Institute of Applied Astronomy
Russian Academy of Sciences

Using positional observations of numbered minor planets for determination of star catalog errors

Yurii Medvedev, Vladimir Kuznetcov

Main goal:

Estimation of the systematic errors of star catalogs using O-C of asteroid positional observations which are calculated when elements of numbered asteroids are improved.

This work is the continuation of the previous work. The considerable variation of the systematic errors for the USNO A2.0 catalog have been shown.

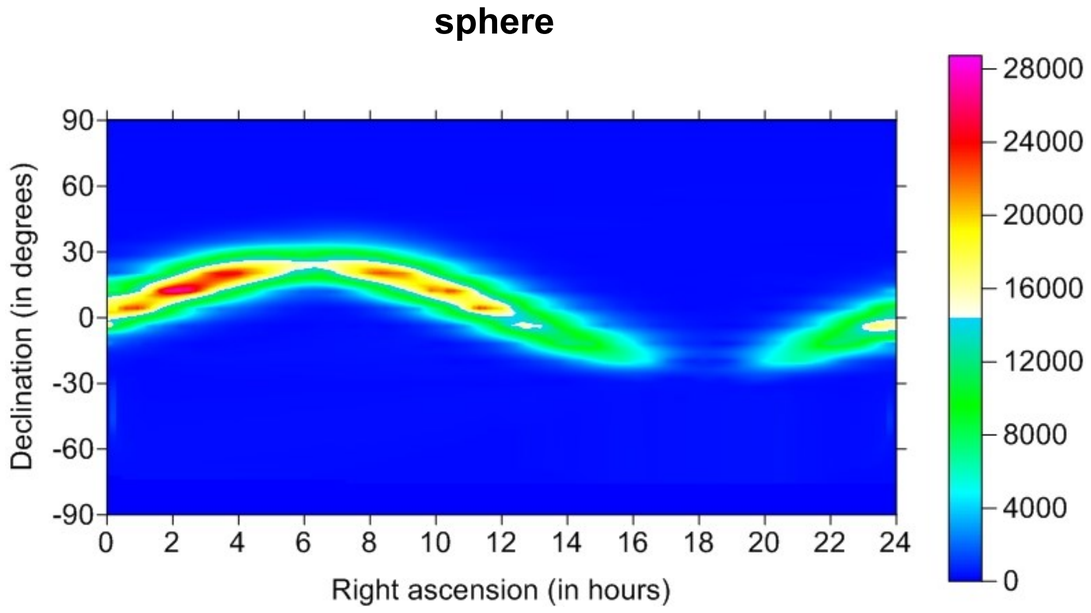
We go on to investigate the biases of this star catalog.

102 760 633 positional observations of 404 941 numbered asteroids were used.

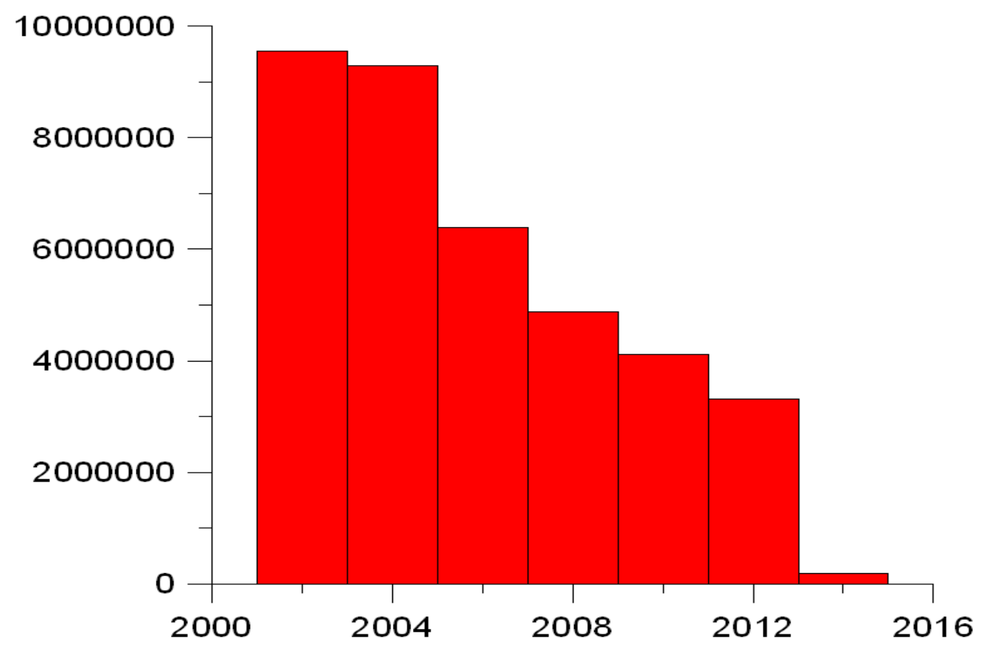
Distribution of observations according to catalogs

USNO A2.0	(1998)	37 732 050 (34 610 829)
UCAC 2 & 3	(2006)	27 529 078 (17 209 447)
USNO B1.0	(2003)	11 778 775 (9 744 401)
UCAC 4	(2012)	4 501 387 (–)

Distribution of observations (USNO A2) on the celestial sphere



Distribution of observations (USNO A2) by years



Calculation of systematic errors

The celestial sphere was divided into 10212 equal areas.
Each O-C value was associated with the corresponding area on celestial sphere .

Estimation of variation of systematic errors for the USNO A2.0

The mean values of individual areas were calculated using O-C referred to six different time intervals: 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2014.

The obtained values were approximated by the linear equations:

$$\begin{cases} \Delta\dot{\alpha}(t_i - 2011.5) + \Delta\alpha_0 = \Delta\alpha_i \\ \Delta\dot{\delta}(t_i - 2011.5) + \Delta\delta_0 = \Delta\delta_i \end{cases}$$

where t_i = 2001.5, 2003.5, …, 2011.5.
Then the overdetermined system was solved by MLS.

Variation of systematic errors and their errors for USNO A2 (in mas per year)

α	δ	$\Delta\dot{\alpha}$	$\Delta\dot{\delta}$
$23^h.914$	$4^o.82$	15 ± 0	17 ± 0
0.082	4.82	7 ± 1	19 ± 5
0.250	3.21	1 ± 2	25 ± 2
0.418	3.21	3 ± 1	27 ± 3
0.586	3.21	3 ± 2	28 ± 4
0.753	3.21	10 ± 0	22 ± 0
0.921	3.21	10 ± 1	20 ± 1
1.089	3.21	11 ± 1	22 ± 2
1.257	3.21	6 ± 3	19 ± 3
1.425	3.21	10 ± 2	21 ± 3
1.593	3.21	12 ± 4	22 ± 4

Catalog biases of USNO A2 at Epoch 2011 and 2014

α	δ	$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha_{2011}$	$\Delta\delta_{2011}$	$\Delta\alpha_{2014}$	$\Delta\delta_{2014}$
$23^h.914$	$4^o.82$	-0″.08	0″.33	-0.01(04)	0.34(32)	0.02(±0.02)	0.39(±0.03)
0.082	4.82	-0.02	0.27	-0.01(19)	0.44(46)	0.02(±0.01)	0.49(±0.05)
0.250	3.21	-0.05	0.35	-0.21 (22)	0.48(48)	-0.21(±0.01)	0.53(±0.05)
0.418	3.21	-0.03	0.46	0.17(13)	0.54(43)	0.21(±0.01)	0.60(±0.03)
0.586	3.21	-0.01	0.47	-0.03(12)	0.49(47)	-0.01(±0.01)	0.56(±0.03)
0.753	3.21	-0.09	0.01	-0.02(10)	0.41(42)	0.02(±0.00)	0.47(±0.03)
0.921	3.21	-0.12	0.24	-0.07(07)	0.31(25)	-0.05(±0.02)	0.36(±0.02)
1.089	3.21	-0.04	0.44	-0.06(07)	0.41(39)	-0.03(±0.02)	0.45(±0.03)
1.257	3.21	-0.14	0.32	0.14(27)	0.59(29)	0.18(±0.04)	0.67(±0.04)
1.425	3.21	-0.11	0.33	-0.18(12)	0.49(47)	-0.16(±0.03)	0.55(±0.04)

where: α, δ (in terms of hours and degrees) are the coordinates of an area center ; $\Delta\alpha$, $\Delta\delta$ (in terms of arcseconds) are the systematic errors of right ascensions and declinations of the USNO A2.0 catalog given in (Chesley et al. Treatment of star catalog biases in asteroid astrometric observations // Icarus, 2010. V. 210. P. 158-181).

$\Delta\alpha_{2011}$, $\Delta\delta_{2011}$ and $\Delta\alpha_{2014}$, $\Delta\delta_{2014}$ (in terms of arcseconds) are errors obtained by us at Epoch 2011 and 2014; the values of previous work and errors in bracket.

Conclusion

The accuracy and number of new positional observations of asteroids allow to estimate the accuracy of reference star catalogs.

The considerable variation of the systematic errors for the USNO A2.0 catalog are shown.

The values of the systematic errors for USNO A2.0 catalog vary from area to area as well as with time.

Using our calculation the observations based on this catalog can be corrected not only depending on the different areas, but the different epochs as well.