



Instituto Geográfico Nacional
REPÚBLICA ARGENTINA



Ministerio de Defensa
Presidencia de la Nación

International Workshop for the
**Implementation of the Global Geodetic Reference Frame
(GGRF) in Latin America**
Buenos Aires, Argentina, Sep 16-20, 2019

Geodetic activities in Argentina

Sergio Cimbaro
President of National Geographic Institute

INFORMATION ABOUT ARGENTINA



INFORMATION ABOUT ARGENTINA (cont.)



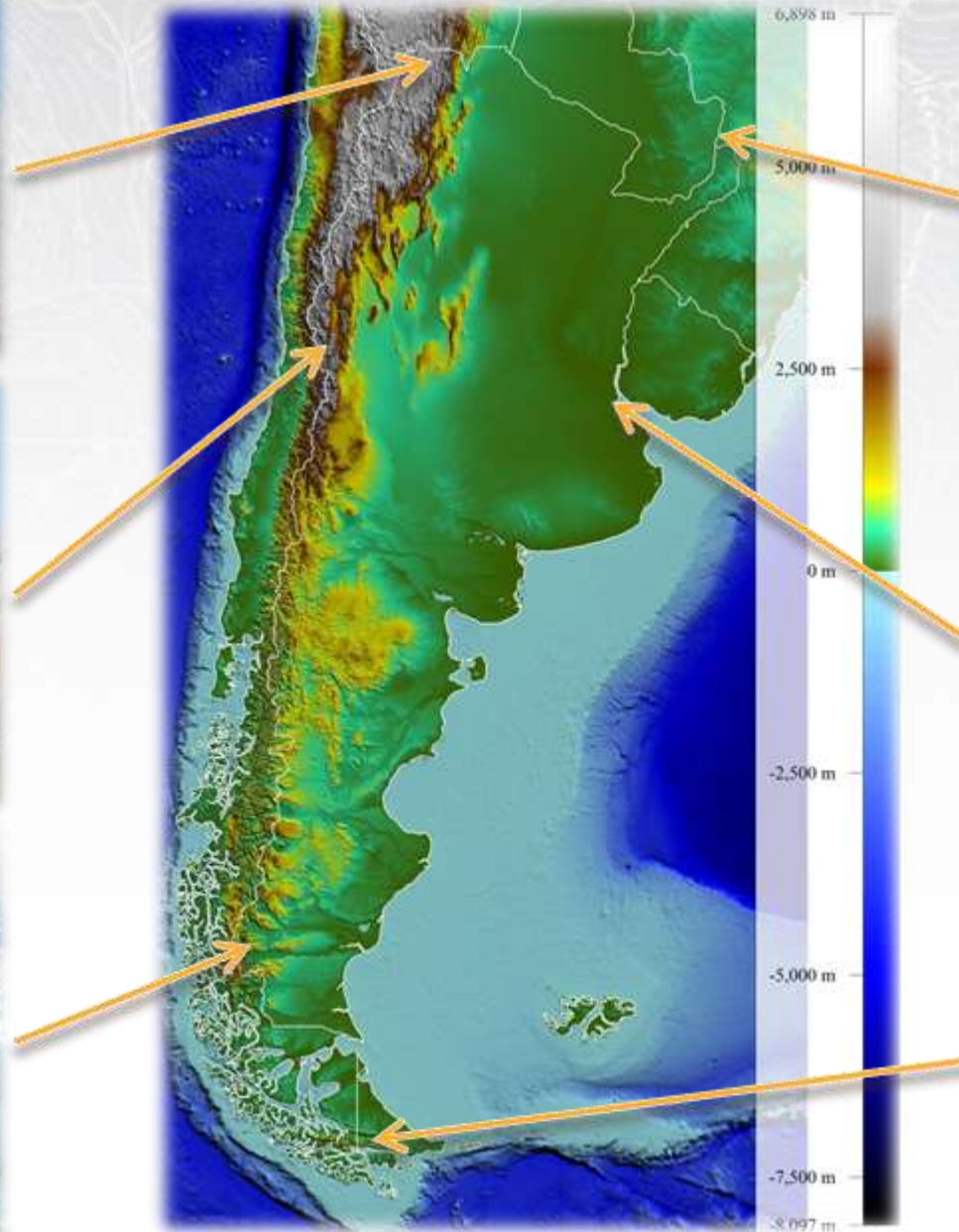
Puna



Aconcagua (6960.8 m)



Perito Moreno Glacier



Iguazú Falls



Buenos Aires



Ushuaia

- ▶ 2,780,400 km² → **eighth-largest** country in the world
- ▶ **second-largest** country in Latin America
- ▶ **largest** Spanish-speaking country in the world
- ▶ **40,177,096 people** (INDEC, 2011)
- ▶ Our geodetic community is not very big, but very active.
- ▶ We have 15 academic units that teach geodesy and geophysics

INFORMATION ABOUT ARGENTINA (cont.)



- ▶ 15 Surveying Engineering (orange dots)
- ▶ 5 Geophysics (blue dots)

- ▶ Argentina is a member of the IUGG since 1927.
- ▶ It has a National Committee of the IUGG with representation of all associations, which is chaired by the NGI.
- ▶ Within that framework there is a Subcommittee on Geodesy where a large number of scientists participate.
- ▶ There is also a non-governmental organization called the Argentine Association of Geophysicists and Geodesists (AAGG)

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- ▶ Was created on September 19, 1959, and this Thursday turns 60 since its creation.
- ▶ **It has among its objectives:**
 - ▶ Contribute to progress in the country, research, knowledge and development in all disciplines related to Geophysics, Geodesy and related sciences, through the resources at your fingertips.
 - ▶ Promote reciprocal knowledge and the relationship between its members,
 - ▶ Maintain relationships with similar national and international scientific associations.
- ▶ It has a scientific journal "**GEOACTA**", which is published in the online version ISSN 1852-7744, which includes original and unpublished scientific articles on topics related to Earth, Water and Atmospheric Sciences.
- ▶ Since its creation it has led to the organization of **28 Scientific Meetings**, and the next one will be from **September 14 to 18, 2020, in the City of Rosario, Santa Fe.**

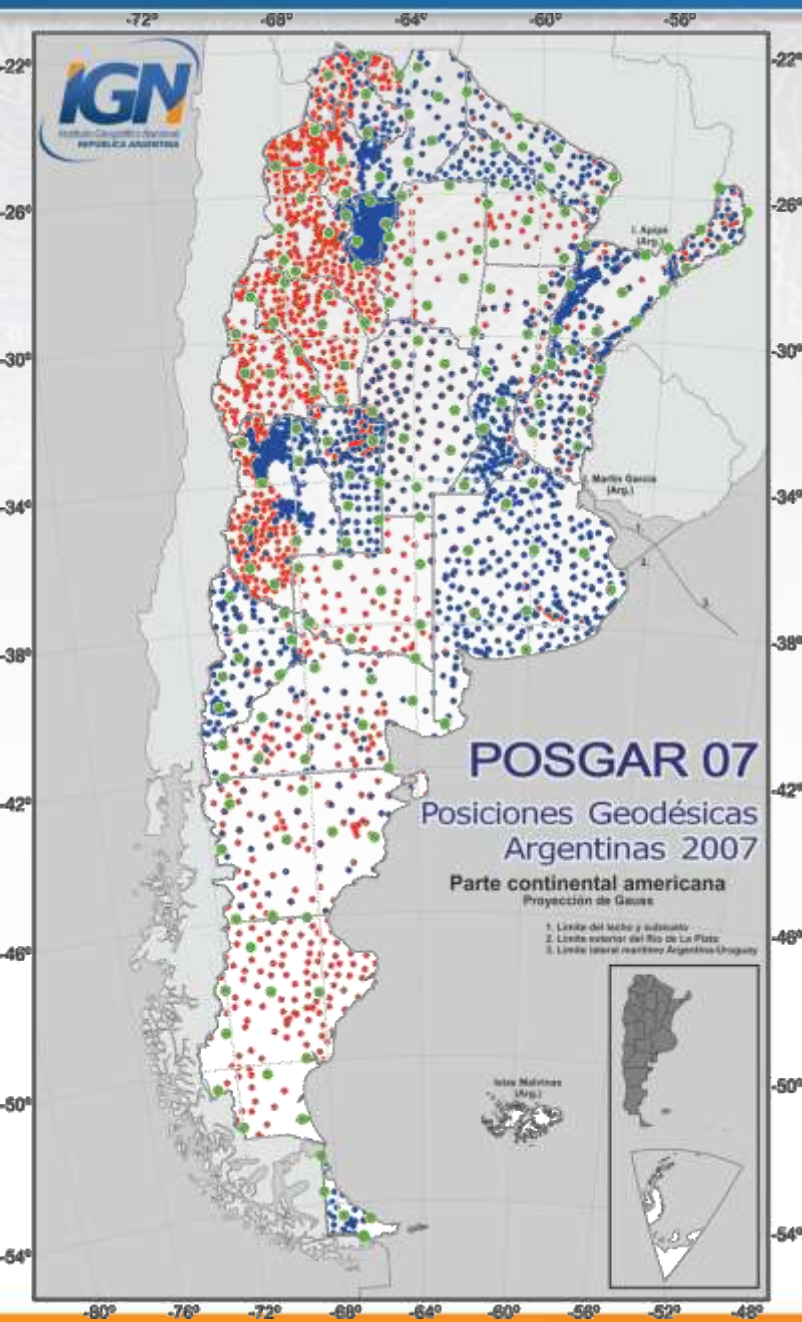
- ▶ It was created in **1879** for military purposes
- ▶ In **2009**, the NGI became a civilian Institution
- ▶ It is a decentralised organisation of the **Ministry of Defence of Argentina**
- ▶ **280 employees** work at the NGI
- ▶ **15 offices** in Argentinean provinces
- ▶ The **mission** of the NGI is to prepare the official cartography of the Nation by capturing precise and essential geospatial information for the integral development of the country.
- ▶ The **vision** of the NGI is to be the lead agency in the production and transfer of geospatial knowledge and information in Argentina

NATIONAL GEOGRAPHIC INSTITUTE



► Geodesy

- The NGI is responsible for the realization and updating of the geodetic reference frames in Argentina (i.e. geocentric, elevation and gravimetric)



POSGAR 07

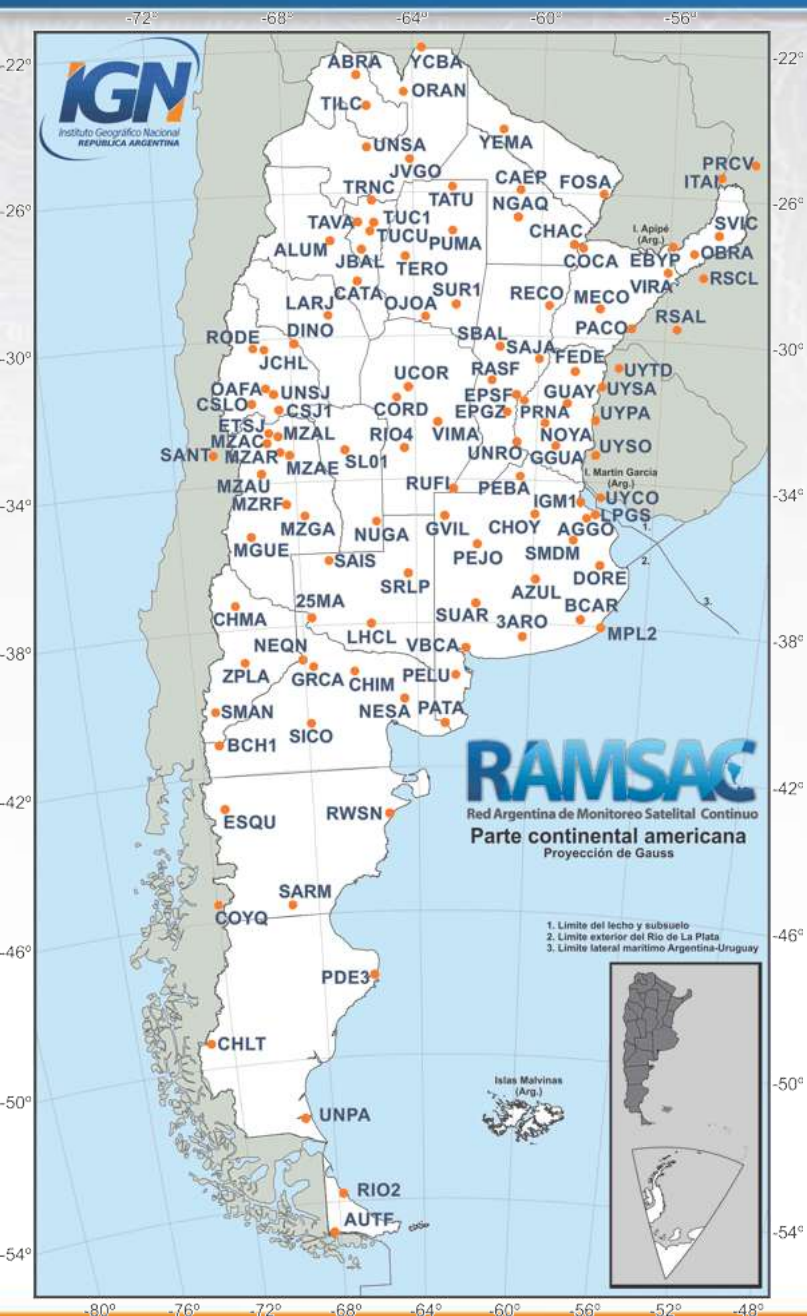
Posiciones Geodésicas Argentinas

► Geocentric Reference Frame (POSGAR 07)

- Established in May 15 **2009**
- **ITRF 05**, 2006.632 epoch
- **178 benchmarks with high precision**
- **> 6000 benchmarks as frame densification**



RESEARCH AREAS AND PROJECTS (Cont.)

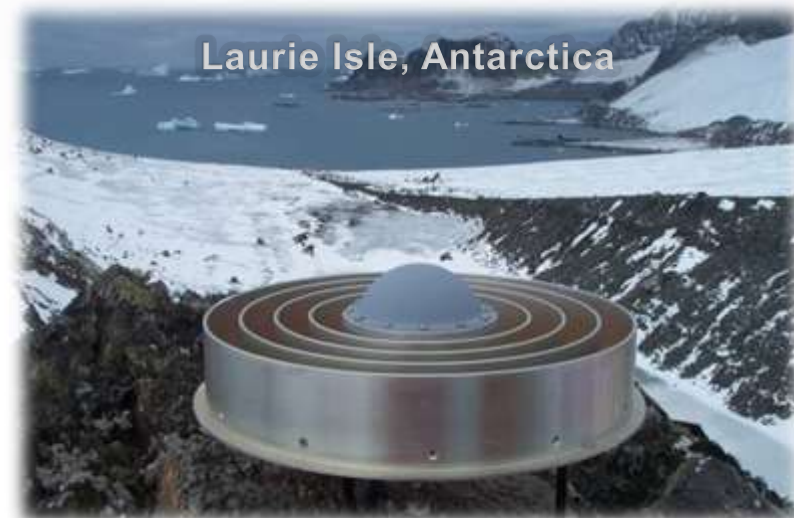


RAMSAC

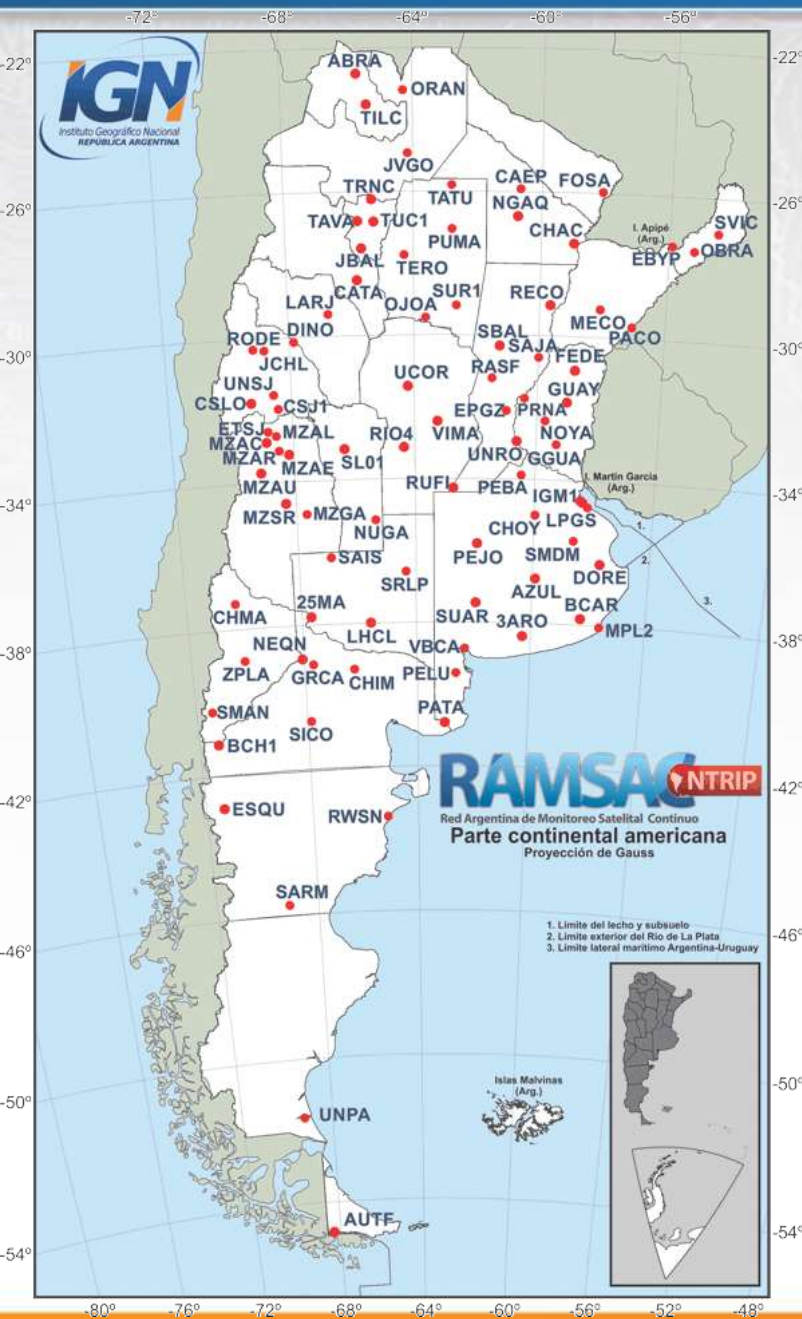
Red Argentina de Monitoreo Satelital Continuo

► CORS network (RAMSAC)

- Started in **1998**
- **120 CORS** (including 3 CORS in Antarctica)
- Free-service
- FTP server and Web interface



RESEARCH AREAS AND PROJECTS (Cont.)



RAMSAC NTRIP

Red Argentina de Monitoreo Satelital Continuo

► NTRIP service (RAMSAC-NTRIP)

- Started in **2010**
- **74 CORS**
- Free-service
- **BKG Professional Caster** in use

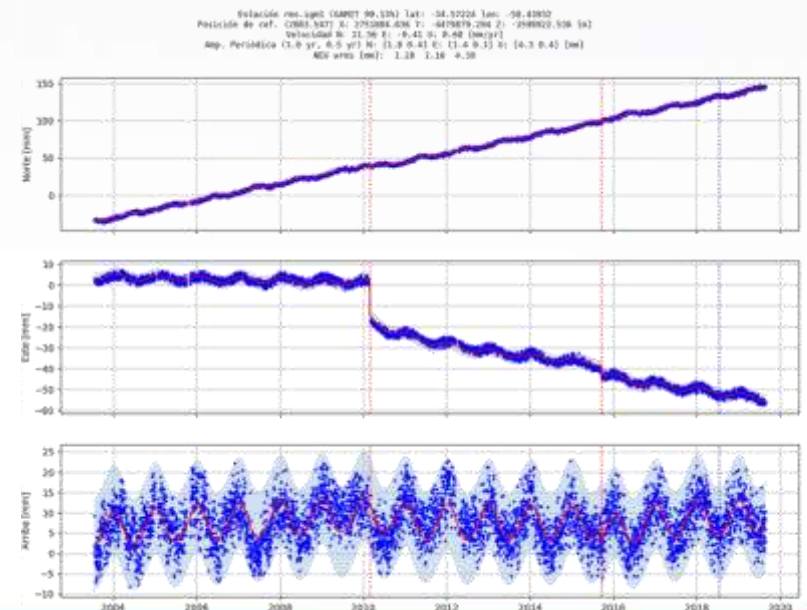




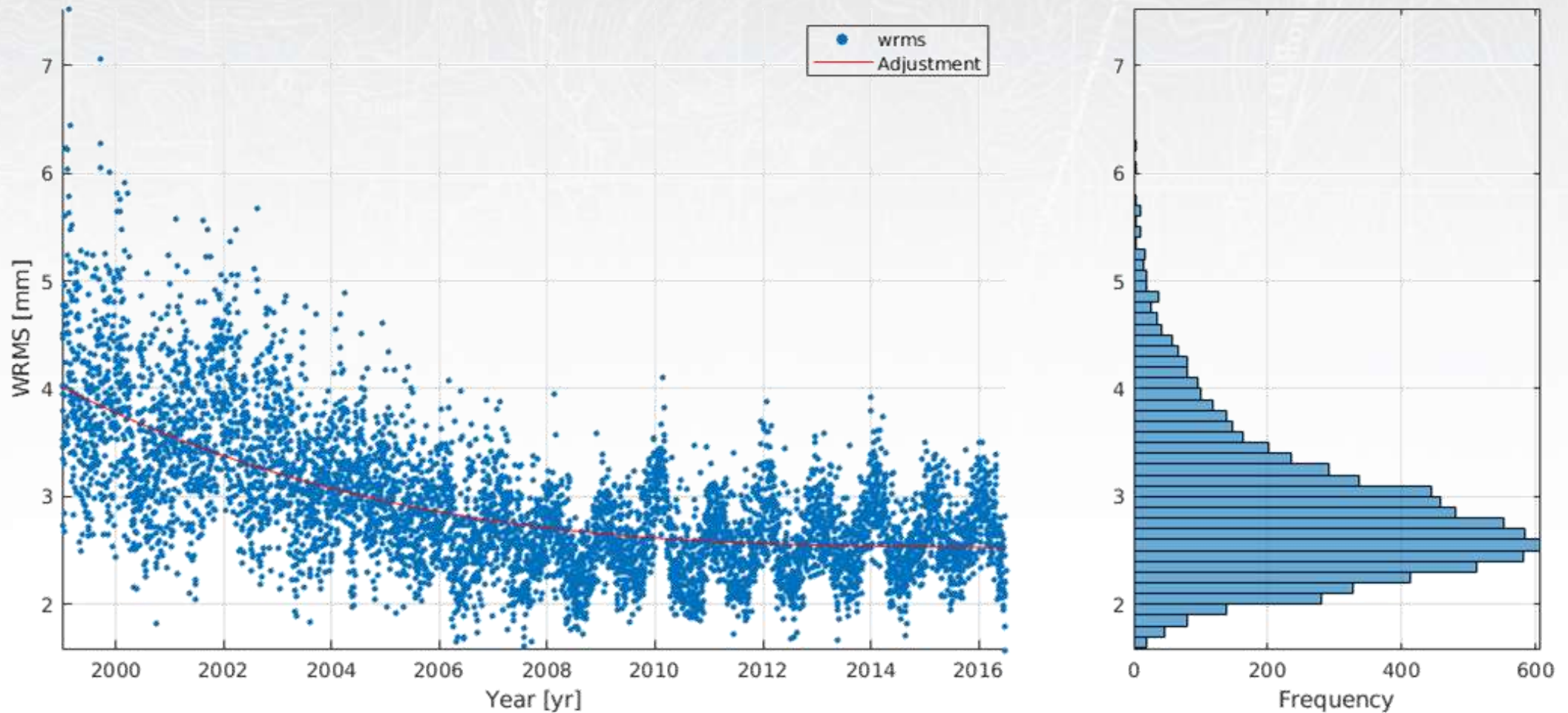
Centro de Procesamiento Científico de datos GPS de Argentina

► GPS processing data center (CPC-Ar)

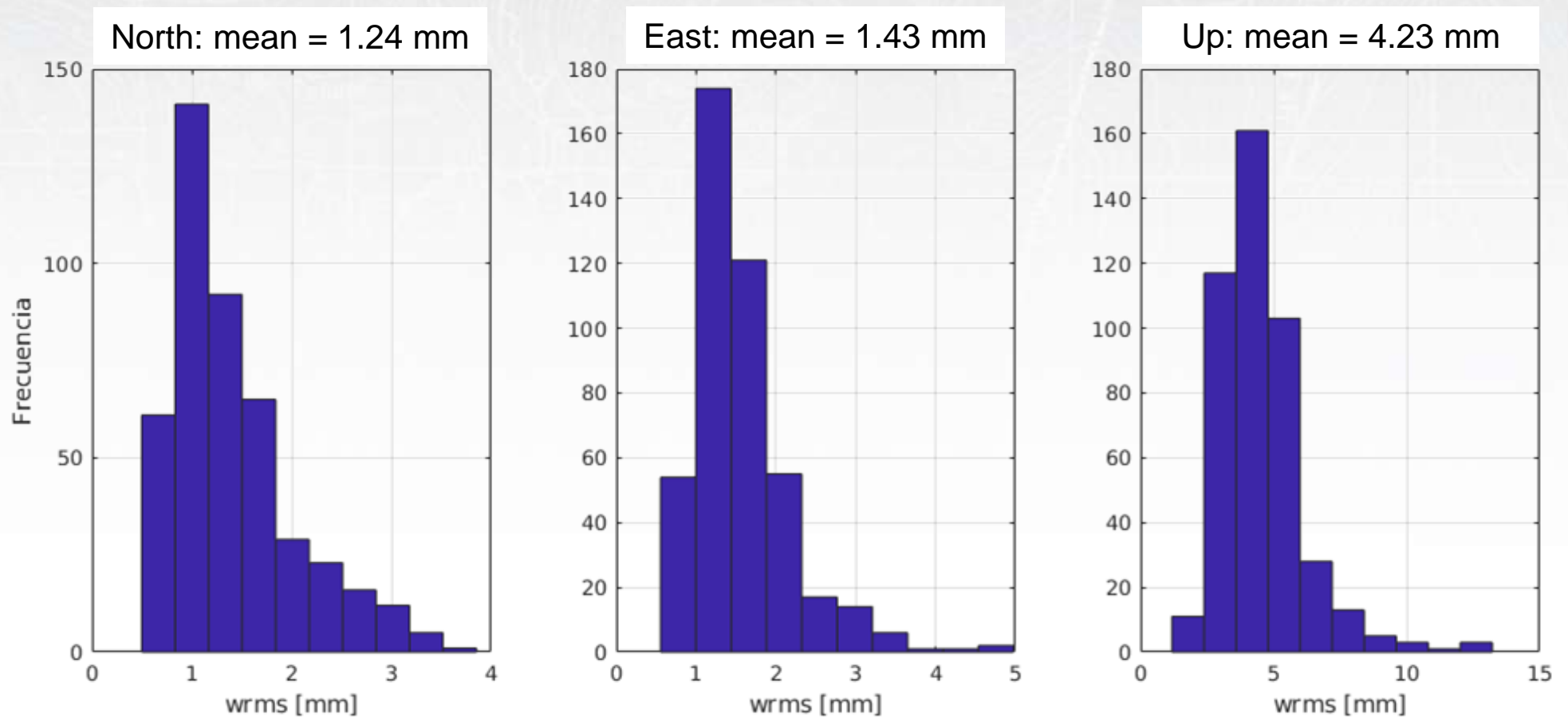
- Started in **2005**
- **GAMIT / GLOBK** software (MIT, USA)
- **2 weekly solutions:**
 - **constrained** (ITRF14) → >400 CORS → Arg. Ref. Frame
 - **loosely-constrained** (ITRF14) → 110 CORS → SIRGAS
- Time Series
- Trajectories



Total WRMS scatter of POSGAR07 (aligned to ITRF14) – daily solutions



NEU WRMS scatter of POSGAR07 (aligned to ITRF14) – daily solutions



► Cluster for GNSS processing

- Based on **Linux**
- **112 cores** (3 nodes)
- **256 GB of RAM** on each node
- **10 TB of storage** for RINEX and processing results
- **PostgreSQL database** to store results and metadata
- Current number of **RINEX files: ~1.4 million**
- **Ready to start processing VLBI** (coming soon)



RESEARCH AREAS AND PROJECTS (Cont.)



Red de Nivelación Argentina

► Spirit-levelling network (RN-Ar)

► Started in **1923**

First-order network

396 levelling lines

~18,000 benchmarks

~59,000 km levelled

Second-order network

329 levelling lines

~8,000 benchmarks

~32,000 km levelled

Third-order network

1298 levelling lines

~8,000 benchmarks

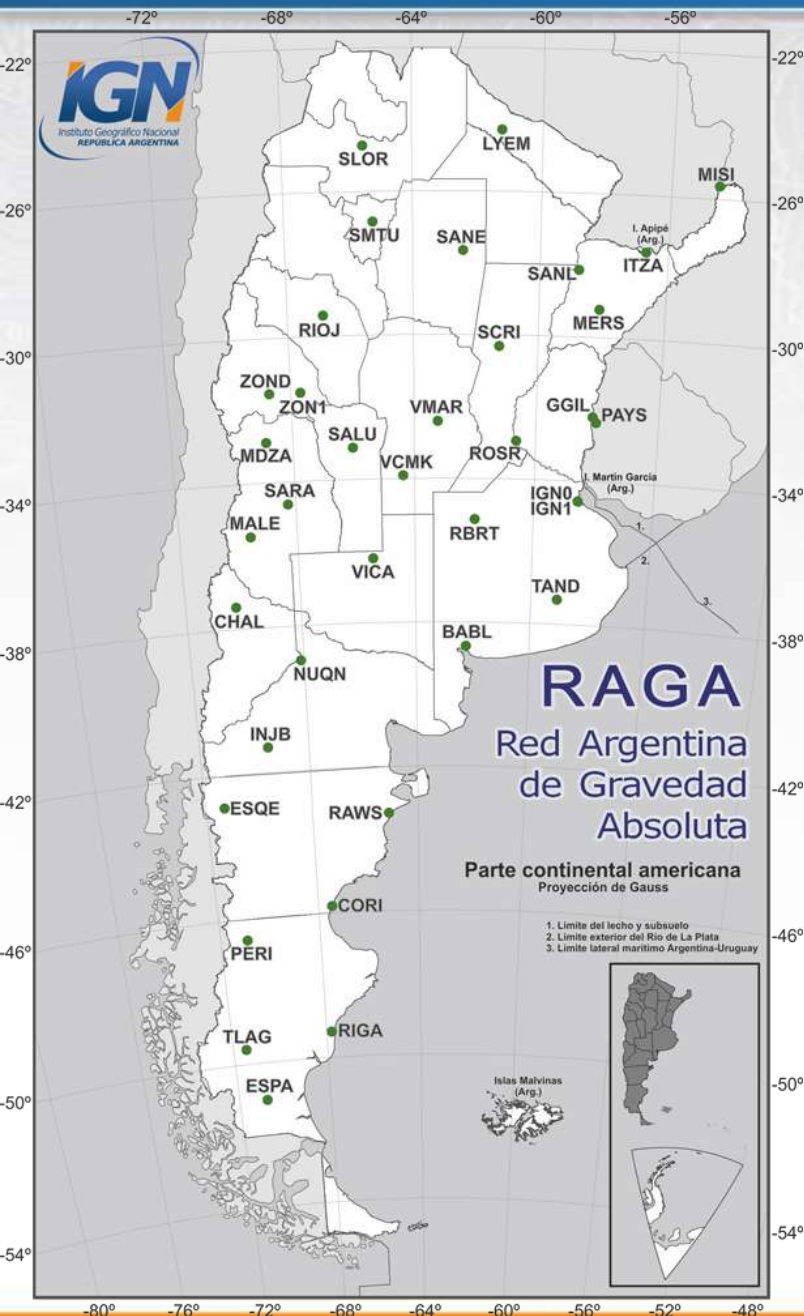
~52,000 km levelled

► In **2010**, a **new project** to **readjust the levelling network** and compute the **orthometric heights (Mader 1954)** of all the benchmarks started.

► In **2016**, the new Height System was officialised.

Cuesta de Lipán, Jujuy





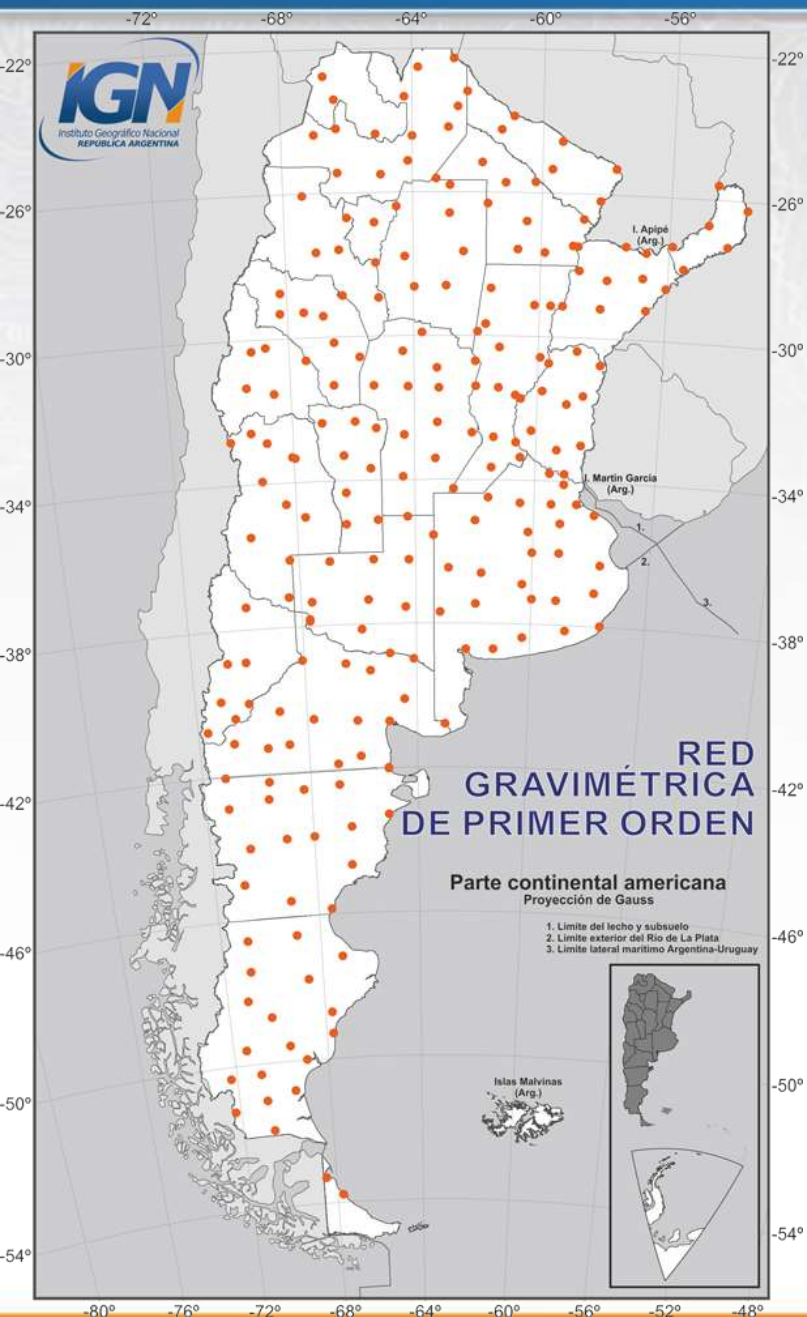
RG-Ar

Red Gravimétrica Argentina

► Argentina Network of Absolute Gravity (RAGA)

- 5 points measured in **1991** by the *Institut für Erdmessung* (Institute of Geodesy of Hannover University, Germany) → **JILAG-3 gravimeter**
- Remeasured in **2014** in collaboration with University of São Paulo (Brazil) and the *Institut de recherche pour le développement* (French Institute of Research for the Development) → **2 Micro-g LaCoste A-10 gravimeters**
- **43 sites**
- Accuracy < **0.02 mgal**





RG-Ar
Red Gravimétrica Argentina

► First-order gravity network

- Measured between **2012-2015**
- **5 relative gravimeter** used (i.e. 2 Scintrex CG-5 and 3 LaCoste & Romberg model G)
- **227 sites**
- Accuracy < **0.025 mgal**





RG-Ar

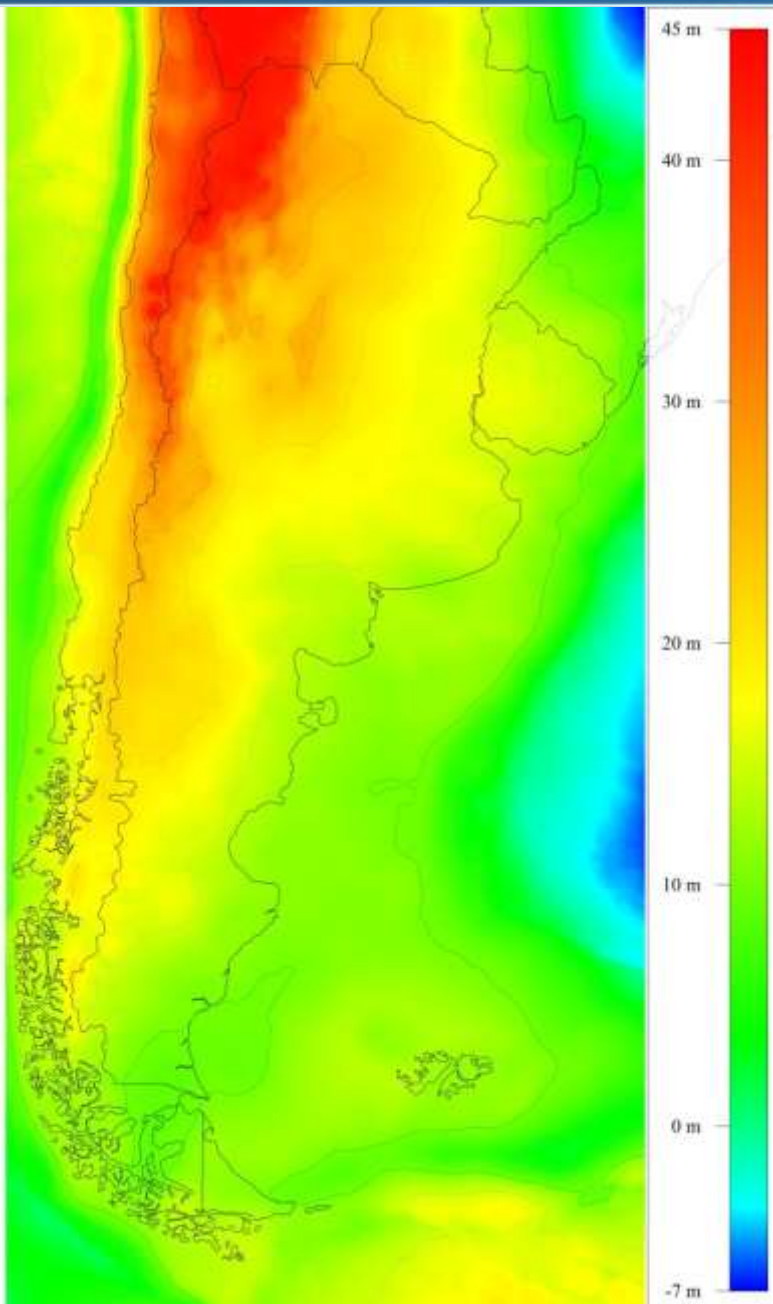
Red Gravimétrica Argentina

► Second-order gravity network

- Measured between **1950-2015**
- Accuracy < **0.1 mgal**
- In **2014**, a new project to **readjust** the network was commenced.
- In **2016**, the network calculation ended.
- **13,871 sites**
- Accuracy < **0.1 mgal**



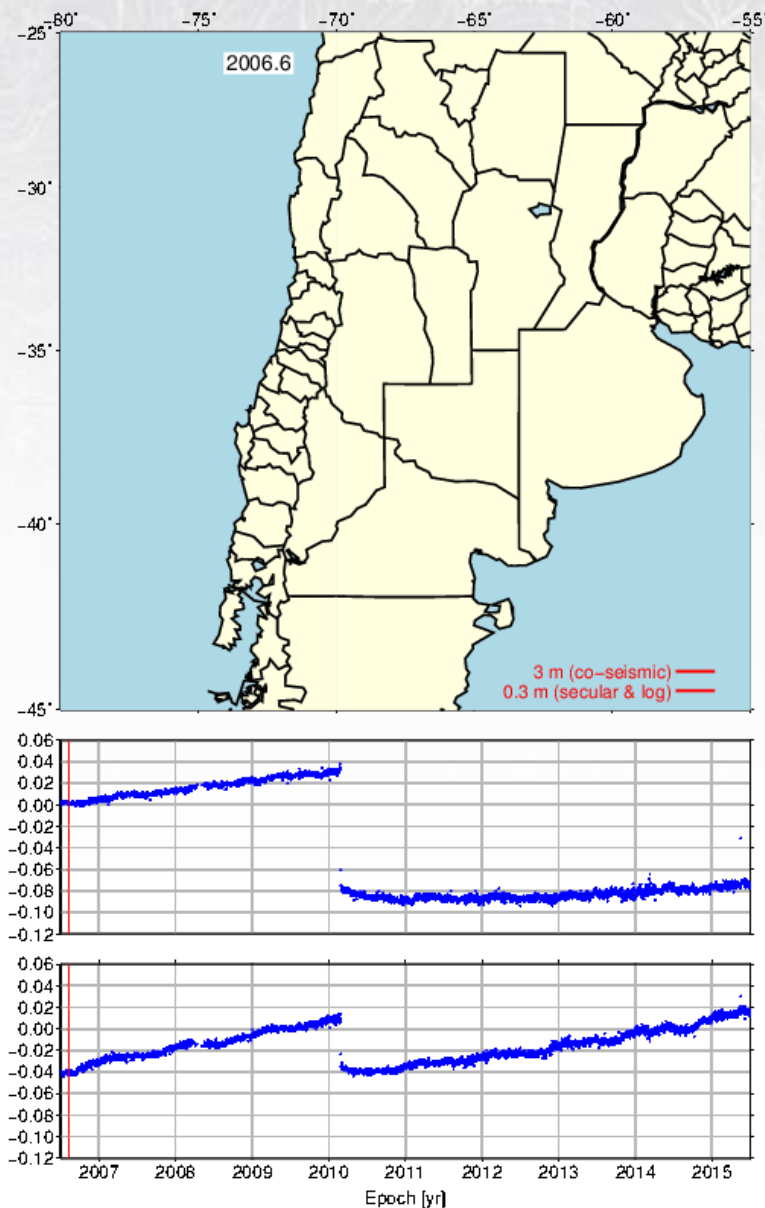
Salinas del Bebedero, San Luis



▶ Geoid model (GEOIDE-Ar16)

- ▶ Determined using the **RCR** technique in the **Helmert-Stokes'** scheme
 - ▶ GGM → **GOCO05S**
 - ▶ ~**650,000** gravity observations
 - ▶ Fill-in voids using the **DTU13** gravity model
 - ▶ Fitted to ~**1,900 GPS-levelling** benchmarks
 - ▶ Accuracy < **10 cm**
- ▶ New **gravimetric observations (2016-2018)** → ~**1200** measurements per year
- ▶ New co-located GPS-levelling observations (**2010-2018**) → ~**400** benchmarks per year

RESEARCH AREAS AND PROJECTS (Cont.)



THE UNIVERSITY OF
MEMPHIS



► Non lineal velocity model (VEL-Ar)

- Argentinean **Geodetic Reference Frame** (called **POSGAR07** and based on **ITRF05**) was officialised in **2009**
- The 27th of February 2010 a **8.8-magnitude earthquake** struck Concepcion (**Chile**)





Bureau
International des
Poids et
Mesures

► Atomic Time Scale

- **New time system** (Microsemi Precise Time Scale System)
- **New caesium clock** (Microsemi 5071A Primary Frequency Standard)
- Contribution with the **International Bureau of Weights and Measures** (BIPM) to maintain the **International Atomic Time** (TAI) using **PPP**
- **NTP service**



- ▶ Some recent international collaboration within Geodesy
 - ▶ **National Geospatial-Intelligence Agency** (NGA, USA)
 - ▶ GPS control ground station until 2017
 - ▶ **National Astronomical Observatory of China** (NOAC, China)
 - ▶ Beidou control ground station since 2015
 - ▶ **Institut de recherche pour le développement** (IRD, France)
 - ▶ Performing gravimetric measurements since 2010
 - ▶ **University of São Paulo** (Brazil)
 - ▶ Performing gravimetric measurements since 1995
 - ▶ **Dresden University** (TUD, Germany)
 - ▶ Gravimetric research project in Patagonia (BKG-TUD)
 - ▶ **Memphis University / The Ohio State University** (USA)
 - ▶ Central Andes Project (CAP) since 1992
 - ▶ **RMIT University** (Australia)
 - ▶ Geoid modelling from 2014 to 2016

- ▶ **Memorandum of Understanding** NGI–BKG, signed in April 2016
- ▶ **GPS+gravimetric measurements** at local-ties benchmarks, August 2016
- ▶ **Agreement** NGI-CONICET-BKG, signed in April 2017
- ▶ Determination of the main **orthometric height** at AGGO, November 2017
- ▶ Calibration of the **FG5 absolute gravity** at AGGO, January 2018
- ▶ **VLBI training course** at **BKG** (Leipzig, Germany), March 2018

COLLABORATION BETWEEN NGI AND BKG (cont.)



AGGO opening, Argentina 2015



AGGO opening, Argentina 2015



Agreement between NGI and BKG, Argentina 2015



Memorandum of Understanding between NGI and BKG, Argentina 2016

COLLABORATION BETWEEN NGI AND BKG (cont.)



AGGO
GENERATE DATA

- Sets the Earth Orientation Parameters.

- It contributes to the definition of a stable, precise and sustainable Reference Frame.

- It allows to improve the strategies to maintain the reference frames POSGAR and SIRGAS.



IGN
PRODUCES SERVICES

IGN defines, materializes and maintains the International Geodetic Reference Frame.

IGN materializes and updates the RAMSAC network.

- Process and adjust its Geodetic Reference Frame in its Scientific Processing Center.



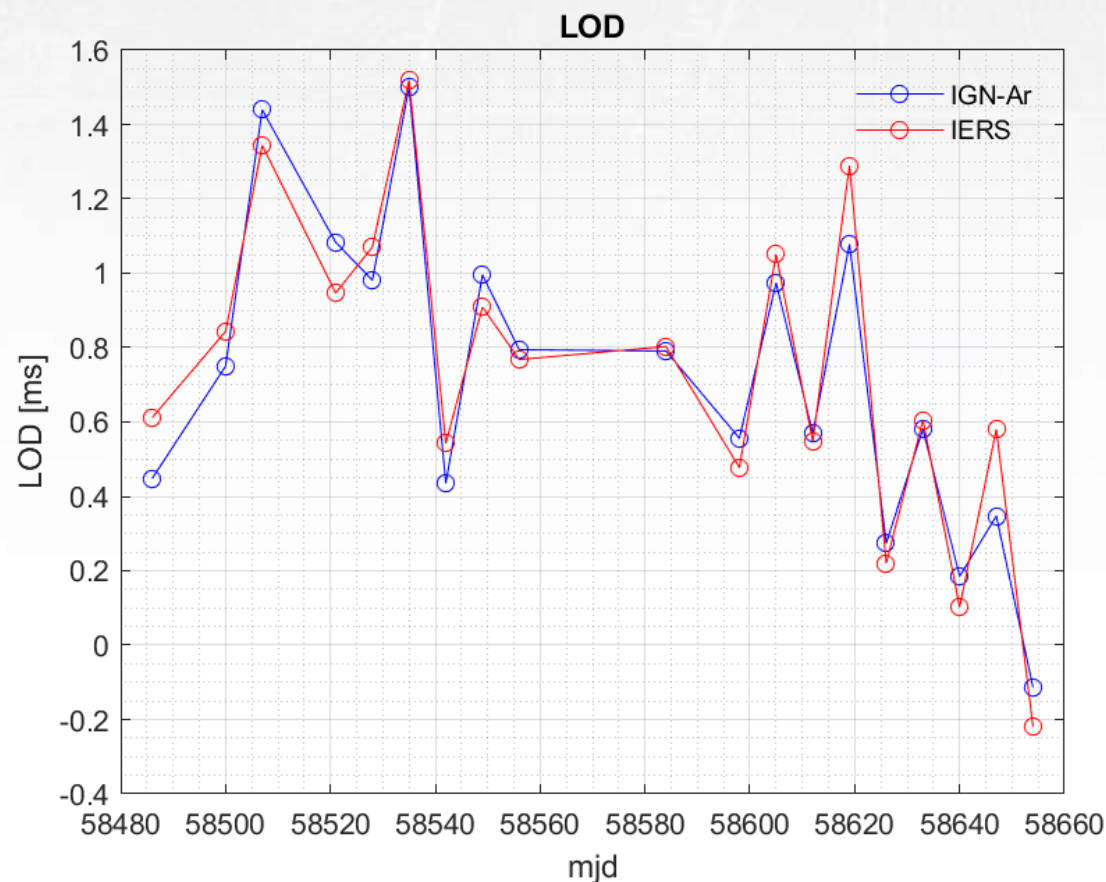
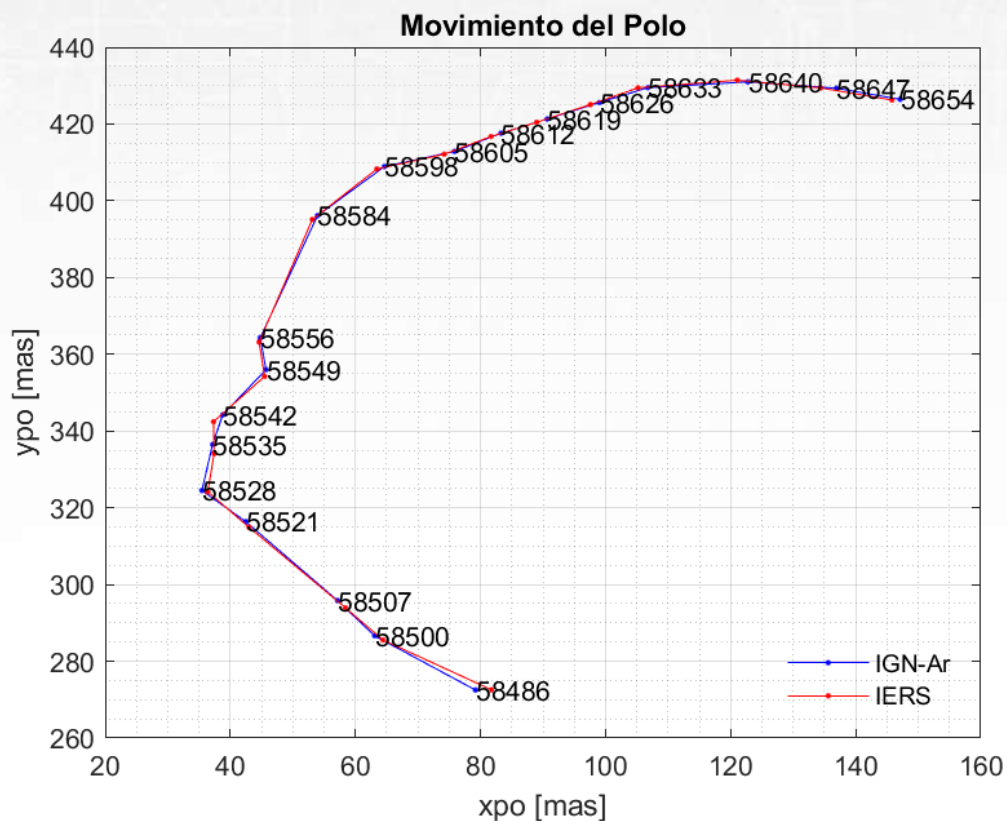
Processing!

CIGA

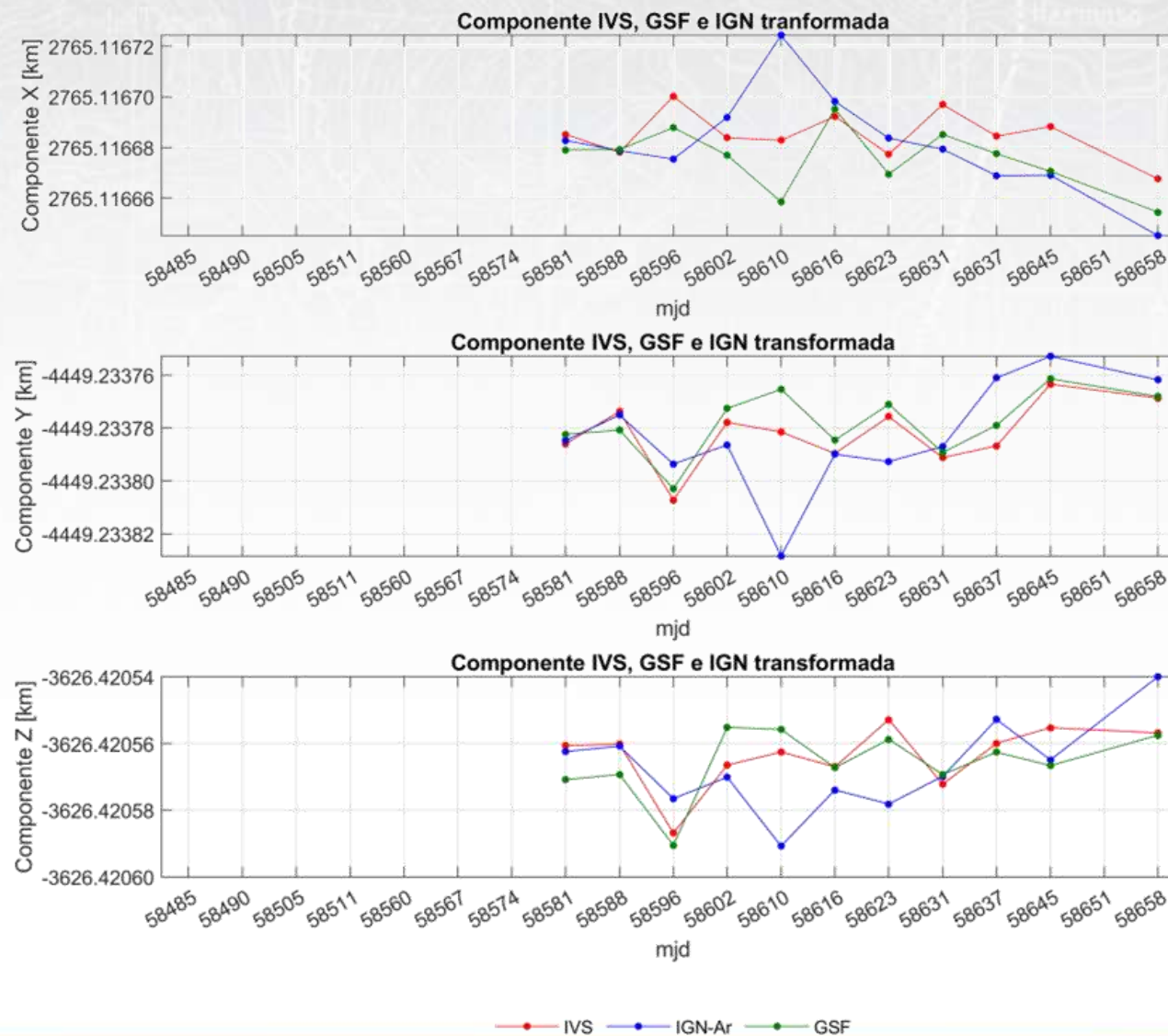
CENTER FOR APPLIED GEODETIC RESEARCH

CIGA: First VLBI data processing center in South America

VLBI Preliminary results: Polar Motion and Length of Day



VLBI Preliminary results: AGGO time series





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MUCHAS GRACIAS