DGFI Report on the comparison and combination of the weekly solutions delivered by the SIRGAS Experimental Processing Centres

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Introduction

SIRGAS-WGI first workshop (Rio de Janeiro, August 2006):

- ☑ To install Experimental Processing Centres (EPC) and Experimental Combination Centres (ECC) for SIRGAS;
- ☑ To emulate processing, quality, and time keeping of the weekly analysis of the SIRGAS-CON network carried out by the IGS-RNAAC-SIR (DGFI);
- ☑ Two sub-networks with a similar number of stations; each station should be included in the same number of individual solutions;
- ☑ EPCs should make available their individual weekly solutions within the three weeks following the processed week;
- ☑ ECCs should compare and combine the EPC individual solutions within the four weeks following the processed week;
- ☑ ECCs shall assess the quality of the combined solutions by comparing them with the weekly solutions delivered by the IGS-RNAAC-SIR;
- ☑ The experiment started at October 1, 2006 (GPS week 1395);
- ☑ DGFI acts as a SIRGAS Experimental Combination Centre.

DGFI Scheme

Pre-processing	☑ Review of solutions available for combination ☑ Survey of processed networks ☑ Identification of station inconsistencies (names, equipments, etc.)
Combination	☑ Evaluation of individual solutions ☑ Relative weighting between EPCs ☑ Stochastic model of the combined solutions ☑ Reduction of stations
Results	☑ Weekly combined solutions ☑ Cumulative combined solutions ☑ Evaluation of combined solutions

Solutions available for combination

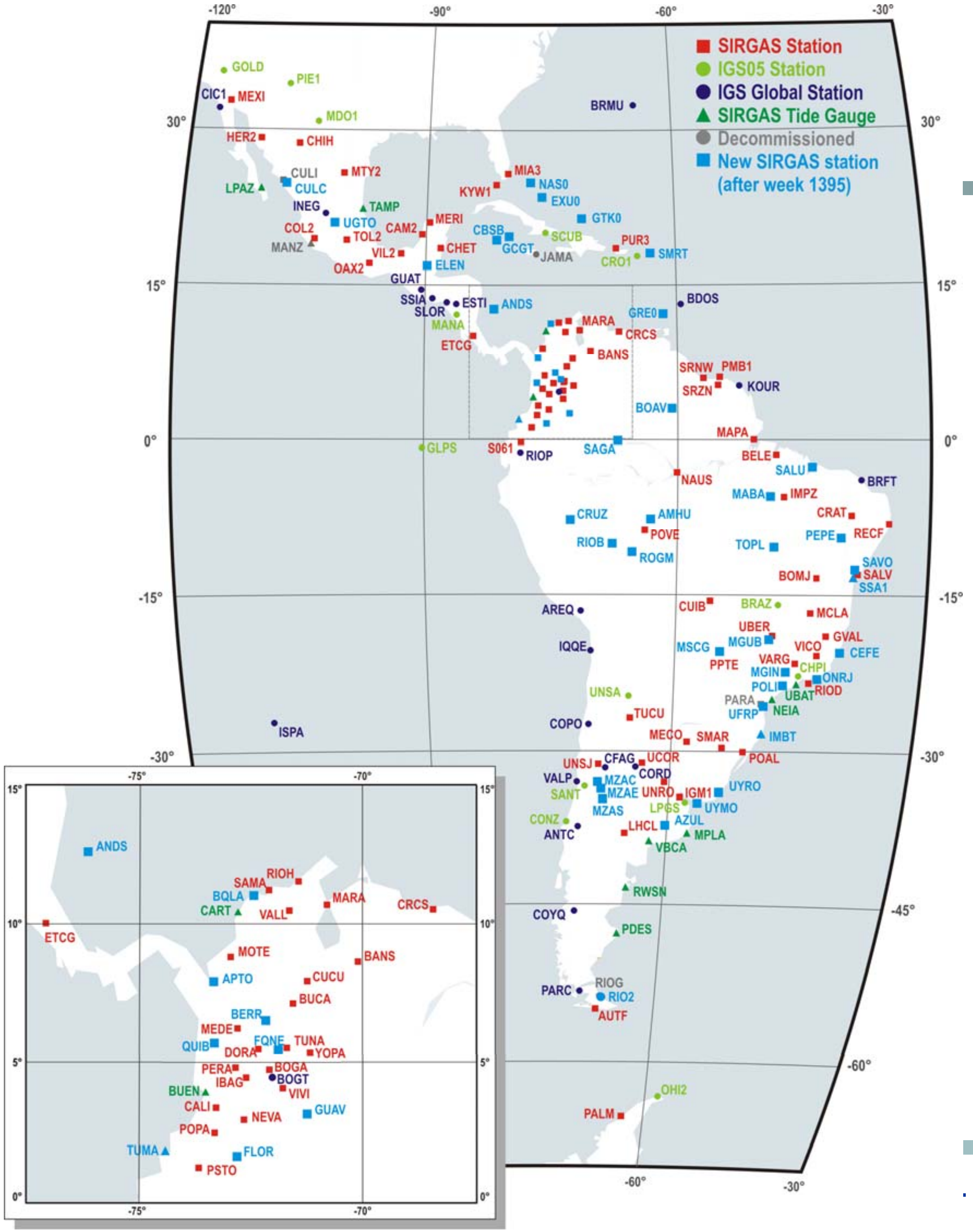
Solutions uploaded by the EPCs to the **DGFI FTP server** between GPS weeks **1395 (October 1, 2006)** and **1468 (March 1, 2008)**:

IBGE (Br):
- ☑ loosely constrained weekly SINEX files and daily NEQ
- ☑ 1395 – 1468 (73 weeks)
- ☑ Software: Bernese

CPLAT (Ar):
- ☑ loosely constrained weekly SINEX files and daily NEQ
- ☑ 1395 – 1468 (73 weeks)
- ☑ Software; Bernese

IGAC (Co):
- ☑ loosely constrained weekly SINEX files and daily NEQ
- ☑ 1395 – 1468 (73 weeks)
- ☑ Software: Bernese

INEGI (Mx):
- ☑ loosely constrained and constrained SINEX files
- ☑ 1395 – 1428 (33 weeks)
- ☑ Software: GIPSY OASIS II



Processed network

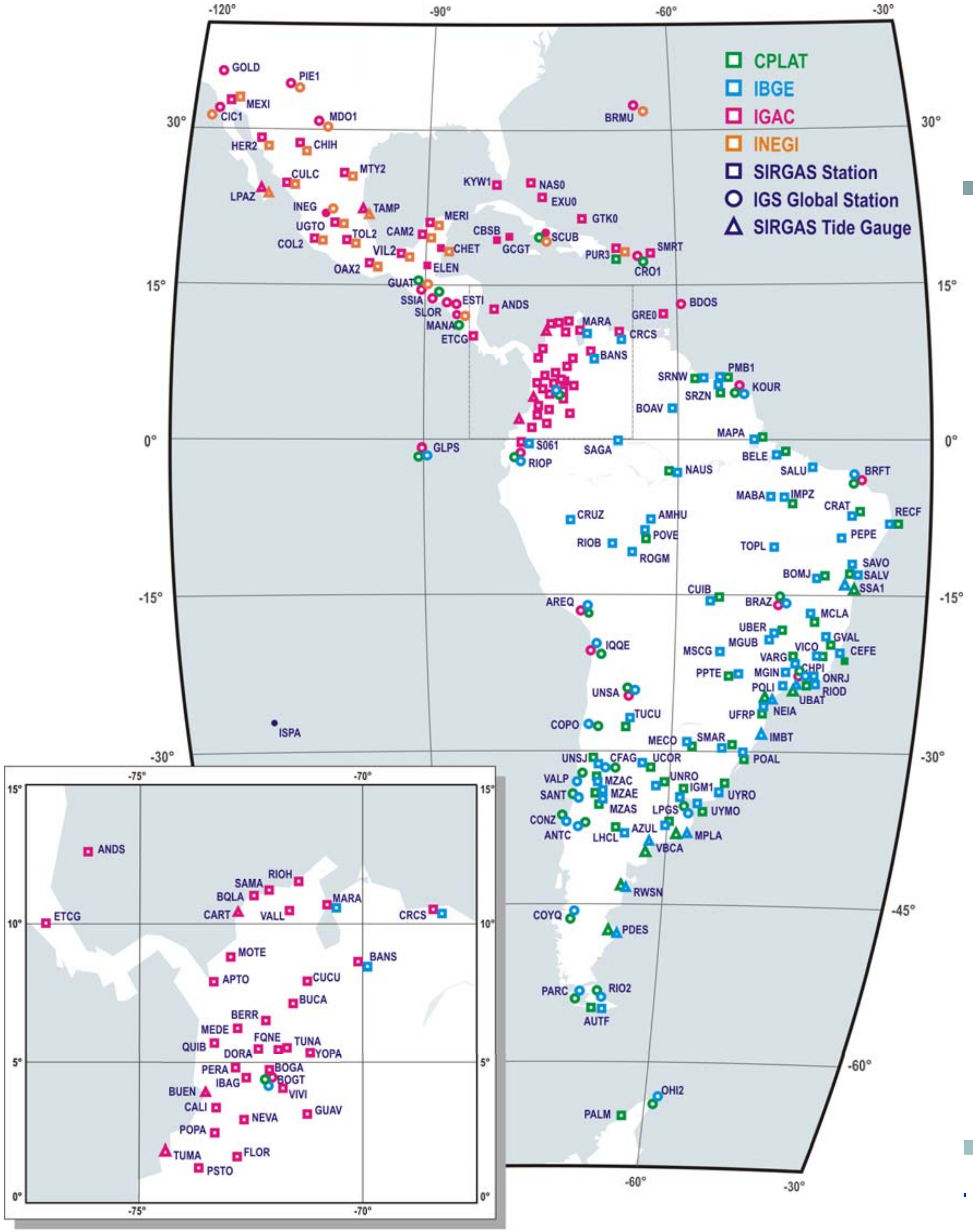
by IGS-RNAAC-SIR:

Week 1395:

- ☑ 128 sites
  (116 in operation)
- ☑ 50 IGS Stations +
  78 regional stations

After week 1395 (until 1468):

- ☑ 46 new regional stations
- ☑ 5 sites decommissioned
  (CULI, JAMA, MANZ,
  PARA, RIOG)
- ☑ 10 stations inactive
  (COPO, COYQ, ESTI,
  IQQE, KYW1, PDES,
  PUR3, RIOP, SLOR,
  VALP)



Processed network

by the SIRGAS EPCs:

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

DGFI

Processed network

- ☑ Station distribution between the SIRGAS EPCs is not homogeneous;
- ☑ Most of the sites included in the northern block are processed by IGAC only;
- ☑ Many of the new stations integrated into the southern block were not taken into account by CPLAT and they are processed by IBGE only;
- ☑ EPCs and DGFI (as IGS-RNAAC-SIR) did not always start to process the new stations at the same time, extreme examples:

  MZAE: IBGE includes this station in its weekly solutions **35** weeks before DGFI;

  POLI: included in the IBGE solutions **10** weeks before in DGFI;

  CULC: included in the DGFI solutions **6** weeks before in IGAC.

Identification of station inconsistencies

Comparison of station information included in SINEX files with respect to site log file content (log file is preferred):

☑ **Name of stations**: four character code + IERS domes number

- Stations without domes number;
- Station with erroneous domes number;
- **All of them were corrected before combination**.

☑ **Height antenna**:

- Station CRAT in CPLAT solutions 1 mm;
- Station POLI in 10 IBGE solutions,
- Stations BELE and POVE in IBGE solutions 0,5 mm (BELE log file was incorrect);
- **All of them were corrected before combination**.

Identification of station inconsistencies

☑ **Antenna type**:

- Processing with erroneous antenna
- Processing with erroneous radome
- Processing without considering radome

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

Differences are **~ 1 mm**, but corrections for the zenith angle dependent phase centre variations must be added. They can reach values until **15 mm** for an elevation angle of 90°. They are not constant and **can not be corrected** in the combination process.

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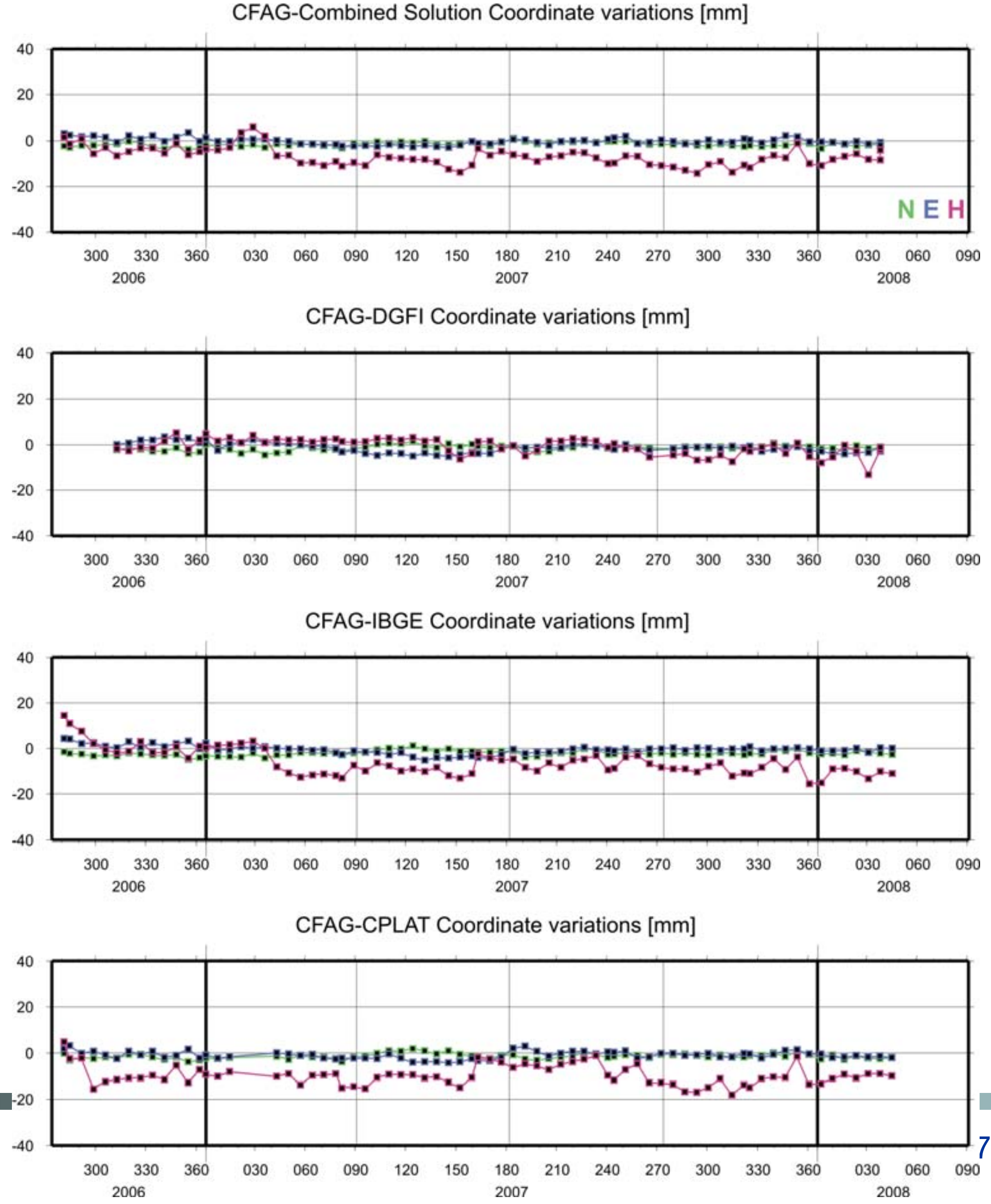
Identification of station inconsistencies



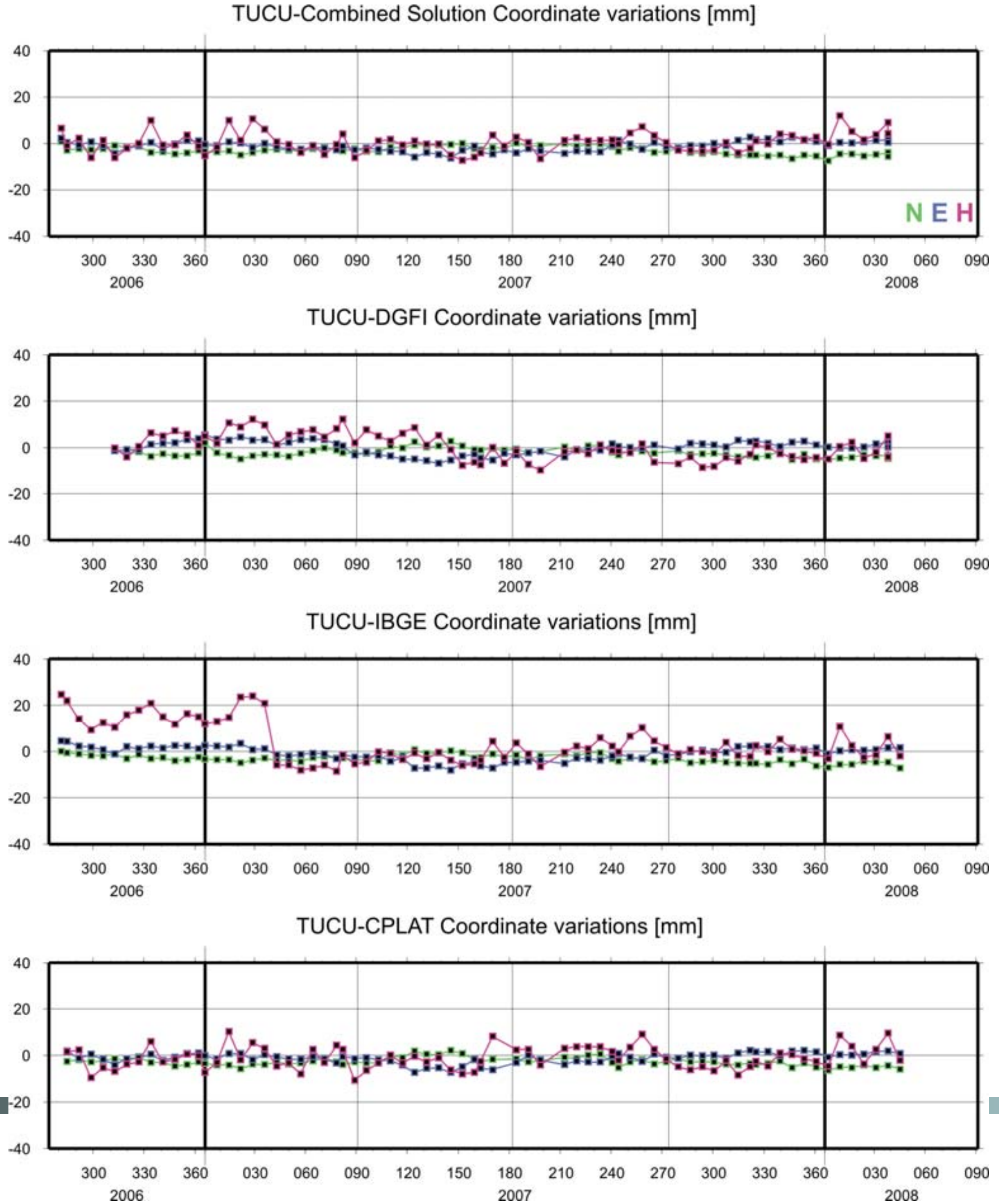
Time series for station CFAG:

CPLAT and IBGE neglected the radome covering the antenna (IBGE since 2007/02/11).

Solutions neglecting the radome are biased about **15 mm**, which are completely translated into the combined solution

The bias is not constant, it can not be reduced in the combination process, and the station must be excluded.

Identification of station inconsistencies



Time series for station TUCU:

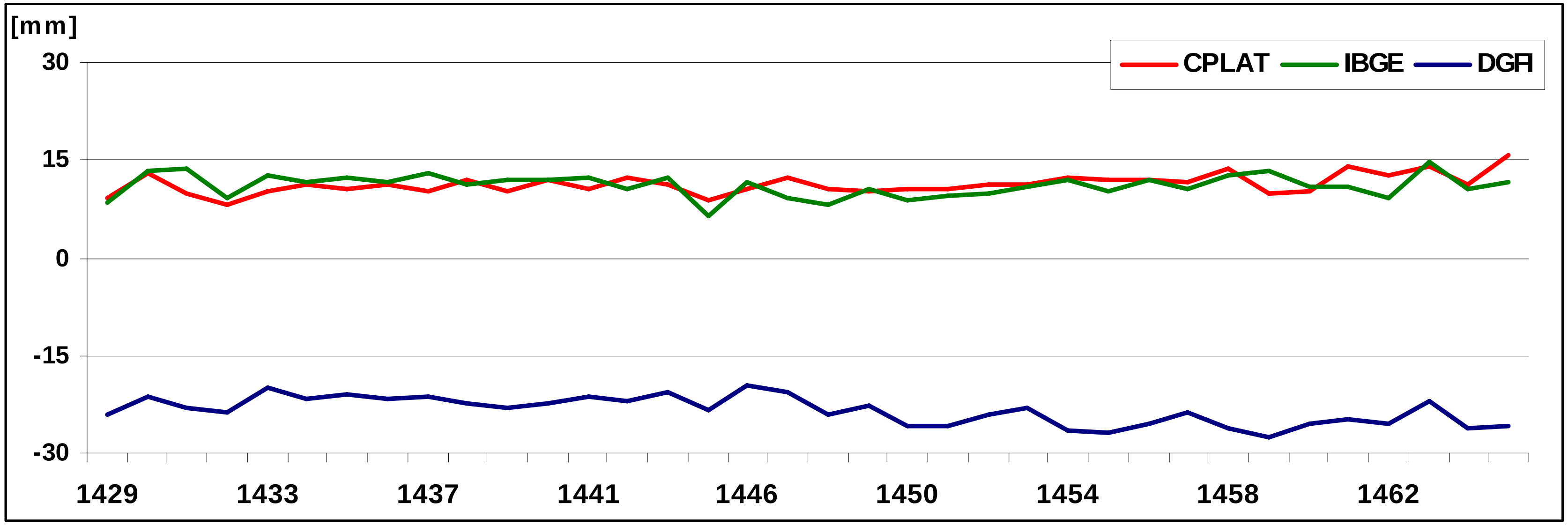
IBGE included (until 2007/02/11) a different antenna as CPLAT and DGFI for the weekly processing.

Height component is therefore **~20 mm** biased.

The combined solution does not include the TUCU station processed by IBGE before2007/02/11.

Identification of station inconsistencies

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**.

Pre-processing

Station inconsistencies in CPLAT solutions

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

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Station inconsistencies in IBGE solutions

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-XII3	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-XII3	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
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

DGFI

Station inconsistencies in IGAC solutions

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

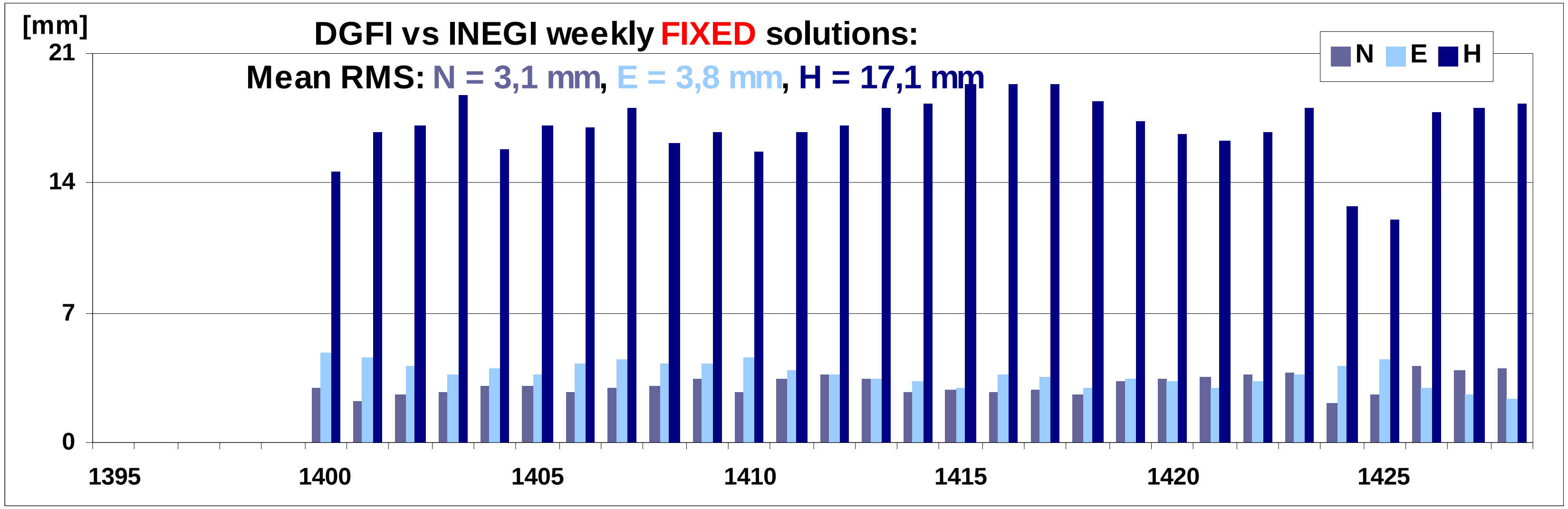
Evaluation of individual EPC solutions

- ☑ Comparison of the free weekly solutions provided by the EPCs and the corresponding free weekly solutions generated by the IGS-RNAAC-SIR (DGFI): 7-parameter similarity transformations between DGFI-INEGI, DGFI-CPLAT, DGFI-IBGE, DGFI-IGAC, CPLAT-IBGE, and IGAC-INEGI;
- ☑ Mean standard deviations for station positions after NNR+NNT with respect to the IGS05 stations included in each weekly EPC solution;
- ☑ RMS residuals after comparing weekly solutions of each EPC with respect to the combined solution CPLAT+IBGE+IGAC (7-parameter similarity transformation). DGFI solutions are not included in the combination;
- ☑ RMS residuals after comparing constrained coordinates derived by NNR+NNT from the EPC weekly solutions with respect to the coordinates obtained from the weekly combination of the IGS global network (files igs*YY*P*wwww*.snx available at ftp://cddis.gsfc.nasa.gov/gps/products/*wwww*) (direct comparison of coordinates, a 7-parameter similarity transformation is not applied here).

DGFI

Evaluation of individual EPC solutions

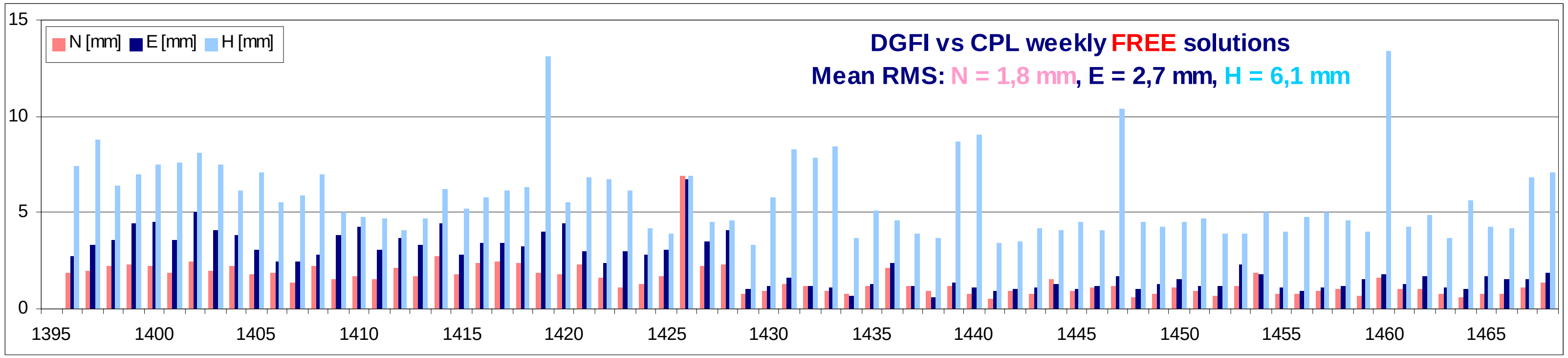
Comparison of INEGI weekly solutions with IGS-RNAAC-SIR

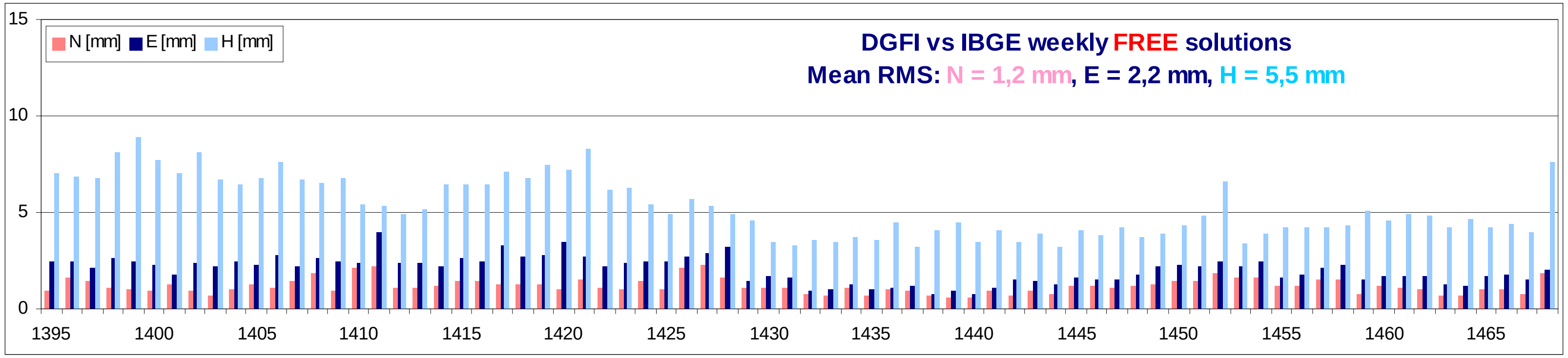


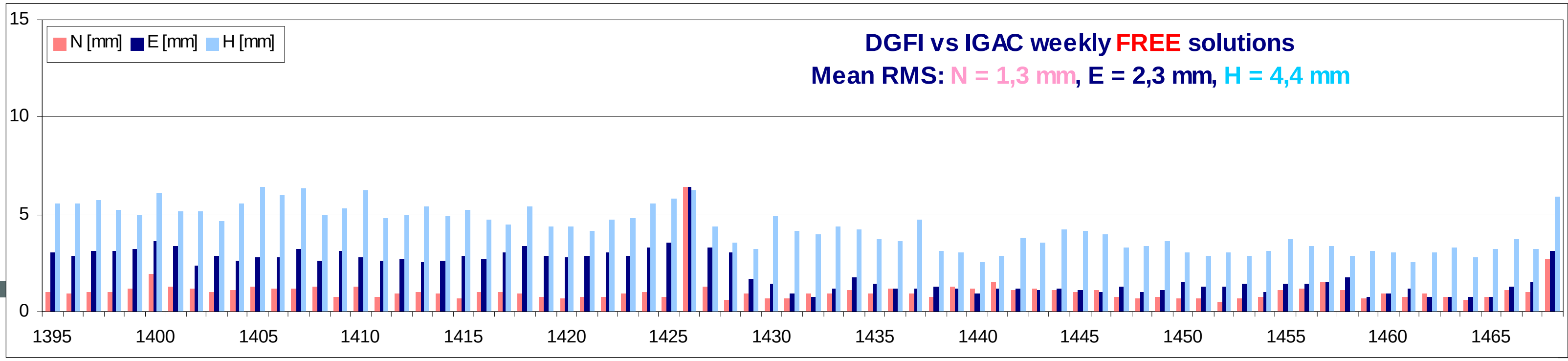
INEGI applies **relative PCVs**, its weekly solutions cannot be included in the combination.

Evaluation of individual EPC solutions

Comparison of free weekly EPC solutions with IGS-RNAAC-SIR







DGFI

Evaluation of individual EPC solutions

Comparison of weekly EPC solutions with IGS-RNAAC-SIR

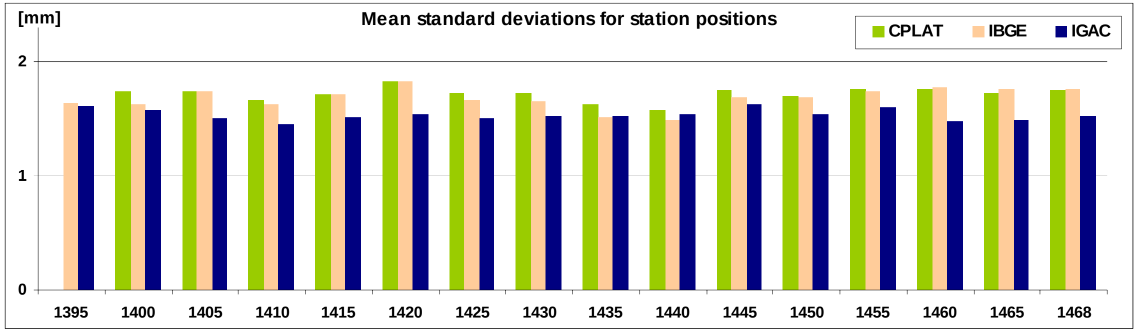
Processing Centre	**DGFI**			**CPLAT**			**IGAC**		
	N [mm]	**E [mm]**	**H [mm]**	**N [mm]**	**E [mm]**	**h [mm]**	**N [mm]**	**E [mm]**	**H [mm]**
CPLAT	1,75	2,69	6,07						
IBGE	1,25	2,16	5,50	1,38	1,95	4,54			
IGAC	1,25	2,33	4,41						
INEGI	3,14	3,76	17,14				2,14	2,57	11,53

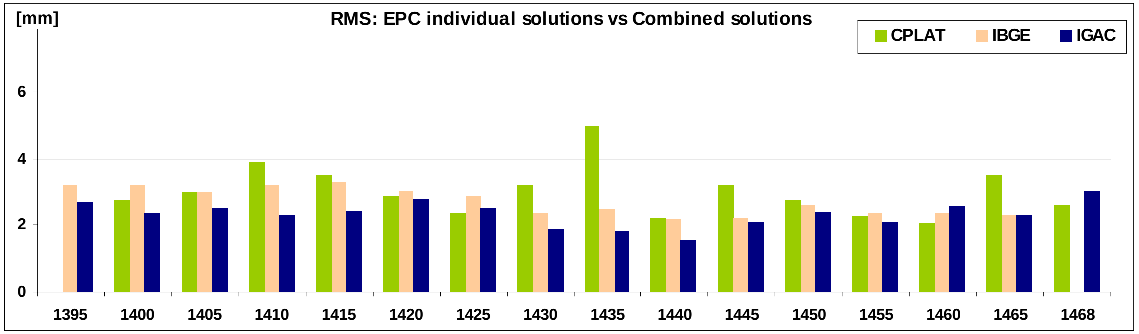
- ☑ Results of this procedure show a very good agreement (**N = 1,4 mm, E = 2,3 mm, H = 5,1 mm**) between the free weekly solutions delivered by the **CPLAT**, **IBGE**, and **IGAC**. They can be combined.
- ☑ **INEGI** solutions cannot be taken into account for combination due to utilization of **relative correction values for the PCV**.

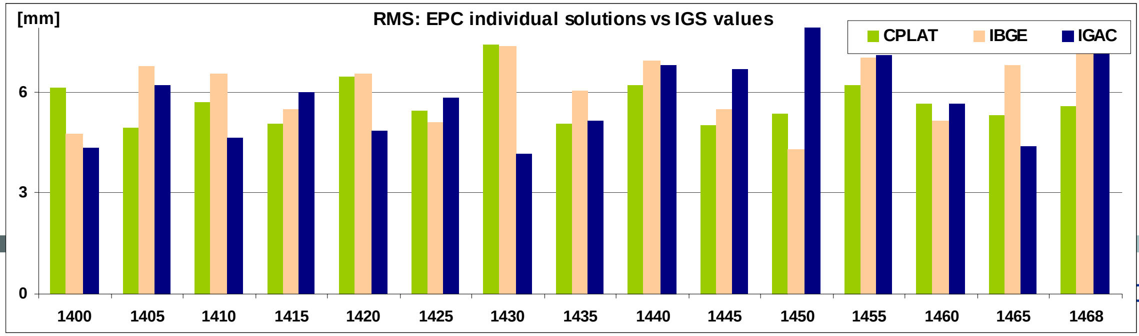
Combination

Evaluation of individual EPC solutions

Standard deviations for 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).







EPC solutions:
Accuracy:
(internal consistency)
~ 1,5 mm in N-E
> 2,5 mm in H

Reliability
(comparison wrt IGS05)
~ 2,5 mm in N-E
~ 4,5 mm in H

Relative weighting between EPCs

- ☑ Relative weighting factors (re-scaling factors) are necessary to compensate possible differences in the stochastic models of the EPCs;
- ☑ To validate the stochastic models, mean standard deviations of coordinates derived from solving the normal equations are compared with mean RMS values derived from the time series of station coordinates;
- ☑ 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, the weighting factors are computed in four different ways:

Relative weighting between EPCs

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

Relative weighting between EPCs

Scale factors (wrt 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

Relative weighting between EPCs

- ☑ The relation between the EPC mean standard deviations is very similar to the relation between the corresponding RMS, i.e. there are no differences in the stochastic models;
- ☑ CPLAT, IBGE, IGAC apply 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;
- ☑ Parameters estimated by each of the contributing solutions are at the same accuracy level;
- ☑ **A relative weighting of the EPCs is not necessary**.

Stochastic model for the combined solutions

Variance-Covariance Matrix

$$\hat{\mathbf{K}}_{\hat{x}\hat{x}} = \hat{\sigma}_0^2 \mathbf{Q}_{\hat{x}\hat{x}}$$

$$\begin{bmatrix}
q_{X1X1} & q_{X1Y1} & q_{X1X2} & q_{X1Y2} & q_{X1X3} & q_{X1Y3} & \cdots & q_{X1XP} & q_{X1YP} \\
q_{Y1X1} & q_{Y1Y1} & q_{Y1X2} & q_{Y1Y2} & q_{Y1X3} & q_{Y1Y3} & \cdots & q_{Y1XP} & q_{Y1YP} \\
q_{X2X1} & q_{X2Y1} & q_{X2X2} & q_{X2Y2} & q_{X2X3} & q_{X2Y3} & \cdots & q_{X2XP} & q_{X2YP} \\
q_{Y2X1} & q_{Y2Y1} & q_{Y2X2} & q_{Y2Y2} & q_{Y2X3} & q_{Y2Y3} & \cdots & q_{Y2XP} & q_{Y2YP} \\
q_{X3X1} & q_{X3Y1} & q_{X3X2} & q_{X3Y2} & q_{X3X3} & q_{X3Y3} & \cdots & q_{X3XP} & q_{X3YP} \\
q_{Y3X1} & q_{Y3Y1} & q_{Y3X2} & q_{Y3Y2} & q_{Y3X3} & q_{Y3Y3} & \cdots & q_{Y3XP} & q_{Y3YP} \\
\cdots & \cdots & \cdots & \cdots & \cdots & \cdots & & \cdots & \cdots \\
q_{XPX1} & q_{XPY1} & q_{XPX2} & q_{XPY2} & q_{XPX3} & q_{XPY3} & \cdots & q_{XPXP} & q_{XPYP} \\
q_{YPX1} & q_{YPY1} & q_{YPX2} & q_{YPY2} & q_{YPX3} & q_{YPY3} & \cdots & q_{YPXP} & q_{YPYP}
\end{bmatrix}$$

- ☑ In the combination, standard deviations of the coordinates are overestimated by a factor of about √ (number of EPCs including each station);
- ☑ To correct the stochastic model:
  - standard deviations have to be multiplied by this factor
  - variance-covariance matrix by the square of the factor

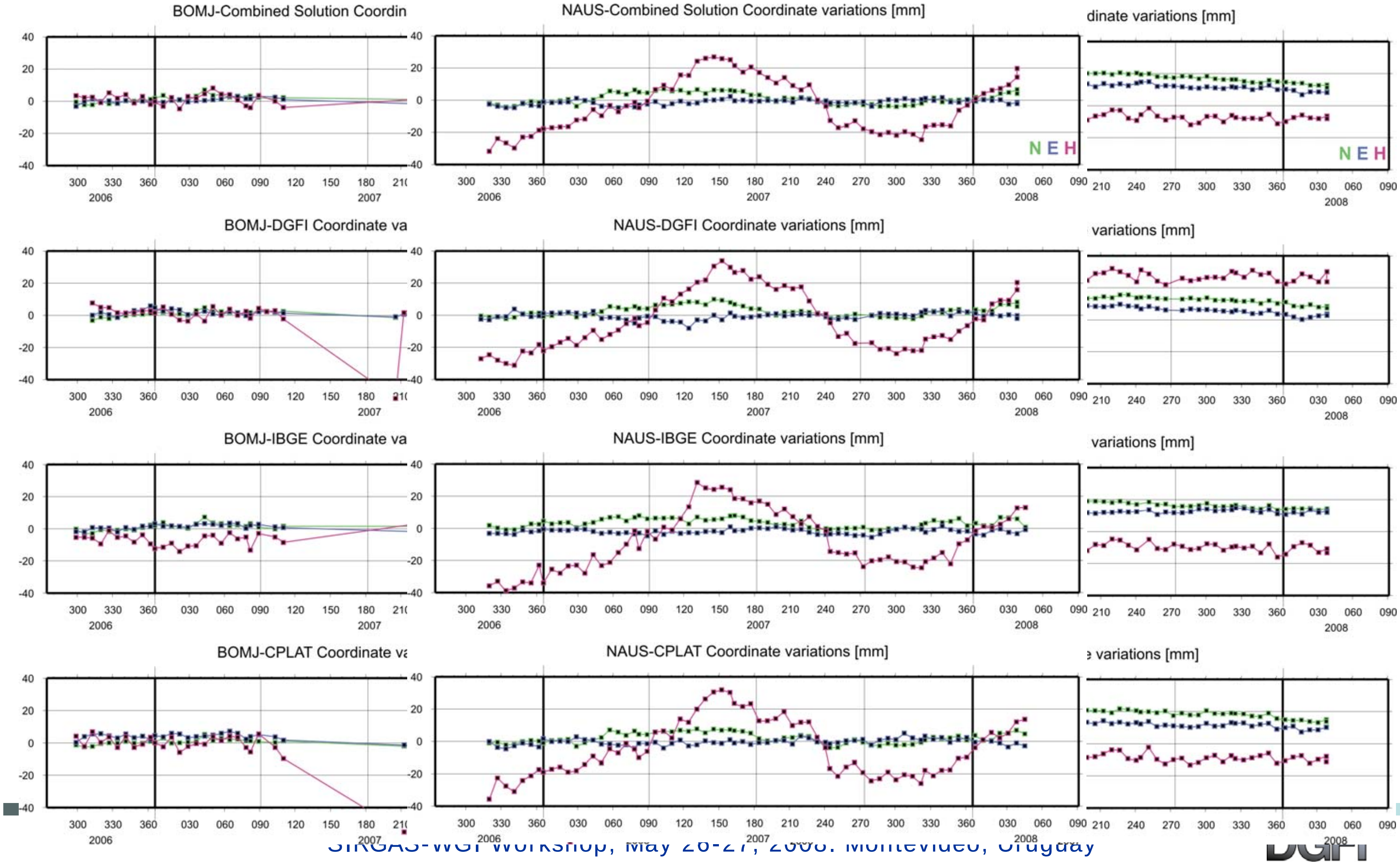
Stochastic model for the combined solutions

- ☑ 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;
- ☑ 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;
- ☑ A good alternative to avoid this procedure is to guarantee that each regional station is included in exactly the same number of individual solutions.

Reduction of stations

- ☑ 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 (**N = (5 x 2) mm**, **E = (5 x 2) mm**, **H = (5 x 4) mm**) were assumed as outliers, and the corresponding stations were excluded from the respective weekly solution.

Reduction of stations



Combination procedure

- ☑ The available solutions are reviewed concerning their SINEX format and the suitability for combination of unconstrained normal equations, i.e. it is 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;
- ☑ Input for the combined solutions are the unconstrained weekly normal equations after reducing stations with large outliers for each EPC;
- ☑ Normal equations are added and solved by applying the BERNESE software;
- ☑ The geodetic datum is realized by NNT+NNR conditions with respect to the IGS05 positions and velocities available in the region.

Results

Three types of combined solutions are generated each week:

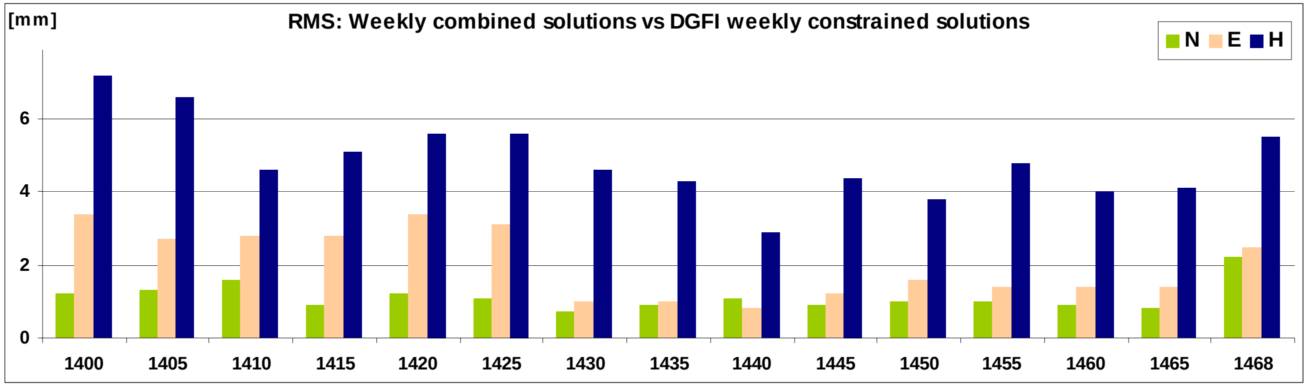
- ☑ A weekly constrained solution (fixed coordinates and cofactor matrix for internal control);
- ☑ A free weekly solution (unconstrained normal equations for later computations);
- ☑ An accumulated constrained solution (fixed coordinates, velocities, and cofactor matrix for applications);

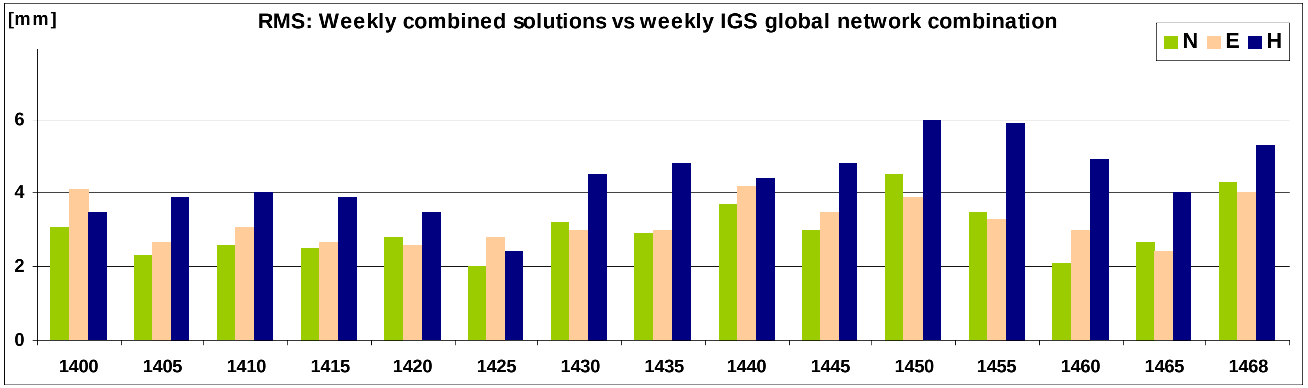
Nevertheless, in the case of the cumulative solutions, it should be kept in mind that 73 weeks (the best case at present) represent a very short time period to estimate reliable velocities.

Results

Evaluation of the weekly combined solutions

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)





Reliability of combined solutions:

~ 3 mm in N-E

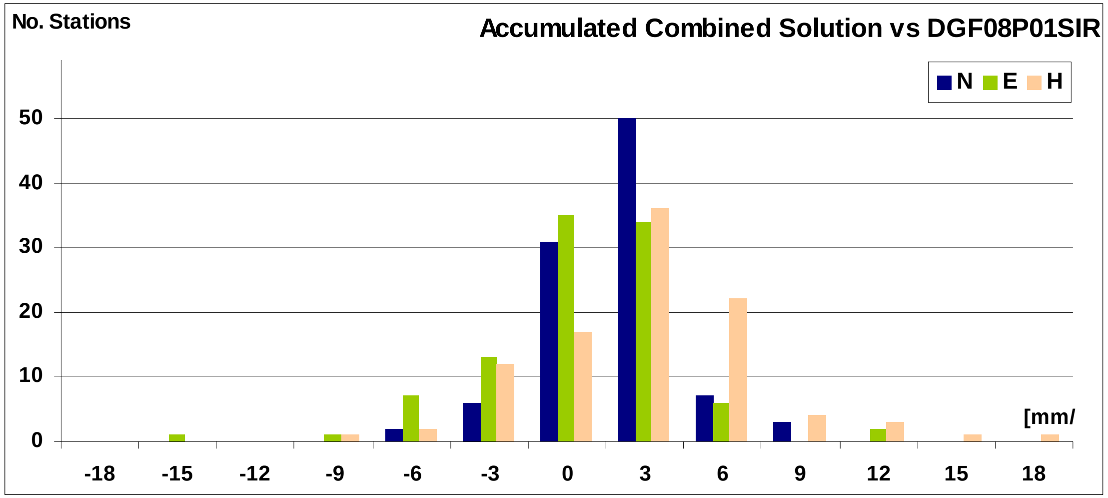
~ 4,5 mm in H

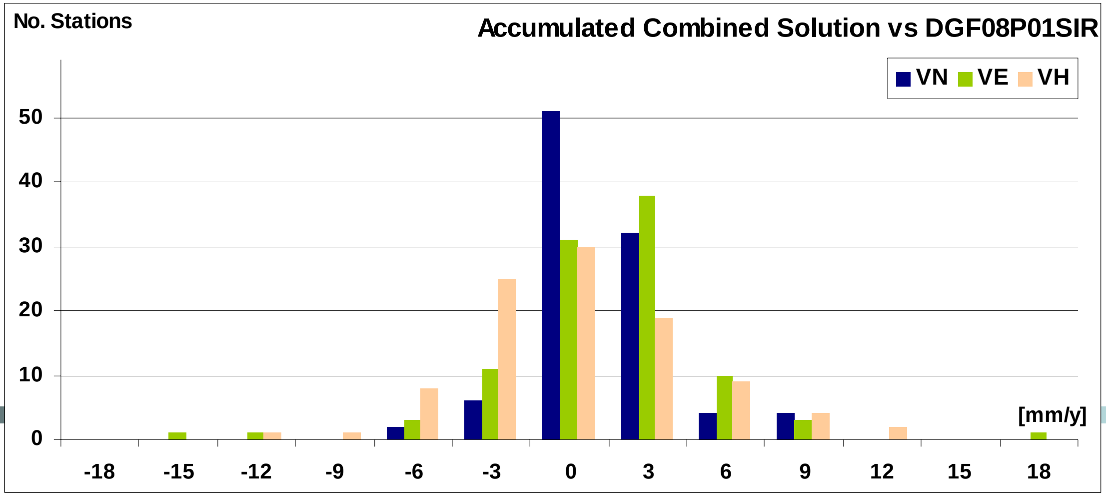
Accumulative combined solution

- ☑ Input for the accumulative solution are the unconstrained weekly combined solutions (CPLAT+IBGE+IGAC);
- ☑ 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:
  - 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;
  - MANA presents a strong jump in the vertical component at the beginning of September, 2007;
  - the time series for PIE1 is too short (less than one year);
  - the time series for SCUB includes RMS values larger than 30 mm.
- ☑ Reference epoch 2006-10-01

Evaluation of the accumulative combined solution GPS week 1468

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.





Evaluation of the accumulative combined solution GPS week 1468

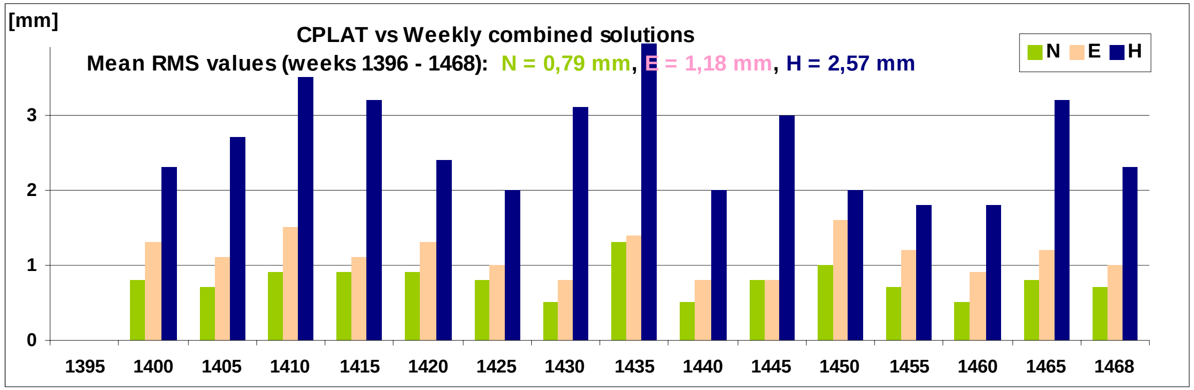
Corrections obtained in the combined cumulative solution for positions and velocities of the IGS05 sites included as reference frame stations, as well as for the excluded ones

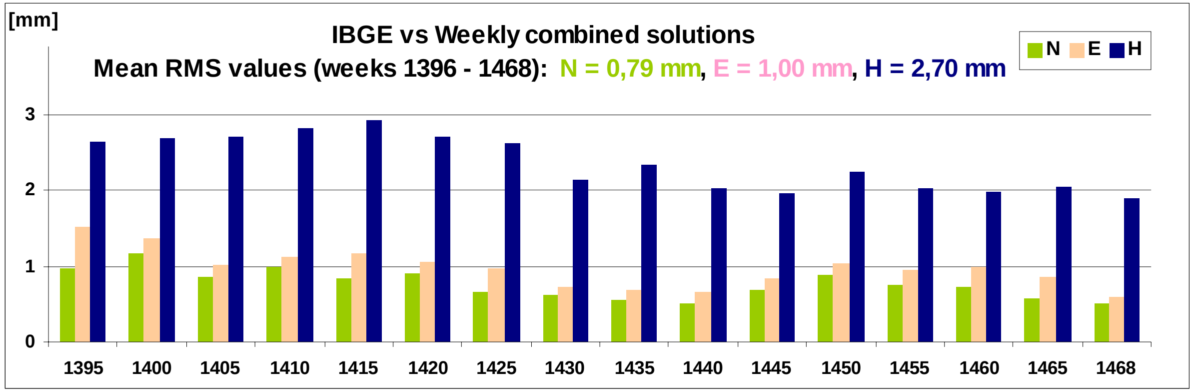
Station	ΔN [mm]	ΔE [mm]	ΔH [mm]	ΔV_N [mm/yr]	ΔV_E [mm/yr]	ΔV_H [mm/yr]
CHPI	0,7	0,9	-4,2	0,3	0,5	1,4
CONZ	-0,5	1,3	2,6	0,2	1,6	0,7
CRO1	2,7	1,8	2,0	1,0	-3,2	-3,3
GLPS	-1,1	-3,5	5,1	1,3	-0,2	3,3
GOLD	1,8	-1,1	-0,7	1,5	0,9	0,7
LPGS	-2,2	3,4	0,8	-0,9	-1,4	0,9
MDO1	1,4	-1,9	-3,1	0,8	0,4	-0,2
OHI2	-0,1	0,7	-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

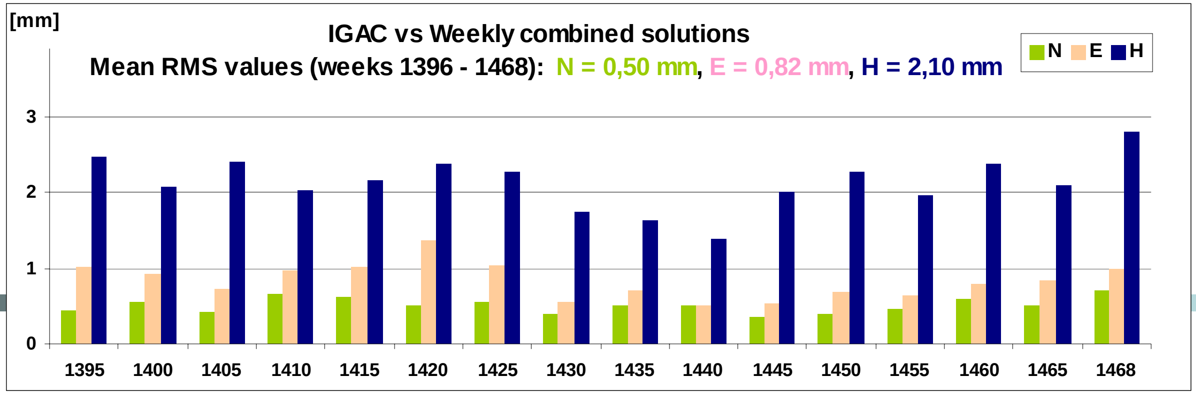
DGFI

Results

Comparison of the individual weekly EPC solutions with the final weekly combined solutions





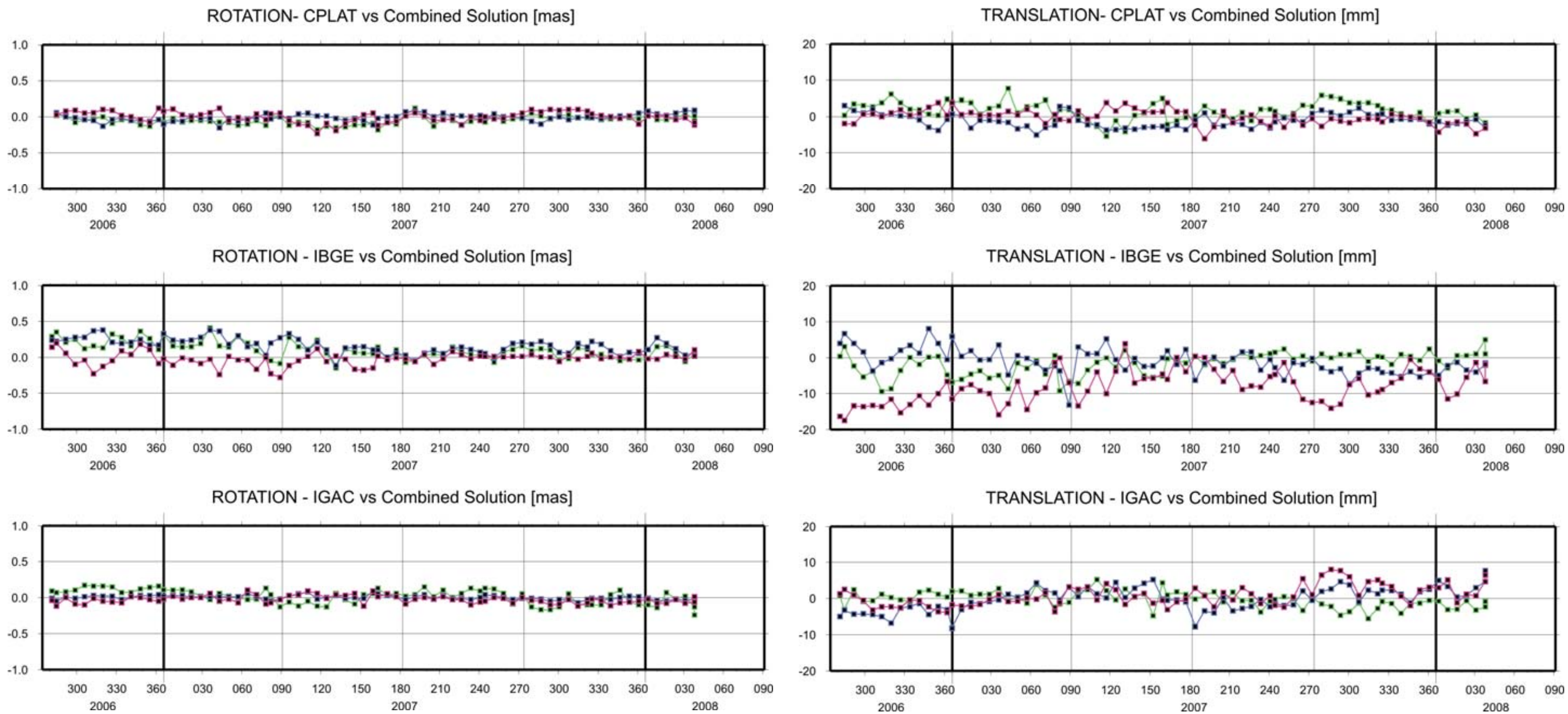


DGFI

Results

Comparison of the individual weekly EPC solutions with the final weekly combined solutions

Time series for the transformation parameters between individual EPC solutions and the final weekly combined solutions (weeks 1395-1468)



Conclusions and recommendations

- ☑ DGFI as a SIRGAS ECC has reviewed, compared, and combined the individual solutions delivered by three SIRGAS EPCs (namely **CPLAT**, **IBGE**, and **IGAC**) between **GPS weeks 1395 – 1468**;
- ☑ These three Processing Centres have become capable to satisfy the administrative and quality processing requirements defined in Rio;
- ☑ 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 N-E and better than 2,5 mm for H**;
- ☑ Their realization accuracy with respect to the IGS05 frame (**external precision**) is about **2,5 mm for N-E and 4,5 mm for H**;
- ☑ The weekly **combination** of the individual solutions provides accuracies of about **3 mm for N-E and 4,5 mm for H**.
- ☑ The major deficiencies in the individual solutions relate to systematic biases caused by applying **erroneous antennae (+ radome)**.

Conclusions and recommendations

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.

Recommendation 4: It is necessary to define a fundamental (core) network with a good continental coverage and stabile site locations to ensure high long-term stability of the reference frame. This core network should serve as frame for the national densification networks. 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.

Conclusions and recommendations

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.