The International Celestial Reference Frame ICRF3, released in August 2018, is the newest realization of the Celestial Reference System (CRS). In this catalog the positions of the radio sources are given as time invariant coordinate pairs. Nevertheless, systematics within the astrometric positions are present, which led to the addition of a small number of conspicuous sources in the ICRF2 catalog. Recombining these two sources in an astrometrically systematic procedure, showing that a majority of the sources is subjected to positional variations, although at different levels and time scales. Such systematics, if neglected, may affect the quality of the CRF, and consequently impair depending parameters such as the Earth orientation parameters (EOP). A proven approach to overcome these shortcomings is to extend the parameterization of the source positions within the VLBI data analysis: the multivariate adaptive regression splines (MARS) algorithm allows complete automation by considering the data’s relative partitioning and spline fitting in an optimal way.

In this study, we investigate source coordinate time series and their residuals after the application of said parameterization. We aim to identify the effect of the parameterization on the noise content and variance within the residual source position time series. To this end we investigate the Allan standard deviation functions from the uncorrected and residual time series exemplary for three different sources.

Our study is based on more than 4500 sessions with global station networks spanning the time frame 1990-2018. The geodetic data analysis is performed using the VLBI software package VieVS [2], and following the conventions of the International Earth Rotation and Reference Systems Service (IERS[9],[8]). The modeling settings are chosen with respect to the routine single-session data analysis strategies of the International VLBI Service for Geodesy and Astronomy (IVS[5]). The resulting source position time-series are used to determine the splines based on the multivariate adaptive regression splines (MARS) algorithm as discussed in [4]. Here we present exemplarily the results for the ICRF3 defining source 0406-097 and the ICRF2 special handling sources 4C39.25 and 2234+282. The resulting splines as seen in Fig. 1 are then used to correct the a-priori source positions which enter the VLBI analysis.

**Results**

0406-097: Despite its ICRF3 defining status, we observed systematics for this source, revealed by the MARS algorithm (Fig. 1) and the Allan standard deviation functions of its two coordinates (Fig. 3). The right ascension is dominated by a random walk at time scales longer than 3 y. The declination is affected by a flicker noise at time scale shorter than 3 y and by a white noise at longer time scales. The correction from the splines (Fig. 4) slightly mitigates the noise level on the right ascension without changing significantly the noise content. On the declination, the flicker noise at shorter time scales was erased but the noise content at longer time-scales was degraded.

4C39.25: This source is known to present exceptionally important systematics in its astrometric position as seen in Fig. 1. Its right ascension systematic is recognized as random walk-like whereas its declination systematic is recognized as flicker noise-like (Fig. 3). Taking into account the corrections from the splines improves the noise content. The right ascension becomes mostly dominated by flicker noise whereas the right ascension is not significantly dominated by the white noise.

2234+282: Its two coordinates are both dominated by flicker noise at time scales shorter than 4 y and by white noise in majority at longer time scales. The linear spline corrections hence in majority the flicker noise and the noise level is diminished at all time scales even if the final residuals are not purely dominated by white noise.

**Conclusions & Outlook**

We present a new approach to model the astrometric position variations of radio sources within VLBI analysis and assess the quality and performance of it in terms of noise in the residuals. The method benefits from two statistical tools: the MARS algorithm enables to extract an empirical model of the source position variation with time; the Allan standard deviation analysis enables to characterize the noise content of data time series. The combination of these allows the tuning of the parameterization in order to retrieve purely white noise source position residuals.

This method will be applied to all sources that we observed within at least 100 geodetic VLBI sessions. For the determination of the MARS splines some options need to be investigated further, e.g. splines which allow more nodes (meaning higher computation times but more refined parameterization), or cubic instead of linear splines. Also the impact of gaps in the time series and/or the VLBI calibration procedure on the parameterization needs to be addressed.

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