Datum realization for the SIRGAS weekly coordinates

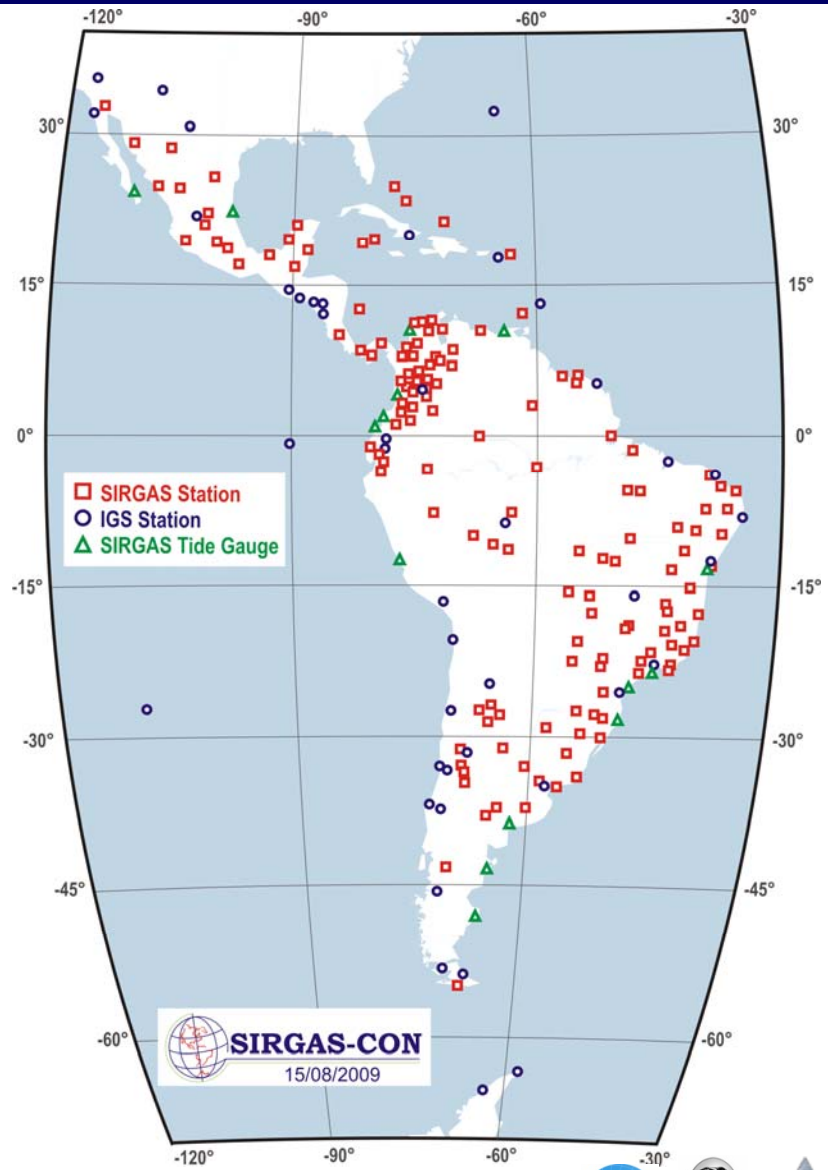
M. V. Mackern
President of the SIRGAS-WGI (Reference System)
Universidad Nacional de Cuyo,
Universidad Juan A. Maza,
Mendoza, Argentina

L. Sánchez
SIRGAS Combination Centre at DGFI
Deutsches Geodätisches Forschungsinstitut (DGFI),
Munich, Germany

Geodesy for Planet Earth, IAG Scientific Assembly 2009
August 31, 2009
Buenos Aires, Argentina

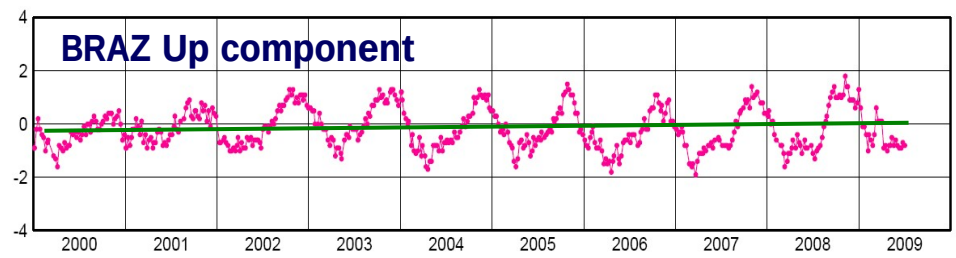
SIRGAS reference frame (SIRGAS-CON)

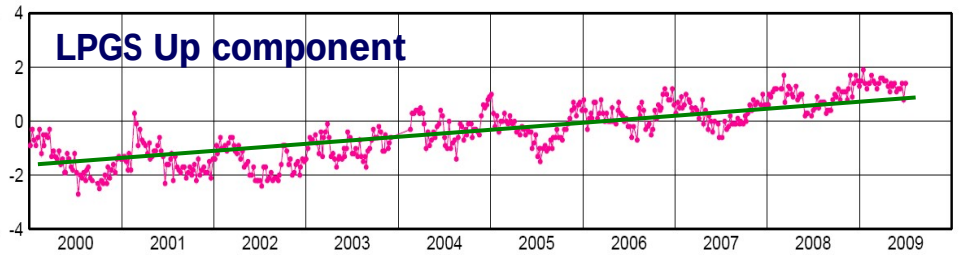
- 208 continuously operating stations (48 of them are IGS sites);
- 128 are included in the latest multi-annual solution (SIR09P01), i.e. positions and velocities are available;
- Remaining stations (80) and new ones (**operating less than 2 years**) can be used as reference stations only, if their weekly coordinates aligned to the ITRF are available.



Motivation (1)

- Regional and national reference frames supporting GNSS positioning must be consistent with the reference frame in which the GNSS orbits are determined, i.e. IGS05;
- Epoch solutions (daily, weekly, multi-annual) of regional reference networks are aligned into the IGS05 using a set of fiducial stations, coordinates of which are at present given with constant velocities only (linear coordinate changes);
- However, GNSS stations show significant seasonal position variations (mainly in the Up component) resulting from a combination of geophysical loading and systematic errors;





Motivation (2)

- Ignoring seasonal variations at reference stations can introduce systematic errors in the datum realization and the reference networks can be significantly deformed.
- These effects are larger in regional networks than in global ones, especially in regions with strong seasonal variations as the SIRGAS region.

Objectives

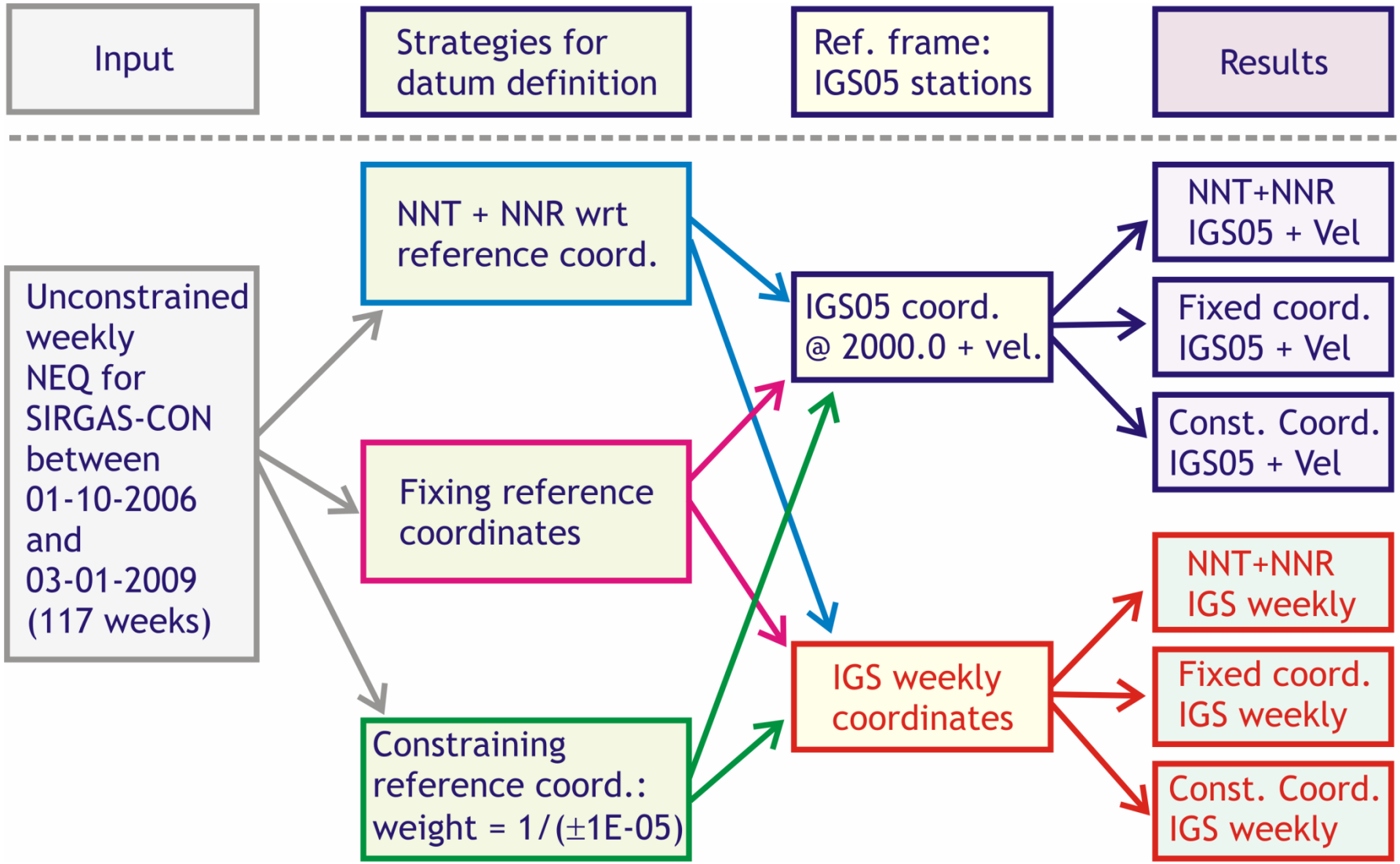
To empirically evaluate three different strategies for the datum realization in the weekly solutions of the SIRGAS reference frame:

NNT + NNR wrt reference coordinates	Fixing reference coordinates	Constraining reference coordinates weight = $1/\sigma^2$

and to select the most appropriate, taking into account:

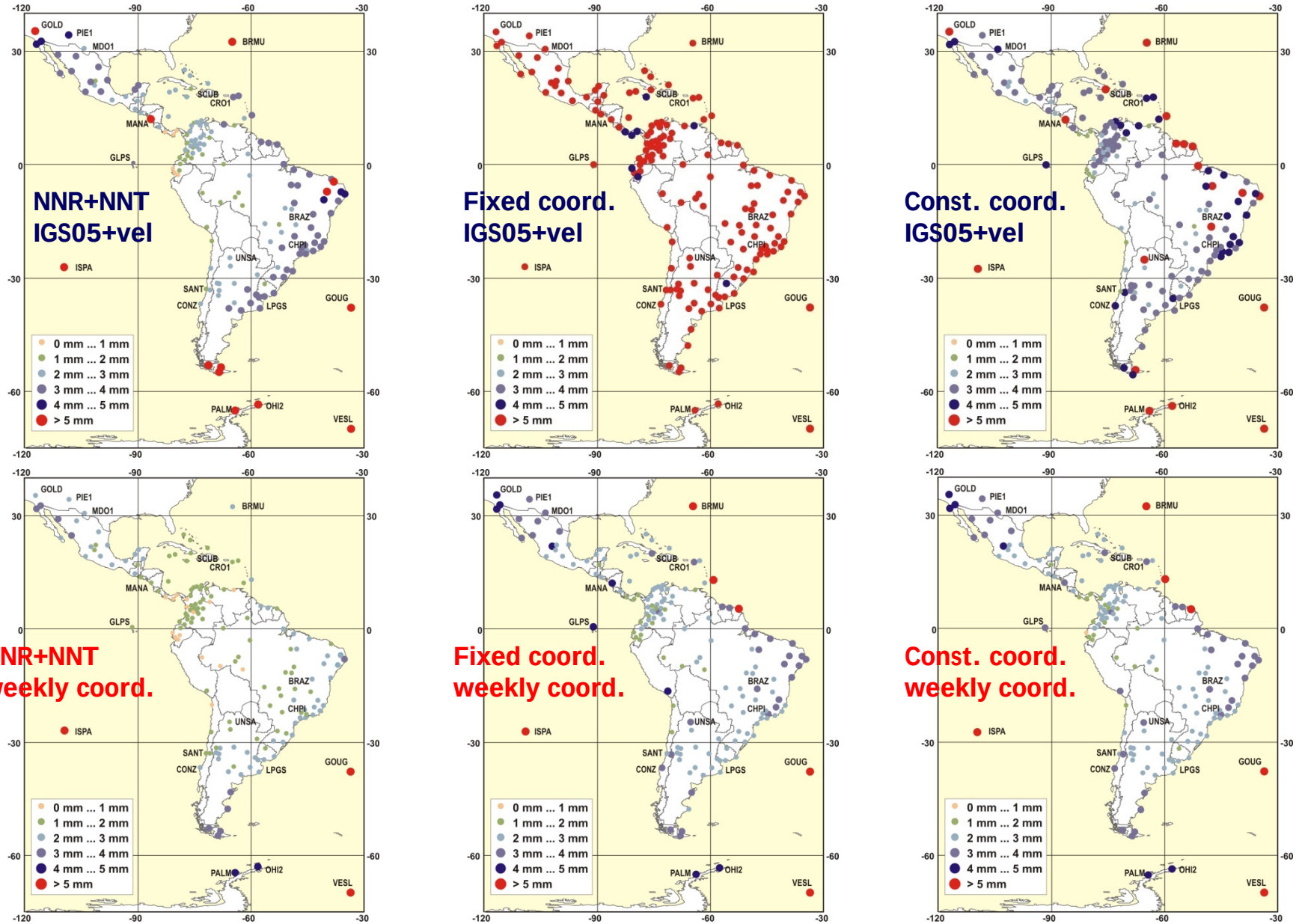
- Minimal network deformation;
- Compatibility of the weekly solutions from week to week;
- Consistency with the IGS weekly solutions of the global network.

Empirical evaluation of different strategies for the datum definition within the SIRGAS weekly processing



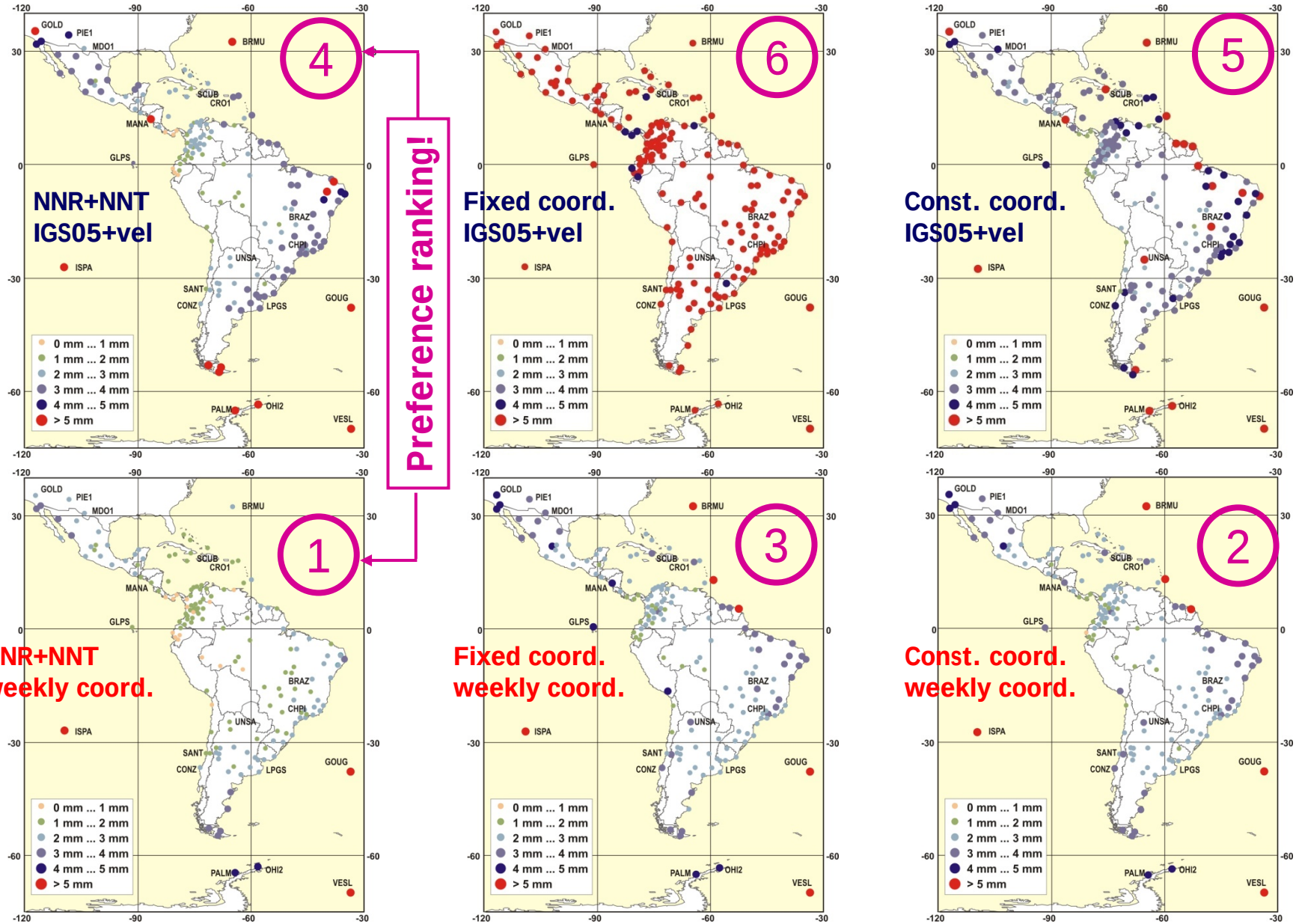
Network deformation: 3D residuals after comparing solutions aligned to the IGS05 with the primary loosely constrained solutions

(mean values for 117 weeks)



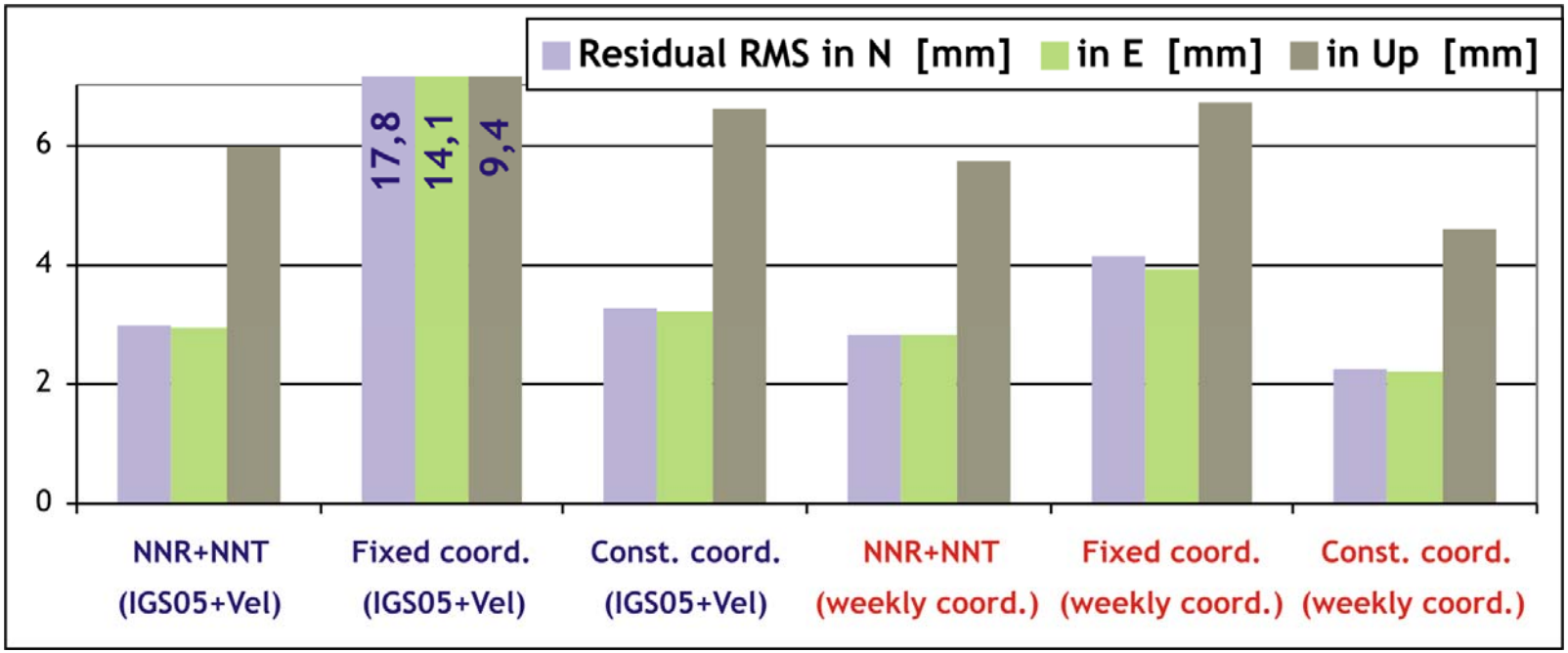
Network deformation: 3D residuals after comparing solutions aligned to the IGS05 with the primary loosely constrained solutions

(mean values for 117 weeks)



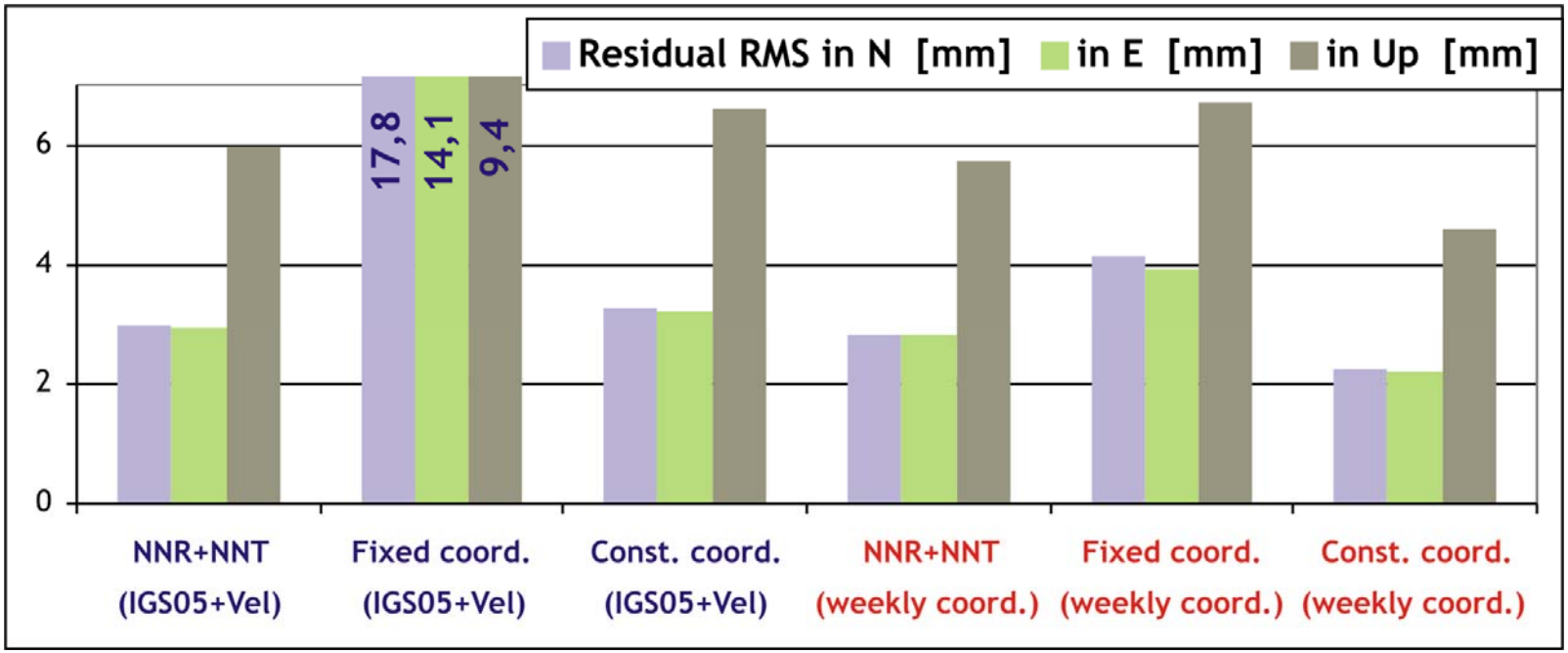
Analysis of the station position time series
(Mean RMS residuals for 117 weeks)

Weekly solutions derived after applying each datum realization strategy are transformed to identical a-priori values and time series for station coordinates are generated.



Analysis of the station position time series
(Mean RMS residuals for 117 weeks)

Weekly solutions derived after applying each datum realization strategy are transformed to identical a-priori values and time series for station coordinates are generated.

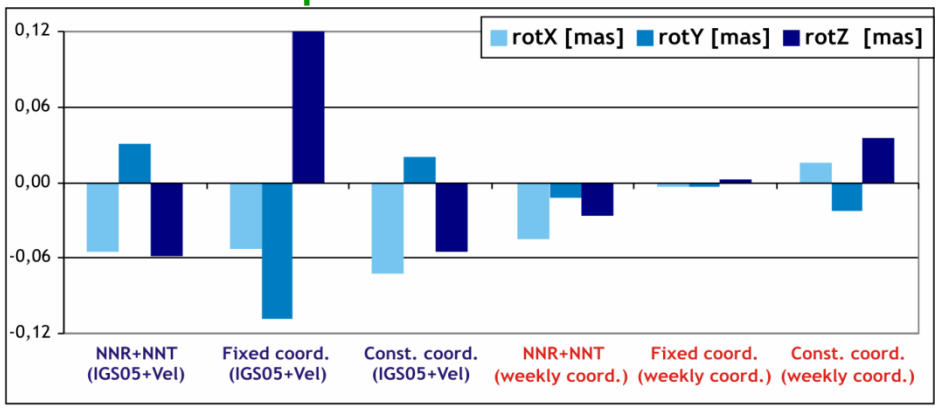


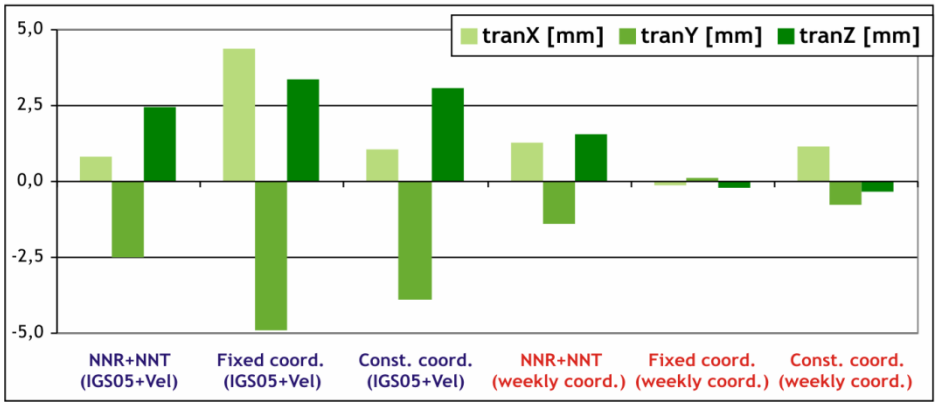
Consistency with the IGS global solutions

(Mean values for 117 weeks)

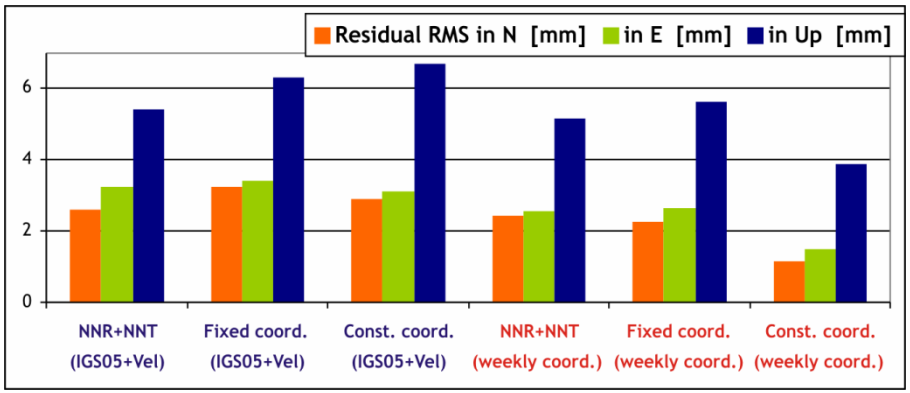
Weekly solutions derived after applying each datum realization strategy are compared with the IGS weekly coordinates using a similarity transformation.

Transformation parameters





RMS residuals after transformation

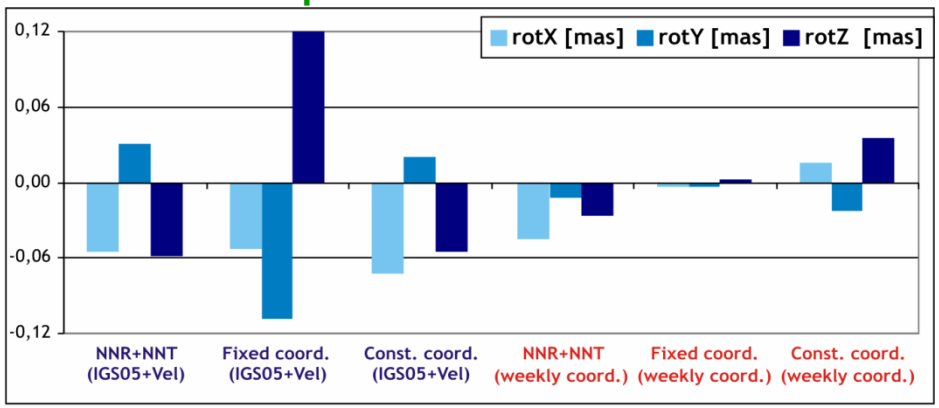


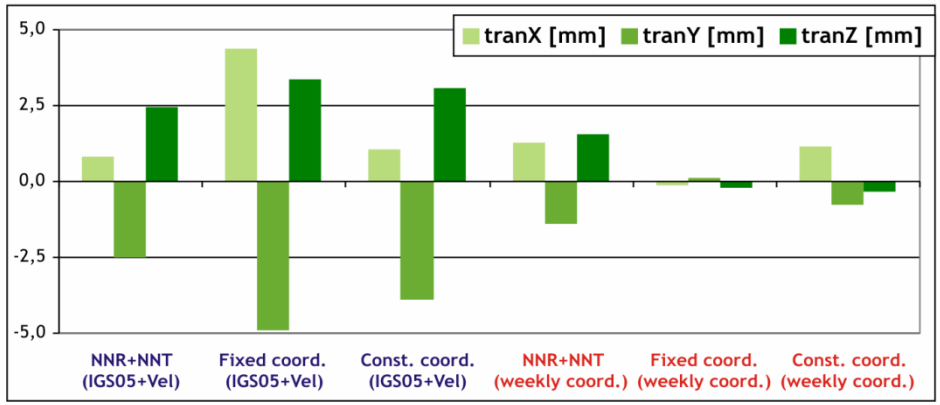
Consistency with the IGS global solutions

(Mean values for 117 weeks)

Weekly solutions derived after applying each datum realization strategy are compared with the IGS weekly coordinates using a similarity transformation.

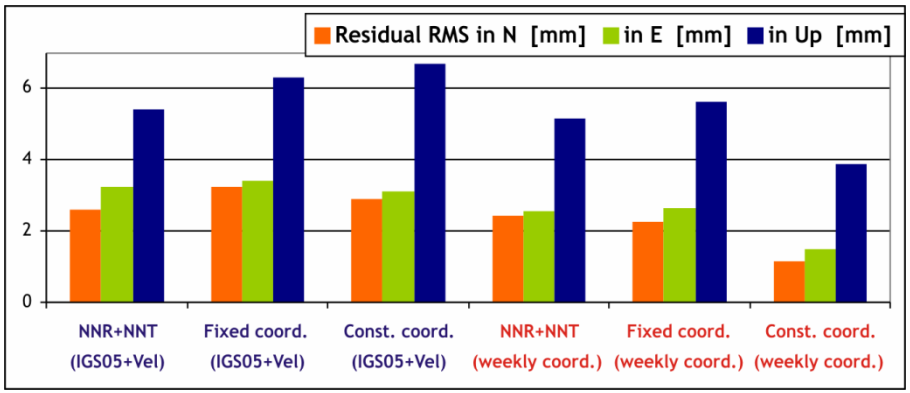
Transformation parameters





4 6 5 3 1 2

RMS residuals after transformation



4 5 6 2 3 1

“Preference ranking” summary

Criteria	NNR+NNT (IGS05+Vel)	Fixed coord. (IGS05+Vel)	Const. coord. (IGS05+Vel)	NNR+NNT (weekly coord.)	Fixed coord. (weekly coord.)	Const. coord. (weekly coord.)
Network deformation	4	6	5	1	3	2
Consistency of weekly coordinates	3	6	4	2	5	1
Datum inconsistencies between SIRGAS and IGS	4	6	5	3	1	2
Deformation of the SIRGAS network wrt the IGS network	4	5	6	2	3	1
Mean	3,8	5,8	5,0	2,0	3,0	1,5
	4	6	5	2	3	1

Concluding remarks

- The network geometry of the loosely constrained solutions is always deformed, when the geodetic datum is realized. This deformation is specially larger at the remote sites of the network.
- To minimize this deformation, position variations caused by station movements (i.e. loading, crustal deformation, plate tectonics, etc.) must not influence the datum realization.
- Strategies based on the linear movement of the reference stations (IGS05@2000 + velocities) introduce the largest errors into the station positions, mainly at the reference stations. This is a consequence of constraining a seasonal signal to be a linear trend.
- It is necessary that the reference frame definition includes, together with the usual linear terms, seasonal variations to improve the modelling of the reference site motions and to make it more reliable.
- In the mean time, weekly solutions of regional reference frames shall be aligned to IGS05 by constraints to the IGS weekly coordinates.