GLONASS status update. MCC activity in GLONASS program.

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Introduction

The Global Navigation Satellite System (GLONASS) is a government satellite navigation system which is designed for providing a continuous all-weather support of an unlimited number of aeronautical, maritime, terrestrial and space-born users with high-precision position-fixing and timing information at any point of the Earth and in the near-Earth outer-space. The Russian Federation Presidential Directive No. 38-RP of February 18, 1999 designated the GLONASS system as a dual-purpose space facility applied for solving the scientific, industrial, economical, social, defense, security and other relevant problems. It was also specified that the Federal Space Agency (Roscosmos) is a co-customer of the GLONASS system on equal footing with the Russian Ministry of Defence.

GLONASS Status

The first GLONASS satellite was launched into orbit on October 12, 1982. The GLONASS system formally attained the initial operation capability with a reduced-scale orbital configuration on September 24, 1993. The fact was approved with Presidential Directive No. 658 RP. Russian Federation Government Directions No. 237 of March 07, 1995 assigned a mission to implement a full-scale deployment of the GLONASS orbital constellation (24 satellites), to provide for mass-production of user equipment and to introduce the GLONASS system as an integral element of the international satellite navigation system for civil users.

The Russian Federation Government approved a long-term program of the GLONASS system modernization on August 20, 2001. It is designated as the Global Navigation System (GNS) federal objective program. The GNS Program covers improvement of space, ground-based and user equipment segments of the GLONASS system. Government commitments are associated with appropriation of funds to the Program for ten years by the State Budget Act.

There are new main tasks with the Presidential Directives issued at January 18, 2006 and at April 19, 2006:

- To ensure GLONASS minimum operational capability (constellation of 18 NSV) by the end of 2007
- To ensure GLONASS full operational capability (constellation of 24 NSV) by the end of 2009
- To ensure GLONASS performance comparable with that of GPS and GALILEO by 2010
- To ensure the navigation equipment mass production: encourage the industry in the manufacture renovation
- Mass market development

The Federal GLONASS Program update was approved by the Government Resolution at July 14 2006, No423.

Main reasons for SLR data application to GLONASS

There are a lot of the civil and scientific applications where navigation data from GPS are not enough for the complete analysis. The GLONASS navigation data are useful and helpful in these situations. Thus it's very important to use the same geodetic base with GPS by the GLONASS data generation. From this point of view it is necessary to calibrate geodetic base, the navigation signals accuracy for GLONASS system as good as possible. On the other hand the Russian Ground-Based Control Facility (GBCF) provides for management of the GLONASS orbital constellation and consists of the GLONASS Control Center and a network of tracking/control stations deployed in different areas of the Russian Federation only. SLR data from world wide stations net is the source of calibration data for ephemeris determination, international geodetic base providing and accuracy factor improving for GNSS etc.

So SLR data from ILRS network provide:

- Improving of the geodetic base for GLONASS on the way to ITRF
- Studying and improving of the SC motion model etc.
- Calibration and validation of the microwave means
- Testing and validation of the software and analysis results
- Monitoring of the real on-board ephemeris and clock

IAC activity in GLONASS Program

Informational Analytical Center (IAC - the department of the Russian Mission Control Center) since August, 15, 2006 has been formally assigned by the Federal Space Agency as the GLONASS official information portal for users with the next issues:

- Daily brief bulletins for GLONASS and GPS status based on the global data available (IGS network)
- GLONASS Control Center (Space Force) information
- NAGU generation
- Monthly bulletins with deep analysis of GLONASS performance
- GLONASS news
- GLONASS ICD, etc.

So, IAC is now acting as positive feed-back in the GLONASS control segment.

The IAC has been making contributions to the International GPS Service (IGS) by providing precise orbits based on SLR observations for those GLONASS satellites that are observed by the ILRS network. These independent orbits help to validate and evaluate precise orbits computed by Analysis Centers from the IGS tracking network observations. Since 1995, the MCC has permanently supported orbit determination of GLONASS satellites based on SLR data. Orbits for GLONASS satellites (in SP3 format) are regularly sent to the CDDIS for the determination of the final orbits based mainly on the GLONASS "phase" data.

GLONASS SLR data analysis

The global products from the International GLONASS service as part of the IGS should facilitate the use of combined GLONASS and GPS observations and analysis results for the civil scientific and engineering applications in the frame of the prototype Global Navigation Satellite System (GNSS). The ILRS supports this effort by a continuous tracking of three GLONASS satellites as part of their standard tracking protocol and by delivering precise GLONASS orbits through one of its Analyses Centers (MCC). Average number of the SLR data pro month for three GLONASS satellites is 500 – 700 passes from 15-18 stations (see the Table 1 as example of the month SLR tracking.)

Table 1.
Time interval: 30.07.2006 – 26.08.2006

SC	Passes	Stations
GLONASS-07	**133**	**14**
GLONASS-22	**154**	**15**
GLONASS-03	**220**	**16**
Total	**507**	**18**

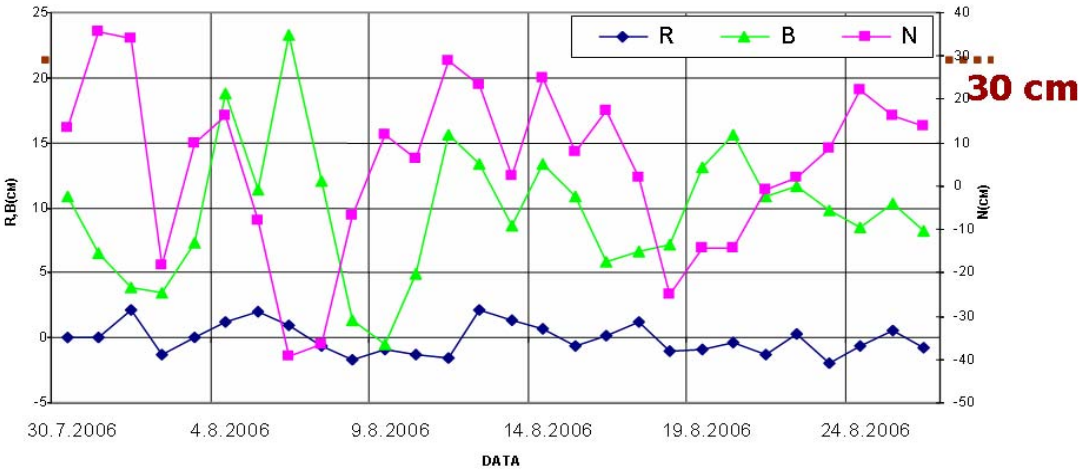

Figure 1. *The average difference between SLR and navigation orbits for GLONASS-89 (August 2006)*

Figure 1 shows the average difference between SLR and “microwave” orbits as potential GLONASS Performance (R-radial, B-across orbit, N- along orbit).

Figure 2 shows the improving of the on-board ephemeris & clock data for GLONASS constellation in the last years (since July 2005).

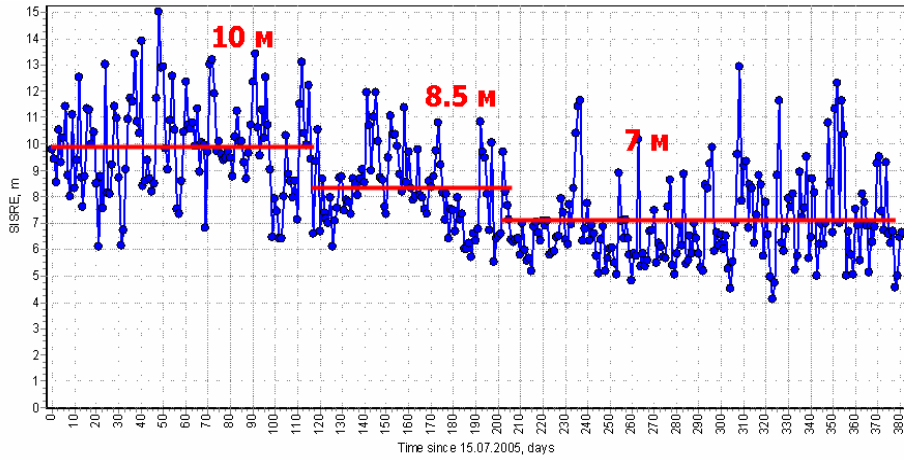

***Figure 2**. Average Signal In Space Range Error (SISRE), м (Since July, 2005)*

Conclusions

- ILRS support is very important for GLONASS modernization by the way to the Global Navigation Satellite System
- Need to continue/increase tracking of GLONASS satellites by ILRS for the realization of the real collocation in space (Microwave / Laser)
- The International GLONASS - Pilot Project demonstrates the extensibility of IGS to accommodate other microwave systems (GLONASS, GALILEO).