Trimble's support for modernized datums in Chile

C. PEARSON, A. SILVA[1], F. CARVAJAL[2], S. VIELLIARD and T. AHMED[2]
[1]TRIMBLE, Colorado, USA;
[2]GEOCOM, Santiago, Chile

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

INTRODUCTION

Maintaining accurate coordinates in Chile is challenging for geodesists because of rapid tectonic motion and repeated great earthquakes caused by the subduction of the Nazca plate under South America. Since 2002, national datums in Chile have been based on various realizations of the Geocentric Reference System for the Americas (SIRGAS), which provide a direct link to the ITRF. Chile serves as an ideal test case for the deformation modeling capabilities within Trimble's Geodetic Library (TGL) due to these exceptionally high rates of tectonic deformation.

OBJECTIVE

Trimble Geodetic Libraries (TGL) support deformation models to correct coordinates from the epoch of measurement (eom) to the reference epoch of national datums. This step is critical for ensuring coordinates from Trimble's RTX system are accurately transformed. Maintaining geodetic accuracy in Chile is uniquely difficult due to: Active Plate Boundaries: High-frequency tectonic activity. Seismic Variation: Complex, time-varying co-seismic and post-seismic crustal movements. This poster describes how TGL tools support users in Chile by accommodating SIRGAS-Chile (Epochs 2016, 2021, and 2025) and REDGEOMIN datums.

METHODS

Converting between ITRF coordinates and national datums requires 14 parameter datum transformations and deformation models to correct for crustal motion between *eom* and the reference epoch of the national datum. TGL has the ability to apply four types of deformation models. With these we can support nearly all national datums.

- For countries that are located in one rigid tectonic plate we estimate the horizontal velocity by applying the absolute Euler Pole for the plate in question.
- For countries that are undergoing tectonic deformation but had no earthquakes since reference epoch we estimate the point velocity from a grid.
- For countries with both tectonic deformation and earthquakes, the crustal motion is determined from a velocity field augmented with grids representing earthquake displacement
- In more complex situations the crustal motion is interpolated from a distortion grid

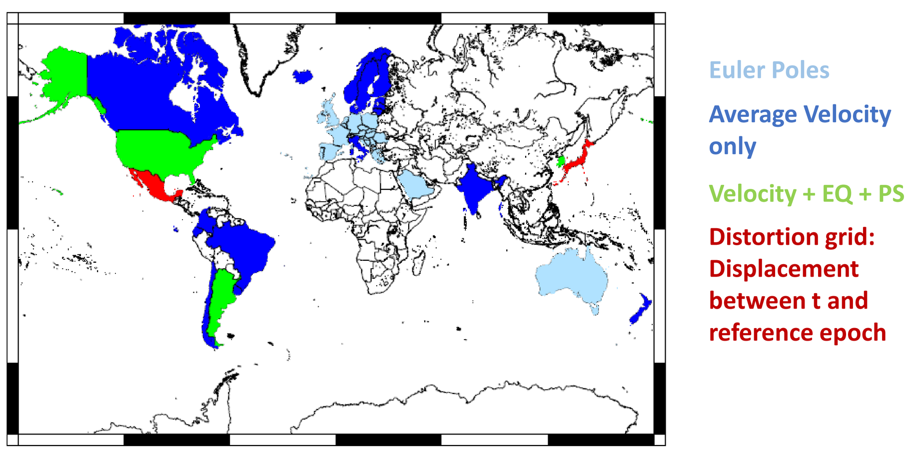

Figure 1: deformations models on TGL

RESULT

TGL supports SIRAGS-Chile Epoch 2016, 2021 and 2025 and the REDGEOMIN datums. The three SIRGAS-Chile datums are static however as explained above, we use deformation models to correct RTX coordinates from epoch of measurement (eom) to the reference epoch of the datums. TGL supports 4 types of deformation models. Three of these (the velocity only and distortion grids) are relevant for Chilian Datums. For SIRAGS-Chile Epoch 2016, 2021.0 and 2025 we use the velocity only deformation model and VEMOS2017 and VEMOS2021 from SIRGAS (https://www.sirgas.org/en/velocity-model/). For Redgeomin we use the distortion grid to model the shift between the reference epoch and USACH's most recent solution of the South American CORS.

Datum	Displacement Model	Reference Epoch
SIRAGS-Chile Epoch 2016.0	VEMOS2017	2016
SIRAGS-Chile Epoch 2021.0	VEMOS2022	2021
SIRAGS-Chile Epoch 2025.0	VEMOS2022	2025
Redgeomin 2024	REDGEOMON2024	2024
PSAD56	NA	NA

Table 1: Chilean datums supported by TGL

The VEMOS2022 velocity model (Drewes et al 2024) has been developed by the Deutsches Geodätisches Forschungsinstitut (DGFI-TUM), Technische Universität München. It is the most recent realization of the SIRGAS velocity field. It is aligned to the to the IGS14 (ITRF2014) datum. The VEMOS velocity grids are distributed as a grid with grid spacing of 1°. This grid is atypical because only points that are on land have values so in order to fill this into a rectangular grid that TGL can support, we used the ITRF2020 Euler pole for the appropriate tectonic plate to fill in the blank nodes. The velocities are also horizontal only which is a significant limitation.

Test points

We took 9 24 hr RINEX files from Chile CORS stations and submitted them to the Trimble RTX-PP system. The resulting ITRF2014 coordinates were converted to the SIRGAS-Chile 2025.0 system. The comparison between the RTX eom coordinates transformed as shown in Table 1 (Pearson et al 2025)

Statistic	East (mm)	North (mm)	Up (mm)
RMS	17.90	6.56	30.50
Max	-1.44	13.50	61.10
Min	-48.10	-5.44	-47.20
Average	-7.60	-0.20	-5.30

Table 2: Comparison results between SIRGAS-Chile 2025.0 and RTX-PP

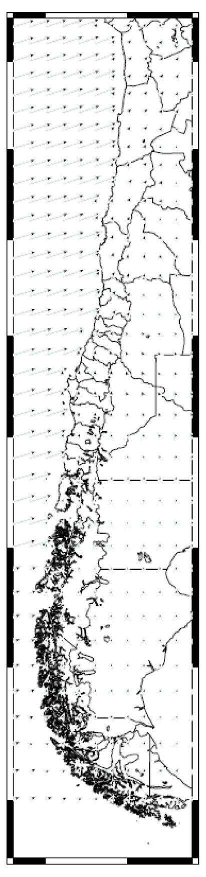

Figure 2: The VEMOS2022 velocity grid

The REDGEOMIN deformation model (Tarrío et al 2024) involves modeling time series for 22 CORS stations in Chile. However, time series estimation is not supported by TGL so implementing this in TGL requires that a new paradigm be introduced.

- We approximated their approach by subtracting the USACH Bernese solution for all of the GNSS stations for the REDGEOMIN epoch (tep) from the most current solution (tsol). We then gridded these to form a datum shift grid.
- We corrected for ongoing displacement by subtracting the current and penultimate (t_{sol-1}) datum shift grids to form a difference grid.
- The REDGEOMIN coordinate is just the interpolated datum shift grid (DSG) plus the difference grid (DG) multiplied by the time between the eom and the epoch of the last solution (Dt).

$$m_k(t_{ep},\theta,\lambda) = DSG_k(t_{ep},t_{sol},\theta,\lambda)t + DG_k(t_{sol-1},t_{sol},\theta,\lambda) * (\Delta t) \quad (1)$$

We tested the REDGEOMIN deformation model using 22 test points. For each test point we submitted a 24 hr RINEX file to RTX-PP

- The ITRF2014 eom coordinates were then converted to REDGEOMIN 2014 coordinates using equation 1 below. We then compared these to the truth values from USACH.

Points (22)	East (mm)	North (mm)	Up (mm)	Combined (mm)
RMS	4.6	3.4	4.0	6.9
Max	4.2	5.5	4.2	18.0
Min	-17.5	-1.1	-7.7	2.7
Average	-2.4	3.2	-1.5	6.2

Table 3: Statistical summary of residuals

Figure 3: Location of test Points. Orange dot shows the worst residual

CONCLUSIONS

TGL now supports time dependent transformations between the ITRF and eom to national datums for 60 countries. In the next few years, we hope to expand coverage to underserved areas like South Pacific, Africa and Asia TGL is generally in line with the OSG's standard for deformation models and we encourage national agencies to support this standard. Chile is a good test case for the deformation models in Trimble Geodetic Library's deformation modelling capability because of the very high rates of tectonic deformation here This study demonstrates that TGL can support SIRGAS Chile epoch 2016, 2021 and 2025 Datums and REDGEOMON. The REGEMON study demonstrates that, for displacement models that differ from the OGC standard, there is suffucent flexability in TGL to support them. In this case we were able to approximate a timeseries based deformation model using a datum grid and a ramp function with acceptable accuracy. TGL also supports transformations to older legacy datums such as PSAD56 and SAD.

REFERENCES

Drewes H., Seitz M., Sánchez L. (2024). Realisation of the Non-Rotating Terrestrial Reference Frame by an Actual Plate Kinematic and Crustal Deformation Model (APKIM2020). International Association of Geodesy Symposia, https://doi.org/10.1007/1345_2024_276

Tarrío Mosquera, Jose & Inzunza, Jesarella & Caceres, Catalina & Isla, Fernando & Caverlotti, Marcelo & Mardones, Cristian. (2021). ADELA Analysis of DE formation beyond Los Andes(2009-2021): The urgency to change from static to kinematic in any geodetic reference frame for Chile.

Pearson C. , Silva A. & Vielliard S. (2025). Initial implementation of Chile's REDGEOMIN datum in Trimble Geodetic Library. FIG Working Week 2025 Library

ABSTRACT ID 89