



IGS

**S E S S I O N 7**  
**F U T U R E P L A N S**



## The Future of IGEX-98

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The IGEX-98 started on October 19, 1998 and was officially terminated on April 19, 1999. Since that time IGEX activities continue on a "best effort basis" (for details see IGEX-mail no. 290). We briefly review the achievements of IGEX-98 in our paper.

In view of the (potential) impact of the GLONASS on space geodetic work (e.g., on time and frequency transfer, or on spaceborne applications), the IGEX Steering Committee proposes to continue the precise GLONASS orbit and clock determination activities in the framework of an internationally coordinated project.

We propose resolutions to be discussed, modified, and approved or declined by the IGEX-98 workshop participants in Nashville, in 1999. The final version of these resolutions shall serve as the basis for the next four years of scientific GLONASS-related tracking and analysis activities.

We furthermore outline a possible structure and affiliation for the future scientific GLONASS tracking and data analysis service for the years 1999-2003 (provided the above question is answered in the affirmative sense). A charter for the new activity is drafted.

## **State of IGEX in September 1999**

The IGEX-98 was organized as the first global scientific GLONASS tracking and data processing campaign. Initially it was scheduled to last for three months towards the end of 1998. Due to technical reasons (availability of combined dual-band GPS/GLONASS receivers) its start had to be postponed for about one month.

IGEX-98 started on October 19, 1998 and was officially terminated on April 19, 1999. The campaign was extended from the end of January 1999 to April 19, 1999 to allow for the three newly launched GLONASS satellites (on December 30, 1998) to be tracked and analyzed during IGEX-98. The satellites actually were successfully observed by the GLONASS and GPS/GLONASS receivers (but due to a naming conflict, not by the SLR stations of the ILRS tracking network) since the January/February 1999 time frame.

Since April 20, 1999 the IGEX activities continue on a "best effort basis" (for details see IGEX-mail no. 290). One has to admit, however, that the initial IGEX momentum is lost to a considerable extent. We thus clearly have to give IGEX a new thrust and a new form, if we want global scientific GLONASS tracking and data processing to continue.

We see the following arguments in favor of such a positive decision:

- (1) A network of currently about 20 combined GLONASS/GPS dual-frequency receivers is still tracking "all in view" GLONASS satellites on a routine basis. There were more than 60 sites (equipped with single- and dual-frequency receivers) during IGEX-98.
- (2) The ILRS network was observing about 70% of the entire GLONASS for the official duration of the campaign; afterwards a subset of the system was and still is tracked by the ILRS. The observational material is well suited to come up with excellent GLONASS orbit models. It seems possible to model GLONASS orbits with the same quality as GPS orbits.
- (3) With a delay of about 10 weeks ephemerides with an accuracy of 1-3 decimeters rms per satellite are available for each day since October 19, 1998 from more than one IGEX analysis center.
- (4) It is an important aspect that IGEX-98 makes GPS and GLONASS orbits available in one and the same terrestrial reference frame (the IERS-realization used by the IGS).
- (5) Since GPS week 988, the orbits are compared by the IGEX-98 coordinator and robust, combined IGEX orbits-98 are available as well.

We see three counter-arguments to continuing IGEX-98:

- (1) The political uncertainty of the future of the Russian system. With the exception of the three new GLONASS satellites (slot nos. 1, 7, and 8) all GLONASS satellites are old (well past the end of their expected lifetime). At present there are only 11 healthy GLONASS satellites available.
- (2) The analysis performed by the IGEX analysis centers is probably not yet automated in a sufficient way. (Too) much human manpower and human interaction is required to maintain the analysis effort.
- (3) It is a non-negligible effort for station managers to operate an additional microwave receiver and to keep the data flow going.

### **Situation of the Sponsoring Organizations**

Three international organizations, namely CSTG, IGS, and ION (in alphabetic order) were conducting the IGEX-98 as a joint experiment. The project was also sponsored by the IERS.

#### *CSTG: Subcommittee on Precise Satellite Microwave Systems*

The project was chaired by the CSTG subcommission on "precise satellite microwave systems". Pascal Willis was the chairman of this subcommission in the time period 1995-1999. Pascal Willis agreed at the CSTG Executive Committee Meeting in Birmingham (July 1999) to continue as chairman of this subcommission of CSTG until a decision is made on the future of the IGEX experiment.

The position of CSTG with respect to IGEX-98 follow-on projects may be summarized as follows. Should the IGEX community decide to continue scientific GLONASS tracking and processing experiments and should it not be possible to accommodate these activities in the IGS framework, CSTG would be ready and willing to "host" the IGEX follow-on experiment. Should another solution be found, the subcommission on precise satellite microwave systems would be formally terminated by the end of 1999.

#### *International GPS Service (IGS)*

It is quite clear that from the technical point of view IGEX-98 was most closely related to the IGS. The IGEX-98 steering committee was deeply interested in having the IGEX tracking network closely collocated with the IGS network. This attempt was only partially successful.

The IGEX-98 formally had the status of an IGS Working Group. Pascal Willis was (and still is) the head of this working group. In this capacity he became a non-voting member of the IGS Governing Board.

### *ION GLONASS-GPS Interoperability Working Group*

The project was actively supported by the Institute of Navigation (ION) and its GLONASS-GPS Interoperability Working Group, chaired by Pratap Misra of MIT Lincoln Laboratory and co-chaired by James Slater of the U.S. National Imagery and Mapping Agency (NIMA).

The Working Group was established several years ago to help resolve some of the interoperability issues surrounding GPS and GLONASS and to act as a forum for discussions of these issues. It has sponsored Russian participation in the Working Group's annual meetings at ION Satellite Division GPS Conferences and has provided extra support for Russian participation in the IGEX campaign.

The issues of greatest interest were related to timing and positioning reference systems, receiver technology, software development, precise ephemerides and institutional matters. These subjects were of concern to the navigation and surveying communities, equipment manufacturers and the scientific community. ION's annual GPS conference has always sponsored sessions on technical and policy developments related to GLONASS. The success of IGEX through ION's collaboration with the other sponsors of the project has effectively accomplished the objectives of the Working Group. As a result, the ION GLONASS-GPS Interoperability Working Group will disband at the end of this year. ION's Satellite Division, however, will continue to actively support the presentation of GLONASS-related research, development and policy in future GPS conferences.

### **IGEX-98 Experiences**

Attention was paid by the IGEX Steering Committee not to abuse the IGS infrastructure or to disturb IGS routine operations and data flow. This was the declared goal of the IGEX-98 Call for Participation sent out in 1998. As a result of this call,

- (1) an independent data structure (at the CDDIS at Goddard Space Flight Center and mirrored at the IGN in Paris) was set up for GLONASS data and products,
- (2) independent IGEX Analysis Centers were appointed,
- (3) an Analysis Center coordinator was appointed, and
- (4) an IGEX tracking network was identified.

Pascal Willis, chair of the IGEX Steering Committee became an official member of the IGS Governing Board in December 1998. It can be said that through these measures, the IGS infrastructure was not used in an excessive way. We believe on the contrary that excellent use was made of the existing IGS infrastructure and products by the IGEX-98 experiment.

IGEX-98 proves that it would be possible, technically and politically, for an IGEX follow-on activity to become an organization closely cooperating with, but independent from, the IGS. For the following reasons the IGEX-98 Steering Committee believes that IGEX follow-on activities should be associated with the IGS:

- (1) It is crystal clear that GLONASS tracking "per se" will not make sense, but that combined GPS/GLONASS receivers, well collocated with the IGS network, will be the backbone of the IGEX Pilot Service (PS) network.
- (2) Full consistency (reference frame, analysis standards, networks, etc.) with the corresponding IGS entities must be the top priority in all IGEX-PS activities.
- (3) Eventually the IGEX and IGS data structures and analyses should be merged into one dual-system service. This will only be possible if the performance of the GPS/GLONASS receivers is at least the same as that of the currently used GPS receivers and if the modeling capabilities are identical for the two systems including their combination.

The Steering Committee only sees one counter-argument for the outlined procedure:

- IGEX-PS might have a better international visibility outside the IGS.

It is believed, however, that such a purely political argument should not have a high weight.

## **Resolutions**

In view of the IGEX-98 achievements outlined, and in view of the (potential) impact of the GLONASS on space geodetic work (e.g., on time and frequency transfer, or on spaceborne applications) the IGEX steering committee proposes

Resolution 1: Global, internationally coordinated GLONASS Tracking and Orbit Determination shall continue in the time interval 1999-2003.

Should Resolution 1 be approved by the IGEX-98 workshop participants, the IGEX Steering Committee proposes to proceed as follows:

Resolution 2a: CSTG and IGS shall continue to collaborate in the IGEX-PS, the International GLONASS Experiment Pilot Service.

Resolution 2b: The collaboration shall be organized according to the rules stated in the memorandum "IGS Policy for the Establishment of IGS Projects and Working Groups" (available through the IGS Central Bureau Information System (IGSCB, <http://www/igscb.jpl.nasa.gov>), see also Attachment 1 of this paper).

The label IGEX-PS should be viewed as a working title for this paper and by no means become the official name.

In view of the close relationships between scientific GPS and GLONASS tracking and analysis efforts, the IGS Steering Committee furthermore proposes

Resolution 3: IGEX-PS shall become an IGS Working Group, initially for the time period 1999-2003. The guidelines given in Attachment 1 will be used in the next section to set up the IGS Working Group "IGEX-PS".

Should the decision be taken that IGS should be the leading organization, the guidelines in Attachment 1 have to be followed literally, in the opposite case the same rules shall be followed in a less verbal sense.

In any case the steering committee of the IGEX-PS has to prepare:

- (1) Charter for the IGEX-PS,
- (2) list of members of IGEX-PS Steering Committee
- (3) an initial duration of IGEX-PS as the time period 1999-2003.
- (4) a new call for participation. This call must in particular include a Central Bureau function.
- (5) draft e-mail message to announce the creation of IGEX-PS.

These documents, together with the proposal of the relationship between the IGEX-PS and the IGS, shall be sent to the Chairman of the IGS Governing Board with the request to put the proposal on the agenda of the next IGS Governing Board meeting.

Should the IGS Governing Board decide not to accept IGEX-PS as a working group, CSTG would be willing to continue coordinating this experiment (which is very much along the lines of the charter of CSTG).

### **Draft Charter for IGEX-PS**

The International GLONASS Experiment Pilot Service (IGEX-PS) organizes permanent global scientific GLONASS tracking and data analysis activities. The main product of the IGEX-PS are precise GLONASS orbits in the most recent IGS realization of the IERS Terrestrial Reference Frame.

The steering committee of IGEX-PS is composed as follows (list to be presented at and approved by the IGEX workshop participants):

- ...
- ...



Proposed chairperson: ...

The most important technical tasks to be accomplished in the near future are

- prepare a call for participation
- improvement of the global coverage of the IGEX tracking network using dual-band combined GPS/GLONASS receivers
- full integration of the IGEX network into the IGS network
- establishment of full compatibility of IGEX analyses with IGS analyses.

The newly elected steering committee will define a structure for IGEX-PS, work out a call for participation in IGEX-PS and present this material to the IGS Governing Board in time for the December 1999 IGS Governing Board meeting. The deadline for the availability of the material is end of November.

### **Epilogue**

The above proposals and resolutions were presented and accepted by the attendees of the IGEX-98 Workshop. Work is now underway on the required documentation, namely a draft charter for the International GLONASS Pilot Service, which will be presented to the IGS Governing Board at its December 1999 meeting.

### **Acknowledgements**

The IGEX-98 Steering Committee believes that IGEX-98 was an exciting space geodetic project and that the experiment was successful beyond expectation. The IGEX-98 Steering Committee wishes to express its sincere thanks to all individuals and organizations having contributed to IGEX-98 and its success and hopes for a further fruitful collaboration.

## **Appendix:**

### IGS POLICY FOR THE ESTABLISHMENT of IGS PROJECTS and WORKING GROUPS

#### GENERAL POLICY:

An IGS Working Group works on a particular topic related to the IGS components according to goals and schedule specified in the working group's Charter.

An IGS Pilot Project aims at the development of one or more particular IGS product(s) using data from the IGS network. The establishment of an IGS Pilot Project always implies that a more definitive, operational phase should follow the pilot phase.

Pilot projects have a finite life span and will be terminated by the Governing Board once the product is generated in a service-like manner, or, alternatively it becomes clear that the aims of the project will not be achieved. Working groups may either have a limited life span or they may be long-term. In the latter case the chairperson will be appointed for a duration of two years (re-appointment possible).

Every working group or project has a membership list. The IGS Analysis Center Coordinator and the Director of the Central Bureau are "members ex officio" of each working group or project. They may send official deputies to meetings, etc. which they cannot attend.

Working groups and projects are operating autonomously under the leadership of the chairperson. After the establishment, the chairperson has in particular the right to add members to the working group. He may also collaborate with other scientific organizations like, e.g., CSTG. List of membership and goals have to be adapted.

The chair of a working group or pilot project prepares at least annually a report about the activities of the group or project. Such reports are included into the IGS Annual Report. The IGS Governing Board regularly organizes special meetings, where IGS projects and working groups are reviewed. The working group chairs are invited to these meetings. Proposals to terminate, to essentially change the Charter, to (re-)appoint chairpersons are made. These proposals are presented at the next IGS Governing Board Meeting.

#### FORMAL ESTABLISHMENT:

Individuals or groups of individuals wishing to establish an IGS Working Group or Pilot Project have to provide the following at least two weeks prior to an official IGS Governing Board Meeting:

- Draft the Working Group's Charter clearly specifying
  - the goals (two pages at maximum),

- the structure of the group or project (what institutions are created),
- working plan including schedule / deadlines including the anticipated end of work.
- only for projects: initial ideas for an operational phase.
- Initial list of members,
- Candidate for a chairperson (optional),
- Draft IGS-mail message to inform the IGS community.

IGS Working Groups and IGS Pilot Projects are set up by the IGS Governing Board at one of its regular meetings. At this "constitutional meeting" the IGS Governing Board

- approves the draft Working Group Charter
- appoints the chair of the Working Group or Project for two years.

