LASER RANGING ARCHIVING AND INFRASTRUCTURE SUPPORT THROUGH THE ILRS DATA CENTERS AND WEB SITE

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ABSTRACT

Two global data centers have supported the International Laser Ranging Service (ILRS) since its start in 1998. The Crustal Dynamics Data Information System (CDDIS), located at NASA's Goddard Space Flight Center, and the Eurolas Data Center (EDC) are active archives of laser ranging data and products derived from these data. The laser data sets consist of on-site normal points and full-rate data. The official ILRS products, currently station positions and EOP, are also made available to the user community through these data centers. Infrastructure support for the ILRS include reports of data holdings and quality, satellite predictions, and station configuration information. This presentation will describe this laser ranging archive available at the ILRS data centers and plans for future enhancements.

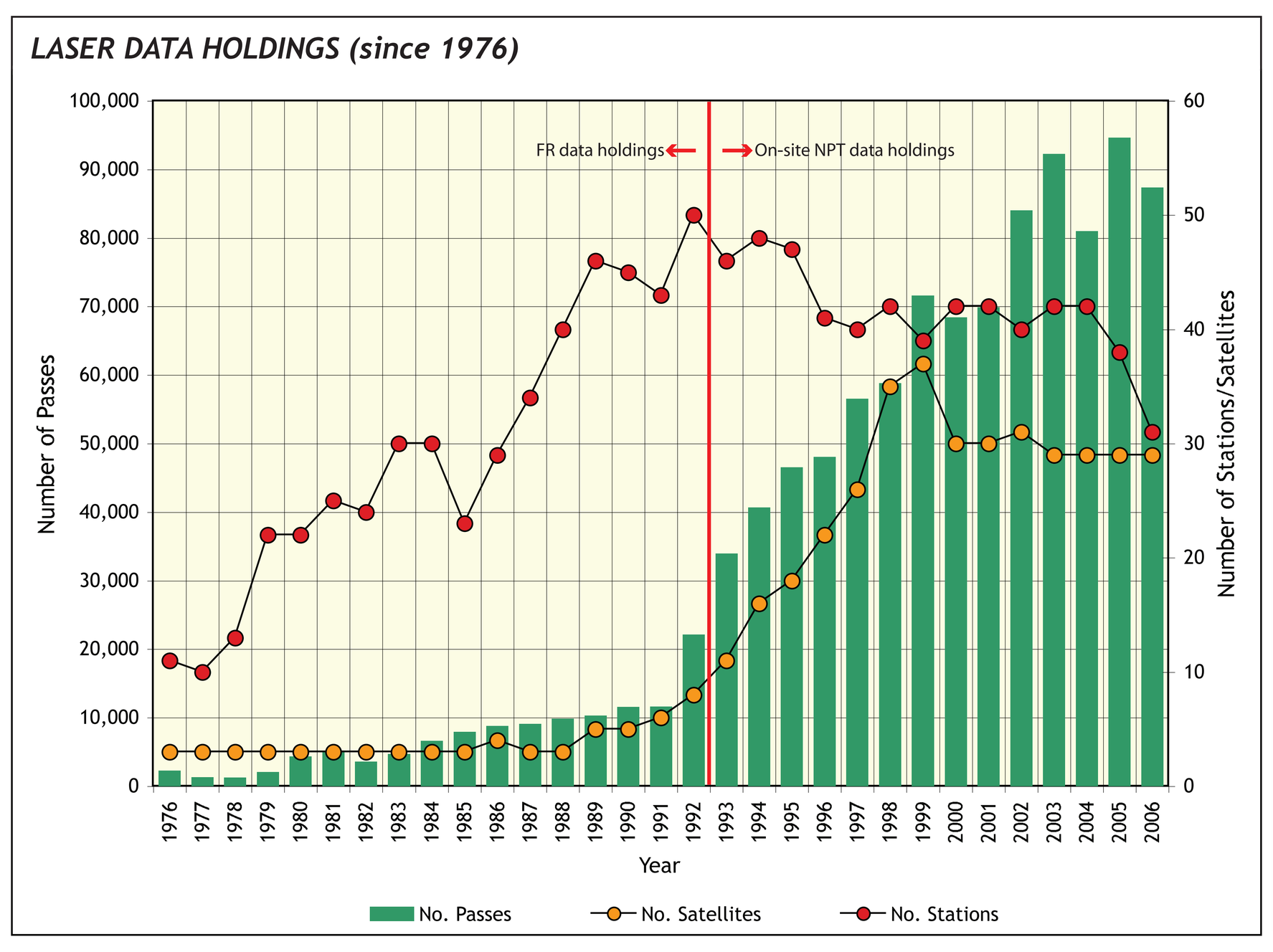
DATA CENTER ARCHIVE CONTENTS

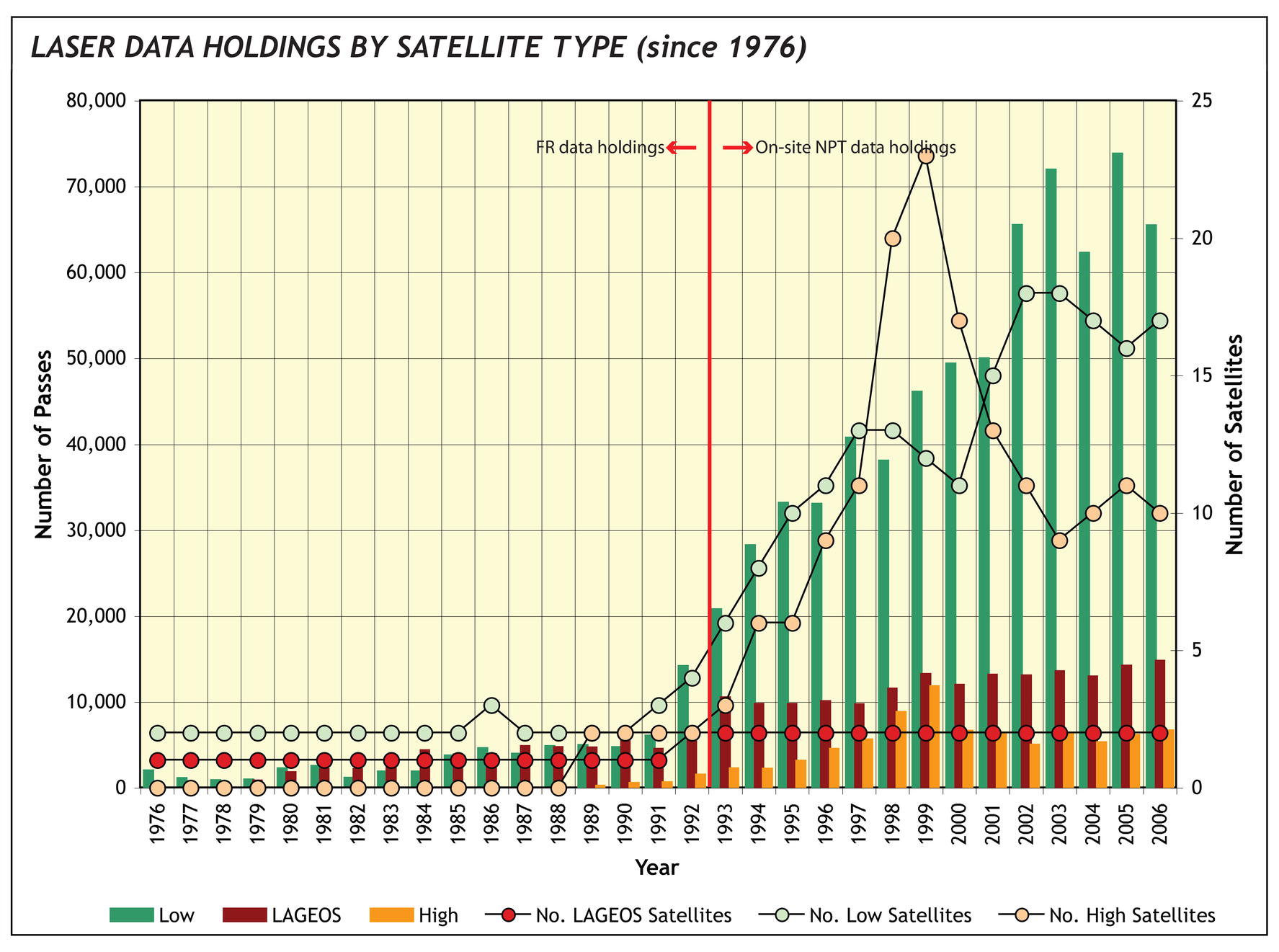
Currently, the ILRS data and product archive consists of both normal point and full-rate data, satellite prediction information, and site positions and velocities. Data since mid-1976 are available at the data centers; ILRS products from January 1993 to the present are also available.

ILRS Data:

Normal point data is the primary ILRS station data product, gradually replacing on-site sampled data and later full-rate data as the primary data product starting in 1991. Normal points are generated on-site very shortly after the satellite pass and transmitted rapidly (within a few hours) to the ILRS operations centers.

Full-rate data was the prime SLR product in the 1970's and early to mid 1980's. In late the 1980's, the normal point generation process was refined and normal points were generated from the full-rate data during post-processing. In the 1990's, on-site normal point generation became the accepted process. In the mid 1990's, the SLR/LLR CSTG subcommission agreed that there was no formal requirement for full-rate due to the transition and acceptance of on-site generated normal points as the prime and only station data product. Many stations, however, continue to provide full-rate data to the ILRS data centers since they are sometimes required for specific needs (e.g., center-of-mass analysis, retroreflector experiments, co-location analysis, etc.). The plots below summarize the data holdings (full-rate or on-site normal point) of the CDDIS archive.





Satellite Prediction Information:

The ILRS currently provides satellite predictions for the network in two formats: Tuned Inter-Range Vectors (TIRVs) and the newer Consolidated Prediction Format (CPF). The newer CPF is now considered the operational format for prediction providers and network stations. However, TIRVs continue to be generated by the prediction providers and made available through email and at the data centers to accommodate stations that are continuing efforts to transition to the CPF.

The CPF information accurately predicts positions and ranges for a much wider variety of laser ranging targets than had been previously possible. Rather than using the tuned IRV's with an integrator, the new predictions provide daily tables of X, Y, and Z positions for each target which can then be interpolated for very accurate predictions. CPF provides an expanded format capability and greatly improves tracking on low satellites because the full modeling potential of the orbit computation at the prediction center will be passed on to the stations. Drag files and special maneuver files are no longer be necessary. These predictions are available via email or via anonymous ftp from the data centers.

Official ILRS Products:

Six ILRS analysis centers (ASI/Italy, BKG/Germany, DGFI/Germany, GFZ/Germany, JCET/USA, NSGF/UK) produce weekly solutions on LAGEOS-1 and -2 for global station coordinates and EOP. These solutions are merged into an official ILRS Combination Product by ASI (official ILRS Combination Center) and DGFI (backup ILRS Combination Center). This combination product is furnished to the IERS on a weekly basis for its multi-technique Combination Pilot Project and its Bulletin A.

ARCHIVE STRUCTURE

OVERVIEW OF DATA CENTER FTP STRUCTURE FOR SLR DATA, PREDICTIONS, AND PRODUCTS

- /pub
  - /slr
    - /cpf_predicts
      - /yyyy → /satname → satname_cpf_yymmdd_nnnv.source
      - /current → satname_cpf_yymmdd_nnnv.source
    - /data
      - /fr → /satname
        - /yyyy → satname_v.yymm.Z
        - /daily → /ssss → ssss_yymmdd_v.satname.Z
        - /npt → /yyyy → satnamev_npt.yymm.Z
      - /npt → /satname → /yyyy → satname.yymmdd, satname.yymm, satnameh.yymmdd
    - /predicts
      - /yyyy → /satname → satname_type_yymmdd_#.source
      - /current → satname_type_yymmdd_#.source
      - /maneuvers → satname_maneuver_yymmdd.source, maneuvers.satname
    - /products
      - /pos+eop → /yymmdd → ac.eop.yymmdd.v#.snx.Z, ac.pos+eop.yymmdd.v#.snx.Z, ac.pos+eop.yymmdd.v#.sum.Z
      - /ac → ac.dsc
  - MORE

DATA CENTER FTP STRUCTURE FOR SLR DATA

- /pub → /slr (MORE)
  - /cpf_predicts — SLR CPF prediction files
  - /data
    - /fr → /satname
      - /yyyy → satname_v.yymm.Z — SLR monthly full-rate data
      - /daily → /ssss → ssss_yymmdd_v.satname.Z — SLR daily full-rate data
      - /npt → /yyyy → satnamev_npt.yymm.Z — SLR monthly normal points from full-rate data
    - /npt → /satname → /yyyy → satname.yymmdd, satname.yymm, satnameh.yymmdd — SLR on-site normal point data (hourly, daily, and monthly)
  - /predicts — SLR TIRV prediction files
  - /products — SLR product files
  - MORE — Other files

DATA CENTER FTP STRUCTURE FOR SLR PRODUCTS

- /pub → /slr (MORE — Other files)
  - /cpf_predicts — SLR CPF prediction files
  - /data — SLR data
  - /predicts — SLR TIRV prediction files
  - /products
    - /ac → ac.dsc — ILRS AC description files
    - /pos+eop → /yymmdd → ac.eop.yymmdd.v#.snx.Z, ac.pos+eop.yymmdd.v#.snx.Z, ac.pos+eop.yymmdd.v#.sum.Z — ILRS pos+eop solutions

DATA CENTER FTP STRUCTURE FOR SLR PREDICTIONS

- /pub → /slr (MORE — Other files)
  - /cpf_predicts
    - /yyyy → /satname → satname_cpf_yymmdd_nnnu.source — SLR CPF prediction files
    - /current → satname_cpf_yymmdd_nnnu.source — Current SLR CPF prediction files
  - /data — SLR data
  - /predicts
    - /yyyy → /satname → satname_type_yymmdd_#.source — SLR TIRV prediction files
    - /current → satname_type_yymmdd_#.source — Current SLR TIRV prediction files
    - /maneuvers → satname_maneuver_yymmdd.source, maneuvers.satname — SLR satellite maneuver files
  - /products — SLR product files

SUBSTITUTION CODES FOR DIRECTORIES AND FILENAMES

Code	Description	Range	Example
yyyy	4-digit year	1976-present	2006
yy	2-digit year	76-present	06
mm	2-digit month of year	01-12	01
dd	2-digit day of month	01-31	01
h	1-character UTC hour of day	a-x (a=00, b=01, ..., x=23)	01
satname	**official** satellite name	N/A	lageos1
ssss	4-digit station number	N/A	7105
type	type of TIRV prediction file	drag=drag functions ephemeris=ephemeris file in TIRV format irvs=ephemeris file in IRV format sao=SAO elements tle=two line element	ephemeris
nnn	3-digit ephemeris version number (*currently DOY+500; DOY when TIRVs no longer produced)	1-366 (*501-866)	501
u	version number of CPF within the day	1-9	1
v	version number of data file	a-d	a
#	version number of solution	1-9	1
ac	analysis center	ilrsa=ILRS primary product center ilrsb=ILRS backup combination center asi=Italian Space Agency, Italy bkg=Bundesamt für Kartographie und Geodäsie dgfi=Deutsches Geodtisches ForschungsInstitut, Germany ga=Geoscience Australia gfz=GeoForschungsZentrum, Germany jcet=Joint Center for Earth Systems Technology, USA ncl=Newcastle University, UK nsgf=NERC Space Geodesy Facility, UK	ilrsa

Denotes directory
Denotes file

EXAMPLES

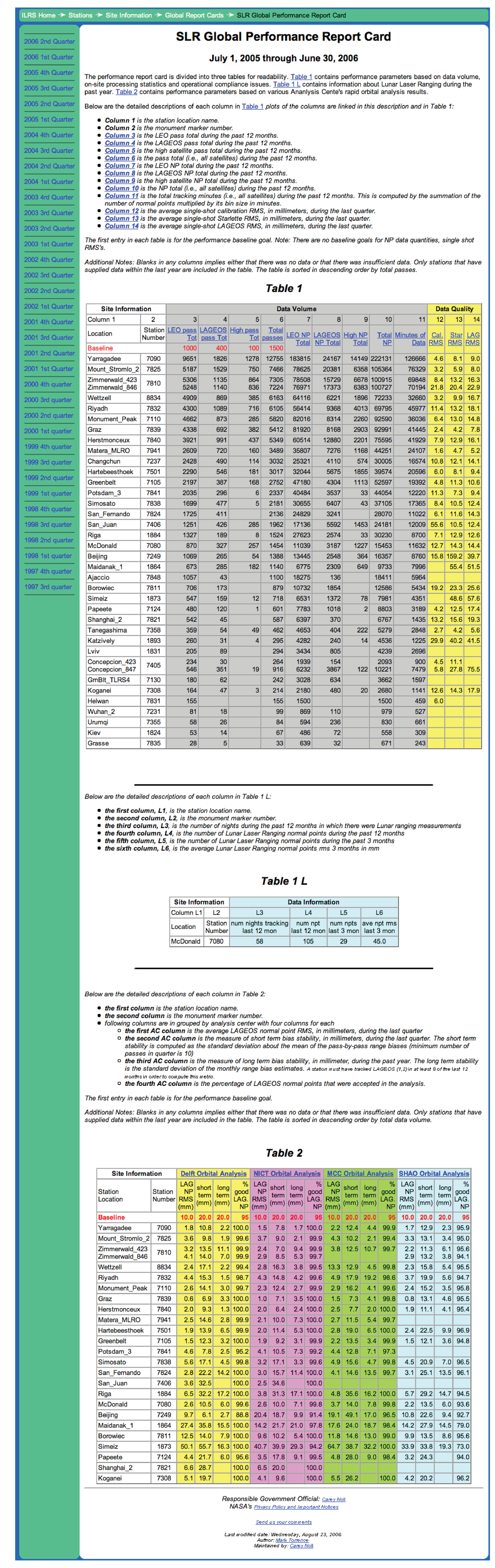
SLR Data/Product Type	Location of Example File in CDDIS ftp Archive
Monthly full-rate LAGEOS-1 SLR data for 01/2006	ftp://cddis.gsfc.nasa.gov/pub/slr/data/fr/lageos1/2006/lageos1_a.0601.Z
On-site LAGEOS-1 normal point data received on 01/01/2006	ftp://cddis.gsfc.nasa.gov/pub/slr/data/npt/lageos1/2006/lageos1.060101
Monthly on-site LAGEOS-1 normal point data for 01/2006	ftp://cddis.gsfc.nasa.gov/pub/slr/data/npt/lageos1/2006/lageos1.0601
LAGEOS-1 CPF from NSGF for 01/2006	ftp://cddis.gsfc.nasa.gov/pub/slr/cpf_predicts/2006/lageos1/lageos1_cpf_060101_5011.sgf
Official ILRS SINEX file (latest version) ending on day 01/07/2006	ftp://cddis.gsfc.nasa.gov/pub/slr/products/pos+eop/060107/ilrsa.pos+eop.060107.v1.snx.Z

NETWORK PERFORMANCE

The ILRS Central Bureau staff has developed various reports and plots to monitor network performance. This information is updated on a frequent basis dependent upon the type of report. Station operators, analysts, and other ILRS groups can view these reports and plots to quickly ascertain how individual stations are performing as well as how the overall network is supporting the various missions. All plots and reports can be accessed through the station pages on the ILRS Web site at URL http://ilrs.gsfc.nasa.gov/stations.

Global "Report Cards":

The ILRS performance "report cards" are generated on a quarterly basis and show data volume, data quality, and ILRS operational compliance information. The statistics are presented in tabular form by station and sorted by total passes in descending order; the latest version of the report card is show in the web page figure at right. Plots of data volume (passes, normal points, minutes of data) and RMS (LAGEOS, Starlette, calibration) are created from this information and available on the report card Web site; example plots from the latest report card are shown below.



SLR Global Performance Report Card

July 1, 2005 through June 30, 2006

The performance report card is divided into three tables for readability. Table 1 contains performance parameters based on data volume, on-site processing statistics and operational compliance issues. Table 1 L contains information about Lunar Laser Ranging during the past year. Table 2 contains performance parameters based on various Ananlysis Cente's rapid orbital analysis results.

Below are the detailed descriptions of each column in Table 1 plots of the columns are linked in this description and in Table 1:

- *Column 1 is the station location name.*
- *Column 2 is the monument marker number.*
- *Column 3 is the LEO pass total during the past 12 months.*
- *Column 4 is the LAGEOS pass total during the past 12 months.*
- *Column 5 is the high satellite pass total during the past 12 months.*
- *Column 6 is the pass total (i.e., all satellites) during the past 12 months.*
- *Column 7 is the LEO NP total during the past 12 months.*
- *Column 8 is the LAGEOS NP total during the past 12 months.*
- *Column 9 is the high satellite NP total during the past 12 months.*
- *Column 10 is the NP total (i.e., all satellites) during the past 12 months.*
- *Column 11 is the total tracking minutes (i.e., all satellites) during the past 12 months. This is computed by the summation of the number of normal points multiplied by its bin size in minutes.*
- *Column 12 is the average single-shot calibration RMS, in millimeters, during the last quarter.*
- *Column 13 is the average single-shot Starlette RMS, in millimeters, during the last quarter.*
- *Column 14 is the average single-shot LAGEOS RMS, in millimeters, during the last quarter.*

The first entry in each table is for the performance baseline goal. Note: There are no baseline goals for NP data quantities, single shot RMS's.

Additional Notes: Blanks in any columns implies either that there was no data or that there was insufficient data. Only stations that have supplied data within the last year are included in the table. The table is sorted in descending order by total passes.

Table 1

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	9651	1826	1278	12755	183815	24167	14149	222131	126666	4.6	8.1	9.0
Mount_Stromlo_2	7825	5187	1529	750	7466	78625	20381	6358	105364	76329	3.2	5.9	8.0
Zimmerwald_423 Zimmerwald_846	7810	5306 5248	1135 1140	864 836	7305 7224	78508 76971	15729 17373	6678 6383	100915 100727	69848 70194	8.4 21.8	13.2 20.4	16.3 22.9
Wettzell	8834	4909	869	385	6163	64116	6221	1896	72233	32660	3.2	9.9	16.7
Riyadh	7832	4300	1089	716	6105	56414	9368	4013	69795	45977	11.4	13.2	18.1
Monument_Peak	7110	4662	873	285	5820	82016	8314	2260	92590	36036	6.4	13.0	14.8
Graz	7839	4338	692	382	5412	81920	8168	2903	92991	41445	2.4	4.2	7.8
Herstmonceux	7840	3921	991	437	5349	60514	12880	2201	75595	41929	7.9	12.9	16.1
Matera_MLRO	7941	2609	720	160	3489	35807	7276	1168	44251	24107	1.6	4.7	5.2
Changchun	7237	2428	490	114	3032	25321	4110	574	30005	16574	10.8	12.1	14.1
Hartebeesthoek	7501	2290	546	181	3017	32044	5675	1855	39574	20596	6.0	8.1	9.4
Greenbelt	7105	2197	387	168	2752	47180	4304	1113	52597	19392	4.8	11.3	10.6
Potsdam_3	7841	2035	296	6	2337	40484	3537	33	44054	12220	11.3	7.3	9.4
Simosato	7838	1699	477	5	2181	30655	6407	43	37105	17365	8.4	10.5	12.4
San_Fernando	7824	1725	411		2136	24829	3241		28070	11022	6.1	11.6	14.3
San_Juan	7406	1251	426	285	1962	17136	5592	1453	24181	12009	55.6	10.5	12.4
Riga	1884	1327	189	8	1524	27623	2574	33	30230	8700	7.1	12.9	12.6
McDonald	7080	870	327	257	1454	11039	3187	1227	15453	11632	12.7	14.3	14.4
Beijing	7249	1069	265	54	1388	13445	2548	364	16357	8760	15.8	159.2	39.7
Maidanak_1	1864	673	285	182	1140	6775	2309	649	9733	7996		55.4	51.5
Ajaccio	7848	1057	43		1100	18275	136		18411	5964			
Borowiec	7811	706	173		879	10732	1854		12586	5434	19.2	23.3	25.6
Simeiz	1873	547	159	12	718	6531	1372	78	7981	4351		48.6	57.6
Papeete	7124	480	120	1	601	7783	1018	2	8803	3189	4.2	12.5	17.4
Shanghai_2	7821	542	45		587	6397	370		6767	1435	13.2	15.6	19.3
Tanegashima	7358	359	54	49	462	4653	404	222	5279	2848	2.7	4.2	5.6
Katzively	1893	260	31	4	295	4282	240	14	4536	1225	29.9	40.2	41.5
Lviv	1831	205	89		294	3434	805		4239	2696			
Concepcion_423 Concepcion_847	7405	234 546	30 351	 19	264 916	1939 6232	154 3867	 122	2093 10221	900 7479	4.5 5.8	11.1 27.8	 75.5
GmBlt_TLRS4	7130	180	62		242	3028	634		3662	1597			
Koganei	7308	164	47	3	214	2180	480	20	2680	1141	12.6	14.3	17.9
Helwan	7831	155			155	1500			1500	459	6.0		
Wuhan_2	7231	81	18		99	869	110		979	527			
Urumqi	7355	58	26		84	594	236		830	661			
Kiev	1824	53	14		67	486	72		558	309			
Grasse	7835	28	5		33	639	32		671	243			

Below are the detailed descriptions of each column in Table 1 L:

- *the first column, L1, is the station location name.*
- *the second column, L2, is the monument marker number.*
- *the third column, L3, is the number of nights during the past 12 months in which there were Lunar ranging measurements*
- *the fourth column, L4, is the number of Lunar Laser Ranging normal points during the past 12 months*
- *the fifth column, L5, is the number of Lunar Laser Ranging normal points during the past 3 months*
- *the sixth column, L6, is the average Lunar Laser Ranging normal points rms 3 months in mm*

Table 1 L

Site Information		Data Information			
Column L1	L2	L3	L4	L5	L6
Location	Station Number	num nights tracking last 12 mon	num npt last 12 mon	num npts last 3 mon	ave npt rms last 3 mon
McDonald	7080	58	105	29	45.0

Below are the detailed descriptions of each column in Table 2:

- *the first column is the station location name.*
- *the second column is the monument marker number.*
- *following columns are in grouped by analysis center with four columns for each*
  - *the first AC column is the average LAGEOS normal point RMS, in millimeters, during the last quarter*
  - *the second AC column is the measure of short term bias stability, in millimeters, during the last quarter. The short term stability is computed as the standard deviation about the mean of the pass-by-pass range biases (minimum number of passes in quarter is 10)*
  - *the third AC column is the measure of long term bias stability, in millimeter, during the past year. The long term stability is the standard deviation of the monthly range bias estimates. A station must have tracked LAGEOS (1,2) in at least 8 of the last 12 months in order to compute this metric.*
  - *the fourth AC column is the percentage of LAGEOS normal points that were accepted in the analysis.*

The first entry in each table is for the performance baseline goal.

Additional Notes: Blanks in any columns implies either that there was no data or that there was insufficient data. Only stations that have supplied data within the last year are included in the table. The table is sorted in descending order by total data volume.

Table 2

Site Information		Delft Orbital Analysis				NICT 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
Baseline		10.0	20.0	20.0	95	10.0	20.0	20.0	95	10.0	20.0	20.0	95	10.0	20.0	20.0	95
Yarragadee	7090	1.8	10.8	2.2	100.0	1.5	7.8	1.7	100.0	2.2	12.4	4.4	99.9	1.7	12.9	2.3	95.9
Mount_Stromlo_2	7825	3.6	9.8	1.9	99.6	3.7	9.0	2.1	99.9	4.3	10.2	2.1	99.4	3.3	13.1	3.4	95.0
Zimmerwald_423 Zimmerwald_846	7810	3.2 4.1	13.5 14.0	11.1 7.0	99.9 99.9	2.4 2.9	7.0 8.5	9.4 5.3	99.9 99.7	3.8	12.5	10.7	99.7	2.2 2.9	11.3 13.2	6.1 3.8	95.6 94.1
Wettzell	8834	2.4	17.1	2.2	99.4	2.8	16.3	3.8	99.5	13.3	12.9	4.5	99.8	2.3	15.8	5.4	95.5
Riyadh	7832	4.4	15.3	1.5	98.7	4.3	14.8	4.2	99.6	4.9	17.9	19.2	98.6	3.7	19.9	5.6	94.7
Monument_Peak	7110	2.6	14.1	3.0	99.7	2.3	12.4	2.7	99.9	2.9	16.2	4.1	99.6	2.4	15.2	3.5	95.8
Graz	7839	0.6	6.9	3.3	100.0	1.0	7.1	3.5	100.0	1.5	7.3	4.1	99.8	0.8	13.1	4.6	95.5
Herstmonceux	7840	2.0	9.3	1.3	100.0	2.0	6.4	2.4	100.0	2.5	7.7	2.0	100.0	1.9	11.1	4.1	95.4
Matera_MLRO	7941	2.5	14.6	2.8	99.9	2.1	10.0	7.3	100.0	2.7	11.5	5.4	99.7				
Hartebeesthoek	7501	1.9	13.9	6.5	99.9	2.0	11.4	5.3	100.0	2.8	19.0	6.5	100.0	2.4	22.5	9.9	96.9
Greenbelt	7105	1.5	12.3	3.2	100.0	1.9	9.2	3.1	99.9	2.2	13.5	3.4	99.9	1.5	12.1	3.6	94.8
Potsdam_3	7841	4.6	7.8	2.5	95.2	4.1	10.5	7.3	99.2	4.4	12.8	7.1	97.3				
Simosato	7838	5.6	17.1	4.5	99.8	3.2	17.1	3.3	99.6	4.9	15.6	4.7	99.8	4.5	20.9	7.0	96.5
San_Fernando	7824	2.8	22.2	14.2	100.0	3.0	15.7	11.4	100.0	4.1	14.6	13.5	99.7	3.1	25.1	13.5	96.1
San_Juan	7406	3.6	32.5		100.0	2.5	34.6		100.0								
Riga	1884	6.5	32.2	17.2	100.0	3.8	31.3	17.1	100.0	4.8	35.6	16.2	100.0	5.7	29.2	14.7	94.5
McDonald	7080	2.6	10.5	6.0	99.6	2.6	10.0	7.1	99.8	3.7	14.0	7.8	99.8	2.2	13.5	6.0	93.6
Beijing	7249	9.7	6.1	2.7	88.8	20.4	18.7	9.9	91.4	19.1	49.1	17.0	96.5	10.8	22.6	9.4	92.7
Maidanak_1	1864	27.4	35.8	15.5	100.0	14.2	21.7	21.0	97.8	17.6	24.0	18.7	98.4	14.2	27.9	14.5	79.0
Borowiec	7811	12.5	14.0	7.9	100.0	9.6	10.2	5.4	100.0	11.8	14.6	13.0	99.0	9.9	13.5	8.6	95.6
Simeiz	1873	50.1	55.7	16.3	100.0	40.7	39.9	29.3	94.2	64.7	38.7	32.2	100.0	33.9	33.8	19.3	73.0
Papeete	7124	4.4	21.7	6.0	95.6	3.5	17.8	9.1	99.5	4.8	28.0	9.0	98.4	3.2	24.3		94.0
Shanghai_2	7821	6.6	28.7		100.0	6.5	20.0		100.0								
Koganei	7308	5.1	19.7		100.0	4.1	9.6		100.0	5.5	26.2		100.0	4.2	20.2		96.2

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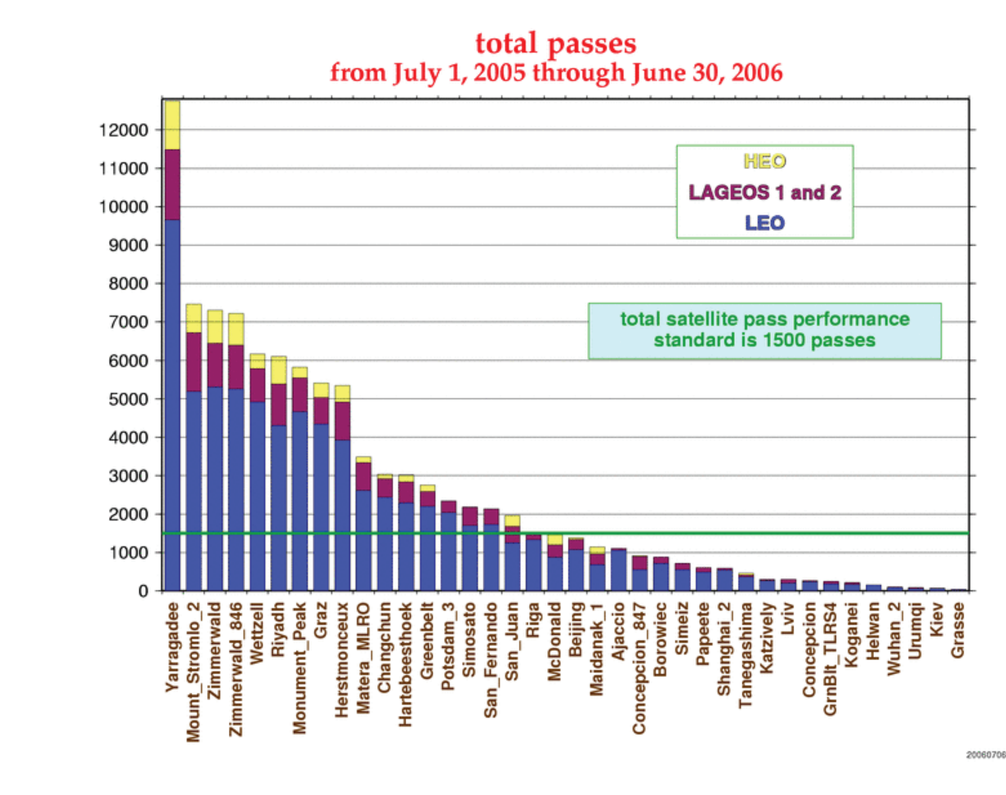
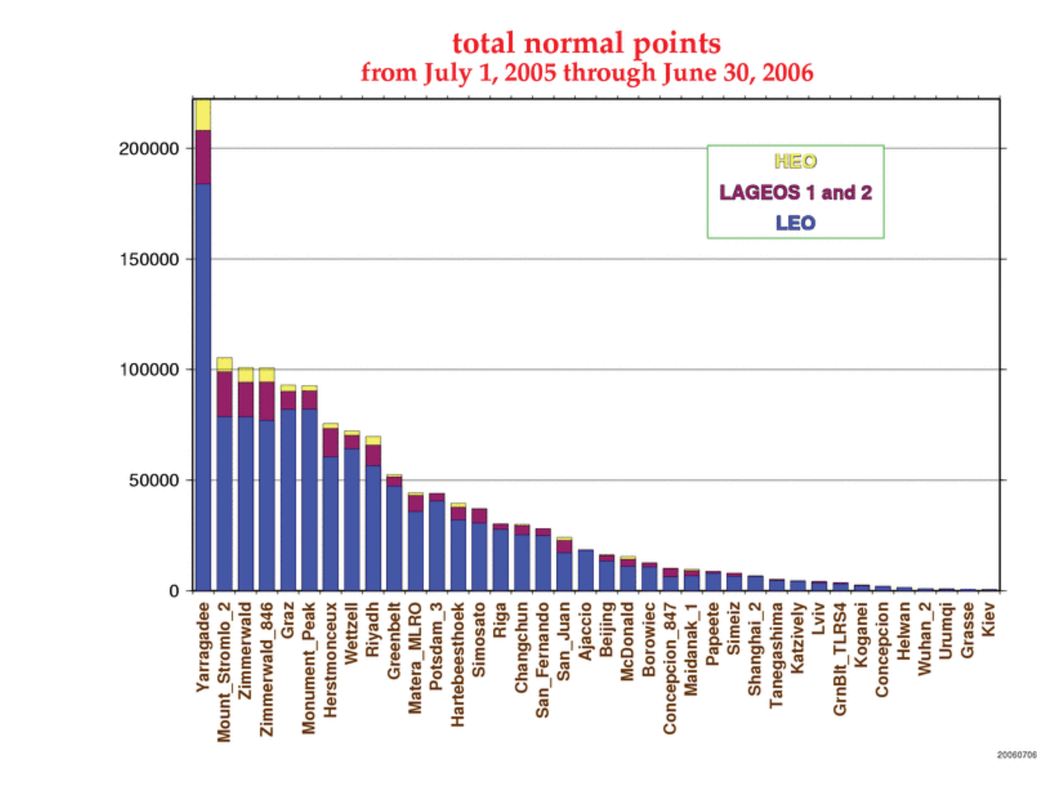
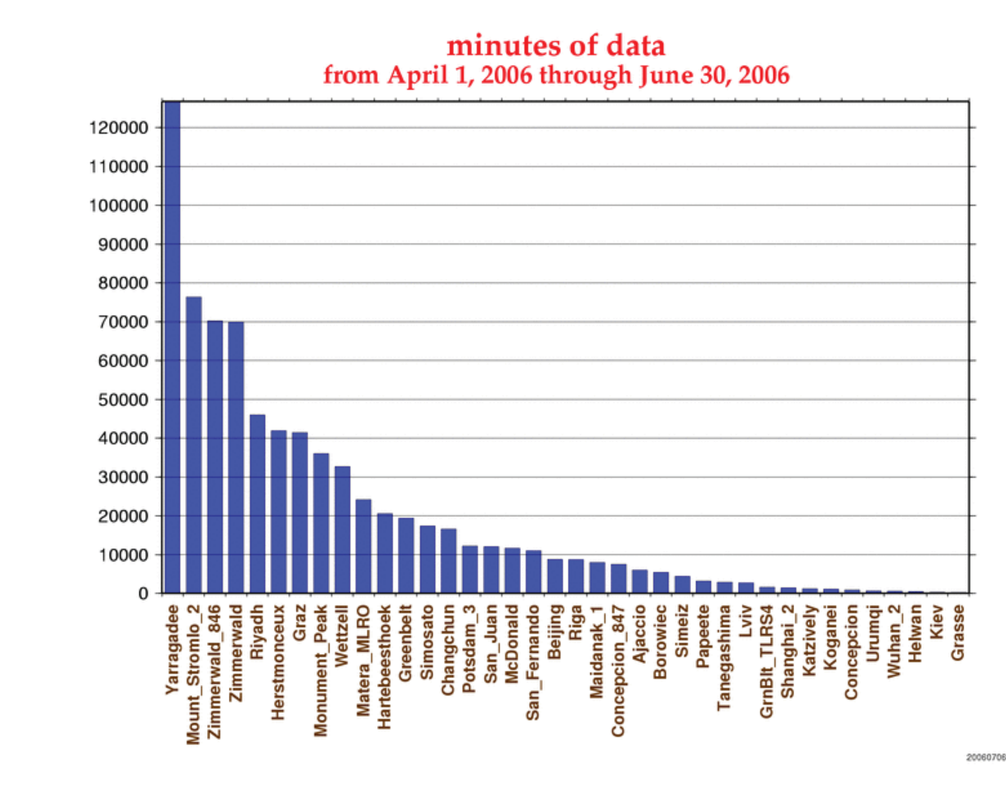
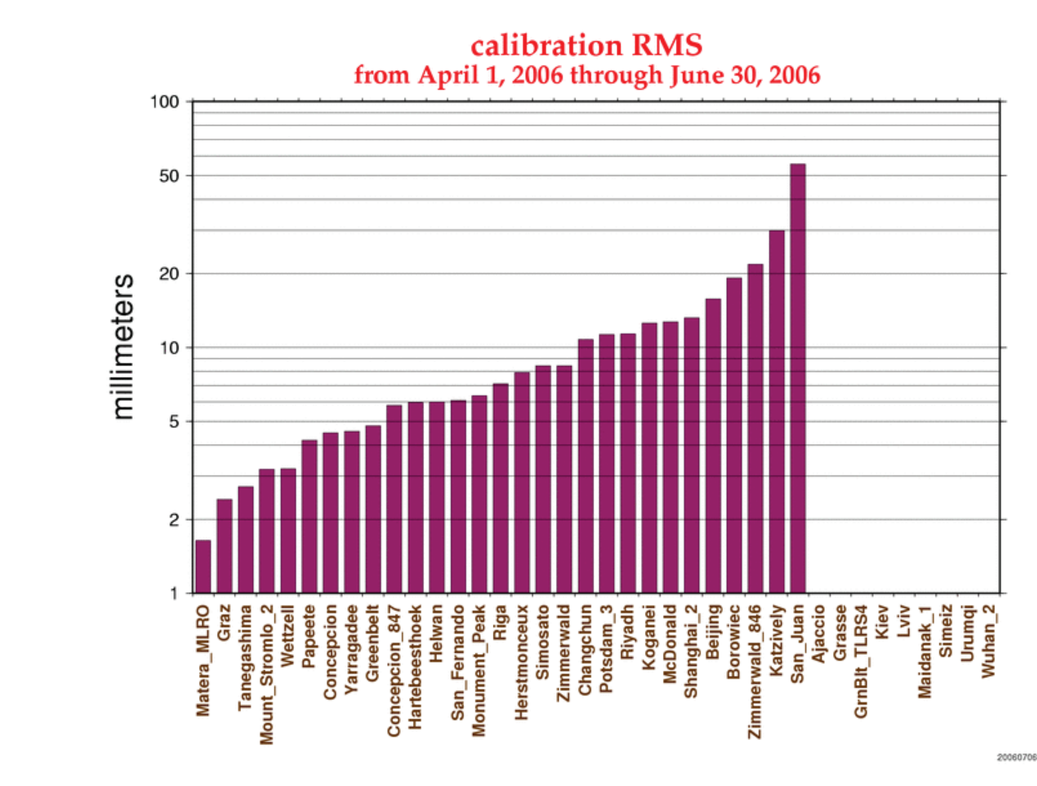
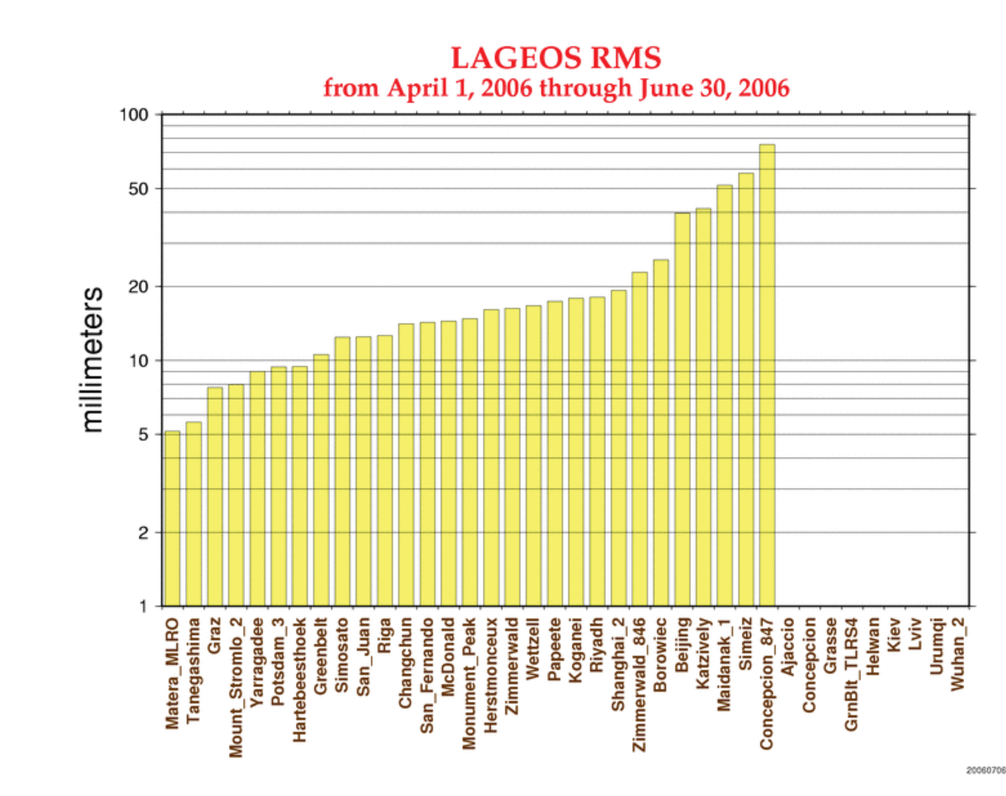
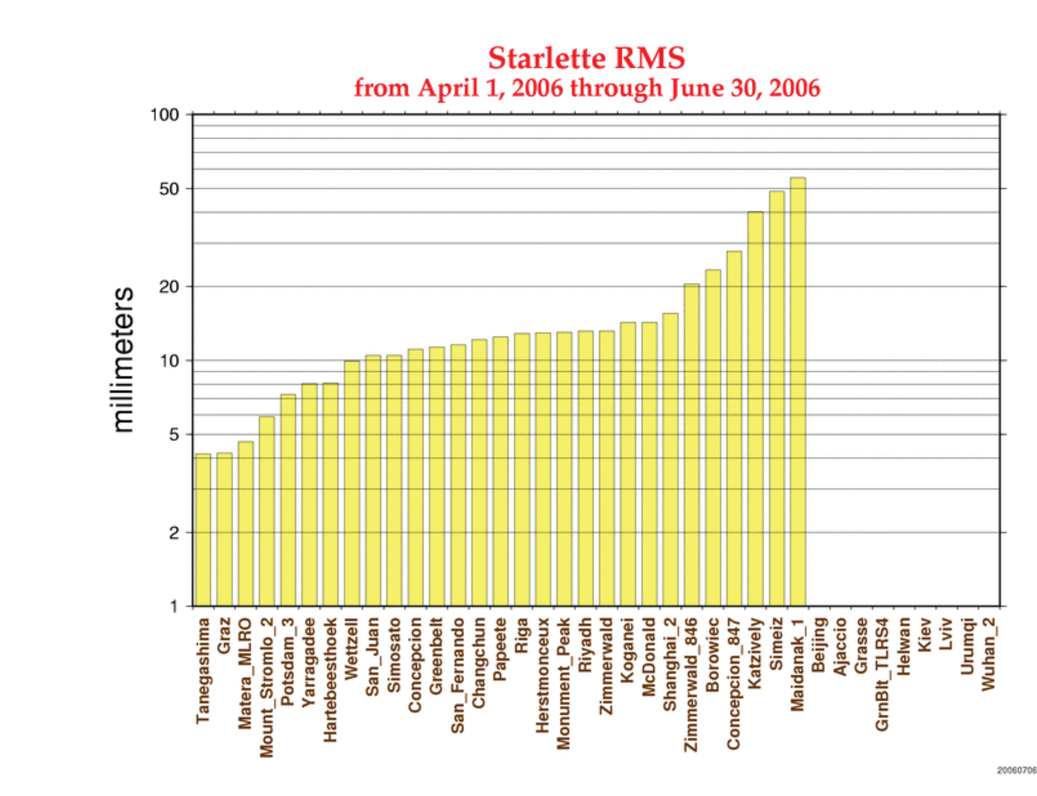


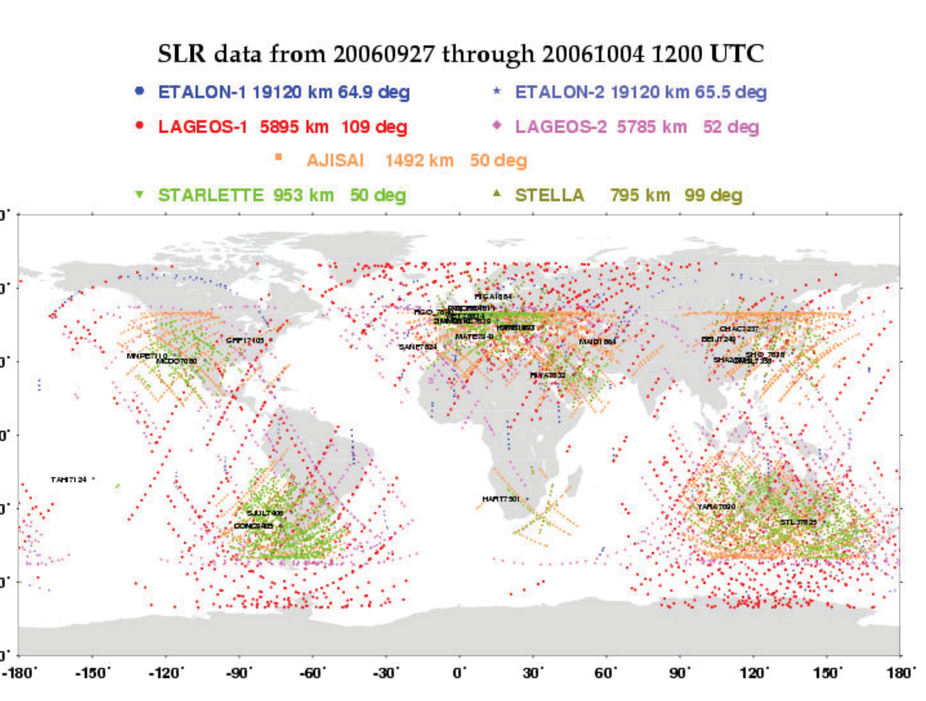










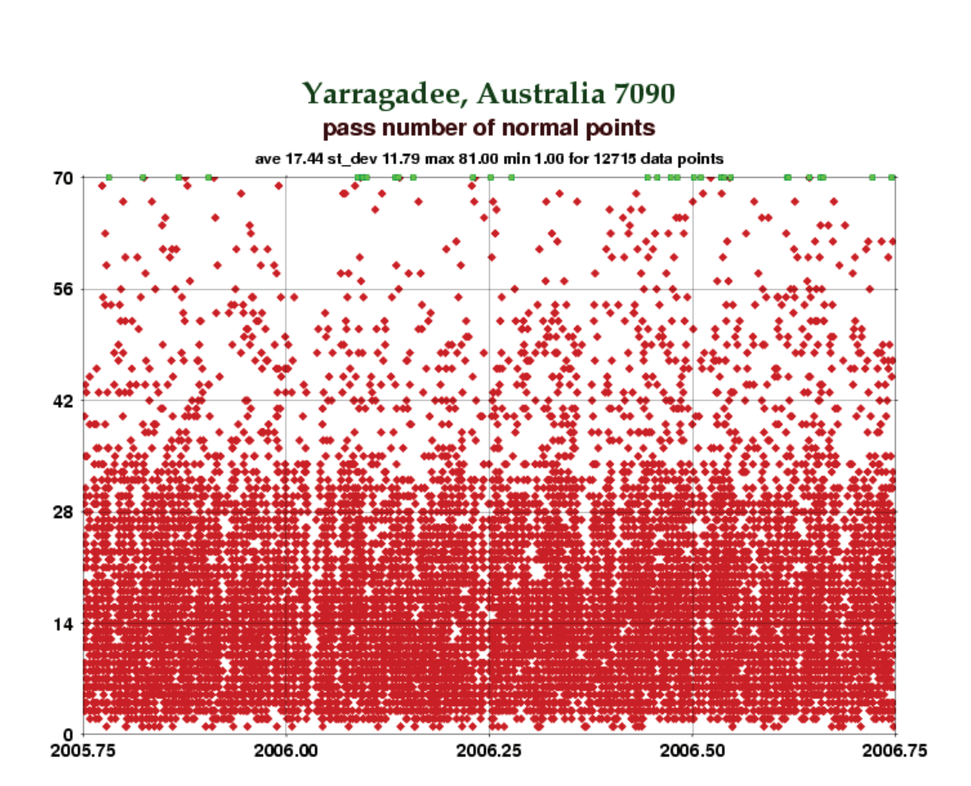


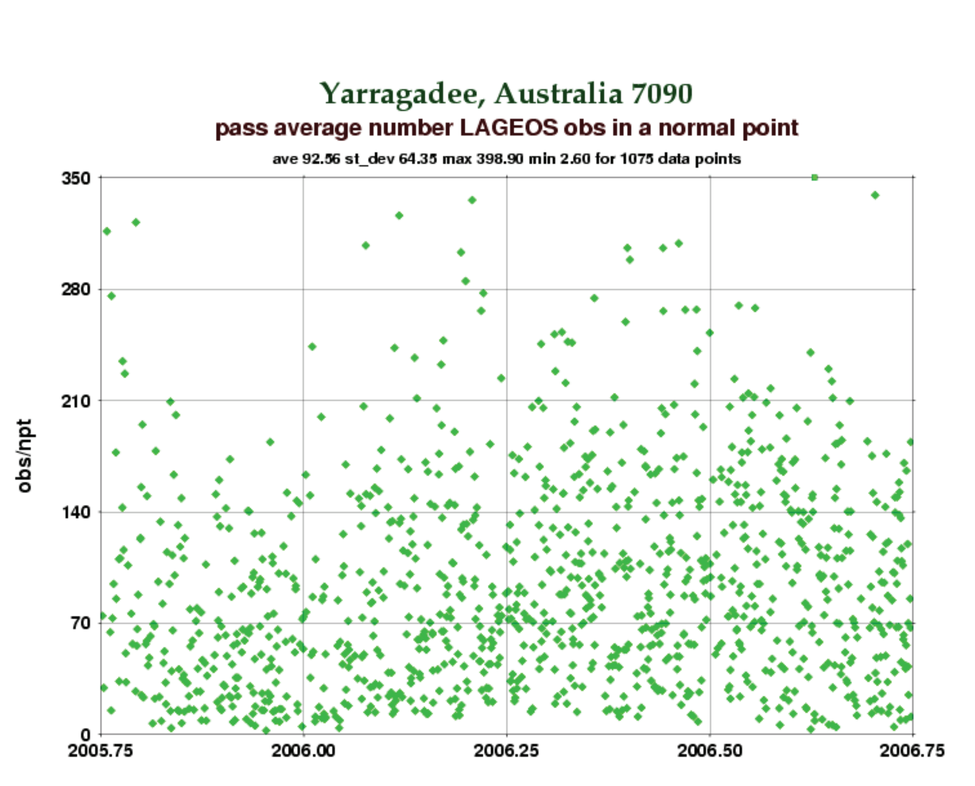
Groundtrack of Last Seven Days of Geodetic Satellite Data:

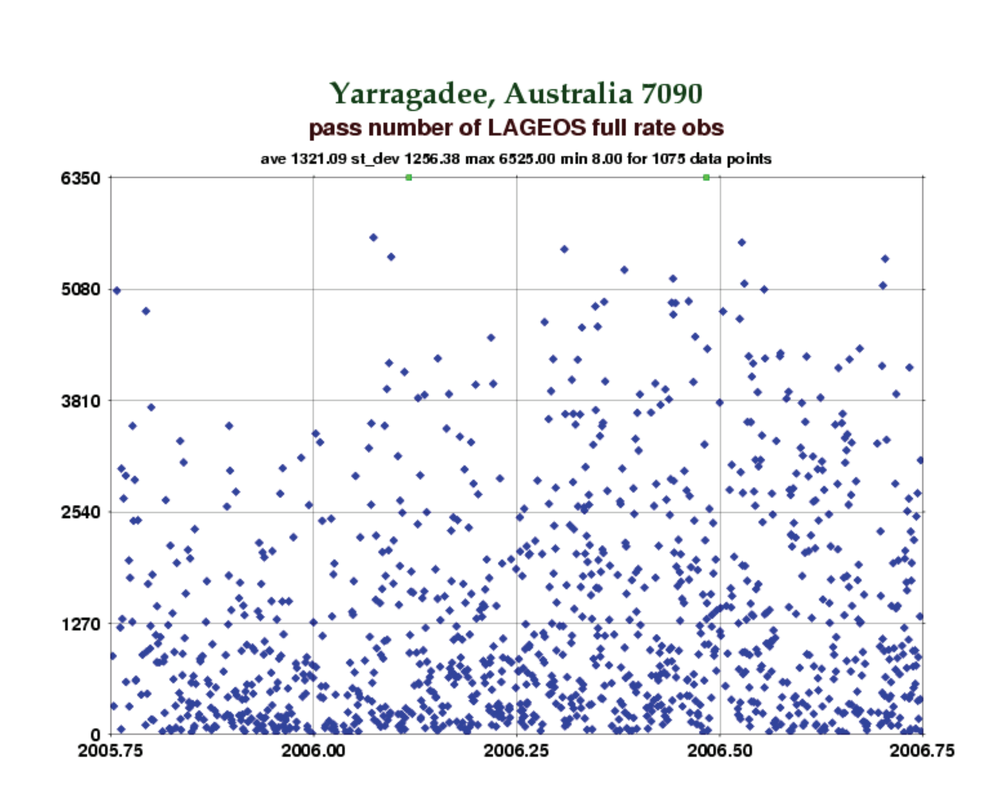
This plot shows the actual network ground tracks of Etalon, LAGEOS, Ajisai, Starlette, and Stella over the previous seven days based upon the archived normal point data. This graph is updated daily; an example of the groundtrack plot is shown at left.

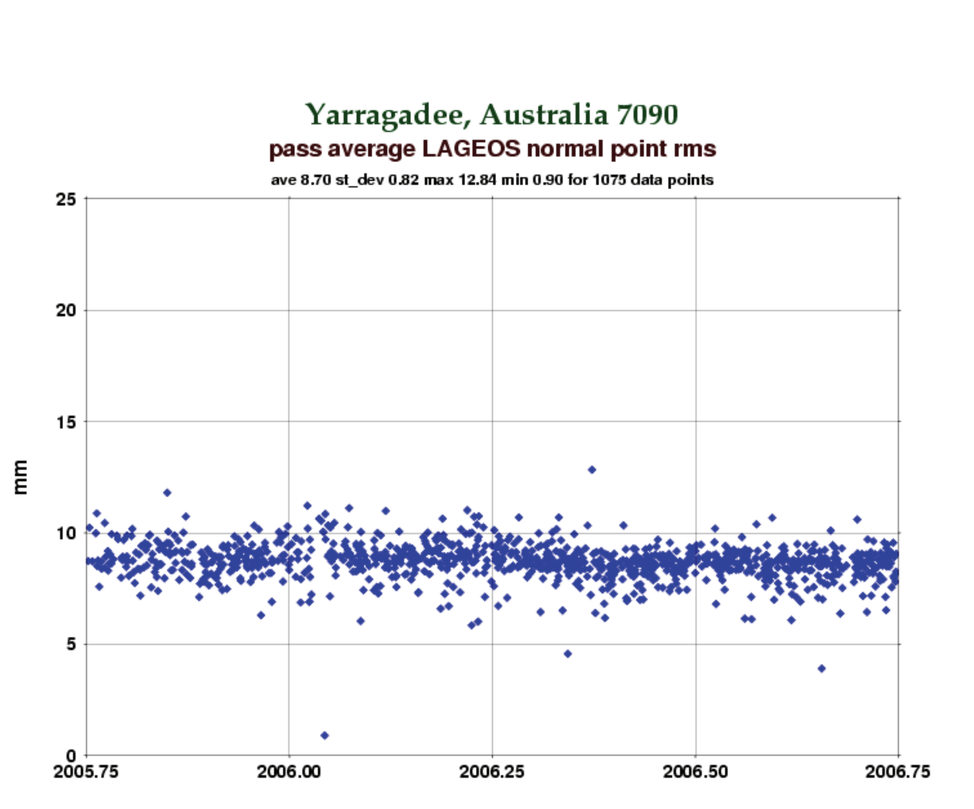
Station-Specific Performance Charts:

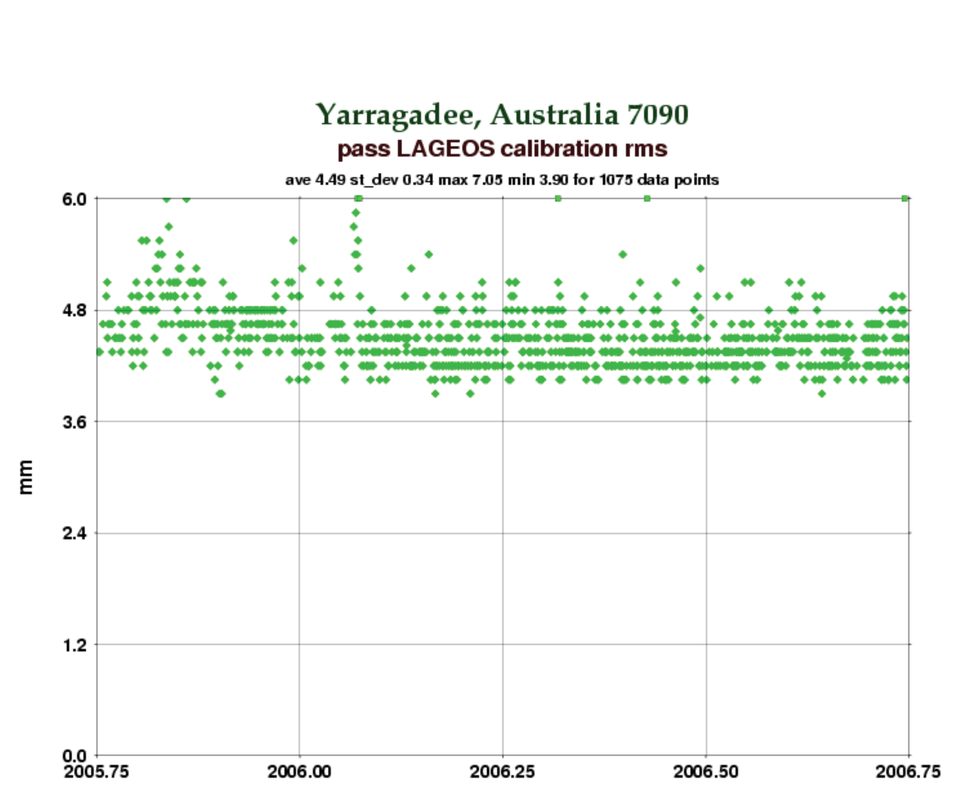
Plots of station performance and environment are generated each week. The plots are sorted by station and come in two forms: for data from the past year and for data since the year 2000. The information presented in these plots for each station in the ILRS network are: total number of normal points, total number of full-rate points, average number of data points per LAGEOS normal point, LAGEOS normal point rms, calibration rms, and system delay, and station temperature, pressure, and humidity (as recorded in the normal point data). Examples of these plots for the Yarragadee station are shown below.

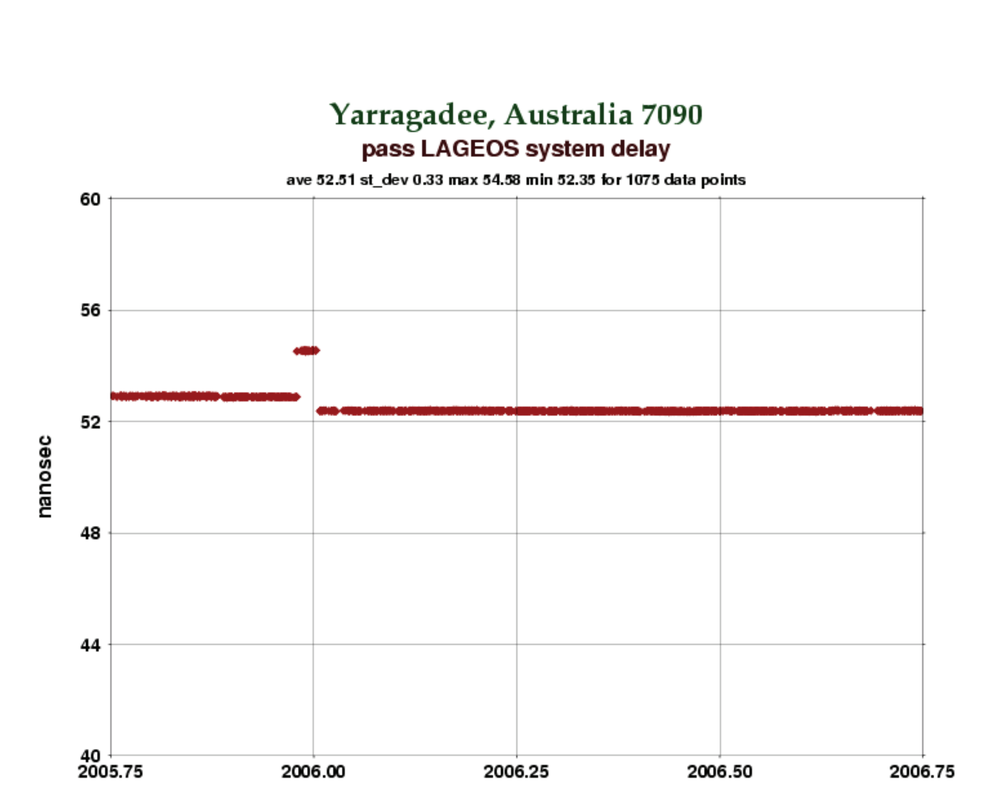


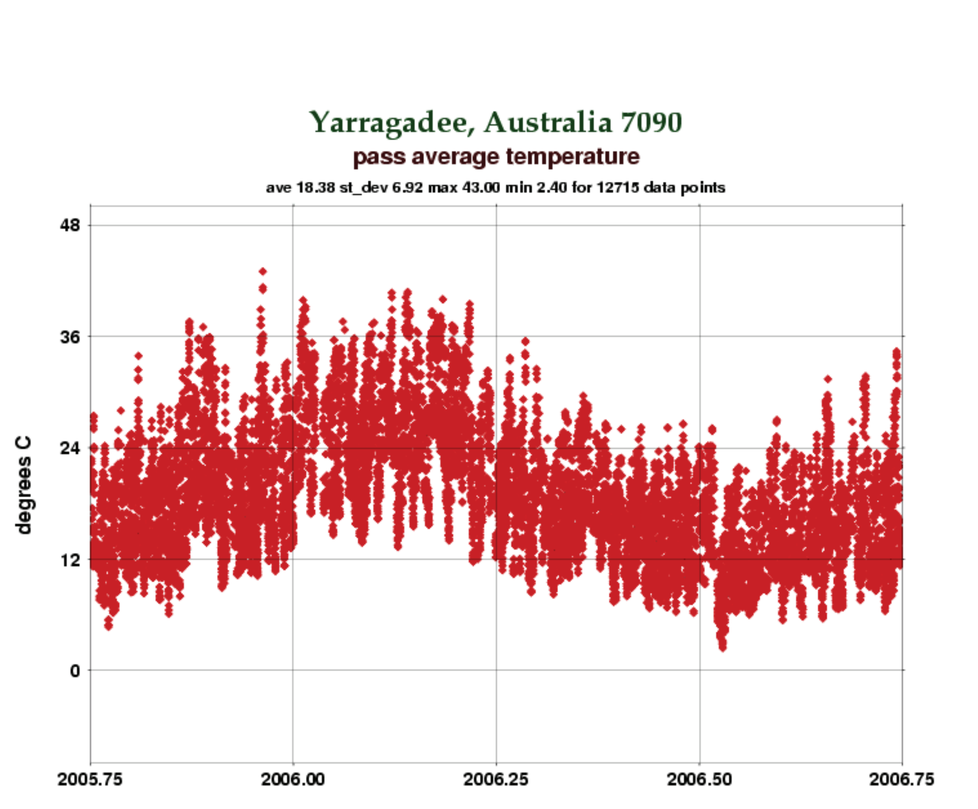


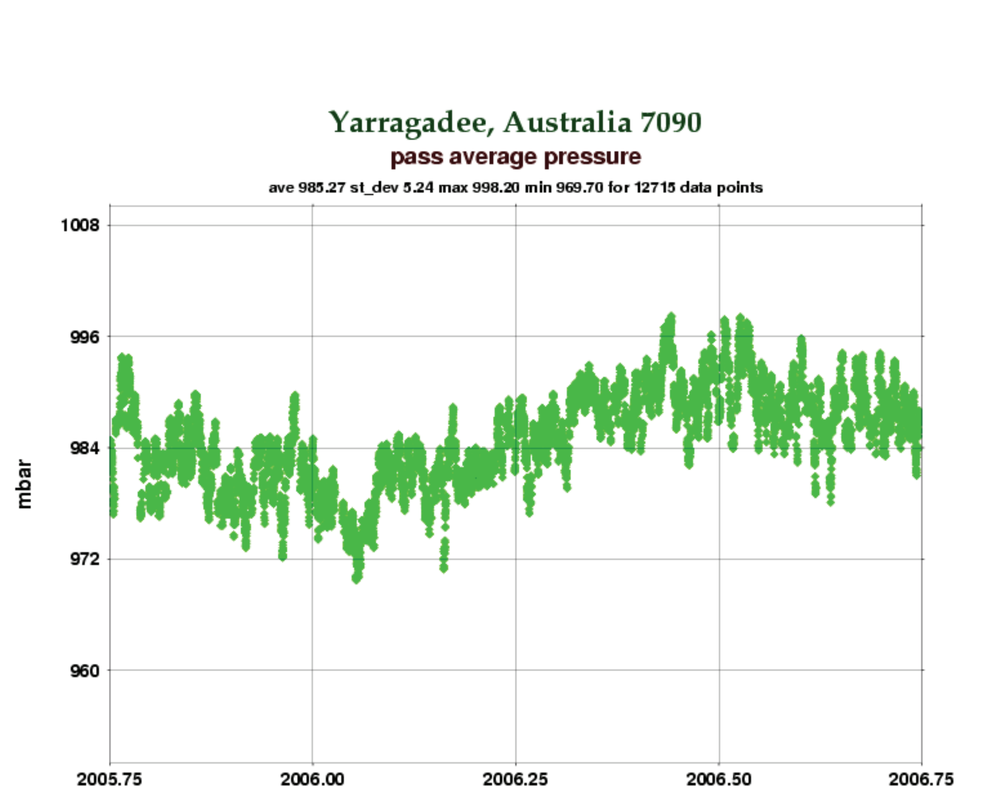


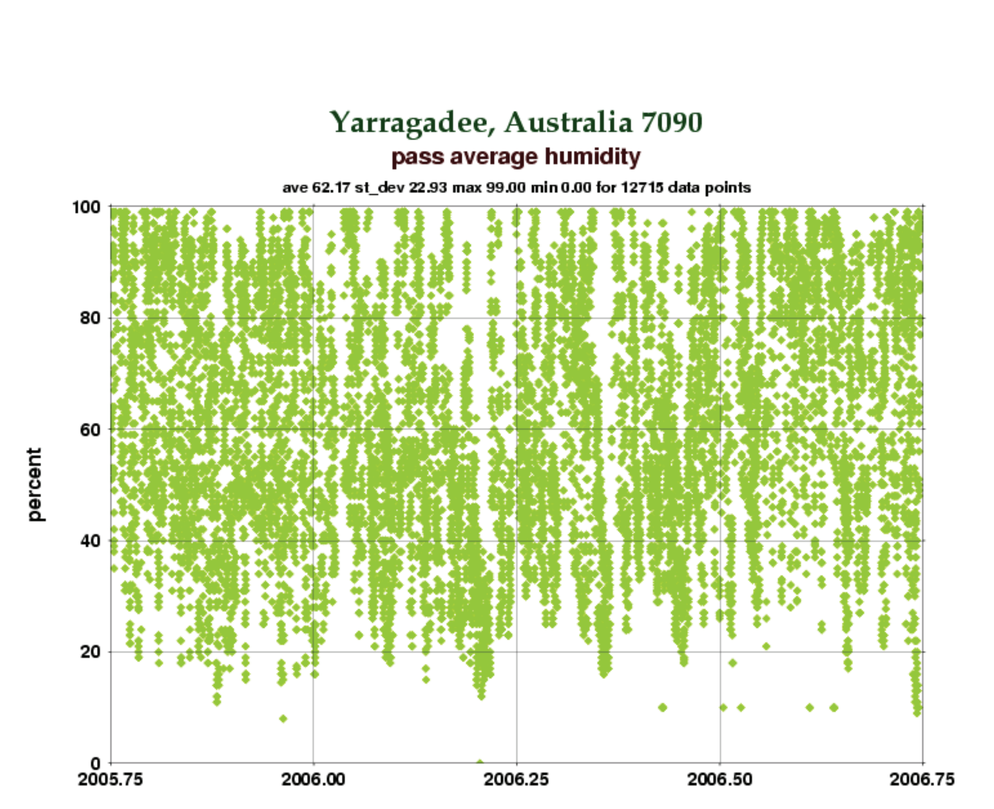






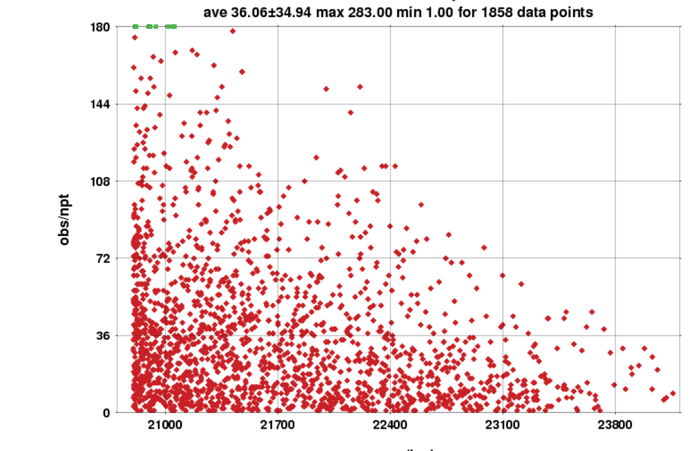


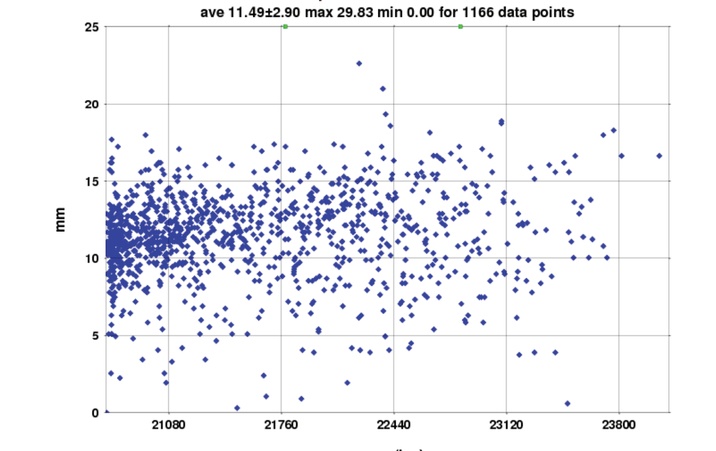


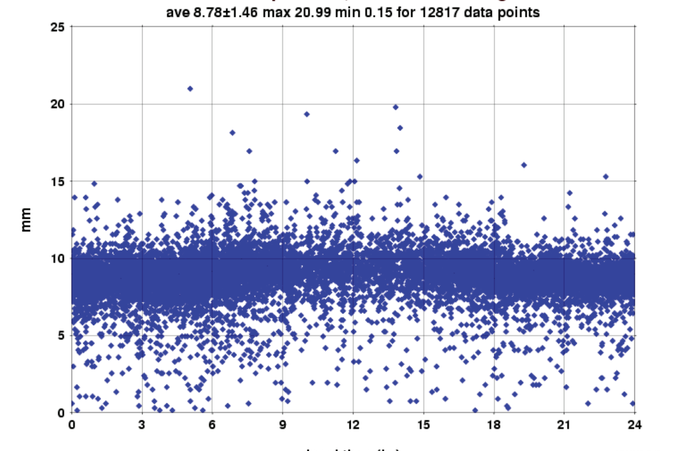


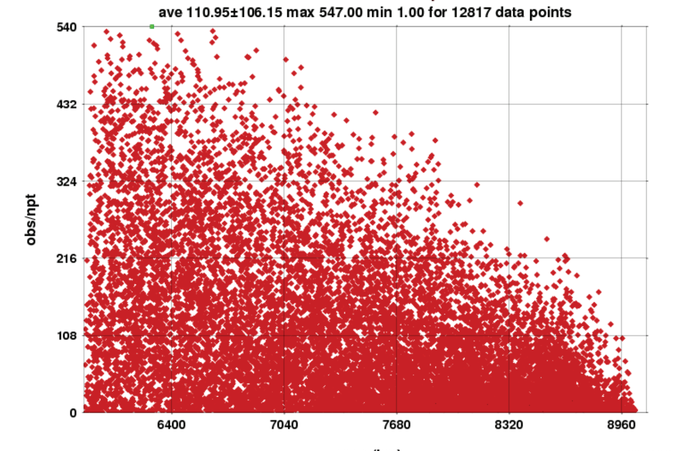
FUTURE PLANS

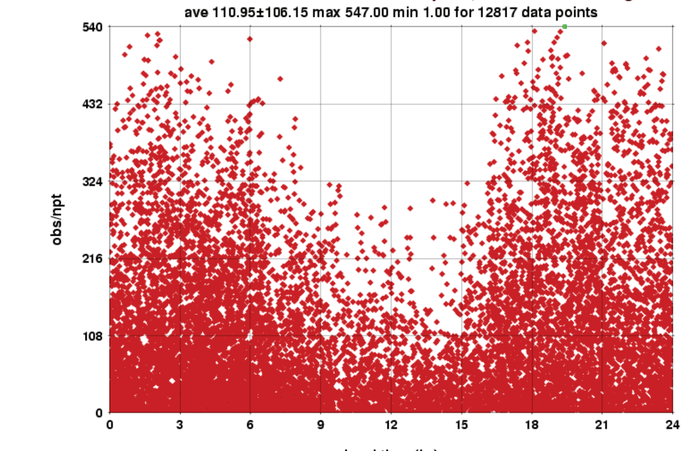
Additional plots of station performance are under development for the ILRS Web site. These plots include statistics for all currently-tracked satellites and all operational stations as a function of time; full-rate observations per normal point and normal point rms are also computed as a function of range and time. Examples of the new charts for the Yarragadee station are shown below.











FOR FURTHER INFORMATION

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