

Multi-year combination of UT1/lod, based on VLBI and GPS observations

Jan Vondrák¹, Jan Kouba², Cyril Ron¹

¹Astronomical Institute, Prague, Czech Rep.

²Geodetic Survey, Ottawa, Canada

Contents:

- ◆ Introduction;
- ◆ Combination of VLBI universal time with GPS length-of-day changes;
- ◆ Comparison of combined solutions with atmospheric & oceanic excitations.



IERS Combination Workshop, Potsdam, October 2005



Introduction:

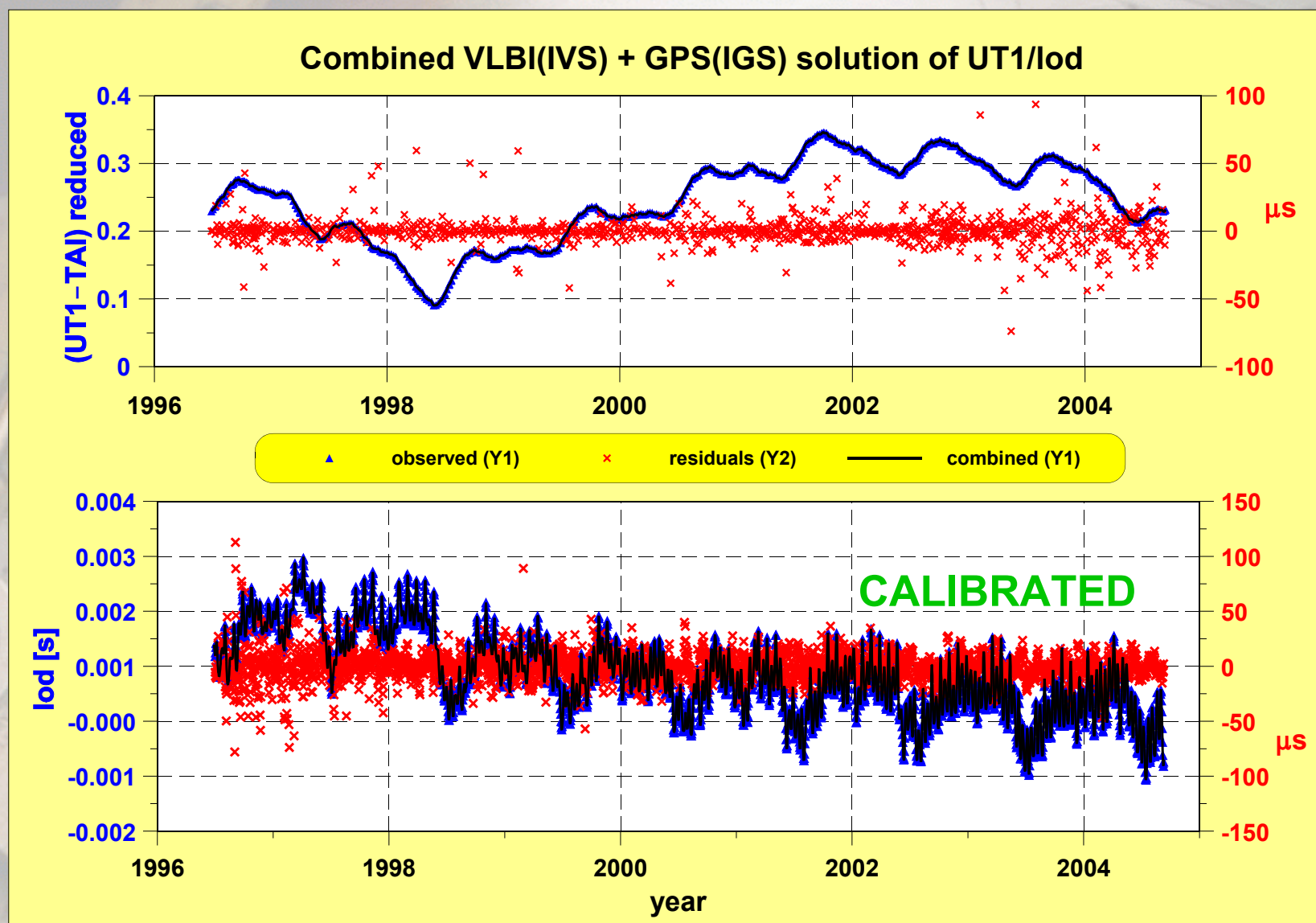
- ◆ IGS empirical calibrations by 21-day averaging the differences between VLBI and GPS lod's is subjective and not optimal;
- ◆ Goal: to find a more optimal method of combining VLBI/GPS to obtain mutually consistent series of UT1 and lod;
- ◆ Method of combined smoothing (*Vondrák, Čepek A&AS 2000*) is used to combine:
 - ★ VLBI-based UT1-TAI (IVS solution) with
 - ★ GPS-based (IGS and CODE solutions)
- ◆ these combined solutions take over the long-term stability of the first series and short-periodic signal of the second one.



Combination of UT1/lod:

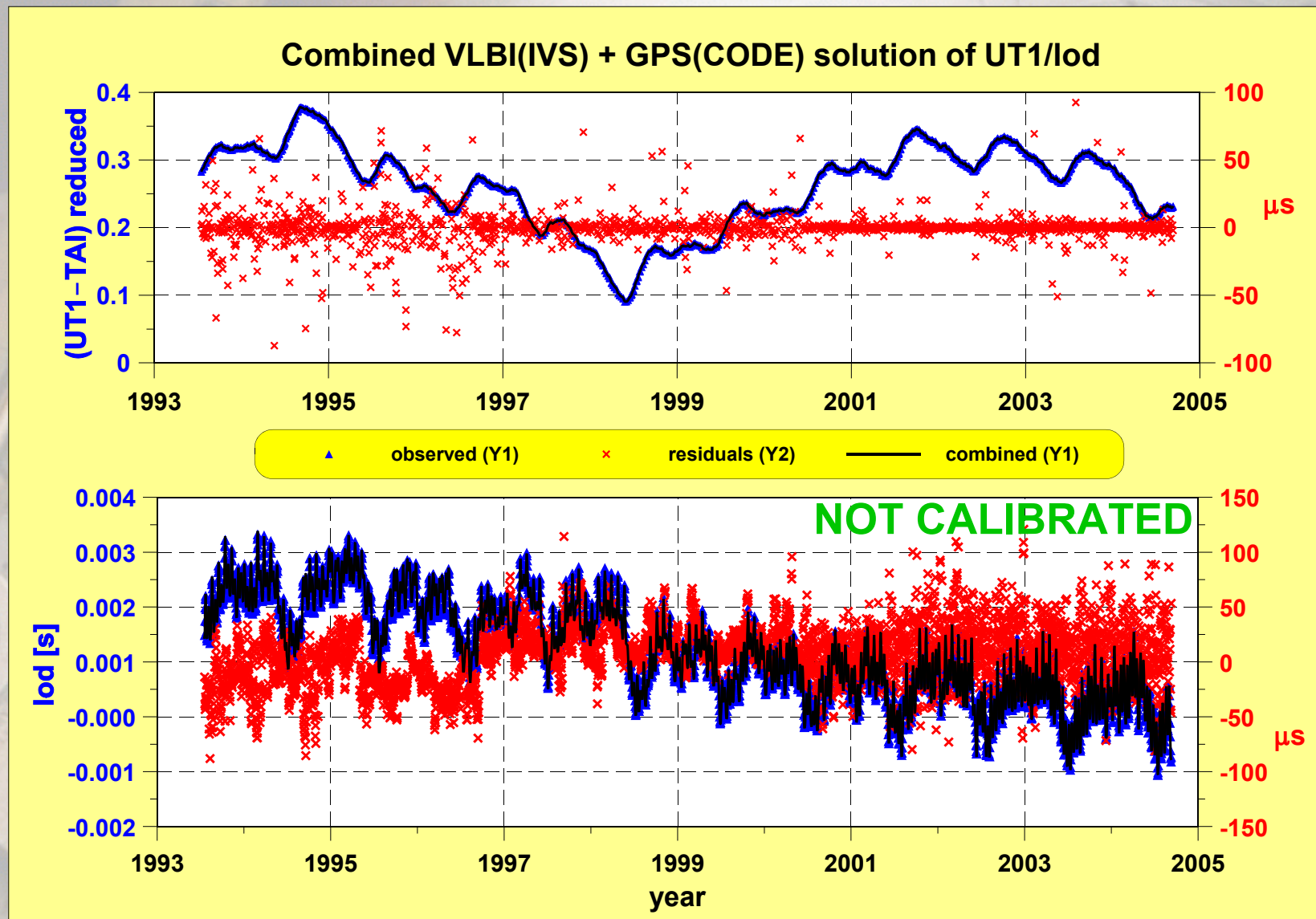
- ◆ We apply the method of combined smoothing to:
 - ★ VLBI data (IVS combined solution ivs04q3x.eops, in the interval 1979.59-2004.69);
 - ★ IGS data (combined solution igs00p02.erp, in the interval 1996.49-2005.63):
 - ★ Calibration to VLBI done by IGS;
 - ★ CODE data (CODE97.erp, in the interval 1993.54-2005.67):
 - ★ Not calibrated to VLBI;
- ◆ to obtain solution in the common interval of determination of UT1-TAI and lod (1996.49-2004.69 and 1993.54-2004.69 respectively).





IERS Combination Workshop, Potsdam, October 2005





IERS Combination Workshop, Potsdam, October 2005



Statistics of the UT1/Iod combination:

$\epsilon = 34d^{-6}$, $\epsilon = 34d^{-4}$ (coeff. of smoothing)

IVS/IGS
(calibrated)

IVS/CODE
(not calibrated)

Interval= 8.20y
 $n_{\text{VLBI}} = 978$, $n_{\text{GPS}} = 2993$

11.15y
 $n_{\text{VLBI}} = 1372$, $n_{\text{GPS}} = 4074$

uncertainties in UT1
a priori : 2.5 μs
a posteriori : 4.6 μs

I.o.d.
10.2 μs
9.4 μs

UT1
2.9 μs
6.2 μs

I.o.d.
11.5 μs
23.1 μs



IERS Combination Workshop, Potsdam, October 2005



Comparison with atmospheric and oceanic excitation (interval September 1997 - July 2000)

Correlation of LODS (tides removed) with AAM+OAM

Period	Bull. A	IGS	Cmb(IGS)	CODE	Cmb(CODE)
All	0.996	0.996	0.996	0.996	0.996
30d	0.944	0.937	0.941	0.943	0.945
15d	0.905	0.888	0.898	0.909	0.905
10d	0.868	0.851	0.864	0.871	0.869
3d	0.699	0.706	0.731	0.726	0.712

IGS 14-day anomaly

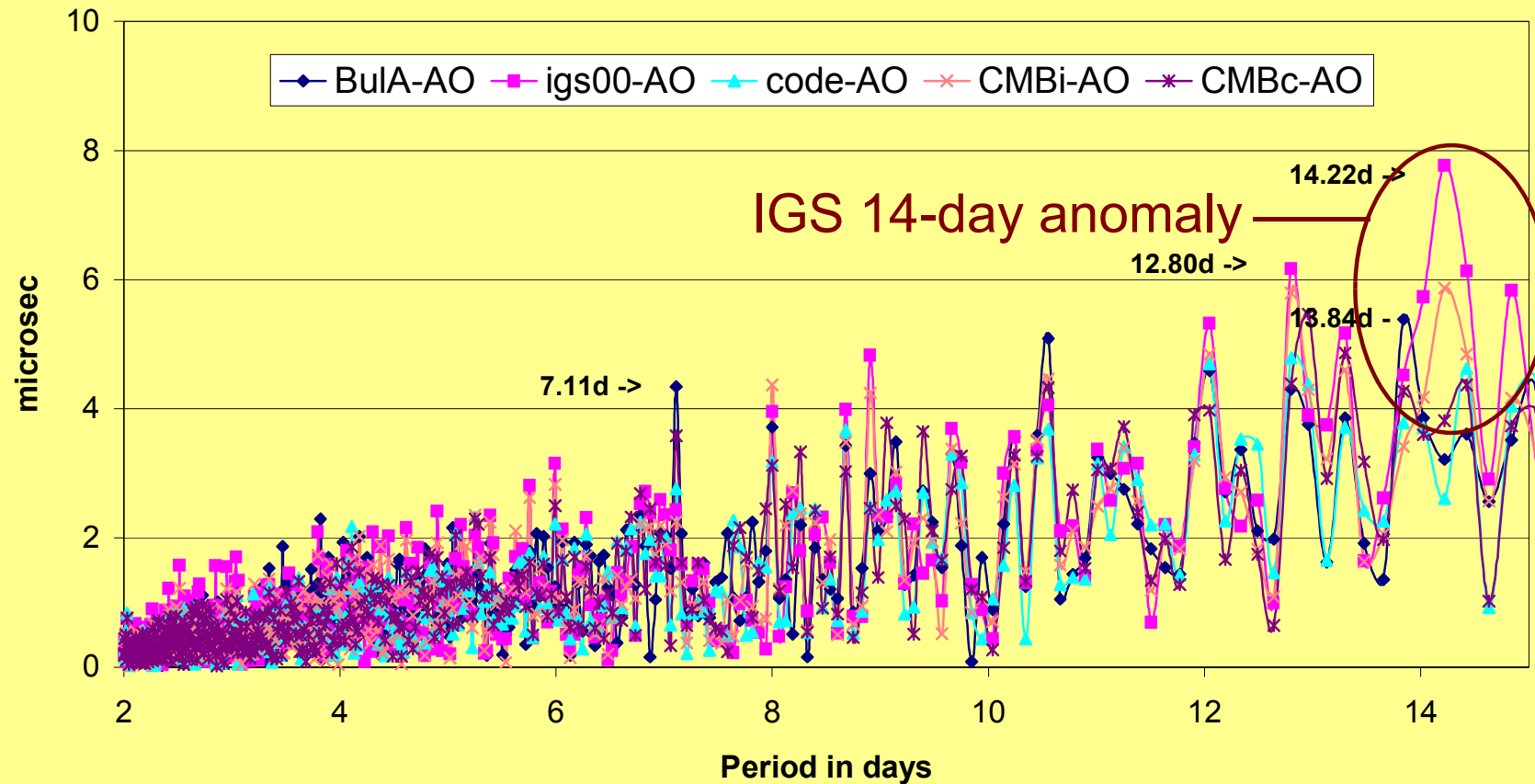


IERS Combination Workshop, Potsdam, October 2005



Code, IGS and BullA LODS (L) - OAM+AAM (OA) (IB) (Sep. 97-Jul 00)

Semi-, annual period signals, rates, scales + 13.63, 13.66, 21.7d tides estimated

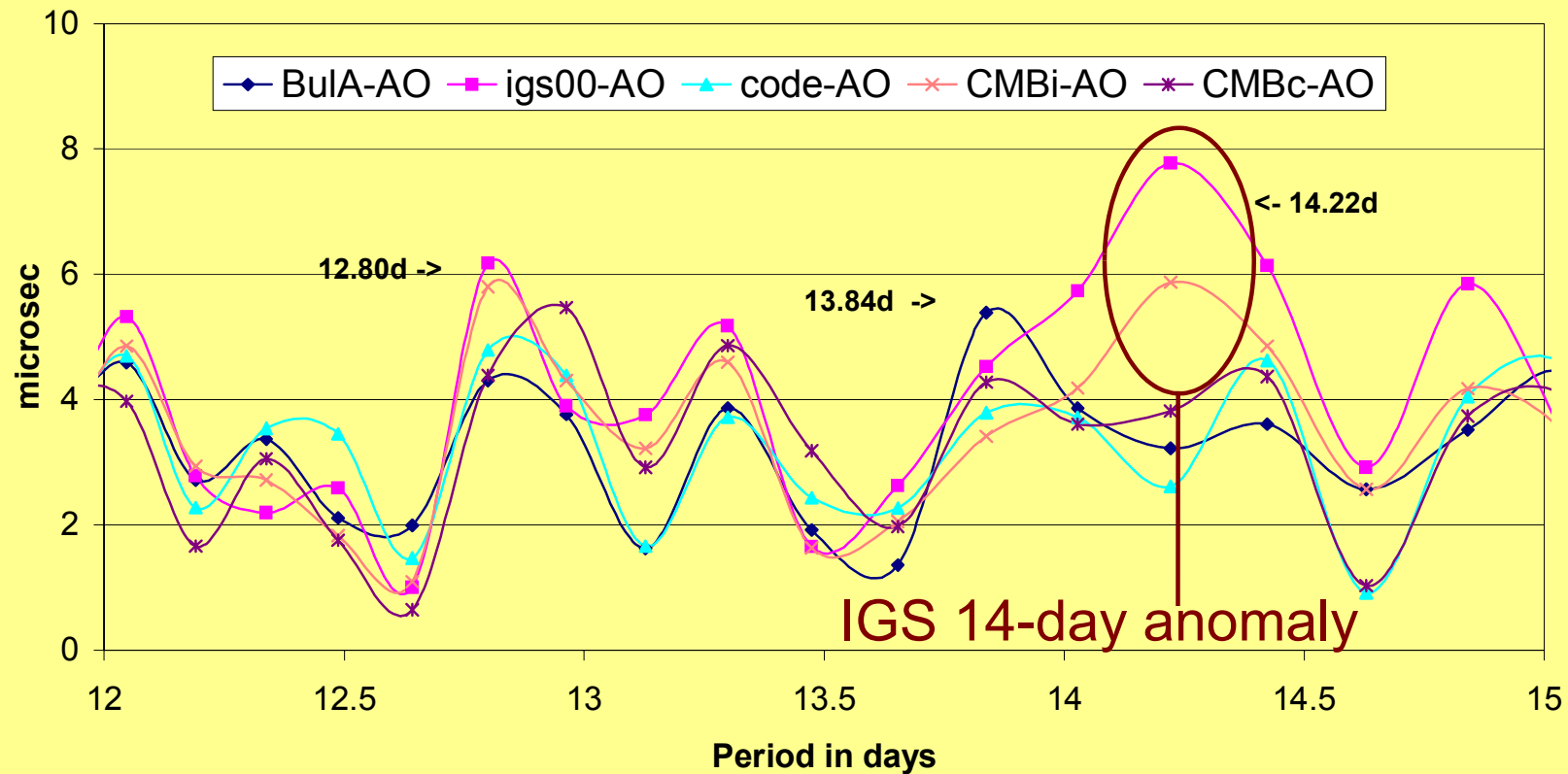


IERS Combination Workshop, Potsdam, October 2005



Code, IGS and BullA LODS (L) - OAM+AAM (OA) (IB), (Sep. 97-Jul 00)

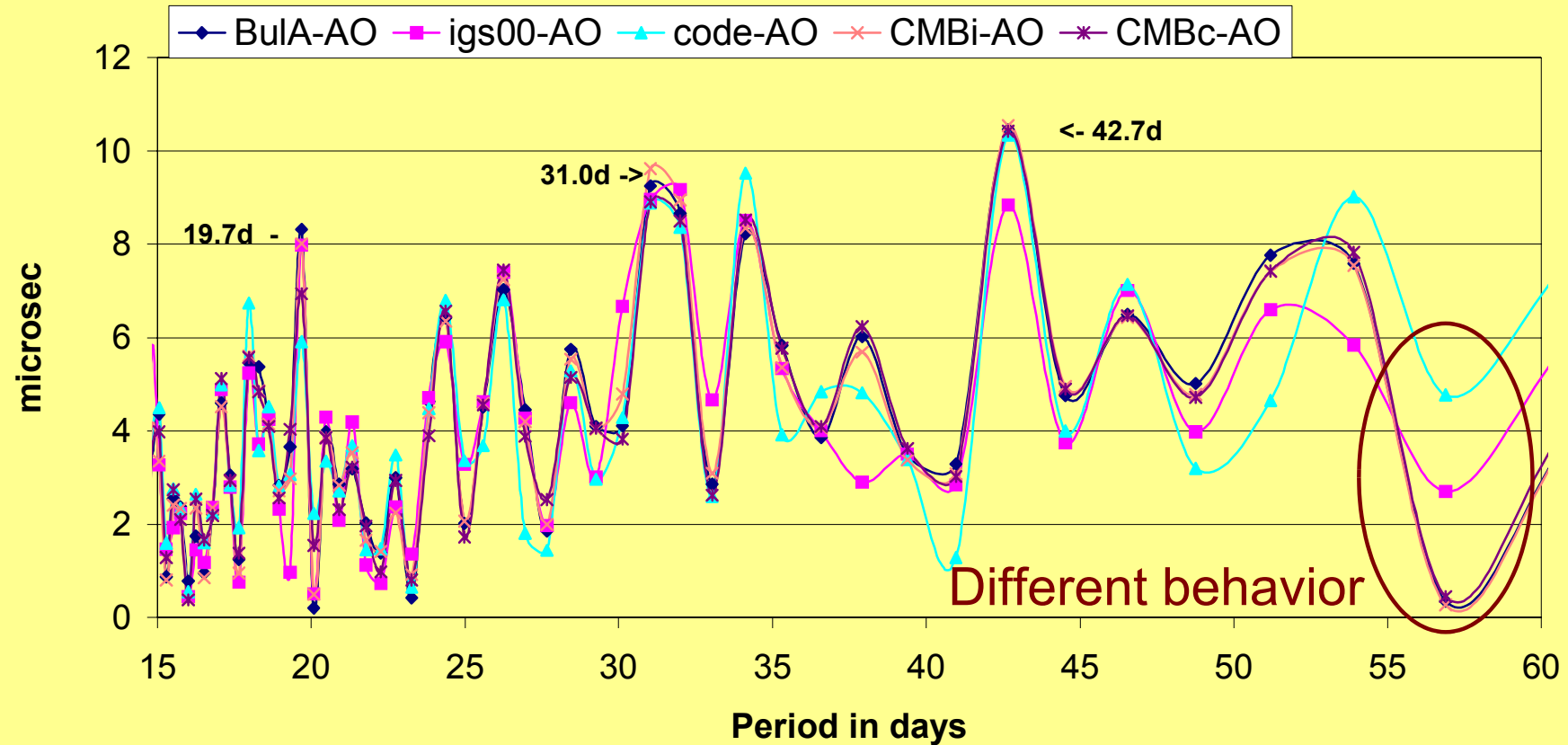
Semi-, annual period signals, rates, scales + 13.63, 13.66, 21.7d tides estimated



IERS Combination Workshop, Potsdam, October 2005



Code, IGS00 and BullA LODS (L) - OAM+AAM (OA) (IB), semi-, annual period signals, rates, scales as well as fortnight (13.63, 13.66 d) and 21.7 day tidal wave amplitudes estimated (Sep. 97-Jul 00)



IERS Combination Workshop, Potsdam, October 2005



CONCLUSIONS:

- ◆ Combination of VLBI-based UT1 with GPS-based lod, using the method of combined smoothing, helps to improve the VLBI-alone solution, both in resolution and accuracy;
- ◆ Combination of VLBI/GPS proves that the accuracy is consistent with formal errors, for both techniques, if a *priori* calibration of GPS to VLBI is made;
- ◆ The correlation of combined lod with atmospheric and oceanic excitation is very good, for shortest periods it is the highest of all series studied;
- ◆ Even if a *priori* calibration is not used, the combination method assures that the combined lod is consistent with VLBI in a long-term sense.

