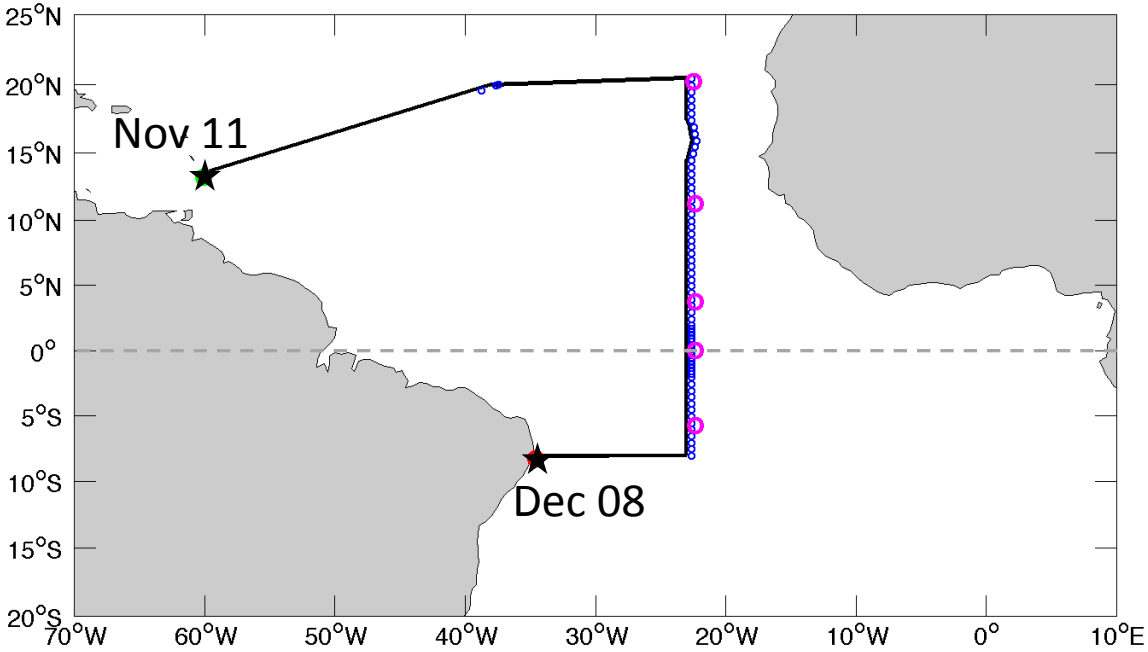
PNE2013b XBT comparison results



O – Locations of XBT comparisons

O – CTD deployments

-- - PNE2013b track

XBT-CTD COMPARISON:
96 XBT and 6 CTD profiles
80 XBT profiles used

Methodology

- 3 probe types: Standard, Experimental, Tight Weight Tolerance (TWT).
- Gradient method: Used to estimate depth biases in the XBT data, i.e., a depth offset (Z0) and a depth linear bias (Zd), such that:

$$Zxbt - Zctd = Z0 + Zd*Zctd \pm zs$$

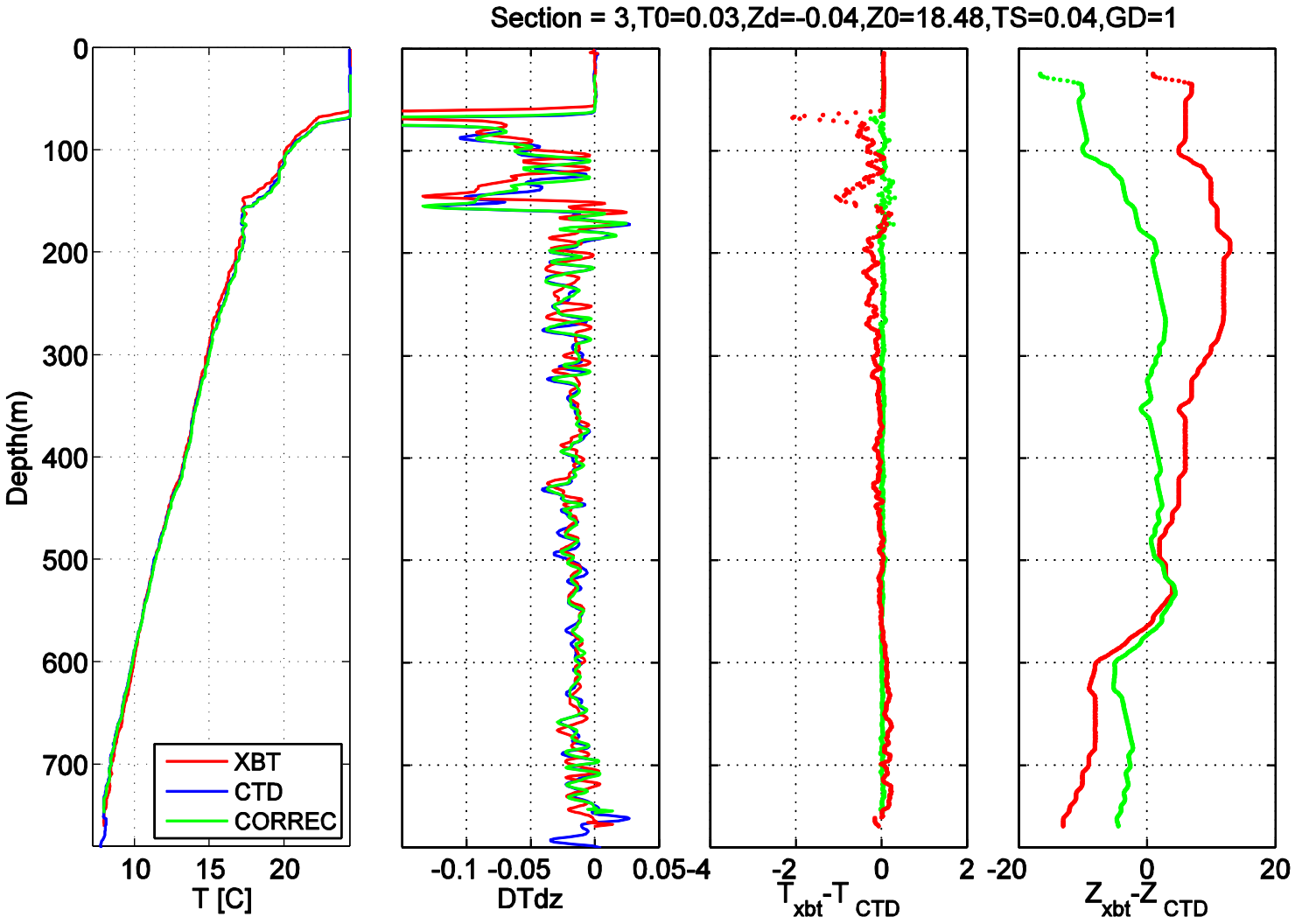
- XBT temperature biases: Estimated after removing depth biases, i.e., a temperature offset (T0) and a temperature precision (ts) which is the standard error of the data, such that:

$$Txbt - Tctd = T0 \pm ts$$

Methodology

- Gradient method: Compares temperature gradients between XBT and CTD, and locates the depth of the best match. The best depth estimate is where (1) the RMSE is minimum, (2) the correlation is maximum, and (3) the temperature difference (DT) is less a threshold (<= 1C).
- This optimization is ran 2x, one with a window of 50 m, and later with a window of 90 meters and DT threshold relaxed to 1C.
- Before applying the method, the data is interpolated to a depth step of 1m, and filtered with a 7-point median and a 11-point Hanning filters. The corrected depth is also filtered with a 11-point Hanning window.
- The goodness of fit is estimated by estimating the number of points in which corrected depth gradients are larger than 10 meters.
- The depth error parameters are estimated by the best fit between 100-680m to avoid the upper and lower layers.

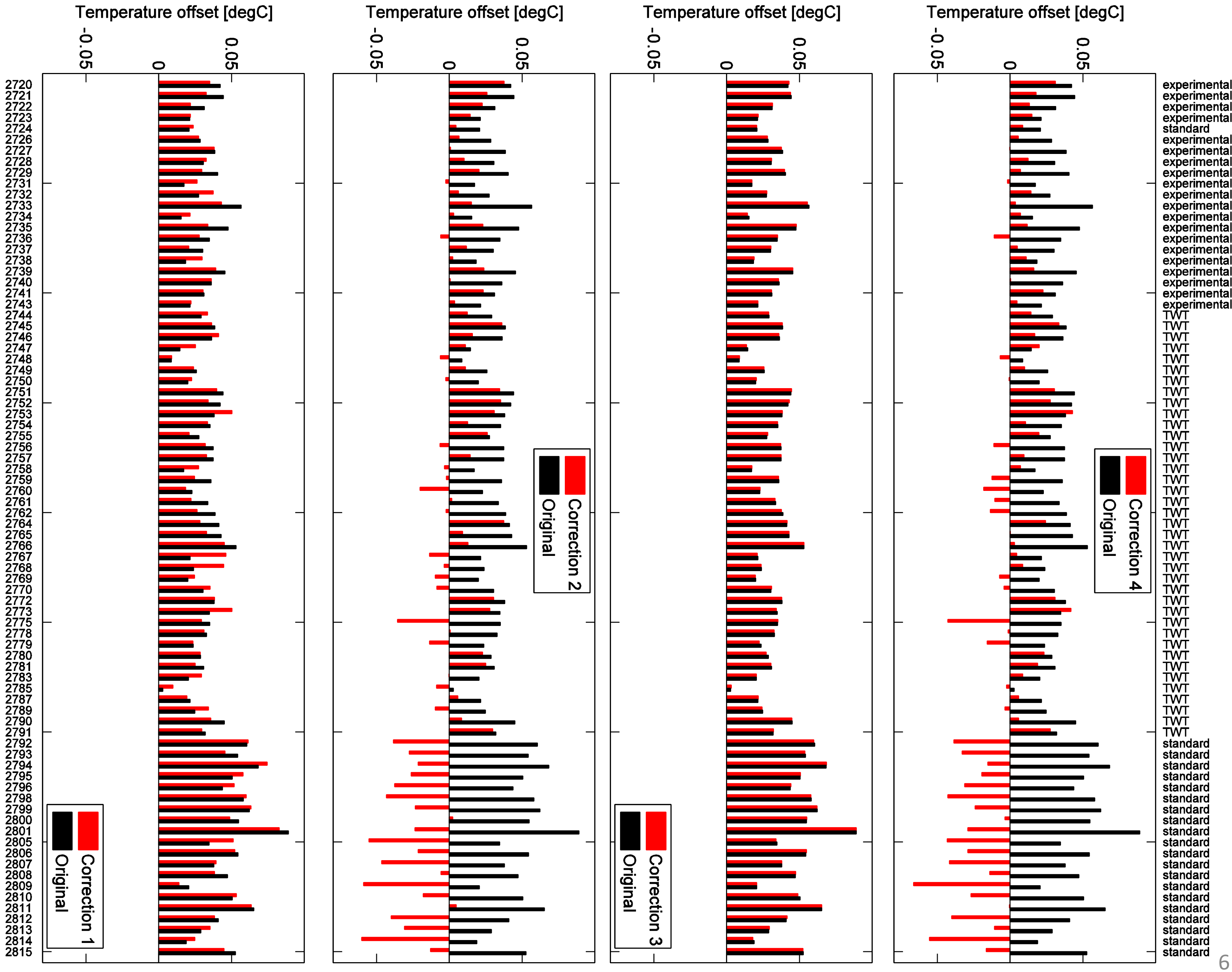
Example of correction



Corrections

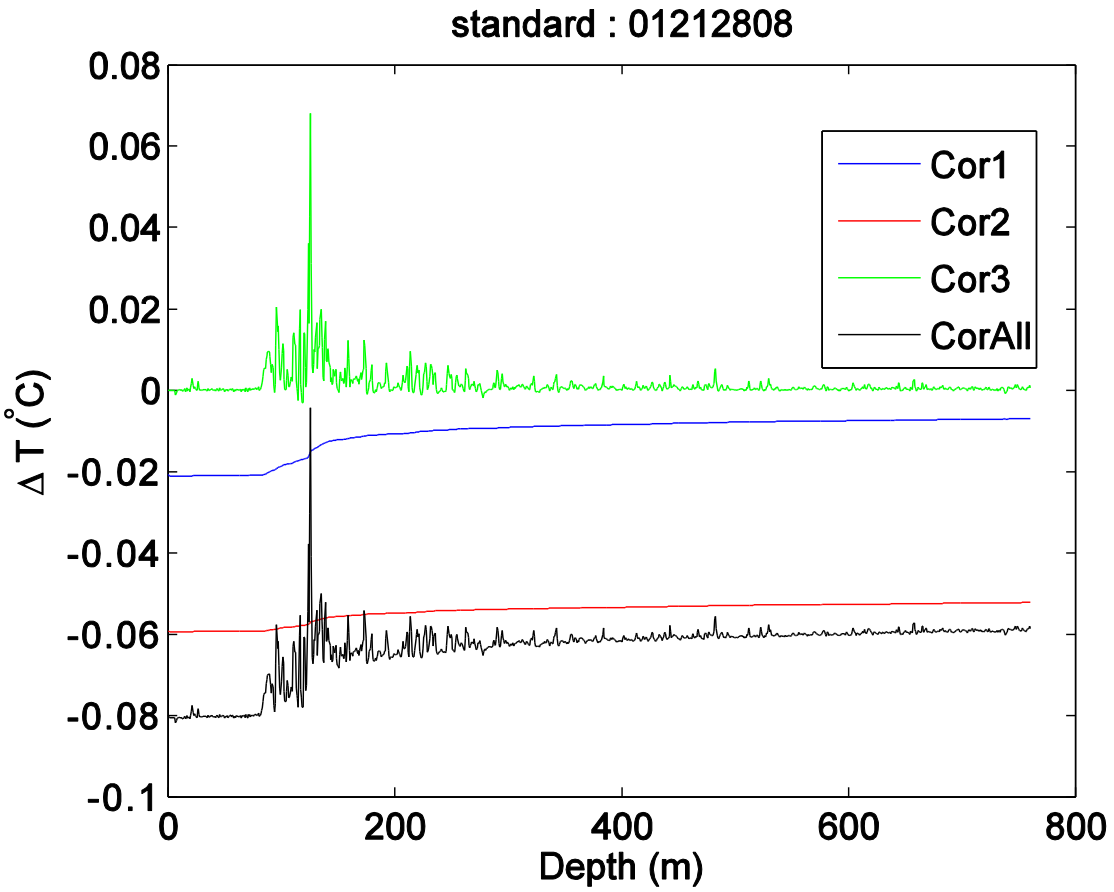
- 3 corrections for thermistor calibration are applied to the XBT data. The biases estimation procedure in the methodology is applied 5 times, on the original data, for the data after each of the three corrections individually, and for all corrections at the same time.
- The corrections are for:

1. Wire imbalance
2. Manufactory thermistor calibration
3. Thermal time constant

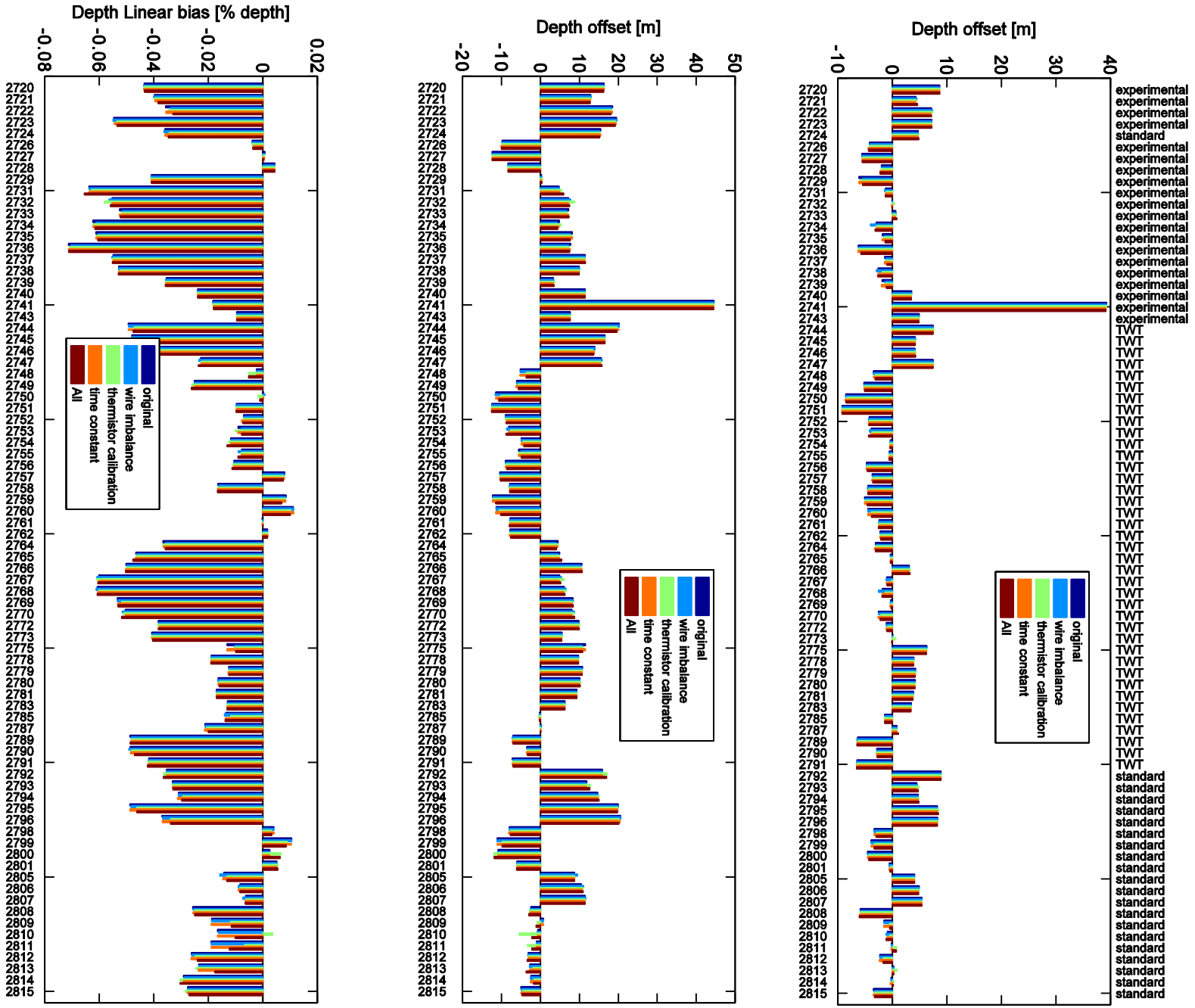


Wire imbalance | Thermistor calib. | Time constant | All corrections

The effect of the corrections on the temperature profile

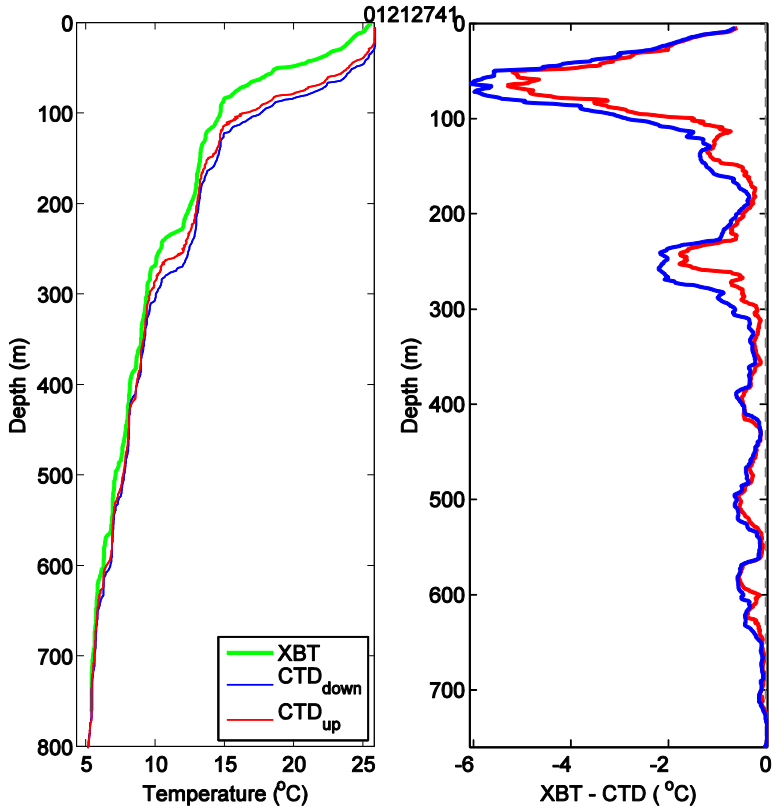


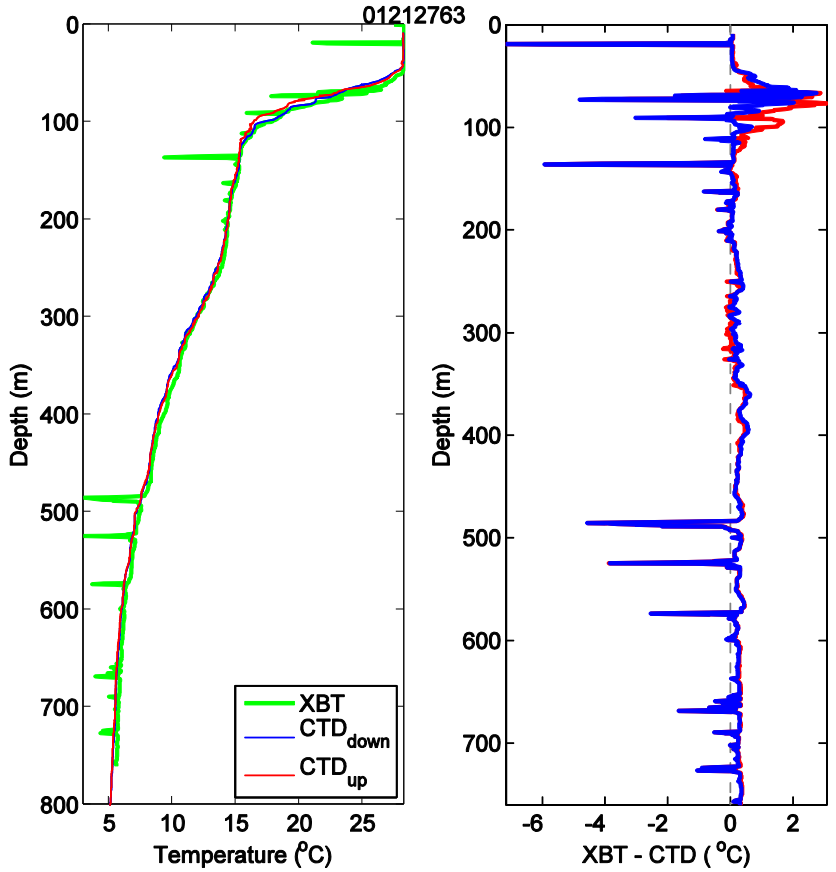
Corrections 2 and 3 overcompensate each other. This may explains the negative peaks in the temperature offset in the standard probes.



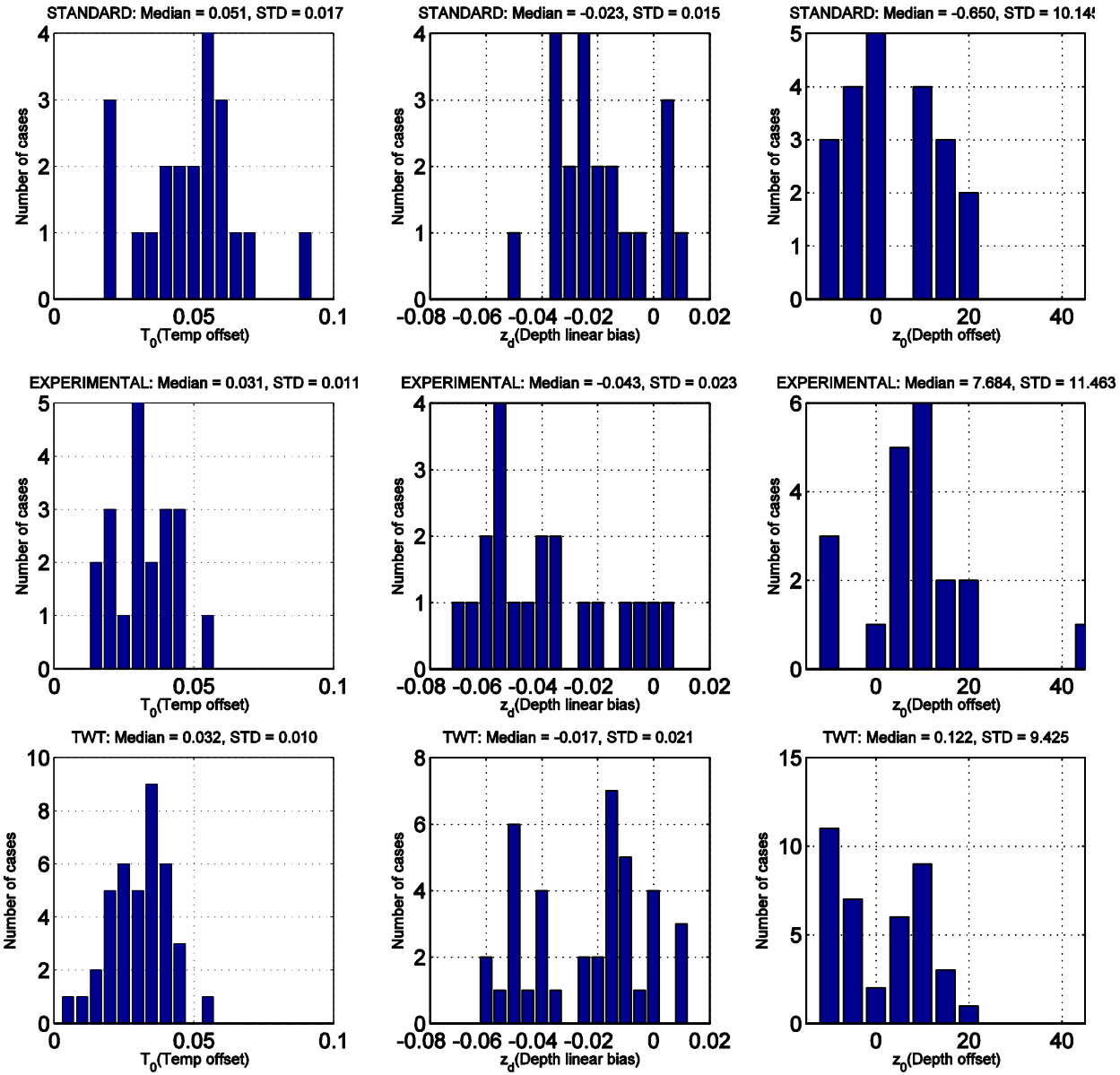
Hamon et al., 2011

Examples of profiles



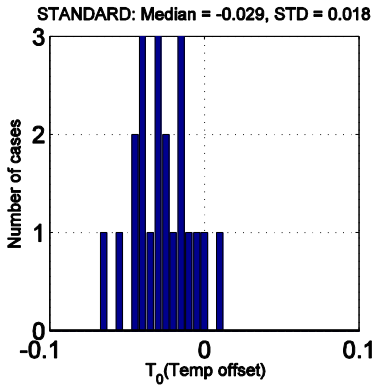


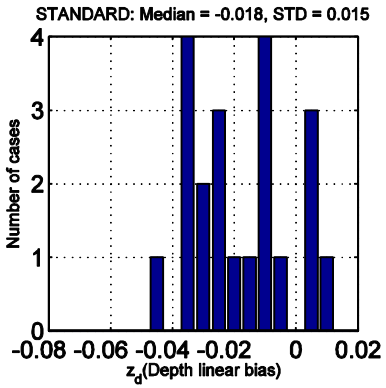
Parameter distribution by probe type

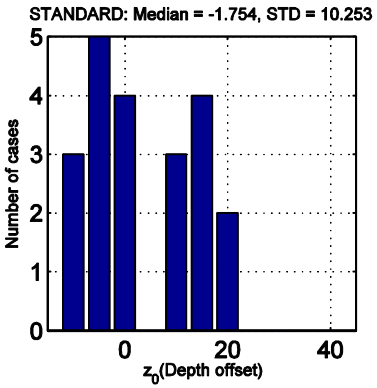


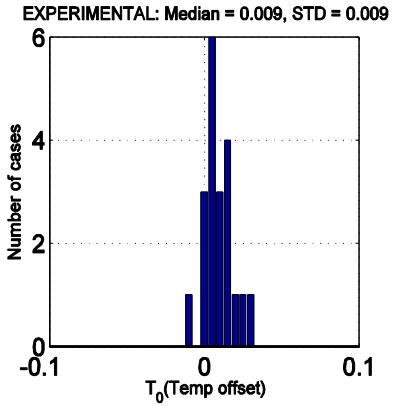
T0 is reduced in the TWT and Experimental probes. However T0 is always positive.

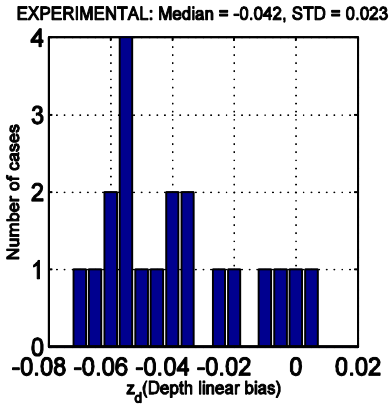
Parameter distribution by probe type after all corrections

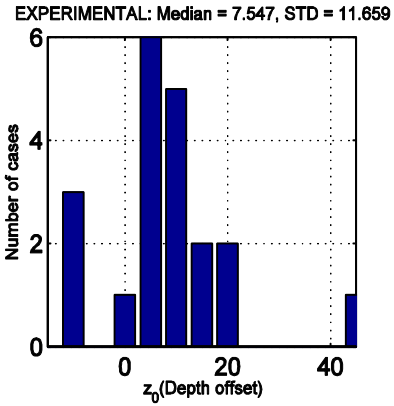


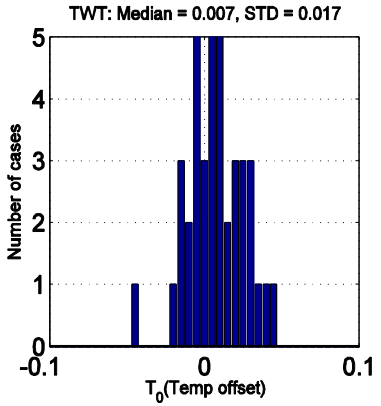


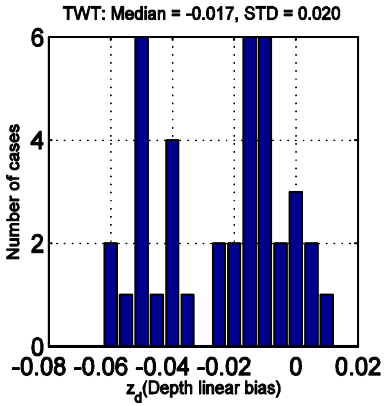


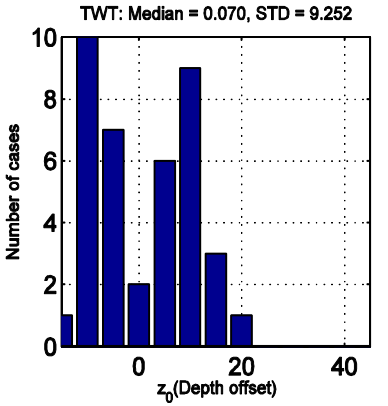












T0 in Experimental closest to the target.

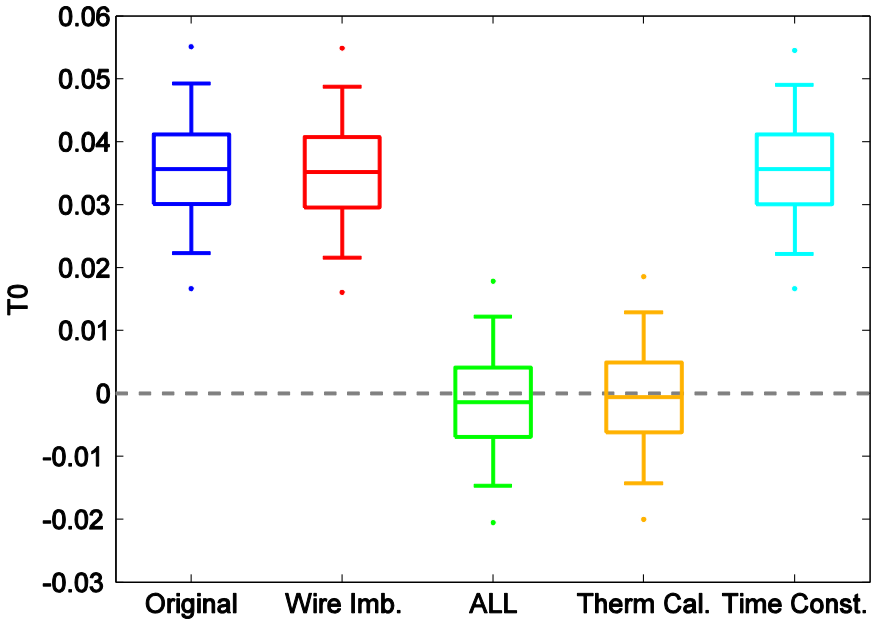
Statistical Analysis

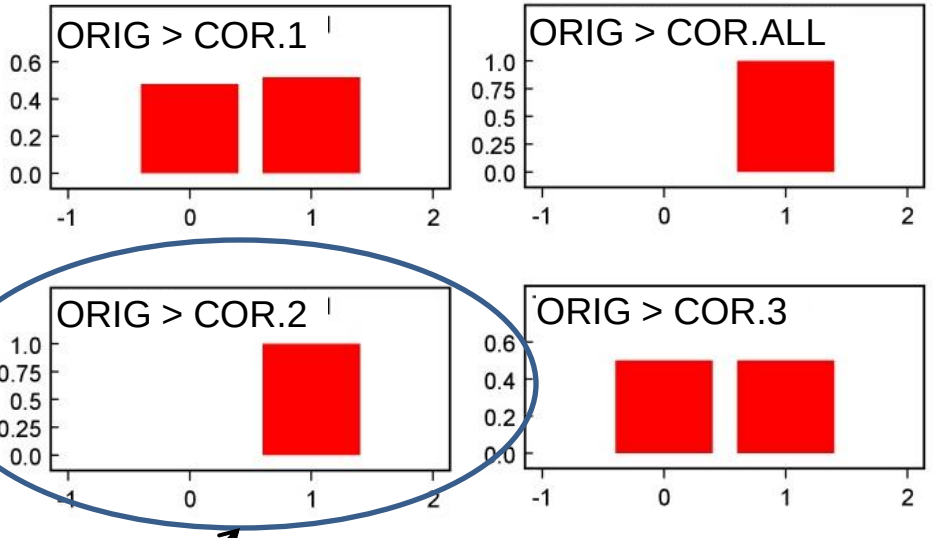
- Monte Carlo method for estimation of mean and variance of the error parameters (e.g., T0,Z0,Zd) of each dataset. From the initial population, it generates several random samples using a normal distribution derived from the data.
- The mean difference between two populations can be retrieved, including a probability on error being greater than other.
- We will test 2 main hypothesis:

1 Is the corrected data different than the original?

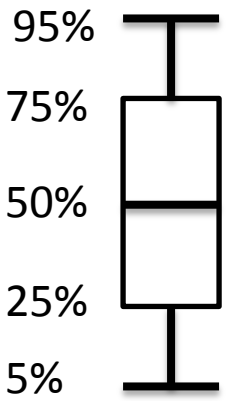
2 How does each probe compare to the standard?

T0 between corrections



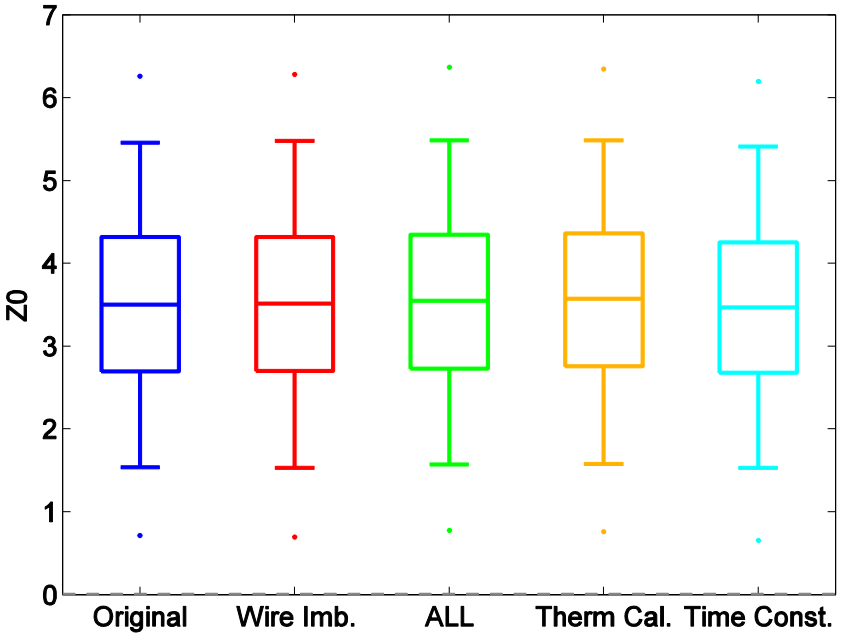


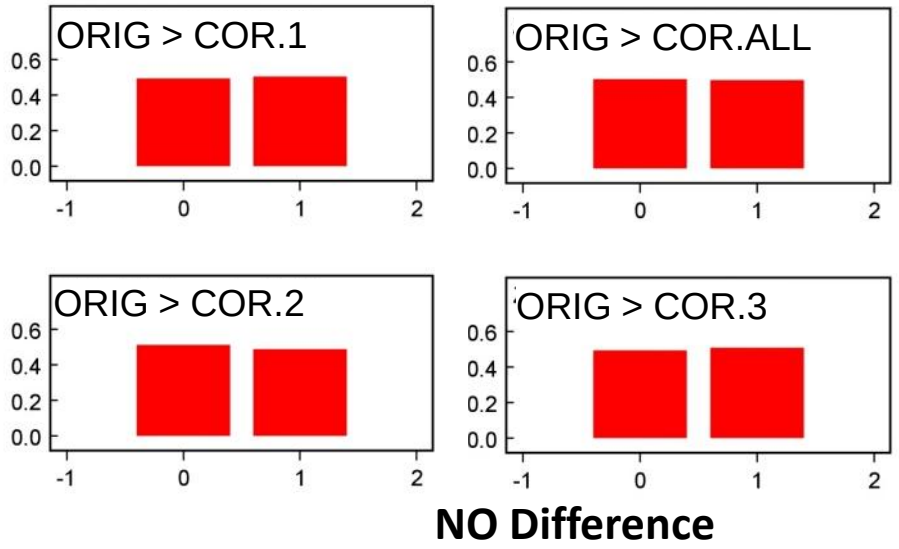
p(COR.2 < ORIG) = 99%
p(ALL < ORIG) = 99%
P(COR.1, COR.3 < ORIG) = 50%



node	mean	Sd	2.5%	median	97.5%
ORIG	0.0357	0.0082	0.0197	0.0356	0.0519
COR.1	0.0352	0.0082	0.0192	0.03523	0.0516
COR.2	-6.0E-4	0.0082	-0.0170	-5.7E-4	0.0156
COR.3	0.0356	0.0082	0.0194	0.0356	0.0515
ALL	-0.0014	0.0082	-0.0173	-0.0013	0.0147
ORIG > COR.1	0.5183	0.4997	0.0	1.0	1.0
ORIG > COR.2	0.9988	0.0346	1.0	1.0	1.0
ORIG > COR.3	0.4996	0.5	0.0	0.0	1.0
ORIG > ALL	0.9992	0.0291	1.0	1.0	1.0

Z0 between corrections

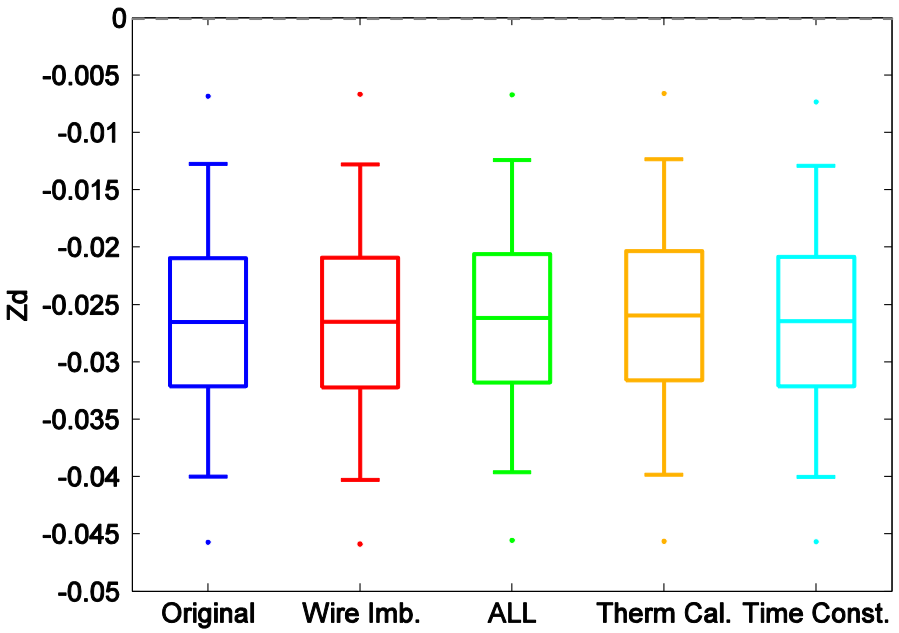


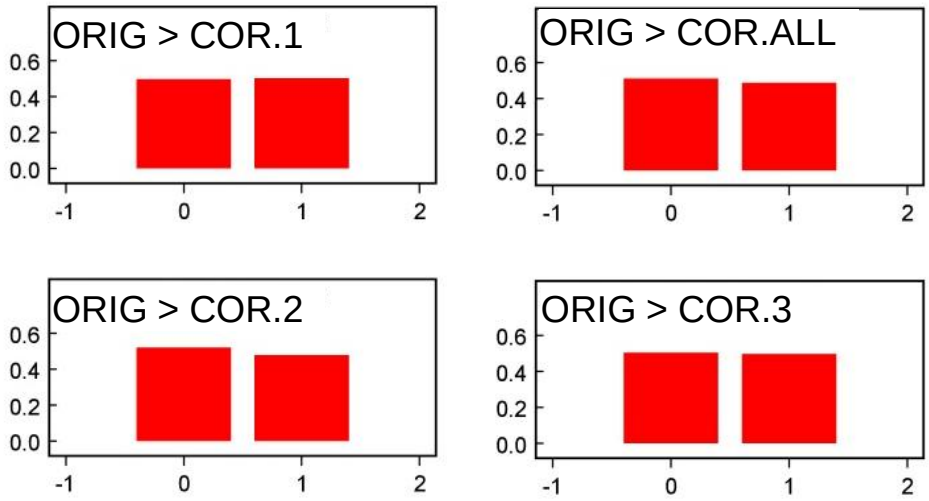


p(COR.1,COR.2, COR.3 < ORIG) = 50%
p(ALL < ORIG) = 50%

	mean	sd	2.5%	median	97.5%
ORIG	3.518	1.192	1.194	3.509	5.868
COR.1	3.496	1.199	1.17	3.502	5.874
COR.2	3.545	1.197	1.163	3.55	5.903
COR.3	3.472	1.194	1.123	3.478	5.786
ALL	3.525	1.193	1.211	3.527	5.857
ORIG > COR.1	0.5056	0.5	0.0	1.0	1.0
ORIG > ALL	0.4968	0.5	0.0	0.0	1.0
ORIG > COR.2	0.4884	0.4999	0.0	0.0	1.0
ORIG > COR.3	0.5069	0.5	0.0	1.0	1.0

Zd between corrections



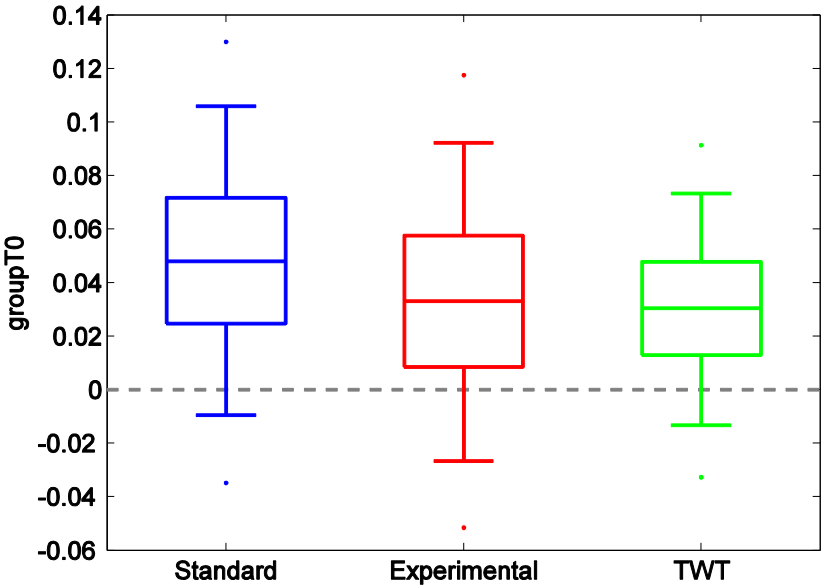


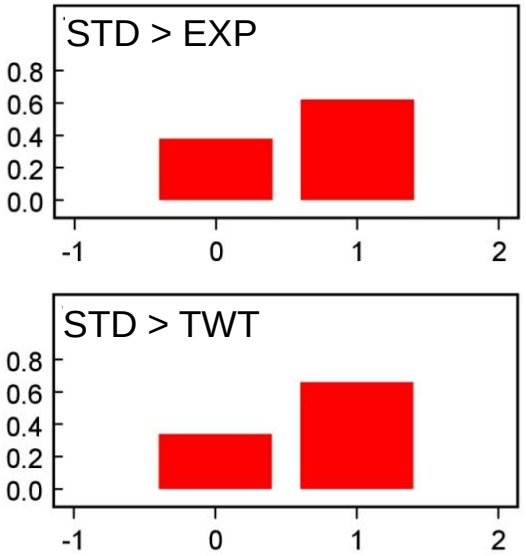
NO Difference

p(COR.1, COR.2, COR.3 < ORIG) = 50%
p(ALL < ORIG) = 50%

node	mean	sd	2.5%	median	97.5%
ORIG	-0.0265	0.0083	-0.0426	-0.0265	-0.0101
COR.1	-0.0265	0.0083	-0.0427	-0.0265	-0.0099
COR.2	-0.0259	0.0083	-0.0426	-0.0259	-0.0096
COR.3	-0.0265	0.0083	-0.0428	-0.0264	-0.0104
ALL	-0.0262	0.0083	-0.0422	-0.0261	-0.0100
ORIG > COR.1	0.5023	0.5	0.0	1.0	1.0
ORIG > ALL	0.4879	0.4999	0.0	0.0	1.0
ORIG > COR.2	0.4782	0.4995	0.0	0.0	1.0
ORIG > COR.3	0.4966	0.5	0.0	0.0	1.0

T0 between different probe types

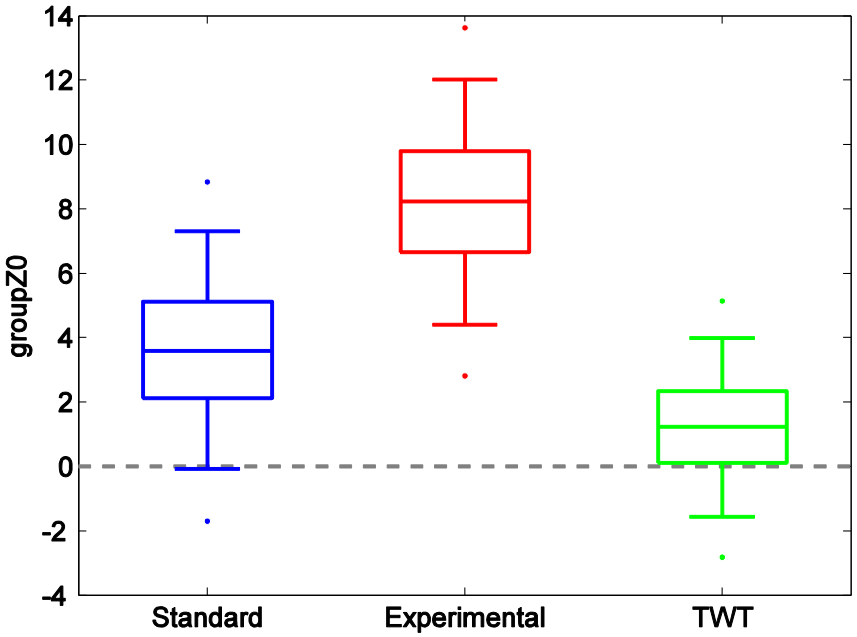


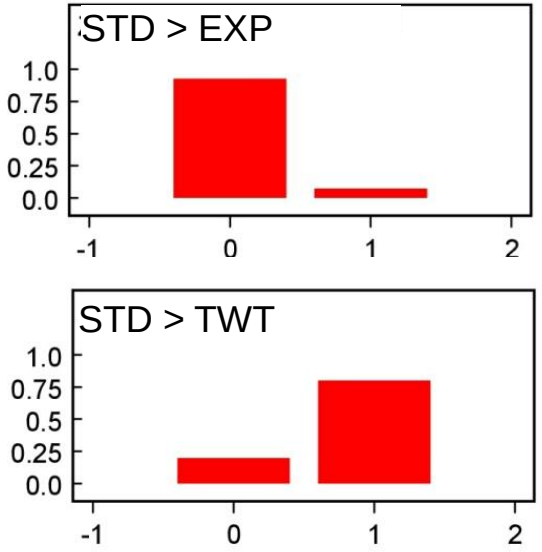


p(TWT < STD) = 66%
p(EXP < STD) = 62%

node	mean	sd	2.5%	median	97.5%
Standard	0.04819	0.0352	-0.0208	0.048	0.117
Experimental	0.03291	0.0365	-0.0381	0.0330	0.1042
TWT	0.0302	0.0263	-0.0223	0.0304	0.0817
STD > EXP	0.6214	0.485	0.0	1.0	1.0
STD > TWT	0.6601	0.4737	0.0	1.0	1.0

Z0 between different probe types

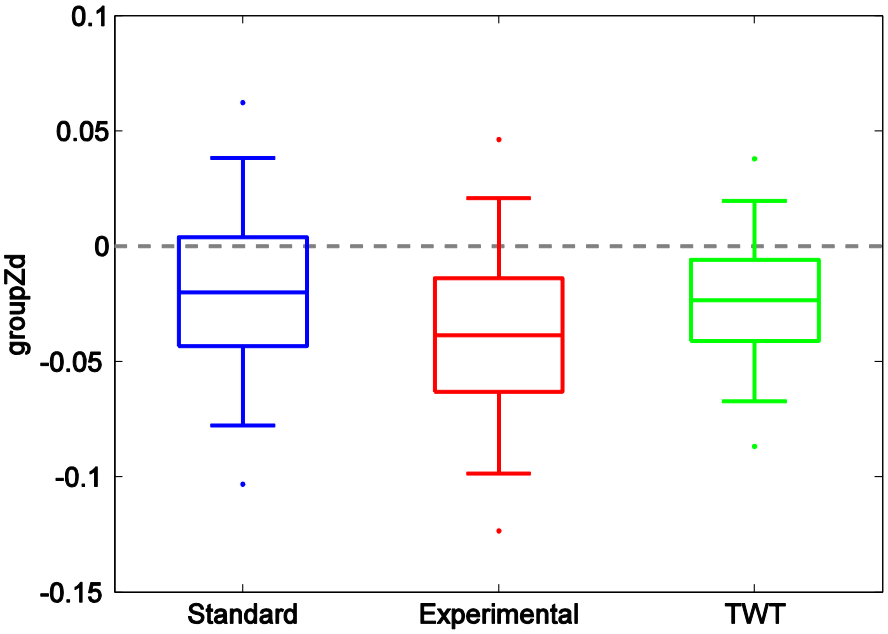


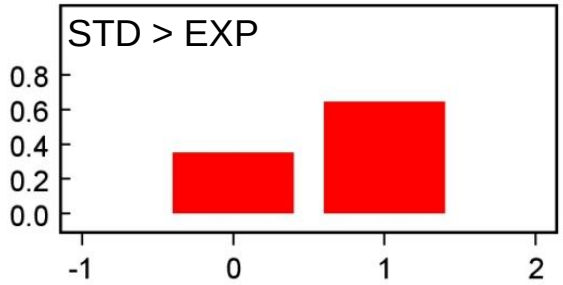


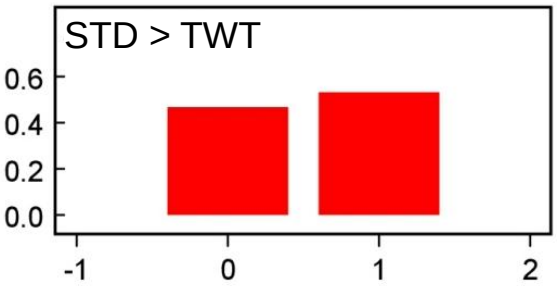
p(TWT < STD) = 80%
p(EXP < STD) = 7%

node	mean	sd	2.5%	median	97.5%
Standard	3.617	2.252	-0.803	3.604	8.014
Experimental	8.218	2.333	3.675	8.224	12.79
TWT	1.226	1.686	-2.138	1.238	4.514
STD > EXP	0.0730	0.2602	0.0	0.0	1.0
STD > TWT	0.8024	0.3982	0.0	1.0	1.0

Zd between different probe types







NO significant Difference

p(TWT < STD) = 53%
p(EXP < STD) = 64%

node	mean	sd	2.5%	median	97.5%
Standard	-0.0198	0.0353	-0.0891	-0.0199	0.0493
Experimental	-0.0386	0.0366	-0.11	-0.0385	0.0329
TWT	-0.0236	0.0265	-0.0763	-0.0234	0.0282
STD > EXP	0.6464	0.4781	0.0	1.0	1.0
STD > TWT	0.5326	0.4989	0.0	1.0	1.0

Conclusions

- Correction 2 (thermistor calibration) has the strongest effect. After its application, the temperature offset is less biases toward positive values.
- The temperature offset is the error parameter most affected by the corrections.
- TWT has the smallest depth offset an the smallest variance of linear depth bias.
- Experimental has the smallest mean and variance of temperature offset after correction.
- Standard did not improve considerably after correction. Instead it is overcorrected.