Geodetic Observatory Pecný – SAA effect analyses

Petr Štěpánek

IDS AWG meeting, Toulouse, 4.-5.4.2013

GOP SPOT-5 data corrective model(s)

❖Štěpánek et al.(2013?): *SPOT-5 DORIS oscillator instability due to South Atlantic Anomaly: mapping the effect and application of data corrective model,* submitted to adv. sp. Res in January 2013.

❖Static model for 2011.0-2012.0

❖Change of the effected observed during 2008.-2011.0

**LCA SPOT-5 data corrective model (data available 2011.0-2012.0)**

LCA Jason-1 data corrective model 2011.0-2012.0

Short-term SPOT-5 onboard oscillator frequency bias, estimated from the observations of the master beacon Kourou
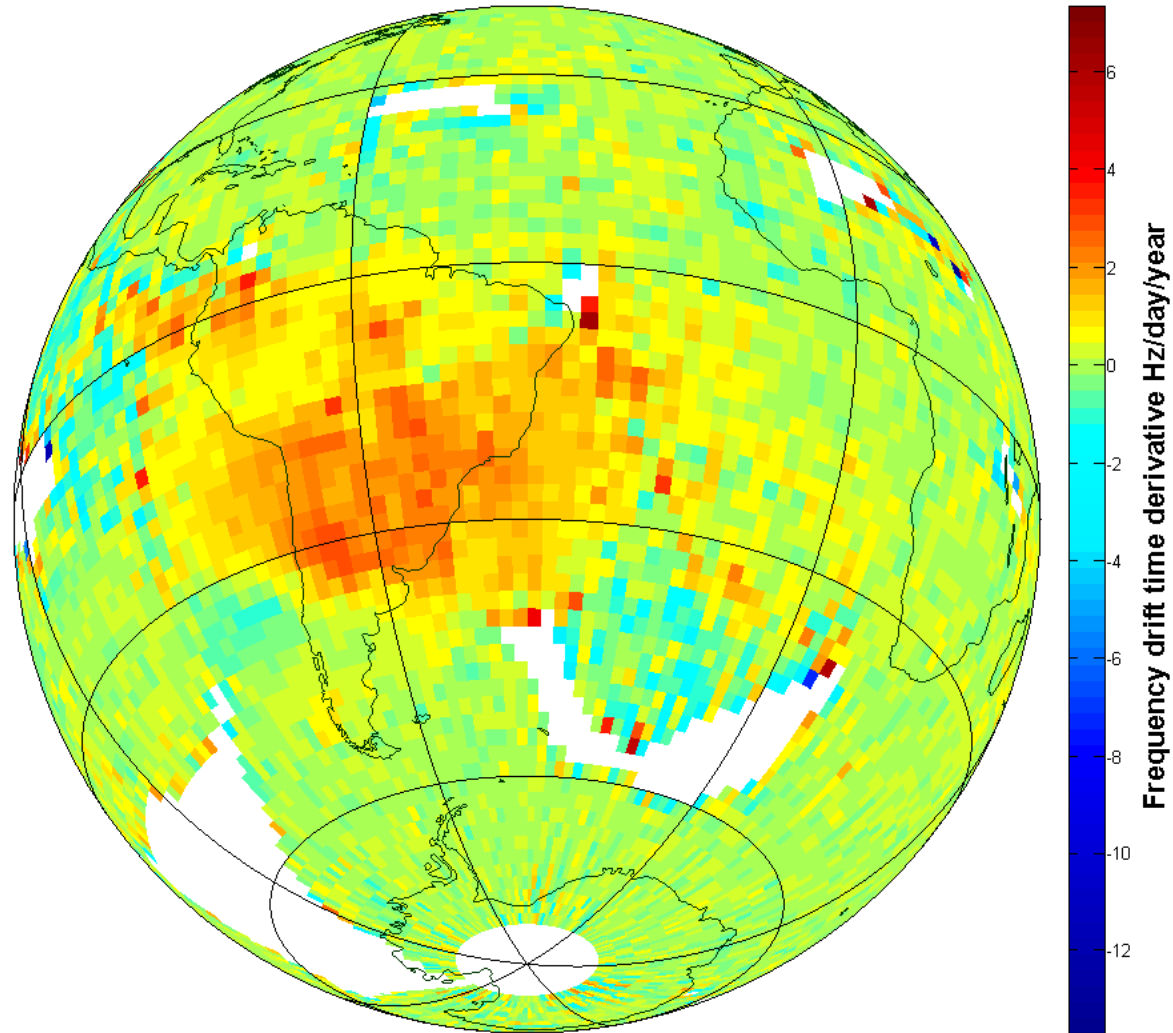
❖compared values for 2004, 2007 and 2010
❖the slope is rising
❖confirmation of previous result (SAA effect on SPOT-5 oscillator rising from 2007/2008)
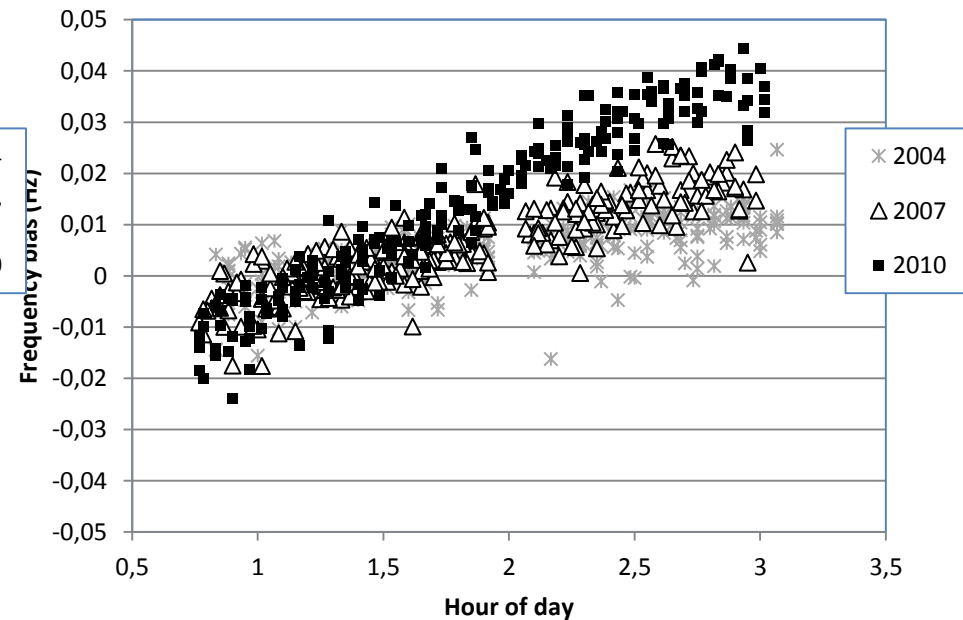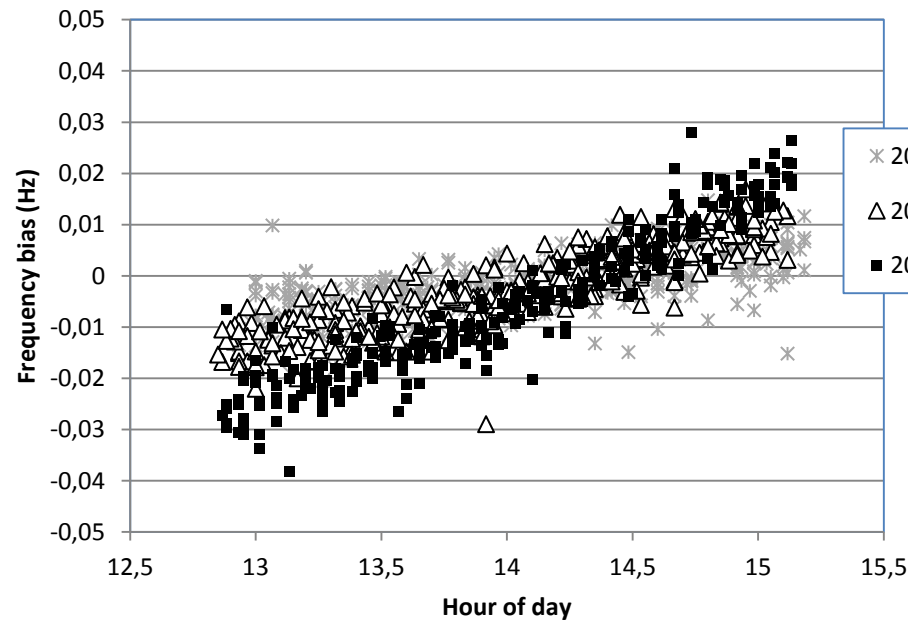
SPOT-5 frequency time derivative, data from 2008.0 − 2012.0
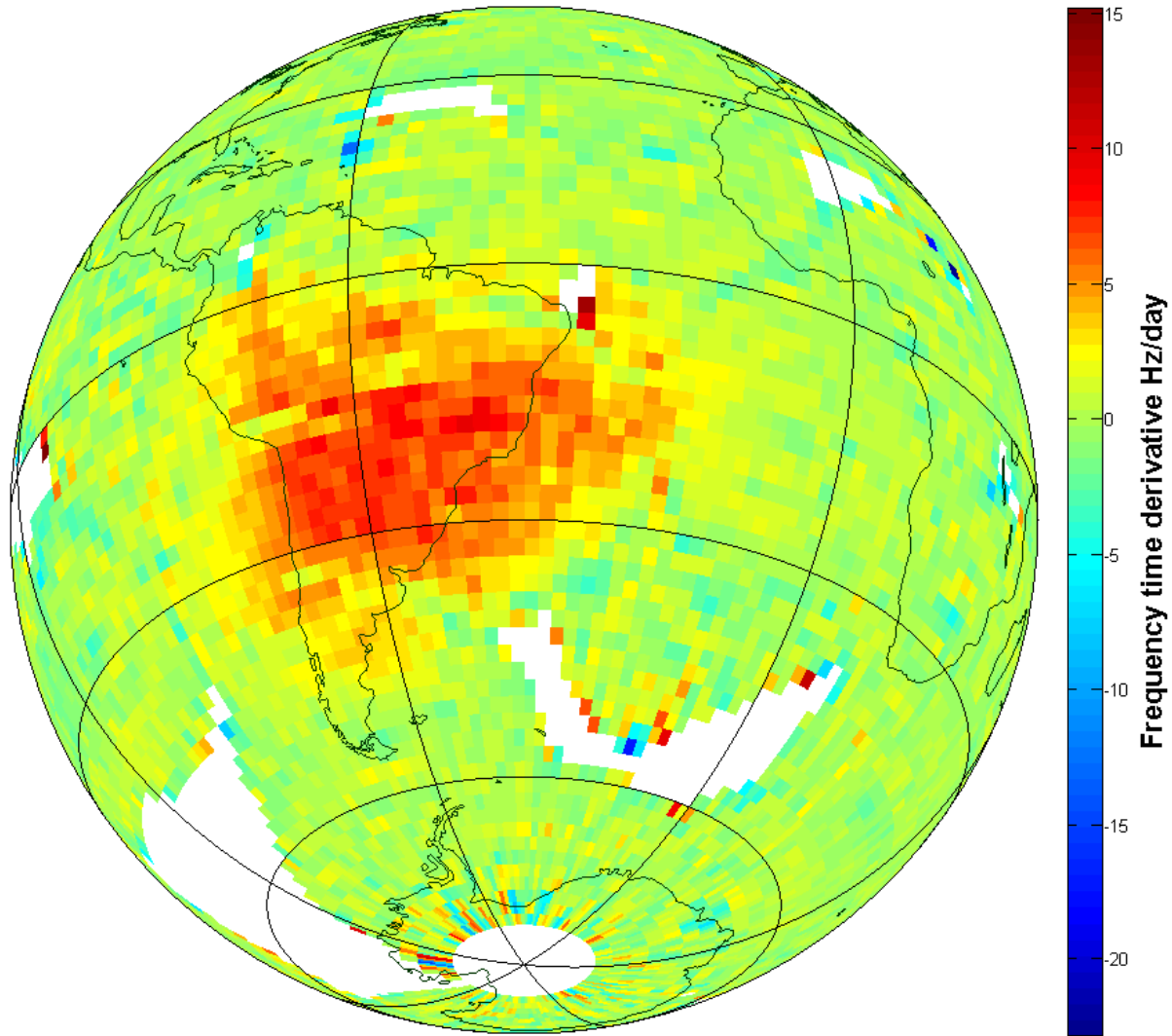
SPOT-5 frequency second time derivative, data from 2008.0 − 2012.0

SPOT-5 data corrective models

❖ data span 2011.0 – 2012.0
❖ SPOT-5 solution compared to S4+EN+J2+CR solution
❖ ZTD compated to the GNSS estimates

	Unc. (mm)	GOP (mm)	LCA (mm)
Arequipa	-68	8	10
Cachoeira Paulista	-98	-17	13
Santiago	-54	4	8
Kourou	-35	-7	-4

ZTD bias w.r.t. GNSS PPP

	Uncorrected			GOP corrections			Reduction %	
	Lat mm	Lon mm	Up mm	Lat mm	Lon mm	Up mm	Horiz.	Vert.
Arequipa	101	-80	-162	35	18	-39	69	76
Cachoeira Paulista	-61	128	-330	-50	123	-79	6	76
Santiago	-170	-75	-131	-49	27	-8	70	94
Kourou	90	-54	14	19	-49	-22	50	-
Ascension	58	-16	-47	9	-8	-30	80	36
St-Helene	-19	55	-26	-25	-17	-18	48	31

Stations coordinate Bias – GOP corrective model

	Uncorrected			LCA corrections			Reduction %	
	Lat mm	Lon mm	Up mm	Lat mm	Lon mm	Up mm	Horiz.	Vert.
Arequipa	101	-80	-162	33	32	-7	64	96
Cachoeira Paulista	-61	128	-330	37	101	13	24	96
Santiago	-170	-75	-131	-25	58	-24	66	82
Kourou	90	-54	14	-8	-71	-16	32	-
Ascension	58	-16	-47	29	-55	-10	-	79
St-Helene	-19	55	-26	-26	19	-4	45	85

Stations coordinate Bias – LCA corrective model

SPOT-5 data corrective models (2)

❖ LCA model – stronger reduction of the latitude and height bias

❖ LCA model – stronger raduction of the latitude and height std. dev. (repeatability)

❖ GOP model – stronger reduction of the longitude bias

	Lat(mm)	Lon(mm)	Up (mm)
Uncorr.	83	68	118
GOP	31	40	33
LCA	26	56	12

Stations coordinate
Bias – 6 SAA stations

	Lat(mm)	Lon(mm)	Up (mm)	3D (mm)
Uncorr.	19.5	34.4	23.9	26.7
GOP	18.1	35.3	21.2	26.0
LCA	15.3	35.2	19.7	24.9

Stations std. dev.– 6 SAA stations

Addional testing of SPOT-5 LCA data corrective model

❖ results for whole network

❖ Polar coordinates – improvement

❖ Reduced Tx and Tz variations

❖ Reduced station RMS w.r.t. DPOD and station std. Dev.

	Pole Mean (mas)		Pole Std (mas)	
	Xp	Yp	Xp	Yp
Uncorr.	0.16	1.03	0.89	0.76
LCA	-0.10	1.03	0.82	0.72

	Mean				Std. dev.				RMS	Std dev
	Tx (mm)	Ty (mm)	Tz (mm)	Sc (ppb)	Tx (mm)	Ty (mm)	Tz (mm)	Sc (ppb)	(mm)	(mm)
Uncorr.	-6.1	-2.4	14.3	2.1	5.2	8.9	19.5	0.8	34.7	18.7
LCA	0.7	-5.1	24.0	1.8	5.2	7.6	18.5	0.8	30.0	18.3

Jason-1 data corrective model testing

❖ only LCA model available

❖data from 2011.0 – 2012.0

❖despite the significant impact, the Jason-1 solution is not accurate

❖ high bias also for some stations outside the SAA region

	Bias w.r.t. S4+EN+CR+J2 solution			Std dev		
	Lat mm	Lon mm	Up mm	Lat mm	Lon mm	Up mm
Arequipa	-63	-411	-194	62.2	101.8	77.1
Cachoeira Paulista	-107	126	34	77	145.7	129.3
Santiago	-21	-178	66	66.7	108.2	83.8
Kourou	92	-49	16	88.5	114.4	85.4
Ascension	-100	113	-4	64.1	150.7	74.9
St-Helene	-47	277	322	107	151.7	108.4

Impact on the multi-satellite solution (LCA models only)

Indicates better consistency with DPOD, not better solution

sol. Id.	SAT*	Corre	Nbr sta renamed	RMS(mm) w.r.t. DPOD	Std(mm)
1	-	-	0	21.1	15.64
2	S5	YES	0	19.7	14.01
3	S5	YES	6	19.9	14.10
4	S5	NO	0	18.6	14.25
5	S5	NO	6	19.9	14.20
6	J1	YES	9	21.0	15.38

sol. Id.	Mean (mm or ppb)				Std. dev.(mm or ppb)			
	Tx	Ty	Tz	Sc	Tx	Ty	Tz	Sc
1	1.4	-7	11.3	0.15	5.6	6.6	11.3	0.37
2	1.7	-7.2	6.8	0.52	4.8	6.2	10.0	0.37
3	1.0	-7.2	6.7	0.53	4.9	6.1	10.0	0.36
4	-0.4	-5.6	7.3	0.44	4.8	6.4	10.3	0.35
5	1.5	-8.2	4.5	0.8	4.8	6.2	10.0	0.37
6	0.0	-4.6	9.7	0.25	5.3	6.5	10.0	0.32

Sol.id.	Mean (mas)		Std. Dev. (mas)	
	Xp	Yp	Xp	Yp
1	-0.28	-0.24	0.69	0.73
2	-0.28	-0.32	0.62	0.65
3	-0.24	-0.38	0.63	0.65
4	-0.3	-0.3	0.63	0.67
5	-0.31	-0.27	0.65	0.67
6	-0.50	-0.13	0.70	0.80

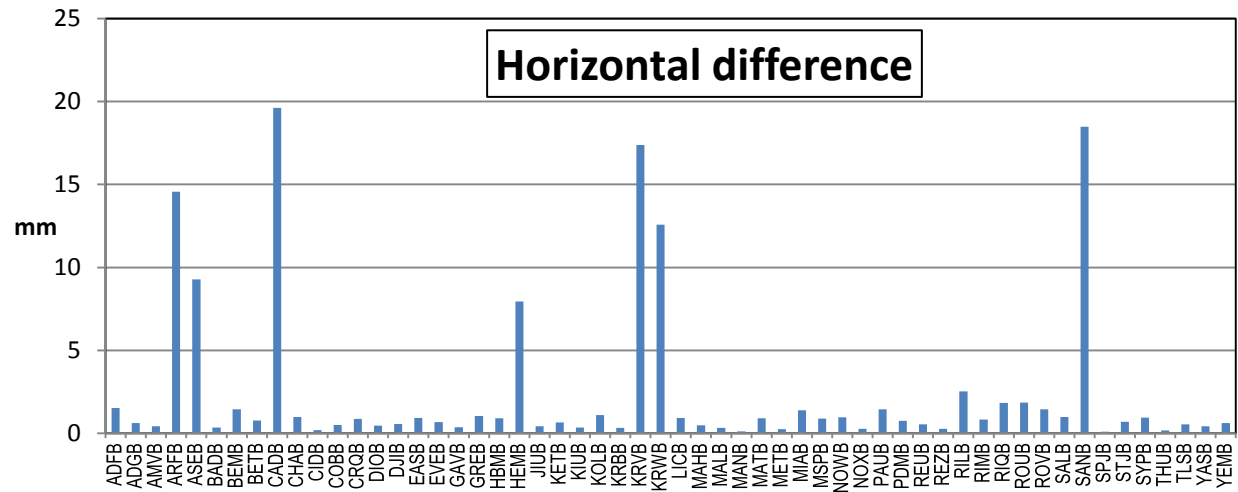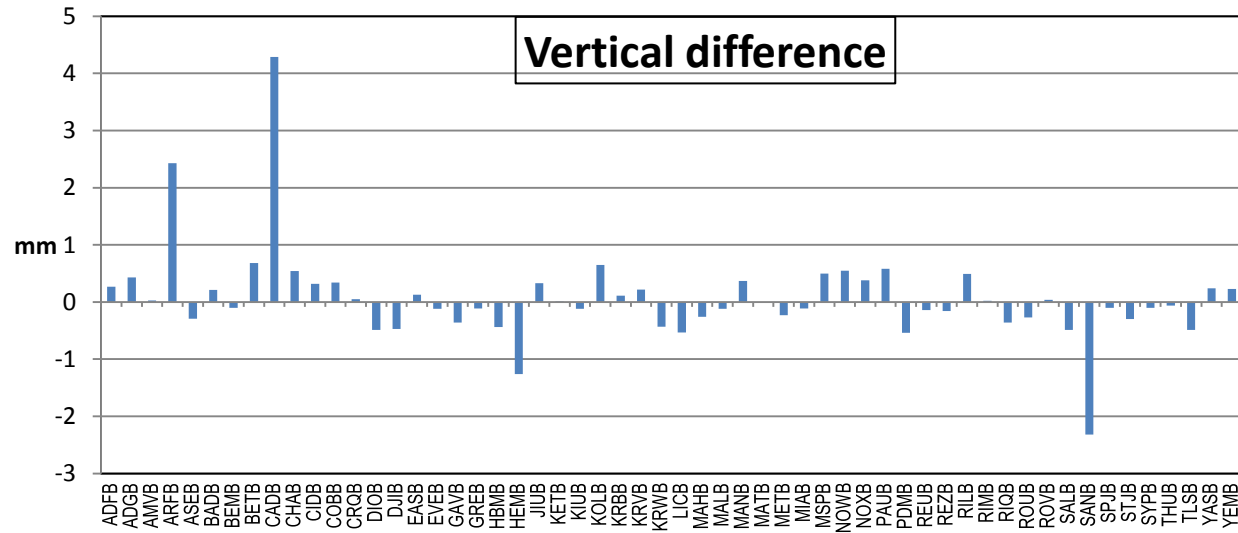# Differences between solution 1 and solution 4

❖ Sol. 1 -> without SAA satellites
❖ Sol. 4 -> plus SPOT-5, *uncorrected*, stations not renamed
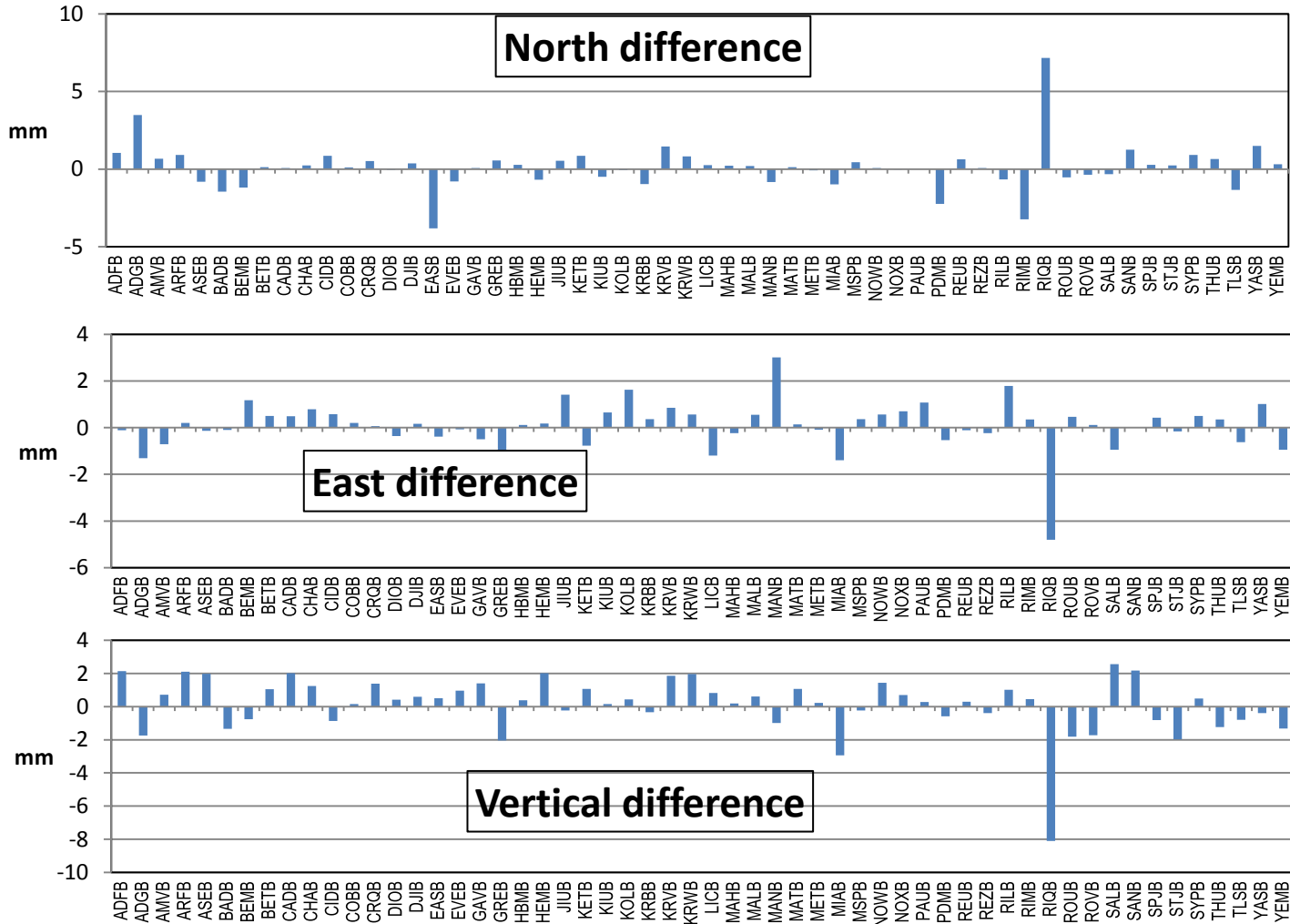

Vertical difference

Horizontal difference
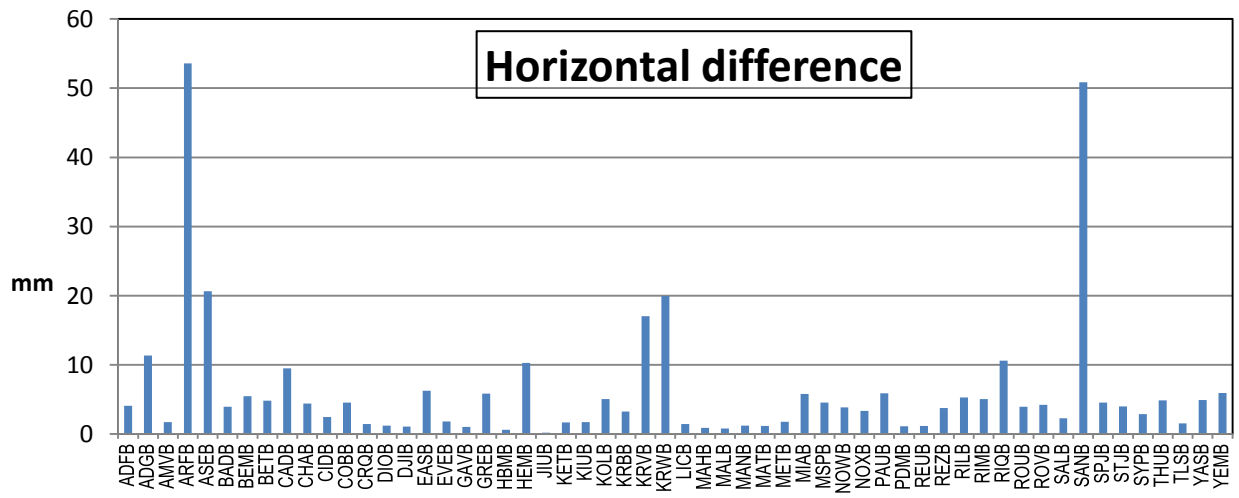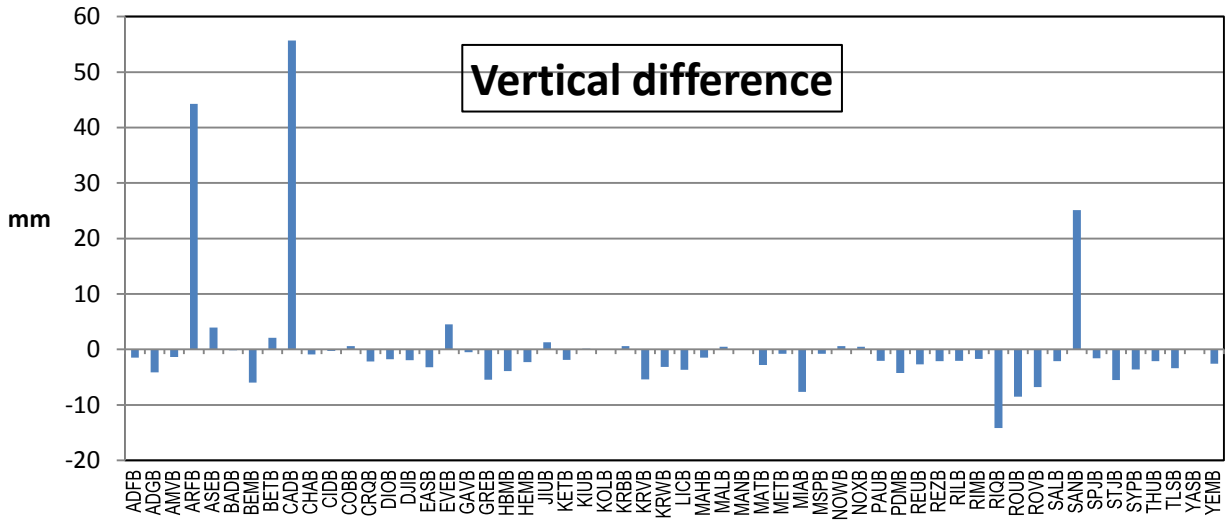
Differences between solution 1 and solution 2

❖ Sol. 1 -> without SAA satellites
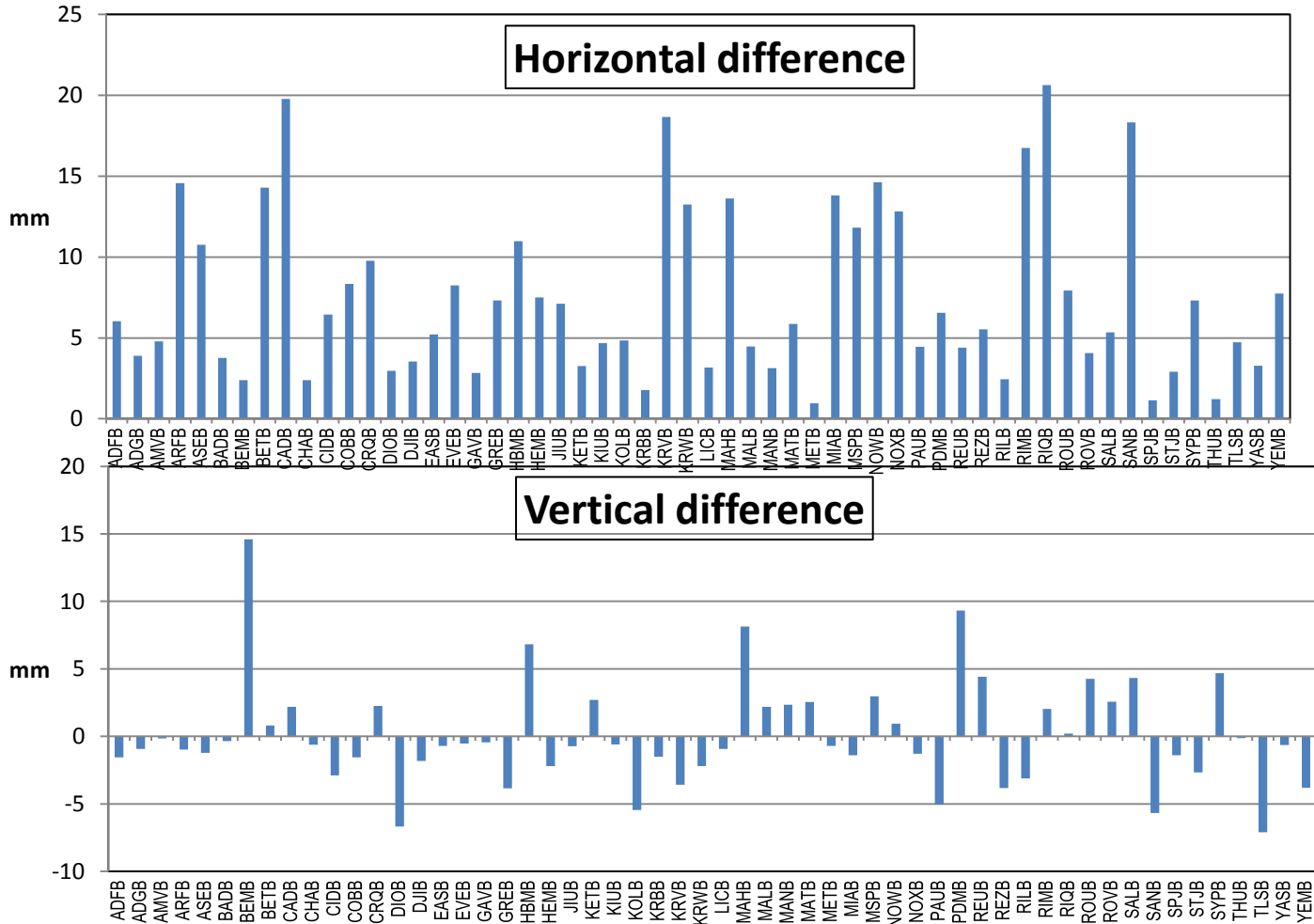❖ Sol. 2 -> plus SPOT-5, *corrected*, stations not renamed

Differences between solution 3 and solution 5

❖ Sol. 3 -> plus SPOT-5, *corrected*, 6 stations renamed
❖ Sol. 5 -> plus SPOT-5, *uncorrected*, 6 stations renamed

Differences between solution 1 and solution 6

❖ Sol. 1 -> without SAA satellites
❖ Sol. 6 -> plus Jason-1, *corrected*, 9 stations renamed

Conclusions

❖ SPOT-5: corrections + renaming stations (remove Cachoira ?)

❖ SPOT-5: data before 2007 – lower effect, easier to be corrected?

❖Jason-1: There is a minor solution improvement, but high risk of systematic errors