Zinovy Malkin: 5,000,000 Delays—Some Statistics, IVS 2004 General Meeting Proceedings, p.47–51
http://ivscc.gsfc.nasa.gov/publications/gm2004/malk1

5,000,000 Delays—Some Statistics

Zinovy Malkin

Institute of Applied Astronomy of Russian Academy of Sciences (IAA)
e-mail: malkin@quasar.ipa.nw.ru

Abstract

5,000,000 VLBI delays are stored now in the IVS data base and available for scientific analysis. This is a remarkable result of more than 20 years of geodetic VLBI history. This paper presents some statistics related to the VLBI observations during almost 25 years of geodetic VLBI.

At the end of 2004, the number of VLBI delays obtained in the framework of the geodetic and astrometric VLBI programs reached 5,000,000! This is one of the major milestones in the VLBI history resulting from almost 25 years of heroic efforts by astronomers and physicists, engineers and programmers, network stations and correlator teams.

Most of the statistics presented here (when not indicated explicitly) are related to all the observing sessions, independent of their duration. As can be seen from Table 1, only number of sessions substantially depends on the session set taken into account, other statistics are practically the same for all sessions and 24h ones (we consider the session as 24h one if its duration is 18 hours or greater). One can see that most of observations were obtained during the 24h and intensives ($< 2h$) sessions. The sessions with duration 2–18h were, evidently, rather sporadic.

Table 1. Statistics depending on the session duration. Number of observations is given in thousands. Number of stations includes also the experimental ones (KASL, MOJAVLBA, NOTOX, LEFT85_1, VLBA85_3, WIDE85_3).

Session duration	All	≥ 18h	< 18h	< 12h	< 6h	< 2h
Number of observations	5005	4913	92	80	68	64
Number of sessions	8528	3757	4771	4737	4633	4528
Number of stations	159	156	53	40	29	17
Number of baselines	1356	1335	167	94	51	33
Number of sources	2254	2248	406	355	201	119

These observations were collected in 8528 sessions (3757 of them with duration 18h or greater) at 159 stations including experimental ones, on 1356 baselines (there was a misprint in the IVS Newsletter of August 2002, number of baselines 1722 given there should be 1272). Totally, 2254 sources were observed, more the half of them during the VLBA Calibrator Survey program.

Figure 1 shows how the overall result was reached. It is interesting to see how much time was needed to get each million observations (Table 2). Apparently, a limit of the capacity of existing IVS network is reached in the late 1990s.

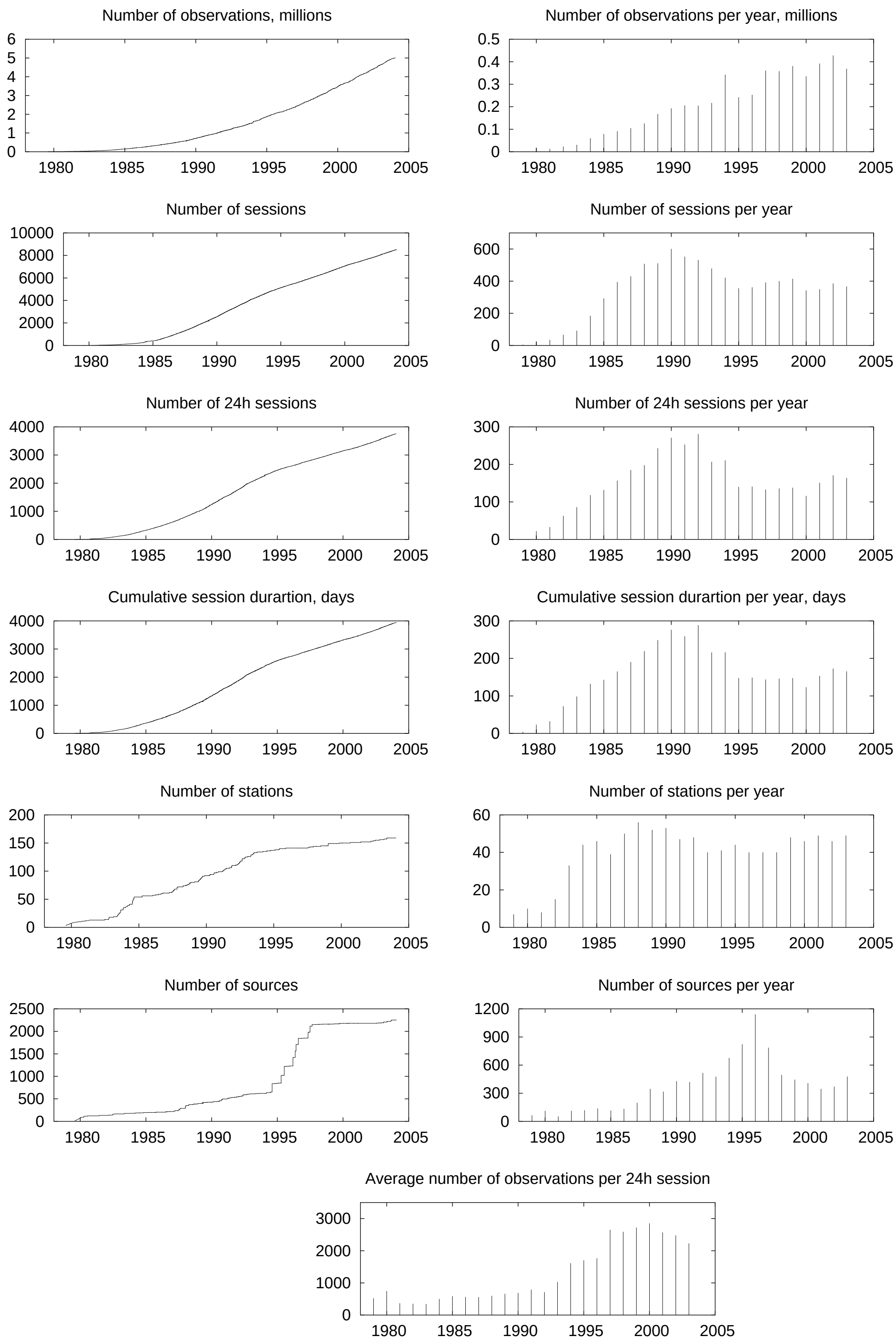

Figure 1. Overall statistics.

Table 2. Time taken to collect each million observations (ΔT), the corresponding period of observations (T_{beg}–T_{end}), and number of sessions. Some inconsistencies between ΔT and T_{beg}–T_{end} are due to rounding.

Million	1st	2nd	3rd	4th	5th
ΔT, years	11.9	3.9	3.3	2.6	2.6
$T_{beg} - T_{end}$	1979.6–1991.5	1991.5–1995.5	1995.5–1998.7	1998.7–2001.4	2001.4–2004.0
# of sessions	3425	1873	1234	1002	976
# of 24h sessions	1628	901	444	348	432

Here are some extreme statistics with examples:

Maximum number of stations:	20	(991220XA)
Maximum number of baselines:	188	(991220XA)
Maximum number of sources:	263	(950715XV)
Maximum number of observations:	34221	(991220XA)
Maximum number of good observations:	30372	(991220XA)
Maximum number of bad observations:	4092	(940812XV)
Maximum percentage of good observations:	100.0	(860223X)
Maximum percentage of bad observations:	90.8	(911205MV)
The longest sessions, h:	99.2	(830520D)

Table 3 shows most active stations during the whole period of observations, and Tables 4–5 present statistics for sources and baselines. The longest attempted baselines is SESHAN25–TIGOCONC (12660 km), but no successful observations (zero quality code in NGS files) was obtained. The longest baseline with successful observations is DSS65–HOBART26 (12520 km). The shortest baselines was KAUAI–KOKEE (39 m)

Table 3. Most active stations, Nobs – number of observations, Nsess – number of sessions.

Ordered by number of observations				Ordered by number of sessions			
All sessions		24h sessions		All sessions		24h sessions	
Station	Nobs	Station	Nobs	Station	Nsess	Station	Nsess
GILCREEK	1016731	GILCREEK	1007188	WETTZELL	6291	WETTZELL	1893
WETTZELL	979313	WETTZELL	916828	WESTFORD	3849	GILCREEK	1731
WESTFORD	876858	WESTFORD	853711	GILCREEK	1937	WESTFORD	1640
KOKEE	541291	KOKEE	529154	KOKEE	1639	KOKEE	953
NYALES20	410231	NYALES20	409257	NRAO20	1389	RICHMOND	734
MATERA	314207	MATERA	311260	NRAO85 3	1145	HRAS 085	732
ONSALA60	292715	ONSALA60	291044	RICHMOND	794	MOJAVE12	726
MOJAVE12	288671	MOJAVE12	286644	HRAS 085	742	FORTLEZA	704
LA-VLBA	268754	LA-VLBA	268754	MOJAVE12	737	HARTRAO	593
ALGOPARK	260134	ALGOPARK	260134	FORTLEZA	706	ALGOPARK	527

Figures 2 and 3 show the evolution of some observational data and EOP uncertainty (IAA EOP series) with time.

Table 4. Most observed sources, Nobs – number of observations, Nsess – number of sessions.

Ordered by number of observations				Ordered by number of sessions			
All sessions		24h sessions		All sessions		24h sessions	
Source	Nobs	Source	Nobs	Source	Nsess	Source	Nsess
0552+398	271721	0552+398	266837	0552+398	5996	0552+398	3517
4C39.25	201307	4C39.25	198602	4C39.25	5137	4C39.25	3231
0059+581	166093	0059+581	163363	0059+581	4299	OJ287	3099
1803+784	146816	1803+784	138602	1803+784	4201	0528+134	2904
OJ287	135129	OJ287	131791	OJ287	3765	1741-038	2640
1739+522	131596	1739+522	131196	1739+522	3333	0727-115	2566
1357+769	125816	1357+769	122314	1357+769	3130	0229+131	2219
0528+134	113163	0528+134	112026	0528+134	2894	1803+784	2162
1308+326	101217	1741-038	99174	1741-038	2814	1334-127	2139
1741-038	99965	1308+326	99173	1308+326	2717	2145+067	2046

Table 5. Most observed baselines, Nobs – number of observations, Nsess – number of sessions.

Ordered by number of observations			
All sessions		24h sessions	
Baseline	Nobs	Baseline	Nobs
WESTFORD WETTZELL	171093	WESTFORD WETTZELL	149602
GILCREEK WESTFORD	134234	GILCREEK WESTFORD	133942
GILCREEK KOKEE	116313	GILCREEK KOKEE	116290
GILCREEK WETTZELL	111450	GILCREEK WETTZELL	111145
NYALES20 WETTZELL	90820	NYALES20 WETTZELL	90703
HRAS 085 WESTFORD	70704	HRAS 085 WESTFORD	70233
KOKEE WETTZELL	65154	MOJAVE12 WESTFORD	63085
MOJAVE12 WESTFORD	63252	FORTLEZA WETTZELL	62451
FORTLEZA WETTZELL	62456	MATERA WETTZELL	59681
MATERA WETTZELL	59945	GILCREEK KAUAI	56883

Ordered by number of sessions			
All sessions		24h sessions	
Baseline	Nsess	Baseline	Nsess
WESTFORD WETTZELL	3312	WESTFORD WETTZELL	1112
KOKEE WETTZELL	1415	GILCREEK WETTZELL	799
NRAO20 WETTZELL	1297	KOKEE WETTZELL	732
GILCREEK WETTZELL	818	GILCREEK WESTFORD	680
GILCREEK WESTFORD	683	HRAS 085 WESTFORD	595
NRAO85 3 WETTZELL	647	GILCREEK KOKEE	591
HRAS 085 WESTFORD	602	FORTLEZA WETTZELL	571
GILCREEK KOKEE	593	RICHMOND WESTFORD	566
FORTLEZA WETTZELL	572	FORTLEZA KOKEE	548
RICHMOND WESTFORD	567	RICHMOND WETTZELL	538

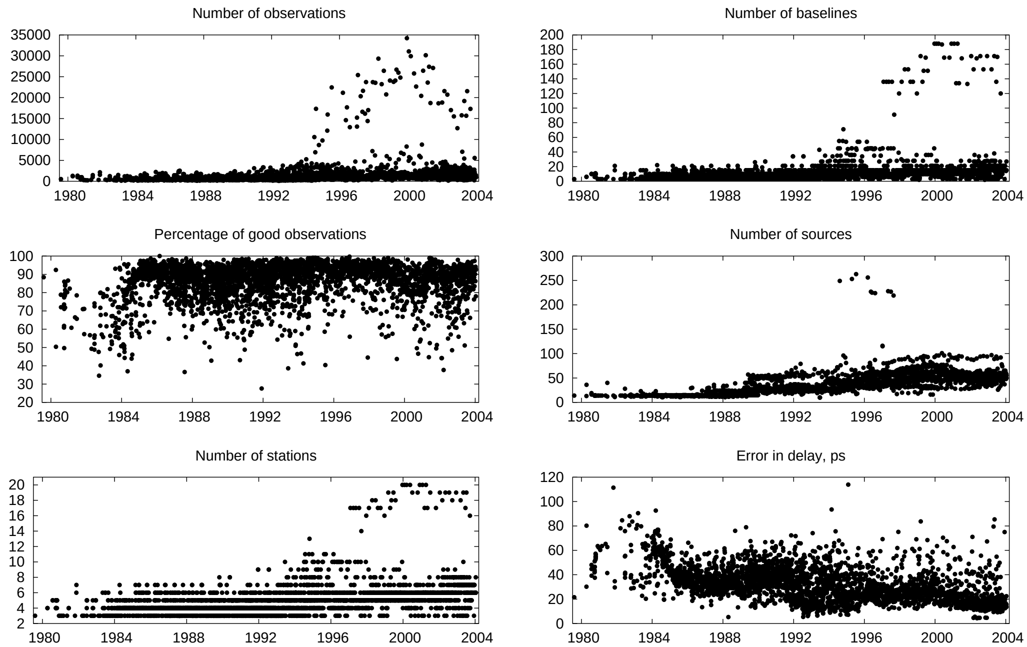

Figure 2. Statistics of the observational data. Each point corresponds to one 24h session. Sessions with the largest numbers of stations/baselines were observed along with VLBA network. Sessions with the largest number of sources were observed in the framework of the VLBA Calibration Survey program.

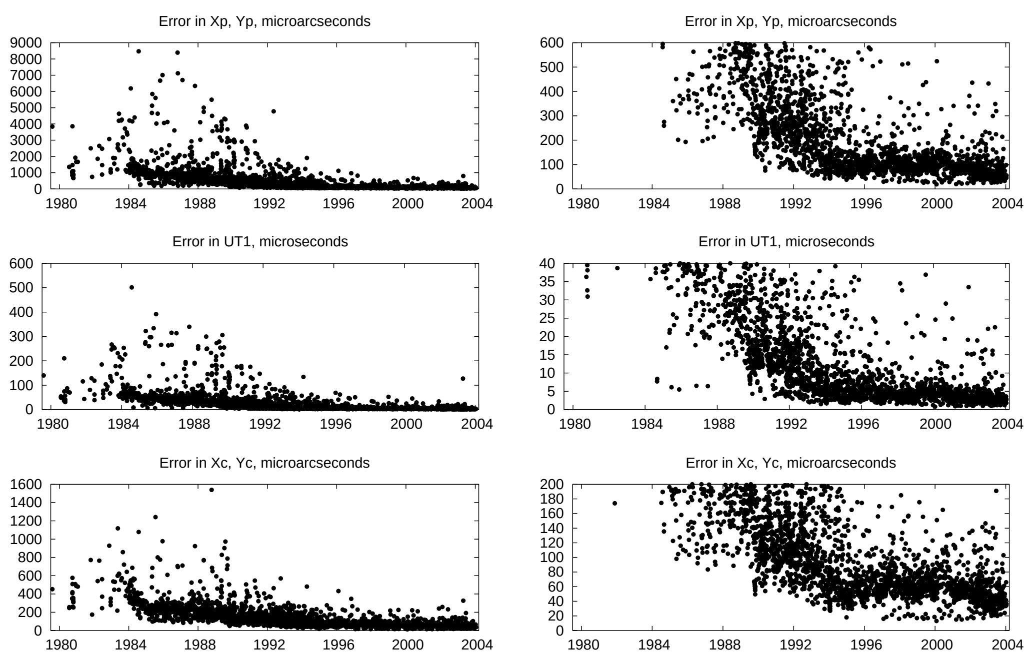

Figure 3. Errors in EOP (on the left are zoomed data). Each point corresponds to one 24h session. Note clear correlation with improvement in delay precision, and also with number of stations/baselines (Figure 2).