0.0.1 Temperature effects on the shear probe

The shear probe responds to temperature in two ways. Its sensitivity changes with temperature, and it has a “pyro-electric” response.

The response of the shear probe to cross-stream velocity fluctuations depends on temperature because the amount of charge released (or absorbed) by the piezo-ceramic beam, per unit of strain, is slightly temperature dependent. The so-called g_{31} coefficient relates the amount of charge produced per unit of strain and its value usually decreases by $\sim 10^{-3}\,°C^{-1}$. However, the mechanical components surrounding the ceramic beam also have temperature-dependent properties. The silicon rubber, the Teflon sheath, and the epoxy all become less stiff with increasing temperature. The net result is that the sensitivity of the shear probe increases with increasing temperature. At least, that was the commonly held view until recently.

Tests conducted at RSI in 2015 on 8 shear probes indicate that there is a spread of temperature coefficients. Most samples had a positive temperature coefficient of about $0.5\,\%\,°C^{-1}$, some had a negligible temperature dependence, and one had a *negative* coefficient of $-0.5\,\%\,°C^{-1}$. Further testing is needed. The shear probes are usually calibrated at room temperature ($\sim$20 °C) and if they are used in an environment of much different temperature, for example in arctic waters, then it may be wise to calibrate them at the target operating temperature.

The pyro-electric effect is a response to a sudden change of temperature of a ceramic. A high rate-of-change of temperature cause a charge to be liberated (or absorbed) by the ceramic, even when there is no strain applied to the beam. The ceramic is fairly well insulated from the environment by the inner layer of epoxy, the Teflon shroud and by the silicon rubber. It does not experience rapid temperature changes in most oceanographic environments. Because of the insulation surrounding the beam, the pyro-electric effect manifests itself as a very low frequency ($\ll$0.1 Hz) response. The front-end charge-transfer amplifier of the shear probe is usually set to high-pass signals above 0.1 Hz and, consequently, the pyro-electric effect is not noticeable in almost all application. However, when a researcher (Wolk and Lueck, 2001) attempts to extend the low-frequency response of the charge-transfer amplifier to 0.01 Hz, the pyro-electric effect is noticeable.

References

Wolk, F., and R. G. Lueck, 2001: Heat flux and mixing efficiency in the surface mixing layer. *Journal of Geophysical Research*, **106**, 19 547–19 562.