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Impact of Covariance Information on the Orientation Parameters Between Radio Source Position Catalogs

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Abstract

As was shown by Jacobs et al. (2010), accounting for correlations between the source positions derived from VLBI global solutions significantly changes the orientation parameters between compared CRF realizations if a microarcsecond level of accuracy is required. In this study we performed more detailed analysis of this effect. We conducted comparisons of a commonly used rotational alignment model of three parameters with three methods of accounting for the covariance information: using the position errors only, using only RA/DE correlations reported in radio source position catalogs in the IERS format, and using the full covariance matrices. CRF solutions from several IVS Analysis Centers providing the CRF solution in the SINEX format were used for this work. Detailed results of this analysis are reported.

1. Introduction

Catalogues of radio source positions (RSC) derived from Very Long Baseline Interferometry (VLBI) observations have been used by the International Astronomical Union (IAU) to establish the International Celestial Reference Frame (ICRF) since 1998. IVS Analysis Centers provide these catalogs in a standard IERS format, where together with radio source positions and other relevant information, RA/DE correlations are reported. The IERS format includes, in fact, only diagonal covariances, and the off-diagonal correlations, except as mentioned, are not published. Meanwhile, some IVS Analysis Centers produce solutions in SINEX format where a full covariance matrix is presented. However, none of this information (not even only the diagonal covariance information) is used for the RSC alignments. Jacobs et al. (2010) investigated the influence of using a full correlation matrix on the rotation parameters. Their results showed that using a full correlation matrix for the radio source positions changes the orientation parameters significantly at the microarcsecond level of accuracy. In this work we present the results of comparison of the conventional model of mutual rotation between individual catalogs with respect to three alternative methods for implementation of the information about covariances: using the position errors only, using only the RA/DE correlation information which is reported in catalogs submitted in the IERS format, and using the full covariance matrix from the SINEX files.

2. Comparisons

CRF solutions in SINEX format from IGG, TU Vienna, and Institute of Applied Astronomy (IAA) IVS Analysis Centers together with CRF solutions in IERS format of the Paris Observatory (OPA), Federal Agency for Cartography and Geodesy (BKG), and the Space Geodesy Center (CGS) have been used in this work. Results are presented in Tables 1 and 2.

Legend for Tables 1 and 2: 1 – using the position errors only, 2 – using position errors and RA/DE correlations (IERS format), and 3 – using the full covariance matrices from SINEX files. SNX in the first column means a SINEX file has been used, and IERS means that a catalog in IERS format has been used. 'WRMS before' and 'WRMS after' mean WRMS differences before and after rotation by angles A1, A2, and A3. Units: 'μas' for angles and 'mas' for WRMS.

Table 1. Orientation parameters between ICRF2 (IERS format) and catalogs, only ICRF2 defining sources.

		A1	**A2**	**A3**	**WRMS before**	**WRMS after**
IAA2009a	**1**	36.790 ± 32.769	-6.506 ± 33.021	9.627 ± 29.338	0.4822	0.4816
(SNX)	**2**	37.222 ± 32.864	-7.580 ± 33.126	9.883 ± 29.374	0.4839	0.4832
	3	37.222 ± 32.864	-7.579 ± 33.126	9.883 ± 29.374	0.4839	0.4832
IAA2009	**1**	19.106 ± 3.859	-22.992 ± 3.889	5.721 ± 3.417	0.0583	0.0552
(IERS)	**2**	19.222 ± 3.830	-23.224 ± 3.864	5.743 ± 3.385	0.0579	0.0548
IGG2012	**1**	0.183 ± 8.627	-31.813 ± 8.692	25.339 ± 7.696	0.1261	0.1234
(SNX)	**2**	1.104 ± 8.309	-32.150 ± 8.382	25.810 ± 7.403	0.1228	0.1200
	3	1.104 ± 8.309	-32.148 ± 8.382	25.808 ± 7.403	0.1228	0.1200
BKG2010	**1**	-23.980 ± 4.083	-11.868 ± 4.116	13.140 ± 3.602	0.0616	0.0590
(IERS)	**2**	-24.175 ± 3.964	-12.425 ± 4.003	15.442 ± 3.495	0.0600	0.0570
CGS2010a	**1**	-20.130 ± 26.046	-13.012 ± 25.265	8.241 ± 23.429	0.0581	0.0557
(IERS)	**2**	-21.436 ± 26.001	-13.001 ± 25.424	12.360 ± 23.405	0.0582	0.0557
OPA2012a	**1**	4.523 ± 3.505	-10.007 ± 3.534	8.136 ± 3.121	0.5260	0.0518
(IERS)	**2**	4.666 ± 3.444	-10.401 ± 3.475	8.980 ± 3.063	0.0520	0.0512

Table 2. Orientation parameters between IGG SINEX catalog and IAA SINEX catalog calculated using ICRF2 defining sources only.

	A1	**A2**	**A3**	**WRMS before**	**WRMS after**
1	−17.474 ±3.414	−11.787 ±3.662	22.401 ±3.082	0.0544	0.0505
2	−17.537 ±3.384	−11.734 ±3.721	21.875 ±3.089	0.0542	0.0504
3	−31.416 ±16.172	−8.301 ±17.817	10.288 ±14.840	0.0487	0.0486

3. Conclusion

Our analysis revealed significant differences between rotation parameters computed without accounting for correlation information, with using the full covariance matrix, and with RA/DE

correlations, which confirms the results of Jacobs et al. (2010). Unfortunately, we could only work with one modern catalog in SINEX format from IGG, so the results should be treated as preliminary.

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References

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