



United Nations/Argentina Workshop on the Applications of Global Navigation Satellite Systems

Supporting GNSS applications in Latin America through the SIRGAS reference frame

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1. Why SIRGAS in Latin America?

- Incompatibilities between classical reference systems together an extensive use of GPS in Latin America were evidents in the 90s.
- Establishing a well-definined reference system in terms of satellite techniques foundations and applications became a requirement (also a challenge) for the regional geo-community.
- In 1993, the first effort to adopt a geocentric reference system brought a new kind of integration and collaboration in Latin America thanks to the SIRGAS Project.
- United Nations (UN) recognized this successful project and recomended to all contries in the region to adopt SIRGAS as reference system.
- Nowadays, SIRGAS is the core geodetic infrastructure for 20 countries and it is based on GNSS.

SIRGAS

(Geocentric Reference System for the Americas)



It is the Sub-commission 1.3 (Regional Reference Frames) of International Association of Geodesy (IAG)



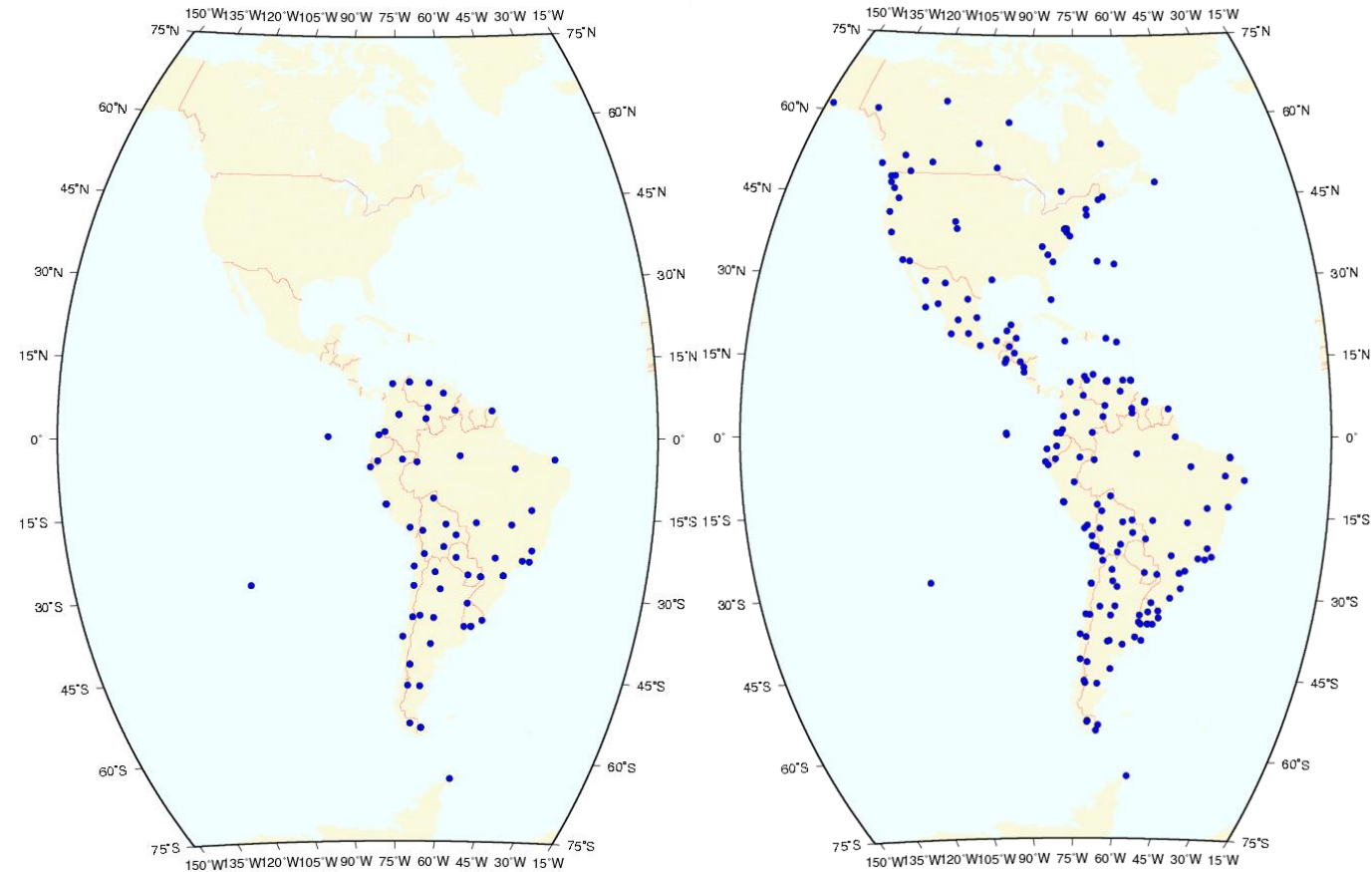
It is a Working Group of the Cartographic Commission of the Pan-American Institute for Geography and History (PAIGH)



It provides the fundamental geospatial infrastructure for the activities of the Regional Committee of the United Nations on Global Geospatial Information Management for the Americas (UN-GGIM: Americas)

2. The SIRGAS reference frame

- The SIRGAS reference system is identical to ITRS (International Terrestrial Reference System) by definition being geocentric and consistent at global scale.
- To get access to ITRS its realization is available, i.e. ITRF (International Terrestrial Reference Frame). In this sense, its regional densification for Latin America is provided by SIRGAS.
- At national and local levels, subsequent densifications of the regional frame guarantee GNSS applications referred to SIRGAS.
- SIRGAS counts with three realizations, in all cases given by high-precision geodetic networks.



1st SIRGAS realization

SIRGAS95

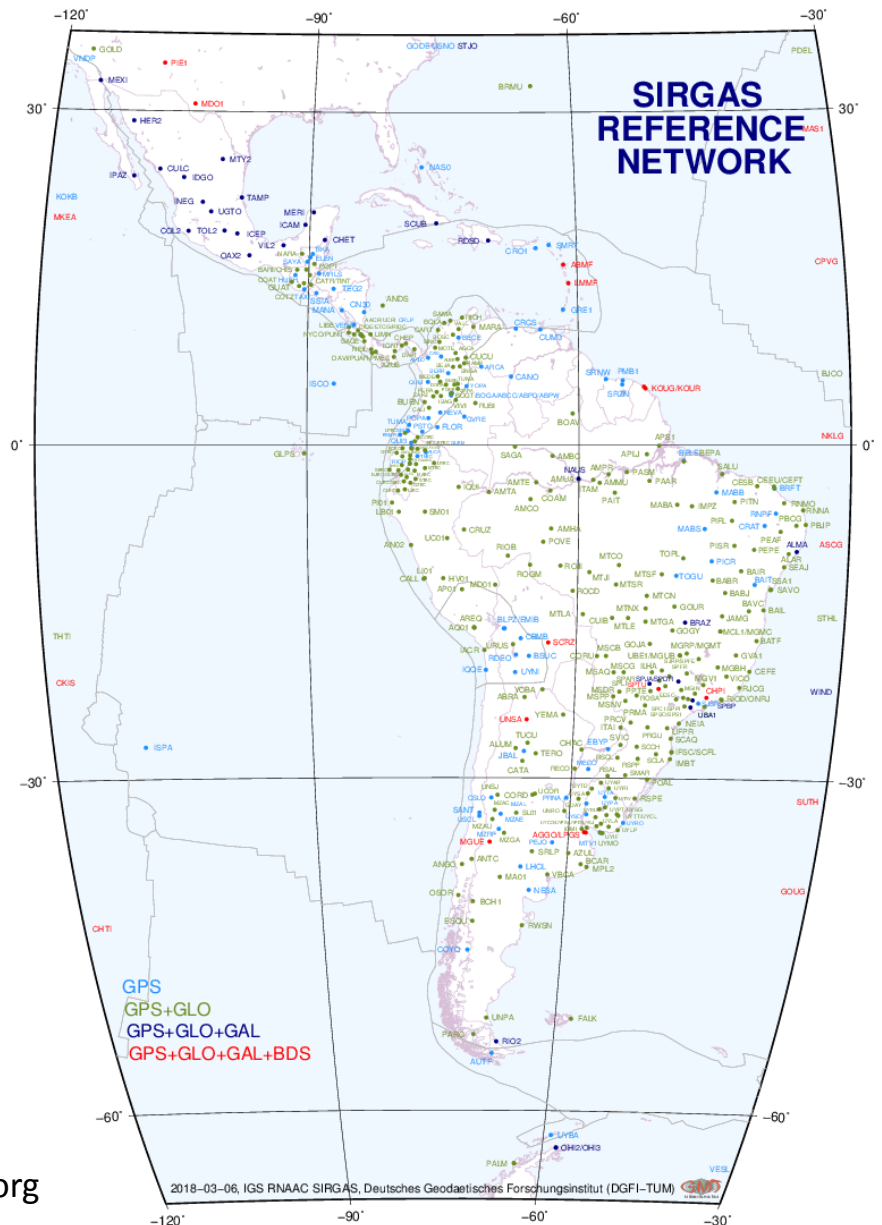
(GPS passive network with 58 stations)

2nd SIRGAS realization

SIRGAS2000

(GPS passive network with 184 stations)

- A continuously GNSS network is the third (and current) SIRGAS realization:
 - It is called SIRGAS-CON (SIRGAS Continuously Operating Network).
 - It extends homogeneously from Mexico to Argentina and includes IGS stations and national networks.
 - It comprises 420 stations tracking GPS, GLONASS, Galileo, BeiDuo.
 - It is processed on a weekly basis by SIRGAS Analysis Centres providing an up-to-date reference frame.
- SIRGAS Working Group I (SIRGAS-WGI, Reference System) is responsible for maintenance of the reference frame through weekly processing of SIRGAS-CON.



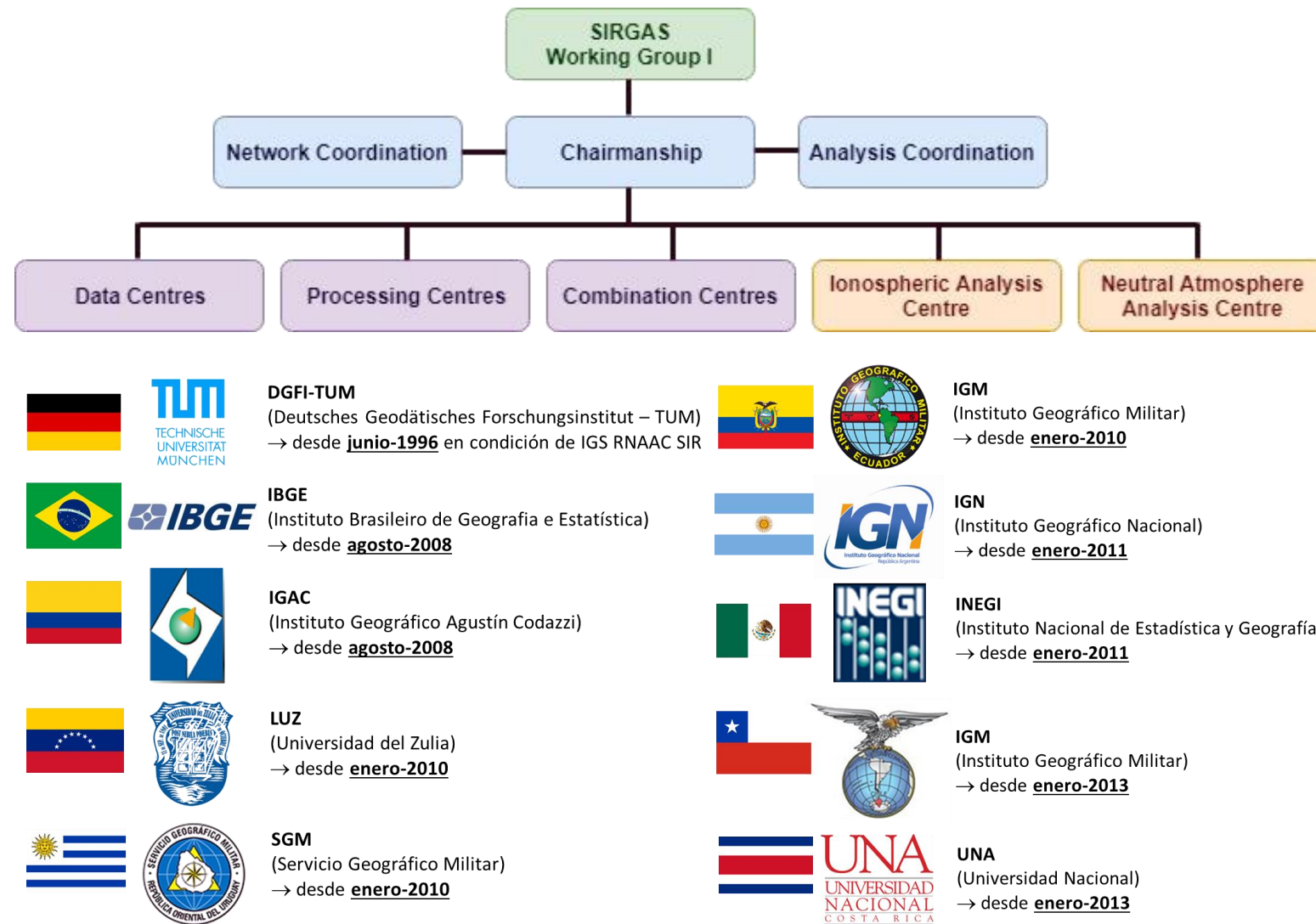
- About SIRGAS Analysis Centres:

- DGFI-TUM* (Germany) is the International GNSS Service Regional Network Associate Analysis Centre for SIRGAS (IGS RNAAC SIRGAS) since 1996.

- Nine Local Analysis Centres operate in Latin America countries being responsible for national densifications.

- The network processing is performed in a rigorous way applying current standards and conventions from IERS* and IGS. Only GPS+GLONASS observations are treated.

- Two Combination Centres combine (adjust) individual solutions defining the frame every week.

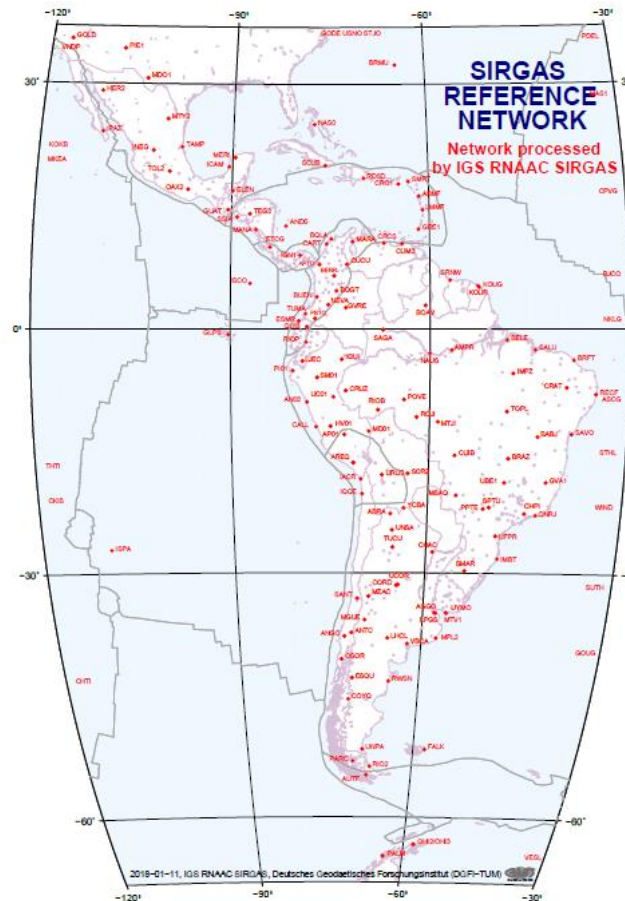


*Deutsches Geodätisches Forschungsinstitut der Technischen Universität München, <http://www.dgfi.tum.de>

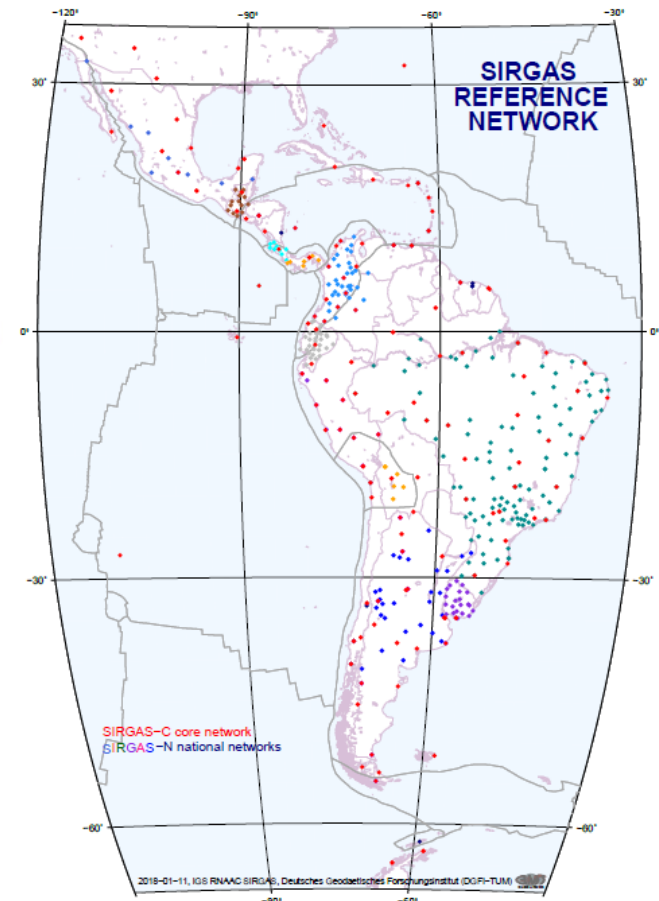
*International Earth Rotation and Reference Systems Service, <http://www.iers.org>

- Each station is processed by three Analysis Centres according to SIRGAS-WGI distribution plan.
- Only IGS RNAAC SIRGAS process the so-called SIRGAS-CON C network.
- Local Analysis Centers generates loosely-constrained solutions for SIRGAS-CON N networks.
- The combination of every solution is the contribution for IGS global polyhedron.
- After alligning the individual solutions to the reference frame, station positions are estimated for every week with

accuracy → $\pm 1\text{mm}$ for horizontal positions
 $\pm 3\text{mm}$ for vertical positions

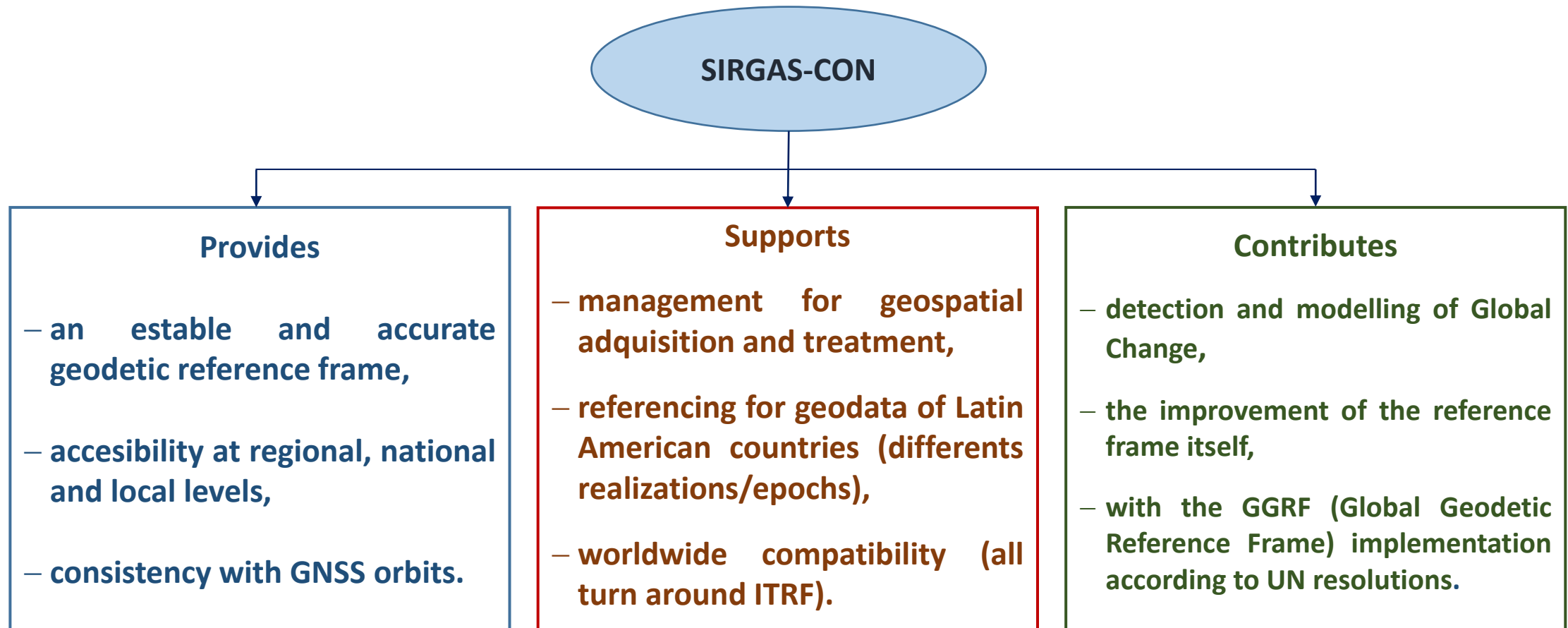


SIRGAS-CON C
(Core network)



SIRGAS-CON N
(National networks)

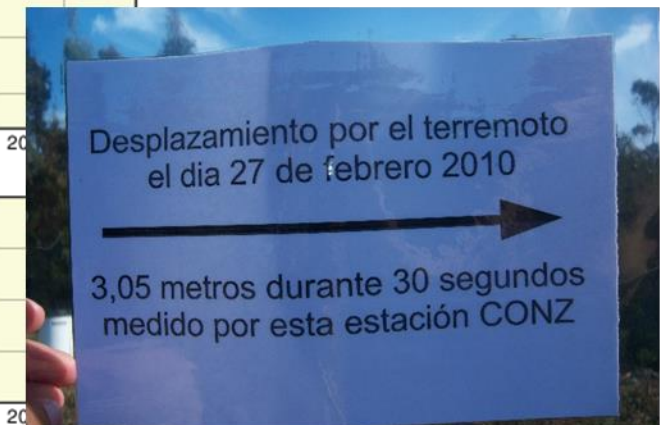
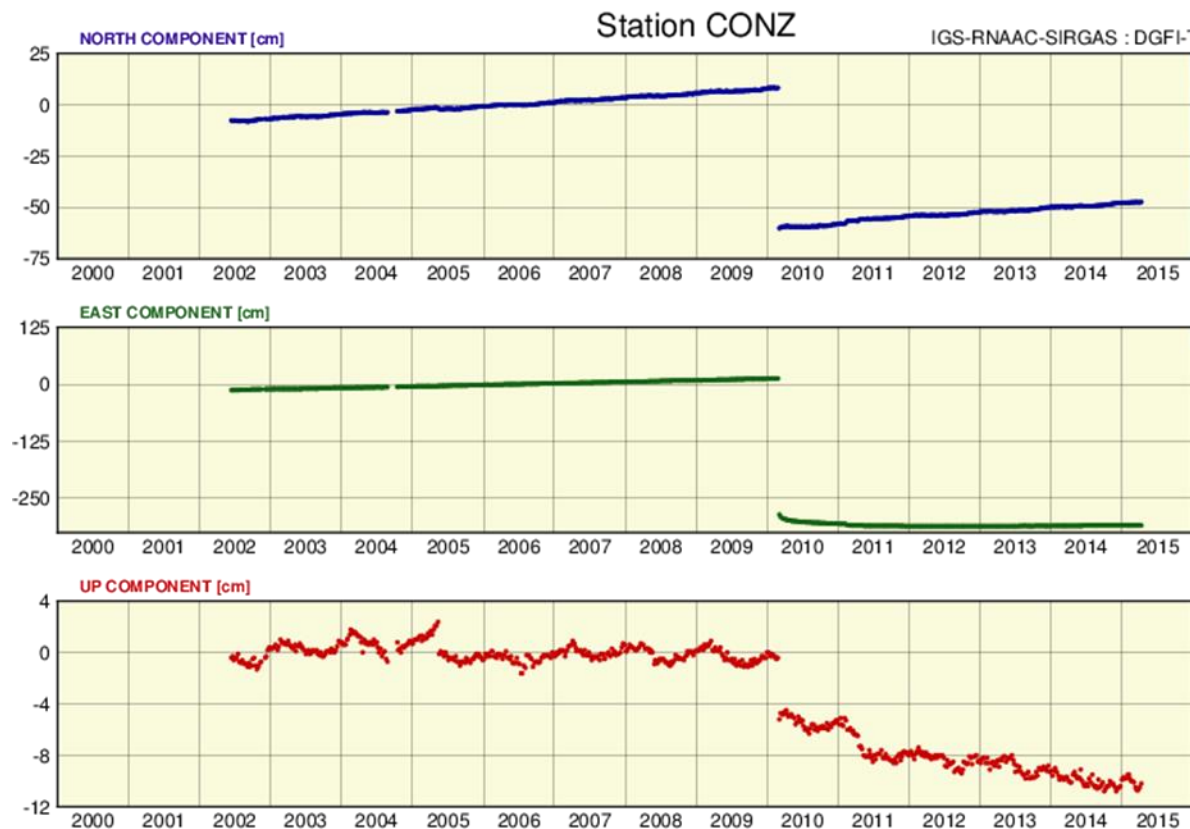
3. Benefits of SIRGAS-CON



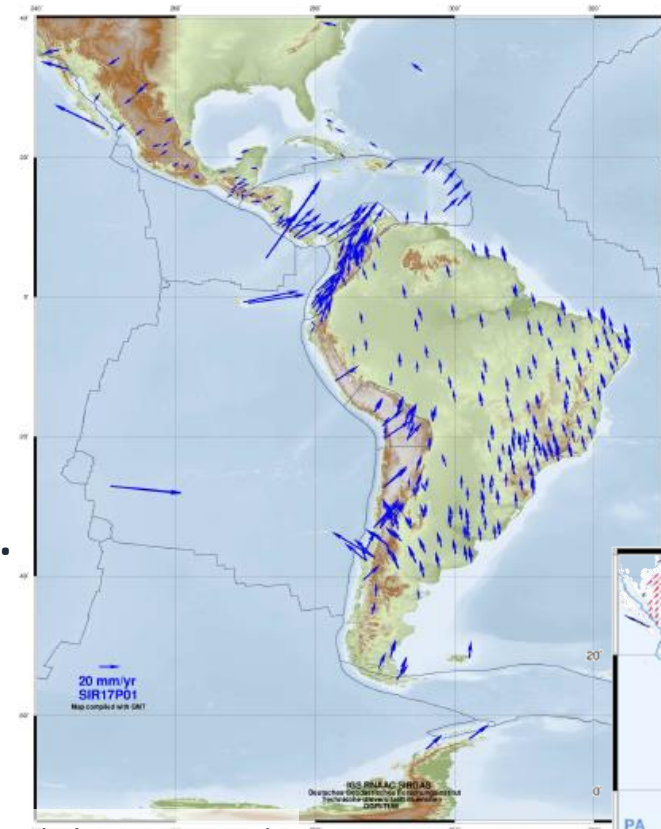
Coordinates estimated (loosely-constrained and aligned to ITRF) within the processing of SIRGAS-CON are key products at weekly and muti-annual basis

- Weekly determination is strongly necessary in the region:

- Secular, seasonal, and sporadic events degrade frame accuracy.
- GNSS is sensitive to this events.
- Response and evolution of the frame must be considered.



- SIRGAS-CON multi-annual determination come from weekly solutions:
 - It realizes the long-term SIRGAS reference frame.
 - Its kinematic can be monitored.
 - Velocities are provided to extrapolate coordinates in time.
 - Deformations due to seismic and seasonal effects on reference frame are under study.



(Sánchez, 2017)

Latest multi-annual solution:

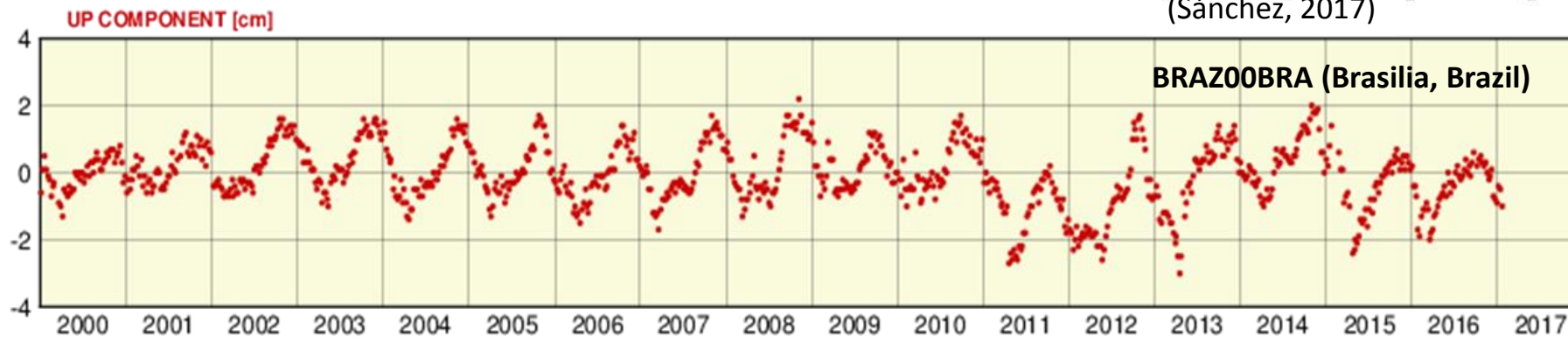
SIR17P01

Latest velocity model:

VEMOS2017



(Drewes y Sánchez, 2017)



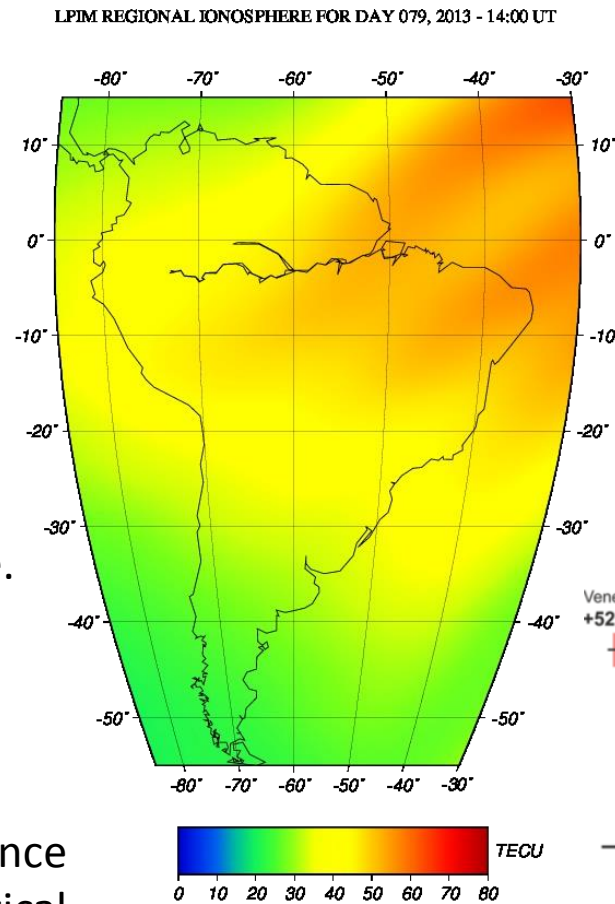
4. Applications of SIRGAS as reference frame

→ Remark: every country in the SIRGAS region realices the reference frame (by GPS/GNSS) at certain epoch.

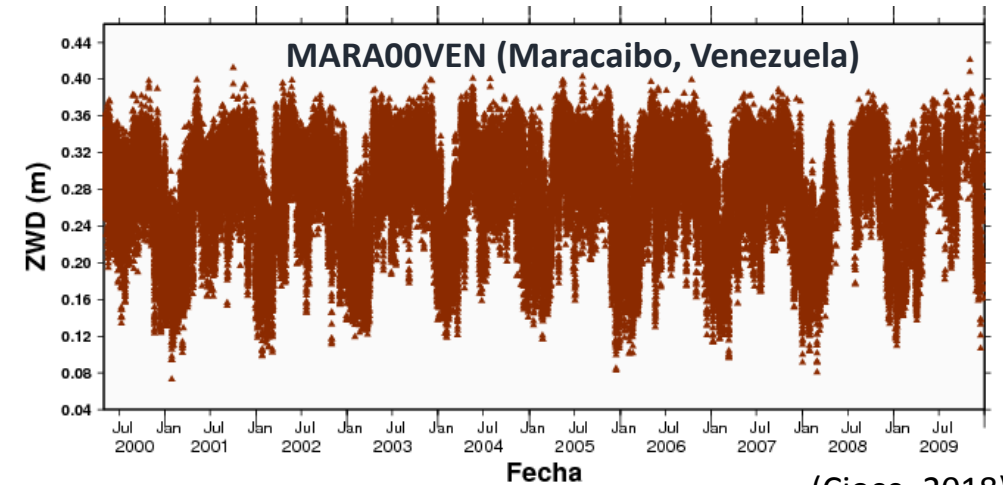
In practice, how the SIRGAS reference frame is implemented?

- Scientific applications:

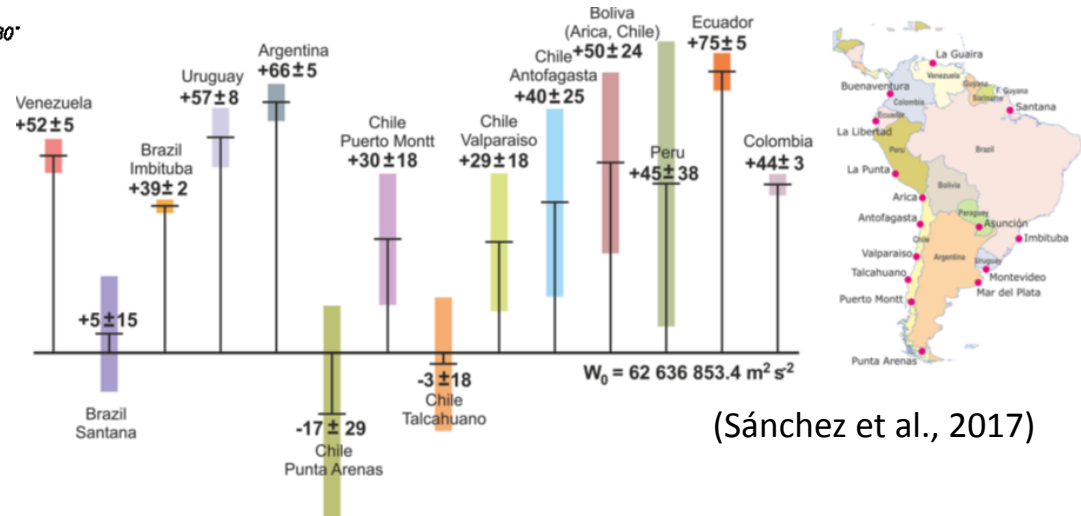
- Maintenance of the reference frame.
- Ionospheric studies.
- Neutral atmosphere studies.
- Redefinition of the vertical reference frame, it is **SIRGAS-WGIII** (Vertical Datum) responsibility.



<http://cplat.fcaglp.unlp.edu.ar>

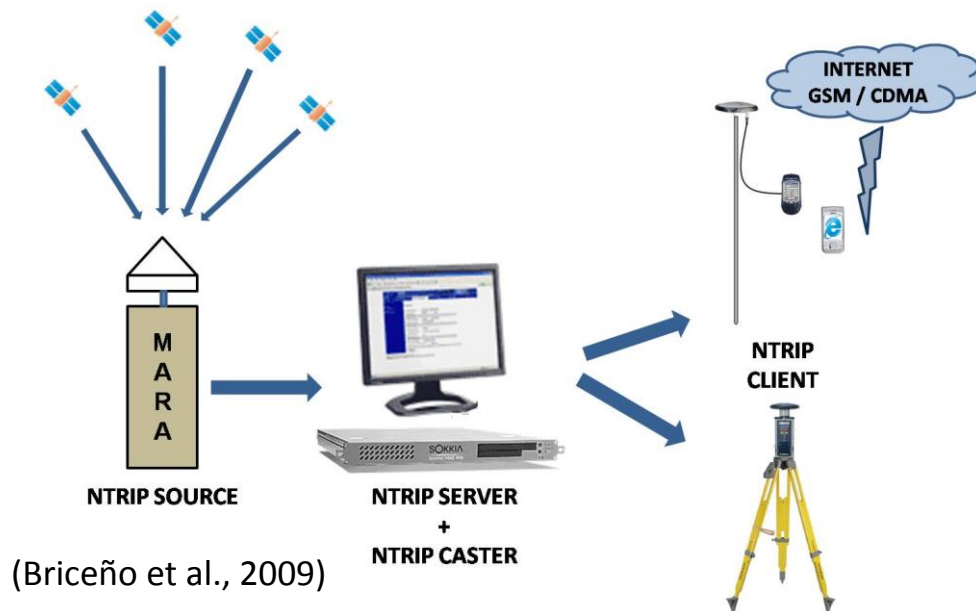


(Cioce, 2018)



(Sánchez et al., 2017)

- Practical applications:
 - Positioning for surveying, geomatics, engineering, navigation and more...
 - Developments in Real Time GNSS (network solution mode).
 - **SIRGAS-WGII** (National Level) is in charge.



REGNA-ROU
 Red Geodésica Nacional Activa de la República Oriental del Uruguay
www.sgm.gub.uy

5. Closing remarks

- SIRGAS is the infrastructure for supporting any scientific and technical application based on GNSS technique in Latin America.
- The SIRGAS Continuously Operating Network (SIRGAS-CON)
 - offers the highest (geodetic) precision in the region.
 - guarantees consistency for any geo-database (since its acquisition to final product generation).
 - establishes and recommend guidelines for geodesy developments in members countries.
- Beyond scientific/technical scopes, SIRGAS is also an example of successful international cooperation.
- Some challenge:
 - reinforcement of SIRGAS-CON.
 - incorporation of other GNSS (Galileo, BeiDou...) to SIRGAS-CON.
 - approaching of SIRGAS to other Space Geodesy techniques.



Sistema de Referencia Geocéntrico para las Américas (SIRGAS)

- Visit our web page:

www.sirgas.org

- Our next symposium will be in

Aguas Calientes, Mexico

(november-2018)

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SIRGAS: Geocentric Reference System for the Americas

SIRGAS is the Geocentric Reference System for the Americas. Its definition corresponds to the International Terrestrial Reference System (ITRS) [\[1\]](#) and it is realized by a regional densification of the International Terrestrial Reference Frame (ITRF) [\[2\]](#) in **Latin America**. Besides the geometrical reference system, SIRGAS includes the definition and realization of a **vertical reference system**, based on ellipsoidal heights as geometrical component and geopotential numbers (referred to a global conventional W_0 value) as physical component.

SIRGAS was created in 1993 during the International Conference for the Definition of a South American Geocentric Reference System held in Asuncion, Paraguay. This conference was promoted and supported by the International Association of Geodesy (IAG) [\[3\]](#), the Pan-American Institute for Geography and History (PAIGH) [\[4\]](#), and the US National Imagery and Mapping Agency (NIMA), today National Geospatial-Intelligence Agency (NGA). The original acronym of SIRGAS (Geocentric Reference System for South America) was changed in 2001 to Geocentric Reference System for the Americas, since the SIRGAS2000 GPS campaign was extended to North- and Central America, and the United Nations Organization, through its 7th Cartographic Conference for The Americas (New York, January 22 – 27, 2001), recommend to adopt SIRGAS as official reference system in all American countries.



Thank you very much!

(specially to the Workshop organizers)

questions?

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