HITOTSUBASHI UNIVERSITY

Systematic Range Error 2013-2014

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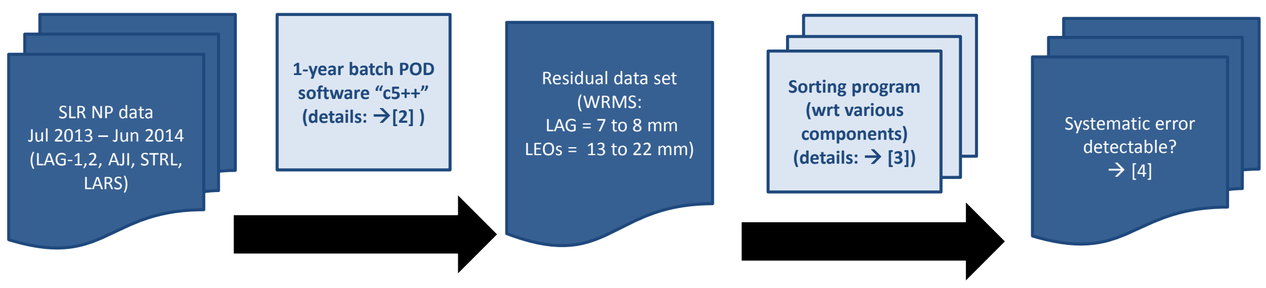
[1] Residual Analysis: Procedure Overview



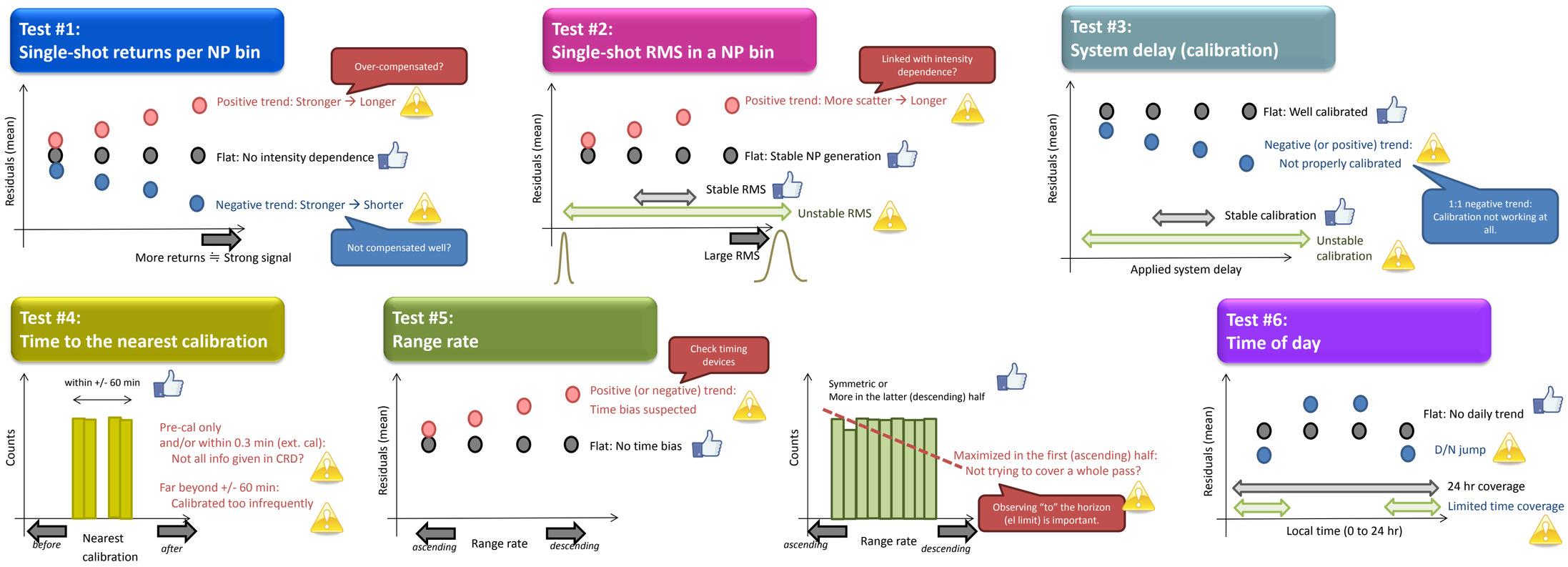
[2] POD Analysis Settings

Different from the 6-hourly QC analysis

Software "c5++"

- 5 satellites (LAGEOS 1+2, AJISAT, STRLETTE & LARES). One-year batch.
- Orbit: 5-day arc for LAGEOS-1 and -2. 3-day arc for LEOs.
- Station-dependent CoM correction for LAG1+2 & AJI.
- Acceleration parameters: Gravity field 4x4 as 1-year common params, and 5 empirical params twice per arc.
- Station coordinates: all solved for with loose constraints. Velocity fixed to SLRF2008.
- Range bias: solved for per station per satellite types ("LAG1+2", "AJI", "STRL", "LARS").

[3] Sorting Procedures and Checklist



[4] Station-by-station diagnosis (more than 1000 charts!)

Please do not take them way until the end of Friday's clinic session.

Find your station's charts below!

- We recommend the representatives of each station to review the observation procedure or hardware especially if a comment tag is attached.
- Note that the post-fit residuals are the mixture of the measurement error at a station and the model error in our orbit computation. **There is a risk of false alarm.**

World Top 12 in data yield (total passes > 3500)

(after SLR Global Performance Report Card; see Torrence's poster in this workshop)

Yarragadee (7090), Changchun (7237), Zimmerwald (7810), Wettzell (8834), Graz (7839), Mt Stromlo (7825), Herstmonceux (7840), Greenbelt (7105), Monument Peak (7110), Matera (7941), Hartebeesthoek (7501) and Shanghai (7821)

#13 to #25 (total passes > 1600)

San Juan (7406), Potsdam (7841), Arequipa (7403), Grasse (7845), Haleakala (7119), Arkhyz (1886), Simosato (7838), Beijing (7249), Badary (1890), Kunming (7820), Katzively (1893), Daedoek (7359) and McDonald (7080)

(Visit http://geo.science.hit-u.ac.jp/ for the charts of these 25 stations.)

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The ILRS "Global Report Card"

Mark Torrence, (*SGT Inc., NASA/GSFC, ILRS CB*)

http://ilrs.gsfc.nasa.gov/network/system_performance/global_report_cards/ {monthly}

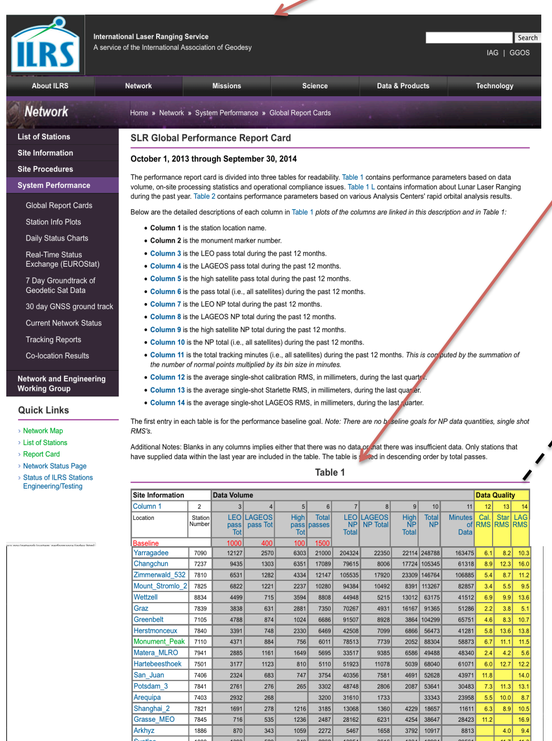
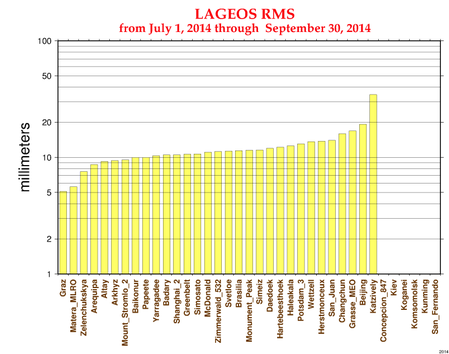


Table 1 contains performance measures based on data volume, and statistics derived from the normal point data. The stations link to station pages; the columns link to plots of the information.

Site Information		Data Volume									Data Quality		
Column 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Location	Station Number	LEO pass Tot	LAGEOS pass Tot	High pass Tot	Total passes	LEO NP Total	LAGEOS NP Total	High NP Total	Total NP	Minutes of Data	Cal. RMS	Star RMS	LAG RMS
Baseline		1000	400	100	1500								
Yarragadee	7090	12127	2570	6303	21000	204324	22350	22114	248788	163475	6.1	8.2	10.3
Changchun	7237	9435	1303	6351	17089	79615	8006	17724	105345	61318	8.9	12.3	16.0
Zimmerwald_532	7810	6531	1282	4334	12147	105535	17920	23309	146764	106885	5.4	8.7	11.2
Mount_Stromlo_2	7825	6822	1221	2237	10280	94384	10492	8391	113267	82857	3.4	5.5	9.5
Wettzell	8834	4499	715	3594	8808	44948	5215	13012	63175	41512	6.9	9.9	13.6
Graz	7839	3838	631	2881	7350	70267	4931	16167	91365	51286	2.2	3.8	5.1
Greenbelt	7105	4788	874	1024	6686	91507	8928	3864	104299	65751	4.6	8.3	10.7
Herstmonceux	7840	3391	748	2330	6469	42508	7099	6866	56473	41281	5.8	13.6	13.8
Monument_Peak	7110	4371	884	756	6011	78513	7739	2052	88304	58873	6.7	11.1	11.5
Matera_MLRO	7941	2885	1161	1649	5695	33517	9385	6586	49488	48340	2.4	4.2	5.6
Hartebeesthoek	7501	3177	1123	810	5110	51923	11078	5039	68040	61071	6.0	12.7	12.2
San_Juan	7406	2324	683	747	3754	40356	7581	4691	52628	43971	11.8		14.0
Potsdam_3	7841	2761	276	265	3302	48748	2806	2087	53641	30483	7.3	11.3	13.1
Arequipa	7403	2932	268		3200	31610	1733		33343	23958	5.5	10.0	8.7
Shanghai_2	7821	1691	278	1216	3185	13068	1360	4229	18657	11611	6.3	8.9	10.5
Grasse_MEO	7845	716	535	1236	2487	28162	6231	4254	38647	28423	11.2		16.9
Arkhyz	1886	870	343	1059	2272	5467	1658	3792	10917	8813		4.0	9.4
Svetloe	1888	1393	520	349	2262	13954	3616	1334	18904	20561		11.7	11.3
Altay	1879	202	207	1704	2113	2211	1173	7219	10603	4977		13.0	9.2
Badary	1890	1528	214	275	2017	15216	1079	875	17170	12239		4.6	10.5
Katzively	1893	1607	221	31	1859	15208	1313	170	16691	12119	30.0	40.1	34.5
Haleakala	7119	1432	411		1843	16909	4092		21001	21989	5.1	8.8	12.6
Beijing	7249	1060	160	539	1759	11274	1212	2730	15216	10188	6.9	12.7	19.3
Simosato	7838	1260	359	104	1723	24173	6350	824	31347	34793	4.9	6.2	10.7
McDonald	7080	1050	347	320	1717	10468	2963	1171	14602	15418	7.8	10.3	11.1
Daedoek	7359	998	249	382	1629	24872	4089	3862	32823	29355	4.5	8.4	11.9
Kunming	7820	1369	200		1569	19920	1156		21076	14407			
Kiev	1824	1352	156	19	1527	9830	667	50	10547	7291	14.0		
Papeete	7124	771	194	379	1344	10132	1612	1607	13351	10607	5.9	8.6	10.0
Zelenchukskya	1889	376	158	643	1177	3341	1033	1947	6321	5432		3.8	7.6
Simeiz	1873	860	190	106	1156	11649	1390	525	13564	9772		11.0	11.6
Baikonur	1887	68	400	555	1023	630	2907	2100	5637	9337		3.6	10.0
Komsomolsk	1868	31	84	886	1001	218	451	3105	3774	1537			
Concepcion_847	7405	383	143	45	571	3357	1343	264	4964	6381	9.5		
Koganei	7308	237	106	211	554	3253	819	1189	5261	4397			
Brasilia	7407	2	86	155	243	23	810	832	1665	2431			11.4
San_Fernando	7824	215			215	2045			2045	1240			



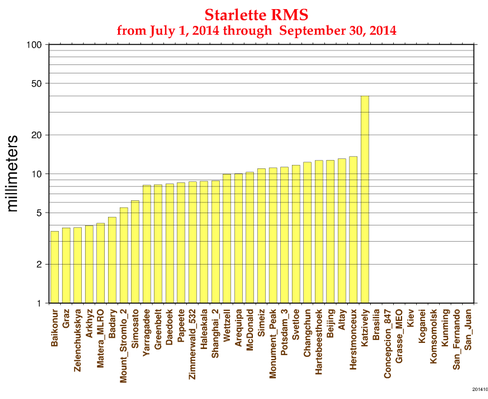
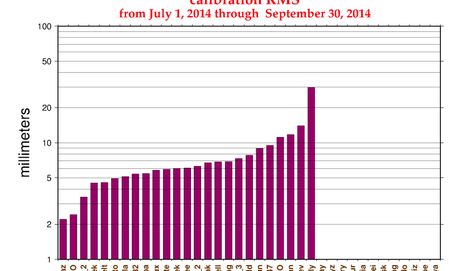
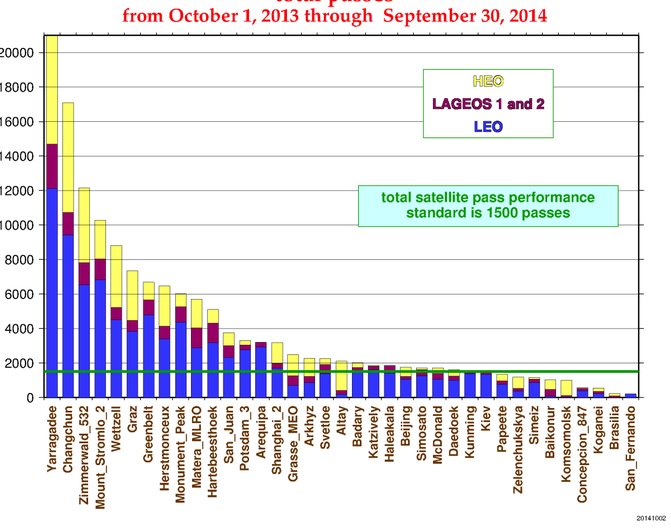


Table 1L shows the amount of Lunar Laser Ranging for the past





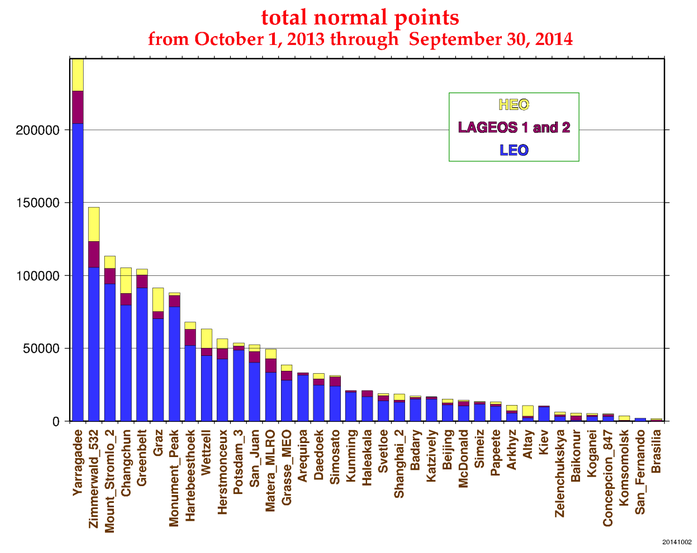


Table 2 contains performance parameters based upon four Quick-Look Analysis Centers' orbital analysis results:

- Deutshces Geodatisches Forshungsinstitut (DGFI)
- Germany; Hitotsubashi Univ. Japan
- Joint Center for Earth Systems Technology (JCET), Univ of MD
- Mission Control Centre (MCC) Moscow, Russia
- Shanghai Astronomical Observatory (SHAO), Chinese Academy of Sciences

The columns for each Quick-Look Analysis Center are statistics for LAGEOS (1,2):

- average normal point RMS, in millimeters, during the last quarter
- short term bias stability (mm) during the last quarter computed as the standard deviation about the mean of the pass-by-pass range biases. If the number of passes greater than 10.
- long term bias stability (mm) during the past year which is the standard deviation of the monthly range bias estimates. If there are at least 8 months in the past 12.
- percent of normal points used in the analysis.

Site Information		DGFI Orbital Analysis				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)	short term (mm)	long term (mm)	% good LAG. NP	LAG NP RMS (mm)	short term (mm)	long term (mm)	% good LAG. NP	LAG NP RMS (mm)	short term (mm)	long term (mm)	% good LAG. NP	LAG NP RMS (mm)	short term (mm)	long term (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	3.6	13.5	2.8	100.0	2.0	6.8	1.2	100.0	2.1	15.1	2.9	99.7	2.4	18.0	3.2	98.7	1.6	10.4	2.4	91.8
Changchun	7237	5.2	24.5	4.8	99.2	3.4	24.3	6.6	99.8	1.9	28.9	6.2	98.0	4.0	22.0	6.4	98.2	1.6	18.8	22.3	89.4
Zimmerwald_532	7810	2.8	12.4	2.6	99.9	1.3	7.4	2.0	99.9	1.2	15.1	2.5	100.0	2.1	11.6	1.4	98.6	1.2	10.8	2.3	94.5
Mount_Stromlo_2	7825	3.7	13.5	1.6	100.0	2.2	7.9	1.6	100.0	2.0	13.5	2.0	99.5	2.7	18.5	5.7	97.4	1.4	10.4	5.8	95.5
Wettzell	8834	3.2	12.1	3.1	100.0	2.1	5.7	4.0	100.0	1.6	11.8	4.4	99.9	2.2	8.7	2.8	98.0	1.5	9.4	6.1	94.0
Graz	7839	2.4	11.4	2.3	100.0	1.2	5.9	1.9	100.0	0.6	12.2	3.3	100.0	1.6	14.4	3.0	96.9	0.4	7.5	3.2	97.5
Greenbelt	7105	3.6	11.4	5.8	100.0	1.9	6.3	1.6	100.0	2.3	12.4	4.4	99.4	2.5	17.2	7.2	98.2	2.2	10.9	9.0	90.6
Herstmonceux	7840	3.3	11.4	2.8	100.0	1.9	7.0	1.0	100.0	1.6	11.5	1.4	100.0	2.8	11.4	2.5	98.5	1.2	10.2	4.8	94.2
Monument_Peak	7110	4.8	17.4	3.5	100.0	2.0	16.7	3.1	100.0	2.4	20.1	4.5	99.5	2.8	18.4	3.6	98.1	1.7	18.7	3.6	89.4
Matera_MLRO	7941	3.1	14.5	4.3	99.9	1.6	7.6	2.5	99.9	1.4	14.8	3.2	99.9	2.1	15.1	4.0	99.3	1.1	15.4	6.4	95.9
Hartebeesthoek	7501	4.0	16.7	3.0	99.9	2.1	8.2	2.7	99.9	2.2	14.0	2.5	99.4	2.6	21.7	6.8	97.5	2.3	16.1	5.4	91.7
San_Juan	7406	9.7	26.4	36.3	99.3	5.4	24.0	22.1	98.9	4.9	23.7	18.9	91.8	7.0	27.2	8.4	94.1	5.1	18.3	6.3	92.1
Potsdam_3	7841	3.6	11.7	3.7	99.8	1.7	6.0	2.9	99.7	1.9	11.3	4.3	98.4	2.1	9.2	4.5	97.7	1.2	6.9		92.9
Arequipa	7403	6.1	33.1	7.7	99.8	2.3	31.8	12.9	99.8	2.3	31.1	12.5	98.9	3.5	19.0	8.6	96.3	2.2	19.6	19.7	92.6
Shanghai_2	7821	4.9	31.0	15.6	100.0	1.0	22.7	12.7	100.0	0.7	36.4	19.7	92.9	1.9	36.0	13.2	100.0				
Grasse_MEO	7845	4.6	14.6	5.1	100.0	2.8	15.6	5.1	100.0	2.8	16.2	4.4	99.4	2.9	15.3	6.0	97.6	2.7	13.8	5.3	95.8
Arkhyz	1886	7.9	25.5	20.5	100.0	6.2	27.1	19.1	100.0	3.2	32.3	24.0	96.2	5.5	22.1	10.8	93.4	4.5	22.8		97.9
Svetloe	1888	8.2	22.3	8.5	100.0	5.7	16.9	9.6	99.9	4.6	23.6	13.9	97.9	6.1	17.6	10.8	97.1	5.1	18.6	22.1	94.8
Altay	1879	5.4	21.8	20.0	100.0	2.9	23.0	40.3	100.0	2.7	21.1	11.5	99.6	3.3	20.0	15.7	99.7	2.0	23.7		94.9
Badary	1890	7.2	15.2	5.7	98.8	28.2	19.0	6.1	100.0	3.4	22.7	10.4	86.4	4.6	19.1	8.7	94.4				
Katzively	1893	17.1	17.1	7.7	97.5	14.5	21.1	9.4	96.7	5.2	21.6	8.6	77.1	14.6	24.8	23.6	87.5	10.1	18.8	16.8	91.8
Haleakala	7119	6.9	16.8	7.0	99.4	3.9	11.0	3.4	99.3	4.0	17.5	5.4	96.3	6.5	20.5	10.3	99.3	4.4	21.5	25.0	85.1
Beijing	7249	10.0	19.4	8.6	99.1	10.8	15.6	8.8	100.0	4.8	11.8	9.5	95.7								
Simosato	7838	5.9	12.4	11.1	99.8	3.7	11.7	13.9	99.6	4.1	10.9	9.7	97.9	4.9	25.4	10.6	98.5	3.7	16.8	8.4	90.5
McDonald	7080	3.8	13.3	3.9	100.0	2.5	9.1	1.8	100.0	2.3	14.3	5.9	99.6	2.4	18.8	8.8	97.9	1.6	14.4	13.0	96.4
Kiev	1824	17.7	52.8	42.6	90.5	13.5	32.4	41.1	89.7	3.7	42.0	42.7	65.9								
Papeete	7124	4.8	14.1	4.6	99.6	3.0	9.8	4.0	99.2	2.6	16.3	7.0	99.1	4.7	16.7	10.2	99.5				
Zelenchukskya	1889	7.1	23.3	11.7	100.0	5.9	18.0	8.8	100.0	3.5	21.3	10.6	100.0	5.4	16.6	11.6	99.1	2.5	27.2	18.5	96.5
Simeiz	1873					22.0	30.5	16.3	98.2	5.8	39.3	15.3	63.5	20.1	41.9	17.0	92.3	18.7	27.2	27.6	87.7
Baikonur	1887	14.5	21.6	25.2	99.7	12.1	21.1	28.6	99.8	6.3	26.5	16.6	83.0	9.5	25.7	14.6	88.4	8.7	22.6	25.3	93.0
Komsomolsk	1868	6.7	52.7	17.1	100.0	4.6	60.9	20.6	100.0					3.8	15.8	37.1	100.0				
Brasilia	7407	6.1	18.5		100.0	3.8	16.1		100.0					5.2	20.6		97.6				
San_Fernando	7824	7.5	52.5		99.7	6.1	50.1		99.9	4.0	47.9		96.2								