Institute of Applied Astronomy
Russian Academy of Sciences

Selection CRF core sources

S. Kurdubov, E. Skurikhina

In earlier work we had suggested ranking method of sources sets in order to select the list of sources that better define the orientation parameters of rigid rotation transformation from one system to another.

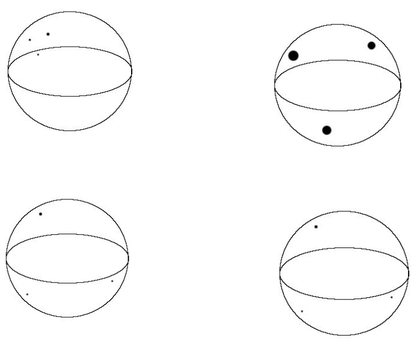
The transformation parameters formal errors were selected as characteristic of sources set. For all catalogues IVS WG2 was selected special order in the sources list and obtained transformation parameters accuracy as function of the number of sources. For all catalogues that function has a minimum between 300 and 400 sources, adding the sources after the minimum leads to increasing formal errors of orientation parameters. After that we selected the common sources which placed before minimum of functions and obtained the "optimal set".

Source position time series were obtained and analyzed for the optimal set of sources. It was shown that some of the core sources have unstable positions and need to be excluded from optimal set. Nevertheless time series shows that mainly optimal source set consists from stable sources.

.

.

The problem – orientation of catalogue defined by distribution of sources and their positions uncertainty.



Solution

- Given catalogue RA, DE, arbitrary catalogue ra, de.
- $dRA_i = RA_i - ra_i$ Rigid rotation transformation model

$$dDE_i = DE_i - de_i$$

$$dRA_i = A_1 \tan(RA_i)\cos(RA_i) + A_2 \tan(DE_i)\sin(RA_i) - A_3$$

$$dDE_i = A_1 \sin(RA_i) + A_2 \cos(RA_i)$$

Least Square for A1, A2, A3 estimation

$$\mathbf{C} = \frac{\partial(dRA, dDE)}{\partial \mathbf{A}}; \mathbf{N} = \mathbf{C}^T\mathbf{C}; \mathbf{A} = \mathbf{N}^{-1}\mathbf{b}$$

$$\sigma_A = \sigma_0 \operatorname{tr}(\mathbf{N}^{-1})$$

Geometry part

Inaccuracy of positions part

If we compare two catalogue (RA,DE) and (ra,de) then

$$\sigma_0 = \frac{\sum (dRA)^2 + \sum (dDE)^2}{2N - 3},$$

But we want statistical characteristic of one catalogue, then we use mean σ_0 :

$$\overline{\sigma_0} = \frac{\sum \sigma_{RA}^2 + \sum \sigma_{DE}^2}{2N - 3},$$

and finally obtain mean formal errors of orientations parameters for given set of sources:

$$\overline{\sigma_A} = \overline{\sigma_0} \operatorname{tr}(\mathbf{N}^{-1})$$

Source set quality characteristic: $q = \mathrm{MAX}(\overline{\sigma_{A1}}, \overline{\sigma_{A2}}, \overline{\sigma_{A3}})$

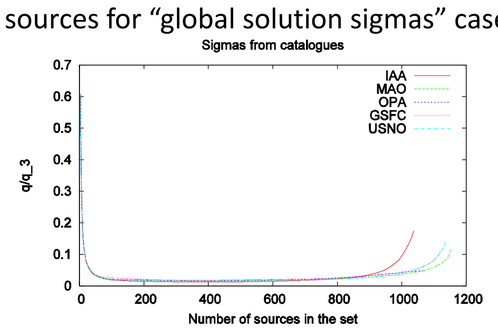
Two approach for the $\sigma_{RA}^2, \sigma_{DE}^2$

1. Use global solution formal errors
2. Use time series variance

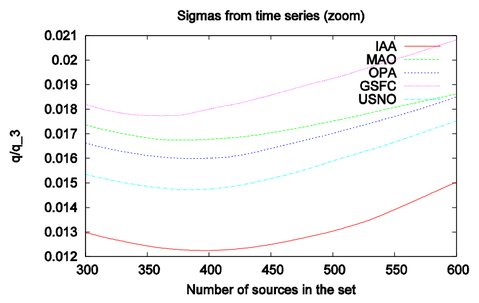
Algorithm for selection of defining sources

1. For each catalogue in analysis:
   - Triple loop over all sources in order to find the best trio what gives minimum to the *q,* thus obtain optimal set for N=3
   - Search over all remaining sources in order to minimize *q* for N+1 sources
   - The sequence of source sets obtained and parameter *q* as function of number of sources in the set
   - For all catalogues that function has a minimum in the point.
2. Take the common part of the “minimum” sets
3. Make 1. and 2. for both global solution and time series and obtain common set

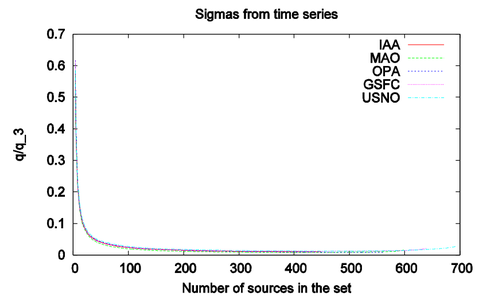
319 common sources for “global solution sigmas” case



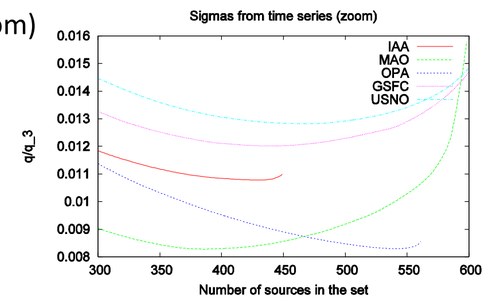
319 common sources before minimum for “global solution sigmas” case (zoom)



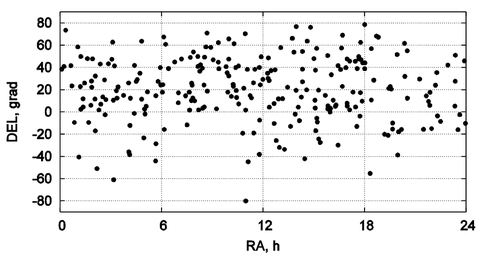
280 common sources for “time series sigmas” case



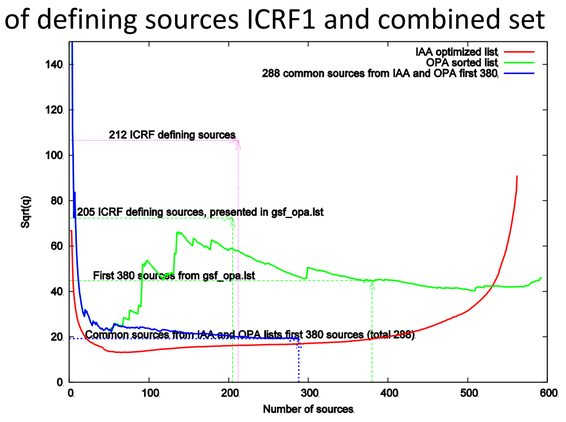
280 common sources before minimum for “time series sigmas” case (zoom)



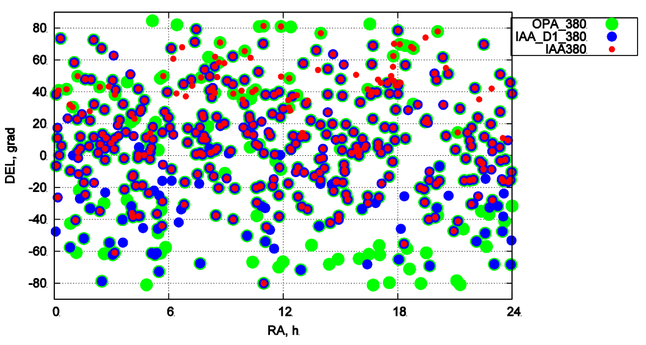
Finally set of 260 sources



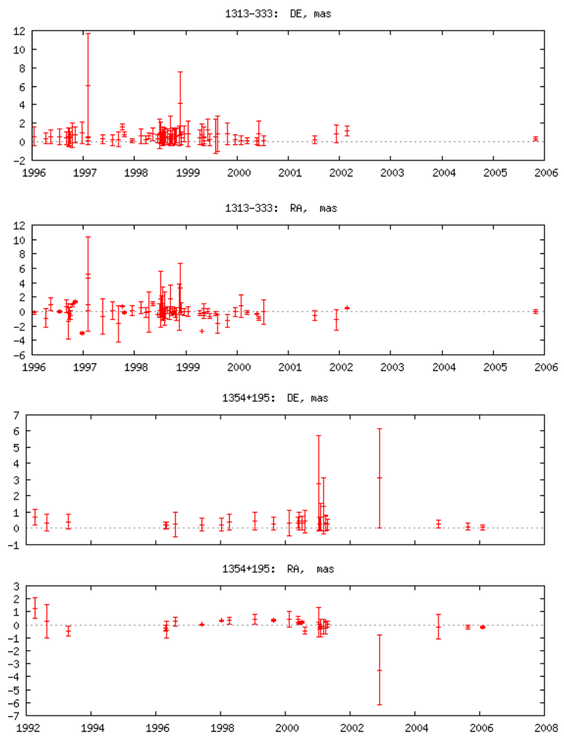
Comparison of IAA list, and 380 sources OPA list, set of defining sources ICRF1 and combined set



Algorithm can be improved with additional condition Sum over all deltas less than 1 degree. Comparison sky coverage of different sets.



Some sources were excluded from the “best sources” sets by using our old covariance criteria for time series.
Sources from IAA list with K>0.5 stability value



Conclusion

The presented algorithm can be used for selection of core sources for new catalogues. We plan to use selected sources for actual computing transformation parameters between catalogues for ICRF3. The algorithm need to be reviewed in case of upcoming of multi wavelength reference frame .