Author: IGS Central Bureau

Subject: Calls for Next-Generation IGS Combination System & for Next Analysis Center Coordinator

Summary

The IGS invites proposals for two key analysis tasks:

- Development of a next-generation IGS product combination system (ACC2.0), starting as soon as possible
- Successor to current Analysis Center Coordinator, starting in 2012

These are linked activities but some groups may wish to propose and accomplish each separately. A combined proposal for both tasks is also welcomed.

Background

The IGS Analysis Center Coordinator (ACC) has overall responsibility for generating the main official IGS combined products. During the period 2008-2011, the IGS ACC functions are performed by NOAA's National Geodetic Survey (NGS) in Silver Spring, Maryland, USA. Currently, there are three IGS product lines for GNSS satellite orbits and clocks, namely the Final (GPS and GLONASS independently), the Rapid (GPS only), and the Ultra-rapid (GPS only) products. During previous periods, the ACC functions have been performed by the GeoForschnungsZentrum (GFZ, Potsdam, Germany during 2003-2008), Center for Orbit Determination in Europe (CODE, Bern, Switzerland and Vienna, Austria during 1999-2003), and Natural Resources Canada (NRC, Ottawa, Canada during 1994-1998).

Certain IGS product combination tasks are shared with the ACC. For the Final products, those components involving the terrestrial reference frame, including the Earth rotation parameters, are produced by a combination of SINEX file submissions at NRC in Ottawa (but will move in 2010). The internally realized timescales of the IGS, formed by a weighted ensemble of the frequency standards available in the IGS clock products, are maintained by the Naval Research Laboratory (NRL, Washington, DC, USA). Such high-stability timescales are supported for the IGS Rapid and Final GPS products, but not for GLONASS or the Ultra-rapids.

Other IGS products are formed by separate working groups not directly linked to the ACC, such as ionosphere maps, tropospheric path delays, and real-time services. Nevertheless, overall consistency should be maintained across all IGS products.

The present ACC combination system traces back to the early 1990s with many diverse components, written in a variety of coding languages, and many modifications since that time to accommodate changes. The system is difficult to maintain or change, and it is not easily transported from one ACC institution to the next. Even more important, the present system will not readily handle the planned new GNSS constellations or signal modulation types. Retrofitting the current system may not be feasible and would certainly be less desirable than building a modern comprehensive system.

A group is invited to rebuild the ACC combination system incorporating new features described below, here called ACC2.0. This task could well take several years and should be performed in concert with one or more of the past or present ACC groups named above having practical experience.

Meanwhile, the term of the current ACC will expire at the end of 2011. A new ACC will be needed to replace Jim Ray (NGS) by early 2012 with a transition and validation phase starting preferably no less than six months earlier. In the likely case that a new ACC2.0 combination system is not yet available, the legacy system would be installed initially and the new system integrated into operation at the earliest opportunity.

These are fundamental tasks within the IGS. Expressions of interest are requested at the earliest opportunity, but no later than:

- 20 November 2009 for a new ACC2.0 product combination system
- 31 August 2010 for the next ACC to succeed NGS starting in January 2012

Selections for the ACC2.0 developer will be made by 1 January and for the next ACC by 31 December 2010 with a hand-over process beginning no later than mid-2011.

<u>Specific ACC2.0 Goals</u>

1. A total update of the ACC software to a more easily supported, ported, maintained, and extensible form, preferably with much improved internal documentation. New features should be considered, such as the ability to combine automated batches for many weeks to handle reprocessings. The coding needs to be unified to reduce the large number of programming and shell languages that are used presently. The entire system needs a simplified and centralized set of controls for all features, rather than the present complicated system. Centralized reading/writing routines are also badly needed to simplify future changes in file formats, such as for the proposed SP4 or ORBEX orbit formats. To accomplish this goal the proposer will need to

become thoroughly familiar with the operation and functions of the current ACC combination system.

2. It is highly desirable to develop a new formalism that permits fully rigorous and self-consistent combinations of Analysis Center (AC) solutions, including the important dynamical parameters, to the extent that this is feasible. The present system uses the expedient of forming separate combinations for batches of geodetic parameters by reducing out certain other parameters (see Kouba et al., 1998). While attempting to enforce a high level of internal consistency, full consistency cannot be achieved. The effects of orbit parameters on station coordinates or Earth rotation parameters, for instance, cannot be quantitatively assessed in the present IGS combinations. This goal will require careful coordination with the incumbent ACC and cooperation among the ACs. It is suggested that this aspect of the work should be performed in parallel with the recoding work and be informed by the advice of a working party of AC representatives and other technical experts.

3. Fundamental reformulation from GPS-only to full GNSS capabilities is required imminently.

4. Integration of TRF, ERP, orbit, and clock combinations into a unified, centralized system is desirable though physical collocation per se is not really necessary if distribution of the components can be done effectively. Presently the TRF/ERP, time scale, and orbit combinations are performed by the Reference Frame Coordinator, Clock Products Coordinator, and the ACC, respectively, in separate locations. Interruptions in network connections can delay product completion in the current framework.

Guiding Principles for ACC Combinations

In pursuing the ACC2.0 objectives outlined above, it is important to reiterate the historic principles that have guided IGS analysis product combinations:

1. Software independence -- The IGS products should not favor any particular AC software design. In particular, simple squares methods cannot have a preference over filter methods.

2. Diversity of approaches -- Diverse modeling approaches are preferred as long as they are physically reasonable and compatible, and conform to accepted conventions. Only in this way can progress be achieved. Nevertheless, all AC solutions must attain comparable levels of accuracy in order for the product combinations to benefit.

3. Objective weighting -- The combination strategy should use AC weights that are objectively based, usually on the basis of best agreement with the mean or with some external standard of sufficient accuracy.

4. Unconstrained -- AC solutions should be either unconstrained or only minimally constrained. Generally the IGS should strive to move in the direction of lesser/weaker solution constraints.

Specific ACC Tasks

1. Working Groups & Pilot Projects -- The ACC is an ex officio member of all IGS working groups and pilot projects, and is also a voting member of the IGS Governing Board. Responsibilities described in the IGS Terms of Reference are given at igs.org/organization/bylaws.html.

2. Core products -- The ACC is responsible for forming and distributing the IGS core products:

    a. Ultra-rapid GPS satellite orbits and clocks with ERPs – presently issued four times daily with an initial delay of 3 hr

    b. Rapid GPS satellite orbits and clocks with ERPs and station clocks -- presently issued daily with a delay of 17 hr

    c. Final GPS & GLONASS satellite orbits and clocks with station clocks -- presently issued weekly with a delay of about 12 days

3. Reprocessed products -- From time to time, the IGS expects to reprocess all GNSS observational data using the latest models and procedures to achieve the highest possible product accuracy and to maintain long-term consistency. (It is desirable for the last previous ACC to assist with this task.)

    a. Detailed specifications and performance metrics for these products are given at acc.igs.org. In the future new or expanded combination products might be indicated.

4. Coordinate with TRF and clock products -- The formation of the Rapid and Final clock time scales and the Final station coordinate/ERP products requires close interaction with the Coordinators for those products. Electronic exchanges of data files must be synchronized and monitored in order to avoid product interruptions.

5. Monitor AC products -- The ACs must be promptly informed whenever problems occur in the quality or availability of their input solutions and it is sometimes necessary to intervene in the combination process to minimize adverse impacts. Changes made by ACs often require corresponding changes in the ACC procedures.

6. Monitor ACC products -- The quality and reliability of the IGS official products must be continuously monitored for any deficiencies, which must be promptly addressed. Difficulties with the flow of product files to the IGS Data Centers must also be resolved as quickly as possible.

7. Report station data problems -- Many types of data anomalies at the tracking stations can have adverse effects on the IGS products. When these are detected it is important to notify the station operators promptly.

8. Maintain external interactions and interfaces -- The ACC procedures depend on data files from certain external organizations which must be continuously updated. Likewise, the ACC products flow continuously to various external users. These interfaces must be reliably maintained and updated as needed, which requires routine interactions with such external groups as the

International Earth Rotation and Reference Systems Service (IERS). Also included in this activity is maintenance of the IERS Conventions upon which the IGS data reductions rely.

9. Research and improvements -- The ACC should normally play an active role, together with the ACs and other scientists, in evaluating the quality and comprehensiveness of present IGS products and developing approaches for their improvement.

10. IGS Workshops -- The ACC ordinarily is an active participant in the planning and organization of IGS workshops.

11. Website -- The ACC maintains a website of information concerning the IGS core products, their quality, and other information helpful to the ACs and general users.

12. Outreach -- It is necessary to provide users information about the combined IGS products on a regular basis, as needed.

13. Reports -- The results of each ACC product combination are documented in regular reports distributed by the IGS. Other reports and scientific papers should be prepared to document future developments and accomplishments.

It is expected that the transition to the next ACC will require a visit to NGS by personnel from the successor host organization.

Responses

Expressions of interest for either or both of the two tasks:

1. ACC2.0 -- development of a next-generation IGS product combination system, starting as soon as possible

2. Next ACC -- successor to current Analysis Center Coordinator, starting in 2012 should be addressed to the IGS Central Bureau at igscb@igscb.jpl.nasa.gov together with the following information:

    - names of key personnel, especially the proposed new ACC
    - level of support to be provided
    - computing system to be used for tasks and other technical information
    - available starting date
    - duration of commitment

Schedule

- 15 Aug 2009 -- this call for proposals

- 15 Oct 2009 -- deadline for submission of expression of interest for ACC2.0 development
- 15 Jan 2010 -- deadline for submission of response for ACC2.0 development
- 01 Feb 2010 – selection of ACC2.0 developer group
- 01 Jun 2010 -- deadline for submission of expression of interest for next ACC
- 31 Sep 2010 -- deadline for submission of response for next ACC
- 31 Dec 2010 -- selection of next ACC
- 01 Jul 2011 -- beginning of test and validation phase for new ACC
- 01 Jan 2012 -- full operational responsibility by new IGS ACC

References

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