Collection and processing in TSNIIMASH (PNT IAC) of GLONASS spacecraft ranging data obtained by Russian and global SLR network stations

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SLR data for GLONASS

Basic conditions of the SLR data:

➤ **World wide SLR stations network**

➤ **Highest direct measurements accuracy**

➤ **Precise geodetic base**

Main goals for SLR data processing in GLONASS:

✓ **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**

Positioning, Navigation and Time Information Analysis Center (PNT IAC)
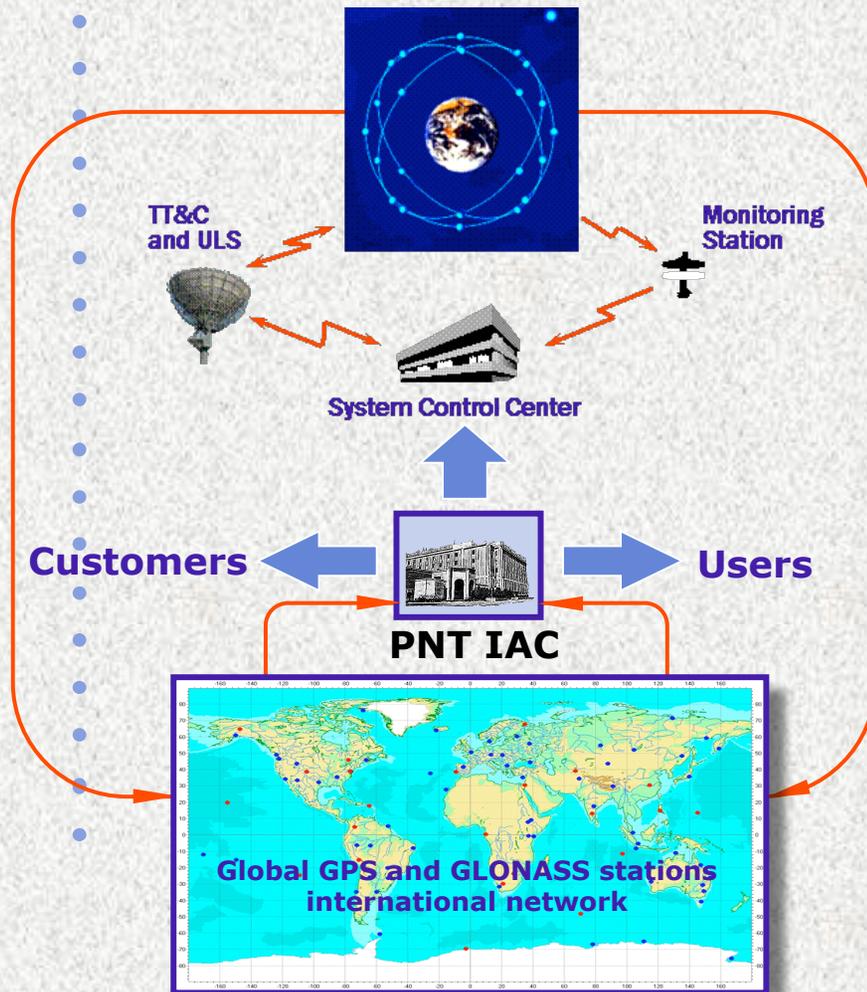
PNT IAC Objectives:

- ❑ **GLONASS Program inputs preparation, support and tracking**

- ❑ **PNT and GLONASS development strategy scientific justification**

- ❑ **GLONASS constellation status monitoring**

- ❑ **GNSS performance estimate**

- ❑ **Information portal for GLONASS users**

PNT IAC Architecture

```
┌──────────────────────────────┐
│      GLONASS/GPS             │
│  Basic Monitoring Station    │
└──────────────────────────────┘
              │
              ▼
┌──────────────────────────────┐
│    Data Acquisition          │
│  and Archiving Facility      │
└──────────────────────────────┘
        │            │
        ▼            ▼
┌───────────┐  ┌──────────────┐
│   GNSS    │  │   GLONASS    │
│(GLONASS/  │  │ Constellation│
│   GPS)    │  │    Status    │
│ Orbit &   │  │  Monitoring  │
│  Clock    │  │   Facility   │
│Processing │  │              │
│ Facility  │  │              │
└───────────┘  └──────────────┘
        │            │
        ▼            ▼
┌──────────────────────────────┐
│      User Interface          │
│ Information Dissemination     │
│        Facility              │
└──────────────────────────────┘
```
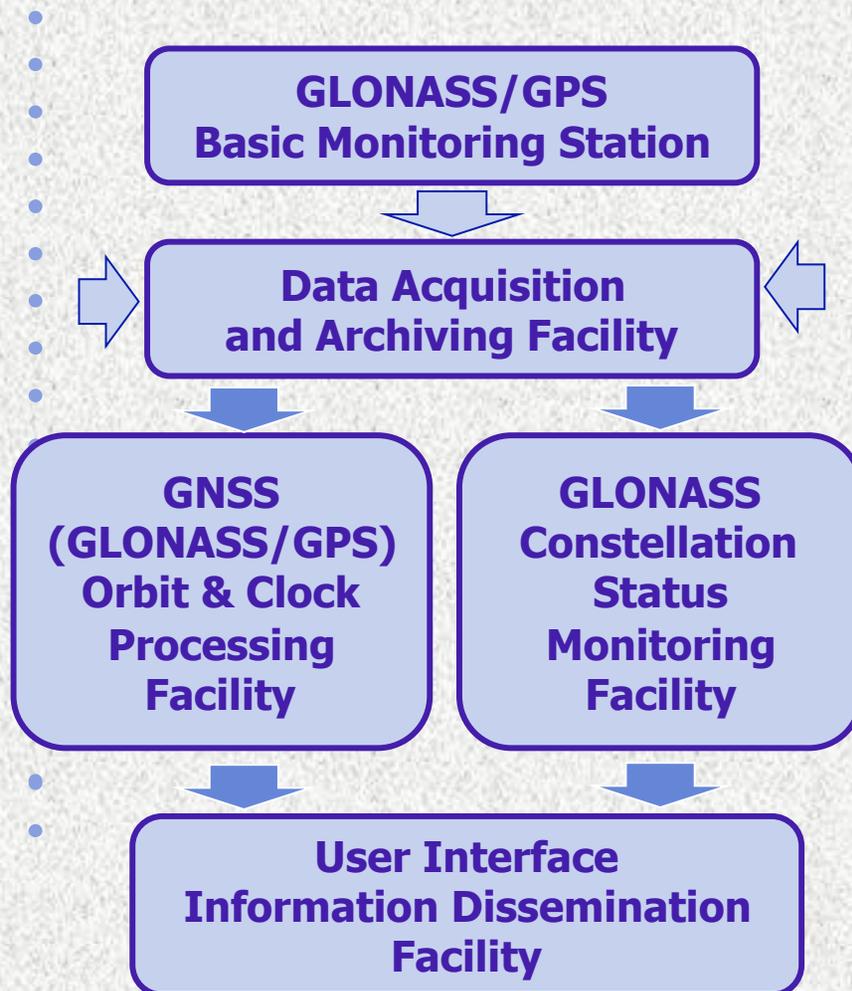
PNT IAC Status:

- ❑ **GLONASS Performance Monitoring Center of Federal Space Agency** *(since 1998)*

- ❑ **International GNSS Service (IGS) Associated Analysis Center** *(since 1999)*

- ❑ **International Laser Ranging Service (ILRS) Associated Analysis Center** *(since 1998)*

- ❑ **International Earth Rotation Service (IERS) Analysis Center** *(since 1994)*

- ❑ **GNSS Radio-Navigation Field Certification Test Laboratory** *(since 2007)*

Data Processing Facility

❑ **PNT IAC Processing Facility was certified for orbit & clock and radio-navigation field parameters analysis**
  - ⇨ **In 2005**
  - ⇨ **By ROSSTANDART**
  - ⇨ **By Ministry of Defense**

❑ **Processing tools:**
  - ⇨ **Software is of PNT IAC production**
  - ⇨ **85 computers**
  - ⇨ **LAN, WAN**
  - ⇨ **Internet**

❑ **PNT IAC Processing Facility has obtained accreditation as a test laboratory for GNSS navigation field monitoring**
  - ⇨ **In 2007**
  - ⇨ **By Federal Space Agency**

GLONASS Status User Interface

- ❑ **GLONASS Constellation Status**

- ❑ **GLONASS Performance**

- ❑ **GLONASS ICD**

- ❑ **Federal Official Documents**

- ❑ **GLONASS News**

- ❑ **NAGU Generation**

www.glonass-ianc.rsa.ru

SLR Data Collection

Time interval: 02.08.2009 – 29.08.2009

SC	Passes	Stations
GLONASS-100 (R23)	92	17
GLONASS-102 (R15)	136	14
GLONASS-109 (R11)	104	14
GLONASS-115 (R08)	205	19
TOTAL	537	23

SLR Data Collection (3)

GLONASS-115 (R08):

DATA	N-P	NPAS	NST	DUR	GPS WK	COMMENTS
2009.08.02	43	8	6	297	15430	
2009.08.03	3	1	1	8	15431	BAD
2009.08.04	21	4	3	187	15432	
2009.08.05	31	5	4	326	15433	
2009.08.06	21	3	2	242	15434	
2009.08.07	41	10	7	320	15435	
2009.08.08	20	6	3	56	15436	
2009.08.09	43	6	5	210	15440	
2009.08.10	11	3	3	34	15441	
2009.08.11	27	9	7	164	15442	
2009.08.12	14	4	3	46	15443	
2009.08.13	30	7	5	317	15444	
2009.08.14	33	8	6	241	15445	
2009.08.15	38	8	5	310	15446	
2009.08.16	37	6	5	331	15450	
2009.08.17	25	4	3	250	15451	
2009.08.18	49	13	10	482	15452	
2009.08.19	43	11	8	414	15453	
2009.08.20	41	5	4	340	15454	
2009.08.21	15	5	5	71	15455	
2009.08.22	9	4	4	23	15456	
2009.08.23	47	7	4	326	15460	
2009.08.24	36	10	6	199	15461	
2009.08.25	37	9	6	275	15462	
2009.08.26	47	16	8	210	15463	
2009.08.27	45	11	7	337	15464	
2009.08.28	26	4	4	143	15465	
2009.08.29	34	9	4	309	15466	

GLONASS-109 (R11):

DATA	N-P	NPAS	NST	DUR	GPS WK	COMMENTS
2009.08.02	8	1	1	32	15430	BAD
2009.08.03	0	0	0	0	15431	BAD
2009.08.04	14	4	3	45	15432	
2009.08.05	19	3	3	248	15433	
2009.08.06	27	3	3	274	15434	
2009.08.07	30	5	5	235	15435	
2009.08.08	16	5	3	61	15436	
2009.08.09	14	3	2	102	15440	
2009.08.10	5	1	1	17	15441	BAD
2009.08.11	2	1	1	4	15442	BAD
2009.08.12	11	4	3	28	15443	
2009.08.13	12	2	2	84	15444	BAD
2009.08.14	16	3	3	201	15445	
2009.08.15	17	4	3	223	15446	
2009.08.16	22	3	2	258	15450	
2009.08.17	21	5	4	150	15451	
2009.08.18	6	2	1	146	15452	BAD
2009.08.19	19	5	4	99	15453	
2009.08.20	35	6	4	300	15454	
2009.08.21	14	2	2	96	15455	BAD
2009.08.22	10	2	2	81	15456	BAD
2009.08.23	26	3	3	258	15460	
2009.08.24	19	3	3	154	15461	
2009.08.25	20	5	4	125	15462	
2009.08.26	0	0	0	0	15463	BAD
2009.08.27	23	9	4	166	15464	
2009.08.28	26	10	5	114	15465	
2009.08.29	48	7	4	335	15466	

GLONASS Program Support

GLONASS-100 (R23):

DATA	N-P	NPAS	NST	DUR	GPS WK	COMMENTS
2009.08.02	8	3	2	56	15430	
2009.08.03	7	1	1	36	15431	BAD
2009.08.04	16	1	1	145	15432	BAD
2009.08.05	6	2	2	110	15433	BAD
2009.08.06	6	1	1	217	15434	BAD
2009.08.07	8	2	2	29	15435	BAD
2009.08.08	0	0	0	0	15436	BAD
2009.08.09	0	0	0	0	15440	BAD
2009.08.10	0	0	0	0	15441	BAD
2009.08.11	28	7	4	449	15442	
2009.08.12	12	4	3	189	15443	
2009.08.13	4	1	1	22	15444	BAD
2009.08.14	7	1	1	96	15445	BAD
2009.08.15	10	2	2	147	15446	BAD
2009.08.16	16	5	2	70	15450	
2009.08.17	23	5	4	134	15451	
2009.08.18	42	9	7	490	15452	
2009.08.19	23	4	4	231	15453	
2009.08.20	27	4	4	213	15454	
2009.08.21	8	1	1	44	15455	BAD
2009.08.22	3	1	1	160	15456	BAD
2009.08.23	13	3	2	142	15460	
2009.08.24	7	3	3	26	15461	
2009.08.25	16	4	3	82	15462	
2009.08.26	13	4	4	50	15463	
2009.08.27	14	4	3	156	15464	
2009.08.28	2	1	1	4	15465	BAD
2009.08.29	22	6	5	221	15466	

SLR Data Processing

GLONASS-115 (R08). Difference between SLR and navigation orbits (3D).

SLR Data Processing (2)
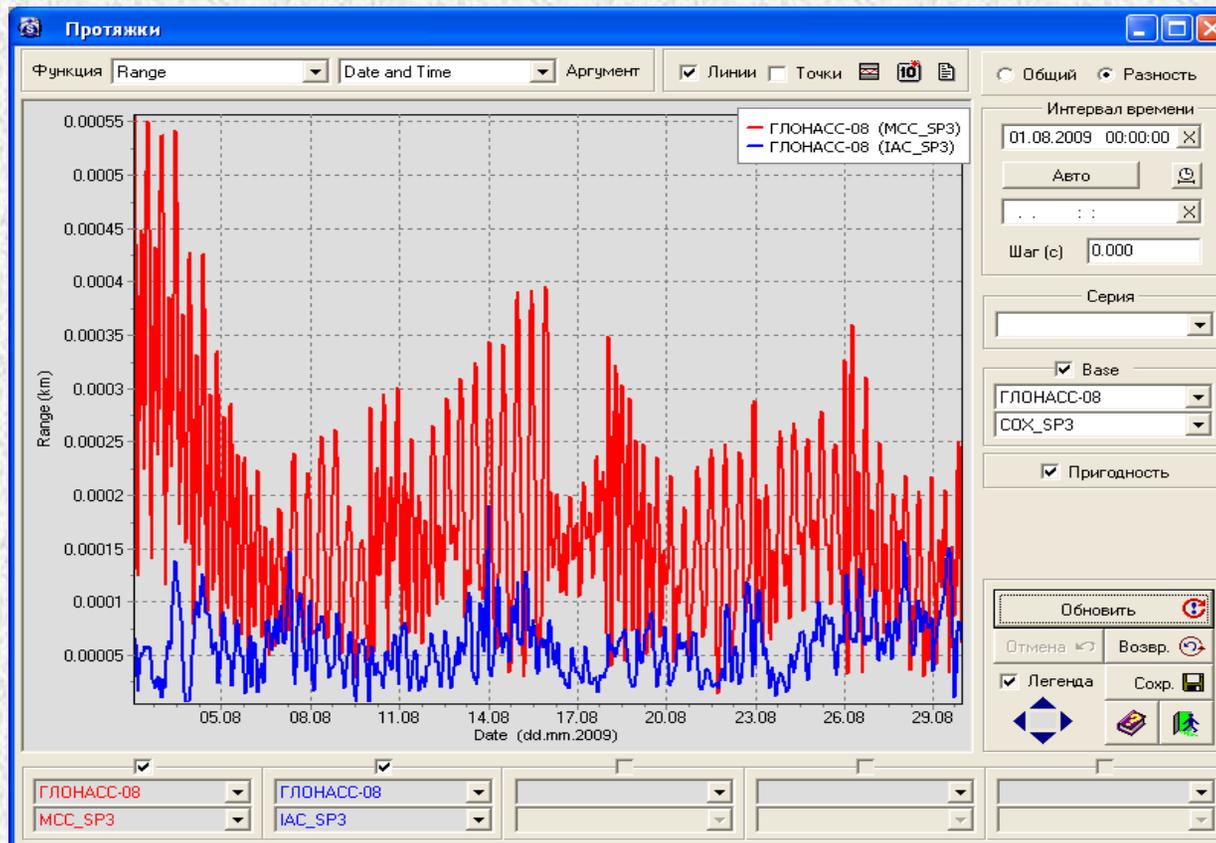
**GLONASS-115 (R08). Difference between SLR and navigation orbits (R).**
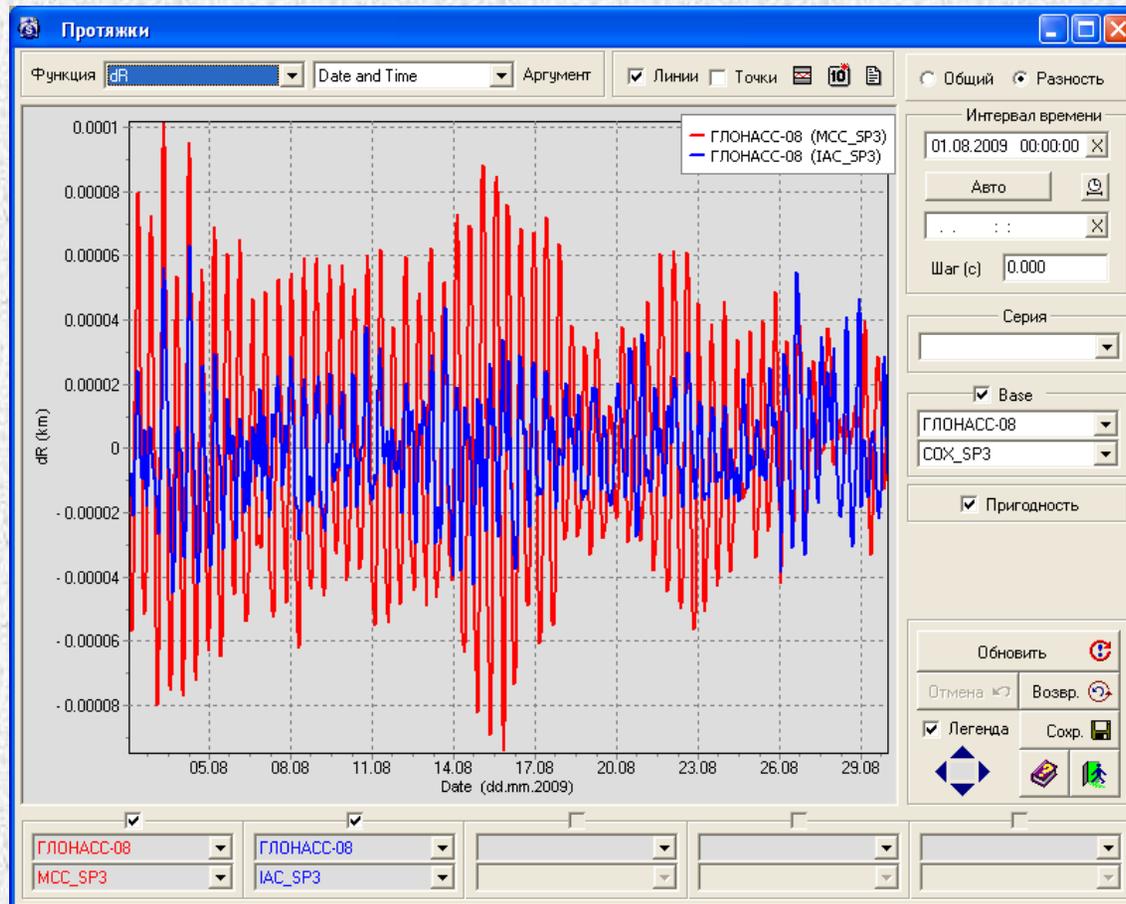
SLR data Processing (3)

GLONASS-115 (R08). Residuals.
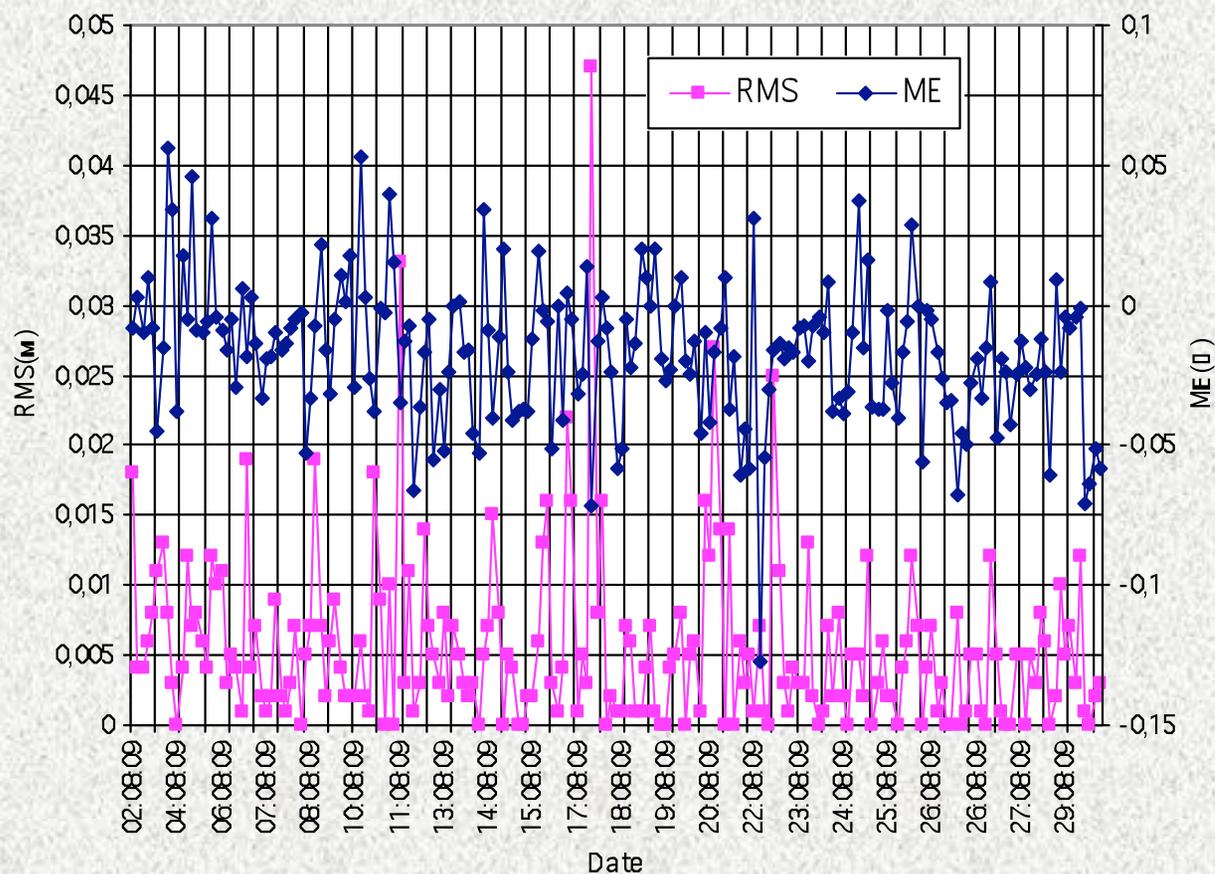
*__Main problems of "SLR orbits for GLONASS":__*

• **Actual information concerning the orientation of GLONASS satellites (the model and actual realization)**

• **Minimization of the COM error**

• **To have enough number of the SLR data for the GLONASS orbit determination**

GLONASS Accuracy

- ❑ **GLONASS accuracy has 5 time improved for last three years**

- ❑ **Now it is the same order of GPS**

- ❑ **Following improvement is expected by 2011**

SISRE (1 sigma)

ГЛОНАСС — GPS

7.2 m
3.7 m ICD
1.8 m
0.95 m

1st phase of Ground Control modernization

20 m (2007)   7.5 m   5 m (end 2008)   2 m

Ideal receiver positioning accuracy

20.02.2006 ~25 m (1 sigma)

20.02.2007 ~18 m (1 sigma)

20.02.2008 ~15 m (1 sigma)

20.02.2009 ~5-7 m (1 sigma)
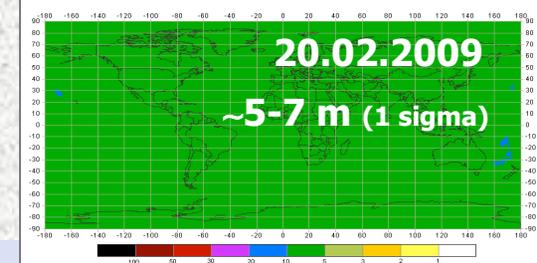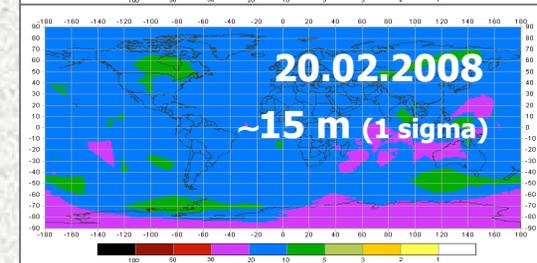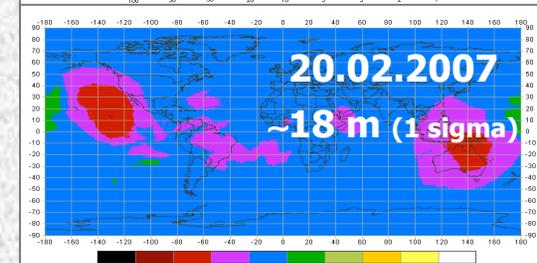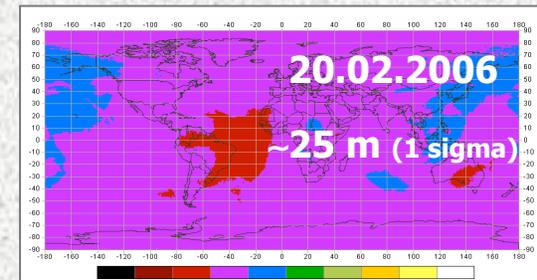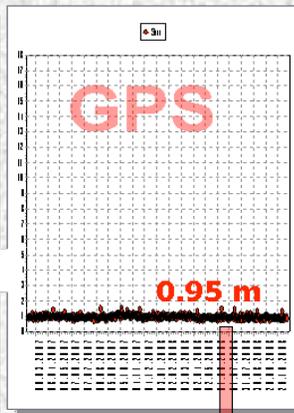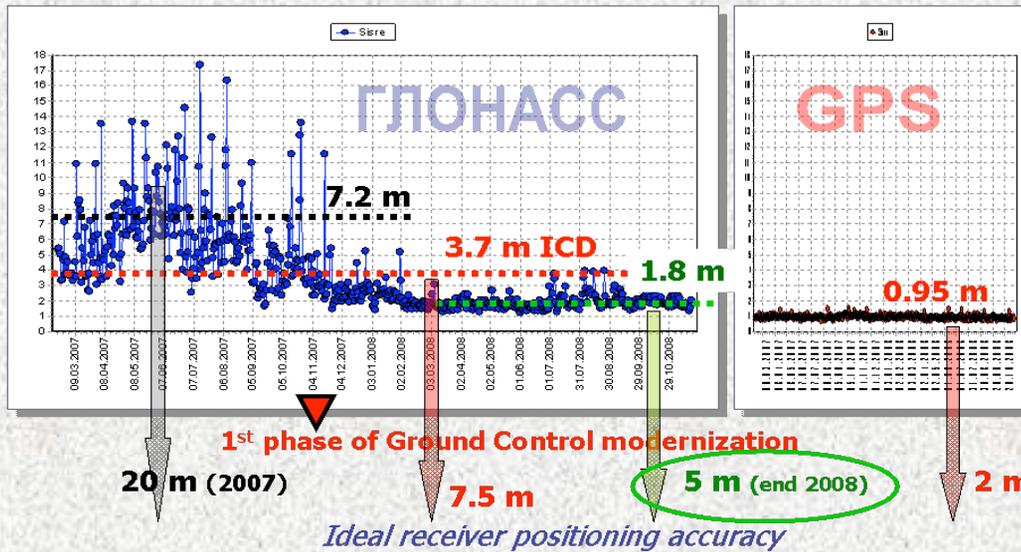
Summary

□ **GLONASS System has significant improvement of its performance during last few years in**
- ↳ **Availability**
- ↳ **Accuracy**

□ **ILRS support is very important for GLONASS modernization by the way to the Global Navigation Satellite System**

□ **Main problems of "SLR orbits for GLONASS":**
- ↳ **Orientation**
- ↳ **COM**
- ↳ **SLR data volume**

Thank you for your attention!