SERVICE
DE GEODESIE
ET NIVELLEMENT

J-C. Poyard

Tristan da Cunha co-location survey

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Mots-clé

Rattachement ; ITRF ; DORIS ; GNSS ; Marégraphe ; Atlantique sud ; Royaume-Uni ; Territoires britanniques d'outre-mer ; Tristan da Cunha, National Oceanography Centre (NOC).

Résumé

Lors de la rénovation de la station DORIS de Tristan da Cunha, l'antenne est déplacée de quelques mètres dans le but de diminuer les masques *(cf. RT154 - Rénovation DORIS Tristan da Cunha - JC Poyard - Juin2012)*. Afin de lier les positions des points de référence des antennes DORIS un rattachement est réalisé. De plus, les points de référence des équipements du NOC (station GNSS et surtout repère du marégraphe) sont également inclus dans cette opération de rattachement. Le vecteur de rattachement entre les points de référence des antennes DORIS participe aux réalisations ITRF de l'International Terrestrial Reference System menées par le Laboratoire de Recherche en Géodésie (LAREG) de l'IGN.

Ce rapport décrit les travaux réalisés et les résultats obtenus.

Matériel

Système d'exploitation	**Logiciel**
Windows 7 Professionnel	Microsoft Word 2010

Validation

	Fonction	**Nom**	**Visa**
Commanditaire	Chef d'unité RSI	Bruno Garayt	26/02/2013 – signé
Rédacteur principal	Responsable de production	Jean-Claude Poyard	14/02/2013 – signé
Lecteur	Responsable SIRS DORIS	Jérôme Saunier	18/02/2013 – signé
Approbateur	Chef de service	Alain Harmel	28/02/2013 – signé
Vérificateur	Responsable qualité	Thierry Person	08/04/2013 – signé

Diffusion

Organisme / Service	Fonction / Nom	Numérique	Papier
IGN / DPR	Directeur de la production / Philippe Gerbe	oui	-
IGN / DPR	DPR adjoint / Didier Moisset	oui	-
IGN / DPSP	Chargé MO géodésie / François Becirspahic	oui	-
IGN / DPR / SDOG / CDOC	Chef du centre documentation / Richard Grimm	oui	-
IGN / DTSI / SR / LAREG	Chef de laboratoire / Olivier Jamet	oui	-
IGN / ENSG / DPTS	Chef de département / Serge Botton	oui	-
IGN / DPR / SGN	Chef de service / Alain Harmel	oui	-
IGN / DPR / SGN	Responsable qualité / Thierry Person	oui	-
IGN / DPR / SGN / PMC	Responsable documentation / Xavier della Chiesa	non	3
IGN / DPR / SGN / PMT	Responsable produits / François L'Ecu	oui	-
IGN / DPR / SGN	Chefs de départements	oui	-
CNES / DCT / ME / OT	Thierry Guinle	oui	-
CNES / DCT / ME / OT	Cédric Tourain	oui	1
CNES / DCT / ME / OT	François Boldo	oui	1
IGN / DPR / SGN / PMM	Thomas Donal	oui	-
IGN / DPR / SGN / PMM	Bruno Garayt	non	1
IGN / DPR / SGN / PMM	Jérôme Saunier	oui	1
IGN / DPR / SGN / PMM	Jean-Claude Poyard	non	-
Administration (TDC)	Sean Burns	oui	-
Administration (TDC)	Cynthia Green	oui	1
NOC (UK)	Peter Foden	oui	-
NOC (UK)	Mark Tamisiea	oui	-
NOC (UK)	Simon Williams	oui	-
NOC (UK)	Philip Woodworth	oui	-
UNESCO / IOC	Thorkild Aarup	oui	-
Université de La Rochelle	Médéric Gravelle	oui	-
Université de La Rochelle	Pascal Tiphaneau	oui	-
Université de La Rochelle	Guy Wöppelmann	oui	-
IGN / DPR / SGN / PMM	Archives DORIS	non	1

Table of contents

INTRODUCTION

In 1986, the first station of the Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) network is installed on behalf of CNES at Tristan da Cunha by Bob Spencer from National Oceanography Centre (NOC - ex. Proudman Oceanographic Laboratory).

Then in January 2002, a first renovation aims at replacing the equipment and in particular the Alcatel antenna by a Starec one. The cable length (15 m) authorizes the concrete pillar to be only a few meters away. The gain in stability of the antenna is at the expense of the open space. During this renovation a connection between the position of the antennas and the tide gauge benchmark is achieved by GPS survey *(cf. CR / G 149, SGN 28037, Renovation of the DORIS station Tristan da Cunha (United Kingdom, South Atlantic) - June 2002, P. Vergez).*

Finally in June 2012, a new DORIS renovation is completed at Tristan da Cunha. The antenna is moved a few meters away in order to reduce the obstructions *(see RT / G 154, SGN 28427, Renovation DORIS Tristan da Cunha - Juin2012, JC Poyard).*

To assign coordinates to the reference point of the new antenna, a connection between the two DORIS positions is carried out by classic topometric surveying method. In addition, the GNSS station belonging to NOC in the immediate vicinity is also included in the tie operation. Lastly a levelling survey is carried out between all the markers, including the tide gauge reference benchmark.

ACKNOWLEDGEMENTS

On behalf of CNES and IGN, I want to acknowledge Tristan's administration and particularly the Administrator for their involvement for many years in the DORIS project. My thanks also go to all those I met at Tristan and who helped me in various works and steps to be taken on the island.

Lastly I especially thank Leon Glass for his indispensable help both for the DORIS renovation and for the levelling survey.

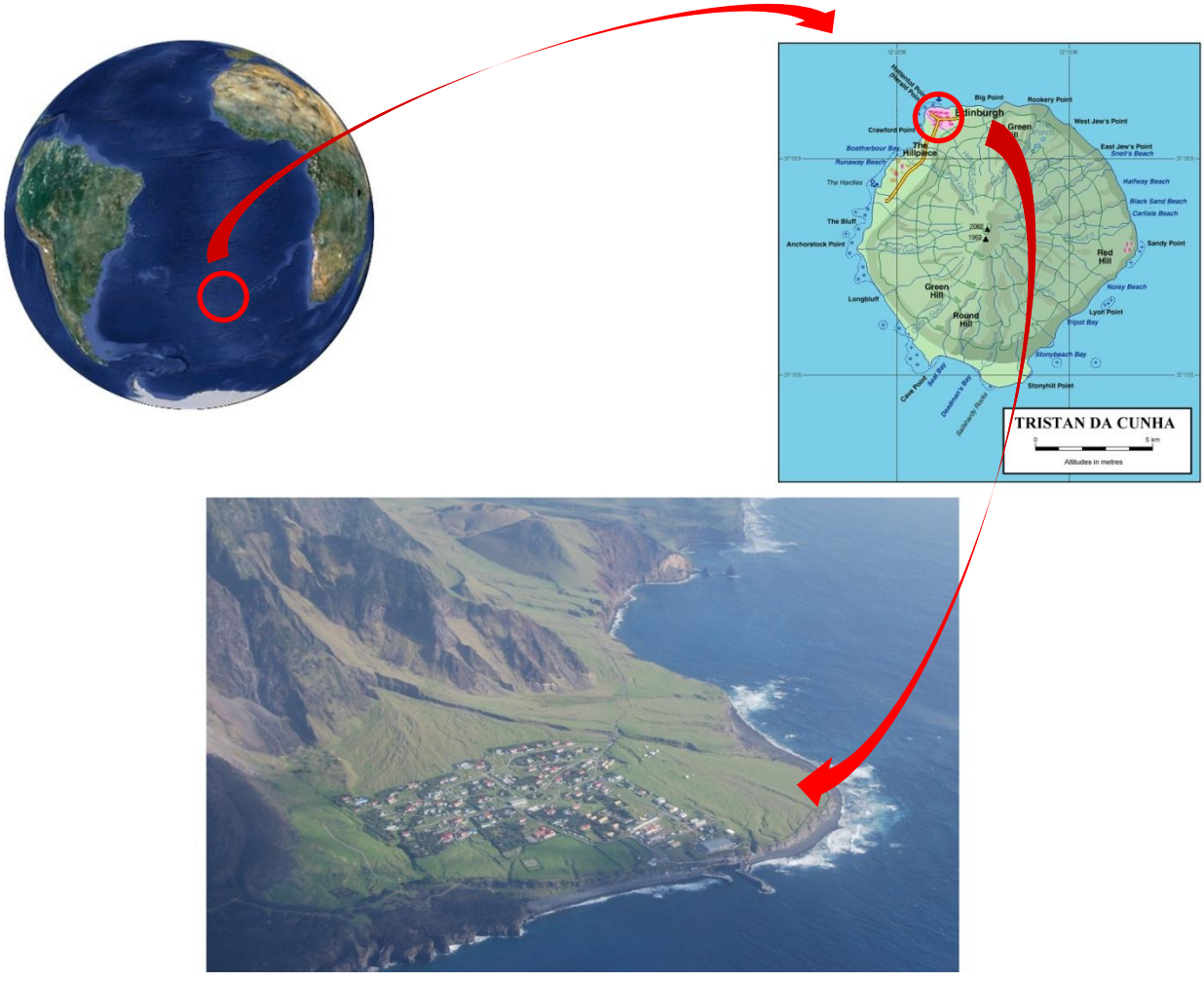
1 SITE DESCRIPTION

The archipelago of Tristan da Cunha is located in the middle of the South Atlantic Ocean, midway between the southern tip of Africa and South America by 37 ° south and 12 ° west. This is a group of mountainous islands of volcanic origin. It consists of three main islands: Nightingale, Inaccessible and Tristan separated from each other by 20 km to 35 km. Only the main island Tristan (96 km^2) is inhabited : the unique village "Edinburgh of the Seven Seas" currently has a population of about 270 people.

From a geodetic point of view, the island is equipped with several scientific instruments :

- a DORIS station
- a GNSS station
- a tide gauge

Tristan da Cunha site location (South Atlantic Ocean)



2 CO-LOCATED POINTS

2.1 DORIS Station

The first DORIS station "TRIA" installed in June 1986 comprises an Alcatel DORIS antenna at the top of a Normand mast secured against the gable wall of the radio shack.
On May 23th, 2001 a fierce storm destroyed the "TRIA" Alcatel antenna and her mast. In January 2002, the first upgrade of the station is completed and a local tie between TRIB and the supposed position of TRIA is completed. Under these conditions, the local tie TRIB ←→TRIA can't be considered accurate. The antenna "TRIB" Starec type is set up on a concrete pillar (1.2 m in height) a few meters east of its original position.
Finally in June 2012, the DORIS antenna is moved further east to reduce surrounding obstructions. The "TRJB" Starec antenna is installed on a 3 m high Leclerc pylon.

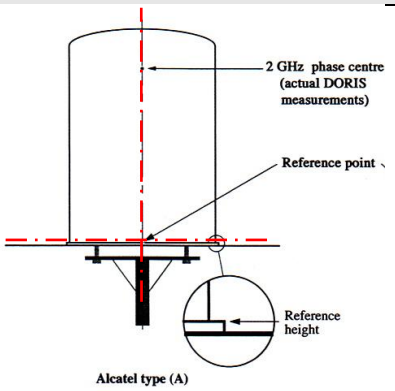
The different positions of the antennas reference points are associated with distinct acronyms and DOMES numbers as summarized in the following table :

Acronym	DOMES number	Designation / Support	Period
TRIA	30604S001	Alcatel / pylon secured against a wall	From June 1986 to May 2001
TRIB	30604S002	Starec / concrete pillar (1,2 m high)	From Jan. 2002 to June 2012
TRJB	30604S003	Starec / Leclerc mast (3 m high)	From June 2012
DORIS mark	30604M001	Domed bronze mark (Ø 12 mm)	From Jan. 2002
DORIS mark 2	30604M003	Domed hexagonal brass mark	From June 2012

NB: TRIA and TRIB antennas don't exist anymore but their positions and markers are tied together.

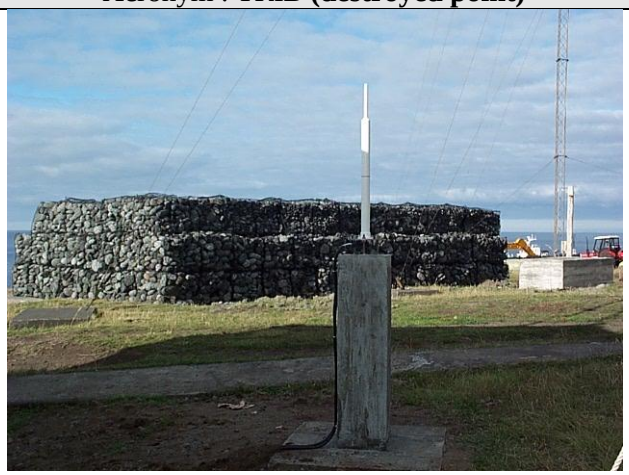
Acronym : TRIA **(destroyed point)** | DOMES number : 30604S001

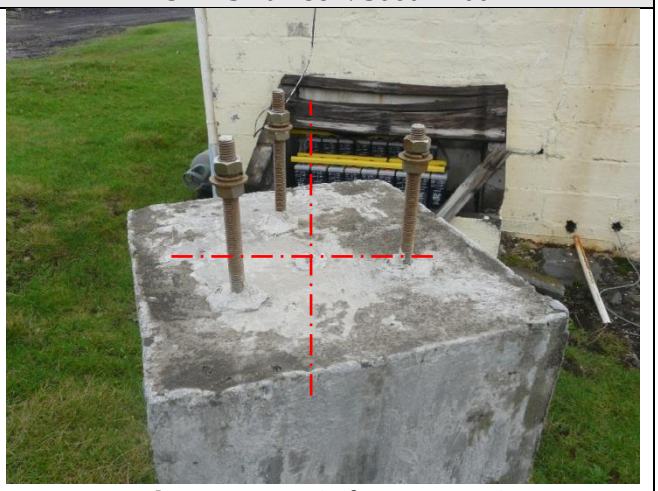
General view

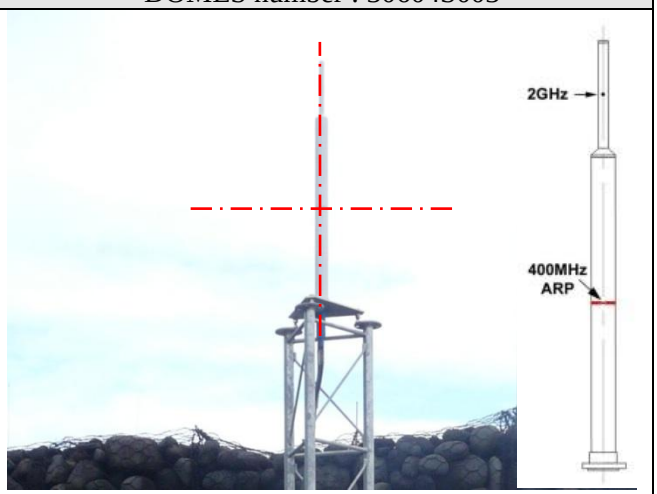


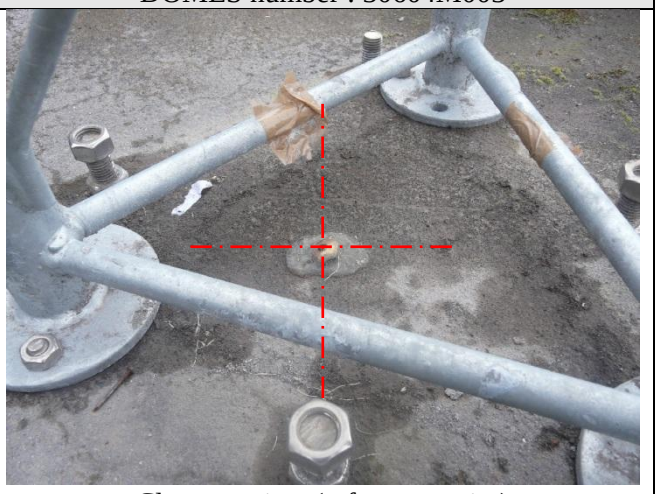
Close-up view (reference point)

Description : DORIS reference point (Alcatel antenna) **(destroyed point)**.

Acronym : TRIB **(destroyed point)**	DOMES number : 30604S002
	
General view	Close-up view (reference point)
Description : DORIS reference point (Starec antenna) **(destroyed point)**.	

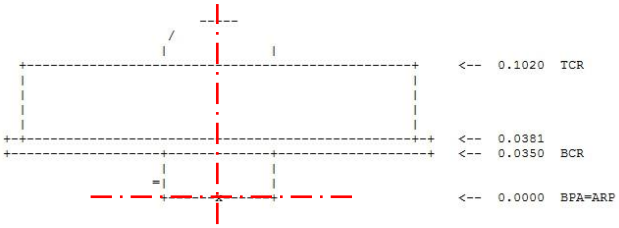
Acronym : DORIS mark	DOMES number : 30604M001
	
General view	Close-up view (reference point)
Description : DORIS hemispheric bronze mark (12 mm in diameter).	

Acronym : TRJB	DOMES number : 30604S003
	
General view	Close-up view (reference point)
Description : DORIS reference point (Starec antenna)	

Acronym : DORIS mark 2	DOMES number : 30604M003
	
General view	Close-up view (reference point)
Description : DORIS domed hexagonal brass mark.	

2.2 GNSS station

A GNSS station managed by NOC is installed on top of a metallic pipe fixed against the gable wall of the radio shack.

station GNSS (NOC)	DOMES number: -
	
General view	Close-up view (reference point)
Description : Antenna reference point (ARP = BPA = **the antenna height is 0.000 m**)	

2.3 Tide gauge

Since 1986, a tide gauge is installed by NOC in the small harbour of Tristan da Cunha. Listed with the acronym "tdcu" and n° 266, it is part of the Global Sea Level Observing System (GLOSS) (see http://www.ioc-sealevelmonitoring.org/station.php?code=tdcu).

The reference mark on pier is :

Acronym : BM2	GLOSS number : 266
	
General view	Close-up view (reference point)
Description : Ball mark (summit) – tide gauge mark on east pier.	

2.4 Other points of interest

Name : Stainless steel rod	
	
General view	Close-up view (reference point)
Description : stainless steel rod (summit) embedded in concrete a few metres to the N-E of the radio shack.	

Name : Ball mark	
	
General view	Close-up view (reference point)
Description : Ball mark from NOC (summit)	

3 SURVEY DESCRIPTION

3.1 Organization

The survey is carried out in two steps : first an altimetric tie by direct levelling between marks performed with the help of Leon Glass on June 11th, 2012; then the next day by topometric method and GPS observations, the local tie between marks and space geodetic instruments reference points.
All the topometric survey instruments and equipment belong to IGN and were sent before the mission for the purpose of this survey.

3.2 Equipment (Instruments)

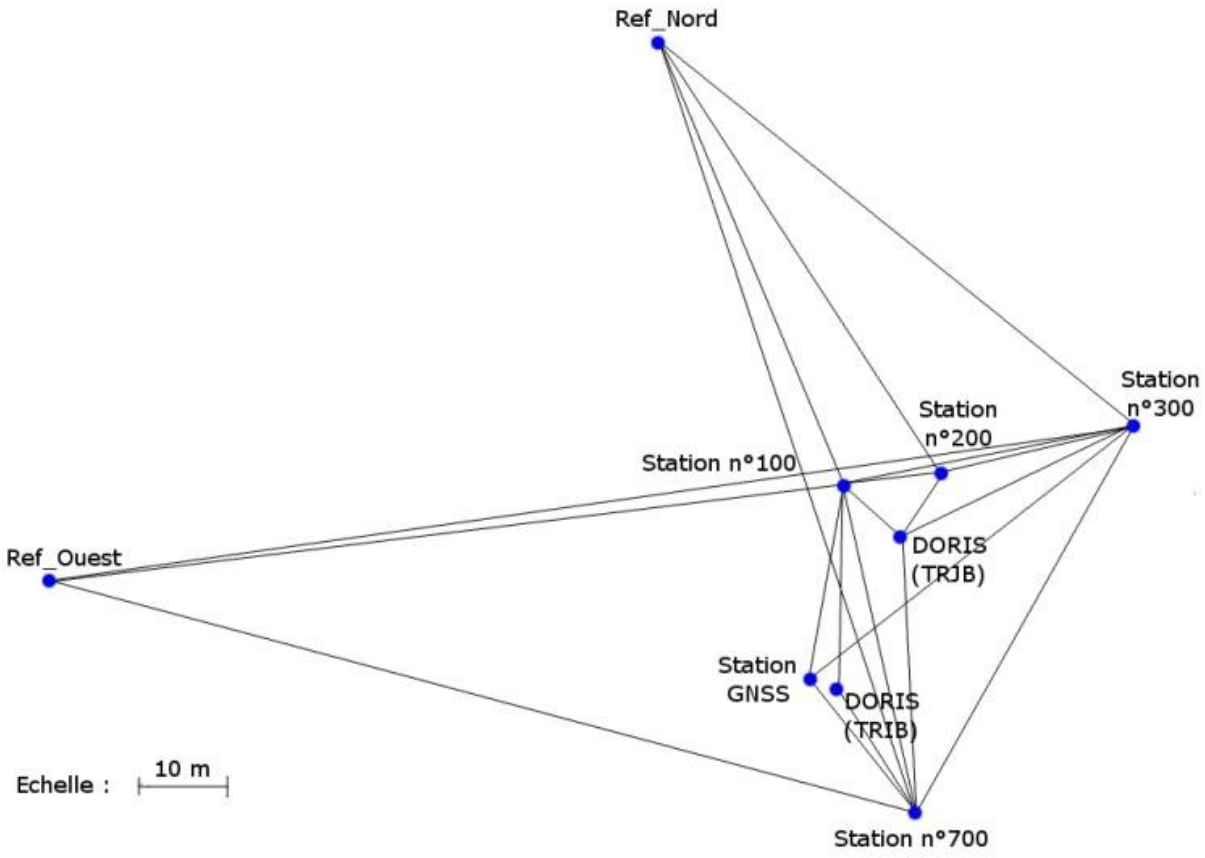
The equipment used is as follows :

- a Leica electronic level (Na3003) associated with 3 m invar bar code levelling rod with a resolution of 0.01 mm.
- a Leica tacheometer (TC2002) 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.
- two Leica 1230+ GNSS receivers associated with Leica choke ring antennas.

All of this equipment is regularly checked and calibrated at IGN.
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 checking.

3.3 Observations polygon

All the survey was conducted in order to provide the highest accuracy in the determination of the 3D vectors between the observing reference points. Hereafter is the observations polygon.
The survey is carried out in the morning before the ship's departure with unfavourable weather (rain). The methodology, however, allows a suitable accuracy on all observed points.



(See also the sketch with the benchmarks in appendix 1)

3.4 Survey method

Four stations (numbered 100, 200, 300 and 700) in the immediate vicinity of the reference points are surveyed. 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 mm x $\sqrt{n}$ (n = number of traverse legs).

Some stations were determined by GNSS technique and used to get the polygon bearing.

3.4.1 Antennas reference points

As our strategy was to keep in place the DORIS or GNSS antennas (i.e. TRJB, GNSS), their reference points had to be determined indirectly.

For the planimetric position :
From each survey station aiming at the antennas, the right and left sides of the antenna theoretically centred on the antenna reference point (ARP) 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 centred position.
For the altimetric position :
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 some centring equations have been included in the adjustment.

3.4.2 Centring equations

Using a theodolite the verticality of the antenna reference points were measured with respect to the corresponding marker. The results of this eccentricity combined with the height above the marker form the centring equations. The height above the marker comes either from the manufacturer value or from a measurement with a two-metre rule.

3.4.3 Levelling

Double-run spirit levelling operations were carried out on the main benchmarks described in paragraph 2.
About the GNSS antennas, the bottom of Choke ring (BCR) was levelled with a 3 m rod in reverse position.

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

Regarding the GNSS antenna, there is a slight lack of horizontality; the difference of 0.7 mm between the two levelling values is not resumed.

3.4.4 GNSS observations

GNSS observations are carried out in order to determine the orientation of the survey. As the data from the semi-permanent GNSS station were not available, orientations are ensured by the baselines between the west reference "REFW" and the stations 300 and 700.

4 COMPUTATION

4.1 On site validation

Levelling data are validated on site the day before departure by comparison of the forward and backward traverses.
However, the GNSS and tacheometric data are not validated before the boat departure by lack of time.

4.2 GNSS network

Back at the office, GNSS baselines are determined with Leica Geo Office V 6.0 software using the original set of “absolute” GNSS antenna calibrations (igs08.atx).
The coordinates of the reference West introduced into the calculation LGO comes from data processed with Bernese v5.0 software.

The LGO report file appears in appendix 2.

4.3 Final adjustment

The final computation is carried out by a 3D least squares adjustment with Microsearch GeoLab 2001 version 2001.9.20.0 software. The input file (see appendix 3) comes from :

- Tacheometric observations : horizontal and zenithal angles, distances
- Spirit levelling : height differences between point
- Centring equations: relative positions between points
- Bearing from the processing of GNSS data
- TRIB coordinates derived from DORIS DPOD2008 epoch 2005.0 constrained at 1 mm

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

- 0.8 mgon for horizontal angles
- 1.2 mgon for vertical angles
- 1 mm for distances
- 0.1 mm x √ n (n = number of traverse legs) for the height differences
- 0.5 to 1 mm for heights measured with a two-metre rule

These values are commonly used in most of our Microsearch GeoLab computation input file. The adjustment provided coordinates and an associated covariance matrix of our survey (appendix 4).

5 RESULTS

5.1 Station name translation table

The following list sums up the most interesting points used in the Microsearch GeoLab input file with the main points in bold (appendix 3).

Point description	Code or DOMES number	Computation name
Former DORIS station • **TRIB Antenna Reference Point**	**30604S002**	**TRIB**
DORIS station and markers • **TRJB Antenna Reference Point** • DORIS pillar / Mark Ø12 mm • DORIS concrete bloc / hexagonal domed mark	**30604S003** 30604M001 30604M002	**TRJB** DORIS_mark DORIS_mark_2
GNSS station (managed by NOC) • Antenna ARP	-	GNSS_ARP
Tide gauge • Tide Gauge Ref Point (marker)	GLOSS n°266 (POL BM2)	BM2
Benchmarks • Ball mark • Stainless steel rod		Ball_mark Rod_mark

5.2 Adjusted coordinates and confidence regions

For the DORIS needs, TRIB constrained **coordinates are not issued from ITRF2008 but from DPOD2008** which is the DORIS terrestrial reference frame for precise orbit determination derived from ITRF2008 and DORIS analysis.

The results of the adjustment are the coordinates of all points as well as their confidence ellipsoids in DPOD2008 reference frame at epoch 2005.0.
The table below provides the 3D coordinates and confidence region at 95% of the points of interest.

```
================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0             GRS 80      UNITS: m,GRAD Page 0004
================================================================================
Adjusted XYZ Coordinates:
                           X-COORDINATE       Y-COORDINATE       Z-COORDINATE
 CODE FFF STATION               STD DEV            STD DEV            STD DEV
 ---- --- ------------ ------------------ ------------------ ------------------
 XYZ      BM2               4978507.2546      -1086658.4648      -3823098.0307 m       0
                                  0.0071             0.0093             0.0086
 XYZ      DORIS_mark        4978461.7510      -1086616.8814      -3823204.1939 m       0
                                  0.0018             0.0019             0.0019
 XYZ      DORIS_mark_2      4978472.1414      -1086611.4863      -3823188.2875 m       0
                                  0.0020             0.0024             0.0023
 XYZ      GNSS_ARP          4978463.7569      -1086620.5901      -3823205.0362 m       0
                                  0.0018             0.0020             0.0020
 XYZ      TRIB              4978462.1340      -1086616.9650      -3823204.4900 m       0
                                  0.0014             0.0014             0.0014
 XYZ      TRJB              4978474.7987      -1086612.0632      -3823190.3414 m       0
                                  0.0023             0.0024             0.0024
 XYZ      ball_mark         4990025.7812       1032247.9206      -3823192.1238 m       0
                                  0.0013             0.0003             0.0010
 XYZ      rod_mark          4990026.0047       1032247.9668      -3823192.2961 m       0
                                  0.0013             0.0003             0.0010
```

```
================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0             GRS 80      UNITS: m,GRAD Page 0012
================================================================================
2-D and 1-D Station Confidence Regions (95.000 and 95.000 percent):
STATION            MAJOR SEMI-AXIS  AZ     MINOR SEMI-AXIS             VERTICAL
------------ -------------------- --- ------------------ --------------------
BM2                         0.0272  30             0.0223               0.0033
DORIS_mark                  0.0048  90             0.0048               0.0033
DORIS_mark_2                0.0063 163             0.0059               0.0033
GNSS_ARP                    0.0052 159             0.0049               0.0033
TRIB                        0.0034  90             0.0034               0.0027
TRJB                        0.0063 163             0.0059               0.0040
ball_mark                   0.0000   0             0.0000               0.0033
rod_mark                    0.0000   0             0.0000               0.0033
```

The whole covariance matrix was computed and a submatrix with the points of interest i.e. TRIB, TRJB and GNSS_ARP is extracted. Finally, this covariance submatrix is converted into the SINEX format using the "geotosnx" tool provided by Z. Altamimi. The resulting SINEX file (30604_IGN_2012-164.SNX) is presented in appendix 5.

5.3 Levelling results and comparison

The following table sums up the elevation differences between the marks.

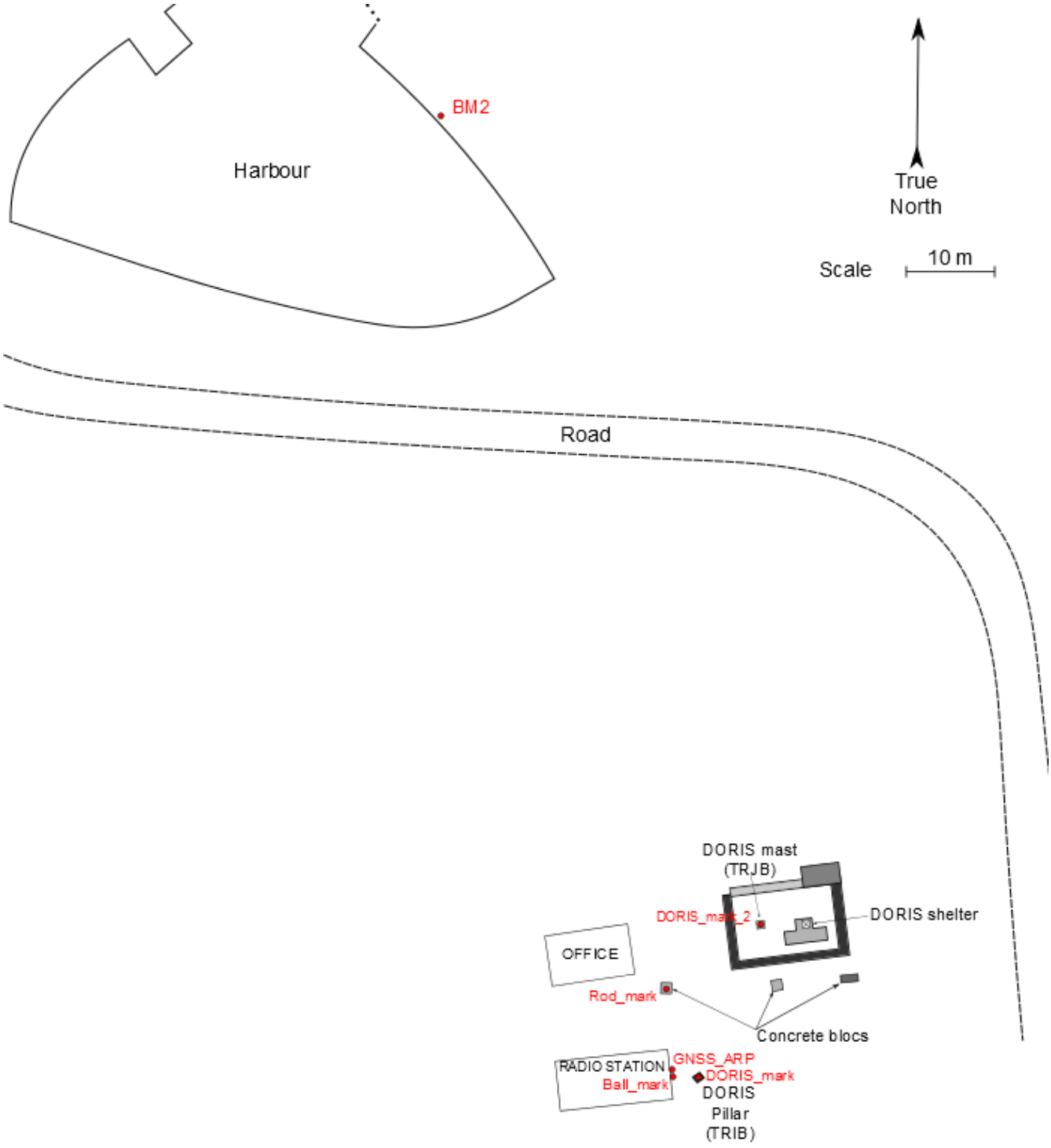
Benchmarks	to the next mark	Elevation differences (in m)
GNSS_ARP	↓	-2,703
DORIS_mark	↓	-1,084
rod_mark	↓	-0,286
ball_mark	↓	-1,035
DORIS_mark_2	↓	-19,031
BM2		

The elevation difference comparison reveals 2.4 centimetres discrepancy between the value surveyed in 2002 by GNSS method and the 2012 levelling value. The value to be taken in account is the new one : -21.436 m.

Benchmarks	Elevation difference comparison (in m)	
	GNSS method (2002)	Levelling method (2012)
from DORIS_mark to BM2	-21,460	-21,436

6 APPENDICES

6.1 Appendix 1 : sketch of levelled points



6.2 Appendix 2 : LGO report

Récapitulatif du Traitement

Tristan_Validation

Informations sur le Projet

Nom du Projet:	Tristan_Validation
Date de création:	06/11/2012 21:27:22
Fuseau Horaire:	0h 00'
Nom Syst. Coordonnées:	WGS 1984
Logiciel d'application:	LEICA Geo Office 8.1
Date et heure de début:	06/12/2012 12:05:45
Date et heure de fin:	06/12/2012 13:20:00
Points occupés manuellement:	4
Noyau de Post-Traitement:	PSI-Pro 3.0
Traité:	10/24/2012 14:38:23

Paramètres de Traitement

Paramètres	**Sélectionnés**
Angle de Coupure:	15°
Type d'Ephémérides:	Radiodiffusées
Type de solution:	Automatique
Type GNSS:	GPS / GLONASS
Fréquence:	L1/E1 et L2
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

REFW - 100	**Référence: REFW**	**Mobile: 100**
Type de capteur / N° S:	GX1230+ GNSS / 482019	GX1230+ GNSS / 482018
Type d'antenne / N° S:	LEIAT504 NONE / -	LEIAT504 NONE / -
Hauteur d'antenne:	0.0000 m	0.0000 m
Coordonnées:		
X:	4978449.3009 m	4978474.9530 m
Y:	-1086708.8686 m	-1086618.6707 m
Z:	-3823193.8173 m	-3823184.3183 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS / GLONASS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	

Plage horaire:	06/12/2012 12:05:45 - 06/12/2012 12:23:30		
Durée:	17' 45"		
Qualité:	ET X: 0.0006 m	ET Y: 0.0003 m	ET Z: 0.0004 m
	Qlté Pos: 0.0004 m	Qlté Alt: 0.0007 m	ET Pente: 0.0003 m
Vecteur Ligne Base:	dX: 25.6521 m	dY: 90.1979 m	dZ: 9.4990 m
	Pente: 94.2546 m	dAlt: -1.0755 m	
DOP (min-max):	GDOP: 1.7 - 1.9		
	PDOP: 1.4 - 1.6	HDOP: 0.7 - 0.8	VDOP: 1.2 - 1.4
Nombre de satellites utilisés:	GPS: 7		
	GLONASS: 6		

REFW - 200	**Référence: REFW**	**Mobile: 200**
Type de capteur / N° S:	GX1230+ GNSS / 482019	GX1230+ GNSS / 482018
Type d'antenne / N° S:	LEIAT504 NONE / -	LEIAT504 NONE / -
Hauteur d'antenne:	0.0000 m	0.0000 m
Coordonnées:		
X:	4978449.3009 m	4978478.5183 m
Y:	-1086708.8686 m	-1086607.8960 m
Z:	-3823193.8173 m	-3823183.3401 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS / GLONASS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	
Plage horaire:	06/12/2012 12:24:30 - 06/12/2012 12:41:00	
Durée:	16' 30"	

Qualité:	ET X: 0.0011 m	ET Y: 0.0004 m	ET Z: 0.0006 m
	Qlté Pos: 0.0007 m	Qlté Alt: 0.0011 m	ET Pente: 0.0004 m
Vecteur Ligne Base:	dX: 29.2174 m	dY: 100.9726 m	dZ: 10.4772 m
	Pente: 105.6357 m	dAlt: -0.7189 m	
DOP (min-max):	GDOP: 1.6 - 2.1		
	PDOP: 1.4 - 1.8	HDOP: 0.7 - 0.9	VDOP: 1.2 - 1.5
Nombre de satellites utilisés:	GPS: 8		
	GLONASS: 6		

REFW - 300	**Référence: REFW**	**Mobile: 300**
Type de capteur / N° S:	GX1230+ GNSS / 482019	GX1230+ GNSS / 482018
Type d'antenne / N° S:	LEIAT504 NONE / -	LEIAT504 NONE / -
Hauteur d'antenne:	0.0000 m	0.0000 m
Coordonnées:		
X:	4978449.3009 m	4978486.5829 m
Y:	-1086708.8686 m	-1086586.3002 m
Z:	-3823193.8173 m	-3823179.0436 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS / GLONASS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	
Plage horaire:	06/12/2012 12:42:00 - 06/12/2012 12:59:30	
Durée:	17' 30"	

Qualité:	ET X: 0.0006 m	ET Y: 0.0002 m	ET Z: 0.0003 m
	Qlté Pos: 0.0003 m	Qlté Alt: 0.0006 m	ET Pente: 0.0002 m
Vecteur Ligne Base:	dX: 37.2820 m	dY: 122.5684 m	dZ: 14.7738 m
	Pente: 128.9621 m	dAlt: -0.6961 m	
DOP (min-max):	GDOP: 1.8 - 1.9		
	PDOP: 1.6 - 1.6	HDOP: 0.8 - 0.8	VDOP: 1.3 - 1.4
Nombre de satellites utilisés:	GPS: 8		
	GLONASS: 5		

REFW - 700	**Référence: REFW**		**Mobile: 700**
Type de capteur / N° S:	GX1230+ GNSS / 482019		GX1230+ GNSS / 482018
Type d'antenne / N° S:	LEIAT504 NONE / -		LEIAT504 NONE / -
Hauteur d'antenne:	0.0000 m		0.0000 m
Coordonnées:			
X:	4978449.3009 m		4978456.8204 m
Y:	-1086708.8686 m		-1086606.1131 m
Z:	-3823193.8173 m		-3823216.7619 m
Type de solution:	Phase: toutes fixes		
Type GNSS:	GPS / GLONASS		
Fréquence:	L1/E1 et L2		
Ambiguïté:	Oui		
Plage horaire:	06/12/2012 13:00:30 - 06/12/2012 13:20:00		
Durée:	19' 30"		
Qualité:	ET X: 0.0017 m	ET Y: 0.0007 m	ET Z: 0.0009 m
	Qlté Pos: 0.0012 m	Qlté Alt: 0.0017 m	ET Pente: 0.0006 m
Vecteur Ligne Base:	dX: 7.5195 m	dY: 102.7555 m	dZ: -22.9446 m
	Pente: 105.5542 m	dAlt: 2.2061 m	
DOP (min-max):	GDOP: 2.5 - 2.9		
	PDOP: 2.1 - 2.4	HDOP: 1.1 - 1.5	VDOP: 1.8 - 2.0
Nombre de satellites utilisés:	GPS: 6		
	GLONASS: 4		

6.3 Appendix 3 : input GeoLab file

```
TITL TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - JUNE 2012 SURVEY

 COMP ADJ
 ELIP GRS 80            6378137.0000  6356752.3141   0.0000   0.0000   0.0000 m
 MAXI         15
 CONF YES YES YES YES NO
 PSOL NO  YES
 PMIS NO  NO
 PRES YES NO
 PADJ NO  YES YES NO  YES 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                                 *
*****************************************************************************************************************

*REFERENCES
*RefN : permanent pole to the north aimed as a reference
*REFW : temporary tripod to the west with a GNSS antenna aimed as a reference
        (coordinates determined by GNSS with Bernese software)


*GNSS STATION
*GNSS_ARP : ANTENNA AXIS AT ARP
*GNSS_TCR : TOP OF CHOKE RING H=0.102 m


*DORIS
*TRIB         : (DOMES 30604S002) = DORIS antenna ref. pt. (Starec type)
*DORIS_mark   : (DOMES 30604M001) = DORIS marker on top of a concrete pillar
*TRJB         : (DOMES 30604S003) = DORIS antenna ref. pt. (Starec type)
*TRJB/2GHz    : DORIS at 2 GHz phase centre
*DORIS_mark_2 : (DOMES 30604M002) = DORIS marker on a concrete block
*rep1_PRI     : Prism on a mini-pole (H=0,20m) on DORIS_mark
*rep2_PRI     : Prism on a mini-pole (H=0,20m) on DORIS_mark_2


*TEMPORARY MARKS (or TEMPORARY STATIONS)
*100 : Station n°100 = theodolite (Intersection of the Theodolite rotation Axes)
*200 : Station n°200 = theodolite (Intersection of the Theodolite rotation Axes)
*300 : Station n°300 = theodolite (Intersection of the Theodolite rotation Axes)
*700 : Station n°700 = theodolite (Intersection of the Theodolite rotation Axes)


*******LEVELLING POINTS DESCRIPTIONS*********
*rod_mark     : stainless steel rod on concrete bloc
*BM2          : Tide Gauge mark on pier
*Ball_mark    : Ball_mark (approximately under DORIS TRIA) setup by POL ?
*DORIS_mark   :(DOMES 30604M001) = DORIS_mark
*GNSS_BCR     : GNSS_Bottom_of_Choke_Ring (level is 3,5 cm above GNSS_ARP)
*DORIS_mark_2 :(DOMES 30604M003) = DORIS_mark_2
*XXXXplate    : top of plate support of DORIS antenna



*********************AZIMUTS DEDUCTED FROM THE GPS DETERMINATIONS*****************************

 AZIM     300          REFW                      291  9     0.2      0.005
 AZIM     700          REFW                      316 52     5.6      0.005


***********************************POINTS COORDINATES*****************************************

*FORCED DPOD2008 EPOCH 2005.0 COORDINATES (issued from DORIS sitelog TRIB20120202.log)
 3DC
 XYZ  000 TRIB               4978462.134       -1086616.965       -3823204.490 m  0
*PLH  000 TRIB         s 37  3 55.007225 w 12 18 44.954795      46.4404 m  0
 COV  CT DIAG                   1
 ELEM               0.000001               0.000001               0.000001
```

```
*******************************APPROXIMATE COORDINATES*****************************************
*points coordonnées temporaires
 PLH  000 100          S 37  3  54.23312 W 12 18  44.91160      44.5664 m       0
 PLH  000 200          S 37  3  54.18462 W 12 18  44.45472      44.9229 m       0
 PLH  000 TRJB/2GHz    s 37  3  55.00685 w 12 18  44.95472      46.9500 m       0
 PLH  000 300          S 37  3  54.00940 W 12 18  43.53105      44.9458 m       0
 PLH  000 rep2_PRI     S 37  3  54.41522 W 12 18  44.64459      43.7311 m       0
 PLH  000 RefN         S 37  3  52.54980 W 12 18  45.80039      45.5850 m       0
 PLH  000 rep1_PRI     S 37  3  55.00346 W 12 18  44.94750      46.2822 m       0
 PLH  000 700          S 37  3  55.47162 W 12 18  44.57150      47.8479 m       0
 PLH  000 GNSS_ARP     S 37  3  54.97151 W 12 18  45.07689      45.5850 m       0
 PLH  000 GNSS_TCR     S 37  3  54.97102 W 12 18  45.07680      45.5850 m       0
 PLH  000 REFW         S 37  3  54.59292 W 12 18  48.70011      45.6418 m       0


***********************************CENTRING EQUATIONS*****************************************

 2DD
 PL   00  GNSS_TCR     s 37  3 54.971510 w 12 18 45.076890
 PL   00  GNSS_ARP     s 37  3 54.971510 w 12 18 45.076890
 COV  LG DIAG
 ELEM               0.000001               0.000001

*vertical antenna centred on marker
 3DD
 PLH  000 TRIB         s 37  3 55.003460 w 12 18 44.947500      46.4910
*Prism on tribrach on plate
 PLH  000 rep1_PRI     s 37  3 55.003460 w 12 18 44.947500      46.3510
 PLH  000 DORIS_mark   s 37  3 55.003460 w 12 18 44.947500      46.0000
 COV  LG DIAG
 ELEM               0.000001               0.000001               0.000001
 ELEM               0.000001               0.000001               0.000001

*vertical antenna not centred on marker (DORIS TRJB ref point is 3mm at est from marker)
 3DD
 PLH  000 TRJB/2GHz    S 37  3  54.41582 W 12 18  44.64442      46.8950
 PLH  000 TRJB         S 37  3  54.41582 W 12 18  44.64442      46.4080
*Prism on mini-pole
 PLH  000 rep2_PRI     S 37  3  54.41582 W 12 18  44.64454      43.2000
 PLH  000 DORIS_mark_2 s 37  3  54.41582 w 12 18  44.64454      43.0000
 COV  LG DIAG
 ELEM               0.000001               0.000001               0.000001
 ELEM               0.000001               0.000001               0.000001
 ELEM               0.000001               0.000001               0.000001



*****************************************************************************************
*                    Theodolite Observations 2012 JC.Poyard                             *
*****************************************************************************************

 SIGM AH         8.0
 SIGM ZA        12.0
 SIGM DP      0.0010

 HIST NEW

 DSET AH
 DIR      700          REFW                      0  0     0.0         10
 DIR      700          GNSS_ARP                 40 14    92.9
 DIR      700          rep1_PRI                 47  7    39.3
 DIR      700          RefN                     62 78    74.2
 DIR      700          100                      69 68    84.3
 DIR      700          TRJB/2GHz                79 96    88.3
 DIR      700          300                     116 48    61.6
 DSET AH
 DIR      300          REFW                      0  0     0.0
 DIR      300          RefN                     51 96    28.9
 DIR      300          700                     341 90    97.5
 DIR      300          GNSS_TCR                366 88    14.3
 DIR      300          TRJB/2GHz               381 72    39.9
 DIR      300          200                     394  9    68.9
 DIR      300          100                     396 20    49.1
 DSET AH
 DIR      200          RefN                      0  0     0.0
 DIR      200          300                     122 30    80.5
 DIR      200          rep2_PRI                274 25    85.7
 DIR      200          TRJB/2GHz               274 23    68.8
 DIR      200          100                     328 76    19.7
 DIR      200          REFW                    329 51    86.8
 DSET AH
 DIR      100          REFW                      0  0     0.0
 DIR      100          rep2_PRI                252 40    22.5
 DIR      100          RefN                     82  3    43.2
 DIR      100          300                     194 80    63.8
 DIR      100          200                     199 14    95.0
```

```
 DIR      100          TRJB/2GHz                252 38    56.6
 DIR      100          700                      293 71    56.0
 DIR      100          rep1_PRI                 309 88    74.0
 DIR      100          GNSS_ARP                 318 81    47.1
 DIR      100          GNSS_TCR                 318 81    60.2

 ZANG ZA  700          rep1_PRI                 105 78    86.3
 ZANG ZA  700          100                      105 32    72.0
 ZANG ZA  700          300                      103 55    17.0
 ZANG ZA  300          700                       96 44    80.2
 ZANG ZA  300          200                      100 11    35.5
 ZANG ZA  300          100                      100 69    79.2
 ZANG ZA  200          300                       99 88    34.3
 ZANG ZA  200          rep2_PRI                 108 79    29.9
 ZANG ZA  200          100                      101 89    82.8
 ZANG ZA  100          rep2_PRI                 106 17    82.8
 ZANG ZA  100          300                       99 30    10.6
 ZANG ZA  100          200                       98 10    37.0
 ZANG ZA  100          700                       94 67    23.7
 ZANG ZA  100          rep1_PRI                  95 41    60.0

 DIST DP  700          rep1_PRI                      17.23268
 DIST DP  700          300                           51.95955
 DIST DP  300          200                           23.44840
 DIST DP  300          100                           34.79969
 DIST DP  200          300                           23.44838
 DIST DP  200          rep2_PRI                       8.59825
 DIST DP  200          100                           11.39351
 DIST DP  100          rep2_PRI                       8.70703
 DIST DP  100          300                           34.79922
 DIST DP  100          700                           39.21558
 DIST DP  100          rep1_PRI                      23.81268


*****************************************************************************************
*                       Spirit Levelling 2012 (JC.Poyard)                               *
*****************************************************************************************

*HIST NEW

* Traverse 1
 OHDF     rod_mark     BM2                        -20.35183    0.00024
 OHDF     BM2          rod_mark                    20.35115    0.00024
* Traverse 2
 OHDF     rod_mark     ball_mark                   -0.28598    0.00010
 OHDF     ball_mark    DORIS_mark                   1.37032    0.00010
 OHDF     DORIS_mark   ball_mark                   -1.37027    0.00010
 OHDF     ball_mark    rod_mark                     0.28593    0.00010
* Traverse 3
 OHDF     rod_mark     GNSS_BCR                     3.82149    0.00010
 OHDF     GNSS_BCR     rod_mark                    -3.82225    0.00010
 OHDF     rod_mark     DORIS_mark_2                -1.32047    0.00017
 OHDF     DORIS_mark_2 rod_mark                     1.32066    0.00017

*value issued from two-meter measurement
 OHDF     DORIS_mark   TRIBplate                    0.10000    0.00050


*value issued from two-meter measurement
 OHDF     DORIS_mark_2 TRJBplate                    3.01700    0.00100

*manufacturer value
 OHDF     TRIBplate    TRIB                         0.39100    0.00100
 OHDF     TRJBplate    TRJB                         0.39100    0.00100
*manufacturer value
 OHDF     GNSS_BCR     GNSS_ARP                    -0.03500    0.00010



*****************************************************************************************
*    The following GNSS vector was surveyed in 2002. It's included to get the tide gauge marker *
* planimetric position. The VSCA (Obs Variance Factor) is set to 200 so that the BM2 altimetric *
* value comes from the levelling survey and not from the GNSS tie.                       *
*****************************************************************************************

*GRP  OBS #00002 GEOSKILAB-2.ASC.IOB
 VSCA              200
 3DD
 DXYZ     TRIB         BM2                45.1019      -41.4954      106.4699 m
 COV  CT UPPR
 ELEM   1.170432315000000E-06  -1.950720525000000E-07  -4.477063500000000E-07 m
 ELEM   2.814154200000000E-07   1.471035150000000E-07                         m
 ELEM   5.244560100000000E-07                                                 m

HIST ALL Toutes les observations
 END
```

6.4 Appendix 4 : output GeoLab file

```
================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0             GRS 80      UNITS: m,GRAD Page 0001
================================================================================
Wed Mar 6 14:52:43 2013

Input file:  D:\JCPOYARD\JCP_Rattachement\2012_06_Tristan\Glb5\GLb_CT\Tristan_LocalTie.iob
Output file: D:\JCPOYARD\JCP_Rattachement\2012_06_Tristan\Glb5\GLb_CT\Tristan_LocalTie.lst
Options file: C:\Program Files (x86)\Microsearch\GeoLab\default.gpj

 ------------------------------------------------------------------------------
|             PARAMETERS               |             OBSERVATIONS              |
|--------------------------------------------------------------------------------|
|   Description    |      Number       |   Description     |      Number       |
|--------------------------------------------------------------------------------|
| No. of Stations  |          21       | Directions        |          30       |
| Coord Parameters |          50       | Distances         |          11       |
| Free Latitudes   |          16       | Azimuths          |           2       |
| Free Longitudes  |          16       | Vertical Angles   |           0       |
| Free Heights     |          18       | Zenithal Angles   |          14       |
| Fixed Coordinates|          13       | Angles            |           0       |
| Astro. Latitudes |           0       | Heights           |           0       |
| Astro. Longitudes|           0       | Height Differences|          15       |
| Geoid Records    |           0       | Auxiliary Params. |           0       |
| All Aux. Pars.   |           4       | 2-D Coords.       |           0       |
| Direction Pars.  |           4       | 2-D Coord. Diffs. |           2       |
| Scale Parameters |           0       | 3-D Coords.       |           3       |
| Constant Pars.   |           0       | 3-D Coord. Diffs. |          18       |
| Rotation Pars.   |           0       |                   |                   |
| Translation Pars.|           0       |                   |                   |
|                  |                   |                   |                   |
|                  |    --------       |                   |    --------       |
| Total Parameters |          54       | Total Observations|          95       |
|--------------------------------------------------------------------------------|
|                      Degrees of Freedom =        41                          |
 ------------------------------------------------------------------------------

--------------------------------------------------------------------------------
                        SUMMARY OF SELECTED OPTIONS
--------------------------------------------------------------------------------
    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
================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0             GRS 80      UNITS: m,GRAD Page 0002
================================================================================
    Generate Initial Coordinates         |   Yes
    Re-Transform Obs After 1st Pass      |   Yes
    Geoid Interpolation Method           |   Bi-Quadratic
--------------------------------------------------------------------------------
```

```
================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0            GRS 80      UNITS: m,GRAD Page 0003
================================================================================
Adjusted PLH Coordinates:
                                LATITUDE          LONGITUDE  ELIP-HEIGHT
 CODE FFF STATION                STD DEV            STD DEV      STD DEV
 ---- --- ------------ ----------------- ----------------- ------------
 PLH  000 100          S 37  3  54.23731 W 12 18  44.91889      44.5875 m       0
                                  0.0021              0.0020       0.0018
 PLH  000 200          S 37  3  54.18894 W 12 18  44.46187      44.9271 m       0
                                  0.0021              0.0021       0.0018
 PLH  000 300          S 37  3  54.01357 W 12 18  43.53831      44.9693 m       0
                                  0.0021              0.0021       0.0019
 PLH  000 700          S 37  3  55.47532 W 12 18  44.57883      47.8656 m       0
                                  0.0021              0.0020       0.0018
 PLH  000 BM2          S 37  3  51.21670 W 12 18  46.20652      24.5133 m       0
                                  0.0107              0.0097       0.0017
 PLH  000 DORIS_mark   S 37  3  55.00723 W 12 18  44.95479      45.9491 m       0
                                  0.0019              0.0019       0.0017
 PLH  000 DORIS_mark_2 S 37  3  54.41952 W 12 18  44.65174      43.5442 m       0
                                  0.0025              0.0024       0.0017
 PLH  000 GNSS_ARP     S 37  3  54.97525 W 12 18  45.08415      48.6517 m       0
                                  0.0021              0.0020       0.0017
 PLH  110 GNSS_BCR     S 37  3  54.55012 E 11 41  14.94259      48.6867 m       0
                                  0.0000              0.0000       0.0017
 PLH  001 GNSS_TCR     S 37  3  54.97530 W 12 18  45.08418      45.5850 m       0
                                  0.0023              0.0020       0.0000
 PLH  001 REFW         S 37  3  54.59704 W 12 18  48.70681      45.6418 m       0
                                  0.0021              0.0027       0.0000
 PLH  001 RefN         S 37  3  52.55428 W 12 18  45.80726      45.5850 m       0
                                  0.0037              0.0028       0.0000
 PLH  000 TRIB         S 37  3  55.00723 W 12 18  44.95479      46.4404 m       0
                                  0.0014              0.0014       0.0014
 PLH  110 TRIBplate    S 37  3  54.55012 E 11 41  14.94259      46.0492 m       0
                                  0.0000              0.0000       0.0017
 PLH  000 TRJB         S 37  3  54.41952 W 12 18  44.65162      46.9520 m       0
                                  0.0025              0.0024       0.0021
 PLH  000 TRJB/2GHz    S 37  3  54.41952 W 12 18  44.65162      47.4389 m       0
                                  0.0021              0.0020       0.0019
 PLH  110 TRJBplate    S 37  3  54.55012 E 11 41  14.94259      46.5611 m       0
                                  0.0000              0.0000       0.0020
 PLH  110 ball_mark    S 37  3  54.55012 E 11 41  14.94259      44.5788 m       0
                                  0.0000              0.0000       0.0017
 PLH  000 rep1_PRI     S 37  3  55.00723 W 12 18  44.95479      46.3008 m       0
                                  0.0019              0.0019       0.0018
 PLH  000 rep2_PRI     S 37  3  54.41952 W 12 18  44.65176      43.7435 m       0
                                  0.0021              0.0020       0.0018
 PLH  110 rod_mark     S 37  3  54.55012 E 11 41  14.94259      44.8648 m       0
                                  0.0000              0.0000       0.0017



================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0            GRS 80      UNITS: m,GRAD Page 0004
================================================================================
Adjusted XYZ Coordinates:
                              X-COORDINATE       Y-COORDINATE       Z-COORDINATE
 CODE FFF STATION                STD DEV            STD DEV            STD DEV
 ---- --- ------------ ------------------ ------------------ ------------------
 XYZ      100                4978474.8550      -1086618.8336      -3823184.4341 m       0
                                   0.0019             0.0020             0.0020
 XYZ      200                4978478.4055      -1086608.0522      -3823183.4490 m       0
                                   0.0019             0.0021             0.0020
 XYZ      300                4978486.4872      -1086586.4629      -3823179.1603 m       0
                                   0.0020             0.0021             0.0020
 XYZ      700                4978456.7282      -1086606.2784      -3823216.8637 m       0
                                   0.0019             0.0020             0.0020
 XYZ      BM2                4978507.2546      -1086658.4648      -3823098.0307 m       0
                                   0.0071             0.0093             0.0086
 XYZ      DORIS_mark         4978461.7510      -1086616.8814      -3823204.1939 m       0
                                   0.0018             0.0019             0.0019
 XYZ      DORIS_mark_2       4978472.1414      -1086611.4863      -3823188.2875 m       0
                                   0.0020             0.0024             0.0023
```

XYZ	GNSS_ARP	4978463.7569	-1086620.5901	-3823205.0362 m	0
		0.0018	0.0020	0.0020	
XYZ	GNSS_BCR	4990028.9911	1032248.5846	-3823194.5997 m	0
		0.0013	0.0003	0.0010	
XYZ	GNSS_TCR	4978461.3651	-1086620.0687	-3823203.1890 m	0
		0.0014	0.0020	0.0018	
XYZ	REFW	4978449.1908	-1086709.0139	-3823193.9185 m	0
		0.0013	0.0027	0.0017	
XYZ	RefN	4978501.5046	-1086647.1140	-3823143.6344 m	0
		0.0019	0.0030	0.0030	
XYZ	TRIB	4978462.1340	-1086616.9650	-3823204.4900 m	0
		0.0014	0.0014	0.0014	
XYZ	TRIBplate	4990026.9302	1032248.1583	-3823193.0100 m	0
		0.0013	0.0003	0.0010	
XYZ	TRJB	4978474.7987	-1086612.0632	-3823190.3414 m	0
		0.0023	0.0024	0.0024	
XYZ	TRJB/2GHz	4978475.1783	-1086612.1461	-3823190.6349 m	0
		0.0020	0.0020	0.0020	
XYZ	TRJBplate	4990027.3302	1032248.2410	-3823193.3185 m	0
		0.0016	0.0003	0.0012	
XYZ	ball_mark	4990025.7812	1032247.9206	-3823192.1238 m	0
		0.0013	0.0003	0.0010	
XYZ	rep1_PRI	4978462.0252	-1086616.9412	-3823204.4059 m	0
		0.0019	0.0019	0.0019	
XYZ	rep2_PRI	4978472.2966	-1086611.5207	-3823188.4076 m	0
		0.0019	0.0020	0.0020	
XYZ	rod_mark	4990026.0047	1032247.9668	-3823192.2961 m	0
		0.0013	0.0003	0.0010	

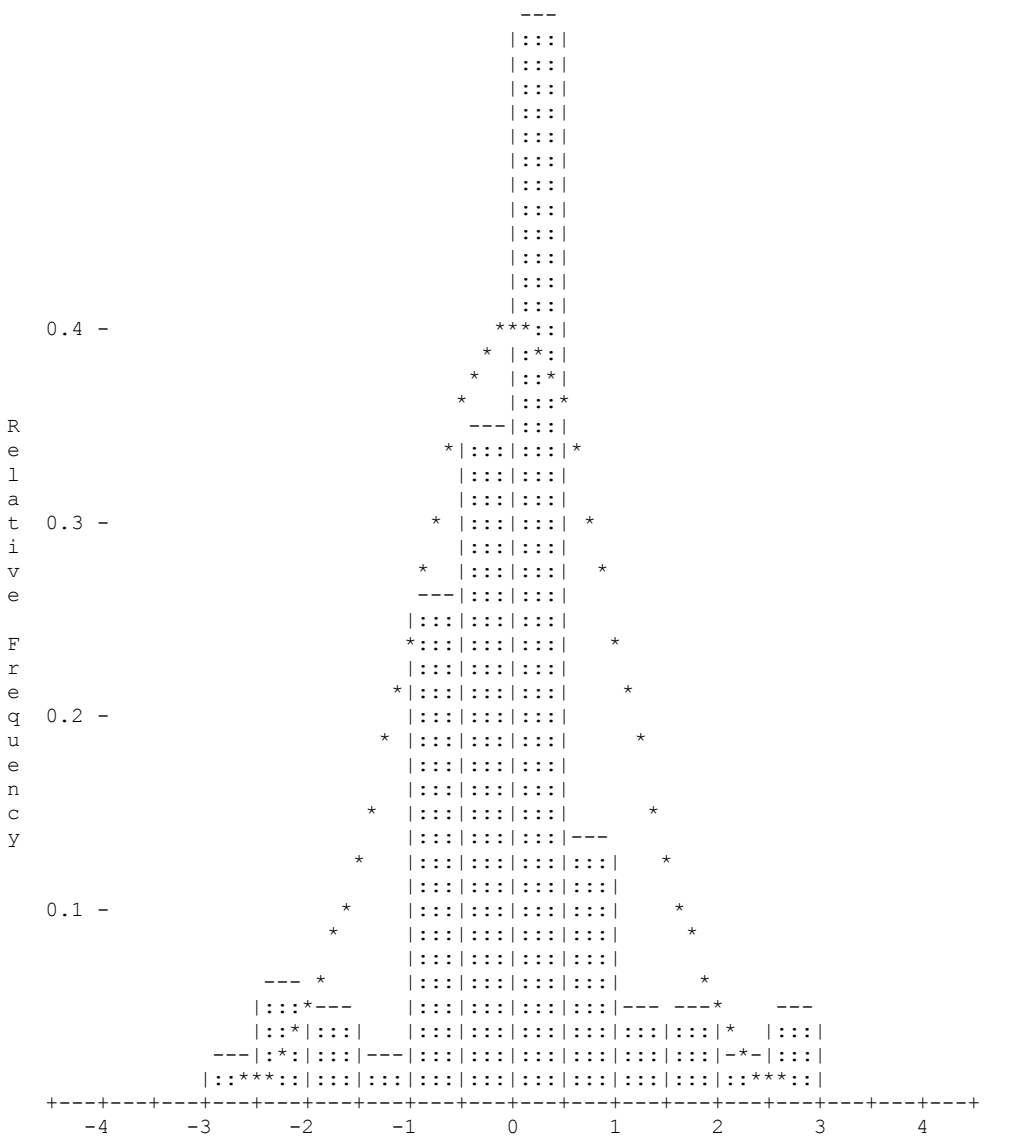
```
================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0            GRS 80      UNITS: m,GRAD Page 0005
================================================================================
Residuals (critical value = 3.425):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                 OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                      STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ----------------- -------- --------
AZIM              300          REFW          291  9      0.2      0.0      0.0
                                                         0.0      0.0        *
AZIM              700          REFW          316 52      5.6     -0.0     -0.0
                                                         0.0      0.0        *
XCT  TRIB                                    4978462.13400   0.0000   0.0000
                                                    0.0010   0.0000        *
YCT  TRIB                                   -1086616.96500  -0.0000  -0.0000
                                                    0.0010   0.0000        *
ZCT  TRIB                                   -3823204.49000   0.0000   0.0000
                                                    0.0010   0.0000        *
ELAT              GNSS_TCR     GNSS_ARP       0 00   0.00000   0.0015   0.0015
                                                    0.0010  -0.0000   486.47
ELON              GNSS_TCR     GNSS_ARP       0 00   0.00000   0.0007   0.7124
                                                    0.0010   0.0009   212.77
ELAT              TRIB         rep1_PRI       0 00   0.00000  -0.0000  -0.0000
                                                    0.0010   0.0001     0.00
ELON              TRIB         rep1_PRI       0 00   0.00000  -0.0000  -0.0000
                                                    0.0010  -0.0000     0.00
EHGT              TRIB         rep1_PRI            -0.14000   0.0004   0.7523
                                                    0.0010   0.0005  2863.67
ELAT              TRIB         DORIS_mark     0 00   0.00000   0.0000   0.0000
                                                    0.0010   0.0001     0.00
ELON              TRIB         DORIS_mark     0 00   0.00000   0.0000   0.0000
                                                    0.0010   0.0000     0.00
EHGT              TRIB         DORIS_mark          -0.49100  -0.0003  -0.3663
                                                    0.0010   0.0007   539.24
ELAT              TRJB/2GHz    TRJB           0 00   0.00000   0.0000   0.0000
                                                    0.0010   0.0001     0.00
ELON              TRJB/2GHz    TRJB           0 00   0.00000   0.0000   0.0000
                                                    0.0010  -0.0000     0.00
EHGT              TRJB/2GHz    TRJB                -0.48700   0.0001   0.1952
                                                    0.0010   0.0005   205.26
ELAT              TRJB/2GHz    rep2_PRI       0 00   0.00000  -0.0000  -0.0074
                                                    0.0010   0.0010     1.99
ELON              TRJB/2GHz    rep2_PRI       0 00   0.00012  -0.0005  -0.5208
```

```
                                                    0.0010   0.0010   139.53
EHGT            TRJB/2GHz    rep2_PRI             -3.69500  -0.0004  -0.7441
                                                    0.0010   0.0005   108.18
ELAT            TRJB/2GHz    DORIS_mark_2    0 00   0.00000   0.0000   0.0000
                                                    0.0010   0.0001     0.00
ELON            TRJB/2GHz    DORIS_mark_2    0 00   0.00012   0.0000   0.4671
                                                    0.0010   0.0000     0.00
EHGT            TRJB/2GHz    DORIS_mark_2         -3.89500   0.0003   0.4719
                                                    0.0010   0.0006    76.98
DIR             700          REFW             0  0      0.0     28.6      2.6
================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0             GRS 80      UNITS: m,GRAD Page 0006
================================================================================
Residuals (critical value = 3.425):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                 OBSERVATION RESIDUAL  STD RES
TYPE AT          FROM         TO                     STD DEV  STD DEV      PPM
---- ----------- ------------ ------------ ----------------- -------- --------
                                                       12.8     11.0
DIR             700          GNSS_ARP        40 14      92.9     -4.2     -2.5
                                                        8.0      1.6
DIR             700          rep1_PRI        47  7      39.3      1.9      0.7
                                                        8.0      2.7
DIR             700          RefN            62 78      74.2      6.6      1.2
                                                        8.0      5.7
DIR             700          100             69 68      84.3      2.0      0.3
                                                        8.0      6.6
DIR             700          TRJB/2GHz       79 96      88.3     -4.8     -0.8
                                                        8.0      6.1
DIR             700          300            116 48      61.6    -12.6     -2.3
                                                        8.0      5.6
DIR             300          REFW             0  0       0.0    -14.9     -2.4
                                                        8.0      6.2
DIR             300          RefN            51 96      28.9     -1.7     -0.7
                                                        8.0      2.7
DIR             300          700            341 90      97.5     11.4      2.0
                                                        8.0      5.6
DIR             300          GNSS_TCR       366 88      14.3     11.5      2.5
                                                        8.0      4.5
DIR             300          TRJB/2GHz      381 72      39.9     -1.4     -0.2
                                                        8.0      5.8
DIR             300          200            394  9      68.9     -5.4     -0.8
                                                        8.0      6.6
DIR             300          100            396 20      49.1      0.6      0.1
                                                        8.0      6.9
DIR             200          RefN             0  0       0.0      5.5      1.0
                                                        8.0      5.3
DIR             200          300            122 30      80.5      2.5      0.5
                                                        8.0      5.0
DIR             200          rep2_PRI       274 25      85.7     -0.2     -0.2
                                                        8.0      1.2
DIR             200          TRJB/2GHz      274 23      68.8     -0.2     -0.1
                                                        8.0      1.8
DIR             200          100            328 76      19.7    -10.4     -2.0
                                                        8.0      5.1
DIR             200          REFW           329 51      86.8      2.8      0.5
                                                        8.0      5.8
DIR             100          REFW             0  0       0.0      0.3      0.1
                                                        8.0      5.4
DIR             100          rep2_PRI       252 40      22.5     -0.6     -0.5
                                                        8.0      1.2
DIR             100          RefN            82  3      43.2     -7.8     -1.7
                                                        8.0      4.5
================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0             GRS 80      UNITS: m,GRAD Page 0007
================================================================================
Residuals (critical value = 3.425):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                 OBSERVATION RESIDUAL  STD RES
TYPE AT          FROM         TO                     STD DEV  STD DEV      PPM
---- ----------- ------------ ------------ ----------------- -------- --------
DIR             100          300            194 80      63.8      0.1      0.0
                                                        8.0      6.2
DIR             100          200            199 14      95.0      9.0      1.7
```

```
                                                   8.0       5.3
DIR          100          TRJB/2GHz       252 38   56.6     -0.7      -0.4
                                                   8.0       1.7
DIR          100          700             293 71   56.0      4.4       0.8
                                                   8.0       5.9
DIR          100          rep1_PRI        309 88   74.0      2.6       0.7
                                                   8.0       3.7
DIR          100          GNSS_ARP        318 81   47.1     -2.3      -0.9
                                                   8.0       2.5
DIR          100          GNSS_TCR        318 81   60.2     -5.0      -1.9
                                                   8.0       2.7
ZANG         700          rep1_PRI        105 78   86.3     -4.3      -0.8
                                                  12.0       5.6
ZANG         700          100             105 32   72.0     -9.2      -0.9
                                                  12.0      10.7
ZANG         700          300             103 55   17.0      9.1       0.8
                                                  12.0      11.0
ZANG         300          700              96 44   80.2    -17.1      -1.6
                                                  12.0      11.0
ZANG         300          200             100 11   35.5     -9.8      -1.0
                                                  12.0       9.9
ZANG         300          100             100 69   79.2     -7.7      -0.7
                                                  12.0      11.0
ZANG         200          300              99 88   34.3    -22.7      -2.3
                                                  12.0       9.9
ZANG         200          rep2_PRI        108 79   29.9     19.0       2.6
                                                  12.0       7.2
ZANG         200          100             101 89   82.8      0.0       0.0
                                                  12.0       9.8
ZANG         100          rep2_PRI        106 17   82.8    -18.3      -2.5
                                                  12.0       7.2
ZANG         100          300              99 30   10.6     -6.0      -0.5
                                                  12.0      11.0
ZANG         100          200              98 10   37.0     18.6       1.9
                                                  12.0       9.8
ZANG         100          700              94 67   23.7      1.0       0.1
                                                  12.0      10.7
ZANG         100          rep1_PRI         95 41   60.0      3.7       0.5
                                                  12.0       7.9
DIST         700          rep1_PRI             17.23260  -0.0004   -0.4456
                                                 0.0010   0.0008     20.93
DIST         700          300                  51.95950   0.0001    0.0805
================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0             GRS 80      UNITS: m,GRAD Page 0008
================================================================================
Residuals (critical value = 3.425):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                   STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ----------------- -------- --------
                                                 0.0010   0.0008      1.25
DIST         300          200                  23.44840  -0.0004   -0.4590
                                                 0.0010   0.0009     17.56
DIST         300          100                  34.79960  -0.0003   -0.3620
                                                 0.0010   0.0009      9.30
DIST         200          300                  23.44830  -0.0003   -0.3475
                                                 0.0010   0.0009     13.30
DIST         200          rep2_PRI              8.59820   0.0003    0.3534
                                                 0.0010   0.0009     39.00
DIST         200          100                  11.39350   0.0002    0.1729
                                                 0.0010   0.0009     13.98
DIST         100          rep2_PRI              8.70700   0.0001    0.0702
                                                 0.0010   0.0009      7.64
DIST         100          300                  34.79920   0.0001    0.0856
                                                 0.0010   0.0009      2.20
DIST         100          700                  39.21550   0.0004    0.4725
                                                 0.0010   0.0008     10.16
DIST         100          rep1_PRI             23.81260   0.0003    0.4005
                                                 0.0010   0.0008     13.53
OHDF         rod_mark     BM2                 -20.35183   0.0003    1.9903
                                                 0.0002   0.0002      0.00
OHDF         BM2          rod_mark             20.35115   0.0003    2.0164
                                                 0.0002   0.0002      0.00
OHDF         rod_mark     ball_mark            -0.28598   0.0000    0.0000
                                                 0.0001   0.0000     95.76*
```

```
OHDF              ball_mark    DORIS_mark             1.37032  -0.0000  -0.0000
                                                      0.0001   0.0000     0.00*
OHDF              DORIS_mark   ball_mark             -1.37027  -0.0000  -0.0000
                                                      0.0001   0.0000     0.00*
OHDF              ball_mark    rod_mark               0.28593   0.0000   0.0000
                                                      0.0001   0.0000    79.09*
OHDF              rod_mark     GNSS_BCR               3.82149   0.0004   0.0004
                                                      0.0001   0.0000    99.43*
OHDF              GNSS_BCR     rod_mark              -3.82225   0.0004   0.0004
                                                      0.0001   0.0000    99.43*
OHDF              rod_mark     DORIS_mark_2          -1.32047  -0.0001  -0.8366
                                                      0.0002   0.0001     0.00
OHDF              DORIS_mark_2 rod_mark               1.32066  -0.0001  -0.7407
                                                      0.0002   0.0001     0.00
OHDF              DORIS_mark   TRIBplate              0.10000   0.0001   0.2991
                                                      0.0005   0.0002     0.00
OHDF              DORIS_mark_2 TRJBplate              3.01700  -0.0001  -0.1930
                                                      0.0010   0.0005     0.00
OHDF              TRIBplate    TRIB                   0.39100   0.0002   0.2991
                                                      0.0010   0.0007     0.00
================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0            GRS 80      UNITS: m,GRAD Page 0009
================================================================================
Residuals (critical value = 3.425):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                 OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                    STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ------------------ -------- --------
OHDF              TRJBplate    TRJB                   0.39100  -0.0001  -0.1930
                                                      0.0010   0.0005     0.00
OHDF              GNSS_BCR     GNSS_ARP              -0.03500   0.0000   0.0000
                                                      0.0001   0.0000     0.00*
DXCT              TRIB         BM2                   45.10190   0.0187   1.2965
                                                      0.0153   0.0144   152.50
DYCT              TRIB         BM2                  -41.49540  -0.0044  -1.2965
                                                      0.0075   0.0034    36.21
DZCT              TRIB         BM2                  106.46990  -0.0106  -1.2965
                                                      0.0102   0.0082    86.59
```

```
================================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0            GRS 80      UNITS: m,GRAD Page 0010
================================================================================
```



TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES - Microsearch GeoLab, V2001.9.20.0 GRS 80 UNITS: m,GRAD Page 0011

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	3.4247
Number of Flagged Residuals	0
Convergence Criterion	0.0001
Final Iteration Counter Value	6
Confidence Level Used	95.0000
Estimated Variance Factor	1.9008
Number of Degrees of Freedom	41

Chi-Square Test on the Variance Factor:

1.2868e+00 < 1.0000 < 3.0908e+00 ?

******** THE TEST FAILS ********

```
 ---------------------------------------------------------------------------

 ---------------------------------------------------------------------------
|                                                                           |
| NOTE:  All confidence regions were computed using the following factors:  |
|        ------------------------------------------------------------       |
|        Variance factor used      =          1.9008                       |
|        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.                                 |
|                                                                           |
 ---------------------------------------------------------------------------
```

```
===========================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0             GRS 80      UNITS: m,GRAD Page 0012
===========================================================================
2-D and 1-D Station Confidence Regions (95.000 and 95.000 percent):
STATION           MAJOR SEMI-AXIS  AZ     MINOR SEMI-AXIS             VERTICAL
----------- --------------------- --- -------------------- --------------------
100                        0.0052 170               0.0049               0.0036
200                        0.0052 167               0.0050               0.0036
300                        0.0053 171               0.0051               0.0036
700                        0.0052 150               0.0049               0.0036
BM2                        0.0272  30               0.0223               0.0033
DORIS_mark                 0.0048  90               0.0048               0.0033
DORIS_mark_2               0.0063 163               0.0059               0.0033
GNSS_ARP                   0.0052 159               0.0049               0.0033
GNSS_BCR                   0.0000   0               0.0000               0.0033
GNSS_TCR                   0.0056   6               0.0050               0.0000
REFW                       0.0067 103               0.0050               0.0000
RefN                       0.0101 149               0.0053               0.0000
TRIB                       0.0034  90               0.0034               0.0027
TRIBplate                  0.0000   0               0.0000               0.0033
TRJB                       0.0063 163               0.0059               0.0040
TRJB/2GHz                  0.0053 163               0.0049               0.0036
TRJBplate                  0.0000   0               0.0000               0.0039
ball_mark                  0.0000   0               0.0000               0.0033
rep1_PRI                   0.0048  90               0.0048               0.0035
rep2_PRI                   0.0053 163               0.0049               0.0036
rod_mark                   0.0000   0               0.0000               0.0033

===========================================================================
   TRISTAN da CUNHA (South Atlantic) GNSS&DORIS&TideGauge TOPOGRAPHIC TIES -
Microsearch GeoLab, V2001.9.20.0             GRS 80      UNITS: m,GRAD Page 0013
===========================================================================
3D Station Confidence Regions (95.000 percent):
STATION         MAJ-SEMI (AZ,VANG)    MED-SEMI (AZ,VANG)    MIN-SEMI (AZ,VANG)
----------- -------------------- -------------------- --------------------
100              0.0059 (350,  0)      0.0056 (260,  0)      0.0051 (154, 90)
200              0.0060 (347,  0)      0.0057 (257,  0)      0.0051 (167, 90)
300              0.0060 (351,  0)      0.0058 (261,  0)      0.0052 (167, 90)
700              0.0059 (330,  0)      0.0056 ( 60,  0)      0.0051 (180, 90)
BM2              0.0311 ( 30,  0)      0.0255 (300,  0)      0.0047 (162, 90)
DORIS_mark       0.0055 ( 71,  0)      0.0055 (341,  0)      0.0047 (165, 90)
DORIS_mark_2     0.0071 (343,  0)      0.0068 ( 73,  0)      0.0047 (167, 90)
GNSS_ARP         0.0060 (339,  0)      0.0056 ( 69,  0)      0.0047 (173, 90)
GNSS_BCR         0.0047 (  0, 90)      0.0000 ( 90,  0)      0.0000 (  0,  0)
GNSS_TCR         0.0064 (  6,  0)      0.0057 ( 96,  0)      0.0000 (  0, 90)
REFW             0.0076 (103,  0)      0.0057 ( 13,  0)      0.0000 (  0, 90)
RefN             0.0115 (329,  0)      0.0061 ( 59,  0)      0.0000 (  0, 90)
TRIB             0.0039 ( 71,  0)      0.0039 (179, 90)      0.0039 (341,  0)
TRIBplate        0.0047 (  0, 90)      0.0000 ( 90,  0)      0.0000 (  0,  0)
TRJB             0.0071 (343,  0)      0.0068 ( 73,  0)      0.0058 (168, 90)
TRJB/2GHz        0.0060 (343,  0)      0.0056 ( 73,  0)      0.0052 (172, 90)
TRJBplate        0.0056 (  0, 90)      0.0000 ( 90,  0)      0.0000 (  0,  0)
ball_mark        0.0047 (  0, 90)      0.0000 ( 90,  0)      0.0000 (  0,  0)
rep1_PRI         0.0055 ( 70,  0)      0.0055 (340,  0)      0.0050 (165, 90)
rep2_PRI         0.0060 (343,  0)      0.0056 ( 73,  0)      0.0051 (164, 90)
rod_mark         0.0047 (  0, 90)      0.0000 ( 90,  0)      0.0000 (  0,  0)

Wed Mar 6 14:52:44 2013
```

6.5 Appendix 5 : sinex file (contribution to ITRF)

```
%=SNX 1.00 IGN 13:065:00000 IGN 12:164:00000 12:164:00000 C 00009
*-------------------------------------------------------------------------------
+FILE/COMMENT
* File created by geotosnx software (Z.Altamimi)
* Original input file: Tristan_Loc.cov
* Matrix Scalling Factor used:         1.0000000000
-FILE/COMMENT
*-------------------------------------------------------------------------------
+SITE/ID
*CODE PT __DOMES__ T _STATION DESCRIPTION__ APPROX_LON_ APPROX_LAT_ _APP_H_
 TRIB  A 30604S002   30604S002              347 41 15.0 -37 03 55.0    46.4
 GNSS  A                                    347 41 14.9 -37 03 54.9    48.7
 TRJB  A 30604S003   30604S003              347 41 15.3 -37 03 54.4    47.0
-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   TRIB  A    1 12:164:00000 m    2 0.497846213400000E+07 0.13787E-02
     2 STAY   TRIB  A    1 12:164:00000 m    2 -.108661696500000E+07 0.13787E-02
     3 STAZ   TRIB  A    1 12:164:00000 m    2 -.382320449000000E+07 0.13787E-02
     4 STAX   GNSS  A    1 12:164:00000 m    2 0.497846375690000E+07 0.18610E-02
     5 STAY   GNSS  A    1 12:164:00000 m    2 -.108662059010000E+07 0.19906E-02
     6 STAZ   GNSS  A    1 12:164:00000 m    2 -.382320503620000E+07 0.19854E-02
     7 STAX   TRJB  A    1 12:164:00000 m    2 0.497847479870000E+07 0.22546E-02
     8 STAY   TRJB  A    1 12:164:00000 m    2 -.108661206320000E+07 0.24304E-02
     9 STAZ   TRJB  A    1 12:164:00000 m    2 -.382319034140000E+07 0.23876E-02
-SOLUTION/ESTIMATE
*-------------------------------------------------------------------------------
+SOLUTION/MATRIX_ESTIMATE L COVA
*PARA1 PARA2 ____PARA2+0__________ ____PARA2+1__________ ____PARA2+2__________
     1     1 0.190077711488123E-05
     2     1 0.712549297451597E-16 0.190077711533955E-05
     3     1 -.351285948585229E-15 0.943326161487318E-16 0.190077711468152E-05
     4     1 0.190077705685698E-05 0.457243411198560E-12 0.273046957712301E-13
     4     4 0.346324869167988E-05
     5     1 -.473127124979677E-12 0.190077713093398E-05 -.622191734574252E-12
     5     4 -.555295453631999E-07 0.396232979101131E-05
     6     1 0.876670254360886E-13 0.602106331317943E-12 0.190077702685360E-05
     6     4 0.841896018093253E-06 -.735159286696118E-07 0.394192218828542E-05
     7     1 0.190077686817579E-05 0.909376644047848E-12 -.754414552475998E-14
     7     4 0.321597018927553E-05 -.452135162023782E-07 0.763204533264633E-06
     7     7 0.508327597367103E-05
     8     1 -.110365763529830E-11 0.190077708625686E-05 -.146107329601786E-11
     8     4 -.356556781631252E-07 0.386831148014168E-05 -.472047811186903E-07
     8     7 -.298436886756696E-07 0.590704387831374E-05
     9     1 -.614678572927249E-13 0.120654869920232E-11 0.190077680165505E-05
     9     4 0.763204537710447E-06 -.598584723456660E-07 0.364990238659791E-05
     9     7 0.108572268781060E-05 -.395102527253413E-07 0.570058110939192E-05
-SOLUTION/MATRIX_ESTIMATE L COVA
%ENDSNX
```

6.6 Appendix 6 : output files (contribution to SONEL/GLOSS)

IOB file :

```
*GNSS STATION
*GNSS_ARP : ANTENNA AXIS AT ARP
*DORIS
*TRIB         : (DOMES 30604S002) = DORIS antenna ref. pt. (Starec type)
*TRJB         : (DOMES 30604S003) = DORIS antenna ref. pt. (Starec type)
*******LEVELLING POINTS DESCRIPTIONS*********
*rod_mark     : stainless steel rod on concrete bloc
*BM2          : Tide Gauge mark on pier
*Ball_mark    : Ball_mark (approximately under DORIS TRIA) setup by POL ?
*DORIS_mark   : (DOMES 30604M001) = DORIS marker on top of a concrete pillar
*GNSS_BCR     : GNSS_Bottom_of_Choke_Ring (level is 3,5 cm above GNSS_ARP)
*DORIS_mark_2 : (DOMES 30604M002) = DORIS marker on a concrete block
*XXXXplate    : top of plate support of DORIS antenna

*********************************************************************************************
*2012-06-11 Campaign   LEICA NA3003 & 3 m invar bar code levelling rod    Spirit Levelling *
*********************************************************************************************
 OHDF     rod_mark     BM2                              -20.35183    0.00024
 OHDF     BM2          rod_mark                          20.35115    0.00024
 OHDF     rod_mark     ball_mark                         -0.28598    0.00010
 OHDF     ball_mark    DORIS_mark                         1.37032    0.00010
 OHDF     DORIS_mark   ball_mark                         -1.37027    0.00010
 OHDF     ball_mark    rod_mark                           0.28593    0.00010
 OHDF     rod_mark     GNSS_BCR                           3.82149    0.00010
 OHDF     GNSS_BCR     rod_mark                          -3.82225    0.00010
 OHDF     rod_mark     DORIS_mark_2                      -1.32047    0.00017
 OHDF     DORIS_mark_2 rod_mark                           1.32066    0.00017
*value issued from two-meter tape measurement
 OHDF     DORIS_mark   TRIBplate                         0.10000    0.00050
 OHDF     DORIS_mark_2 TRJBplate                         3.01700    0.00100
*manufacturer value
 OHDF     TRIBplate    TRIB                              0.39100    0.00100
 OHDF     TRJBplate    TRJB                              0.39100    0.00100
*manufacturer value
 OHDF     GNSS_BCR     GNSS_ARP                         -0.03500    0.00010
```

GeoLab_1D file :

Heights hereafter are deduced from **TRIB height constrained at 0.1 mm issued from DPOD2008 (**which is the DORIS terrestrial reference frame for precise orbit determination derived from ITRF2008 and DORIS analysis).

```
* Extracted coordinates follow: (extracted on Fri Mar 15 18:16:59 2013)
* Source (GeoLab adjustment): Tristan_LocalTie
* Variance factor of adjustment = 1.900777
* Variance factor used in computing covariance matrix = 1.900777
* Number of degrees of freedom of adjustment = 41
* Number of stations in adjusted network = 21
* Number of stations extracted = 8
*
 EHGT     TRIB                                          46.4404     0.0001 m
 EHGT     GNSS_ARP                                      48.6517     0.0010 m
 EHGT     DORIS_mark                                    45.9491     0.0010 m
 EHGT     TRJB                                          46.9520     0.0015 m
 EHGT     DORIS_mark_2                                  43.5442     0.0010 m
 EHGT     rod_mark                                      44.8648     0.0010 m
 EHGT     BM2                                           24.5133     0.0010 m
 EHGT     ball_mark                                     44.5788     0.0010 m
*
* End of extracted coordinates
```