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GRGS ILRS ANALYSIS CENTER CONTRIBUTION FOR THE ITRF2008 REALIZATION

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Abstract. The French Groupe de Recherche de Géodésie Spatiale (GRGS) became an official ILRS Analysis Centre (AC) in September 2007, and thus joined the ILRS Analysis Working Group (AWG) among other official analysis centres. It now delivers routinely products including Station Space Coordinates (SSC), Earth Orientation Parameters (EOP), and other ones, after being involved in SLR data processing since the early eighties. This paper aims to recall some recent research achievements carried out in the framework of the activities of this AC, and in particular ILRS contribution for ITRF2008. We also compare our results to those obtained by other ACs, in terms of SSC, EOP, translations, scale factors, and rotations.

1 Introduction

The Terrestrial Reference Frame (TRF) realizations are established and maintained with the global space geodetic networks. The network measurements must be precise, continuous, worlwide, and interconnected by co-location of different observing techniques. The requirements to be followed in the framework of the GGOS project are to perform a global TRF with an accuracy of 1.0 mm, and a stability of 0.1 mm/yr, ensuring a sea level rise measurement coherent with the altimetric data precision. It has to be noticed that for every 1 mm/yr Z-trend in the TRF origin, sea level rates are affected by 0.2 mm/yr (Beckley et al, 2007, Fig4).

The Satellite Laser Ranging (SLR) network is one of these geodetic networks, organized through the International Laser Ranging Service (ILRS) (Pearlman et al., 2002). Its Analysis Working Group (AWG) is producing, on a weekly basis, a 7-day arc combined solution with a minimum latency of 4 days, providing daily EOPs and weekly site coordinates, based on the contribution of up to 8 Analysis Centers (ACs). Each AC solution contains Space Station Coordinates (SSC) and daily EOPs, using Lageos and Etalon data, according to ILRS/AWG guidelines. As an official ILRS AC, GRGS (Groupe de Recherche de Géodésie Spatiale) provides such products, that are compared to each individual solution, and to the combined solution.

This work, performed over a long period of time, is the ILRS answer to the call for participation in ITRF2008, that was sent by the Combination Centers during the 2009 summer. We present here the work that was done by GRGS, and we analyse the comparison wrt the combined solution.

2 Post-fit analysis of Satellite Laser Ranging Data

Two geodetic satellites were used in this study to derive time series: Lageos-1 and Lageos-2. The network of tracking stations involves about 30 stations (most of them located in the northern hemisphere, due to a well-known inhomogeneity of the ILRS network), gathering up a total of 2000 to 3000 normal points per week. For the two satellites, over the 1993-2009 period, the averaged post-fit residual level is of the order of 1.4cm. The a priori force modelling accounts for the influence of the gravity field of the Earth, developed in spherical harmonics up to degree and order 30, and including a time-varying part due to oceanic and terrestrial tides,

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third bodies effects. A set of six empirical coefficients is adjusted every week as well, to compensate the lackness of non gravitational force modelling acting on the trajectories: a factor for the solar radiation pressure (very close to 1, at the level of 10^{-6}), three coefficients towards the tangential direction (1 constant term, and two terms at the revolution period), two coefficients towards the normal direction (at the revolution period). Weekly normal matrices are derived relatively to the parameters to be kept in the combination: no range bias, except for a very limited number of stations (following the recommendations provided by the ILRS AWG), a set of SSC per week (relatively to the a priori TRF), daily EOPs.

Figure 1 and Figure 2 show the level of post-fit residuals analysis of weekly arcs. It is at the order of 1 cm.

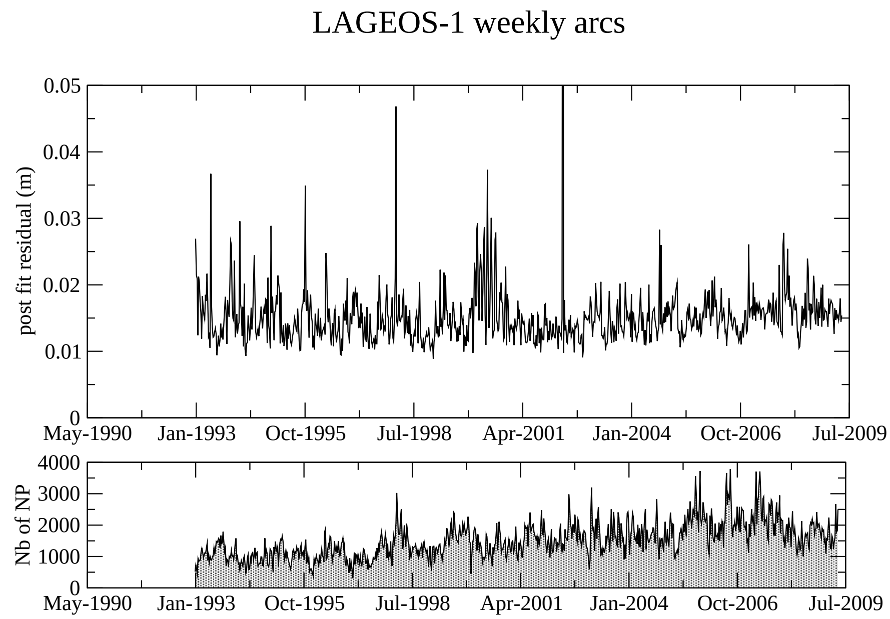

Fig. 1. Lageos-1 post-fit level of weekly residuals, over the period 1993-2009

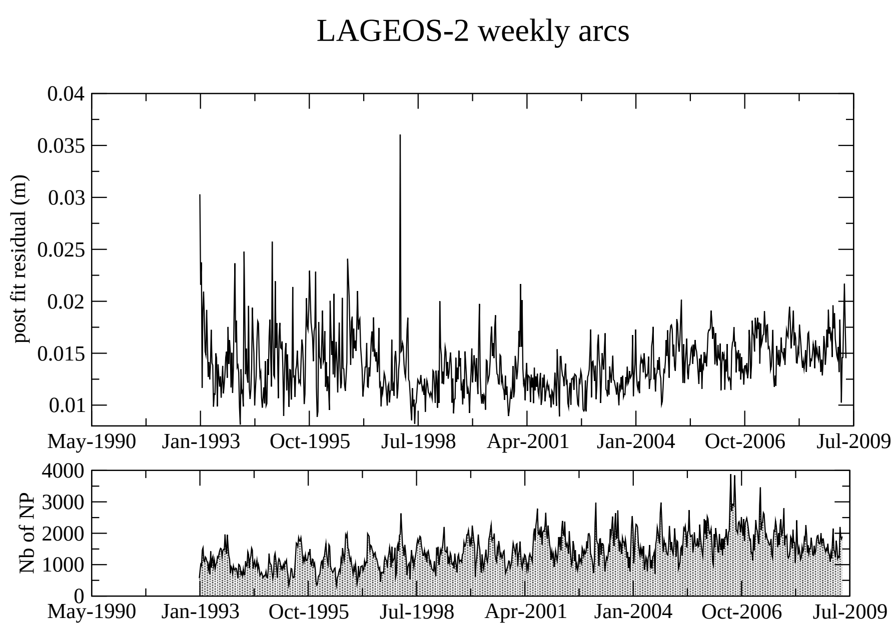

Fig. 2. Lageos-2 post-fit level of weekly residuals, over the period 1993-2009

3 Comparisons with the ILRS combined solution

Figure 3 and Figure 4 show the comparison, for the main parameters defining a TRF deduced from the orbit computations, between the ILRS combined solution and each AC contribution. It appears that, at least over that period of time, GRGS contribution is one of the closest to the combined solution.

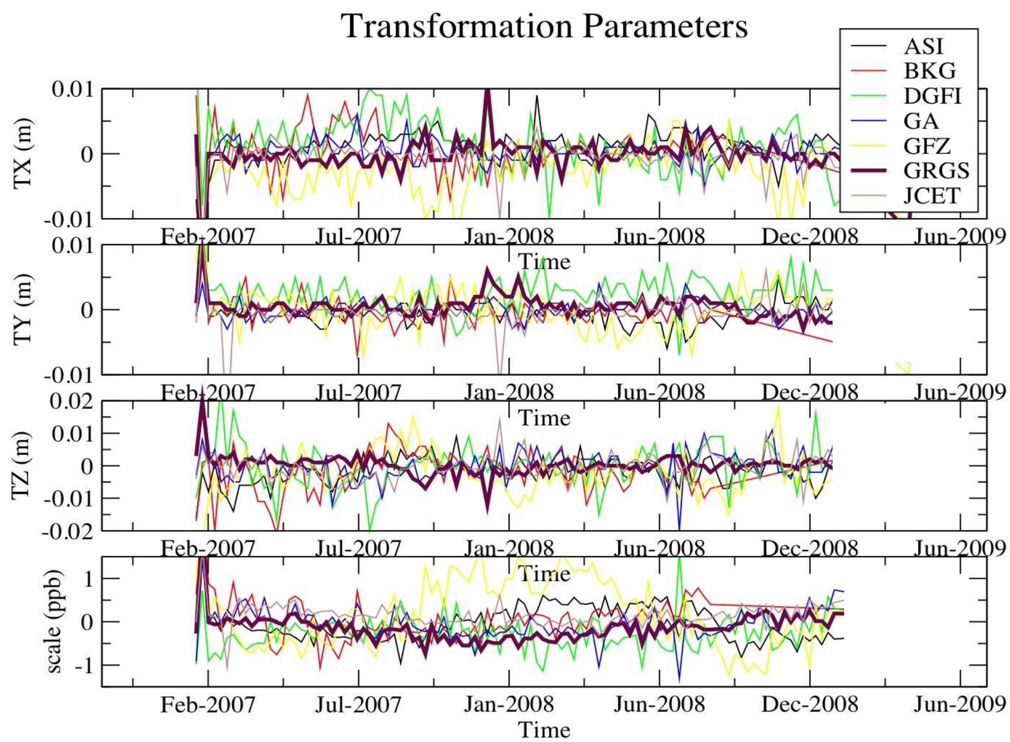

Fig. 3. Comparaison between Translation and Scale parameters provided by the different ACs, over 2007 and 2008, wrt the combined solution

Compared to the combined solution, the weekly mean residuals of the polar motion X and Y components of the solution provided by GRGS have a mean value at the level of 10 and 6 μas respectively, and a standard deviation of the order of 300 μas. The weekly mean residuals of the LOD values provided over 1992-2009 have a mean value at the level of 1 μs, and a standard deviation of the order of 60 μs. All these values are at the level of the solutions provided by the "best" ACs.

4 Impact of the a priori data corrections

ITRF retrieves coordinates and velocities from coordinate time series, under the asumption of linear station motion. But, unknown physical reasons or reasons due to technological evolution of a station equipment may induce a discontinuity within the corresponding coordinate time series. The AWG of the ILRS has identified part of these discontinuities, which have to be corrected by the insertion (and estimation) of biases to be applied before the computations. For the remaining cases, the time series is better fitted with a piece-wise linear function, estimating more than one set of coordinates and velocities. Figure 5 (Coulot et al., 2009) shows the impact of bias on the final products. It appears that the scale factor time series are more stable when station range biases are rigorously estimated and applied, and this rigorous estimation is one of the corner stones of the SLR technique, for which much work is still required by ACs, and GRGS in particular.

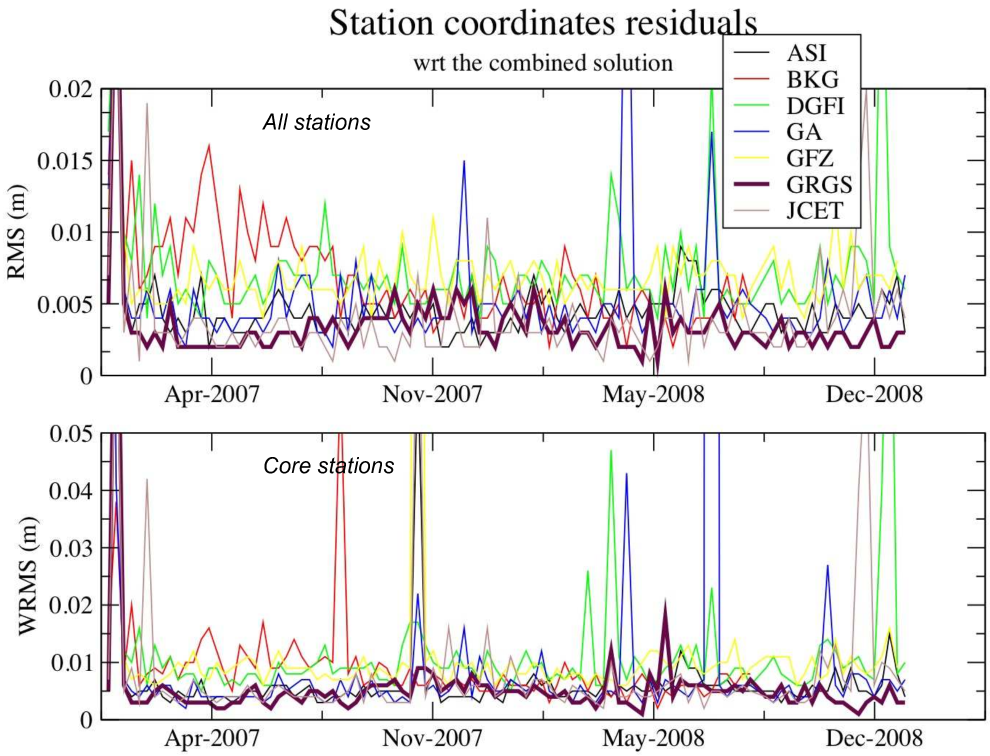

Fig. 4. Comparaison between Station Space Coordinate residuals provided by the different ACs, over 2007 and 2008, wrt the combined solution

5 Conclusion

GRGS, as an official Analysis Center of the ILRS, provides on a daily and weekly basis operational products that are available on ILRS website (http://ilrs.gsfc.nasa.gov), and on the OV-GAFF working group page (http://grg2.fr). These products are based on the recommendations provided by the AWG of the ILRS, and constitue the french SLR part of the realization of the new release of the International Terrestrial Reference Frame. Further investigation is still required to analyse precisely the accuracy and precision of the time series.

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References

Beckley B. D., F. G. Lemoine, S. B. Luthcke, R. D. Ray, N. P. Zelensky, 2007, Geophys. Res. Lett., 34, L14608, doi:10.1029/2007GL030002.

Coulot D., P. Berio, P. Bonnefond, P. Exertier, Dominique Feraudy, O. Laurain, F. Deleflie, Proceedings of the 2007 IAG General Assembly, Perugia, Italy, July 2 - 13, 2007, vol. 133, pages 39–46, Springer, IAG, 2009

Pearlman, M.R., Degnan, J.J., and Bosworth, J.M. 2002, The International Laser Ranging Service, Advances in Space Research, Vol. 30, No. 2, pp. 135-143, DOI:10.1016/S0273-1177(02)00277-6.

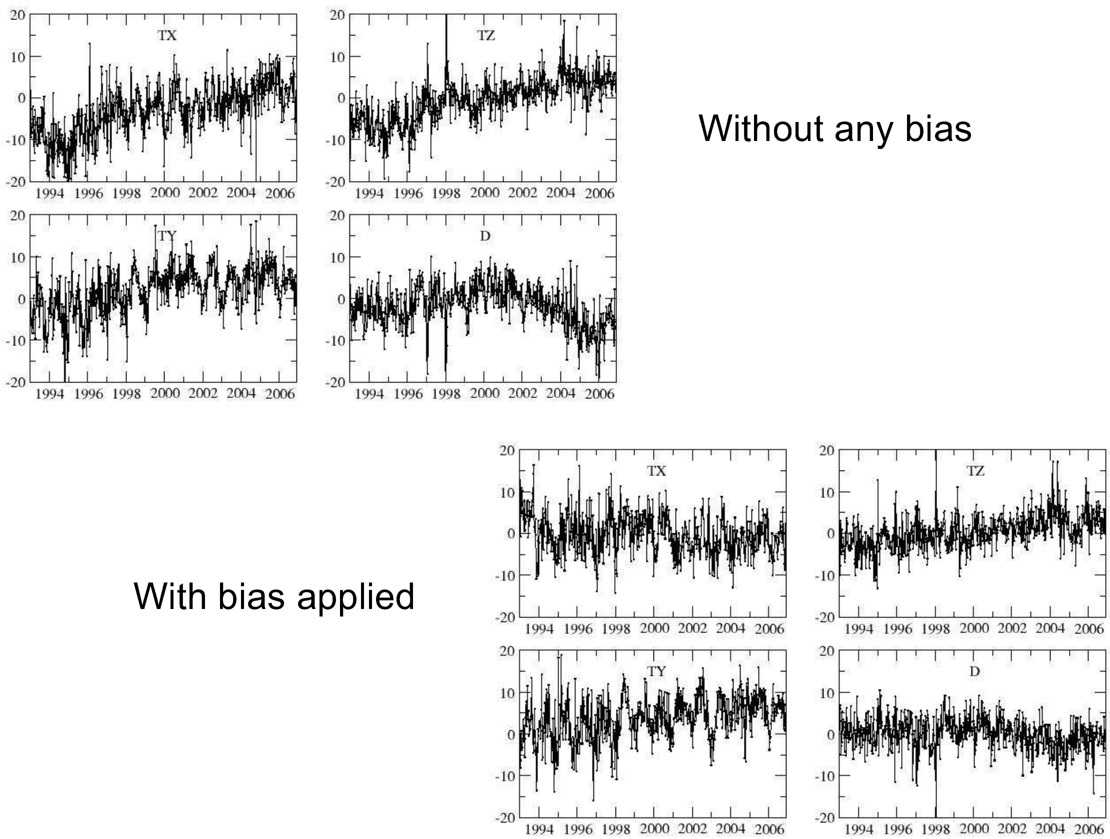

Fig. 5. Three translations and scale factor time series between weekly terrestrial frames and ITRF2000 in mm