Analysis Coordinator Report

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Abstract I summarize some of the important issues related to IVS analysis that have surfaced over the last two years.

1 Analysis Comments

The Goddard VLBI group has the responsibility to analyze specific VLBI sessions (e.g., R1s, RDVs) and produce edited and ambiguity-resolved databases for use by the IVS. However, the Goddard VLBI group actually analyzes all VLBI sessions 'from scratch'. Beginning in 2000, the Goddard VLBI group began writing 'Analysis Comments' and making these available on the IVS session Web pages. These contain descriptions of how the data was analyzed and any issues that were found in the analysis, for example, clock breaks, missing data, or problems at the station. These are a valuable source of information for other scientists who use the data, and also provide a historical record of what was done and why. One issue is that since Goddard analyzes each database 'from scratch', the database that Goddard works with may not be the official IVS database. For example, USNO provides the official databases for the R4s and CRFs, BKG for the T2s and Euros. The editing and ambiguity resolution in the official database may be different than Goddard's database. Because of this there were sometimes slight inconsistencies in the Analysis Comments reports and the databases. Hence it is desirable that the

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institution that does the official analysis also write the Analysis Comments. USNO began submitting Analysis Comments beginning in 2015. Because of the time lag between when data is taken and when the sessions are analyzed, the first session that was done was R4665 (14DEC11XE). Going forward, I would like other IVS ACs that are responsible for submitting the IVS databases to submit Analysis Comments that will appear on the IVS session Web pages.

2 ITRF2014

In March 2013, Zuheir Altamimi issued a call to the geometric services (IDS, IGS, ILRS, IVS) for participation in ITRF2013. This was to include data through December 31, 2013, and the various techniques were supposed to submit their solutions in early 2014. Because of various control issues, the IGS had still not submitted a solution by December 2014. Zuheir asked the Analysis Coordinators of the different services if they would be willing to submit a solution including all available data through 2014, with a firm deadline of February 28, 2015. After internal discussions involving the IVS Combination Center and the IVS Analysis Centers the IVS agreed to this. Ten IVS Analysis Centers submitted solutions to the IVS Combination Center. The software and the number of ACs using it are, in order of popularity: A) Calc/Solve, five; B) VieVS, two; C) Geosat, one; D) Occam, one, and E) Quasar, one. The IVS Combination Center compared the input from the various ACs and produced a combined solution for use by the IERS Combination Centers (DGFI, IGN, and JPL). In the process of comparing the input from different ACs numerous issues were uncovered,

most of which were subsequently fixed. Two of the submissions had such serious problems that they were not used in the IVS combination solution.

ITRF2014 differs from previous ITRFs in that it includes models for post-seismic deformation (PSD) at sites that had earthquakes. These models were derived by using data from GPS receivers located at these sites. Previously, PSD was handled on an ad hoc basis by different VLBI analysis packages. For example, Calc/Solve estimated splines for sites. Several IVS ACs compared the use of ITRF2014 vs. ITRF2008, and the general consensus was that ITRF2014 was a better a priori model.

In December 2016, the IERS Directing Board requested that the geometric services begin using ITRF2014 in their analysis as soon as possible. I passed this message along to the IVS ACs. In order to have a smooth transition I requested that ACs submit two sets of sinex files: one using ITRF2008 and the other ITRF2014 until a sufficient number of ACs had made the transition. GSFC began doing so in October 2016, and GFZ in January 2017. Several ACs indicated that they would switch over to ITRF2014 in the beginning of 2017.

3 Transition to Multitone Phasecal

In 2013, Arthur Niell (Haystack) suggested that the correlators should switch over to begin using Multitone phasecal. Prior to doing the switchover I thought it would be good to process some sessions using both multi-tone and single-tone phasecal and compare the results. Alessandra Bertarini (Bonn Correlator) agreed to correlate the CONT14 sessions using both methods. David Gordon (Goddard) edited these sessions, and I compared the results of the two data sets. The multi-tone results tended to be better by several criteria: The number of observations successfully correlated was larger. The session fit was slightly lower, indicating that the data within a session was more consistent. The baseline scatter over CONT14 was slightly less, indicating that the data were more consistent across sessions. However, it turned out that there was a difference of 1 cm in the up component of the station position for Zelenchukskaya between the single-tone and multi-tone. Ultimately this was traced to elevation dependence of the S-band phase-cal tones. The physi-

cal cause of this remains uncertain. These results were presented at the 2015 IVS Analysis Workshop held in Ponta Delgada, Portugal. During this workshop, suggestions were made for further investigations to try to isolate the cause, and further work was done over the next year, but the results were not conclusive. This issue was also discussed at a special meeting held at Haystack in September 2016. At the end of this meeting I decided to instruct the correlators to switch to multi-toned phase-cal for all sessions beginning after December 31, 2016. An email message was sent out to the ACs about this, with the caveat that people should be aware that there might be a change in the reference frame.

4 2015 Analysis Workshop in Ponta Delgada

The 2015 IVS Analysis Workshop was held in conjunction with the 2015 EVGA meeting in Ponta Delgada. In this section I will mention a few highlights.

Several groups (GSFC, BKG, and IAA) noticed systematic declination differences between the ICRF2 source positions (which used data into mid-2008), and solutions using data through 2014. GSFC, BKG, and IAA all see similar effects. The origin of this difference is still not understood, but appears to be related to having more data from southern stations, particularly AuScope and Warkworth. At the time of the meeting it was unclear which solution was better. Subsequently it looks like the solution with more data is more accurate. Some evidence for this is that this solution agrees better with X/Ka source positions from Chris Jacobs (JPL).

There was some discussion on how to handle galactic aberration. This is a real but small apparent change in the source position due to the acceleration of the Solar System around the galactic center. Subsequently an IVS Working Group on Galactic Aberration was established with Dan MacMillan (GSFC) as chair. They are to make a recommendation in early 2017.

It was proposed to increase the data rate for the R1s from 256 Mbs to 512 Mbs to improve the precision. This would also mean that twice as much data would need to be transferred. After some discussion it was decided to schedule one R1 a month at the increased data rate. Subsequently this has been increased to two R1s

a month. An outstanding issue is to see if this actually improves the precision.

Thomas Hobiger (Onsala) suggested a software comparison project where different groups submitted their O-Cs for a 'pseudo-session'. This would help ensure consistency of the packages. Several ACs participated in this effort. There were no major discrepancies uncovered.

5 2016 IVS Analysis Workshop

The 2016 Analysis Workshop was held in South Africa in conjunction with the 2016 IVS General Meeting.

Much of the discussion focused on differences between ITRF2008 and ITRF2014. Here is a summary of some of the findings. There is a 5 mm offset in Z between the two coordinate systems. There is also a shift in Ypole of about 0.05 mas. The post-seismic models agree very well with independent VLBI position time series. Using ITRF2014 there is better agreement between estimated polar motion and USNO finals. There is also better agreement with IGS. All of this indicates that ITRF2014 provides a better a priori position model than ITRF2008.

At the conclusion of the Analysis Workshop, I asked different software developers to share their plans for the future. In addition to Calc/Solve (GSFC) (one of the oldest and the most widely used VLBI analysis package) there were several new, and some not so new packages discussed. These include C++ (Chalmers), VieVs (Vienna), Vievs@GFZ (GFZ), Naviance (ESOC), ASCOT (BKG) and GINNS (NMA). It is good to have so many independent analysis systems. I am sure that friendly competition will be a spur for future improvement.

References

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