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Interpretation of VLBI Results in Geodesy, Astrometry and Geophysics

Comparison and Combination of CRF Catalogs

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Abstract. In 2007, a joint IERS/IVS Working Group has been established to consider practical issues of creating the next generation ICRF, ICRF-2. The goal of the WG is to seek after ways to improve the existing ICRF. In this study we investigate a possibility of ICRF improvement by means of using a combined ICRF catalog instead of a catalog computed at a single analysis center, even though using most advanced models and software. In this work, we present a new version of the Pulkovo combined catalog of radio source positions computed using the method proposed in [5]. Radio source catalogs that were submitted in 2007 in the framework of the WG activity were used as input for mutual comparison and combination. Four combined catalogs have been calculated: the first two provide a stochastic improvement of the ICRF, and the other two allow us to account also for systematic errors in the current ICRF version.

1. Introduction

The celestial reference frame (CRF), as realized by a set of coordinates for selected celestial objects, is widely used for numerous astronomy, navigation, time and other measurements. The CRF accuracy and stability are all-important for successful solutions of all these tasks. After publishing the first VLBI radio source catalog (RSCs), attempts were made to improve the accuracy of radio-band CRF by means of constructing combined catalogs, as it was customary in optical astronomy, where fundamental catalogs served as an international standard for astrometry and other measurements on the sky. Different methods were used to obtain a combined RSC, e.g. [1, 2, 3, 4] Also, up to 1995, the IERS (International Earth Rotation Service, now International Earth Rotation and Reference Systems Service) used derived combined RSC for the maintenance of the IERS Celestial Reference Frame. In 2007, a joint IERS/IVS Working Group has been established to consider practical issues of creating the next generation ICRF, dubbed ICRF-2. The goal of the WG is to seek after ways to improve the existing ICRF. Large experience accrued by optical astrometry over centuries shows that combining catalogs of star positions

leads to better random and systematic accuracy than individual catalogs. In this work, we present a new version of the Pulkovo combined catalog of radio source positions computed using the method proposed in [5]. Radio source catalogs that were submitted in 2007 in the framework of the WG activity were used as input for mutual comparison and combination. Four combined catalogs have been calculated.

1. The first two catalogs (the first has been calculated using all input catalogs, while the second one used only catalogs obtained with the CALC/SOLVE software) provide a stochastic improvement of the ICRF.
2. The other two catalogs allow us to account also for systematic errors in the current ICRF version.

All computations have been done for the set of 194 ICRF defining sources included in all input catalogs.

2. Input Catalogs and Comparisons

Table 1. Information about input catalogs

IVS Centre	Soft	Time span (mon/yr)	# of delays	# of sources
AUS, Australia	OCCAM	11/1979 - 04/2007	2647809	1515 (212 def)
BKG, Germany	Calc/Solve	01/1984 - 10/2007	5156489	1076 (212 def)
DGFI, Germany	OCCAM	01/1980 - 01/2005	3650771	686 (199 def)
CGS, Italy	Calc/Solve	08/1979 - 07/2006	4640972	625 (161 def)
USNO, USA	Calc/Solve	08/1979 - 05/2007	5238056	923 (212 def)
GSFC, USA	Calc/Solve	08/1979 - 03/2007	5510462	923 (212 def)
MAO, Ukraine	SteelBreeze	04/1980 - 05/2007	5194922	2541 (26 def)
IAA, Russia	QUASAR	08/1979 - 05/2007	5116010	907 (212 def)

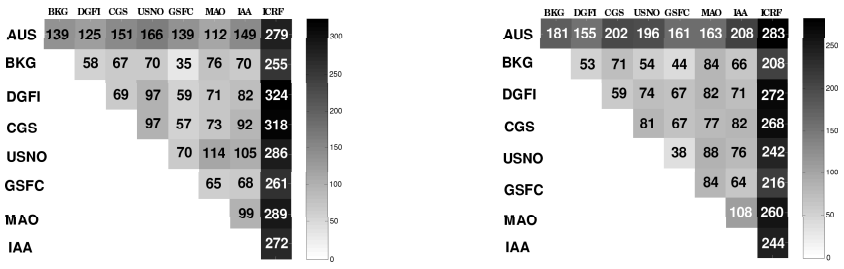

Figure 1. WRMS of the intercomparison of the source coordinates by $\Delta\alpha$ (left) and by $\Delta\delta$ (right) for 194 common sources. Unit: microarcseconds

Weighted root-mean-square (WRMS) differences of the radio source coordinates between the input catalogs and ICRF are shown in Fig. 1. One can see

from Fig. 1 that WRMS differences have the smallest values for catalogs computed with the Calc/Solve software, both in intercomparisons of these catalogs and in comparison with the ICRF. The latter is most probably caused by the fact that the ICRF was constructed using the Calc/Solve software. Moreover, it can be clearly seen that all the input catalogs demonstrate rather large differences with the ICRF, which may indicate significant systematic errors in the latter.

3. Combined Catalogs

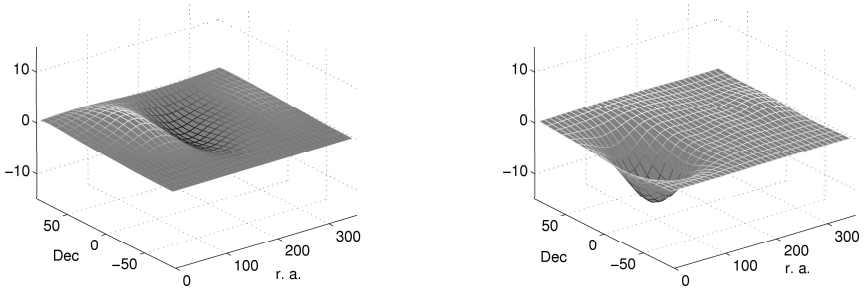

Figure 2. PUL08C01a – ICRF, by $\Delta\alpha$ (left) and by $\Delta\delta$ (right), Unit: mas

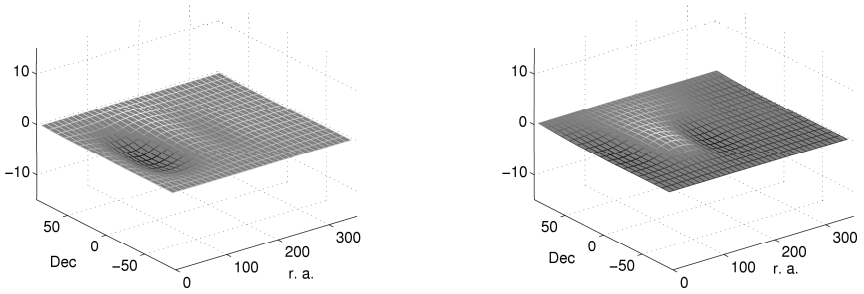

Figure 3. PUL08C01b – ICRF, by $\Delta\alpha$ (left) and by $\Delta\delta$ (right), Unit: mas

The systematic differences between the input catalogs and the ICRF found by LF method were applied to all the input catalogs in order to transform them into the ICRF system. After that, the coordinates of all sources in the transformed catalogs were averaged with weights depending on the formal errors of the coordinates. As a result, the combined catalog PUL08C01a and PUL08C01b (only input catalogs constructed using CALC/SOLVE were used) were constructed.

Fig. 2 shows the systematic differences between the combined catalog PUL08C01a and the ICRF. One can see that the catalog PUL08C01a rep-

resents the ICRF system at a level of about 10 μas.

Fig. 3 shows the systematic differences between the combined catalog PUL08C01b and the ICRF. The catalog PUL08C01b represents the ICRF system at a level of about 5 μas.

4. Short Summary

Four combined radio source catalogs have been constructed. The first two of them, PUL08C01a and PUL08C01b, can be considered as stochastic improvement of the current realization of ICRF. The final combined catalogs PUL08C02a and PUL08C02b provide both stochastic and systematic improvements of the ICRF.

References

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