ASI Analysis Center activities

V. Luceri – e-GEOS S.p.A.
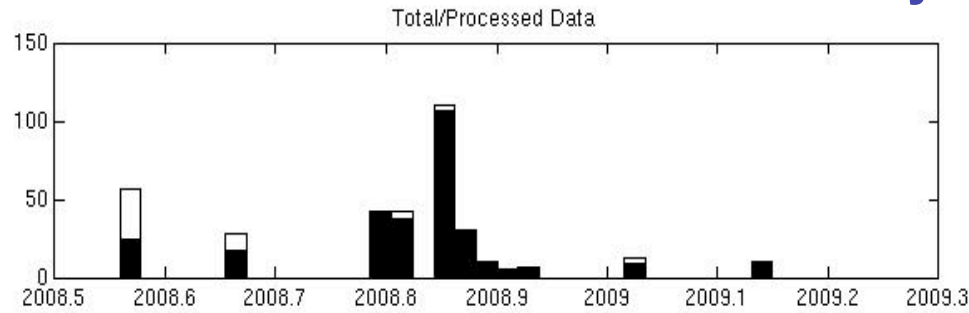
C. Sciarretta - Telespazio S.p.A.

G. Bianco - Agenzia Spaziale Italiana
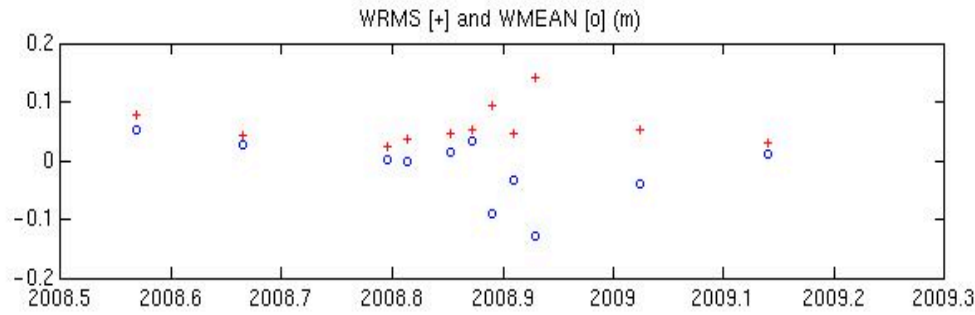
ILRS AWG Meeting, 24 April 2009, Wien

Main activities

- 1983-2008 v20 time series for ITRF
- Station qualification
- CRD format test
- Assessment of Herstmonceux biases
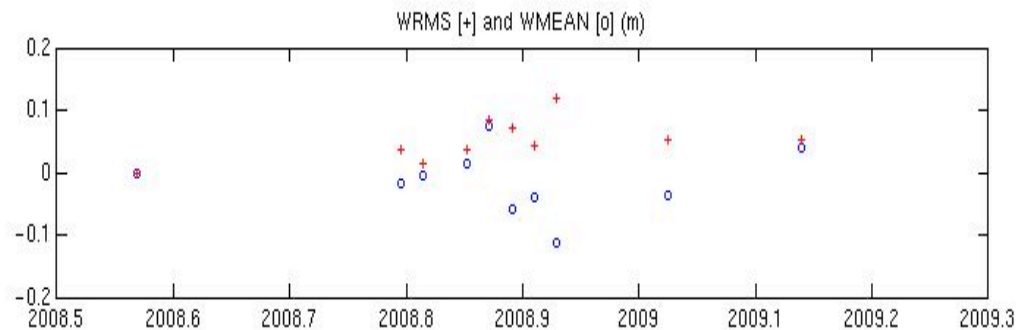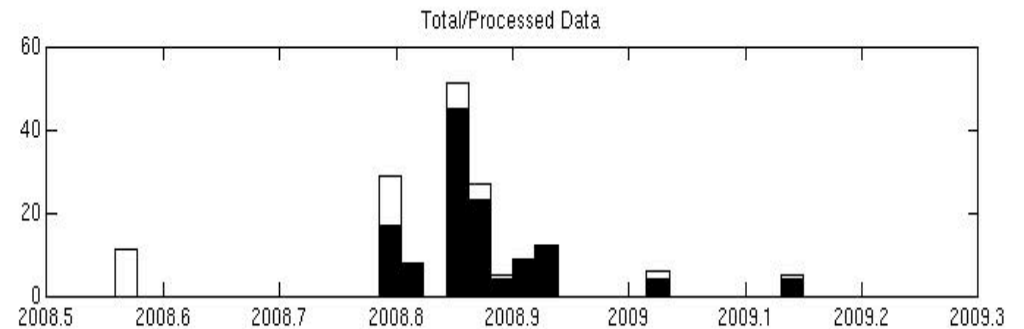- Test on San Juan data (worse data from april-may 2008) with ad hoc solutions

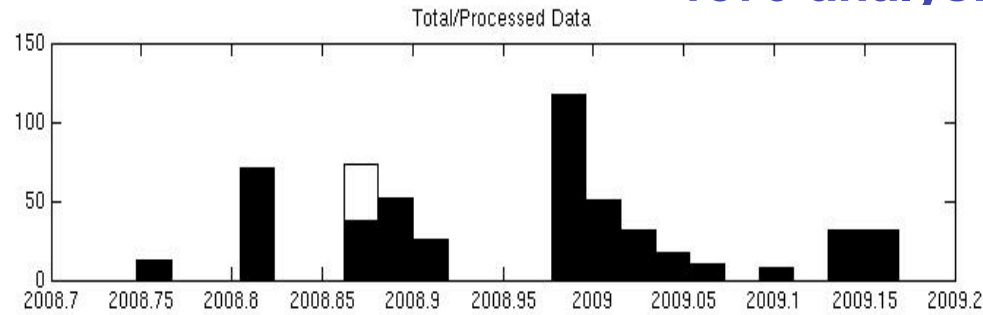# 1824 analysis results

LAGEOS-1 NP residuals

LAGEOS-2 NP residuals

Site coordinates at 08:214:00000 (aug 1st, 2008)
Velocities from GPS

STAX	1824	0.3512989135E+07 m
STAY	1824	0.2068968885E+07 m
STAZ	1824	0.4888817405E+07 m
VELX	1824	-.1937625E-01 m/y
VELY	1824	0.1412943E-01 m/y
VELZ	1824	0.833133E-02 m/y

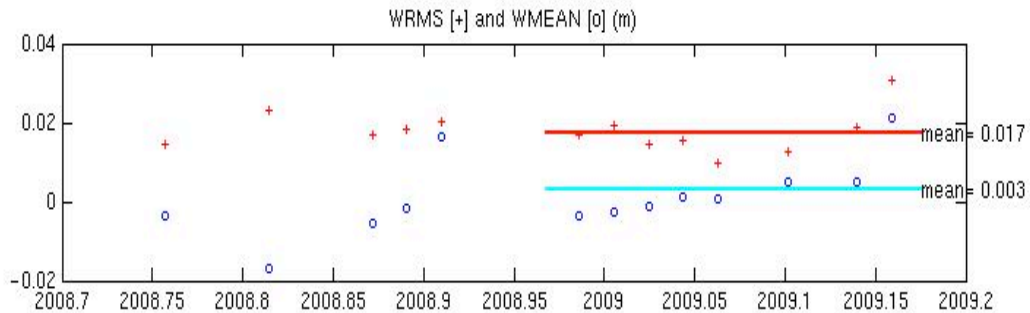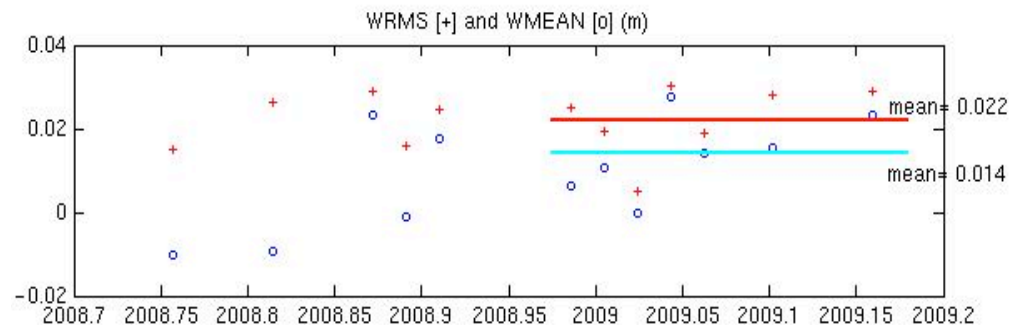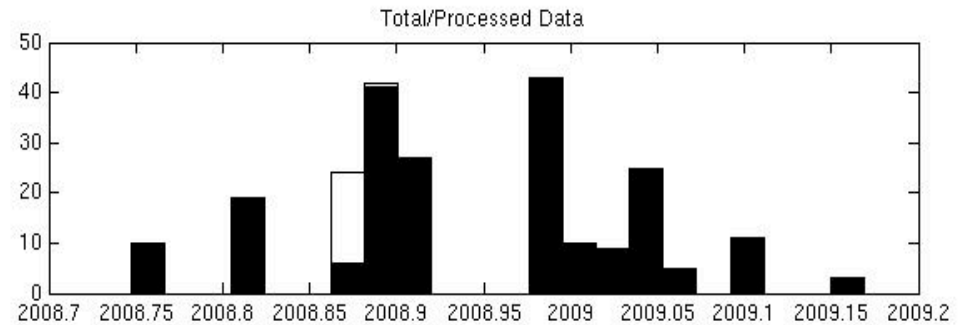# 1879 analysis results

LAGEOS-1 NP residuals

LAGEOS-2 NP residuals

Site coordinates at 08:275:00000 (oct 1st, 2008)
velocities from Nuvel1-A (Unavco Plate Motion calculator)

    STAX   1879 0.5434058633E+06 m
    STAY   1879 0.3955302301E+07 m
    STAZ   1879 0.4957821012E+07 m
    VELX   1879 -.2494400000E-02 m/y
    VELY   1879 -.2116850000E-01 m/y
    VELZ   1879 0.1704650000E-01 m/y
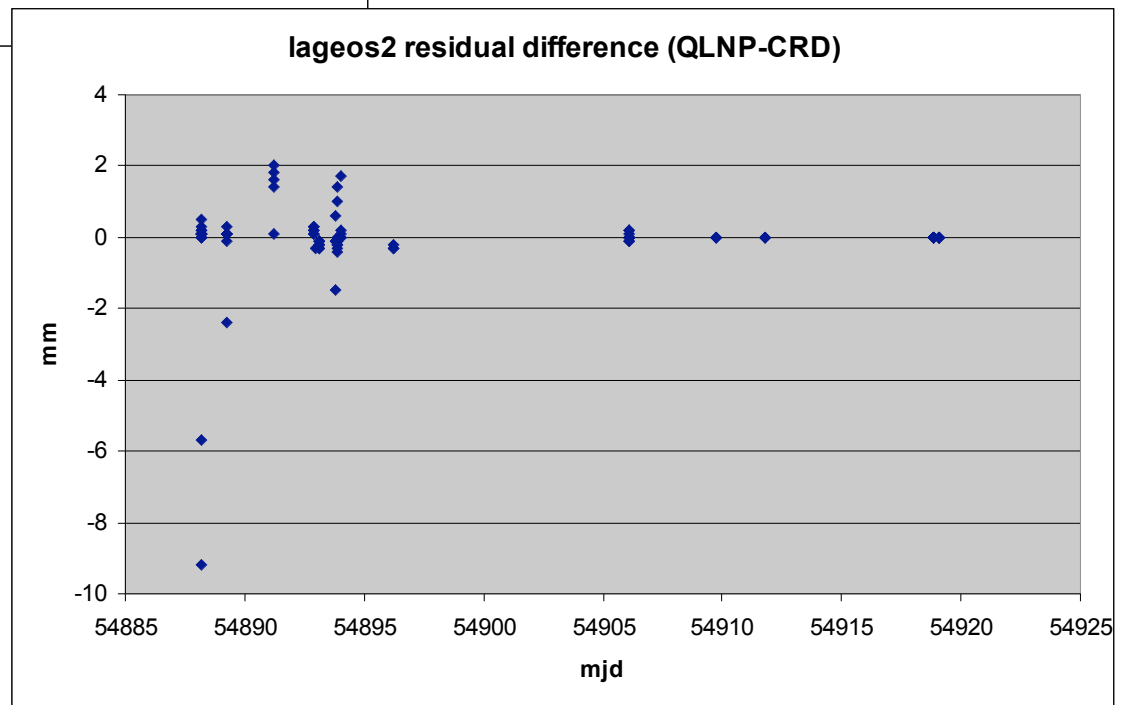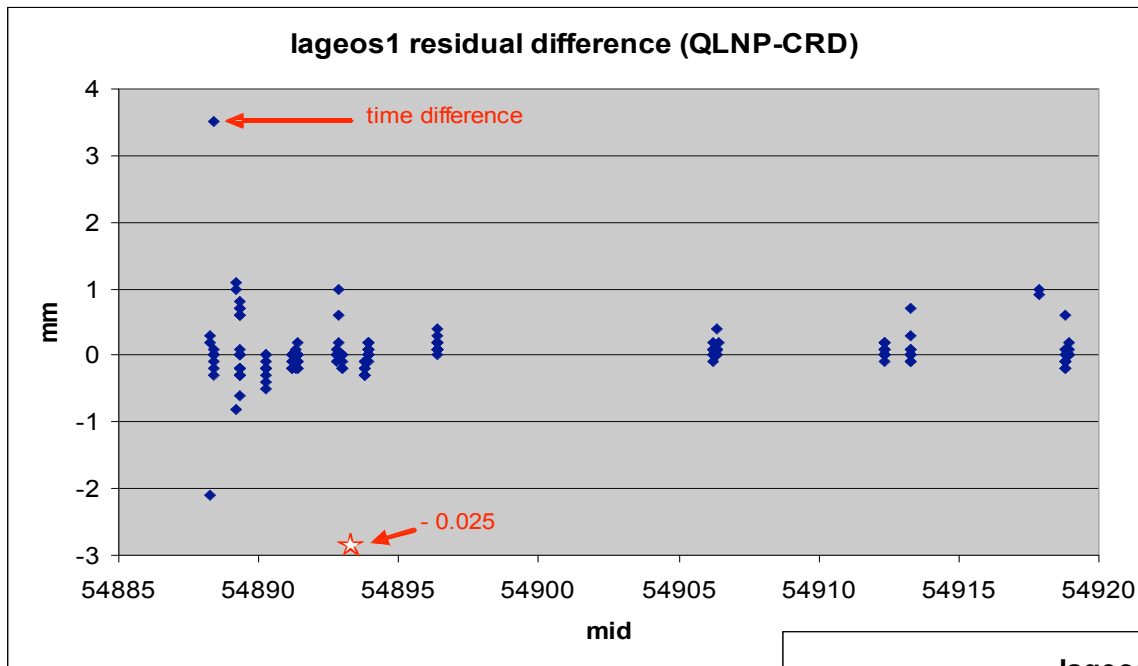
Test of CRD format for 7080

70802419 = the site id for QLNP data

90802419 = the site id for CRD data

Data set: from 25/2/2009 to 1/4/2009

start_stop	sta	obs	w_obs	mean	rms	wmean	wrms
Lageos 2							
090225_090304	70802419	56	56	0.00638	0.01904	0.00638	0.01904
090225_090304	90802419	56	56	0.00652	0.01969	0.00652	0.01969
090304_090311	70802419	8	8	0.02383	0.01674	0.02383	0.01674
090304_090311	90802419	13	10	0.01905	0.01879	0.01905	0.01879
090311_090318	70802419	21	21	0.02903	0.01982	0.02903	0.01982
090311_090318	90802419	16	16	0.02952	0.02258	0.02952	0.02258
090318_090325	90802419	8	0	NaN	NaN	NaN	NaN
090318_090325	70802419	8	0	NaN	NaN	NaN	NaN
090325_090401	70802419	18	18	0.0093	0.01252	0.0093	0.01252
090325_090401	90802419	18	18	0.00937	0.01246	0.00937	0.01246
Lageos1							
090225_090304	70802419	101	101	0.00484	0.02006	0.00484	0.02006
090225_090304	90802419	98	98	0.00444	0.01943	0.00444	0.01943
090304_090311	70802419	18	18	-0.00547	0.01423	-0.00547	0.01423
090304_090311	90802419	13	13	-0.0075	0.01577	-0.0075	0.01577
090311_090318	90802419	26	26	0.01396	0.02678	0.01396	0.02678
090311_090318	70802419	26	26	0.01406	0.02676	0.01406	0.02676
090318_090325	70802419	23	23	-0.00535	0.00963	-0.00535	0.00963
090318_090325	90802419	23	23	-0.00542	0.00962	-0.00542	0.00962
090325_090401	70802419	16	16	0.00028	0.01846	0.00028	0.01846
090325_090401	90802419	16	16	0.00015	0.01837	0.00015	0.01837
Etalon1							
090311_090318	70802419	3	3	0.04069	0.00329	0.04069	0.00329
090311_090318	90802419	3	3	0.04065	0.00321	0.04065	0.00321
Etalon2							
090304_090311	70802419	4	4	0.05926	0.00491	0.05926	0.00491
090318_090325	90802419	4	4	0.04169	0.0028	0.04169	0.0028
090318_090325	70802419	4	4	0.04173	0.00279	0.04173	0.00279

Lageos residual differences

lageos1 residual difference (QLNP-CRD)

lageos2 residual difference (QLNP-CRD)

Lageos 1 differences

LAGEOS 1 - Differences in range

LAGEOS 1 - Differences in residuals
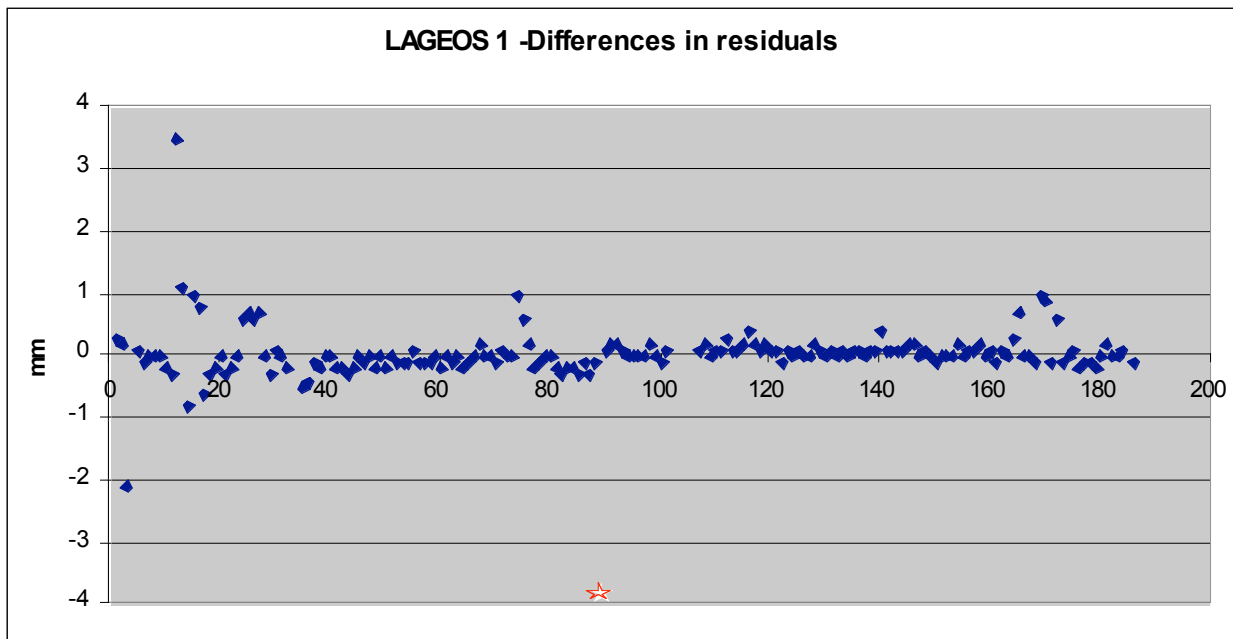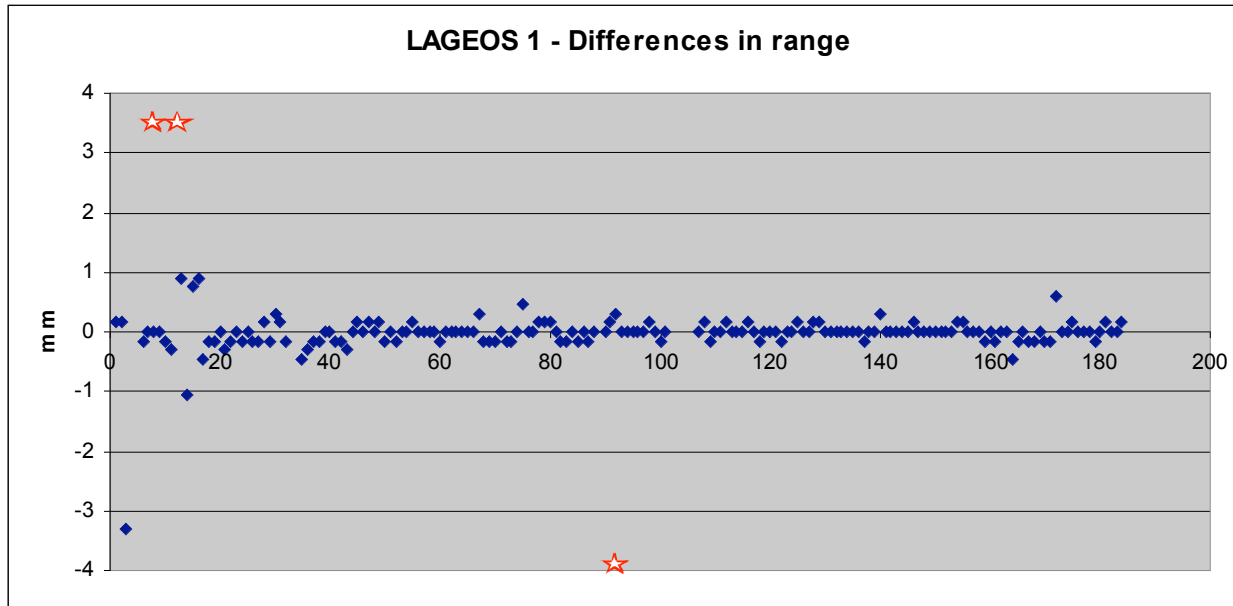
Etalon residual differences

etalon 1 residual difference (QLNP-CRD)

etalon 2 residual difference (QLNP-CRD)
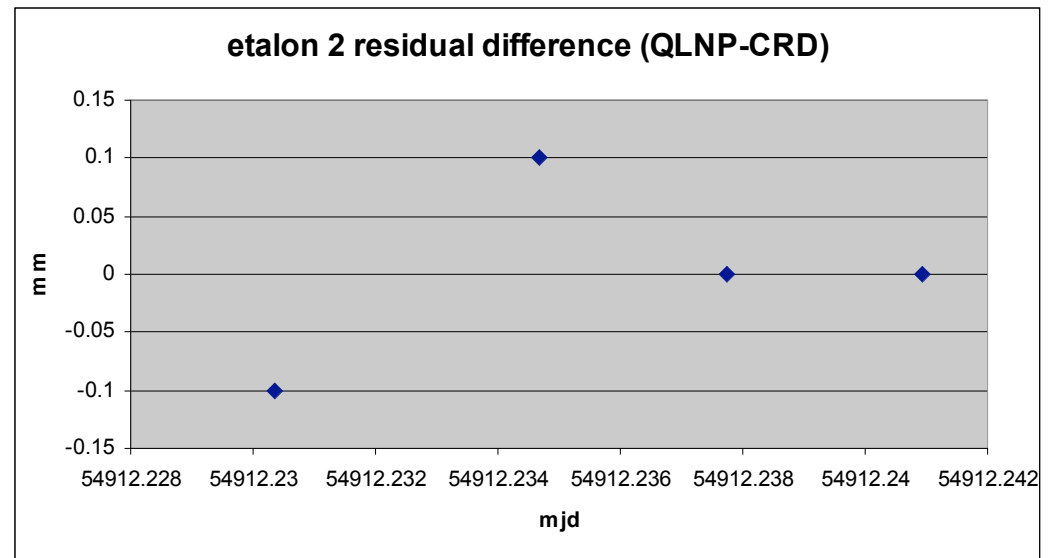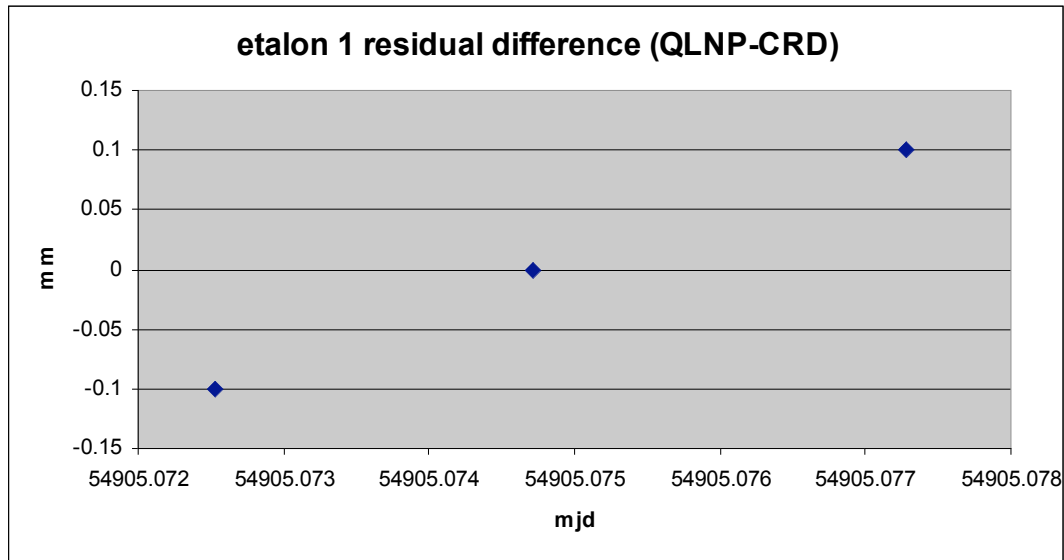
McDonald Coordinate differences

	site id	date	value(m)	sigma	site id	value(m)	sigma	difference (mm)
STAX	7080	09:059:43200	-1330022.11466	0.42480	9080	-1330022.11434	0.42480	0.33
STAY	7080	09:059:43200	-5328400.13132	0.18125	9080	-5328400.13168	0.18124	-0.36
STAZ	7080	09:059:43200	3236483.13125	0.24530	9080	3236483.13154	0.24529	0.29
STAX	7080	09:066:43200	-1330020.37737	0.33810	9080	-1330020.36287	0.33809	14.50
STAY	7080	09:066:43200	-5328401.29080	0.14613	9080	-5328401.30734	0.14612	-16.54
STAZ	7080	09:066:43200	3236481.89553	0.19555	9080	3236481.90572	0.19549	10.18
STAX	7080	09:073:43200	-1330020.66933	0.34815	9080	-1330020.67685	0.34812	-7.51
STAY	7080	09:073:43200	-5328400.02060	0.14952	9080	-5328400.01492	0.14949	5.68
STAZ	7080	09:073:43200	3236483.84327	0.20235	9080	3236483.84285	0.20235	-0.42
STAX	7080	09:080:43200	-1330020.80786	0.28935	9080	-1330020.80788	0.28935	-0.02
STAY	7080	09:080:43200	-5328400.75613	0.12462	9080	-5328400.75616	0.12462	-0.03
STAZ	7080	09:080:43200	3236482.61250	0.16615	9080	3236482.61259	0.16615	0.09
STAX	7080	09:087:43200	-1330020.83820	0.33097	9080	-1330020.83815	0.33097	0.05
STAY	7080	09:087:43200	-5328400.57861	0.14230	9080	-5328400.57883	0.14230	-0.22
STAZ	7080	09:087:43200	3236482.94139	0.19206	9080	3236482.94132	0.19206	-0.07

Difference in the input dataset

7080 = the site id for QLNP data

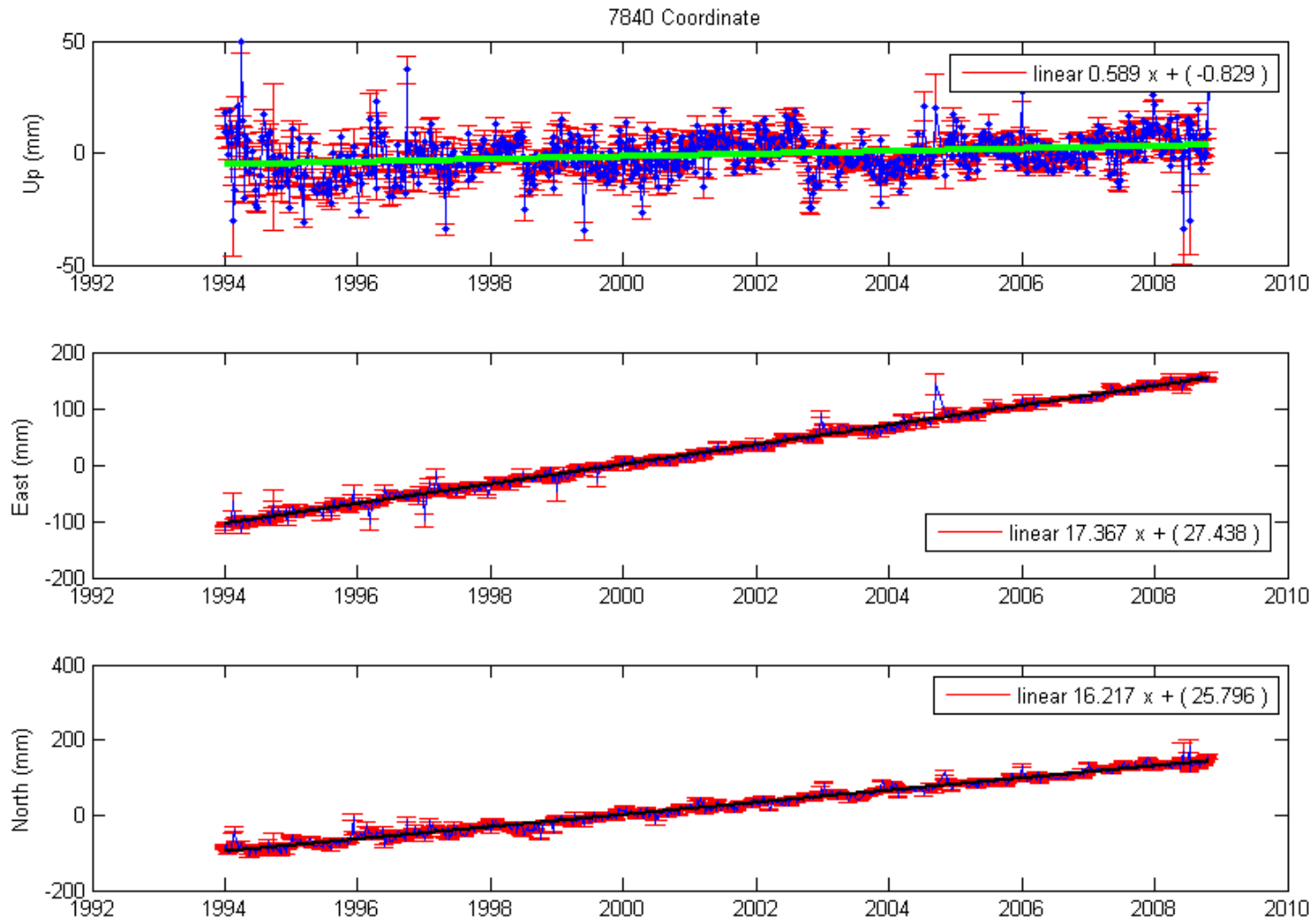9080 = the site id for CRD data

Remarks on the CRD check

- Datafiles contain a different numbers of data: some passes or points missing in one of the two format. Is that a problem?
  Did the operation center find the discrepancy?

- Some points have different epochs. Is that a problem?
  Did the operation center find the discrepancy?

- When epochs are identical, the residual differences are below the millimeter: higher differences are generally due to range differences

- Estimated coordinate differences smaller than half a millimeter

New corrections for 7840 – December 2008

Start Year-doy (yymmdd at 00:00)	Stop Year-doy (yymmdd at 00:00)	Stanford 2-way ps	Stanford 1-way mm	Non-linear (mm)	Total corr 1-way mm
1994 013 (940113)	1994 273 (941001)	+40	+6		+6
1994 274 (941001)	1996 136 (960516)	+40	+6	+8	+14
1996 137 (960516)	1997 294 (971022)	+25	+4	+8	+12
1997 295 (971022)	1999 209 (990729)	+15	+2	+8	+10
1999 210 (990729)	2001 079 (010321)	+60	+9	+8	+17
2001 080 (010321)	2002 031 (020201)	0	0	+8	+8
2002 032 (020201)	2002 276 (021004)	0	0	0	0
2002 277 (021004)	2006 199 (060719)	+90	+13	0	+13
2006 200 (060719)	2007 041 (070211)	+80	+12	0	+12
2007 042 (070211)	–	0	0	0	0

ASI time series – New corrections from Appleby
Trended 7840 coordinates

7840 Coordinate

ASI time series – New corrections from Appleby
7840 Residual coordinates w.r.t. SLRF2005 (SOLN 2)

7840 bias from ASI multi-year solution 1983-2008

Some Remarks

•Mean values of the estimated biases have been computed over the periods indicated by Graham

•The Lageos-1 and Lageos-2 estimated biases are different from 1994 up to 2002: ~5 mm difference exists

•The estimated biases have been grouped when similar and a rough mean value between L1 and L2 computed

•A new test performed with the use of

Start Year-doy (yymmdd at 00:00)	Stop Year-doy (yymmdd at 00:00)	Total corr 1-way mm
1994 013 (940113)	1999 209 (990729)	+9
1999 210 (990729)	2002 031 (020201)	+13
2002 032 (020201)	2007 041 (070211)	+9
2007 041 (070211)	-----	0

**ASI time series – Corrections from multi-year solution
Trended 7840 coordinates**

7840 Coordinate

ASI time series – Comparison of the fit residuals

The difference between the two time series is, above all, in the jumps indicated by the green arrows: smaller with the corrections from the multi-year solution.
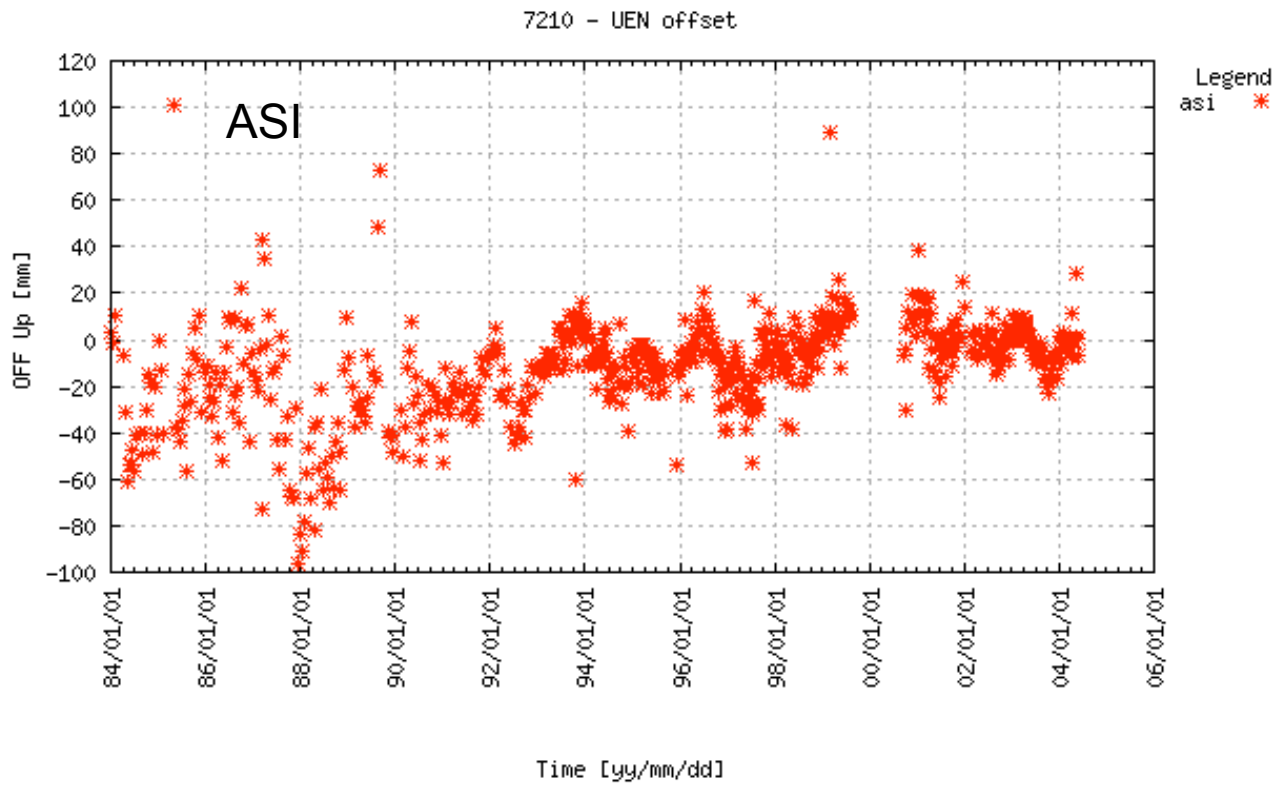
Quincy 7810 residuals w.r.t. SLRF2005

7109 – UEN offset

Legend
ilrsa

OFF Up [mm]

Time [yy/r

7109 – UEN offset

Legend
asi
gfz
dgfi
jcet
nsgf
ilrsa
grgs
ga
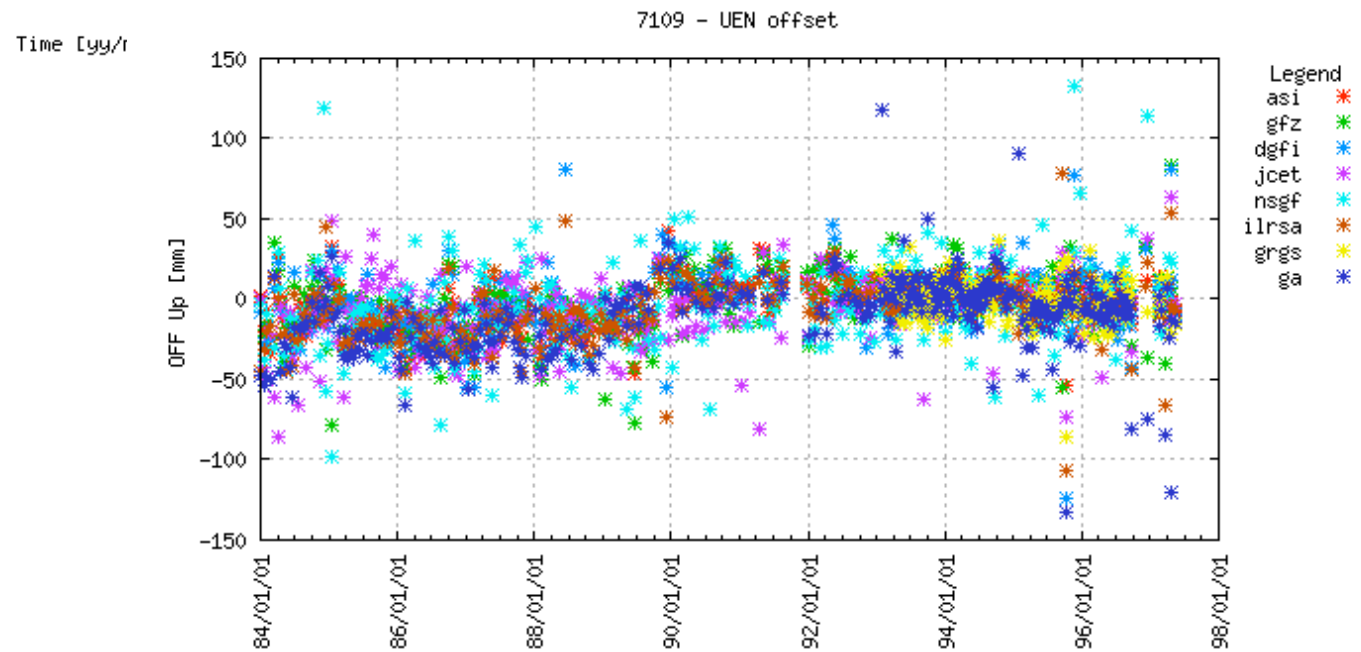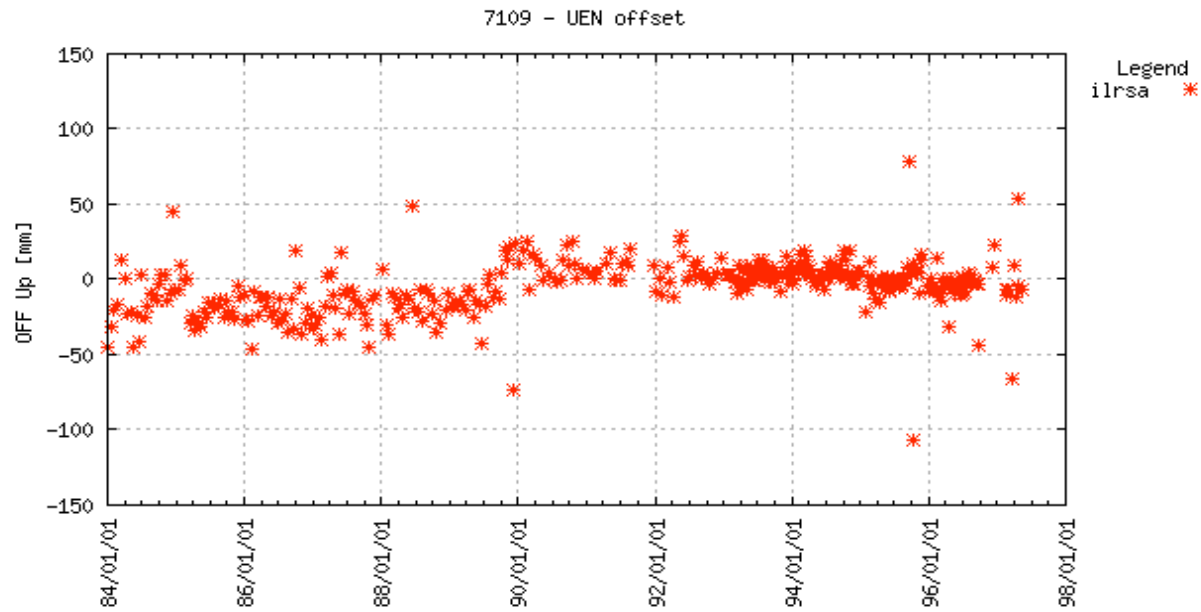
Quincy 7810 range residuals from ASI multi-year solution
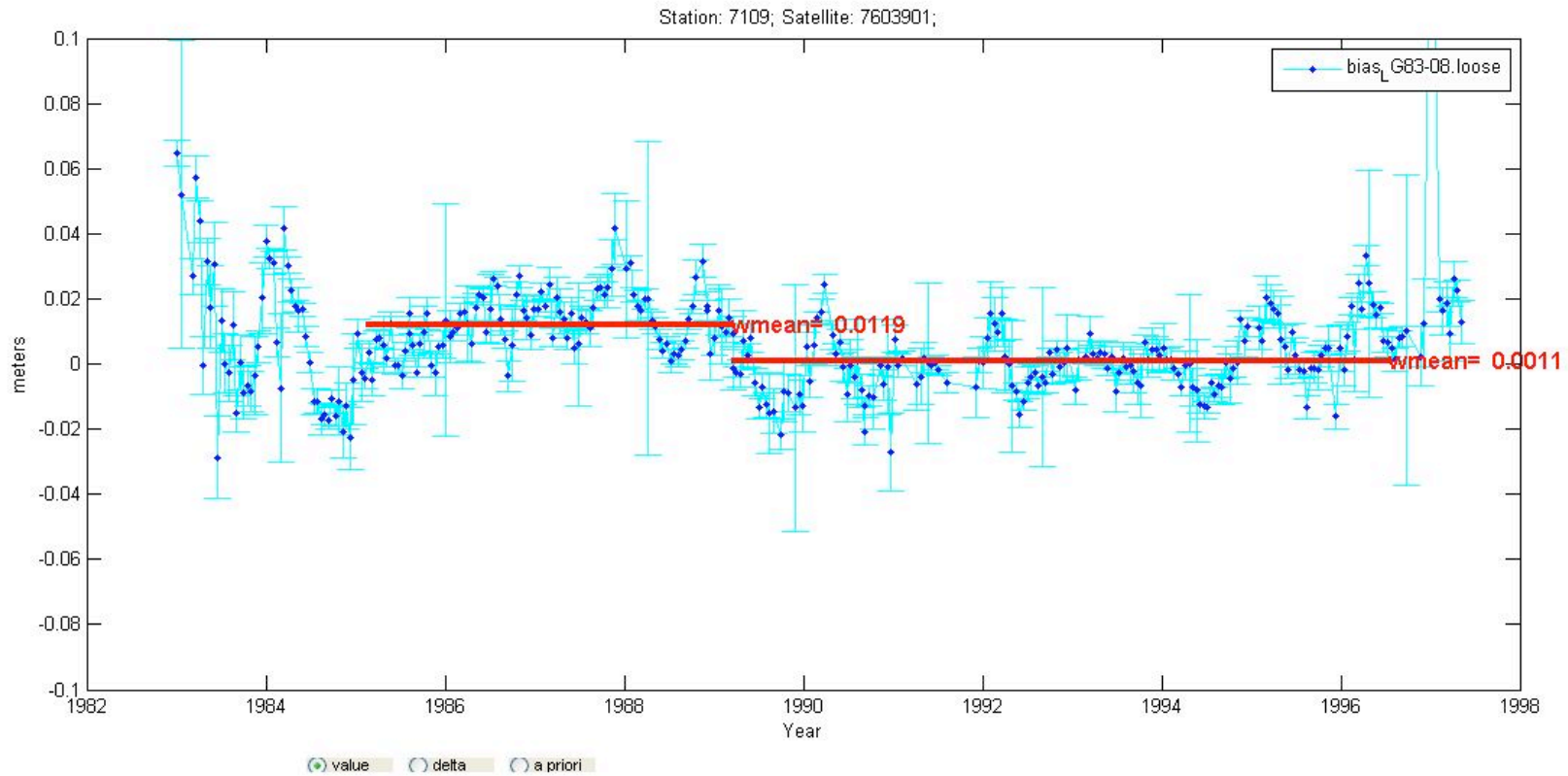
Haleakala: range residuals from solution CGS2006_new
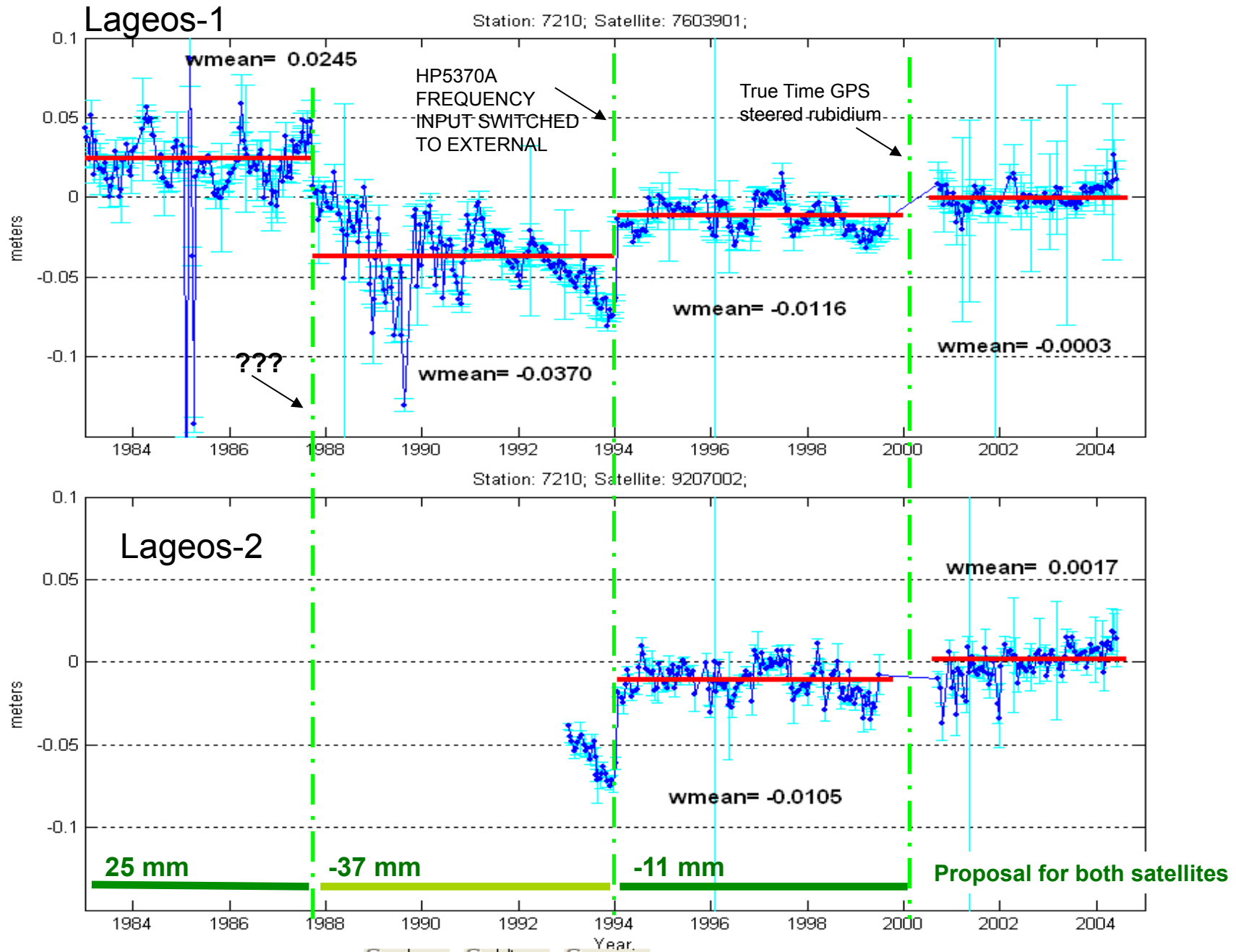
Haleakala 7210 residuals w.r.t. SLRF2005

7210 - UEN offset
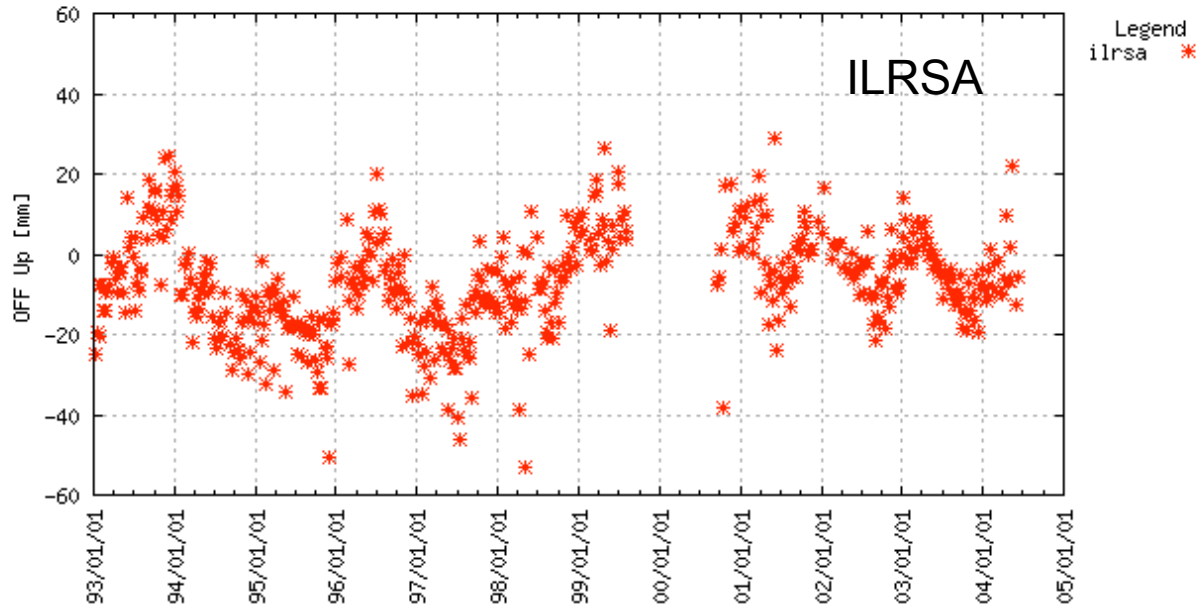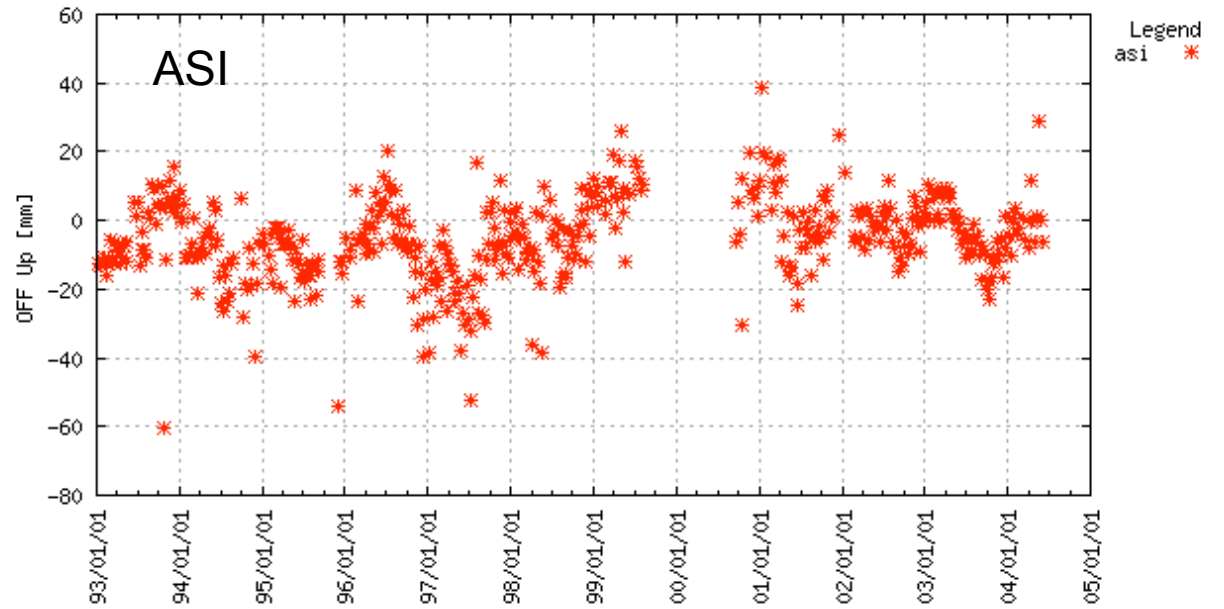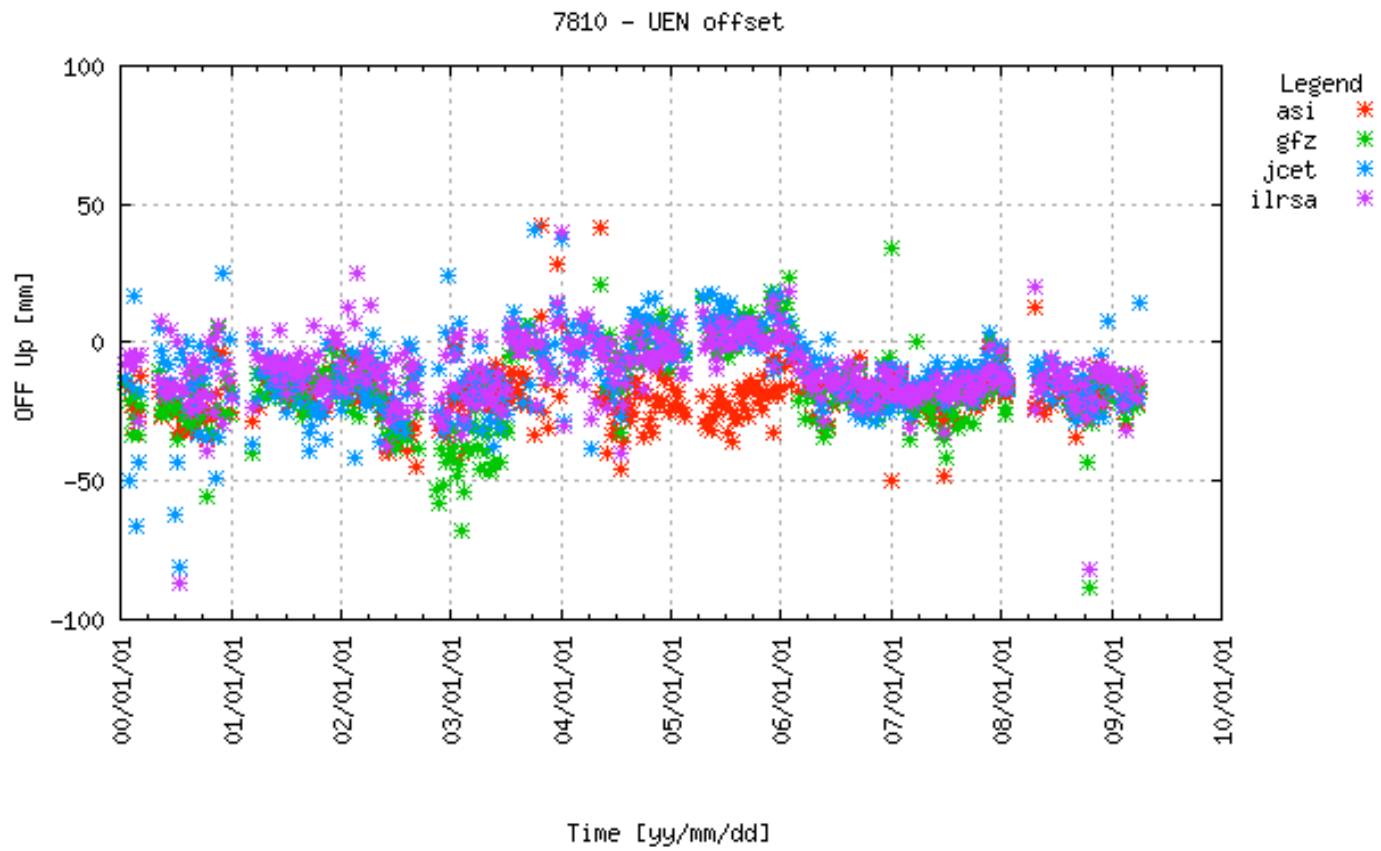
Haleakala 7210 residuals w.r.t. SLRF2005

Zimmerwald 7810 residuals w.r.t. SLRF2005

7810 - UEN offset

Zimmerwald 7810 residuals w.r.t. SLRF2005

7810 - UEN offset
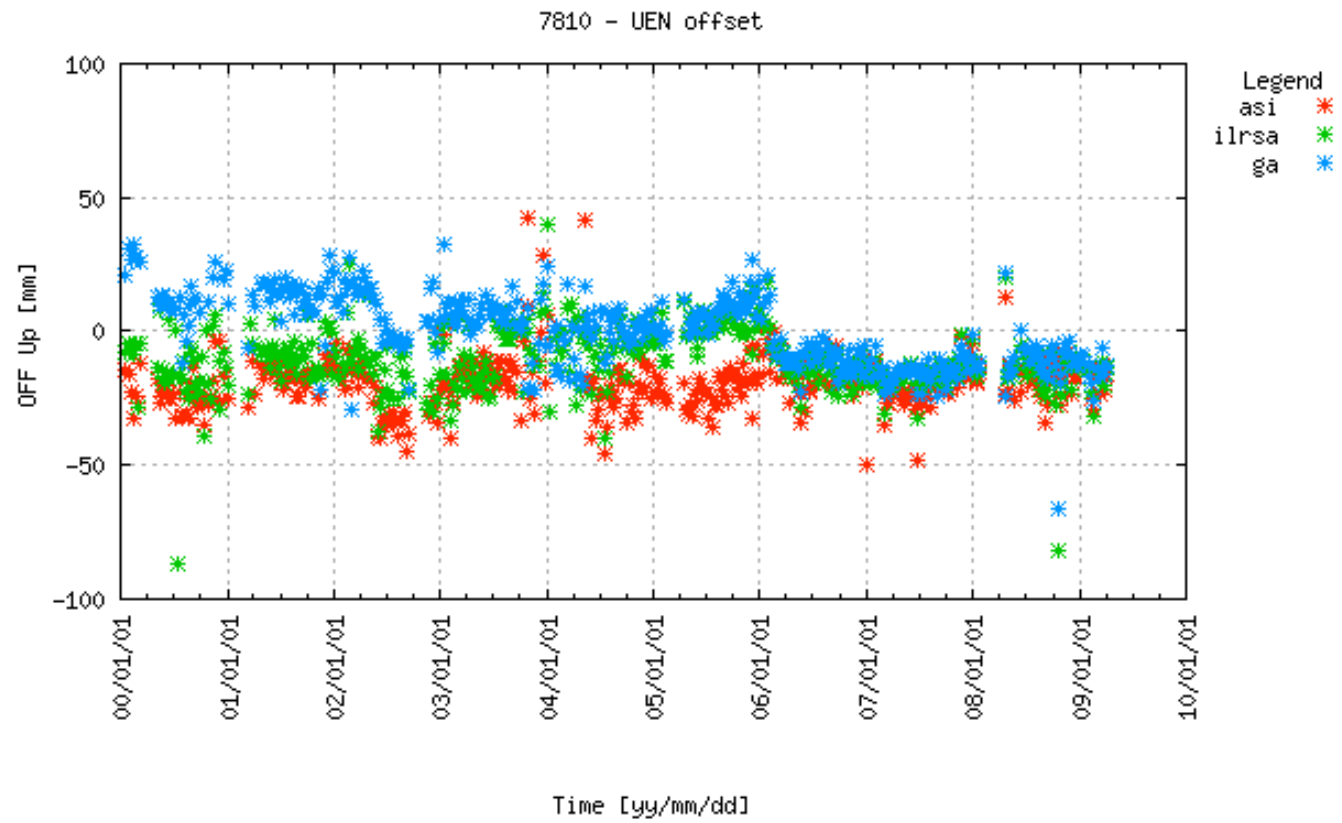
Zimmerwald: blue range bias from solution CGS2006_new

# New corrections for 7840 – December 2008

Start Year-doy (yymmdd at 00:00)	Stop Year-doy (yymmdd at 00:00)	Stanford 2-way ps	Stanford 1-way mm	Non-linear (mm)	Total corr 1-way mm
1994 013 (940113)	1994 273 (941001)	+40	+6		**+6**
1994 274 (941001)	1996 136 (960516)	+40	+6	+8	**+14**
1996 137 (960516)	1997 294 (971022)	+25	+4	+8	**+12**
1997 295 (971022)	1999 209 (990729)	+15	+2	+8	**+10**
1999 210 (990729)	2001 079 (010321)	+60	+9	+8	**+17**
2001 080 (010321)	2002 031 (020201)	0	0	+8	**+8**
2002 032 (020201)	2002 276 (021004)	0	0	0	**0**
2002 277 (021004)	2006 199 (060719)	+90	+13	0	**+13**
2006 200 (060719)	2007 041 (070211)	+80	+12	0	**+12**
2007 042 (070211)	–	0	0	0	**0**

ASI time series – New corrections from Appleby
Trended 7840 coordinates

ASI time series – New corrections from Appleby
7840 Residual coordinates w.r.t. SLRF2005 (SOLN 2)
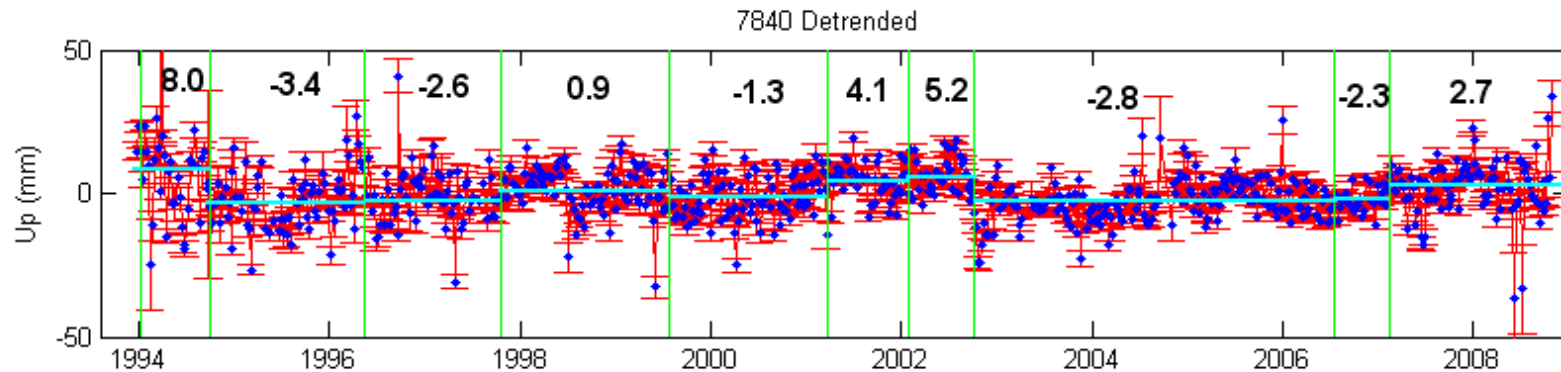
Weighted mean of residuals
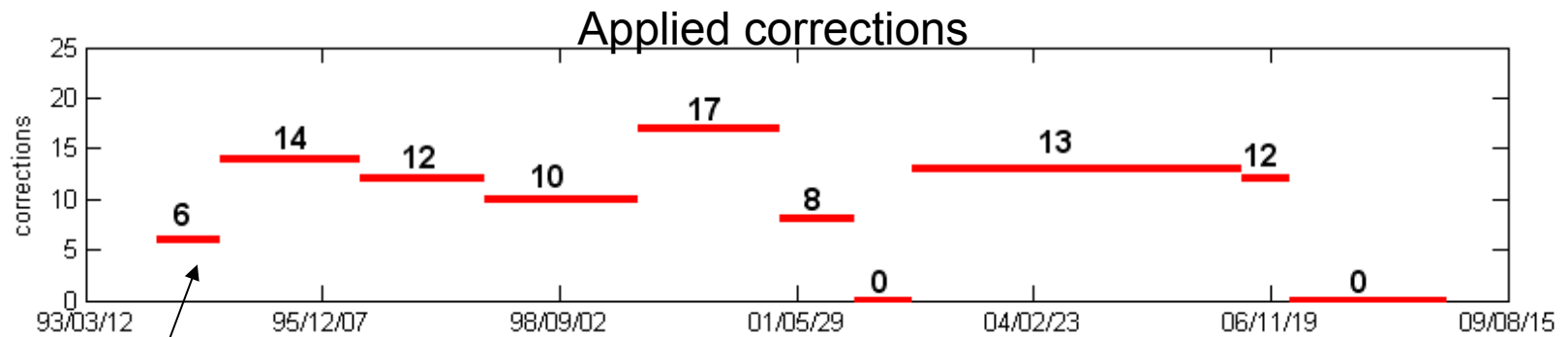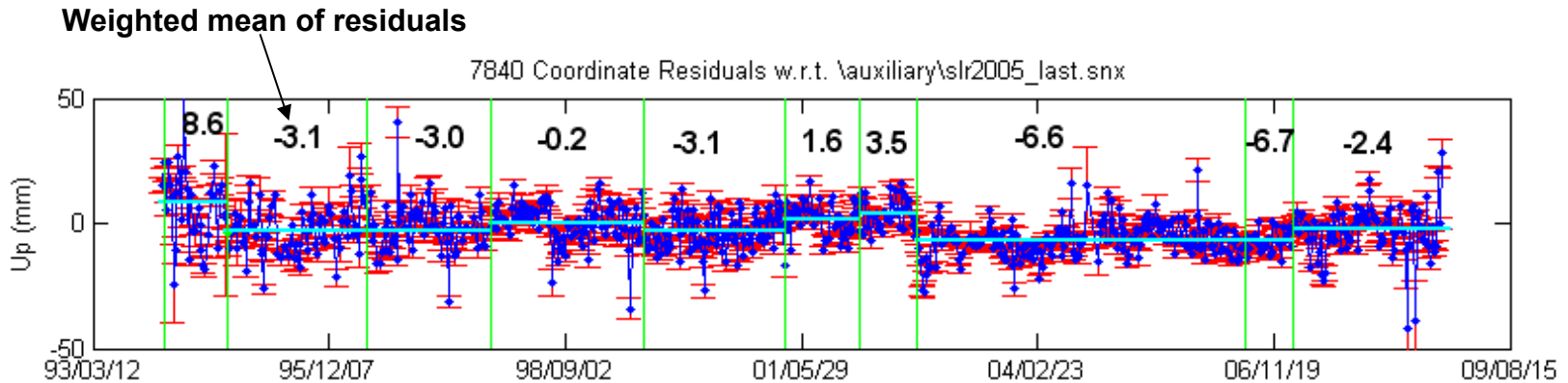
Higher (~10 mm more) correction needed from 1994:013 to 1994:273?

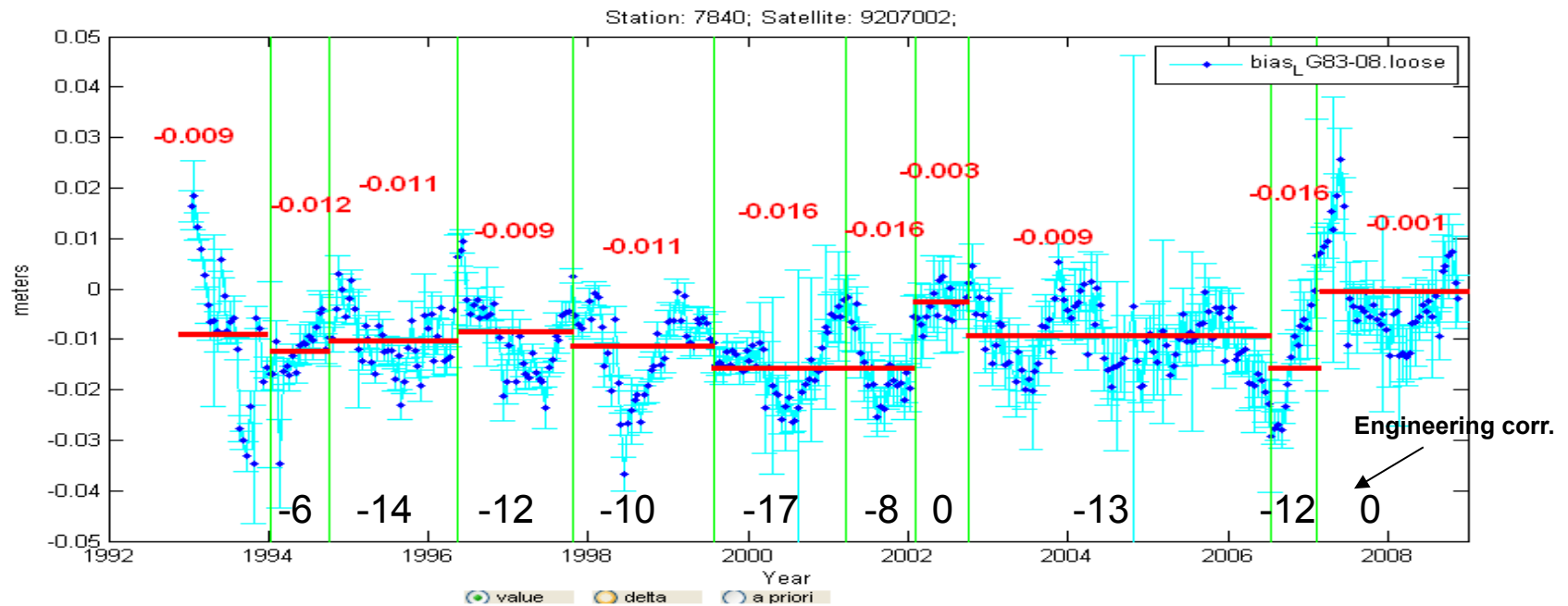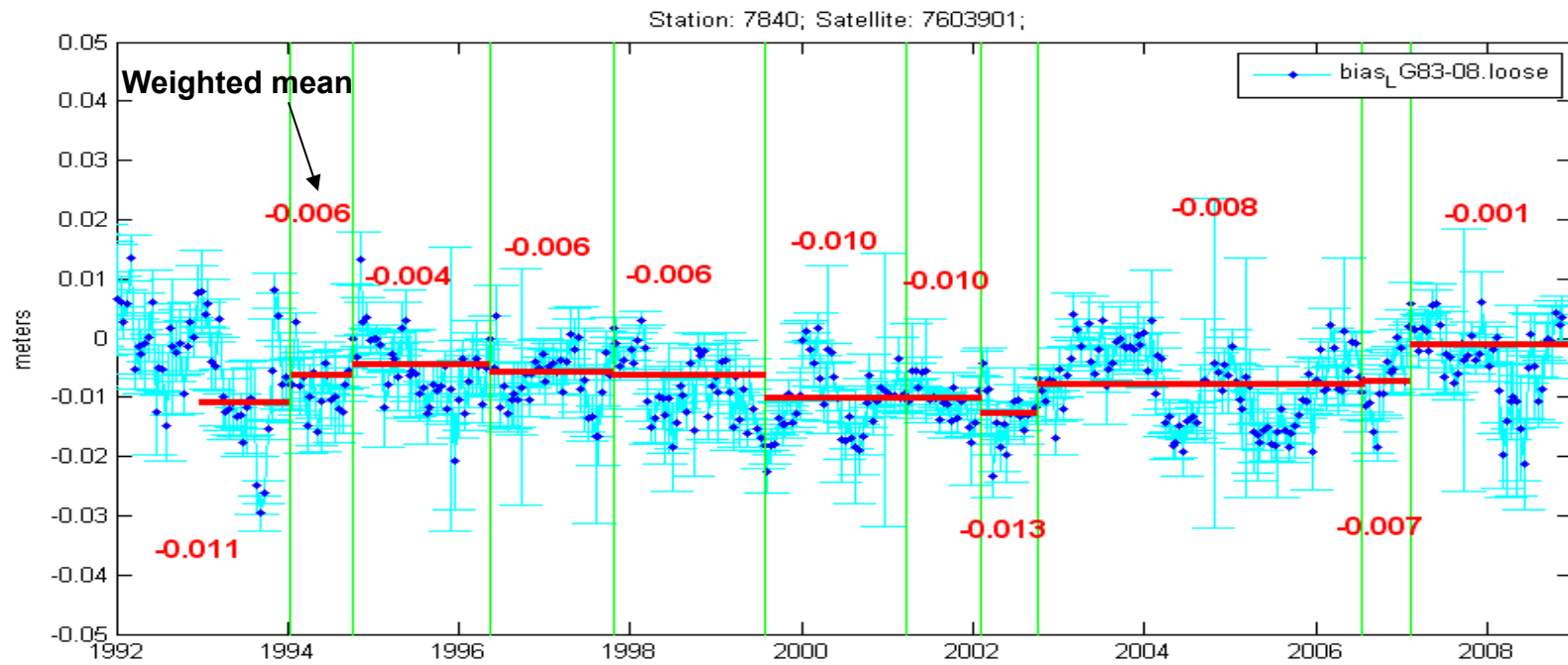Corrections from 2001:080 to 2002:276 seem too small (~5-6 mm smaller)

Corrections from 2002:276 to 2007:041 seem to high (~4 mm higher)

ASI time series – New corrections from Appleby 7840 Residual coordinates w.r.t. weighted fit
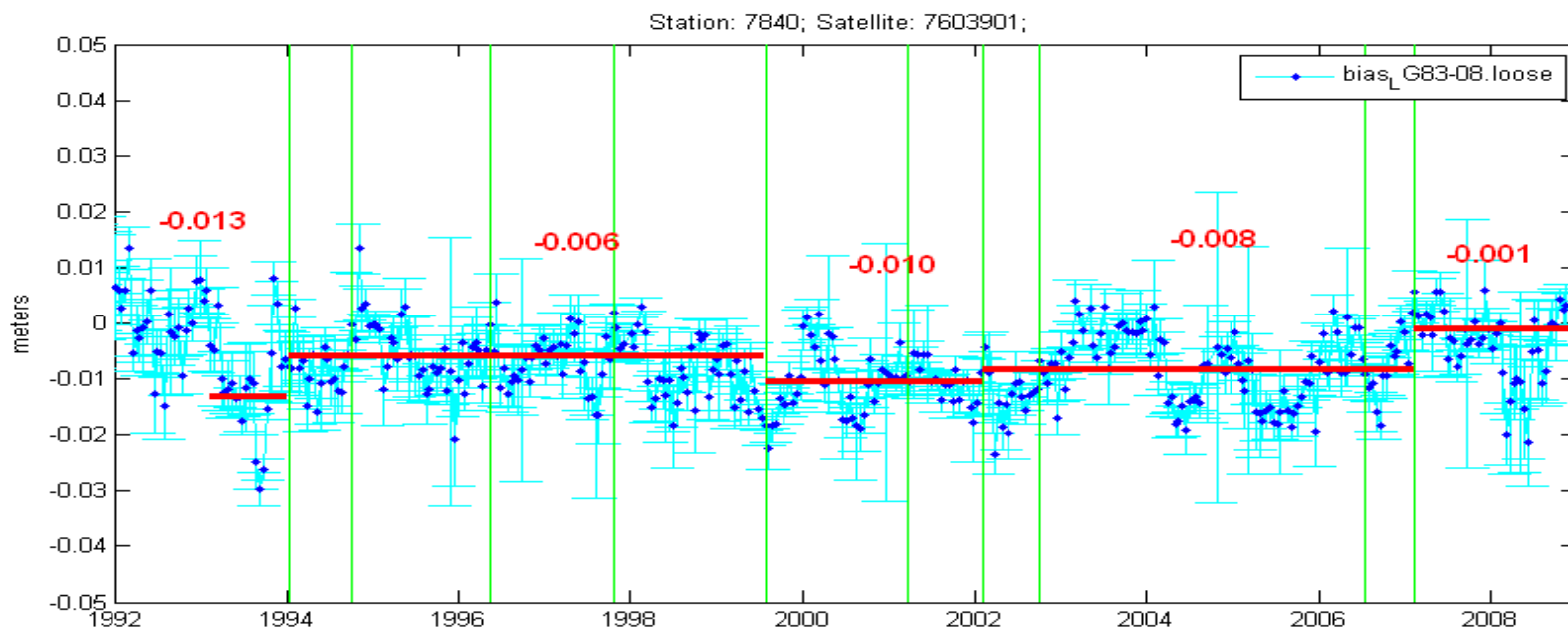

- The weighted linear fit is not able to completely remove the linear trend.
- SLRF2005 (SOLN 2) velocities seem to work better.
- Anyway the jumps in the time series are similar to those obtained using SLRF2005 (previous slide)

7840 bias from ASI multi-year solution 1983-2008
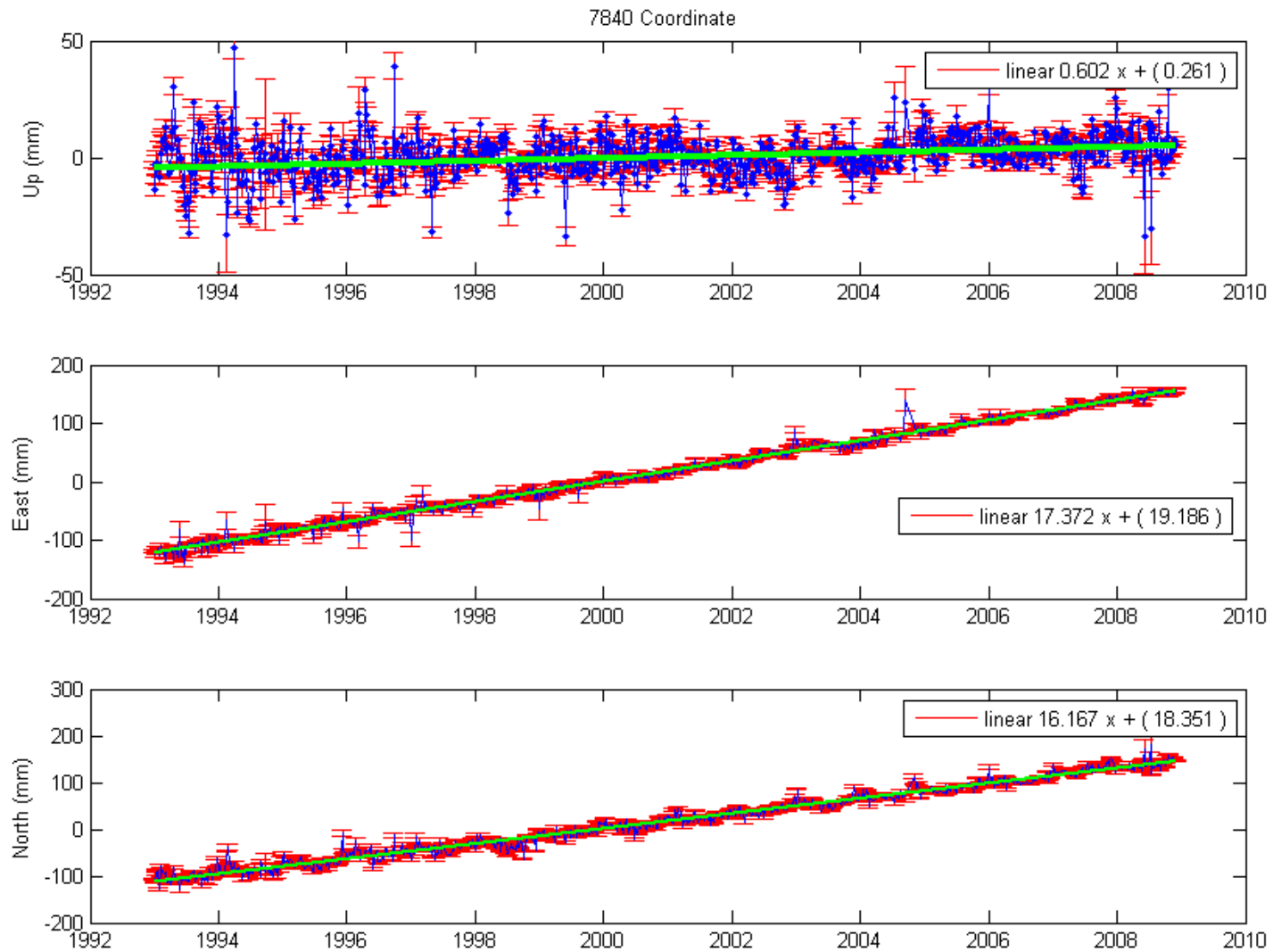
7840 bias from ASI multi-year solution 1983-2008

Remarks

• Mean values of the estimated biases have been computed over the periods indicated by Graham

• The Lageos-1 and Lageos-2 estimated biases are different from 1994 up to 2002: ~5 mm difference exists

• The estimated biases have been grouped when similar and a rough mean value between L1 and L2 computed

• A new test performed with the use of

| Start Year-doy (yymmdd at 00:00)	Stop Year-doy (yymmdd at 00:00)	Total corr 1-way mm
1994 013 (940113)	1999 209 (990729)	+9
1999 210 (990729)	2002 031 (020201)	+13
2002 032 (020201)	2007 041 (070211)	+9
2007 041 (070211)	-----	0

ASI time series – Corrections from multi-year solution Trended 7840 coordinates
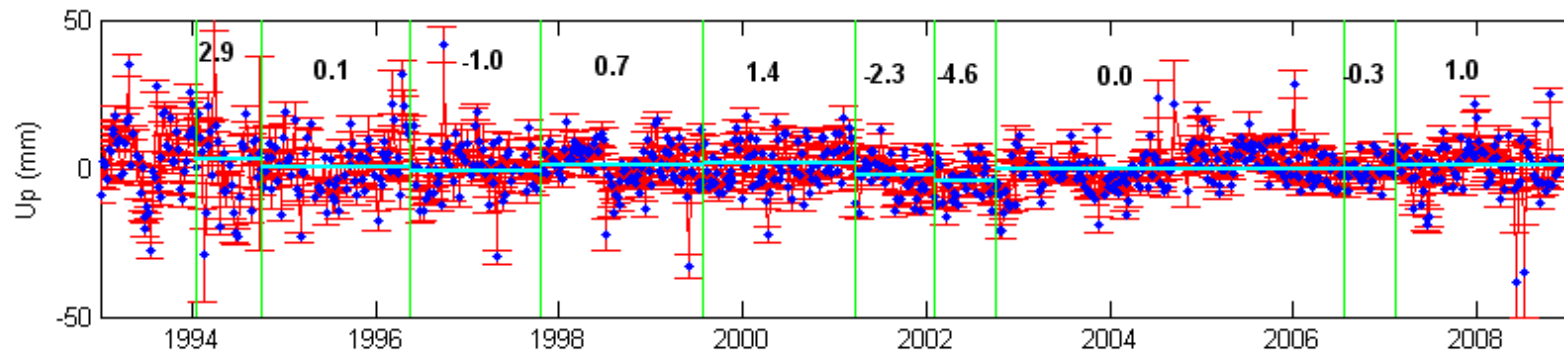

7840 Coordinate

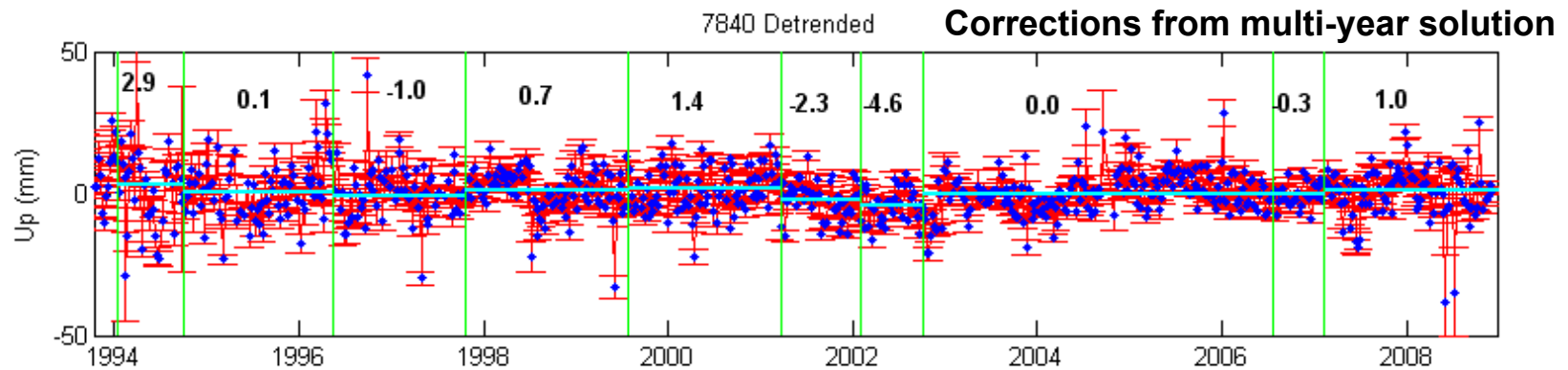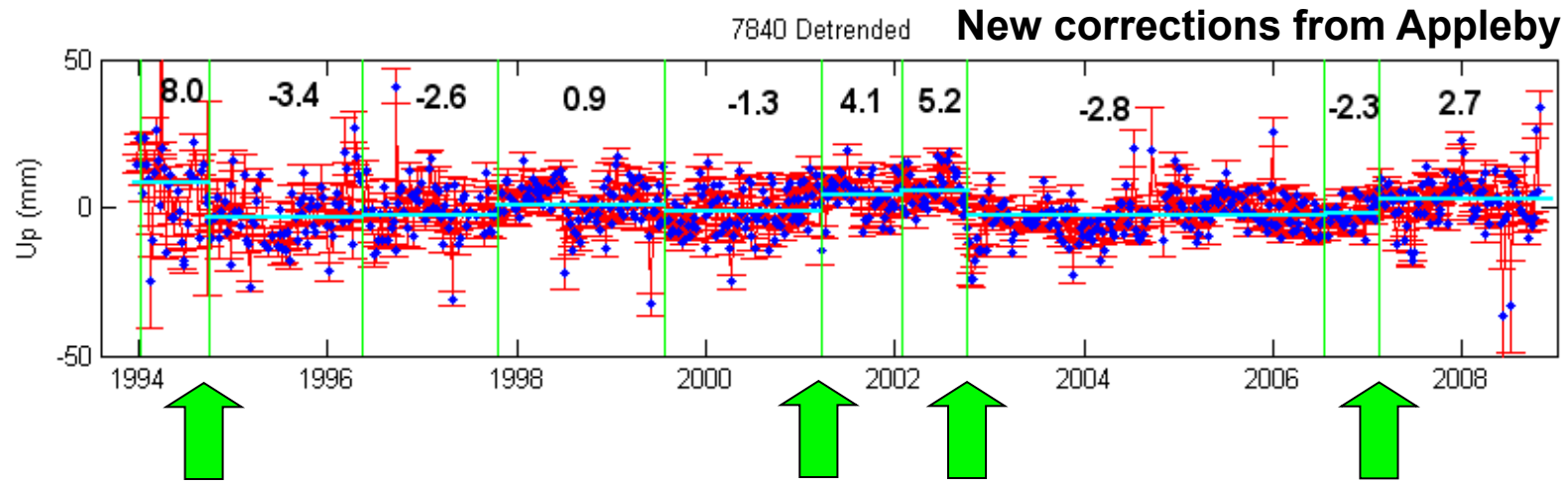# ASI time series – Corrections from multi-year solution

7840 Residual coordinates w.r.t. SLRF2005 (SOLN 2)
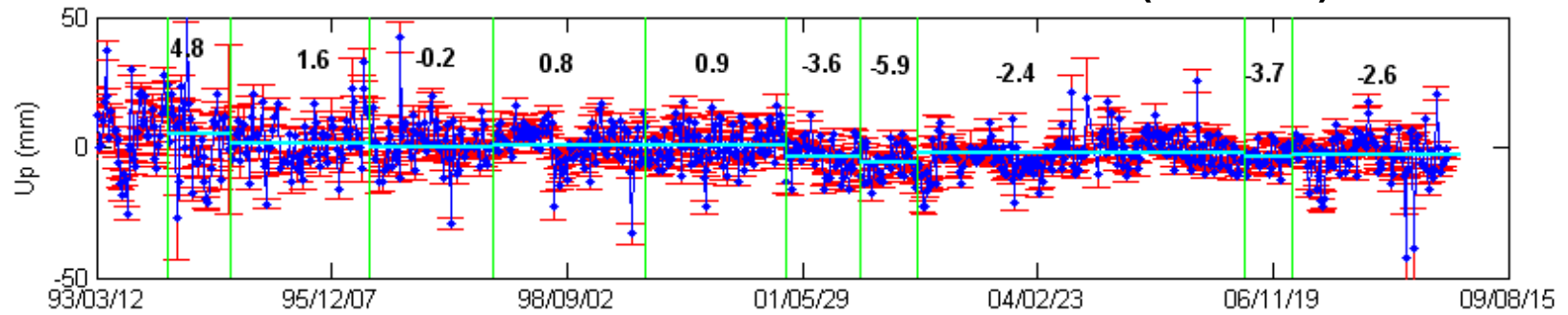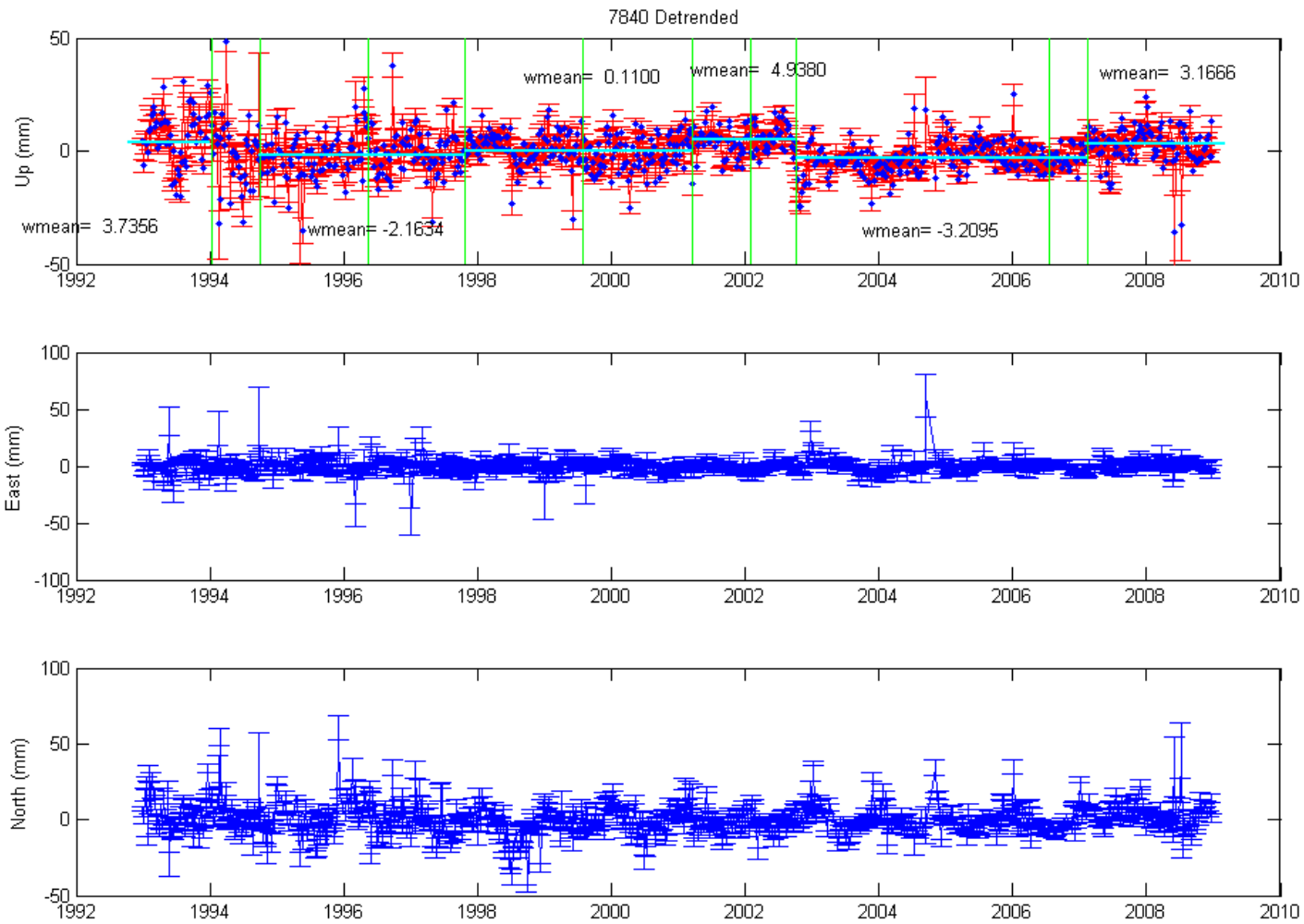

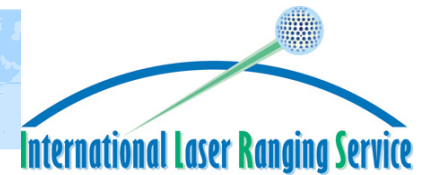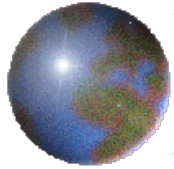## 7840 Residual coordinates w.r.t. weighted fit

ASI time series – Comparison of the fit residuals

The difference between the two time series is, above all, in the jumps indicated by the green arrows: smaller with the corrections from the multi-year solution.

ASI time series v20

ILRSA CC
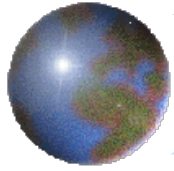# *Status of the ITRF product*

C. Sciarretta
Telespazio S.p.A., Roma

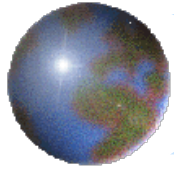**V. Luceri**
eGEOS S.p.A., CGS – Matera

G. Bianco
Agenzia Spaziale Italiana, CGS - Matera

ILRS AWG Meeting, 24 April 2009, Wien

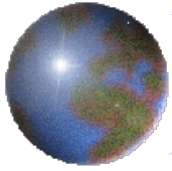# *Contents*

▶ 1993-2008 Re-analysis

▶ 1984-1992 Re-analysis

1993-2008 Re-analysis

The following solutions contribute to the present ILRSA combination solution V20, issued at 25 Mar 09

|		
ASI	v20	02 Feb 09
DGFI	v21*	27 Feb 09
GA	v21*	19 Feb 09
GFZ	v21*	05 Mar 09
GRGS	v20*	19 Feb 09
JCET	v20	11/19 Feb 09
NSGF	v20	19 Feb 09

A preliminary quality assessment has been performed on the submitted time series to

➢ check the correct implementation of the AWG decisions (data to be deleted, bias to estimated/applied)

> ➢ **Each contribution solution has been framed into SLRF2005 and the site time series has been analysed to check if coordinate estimates are provided for a wrong period (i.e. data to be deleted)**
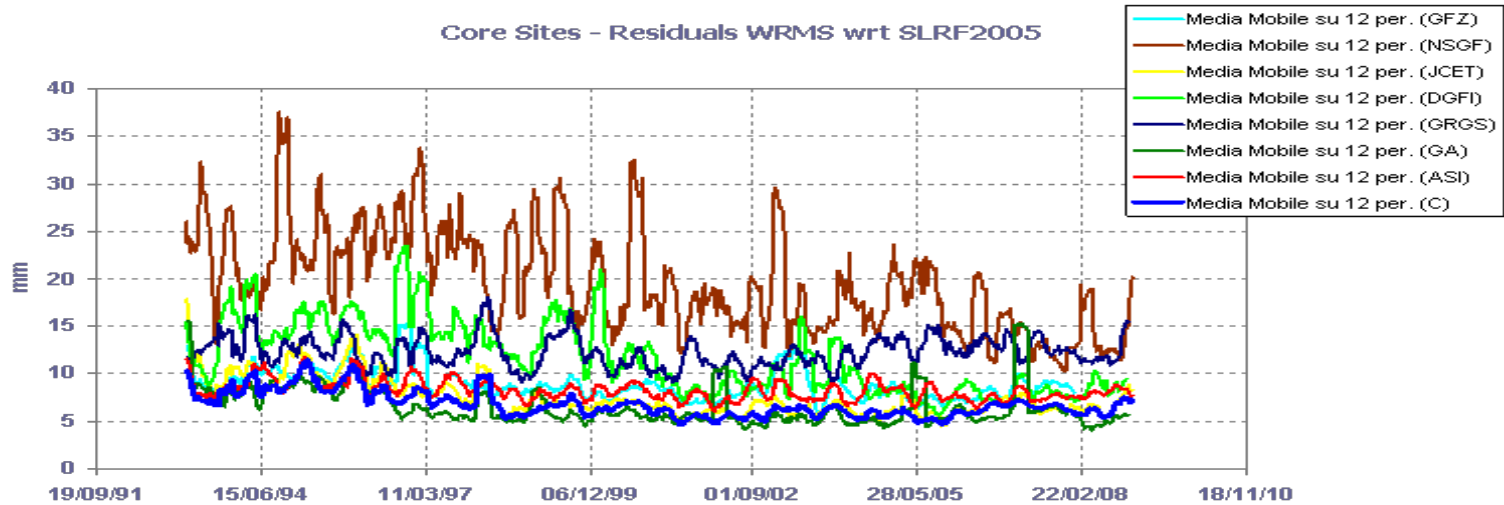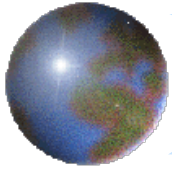
➢ draw an overall quality assessment

1993-2008 Re-analysis

Core Sites – Residuals WRMS wrt SLRF2005
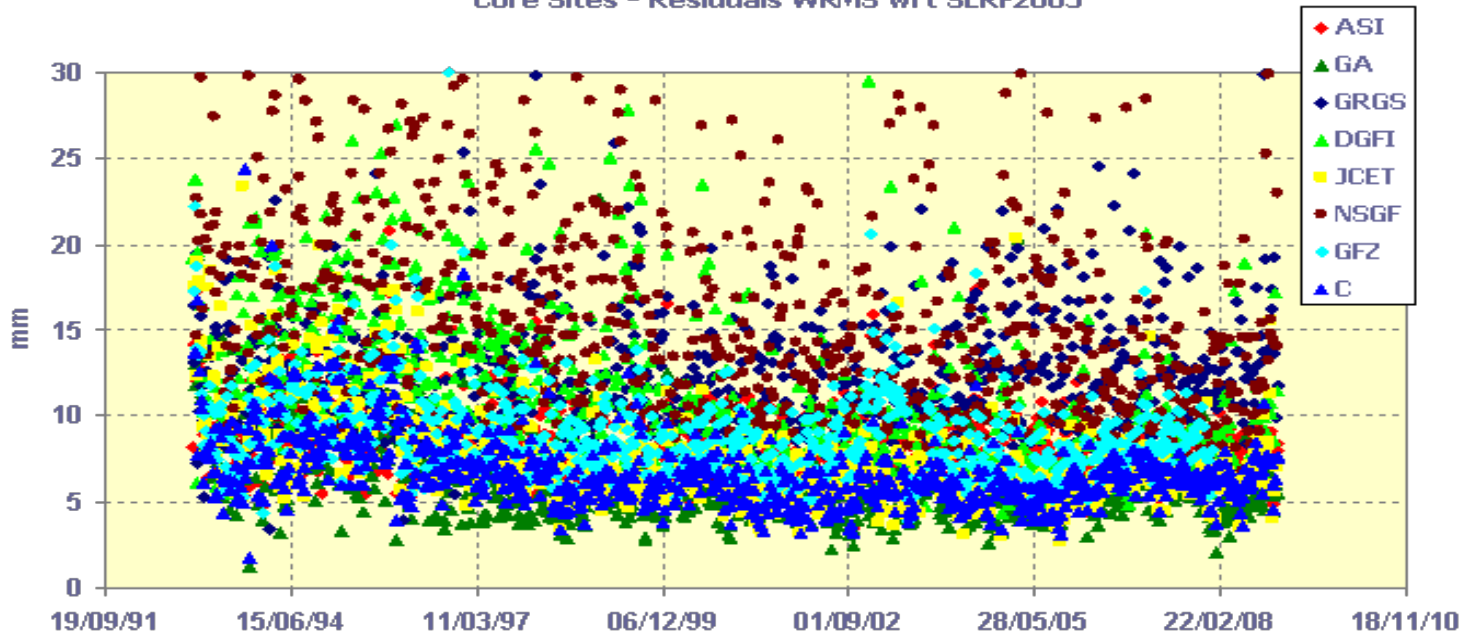
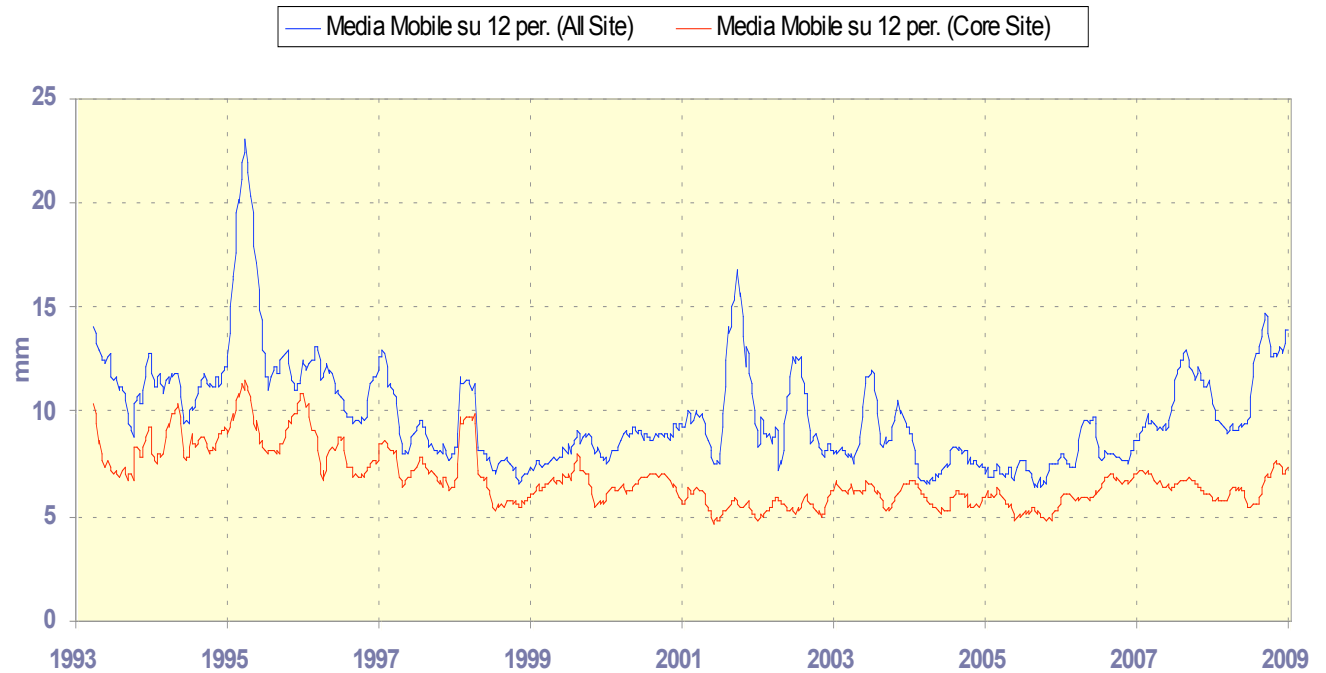Core Sites – Residuals WRMS wrt SLRF2005

1993-2008 Re-analysis

	allsite	coresite
asi	10+/-3	8+/-2
	10	9
dgfi	18+/-10	12+/-8
	21	14
grgs	18+/-8	12+/-4
	20	13
jcet	10+/-4	8+/-3
	11	8
nsgf	27+/-19	20+/-15
	33	25
ga	8+/-18	7+/-6
	20	9
gfz	13+/-5	9+/-3
	14	10
C	9+/-3	6+/-2
	10	7

ILRSA - Weekly 3D WRMS

— Media Mobile su 12 per. (All Site)   — Media Mobile su 12 per. (Core Site)

Running mean on 3 months

1993-2008 Re-analysis

Helmert (Tx)
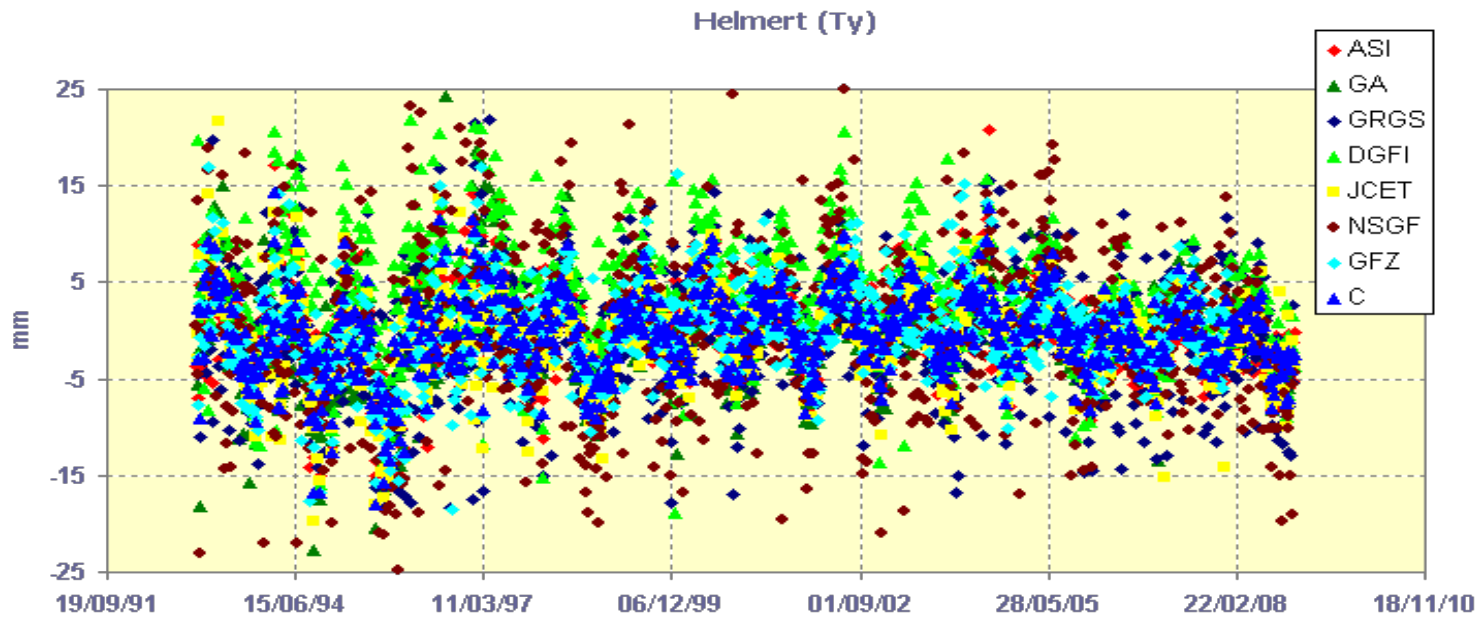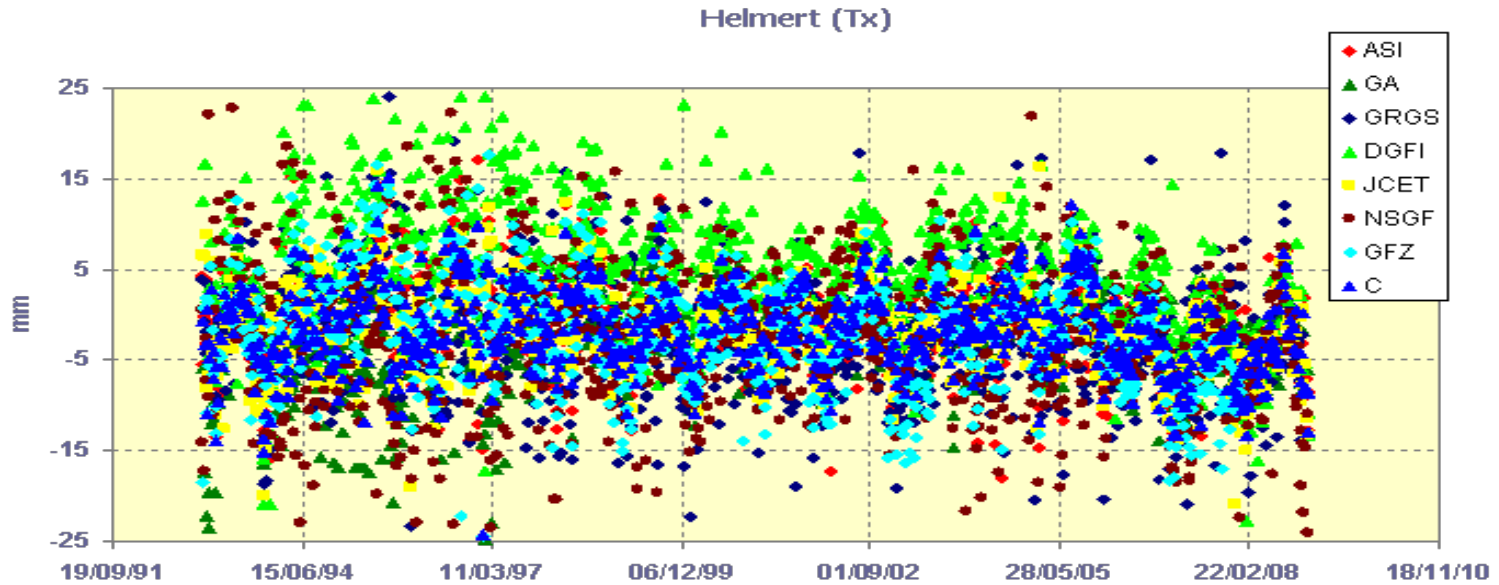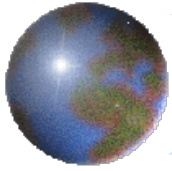
Helmert (Ty)

1993-2008 Re-analysis

Helmert (Tz)

1993-2008 Re-analysis

	Tx (mm)	Ty (mm)	Tz (mm)	Scale (mm)
asi	-1+/-5	0+/-5	-2+/-10	6+/-5
<σ>	4	4	10	3
dgfi	5+/-8	3+/-6	3+/-13	5+/-5
<σ>	5	4	12	4
grgs	-3+/-7	0+/-7	0+/-11	8+/-7
<σ>	6	6	5	4
jcet	-2+/-5	-1+/-5	0+/-11	5+/-5
<σ>	3	3	9	3
nsgf	-3+/-12	0+/-12	-1+/-23	6+/-9
<σ>	8	7	18	6
ga	-3+/-7	-1+/-6	0+/-11	6+/-5
<σ>	3	3	8	2
gfz	-2+/-6	0+/-5	-3+/-11	6+/-5
<σ>	4	4	10	4
C	-2+/-4	0+/-4	0+/-9	6+/-4
<σ>	3	3	6	2

ILRSA - Weekly Helmert Parameters

Legend: Media Mobile su 12 per. (Tx) — Media Mobile su 12 per. (Ty) — Media Mobile su 12 per. (Tz) — Media Mobile su 12 per. (Scale)
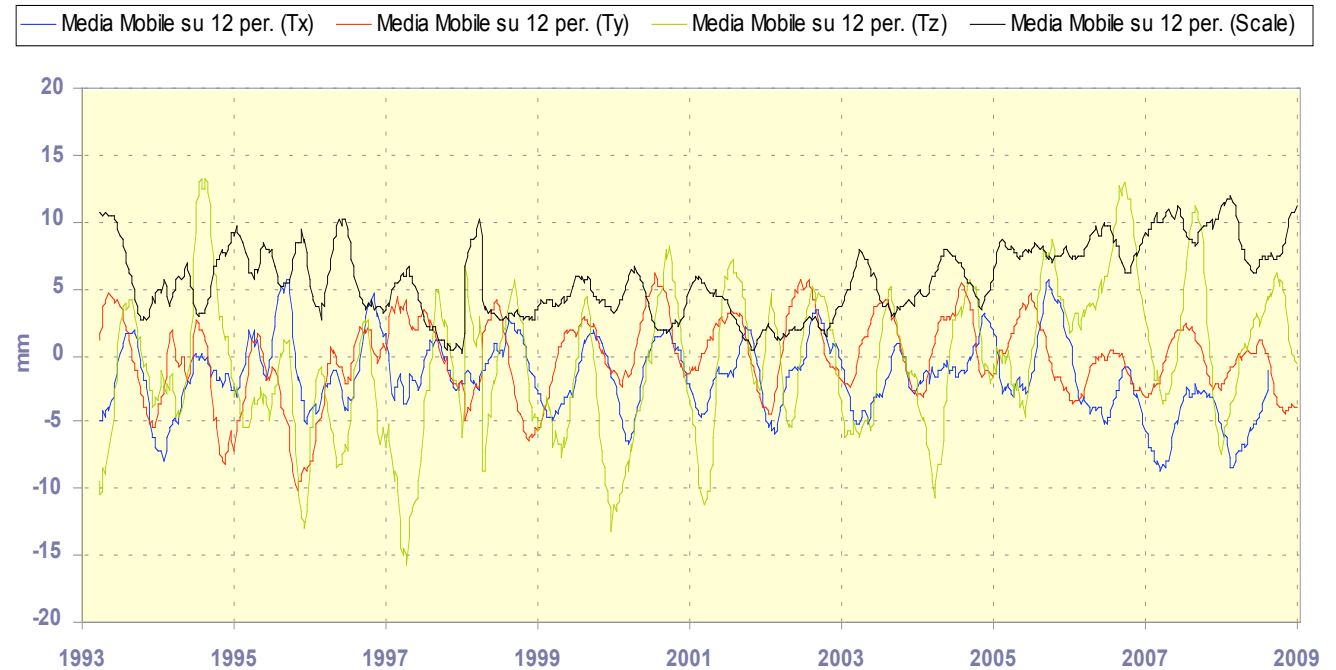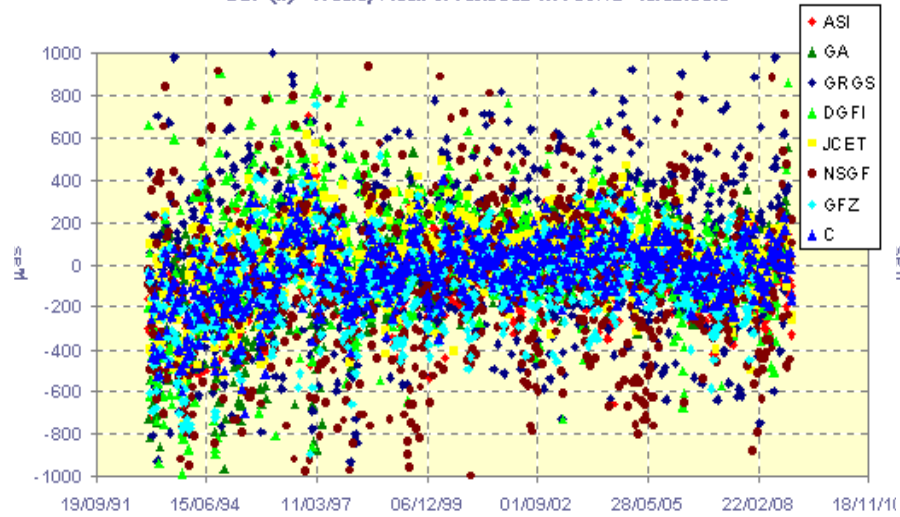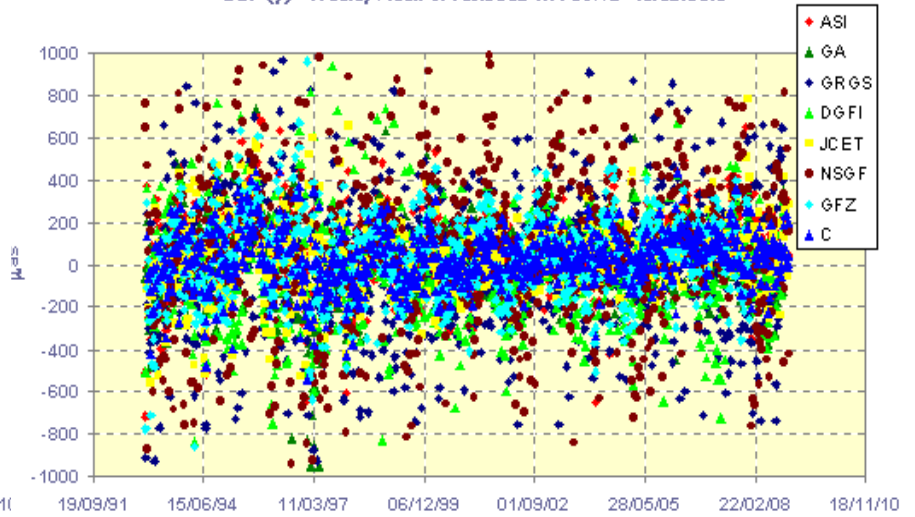
Running mean on 3 months
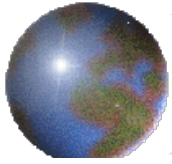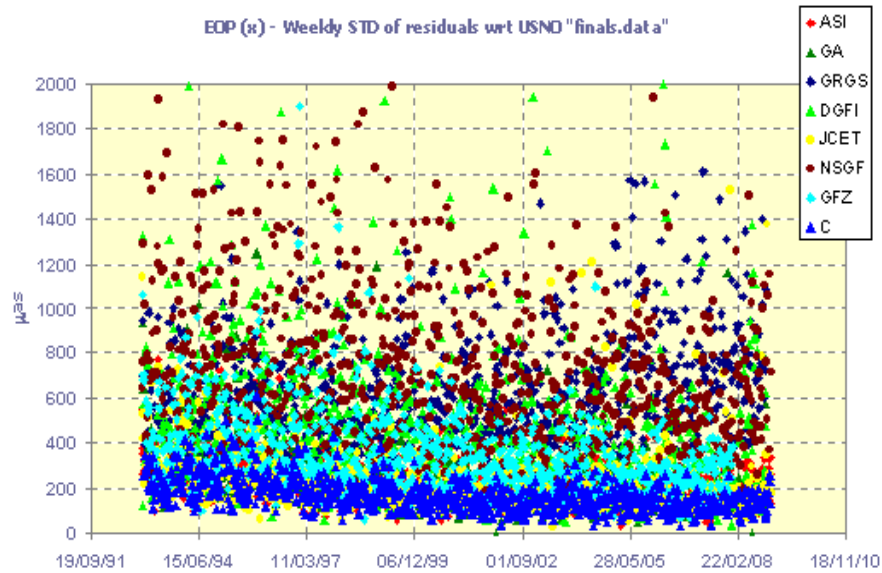
1993-2008 Re-analysis

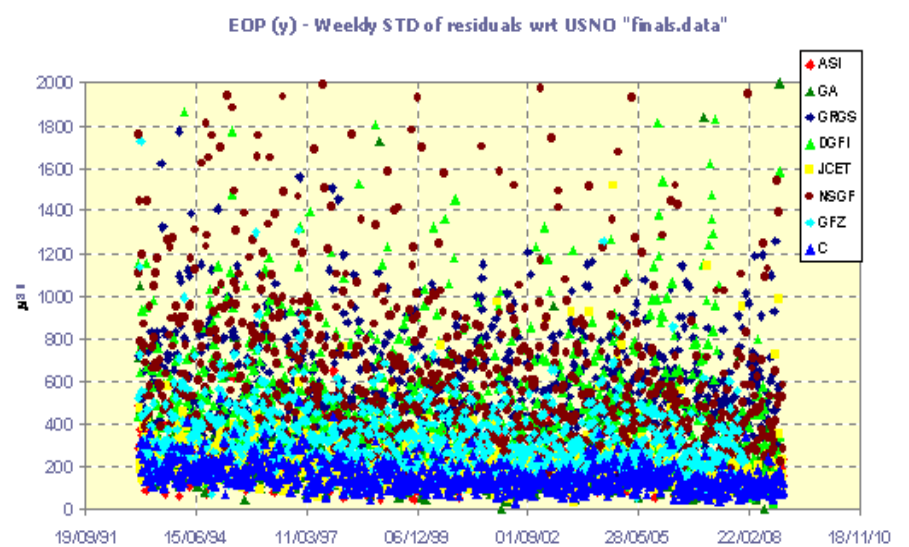EOP (x) – Weekly Mean of residuals wrt USNO "finals.data"

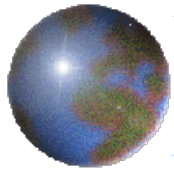EOP (y) – Weekly Mean of residuals wrt USNO "finals.data"

EOP (x) – Weekly STD of residuals wrt USNO "finals.data"

EOP (y) – Weekly STD of residuals wrt USNO "finals.data"

1993-2008 Re-analysis

EOP (LOD) - Weekly Mean of residuals wrt USNO "finals.data"

EOP (LOD) - Weekly STD of residuals wrt USNO "finals.data"

EOP (LOD) - Weekly Mean of residuals wrt USNO "finals.data"

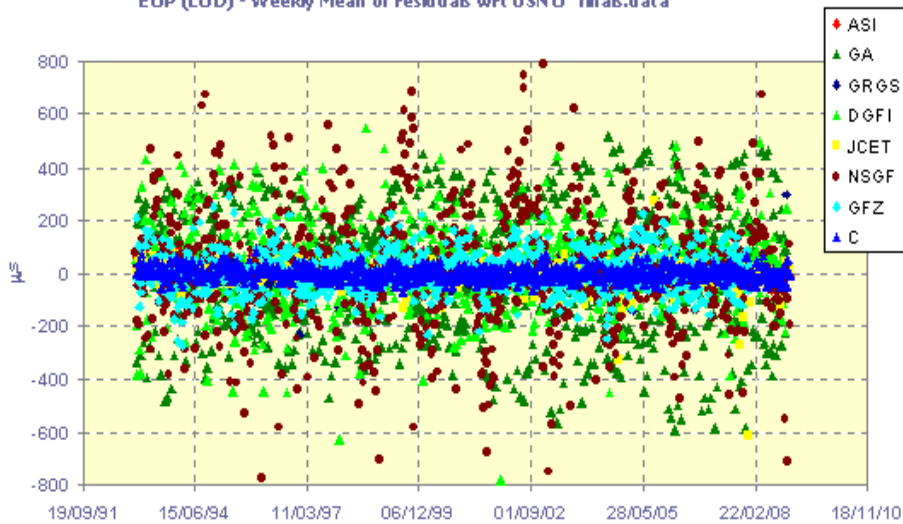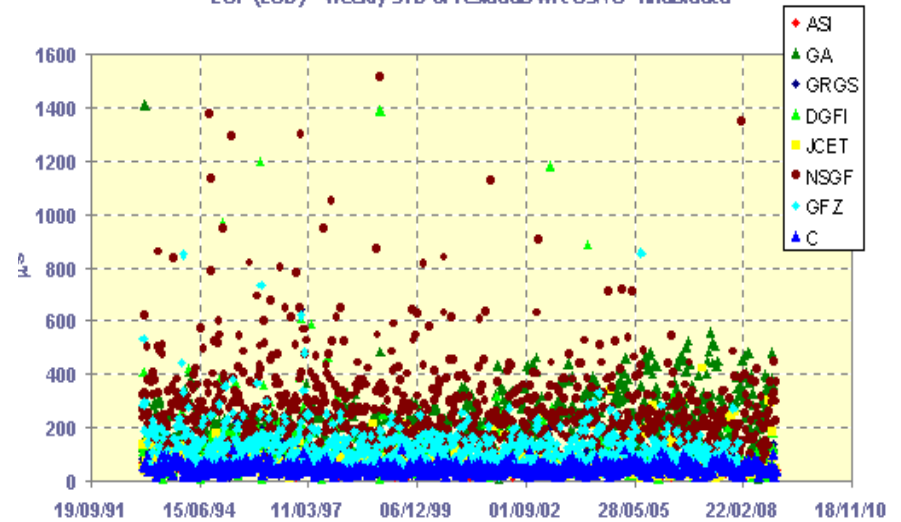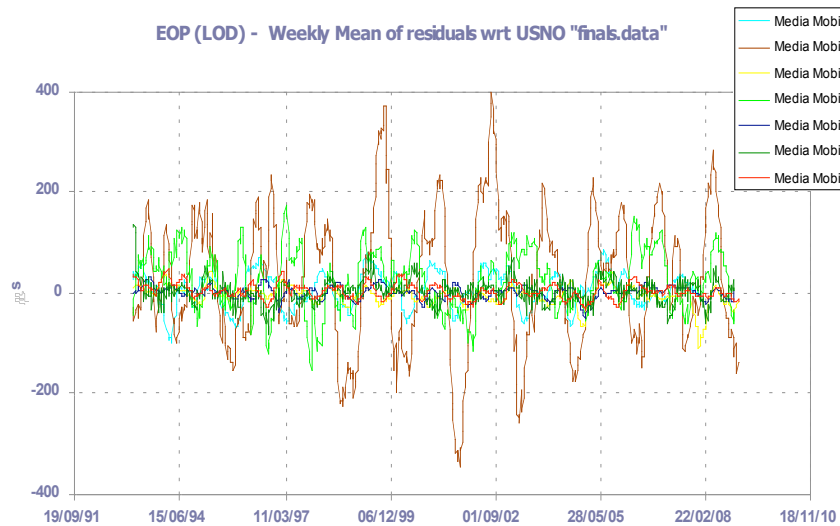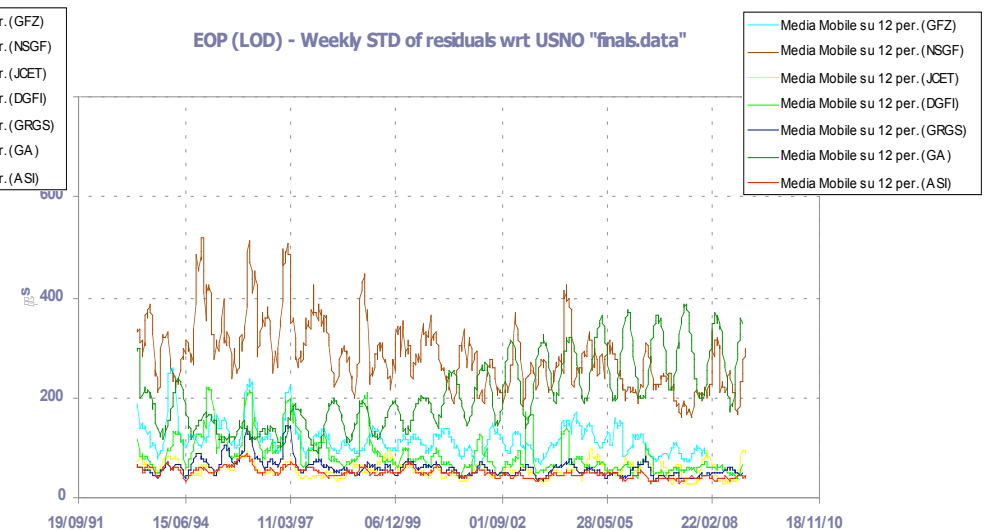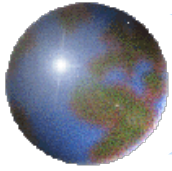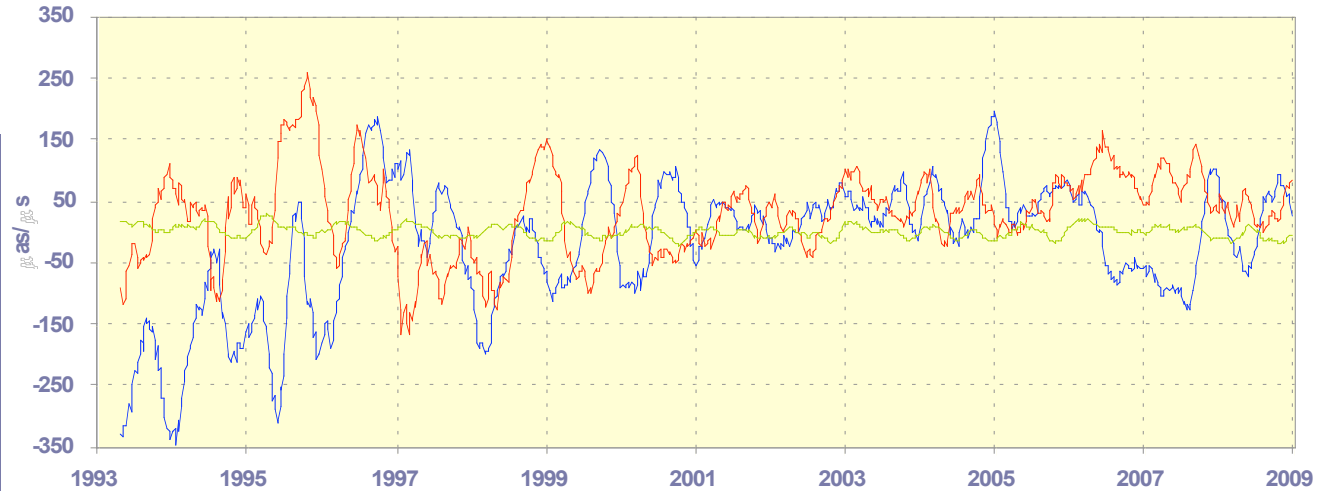EOP (LOD) - Weekly STD of residuals wrt USNO "finals.data"

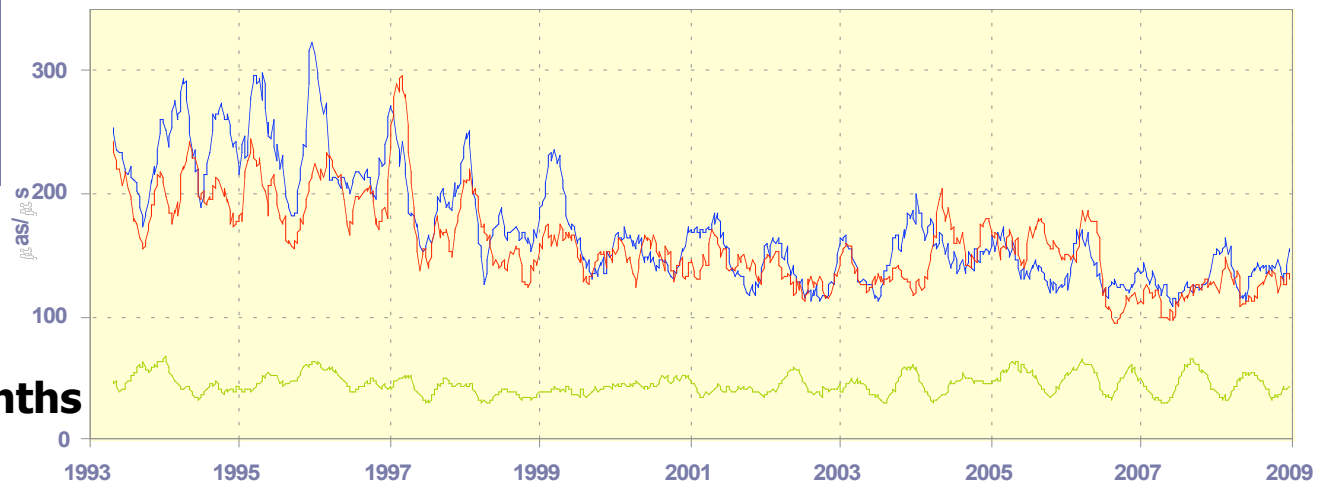**Running mean on 3 months**

1993-2008 Re-analysis

	Xp (µas)	Yp (µas)	LOD (µs)
asi	-64+/-176	58+/-177	3+/-31
<σ>	229	210	51
dgfi	35+/-333	-9+/-346	24+/-162
<σ>	491	539	87
grgs	37+/-360	10+/-390	1+/-30
<σ>	613	575	61
jcet	13+/-180	31+/-157	-5+/-43
<σ>	231	209	56
nsgf	-103+/-486	56+/-511	26+/-232
<σ>	818	731	286
ga	-47+/-240	2+/-367	3+/-235
<σ>	266	213	209
gfz	-87+/-206	35+/-194	6+/-80
<σ>	352	334	119
C	-24+/-156	30+/-131	1+/-24
<σ>	172	159	45

Legend: Media Mobile su 12 per. (XP) — Media Mobile su 12 per. (YP) — Media Mobile su 12 per. (LOD)

ILRSA - Weekly STD wrt USNO

Legend: Media Mobile su 12 per. (XP) — Media Mobile su 12 per. (YP) — Media Mobile su 12 per. (LOD)

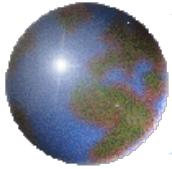

Running mean on 3 months

1993-2008 Re-analysis: next steps

The overall quality of the contributing solutions and hence of the combined solutions is good:

- ➢ **3D SSC WRMS < 10 mm (Core Sites)**

- ➢ **EOP accuracy (30+/-150 μas (Xp, Yp); 1+/-25 μs (LOD)**

        ….BUT….

- ➢ **GA, DGFI, NSGF LOD excluded from combination**

- ➢ **NSGF 3D SSC WRMS o(20 mm) (Core Sites)**

- ➢ **ILRS AWG bias/deleting data recommendations not fully applied; several solutions 'mended' a-posteriori: not all the problems solved!!!   BIAS!!!**

- ➢ **"Site by site" check to be prosecuted: DOMES number, occupation, …**

- ➢ **Zuheir's feedback evaluation and solution correction (weak point problem)**

- ➢ **Spurious combined solutions missing**

As far as possible, ACs will not be required to generate again solution time series: all the possible a-posteriori corrections will be applied -> FINAL COMBINATION < 20 MAY
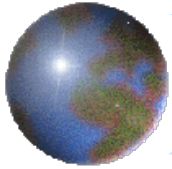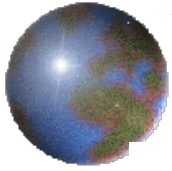
1984-1992 Re-analysis (hystorical data)

The following solutions contribute to the present ILRSA combination solution V20, issued at 02 Apr 09

|		
ASI	v20	20 Feb 09
DGFI	v21	23 Feb 09
GA	v20	01 Mar 09
GFZ	v21	12 Mar 09
JCET	v20	18 Feb 09 (upd 09 Apr)
NSGF	v20	19 Feb 09

A preliminary quality assessment has been performed on the submitted time series to

➢ check the correct implementation of the AWG decisions (data to be deleted, bias to estimated/applied)

> ➢ **Each contribution solution has been framed into SLRF2005 and the site time series has been analysed to check if coordinate estimates are provided for a wrong period (i.e. data to be deleted)**

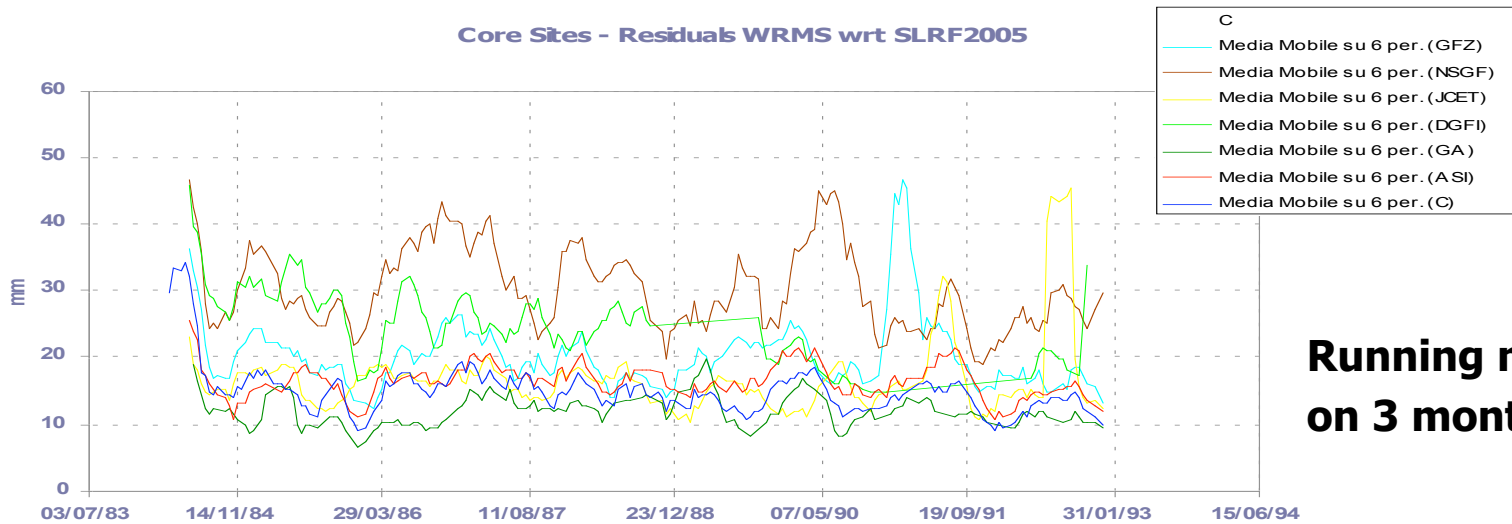➢ draw an overall quality assessment

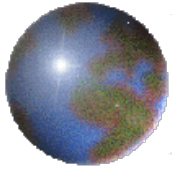# *1984-1992 Re-analysis (hystorical data)*
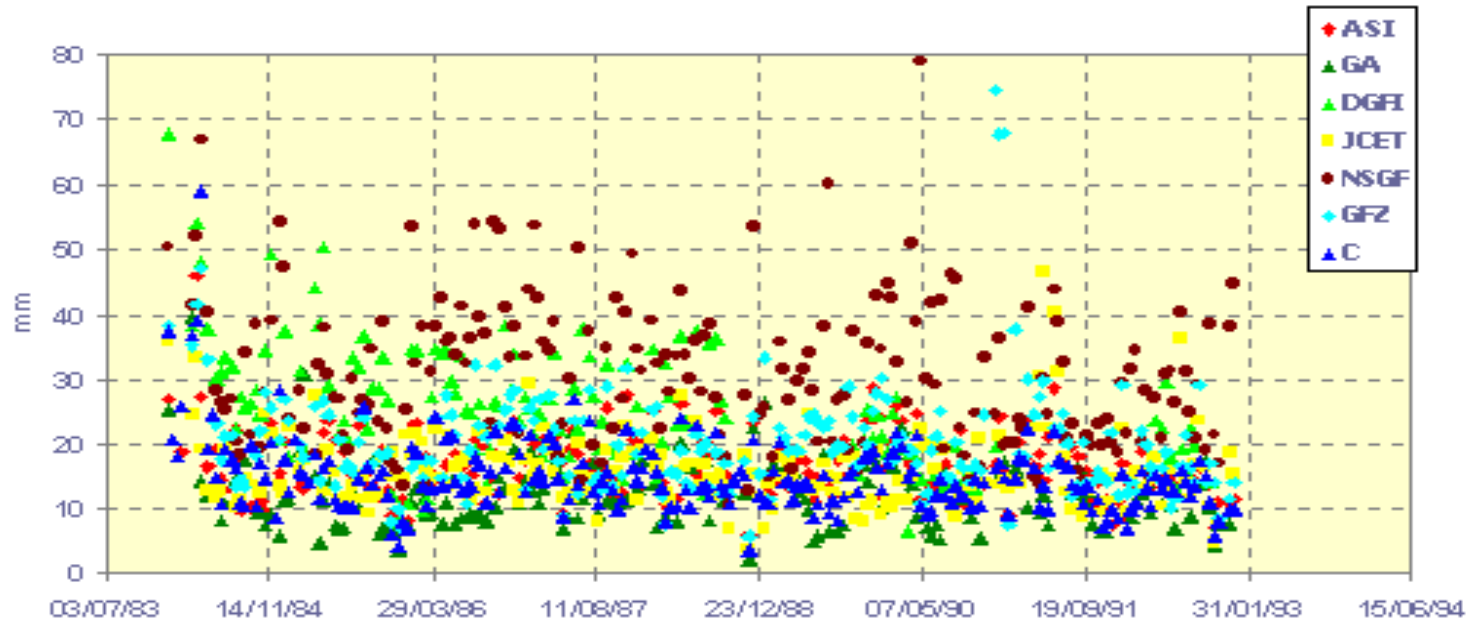
Running mean on 3 months

1984-1992 Re-analysis (hystorical data)

	allsite	coresite
asi	24+/-8	16+/-5
	25	17
dgfi	145+/-283	26+/-12
	318	28
jcet	25+/-16	17+/-12
	30	21
nsgf	40+/-14	30+/-11
	42	32
ga	15+/-6	12+/-5
	16	13
gfz	26+/-12	20+/-9
	28	22
C	33+/-41	14+/-4
	52	15

ILRSA - Weekly 3D WRMS

!!

— Media Mobile su 6 per. (All Site)   — Media Mobile su 6 per. (Core Site)
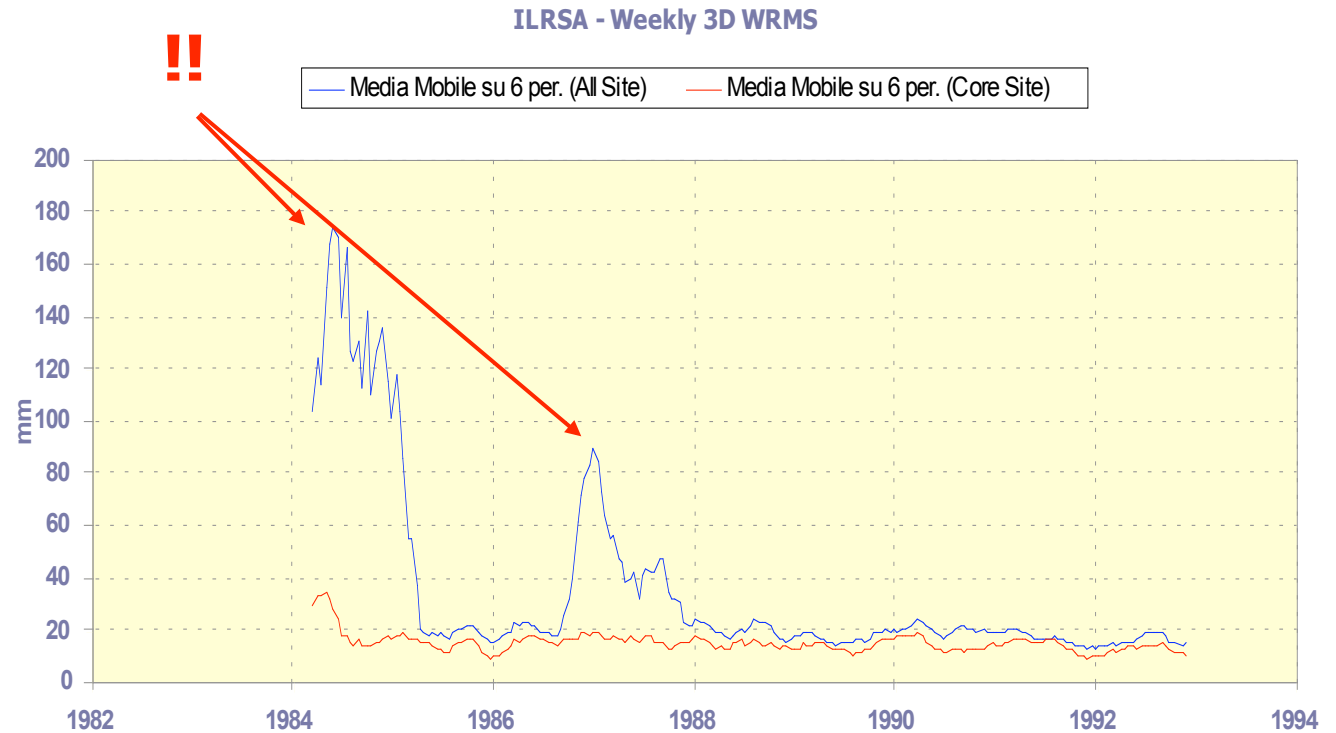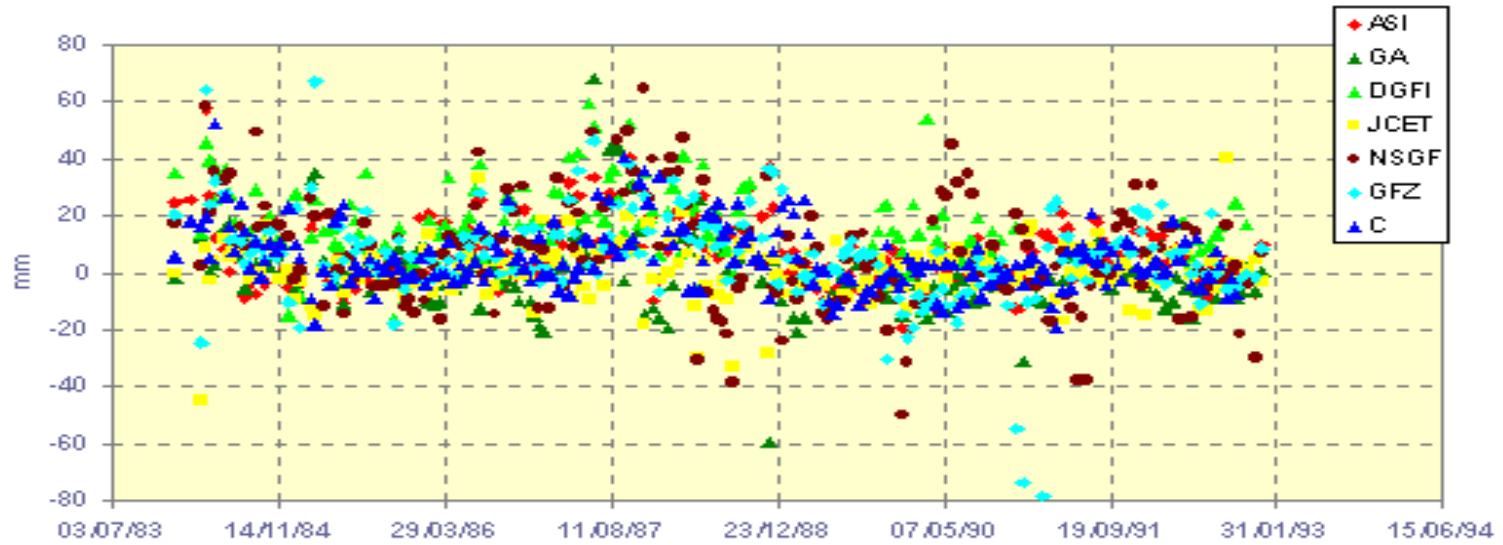

Running mean on 3 months
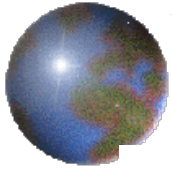
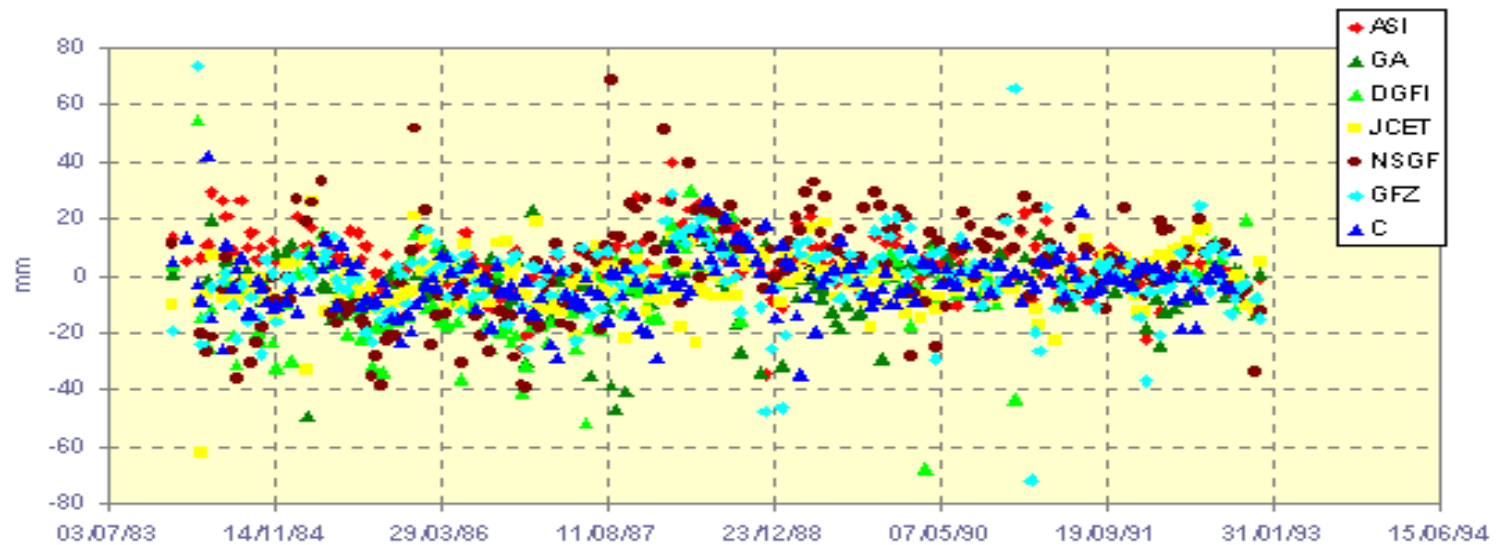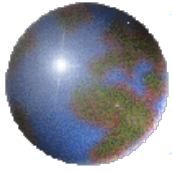# 1984-1992 Re-analysis *(hystorical data)*

Helmert (Tx)

Helmert (Ty)

Helmert (Tz)

Scale

1984-1992 Re-analysis (hystorical data)

ILRSA - Weekly Helmert Parameters

	Tx (mm)	Ty (mm)	Tz (mm)	Scale (mm)
asi	7+/ -11	5+/ -10	-17+/ -27	6+/ -9
<σ>	8	8	24	7
dgfi	17+/ -13	-7+/ -16	-29+/ -37	-11+/ -17
<σ>	12	12	35	12
jcet	1+/ -10	-2+/ -9	4+/ -33	5+/ -14
<σ>	9	8	29	11
nsgf	7+/ -19	3+/ -19	-18+/ -42	-1+/ -14
<σ>	14	13	38	12
ga	-1+/ -14	-4+/ -12	-23+/ -25	3+/ -10
<σ>	7	6	17	5
gfz	6+/ -17	0+/ -17	-28+/ -49	4+/ -19
<σ>	11	11	30	13
C	4+/-10	-2+/-9	-19+/-20	3+/-8
<σ>	7	7	21	6

Legend: Media Mobile su 6 per. (Tx) — Media Mobile su 6 per. (Ty) — Media Mobile su 6 per. (Tz) — Media Mobile su 6 per. (Scale)

Running mean on 3 months
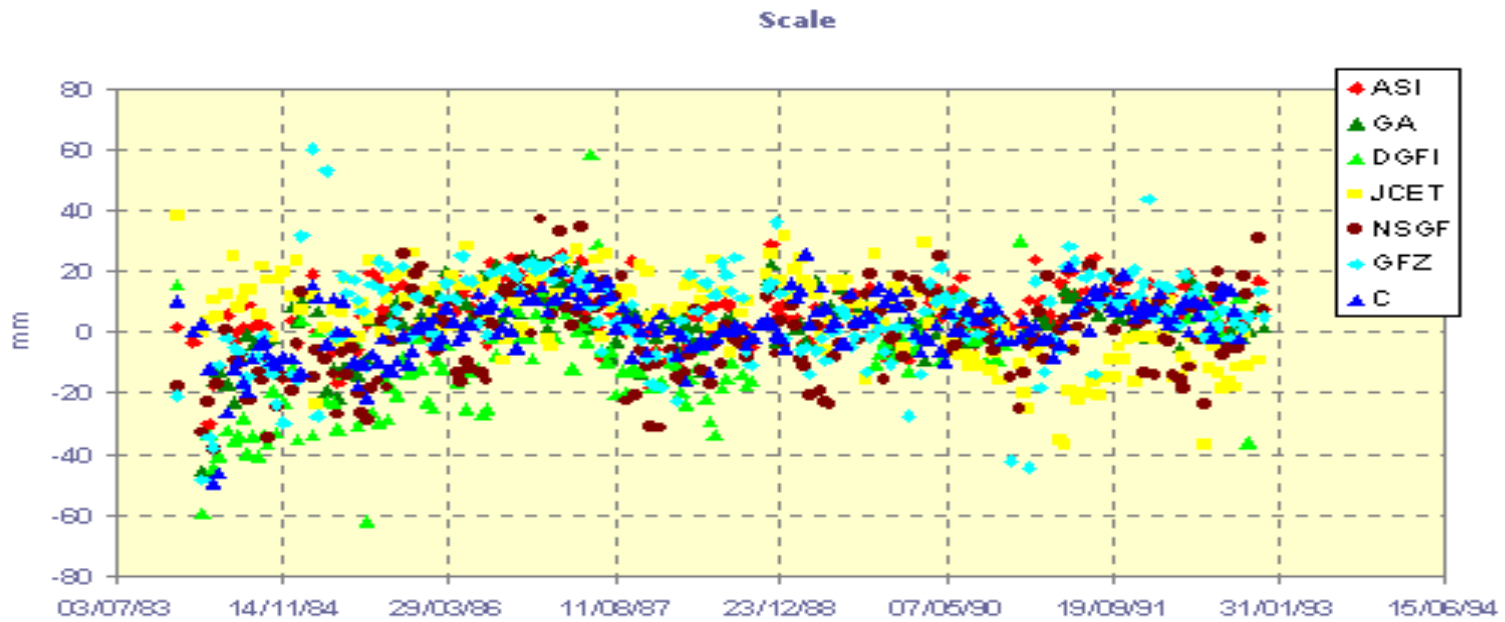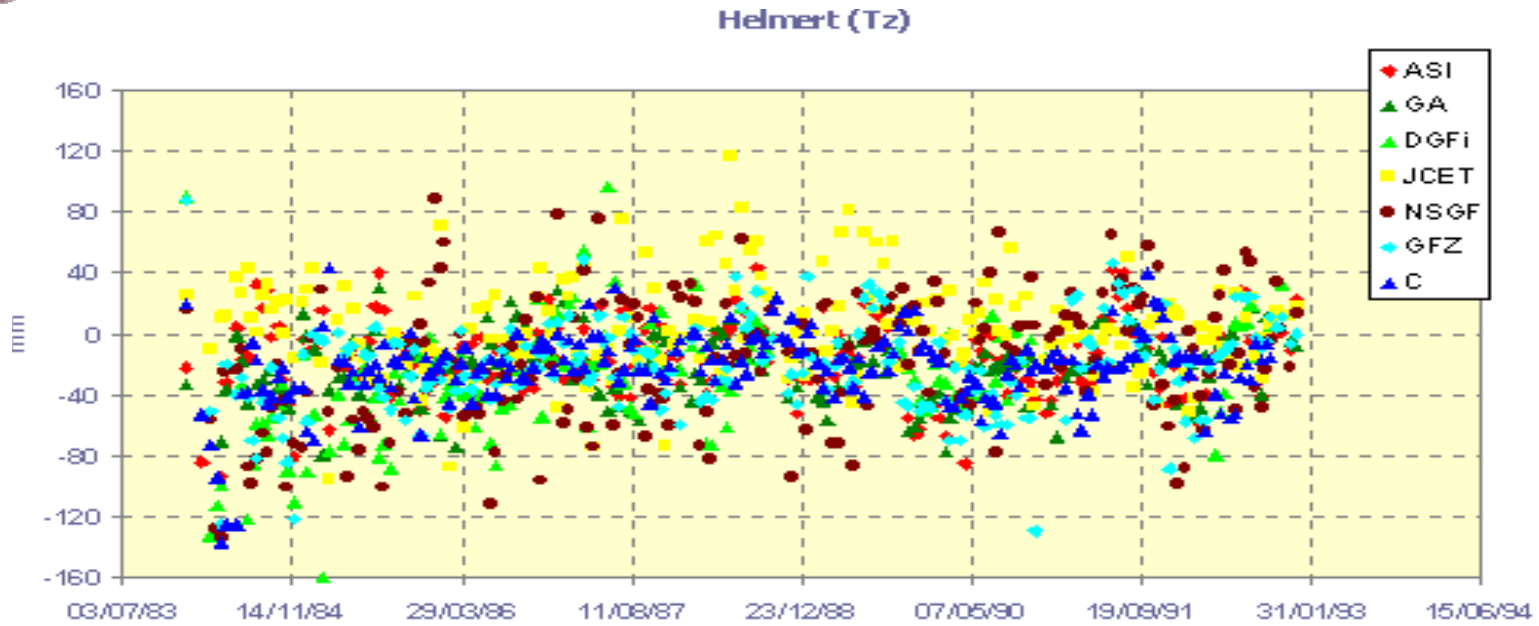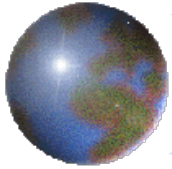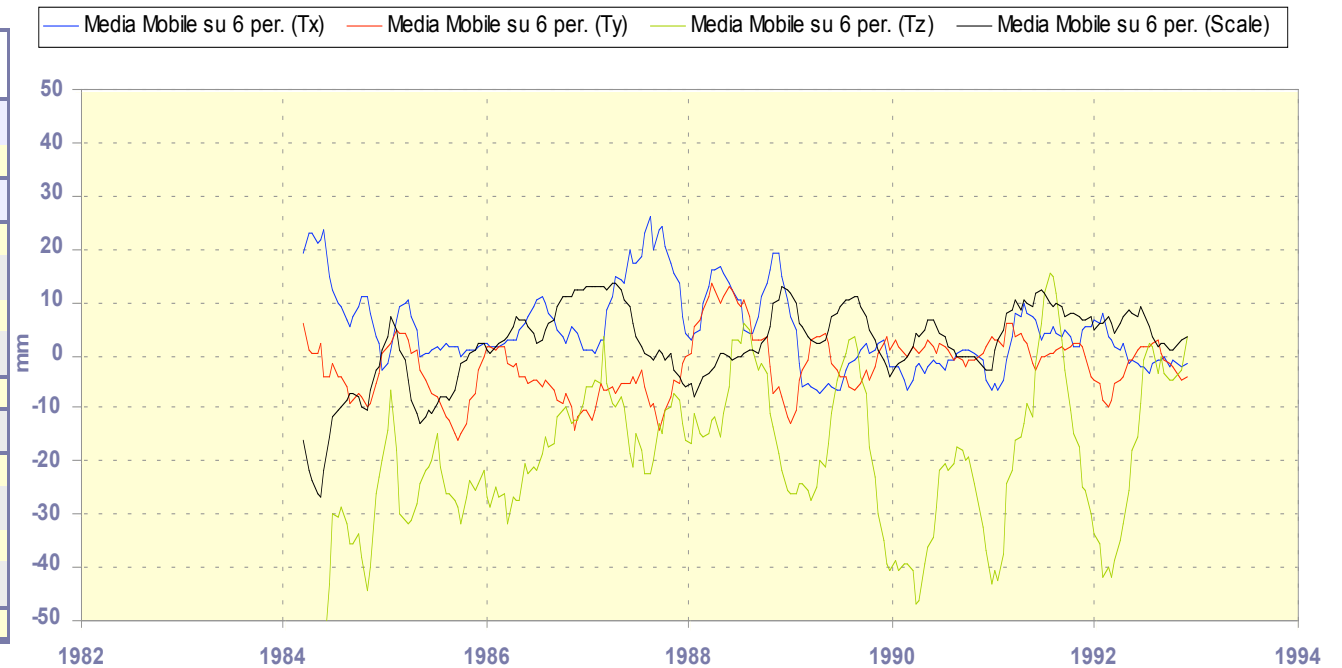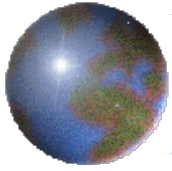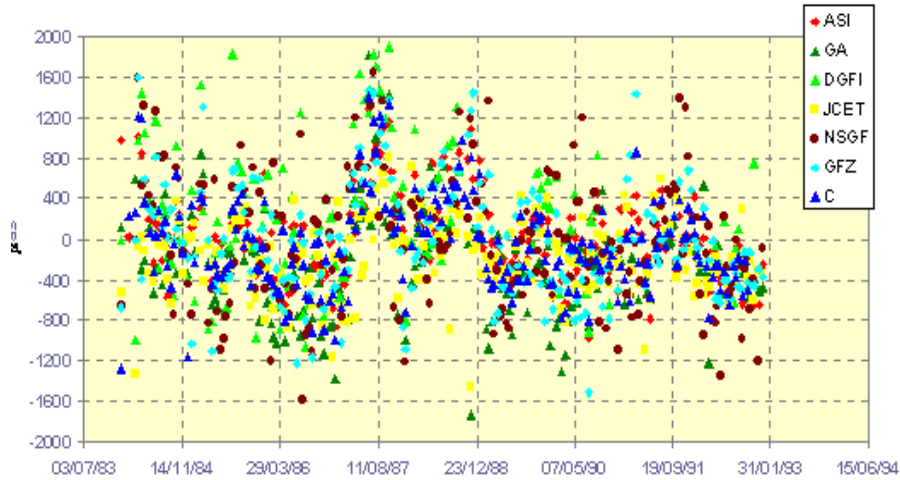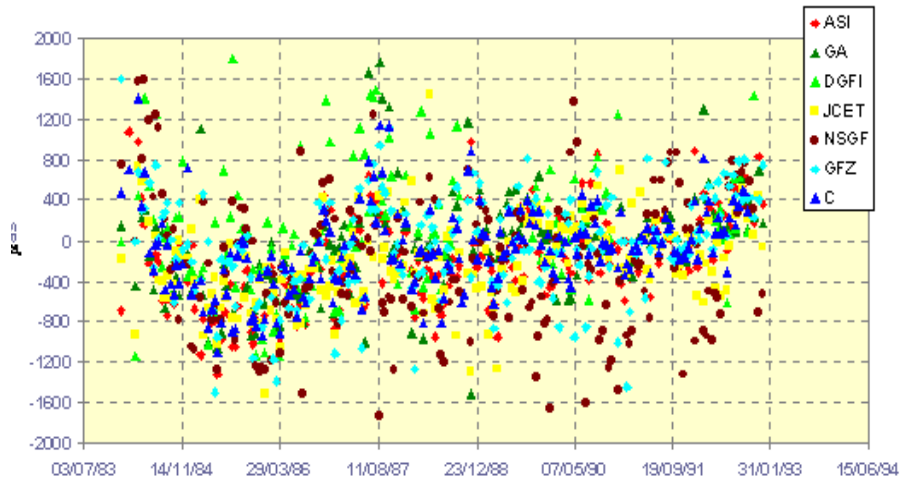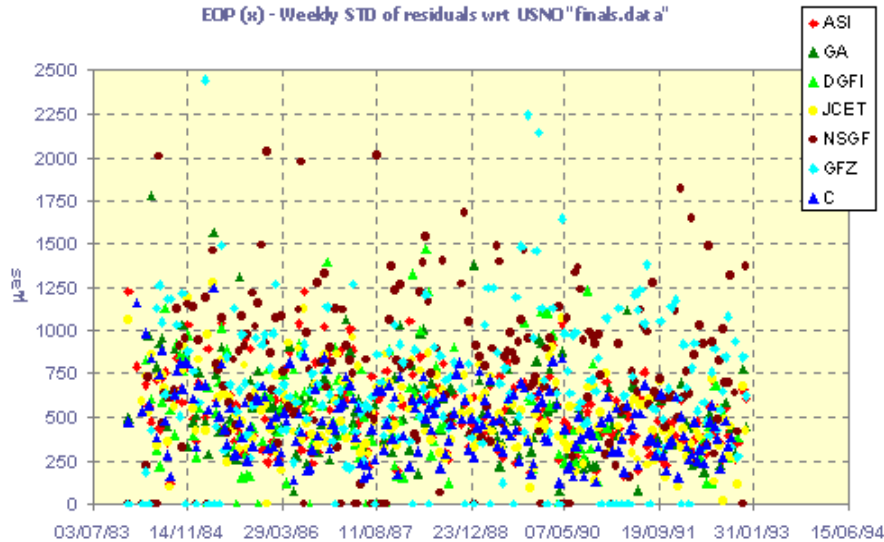
1984-1992 Re-analysis (hystorical data)

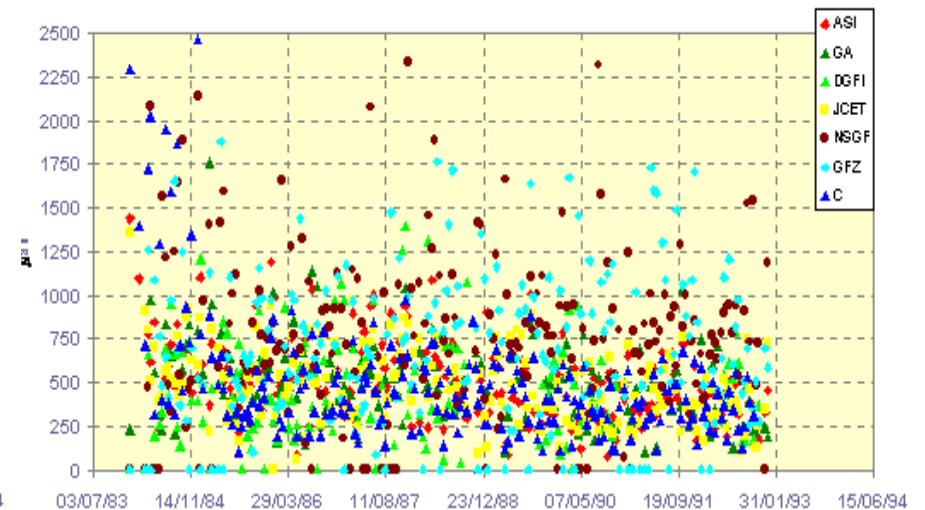EOP (x) - Weekly Mean of residuals wrt USNO "finals.data"

EOP (y) - Weekly Mean of residuals wrt USNO "finals.data"
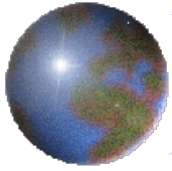
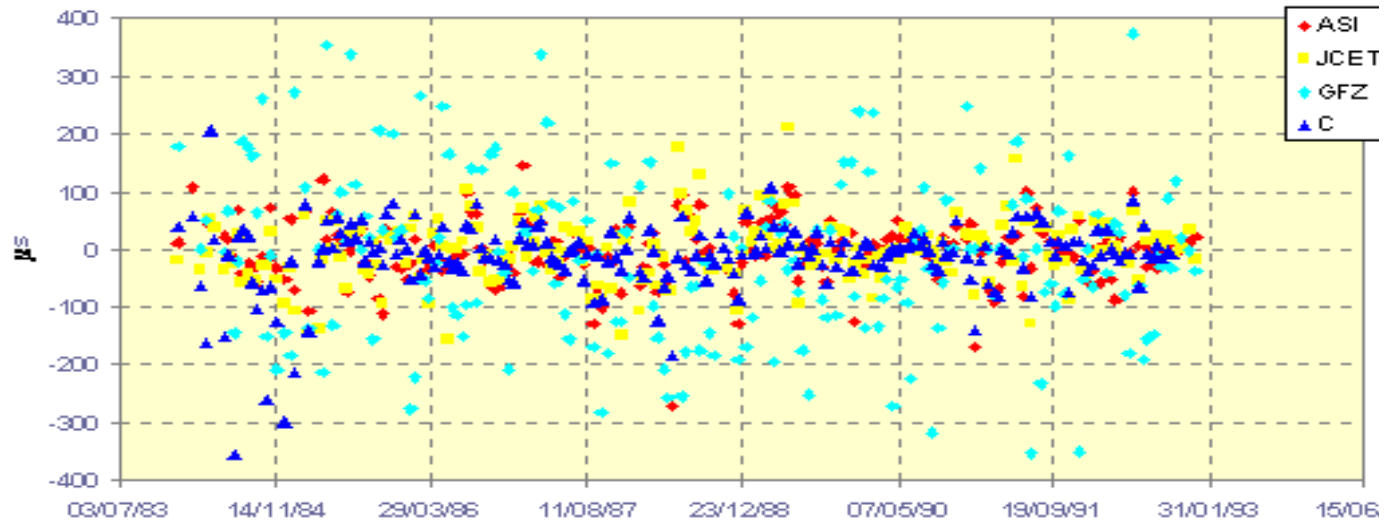EOP (x) - Weekly STD of residuals wrt USNO "finals.data"

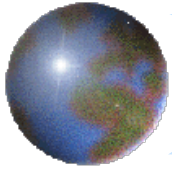EOP (y) - Weekly STD of residuals wrt USNO "finals.data"

1984-1992 Re-analysis (hystorical data)

EOP (LOD) – Weekly Mean of residuals wrt USNO "finals.data"

1984-1992 Re-analysis (hystorical data)

	Xp (μas)	Yp (μas)	LOD (μs)
asi	16 +/ -434	-186 + / -449	-5 +/ -53
$\langle\sigma\rangle$	529	496	97
dgfi	194 + / -681	105 + / -607	-
$\langle\sigma\rangle$	508	441	-
jcet	-182 + / -373	-187 + / -419	-3 +/ -54
$\langle\sigma\rangle$	513	479	96
nsgf	-6 + / -638	-204 + / -658	-
$\langle\sigma\rangle$	761	764	-
ga	-259 + / -554	-61 + / -511	-
$\langle\sigma\rangle$	531	483	-
gfz	-5 + / -568	-44 + / -502	-27 + / -202
$\langle\sigma\rangle$	654	671	189
C	-58 + / -468	-92 + / -434	-12 + / -61
$\langle\sigma\rangle$	470	487	98

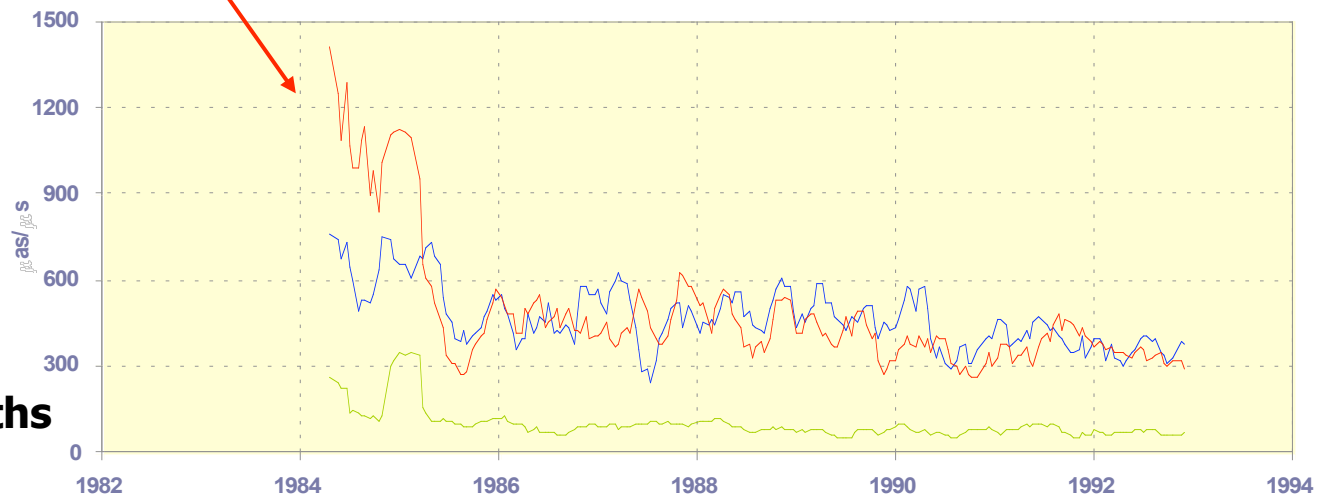**Running mean on 3 months**

!!

ILRSA - Weekly mean wrt USNO

Media Mobile su 6 per. (XP) — Media Mobile su 6 per. (YP) — Media Mobile su 6 per. (LOD)
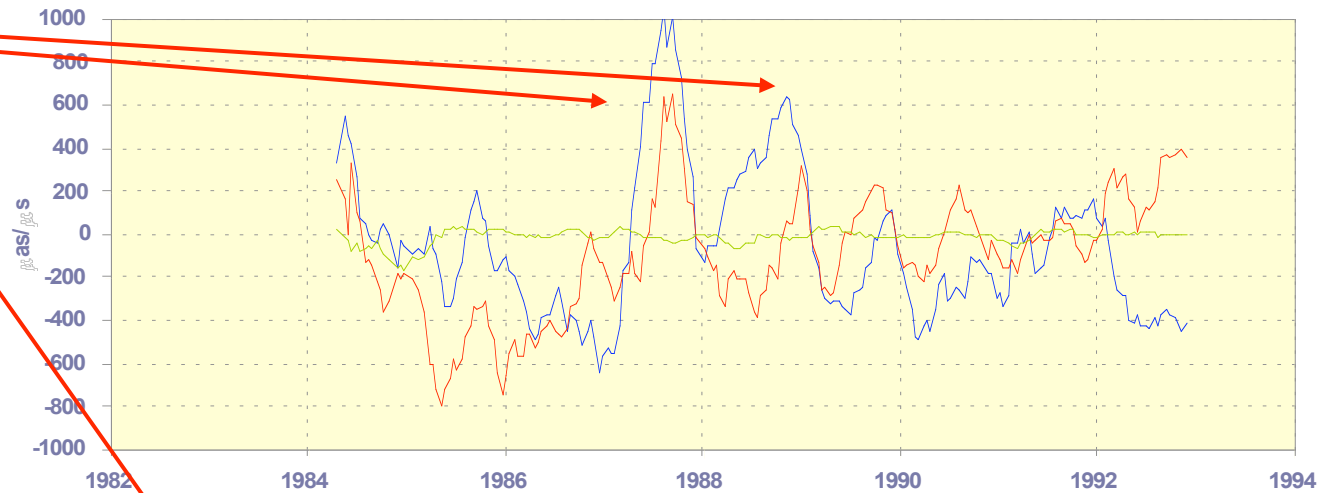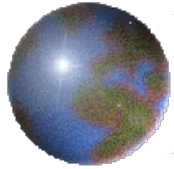

ILRSA - Weekly STD wrt USNO

Media Mobile su 6 per. (XP) — Media Mobile su 6 per. (YP) — Media Mobile su 6 per. (LOD)

1984-1992 Re-analysis (hystorical data)

The overall quality of the contributing solutions and hence of the combined solutions is "good":

➢ **3D SSC WRMS < 20 mm (Core Sites)**

➢ **EOP accuracy (60+/-450 μas (Xp, Yp); 10+/-65 μs (LOD)**

   ....BUT....

➢ **GA, DGFI, NSGF LOD excluded (directly) from combination**

➢ **NSGF 3D SSC WRMS o(30 mm) (Core Sites)**

➢ **ILRS AWG bias/deleting data recommendations not fully applied; several solutions 'mended' a-posteriori: not all the problems solved!!!   BIAS!!!**

➢ **"Site by site" check to be prosecuted: DOMES number, occupation, ... Evident problems in the overall 3D SSC WRMS (All Sites) and in the EOP (Xp mainly)**

➢ **Zuheir's feedback evaluation and solution correction (weak point problem)**

➢ **1983 to be generated**

➢ **Spurious combined weeks to be generated**

As far as possible, ACs will not be required to generate again solution time series: all the possible a-posteriori corrections will be applied -> FINAL COMBINATION < 20 MAY
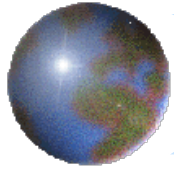
Daily solution

Since February 25, 5 ILRS ACs have been contributing steadily to the pre-operational phase of the "daily" solution generation: ASI, BKG, GFZ, JCET, NSGF.

Daily solution main features

Data batch   7 days

Generation frequency   1/day

Age of estimates   2-8 days

The ILRSA combination is performed automatically and seems to be robust: only a specific problem arose in August (few solutions were not timely issued) but that was expected as related to the present HW configuration still not included in the Matera ASI/CGS operational environment.

A dedicated analysis has been performed to evaluate the quality (accuracy/precision) of the solution vs the single estimates "age": from each daily solution "same age" estimates have been arranged in time series and compared to EOP reference values (USNO "finals.data")