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Recent activities of the IGS Regional Network Associate Analysis Centre for SIRGAS (IGS RNAAC SIRGAS)

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The present realization of SIRGAS is a network of about 450 continuously operating GNSS stations, which are processed in a weekly basis to generate instantaneous weekly station positions aligned to the ITRF and multiyear (cumulative) reference frame solutions. The instantaneous weekly positions are especially useful when strong earthquakes cause co-seismic jumps or strong relaxation motions at the SIRGAS stations making the previous coordinates useless. The multiyear solutions provide station constant velocities and positions referring to a certain epoch and allow monitoring deformations of the reference frame. The SIRGAS reference network comprises two hierarchy levels: a core network (SIRGAS-C) providing the primary link to the global ITRF; and national reference networks (SIRGAS-N) improving the geographical distribution of the reference stations to ensure accessibility to the reference frame at national level. The SIRGAS stations are processed by 10 SIRGAS Processing Centres (CEPGE Ecuador, CNPDG-UNA Costa Rica, CPAGS-LUZ Venezuela, DGFI-TUM Germany, IBGE Brazil, IGAC Colombia, IGN Argentina, IGM Chile, INEGI Mexico, SGM Uruguay), who generate loosely constrained weekly solutions to be integrated in a unified solution for the entire network. The individual solutions are combined by the SIRGAS Combination Centres: DGFI-TUM and IBGE.

As responsible for the IGS Regional Network Associate Analysis Centre for SIRGAS (IGS RNAAC SIRGAS), DGFI-TUM processed the entire SIRGAS network since June 1996 until August 2008. Now, DGFI-TUM supports SIRGAS by:

1) processing the SIRGAS-C core network (Fig. 1)
2) combining the core network with the national networks (Fig. 2)
3) ensuring that the SIRGAS analysis strategy conforms the IERS standards and IGS guidelines (Fig. 3)
4) developing strategies to guarantee the reliability of the reference frame through time; this includes
   - estimation of the reference frame kinematics (Fig. 4)
   - evaluation of the seismic impacts on the reference frame (Fig. 5)
   - modelling crustal deformation in the SIRGAS region (Fig. 6)
5) making available the SIRGAS products via www.sirgas.org and ftp.sirgas.org (Fig. 7).

This report summarizes the main activities carried out by DGFI-TUM as IGS RNAAC SIR during the last year.

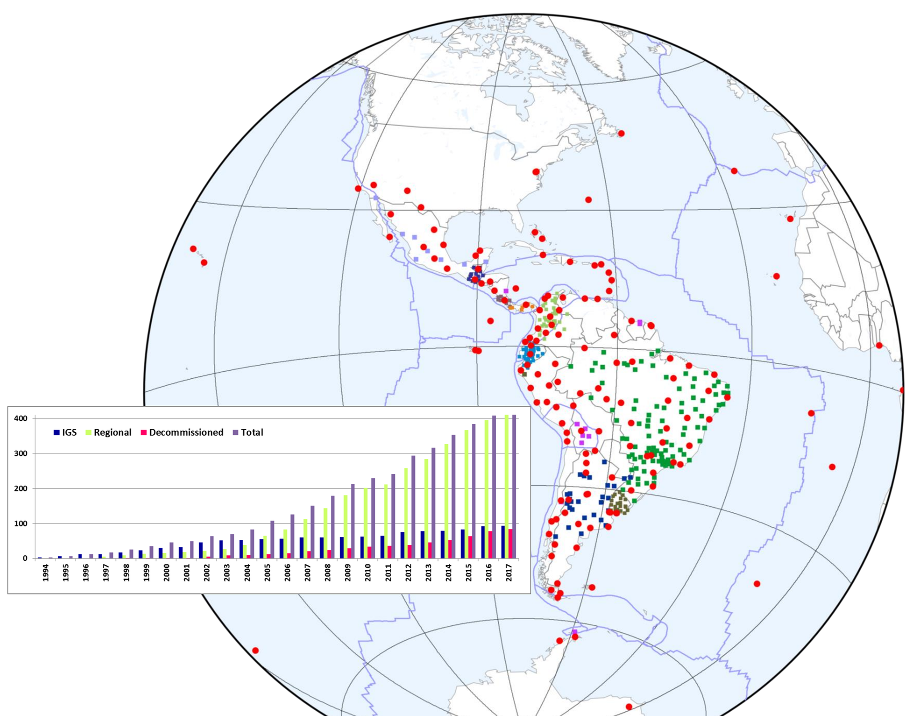
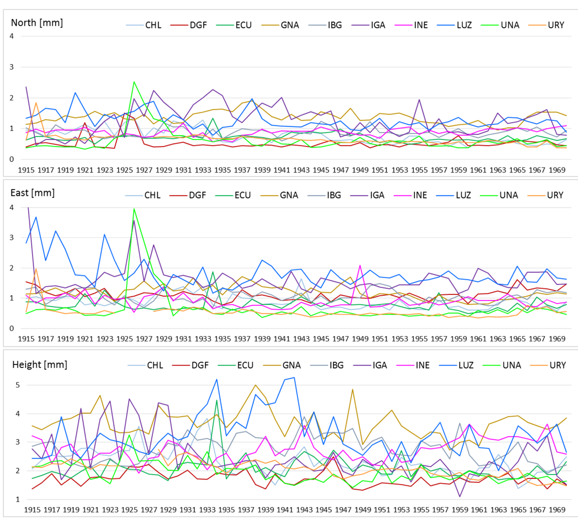
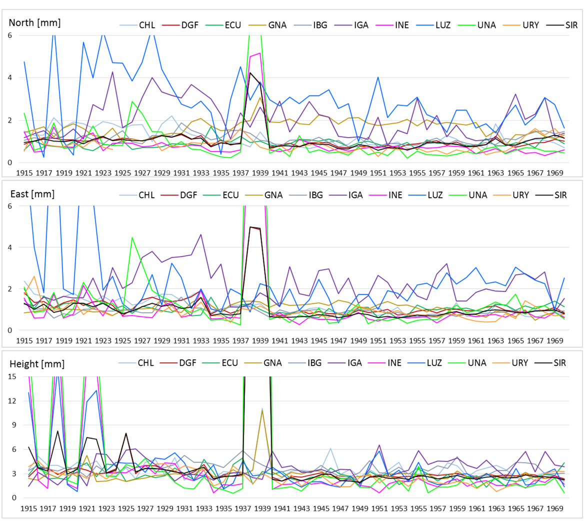


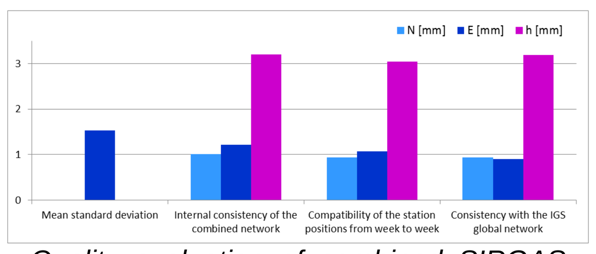
Fig. 1 – Core (red dots) and national (colour coded dots) networks within the SIRGAS reference frame (as of November, 2017). The bar graph shows the yearly increment of continuously operating SIRGAS stations.



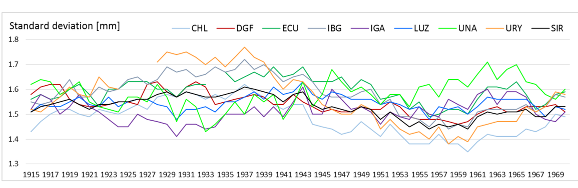
Time series of the RMS of the station position residuals for each analysis centre with respect to the SIRGAS weekly solutions.



Time series of the RMS of the station position residuals for each analysis centre with respect to the IGS weekly solutions. This comparison allows to assess the accuracy of the individual solutions in about ±1.5 mm in the North and the East, and ±4 mm in the height. Outliers in GPS weeks 1915 to 1923 are caused by changes in the Mexican stations' equipment, which were not noted by IGS opportunely. Outliers in weeks 1937 to 1939 are caused by an antenna change in station MDO1, which was not noted by IGS opportunely.



Quality evaluation of combined SIRGAS solutions: The mean standard deviation of the combined solutions agrees quite well with those computed for the individual contributions, i.e. the quality of the individual solutions is maintained and their combination does not deform or damage the internal accuracy of the entire SIRGAS network. The coordinates repeatability in the weekly combinations provides an estimate of the accuracy (internal consistency) of the weekly combinations of about ±1.0 mm in the horizontal component and about ±3.0 mm in the vertical one. The RMS values derived from the time series for station positions and with respect to the IGS weekly coordinates indicate that the reliability of the network (external precision) is about ±1.0 mm in the horizontal position and ±3.0 mm in the height.



Standard deviation of station positions after solving the individual solutions with respect to the IGS reference frame. These values represent the formal errors of the individual solutions. Processing centres applying the Bernese GNSS Software present values about ±1,6 mm, while processing centres using GAMIT/GLOBK have values of ±2,0 mm (GNA and INE, not shown).

Fig. 2 – Quality control of the individual solutions delivered by the SIRGAS analysis centres as well as of the combined solutions computed by the IGS RNAAC SIRGAS, time span from GPS week 1915 (18-09-2016) to week 1970 (14-10-2017).

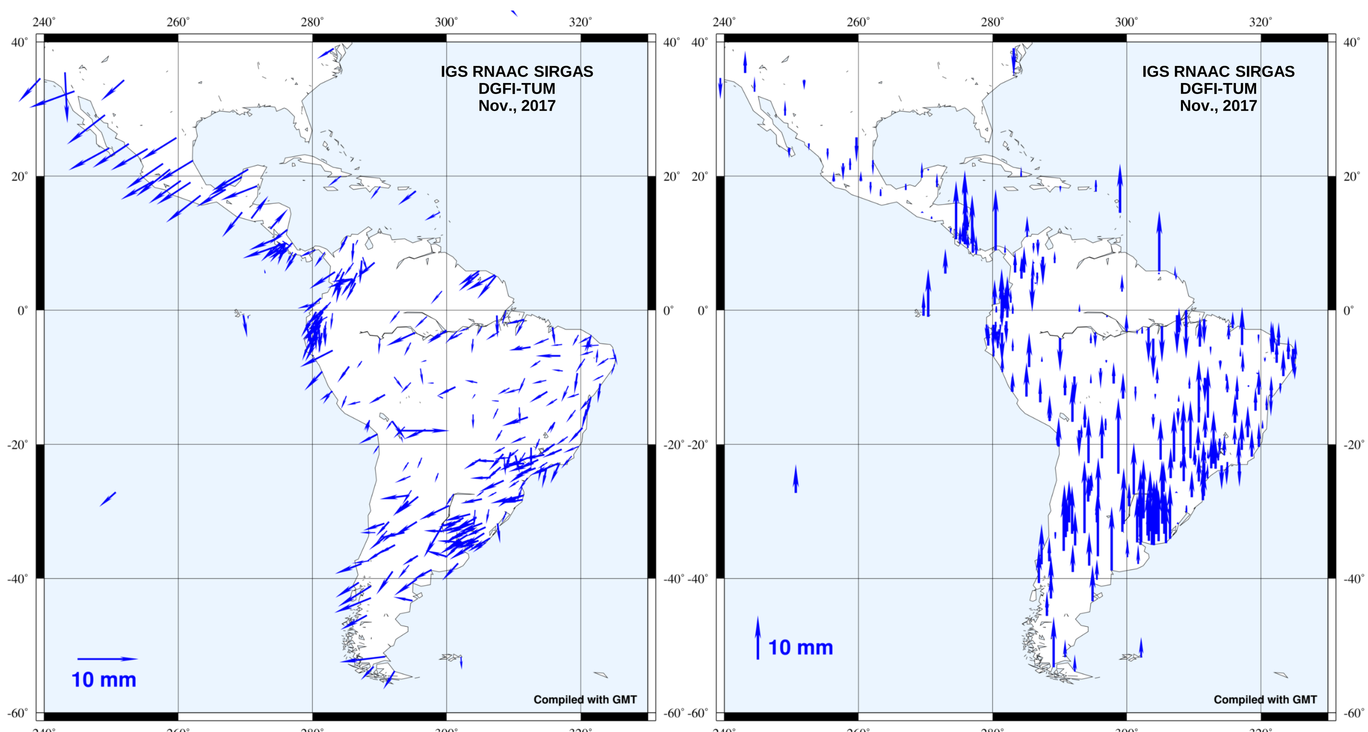


Fig. 3 – Impact of changing the frame IGS08/IGb08 by the IGS14 in the SIRGAS coordinates. Values obtained after processing simultaneously four GPS weeks (1930 to 1933, January 2017) using the same analysis strategy and input data, but varying PCV model, satellite ephemeris, EOPs and reference station coordinates. In one computation, they refer to the IGS08/IGb08; in the second computation, they refer to the IGS14. Differences in north component from -8.4 mm to +5.4 mm, in the east component from -8.5 mm to +11.3 mm, and in the height from -13.5 mm to 18.8 mm. A systematic behaviour of the differences is more or less identifiable; in general, one can say that the SIRGAS network is translating to the south-west and is going up; i.e. the distance to the geocentre increases. We can state that the introduction of the IGS14 causes a translation of -3.0 mm, -2.6 mm and +3.4 mm in the X, Y, Z directions, respectively, and that the new PCV model generates a scale factor of 0.5 ppb. These values are only indicative for the SIRGAS region and are valid for January 2017; i.e., they may be influenced by seasonal effects. These values are in agreement with those obtained after applying the latitude-dependent PCV models recommended by the IGS.

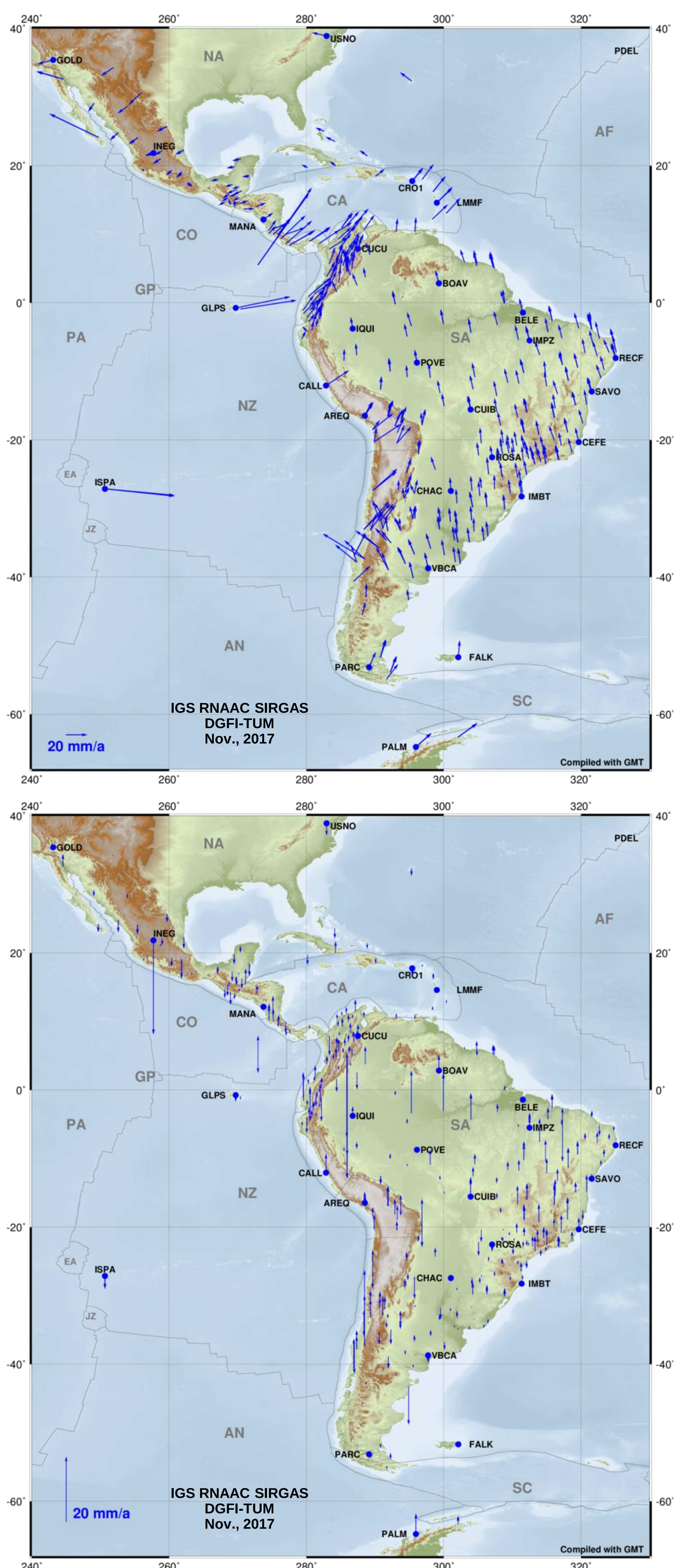


Fig. 4 – Horizontal (above) and vertical (below) velocities of the multiyear solution SIR17P01. It covers from 17-04-2011 to 28-01-2017 and includes only weekly solutions referring to the IGS08/IGb08 frame. This solution has been aligned to the IGS14 frame as shown in Fig. 3 and it is consistent with the igs14.atx ground antenna calibrations. It includes 345 stations with 504 occupations. Coordinates refer to the IGS14, epoch 2015.0. Its estimated precision is ±1,2 mm (horizontal) and ±2,5 mm (vertical) for the station positions at the reference epoch, and ±0,7 mm/a (horizontal) and ±1,1 mm/a (vertical) for the velocities. Black labels identify the fiducial stations.

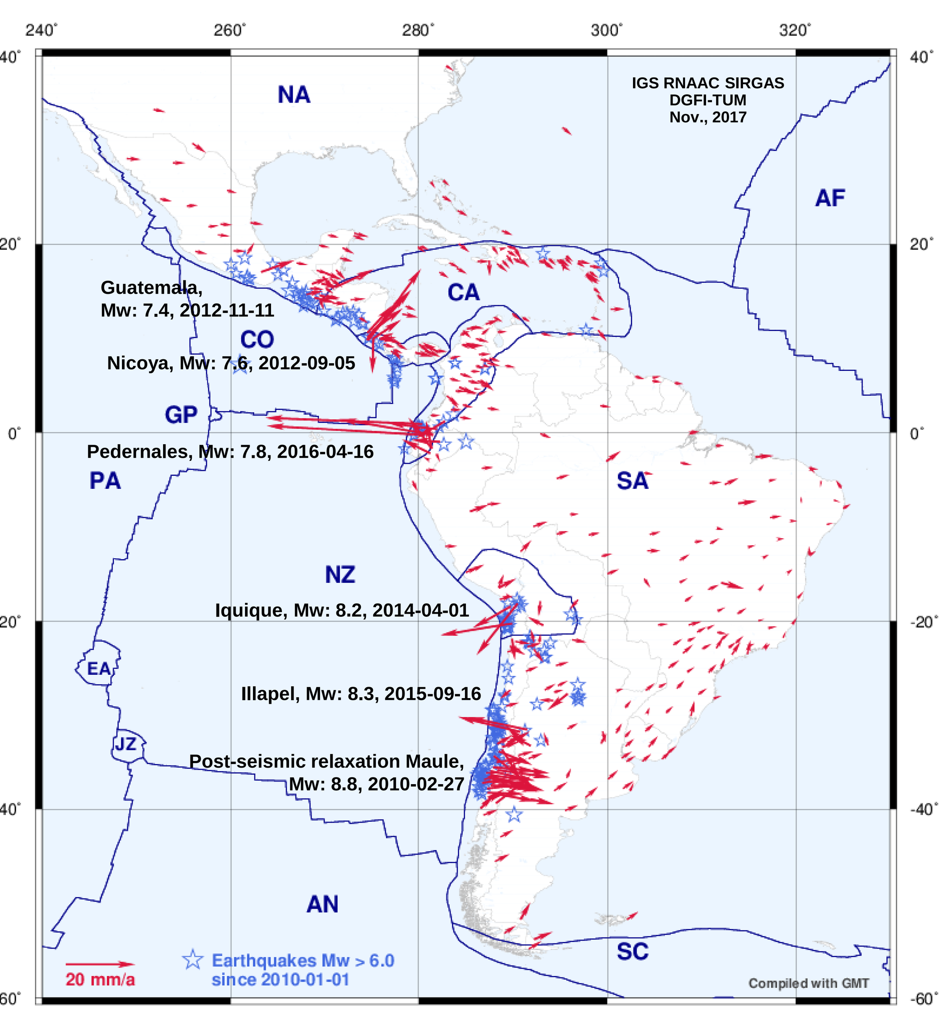
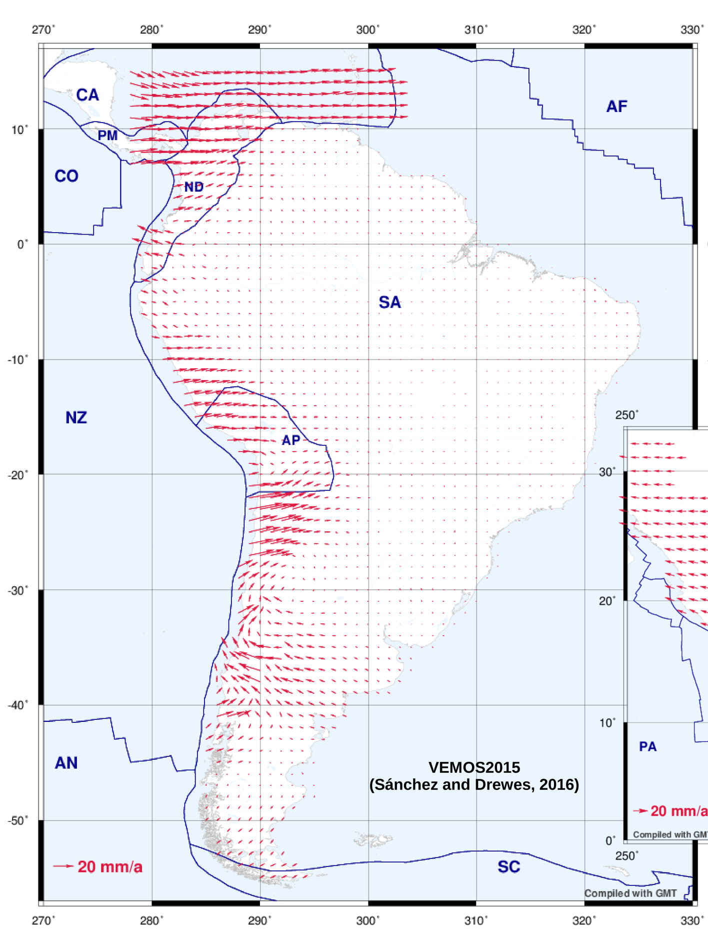


Fig. 5 – Differences between the horizontal velocities estimated in the SIRGAS multiyear solutions SIR17P01 (covering the time span 2014.0 - 2017.1) and SIR15P01 (covering the time span 2010.2 [2012.2] - 2015.2). Large discrepancies appear as a consequence of strong earthquakes (see black labels). They may be understood as post-seismic relaxation motions.



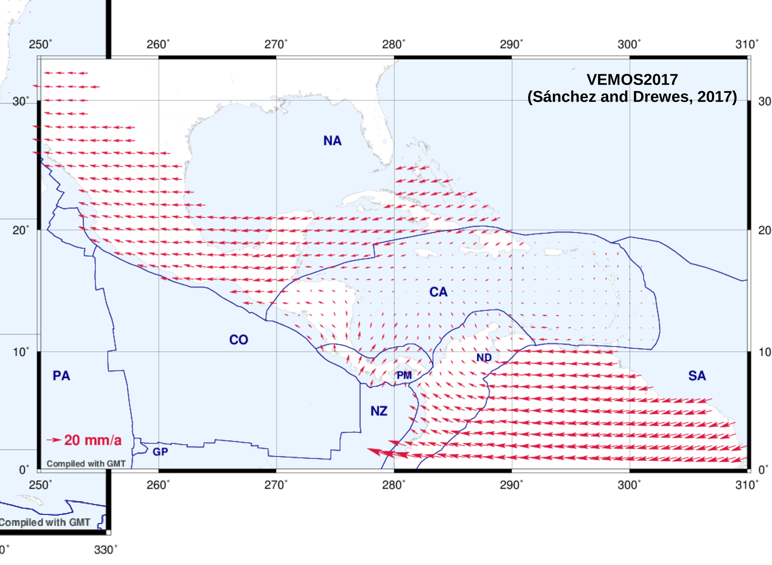


Fig. 6 – Surface-kinematics model inferred from the multiyear solution SIR17P01 (see Fig. 4): relative to the South American plate (left) and to the Caribbean plate (below). This model is called VEMOS2017 and considers only station velocities estimated from 2014.0 to 2017.1.

Fig. 7 – The SIRGAS web page www.sirgas.org was migrated from typo3 to Django. Its contents was reorganised and updated. In addition, together with the Spanish and English versions, a complete version in Portuguese is now available. The translation to the Portuguese language was performed (and will be further provided) by Wagner Carrupt Machado and Gabriel do Nascimento Guimarães from the Universidade Federal de Uberlândia (Brazil).