Quality assessment of the ILRS EOP „Daily" Product

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ILRS Weekly Solution

Since **2004**, ILRS has been providing, routinely, the weekly combined *SSC/EOP* solutions to support IERS for the EOP computation and the SLR community for the data reduction.

For each weekly solution

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

are provided in 3 different files available at **CDDIS** and **EDC**:

ilrs.pos+eop.***yymmdd***.v***nn***.snx

ilrs.pos+eop.***yymmdd***.v***nn***.sum

ilrs.eop.***yymmdd***.v***nn***.snx

ILRS Weekly Solution

At present, **8 ACs** contribute to the weekly ILRS combined solution:

ASI BKG DGFI GA GFZ GRGS JCET NSGF

Each *Wednesday*, the official ILRS combined solutions (ILRSA, official; ILRSB, backup) are issued along 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 estimates age	**4-10 days**

ILRSA combination approach

The ASI-CGS combination procedure is based on the direct combination of loose constrained solutions (*"Methodology for global geodetic time series estimation: A new tool for geodynamics"*, Davies and Blewitt, 2000).

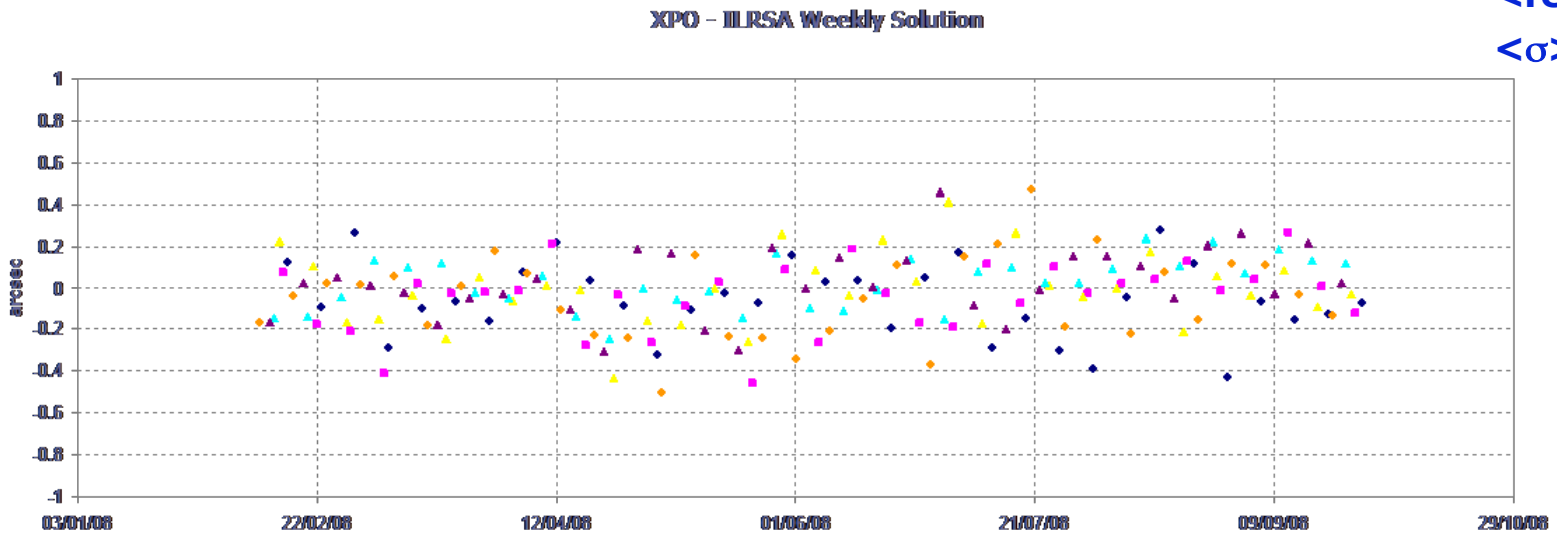
Site Coordinates
Site Velocities
E.O.P.
E.O.P. Rates

$$\begin{pmatrix} \mathbf{X}_1(t_1) \\ \mathbf{X}_{1dot}(t_1) \\ \mathbf{Y}_1(t_{1j}) \\ \mathbf{Y}_{1dot}(t_{1j}) \end{pmatrix} = \mathbf{P} \begin{pmatrix} \mathbf{X}_0(t_0) \\ \mathbf{X}_{0dot}(t_0) \\ \mathbf{Y}_0(t_{0j}) \\ \mathbf{Y}_{0dot}(t_{0j}) \end{pmatrix} = \begin{pmatrix} \mathbf{I} & (t_1 - t_0)\mathbf{I} & 0 & 0 \\ 0 & \mathbf{I} & 0 & 0 \\ 0 & 0 & \mathbf{I} & (t_{1j} - t_{0j})\mathbf{I} \\ 0 & 0 & 0 & \mathbf{I} \end{pmatrix} \begin{pmatrix} \mathbf{X}_0(t_0) \\ \mathbf{X}_{0dot}(t_0) \\ \mathbf{Y}_0(t_{0j}) \\ \mathbf{Y}_{0dot}(t_{0j}) \end{pmatrix}$$

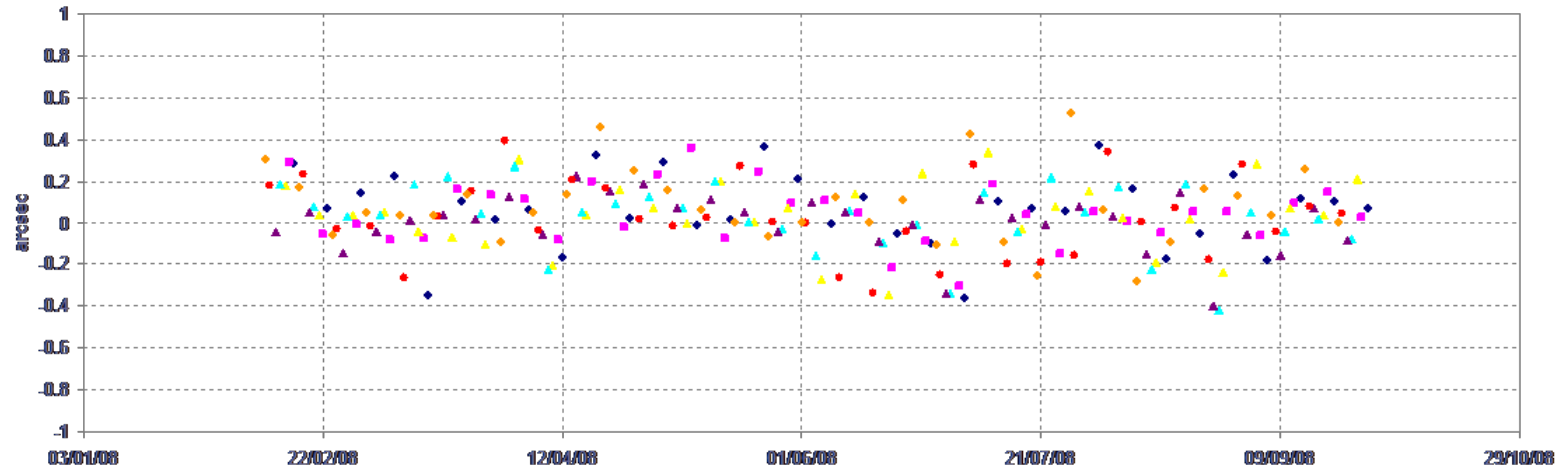
The combination is performed along the lines of the iterative Weighted Least Square technique: each contributing solution plays the role of an 'observation' whose residuals with respect to the combined solution must be minimized.

ILRSA EOP performance – a sample

<res>=-21+/-168 μas
<σ>=48 μas

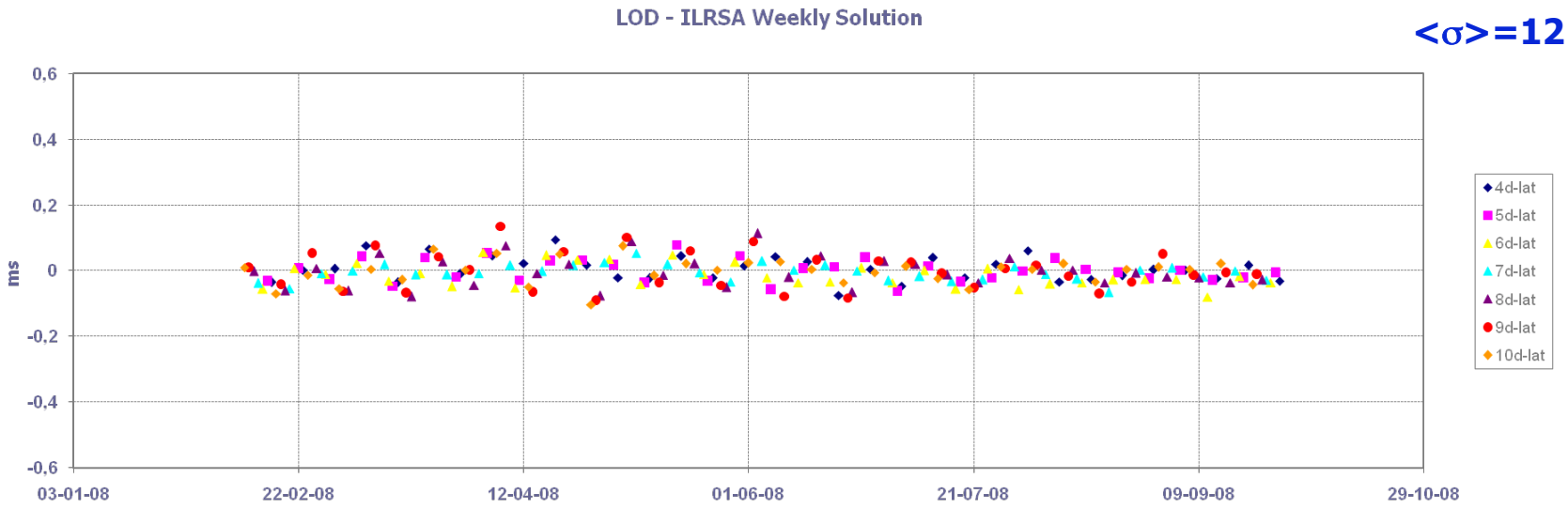


<res>=38+/-165 μas
<σ>=47 μas



ILRSA EOP performance – a sample

<res>=-4+/-41 μs
<σ>=12 μs



A new ILRS product: Daily Solution

The consolidated ILRS weekly product has generated the concept of a **'rolling' weekly product** to be issued daily 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 "***acx*.pos+eop.*yymmdd*.v100.snx**" spanning the period *[N-8, N-2]*; at day *N*, CCs generate the combined solution, "***ccx*.eop.*yymmdd*.v100.snx**".

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

Daily Solution: the ILRSA strategy

ILRSA strategy

- 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 (necessity of computing a reference value for the last LOD estimate).

- 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.

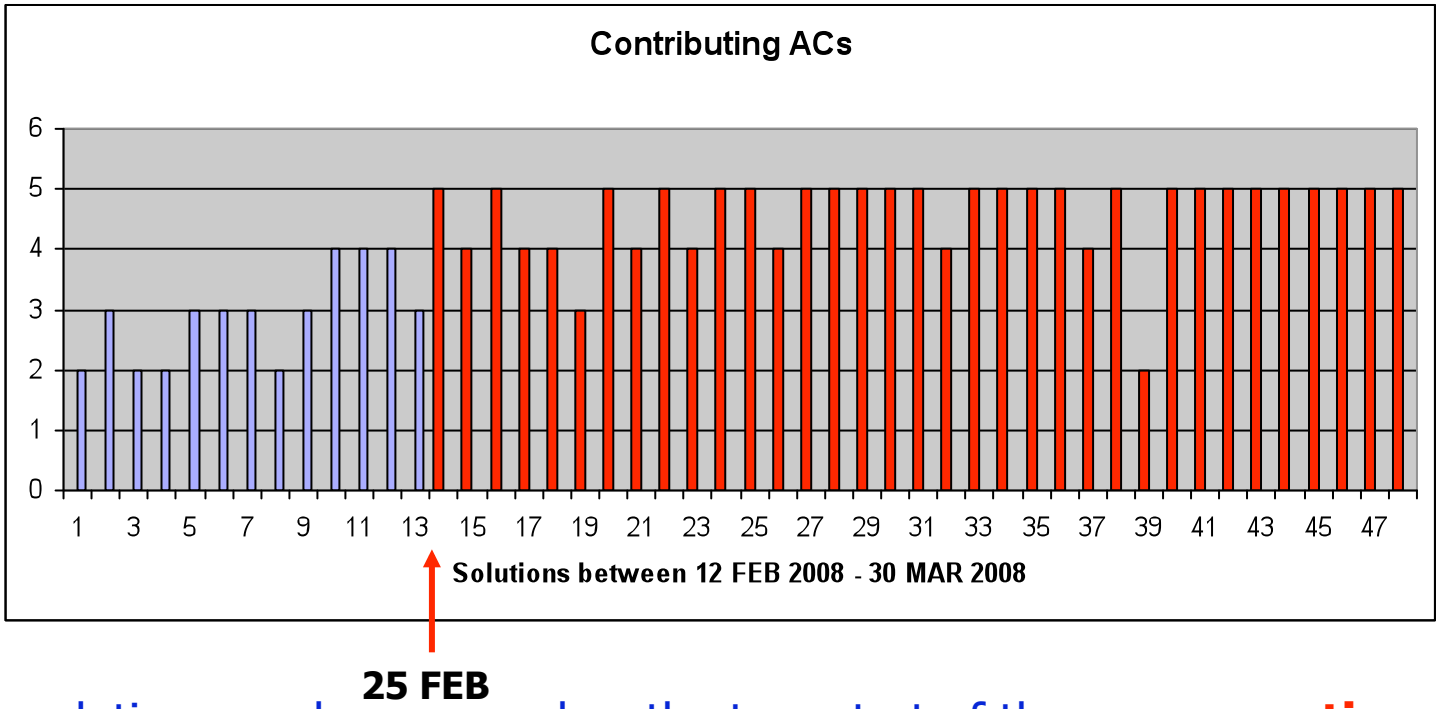
- Even if not necessary, the SSC/EOP combined, loose SINEX files ("pos +eop") have been kept available at the archives.

- 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.

Daily Solution: pre-operational phase

At present, **5 ACs** contribute to the daily ILRS combined solution:

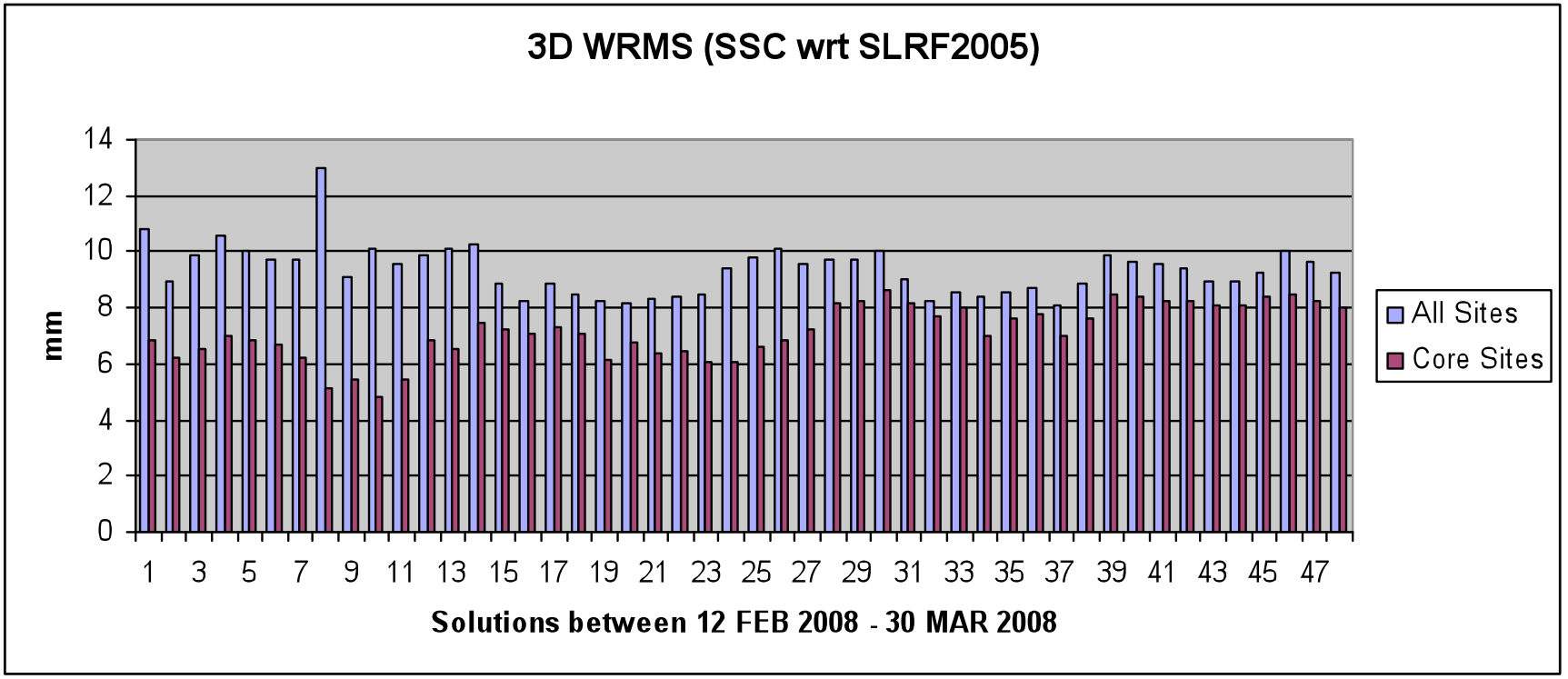
ASI BKG GFZ JCET NSGF



25 Feb solution may be assumed as the true start of the **pre-operational phase** of the daily ILRSA product: it is the first date when all the 5 ACs submitted fully operational solutions (i.e. several small problems were fixed); after 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.

Quality assessment of the Daily Solution

The Core station list as agreed after Grasse ILRS AWG (09/07) has been 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 is slightly above 7mm.



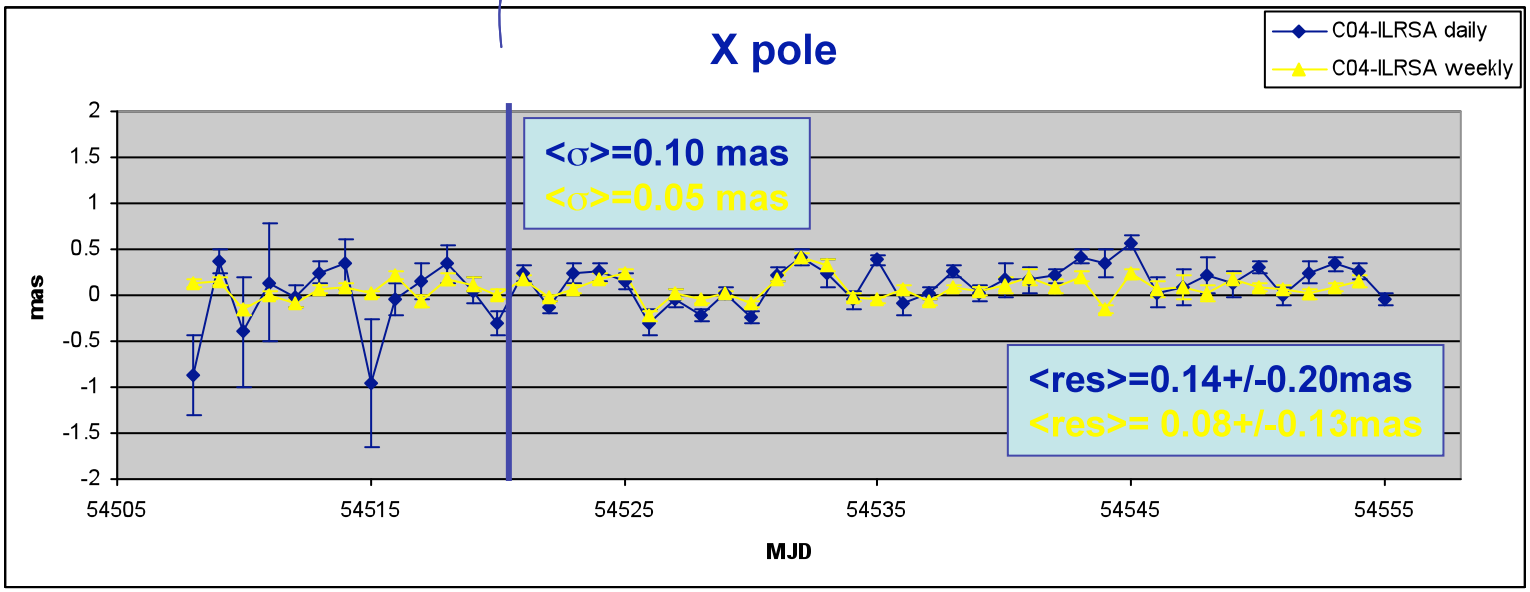
Quality assessment of the Daily Solution

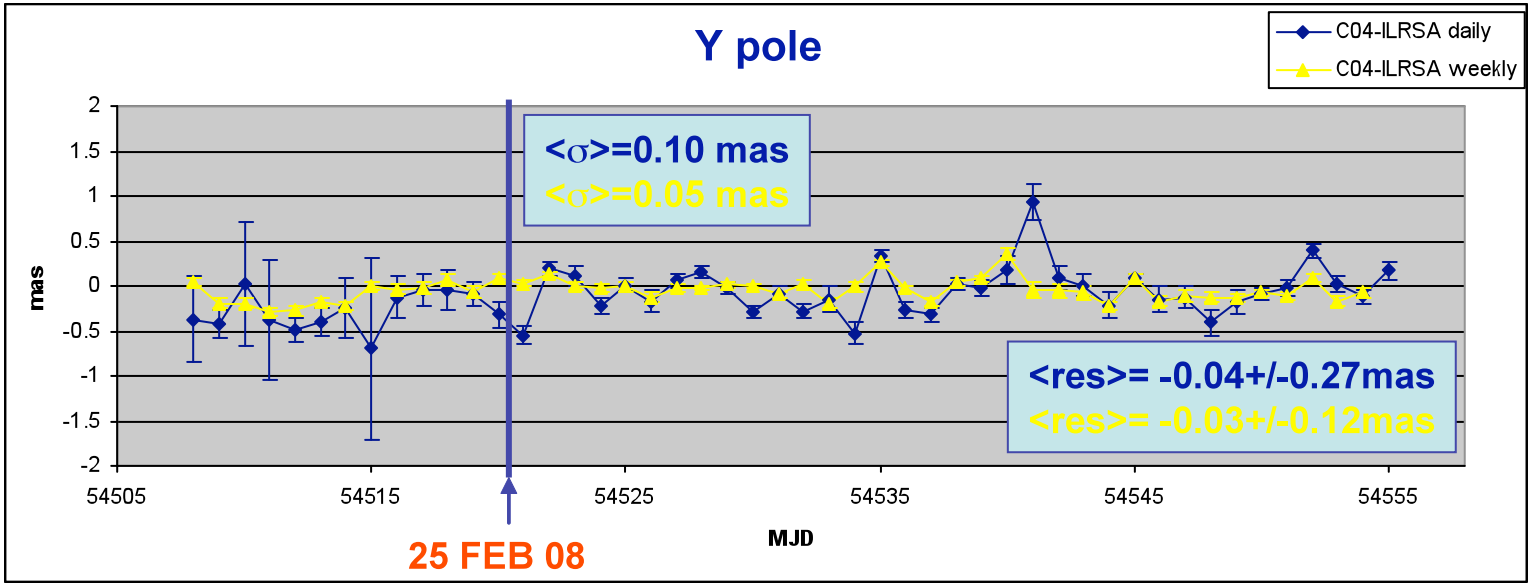
A preliminary quality evaluation of the daily solution results at the start of the pre-operational phase has been made through the cross comparison with eop C04 and with ILRSA weekly solutions, focussing on the **last day EOP estimate**, being that one the most critical from the product latency point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

The results, based on a month of solutions, indicate an overall precision level (<σ>) of the last day estimates of the order of 100 μas/26μs and an accuracy level (WRMS(res)) of the order of 250 μas/70μs.

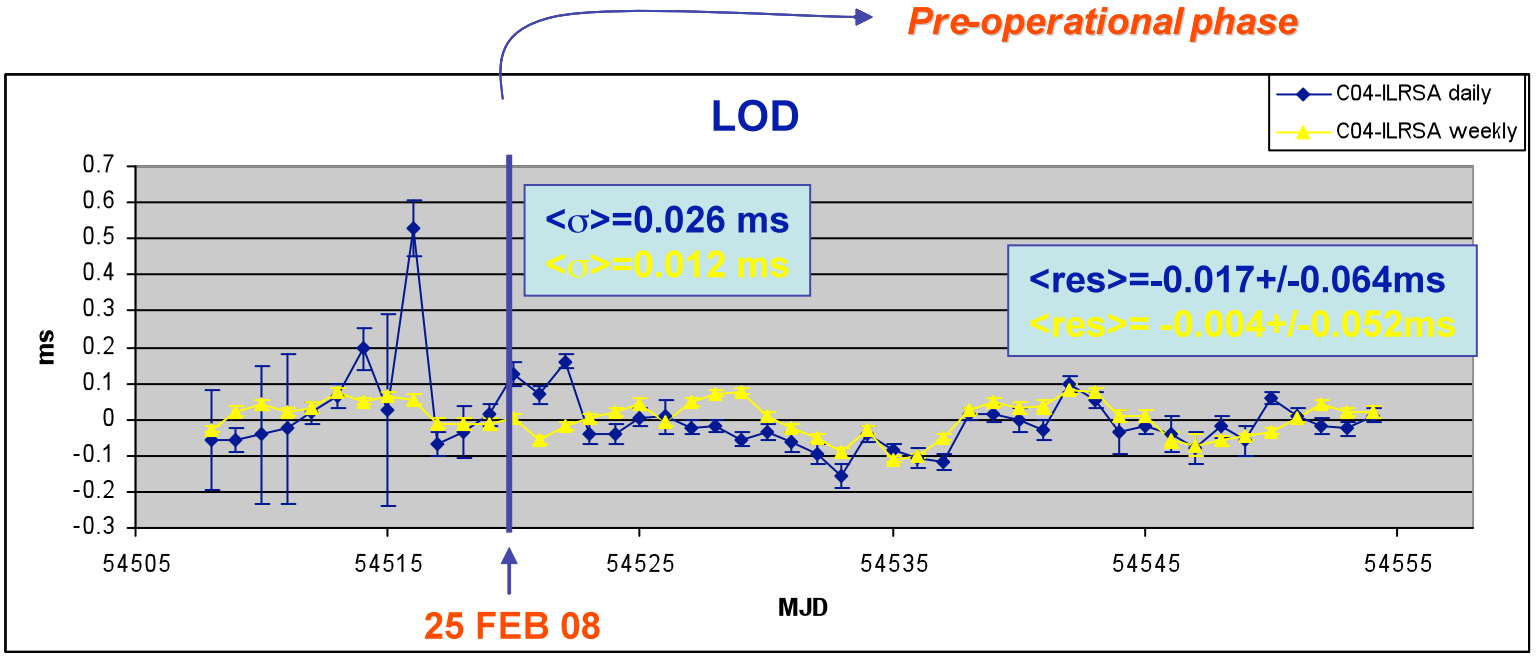
Quality assessment of the Daily Solution

Pre-operational phase





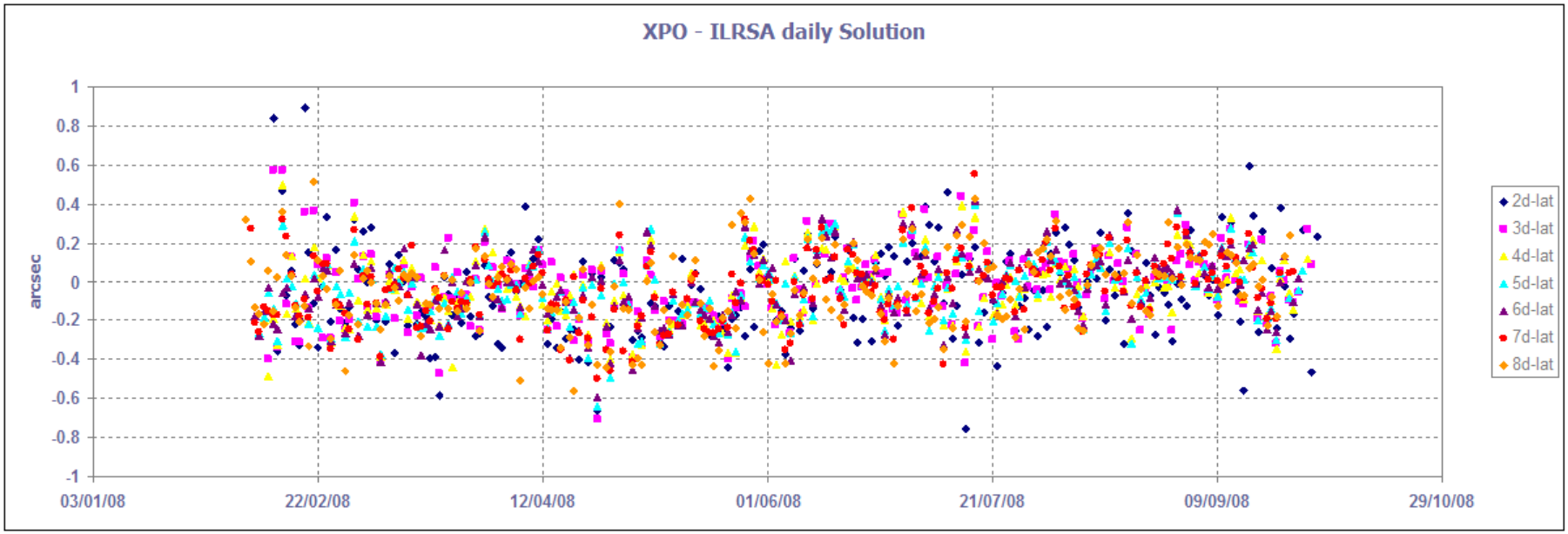
Quality assessment of the Daily Solution



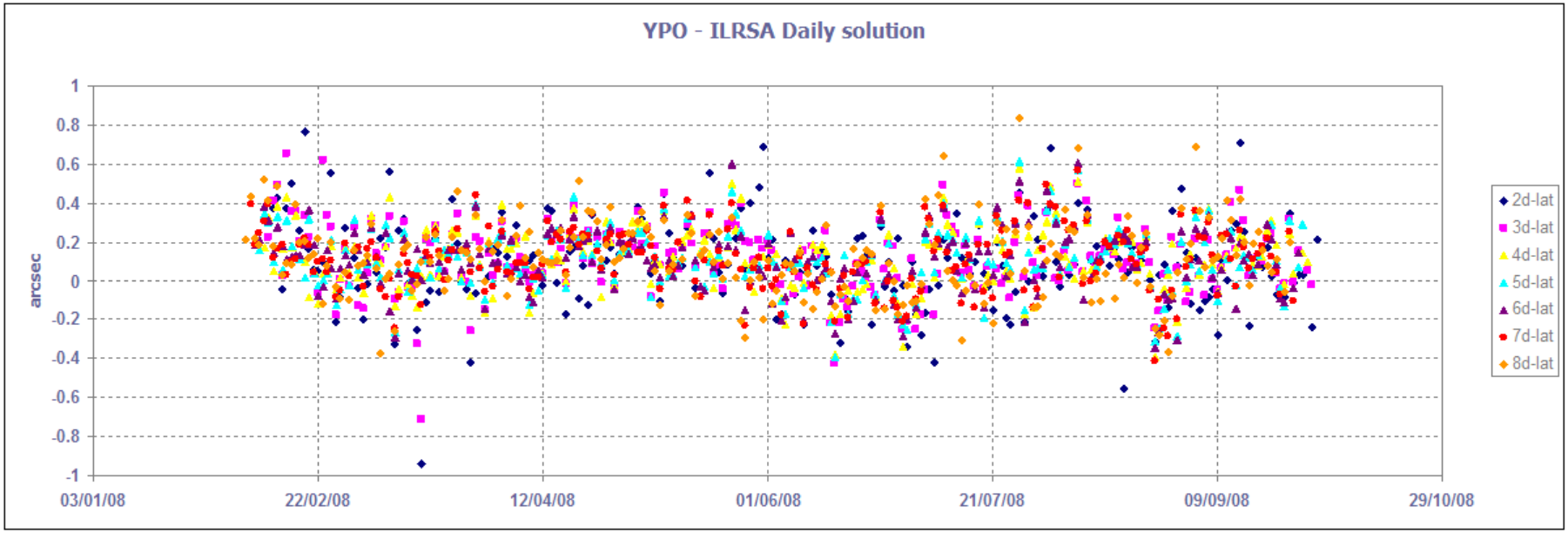
Further quality assessment

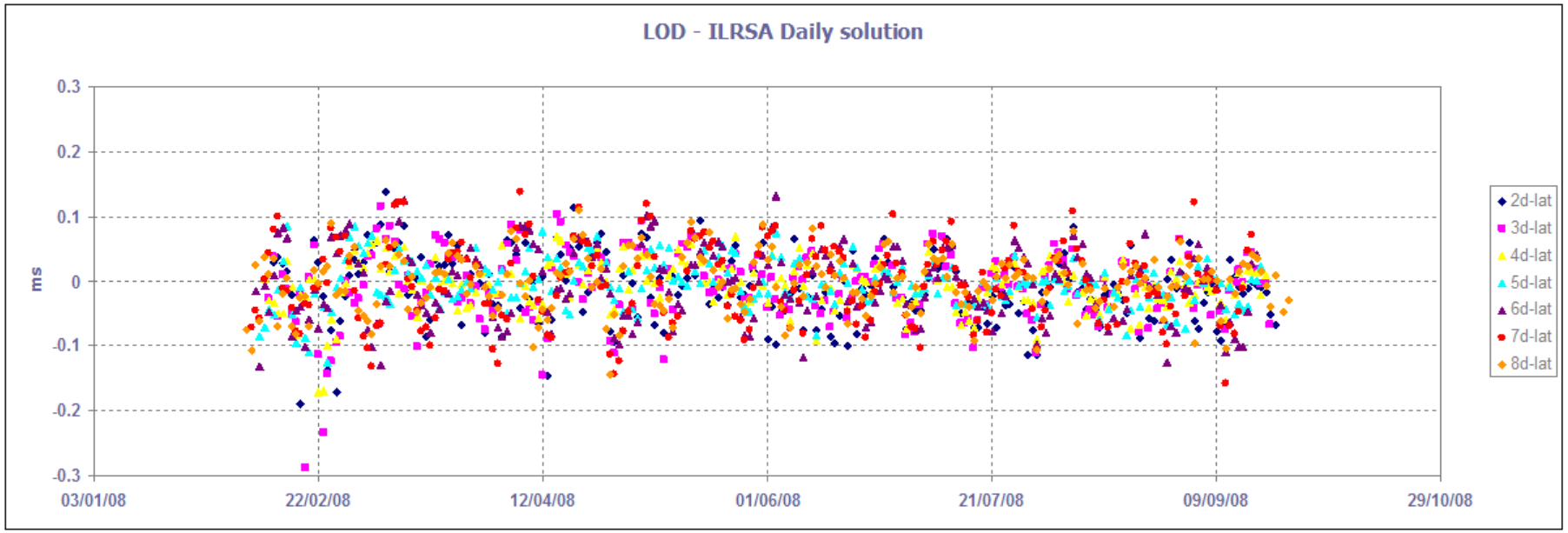
The accumulation of solutions allows a deeper insight into the performance of the product vs. the age of the estimated EOP.

Up to now, **more than 6 months** of individual and combined solutions are available: from them, **"same age" EOP time series** have been constructed and their quality evaluated.

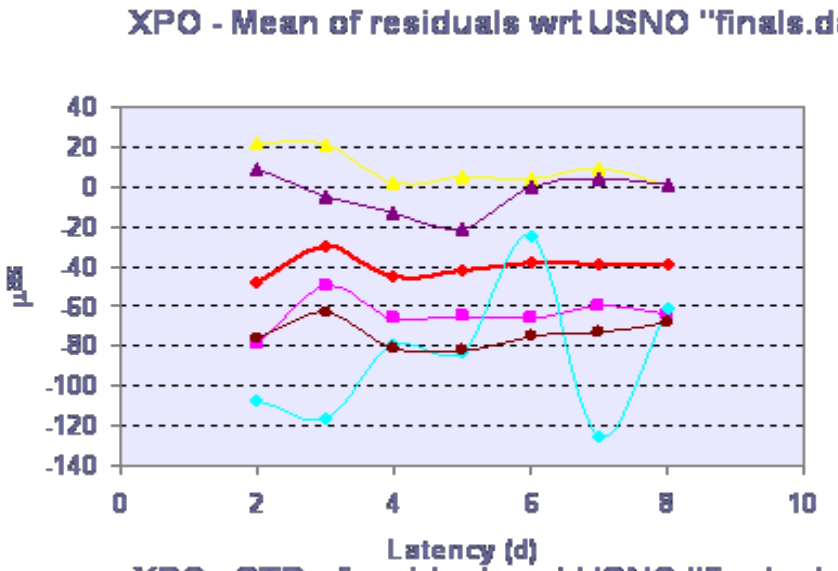


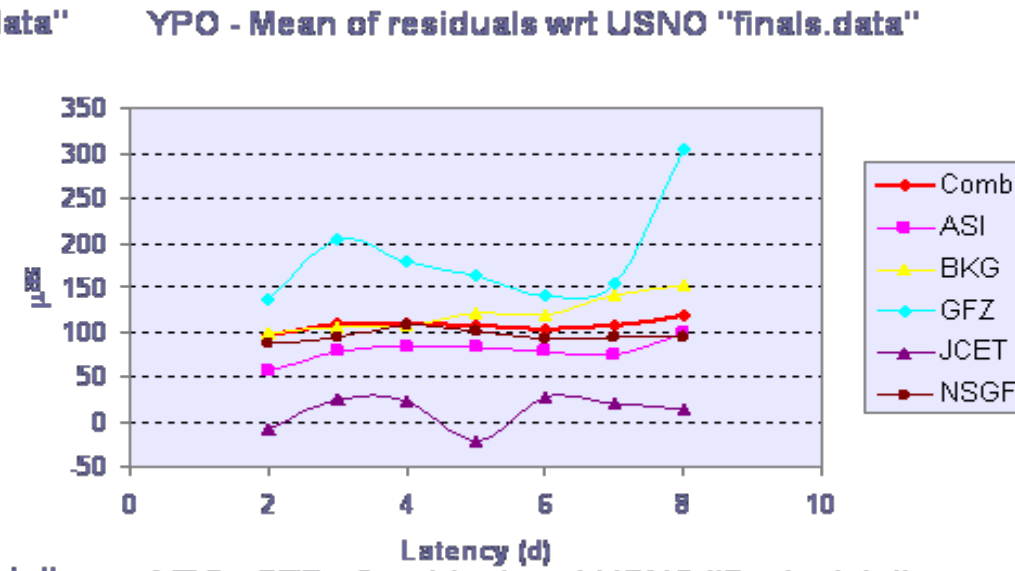
Further quality assessment

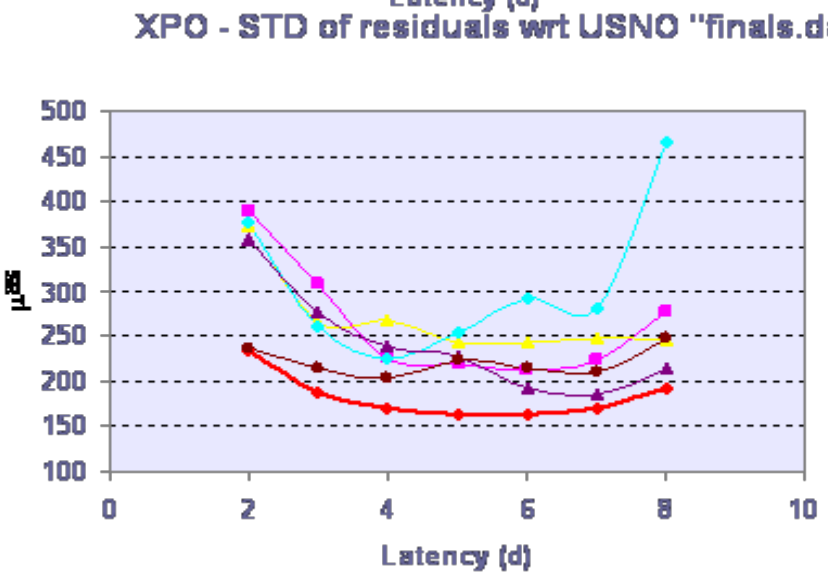


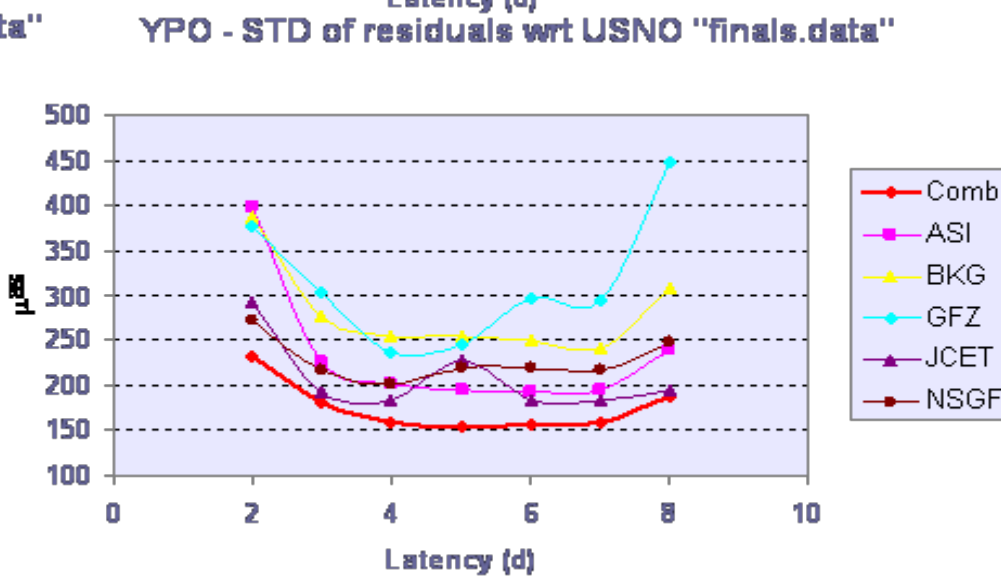


Daily solution: quality vs EOP age

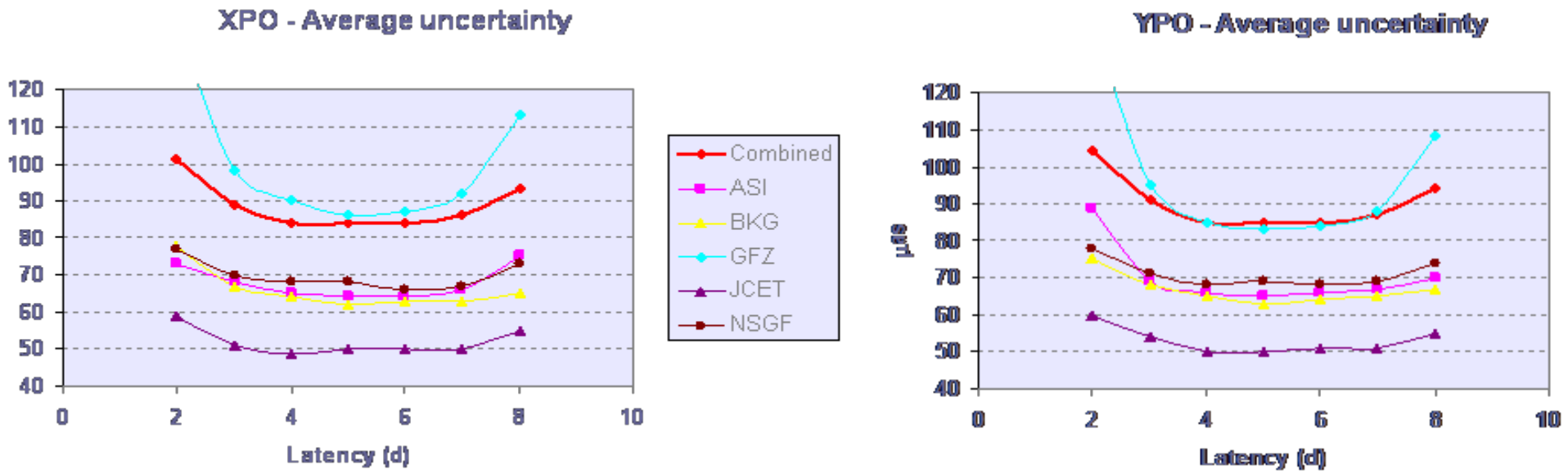








Daily solution: quality vs EOP age



An "arc edge" effect is evident for all the contributing solutions and the combination (each one with a specific level of sensitivity), both in the estimate residuals and in the estimates uncertainty.

The edge effect, present also in the combined weekly product, is a key feature to be investigated (and mitigated) to provide low latency, accurate EOP estimates.

„Arc edge" effect: remarks

- Part of the "arc edge" effect, for the 'last day' estimates is due to partial lack of observation data: that 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 at the AC level to mitigate „arc edge" effect in the contributing solutions
- New contributors will improve the quality of the daily product

Summary

- ILRS is able to provide routinely a daily EOP product with high quality level: the product is in a **pre-operational phase**

- The ILRS daily product allows to provide EOP estimates with **constant latency lower than the minimum latency of the ILRS weekly solution**

- The present **quality level** of the daily product can be further raised by adding contributing solutions, revising the length of the data arc, tuning the analysis strategy