STABLE RADIO SOURCES AND REFERENCE FRAME

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ABSTRACT. The analysis of geodetic VLBI sessions since the early days of VLBI allows one to get time series of radio source coordinates. The analysis of these time series in terms of time stability can help us in our quest for a subset of radio sources suitable for defining the axes of the next ICRF. What we do here is (i) to compute the time series, (ii) to select the most stable sources, and (iii) to assess that the reference frame as defined with these sources is more stable than the previously defined ICRF.

1. THE TIME SERIES AND THEIR SEMI-ANNUAL REPRESENTATIONS

We investigate time series of 521 sources having more than 10 observations between 1984.0 and 2007.5. Their characteristics are reported in Fig. 1. One sees the dependence of the noise and of the slope in declination, likely a consequence of the mis-corrected troposphere effect. It appears also that the time series are so noisy or sparse that only two statistical quantities can immediately be extracted (without refinement) with a good reliability (i) a (weighted) rms, and (ii) an irregular pattern, that can be obtained by filtering or by building (weighted) normal points at regular time intervals. For the latter item, we construct semi-annual normal points by taking the weighted mean of all data contained in a 1-yr interval around the epoch. Their associated uncertainty is simply the weighted rms of the same data.

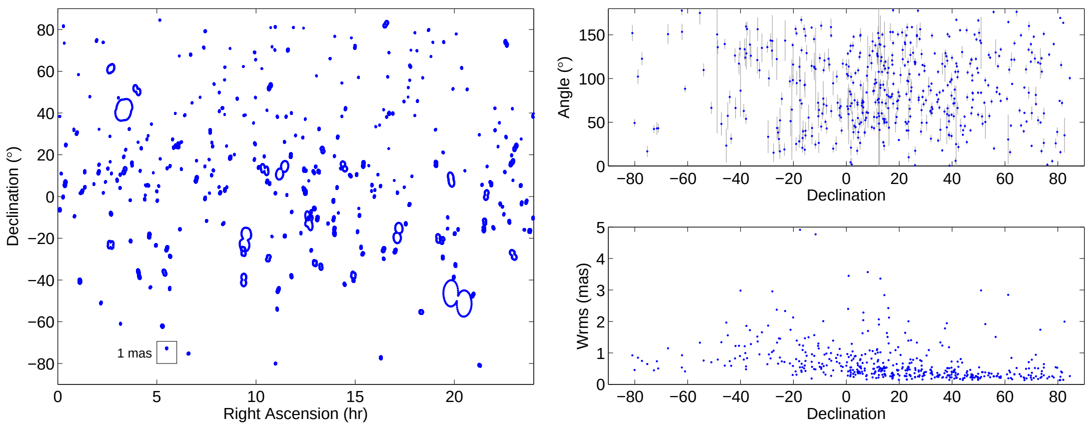

Figure 1: Left: Envelopes of variability (defined as the rms in a given direction) of the 521 radio sources investigated in this study. Top: Dependence of the angle of maximal variability with the declination. Bottom: Dependence of the rms on the declination.

2. STABLE SOURCES SELECTION SCHEME

We apply a simple selection scheme only playing with the rms and the slope. A source cannot actually be rejected only because of a high rms: if its position varies uniformly around the mean position, the net position of the source over a global analysis of a large number of sessions will be zero. However, an irregular pattern is a sign of danger: the source position can move away from the mean position during a long period of time and drive away the CRF axes during this period. Such a behavior is detectable by comparing the rms of the session time series against the rms of the normal points time series: indeed, in the latter case, the rms should remain high if an irregular pattern is present. If the period of time on which the irregular pattern shows up is sufficiently long compared to the complete time span of the global analysis, the irregular pattern should appear as a slope. When the slope is not extreme (a phenomenon due either to a real, huge drift of the source or to an important lack of data) the relevant quantity to be estimated is the ratio of the slope by its uncertainty. A quite large slope associated with a large uncertainty does not mean that the slope is significant. Inversely, a slope having a small uncertainty means a violent underlying physical process moving the radio center away, and that the source have to be taken with great care (and even rejected!). In our investigation, the selection parameters have been tuned so that the number of elected sources reaches 200. Our subset contains 197 sources, of which 32% are in the 212 ICRF defining sources (Ma et al. 1998) and 68% in the 247 stable sources of Feissel-Vernier et al. (2006, referred to as MFV).

3. CHECKING THE STABILITY OF THE REFERENCE FRAME

The axis stability of the reference frame defined by the above-selected sources is assessed using the normal point time series. Four parameters of transformation between a semi-annual reference frame (defined by the semi-annual coordinates of the selected radio sources, if observed at the considered epoch) and a reference catalogue (here, the ICRF-Ext.2 of Fey et al. 2004) are computed. The relevant quantities to be examined are the relative variations of the four parameters from one to another epoch. The same computation is also done for two well-known subsets: the 212 ICRF defining sources and the 247 of MFV (Fig. 2). It appears that our selection of sources leads to significantly better stabilities for the angles A1 and A2 and for the tilt parameter dz compared to previously done selections (ICRF and MFV). For A3, MFV appears to be better than us. This study shows that the investigation of time series of radio source coordinates can give an interesting selection of sources suitable for defining a stable reference frame. It is obvious that this selection must supplemented by other selections done through other criteria (e.g., source compactness), particularly since our selection yields a poor number of sources in the southern hemisphere.

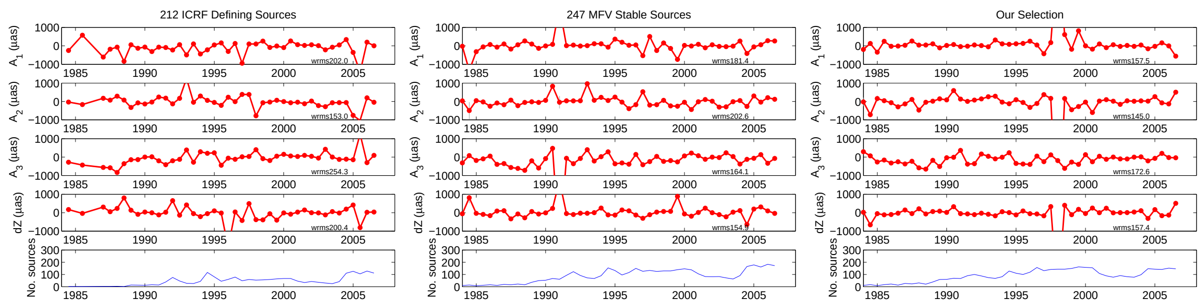

Figure 2: Transformation parameters between semi-annual reference frames with axes defined by the 212 ICRF defining sources, the MFV sources and our selection, respectively, as an illustration of the stability of the celestial reference frame.

4. REFERENCES

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