SERVICE
DE GEODESIE
ET NIVELLEMENT

Kévin Eyermann

Wuhan - Jiufeng (China) local tie survey

October 2012

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DIFFUSION LIMITEE

Mots-clé

Rattachement; ITRF; DORIS; GNSS; marégraphe; REGINA; China

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). Cette combinaison utilise les résultats de rattachement sur des sites co-localisés.

Matériel

Système d'exploitation	**Logiciel**
Ubuntu 13.10 Saucy Salamander	LibreOffice Writer 4.1.2.3

Validation

	Fonction	**Nom**	**Visa**
Commanditaire	Chef d'unité RSI	Bruno Garayt	
Rédacteur principal	Opérateur	Kévin Eyermann	
Lecteur	Technicien d'études	Charles Velut	
Lecteur	Responsable SIRS DORIS	Jérôme Saunier	
Approbateur	Chef de service	Alain Harmel	
Vérificateur	Responsable qualité	Thierry Person	

Diffusion

Organisme / Service	Fonction / Nom	Numérique	Papier
IGN / DPR	Directeur de la production des référentiels / Philippe Gerbe	oui	-
IGN / DPR	DPR adjoint / Didier Moisset	oui	-
IGN / DPC / SP / CKP	Chargé MO géodésie / François Becirspahic	oui	-
IGN / DRE / CDOS	Chef du CDoS / Anne Berry	oui	-
IGN / DRE / SRSIG / LAREG	Chef de laboratoire / Olivier Jamet	oui	-
IGN / DRE / DE / 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	oui	-
IGN / DPR / SGN / PMM	Jean-Claude Poyard	oui	-
IGN / DPR / SGN / PMM	Jérôme Saunier	oui	-
IGN / DPR / SGN / PMM	Kévin Eyermann	oui	1
IGN / DPR / SGN / PMM	Charles Velut	oui	1
CNES / DCT / ME / NC	Alain Brissaud	oui	-
IGN / DPR / SGN / PMM	Archives DORIS	oui	1
IGN / DPR / SGN / PMM	Site web ITRF	Oui	-

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1. INTRODUCTION

The International Terrestrial Reference Frame is the result of a combination of different terrestrial reference frames provided by the four space geodetic techniques (i.e. 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 observing and where tie vectors between their reference points have been surveyed in three dimensions.
The new REGINA GNSS station was installed during the campaign. It is dedicated to the GNSS real time Network for IGS and Navigation (REGINA - Réseau GNSS pour l'IGS et la NAvigation) project.

The local ties survey accuracy as stated by GGOS should reach 1 mm.

As soon as a DORIS or REGINA site is co-located, a local tie is carried out by IGN with the triple purpose :

- Assign coordinates to the reference point of new instruments ;
- Provide tie vectors between instruments reference points (i.e. DORIS, GNSS, tide gauge) ;
- Provide a local tie SINEX file.

Within th framework of the REGINA station installation and the DORIS station renovation at Jiufeng, the local tie survey has been carried out from the 10th to the 12th of October 2012, by Kevin Eyermann and JC Poyard, IGN.

2. ACKNOWLEDGEMENTS

On behalf of CNES and IGN, I want to acknowledge the Institute of Geodesy and Geophysics (IGG) and particularly Zheng Shaohuai for their involvement for many years in the DORIS project and now in the REGINA project. My thanks also go to all those I met at Jiufeng and who helped me in various works and steps to be taken on the site.

3. HISTORY

December 2003 :

The Chinese DORIS station was re-located at Jiufeng just before the first ITRF colocation survey operated by IGN there in order to tie the SLR and the GPS (WHJF, EGNOS station) stations and the new DORIS station JIUB.

October 2012 :

Changing of the DORIS antenna support. Installation of the new GNSS REGINA station (JFNG) and new local tie survey between JIVB, WHJF, WHO1 (a new local GNSS station) and JFNG.

4. CO-LOCATED SITE DESCRIPTION

4.1. SITE DESCRIPTION

Jiufeng site is a small hill housing the Jiufeng Geodynamic Observatory. It is located by 30° N & 115° E in the middle-east continental China, about 10km from the center of Wuhan, the capital of the Hubei province with about 10 million residents.

From a geodetic point of view, this site is equipped with various scientific instruments :

- 3 GNSS stations (The JAVAD station, JFNG the new REGINA station and WHO1)
- A DORIS station
- A SLR telescope (which has not been included in that operation)

4.2. CO-LOCATED POINTS DESCRIPTION

Acronym	DOMES number	Antenna type / Support	Period
JIUB	21602S005	Starec 52291 antenna type *(S/N : 100)* / Concrete pillar	From Dec. 2003 to Oct. 2012
JIVB	21602S006	Starec 52291 type *(S/N : 165)* / Stainless Steel structure 40cm height on concrete pillar	From Oct. 2012 till now
DORIS mark	21602M005	Domed brass screw at the top of the concrete pillar	From Dec. 2003 till now
JFNG	21602M006	TRIMBLE TRM59800.00 / Concrete pillar	From Oct. 2012 till now
WHFJ	21602M003	JPSREGANT_DD_E / Roof of the local	From at least 2003 till now
WHO1	-	TRIMBLE TRM59800.00 / Concrete pillar	Till now

4.2.1. JFNG - REGINA GNSS station

The antenna is set up on a forced centering metallic support fixed on top of a concrete pillar. Until now, this support was the EGNOS station antenna support which had been decommissioned. The reference point is defined as the top and axis of the stainless steal support which exactly match the antenna bottom of preamplifier (the antenna height is set to 0.000 in the three components)

A benchmark exists for leveling at the bottom of the pillar.

Acronym : **JFNG**	DOMES number : **21602M006**
	
General view	Close-up view (reference point)
Description : REGINA antenna monument & reference point. Antenna height is **0,000 m**.	

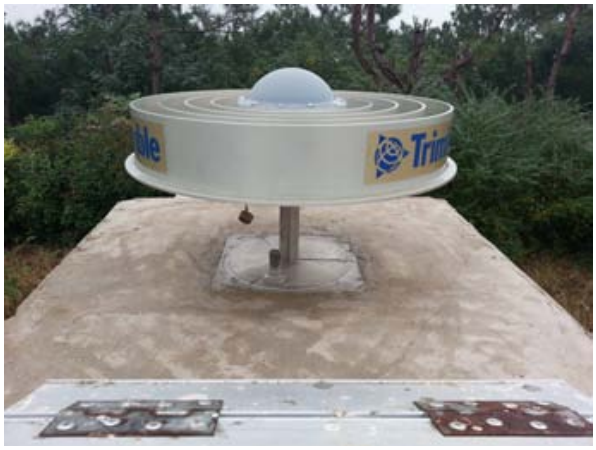
4.2.2. WHFJ - GNSS station

This GNSS station is a permanent station, recording daily observations. The data are recorded on a PC, converted into RINEX and exported. The antenna is a JPSREGANT_DD_E type. It's set up on an adapter on a pier. The reference point is at the top and center of the adapter which exactly match the antenna bottom of preamplifier (the antenna height is set to 0.000 in the three components).

Acronym : **WHFJ**	DOMES number : **21602M003**
	
General view	Close-up view (reference point)
Description : JAVAD antenna monument & reference point. Antenna height is **0,000 m**.	

4.2.3. WHO1 – GNSS station

This is a new GNSS station recently installed by the Institute of Geodesy and Geophysics. The antenna is set up on a new concrete pillar, close to the JFNG REGINA antenna. The receiver is a Trimble NET-R8 and the Choke Ring antenna is a TRM59800.00 type. The reference point is defined as the top and axis of the stainless steal support which exactly match the antenna bottom of preamplifier (the antenna height is set to 0.000 in the three components).

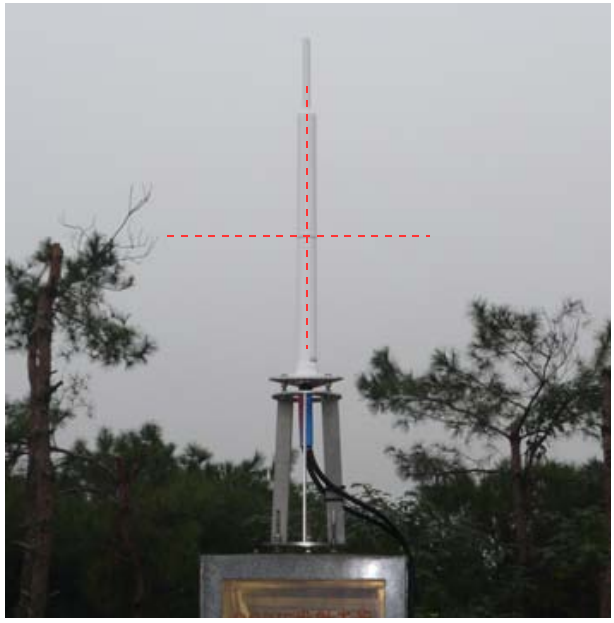
Acronym : **WHO1**	DOMES number : **unknown**
	
General view	Close-up view (reference point)
Description : GNSS antenna monument & reference point. Antenna height is **0,000 m**.	

4.2.4. DORIS station

The DORIS station was initially set up on December 2003. The DORIS antenna was installed on 1.5 meter high, 50 cm sided square concrete pillar and bear the acronym “JIUB”. Before the local survey, the antenna

has been changed and moved to a stainless steel structure 40 cm high on top of the same pillar. The new DORIS reference point is JIVB.

Acronym **: JIUB**	DOMES number : **21602S005**
 General view	 Close-up view (reference point)
Description : DORIS antenna monument & reference point (old point).	

Acronym : **JIVB**	DOMES number : **21602S006**
 General view	 Close-up view (reference point)
Description : DORIS antenna monument & reference point (new point).	

The above DORIS reference points are tied with the hereafter mark.

Acronym : **DORIS mark**	DOMES number : **21602M005**
 Close-up view 1 (reference point)	 Close-up view 2 (reference point)
Description : DORIS mark	

5. LOCAL TIE DESCRIPTION

5.1. ORGANIZATION

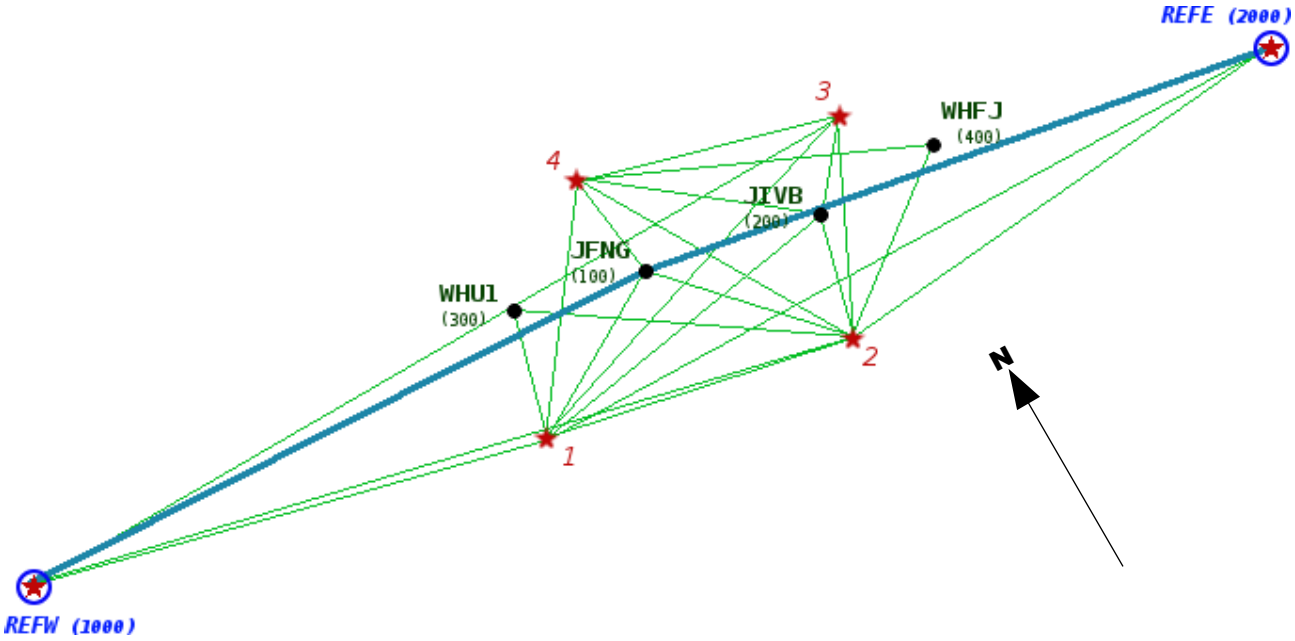
All the topometric survey instruments and equipments were generously provided by the Institute of Geodesy and Geophysics for the purpose of the survey.

5.2. INSTRUMENTS CARACTERISTICS

Equipment	Trademark, Serial ref. n°	Specifications, accuracy
Total station	Leica TCA 2003 SN: *unknown*	EDM st. dev. 1mm + 1 pmm Angular st. dev. 0.15 mgon *(Manufacturer info.)*
3 Prisms	*unknown*	Dist. Corr. 3.6 mm (validated onsite)
Meteorological station	Kestrel 4500NV serial n°672710	Temp. st. dev. 0.5°C Pressure st. dev. 1 hPa
GNSS unit	Receiver : NET R8 Ant. : TRIMBLE TRM29659.00	
5 Tripods	*unknown*	Wood tripod
Level	Leica NA2	
Rod	Telescopic ~4m rod	

5.3. 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 schema (not to scale).



There is also a benchmark in front of the JFNG (REGINA) station, which has been directly leveled with JFNG reference point.

5.4. SURVEY METHOD

Four stations (numbered 1, 2, 3 and 4) in the immediate vicinity of the GNSS and DORIS reference points were 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.

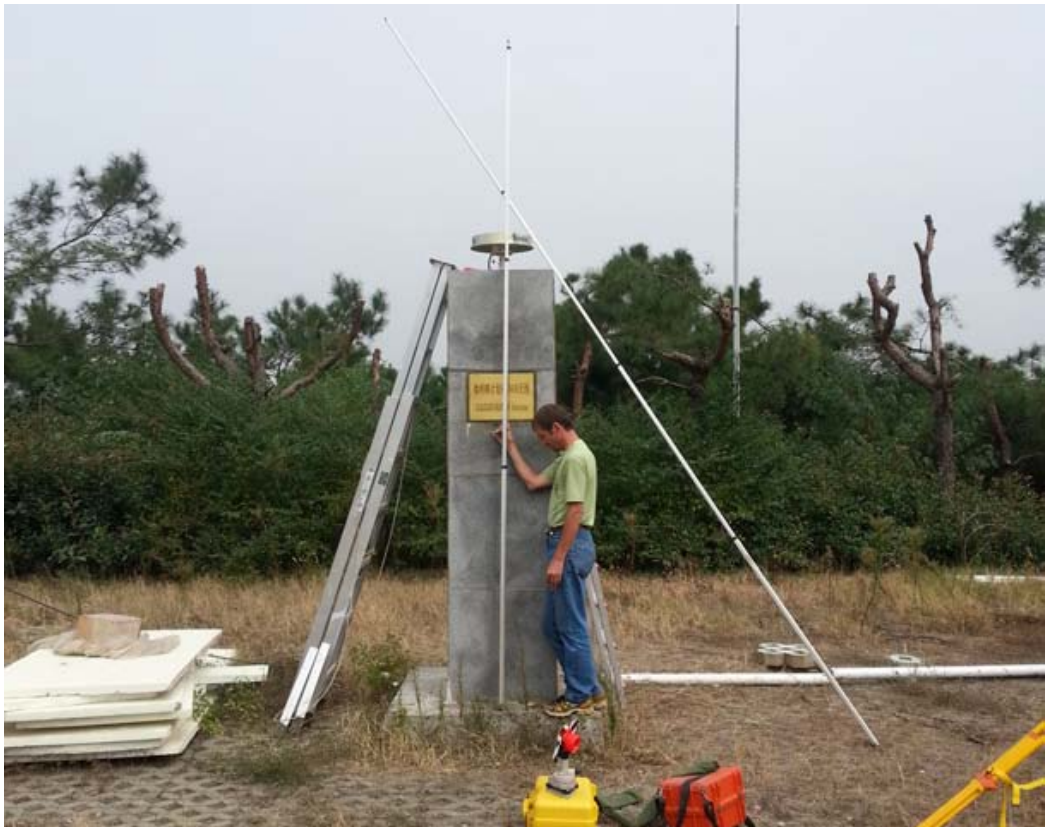
The prism constant was determined on-site (3.6mm) and used for the survey.

5.4.1. Centering equations for DORIS

Using a theodolite the eccentricity of the antenna reference points with respect to the corresponding marker was measured . The eccentricity combined with the height above the marker form the centering equations. The height above the marker comes from manufacturer value or from a measurement with a two-meter rule.

5.4.2. Leveling

Direct leveling operations were carried out on the benchmark located at the base of the REGINA monument.



Combined with indirect leveling for validation, it shows a height difference of 2,612 m between the bench-mark and the reference mark of the JFNG station (REGINA).

5.4.3. GNSS observations

GNSS observations are carried out in order to determine the orientation of the survey figure. Orientations are ensured by the baselines between the reference points “REFW”, “REFE”, the JFNG Regina station.

6. COMPUTATION

6.1. GNSS network

Back at the office, GNSS baselines were processed with Leica Geo Office V 6.0 software (see report file in appendix 3) using the original set of "absolute" GNSS antenna calibrations (igs08.atx).
The coordinates of the JFNG station (REGINA) introduced into the calculation LGO comes from data processed with Bernese v5.0 software.

6.2. 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 4) comes from :
Tacheometric observations : horizontal and zenithal angles, distances
Levelling : height differences between the points
Centring equations: relative positions between the points
Bearing from the processing of GNSS data

The a priori standard deviations used for the different observations are :
0.8 mgon for horizontal angles (1.2 mgon for station 3)
1.5 mgon for vertical angles
1.5 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 the survey.

7. RESULTS

7.1. 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
DORIS station and markers		
JIVB Antenna Reference Point	**21602S006**	**JIVB**
JIUB Antenna Reference Point	**21602S005**	**JIUB**
DORIS pillar mark	21602M005	DORIS
DORIS 2GHz reference	-	*DORIS2GHz*
DORIS mark with small prism stick	-	*DORIS-UP*
DORIS new support – Ant. ARP	-	*DORIS-GPS*
GNSS Stations		
JFNG (REGINA) – Ant. ARP	**21602M006**	**JFNG**
WHFJ (JAVAD) – Ant. ARP	21602M003	JAVAD
WHO1 (admin. by the IGG) – Ant. ARP	-	WHO1

7.2. Adjusted coordinates and confidence regions

Epoque : 2012.285

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0              WGS 84      UNITS: m,GRAD Page 0004
================================================================================
Adjusted XYZ Coordinates:
                             X-COORDINATE       Y-COORDINATE       Z-COORDINATE
 CODE FFF STATION                 STD DEV            STD DEV            STD DEV
 ---- --- ------------ ------------------ ------------------ ------------------
 XYZ      DORIS (mark)      -2279839.5422       5004701.1770       3219775.6549 m       0
                                   0.0011             0.0011             0.0011
 XYZ      DORIS2GHz         -2279840.0181       5004702.2227       3219776.3324 m       0
                                   0.0011             0.0010             0.0011
 XYZ      JAVAD             -2279850.9786       5004696.6760       3219777.6949 m       0
                                   0.0017             0.0014             0.0012
 XYZ      JFNG              -2279828.8524       5004706.5393       3219777.4623 m       0
                                   0.0010             0.0010             0.0010
 XYZ      JIUB              -2279839.7137       5004701.5585       3219775.9024 m       0
                                   0.0015             0.0015             0.0015
 XYZ      JIVB              -2279839.8450       5004701.8418       3219776.0855 m       0
                                   0.0015             0.0015             0.0015
 XYZ      REFE              -2279921.0615       5004671.9738       3219760.1036 m       0
                                   0.0299             0.0103             0.0052
 XYZ      REFW              -2279724.9940       5004754.9703       3219785.5909 m       0
                                   0.0013             0.0007             0.0009
 XYZ      WHO1              -2279824.3020       5004708.1129       3219778.1224 m       0
                                   0.0010             0.0010             0.0010
```

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      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
------------ --------------------- --- ------------------- --------------------
Benchmark                   0.0000   0              0.0000               0.0024
DORIS (mark)                0.0027  48              0.0026               0.0020
DORIS2GHz                   0.0027  54              0.0026               0.0020
JAVAD                       0.0048  71              0.0026               0.0021
JFNG                        0.0025  90              0.0025               0.0020
JIUB                        0.0036  48              0.0036               0.0028
JIVB                        0.0036  48              0.0036               0.0028
WHO1                        0.0026  97              0.0026               0.0020
```

7.3. Vector comparison

DORIS mark → JIUB			
Vector year	X (m)	Y (m)	Z (m)
2003	-0.1736	0.3810	0.2468
2012	-0.1715	0.3815	0.2475
Differences	0.0021	0.0005	0.0007

DORIS mark → WHJF *(JAVAD)*			
Vector year	X (m)	Y (m)	Z (m)
2003	-11.4360	-4.5004	2.0376
2012	-11.4364	-4.5010	2.0400
Differences	-0.0004	-0.0006	0.0024

DORIS mark → EGNOS / JFNG *(REGINA)*			
Vector year	E (dd)	N (dd)	H (m)
2003 (**EGNOS**)	-0.00012449	0.00001196	1.4629
2012 (**REGINA**)	-0.00012451	0.00001199	1.3040
Differences	-0.00000001	0.00000003	-0.1589*

* *Supposed size of the support extension for EGNOS.*

8. APPENDICES

Appendix 1 : "JIVB" DORIS station site log (extract)

Note : only the most relevant points 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

```
2. DORIS antenna and reference point information

2.2
    Four character ID         : JIVB
    Antenna model             : Starec 52291 type
    Antenna serial number     : 165
    IERS DOMES number         : 21602S006
    CNES/IGN number           : 216022
    DORIS SSALTO number       : 335
    Date installed (dd/mm/yy): 12/10/2012
    Date removed (dd/mm/yy)   :
    Antenna support type      : Stainless steel structure 40 cm high
    Installed on              : concrete pillar 1.5 m high
    Height above ground mark  : 0.848 m
    Ground mark type          : Domed brass screw at the top of the pillar
    Ground mark DOMES number  : 21602M005
    Notes                     :

3. DORIS beacons information

3.4
    Beacon serial number         : 2819026
    Beacon model                 : 3.0
    USO serial number            : 3.310
    4 Char. ID of the REF point  : JIVB
    Date installed (dd/mm/yy)    : 28/05/2013
    Date removed (dd/mm/yy)      :

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

    Solution          : ITRF2008
    Epoch             : 2005.0

    X = -2279839.599 m    Y = 5004701.910 m    Z = 3219776.153 m
    Sig X = 0.003 m    Sig Y = 0.003 m    Sig Z = 0.003 m

    VX = -0.0298 m/y    VY = -0.0115 m/y    VZ = -0.0078 m/y
    Sig VX = 0.0013 m/y    Sig VY = 0.0011 m/y    Sig VZ = 0.0009 m/y

5. IERS colocation information

5.1
    Instrument type       : GNSS
    Status                : Permanent
    DOMES number of the
    instrument ref. point : 21602M003
    Notes                 : Permanent GPS station (WHJF)
```

```
5.2
    Instrument type       : GNSS
    Status                : Permanent
    DOMES number of the
    instrument ref. point : 21602M004
    Notes                 : Permanent GNSS station REGINA (JFNG)

5.3
    Instrument type       : SLR
    Status                : Permanent
    DOMES number of the
    instrument ref. point : 21602S004
    Notes                 : CDP 7231

7. Local site ties

7.1
    Point description      : SLR station axes intersection (CDP 7231)
    DOMES number           : 21602S004
    Differential components from the current DORIS ref. point (JIVB)
    to the above point (in the ITRS) :
    dX (m)                 : 125.174
    dY (m)                 : 65.516
    dZ (m)                 : 17.795
    Accuracy (m)           : 0.001
    Date measured          : 01/12/2003
    Additional information : Survey by IGN-F 2003

7.2
    Point description      : DORIS Starec antenna reference point (JIUB)
    DOMES number           : 21602S005
    Differential components from the current DORIS ref. point (JIVB)
    to the above point (in the ITRS) :
    dX (m)                 : 0.131
    dY (m)                 : -0.283
    dZ (m)                 : -0.183
    Accuracy (m)           : 0.001
    Date measured          : 11/10/2012
    Additional information : Survey by IGN-F 2012

7.3
    Point description      : Mark under the DORIS antenna
    DOMES number           : 21602M005
    Differential components from the current DORIS ref. point (JIVB)
    to the above point (in the ITRS) :
    dX (m)                 : 0.303
    dY (m)                 : -0.665
    dZ (m)                 : -0.431
    Accuracy (m)           : 0.001
    Date measured          : 11/10/2012
    Additional information : Survey by IGN-F 2012

7.4
    Point description      : Permanent GNSS station REGINA (JFNG)
    DOMES number           : 21602M004
    Differential components from the current DORIS ref. point (JIVB)
    to the above point (in the ITRS) :
    dX (m)                 : 10.993
    dY (m)                 : 4.701
```

```
    dZ (m)                 : 1.375
    Accuracy (m)           : 0.002
    Date measured          : 11/10/2012
    Additional information : Survey by IGN-F 2012

7.5
    Point description      : Permanent GPS station (WHJF)
    DOMES number           : 21602M003
    Differential components from the current DORIS ref. point (JIVB)
    to the above point (in the ITRS) :
    dX (m)                 : -11.131
    dY (m)                 : -5.164
    dZ (m)                 : 1.607
    Accuracy (m)           : 0.001
    Date measured          : 11/10/2012
    Additional information : Survey by IGN-F 2012

8. Meteorological Instrumentation

8.2 Pressure sensor
    Model        : PTU200 class B
    Manufacturer : VAISALA
    Accuracy     : +/- 0.25 hPa
    Height       : 1.2 m above the current DORIS ref. point (JIVB)
    Notes        : long term stability = +/- 0.1 hPa/year
```

Appendix 2 : "JFNG" GNSS station site log (extract)

```
     JFNG Site Information Form (site log)
     International GNSS Service
     See Instructions at:
       ftp://igscb.jpl.nasa.gov/pub/station/general/sitelog_instr.txt


0.   Form

     Prepared by (full name)  : Jean-Paul CARDALIAGUET, Kevin EYERMANN
     Date Prepared            : 2012-10-29
     Report Type              : NEW
     If Update:
      Previous Site Log       : (ssss_ccyymmdd.log)
      Modified/Added Sections : (n.n,n.n,...)


1.   Site Identification of the GNSS Monument

     Site Name                : JIUFENG
     Four Character ID        : JFNG
     Monument Inscription     : None
     IERS DOMES Number        : 21602M006
     CDP Number               : (A4)
     Monument Description     : (PILLAR/BRASS PLATE/STEEL MAST/etc)
       Height of the Monument : 2.5 m
       Monument Foundation    : Concrete pillar
       Foundation Depth       : 2 m
     Marker Description       : (CHISELLED CROSS/DIVOT/BRASS NAIL/etc)
     Date Installed           : 2012-10-10T10:00Z
     Geologic Characteristic  : BEDROCK
       Bedrock Type           : METAMORPHIC
       Bedrock Condition      : WEATHERED
       Fracture Spacing       : 1-10 cm
       Fault zones nearby     : NO
         Distance/activity    : (multiple lines)
     Additional Information   : (multiple lines)


2.   Site Location Information

     City or Town             : Jiufeng
     State or Province        : Hubei
     Country                  : China
     Tectonic Plate           : Eurasia
     Approximate Position (ITRF)
       X coordinate (m)       : -2279828.8529
       Y coordinate (m)       : 5004706.5404
       Z coordinate (m)       : 3219777.4631
       Latitude (N is +)      : +303056.03
       Longitude (E is +)     : +1142927.66
       Elevation (m,ellips.)  :    71.3
     Additional Information   : (multiple lines)


3.   GNSS Receiver Information

3.1  Receiver Type            : TRIMBLE NETR9
```

```
     Satellite System         : GPS+GLO+GAL+SBAS
     Serial Number            : 85816
     Firmware Version         : 4.62
     Elevation Cutoff Setting : 3 deg
     Date Installed           : 2012-10-10T00:00Z
     Date Removed             : CCYY-MM-DDThh:mmZ
     Temperature Stabiliz.    : 25 +/- 5
     Additional Information   : (multiple lines)

3.x  Receiver Type            : (A20, from rcvr_ant.tab; see instructions)
     Satellite System         : (GPS+GLO+GAL+CMP+QZSS+SBAS)
     Serial Number            : (A20, but note the first A5 is used in SINEX)
     Firmware Version         : (A11)
     Elevation Cutoff Setting : (deg)
     Date Installed           : (CCYY-MM-DDThh:mmZ)
     Date Removed             : (CCYY-MM-DDThh:mmZ)
     Temperature Stabiliz.    : (none or tolerance in degrees C)
     Additional Information   : (multiple lines)


4.   GNSS Antenna Information

4.1  Antenna Type             : TRM59800.00     NONE
     Serial Number            : 54160
     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 deg
     Antenna Radome Type      : NONE
     Radome Serial Number     :
     Antenna Cable Type       : TRIMBLE
     Antenna Cable Length     : 50 m
     Date Installed           : 2012-10-10T00:00Z
     Date Removed             : CCYY-MM-DDThh:mmZ
     Additional Information   : (multiple lines)

4.x  Antenna Type             : (A20, from rcvr_ant.tab; see instructions)
     Serial Number            : (A*, but note the first A5 is used in SINEX)
     Antenna Reference Point  : (BPA/BCR/XXX from "antenna.gra"; see instr.)
     Marker->ARP Up Ecc. (m)  : (F8.4)
     Marker->ARP North Ecc(m) : (F8.4)
     Marker->ARP East Ecc(m)  : (F8.4)
     Alignment from True N    : (deg; + is clockwise/east)
     Antenna Radome Type      : (A4 from rcvr_ant.tab; see instructions)
     Radome Serial Number     :
     Antenna Cable Type       : (vendor & type number)
     Antenna Cable Length     : (m)
     Date Installed           : (CCYY-MM-DDThh:mmZ)
     Date Removed             : (CCYY-MM-DDThh:mmZ)
     Additional Information   : (multiple lines)


5.   Surveyed Local Ties

5.1  Tied Marker Name         : DORIS antenna ref. pt. (JIUB)
     Tied Marker Usage        : (SLR/VLBI/LOCAL CONTROL/FOOTPRINT/etc)
     Tied Marker CDP Number   : (A4)
     Tied Marker DOMES Number : 21602S005
     Differential Components from GNSS Marker to the tied monument (ITRS)
```

```
       dx (m)                 : (m)
       dy (m)                 : (m)
       dz (m)                 : (m)
     Accuracy (mm)            : (mm)
     Survey method            : TRIANGULATION
     Date Measured            : 2012-10-12
     Additional Information   : high geodetic surveying

5.2  Tied Marker Name         : Marker DORIS
     Tied Marker Usage        : (SLR/VLBI/LOCAL CONTROL/FOOTPRINT/etc)
     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            : TRIANGULATION
     Date Measured            : 2012-10-12
     Additional Information   : high geodetic surveying

5.x  Tied Marker Name         :
     Tied Marker Usage        : (SLR/VLBI/LOCAL CONTROL/FOOTPRINT/etc)
     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   : (multiple lines)


6.   Frequency Standard

6.1  Standard Type            : INTERNAL
       Input Frequency        : (if external)
       Effective Dates        : 2012-10-10/CCYY-MM-DD
       Notes                  : (multiple lines)

6.x  Standard Type            : (INTERNAL or EXTERNAL H-MASER/CESIUM/etc)
       Input Frequency        : (if external)
       Effective Dates        : (CCYY-MM-DD/CCYY-MM-DD)
       Notes                  : (multiple lines)


7.   Collocation Information

7.1  Instrumentation Type     : DORIS
       Status                 : PERMANENT
       Effective Dates        : 2003-12-10/CCYY-MM-DD
       Notes                  : (multiple lines)

7.x  Instrumentation Type     : (GPS/GLONASS/DORIS/PRARE/SLR/VLBI/TIME/etc)
       Status                 : (PERMANENT/MOBILE)
       Effective Dates        : (CCYY-MM-DD/CCYY-MM-DD)
       Notes                  : (multiple lines)
```

```
8.   Meteorological Instrumentation

8.1.x  Humidity Sensor Model  :
       Manufacturer           :
       Serial Number          :
       Data Sampling Interval : (sec)
       Accuracy (% rel h)     : (% rel h)
       Aspiration             : (UNASPIRATED/NATURAL/FAN/etc)
       Height Diff to Ant     : (m)
       Calibration date       : (CCYY-MM-DD)
       Effective Dates        : (CCYY-MM-DD/CCYY-MM-DD)
       Notes                  : (multiple lines)

8.2.x  Pressure Sensor Model  :
       Manufacturer           :
       Serial Number          :
       Data Sampling Interval : (sec)
       Accuracy               : (hPa)
       Height Diff to Ant     : (m)
       Calibration date       : (CCYY-MM-DD)
       Effective Dates        : (CCYY-MM-DD/CCYY-MM-DD)
       Notes                  : (multiple lines)

8.3.x  Temp. Sensor Model     :
       Manufacturer           :
       Serial Number          :
       Data Sampling Interval : (sec)
       Accuracy               : (deg C)
       Aspiration             : (UNASPIRATED/NATURAL/FAN/etc)
       Height Diff to Ant     : (m)
       Calibration date       : (CCYY-MM-DD)
       Effective Dates        : (CCYY-MM-DD/CCYY-MM-DD)
       Notes                  : (multiple lines)

8.4.x  Water Vapor Radiometer :
       Manufacturer           :
       Serial Number          :
       Distance to Antenna    : (m)
       Height Diff to Ant     : (m)
       Calibration date       : (CCYY-MM-DD)
       Effective Dates        : (CCYY-MM-DD/CCYY-MM-DD)
       Notes                  : (multiple lines)

8.5.x  Other Instrumentation  : (multiple lines)


9.   Local Ongoing Conditions Possibly Affecting Computed Position

9.1.x  Radio Interferences    : (TV/CELL PHONE ANTENNA/RADAR/etc)
       Observed Degradations  : (SN RATIO/DATA GAPS/etc)
       Effective Dates        : (CCYY-MM-DD/CCYY-MM-DD)
       Additional Information : (multiple lines)

9.2.x  Multipath Sources      : (METAL ROOF/DOME/VLBI ANTENNA/etc)
       Effective Dates        : (CCYY-MM-DD/CCYY-MM-DD)
       Additional Information : (multiple lines)

9.3.x  Signal Obstructions    : (TREES/BUILDLINGS/etc)
       Effective Dates        : (CCYY-MM-DD/CCYY-MM-DD)
```

```
      Additional Information : (multiple lines)


10.  Local Episodic Effects Possibly Affecting Data Quality

10.x  Date                   : (CCYY-MM-DD/CCYY-MM-DD)
      Event                  : (TREE CLEARING/CONSTRUCTION/etc)


11.  On-Site, Point of Contact Agency Information

     Agency                 : Institute of Geodesy and Geophysics
     Preferred Abbreviation : IGG
     Mailing Address        : 340 XuDong Road, Wuhan 430077, Hubei, China
     Primary Contact
       Contact Name         : Zheng Shaohuai
       Telephone (primary)  : +86 27 68881390
       Telephone (secondary) :
       Fax                  : +86 27 68881362
       E-mail               : zhengsh1102@sina.com
     Secondary Contact
       Contact Name         :
       Telephone (primary)  :
       Telephone (secondary) :
       Fax                  :
       E-mail               :
     Additional Information : (multiple lines)


12.  Responsible Agency (if different from 11.)

     Agency                 : Centre National d'Etudes Spatiales
     Preferred Abbreviation : CNES
     Mailing Address        : CNES DCT/ME/NC 18, avenue Edouard Belin
                            : 31401 Toulouse cedex 09 - France
     Primary Contact
       Contact Name         : Alain Brissaud
       Telephone (primary)  :
       Telephone (secondary) :
       Fax                  :
       E-mail               : alain.brissaud@cnes.fr
     Secondary Contact
       Contact Name         : Jean Paul Cardaliaguet
       Telephone (primary)  : (33) 5.61.27.31.98
       Telephone (secondary) : (33) 5.61.28.35.22
       Fax                  :
       E-mail               : jean-paul.cardaliaguet@cnes.fr
     Additional Information : generic email - regina.operation@cnes.fr


13.  More Information

     Primary Data Center    : IGNI
     Secondary Data Center  : CDDIS
     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

TRM59800.00

                        -----
                      /       \
                     |         |
  +-------------------------------------------------+     <--  0.1020  TCR
  |                                                 |
  |                                                 |
  |                                                 |
  |                                                 |
+-+-------------------------------------------------+-+   <--  0.0381
+-------------------+-------------+-------------------+   <--  0.0350  BCR
                    |             |
                    |             |
                    +------x------+                       <--  0.0000  BPA=ARP

<--                      0.3810                     -->
```

Appendix 3 : LEICA Geo Office report file

Récapitulatif du Traitement

JFG

Informations sur le Projet

Nom du Projet:	JFG
Date de création:	01/08/2013 10:53:38
Fuseau Horaire:	1h 00
Nom Syst. Coordonnées:	WGS 1984
Logiciel d'application:	LEICA Geo Office 8.1
Date et heure de début:	10/09/2012 09:47:45
Date et heure de fin:	10/15/2012 07:03:15
Points occupés manuellement:	Oui
Noyau de Post-Traitement:	PSI-Pro 3.0
Traité	8

Paramètres de Traitement

Paramètres	Sélectionnés
Angle de Coupure:	15°
Type d'Ephémérides:	Radiodiffusées
Type de solution:	Automatique
Type GNSS:	Automatique
Fréquence:	Automatique
Fixer les ambiguïtés jusqu'à:	80 km
Durée mini pour solution flottante (static	5' 00"
Taux d'enregistrement:	Tout Utiliser
Modèle Troposphérique:	Hopfield
Modèle Ionosphérique:	Automatique
Utiliser modélisation statistique:	Oui
Distance mini.:	8 km
Activité ionosphérique:	Automatique

Ligne de Base - Aperçu

JFNG - DORIS	Référence: JFNG	Mobile: DORIS
Coordonnées:		
Latitude:	30° 30' 56.03529" N	30° 30' 56.03855" N
Longitude:	114° 29' 27.66897" E	114° 29' 28.11728" E
Hteur Ellip.:	71.3236 m	70.4890 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	
JFNG - JAVAD	Référence: JFNG	Mobile: JAVAD
Coordonnées:		
Latitude:	30° 30' 56.03529" N	30° 30' 56.03855" N
Longitude:	114° 29' 27.66897" E	114° 29' 28.57751" E
Hteur Ellip.:	71.3236 m	71.6090 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS / GLONASS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	
JFNG - REFE	Référence: JFNG	Mobile: REFE
Coordonnées:		
JFNG - JAVAD	Référence: JFNG	Mobile: JAVAD
Coordonnées:		
Latitude:	30° 30' 56.03529" N	30° 30' 55.43882" N
Longitude:	114° 29' 27.66897" E	114° 29' 31.34881" E
Hteur Ellip.:	71.3236 m	68.3407 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	
JFNG - WHO1	Référence: JFNG	Mobile: WHO1
Coordonnées:		
Latitude:	30° 30' 56.03529" N	30° 30' 56.06125" N
Longitude:	114° 29' 27.66897" E	114° 29' 27.48924" E
Hteur Ellip.:	71.3236 m	71.2659 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	
JFNG - WHO1	Référence: JFNG	Mobile: WHO1
Coordonnées:		
Latitude:	30° 30' 56.03529" N	30° 30' 56.06127" N
Longitude:	114° 29' 27.66897" E	114° 29' 27.48922" E
Hteur Ellip.:	71.3236 m	71.2658 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	
JFNG - REFW	Référence: JFNG	Mobile: REFW
Coordonnées:		
Latitude:	30° 30' 56.03529" N	30° 30' 56.24586" N
Longitude:	114° 29' 27.66897" E	114° 29' 23.37123" E
Hteur Ellip.:	71.3236 m	76.3284 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	

Latitude:	30° 30' 56.03529" N	30° 30' 56.03856" N
Longitude:	114° 29' 27.66897" E	114° 29' 28.57750" E
Hteur Ellip.:	71.3236 m	71.6086 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS / GLONASS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	
JFNG - JAVAD	Référence: JFNG	Mobile: JAVAD
Coordonnées:		
Latitude:	30° 30' 56.03529" N	30° 30' 56.03854" N
Longitude:	114° 29' 27.66897" E	114° 29' 28.57751" E
Hteur Ellip.:	71.3236 m	71.6088 m
Type de solution:	Phase: toutes fixes	
Type GNSS:	GPS / GLONASS	
Fréquence:	L1/E1 et L2	
Ambiguïté:	Oui	

Appendix 4 : Azimuth

Azimuth were calculated with the NGS "INVERSE" program.
You can download it here: http://www.ngs.noaa.gov/PC_PROD/Inv_Fwd/inverse.exe

JFNG → REFW

Ellipsoid : GRS80 / WGS84 (NAD83)
Equatorial axis, a = 6378137.0000
Polar axis, b = 6356752.3141
Inverse flattening, 1/f = 298.25722210088

First Station : JFNG

LAT = 30 30 56.03529 North
LON = 114 29 27.66897 East

Second Station : REFW

LAT = 30 30 56.24586 North
LON = 114 29 23.37123 East

Forward azimuth FAZ = **273 14 21.1554** From North
Back azimuth BAZ = 93 14 18.9732 From North
Ellipsoidal distance S = 114.7702 m

JFNG → REFE

Ellipsoid : GRS80 / WGS84 (NAD83)
Equatorial axis, a = 6378137.0000
Polar axis, b = 6356752.3141
Inverse flattening, 1/f = 298.25722210088

First Station : JFNG

LAT = 30 30 56.03529 North
LON = 114 29 27.66897 East

Second Station : REFE

LAT = 30 30 55.43882 North
LON = 114 29 31.34881 East

Forward azimuth FAZ = **100 36 13.1127** From North
Back azimuth BAZ = 280 36 14.9812 From North
Ellipsoidal distance S = 99.8170 m

Appendix 5 : Local survey adjustment input file

```
TITL  JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
COMP ADJ
ELIP WGS 84             6378137.000  6356752.3142   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  NO  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

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

PLH  000 DORIS-GPS    n 30 30 55.992196 e114 29 28.117285      70.4891 m  0
PLH  000 JAVAD        n 30 30 56.038551 e114 29 28.577503      71.6088 m  0
PLH  000 REFE         n 30 30 55.438822 e114 29 31.348809      68.3408 m  0
PLH  000 REFW         n 30 30 56.245862 e114 29 23.371228      76.3285 m  0
PLH  000 WHO1         n 30 30 56.061258 e114 29 27.489225      71.2659 m  0

************************APPROXIMATE COORDINATES*************************************

PLH  000 1            n 30 30 55.817870 e114 29 27.383050      70.2190 m  0
PLH  000 11           n 30 30 55.817850 e114 29 27.383000      70.2017 m  0
PLH  000 2            n 30 30 55.815660 e114 29 28.081330      69.9165 m  0
PLH  000 21           n 30 30 55.815640 e114 29 28.081310      69.9077 m  0
PLH  000 3            n 30 30 56.120100 e114 29 28.280200      69.6799 m  0
PLH  000 31           n 30 30 56.120100 e114 29 28.280200      69.6711 m  0
PLH  000 4            n 30 30 56.186250 e114 29 27.610250      70.1225 m  0
PLH  000 41           n 30 30 56.186260 e114 29 27.610300      70.1045 m  0
PLH  000 DORIS        n 30 30 55.992170 e114 29 28.117250      70.0181 m  0
PLH  000 DORIS-UP     n 30 30 55.992170 e114 29 28.117250      70.1578 m  0
PLH  000 DORIS2GHz    n 30 30 55.992150 e114 29 28.117230      71.3519 m  0
```

```
**********************************CENTRING EQUATIONS************************************

AZIM     JFNG         REFE                      111 78    18.2      0.003
AZIM     JFNG         REFW                      303 59    91.2      0.001

3DC
XYZ  000 JFNG              -2279828.8524       5004706.5393       3219777.4623
COV  CT DIAG
ELEM               0.000001               0.000001               0.000001

3DD
PLH  000 JIUB         n 30 30 55.992225 e114 29 28.117201 70.5041 m  0
PLH  000 DORIS        n 30 30 55.992196 e114 29 28.117280 70.0181 m  0
COV  LG DIAG
ELEM               0.000001               0.000001               0.000001

3DD
PLH  000 JIVB         n 30 30 55.992199 e114 29 28.117280 70.8661 m  0
PLH  000 DORIS        n 30 30 55.992196 e114 29 28.117280 70.0181 m  0
COV  LG DIAG
ELEM               0.000001               0.000001               0.000001

3DD
PLH  000 DORIS-UP     n 30 30 55.992196 e114 29 28.117280 70.1578 m  0
PLH  000 DORIS        n 30 30 55.992196 e114 29 28.117280 70.0181 m  0
COV  LG DIAG
ELEM             0.00000004             0.00000004             0.00000009

3DD
PLH  000 DORIS-UP     n 30 30 55.992196 e114 29 28.117280      70.1578 m  0
PLH  000 DORIS        n 30 30 55.992196 e114 29 28.117280      70.0181 m  0
COV  LG DIAG
ELEM             0.00000004             0.00000004               0.00000009

3DD
PLH  000 1            n 30 30 56.000000 e114 29 27.190000       70.118 m  0
PLH  000 11           n 30 30 56.000000 e114 29 27.190000       70.100 m  0
COV  LG DIAG
ELEM               0.000001               0.000001                0.0000004

2DD
PL   00  2            n 30 30 56.020000 e114 29 27.790000
PL   00  21           n 30 30 56.020000 e114 29 27.790000
COV  LG DIAG
ELEM               0.000001               0.000001

2DD
PL   00  3            n 30 30 56.260000 e114 29 28.140000
PL   00  31           n 30 30 56.260000 e114 29 28.140000
COV  LG DIAG
ELEM               0.000001               0.000001

3DD
PLH  000 4            n 30 30 56.340000 e114 29 27.460000       70.018 m  0
PLH  000 41           n 30 30 56.340000 e114 29 27.460000       70.000 m  0
COV  LG DIAG
ELEM               0.000001               0.000001                0.0000004
```

**********SURVEY**********

```
 SIGM AH         8.0
 SIGM A3        12.0
 HIST NEW
 DSET AH
 DIR      1            REFW                      0  0     0.0
 DIR      1            WHO1                    115 18    33.4
 DIR      1            JFNG                    146 31    43.8
 DIR      1            JAVAD                   178 80    94.5
 DIR      1            31                      168 57    12.4
 DIR      1            DORIS2GHz               175 15    67.1
 DIR      1            21                      192 42    89.5
* DIR      1            DORIS-UP                175 15    59.9
 DSET AH
 DIR      2            REFW                      0  0     0.0
 DIR      2            WHO1                     21 75    06.7
 DIR      2            JFNG                     28 42    18.0
 DIR      2            DORIS2GHz               104 40    80.5
 DIR      2            DORIS                   104 41    24.7
* DIR      2            31                      126  8     8.2
 DIR      2            JAVAD                   162 84 44.0
 DIR      2            REFE                    201 74    27.8
 DIR      2            11                      393 53    74.8
 DSET AH
 DIR      1            REFW                      0  0     0.0
 DIR      1            31                      168 57    11.0
 DSET A3
* DIR      3            REFW                      0  0     0.0
 DIR      3            21                      330 89    67.8
 DIR      3            DORIS-UP                351 22 91.4
 DIR      3            DORIS2GHz               351 23     6.0
 DIR      3            11                      374 50    95.2
 DIR      3            JFNG                    388  1    51.3
* DIR      3            WHO1                    392 66    35.1
 DSET AH
 DIR      4            JAVAD                     0  8    36.4
 DIR      4            DORIS                    15 47    91.1
 DIR      4            DORIS2GHz                15 48    12.7
 DIR      4            21                       35 92    96.1
 DIR      4            JFNG                     68 29 48.4
 DIR      4            11                      120 20    11.7
 DIR      4            WHO1                    133 40    25.2
 DIR      4            31                      396 20     7.7
 DSET AH
 DIR      2            11                        0  0     0.0
 DIR      2            41                       46 72    60.6
 DIR      2            31                      132 53    29.7

 SIGM ZA        15.0
*ZANG ZA  1            REFW                     96 38    77.7
 ZANG ZA  1            WHO1                     91 72    89.6
 ZANG ZA  1            JFNG                     93 10    32.5
 ZANG ZA  1            JAVAD                    97 28    46.6
 ZANG ZA  1            31                      101 35    91.5
 ZANG ZA  1            DORIS2GHz                96 45    10.5
*ZANG ZA  1            21                      101  9    28.7
 ZANG ZA  1            DORIS-UP                100 19    19.7
*ZANG ZA  2            REFW                     96 76    35.8
 ZANG ZA  2            WHO1                     95 10    25.9
 ZANG ZA  2            JFNG                     93  9    23.9
 ZANG ZA  2            DORIS2GHz                83 80    18.3
*ZANG ZA  2            DORIS                    98 83    30.1
 ZANG ZA  2            31                      101 45     6.5
 ZANG ZA  2            JAVAD                    92 79    92.1
*ZANG ZA  2            REFE                    101 73    91.6
 ZANG ZA  2            11                       99  2    47.6
```

```
*ZANG ZA  1            REFW                      96 38    68.8
 ZANG ZA  1            31                       101 35    86.0
*ZANG ZA  3            REFW                      96 76    35.4
 ZANG ZA  3            21                        98 65    47.6
 ZANG ZA  3            DORIS-UP                  94 82    54.5
 ZANG ZA  3            DORIS2GHz                 82 32    15.8
 ZANG ZA  3            11                        98 70    62.8
 ZANG ZA  3            JFNG                      93 68    57.7
 ZANG ZA  3            WHO1                      95 23    78.1
 ZANG ZA  4            JAVAD                     96 38    85.9
 ZANG ZA  4            DORIS                    100 44    83.7
 ZANG ZA  4            DORIS2GHz                 94 71    24.5
 ZANG ZA  4            21                       100 80    48.9
 ZANG ZA  4            JFNG                      84 72    93.4
 ZANG ZA  4            11                        99 60    70.7
 ZANG ZA  4            WHO1                      85 75    01.5
*ZANG ZA  4            31                       101 61    95.3
 ZANG ZA  2            11                        99  2    47.4
*ZANG ZA  2            41                        99 26    23.7
*ZANG ZA  2            31                       101 48    73.9

 SIGM DP   0.0015
 DIST DP  1            REFW                          107.94901
 DIST DP  1            31                             25.67225
 DIST DP  1            21                             18.62009
 DIST DP  2            REFW                          126.44397
 DIST DP  2            31                             10.77266
 DIST DP  2            11                             18.62013
 DIST DP  1            REFW                          107.94889
 DIST DP  1            31                             25.67254
* DIST DP  3            REFW                          131.11323
 DIST DP  3            21                             10.77308
 DIST DP  3            11                             25.67258
 DIST DP  4            21                             16.96983
 DIST DP  4            11                             12.86061
 DIST DP  4            31                             17.98215
 DIST DP  2            11                             18.62016
 DIST DP  2            41                             16.96958
 DIST DP  2            31                             10.77273

********************************** DIRECT LEVELING ************************************

 OHDF     JFNG         Benchmark                      -2.6115      0.001

******************************** INDIRECT LEVELING ************************************

 OHDF     JFNG         Benchmark                      -2.6121      0.001

 HIST ALL Toutes les observations
 END
```

Appendix 6 : Local survey adjustment output file

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      UNITS: m,GRAD Page 0001
================================================================================
Wed Dec 4 09:56:29 2013

Input file:  D:\data\JFNG_2012_02.iob
Output file: D:\data\JFNG_2012_02.lst
Options file: C:\Program Files (x86)\Microsearch\GeoLab\default.gpj
```

PARAMETERS		OBSERVATIONS	
Description	Number	Description	Number
No. of Stations	20	Directions	33
Coord Parameters	53	Distances	16
Free Latitudes	18	Azimuths	2
Free Longitudes	18	Vertical Angles	0
Free Heights	17	Zenithal Angles	27
Fixed Coordinates	7	Angles	0
Astro. Latitudes	0	Heights	0
Astro. Longitudes	0	Height Differences	2
Geoid Records	0	Auxiliary Params.	0
All Aux. Pars.	6	2-D Coords.	0
Direction Pars.	6	2-D Coord. Diffs.	4
Scale Parameters	0	3-D Coords.	3
Constant Pars.	0	3-D Coord. Diffs.	18
Rotation Pars.	0		
Translation Pars.	0		
	--------		--------
Total Parameters	59	Total Observations	105
Degrees of Freedom =	46		

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

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      UNITS: m,GRAD Page 0002
================================================================================
```

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

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

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      UNITS: m,GRAD Page 0003
================================================================================
Adjusted PLH Coordinates:
                                  LATITUDE          LONGITUDE  ELIP-HEIGHT
 CODE FFF STATION                  STD DEV            STD DEV      STD DEV
 ---- --- ------------ ----------------- ----------------- ------------
 PLH  000 1            N 30 30  55.81785 E114 29  27.38302      70.2190 m       0
                                  0.0011             0.0011       0.0010
 PLH  000 11           N 30 30  55.81784 E114 29  27.38302      70.2018 m       0
                                  0.0011             0.0011       0.0010
 PLH  000 2            N 30 30  55.81565 E114 29  28.08128      69.9166 m       0
                                  0.0010             0.0011       0.0010
 PLH  000 21           N 30 30  55.81563 E114 29  28.08129      69.9077 m       0
                                  0.0011             0.0011       0.0010
 PLH  000 3            N 30 30  56.12012 E114 29  28.28013      69.6799 m       0
                                  0.0012             0.0011       0.0010
 PLH  000 31           N 30 30  56.12008 E114 29  28.28012      69.6712 m       0
                                  0.0011             0.0012       0.0010
 PLH  000 4            N 30 30  56.18622 E114 29  27.61026      70.1224 m       0
                                  0.0010             0.0010       0.0010
 PLH  000 41           N 30 30  56.18622 E114 29  27.61027      70.1044 m       0
                                  0.0012             0.0012       0.0012
 PLH  110 Benchmark    N 30 30  55.98172 E114 29  27.88783      68.7104 m       0
                                  0.0000             0.0000       0.0012
 PLH  000 DORIS        N 30 30  55.99212 E114 29  28.11720      70.0182 m       0
                                  0.0011             0.0011       0.0010
 PLH  111 DORIS-GPS    N 30 30  55.99220 E114 29  28.11728      70.4891 m       0
                                  0.0000             0.0000       0.0000
 PLH  000 DORIS-UP     N 30 30  55.99211 E114 29  28.11721      70.1578 m       0
                                  0.0011             0.0011       0.0010
 PLH  000 DORIS2GHz    N 30 30  55.99213 E114 29  28.11719      71.3520 m       0
                                  0.0011             0.0011       0.0010
 PLH  000 JAVAD        N 30 30  56.03855 E114 29  28.57753      71.6097 m       0
                                  0.0012             0.0019       0.0011
 PLH  000 JFNG         N 30 30  56.03529 E114 29  27.66897      71.3222 m       0
                                  0.0010             0.0010       0.0010
 PLH  000 JIUB         N 30 30  55.99215 E114 29  28.11713      70.5042 m       0
                                  0.0015             0.0015       0.0014
 PLH  000 JIVB         N 30 30  55.99212 E114 29  28.11720      70.8662 m       0
                                  0.0015             0.0015       0.0014
 PLH  001 REFE         N 30 30  55.43804 E114 29  31.35362      68.3408 m       0
                                  0.0060             0.0315       0.0000
 PLH  001 REFW         N 30 30  56.24586 E114 29  23.37113      76.3285 m       0
                                  0.0010             0.0014       0.0000
 PLH  000 WHO1         N 30 30  56.06125 E114 29  27.48919      71.2659 m       0
                                  0.0010             0.0010       0.0010
```

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      UNITS: m,GRAD Page 0004
================================================================================
Adjusted XYZ Coordinates:
                             X-COORDINATE       Y-COORDINATE       Z-COORDINATE
 CODE FFF STATION                 STD DEV            STD DEV            STD DEV
 ---- --- ------------ ----------------- ----------------- -----------------
 XYZ      1                -2279822.9298       5004711.9291       3219771.1336 m       0
                                  0.0011             0.0011             0.0011
 XYZ      11               -2279822.9235       5004711.9159       3219771.1245 m       0
                                  0.0011             0.0011             0.0011
 XYZ      2                -2279839.7783       5004704.0056       3219770.9217 m       0
                                  0.0011             0.0010             0.0010
 XYZ      21               -2279839.7753       5004703.9987       3219770.9166 m       0
                                  0.0011             0.0011             0.0011
 XYZ      3                -2279842.5449       5004697.2894       3219778.8790 m       0
                                  0.0011             0.0011             0.0012
 XYZ      31               -2279842.5417       5004697.2833       3219778.8735 m       0
                                  0.0011             0.0011             0.0011
 XYZ      4                -2279826.0209       5004704.0999       3219780.8573 m       0
                                  0.0010             0.0010             0.0010
 XYZ      41               -2279826.0147       5004704.0857       3219780.8482 m       0
                                  0.0013             0.0012             0.0012
 XYZ      Benchmark        -2279833.5773       5004702.8349       3219774.7149 m       0
                                  0.0004             0.0010             0.0006
 XYZ      DORIS            -2279839.5422       5004701.1770       3219775.6549 m       0
                                  0.0011             0.0011             0.0011
 XYZ      DORIS-GPS        -2279839.7118       5004701.5442       3219775.8961 m       0
                                  0.0000             0.0000             0.0000
 XYZ      DORIS-UP         -2279839.5922       5004701.2865       3219775.7256 m       0
                                  0.0011             0.0011             0.0011
 XYZ      DORIS2GHz        -2279840.0181       5004702.2227       3219776.3324 m       0
                                  0.0011             0.0010             0.0011
 XYZ      JAVAD            -2279850.9786       5004696.6760       3219777.6949 m       0
                                  0.0017             0.0014             0.0012
 XYZ      JFNG             -2279828.8524       5004706.5393       3219777.4623 m       0
                                  0.0010             0.0010             0.0010
 XYZ      JIUB             -2279839.7137       5004701.5585       3219775.9024 m       0
                                  0.0015             0.0015             0.0015
 XYZ      JIVB             -2279839.8450       5004701.8418       3219776.0855 m       0
                                  0.0015             0.0015             0.0015
 XYZ      REFE             -2279921.0615       5004671.9738       3219760.1036 m       0
                                  0.0299             0.0103             0.0052
 XYZ      REFW             -2279724.9940       5004754.9703       3219785.5909 m       0
                                  0.0013             0.0007             0.0009
 XYZ      WHO1             -2279824.3020       5004708.1129       3219778.1224 m       0
                                  0.0010             0.0010             0.0010
```

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      UNITS: m,GRAD Page 0005
================================================================================
Residuals (critical value = 3.469):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                    OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                       STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ----------------- -------- --------
AZIM              JFNG         REFE           111 78     18.2     -0.0     -0.0
                                                          0.0      0.0         *
AZIM              JFNG         REFW           303 59     91.2     -0.0     -0.0
                                                          0.0      0.0         *
XCT  JFNG                                   -2279828.85240  -0.0000  -0.0000
                                                     0.0010   0.0000         *
YCT  JFNG                                    5004706.53930   0.0000   0.0000
                                                     0.0010   0.0000         *
ZCT  JFNG                                    3219777.46230   0.0000   0.0000
                                                     0.0010   0.0000         *
ELAT              JIUB         DORIS            0 00   0.00003   0.0000   0.0000
                                                     0.0010   0.0000     0.00*
ELON              JIUB         DORIS            0 00   0.00008  -0.0000  -0.0000
                                                     0.0010   0.0000     0.00*
EHGT              JIUB         DORIS                  -0.48600   0.0000   0.0000
                                                     0.0010   0.0000     0.00*
ELAT              JIVB         DORIS            0 00   0.00000  -0.0000  -0.0000
                                                     0.0010   0.0000     0.00*
ELON              JIVB         DORIS            0 00   0.00000  -0.0000  -0.0000
                                                     0.0010   0.0000     0.00*
EHGT              JIVB         DORIS                  -0.84800   0.0000   0.0000
                                                     0.0010   0.0000     0.00*
ELAT              DORIS-UP     DORIS            0 00   0.00000   0.0001   0.8527
                                                     0.0002   0.0002   923.65
ELON              DORIS-UP     DORIS            0 00   0.00000  -0.0001  -0.7825
                                                     0.0002   0.0001   838.19
EHGT              DORIS-UP     DORIS                  -0.13970   0.0001   0.3448
                                                     0.0003   0.0002   577.15
ELAT              DORIS-UP     DORIS            0 00   0.00000   0.0001   0.8527
                                                     0.0002   0.0002   923.65
ELON              DORIS-UP     DORIS            0 00   0.00000  -0.0001  -0.7825
                                                     0.0002   0.0001   838.19
EHGT              DORIS-UP     DORIS                  -0.13970   0.0001   0.3448
                                                     0.0003   0.0002   577.15
ELAT              1            11               0 00   0.00000  -0.0004  -0.4890
                                                     0.0010   0.0009 24894.48
ELON              1            11               0 00   0.00000  -0.0002  -0.2180
                                                     0.0010   0.0010 12113.39
EHGT              1            11                     -0.01800   0.0008   1.2995
                                                     0.0006   0.0006 44280.06
ELAT              2            21               0 00   0.00000  -0.0006  -0.7648
                                                     0.0010   0.0007 63464.28
ELON              2            21               0 00   0.00000   0.0001   0.1045
                                                     0.0010   0.0009 10854.44
ELAT              3            31               0 00   0.00000  -0.0013  -1.7189
```

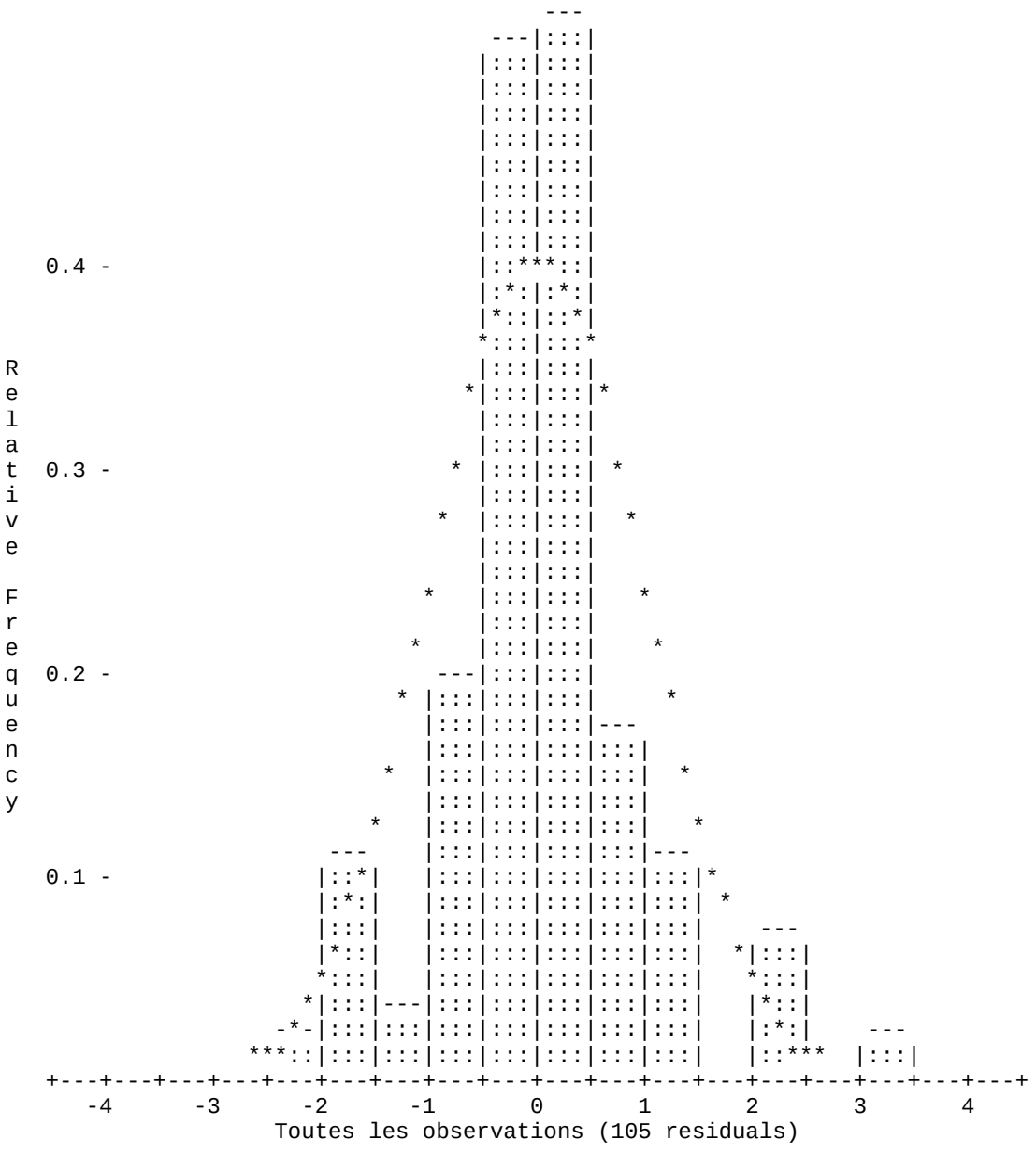
```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      UNITS: m,GRAD Page 0006
================================================================================
Residuals (critical value = 3.469):
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   0.0007 142026.0
ELON              3            31              0 00   0.00000  -0.0003  -0.3305
                                                        0.0010   0.0009 32986.40
ELAT              4            41              0 00   0.00000  -0.0000  -0.0193
                                                        0.0010   0.0006   613.40
ELON              4            41              0 00   0.00000   0.0003   0.3521
                                                        0.0010   0.0007 14173.14
EHGT              4            41                    -0.01800  -0.0000  -0.0000
                                                        0.0006   0.0005     0.00
DIR               1            REFW             0  0      0.0     -0.1     -0.0
                                                          8.0      4.6
DIR               1            WHO1           115 18     33.4     -1.0     -0.6
                                                          8.0      1.6
DIR               1            JFNG           146 31     43.8      2.8      1.5
                                                          8.0      1.9
DIR               1            JAVAD          178 80     94.5     -0.1     -0.0
                                                          8.0      6.1
DIR               1            31             168 57     12.4    -11.3     -1.8
                                                          8.0      6.2
DIR               1            DORIS2GHz      175 15     67.1     17.6      3.1
                                                          8.0      5.6
DIR               1            21             192 42     89.5     -8.0     -1.9
                                                          8.0      4.1
DIR               2            REFW             0  0      0.0     -5.7     -1.7
                                                          8.0      3.4
DIR               2            WHO1            21 75      6.7      0.7      0.6
                                                          8.0      1.2
DIR               2            JFNG            28 42     18.0      0.2      0.1
                                                          8.0      2.5
DIR               2            DORIS2GHz      104 40     80.5     -6.8     -3.5
                                                          8.0      2.0
                                                ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
DIR               2            DORIS          104 41     24.7      4.5      2.4
                                                          8.0      1.9
DIR               2            JAVAD          162 84      4.0      0.0      0.0
                                                          8.0      1.7
DIR               2            REFE           201 74     27.8     -0.0     -0.0
                                                          8.0      0.0
DIR               2            11             393 53     74.8      7.0      1.9
                                                          8.0      3.6
DIR               1            REFW             0  0      0.0      4.9      1.1
                                                          8.0      4.5
DIR               1            31             168 57     11.0     -4.9     -1.1
                                                          8.0      4.5
DIR               3            21             330 89     67.8     -4.3     -1.1
```

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      UNITS: m,GRAD Page 0007
================================================================================
Residuals (critical value = 3.469):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                  OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                     STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ----------------- -------- --------
                                                        12.0      4.0
DIR               3            DORIS-UP       351 22      9.0     11.6      2.4
                                                        12.0      4.8
DIR               3            DORIS2GHz      351 23      6.0     -9.3     -1.8
                                                        12.0      5.2
DIR               3            11             374 50     95.2     -7.4     -1.0
                                                        12.0      7.0
DIR               3            JFNG           388  1     51.3      9.4      1.4
                                                        12.0      6.9
DIR               4            JAVAD            0  8     36.4      0.0      0.0
                                                         8.0      2.1
DIR               4            DORIS           15 47     91.1      8.2      2.4
                                                         8.0      3.4
DIR               4            DORIS2GHz       15 48     12.7    -18.5     -4.3
                                                         8.0      4.3
                                                  ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
DIR               4            21              35 92     96.1      4.6      1.3
                                                         8.0      3.5
DIR               4            JFNG            68 29      4.0      0.8      0.9
                                                         8.0      0.9
DIR               4            11             120 20     11.7      0.7      0.4
                                                         8.0      1.9
DIR               4            WHO1           133 40     25.2     -0.6     -0.6
                                                         8.0      1.0
DIR               4            31             396 20      7.7      4.9      1.5
                                                         8.0      3.4
DIR               2            11               0  0      0.0     -4.1     -1.8
                                                         8.0      2.2
DIR               2            41              46 72     60.6     -0.3     -0.2
                                                         8.0      1.5
DIR               2            31             132 53     29.7      4.4      2.4
                                                         8.0      1.9
ZANG              1            WHO1            91 72     89.6      7.1      0.7
                                                        15.0      9.8
ZANG              1            JFNG            93 10     32.5    -25.5     -2.2
                                                        15.0     11.5
ZANG              1            JAVAD           97 28     46.6     14.9      1.1
                                                        15.0     13.7
ZANG              1            31             101 35     91.5      3.9      0.3
                                                        15.0     13.6
ZANG              1            DORIS2GHz       96 45     10.5      9.2      0.7
                                                        15.0     13.9
ZANG              1            DORIS-UP       100 19     19.7     -1.3     -0.1
                                                        15.0     13.5
ZANG              2            WHO1            95 10     25.9     -0.1     -0.0
```

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      UNITS: m,GRAD Page 0008
================================================================================
Residuals (critical value = 3.469):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                 OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                     STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ----------------- -------- --------
                                                        15.0     13.7
ZANG              2            JFNG           93  9     23.9    -24.1     -1.9
                                                        15.0     12.7
ZANG              2            DORIS2GHz      83 80     18.3     17.1      2.4
                                                        15.0      7.1
ZANG              2            31            101 45      6.5     -1.0     -0.1
                                                        15.0      7.1
ZANG              2            JAVAD          92 79     92.1     -7.2     -0.8
                                                        15.0      8.6
ZANG              2            11             99  2     47.6     -4.5     -0.3
                                                        15.0     13.1
ZANG              1            31            101 35     86.0     -1.6     -0.1
                                                        15.0     13.6
ZANG              3            21             98 65     47.6      6.1      0.8
                                                        15.0      7.6
ZANG              3            DORIS-UP       94 82     54.5      4.1      0.8
                                                        15.0      5.5
ZANG              3            DORIS2GHz      82 32     15.8     -7.2     -1.0
                                                        15.0      7.4
ZANG              3            11             98 70     62.8      3.8      0.3
                                                        15.0     13.9
ZANG              3            JFNG           93 68     57.7      1.7      0.1
                                                        15.0     13.5
ZANG              3            WHO1           95 23     78.1     -8.0     -0.6
                                                        15.0     14.1
ZANG              4            JAVAD          96 38     85.9      0.5      0.0
                                                        15.0     13.0
ZANG              4            DORIS         100 44     83.7     -9.4     -0.8
                                                        15.0     11.4
ZANG              4            DORIS2GHz      94 71     24.5    -33.0     -2.5
                                                        15.0     13.4
ZANG              4            21            100 80     48.9     -9.7     -0.8
                                                        15.0     11.9
ZANG              4            JFNG           84 72     93.4     22.0      3.0
                                                        15.0      7.2
ZANG              4            11             99 60     70.7     -4.2     -0.4
                                                        15.0     10.9
ZANG              4            WHO1           85 75      0.0     -2.6     -0.4
                                                        15.0      7.1
ZANG              2            11             99  2     47.4     -4.7     -0.4
                                                        15.0     13.1
DIST              1            REFW                107.94900  -0.0001  -0.0413
                                                      0.0015   0.0012     0.46
DIST              1            31                   25.67220  -0.0005  -0.3809
                                                      0.0015   0.0014    20.27
```

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      UNITS: m,GRAD Page 0009
================================================================================
Residuals (critical value = 3.469):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                    OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                       STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ----------------- -------- --------
DIST              1            21                    18.62000   0.0002   0.1259
                                                        0.0015   0.0014     9.60
DIST              2            REFW                 126.44390  -0.0001  -0.0694
                                                        0.0015   0.0012     0.65
DIST              2            31                    10.77260   0.0004   0.2693
                                                        0.0015   0.0014    34.33
DIST              2            11                    18.62010  -0.0002  -0.1691
                                                        0.0015   0.0014    12.55
DIST              1            REFW                 107.94880   0.0001   0.1235
                                                        0.0015   0.0012     1.39
DIST              1            31                    25.67250  -0.0008  -0.6004
                                                        0.0015   0.0014    31.96
DIST              3            21                    10.77300   0.0013   0.9113
                                                        0.0015   0.0014   117.18
DIST              3            11                    25.67250  -0.0003  -0.2160
                                                        0.0015   0.0013    11.15
DIST              4            21                    16.96980   0.0011   0.7768
                                                        0.0015   0.0014    65.66
DIST              4            11                    12.86060   0.0006   0.4530
                                                        0.0015   0.0014    49.25
DIST              4            31                    17.98210  -0.0005  -0.3385
                                                        0.0015   0.0014    25.75
DIST              2            11                    18.62010  -0.0002  -0.1691
                                                        0.0015   0.0014    12.55
DIST              2            41                    16.96950   0.0004   0.3641
                                                        0.0015   0.0012    26.02
DIST              2            31                    10.77270   0.0003   0.1964
                                                        0.0015   0.0014    25.05
OHDF              JFNG         Benchmark             -2.61150  -0.0003  -0.4243
                                                        0.0010   0.0007    45.44
OHDF              JFNG         Benchmark             -2.61210   0.0003   0.4243
                                                        0.0010   0.0007    45.44
```

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      UNITS: m,GRAD Page 0010
================================================================================
```



```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      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	3.4693
Number of Flagged Residuals	2
Convergence Criterion	0.0001
Final Iteration Counter Value	3
Confidence Level Used	95.0000
Estimated Variance Factor	1.0185
Number of Degrees of Freedom	46

Chi-Square Test on the Variance Factor:

7.0332e-01 < 1.0000 < 1.6067e+00 ?

THE TEST PASSES

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

Variance factor used	=	1.0185
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.

```
================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      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
------------ -------------------- --- ------------------ --------------------
1                           0.0028  51             0.0025               0.0020
11                          0.0028  91             0.0026               0.0020
2                           0.0026 118             0.0025               0.0020
21                          0.0027  65             0.0026               0.0020
3                           0.0030  31             0.0027               0.0020
31                          0.0029  56             0.0026               0.0020
4                           0.0026  15             0.0025               0.0020
41                          0.0032 132             0.0026               0.0024
Benchmark                   0.0000   0             0.0000               0.0024
DORIS                       0.0027  48             0.0026               0.0020
DORIS-UP                    0.0027  51             0.0026               0.0020
DORIS2GHz                   0.0027  54             0.0026               0.0020
JAVAD                       0.0048  71             0.0026               0.0021
JFNG                        0.0025  90             0.0025               0.0020
JIUB                        0.0036  48             0.0036               0.0028
JIVB                        0.0036  48             0.0036               0.0028
REFE                        0.0784 101             0.0025               0.0000
REFW                        0.0033  93             0.0025               0.0000
WHO1                        0.0026  97             0.0026               0.0020

================================================================================
              JFNG (CHINA) REGINA&DORIS TIES - OCTOBER 2012 SURVEY
Microsearch GeoLab, V2001.9.20.0             WGS 84      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)
------------ -------------------- -------------------- --------------------
1                0.0032 ( 51,  0)      0.0029 (319, 90)      0.0029 (141,  0)
11               0.0032 (271,  0)      0.0030 (181,  0)      0.0029 (  5, 90)
2                0.0030 (118,  0)      0.0029 (208,  0)      0.0029 (331, 90)
21               0.0031 (245,  0)      0.0030 (335,  0)      0.0029 (144, 90)
3                0.0034 (211,  0)      0.0031 (301,  0)      0.0029 ( 33, 90)
31               0.0033 ( 56,  0)      0.0030 (146,  0)      0.0029 (299, 90)
4                0.0029 (195,  0)      0.0029 (285,  0)      0.0028 (105, 90)
41               0.0037 (132,  0)      0.0034 (333, 90)      0.0030 (222,  0)
Benchmark        0.0035 (  0, 90)      0.0000 ( 90,  0)      0.0000 (  0,  0)
DORIS            0.0031 ( 48,  0)      0.0030 (318,  0)      0.0029 (139, 90)
DORIS-UP         0.0031 ( 51,  0)      0.0030 (141,  0)      0.0029 (302, 90)
DORIS2GHz        0.0031 ( 54,  0)      0.0030 (144,  0)      0.0029 (278, 90)
JAVAD            0.0054 ( 71,  0)      0.0030 (161,  0)      0.0030 (338, 90)
JFNG             0.0028 ( 88, 90)      0.0028 (265,  0)      0.0028 (355,  0)
JIUB             0.0042 (228,  0)      0.0041 (318,  0)      0.0040 (115, 90)
JIVB             0.0042 ( 48,  0)      0.0041 (318,  0)      0.0040 (150, 90)
REFE             0.0896 (101,  0)      0.0028 ( 11,  0)      0.0000 (  0, 90)
REFW             0.0038 ( 93,  0)      0.0028 (  3,  0)      0.0000 (  0, 90)
WHO1             0.0029 ( 97,  0)      0.0029 (  7,  0)      0.0028 (211, 90)

Wed Dec 4 09:56:29 2013
```

Appendix 7 : Jiufeng SINEX File

```
%=SNX 1.00 IGN 13:338:00000 IGN 12:285:00000 12:285:00000 C 00018
*-------------------------------------------------------------------------------
+FILE/COMMENT
* File created by geotosnx software (Z.Altamimi)
* Original input file: jfng.cov
* Matrix Scalling Factor used:         1.0000000000
-FILE/COMMENT
*-------------------------------------------------------------------------------
+SITE/ID
*CODE PT __DOMES__ T _STATION DESCRIPTION__ APPROX_LON_ APPROX_LAT_ _APP_H_
 JAVA  A 21602M003                         114 29 28.5  30 30 56.0    71.6
 WHO1  A                                   114 29 27.4  30 30 56.0    71.3
 DORI  A 21602M005                         114 29 28.1  30 30 55.9    70.0
 JFNG  A 21602M006                         114 29 27.6  30 30 56.0    71.3
 JIUB  A 21602S005                         114 29 28.1  30 30 55.9    70.5
 JIVB  A 21602S006                         114 29 28.1  30 30 55.9    70.9
-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   JAVA  A    1 12:285:00000 m    2 -.227985097860000E+07 0.12194E-02
     2 STAY   JAVA  A    1 12:285:00000 m    2 0.500469667600000E+07 0.15486E-02
     3 STAZ   JAVA  A    1 12:285:00000 m    2 0.321977769490000E+07 0.14761E-02
     4 STAX   WHO1  A    1 12:285:00000 m    2 -.227982430200000E+07 0.10267E-02
     5 STAY   WHO1  A    1 12:285:00000 m    2 0.500470811290000E+07 0.10466E-02
     6 STAZ   WHO1  A    1 12:285:00000 m    2 0.321977812240000E+07 0.10404E-02
     7 STAX   DORI  A    1 12:285:00000 m    2 -.227983954220000E+07 0.10457E-02
     8 STAY   DORI  A    1 12:285:00000 m    2 0.500470117700000E+07 0.10875E-02
     9 STAZ   DORI  A    1 12:285:00000 m    2 0.321977565490000E+07 0.10603E-02
    10 STAX   JFNG  A    1 12:285:00000 m    2 -.227982885240000E+07 0.10092E-02
    11 STAY   JFNG  A    1 12:285:00000 m    2 0.500470653930000E+07 0.10092E-02
    12 STAZ   JFNG  A    1 12:285:00000 m    2 0.321977746230000E+07 0.10092E-02
    13 STAX   JIUB  A    1 12:285:00000 m    2 -.227983971370000E+07 0.14533E-02
    14 STAY   JIUB  A    1 12:285:00000 m    2 0.500470155850000E+07 0.14836E-02
    15 STAZ   JIUB  A    1 12:285:00000 m    2 0.321977590240000E+07 0.14638E-02
    16 STAX   JIVB  A    1 12:285:00000 m    2 -.227983984500000E+07 0.14533E-02
    17 STAY   JIVB  A    1 12:285:00000 m    2 0.500470184180000E+07 0.14836E-02
    18 STAZ   JIVB  A    1 12:285:00000 m    2 0.321977608550000E+07 0.14638E-02
-SOLUTION/ESTIMATE
*-------------------------------------------------------------------------------
+SOLUTION/MATRIX_ESTIMATE L COVA
*PARA1 PARA2 ____PARA2+0__________ ____PARA2+1__________ ____PARA2+2__________
     1     1 0.148698113464221E-05
     2     1 0.664047042425305E-06 0.239814106534855E-05
     3     1 -.625027029281712E-06 -.112662838322907E-05 0.217901006095327E-05
     4     1 0.106545914430958E-05 0.977951509411191E-07 -.631829989602527E-07
     4     4 0.105402163340161E-05
     5     1 -.101509371037096E-07 0.101202284402865E-05 0.172221742205766E-07
     5     4 0.389110142194476E-09 0.109532288456943E-05
     6     1 -.631829989827346E-07 -.165920161929821E-06 0.113541525965311E-05
     6     4 -.256365476172778E-07 -.660167888339636E-09 0.108240637788433E-05
     7     1 0.108278714770030E-05 0.176061176775552E-06 -.902211190540169E-07
     7     4 0.102644449479743E-05 0.271632376465800E-07 0.299299410858727E-08
```

```
     7     7 0.109343113569970E-05
     8     1 0.552489940239026E-07 0.140953949788910E-05 -.937359567334025E-07
     8     4 -.346688349970543E-08 0.102374998102411E-05 0.588194674679814E-08
     8     7 0.116041692219128E-07 0.118259879424590E-05
     9     1 -.902211190628859E-07 -.298707028649964E-06 0.118267982631912E-05
     9     4 0.299299407888604E-08 -.460854014095244E-07 0.102313065652858E-05
     9     7 -.278149365175219E-07 -.196877413417454E-07 0.112422778888056E-05
    10     1 0.101853874205306E-05 -.116781163699640E-11 0.408065878915244E-13
    10     4 0.101853871579406E-05 -.221709718887805E-12 -.599398066334410E-14
    10     7 0.101853856915260E-05 -.572625081231929E-12 -.729409922067090E-13
    10    10 0.101853872008071E-05
    11     1 0.113623330673779E-11 0.101853867695189E-05 -.192774243031961E-11
    11     4 0.235144599438692E-12 0.101853870911348E-05 -.398952768862656E-12
    11     7 0.565472352346928E-12 0.101853869628039E-05 -.959397858839887E-12
    11    10 0.427360695617374E-14 0.101853870624625E-05
    12     1 0.407839603953104E-13 0.198129363110136E-11 0.101853869691192E-05
    12     4 -.599357569468965E-14 0.376154016868696E-12 0.101853872243073E-05
    12     7 -.729712913415376E-13 0.971532795149636E-12 0.101853864992914E-05
    12    10 0.209481488031439E-14 -.725063766609545E-14 0.101853871776134E-05
    13     1 0.108278714771660E-05 0.552489939290500E-07 -.902211194597136E-07
    13     4 0.102644449479388E-05 0.271632377396128E-07 0.299299448129253E-08
    13     7 0.109343113570861E-05 0.116041691211930E-07 -.278149369188207E-07
    13    10 0.101853856915260E-05 0.565379525886373E-12 -.733364893384850E-13
    13    13 0.211196985703300E-05
    14     1 0.176061176889755E-06 0.140953949791026E-05 -.298707028861640E-06
    14     4 -.346688359511612E-08 0.102374998102278E-05 0.588194692166830E-08
    14     7 0.116041693263504E-07 0.118259879425034E-05 -.196877415376793E-07
    14    10 -.572532254170726E-12 0.101853869628039E-05 0.971357577832935E-12
    14    13 0.116041692256304E-07 0.220113751557026E-05
    15     1 -.902211186354957E-07 -.937359564711129E-07 0.118267982623539E-05
    15     4 0.299299371624184E-08 -.460854015852591E-07 0.102313065652173E-05
    15     7 -.278149361234753E-07 -.196877411341449E-07 0.112422778886720E-05
    15    10 -.725757946323475E-13 -.959222641787948E-12 0.101853864992914E-05
    15    13 -.278149365247737E-07 -.196877413300785E-07 0.214276651016931E-05
    16     1 0.108278714769884E-05 0.552489940083944E-07 -.902211190666128E-07
    16     4 0.102644449479710E-05 0.271632376583041E-07 0.299299411459355E-08
    16     7 0.109343113569973E-05 0.116041692085456E-07 -.278149365240763E-07
    16    10 0.101853856915260E-05 0.565460737305890E-12 -.729774327275811E-13
    16    13 0.109343113570865E-05 0.116041693129831E-07 -.278149361300298E-07
    16    16 0.211196985701524E-05
    17     1 0.176061176787293E-06 0.140953949788910E-05 -.298707028643045E-06
    17     4 -.346688351141524E-08 0.102374998102411E-05 0.588194673989873E-08
    17     7 0.116041692341938E-07 0.118259879424590E-05 -.196877413345071E-07
    17    10 -.572613467355580E-12 0.101853869628039E-05 0.971539640497879E-12
    17    13 0.116041691334740E-07 0.118259879425034E-05 -.196877411269066E-07
    17    16 0.116041692208267E-07 0.220113751556137E-05
    18     1 -.902211190486737E-07 -.937359567425406E-07 0.118267982632059E-05
    18     4 0.299299407324264E-08 -.460854014026140E-07 0.102313065652891E-05
    18     7 -.278149365110076E-07 -.196877413496210E-07 0.112422778888052E-05
    18    10 -.729348512202454E-13 -.959404702081716E-12 0.101853864992914E-05
    18    13 -.278149369123064E-07 -.196877415455548E-07 0.112422778886716E-05
    18    16 -.278149365175619E-07 -.196877413423826E-07 0.214276651019596E-05
-SOLUTION/MATRIX_ESTIMATE L COVA
%ENDSNX
```