Biases in historical Expendable BathyThermograph (XBT) data based on XBT/CTD intercomparisons

- Rebecca Cowley, Susan Wijffels (CSIRO)
- Liqing Cheng (Chinese Academy of Sciences)
- Tim Boyer (NODC, NOAA)
- Shoichi Kizu (Tohoku University, Japan)

WEALTH FROM OCEANS
www.csiro.au

Why so warm?
XBT data comprises a large proportion (~30%) of available ocean heat content (GOHC) data. Previous calculations of global ocean heat content (GOHC) have been biased warm by errors in XBT data (Gouretski and Koltermann, 2007), possibly caused by depth errors and/or a pure temperature bias.

The pairs database and what we can do with it
We have collected 41,524 co-located (in space and time) XBT and CTD profile pairs. (a) Location and decade of collection. (b) Distribution of XBT probe types over time.

Calculating the depth error
Using the method of Hanawa and Yoritaka (1986) where temperature gradients are matched between the CTD and XBT profiles, we are able to fit a linear model to the depth errors in the XBT data for each pair ($\Delta z = a + b \Delta T$, where $\Delta z$ is the depth error (m) and $b$ is the XBT depth (m) corrected to the Hanawa (1995) fall rate).

Does the temperature bias vary with time?
By looking at the $a$ term from the linear model, we can see changes in the depth error over time. The grey shading indicates the number of pairs in each group and two times standard error is indicated by the size of each box. $\Delta z_0$ indicates the original Sippican fall rate and ‘H95’ the Hanawa (1995) fall rate. $\pm 0.02$m/m is the manufacturer’s allowed error.

Does the temperature bias vary with depth?
After correcting each XBT in the pairs database for it’s individual depth error, we can assess the remaining temperature bias ($\Delta T = T_{XBT} - T_{CTD}$ (°C)). Looking at good quality, high resolution T7/DB data: after depth correction the temperature bias is ~0.04°C warm and consistent with depth.

Application of XBT corrections to improve GOHC estimates
After applying the corrections derived from the pairs database, we see a reduction in estimates of GOHC. GOHC estimates are shown from data with no XBT corrections (dotted line), with corrections using the method of Levitus et al. (2009) (black line), with corrections from this study (red line) and from an alternative method (Cheng et al., 2010) applied to this pairs database (green line).

Does the depth error vary with time?
Removing the depth error does not remove all of the temperature bias in Sippican T/6 and T/DB XBTs. These warmer biases early in the XBT record may be due to the recording systems used. The grey shading indicates the number of pairs in each group and two times standard error is indicated by the size of each box.

References
H95
S65
BCF02110635.