ASI AC&CC report

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ILRS ASC Meeting, 22 April 2016, Vienna

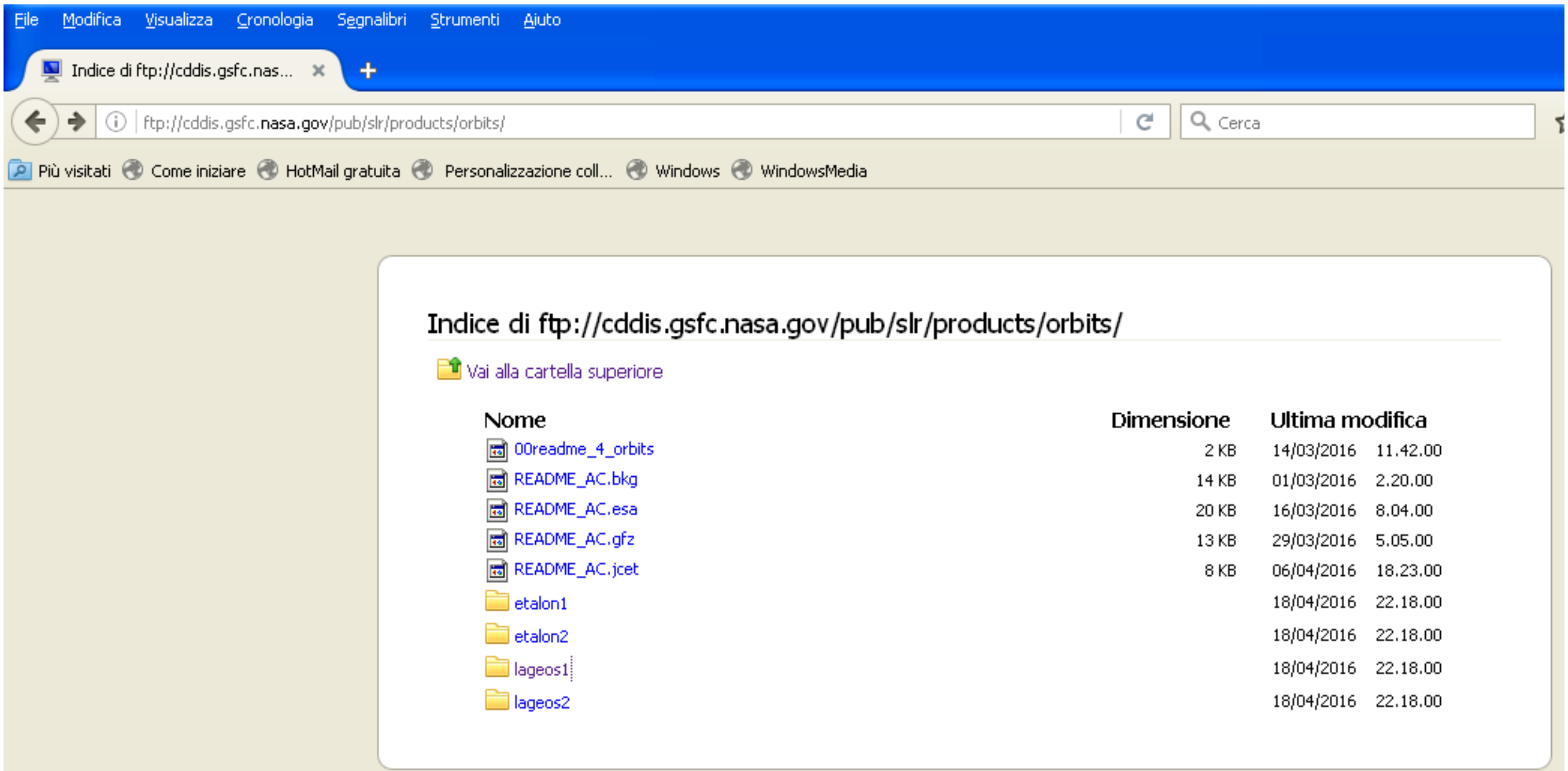
Main activities

- Official ILRS orbit delivery:
  - The combine products are weekly delivered starting from March 2016
  - All ACs are contributing to LAGEOS orbits.
  - DGFI and GFZ are not contributing to ETALON orbits
  - The quality assessment was presented at the AWG meeting in Matera

- Bias Pilot Project

ILRS orbits at data centers

ftp://cddis.gsfc.nasa.gov/pub/slr/products/orbits/
ftp://edc.dgfi.tum.de/pub/slr/products/orbits/



ILRS orbits summary from ASI CC

```
---------------------------------------------------------------------------------------------------
Report on the ILRS combination of orbit solutions
Centro di Geodesia Spaziale, Agenzia Spaziale Italiana, Matera, ITALY
File: ilrsa.orb.lageos2.160409.v35.sp3
Contact: cinzia.luceri@e-geos.it
---------------------------------------------------------------------------------------------------


 |========================|
 | CONTRIBUTING SOLUTIONS |
 |========================|


 CHECKING SP3 FILES - AVAILABILITY
---------------------------------------------------------------------------------------------------
asi.orb.lageos2.160409.v35.sp3  available
bkg.orb.lageos2.160409.v35.sp3  available
dgfi.orb.lageos2.160409.v35.sp3 available
esa.orb.lageos2.160409.v35.sp3  available
gfz.orb.lageos2.160409.v35.sp3  available
grgs.orb.lageos2.160409.v35.sp3 available
jcet.orb.lageos2.160409.v35.sp3 available
nsgf.orb.lageos2.160409.v35.sp3 available
---------------------------------------------------------------------------------------------------


 CHECK SP3 FILES - COMPLETENESS and FORMAT PROBLEMS
---------------------------------------------------------------------------------------------------
bkg  lageos2 incorrect epochs (seconds)
dgfi lageos2 incorrect epoch: 2016 4 7 24
---------------------------------------------------------------------------------------------------
```

ILRS orbits summary from ASI CC

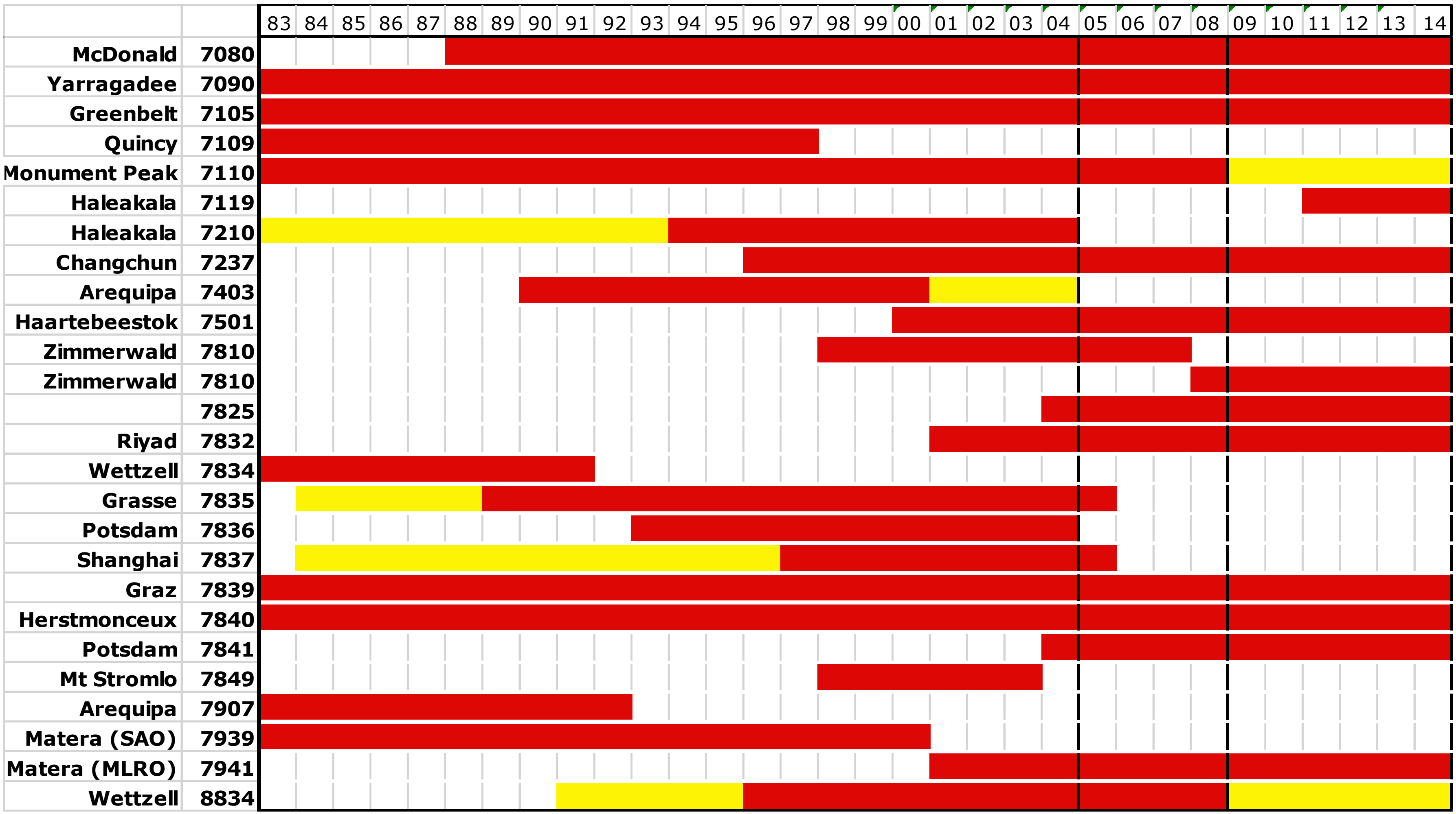
```
==============================================================================
ASI vs COMB for lageos2
==============================================================================
Lageos2: number of edited positions 0/5040
Lageos2: number of edited velocities 45/5040
------------------------------------------------------------------------------
                                              STATISTICAL SUMMARY OF ORBIT DIFFERENCES
             POSITION DIFFERENCES (METERS)                                              VELOCITY DIFFERENCES (M/SEC)
                  RADIAL       CROSS TRACK     ALONG TRACK                                 RADIAL       CROSS TRACK      ALONG TRACK
MINIMUM          -0.0173         -0.1388         -0.0806              MINIMUM            -0.000026      -0.000098        -0.000022
MAXIMUM           0.0156          0.1415          0.0542              MAXIMUM             0.000041       0.000096         0.000026
MEAN             -0.0003          0.0010         -0.0057              MEAN                0.000002       0.000000         0.000001
RMS               0.0040          0.0416          0.0254              RMS                 0.000011       0.000026         0.000009
------------------------------------------------------------------------------
          COORDINATE SYSTEM ANALYSIS SUMMARY
        SCALE AND ROTATION (ARCSEC) PARAMETERS
             VALUE                 SIGMA
S          -0.00002451          0.00115814
X           0.00000594          0.00029505
Y           0.00009247          0.00029419
Z          -0.00012682          0.00028860
------------------------------------------------------------------------------

==============================================================================
COD vs COMB for lageos2
==============================================================================
Lageos2: number of edited positions 0/5040
```

Available Bias PP time series

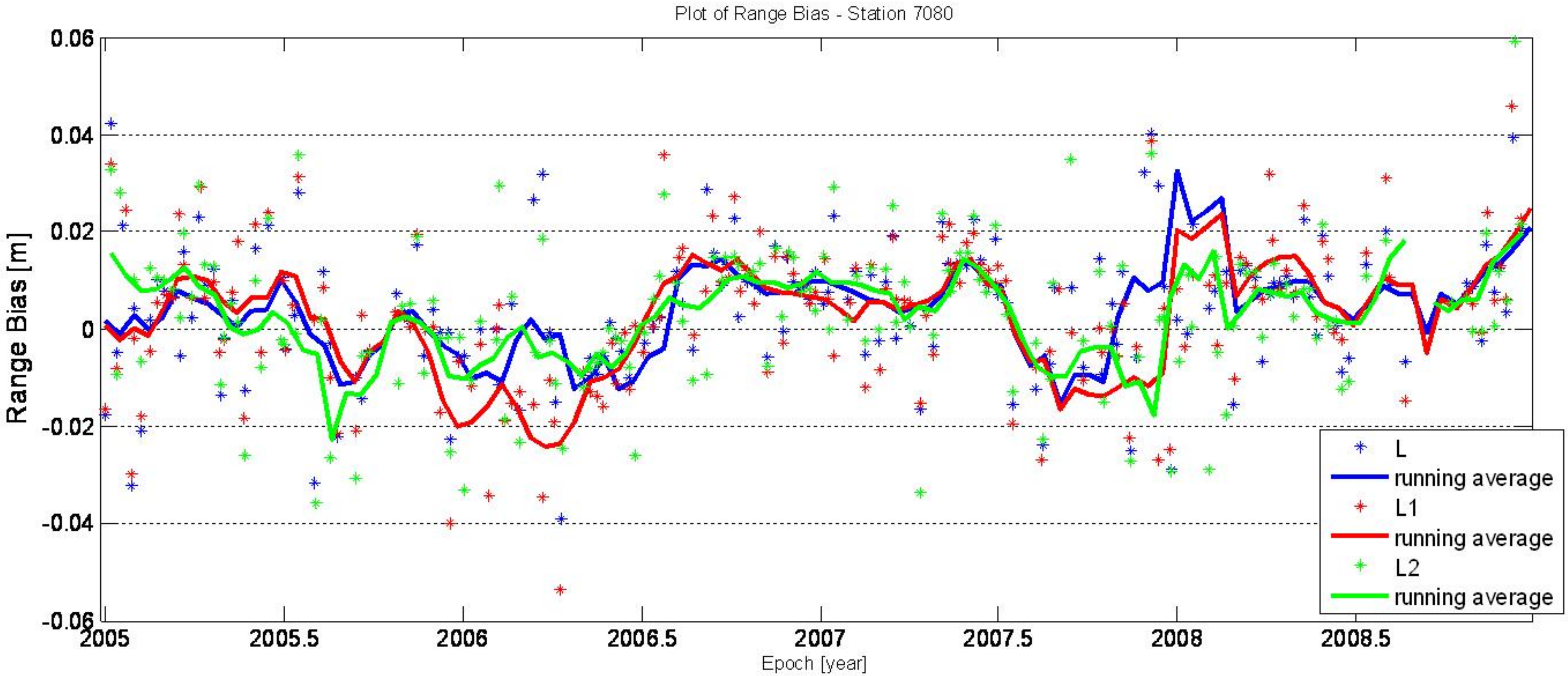
AC	Date of submission
ASI	2 March 2016 (resubmission on 14 April 2016 - minor issues)
DGFI	31 March 2016
GFZ	18 April 2016
JCET	1 April 2016
NSGF	15 April 2016

Actually the check performed on ASI solution

Core Sites

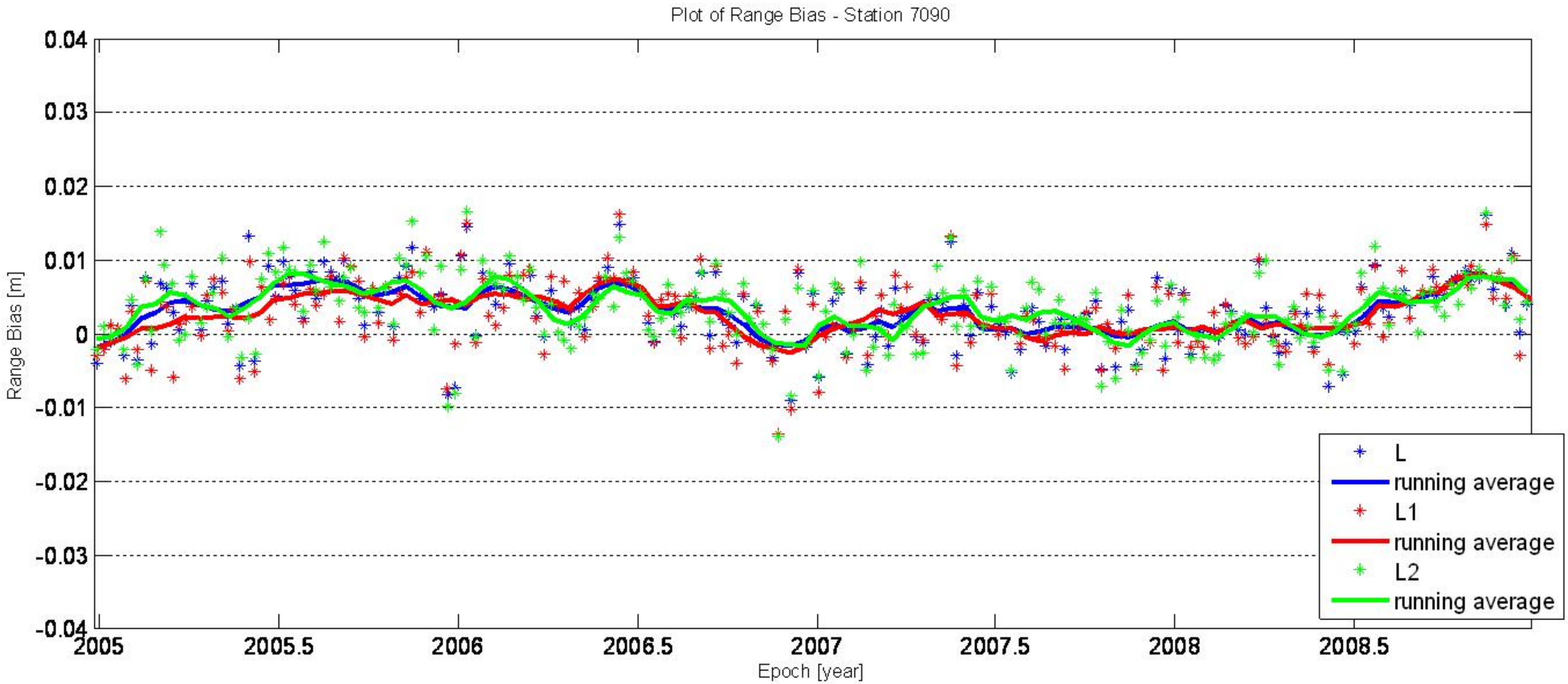

83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14
McDonald 7080
Yarragadee 7090
Greenbelt 7105
Quincy 7109
Monument Peak 7110
Haleakala 7119
Haleakala 7210
Changchun 7237
Arequipa 7403
Haartebeestok 7501
Zimmerwald 7810
Zimmerwald 7810
7825
Riyad 7832
Wettzell 7834
Grasse 7835
Potsdam 7836
Shanghai 7837
Graz 7839
Herstmonceux 7840
Potsdam 7841
Mt Stromlo 7849
Arequipa 7907
Matera (SAO) 7939
Matera (MLRO) 7941
Wettzell 8834

McDonald



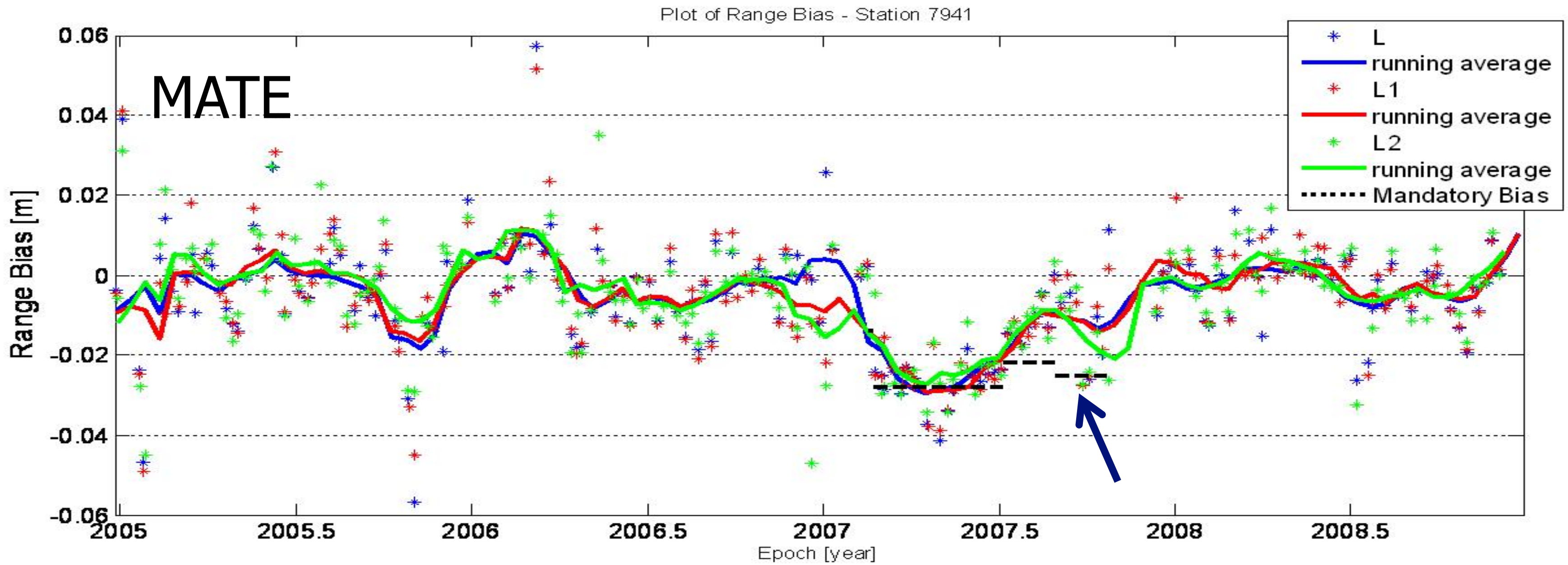
Plot of Range Bias - Station 7080
Range Bias [m]
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
2005
2005.5
2006
2006.5
2007
2007.5
2008
2008.5
Epoch [year]
L
running average
L1
running average
L2
running average

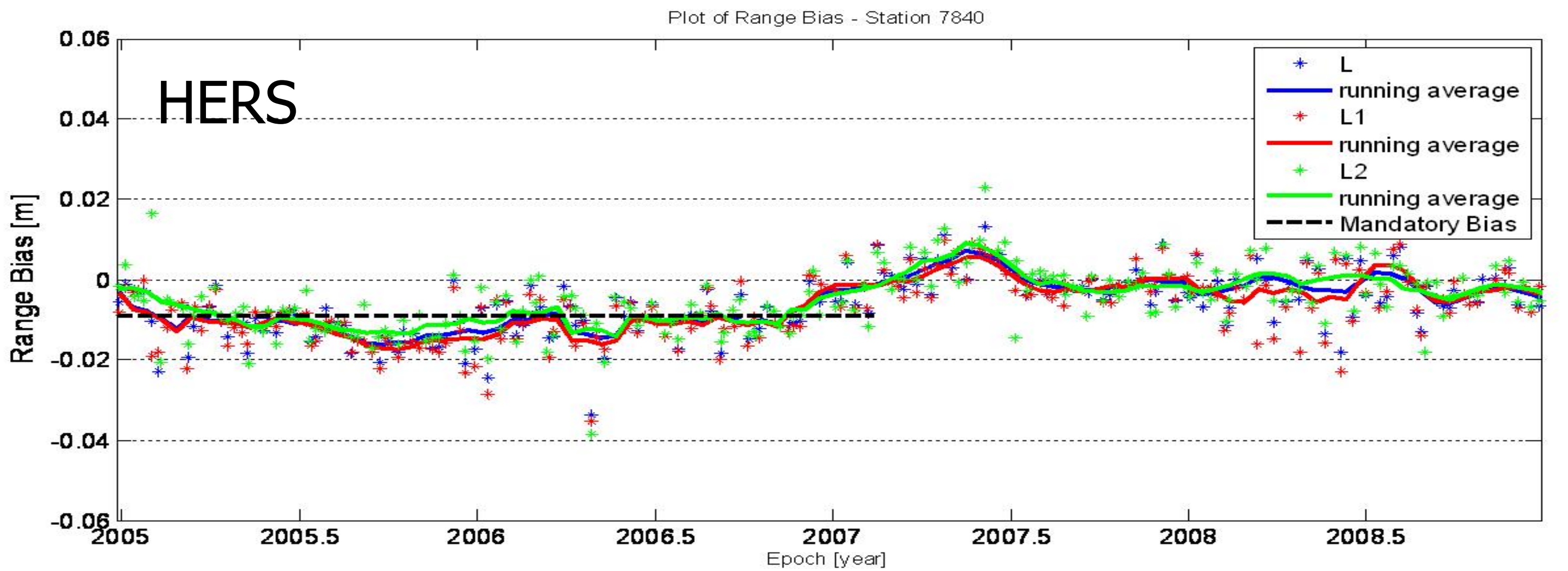
Yarragadee



Plot of Range Bias - Station 7090
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
Range Bias [m]
2005
2005.5
2006
2006.5
2007
2007.5
2008
2008.5
Epoch [year]
L
running average
L1
running average
L2
running average

Comparison with standard ASC biases

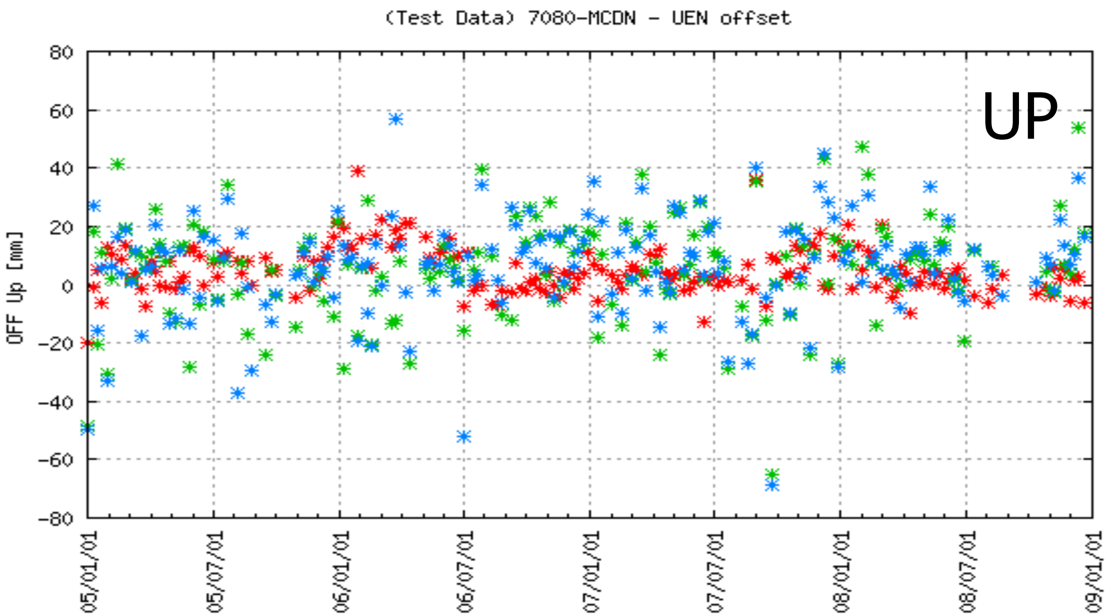




Comparison with standard ASC biases

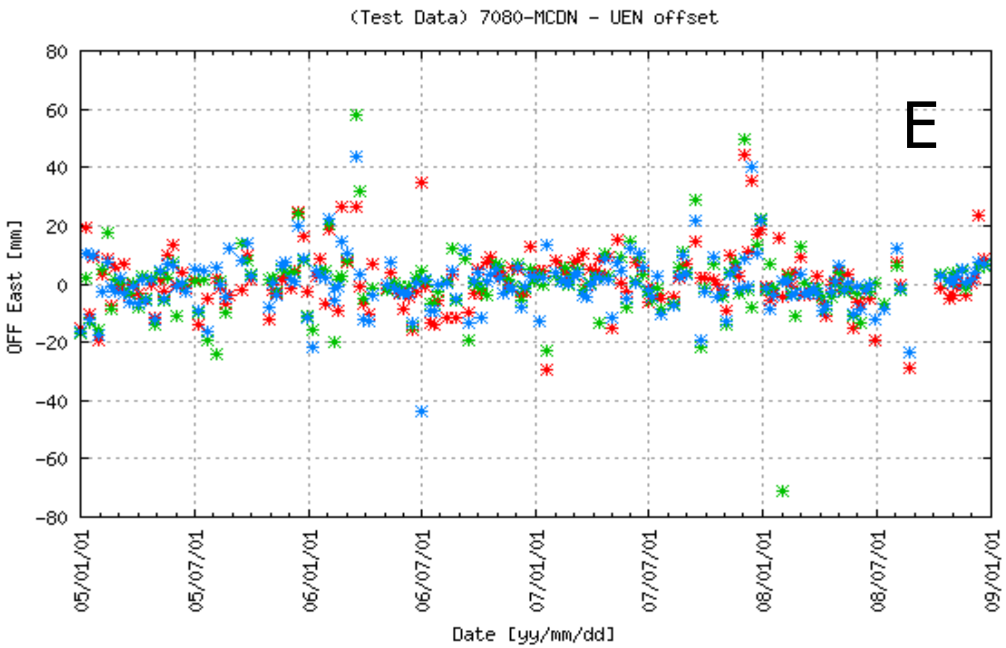
Station	Time	ASC Bias	L	L1	L2
7840	02:032:00000 07:042:00000	-0,009	-0,0106	-0,0112	-0,0094
7941	07:053:00000 07:187:39600	-0,028	-0,0265	-0,0262	-0,0243
7941	07:187:39600 07:241:28800	-0,022	-0,0105	-0,0128	-0,0098
7941	07:242:00000 07:295:50400	-0,025	-0,0146	-0,0135	-0,0147

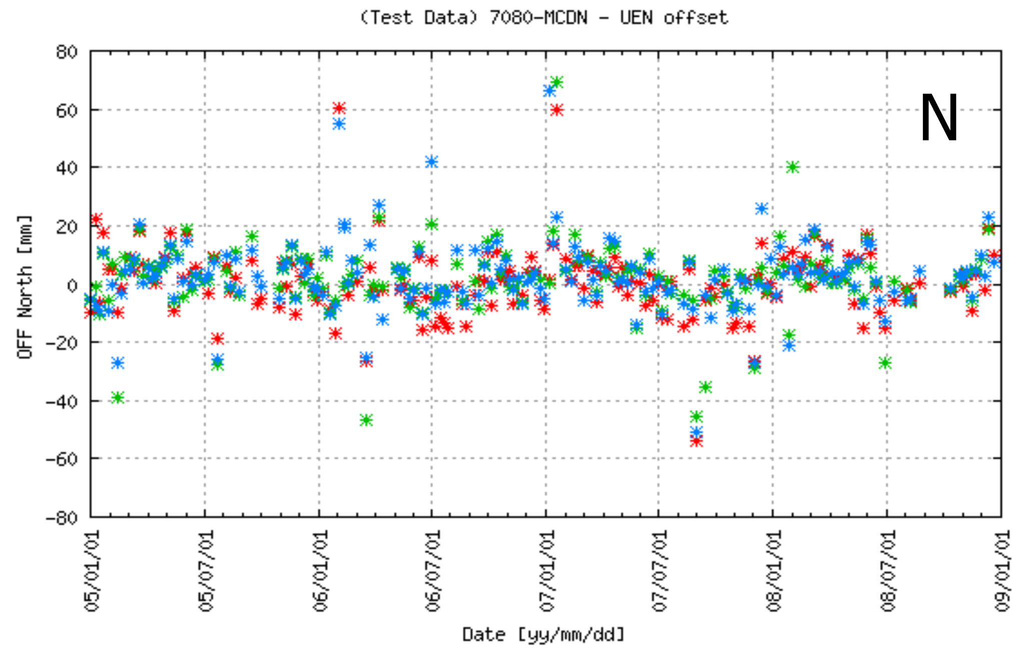
McDonald coordinates



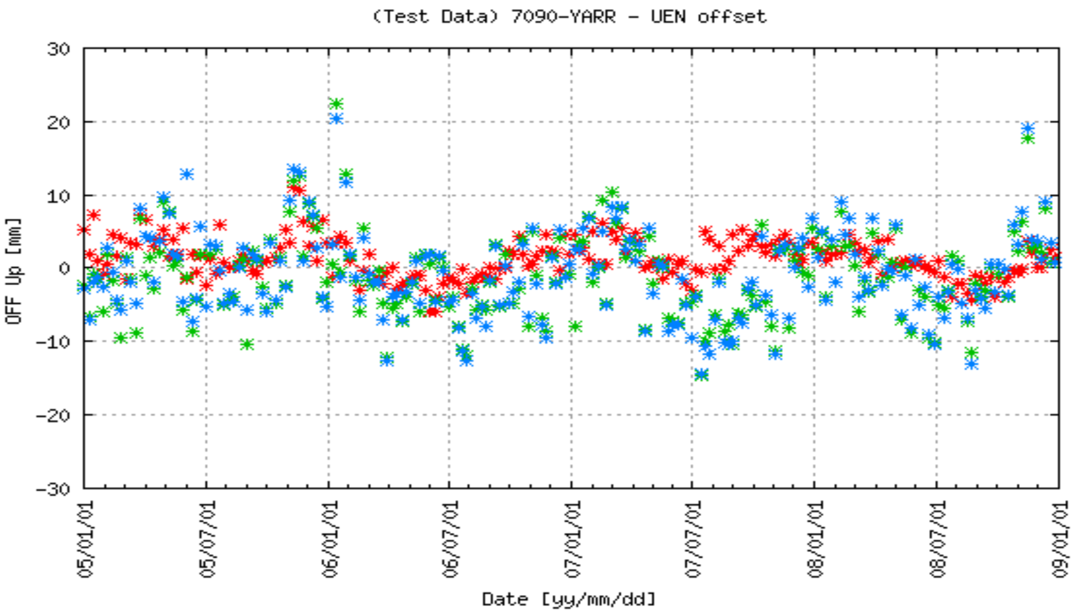
Standard
L12 bias
Common bias

	UP		EAST		NORTH	
	rms	sig	rms	sig	rms	sig
Std	9.8	12.0	10.2	12.6	11.6	12.5
L12	24.1	29.3	13.6	18.5	12.6	25.1
comm	24.7	23.1	12.5	14.3	12.3	25.3



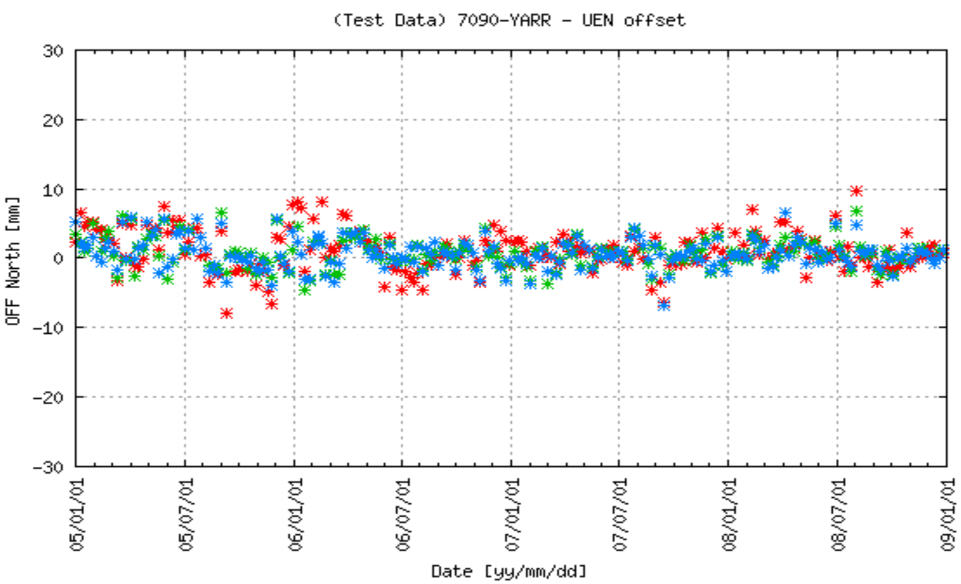


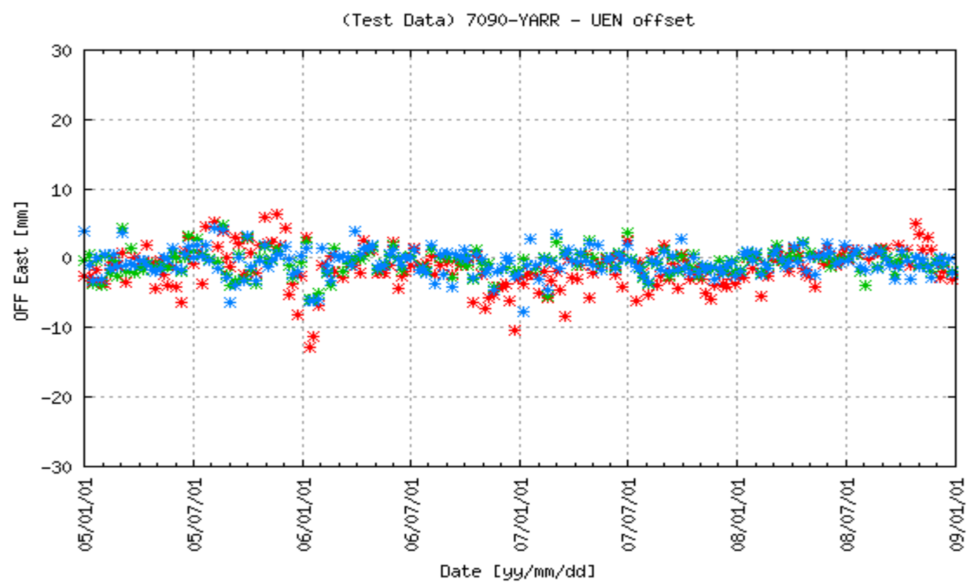
Yarragadee coordinates



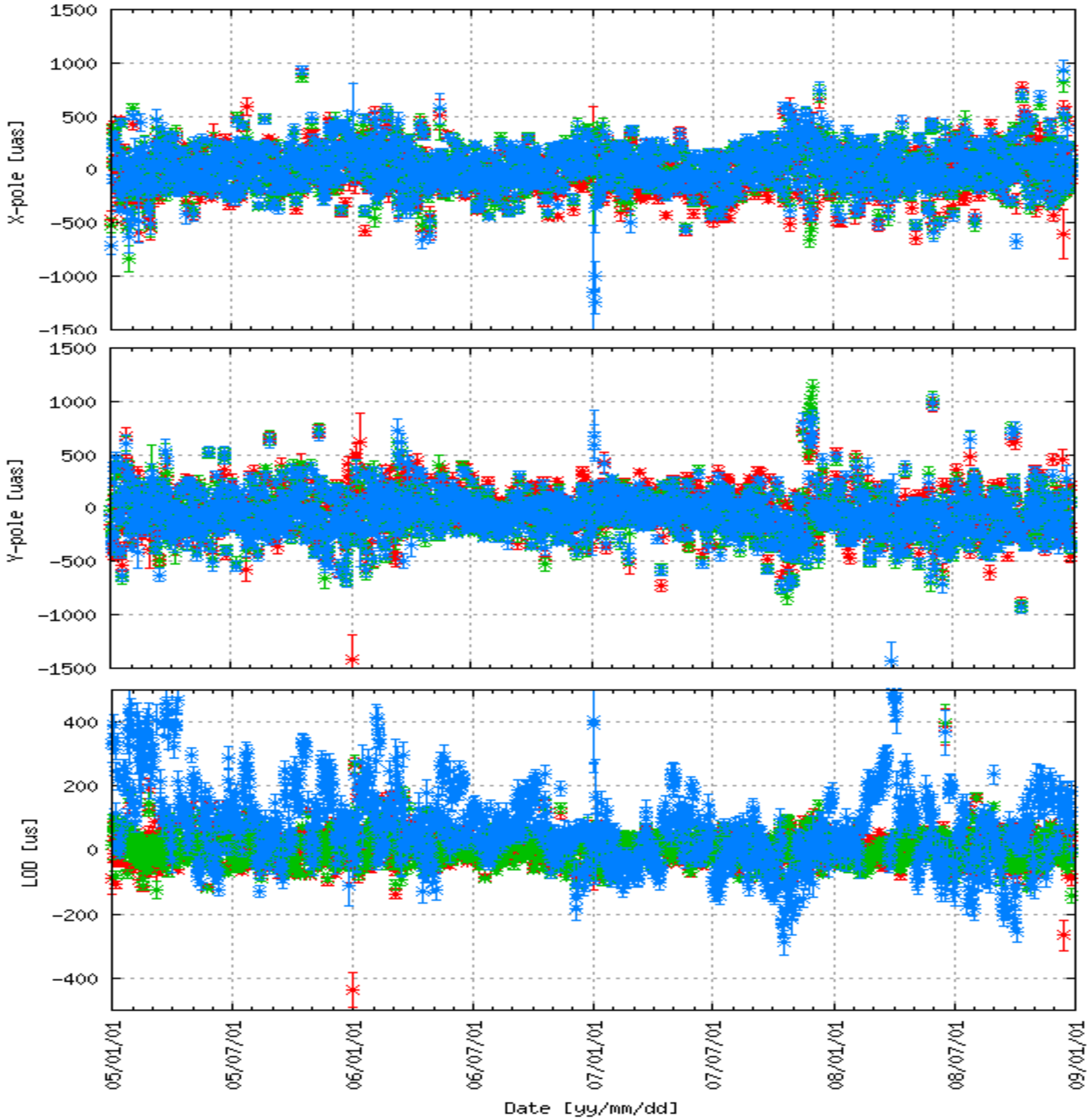
Standard
L12 bias
Common bias

	UP		EAST		NORTH	
	rms	sig	rms	sig	rms	sig
Std	3.0	3.7	3.2	3.3	3.0	4.4
L12	5.7	5.0	1.9	3.7	2.2	5.1
comm	5.9	5.6	2.0	4.1	4.6	5.8



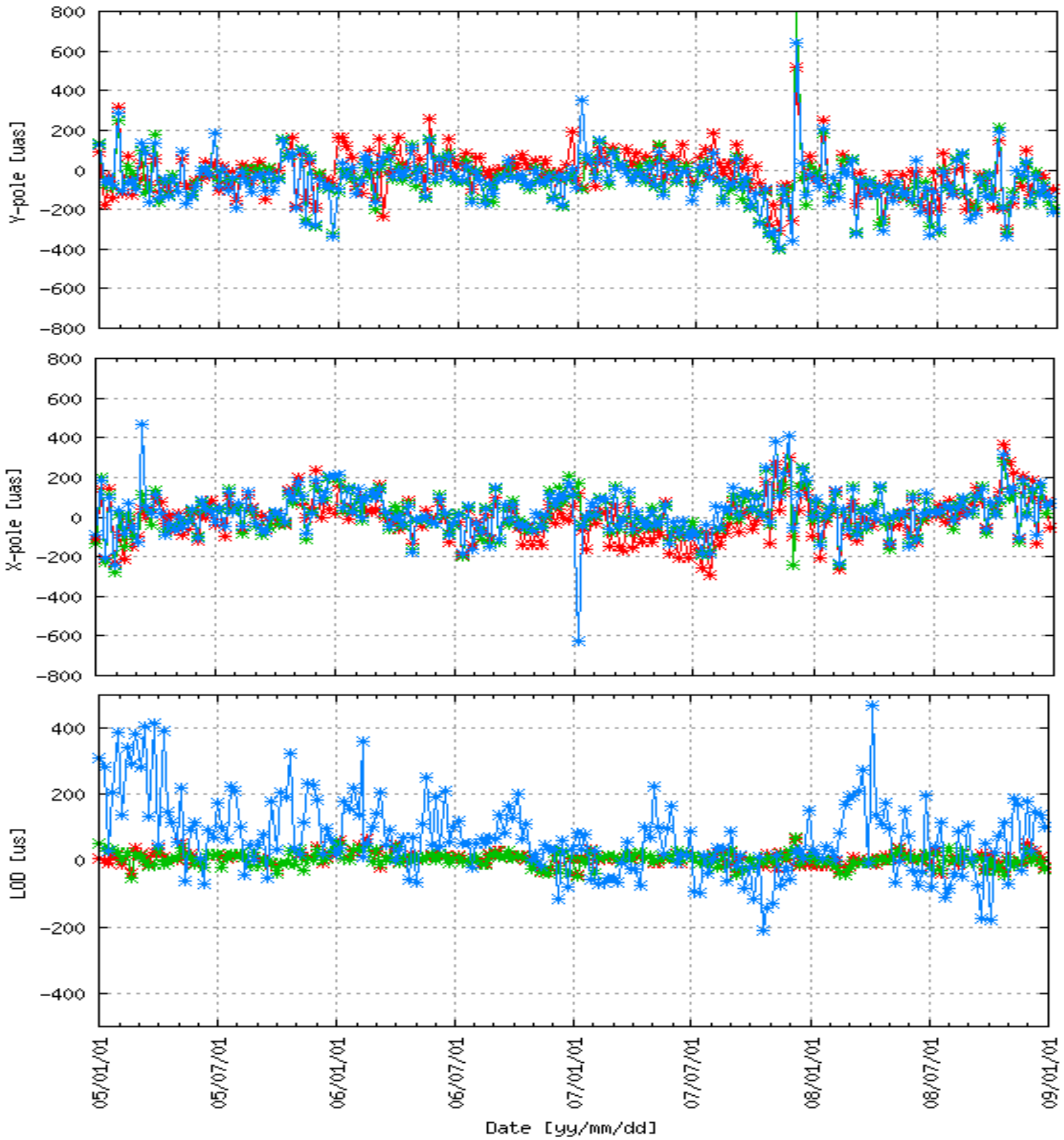


EOP w.r.t. USNO



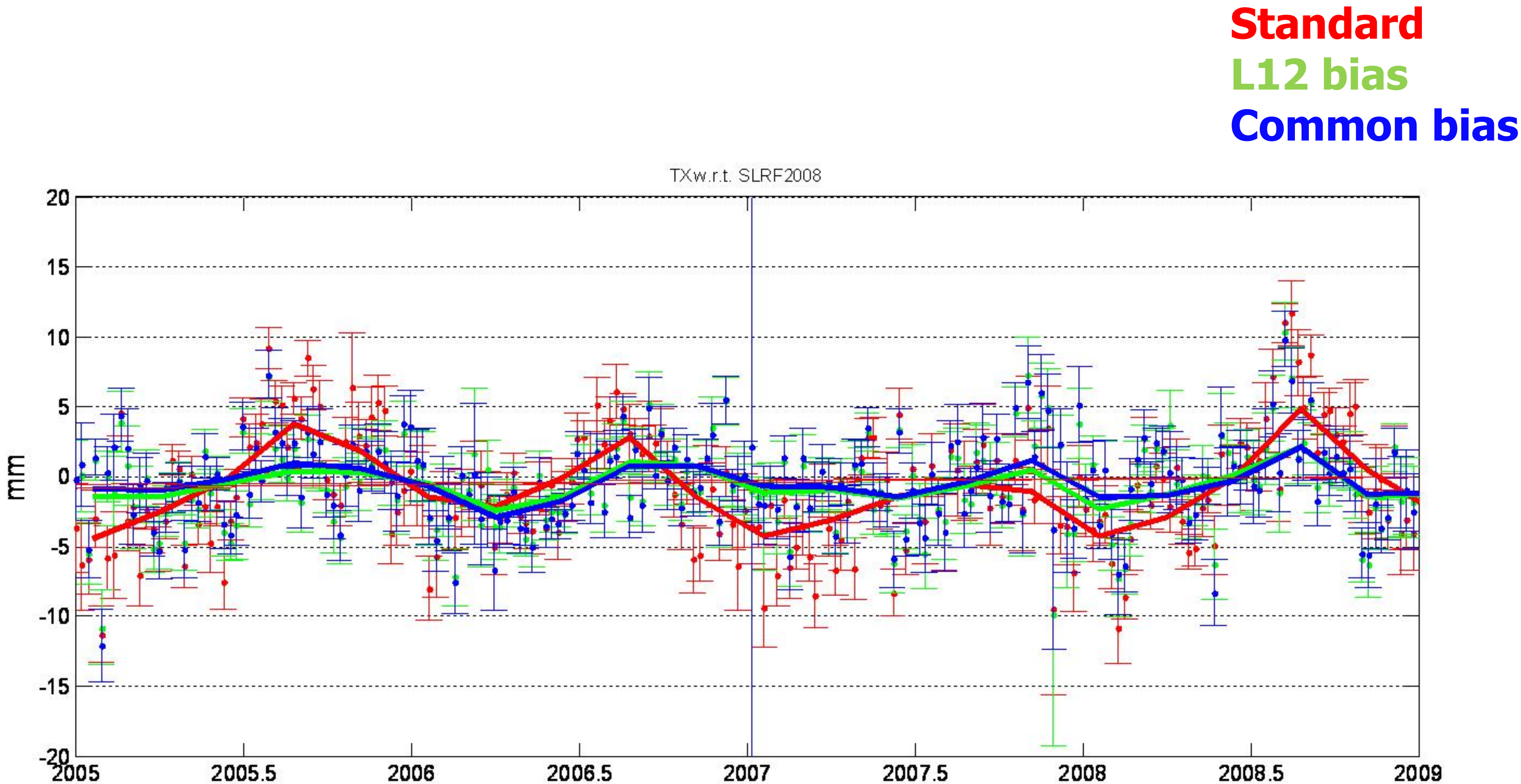
Standard
L12 bias
Common bias

EOP w.r.t. USNO: weekly mean



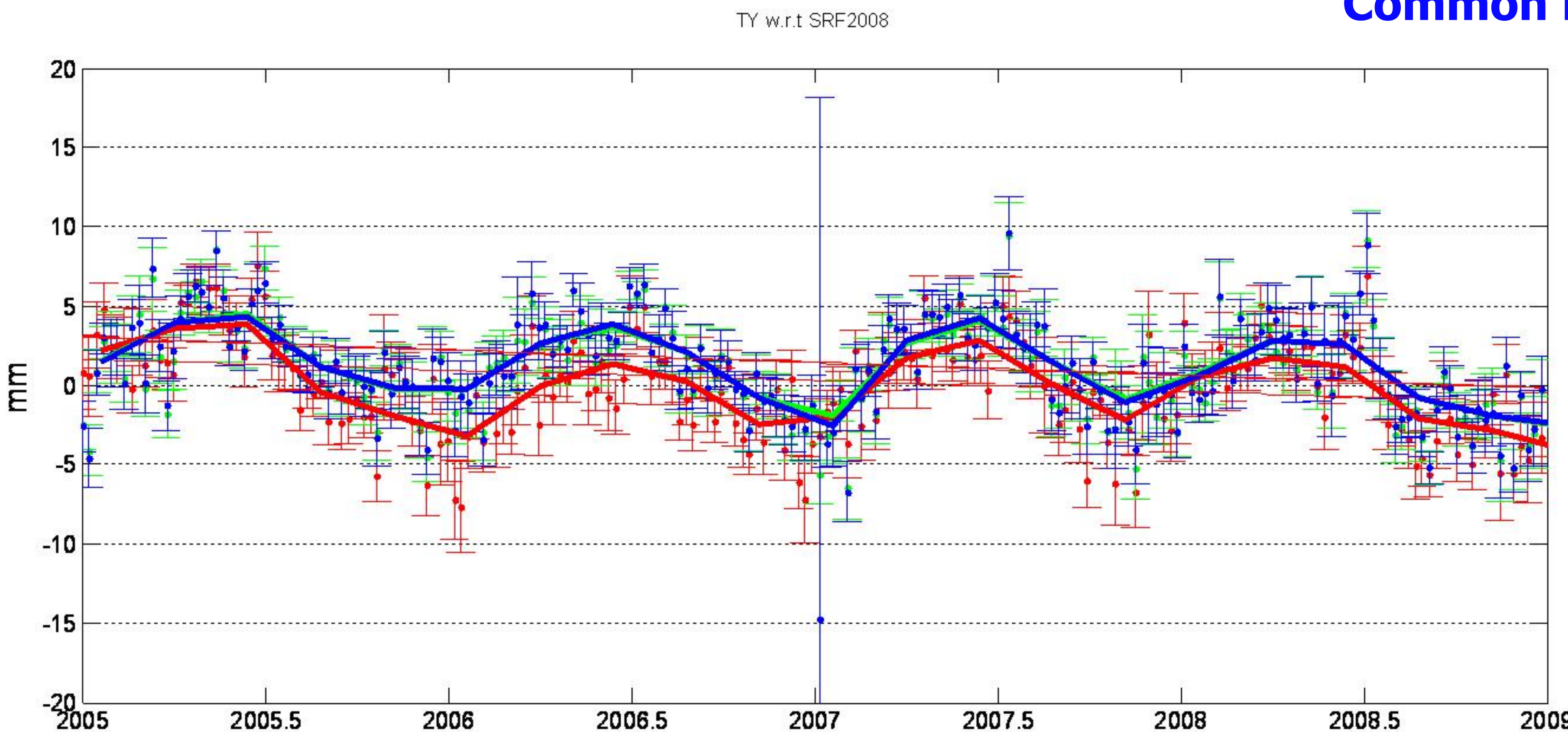
Standard
L12 bias
Common bias

TX w.r.t. SLRF2008

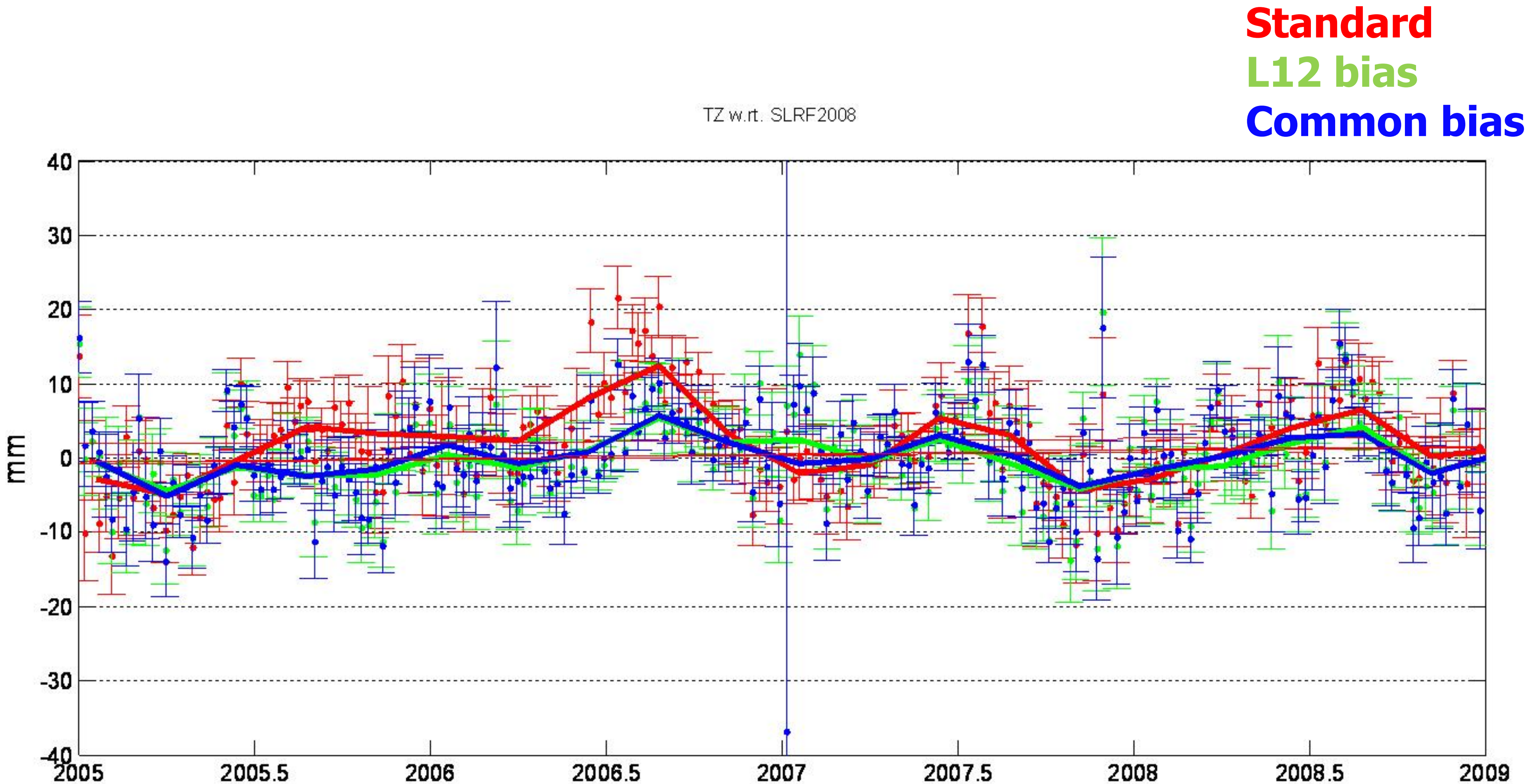


TY w.r.t. SLRF2008

Standard
L12 bias
Common bias



TZ w.r.t. SLRF2008

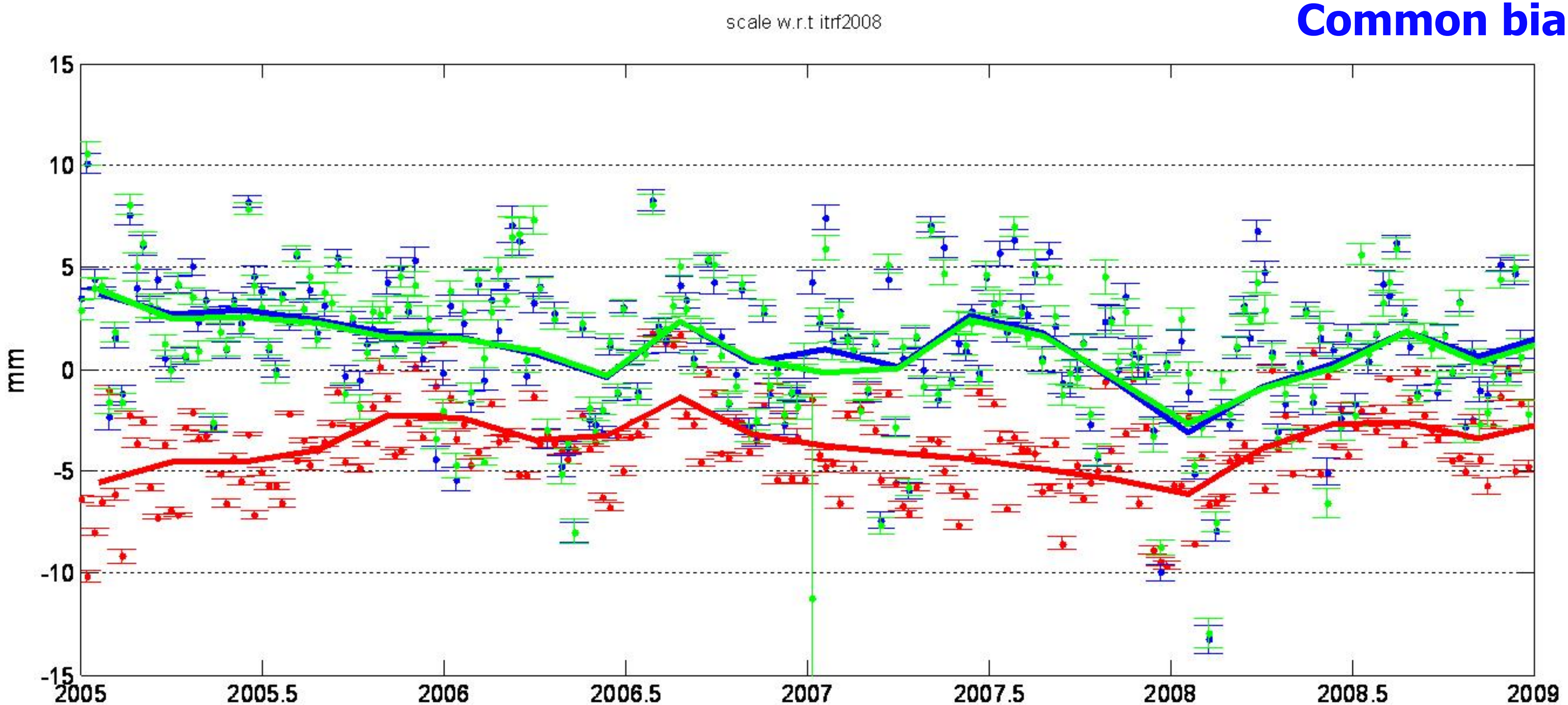


SCALE w.r.t. SLRF2008

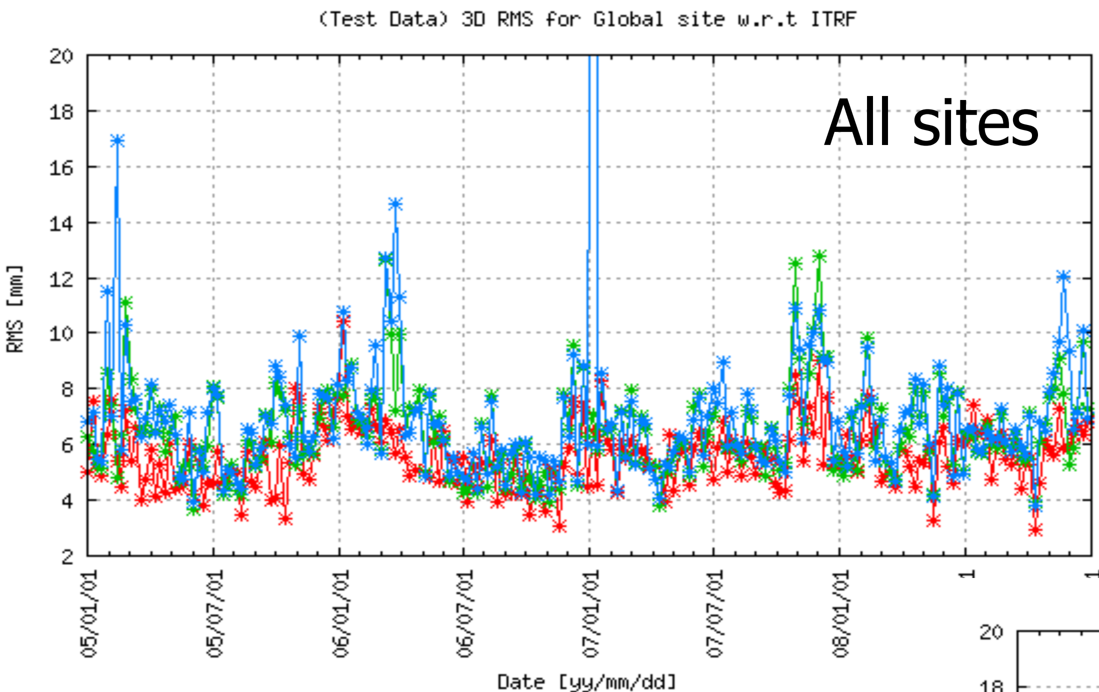
Standard

L12 bias

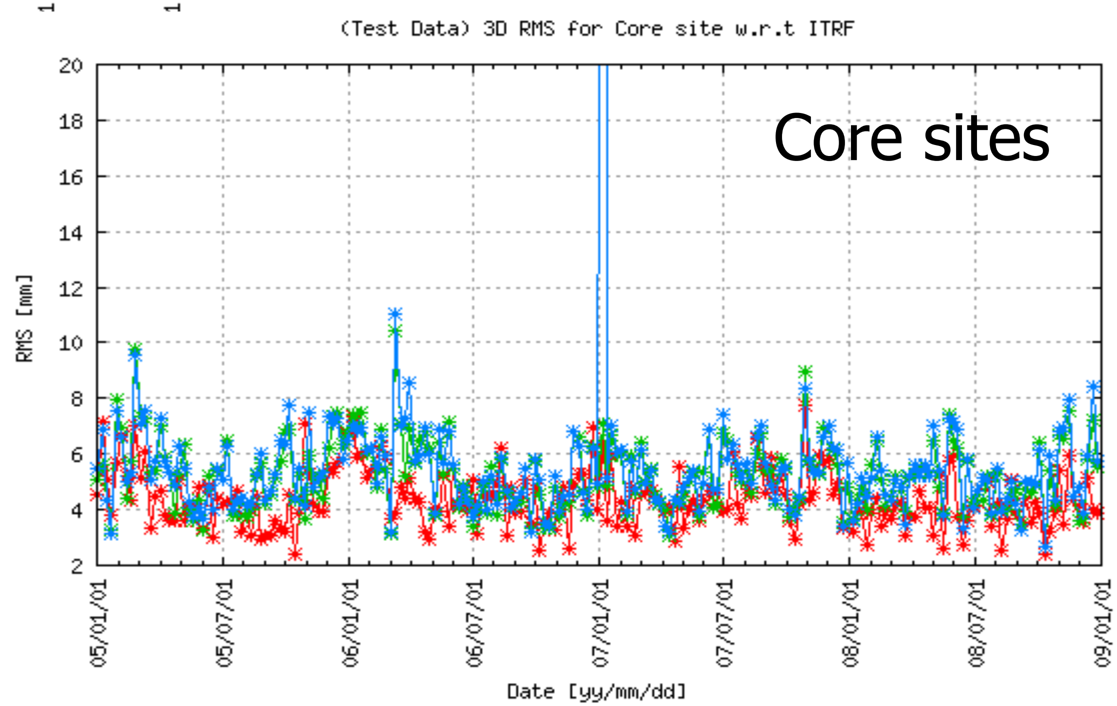
Common bias



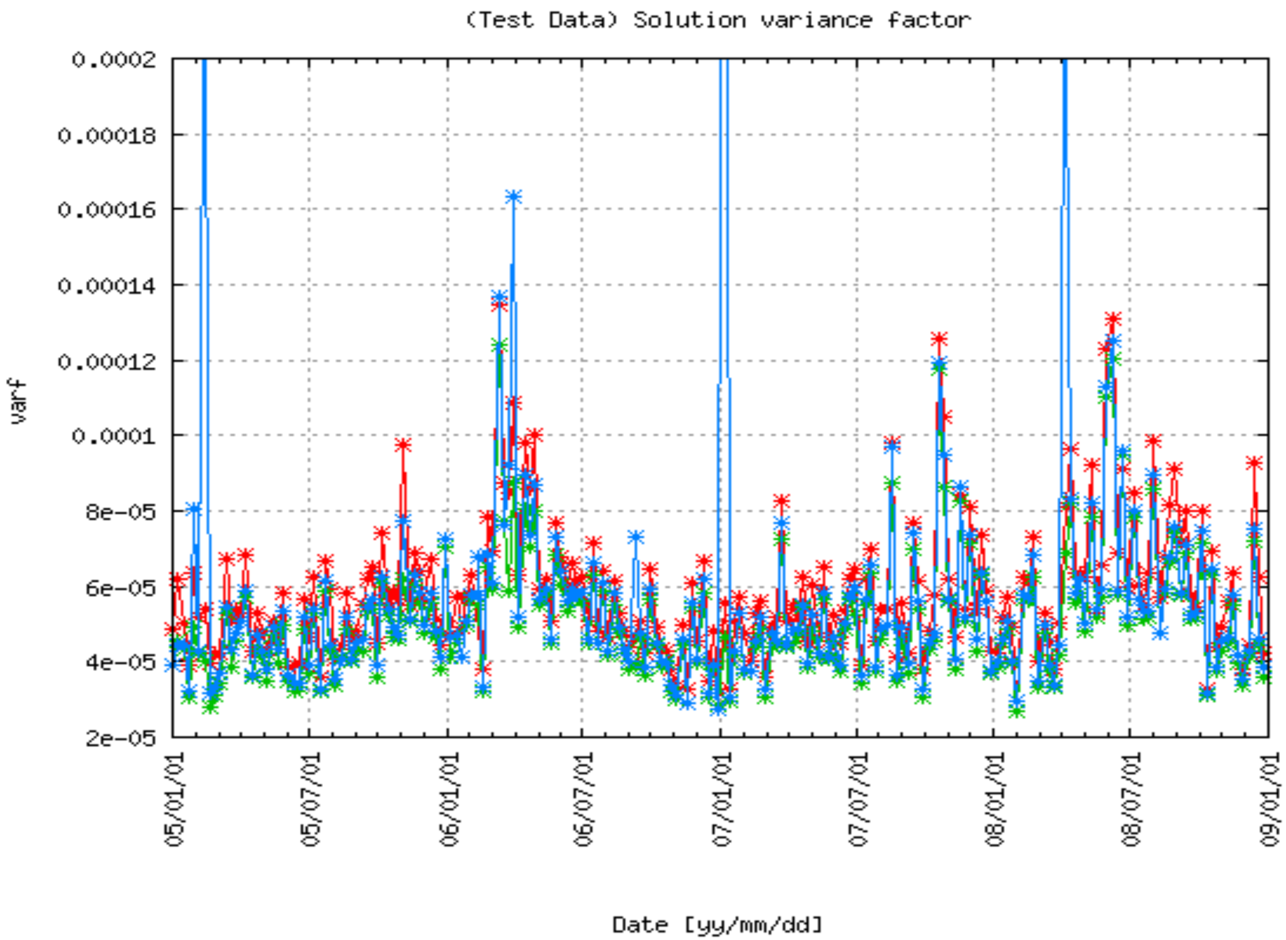
3D coordinate residual WRMS



Standard
L12 bias
Common bias

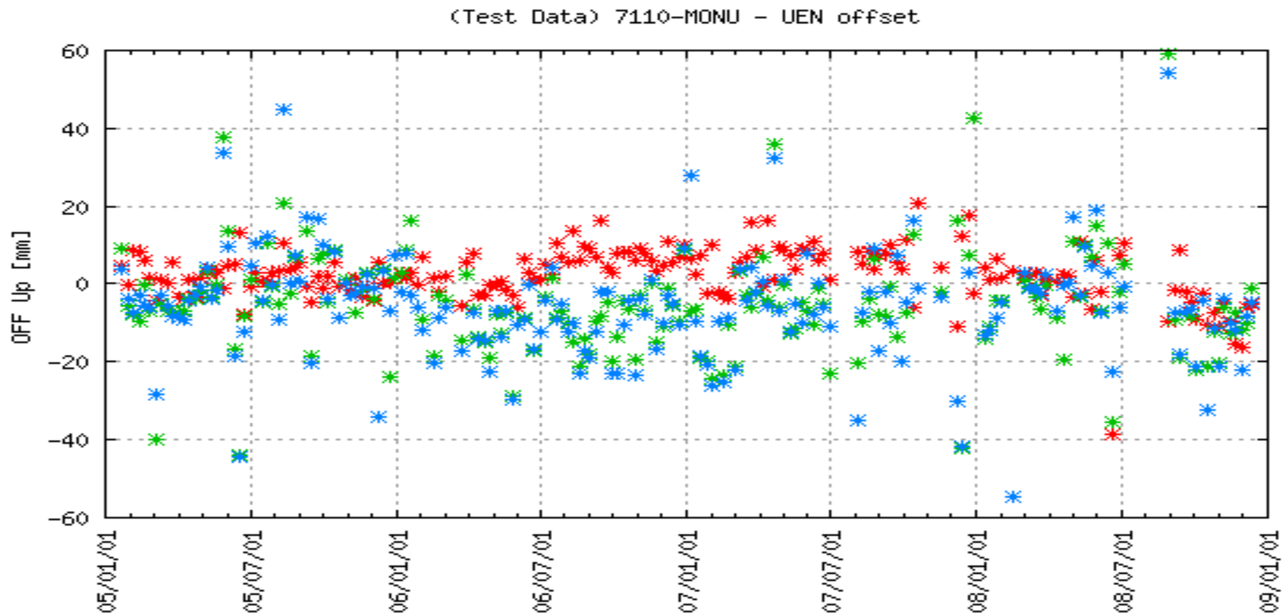


Solution variance factor

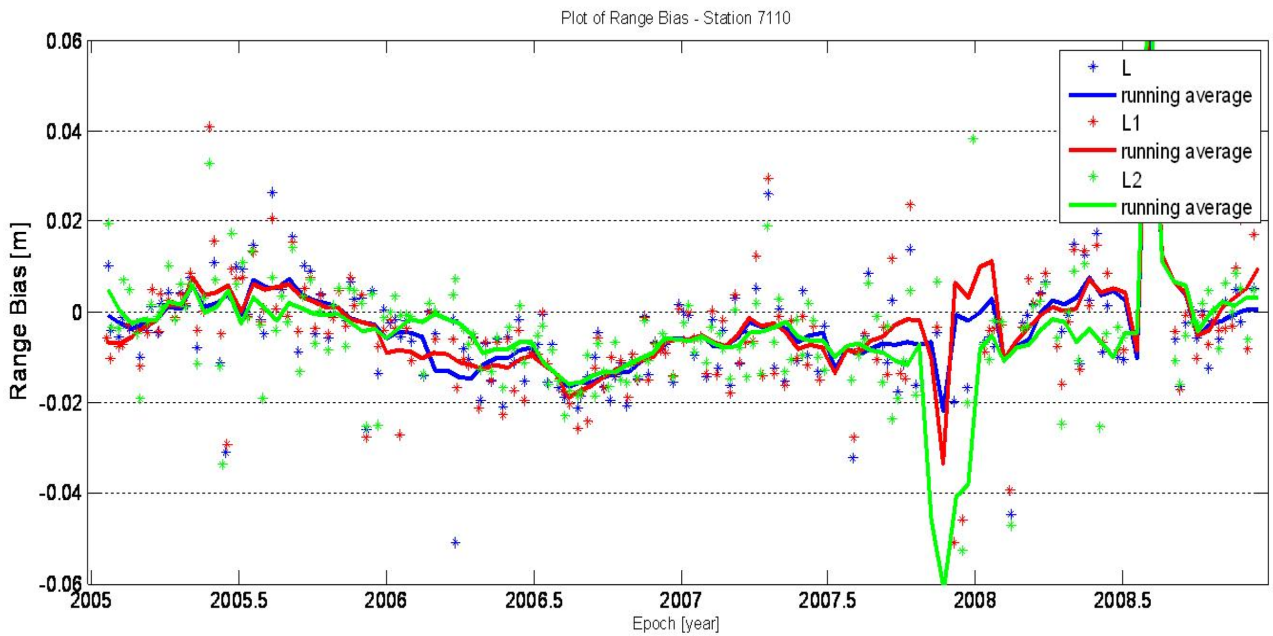


Standard
L12 bias
Common bias

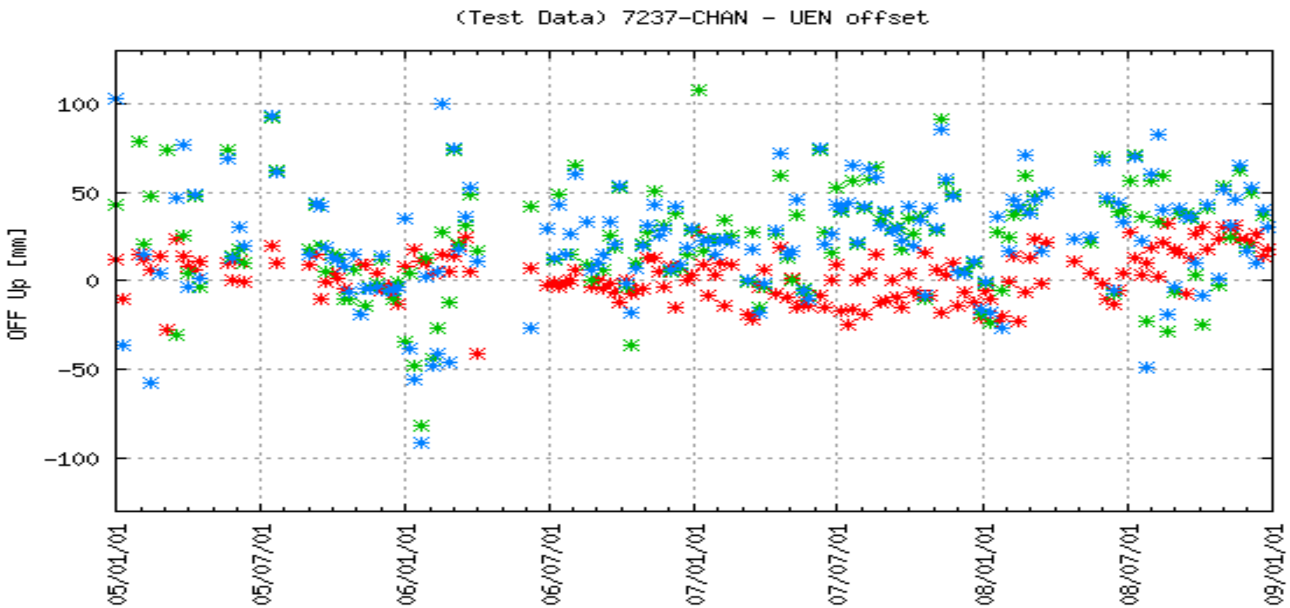
Monument Peak

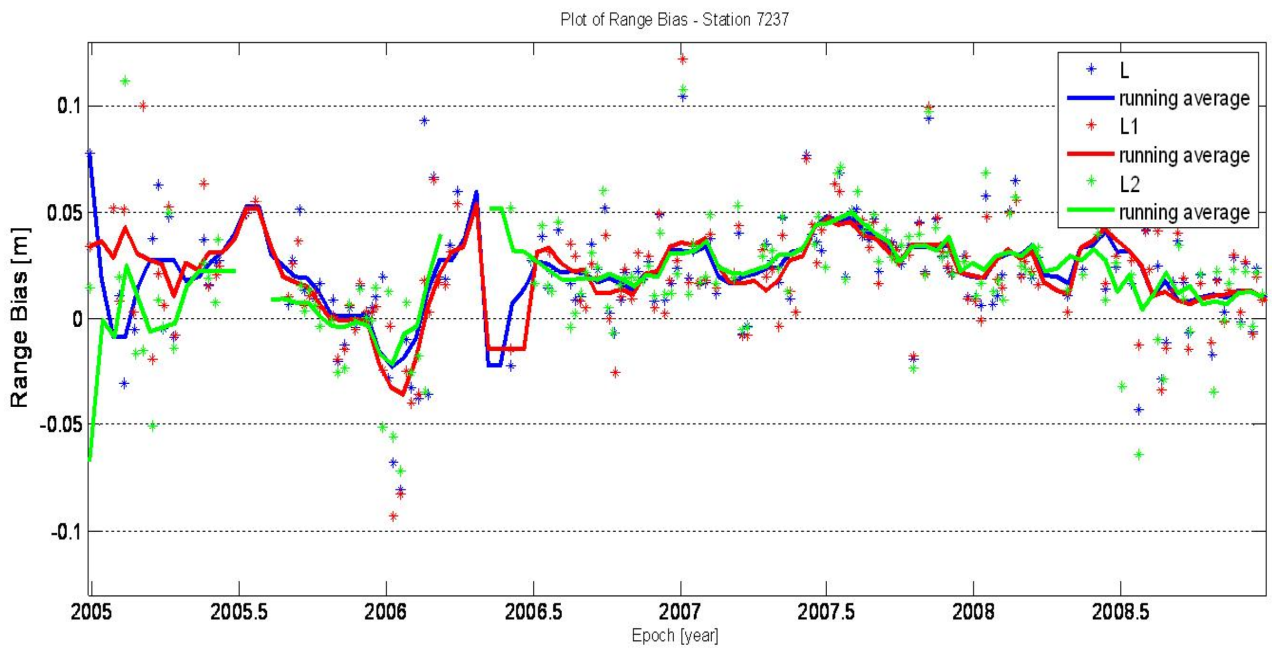


Standard
L12 bias
Common bias



Changchun



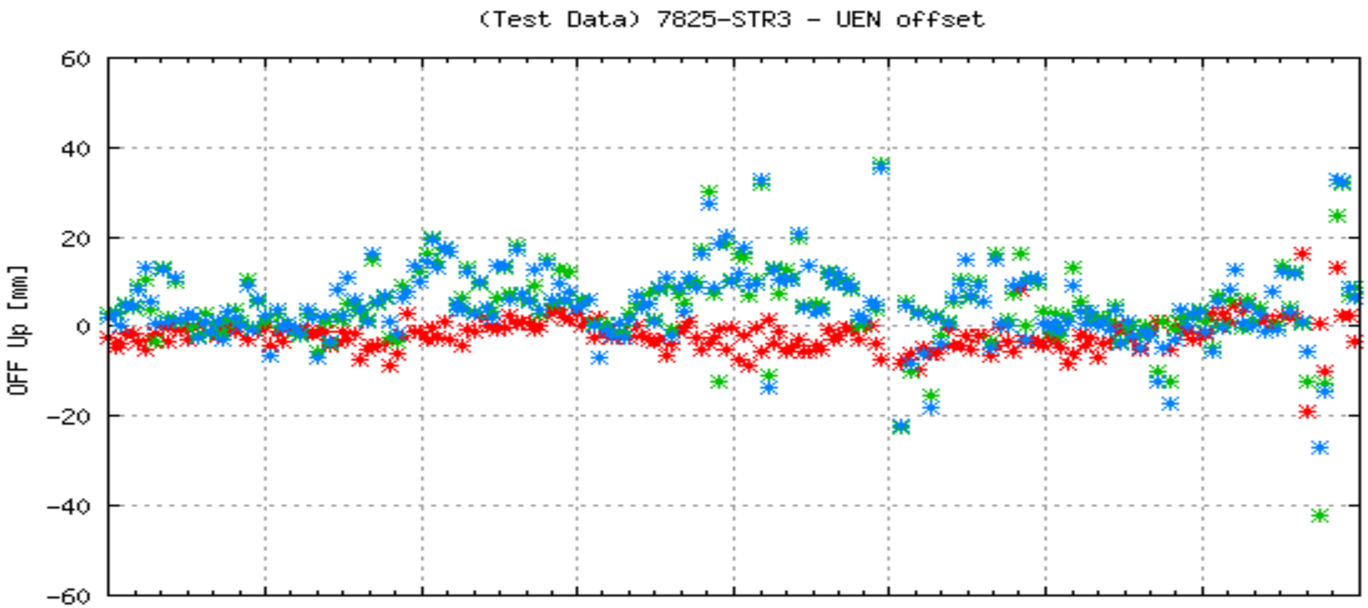


Standard

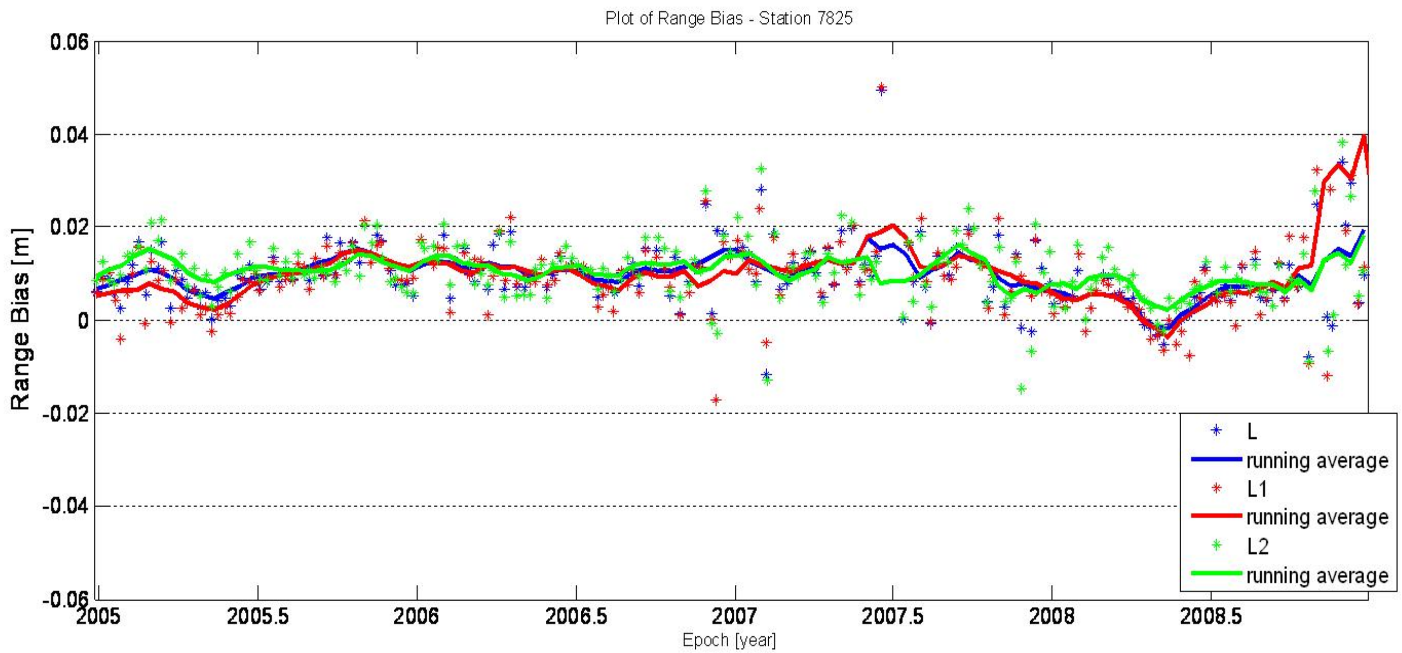
L12 bias

Common bias

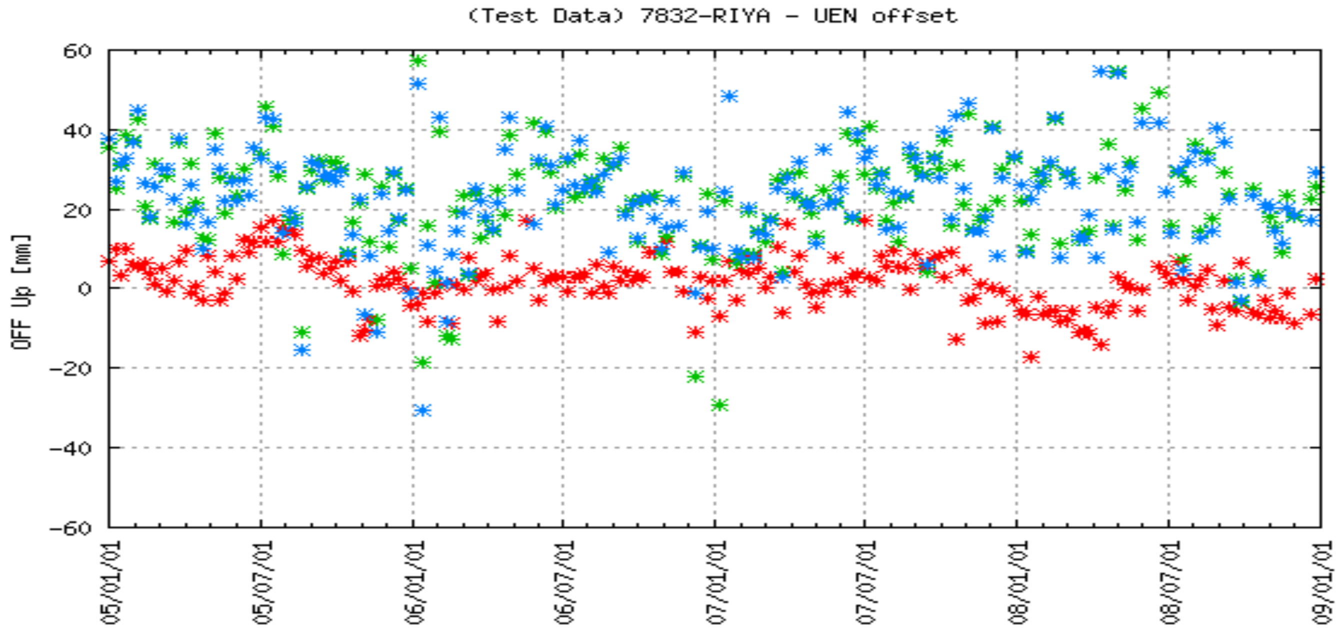
Mt. Stromlo



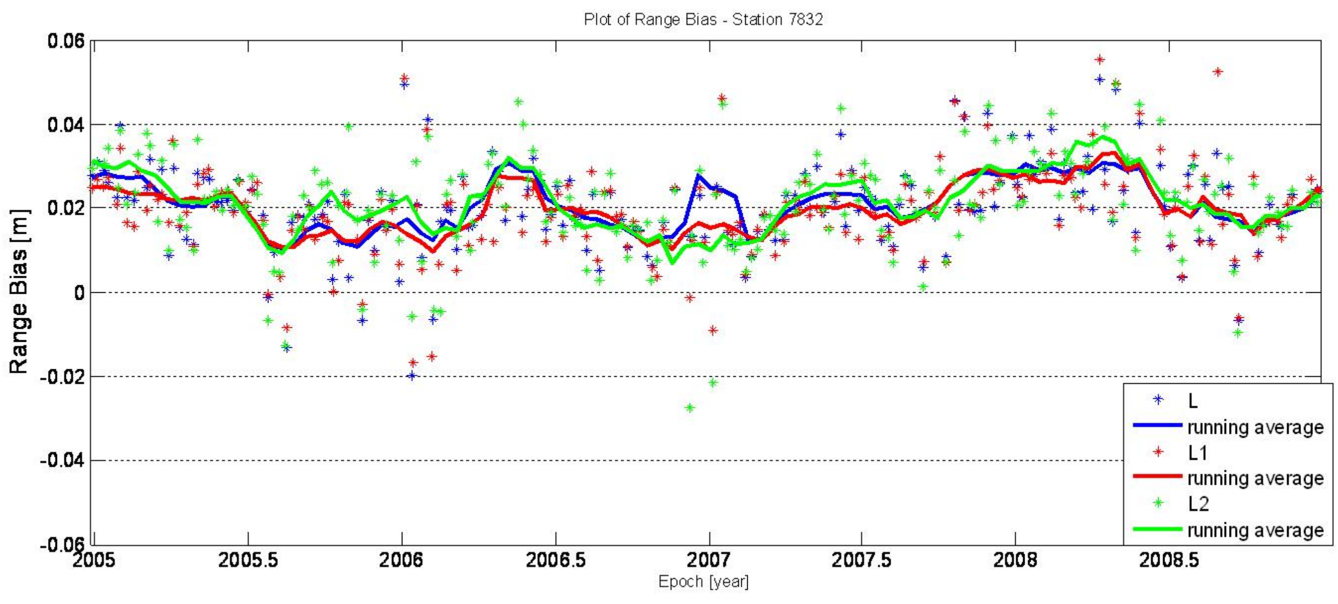
Standard
L12 bias
Common bias



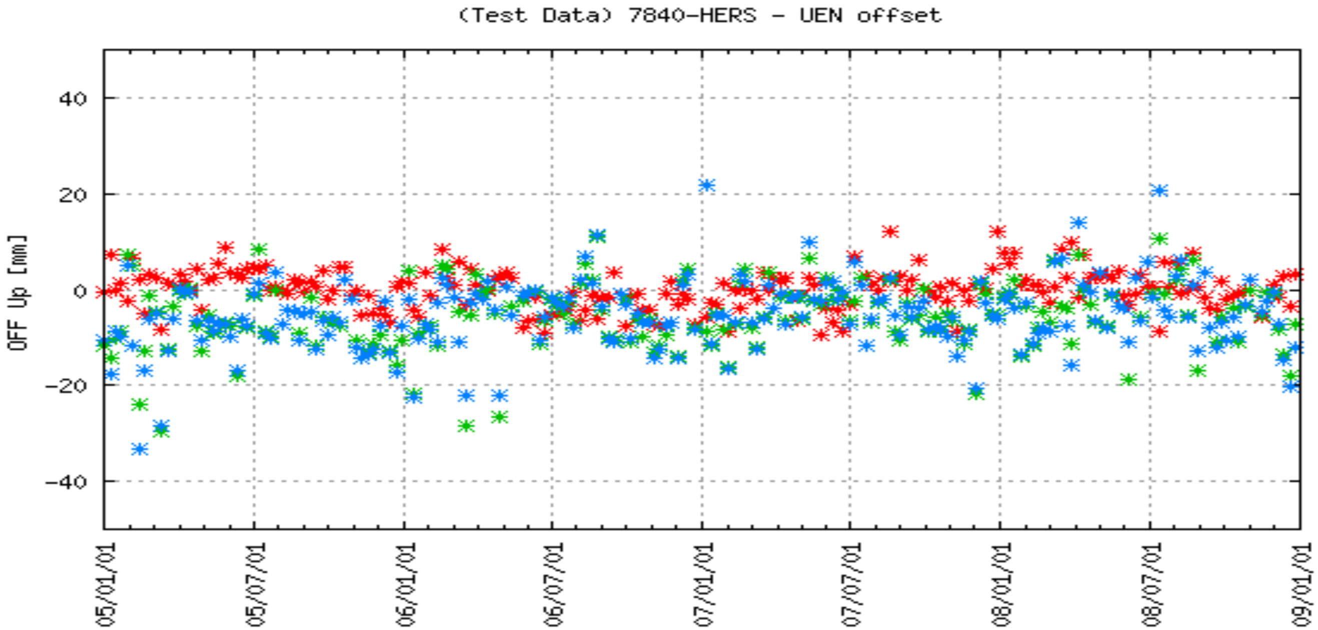
Riyadh

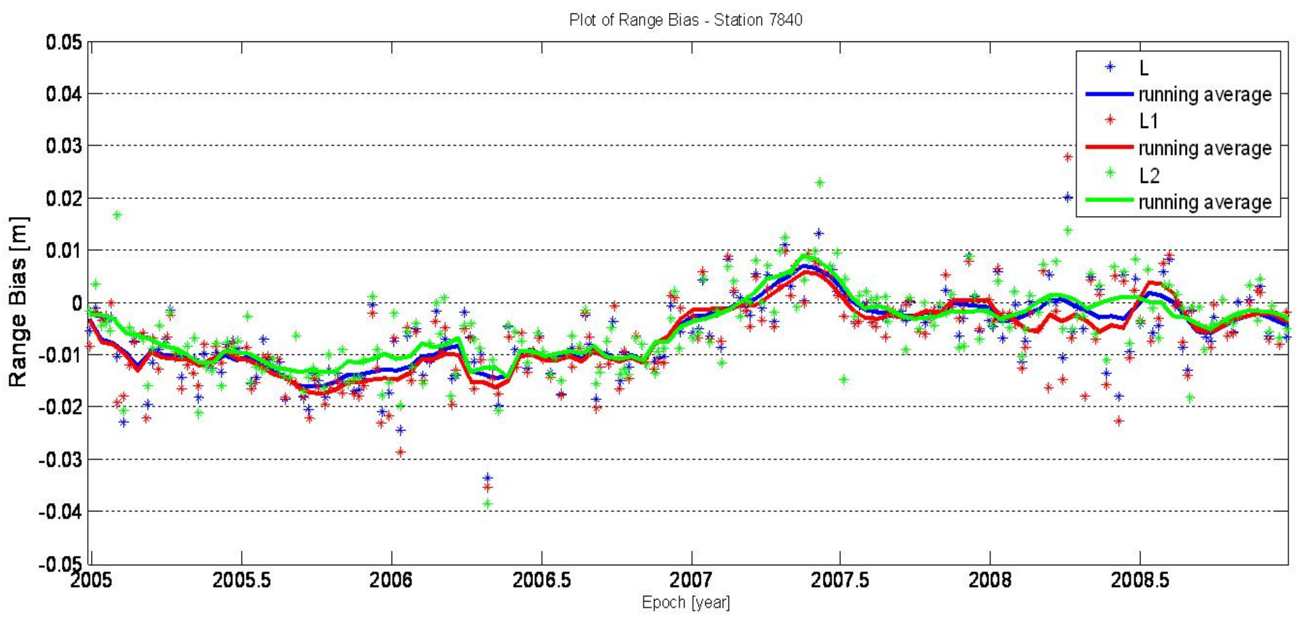


Standard
L12 bias
Common bias



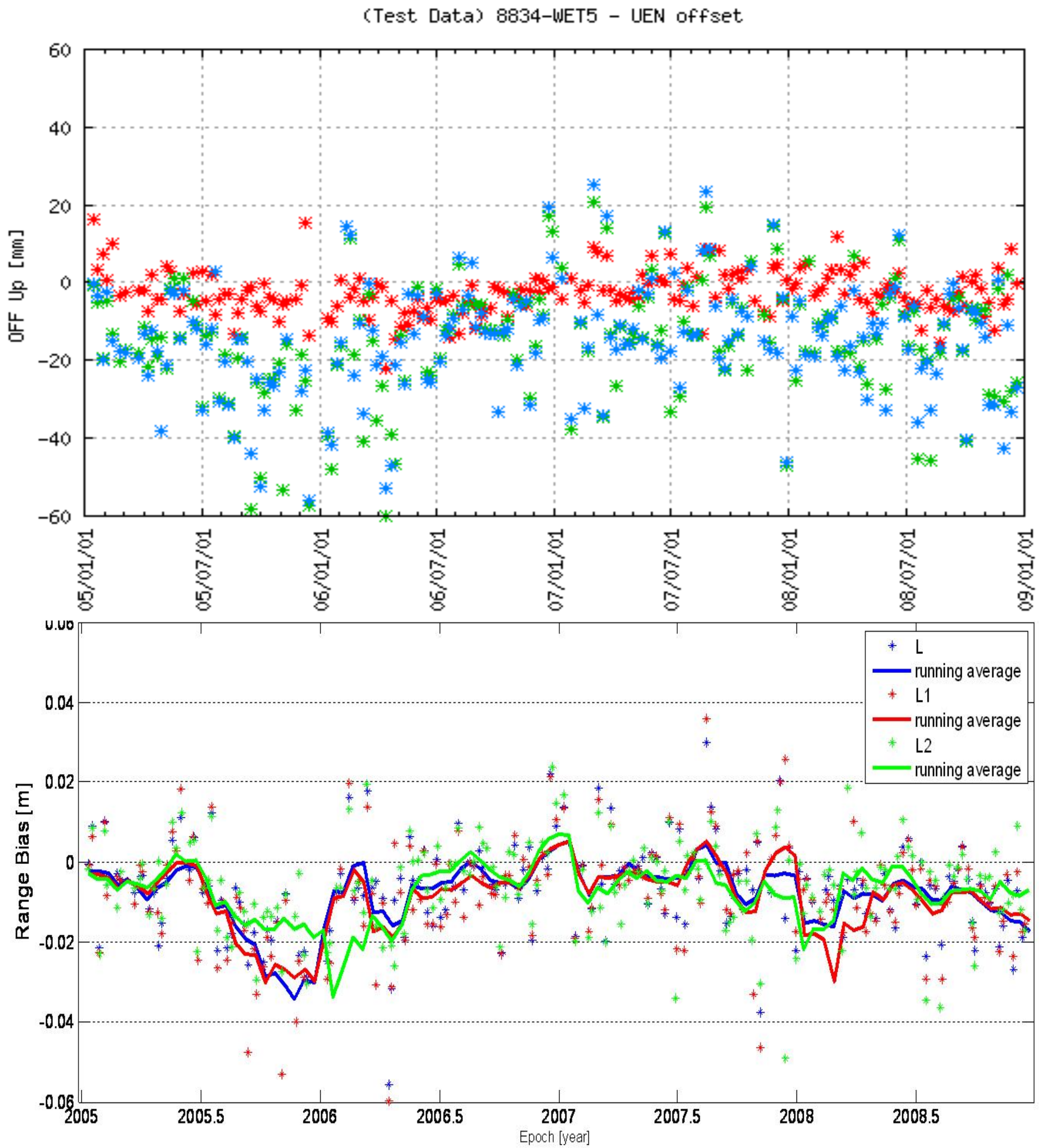
Herstmonceux





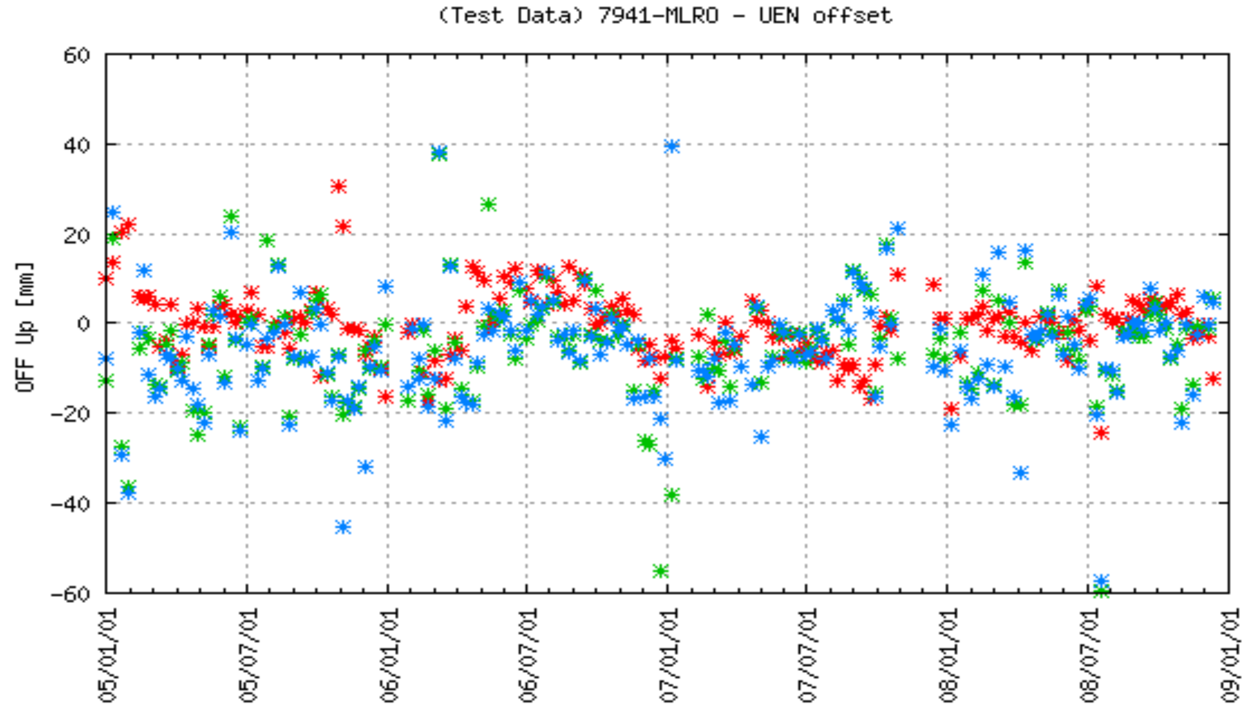
Standard
L12 bias
Common bias

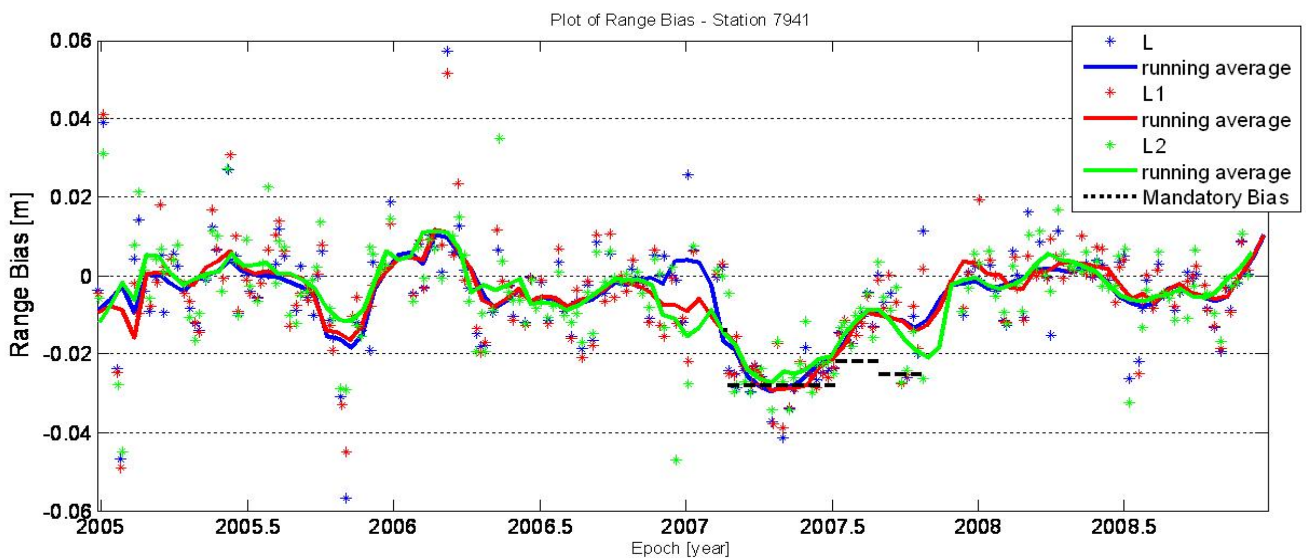
Wettzell



Standard
L12 bias
Common bias

Matera coordinates





Standard

L12 bias

Common bias

Format Issue

SINEX format: multiple wavelength and no direct correspondence with sites with different PT codes in the SOLUTION/ESTIMATE block
7810 SOLN 2 for wvl 846
7405 SOLN 2 for wvl 847

```
+BIAS/EPOCHS
*CODE PT SOLN T _DATA_START_ __DATA_END__ _MEAN_EPOCH_
 1831 L1     1 R 05:017:16134 05:018:11408 05:017:62700
 1831 L2     1 R 05:018:13033 05:018:13597 05:018:13315
 7405 L1     2 R 05:017:76988 05:017:78003 05:017:77496
 7405 L2     2 R 05:018:08386 05:019:30271 05:019:02930
 7810 L1     2 R 05:016:19778 05:022:68676 05:018:39532
 7810 L2     2 R 05:016:11027 05:022:45538 05:017:48197
 ...............................

+SOLUTION/ESTIMATE
*INDEX _TYPE_ CODE PT SOLN _REF_EPOCH__ UNIT S '__ESTIMATED VALUE____ __STD_DEV_
     1 RBIAS  1831 L1    1 05:017:62700 m    2 0.163319098038446E+00 .370439E-01
     2 RBIAS  1831 L2    1 05:018:13315 m    2 0.153068393363257E+00 .386664E-01
     3 RBIAS  7405 L1    2 05:017:77496 m    2 0.249763868855504E-01 .493191E-02
     4 RBIAS  7405 L2    2 05:019:02930 m    2 0.158990843744622E-01 .458641E-02
     5 RBIAS  7810 L1    2 05:018:39532 m    2 -.181429871702343E-01 .133180E-02
     6 RBIAS  7810 L2    2 05:017:48197 m    2 -.129832927545893E-01 .143155E-02
..................
   110 STAX   7810  B    1 05:019:43200 m    2 0.433128308108095E+07 .709719E-01
```

Next steps

- Correlation analysis
- Same test using a scaled a priori TRF e.g. apply 1 ppb scale to SLRF2008 considering only the case of separate biases for L1 and L2
- Check of the AC time series
- AC Combination

Question:
How can we use the bias time series?

Handling of the post-seismic deformation model

Rolf Koenig, Karl Hans Neumayer

GFZ
Helmholtz Centre
POTSDAM

Questions to the post-seismic deformation model

- Add or subtract the deformations?
  - From ftp://itrf.ign.fr/pub/itrf/itrf2014/ITRF2014-PSD-model-eqs-IGN.pdf:

ITRF2014: Equations of post-seismic deformation models

After an Earthquake, the position of a station during the post-seismic trajectory, X_{PSD}, at an epoch t could be written as:

$$X_{PSD}(t) = X(t_0) + \dot{X}(t - t_0) + \delta X_{PSD}(t) \qquad (1)$$

where $\dot{X}$ is the station linear velocity vector, and $\delta X_{PSD}(t)$ is the total sum of the post-seismic deformation (PSD) corrections at epoch t. For each component $L \in \{\mathrm{E,N,U}\}$, we note δL the total sum of PSD corrections expressed in the local frame at epoch t:

$$\delta L(t) = \sum_{i=1}^{n^l} A_i^l \log\left(1 + \frac{t - t_i^l}{\tau_i^l}\right) + \sum_{i=1}^{n^e} A_i^e \left(1 - \mathrm{e}^{-\frac{t - t_i^e}{\tau_i^e}}\right) \qquad (2)$$

.

Questions to the post-seismic deformation model

- Add or subtract the deformations (cont.)?
  - From psd-example.f:

```
      call parametric (mode,dtq,ae1,te1,ae2,te2,de)
      call parametric (modn,dtq,an1,tn1,an2,tn2,dn)
      call parametric (modu,dtq,au1,tu1,au2,tu2,du)

      de = de/1000.0d0
      dn = dn/1000.0d0
      du = du/1000.0d0
C
C     call your own routine to transform dENU --> dXYZ
C     Output --> dx, dy, dz
C
C

        x = x - dx
        y = y - dy
        z = z - dz
```

Questions to the post-seismic deformation model

- t in Eq. (2)?
  - Holds for all times, even before earthquake?
  - Needs to be larger than earthquake time?

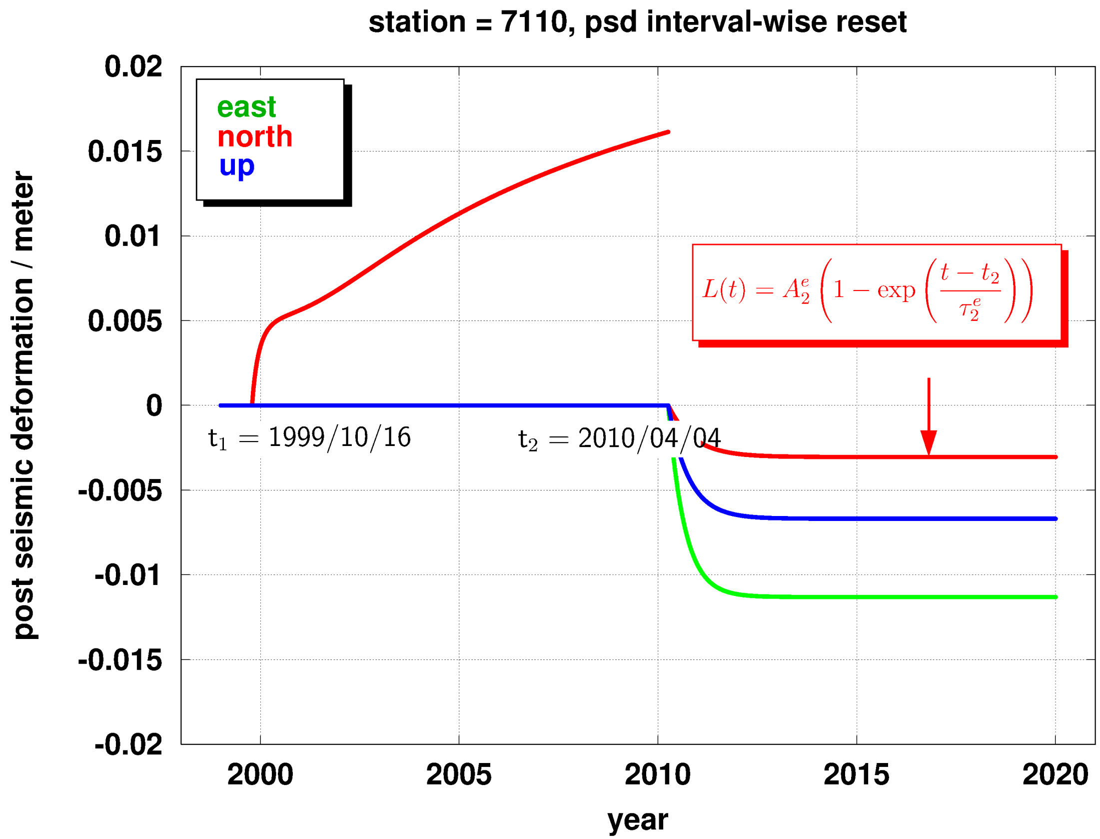
Questions to the post-seismic deformation model

- How to accumulate the deformations?
  - Example 7110 Monument Peak
  - Excerpt from psdmodel.dat :

```
7328  A 21704M004 11:070:20783 E 3   95.72  0.4278   61.65  0.0619     SLR
                               N 0
                               U 2   30.94  0.0980
7110  A 40497M001 99:289:35204 E 0                                     SLR
                               N 3    7.16  0.1528  -14.23  0.9905
                               U 0
7110  A 40497M001 10:094:81643 E 2  -11.30  0.4112                     SLR
                               N 2   -3.04  0.6265
                               U 2   -6.68  0.5085
7821  A 21605S010 11:070:20783 E 2    5.25  1.1955                     SLR
                               N 0
                               U 0
```

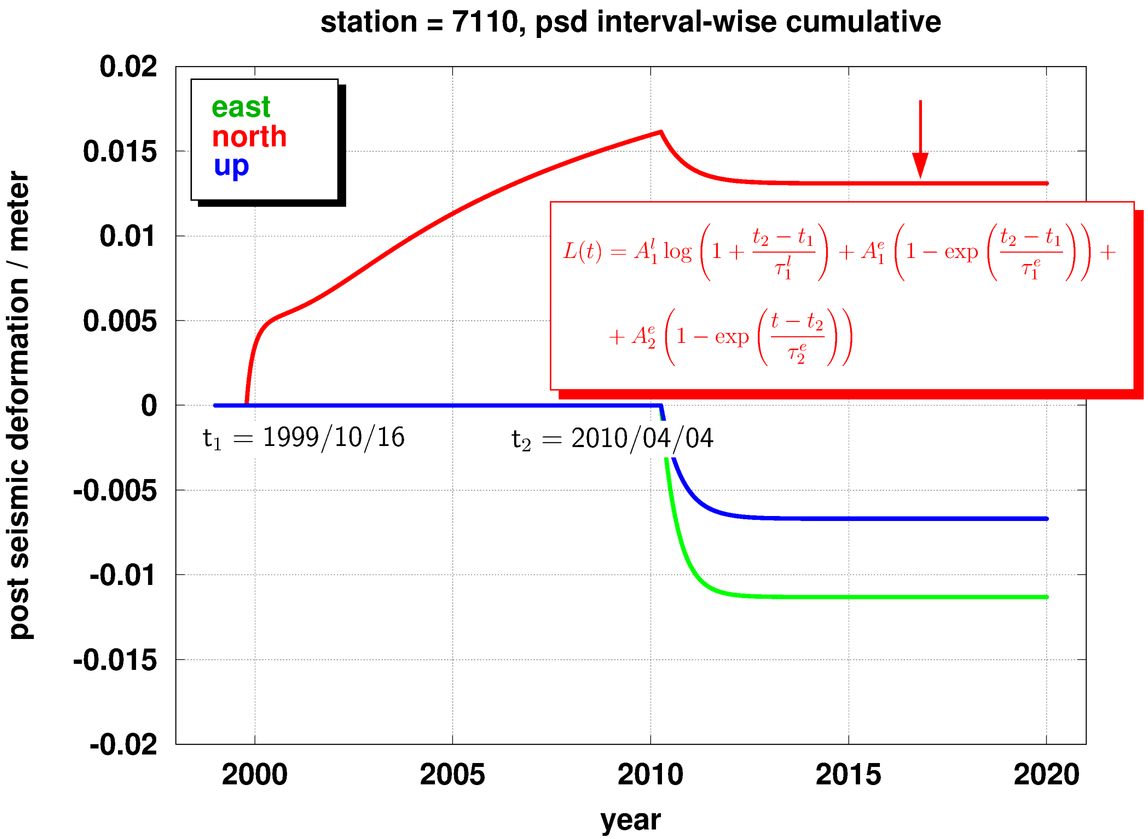
Questions to the post-seismic deformation model

- Per interval inbetween earthquakes?



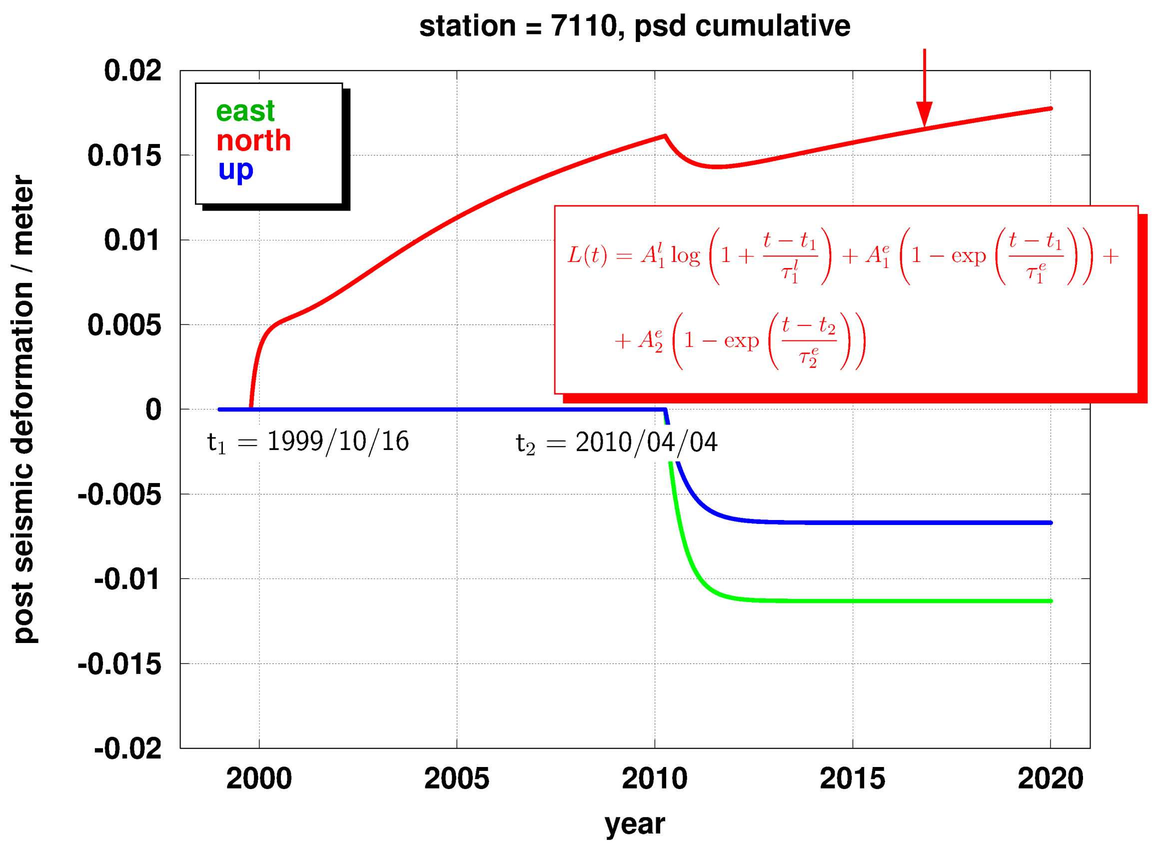
Questions to the post-seismic deformation model

- Per interval, continuing at the deformation left by the previous interval?



Questions to the post-seismic deformation model

- Accumulating through all history?



Handling of quarantine stations

Rolf Koenig, Margarita Vei

Quarantine station data at AC

- We need an official, up-to-date file at ILRS for an automated update of our daily and weekly operations to avoid usage of quarantine data or to allow approved, previously quarantined data

Quarantine station data at AC

- Currently available files (besides emails):
  - http://ilrs.gsfc.nasa.gov/network/site_procedures/station_upgrade_status.html

Status of ILRS Stations Engineering/Testing

This table summarizes the status of upgrades, repairs, and testing of stations in the ILRS network.

(as of Friday, April 15, 2016)

Station upgrade procedures can be viewed at http://ilrs.gsfc.nasa.gov/network/site_procedures/station_upgrades.html

Click on a column heading to sort table. Date format is YYYY-MM-DD.

Site Name	Sta. No.	ILRS Code	Upgrade start	Upgrade end	SOD Update	Description	Quarantine Start	Data Released
Lviv *	1831	LVIV	2009-12			Laser repair		
McDonald	7080	MDOL	2013-08-21	2013-08-21	No update	Real-time controller system installation	2013-08-21	2013-10-23
Greenbelt	7105	GODL	2010-04	2010-12-04	No update	System down for operational issues	2010-12-04	2011-01-20

Quarantine station data at AC

- Currently available files (besides emails), cont.:
  - http://edc.dgfi.tum.de/en/stations/

Station	Code	Site	DC	SOD	DOMES	First Data	Last Data	No data
8834	WETL	Wettzell, Germany (WLRS)	EDC	88341001	14201S018	1991-01-08	2016-04-16	2 day(s)

Quarantine Stations

Station	Code	Site	DC	SOD	DOMES	First Data	Last Data	No data
1831	LVIL	Lviv, Ukraine	EDC	18318501	12368S001	2002-05-07	2009-11-26	2335 day(s)
1863	MAID	Maidanak 2, Uzbekistan	EDC	18635101	12340S001	1991-07-31	2004-01-17	4475 day(s)
1864	MAIL	Maidanak 1, Uzbekistan	EDC	18645401	12340S002	1992-06-02	2008-10-17	2740 day(s)
1887	BAIL	Baikonur, Kazakhstan	EDC	18879701	25603S001	2011-10-17	2016-04-13	5 day(s)
7080	MDOL	McDonald Observatory, Texas	CDDIS	70802419	40442M006	1993-06-11	2016-04-10	8 day(s)
7231	WUHL	Wuhan, China	CDDIS	72312901	21602S004	2000-04-26	2005-12-18	3774 day(s)
7308	KOGC	Koganei, Japan(CRL)	CDDIS	73085001	21704S002	1992-11-21	2015-01-07	467 day(s)
7358	GMSL	Tanegashima, Japan	CDDIS	73588901	21749S001	2004-09-01	2014-08-28	599 day(s)
7359	DAEK	Daedeok, Korea	EDC	73592601	23902S002	2013-04-12	2014-11-18	517 day(s)
7406	SJUL	San Juan, Argentina	EDC	74068801	41508S003	2006-02-22	2014-11-19	516 day(s)
7806	METL	Metsahovi, Finland	CDDIS	78067601	10503S014	1997-09-26	2005-05-20	3986 day(s)
7810	ZIML	Zimmerwald, Switzerland	EDC	78106801	14001S007	1996-12-18	2016-04-14	4 day(s)
7811	BORL	Borowiec, Poland	EDC	78113802	12205S001	1988-05-13	2016-04-14	4 day(s)
7820	KUNL	Kunming, China	EDC	78208201	21609S002	1998-12-17	2015-12-14	126 day(s)
7824	SFEL	San Fernando, Spain	EDC	78244502	13402S007	1999-04-06	2016-04-17	1 day(s)
7831	HLWL	Helwan, Egypt	EDC	78314601	30101S001	1983-10-25	2011-09-19	1673 day(s)
7832	RIYL	Riyadh, Saudi Arabia	EDC	78325501	20101S001	1995-09-12	2012-08-11	1346 day(s)
7841	POT3	Potsdam, Germany	EDC	78418701	14106S011	2010-02-27	2016-04-16	2 day(s)

Past Stations

Station	Code	Site	DC	SOD	DOMES	First Data	Last Data
1148	---	Ondrejov, Czech Republic	---	11480901	---	1989-01-29	1989-01-29

Quarantine station data at AC

- Currently available files (besides emails), cont.:
  - http://ilrs.dgfi.tum.de/fileadmin/data_handling/ILRS_Data_Handling_File.snx

```
 For stations in quarantine data should not be available on the public directories at
 the data centers.  Stations marked with N, unreliable should be handled carefully,
 unexpected range or time may occur.

 SOLUTION/DATAHANDLING
 ---------------------
 "M" Models codes:
      X = Exclude/delete data
      C = Target signature bias, Center-of-mass correction different to standard
      E = Estimation of range bias, known a priori values are given
      H = humidity error (correction in %)
      N = non reliable station, should not be used for routine processing
      P = pressure bias
      Q = Station with data in quarantine, should not be used
      R = Range bias to be applied, no estimation of bias
      S = Stanford event counter bias
      T = Time bias in msec. to be applied, but not estimated
      U = Estimation of time bias in msec
      V = Station with not validated coordinates, not solving for biases

  estimate values where provided must be subtracted from the one-way observations
                                        ##########

-FILE/COMMENT
*---------------------------------------------------------------------------------
+INPUT/ACKNOWLEDGMENTS
*AGY ______________FULL_DESCRIPTION_____________________________________________
 DGF Deutsches Geodaetisches Forschungsinstitut (DGFI), Munich, Germany
 GFZ GeoForschungsZentrum Potsdam (GFZ), Potsdam, Germany
     + Several individuals.
-INPUT/ACKNOWLEDGMENTS
```

The JCET AC/CC & Systematics Monitoring PP
Report to the ILRS ASC

April 22, 2016

E. C. Pavlis, M. Kuzmicz-Cieslak and D. König,

JCET Activities Since Matera Meeting

- **Examined the final release of ITRF2014 and identified some discrepancies in the dates used for the PSD (final release) and our "Discontinuities File"**

  - We need to harmonize these to be sure we all apply the PSD to the same station positions

- **The orbital files (SP3c) combination process restarted**

  - We provide routinely weekly combination of the submitted SP3c files from all ACs

  - We still need to work on generating a summary file with the statistics of the combination and other figures of merit for the input series

Station Discontinuities File for ITRF2014

Edited version based on ZA PSD model

	Discontinuities FINAL (mkc)					
Site ID#	yyyy:doy	yyyy:doy	yyyy:doy	yyyy:doy	yyyy:doy	yyyy:doy
1868	2003:155					
1893	2008:300					
7110	1999:289 E	2010:094 E				
7122	1985:264	1991:091				
7124	2001:207					
7210	1989:256	1994:022	2000:264			
7237	2011:070 E					
7249	2011:070 E					
7307	1997:307					
7308	2011:070 E					
7328	2011:070 E					
7358	2011:070 E					
7403	1994:160	1996:317	2001:174 E	2001:188	2007:227	2014:091
7405	2010:058 E	2010:064 E (new)	2011:043			
7406	2010:058					
7501	2012:099					
7811	2002:208					
7820	2002:098	2007:245 (new)				
7821	2008:001	2010:028	2011:070 E			
7835	1990:071	1999:335				
7837	1995:274					
7838	2004:249	2011:070 E				
7839	1995:361	1999:315				
7843	1988:001	1992:121				
7907	1988:103					
8834	2000:344	2009:045	2010:323			

2002:098	*not exist in the Z file*
2007:245 (new)	*what was changed*
7307	not is Z file
7328	not is C file

Z file = Zuheir's Final ITRF2014 file of discontinuities

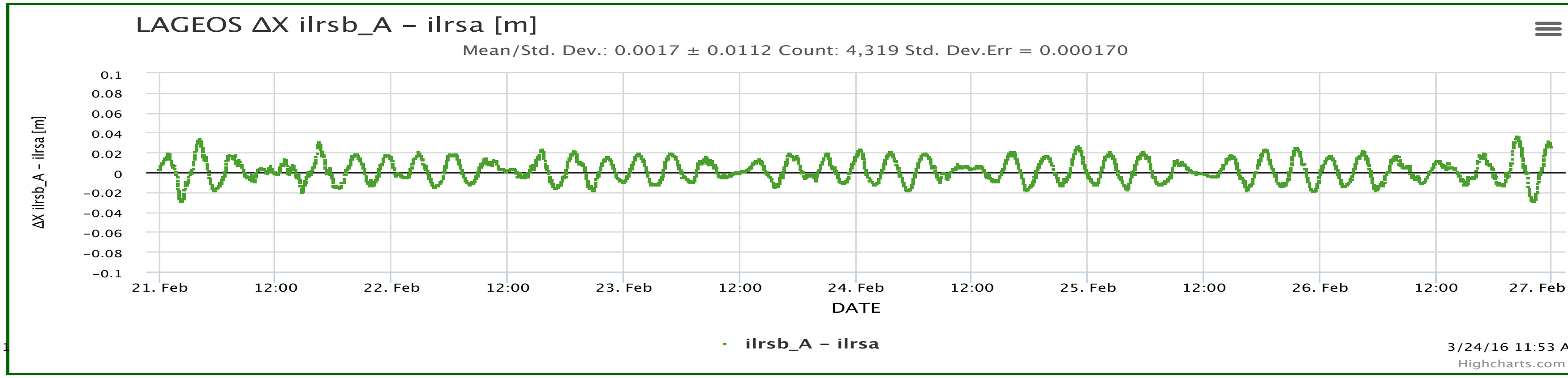
C file = Cinzia's Excel file of discontinuities "FINAL (ORG)"

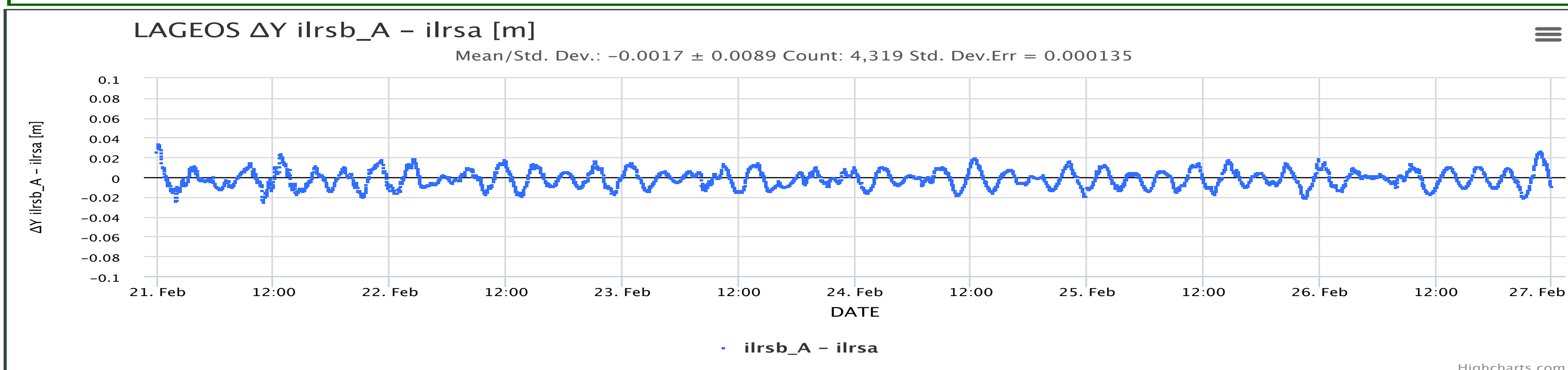
As shown in Matera

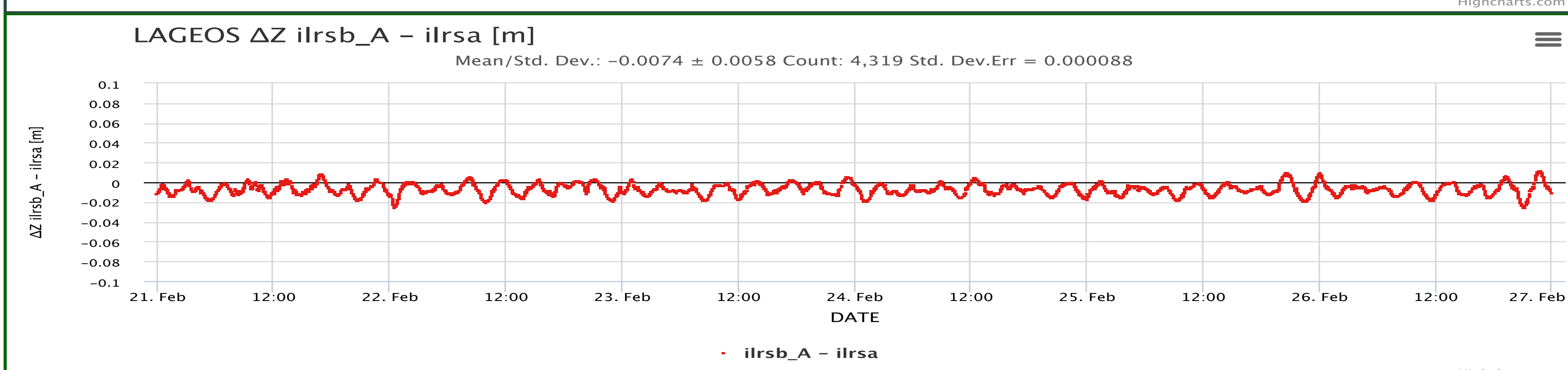
	Discontinuities FINAL (ORG)					
Site ID#	yyyy:doy	yyyy:doy	yyyy:doy	yyyy:doy	yyyy:doy	yyyy:doy
1868	2003:157					
1893	2008:298					
7110	1999:289 E	2010:092 E				
7122	1985:266	1991:087				
7124	2001:138					
7210	1989:263	1994:020	1999:216			
7237	2011:069 E					
7249	2011:031 E					
7307	1997:307					
7308	2011:056 E					
7358	2011:064 E					
7403	1994:161	1996:321	2001:166 E	2001:186	2007:230	2014:093
7405	2010:058 E	2011:038				
7406	2010:051					
7501	2012:098					
7811	2002:208					
7820	2002:098					
7821	2009:135	2010:028	2011:068 E			
7835	1990:071	1999:335				
7837	1995:229					
7838	2004:249	2011:070 E				
7839	1995:332	1999:316				
7843	1988:001	1992:121				
7907	1988:104					
8834	2000:343	2009:045				

LAGEOS SP3c ΔPOSITION: ILRS (b—a)

MONITORING SP3







ILRS (b-a) Orbit Differences over a 2-week Period

ΔX ilrsb_A - ilrsa [m] LAGEOS	ΔY ilrsb_A - ilrsa [m] LAGEOS	ΔZ ilrsb_A - ilrsa [m] LAGEOS
Mean/Std. Dev.: 0.0017 ± 0.0112 Count: 4,319 Std. Dev.Err = 0.000170	Mean/Std. Dev.: -0.0017 ± 0.0089 Count: 4,319 Std. Dev.Err = 0.000135	Mean/Std. Dev.: -0.0074 ± 0.0058 Count: 4,319 Std. Dev.Err = 0.000088

ΔVX ilrsb_A - ilrsa [mm/s] LAGEOS	ΔVY ilrsb_A - ilrsa [mm/s] LAGEOS	ΔVZ ilrsb_A - ilrsa [mm/s] LAGEOS
Mean/Std. Dev.: -0.0001 ± 0.0832 Count: 4,319 Std. Dev.Err = 0.001261	Mean/Std. Dev.: -0.0007 ± 0.0849 Count: 4,319 Std. Dev.Err = 0.001286	Mean/Std. Dev.: 0.0014 ± 0.0320 Count: 4,319 Std. Dev.Err = 0.000485

ILRS Orbital Product Archives

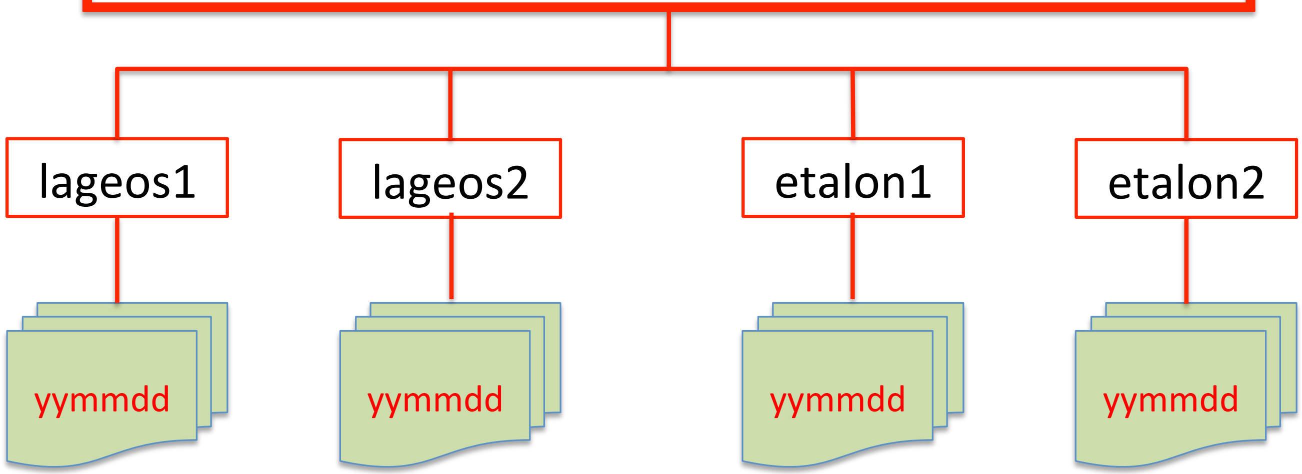
ILRS Orbital Product Archive @ CDDIS

PRESENT (TEST PHASE):

ftp://cddis.gsfc.nasa.gov/pub/slr/products/test/4risonly

OPERATIONAL PHASE:

ftp://cddis.gsfc.nasa.gov/pub/slr/products/orbits



File organization within the archive:

- At the top level:

  ftp://cddis.gsfc.nasa.gov/pub/slr/products/orbits

  – "README" files from each AC and CC, e.g.:
    - README_AC.asi, README_AC.bkg, etc.
    - README_CC.ilrsa, README_CC.ilrsb

- The README_AC.xxx files should be based on the description of the analysis which each AC includes in their POS+EOP SINEX, with appropriate additions/modifications
- The README_CC.xxx files should describe the combination process followed by the "xxx" CC.

Combined Orbit file info:

- The combined orbit SP3 files will replace the four comment records with standard content that will follow the scheme:

/* “ilrsa.orb.yymmdd.v#,sp3”, Reference TRF: SLRF2008
/* Input orbits: ASI v#, BKG v#, …..
/*   JCET v#, NSGF v#
/* Combination details in README_CC.ilrsa

ILRS Orbital Product Archives: Status

CDDIS

00readme_4_orbits
etalon1
etalon2
lageos1
lageos2
README_AC.bkg
README_AC.esa
README_AC.gfz
README_AC.jcet

ESA Documentation NOT available in EDC !!!

EDC

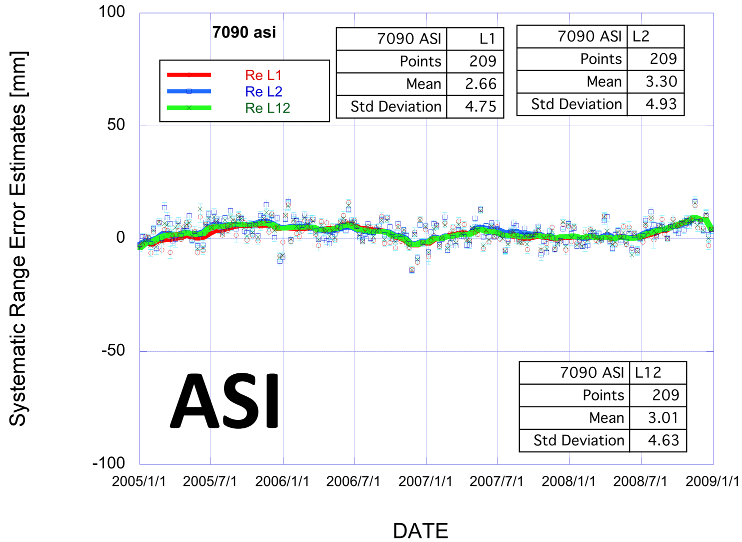
00readme_4_orbits
etalon1
etalon2
lageos1
lageos2
README_AC.bkg
README_AC.gfz
README_AC.jcet

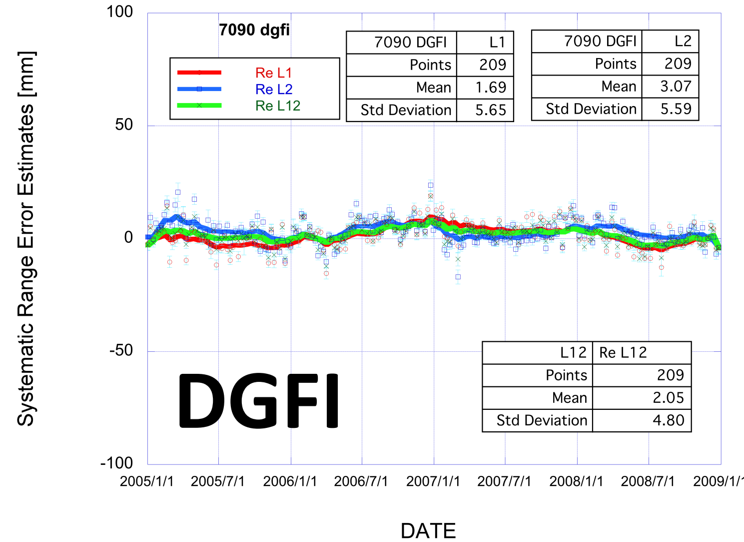
Monitoring SLR Systematics PP

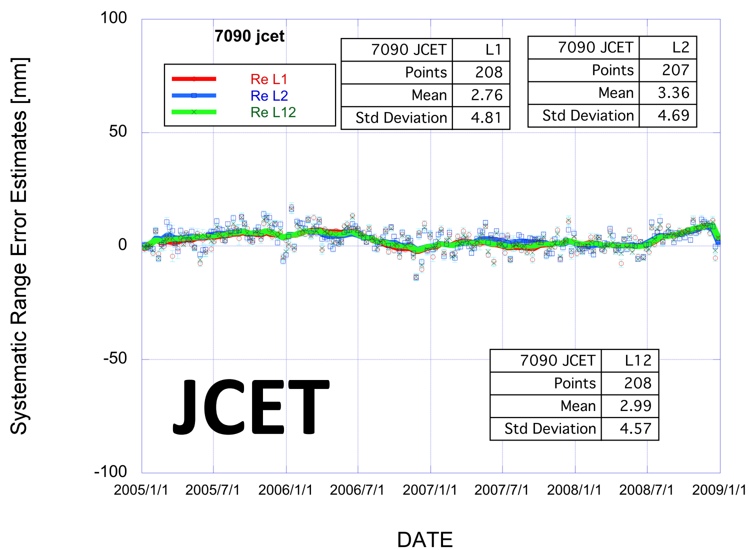
◆ AC-contributed series that we received so far:

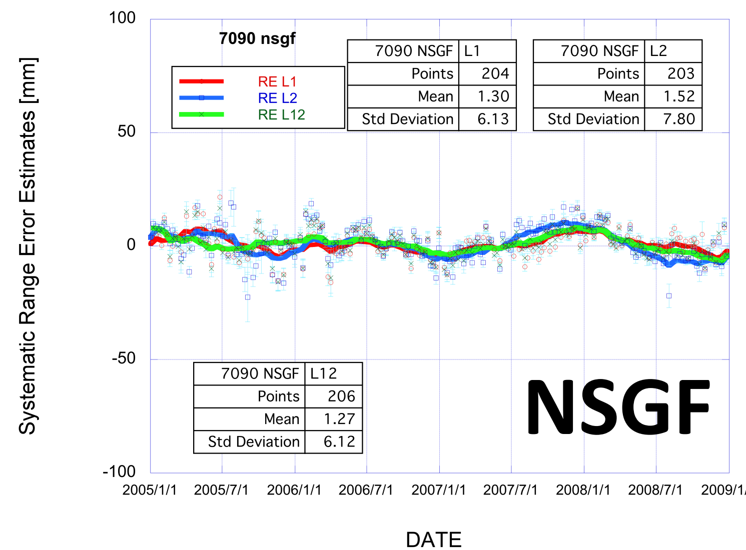
Analysis Center	Date of Submission
ASI	March 2, 2016
DGFI	March 31, 2016
JCET	April 1, 2016
NSGF	April 15, 2016
GFZ (ONLY v200)	April 18, 2016

PP Results: Yarragadee (7090)

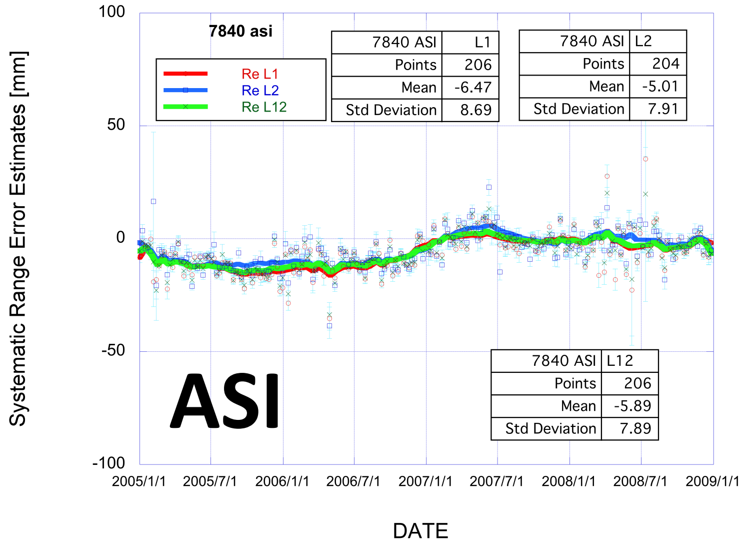


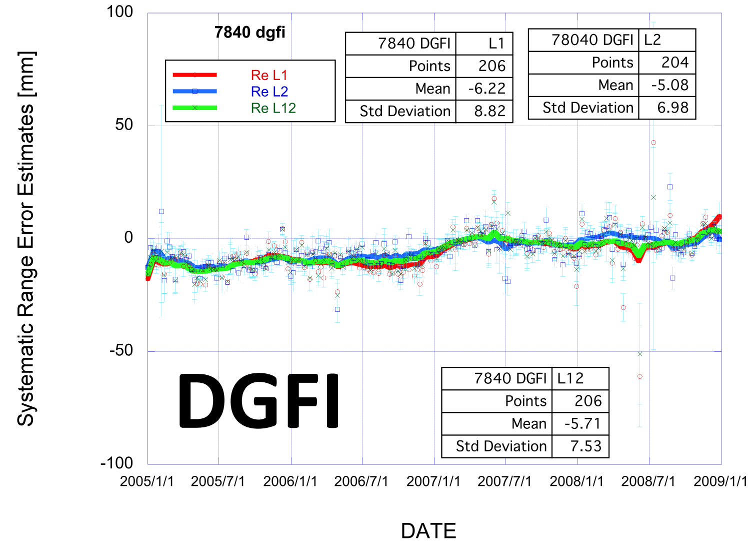


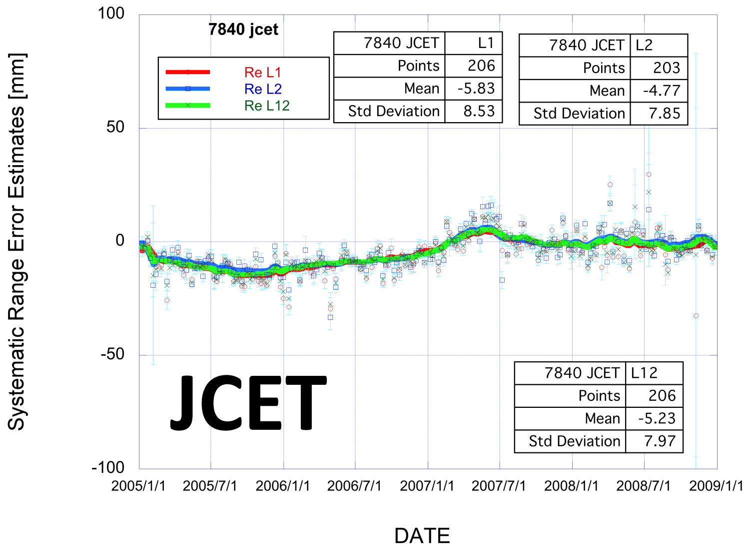


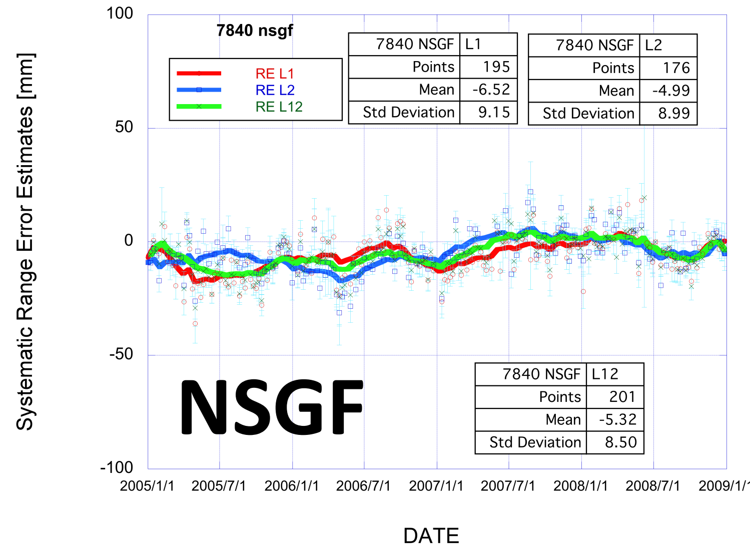


PP Results: Herstmonceux (7840)

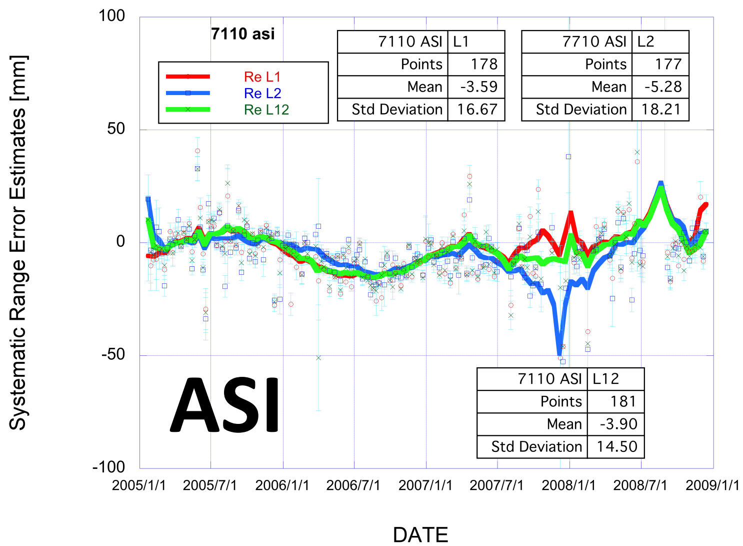


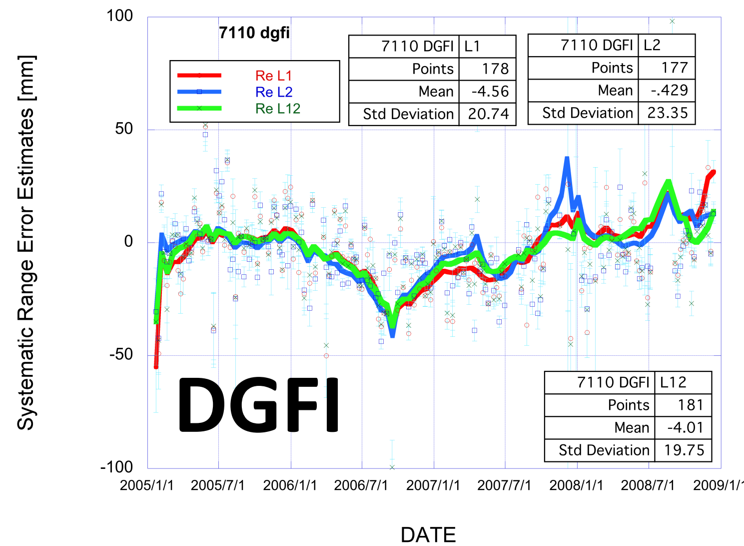


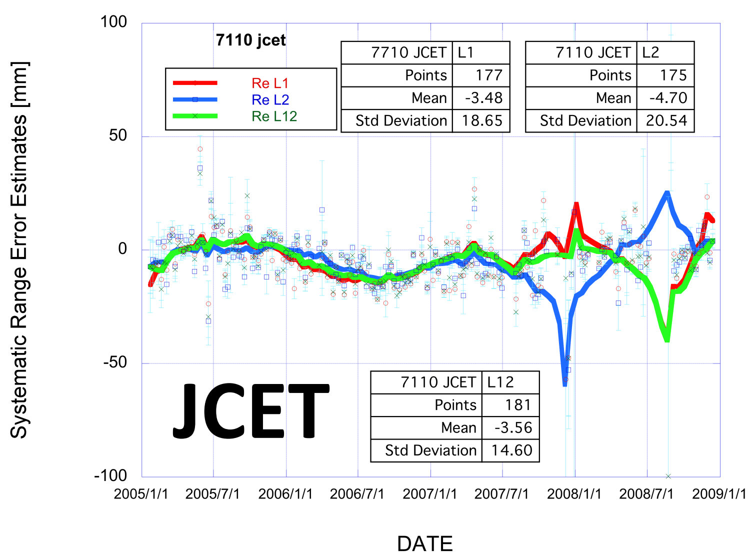


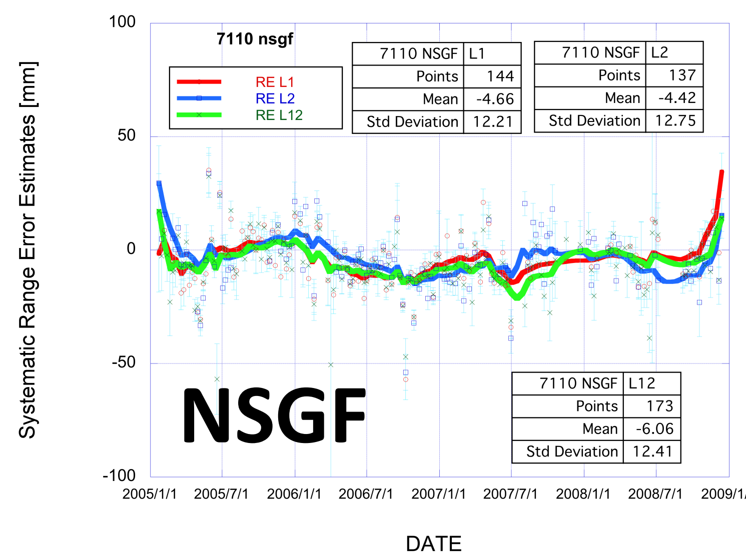


PP Results: Monument Peak (7110)

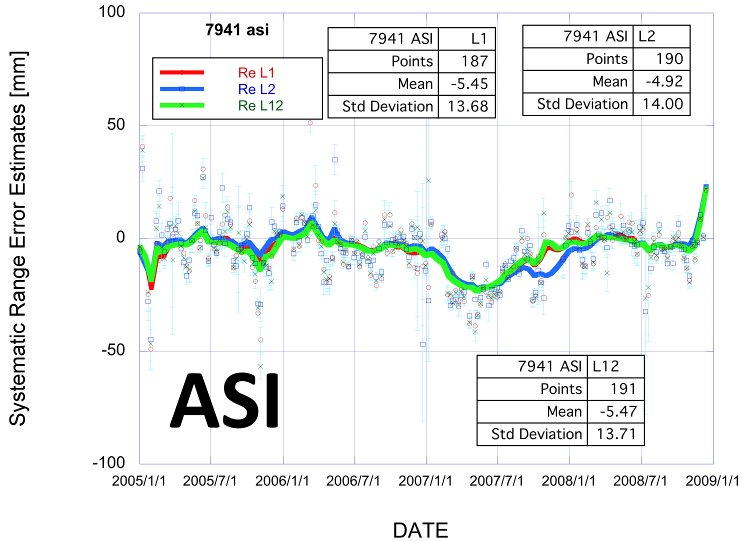


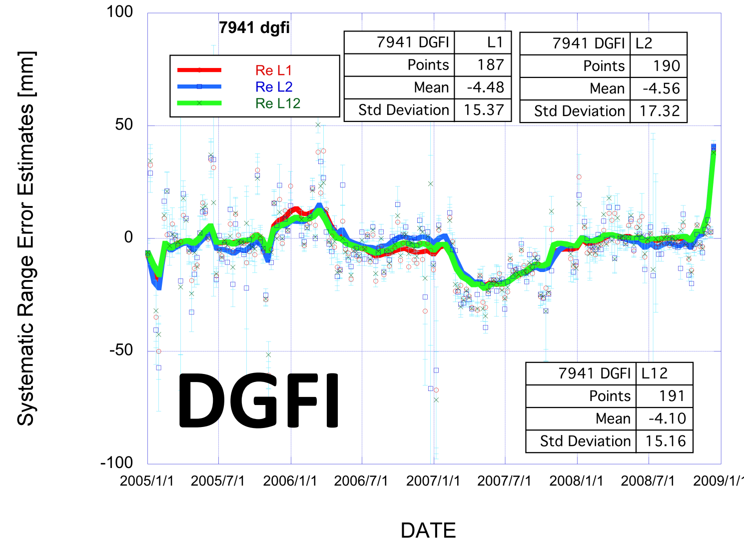


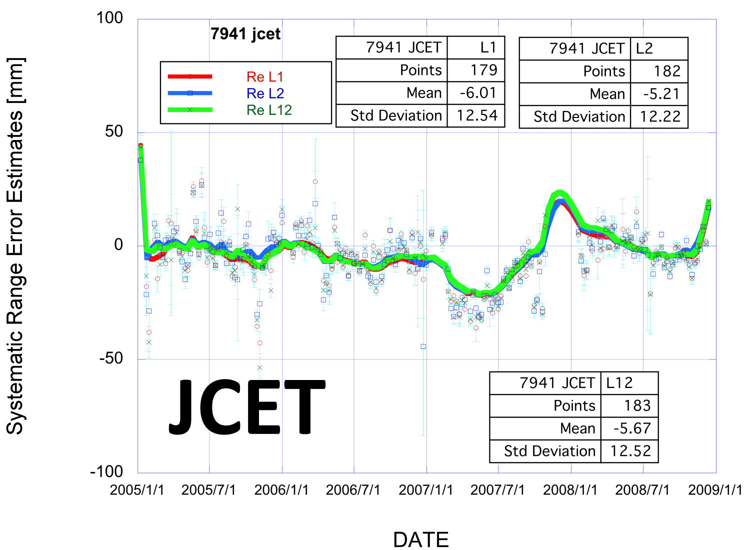


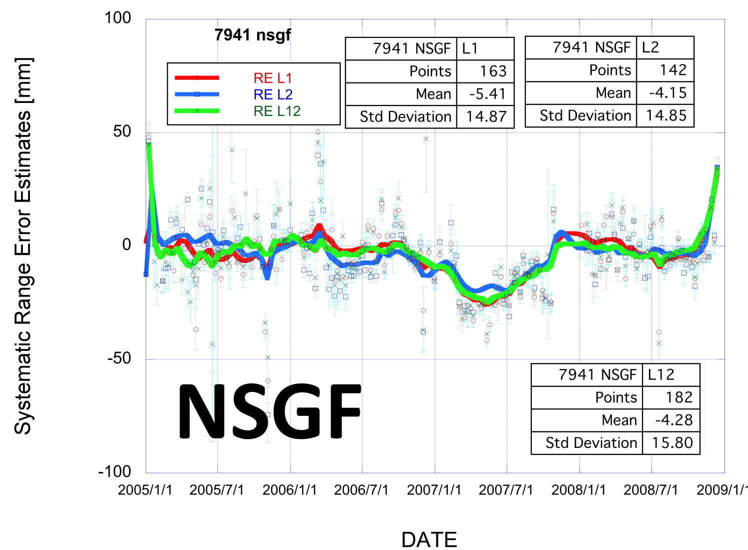


PP Results: Matera (7941)









Website of Data Base with PP Results

Satellite

v200	v200	v210
[x] ASI L1	[x] ASI L2	[x] ASI L
[ ] BKG L1	[ ] BKG L2	[ ] BKG L
[ ] DGFI L1	[ ] DGFI L2	[ ] DGFI L
[ ] ESA L1	[ ] ESA L2	[ ] ESA L
[ ] GRGS L1	[ ] GRGS L2	[ ] GRGS L
[ ] GFZ L1	[ ] GFZ L2	[ ] GFZ L
[ ] JCET L1	[ ] JCET L2	[ ] JCET L
[x] NSGF L1	[x] NSGF L2	[x] NSGF L
[ ] ILRSA L1	[ ] ILRSA L2	[ ] ILRSA L
[ ] ILRSB L1	[ ] ILRSB L2	[ ] ILRSB L

Start (MM-DD-YYYY): 1-01-2005

End Date (MM-DD-YYYY) 12-31-2008

Station 7840 Herstmonceux

Plot Size Minimum Maximum

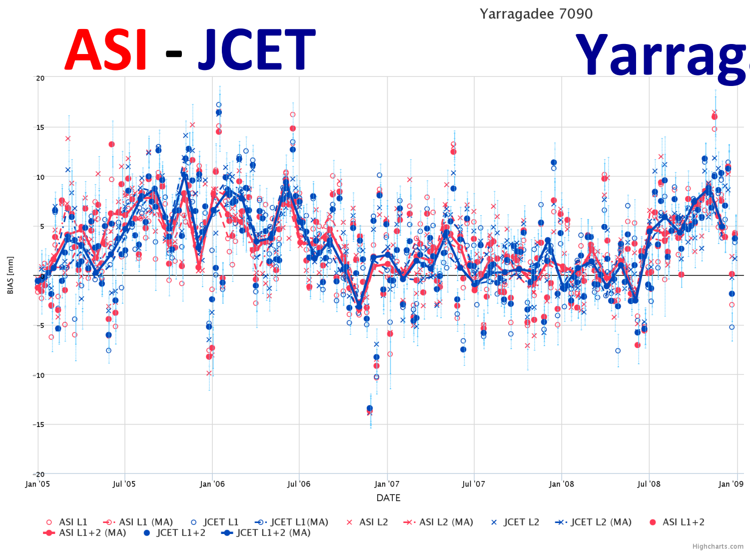
Y axis -20 20

Submit Reset form

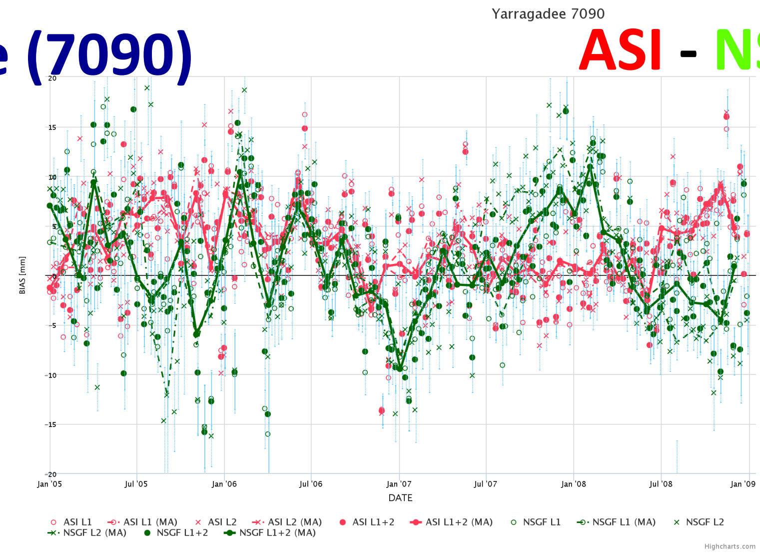
Website of Data Base with PP Results

Yarragadee (7090)

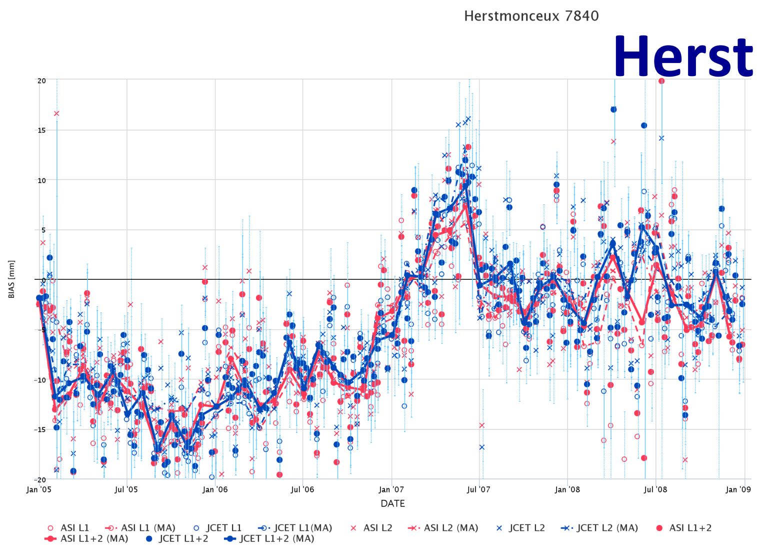
ASI - JCET

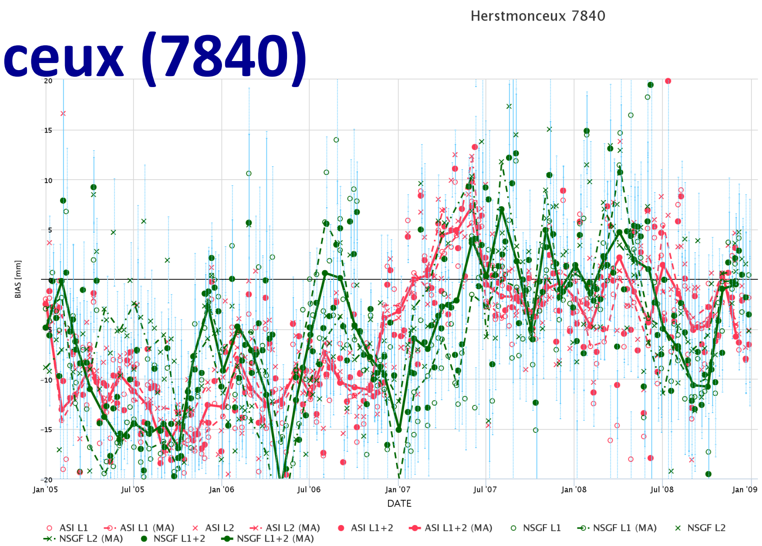


ASI - NSGF



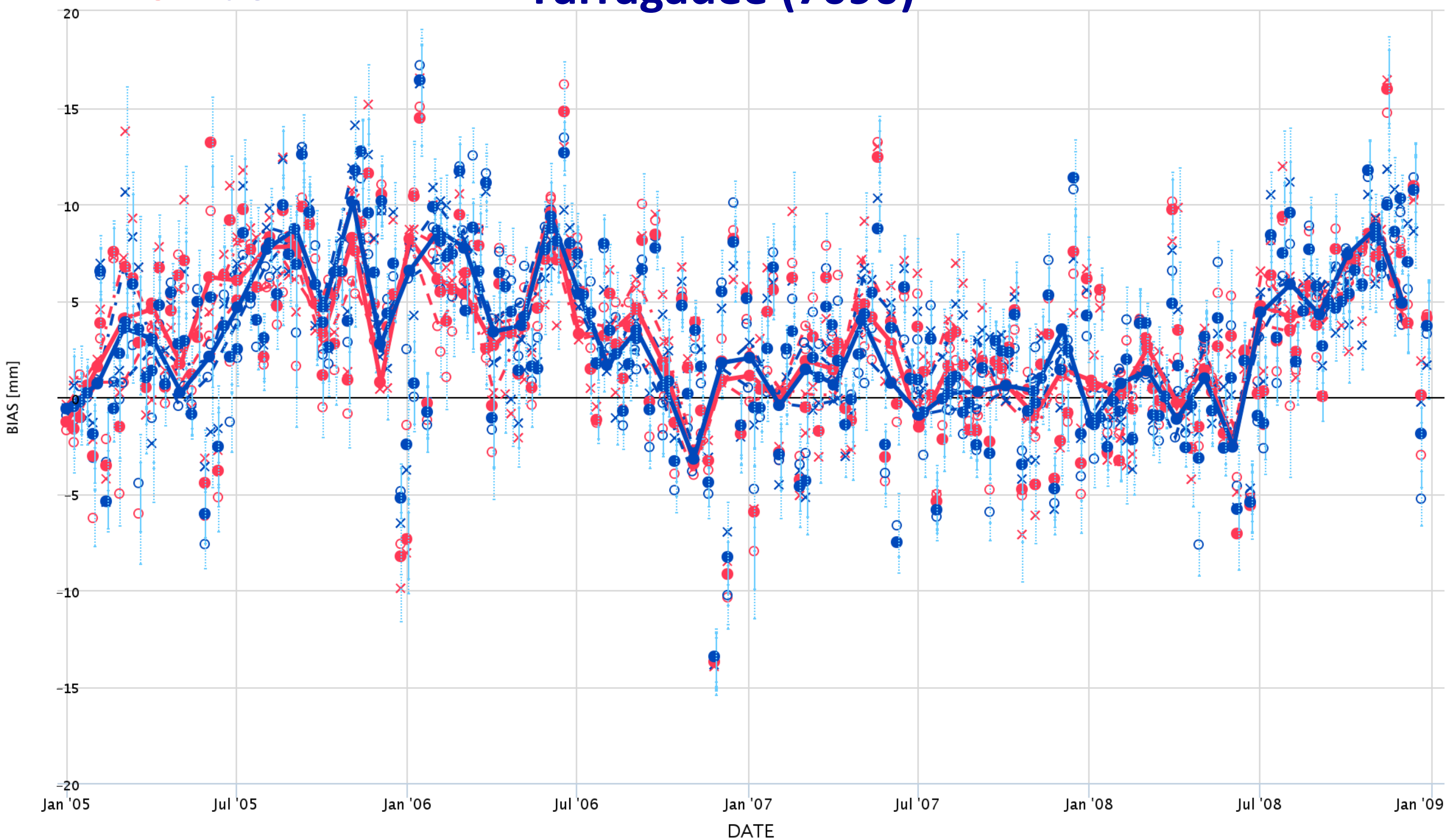
Herstmonceux (7840)





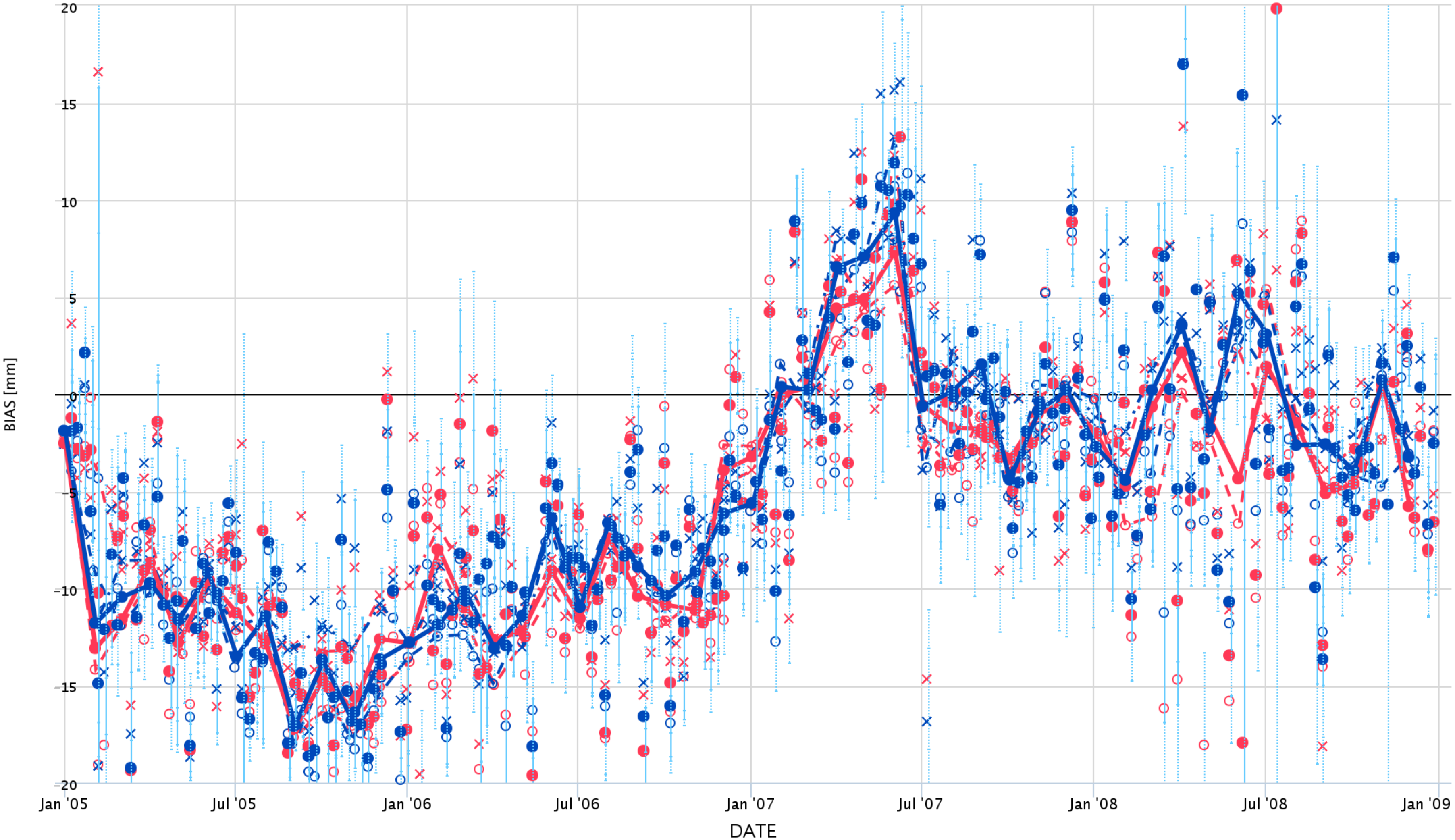
Comparison of PP Results - 1

ASI - JCET Yarragadee (7090)

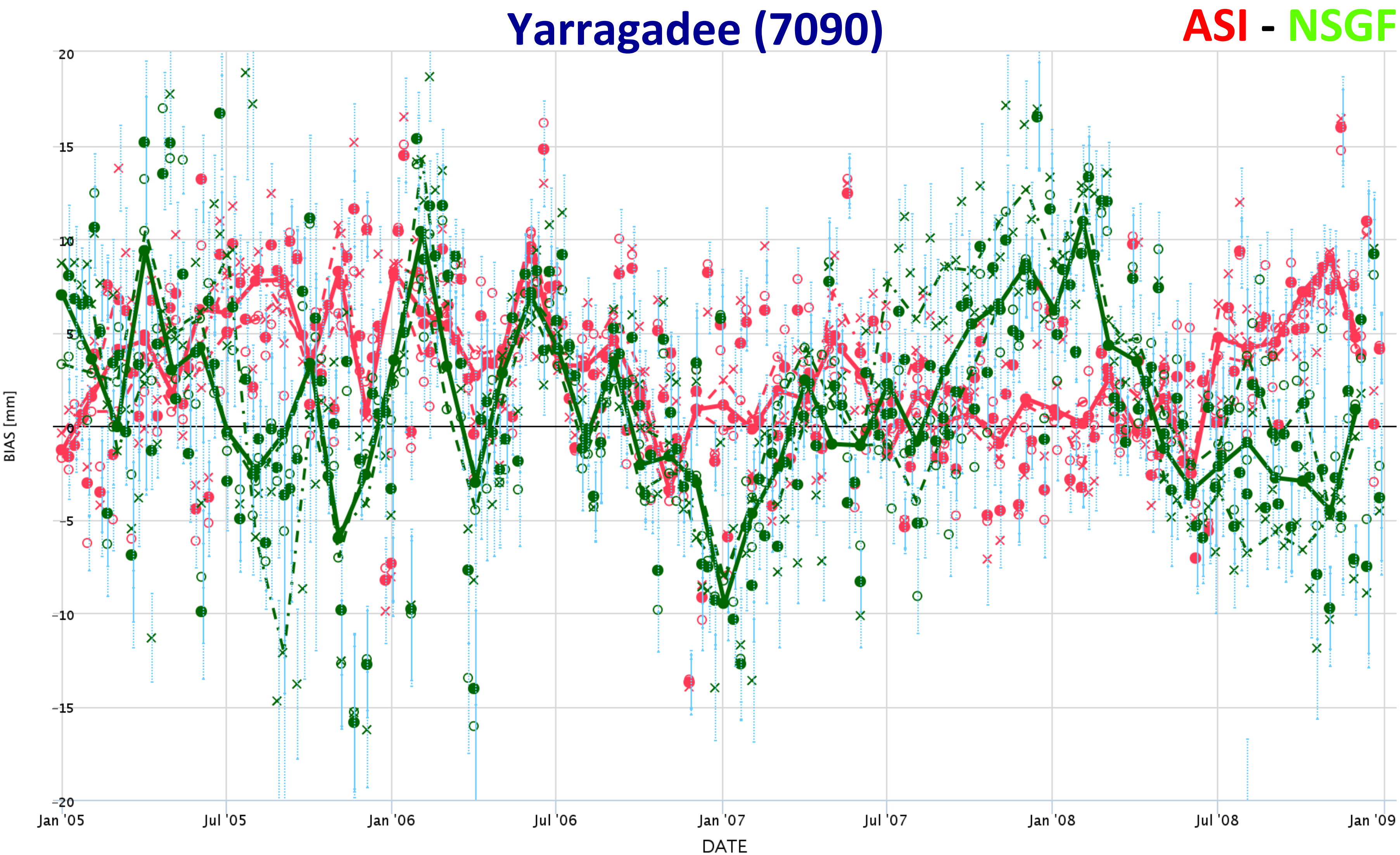


Comparison of PP Results - 2

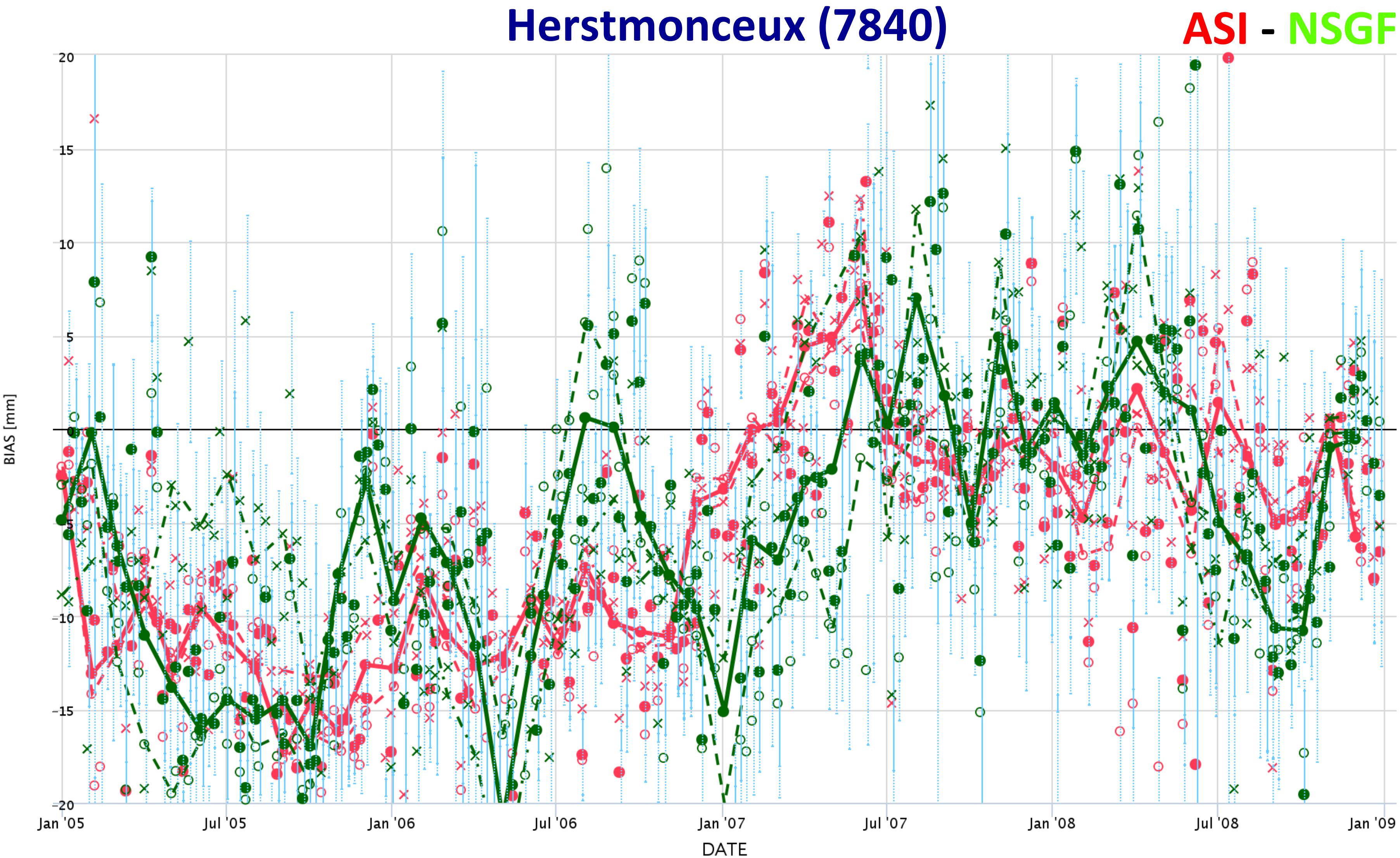
ASI - JCET **Herstmonceux (7840)**



Comparison of PP Results - 3



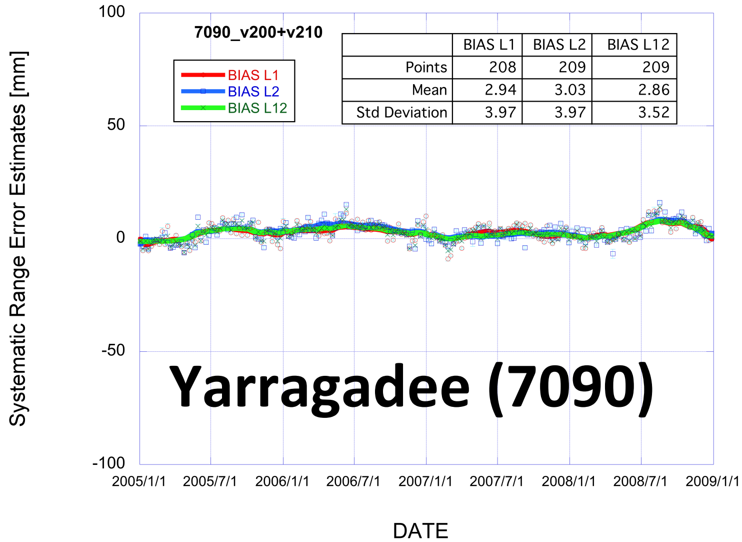
Comparison of PP Results - 4

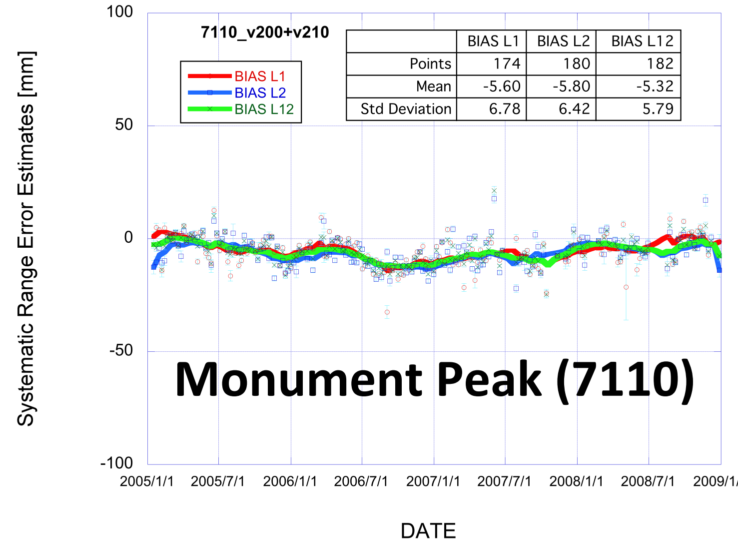


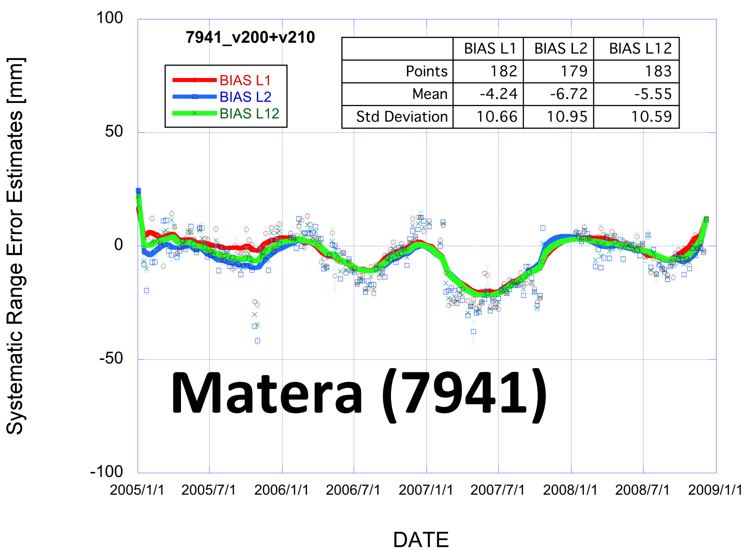
Multi-year JCET Solutions

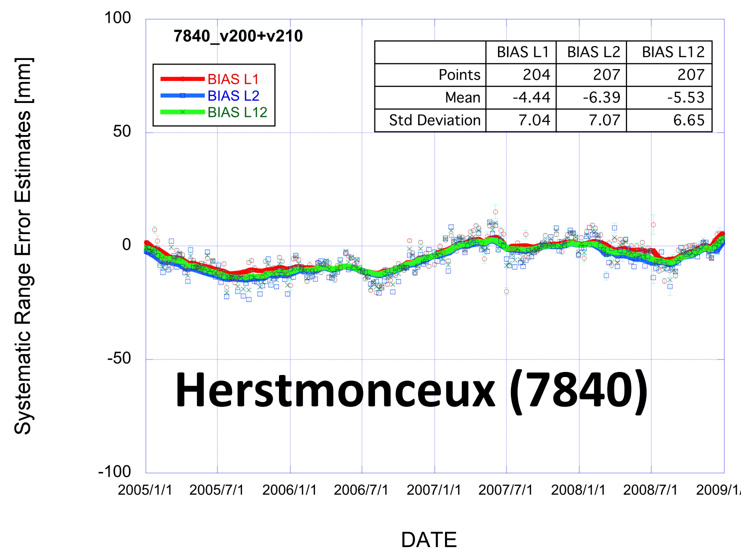
- Four multi-year solutions generated with the JCET NEQs (ONE Epoch site positions and velocities fixed to *a priori*):
  - Separate and joint LAGEOS 1 & 2 systematic errors estimates (*i.e. just like official PP versions v200 & v210*)
  - Systematic errors adjusted:
    - Once per each week over the four years
    - Constant error for each station for the entire 4-year period
- The above resulted in four different "TRF" estimates and system errors
- The impact of the different approaches on the origin and scale of the TRF were assessed (wrt SLRF2008)

JCET Multi-year Estimates (weekly errors)

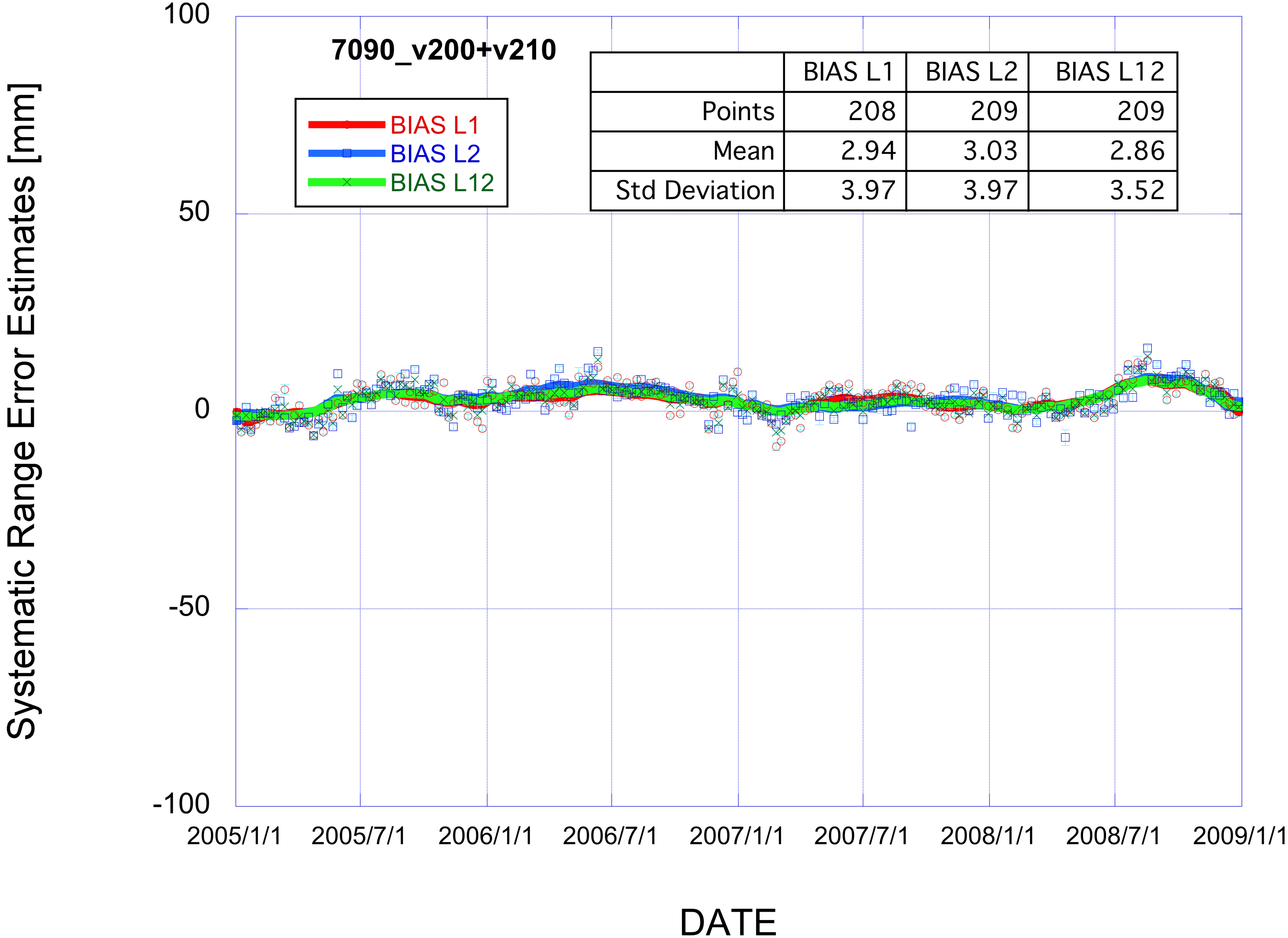






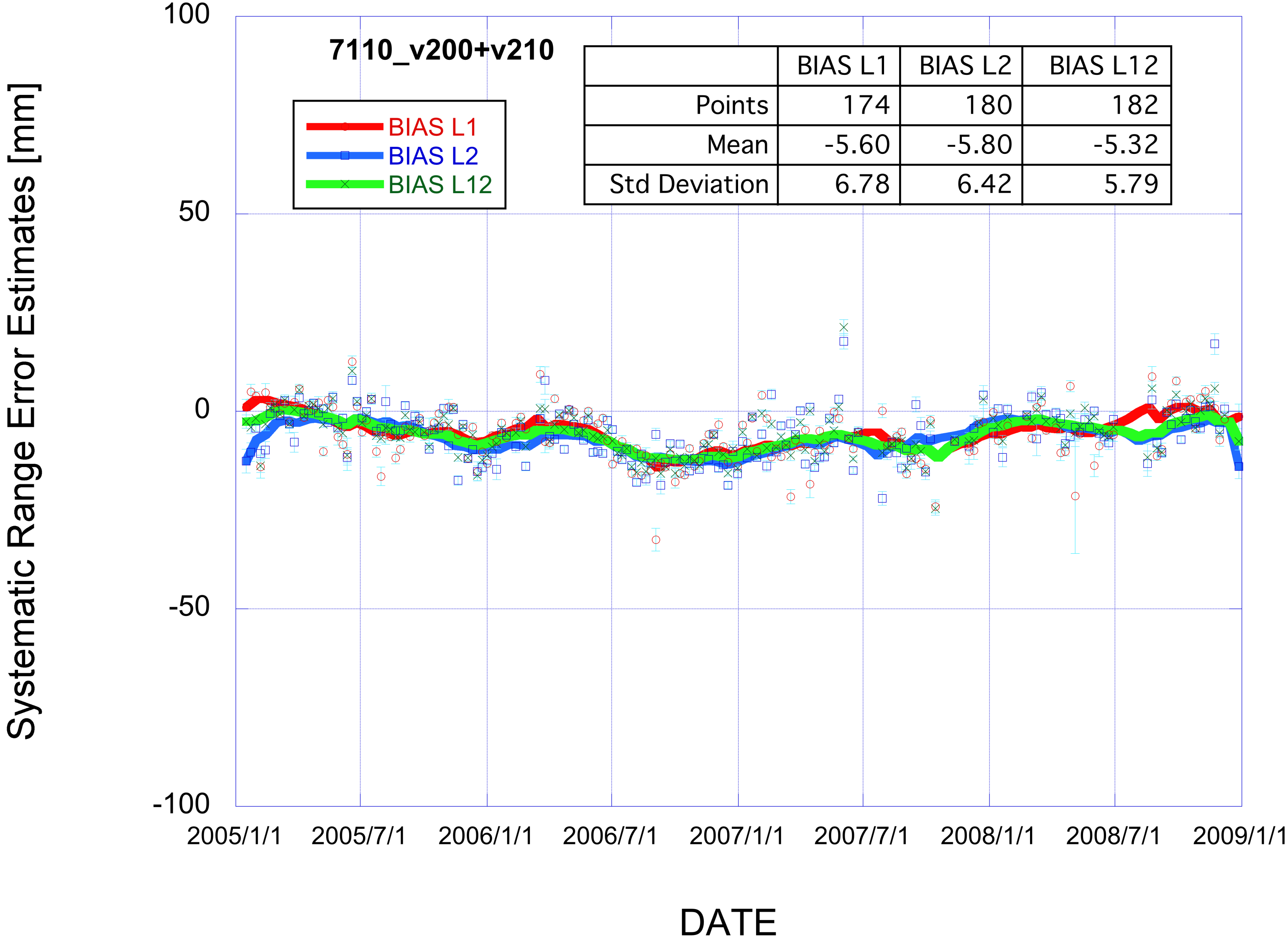


JCET M-year Results: Yarragadee (7090)



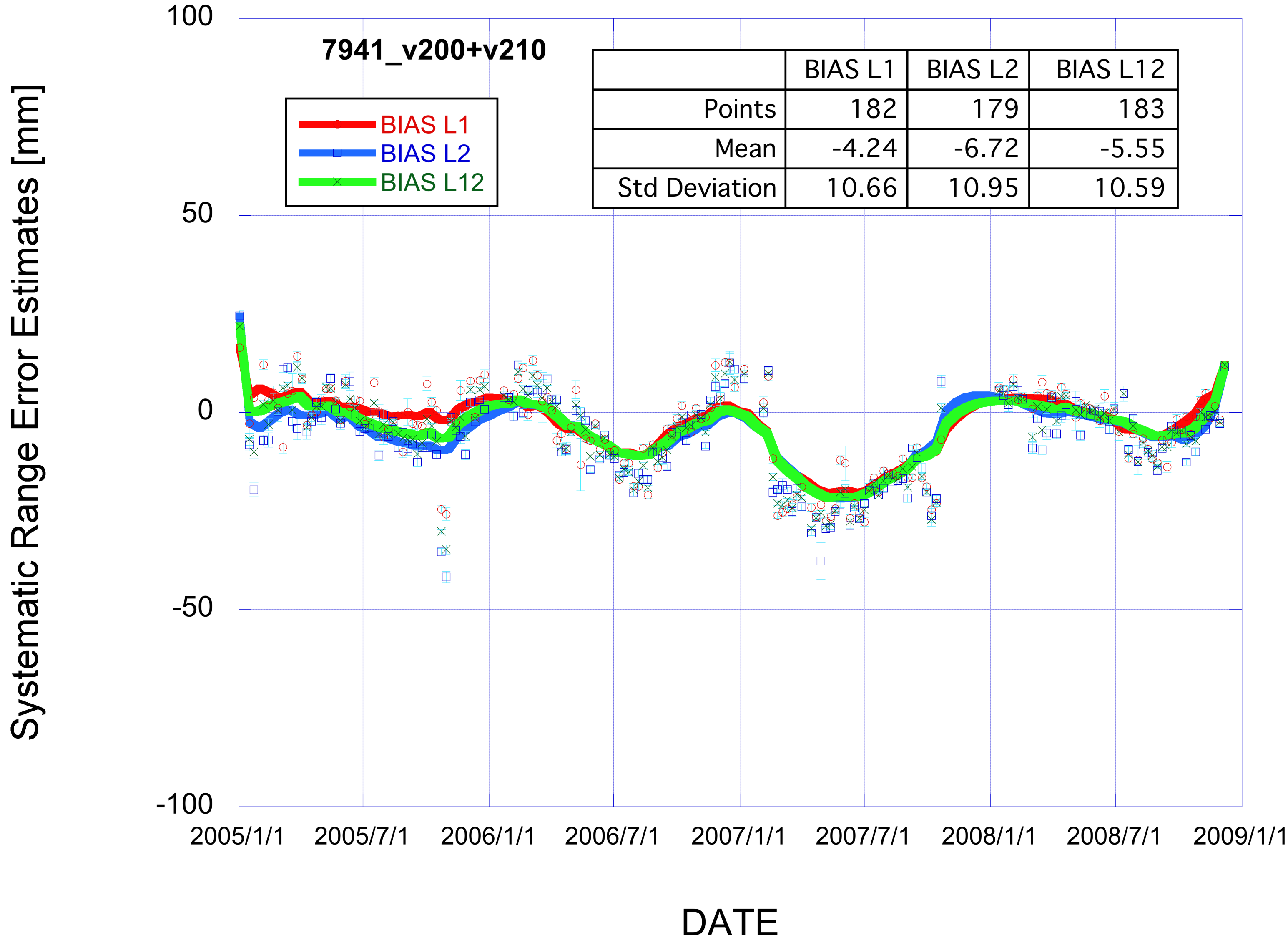
	BIAS L1	BIAS L2	BIAS L12
Points	208	209	209
Mean	2.94	3.03	2.86
Std Deviation	3.97	3.97	3.52

JCET M-year Results: Monument Peak (7110)



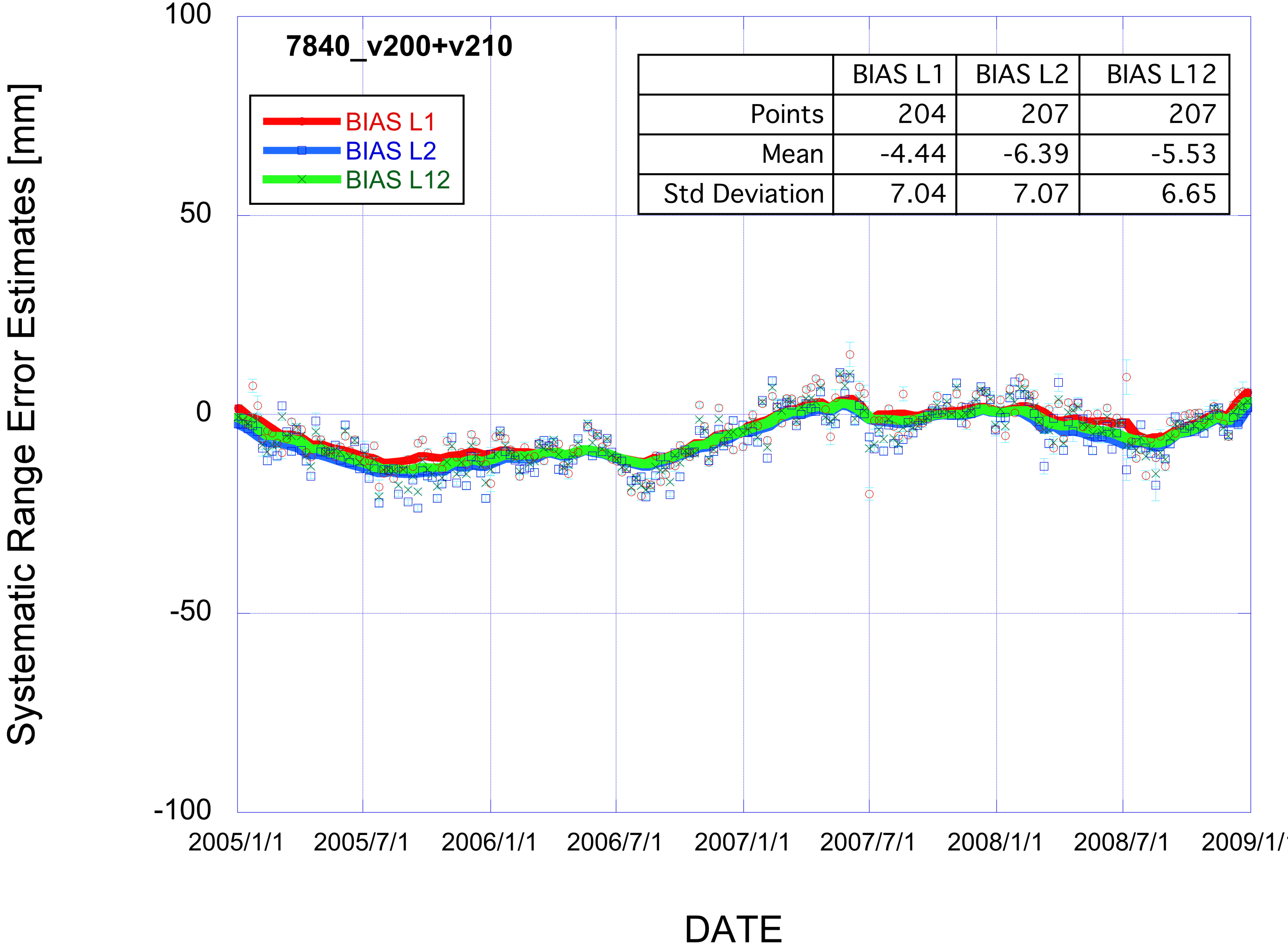
	BIAS L1	BIAS L2	BIAS L12
Points	174	180	182
Mean	-5.60	-5.80	-5.32
Std Deviation	6.78	6.42	5.79

JCET M-year Results: Matera (7941)



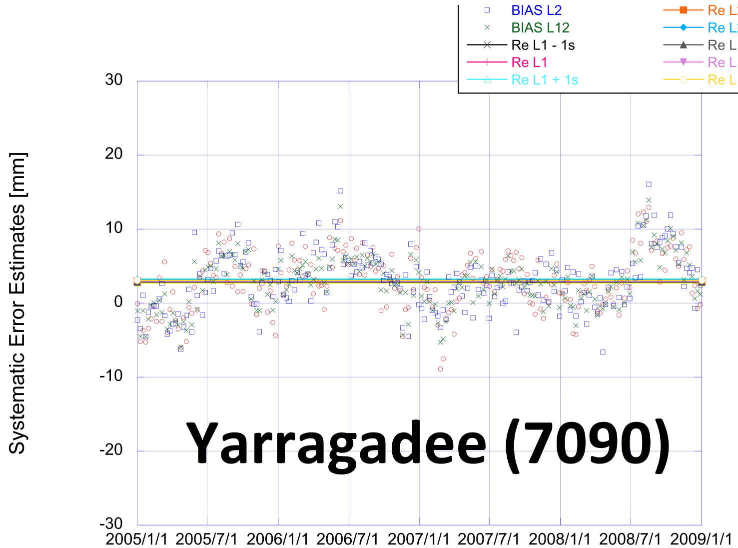
	BIAS L1	BIAS L2	BIAS L12
Points	182	179	183
Mean	-4.24	-6.72	-5.55
Std Deviation	10.66	10.95	10.59

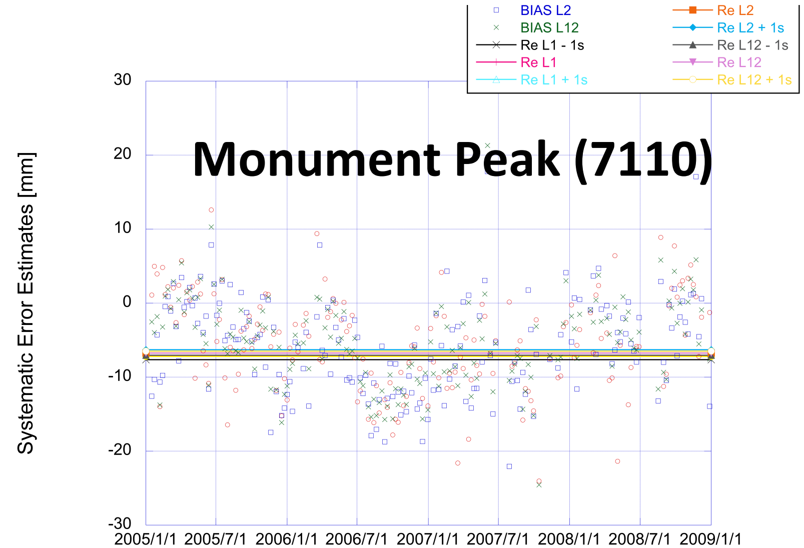
JCET M-year Results: Herstmonceux (7840)

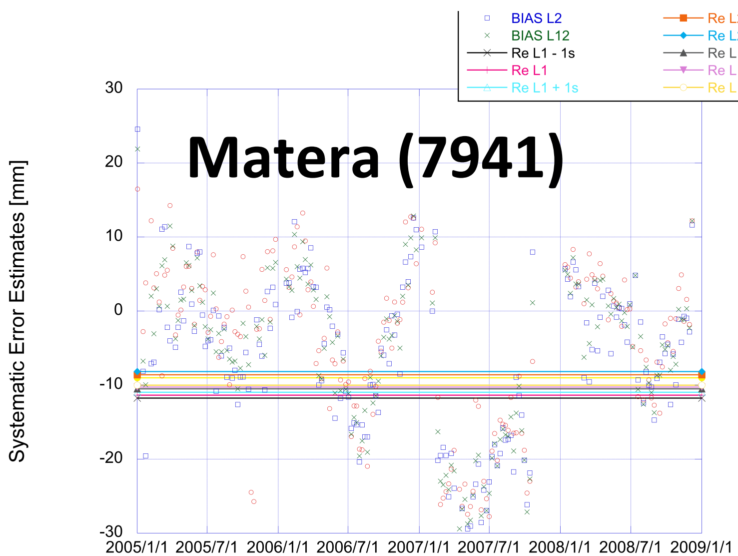


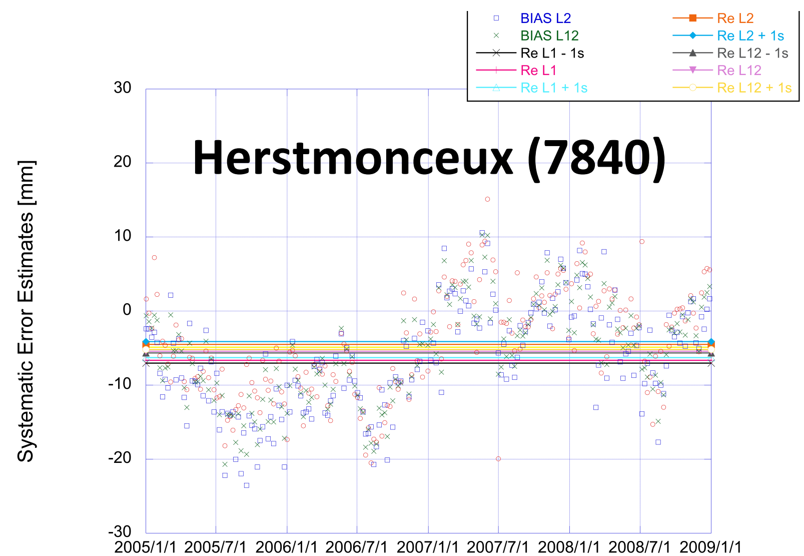
	BIAS L1	BIAS L2	BIAS L12
Points	204	207	207
Mean	-4.44	-6.39	-5.53
Std Deviation	7.04	7.07	6.65

JCET Multi-year Estimates (single error)

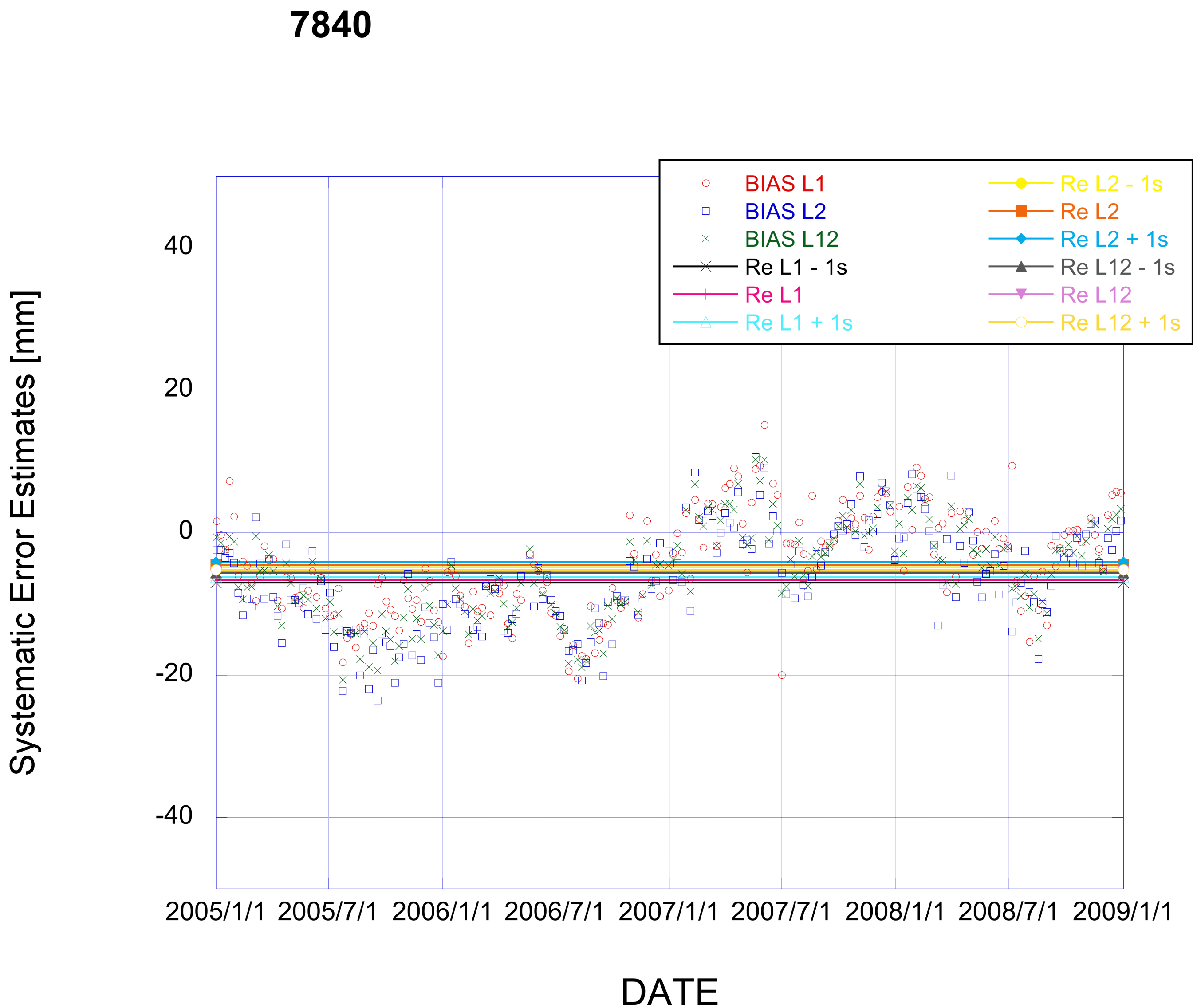




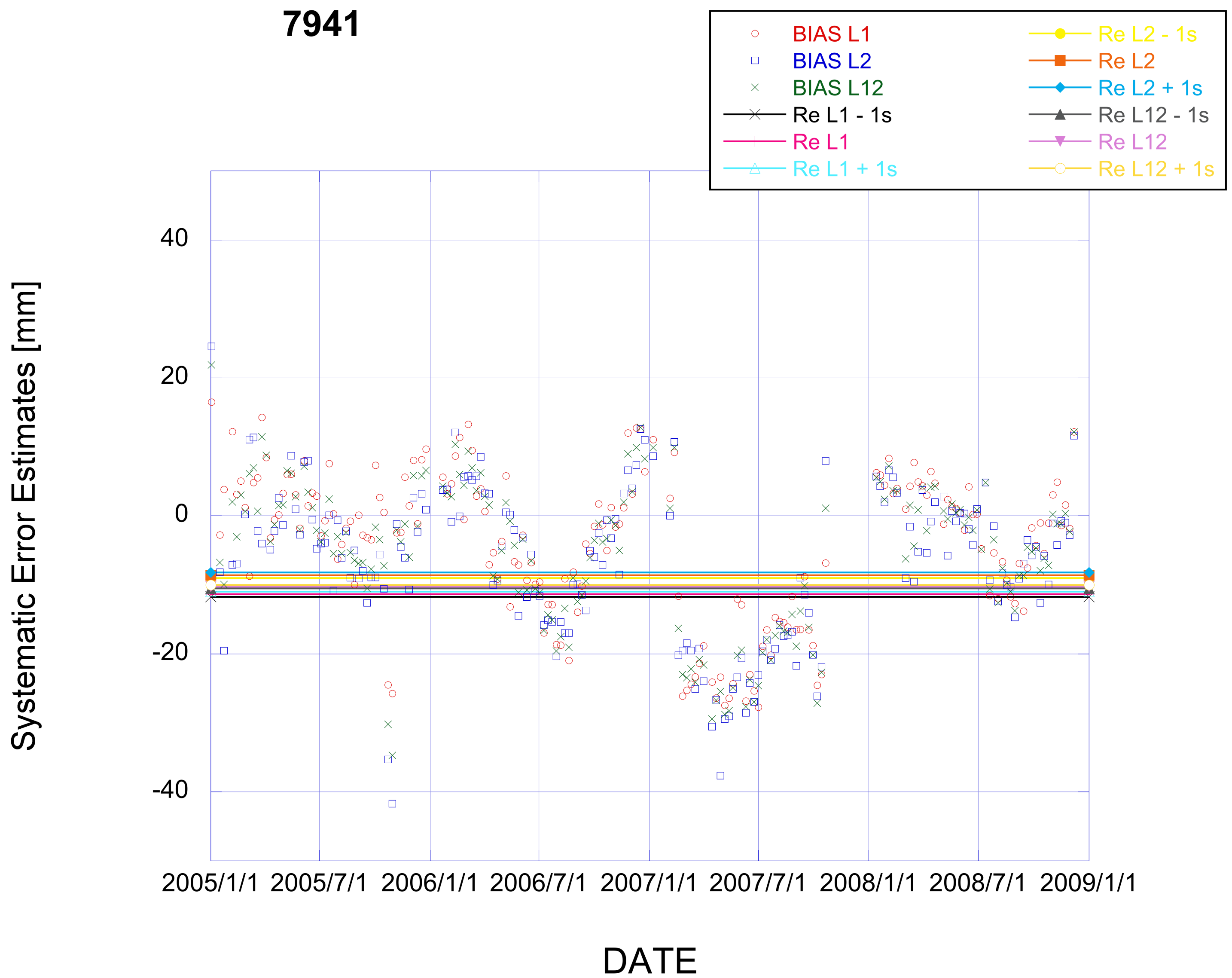




Herstmonceux (7840)



Matera (7941)


7941
BIAS L1
BIAS L2
BIAS L12
Re L1 - 1s
Re L1
Re L1 + 1s
Re L2 - 1s
Re L2
Re L2 + 1s
Re L12 - 1s
Re L12
Re L12 + 1s
Systematic Error Estimates [mm]
40
20
0
-20
-40
2005/1/1
2005/7/1
2006/1/1
2006/7/1
2007/1/1
2007/7/1
2008/1/1
2008/7/1
2009/1/1
DATE

Impact on TRF Origin & Scale

	Statistic	Separate Error Estimate for L1 & L2					Single Error Estimate for L1 & L2				
	Component [mm]	ΔX	ΔY	ΔZ	Δh	D_s^{ppb}	ΔX	ΔY	ΔZ	Δh	D_s^{ppb}
WEEKLY ERRORS	Mean ΔXYZ	-1.13	+1.90	+0.42	+2.24	+0.35	-1.71	+2.08	+1.57	+2.75	+0.43
	ΔXYZ Scatter	5.11	5.77	4.15	7.29		5.85	5.51	4.41	7.25	
	Average σ	0.71	0.74	0.75	1.07	0.17	0.70	0.73	0.77	1.08	0.17
SINGLE ERROR	Mean ΔXYZ	-1.31	+1.20	-0.29	+0.73	+0.11	-1.75	+1.06	+0.54	+0.82	+0.13
	ΔXYZ Scatter	6.32	6.12	7.16	9.47		7.03	5.93	7.14	9.42	
	Average σ	1.39	1.45	1.52	2.16	0.34	0.86	0.90	0.94	1.34	0.21

JCET Multi-year Solutions Summary

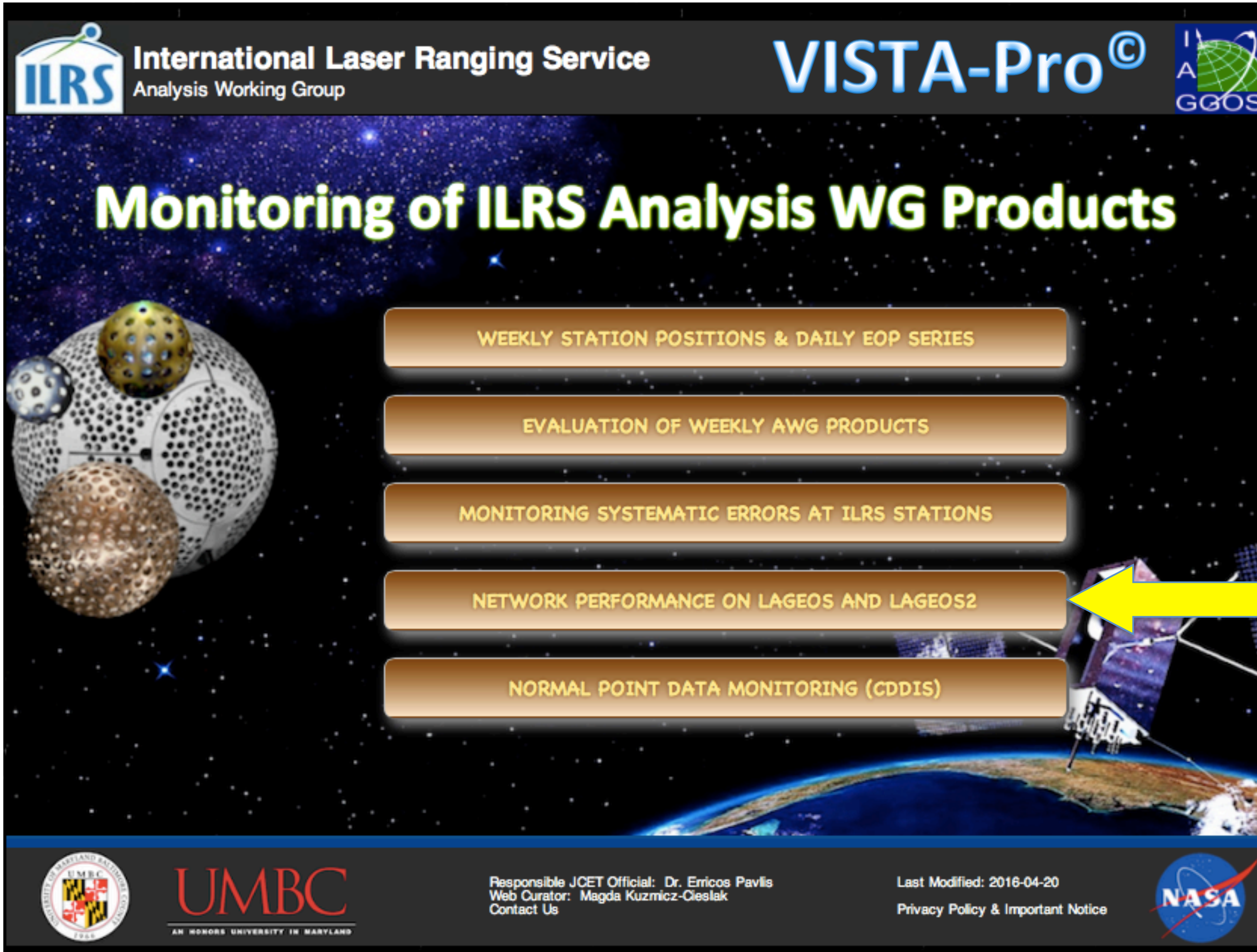
- While the weekly error estimates look very much like those obtained under the official PP plan (where we are adjusting the stations each week), their scatter looks smaller in this solution (where we adjusted the stations at one epoch)

- When a single error for all four years is estimated, for each system, the estimate is close to the mean of the weekly results, but the statistics of the station positions (especially their height *h!*) worsen significantly, as they absorb non-accommodated error.

Summary

- Upon completing this PP we should move to the next phase:
  - Adopting a standard procedure for continuous monitoring of system errors
  - Making the results publicly available in a self-explanatory manner and communicating these to the stations in order to take appropriate action
- This is a long-term project, overseen by Analysts, Engineers, Network Managers and the ILRS CB that comprise the newly established Quality Control Board (QCB)

Visualization of ILRS Systems & Technique Analysis Products – VISTA-Pro©



NETWORK PERFORMANCE BASED ON LAGEOS 1 & 2

Satellite — Satellite

Start (YYYY-MM-DD):

End (YYYY-MM-DD):

Minimumn elevation [°] — 10

STATIONS ☐ Select All

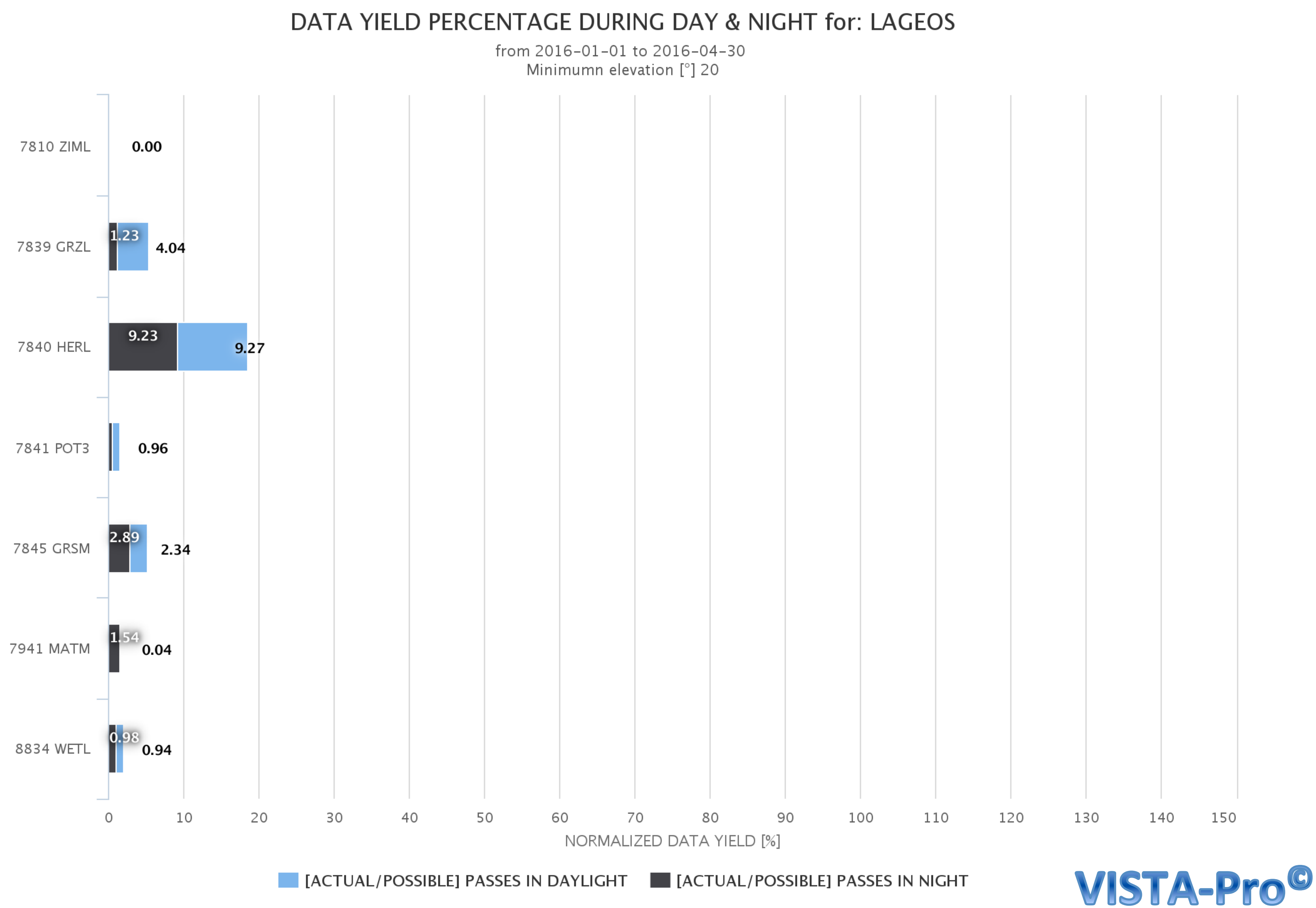
- ☐ 1824 Golosiiv
- ☐ 1868 Komsomolsk-na-Amure
- ☐ 1873 Simeiz
- ☐ 1874 Mendeleevo 2
- ☐ 1879 Altay
- ☐ 1884 Riga
- ☐ 1886 Arkhyz
- ☐ 1887 Baikonur
- ☐ 1888 Svetloe
- ☐ 1889 Zelenchukskya
- ☐ 1890 Badary
- ☐ 1893 Katzively
- ☐ 7080 McDonald Observatory
- ☐ 7090 Yarragadee
- ☐ 7105 Greenbelt
- ☐ 7110 Monument Peak
- ☐ 7119 Haleakala
- ☐ 7124 Tahiti
- ☐ 7501 Hartebeesthoek
- ☐ 7403 Arequipa
- ☐ 7237 Changchun
- ☐ 7249 Beijing
- ☐ 7308 Koganei
- ☐ 7359 Daedeok
- ☐ 7405 Concepcion
- ☐ 7406 San Juan
- ☐ 7820 Kunming
- ☐ 7821 Shanghai
- ☐ 7825 Mt Stromlo
- ☐ 7838 Simosato
- ☐ 7810 Zimmerwald
- ☐ 7839 Graz
- ☐ 7840 Herstmonceux
- ☐ 7841 Potsdam
- ☐ 7845 Grasse
- ☐ 7941 Matera
- ☐ 8834 Wettzell

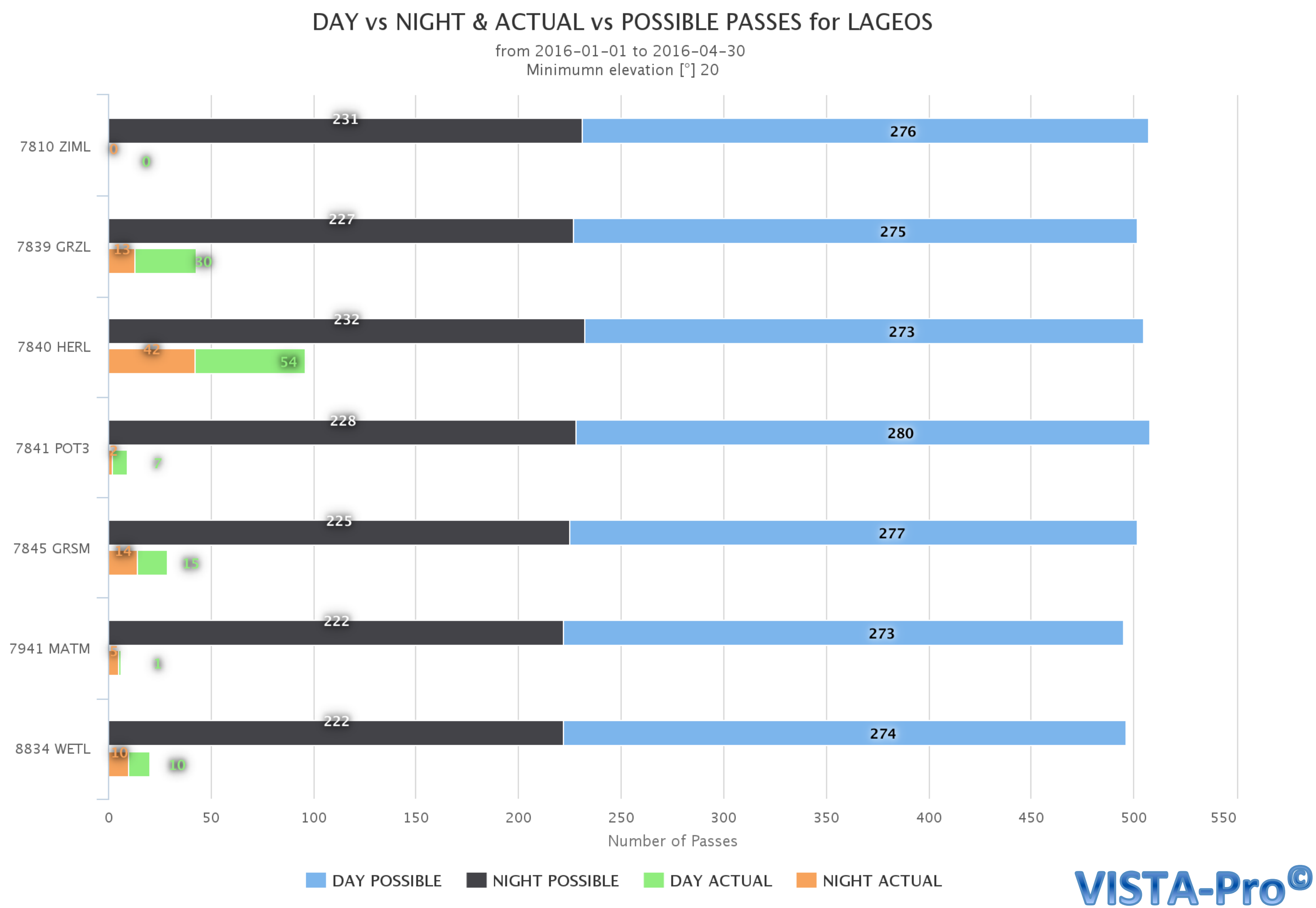
- ○ DAY vs NIGHT TRACKED NPs
- ○ DAY vs NIGHT TRACKED PASSES
- ○ DAY vs NIGHT NORMALIZED DATA YIELD (%)

Submit

Last Modified: 2016-04-21

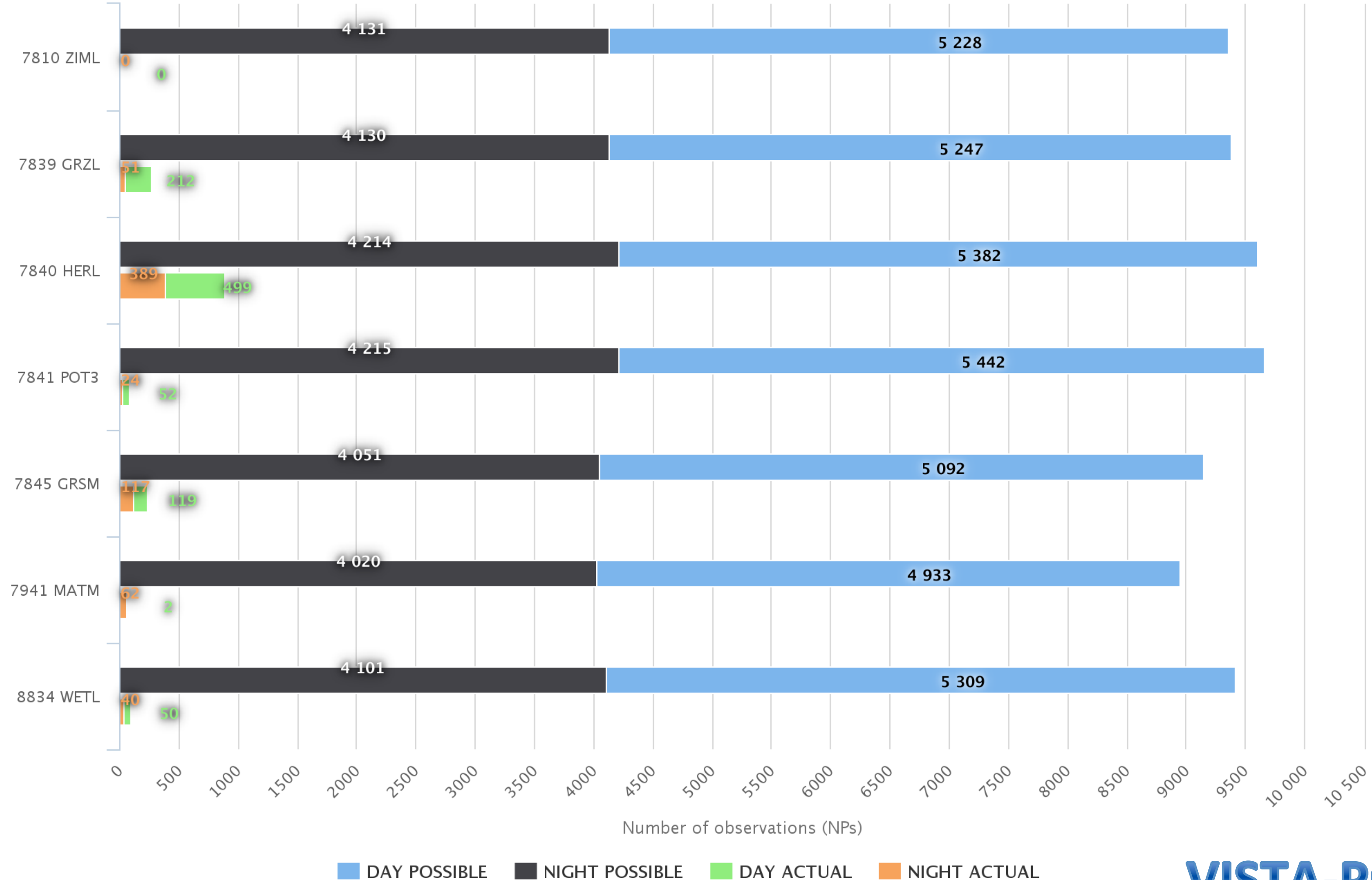
VISTA-Pro©


DATA YIELD PERCENTAGE DURING DAY & NIGHT for: LAGEOS
from 2016-01-01 to 2016-04-30
Minimumn elevation [°] 20
7810 ZIML
0.00
7839 GRZL
1.23
4.04
7840 HERL
9.23
9.27
7841 POT3
0.96
7845 GRSM
2.89
2.34
7941 MATM
1.54
0.04
8834 WETL
0.98
0.94
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
NORMALIZED DATA YIELD [%]
[ACTUAL/POSSIBLE] PASSES IN DAYLIGHT
[ACTUAL/POSSIBLE] PASSES IN NIGHT
VISTA-Pro©


DAY vs NIGHT & ACTUAL vs POSSIBLE PASSES for LAGEOS
from 2016-01-01 to 2016-04-30
Minimumn elevation [°] 20
7810 ZIML
231
276
0
0
7839 GRZL
227
275
13
30
7840 HERL
232
273
42
54
7841 POT3
228
280
2
7
7845 GRSM
225
277
14
15
7941 MATM
222
273
5
1
8834 WETL
222
274
10
10
0
50
100
150
200
250
300
350
400
450
500
550
Number of Passes
DAY POSSIBLE
NIGHT POSSIBLE
DAY ACTUAL
NIGHT ACTUAL
VISTA-Pro©

DAY vs NIGHT & ACTUAL vs POSSIBLE NPs for: LAGEOS

from 2016-01-01 to 2016-04-30
Minimumn elevation [°] 20

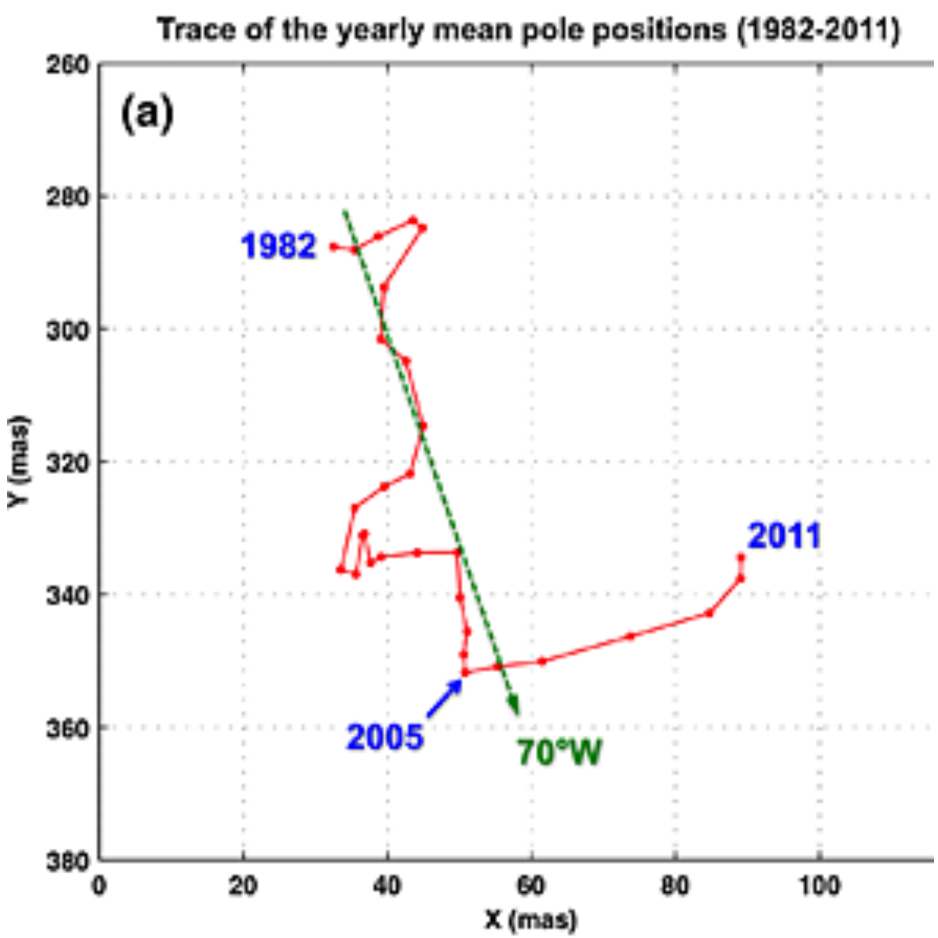


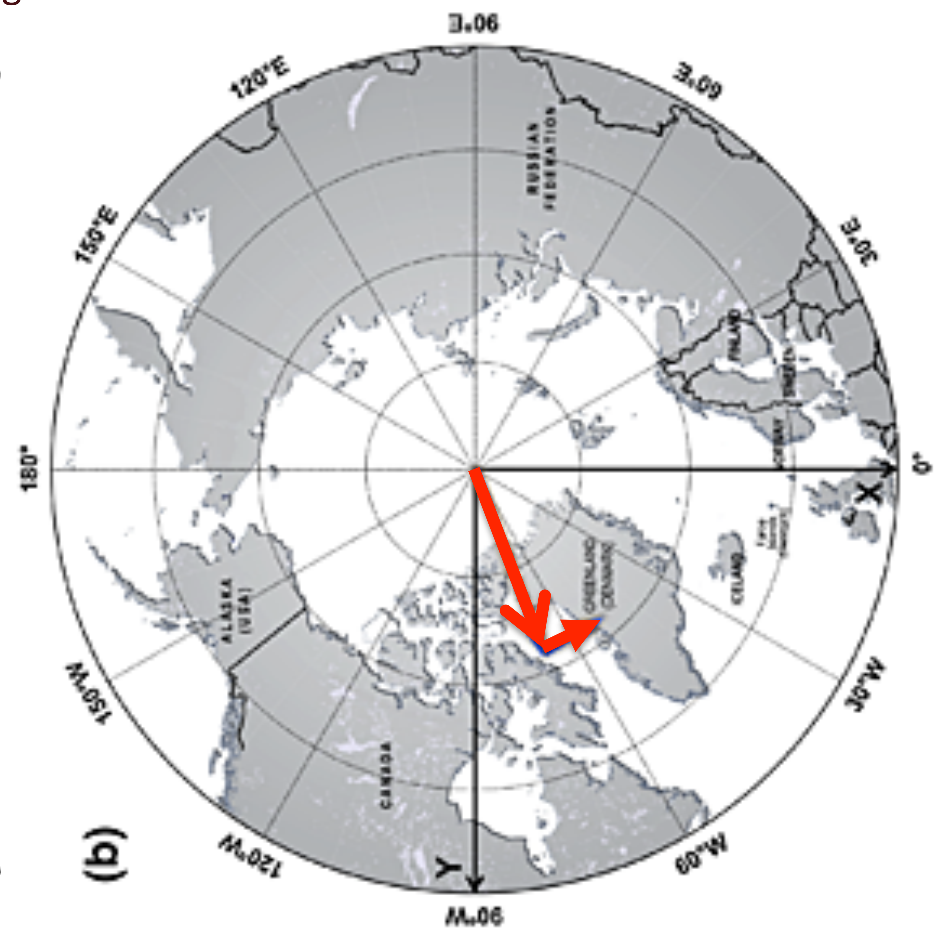
VISTA-Pro©

Rapid ice melting drives Earth's pole to the east

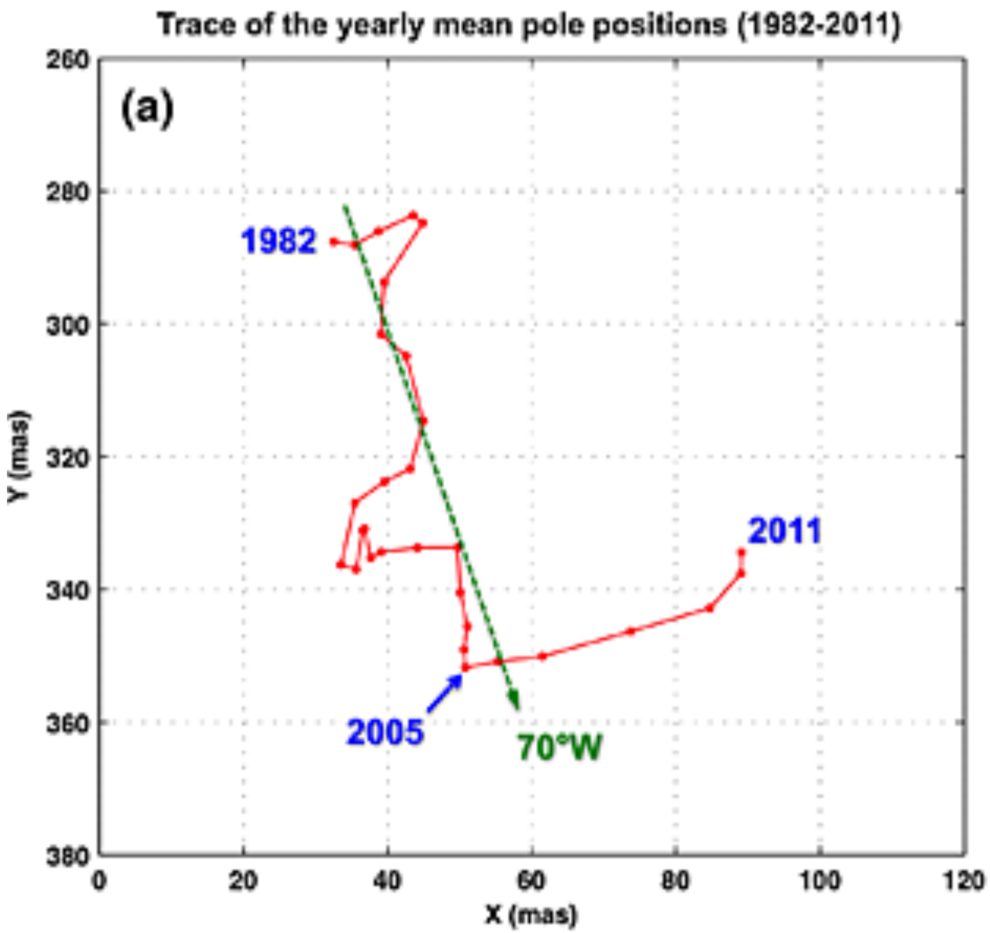
J. L. Chen[1], C. R. Wilson[1,2], J. C. Ries[1], B. D. Tapley[1]

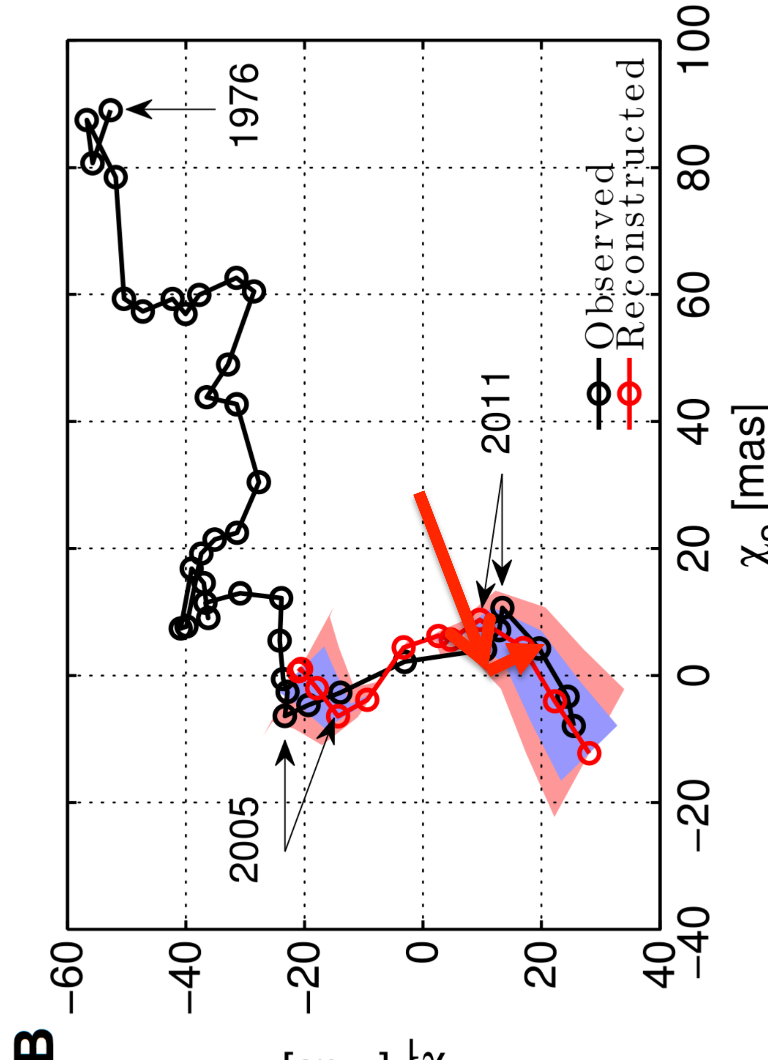
DOI: 10.1002/grl.50552





S. Adhikari & Erik R. Ivins
JPL





Climate-driven Polar Motion: 2003-2015

S. Adhikari & Erik R. Ivins /JPL

Sci. Adv. 2016;2:e1501693 8 April 2016

RESEARCH ARTICLE

CLIMATOLOGY

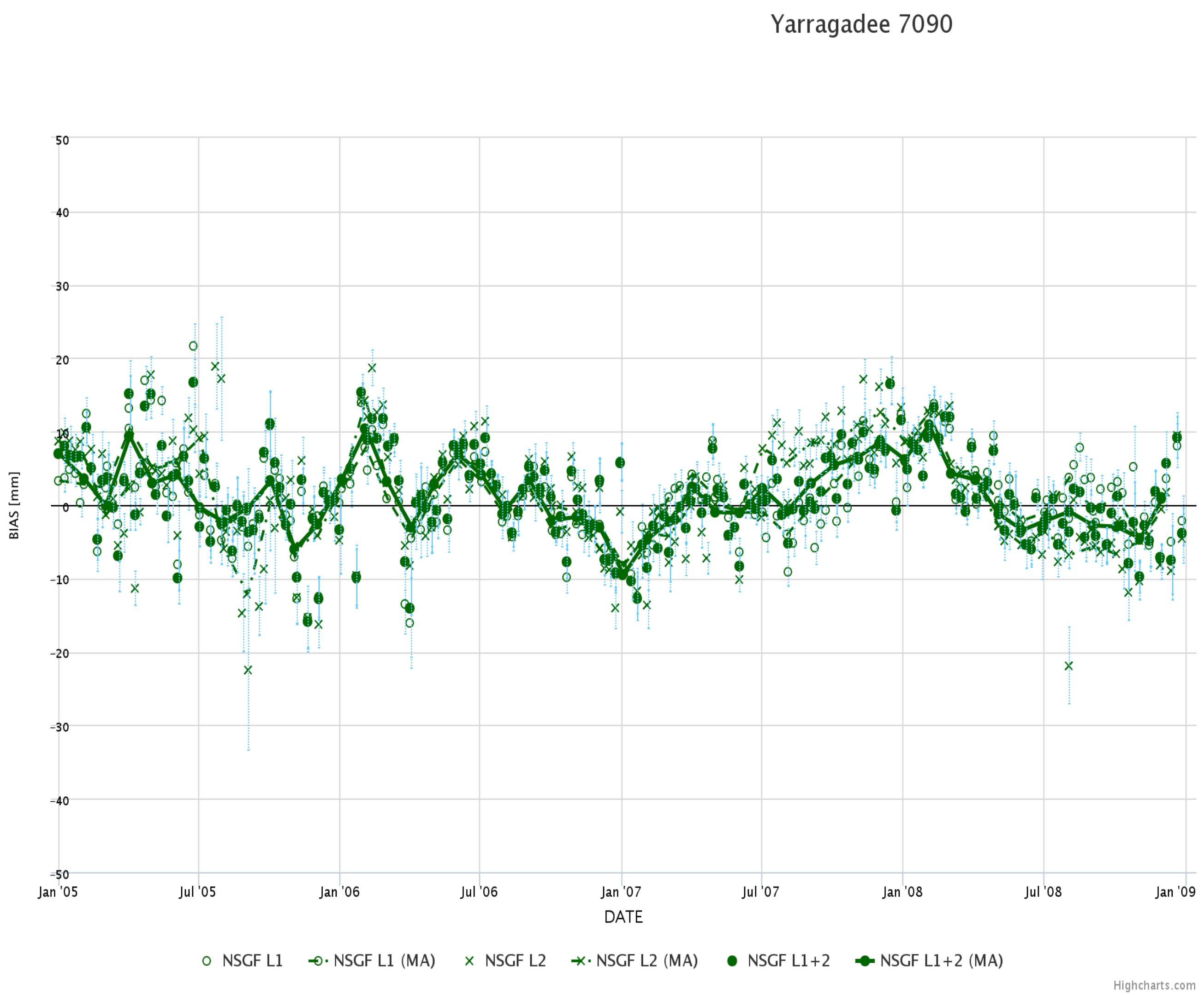
Climate-driven polar motion: 2003–2015

Surendra Adhikari* and Erik R. Ivins

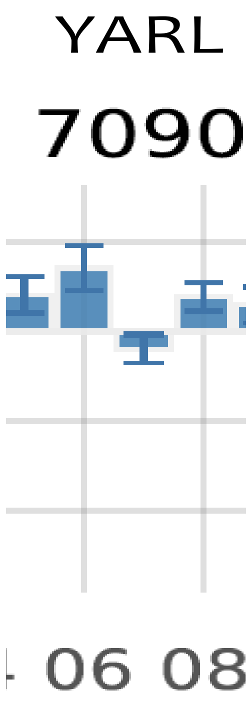
10.1126/sciadv.1501693

Earth's spin axis has been wandering along the Greenwich meridian since about 2000, representing a 75° eastward shift from its long-term drift direction. The past 115 years have seen unequivocal evidence for a quasi-decadal periodicity, and these motions persist throughout the recent record of pole position, in spite of the new drift direction. We analyze space geodetic and satellite gravimetric data for the period 2003–2015 to show that all of the main features of polar motion are explained by global-scale continent-ocean mass transport. The changes in terrestrial water storage (TWS) and global cryosphere together explain nearly the entire amplitude (83 ± 23%) and mean directional shift (within 5.9° ± 7.6°) of the observed motion. We also find that the TWS variability fully explains the decadal-like changes in polar motion observed during the study period, thus offering a clue to resolving the long-standing quest for determining the origins of decadal oscillations. This newly discovered link between polar motion and global-scale TWS variability has broad implications for the study of past and future climate.

7090

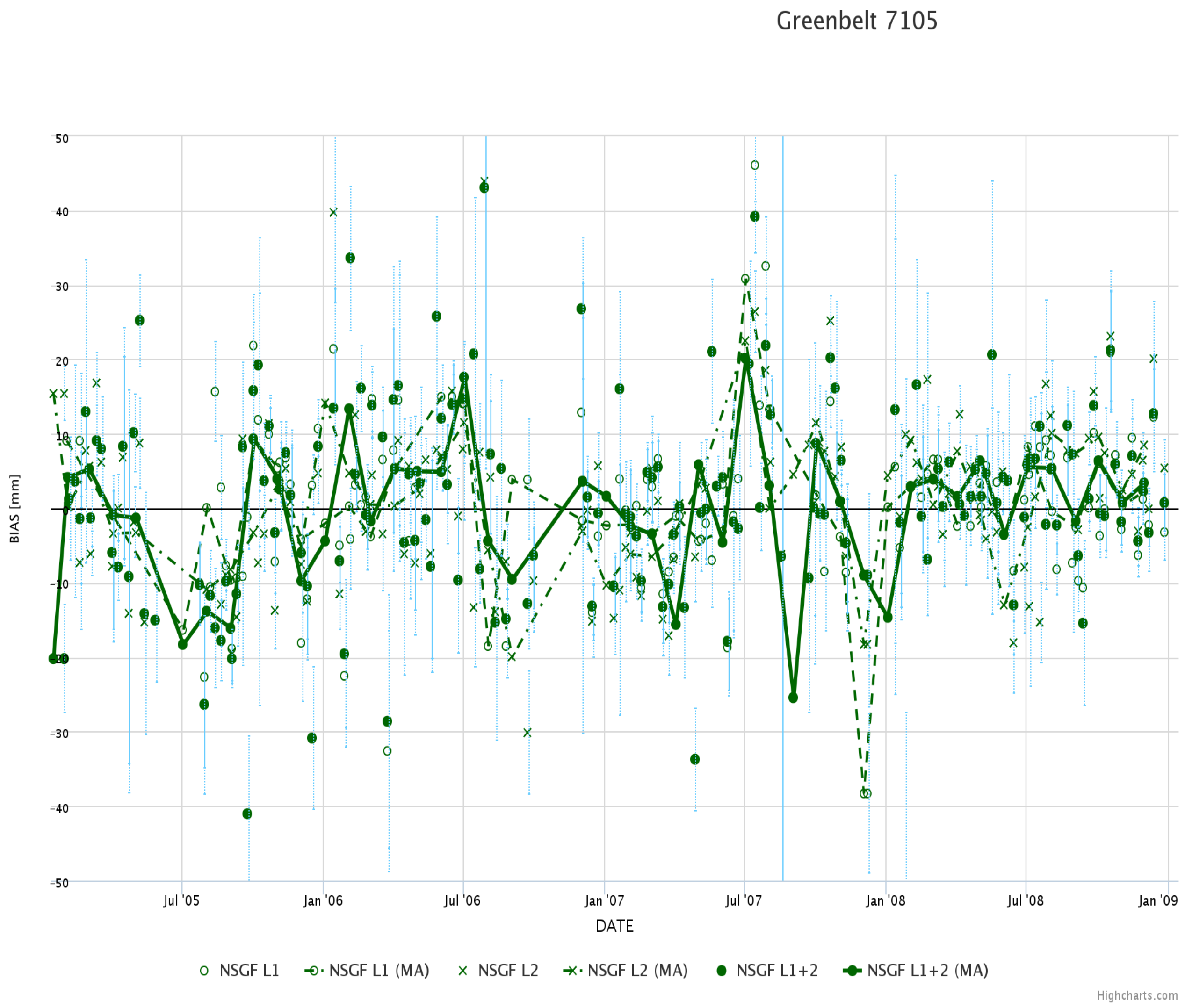


Yarragadee 7090
BIAS [mm]
50
40
30
20
10
0
-10
-20
-30
-40
-50
Jan '05
Jul '05
Jan '06
Jul '06
Jan '07
Jul '07
Jan '08
Jul '08
Jan '09
DATE
NSGF L1
NSGF L1 (MA)
NSGF L2
NSGF L2 (MA)
NSGF L1+2
NSGF L1+2 (MA)
Highcharts.com

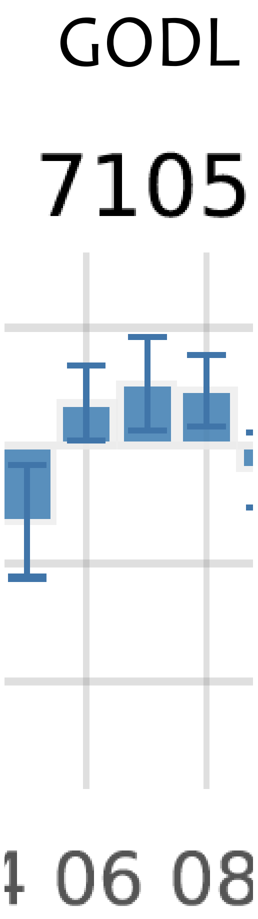


YARL
7090
06 08

7105

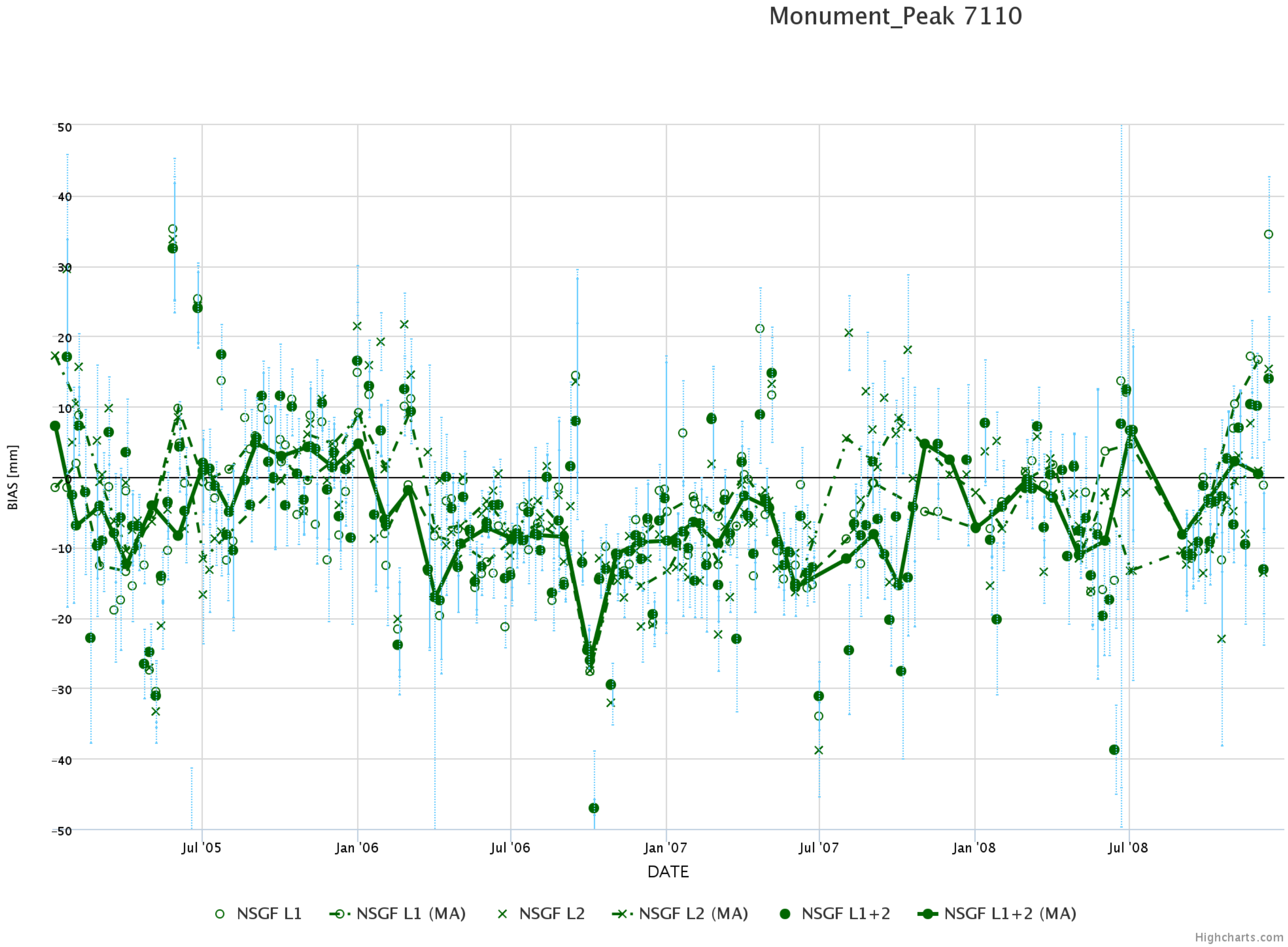


Greenbelt 7105
50
40
30
20
10
0
-10
-20
-30
-40
-50
BIAS [mm]
Jul '05
Jan '06
Jul '06
Jan '07
Jul '07
Jan '08
Jul '08
Jan '09
DATE
NSGF L1
NSGF L1 (MA)
NSGF L2
NSGF L2 (MA)
NSGF L1+2
NSGF L1+2 (MA)
Highcharts.com



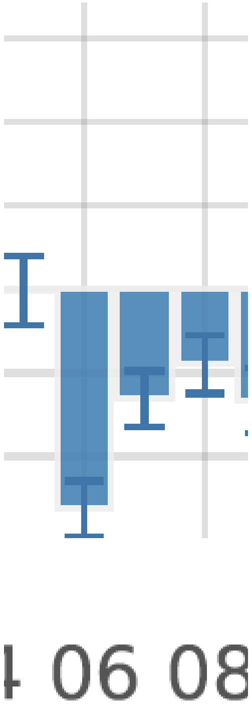
GODL
7105
06 08

7110



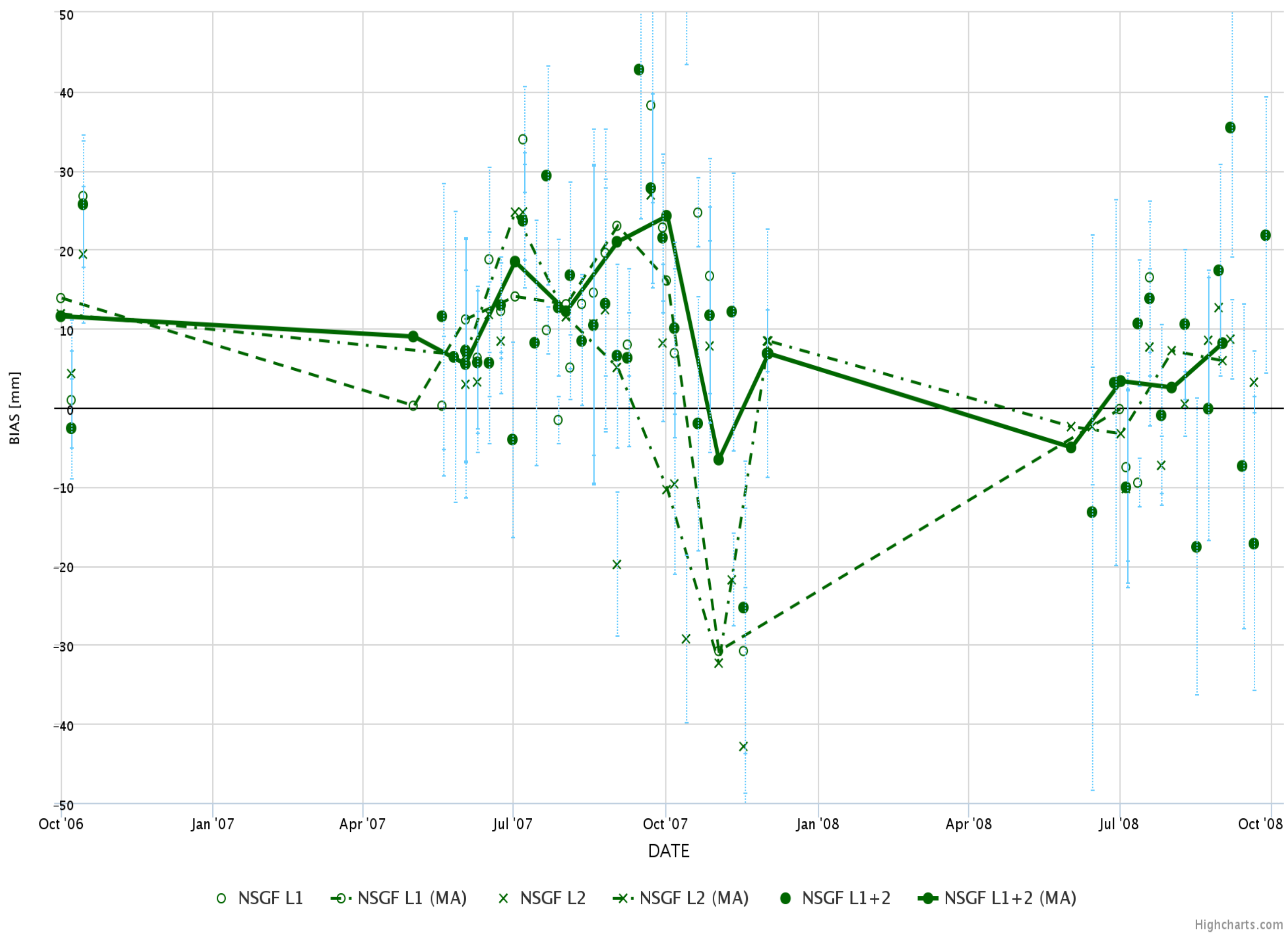
MONL

7110



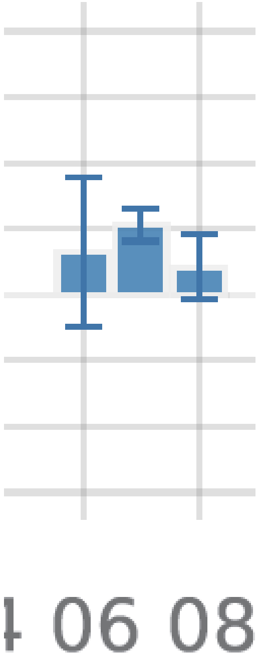
7403

Arequipa 7403

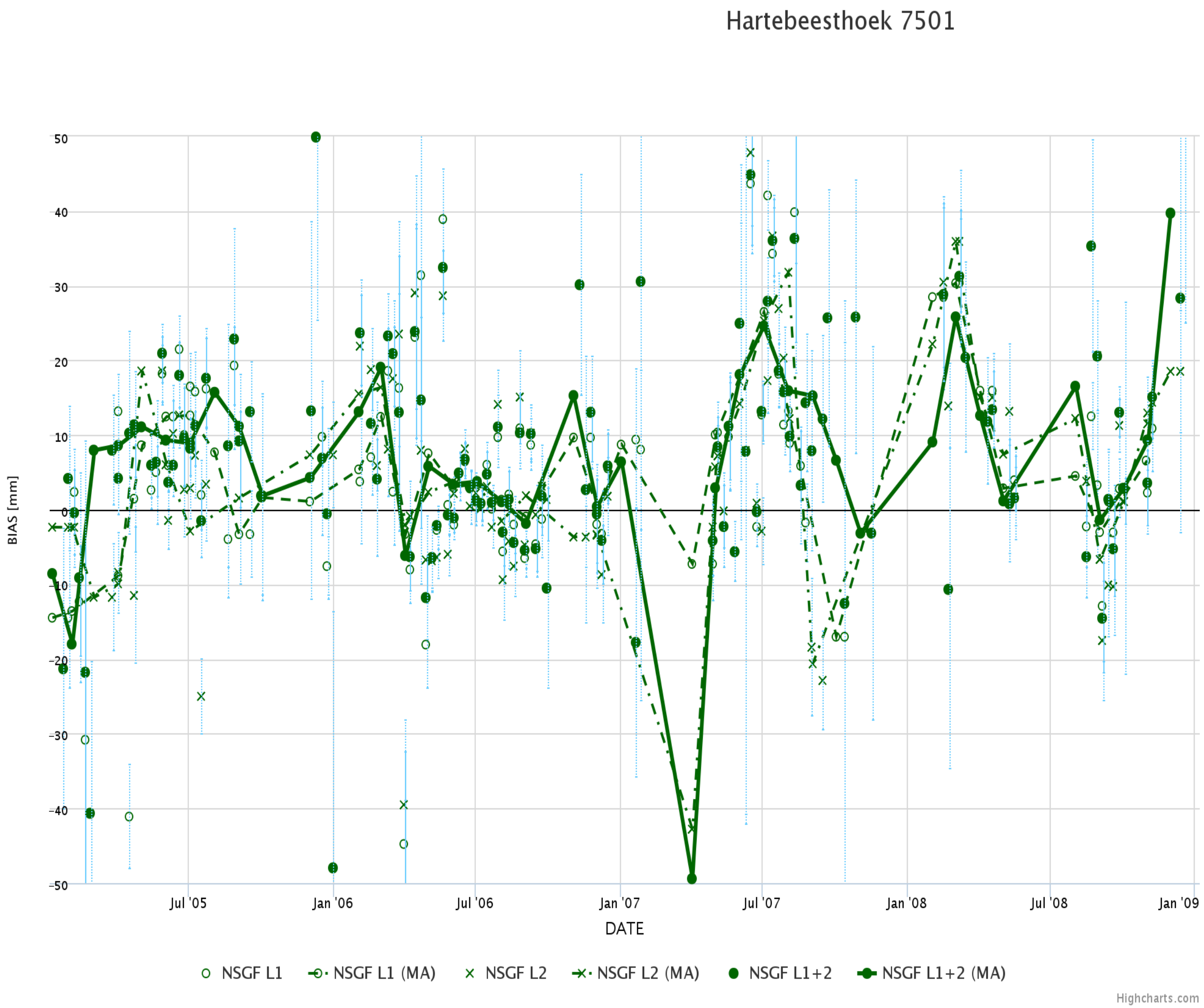


AREL

7403



7501



HARL

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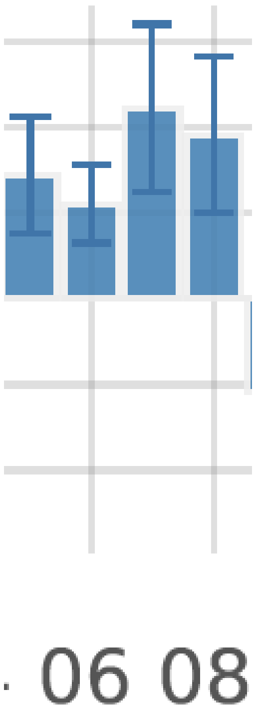
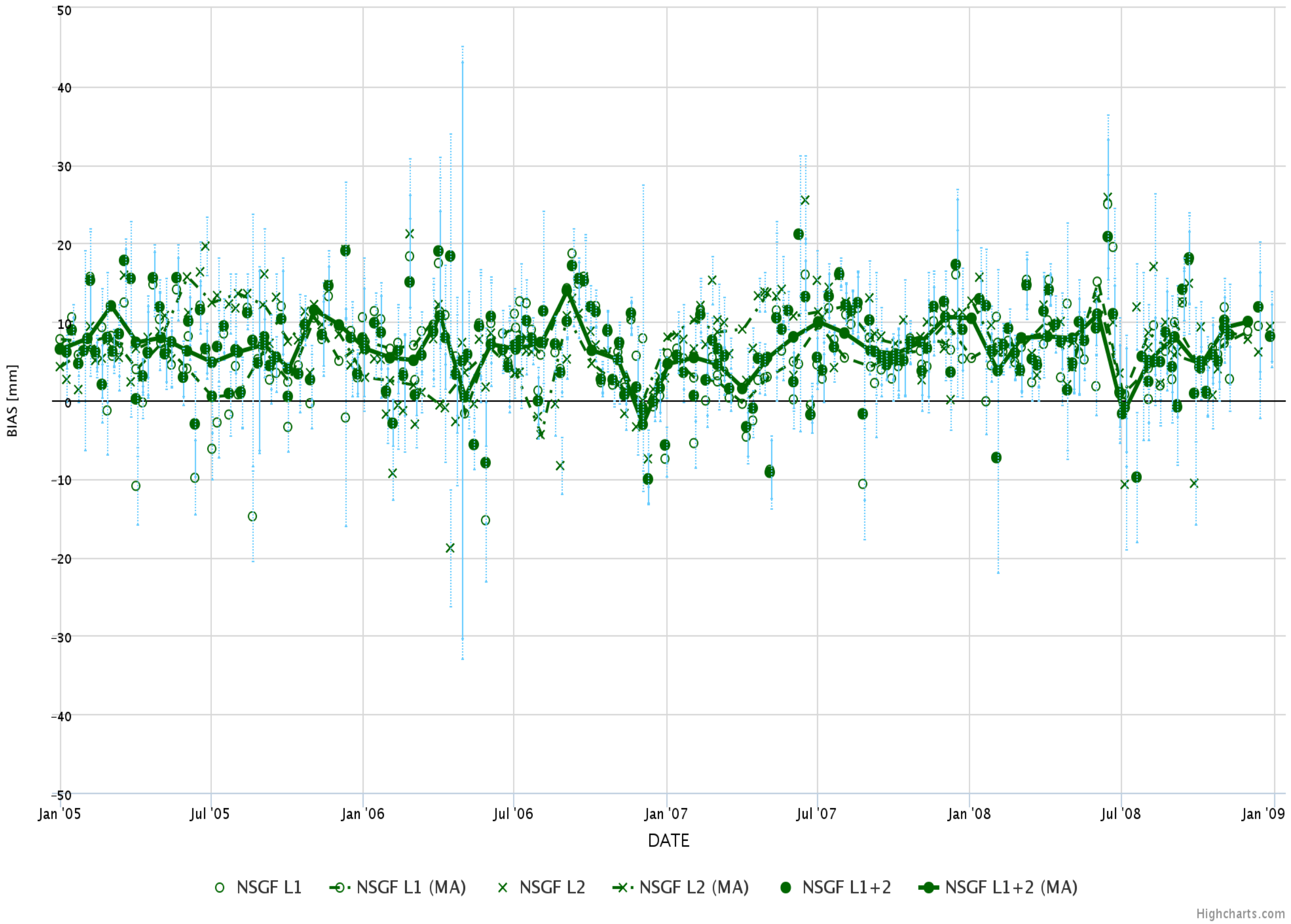


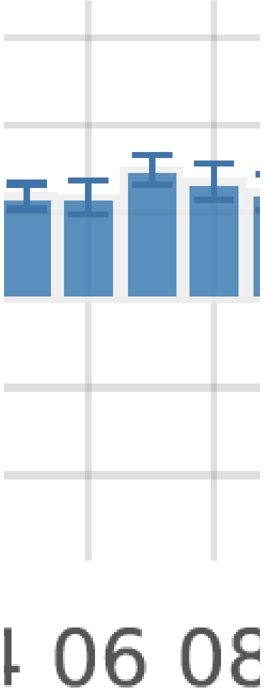
7839

Graz 7839

GRZL

7839





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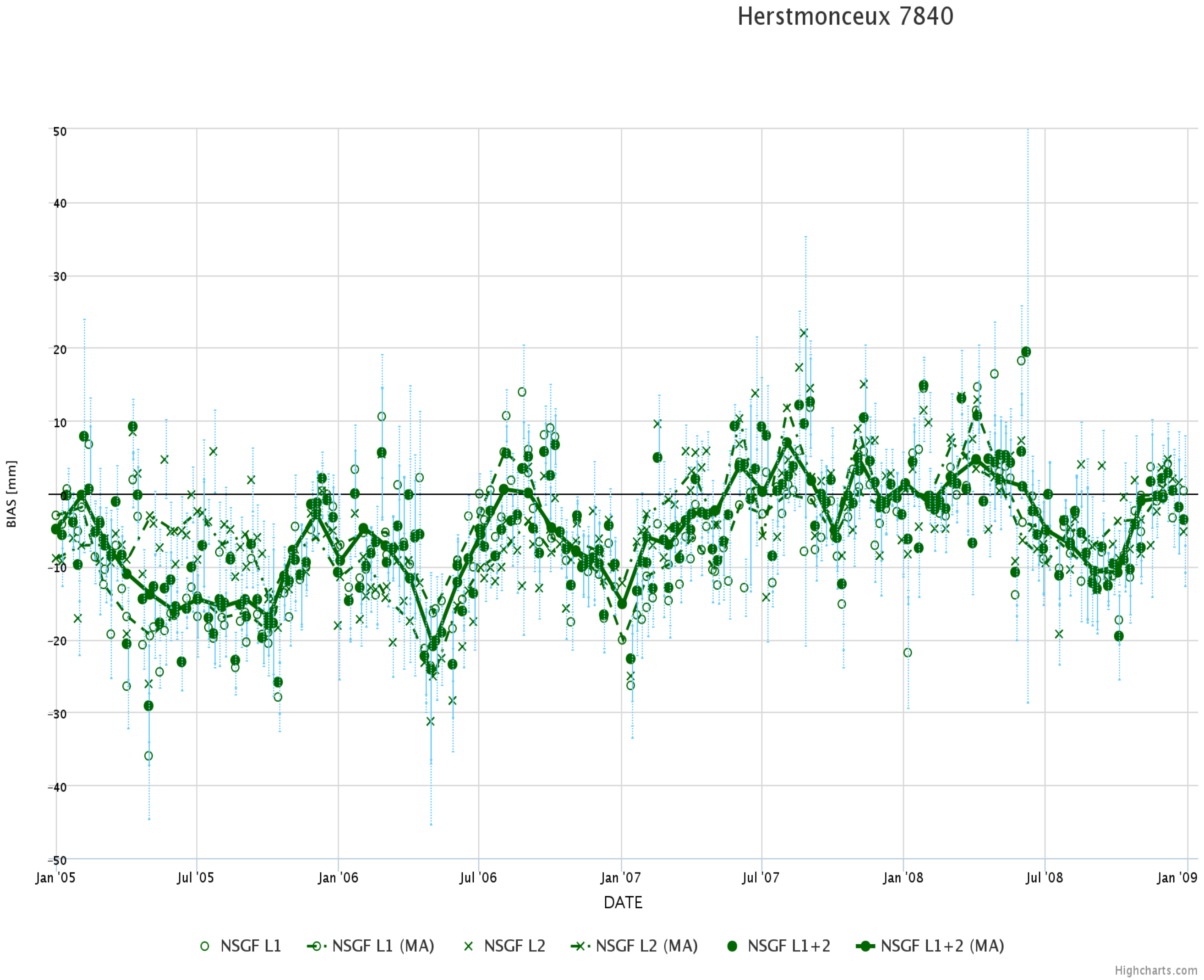
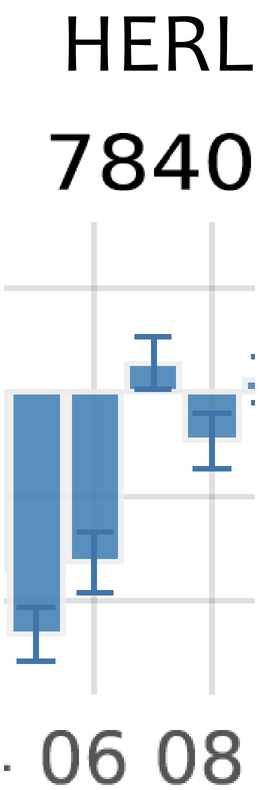
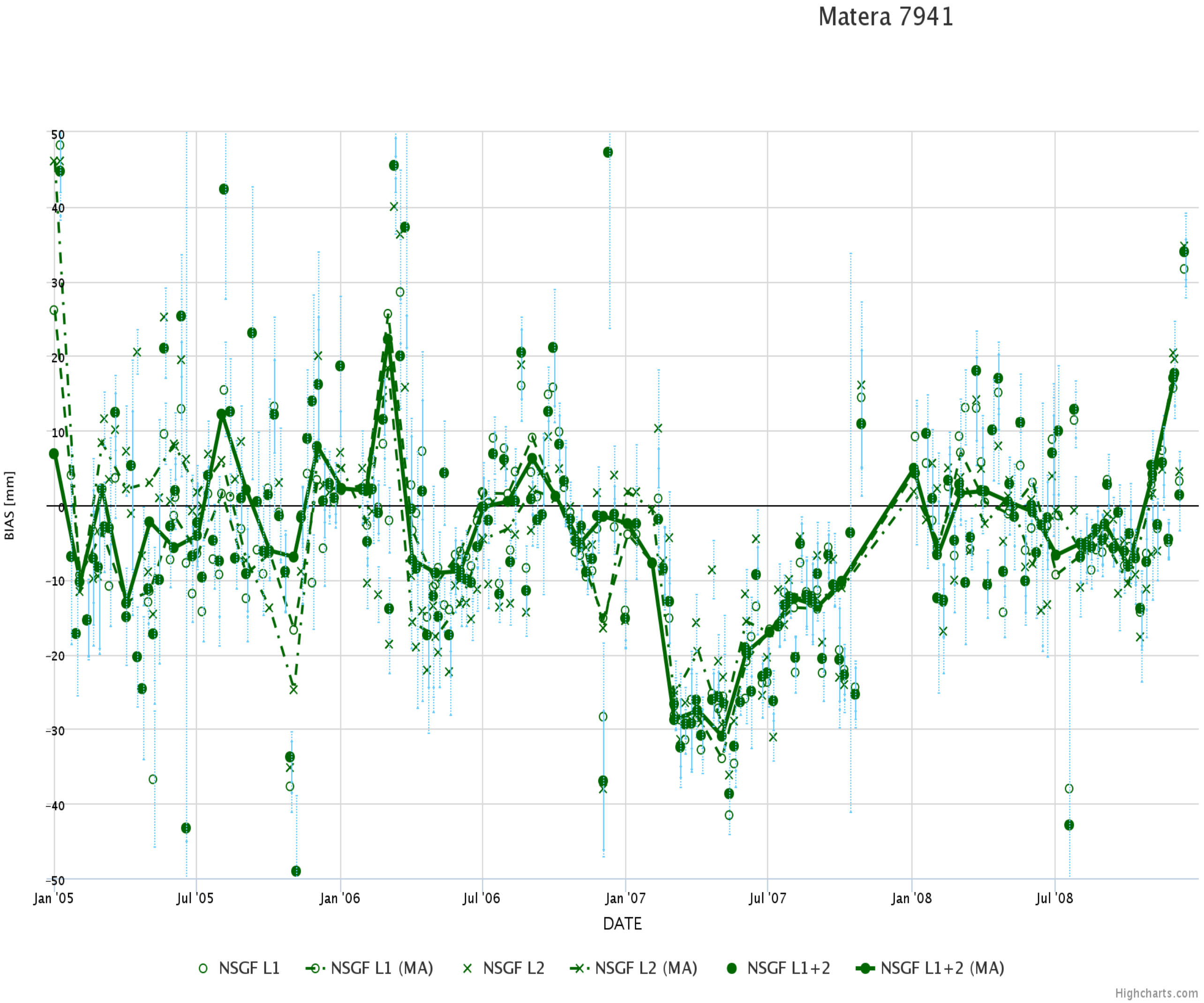

Herstmonceux 7840
BIAS [mm]
50
40
30
20
10
-10
-20
-30
-40
-50
Jan '05
Jul '05
Jan '06
Jul '06
Jan '07
Jul '07
Jan '08
Jul '08
Jan '09
DATE
NSGF L1
NSGF L1 (MA)
NSGF L2
NSGF L2 (MA)
NSGF L1+2
NSGF L1+2 (MA)
Highcharts.com

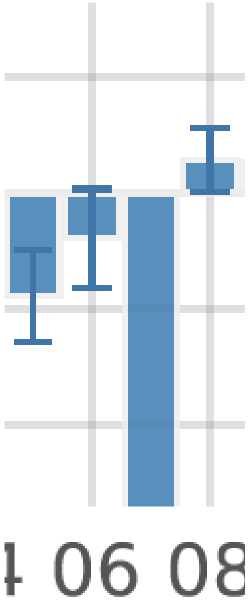

HERL
7840
06 08

7941



MATM

7941



LLR Status Report
- 2016 -

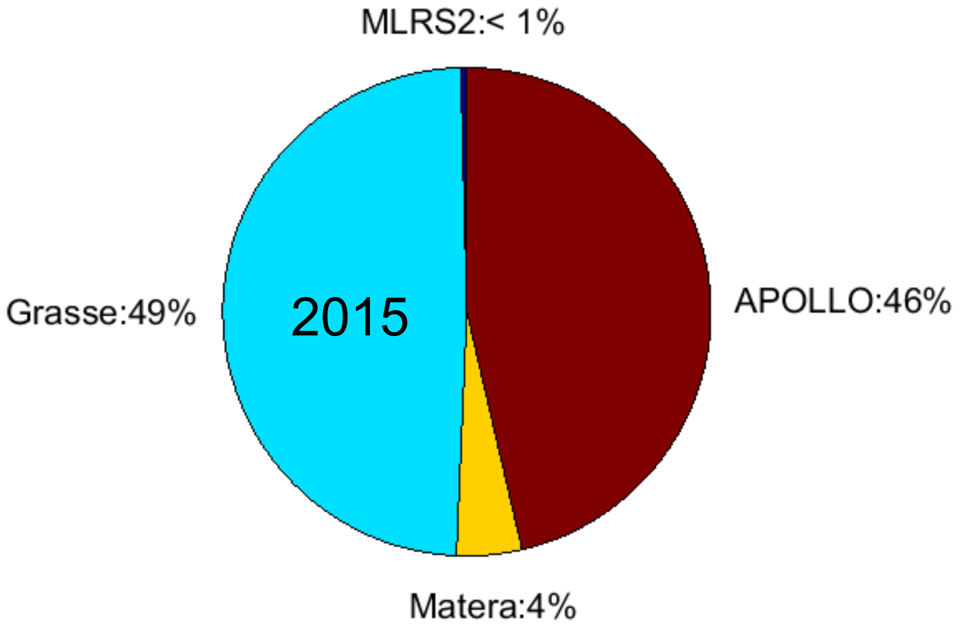
Jürgen Müller

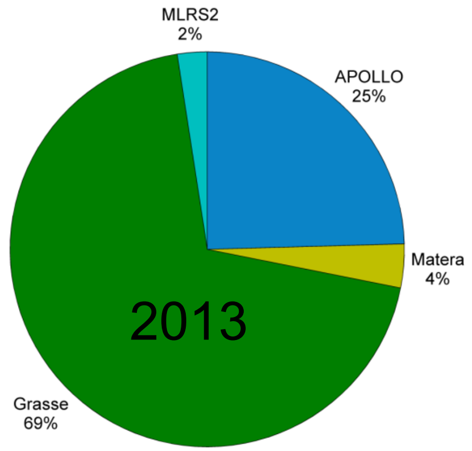
Institut für Erdmessung (Institute of Geodesy) and

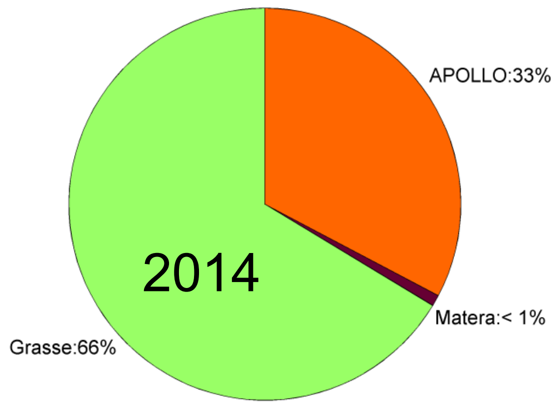
Leibniz Universität Hannover (University of Hannover)

Statistics – observatories 2015

Normal points	2014	2015
APOLLO	212	236
McDonald	--	2
Grasse	430	249
Matera	6	22
In total	**648**	**509**







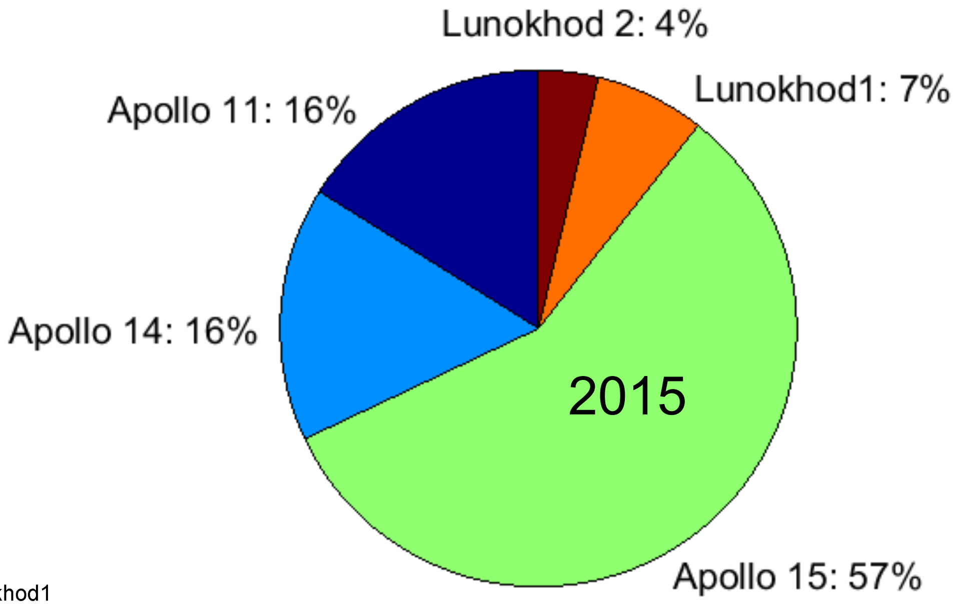
Status, perspective at the LLR sites

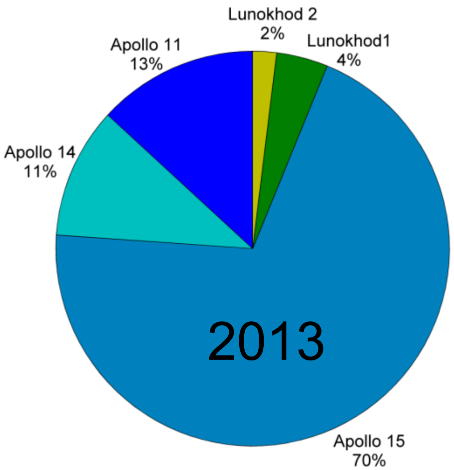
- McDonald – 2 LLR tracks in 2015, after complete gap in 2014
- Matera - lunar tracking increased a little bit
- APOLLO - good coverage of all reflectors
- Grasse - good performance, also infrared data;

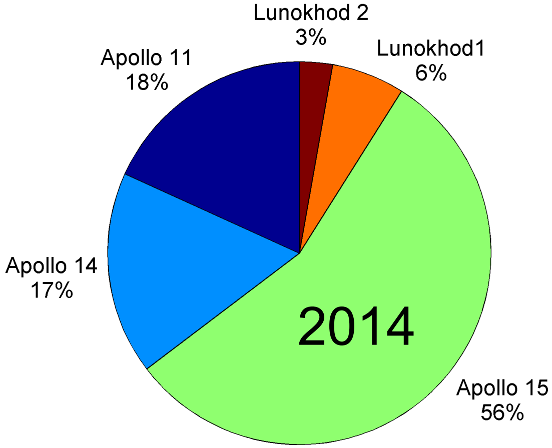
  new: provision of LLR data with some screening options
- Wettzell, Hartebeesthoek - systems prepared

Statistics – retro-reflectors 2015

Normal points	**2014**	**2015**
Apollo 11	118	82
Apollo 14	111	81
Apollo 15	361	292
Lunokhod 1	40	35
Lunokhod 2	18	19
In total	**648**	**509**

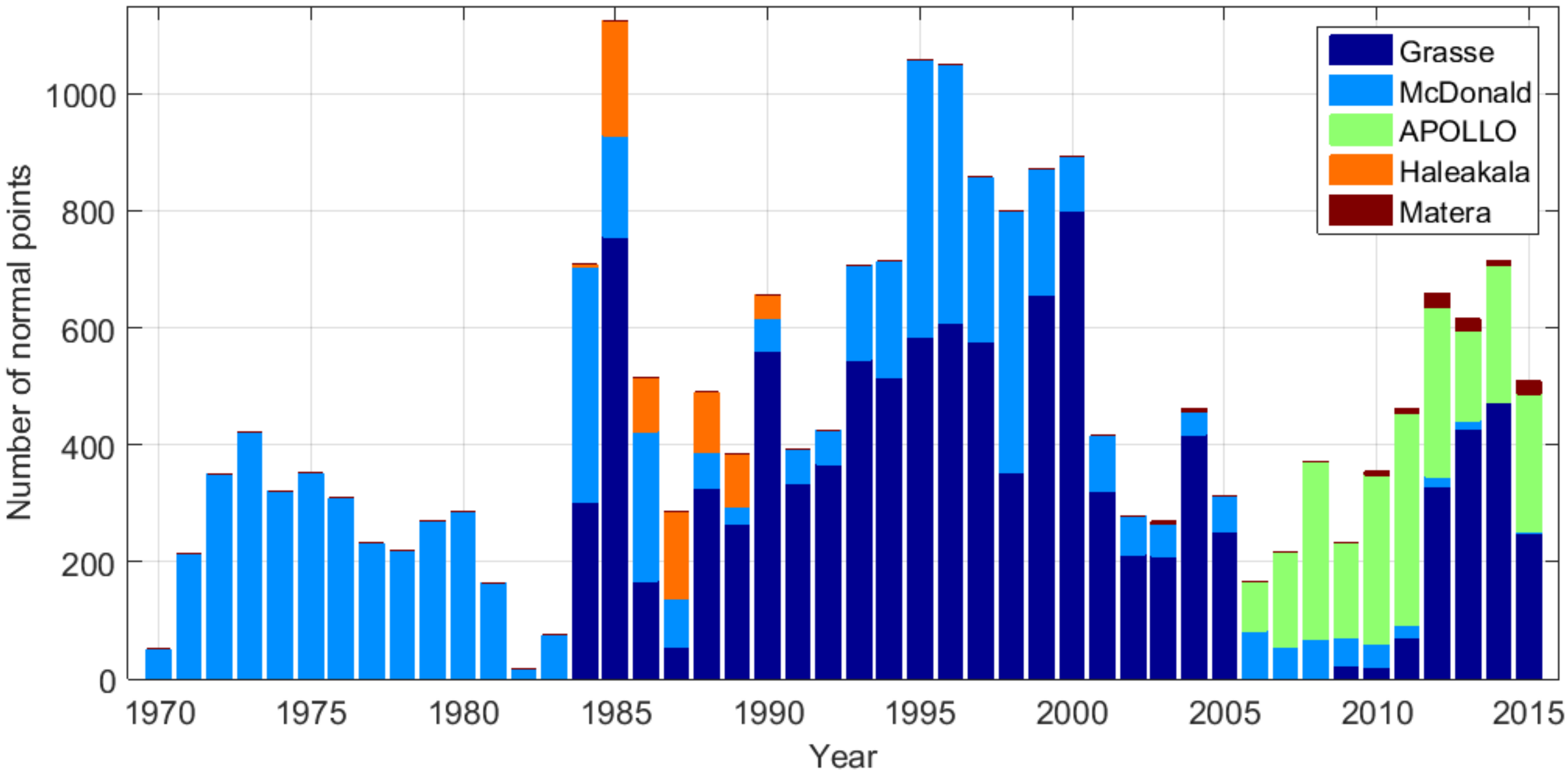






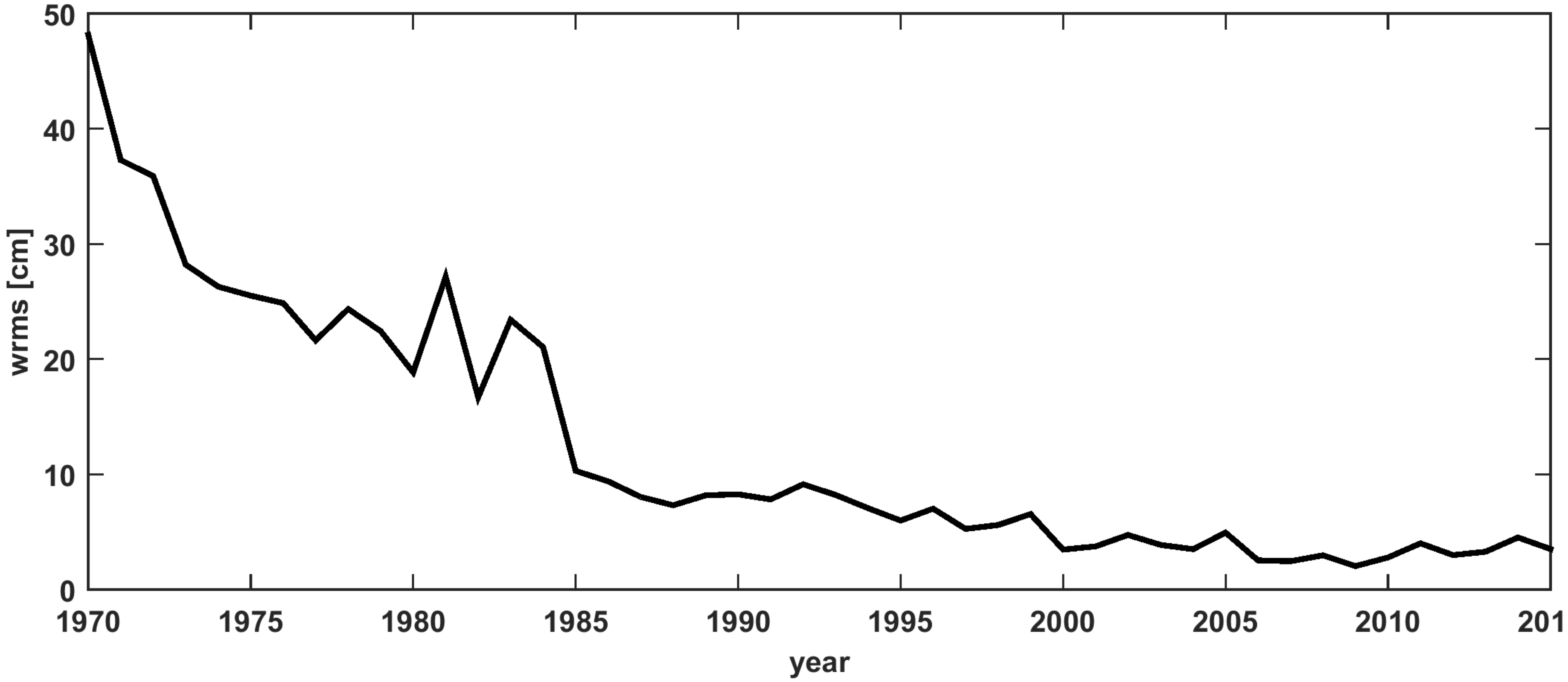
Number of normal points

1970 - 2015: 21,273 normal points



Weighted annual residuals

annual wrms values



Major LLR-related activities

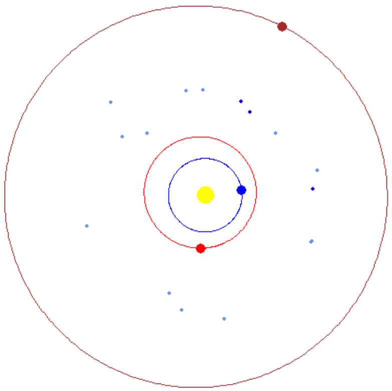
- 6 LLR analysis centers: JPL (USA); CFA (USA); POLAC (France); IfE (Germany); INFN (Italy); SOKENDAI (Japan)

  - with different focus (relativity, lunar interior, etc.)

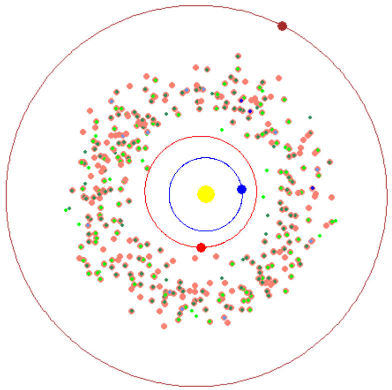
  - ongoing improvement of LLR modelling, s/w packages

- Some funding of LLR projects at IfE, Germany and at other institutions

Ephemeris with refined asteroid modeling



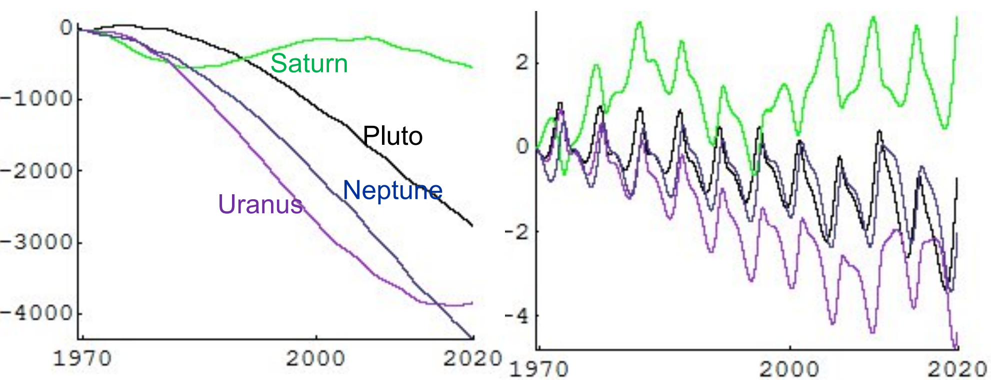
situation before extension



situation after extension

Comparisons with established ephemerides (e.g., DE430) in terms of relative deviations in heliocentric or geocentric distances.

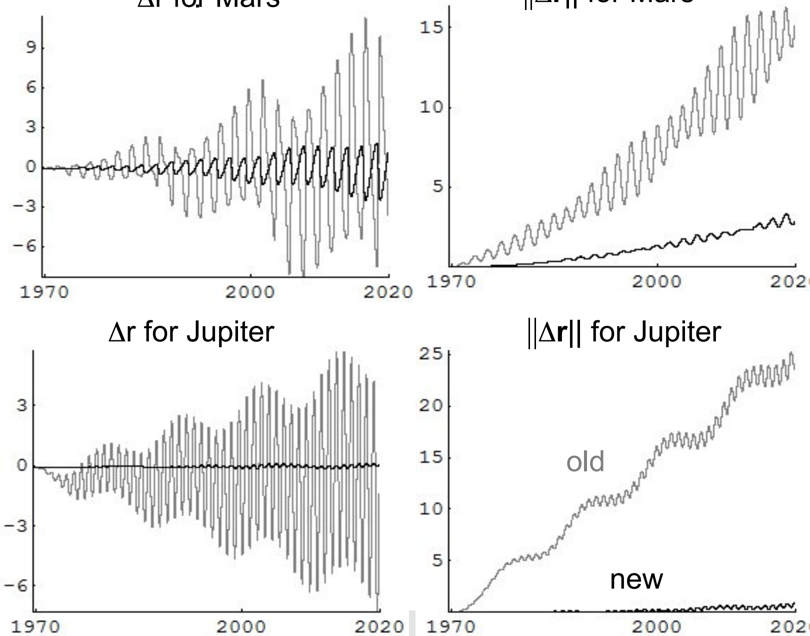
before extension　　after extension



Δr^{Sun}_{Planet} in m for IFE (old/new)

in case of Saturn, Uranus, Neptune, Pluto.

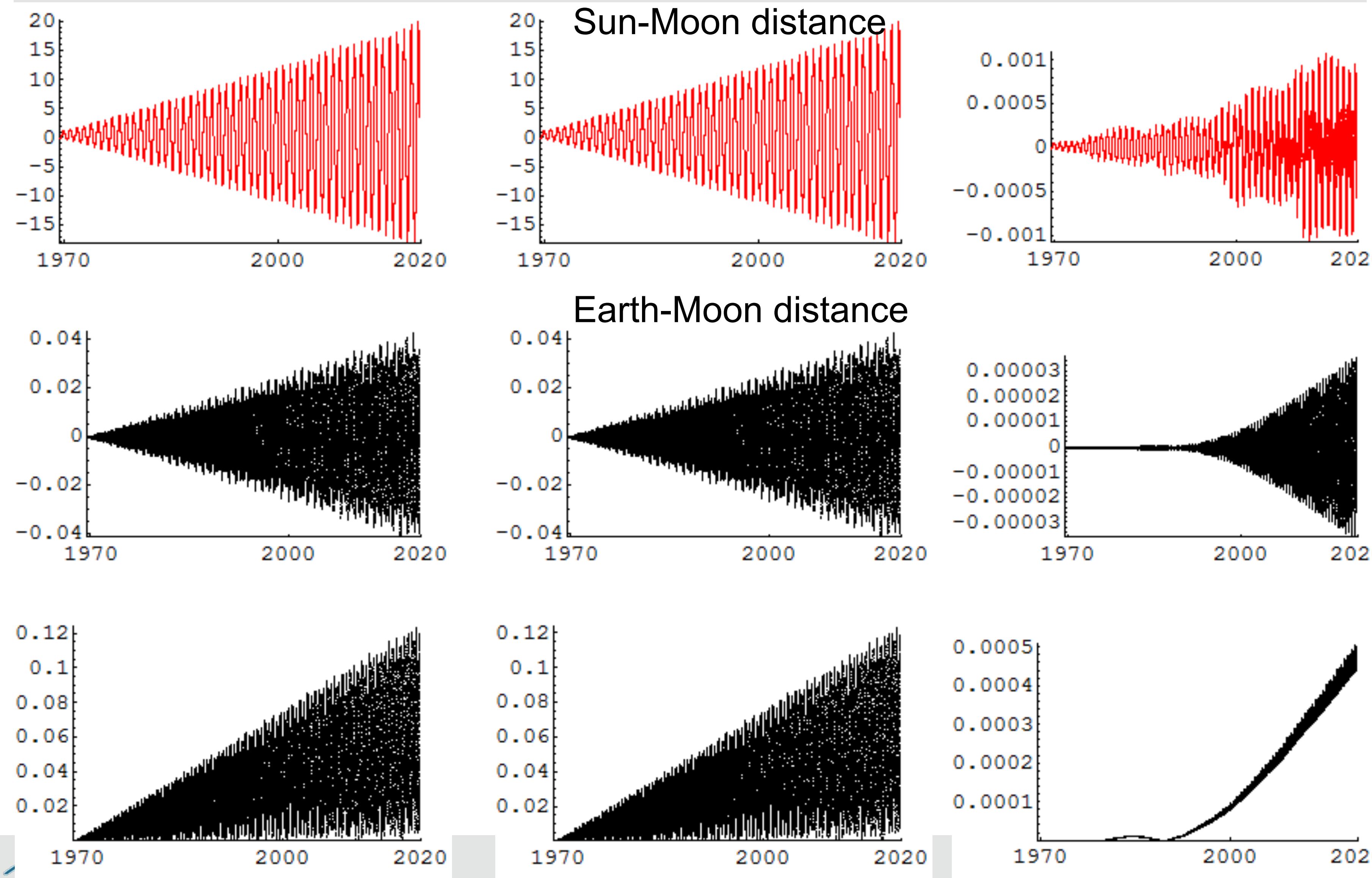
$\Delta r^{Earth}_{Planet}$ and $\|\Delta r^{Earth}_{Planet}\|$ in km



MASS RING EFFECTS – MOON

heliocentric dr	(11+AR)-(11)	(11+AR+TR)-(11)	(11+AR+TR)-(11+AR)
geocentric dr	(11+AR)-(11)	(11+AR+TR)-(11)	(11+AR+TR)-(11+AR)
spatial Δr	(11+AR)-(11)	(11+AR+TR)-(11)	(11+AR+TR)-(11+AR)

ALL VALUES IN METERS

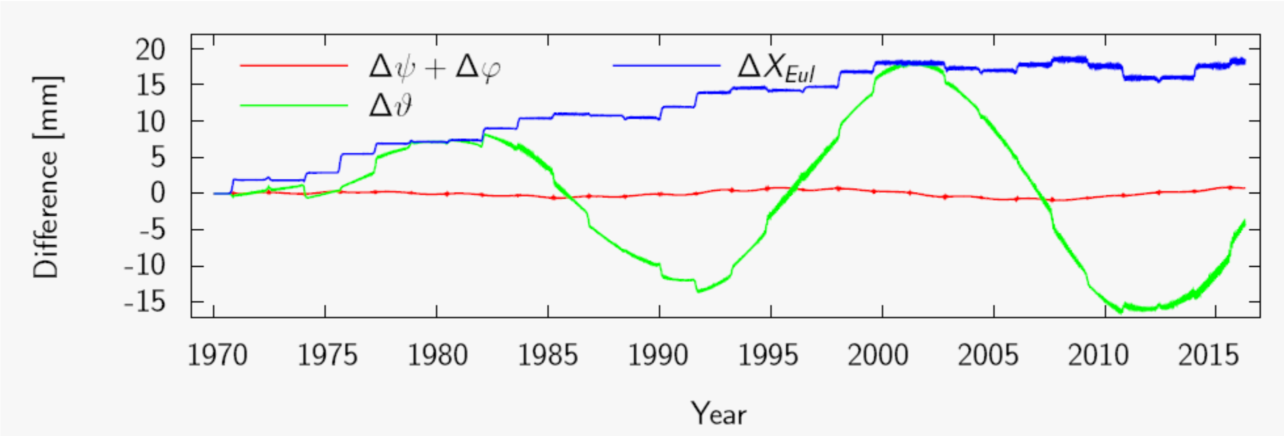


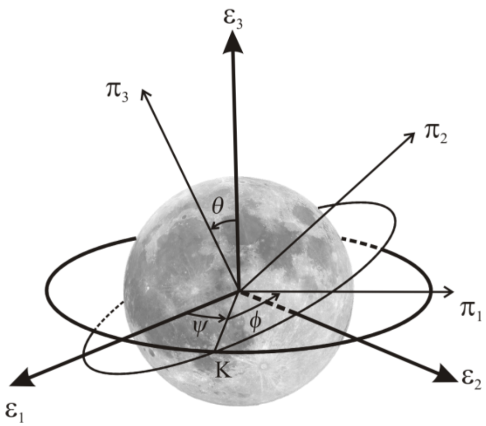
Enhanced interaction of Moon and planets

- Max. effect on lunar orbit and positions on the lunar surface (planets as point masses act on the Moon modelled up to degree/ order 2, for Sun up to degree/order 3)

	Mercury	Venus	Mars	Jupiter	Saturn	Uranus	Sun
ΔX_{EM} [mm]	< 0.01	0.02	< 0.01	0.14	0.01	0.02	0.31
$\Delta X_{Eul,max}$ [mm]	0.15	**18.8**	0.46	3.7	0.32	0.02	0.64

- Effect of Venus on Euler angles (scaled with R_{Moon}) and coordinate differences of network $|\Delta X_{Eul}|$





Major LLR-related activities

- 6 LLR analysis centers: JPL (USA); CFA (USA); POLAC (France); IfE (Germany); INFN (Italy); SOKENDAI (Japan)

  - with different focus (relativity, lunar interior, etc.)

  - ongoing improvement of LLR modelling, s/w packages

- Some funding of LLR projects at IfE, Germany and at other institutions

- Simulation of impact of new LLR sites and/or reflectors with various options – new study in preparation with D. Currie

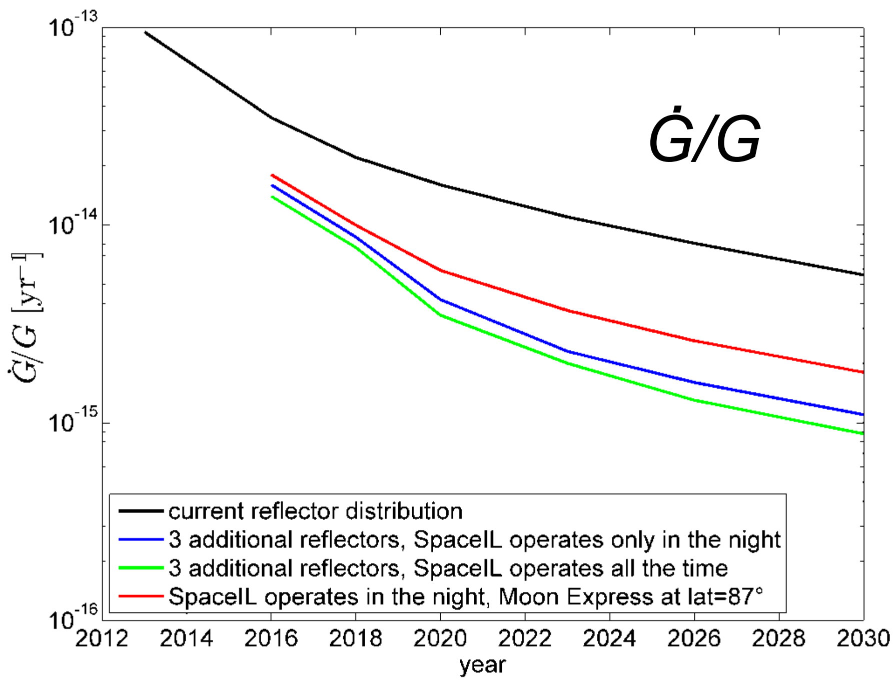
- Update of LLR part on ILRS website delayed

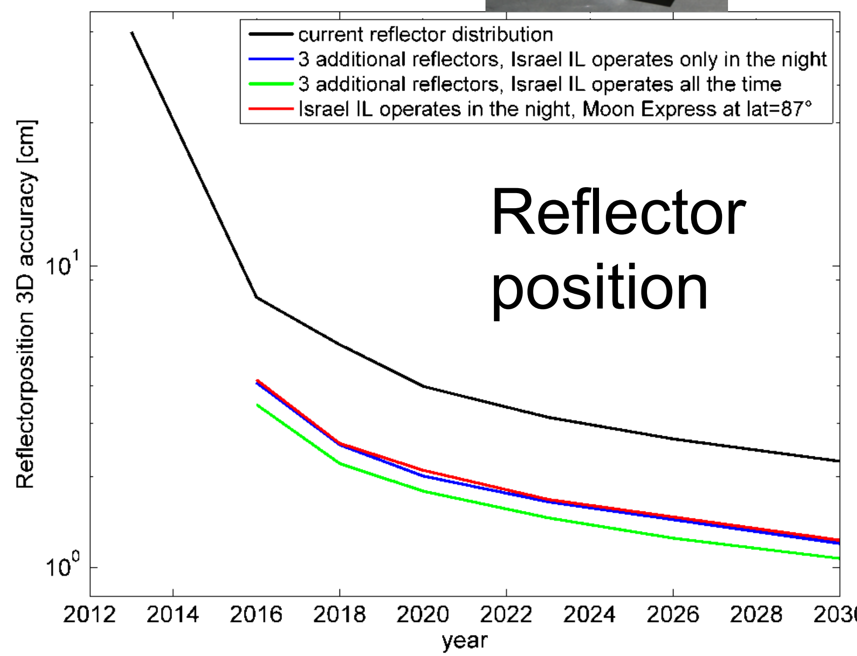
Simulation – effect of new reflectors

- Only with current reflectors
  - improvement ~ factor 10 (15 years)
- including 3 new reflectors
  - further improvement by factor 2-3

Added 1σ noise to simulated LLR data

	existing CCRs	new CCRs
APOLLO	5.0 mm	1.0 mm
other stations	10.0 mm	2.0 mm



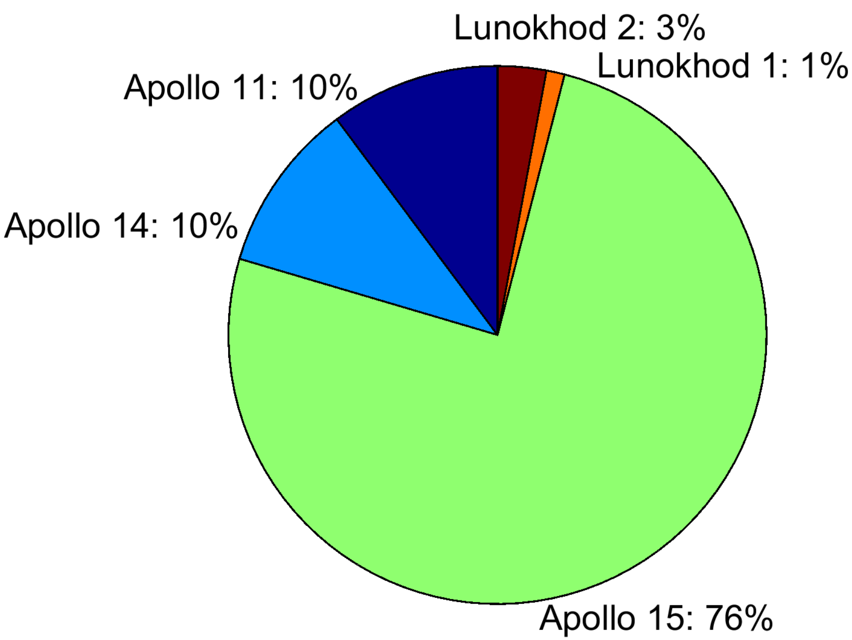


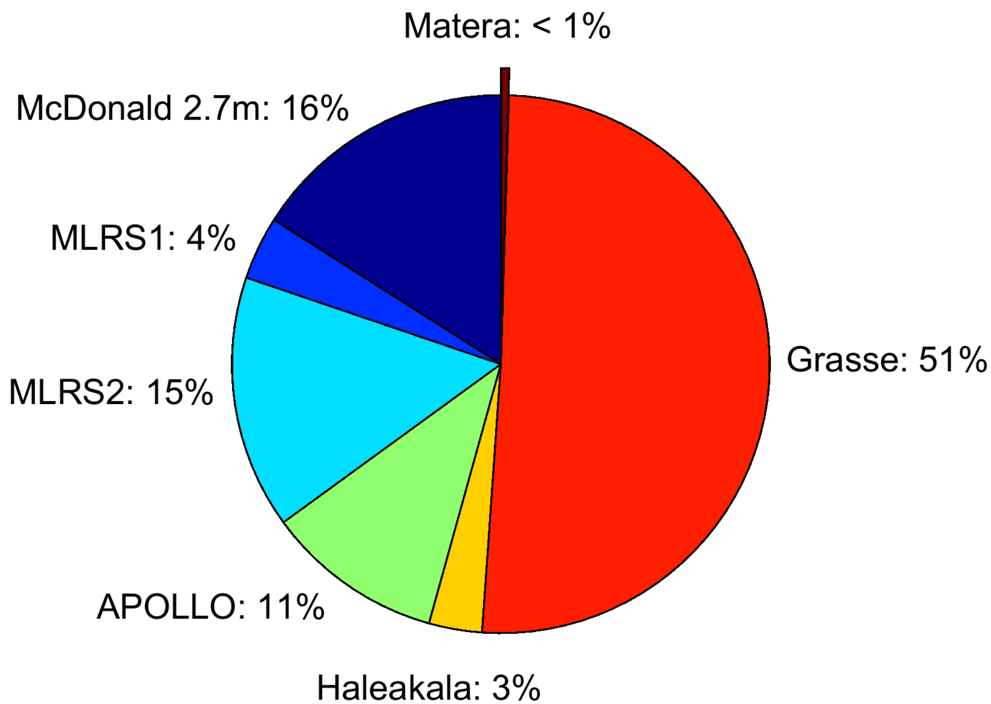
Final remarks

- LLR is a unique tool for testing general relativity, e.g.
  - Equivalence principle $\eta = (3.0 \pm 3.6) \times 10^{-4}$
  - Yukawa test $\alpha_{\lambda=400000\,\mathrm{km}} = (-0.6 \pm 1.8) \cdot 10^{-11}$
  - Gravitational constant $\dot{G}/G = (1.2 \pm 1.5) \cdot 10^{-13}\ {}^{1}\!/_{yr}$
- LLR is an excellent technique for studying the Earth-Moon system and contributing to GGOS objectives
- Further LLR sites on Earth or new reflectors on the Moon would clearly improve the results for many LLR parameters
- Good results are only possible because of fantastic long-term lunar tracking by observatories (> 46 years of data)

Statistics – retro-reflectors and observatories

Time span **1970-2015**





… and a few lunar tracks from

- **Orroral**
- **Wettzell**

now about **21,273** LLR normal points

NSGF report
ILRS ASC meeting Vienna 2016

Graham Appleby, José Rodríguez
NSGF AC Herstmonceux

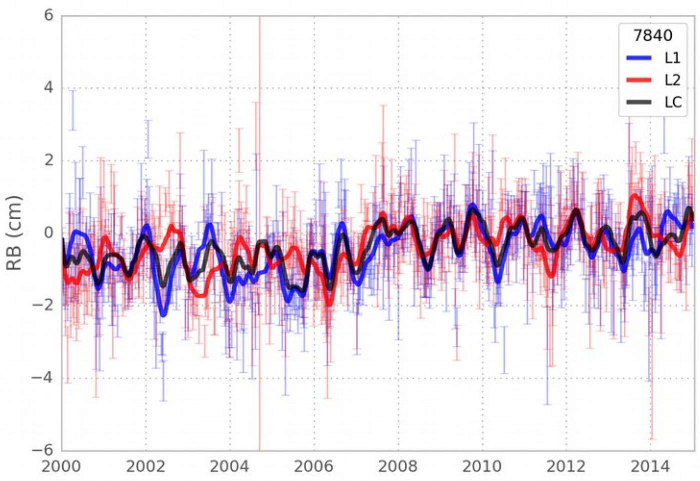
NSGF AC

- Gravity field estimation ready in development branch, but proper output in SINEX format not implemented yet
- Bias PP series 2005-2008 delivered
- Switch to ITRF2014-like branch for operational product relatively easy in theory (*)
- Investigation on Etalon RB and connection with CoM

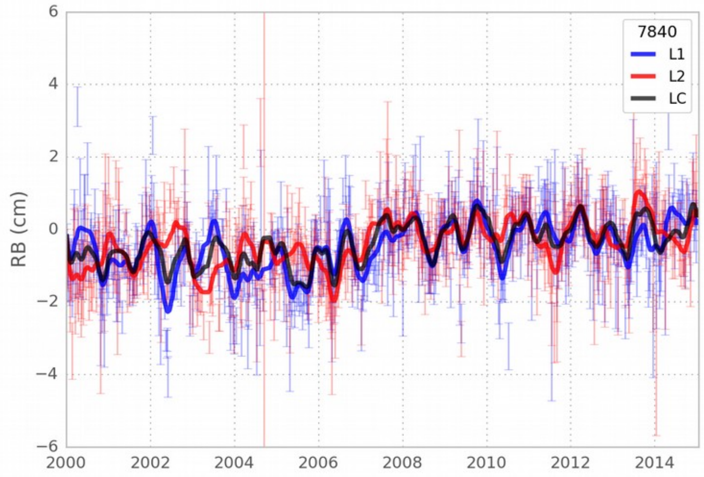
(*) Experience suggests here be dragons

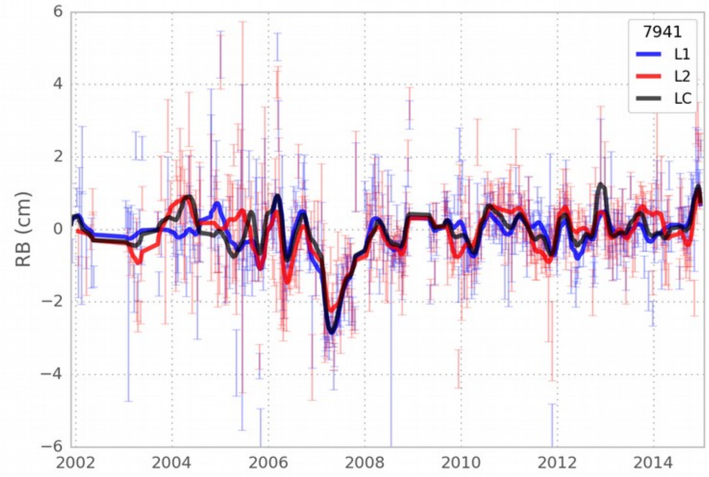
Bias PP

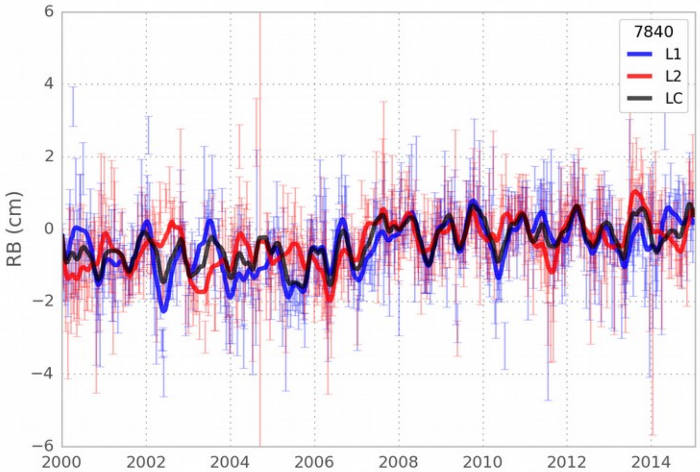
- Series v200 and v210 for 2005-2008 delivered, computed 2000-2015, no bias corrections from data handling file applied
- No major differences between the L1 and L2 RB estimates
- Values for combined bias estimates mostly lie in between those from the separate solutions
- RB issues in data handling file correctly identified
- Quite small changes in coordinates between v200 and v210
- Significant scale change in both series wrt standard solution, in the direction of reducing the scale difference wrt VLBI

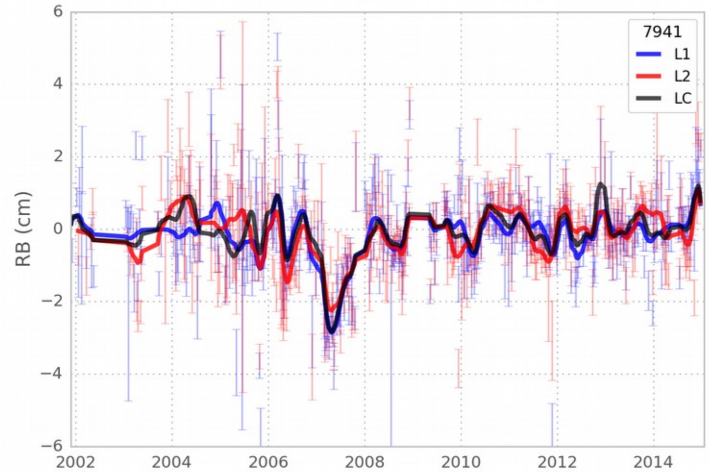


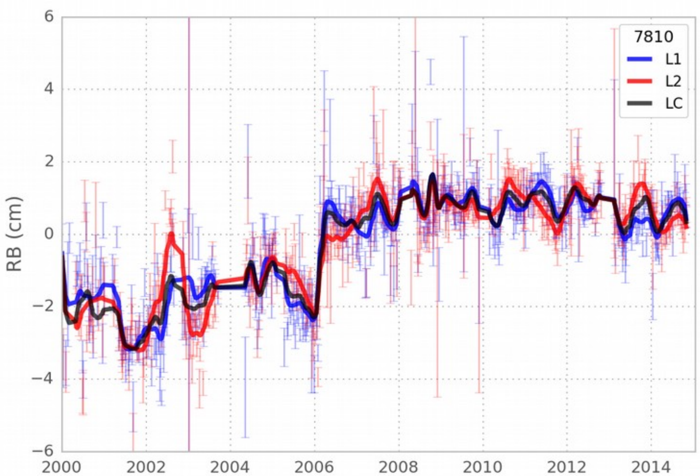
7840
L1
L2
LC
RB (cm)
6
4
2
0
−2
−4
−6
2000
2002
2004
2006
2008
2010
2012
2014

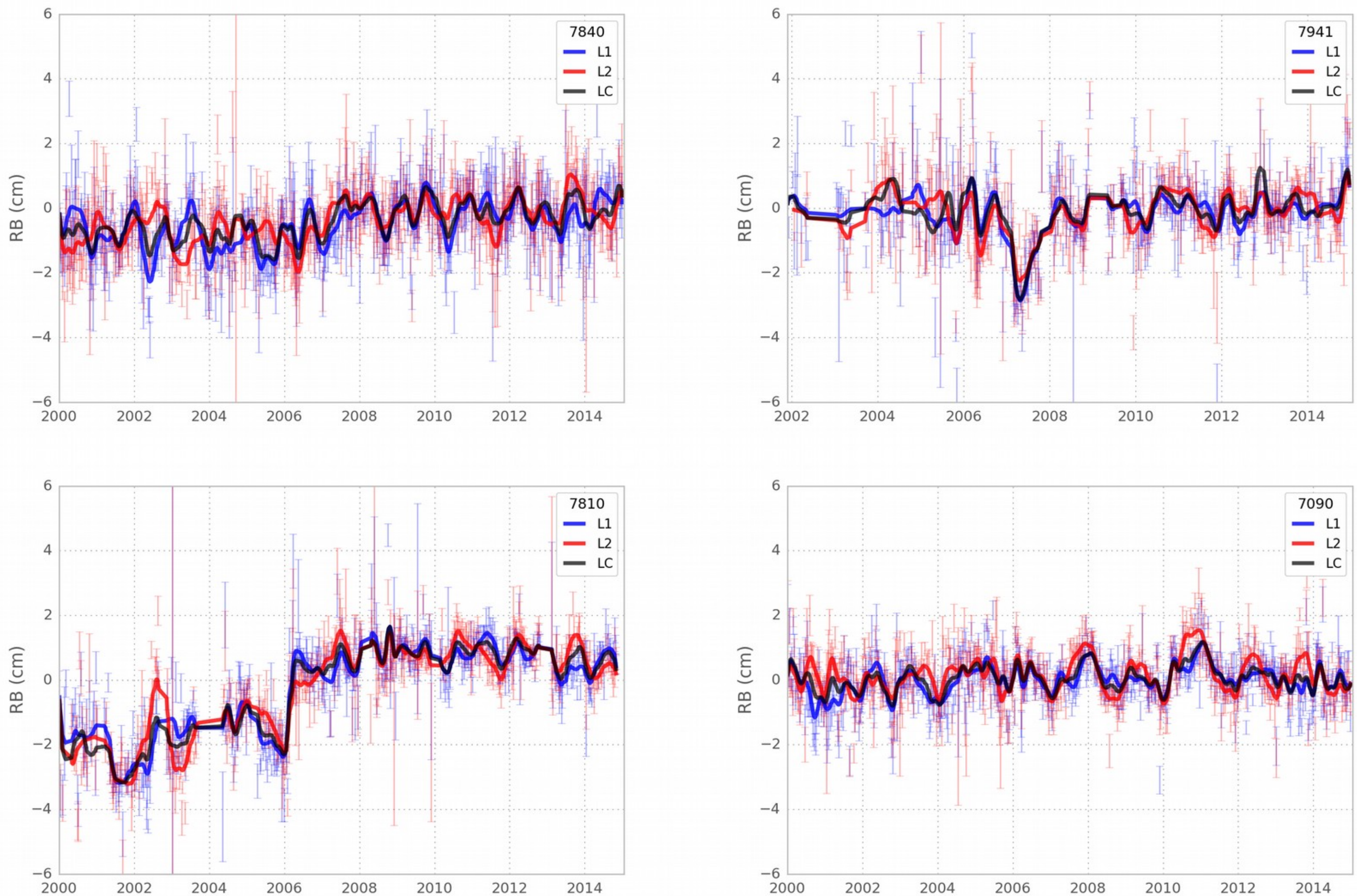

7840
L1
L2
LC
RB (cm)
6
4
2
0
−2
−4
−6
2000
2002
2004
2006
2008
2010
2012
2014

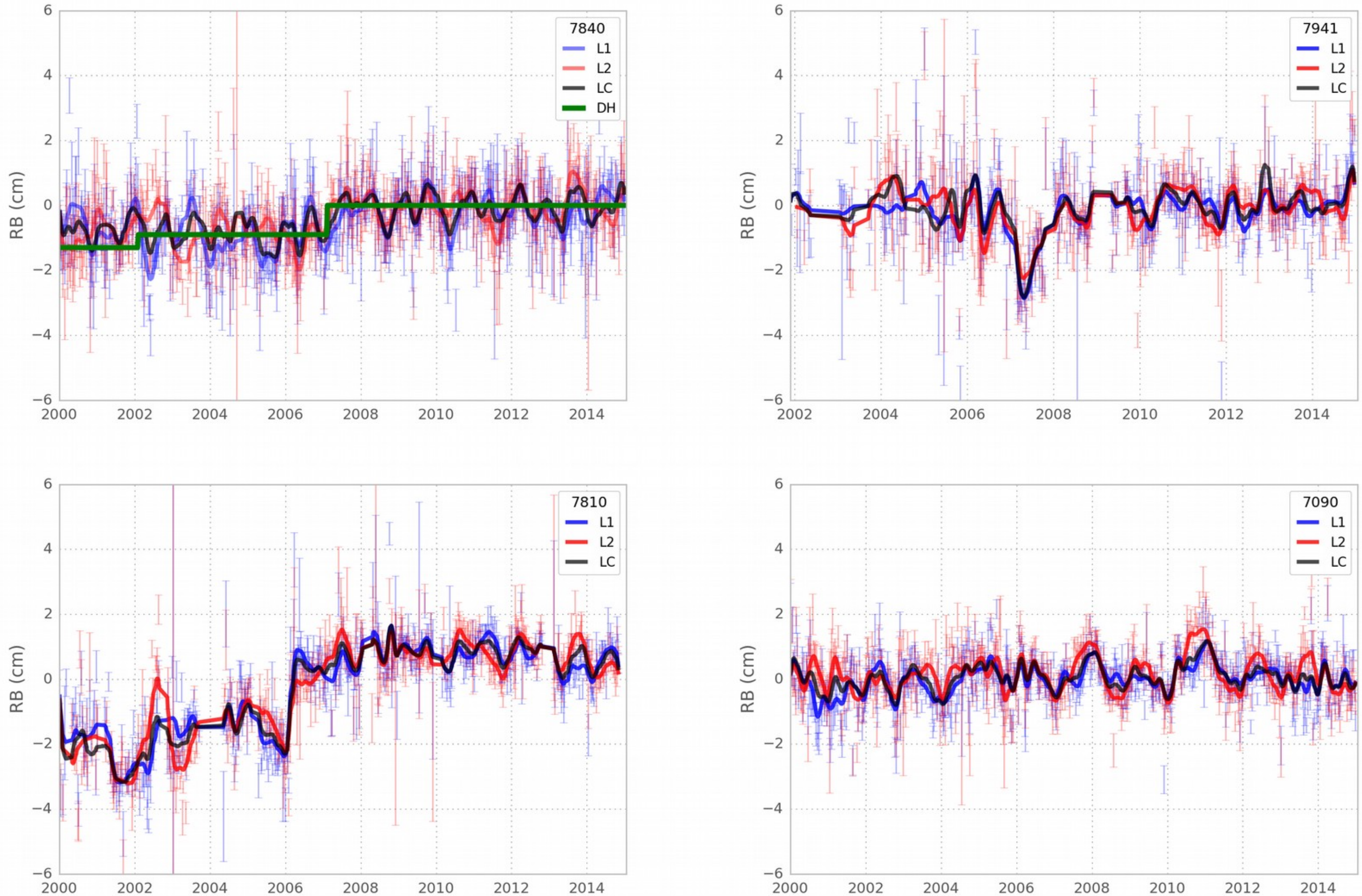

7941
L1
L2
LC
RB (cm)
6
4
2
0
−2
−4
−6
2002
2004
2006
2008
2010
2012
2014

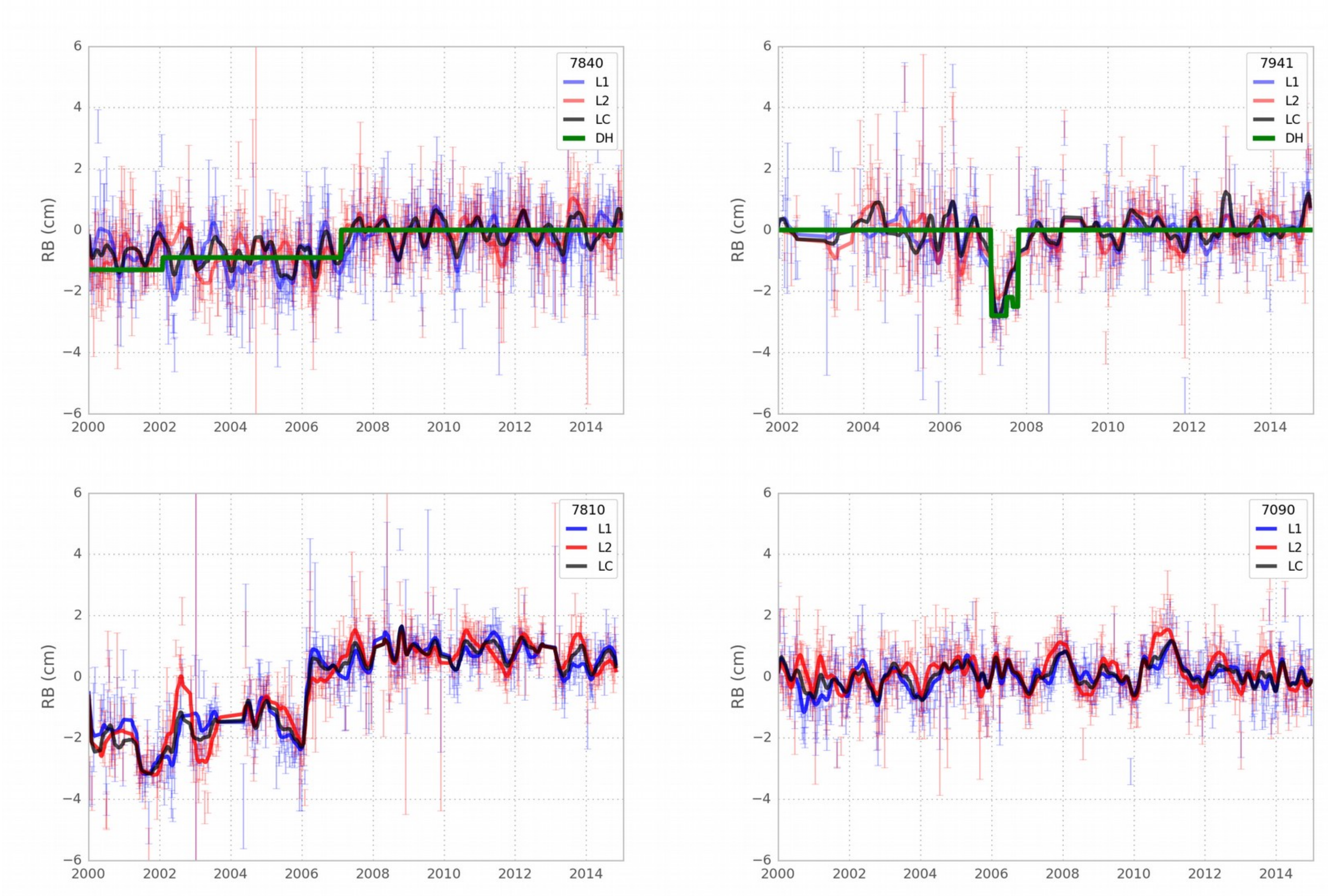

7840
L1
L2
LC
RB (cm)
6
4
2
0
−2
−4
−6
2000
2002
2004
2006
2008
2010
2012
2014

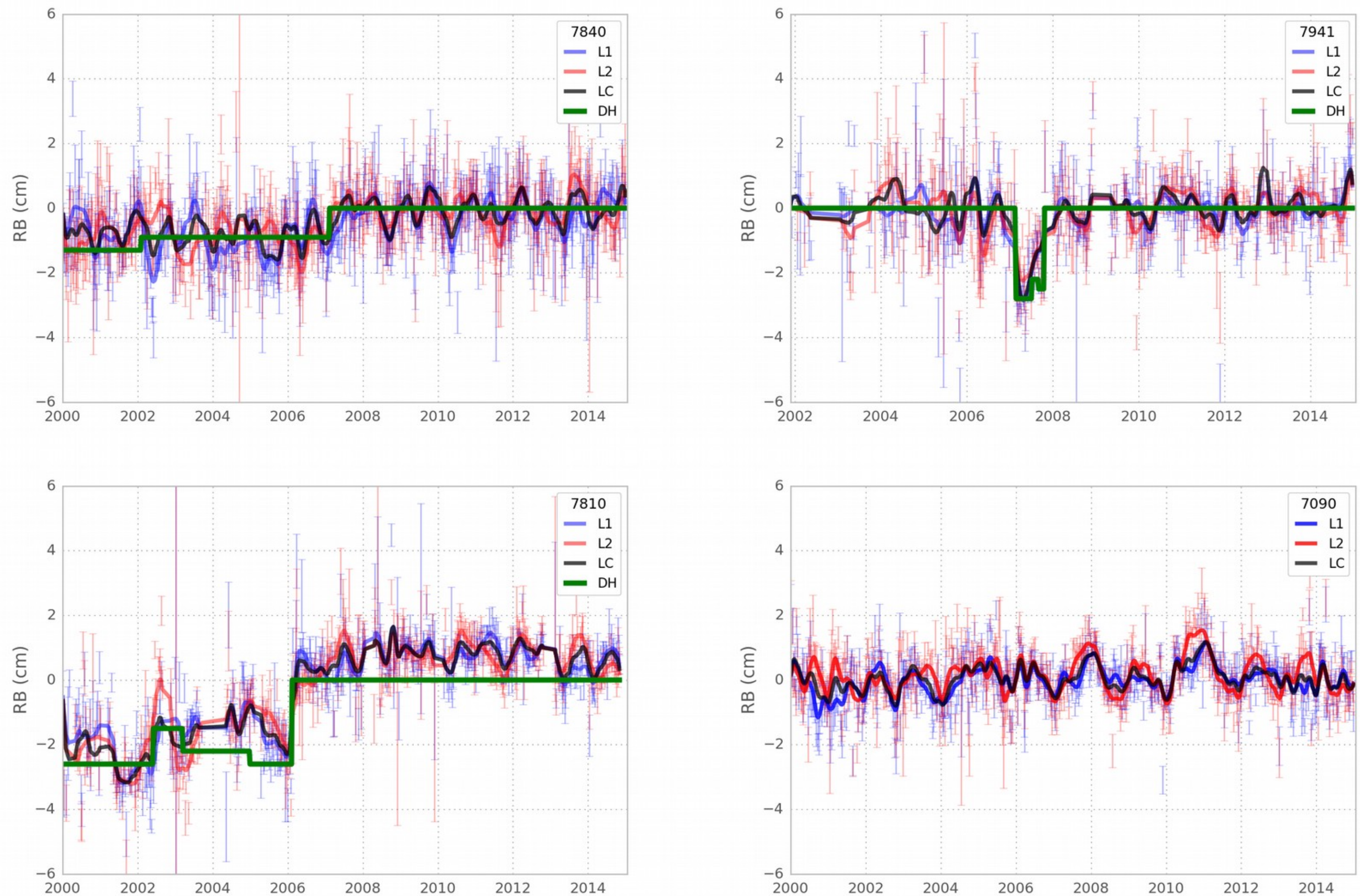

7941
L1
L2
LC
RB (cm)
6
4
2
0
−2
−4
−6
2002
2004
2006
2008
2010
2012
2014

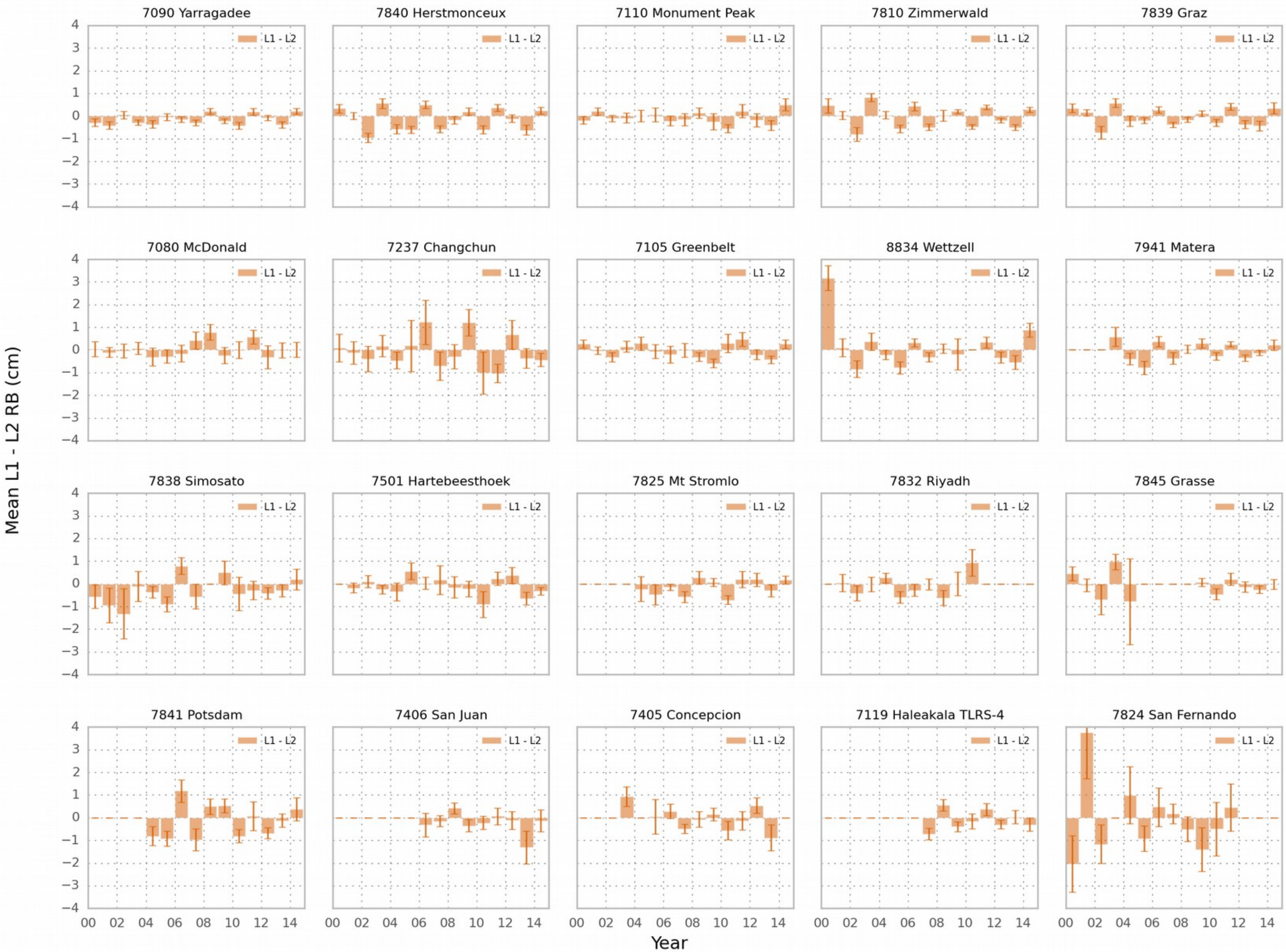

7810
L1
L2
LC
RB (cm)
6
4
2
0
−2
−4
−6
2000
2002
2004
2006
2008
2010
2012
2014

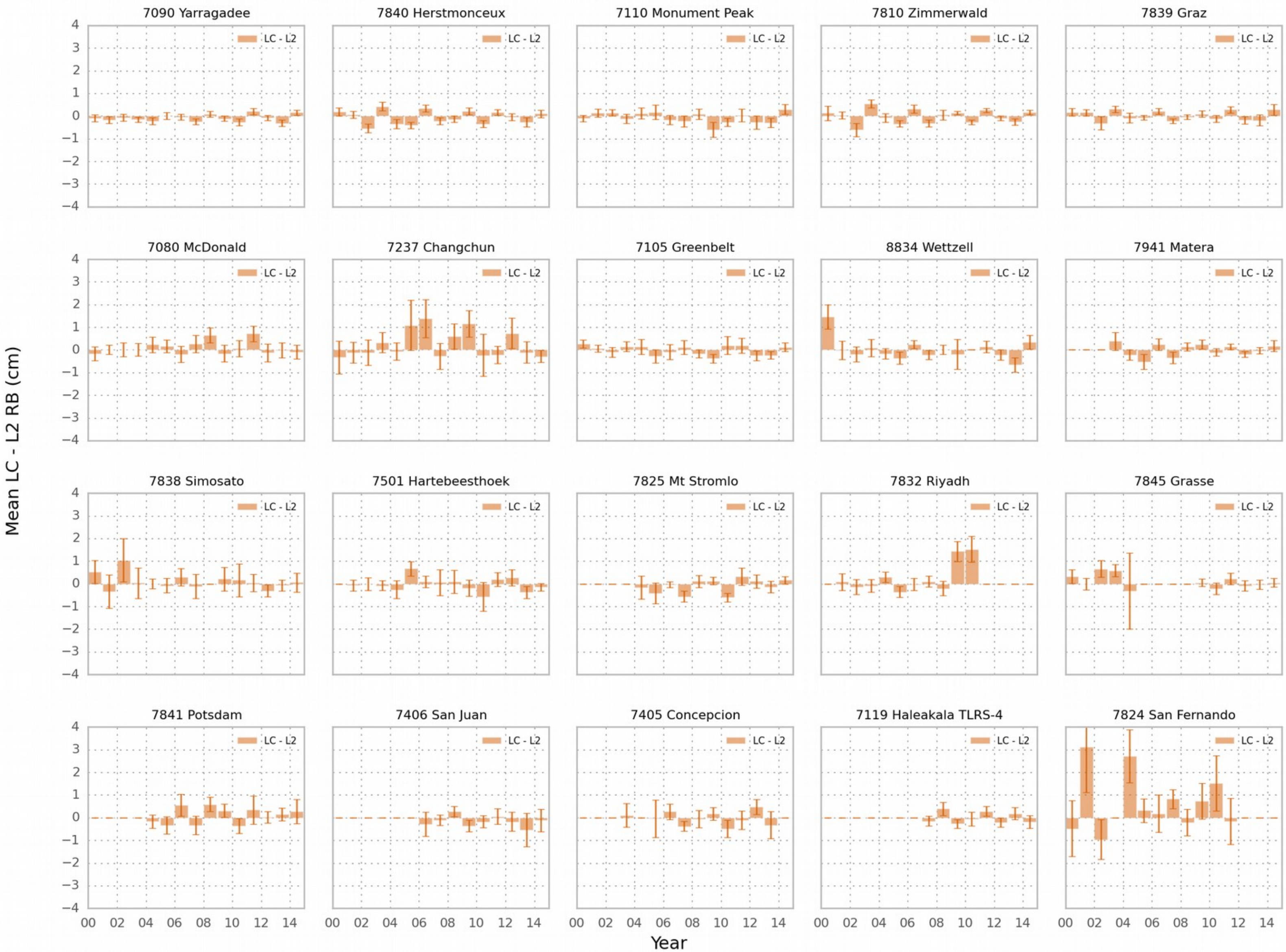

7840
L1
L2
LC
7941
L1
L2
LC
7810
L1
L2
LC
7090
L1
L2
LC
RB (cm)
6
4
2
0
−2
−4
−6
2000
2002
2004
2006
2008
2010
2012
2014


7840
L1
L2
LC
DH
RB (cm)
7941
L1
L2
LC
7810
L1
L2
LC
RB (cm)
7090
L1
L2
LC


7840
L1
L2
LC
DH
7941
L1
L2
LC
DH
7810
L1
L2
LC
7090
L1
L2
LC
RB (cm)
6
4
2
0
−2
−4
−6
2000
2002
2004
2006
2008
2010
2012
2014

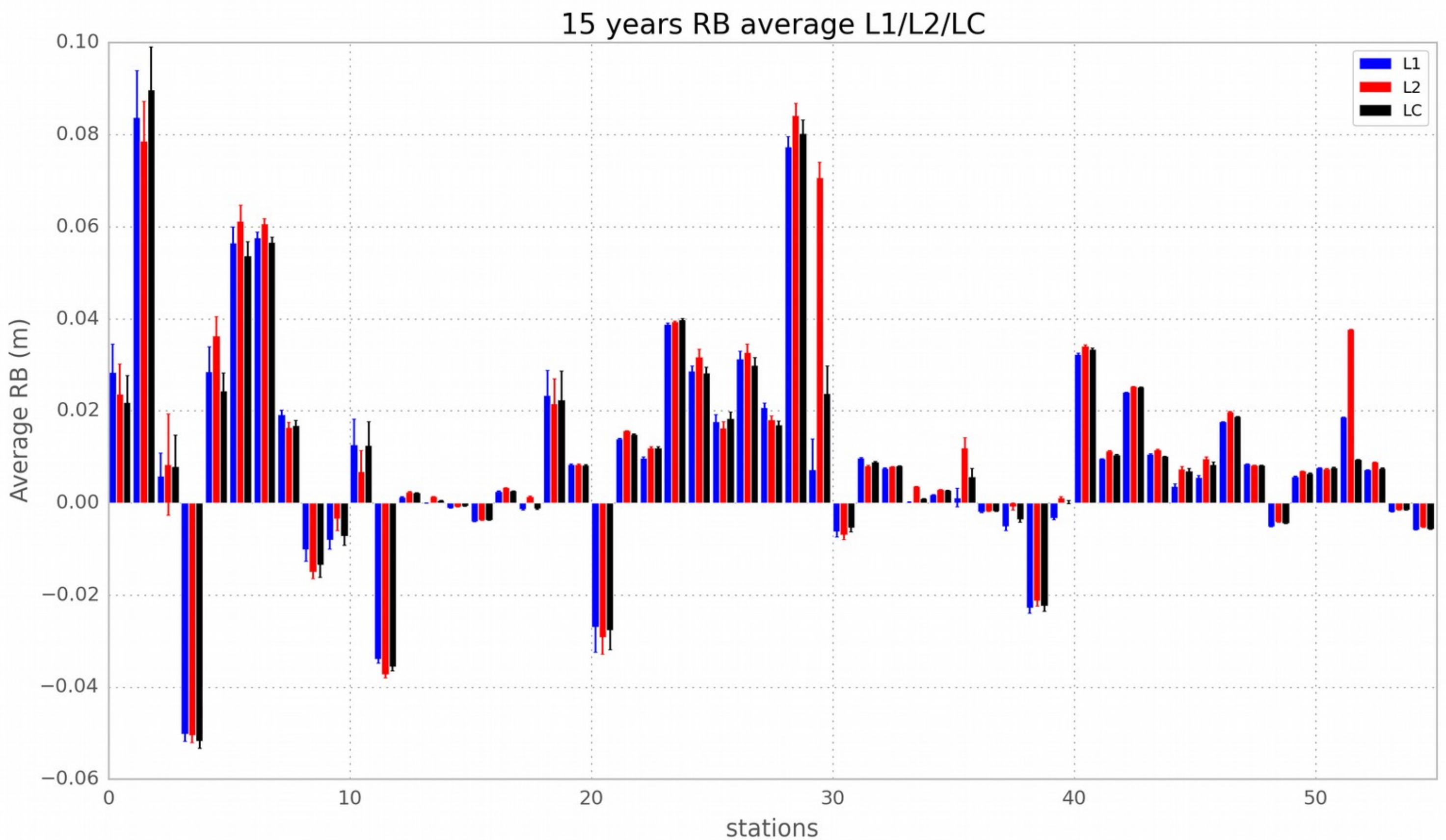

7840
L1
L2
LC
DH
RB (cm)
7941
L1
L2
LC
DH
RB (cm)
7810
L1
L2
LC
DH
RB (cm)
7090
L1
L2
LC
RB (cm)


7090 Yarragadee
7840 Herstmonceux
7110 Monument Peak
7810 Zimmerwald
7839 Graz
7080 McDonald
7237 Changchun
7105 Greenbelt
8834 Wettzell
7941 Matera
7838 Simosato
7501 Hartebeesthoek
7825 Mt Stromlo
7832 Riyadh
7845 Grasse
7841 Potsdam
7406 San Juan
7405 Concepcion
7119 Haleakala TLRS-4
7824 San Fernando
L1 - L2
Mean L1 - L2 RB (cm)
Year



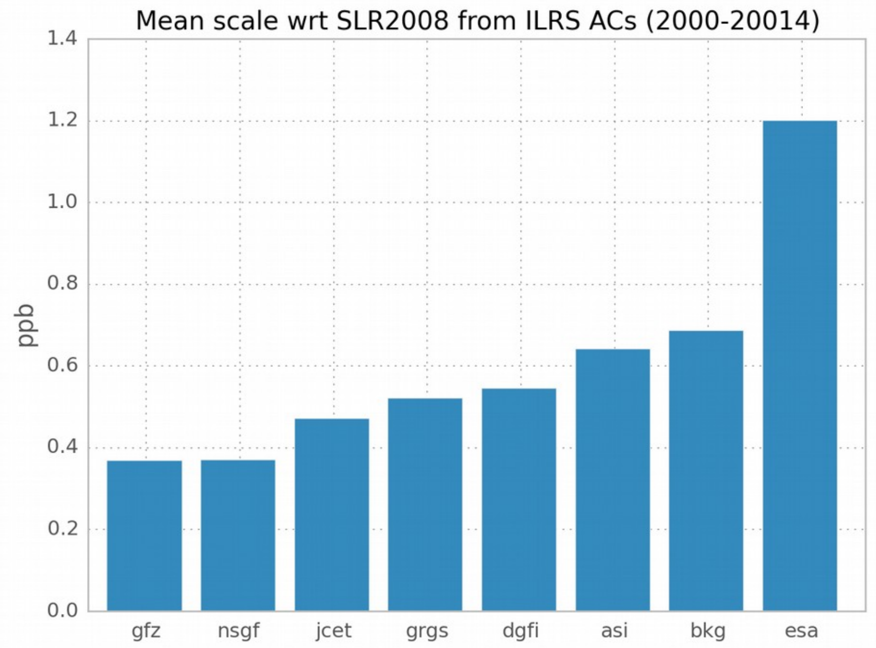
7090 Yarragadee
7840 Herstmonceux
7110 Monument Peak
7810 Zimmerwald
7839 Graz
7080 McDonald
7237 Changchun
7105 Greenbelt
8834 Wettzell
7941 Matera
7838 Simosato
7501 Hartebeesthoek
7825 Mt Stromlo
7832 Riyadh
7845 Grasse
7841 Potsdam
7406 San Juan
7405 Concepcion
7119 Haleakala TLRS-4
7824 San Fernando
LC - L2
Mean LC - L2 RB (cm)
Year


7090 Yarragadee
7840 Herstmonceux
7110 Monument Peak
7810 Zimmerwald
7839 Graz
7080 McDonald
7237 Changchun
7105 Greenbelt
8834 Wettzell
7941 Matera
7838 Simosato
7501 Hartebeesthoek
7825 Mt Stromlo
7832 Riyadh
7845 Grasse
7841 Potsdam
7406 San Juan
7405 Concepcion
7119 Haleakala TLRS-4
7824 San Fernando
LC - L1
Mean LC - L1 RB (cm)
Year
00 02 04 06 08 10 12 14
4 3 2 1 0 −1 −2 −3 −4


15 years RB average L1/L2/LC
L1
L2
LC
Average RB (m)
0.10
0.08
0.06
0.04
0.02
0.00
−0.02
−0.04
−0.06
0
10
20
30
40
50
stations

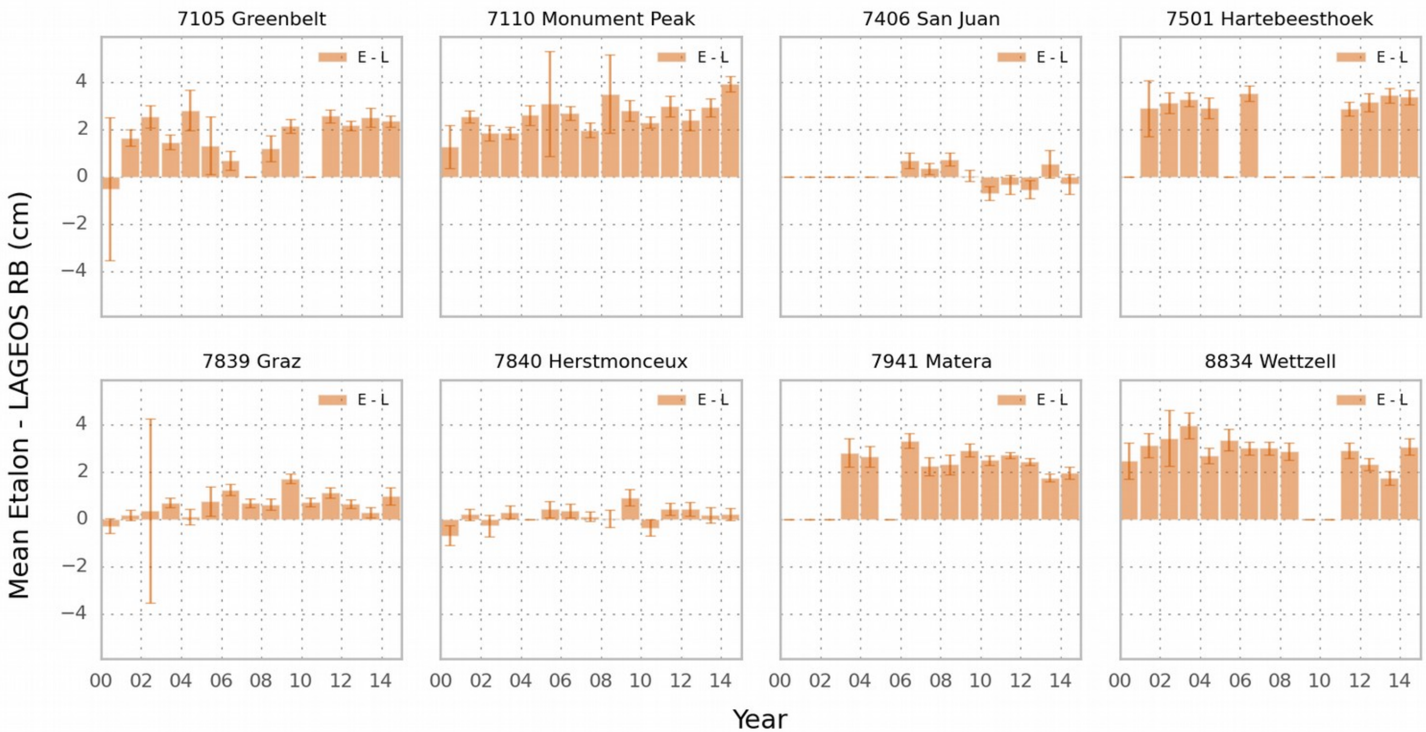
Bias PP

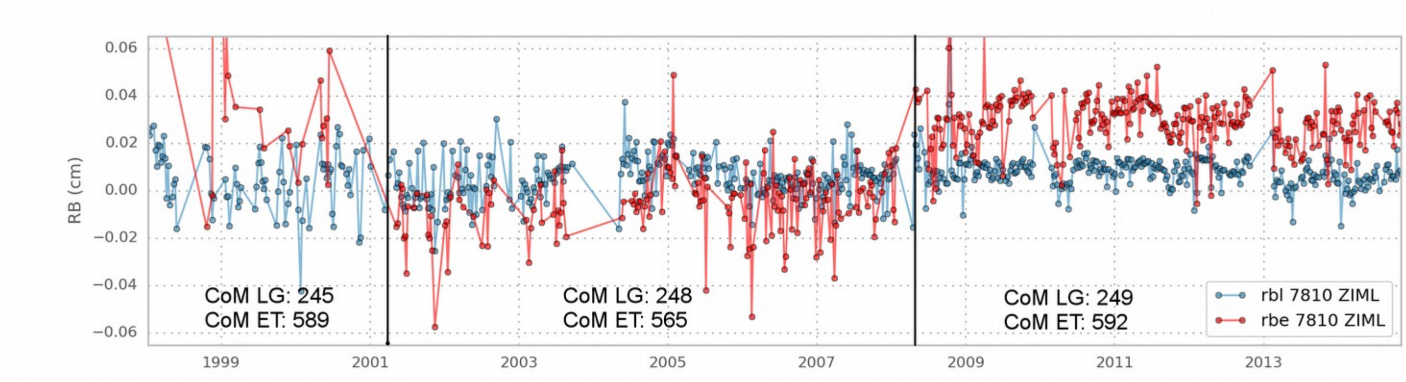
	standard	RB L1 & L2		RB LC	
	scale wrt ITRF2014	scale wrt ITRF2014	Δs wrt standard sol	scale wrt ITRF2014	Δs wrt standard sol
2000-2014	0.32	-0.45	0.77	-0.57	0.87
2005-2008	0.44	-0.45	0.89	-0.56	1.00


Mean scale wrt SLR2008 from ILRS ACs (2000-20014)
ppb
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
gfz
nsgf
jcet
grgs
dgfi
asi
bkg
esa

RB/CoM Etalon

- Produced solutions for 2000-2014 with Etalon and LAGEOS RB estimation
- For stations with sufficient Etalon NP data results are surprisingly good
- Subtracting estimated biases for both satellites should get rid of potential station errors and reveal either modeling deficiencies or CoM inaccuracies
- Analysis reveals cm-level problems in many stations, especially high return rate ones


7105 Greenbelt
7110 Monument Peak
7406 San Juan
7501 Hartebeesthoek
7839 Graz
7840 Herstmonceux
7941 Matera
8834 Wettzell
E - L
Mean Etalon - LAGEOS RB (cm)
Year
4
2
0
−2
−4
00
02
04
06
08
10
12
14



- Most likely to be a CoM modeling issue
- CoM values computed from simulated detected distributions and target response impulse functions from a range of laser widths, total system noise, return rate and lower return energy threshold settings
- Return rate differences might only explain part of the problem
- Insufficient knowledge about system features and behavior makes it hard to improve current CoM estimates for high energy stations


Questions/thoughts?