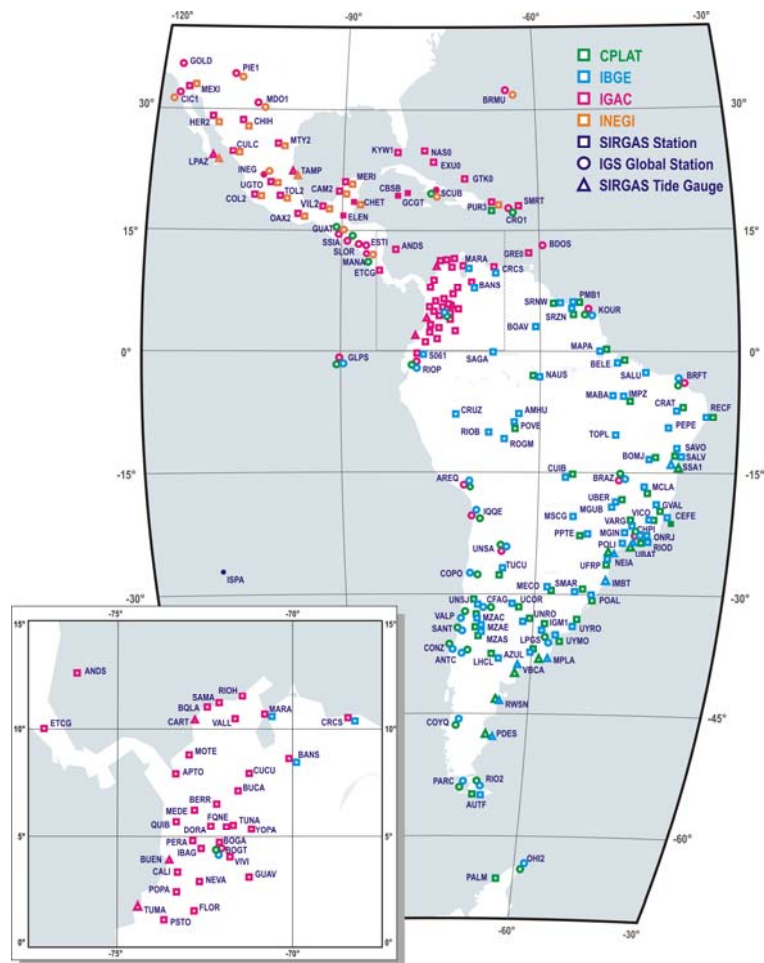


DGFI Report No. 80

Comparison and combination of the weekly solutions delivered by the SIRGAS Experimental Processing Centres

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SIRGAS-CON stations processed by the SIRGAS Experimental Processing Centres



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1 Introduction

In August 2006, the SIRGAS Working Group I (Reference System) initiated a one-year project to establish Experimental Processing Centres (EPC) and Experimental Combination Centres (ECC) for SIRGAS. This implied the distribution of the regional stations between the participating EPCs to guarantee that each station is included in the same number of individual solutions, getting identical weights for all the stations in the combined solutions. In this way, the SIRGAS Continuously Operating Network (SIRGAS-CON) was divided into two blocks with a similar number of stations, namely a northern and a southern block. These blocks are connected by means of IGS Reference Stations (i.e. IGS05 frame stations), which serve also as fiducial points. The weekly free normal equations obtained by each EPC must be delivered to DGFI (which continues in charge of the official IGS-RNAAC-SIR) and to the other ECCs. They shall combine the individual solutions and carry out comparisons with the official solution provided by DGFI to establish the quality of the computations obtained by the EPCs. The following institutions provided solutions: Instituto Nacional de Estadística, Geografía e Informática (INEGI, Mexico), Instituto Geográfico Agustín Codazzi (IGAC, Colombia), Instituto Brasileiro de Geografia e Estatística (IBGE, Brazil), and Universidad Nacional de La Plata (CPLAT: Centro de Procesamiento de La Plata, Argentina). INEGI and IGAC compute the northern block, while IBGE and CPLAT process the southern one.

The resolutions related to the experiment were adopted in the first workshop of the SIRGAS-WGI, held in Rio de Janeiro in August 2006. They will be called in the following “Rio Agreement” and can be summarized as:

1.1 Rio Agreement about SIRGAS-CON Stations:

- a) Each SIRGAS-CON station must be completely described by means of an updated log file (IGS format);
- b) SIRGAS-CON stations should not have long data interruptions. If it is the case, these interruptions should be immediately reported (by means of the SIRGAS mail exploder);
- c) The tracked data must be prepared in RINEX files and be available within the two following weeks after the observation day;
- d) Each SIRGAS-CON station should be processed by two EPCs;

1.2 Rio Agreement about Experimental Processing Centres and Experimental Combination Centres:

- a) The EPCs should make available their individual weekly solutions within the three weeks following the processed week (for this purpose, DGFI made available a FTP server: <ftp.dgfi.badw-muenchen.de>);
- b) The ECCs should compare and combine the EPC individual solutions and interchange their results within the four weeks following the processed week in order to assess the quality of the combined solutions by comparing them with the weekly solutions delivered by the IGS-RNAAC-SIR;
- c) The ECC are also responsible for the statistics about the project efficiency;
- d) The experiment started on October 1st, 2006 (GPS week 1395).

1.3 Rio Agreement about processing strategy (refers to the GNSS data processing, guidelines for the combination procedures were not defined):

- a) Sampling rate: 30 sec;
- b) Elevation cut-off: 3°;
- c) Satellite orbits, satellite clock offsets, and Earth orientation parameters should be fixed to the combined IGS solutions (initially, they referred to the IGB00 reference frame; after the GPS week 1400, they refer to the IGS05 reference frame);
- d) Absolute calibration values for the antenna phase centre corrections must be applied (the values published by the IGS are available since GPS week 1400, before the file generated by the University of Berne was applied);
- e) Daily and weekly solutions should be datum free (loosely constrained), i.e. a priori σ for station positions should be $\sigma = \pm 1$ m. Troposphere and ambiguity parameters must be pre-eliminated in the daily solutions;
- f) The processing characteristics that have not been explicitly mentioned were left to the discretion of each EPC.

Based on these resolutions, the present report describes the activities carried out by DGFI as a SIRGAS Experimental Combination Centre. Its main components are related to: i) comparison and evaluation of the weekly individual solutions delivered by the EPCs: CPLAT, IBGE, IGAC, and INEGI, ii) definition of an adequate combination strategy, and iii) ascertaining the quality of the weekly and accumulated combined solutions by comparing them with those produced by the IGS-RNAAC-SIR and the weekly solutions (combinations) of the IGS Global Network. These issues are faced by analysing not only the accuracy of the individual free solutions and their combination, but also operational aspects related with the punctuality on delivering the SINEX files, the observance of the Rio Agreement, accordance with the log files information, etc.

The procedures, analysis, and conclusions contained in this report are based on the weekly solutions delivered by each EPC to the DGFI FTP server between the GPS weeks 1395 (October 1st, 2006) and 1468 (March 1st, 2008). Annex 1 lists the weekly solutions deposited in the DGFI FTP server including the submission deadline and the effective delivering date. Details about the processing strategies applied by the EPCs are presented in the following reports: Reporte INEGI 2008: Centro de Procesamiento Piloto INEGI (Gonzalez 2008), Reporte del Centro Experimental de Procesamiento SIRGAS IGAC (De La Rosa et al. 2008), and Análises e Resultados do Centro de Processamento Piloto do IBGE (Da Silva, Costa 2008). These reports were presented in the Second Workshop of the SIRGAS-WGI held in Montevideo, Uruguay, between 26 and 27 May 2008. They are available at www.sirgas.org.

2 Processed network

The SIRGAS-CON stations distributed between the different EPCs correspond to those processed by the IGS-RNAAC-SIR. Annex 2 summarizes the stations each EPC should process according with the Rio Agreement and the missing (or additional) stations in the delivery weekly solutions. In August 2006 this network included 128 sites, 50 IGS stations, and 78 regional stations. From these 128 sites 116 were in operation. Since the GPS week 1395 46 new stations (Table 1) were integrated into the SIRGAS-CON network, and 5 sites (CULI, JAMA, MANZ, PARA, RIOG) were formerly decommissioned. Additionally, 10

GPS stations (COPO, COYQ, ESTI, IQQE, KYW1, PDES, PUR3, RIOP, SLOR, VALP) are inactive, i.e. they have not delivered observational data in the last three months. Figure 1 and Figure 2 show the stations processed at present, indicating the new stations and the decommissioned ones, as well as the stations that each operating EPC is processing. The statistics presented for INEGI are valid only for the period between GPS weeks 1395 and 1428.

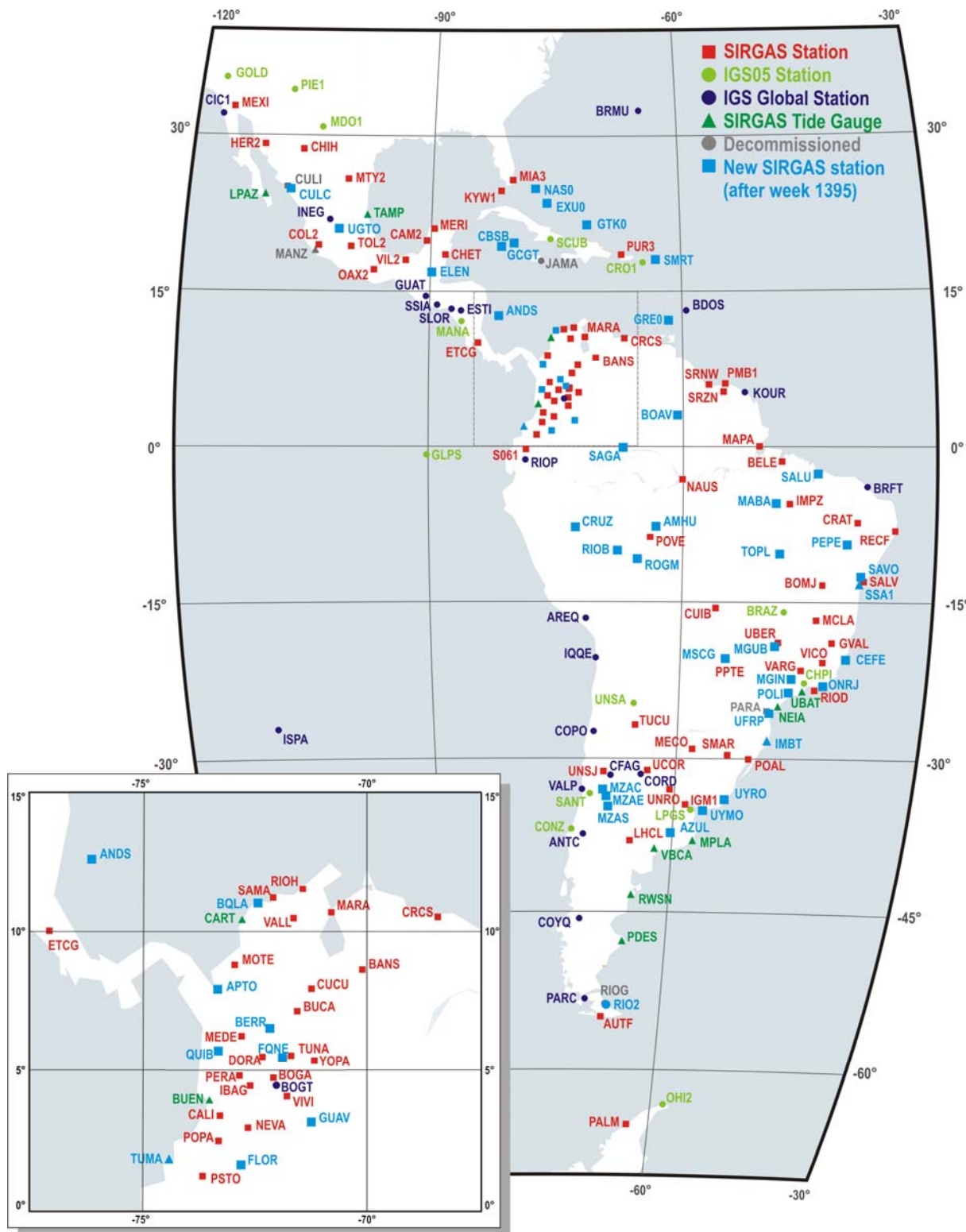


Figure 1. Stations processed within the SIRGAS-CON network since GPS week 1395.

Table 1. New SIRGAS-CON stations (after week 1395) included in the EPC weekly solutions.

| Southern part of the SIRGAS-CON network | | | | | | Northern part of the SIRGAS-CON network | | | | | |
|---|-------------------------|------|---------|------|-------|---|-------------------------|------|-------|------|---------|
| Code | Included since GPS week | | | | | Code | Included since GPS week | | | | |
| | DGFI | IBGE | CPLAT | IGAC | INEGI | | DGFI | IBGE | CPLAT | IGAC | INEGI |
| AMHU | 1464 | 1465 | missing | | | ANDS | 1426 | | | 1426 | missing |
| AZUL | 1466 | 1470 | 1470 | | | APTO | 1452 | | | 1453 | missing |
| BOAV | 1443 | 1441 | missing | | | BERR | 1428 | | | 1429 | missing |
| CEFE | 1443 | 1441 | missing | | | BQLA | 1446 | | | 1448 | missing |
| CRUZ | 1443 | 1443 | missing | | | CULC | 1447 | | | 1453 | missing |
| IMBT | 1443 | 1441 | missing | | | ELEN | 1437 | | | 1442 | missing |
| MABA | 1443 | 1441 | missing | | | EXU0 | 1439 | | | 1442 | missing |
| MGIN | 1466 | 1466 | missing | | | FLOR | 1399 | | | 1399 | missing |
| MGUB | 1462 | 1464 | missing | | | FQNE | 1447 | | | 1449 | missing |
| MSCG | 1462 | 1464 | missing | | | GRE0 | 1439 | | | 1442 | missing |
| MZAE | 1466 | 1431 | 1470 | | | GTK0 | 1439 | | | 1442 | missing |
| MZAS | 1426 | 1424 | 1425 | | | GUAV | 1468 | | | 1468 | missing |
| ONRJ | 1421 | 1422 | 1424 | | | NAS0 | 1439 | | | 1442 | missing |
| PEPE | 1462 | 1464 | missing | | | QUIB | 1465 | | | 1465 | missing |
| POLI | 1417 | 1407 | 1424 | | | SMRT | 1439 | | | 1442 | missing |
| RIO2 | 1425 | 1429 | 1426 | | | TUMA | 1399 | | | 1399 | missing |
| RIOB | 1443 | 1442 | missing | | | UGTO | 1437 | | | 1442 | missing |
| ROGM | 1462 | 1464 | missing | | | | | | | | |
| SAGA | 1445 | 1445 | missing | | | | | | | | |
| SALU | 1443 | 1441 | missing | | | | | | | | |
| SAVO | 1443 | 1441 | missing | | | | | | | | |
| SSA1 | 1443 | 1442 | missing | | | | | | | | |
| TOPL | 1462 | 1465 | missing | | | | | | | | |
| UFPR | 1443 | 1443 | missing | | | | | | | | |
| UYMO | 1451 | 1454 | 1470 | | | | | | | | |
| UYRO | 1468 | 1470 | 1470 | | | | | | | | |

Table 1, Figure 2, and Annex 2 let us conclude that the distribution of the regional SIRGAS-CON stations between the EPCs is not homogeneous. Most of the sites included in the northern block are processed by IGAC only, while many of the new stations integrated into the southern block was not taken into account by CPLAT and they are processed by IBGE only. Another discrepancy to mention is the fact that the EPCs and DGFI (as IGS-RNAAC-SIR) did not always start to process the new stations at the same time, extreme examples are station MZAE (IBGE includes this station in its weekly solutions 35 weeks before DGFI), POLI (included in the IBGE solutions 10 weeks before than in those of DGFI), and CULC (included in the DGFI solutions 6 weeks before than in those of IGAC). Table 2 summarizes the number of common stations processed by the EPCs and DGFI.

Table 2. Number of common stations processed by the Experimental Processing Centres and the IGS-RNAAC-SIR (GPS weeks 1395 – 1468).

| EPC | DGFI | CPLAT | IBGE | IGAC | INEGI |
|-------|------|-------|------|------|-------|
| DGFI | 159 | 68 | 88 | 82 | 24 |
| CPLAT | | 68 | 60 | 16 | 4 |
| IBGE | | | 88 | 13 | 0 |
| IGAC | | | | 82 | 24 |
| INEGI | | | | | 24 |

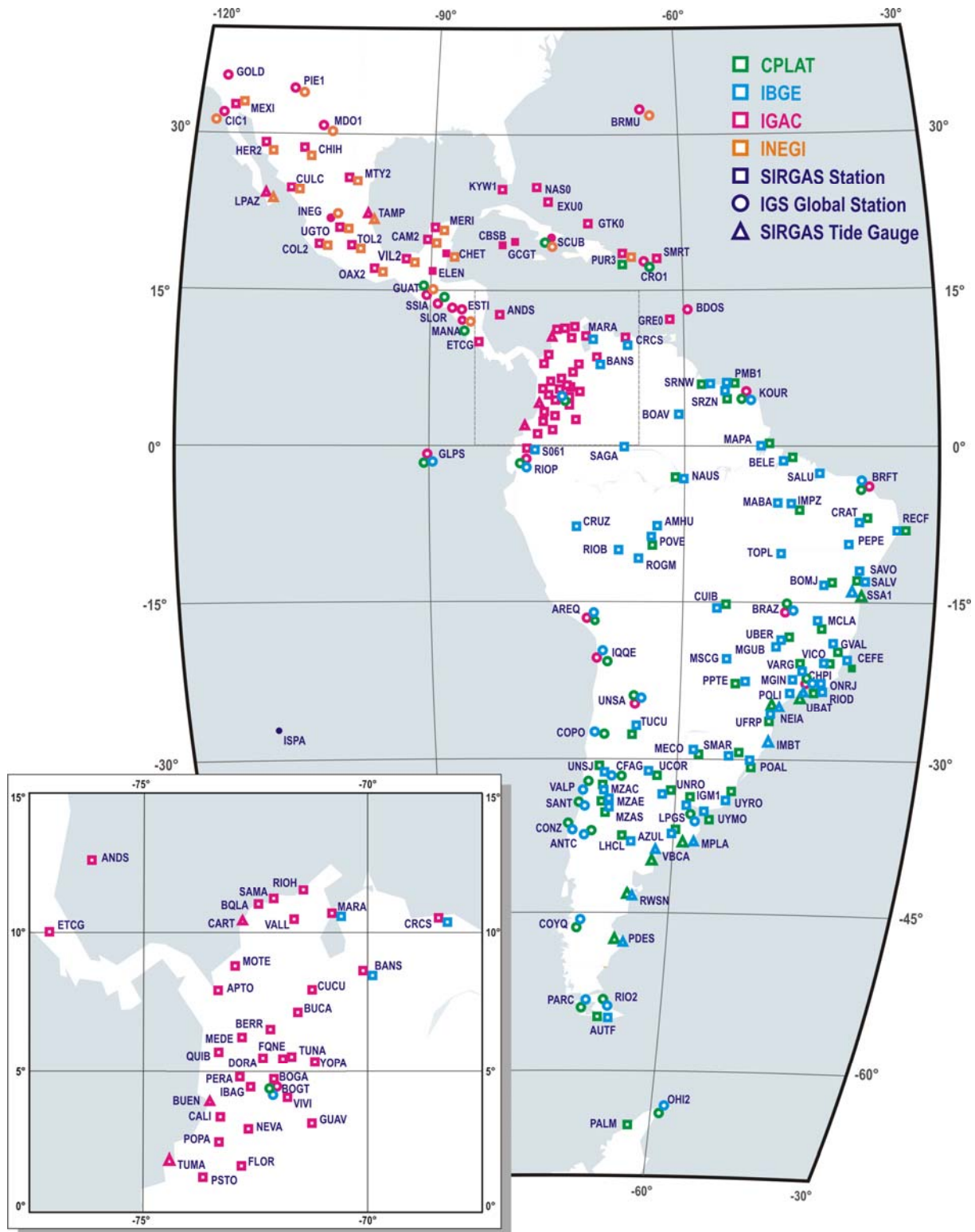


Figure 2. Regional SIRGAS-CON stations processed by the Experimental Processing Centres.

3 Review of the weekly solutions delivered by the EPCs

The EPCs put their weekly solutions on the DGFI FTP server conditioned for the SIRGAS activities. Processing Centres CPLAT, IBGE, and IGAC apply the BERNSE Software (<http://www.bernese.unibe.ch/index.html>) for the analysis, while INEGI applies GIPSY OASIS II (http://facility.unavco.org/software/processing/gipsy/gipsy_info.html). CPLAT,

IBGE, and IGAC submitted free weekly solutions in SINEX format (SNX), as well as daily normal equations (NQ0) in binary and ASCII format for the GPS weeks 1395 until 1468. INEGI provided free and constrained weekly solutions in SINEX format (SNX) for the GPS weeks 1395 until 1428.

As a first step, a comparison between the weekly solutions provided by the EPCs and the corresponding free weekly solutions generated by the IGS-RNAAC-SIR (DGFI) was carried out. For this purpose, 7-parameter similarity transformations were weekly calculated between the loosely constrained coordinates contained in the SINEX files as follows: DGFI-INEGI, DGFI-CPLAT, DGFI-IBGE, DGFI-IGAC, CPLAT-IBGE, and IGAC-INEGI. As an example, figure 3 presents the weekly RMS values obtained from the comparison between the weekly coordinates calculated by the IGS-RNAAC-SIR and those submitted by INEGI, the mean values (over 33 weeks) are 3,1 mm for the north component, 3,8 mm for the east component, and 17,1 mm for the vertical component. The discrepancy in the vertical component is a consequence of the relative correction values, instead of the absolute ones, for the antenna phase centre variations (PCV) applied by INEGI.

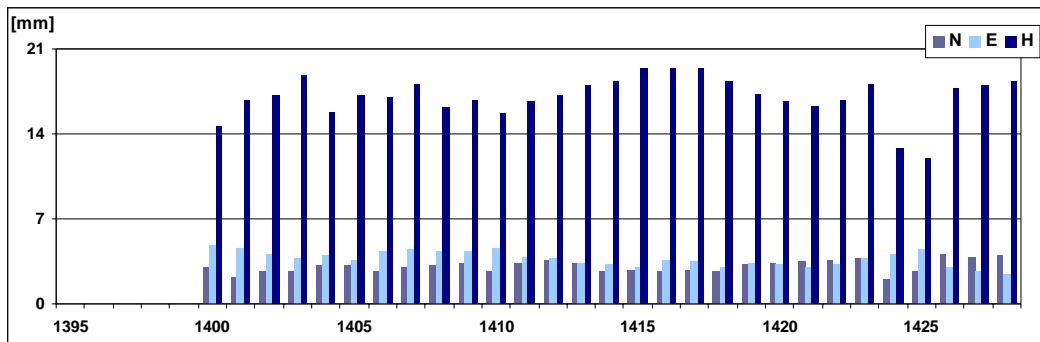


Figure 3. Comparison between the constrained weekly solutions delivered by INEGI and the corresponding solutions generated by the IGS-RNAAC-SIR: RMS residuals after a 7-parameter similarity transformation. Mean RMS: N = 3,1 mm, E = 3,8 mm, h = 17,1 mm. (Comparison starts in week 1400 because since this week absolute PCVs were applied by IGS-RNAAC-SIR).

Table 3 summarizes the mean RMS values of the residuals in the three components (N, E, H) for the other comparisons. Complementary, Annex 3 displays the weekly RMS values in bar-graphics, as well as the outliers for the 73 weeks. Results of this procedure show a very good agreement (N = 1,4 mm, E = 2,3 mm, H = 5,1 mm) between the free weekly solutions delivered by the CPLAT, IBGE, and IGAC. INEGI solutions can not be taken into account for combination due to utilization of relative correction values for the PCV. Therefore, in the following our discussion concentrates on three EPCs: CPLAT, IBGE and IGAC.

Table 3. RMS values after a 7-parameter similarity transformation between free weekly solutions delivered by the EPCs and IGS-RNAAC-SIR (mean values over the GPS weeks 1395 – 1468).

| Processing Centre | DGFI | | | CPLAT | | | IGAC | | |
|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| | N [mm] | E [mm] | H [mm] | N [mm] | E [mm] | h [mm] | N [mm] | E [mm] | H [mm] |
| CPLAT | 1,75 | 2,69 | 6,07 | | | | | | |
| IBGE | 1,25 | 2,16 | 5,50 | 1,38 | 1,95 | 4,54 | | | |
| IGAC | 1,25 | 2,33 | 4,41 | | | | | | |
| INEGI* | 3,14 | 3,76 | 17,14 | | | | 2,14 | 2,57 | 11,53 |

*The INEGI coordinates applied for comparison correspond to weekly constrained solutions.

The available solutions were reviewed concerning their SINEX format and the suitability for combination of unconstrained normal equations. For this purpose, it was necessary to remove the a-priori datum constraints which are included in the weekly solutions. The generation of unconstrained normal equations from the SINEX file provided by CPLAT for the week 1395 failed and it could not be included into the combination.

4 Pre-processing of solutions

Before combining the individual solutions delivered by the EPCs on the level of unconstrained normal equations various pre-processing steps were performed:

4.1 Renaming of stations

The Rio Agreement recommends that all SIRGAS-CON stations shall be identified by an IERS domes number. So, the station information provided in the SINEX files must be consistent with the IERS domes number data bank (<http://itrf.ensg.ign.fr/select.php>). However, some stations were integrated in the EPC's routinely processing before they had the corresponding domes number, and in some cases, erroneous domes numbers were given. Consequently, it was necessary to identify this kind of mistakes and to rename the stations, avoiding inconsistencies and ensuring that the combined positions refer to a unique reference point.

4.2 Transformation of normal equations to identical a-priori values and generation of time series for station coordinates

The free weekly solutions delivered by each EPC are aligned to the IGS05 positions of the current epoch using a 7-parameter similarity transformation (the IGS05 stations available in the region are displayed in Figure 1, coordinates and velocities are available at <ftp://igscb.jpl.nasa.gov/igscb/station/coord/IGS05.snx>). After that, coordinate time series are generated for each EPC and compared with each other and with DGFI. This procedure is helpful to identify outliers in the time series and their possible causes: if outliers, jumps, or interruptions are identifiable in the different EPCs series, the problems may be associated to the station (tracking deficiencies, equipment changes, failure of the data submission, etc.). If outliers, jumps, or interruptions are not present in all time series, the deficiencies may be associated to administrative issues (neglecting of stations, incomplete download of RINEX files, not observance of the log files, etc.). Annex 8 presents the 'original' time series derived for the EPCs, i.e., they contain all outliers, stations inconsistencies, etc. In general, the individual time series are very similar. The prevalent discrepancies between the series derived from the EPCs and those from DGFI are related to the exclusion of some stations during some weeks; see for instance AUTF, BANS, ETCG, MARA, PIE1, and VBCA. (DGFI series start in the GPS week 1400 because before relative PCVs were applied). The real serious discrepancies are caused by including in the processing erroneous antenna types for some sites. In this way, wrong corrections for the PCVs are applied and these stations are biased in the weekly solutions. Selected examples of this incorrectness are CFAG, TUCU, and MZAS. DGFI processes station CFAG taken into account the radome covering the antenna (according to the site log file), CPLAT neglected the radome during the considered period (GPS weeks 1395 until 1468), and IBGE took into account the radome until GPS week 1414 (2007/02/11); after that, IBGE neglected the radome, too. Solutions neglecting the radome are biased about 15 mm, which are completely translated into the combined solution (Figure 4).

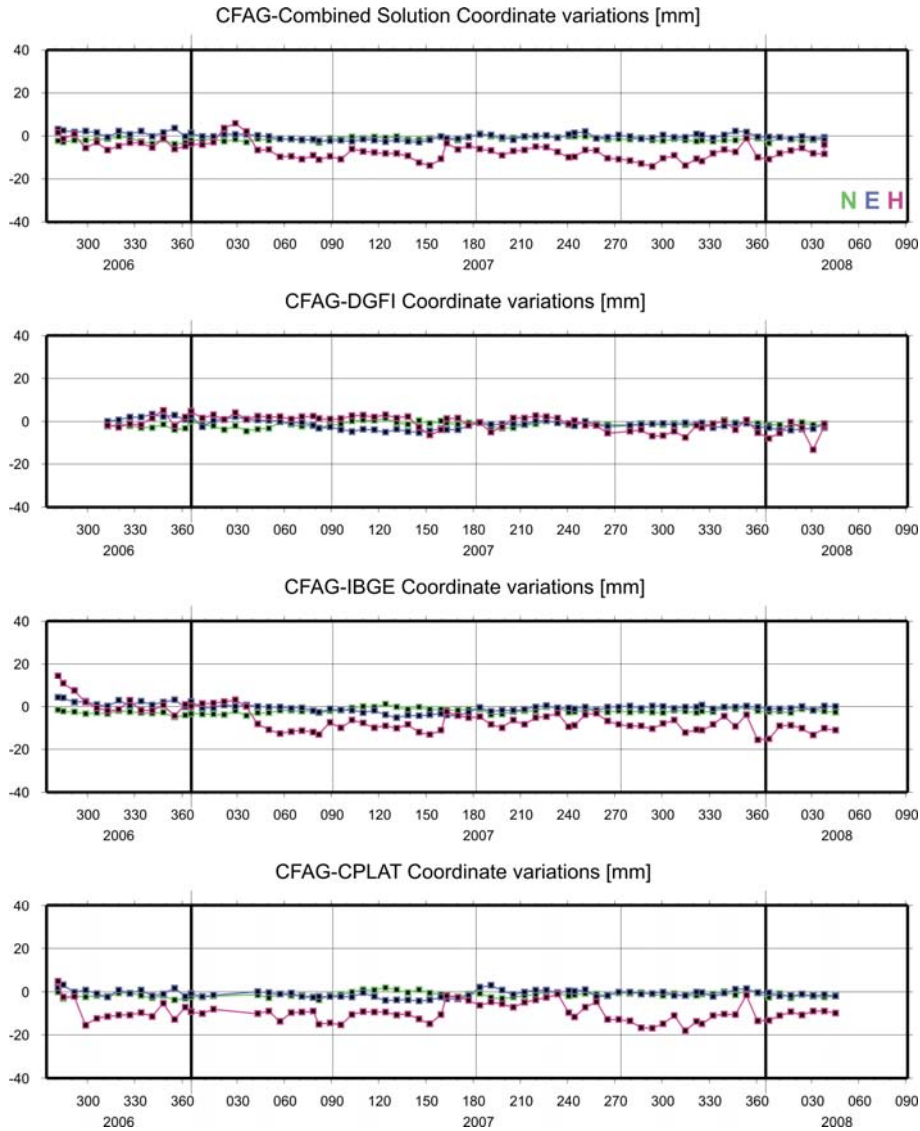


Figure 4. Time series for station CFAG: CPLAT and IBGE neglected the radome covering the antenna (IBGE since 2007/02/11). As a consequence, the vertical component is biased by about 15 mm.

Table 4 summarizes the differences between the phase centre offsets for the antenna without and with the corresponding radome. Although these differences are under the 1 mm-level, it should keep in mind that the corrections for the zenith-dependent phase variations are added to these offsets, and they can reach values until 15 mm for an elevation angle of 90° . Therefore, the caused bias is not constant, it can not be reduced in the combination process, and the station must be excluded.

In the second example, station TUCU, IBGE considered an erroneous antenna until GPS week 1414 (2007/02/11). It causes a bias of about 20 mm in the height component (Figure 5). Again, the discrepancies between the corresponding offsets presented in Table 4 are under the 1 mm-level, but the biases in the final positions are considerably larger. For station MZAS, DGFI did not take into account the radome, while CPLAT and IBGE did it. By comparing the individual solutions, DGFI presents a discrepancy of about 35 mm with respect to the other two solutions (Figure 6). Annex 4 summarizes the station information inconsistencies (with respect to the site log files) found in the weekly solutions delivered by CPLAT, IBGE, and IGAC.

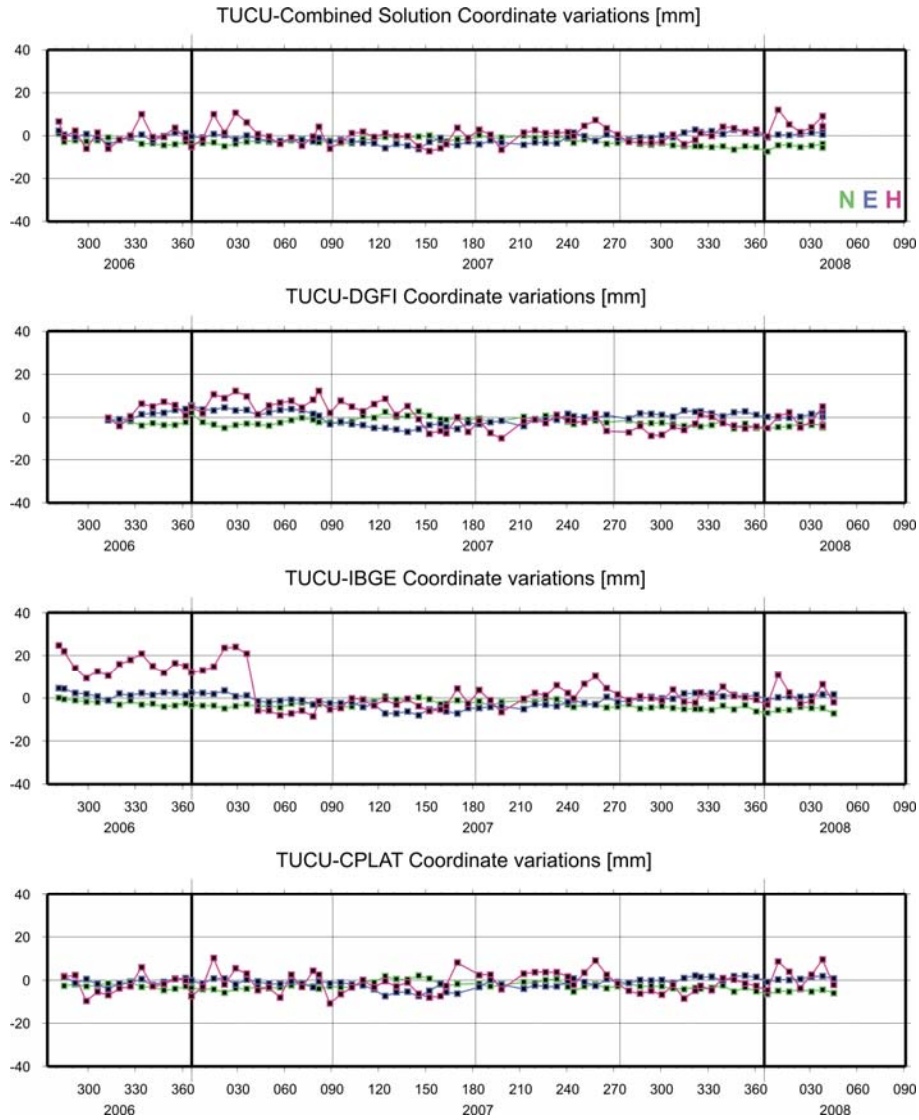


Figure 5. Time series for station TUCU: IBGE included (until 2007/02/11) a different antenna as CPLAT and DGFI for the weekly processing. Height component is therefore biased. The combined solution does not include the TUCU station processed by IBGE before 2007/02/11.

Table 4. PCV offset differences between the antenna type described in the site log files and the antenna type reported in the SINEX files for stations CFAG, TUCU and MZAS.

| Station | Erroneous Antenna | L | Phase centre offsets [mm] | | | Correct Antenna | Phase centre offsets [mm] | | | Differences [mm] | | |
|---------|----------------------|---|---------------------------|------|-------|----------------------|---------------------------|------|-------|------------------|------|------|
| | | | N | E | h | | N | E | h | N | E | h |
| CFAG | ASH700936D_M SNOW | 1 | 0,5 | -0,1 | 91,0 | ASH700936D_M NONE | 0,8 | 0,0 | 91,5 | 0,3 | 0,1 | 0,5 |
| | | 2 | 0,3 | 0,0 | 120,2 | | 0,8 | 0,0 | 120,4 | 0,5 | 0,0 | 0,2 |
| TUCU | AOAD/M_T NONE | 1 | 0,6 | -0,5 | 91,2 | ASH700936C_M SNOW | -0,1 | -0,5 | 90,4 | -0,7 | 0,0 | -0,8 |
| | | 2 | -0,1 | -0,6 | 120,1 | | -0,5 | 0,4 | 120,1 | -0,4 | 1,0 | 0,0 |
| MZAS | TRM29659,00 NONE | 1 | -0,1 | -0,9 | 92,0 | TRM29659,00 UNAV | 1,4 | 1,4 | 88,9 | 1,5 | 2,3 | -3,1 |
| | | 2 | -0,2 | 0,2 | 120,5 | | -0,8 | -0,7 | 119,4 | -0,6 | -0,9 | -1,1 |

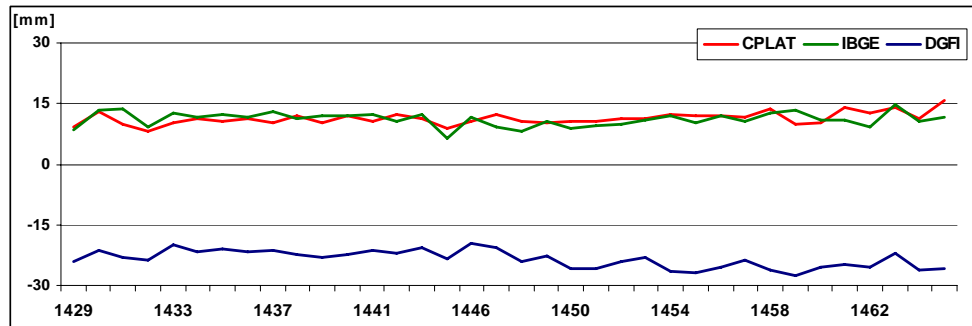


Figure 6. Residuals for the height of station MZAS: CPLAT and IBGE took into account the radome covering the antenna, DGFI did not. DGFI estimates are biased by about 35 mm.

4.3 Reduction of stations for the weekly combination of individual solutions

To avoid deformations in the combined network, those stations with very large outliers (more than 50 mm in any component) are reduced from the weekly normal equations. The identification of these outliers is carried out by means of:

- a) Determination of time series for each station included in the individual solutions and the consequent analysis of the weekly RMS values. If these values are larger than 50 mm and they appear sporadically (without pattern), the station is reduced from the normal equation for the corresponding week. As an example, we can mention the CPLAT time series for station BOMJ (Annex 8), it presents this kind of outliers for the weeks 1438, 1439 and 1458;
- b) Combination of the free weekly solutions provided by the EPCs with those generated by DGFI. Stations with RMS values larger than 50 mm with respect to the other solutions are analysed in order to identify the possible reasons for outliers. If they can not be corrected, the stations are reduced for the corresponding week. DGFI weekly solutions are not included in the final combination (see Section 5).

Annex 5 summarizes the reduced stations from the individual solutions, including the time period and the reason for reduction. In general, the largest outliers are associated to the erroneous antenna identification.

5 Combination

Input data for the combination are normal equations obtained from the three EPCs CPLAT, IBGE, and IGAC after reducing large outliers. The combination consists of the following steps:

5.1 Datum realization

The geodetic datum is defined by constraining coordinates and velocities by the conditions ‘no net rotation’ (NNR) and ‘no net translation’ (NNT) with respect to the IGS05 stations available in the region (Figure 1).

5.2 Relative weighting of individual EPC solutions

The determination of relative weighting factors (also called re-scaling factors) is necessary to compensate possible differences in the stochastic models of the EPCs. To validate the stochastic models we compare mean standard deviations of coordinates derived from solving the normal equations (see item a) with mean RMS values derived from the time series of station coordinates. The last ones reflect the real accuracy of the daily/weekly coordinate solutions. If the relation between the standard deviations of the different EPCs is the same as the relation between the RMS values, the stochastic models of the EPCs are comparable and it is not necessary to apply relative weighting factors. To ensure that the RMS values are not dominated by individual stations, they are computed in four different ways (items b to e). The computation of the standard deviations and RMS values was done as follows:

- a) Determination of mean standard deviations based on minimum datum conditions (NNR+NNT) with respect to the IGS05 stations;
- b) Evaluation of the daily coordinate repeatability with respect to the weekly solutions derived for each EPC separately (the solutions were obtained from free daily normal equations constrained to the IGS05 coordinates). The RMS values were analyzed including all processed stations, as well as the IGS05 stations only;
- c) Evaluation of the individual weekly repeatability of station coordinates with respect to a cumulative solution calculated separately for each EPC;
- d) Comparison of the individual weekly solutions with respect to the combined weekly solution;
- e) Comparison of the individual weekly solutions with respect to the weekly IGS Global Network combination (files `igsYYPwww.snx` available at <ftp://cddis.gsfc.nasa.gov/gps/products/www/>);

Table 5 summarizes the mean values for the described approaches over the total analyzed period (GPS weeks 1395 until 1468). The different RMS values b), c) and d) agree very well and can be averaged. The RMS values derived from approach e) look a bit different. As they are computed with respect to an independent solution, they are not used in the averaging. The scaling factors are calculated with respect to the IGAC values. In general, it seems that CPLAT solutions are more imprecise (in a factor of 1,2) than those from IBGE and IGAC, while these two are in a better agreement with each other. This relation is shown by the standard deviations and the RMS values as well. However, keeping in mind that the three processing centres are applying the same processing strategy (double differences), the same software (BERNESE), the same satellite orbits, satellite clock offsets, and Earth orientation parameters (final IGS products), as well as the same observations (RINEX files) for the common stations, we can conclude that the parameters estimated by each of the contributing solutions are at the same accuracy level (i.e. there are no differences in the stochastic models) and a relative weighting of the EPCs is not necessary.

Table 5. Scale factors (with respect to IGAC values) for the individual normal equations generated by each Experimental Processing Centre following different approaches.

| Approach | CPLAT | | | | IBGE | | | | IGAC | | | | Scaling factors wrt IGAC | | |
|--|-------|------|------|-------|------|------|------|-------|------|------|------|-------|--------------------------|------|------|
| | N | E | H | Total | N | E | H | Total | N | E | H | Total | CPLAT | IBGE | IGAC |
| a) Mean standard deviation | 1,92 | | | | 1,68 | | | | 1,52 | | | | 1,3 | 1,1 | 1,0 |
| b) RMS residuals for daily repeatability [mm]: | | | | | | | | | | | | | | | |
| all stations | 2,19 | 2,52 | 6,27 | 7,10 | 2,05 | 2,02 | 5,74 | 6,42 | 1,94 | 1,89 | 5,37 | 6,02 | 1,2 | 1,1 | 1,0 |
| IGS05 stations only | 2,24 | 2,67 | 6,46 | 7,34 | 1,99 | 2,03 | 5,47 | 6,17 | 1,82 | 1,91 | 5,31 | 5,93 | 1,2 | 1,0 | 1,0 |
| c) RMS residuals for weekly repeatability [mm] | 2,21 | 2,08 | 5,22 | 6,03 | 1,97 | 1,77 | 4,72 | 5,41 | 2,29 | 1,87 | 3,98 | 4,95 | 1,2 | 1,1 | 1,0 |
| d) RMS residuals wrt combined solution [mm] | 0,79 | 1,18 | 2,57 | 2,94 | 0,79 | 1,00 | 2,39 | 2,70 | 0,50 | 0,82 | 2,10 | 2,29 | 1,3 | 1,2 | 1,0 |
| Mean value | | | | | | | | | | | | | 1,2 | 1,1 | 1,0 |
| e) RMS residuals wrt IGS Global Stations [mm] | 2,65 | 2,72 | 4,11 | 5,60 | 2,91 | 3,10 | 4,35 | 6,08 | 2,31 | 3,02 | 4,30 | 5,72 | 1,0 | 1,1 | 1,0 |

5.3 Correction for the stochastic model of the combined solutions

The individual EPC solutions contributing to the combined one include common stations and they are therefore highly correlated. In spite of this, the EPC solutions are initially treated as independent within the combination. In this manner, the stochastic model of the combined solution is damaged: the standard deviations of the coordinates are overestimated by a factor of about \sqrt{n} (number of EPCs including each station). To correct the stochastic model, the standard deviations have to be multiplied by this factor and the variance-covariance matrix by the square of the factor, respectively. If each station is included in exactly the same number of individual solutions, this procedure can easily be carried out. However, due to different causes the station distribution between the EPCs included in the Rio Agreement is not fulfilled at present: some of the stations are included in one solution, in two solutions, or in the three solutions (Figure 2). It implies that the stochastic model of the combined solution cannot be corrected by one (unique) factor. It is necessary to determine separately correction factors for the stations, depending on the number of contributing EPC solutions where they are included. At present, we are trying to implement a method to compute and apply these factors directly in the combination software. In the mean time, it is not possible and therefore, this report does not take into account corrections for the stochastic model of the combined solutions. A good alternative to avoid this procedure is to guarantee that each regional station is included in exactly the same number of individual solutions. For that, a redistribution of the stations between the different EPCs would be necessary.

5.4 Identification and rejection of outliers

In the pre-processing step, stations with large residuals (more than 50 mm), caused mainly by antenna information inconsistencies, were reduced. Nevertheless, it is expected that additional discrepancies between the individual solutions are identified in the weekly combination. The detection of these discrepancies was carried out by comparing each station in each solution with the mean of the other two solutions. Differences exceeding

five times the mean RMS values derived from the time series (i.e. $N = (5 \times 2)$ mm, $E = (5 \times 2)$ mm, $H = (5 \times 4)$ mm) were assumed as outliers, and the corresponding stations were excluded from the respective weekly solution. Annex 5 lists all stations that were reduced from the EPCs normal equations before the combination.

5.5 Combined solutions

Input for the combined solutions are the unconstrained weekly normal equations after reducing stations with large outliers for each EPC. These normal equations are added and solved by applying the BERNESE software. The geodetic datum is realized by NNT and NNR conditions with respect to the IGS05 positions and velocities available in the region (Figure 1). Three types of combined solutions are generated each week: a weekly constrained solution (fixed coordinates and cofactor matrix for internal control), an accumulated constrained solution (fixed coordinates, velocities, and cofactor matrix for applications), and a free weekly solution (unconstrained normal equations for later computations). Nevertheless, in the case of the cumulative solutions, it should be kept in mind that 73 weeks (the best case at present) represent a very short time period to estimate reliable velocities.

6 Evaluation of individual and combined solutions

The accuracy evaluation of the different steps included in the experimental project initiated in Rio (processing of SIRGAS-CON sub networks and their combination) was performed as follows:

6.1 Individual solutions

The combined solution was used to evaluate the accuracy of the individual solutions delivered by the EPCs. Mean standard deviations for station positions were estimated by using the reference IGS05 stations included in each weekly solution. In addition, RMS residuals were computed by comparing weekly solutions of each EPC with respect to i) the combined solution, and ii) the weekly combination of the IGS global network. The results are summarized in Figure 7. To simplify the diagrams, values for each fifth week are presented. The mean standard deviations, which represent the formal errors of the individual solutions, are in reasonable agreement. They are about 1,9 mm for CPLAT, 1,7 mm for IBGE, and 1,5 mm for IGAC. The RMS values obtained after comparing the individual solutions with the combined one are smaller than those derived from comparing the individual solutions with the weekly combination of the IGS global network. The last ones are larger about 1,9 mm in the horizontal component and 1,7 mm in the vertical component. Residuals for CPLAT and IBGE agree quite well, since they are processing almost the same sub network. It seems that IGAC fits the combined solution better than the other two EPCs, but this can be explained by the fact, that the network processed by IGAC is not contained in another contributing solution. The discrepancies between the individual solutions and the IGS global network values can be a consequence of the inhomogeneous distribution of IGS stations in the region, as well as, of particular problems in some of them. For instance, some stations (like MANA or OHI2) frequently present jumps in their time series, stations with periodical signals (like BRAZ, CRO1 or CHPI) are considered with linear movements, etc.



Figure 7. Mean standard deviations for the individual EPC solutions and RMS residuals between the EPC's weekly solutions and the combined solutions, as well as, with respect to the weekly IGS global network combination. (values for each fifth week are presented).

In general, one can say that the individual solutions present accuracies (internal consistency) of about 1,5 mm for the horizontal position and better than 2,5 mm for the vertical one, while their reliability (comparison with respect to IGS05 values) is about 2,5 mm for the horizontal components and 4,5 mm for the vertical one. Annexes 6 and 7 present the same content of Figure 7 by showing the north, east, and height components for each EPC. It also includes time series for the 7 transformation parameters obtained by comparing the individual weekly solutions with the combined ones. The comparison between the individual solutions and the weekly IGS global network combination was carried out with coordinate values directly; a 7-parameter similarity transformation was not applied here.

6.2 Weekly combined solutions

The weekly combined solutions are constrained by means of NNR+NNT conditions to the IGS05 values of the reference stations (Figure 1). The obtained coordinates are compared with the weekly constrained solutions made available by DGFI at the server <ftp.dgfi.badw-muenchen.de/pub/gps/DGF>, and with the weekly IGS global network combination (files `igsYYP_www.snx` available at <ftp://cddis.gsfc.nasa.gov/gps/>

[products/www](#)). Figure 8 summarizes the results. Similarly to Figure 7, values for each fifth week are shown.

Although the combined network normally contains the same stations processed by IGS-RNAAC-SIR, the discrepancies between the combined solutions and DGFI are considerably large, specially in the vertical component (~ 3 mm). The processed network has a larger coverage in the north-south direction than in the east-west direction. It can explain the smaller residuals for the north component than for the east component. The residuals of the combined solutions with respect to the IGS global stations agree quite well with the residuals obtained after comparing the individual solutions with the IGS global network points. The reliability of the weekly combined solutions over the analyzed period is about 3 mm for the horizontal component and 4,5 mm for the vertical one.

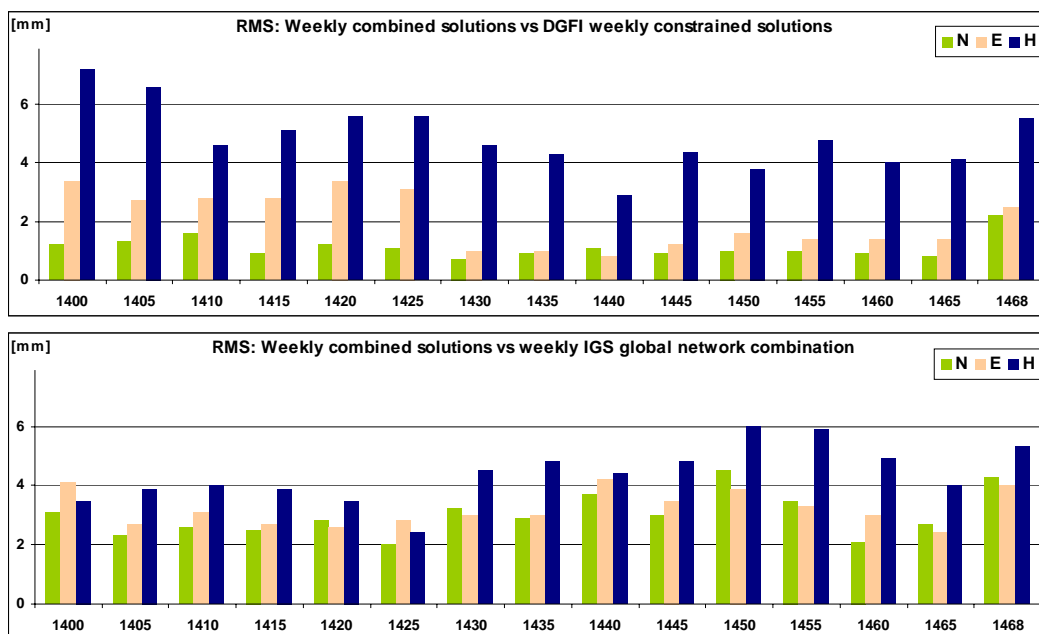


Figure 8. RMS residuals between the weekly combined solution and the constrained IGS-RNAAC-SIR coordinates, as well as with respect to the weekly IGS global network combination (values for each fifth week are presented).

6.3 Cumulative combined solution

Cumulative solutions are necessary to find outliers in the time series of the weekly combined solutions and to make available station velocities. However, since the time period is too short (73 weeks), this procedure is included in the present report only to show how to perform this step, when the SIRGAS processing and combination strategy is installed as a routinely process. As an example, the cumulative solution for the GPS week 1468 is presented. The geodetic datum was defined by the NNR+NNT conditions with respect to the IGS05 coordinates and velocities of the following sites: CHPI, CONZ, CRO1, GLPS, GOLD, LPGS, MDO1, OHI2, SANT, and UNSA (until 2007/12/31, after that this station shows too large residuals). Stations BRAZ, MANA, PIE1, and SCUB are not included as reference points because: i) the year signal component in the height variations of BRAZ is not totally represented in the analyzed time period and the linear velocity included in IGS05 is not reliable; ii) MANA presents a strong jump in the vertical component at the beginning of September, 2007; iii) the time series for PIE1 is

too short (less than one year); iv) the time series for SCUB includes RMS values larger than 20 mm.

Resulting coordinates and velocities are compared with the latest IGS-RNAAC-SIR solution (DGF08P01-SIR, available at www.sirgas.org), and the IGS05 reference values (<ftp://igscb.jpl.nasa.gov/igscb/station/coord/IGS05.snx>). Figure 9 presents the histograms with position and velocity differences between DGF08P01-SIR and the cumulative solution for GPS week 1468 for 99 common stations. For about 80% of all common sites the difference in positions and velocities are below 3 mm and 3 mm/yr, respectively. However, there are about 11 stations with position and velocity differences larger than 10 mm and 10 mm/yr. Table 6 summarizes the corrections obtained for positions and velocities of the IGS05 sites included as reference frame stations, as well as for the excluded ones. The large differences in the velocities (more than 3 mm/yr) are a consequence of the short time period considered in the cumulative solution. All compared coordinates were reduced to the same reference epoch, in this case 2006-10-01.

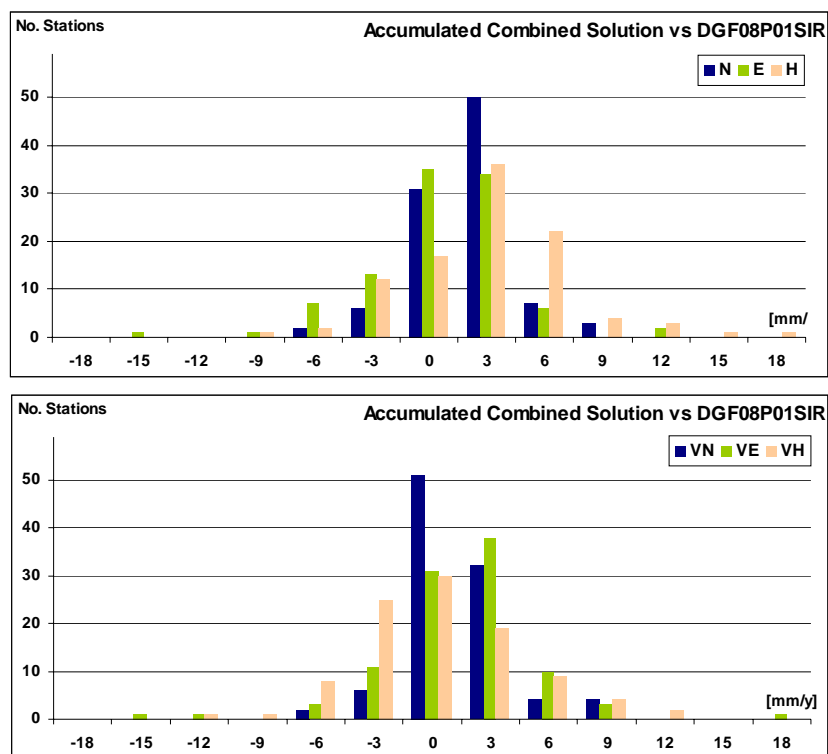


Figure 9. Differences between the combined cumulative solution for week 1468 and the multi-year solution DGF08P01-SIR in station positions (above) and velocities (bellow) for 99 common stations.

Table 6. Corrections obtained in the combined cumulative solution for positions and velocities of the IGS05 sites included as reference frame stations, as well as for the excluded ones.

| Station | ΔN [mm] | ΔE [mm] | ΔH [mm] | ΔV_N [mm/yr] | ΔV_E [mm/yr] | ΔV_H [mm/yr] |
|--|-----------------|-----------------|-----------------|----------------------|----------------------|----------------------|
| CHPI | 0,7 | 0,9 | -4,2 | 0,3 | 0,5 | 1,4 |
| CONZ | -0,5 | 1,3 | 2,6 | 0,2 | 1,6 | 0,7 |
| CRO1 | 2,7 | 1,8 | 2,0 | 1,0 | -3,2 | -3,3 |
| GLPS | -1,1 | -3,5 | 5,1 | 1,3 | -0,2 | 3,3 |
| GOLD | 1,8 | -1,1 | -0,7 | 1,5 | 0,9 | 0,7 |
| LPGS | -2,2 | 3,4 | 0,8 | -0,9 | -1,4 | 0,9 |
| MDO1 | 1,4 | -1,9 | -3,1 | 0,8 | 0,4 | -0,2 |
| OHI2 | -0,1 | 0,7 | -3,5 | -3,1 | 1,0 | 0,4 |
| SANT | -1,4 | -2,0 | 2,9 | -1,1 | -0,2 | -1,0 |
| UNSA | -2,1 | 2,1 | 2,1 | -1,0 | 0,7 | 0,4 |
| IGS05 sites that were not used as reference frame stations | | | | | | |
| BRAZ | -0,9 | -2,9 | 0,3 | 0,7 | -1,5 | 7,3 |
| MANA | -6,9 | -2,2 | -3,6 | -2,3 | 3,2 | -11,6 |
| PIE1 | 8,5 | -3,2 | -8,0 | 0,7 | -1,7 | -0,3 |
| SCUB | 2,9 | 4,7 | 7,3 | 3,2 | 0,0 | -8,3 |

7 Conclusions and recommendations

DGFI as a SIRGAS Experimental Combination Centre has reviewed, compared, and combined the individual solutions delivered by three SIRGAS Experimental Processing Centres (namely CPLAT, IBGE, and IGAC) installed in Rio de Janeiro in August 2006. The analyzed period corresponds to the GPS weeks 1395 - 1468. The results permit to conclude that these three Processing Centres become capable to satisfy the administrative and quality processing requirements defined in the Rio Agreement. Their weekly solutions are at the same accuracy level with respect to each other and with respect to the IGS-RNAAC-SIR solutions. The individual solutions present accuracies (internal consistency) of about 1,5 mm for the horizontal position and better than 2,5 mm for the vertical one. Their realization accuracy with respect to the IGS05 frame (external precision) is about 2,5 mm for the horizontal components and 4,5 mm for the vertical one. In the same way, the weekly combination of the individual solutions provides accuracies of about 3 mm for the horizontal component and 4,5 mm for the vertical one.

The major deficiencies in the individual solutions relate to systematic biases caused by applying erroneous antennae (+ radome) in the weekly processing. This is a consequence of:

- a) Log files do not include always the correct denomination for the equipment, i.e. they are not aligned with the conventional names given by the IGS (http://igsceb.jpl.nasa.gov/igsceb/station/general/rcvr_ant.tab);
- b) There are two or more valid log files for some sites. These log files present different equipments for the same period and the same station, and it is not clear which one is the correct one;
- c) Changes in the station equipments are not opportunely reported. There are often time spans in which e.g. the station has a new antenna, but the log file is not appropriately updated;
- d) Processing centres are informed about the equipment changes too late.

Recommendation 1: It is mandatory to review and to update the existing log files for the regional SIRGAS-CON stations and to ensure completeness and correctness of their content. For the IGS global stations, IGS log files must be applied. Detected discrepancies have to be reported to IGS.

Recommendation 2: Processing centres must align their station information reference files with the actualized log files as soon as possible.

Recommendation 3: Operators of SIRGAS-CON stations shall routinely inform about changes or problems in the stations. The SIRMAIL exploder is very useful for this purpose.

The SIRGAS-CON network has improved continuously in terms in the number of sites (in GPS week 1468, it comprises 169 stations) as well as their continental distribution. At present, more and more Latin American countries are qualifying their national reference frames by installing continuously operating GNSS stations. Until now, SIRGAS procured to include all available stations in the SIRGAS-CON network; however, not all of them operate homogeneously. About 20% of the processed stations present very large data gaps, or jumps in their time series; i.e. all SIRGAS-CON stations do not fully satisfy accuracy, reliability, and homogeneity requirements for a precise reference frame with long-term stability. Additionally, if the number of continuously operating stations is continuously increasing with the same velocity as it does until now; in the near future the operational capabilities of the processing centres will be overloaded. Therefore:

Recommendation 4: Similarly to the first SIRGAS campaign performed in 1995, it is necessary to define a core network with a good continental coverage and stable site locations to ensure high long-term stability of the reference frame. This core network should serve as frame for the national densification networks, which, despite of being composed by continuously operating stations, remain densification networks and their stations do not have to be included in the continental reference frame. The SIRGAS-CON ‘core’ network shall contain those sites that, due to their quality and reliability, can be included into the IGS global network as well as in the ITRF solutions.

The combination strategy applied in this report is based on the combination of normal equations; this approach directly allows the analysis of constraints (which eventually might be introduced in the computations), and, in the case of unconstrained normal equations, the combination can be directly done without inversion. To ensure a high consistency and accuracy of the combined solution, it is essential that the solutions of the EPC are consistent concerning modelling and parameterization. This demands the adoption of common standards and models according to the most recent set of conventions, e.g. IERS conventions (<http://www.iers.org/>); presentations and conclusions of the GGOS Unified Analysis Workshop, held in Monterey, USA, December 5th to 7th, 2007 (<http://www.iers.org/MainDisp.csl?pid=66-1100205>). According to this:

Recommendation 5: SIRGAS analysis centres shall permanently align their processing strategies to the IERS (i.e. IGS) conventions, but coordinated under the umbrella of the

SIRGAS-WGI to update simultaneously their strategies. The individual solutions delivered for combination should include common standards and models, and in order to avoid problems concerning the reduction of constraints, unconstrained normal solutions should be provided.

Recommendation 6: If constrained solutions are delivered, all constraints have to be reported in the corresponding SINEX files, i.e. the statistical information (e.g., number of observations, number of unknowns, variance factor) necessary for combining at the normal equation level, has to be included in the SINEX files.

Recommendation 7: To get homogeneous accuracies for station positions and velocities in the combined solutions, it is desirable to redistribute the regional SIRGAS-CON stations between the operative processing centres in such a way that each regional SIRGAS-CON station is included in the same number (one, two or more) of individual solutions.

Annex 1: Solution delivery of the SIRGAS Experimental Processing Centres

| EAC | CPL | GMA | IBG | IGA | INE |
|-----------------|----------|----------|----------|-------------------|----------|
| 1395 / 30.10.06 | 17.11.06 | | 04.12.06 | 14.12.06/01.02.07 | 08.01.08 |
| 1396 / 06.11.06 | 20.11.06 | | 04.12.06 | 15.12.06/01.02.07 | 08.01.08 |
| 1397 / 13.11.06 | 20.11.06 | | 04.12.06 | 01.02.07 | 08.01.08 |
| 1398 / 20.11.06 | 27.12.06 | | 04.12.06 | 01.02.07 | 08.01.08 |
| 1399 / 27.11.06 | 27.12.06 | | 04.12.06 | 01.02.07 | 08.01.08 |
| 1400 / 04.12.06 | 26.12.06 | 06.06.07 | 07.12.06 | 01.02.07 | 08.01.08 |
| 1401 / 11.12.06 | 27.12.06 | | 18.12.06 | 01.02.07 | 08.01.08 |
| 1402 / 18.12.06 | 28.12.06 | | 21.12.06 | 01.02.07 | 08.01.08 |
| 1403 / 25.12.06 | 02.01.07 | | 28.12.06 | 01.02.07 | 08.01.08 |
| 1404 / 01.01.07 | 03.01.07 | | 02.01.07 | 01.02.07 | 08.01.08 |
| 1405 / 08.01.07 | 04.01.07 | | 08.01.07 | 01.02.07 | 08.01.08 |
| 1406 / 15.01.07 | 09.01.07 | | 16.01.07 | 06.02.07 | 08.01.08 |
| 1407 / 22.02.07 | 22.01.07 | | 23.01.07 | 01.02.07 | 08.01.08 |
| 1408 / 29.01.07 | 01.02.07 | | 26.01.07 | 06.02.07 | 08.01.08 |
| 1409 / 05.02.07 | 05.02.07 | | 05.02.07 | 14.02.07 | 08.01.08 |
| 1410 / 12.02.07 | 07.02.07 | | 13.02.07 | 13.02.07 | 08.01.08 |
| 1411 / 19.02.07 | 13.02.07 | | 15.02.07 | 21.02.07 | 08.01.08 |
| 1412 / 26.02.07 | 20.02.07 | | 23.02.07 | 27.02.07 | 08.01.08 |
| 1413 / 05.03.07 | 27.02.07 | | 09.03.07 | 13.04.07 | 08.01.08 |
| 1414 / 12.03.07 | 06.03.07 | | 13.03.07 | 13.04.07 | 08.01.08 |
| 1415 / 19.03.07 | 13.03.07 | | 19.03.07 | 13.04.07 | 08.01.08 |
| 1416 / 26.03.07 | 20.03.07 | | 26.03.07 | 15.04.07 | 08.01.08 |
| 1417 / 02.04.07 | 27.03.07 | | 29.03.07 | 23.04.07 | 08.01.08 |
| 1418 / 09.04.07 | 11.04.07 | | 19.04.07 | 20.04.07 | 08.01.08 |
| 1419 / 16.04.07 | 20.04.07 | | 19.04.07 | 25.04.07 | 08.01.08 |
| 1420 / 23.04.07 | 24.04.07 | | 25.04.07 | 26.04.07 | 08.01.08 |
| 1421 / 30.04.07 | 02.05.07 | | 04.05.07 | 30.04.07 | 08.01.08 |
| 1422 / 07.05.07 | 09.05.07 | | 08.05.07 | 16.05.07 | 08.01.08 |
| 1423 / 14.05.07 | 15.05.07 | | 11.05.07 | 16.05.07 | 08.01.08 |
| 1424 / 21.05.07 | 23.05.07 | | 29.05.07 | 30.05.07 | 08.01.08 |

in time

acceptabel

too late

| EAC | CPL | GMA | IBG | IGA | INE |
|-----------------|----------|-----|----------|----------|----------|
| 1425 / 28.05.07 | 29.05.07 | | 01.06.07 | 30.05.07 | 08.01.08 |
| 1426 / 04.06.07 | 02.06.07 | | 12.06.07 | 30.05.07 | 08.01.08 |
| 1427 / 11.06.07 | 10.06.07 | | 12.06.07 | 13.06.07 | 08.01.08 |
| 1428 / 18.06.07 | 20.06.07 | | 15.06.07 | 15.06.07 | 08.01.08 |
| 1429 / 25.06.07 | 24.06.07 | | 25.06.07 | 21.06.07 | |
| 1430 / 02.07.07 | 27.06.07 | | 28.06.07 | 27.06.07 | |
| 1431 / 09.07.07 | 13.07.07 | | 06.07.07 | 06.07.07 | |
| 1432 / 16.07.07 | 13.07.07 | | 16.07.07 | 18.07.07 | |
| 1433 / 23.07.07 | 17.07.07 | | 18.07.07 | 19.07.07 | |
| 1434 / 30.07.07 | 26.07.07 | | 26.07.07 | 14.08.07 | |
| 1435 / 06.08.07 | 04.08.07 | | 03.08.07 | 14.08.07 | |
| 1436 / 13.08.07 | 10.08.07 | | 16.08.07 | 15.08.07 | |
| 1437 / 20.08.07 | 15.08.07 | | 17.08.07 | 21.08.07 | |
| 1438 / 27.08.07 | 25.08.07 | | 23.08.07 | 24.08.07 | |
| 1439 / 03.09.07 | 01.09.07 | | 30.08.07 | 28.08.07 | |
| 1440 / 10.09.07 | 08.09.07 | | 04.09.07 | 03.09.07 | |
| 1441 / 17.09.07 | 12.10.07 | | 12.09.07 | 11.09.07 | |
| 1442 / 24.09.07 | 13.10.07 | | 21.09.07 | 18.09.07 | |
| 1443 / 01.10.07 | 14.10.07 | | 26.09.07 | 21.09.07 | |
| 1444 / 08.10.07 | 12.10.07 | | 05.10.07 | 02.10.07 | |
| 1445 / 15.10.07 | 12.10.07 | | 11.10.07 | 05.10.07 | |
| 1446 / 22.10.07 | 22.10.07 | | 17.10.07 | 12.10.07 | |
| 1447 / 29.10.07 | 25.10.07 | | 01.11.07 | 20.10.07 | |
| 1448 / 05.11.07 | 02.11.07 | | 01.11.07 | 29.10.07 | |
| 1449 / 12.11.07 | 09.11.07 | | 21.11.07 | 02.11.07 | |
| 1450 / 19.11.07 | 15.11.07 | | 22.11.07 | 14.11.07 | |
| 1451 / 26.11.07 | 28.11.07 | | 27.11.07 | 20.11.07 | |
| 1452 / 03.12.07 | 28.11.07 | | 29.11.07 | 23.11.07 | |
| 1453 / 10.12.07 | 05.12.07 | | 05.12.07 | 26.12.07 | |
| 1454 / 17.12.07 | 12.12.07 | | 13.12.07 | 26.12.07 | |

in time

acceptabel

too late

| EAC | CPL | GMA | IBG | IGA | INE |
|-----------------|----------|-----|----------|----------|-----|
| 1455 / 24.12.07 | 19.12.07 | • | 19.12.07 | 26.12.07 | |
| 1456 / 31.12.07 | 24.12.07 | | 08.01.08 | 28.12.07 | |
| 1457 / 07.01.08 | 03.01.08 | | 08.01.08 | 08.01.08 | |
| 1458 / 14.01.08 | 07.01.08 | | 17.01.08 | 08.01.08 | |
| 1459 / 21.01.08 | 18.01.08 | | 22.01.08 | 11.01.08 | |
| 1460 / 28.01.08 | 28.01.08 | | 23.01.08 | 21.01.08 | |
| 1461 / 04.02.08 | 01.02.08 | | 08.02.08 | 28.01.08 | |
| 1462 / 11.02.08 | 06.02.08 | | 12.02.08 | 13.02.08 | |
| 1463 / 18.02.08 | 13.02.08 | | 19.02.08 | 13.02.08 | |
| 1464 / 25.02.08 | 21.02.08 | | 27.02.08 | 15.02.08 | |
| 1465 / 03.03.08 | 03.03.08 | | 28.02.08 | 05.03.08 | |
| 1466 / 10.03.08 | 10.03.08 | | 06.03.08 | 07.03.08 | • |
| 1467 / 17.03.08 | 12.03.08 | | 12.03.08 | 13.03.08 | |
| 1468 / 24.03.08 | 19.03.08 | | 20.03.08 | 18.03.08 | |
| 1469 / 31.03.08 | 01.04.08 | | 26.03.08 | 26.03.08 | |
| 1470 / 07.04.08 | 16.04.08 | | 04.04.08 | 01.04.08 | |
| 1471 / 14.04.08 | | | | | |
| 1472 / 21.04.08 | | | | | |
| 1473 / 28.04.08 | | | | | |
| 1474 / 05.05.08 | | | | | |
| 1475 / 12.05.08 | | | | | • |
| 1476 / 19.05.08 | | | | | |
| 1477 / 26.05.08 | | | | | |
| 1478 / 02.06.08 | | | | | |
| 1479 / 09.06.08 | | | | | |
| 1480 / 16.06.08 | | | | | |
| 1481 / 23.06.08 | | | | | |
| 1482 / 30.06.08 | | | | | |
| 1483 / 07.07.08 | | | | | |
| 1484 / 14.07.08 | | | | | |

in time

acceptabel

too late

2. Regional SIRGAS-CON stations included in the individual weekly solutions delivered by the SIRGAS Experimental Processing Centres

Southern part of the SIRGAS-CON network

| Code | Country | CPLAT | IBGE | IGAC | INEGI |
|------|---------|---------|---------|-------|-------|
| AMHU | BR | ok | ok | | |
| ANTC | CL | ok | ok | | |
| AREQ | PE | ok | ok | extra | |
| AUTF | AR | ok | ok | | |
| AZUL | AR | ok | ok | | |
| BELE | BR | ok | ok | | |
| BOAV | BR | ok | missing | | |
| BOMJ | BR | ok | ok | | |
| BRFT | BR | ok | ok | | |
| CEFE | BR | ok | missing | | |
| CFAG | AR | ok | ok | | |
| COPO | CL | ok | ok | | |
| CRAT | BR | ok | ok | | |
| CRUZ | BR | ok | missing | | |
| CUIB | BR | ok | ok | | |
| GVAL | BR | ok | ok | | |
| IGM1 | AR | ok | ok | | |
| IMBT | BR | ok | ok | | |
| IMPZ | BR | ok | ok | | |
| KOUR | FR | ok | ok | extra | |
| LHCL | AR | ok | ok | | |
| MABA | BR | ok | ok | | |
| MAPA | BR | ok | missing | | |
| MCLA | BR | ok | ok | | |
| MECO | AR | ok | ok | | |
| MGIN | BR | ok | ok | | |
| MGUB | BR | ok | missing | | |
| MPLA | AR | ok | ok | | |
| MSCG | BR | ok | missing | | |
| MZAC | AR | ok | ok | | |
| MZAE | AR | ok | ok | | |
| MZAS | AR | ok | ok | | |
| NAUS | BR | ok | ok | | |
| NEIA | BR | ok | ok | | |
| ONRJ | BR | ok | ok | | |
| PALM | AQ | missing | ok | | |
| PARC | CL | ok | ok | | |
| PDES | AR | ok | ok | | |
| PEPE | BR | ok | missing | | |
| PMB1 | SR | ok | ok | | |
| POAL | BR | ok | ok | | |
| POLI | BR | ok | ok | | |
| POVE | BR | ok | ok | | |
| PPTE | BR | ok | ok | | |
| RECF | BR | ok | ok | | |
| RIO2 | AR | ok | ok | | |
| RIOB | BR | ok | missing | | |
| RIOD | BR | ok | ok | | |
| RIOG | AR | ok | ok | | |
| ROGM | BR | ok | missing | | |
| RWSN | AR | ok | ok | | |
| SAGA | BR | ok | missing | | |
| SALU | BR | ok | missing | | |
| SALV | BR | ok | ok | | |

Northern part of the SIRGAS-CON network

| Code | Country | CPLAT | IBGE | IGAC | INEGI |
|------|---------|-------|-------|------|---------|
| ANDS | CO | | | ok | missing |
| APTO | CO | | | ok | missing |
| AREQ | PE | | | ok | missing |
| BANS | VE | | extra | ok | missing |
| BDOS | BB | | | ok | ok |
| BERR | CO | | | ok | missing |
| BOGA | CO | | | ok | missing |
| BOGT | CO | extra | extra | ok | missing |
| BQLA | CO | | | ok | missing |
| BRMU | UK | | | ok | ok |
| BUCA | CO | | | ok | missing |
| BUEN | CO | | | ok | missing |
| CALI | CO | | | ok | missing |
| CAM2 | MX | | | ok | ok |
| CART | CO | | | ok | missing |
| CBSB | UK | | | ok | missing |
| CHET | MX | | | ok | ok |
| CHIH | MX | | | ok | ok |
| CIC1 | MX | | | ok | ok |
| COL2 | MX | | | ok | ok |
| CRCS | VE | | extra | ok | missing |
| CUCU | CO | | | ok | missing |
| CULC | MX | | | ok | ok |
| CULI | MX | | | ok | ok |
| DORA | CO | | | ok | missing |
| ELEN | GT | | | ok | missing |
| ETCG | CR | | | ok | missing |
| EXU0 | BS | | | ok | missing |
| FLOR | CO | | | ok | missing |
| FQNE | CO | | | ok | missing |
| GCGT | UK | | | ok | missing |
| GRE0 | GD | | | ok | missing |
| GTK0 | UK | | | ok | missing |
| GUAT | GT | | | ok | ok |
| GUAV | CO | | | ok | missing |
| HER2 | MX | | | ok | ok |
| IBAG | CO | | | ok | missing |
| INEG | MX | | | ok | ok |
| JAMA | JM | extra | | ok | ok |
| KYW1 | US | | | ok | missing |
| LPAZ | MX | | | ok | ok |
| MARA | VE | | extra | ok | missing |
| MEDE | CO | | | ok | missing |
| MER1 | MX | | | ok | ok |
| MEXI | MX | | | ok | ok |
| MOTE | CO | | | ok | missing |
| MTY2 | MX | | | ok | ok |
| NAS0 | BS | | | ok | missing |
| NEVA | CO | | | ok | missing |
| OAX2 | MX | | | ok | ok |
| PERA | CO | | | ok | missing |
| POPA | CO | | | ok | missing |
| PSTO | CO | | | ok | missing |
| PUR3 | PR | | | ok | ok |

Southern part of the SIRGAS-CON network

| Code | Country | CPLAT | IBGE | IGAC | INEGI |
|------|---------|-------|---------|------|-------|
| SAVO | BR | ok | missing | | |
| SMAR | BR | ok | ok | | |
| SRNW | SR | ok | ok | | |
| SRZN | SR | ok | ok | | |
| SSA1 | BR | ok | missing | | |
| TOPL | BR | ok | missing | | |
| TUCU | AR | ok | ok | | |
| UBAT | BR | ok | ok | | |
| UBER | BR | ok | ok | | |
| UCOR | AR | ok | ok | | |
| UFPR | BR | ok | ok | | |
| UNRO | AR | ok | ok | | |
| UNSJ | AR | ok | ok | | |
| UYMO | UY | ok | ok | | |
| UYRO | UY | ok | ok | | |
| VARG | BR | ok | ok | | |
| VBCA | AR | ok | ok | | |
| VESL | AQ | ok | ok | | |
| VICO | BR | ok | ok | | |

Northern part of the SIRGAS-CON network

| Code | Country | CPLAT | IBGE | IGAC | INEGI |
|------|---------|-------|-------|------|---------|
| QUIB | CO | | | ok | missing |
| RIOH | CO | | | ok | missing |
| RIOP | EC | extra | extra | ok | missing |
| S061 | EC | | extra | ok | missing |
| SAMA | CO | | | ok | missing |
| SMRT | NL | | | ok | missing |
| SSIA | SV | | | ok | ok |
| TAMP | MX | | | ok | ok |
| TOL2 | MX | | | ok | ok |
| TUMA | CO | | | ok | missing |
| TUNA | CO | | | ok | missing |
| UGTO | MX | | | ok | missing |
| VALL | CO | | | ok | missing |
| VIL2 | MX | | | ok | ok |
| VIVI | CO | | | ok | missing |
| YOPA | CO | | | ok | missing |

Annex 3: Comparison between the free weekly solutions provided by the SIRGAS Experimental Processing Centres and the corresponding free weekly solutions generated by the IGS-RNAAC-SIR

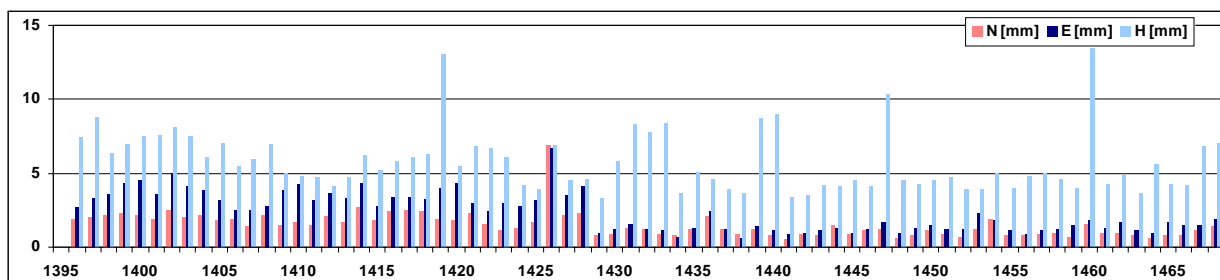


Figure A3.1. RMS residuals after a 7-parameter similarity transformation between the free weekly solutions delivered by CPLAT and the corresponding free weekly SINEX files generated by the IGS-RNAAC-SIR. Mean RMS values: $N = 1,8$ mm, $E = 2,7$ mm, $H = 6,1$ mm.

Table A3.1. Outliers after a 7-parameter similarity transformation between the free weekly solutions delivered by CPLAT and the corresponding free weekly SINEX files generated by the IGS-RNAAC-SIR.

| Week | Station | N [mm] | E [mm] | H [mm] |
|------|---------|--------|--------|--------|
| 1419 | PUR3 | -3,1 | -10,4 | -69,7 |
| 1426 | SSIA | -47,6 | 38,8 | -32,8 |
| 1447 | POAL | 3,2 | 1,0 | 66,8 |
| 1460 | BOMJ | -2,8 | -4,4 | -53,4 |
| 1460 | CRAT | -5,6 | -5,0 | -69,1 |

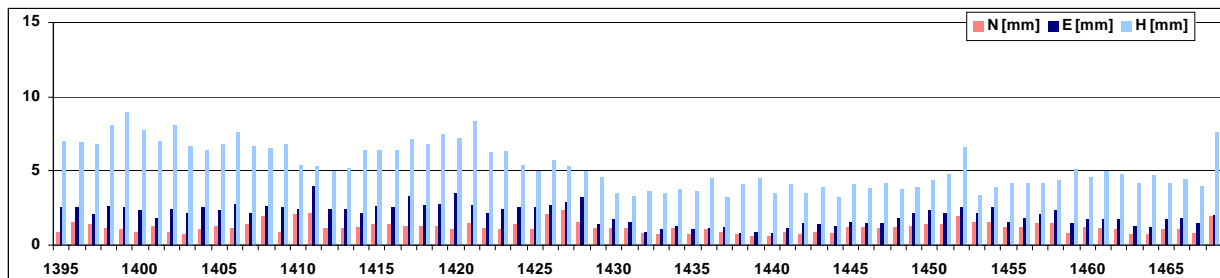


Figure A3.2. RMS residuals after a 7-parameter similarity transformation between the free weekly solutions delivered by IBGE and the corresponding free weekly SINEX files generated by the IGS-RNAAC-SIR. Mean RMS values: $N = 1,2$ mm, $E = 2,2$ mm, $H = 5,5$ mm.

Table A3.2. Outliers after a 7-parameter similarity transformation between the free weekly solutions delivered by IBGE and the corresponding free weekly SINEX files generated by the IGS-RNAAC-SIR.

| Week | Station | N [mm] | E [mm] | H [mm] |
|------|---------|--------|--------|--------|
| 1399 | AREQ | -1,2 | 0,1 | -32,6 |
| 1421 | POLI | -0,8 | 8,8 | 24,3 |

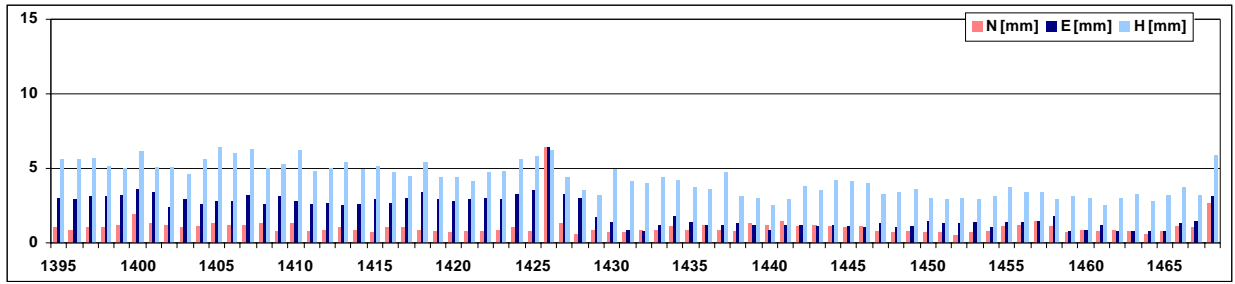


Figure A3.3. RMS residuals after a 7-parameter similarity transformation between the free weekly solutions delivered by IGAC and the corresponding free weekly SINEX files generated by the IGS-RNAAC-SIR.
Mean RMS values: $N = 1,3$ mm, $E = 2,3$ mm, $H = 4,4$ mm.

Table A3.3. Outliers after a 7-parameter similarity transformation between the free weekly solutions delivered by IGAC and the corresponding free weekly SINEX files generated by the IGS-RNAAC-SIR.

| Week | Station | N [mm] | E [mm] | H [mm] |
|------|---------|--------|--------|--------|
| 1405 | BDOS | 7,0 | 8,7 | -30,7 |
| 1426 | SSIA | -47,1 | 40,5 | -34,6 |

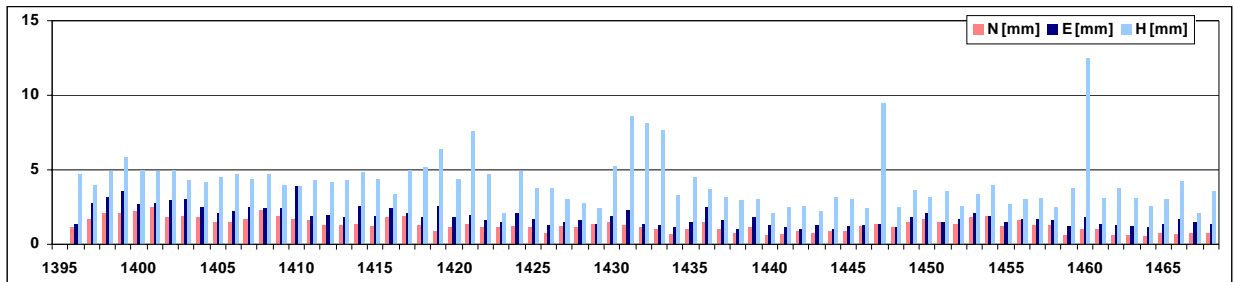


Figure A3.4. RMS residuals after a 7-parameter similarity transformation between the free weekly solutions delivered by CPLAT and IBGE.
Mean RMS values: $N = 1,4$ mm, $E = 1,9$ mm, $H = 4,5$ mm.

Table A3.4. Outliers after a 7-parameter similarity transformation between the free weekly solutions delivered by CPLAT and IBGE.

| Week | Station | N [mm] | E [mm] | H [mm] |
|------|---------|--------|--------|--------|
| 1431 | CRAT | 3,5 | 1,3 | 54,8 |
| 1447 | POAL | -3,9 | -1,8 | -61,7 |
| 1460 | BOMJ | 2,5 | 1,5 | 50,1 |
| 1460 | CRAT | 0,0 | 2,0 | 60,5 |

Annex 4: Station information inconsistencies between data included in the delivered SINEX files by each SIRGAS Experimental Processing Centre and the corresponding site log files (valid for the period GPS weeks 1395 - 1468)

Experimental Processing Centre CPLAT

| From | To | Station | Inconsistency | CPLAT SINEX file | Log File |
|------------|------------|----------------|---------------|-------------------|-------------------|
| 2007 12 23 | 2008 03 01 | BOGT 41901M001 | Antenna type | ASH701945G_M NONE | ASH701945E_M NONE |
| 2007 08 05 | 2008 01 05 | BOMJ 41612M001 | Receiver type | TRIMBLE 4000SSI | TRIMBLE NETR5 |
| 2006 10 01 | 2008 03 01 | CFAG 41517S001 | Antenna type | ASH700936D_M SNOW | ASH700936D_M NONE |
| 2007 06 10 | 2008 01 04 | CRAT 41619M001 | Antenna type | TRM29659.00 NONE | TRM55971.00 NONE |
| 2007 12 30 | 2008 01 04 | CRAT 41619M001 | Receiver type | TRIMBLE 4000SSI | TRIMBLE NETR5 |
| 2007 12 30 | 2008 01 04 | CRAT 41619M001 | Ant ecc (up) | 0,0070 m | 0,0080 m |
| 2006 10 12 | 2007 05 08 | CRAT 41619M001 | Ant ecc (up) | 0,0080 m | 0,0070 m |
| 2007 04 07 | 2007 04 14 | CUIB 41603M001 | Receiver type | TRIMBLE 4000SSI | TRIMBLE NETRS |
| 2007 04 07 | 2007 04 14 | CUIB 41603M001 | Antenna type | TRM29659.00 NONE | TRM41249.00 NONE |
| 2006 10 01 | 2008 03 01 | GVAL 41623M001 | Receiver type | ASHTECH Z-FX | ASHTECH UZ-12 |
| 2006 10 06 | 2006 12 09 | IGM1 41505M003 | Receiver type | ASHTECH UZ-12 | TRIMBLE NETRS |
| 2007 12 30 | 2008 01 04 | IMPZ 41615M001 | Receiver type | TRIMBLE NETRS | TRIMBLE NETR5 |
| 2008 01 16 | 2008 03 01 | KOUR 97301M210 | Antenna type | ASH701945C_M NONE | ASH701946.3 NONE |
| 2008 01 16 | 2008 03 01 | KOUR 97301M210 | Receiver type | ASHTECH UZ-12 | JPS LEGACY |
| 2007 04 14 | | MAPA 41629M001 | Receiver type | TRIMBLE 4000SSI | TRIMBLE NETRS |
| 2006 10 01 | 2008 03 01 | MCLA 41624M001 | Receiver type | ASHTECH Z-FX | ASHTECH UZ-12 |
| 2007 11 13 | 2008 03 01 | OHI2 66008M005 | Receiver type | AOA SNR-8000 ACT | JPS E_GGD |
| 2007 09 30 | 2007 10 04 | POAL 41616M001 | Antenna type | TRM55971.00 NONE | TRM29659.00 NONE |
| 2007 08 19 | 2008 03 01 | POVE 41628M001 | Receiver type | TRIMBLE 4000SSI | TRIMBLE NETR5 |
| 2007 03 20 | 2007 03 21 | RIOD 41608M001 | Antenna type | TRM29659.00 NONE | TRM41249.00 NONE |
| 2007 03 20 | 2007 03 21 | RIOD 41608M001 | Receiver type | TRIMBLE 4000SSI | TRIMBLE NETRS |
| 2007 05 14 | 2007 05 26 | RIOP 42006M001 | Antenna type | TRM29659.00 SCIT | TRM29659.00 NONE |
| 2007 05 18 | 2007 06 07 | SMAR 41621M001 | Receiver type | TRIMBLE 4000SSI | TRIMBLE NETRS |
| 2007 05 18 | 2007 06 07 | SMAR 41621M001 | Antenna type | TRM29659.00 NONE | TRM41249.00 NONE |
| 2006 10 01 | 2008 03 01 | UBER 41625M001 | Receiver type | ASHTECH Z-FX | ASHTECH UZ-12 |
| 2006 10 01 | 2008 03 01 | VARG 41626M001 | Receiver type | ASHTECH Z-FX | ASHTECH UZ-12 |

Experimental Processing Centre IBGE

| From | To | Station | Inconsistency | IBGE SINEX file | Log File |
|------------|------------|----------------|---------------|-------------------|-------------------|
| 2007 06 03 | 2008 03 01 | BELE 41622M001 | Ant ecc (up) | 0,0080 m | 0,0075 m |
| 2007 12 16 | 2008 03 01 | BOGT 41901M001 | Antenna type | ASH701945G_M NONE | ASH701945E_M NONE |
| 2006 10 02 | 2007 03 11 | BRAZ 41606M001 | Antenna type | TRM29659.00 NONE | AOAD/M_T NONE |
| 2006 10 01 | 2007 02 10 | CFAG 41517S001 | Receiver type | ASHTECH Z-XI3 | TRIMBLE NETRS |
| 2007 02 11 | 2008 03 01 | CFAG 41517S001 | Antenna type | ASH700936D_M SNOW | ASH700936D_M NONE |
| 2007 02 25 | 2007 03 03 | CFAG 41517S001 | Receiver type | TRIMBLE NETR5 | TRIMBLE NETRS |
| 2006 10 01 | 2007 02 10 | CONZ 41719M002 | Receiver type | JPS LEGACY | TPS E_GGD |
| 2006 10 12 | 2007 05 08 | CRAT 41619M001 | Ant ecc (up) | 0,0080 m | 0,0070 m |
| 2006 10 01 | 2008 03 01 | GVAL 41623M001 | Receiver type | ASHTECH Z-FX | ASHTECH UZ-12 |
| 2006 10 02 | 2007 02 10 | IGM1 41505M003 | Antenna type | ASH700936C_M SNOW | ASH700936D_M SNOW |
| 2006 10 06 | 2007 02 10 | IGM1 41505M003 | Receiver type | ASHTECH UZ-12 | TRIMBLE NETRS |
| 2006 10 12 | 2006 11 19 | KOUR 97301M210 | Receiver type | ASHTECH UZ-12 | JPS LEGACY |
| 2007 04 14 | | MAPA 41629M001 | Receiver type | TRIMBLE NETRS | TRIMBLE 4000SSI |
| 2006 10 01 | 2008 03 01 | MCLA 41624M001 | Receiver type | ASHTECH Z-FX | ASHTECH UZ-12 |
| 2006 11 19 | 2007 06 16 | PARC 41716S001 | Receiver type | ASHTECH Z-XI3 | TRIMBLE NETRS |
| 2006 10 01 | 2007 03 22 | POVE 41628M001 | Ant ecc (up) | 0,0080 m | 0,0075 m |
| 2007 05 19 | 2007 06 16 | RIOP 42006M001 | Receiver type | ROGUE SNR-8000 | TRIMBLE 4000SSI |
| 2007 05 19 | 2007 06 16 | RIOP 42006M001 | Antenna type | AOAD/M_T NONE | TRM29659.00 NONE |
| 2007 05 29 | | SMAR 41621M001 | Receiver type | TRIMBLE 4000SSI | TRIMBLE NETRS |
| 2007 05 29 | | SMAR 41621M001 | Antenna type | TRM29659.00 NONE | TRM41249.00 NONE |

| From | To | Station | Inconsistency | IBGE SINEX file | Log File |
|-------------|------------|----------------|----------------------|------------------------|-------------------|
| 2006 10 01 | 2007 02 10 | TUCU 41520S001 | Antenna type | AOAD/M_T NONE | ASH700936C_M SNOW |
| 2006 10 01 | 2007 02 10 | TUCU 41520S001 | Receiver type | ASHTECH Z-XII3 | TRIMBLE NETRS |
| 2006 10 01 | 2008 03 01 | UBER 41625M001 | Receiver type | ASHTECH Z-FX | ASHTECH UZ-12 |
| 2006 10 01 | 2008 03 01 | VARG 41626M001 | Receiver type | ASHTECH Z-FX | ASHTECH UZ-12 |

Experimental Processing Centre IGAC

| From | To | Station | Inconsistency | IGAC SINEX file | Log File |
|-------------|------------|----------------|----------------------|------------------------|-------------------|
| 2007 12 23 | 2008 01 05 | BOGT 41901M001 | Antenna type | ASH701945G_M NONE | ASH701945E_M NONE |
| 2007 02 11 | 2007 03 03 | PIE1 40456M001 | Antenna type | AOAD/M_T NONE | ASH701945E_M NONE |
| 2007 04 22 | 2007 05 23 | SSIA 41401S001 | Receiver type | TRIMBLE 4000SSI | TRIMBLE NETRS |

Annex 5: Reduced stations from the individual EPC solutions before combination (valid for the period GPS weeks 1395 - 1468)

Experimental Processing Centre CPLAT

| Station | From | | To | | Reason |
|----------------|------|----------------|------|----------------|---------------------|
| | YY | MMDDHH MM SS | YY | MMDDHH MM SS | |
| AREQ 42202M005 | 2006 | 10 03 00 00 00 | 2006 | 10 03 23 59 30 | U -30,39 |
| AREQ 42202M005 | 2007 | 03 09 00 00 00 | 2007 | 03 09 23 59 30 | U -34,91 |
| AREQ 42202M005 | 2007 | 03 17 00 00 00 | 2007 | 03 17 23 59 30 | U -41,99 |
| BELE 41622M001 | 2007 | 01 09 00 00 00 | 2007 | 01 09 23 59 30 | U 33,15 |
| BELE 41622M001 | 2007 | 01 14 00 00 00 | 2007 | 01 20 23 59 59 | C1_1410 |
| BELE 41622M001 | 2007 | 01 17 00 00 00 | 2007 | 01 17 23 59 30 | E 31,10 |
| BOGT 41901M001 | 2006 | 10 04 00 00 00 | 2006 | 10 04 23 59 30 | U -52,27 |
| BOGT 41901M001 | 2007 | 06 17 00 00 00 | 2007 | 06 17 23 59 30 | U -31,83 |
| BOMJ 41612M001 | 2007 | 08 05 00 00 00 | 2007 | 08 18 23 59 59 | I1_1439_1440 |
| BOMJ 41612M001 | 2007 | 08 05 00 00 00 | 2007 | 08 18 23 59 30 | U 47,24...58,95 |
| BOMJ 41612M001 | 2007 | 12 30 00 00 00 | 2008 | 01 05 23 59 59 | C1_1460 |
| BOMJ 41612M001 | 2007 | 12 30 00 00 00 | 2008 | 01 05 23 59 30 | U 38,14...53,29 |
| BRAZ 41606M001 | 2006 | 10 12 00 00 00 | 2006 | 10 12 23 59 30 | U 38,47 |
| BRAZ 41606M001 | 2007 | 03 11 00 00 00 | 2007 | 03 17 23 59 59 | C1_1418 |
| CFAG 41517S001 | 2007 | 08 26 00 00 00 | 2007 | 08 26 23 59 30 | U -30,50 |
| CONZ 41719M002 | 2006 | 10 10 00 00 00 | 2006 | 10 10 23 59 30 | U -43,01 |
| CONZ 41719M002 | 2006 | 11 09 00 00 00 | 2006 | 11 09 23 59 30 | U -30,85 |
| CRAT 41619M001 | 2007 | 06 10 00 00 00 | 2008 | 01 04 23 59 59 | Antenna Type |
| CRO1 43201M001 | 2006 | 10 02 00 00 00 | 2006 | 10 03 23 59 30 | U -51,29...-40,91 |
| CRO1 43201M001 | 2006 | 10 12 00 00 00 | 2006 | 10 12 23 59 30 | U -33,02 |
| CRO1 43201M001 | 2006 | 12 31 00 00 00 | 2006 | 12 31 23 59 30 | U -34,77 |
| CRO1 43201M001 | 2007 | 03 21 00 00 00 | 2007 | 03 21 23 59 30 | U -38,44 |
| CRO1 43201M001 | 2007 | 05 29 00 00 00 | 2007 | 05 29 23 59 30 | U 37,74 |
| CRO1 43201M001 | 2007 | 06 08 00 00 00 | 2007 | 06 08 23 59 30 | U 35,63 |
| CRO1 43201M001 | 2007 | 08 26 00 00 00 | 2007 | 08 26 23 59 30 | E 31,56 |
| CUIB 41603M001 | 2007 | 04 01 00 00 00 | 2007 | 04 14 23 59 59 | Antenna Type |
| CUIB 41603M001 | 2008 | 02 06 00 00 00 | 2008 | 02 06 23 59 30 | U -34,34 |
| GLPS 42005M002 | 2006 | 10 10 00 00 00 | 2006 | 10 10 23 59 30 | U 34,55 |
| GLPS 42005M002 | 2007 | 08 27 00 00 00 | 2007 | 08 27 23 59 30 | E 29,06 |
| GUAT 40901S001 | 2007 | 08 26 00 00 00 | 2007 | 08 27 23 59 30 | E 32,53...35,17 |
| GVAL 41623M001 | 2006 | 10 02 00 00 00 | 2006 | 10 07 23 59 59 | C1_1395 |
| GVAL 41623M001 | 2006 | 11 12 00 00 00 | 2006 | 11 12 23 59 30 | U 30,72 |
| GVAL 41623M001 | 2006 | 11 30 00 00 00 | 2006 | 11 30 23 59 30 | U 33,26 |
| GVAL 41623M001 | 2007 | 09 19 00 00 00 | 2007 | 09 19 23 59 30 | U -32,09 |
| JAMA 42601S001 | 2006 | 10 02 00 00 00 | 2006 | 10 02 23 59 30 | U 30,01 |
| JAMA 42601S001 | 2006 | 10 06 00 00 00 | 2006 | 10 06 23 59 30 | U 33,00 |
| JAMA 42601S001 | 2007 | 08 12 00 00 00 | 2007 | 09 01 23 59 59 | I1_1440_1441_1442 |
| JAMA 42601S001 | 2007 | 08 26 00 00 00 | 2007 | 08 27 23 59 30 | E -366,24...-362,17 |
| LPGS 41510M001 | 2007 | 04 15 00 00 00 | 2007 | 04 21 23 59 59 | C2_1423 |
| MANA 41201S001 | 2006 | 10 19 00 00 00 | 2006 | 10 19 23 59 30 | U 34,48 |
| MANA 41201S001 | 2007 | 07 10 00 00 00 | 2007 | 07 10 23 59 30 | U 33,24 |
| MANA 41201S001 | 2007 | 09 02 00 00 00 | 2007 | 09 15 23 59 59 | C1_1443_1444 |
| MCLA 41624M001 | 2008 | 02 04 00 00 00 | 2008 | 02 04 23 59 30 | U 30,32 |
| OHI2 66008M005 | 2006 | 10 02 00 00 00 | 2006 | 10 13 23 59 30 | U -30,92...37,46 |
| OHI2 66008M005 | 2006 | 10 24 00 00 00 | 2006 | 10 24 23 59 30 | U -30,92 |
| OHI2 66008M005 | 2007 | 07 08 00 00 00 | 2007 | 07 08 23 59 30 | U 31,75 |
| PMB1 43702S001 | 2007 | 03 19 00 00 00 | 2007 | 03 19 23 59 30 | U -32,29 |
| PMB1 43702S001 | 2007 | 10 06 00 00 00 | 2007 | 10 06 23 59 30 | U 31,62 |
| POAL 41616M001 | 2007 | 09 30 00 00 00 | 2007 | 10 04 23 59 59 | Antenna Type |
| POVE 41628M001 | 2007 | 01 31 00 00 00 | 2007 | 01 31 23 59 30 | U -31,90 |

| Station | From YY MM DD HH MM SS | To YY MM DD HH MM SS | Reason |
|----------------|----------------------------------|--------------------------------|-------------------|
| PUR3 82001S003 | 2006 10 02 00 00 00 | 2006 10 03 23 59 30 | U -39,02...-40,14 |
| PUR3 82001S003 | 2007 03 18 00 00 00 | 2007 03 31 23 59 59 | C1_1419_1420 |
| PUR3 82001S003 | 2007 03 21 00 00 00 | 2007 03 25 23 59 30 | U 64,75...90,56 |
| RIOD 41608M001 | 2007 03 20 00 00 00 | 2007 03 21 23 59 30 | Antenna Type |
| RIOP 42006M001 | 2007 05 14 00 00 00 | 2007 05 26 23 59 30 | Antenna Type |
| SCUB 40701M001 | 2006 10 03 00 00 00 | 2006 10 03 23 59 30 | U 67,64 |
| SCUB 40701M001 | 2007 09 09 00 00 00 | 2007 09 15 23 59 30 | C4_1444 |
| SMAR 41621M001 | 2007 05 18 00 00 00 | 2007 06 09 23 59 30 | Antenna Type |
| SSIA 41401S001 | 2007 08 26 00 00 00 | 2007 08 27 23 59 30 | E 33,18...35,93 |
| SSIA 41401S001 | 2007 10 20 00 00 00 | 2007 10 20 23 59 30 | U -32,51 |
| UBAT 41627M001 | 2007 04 12 00 00 00 | 2007 04 12 23 59 30 | U -30,22 |
| UBER 41625M001 | 2006 10 12 00 00 00 | 2006 10 12 23 59 30 | U 40,50 |

Experimental Processing Centre IBGE

| Station | From YY MM DD HH MM SS | To YY MM DD HH MM SS | Reason |
|----------------|----------------------------------|--------------------------------|---------------------|
| AREQ 42202M005 | 2006 11 12 00 00 00 | 2006 11 12 23 59 30 | U -42,63 |
| AREQ 42202M005 | 2007 01 02 00 00 00 | 2007 01 02 23 59 30 | U -52,47 |
| AREQ 42202M005 | 2007 01 24 00 00 00 | 2007 01 24 23 59 30 | U -30,31 |
| AREQ 42202M005 | 2007 01 30 00 00 00 | 2007 01 30 23 59 30 | U -34,61 |
| AREQ 42202M005 | 2007 02 26 00 00 00 | 2007 02 26 23 59 30 | U -32,94 |
| AREQ 42202M005 | 2007 03 13 00 00 00 | 2007 03 13 23 59 30 | U -37,19 |
| AREQ 42202M005 | 2007 03 16 00 00 00 | 2007 03 16 23 59 30 | U 33,69 |
| AREQ 42202M005 | 2007 03 25 00 00 00 | 2007 03 25 23 59 30 | U 33,07 |
| AREQ 42202M005 | 2007 04 28 00 00 00 | 2007 04 28 23 59 30 | U 30,49 |
| AREQ 42202M005 | 2008 02 14 00 00 00 | 2008 02 14 23 59 30 | U -40,61 |
| BANS 42403M001 | 2008 03 05 00 00 00 | 2008 03 05 23 59 30 | U 32,59 |
| BELE 41622M001 | 2007 01 09 00 00 00 | 2007 01 09 23 59 30 | U 40,81 |
| BOGT 41901M001 | 2006 10 25 00 00 00 | 2006 10 25 23 59 30 | E 30,78 |
| BOMJ 41612M001 | 2007 12 30 00 00 00 | 2008 01 05 23 59 59 | C1_1460 |
| BRAZ 41606M001 | 2006 10 02 00 00 00 | 2007 03 11 23 59 59 | Antenna Type |
| BRFT 41602M002 | 2007 02 28 00 00 00 | 2007 02 28 23 59 30 | U 38,71 |
| CONZ 41719M002 | 2008 01 13 00 00 00 | 2008 01 19 23 59 30 | U -88,63...E 139,56 |
| CRAT 41619M001 | 2007 06 10 00 00 00 | 2007 06 16 23 59 59 | C1_1431 |
| CRAT 41619M001 | 2007 06 24 00 00 00 | 2007 06 30 23 59 59 | C1_1433 |
| CRAT 41619M001 | 2007 12 27 00 00 00 | 2008 01 05 23 59 59 | C1_1460 |
| CRCS 42401M001 | 2006 10 25 00 00 00 | 2006 10 25 23 59 30 | E 32,97 |
| CRCS 42401M001 | 2008 02 25 00 00 00 | 2008 02 25 23 59 30 | U 30,48 |
| CRCS 42401M001 | 2006 11 19 00 00 00 | 2006 11 19 23 59 30 | U -30,19 |
| CUIB 41603M001 | 2007 09 24 00 00 00 | 2007 09 24 23 59 30 | U 34,45 |
| CUIB 41603M001 | 2007 04 01 00 00 00 | 2007 04 07 23 59 59 | C1_1421 |
| GLPS 42005M002 | 2008 02 24 00 00 00 | 2008 03 01 23 59 59 | C1_1468 |
| GLPS 42005M002 | 2006 10 09 00 00 00 | 2006 10 09 23 59 30 | U 36,14 |
| GLPS 42005M002 | 2007 03 20 00 00 00 | 2007 03 20 23 59 30 | N 33,96 |
| GVAL 41623M001 | 2007 01 20 00 00 00 | 2007 01 20 23 59 30 | U -40,82 |
| IGM1 41505M003 | 2006 10 02 00 00 00 | 2007 02 10 23 59 59 | Antenna Type |
| IMBT 41638M001 | 2007 09 01 00 00 00 | 2007 09 01 23 59 30 | U -31,20 |
| IMPZ 41615M001 | 2006 10 23 00 00 00 | 2006 10 23 23 59 30 | U -37,83 |
| IMPZ 41615M001 | 2007 01 19 00 00 00 | 2007 01 19 23 59 30 | U 30,10 |
| IMPZ 41615M001 | 2007 09 26 00 00 00 | 2007 09 26 23 59 30 | U 33,09 |
| IMPZ 41615M001 | 2007 10 31 00 00 00 | 2007 10 31 23 59 30 | U 32,40 |
| KOUR 97301M210 | 2007 01 19 00 00 00 | 2007 01 19 23 59 30 | U 30,35 |
| KOUR 97301M210 | 2007 03 25 00 00 00 | 2007 03 25 23 59 30 | U -35,90 |
| LPGS 41510M001 | 2007 09 16 00 00 00 | 2007 09 29 23 59 59 | C1_1445 C3_1446 |
| LPGS 41510M001 | 2007 04 15 00 00 00 | 2007 04 21 23 59 59 | C1_1423 |
| MABA 41642M001 | 2007 12 22 00 00 00 | 2007 12 22 23 59 30 | U 30,45 |

| Station | From YY MMDDHH MM SS | To YY MMDDHH MM SS | Reason |
|----------------|--------------------------------|------------------------------|-----------------|
| MABA 41642M001 | 2008 01 09 00 00 00 | 2008 01 09 23 59 30 | U 31,27 |
| MARA 42402M001 | 2006 10 09 00 00 00 | 2006 10 09 23 59 30 | U -55,00 |
| MARA 42402M001 | 2007 09 24 00 00 00 | 2007 09 24 23 59 30 | U -35,81 |
| MARA 42402M001 | 2006 10 25 00 00 00 | 2006 10 25 23 59 30 | E 28,05 |
| MARA 42402M001 | 2008 02 29 00 00 00 | 2008 02 29 23 59 30 | U 33,65 |
| MCLA 41624M001 | 2008 02 04 00 00 00 | 2008 02 04 23 59 30 | U 37,04 |
| MZAS 41528M001 | 2007 04 22 00 00 00 | 2007 04 22 23 59 30 | U -30,11 |
| MZAS 41528M001 | 2007 05 03 00 00 00 | 2007 05 03 23 59 30 | U -30,26 |
| MZAS 41528M001 | 2007 05 06 00 00 00 | 2007 05 06 23 59 30 | U -30,14 |
| NEIA 41620M002 | 2007 04 26 00 00 00 | 2007 04 26 23 59 30 | U 33,35 |
| NEIA 41620M002 | 2007 02 14 00 00 00 | 2007 02 14 23 59 30 | U -33,27 |
| NEIA 41620M002 | 2008 01 13 00 00 00 | 2008 01 13 23 59 30 | U -36,59 |
| OH12 66008M005 | 2006 10 02 00 00 00 | 2006 10 12 23 59 30 | U 35,16...62,13 |
| OH12 66008M005 | 2006 10 19 00 00 00 | 2006 10 19 23 59 30 | U 30,18 |
| OH12 66008M005 | 2006 10 23 00 00 00 | 2006 10 23 23 59 30 | U -31,20 |
| OH12 66008M005 | 2007 03 20 00 00 00 | 2007 03 20 23 59 30 | U -31,39 |
| ONRJ 41635M001 | 2007 12 08 00 00 00 | 2007 12 08 23 59 30 | U -36,89 |
| PMB1 43702S001 | 2006 10 25 00 00 00 | 2006 10 25 23 59 30 | E 37,79 |
| POAL 41616M001 | 2007 09 30 00 00 00 | 2007 10 06 23 59 59 | C1_1447 |
| POLI 41630M001 | 2007 01 19 00 00 00 | 2007 01 19 23 59 30 | U -33,11 |
| POLI 41630M001 | 2007 03 04 00 00 00 | 2007 03 10 23 59 59 | C4_1417 |
| RECF 41617M001 | 2007 07 10 00 00 00 | 2007 07 10 23 59 30 | U 31,93 |
| RIOP 42006M001 | 2007 05 19 00 00 00 | 2007 06 16 23 59 30 | Antenna Type |
| SMAR 41621M001 | 2007 05 29 00 00 00 | 2007 05 29 23 59 30 | U 32,77...39,48 |
| SMAR 41621M001 | 2007 08 18 00 00 00 | 2007 08 19 23 59 30 | U 32,77...39,48 |
| SRNW 43703M001 | 2007 11 18 00 00 00 | 2007 11 18 23 59 30 | U 35,95 |
| SRNW 43703M001 | 2008 02 08 00 00 00 | 2008 02 08 23 59 30 | U 30,86 |
| SRNW 43703M001 | 2006 10 25 00 00 00 | 2006 10 25 23 59 30 | E 36,66 |
| SRZN 43701S005 | 2006 10 25 00 00 00 | 2006 10 25 23 59 30 | E 40,59 |
| TUCU 41520S001 | 2006 10 02 00 00 00 | 2007 02 10 23 59 30 | Antenna Type |
| TUCU 41520S001 | 2007 02 15 00 00 00 | 2007 02 15 23 59 30 | U 35,72 |
| TUCU 41520S001 | 2007 01 24 00 00 00 | 2007 01 24 23 59 30 | U -31,33 |
| UBAT 41627M001 | 2008 03 14 00 00 00 | 2008 03 14 23 59 30 | U 32,41 |
| UBER 41625M001 | 2006 12 08 00 00 30 | 2006 12 08 23 59 30 | U 37,23 |
| UBER 41625M001 | 2007 12 03 00 00 00 | 2007 12 03 23 59 30 | U 32,55 |
| UNSA 41514M001 | 2007 01 04 00 00 00 | 2007 01 04 23 59 30 | U -30,15 |
| UNSA 41514M001 | 2007 12 16 00 00 00 | 2007 12 17 23 59 30 | N 30,35...28,47 |

Experimental Processing Centre IGAC

| Station | From YY MMDDHH MM SS | To YY MMDDHH MM SS | Reason |
|----------------|--------------------------------|------------------------------|---------------|
| BDOS 43401M001 | 2006 12 08 00 00 00 | 2006 12 08 23 59 30 | U -30,76 |
| BDOS 43401M001 | 2007 01 14 00 00 00 | 2007 01 20 23 59 59 | C3_1410 |
| BDOS 43401M001 | 2007 08 03 00 00 00 | 2007 08 03 23 59 30 | U -31,70 |
| BQLA 41934S001 | 2007 12 17 00 00 00 | 2007 12 17 23 59 30 | U -31,36 |
| CAM2 40514M001 | 2007 09 30 00 00 00 | 2007 09 30 23 59 30 | U -30,13 |
| CHPI 41609M003 | 2007 01 16 00 00 00 | 2007 01 16 23 59 30 | U -30,30 |
| CRO1 43201M001 | 2007 06 03 00 00 00 | 2007 06 09 23 59 59 | C2_1430 |
| FLOR 41916S001 | 2007 04 01 00 00 00 | 2007 04 01 23 59 30 | U 35,61 |
| GLPS 42005M002 | 2008 02 24 00 00 00 | 2008 03 01 23 59 59 | C1_1468 |
| JAMA 42601S001 | 2007 04 12 00 00 00 | 2007 04 12 23 59 30 | U 30,87 |
| MANA 41201S001 | 2006 10 15 00 00 00 | 2006 10 21 23 59 30 | C4_1397 |
| MANA 41201S001 | 2007 02 23 00 00 00 | 2007 02 23 23 59 30 | U -50,92 |
| MANA 41201S001 | 2007 05 14 00 00 00 | 2007 05 14 23 59 30 | U 31,17 |
| MANA 41201S001 | 2007 07 08 00 00 00 | 2007 07 14 23 59 59 | C1_1435 |
| MANA 41201S001 | 2007 07 22 00 00 00 | 2007 07 28 23 59 59 | C1_1437 |

| Station | From | | To | | Reason |
|----------------|------|----------------|------|----------------|-------------------|
| | YY | MMDDHH MM SS | YY | MMDDHH MM SS | |
| MANA 41201S001 | 2007 | 08 19 00 00 00 | 2007 | 08 25 23 59 59 | C2_1441 |
| MANA 41201S001 | 2007 | 09 30 00 00 00 | 2007 | 10 06 23 59 59 | C3_1447 |
| OAX2 40517M001 | 2007 | 12 03 00 00 00 | 2007 | 12 04 23 59 30 | U 32,65...33,16 |
| OAX2 40517M001 | 2007 | 12 16 00 00 00 | 2007 | 12 16 23 59 30 | U 30,63 |
| OAX2 40517M001 | 2007 | 12 30 00 00 00 | 2007 | 12 30 23 59 30 | U 34,11 |
| OAX2 40517M001 | 2008 | 01 11 00 00 00 | 2008 | 01 11 23 59 30 | U 30,40 |
| OAX2 40517M001 | 2008 | 01 23 00 00 00 | 2008 | 01 23 23 59 30 | U 30,84 |
| PUR3 82001S003 | 2007 | 03 18 00 00 00 | 2007 | 03 31 23 59 59 | I1_1419_1420 |
| RIOH 41927S001 | 2006 | 11 25 00 00 00 | 2006 | 11 25 23 59 30 | U -33,68 |
| SAMA 41928S001 | 2006 | 10 02 00 00 00 | 2006 | 10 02 23 59 30 | U -30,93 |
| SAMA 41928S001 | 2006 | 11 10 00 00 00 | 2006 | 11 10 23 59 30 | U -30,10 |
| SAMA 41928S001 | 2007 | 11 27 00 00 00 | 2007 | 11 30 23 59 30 | U -30,43...-51,90 |
| SAMA 41928S001 | 2007 | 12 04 00 00 00 | 2007 | 12 04 23 59 30 | U -30,43 |
| SAMA 41928S001 | 2007 | 12 17 00 00 00 | 2007 | 12 17 23 59 30 | U -35,28 |
| SAMA 41928S001 | 2008 | 01 17 00 00 00 | 2008 | 01 17 23 59 30 | U -39,78 |
| SCUB 40701M001 | 2007 | 09 09 00 00 00 | 2007 | 09 15 23 59 59 | C3_1444 |
| SCUB 40701M001 | 2007 | 12 11 00 00 00 | 2007 | 12 11 23 59 30 | U -38,13 |
| UNSA 41514M001 | 2007 | 12 16 00 00 00 | 2007 | 12 18 23 59 30 | N 20,20...27,90 |
| VIL2 40527M001 | 2007 | 09 23 00 00 00 | 2007 | 09 23 23 59 30 | U -31,87 |
| VIL2 40527M001 | 2007 | 10 11 00 00 00 | 2007 | 10 11 23 59 30 | U -32,95 |
| VIL2 40527M001 | 2007 | 11 03 00 00 00 | 2007 | 11 03 23 59 30 | U -34,51 |
| VIVI 41931S001 | 2007 | 02 15 00 00 00 | 2007 | 02 15 23 59 30 | U 33,04 |

Annex 6: Comparison of the individual weekly Experimental Processing Centre solutions with the final weekly combined solutions

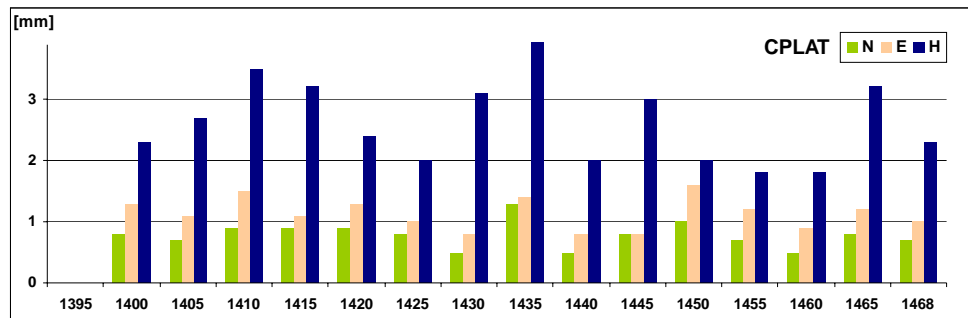


Figure A6.1. Residuals after a 7-parameter similarity transformation between weekly CPLAT solutions and the final weekly combined solutions (values each fifth week are shown.)

Mean RMS values over the period GPS weeks 1396 - 1468:

$N = 0,79 \text{ mm}$, $E = 1,18 \text{ mm}$, $H = 2,57 \text{ mm}$.

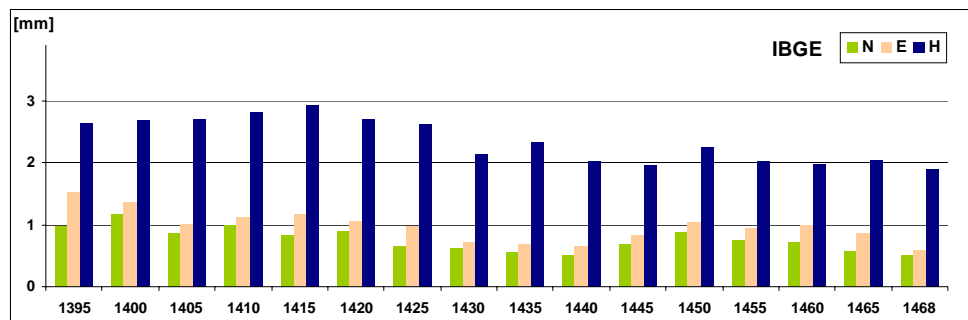


Figure A6.2. Residuals after a 7-parameter similarity transformation between weekly IBGE solutions and the final weekly combined solutions (values each fifth week are shown.)

Mean RMS values over the period GPS weeks 1396 - 1468:

$N = 0,79 \text{ mm}$, $E = 1,00 \text{ mm}$, $H = 2,70 \text{ mm}$.

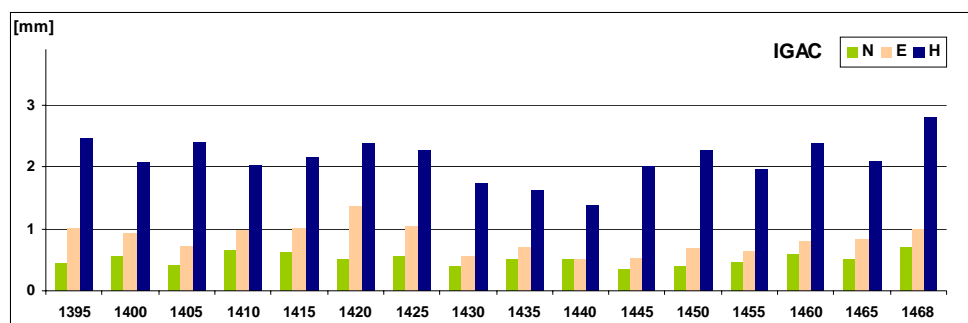


Figure A6.3. Residuals after a 7-parameter similarity transformation between weekly IGAC solutions and the final weekly combined solutions (values each fifth week are shown.)

Mean RMS values over the period GPS weeks 1396 - 1468:

$N = 0,50 \text{ mm}$, $E = 0,82 \text{ mm}$, $H = 2,10 \text{ mm}$.

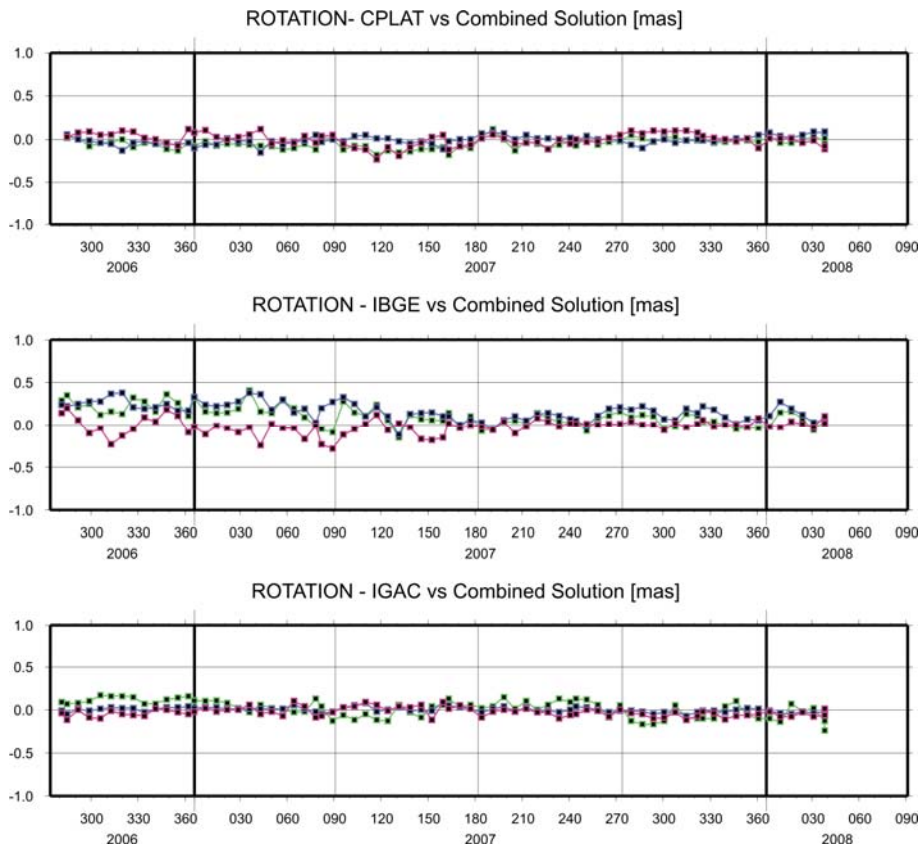


Figure A6.4. Time series for the rotation parameters in X, Y, Z between individual EPC solutions and the final weekly combined solutions after a 7-parameter similarity transformation.

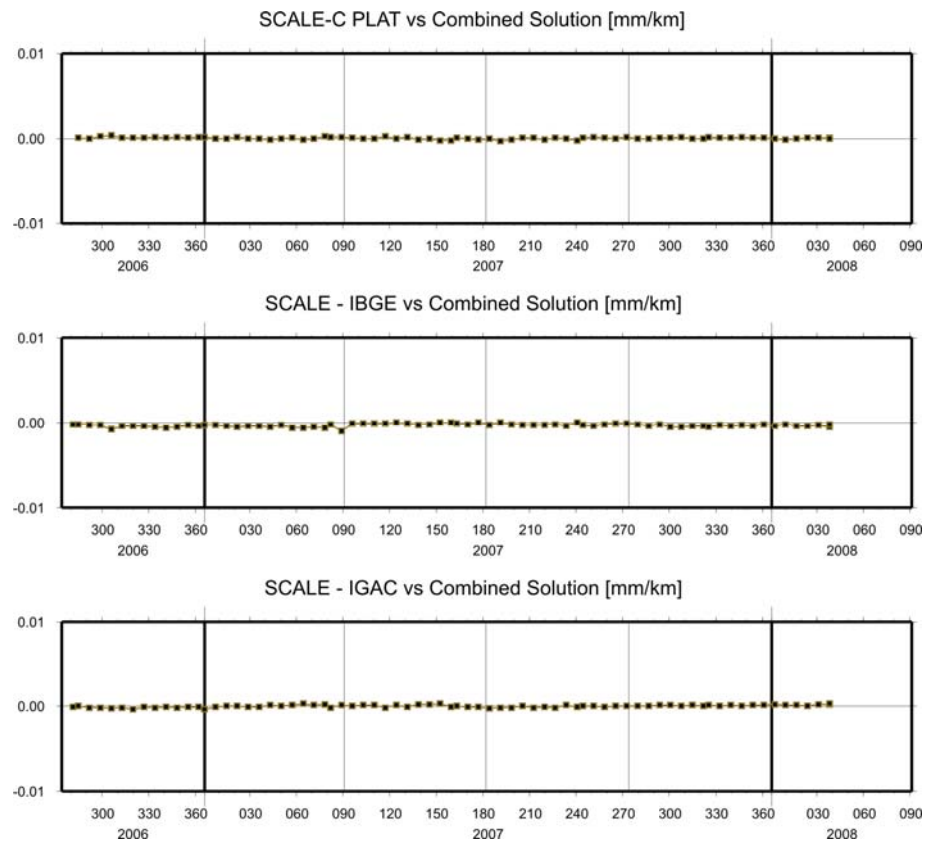


Figure A6.5. Time series for the scale parameter between individual EPC solutions and the final weekly combined solutions after a 7-parameter similarity transformation.

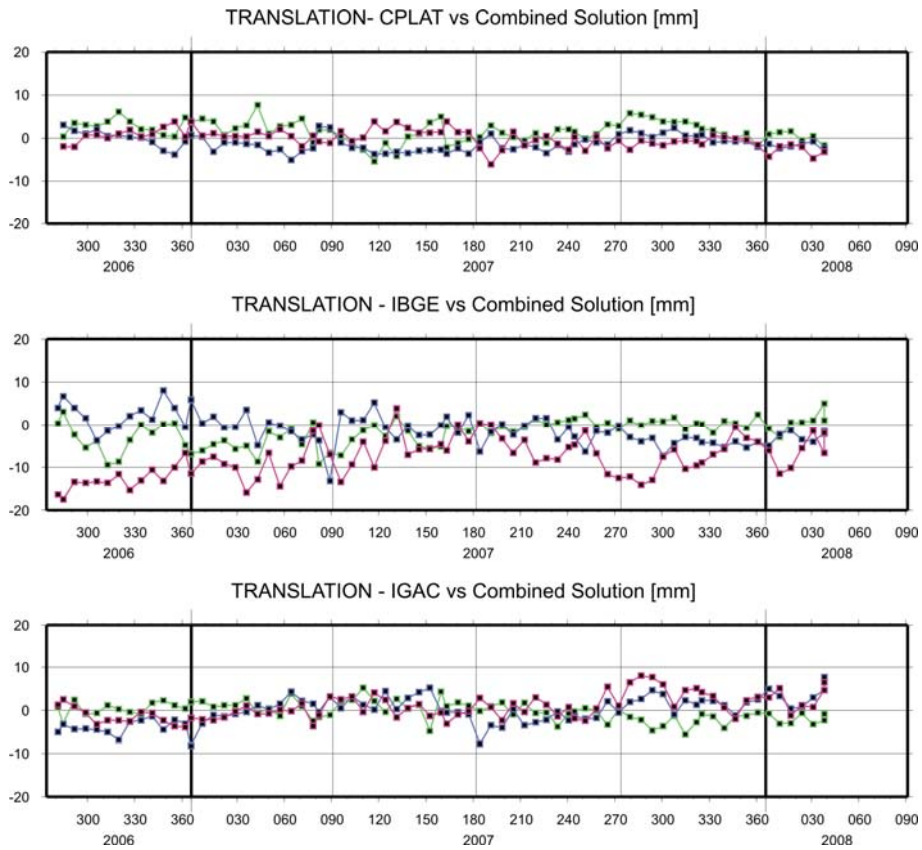


Figure A6.6. Time series for the translation parameters in X, Y, Z between individual EPC solutions and the final weekly combined solutions after a 7-parameter similarity transformation.

Annex 7: Comparison of the individual weekly Experimental Processing Centre solutions with the weekly combination of the IGS Global Network

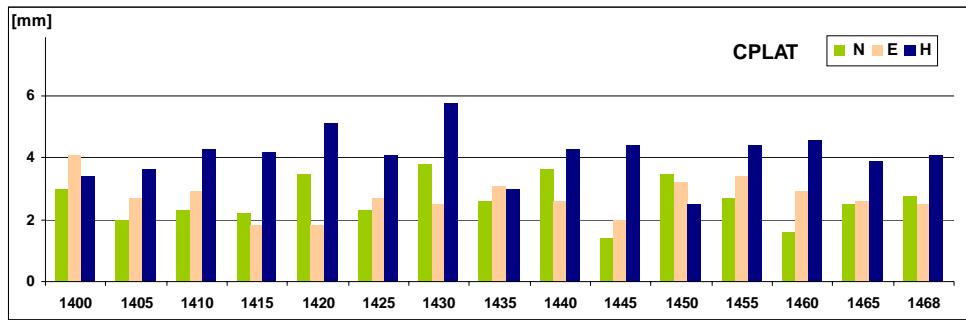


Figure A7.1. Residuals after a direct comparison between constrained weekly CPLAT coordinates (after NNT+NNR to IGS05 values) and weekly coordinates from the IGS global network combination (values each fifth week are shown),

Mean RMS values over the period GPS weeks 1396 - 1468:
 $N = 2,65 \text{ mm}$, $E = 2,72 \text{ mm}$, $H = 4,11 \text{ mm}$.

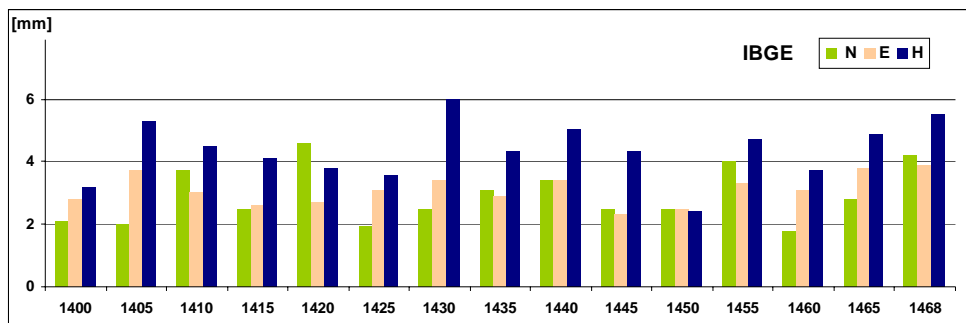


Figure A7.2. Residuals after a direct comparison between constrained weekly IBGE coordinates (after NNT+NNR to IGS05 values) and weekly coordinates from the IGS global network combination (values each fifth week are shown),

Mean RMS values over the period GPS weeks 1396 - 1468:
 $N = 2,91 \text{ mm}$, $E = 3,10 \text{ mm}$, $H = 4,35 \text{ mm}$.

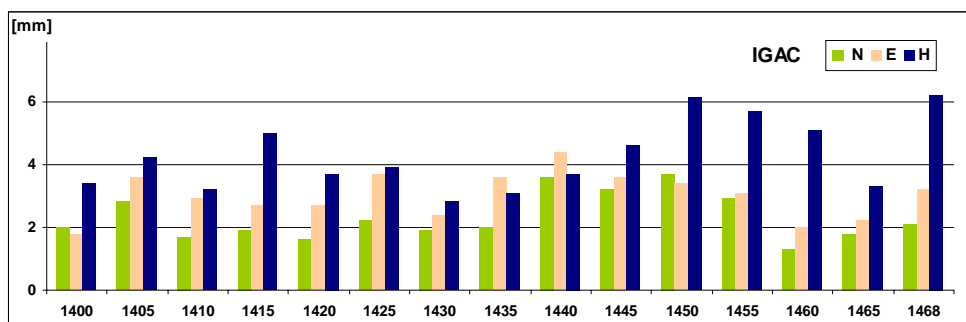
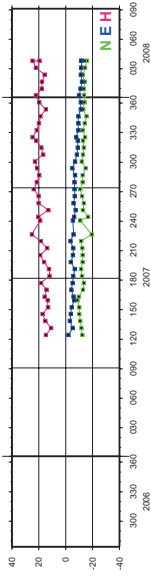


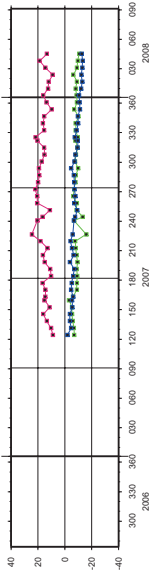
Figure A7.1. Residuals after a direct comparison between constrained weekly IGAC coordinates (after NNT+NNR to IGS05 values) and weekly coordinates from the IGS global network combination (values each fifth week are shown),

Mean RMS values over the period GPS weeks 1396 - 1468:
 $N = 2,31 \text{ mm}$, $E = 3,02 \text{ mm}$, $H = 4,30 \text{ mm}$.

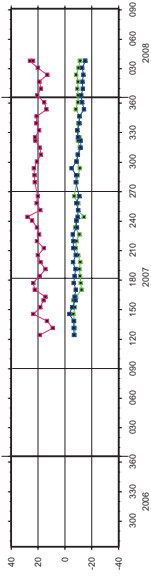
ANDS-Combined Solution Coordinate variations [mm]



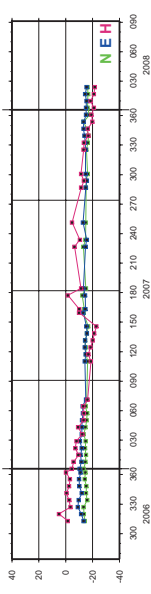
ANDS-IGAC Coordinate variations [mm]



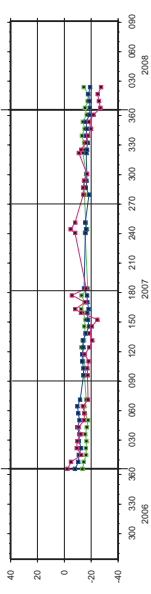
ANDS-DGFI Coordinate variations [mm]



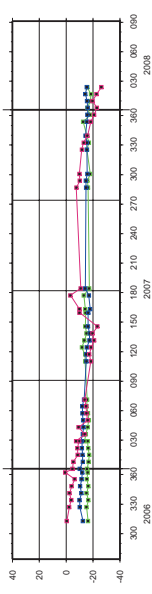
ANTC-Combined Solution Coordinate variations [mm]



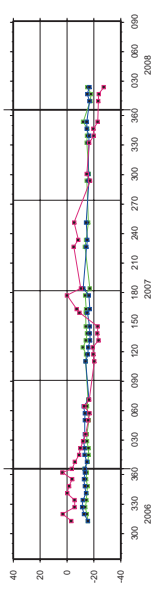
ANTC-DGFI Coordinate variations [mm]



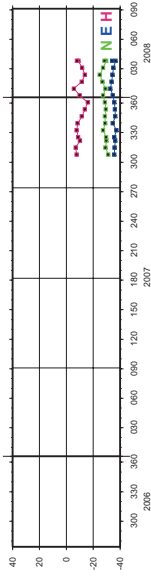
ANTC-IBGE Coordinate variations [mm]



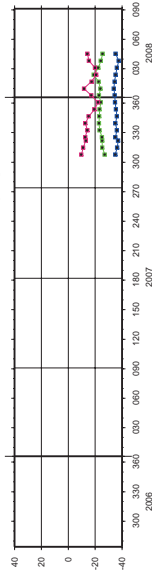
ANTC-CPLAT Coordinate variations [mm]



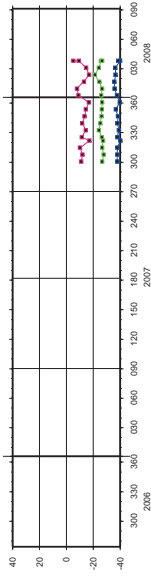
APTO-Combined Solution Coordinate variations [mm]



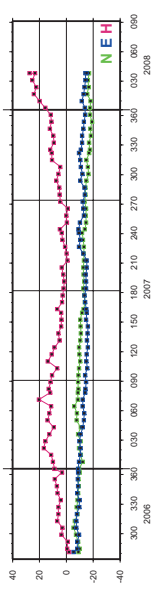
APTO-IGAC Coordinate variations [mm]



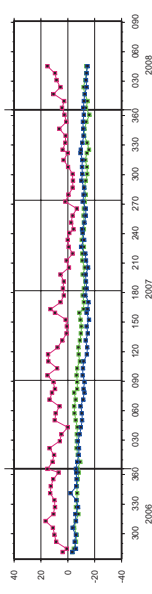
APTO-DGFI Coordinate variations [mm]



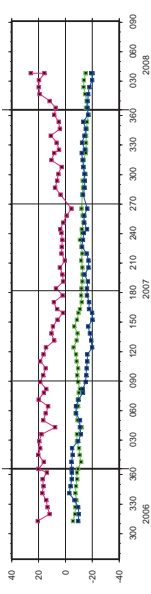
AREQ-Combined Solution Coordinate variations [mm]



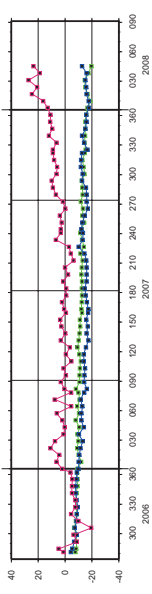
AREQ-IGAC Coordinate variations [mm]



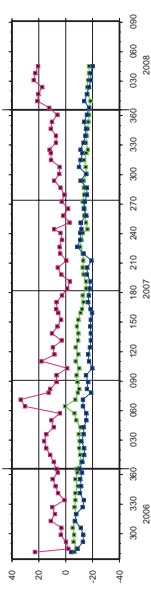
AREQ-DGFI Coordinate variations [mm]

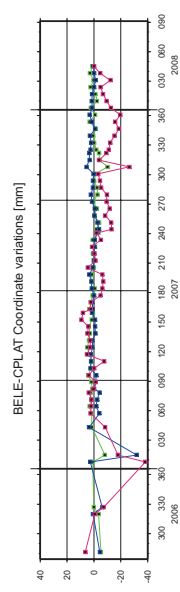
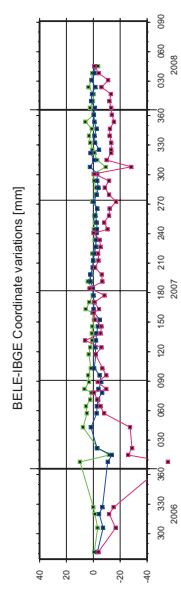
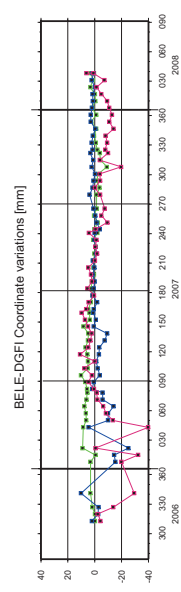
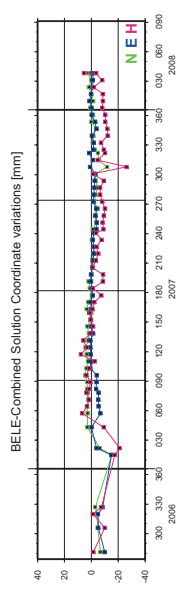
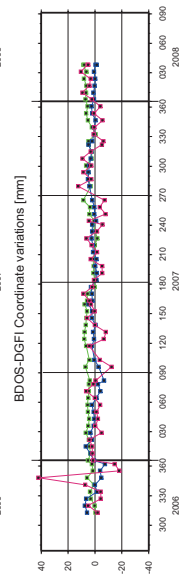
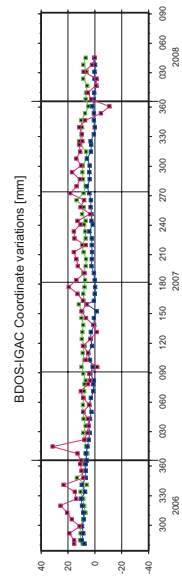
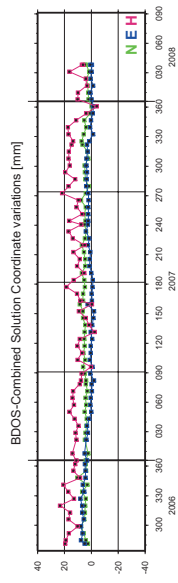
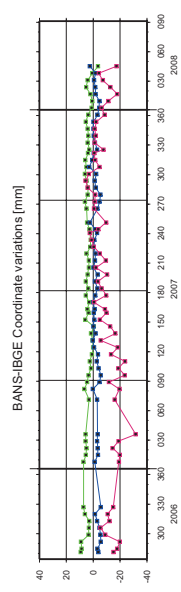
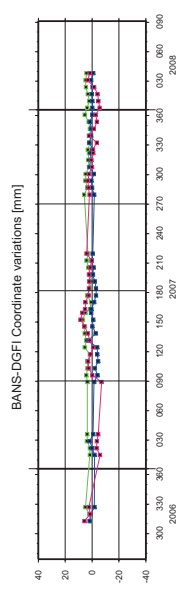
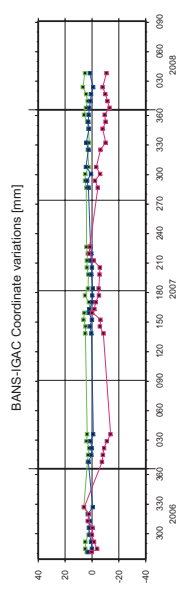
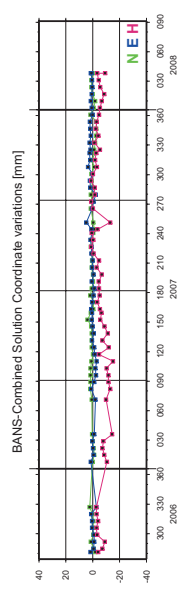
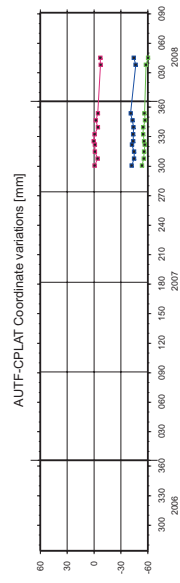
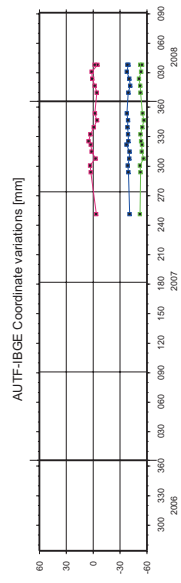
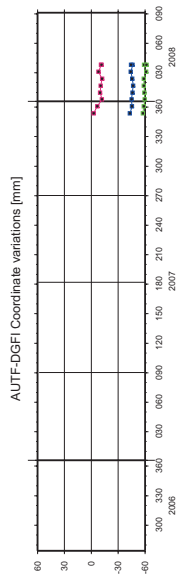
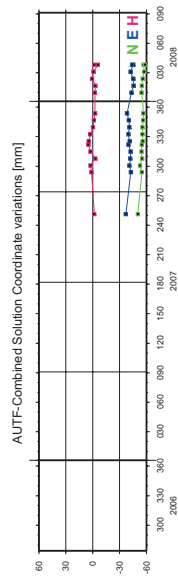


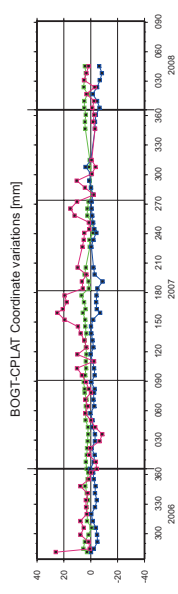
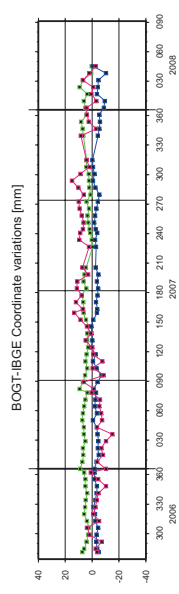
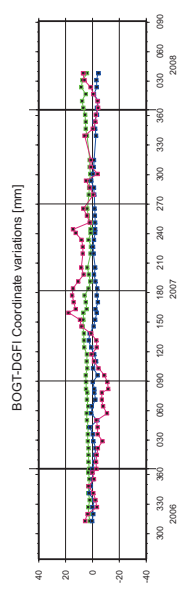
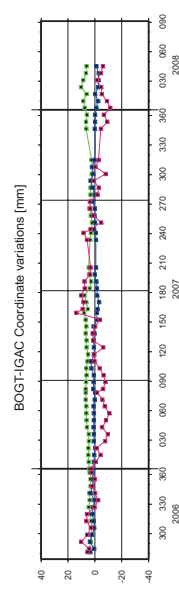
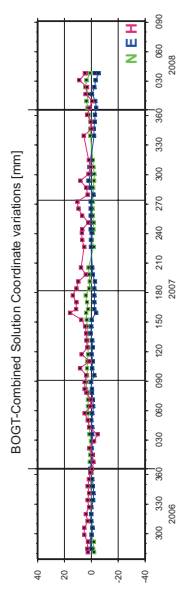
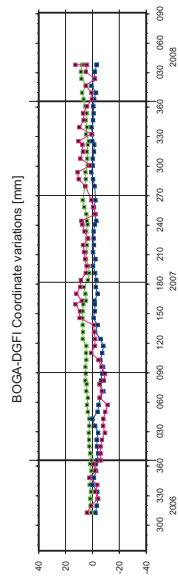
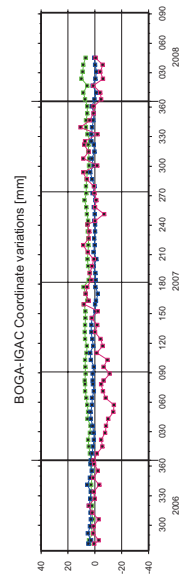
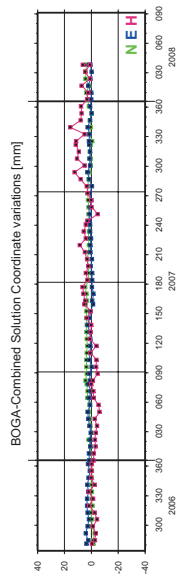
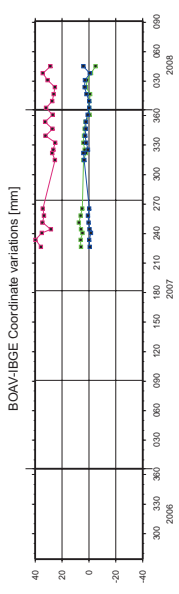
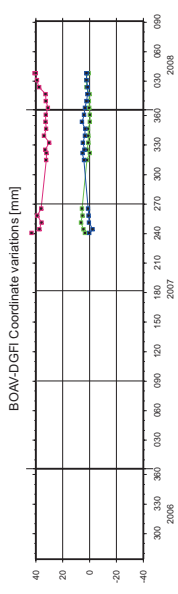
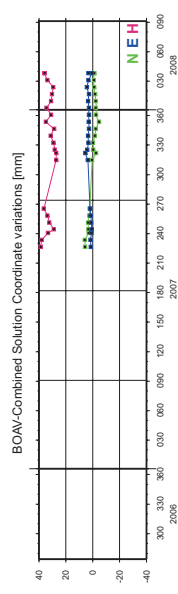
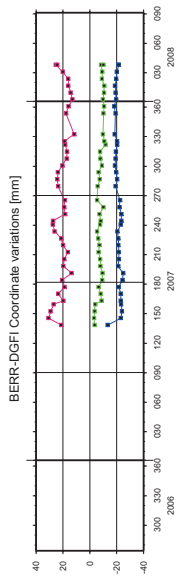
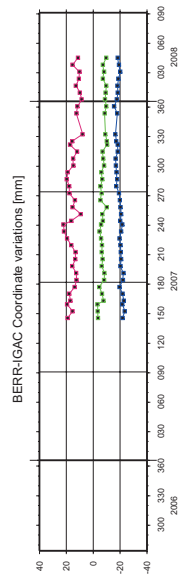
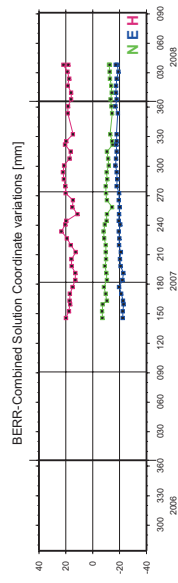
AREQ-IBGE Coordinate variations [mm]

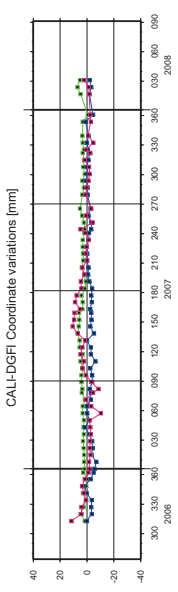
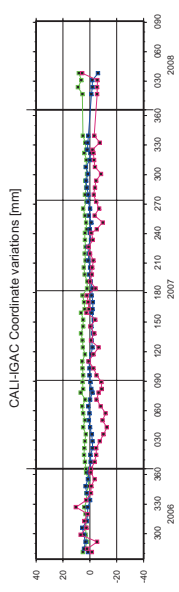
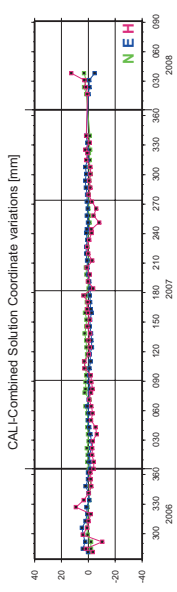
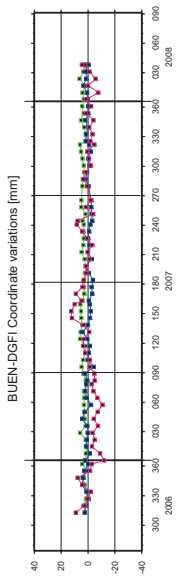
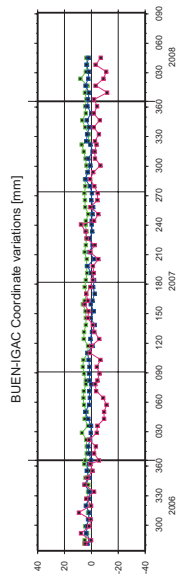
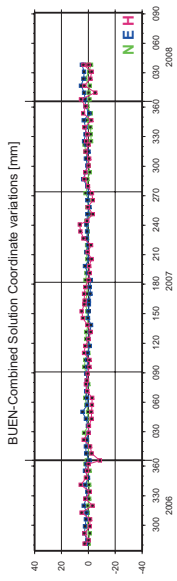
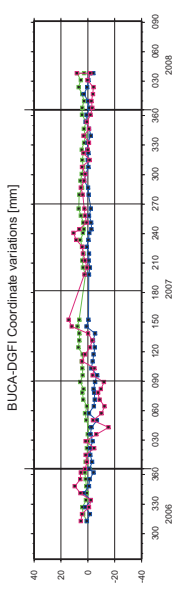
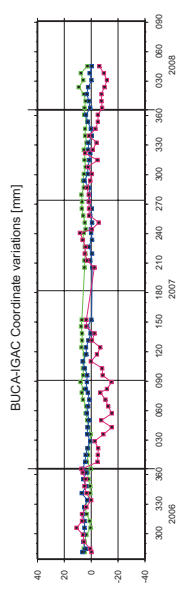
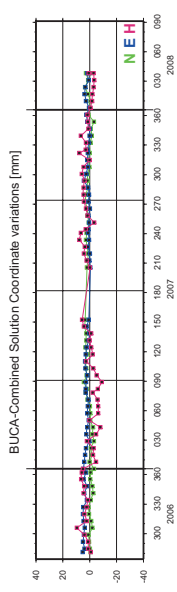
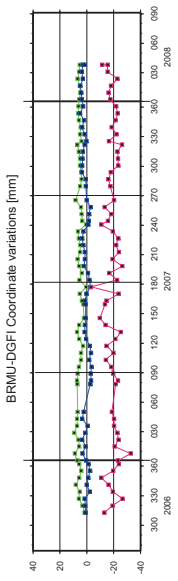
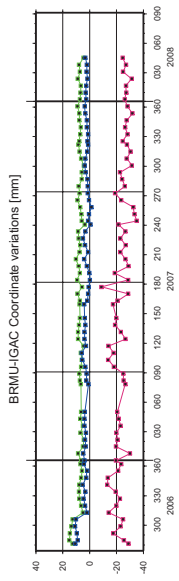
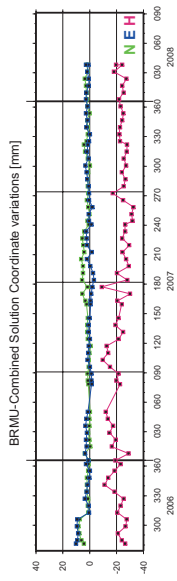


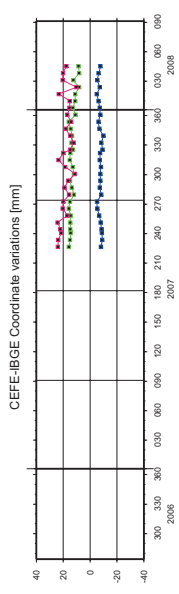
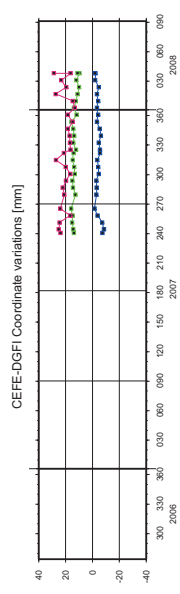
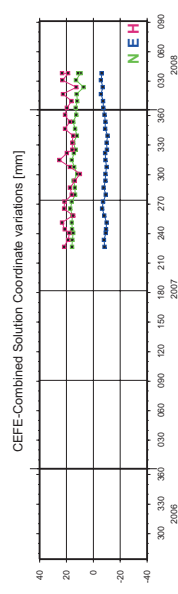
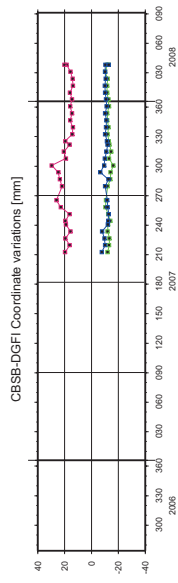
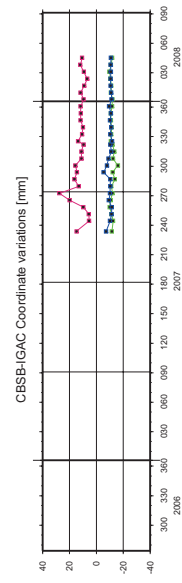
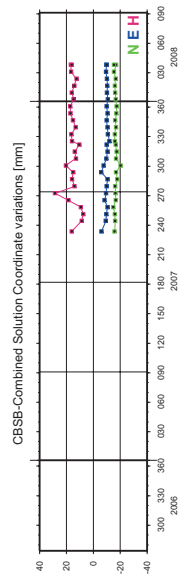
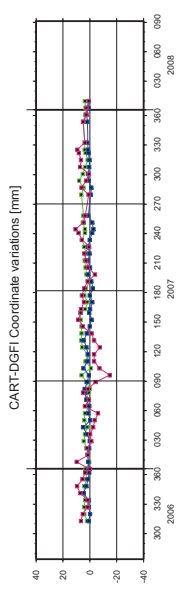
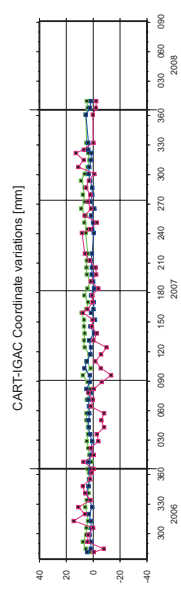
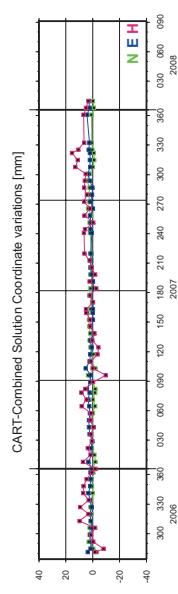
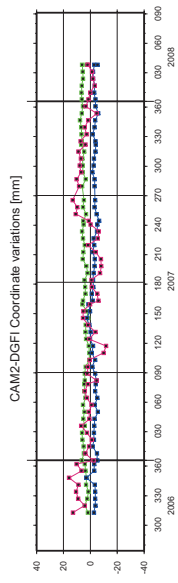
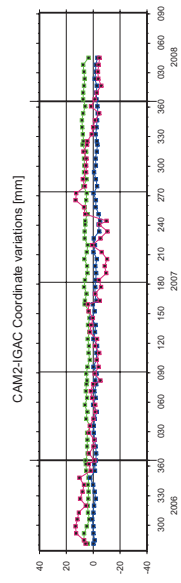
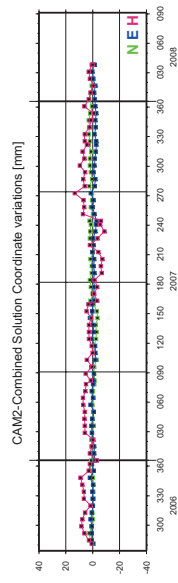
AREQ-CPLAT Coordinate variations [mm]

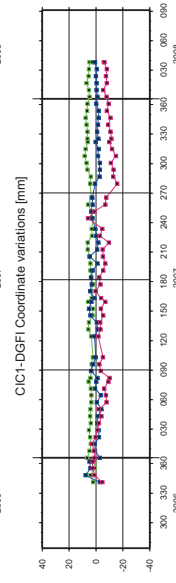
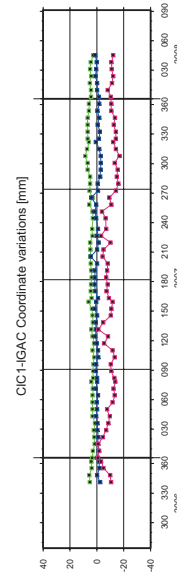
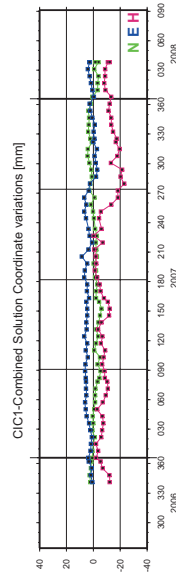
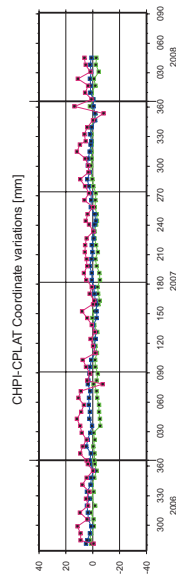
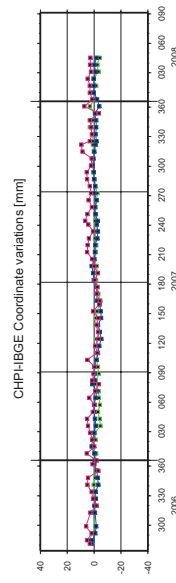
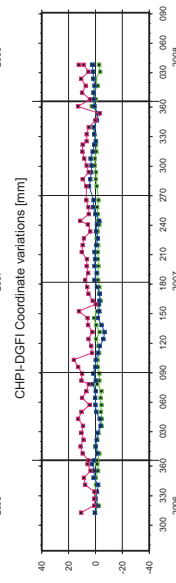
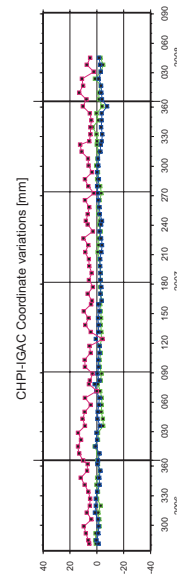
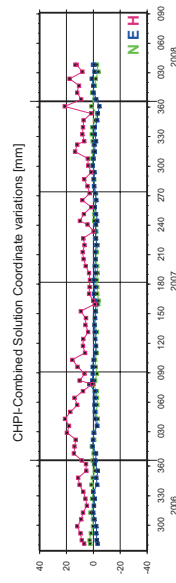
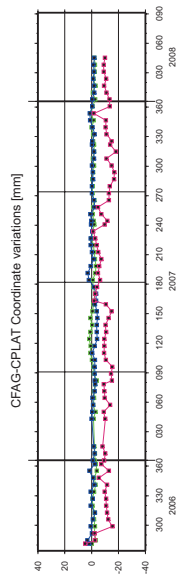
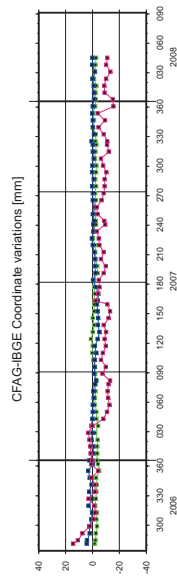
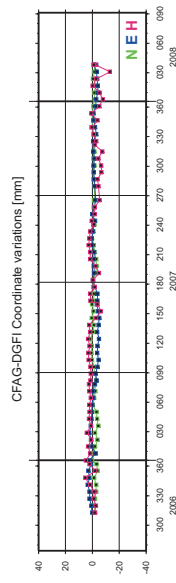
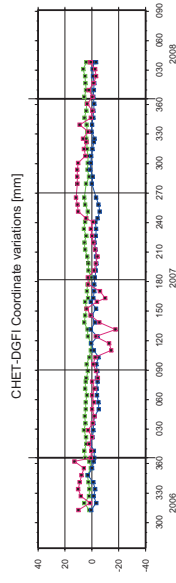
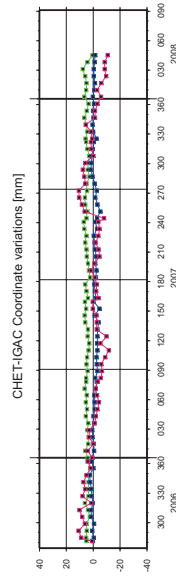
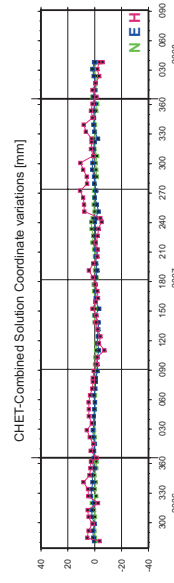


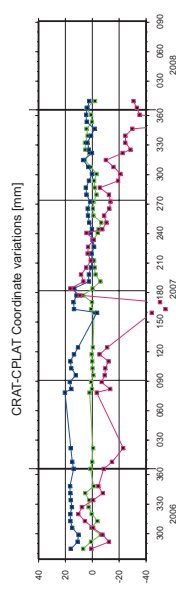
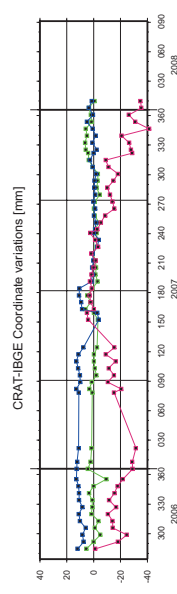
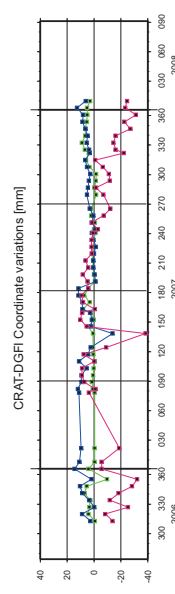
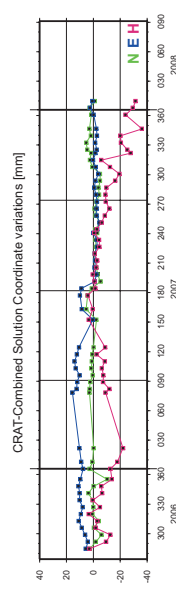
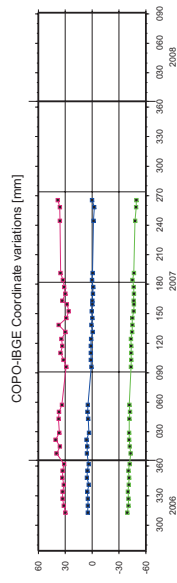
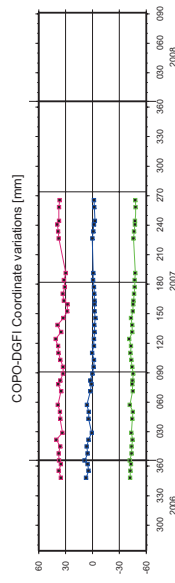
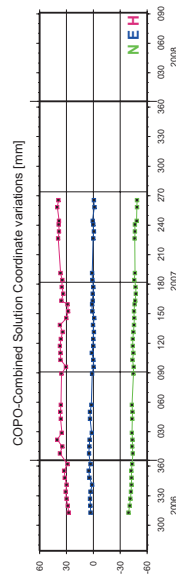
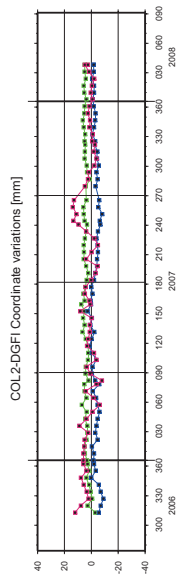
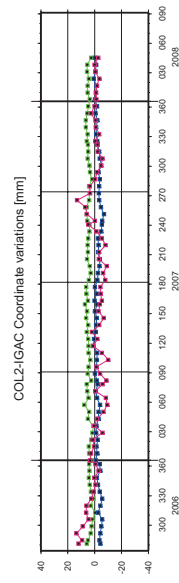
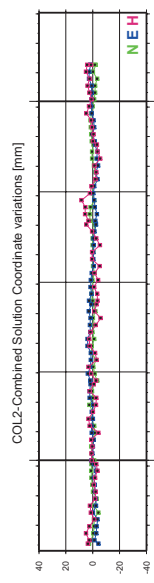
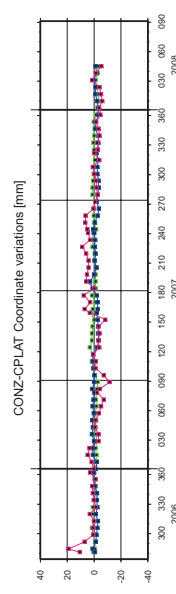
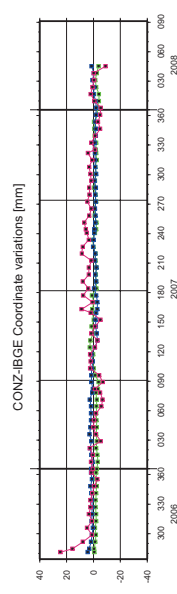
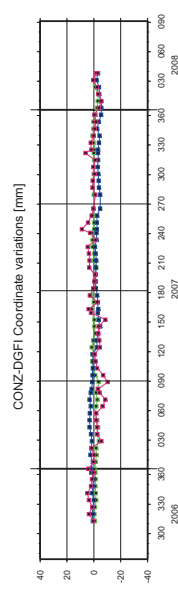
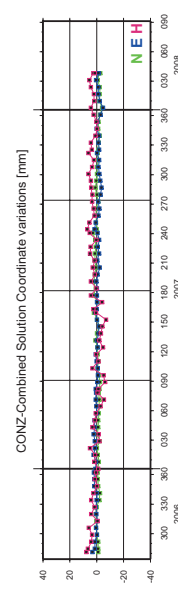
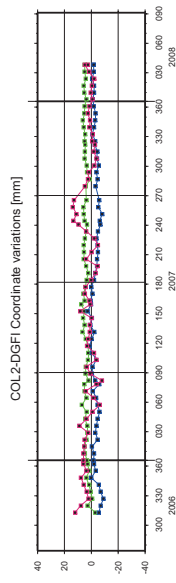
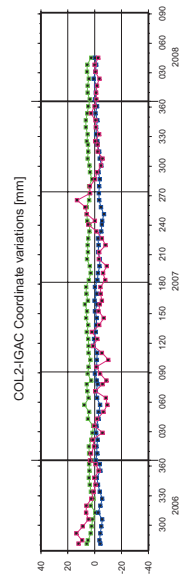
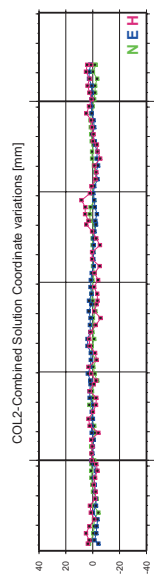


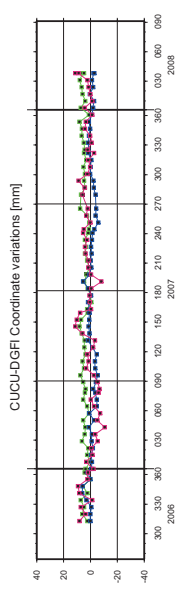
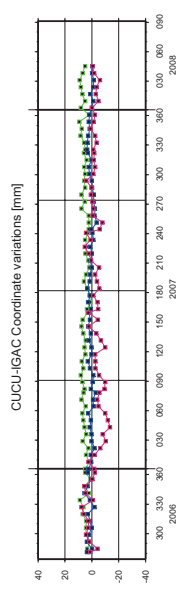
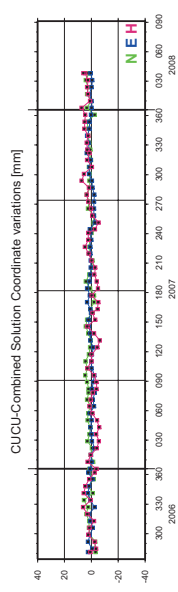
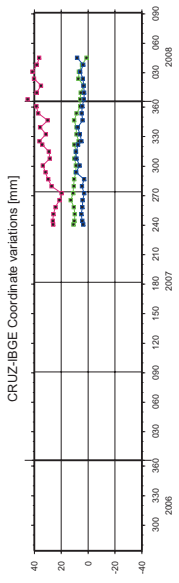
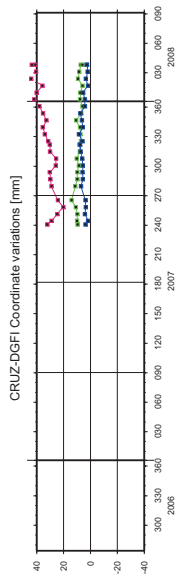
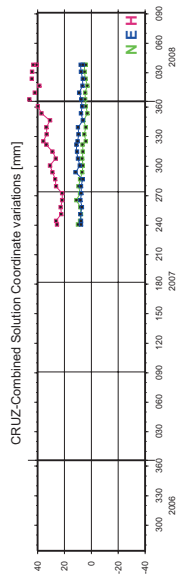
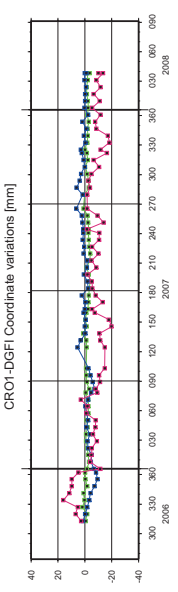
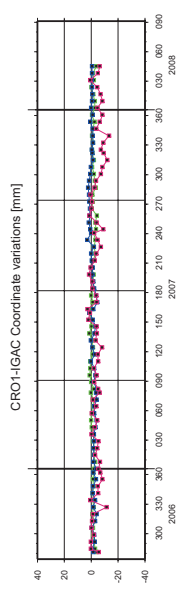
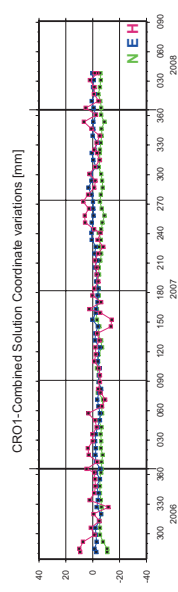
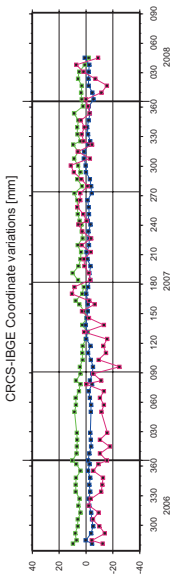
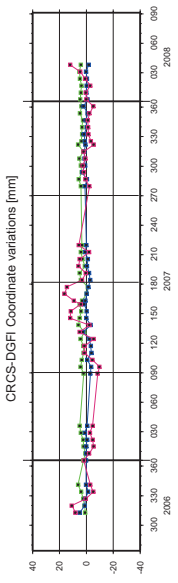
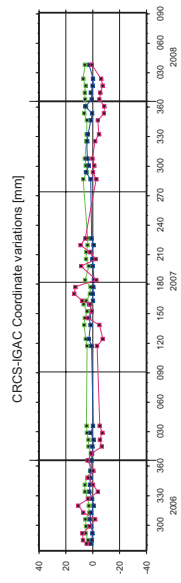
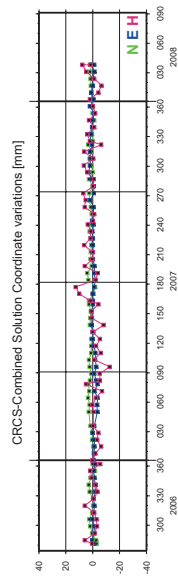


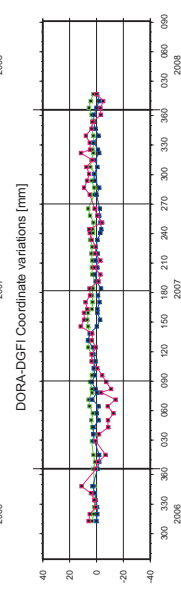
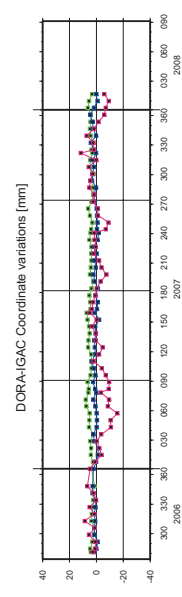
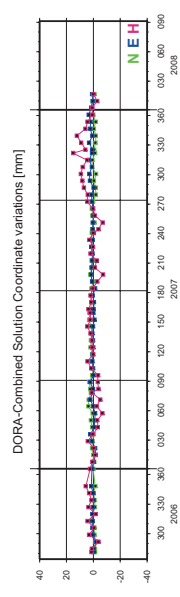
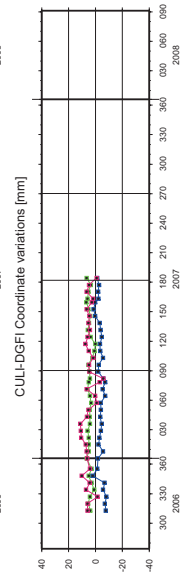
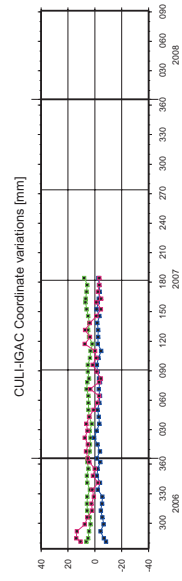
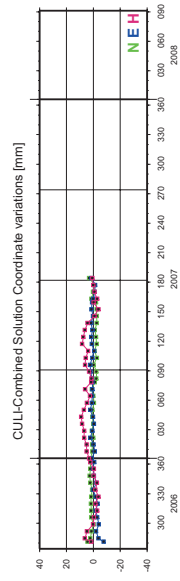
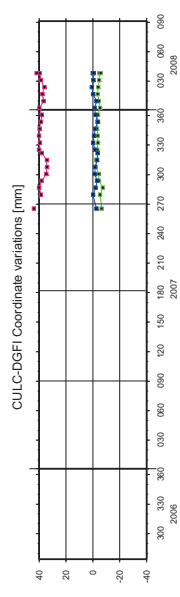
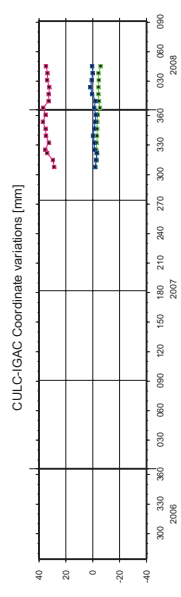
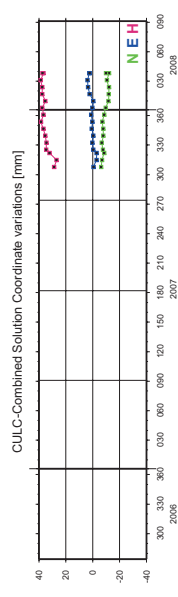
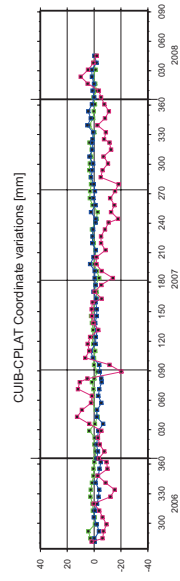
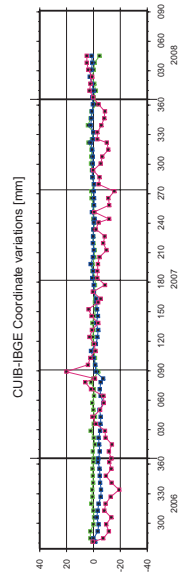
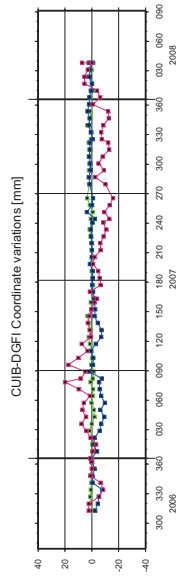
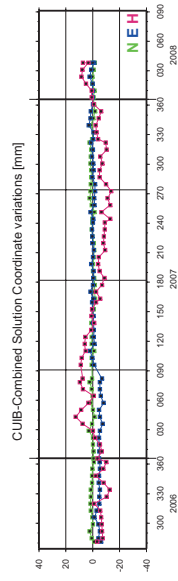




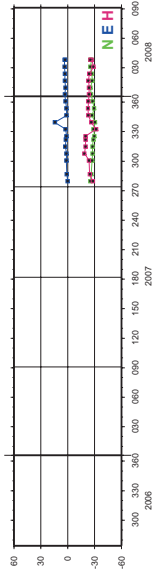




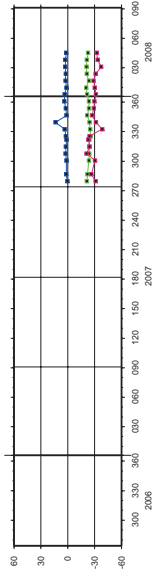




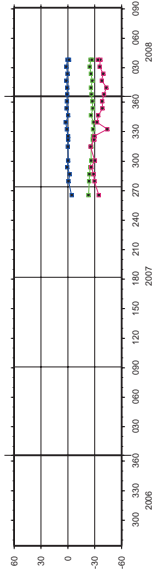
FONE-Combined Solution Coordinate variations [mm]



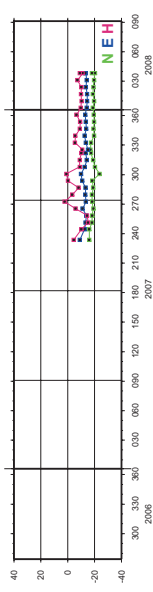
FONE-IGAC Coordinate variations [mm]



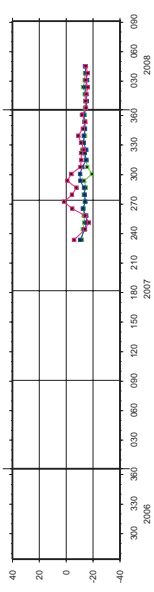
FONE-DGFI Coordinate variations [mm]



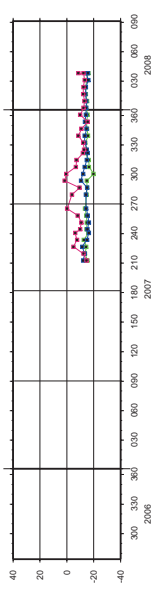
GCGT-Combined Solution Coordinate variations [mm]



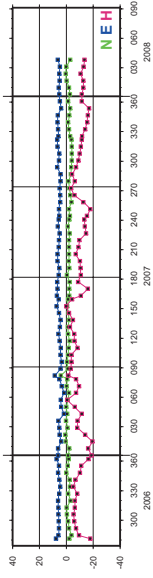
GCGT-IGAC Coordinate variations [mm]



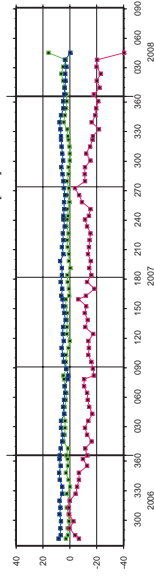
GCGT-DGFI Coordinate variations [mm]



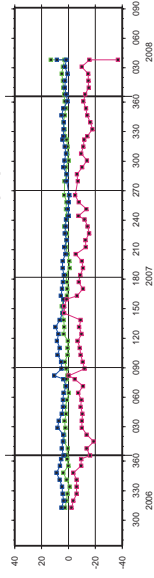
GLPS-Combined Solution Coordinate variations [mm]



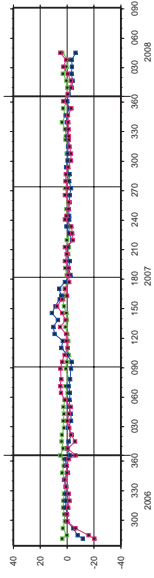
GLPS-IGAC Coordinate variations [mm]



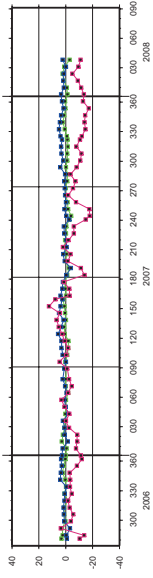
GLPS-DGFI Coordinate variations [mm]



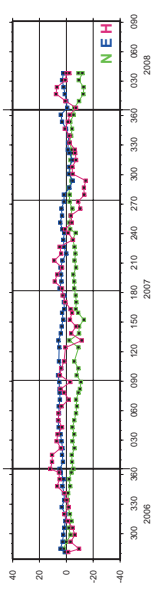
GLPS-IBGE Coordinate variations [mm]



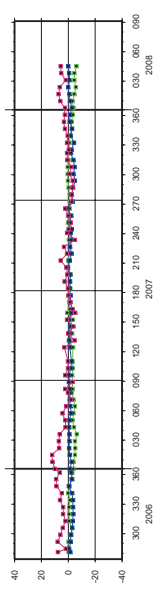
GLPS-CPLAT Coordinate variations [mm]



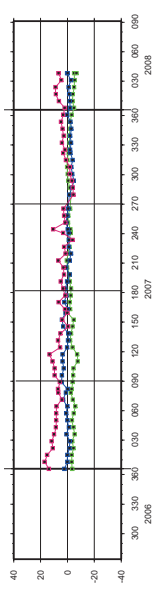
GOLD-Combined Solution Coordinate variations [mm]

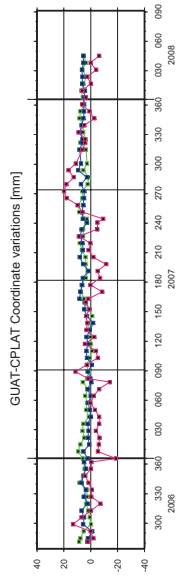
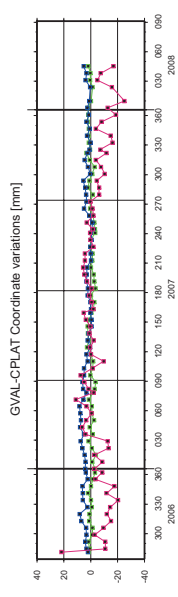
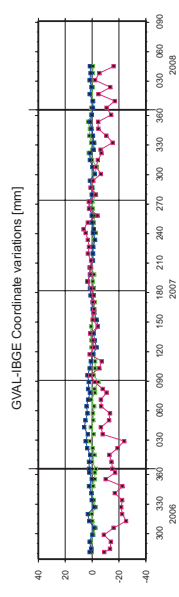
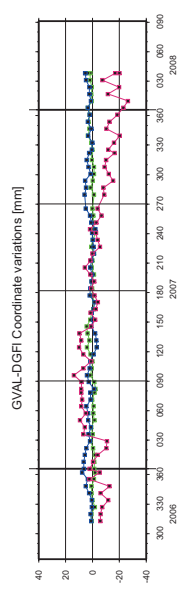
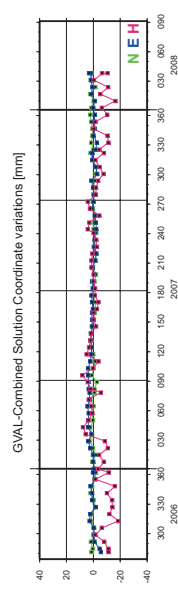
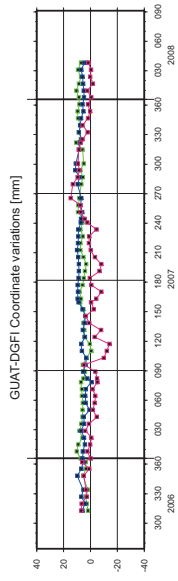
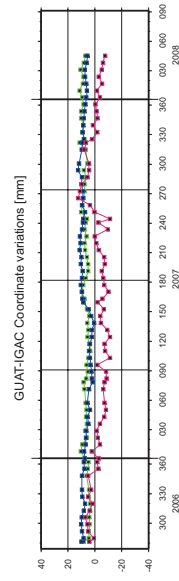
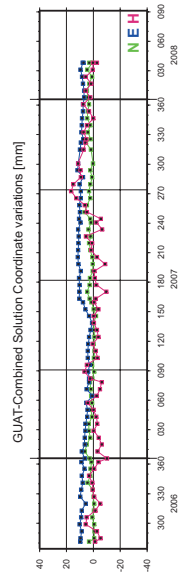
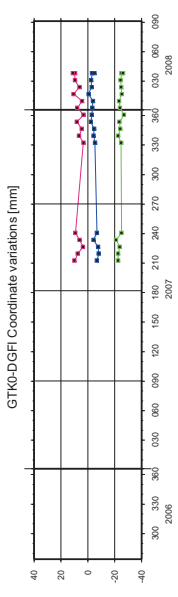
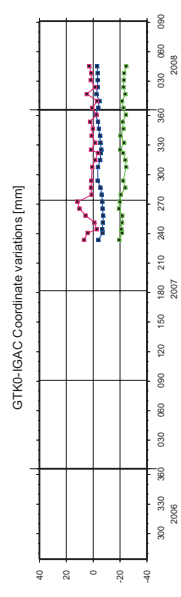
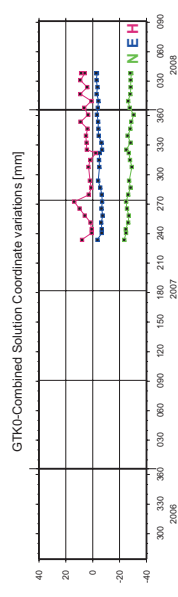
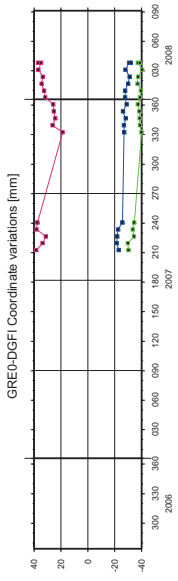
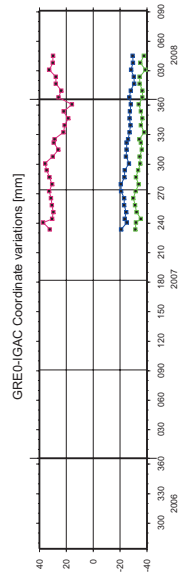
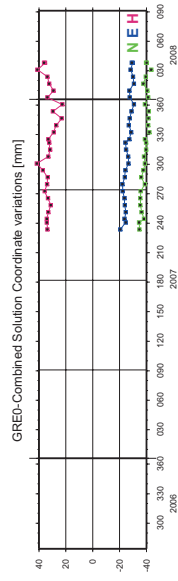


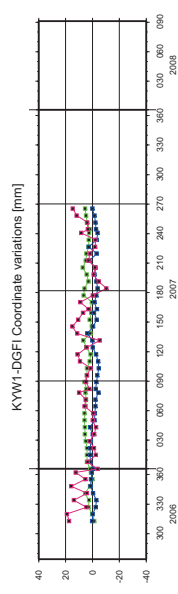
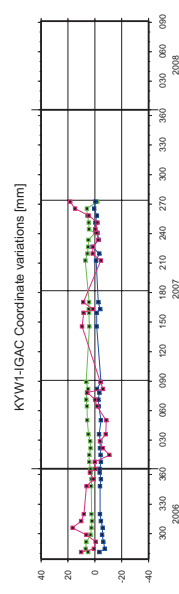
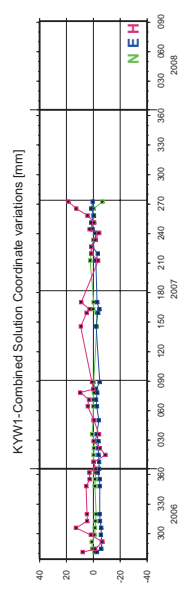
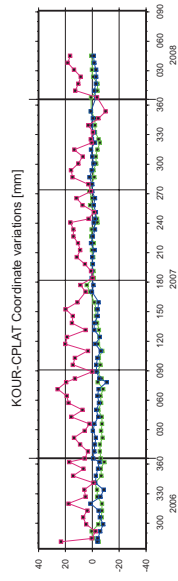
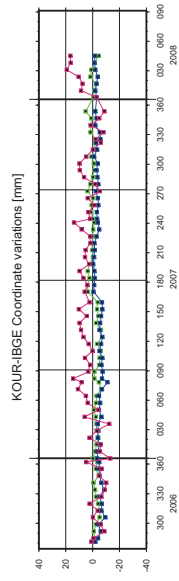
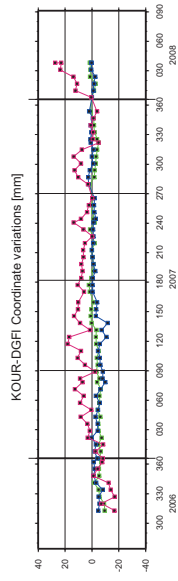
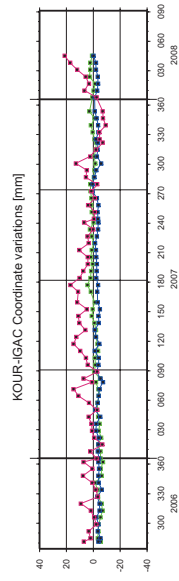
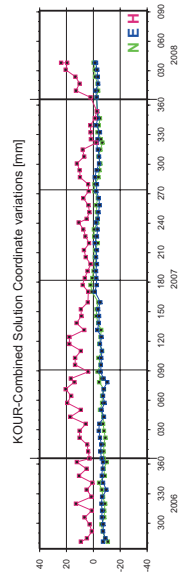
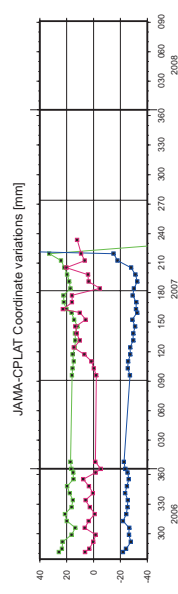
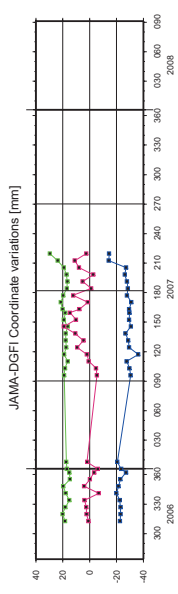
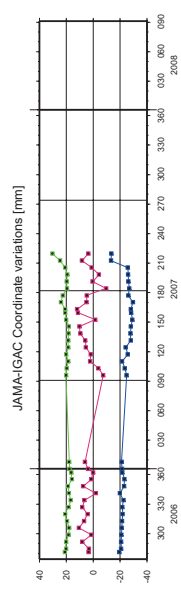
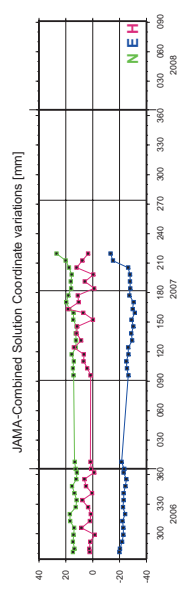
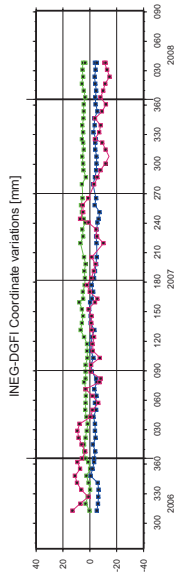
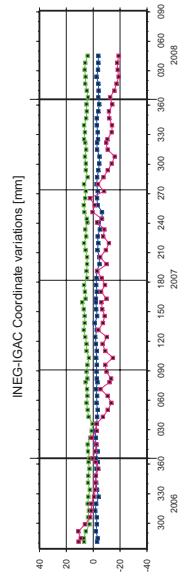
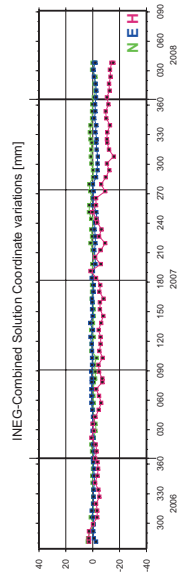
GOLD-IGAC Coordinate variations [mm]

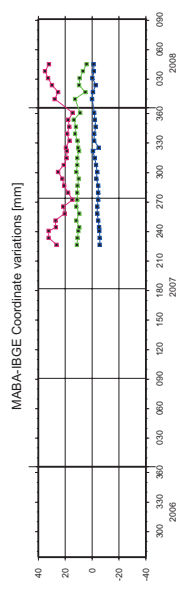
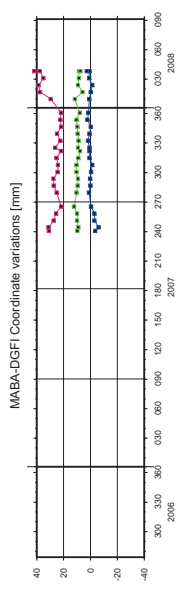
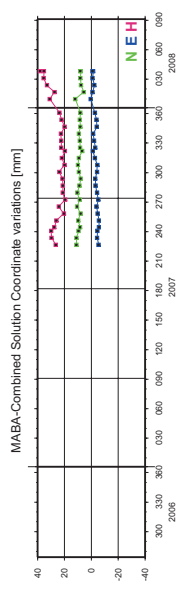
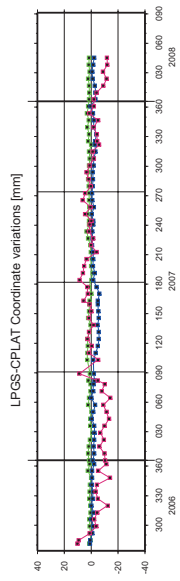
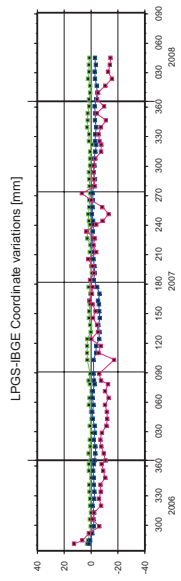
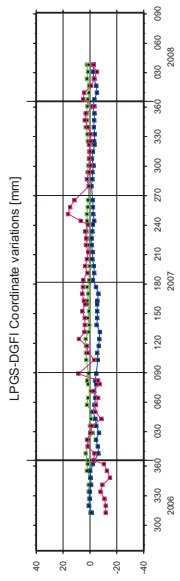
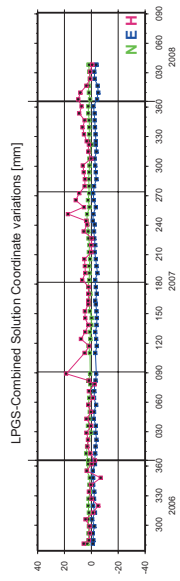
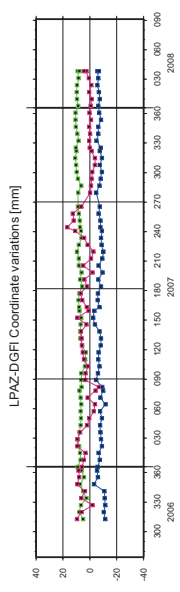
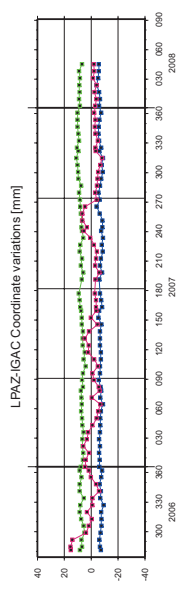
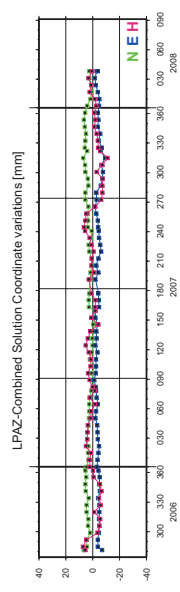
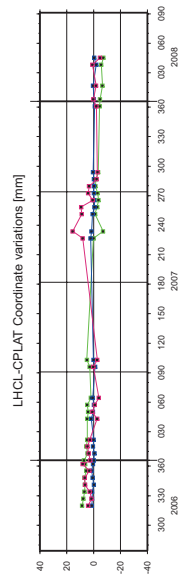
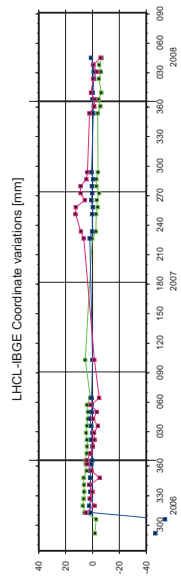
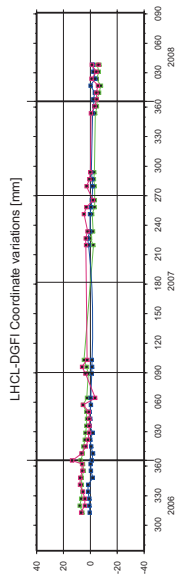
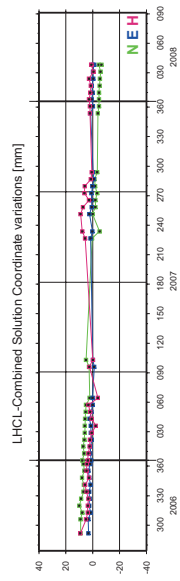


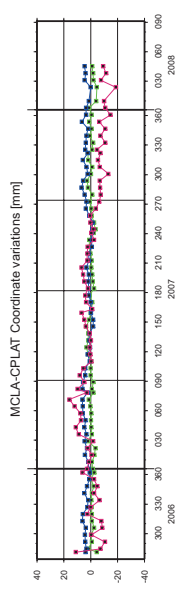
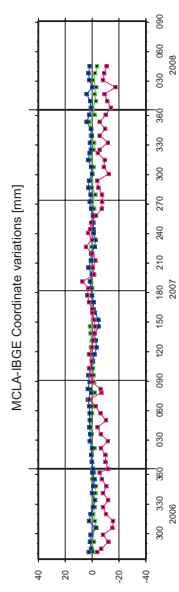
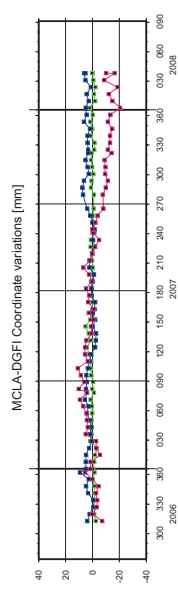
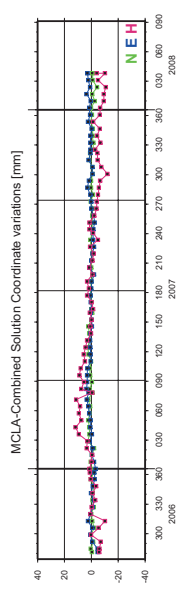
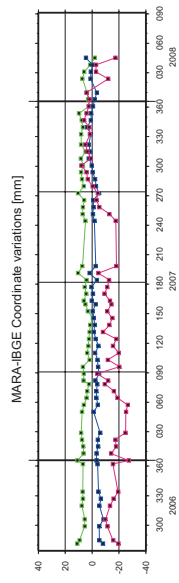
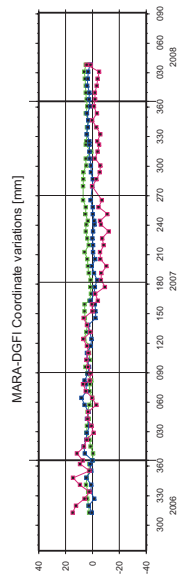
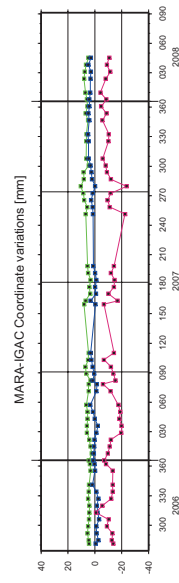
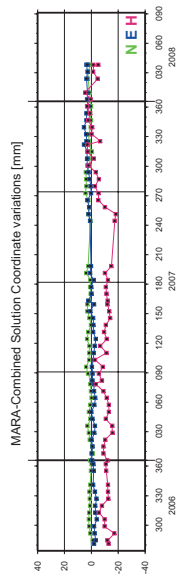
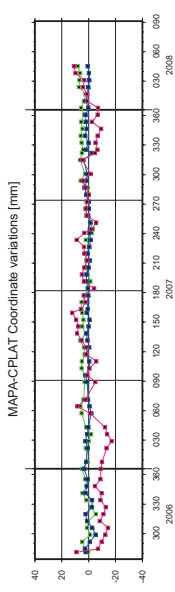
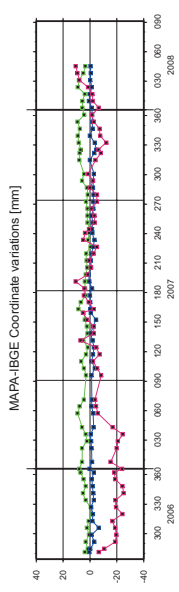
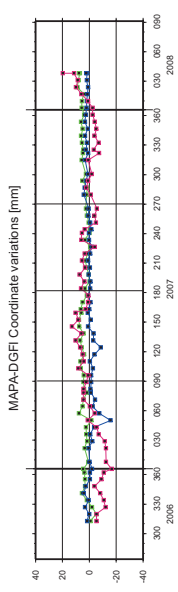
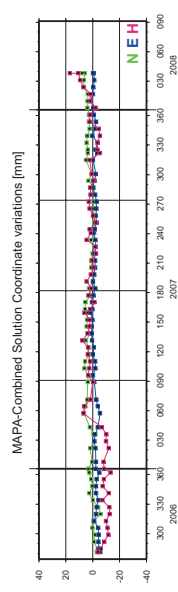
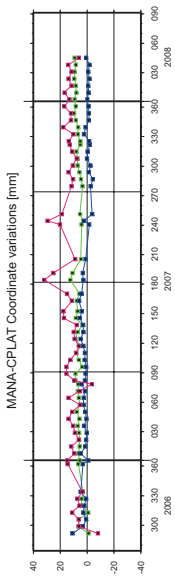
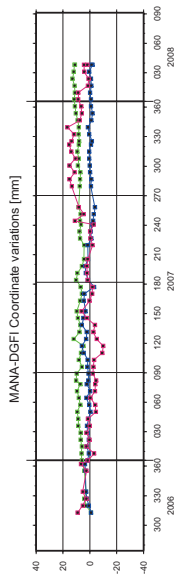
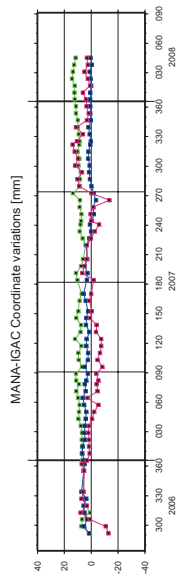
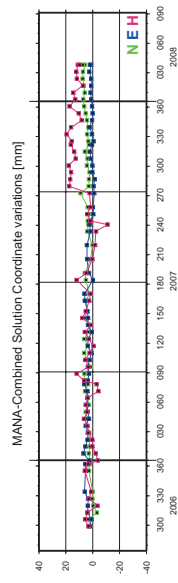
GOLD-DGFI Coordinate variations [mm]

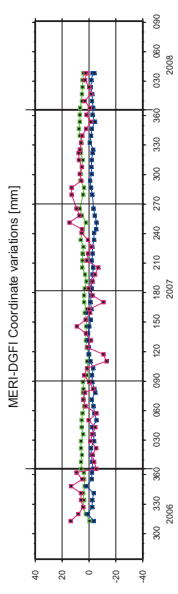
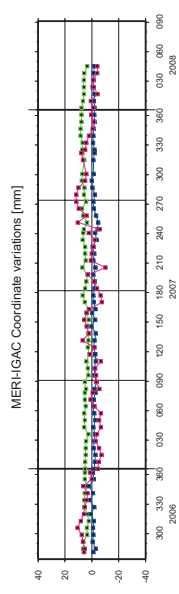
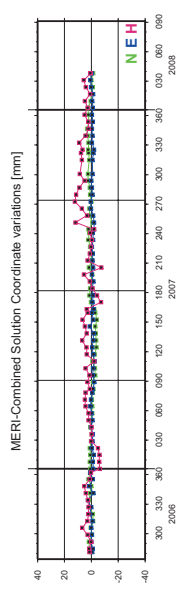
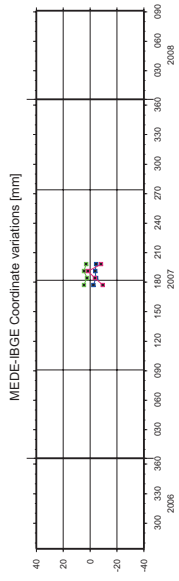
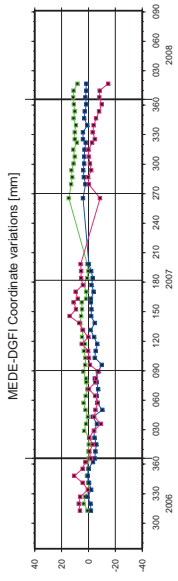
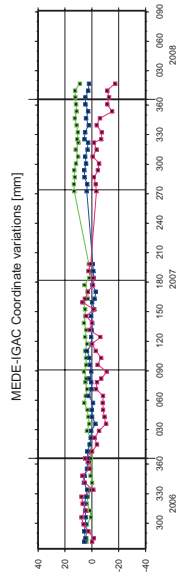
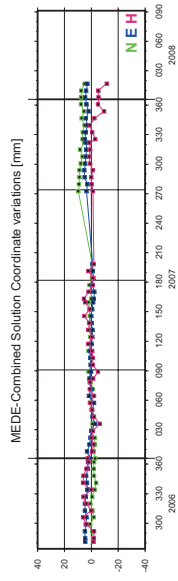
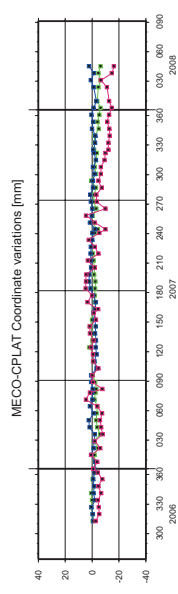
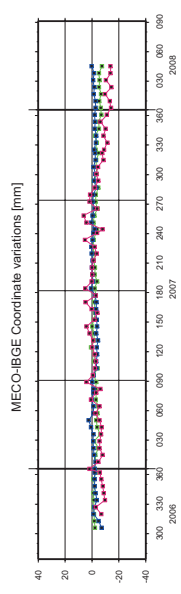
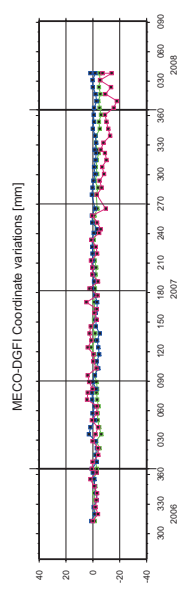
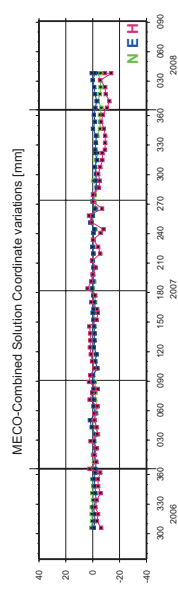
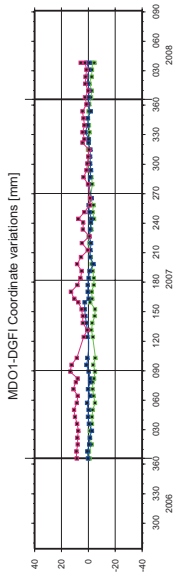
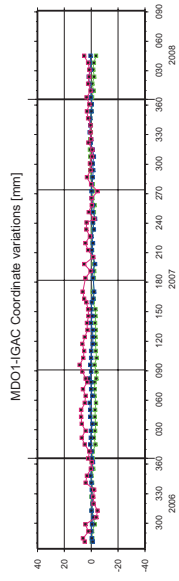
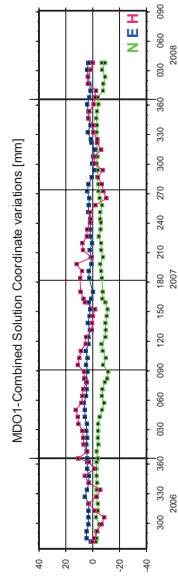


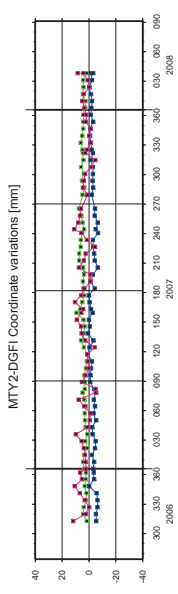
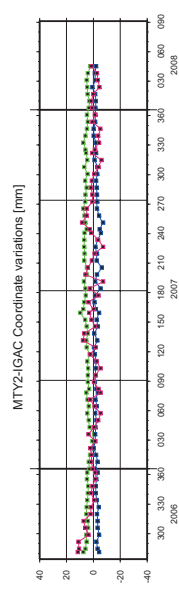
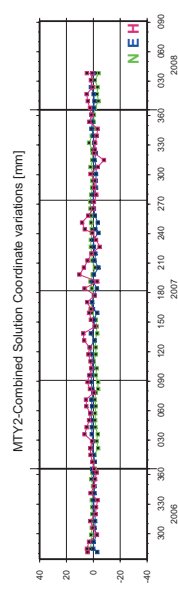
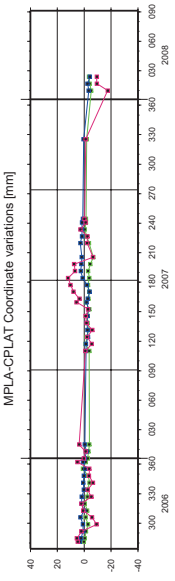
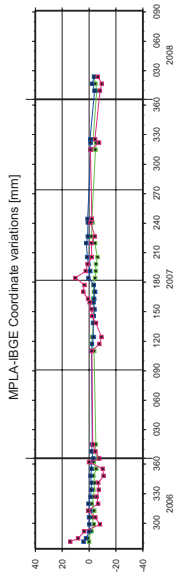
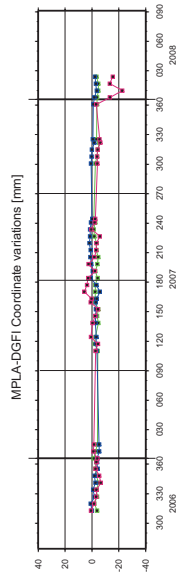
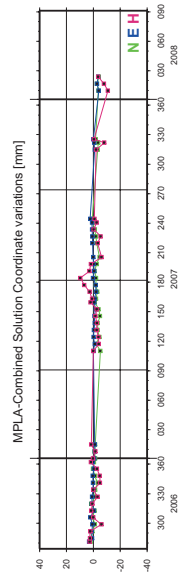
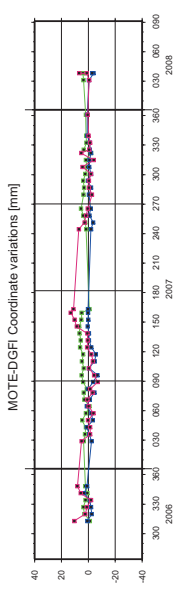
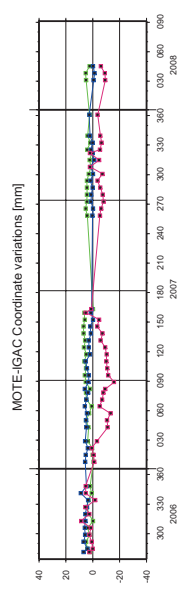
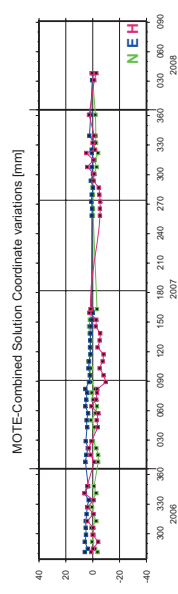
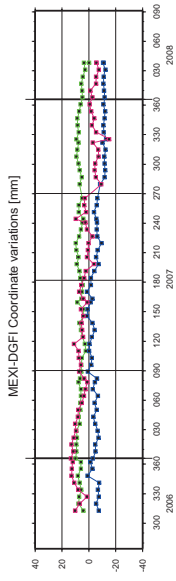
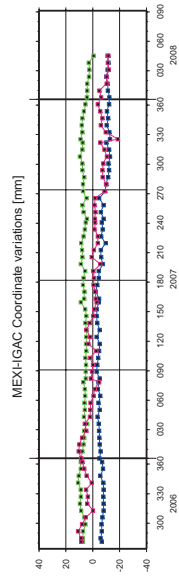
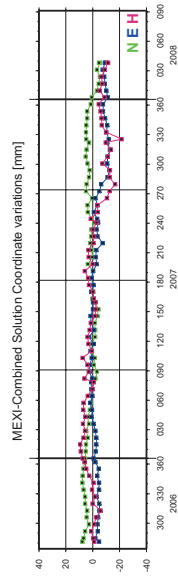


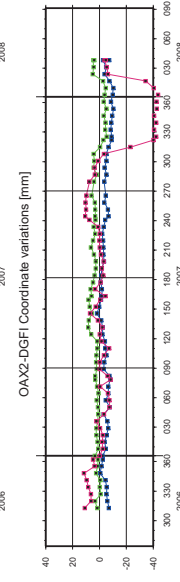
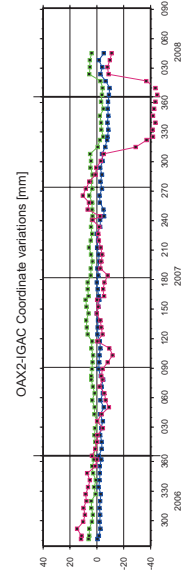
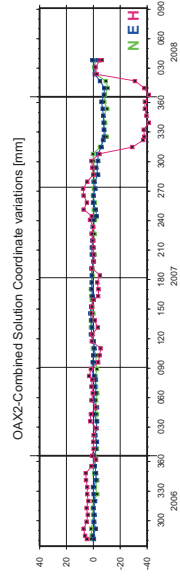
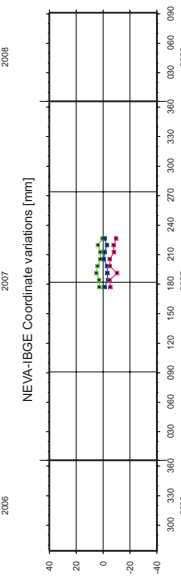
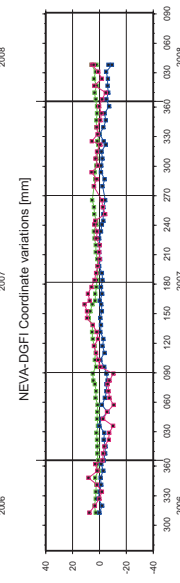
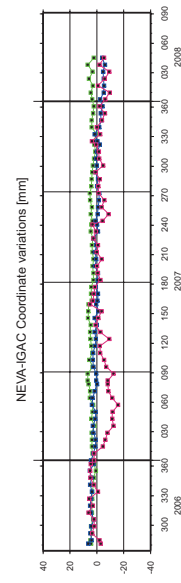
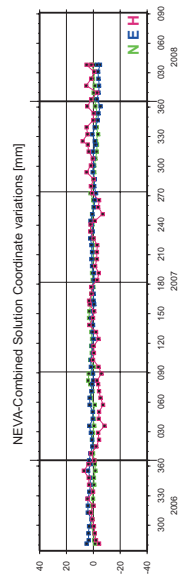
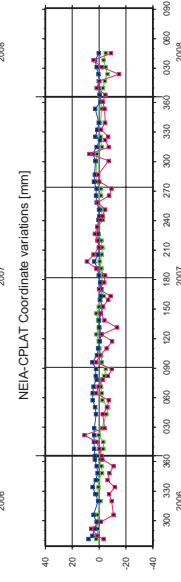
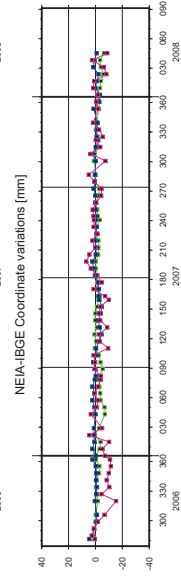
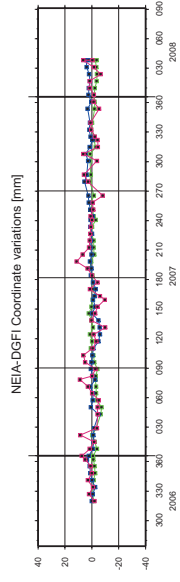
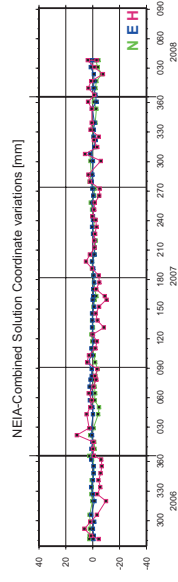
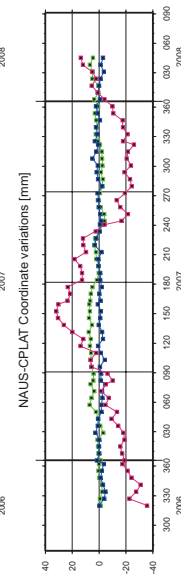
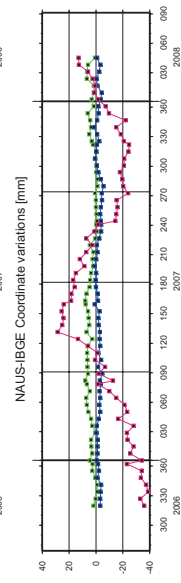
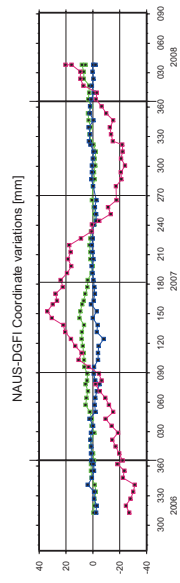
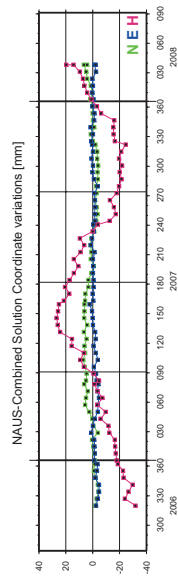


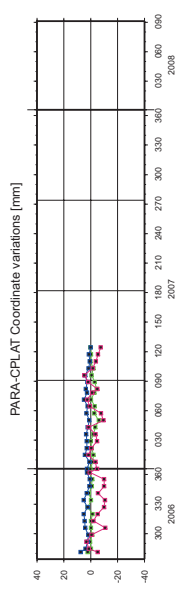
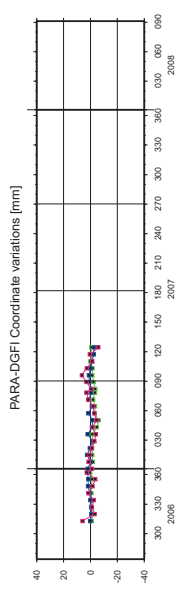
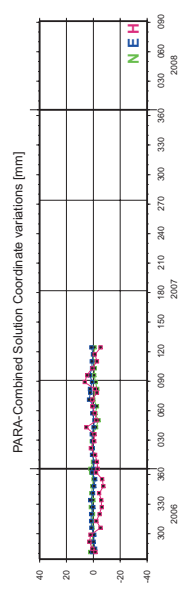
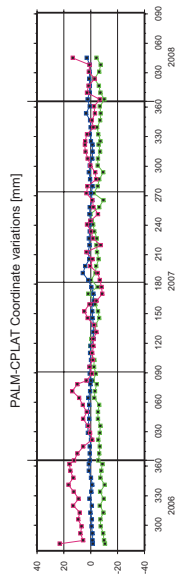
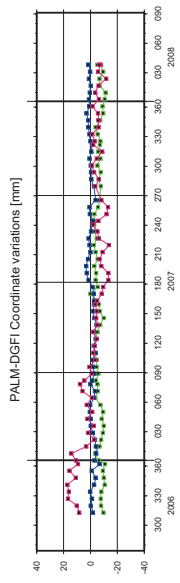
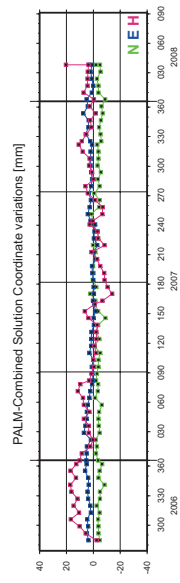
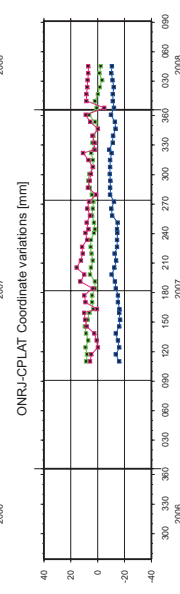
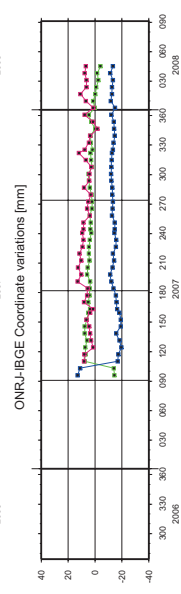
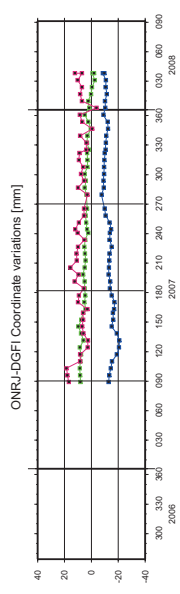
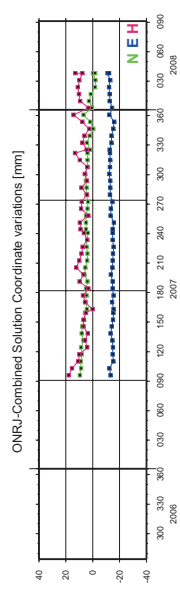
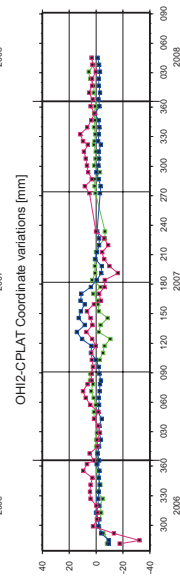
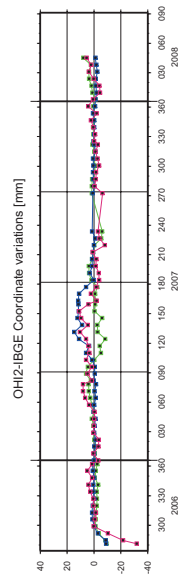
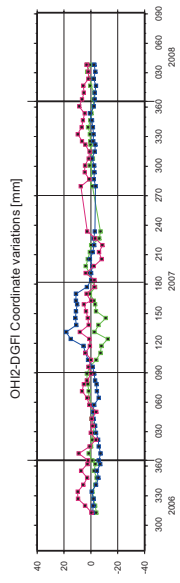
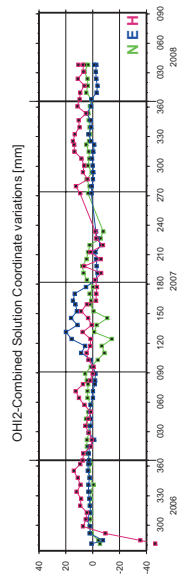


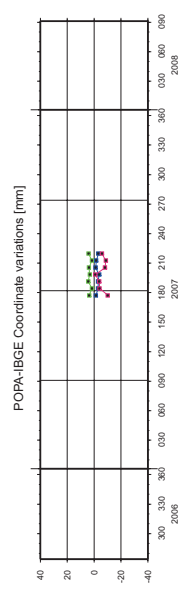
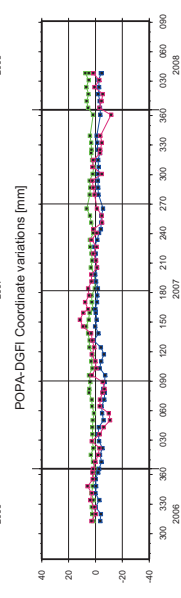
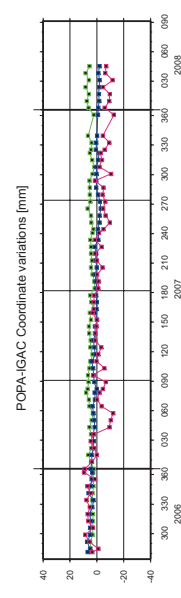
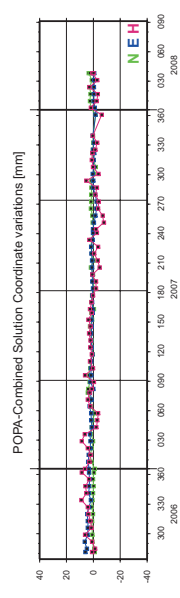
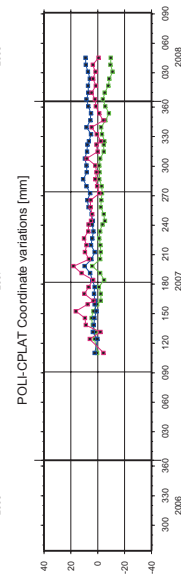
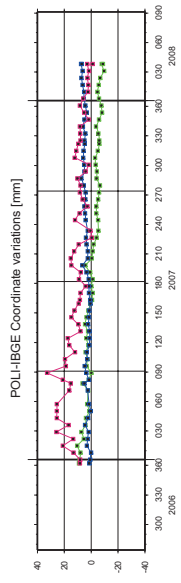
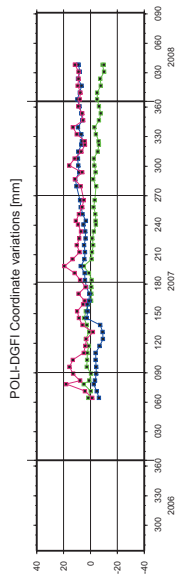
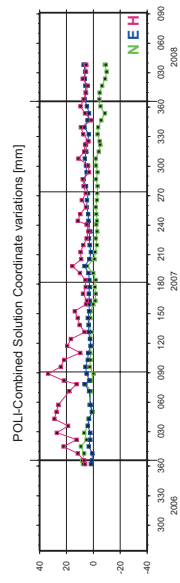
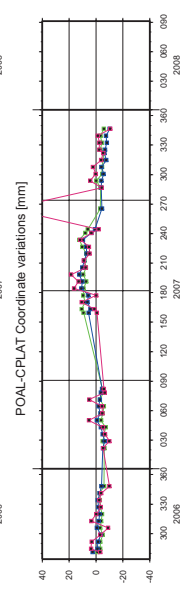
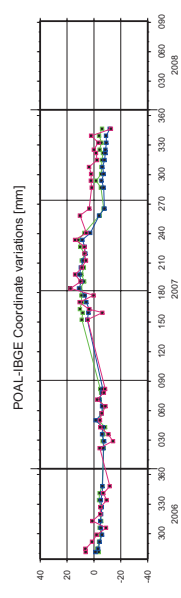
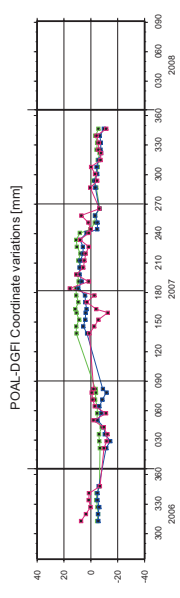
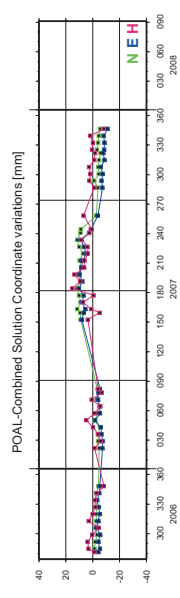
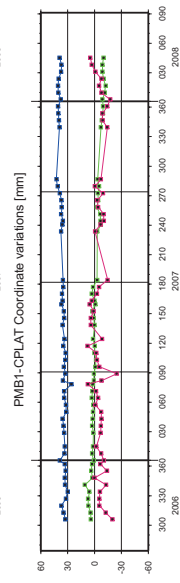
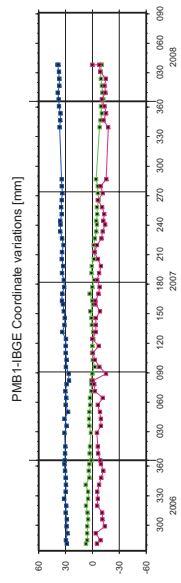
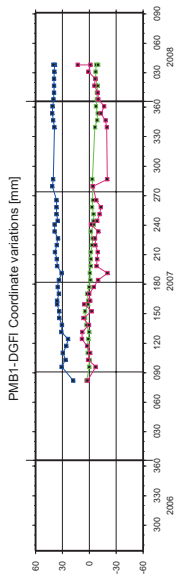
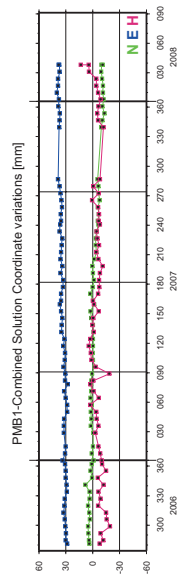


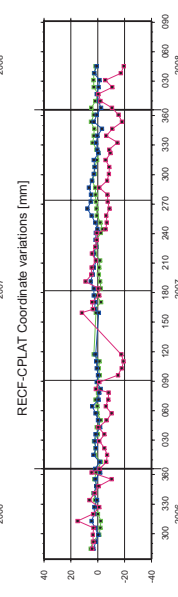
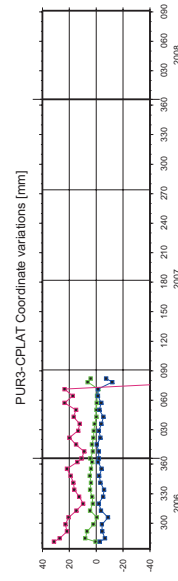
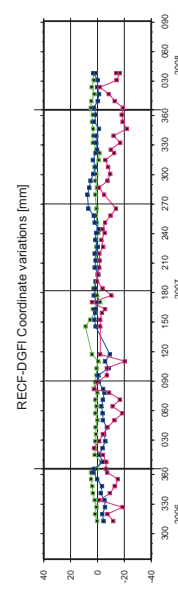
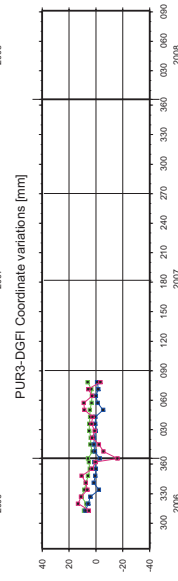
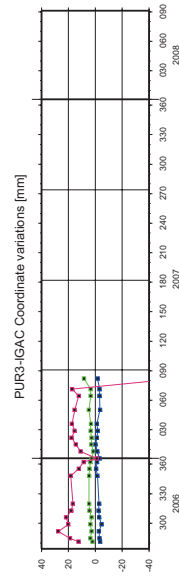
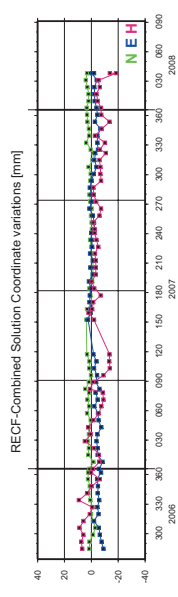
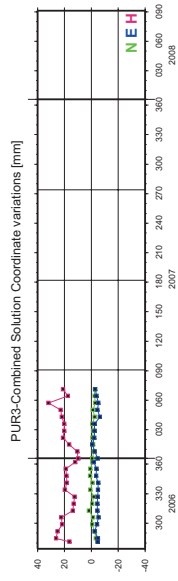
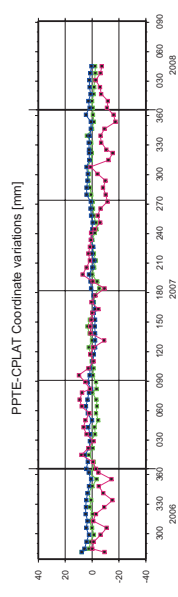
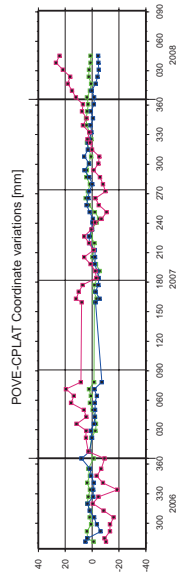
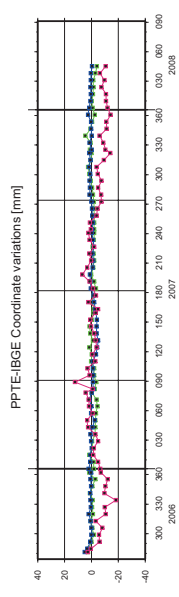
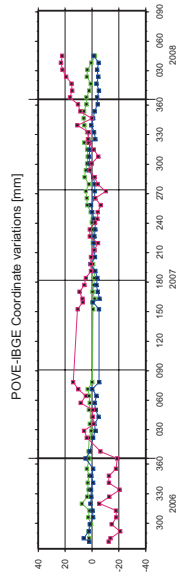
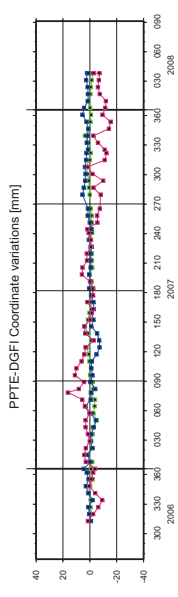
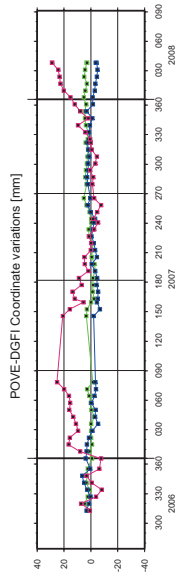
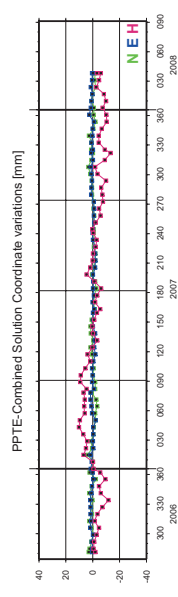
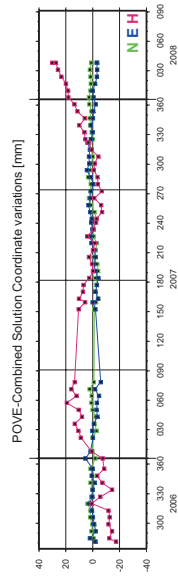


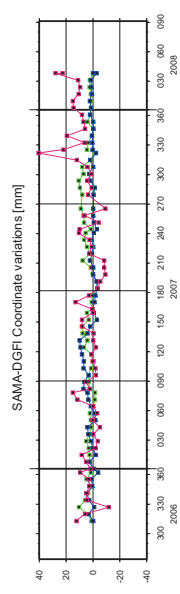
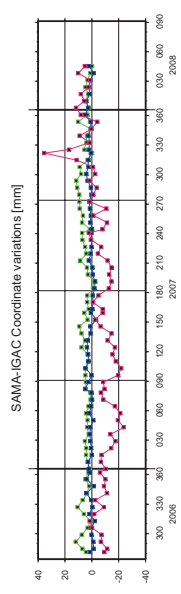
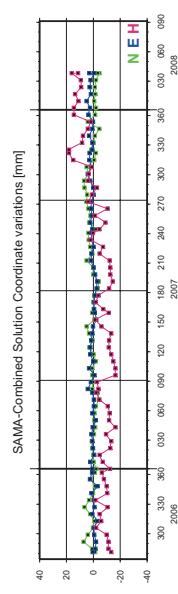
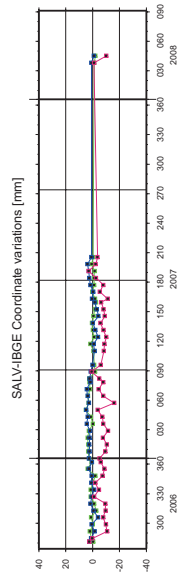
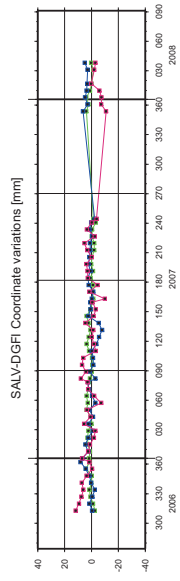
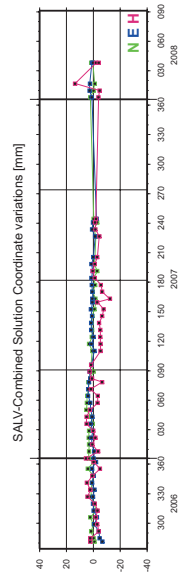
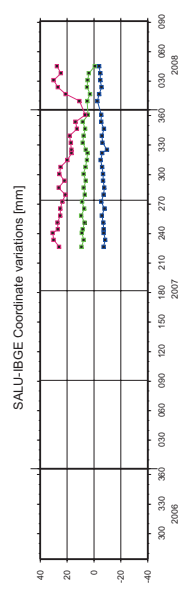
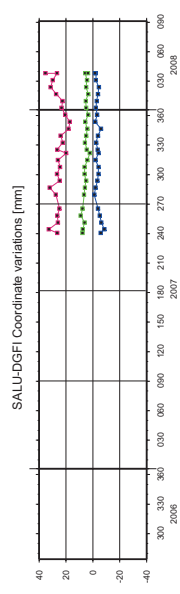
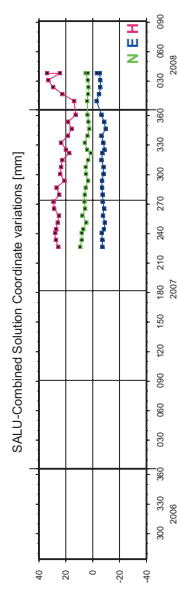
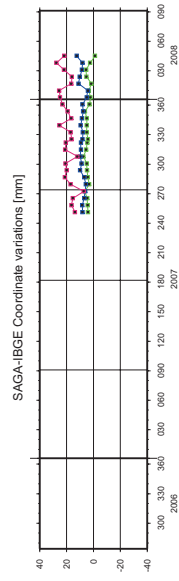
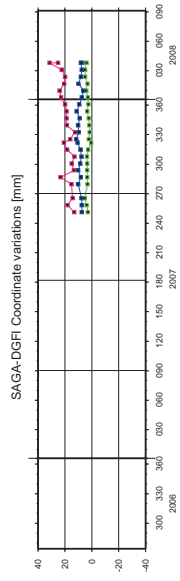
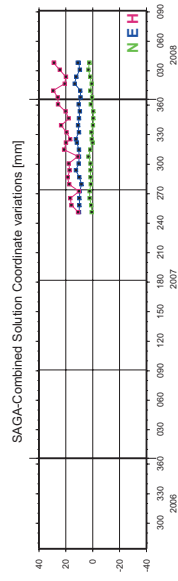


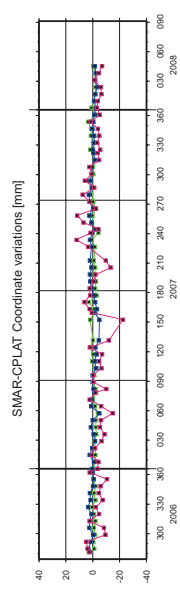
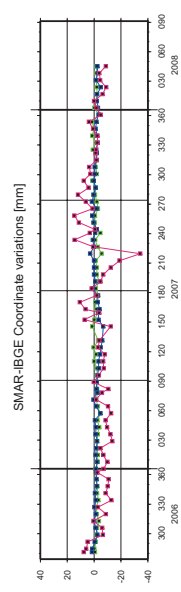
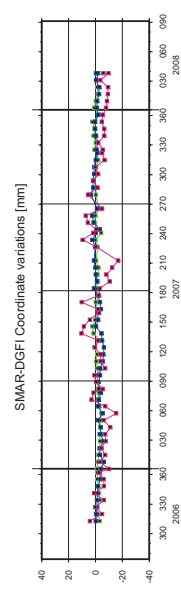
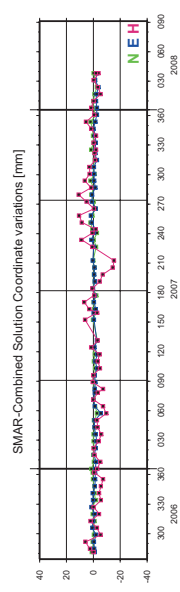
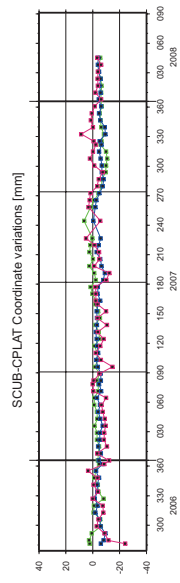
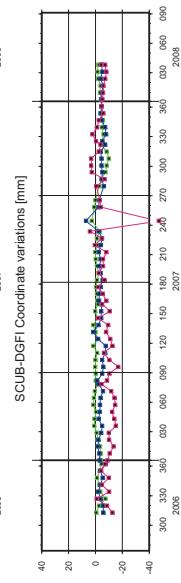
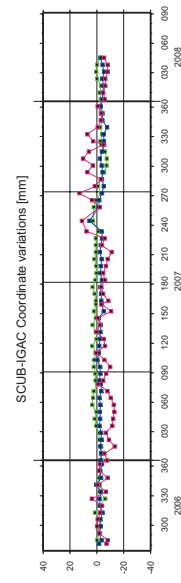
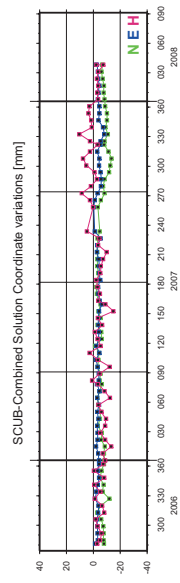
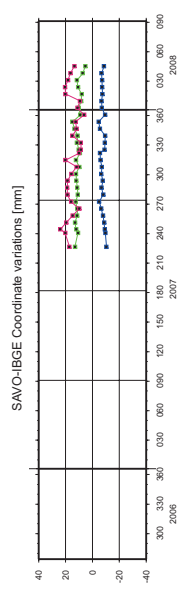
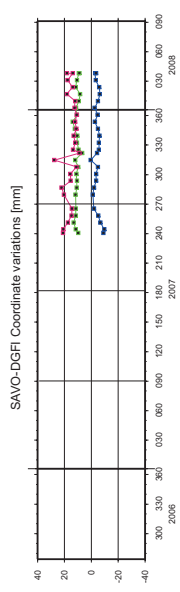
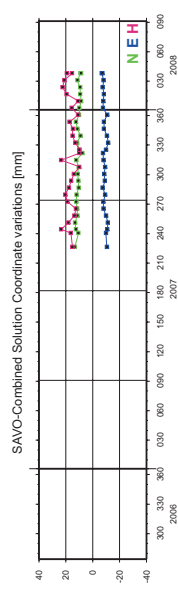
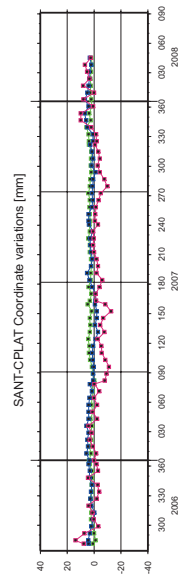
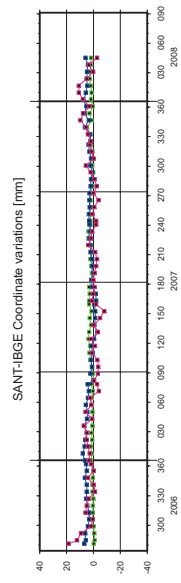
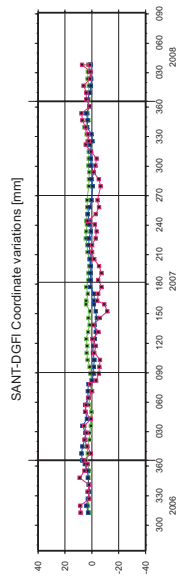
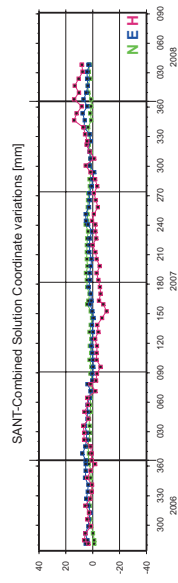


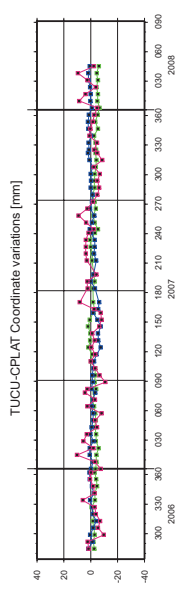
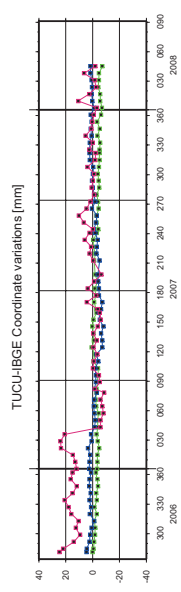
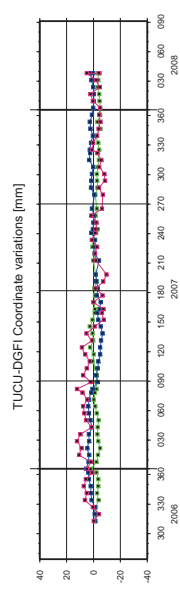
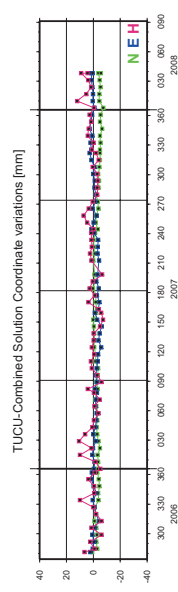
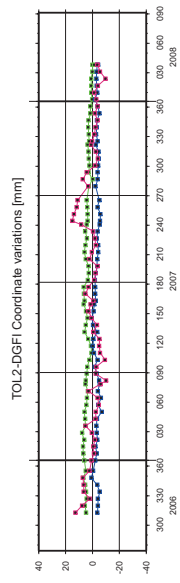
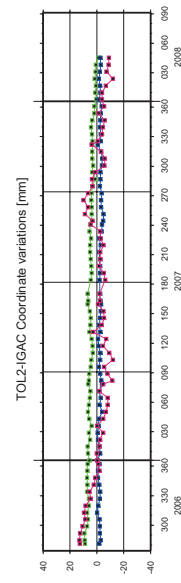
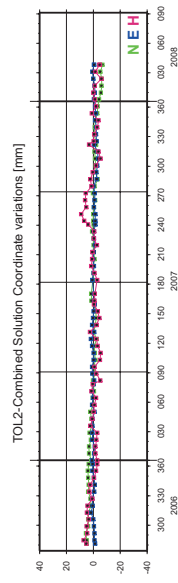
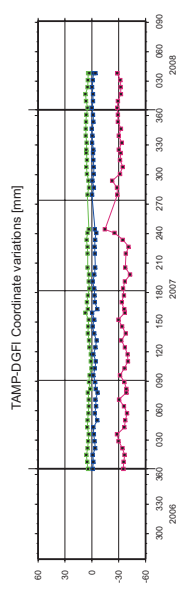
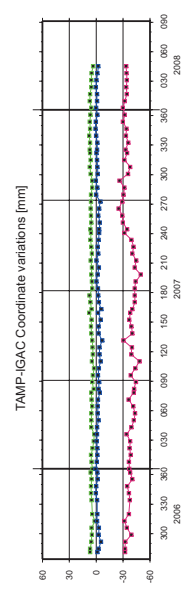
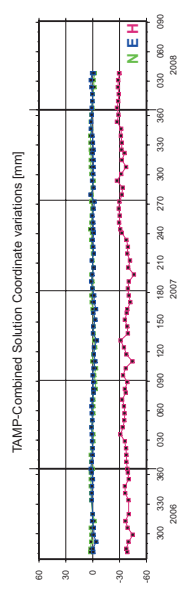
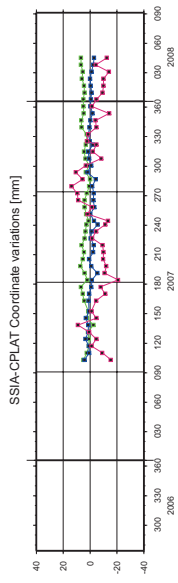
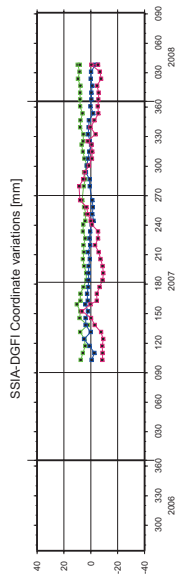
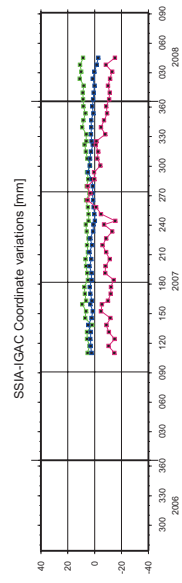
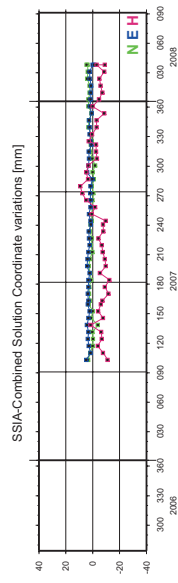


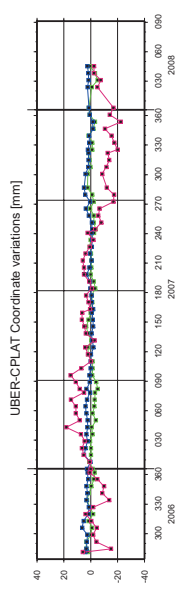
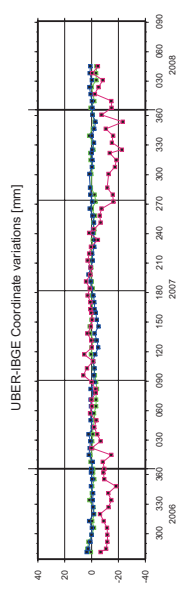
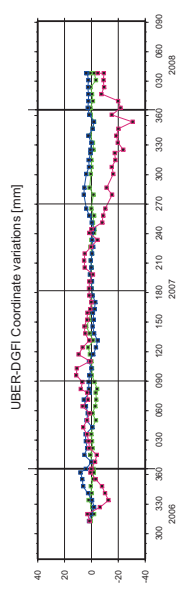
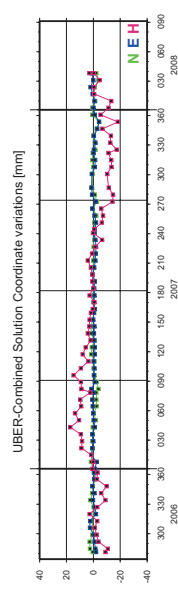
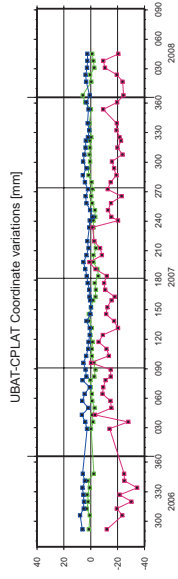
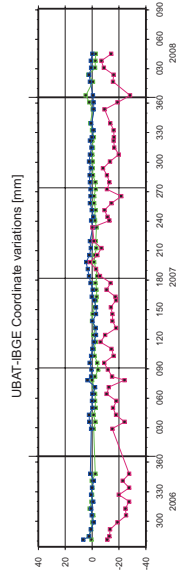
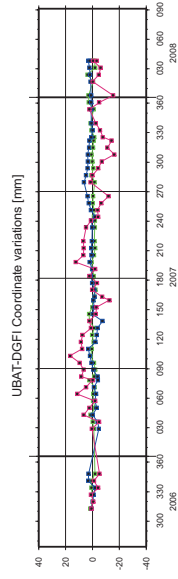
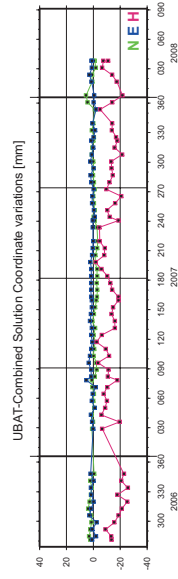
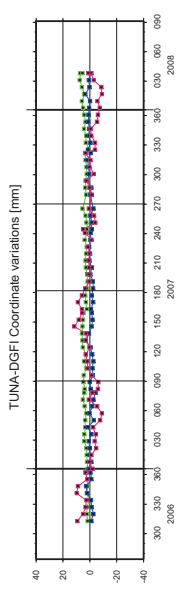
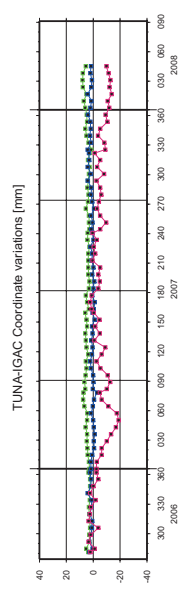
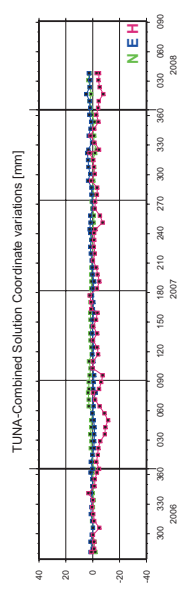
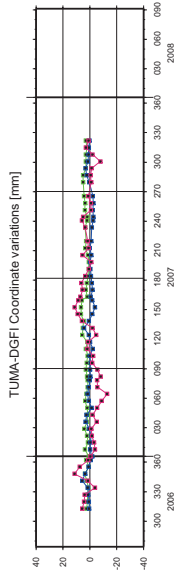
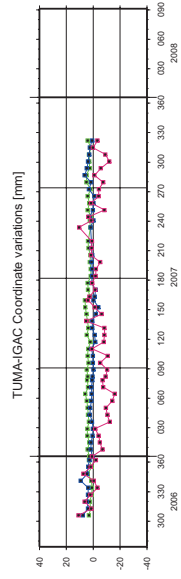
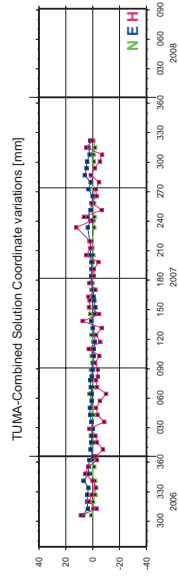


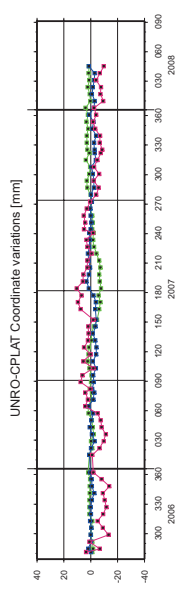
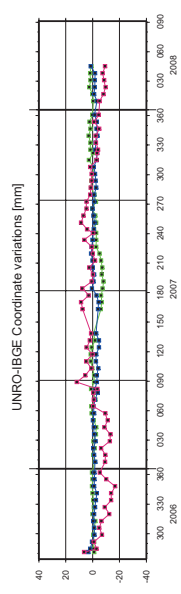
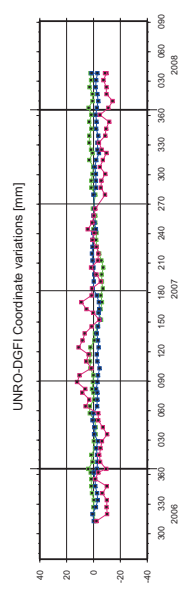
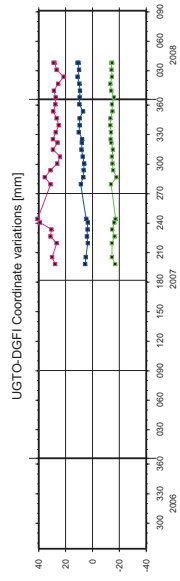
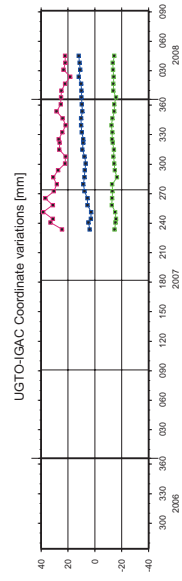
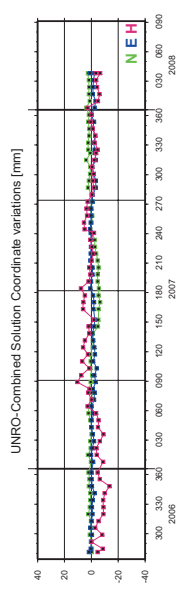
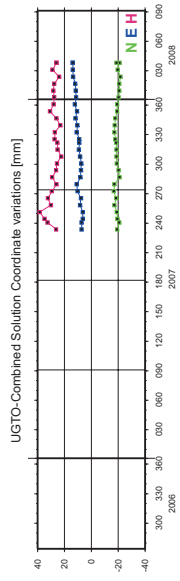
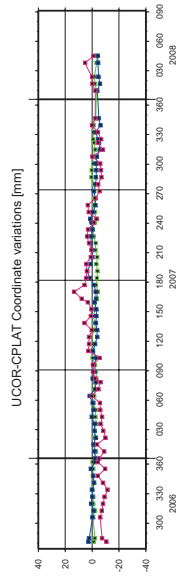
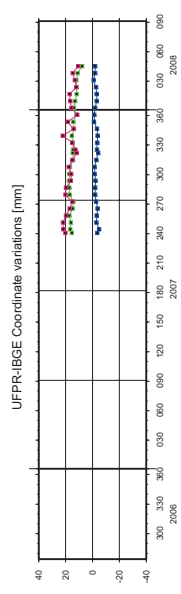
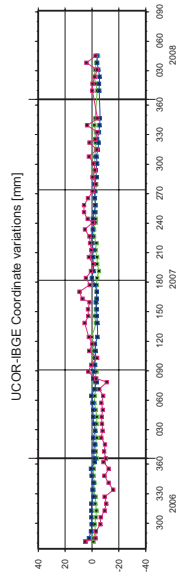
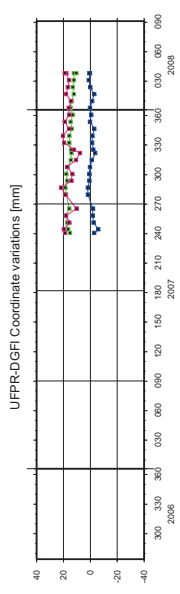
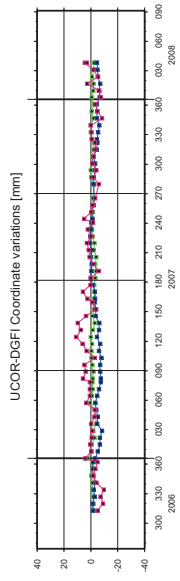
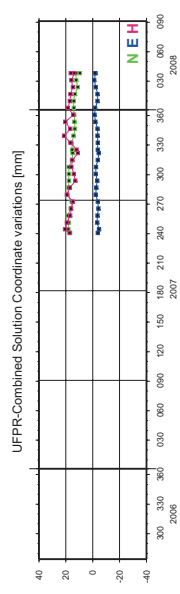
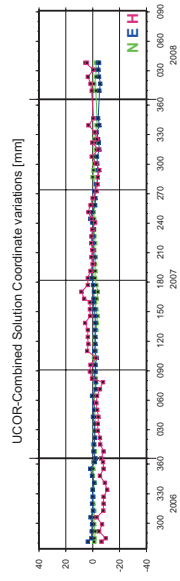


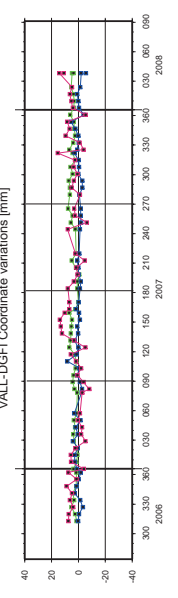
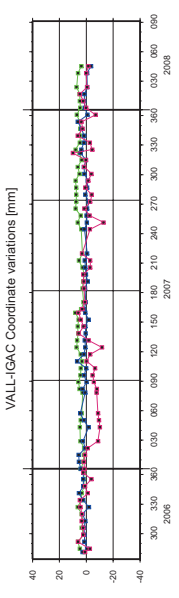
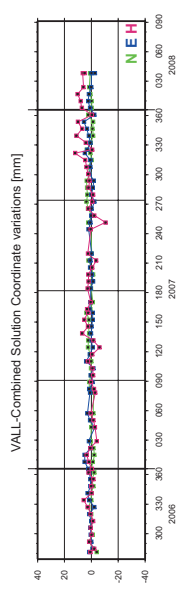
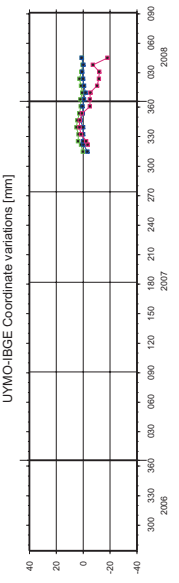
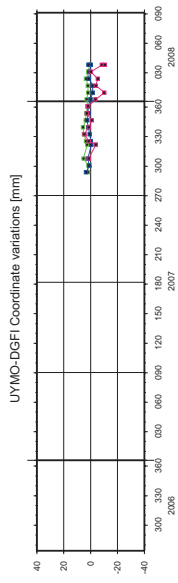
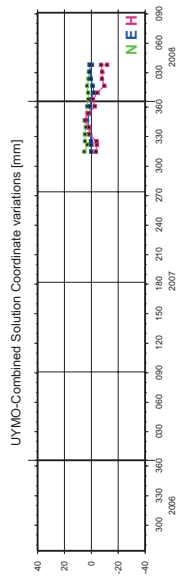
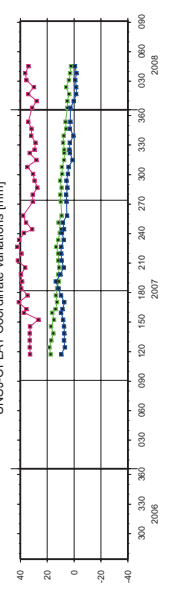
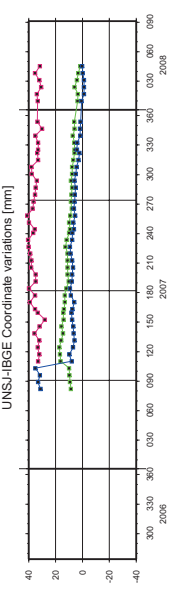
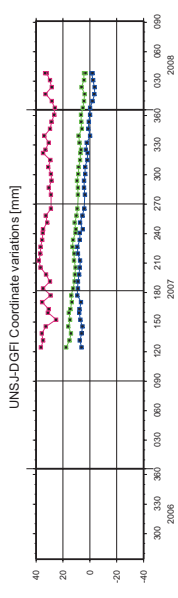
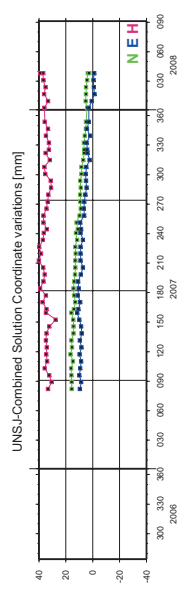
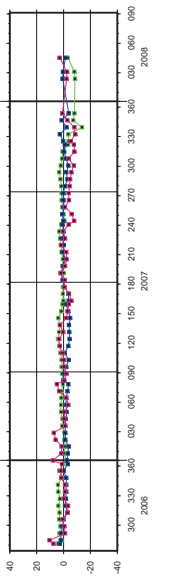
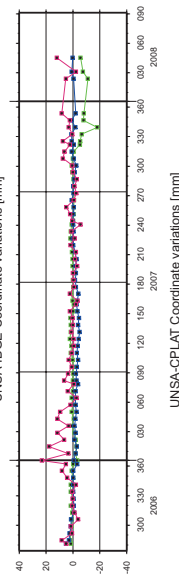
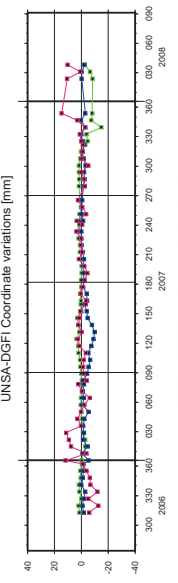
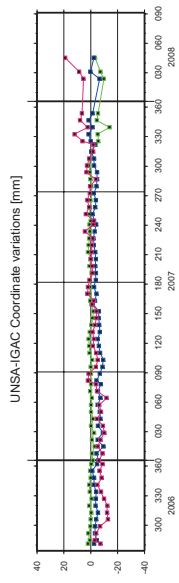
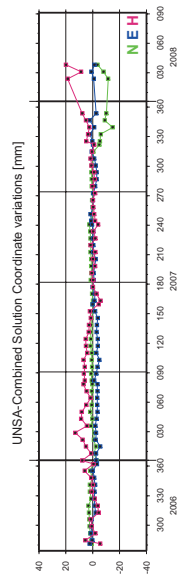


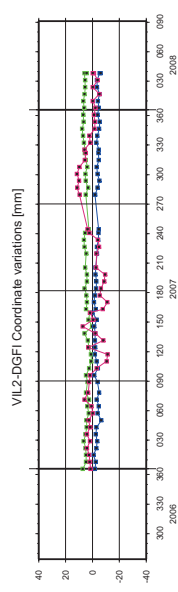
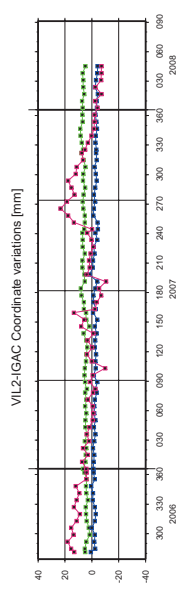
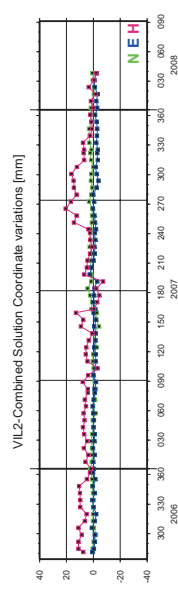
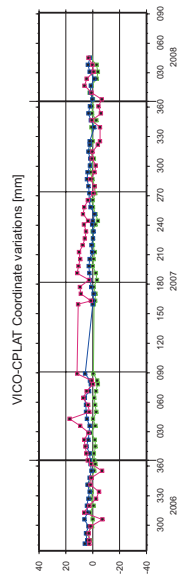
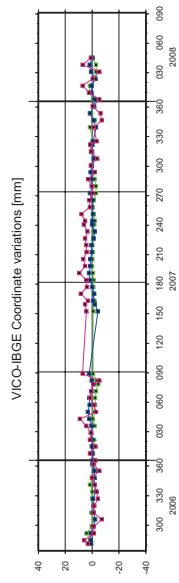
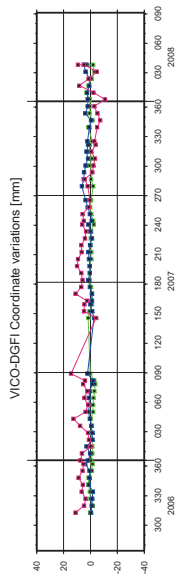
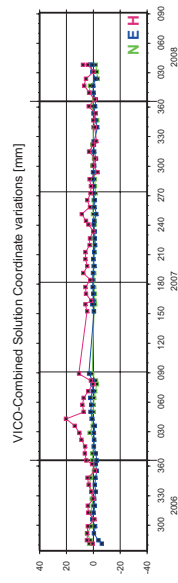
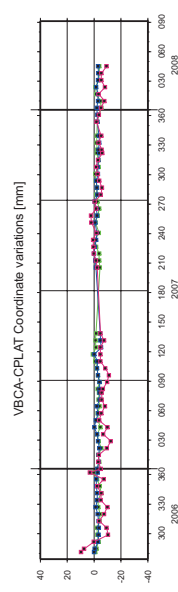
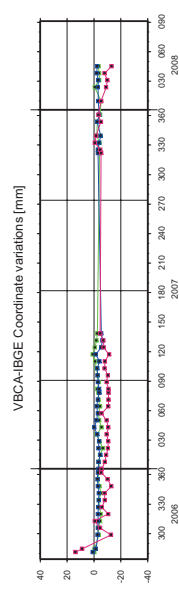
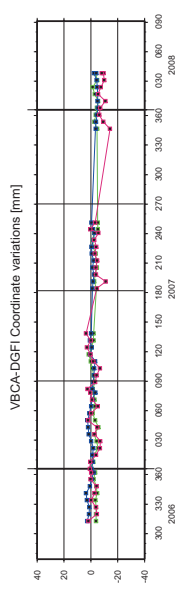
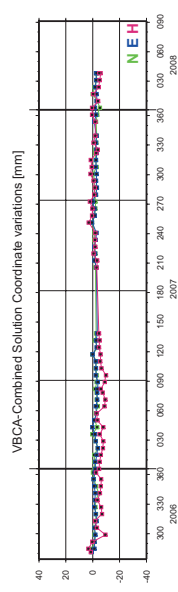
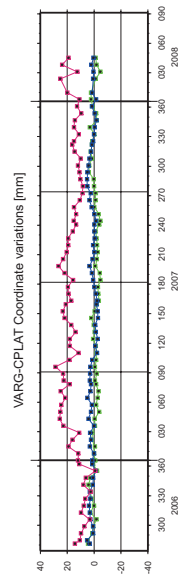
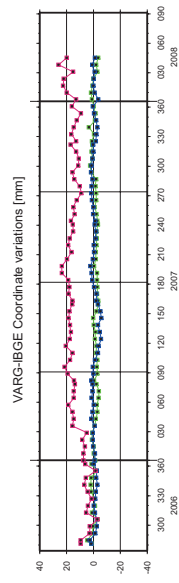
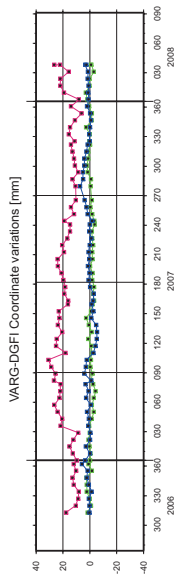
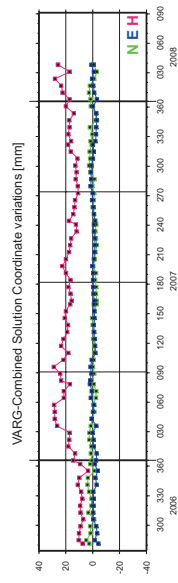




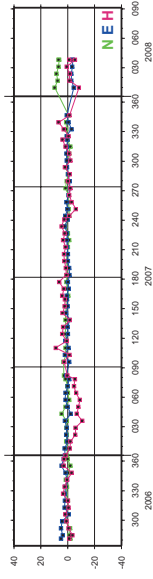




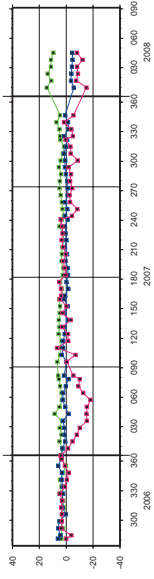




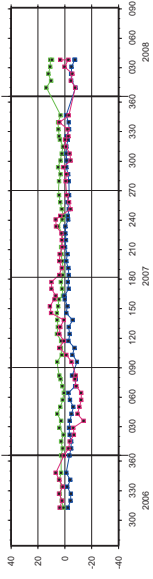
VVI-Combined Solution Coordinate variations [mm]



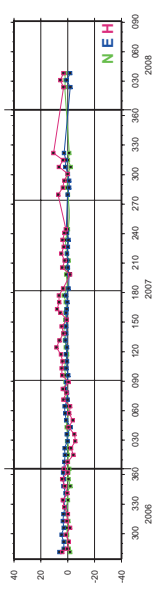
VVI-IGAC Coordinate variations [mm]



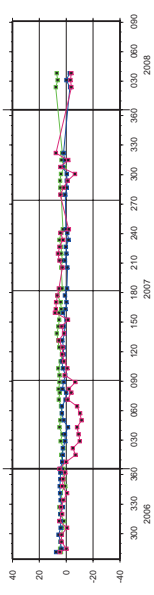
VVI-DGFI Coordinate variations [mm]



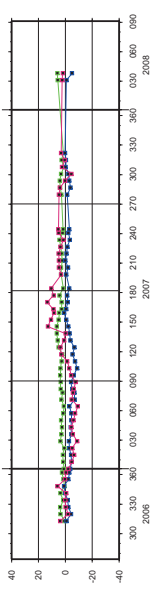
YOPA-Combined Solution Coordinate variations [mm]



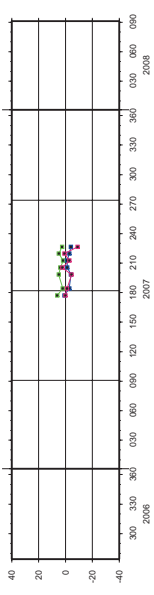
YOPA-IGAC Coordinate variations [mm]



YOPA-DGFI Coordinate variations [mm]



YOPA-IBGE Coordinate variations [mm]



Annex 8: Time series for station coordinates after each SIRGAS Experimental Processing Centre, the final combined solution, and the constrained weekly solutions processed by the IGS-RNAAC-SIR (DGFI) for the period covered by the GPS weeks 1395 until 1468

In the following, the time series for 142 stations are presented. Time series for the SIRGAS Experimental Processing Centres correspond to the original delivered solutions, i.e. they include outliers, station equipment inconsistencies, etc. Combined solution comprised the individual solutions of CPLAT, IBGE, and IGAC. Time series for the combination correspond to the final computation, i.e. stations listed in Annex 5 are already reduced. DGFI time series start in the GPS week 1400, because before relative PCVs were applied. All time series are derived after constraining the networks by not net rotation and not net translation conditions with respect to the IGS05 stations included in each solution. The presentation diagram is:

