Paris Observatory (OPAR) Analysis Center

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Abstract We report on operational and research activities at the Paris Observatory VLBI Analysis Center (OPAR) for calendar year 2013. Our achievements include the reanalysis of opa2013a and two research topics concerning the time stability of the ICRF2 axes and the more accurate determination of the Solar system acceleration.

1 Analysis Service

1.1 Operational Solutions

A reanalysis of the complete diurnal session database was done (identified as opa2013a), 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 (e.g., TIGOCONC, TSUKUB32) instead of with the spline parameterization used in the previous OPAR solutions. 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 24 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.

Diurnal sessions were analyzed routinely within 24 hours after version 4 of the observation file was submitted to the IVS. The operational solution is aligned to the opa2013a 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 2006, started in 2011, was also continued (opa2011i) together with corresponding SINEX files. The solution opa2011i processed Intensive sessions in order to produce UT1 consistent with VTRF 2008A, ICRF2, and the IERS EOP 08 C 04 Earth orientation data.

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 Products

Station and radio source coordinate time series were updated. 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 sofware 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).

The free core nutation (FCN) is a free oscillation of the Earth's figure axis in space due to the presence of a liquid core rotation inside the viscoelastic mantle. Its period is close to 430 days and is retrograde. Understanding the excitation of the FCN and its amplitude and phase variations is still an open question, although the community generally believes that the key resides in improved atmospheric and oceanic circulation modeling at diurnal and subdiurnal frequencies. At OPAR, we maintain an FCN model directly fitted to routinely estimated nutation offsets (Figure 1). In addition to the FCN, amplitudes and phases of a set of 42 prograde and retrograde tidal waves are also fitted to the data. These tidal terms are interpreted as small deficiencies of the IAU 2000A nutation model and can be used together with the FCN model to build up a better a priori nutation. Research is ongoing to identify some other terms showing up in the residuals at the level of ten microseconds of arc.

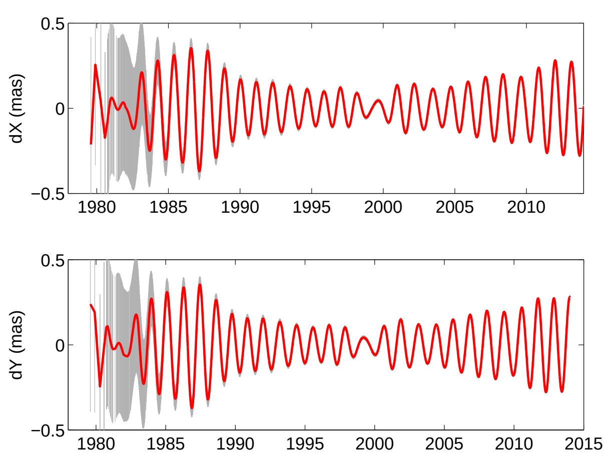

Fig. 1 The amplitude of the free core nutation.

2 Research

2.1 Time Stability of the ICRF2 Axes

In Lambert (2013, A&A 553, 122), one assessed the stability of the ICRF2 295 defining sources and of the ICRF2 axes. This was achieved by deriving coordinate time series of hundreds of quasars monitored by the regular geodetic VLBI program of the IVS. The axis stability was studied by constructing annual reference frames based on the ICRF2 defining sources. The time variable frame stability was obtained by computing the deformation parameters that lead from one frame to the next. The study showed that, although the astrometric stability of some of the ICRF2 defining sources has slightly degraded since 2009.2, the ensemble still constitutes a very stable frame of reference. The estimation of the axis stability over 1979.6–2013.1 remains at the same level as the one estimated in the ICRF work, i.e., on the order of 20 μas for each axis.

2.2 Improved VLBI Measurement of the Solar System Acceleration

In a study by Titov & Lambert (2013, A&A 559, 95), the authors proposed new estimates of the secular aberration drift, which is mainly caused by the rotation of the solar system about the Galactic center, based on up-to-date VLBI observations and improved method of outlier elimination. We fitted degree-2 vector spherical harmonics to the extragalactic radio source proper motion field derived from geodetic VLBI observations during 1979–2013. We paid particular attention to the outlier elimination procedure that removes outliers from (i) radio source coordinate time series and (ii) the proper motion sample. We obtain more accurate values of the Solar system acceleration than in our previous paper (Titov et al. 2011, A&A 529, 91). The acceleration vector is oriented towards the Galactic center within $\sim 7^{\circ}$. The component perpendicular to the Galactic plane is statistically insignificant. We show that an insufficient cleaning of the data set can lead to strong variations in the dipole amplitude and orientation and hence to statistically biased results (see Figure 2).

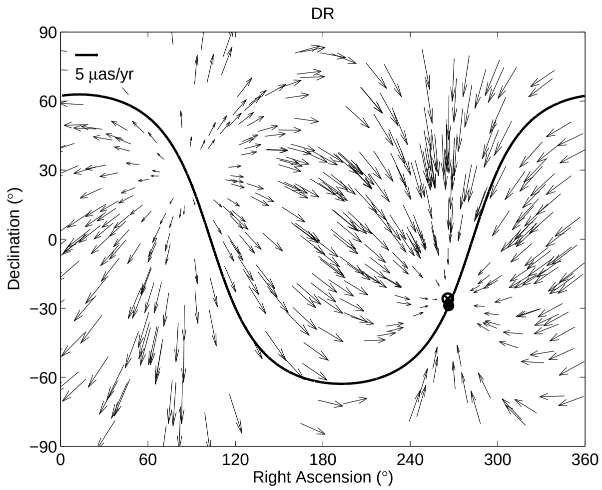

Fig. 2 The dipole pattern in the radiosource apparent proper motion field.