Impact of covariance information on the orientation parameters between radio source position catalogues

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Abstract. As was shown by Jacobs et al. (2010), accounting for correlations between the source positions derived from VLBI global solution changes significantly 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 commonly used rotational alignment model of 3 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 catalogues in the IERS format, and using the full covariance matrices. CRF solutions from several IVS Analysis Centres providing the CRF solution in the SINEX format are used for this work. Detailed results of this analysis are reported.

Introduction:

Catalogues of radio source positions (RSC) derived form Very Long Baseline Interferometry (VLBI) observations are used by the International Astronomical Union (IAU) to establish the International Celestial Reference Frame (ICRF) since 1998. IVS Analysis Centres provides these catalogues in a standard IERS format, where together with radio-sources positions and other relevant information RA/DE correlations are reported. IERS format includes, in fact, only diagonal covariance, and the off-diagonal correlations, except mentioned, are not published. Meanwhile, some IVS Analysis Centres produce solutions in SINEX format, where the whole covariance matrix is presented. However, this information (even only diagonal covariance) as usual is not accounted for during RSC alignments.

Jacobs et al. (IVS GM 2010) undertook an investigation of an influence of an accounting for a correlation information on rotation parameters. In their work, catalogues with diagonal-only parameter covariance matrix and full covariance matrix were used. The results show that an accounting for correlations between the source positions derived from VLBI global solution changes significantly the orientation parameters between compared CRF realizations if a microarcsecond level of accuracy is required.

In this work we present the results of our comparison of commonly used rotational alignment model with three methods of accounting for the covariance information: using the position errors only, using only RA/DE correlations reported catalogues in the IERS format, and using the full covariance matrices from SINEX files.

Comparisons:

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

Conclusion:

Our analysis revealed significant differences between rotation parameters computed without accounting for correlation information, with using full covariance matrix and with RA/DE correlations , which confirms result of Jacobs et al (2010).

Unfortunately, we could work only with one modern catalogue in SINEX format from IGG, thus results should be treated as preliminary.

Legend for Table 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 a first column means SINEX file has been used, IERS means that catalogue in IERS format has been used. 'WRMS before ' and 'WRMS after' mean WRMS differences before and after rotation by angles A1, A2 and A3. Unit: µas for angles and mas for WRMS.

Table 1. Orientation parameters between ICRF 2 (IERS format) and catalogues, only ICRF2 defining sources.

		A1	A2	A3	WRMS before	WRMS after
Iaa2009a SNX	1	36.790 +/- 32.769	-6.506 +/- 33.021	9.627 +/- 29.338	0.4822	0.4816
	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
Iaa2009a IERS	1	19.106 +/- 3.859	-22.992 +/- 3.889	5.721 +/- 3.417	0.0583	0.0552
	2	19.222 +/- 3.830	-23.224 +/- 3.864	5.743 +/- 3.385	0.0579	0.0548
TUWien SNX	1	0.183 +/- 8.627	-31.813 +/- 8.692	25.339 +/- 7.696	0.1261	0.1234
	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
Iaa2008a SNX	1	1.663 +/- 34.091	-29.927 +/- 34.319	19.854 +/- 30.402	0.4861	0.4855
	2	1.806 +/- 34.480	-30.750 +/- 34.737	21.830 +/- 30.699	0.4890	0.4884
	3	1.807 +/- 34.480	-30.750 +/- 34.737	21.830 +/- 30.699	0.4890	0.4884
Iaa2008a IERS	1	18.012 +/- 3.855	-24.554 +/- 3.885	6.545 +/- 3.415	0.0584	0.0552
	2	18.150 +/- 3.835	-24.622 +/- 3.871	6.569 +/- 3.396	0.0583	0.0550
bkg2010 IERS	1	-23.980 +/- 4.083	-11.868 +/- 4.116	13.140 +/- 3.602	0.0616	0.0590
	2	-24.175 +/- 3.964	-12.425 +/- 4.003	15.442 +/- 3.495	0.0600	0.0570
cgs2010a IERS	1	-20.130 +/- 26.046	-13.012 +/- 25.265	8.241 +/- 23.429	0.0581	0.0557
	2	-21.436 +/- 26.001	-13.001 +/- 25.424	12.360 +/- 23.405	0.0582	0.0557
opa2012al ERS	1	4.523 +/- 3.505	-10.007 +/- 3.534	8.136 +/- 3.121	0.5260	0.0518
	2	4.666 +/- 3.444	-10.401 +/- 3.475	8.980 +/- 3.063	0.0520	0.0512

Table 2. Orientation parameters between IGG SINEX catalogue and IAA SINEX catalogue 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

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