

## **An assessment of the effect of variance in probe weight on the fall-rate of expendable bathythermograph and pure temperature bias**

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In order to clarify how fall-rate variation of XBTs reported by various recent papers can arise, we tried to evaluate the effect of difference in probe weight on the fall-rate of XBTs by conducting a sea test to compare fall-rates of ordinary T7 XBTs manufactured by LMS and TSK to those of TSK T7's with lightened nose weight. We dropped two or three dozens for each of 1) ordinary TSK T7, 2) 10g-reduced TSK T7, 3) 20g-reduced TSK T7, and 4) LMS T-7 at CTD stations in the sea south of Japan during KH11-3 cruise (Feb-Mar 2011) by R/V Hakuho Maru of the JAMSTEC. We confirmed the main finding of Kizu et al. (2011; Ocean Science) that recent LMS T7 falls more slowly than recent TSK T7 by a few percent. We also found that the former, which is about 10g lighter than the latter in the air, falls obviously more slowly than 20g-reduced TSK T7. It means that factors other than total weight, namely the differences in shape, structure or weight balance, dominate in the fall-rate difference. It also implies that the claimed tolerance for probe weight in the manufacture process (5g for LMS and 1g for TSK) is too small to explain the reported variation in fall-rate in the history and the inter-manufacturer fall-rate difference. These results agree with our past experience: TSK T5 falls slower than 10g-lighter LMS T5; XBTs do not change their speed during fall so much as the weight change due to wire loss. It is still unknown which element of the structure is most effective, but our results strongly suggest that we will need to keep regular monitoring of the fall-rate in the future.

After correcting depths of the individual XBT profiles according to concurrent CTD measurement, we estimated pure temperature errors for each of them. Not a few profiles obtained by LMS T7 showed sizable positive temperature error (or bias) which sometimes accumulated as depth. The temperature bias was much smaller with TSK T7.