Progress in the 2nd Realization of the ICRF

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International Celestial Reference System (ICRS)

The ICRS is the idealized barycentric coordinate system to which celestial positions are referred. It is kinematically nonrotating with respect to the ensemble of distant extragalactic objects. It has no intrinsic orientation but was aligned close to the mean equator and dynamical equinox of J2000.0 for continuity with previous fundamental reference systems. Its orientation is independent of epoch, ecliptic or equator and is realized by a list of adopted coordinates of extragalactic sources.

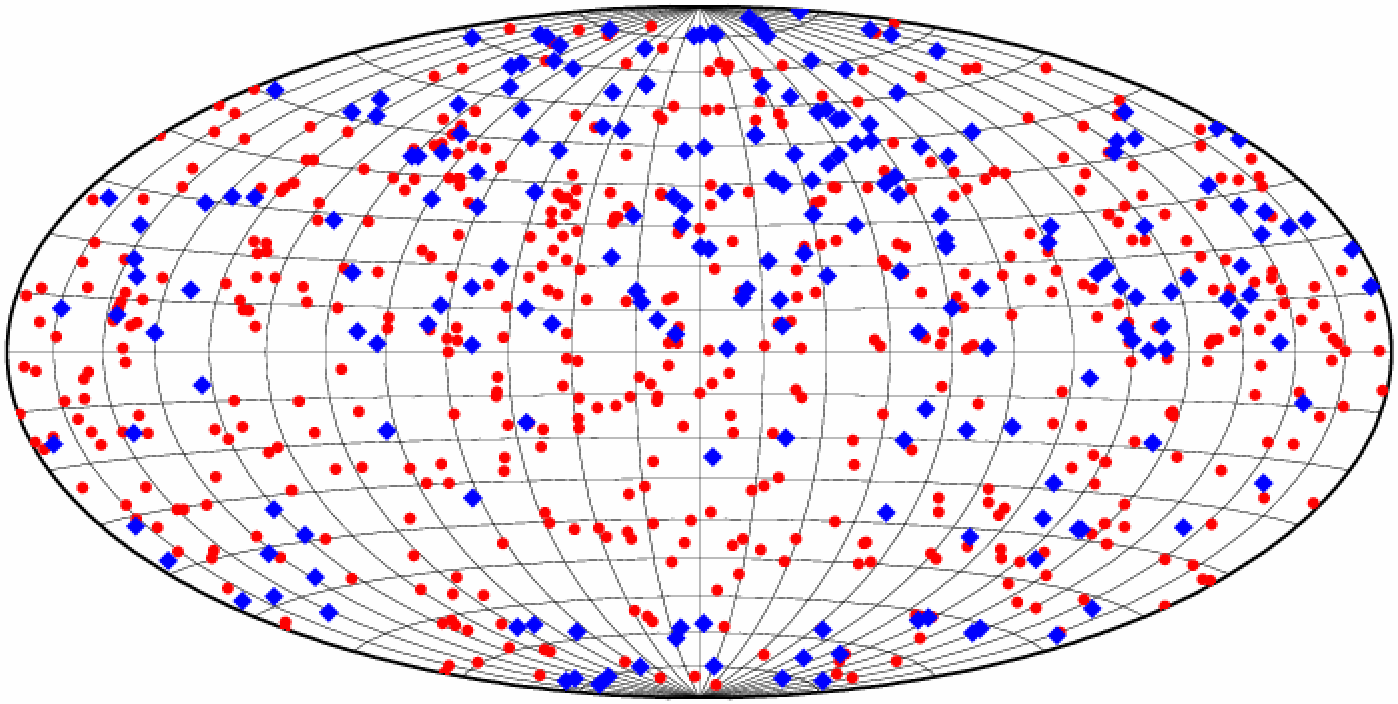
International Celestial Reference Frame (ICRF)

The ICRF is a set of extragalactic objects whose adopted positions and uncertainties realize the ICRS axes and give the uncertainties of the axes. It is also the name of the radio catalog whose 212 defining sources are currently the most accurate realization of the ICRS. Note that the orientation of the ICRF catalog was carried over from earlier IERS radio catalogs and was within the errors of the standard stellar and dynamical frames at the time of adoption. Successive revisions of the ICRF are intended to minimize rotation from its original orientation. Other realizations of the ICRS have specific names (e.g., the Hipparcos Celestial Reference Frame).

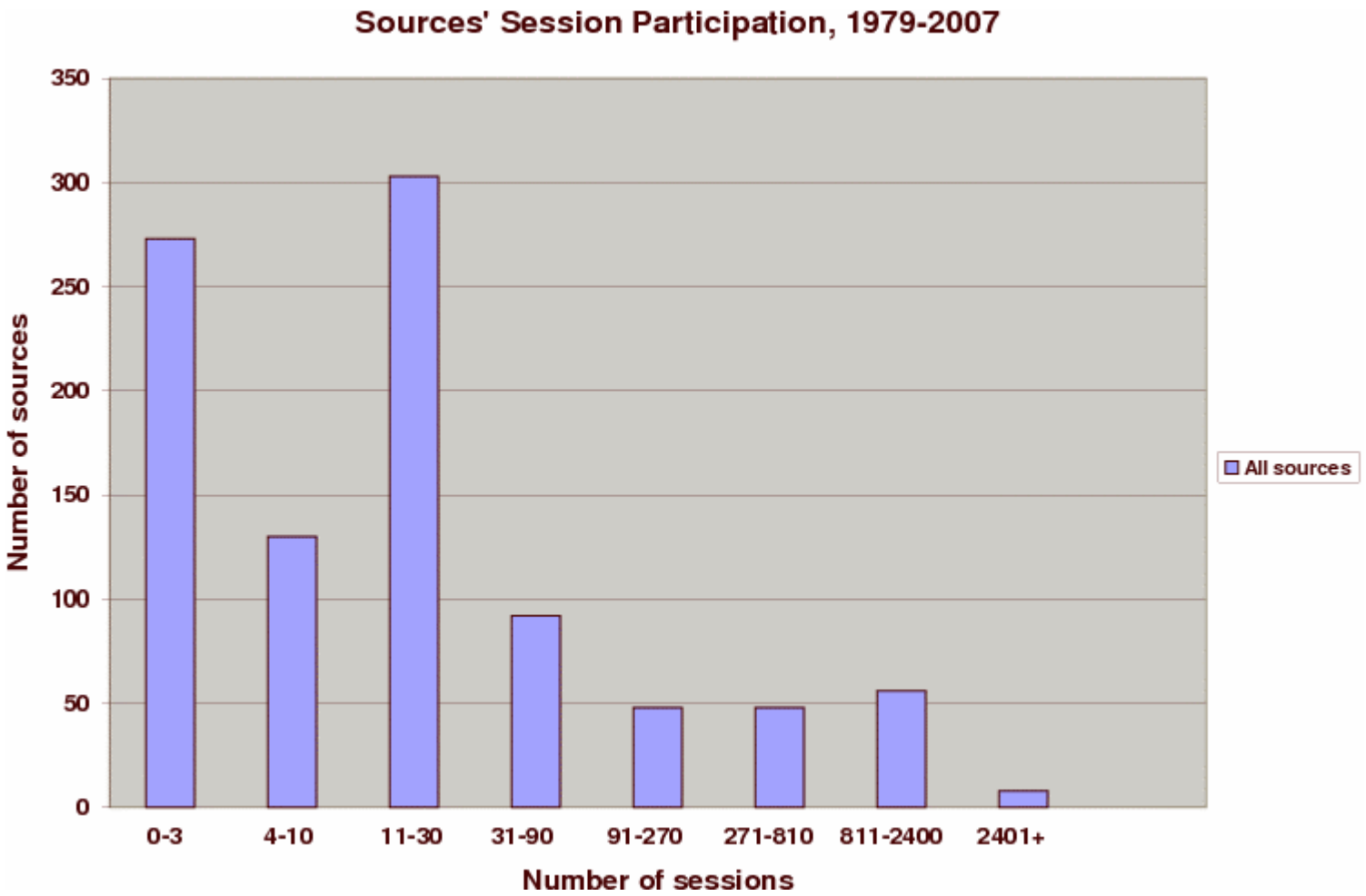
ICRF

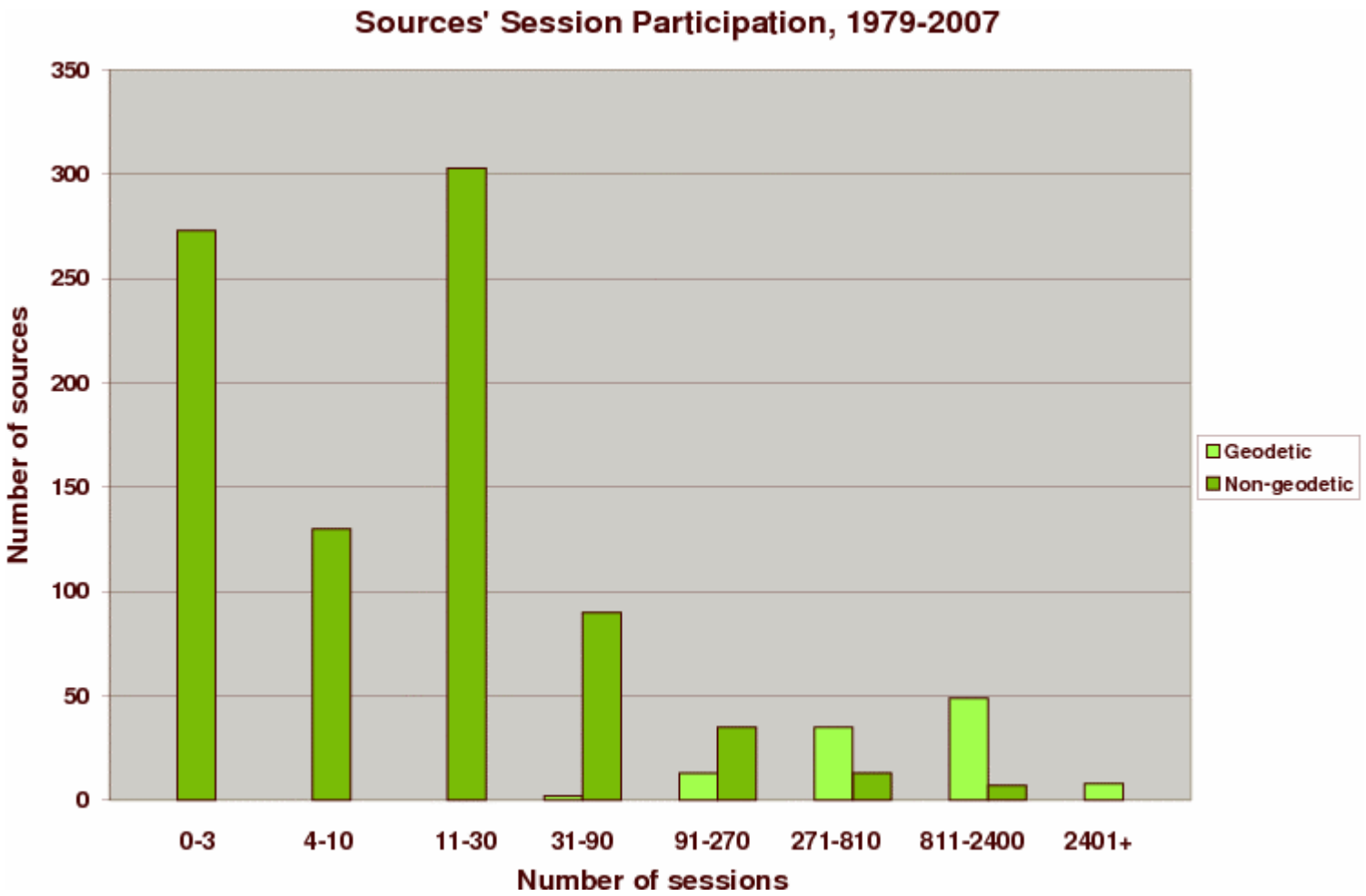
- S/X data and analysis through 1995
- ICRF-Ext.1, ICRF-Ext.2
- 212 defining sources
- Position uncertainty ≥ 250 μas
- Accuracy of axes ~30 μas
- Orientation independent of equator, ecliptic and equinox

ICRF Ext.2 Sources



◆ 212 defining • 505 non-defining


Sources' Session Participation, 1979-2007
Number of sources
350
300
250
200
150
100
50
0
0-3
4-10
11-30
31-90
91-270
271-810
811-2400
2401+
Number of sessions
All sources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100
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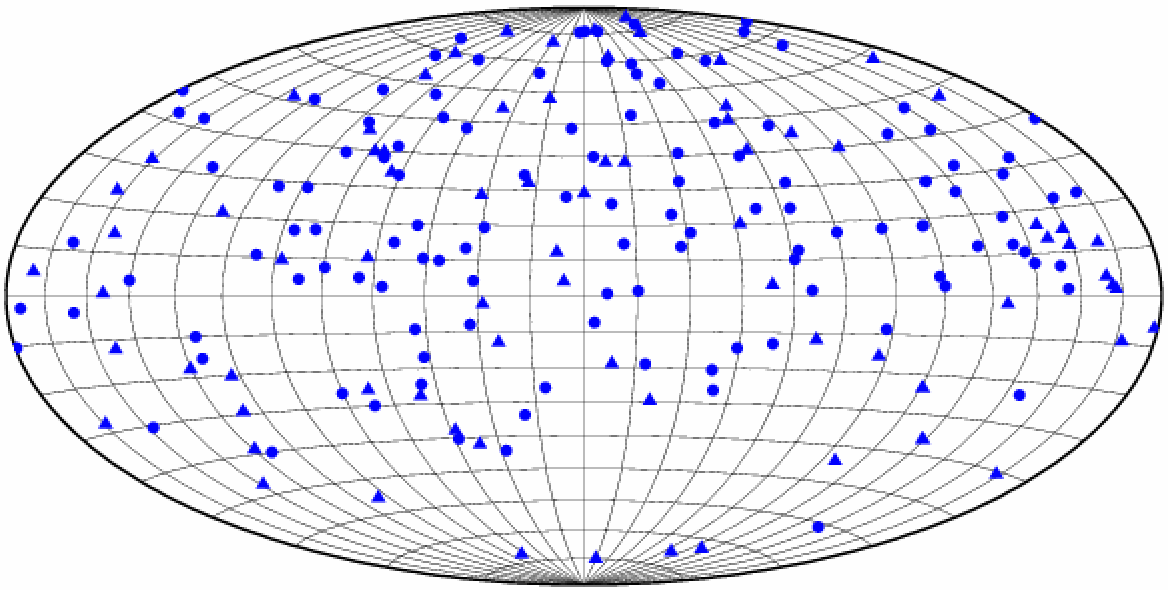
0
0-3
4-10
11-30
31-90
91-270
271-810
811-2400
2401+
Number of sessions
Geodetic
Non-geodetic

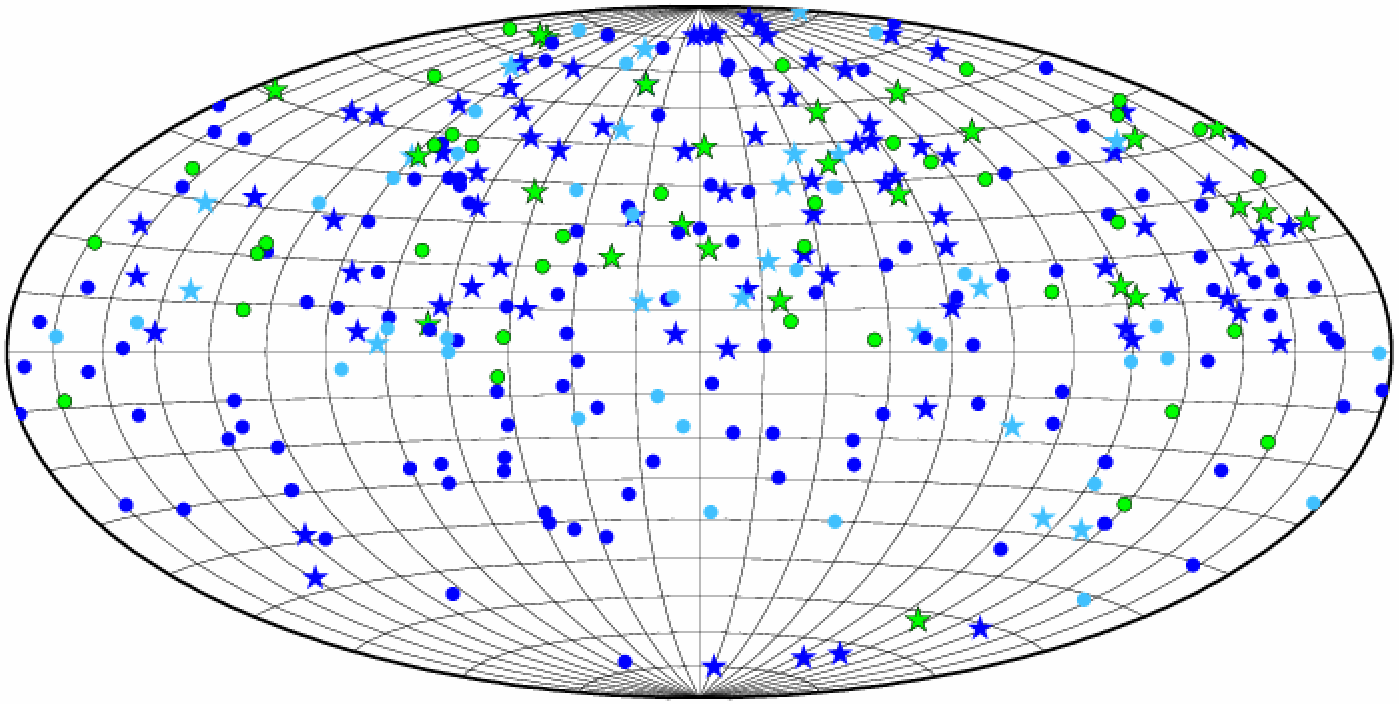
Stable Sources from Feissel-Vernier A&A 2003



▲ 77 geodetic

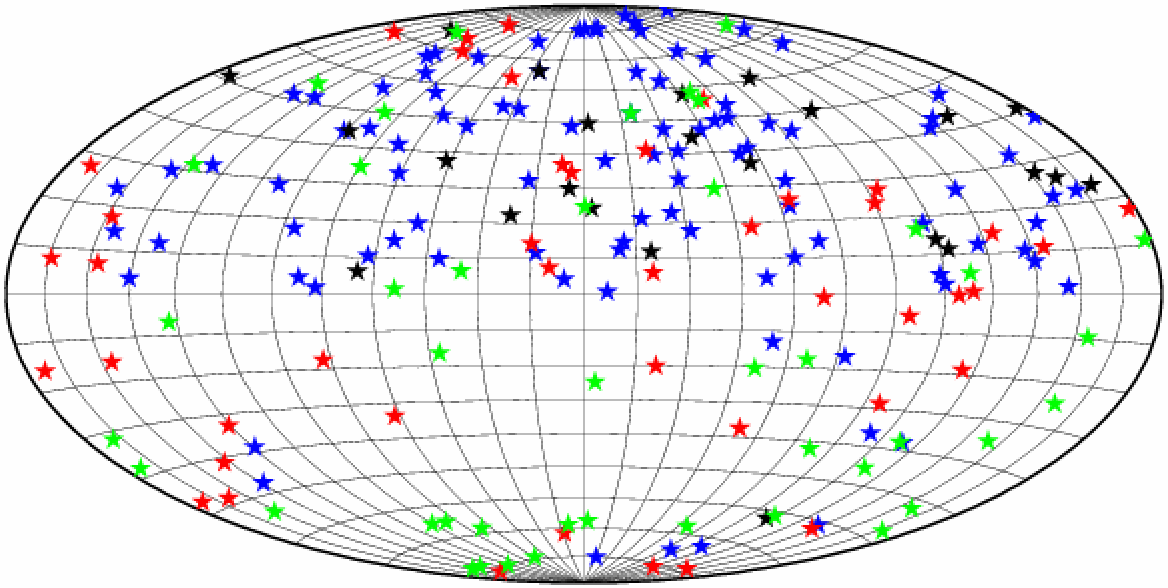
• 121 non-geodetic

Stable and Potentially Stable Sources



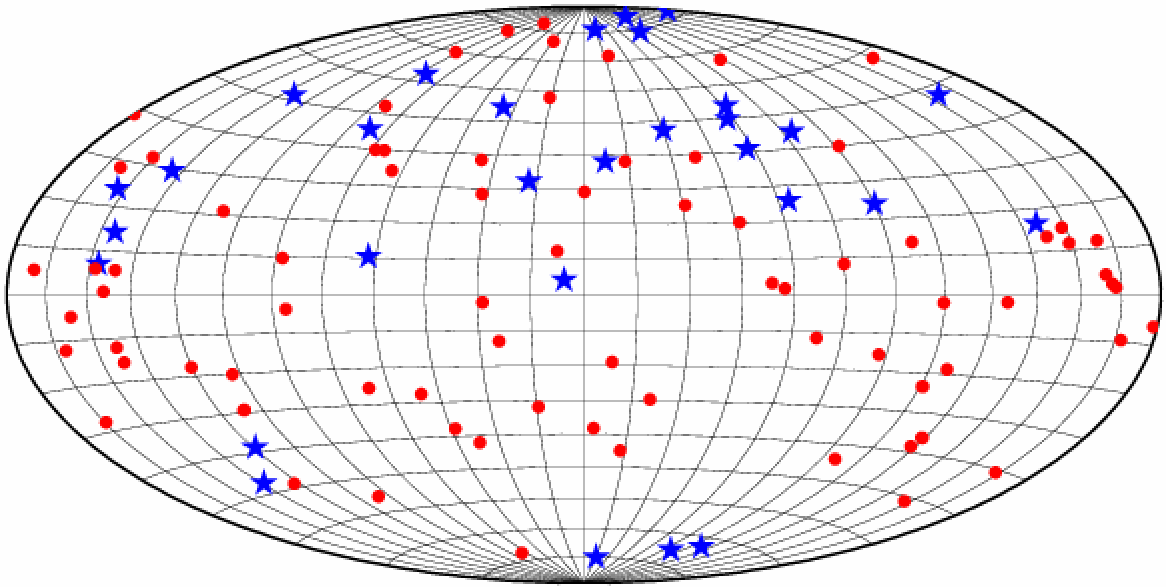
Defining: ★81 Stable: F.-V.A&A 2003 ★20 Stable: F.-V. additional ★25 Potentially stable
Other: • 117 Stable: F.-V.A&A 2003 • 33 Stable: F.-V. additional • 36 Potentially stable

ICRF Defining Sources



★101 Stable
★44 Unstable
★24 Potentially Stable
★43 Too little data

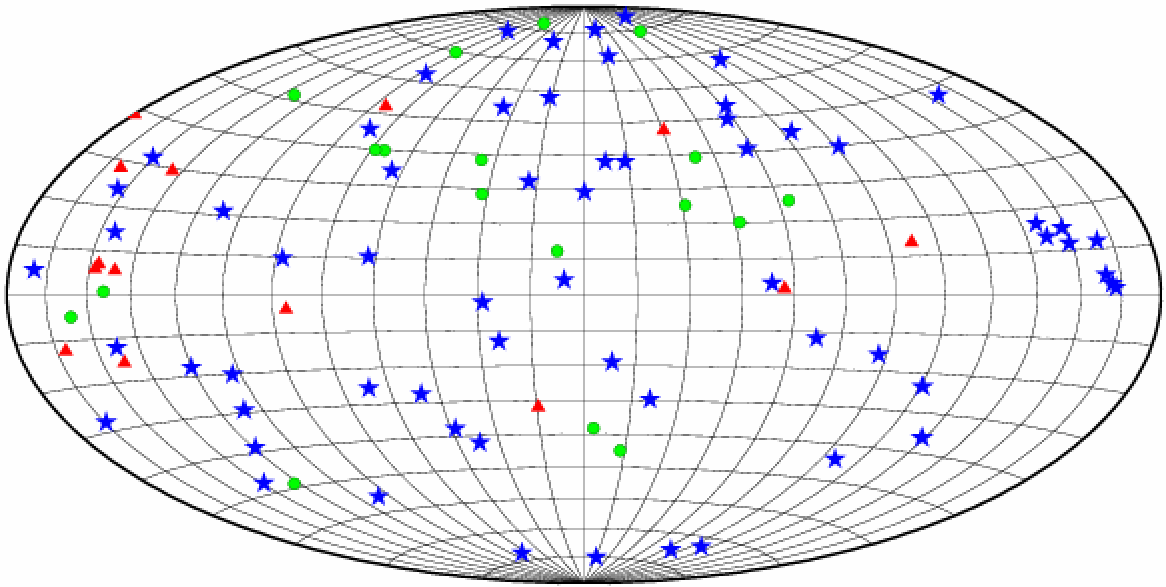
Geodetic Sources



★ 30 ICRF Defining

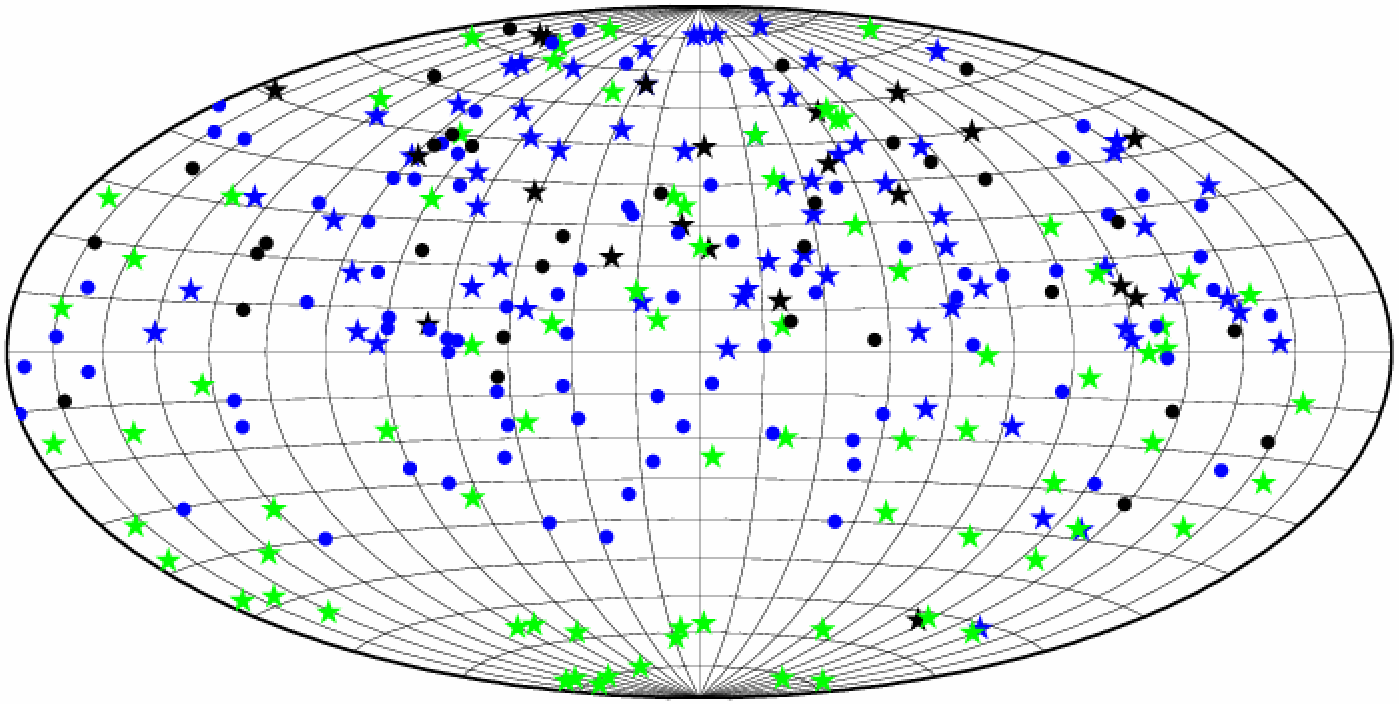
• 77 others

Geodetic Source Stability
Feissel Version 1

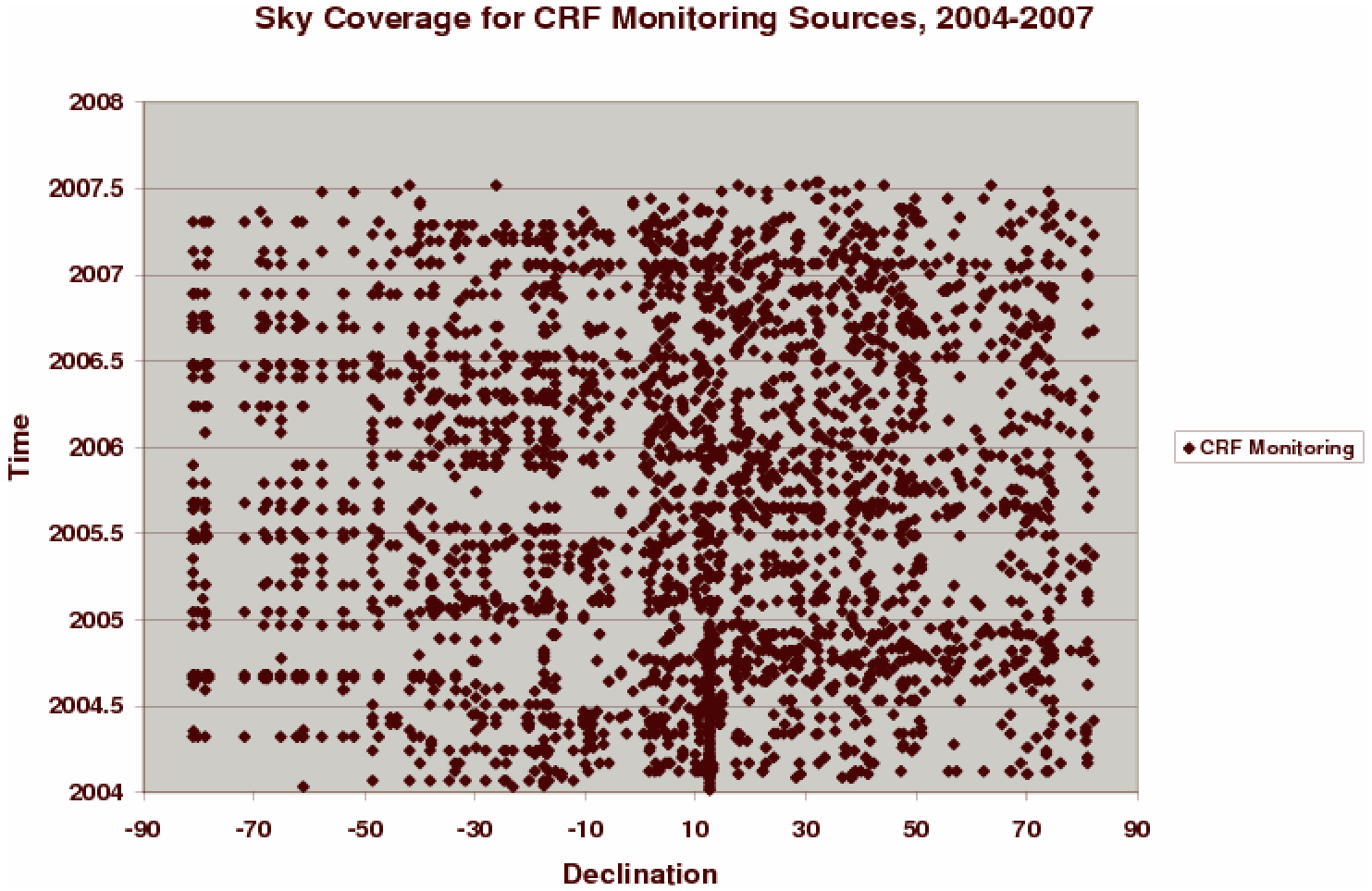


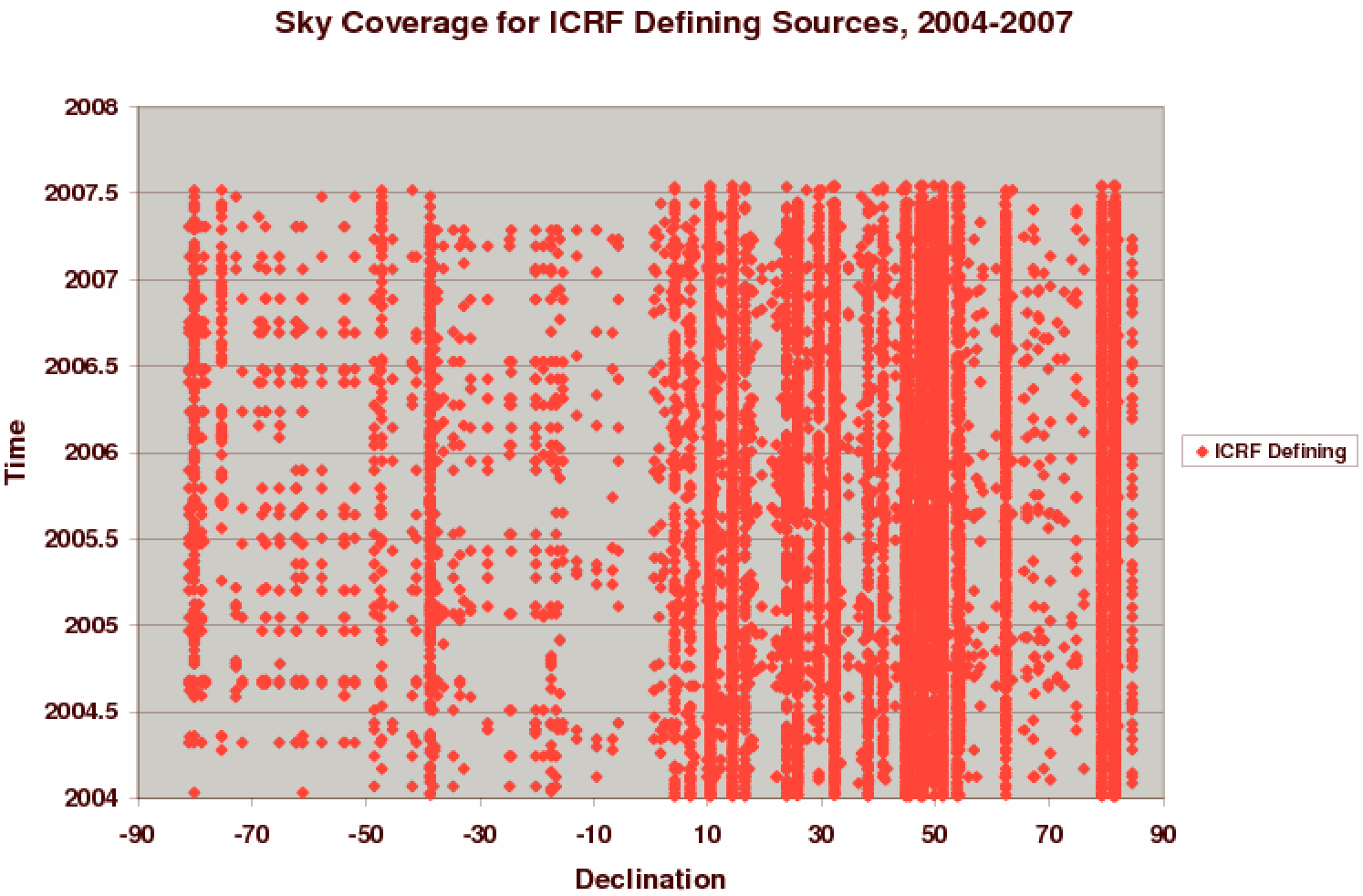
★ 67 Stable ▲ 18 Unstable ● 22 Other

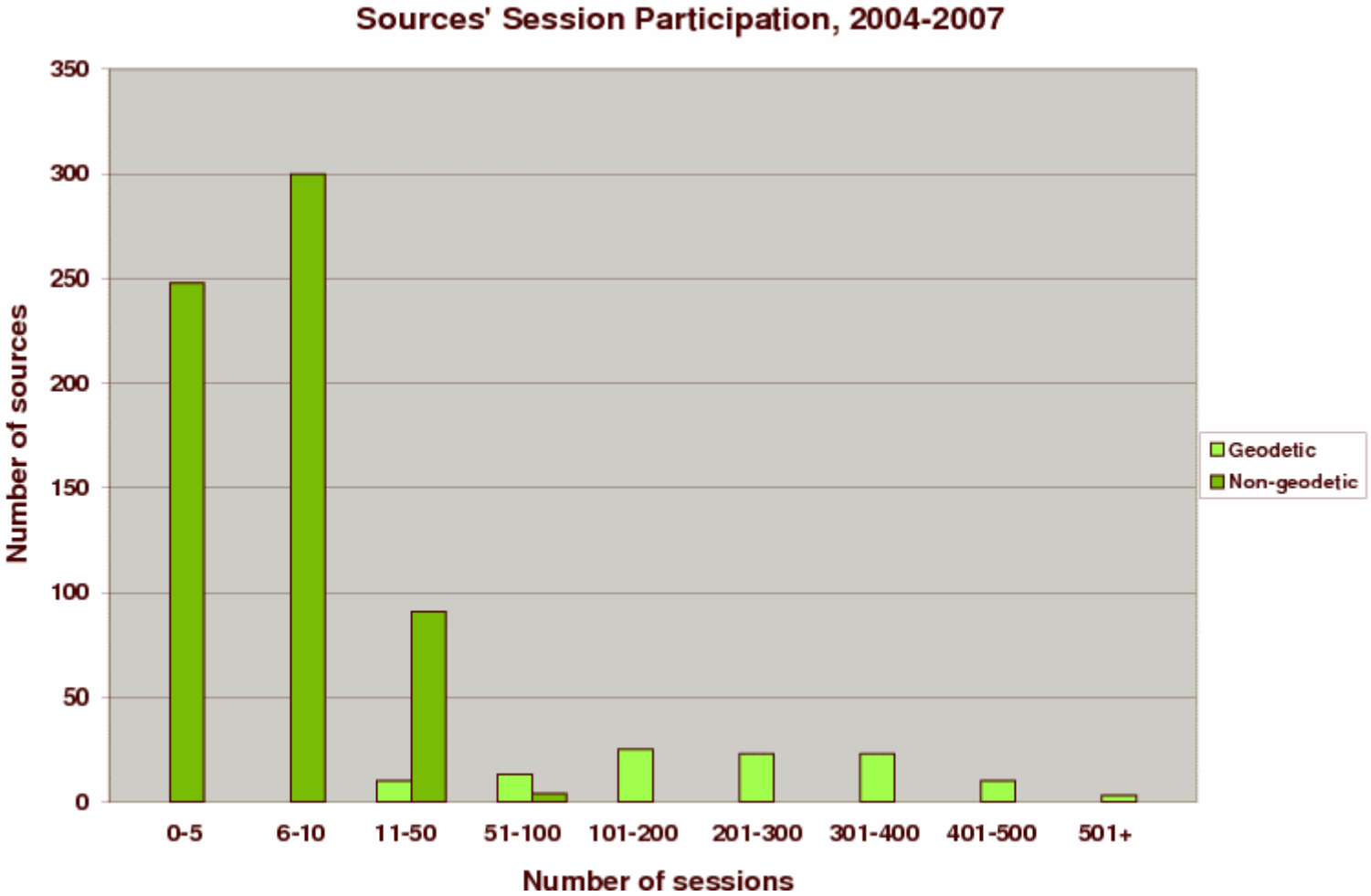
Total CRF Monitoring Sources

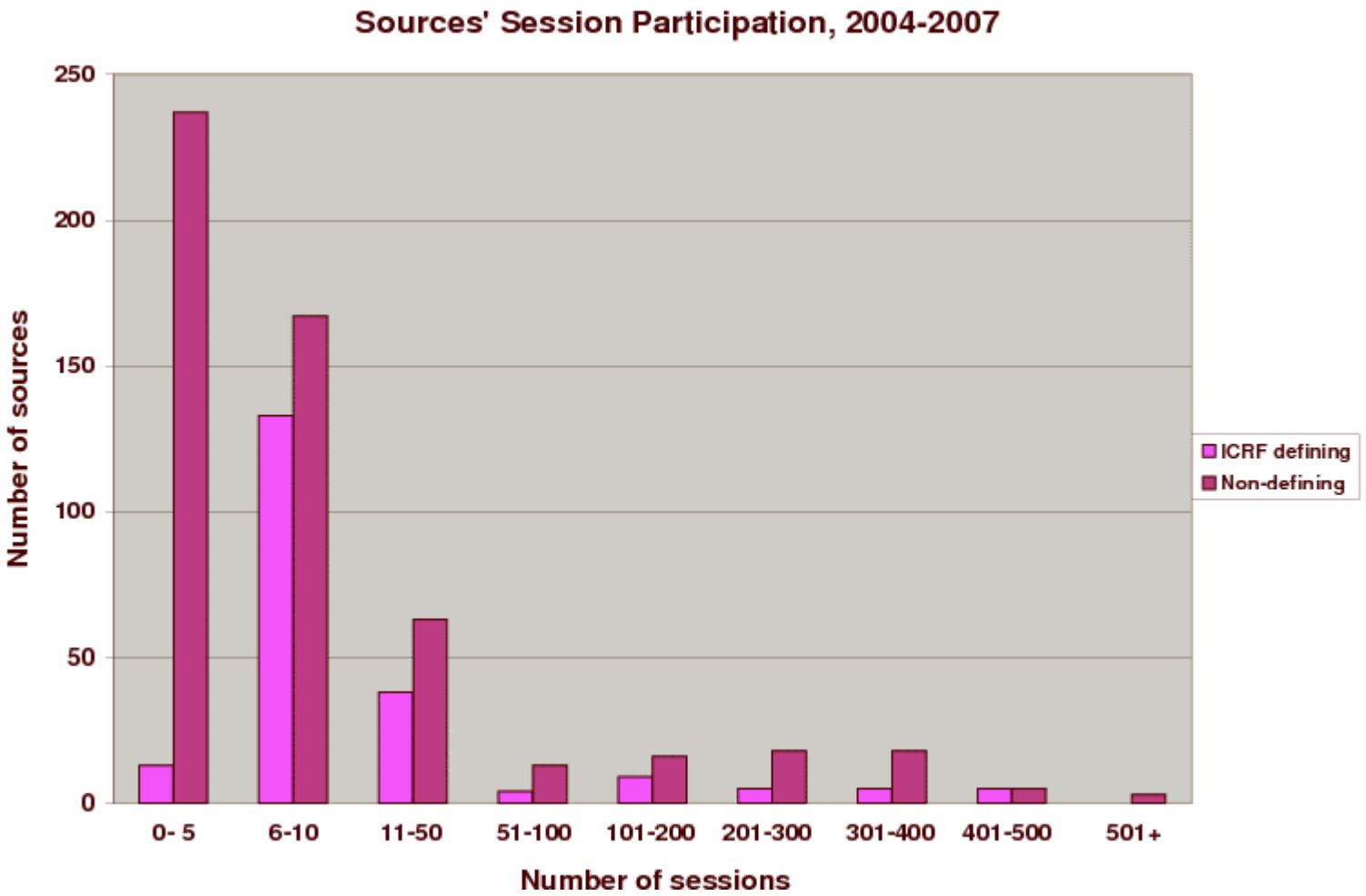


★ 74 Stable ICRF
• 89 Stable other
★ 25 Potentially stable ICRF
• 36 Potentially stable other
★ 83 Other ICRF defining

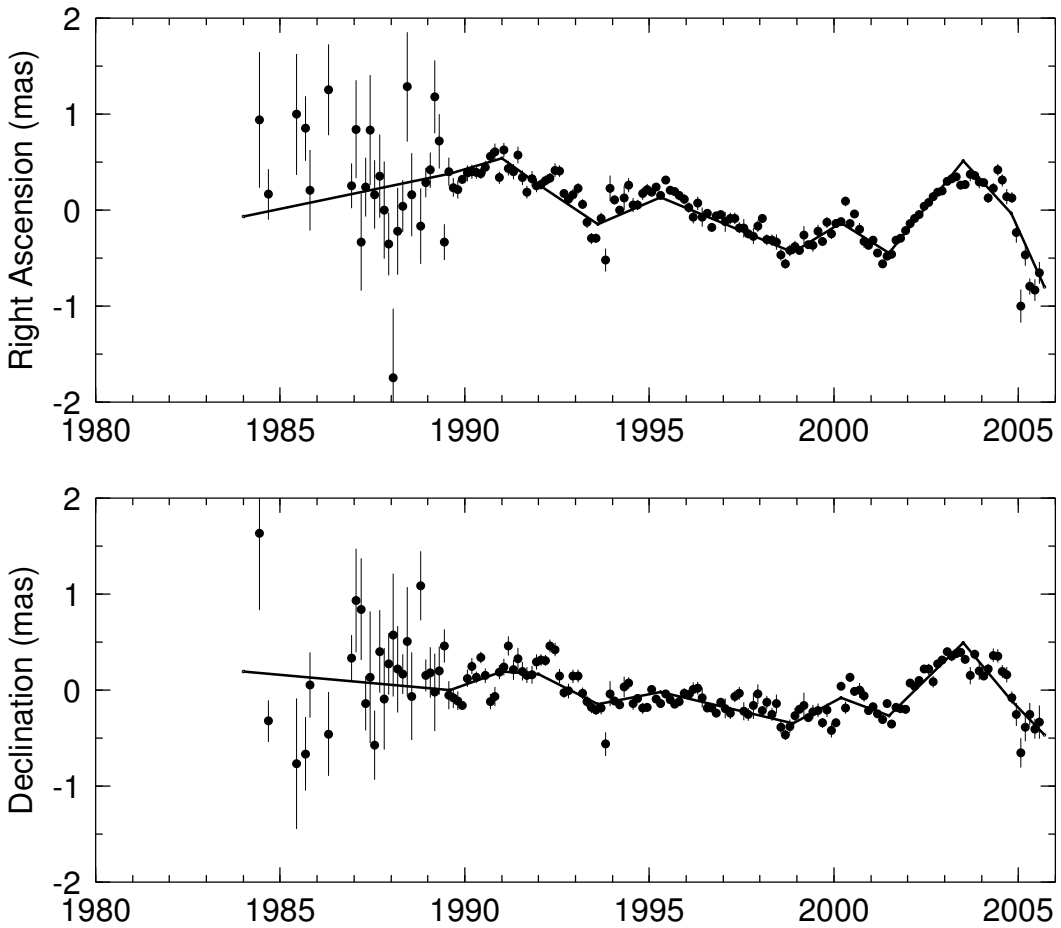

Sky Coverage for CRF Monitoring Sources, 2004-2007
Time
2008
2007.5
2007
2006.5
2006
2005.5
2005
2004.5
2004
-90
-70
-50
-30
-10
10
30
50
70
90
Declination
CRF Monitoring


Sky Coverage for ICRF Defining Sources, 2004-2007
Time
2008
2007.5
2007
2006.5
2006
2005.5
2005
2004.5
2004
-90
-70
-50
-30
-10
10
30
50
70
90
Declination
ICRF Defining

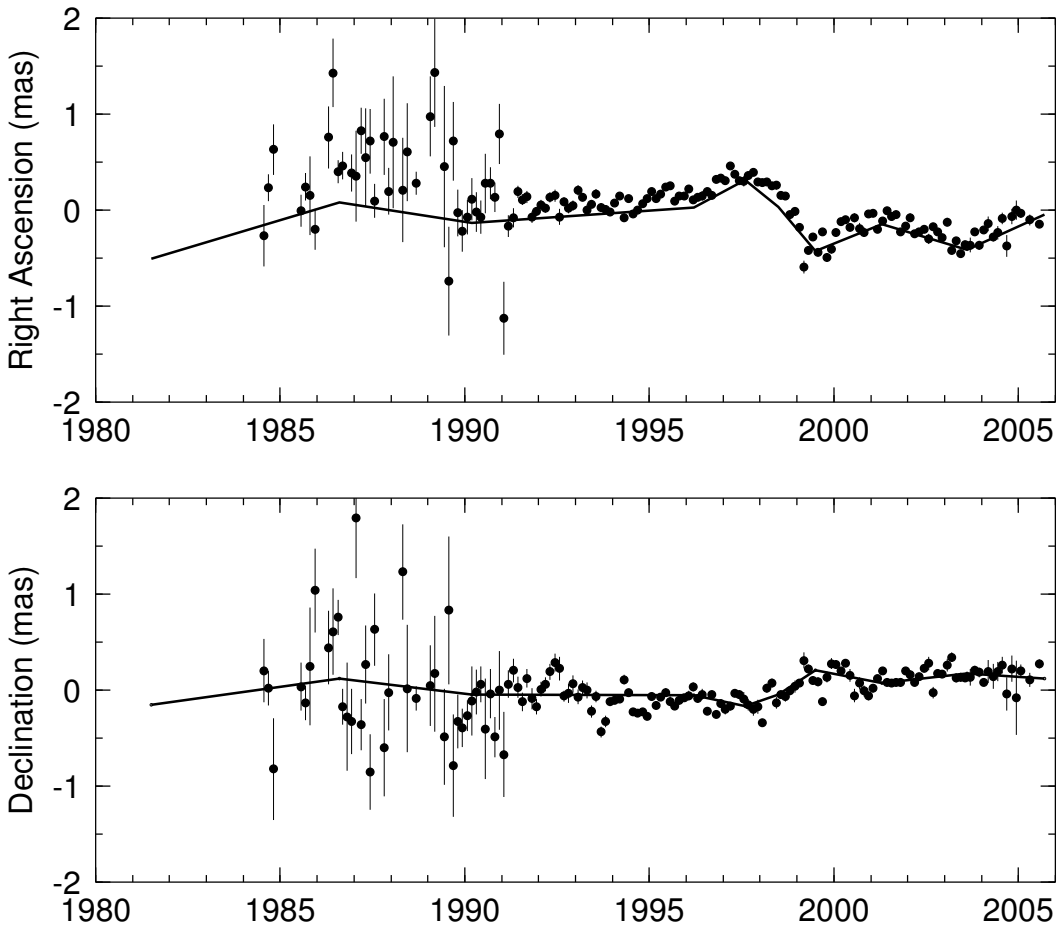

Sources' Session Participation, 2004-2007
Number of sources
350
300
250
200
150
100
50
0
0-5
6-10
11-50
51-100
101-200
201-300
301-400
401-500
501+
Number of sessions
Geodetic
Non-geodetic


Sources' Session Participation, 2004-2007
Number of sources
250
200
150
100
50
0
0- 5
6-10
11-50
51-100
101-200
201-300
301-400
401-500
501+
Number of sessions
ICRF defining
Non-defining

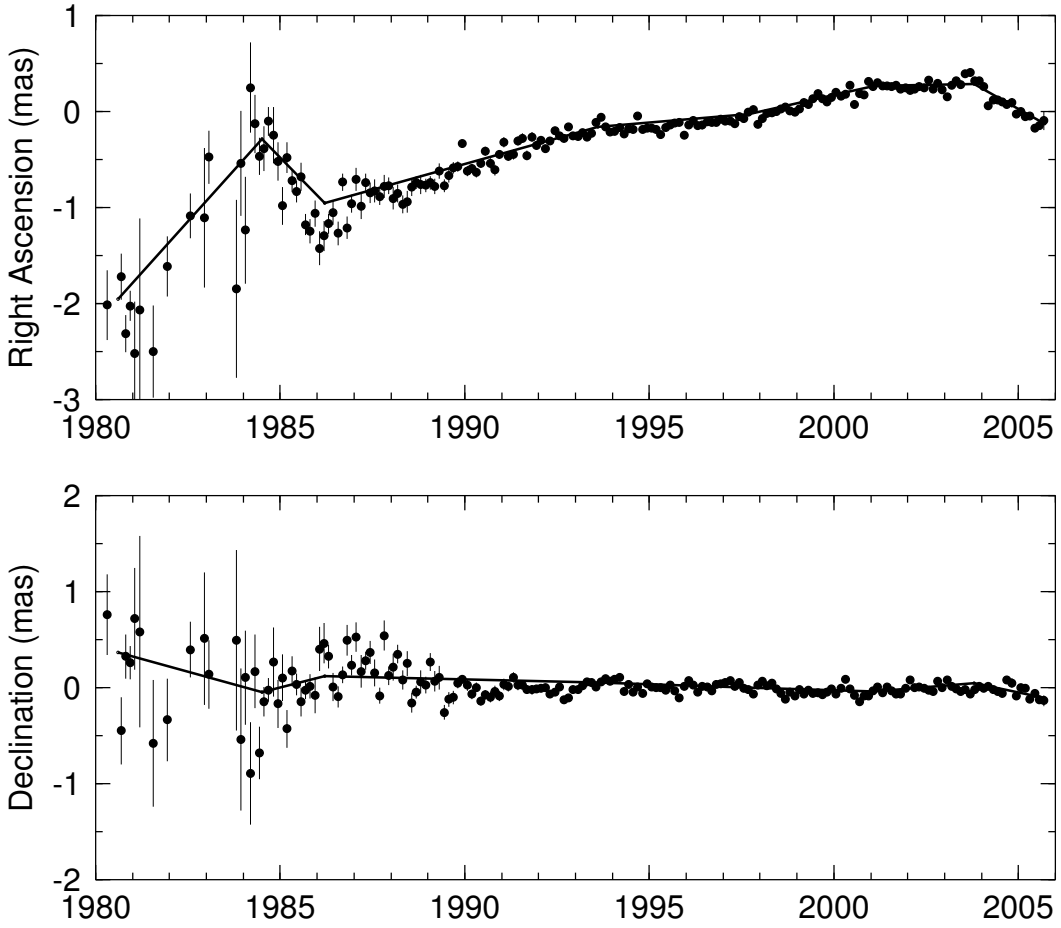
2234+282

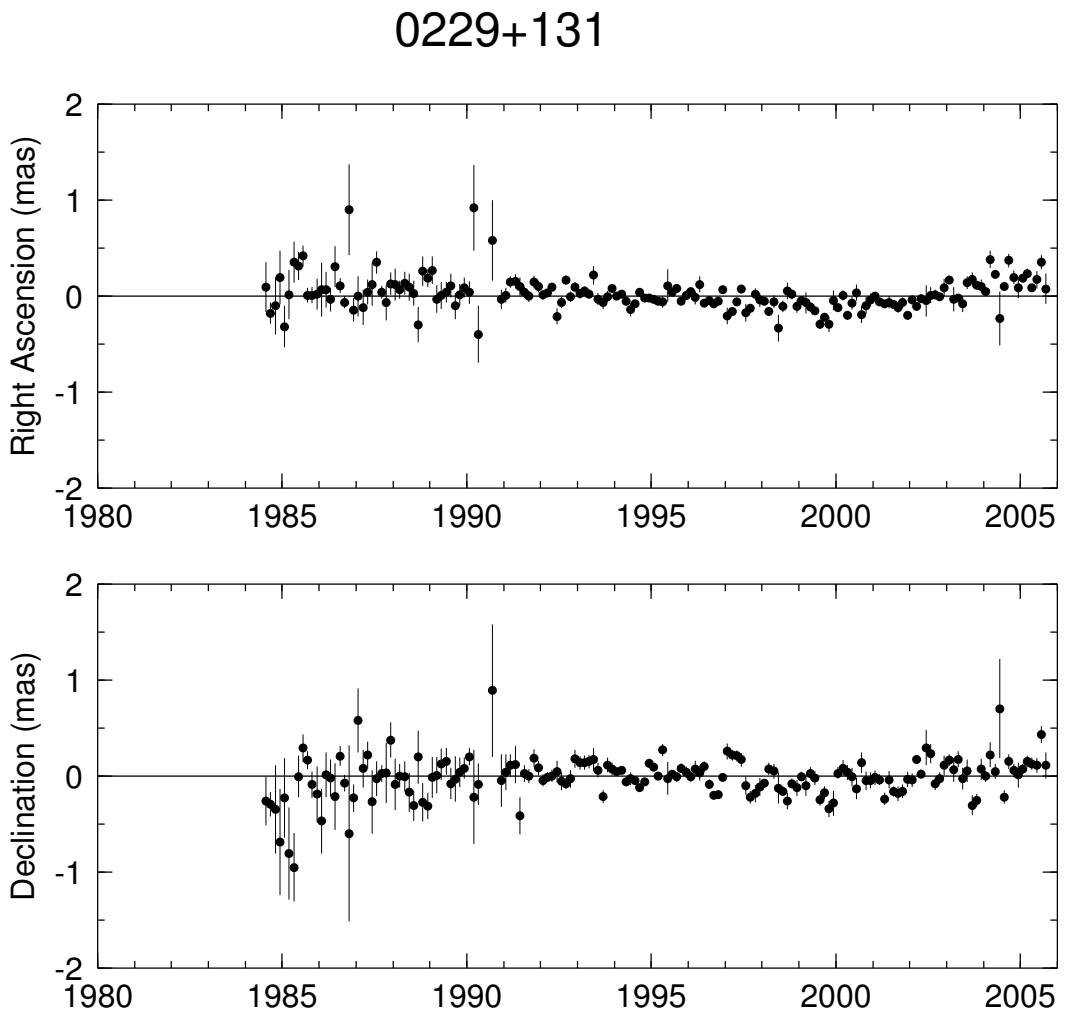

Right Ascension (mas)
Declination (mas)
2
1
0
-1
-2
1980
1985
1990
1995
2000
2005

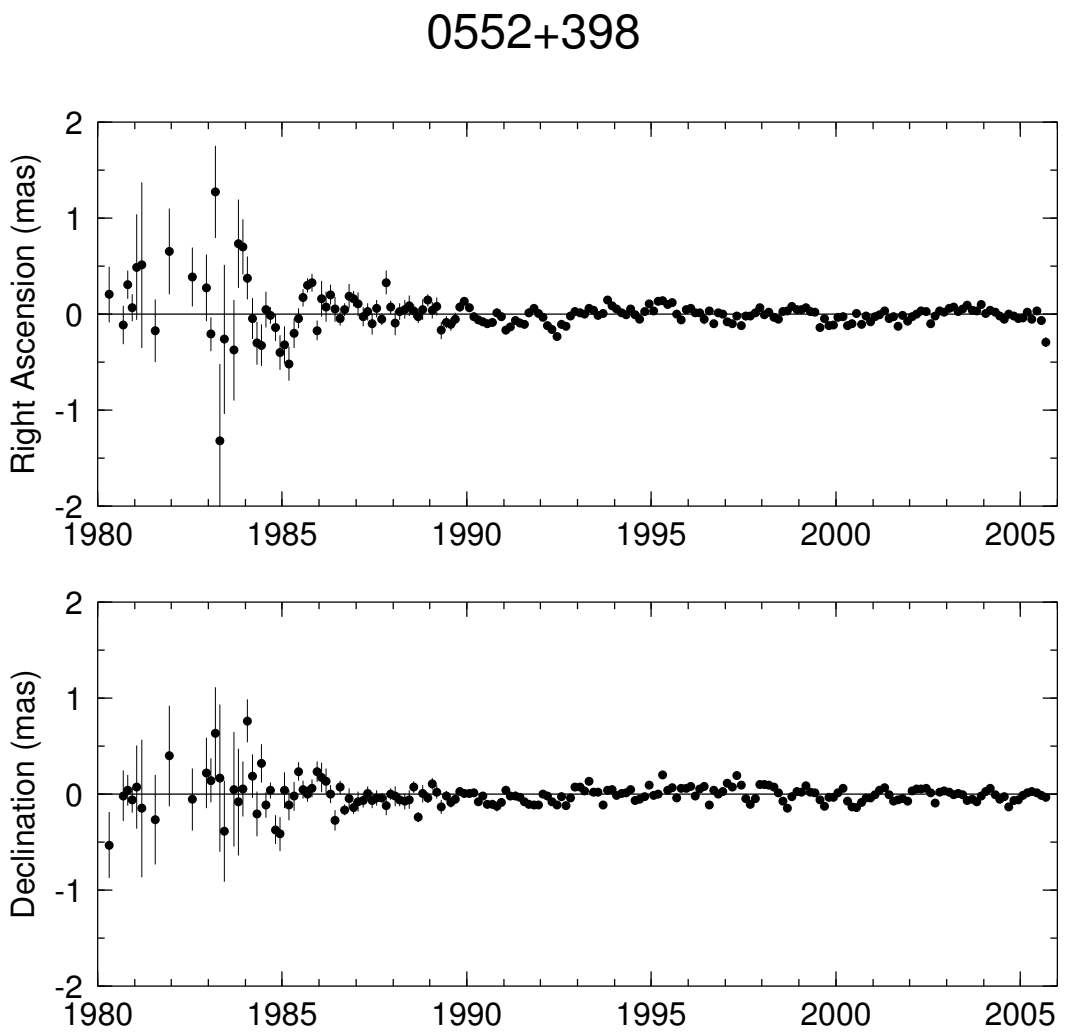
2145+067


Right Ascension (mas)
Declination (mas)
2
1
0
-1
-2
1980
1985
1990
1995
2000
2005

4C39.25


Right Ascension (mas)
1
0
-1
-2
-3
1980
1985
1990
1995
2000
2005
Declination (mas)
2
1
0
-1
-2
1980
1985
1990
1995
2000
2005


0229+131
Right Ascension (mas)
Declination (mas)
2
1
0
-1
-2
1980
1985
1990
1995
2000
2005


0552+398
Right Ascension (mas)
Declination (mas)
2
1
0
-1
-2
1980
1985
1990
1995
2000
2005

Source Position Time Series

Geoscience Australia

Paris Observatory

BKG (Germany)

DGFI (Germany)

Institute of Applied Astronomy (Russia)

Main Astronomical Observatory (Ukraine)

Goddard Space Flight Center (USA)

U.S. Naval Observatory

Solution Strategies

Treat some sources as global parameters and others as arc parameters

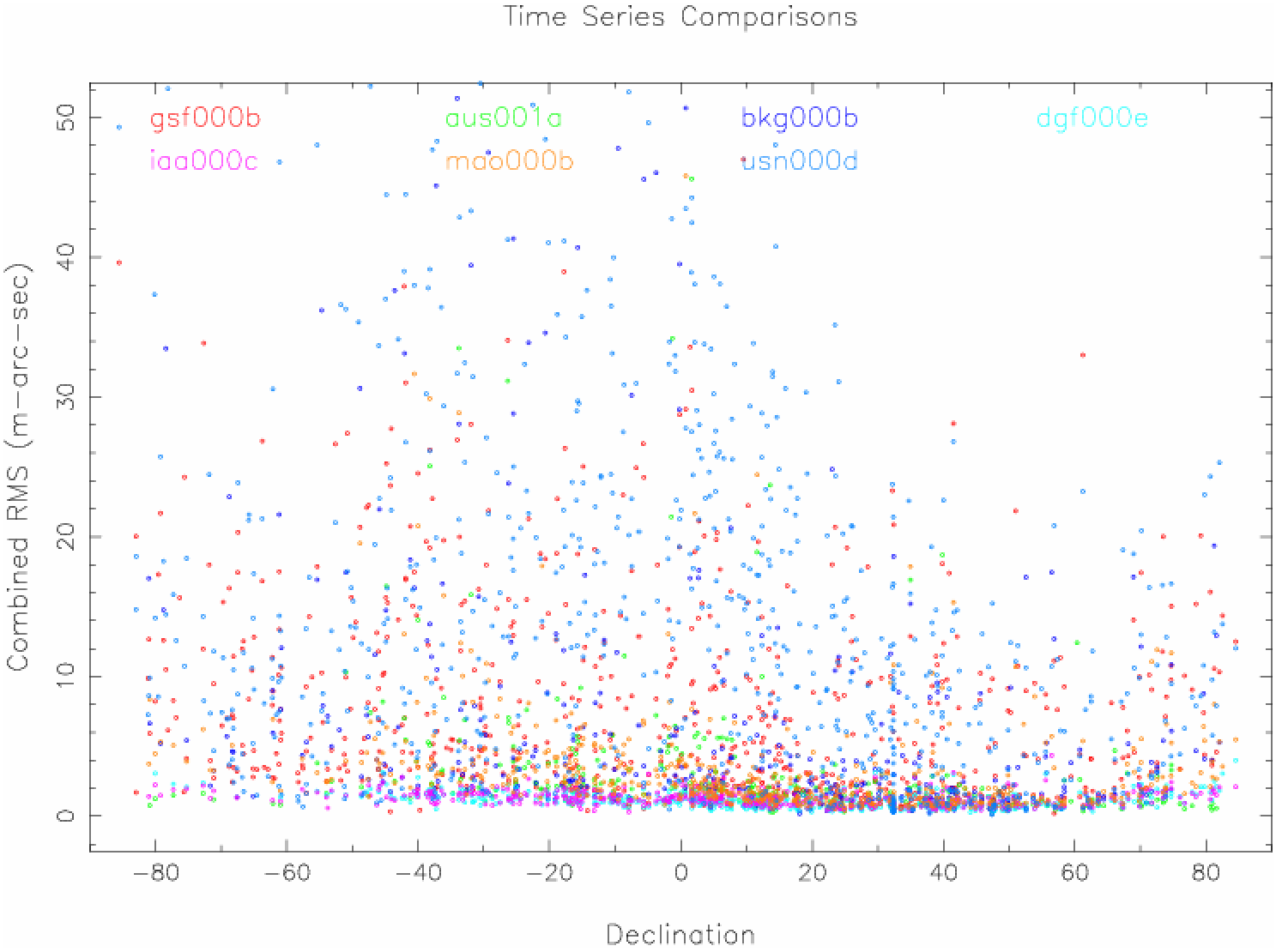
Treat all sources as arc parameters

Treat only stable sources as global parameters

Cycle through sources as global parameters in several solutions

Set reference frame using ICRF defining sources

Set reference frame using stable sources


Time Series Comparisons
gsf000b
aus001a
bkg000b
dgf000e
iaa000c
mao000b
usn000d
Combined RMS (m-arc-sec)
0
10
20
30
40
50
-80
-60
-40
-20
0
20
40
60
80
Declination

Application of Time Series to Select Defining Sources

Comparisons to determine “best” strategy for generation

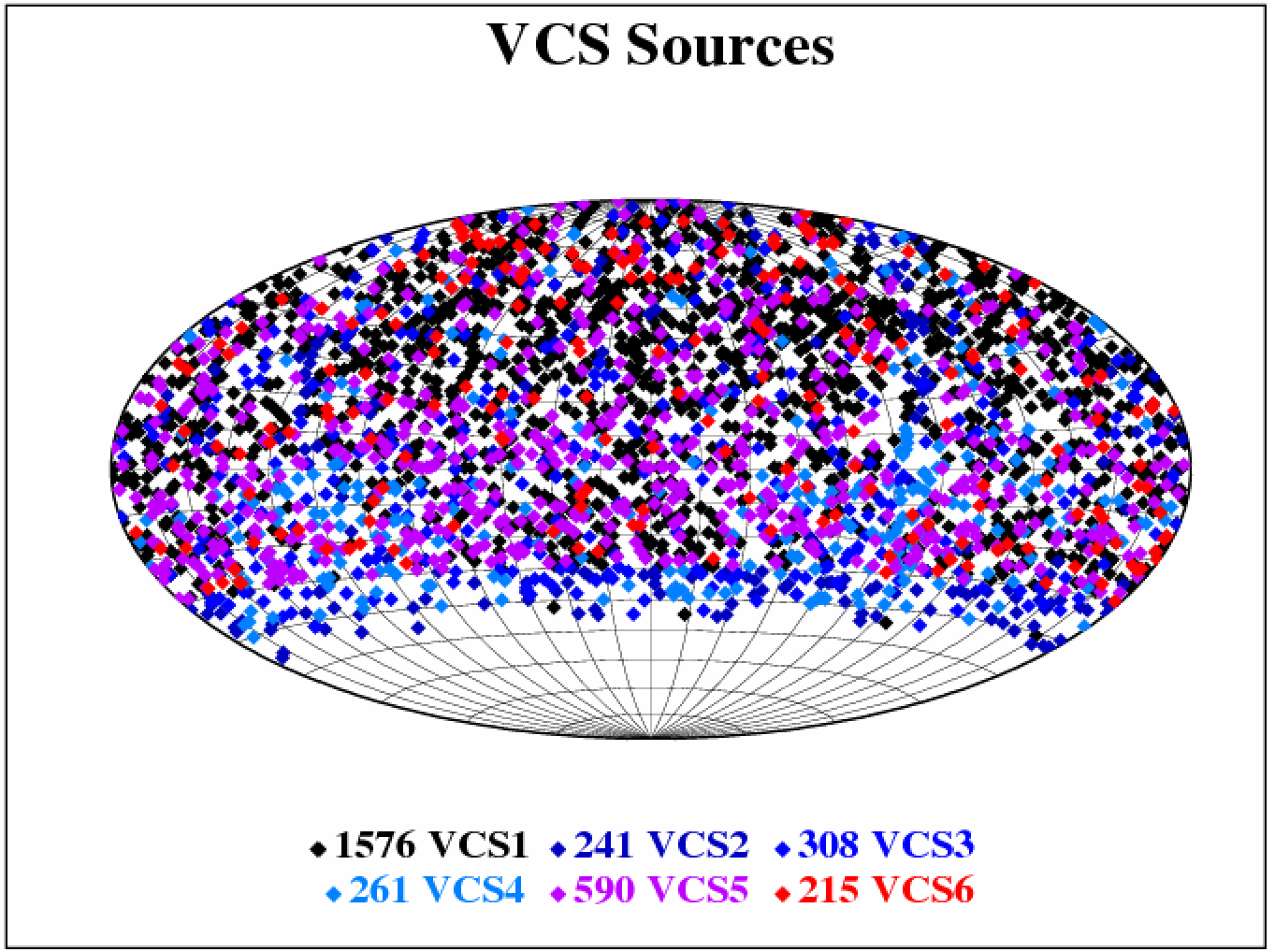
Analysis - statistical measures (standard deviation, Allan variance, …)

treatment of dense (many sessions / year) vs sparse (2-3 / yr) series

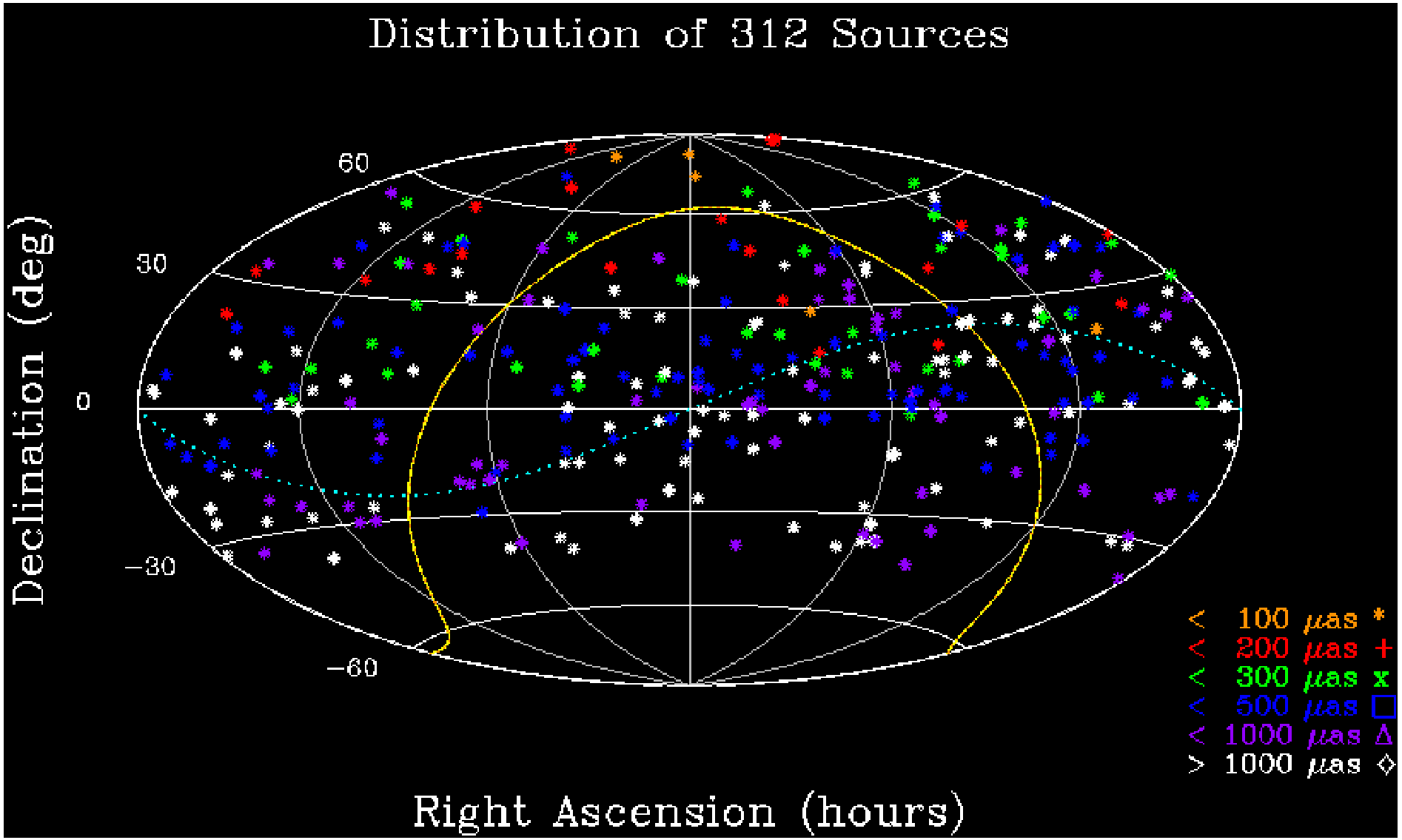
setting criteria for stable and unstable sources

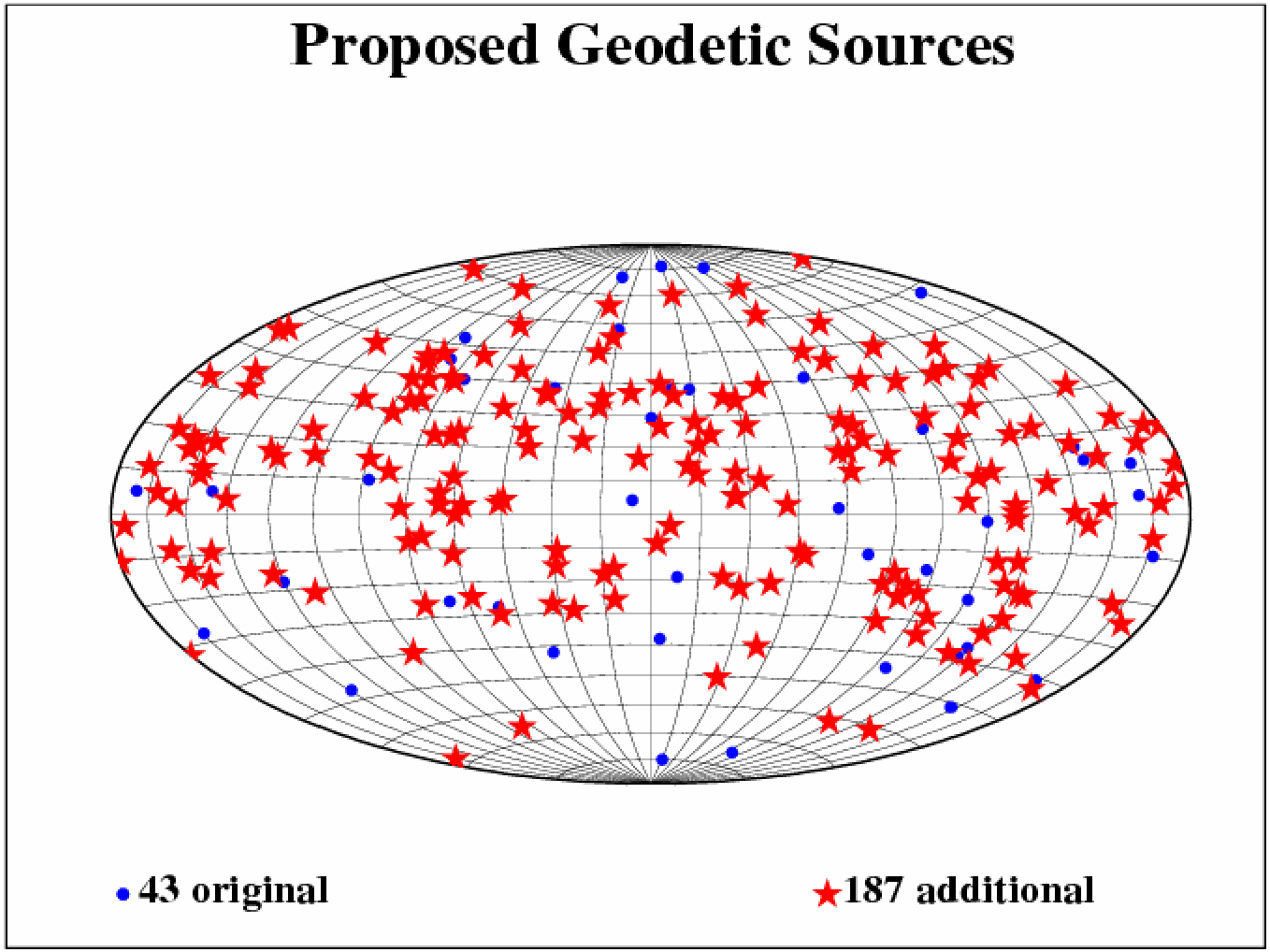
Issues for the next radio ICRF

- Selection of defining sources
- Treatment of source position variations
- Improvement of geophysical and astronomical modeling
- Selection of data
- Integration of ICRF, ITRF and EOP
- Generation of final catalogue


VCS Sources
1576 VCS1
241 VCS2
308 VCS3
261 VCS4
590 VCS5
215 VCS6

X/Ka (8.4/32 GHz results: 312 Sources detected




Proposed Geodetic Sources
43 original
187 additional