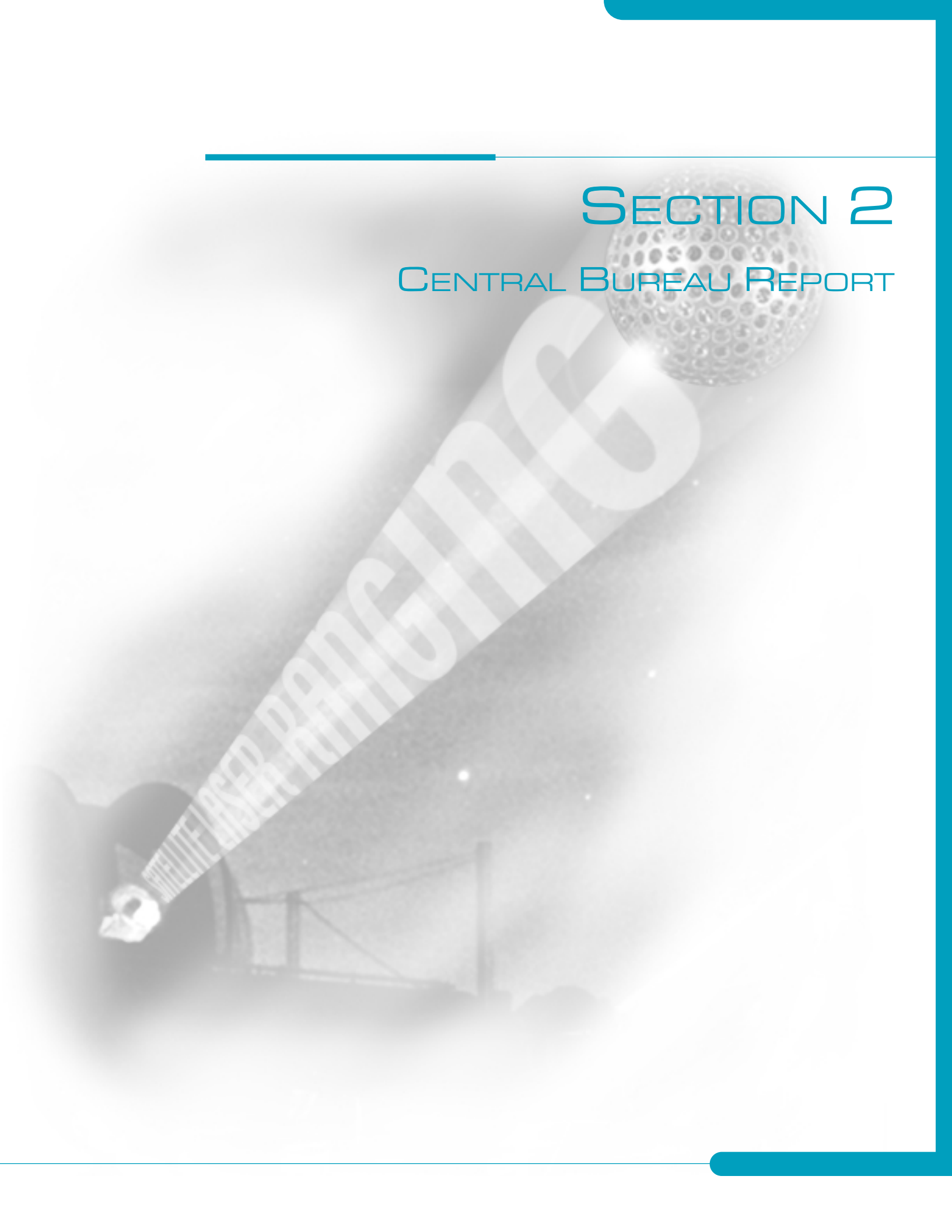
Section 2

Central Bureau Report



SECTION 2 - CENTRAL BUREAU REPORT

Michael Pearlman, *Harvard-Smithsonian Center for Astrophysics*

The Central Bureau (CB) is responsible for the daily coordination and management of ILRS activities to ensure ILRS objectives are achieved consistently and continuously. It facilitates communications and information transfer and promotes ILRS standards. The CB monitors network data quality and quantity to ensure mission requirements are being achieved. It maintains ILRS documentation; provides scientific, technology and administrative databases; and organizes meetings and workshops. The CB coordinates the completion of the ILRS Annual Report. The Science Coordinator and Analyst Specialists, within the CB, strengthen the ILRS interface with the scientific community to promote Satellite and Lunar Laser Ranging goals, capabilities, and accomplishments, and to lead efforts to ensure that ILRS data products meet the needs of the user community.

2.1 STATUS AND ACTIVITIES

Van Husson, *Honeywell Technology Solutions, Inc.*

ORGANIZATION

The Central Bureau (cb@ilrs.gsfc.nasa.gov), funded by NASA, provides the necessary skill mix to support the technical and administrative services required by the ILRS. The Central Bureau Staff includes personnel from NASA GSFC, the Harvard-Smithsonian Center for Astrophysics (CFA), Honeywell Technology Solutions Inc (HTSI), Raytheon Information and Technology and Scientific Services (RITSS), and the three regional networks (see Table 2.1-1):

Name	Title	Institution
John Bosworth	Directory	NASA GSFC
Michael Pearlman	Secretary	CfA
Steve Klosko	Science Coordinator	Raytheon ITSS
Van Husson	SLR Systems Specialist	HTSI
Peter Dunn	Analyst Specialist	Raytheon ITSS
Mark Torrence	Analyst Specialist	Raytheon ITSS
Scott Wetzel	Operations Specialist	HTSI.
Julie Horvath	Operations Specialist	HTSI
Carey Noll	Web Master	NASA GSFC
Erricos Pavlis	Analyst Specialist	JCET
Georg Kirchner	EUROLAS Net. Coordinator	Austrian Academy of Sciences
Hiroo Kunimori	WPLTN Net. Coordinator	CRL
David Carter	NASA Net. Coordinator	NASA GSFC

Table2.1-1. Members of the ILRS Central Bureau.

ACTIVITIES

During the last year, the Central Bureau has worked with ILRS entities and their members to add or enhance services that were deemed necessary. Many of these services were formulated as joint action items between one or more working groups and the Central Bureau. Some of the key accomplishments for the last year include:

- daily prediction service with redundant distribution channels;
- strawman process for qualification for ILRS station participation;
- procedure for station status reporting and associated databases;
- hourly normal point data delivery service including back-up procedures to ensure continuous data flow;
- the 1st ILRS Annual Report;
- new communication services (i.e. Predictions exploder, urgent mail, maneuver messages, cataloging of ILRS outgoing messages);
- consolidated electronic reports into slreport;
- ILRS quick reference card;
- completion of ILRS site logs
- coordinated new mission support requirements;
- governing Board elections;
- ILRS web site enhancements

Others still in process include:

- automated quality control (i.e. format and data integrity) of site log information and development of a automatic master site description data base;
- enhanced web site navigation scheme through the addition of a better search engine and addition of a common navigation bars with pull downs menus only;
- enhanced search capability of the ILRS Bibliography using keywords.

Since the inception of the Central Bureau, a core group of its members has met monthly to monitor progress on its action items, to assess station performance and interactions with other entities, and to monitor the status of Working Group activities.

MEETINGS

The Central Bureau organized the ILRS General Assemblies in Nice, France in April 2000 and in Matera, Italy in November 2000. Reports on the meetings are available on the ILRS web site. A presentation on the ILRS was given at the 33rd COSPAR Scientific Assembly in Warsaw, Poland in July 2000.

CHALLENGES

Although many tasks were accomplished by the end of 2000, near and long term challenges for the Central Bureau include:

- strengthening the promotion of SLR and LLR goals, capabilities and accomplishments;
- encouraging and assisting stations and Analysis Centers to meet their minimum performance criteria;
- continuing the maturation of the ILRS web site and supporting data bases;
- encouraging and assisting stations in their timely maintenance of their site information logs; and
- encouraging advancements in SLR technology to achieve millimeter accuracy.

2.2 NETWORK PERFORMANCE EVALUATION

Van Husson, *Honeywell Technology Solutions, Inc.*

CURRENT ACTIVITIES

The Central Bureau (CB) is responsible for network performance evaluation and coordination of data problem resolution. The data team at HTSI, part of the CB, maintains and develops diagnostic tools using the weekly orbital solutions from the Analysis Centers and critical data processing parameters contained in the normal point data.

When the diagnostics indicate a potential problem, an investigation is initiated. The investigation involves close coordination with the Analysis Centers, the station, engineering, and the broader CB team. If the data problem is recoverable, it is documented and communicated to the community. The data correction algorithm is published on the ILRS web site and added to the historical data problem listing.

The CB generates the quarterly Network Performance Report Card, which is available from the ILRS web site at:

http://ilrs.gsfc.nasa.gov/performance_statistics.html

The Report Card contains metrics for each station, which are evaluated by their comparison to established ILRS performance standards. The performance goals are divided into three categories (data quantity, data quality, and operational compliance) and have evolved from the performance guidelines presented at the Shanghai 10th International Workshop on Laser Ranging in November 1996. The last report card in 2000 appears in Section 8.4.

FUTURE ACTIVITIES

The CB will continue to enhance its tools for more sensitive data diagnostics. These enhancements include:

- automated comparison of Analysis Centers aggregated LAGEOS range and time bias estimates and station coordinates;
- long arc collocation analysis technique by differencing monthly LAGEOS range bias estimates from systems in the same geographic region;
- refined barometric pressure data integrity check based on historical data; and
- knowledge base of data problem symptoms and their causes.

The major goal of the CB engineering team is to push data quality assessment responsibility to the stations (operations and engineering). The CB will continue its ongoing training in this area to assist stations by providing performance evaluation algorithms and by giving presentations at ILRS meetings and workshops.

2.3 NETWORK PRIORITIES AND CAMPAIGNS

Scott Wetzel, *Honeywell Technology Solutions, Inc.*
Julie Hovrath, *Honeywell Technology Solutions, Inc.*

NETWORK PRIORITIES

ILRS tracking priorities typically decrease with increasing orbital altitude and orbital inclination (at a given altitude). Priorities may then be increased on some satellites to intensify support for (1) active missions (such as altimetry), (2) special campaigns (such as IGEX 98), (3) post-launch intensive tracking phases, and (4) missions of greatest importance to the scientific and analysis communities.

Tracking priorities are formally reviewed semiannually at the ILRS General Assembly Meetings. Updates are made as necessary at the discretion of the Governing Board. The ILRS satellite tracking priorities as of December 31, 2000 are given in Table 1.-2.

NEW MISSIONS IN 2000

One new mission was added to the SLR priorities in year 2000 (Table 2.3-1)

Mission	Initiated by	Launch Date	Purpose	No. Passes
CHAMP	GFZ	July 15, 2000	Gravity and Magnetic Field Mapping	883

Table 2.3-1. ILRS Campaigns Completed in 2000.

The CHAllenging Mini-Satellite Payload (CHAMP) was launched into a 470 km orbit on July 15th, 2000. This satellite measures long-term temporal variations in the magnetic field, the gravity field and the atmosphere. SLR data is used for precise orbit determination in connection with GPS for gravity field recovery; calibration of the on-board microwave orbit determination system (GPS); and two-color ranging experiments. More details on the CHAMP Mission are available at:

http://ilrs.gsfc.nasa.gov/champ.html

CAMPAIGNS

The ILRS is responsible for the tasking and coordinating of special SLR tracking campaigns that are requested by users, supported by the Missions Working Group, and approved by the ILRS Governing Board. A user can request a tracking campaign through the ILRS Central Bureau by first completing the on-line SLR Mission Support Request Form accessible through the ILRS web site at:

http://ilrs.gsfc.nasa.gov/ilrssup.html

The form provides the ILRS with a description of the mission objectives; mission requirements; responsible individuals, organizations, and contact information; timeline; satellite subsystems (including details of the retroreflector array and its placement on the satellite).

Two campaigns were completed in 2000 (see. Table 2.3-2).

Campaign	Initiated by	Start Date	End Date	Purpose	No. Passes
ERS-1	GFZ	Jul. 10, 1998	Mar. 10, 2000	Gravity Field Modeling; Tandem Mission with ERS-2	6591
SUNSAT	Stellenbosch Univ.	May 7, 1999	Jun. 23, 2000	Imaging and email communications, OD	1808

Table 2.3-2. ILRS Campaigns Completed in 1999.

ERS-1

European Remote Sensing satellite (ERS-1), launched in 1991, was the first Earth Observation Satellite with a radar altimeter and a synthetic aperture radar (SAR) to study the topography of the ocean surface. With the early failure of the on-board PRARE system, SLR was the only means of precision tracking. After ERS-2 was launched in 1995, and a tandem mission was completed, ERS-1 was placed in a dormant mode. In 1998 the European Space Agency (ESA) reactivated ERS-1 for another tandem mission to map details of the ocean surface. The tandem campaign continued until the failure of the on-board attitude control system on March 10, 2000. More details of the ERS-1 satellite SLR mission can be found at the ILRS web site at:

http://ilrs.gsfc.nasa.gov/ers1.html

Final campaign statistics can be found on the ILRS web site at:

http://ilrs.gsfc.nasa.gov/ers1_campaign.html

SUNSAT

Stellenbosch UNiversity SATellite (SUNSAT) was a micro-satellite designed and built by electrical engineering students at the Stellenbosch University in South Africa. As an engineering project, the mission objectives were optical imaging of Earth surface conditions, email communications, studies of the Earth's magnetic and gravity fields, mapping the atmosphere and the ionosphere, and evaluation of the on-board GPS system. SLR provided accurate orbits with which to evaluate the GPS. On June 23, 2000, satellite operators inverted SUNSAT to provide more adequate thermal protection and to maintain the spacecraft health. This masked the retroreflector array from the SLR sites temporarily suspending all laser ranging operations. On January 19, 2001, the satellite experienced an irreversible failure that ceased all operations. Detailed information of the SUNSAT satellite can be found at the ILRS web site:

http://ilrs.gsfc.nasa.gov/sunsat.html

Final tracking statistics can be found at the ILRS web site:

http://ilrs.gsfc.nasa.gov/sunsat_final_tracking_statistics.html

SUNSAT press release on the End of SUNSAT's functional life in orbit can be found at:

http://sunsat.ee.sun.ac.za/news/20010201.html#en

ONGOING CAMPAIGNS

Two campaigns initiated prior to the year 2000 are still underway (Table 2.3-3).

Campaign	Initiated by	Start Date	Planned End Date	Purpose	No. Passes
BE-C	Univ. of Texas Minkang Cheng	July 15, 1999	December 31, 2000	Gravity field modeling	2557
GFO-1	NASA Frank Lemoine	Apr. 22, 1998	October 31, 2000	POD for ocean surface studies	4461

Table 2.3-3. Ongoing ILRS Campaigns.

Beacon Explorer-C

Beacon-C (BE-C) was launched in 1965 as part of the US National Geodetic Satellite Program. It was the second retroreflector equipped Earth satellite to be launched to support measurement technique intercomparison, determination of station positions, and modeling of the gravity field.

Tracking on BE-C was reactivated after many years to augment the current complex of satellites used to study the secular and long period tidal variations in the Earth's gravity field

A six month campaign was initiated in July 1999. An extension was authorized through December 2000, based on the success to date. Additional information can be found on the ILRS web site at:

http://ilrs.gsfc.nasa.gov/beaconC.html

GFO-1

The GEOSAT Follow-On 1 (GFO-1) program is the U.S. Navy's initiative to develop an operational family of radar altimeter satellites to maintain continuous ocean observation, including precise measurement of both mesoscale and basin-scale oceanography. Satellite altimetry is used by which oceanographers to precisely measure sea surface topography.

GFO-1 was launched on 10 February 1998 and ILRS tracking support commenced on 22 April 1998. With the failure of those the on-board GPS system, SLR became the primary source of precise orbit data

Additional information can be found on the ILRS web site at:

http://ilrs.gsfc.nasa.gov/gfo.html

2.4 UPCOMING MISSIONS AND CAMPAIGNS

Scott Wetzel, *Honeywell Technology Solutions, Inc.*
Julie Hovrath, *Honeywell Technology Solutions, Inc.*

Request for tracking support for new missions are submitted to the Central Bureau, reviewed by the Missions Working Group and approved by the Governing Board. New missions request tracking support by first completing an on-line SLR Missions Support Request Form accessible through the ILRS web site at:

http://ilrs.gsfc.nasa.gov/ilrsup.html

Nine new missions and campaigns are anticipated during 2001 – 2002 (see Table 2.4-1)

Mission Name	Support Requester	Planned/Actual Launch Date	Mission Duration	Altitude (km)	Inclin-ation (Deg)	Received Mission Request Form	Application
H2A/LRE	NASDA Japan	Aug. 2001	1 month campaign	250 - 36000	28.5	Yes	Test new launch vehicle for placing satellites in geosynchronous transfer orbit
Starshine III	NRL USA	Aug. 2001	3 - 5 yrs	470	67	Yes	Atmosphere, education
Jason-1	CNES/NASA France/USA	Oct. 2001	5 yrs	1336	66	Yes	Oceans and atmosphere
ENVISAT-1	ESA Europe	Nov. 2001	5 yrs	800	98.5	Yes	Environmental change
GRACE	NASA GFZ	Nov. 2001	5 yrs	500 - 300	89	Yes	Gravity field modeling
Starshine II	NRL USA	Dec. 2001	3 - 5 yrs	360	39	Yes	Atmosphere, education
ADEOS-II	NASDA Japan	Feb. 2002	3 yrs	803	98.6	Yes	Ocean circulation; atmosphere-ocean interaction
ICESat (GLAS)	NASA USA	May 2002	3-5 yrs	600	94	Yes	ice level and ocean surface topography
Gravity Probe B *(GP-B)*	NASA-JPL USA	May 2002	1-2 yrs	400	90	Yes	Relativity

Table 2.4-1. New Missions and Campaigns Planned for 2001-2002.

(Dates are current as of Aug. 22, 2001)

UPCOMING MISSIONS

H2A/LRE

Laser Ranging Equipment (LRE) is a test by NASDA of a new launch vehicle, H2A, for the transfer of satellites into geosynchronous orbit. SLR tracking will help evaluate the trajectory of the transfer vehicle. help monitor vehicle spin rates, and support tests on the degradation of low-cost BK-7 retroreflectors. Tracking will also provide a means of calibrating SLR systems over a broad range of distances. This mission, with its highly eccentric orbit, will also be used to refine current air drag and gravity field models.

Additional information can be found on the NASDA web site at:

http://god.tksc.nasda.go.jp/lr/lre.html

Starshine II and III

The Starshine Satellite Program sponsored by NRL promotes the study of math and science by combining classroom study with a real application. Students learn about satellite orbits, astronomy, the Earth's atmosphere, the effects of solar activity on the Earth, and the construction and testing of satellite hardware. Student observers record the position of the satellite to be used to determine the satellite's orbit. The Starshine SLR data will also be used to study solar effects on the Earth's upper atmosphere.

Additional information can be found on the Starshine web site at:

http://www.azinet.com/starshine/

Jason-1

Jason-1 is an oceanography mission to monitor global ocean circulation, study the tie between the oceans and atmosphere, improve global climate predictions, and monitor events such as El Niño conditions and ocean eddies. The Jason-1 satellite, a joint France/USA mission with a microwave radiometer and a dual frequency altimeter, is a follow-on to the highly successful TOPEX/Poseidon altimeter mission.

To provide the best orbital accuracy possible, Jason-1 will be tracked with GPS, DORIS, and SLR. SLR will provide the crucial centering of the orbit relative to the Earth's center of mass, and will provide the absolute calibration of the radial orbit error for the altimeter.

Additional information can be found on the ILRS web site at:

http://ilrs.gsfc.nasa.gov/jason1.html

ENVISAT-1

ENVIronmental SATellite (EnviSat) -1 is the successor to the European Space Agency (ESA) Remote Sensing Satellites ERS-1 and ERS-2. It will provide continuity with most of the ERS-1, 2 altimeter and SAR measurements and adds significant new capabilities. The mission will provide long term data sets for both climatological and environmental research. EnviSat-1 mission will monitor conditions and support studies for the management and monitoring of the Earth's resources, both renewable and non-renewable; and the development of a better understanding of the structure and dynamics of the Earth's crust and interior.

SLR will be used to calibrate the radar altimeter to monitor ocean height for studies of global ocean circulation, regional ocean current systems, and marine gravity field.

Additional information can be found on the ILRS web site at:

http://ilrs.gsfc.nasa.gov/envisat.html

GRACE

The Gravity Recovery And Climate Experiment (GRACE) is a joint US/German satellite mission, which will provide global high resolution estimates of the Earth's gravity field and its variability in time. The GRACE mission will have two identical spacecrafts flying about 220 kilometers apart in a polar orbit 500 kilometers above the Earth.

GRACE will map the broad to finer-scale features of Earth's gravitational field using GPS and a microwave satellite to satellite ranging system. The results from this mission will yield crucial information about the distribution and flow of mass within the Earth and it's surroundings.

The SLR data will (in combination with GPS) support precise orbit determination for gravity field recovery, calibration of the on-board GPS, and technological experiments such as two-colour ranging.

Additional information can be found on the ILRS web site at:

http://ilrs.gsfc.nasa.gov/grace.html

ADEOS-II

The ADvanced Earth Observing Satellite 2 (ADEOS-2) Mission is a NASDA follow-on mission ADEOS-1. ADEOSII will cary a microwave scanning radiometer, an atmospheric limb spectrometer, and several other remote sensing instruments to monitor global environmental changes while continuing and furthering the broad-ranging observation technology created by ADEOS-1.

The ADEOS-II array design is identical to that of GFO-1 and ADEOS-II. SLRwill used support a precise orbit determination, strengthening and validating the primary GPS solutions.

Additional information on ADEOS-II can be found at:

http://ilrs.gsfc.nasa.gov/adeos2.html

ICESat (GLAS)

The Ice Cloud and land Elevation Satellite (ICESat) mission is being launched by NASA to better understand the mass balance of the polar ice sheets and their contributions to global sea level change and to obtain essential data for prediction of future changes in ice volume and sea-level. Secondary objectives are to measure cloud heights and the vertical structure of clouds and aerosols in the atmosphere; to map the topography of land surfaces; and to measure roughness, reflectivity, vegetation heights, snow-cover, and sea-ice surface characteristics. The primary instrument onboard ICESat , the Geoscience Laser Altimeter System (GLAS), is designed to measure ice-sheet topography and associated temporal changes, cloud and atmospheric properties, and some land and water topography.

Satellite laser ranging data will be used for validation of GPS Precision Orbit Determination (POD), back-up POD, and orbit maintenance.

For more information on ICESat refer to:

http://ilrs.gsfc.nasa.gov/icesat.html

Gravity Probe B (GP-B)

Gravity Probe B will carry the Relativity Gyroscope Experiment being developed by NASA and Stanford University to test two, unverified predictions of Einstein's General Theory of Relativity. The experiment will check, very precisely, tiny changes in the direction of spin of four gyroscopes contained in an Earth satellite orbiting at 400-mile altitude directly over the poles. So free are the gyroscopes from disturbance that they will provide an almost perfect space-time reference system. They will measure how space and time are warped by the presence of the Earth, and how the Earth's rotation drags space-time around with it. These effects, though small for the Earth, have far-reaching implications for the nature of matter and the structure of the Universe.

SLR and GPS will be used for precision orbit determination.

Additional information on Gravity Probe-B can be found at:

http://ilrs.gsfc.nasa.gov/gravity_probe_b.html

2.5 SCIENCE COORDINATION REPORT

Mark Torrence, *Raytheon Information Technology and Scientific Services*

As established by the ILRS governing board, the science coordination activity of the ILRS is to:

- enhance science dialogue
- promote SLR goals and capabilities
- enhance the program/mission coordination and response
- help define and focus SLR science and technology goals
- operate proactively to simulate new or improved science products.

The online bibliography of SLR science and engineering related publications was updated:

http://ilrs.gsfc.nasa.gov/bibliographic_info/index.html).

Brief presentations were made at each ILRS general meetings concerning how SLR contributes to scientific knowledge about the solid Earth and its' surface, about Lunar science, and to tests of relativity. Future science coordination activities will focus on the promotion of the unique contributions of SLR to science, and to the assessment of the evolving needs of the science community. This activity will participate in the formulation of a methodology to quality control science products and to provide standard test data sets for the analysis centers.