Works on comparison and combination of radio source position catalogs in Pulkovo Observatory

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Motivation

1. Most accurate CRF realizations in classical astronomy (Fundamental catalogs) are obtained though combination of individual catalogs.

2. Investigation and accounting for the systematic differences between the individual catalogs is a necessary step in combination.

3. Systematic differences between the catalogs cannot be described with sufficient accuracy by using the simple rotation or IERS model, even extended (Lambert and Arias, Bolotin); more rigorous methods should be used.

Analytical representation of systematic differences

Representation by orthogonal functions (Brosche's method):

$$\begin{Bmatrix} \Delta\alpha \\ \Delta\delta \end{Bmatrix} = \sum_{j=0}^{g} b_j Y_j(\alpha,\delta) + \varepsilon$$

$$Y_j = K_i(\alpha,\delta) = \begin{cases} P_{n0}(\delta), & k=0, l\neq 1 \\ P_{nk}(\delta)\sin(k\alpha), & k\neq 1, l=0 \\ P_{nk}(\delta)\sin(k\alpha), & k\neq 1, l=0 \end{cases}$$

where P_{n0} and P_{nk} are Legendre polynomials.

Coefficients b_j are computed by LS for each catalog minus ICRFn. Set of these coefficients for given input catalog can be called as the "system" of this catalog w.r.t. ICRFn.

Two-step procedure

1. Stochastic improvement of ICRFn

a) The systematic differences between the input catalogues and the ICRF found by the LF method are applied to the input catalogues to transform them to the ICRF system.

b) The coordinates of all the sources in the transformed catalogues are averaged with weights depending on the formal errors of coordinates. Based on this, the combined catalogue C01 is constructed, which can be considered as a stochastic improvement of ICRFn.

2. Systematic improvement of ICRFn

a) Individual systems are averaged with weights (0.35 to 1 in the latest combined catalog).

b) The average system is used to compute the corrections to the source positions in C01 catalog to obtain the final catalog C02.

Catalogs used

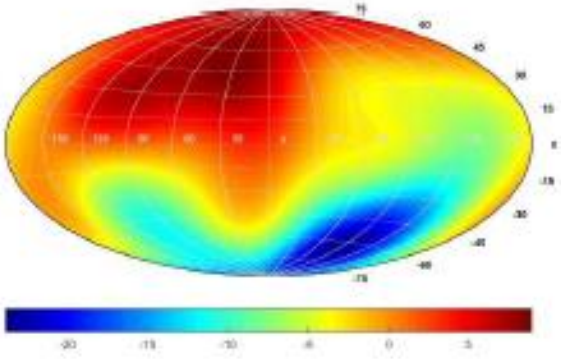
1. The latest versions of the catalogs available online at the IVS data center or institutional websites:

AUS, BKG, GSF, USN (, OPA)

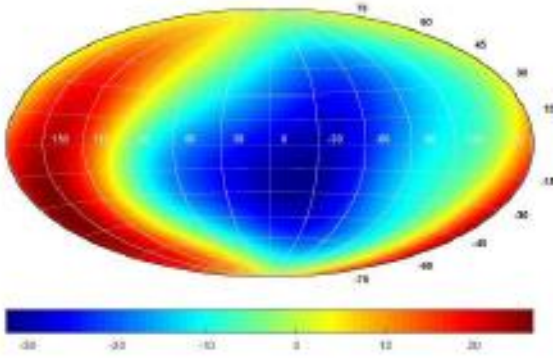
2. Catalogs provided by the authors:

GFZ, IAA, IGG/VIE

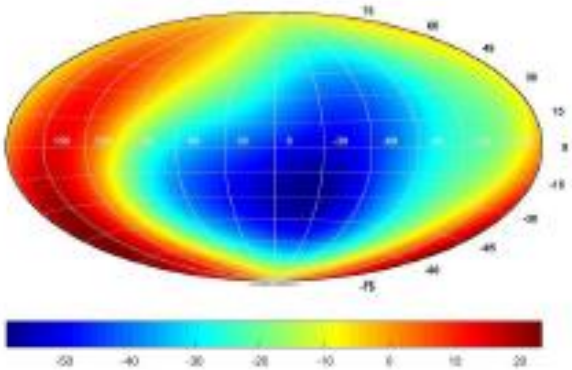
Systematic differences with ICRF2, Δα cos δ



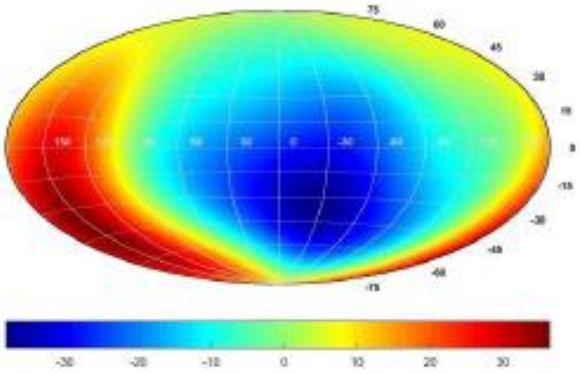
AUS/Occam
-20 ... +5 μas



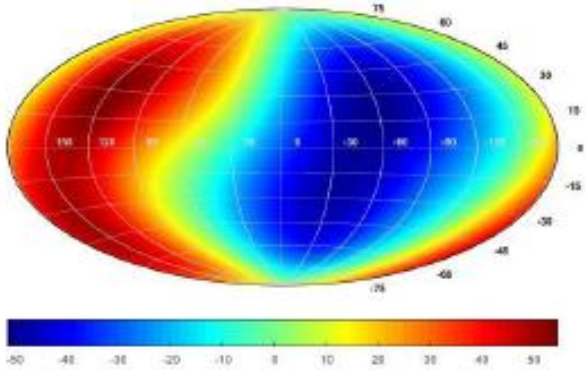
BKG/Solve
-30 ... +20 μas



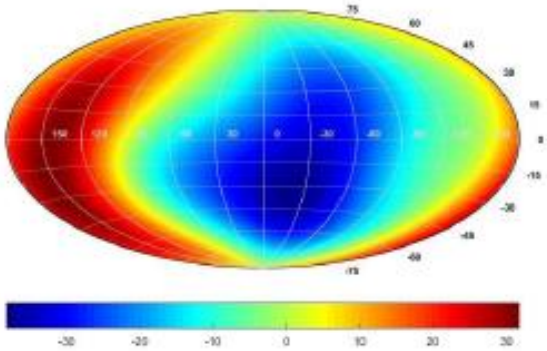
IGG/VieVS
-50 ... +20 μas



GSF/Solve
-30 ... +20 μas

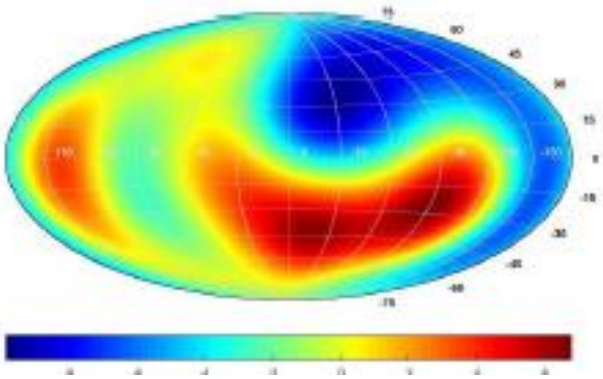


IAA/Quasar
-50 ... +50 μas

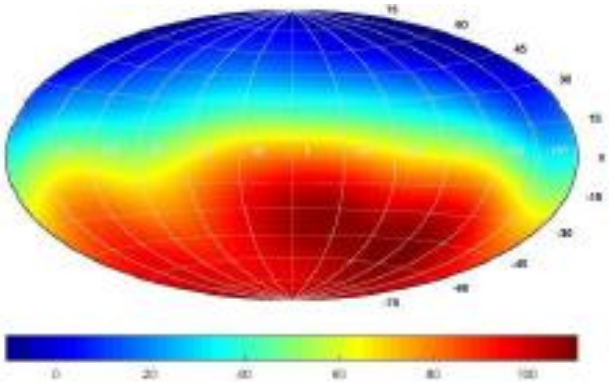


USN/Solve
-30 ... +30 μas

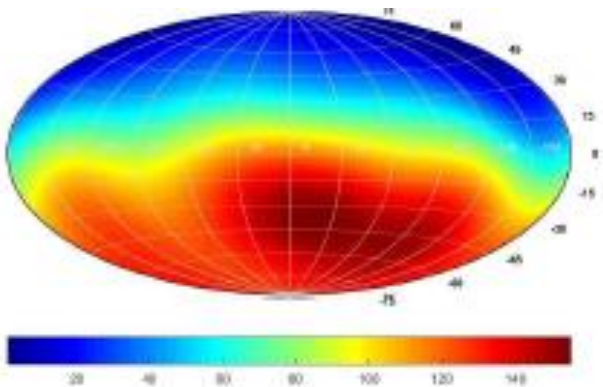
Systematic differences with ICRF2, Δδ



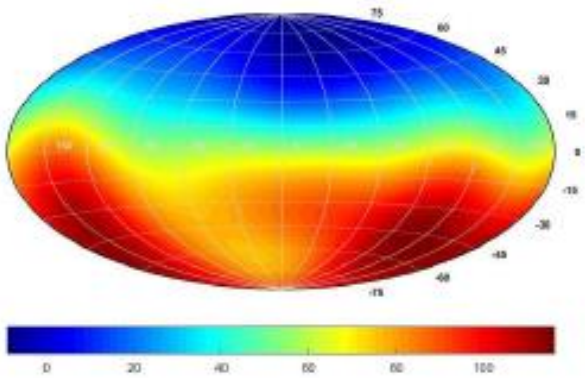
AUS/Occam
-8 ... +6 μas



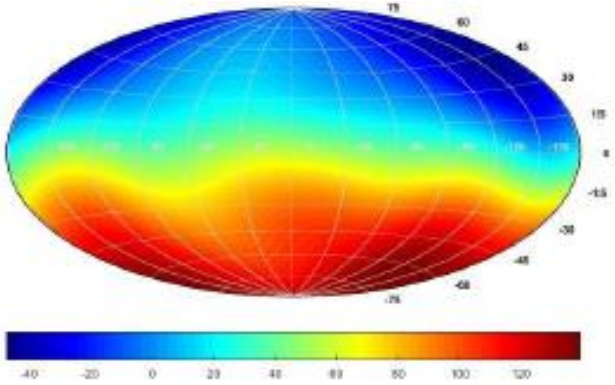
BKG/Solve
0 ... +100 μas



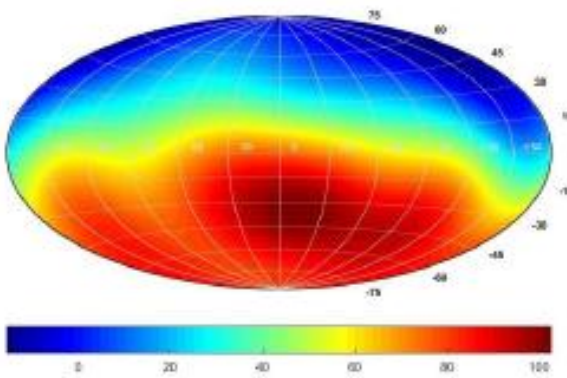
IGG/VieVS
20 ... +140 μas



GSF/Solve
0 ... +100 μas



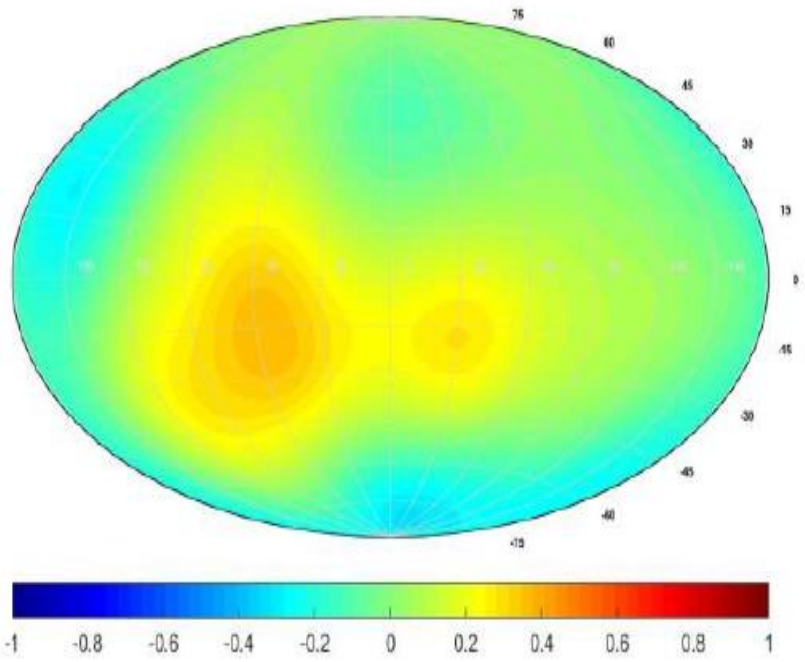
IAA/Quasar
-40 ... +120 μas



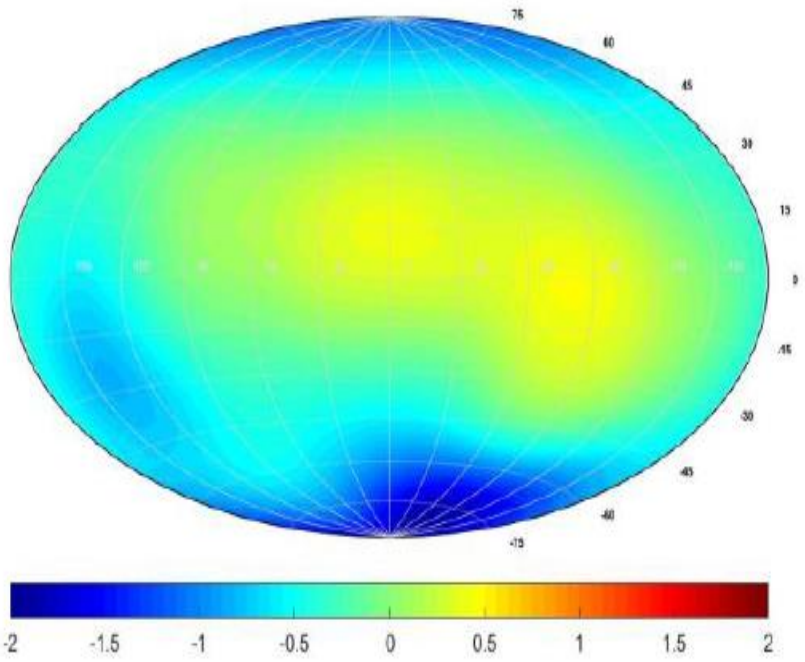
USN/Solve
0 ... +100 μas

ICRF2 minus combined catalog PulC01

Δα cos δ
-1 ... +1 μas

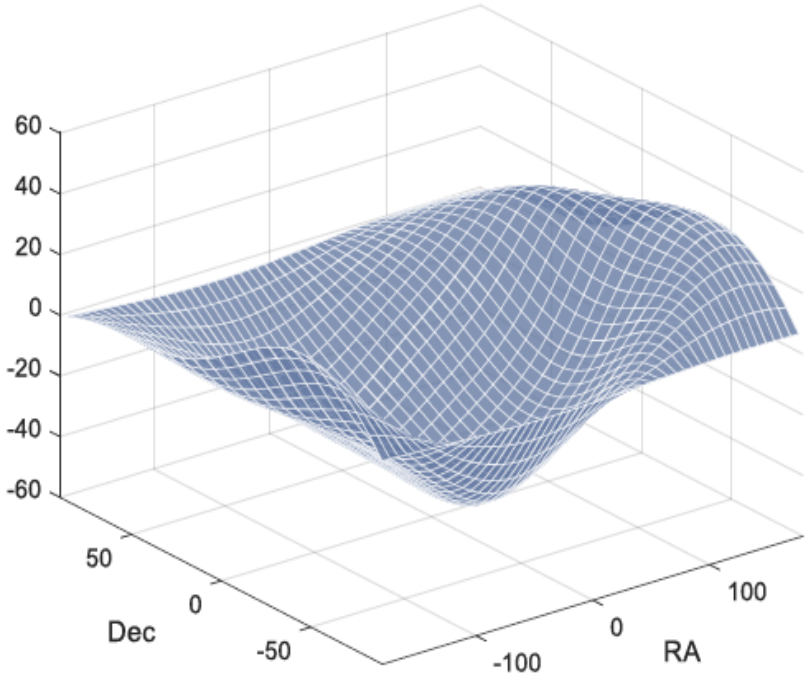


Δδ
-2 ... +2 μas

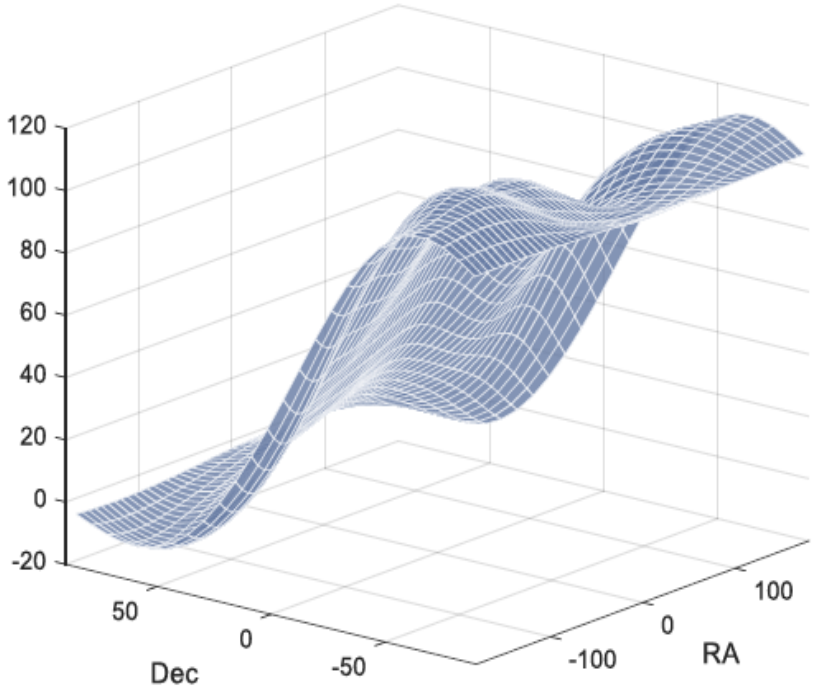


ICRF2 minus combined catalog PulC02

Δα cos δ
-50 ... +30 μas



Δδ
-20 ... +120 μas



Summary

A method to compute CRF-only combined catalogs based on modified classical astrometric approach is realized and tested in the Pulkovo Observatory. Further developments are underway.

CRF-only combined catalogs can have advantage over combined CRF-TRF-EOP solution because of accounting for full systematics. Therefore, comparison of CRF-only and CRF-TRF-EOP combinations would be a useful step in assessment of the systematic errors of ICRF.

Impact of correlations among source positions in the input catalogs is substantial if the full covariance matrix is used, and it is weak if only RA/DE correlations are available. Therefore, publication of catalogs in SINEX is preferable.

Publications

Sokolova Ju., Malkin Z. On comparison and combination of catalogues of radio source positions. Astron. Astrophys., 2007, v. 474, No. 2, pp. 665-670.

Sokolova Yu.R., Malkin Z.M. Pulkovo Combined Catalogue of Radio Source Positions PUL 2013. Astron. Lett., 2014, v. 40, No. 5, pp. 268-277. (Erratum: Astron. Lett., 2014, Vol. 40, No. 12, p. 829)

Sokolova Y., Malkin Z. On the Impact of Correlation Information on the Orientation Parameters Between Celestial Reference Frame Realizations. In: IAG 150 Years, C. Rizos, P. Willis (eds.), IAG Symposia, 2016, v. 143, pp. 41-44.

and several publications in conference proceedings available at *http://zmalkin.com*

Thank you for your attention!