IGS 2026 WORKSHOP
SANTIAGO DE CHILE
33°26' S 70°39' O

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ADELA
Analysis of DEformation beyond Los Andes

T. José Antonio[1], C. Catalina[1], M. Miguel[1] , G. Juan[1], C. Catalina[1] and C. Marcelo [1]

[1] Centro de Procesamiento y Análisis Geodésico USC

Time-Dependent GNSS Reference Frames in Tectonically Active Regions: The ADELA Approach within SIRGAS

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Motivation and Problem statement

- Seismically active regions challenge the long-term stability of geodetic reference frames.
- Large earthquakes and post-seismic deformation generate non-linear surface displacements.
- Irregular spatial distribution of GNSS stations complicates consistent coordinate propagation.

These effects impact geodetic traceability, surveying and operational GNSS applications.

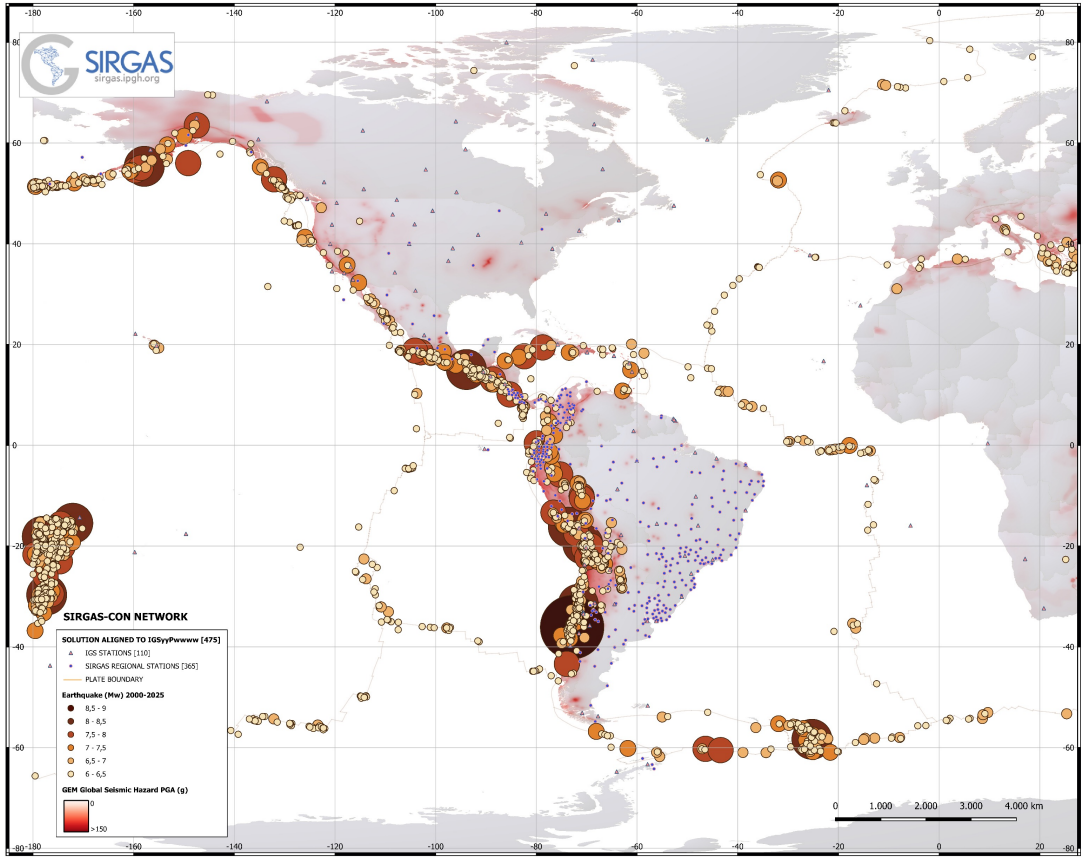


Fig 1: Earthquakes Mw ≥ 6.0 since 2000.

Toward operational kinematic reference frames in SIRGAS

- SIRGAS provides the regional geodetic reference frame for the Americas.
- SIRGAS products already include a linear velocity model through VEMOS.
- VEMOS represents mean yearly horizontal surface displacements.
- Linear velocity models need to be complemented with non-linear time-dependent deformation modelling.

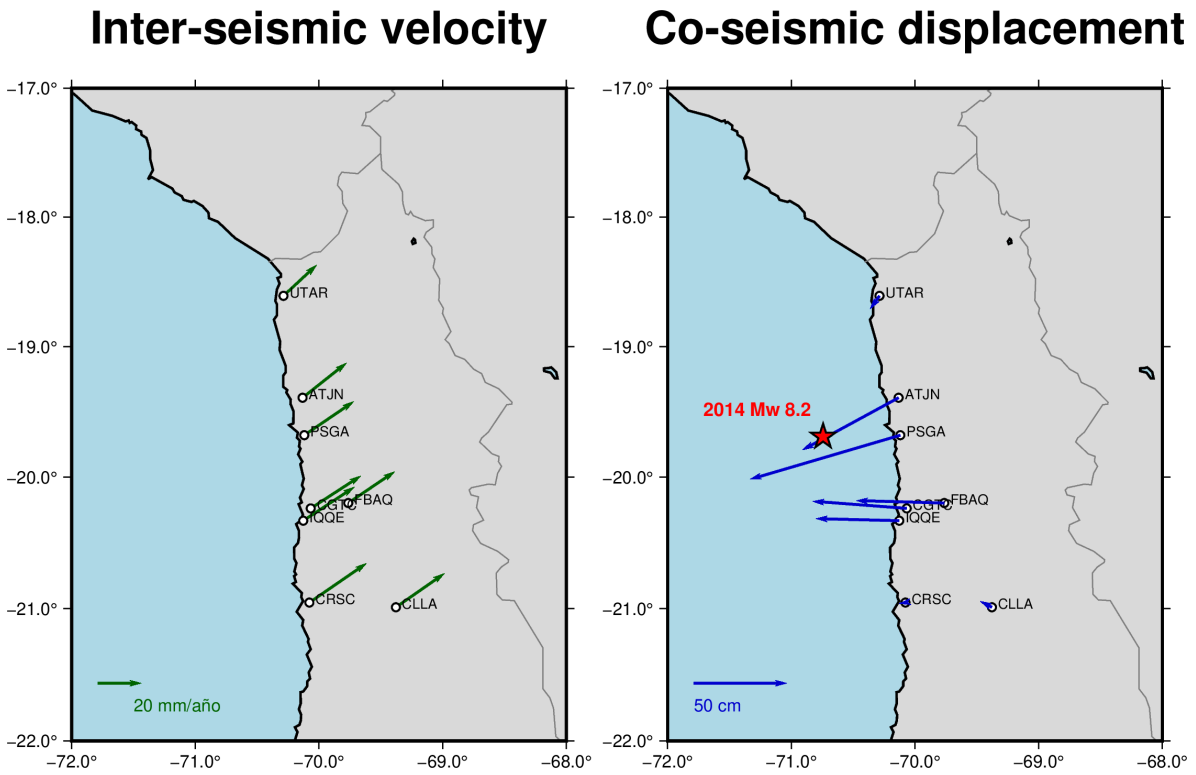


Fig 2: Velocities and co-seismic displacement for the Mw 8.2 earthquake in Northern Chile in 2014.

What is ADELA?

ADELA: Analysis of Deformation beyond Los Andes.

- ADELA is a time-dependent reference frame approach designed to operate within SIRGAS.
- ADELA can complement SIRGAS by adding the non-linear deformation component.

GNSS Data = Linear + Seasonal + Offsets + Transient

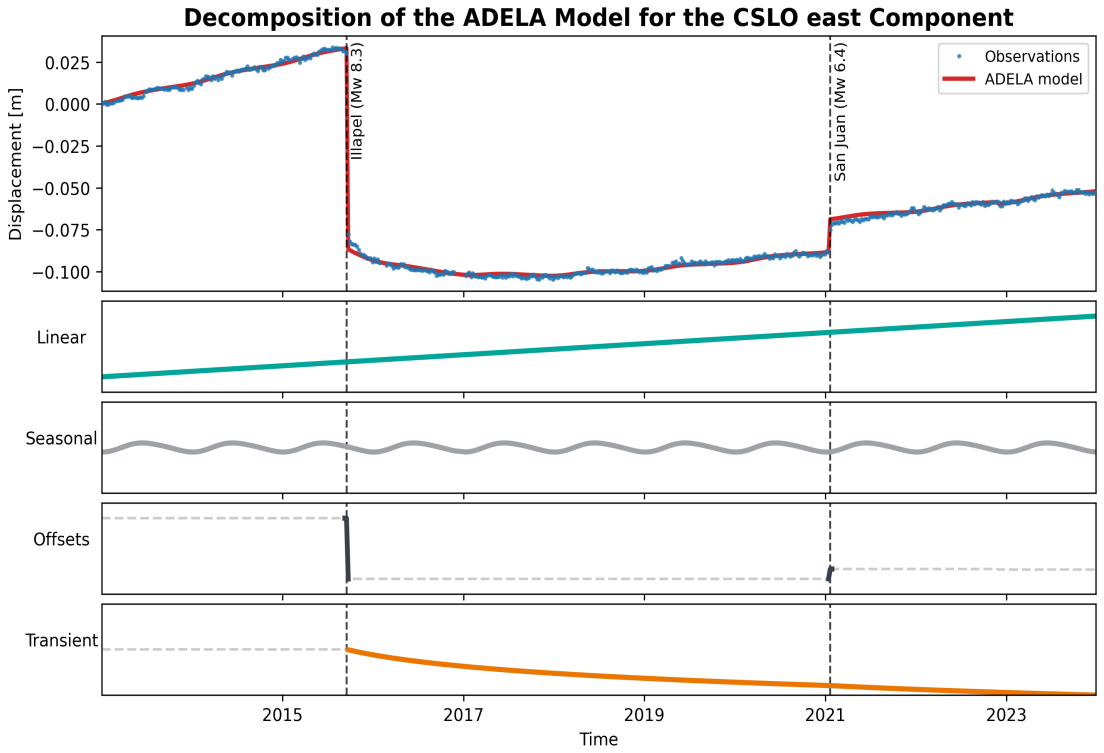
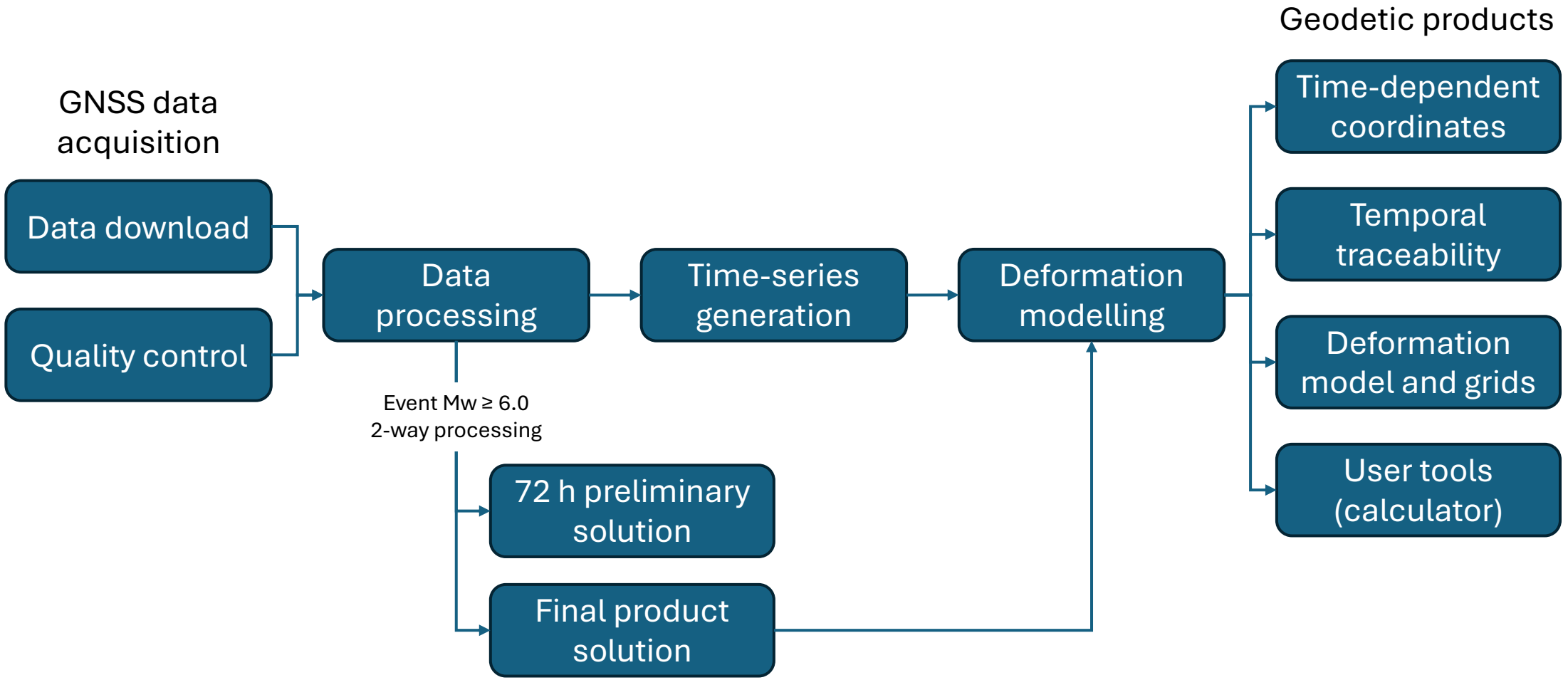


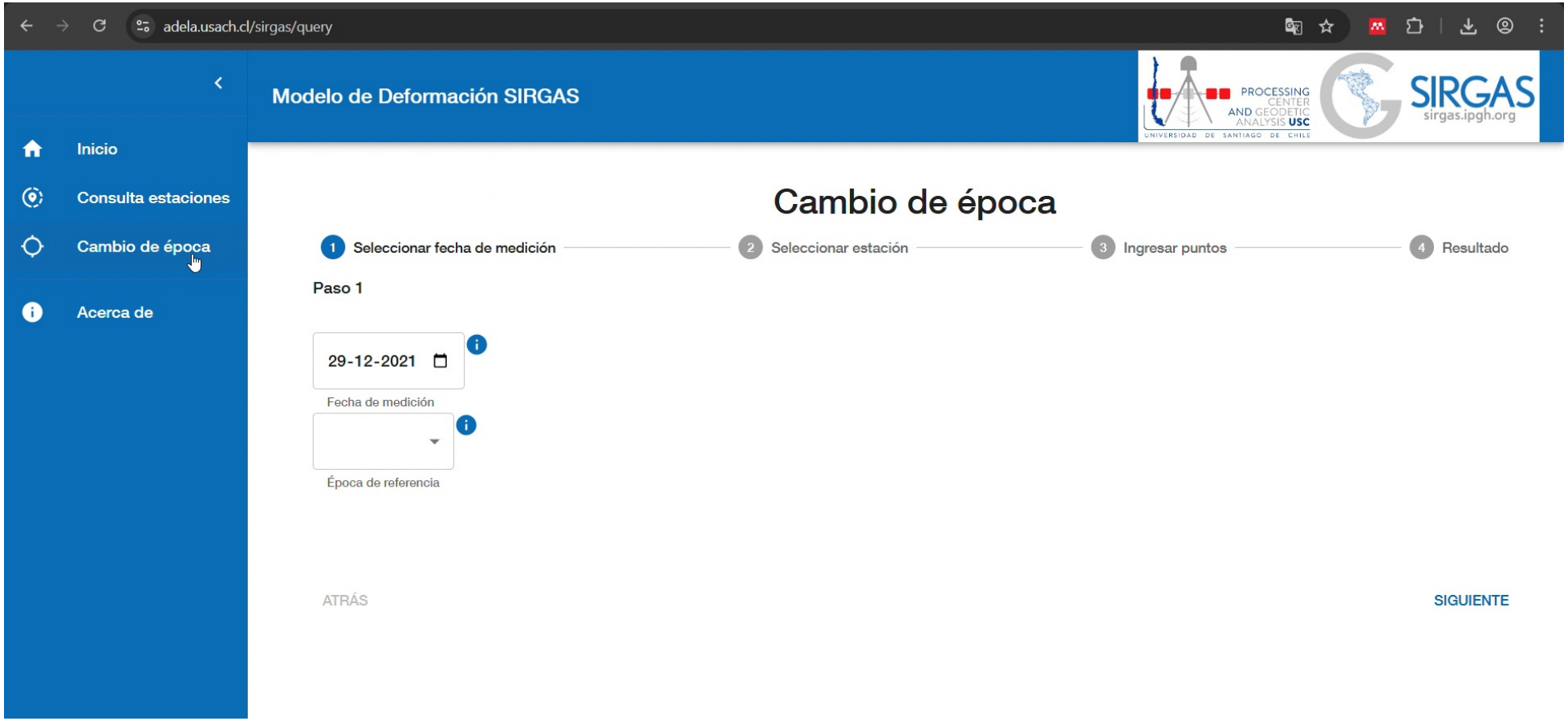
Fig 3: Decomposition of a GNSS time series.

ADELA evolution and objective

- Originated as a research initiative at **Universidad de Santiago de Chile** (USACH).
- It has been supported by the **Ministry of Science** (ID23I10147) and the **Ministry of Mining.**
- Initial focus: deformation model with a focus on high-precision applications in Chilean mining.
- Long-term objective: a structured workflow that supports kinematic reference frame where it’s needed.

Operational Workflow




adela.usach.cl/sirgas/query
Modelo de Deformación SIRGAS
PROCESSING CENTER AND GEODETIC ANALYSIS USC
UNIVERSIDAD DE SANTIAGO DE CHILE
SIRGAS
sirgas.ipgh.org
Inicio
Consulta estaciones
Cambio de época
Acerca de
Cambio de época
1 Seleccionar fecha de medición
2 Seleccionar estación
3 Ingresar puntos
4 Resultado
Paso 1
29-12-2021
Fecha de medición
Época de referencia
ATRÁS
SIGUIENTE

Tested Networks

- ADELA has been tested using REDGEOMIN and SIRGAS-CON.
- In CORS, position accuracy reaches the mm level.
- In survey marks, accuracy depends on GNSS station density, solution update frequency and interpolation strategy.
- Cross-validation tests show that ADELA improves reference-frame stability from the centimetre level to the millimetre level.

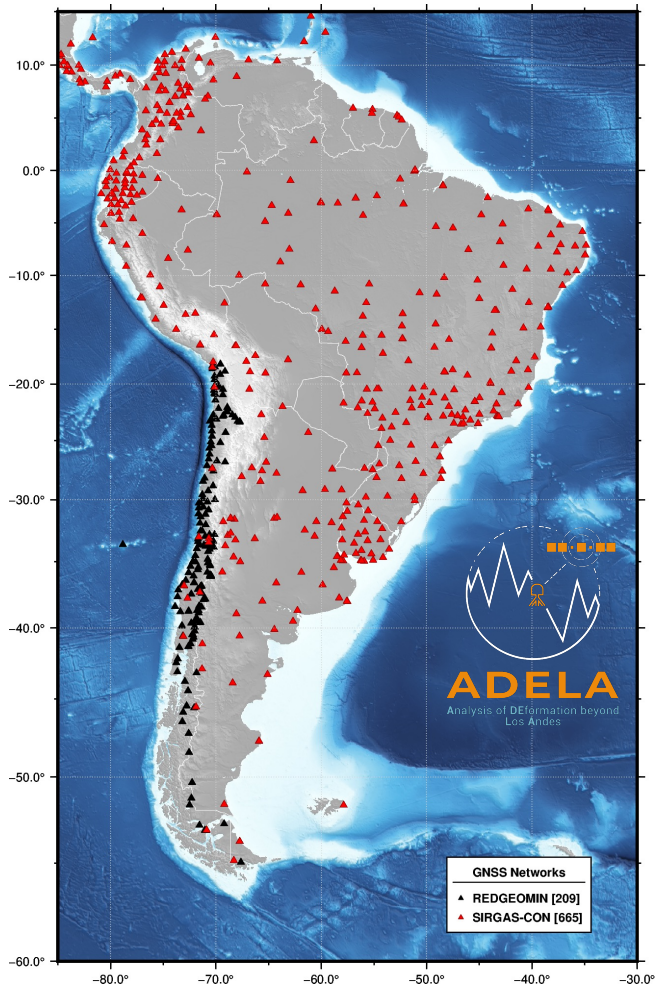


Fig 4: Tested networks of ADELA: REDGEOMIN and SIRGAS-CON.

REDGEOMIN: Chilean implementation

- REDGEOMIN is the implementation of ADELA in Chile.
- It acts as a densification of SIRGAS-CON for high-precision mining applications.
- It provides the operational environment to validate ADELA products in Chile.
- ADELA enables epoch updates beyond CORS stations through deformation model interpolation.
- This supports survey marks and users working outside dense GNSS station areas.

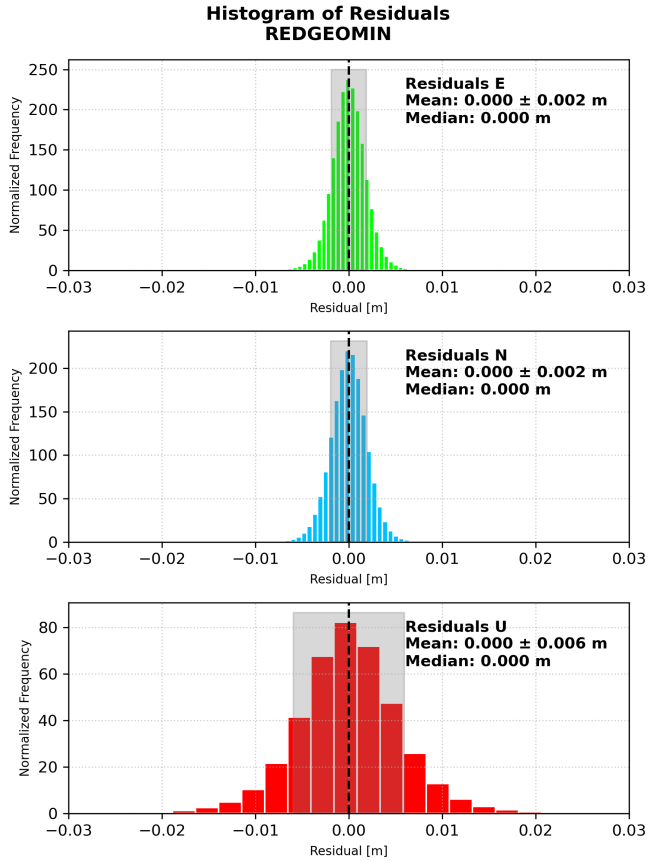


Fig 5: Model residuals for REDGEOMIN.

ADELA within SIRGAS

- ADELA is currently operational in beta version for the SIRGAS region.
- It maintains consistency with ITRF/IGS and SIRGAS-CON.
- Standardized metadata and catalogues support reproducibility and transparency.
- Products are designed for integration with GNSS software and spatial data infrastructures.
- This approach provides a reproducible model for implementing operational KRFs in deforming regions.

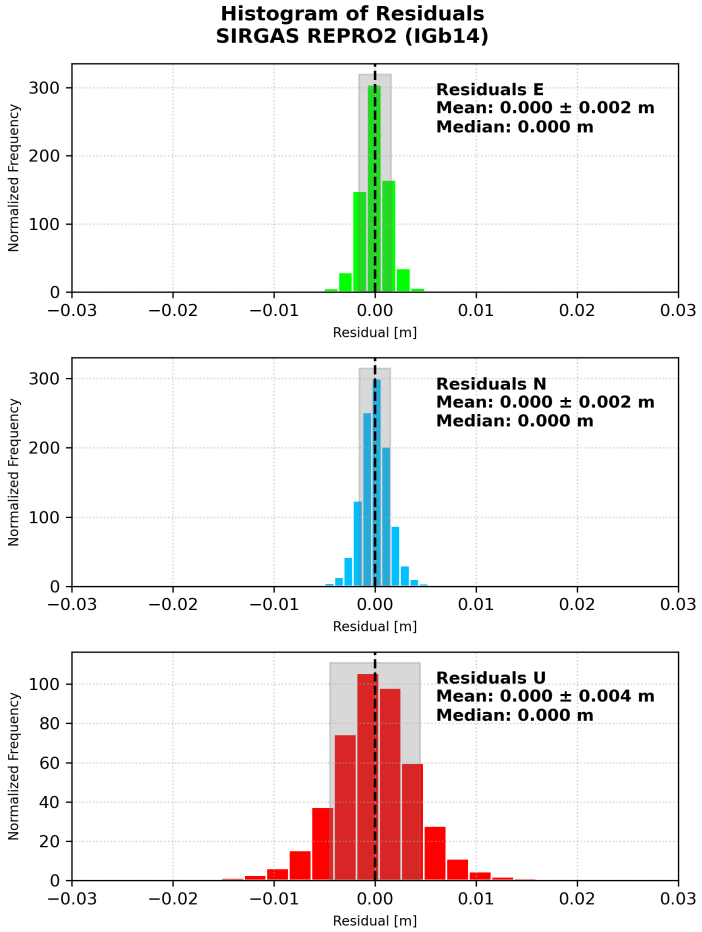


Fig 6: Model residuals for SIRGAS-CON.

Conclusions

Operational KRF for deforming regions

- Tectonic deformation challenges the stability of static reference frames.
- ADELA implements a time-dependent approach within SIRGAS.
- ADELA could complement linear VEMOS velocity models by incorporating non-linear deformation modelling.
- REDGEOMIN demonstrates the feasibility of the approach in Chile.
- ADELA provides a reproducible workflow and a continental roadmap for the transition toward kinematic reference frames.

What's next? ADELA in the Iberian region

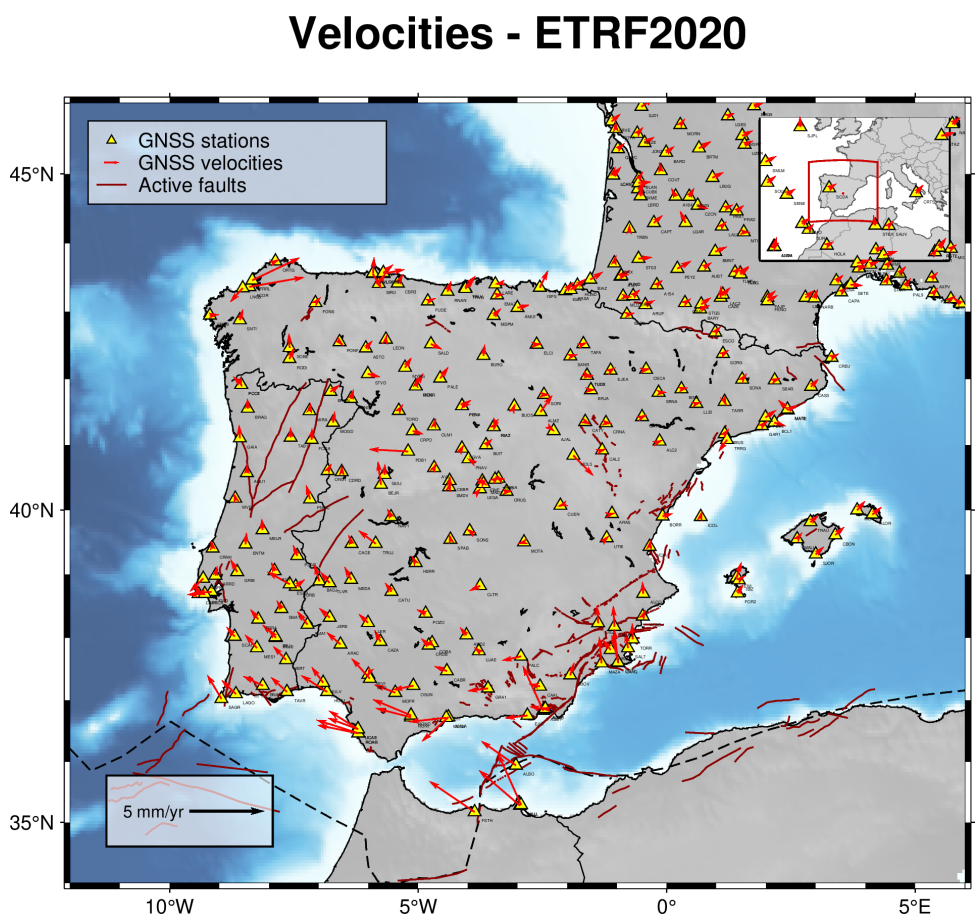


Fig 7: GNSS velocities fixed to the EU plate.

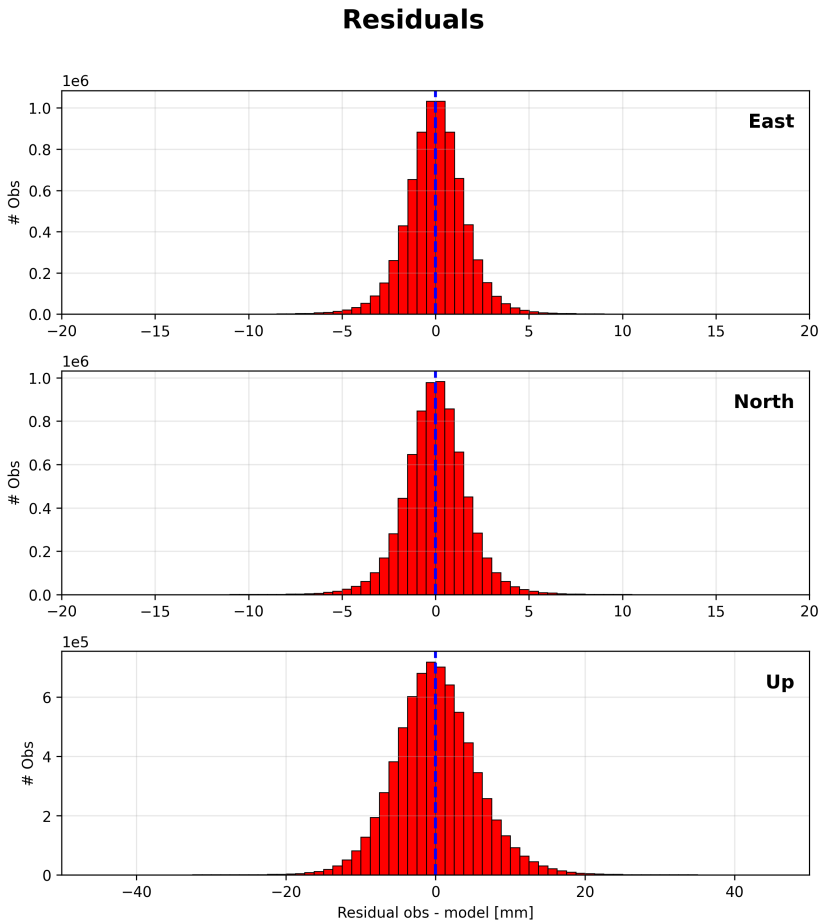


Fig 8: Residuals between ADELA model and observations.

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Thank you