Paris Observatory (OPAR) Analysis Center

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Abstract We report on the operational and research activities at the Paris Observatory VLBI Analysis Center (OPAR) for 2014. Our achievements include the reanalysis of opa2014a and research related to celestial reference frames.

1 Analysis Service

1.1 Operational Solutions

A reanalysis of the complete 24-hour session database was done (identified as opa2014a), and the resulting EOP series and radio source catalogs were sent to the IVS. This solution estimated EOP and rates as session parameters, most of the station coordinates and the velocities as global parameters, and most of the sources' coordinates as global parameters. Stations undergoing strong nonlinear displacements were estimated as session parameters (TIGOCONC, TSUKUB32, KASHIM11, KASHIM34, VERAMZSW, KOGANEI, and USUDA64). Troposphere and clock parameters were estimated every 20 minutes and 60 minutes, respectively, and gradients were estimated every six hours (at all sites). Axis offsets were estimated as global parameters for a list of 80 stations. We used up-to-date geophysical and astronomical modeling to compute the theoretical delay and partials, including the IAU 2006 nutation and precession, the Vienna mapping functions 1, the FES 2004 ocean loading model, and the antenna thermal deformations as provided by A. Nothnagel (2009, J. Geod., 83, 787). Constraints were applied to the 295 ICRF2 defining sources (no-net rotation) and to 27 stations (no-net rotation and no-net translation of positions and velocities). We used the latest version of the Calc/Solve geodetic VLBI analysis software package.

24-hour sessions were analyzed routinely within 24 hours after version 4 of the observation database file was submitted to the IVS. The operational solution is aligned to the opa2014a global solution. Unconstrained normal equations relevant to EOP, rates, and station and source coordinates were sent to the IVS in SINEX format for combination in the framework of the IVS Analysis Coordinator's task.

An operational solution analyzing Intensive sessions after 2002 was started (opa2014i). The solution opa2014i included Intensive sessions in order to produce UT1 consistent with VTRF 2013D, ICRF2, and the IERS EOP 08 C04 Earth orientation data. To account for the nonlinear displacement of TSUKUB32, we modeled the antenna displacement by a transient decay model fitted to the station coordinate time series (see next section).

All the above products, except SINEX files, were published on the OPAR Web site at

`http://ivsopar.obspm.fr`

together with exhaustive explanations and plots. SINEX files were only sent to the Data Centers.

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1.2 Other Contributions

Station and radio source coordinate time series are updated as new observations arrive. For each source, a page displays the time series and provides links to source information at various external databases (e.g., the French Virtual Observatory software package Aladin that permits a user to get the optical counterpart of the VLBI quasars, or the Bordeaux VLBI Image Database that gives the VLBI structure).

As for past years, the Earth's free core nutation (FCN) is regularly monitored at OPAR: we maintain an FCN model directly fitted to routinely estimated nutation offsets (Figure 1). It is worth noting that the FCN amplitude seems to be approaching a maximum. The follow-up of this variation in the next years will certainly improve our knowledge of the FCN phenomenon.

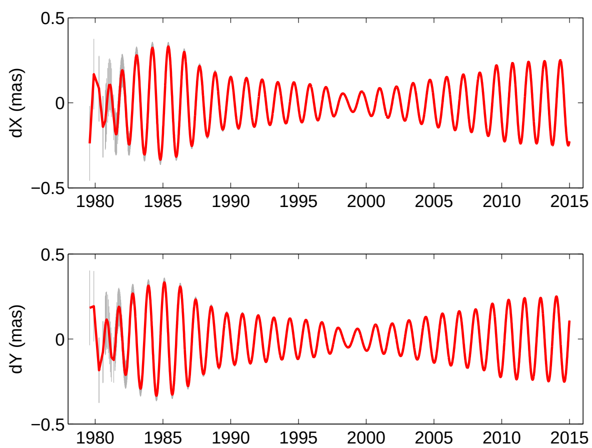

Fig. 1 The amplitude of the free core nutation.

OPAR also contributed to the ITRF 2013 (now ITRF 2014) solution. Late in 2014, the Analysis Center continued to submit SINEX files for sessions up to the end of the year.

2 Research

2.1 VLBI Astrometry and Geodesy

In Lambert (2014, A&A 570, 108), astrometric catalogs obtained by several IVS Analysis Centers and submitted to the IVS in 2012 and 2013 were compared to the ICRF2 in terms of radio source coordinates, global second-degree deformations, and error distribution. All catalogs were found to be consistent with the ICRF2 within 20 μas. But at high observational rates, the formal error is limited to the level of $\sim$10 μas likely by correlated-noise errors. Comparison of differences to ICRF2 against formal errors raised noise floors of the differences between 50 μas and 100 μas, and hence no improvement occurred with respect to the ICRF2. The inconsistencies between catalogs result in differences significantly larger than the accuracy expected for the future ICRF realizations. These inconsistencies have to be clarified in the near future in view of the ICRF3 and accurate linking to reference frames at other frequencies.

In parallel, C. Gattano (PhD student at SYRTE under the supervision of C. Bizouard and S. Lambert) is currently studying the link between precise VLBI astrometry and estimation of nutation, as well as the possibility of increasing the accuracy of both products for benefits in astronomy and geophysics.

2.2 Optical Counterpart

The astrometry team of the SYRTE has also been contributing to improving the Large Quasar Astrometry Catalog (LQAC; Souchay et al. 2009, A&A 494, 799), which contains accurate positions and optical information of more than 300,000 extragalactic objects including geodetic VLBI sources.

F. Taris is the principal investigator of a quasar monitoring program in the optical frequencies (Taris et al. 2013, A&A 552, 98) using large telescopes (e.g., ESO) for monitoring of morphology and small robotic telescopes for measuring magnitude variability. The work aims at a better understanding of the link between radio and optical positions. Targets are both ICRF sources and sources designed for the link with Gaia.

The team will soon release a database gathering radio (VLBI) and optical (LQAC, morphology imaging and magnitude records) information.

More recently, the team also worked on dynamical modeling of AGN core from VLBI observations (Roland et al. 2014, A&A, accepted for publication). This work, devoted to 1926+738, indicates the possible presence of systems of black holes separated by more than 0.1 mas, and even multiple systems separated by more than 1 mas. Such configurations could have strong implications in the radio-to-optical link, depending on whether the various black holes are emitting in optical and/or radio frequencies.