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

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On behalf of SIRGAS www.sirgas.org

SIRGAS: the Geocentric Reference System for the Americas

Objective

To provide a reliable reference frame for:

1) Earth System research;
2) Scientific and practical applications based on high-precise positioning.

This implies a reference system realisation with

1) A significantly higher accuracy than the magnitude of the phenomena we want to study;
2) Homogeneous reliability and global consistency (the same accuracy everywhere);
3) Long-term stability (the same accuracy at any time).

SIRGAS components

SIRGAS comprises:

1) A regional densification of the ITRF (the realisation of the ITRS), as continental reference frame;

2) National densifications of the continental reference frame;

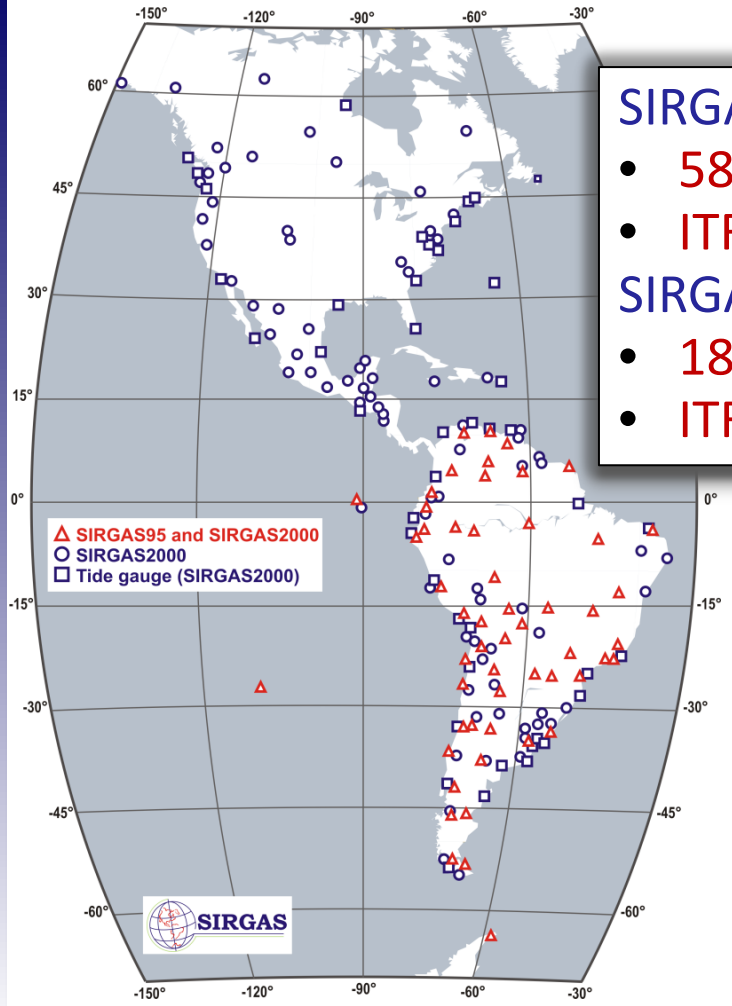
3) A unified vertical reference system.

To guarantee:

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

Continuous monitoring of the reference frame

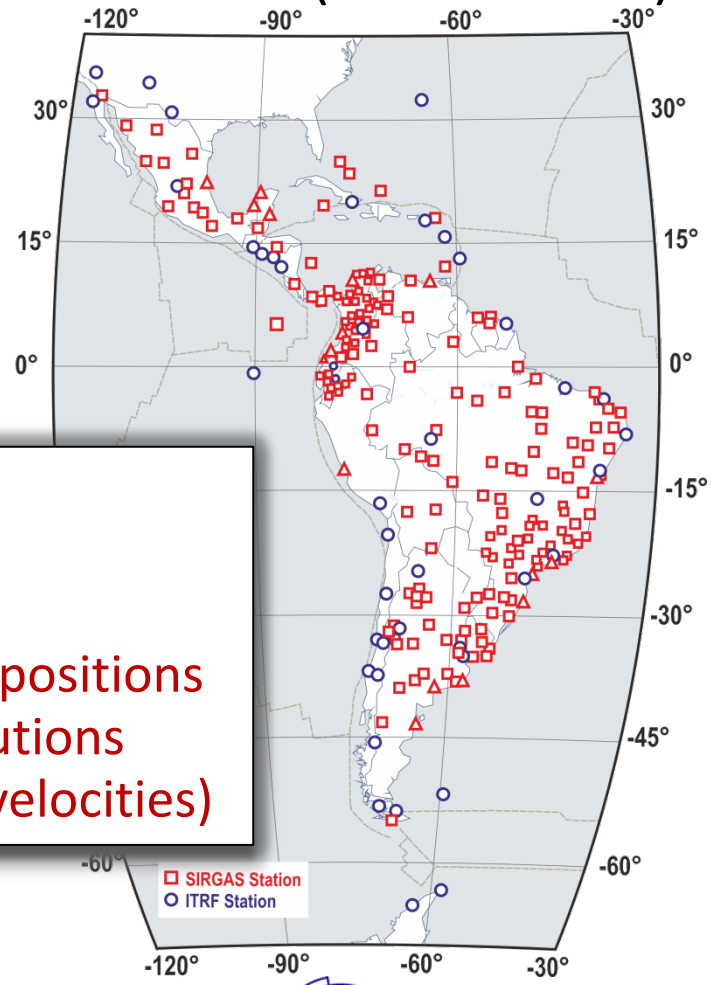
Initially: Realization by means of GPS campaigns



SIRGAS95
- 58 stations
- ITRF94, 1995.4

SIRGAS2000
- 184 stations
- ITRF2000, 2000.4

Today: Realization by means of a continuously operating GNSS network (SIRGAS-CON)



SIRGAS-CON
- 296 stations
- Current ITRF
- Weekly station positions
- Cumulative solutions (positions and velocities)

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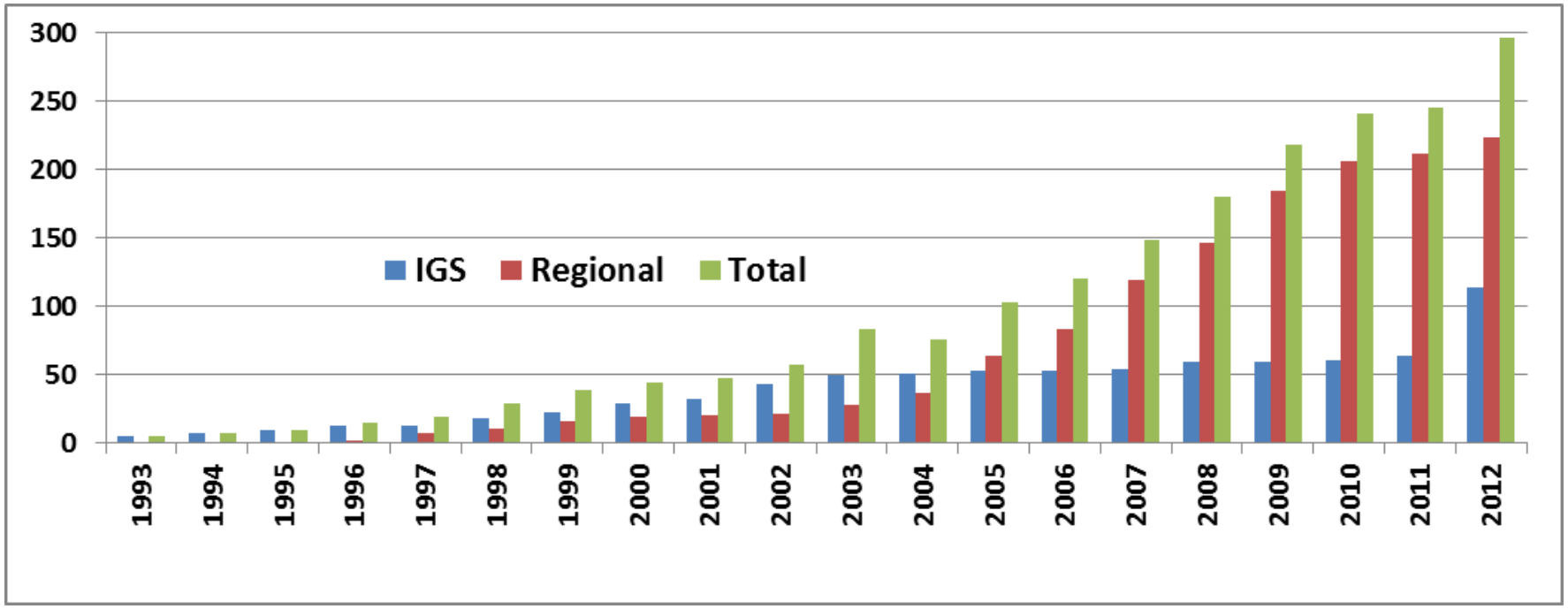
Geographical densification of the reference stations



- Improvement of the national reference frames by installing continuously operating GNSS stations (intensively since 2005);
- Integration of the national GNSS reference stations into the continental reference frame (SIRGAS-CON) for common processing and to guarantee consistency with the ITRF;
- Incorporation of 40 SIRGAS stations in the IGS contribution to the ITRF.

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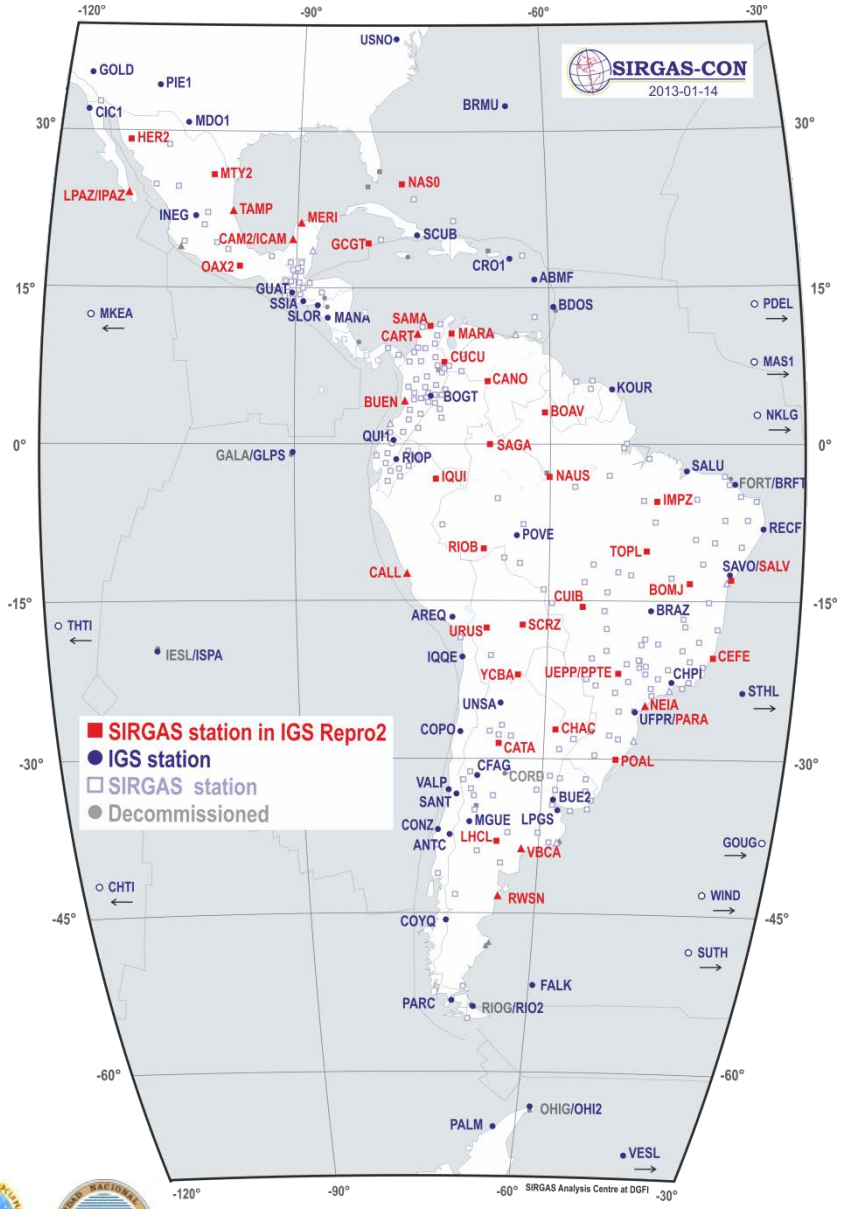
Improvement of the ITRF station coverage in Latin America



- 40 SIRGAS regional stations included in the routine weekly analysis of the IGS network since June 2012;
- Historical data remitted to the IGS for incorporation in the Second IGS Reprocessing;
- Next ITRF (2013) will contain these 40 stations;

Advantages:

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

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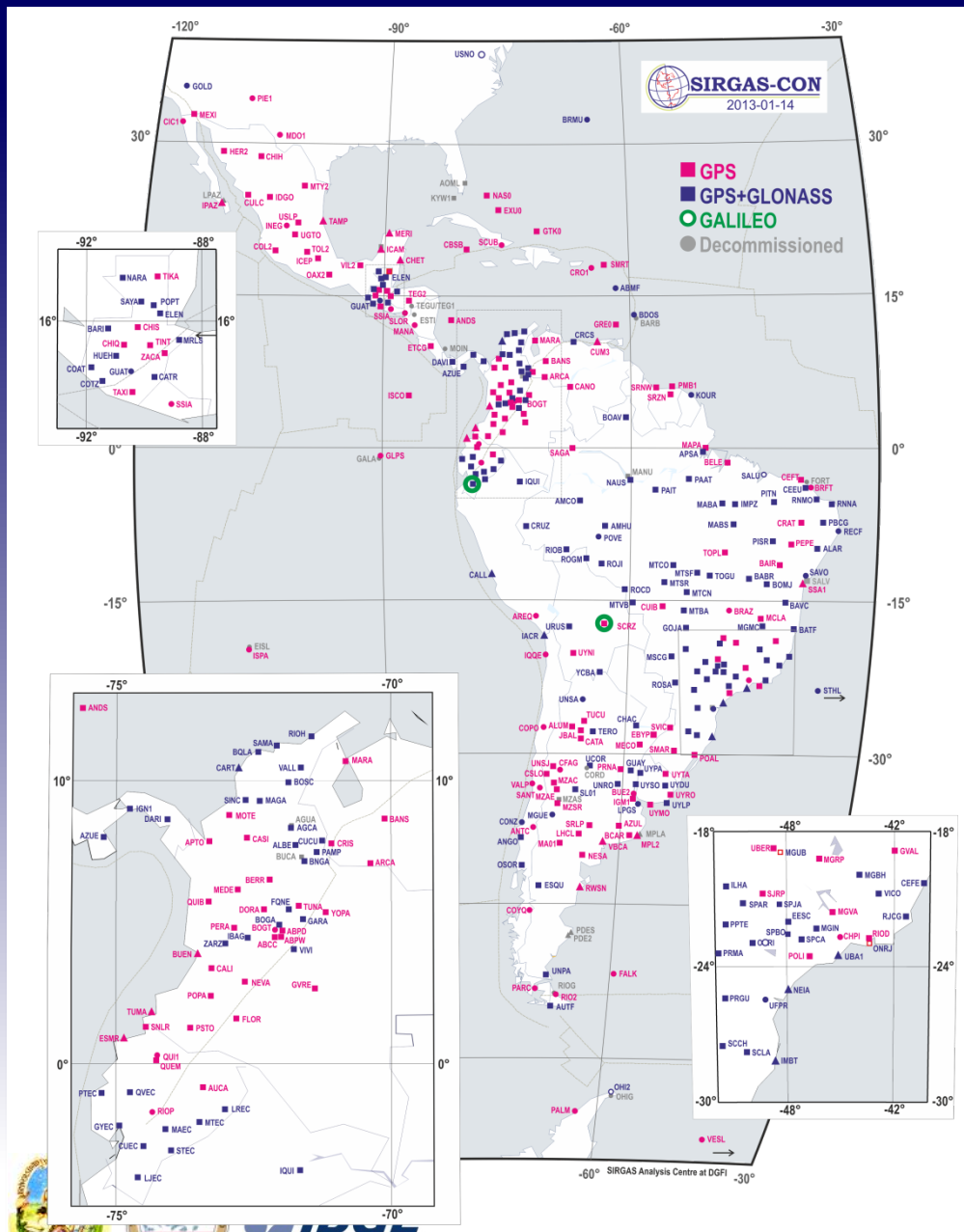
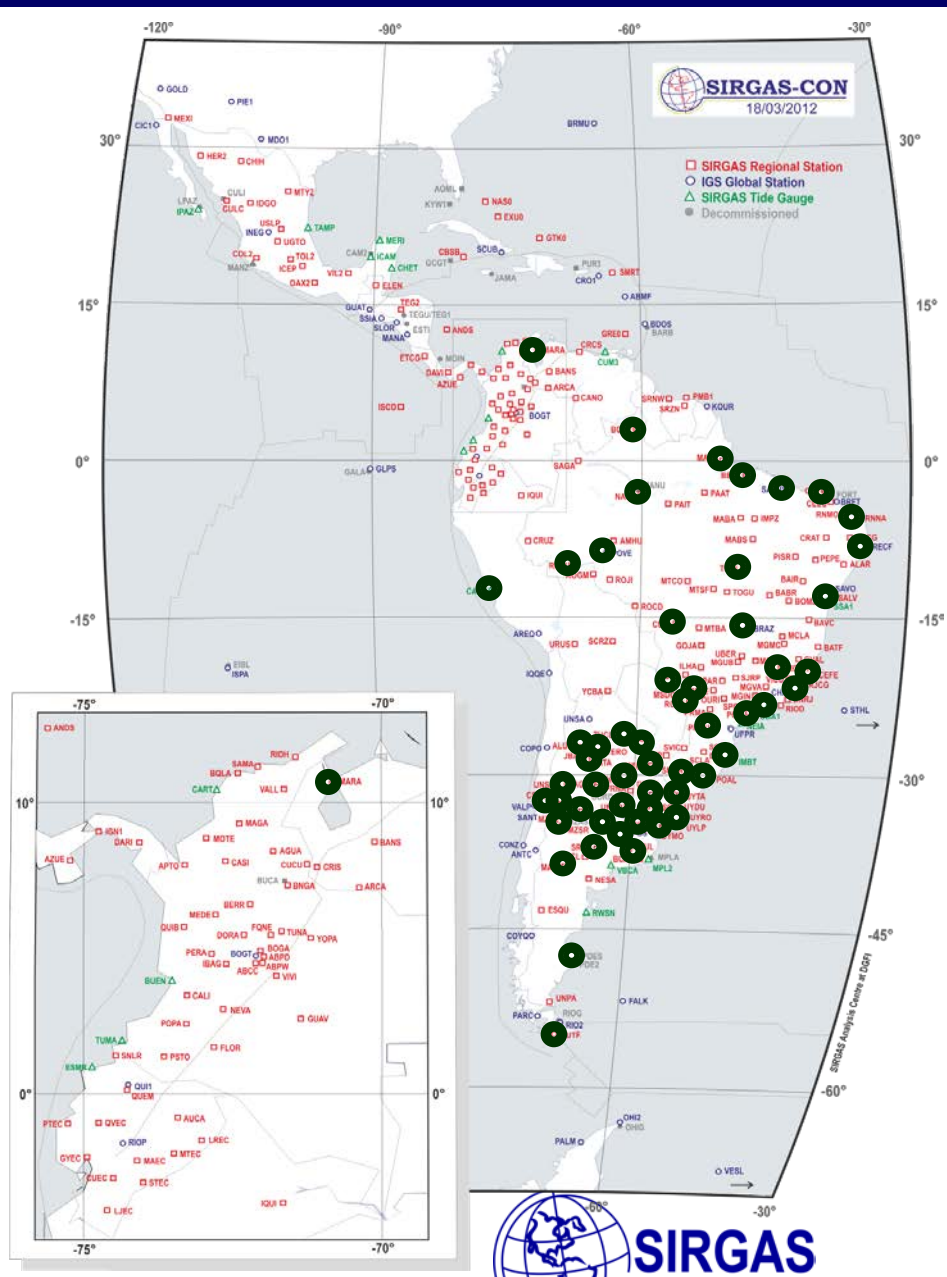
GLONASS, GALILEO and real time capability





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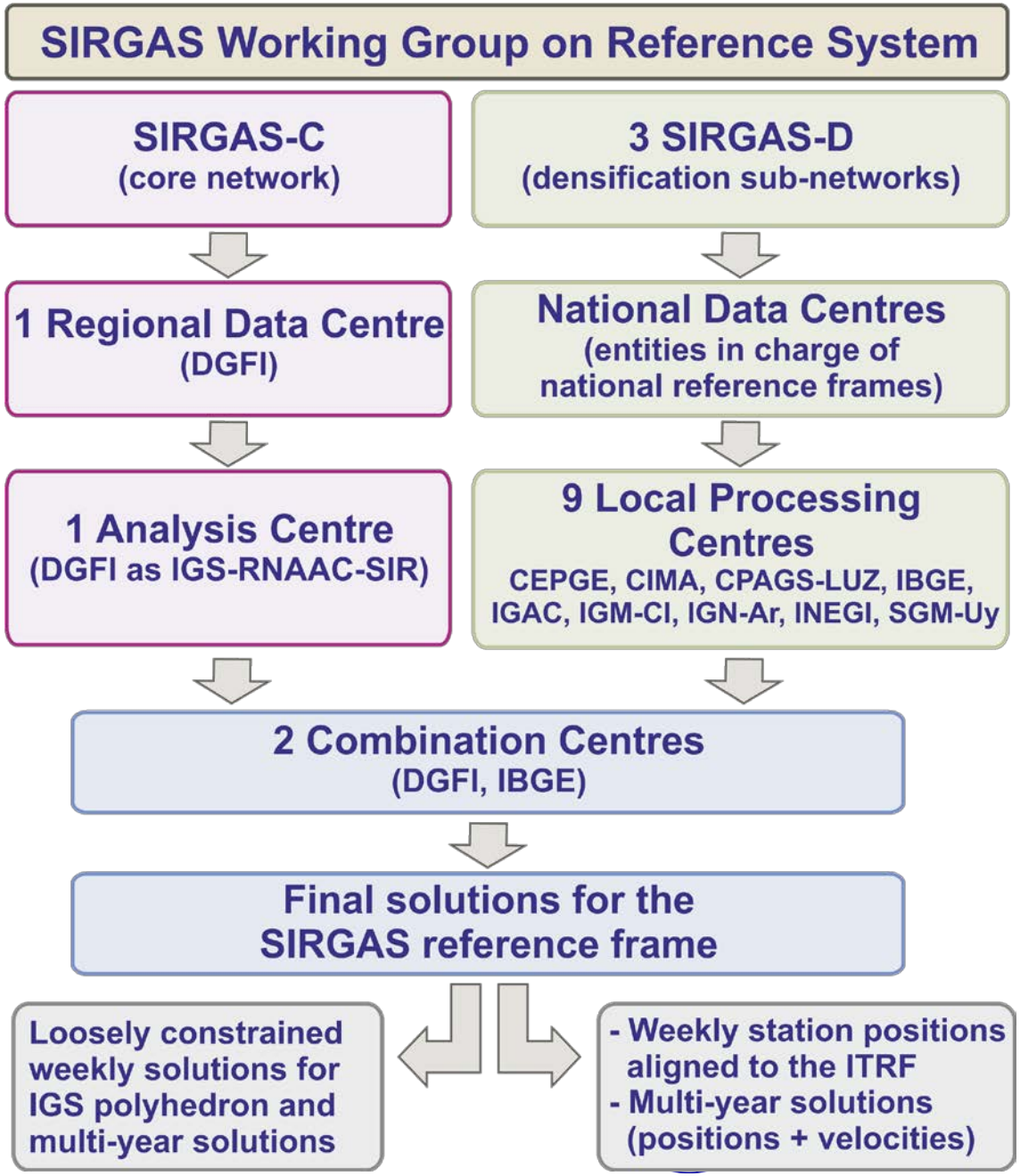
Redundancy in the analysis of the reference frame

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.



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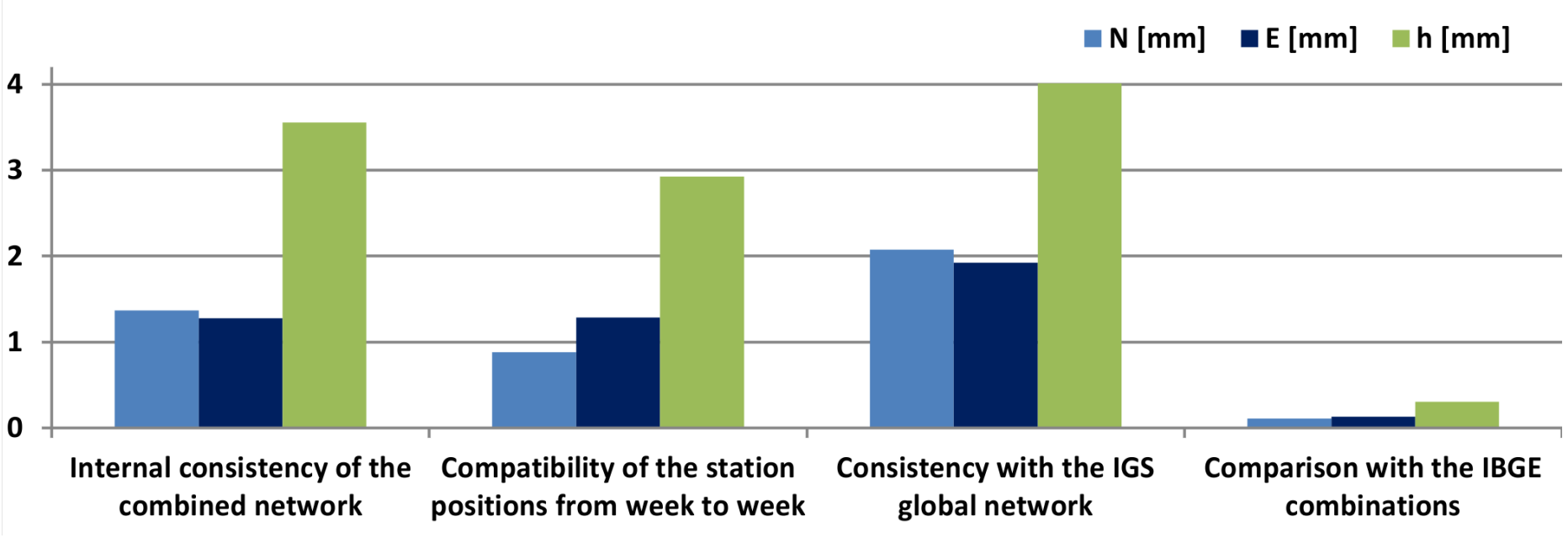
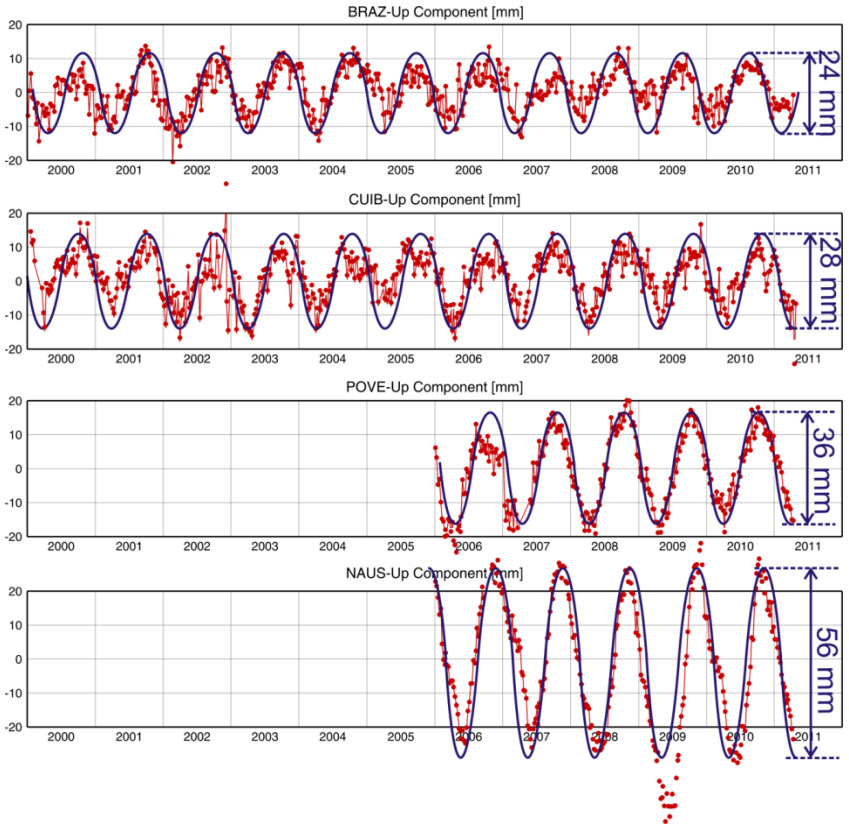
Quality of the weekly SIRGAS station positions

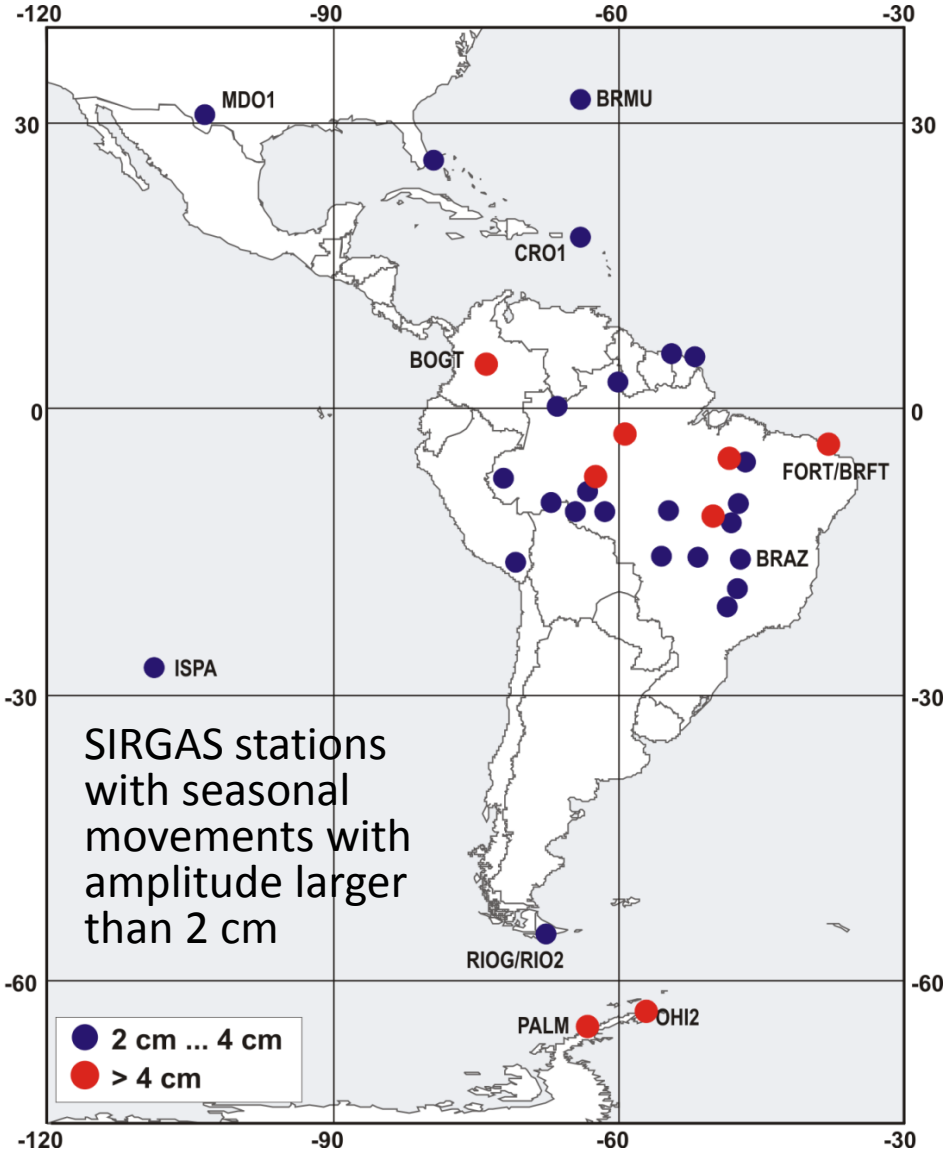


- Precision (internal consistency) of the weekly combinations: ±1,4 mm in N-E and ±3,6 mm in the vertical coordinate;
- Reliability of the final coordinates (external accuracy): ±2,0 mm in N-E and ±4,0 mm in the vertical coordinate.

Present challenges: modelling station seasonal movements

Most of the SIRGAS stations present significant seasonal position variations (mainly in the vertical component). These variations are ignored (as in any reference frame) when constant velocities (linear position changes) are computed.





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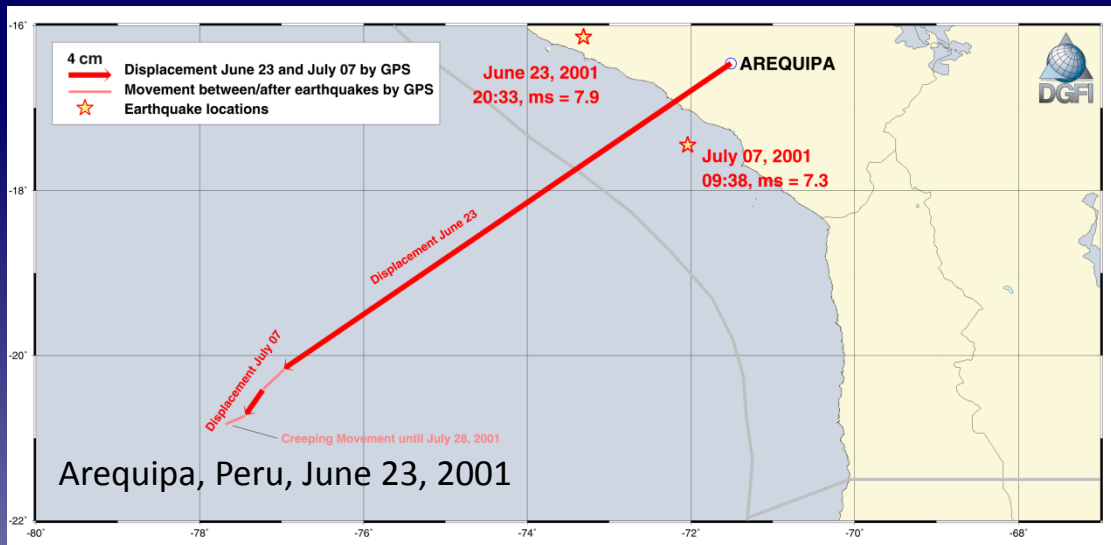
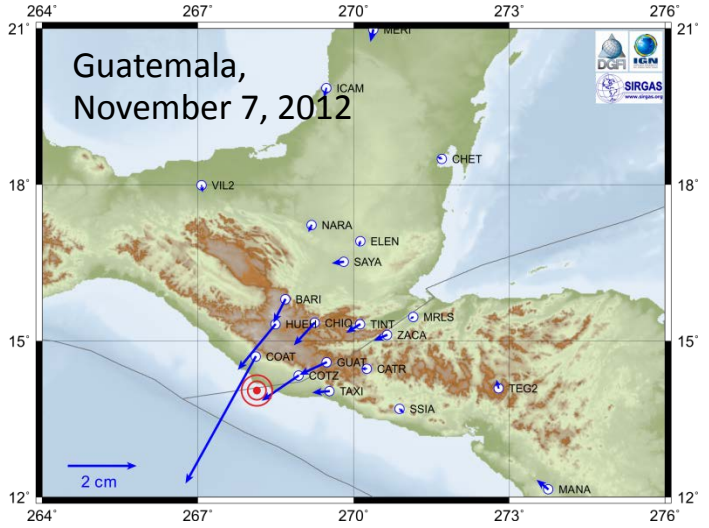
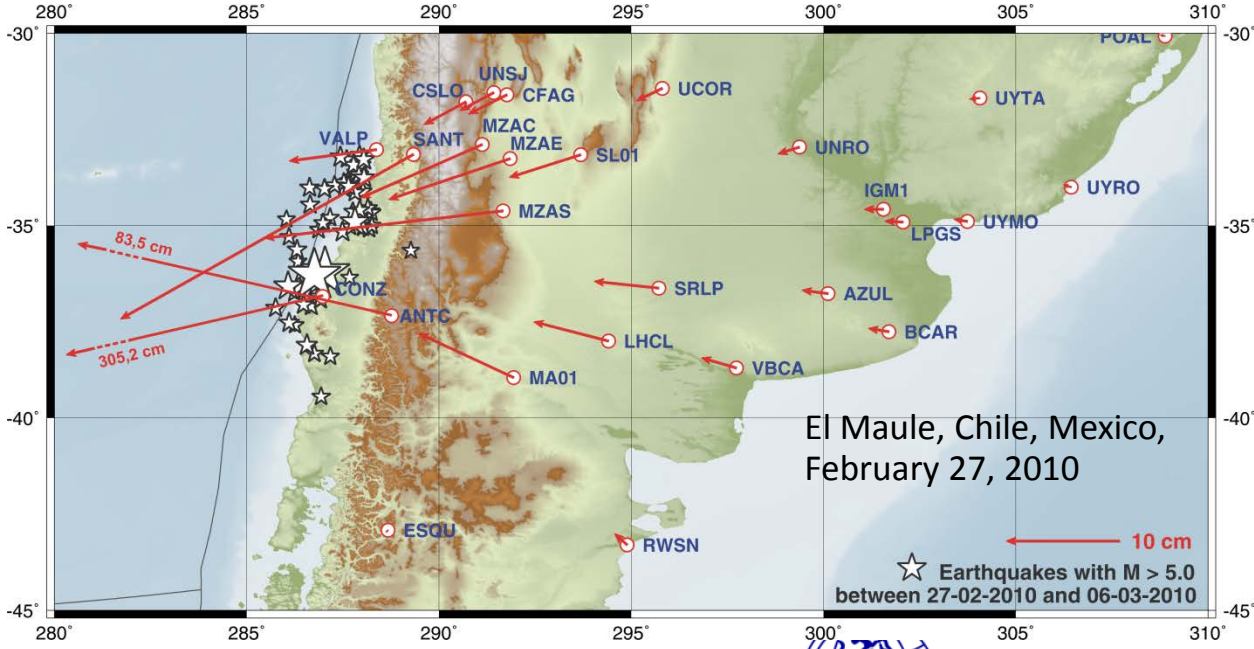
Present challenges: modelling reference frame deformations due to seismic events



Arequipa, Peru, June 23, 2001



Baja California, Mexico,
April 4, 2010



El Maule, Chile, Mexico,
February 27, 2010

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Present challenges: modelling reference frame deformations due to seismic events

- Strong earthquakes produce not only discontinuities in the station position time series, but also in the “usual” lineal movement of the stations;
- The caused deformations are not homogeneous along the reference frame and, therefore, the transformation between the pre-seismic and the post-seismic coordinates can not be carried out with the usual network transformations (like similarity or affine);
- Seismic deformations in the SIRGAS region make the existing ITRF solutions unusable and ITRF updates (re-computations) take too long;
- Geospatial information referring to the pre-seismic coordinates has to be transformed (recovered) to the post-seismic reference frame to continue being valid (specially in official maters like legal borders, cadastre, land management, etc.).

On-going activities regarding the continental reference frame

1) Second reprocessing of the entire SIRGAS reference frame:
   - New computation of daily normal equations between January 1, 1997 until December 31, 2012
   - Including the new geodetic standards outlined by the IERS (International Earth Rotation and Reference Systems Service) and the IGS (International GNSS Service);
   - Inclusion of GLONASS measurements;
2) Modelling of seasonal movements at the combination level of the weekly solutions;
3) Computation of deformation models derived from discrete (weekly) station positions to incorporate seismic discontinuities in the computation of the reference frame.

Acknowledgments

The results described in this presentation are a consequence of a **successful international geodetic cooperation** possible thanks to the active participation of more than **50 Latin American and Caribbean colleagues and 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**.

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More details about SIRGAS in **www.sirgas.org**.