



SIRGAS: the core geodetic infrastructure in Latin America and the Caribbean



C. Brunini

Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina



L. Sánchez, H. Drewes

Deutsches Geodätisches Forschungsinstitut, Germany



V. Mackern

Universidad Nacional de Cuyo, Argentina



W. Martínez

Instituto Geográfico Agustín Codazzi, Colombia

On behalf of SIRGAS

SIRGAS: the Geocentric Reference System for the Americas

IAG Scientific Assembly, Potsdam, Germany, September 1-6, 2013

Introduction

SIRGAS efforts are driven by two complementary paradigms: one established by the IAG and the other by Pan-American Institute of Geography and History.

SIRGAS is primarily concerned on the establishment, maintenance and extension of the ITRF in the Latin American and Caribbean regions according to the IAG paradigms.

From the side of the Pan-American Institute, the priority is the development of the Americas' Geospatial Database Infrastructure and SIRGAS is requested to provide the fundamental layer.

Presently SIRGAS is the official reference frame of 15 countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, French Guyana, Guatemala, Mexico, Panama, Peru, Uruguay and Venezuela.

More than 50 institutions are committed to SIRGAS in a voluntary partnership.



SIRGAS components

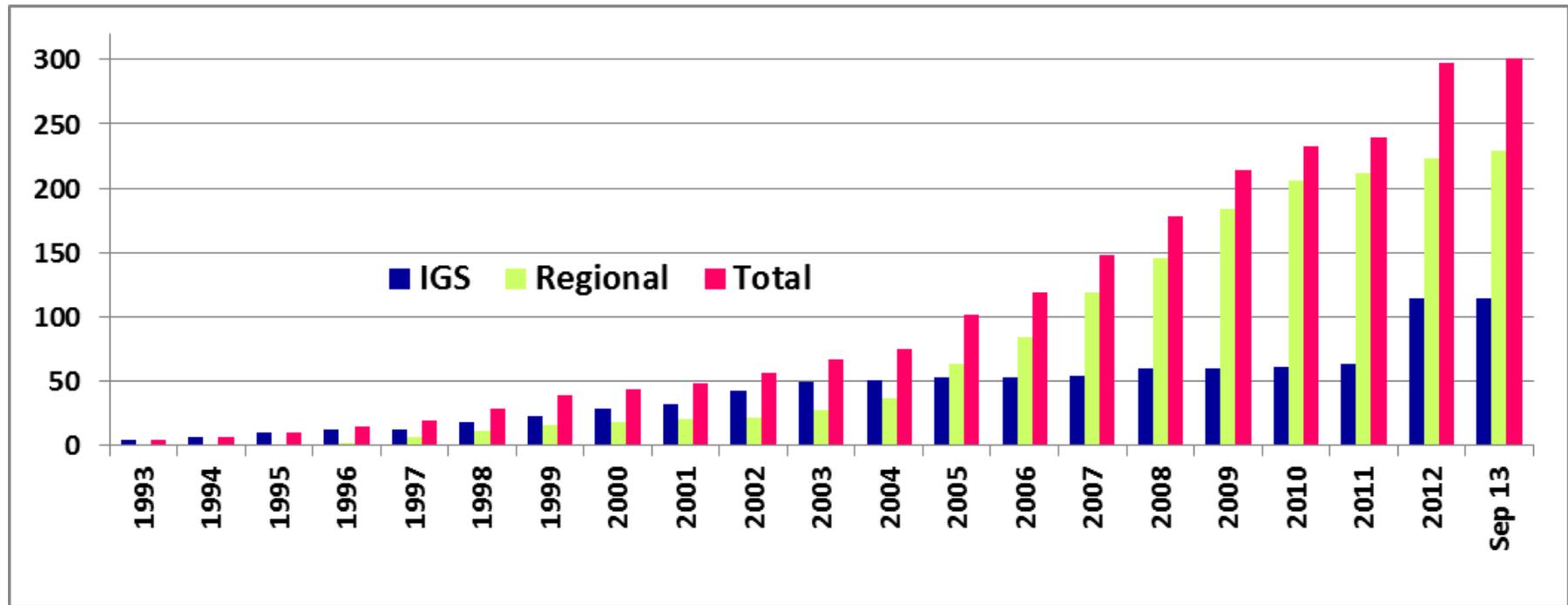
SIRGAS comprises:

- 1) A regional densification of the ITRF as the continental reference frame;
- 2) National densifications of the continental reference frame;
- 3) A unified vertical reference system.

To guarantee:

- Accessibility to the global reference system at regional, national, and local levels.
- Full consistency with the GNSS and other satellite orbits.
- Standardisation of the gravity field-related heights.
- Precise combination of physical and geometrical parameters.

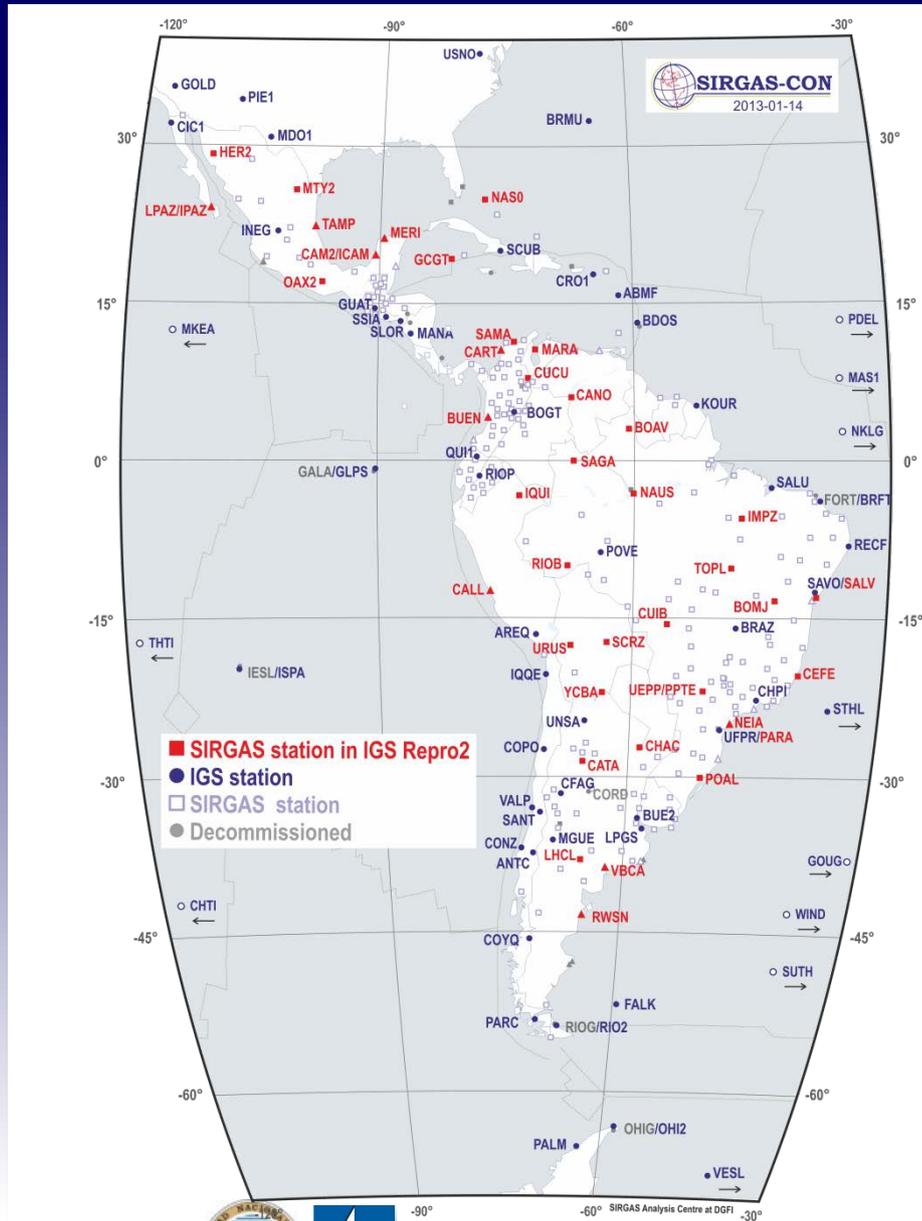
Geographical densification of the reference stations



- SIRGAS frame is materialized by a continuously operating GNSS network (SIRGAS-CON) that presently encompassed ~300 stations.
- In the early years of SIRGAS the stations were installed mostly by the IGS.
- By 2003 the national organizations committed to a policy aimed at improving the geodetic infrastructure of the Americas and the number of stations began to grow quickly.

Improvement of the ITRF station coverage in Latin America

IAG Scientific Assembly, Potsdam, Germany, September 1-6, 2013

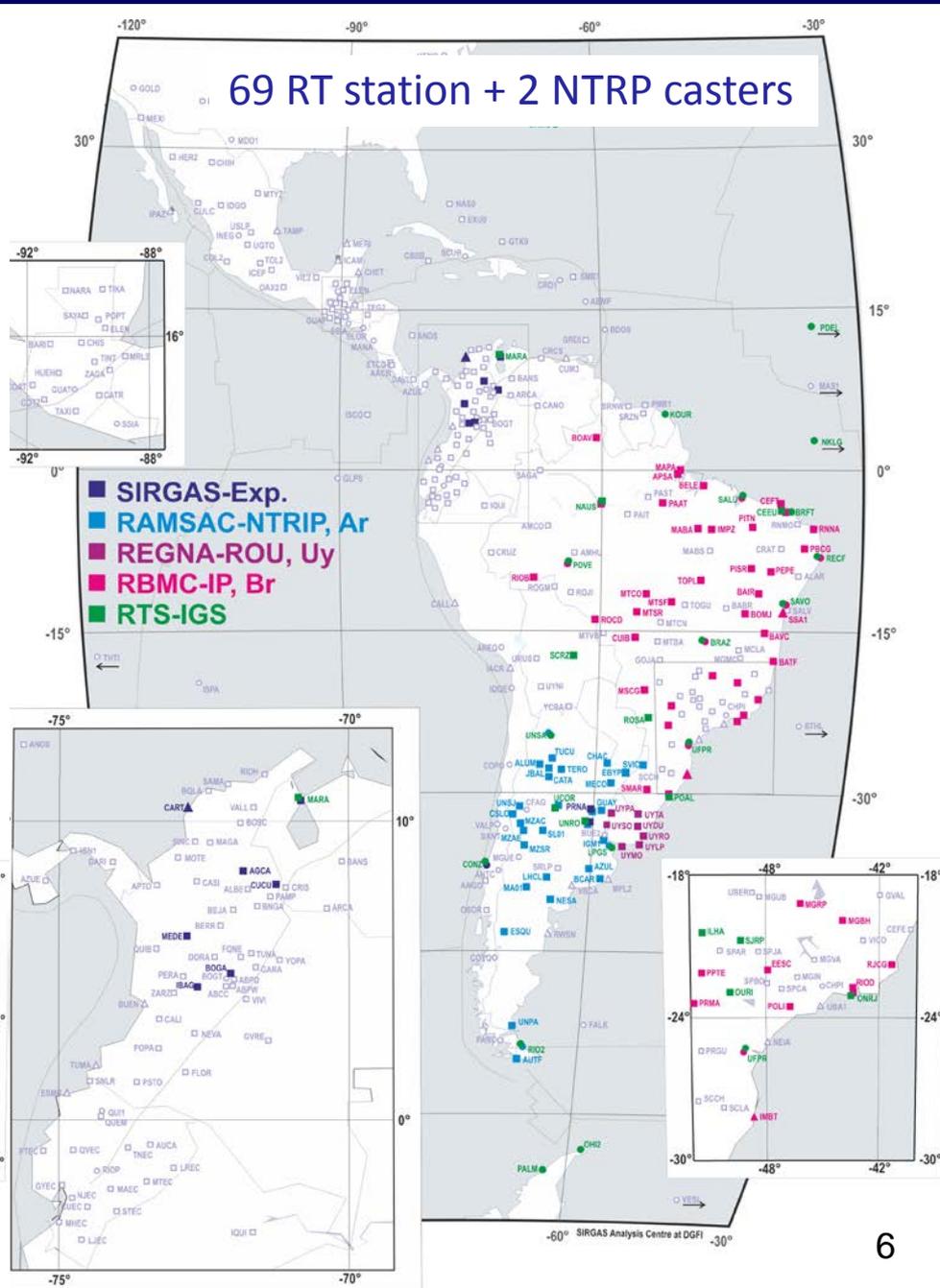
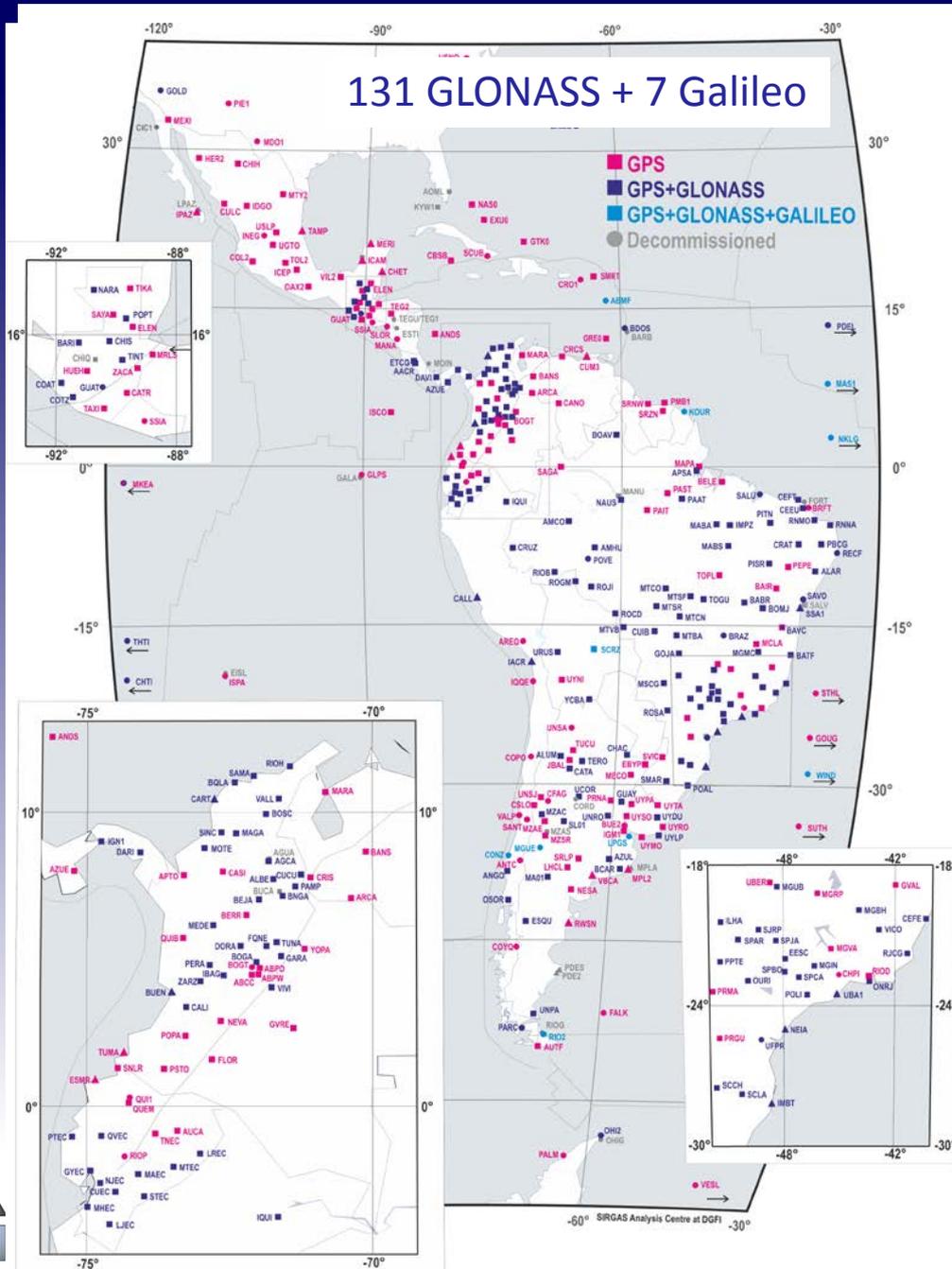


- in June 2012, 40 SIRGAS regional stations were added to the IGS;
- Historical data remitted to be incorporated in the Second IGS Reprocessing;
- Next ITRF (2013) will contain ~100 stations in the SIRGAS region;

Advantages:

- More fiducial stations in the SIRGAS region, but also,
- Better global distribution of the ITRF stations.

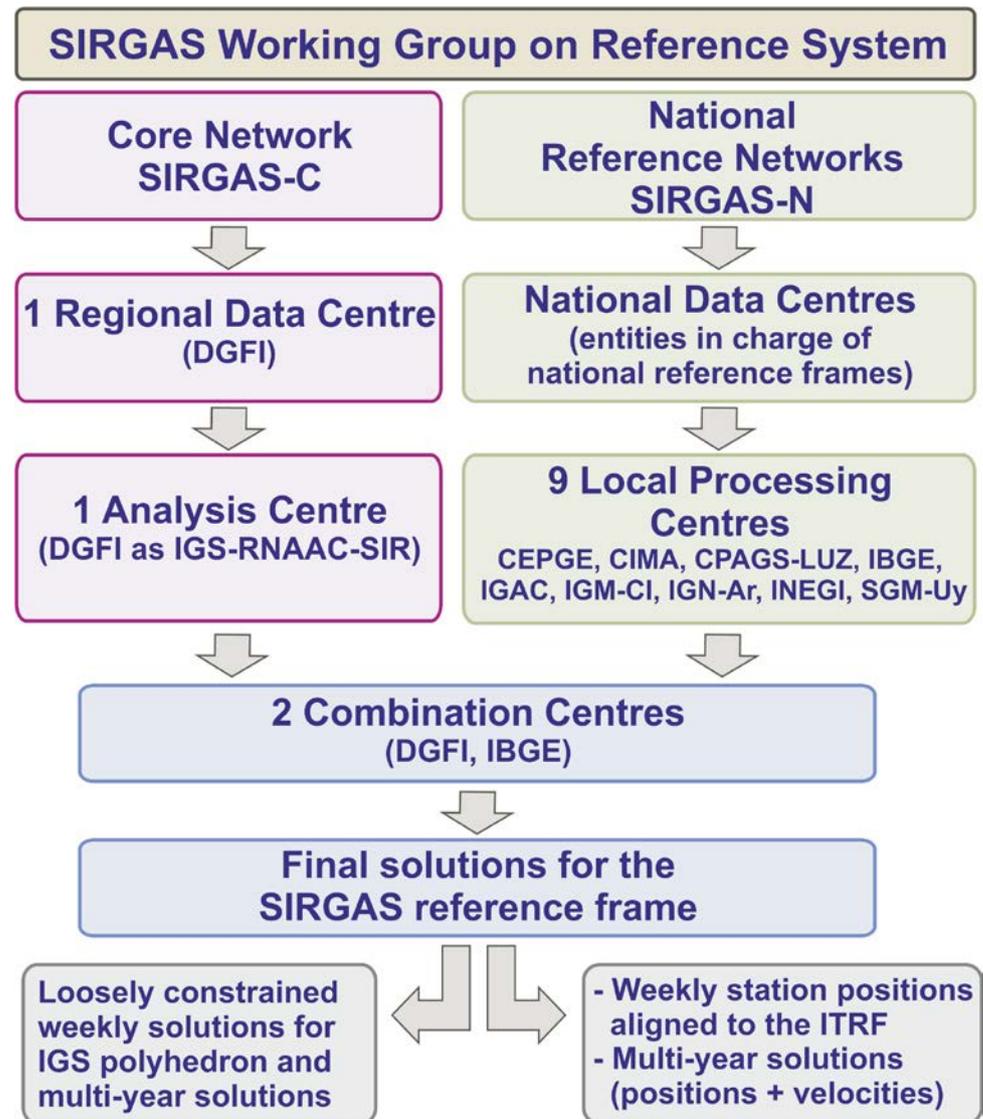
GLONASS, GALILEO and real time capability



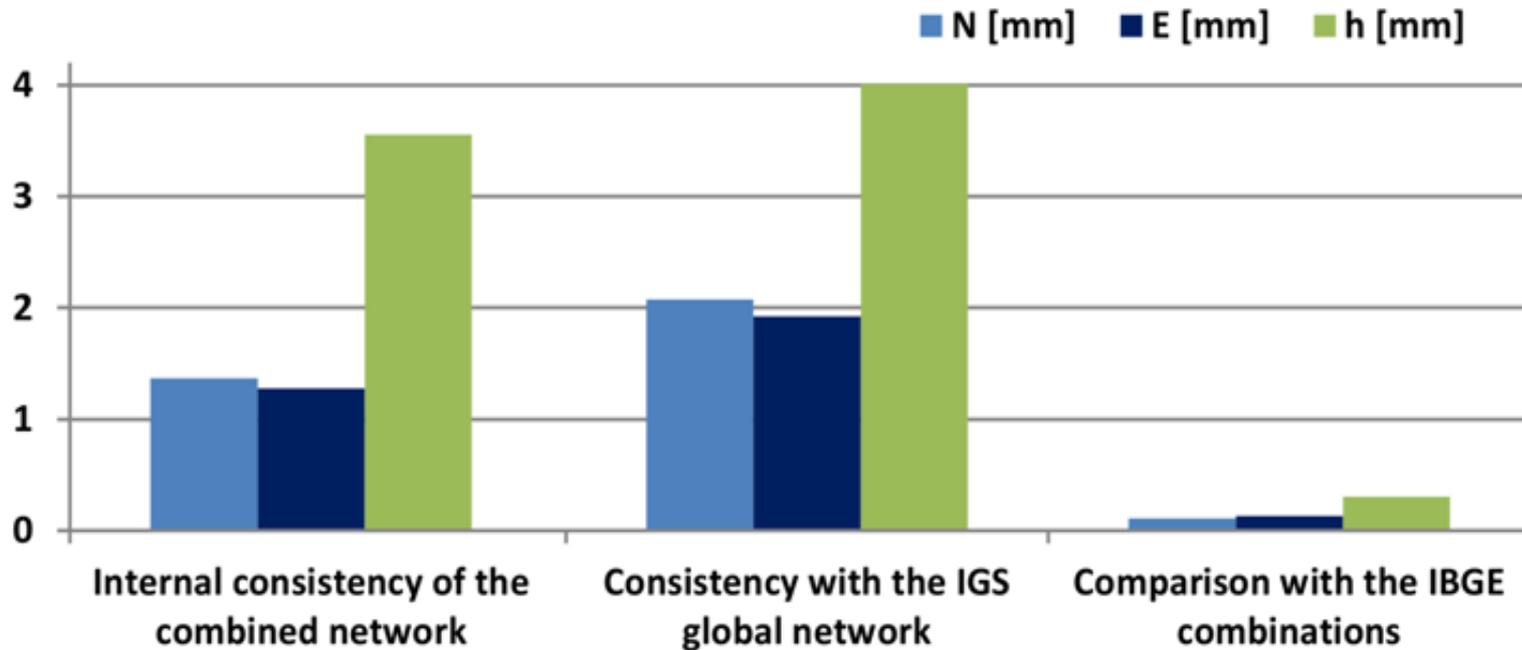
Redundancy in the analysis of the reference frame

Each station is processed by 3 analysis centres:

- 9 processing centres: Argentina (2), Brazil, Chile, Colombia, Ecuador, Germany, Uruguay, Venezuela;
- 2 in experimental phase: Costa Rica, Bolivia;
- 2 combination centres: Brazil, Germany.



Quality of the weekly SIRGAS station positions

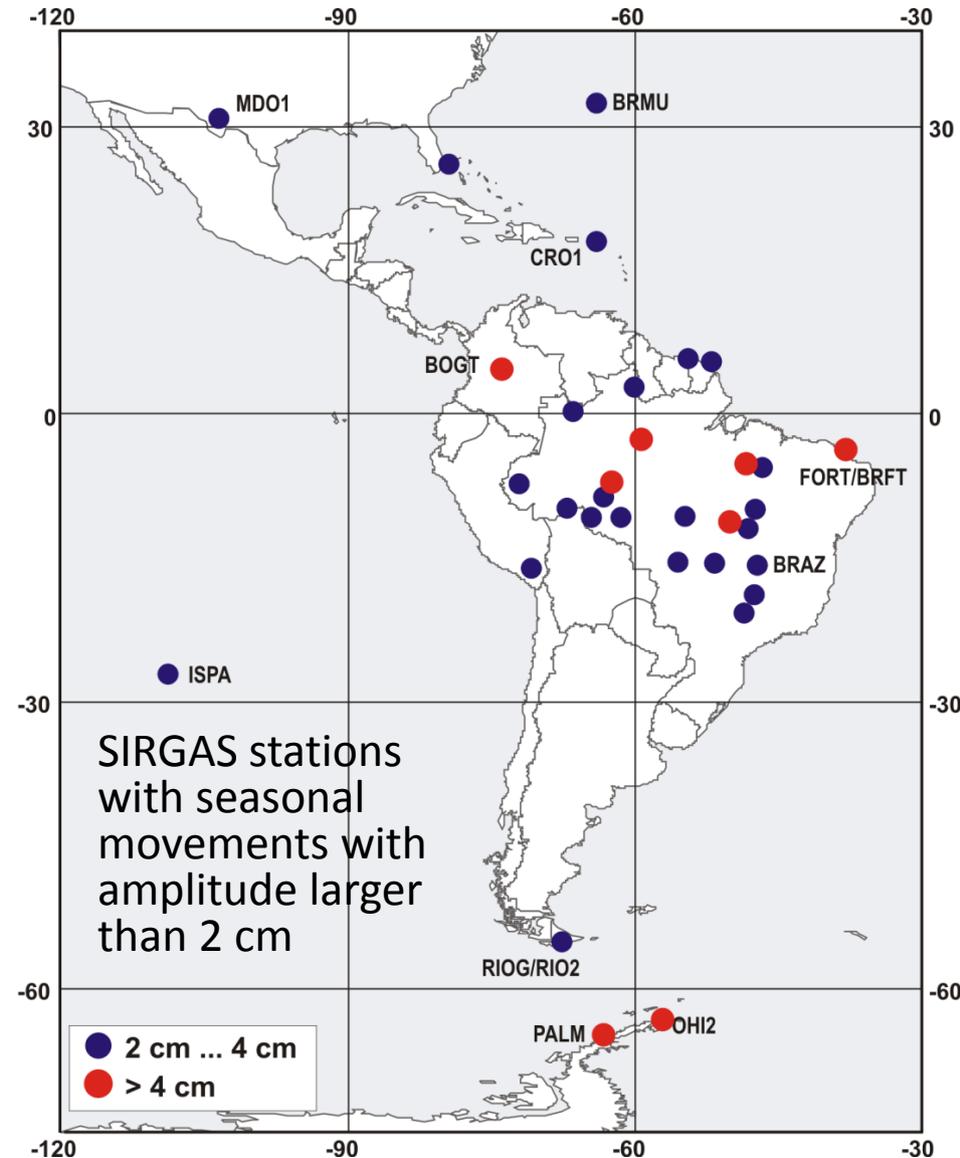
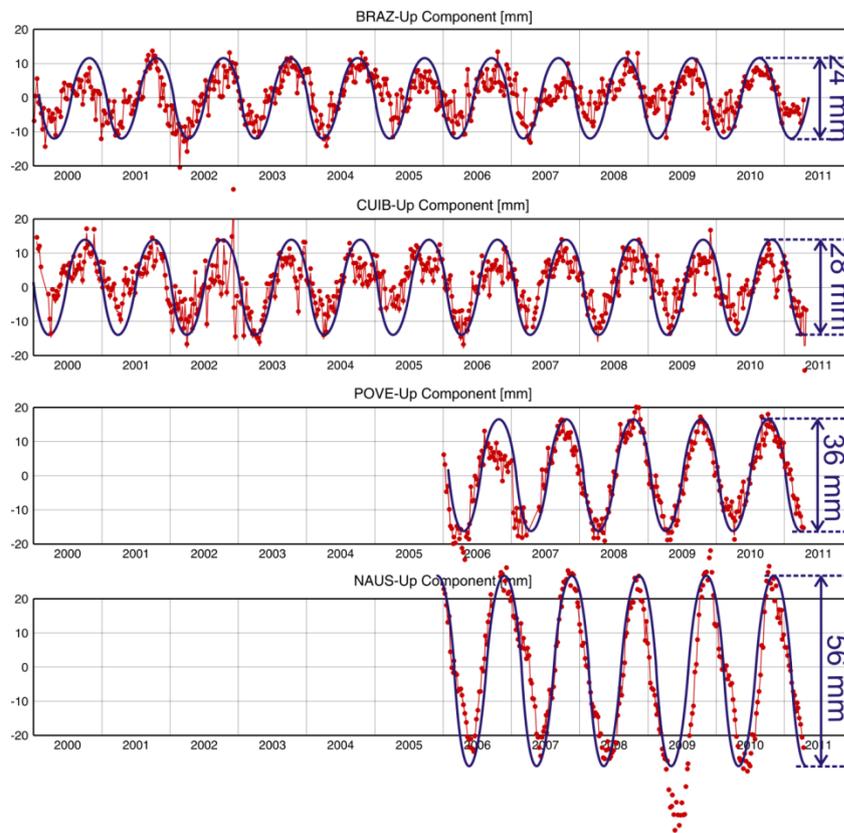


- Internal consistency: standard deviation of the residuals of weekly combinations: $\pm 1,4$ mm in N-E and $\pm 3,6$ mm in the vertical coordinate;
- External consistency: standard deviation of the residuals between combined and IGS coordinates: $\pm 2,0$ mm in N-E and $\pm 4,0$ mm in vertical

Present challenges: modelling station seasonal movements

IAG Scientific Assembly, Potsdam, Germany, September 1-6, 2013

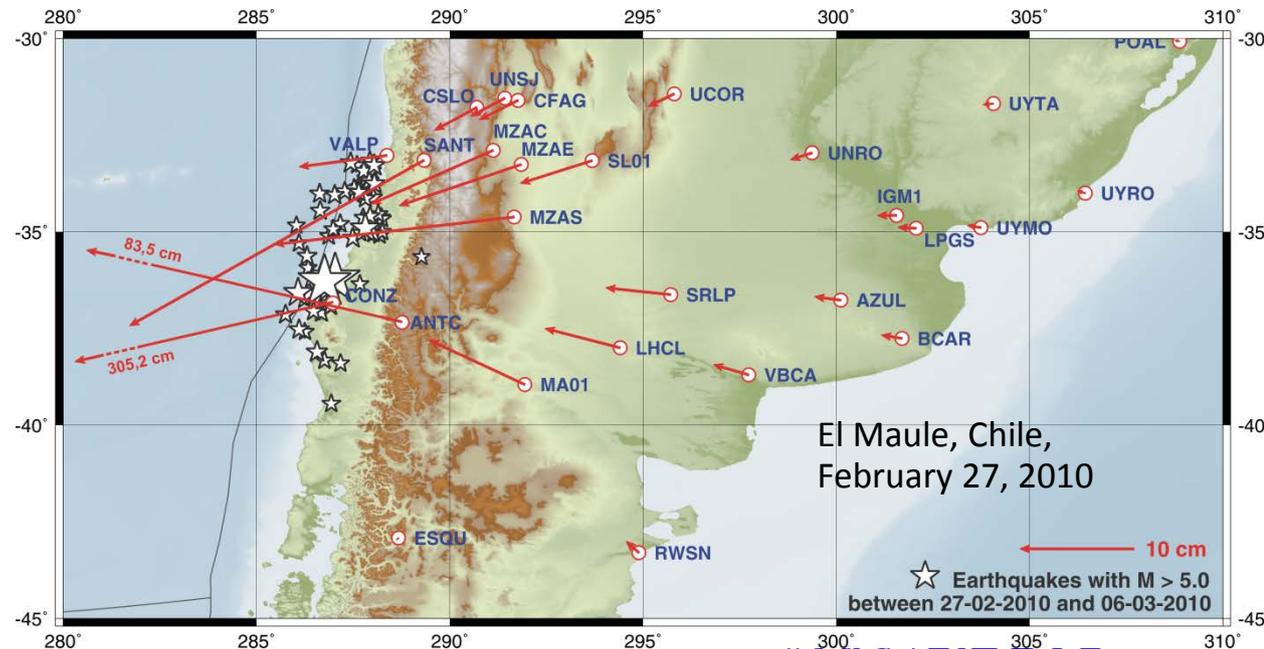
Many SIRGAS stations present significant seasonal position variations (mainly in the vertical), which are ignored when constant velocities are computed.



Present challenges: modeling reference frame deformations due to seismic events

Strong earthquakes produce discontinuities both in the station position and velocity;

Transformation between pre- and post-seismic coordinates cannot be done with usual network transformations.

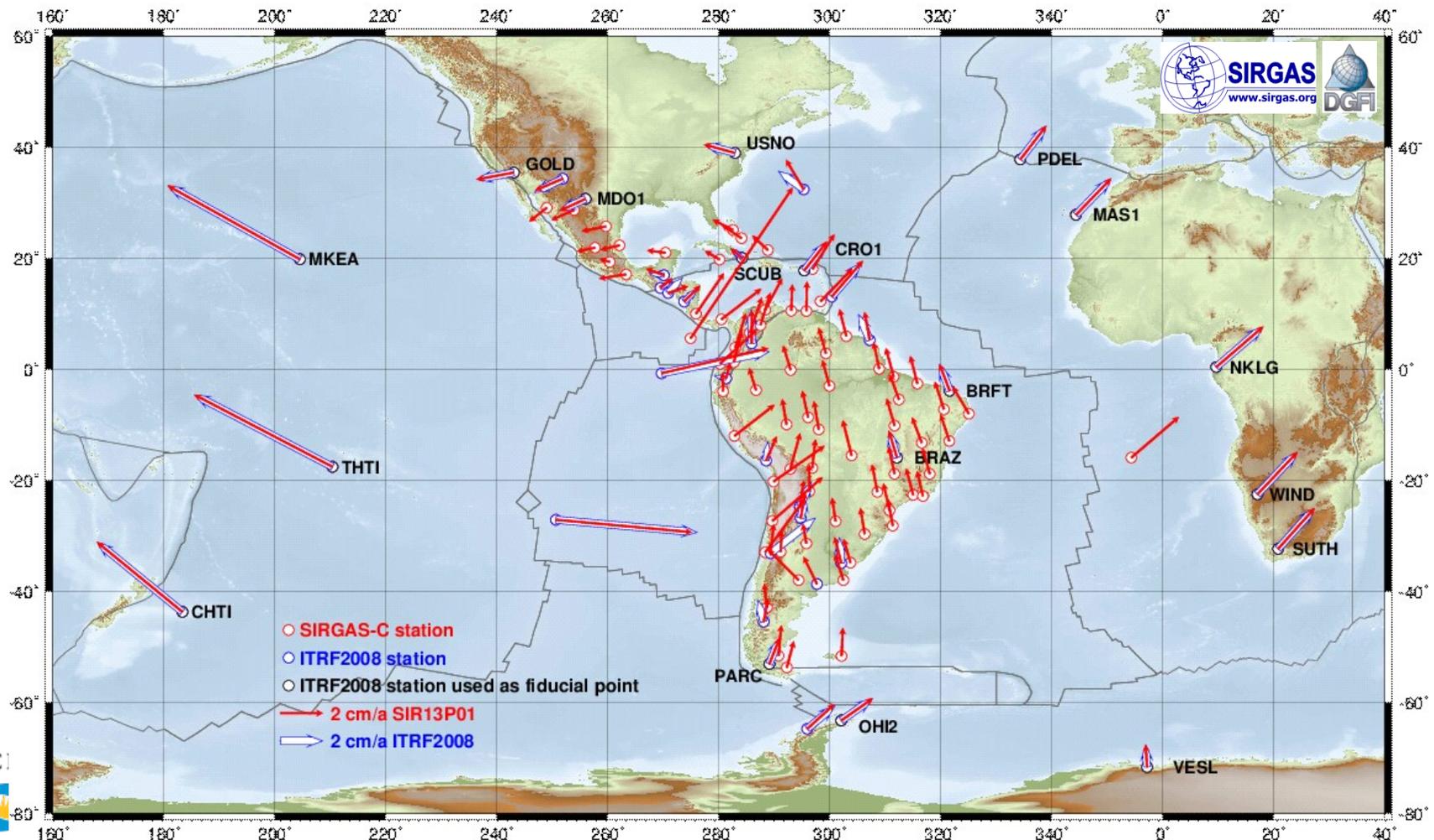


On-going activities regarding the continental reference frame

- 1) Second reprocessing of the entire SIRGAS reference frame:
 - New computation of daily normal equations from 1997 to 2012;
 - Inclusion of the new IERS and IGS standards;
 - Processing GPS + GLONASS measurements;
- 2) Modelling of seasonal movements at the combination level of the weekly solutions;
- 3) Computation of deformation models derived from weekly solutions to account for seismic discontinuities in the computation of the reference frame.

Cumulative solution: April 2010 to June 2013

- Recomputed weekly normal equations applying new IGS/IERS standards;
- Core stations (108), without co-seismic jumps;
- ITRF2008, 2012.0
- Precision: Pos.: N - E = $\pm 1,4$ mm, h = $\pm 2,5$ mm; Vel.: N - E = 0,8 mm/a; h = 1,2 mm/a.



Maule earthquake (Feb. 2010): pre- and post-seismic velocities

IAG Scientific Assembly, Potsdam, Germany, September 1-6, 2013



Final remarks

More than 50 institutions are committed to SIRGAS and contribute to maintain a regional densification of the ITRF which is the official reference frame of 15 countries.

Weekly solutions aligned to the current ITRF are computed in a disaggregated but redundant way by 9 analysis centers and 2 combination centers.

Precision of positions and velocities probed to be according to the state-of-the-art.

Present activities are focused on:

- Re-computing the network according to the new IGS / ITRF standards;
- Account for seasonal displacement in the frame realization;
- Model jumps between pre- and pos-seismic episodes.

Acknowledgments

The results described in this presentation are a consequence of a **successful international geodetic cooperation** possible thanks to the active participation of many **colleagues from more than 50 Latin American and Caribbean institutions**, who not only make the measurements of the stations available, but also operate SIRGAS Analysis Centres, and execute projects to continue improving the reference frame. **This cooperation is highly recognized.**

We also thank for the strong support provided by the **International Association of Geodesy (IAG)**, the **Pan-American Institute for Geography and History (PAIGH)** and the **International Union of Geodesy and Geophysics (IUGG)**.

More details about SIRGAS in www.sirgas.org.