

System Biases Session A: Analytic Results

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•How do we estimate our system biases in our processing and analysis systems?

•What examples of biases have been seen from the Q/C and final processing systems?

•What are the likely sources of biases? What are the big issues?

FIRST question How do we estimate our system biases in our processing and analysis systems?

Within ILRS there are basically 2 types of approaches to estimate system biases:

- <u>Fast delivery Quality Check</u>: pass by pass estimation of range and time bias available for some satellites and at different delivery frequencies depending on the AC
- Short/medium/long term estimation: weekly, monthly, yearly biases typically estimated in multiyear solutions by some ILRS Analysis Centers, mostly for Lageos

Fast delivery Quality Check

- Deutsches Geodätisches Forschungsinstitut (DGFI) Germany
- Hitotsubashi University Japan
- Joint Center for Earth System Technology/GSFC (JCET/GSFC) Greenbelt, Maryland, USA
- Russian Mission Control Centre, (MCC) Moscow, Russia
- SHAO Shanghai Atronomical Observatory CAS China

DGFI Q/C Procedure

- Q/C is part of the processing chain for the daily/weekly ILRS products and is used for data editing
- Q/C runs twice a day 08:00 and 13:00 h UTC
- Pass by pass bias analysis for all stations, including quarantine stations
- We are processing Lageos1 and Lageos2
- Results are published on DGFI-Webpage http://www.ilrs.dgfi.quality
- Plans are to process other satellites as well
- For new stations a coordinate update will be processed if required

QC Analysis & Report @ HIT-U

Product: Pass-by-pass range bias & time bias.

History: 1998-present (CRL \rightarrow NICT \rightarrow HIT-U).

Frequency: Currently updated every 6 hrs. Latency 2.5-8.5 hrs.

Software: c5++.

Availability: web (geo.science.hit-u.ac.jp), SLReport, CDDIS ftp, etc. Problems reported via Email (RapidServiceMail). Stations: operational & under quarantine.

Satellites: LAGEOS-1, 2, AJISAI, ETALON-1, 2, LARES, STARLETTE, STELLA, JASON-2, SARAL, CRYOSAT-2, BEACON-C, GPS, GLONASS, GALILEO.

Recent upgrade: Automatic anomaly notification (done). Plan: SLRF2008 → ITRF2014. Discontinuity expected. Adding more satellites



Hitotsubashi University

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Lageos-2	13	260 / 2409	🏴 Changchun	(7237) 37/189		(7090) 35/392					
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QC Analysis & Reports @ JCET

Product: Pass-by-pass range & time bias from 7-day arc. History: 2007-present (JCET→ GEST→ JCET). Frequency: Currently updated every day - Latency 2 days. Software: GEODYN II (FORTRAN)

Availability:

http://ilrs.gsfc.nasa.gov/network/system_performance/global_report_cards/mo nthly/perf_201509_wLLR.html

CDDIS ftp

Problems reported via email (RapidServiceMail).

Stations: operational & under quarantine.

Satellites: LAGEOS-1, 2, ETALON-1, 2, LARES, AJISAI,

STARLETTE.

Upcoming upgrade: Series visualization accessible by users Planned: SLRF2008 → ITRF2014. (~January 2016 ???) Addition of more (GNSS) satellites.

Documentation: <u>ftp://cddis.gsfc.nasa.gov/slr/products/ac/jcet_qc.txt</u>

QC Analysis & Reports @ JCET

History

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@Data span 151019-151025 # @contact epavlis@umbc.edu

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<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee ! # #STA ID YY/MM/DD HI # 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 09:49 L1 13:17 L1 14:12 L2 16:37 L1 17:53 L2 19:59 L1 22:17 L2 08:39 L1	21ease Fla 1 elevatio 1 elevatio 600D 0BS 5 18 16 10 12 21 16 8	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 23.3 7.2 3.7 6.8	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.9	s 130) RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5	BIAS SIGMA 9.8 2.4 7.9 12.9 9.3 1.9 2.6 6.7	BIAS [us] 10.7 1.3 4.2 -0.9 3.6 -6.0 -1.3 -1.1	BIAS SIGMA 7.6 3.2 3.4 5.0 3.2 2.5 2.5 2.5 3.9	DUR [MIN] 0 0 0 0 0 0 0 0 0 0	0BS 0 0 0 0 0 0 0 0 0 0	MEAN [mm] 15197 E 15197 E 15193 E 15193 E 15194 E 15194 E 15195 E 15198 E	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 0 F 2 F 2 F 1 F 2 F 3 F 0 F	RMS [mm] (mm] (mm)	[K] 290.3 292.5 288.0 287.4 284.7 284.3 284.9 285.5	% 56.0 51.4 67.0 71.0 79.0 79.2 78.8 75.3	[hPa] 990.6 987.9 989.1 989.0 988.4 987.9 987.5 988.0	[nm] 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0	C C R H I F 4 1 0 4 1 0	MAX [deg 54.0 85.3 29.5 20.6 24.2 83.2 76.5 43.8
<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee # # # 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/20</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 09:49 L1 13:17 L1 14:12 L2 16:37 L1 17:53 L2 19:59 L1 22:17 L2 08:39 L1 11:59 L1	elease Fla elevatio elevatio GOOD OBS 5 18 16 10 12 21 16 8 11	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 23.3 7.2 3.7 6.8 5.5	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.9 2.3	s 130) RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5 5.0	BIAS SIGMA 9.8 2.4 7.9 12.9 9.3 1.9 2.6 6.7 4.4	BIAS [us] 10.7 1.3 4.2 -0.9 3.6 -6.0 -1.3 -1.1 -2.3	BIAS SIGMA 7.6 3.2 3.4 5.0 3.2 2.5 2.5 2.5 3.9 2.2	DUR [MIN] 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0BS 0 0 0 0 0 0 0 0 0 0	MEAN [mm] 15197 E 15193 E 15193 E 15194 E 15194 E 15195 E 15198 E 15196 E	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 0 F 2 F 2 F 1 F 2 F 3 F 0 F 0 F	RMS [mm]	[K] 290.3 292.5 288.0 287.4 284.7 284.3 284.9 285.5 298.6	% 56.0 51.4 67.0 71.0 79.0 79.2 78.8 75.3 33.5	[hPa] 990.6 987.9 989.1 989.0 988.4 987.9 987.5 988.0 984.7	[nm] 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0	C C R H I F 4 1 0 4 1 0	MAX [deg 54.0 85.3 29.5 20.6 24.2 83.2 76.5 43.8 52.2
<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee # #STA ID YY/MM/DD HI # 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 09:49 L1 31:7 L1 14:12 L2 16:37 L1 14:12 L2 16:37 L1 14:53 L1 19:59 L1 12:51 L1 11:52 L1 11:52 L1 16:21 L2	21ease Fla 1 elevatio 1 elevatio 600D 0BS 5 18 16 10 12 21 16 8 11 16 8 11 20 12 23	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 23.3 7.2 3.7 6.8 5.5 1.8 6.8 7.4	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.9 2.3 1.3 3.0 1.9	s 130) RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5 5.0 -1.2 -6.1 7.1	BIAS SIGMA 9.8 2.4 7.9 12.9 9.3 1.9 2.6 6.7 4.4 3.3 5.3 3.7	BIAS [us] 10.7 1.3 4.2 -0.9 3.6 -6.0 -1.3 -1.1 -2.3 -5.6 -7.1 -0.8	BIAS SIGMA 7.6 3.2 3.4 5.0 3.2 2.5 2.5 2.5 2.5 3.9 2.2 2.1 2.6 2.4	DUR [MIN] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	OBS 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	MEAN [mm] 15197 E 15197 E 15193 E 15193 E 15194 E 15194 E 15195 E 15196 E 15195 E	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 0 F 2 F 1 F 2 F 3 F 0 F 0 F 0 F 0 F 0 F 0 F 1 F -1 F	RMS [mm] 10 9 10 9 10 9 10 9 10 9 10 9 10 9 10 9 10 9 10 9 10 9 10 9 9 10 9 9 10 9 9 10 9 9 10 9 9 10 9 9 10 9 9 10 9 9 10 9 9 10 9 9 10 9 9 10 9 10 9 10 9 10 9 10 9 10 9 10 9 10 10 10 10 9 10	[K] 290.3 292.5 288.0 287.4 284.7 284.3 284.9 285.5 298.6 291.6 291.6 291.6 291.8 3 288.3	% 56.0 51.4 67.00 79.0 79.2 78.8 75.3 33.5 53.0 59.0 59.0 57.0	[hPa] 990.6 987.9 989.0 988.4 987.9 987.5 988.0 984.7 986.5 985.9 985.6	[nm] 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0	C C R H I F 4 1 0 4 1 0 0	MAX [deg 54.0 85.3 29.5 20.6 24.2 83.2 76.5 43.8 52.2 43.8 52.2 46.2 19.7 59.8
<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee # # \$STA ID YY/MM/DD HI # 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 09:49 L1 13:17 L1 14:12 L2 16:37 L1 17:53 L2 19:59 L1 22:17 L2 08:39 L1 11:59 L1 15:21 L1 16:01 L2 18:37 L1	elease Fla elevatio elevatio 0000 0005 5 18 16 10 12 21 16 8 11 20 12 23 13	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 23.3 7.2 3.7 6.8 5.5 1.8 6.8 5.5 1.8 6.8 7.4 3.0	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.5 3.7 3.9 2.3 1.3 3.0 1.9 2.8	s 130) RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5 5.0 -1.2 -6.1 7.1 -1.1	BIAS SIGMA 9.8 2.4 7.9 12.9 9.3 1.9 2.6 6.7 4.4 3.3 5.3 3.7 3.5	BIAS [us] 10.7 1.3 4.2 -0.9 3.6 -6.0 -1.3 -1.1 -2.3 -5.6 -7.1 -0.8 -0.7	BIAS SIGMA 7.6 3.2 3.4 5.0 3.2 2.5 2.5 3.9 2.2 2.1 2.1 2.1 2.4 2.4 2.2	DUR [MIN] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	OBS 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	MEAN [mm] 15197 E 15197 E 15193 E 15193 E 15194 E 15194 E 15196 E 15196 E 15195 E 15195 E	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 0 F 2 F 1 F 2 F 3 F 0 F 3 F 0 F 3 F 3 F 0 F 3 F 1 F 1 F 1 F	RMS [mm] 2 11 2 10 2 10 2 10 2 10 2 10 2 10 2 9 2 10 2 9 2 10 2 9 2 10 2 9 2 10 2 10 2 9 2 10 2 10 2 10 2 11 2 10 2 10 2 10 2 10	[K] 290.3 292.5 288.0 287.4 284.7 284.3 284.9 285.5 298.6 291.6 288.3 288.3 288.3 288.3	% 56.0 51.4 67.0 79.0 79.0 79.0 79.0 79.0 78.8 75.3 33.5 53.0 59.0 57.0 64.0	[hPa] 990.6 987.9 989.1 989.0 988.4 987.5 988.0 987.5 988.0 984.7 986.5 985.6 985.9 985.6 984.5	[nm] 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0	C C R H I F 4 1 0 4 1 0	MAX [deg 54.0 85.3 29.5 20.6 24.2 83.2 76.5 43.8 52.2 46.2 19.7 59.8 49.7
<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee # # Yo900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 09:49 L1 13:17 L1 14:12 L2 16:37 L1 17:53 L2 19:59 L1 22:17 L2 08:39 L1 15:59 L1 15:51 L1 15:51 L1 15:51 L1 15:51 L1 15:31 L1 15:37 L1 20:09 L2	Elease Fla elevatio elevatio 600D 0BS 5 18 16 10 12 21 16 8 11 20 12 23 13 9	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 23.3 7.2 3.7 6.8 5.5 1.8 6.8 7.4 3.0 3.0	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.9 2.3 1.3 3.0 1.9 2.8 2.3	s 130) RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5 5.0 -1.2 -6.1 7.1 -1.1 2.0	BIAS SIGMA 9.8 2.4 7.9 12.9 9.3 1.9 2.6 6.7 4.4 3.3 5.3 3.7 3.5 5,7.2	BIAS [us] 10.7 1.3 4.2 -0.9 3.6 -6.0 -1.3 -1.1 -2.3 -5.6 -7.1 -0.8 -0.7 -7.8	BIAS SIGMA 7.6 3.2 3.4 5.0 3.2 2.5 2.5 2.5 2.5 2.5 2.2 2.1 2.6 2.4 2.4 2.2 2.4	DUR [MIN] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	OBS 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	MEAN [mm] 15197 E 15197 E 15193 E 15193 E 15194 E 15194 E 15195 E 15194 E 15195 E 15195 E 15195 E 15195 E 15195 E	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 0 F 2 F 2 F 2 F 2 F 2 F 3 F 0 F 0 F 3 F -1 F -1 F 0 F 0 F	RMS [mm] 0 11 0 10 0	[K] 290.3 292.5 288.0 287.4 284.7 284.3 284.9 285.5 298.6 291.6 288.3 288.3 288.3 287.3 287.0	% 56.0 51.4 67.0 79.0 79.2 78.8 75.3 33.5 53.0 59.0 57.0 64.0 67.0	[hPa] 990.6 987.9 989.1 988.4 987.9 987.5 988.0 984.7 986.5 985.6 985.6 985.6 984.8	[nm] 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0	C C R H I F 4 1 0 4 1 0	MAX [deg 54.0 85.3 29.5 20.6 24.2 83.2 76.5 43.8 52.2 46.2 19.7 59.8 49.7 49.2
<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee # #STA ID YY/MM/DD HI # 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 09:49 L1 31:17 L1 14:12 L2 16:37 L1 14:12 L2 16:37 L1 19:59 L1 22:17 L2 08:39 L1 15:51 L1 16:01 L2 18:37 L1 20:09 L2 22:03 L1	Elease Fla elevatio elevatio GOOD OBS 5 18 16 10 12 21 16 8 11 16 8 11 20 12 23 13 9 20	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 23.3 7.2 3.7 6.8 5.5 1.8 6.8 7.4 3.0 2.6	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.9 2.3 1.3 3.0 1.9 2.8 2.3 2.4	RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5 5.0 -1.2 -6.1 7.1 -1.1 2.0 -1.2	BIAS SIGMA 9.8 2.4 7.9 12.9 9.3 1.9 2.6 6.7 4.4 3.3 5.3 3.7 3.5 7.2 3.4	BIAS [us] 10.7 1.3 4.2 -0.9 3.6 -6.0 -1.3 -1.1 -2.3 -5.6 -7.1 -0.8 -0.7 -7.8 1.2	BIAS SIGMA 7.6 3.2 3.4 5.0 3.2 2.5 2.5 2.5 2.5 2.5 2.5 2.2 2.1 2.6 2.4 2.4 2.2 4.1 2.4	DUR [MIN] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	OBS	MEAN [mm] 15197 E 15197 E 15193 E 15193 E 15194 E 15194 E 15196 E 15196 E 15195 E 15195 E 15195 E 15195 E 15194 E	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 0 F 2 F 2 F 2 F 3 F 0 F 3 F 0 F 3 F -1 F 1 F 0 F 0 F 0 F 0 F 0 F 0 F 0 F 0	RMS [mm]	[K] 290.3 292.5 288.0 287.4 284.3 284.9 285.5 298.6 291.6 288.3 287.3 287.3 287.0 287.7	% 56.0 51.4 67.0 79.0 79.2 78.8 75.3 33.5 53.0 59.0 57.0 64.0 67.0 68.2	[hPa] 990.6 987.9 989.1 989.0 987.5 988.0 987.5 988.0 984.7 986.5 985.9 985.6 985.6 984.5 984.5	[nm] 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0	C C R H I F 4 1 0 4 1 0	MAX [deg 54.0 85.3 29.5 20.6 24.2 83.2 76.5 43.8 52.2 46.2 19.7 59.8 49.7 49.2 48.7
<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee # #STA ID YY/MM/DD HI # 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/20 70900513 15/10/21</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 09:49 L1 31:77 L1 31:77 L1 14:12 L2 16:37 L1 14:12 L2 16:37 L1 19:59 L1 19:59 L1 19:59 L1 19:51 L1 16:01 L2 18:37 L1 20:09 L2 22:03 L1 00:33 L2	Coop Coop Coop Coop Coop Coop Coop Coop	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 23.3 7.2 3.7 6.8 5.5 1.8 6.8 7.4 3.0 3.0 2.6 6.8	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.9 2.3 1.3 3.0 1.9 2.8 2.3 2.4 2.6	s 130) RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5 5.0 -1.2 -6.1 7.1 -1.1 2.0 -1.2 6.3	BIAS SIGMA 9.8 2.4 7.9 12.9 9.3 1.9 2.6 7.4 4.4 3.3 5.3 3.7 3.5 7.2 3.4 3.2	BIAS [us] 10.7 1.3 4.2 -0.9 3.6 -6.0 -1.3 -1.1 -2.3 -5.6 -7.1 -0.8 -0.7 -7.1 -0.8 2.6	BIAS SIGMA 7.6 3.2 3.4 5.0 3.2 2.5 2.5 2.5 3.9 2.2 2.5 3.9 2.2 2.6 2.4 2.4 2.2 4.1 2.4 3.5	DUR [MIN] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	OBS	MEAN [mm] 15197 E 15197 E 15197 E 15193 E 15193 E 15194 E 15194 E 15195 E 15194 E 15195 E 15195 E 15195 E 15194 E 15195 Z	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 2 F 2 F 2 F 2 F 3 F 3 F 0 F 3 F -1 F 1 F 0 F 0 F -1 F 1 F 0 F -1 F 1 F -1 F 1 F -1	RMS [mm] 11 10 12	[K] 290.3 292.5 288.0 287.4 284.7 284.3 284.9 285.5 298.6 291.6 288.3 288.3 288.3 288.3 288.3 287.3 287.7 285.7 7 295.3	% 56.0 51.4 67.0 79.0 79.2 78.8 75.3 33.5 53.0 59.0 64.0 67.0 64.0 67.0 68.2 40.0	[hPa] 990.6 987.9 989.1 989.4 988.4 987.5 988.0 984.7 986.5 985.6 984.5 985.6	[nm] 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0	C C R H I F 4 1 0 4 1 0	MAX [deg 54.0 85.3 29.5 20.6 24.2 83.2 76.5 43.8 52.2 46.2 19.7 59.8 49.7 49.2 48.7 49.2 48.7 61.2
<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee # # 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/21 70900513 15/10/21</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 09:49 L1 13:17 L1 14:12 L2 16:37 L1 17:53 L2 19:59 L1 22:17 L2 08:39 L1 15:52 L1 15:52 L1 16:01 L2 18:37 L1 20:09 L2 22:03 L1 00:33 L2 00:33 L2 00:33 L2 00:33 L2 00:33 L2 00:33 L2 00:33 L2	21ease Fla 1 elevatio 1 elevatio 0005 5 18 16 10 12 21 16 8 11 20 12 23 13 9 20 11 9	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 23.3 7.2 3.7 6.8 5.5 1.8 6.8 5.5 1.8 6.8 7.4 3.0 3.0 2.6 6.8 5.6	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.9 2.3 1.3 3.0 1.9 2.8 2.3 1.9 2.8 2.3 2.4 2.3 2.4 2.6 3.3	s 130) RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5 5.0 -1.2 -6.1 7.1 -1.1 2.0 -1.2 6.3 4.5	BIAS SIGMA 9.8 2.4 7.9 9.3 1.9 2.6 6.7 4.4 3.3 5.3 3.7 4.4 3.3 5.3 3.5 7.2 3.4 3.2 7.6	BIAS [us] 10.7 1.3 4.2 -0.9 3.6 -6.0 -1.3 -1.1 -2.3 -5.6 -7.1 -0.8 -0.7 -7.8 1.2 2.6 10.9	BIAS SIGMA 7.6 3.2 3.4 5.0 3.2 2.5 2.5 2.5 2.5 3.9 2.2 2.1 2.6 2.2 4.1 2.4 3.5 3.9	DUR [MIN] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	OBS	MEAN [mm] 15197 E 15197 E 15193 E 15193 E 15194 E 15194 E 15196 E 15196 E 15195 E 15195 E 15195 E 15195 E 15195 E 15194 E 15197 E	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 0 F 2 F 2 F 3 F 0 F 3 F 0 F 3 F 1 F 3 F 0 F 0 F 0 F 1 F 1 F 2 F 2 F 3 F 0 F 2 F 2 F 3 F 2 F 2 F 3 F 7 F 2 F 3 F 7 F 2 F 3 F 7 F 0 F 7 F 1 F 7 F 2 F 3 F 7 F 0 F 7 F 1 F 7 F 2 F 7 F 1 F 7 F 0 F 7 F 2 F 7 F 0 F 7 F 1 F 7 F 2 F 7 F 0 F 7 F 1 F 7 F 2 F 7 F 1 F 7 F 7 F 7 F 7 F 7 F 7 F 7 F 7	RMS [mm] 11 10 12 12 10	[K] 290.3 292.5 288.0 287.4 284.7 284.3 284.9 285.5 298.6 291.6 298.6 291.6 288.3 287.3 287.0 287.7 295.7 295.7 295.7 306.0	% 56.0 51.4 67.0 79.0 79.0 79.2 78.8 75.3 33.5 53.0 59.0 57.0 64.0 67.0 68.2 40.0 24.0	[hPa] 990.6 987.9 989.1 988.4 987.5 988.0 984.7 986.5 985.6 984.5 985.6 984.5 984.8 984.8 984.9 985.0 985.2	[nm] 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0	C C R H I F 4 1 0 4 1 0	MAX [deg 54.0 85.3 29.5 20.6 24.2 83.2 76.5 83.2 76.5 85.2 2 46.2 19.7 59.8 49.7 49.2 48.7 61.2 40.7
<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee 1 # #STA ID YY/MM/DD HI # 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/21 70900513 15/10/21 70900513 15/10/21 70900513 15/10/21</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 00:49 L1 13:17 L1 14:12 L2 16:37 L1 17:53 L2 19:59 L1 22:17 L2 08:39 L1 15:59 L1 15:51 L1 15:51 L1 16:61 L2 18:37 L1 16:00 L2 22:03 L1 00:33 L2 04:53 L2 07:17 L1	Coop Coop Coop Coop Coop Coop Coop Coop	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 7.2 3.7 6.8 5.5 1.8 6.8 7.4 3.0 3.0 2.6 6.8 5.6 22.8	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.9 2.3 1.3 3.0 1.9 2.8 2.3 2.4 2.6 3.3 4.5	s 130) RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5 5.0 -1.2 -6.1 7.1 -1.1 2.0 -1.2 6.3	BIAS SIGMA 9.8 2.4 7.9 12.9 9.2.6 6.7 4.4 3.3 5.3 3.7 3.5 7.2 3.4 3.2 7.6 5.9	BIAS [us] 10.7 1.3 4.2 -0.9 3.66 -6.0 -1.3 -1.1 -2.3 -5.6 -7.1 -0.8 -0.7 -7.8 1.2 2.6 10.9 -5.5	BIAS SIGMA 7.6 3.2 3.4 5.0 3.2 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2	DUR [MIN] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	OBS	MEAN [mm] 15197 E 15197 E 15193 E 15193 E 15194 E 15194 E 15195 E 15194 E 15195 E 15195 E 15195 E 15195 E 15195 E 15197 E 15197 E 15197 E 15196 E	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 0 F 2 F 2 F 2 F 2 F 3 F 0 F 3 F 0 F 3 F 0 F 0 F 1 F 1 F 1 F 1 F 1 F 1 F 1 F 1	RMS [mm] 0 11 0 10 0	[K] 290.3 292.5 288.0 287.4 284.9 285.5 298.6 291.6 288.3 288.3 288.3 287.0 287.7 295.3 306.0 301.1	% 56.0 51.4 67.0 79.0 79.2 78.8 75.3 33.5 53.0 59.0 57.0 64.0 68.2 40.0 24.0 24.0 37.5	[hPa] 990.6 987.9 989.1 988.4 987.9 987.5 988.0 984.7 986.5 984.7 986.5 985.6 984.8 984.8 984.8 984.9 985.0 985.0 982.3 981.9	[nm] 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0 532.0	C C R H I F 4 1 0 4 1 0	MAX [deg 54.0 85.3 29.5 20.6 24.2 83.2 76.5 43.8 52.2 46.2 19.7 59.8 49.7 49.2 48.7 61.2 48.7 61.2 25.7
<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee # # 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/21 70900513 15/10/21</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 09:49 L1 31:17 L1 14:12 L2 16:37 L1 17:53 L2 16:37 L1 15:59 L1 22:17 L2 08:39 L1 15:59 L1 15:51 L1 16:01 L2 18:37 L1 20:09 L2 22:03 L1 00:33 L2 04:53 L2 07:17 L1	Elease Fla elevatio elevatio 600D 0BS 5 18 16 10 12 21 16 8 11 20 12 23 13 9 20 11 9 6	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 23.3 7.2 3.7 6.8 5.5 1.8 6.8 5.5 1.8 6.8 7.4 3.0 3.0 2.6 6.8 5.6	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.9 2.3 1.3 3.0 1.9 2.8 2.3 1.9 2.8 2.3 2.4 2.3 2.4 2.6 3.3	s 130) RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5 5.0 -1.2 -6.1 7.1 1.1 2.0 -1.2 6.3 4.5 22.3	BIAS SIGMA 9.8 2.4 7.9 9.3 1.9 2.6 6.7 4.4 3.3 5.3 3.7 4.4 3.3 5.3 3.5 7.2 3.4 3.2 7.6	BIAS [us] 10.7 1.3 4.2 -0.9 3.6 -6.0 -1.3 -1.1 -2.3 -5.6 -7.1 -0.8 -0.7 -7.8 1.2 2.6 10.9	BIAS SIGMA 7.6 3.2 3.4 5.0 3.2 2.5 2.5 2.5 2.5 3.9 2.2 2.1 2.6 2.2 4.1 2.4 3.5 3.9	DUR [MIN] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	OBS	MEAN [mm] 15197 E 15197 E 15193 E 15193 E 15194 E 15194 E 15196 E 15196 E 15195 E 15195 E 15195 E 15195 E 15195 E 15194 E 15197 E	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 0 F 2 F 2 F 3 F 0 F 3 F 0 F 3 F 1 F 3 F 0 F 0 F 0 F 1 F 1 F 2 F 2 F 3 F 0 F 2 F 2 F 3 F 2 F 3 F 2 F 2 F 3 F 7 F 2 F 3 F 7 F 2 F 3 F 7 F 0 F 7 F 1 F 7 F 2 F 7 F 1 F 7 F 2 F 7 F 0 F 7 F 1 F 7 F 0 F 7 F 1 F 7 F 2 F 7 F 0 F 7 F 1 F 7 F 2 F 7 F 1 F 7 F 7 F 7 F 7 F 7 F 7 F 7 F 7	RMS [mm] 0 11 0 10 0 10 0 10 0 10 0 10 0 10 0 10 0 9 0 10 0 9 0 10 0 9 0 10 0 10	[K] 290.3 292.5 288.0 287.4 284.7 284.3 284.9 285.5 298.6 291.6 298.6 291.6 288.3 287.3 287.0 287.7 295.7 295.7 295.7 306.0	% 56.0 51.4 67.0 79.0 79.0 79.2 78.8 75.3 33.5 53.0 59.0 57.0 64.0 67.0 68.2 40.0 24.0	[hPa] 990.6 987.9 989.1 988.4 987.5 988.0 984.7 986.5 985.6 984.5 985.6 984.5 984.8 984.8 984.9 985.0 985.2	[nm] 532.0 5	C C R H I F 4 1 0 4 1 0	MAX [deg 54.0 85.3 29.5 20.6 24.2 83.2 76.5 43.8 52.2 46.2 19.7 59.8 49.7 49.2 48.7 49.2 48.7 61.2 40.7
<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee 1 # #STA ID YY/MM/DD HI # 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/21 70900513 15/10/21 70900513 15/10/21 70900513 15/10/21 70900513 15/10/21</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 09:49 L1 31:17 L1 14:12 L2 16:37 L1 17:53 L1 14:12 L2 16:37 L1 19:59 L1 15:51 L1 16:01 L2 18:39 L1 16:01 L2 18:37 L1 20:09 L2 22:03 L1 00:33 L2 04:53 L2 07:17 L1 10:37 L1 14:07 L1	Elease Fla elevatio elevatio GOOD OBS 5 18 16 10 12 21 16 8 11 20 12 23 13 9 20 11 11 11 11 11 11 11 11 11 1	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 23.3 7.2 3.7 6.8 5.5 1.8 6.8 7.4 3.0 2.6 6.8 5.6 22.8 4.3	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.9 2.3 1.3 3.0 1.9 2.8 2.3 2.4 2.6 3.3 4.5 2.1	s 130) RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5 5.0 -1.2 -6.1 7.1 -1.1 2.0 -1.2 6.3 4.5 2.0 3.7	BIAS SIGMA 9.8 2.4 7.9 12.9 9.3 1.9 2.6 6.7 4.4 3.3 5.3 3.7 3.5 7.5 3.5 3.2 3.4 3.2 7.6 5.9 2.2	BIAS [us] 10.7 1.3 4.2 -0.9 3.6 -6.0 -1.3 -5.6 -7.1 -0.8 -0.7 -7.8 1.2 2.6 10.9 -5.5 -4.4	BIAS SIGMA 7.6 3.2 3.4 5.0 3.2 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2	DUR [MIN] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	OBS	MEAN [mm] 15197 E 15197 E 15193 E 15193 E 15194 E 15194 E 15194 E 15196 E 15195 E 15195 E 15195 E 15197 E 15197 E 15197 E 15197 E 15196 E 15196 E 15192 E	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 0 F 2 F 2 F 2 F 3 F 0 F 0 F 0 F 1 F 0 F 0 F 0 F 0 F 0 F 0 F 0 F 0	RMS [mm] 11 10 7 7 10 7 10 7 10 7 10 7 10 7 10 7 10 7 10 7 10 7 10 7 10 7 10 7 10 7 10 7 10	[K] 290.3 292.5 288.0 287.4 284.7 284.3 284.9 285.5 298.6 291.6 288.3 287.3 287.3 287.3 287.7 295.3 306.0 281.1 292.8	% 56.0 51.4 67.0 79.0 79.2 78.8 75.3 33.5 53.0 59.0 64.0 67.0 68.2 40.0 24.0 37.5 72.1	[hPa] 990.6 987.9 989.0 988.4 987.9 987.5 988.0 984.5 985.6 985.6 984.8 984.9 985.0 985.0 982.3 982.3 983.4	[nm] 532.0 5	C C R H I F 4 1 0 4 1 0	MAX [deg 54.0 85.3 29.5 20.6 24.2 83.2 76.5 43.8 52.2 46.2 19.7 59.8 49.7 49.2 48.7 61.2 48.7 61.2 40.7 25.7 72.0
<pre># DRF # ELEVATION MAX # ELEVATION MIN # #70900 Yarragadee # #STA ID YY/MM/DD H # 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/19 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/20 70900513 15/10/21 70900513 15/10/21 70900513 15/10/21 70900513 15/10/21 70900513 15/10/21 70900513 15/10/21 70900513 15/10/21</pre>	= Data Re = maximum = minimum 50107M001 H:MM SAT 00:37 L2 09:49 L1 13:17 L1 14:12 L2 16:37 L1 14:12 L2 16:37 L1 17:53 L2 19:59 L1 15:21 L1 16:01 L2 18:37 L1 10:33 L2 00:33 L2 00:35 L2 0:	Coop Coop Coop Coop Coop Coop Coop Coop	g (ILRS FR n for pass n for pass RAW RMS [mm] 7.1 9.1 5.4 16.3 23.3 7.2 3.7 6.8 5.5 1.8 6.8 7.4 3.0 2.6 6.8 5.6 22.8 4.3 5.0	format col [degrees] [degrees] PREC EST [mm] 2.1 2.0 1.8 2.3 3.7 3.5 3.7 3.9 2.3 1.3 3.0 1.9 2.8 2.3 2.4 2.6 3.3 4.5 2.1 4.9	s 130) RANGE BIAS [mm] 6.8 8.9 -5.1 16.2 -23.0 6.3 -0.5 5.5 5.0 -1.2 -6.1 7.1 -1.1 2.0 0 -1.2 6.3 4.5 22.3 3.7 0.5	BIAS SIGMA 9.8 2.4 7.9 12.9 9.3 1.9 2.6 6.7 4.4 3.3 5.3 3.7 3.5 7.2 3.4 3.2 7.6 5.9 2.2 7.7	BIAS [us] 10.7 1.3 4.2 -0.9 3.6 -6.0 -1.3 -1.1 -2.3 -5.6 -7.1 8 -0.7 -7.8 1.2 2.66 10.9 -5.5 -4.4 -6.0	BIAS SIGMA 7.6 3.2 3.4 5.0 2.5 2.5 2.5 2.5 2.5 2.5 2.2 2.1 2.6 2.4 2.2 4.1 2.4 3.5 3.9 4.3 3.9 4.3 2.1 3.0	DUR [MIN] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	OBS 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	MEAN [mm] 15197 E 15197 E 15193 E 15193 E 15194 E 15194 E 15194 E 15196 E 15195 E 15195 E 15195 E 15195 E 15194 E 15197 E 15196 E 15196 E 15192 E	SDEV [mm] 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	SHIFT [mm] 1 F 2 F 2 F 2 F 3 F 0 F 3 F 0 F 0 F 1 F 0 F 1 F 0 F 1 F 1 F 1 F 1 F 1 F 1 F 1 F 1	RMS [mm] 11 10 12 10 12 10 10 12 10 10 12 10 10 12 10 10 12 10 10 12 10 10 10 12 10 10 10 10 10 10 10 10 10 10 10 10 10 10 12 10 12	[K] 290.3 292.5 288.0 287.4 284.7 284.3 285.5 298.6 291.6 291.6 288.3 288.3 288.3 288.3 287.3 287.0 287.7 295.3 306.0 301.1 292.8 290.1	% 56.0 51.4 67.0 79.0 79.2 78.8 75.3 33.5 53.0 57.0 64.0 64.0 64.0 64.0 64.0 24.0 37.5 72.1 91.0	[hPa] 990.6 987.9 989.1 989.4 987.5 988.0 984.7 986.5 984.7 985.6 984.5 985.6 984.5 984.8 984.5 985.0 984.8 984.9 985.0 982.3 981.9 983.4 984.6	[nm] 532.0 5	C C R H I F 4 1 0 4 1 0	MAX [deg 54.0 85.3 20.6 24.2 83.2 76.5 43.8 52.2 46.2 19.7 49.7 49.7 49.7 49.2 48.7 49.7 49.7 49.2 40.7 25.7 6 22.6

QC Analysis & Report @ IAC PNT (MCC)

- **Product:** Pass-by-pass range bias & time bias. **History:** 1997-present (MCC \rightarrow IAC PNT).
- Frequency: Currently updated every working day. Software: Stark (MCC-IAC PNT).
- Availability: web (https://www.glonass-iac.ru/), CDDIS ftp,
- Stations: operational.
- Satellites: LAGEOS-1, 2.
- Recent upgrade: Oracle DB (done).
- **Plan:** SLRF2008 \rightarrow ITRF2014. Adding more satellites.

Russian Mission Control Center Residual Analysis Report

Residuals	are summarize	d for the	following 3-day arcs:	wtd rms(cm)
Lageos-1	3-day arc	14.10.15	00:00 - 17.10.15 00:00	1.4
Lageos-1	3-day arc	15.10.15	00:00 - 18.10.15 00:00	1.0
Lageos-1	3-day arc	16.10.15	00:00 - 19.10.15 00:00	1.8
Lageos-1	3-day arc	17.10.15	00:00 - 20.10.15 00:00	1.6
Lageos-1	3-day arc	18.10.15	00:00 - 21.10.15 00:00	1.5
Lageos-1	3-day arc	19.10.15	00:00 - 22.10.15 00:00	1.6
Lageos-1	3-day arc	20.10.15	00:00 - 23.10.15 00:00	1.7
Lageos-1	3-day arc	21.10.15	00:00 - 24.10.15 00:00	1.8
Lageos-1	3-day arc	22.10.15	00:00 - 25.10.15 00:00	1.8
Lageos-1	3-day arc	23.10.15	00:00 - 26.10.15 00:00	1.3
Lageos-1	3-day arc	24.10.15	00:00 - 27.10.15 00:00	1.3
Lageos-2	3-day arc	14.10.15	00:00 - 17.10.15 00:00	1.4
Lageos-2	3-day arc	15.10.15	00:00 - 18.10.15 00:00	1.0

MLRO (7941)

	DATA	T ini	T fin	sc	TTL	INC	ME	RMS	ORMS	ELEV	Т	P	Н	CALIB	TB	RB	PRMS S
							mm	mm	mm	deg	С	mbar	8	mm	us	mm	mm
7941	16.10.15				3	3	10	2	10	021-026	16	960.7	62	70599	*	10	3
7941	16.10.15	22:35	23:08	L2	18	18	57	19	60	020-052	16	960.6	65	70595	18	43	1
7941	17.10.15	03:23	03:26	L1	3	3	-10	0	10	041-045	14	960.5	83	70597	*	-10	0
7941	17.10.15	03:41	03:44	L1	3	3	0	1	1	042-046	14	960.5	88	70597	*	0	1
7941	17.10.15	10:13	10:32	L1	11	11	8	6	10	022-035	18	962.1	89	70603	7	13	2
7941	17.10.15	12:49	12:52	L2	3	3	11	0	11	036-041	20	961.3	89	70601	*	11	0
7941	17.10.15	13:35	13:50	L1	9	9	11	4	12	033-067	20	961.5	89	70601	5	19	1
7941	17.10.15	16:15	16:19	L2	3	2	5	0	5	024-032	16	961.6	89	70601	*	5	0
7941	17.10.15	16:35	16:46	L2	5	5	41	4	41	062-065	16	961.7	89	70600	7	41	0
7941	17.10.15	17:11	17:16	L1	4	4	-5	0	5	026-032	16	962.0	89	70600	*	-5	1
7941	17.10.15	17:35	17:40	L1	4	4	7	1	7	028-034	16	962.1	81	70600	*	7	1
7941	24.10.15	07:57	08:18	L1	12	12	-1	2	3	030-043	13	961.8	88	70602	-2	-1	1
7941	24.10.15	11:11	11:18	L1	5	5	13	2	14	025-036	15	961.8	71	70603	6	24	2
7941	24.10.15	11:29	11:31	L2	2	2	16	0	16	049-052	16	961.9	74	70604	*	16	0
7941	24.10.15	14:37	14:52	L1	9	9	19	5	19	037-082	14	962.3	79	70594	6	28	2
7941	24.10.15	15:09	15:31	L2	12	12	14	3	14	043-067	14	962.5	82	70586	4	17	1
7941	24.10.15	15:41	15:44	L2	3	3	17	1	17	039-044	13	962.3	89	70586	*	17	1
7941	25.10.15	06:28	06:28	L1	1	1	16	0	16	028-028	11	964.7	87	70581	*	16	16
7941	25.10.15	06:35	07:02	L1	12	12	7	2	7	032-058	11	964.8	89	70600	0	7	2
7941	25.10.15	09:29	09:44	L2	9	9	-4	5	7	023-033	15	965.1	78	70601	-11	5	1
7941	25.10.15	09:55	10:20	L1	13	13	5	3	5	024-035	16	965.1	74	70602	-2	4	1
7941	25.10.15	13:11	13:16	L1	4	4	0	1	1	024-036	18	964.0	54	70599	*	0	1
7941	25.10.15				7	7	19	1		069-083	18	964.0	51	70599	2	19	0
					-	-		-							-		-

Share Constraints Share	anghai Astronomical Observatory
ANALYSIS CENTRE	Shanghai Astronomical Observatory, Chinese Academy of Sciences, Shanghai, China(SHAO)
CONTACT PERSONS	Wang Xiaoya (<u>wxy@shao.ac.cn,Tel:(86)21-34775203</u>) Hu Xiaogong(hxg@shao.ac.cn, Tel:(86)21-34775202)
SOFTWARE USED	SHORD-II
ILRS PRODUCTS	weekly solutions for range biases and time biases of global SLR stations
QC report issued date	unfixed (if required it can be fixed at someday e.g. every Monday)
issued place	email to ILRS (<u>slreport@dgfi.badw-muenchen.de</u>); also see our website (<u>http://cers.shao.ac.cn/en/data-products/slrcentre-en, unfinished</u>
agenzia spaziale italiana	Network Performance and Future Expectations for ILRS Support of GNSS, Time Transfer and Space Debris Tracking
	October 26 – 30, 2015, Matera, Italy



ZZ

Shanghai Astronomical Observatory

Satellites used	LAGEOS-1, LAGEOS-2, ETALON-1, ETALON-2 BDS,LARES
Range and time biases estimation methods	calculated for all the stations based on the residual analysis of weekly SLR quick orbit determination.
Plot a time series of range and time biases	Yes, it will be plotted in time by our website. Now it is not automatic.
Future upgrade	SHORD-II Version 2.0 will be used(better models such as CoM, Troposphere model, weighting methods and so on).
	More satellites will be processed since January 2016.
വി	2015 ILRS Technical Workshop



Network Performance and Future Expectations for ILRS Support of GNSS, Time Transfer and Space Debris Tracking



October 26 – 30, 2015, Matera, Italy

Fast Delivery Quality Check

	DGFI	Hitotsubashi University	JCET	MCC	SHAO	AIUB combined
satellites	LAGEOS-1,-2;	LAGEOS-1,-2; Etalon-1,-2; Ajisai; Stella; Starlette; LARES; Jason-2; CRYOSAT-2; BEACON-C; GPS; GALILEO; GLONASS	LAGEOS-1,-2; Etalon-1,-2	LAGEOS-1,-2; GLONASS	LAGEOS-1,-2; Etalon-1,-2 BDS LARES	LAGEOS1-2
Frequency	Twice a day	•6-hours	daily	daily	weekly	daily
Distribution	DGFI ILRS site	web SLReport CDDIS (one for each week)	•CDDIS •e-mail	CDDIS	SLR Report CDDIS	SLReport

ILRS Combined Range Bias Report 1

Compiled by SLR Observatory Zimmerwald for LAGEOS1-2

Author: Martin Ploner

ILRS Combined Range Bias Report 1

2015-10-06 00:00 UT - 2015-10-16 00:00 UT

Compiled by: SLR Observatory Zimmerwald Date : 2015-10-16 12:30 UT E-Mail : martin.ploner@aiub.unibe.ch

1824	GLSL Golos:	iiv			DG	FI	MC	С	HI	T-U	SA	0.	JC	EΤ
					rb	-		-	rb	-		-	rb	-
1824	2015-10-07			532	-248	36			-194				-222	8
1824	2015-10-08	21:31	LAG2	532	75	48			86	19			109	12
1824	2015-10-09	19:45	LAG2	532	-19	35			-110	15			-89	6
1824	2015-10-10	17:37	LAG2	532	-83	23			101	58			-87	7
1824	2015-10-10	21:50	LAG2	532	32	47			50	13			45	0
1824	2015-10-14	18:23	LAG2	532	-171	38			-274	17				
	2015-10-15			532	-254	10								
1824				532	-95	33			-56				-48	6
1868	KOML Komsor	nolsk			DG	FI	 MC	с.	 HI	 T-U	 SA	.0	JC	ET
								-	rb	7.000		T		-
1868	2015-10-07					5			157				173	
1868	Average			532	158	5			157	3			173	5

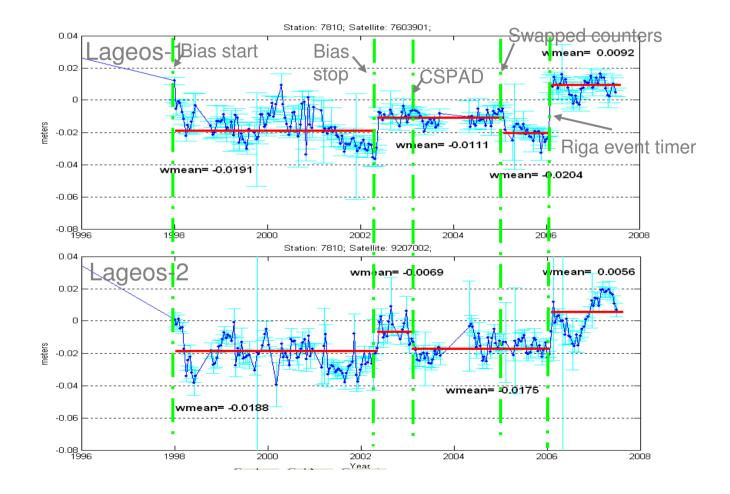
Short term and long term stability

Table 2

Site Informat	ion	DGFI	Orbita	nl Ana	lysis	Hitotsubashi Univ. Orbital Analysis			JCET Orbital Analysis				MCC Orbital Analysis				SHAO Orbital Analysis				
Station Location	Station Number	LAG NP RMS (mm)	short term (mm)	long term (mm)	% good LAG. NP	LAG NP RMS (mm)	term (mm)	long term (mm)	% good LAG. NP	LAG NP RMS (mm)	term	long term (mm)	% good LAG. NP	LAG NP RMS (mm)			NP	LAG NP RMS (mm)) term (mm)) (mm)) good LAG. NP
Baseline		10.0	20.0	10.0	95	10.0	20.0	10.0	95	10.0	20.0	10.0	95	10.0	20.0	10.0	95	10.0	20.0	10.0	95
Yarragadee	7090	4.1	23.5	2.9	99.9	2.2	7.5	1.9	100.0	2.7	18.4	2.4	99.4	2.7	20.5	2.7	97.5	2.1	12.6	1.3	92.2
Changchun	7237	6.5	29.3	4.5	99.9	5.5	24.9	6.1	99.9	2.5	28.8	7.1	96.3	5.4	30.6	16.1	95.2				
Mount_StromIo_2	7825	3.9	19.9	3.6	99.4	2.9	8.9	1.9	100.0	2.2	15.2	3.4	99.1	3.0	15.0	11.5	97.6	1.7	13.7	4.0	96.6
Greenbelt	7105	4.0	17.3	3.2	99.7	2.1	7.3	2.2	99.8	2.3	15.1	3.9	99.1	2.3	15.6	3.6	98.2	2.4	12.3	2.3	91.4
Matera_MLRO	7941	2.5	17.7	6.3	99.8	1.1	8.9	3.6	100.0	1.1	16.3	5.7	100.0	1.3	17.5	4.3	99.5	0.9	14.0	3.5	96.3
Herstmonceux	7840	2.3	16.4	3.1	99.6	1.0	6.0	2.0	100.0	0.7	13.4	3.0	99.3	1.7	14.1	2.1	98.9	0.8	8.8	3.4	98.3
Monument_Peak	7110	4.7	20.5	5.0	99.9	2.0	14.7	4.6	99.9	2.4	19.9	6.1	99.2	2.3	18.5	6.5	97.2	1.7	17.8	4.8	91.7
Zimmerwald_532	7810	3.1	18.8	4.5	99.7	1.5	7.2	1.6	99.9	1.1	13.4		99.9	2.7	15.5		97.5	1.5	5 10.9		94.2
Graz	7839	2.1	13.3	4.5	99.7	1.2	5.6	1.9	100.0	0.3	12.2	5.2	98.6	2.0	11.0	9.7	97.5	0.2	2 7.0	6.0	99.1
Wettzell	8834	3.6	13.2	4.8	100.0	2.5	7.9	2.7	100.0	2.3	11.6	3.3	99.7	3.0	9.3	8.5	98.6	3.0	11.6	5.1	92.9
Shanghai_2	7821	2.2	20.6	5.1	100.0	1.0	9.3	4.1	100.0	0.8	18.1	8.4	100.0	1.2	18.8	9.7	100.0				
Hartebeesthoek	7501	5.6	26.9	8.2	99.9	3.2	8.9	3.4	99.8	3.0	18.7	5.6	96.8	3.1	20.4	6.5	95.2	2.4	16.2	8.2	92.1
Badary	1890	8.9	19.4	5.6	100.0	6.9	18.1	4.9	100.0	4.0	19.9	5.7	93.9	6.0	20.7	7.6	95.5				
Potsdam_3	7841	4.0	14.3	4.9	98.8	1.9	8.4	2.9	99.3	1.7	12.9	4.1	98.4	2.7	14.1	3.7	93.5	1.0	9.2	2 7.2	95.7
Arequipa	7403	6.8	34.2	26.0	100.0	3.2	35.5	23.1	100.0	3.5	32.8	19.5	97.6	3.5	37.6	25.1	94.6				
Altay	1879	5.0	30.9	17.5	100.0	2.9	23.4	14.9	100.0	2.3	24.1	17.4	99.2	2.5	23.8	10.7	100.0	1.5	5 15.7	20.2	98.4
San_Fernando	7824	7.9	28.7	20.5	100.0	6.4	22.2	19.8	100.0	3.2	21.6	21.3	94.9	8.2	31.1	10.6	96.2				
Komsomolsk	1868	10.7	61.0	23.4	100.0	5.1	65.6	21.0	100.0					4.6	31.5	23.5	96.9				
Katzively	1893	15.1	20.9	11.4	98.4	13.0	19.7	8.6	96.6	5.7	15.1	9.4	77.5	10.7	23.2	18.8	86.4				
Arkhyz	1886	11.9	35.4	12.6	100.0	9.5	31.3	8.9	99.7	4.7	40.5	19.3	82.7	8.8	27.6	11.9	93.1				
Svetloe	1888	8.1	22.6	4.9	99.8	5.7	21.4	5.8	99.7	4.5	26.1	14.3	93.3	6.9	19.4	7.9	92.9	4.4	27.1	5.7	91.0
Zelenchukskya	1889	7.2	16.4	7.5	98.6	5.1	16.3	8.5	100.0	4.0	15.1	5.6	95.9	6.0	27.6	12.7	97.5				
Simeiz	1873	28.0	44.0	21.7	93.4	26.8	45.3	17.0	97.4	5.2	42.8	13.5	58.8	23.4	43.8	14.6	91.5				
Haleakala	7119	4.4	24.0	4.9	99.8	2.6	8.5	3.3	99.6	2.6	11.4	3.7	98.3	2.9	14.9	5.1	99.1	2.0	16.0	6.0	92.7
Papeete	7124	3.7	16.3	4.9	100.0	2.0	9.2	2.2	100.0	2.3	12.0	5.2	100.0	2.5	19.9	13.6	99.6		T		
McDonald	7080					4.3	11.7	7.3	100.0												
Brasilia	7407	4.6	25.8	7.4	100.0	4.0	18.6	5.7	100.0	2.7	34.5		100.0	8.0	22.1	14.8	97.6				
Simosato	7838	5.9	25.7	4.8	100.0	3.2	10.3	5.0	99.6	3.3	18.0	5.9	98.1	5.9	26.0	31.3	100.0	2.8	13.1	5.3	91.9
Baikonur	1887	10.3	17.4	22.1	100.0	6.3	14.7	20.3	100.0	6.0	21.4	19.2	95.7	6.1	8.4	8.9	98.8				
Grasse_MEO	7845	5.0	13.8	6.1	99.9	2.6	10.1	4.8	100.0	2.6	20.6	4.2	98.8	3.5	14.1	7.2	95.9	2.7	13.4	4.8	94.8
Mendeleevo	1874	4.8	16.4	6.9	100.0					3.3	10.4		98.0	4.5	7.3	10.1	99.2				
likutsk	1891	6.3	12.7		99.9	4.7	10.3	4.4	99.6	3.8	13.6		95.6	5.2	12.1	12.4	98.7		1		

Multi-year analysis

The goal of multiyear analyses is the recovery of the station time series over its tracking history in order to detect discontinuities, appear/disappear of biases over medium/long term (i.e. months, years)

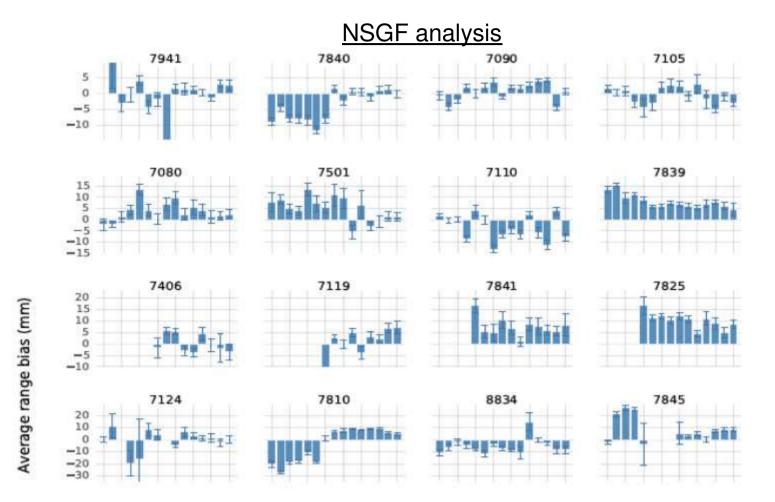


Multi-year analysis

The multiyear analysis was useful when building up the AWG data handling file, now available at the ILRS website and maintained by the AWG (DGFI)

104 1	-	11011	A		00.000.00000	X		new station
				그는 그는 그는 것이 같은 것을 가지 않는 것을 가지 않는 것을 했다.	ases to be app reprocessing			(ILRS/AWG Oct 2007)
1873		mm	A	95:001:00000	00:001:00000	R	-270.00	
7080		mm	A	88:001:00000	89:349:00000	R	-40.00	
7080		mm	A	90:094:00000	93:168:00000	R	25.00	IRLS/AWG 14/04/04
7080		mB	A	95:065:00000	96:026:00000	P	-2.10	source CDDIS
7080		mB	A	96:026:00000	96:116:00000	Ρ	-10.30	source CDDIS
7080		mB	A	96:116:00000	96:130:00000	P	-9.70	source CDDIS
7109		mm	A	00:000:00000	88:347:00000	R	10.00	ILRS/AWG 09/05/06
7109		mm	A	97:009:00000	97:018:00000	R	164.90	source CDDIS
7110		mm	A	84:001:00000	84:136:00000	R	30.00	
7110		mm	A	87:300:00000	88:025:00000	R	30.00	
7110		mm	A	96:240:00000	96:277:00000	R	163.60	source CDDIS
7122		mm	A	84:122:00000	87:074:00000	R	30.00	
7123		mm	A	87:195:00000	87:282:00000	R	-30.00	source CDDIS
7210		mm	A	83:001:00000	87:255:00000	R	25.00	
7210		mm	A	87:255:00000	94:021:00000	R	-37.00	
7210		mm	A	94:021:00000	00:001:00000	R	-11.00	
7237		mm	A	96:001:00000	98:001:00000	R	20.000	
7237		mm	A	98:001:00000	02:171:00000	R	-20.000	
7249		mm	A	01:020:00000	12:001:00000	R	20.000	
7512		mm	A	92:061:00000	92:153:00000	R	-30.00	
7517		mm	A	92:153:00000	92:245:00000	R	-80.00	ILRS/AWG 13/11/29

Multi-year analysis



AWG Pilot Project for routine estimation of systematic errors for all sites •ILRS official product

•open data-base accessible by stations, researchers, public, etc.

Are the analysis results used by the stations?

- An alert is issued by the QC analysis whenever a strong bias is present
- What can we do for smaller biases?
- Any tool available at the station?
- Is it necessary a centralized ILRS tool to be used by the stations for QC, medium/long term bias and bias stability?

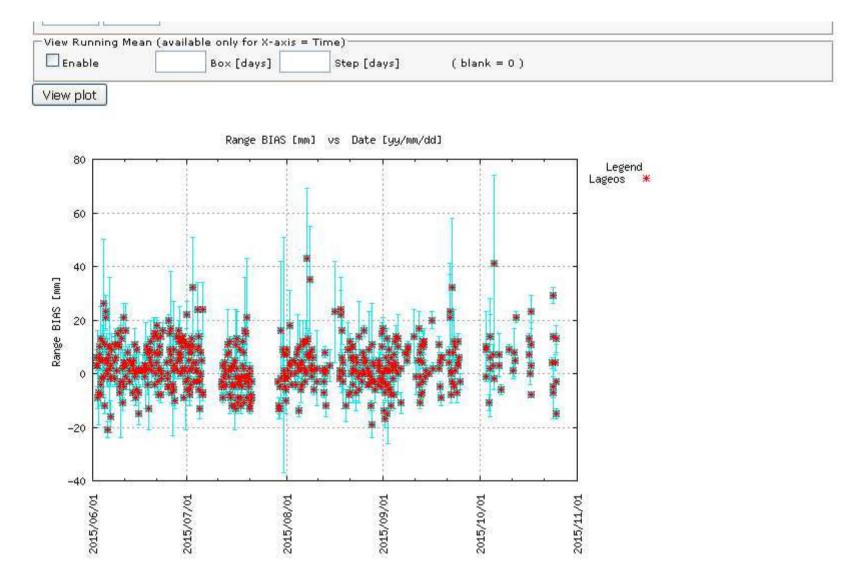
An example at Matera MLRO



MLRO System Performance

	MLRO bias	
 MLRO System Performance (SP) MLRO Calibration Performance (CP) 	START date: Year/Month/Day	 MLRO SP files Documentation MLRO System Performance
 MLRO Data Volume MLRO Acquired pass per hour MLRO Pass Statistics MLRO bias 	STOP date: Year/Month/Day 2015 / 10 / 26 Select X axis parameter	ILRS ILRS Mission Priorities Multi-Satellite Bias Analysis Report
 MLRO coordinate offsets MLRO go-no-go monitor 	Ima O System delay I) Satellite option: category Image: Statellite category High Image: Statellite category Image: Statellite category	SLR stations monitor
	2) Satellite option: name (multiple choice)	
	Select Y axis parameter ③ Range BIAS 〇 Time BIAS	
	_ View sigma bar	
	X-Scale: min/max (blank=automatic)	
	View Kunning Mean (available only for X-axis = Time)	

An example at Matera MLRO



SECOND question

What examples of biases have been seen from the Q/C and final processing systems?

Addressed in the presentation by Toshi Otsubo, responsible of the QC analysis made at HITU

LAST questions

What are the likely sources of biases? What are the big issues?

- Major sources:
 - calibration issues
 - synchronization issues
 - hardware malfunctioning
- Feedback from the stations after a QC alert
- Interactive session given by Toshi
- System Bias Session B