XBT science workshop, Melbourne

Analyses on depth error in historical XBT data based on side-by-side comparisons

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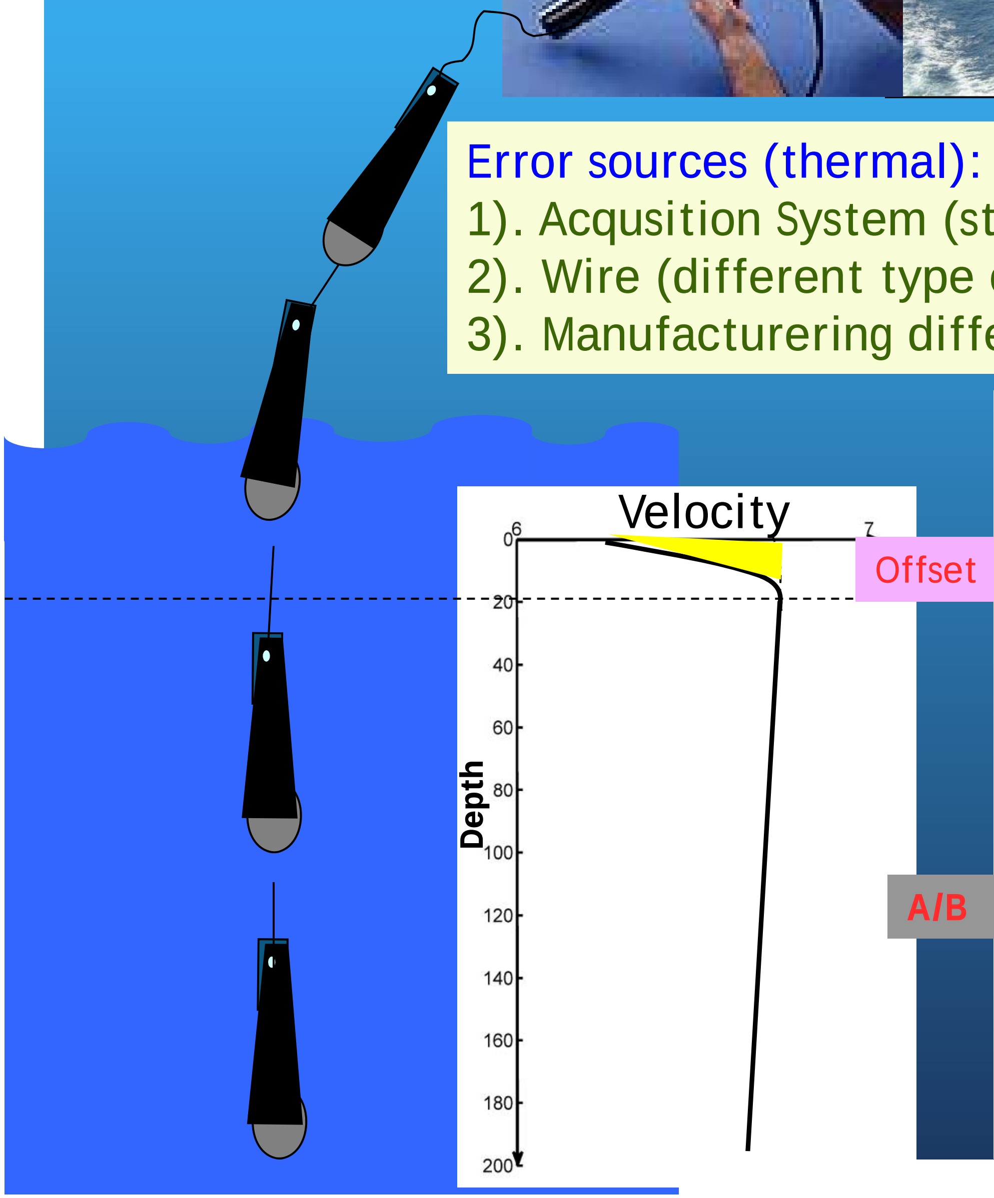
XBT error sources

Manuf: $Depth = At - Bt^2$

$Depth = At - Bt^2 - Offset$



Error sources (thermal):

Thermal bias

1). Acqusition System (strip-chart/digital recorders,ETC…)
2). Wire (different type of insulation)
3). Manufacturering differences in thermistor.

Error sources (depth):

1). Launch condition (height, air temperature, sea-ice, ship-wake, angle into water)
2). Probe adjustment at the first secords (spin rate, angle).
3). Viscosity~water temperature, ocean current
4). Wire stretch
5). Probe characteristics (slight manufacturing differences in probe weight, probe shape/size,construction)
6). Wire unspooling

Integrated Method

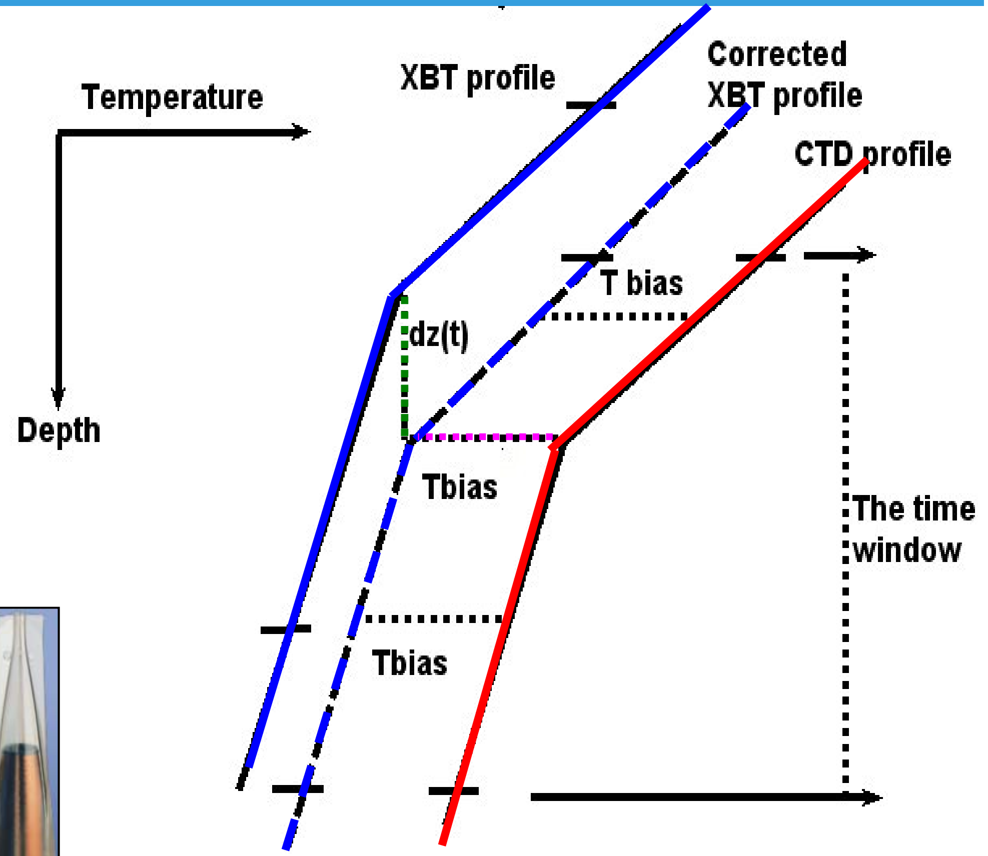
Basic Assumption:

- 1. fall-rate model: Depth=**A**t-**B**t^2-**Offset** (Manufacturer: **Depth=At-Bt^2**).
- 2. The falling is stable from 20m to the bottom.

Method:

- **Depth error**
- Shift up and down – *Offset*
- Stretch or shrink– *A, B*

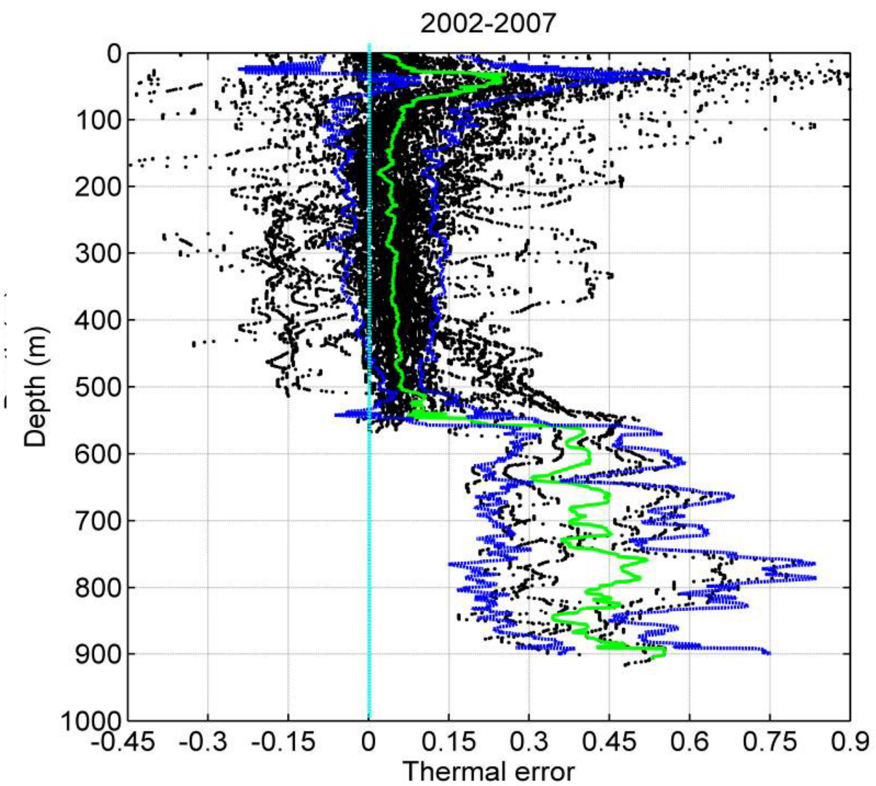
  ---To minimize the std. deviation of the temperature differences between XBT and CTD profile.
- **Pure temperature error**
- Regression of the temperature offset after removing depth-error



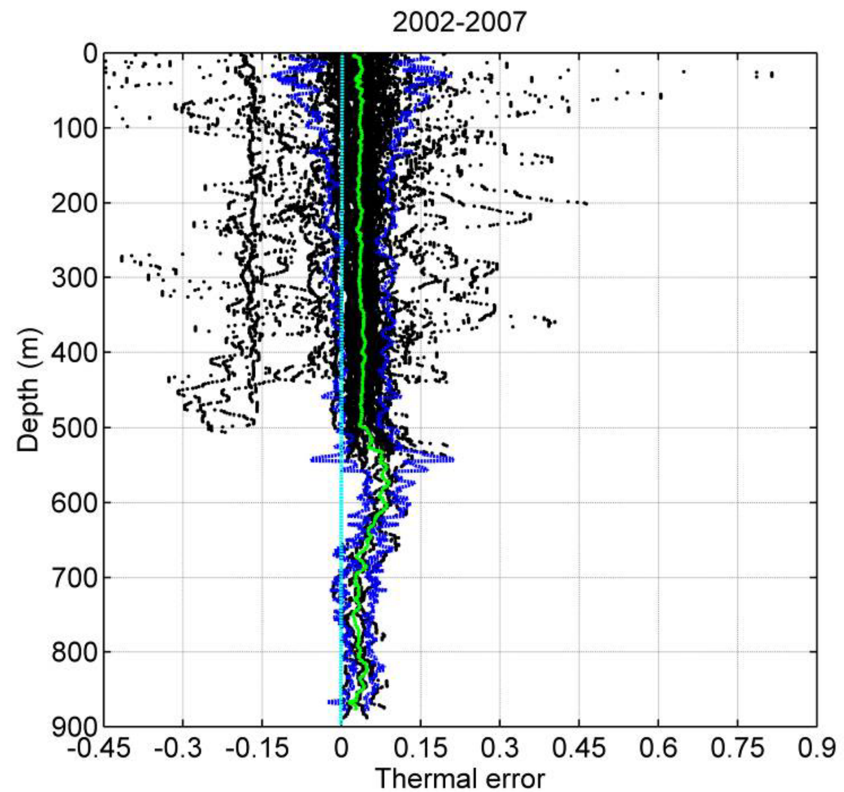
Theoretically, the new method is more noise-resistant because it uses the integral property instead of gradients

Tests on method and model

Uncorrected



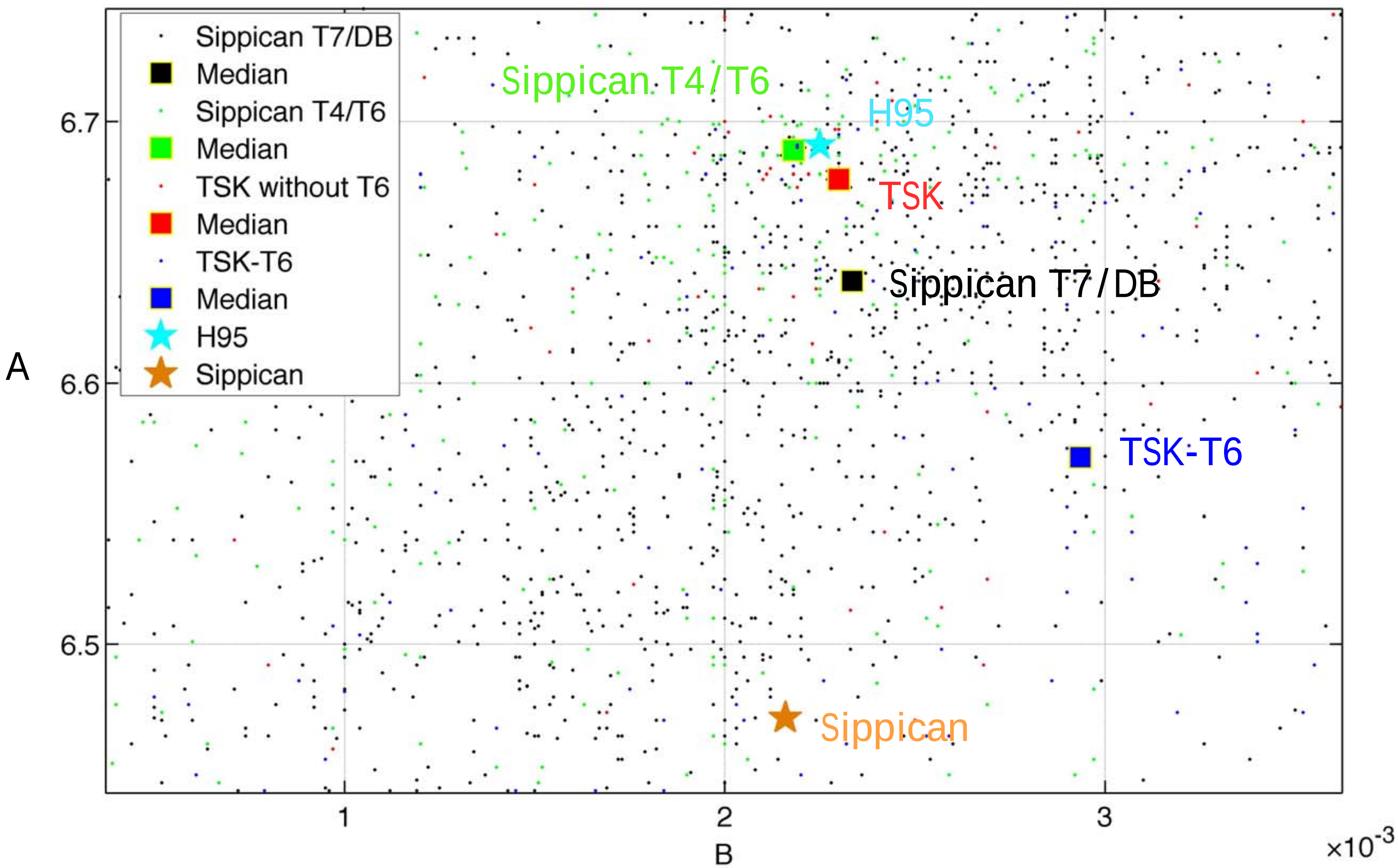
Depth error corrected



After depth error corrections by the integrated method:
1). Depth error is zero.
2). Thermal error is constant with depth.

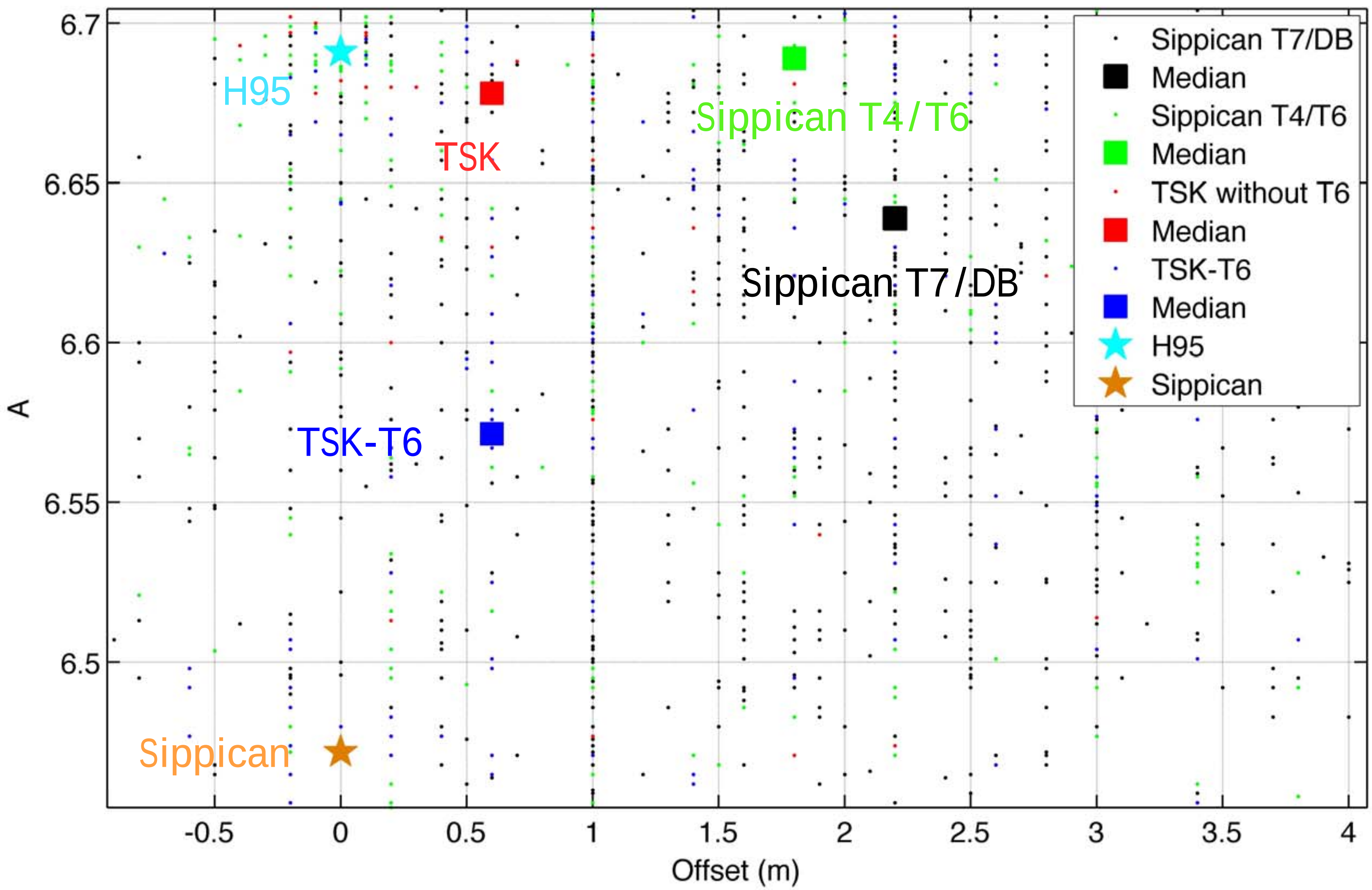
Collection of A/B/Offset

1. Sippican-T4/T6 and TSK, near H95
2. TSK-T6 away form both H95 and manuf.



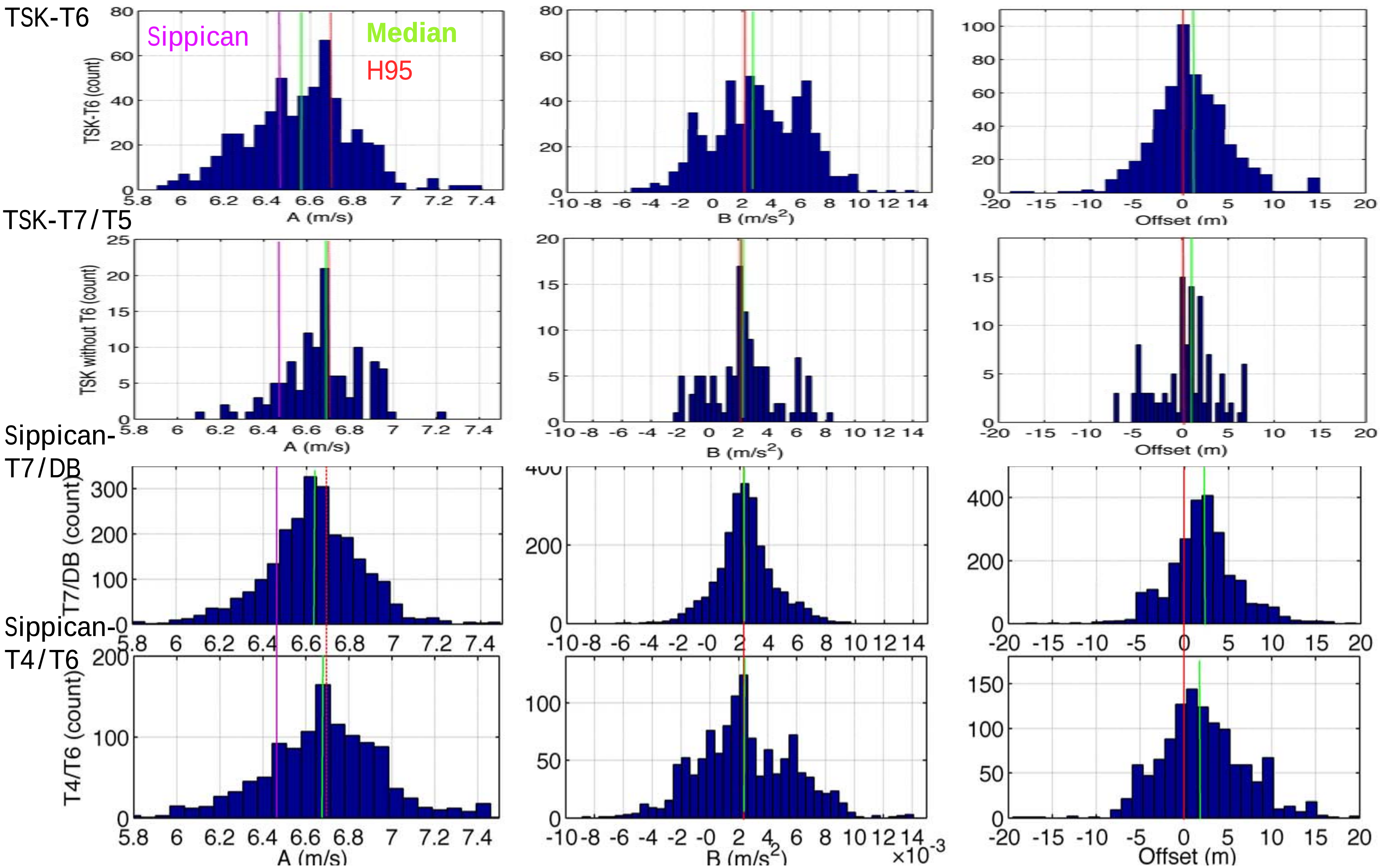
Collection of A/B/Offset

1. Positive Offset
2. Sippican Offset ~2m, TSK Offset ~0.6m

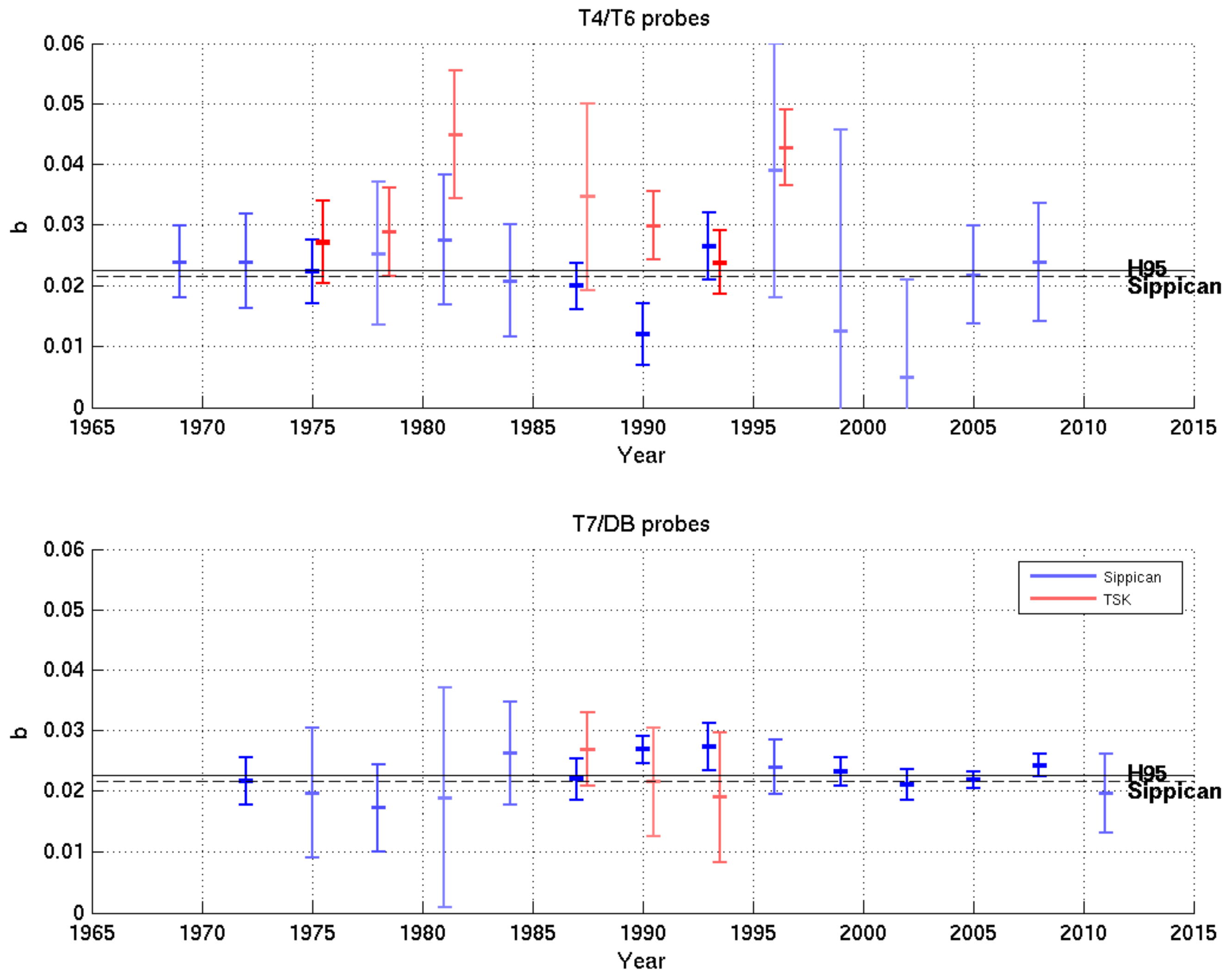


Collection of A/B/Offset

1). Smaller A than H95, especially TSK-T6
2). Similar B with H95, except TSK-T6 (~0.0029).
3). Positive Offset.

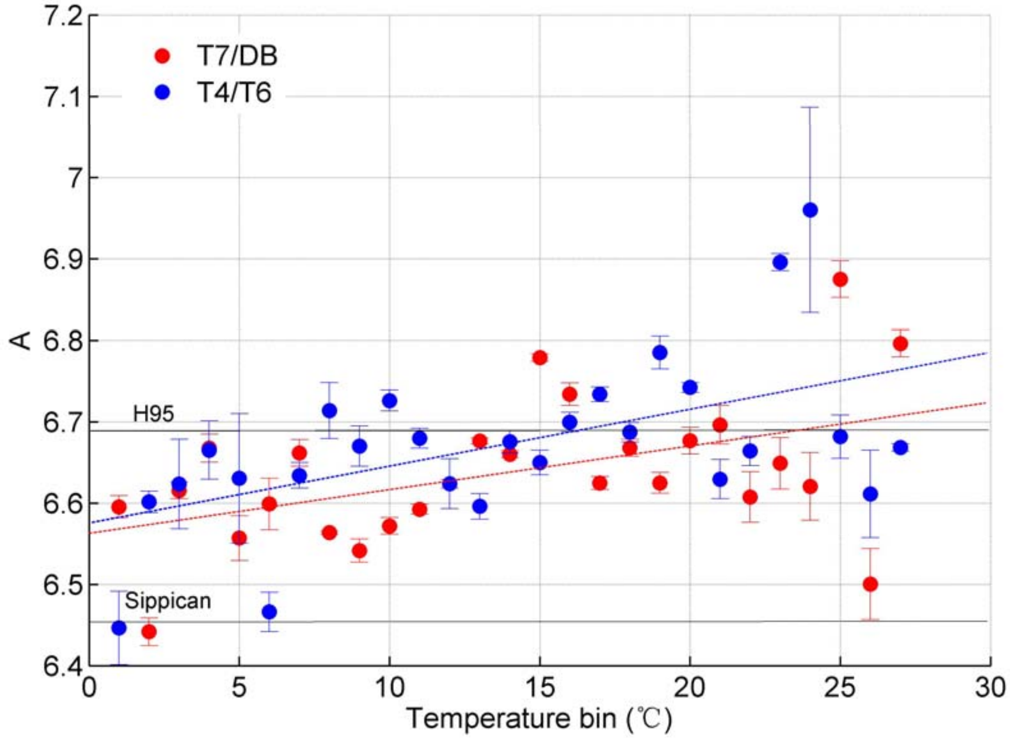


Initial fall-rate (Coefficient A)/Deceleration (Coefficient B) with time



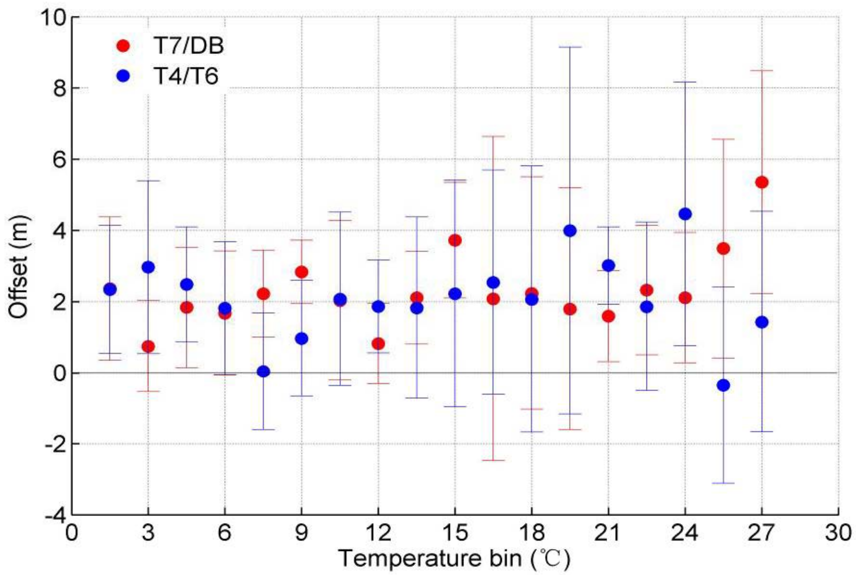
1. Initial velocity A: a shift after ~1996; No hump at 1970s
2. Different history of TSK and Sippican

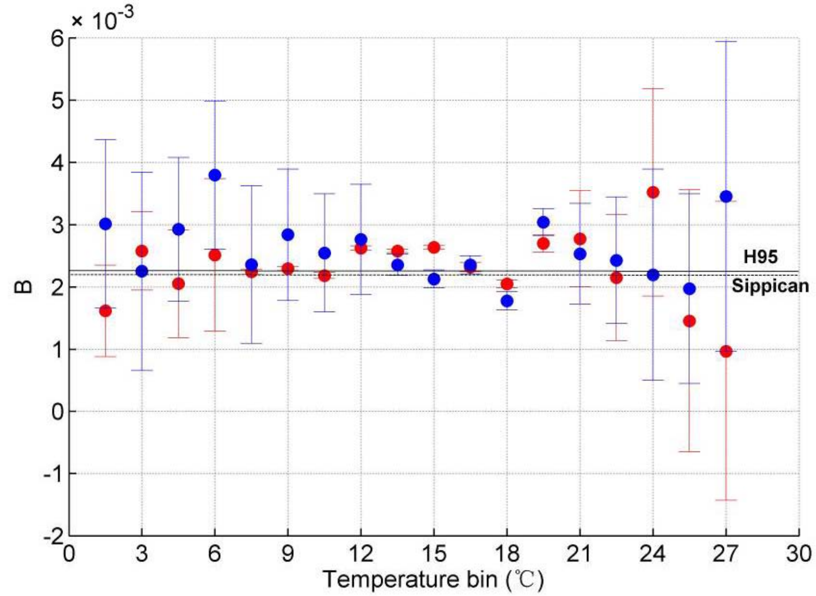
A/B/Offset (with temperature)



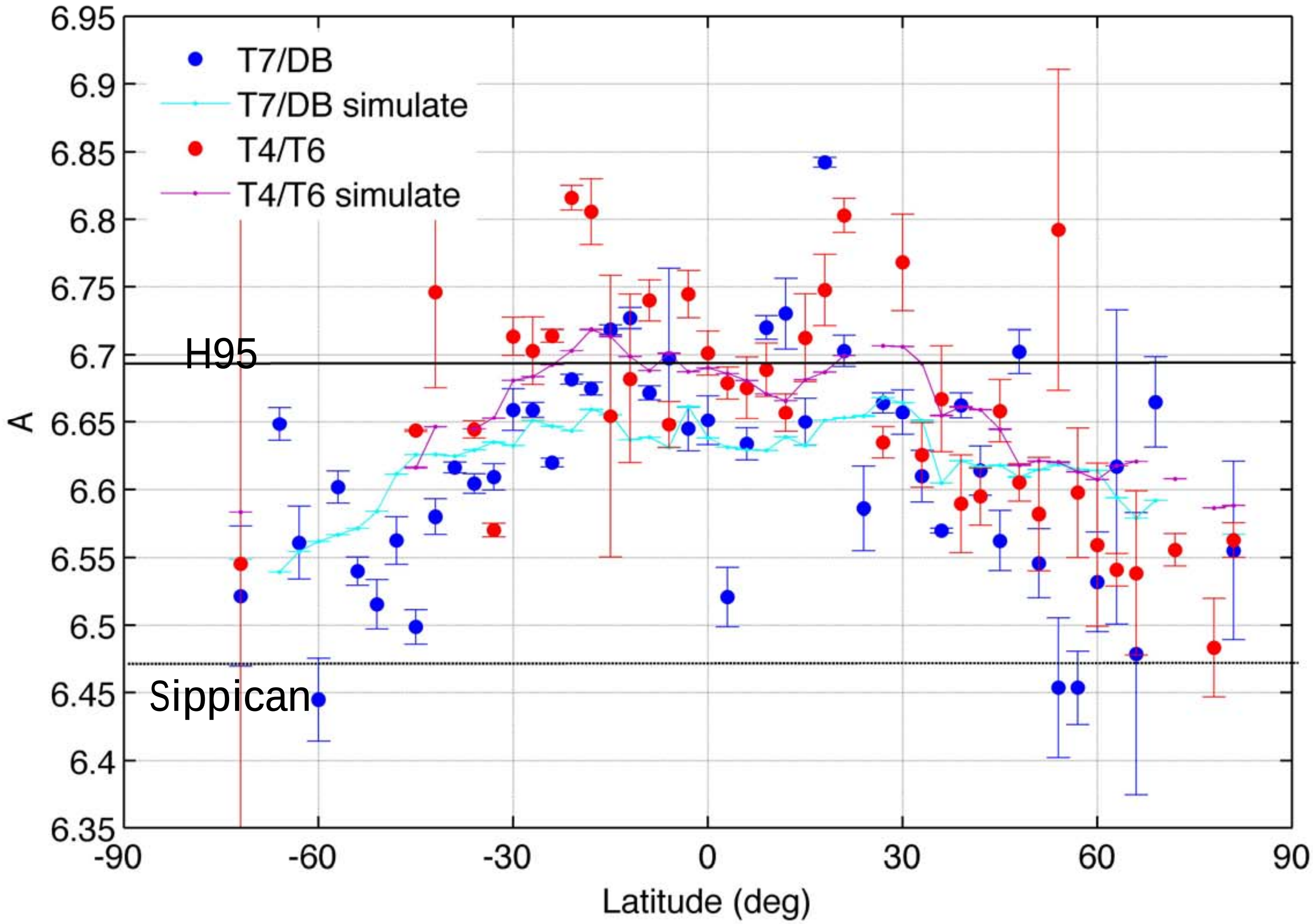
1). Temperature-varying fall-rate (Coefficient A), which reflects the impact of water viscosity on fall-rate.
2). Constant B/Offset.

Temperature is a factor influencing XBT bias.



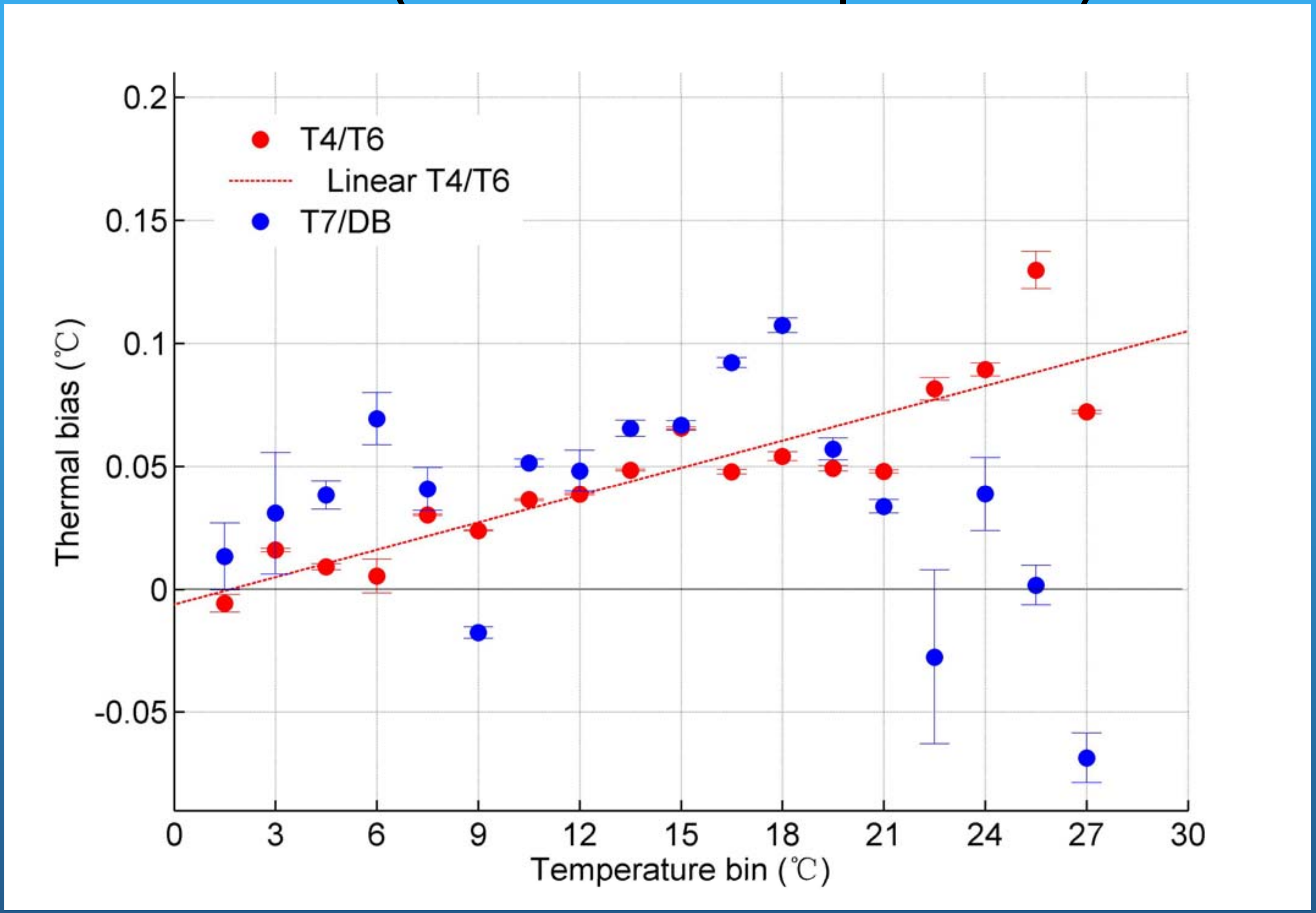


A with latitude



- Simulate A(latitude) by using A(temperature) relationship (T7/DB, T4/T6).
- A-Temperature relation partly explains latitude-varying fall-rate
- *1970s hump: is that because of geographical distribution of XBT data??*

Initial fall-rate (with water temperature)

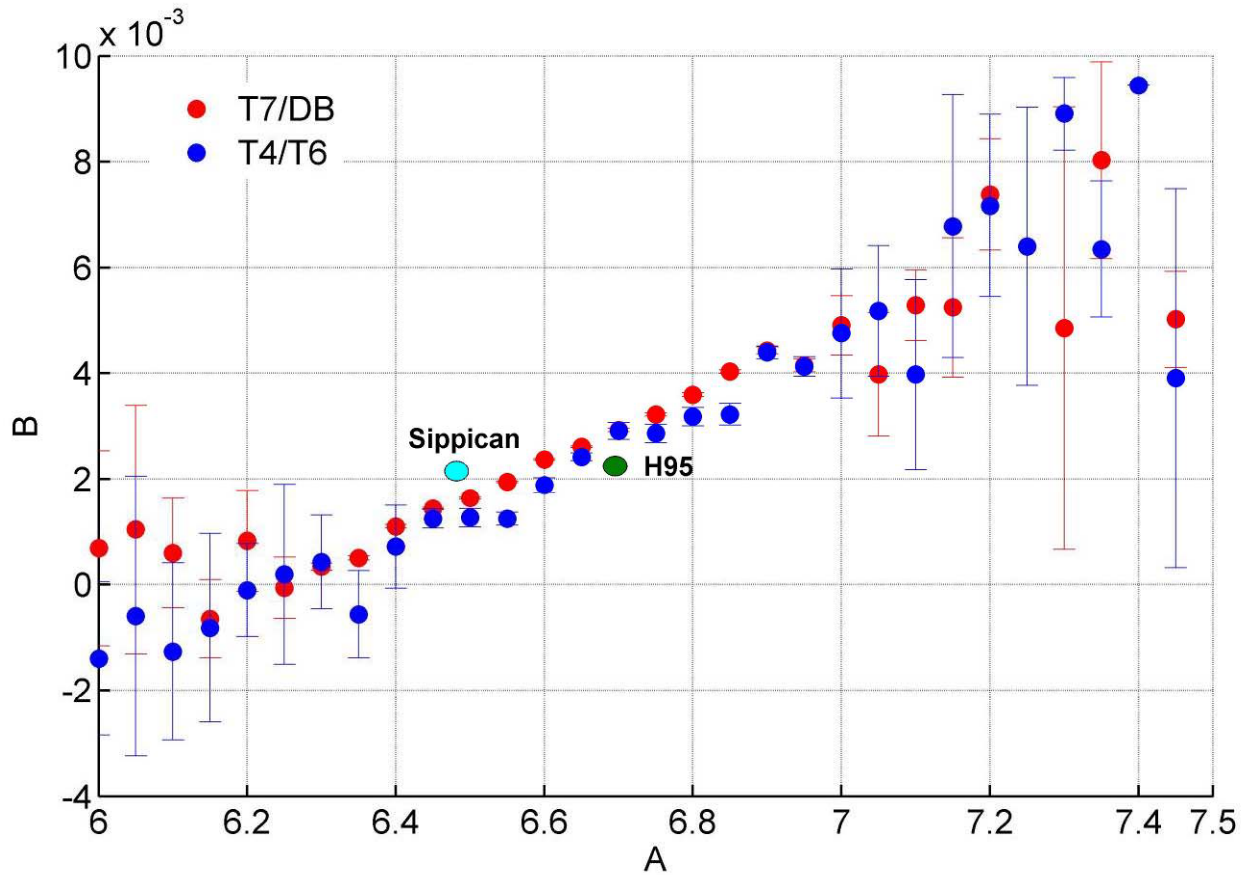


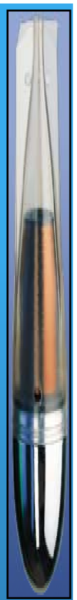
- Temperature-varying thermal bias.

Temperature is a factor influencing XBT thermal bias (minor).

Coefficient A/B correlation

(T7/DB/T4/T6) A-B correlation

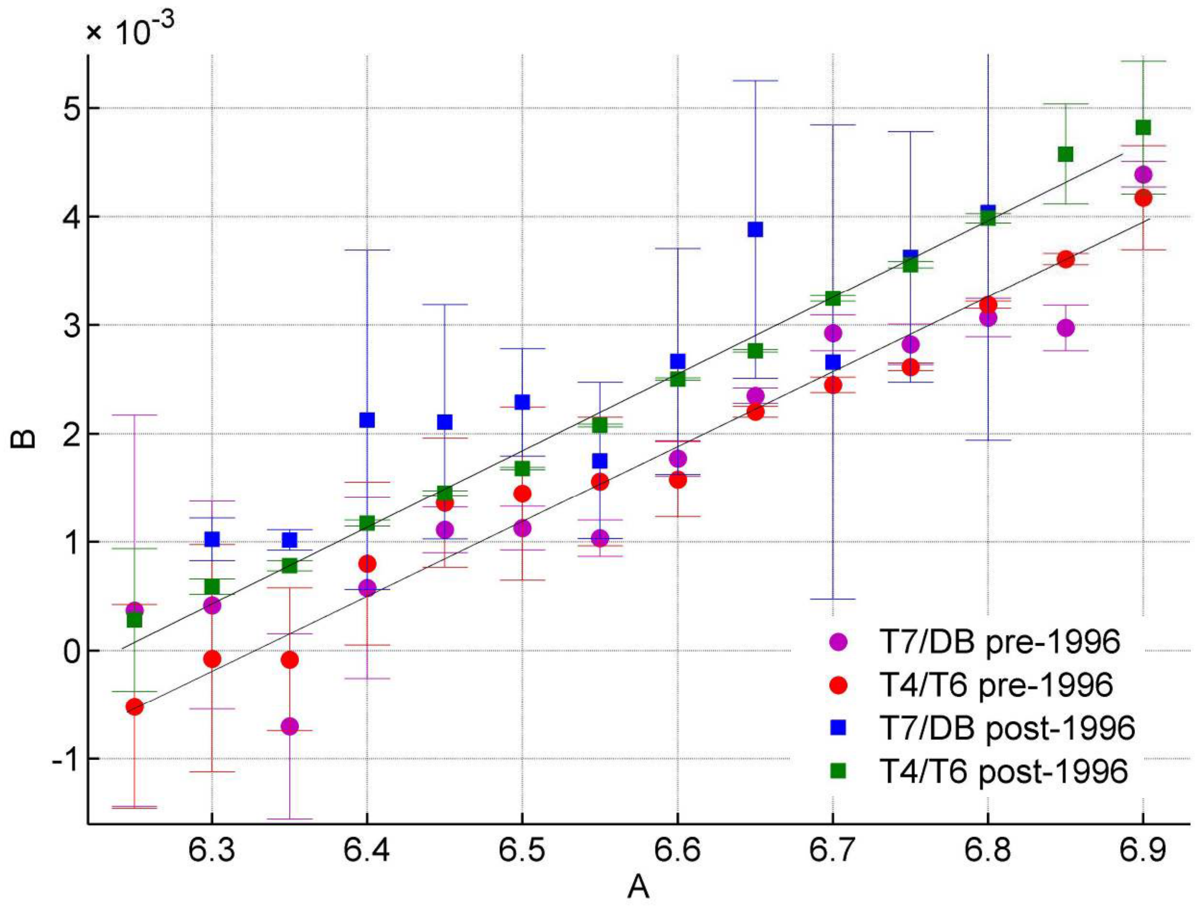




1). Significant A/B correlation.

2). No differences between T4/T6 and T7/DB.

XBT-Probe design evolution (Probe weight)

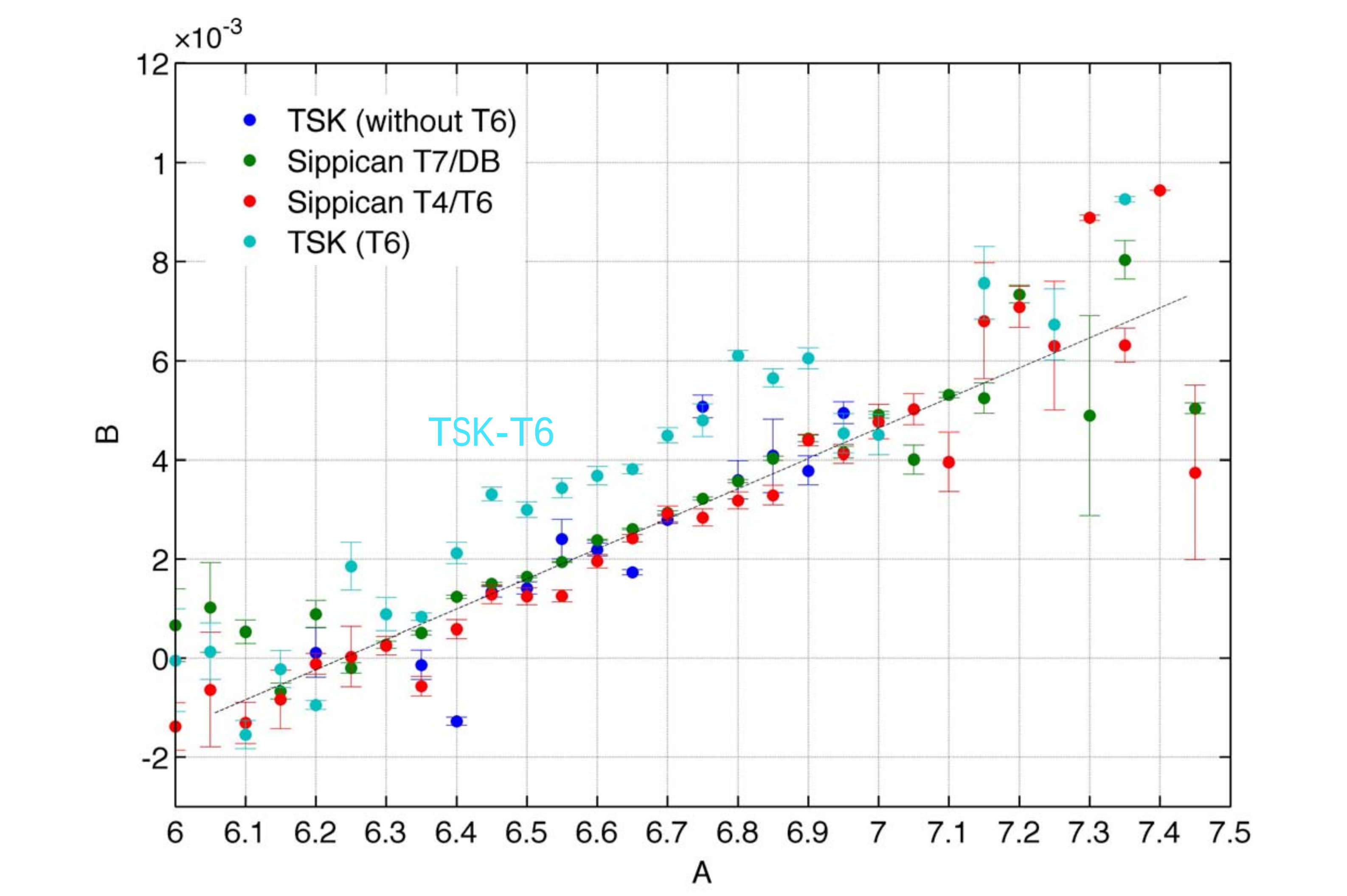


- Probe weight?
- In 1996, the manufacturer improved the wire coughing technical, so that the probe mass was reduced.

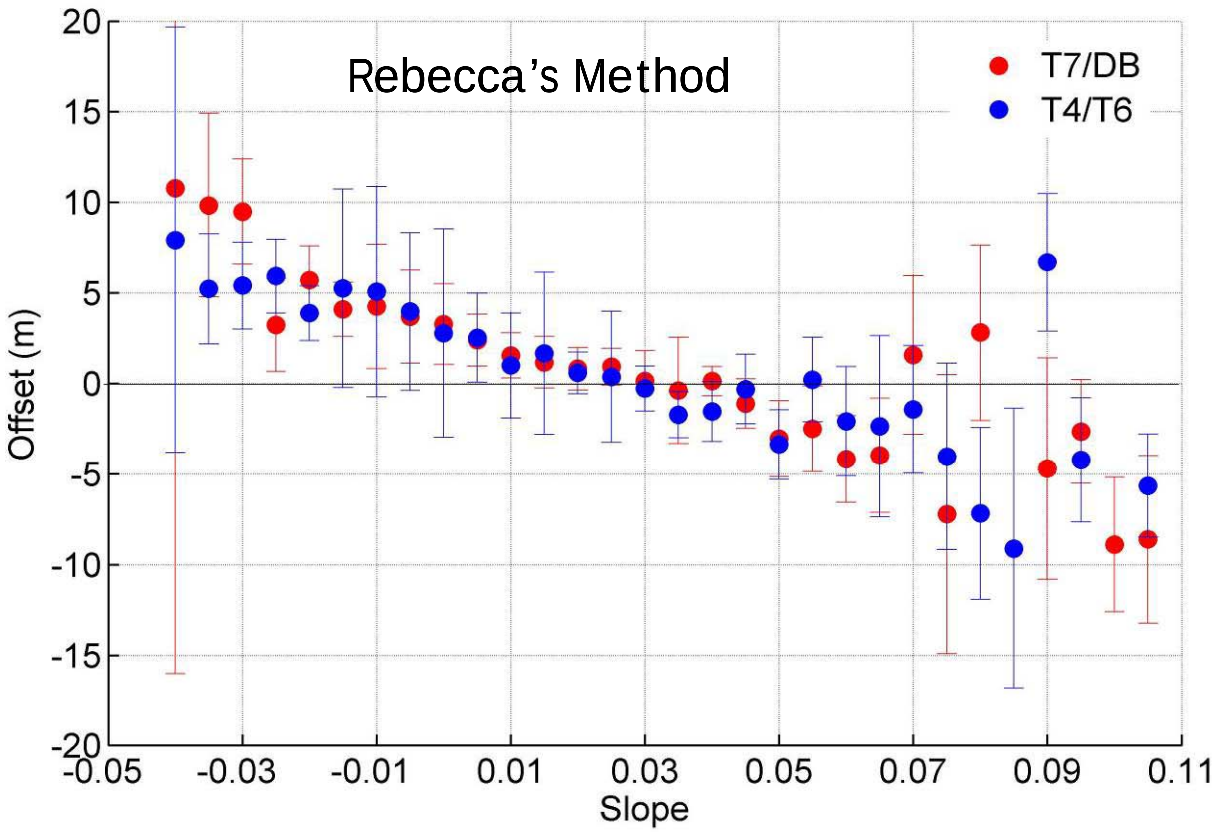
	Sippican
1992-1995 (T4)	732.6 – 736.5g
1998–2004 (T4)	726.4 – 731.0g
2007–2008 (DB)	727.2 – 734.9g

From Gouretski et al, 2010

What happened to TSK-T6 ?



Coefficient A/Offset correlation



- The substantial correlation between estimated values of offset and A shows the the two parameters (i.e., offset and A) are not totally independent factors in modeling the XBT bias.
- One implication is that the XBT bias model (i.e.,depth=offset+At+Bt^2) is not a perfect model with a bias that has a vertical coherent structure. This vertical coherent bias will lead the estimated values of offset and A to compensate each other and thus creates the correlation.

Summary

- We found some factors influencing XBT biases based on historical high-quality XBT/CTD comparisons
- 1). Temperature influences of fall-rate/thermal bias.
- 2). Maybe probe weight influences on XBT fall-rate.
- 3). Correlation of the fall-rate coefficients A/B and A/Offset.
- 4). Time-varying/Latitude-varying.
- What happened to TSK-T6 ?

- Based on our results:
- We still need to determine/quantify the impacts of physical properties of sea water and XBT probe on XBT biases.
- Further tests are needed combined with global-scale XBT data.

Thanks