

Quality Assessment of the ILRS EOP 'Daily' Product

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Abstract

The ILRS Analysis Community has been developing, since several years, global, long term, very accurate geodetic products. In the last few years, even short term (weekly data arcs) and fast updated (every week) geodetic solutions have been produced, conveyed into official ILRS combined 'weekly' product, thus allowing the users to benefit of SSC and EOP estimates which are either accurate and fast. In the case of EOP, the users are provided with daily estimates over a week with a minimum latency, at the generation day, of 4 days and a maximum latency of 11 days. The 'weekly' product performance triggered the generation of a faster, lower latency combined product, now still under testing. This product is labelled 'daily' due to its updating frequency: a sliding window of 7 days worth of data is analyzed daily, reducing the overall product latency to 2 days. In this presentation, the performance of the presently available 'daily' EOP combined product is reported. In particular, the stability and reliability of the product with respect to its latency is analysed, as well as the effect of the combination process.

The ILRS Weekly Solution experience

Since 2004, ILRS has been providing, routinely, the weekly combined SSC/EOP solutions mainly to support IERS for the EOP computation, give the scientific community an updated coordinate time series and contribute to the reference frame maintenance. Each weekly solution consists of

- daily estimated ITRF-framed and loosely constrained EOP values (XPO, YPO, LOD)
- a set of loose constrained coordinates for the acquisition network
- several quality evaluation indicators

provided in three different files available at CDDIS and EDC.

At present, eight Analysis Centers (ACs) contribute to the weekly ILRS combined solution issued by the Official ILRS Combination Centers (hereafter CCs): ASI, BKG, DGFI, GA, GFZ, GRGS, JCET, NSGF. ASI-CGS is the Primary ILRS CC and its product (named ILRSA) follows the combination procedure based on the direct combination of loosely constrained solutions (Davies and Blewitt, 2000; Bianco, Devoti, Luceri, 2003). The combination is performed along the lines of the iterative Weighted Least Square technique: each contributing solution plays the role of an 'observation' whose residuals with respect to the combined solution must be minimized.

Each Wednesday, the official ILRS combined solutions are issued following the same timeline: the SLR data acquired (Lageos1/2, Etalon1/2) during a 7-day period (Sunday-Saturday) are processed by the ACs and made available to the CCs within Tuesday.

√ Data arc

7 days

√ Generation frequency 1/week
 √ EOP estimate age 4-10 days

In Figure 1, a sample (Jan-Oct 2008) of EOP ILRSA residuals with respect to the USNO finals values is shown; different age of the estimates are indicated. The relevant overall statistics is reported in Table 1.

Table 1. ILRSA weekly solution EOP residuals wrt USNO EOP “finals.data”

X (mas)		Y (mas)		LOD (0.1ms)	
<res>+/-std	<σ>	<res>+/-std	<σ>	<res>+/-std	<σ>
0.02+/-0.17	0.05	0.04+/-0.17	0.05	0.04+/-0.41	0.12

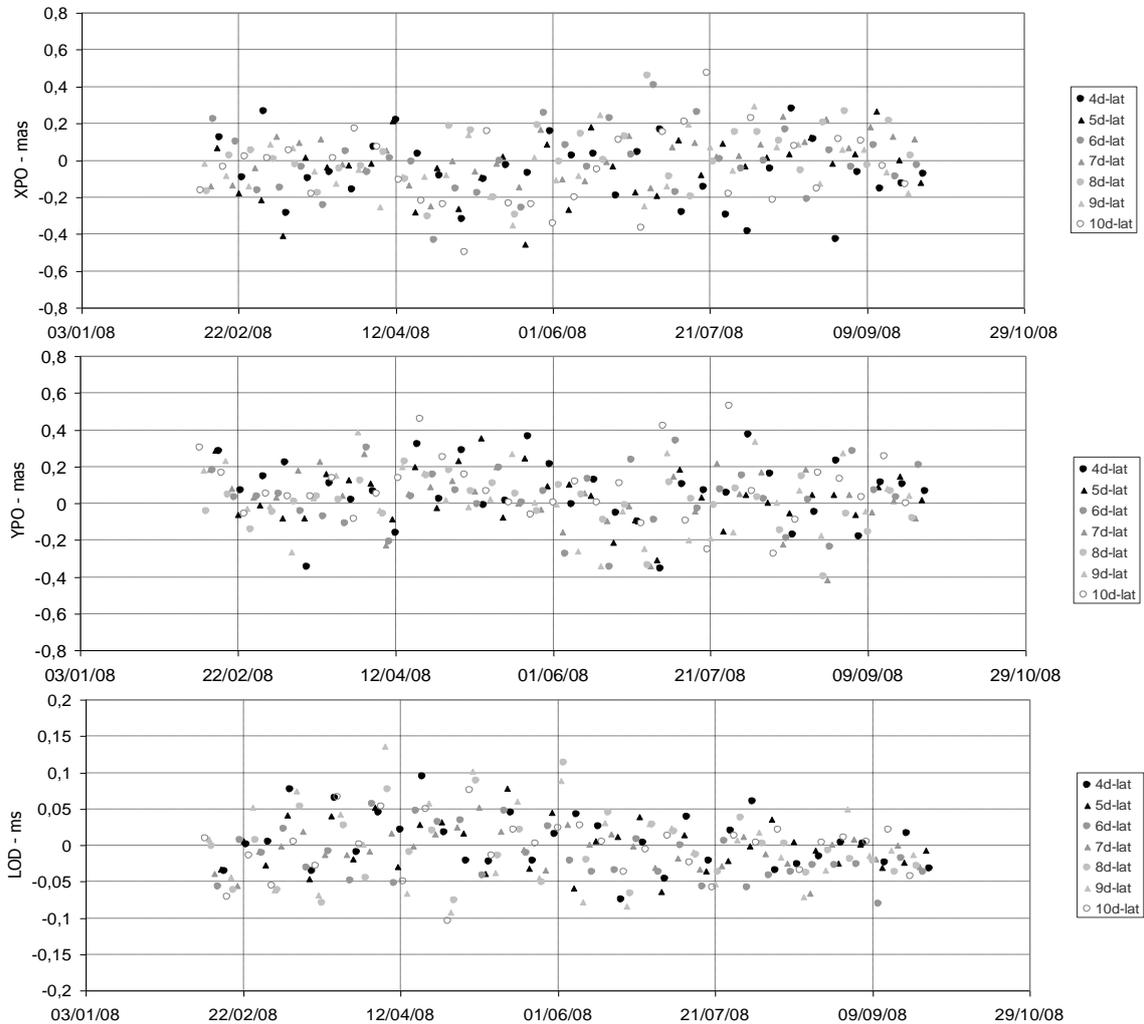


Figure 1. ILRSA weekly solution EOP residuals wrt USNO EOP “finals.data”

An enhanced ILRS product: the Daily Solution

The consolidated, well performing ILRS weekly product (Bianco, Luceri, Sciarretta, 2006) has suggested the concept of a ‘rolling’ weekly product to be issued daily in order to provide the minimum latency SLR contribution to the IERS EOP estimation.

At day N-1, within midnight UTC, each contributing AC makes available its weekly solution spanning the period [N-8, N-2]; at day N, the CCs generate the combined solution. The following features are common:

- √ Data arc 7 days
- √ Generation frequency 1/day
- √ EOP estimates age 2-8 days

ASI-CGS CC adapted the ILRSA weekly combination strategy to the daily product; only a slight tuning has been performed to allow the proper handling of the USNO “finals.daily” as reference values, due to the necessity of computing a reference value for the most recent LOD estimate, not provided by that EOP series.

Moreover, a careful revision of the combination procedure has been performed, in order to allow the fully automated generation of the solutions, including the reporting, to avoid (or minimize) the daily intervention of the analyst. The automated ILRSA combination procedure, at present, starts every day at 1:30 AM UTC; the starting time may be modified according to ILRS/IERS recommendations.

At present, 5 ACs contribute to the daily ILRS combined solution: ASI, BKG, GFZ, JCET, NSGF.

A preliminary overall assessment of the Daily Solution

February 25th, 2008 may be assumed as the true start date of the pre-operational generation of the daily ILRSA product: that is the first date when all the 5 ACs submitted fully operational solutions after a brief tuning phase. Since then, only few sporadic cases of missing solutions occurred. If late solutions were submitted, they were not analysed to stress the ILRSA combination procedure under realistic operational conditions.

The Core station list, as agreed after the Grasse ILRS AWG (Sep.’07) meeting, is used in the ILRSA daily product. As for the consolidated weekly product, 3d WRMS for all sites is below 10mm, while for the Core sites it is slightly above 7mm.

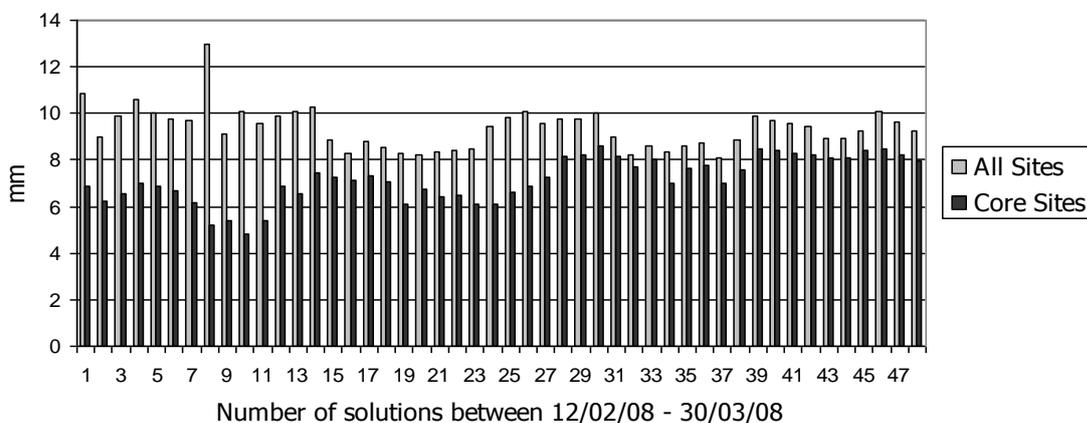


Figure 2. ILRSA daily solution: a sample SSC 3D WRMS wrt SLRF2005

A preliminary quality evaluation of the daily solution results at the start of the pre-operational phase has been made through the cross comparison with IERS EOP C04 and with ILRSA weekly solutions, focussing on the **most recent day EOP estimate**, being that one the most critical from the product latency, and hence efficacy, point of view.

The results, based on a month of solutions, indicate an overall precision level ($\langle\sigma\rangle$) of the last day estimates of the order of 0.10mas/0.026ms and an accuracy level (WRMS(res)) of the order of 0.25mas/0.070ms, roughly twice, twice-and-half larger than the values relevant to the Weekly solution.

Table 2. ILRSA weekly solution EOP residuals wrt USNO EOP “finals.data”

	X (mas)		Y (mas)		LOD (0.1ms)	
	$\langle\text{res}\rangle\pm\text{std}$	$\langle\sigma\rangle$	$\langle\text{res}\rangle\pm\text{std}$	$\langle\sigma\rangle$	$\langle\text{res}\rangle\pm\text{std}$	$\langle\sigma\rangle$
D	0.14 \pm 0.20	0.10	-0.04 \pm 0.27	0.10	-0.017 \pm 0.064	0.026
W	0.08 \pm 0.13	0.05	-0.03 \pm 0.12	0.05	-0.004 \pm 0.052	0.012

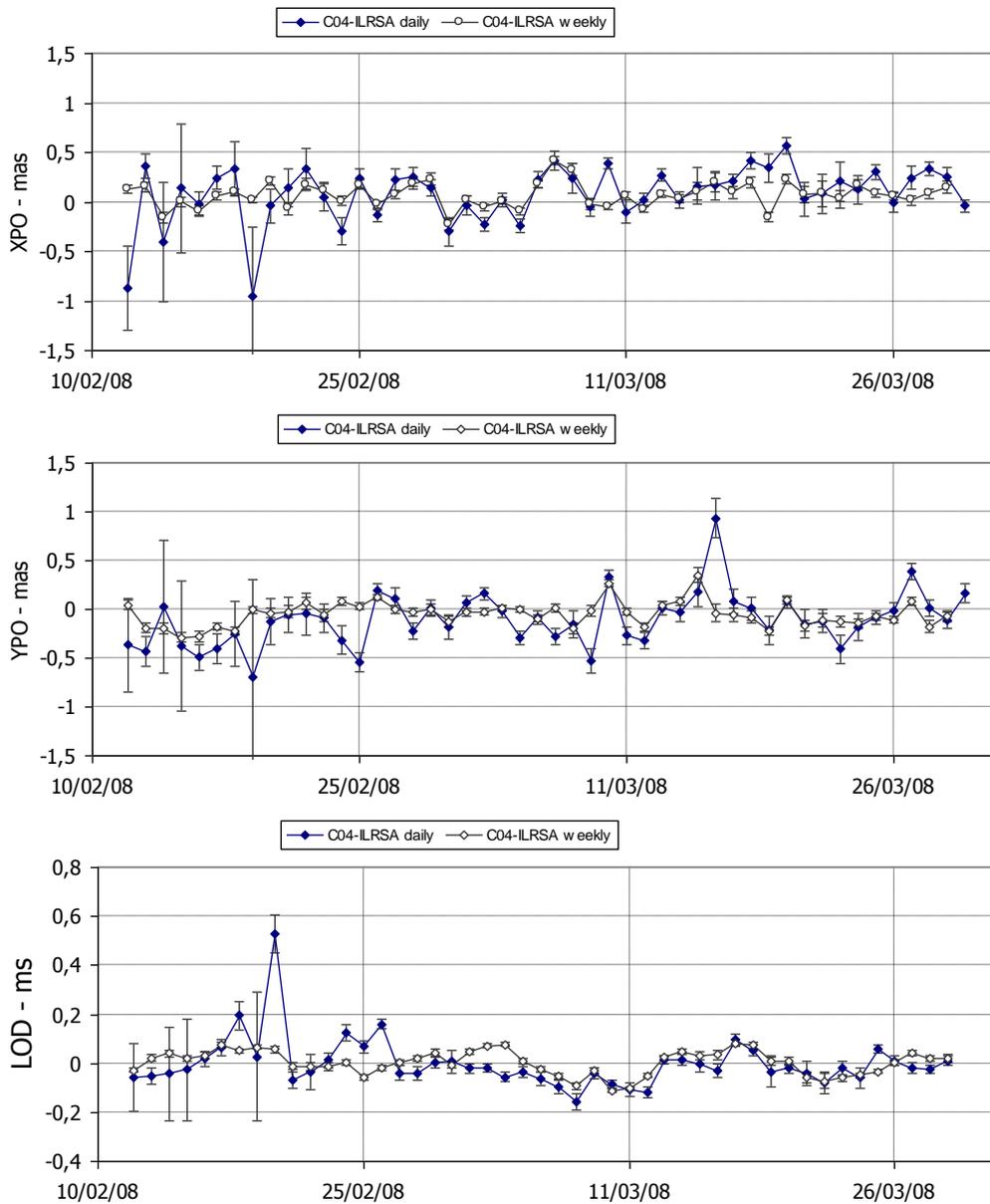


Figure 3. Sample assessment on the ‘last day’ ILRSA daily EOP estimates

An assessment of the Daily Solution in terms of ‘age’ of estimates

The accumulation of solutions allows a deeper insight into the performance of the product versus the ‘age’ of the estimated EOP’s, keeping in mind that the potential added value of the daily product is the availability of the fastest EOP, as possible, with the best accuracy level. Up to October 2008, more than 6 months of individual and combined solutions were available and they have been used to construct EOP time series with the “same age”. The quality of the sampled series has been evaluated by computing the relevant statistics for each contributing AC: an “arc edge” effect is evident in the x-pole and y-pole estimates (Fig. 4, Fig.5, Fig.6, Fig.7) both in the RMS of the residuals with respect to the USNO “finals.data” and in the estimate uncertainties.

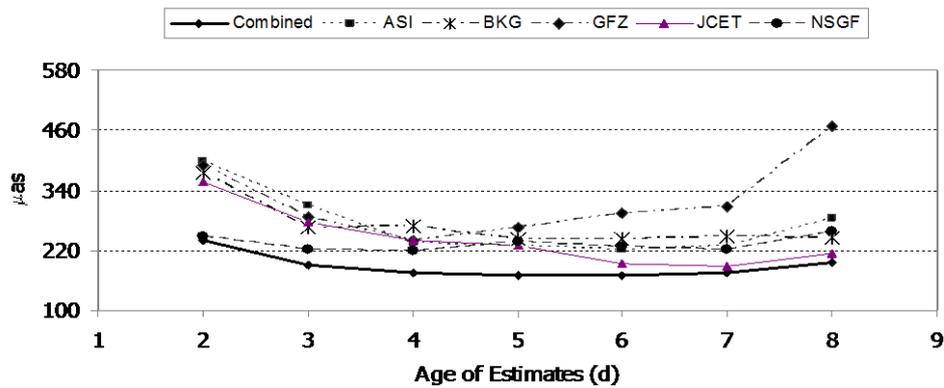


Figure 4. RMS of XPO residuals w.r.t. USNO “finals.data” vs “age”

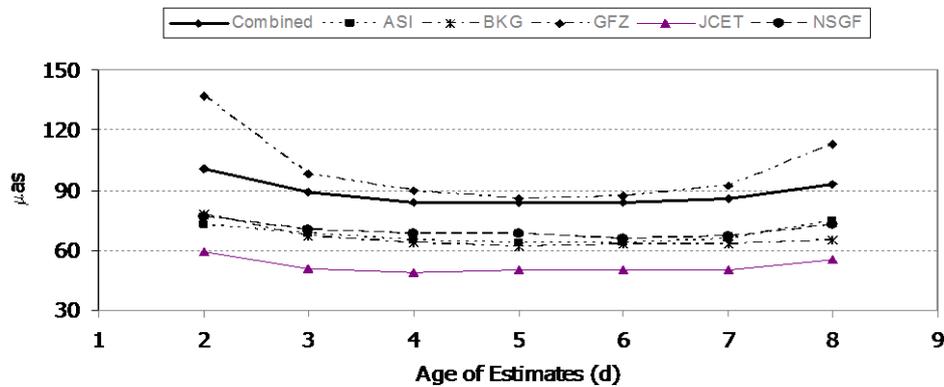


Figure 5. Average uncertainty of XPO estimates vs “age”

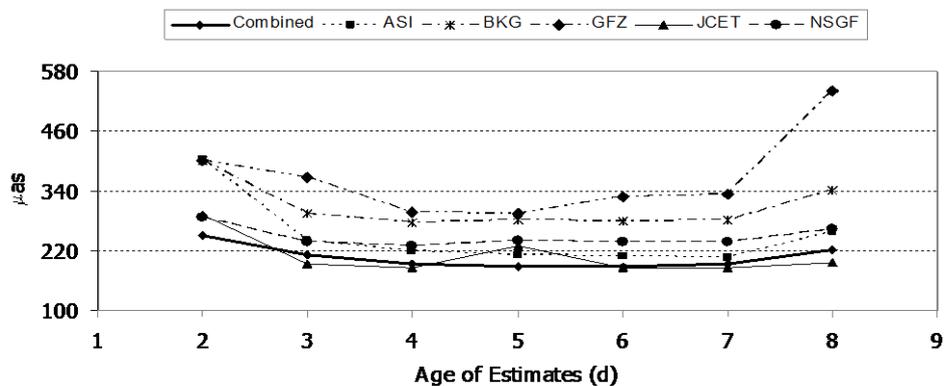


Figure 6. RMS of YPO residuals w.r.t. USNO “finals.data” vs “age”

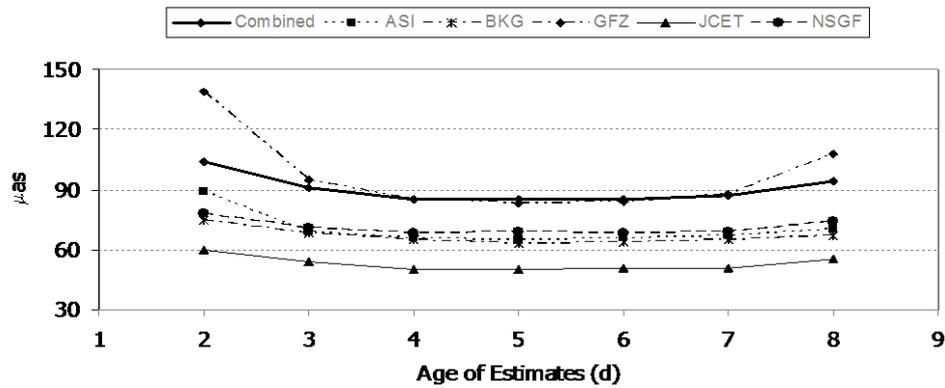


Figure 7. Average uncertainty of YPO estimates vs "age"

The edge effect, also present in the combined weekly product, is a key feature to be investigated to provide the lowest latency (2 days), accurate EOP estimates, that is the primary target of the daily solution product; the combined product mitigates the effect especially in the accuracy of estimates, but their uncertainties, rescaled by the post fit variance factor, are affected both by the imprecision of the contributing estimates and by their discrepancies. The following comments hold:

- part of the "arc edge" effect, for the 'last day' estimates is due to partial lack of observation data: the problem can be overpassed by pushing some hours later the issue epoch of the contributing solutions to collect more data;
- discrepant values among contributing solutions raise the uncertainty and accuracy of the final combined values;
- fine tuning of the analysis strategy should be done by the ACs to mitigate the "arc edge" effect in the contributing solutions, showing different levels of evidence;
- new contributors will improve the quality of the daily product.

It is worth to be noted that the 3-day-old EOP estimates show a good level of accuracy and precision and represent already an operational upgrade of the performance of the weekly solution, providing the same level of accuracy at a homogeneous and faster latency.

Conclusive remarks

At present, ILRS is able to provide daily, in a pre-operational phase, a combined solution with high level quality, daily, EOP estimates, covering a weekly arc, and with a constant latency lower than the minimum latency of the ILRS weekly solution (4 days). The minimum constant latency possible for the product is 2 days; in this extremal case, however, several actions have to be undertaken to mitigate the "arc edge" effect, degrading the potential quality of the 'last day' EOP estimates: adding contributing solutions, revising the length of the data arc, tuning the AC analysis strategies will raise the quality of the product. The 3-day latency EOP estimates, however, can be considered, at present, an optimal trade-off between accuracy and latency requirements.

References

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