

Developing Filters: What is the vertical resolution of XCTD data?

Expendable Conductivity Temperature Depth probes (XCTDs) are used as a quick means to obtain upper ocean profiles of temperature, salinity, and depth. XCTDs can provide basic information about the large-scale hydrographic properties of the upper ocean. They also have potential to yield information about the small-scale vertical structure of the upper ocean. Digital probes now return data with a sampling rate of 25 Hz, which translates into about one measurement every 13 cm. Since the probes fall freely, they are not subject to ship roll. For this reason, several recent studies have been use of high wavenumber information, in particular to estimate vertical diffusivity. But how much does noise contaminate the XCTD measurements? What is the true vertical resolution of the XCTD observations?

Using measurements from Drake Passage (or from the North Pacific), assess the vertical resolution of the XCTD probes.

1. Compute vertical wavenumber spectra for the XCTD data? Does the shape of the spectrum vary depending on whether you demean and detrend the spectra? Does it matter whether you window the data using a Hanning window? How should you average in order to have meaningful and useful error bars?
2. In these data, noise might be characterized either because it has high-frequency spectral peaks or because it has a white spectrum rather than a red spectrum. What do the observed spectra indicate? What frequencies would you want to filter to remove noise from the data?
3. Develop a filter to remove noise from the data. (You may do this using the Matlab filter design toolbox, but be sure to read the documentation carefully so that you are able to explain the procedure.) How many points do you need to use to define an appropriate digital filter?
4. Plot spectra and profiles for the filtered data. Do they behave as you expect? What is the best vertical resolution that you can obtain after filtering?