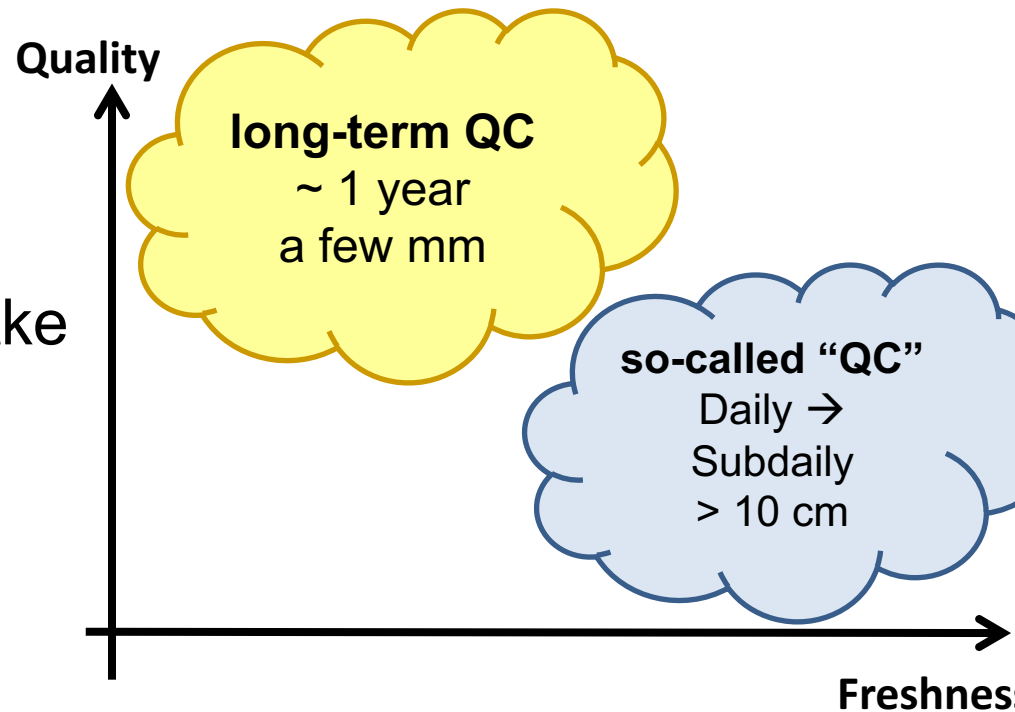


# The ILRS Rapid Service Mail: a tool to inform stations quickly about potential problems

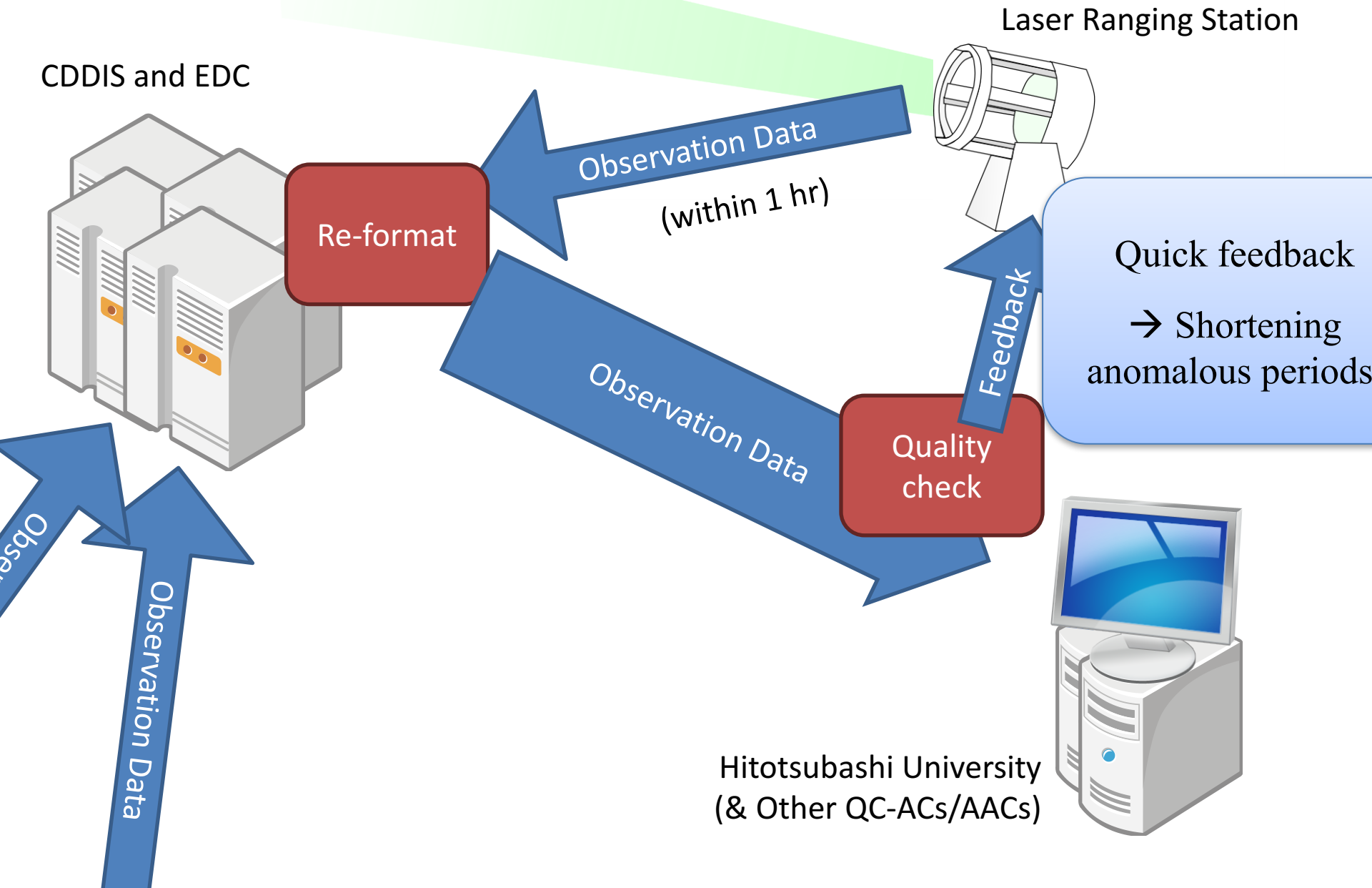
Toshimichi Otsubo  
(Hitotsubashi Univ)

Horst Müller, Christian Schwatke  
(DGFI TUM)

Erricos C Pavlis  
(JCET/UMBC)



# Data Flow



CDDIS and EDC

Laser Ranging Station

Re-format

Observation Data  
(within 1 hr)

Quick feedback  
→ Shortening  
anomalous periods

Feedback

Observation Data

Quality  
check

Hitotsubashi University  
(& Other QC-ACs/AACs)

Obs

Observation Data



# QC Reports from Hitotsubashi Univ

Utsubo

[v2] Multi-satellite bias a X

geo.science.hit-u.ac.jp/slr/bias/



## Multi-Satellite Bias Analysis Report v2

for Worldwide Satellite Laser Ranging Stations

being updated every 6 hours!

Latest Analysis Report: >> [from 06h UTC, 12 Sep 2017 to 06h UTC, 26 Sep 2017](#) (updated 08:25 UTC, 26 Sep 2017)

### Stations with high productivity

sat	orbit fit		1st site(ID)		2nd site(ID)		3rd site(ID)	
	WRMS in mm	# pass/# NP	# pass/# NP	# pass/# NP	# pass/# NP	# pass/# NP	# pass/# NP	
<a href="#">Lageos-1</a>	8	414 / 3235	Mt Stromlo (7825) 42/315	Changchun (7237) 37/200	Yarragadee (7090) 36/322			
<a href="#">Lageos-2</a>	10	326 / 3208	Matera (7941) 37/432	Mt Stromlo (7825) 37/402	Yarragadee (7090) 32/291			
<a href="#">Etalon-1</a>	20	68 / 330	Matera (7941) 14/109	Yarragadee (7090) 12/51	Mt Stromlo (7825) 9/34			
<a href="#">Etalon-2</a>	15	50 / 203	Yarragadee (7090) 13/67	Mt Stromlo (7825) 9/23	Matera (7941) 6/41			
<a href="#">Ajisai</a>	22	585 / 6556	Yarragadee (7090) 57/754	Changchun (7237) 54/314	Mt Stromlo (7825) 53/586			
<a href="#">Lares</a>	14	312 / 2897	Changchun (7237) 33/171	Mt Stromlo (7825) 32/275	Yarragadee (7090) 30/363			
<a href="#">Starlette</a>	23	375 / 3457	Mt Stromlo (7825) 46/465	Changchun (7237) 42/214	Matera (7941) 40/341			
<a href="#">Stella</a>	28	246 / 1726	Yarragadee (7090) 27/276	Changchun (7237) 23/88	Mt Stromlo (7825) 21/205			

and more satellites (GNSS and LEO) are included in the reports!!

Archive: (each covers 14 days from the date) [2016](#) [2015](#) [2014](#) [2013](#) [2012](#) v1: Year [2011](#) [2010](#) [2009](#) [2008](#) [2007](#) [2006](#) [2005](#)

Sep 2017	Aug 2017	Jul 2017	Jun 2017	May 2017	Apr 2017	Mar 2017	Feb 2017	Jan 2017
12 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	31 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	31 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	30 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	31 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	30 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	31 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	28 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	31 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )
11 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	30 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	30 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	29 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	30 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	29 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	30 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	27 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	30 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )
10 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	29 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	29 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	28 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	29 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	28 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	29 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	26 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )	29 ( <a href="#">00</a> <a href="#">06</a> <a href="#">12</a> <a href="#">18</a> )

600 to 700 kB  
per report

```

GL31 1884 2017/09/24 19:54 56      68 ( 11 ) -----.- ( ----.- )      3 0 / 3 86
##
## 1884 = RIGA
## sat site      date  time dur      rb mm      error      tb us      error      prec bad total      rms      pres      temp hum
AJI1 1884 2017/09/16 18:04 9      51 ( 5 )      14.8 ( 2.4 )      3 0 / 21 25 1014.2 284.9 87
JAS3 1884 2017/09/16 18:16 2      104 ( 33 ) -----.- ( ----.- )      22 0 / 11 13 1014.2 284.8 87
AJI1 1884 2017/09/16 20:04 3      -36 ( 45 )      -16.8 ( 13.1 )      3 0 / 8 29 1014.6 283.6 88
JAS3 1884 2017/09/16 20:08 7      38 ( 7 )      5.9 ( 2.2 )      3 0 / 31 19 1014.6 283.6 89
JAS3 1884 2017/09/23 18:53 8      41 ( 15 )      -10.0 ( 4.6 )      9 0 / 34 21 1026.0 287.9 73
AJI1 1884 2017/09/23 19:49 11     98 ( 12 )      2.2 ( 3.8 )      6 1 / 24 33 1026.3 287.4 76
GL31 1884 2017/09/23 21:41 33     -22 ( 12 ) -----.- ( ----.- )      22 0 / 8 27 1026.6 286.6 79
LAG1 1884 2017/09/23 22:19 11     12 ( 19 )      0.6 ( 24.2 )      6 0 / 7 26 1027.0 286.2 81
GL36 1884 2017/09/23 22:37 8      31 ( 14 ) -----.- ( ----.- )      3 0 / 3 4 1027.1 286.1 81
JAS3 1884 2017/09/23 22:50 5      77 ( 23 )      -0.0 ( 9.7 )      8 0 / 23 21 1027.1 285.9 81
LARS 1884 2017/09/23 23:22 4      7 ( 13 )      9.5 ( 5.2 )      3 0 / 11 13 1027.2 285.8 82
CRY2 1884 2017/09/23 23:48 1      22 ( 27 ) -----.- ( ----.- )      7 0 / 7 17 1027.2 285.6 83
JAS3 1884 2017/09/24 00:44 9      39 ( 5 )      1.5 ( 1.5 )      3 0 / 39 13 1027.4 285.4 83
AJI1 1884 2017/09/24 16:57 8      41 ( 7 )      1.7 ( 2.9 )      3 0 / 19 16 1030.6 289.2 67
JAS3 1884 2017/09/24 17:21 5      84 ( 8 )      -6.0 ( 4.0 )      4 0 / 24 9 1030.7 289.1 68
AJI1 1884 2017/09/24 18:57 4      8 ( 34 )      -6.6 ( 15.2 )      9 0 / 10 25 1031.4 287.6 70
GL36 1884 2017/09/24 19:04 40     -3 ( 8 ) -----.- ( ----.- )      6 0 / 7 18 1031.4 287.6 70
JAS3 1884 2017/09/24 19:15 4      -31 ( 22 )      -19.2 ( 6.1 )      4 0 / 20 11 1031.4 287.4 71
F205 1884 2017/09/24 19:23 2      -21 ( 214 ) -----.- ( ----.- )      30 0 / 2 4 1031.5 287.2 72
GL31 1884 2017/09/24 20:24 13     6 ( 16 ) -----.- ( ----.- )      15 0 / 4 21 1031.9 286.8 75
LAG1 1884 2017/09/24 20:51 18     31 ( 13 )      13.5 ( 13.4 )      4 0 / 11 27 1032.2 286.6 75
LARS 1884 2017/09/24 22:19 4      2 ( 33 )      17.3 ( 9.5 )      5 0 / 11 14 1032.6 285.9 78
AJI1 1884 2017/09/24 23:01 2      88 ( 28 ) -----.- ( ----.- )      7 0 / 6 24 1032.7 285.4 79
JAS3 1884 2017/09/24 23:09 10     115 ( 5 )      -0.2 ( 1.6 )      3 0 / 41 14 1032.7 285.4 79
LARS 1884 2017/09/25 00:15 6      -28 ( 11 )      4.5 ( 4.5 )      4 0 / 14 16 1032.7 285.1 79
LAG1 1884 2017/09/25 00:25 25     -60 ( 14 )      16.0 ( 8.5 )      9 0 / 10 28 1032.7 285.1 79
CRY2 1884 2017/09/25 00:35 4      35 ( 10 )      3.0 ( 3.2 )      4 0 / 18 13 1032.7 284.9 79
STEL 1884 2017/09/25 00:55 3      56 ( 20 )      1.5 ( 8.4 )      8 0 / 9 13 1032.6 284.8 79
JAS3 1884 2017/09/25 01:09 8      59 ( 7 )      9.7 ( 2.1 )      4 0 / 34 13 1032.7 284.8 79
CRY2 1884 2017/09/25 02:13 3      93 ( 23 )      -6.3 ( 5.8 )      3 0 / 14 15 1033.0 284.1 81
LARS 1884 2017/09/25 02:17 4      123 ( 35 )      -2.0 ( 17.5 )      7 0 / 10 12 1033.0 284.1 81











```

# “Google Analytics” statistics: last 5 years

> 43000 page views (“wget” users & direct fetching not included)

Thank you for visiting us!

# page views

ページ ?	国 ?	ページビュー数 ? ↓
		<b>43,767</b> 全体に対する割合: 34.96% (125,195)
1. /slr/bias/	 Australia	<b>10,979</b> (25.09%)
2. /slr/bias/	 Japan	<b>10,500</b> (23.99%)
3. /slr/bias/	 China	<b>7,588</b> (17.34%)
4. /slr/bias/	 Ukraine	<b>3,704</b> (8.46%)
5. /slr/bias/	 Latvia	<b>3,089</b> (7.06%)
6. /slr/bias/	 United States	<b>1,652</b> (3.77%)
7. /slr/bias/	 Switzerland	<b>1,586</b> (3.62%)
8. /slr/bias/	 Russia	<b>883</b> (2.02%)
9. /slr/bias/	 Poland	<b>725</b> (1.66%)
10. /slr/bias/	 Italy	<b>659</b> (1.51%)

# QC Reports from Hitotsubashi Univ

## More frequent and fresher

1999- **Weekly**

2005- **Daily**

2012- **Subdaily (every 6 hrs)**

**New report uploaded at 2.30, 8.30, 14.30, 20.30 UTC.**

## Updates:

2014-2015 **Automatic anomaly detection**

→ **Internal email notification** → **Human decision**

→ **RapidServiceMail (roughly 10 messages/year)**

2017.5 **9 GNSS satellites added**

2017.6 **TRF switched to SLRF2014 (was SLR2008)**

**POD software “c5++” upgraded**

# How to detect anomalous passes

## Statistical and automatic procedure

- Read past 10 sets (20 weeks) for each station
- Assess both the formal error in “( )”  
and the stdev of the past data



## Filters :

Out of  
 $3 \times$  formal  
error ?

Out of  
 $3 \times$  stdev  
?

3 or more  
anomalous  
passes ?

Multiple  
satellites ?



# Quick QC

## Quick feedback to the stations

**16 incidents reported via RapidServiceMail (operated at DGFI) in the last 1 year. 15 from HITU & 1 from DGFI.**

**Improved responses & quick recovery.**

**Obsolete contact info remaining on the ILRS Website.**

## Visualization & Combination/Comparison

**NERC, JCET: Web Tools**

**AIUB: Combined RB Report**

**ILRS CB: Global Performance Card**

# Quality control at DGFI-TUM

- Frequency of processing 4 hours
- Results published at DGFI-Webpage ([https://ilrs.dgfi.tum.de/quality/weekly\\_biases/](https://ilrs.dgfi.tum.de/quality/weekly_biases/))
  - List per satellite, passbased range and time biases, weekly files
  - List per station (2015 – actual date)
    - Lageos1/2 range biases with errors and running averages
    - All spherical satellites running averages
- Used Software: DOGSOC 5.4
  - Weekly arcs
  - Bias estimation and outlier detection
- Rapid Service Mail:
  - In case of big ( $> 15$  cm) range bias or ( $> 0.1$  msec) time bias
  - Only after check of validity
  - Check if other centres have already contacted station
  - Distribution to Rapid Service Mail and station representatives
- No of Rapid Service Mails from DGFI-TUM:
  - 2017: 0
  - 2016: 4
  - $< 2016$ : 23

# Example of weekly files

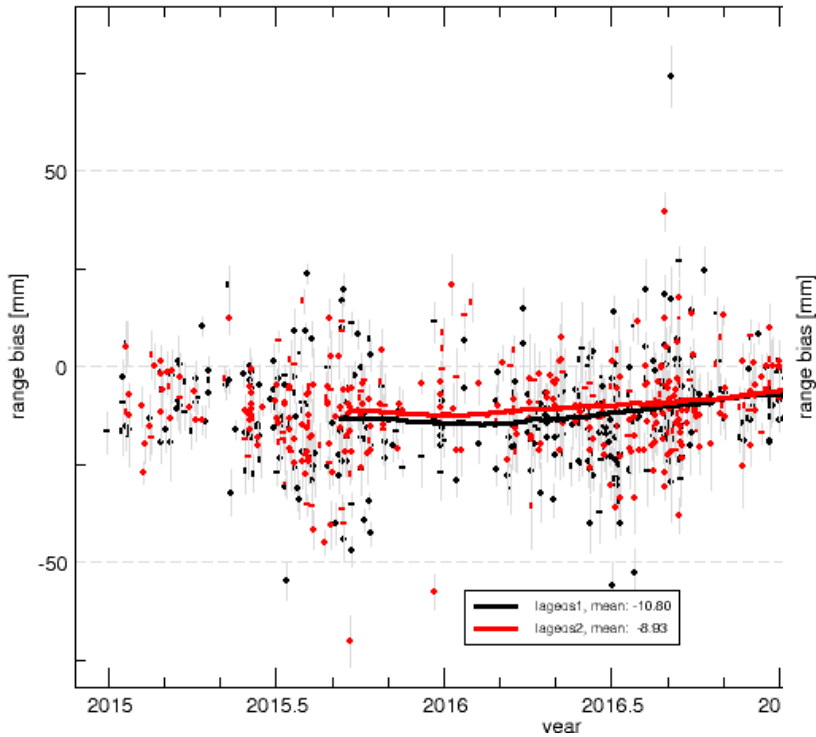
Lageos1 GPS week 1967: (part)

Station	year	mm	dd	hh	mm	range-bias [cm]	sigma [cm]	prec.est. [cm]	no of observations	edit.	time-bias [microsec.]	sigma	
Kiev	2017	9	18	22:18	:	-105.36	0.83	3.61	3	0	-20.10	4.25	1824
Komsomol	2017	9	22	12:22	:	3.50	0.72	0.57	7	0			1868
Simeiz	2017	9	17	00:45	:	1.14	0.45	2.03	7	0	16.34	2.53	1873
Simeiz	2017	9	17	23:36	:	3.59	0.60	1.84	5	1			1873
Simeiz	2017	9	18	22:06	:	0.33	0.42	1.83	5	0			1873
Simeiz	2017	9	19	20:43	:	0.72	0.45	2.20	6	0			1873
Simeiz	2017	9	22	23:37	:	-1.05	0.53	2.86	7	0	27.33	3.38	1873
Simeiz	2017	9	23	22:20	:	-0.06	0.56	1.87	4	0			1873
Simeiz	2017	9	24	20:55	:	4.14	0.40	1.88	7	0	16.92	2.82	1873
Altay	2017	9	17	15:51	:	-0.01	0.80	0.65	6	0			1879
Riga	2017	9	23	22:20	:	0.92	0.41	0.63	7	0			1884
Riga	2017	9	24	20:53	:	3.16	0.42	0.95	11	0	8.44	2.68	1884
Riga	2017	9	25	00:27	:	-5.80	0.36	1.19	10	0	12.85	1.96	1884
Riga	2017	9	25	23:08	:	1.82	0.55	0.32	3	0			1884
Arkhyz	2017	9	18	22:01	:	3.71	0.77	1.46	4	0			1886
Arkhyz	2017	9	19	20:41	:	4.49	0.41	0.52	7	0			1886
Arkhyz	2017	9	20	00:17	:	2.23	0.51	0.35	4	0			1886
Arkhyz	2017	9	20	22:56	:	2.69	0.42	0.59	6	0			1886
Baikonur	2017	9	17	19:49	:	-1.80	0.49	1.02	5	0			1887

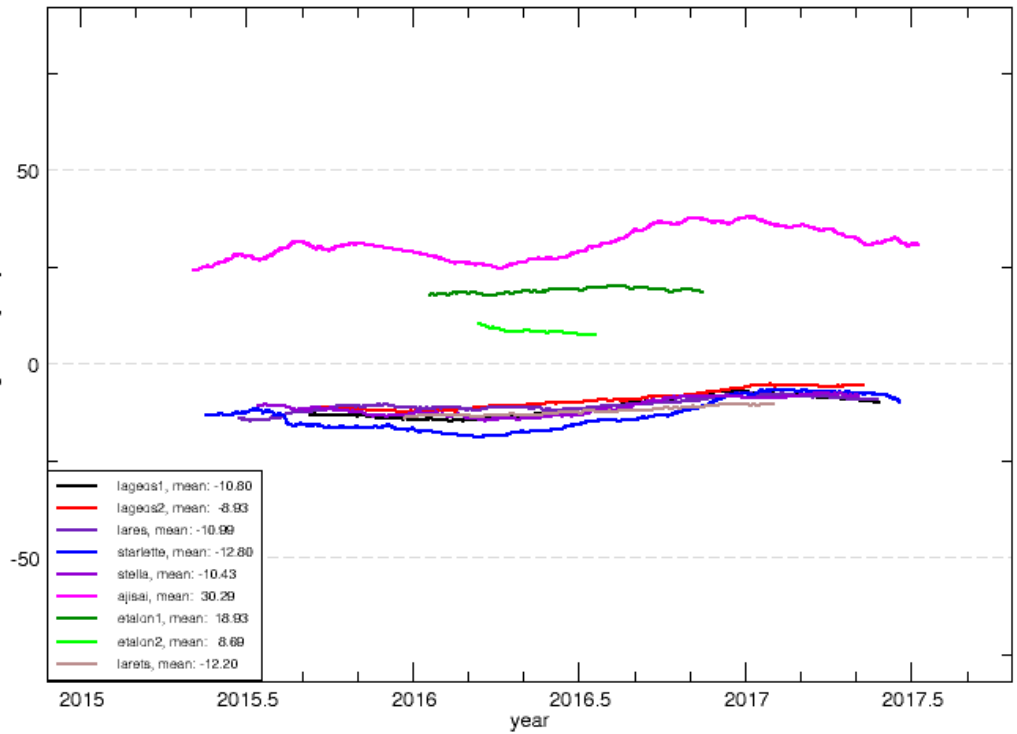
# Example of station plots

## Wetzell

SLRF2014 bias analysis: one per pass and running average  
Wetzell (8834)



SLRF2014 bias analysis: running average of 300 passes  
Wetzell (8834)



# Rapid Service Mail

- Mailman based scripts
  - Distribution to list members (presently 14)
- FTP-archive at: <ftp://edc.dgfi.tum.de/pub/slr/rapid servicemail/>
  - Yearly directories
  - Index of rapid service mails

RapidServiceMail Summary - Last update: 2017-09-26 01:00:01

#No	Date	From	Subject
130	2017-06-16	Toshimichi Otsubo	(HITU) -200 microsec time bias in Mt Stromlo (7825) data
129	2017-03-09	Van Husson	(Van-Husson) 1 millisecond time bias detected in Changchun (7237) data
128	2017-02-17	Toshimichi Otsubo	(HITU) 1 ms time bias detected in Changchun (7237) data
127	2016-12-22	Toshimichi Otsubo	(HITU) -150 microsec time bias in Mt Stromlo (7825) data
126	2016-11-24	Toshimichi Otsubo	(HITU) 26 m range bias in Mt Stromlo (7825) data
125	2016-10-03	Toshimichi Otsubo	(HITU) 2.2 msec time bias in Simeiz data
124	2016-08-31	=?UTF-8?Q?Stanis=c5=82aw_Schillak?=@	Re: (HITU) 20-30 cm range bias in Borowiec data
123	2016-08-31	=?UTF-8?Q?Stanis=c5=82aw_Schillak?=@	Re: (HITU) 20-30 cm range bias in Borowiec data
122	2016-08-31	=?UTF-8?Q?Pawe=c5=82_Lejba?=@	Re: (HITU) 20-30 cm range bias in Borowiec data
121	2016-08-31	Toshimichi Otsubo	(HITU) 20-30 cm range bias in Borowiec data
120	2016-08-23	Toshimichi Otsubo	(HITU) Large bias in Changchun data since 22 Aug
119	2016-08-12	Toshimichi Otsubo	(HITU) -8.5 metre bias in Yarragadee (7090) data
118	2016-06-24	Toshimichi Otsubo	Re: (HITU) 200 ms time bias in Arequipa (7403) data
117	2016-06-24	ESTACION NASA-UNSA	Re: (HITU) 200 ms time bias in Arequipa (7403) data
116	2016-06-23	Toshimichi Otsubo	(HITU) 200 ms time bias in Arequipa (7403) data
115	2016-05-31	Parkhomenko Natalia	Re: (DGFI-TUM) 22 metre range bias at station 7407 (Brazilia)
114	2016-05-31	Horst Mueller	(DGFI-TUM) Range bias for all Russian stations of 22 meter
113	2016-05-31	Horst Mueller	(DGFI-TUM) 22 metre range bias at station 7407 (Brazilia)
112	2016-05-09	plejba	Re: (DGFI) Time bias of 1 second at Borowiec station
111	2016-05-09	Horst Mueller	(DGFI) Time bias of 1 second at Borowiec station
110	2016-03-17	Horst Mueller	(DGFI) Big range biases from station 1824 since yesterday (March 15 2016)
109	2016-03-16	Toshimichi Otsubo	(HITU) 2.7 m range bias in Simeiz (1873) data
108	2016-02-26	Horst Mueller	(DGFI) big range/time biases: station Zelenchukskya (1889) on Feb. 24 2016

#No | Date | From | Subject

130 | 2017-06-16 | Toshimichi Otsubo

| (HITU) -200 microsec time bias in Mt Stromlo (7825) data

129 | 2017-03-09 | Van Husson

| (Van-Husson) 1 millisecond time bias detected in Changchun (7237) data

128 | 2017-02-17 | Toshimichi Otsubo

| (HITU) 1 ms time bias detected in Changchun (7237) data

→ 127 | 2016-12-22 | Toshimichi Otsubo

| (HITU) -150 microsec time bias in Mt Stromlo (7825) data

126 | 2016-11-24 | Toshimichi Otsubo

| (HITU) 26 m range bias in Mt Stromlo (7825) data

125 | 2016-10-03 | Toshimichi Otsubo

| (HITU) 2.2 msec time bias in Simeiz data

**Changchun & Mt Stromlo reacted quickly and solved the problems sometimes before my message.**

LAG2	7825	2016/12/18	00:10	22	28 ( 18 )	15.1 ( 12.4 )	3 0 / 7	7	928.1 291.1	42	26349	7	3 0 0 0	532
AJ11	7825	2016/12/18	01:36	8	1 ( 6 )	-0.7 ( 2.6 )	10 0 / 18	25	927.7 292.4	37	26349	15	3 0 0 0	532
AJ11	7825	2016/12/18	03:40	9	-5 ( 5 )	0.9 ( 2.5 )	8 0 / 19	22	927.0 294.7	27	26349	0	3 0 0 0	532
LARS	7825	2016/12/18	04:06	6	32 ( 9 )	-2.9 ( 2.9 )	4 0 / 5	5	926.9 295.1	28	26349	0	3 0 0 0	532
STEL	7825	2016/12/18	04:36	6	5 ( 4 )	0.5 ( 1.0 )	2 0 / 14	3	926.8 295.2	28	26349	0	3 0 0 0	532
JAS3	7825	2016/12/18	05:32	6	17 ( 3 )	-11.3 ( 1.6 )	2 0 / 26	5	926.7 293.0	45	26349	0	3 0 0 0	532
AJ11	7825	2016/12/18	05:43	8	-4 ( 5 )	0.5 ( 1.9 )	6 0 / 19	24	926.7 292.7	46	26349	0	3 0 0 0	532
STRL	7825	2016/12/18	05:53	8	5 ( 7 )	-10.2 ( 1.4 )	6 0 / 8	4	926.9 292.6	45	26349	0	3 0 0 0	532
GA02	7825	2016/12/18	06:58	112	6 ( 6 )	----- ( ----- )	5 0 / 5	11	929.1 287.3	59	26349	0	3 0 0 0	532
STRL	7825	2016/12/18	07:46	0	----- ( ----- )	----- ( ----- )	----- 0 / 1	1	928.6 288.1	56	26350	1	3 0 0 0	532
AJ11	7825	2016/12/18	07:52	3	-25 ( 48 )	16.7 ( 13.3 )	7 0 / 8	28	928.7 287.9	57	26350	1	3 0 0 0	532
F202	7825	2016/12/20	05:17	19	1 ( 2 )	----- ( ----- )	3 0 / 3	7	917.5 298.2	35	26349	-2	3 0 0 0	532
JAS3	7825	2016/12/20	06:21	4	40 ( 10 )	-162.7 ( 2.4 )	1 0 / 19	3	916.9 297.8	38	26347	2	4 0 0 0	532
STRL	7825	2016/12/20	06:37	2	-560 ( 15 )	----- ( ----- )	4 0 / 7	6	917.3 297.9	37	26347	2	4 0 0 0	532
GL28	7825	2016/12/20	06:47	5	109 ( 19 )	----- ( ----- )	8 0 / 2	15	917.4 297.9	36	26347	2	4 0 0 0	532
STRL	7825	2016/12/20	08:26	3	6 ( 0 )	-164.0 ( 0.3 )	0 4 / 8	5	918.7 296.6	30	26349	13	3 0 0 0	532
F208	7825	2016/12/20	11:28	7	14 ( 7 )	----- ( ----- )	5 0 / 3	6	920.3 293.2	37	26348	12	3 0 0 0	532
GL33	7825	2016/12/20	11:46	14	31 ( 16 )	----- ( ----- )	4 0 / 4	8	920.1 293.1	38	26348	13	3 0 0 0	532
STRL	7825	2016/12/20	12:05	8	14 ( 4 )	-164.0 ( 1.0 )	1 0 / 18	4	920.0 292.9	40	26348	13	3 0 0 0	532
LAG1	7825	2016/12/20	12:49	18	23 ( 8 )	-158.1 ( 9.6 )	3 3 / 11	7	920.0 290.9	45	26348	13	3 0 0 0	532
STRL	7825	2016/12/20	13:55	1	297 ( 12 )	----- ( ----- )	3 0 / 5	5	919.9 290.2	45	26348	2	3 0 0 0	532
LARS	7825	2016/12/20	14:06	0	----- ( ----- )	----- ( ----- )	----- 0 / 1	2	920.0 290.1	46	26348	2	3 0 0 0	532
STEL	7825	2016/12/20	15:00	3	58 ( 10 )	-154.4 ( 4.8 )	3 0 / 8	6	919.9 289.5	46	26348	2	3 0 0 0	532
JAS3	7825	2016/12/20	16:10	9	19 ( 2 )	-167.5 ( 0.6 )	1 0 / 38	4	919.7 289.1	46	26351	16	4 0 0 0	532
LAG1	7825	2016/12/20	16:27	0	----- ( ----- )	----- ( ----- )	----- 0 / 1	7	919.7 288.9	47	26351	16	4 0 0 0	532
STEL	7825	2016/12/20	16:42	1	-651 ( 4 )	----- ( ----- )	1 0 / 5	6	919.7 288.5	49	26351	0	4 0 0 0	532
GA04	7825	2016/12/20	17:48	7	2 ( 9 )	----- ( ----- )	6 0 / 3	10	920.3 288.5	41	26351	2	4 0 0 0	532
LAG2	7825	2016/12/20	18:27	9	17 ( 12 )	-176.6 ( 19.2 )	2 0 / 6	8	920.9 288.8	38	26351	0	4 0 0 0	532
GA03	7825	2016/12/20	20:58	21	-17 ( 10 )	----- ( ----- )	2 0 / 6	10	922.5 288.9	47	26351	-1	3 0 0 0	532
GL28	7825	2016/12/20	21:42	23	-2 ( 16 )	----- ( ----- )	13 0 / 3	13	922.8 290.7	40	26351	-1	3 0 0 0	532
LAG2	7825	2016/12/20	22:38	16	15 ( 2 )	-152.4 ( 3.8 )	1 0 / 9	6	922.8 292.5	35	26349	1	3 0 0 0	532
LAG1	7825	2016/12/20	23:11	19	27 ( 16 )	-169.2 ( 7.7 )	2 0 / 9	5	923.1 293.6	33	26349	1	3 0 0 0	532
LARS	7825	2016/12/21	02:59	1	-665 ( 10 )	----- ( ----- )	2 0 / 4	4	922.9 297.8	27	26351	-1	4 0 0 0	532
LAG2	7825	2016/12/21	03:22	1	-360 ( 61 )	----- ( ----- )	9 0 / 2	9	922.7 297.6	27	26351	-1	4 0 0 0	532
LARS	7825	2016/12/21	04:52	1	5 ( 4 )	----- ( ----- )	1 0 / 4	3	922.8 298.7	27	26349	-1	3 0 0 0	532
STEL	7825	2016/12/21	04:57	3	-178 ( 110 )	-106.4 ( 30.1 )	23 0 / 6	3	922.7 299.1	26	26349	-1	3 0 0 0	532
STRL	7825	2016/12/21	05:01	6	-43 ( 6 )	-155.1 ( 1.5 )	2 0 / 14	5	922.7 299.1	26	26349	-1	3 0 0 0	532
AJ11	7825	2016/12/21	05:08	5	14 ( 88 )	-158.6 ( 22.7 )	8 0 / 12	28	922.7 298.9	26	26349	-1	3 0 0 0	532
JAS3	7825	2016/12/21	06:44	2	-661 ( 4 )	----- ( ----- )	1 0 / 13	5	922.8 298.6	27	26349	-1	3 0 0 0	532
STRL	7825	2016/12/21	06:54	4	-34 ( 12 )	-145.4 ( 4.7 )	3 0 / 11	6	922.9 298.6	28	26349	-1	3 0 0 0	532
AJ11	7825	2016/12/21	07:09	4	15 ( 58 )	-155.3 ( 21.1 )	6 0 / 9	5	922.8 298.7	27	26349	12	3 0 0 0	532
GA01	7825	2016/12/21	07:52	94	22 ( 9 )	----- ( ----- )	3 0 / 1	1	922.8 298.7	27	26349	12	3 0 0 0	532
STRL	7825	2016/12/21	08:45	3	-3 ( 8 )	-147.4 ( 10.7 )	2 0 / 14	5	922.7 299.1	26	26349	12	3 0 0 0	532
GL33	7825	2016/12/21	09:46	0	----- ( ----- )	----- ( ----- )	----- 0 / 1	1	922.8 298.7	27	26349	12	3 0 0 0	532
STRL	7825	2016/12/21	10:34	3	18 ( 10 )	-151.9 ( 4.4 )	6 0 / 14	5	922.7 299.1	26	26349	12	3 0 0 0	532
LAG1	7825	2016/12/21	21:48	19	28 ( 34 )	-172.0 ( 17.9 )	3 0 / 11	6	922.9 298.6	28	26349	-1	3 0 0 0	532
AJ11	7825	2016/12/22	00:00	8	-9 ( 21 )	-155.2 ( 8.9 )	8 0 / 12	28	922.7 298.9	26	26349	-1	3 0 0 0	532
LAG2	7825	2016/12/22	00:53	4	163 ( 14 )	----- ( ----- )	11 0 / 1	1	922.8 298.7	27	26349	-1	3 0 0 0	532
LAG1	7825	2016/12/22	01:19	19	16 ( 14 )	-175.2 ( 19.5 )	3 0 / 10	4	926.1 297.1	38	26349	-1	3 0 0 0	532
AJ11	7825	2016/12/22	02:05	7	-5 ( 9 )	-143.0 ( 8.7 )	7 0 / 16	5	922.7 299.1	26	26351	-1	3 0 0 0	532
STRL	7825	2016/12/22	03:34	5	30 ( 4 )	-169.0 ( 1.6 )	1 0 / 12	5	927.0 296.2	41	26350	-1	4 0 0 0	532
STEL	7825	2016/12/22	04:30	5	6 ( 5 )	4.9 ( 1.1 )	1 0 / 12	5	926.6 296.7	40	26349	1	3 0 0 0	532
JAS3	7825	2016/12/22	05:05	8	3 ( 2 )	0.5 ( 0.5 )	1 0 / 36	4	926.4 297.4	38	26349	1	3 0 0 0	532
STRL	7825	2016/12/22	05:25	4	4 ( 17 )	2.4 ( 4.2 )	2 0 / 10	4	926.1 297.1	38	26349	1	3 0 0 0	532

System reboot at  
4:00, 22 Dec.  
(C Moore)

# Final Remarks

**QC reports useful to minimise the anomalous data flowing.  
Please give a reply when we send an alert message.**

**Large bias (> 10 cm) less harmful than small (a few cm or less) bias.**

**Fewer issues reported in 2017.**

Good communications!

Keep the site log (→ILRS web) info fresh.

**Leap second on 1 Jan 2017.**

No bias detected.

Significantly reduced observations on 1 Jan.