

## Summary of the 7th IVS Analysis Workshop

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### Abstract

On January 12, 2006, the 7th IVS Analysis Workshop was held in Concepción, Chile, in connection with the Fourth IVS General Meeting. This summary briefly describes the most important discussions and decisions.

### 1. Introduction and General Information

As has been good practice at previous IVS General Meetings, the gathering at Concepción offered a good opportunity to call for an IVS Analysis Workshop. On invitation of Hayo Hase, BKG, and the Universidad de Concepción, the 7th IVS Analysis Workshop was, thus, held in Concepción on January 12, 2006. Close to 40 participants attended the one-day workshop in the building of the Facultad de Ingeniería with many fruitful discussions and decisions on procedures of IVS data analysis. This summary will address the most important ones.

### 2. Calc 10

Very recently, implementation and testing of the Calc 10 routines with their improved modelling have been completed by the Goddard VLBI group (GSFC). The plans for the transition from Calc 9 to Calc 10 will have an immediate effect also on the general way of IVS analysis procedures and are, therefore, outlined here.

Around March 1, 2006, the GSFC group will release new versions of Calc/Solve based on Calc 10. They incorporate the changes within Solve which are necessary to accommodate also the Calc 10 LCODES. At the same time the group will start re-calc'ing all databases available at IVS Data Centers and re-submit them as Calc 10 databases. In order to be able to use these new databases the IVS Analysis Centers using Calc/Solve as their standard software are required to update their software as well. As soon as the existing databases have been converted to Calc 10, only Calc 10 databases should be submitted to the IVS Data Centers in order to avoid confusion. VLBI observation data in NGS format will not be affected by this transition. The whole process should be completed by the end of March 2006.

### 3. Combination Issues

The combination of VLBI products of different IVS Analysis Centers and with those of other techniques has become an important issue within the IAG and its services. This has been demonstrated by the enormous endeavours which have been invested in the GGOS project (Global Geodetic Observing System). We have been very glad that Markus Rothacher, the IERS Analysis Coor-

dinator and Chairman of the GGOS Project, was able to attend the IVS Analysis Workshop and to give direct input and advice on a number of topics.

### 3.1. Precession and Nutation

The imminent completion of implementation and testing of the Calc 10 routines offers a good opportunity to realize the change-over from the old equinox-based precession and nutation models to the new ones which refer to the non-rotating origin and the celestial intermediate pole (CIP). In order to maintain consistency with the IAU 2000 resolutions the position of the CIP should be described in X and Y components

After some discussion it was decided that IVS and its analysis centers will publish offsets with respect to X and Y only ( $\Delta X$  and  $\Delta Y$ ) in units of milliarcseconds (mas). In order to avoid inconsistencies from the fact that free core nutation (FCN) in the MHB2000/IAU2000a model [1] is modelled properly only until the year 2000, FCN should not be modelled at all in standard VLBI data analysis for submissions of Earth orientation parameters (EOP).

In the describing text of EOP time series and in the SINEX files it should be clearly stated which apriori precession and nutation model was used and that FCN was switched off. The precession model is also of importance since the IAU will adopt a new model (P03) later this year. Although the latest SINEX file format description foresees nutation rates also, it is possible that these may be reported as a standard parameter only at a later stage.

### 3.2. EOP Epochs

For the combination process with other space techniques, especially SLR and GPS, the VLBI EOP results always have to be transformed to the 1200 UTC epoch. Although this transformation/interpolation adds an extra amount of noise to the uncertainties of the VLBI results, the satellite techniques dominate this process and interpolation of the VLBI results cannot be avoided. There are two options to accommodate this:

- The IVS Analysis Centers continue to submit EOP at their epoch of choice (mainly middle of session but may depend on weighting and outlier elimination) and the IVS Analysis Coordinator's office does the interpolation. This can be done either by a scheme which takes into account the behaviour of the EOP within a frame of five days with the deterministics coming from the IERS C04 series (Feissel-Vernier, priv. comm.) or by using the rates reported by the analysis centers. The EOP rates reported by the analysis centers heavily depend on the particular way of doing the analysis and show quite a large scatter between analysis centers.
- The second option is that the IVS Analysis Centers report EOP at 12.00h UTC. This option bears the advantage that the interpolation to a common reference epoch stays in the hands of the analyst and any peculiarities of modelling the intra-day behaviour of the EOP is contained in the VLBI analysis.

We, therefore, suggest that all IVS Analysis Centers modify their EOP reference epoch to 1200 UTC changing to this epoch as soon as possible but not later than June 30, 2006.

### 3.3. SINEX Combination

It is well known that EOP determinations are heavily dependent on the a priori TRF and that the discrepancies between EOP results of different analysis centers, to a certain extent, are a consequence of the use of different realisations of the TRF. In order to apply a common TRF to all solutions the IVS Analysis Coordinator plans to change the general reporting procedure of the IVS Analysis Centers from submissions of EOP time series to datum-free normal equations in SINEX format. The date of the transition is set to January 1, 2007. From this time onwards only combinations on the basis of datum-free normal equations in SINEX files will be used for the official IVS EOP products.

Within the topic of the SINEX submissions it was also discussed how to handle the different levels of modelling details in VLBI data analysis. For the ITRF2005 initiative a special GSFC solution has been generated on the basis of the smallest common denominator, e.g. without applying atmospheric loading corrections. The SINEX files of this and the standard solution are stored in separate directories in the IVS Data Centers. This situation should not be maintained beyond the process of generating the input for ITRF2005. The IVS Analysis Coordinator proposes that SINEX files are generated by all analysis centers on a best effort basis and that each analysis center maintains only one directory in the IVS Data Centers. The argument for this is that differences in the results of the individual analyses are still larger than discrepancies which originate from different geophysical models alone.

In a further step of combination, the VLBI zenith delay estimates will be combined with results from GPS. In order to make this work it is necessary that the epochs of the atmosphere parameters are not arbitrary but will match full hour epochs. When fractions of days like 15, 20, or 30 minute intervals are chosen, they should also be set to fit the full hour intervals. Analysts and program developers should start preparing their code for an easy implementation of this scheme. The implications of this process will be discussed again at the next IVS Analysis Workshop.

## 4. Surface Meteorological Data

At present, standard procedures read meteorological data from the sensors at the observatories and store them in the current log file. The log files normally do not contain any information about calibrations of the sensors or any other meta data. In order to overcome this deficit a new scheme has been proposed. It calls for the introduction of separate files for the meteorological sensor readings which should then also contain adequate meta data. A small analysis working group headed by Arthur Niell was formed to prepare a full proposal for a transition to this new scheme.

## 5. Miscellaneous

- The IERS Analysis Coordinator, Markus Rothacher, will contact the IERS Sub-Bureau for Loading for a decision on a generalized treatment of reference pressure values for space geodetic observing sites. At the same time the IERS will devise a plan for official reference temperatures.
- On the IVS Analysis Coordinator Web site (<http://vlbi.geod.uni-bonn.de/IVS-AC>) a page

has been set up which is meant to be filled with helpful information about problems which have been solved by colleagues already. The Analysis Coordinator will maintain this web page and is eagerly awaiting your input. The more information that is made available, the better we can spread the experience.

- The IVS Pilot Project “Baseline Lengths” is progressing well (see <http://vlbi.geod.uni-bonn.de/baseline-project/index.php>). Contributing analysis centers should see that all geodetic VLBI sessions since 1984.0 have been processed. Otherwise the combined results are distorted.
- Estimated EOP rates show large discrepancies between results of individual analysis centers. However, the formal errors indicate already that the quality of the EOP rates is similar to the level of the discrepancies. In this context, possible differences of the software packages in the modelling of sub-daily variations was briefly addressed but not discussed any further. Here, it would be helpful if analysts could check their programs and models how the EOP rates are handled and how they may be affected by sub-daily variations.
- The next IVS Analysis Workshop will take place in Vienna, Austria, at the Institute for Geodesy and Geophysics of the Vienna University of Technology on Saturday, April 14, 2007 just prior to the General Assembly of the European Geosciences Union.

## References

- [1] Mathews P.M., T.A. Herring, B.A. Buffet (2002): Modeling of nutation-precession: New nutation series for the non-rigid Earth, and insights into the Earth's Interior; *J. Geophys. Res.*, 107, B4, 10.1029/2001JB000390