Kinematics of the Costa Rica's New Geodetic Reference Frame

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1. Abstract

On April 17th, 2018, the Instituto Geográfico Nacional de Costa Rica (IGNCR), through Executive Decree D-40962-MJP, formalized the new national geodetic reference known as CR-SIRGAS. The new geodetic reference frame is officially linked to SIRGAS.

The Executive Decree represents a huge advance in national geodesy, since for the first time the country is directly linked to the International Terrestrial Reference Frame (ITRF) through the weekly scientific solutions of the GNSS stations of the SIRGAS-CON, now having a dynamic reference geodetic frame.

CR-SIRGAS is defined by 8 (CIQE, LIBE, LIMN, NEIL, NICY, PUNT, RIDC, SAGE) of the 14 stations of the SIRGAS-CON network in Costa Rica, whose administration is the responsibility of the IGNCR.

Additionally, in the establishment of CR-SIRGAS, a series of passive points were contemplated, which will serve as a base for the transforming process from geodetic old references to CR-SIRGAS (figure 1).

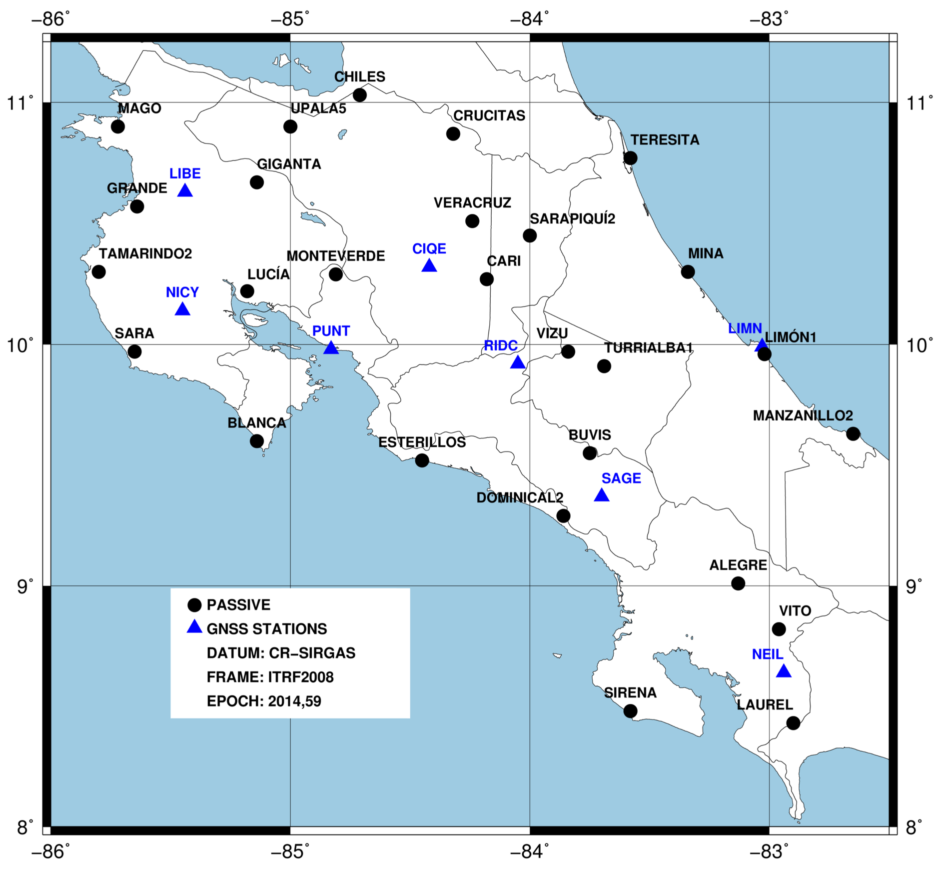

Figure 1. Location of the passive and active points of the new Costa Rica's national geodetic reference frame CR-SIRGAS

Together with the officialization of CR-SIRGAS and its mandatory compliance, the coordinates (X, Y, Z) and velocities (VX, VY, VZ) of the stations defining the frame were made available to users.

CR-SIRGAS has been aligned to ITRF2008 (IGb2008) and reduced 2014,59 epoch, week 1803 and it is the base of national cartographic projection called Costa Rica's Transverse Mercator (CRTM)

The results of a kinematic analysis regarding these values and the final weekly positions given by the SIRGAS CP's provide an idea about the general behavior of the new national geodetic frame, emphasizing the obvious need to always have linked coordinates at the observation epoch.

In addition, estimates of the velocity of the national geodetic frame made with the VelMIC tool (Moya and Bastos, 2014) and its validation regarding the final weekly solutions of SIRGAS are presented (figures 2 to 7).

2. Methodology

The geocentric coordinates and velocity values associated to the CR-SIRGAS and that are valid for the epoch 2014,59 (week 1803), an extrapolation was made of the geocentric positions of 6 of the 8 stations continuous operation GNSS (LIBE, LIMN, NEIL, PUNT, RIDC and SAGE) until week 1933, which is the week before the adoption of the ITRF2014 frame.

Working with 130 weeks, the geocentric positions were calculated for the 6 stations using the following three criteria:

1. The final SIRGAS coordinates at the observation epoch, that is one every week.
2. The product coordinates of the components of geocentric velocities reported by the IGNCR.
3. The product coordinates of the velocity values geocentric calculated using VelMIC.

3. Time Series of CR-SIRGAS stations

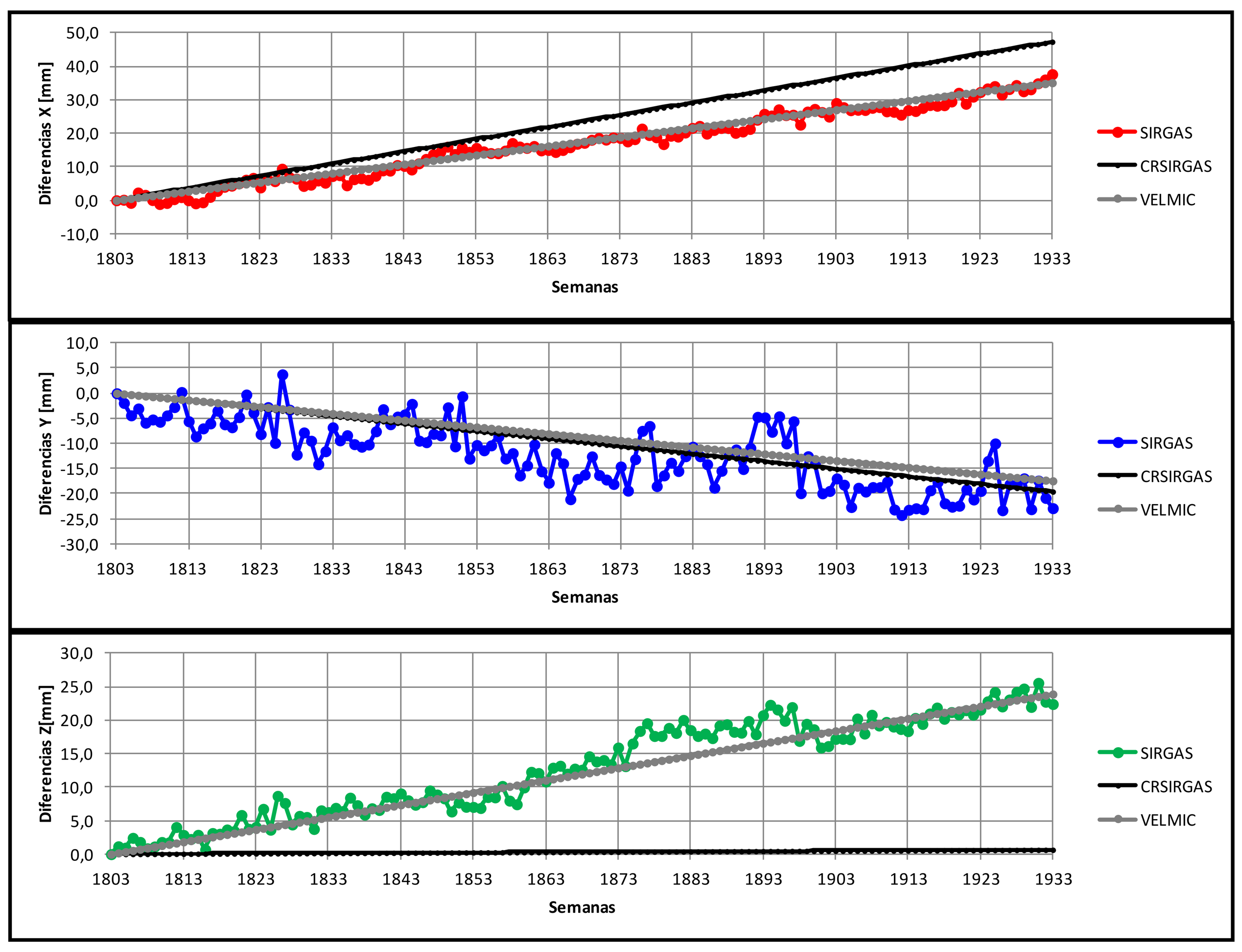

Figure 2. Comparison of the geocentric positions of the LIMN station from week 1803 to week 1933 given by SIRGAS and the CR-SIRGAS velocity and VelMIC velocity values

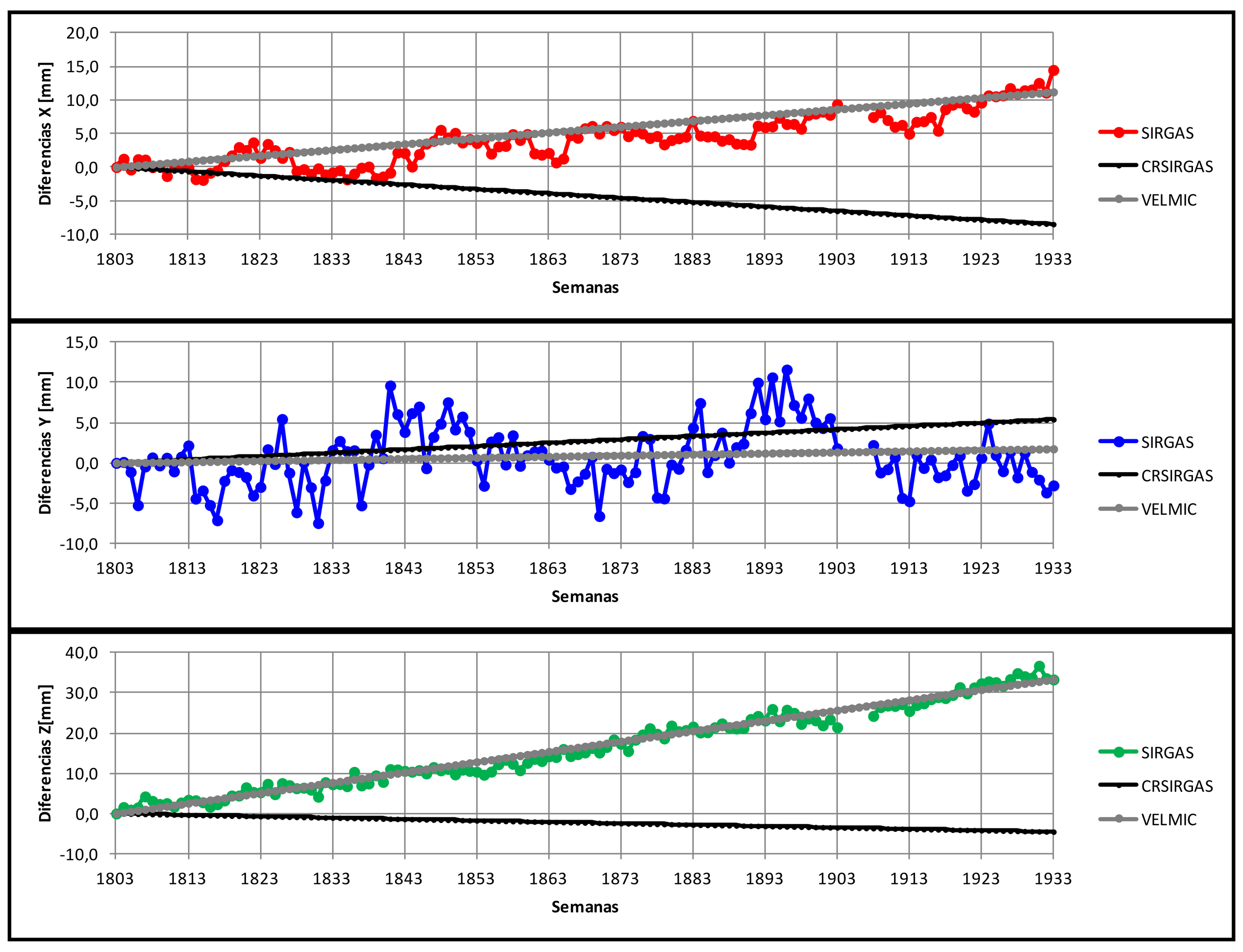

Figure 3. Comparison of the geocentric positions of the LIBE station from week 1803 to week 1933 given by SIRGAS and the CR-SIRGAS velocity and VelMIC velocity values

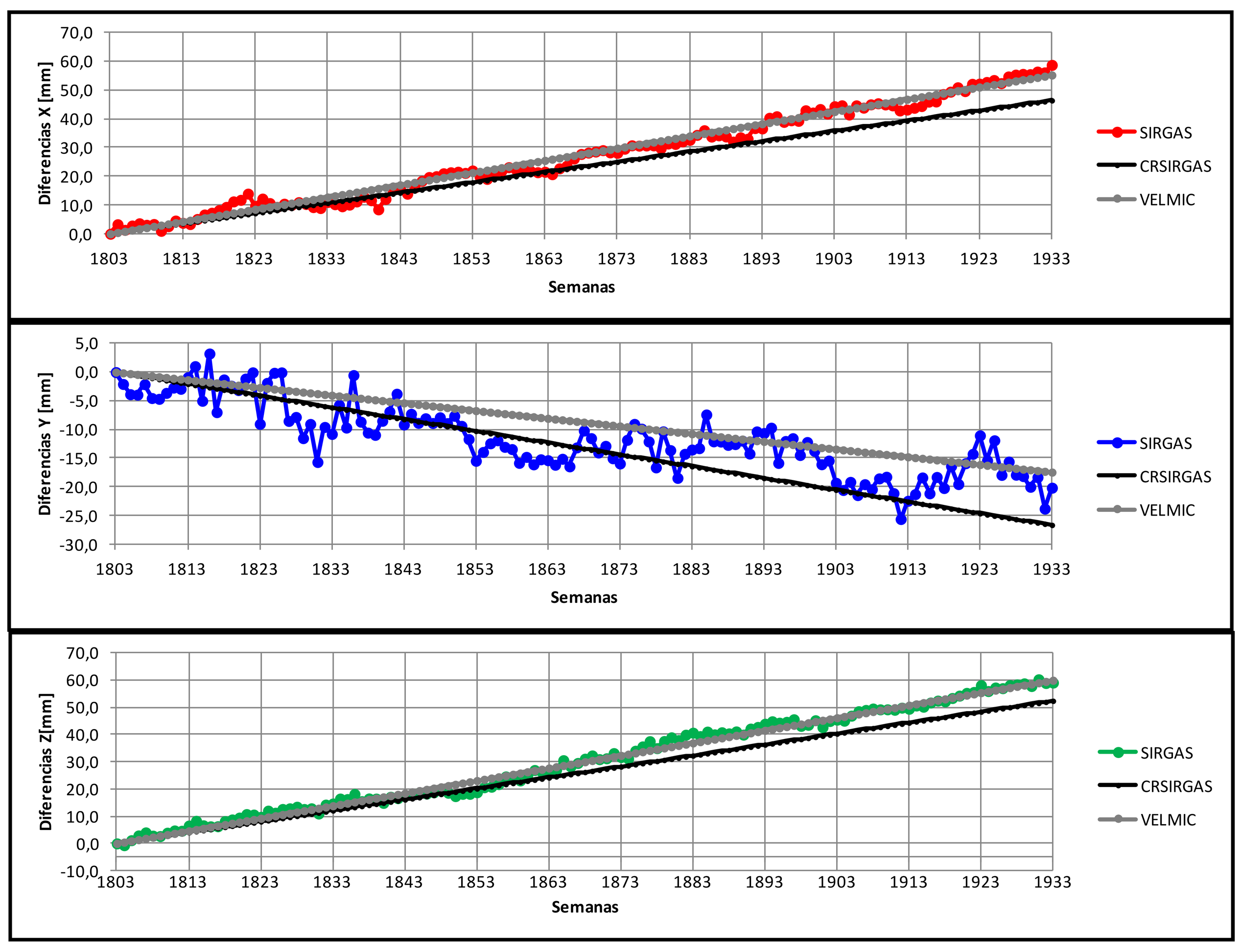

Figure 4. Comparison of the geocentric positions of the NEIL station from week 1803 to week 1933 given by SIRGAS and the CR-SIRGAS velocity and VelMIC velocity values

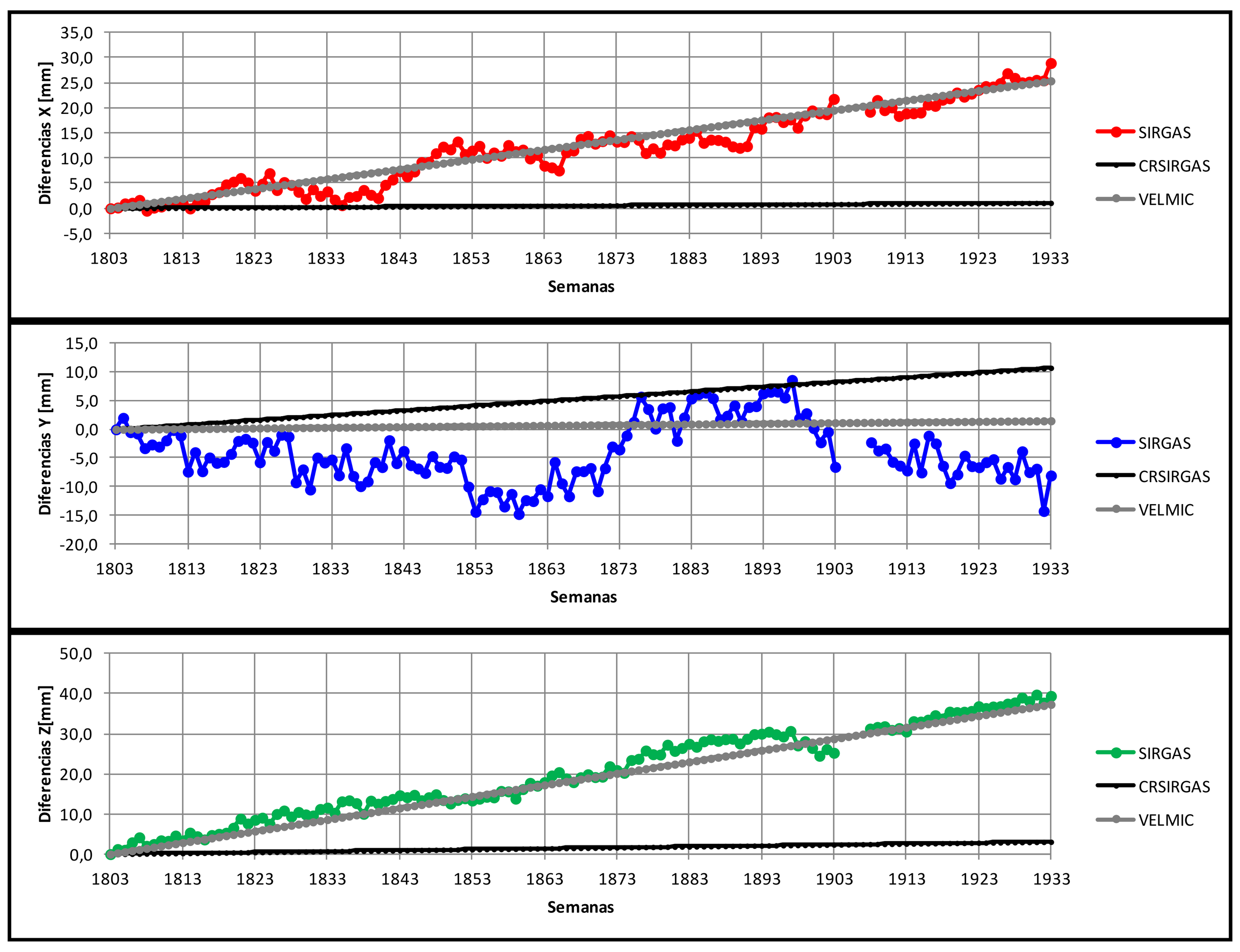

Figure 5. Comparison of the geocentric positions of the PUNT station from week 1803 to week 1933 given by SIRGAS and the CR-SIRGAS velocity and VelMIC velocity values

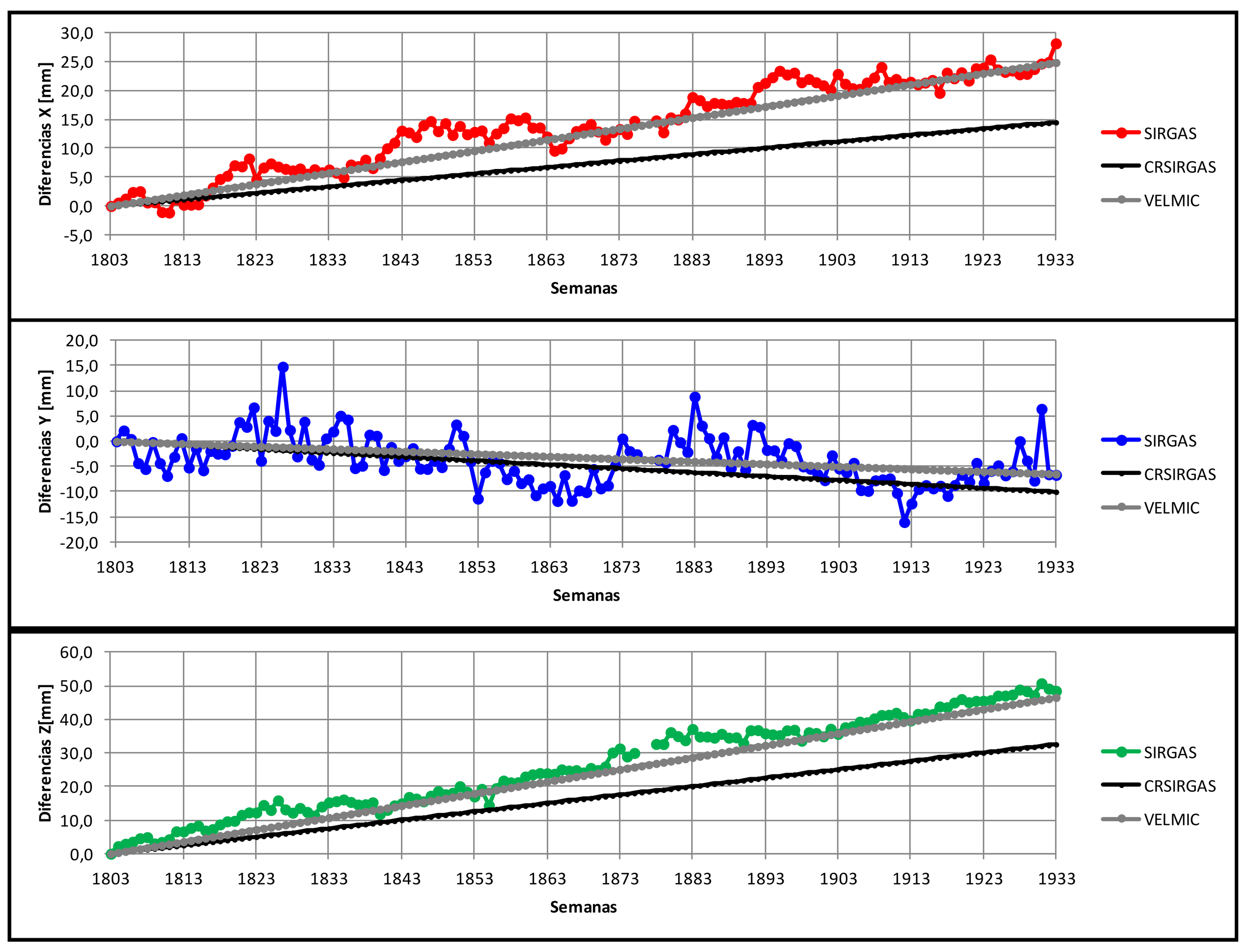

Figure 6. Comparison of the geocentric positions of the RIDC station from week 1803 to week 1933 given by SIRGAS and the CR-SIRGAS velocity and VelMIC velocity values

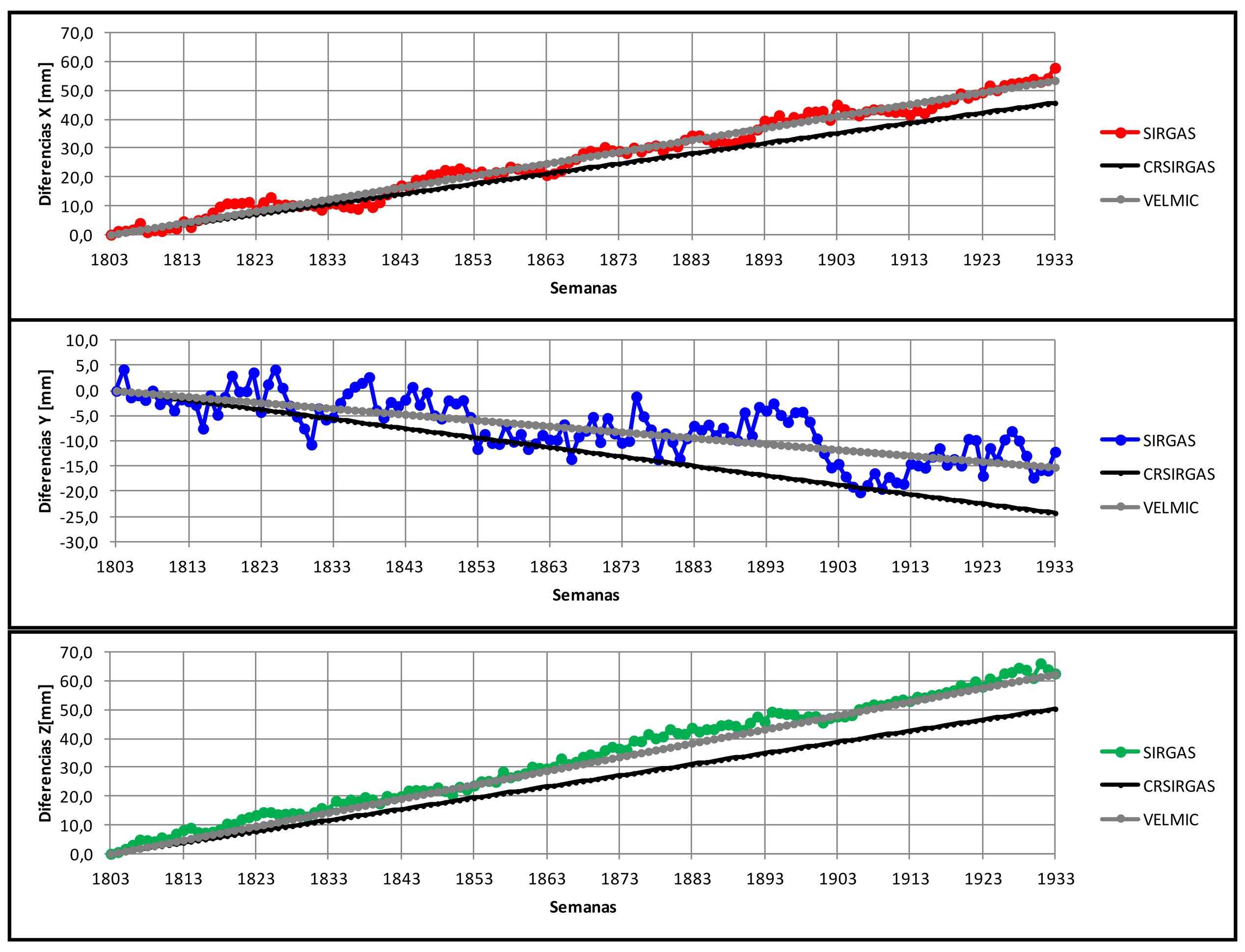

Figure 7. Comparison of the geocentric positions of the SAGE station from week 1803 to week 1933 given by SIRGAS and the CR-SIRGAS velocity and VelMIC velocity values

4. Velocities comparison

Table 1 shows the results of a preliminary comparison of the VelMIC geocentric velocities given to the 2014,59 epoch, ITRF08, with those reported by SIRGAS in its latest multiyear solution (SIR17P01) ITRF14 epoch 2015,0 (Sánchez , 2017). Maximum differences of 0,2 mm/y are observed in VX, 1,8 mm/y in VY and 3,5 mm/y in VZ considering that they are not in the same frame of reference or time. VelMIC velocities must be recalculated to ITRF14 to be consistent with SIRGAS.

Station	VelMIC velocities			SIRGAS multiyear solution		
	VX [m/y]	VY [m/y]	VZ [m/y]	VX [m/y]	VY [m/y]	VZ [m/y]
LIBE	0,0045	-0,0007	0,0134	0,0043	-0,0006	0,0104
LIMN	0,0141	0,0070	0,0096	0,0157	0,0079	0,0061
NEIL	0,0222	0,0070	0,0241	0,0220	0,0088	0,0220
PUNT	0,0102	-0,0006	0,0150	0,0101	0,0005	0,0121
RIDC	0,0100	0,0026	0,0187	0,0091	0,0031	0,0159
SAGE	0,0215	0,0061	0,0251	0,0207	0,0070	0,0224

Table 1. VelMIC and SIRGAS multiyear solution velocities comparison

5. Conclutions

- The figures first show a consistency between the velocities determined by VelMIC and the actual dispersion of the stations given by the final weekly solutions of SIRGAS.
- There is no match between extrapolated values according to CR-SIRGAS velocites and its actual positions. However, special care should be taken with the interpretation, since CR-SIRGAS velocities were considered acceptable in the period covered by their determination, but it is found that they do not represent the best values to be used in the coordinate update. It is necessary a kinematic model that incorporates in addition to the linear component, other factors that allow a better description of the stations contemplating the jumps and effects in the series

Reference:

- Moya, J. y S. Bastos (2014). Cálculo, mediante la aplicación del algoritmo de ajuste por mínimos cuadrados, de los componentes.... Uniciencia Vol. 28, No. 2 [1-14]
- Sánchez L. (2017) SIRGAS reference frame realization SIR17P01, Technische Universitaet Muenchen, Deutsches Geodaetisches Forschungsinstitut DGFI-TUM, IGS RNAAC SIRGAS, supplement to: Sánchez L. (2017) Kinematics of the SIRGAS reference frame, Symposium SIRGAS2017. Mendoza, Argentina.

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