VLBI realisations of the celestial reference frame

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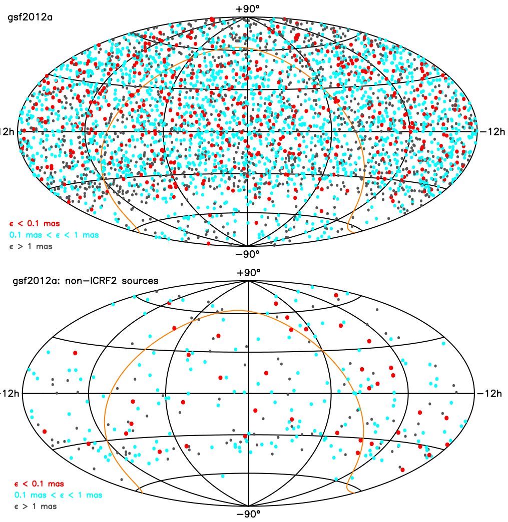
The ICRS Product Center of the IERS is in charge of validating newly submitted astromeric catalogs. This task consists of assessing their accuracy, their consistency with respect to ICRF2, and their internal noise. Four VLBI radio source catalogs were sumbitted in 2012, for which we propose a compared analysis.

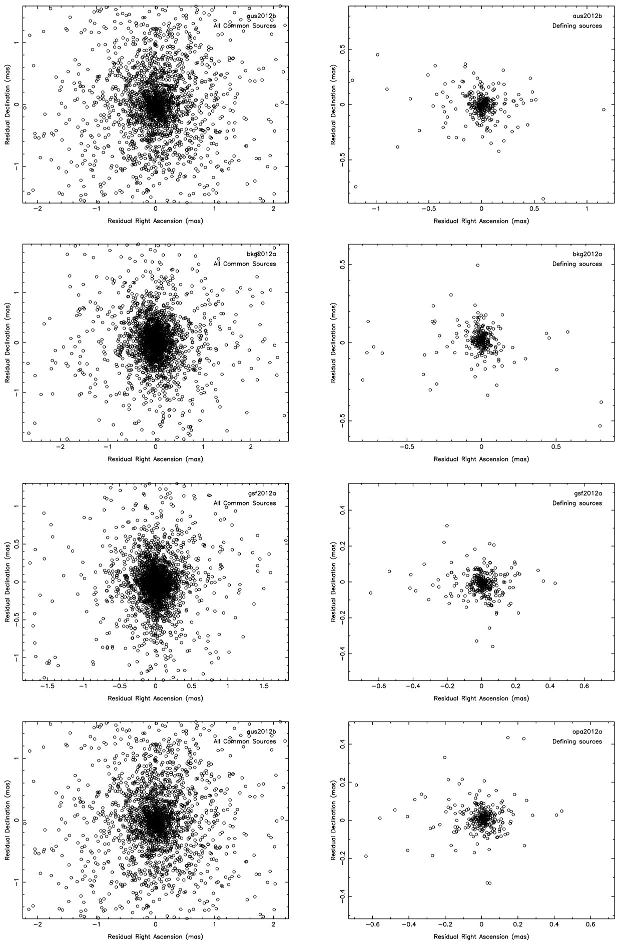
Three of them (bkg2012a, gsf2012a, opa2012a) were computed with Calc/Solve and slightly different analysis configurations. The remaining catalog was built with OCCAM. It appears that (i) only opa2012a gives positions for the full set of defining sources, and (ii) none of them give positions for all the ICRF2 sources. We therefore encourage analysis centers to establish their session list so that all the ICRF2 source coordinates are reestimated.



The catalog gsf2012a (Top) and its non-ICRF2 sources (Bottom).

Statistics of each catalog (in μas).

	No. Sources			Difference to ICRF2			
				Right Ascension		Declination	
	Total	ICRF2	Defining	Mean	WRMS	Mean	WRMS
aus2012b	2895	2879	288	3.1	94.2	−7.2	83.6
bkg2012a	3253	3091	287	0.2	60.5	21.6	65.5
gsf2012a	3708	3407	294	3.5	55.6	−8.3	54.1
opa2012a	3526	3355	295	8.6	51.5	10.2	51.9



Distance to ICRF2 counterparts for all common sources (Left) and common defining sources (Right).

Global deformation

The global deformation between the catalogs and the ICRF2 was modeled by 6 parameters, as recommended by the IERS:

$$\Delta\alpha = A_1 \cos\alpha \sin\delta + A_2 \sin\alpha \sin\delta - A_3 + D_\alpha (\delta - \delta_0)$$
$$\Delta\delta = -A_1 \sin\alpha + A_2 \cos\alpha + D_\delta (\delta - \delta_0) + B_\delta$$

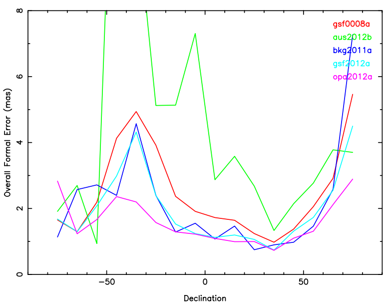
We also propose a modeling including a rotation plus a glide, which is more general than the IERS one:

$$\Delta\alpha = R_1 \cos\alpha \tan\delta + R_2 \sin\alpha \tan\delta - R_3 - (D_1 \sin\alpha - D_2 \cos\alpha) / \cos\delta$$
$$\Delta\delta = -R_1 \sin\alpha + R_2 \cos\alpha - D_1 \cos\alpha \sin\delta - D_2 \sin\alpha \sin\delta + D_3 \cos\delta$$

All catalogs appear to be consistent with ICRF2 within 0.02 mas. The aus2012b solution shows the larger deformation at the level of 0.03 mas (rotation around the X-axis). The larger coefficient in B_δ (or D_3) comes likely from the lack of southern sources.

Deformation parameters of each catalog (in μas).

	A_1	A_2	A_3	D_α	D_δ	B_δ
aus2012b	−23.4	3.6	2.8	0.6	0.4	−13.6
±	*4.9*	*5.0*	*4.7*	*0.2*	*0.1*	*4.7*
bkg2012a	6.7	15.2	0.6	0.1	0.3	17.6
±	*4.6*	*4.7*	*4.3*	*0.2*	*0.1*	*4.4*
gsf2012a	−2.6	6.8	−2.9	0.0	0.3	−13.7
±	*4.5*	*4.6*	*4.2*	*0.2*	*0.1*	*4.3*
opa2012a	−4.1	12.3	−6.7	0.2	0.1	9.7
±	*4.6*	*4.7*	*4.2*	*0.2*	*0.1*	*4.3*
	R_1	R_2	R_3	D_1	D_2	D_3
aus2012b	−27.2	0.1	−2.4	−3.0	5.5	−14.1
±	*5.3*	*5.4*	*4.5*	*5.0*	*5.1*	*5.1*
bkg2012a	9.4	12.6	0.5	−1.9	−6.8	27.5
±	*5.0*	*5.1*	*4.1*	*4.6*	*4.7*	*4.8*
gsf2012a	−1.1	3.0	−2.7	−5.0	−5.2	−14.0
±	*4.8*	*4.9*	*4.0*	*4.5*	*4.6*	*4.7*
opa2012a	−2.4	7.1	−7.6	−10.4	−5.2	11.9
±	*4.9*	*5.0*	*4.1*	*4.5*	*4.6*	*4.7*



Formal error averaged per band of declination.

Internal noise

The determination of the noise of each catalog necessitates inversion methods like the three-cornered hat. This method assumes however non correlated errors. This assumption looks not serious when considering catalogs made with (almost) the same session lists, similar analysis configurations, and the same software package. In writing the three-cornered hat equations, we deselected relations between these catalogs. However, we considered a sixth catalog (iaa2009a) computed with a different code. It appears that most of Calc/Solve solutions are at the noise level of the gsf0008a catalog. However, other software packages produce noisier solutions. We currently investigate a more refined algorithm to take into account rigorously the fact that error are correlated.

Individual noise level of each calalog (in μas).

	$\alpha\cos\delta$	δ
gsf0008a	15	22
iaa2009a	26	45
aus2012b	39	45
bkg2012a	16	29
gsf2012a	16	22
opa2012a	14	24