Status of ITRF2013 reprocessing

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Content

- Evaluation of AC' ITRF2013 processing
  - ESA
  - GOP
  - GSC
  - IGN
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  - LCA
- Scales issues
  - Origin of scale increase in 2012
  - Scales of Spot-2 and Spot-5
  - Phase laws impact on the scale from GSC and IGN
- Proposition of combined solution

ESA (1993-2012)

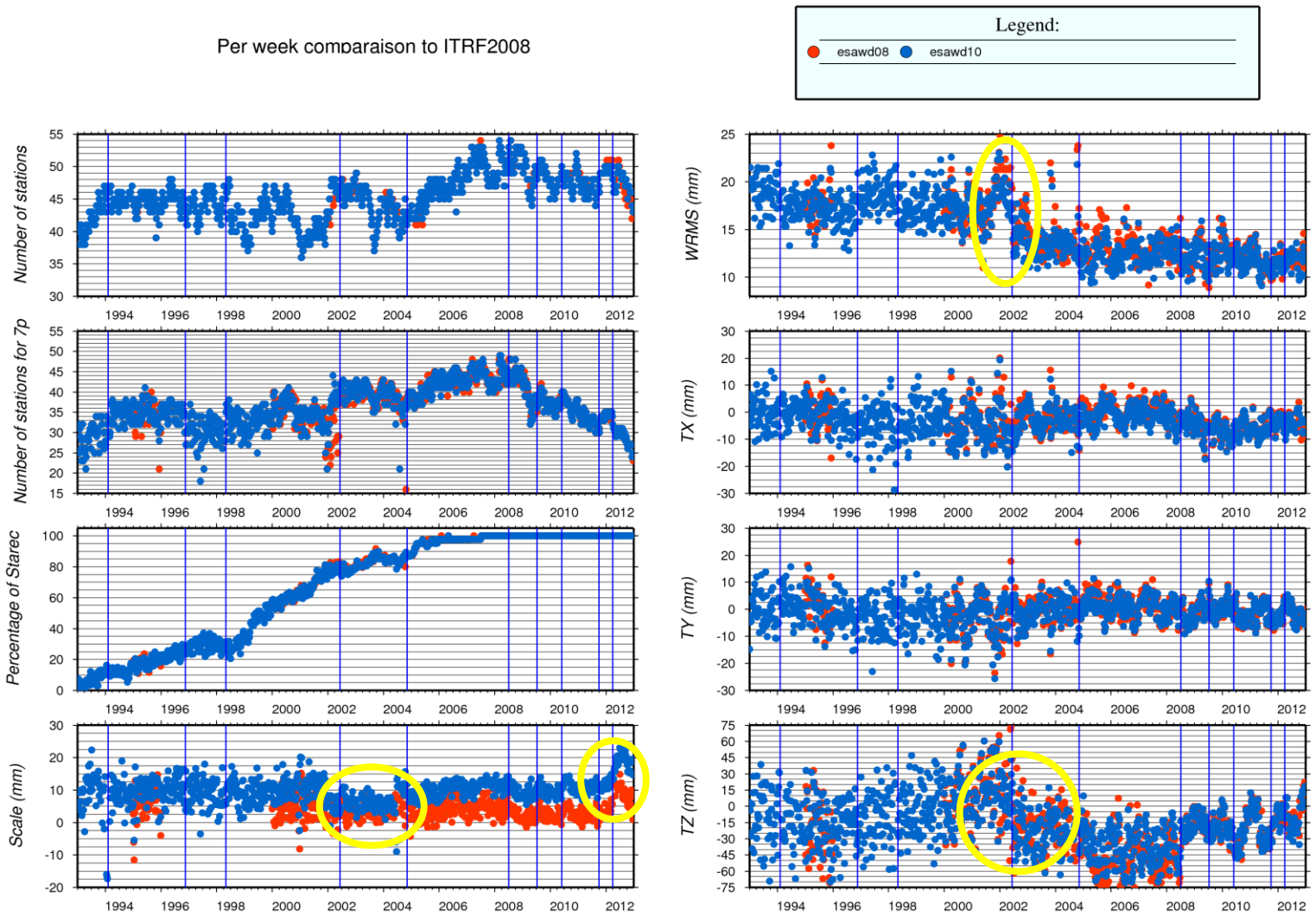
ESA contribution

- ESA 08 (1995 + 2000 - 2012) == Reference

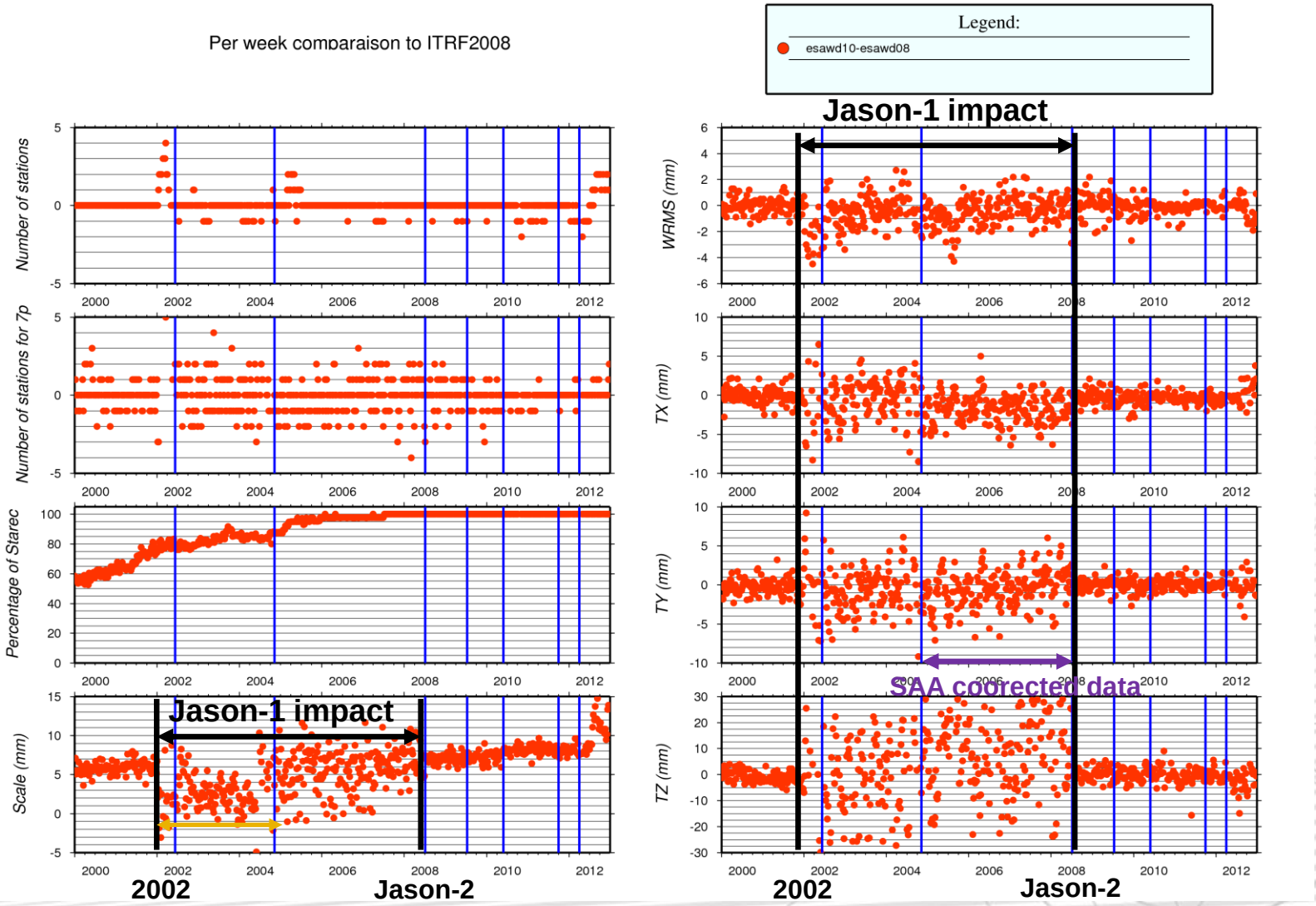
- ESA 10 == ESA 08 + Phase laws + time variable gravity field + Jason-1 (from 2002-020 to 2008-195)

- ESA 08 and ESA 10 include HY-2A, no Saral
- ESA 08 and 10 use SAA corrected data for Jason-1 and Spot-5
- Cut-off = 7 degrees

ESA – Helmert parameters wrt ITRF2008



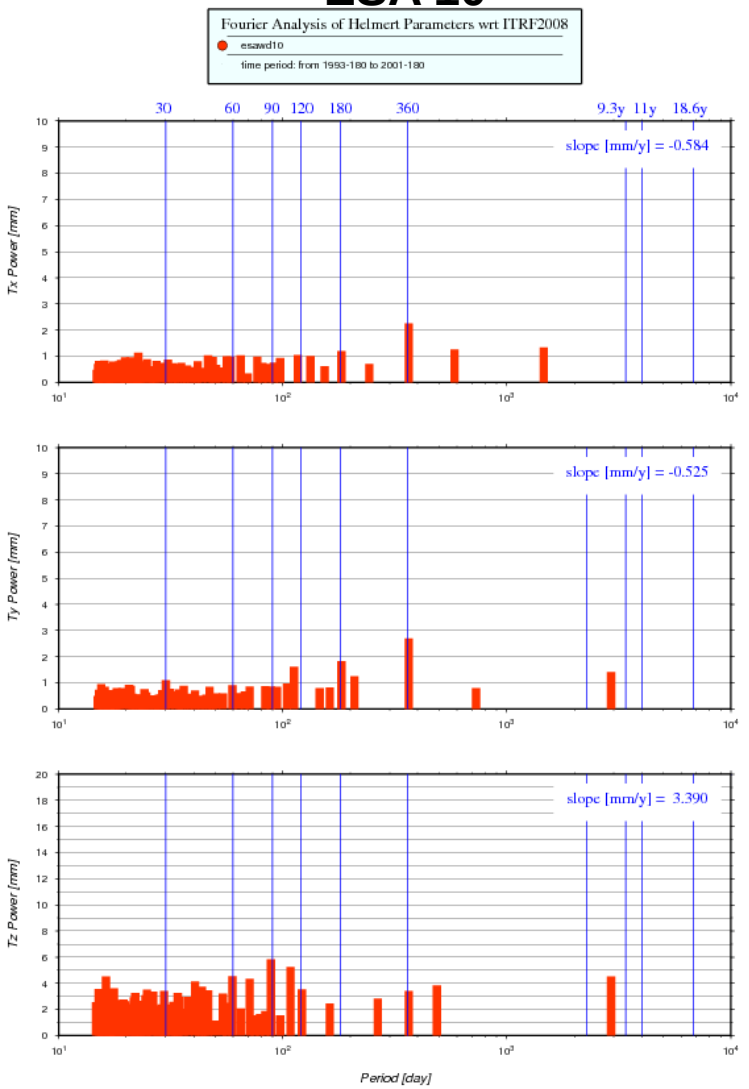
ESA – Differences of Helmert parameters



ESA – FFT of translations (1993-2001)

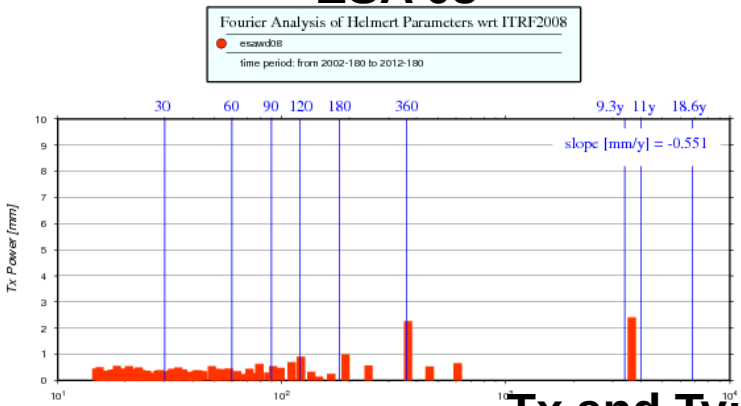
No results for ESA 08
since one year only (1995)

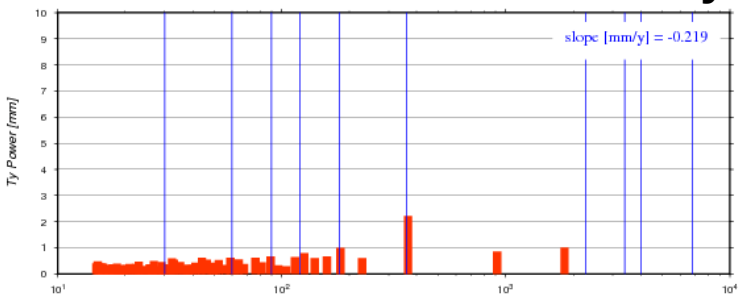
ESA 10

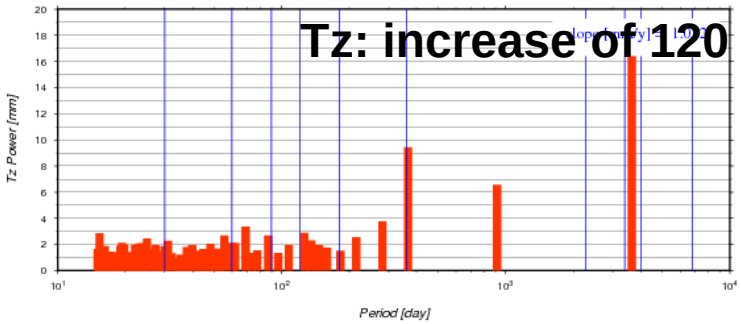


ESA – FFT of translations (2002-2012)

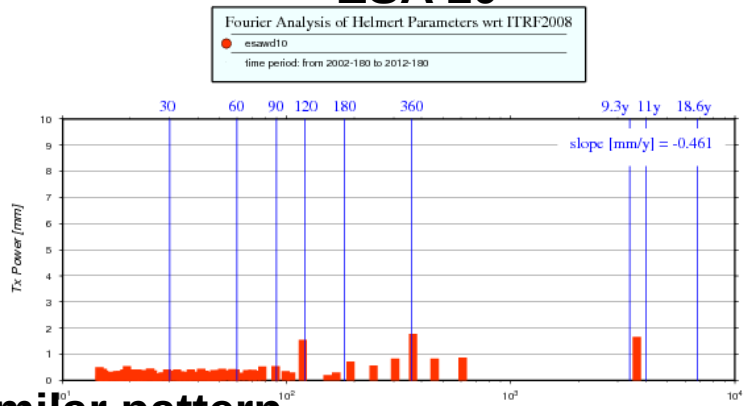
ESA 08

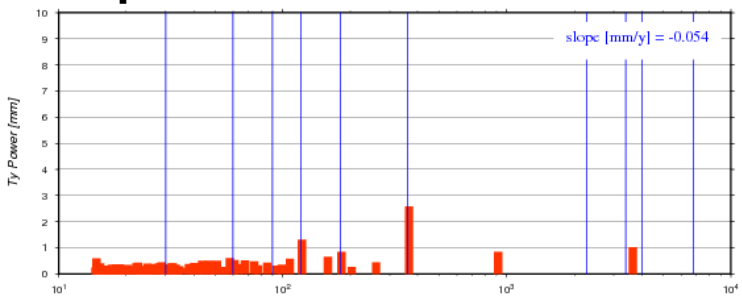


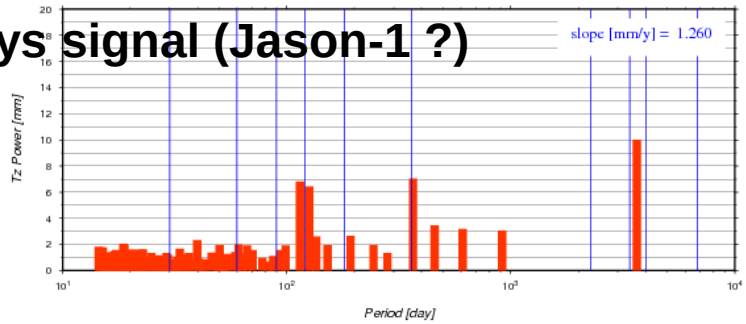




ESA 10



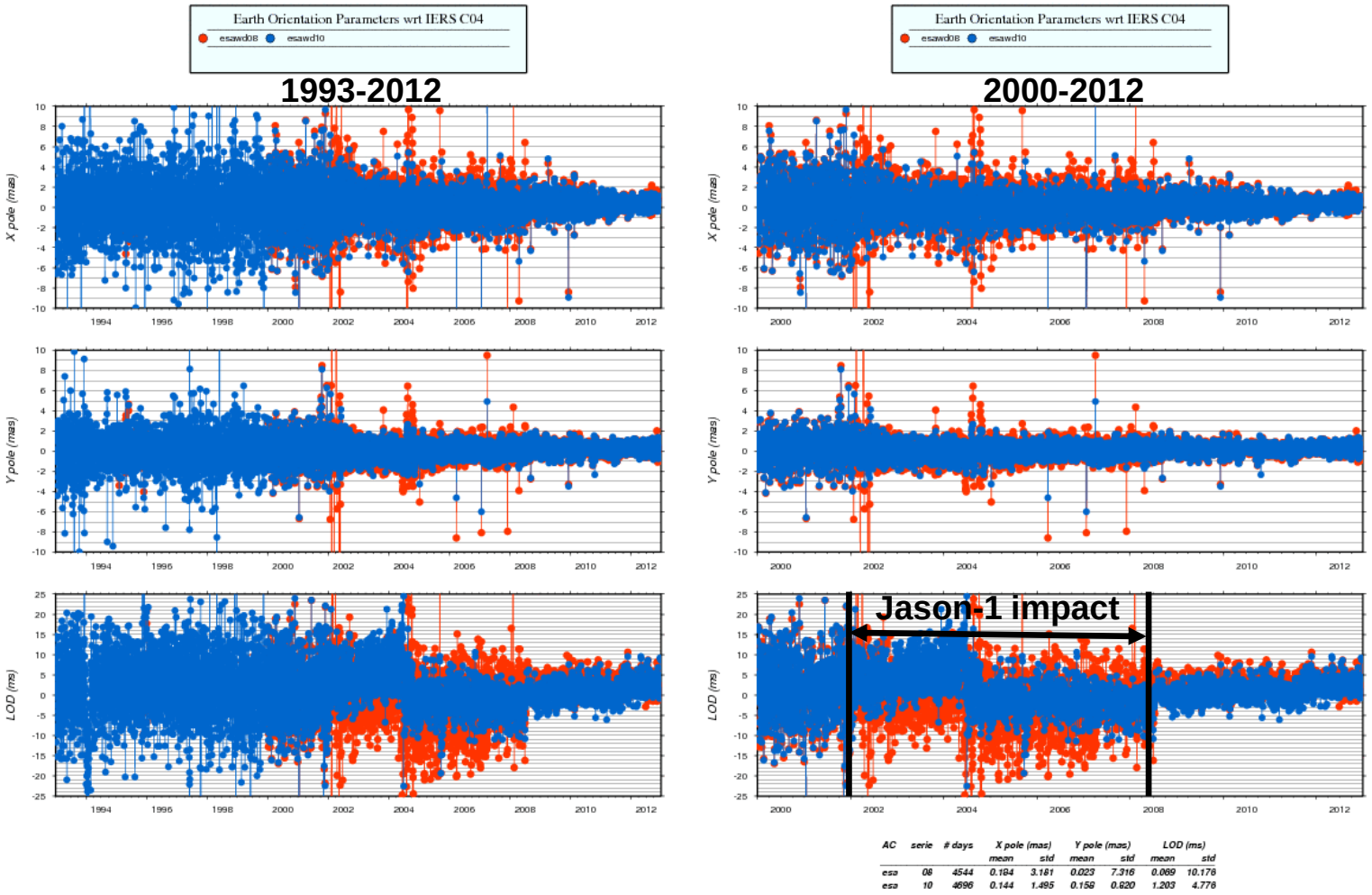




Tx and Ty: similar pattern

Tz: increase of 120 days signal (Jason-1 ?)

ESA – EOPs differences wrt IERS C04



AC	serie	# days	X pole (mas)		Y pole (mas)		LOD (ms)	
			mean	std	mean	std	mean	std
esa	08	4544	0.184	3.181	0.023	7.316	0.069	10.176
esa	10	4696	0.144	1.495	0.158	0.920	1.203	4.776

Better STDs of ESA 10 (2 times smaller)

ESA contribution - Conclusions

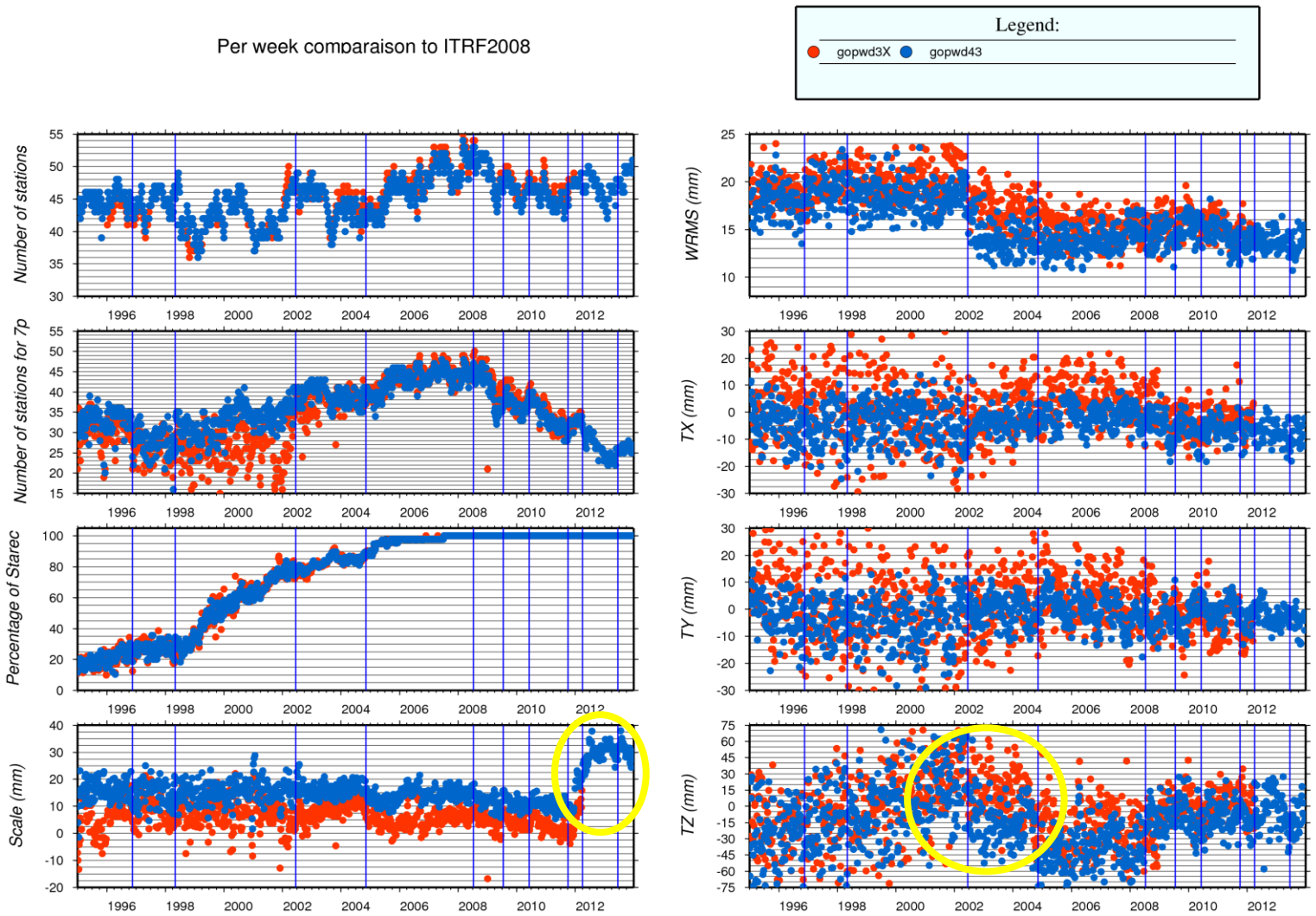
- So far, ESA 10 present several improvements compared to previous series.
- Nevertheless, IDS CC recommends to look at Jason-1 between 2002-020 and End of Topex.
- Phase laws impact on scale seems to a linear trend with positive slope.
- Scale increase early 2012.
- Tz jump while including Envisat and Spot-5 (also observed by IGN and LCA).

GOP (1995-2013)

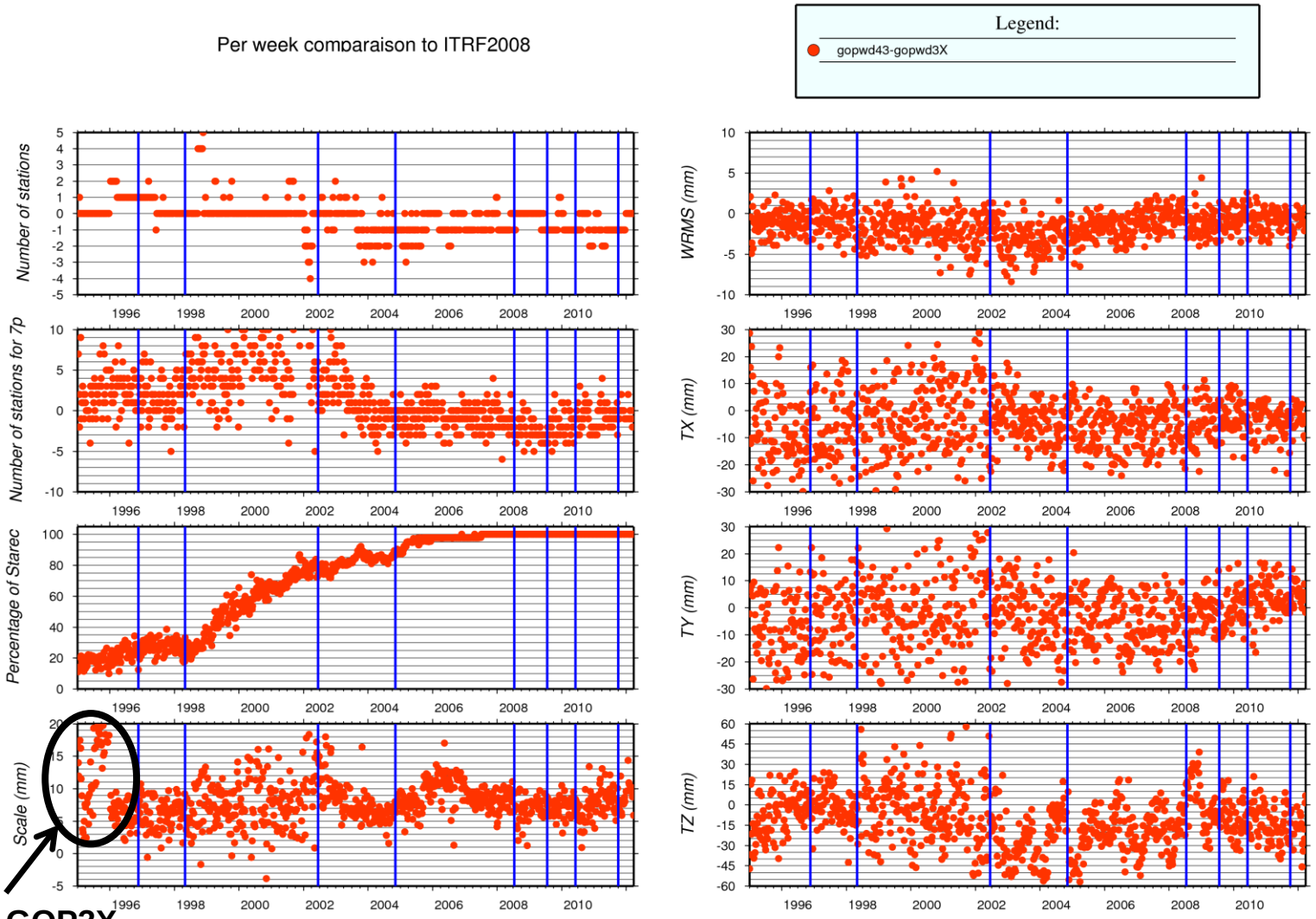
GOP contribution

- Reference = GOP 31,32, 33, 34 (93001-12085) – Operational series
- GOP 42 == GOP3X (95001-13356) + phase laws + time variable gravity field + Spot-5 SAA corrected data (no station selection)
- GOP 43 == GOP 42 - cross track harmonics
- GOP 44 == GOP43 – (HY-2A)
- No Jason-1 in all the series

GOP – Helmert parameters wrt ITRF2008



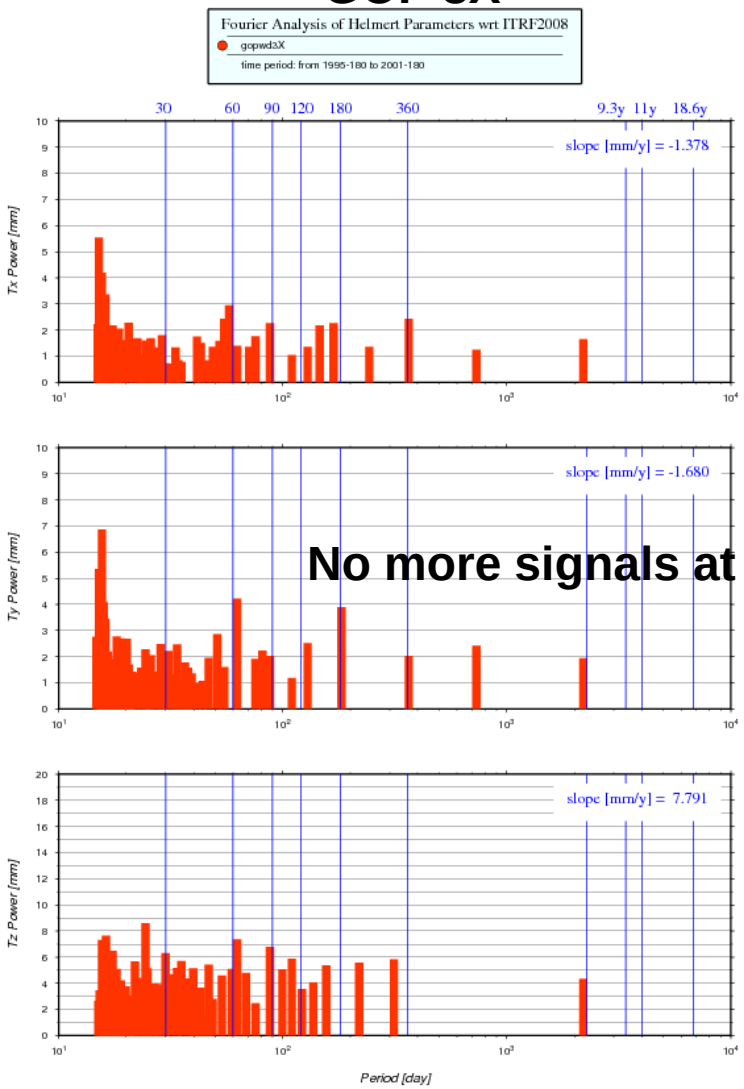
GOP – Differences of Helmert parameters



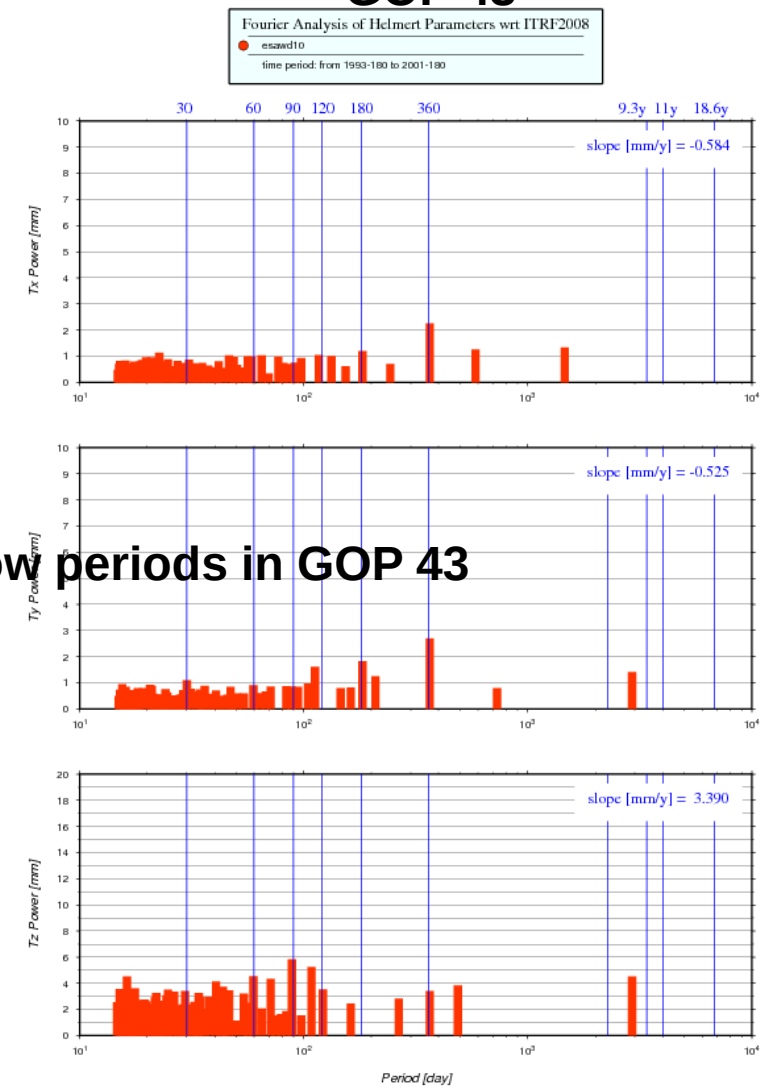
Origin: GOP3X

GOP – FFT of translations (1995-2001)

GOP 3X



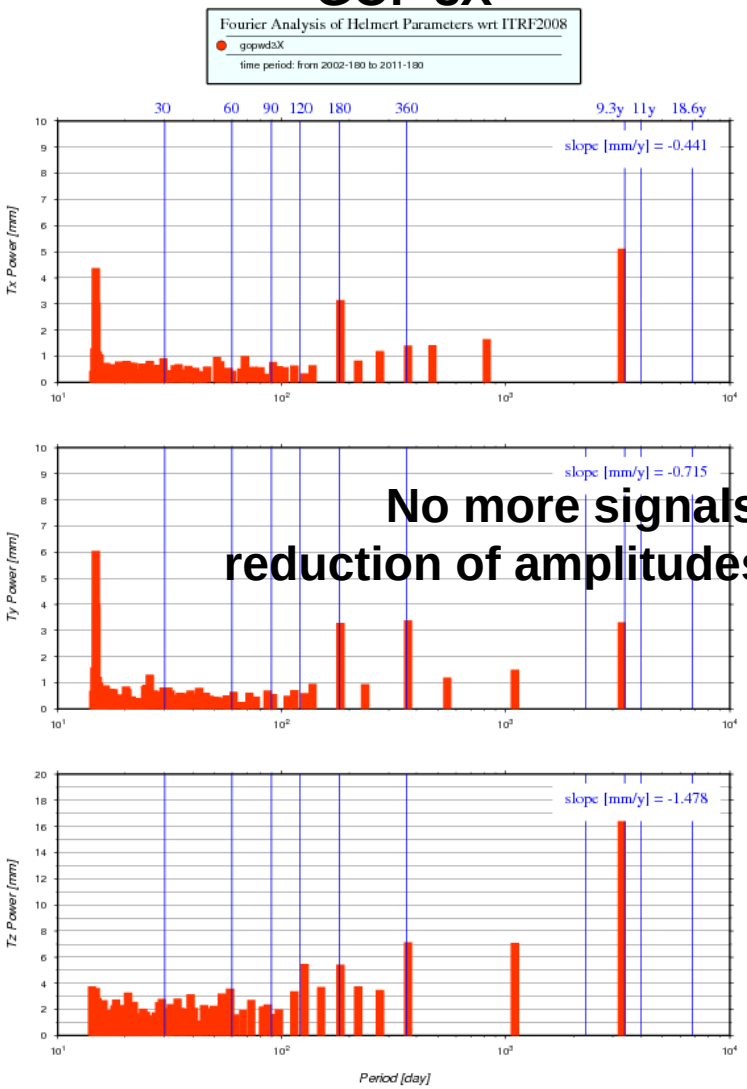
GOP 43



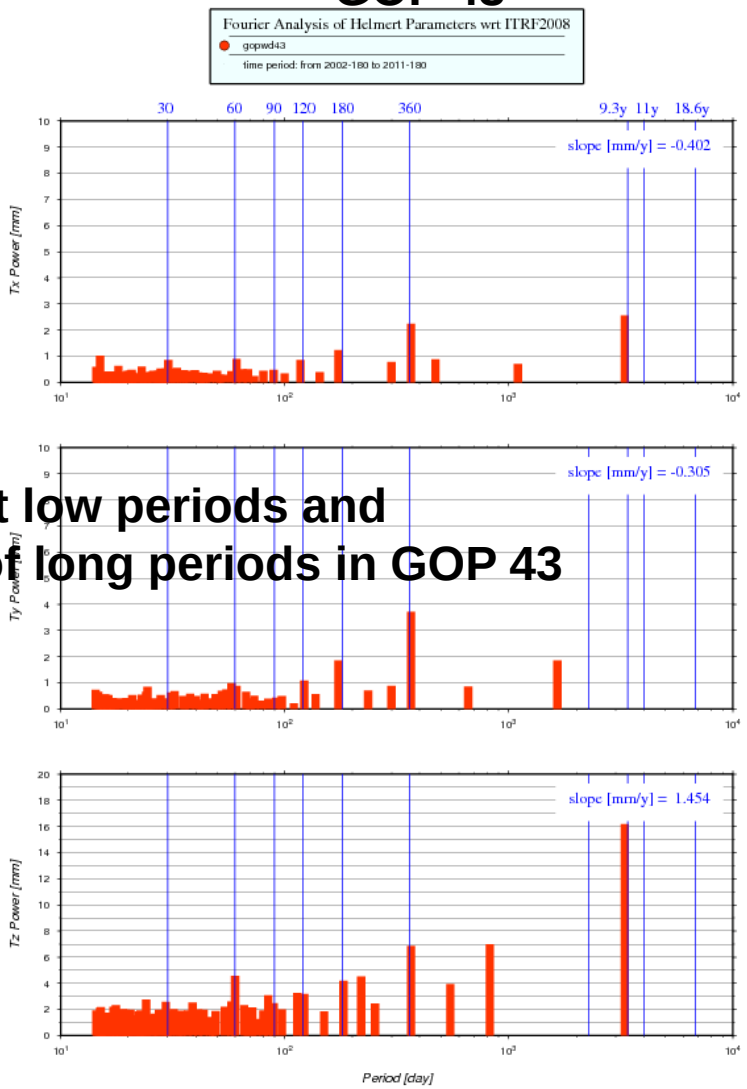
No more signals at low periods in GOP 43

GOP – FFT of translations (2002-2011)

GOP 3X

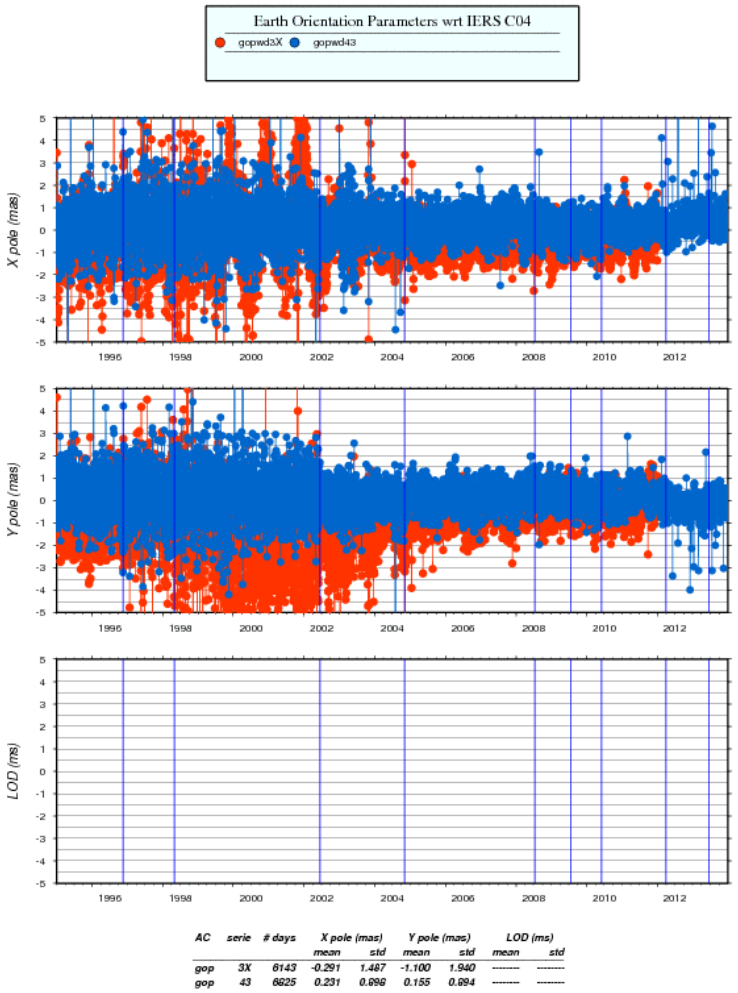


GOP 43



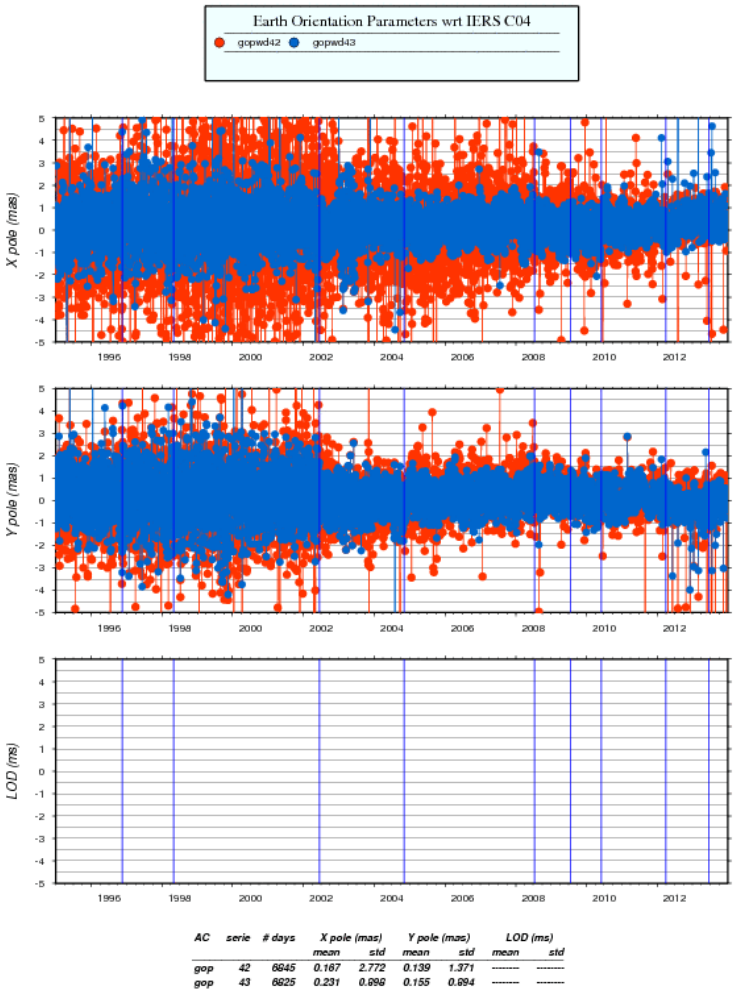
No more signals at low periods and reduction of amplitudes of long periods in GOP 43

GOP – EOPs differences wrt IERS C04



AC	serie	# days	X pole (mas)		Y pole (mas)		LOD (ms)	
			mean	std	mean	std	mean	std
gop	3X	6143	-0.291	1.487	-1.100	1.940	--------	--------
gop	43	6625	0.231	0.998	0.155	0.994	--------	--------

Better STDs of GOP 43 Compared to GOP3X



AC	serie	# days	X pole (mas)		Y pole (mas)		LOD (ms)	
			mean	std	mean	std	mean	std
gop	42	6645	0.167	2.772	0.139	1.371	--------	--------
gop	43	6625	0.231	0.998	0.155	0.994	--------	--------

Better STDs of GOP 43 (2 times smaller than GOP 42)

GOP contribution - Conclusions

- Series 42 and 43 present improvements compared to series 3X
- Series 43 gives smaller EOP STDs than GOP 42

➔ Selection of GOP 43

- Petr found a bug in the implementation of Alcatel phase law so he will reprocess data between 1993 and 2005

  ➔ no GOP contribution to the IDS combined solution V1 before 2005

- Scale increase early 2012.

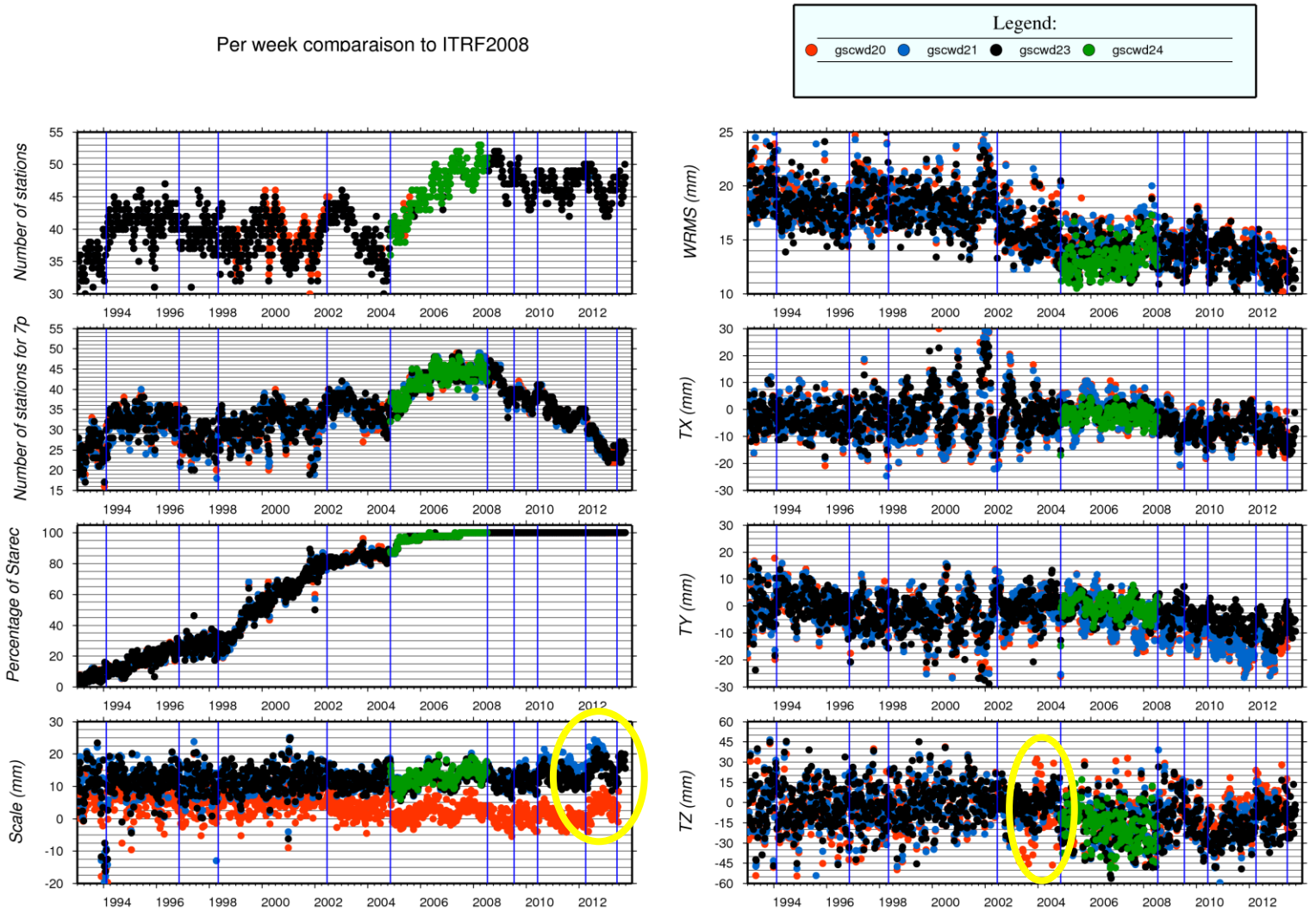
- Tz: intermediate step after 2002 jump, maybe due to no use of Jason-1.

GSC (1993-2013)

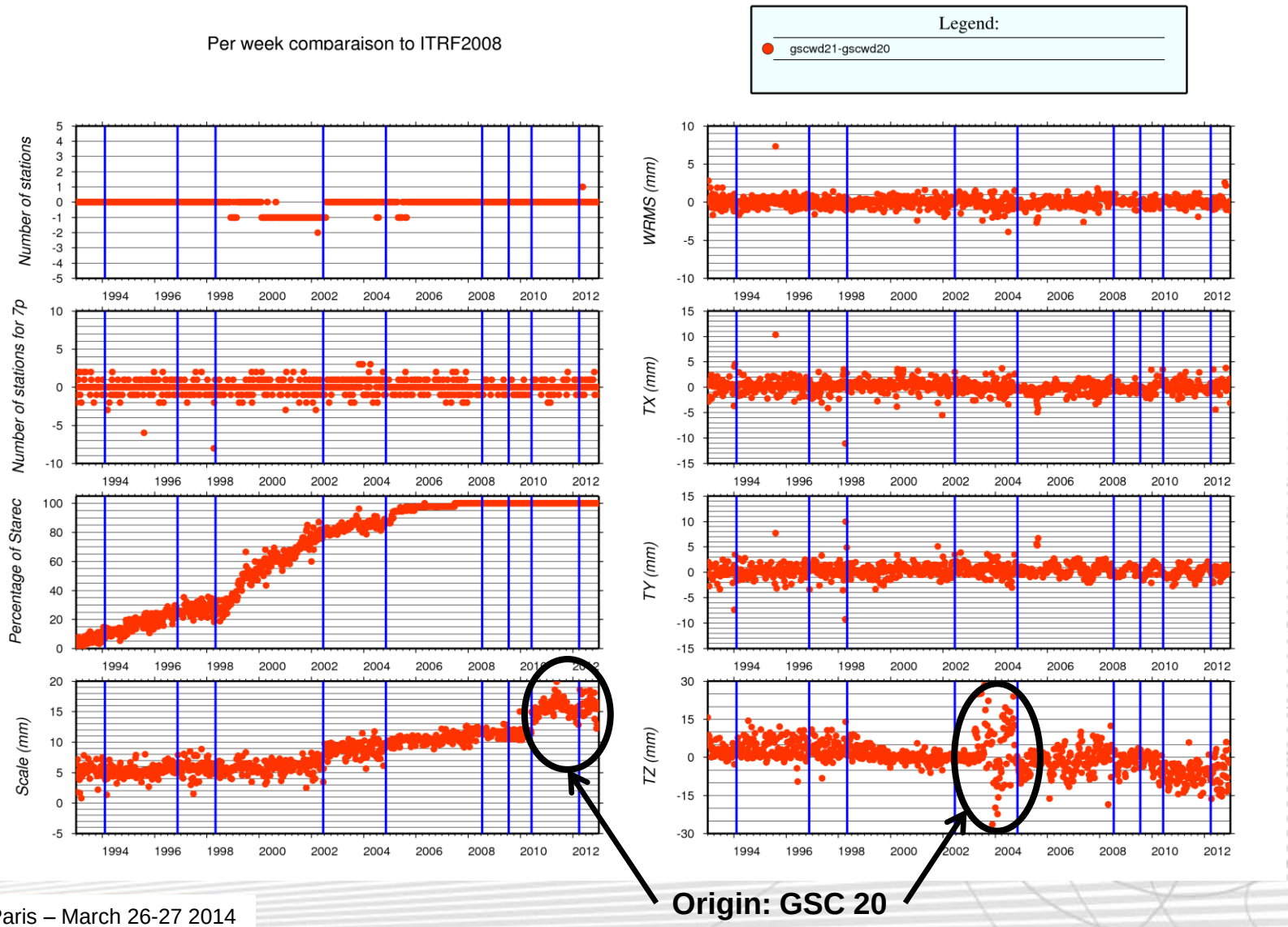
GSC contribution

- Reference = GCS 20 – Operational series
- GSC 21 == GSC 20 + phase laws
- GSC 23 == GSC 21 + time variable gravity field
- GSC 24== GSC 23 + Jason-1 between Topex and Jason-2
- No HY-2A, no Saral

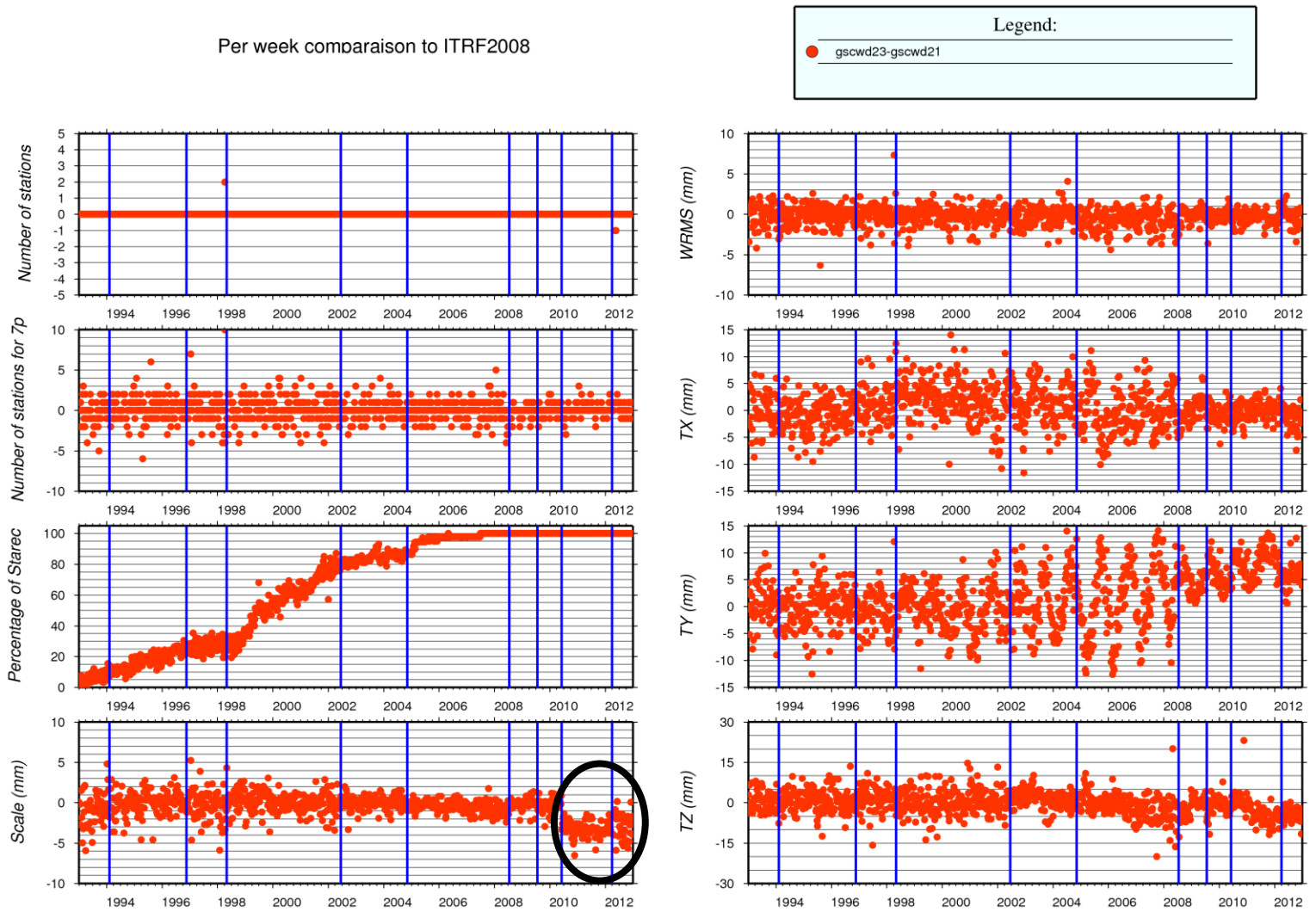
GSC – Helmert parameters wrt ITRF2008



GSC – Differences of Helmert parameters
Phase laws impact

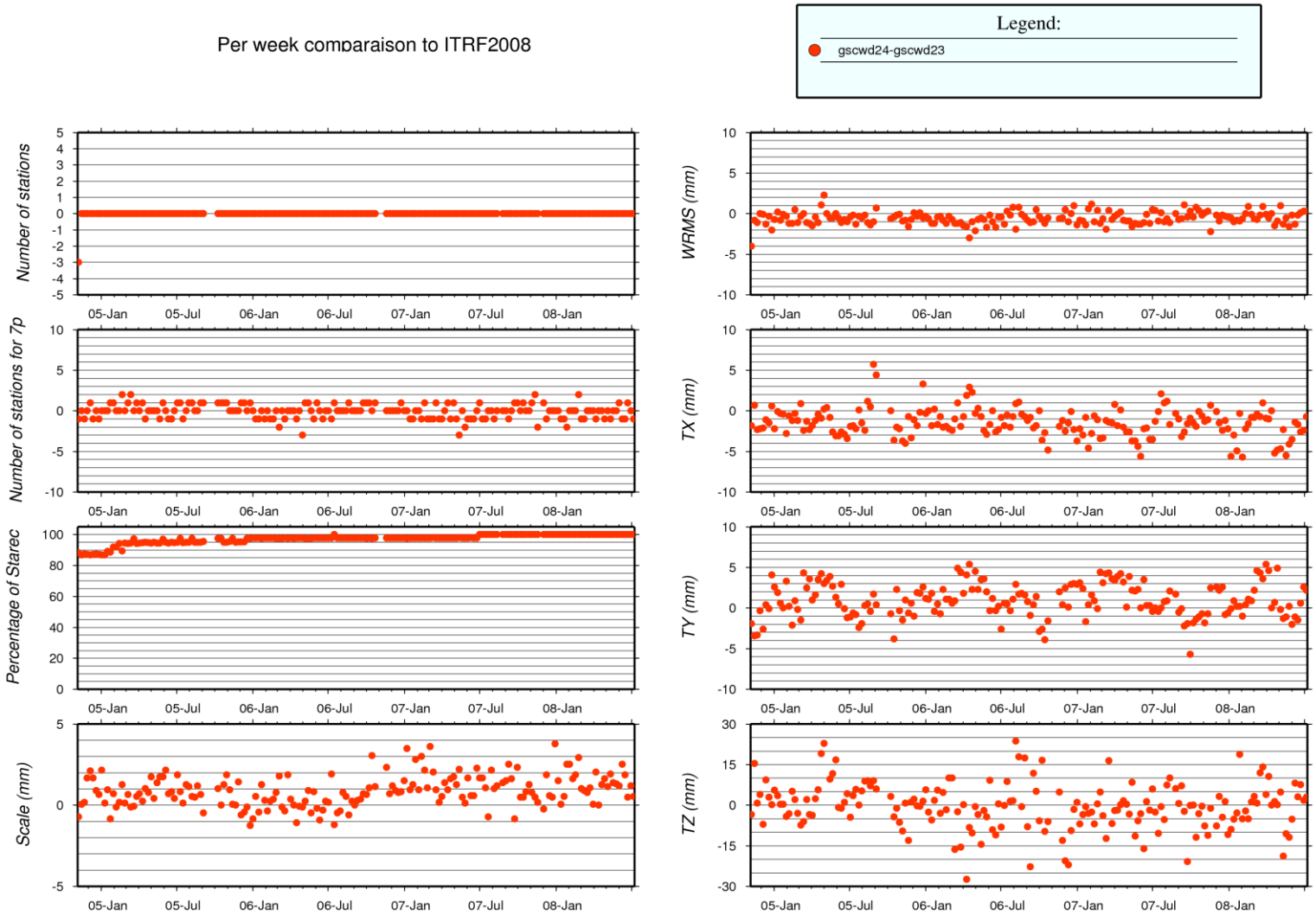


GSC – Differences of Helmert parameters
Time variable gravity field impact



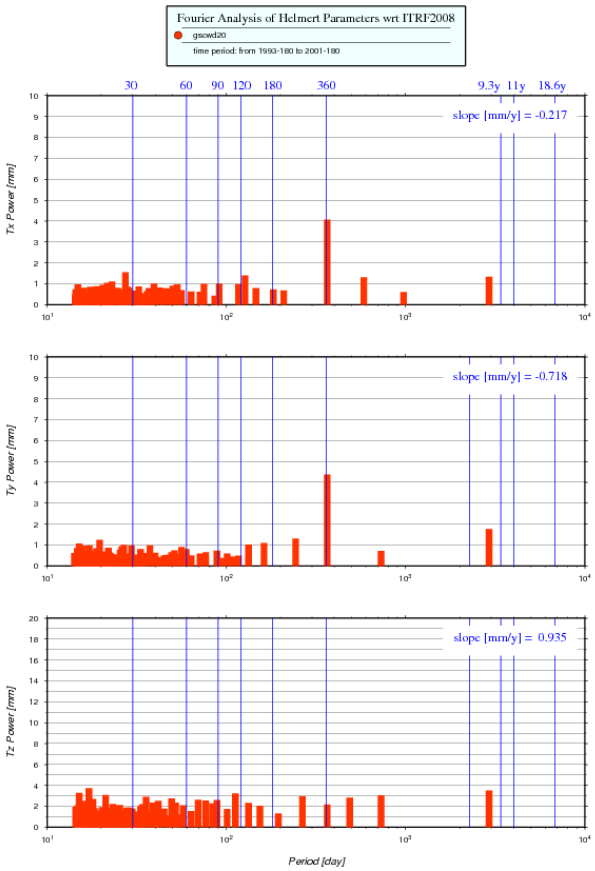
Cryosat-2 ?

GSC – Differences of Helmert parameters
Jason-1 impact

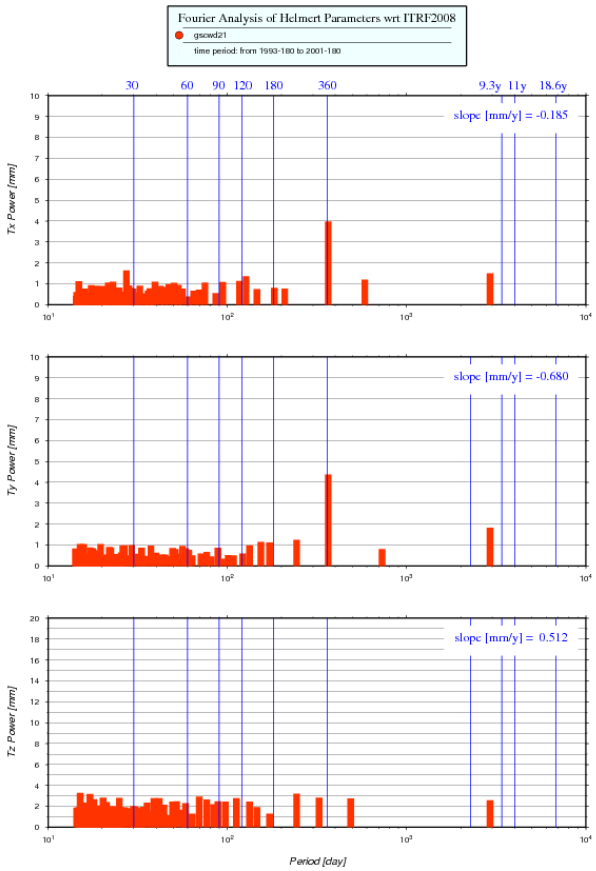


GSC – FFT of translations (1993-2001)

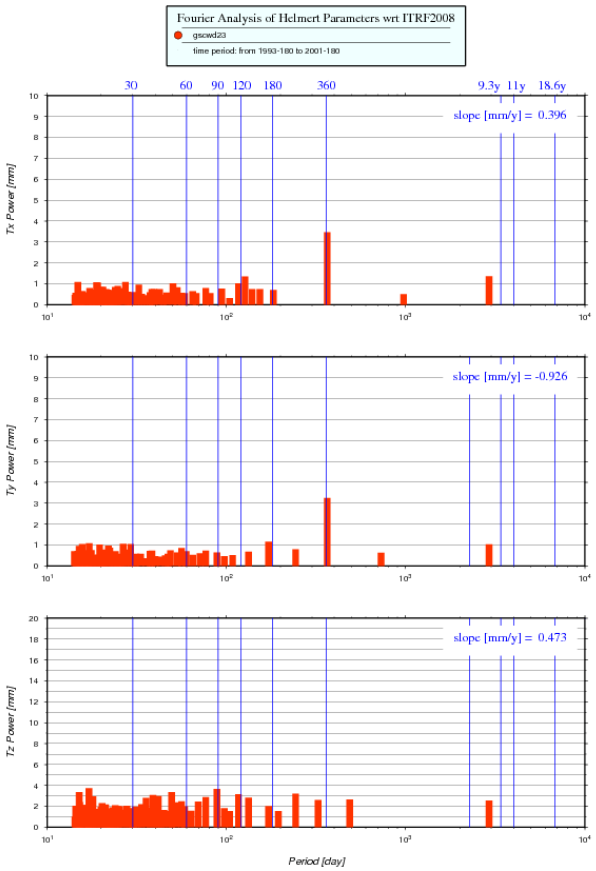
GSC 20



GSC 21



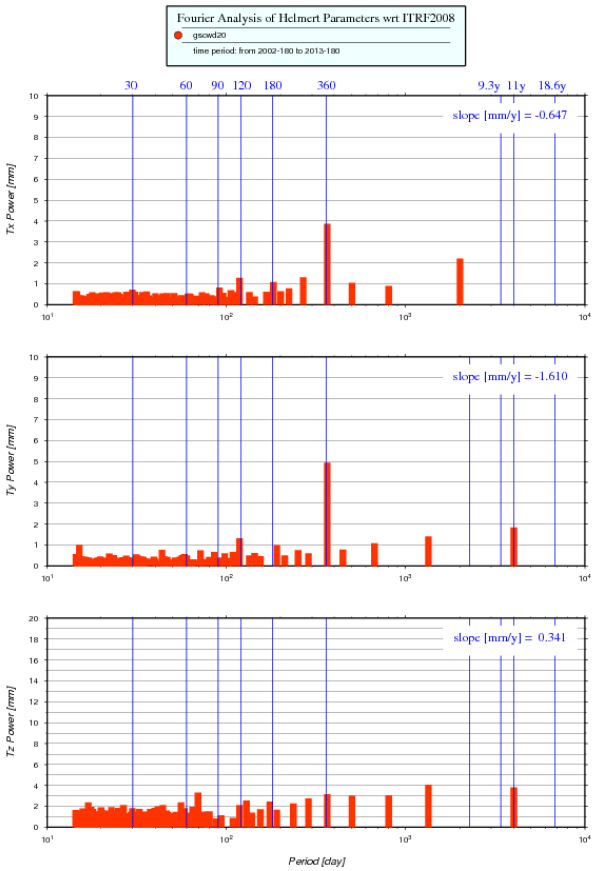
GSC 23



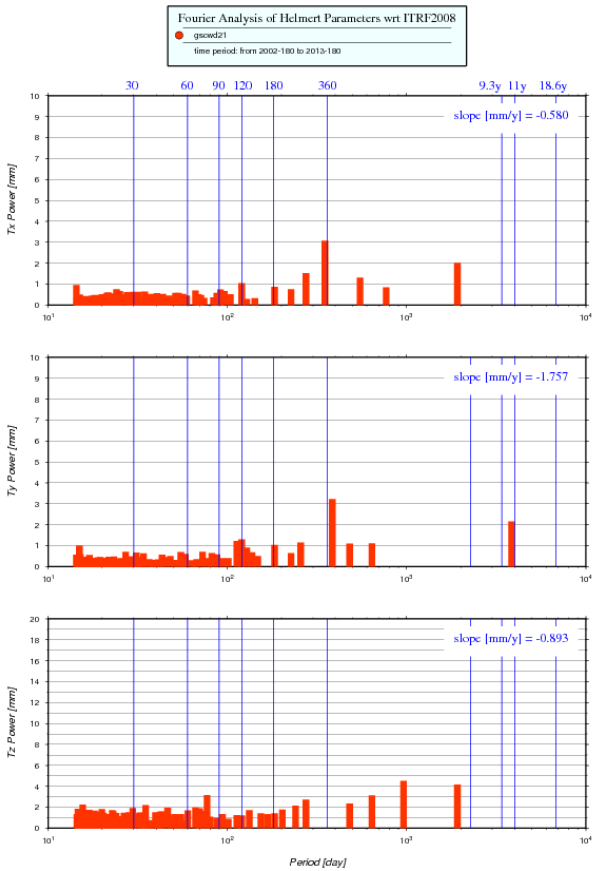
Similar results for all the series

GSC – FFT of translations (2002-2013)

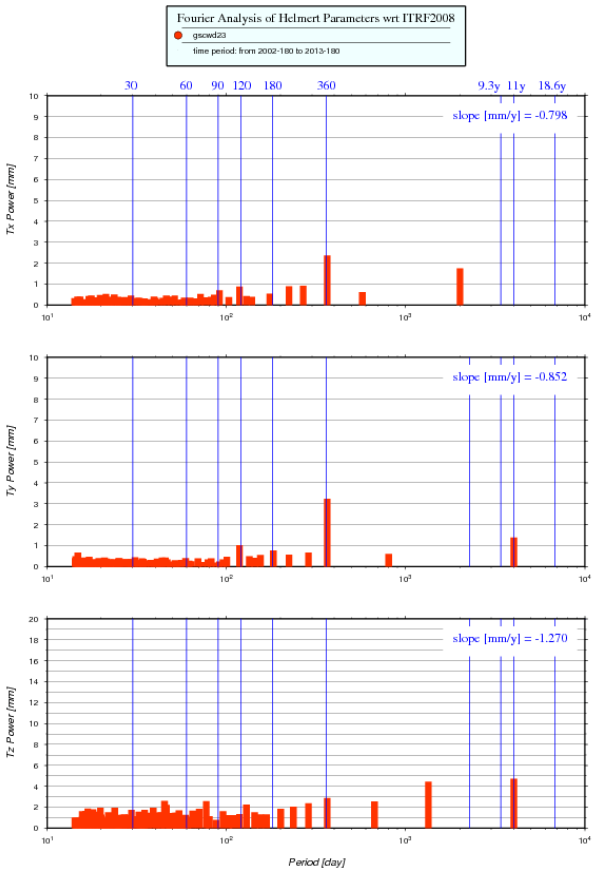
GSC 20



GSC 21

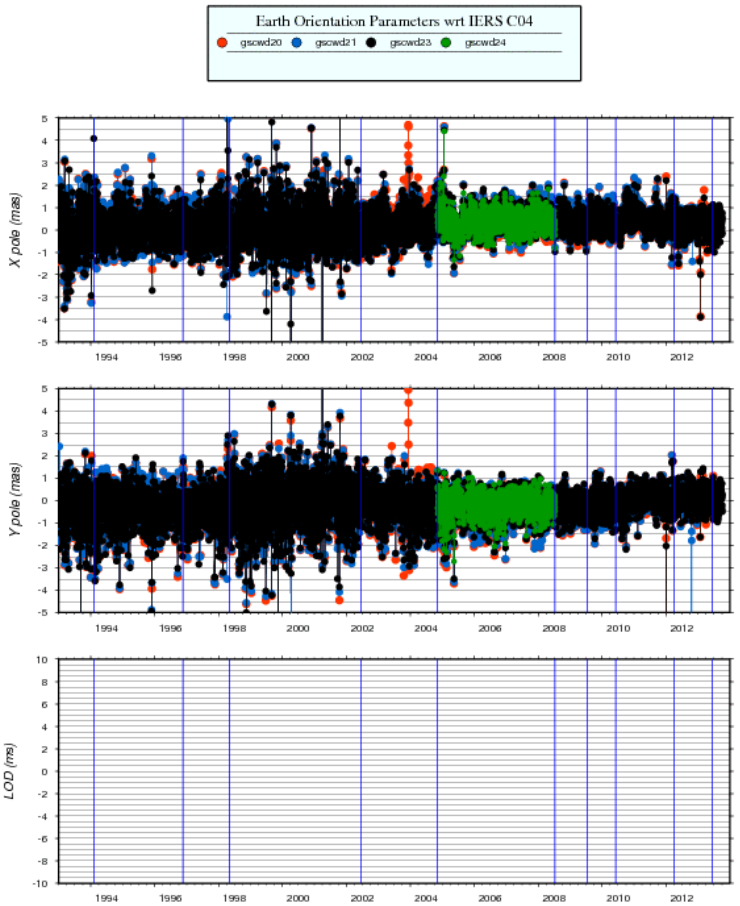


GSC 23



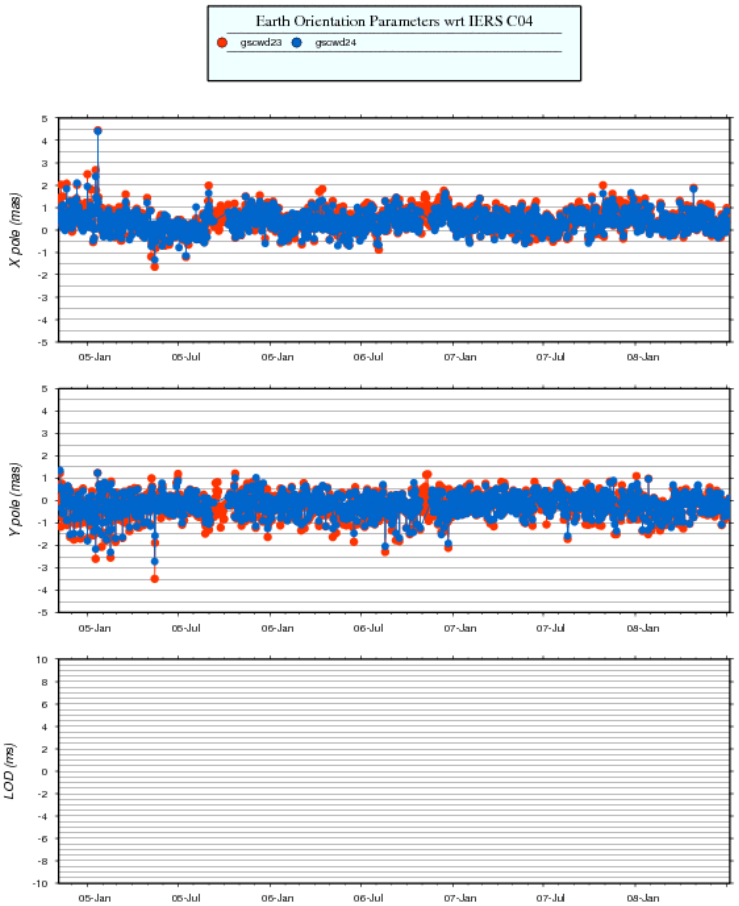
Tx, Ty: Smaller annual signals in GSC 21, 23, 24
Similar results for GSC 21, 23 and 24

GSC – EOPs differences wrt IERS C04



AC	serie	# days	X pole (mas)		Y pole (mas)		LOD (ms)	
			mean	std	mean	std	mean	std
gsc	20	7470	0.272	0.719	-0.227	0.902	--------	--------
gsc	21	7302	0.299	0.716	-0.206	0.796	--------	--------
gsc	23	7603	0.241	0.683	-0.177	0.746	--------	--------
gsc	24	1293	0.361	0.437	-0.186	0.457	--------	--------

Slightly better STDs for GSC 23 compared to GSC 20 and 21



AC	serie	# days	X pole (mas)		Y pole (mas)		LOD (ms)	
			mean	std	mean	std	mean	std
gsc	23	1342	0.445	0.484	-0.225	0.519	--------	--------
gsc	24	1279	0.383	0.436	-0.186	0.457	--------	--------

No impact from Jason-1

GSC contribution - Conclusions

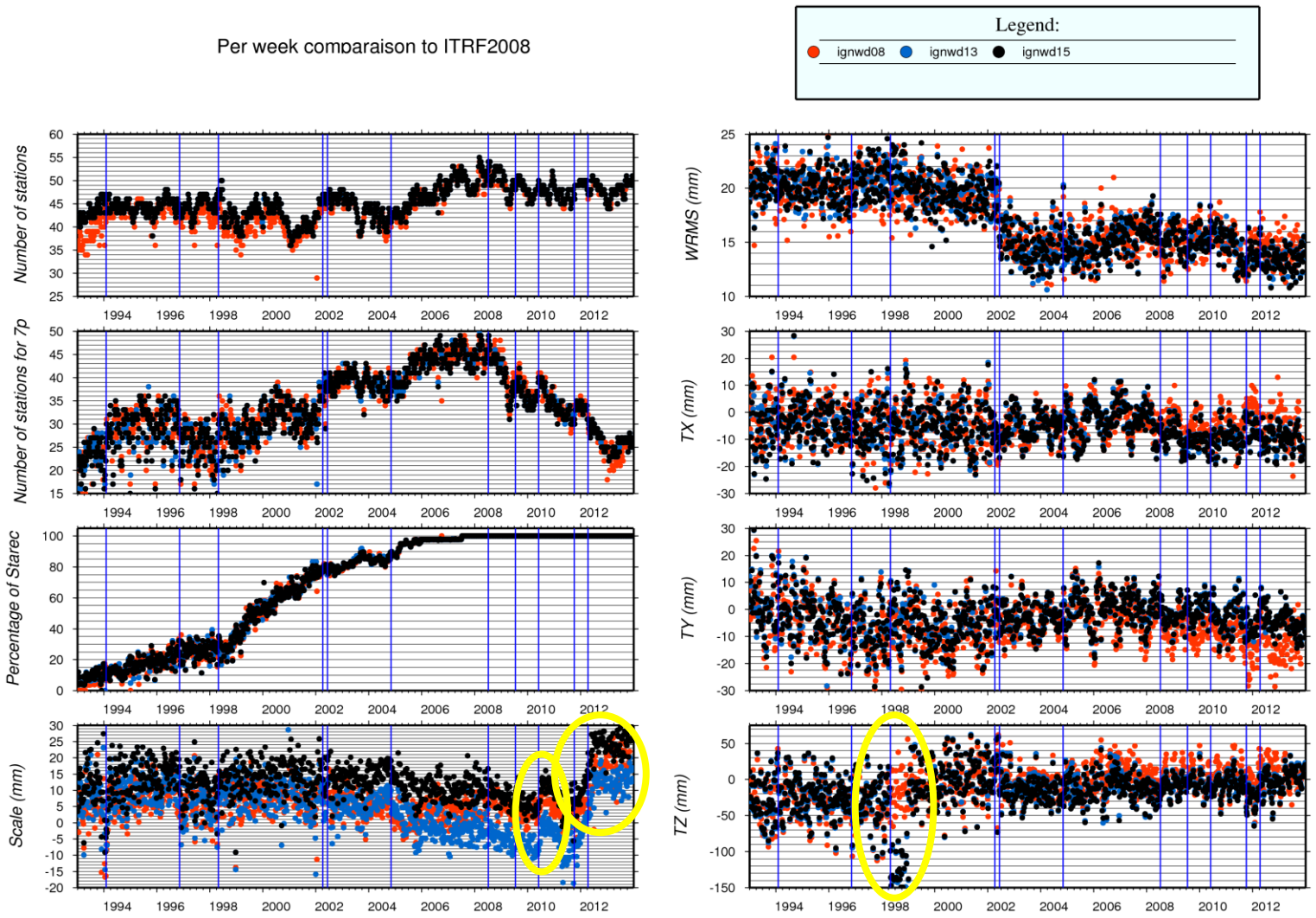
- GSC 24 (23+Jason-1) is the baseline for GSC contribution to ITRF2013.
- Scale increase early 2012.
- Next ? HY-2A ?

IGN (1993-2013)

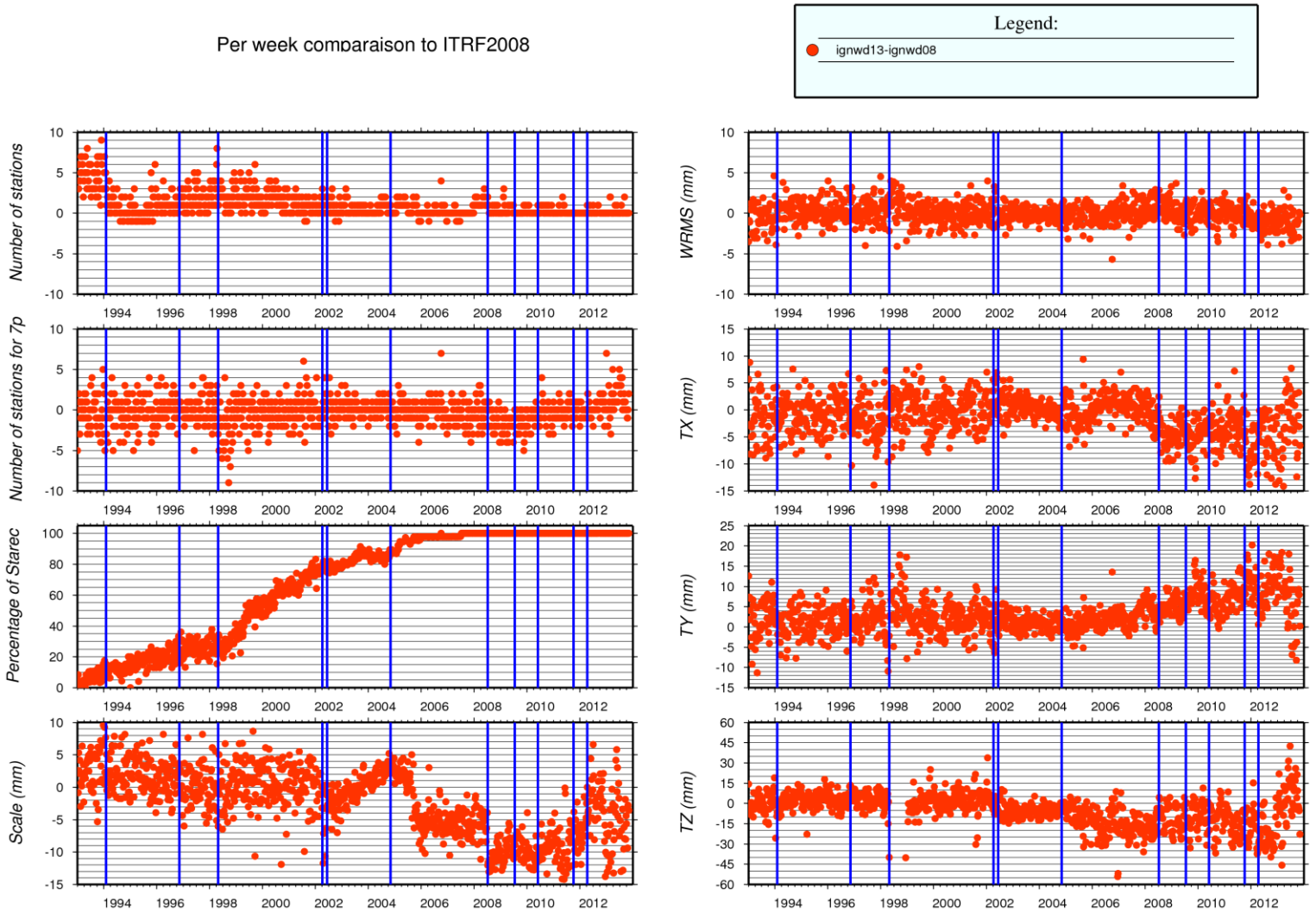
IGN contribution

- Reference = IGN 08 (93001-13356) – Operational series
- IGN 13 == IGN 08 + time variable gravity field
- IGN 15 == IGN 13 + phase laws
- No Jason-1 in all the series
- HY-2A and Saral in all the series
- Cut-off: 7degrees

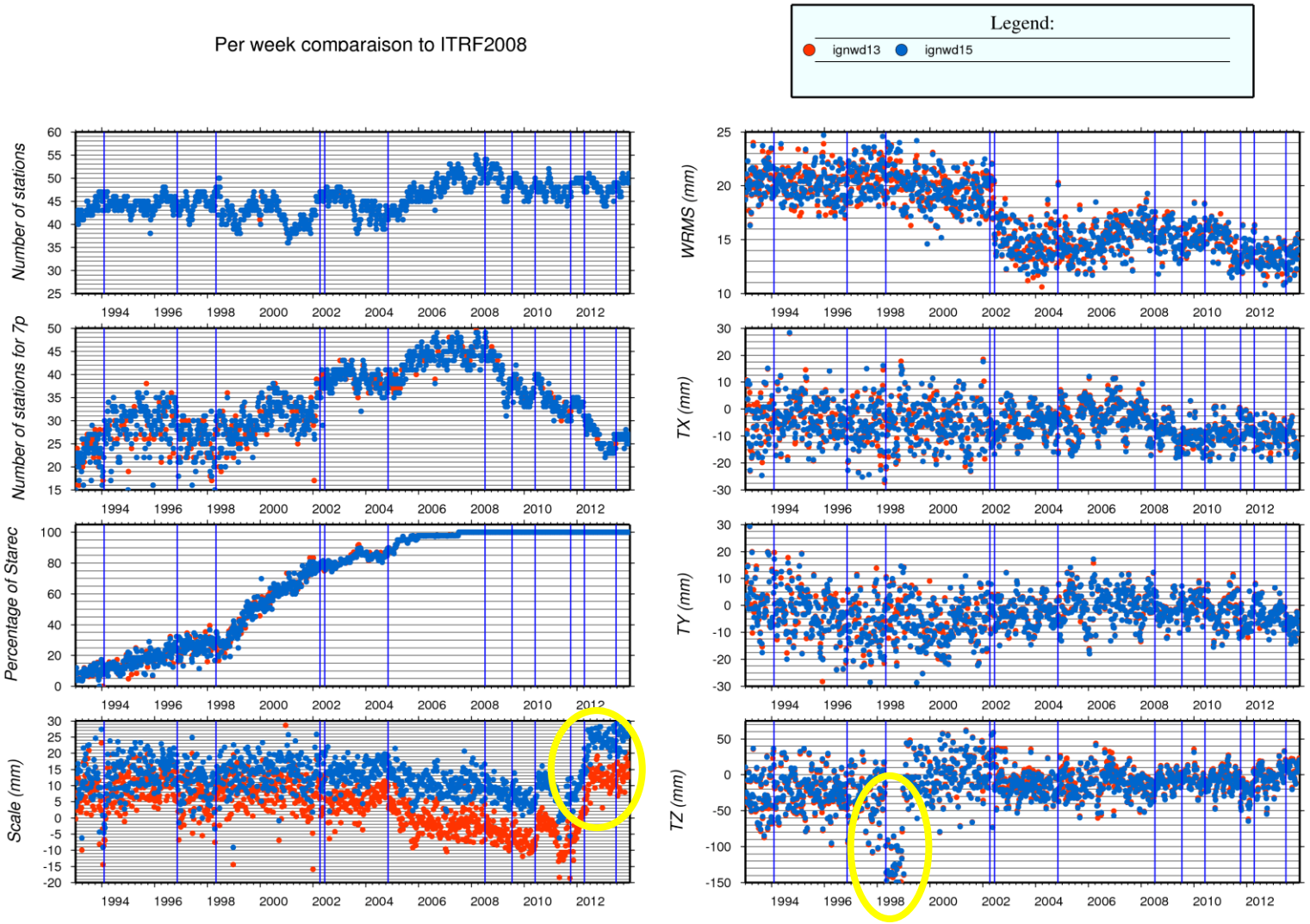
IGN – Helmert parameters wrt ITRF2008



IGN – Differences of Helmert parameters

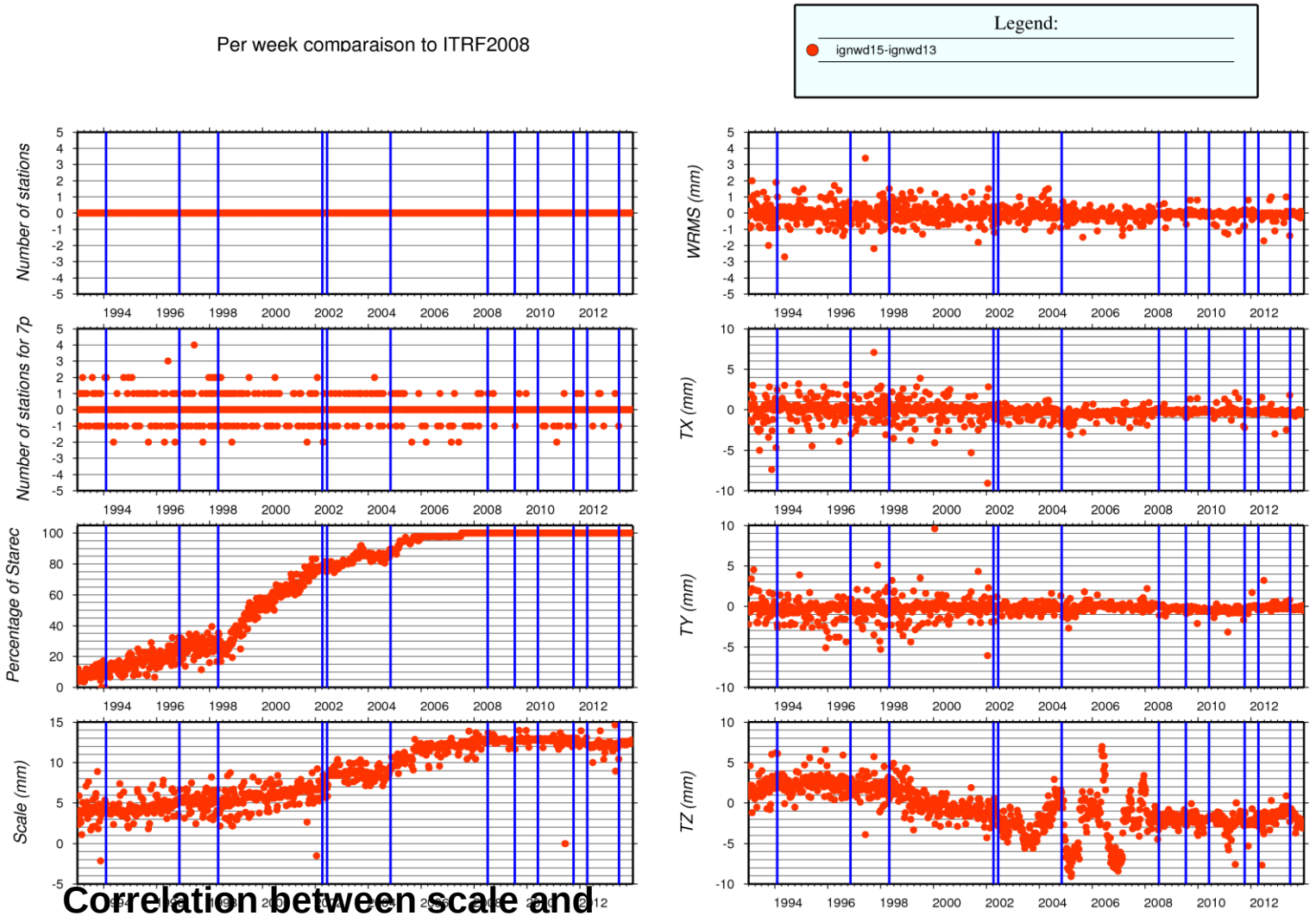


IGN – Helmert parameters wrt ITRF2008



Older Spot-4 data

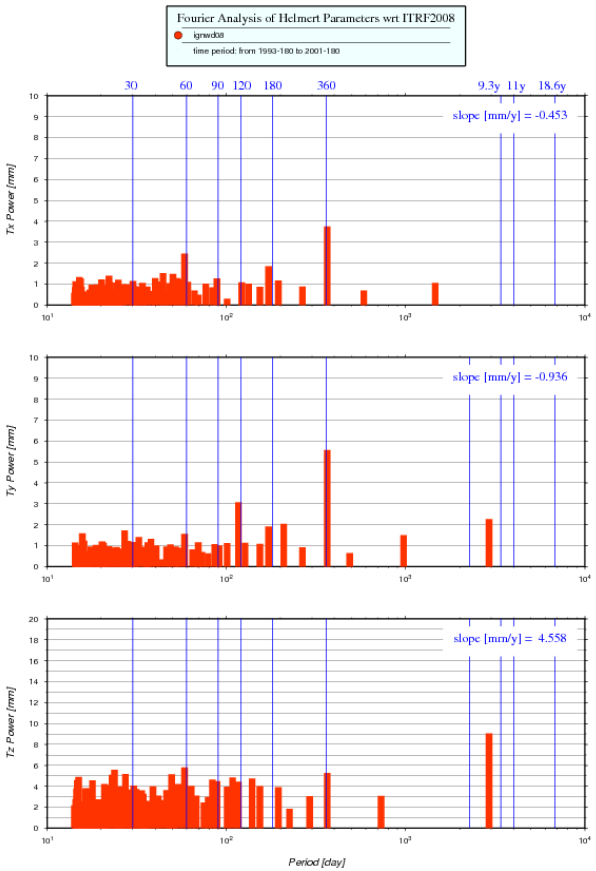
IGN – Differences of Helmert parameters
Phase laws impact



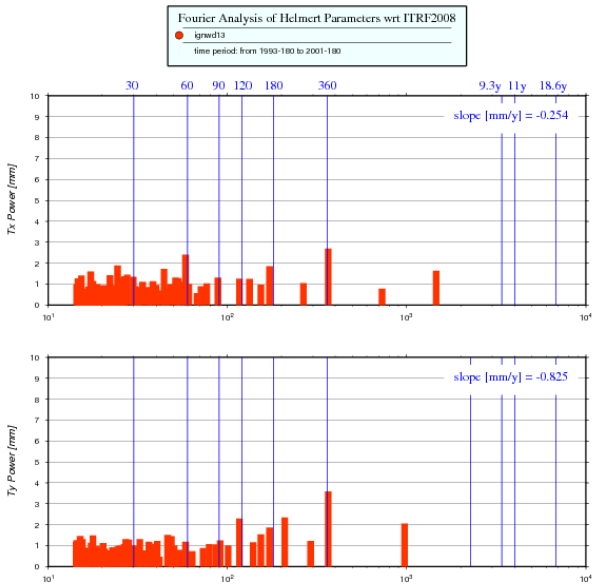
Correlation between scale and antennas DORIS network evolution

IGN – FFT of translations (1993-2001)

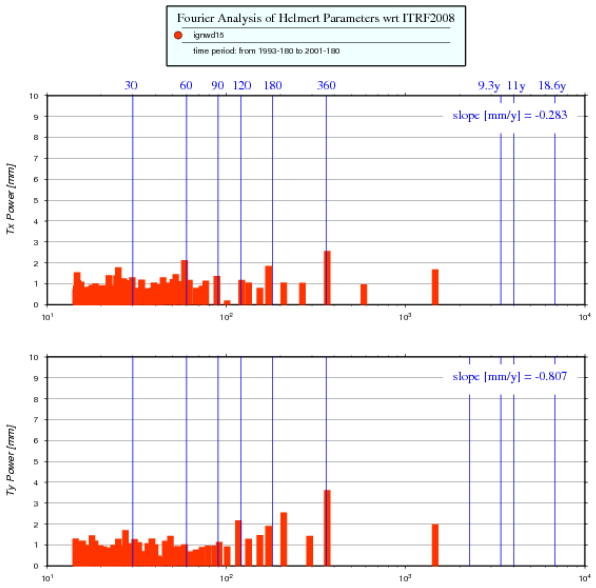
IGN 08



IGN 13



IGN 15

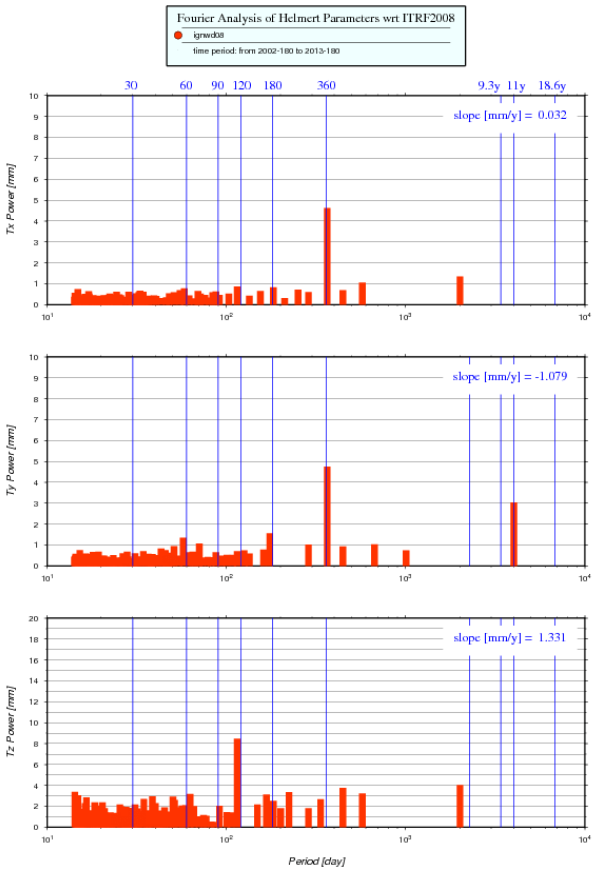


No Tz analyisis for IGN 13 and IGN 15 due to Spot-4 data pb
➔ Tz discontinuity in 1998

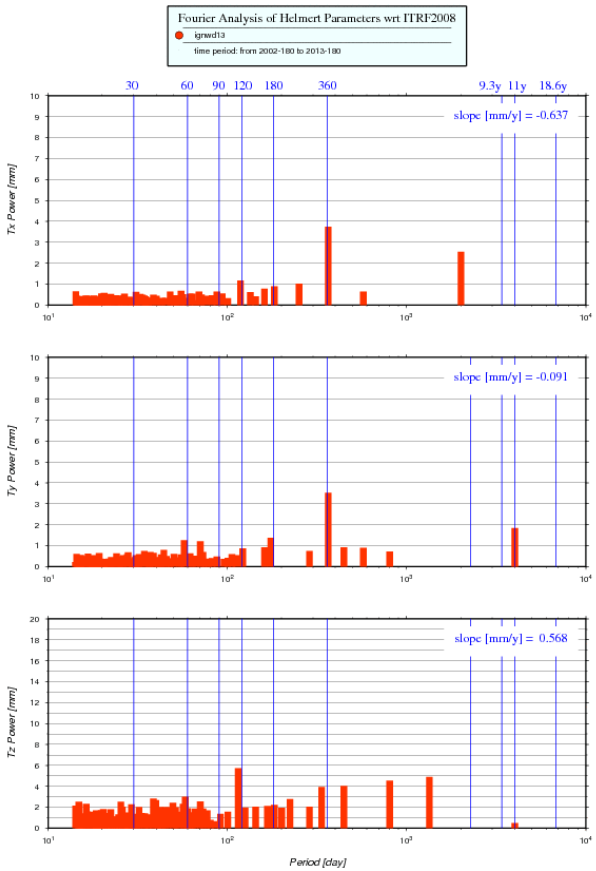
Tx and Ty: Reduction of annual in signals IGN 13 vs IGN 08
Similar results for IGN 13 and IGN 15

IGN – FFT of translations (2002-2013)

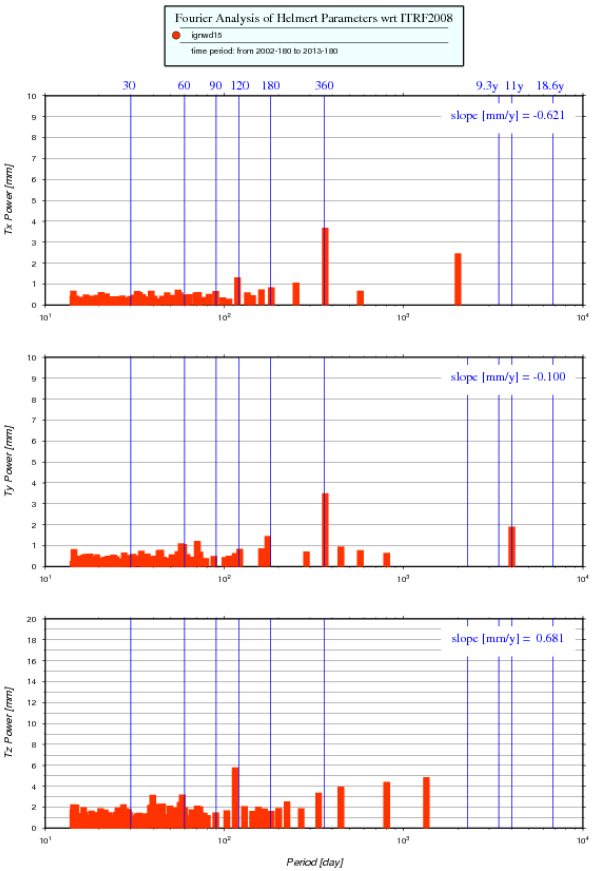
IGN 08



IGN 13

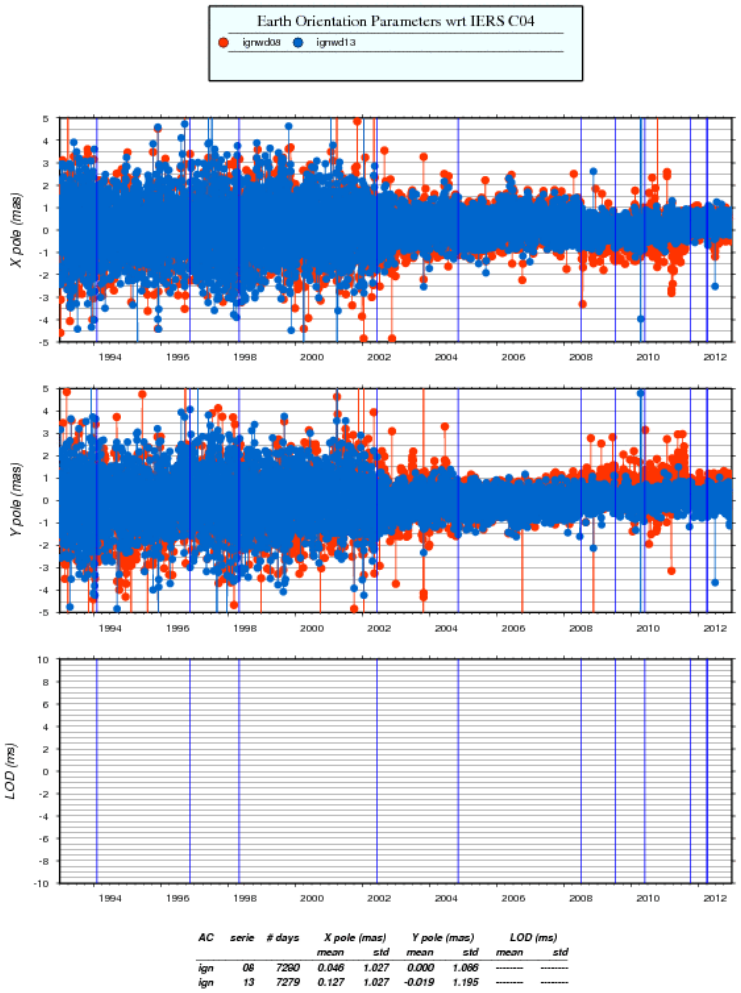


IGN 15

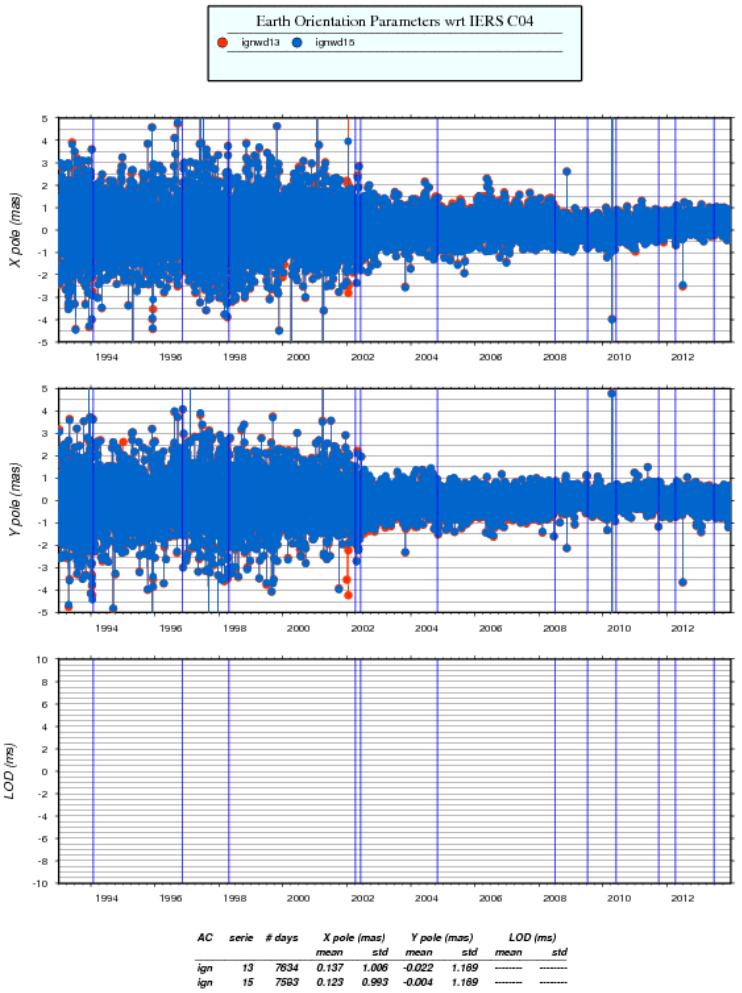


Tx and Ty: Reduction of annual in signals IGN 13 vs IGN 08
Tz: Reduction of 120 days signals IGN 13 vs IGN 08
Similar results between IGN 13 and IGN 15

IGN – EOPs differences wrt IERS C04



AC	serie	# days	X pole (mas)		Y pole (mas)		LOD (ms)	
			mean	std	mean	std	mean	std
ign	08	7290	0.046	1.027	0.000	1.086	--------	--------
ign	13	7279	0.127	1.027	-0.019	1.195	--------	--------



AC	serie	# days	X pole (mas)		Y pole (mas)		LOD (ms)	
			mean	std	mean	std	mean	std
ign	13	7634	0.137	1.006	-0.022	1.189	--------	--------
ign	15	7583	0.123	0.993	-0.004	1.189	--------	--------

Slightly better results for IGN 13

Same results for IGN 13 and 15

IGN contribution - Conclusions

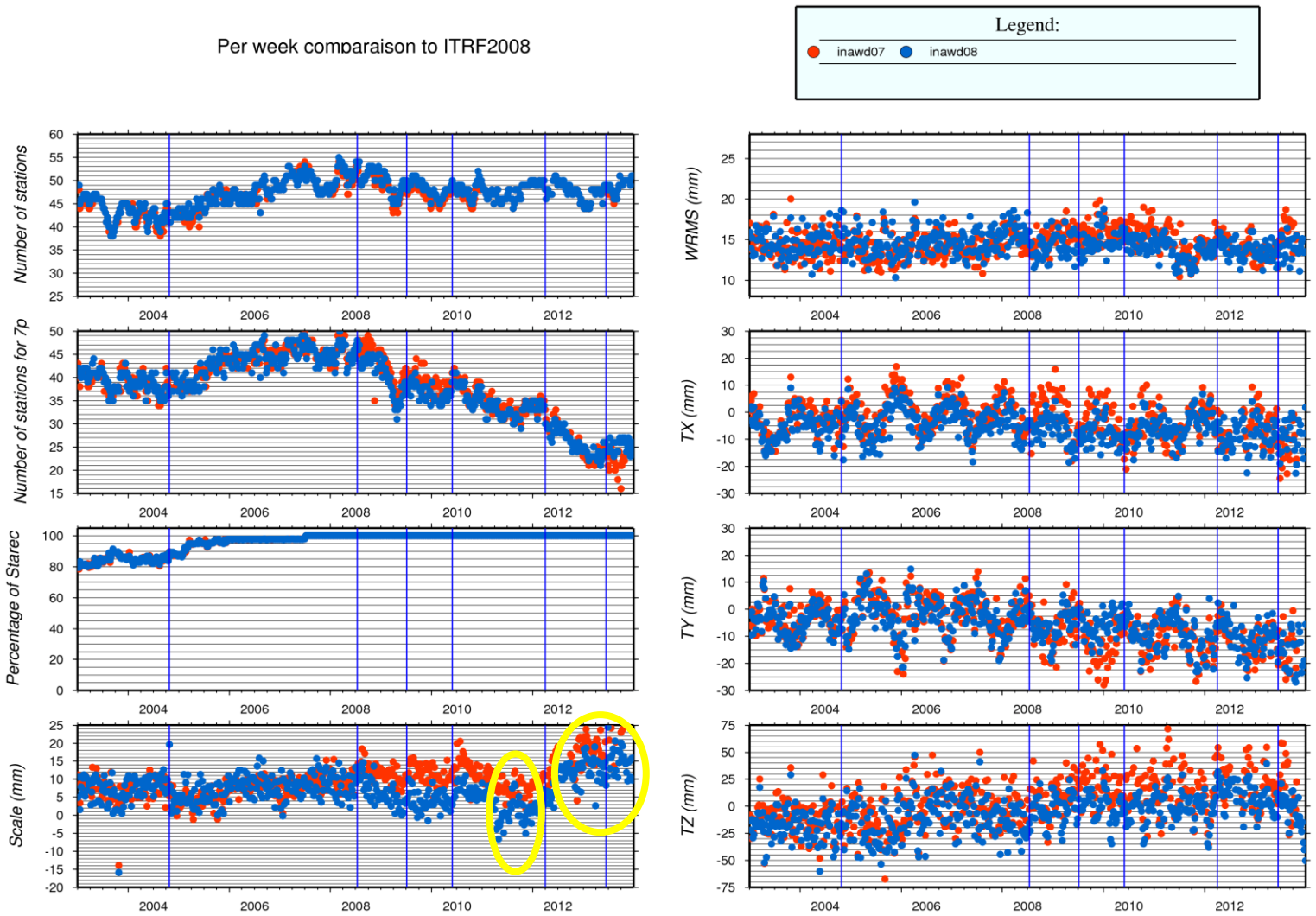
- Re-processing of year 1998 for series 13 and 15 due to older Spot-4 Doris data files from CNES.
- Scale increase early 2012.
- IGN 15 should be used ➔ IGN will contribute to the combined scale

INA (2003-2013)

INA contribution

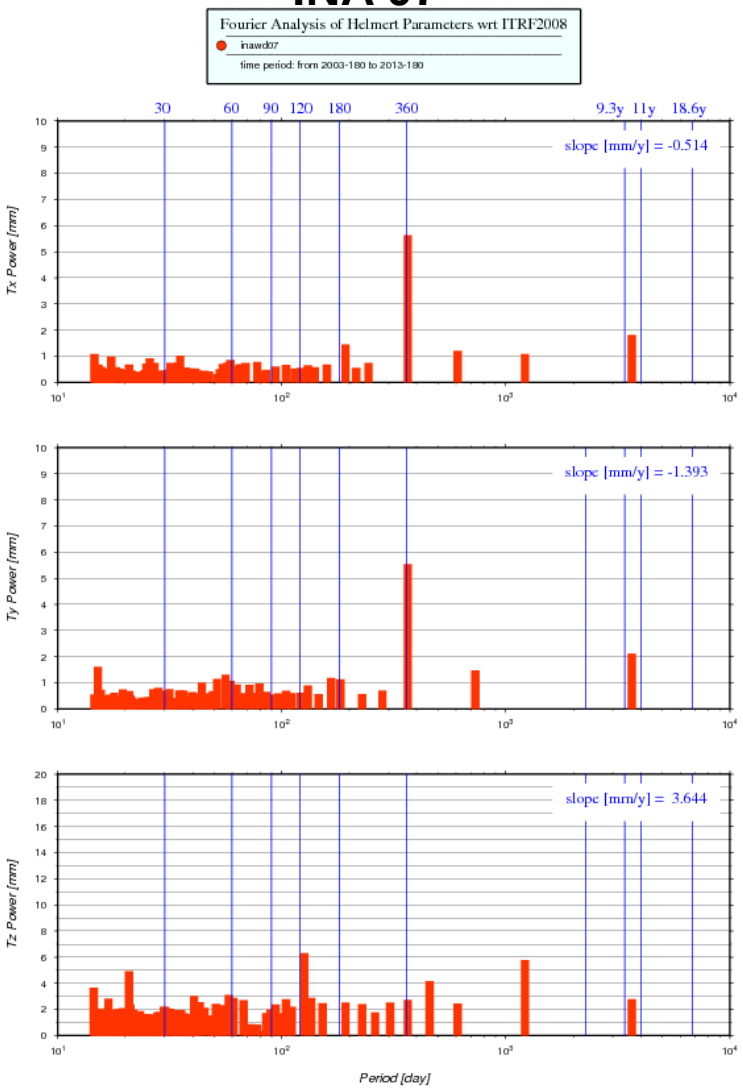
- Reference = INA 07 (93001-13300) – Operational series
- INA 08 == INA 07 + time variable gravity field + Spot-5 SAA corrected data
- No phase law in both series 07 and 08
- No Jason-1 in all the series
- Cut-off angle: 15 deg in INA 07 → 12 deg in INA 08

INA – Helmert parameters wrt ITRF2008

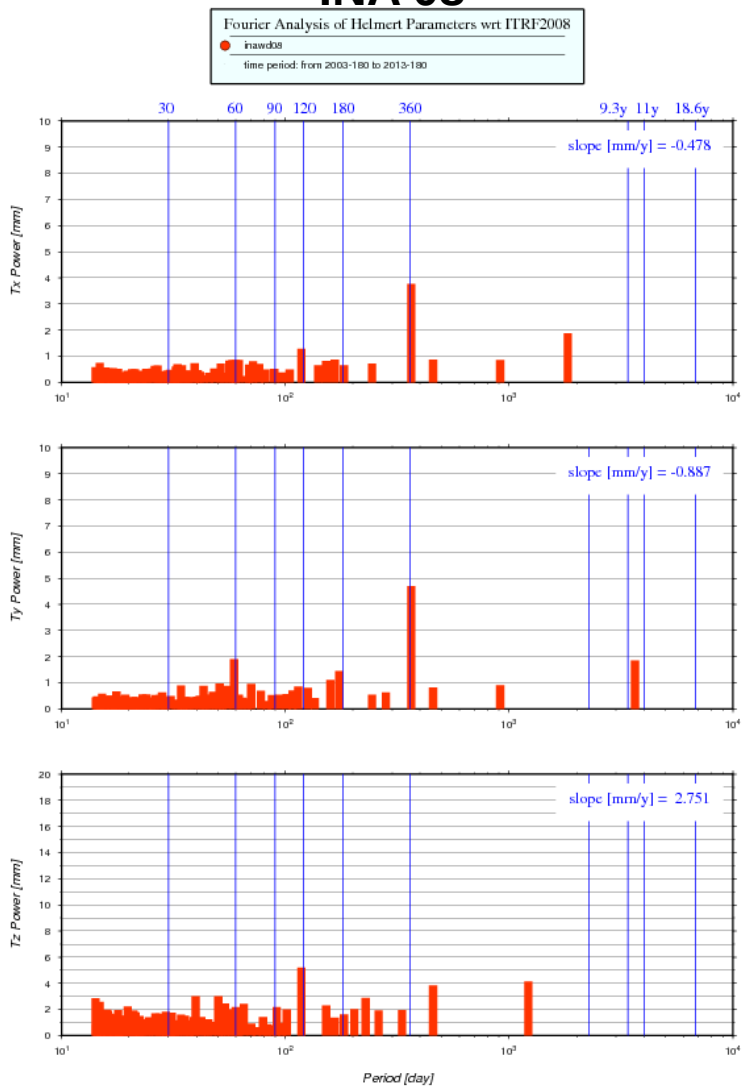


INA – FFT of translations (2003-2013)

INA 07

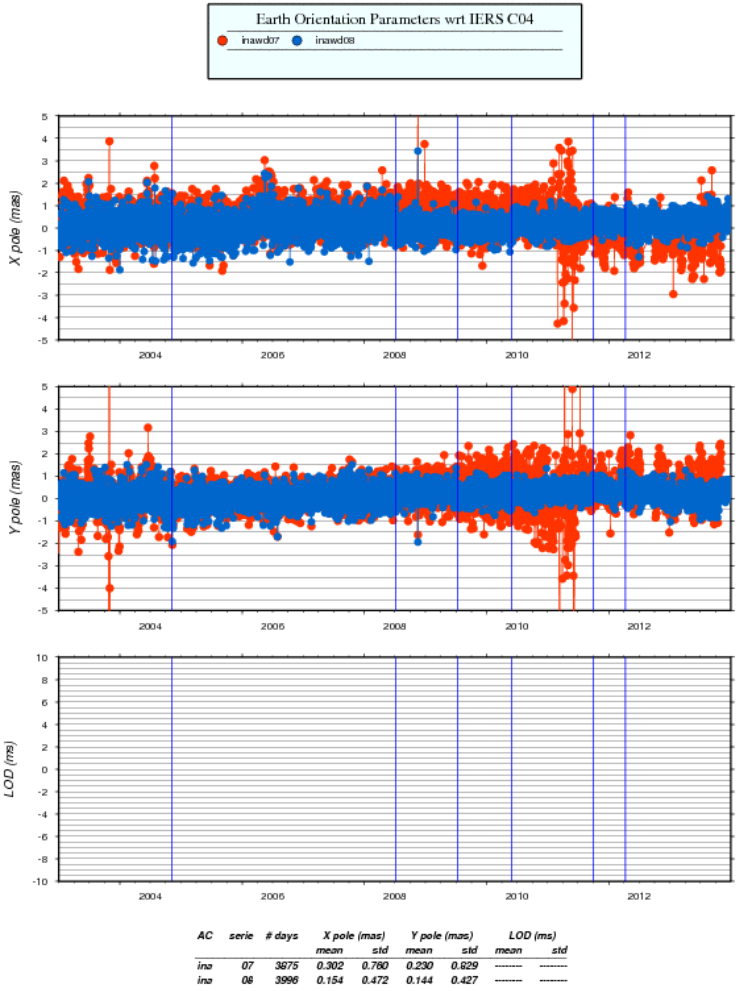


INA 08



Similar results for INA 07 and INA 08

INA – EOPs differences wrt IERS C04



AC	serie	# days	X pole (mas)		Y pole (mas)		LOD (ms)	
			mean	std	mean	std	mean	std
ina	07	3875	0.302	0.760	0.230	0.929	--------	--------
ina	08	3996	0.154	0.472	0.144	0.427	--------	--------

Better results for INA 08
(STDs divided by nearly 2)

INA contribution - Conclusions

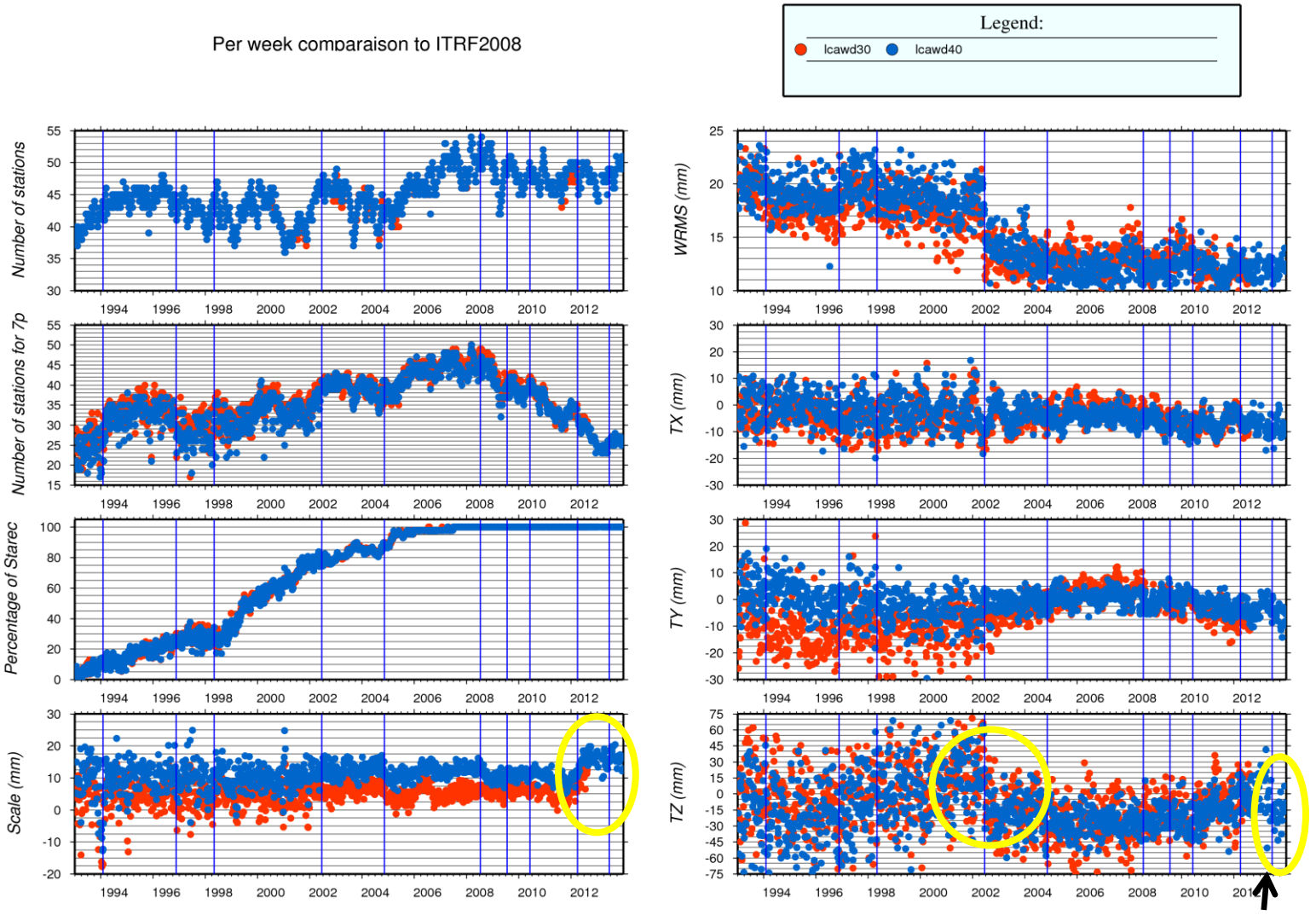
- So far, INA08 performs better than INA07.
- INA08 will not contribute to the combined scale since it does not include phase laws.

LCA (1993-2013)

LCA contribution

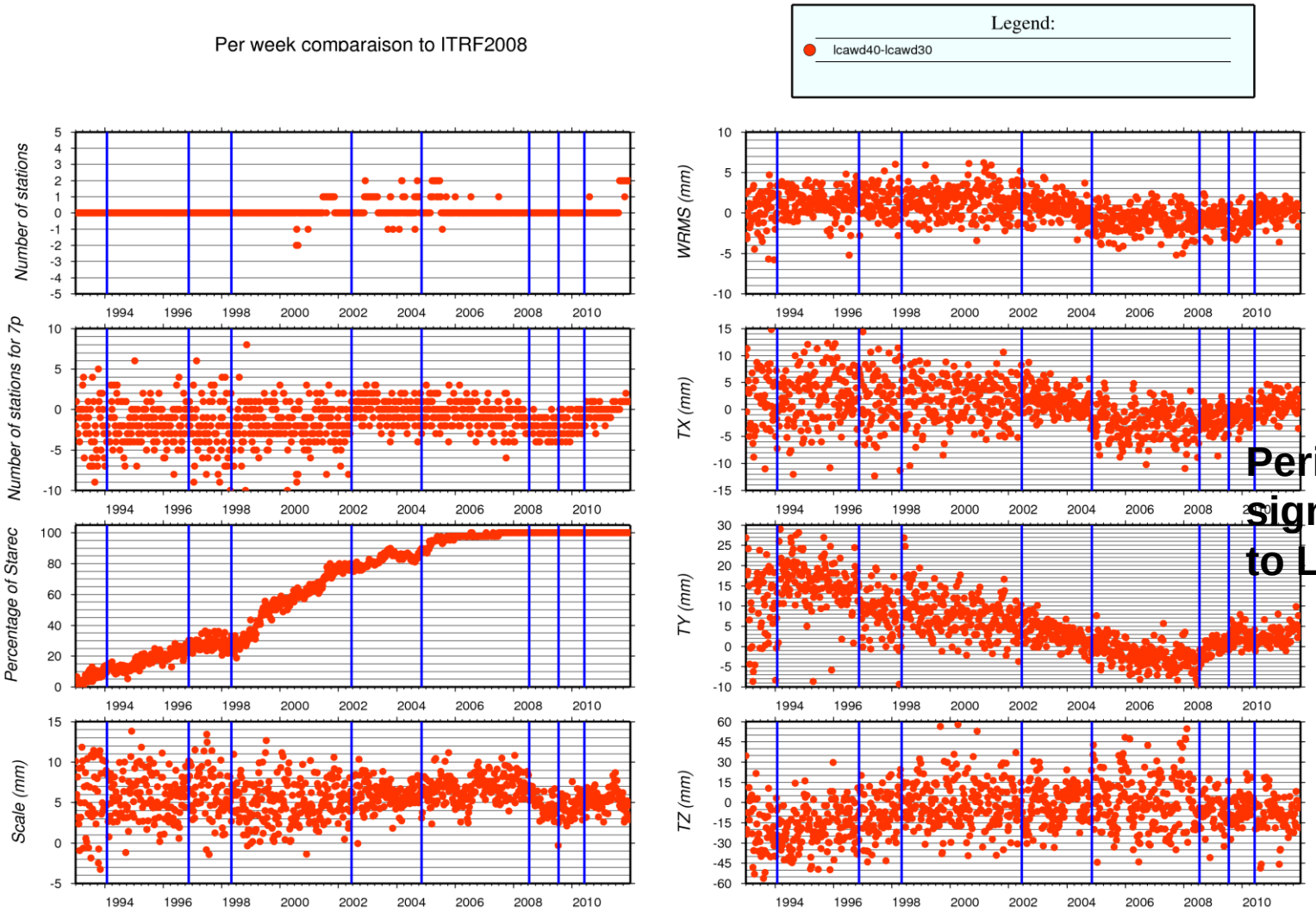
- Reference = LCA 30 (93001 - 12225) – Operational series
- LCA 40 == LCA 30 + Phase laws + new time variable gravity field + Jason-1 (from 2004- to 2008-188) + Spot-5 SAA corrected data + tropospheric gradients +…
- No Saral, no HY-2A

LCA – Helmert parameters wrt ITRF2008



Spot-4 end's effect ?

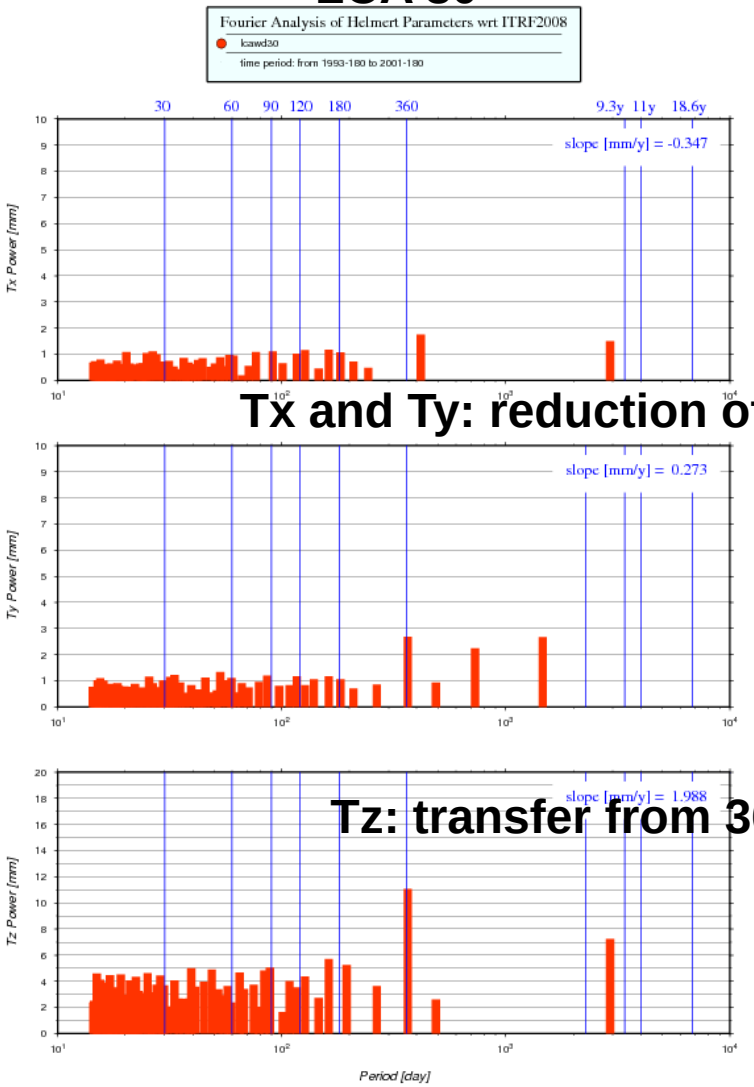
LCA – Differences of Helmert parameters



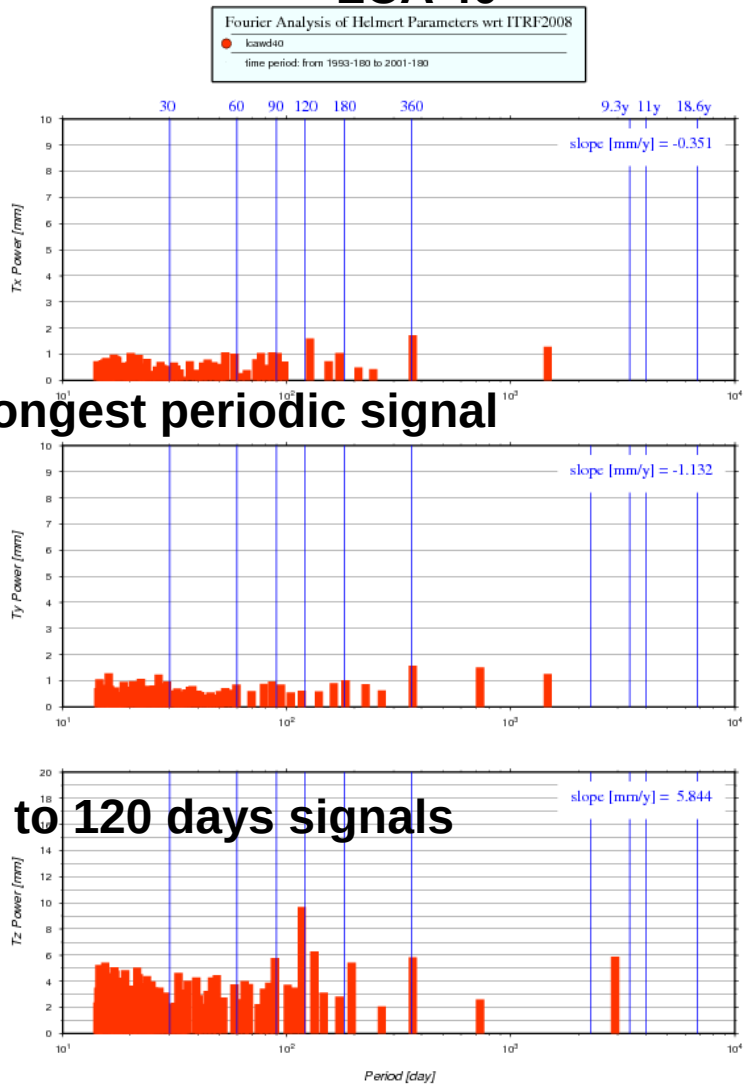
Periodic signal is due to LCA 30

LCA – FFT of translations (1993-2001)

LCA 30



LCA 40

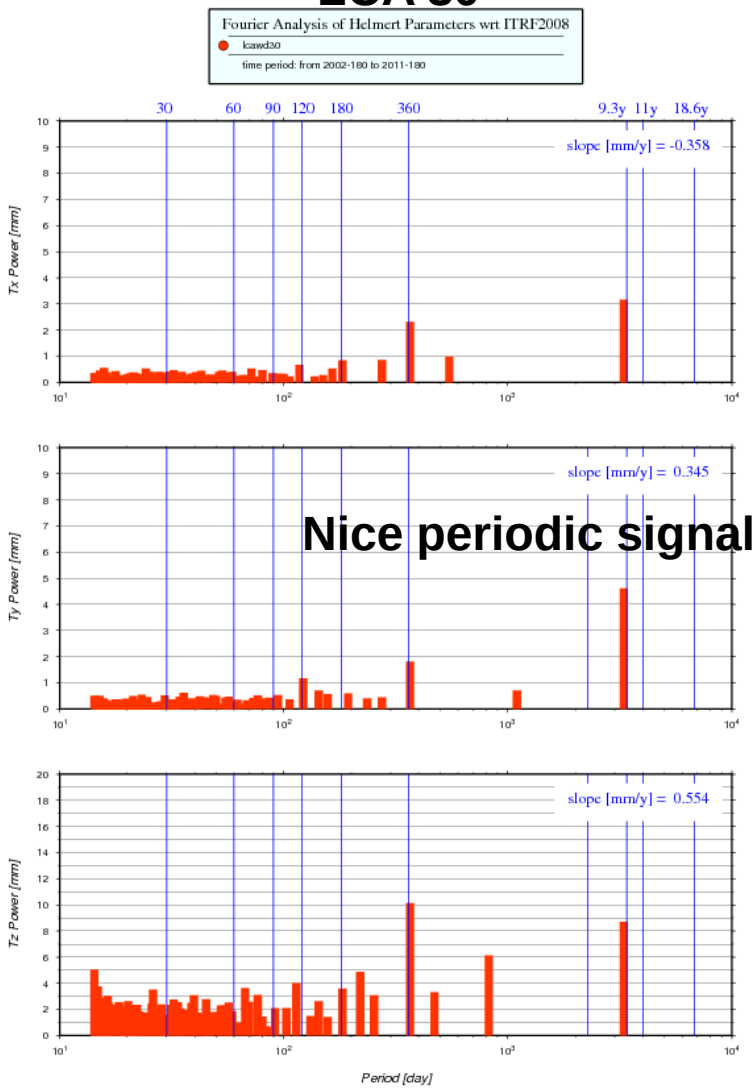


Tx and Ty: reduction of longest periodic signal

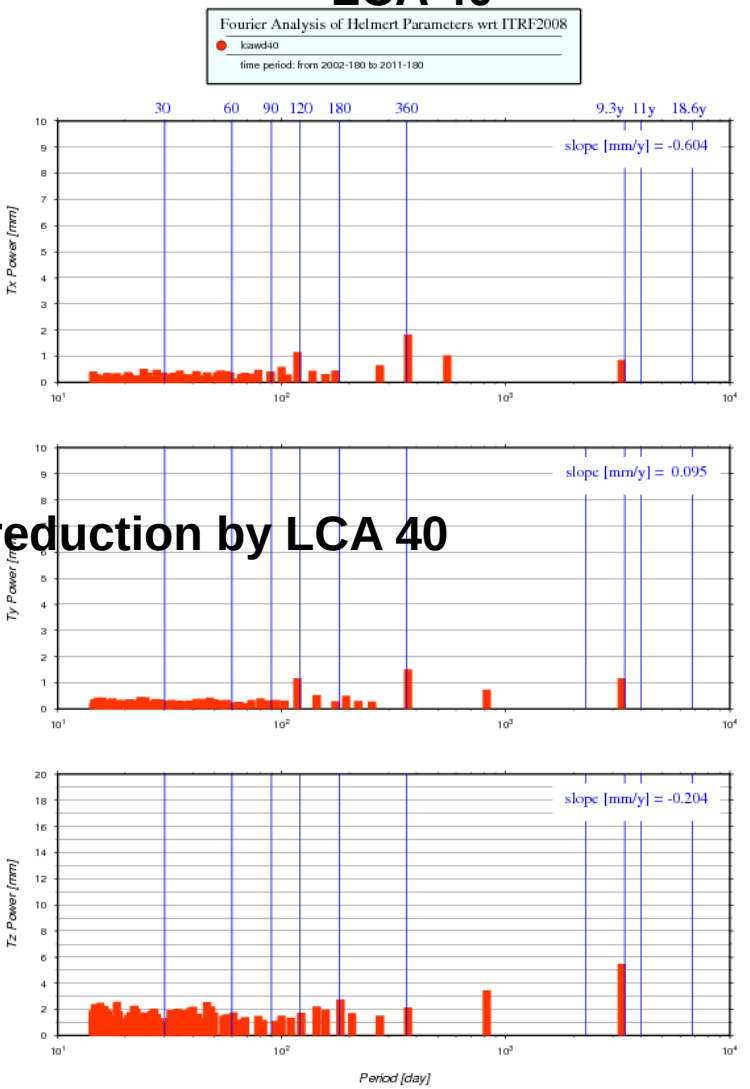
Tz: transfer from 360 to 120 days signals

LCA – FFT of translations (2002-2011)

LCA 30

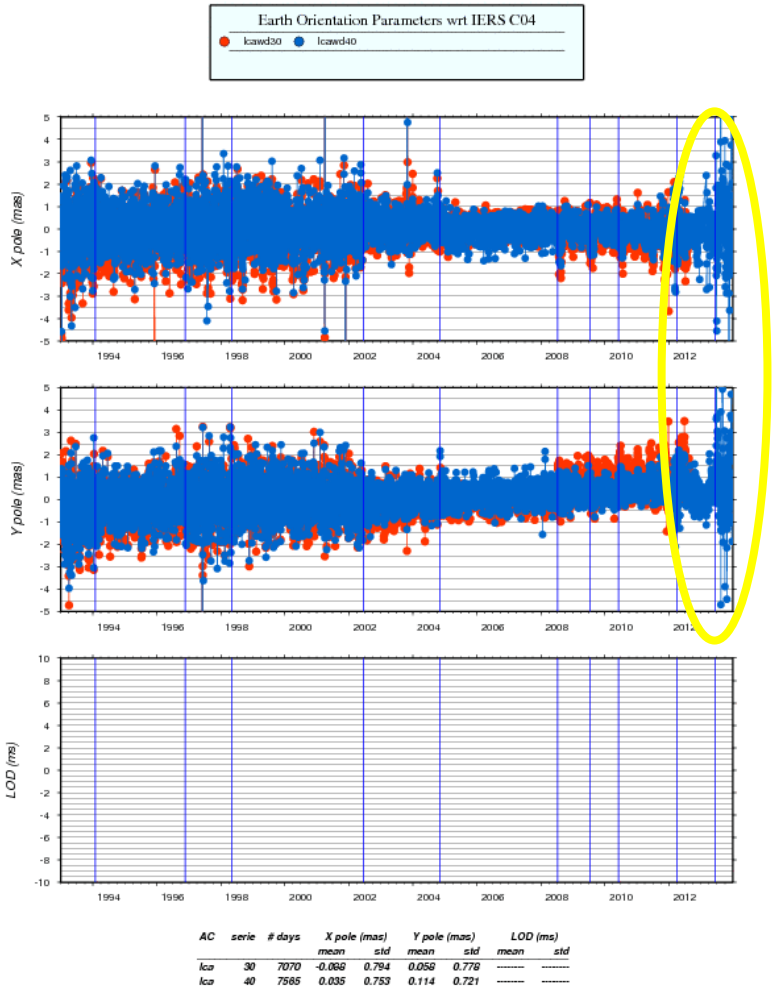


LCA 40



Nice periodic signals reduction by LCA 40

LCA – EOPs differences wrt IERS C04



AC	serie	# days	X pole (mas)		Y pole (mas)		LOD (ms)	
			mean	std	mean	std	mean	std
lca	30	7070	-0.099	0.794	0.058	0.778	--------	--------
lca	40	7565	0.035	0.753	0.114	0.721	--------	--------

LCA 40: status-quo until Jason-2 and slight improvements afterwards

LCA contribution - Conclusions

- So far, LCA 40 shows clear improvements on the reduction of periodic signals on Helmert parameters.
- LCA should look at Spot-4 end's effect on Tz as well as on EOPs.
- Scale increase early 2012.
- Tz jump while including Envisat and Spot-5 (as seen by ESA and IGN).

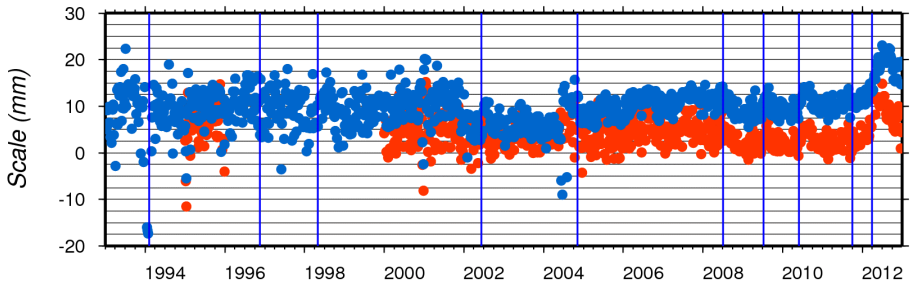
SCALE ISSUES

Scale increase in 2012

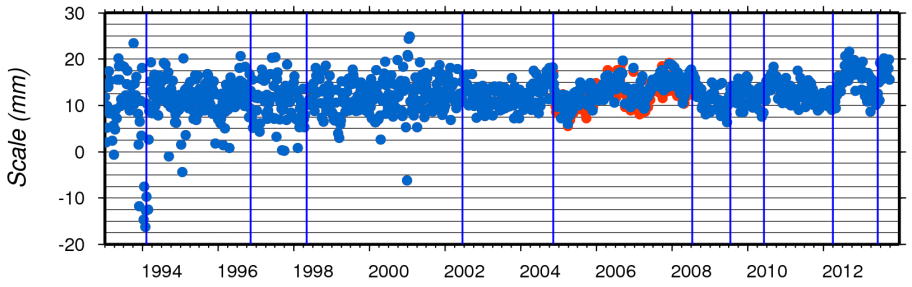
(With HY-2A)

(Without HY-2A)

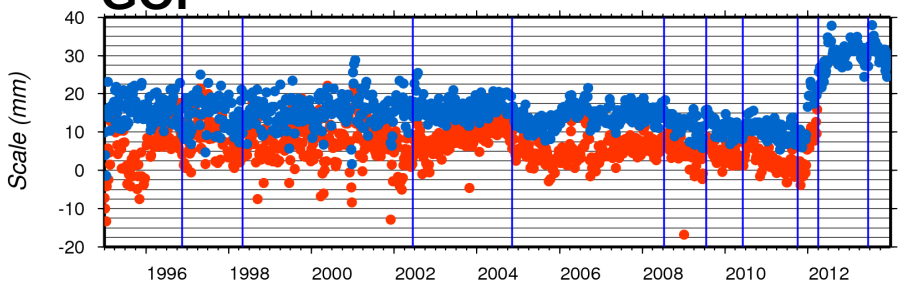
ESA



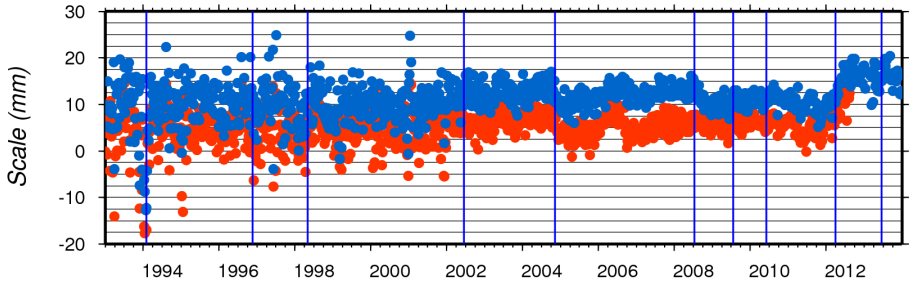
GSC



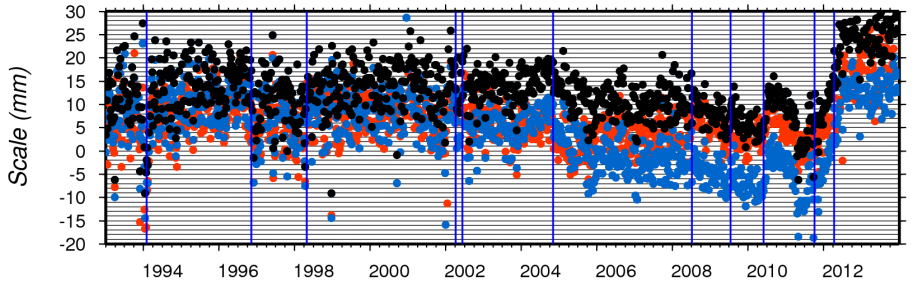
GOP



LCA

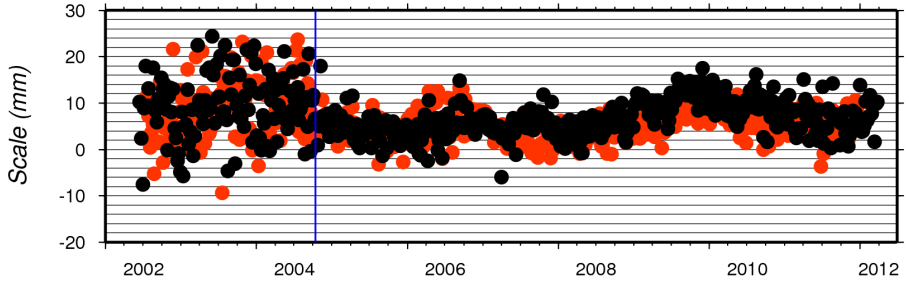


IGN

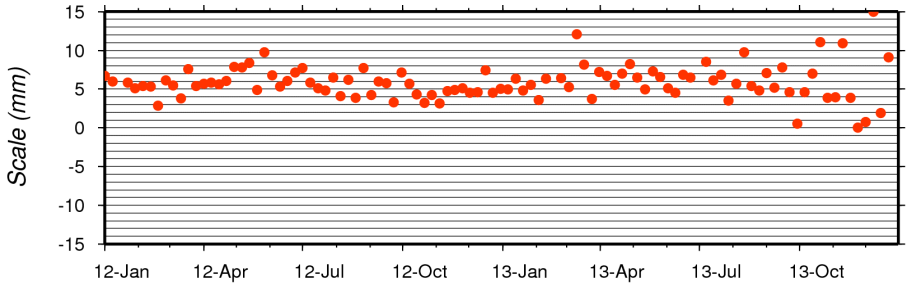


Scale increase in 2012: Origin ?

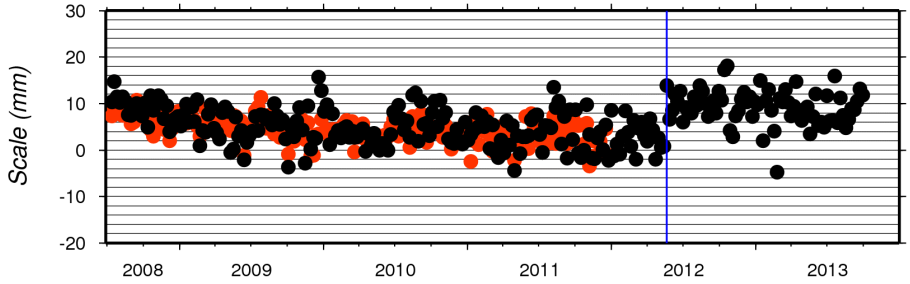
GSC & LCA – Envisat



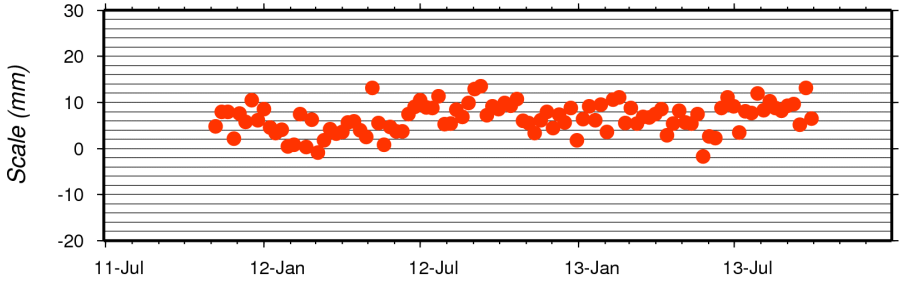
GOP 43 – GOP 44 ➔ HY-2A



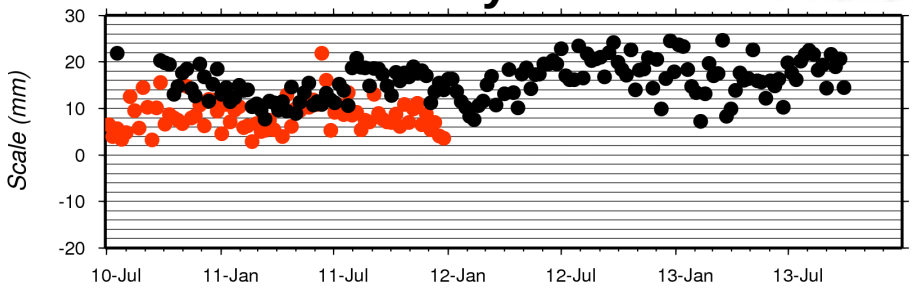
GSC & LCA – Jason-2



GSC – HY-2A

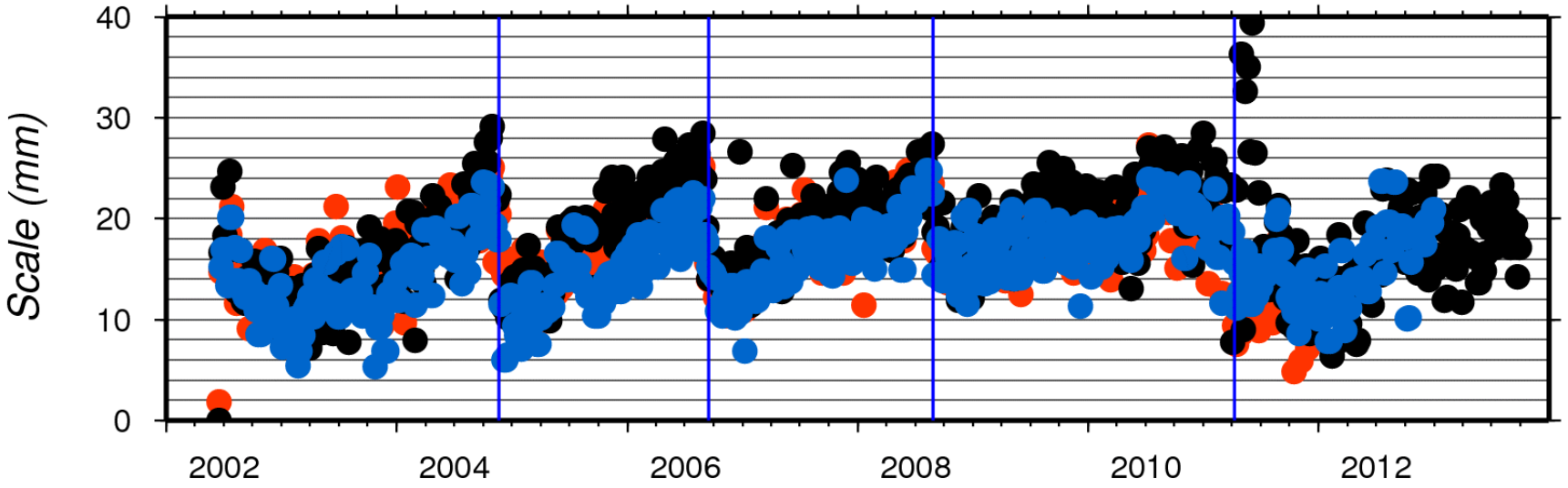


GSC & LCA – Cryosat-2



Origin: Jason-2 scale jump + Cryosat-2 scale increase combined to Envisat end ?

Spot-5 & Scale (ESA, GSC, LCA)



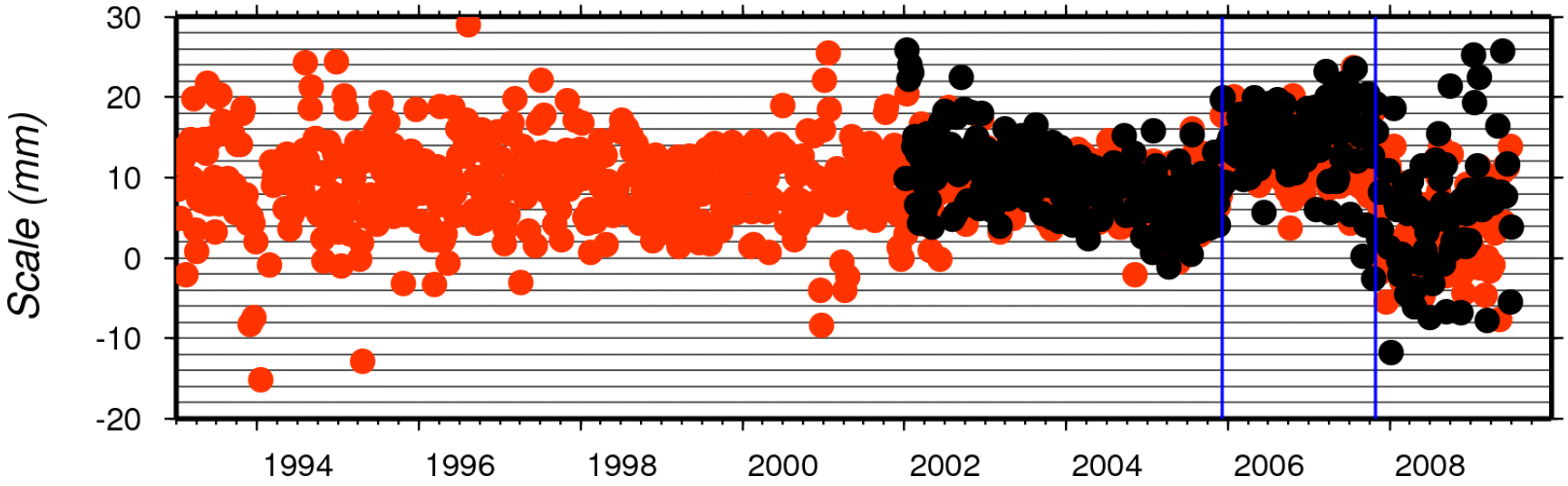
Piecewise linear patterns with jumps at nearly

- 2004-326 (2004/11/22)
- 2006-260 (2006/09/18)
- 2008-240 (2008/08/28)
- 2011-100 (2011/04/11).

These dates correspond quite well with nominal maneuvers already well-known.

➔ **Scale variations still unknown**

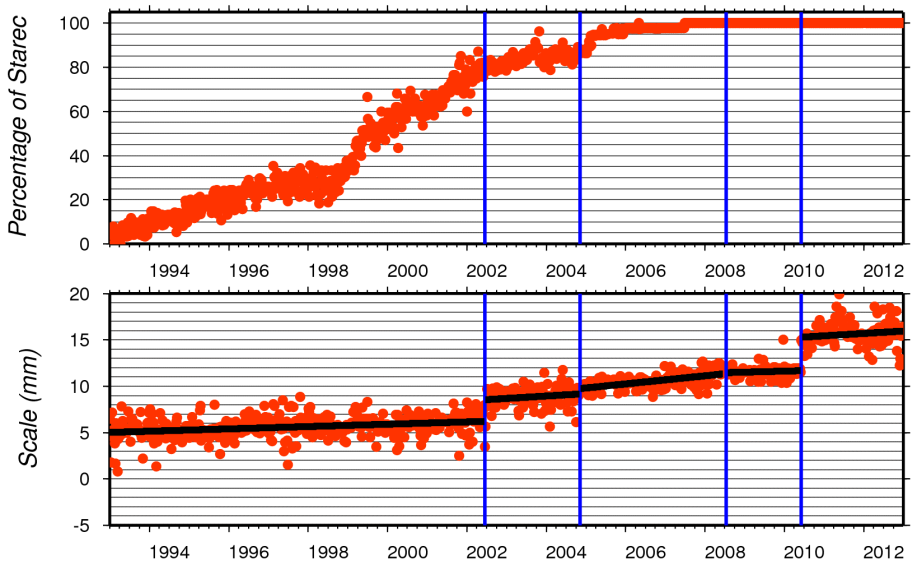
Spot-2 & Scale (GSC, LCA)



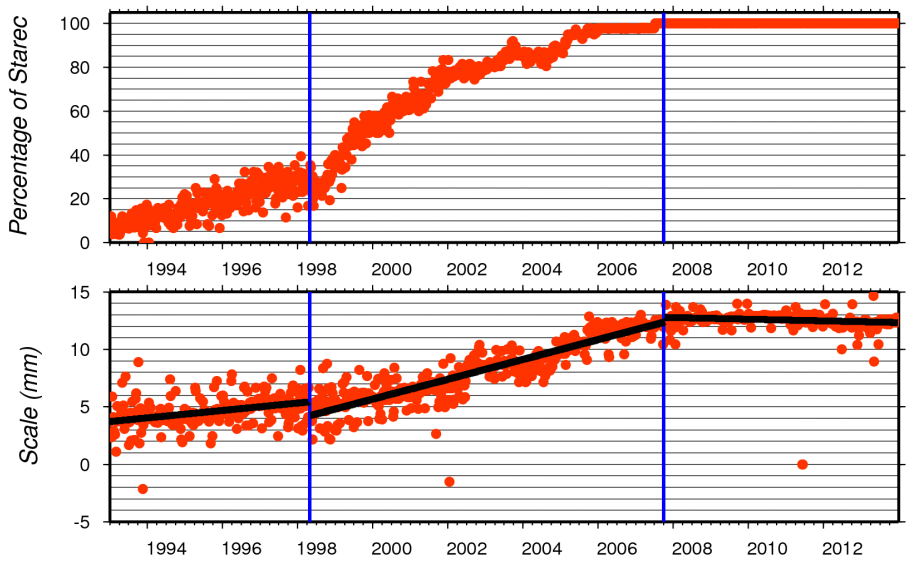
Time period (from 2005 end to 2007 end) into blue vertical line corresponds to a period with less Spot-2 DORIS data due to events such as software failure (first on 2005/12/25 and last ends on 2007/12/19), Satellite Control Centre and Instrument failure.

Phase laws impact

GSC



IGN



Correlations with time evolution of DORIS antenna network

ITRF2013 PLANS

- **Objective 1: delivery of Version 1 to IERS no later than April 20th**

➔ Construction of V1 starts on March 31 with contributions already available.

- Contributors:
  - ESA 10 – Time period 2002-020 to 2004-275 may not contribute to the combined scale
  - GOP 43
  - GSC 24 (23+Jason-1)
  - IGN 15 - Will contribute to the combined scale
  - INA 08 from 1993 to 2013 – Will not contribute to the combined scale
  - LCA 40

- Computations backward from 2011 – 2012/2013 will be addressed at the end in order to eventually take benefits of study over these 2 years.
- Evaluation wrt ITRF2008, IDS-3 solution, week-to-week repeatability…
- Coordinates times series analysis
- Stacking

- **Objective 2: delivery of Version 2 to IERS no later than May 30th**

- V2 == V1 +
  - ESA 10 between 2002 and 2004 (if not fixed in V1)
  - GOP 43 from 1993 to 2005
  - Latest series from other ACs

  - Feedbacks from IERS on V1