3.4.2 International Laser Ranging Service (ILRS)

Introduction

The International Laser Ranging Service (ILRS), established in 1998, is responsible for the coordination of SLR/LLR missions, technique development, operations, analysis and scientific interpretation. A number of these aspects will be discussed here briefly.

Network

The network of SLR/LLR stations, under the aegis of the ILRS, has been subject to change over the years. From a technical perspective, the quality of the observations has improved drastically during the past decade. At this moment, the single-shot precision of an average station is better than 10 mm (the best stations go well below that number). Also, the absolute quality of the individual observations is at the 10 mm level, with a significant number of stations doing better.

The geometry of the SLR network has been a point of concern over the years. However, at this moment the layout of the network is in better shape (cf. Figure 1). Although the network has been

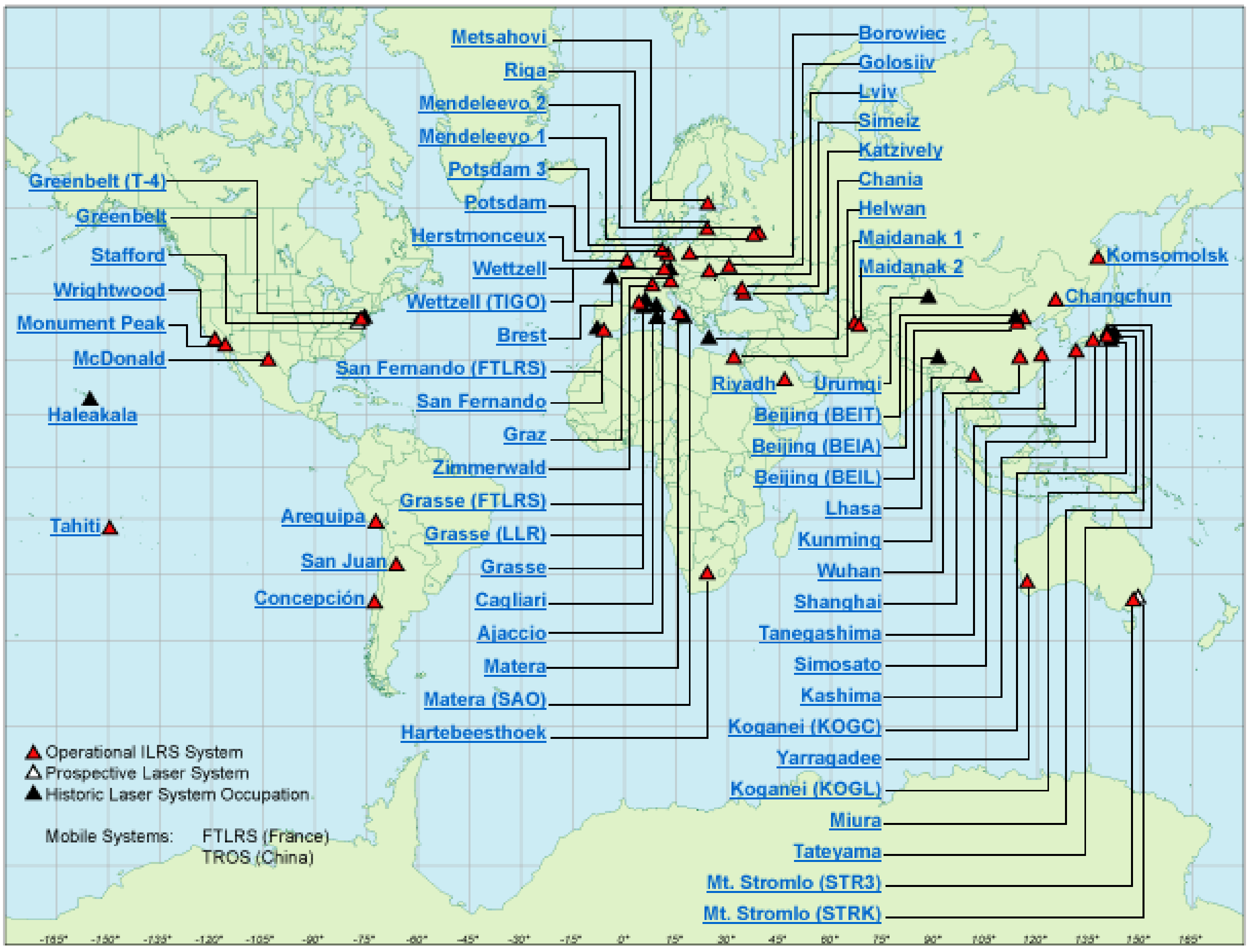

Figure 1: The global network of SLR stations (status early 2006).

dominated traditionally by stations in the Northern Hemisphere, the Southern Hemisphere now contains a number of high-quality stations, that have come on line recently or that have developed and proved themselves over the past few years. In French Polynesia, Tahiti is coming back on line; in South America, Arequipa is returning soon whereas Concepcion and San Juan are in operational service; in South Africa, Hartebeesthoek has proven itself to be a highly reliable, top-quality and productive station; and in Australia the station Mt. Stromlo is a role model for modern, autonomous operation. The contributions from stations in the Southern Hemisphere are of course complemented by the activities of Yarragadee, at the West coast of the continent, which has been the number one station in the network on many different aspects for a long time.

Missions

In 2004, a total of 29 satellites (including the Moon) were being laser-tracked. In 2005, 5 new SLR targets were orbited: on August 23, the Japanese satellite OICETS was put into orbit. On December 25, the trio Glonass-98, Glonass-99 and Glonass-100 was launched. The fifth satellite that is new in 2005 is the first test satellite of the future European satellite navigation system Galileo: GIOVE-A, launched on December 28. Clearly, the emphasis of these new missions is on navigation. All spacecraft, including these 5 newcomers, are regularly if not intensively tracked, depending on mission demands.

Noteworthy in this context is the fact that ICESat and ALOS, recently launched downward-looking satellites, have challenged the SLR network with several special requirements (any interference between the laser signal and the instrumentation is to be avoided). Many stations have responded quickly and carefully and are now compiling a good record of observational passes on both these targets.

Analysis and science

In combination with improvements in modeling the various entries in the range equation (satellite signature, tropospheric delay, etcetera) SLR provides an extremely valuable and unique tool to relate (the center-of-mass of) satellites to reference points on the Earth’s surface with unprecedented absolute accuracy. The SLR observations find their way into many studies at the edge of our knowledge: crustal deformation (reference frame, origin, scale, motions), gravity field (direct inversion and/or calibration of solutions derived with other techniques), oceanography (sea-level change, tides), earth rotation (observation of relevant parameters), orbital mechanics (satellite motion). A number of these aspects will be elaborated hereafter.

Some ILRS analysis products are of particular interest to IERS. In particular, SLR plays an important role in the assessment of the

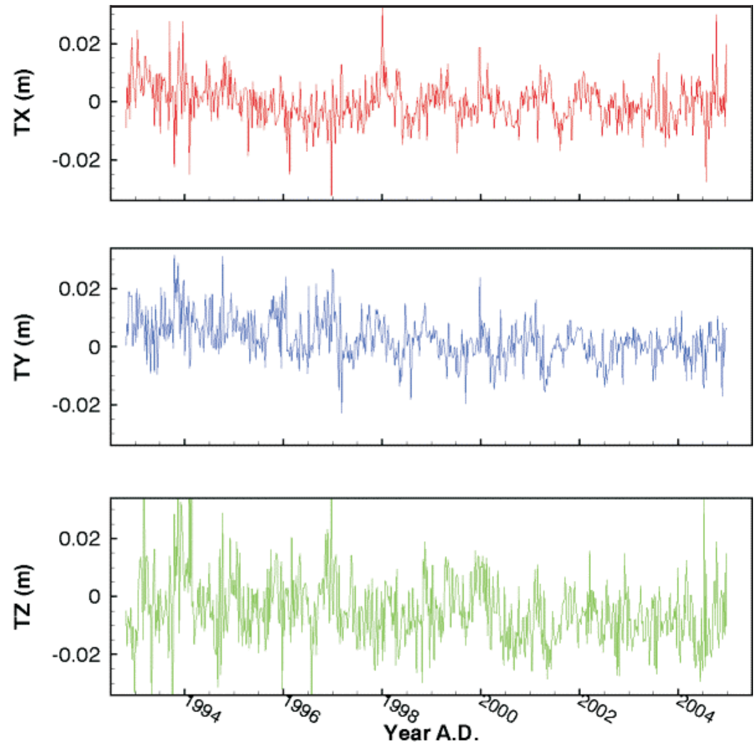

Figure 2: Time-series of solutions for geocenter as observed by with the SLR technique (covering 1993.0 – 2005.0) (courtesy of GFZ).

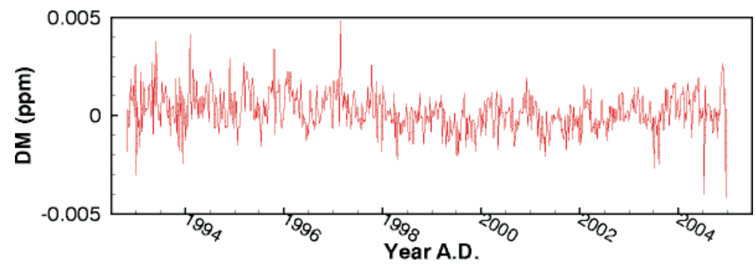

Figure 3: Time-series of solutions for global scale as observed by with the SLR technique (covering 1993.0 – 2005.0) (courtesy of GFZ).

terrestrial reference system, since the laser technique provides unique information on the exact location of the Earth's geocenter and (shared with VLBI) absolute scale.

Specifically, the ILRS Analysis Working Group (AWG) coordinates the generation of a number of relevant data products. Since 2003, the AWG produces weekly time-series of solutions for station coordinates (and their derivatives geocenter and scale) and Earth Orientation Parameters (EOPs; more specifically: x-pole and y-pole and excess Length of Day). These solutions are based on

SLR data taken on the satellites LAGEOS-1, LAGEOS-2, Etalon-1 and Etalon-2. Individual solutions are computed by 6 different institutes: ASI/Italy, BKG/Germany, DGFI/Germany, GFZ/Germany, JCET/USA and NSGF/UK. Next, these solutions are merged into two combination solutions, which is done by ASI (responsible for the official ILRS primary combination product) and DGFI (the official backup combination product center). The organization (of generating these solutions) is such that the backup institute is able to take over the role of the primary institute at any time. Such solutions are generated on a weekly basis, and are available on each Tuesday.

The combination solutions are used for a variety of purposes: the IERS Combination Pilot Project, the IERS/NOAA Bulletin A, etc. A very important target for their use is the new IERS ITRF2005 solution, which will be based on input from all 4 geodetic services, but with a primary role for SLR when it comes to defining origin and (shared with VLBI) global scale.

To improve the strength, value and reliability of its contribution, the ILRS has started an effort to extend the time-series of such solutions, and by the end of 2005 has been able to deliver similar solutions for the period from January 1, 1993 onwards. A clear illustration of the solutions is shown in Figures 2 and 3: these show the time-series of geocenter components and global scale, respectively. Seasonal effects are visible, but systematic effects are absent. The root-mean-square (RMS) of the geocenter positions and scale is 8.1 mm, 7.5 mm, 12.4 mm and 1.1 ppb, respectively.

Although not directly relevant to the new ITRF2005 product, the ILRS AWG has decided to extend the time-span of the solutions even further: an effort has been started to go back to September 1983, the onset of the so-called MERIT campaign (“Monitor Earth Rotation and Intercomparison of Techniques”). However, recognizing the reduced number of satellites available, the geometry of the network, the quality of the observations and other aspects, this re-analysis cannot be expected to result in data products that are of similar quality and resolution as what is being obtained from contemporary SLR observations. Nevertheless, this analysis effort will extend the time-span to 20+ years, and will provide valuable information on some of the most crucial elements of (understanding and describing) System Earth.

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