ITRF and Collocation Sites

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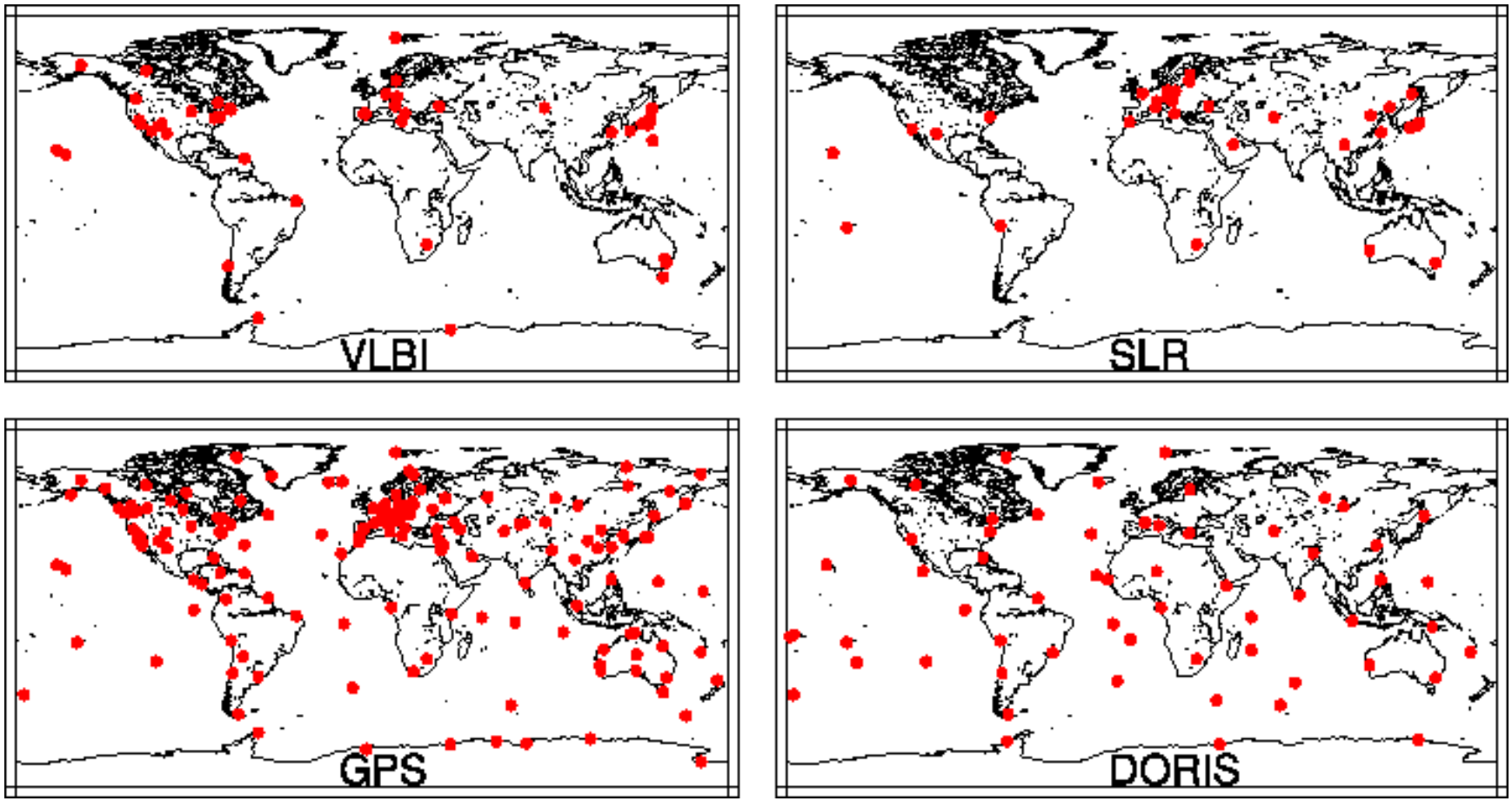
Definition of a Collocation Site

- **Two or more Space Geodesy instruments occupying close locations precisely surveyed**
- **Inter-marker distance (ideally few 100's m)**
- **Accuracy of the local tie (1-3 mm)**
- **Goal:**
  - **1 mm**
  - **Full Var-Cov in SINEX format**

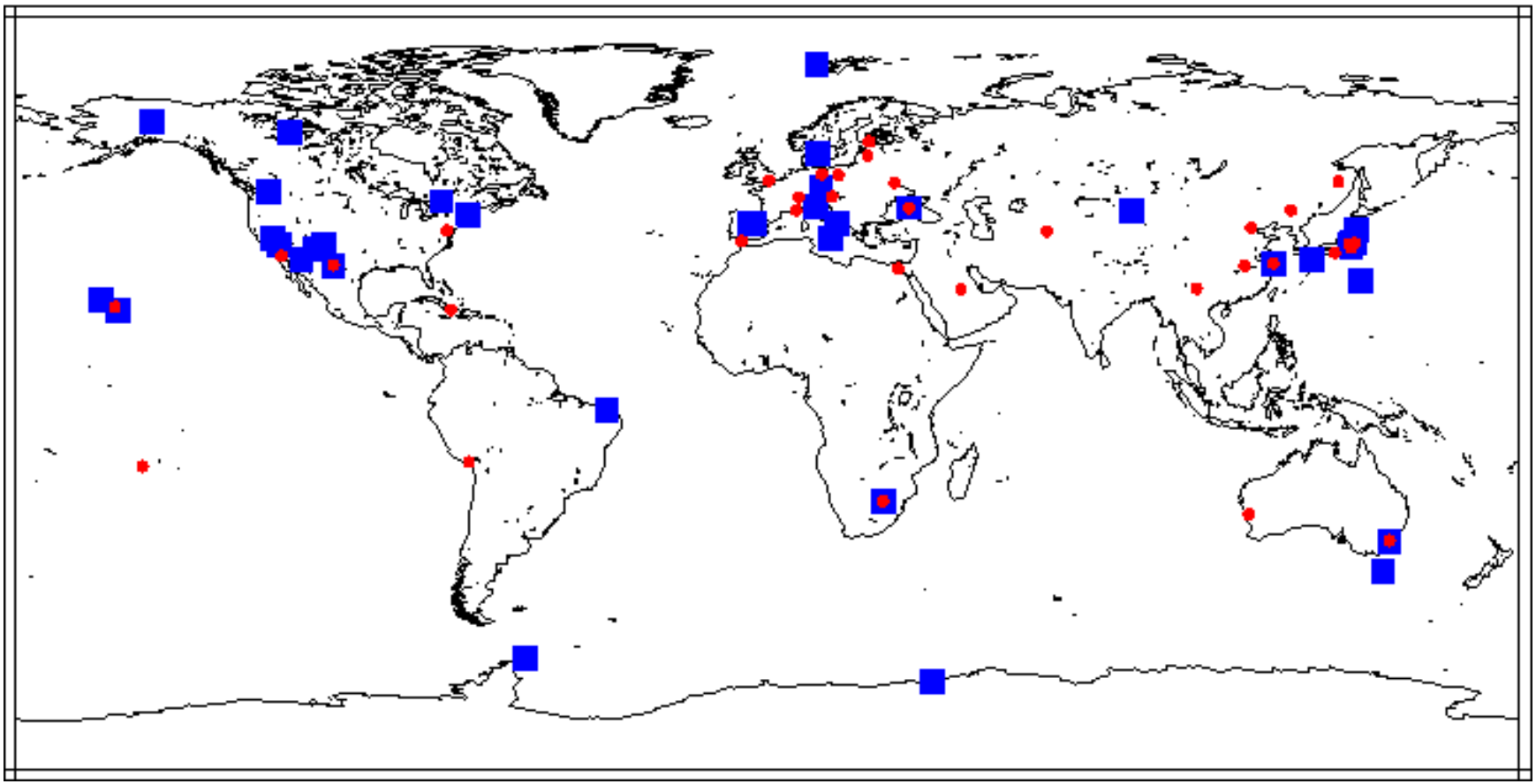
Current Use of Ties (ITRF2000)

- **As observation with variances (converted in SINEX)**
- **Variances often not available**
- $\sigma = \mathrm{DSQR}\left[(3_{mm})^2 + (10^{-6} \cdot D)^2\right]$
- **5 Full SINEX files in ITRF2000 from AUSLIG**
- **200 local tie vectors were included**
- **38 missing and 20 dubious (inconsistent)**

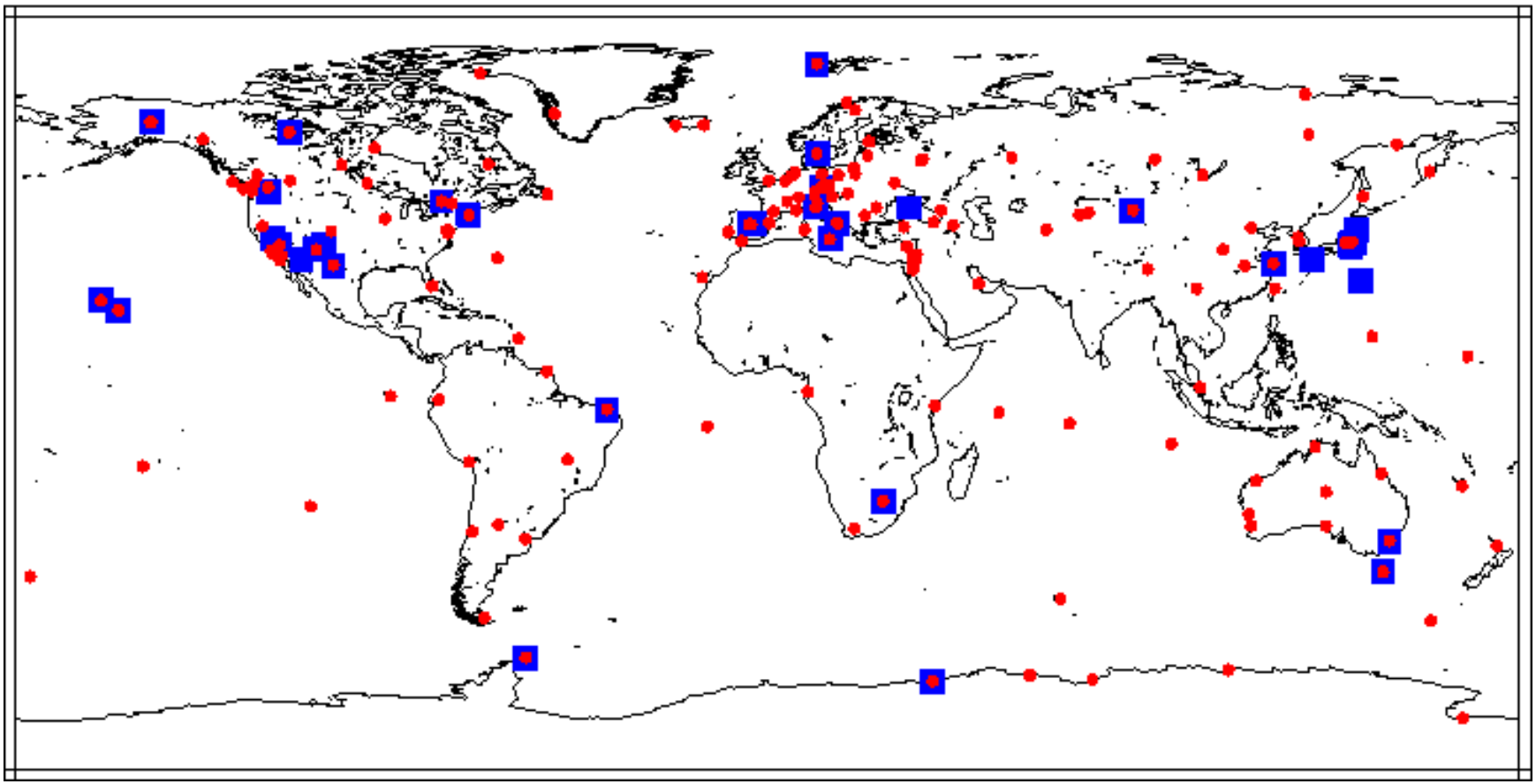
Current Networks (since ~ 5 yrs)



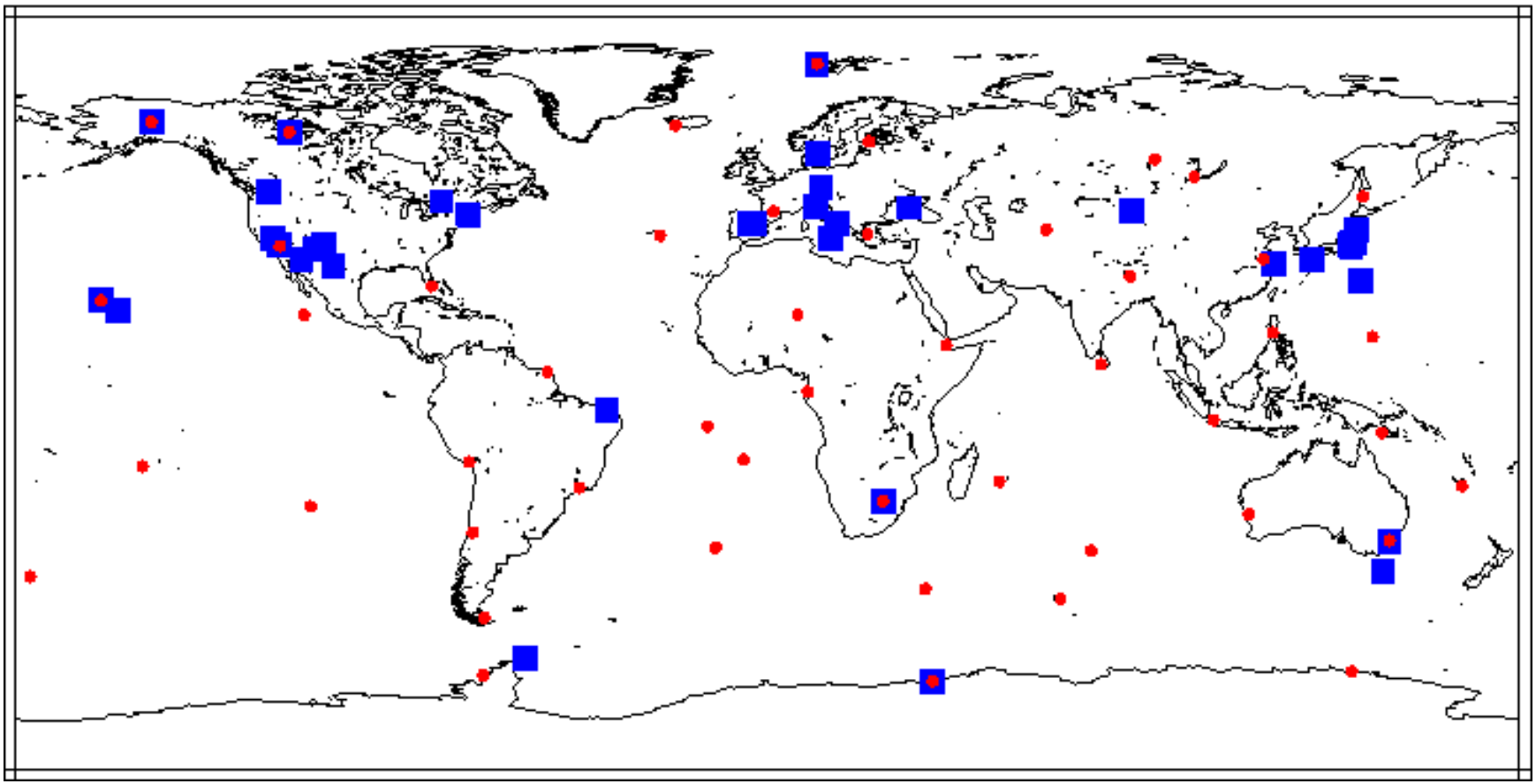
Current VLBI-SLR Collocations



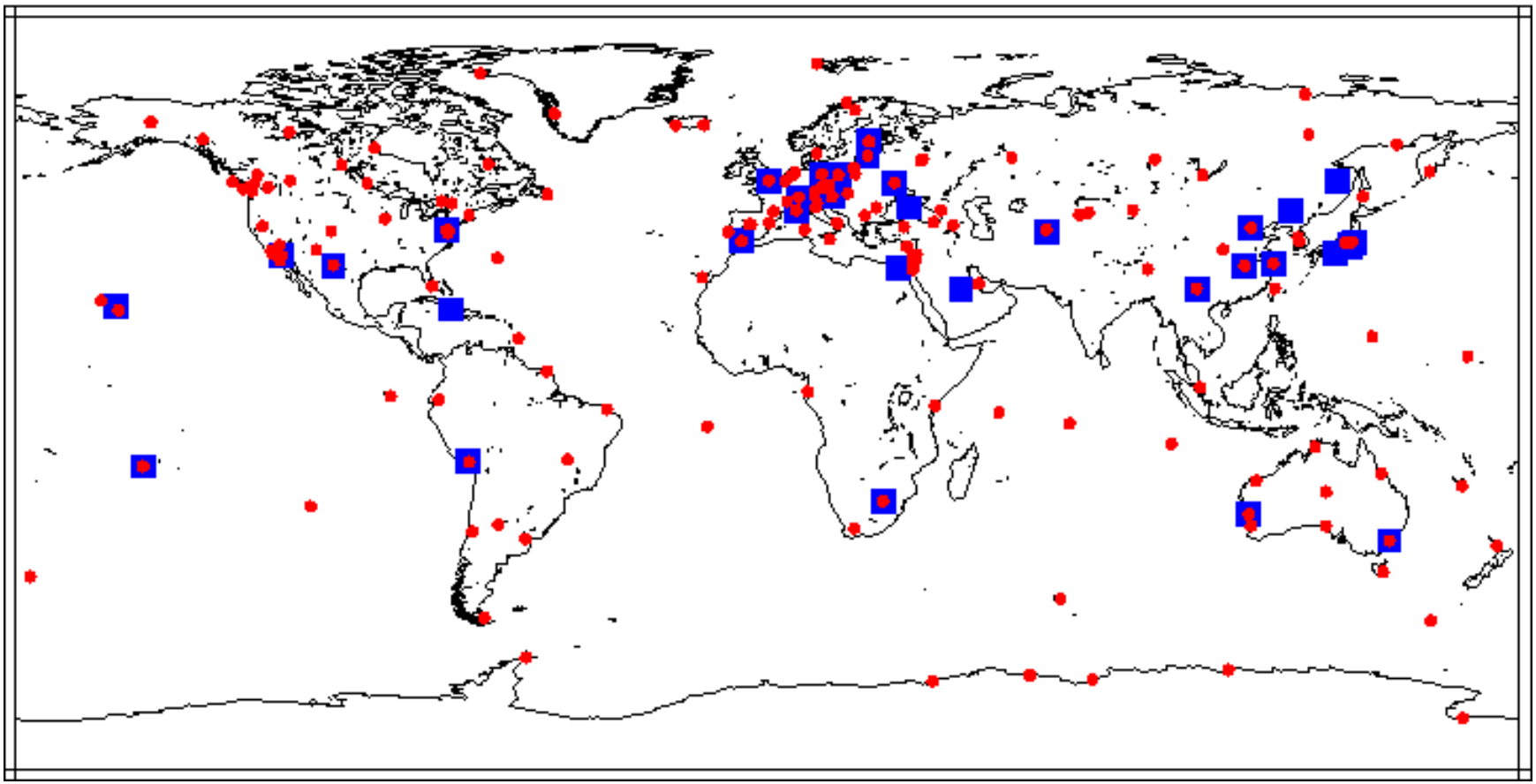
Current VLBI-GPS Collocations



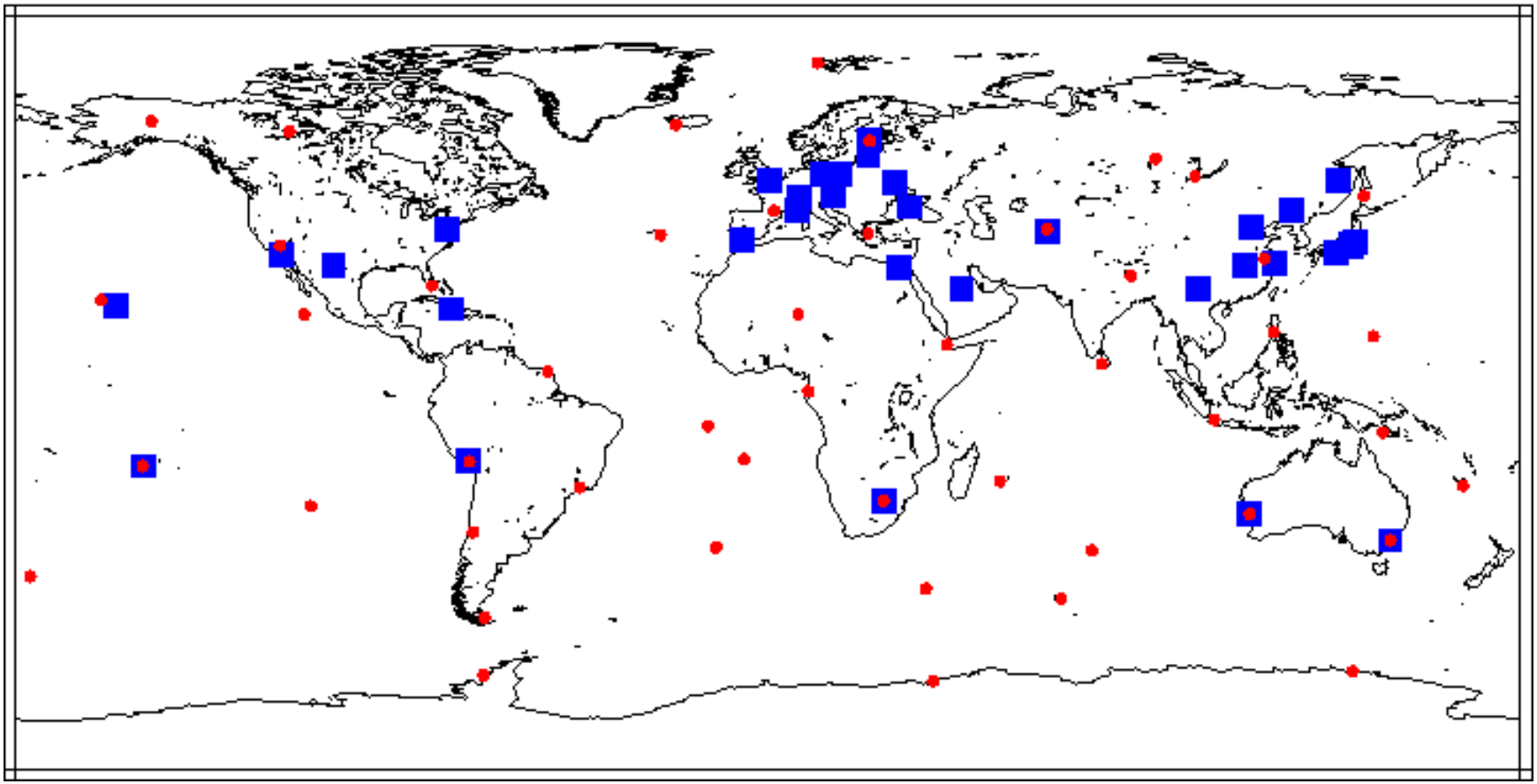
Current VLBI-DORIS Collocations



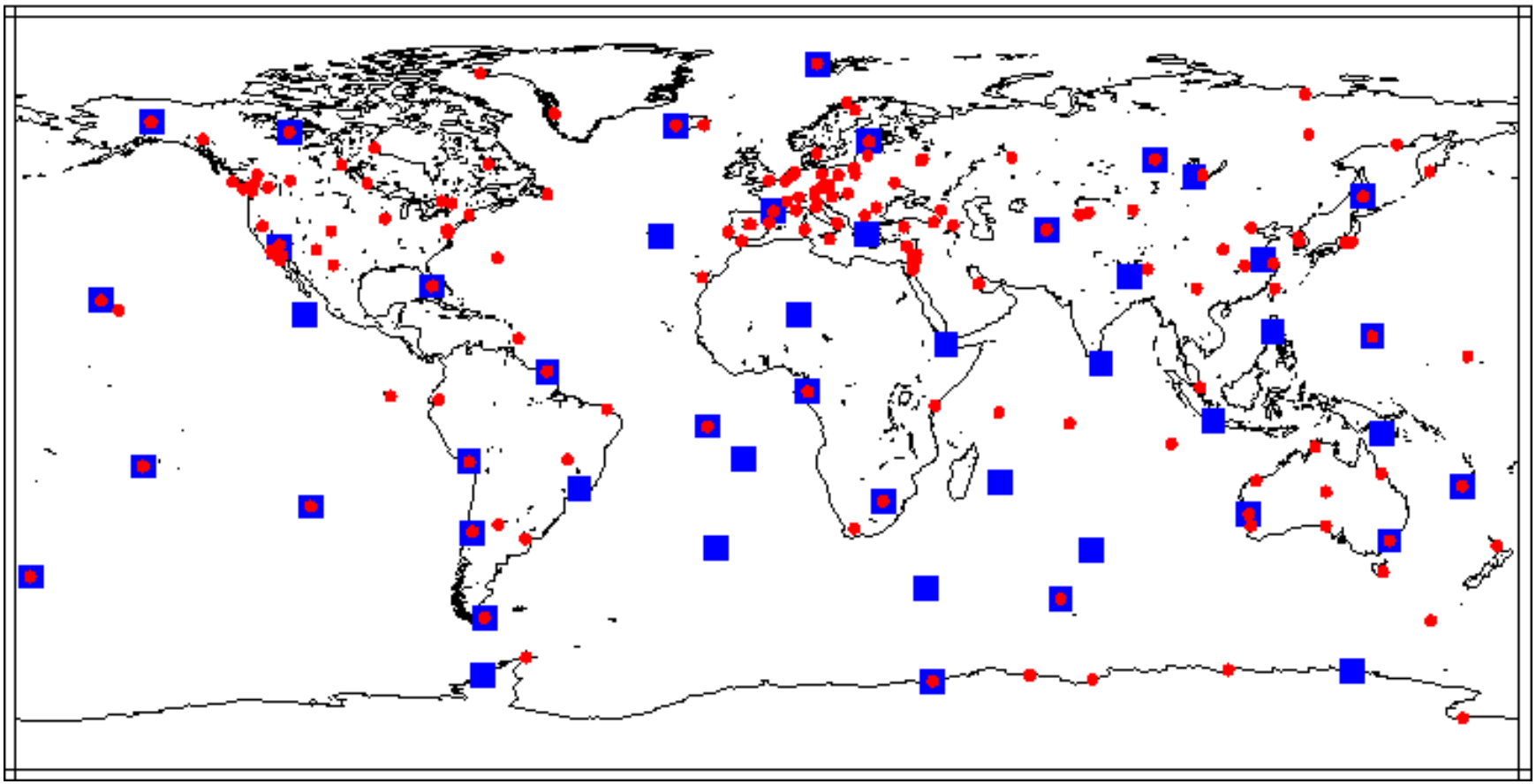
Current SLR-GPS Collocations



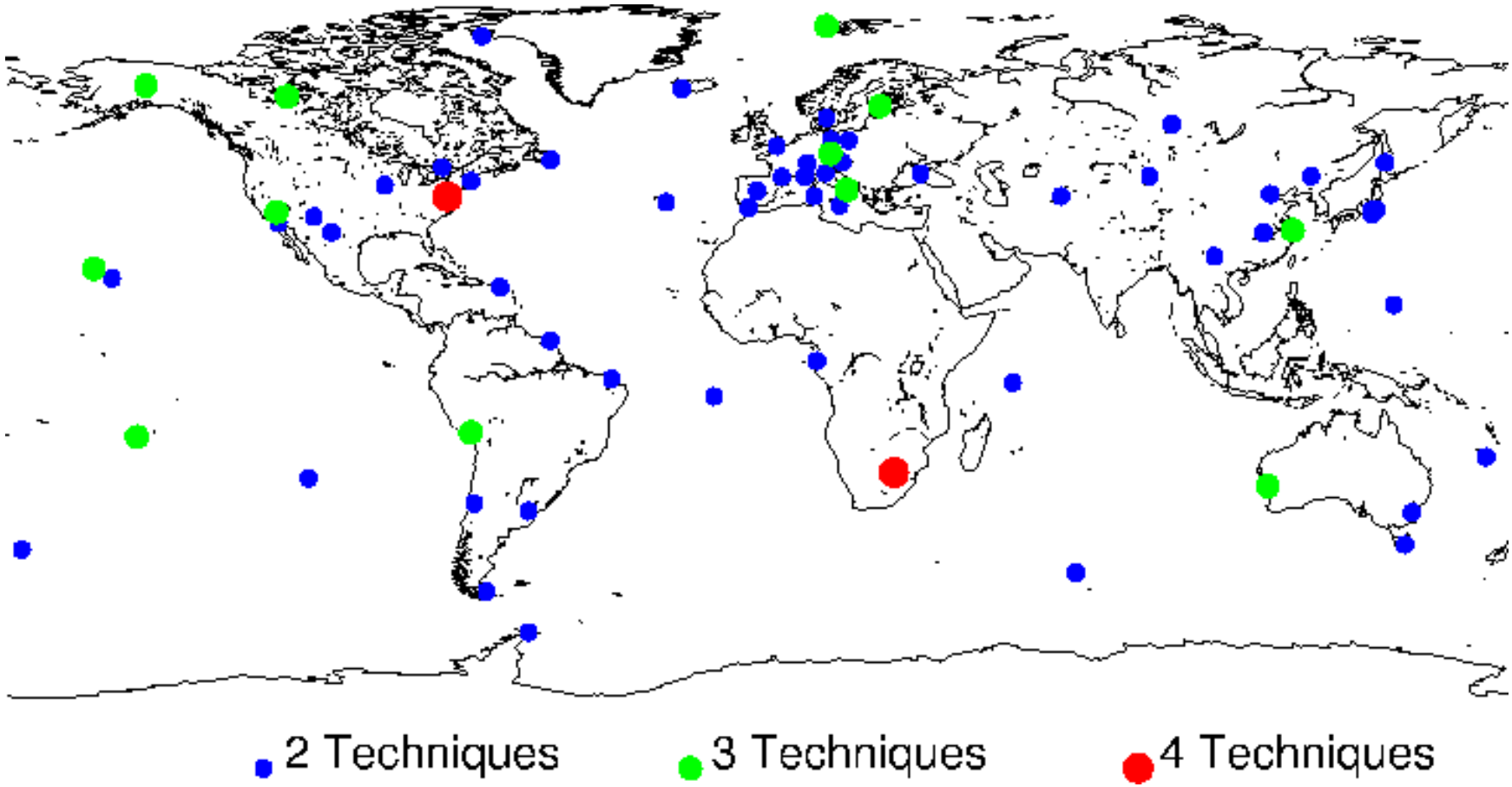
Current SLR-DORIS Collocations



Current DORIS-GPS Collocations



Current Collocations (since ~5 y)



Summary of Current Situation (1/2)

- **SLR and VLBI observing stations are poorly distributed**
- **Sparse VLBI sessions not connectable for a period less than 1 year**
- **# of VLBI collocations with other techniques is not sufficient and is not the same from 1 wk to another**
- **6 SLR-VLBI collocations (ITRF Scale !)**
- **All VLBI sites collocated with GPS**
- **6 SLR sites are still not collocated with GPS**
- **8 VLBI-DORIS collocations**
- **7 SLR-DORIS collocations**
- **~30 well distributed GPS-DORIS collocations**

Summary of Current Situation (2/2)

- **72 Collocations in total (101 in ITRF2000)**
- **58 with 2 techniques**
- **12 with 3 techniques, not well distributed**
- **Only 2 with 4 techniques : HBK & Greenbelt**
- **8 with inconsistent local ties**
- **8 missing ties**

Long-term maintenance of collocations

ITRF Core Collocation Sites (ICCS)

ITRF Pillars

New Local Ties Evaluation

Multi-technique Combination based on time series:

- **VLBI: GSFC session SINEX: 1990-2003**
- **SLR: ASI wkly solutions:1993-2003**
- **GPS: IGS wkly combined solutions: 1999-2003**
- **DORIS: IGN-JPL weekly solutions over 1993-2003**

Currently Missing Ties

DOMES	Name	Techniques involved
12329	YUZHNO-SAKHALINSK	GPS-DORIS
12337	SIMEIS KATZIVELY	SLR-VLBI
12725	CAGLIARI	GPS (CAGZ)-SLR
14201	WETTZELL	VLBI TIGO-SLR/GPS
21602	WUHAN	SLR-GPS
21605	SHANGHAI	GPS-SLR/VLBI
21609	KUNMING	SLR-GPS
21612	URUMQI	VLBI-SLR/GPS
21729	USUDA	GPS-VLBI
30314	SUTHERLAND	GPS SUTM - SLR
40419	KODIAK	Mobile VLBI-GPS
40424	KAUAI	DORIS-GPS
40445	MAUI	GPS-SLR
40499	RICHMOND	VLBI-SLR/GPS
41609	CACHOEIRA PAULISTA	GPS-DORIS
41705	SANTIAGO	SLR-GPS
41719	CONCEPCION	TIGO points (Imprecise tie (+/- 2cm))

Inconsistent local ties

Tie Vector FROM	TO	dX	dY	dZ	dE	dN	dUP	CODE	CODE	Techniques
		----------	----------	----------	cm ----------	----------	----------			
10317M003	10317S002	0.2	2.7	-1.1	2.6	-0.9	-0.9	NYA1	SPIA	GPS-DORIS
10503S011	10503S014	-0.5	-0.2	-0.9	0.0	0.1	-1.0	METS	7806	GPS-SLR
12349M002	12349S001	-1.8	-2.1	-1.5	1.9	0.8	-2.4	KSTU	KRAB	GPS-DORIS
12334S006	12334M001	4.7	-4.8	-0.9	-6.3	0.9	-2.6	KIT3	KIUB	GPS-DORIS
12717S001	12717M003	-0.7	0.4	0.9	0.5	1.1	0.0	7547	NOTO	VLBI-GPS
12734M004	12734S005	0.8	-1.0	-0.3	-1.2	-0.6	0.2	7541	7243	SLR-VLBI
12734M008	12734S005	0.8	-1.0	-0.3	-1.2	-0.6	0.1	MATE	7243	GPS-VLBI
12734S001	12734S005	0.8	-0.9	-0.9	-1.1	-1.0	-0.2	7939	7243	SLR-VLBI
13402M004	13402S007	-2.2	1.1	-1.9	0.9	-0.1	-3.0	SFER	7824	GPS-SLR
13420M001	13420S001	-1.5	0.2	-0.1	0.1	0.9	-1.2	YEBE	7333	GPS-VLBI
14106S011	14106M003	2.2	2.1	3.2	1.5	-0.1	4.1	7841	POTS	SLR-GPS
21601S004	21601M001	0.8	-1.0	-2.7	-0.3	-1.3	-2.7	7249	BJFS	SLR-GPS
21605S001	21605S009	-2.4	1.3	1.9	1.4	0.5	3.0	7837	7227	SLR-VLBI
39801S005	39801M001	7.0	3.4	0.5	-3.8	1.0	6.6	SEY1	MAHB	GPS-DORIS
40127M003	40127M004	-0.1	0.3	-1.0	-0.2	-0.3	-1.0	YELL	7296	GPS-MVLBI
40405S005	40405S019	4.0	3.3	-0.4	2.1	2.4	-4.1	GOMA	1515	DORIS-VLBI
40405S019	40405S035	0.9	0.2	2.6	0.7	2.4	1.0	1515	GOLA	VLBI-DORIS
40405S019	40405S037	-3.5	-3.8	0.5	-1.4	-2.5	4.3	1515	GOMB	VLBI-DORIS
40408M001	40408S004	1.9	2.9	-1.3	-1.4	2.3	-2.5	FAIR	FAIA	GPS-DORIS
40424M004	40424S001	3.0	-1.3	3.3	2.3	4.0	-0.9	KOKB	1311	GPS-VLBI
40424M004	40424S007	3.1	-1.2	3.1	2.2	3.8	-1.1	KOKB	7298	GPS-VLBI
40424M004	40424S008	2.6	-1.6	3.2	2.4	3.6	-0.5	KOKB	KOKA	GPS-DORIS
40442M006	40442S017	-0.4	-0.7	1.0	-0.2	0.4	1.2	7080	7613	SLR-VLBI
40442M012	40442S017	-0.4	-0.9	0.4	-0.2	-0.2	1.1	MDO1	7613	GPS-VLBI
40456M001	40456S001	-1.0	0.9	-0.9	-1.2	-0.4	-1.0	PIE1	7234	GPS-VLBI
40499M002	40499S001	0.2	0.9	-1.1	0.4	-0.6	-1.2	7295	7219	SLR-VLBI
41507S005	41507M004	-2.5	1.8	1.9	-1.6	-0.9	-3.1	RIPB	RIOG	DORIS-GPS
50103M108	50103S007	2.7	-1.0	1.6	-0.5	-0.3	-3.2	TIDB	7843	GPS-SLR
50103M108	50103S202	3.1	-1.1	1.6	-0.6	-0.6	-3.5	TIDB	ORRB	GPS-DORIS

Priority List

DOMES	Name	VLBI	SLR	GPS	DORIS	Missing	Inconsistent
12329	YUZHNO-SAKHALINSK			x	x	x	
12337	SIMEIS KATZIVELY	x	x			x	
12334	KITAB			x	x		x
12349	KRASNOYARSK			x	x		x
12711	NOTO	x	x	x			x
12734	MATERA	x	x	x			x
13402	San Fernando		x	x			x
14106	POTSDAM		x	x			x
21601	BEIJING		x	x			x
21602	WUHAN		x	x		x	
21605	SHANGHAI	x	x	x		x	x
21609	KUNMING		x	x		x	
21612	URUMQI	x	x	x		x	
21729	USUDA	x		x		x	
39801	MAHE ISLAND			x	x		x
40405	GOLDSTONE	x	x	x	x		x
40408	FAIRBANKS	x		x	x	EQ	
40424	KAUAI	x		x	x		x
40442	FORT DAVIS	x	x	x			x
40446	PIE TOWN	x		x			x
40445	MAUI	x		x		x	
42202	AREQUIPA		x	x	x	EQ	

Recommendation 1
How to improve collocations?

- Improve VLBI-SLR collocations (SLR2000!)
- IVS to schedule repeated Global-TRF observing sessions
- IDS to consider installing DORIS beacons at all SLR and VLBI

Recommendation 2

The Working Group on Local Ties is asked to organize repeated (yearly !) local surveys in the all available collocation sites. Per-site local tie components (at the survey epoch) and their time variations should be provided in SINEX format with full variance-covariance matrix. Start with:

-missing and dubious ties

-after Earthquakes, e.g. Arequipa, Fairbanks

-Sites with no complete SINEX files

Recommendation 3

The IERS Directing Board is asked to consider establishing:

Associated Analysis Centers* for Local Ties survey and analysis, analogous to the existing Analysis Centers of space geodesy techniques

***or « Local Ties Product Center »:**

open for Discussion

Recommendation 4

For the long term maintenance of collocation sites and thus the ITRF global stability, the urgent action is to envisage new design of ITRF Core Collocation Sites (ICCS), the indispensable "ITRF Pillars", with global coverage, stable and solid monumentation, regularly/repeatedly surveyed and geophysicaly monitored.

Recommendation 5

The technique services (IGS, IVS, ILRS, IDS) should try to detect and assess the size of systematic biases that may be present in their solutions.

HARTEBEESTHOEK: Old Situation

30302M003	30302M004	-6.4	-3.4	4.8	0.0	1.1	-8.6	7501 HRAO	SLR-GPS
30302M004	30302M007	-0.3	0.9	-0.1	0.9	0.0	0.2	HRAO HARK	GPS-GPS
30302M004	30302S001	0.1	1.0	-2.0	0.9	-1.6	1.4	HRAO 7232	GPS-VLBI
30302M004	30302S005	3.8	-5.0	-1.4	-6.2	-0.8	1.5	HRAO HBLA	GPS-DORIS
30302M004	30302S202	3.6	-3.6	-1.7	-4.9	-0.9	2.1	HRAO HBKA	GPS-DORIS
30302M007	30302S001	0.3	0.1	-1.9	0.0	-1.5	1.2	HARK 7232	GPS-VLBI
30302M007	30302S005	4.1	-5.9	-1.3	-7.1	-0.8	1.3	HARK HBLA	GPS-DORIS
30302M007	30302S202	3.9	-4.6	-1.6	-5.8	-0.9	1.9	HARK HBKA	GPS-DORIS
30302S001	30302S005	3.7	-6.1	0.6	-7.1	0.8	0.1	7232 HBLA	VLBI-DORIS
30302S001	30302S202	3.5	-4.7	0.3	-5.8	0.7	0.7	7232 HBKA	VLBI-DORIS

30302 HARTEBEESTHOEK

Positions

M003 1 7501 TIE30302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.0	0.0	3:214
M003 1 7501 ASI	-0.0004	0.0020	0.0005	0.0020	0.0007	0.0003	0.8	0.3	0.2	1:237
M004 1 HRAO TIE30302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1	0.0	-0.1	3:214
M004 1 HRAO IGS	-0.0009	0.0004	-0.0014	0.0008	-0.0015	0.0000	0.5	-1.1	0.0	1:269
M006 1 DORM TIE30302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2	0.0	-0.3	3:214
M007 1 HARK IGS	-0.0020	0.0001	0.0010	0.0010	0.0001	-0.0020	0.4	0.0	-0.5	99:290
M009 1 HARB TIE30302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2	0.0	-0.3	3:214
M009 1 HARB IGS	-0.0048	0.0003	0.0008	0.0025	-0.0011	-0.0041	1.2	-0.6	-1.2	2:172
S001 1 7232 TIE30302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.1	0.0	0.1	3:214
S001 1 7232 GSF	-0.0003	0.0004	-0.0005	0.0005	-0.0005	0.0002	0.6	-0.6	0.2	96:206
S005 1 HBLA DORIS	0.0010	-0.0002	0.0013	-0.0006	0.0015	0.0001	-0.1	0.3	0.0	99: 47
S006 1 HBKB TIE30302	-0.0001	0.0000	0.0000	0.0000	0.0000	-0.0001	0.3	0.0	-0.4	3:214
S006 1 HBKB DORIS	0.0607	-0.0375	-0.0185	-0.0615	-0.0008	0.0408	-10.1	-0.2	8.3	2: 65
S202 1 HBKA DORIS	0.0032	-0.0040	0.0021	-0.0050	0.0023	0.0000	-0.8	0.5	0.0	95:176

Velocities

M003	1	7501	TIE30302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.0	0.0
M003	1	7501	ASI	-0.0014	-0.0009	-0.0015	-0.0002	-0.0021	-0.0008	-0.2	-2.5	-1.1
M004	1	HRAO	TIE30302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.0	0.0
M004	1	HRAO	IGS	-0.0013	-0.0009	-0.0004	-0.0002	-0.0010	-0.0013	-0.2	-1.3	-0.9
M006	1	DORM	TIE30302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.0	0.0
M007	1	HARK	IGS	-0.0133	-0.0028	0.0047	0.0037	-0.0015	-0.0138	0.8	-0.4	-1.6
M009	1	HARB	TIE30302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.0	0.0
M009	1	HARB	IGS	-0.0019	-0.0009	-0.0007	0.0001	-0.0016	-0.0016	0.0	-0.5	-0.3
S001	1	7232	TIE30302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.0	0.0
S001	1	7232	GSF	-0.0002	0.0001	0.0001	0.0002	0.0000	-0.0002	1.3	0.3	-1.0
S005	1	HBLA	DORIS	0.0006	0.0030	-0.0014	0.0023	-0.0004	0.0024	0.7	-0.2	0.9
S006	1	HBKB	TIE30302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.0	0.0
S006	1	HBKB	DORIS	0.0006	0.0030	-0.0014	0.0023	-0.0004	0.0024	0.7	-0.2	0.9
S202	1	HBKA	DORIS	0.0006	0.0030	-0.0014	0.0023	-0.0004	0.0023	0.7	-0.2	0.9