS station</b>		
• <b>ROTB Antenna Ref Point</b>	<b>66007S002</b>	<b>ROTB</b>
• <b>ROUB Antenna Ref Point</b>	<b>66007S003</b>	<b>ROUB</b>
DORIS station		
• <b>ROVB Antenna Reference Point</b>	<b>66007S004</b>	<b>ROVB</b>
• <b>DORIS pillar / domed mark</b>	<b>66007M002</b>	<b>DORIS_m</b>
GNSS permanent station		
• <b>ROTH IGS reference point</b>	<b>66007M003</b>	<b>ROTH</b>
• Antenna ARP	-	<b>ROTH_ARP</b>
GNSS permanent station		
• BAS reference point (marker)	-	GAP98
• Antenna ARP	-	BAS_ARP
GAP / SCAR Epoch Campaigns Point		
• <b>GAP 1995 mark</b>	<b>66007M001</b>	<b>ROT1</b>
Tide gauge		
• Tide Gauge Ref Point (marker)	WOCE n°9100 (POL BM5)	TG_m
Geodetic Point		
• CELINA (flag = axis)		CEL_AX
• CELINA Ref Point (marker)		CELINA
Gravimetric Point		
• Reference Point (marker)		GRAVI

### 5.2 Adjusted coordinates and confidence regions

The results of the adjustment are the coordinates of all points as well as their confidence ellipsoids in the ITRF2005 at the mean epoch of the observations (i.e. epoch 2011:033).



The table below provides the 3D coordinates and confidence region at 95% of the points of interest.

```

=====
ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA
Microsearch GeoLab, V2001.9.20.0          GRS80          UNITS: m,GRAD Page 0005
=====
Adjusted XYZ Coordinates:

```

CODE	FFF	STATION	X-COORDINATE STD DEV	Y-COORDINATE STD DEV	Z-COORDINATE STD DEV		
XYZ		BAS_ ARP	909204.8918 0.0013	-2264786.1419 0.0013	-5873048.2029 0.0012	m	0
XYZ		CELINA	909204.0432 0.0023	-2265149.3626 0.0028	-5872888.9249 0.0036	m	0
XYZ		<b>DORIS_m</b>	909182.7176 0.0014	-2264787.2648 0.0013	-5873051.8010 0.0012	m	0
XYZ		GAP98	909204.7254 0.0013	-2264785.7194 0.0013	-5873047.1417 0.0012	m	0
XYZ		GRAVI	909364.2484 0.0002	-2264995.2395 0.0004	-5872927.5364 0.0011	m	0
XYZ		<b>ROT1</b>	909255.3527 0.0016	-2264721.4084 0.0016	-5873063.0320 0.0013	m	0
XYZ		<b>ROTB</b>	909182.7878 0.0018	-2264787.4397 0.0019	-5873052.2576 0.0024	m	0
XYZ		<b>ROTH</b>	909246.0917 0.0011	-2264764.1569 0.0011	-5873056.3103 0.0011	m	0
XYZ		<b>ROUB</b>	909182.8091 0.0018	-2264787.4928 0.0019	-5873052.3963 0.0024	m	0
XYZ		<b>ROVB</b>	909182.8333 0.0018	-2264787.5558 0.0019	-5873052.5675 0.0024	m	0
XYZ		TG_m	909099.3552 0.0002	-2264815.6112 0.0004	-5873028.3788 0.0011	m	0

```

=====
ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA
Microsearch GeoLab, V2001.9.20.0          GRS80          UNITS: m,GRAD Page 0016
=====
2-D and 1-D Station Confidence Regions (95.000 and 95.000 percent):

```

STATION	MAJOR SEMI-AXIS	AZ	MINOR SEMI-AXIS	VERTICAL
BAS_ ARP	0.0033	37	0.0031	0.0022
CELINA	0.0064	143	0.0055	0.0074
<b>DORIS_m</b>	0.0034	46	0.0033	0.0022
GAP98	0.0033	29	0.0031	0.0022
GRAVI	0.0000	0	0.0000	0.0024
<b>ROT1</b>	0.0043	25	0.0037	0.0023
<b>ROTB</b>	0.0043	46	0.0043	0.0049
<b>ROTH</b>	0.0027	90	0.0027	0.0022
<b>ROUB</b>	0.0043	46	0.0043	0.0049
<b>ROVB</b>	0.0043	46	0.0043	0.0049
TG_m	0.0000	0	0.0000	0.0024

The whole covariance matrix was computed, then it was possible to extract from it the covariance submatrix for the 6 main points of interest i.e. ROTH, ROT1, DORIS\_m, ROTB, ROUB and ROVB, for the ITRF2005 computation. Finally, this covariance submatrix has been converted into the SINEX format using the « geotosnx » tool provided by Z. Altamimi. The resulting SINEX file (66007\_IGN\_2011-033.SNX) is presented in appendix 6.6.



## 6 APPENDIXES

6.1	Appendix 1 : "ROUB" DORIS station site log (extract) .....	18
6.2	Appendix 2 : "ROTH" GNSS station site log (extract) .....	20
6.3	Appendix 3 : LEICA Geo Office report file .....	23
6.4	Appendix 4 : adjustment input file .....	24
6.5	Appendix 5 : adjustment output file .....	29
6.6	Appendix 6 : Rothera SINEX File .....	41

## 6.1 Annex 1 : "ROUB" DORIS station site log (extract)

Note : only the points most relevant to this survey were retained in the following extract.

The complete version of this site log is available at : <http://ids-doris.org/network/sitelogs.html>

ROTHERA DORIS site description form

### 0. Form

Prepared by : SIMB (DORIS installation and maintenance department)  
Date prepared : 9/12/2008  
Report type : UPDATE

### 1. Site location information

Site name : ROTHERA  
Site DOMES number : 66007  
Host agency : BRITISH ANTARCTIC SURVEY  
City : Rothera base (Adelaide Island)  
State or province :  
Country : ANTARCTICA (U. K. base)  
Tectonic plate (PB2002) : Antarctica  
Geological information :

Geographical coordinates (ITRF) :  
North Latitude : -67 deg 34' 17''  
East Longitude : -68 deg 7' 39''  
Ellipsoid height : 35 m  
Approximate altitude : 28 m

### 2. DORIS antenna and reference point information

#### 2.1

Four character ID : ROTA  
Antenna model : Alcatel  
Antenna serial number : 71  
IERS DOMES number : 66007S001  
CNES/IGN number : 660071  
CTDP number : 1049  
Date installed (dd/mm/yy) : 03/02/1993  
Date removed (dd/mm/yy) : 09/02/2005  
Antenna support type : 1 metre tower  
Installed on : Side wall of a timbered laboratory (1 level)  
Height above ground mark : m  
Ground mark type : None  
Ground mark DOMES number : 66007  
Notes :

#### 2.2

Four character ID : ROTB  
Antenna model : Starec 52291 type  
Antenna serial number : 103  
IERS DOMES number : 66007S002  
CNES/IGN number : 660072  
CTDP number : 246  
Date installed (dd/mm/yy) : 01/03/2005  
Date removed (dd/mm/yy) : 28/10/2007  
Antenna support type : Concrete pillar 1.5 m high, 0.4 m sided.  
Installed on : Solid bedrock  
Height above ground mark : 0.494 m  
Ground mark type : Domed brass screw  
Ground mark DOMES number : 66007M002  
Notes :

#### 2.3

**Four character ID : ROUB**  
Antenna model : Starec 52291 type  
Antenna serial number : 116  
**IERS DOMES number : 66007S003**  
CNES/IGN number : 660073  
CTDP number : 280  
Date installed (dd/mm/yy) : 29/10/2007  
Date removed (dd/mm/yy) :  
Antenna support type : Concrete pillar 1.5 m high, 0.4 m sided  
Installed on : Solid bedrock  
Height above ground mark : 0.644 m  
Ground mark type : Domed brass screw  
Ground mark DOMES number : 66007M002  
Notes : Antenna raised by 15 cm in order to remove the  
: N-type bent cable connectors

### 3. DORIS beacons information

(...)

4. ITRF coordinates and velocities of the current DORIS ref. point (ROUB)

Solution : ITRF2005 (tie to ROTB)  
Epoch : 2000.0

X = 909182.616 m      Y = -2264787.440 m      Z = -5873052.374 m  
Sig X = 0.002 m      Sig Y = 0.002 m      Sig Z = 0.002 m

VX = 0.0199 m/y      VY = -0.0044 m/y      VZ = 0.0008 m/y  
Sig VX = .0003 m/y      Sig VY = .0003 m/y      Sig VZ = .0003 m/y

5. IERS co-location information

6. Tide gauge co-location information

7. Local site ties

7.1

Point description : DORIS Starec antenna reference point (ROTB)  
DOMES number : 66007S002

Differential components from the current DORIS ref. point (ROUB)  
to the above point (in the ITRS) :

dX (m) : -0.021  
dY (m) : 0.053  
dZ (m) : 0.139

Accuracy (m) : 0.001  
Date measured : October 2007  
Additional information : Survey by BAS

7.2

Point description : DORIS Alcatel antenna reference point (ROTA)  
DOMES number : 66007S001

Differential components from the current DORIS ref. point (ROUB)  
to the above point (in the ITRS) :

dX (m) : 195.622  
dY (m) : -147.114  
dZ (m) : 95.513

Accuracy (m) : 0.002  
Date measured : February 2005  
Additional information : Survey by IGN-F

7.3

Point description : Mark under the permanent GPS "ROTH" (point no more called "ROTH" but "BAS")  
DOMES number :

Differential components from the current DORIS ref. point (ROUB)  
to the above point (in the ITRS) :

dX (m) : 21.918  
dY (m) : 1.761  
dZ (m) : 5.262

Accuracy (m) : 0.001  
Date measured : February 2005  
Additional information : Survey by IGN-F

7.4

Point description : DORIS concrete pillar / domed brass mark  
DOMES number : 66007M002

Differential components from the current DORIS ref. point (ROUB)  
to the above point (in the ITRS) :

dX (m) : -0.092  
dY (m) : 0.228  
dZ (m) : 0.595

Accuracy (m) : 0.001  
Date measured : October 2007  
Additional information : Survey by BAS

8. Meteorological Instrumentation

(...)

9. DORIS network contacts

Primary contact:

(...)

Secondary contact:

Name : Francois BOLDO  
Agency : Institut Geographique National  
Mailing address : CNES (DCT/ME/OT)  
: 18 Avenue Edouard BELIN  
: 31401 TOULOUSE Cedex FRANCE  
Telephone : + 33 5 61 27 40 72  
Fax : + 33 5 61 28 25 95  
E-mail : Simb.Doris@cnes.fr

## 6.2 Annex 2 : "ROTH" GNSS station site log (extract)

Note : only the points most relevant to this survey were retained in the following extract.

The complete version of this site log is available at : <http://igscb.jpl.nasa.gov/network/site/roth.html>

ROTH Site Information Form (site log)

International GNSS Service

See Instructions at:

[ftp://igscb.jpl.nasa.gov/pub/station/general/sitelog\\_instr.txt](ftp://igscb.jpl.nasa.gov/pub/station/general/sitelog_instr.txt)

### 0. Form

Prepared by (full name) : Matt King  
Date Prepared : 2011-06-01  
Report Type : UPDATE  
If Update:  
Previous Site Log : roth\_20110314.log  
Modified/Added Sections : 3.5, 3.6

### 1. Site Identification of the GNSS Monument

Site Name : Rothera Station, Antarctica  
**Four Character ID** : **ROTH**  
Monument Inscription : NONE  
**IERS DOMES Number** : **66007M003**  
CDP Number : (A4)  
Monument Description : BEDROCK-BOLTED TECH2000 ALUMINIUM MAST  
Height of the Monument : (m)  
Monument Foundation : STEEL EXPANSION BOLTS  
Foundation Depth : 0.2 m  
Marker Description : NONE  
Date Installed : 2009-12-15T21:15Z  
Geologic Characteristic : BEDROCK  
Bedrock Type : IGNEOUS  
Bedrock Condition : WEATHERED  
Fracture Spacing : 1-10 cm  
Fault zones nearby : NO  
Distance/activity : (multiple lines)  
Additional Information : The bedrock surface is frost shattered

### 2. Site Location Information

City or Town : Rothera Station  
State or Province : Antarctic Peninsula  
Country : Antarctica  
Tectonic Plate : Antarctica  
Approximate Position (ITRF)  
X coordinate (m) : 909246.711  
Y coordinate (m) : -2264763.494  
Z coordinate (m) : -5873056.980  
Latitude (N is +) : -673417.0479  
Longitude (E is +) : -0680732.6865  
Elevation (m,ellips.) : 39.793  
Additional Information : (multiple lines)

### 3. GNSS Receiver Information

- 3.1 Receiver Type : LEICA GRX1200+GNSS  
(...)
- 3.2 Receiver Type : LEICA GRX1200+GNSS  
(...)
- 3.3 Receiver Type : LEICA GRX1200+GNSS  
(...)
- 3.4 Receiver Type : LEICA GRX1200+GNSS  
(...)
- 3.5 Receiver Type : LEICA GRX1200+GNSS  
(...)
- 3.6 Receiver Type : LEICA GRX1200+GNSS  
Satellite System : GPS+GLONASS  
Serial Number : 495029  
Firmware Version : 8.20/4.007  
Elevation Cutoff Setting : 0  
Date Installed : 2011-06-01T07:50Z  
Date Removed : (CCYY-MM-DDThh:mmZ)  
Temperature Stabiliz. :  
Additional Information : FW is 8.20, measurement engine is V4.007



4. GNSS Antenna Information

4.1 **Antenna Type** : LEIAR25  
Serial Number : 765734  
**Antenna Reference Point** : BPA  
**Marker->ARP Up Ecc. (m)** : 0.0000  
**Marker->ARP North Ecc(m)** : 0.0000  
**Marker->ARP East Ecc(m)** : 0.0000  
Alignment from True N : 0  
Antenna Radome Type : LEIT  
Radome Serial Number :  
Antenna Cable Type : Leica 632390  
Antenna Cable Length : 30  
Date Installed : 2009-12-14T21:15Z  
Date Removed : (CCYY-MM-DDThh:mmZ)  
Additional Information : (multiple lines)

5. Surveyed Local Ties

5.1 Tied Marker Name : ROTB  
Tied Marker Usage : DORIS  
Tied Marker CDP Number : (A4)  
Tied Marker DOMES Number : (A9)  
Differential Components from GNSS Marker to the tied monument (ITRS)  
dx (m) : (m)  
dy (m) : (m)  
dz (m) : (m)  
Accuracy (mm) : (mm)  
Survey method : (GPS CAMPAIGN/TRILATERATION/TRIANGULATION/etc)  
Date Measured : (CCYY-MM-DDThh:mmZ)  
Additional Information : Local tie observed in Feb 2011, data to follow

5.2 Tied Marker Name : ROT1  
Tied Marker Usage : SCAR Campaign GPS  
Tied Marker CDP Number : (A4)  
Tied Marker DOMES Number : (A9)  
Differential Components from GNSS Marker to the tied monument (ITRS)  
dx (m) : (m)  
dy (m) : (m)  
dz (m) : (m)  
Accuracy (mm) : (mm)  
Survey method : (GPS CAMPAIGN/TRILATERATION/TRIANGULATION/etc)  
Date Measured : (CCYY-MM-DDThh:mmZ)  
Additional Information : Local tie observed in Feb 2011, data to follow

6. Frequency Standard  
(...)

7. Collocation Information

7.1 Instrumentation Type : DORIS  
Status : PERMANENT  
Effective Dates : (CCYY-MM-DD/CCYY-MM-DD)  
Notes : (multiple lines)

8. Meteorological Instrumentation  
(...)

9. Local Ongoing Conditions Possibly Affecting Computed Position  
(...)

10. Local Episodic Effects Possibly Affecting Data Quality  
(...)

11. On-Site, Point of Contact Agency Information

Agency : British Antarctic Survey  
Preferred Abbreviation : BAS  
Mailing Address : British Antarctic Survey, Madingley Road  
: Cambridge, UK  
Primary Contact  
Contact Name : Edward King  
Telephone (primary) : 0441223221344  
Telephone (secondary) :  
Fax :  
E-mail : ecki@bas.ac.uk  
Secondary Contact  
Contact Name : Matt King  
Telephone (primary) : 0441912227833  
Telephone (secondary) :  
Fax :  
E-mail : m.a.king@ncl.ac.uk  
Additional Information : (multiple lines)

12. Responsible Agency (if different from 11.)

```

Agency : Newcastle University
Preferred Abbreviation : NCL
Mailing Address : School of Civil Engineering & Geosciences,
                 Newcastle University, Cassie Building,
                 Newcastle Upon Tyne, NE17RU, UK (multiple lines)

Primary Contact
Contact Name : Matt King
Telephone (primary) : 0441912227833
Telephone (secondary) :
Fax :
E-mail : m.a.king@ncl.ac.uk

Secondary Contact
Contact Name :
Telephone (primary) :
Telephone (secondary) :
Fax :
E-mail :
Additional Information : (multiple lines)

```

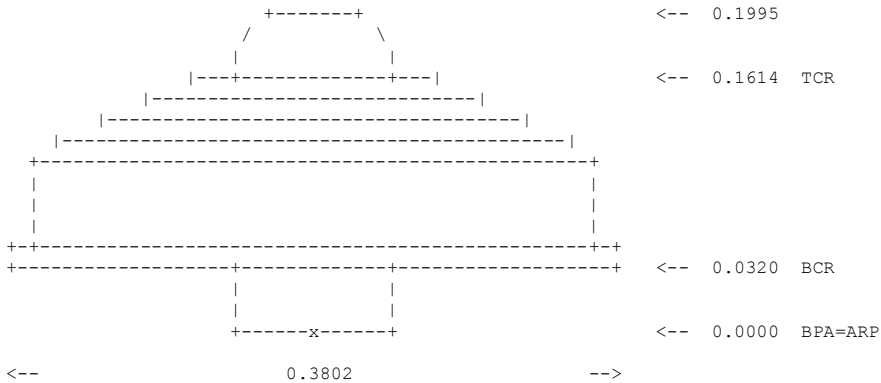
13. More Information

```

Primary Data Center : Bundesamt fuer Kartographie und Geodasie (BKG)
Secondary Data Center : Scripps Institute of Oceanography (SIO)
URL for More Information :
Hardcopy on File
Site Map : (Y or URL)
Site Diagram : (Y or URL)
Horizon Mask : (Y or URL)
Monument Description : (Y or URL)
Site Pictures : (Y or URL)
Additional Information : (multiple lines)
Antenna Graphics with Dimensions

```

LEIAR25



### 6.3 Annex 3 : LEICA Geo Office report file

## Récapitulatif du Traitement

### Roth\_LGO

#### Informations sur le Projet

Nom du Projet:	Roth_LGO
Date de création:	06/14/2011 18:48:27
Fuseau Horaire:	0h 00'
Nom Syst. Coordonnées:	WGS 1984
Logiciel d'application:	LEICA Geo Office 8.1
Date et heure de début:	02/02/2011 16:03:15
Date et heure de fin:	02/03/2011 00:56:45
Points occupés manuellement:	2
Noyau de Post-Traitement:	PSI-Pro 3.0
Traité:	08/30/2011 17:10:06

#### Paramètres de Traitement

Paramètres	Sélectionnés
Angle de Coupure:	10°
Type d'Ephémérides:	Précises
Type de solution:	Automatique
Type GNSS:	Automatique
Fréquence:	Automatique
Fixer les ambiguïtés jusqu'à:	80 km
Durée mini pour solution flottante (statique):	5' 00"
Taux d'échantillonnage:	Tout Utiliser
Modèle Troposphérique:	Saastamoinen
Modèle Ionosphérique:	Automatique
Utiliser modélisation statistique:	Oui
Distance mini.:	8 km
Activité ionosphérique:	Automatique

#### Ligne de Base - Aperçu

ROTH - ROVB	Référence: ROTH	Mobile: ROVB
Coordonnées:		
Latitude:	67° 34' 16.99766" S	67° 34' 17.00683" S
Longitude:	68° 07' 32.79065" O	68° 07' 38.48907" O
Hteur Ellip.:	39.7112 m	35.5400 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	
ROTH - CELINA	Référence: ROTH	Mobile: CELINA
Coordonnées:		
Latitude:	67° 34' 16.99766" S	67° 34' 04.73774" S
Longitude:	68° 07' 32.79065" O	68° 07' 48.21638" O
Hteur Ellip.:	39.7112 m	15.4186 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	

## 6.4 Annex 4 : Adjustment input file

TITL ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUARY 2011 SURVEY

COMP ADJ  
ELIP GRS80 6378137.0000 6356752.3141 0.0 0.0 0.0  
MAXI 15  
CONF YES YES YES YES NO  
PSOL NO YES  
PMIS NO NO  
PRES YES NO  
PADJ NO NO YES NO YES NO NO NO  
VARF YES YES NO  
RTST TAU MAX  
LUNT m 1.000000000000  
CONV 0.00010  
CLEV 95.000  
ANGT GRD  
LDEC 4

\*\*\*\*\*  
\* ITRF ACRONYMS, n° DOMES and POINTS DESCRIPTION \*

\*DORIS  
\*ROVB : (DOMES 66007S004) = DORIS Ant. Ref. Pt. (Starec type)  
\*DORIS\_m : (DOMES 66007M002) = DORIS concrete pillar / domed brass mark  
  
\*FORMER DORIS POINTS  
\*(destroyed point) ROTA : (DOMES 66007S001) = DORIS Ant. Ref. Pt. (Alcatel type)  
\*ROTB : (DOMES 66007S002) = DORIS Ant. Ref. Pt. (Starec type)  
\*ROUB : (DOMES 66007S003) = DORIS Ant. Ref. Pt. (Starec type)  
  
\*PERMANENT GNSS STATIONS  
\*ROTH : (DOMES 66007M003) = CONCRETE PILLAR WITH BRASS ANTENNA BASE / GLONASS MARKER (= IGS reference point)  
  
\*GEODETTIC POINT  
\*ROT1 : (DOMES 66007M001) = GAP 1995 = GAP / SCAR EPOCH CAMPAIGNS

\*\*\*\*\*  
\* LIST OF POINTS for the SURVEY ADJUSTMENT \*

\*POINTS OF INTEREST  
\*BAS : (no DOMES number) = BAS GPS above a SCAR/GAP1998 MARK  
\*BAS\_ARP : ANTENNA AXIS AT ARP (seems to be slightly leaning) and a little less (3 mm) than 1,157 m above the SCAR/GAP1998 mark  
\*GAP98 : BAS GPS reference point = SCAR/GAP1998 mark

\*TEMPORARY MARKS  
\*ROT1\_TH : Theodolite above ROT1 (intersection of the theodolite rotation axes)  
\*ROT1\_PRI : PRISM above ROT1 (same prism height than theodolite)  
\*(or TEMPORARY STATIONS)  
\*TM1 TM2 TM3 Temporary stations on HEAVY tripod (very stable)  
\*TM1\_TH : Theodolite on TM1 (intersection of the theodolite rotation axes)  
\*TM1\_PRI : PRISM on TM1 (same prism height than theodolite)  
\*TM2\_TH : Theodolite on TM2 (intersection of the theodolite rotation axes)  
\*TM2\_PRI : PRISM on TM2 (same prism height than theodolite)  
\*TM3\_TH : Theodolite on TM3 (intersection of the theodolite rotation axes)  
\*TM3\_PRI : PRISM on TM3 (same prism height than theodolite)  
\*TG\_PRI : PRISM above the tide gauge but it's better to use the levelled value  
\*DORIS\_TH : Theodolite above DORIS\_marker (intersection of the theodolite rotation axes)  
\*DORIS\_PRI : PRISM above DORIS\_marker (same prism height than theodolite)  
\*CELINA : Geodetic Point determined by GPS and used for the bearing (top of rod) : CELINA ref point (marker)  
\*CEL\_PRI : PRISM above CELINA  
\*CEL\_AX : CELINA flag axis

\*\*\*\*\*LEVELLING POINTS DESCRIPTIONS\*\*\*\*\*  
\*GRAVI : = GEOLOGICAL SURVEY POSITION / ROTHERA GRAV 1975-1976 (gravimetric point)  
\*TG\_m : Tide Gauge marker (WOCE n°9100) = top of marker on the sea water well = (described as POL BM5 in Klaus Lindner report Feb. 1995)  
\*TG\_dev : top of a special device for levelling (iron piece 3,21 cm in height measured with a calliper rule) on the Tide Gauge brassout  
\*TempPt : temporary levelling nail

\*\*\*\*\*  
\* GPS Observations 2011 JC.Poyard  
\*\*\*\*\*  
\*BASELINES PROCESSED WITH LEICA GEO OFFICE SOFTWARE  
\*GRP Obs #00001 LB\_ROTH.asc

```
*3DD
*DXYZ ROTH ROVB -63.2591 -23.3981 3.7473 m
*COV CT UPPR
*ELEM 6.3608272000000000e-09 -1.4678832000000000e-09 -3.4250608000000000e-09 m
*ELEM 7.3394160000000001e-09 4.8929440000000000e-09 m
*ELEM 4.5015084800000000e-08 m
```

```
*GRP Obs #00002 LB_ROTH.asc
*3DD
*DXYZ ROTH CELINA -42.0487 -385.2082 167.3787 m
*COV CT UPPR
*ELEM 9.5902149000000001e-09 -2.7400614000000000e-09 -7.7635072999999999e-09 m
*ELEM 1.3700307000000000e-08 1.0503568700000000e-08 m
*ELEM 8.2201842000000001e-08 m
```

\*\*\*\*\*AZIMUT DEDUCTED FROM THE GPS DETERMINATION\*\*\*\*\*

```
AZIM ROTH CEL_AX 371 47 91.0 0.002
```

\*\*\*\*\*POINTS COORDINATES\*\*\*\*\*

```
*FORCED ITRF2005 EPOCH 2011:033 COORDINATES
3DC
XYZ 000 ROTH 909246.0917 -2264764.1569 -5873056.3103
COV CT DIAG 1
ELEM 0.000001 0.000001 0.000001
```

\*\*\*\*\*APPROXIMATE COORDINATES\*\*\*\*\*

```
PLH 110 TG_m s 67 34 16.860000 w 68 7 45.920000 10.000
PLH 110 TG_dev s 67 34 16.860000 w 68 7 45.920000 10.000
PLH 110 GRAVI s 67 34 07.700000 w 68 7 30.800000 15.000
PLH 110 TempPt s 67 34 9.000000 w 68 7 32.600000 15.000
```

\*\*\*\*\*CENTRING EQUATIONS\*\*\*\*\*

```
3DD
PLH 000 ROT1 s 67 34 18.161000 w 68 7 30.720000 32.000
PLH 000 ROT1_TH s 67 34 18.161000 w 68 7 30.720000 33.506
PLH 000 ROT1_PRI s 67 34 18.161000 w 68 7 30.720000 33.506
COV LG DIAG
ELEM 0.000001 0.000001 0.000001
ELEM 0.000001 0.000001 0.000001
```

```
3DD
PLH 000 TM1_TH s 67 34 15.500000 w 68 7 37.000000 35.000
PLH 000 TM1_PRI s 67 34 15.500000 w 68 7 37.000000 35.000
COV LG DIAG
ELEM 0.00000025 0.00000025 0.00000025
```

```
3DD
PLH 000 TM2_TH s 67 34 17.900000 w 68 7 36.060000 43.850
PLH 000 TM2_PRI s 67 34 17.900000 w 68 7 36.060000 43.850
COV LG DIAG
ELEM 0.00000025 0.00000025 0.00000025
```

```
3DD
PLH 000 TM3_TH s 67 34 17.280000 w 68 7 33.290000 40.200
PLH 000 TM3_PRI s 67 34 17.280000 w 68 7 33.290000 40.200
COV LG DIAG
ELEM 0.00000025 0.00000025 0.00000025
```

```
*3DD
*PLH 000 TG_m s 67 34 16.860000 w 68 7 45.901000 11.000
*PLH 000 TG_PRI s 67 34 16.860000 w 68 7 45.901000 11.309
*COV LG DIAG
*ELEM 0.000004 0.000004 0.000004
```

```
3DD
PLH 000 DORIS_m s 67 34 17.006430 w 68 7 38.495740 34.700
PLH 000 DORIS_TH s 67 34 17.006430 w 68 7 38.495740 35.055
PLH 000 DORIS_PRI s 67 34 17.006430 w 68 7 38.495740 35.055
PLH 000 ROTB s 67 34 17.006430 w 68 7 38.495740 35.194
PLH 000 ROUB s 67 34 17.006430 w 68 7 38.495740 35.344
COV LG DIAG
ELEM 0.000001 0.000001 0.000004
ELEM 0.000001 0.000001 0.000004
ELEM 0.000001 0.000001 0.000004
ELEM 0.000001 0.000001 0.000004
```

\*The new DORIS tripod isn't exactly centred on the marker

```
3DD
PLH 000 DORIS_m s 67 34 17.006430 w 68 7 38.495740 34.700
PLH 000 ROVB s 67 34 17.006526 w 68 7 38.495828 35.528
COV LG DIAG
```

```

ELEM          0.000001          0.000001          0.000004

*(BAS slightly leaning)
3DD
PLH 000 BAS_ARP      s 67 34 16.750770 w 68 7 36.711150      34.154
PLH 000 GAP98        s 67 34 16.751254 w 68 7 36.710812      33.000
COV LG DIAG          0.000000  1.000000  0.000000  1.000000  0.000000
ELEM                0.000009          0.000009          0.000004

3DD
PLH 000 CELINA       s 67 34 4.735220 w 68 7 48.224820      15.0000
PLH 000 CEL_PRI      s 67 34 4.735220 w 68 7 48.224820      15.8753
COV LG DIAG
ELEM                0.000004          0.000004          0.000004

2DD
PL 000 CELINA        s 67 34 4.735220 w 68 7 48.224820
PL 000 CEL_AX        s 67 34 4.735220 w 68 7 48.224820
COV LG DIAG
ELEM                0.000004          0.000004

```

HIST NEW

```

*****
*                               Theodolite Observations 2011 JC.Poyard
*****

```

\*Données reduites

\* E:\2011001\_Rothera\2011001\_Observations\2011001\_Plan1\roth\_plani.obs

\*Tours d'horizon

\* Station n°1 31

\* Temperature : 3.7 °C - Pression : 731.5 mmHg - Correction meteo : 2.4 ppm

```

DSET
DIR   TM3_TH      CEL_AX          + 0 0      0.0      8
DIR   TM3_TH      ROT1_PRI         +173 96    96.0      8
DIR   TM3_TH      TM2_PRI          +293 42    27.0      8

*ZANG  TM3_TH      CEL_AX          +103 72    94.0      8
ZANG  TM3_TH      ROT1_PRI         +110 25    55.0      8
ZANG  TM3_TH      TM2_PRI          + 94 46    64.0      8

DIST  TM3_TH      ROT1_PRI          41.4740    0.0010
DIST  TM3_TH      TM2_PRI          38.1698    0.0010

```

\* Station n°2 21

\* Temperature : 3.7 °C - Pression : 731.5 mmHg - Correction meteo : 2.4 ppm

```

DSET
DIR   TM2_TH      CEL_AX          + 0 0      0.0      8
DIR   TM2_TH      TM3_PRI          + 87 84    53.0      8
DIR   TM2_TH      ROT1_PRI         +129 83    93.0      8

*ZANG  TM2_TH      CEL_AX          +104 17     0.0      8
ZANG  TM2_TH      TM3_PRI          +105 53    73.0      8
ZANG  TM2_TH      ROT1_PRI         +109 88    11.0      8

DIST  TM2_TH      TM3_PRI          38.1704    0.0010
DIST  TM2_TH      ROT1_PRI         64.4808    0.0010

```

\* Station n°3 11

\* Temperature : 2.9 °C - Pression : 732.5 mmHg - Correction meteo : 1.2 ppm

```

DSET
DIR   ROT1_TH     TM2_PRI          + 0 0      0.0     10
DIR   ROT1_TH     TM3_PRI          + 38 55    13.0     10
DIR   ROT1_TH     ROTH            + 53 73    14.0     10

ZANG  ROT1_TH     TM2_PRI          + 90 12    19.0     10
ZANG  ROT1_TH     TM3_PRI          + 89 74    82.0     10
ZANG  ROT1_TH     ROTH            + 91 14    59.0     10

DIST  ROT1_TH     TM2_PRI          64.4806    0.0010
DIST  ROT1_TH     TM3_PRI          41.4739    0.0010

```

\* Station n°4 31

\* Temperature : 2.8 °C - Pression : 732.0 mmHg - Correction meteo : 1.2 ppm

```

DSET
DIR   TM3_TH      CEL_AX          + 0 0      0.0      8
DIR   TM3_TH      ROTH            + 65 21    84.0      8
DIR   TM3_TH      TM2_PRI         +293 42    17.0      8
DIR   TM3_TH      DORIS_m         +335 72     3.0      8
DIR   TM3_TH      DORIS_PRI        +335 72     3.0      8
DIR   TM3_TH      BAS_ARP         +351 57    33.0      8
DIR   TM3_TH      TM1_PRI         +384 14    34.0      8

```



*ZANG	TM3_TH	CEL_AX	+103 72	49.0	8
ZANG	TM3_TH	ROTH	+103 36	8.0	8
ZANG	TM3_TH	TM2_PRI	+ 94 46	12.0	8
ZANG	TM3_TH	DORIS_m	+105 66	66.0	8
ZANG	TM3_TH	DORIS_PRI	+105 30	55.0	8
ZANG	TM3_TH	BAS_ARP	+108 84	30.0	8
ZANG	TM3_TH	TM1_PRI	+104 82	26.0	8
DIST	TM3_TH	DORIS_PRI		62.3450	0.0010
DIST	TM3_TH	TM1_PRI		70.5639	0.0010

\* Station n°5 21

\* Temperature : 4.0 °C - Pression : 732.0 mmHg - Correction meteo : 2.5 ppm

DSET					
DIR	TM2_TH	CEL_AX	+ 0 0	0.0	8
DIR	TM2_TH	BAS_ARP	+ 7 91	32.0	8
DIR	TM2_TH	GAP98	+ 7 91	25.0	8
DIR	TM2_TH	TM1_PRI	+ 12 3	75.0	8
DIR	TM2_TH	ROTH	+ 81 88	13.0	8
DIR	TM2_TH	TM3_PRI	+ 87 84	65.0	8
DIR	TM2_TH	DORIS_m	+370 21	42.0	8
DIR	TM2_TH	DORIS_PRI	+370 21	90.0	8
*ZANG	TM2_TH	CEL_AX	+104 15	56.0	8
*ZANG	TM2_TH	BAS_ARP	+116 6	79.0	8
*ZANG	TM2_TH	GAP98	+117 53	42.0	90
ZANG	TM2_TH	TM1_PRI	+107 31	75.0	8
ZANG	TM2_TH	ROTH	+105 15	51.0	8
ZANG	TM2_TH	TM3_PRI	+105 53	43.0	8
ZANG	TM2_TH	DORIS_m	+113 93	66.0	8
ZANG	TM2_TH	DORIS_PRI	+113 39	39.0	8
DIST	TM2_TH	TM1_PRI		75.4603	0.0010
DIST	TM2_TH	DORIS_PRI		40.7231	0.0010

\* Station n°6 51

\* Temperature : 4.0 °C - Pression : 733.0 mmHg - Correction meteo : 2.1 ppm

DSET					
DIR	DORIS_TH	CEL_AX	+ 0 0	0.0	8
DIR	DORIS_TH	TM1_PRI	+ 41 65	92.0	8
DIR	DORIS_TH	BAS_ARP	+ 95 42	49.0	8
DIR	DORIS_TH	GAP98	+ 95 46	73.0	8
DIR	DORIS_TH	ROTH	+118 45	62.0	8
DIR	DORIS_TH	TM3_PRI	+127 26	56.0	8
DIR	DORIS_TH	TM2_PRI	+167 33	86.0	8
*ZANG	DORIS_TH	CEL_AX	+103 16	59.0	8
ZANG	DORIS_TH	TM1_PRI	+100 19	24.0	8
ZANG	DORIS_TH	BAS_ARP	+102 62	6.0	8
ZANG	DORIS_TH	GAP98	+105 87	44.0	8
ZANG	DORIS_TH	ROTH	+ 95 62	48.0	8
ZANG	DORIS_TH	TM3_PRI	+ 94 69	46.0	8
ZANG	DORIS_TH	TM2_PRI	+ 86 60	75.0	8
DIST	DORIS_TH	TM1_PRI		49.7714	0.0010

\* Station n°7 81

\* Temperature : 3.9 °C - Pression : 733.0 mmHg - Correction meteo : 2.0 ppm

DSET					
DIR	TM1_TH	CEL_AX	+ 0 0	0.0	8
DIR	TM1_TH	ROTH	+171 73	28.0	8
DIR	TM1_TH	TM3_PRI	+181 6	51.0	8
DIR	TM1_TH	TM2_PRI	+214 53	75.0	8
DIR	TM1_TH	GAP98	+218 41	77.0	8
DIR	TM1_TH	BAS_ARP	+218 42	05.0	8
DIR	TM1_TH	DORIS_PRI	+247 3	88.0	8
DIR	TM1_TH	DORIS_m	+247 4	16.0	8
*ZANG	TM1_TH	CEL_AX	+103 47	54.0	8
ZANG	TM1_TH	ROTH	+ 95 52	57.0	8
ZANG	TM1_TH	TM3_PRI	+ 95 17	92.0	8
ZANG	TM1_TH	TM2_PRI	+ 92 68	39.0	8
ZANG	TM1_TH	GAP98	+103 17	30.0	8
ZANG	TM1_TH	BAS_ARP	+101 27	81.0	8
ZANG	TM1_TH	DORIS_PRI	+ 99 81	0.0	8
ZANG	TM1_TH	DORIS_m	+100 26	32.0	8
DIST	TM1_TH	DORIS_PRI		49.7700	0.0010

\*STATIONS n°8 n°9 and n°10 were for the tide gauge brassout indirect levelling

\*IT'S BETTER TO USE THE SPIRIT LEVELLING VALUES

\* Station n°8 51

\* Temperature : 2.5 °C - Pression : 733.5 mmHg - Correction meteo : 0.4 ppm

```
*DSET
*DIR      DORIS_TH  CEL_AX      + 0 0      0.0      8
*DIR      DORIS_TH  TG_PRI      +322 3     56.0      8

**ZANG    DORIS_TH  CEL_AX      +103 16    51.0      8
*ZANG    DORIS_TH  TG_PRI      +116 66    10.0      8

*DIST     DORIS_TH  TG_PRI                      90.9123    0.0010
```

\* Station n°9 21  
\* Temperature : 2.0 °C - Pression : 733.0 mmHg - Correction meteo : 0.0 ppm

```
*DSET
*DIR      TM2_TH   CEL_AX      + 0 0      0.0      8
*DIR      TM2_TH   TG_PRI      +338 73    4.0      8

**ZANG    TM2_TH   CEL_AX      +104 15    82.0      8
*ZANG    TM2_TH   TG_PRI      +116 49    71.0      8

*DIST     TM2_TH   TG_PRI                      124.9827   0.0010
```

\* Station n°10 81  
\* Temperature : 2.0 °C - Pression : 733.5 mmHg - Correction meteo : -0.2 ppm

```
*DSET
*DIR      TM1_TH   CEL_AX      + 0 0      0.0      8
*DIR      TM1_TH   TG_PRI      +299 92    53.0      8

**ZANG    TM1_TH   CEL_AX      +103 47    54.0      8
*ZANG    TM1_TH   TG_PRI      +112 94    92.0      8

*DIST     TM1_TH   TG_PRI                      115.7023   0.0010
```

\* Station n°11 21  
\* Temperature : 2.7 °C - Pression : 735.2 mmHg - Correction meteo : -0.1 ppm

```
DSET
DIR      TM2_TH   CEL_AX      + 0 0      0.0      8
DIR      TM2_TH   CEL_PRI      + 0 0      0.0      8

*ZANG    TM2_TH   CEL_AX      +104 16    4.0      8
ZANG    TM2_TH   CEL_PRI      +104 1     57.0      8      0.16

DIST     TM2_TH   CEL_PRI                      433.1484   0.0010
```

\* Station n°12 31  
\* Temperature : 2.7 °C - Pression : 735.2 mmHg - Correction meteo : -0.1 ppm

```
DSET
DIR      TM3_TH   CEL_AX      + 0 0      0.0      8
DIR      TM3_TH   CEL_PRI      +399 99    95.0      8

*ZANG    TM3_TH   CEL_AX      +103 72    27.0      8
ZANG    TM3_TH   CEL_PRI      +103 57    59.0      8      0.16

DIST     TM3_TH   CEL_PRI                      427.3819   0.0010
```

\* Station n°13 51  
\* Temperature : 2.7 °C - Pression : 736.2 mmHg - Correction meteo : -0.5 ppm

```
DSET
DIR      DORIS_TH  CEL_AX      + 0 0      0.0      8
DIR      DORIS_TH  CEL_PRI      + 0 0      2.0      8

*ZANG    DORIS_TH  CEL_AX      +103 16    72.0      8
ZANG    DORIS_TH  CEL_PRI      +103 1     6.0      8      0.16

DIST     DORIS_TH  CEL_PRI                      397.5909   0.0010
```

\* Station n°14 81  
\* Temperature : 2.5 °C - Pression : 736.2 mmHg - Correction meteo : -0.7 ppm

```
DSET
DIR      TM1_TH   CEL_AX      + 0 0      0.0      8
DIR      TM1_TH   CEL_PRI      +399 99    99.0      8

*ZANG    TM1_TH   CEL_AX      +103 47    73.0      8
ZANG    TM1_TH   CEL_PRI      +103 30    45.0      8      0.16

DIST     TM1_TH   CEL_PRI                      359.4199   0.0010
```

\*\*\*\*\*  
\* Spirit Levelling 2011 (JC.Poyard) \*

```
*****
*Levelling from Feb 1st 2011
OHDF   DORIS_m   BAS_ ARP      -0.57171   0.00020
OHDF   BAS_ ARP   GAP98      -1.15416   0.00017
OHDF   GAP98     BAS_ ARP      1.15427   0.00017
OHDF   BAS_ ARP   DORIS_m     0.57155   0.00020
OHDF   DORIS_m   ROTH        4.99414   0.00030
OHDF   ROTH      DORIS_m    -4.99432   0.00030
OHDF   DORIS_m   ROT1       -2.61115   0.00030
OHDF   ROT1      DORIS_m     2.61075   0.00030

*Levelling from Feb 3rd 2011
OHDF   GAP98     TempPt     -14.21490  0.00048
OHDF   TempPt    GRAVI      0.52246   0.00020
OHDF   GRAVI     TempPt    -0.52219  0.00020
OHDF   TempPt    TG_dev    -7.48965  0.00039
OHDF   TG_dev    TempPt     7.48962  0.00039
OHDF   TempPt    GAP98     14.21447  0.00048

*Device height measured with a calliper gauge is 3,21 cm
OHDF   TG_m      TG_dev     0.03210   0.00010
OHDF   TG_dev    TG_m      -0.03210  0.00010
```

HIST ALL

END

## 6.5 Annex 5 : Adjustment output file

```
=====
ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA
Microsearch GeoLab, V2001.9.20.0          GRS80          UNITS: m,GRAD Page 0001
=====
Wed Aug 31 11:22:44 2011

Input file: X:\2011001_GeoLab\new_Calc_final\Roth_AlphaNum_TOUT.iob
Output file: X:\2011001_GeoLab\new_Calc_final\Roth_AlphaNum_TOUT.lst
Options file: C:\Program Files\Microsearch\GeoLab\default.gpj
```

PARAMETERS		OBSERVATIONS	
Description	Number	Description	Number
No. of Stations	25	Directions	47
Coord Parameters	66	Distances	16
Free Latitudes	21	Azimuths	1
Free Longitudes	21	Vertical Angles	0
Free Heights	24	Zenithal Angles	35
Fixed Coordinates	9	Angles	0
Astro. Latitudes	0	Heights	0
Astro. Longitudes	0	Height Differences	16
Geoid Records	0	Auxiliary Params.	0
All Aux. Pars.	11	2-D Coords.	0
Direction Pars.	11	2-D Coord. Diffs.	2
Scale Parameters	0	3-D Coords.	3
Constant Pars.	0	3-D Coord. Diffs.	36
Rotation Pars.	0		
Translation Pars.	0		
	-----		-----
Total Parameters	77	Total Observations	156
Degrees of Freedom =		79	

SUMMARY OF SELECTED OPTIONS

Rothera ITRF co-location survey

OPTION	SELECTION
Computation Mode	Adjustment
Maximum Iterations	15
Convergence Criterion	0.00010
Residual Rejection Criterion	Tau Max
Confidence Region Types	1D 2D 3D Station
Variance Factor (VF) Known	Yes
Scale Covariance Matrix With VF	Yes
Scale Residual Variances With VF	No
Force Convergence in Max Iters	No
Distances Contribute To Heights	No
Compute Full Inverse	Yes
Optimize Band Width	Yes

=====

ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0002

=====

Generate Initial Coordinates	Yes
Re-Transform Obs After 1st Pass	Yes
Geoid Interpolation Method	Bi-Quadratic

-----

=====

ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0003

=====

Adjusted PLH Coordinates:

CODE	FFF	STATION	LATITUDE STD DEV	LONGITUDE STD DEV	ELIP-HEIGHT STD DEV
PLH	000	BAS_ARP	S 67 34 16.747063 0.0013	W 68 7 36.714387 0.0013	34.1450 m 0.0011
PLH	000	CELINA	S 67 34 4.737729 0.0025	W 68 7 48.216287 0.0024	15.4116 m 0.0038
PLH	001	CEL_AX	S 67 34 4.737726 0.0031	W 68 7 48.216283 0.0018	30.6554 m 0.0000
PLH	000	CEL_PRI	S 67 34 4.737732 0.0016	W 68 7 48.216292 0.0026	16.2869 m 0.0030
PLH	000	DORIS_PRI	S 67 34 17.006742 0.0014	W 68 7 38.488791 0.0013	35.0710 m 0.0012
PLH	000	DORIS_TH	S 67 34 17.006742 0.0013	W 68 7 38.488829 0.0014	35.0711 m 0.0011
PLH	000	DORIS_m	S 67 34 17.006762 0.0014	W 68 7 38.488961 0.0014	34.7166 m 0.0011
PLH	000	GAP98	S 67 34 16.747543 0.0013	W 68 7 36.714135 0.0013	32.9908 m 0.0011
PLH	110	GRAVI	S 67 34 7.700000 0.0000	W 68 7 30.800000 0.0000	19.2985 m 0.0012
PLH	000	ROT1	S 67 34 18.161130 0.0017	W 68 7 30.718139 0.0016	32.1055 m 0.0012
PLH	000	ROT1_PRI	S 67 34 18.161134 0.0014	W 68 7 30.718160 0.0014	33.6089 m 0.0012
PLH	000	ROT1_TH	S 67 34 18.161125 0.0018	W 68 7 30.718118 0.0014	33.6101 m 0.0012
PLH	000	ROTB	S 67 34 17.006762 0.0018	W 68 7 38.488961 0.0018	35.2106 m 0.0025
PLH	000	ROTH	S 67 34 16.997664 0.0011	W 68 7 32.790653 0.0011	39.7113 m 0.0011
PLH	000	ROUB	S 67 34 17.006762 0.0018	W 68 7 38.488961 0.0018	35.3606 m 0.0025

Rothera ITRF co-location survey

PLH	000	ROVB	S	67	34	17.006858	W	68	7	38.489049	35.5446	m	0
						0.0018				0.0018	0.0025		
PLH	110	TG_dev	S	67	34	16.860000	W	68	7	45.920000	11.2865	m	0
						0.0000				0.0000	0.0012		
PLH	110	TG_m	S	67	34	16.860000	W	68	7	45.920000	11.2544	m	0
						0.0000				0.0000	0.0012		
PLH	000	TM1_PRI	S	67	34	15.503383	W	68	7	37.005707	34.9213	m	0
						0.0013				0.0013	0.0012		
PLH	000	TM1_TH	S	67	34	15.503392	W	68	7	37.005704	34.9216	m	0
						0.0013				0.0013	0.0012		
PLH	000	TM2_PRI	S	67	34	17.895792	W	68	7	36.057512	43.5758	m	0
						0.0013				0.0013	0.0012		
PLH	000	TM2_TH	S	67	34	17.895783	W	68	7	36.057521	43.5760	m	0
						0.0013				0.0013	0.0012		
PLH	000	TM3_PRI	S	67	34	17.275059	W	68	7	33.284930	40.2609	m	0
						0.0013				0.0012	0.0012		

ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0004

Adjusted PLH Coordinates:

CODE	FFF	STATION		LATITUDE		LONGITUDE		ELIP-HEIGHT					
				STD DEV		STD DEV		STD DEV					
PLH	000	TM3_TH	S	67	34	17.275055	W	68	7	33.284936	40.2607	m	0
						0.0013				0.0012	0.0011		
PLH	110	TempPt	S	67	34	9.000000	W	68	7	32.600000	18.7762	m	0
						0.0000				0.0000	0.0012		

ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0005

Adjusted XYZ Coordinates:

CODE	FFF	STATION	X-COORDINATE	Y-COORDINATE	Z-COORDINATE	
			STD DEV	STD DEV	STD DEV	
XYZ		BAS_ARP	909204.8918	-2264786.1419	-5873048.2029	m 0
			0.0013	0.0013	0.0012	
XYZ		CELINA	909204.0432	-2265149.3626	-5872888.9249	m 0
			0.0023	0.0028	0.0036	
XYZ		CEL_AX	909206.2100	-2265154.7608	-5872903.0151	m 0
			0.0011	0.0032	0.0012	
XYZ		CEL_PRI	909204.1675	-2265149.6725	-5872889.7340	m 0
			0.0027	0.0016	0.0029	
XYZ		DORIS_PRI	909182.7700	-2264787.3900	-5873052.1283	m 0
			0.0013	0.0013	0.0012	
XYZ		DORIS_TH	909182.7696	-2264787.3902	-5873052.1284	m 0
			0.0014	0.0013	0.0012	
XYZ		DORIS_m	909182.7176	-2264787.2648	-5873051.8010	m 0
			0.0014	0.0013	0.0012	
XYZ		GAP98	909204.7254	-2264785.7194	-5873047.1417	m 0
			0.0013	0.0013	0.0012	
XYZ		GRAVI	909364.2484	-2264995.2395	-5872927.5364	m 0
			0.0002	0.0004	0.0011	
XYZ		ROT1	909255.3527	-2264721.4084	-5873063.0320	m 0
			0.0016	0.0016	0.0013	
XYZ		ROT1_PRI	909255.5661	-2264721.9407	-5873064.4218	m 0
			0.0015	0.0014	0.0012	
XYZ		ROT1_TH	909255.5669	-2264721.9412	-5873064.4228	m 0
			0.0016	0.0016	0.0013	
XYZ		ROTB	909182.7878	-2264787.4397	-5873052.2576	m 0
			0.0018	0.0019	0.0024	
XYZ		ROTH	909246.0917	-2264764.1569	-5873056.3103	m 0
			0.0011	0.0011	0.0011	

Rothera ITRF co-location survey

XYZ	ROUB	909182.8091	-2264787.4928	-5873052.3963	m	0
		0.0018	0.0019	0.0024		
XYZ	ROVB	909182.8333	-2264787.5558	-5873052.5675	m	0
		0.0018	0.0019	0.0024		
XYZ	TG_dev	909099.3598	-2264815.6226	-5873028.4085	m	0
		0.0002	0.0004	0.0011		
XYZ	TG_m	909099.3552	-2264815.6112	-5873028.3788	m	0
		0.0002	0.0004	0.0011		
XYZ	TM1_PRI	909215.0720	-2264820.7524	-5873034.2199	m	0
		0.0014	0.0013	0.0012		
XYZ	TM1_TH	909215.0720	-2264820.7523	-5873034.2203	m	0
		0.0014	0.0013	0.0012		
XYZ	TM2_PRI	909201.1891	-2264756.0574	-5873070.4983	m	0
		0.0013	0.0012	0.0012		
XYZ	TM2_TH	909201.1891	-2264756.0577	-5873070.4985	m	0
		0.0013	0.0012	0.0012		
XYZ	TM3_PRI	909237.7831	-2264759.1584	-5873060.0971	m	0
		0.0013	0.0012	0.0012		

=====  
ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0006  
=====

Adjusted XYZ Coordinates:

CODE	FFF	STATION	X-COORDINATE STD DEV	Y-COORDINATE STD DEV	Z-COORDINATE STD DEV	
XYZ		TM3_TH	909237.7830	-2264759.1585	-5873060.0969	m 0
			0.0013	0.0012	0.0011	
XYZ		TempPt	909330.5384	-2264968.4429	-5872942.4212	m 0
			0.0002	0.0004	0.0011	

=====  
ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0007  
=====

Residuals (critical value = 3.642):

NOTE: Observation values shown are reduced to mark-to-mark.

TYPE	AT	FROM	TO	OBSERVATION STD DEV	RESIDUAL STD DEV	STD RES PPM
AZIM		ROTH	CEL_AX	371 47 91.0	-0.0	-0.0
				0.0	0.0	*
XCT	ROTH			909246.09170	-0.0000	-0.0000
				0.0010	0.0000	*
YCT	ROTH			-2264764.15690	0.0000	0.0000
				0.0010	0.0000	*
ZCT	ROTH			-5873056.31030	0.0000	0.0000
				0.0010	0.0000	*
ELAT		ROT1	ROT1_TH	0 00 0.000000	0.0001	0.3152
				0.0010	0.0004	89.38
ELON		ROT1	ROT1_TH	0 00 0.000000	0.0002	0.4404
				0.0010	0.0006	165.99
EHGT		ROT1	ROT1_TH	1.50600	-0.0014	-1.5427
				0.0010	0.0009	910.81
ELAT		ROT1	ROT1_PRI	0 00 0.000000	-0.0001	-0.3152
				0.0010	0.0004	89.45
ELON		ROT1	ROT1_PRI	0 00 0.000000	-0.0002	-0.4404
				0.0010	0.0006	166.13
EHGT		ROT1	ROT1_PRI	1.50600	-0.0026	-2.9280
				0.0010	0.0009	1727.75
ELAT		TM1_TH	TM1_PRI	0 00 0.000000	0.0003	1.2221
				0.0005	0.0003	705417.9
ELON		TM1_TH	TM1_PRI	0 00 0.000000	-0.0000	-0.1045
				0.0005	0.0003	62984.80
EHGT		TM1_TH	TM1_PRI	0.000000	-0.0003	-0.8929



Rothera ITRF co-location survey

ELAT	TM2_TH	TM2_PRI	0 00	0.000000	-0.0003	-0.8212
				0.0005	0.0003	705986.7
ELON	TM2_TH	TM2_PRI	0 00	0.000000	0.0001	0.3464
				0.0005	0.0003	255164.4
EHGT	TM2_TH	TM2_PRI		0.000000	-0.0003	-0.6801
				0.0005	0.0004	672631.4
ELAT	TM3_TH	TM3_PRI	0 00	0.000000	-0.0001	-0.3004
				0.0005	0.0003	387617.8
ELON	TM3_TH	TM3_PRI	0 00	0.000000	0.0001	0.2626
				0.0005	0.0003	297666.4
EHGT	TM3_TH	TM3_PRI		0.000000	0.0002	0.5667
				0.0005	0.0004	872437.4
ELAT	DORIS_m	DORIS_TH	0 00	0.000000	0.0006	0.5249
				0.0010	0.0012	1726.32
ELON	DORIS_m	DORIS_TH	0 00	0.000000	0.0016	1.9673
				0.0010	0.0008	4430.49
EHGT	DORIS_m	DORIS_TH		0.35500	-0.0005	-0.2897
				0.0020	0.0018	1471.42
ELAT	DORIS_m	DORIS_PRI	0 00	0.000000	0.0006	0.7189

ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0008

Residuals (critical value = 3.642):

NOTE: Observation values shown are reduced to mark-to-mark.

TYPE	AT	FROM	TO	OBSERVATION STD DEV	RESIDUAL STD DEV	STD RES PPM	
				0.0010	0.0008	1700.63	
ELON		DORIS_m	DORIS_PRI	0 00	0.000000	0.0020	2.3983
				0.0010	0.0008	5699.90	
EHGT		DORIS_m	DORIS_PRI		0.35500	-0.0006	-0.3314
				0.0020	0.0020	1833.94	
ELAT		DORIS_m	ROTB	0 00	0.000000	0.0000	0.0000
				0.0010	0.0000	0.00*	
ELON		DORIS_m	ROTB	0 00	0.000000	0.0000	0.0000
				0.0010	0.0000	0.00*	
EHGT		DORIS_m	ROTB		0.49400	0.0000	0.0000
				0.0020	0.0000	0.00*	
ELAT		DORIS_m	ROUB	0 00	0.000000	0.0000	0.0000
				0.0010	0.0000	0.00*	
ELON		DORIS_m	ROUB	0 00	0.000000	0.0000	0.0000
				0.0010	0.0000	0.00*	
EHGT		DORIS_m	ROUB		0.64400	0.0000	0.0000
				0.0020	0.0000	0.00*	
ELAT		DORIS_m	ROVB	0 00	0.000096	0.0000	0.0000
				0.0010	0.0000	0.00*	
ELON		DORIS_m	ROVB	0 00	0.000088	0.0000	0.0000
				0.0010	0.0000	0.00*	
EHGT		DORIS_m	ROVB		0.82800	0.0000	0.0000
				0.0020	0.0000	0.00*	
ELAT		BAS_ARP	GAP98	0 00	0.000484	0.0001	0.0381
				0.0030	0.0030	98.11	
ELON		BAS_ARP	GAP98	0 00	0.000338	-0.0010	-0.3437
				0.0030	0.0030	883.50	
EHGT		BAS_ARP	GAP98		-1.15400	-0.0002	-0.0926
				0.0020	0.0020	160.23	
ELAT		CELINA	CEL_PRI	0 00	0.000000	-0.0001	-0.2601
				0.0020	0.0003	95.41	
ELON		CELINA	CEL_PRI	0 00	0.000000	-0.0001	-0.0667
				0.0020	0.0008	64.56	
EHGT		CELINA	CEL_PRI		0.87530	-0.0000	-0.0000
				0.0020	-0.0000	0.00	
ELAT		CELINA	CEL_AX	0 00	0.000000	0.0001	0.0001
				0.0020	-0.0000	5.48	
ELON		CELINA	CEL_AX	0 00	0.000000	0.0001	0.1038
				0.0020	0.0005	3.71	
DIR		TM3_TH	CEL_AX	0 0	0.0	0.8	0.2
				8.0	5.1		
DIR		TM3_TH	ROT1_PRI	173 96	96.0	-1.3	-0.4
				8.0	3.2		
DIR		TM3_TH	TM2_PRI	293 42	27.0	0.5	0.1
				8.0	4.8		

Rothera ITRF co-location survey

ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0009

Residuals (critical value = 3.642):

NOTE: Observation values shown are reduced to mark-to-mark.

TYPE	AT	FROM	TO	OBSERVATION		RESIDUAL	STD RES
				STD DEV	STD DEV		
ZANG		TM3_TH	ROT1_PRI	110 25	55.0	7.0	1.4
					8.0	5.0	
ZANG		TM3_TH	TM2_PRI	94 46	64.0	23.0	3.4
					8.0	6.8	
DIST		TM3_TH	ROT1_PRI		41.47400	0.0002	0.2105
					0.0010	0.0007	3.78
DIST		TM3_TH	TM2_PRI		38.16980	-0.0001	-0.1047
					0.0010	0.0009	2.36
DIR		TM2_TH	CEL_AX	0 0	0.0	-4.6	-0.8
					8.0	5.4	
DIR		TM2_TH	TM3_PRI	87 84	53.0	4.5	0.9
					8.0	5.2	
DIR		TM2_TH	ROT1_PRI	129 83	93.0	0.1	0.0
					8.0	4.8	
ZANG		TM2_TH	TM3_PRI	105 53	73.0	9.5	1.4
					8.0	6.6	
ZANG		TM2_TH	ROT1_PRI	109 88	11.0	6.1	0.9
					8.0	6.7	
DIST		TM2_TH	TM3_PRI		38.17040	-0.0007	-0.8376
					0.0010	0.0009	18.96
DIST		TM2_TH	ROT1_PRI		64.48080	-0.0001	-0.1125
					0.0010	0.0007	1.29
DIR		ROT1_TH	TM2_PRI	0 0	0.0	-5.7	-0.9
					10.0	6.1	
DIR		ROT1_TH	TM3_PRI	38 55	13.0	3.0	0.5
					10.0	6.5	
DIR		ROT1_TH	ROTH	53 73	14.0	2.6	0.4
					10.0	5.9	
ZANG		ROT1_TH	TM2_PRI	90 12	19.0	2.4	0.3
					10.0	8.9	
ZANG		ROT1_TH	TM3_PRI	89 74	82.0	10.7	1.4
					10.0	7.5	
ZANG		ROT1_TH	ROTH	91 14	59.0	-22.5	-2.8
					10.0	8.0	
DIST		ROT1_TH	TM2_PRI		64.48060	0.0002	0.2737
					0.0010	0.0007	3.09
DIST		ROT1_TH	TM3_PRI		41.47390	0.0002	0.2343
					0.0010	0.0007	3.78
DIR		TM3_TH	CEL_AX	0 0	0.0	-4.0	-0.6
					8.0	6.3	
DIR		TM3_TH	ROTH	65 21	84.0	1.1	0.8
					8.0	1.4	
DIR		TM3_TH	TM2_PRI	293 42	17.0	5.7	1.1
					8.0	5.4	
DIR		TM3_TH	DORIS_m	335 72	3.0	-2.2	-0.4

ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0010

Residuals (critical value = 3.642):

NOTE: Observation values shown are reduced to mark-to-mark.

TYPE	AT	FROM	TO	OBSERVATION		RESIDUAL	STD RES
				STD DEV	STD DEV		
DIR		TM3_TH	DORIS_PRI	335 72	8.0	6.2	1.1
					3.0	6.7	
DIR		TM3_TH	BAS_ARP	351 57	33.0	1.2	0.2
					8.0	5.2	
DIR		TM3_TH	TM1_PRI	384 14	34.0	-8.6	-1.4
					8.0	6.1	
ZANG		TM3_TH	ROTH	103 36	8.0	-4.8	-1.6
					8.0	3.0	
ZANG		TM3_TH	TM2_PRI	94 46	12.0	-29.0	-4.3
					8.0	6.8	
ZANG		TM3_TH	DORIS_m	105 66	66.0	6.5	0.8

Rothera ITRF co-location survey

ZANG	TM3_TH	DORIS_PRI	105 30	55.0	-2.2	-0.3
				8.0	6.9	
ZANG	TM3_TH	BAS_ARP	108 84	30.0	9.0	1.2
				8.0	7.4	
ZANG	TM3_TH	TM1_PRI	104 82	26.0	5.3	0.7
				8.0	7.2	
DIST	TM3_TH	DORIS_PRI		62.34500	0.0004	0.4941
				0.0010	0.0008	6.61
DIST	TM3_TH	TM1_PRI		70.56390	-0.0003	-0.3420
				0.0010	0.0008	4.09
DIR	TM2_TH	CEL_AX	0 0	0.0	1.0	0.2
				8.0	6.2	
DIR	TM2_TH	BAS_ARP	7 91	32.0	-0.7	-0.1
				8.0	5.1	
DIR	TM2_TH	GAP98	7 91	25.0	1.7	0.4
				8.0	4.7	
DIR	TM2_TH	TM1_PRI	12 3	75.0	-0.6	-0.1
				8.0	6.6	
DIR	TM2_TH	ROTH	81 88	13.0	-4.7	-0.8
				8.0	6.0	
DIR	TM2_TH	TM3_PRI	87 84	65.0	-1.9	-0.3
				8.0	5.5	
DIR	TM2_TH	DORIS_m	370 21	42.0	11.9	2.4
				8.0	4.9	
DIR	TM2_TH	DORIS_PRI	370 21	90.0	-6.8	-1.4
				8.0	5.0	
ZANG	TM2_TH	TM1_PRI	107 31	75.0	-4.8	-0.7
				8.0	7.2	
ZANG	TM2_TH	ROTH	105 15	51.0	1.6	0.2
				8.0	7.2	
ZANG	TM2_TH	TM3_PRI	105 53	43.0	-20.5	-3.1

ROThERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0011

Residuals (critical value = 3.642):

NOTE: Observation values shown are reduced to mark-to-mark.

TYPE	AT	FROM	TO	OBSERVATION		RESIDUAL	STD RES
				STD DEV	STD DEV		
				PPM			
				8.0	6.6		
ZANG	TM2_TH	DORIS_m	113 93	66.0	18.7	2.7	
				8.0	6.9		
ZANG	TM2_TH	DORIS_PRI	113 39	39.0	-4.5	-0.8	
				8.0	5.5		
DIST	TM2_TH	TM1_PRI		75.46030	0.0001	0.1319	
				0.0010	0.0008	1.48	
DIST	TM2_TH	DORIS_PRI		40.72310	0.0008	0.9933	
				0.0010	0.0008	20.42	
DIR	DORIS_TH	CEL_AX	0 0	0.0	4.1	0.7	
				8.0	5.6		
DIR	DORIS_TH	TM1_PRI	41 65	92.0	5.2	1.1	
				8.0	4.5		
DIR	DORIS_TH	BAS_ARP	95 42	49.0	0.5	0.2	
				8.0	2.4		
DIR	DORIS_TH	GAP98	95 46	73.0	0.2	0.2	
				8.0	0.8		
DIR	DORIS_TH	ROTH	118 45	62.0	-1.5	-0.2	
				8.0	6.1		
DIR	DORIS_TH	TM3_PRI	127 26	56.0	-7.7	-1.2	
				8.0	6.4		
DIR	DORIS_TH	TM2_PRI	167 33	86.0	-0.7	-0.2	
				8.0	4.4		
ZANG	DORIS_TH	TM1_PRI	100 19	24.0	5.6	0.9	
				8.0	6.4		
ZANG	DORIS_TH	BAS_ARP	102 62	6.0	-2.6	-0.4	
				8.0	6.0		
ZANG	DORIS_TH	GAP98	105 87	44.0	0.3	0.0	
				8.0	5.9		
ZANG	DORIS_TH	ROTH	95 62	48.0	-8.6	-1.1	
				8.0	7.7		
ZANG	DORIS_TH	TM3_PRI	94 69	46.0	-2.4	-0.3	
				8.0	7.3		
ZANG	DORIS_TH	TM2_PRI	86 60	75.0	6.5	1.0	

Rothera ITRF co-location survey

				8.0	6.6	
DIST	DORIS_TH	TM1_PRI		49.77140	0.0000	0.0284
				0.0010	0.0008	0.46
DIR	TM1_TH	CEL_AX	0 0	0.0	2.5	0.5
				8.0	5.1	
DIR	TM1_TH	ROTH	171 73	28.0	6.0	1.1
				8.0	5.5	
DIR	TM1_TH	TM3_PRI	181 6	51.0	3.7	0.6
				8.0	6.4	
DIR	TM1_TH	TM2_PRI	214 53	75.0	-3.8	-0.6
				8.0	6.8	

ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0012

Residuals (critical value = 3.642):

NOTE: Observation values shown are reduced to mark-to-mark.

TYPE AT	FROM	TO	OBSERVATION		RESIDUAL	STD RES
			STD DEV	STD DEV	STD DEV	PPM
DIR	TM1_TH	GAP98	218 41	77.0	1.4	0.3
				8.0	5.1	
DIR	TM1_TH	BAS_ARP	218 42	5.0	0.5	0.1
				8.0	5.3	
DIR	TM1_TH	DORIS_PRI	247 3	88.0	-1.9	-0.3
				8.0	5.5	
DIR	TM1_TH	DORIS_m	247 4	16.0	-8.4	-1.7
				8.0	5.1	
ZANG	TM1_TH	ROTH	95 52	57.0	-9.3	-1.2
				8.0	7.6	
ZANG	TM1_TH	TM3_PRI	95 17	92.0	5.1	0.7
				8.0	7.4	
ZANG	TM1_TH	TM2_PRI	92 68	39.0	6.5	0.9
				8.0	7.5	
ZANG	TM1_TH	GAP98	103 17	30.0	-8.4	-1.2
				8.0	6.8	
ZANG	TM1_TH	BAS_ARP	101 27	81.0	0.1	0.0
				8.0	6.9	
ZANG	TM1_TH	DORIS_PRI	99 81	0.0	7.9	1.3
				8.0	6.2	
ZANG	TM1_TH	DORIS_m	100 26	32.0	7.5	1.0
				8.0	7.3	
DIST	TM1_TH	DORIS_PRI		49.77000	0.0010	1.2108
				0.0010	0.0008	19.97
DIR	TM2_TH	CEL_AX	0 0	0.0	0.1	0.0
				8.0	5.4	
DIR	TM2_TH	CEL_PRI	0 0	0.0	-0.1	-0.0
				8.0	5.4	
ZANG	TM2_TH	CEL_PRI	104 1	53.5	-2.7	-0.4
				8.0	7.1	
DIST	TM2_TH	CEL_PRI		433.14840	-0.0004	-0.4504
				0.0010	0.0008	0.84
DIR	TM3_TH	CEL_AX	0 0	0.0	-2.4	-0.4
				8.0	5.4	
DIR	TM3_TH	CEL_PRI	399 99	95.0	2.4	0.4
				8.0	5.4	
ZANG	TM3_TH	CEL_PRI	103 57	55.6	4.7	0.7
				8.0	7.1	
DIST	TM3_TH	CEL_PRI		427.38190	-0.0007	-0.8592
				0.0010	0.0008	1.61
DIR	DORIS_TH	CEL_AX	0 0	0.0	1.1	0.2
				8.0	5.4	
DIR	DORIS_TH	CEL_PRI	0 0	2.0	-1.1	-0.2
				8.0	5.4	
ZANG	DORIS_TH	CEL_PRI	103 1	2.8	-5.3	-0.8

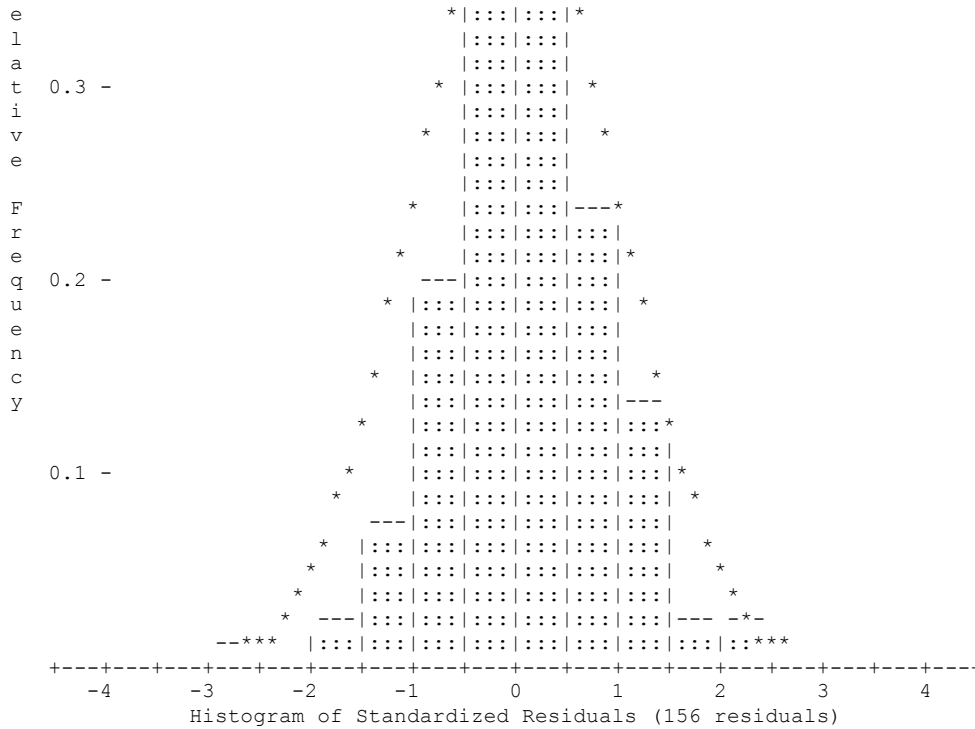
ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0013

Residuals (critical value = 3.642):

NOTE: Observation values shown are reduced to mark-to-mark.

TYPE AT	FROM	TO	OBSERVATION		RESIDUAL	STD RES
			STD DEV	STD DEV	STD DEV	PPM
				8.0	6.9	





ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0015

S T A T I S T I C S S U M M A R Y

Residual Critical Value Type	Tau Max
Residual Critical Value	3.6421
Number of Flagged Residuals	1
Convergence Criterion	0.0001
Final Iteration Counter Value	5
Confidence Level Used	95.0000
Estimated Variance Factor	1.2434
Number of Degrees of Freedom	79

Chi-Square Test on the Variance Factor:

9.3131e-01 < 1.0000 < 1.7444e+00 ?

THE TEST PASSES

NOTE: All confidence regions were computed using the following factors:

Variance factor used	=	1.2434
1-D expansion factor	=	1.9600
2-D expansion factor	=	2.4477
3-D expansion factor	=	2.7955

Note that, for relative confidence regions, precisions are computed from the ratio of the major semi-axis and the spatial distance between the two stations.

=====  
ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0016  
=====

2-D and 1-D Station Confidence Regions (95.000 and 95.000 percent):

STATION	MAJOR SEMI-AXIS	AZ	MINOR SEMI-AXIS	VERTICAL
BAS_ARP	0.0033	37	0.0031	0.0022
CELINA	0.0064	143	0.0055	0.0074
CEL_AX	0.0083	154	0.0027	0.0000
CEL_PRI	0.0066	69	0.0032	0.0059
DORIS_PRI	0.0033	30	0.0032	0.0023
DORIS_TH	0.0034	88	0.0033	0.0022
DORIS_m	0.0034	46	0.0033	0.0022
GAP98	0.0033	29	0.0031	0.0022
GRAVI	0.0000	0	0.0000	0.0024
ROT1	0.0043	25	0.0037	0.0023
ROT1_PRI	0.0037	36	0.0033	0.0024
ROT1_TH	0.0047	21	0.0033	0.0024
ROTB	0.0043	46	0.0043	0.0049
ROTH	0.0027	90	0.0027	0.0022
ROUB	0.0043	46	0.0043	0.0049
ROVB	0.0043	46	0.0043	0.0049
TG_dev	0.0000	0	0.0000	0.0024
TG_m	0.0000	0	0.0000	0.0024
TM1_PRI	0.0034	46	0.0031	0.0023
TM1_TH	0.0033	51	0.0031	0.0023
TM2_PRI	0.0032	48	0.0030	0.0023
TM2_TH	0.0033	56	0.0030	0.0023
TM3_PRI	0.0032	42	0.0029	0.0023
TM3_TH	0.0033	38	0.0028	0.0022
TempPt	0.0000	0	0.0000	0.0024

=====  
ROTHERA (ANTARCTICA - BAS) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - FEBRUA  
Microsearch GeoLab, V2001.9.20.0 GRS80 UNITS: m,GRAD Page 0017  
=====

3D Station Confidence Regions (95.000 percent):

STATION	MAJ-SEMI (AZ,VANG)	MED-SEMI (AZ,VANG)	MIN-SEMI (AZ,VANG)
BAS_ARP	0.0037 ( 37, 0)	0.0036 (127, 0)	0.0032 (233, 90)
CELINA	0.0105 (254, 90)	0.0073 (143, 0)	0.0063 ( 53, 0)
CEL_AX	0.0095 (334, 0)	0.0031 ( 64, 0)	0.0000 ( 0, 90)
CEL_PRI	0.0085 (250, 90)	0.0075 ( 69, 0)	0.0037 (159, 0)
DORIS_PRI	0.0038 ( 30, 0)	0.0036 (300, 0)	0.0033 (145, 90)

---

DORIS_TH	0.0038 (268, 0)	0.0037 (358, 0)	0.0032 (177, 90)
DORIS_m	0.0038 ( 46, 0)	0.0038 (316, 0)	0.0032 (206, 90)
GAP98	0.0038 ( 29, 0)	0.0036 (119, 0)	0.0032 (225, 90)
GRAVI	0.0034 ( 0, 90)	0.0000 ( 90, 0)	0.0000 ( 0, 0)
ROT1	0.0049 (205, 0)	0.0042 (295, 0)	0.0032 ( 61, 90)
ROT1_PRI	0.0042 (216, 0)	0.0038 (306, 0)	0.0034 ( 47, 90)
ROT1_TH	0.0053 (201, 0)	0.0037 (291, 0)	0.0034 ( 93, 90)
ROTB	0.0070 (277, 90)	0.0049 ( 46, 0)	0.0049 (136, 0)
ROTH	0.0031 ( 64, 0)	0.0031 (162, 90)	0.0031 (334, 0)
ROUB	0.0070 (277, 90)	0.0049 ( 46, 0)	0.0049 (136, 0)
ROVB	0.0070 (279, 90)	0.0049 ( 46, 0)	0.0049 (136, 0)
TG_dev	0.0035 ( 0, 90)	0.0000 ( 90, 0)	0.0000 ( 0, 0)
TG_m	0.0035 ( 0, 90)	0.0000 ( 90, 0)	0.0000 ( 0, 0)
TM1_PRI	0.0038 ( 46, 0)	0.0036 (136, 0)	0.0033 (248, 90)
TM1_TH	0.0038 ( 51, 0)	0.0036 (141, 0)	0.0032 (239, 90)
TM2_PRI	0.0037 ( 48, 0)	0.0034 (318, 0)	0.0032 (146, 90)
TM2_TH	0.0037 ( 56, 0)	0.0034 (326, 0)	0.0032 (154, 90)
TM3_PRI	0.0037 ( 42, 0)	0.0033 (132, 0)	0.0032 (228, 90)
TM3_TH	0.0038 ( 38, 0)	0.0032 (308, 0)	0.0031 (130, 90)
TempPt	0.0034 ( 0, 90)	0.0000 ( 90, 0)	0.0000 ( 0, 0)

Wed Aug 31 11:22:47 2011



## 6.6 Annex 6 : Rothera SINEX File

%=SNX 1.00 IGN 11:243:00000 IGN 11:033:00000 11:033:00000 C 00018

```

*-----
+FILE/COMMENT
* File created by geotosnx software (Z.Altamimi)
* Original input file: Roth3.cov
* Matrix Scaling Factor used:          1.0000000000
-FILE/COMMENT
*-----
+SITE/ID
*CODE PT  DOMES  T  STATION DESCRIPTION  APPROX_LON  APPROX_LAT  APP_H
ROTH  A  66007M003  66007M003  291 52 27.2 -67 34 16.9 39.7
ROT1  A  66007M001  66007M001  291 52 29.2 -67 34 18.1 32.1
DORm  A  66007M002  66007M002  291 52 21.5 -67 34 17.0 34.7
ROTB  A  66007S002  66007S002  291 52 21.5 -67 34 17.0 35.2
ROUB  A  66007S003  66007S003  291 52 21.5 -67 34 17.0 35.4
ROVB  A  66007S004  66007S004  291 52 21.5 -67 34 17.0 35.5
-SITE/ID
*-----
+SOLUTION/EPOCHS
*Code PT SOLN T Data_start  Data_end  Mean_epoch
-SOLUTION/EPOCHS
*-----
+SOLUTION/ESTIMATE
*INDEX TYPE  CODE PT SOLN  REF_EPOCH  UNIT S  ESTIMATED VALUE  STD_DEV
  1 STAX  ROTH  A  1 11:033:00000  m  2  0.909246091700000E+06  0.11151E-02
  2 STAY  ROTH  A  1 11:033:00000  m  2  -0.226476415690000E+07  0.11151E-02
  3 STAZ  ROTH  A  1 11:033:00000  m  2  -0.587305631030000E+07  0.11151E-02
  4 STAX  ROT1  A  1 11:033:00000  m  2  0.909255352700000E+06  0.14547E-02
  5 STAY  ROT1  A  1 11:033:00000  m  2  -0.226472140840000E+07  0.17656E-02
  6 STAZ  ROT1  A  1 11:033:00000  m  2  -0.587306303200000E+07  0.12091E-02
  7 STAX  DORm  A  1 11:033:00000  m  2  0.909182717600000E+06  0.13230E-02
  8 STAY  DORm  A  1 11:033:00000  m  2  -0.226478726480000E+07  0.13680E-02
  9 STAZ  DORm  A  1 11:033:00000  m  2  -0.587305180100000E+07  0.11660E-02
 10 STAX  ROTB  A  1 11:033:00000  m  2  0.909182787800000E+06  0.18806E-02
 11 STAY  ROTB  A  1 11:033:00000  m  2  -0.226478743970000E+07  0.17649E-02
 12 STAZ  ROTB  A  1 11:033:00000  m  2  -0.587305225760000E+07  0.24063E-02
 13 STAX  ROUB  A  1 11:033:00000  m  2  0.909182809100000E+06  0.18806E-02
 14 STAY  ROUB  A  1 11:033:00000  m  2  -0.226478749280000E+07  0.17649E-02
 15 STAZ  ROUB  A  1 11:033:00000  m  2  -0.587305239630000E+07  0.24063E-02
 16 STAX  ROVB  A  1 11:033:00000  m  2  0.909182833300000E+06  0.18806E-02
 17 STAY  ROVB  A  1 11:033:00000  m  2  -0.226478755580000E+07  0.17649E-02
 18 STAZ  ROVB  A  1 11:033:00000  m  2  -0.587305256750000E+07  0.24063E-02
-SOLUTION/ESTIMATE
*-----
+SOLUTION/MATRIX_ESTIMATE L COVA
*PARA1 PARA2  PARA2+0  PARA2+1  PARA2+2
  1  1  0.124338474560808E-05
  2  1  -.150769205690885E-15  0.124338474565720E-05
  3  1  0.377133324768708E-16  -.622305516455512E-16  0.124338474553227E-05
  4  1  0.124338358066080E-05  0.106435399919047E-10  -.301352831548663E-12
  4  4  0.211626752582212E-05
  5  1  -.109143134028182E-10  0.124338455275306E-05  -.450482700439412E-11
  5  4  -.473723973324779E-07  0.311726272226011E-05
  6  1  -.301316906366508E-12  0.439315915152702E-11  0.124338418628958E-05
  6  4  0.325504678457594E-06  -.195531201967763E-07  0.146200299320924E-05

```

**Rothera ITRF co-location survey**

7	1	0.124338426206934E-05	-.298621249685767E-10	-.381646044689864E-13
7	4	0.134156408188161E-05	-.299836081205638E-09	0.265048006119051E-07
7	7	0.175036418835950E-05		
8	1	0.292090998503324E-10	0.124338488229665E-05	0.120558440568311E-10
8	4	-.155987582829277E-06	0.158740927877567E-05	-.643844124152388E-07
8	7	-.214917226233742E-07	0.187131323851922E-05	
9	1	-.382493492988544E-13	-.123256935427242E-10	0.124338433898137E-05
9	4	0.265048006879259E-07	-.123758688300203E-09	0.128828942208332E-05
9	7	0.194451714302377E-06	-.887078290776403E-08	0.135951616575397E-05
10	1	0.124338426206934E-05	-.298621249708843E-10	-.381646035980427E-13
10	4	0.134156408188161E-05	-.299836081203489E-09	0.265048006119044E-07
10	7	0.175036418835950E-05	-.214917226233777E-07	0.194451714302378E-06
10	10	0.353673258834847E-05		
11	1	0.292090998522990E-10	0.124338488229665E-05	0.120558440573217E-10
11	4	-.155987582829280E-06	0.158740927877567E-05	-.643844124152391E-07
11	7	-.214917226233715E-07	0.187131323851922E-05	-.887078290776329E-08
11	10	-.214917271469403E-07	0.311469798404394E-05	
12	1	-.382493499223159E-13	-.123256935430605E-10	0.124338433898137E-05
12	4	0.265048006879269E-07	-.123758688299637E-09	0.128828942208332E-05
12	7	0.194451714302376E-06	-.887078290776459E-08	0.135951616575397E-05
12	10	-.112106397548433E-05	-.887077194827944E-08	0.579007149338856E-05
13	1	0.124338426206934E-05	-.298621249719762E-10	-.381646031363209E-13
13	4	0.134156408188161E-05	-.299836081202362E-09	0.265048006119040E-07
13	7	0.175036418835950E-05	-.214917226233790E-07	0.194451714302379E-06
13	10	0.175036418835950E-05	-.214917226233764E-07	0.194451714302378E-06
13	13	0.353673258834847E-05		
14	1	0.292090998532726E-10	0.124338488229664E-05	0.120558440575621E-10
14	4	-.155987582829281E-06	0.158740927877567E-05	-.643844124152394E-07
14	7	-.214917226233698E-07	0.187131323851922E-05	-.887078290776275E-08
14	10	-.214917226233736E-07	0.187131323851922E-05	-.887078290776333E-08
14	13	-.214917271469399E-07	0.311469798404394E-05	
15	1	-.382493503279446E-13	-.123256935433534E-10	0.124338433898137E-05
15	4	0.265048006879274E-07	-.123758688299329E-09	0.128828942208332E-05
15	7	0.194451714302376E-06	-.887078290776485E-08	0.135951616575397E-05
15	10	0.194451714302377E-06	-.887078290776414E-08	0.135951616575397E-05
15	13	-.112106397548433E-05	-.887077194827971E-08	0.579007149338856E-05
16	1	0.124338426206932E-05	-.298628118915687E-10	-.381923833236358E-13
16	4	0.134156408188118E-05	-.299835348121834E-09	0.265048006417796E-07
16	7	0.175036418836703E-05	-.214917236570062E-07	0.194451714276912E-06
16	10	0.175036418836703E-05	-.214917236570035E-07	0.194451714276911E-06
16	13	0.175036418836703E-05	-.214917236570018E-07	0.194451714276910E-06
16	16	0.353673258842230E-05		
17	1	0.292097867730751E-10	0.124338488229663E-05	0.120554650281653E-10
17	4	-.155987583704822E-06	0.158740927870912E-05	-.643844119348229E-07
17	7	-.214917217156404E-07	0.187131323851006E-05	-.887078321476674E-08
17	10	-.214917217156439E-07	0.187131323851005E-05	-.887078321476729E-08
17	13	-.214917217156453E-07	0.187131323851005E-05	-.887078321476762E-08
17	16	-.214917265718430E-07	0.311469798402560E-05	
18	1	-.382215674961332E-13	-.123253145144867E-10	0.124338433898137E-05
18	4	0.265048006592190E-07	-.123759066374608E-09	0.128828942208387E-05
18	7	0.194451714334923E-06	-.887078233779988E-08	0.135951616575561E-05
18	10	0.194451714334924E-06	-.887078233779909E-08	0.135951616575561E-05
18	13	0.194451714334924E-06	-.887078233779857E-08	0.135951616575561E-05
18	16	-.112106397553632E-05	-.887077338365523E-08	0.579007149333307E-05

-SOLUTION/MATRIX\_ESTIMATE L COVA  
%ENDSNX