Source structure influence on GeoVLBI observations

Nataliya Zubko[1], Elizaveta Rastorgueva-Foi[2], Lucia Plank[2]

[1]*Finnish Geospatial Research Institute (FGI), National Land Survey of Finland, Geodeetinrinne 2, FI-02430 Masala, Finland, nataliya.zubko@nls.fi*;
[2]*University of Tasmania, Churchill Avenue, Sandy Bay, Hobart, Australia*

INTRODUCTION. We present results on study of the source structure effect on the estimated GeoVLBI parameters. The extended source structures introduce an additional time delay component into the measured time delay and, thereby, it affects the estimated geodetic parameters. We study this impact for several defining radio sources, which were observed on a regular basis with GeoVLBI. Despite the fact that the defining sources are selected based on their stability, many of them have considerable extended structure. We select ten radio sources among the defining sources, which revealed noticeable variations in their extended structure over the time. Here we present results for source 0552+398. This apparently compact source reveals a double inner structure with Structure Index varying between 1 and 2 during the study period. We have investigated a capability to detect a source structure effect on the estimated parameters. Also we performed simulations of source structure and obtained quantifiable results of the source structure effect. We have investigated a capability to detect a source structure effect on the estimated parameters.

VLBI Kinematic Study

VLBI kinematics of source 0552+398 were studied using X-band pre-calibrated VLBA and Global VLBI array data from AstroGeo database[1]. Source structure was modelled in the *uv-plane* with a set of circular and elliptical components with Gaussian brightness distribution using standard Difmap *modelfit* procedure. Structure kinematics was studied during the period 1999-2012.
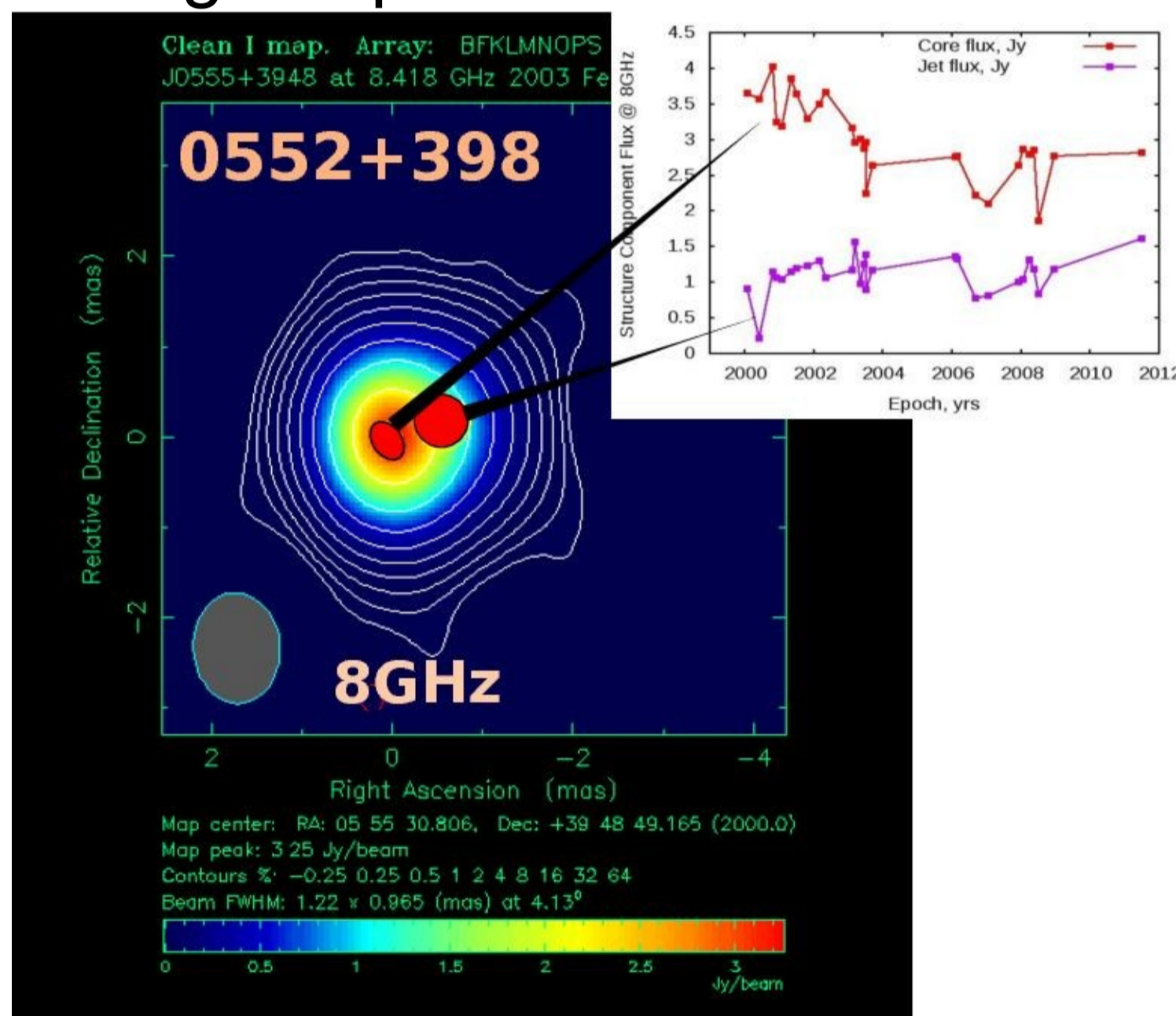

Fig.1 VLBI image of 0552+398. Core and jet flux time series

Geodetic analysis

The analysis of geodetic VLBI data was performed with VieVS software[2]. Polar motion, nutation and celestial coordinates of radio source 0552+358 were estimated. The results presented here are obtained with 1000 sessions. In a typical schedule of 24-hours geodetic VLBI session about 50 - 60 radio sources are included. An exclusion of a source from the observation should not effect estimated geodetic parameters significantly. However, our calculations shows that exclusion of source can change the estimated offset value up to 15%.
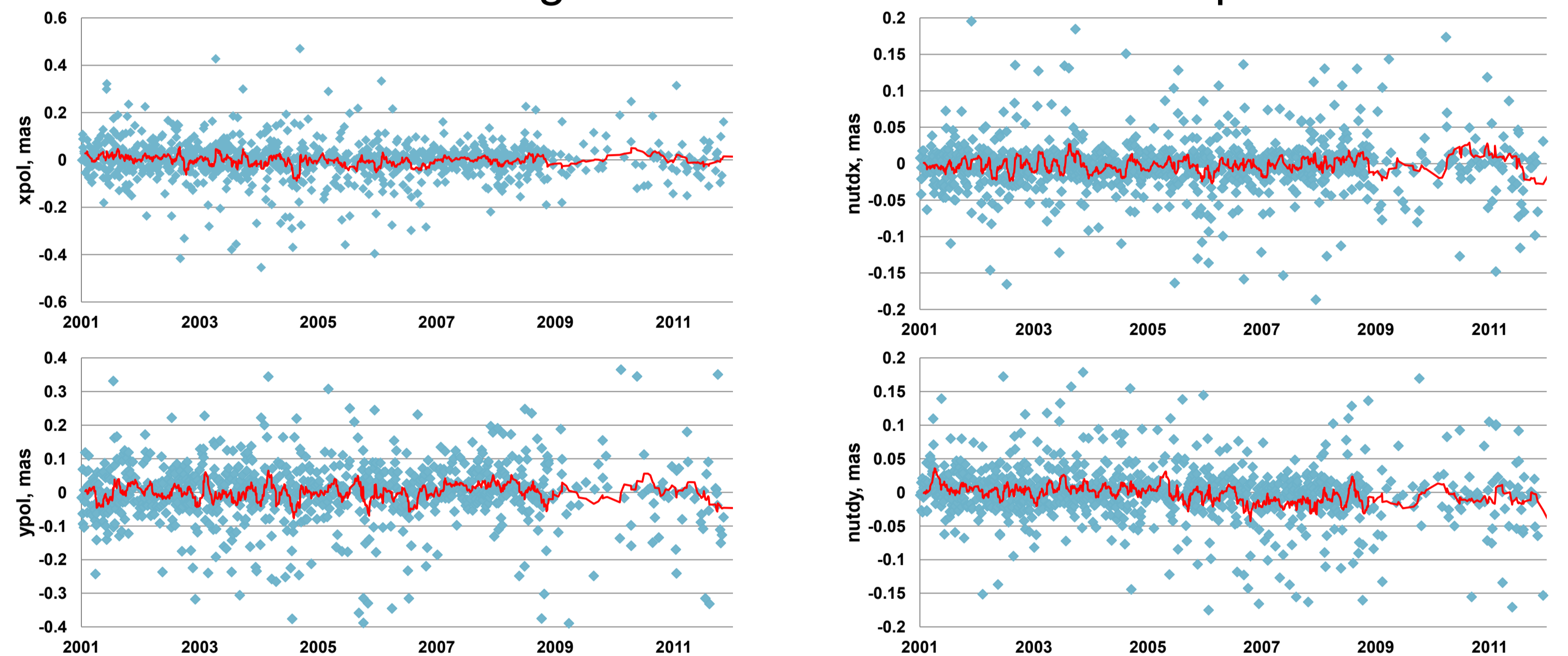

Fig.2 Difference of xpol and ypol polar motion coordinates (symbols) and their moving averages (red lines) on the left, when source 0552+398 was excluded from the soulution . Difference of dx and dy celestial pole coordinates (symbols) on the left.

Simulation

To evaluate a source structure effect we performed simulation with VieVS software. We have simulated troposphere and clocks time delay, a white noise equal to 30 ps was added to the simulated observations. We analysed the simulated sessions and estimated EOP. Further, the structure corrections of source 0552+398 was applied to the simulated sessions and new EOP were estimated. To estimate the effect of source structure corrections we obtained difference between sessions with and without source structure corrections. In Fig.3 such differences for the estimated coordinates of polar motion are shown. In Fig. 3 (left) two sets of data represent source structure corrections, when source structure is constant and when it is variable in time. Six double-Gaussian models obtained during the year 2003 are used in the simulations. (Fig.4).

We also have evaluated how the source structure effect reveals itself in different observational network. (Fig. 3, right)
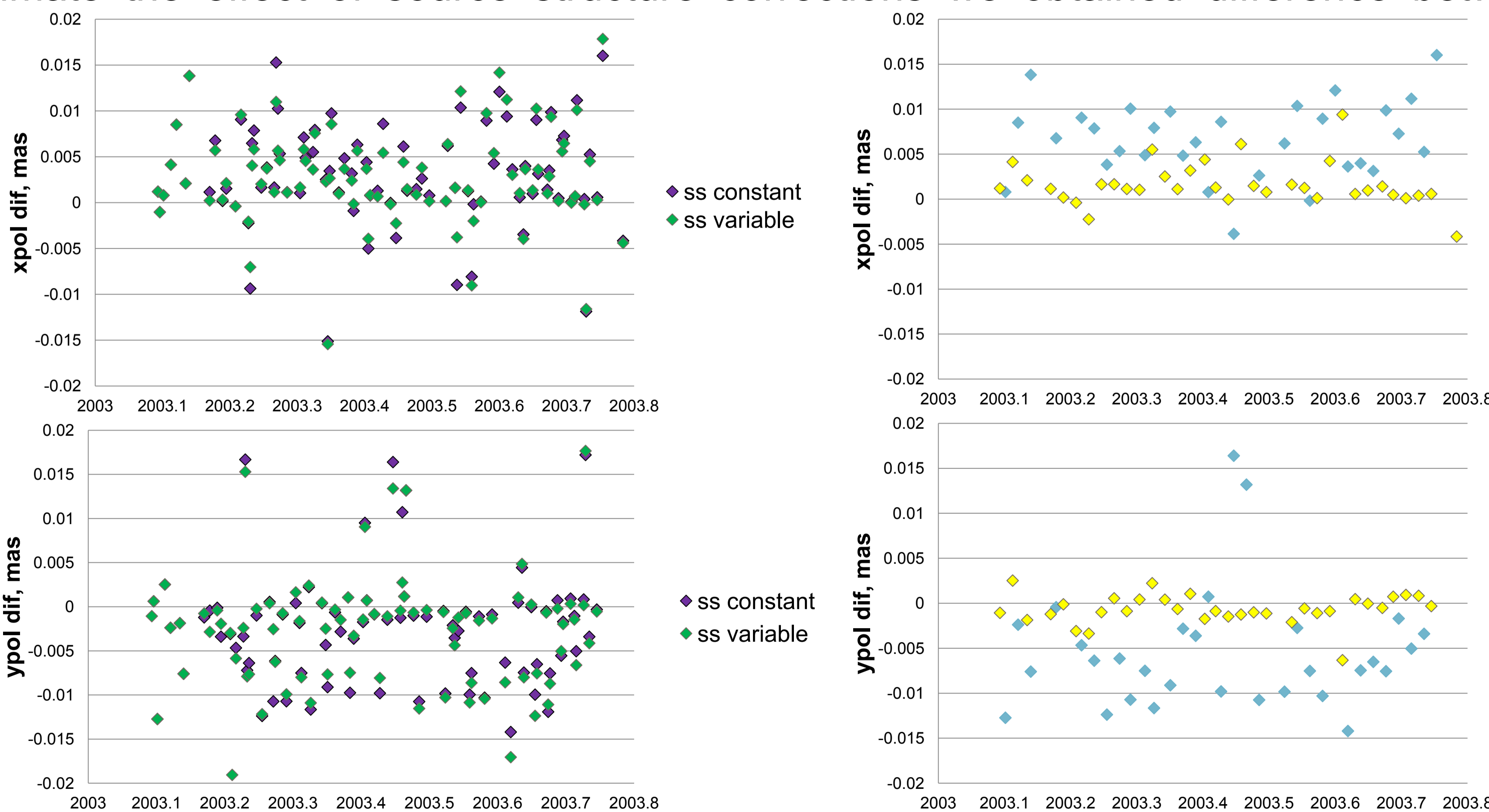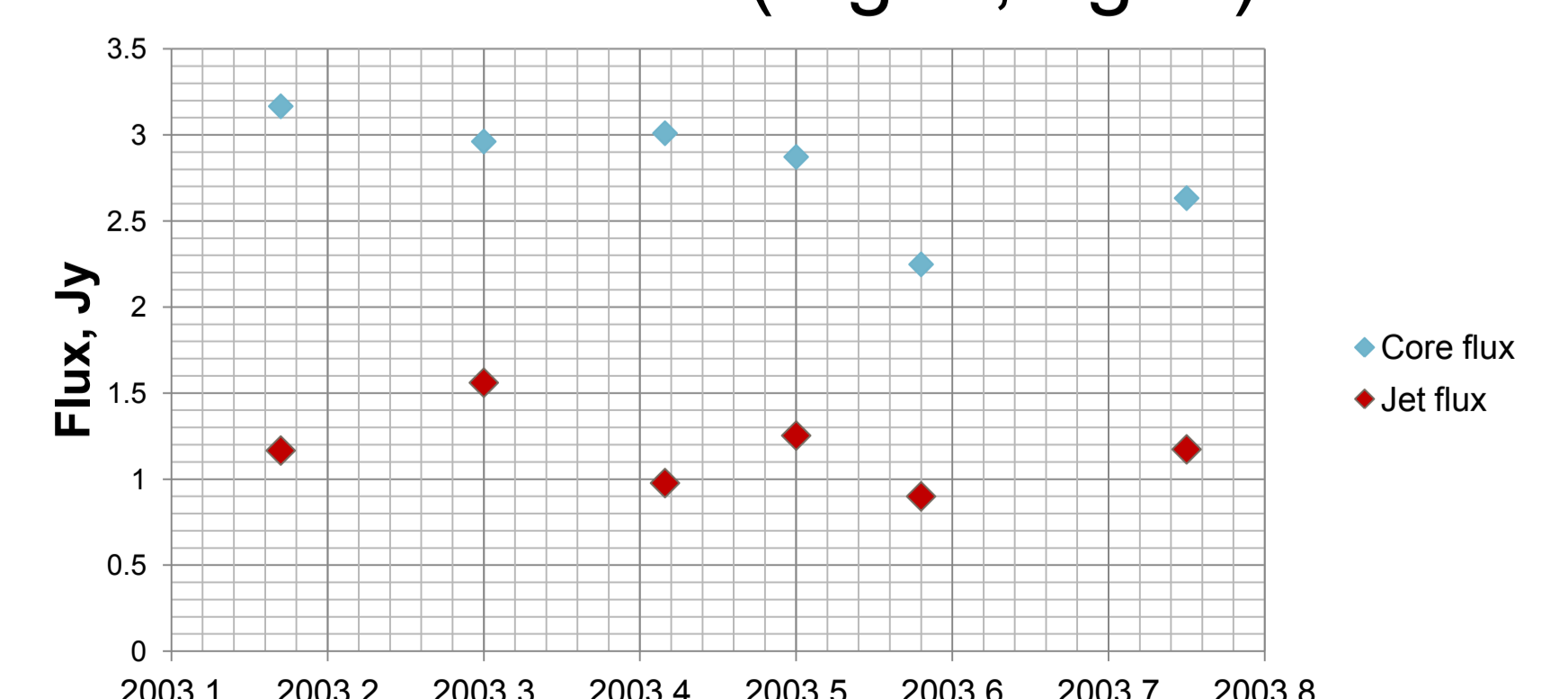

Fig.3 Source structure effect on the estimated polar motion coordinates with constant (image from 17.02.2003) and variable (according to a time series of images) source structure on the left.
Source structure effect (with constant source structure) on the estimated polar motion coordinates observed with *R1* and *R2* networks on the right.

Fig.4 Core and jet fluxe time series of source 0552+398 at 8 GHz

References:
1. Astrophysics database http://astrogeo.org/
2. J. Böhm, S. Böhm, T. Nilsson, A. Pany, L. Plank, H. Krásná, K. Teke, H. Schuh. The new Vienna VLBI Software VieVS. In:Proceedings of IAG Scientific Assembly 2009, International Association of Geodesy Symposia Series Vol. 136, ed. by S. Kenyon, M. C. Pacino, and U. Marti, pp. 1007-1011, 2012.