The Equation of State

- $\frac{d\alpha}{\alpha} = \beta dT - \mathrm{b}dS - \mathrm{K}dP$
- $\beta \equiv \frac{1}{\alpha}\frac{\partial\alpha}{\partial T}\Big|_{\mathrm{S,P}}$: The Coefficient of Thermal Expansion
- $\mathrm{b} \equiv -\frac{1}{\alpha}\frac{\partial\alpha}{\partial S}\Big|_{\mathrm{T,P}}$: The Coefficient of Saline Contraction
- $\mathrm{K} \equiv -\frac{1}{\alpha}\frac{\partial\alpha}{\partial P}\Big|_{\mathrm{S,T}}$: The Coefficient of Compressibility

  You may ask, why all the negative signs that cancel each other out – so that β, b, and K are greater than 0.

- **b** $\sim$ constant. This means that salinity has about the same effect on water whether it is at great depth or at the surface, whether it is warm or cold.
- $\beta > 0$ for S > 24.695. $\beta = \beta(T)$ What does this mean? You may have heard that there is a density maximum for water at 4°C. This is true only for fresh water. Sea water, with S $>$ 24.695, is increasingly denser the colder it gets.

  $\frac{\partial\beta}{\partial T} > 0$ means β is smaller for cold water, i.e., warm water experiences a larger change in density for a given dT than does cold water. This has implications for the stability of the water column and the strength of vertical mixing, especially in polar regions, and the phenomenon of cabbeling.