SIO176 HW1

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1 Description of instrument or platform

Instrument: **Expendable Bathythermograph or Expendable Sound Velocimeter (XBT/XSV)**

1.1 What is it used to measure? (0.5-1 page)

The XBT is used to measure temperature of seawater. Ultimately this instrument is composed of an expendable probe, data recording and processing system and a launcher. When the probe is launched and the electrode of the probe touches seawater, the electrical circuit completes using seawater as a ground. The probe contains a thermistor which is made of a semiconductor material. The resistance of the material changes with the temperature/depth and henceforth, we can process these changes and retrieve temperature data. The probe measures raw data which is telemetered back to the data processing system on the ship and thus we can see real-time temperature and velocity (for the XSV) profiles as the probe falls into the depth. To make sure that the probe is free-falling without any influence from ship movement, the probe canister contains a wire which simultaneously unwinds as the probe sinks. Furthermore, the nose of each expendable probe is precision weighted and unit-spin stabilized to assure a predictable descent rate. This allows us to know the depth of the probe to an error of $\pm 2\%$ units of depth. The accuracy of temperature values are of $\pm 0.1°C$. The XSV, on the other hand, is able to obtain accurate speed of sound profiles in water using a sing around sound velocity sensor. The accuracy is $\pm 0.25ms^{-1}$ at depths up to 2000m.

1.2 Example (1-2 paragraphs)

These two instruments measure profiles of temperature and speed of sound in water. One example from class for uses of these instruments was that the XBT can be used in remote locations via helicopter, where ships often have trouble accessing due to ice. In general this instrument, I think, can be used to determine locations of mixed layers, thermoclines, and the general structure of the ocean.

2 Synthesis of Assigned Paper (0.5 page w/o figure)

This paper answered the question of identifying systematic depth errors in 52 XBT temperature profiles. This was confirmed due changes in fall-rate characteristics caused by minor changes in probe manufacturing over time. These 52 XBTs were manufactured by the same company and used the same data acquisition system. The approach was as such: the same drop height of 2.5m, similar atmospheric conditions, and storing the XBT away from any influences that could force errors. They estimated depth errors in each XBT profiles by so: 1. Comparing XBT profiles to CTD profiles. 2. Interpolation into 1-m resolution profiles from 2-m deep to 800-m deep due to the fact that CTDs don't collect data until the latter depth. 3. XBT and CTD data are filtered with a second-order Butterworth filter with a 5-m low-pass cutoff to eliminate small scale geophysical and instrumental noise. 4. The XBT depth is estimated using the fall-rate equation. Each XBT depth is then shifted such that there is correlation coefficient is at a max between the CTD and XBT-shifted profile. They found that all profiles show depth errors that increase with depth. Specifically, they found a cold XBT fall-rate bias that changed from (-3.77 $\pm$ 0.57)% to (-1.05 $\pm$ 1.34)% between 1986 and 2008. such that the recorded depths are lower than their actual values. The finding of a 0.1°C cold bias have implications of studying thermal stratification of seasonal thermoclines in response to global warming. A remaining question is posed such as whether XBT biases are caused strictly due to temperature bias or fall-rate bias.

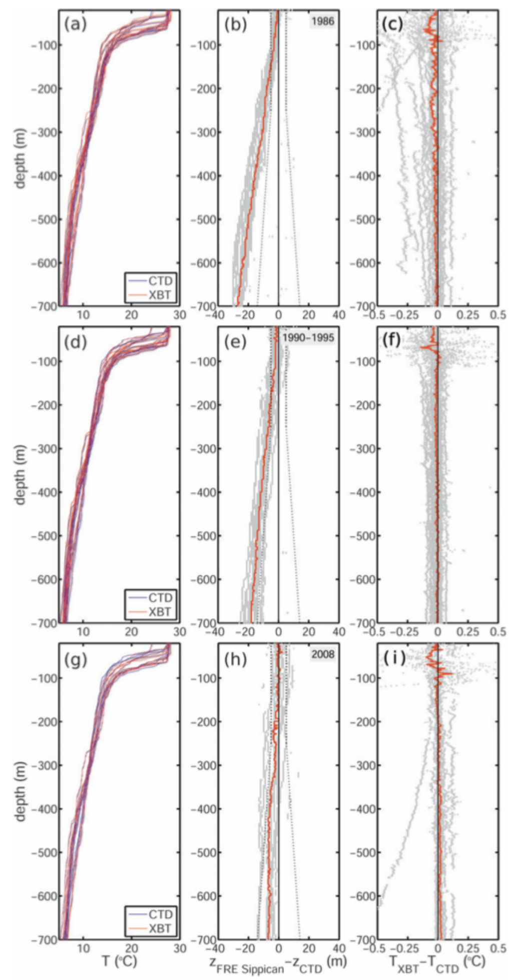

FIG. 3. (left) Temperature profiles obtained from CTDs (blue) and XBTs (red) manufactured in (a) 1986, (d) 1990–95, and (g) 2008. (center) Differences between the depth estimated by the XBT FRE with the original Sippican coefficients minus the true XBT depth estimated using the methodology described in the text (gray dots). The profiles are separated according to the manufacture date of the XBTs: (b) 1986, (e) 1990–95, and (h) 2008. The median value of the depth differences is shown in red. Depth differences are in meters. The dotted lines determine the XBT depth error specified by Sippican: 2% of depth or 5 m, whichever is larger. (right) XBT minus CTD temperature as function of depth after the depth of the XBT profile is adjusted using the methodology described in the text (gray dots). The profiles are separated according to the manufacture date of the XBTs: (c) 1986, (f) 1990–95, and (i) 2008. The median value of the temperature differences is shown in red. Temperature differences are in °C.

Figure 1: