

Strengths and weaknesses of the IGS contribution to the ITRF



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Outline

- **Summary of GNSS strengths & weaknesses**
- **Extended analysis beyond ITRF2008 time span**
 - Revisit the relative weighting btw space geodesy (SG) and local ties
 - Impact of uncalibrated radomes at co-location sites?
 - Re-assess the scale and origin “accuracy”
 - **Working analysis in preparation for ITRF2013**
 - **Results shown are not definitive**
- **Recommendations to IGS for future contribution (ITRF2013)**

Strengths of GNSS

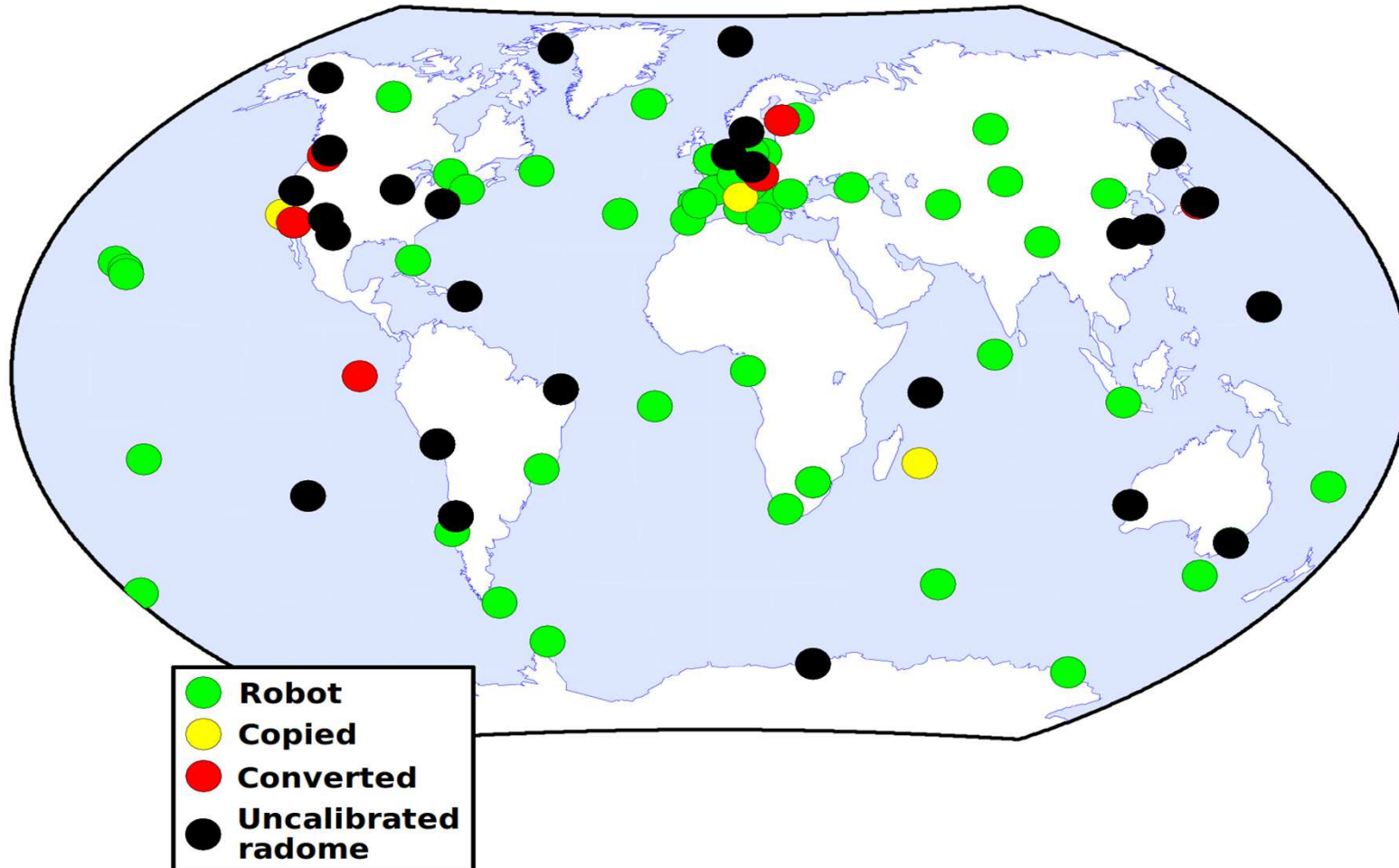
- GNSS/IGS **IS** the link between DORIS, SLR and VLBI networks in the ITRF combination
- Geographic density
 - Covering most tectonic plates
 - Precise determination of the ITRF orientation time evolution
- Most precise and accurate polar motion
- Real, near real time and universal access to ITRF using IGS products

Weaknesses of GNSS

- Imprecise TRF origin (esp in Z) due to mainly orbit mismodeling errors;
- Under-determined TRF scale due to phase center variations & offsets of the ground and satellite antennas;
- 50 % of the IGS sites have discontinuities in the position time series due to equipment changes
 - Serious impact on site velocities
- Sites with uncalibrated radomes, esp at co-location sites.

Antenna calibration types

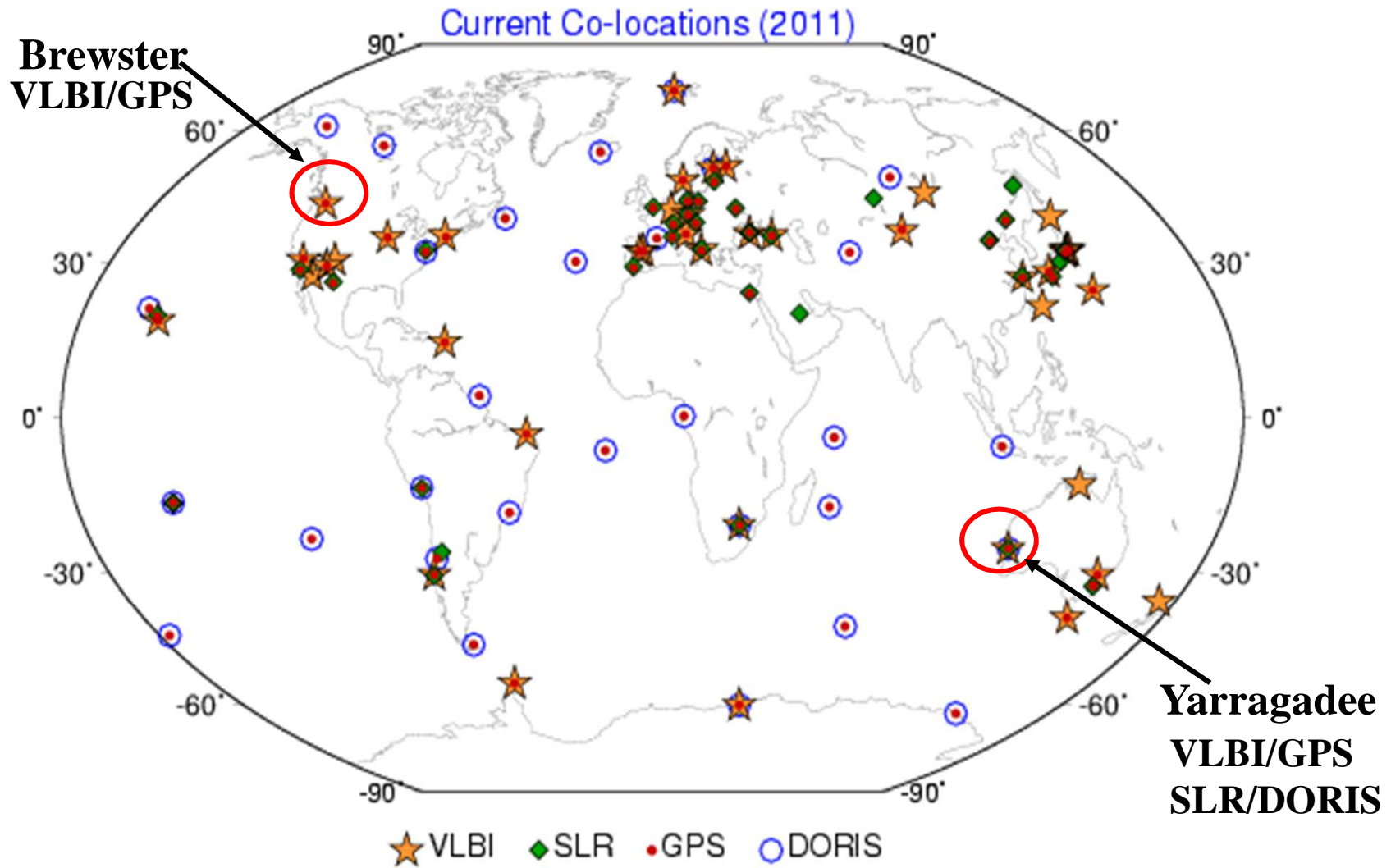
Antenna calibration types
at co-located ITRF2008 GNSS stations



Next ITRF solution (ITRF2013)

- **To be ready in mid 2014:**
 - CfP for ITRF2013 will be issued by Fall 2012
 - Outcome of the evaluation of solutions submitted following the ITRS/GGFC call, with & without atmospheric loading corrections
 - All techniques to submit solutions by Jan-Feb, 2014
- **Expected Improvements & Developments:**
 - Reprocessed solutions;
 - **Revisiting the weighting of Local Ties and Space Geodesy solutions included in the ITRF combination;**
 - Improving the process of detection of discontinuities in the time series;
 - Modelling the post-seismic & non-linear station motions.

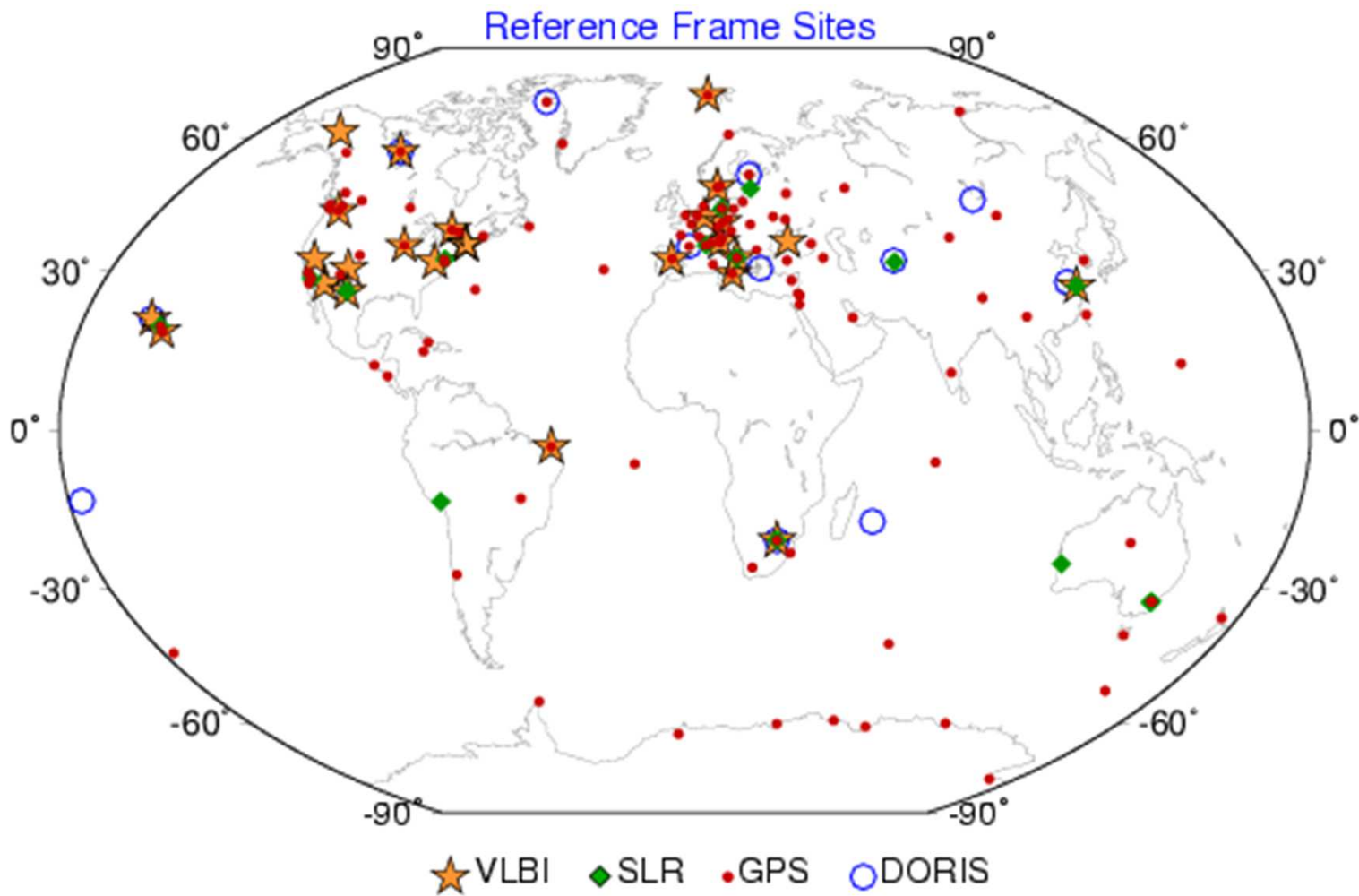
Current Co-locations



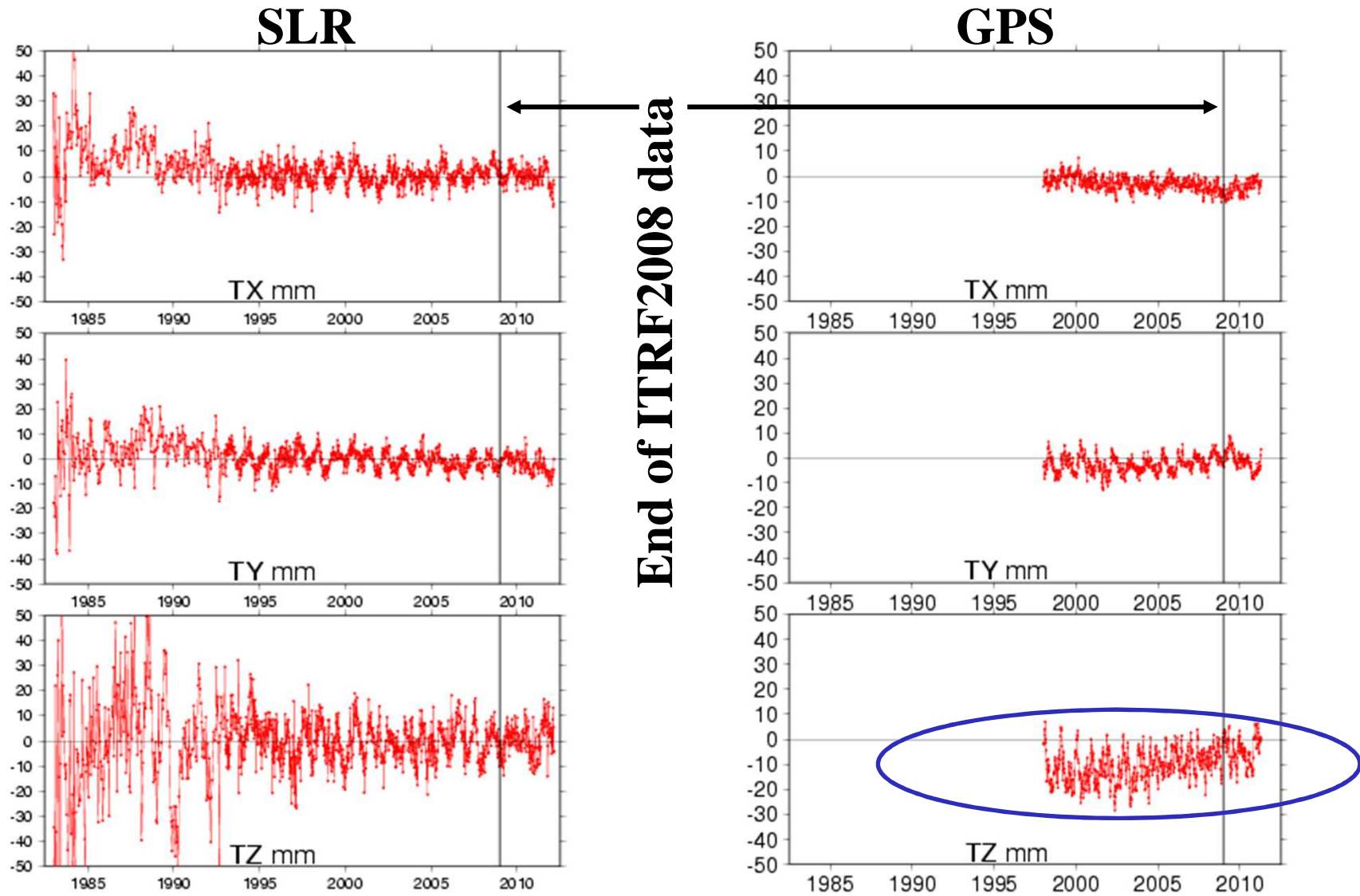
Extended analysis beyond ITRF2008 time-span

- **VLBI: IVS daily SINEX files up to epoch 2012.0 (S. Bachmann)**
- **SLR: ILRSA weekly SINEX up to epoch 2012.1**
- **GPS: Improved IGS combined weekly SINEX up to 2011.3 where mean origin and scale are preserved**
- **DORIS: Extended by weekly solutions up to 2011.7, provided by G. Moreaux**

Reference Frame Sites

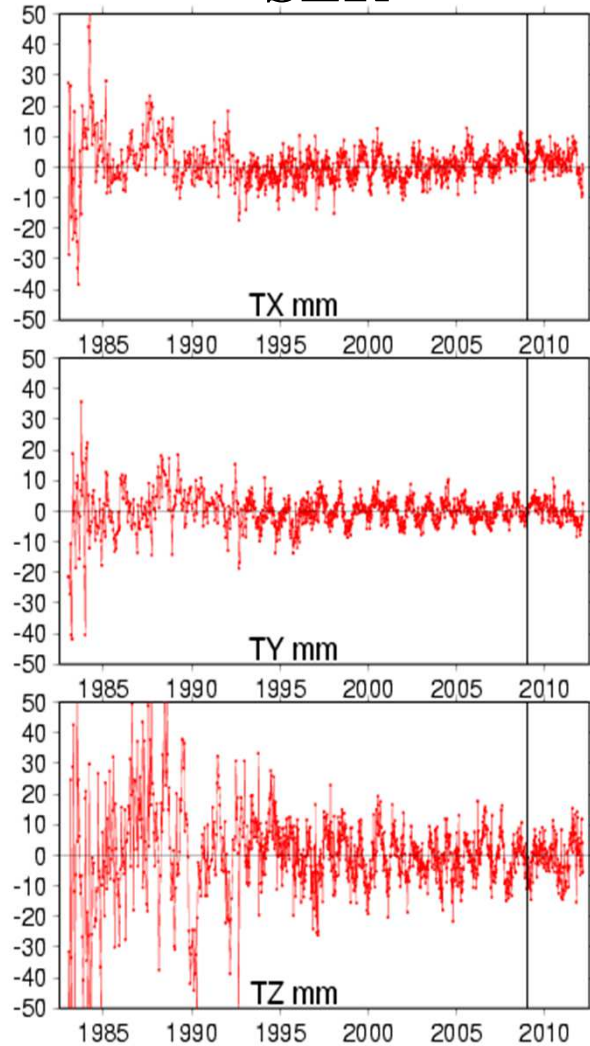


Origin components wrt ITRF2008

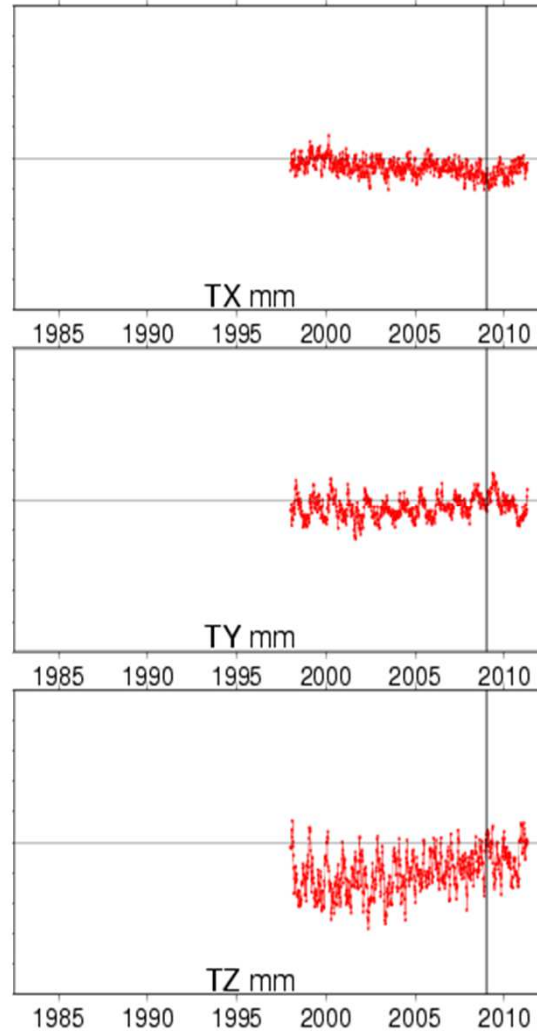


Origin components wrt ITRF2008

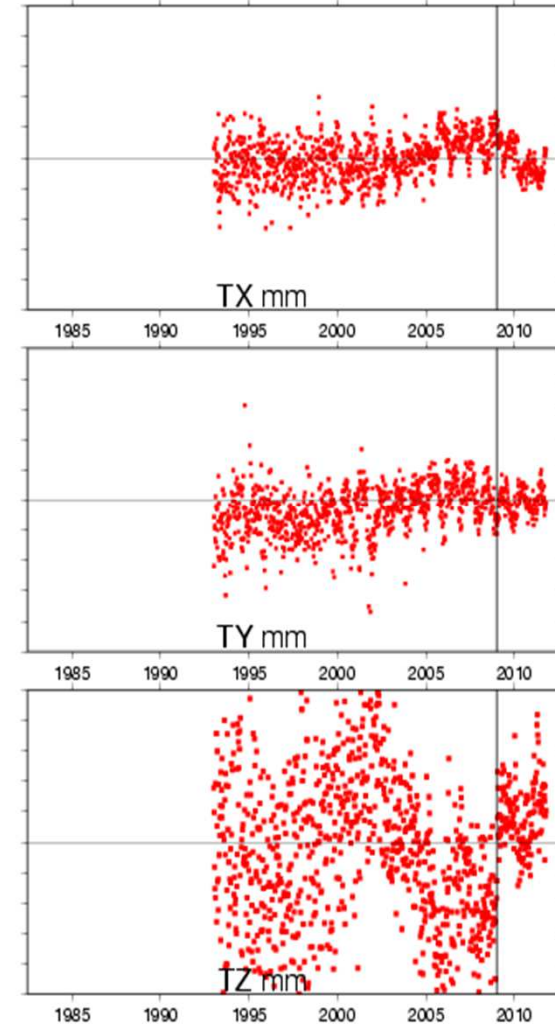
SLR



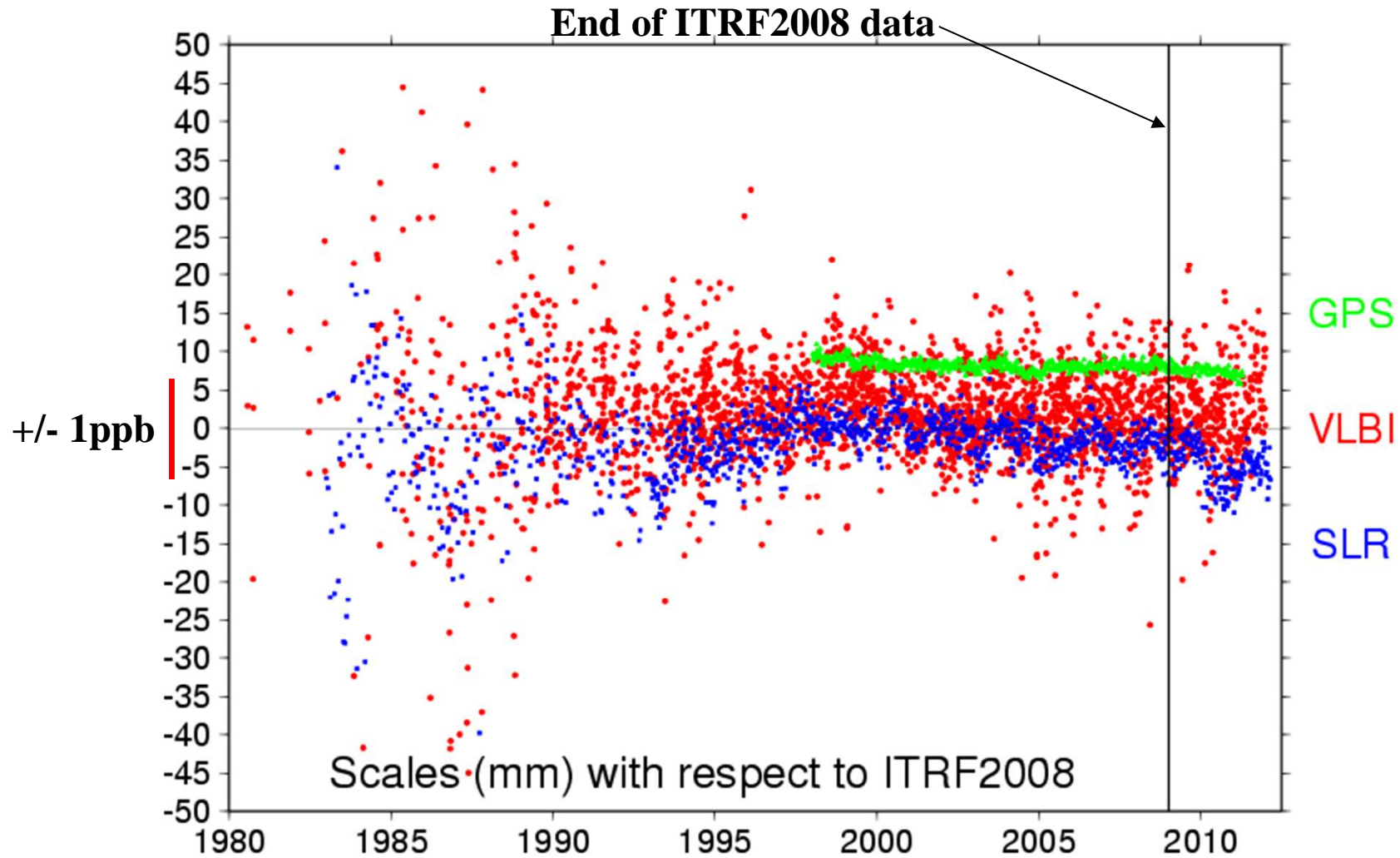
GPS



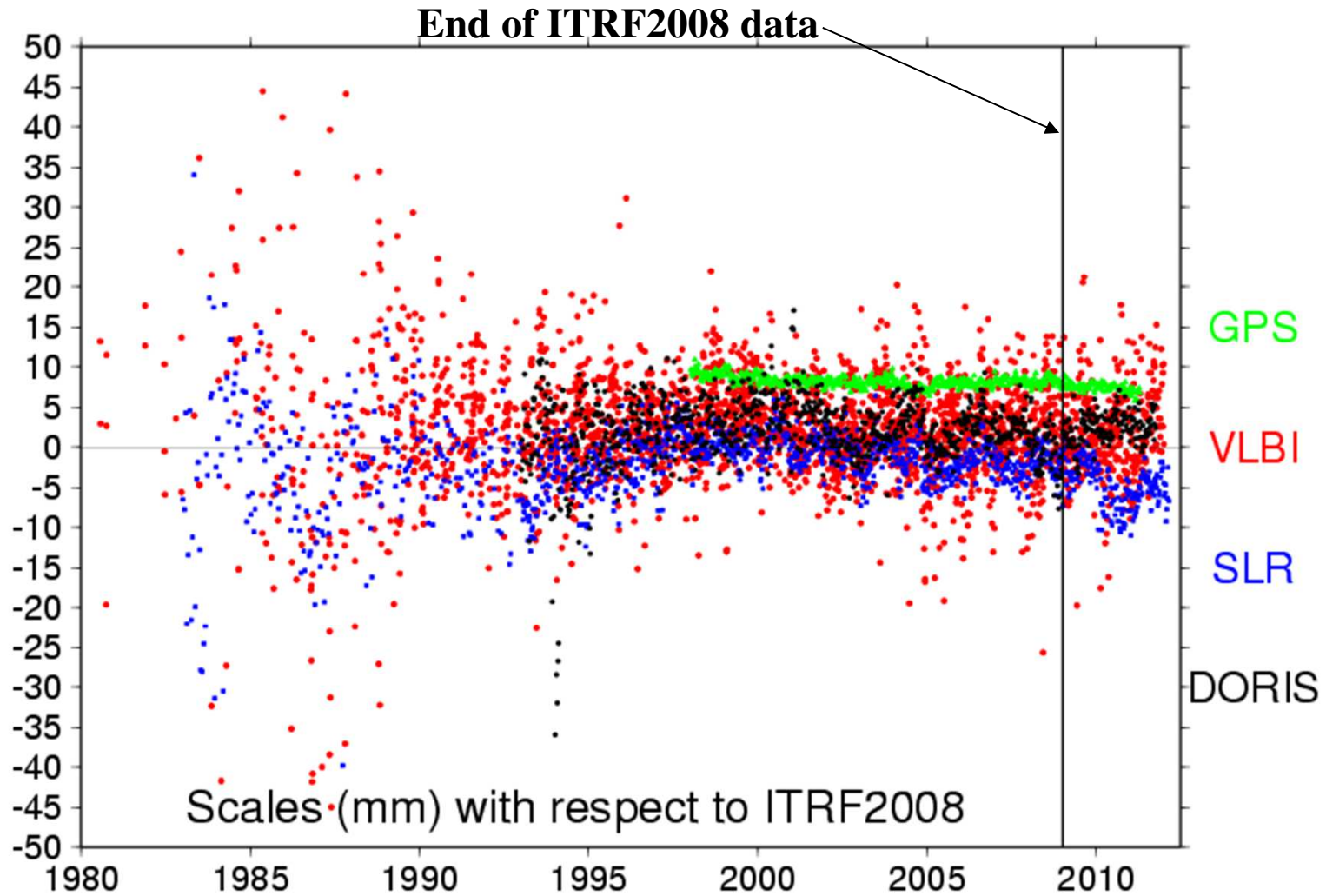
DORIS



Scale factors wrt ITRF2008



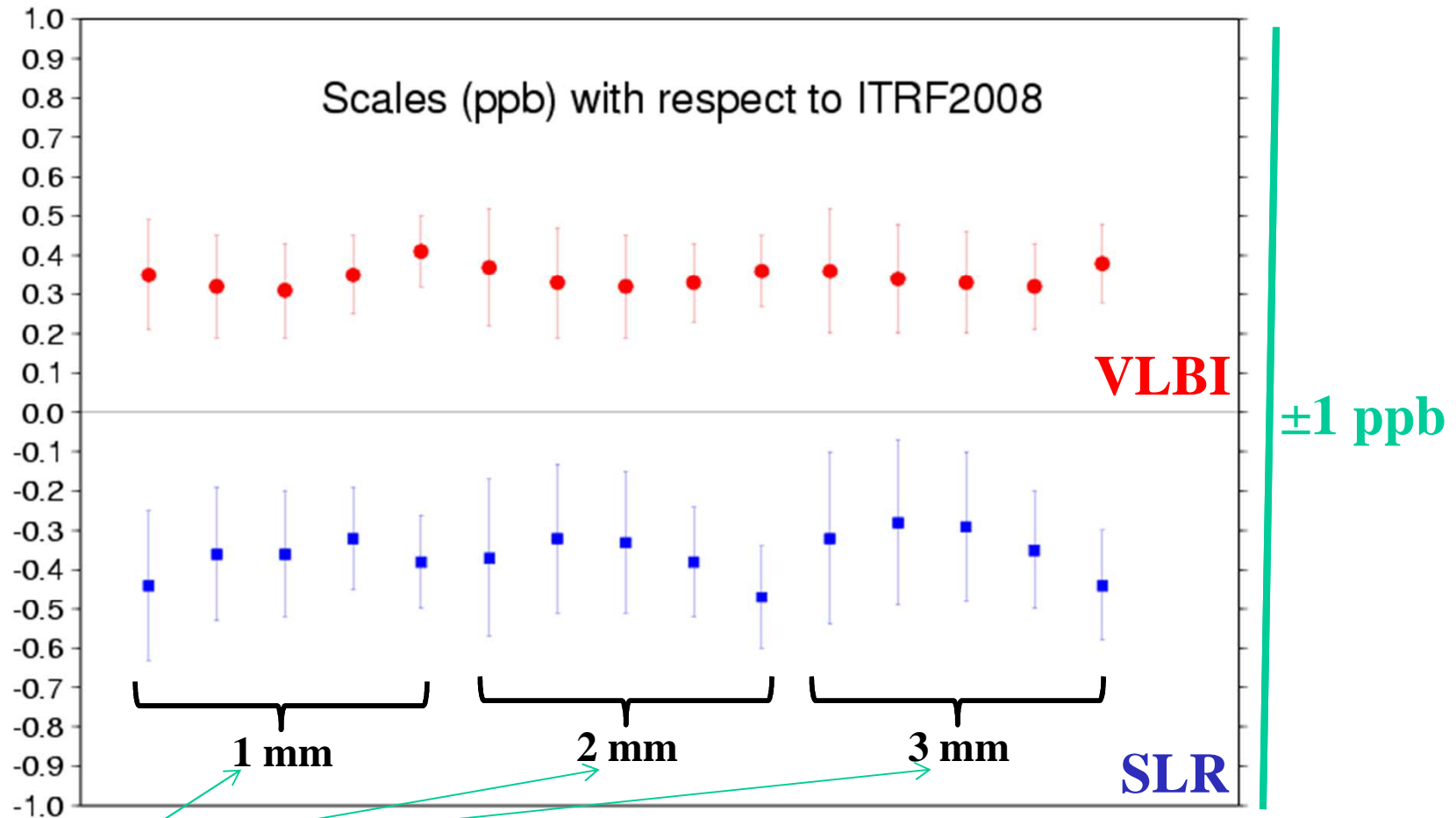
Scale factors wrt ITRF2008



Revisit the weighting btw local ties and SG solutions

- **Difficulties:**
 - Velocity disagreements btw techniques for some sites
 - Large “tie” discrepancies for 50% of sites
 - Epochs of ties and discontinuities (?)
 - Local tie accuracy (?)
- **Procedure: Estimate variance factors (VF) for SG solutions via velocity fields combination**
 - Add local tie SINEX files and **iterate** (re-evaluate tie VF) until convergence ==> unit weight close to 1.
- **15 test combinations, by varying floor sigmas of:**
 - Local Ties (1, 2, 3) mm
 - Velocity constraints (0.01, 0.05, 0.1, 0.5, 1.0) mm/yr

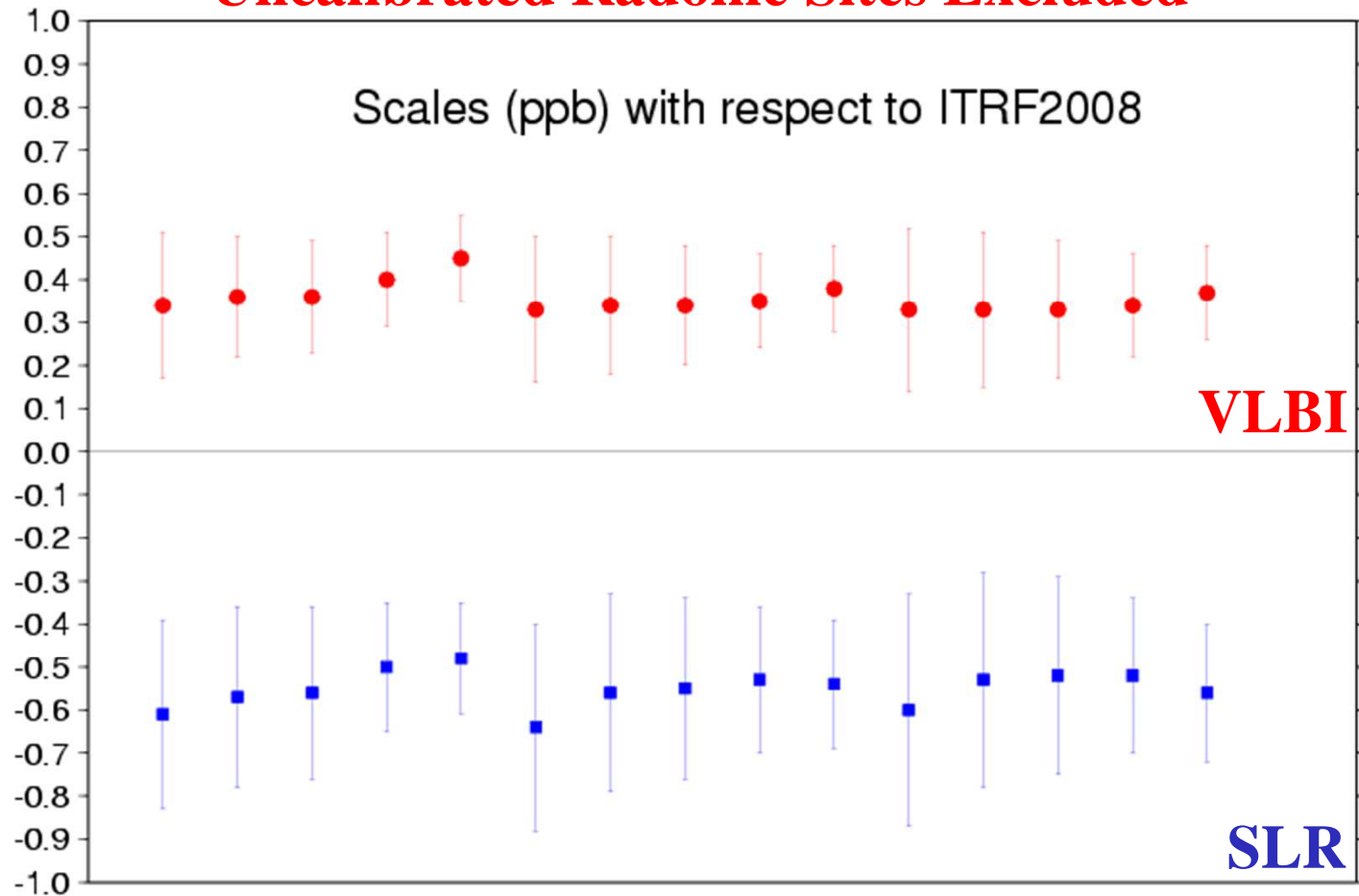
Scale factors wrt ITRF2008



Tests : Floor σ Ties (1, 2, 3 mm), and σ Velocity (0.01, 0.05, 0.1, 0.5, 1 mm/yr)

Scale factors wrt ITRF2008

Uncalibrated Radome Sites Excluded



Tests : Floor σ Ties (1, 2, 3 mm), and σ Velocity (0.01, 0.05, 0.1, 0.5, 1 mm/yr)

Scale Difference (VLBI-SLR) amplified by 0.2 ppb

Uncalibrated Radomes: Tie Residuals

Site	E (mm)	N (mm)	Up (mm)	Comment
CRO1	4.9	-1.2	-1.4	VLBA, seems OK
FORT	1.7	-3.8	1.9	VLBI, but tie corrected by J. Ray
GODE	-3.0	5.2	-6.8	SLR
MDO1	1.8	-3.0	17.0	SLR
MDO1	4.3	-10.0	7.0	VLBI
NLIB	-0.4	1.9	-8.5	VLBI
ONSA	6.7	-1.3	-1.6	VLBI
SHAO	1.7	-6.8	-17.2	SLR: probably GPS problem in N
SHAO	-2.8	-6.8	-0.5	VLBI: probably GPS problem in N
TIDB	0.0	2.2	3.3	VLBI, seems OK
TSKB	2.2	2.1	0.9	VLBI, seems OK
WTZZ	-0.5	4.6	2.3	VLBI: probably GPS problem in N
WTZZ	0.1	4.6	8.1	SLR: probably GPS problem in N
YARR	4.0	-2.1	17.2	SLR

Examples of “velocity tie” problems

Site	E mm	N mm	Up mm	Comment
GODE	-3.0 -1.5	5.2 3.2	-6.8 -3.0	SLR: Total residuals at tie epoch Due to velocity discrepancy
MDO1	1.8 0	-3.0 0	17.0 3.5	SLR: Total residuals at tie epoch Due to velocity discrepancy
MDO1	4.3 0	-10.0 -2.0	7.0 1.3	VLBI: Total residuals at tie epoch Due to velocity discrepancy
NLIB	-0.4 -1.6	1.9 2.8	-8.5 -3.6	VLBI: Total residuals at tie epoch Due to velocity discrepancy
MEDI	-0.5 0.6	-2.6 -0.6	9.4 2.0 -8.9	VLBI: Total residuals at tie epoch Due to velocity discrepancy Effect of VLBI antenna sag (P. Sarti)

Summary of the extended analysis

- **Scale (at 2005.0):**
 - Agreement btw SLR&VLBI : **between 0.7 & 1 ppb**
 - GPS : **N/A**
 - DORIS : **in between SLR and VLBI**
 - **Scale rate wrt ITRF2008 in ppb/yr :**
 - SLR, VLBI & DORIS : **between -0.03 & 0.03 (± 0.02)**
 - GPS : **-0.02**
 - **Origin wrt ITRF2008 (at 2005.0):**
 - SLR : **0 (± 1) mm**
 - GPS : **up to 10 mm in Z**
 - DORIS : **unreliable in Z**
 - **Origin rate with respect to ITRF2008 :**
 - SLR : **(-0.3, 0, 0) (± 0.1) mm/yr**
 - GPS : **0.7 mm/yr in Z**
 - DORIS : **unreliable in Z**
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- **Uncalibrated radome effect : 0.2 ppb**

Conclusion & Recommendations to IGS

- How many IGS stations should be in the ITRF ?
 - ~ 400 (**but the best and homogeneously distributed stations!**)
 - The ITRF is a global reference, its densification is the task of regional entities of IAG Com. 1: AFREF, EUREF, etc.
- IGS RF sites are fundamental not only to IGS, but also to ITRF itself (ITRF orientation time evolution)
- ITRF current accuracy: ~1cm over its time-span
- Results of extended analysis: consistent with ITRF2008
 - ==> **ITRF2013 scale may be fixed to ITRF2008**
- Impact of uncalibrated radomes: ~ 0.2 ppb (**undesirable**)
 - GPS & VLBI might have the same (opposite) error (e.g. Tsukuba)
- ACs to adopt same strategy for Earthquakes (poster by Lercier et al.):
 - Discard observations at the time of the Earthquake, or/and
 - Estimate two positions: before and after the event