The 5^{th} IVS General Meeting Proceedings, 2008, p. 261–264

Interpretation of VLBI Results in Geodesy, Astrometry and Geophysics

On Selection of "Defining" Sources for ICRF-2

David Gordon [1], *Chopo Ma* [2], *John Gipson* [1], *Leonid Petrov* [1], *Daniel MacMillan* [1]

[1)] *NVI, Inc./NASA Goddard Space Flight Center, USA*

[2)] *NASA Goddard Space Flight Center, USA*

Abstract. Generation of the second realization of the ICRF catalog is scheduled for the end of this year. Selection of a subset of so-called "defining" sources with very stable measured positions is necessary in the next few months. Towards this goal, 8 institutions generated source position time series files using thousands of VLBI databases. Using these time series files, we investigated whether there are enough stable sources distributed evenly about the sky to adequately define the frame of the ICRF-2. Using data from the GSFC time series file, we were able to select 300 stable sources distributed evenly in declination, and fairly evenly in right ascension. It is necessary to use the one-baseline southern hemisphere CRF sessions conducted over the past few years by USNO in order to accomplish this.

1. Introduction

The second realization of the International Celestial Reference Frame, ICRF-2, is scheduled to be generated at the end of 2008 and presented to the IAU for approval in 2009. Therefore, selection of a set of "defining" sources must be made soon. The first ICRF used 212 "defining" sources. These were sources whose positions were initially solved for, and then held fixed to these "defined" positions. They provided a rigid framework which essentially defined the ICRF-1 reference frame. However, some problems became apparent in the realization of this rigid framework. The southern hemisphere was very under-represented in the list of 212 defining sources, and many of the far-south defining sources were only sparsely observed. Also, quite a few of the original defining sources have turned out to be unstable; their effective positions have varied by tenths of milli-arc-seconds or more due to structure brightness variations. A goal for the second realization of the ICRF should be to avoid these two deficiencies. What is needed is a set of defining sources distributed more evenly around the sky, and with long histories of stable positions.

2. Time Series Solutions

In order to study the positional stability of the VLBI geodetic sources, the analysis centers participating in ICRF-2 development were asked to generate time series files. These were to be large files of each source's position in each session. Eight analysis centers generated such files and submitted them to a designated FTP site. The 8 analysis centers and the software systems were:

gsf	NASA/GSFC	Calc/Solve,
usn	USNO	Calc/Solve,
bkg	BKG	Calc/Solve,
opa	Paris Observatory	Calc/Solve,
dgf	DGFI	Occam,
aus	Geoscience Australia	Occam,
iaa	Inst. Applied Astronomy	Quasar,
mao	Main Astronomical Obs.	Steel Breeze.

At GSFC, we produced a time series file called gsf001a.ts. A preliminary list of 300 sources was selected based on sky coverage, observing history, and stability in the usn001a.ts time series. A first Solve/Globl solution was run in which the positions of these 300 sources were solved for globally, and all others source positions were solved as arc parameters (a separate position for each session). Four other solutions were run in which a different 75 of the 300 stable sources were solved as arcs. All of the arc solutions were then combined and sorted to give a large time series file of source positions. For the GSFC solution, we included all of the one-baseline southern hemisphere CRF sessions that USNO has been performing over the past few years to improve the source statistics in the south. Only the GSFC, DGFI, and USNO groups included these sessions in their solutions, and it turns out that their use is crucial towards obtaining an evenly distributed set of defining sources.

At GSFC, we studied our own and the other time series files. We computed the WRMS of each source's RA and Dec positions, and made various plots. The position WRMS's represent a combination of observing noise and source structure position variations. A plot for the gsf001a.ts file is shown in Fig. 1. Plotted is the combined RA and Dec WRMS's (added in quadruture) versus declination. A clear declination effect is seen. Data for sources south of approximately $-20\,^\circ$ is clearly noisier, with a peak at around $-40\,^\circ$. Much of the data for sources in the far-south comes from one-baseline CRF sessions, and without them, this area would be very sparsely represented. Presumably, southern sources are not inherently less stable than northern sources, they are just less well observed.

3. Results

An initial goal of this study was to determine if a set of prospective "defining" sources could be picked that filled the sky fairly evenly with "stable"

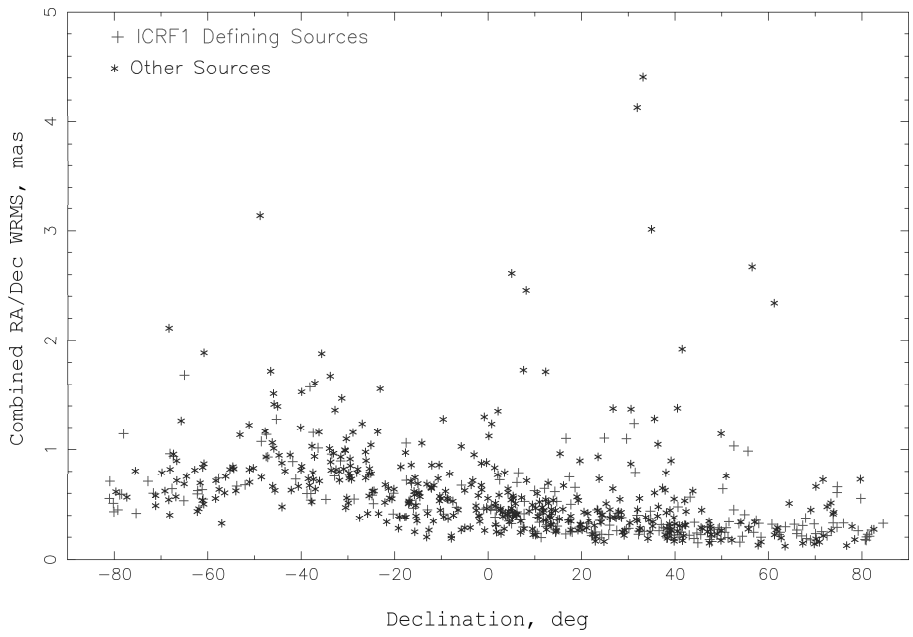

Figure 1. Combined RA/Dec position WRMS's for GSFC time series

sources. We chose arbitrarily 300 as the number of prospective defining sources. As a start, we sorted the sources from gsf001a.ts by increasing combined RA and Dec WRMS's. The sky distribution of the 300 sources with the smallest combined WRMS's is shown in Fig. 2. Clearly the southern sky is underrepresented and this would not be an adequate way to select defining sources.

Next we split the sky into 17 declination zones - two 15-degree polar caps and fifteen 10-degree wide zones in between. Sources were sorted by increasing combined RA and Dec WRMS's in each zone, and we picked the best sources in each zone. The number of sources per zone was set proportional to the cosine of the average declination of the zone. There were 26 in the equatorial zone, decreasing to 5 in the polar zones, and adding up to 300 sources. There was no attempt to get even RA distribution. We further looked through time series plots of each source picked, and identified 4 that showed clear systematic position variations, even though their WRMS's were small. These 4 were replaced by other stable sources in their zones. A plot of these 300 prospective defining sources is shown in Fig. 3. This list contains 111 of the original ICRF-1 defining sources. The sky distribution is clearly a large improvement over ICRF-1, and demonstrates that there should be enough stable southern sources to adequately anchor the ICRF-2 reference frame without the deficiencies seen in ICRF-1, provided the one-baseline southern hemisphere CRF sessions are used.

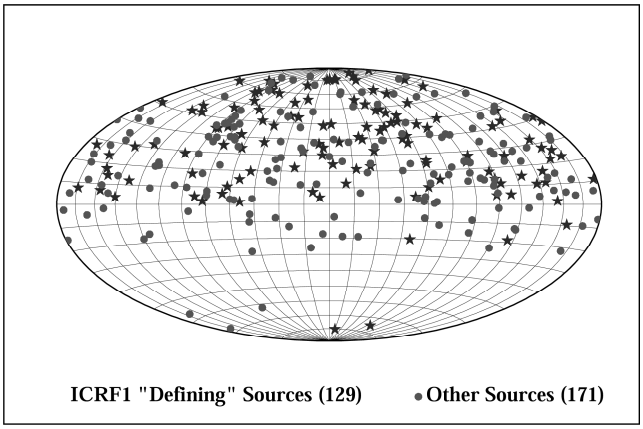

Figure 2. 300 best sources

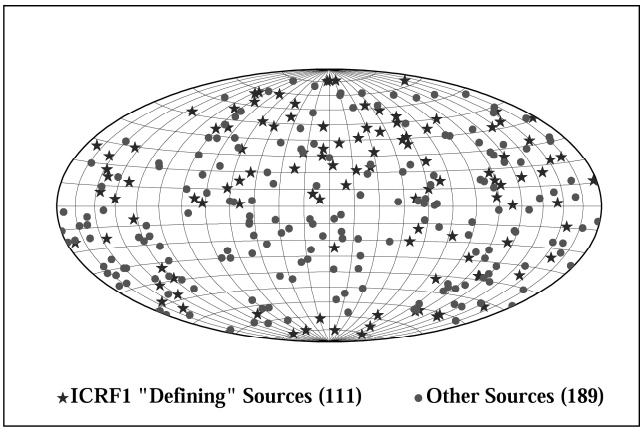

Figure 3. 300 best sources by declination zones