Updating the XBT Bias Correction Scheme

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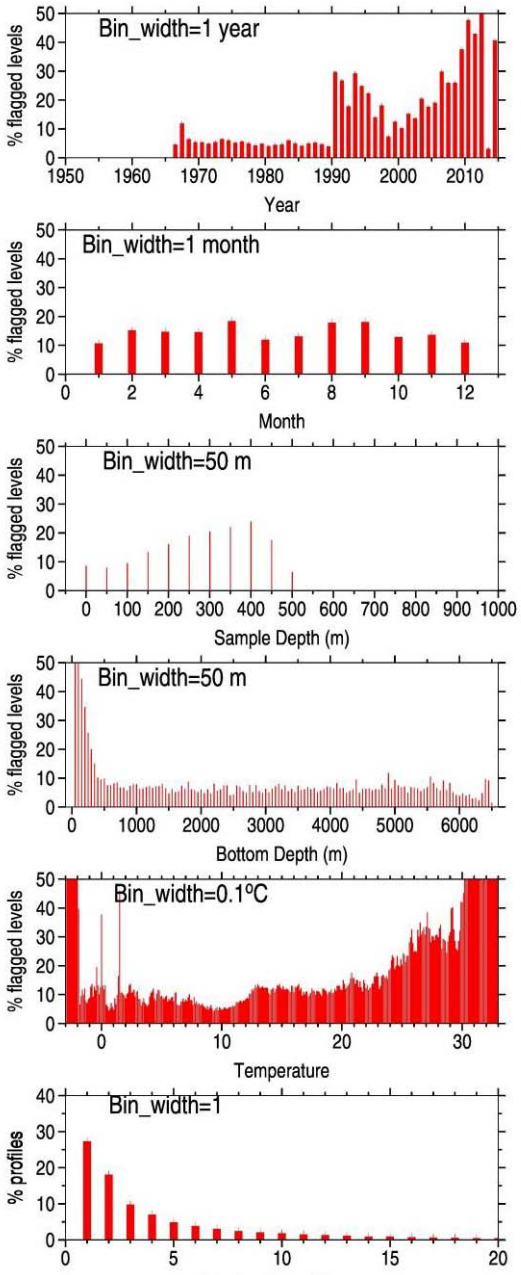
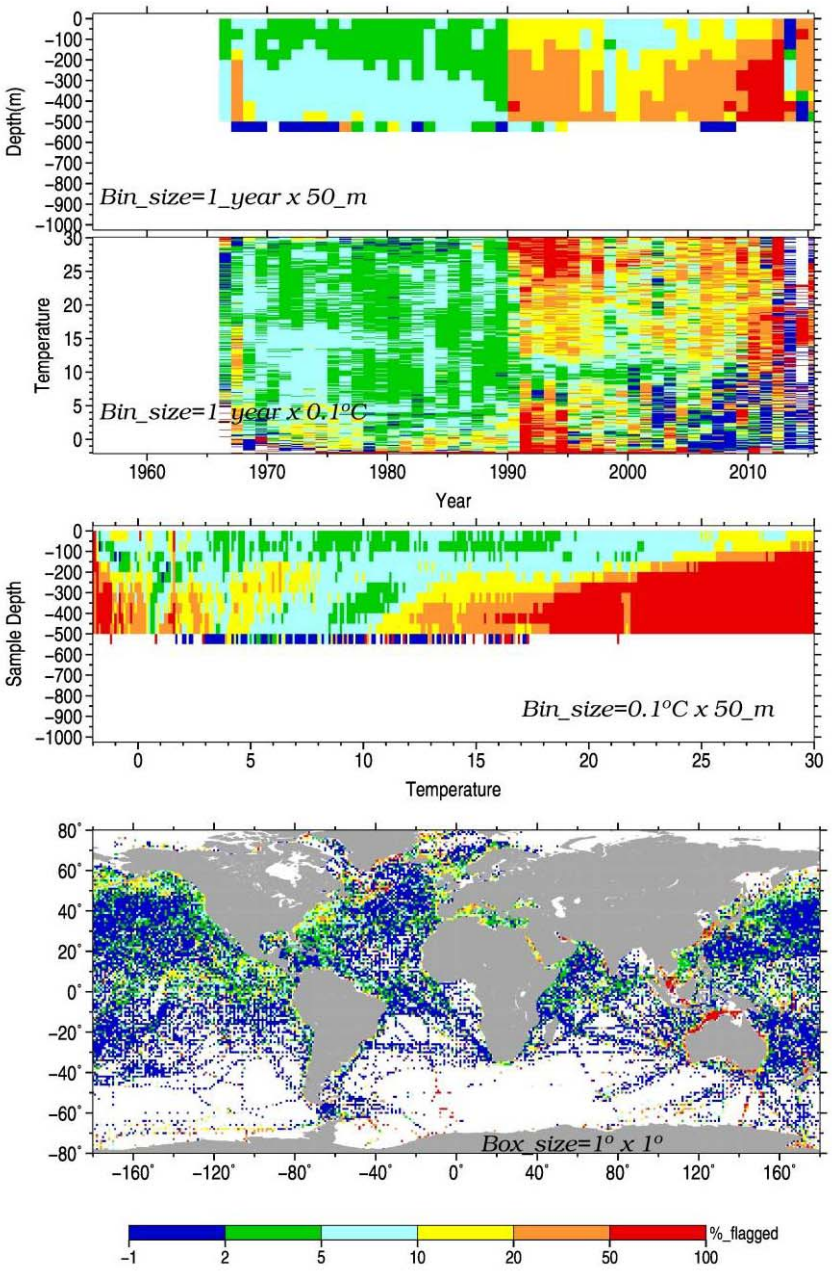
Database and Correction Scheme

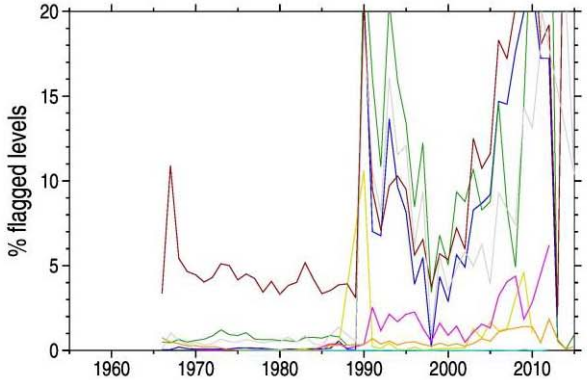
- WOD13 (as for Dec 2015)
- XBT profiles: only T4, T6, T7 and DeepBlue
- Reference temperature profiles: OSD + CTD + PFL
- Correction scheme: Gouretski&Reseghetti 2010

Quality Check Diagnostics for the T4 & T6 profiles



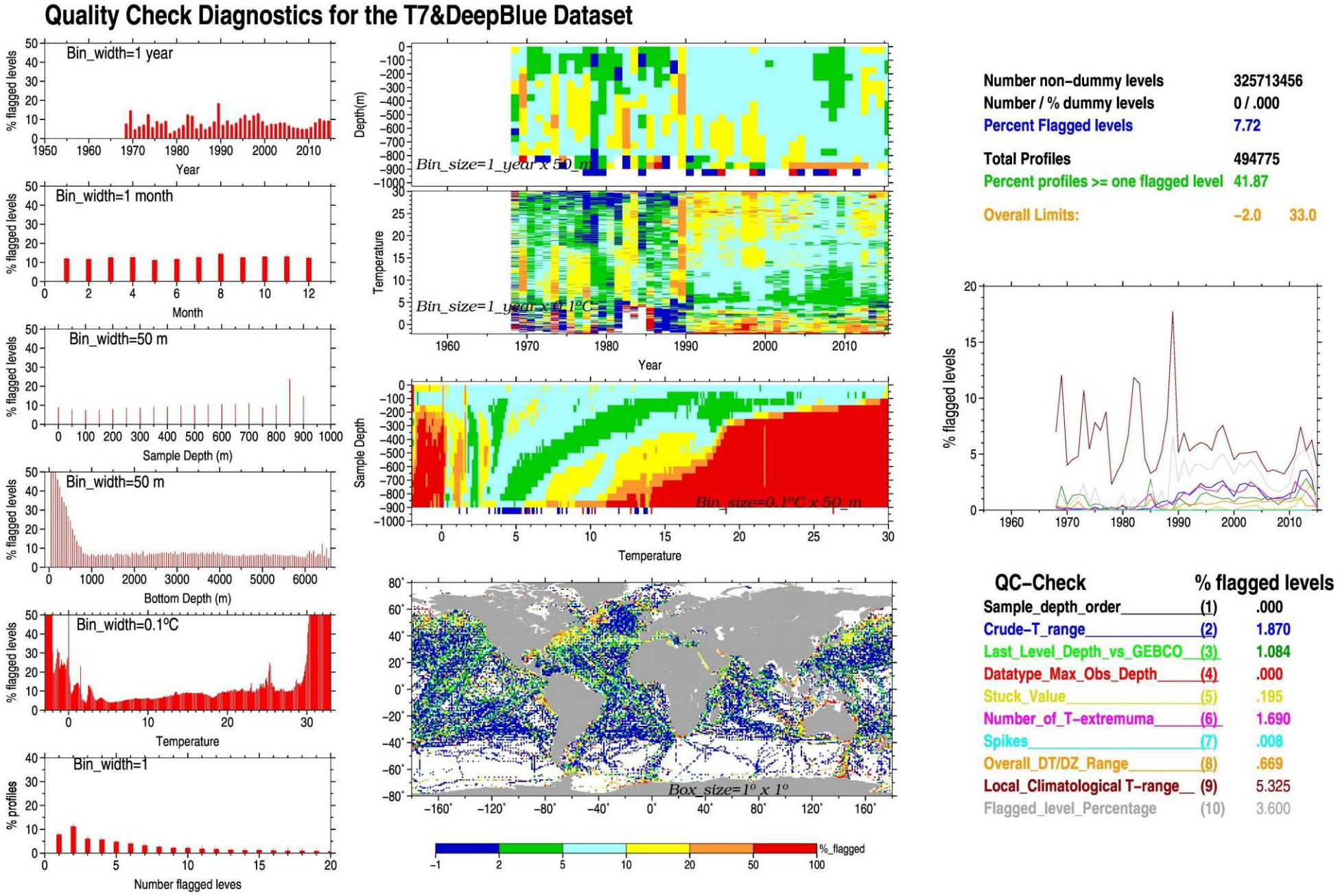


Number non-dummy levels	27858815
Number / % dummy levels	0 / .000
Percent Flagged levels	14.63
Total Profiles	435230
Percent profiles >= one flagged level	25.92
Overall Limits:	-2.0 33.0



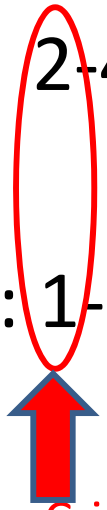
QC-Check		% flagged levels
Sample_depth_order	(1)	.000
Crude-T_range	(2)	5.188
Last_Level_Depth_vs_GEBCO	(3)	7.878
Datatype_Max_Obs_Depth	(4)	.000
Stuck_Value	(5)	.415
Number_of_T-extremuma	(6)	1.158
Spikes	(7)	.009
Overall_DT/DZ_Range	(8)	.381
Local_Climatological T-range	(9)	7.380
Flagged_level_Percentage	(10)	5.798

Quality Check Diagnostics for the T7 & DeepBlue profiles



Collocation Parameters

- Spatial Collocation Radius: 2-4-8-16-32 km
- Temporal Collocation Radius: 1-2-4-8-16 Days

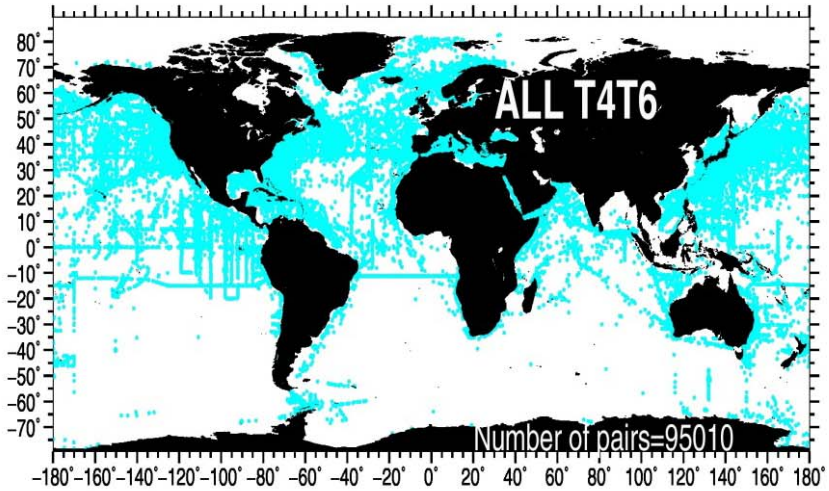


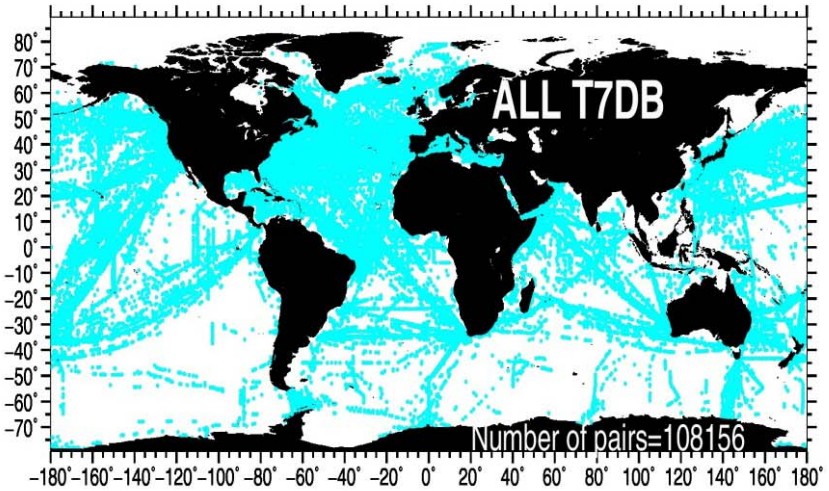
Proximity Criteria for
side-by-side profile pairs

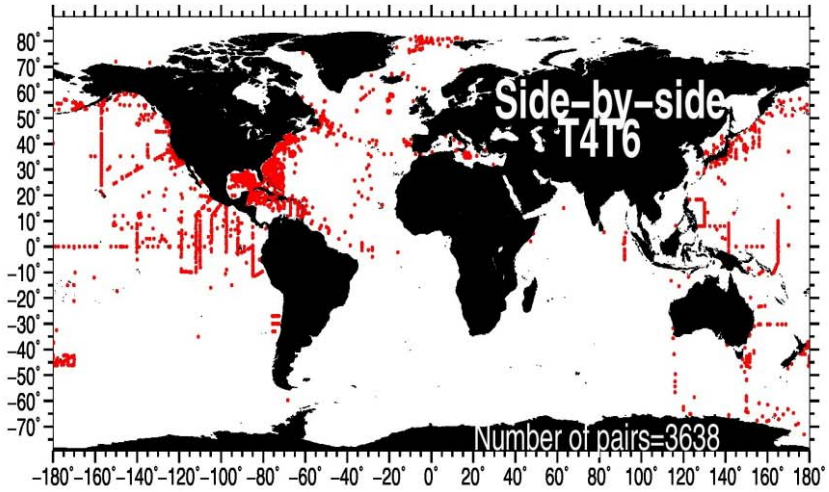
$$B^{total}(z) = \text{median}\{T^{xbt}(z) - T^{ref}_{i}(z)\},$$

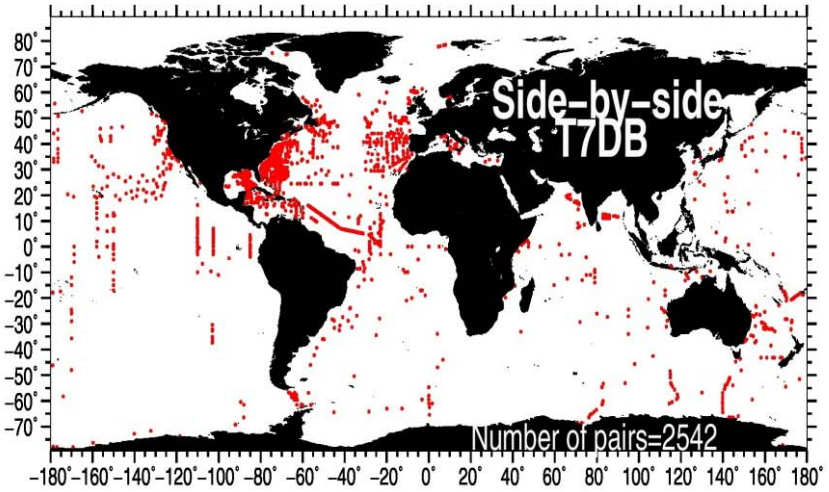
i=1,…,N within the collocation radii

Collocated *Sippican* XBT/REF Profiles

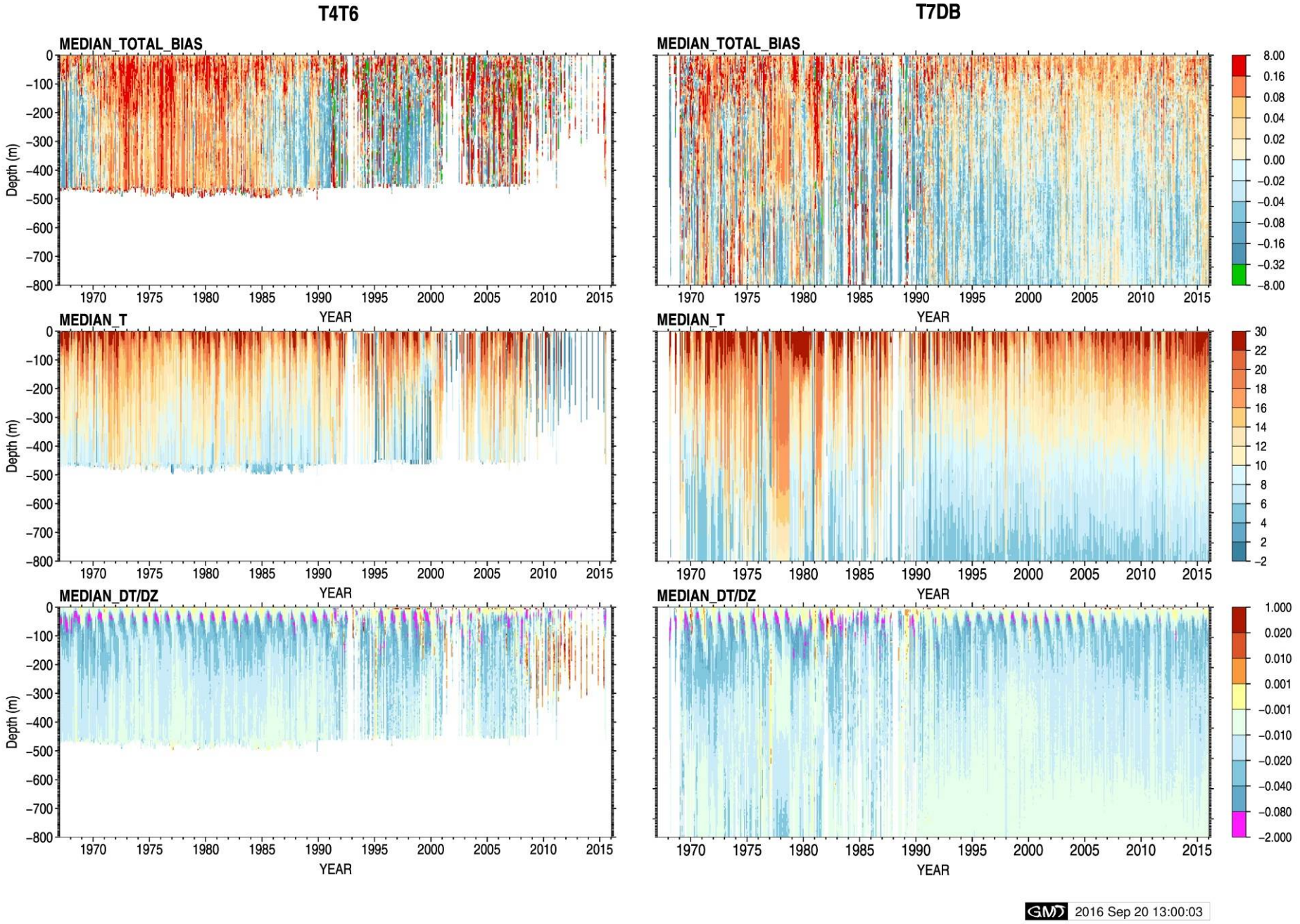




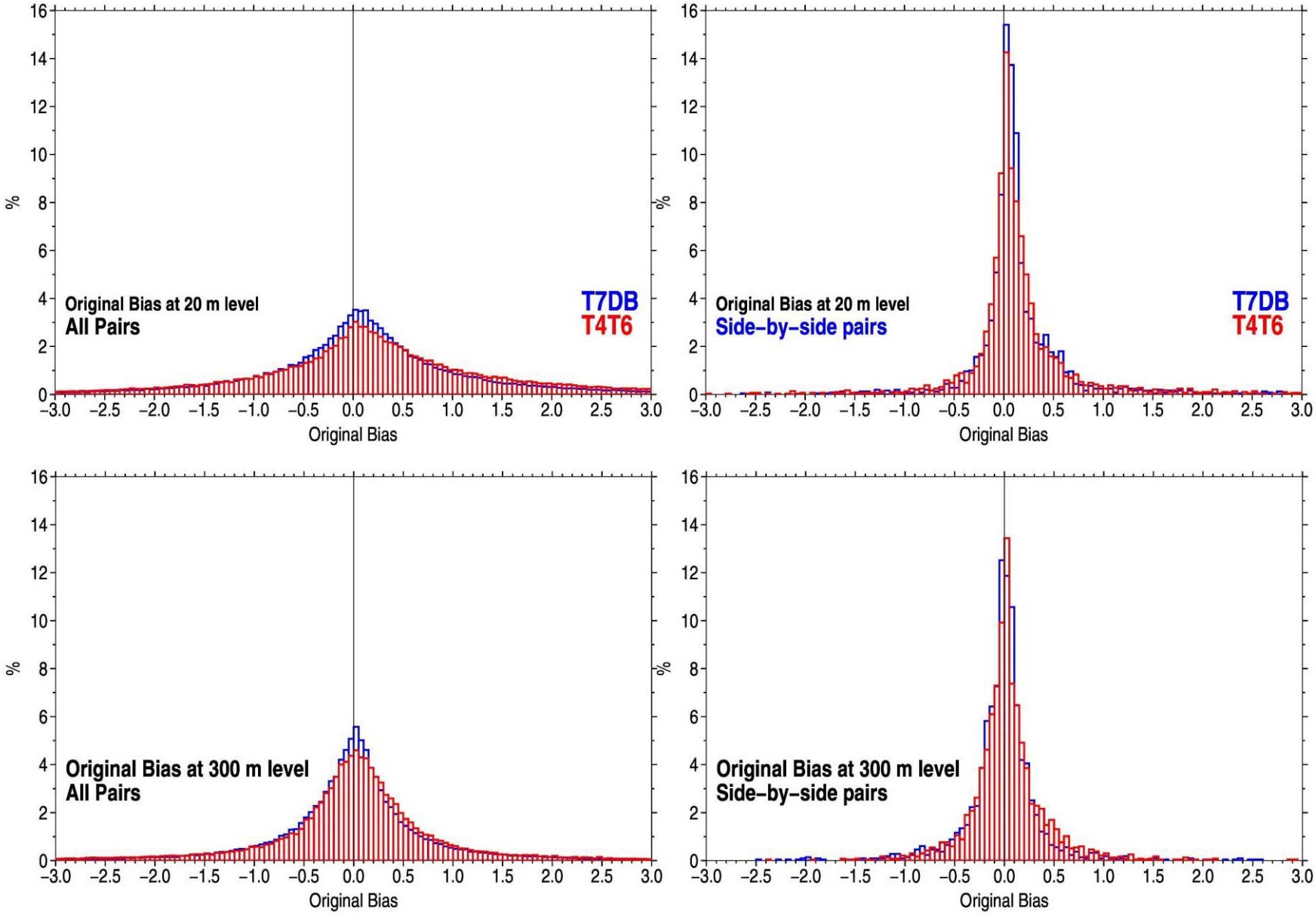




Monthly Total Temperature Bias, Water Temperature and Vertical Temperature Gradient



Total T-Bias Histograms



XBT Bias Components

- **Thermal Bias** (caused by thermistor, acquisition system, wire,…)
- **Depth-Bias** (variations in the probe physical characteristics, water viscosity, launch height,… which influence the fall rate velocity)
- **The two biases** are independent from each other
- Thermal bias must be properly excluded to diagnose the depth bias (note warning in *Hanawa et al., 1994*)

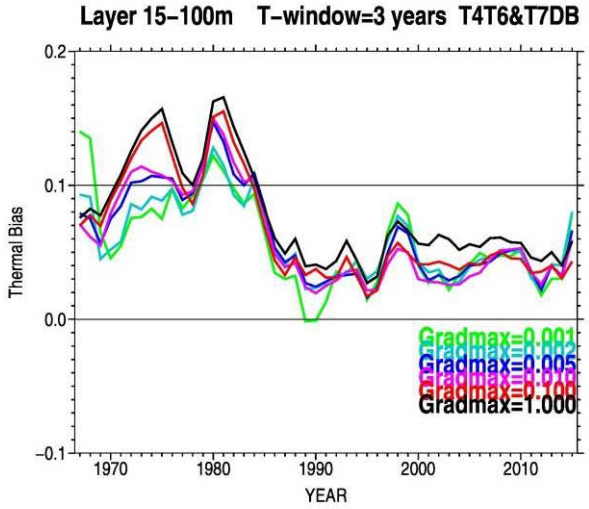
Direct estimation of the thermal bias: problems

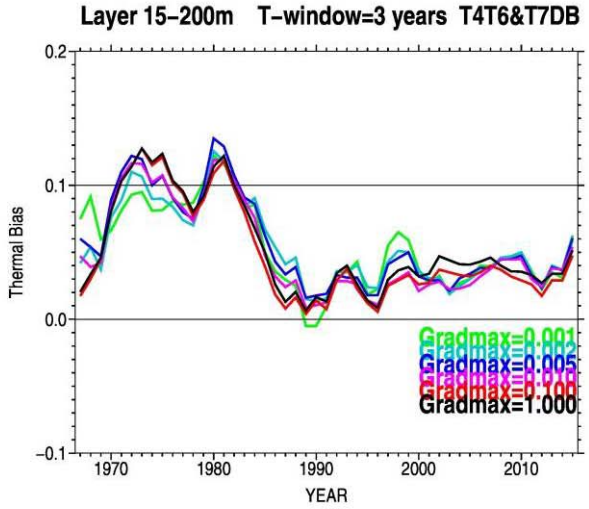
- **The thermal bias** can be estimated from the collocated analysis for the low-gradient regions/layers. However the number of suitable profile pairs reduces significantly.

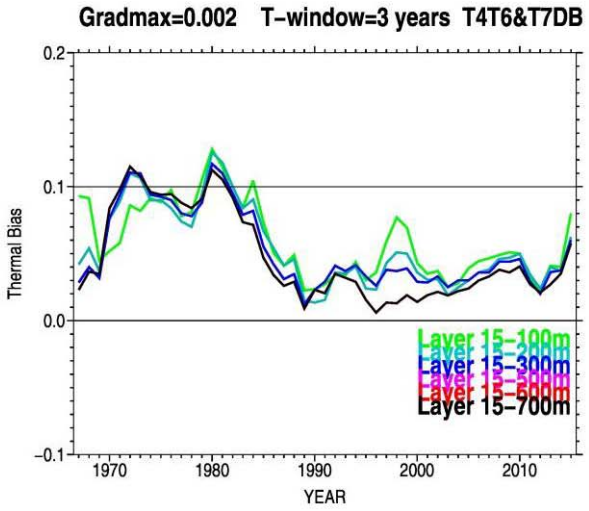
  It is not known whether these estimates are representative for the whole XBT dataset

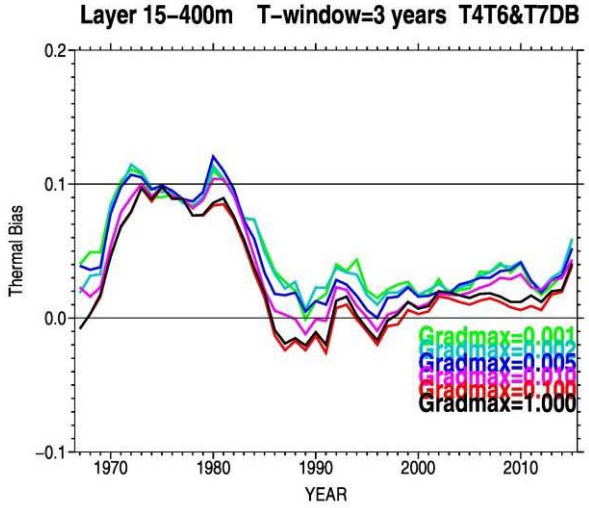
- There are indications for **the thermal bias** to be **temperature-dependent** (Reverdin et al., 2009)

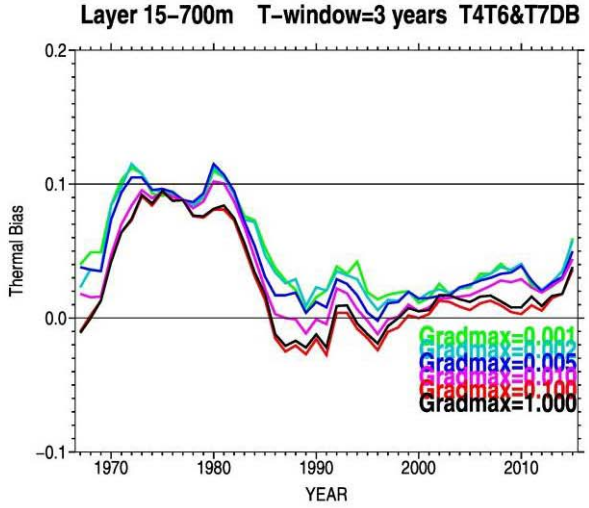
Thermal Bias Calculations: Dependence on vertical temperature gradient and layer











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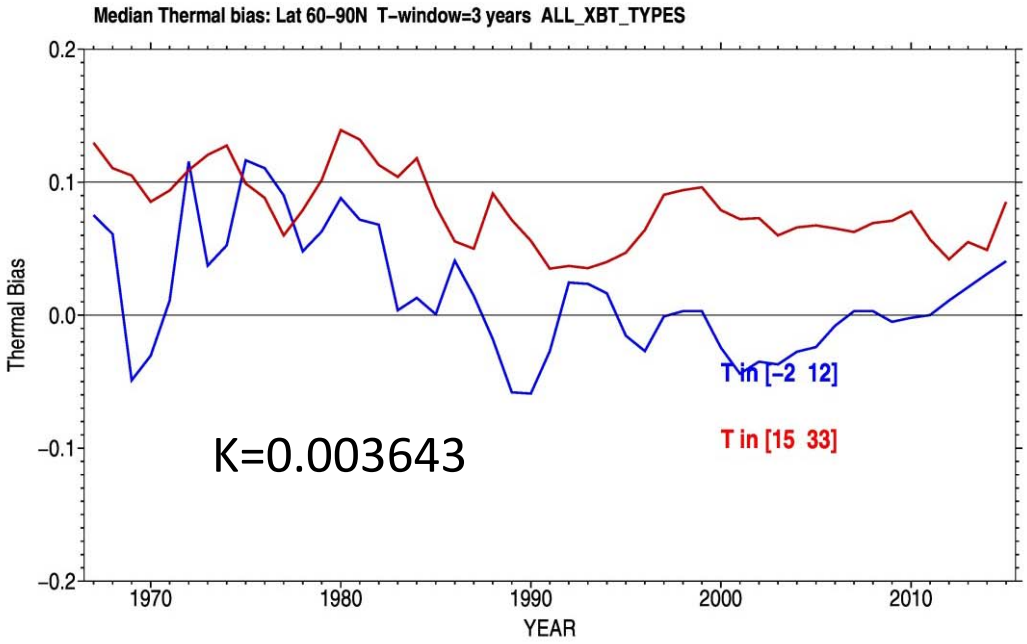
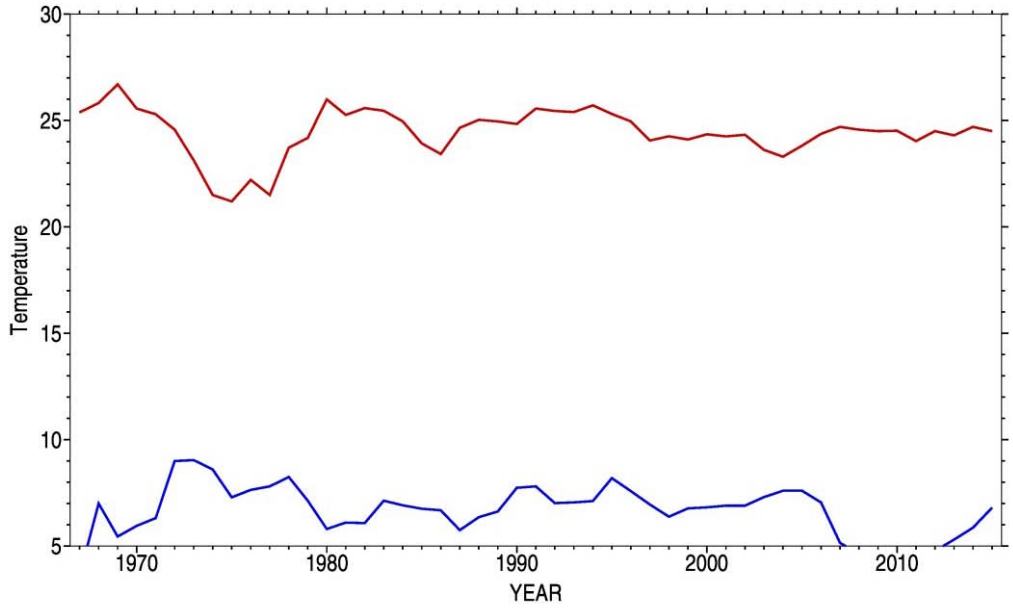
Thermal Bias Calculation: dependence on water temperature





B=kT-Tref

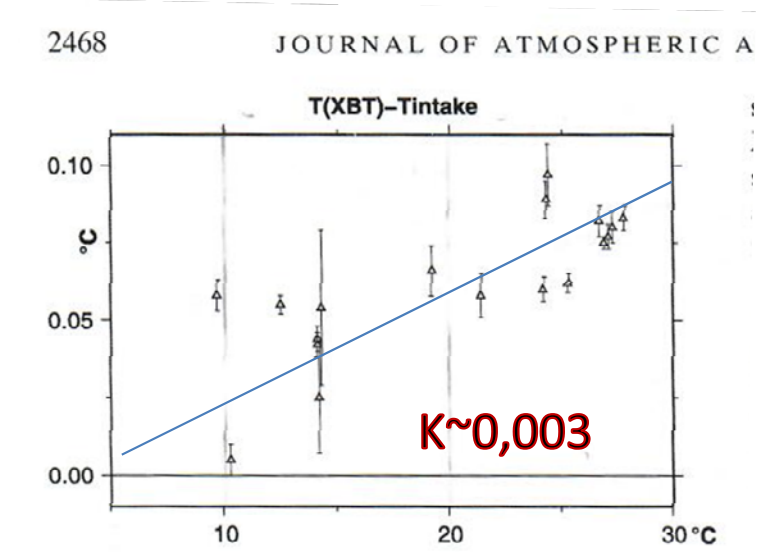


FIG. 2. Comparison of near-surface temperature from XBTs with corrected intake temperatures. For each cruise, the average difference and its associated error are indicated as a function of average intake temperature (see Tables 1 and 2). Notice that for the two "coldest" cruises Ovide2002 and Ovide2004, the intake temperature was corrected based on comparison with nonsimultaneous CTD measurements. The values for the two 2007 cruises Egee5 and Egee6, which exhibit smaller differences, have not been plotted.

From Reverdin et al.2009

Bias Model (*Gouretski&Reseghetti 2010*)

- Bias decomposition: $B^{total} = B^{thermal} + B^{depth}$

- For the diagnosed depth bias the following approximation is used:

  $B^{depth} = a + bz$, where a is the depth offset

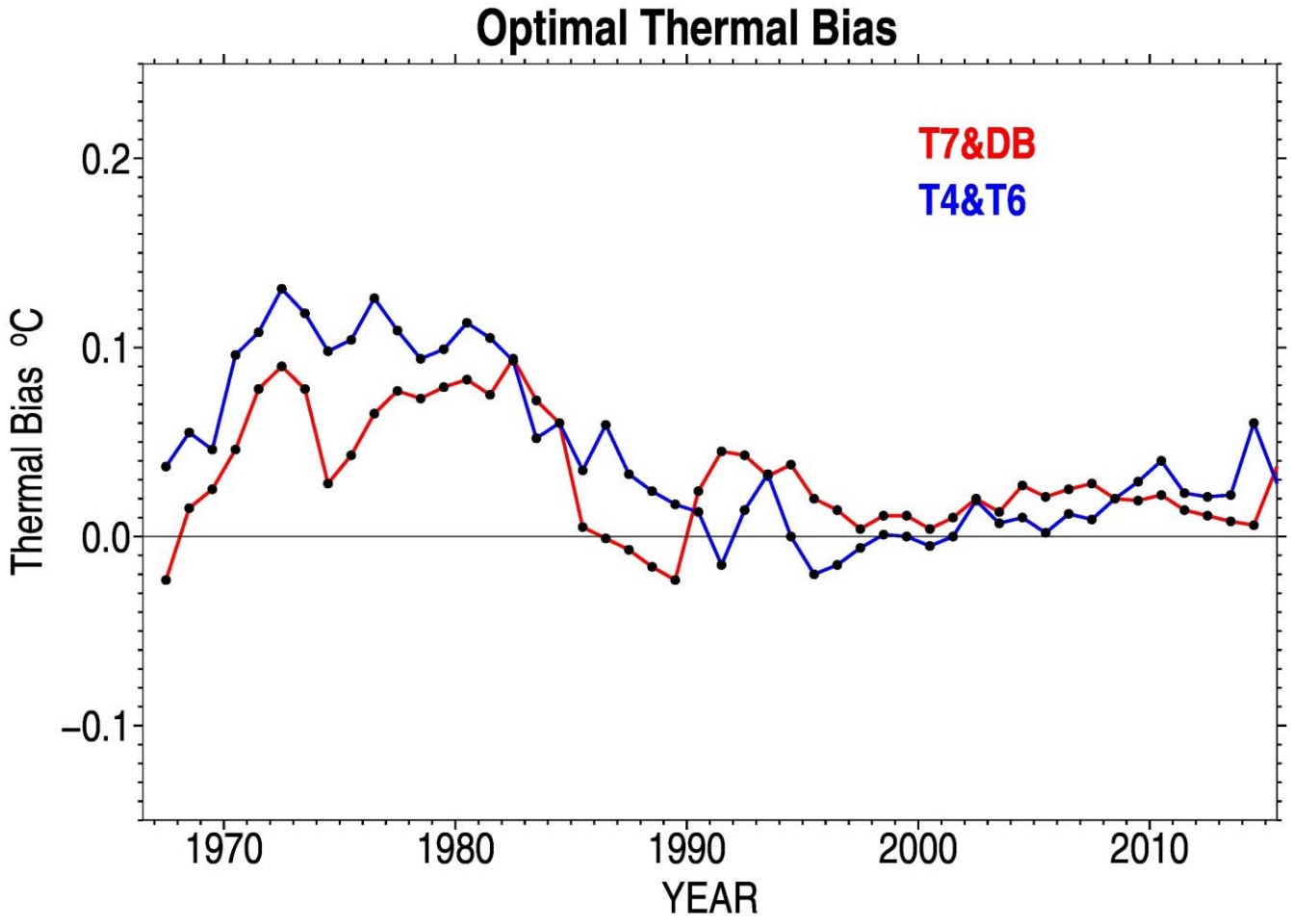
- A three-year time-window is used to guarantee the sufficient amount of the data

- Thermal bias is obtained by the minimization of the vertically averaged residual bias

- MODEL 1: T- independent thermal bias
- MODEL 2: T- dependent thermal bias

Estimation of the „optimal“ thermal bias

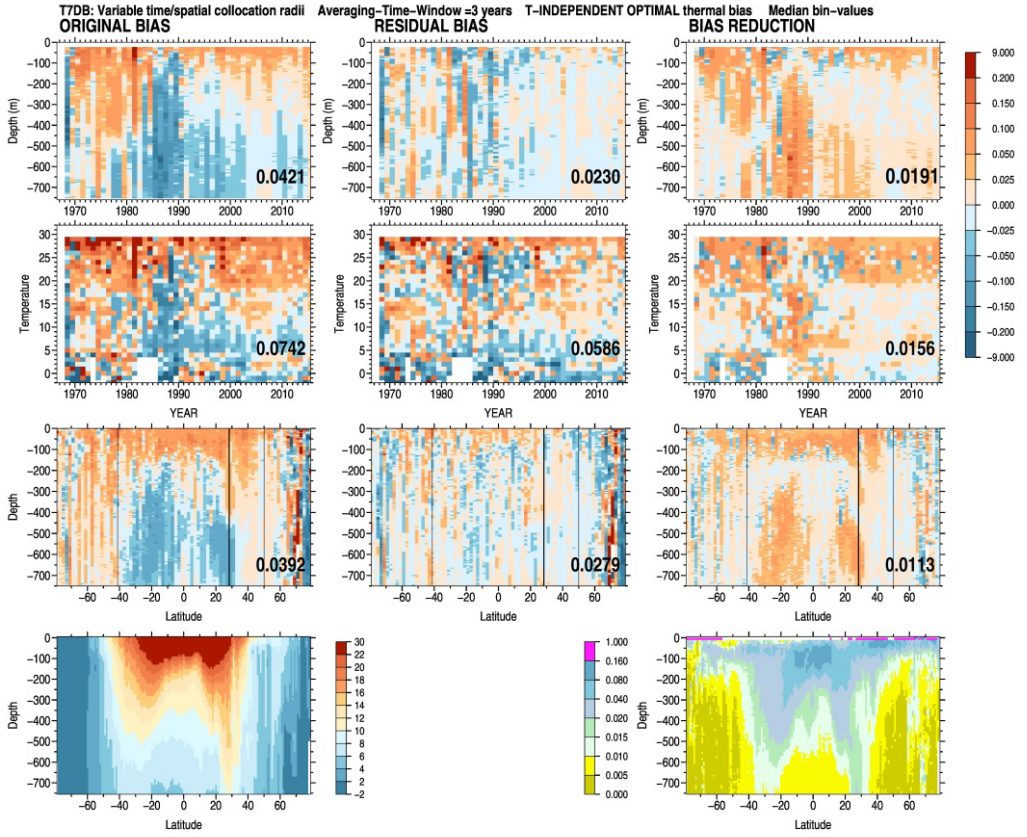
- The „optimal“ thermal bias is obtained by the minimization of the vertically averaged residual bias



MODEL1:

T-independent thermal bias

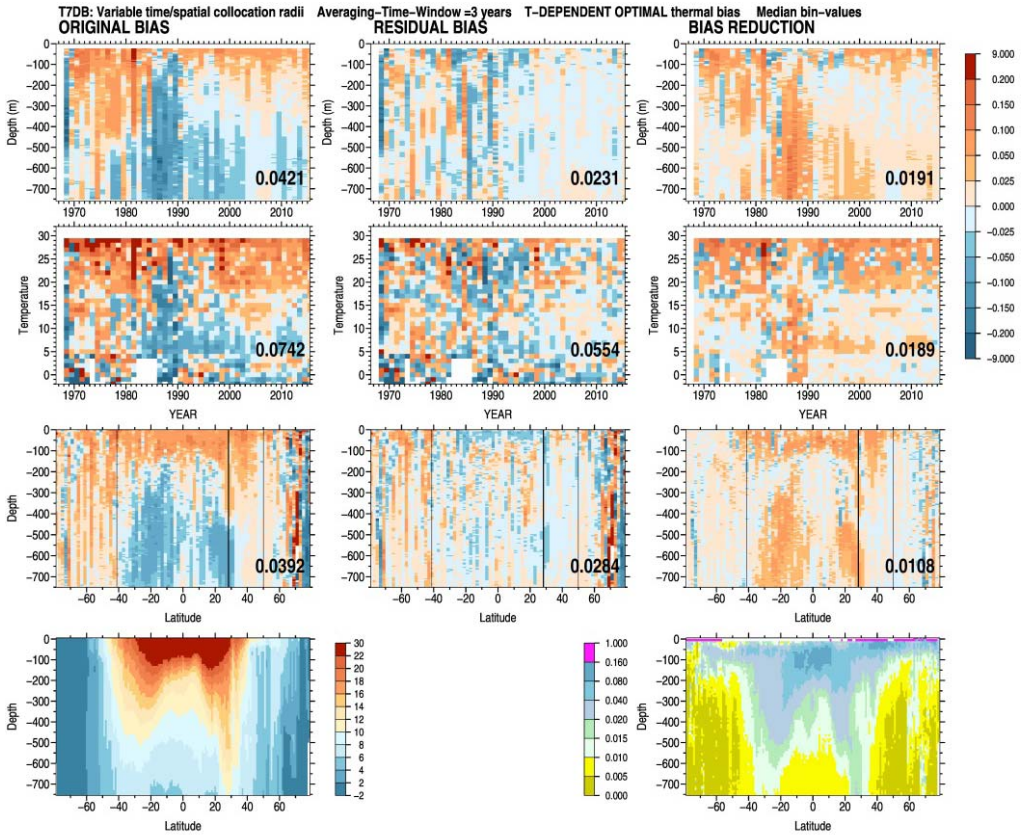
T7 & DeepBlue



MODEL2:

T-dependent thermal bias

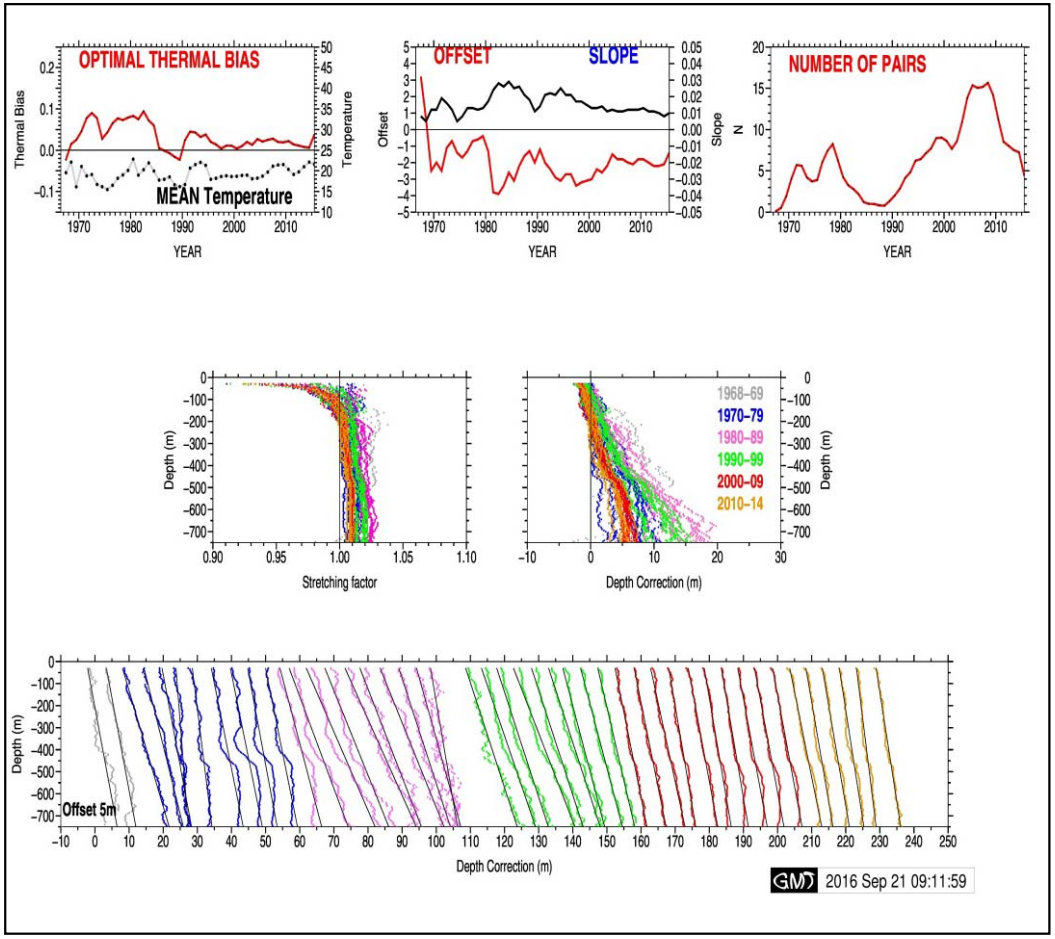
T7 & DeepBlue



MODEL1:

T-independent thermal bias

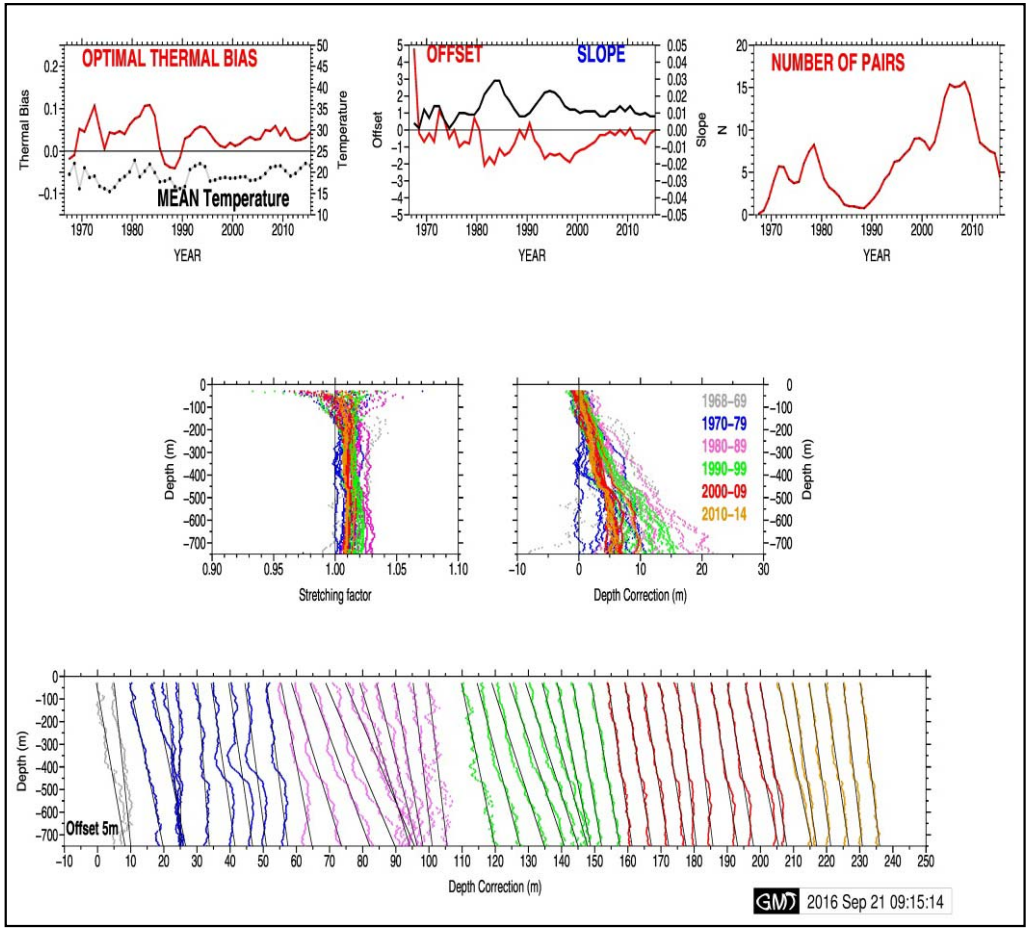
T7 & DeepBlue



MODEL2:

T-dependent thermal bias

T7 & DeepBlue

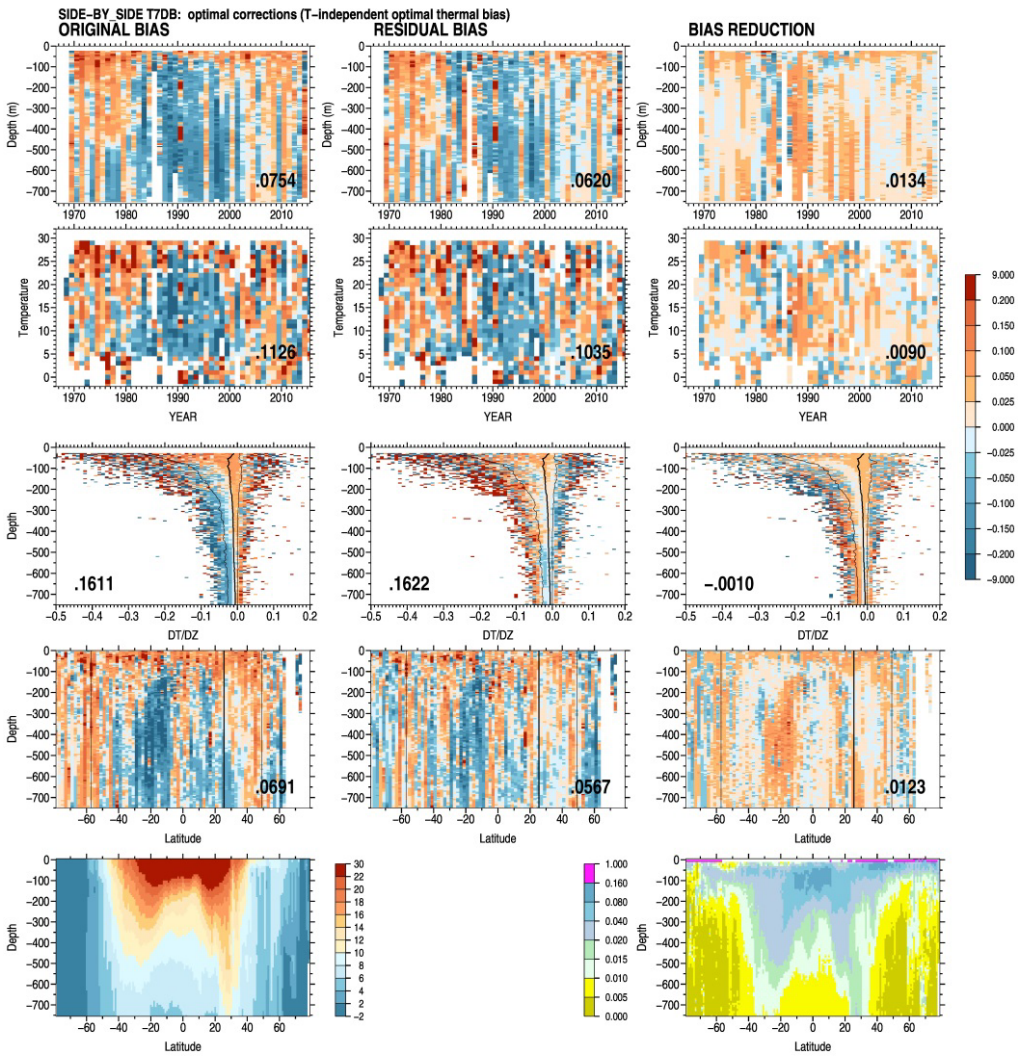


Application of the bias model to the side-by-side profiles

MODEL1:

T-independent thermal bias

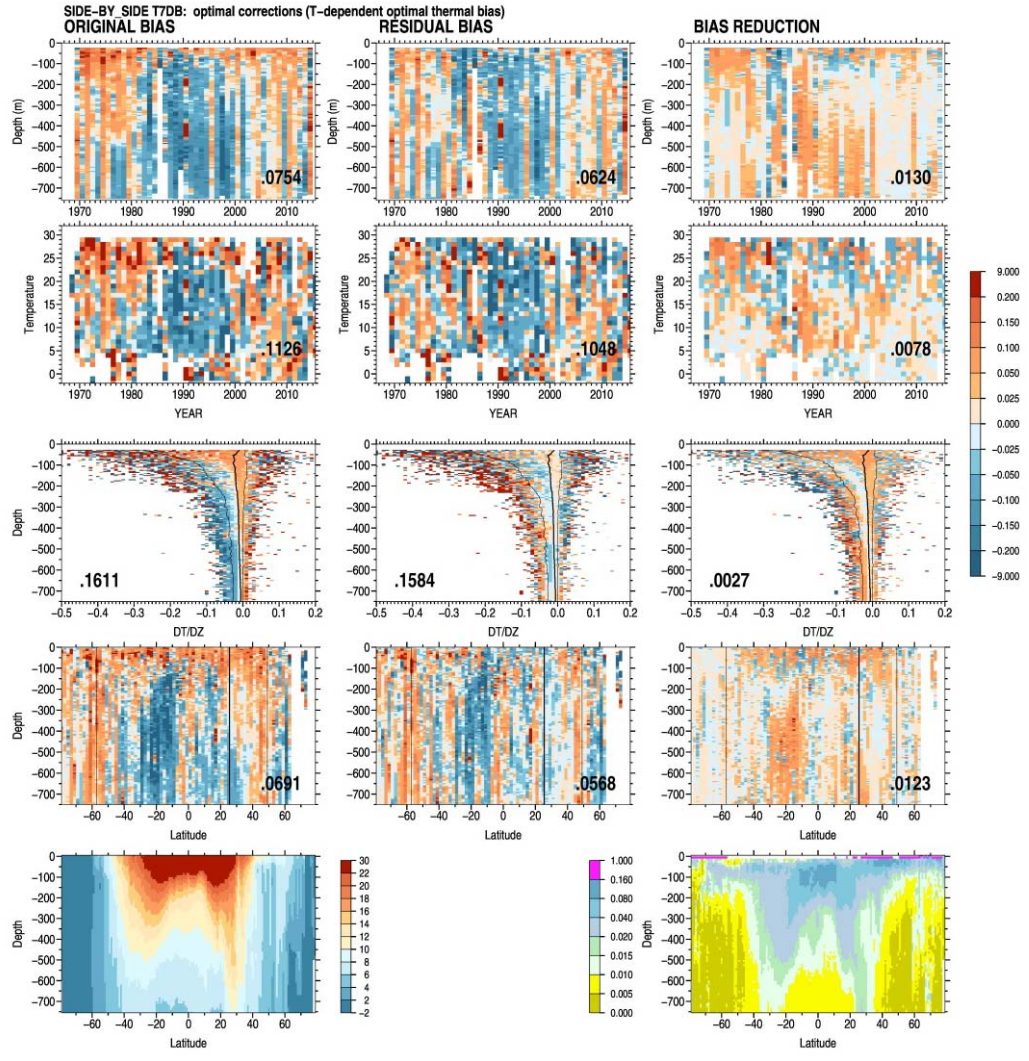
T7 & DeepBlue



MODEL2:

T-dependent thermal bias

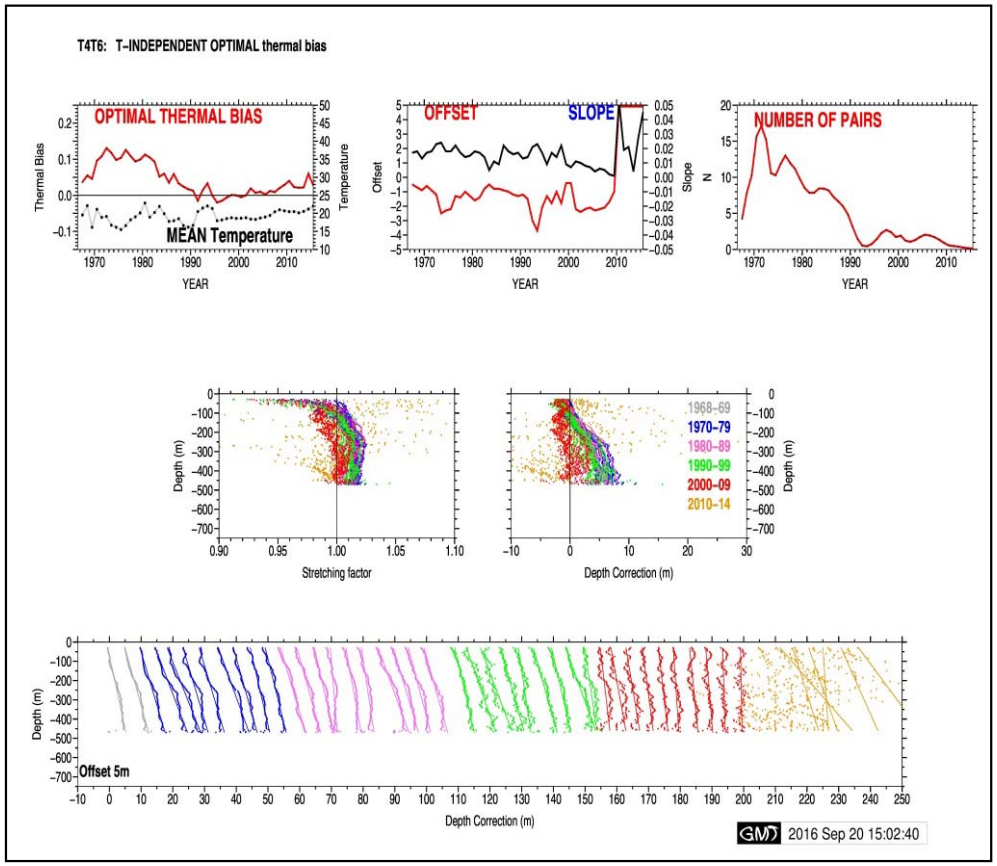
T7 & DeepBlue



MODEL1:

T-independent thermal bias

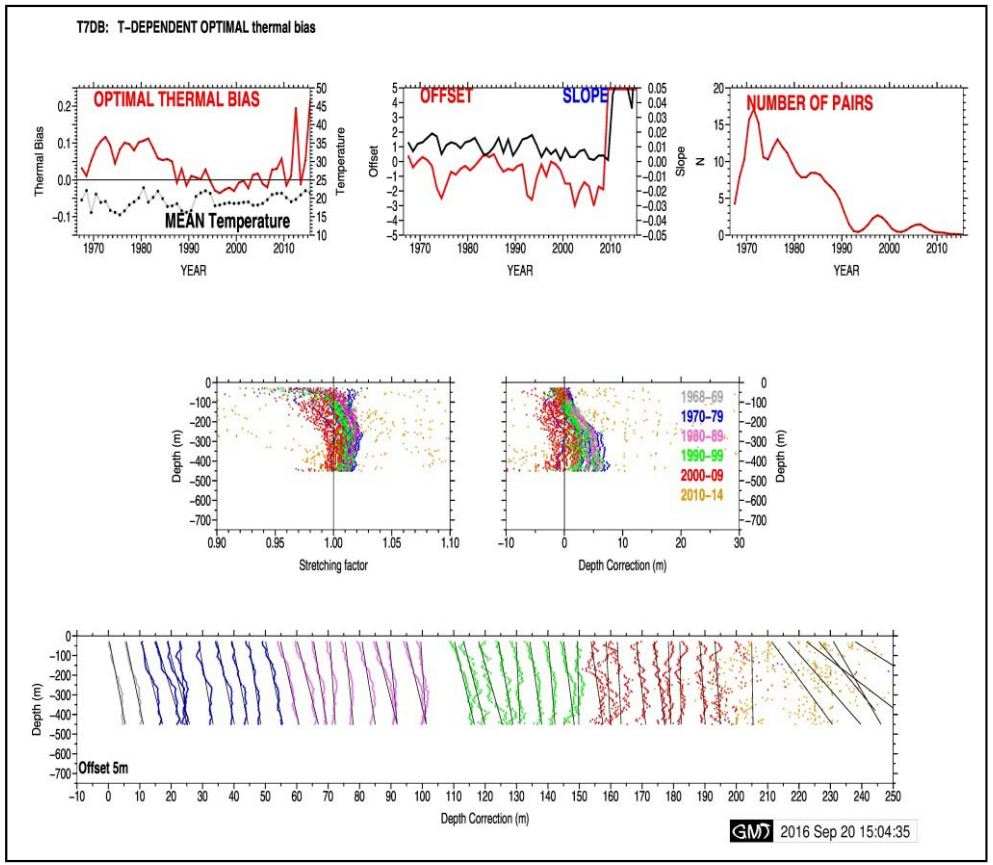
T4 & T6 (Sippican)



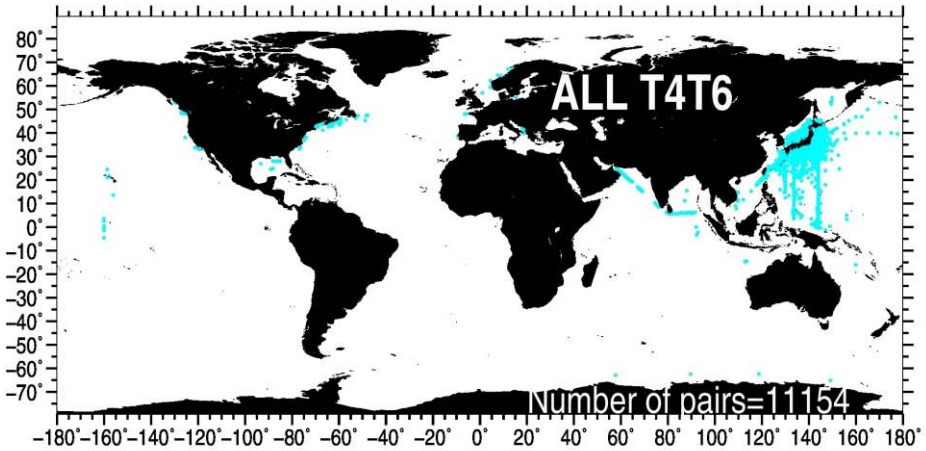
MODEL2:

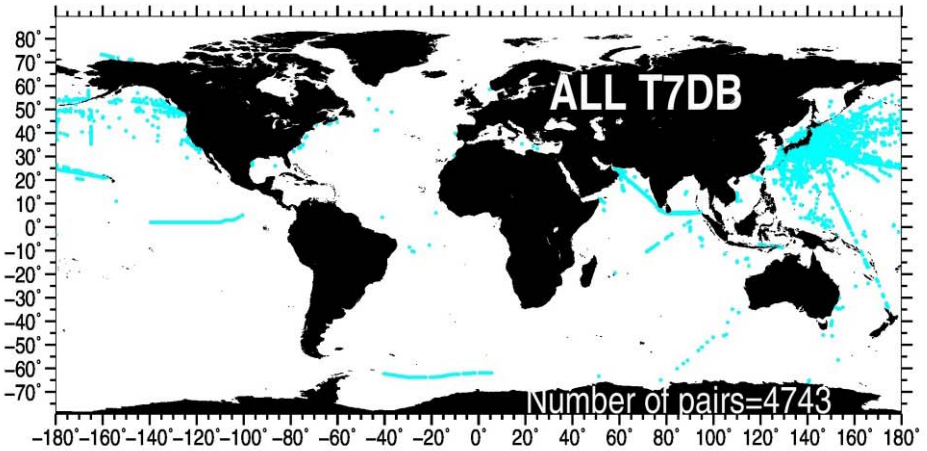
T-dependent thermal bias

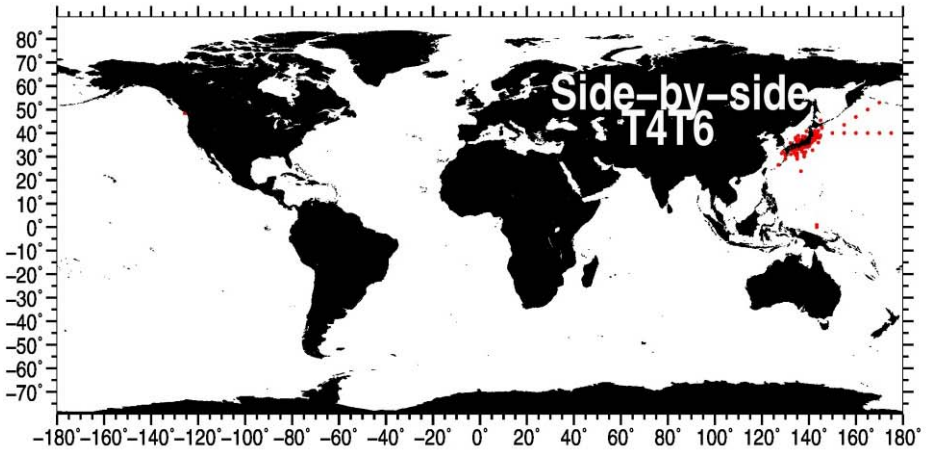
T4 & T6 (Sippican)

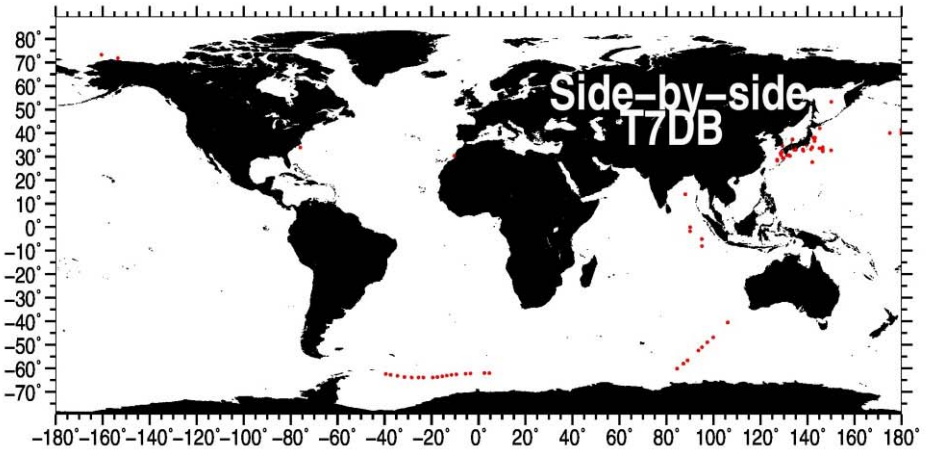


Collocated *TSK* XBT/REF Profiles





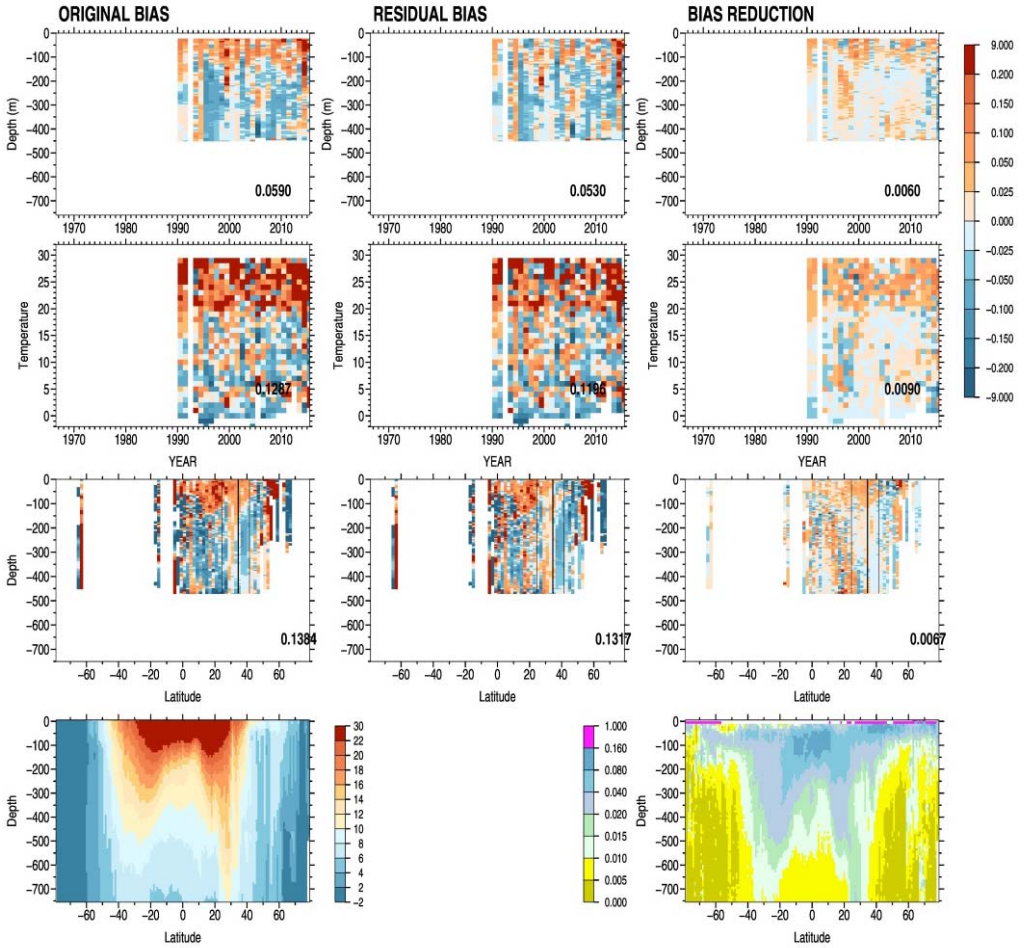




Application of the bias model to the TSK probes

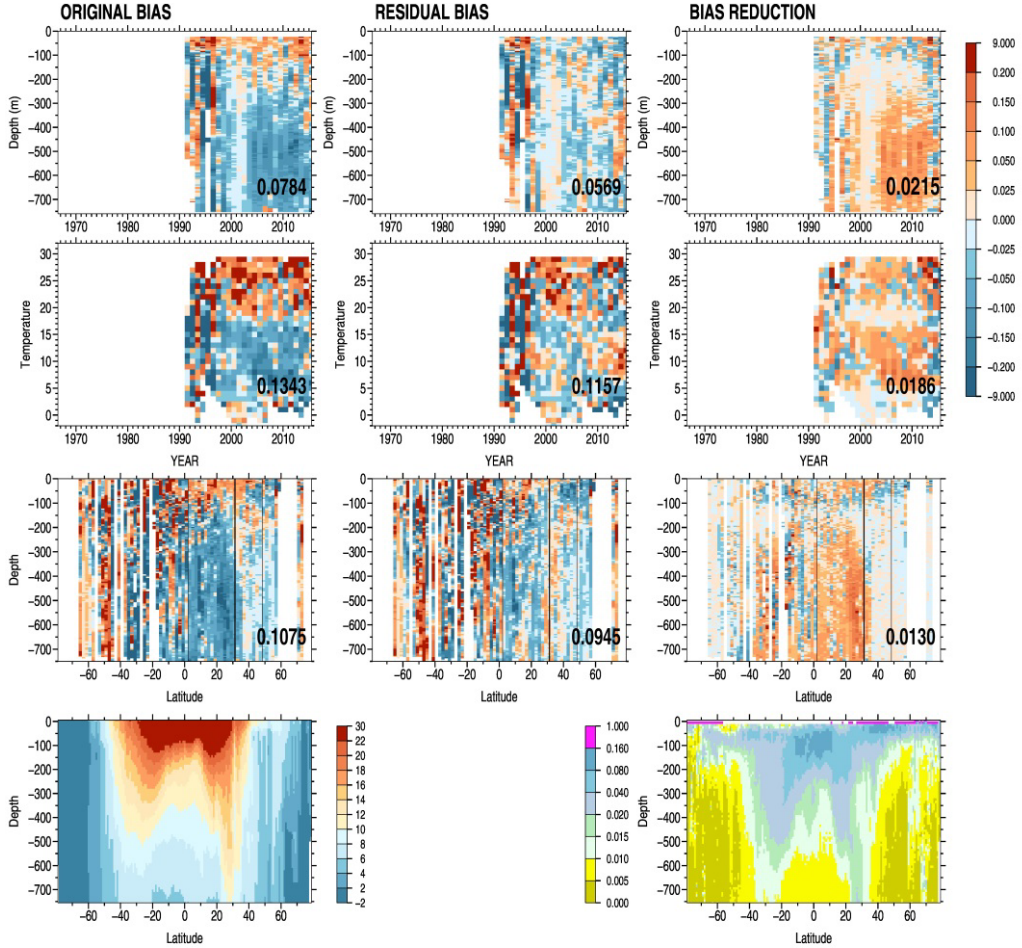
T-independent thermal bias

T4 &T6

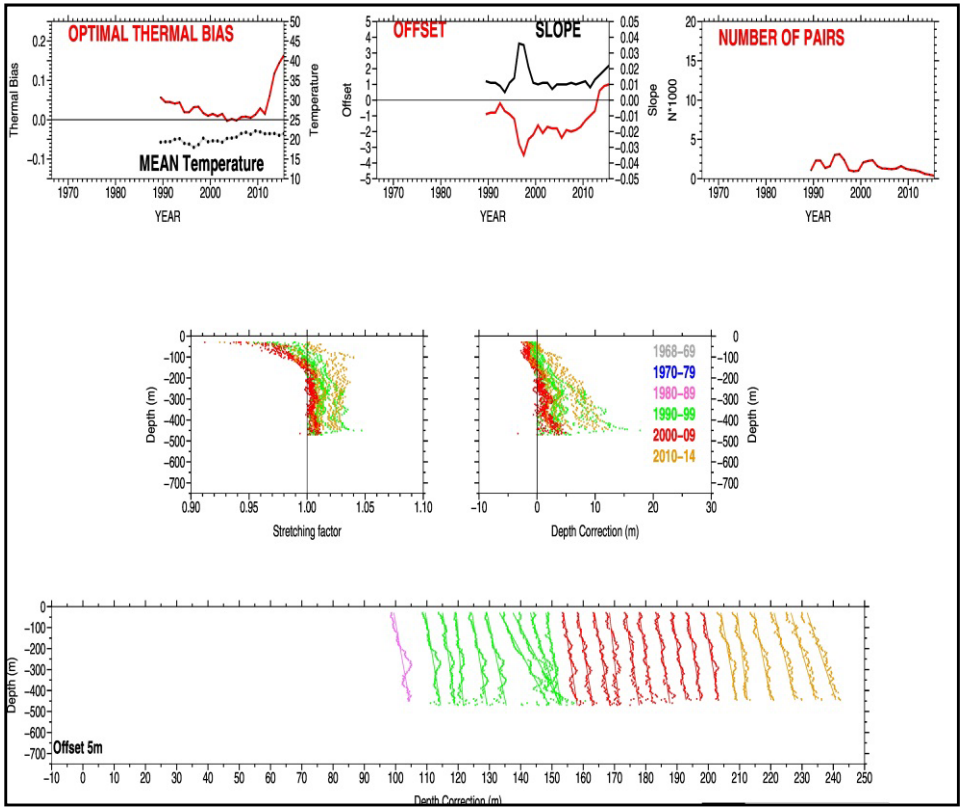


T-independent thermal bias

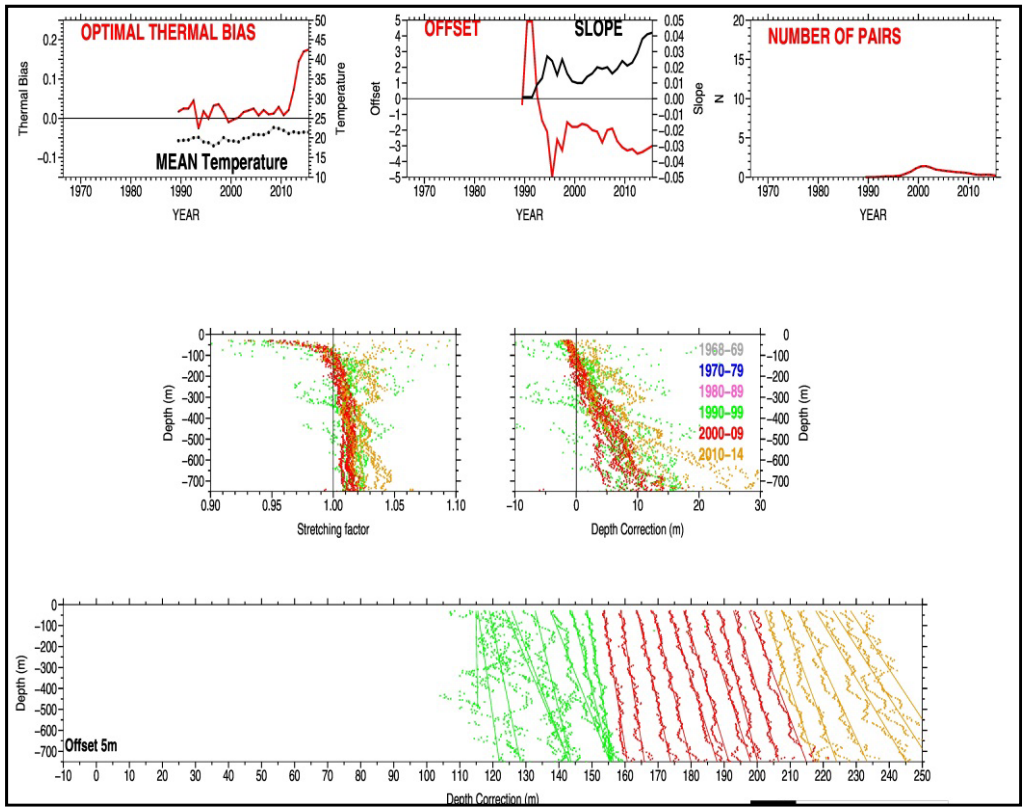
T7 & DeepBlue



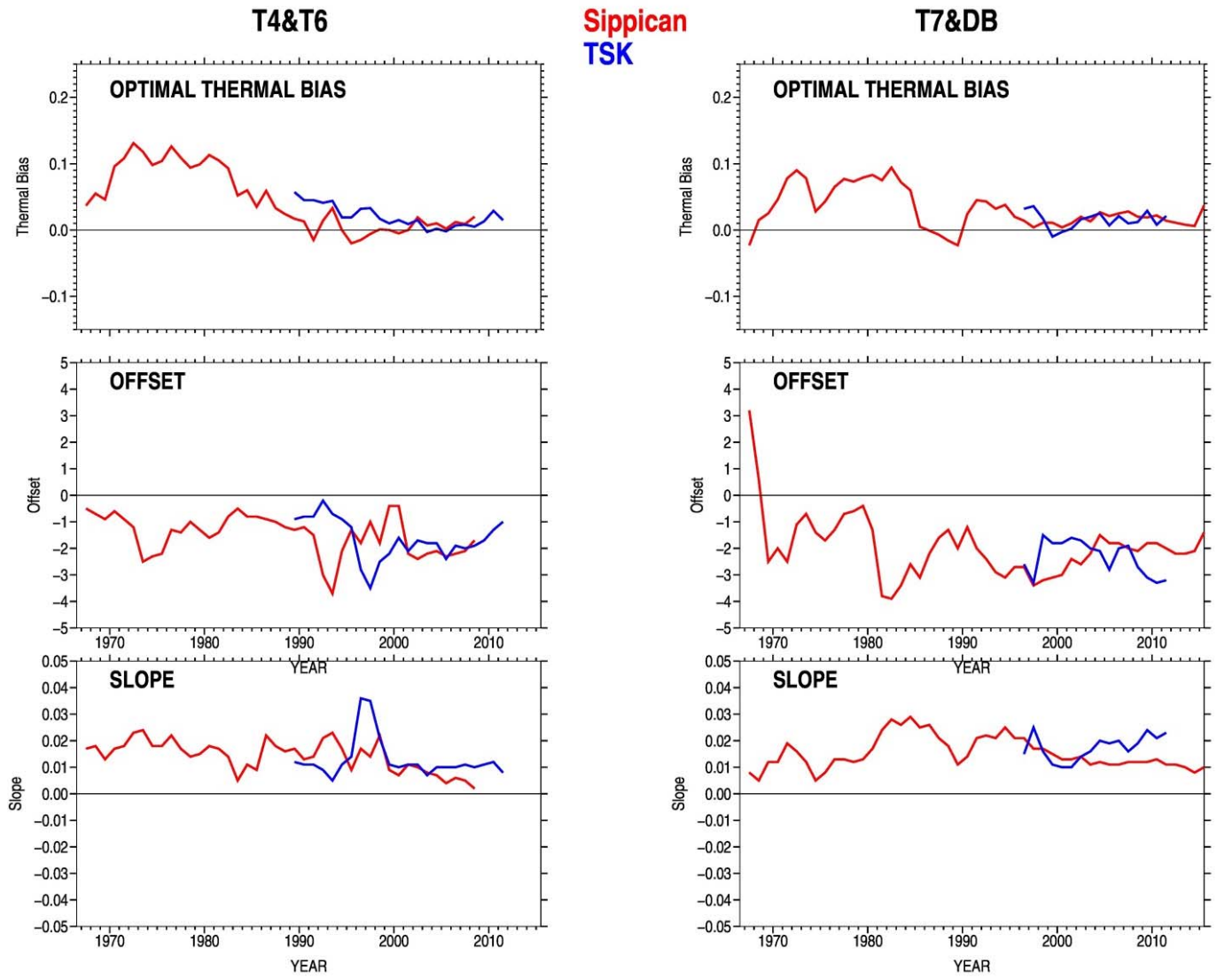
T-independent thermal bias
T4 & T6 (TSK)



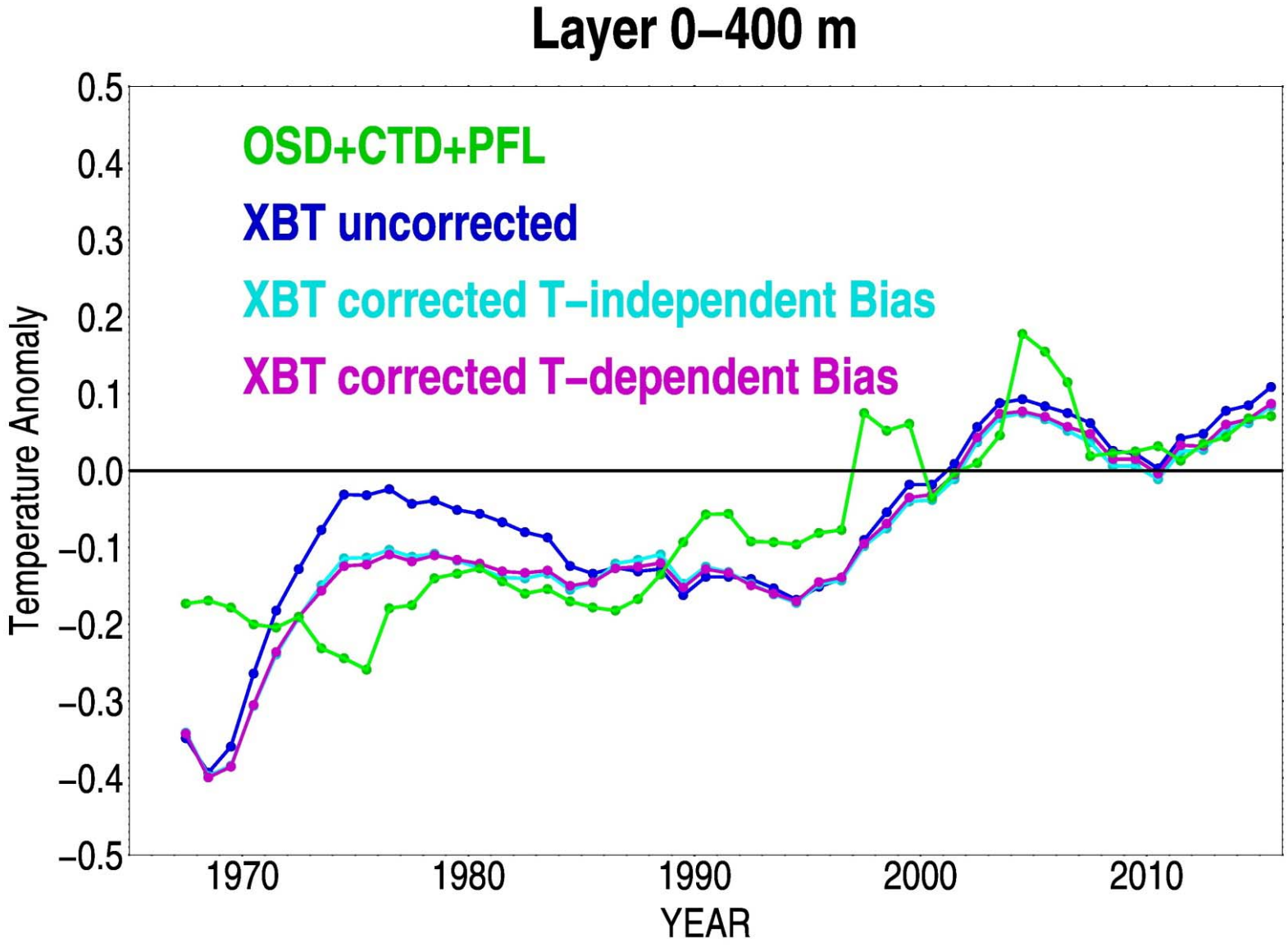
T-independent thermal bias
T7 & DeepBlue (TSK)



Bias Corrections for *Sippican* and *TSK* Probes



Global Ocean Temperature Time Series



Summary

- Application of the bias model reduces the total temperature bias both for the collocated and the side-by-side dataset

- The „optimal“ thermal biases for T4T6 and T7DB XBT types agree qualitatively with the yearly mean difference of about

  0.02 degr. C

- Taking account for the thermal bias temperature dependence slightly reduces the residual bias

- Application of temperature and depth corrections reduces the decadal-scale variability of the global temperature time series