

Selection of stable sources from VLBI observations from 1984 to 2006†

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Abstract. Based on the Calc/Solve system and aiming at the selection of stable sources, we have obtained a series of global solutions to astrometric/geodetic VLBI observations from 1984 to 2006 by changing the settings of the control parameters. After comparing the solutions and performing statistical analysis we proposed a list of 173 candidate stable sources. We also compared the list with those recommended by others authors.

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1. Introduction

The International Celestial Reference Frame (ICRF) (Ma *et al.* 1998) contains three categories of sources: defining, candidate and others. The latest version of ICRF is ICRF-ext2 (Fey *et al.* 2004), including 717 sources among which 212 are defining. The defining sources are used for the definition of ICRF and are the most important. They should be selected to be relatively stable and compact with comprehensive consideration of various kind of information. There are three representative schemes, namely, Ma *et al.*(1998), Fey & Charlot(1997) and Feissel (2003). The three resulting lists of stable sources are quite different from each other. In this report we will further discuss the selection of stable sources.

2. Our selection scheme

We prepared a working list of sources using the Calc/Solve system based on a global solution of VLBI data acquired from 1984 to 2006, with all ICRF-ext2 sources serving as the global parameters and the rest – as arc parameters. In the solution, all sources with coordinate uncertainties larger than 1mas and/or the coordinate correlation coefficient larger than 0.3 are removed. The 826 remaining objects form a working list of stable sources.

The working list is sorted by declination and then is divided into six groups. Mathematically, the i^{th} source belongs to group j where $j = \text{mod}(i/6)$, and if $j = 0$ then set $j = 6$. By doing so the six groups have a similar sky coverage. Take each of the six groups in turn as arc parameters and all the others as global parameters to obtain the global solution of the VLBI data. In each of the six solutions, the frame orientation is constrained to ICRF while different solutions may still have their own orientations that are slightly different from each other. We unify the orientations of all six solutions by

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Table 1. Criteria of source index.

Index	1	2	3	4
LV	$\leq 50\mu\text{as}/\text{yr}$	$(50\mu\text{as}/\text{yr}, 60\mu\text{as}/\text{yr}]$	$(60\mu\text{as}/\text{yr}, 80\mu\text{as}/\text{yr}]$	$> 80\mu\text{as}/\text{yr}$
WRMS	$\leq 150\mu\text{as}/\text{yr}$	$(150\mu\text{as}/\text{yr}, 300\mu\text{as}/\text{yr}]$	$(300\mu\text{as}/\text{yr}, 450\mu\text{as}/\text{yr}]$	$> 450\mu\text{as}/\text{yr}$
ASV	$\leq 150\mu\text{as}/\text{yr}$	$(150\mu\text{as}/\text{yr}, 300\mu\text{as}/\text{yr}]$	$(300\mu\text{as}/\text{yr}, 450\mu\text{as}/\text{yr}]$	$> 450\mu\text{as}/\text{yr}$

performing small angle rotations in order to let all the arc parameters of the six solutions be referred to a unique system.

The working list is then further cleaned up with the following criteria: (1) The arc positions of sources are rejected if the uncertainties of their coordinates are larger than 1mas; (2) A source is deleted if the standard deviation of the mean of its arc positions is larger than 0.5mas; (3) A source is removed if the observations were made in less than 20 sessions and/or the epoch coverage is less than 2 years.

The above exercise produced 344 sources out of the 826 available ones, among which 116, 108, 76 and 16 are respectively the ICRF defining, candidate, other, and new sources. With the selected 344 well observed sources, we calculate their yearly mean of right ascension and declination and then compose a time series of coordinates for each source.

The source index is classified as shown in Table 1 by referring to the following quantities:

(1) **Linear velocity (LV):** the yearly average velocity of source coordinates derived by least-squares (LS) estimate.

(2) **Weighted root mean square (WRMS):** $WRMS = \sqrt{\sum_{i=1}^N (\frac{x_i - \bar{x}}{\sigma_i})^2 / \sum_{i=1}^N \frac{1}{\sigma_i^2}}$

(3) **Allan standard variance (ASV):** $\sigma_A^2(\tau) = \frac{1}{2N} \sum_{i=1}^N (x_{i+1} - x_i)^2$

Sources with index 1 or 2 are considered to be stable but 3 or 4 as unstable. We rejected the sources with index 4. Due to the page limit we omit detailed information about these sources. Among the above 316 sources, 235, 259 and 225 have indices of 1 or 2 for the LV, WRMS and ASV criteria respectively. Furthermore, 173 sources have indices of 1 or 2 under all the three criteria and we consider them as stable. Comparison shows that among our list of stable sources there are respectively 64, 60, 41 and 8 ICRF defining, candidate, other and new sources. While in Feissel's list the stable, unstable and new sources are 119, 25 and 29 respectively, but in Fey & Charlot's list, there are 111, 32 and 30 such sources.

Some sources could be apparently stable within relative short time spans, but with accumulation of new data they may exhibit instability. Noting that the data we analyzed cover more than 20 years, refinement of the list of stable sources is a long term pursuit.

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