12 Alignment of ICRF2 onto ICRS and Axis Stability (AMG, EFA, SBL)

12.1 Linking sources

Among the 295 selected defining sources of the ICRF2, only 97 are also defining sources of the ICRF1. Most of them are in the northern hemisphere, making the sample badly distributed for a reliable estimation of rotation angles. To remedy, 41 ICRF2 defining sources (but not defining sources of the ICRF1) preferably taken in the southern hemisphere were added, resulting in 138 common objects for comparison which have been used for the link between the gsf008a catalogue and ICRF1-Ext2. The defining sources, the linking sources and the common to both ICRF1 and ICRF2 are displayed in Figure 40. The status in ICRF1-Ext.2 of the 41 additional sources is: 24 candidate sources, 16 other, and 1 new. Figure 41 displays the distribution of formal errors of the various subsets of sources before inflation, after inflation (see next paragraph), and of the corresponding errors in the ICRF1-Ext.2.

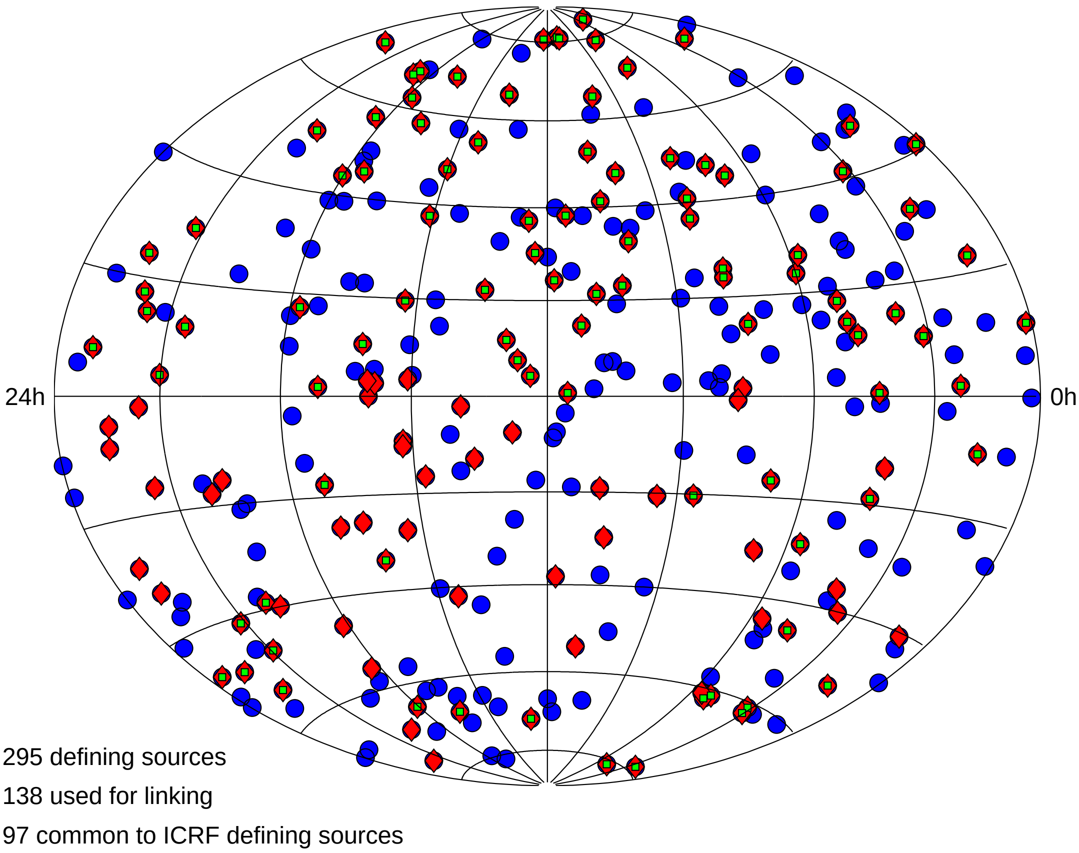

Figure 40: Distribution of the 295 defining sources (blue circles), of the 138 used for linking ICRF2 to ICRF1-Ext.2 (red diamonds). The 97 ICRF2 defining sources that are also defining sources of the ICRF1 are marked with green squares.

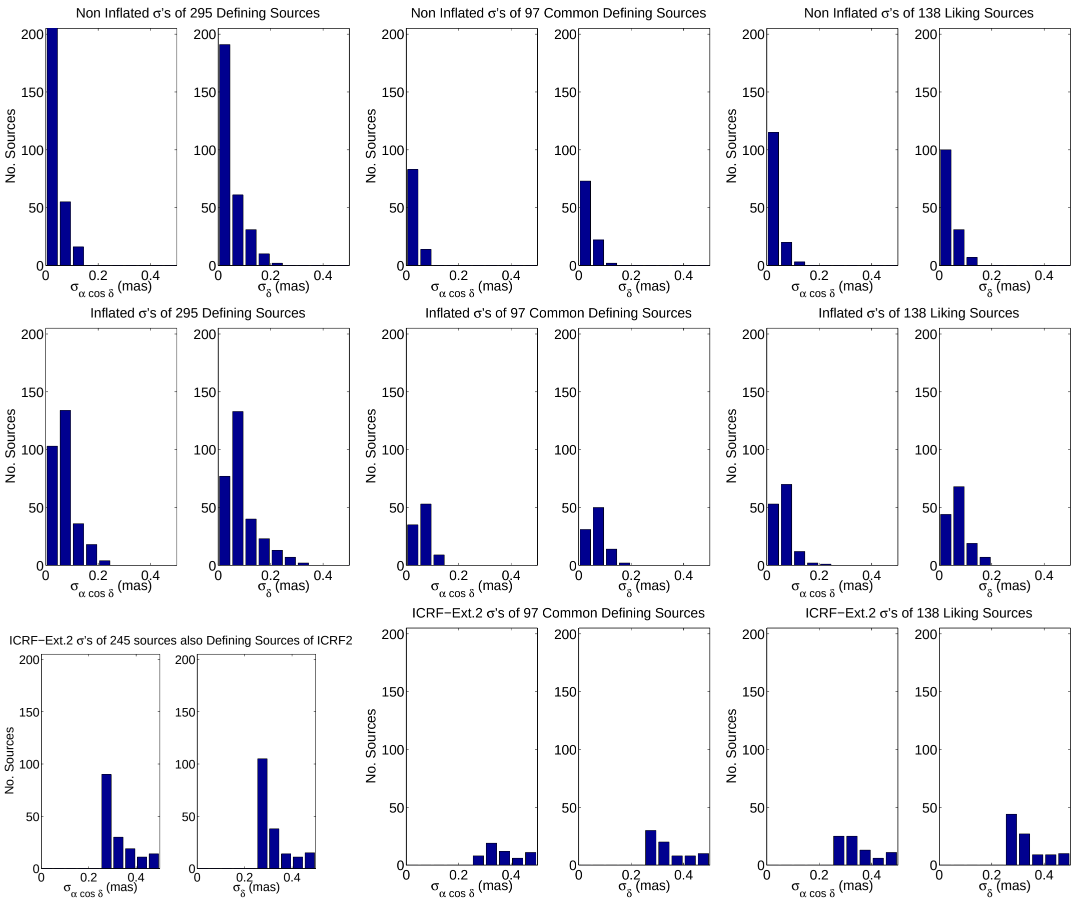

Figure 41: Distribution of formal errors of the defining, common and linking sources before inflation, after inflation, and of the corresponding errors in the ICRF1-Ext.2.

12.2 Rotation

The gsf008a catalogue, wherein the formal errors were inflated following the formula

$$\sigma^2_{\alpha\cos\delta} = (1.5\,\sigma_{\alpha\cos\delta,0})^2 + (0.04\text{ mas})^2 \qquad (10)$$

$$\sigma^2_{\delta} = (1.5\,\sigma_{\delta,0})^2 + (0.04\text{ mas})^2 \qquad (11)$$

was compared to the ICRF1-Ext.2 using a 4-parameter transformation in which the coordinate difference is modeled by three rotations of angles A_1, A_2 and A_3, around the X, Y and Z axes of the celestial frame, respectively, and a parameter dz accounting for a global translation of the source coordinates in declination (see, e.g., IERS [1996] or Feissel-Vernier et al. [2006]):

$$\Delta\alpha = A_1 \tan\delta\cos\alpha + A_2\tan\delta\sin\alpha - A_3 \qquad (12)$$

$$\Delta\delta = -A_1\sin\alpha + A_2\cos\alpha + dz \qquad (13)$$

The additional two deformation parameters used in the transformation formula for the alignment of the first realization of the ICRF1 [Ma et al., 1998] were found negligible and are not estimated here. Values of parameters are reported in Table 16.

Improvements in the models and procedures applied in the gsf008a catalogue solution resulted in a frame less corrupted by deformations than

Table 16: Relative orientation and deformation parameter to transform ICRF2 into ICRF1-Ext.2. A_1, A_2, A_3 are the small rotation angles between axes of the frames; dz (formerly B_δ) is the bias in declination. All these parameters have been adjusted on the basis of the 138 defining sources in ICRF2 used for the link to ICRF1-Ext.2. r_α and r_δ are the wrms residuals in $\alpha \cos \delta$ and δ, respectively. Unit is μas.

A_1	A_2	A_3	dz	r_α	r_δ
23.3	−33.5	7.8	11.2	9.2	12.4
±19.2	±19.5	±18.4	±16.6		

ICRF1-Ext.2, but with a slight mis-orientation. In the procedure applied to rotate the gsf008a catalogue positions into the ICRS, care was taken not to transfer the deformations of ICRF1-Ext.2 to ICRF2. Consequently the radio source coordinates of the gsf008a catalogue were rotated onto the ICRS using only the three rotation angles A_1, A_2, and A_3. The rotated gsf008a catalogue constitutes the ICRF2.

12.3 Axis stability

The stability of the system axes was tested by estimating the relative orientation between ICRF2 and ICRF1-Ext.2 on the basis of various subsets of sources (see Table 17). The scatter of the rotation parameters obtained in the different comparisons indicate that the axes are stable to within 10 μas.

Table 17: Axis stability tests: transformation parameters between ICRF2 and ICRF1-Ext.2 for various subsets of defining sources. Unit is μas.

	No. sources	A_1	±	A_2	±	A_3	±	dz	±	r_α	r_δ
ICRF2 sources common to ICRF1-Ext.2											
All	710	18.2	9.1	−5.6	8.5	8.2	8.3	15.2	8.1	4.52	5.87
North	435	26.7	9.0	−6.2	8.5	5.9	8.8	21.1	8.8	5.18	5.03
South	275	−11.5	23.4	−2.9	21.0	10.9	17.7	1.2	18.2	8.91	13.18
Used for NNR	207	1.0	20.0	4.5	19.7	−14.1	21.0	−2.7	17.5	9.71	13.44
ICRF2 defining sources											
Common to ICRF-Ext.2	245	5.2	11.0	−5.1	10.5	14.0	10.4	22.0	10.0	5.32	7.43
Used for linking	138	−0.0	19.2	0.0	19.5	0.0	18.4	11.1	16.6	9.20	12.44
North	148	17.0	10.7	−1.2	10.4	12.7	10.7	26.1	10.2	6.07	7.51
South	97	−35.4	28.0	−18.6	24.8	11.2	22.3	19.9	22.3	10.46	16.51
Decimation rate = 2	128	−1.9	14.9	15.3	15.7	17.9	14.5	20.1	13.9	7.07	10.66
Decimation rate = 3	166	4.5	11.3	−19.3	10.5	20.2	11.1	13.6	10.5	5.62	7.62
Overall wrms		12.4		7.9		6.8		7.0			