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Effect of Reference Radio Source Instabilities on the TRF Solution

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Abstract

The goal of this paper is to evaluate the effect of reference radio source instabilities on daily estimates of station positions and, finally, on VLBI site coordinate estimates. It was shown that geodetic positions of Southern Hemisphere VLBI sites are more strongly due to the scarcity of the reference radio source positions.

1. Introduction

The radio source positions for the ICRF are obtained with VLBI technique and referred to a fixed time epoch J2000. The first catalogue consisted of 608 objects, 212 of them were 'defining' sources forming the core of the ICRF [1]. In addition 294 'candidate' sources having fewer observations and, finally, 102 'other' sources were added to densify the ICRF.

Many radio sources, presumably considered pointlike, show an extended structure [2]. The structure instability causes temporal variations of the radio source astrometric position. Gontier et al. [3] noted a variability of the differential rotation angles from year to year of several hundred sources over 1987-1999, mostly before 1990. Feissel-Vernier [4] developed a detailed scheme for the selection of stable radio sources using time series of the position estimates during 1979-2002 produced by the US Naval Observatory. The yearly values from 1990.0 to 2002.0 of the right ascension and declination averaged from their original daily positions were analysed to derive several statistical parameters for 362 preselected radio sources. Finally, 199 radio sources were recommended for further improvement of the ICRF, as being 'stable'. It was found that the new selection scheme improved the stability of the ICRF [5] in comparison with the 'defining' ICRF radio source list.

Unfortunately, there are only 77 common objects in the lists of 212 'defining' and 199 'stable' radio sources. Therefore, the daily station position estimates differ, depending on the reference radio source list that is used.

2. VLBI Data Analysis and Geodetic Results

The geodetic time-series were obtained from two global VLBI solutions from about 3 million group delays between 1979 and 2005. All data were processed using the OCCAM software [6] with the least squares collocation method [7]. The strategy and observational data set of both solutions differ only by the list of radio sources treated as global parameters. The first solution (designated as aus2005b1) uses the 207 ICRF-Ext.2 objects [8] as global radio sources with the NNR-constraints, whereas the second solution (aus2005b2) uses the list of 199 'stable' radio sources [4]. 107 radio sources (102 'other' and 5 'defining') are treated as 'arc' parameters for the aus2005b1 solution, and 163 'unstable' radio sources for the aus2005b2. All other radio sources were considered as global parameters without the NNR-constraints.

Both solutions were done in two steps. The first step the positions of the radio sources, treated as global parameters, were only estimated. The second step all 'arc' parameters (including daily estimates of the VLBI site coordinates) were estimated with respect to the reference radio source positions, improved in the previous step.

From daily coordinates of all the VLBI sites we estimate the initial position (for epoch 1997.0) and linear drift of each site. Then, the time-series of differences between the aus2005b1 and aus2005b2 solutions for each component were generated. The mean offset and weighted RMS statistic were used to evaluate the ICRF uncertainty effect on the resulting geodetic parameters.

There is no evidence of a geodetic position bias due to radio source instabilities for VLBI sites in the Northern Hemisphere at the level larger than 3 mm.

However, in the Southern Hemisphere the mean offset of geodetic positions for VLBI sites can be larger. For example, Hobart has a statistically significant offset (10.6 +/- 1.4 mm) in its vertical component.

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