Turbulence mixing schemes

recap

Main dependent variables (mean quantities)

- Velocities (u,v)
- Salinity (S)
- Temperature (T)
- Sea surface height (ζ)

- Primitive equation models solve for (u,v,S,T,ζ)
- Additional quantities are needed, for example density, eddy viscosity, eddy diffusivities
- Several choices:
    - **Simple estimation:** use constant values. Note, density = constant implies (S,T) = constant
    - **Diagnose:** use predefined expressions based on main dependent variables. Examples, density from equation of state (EOS), KPP mixing scheme (=diagnostic scheme).
    - **Predict:** construct deterministic model for the additional quantities. Example, GLS mixing scheme (=prognostic scheme).

Construction, KPP and GLS

- In KPP we define a surface layer depth *h*
- Here, we have predetermined vertical profiles (MO theory)

$$K_x(\sigma) = h w_x(\sigma) G(\sigma)$$

- KPP includes a nonlocal transport term

$$-\overline{w'x'} = K_x \left(\frac{\partial \overline{x}}{\partial z} - \gamma_x \right).$$

- Time dependence, *h*(*t*), determined using bulk Richardson number
- Mixing below the surface layer due to
  - shear
  - internal waves
  - double diffusion
- Matching at the bottom of the surface layer

- In GLS we solve the TKE equation

$$\frac{\mathrm{D}k}{\mathrm{D}t} = \mathcal{D}_k + P + G - \epsilon,$$

- Eddy viscosity and diffusivities require knowledge about the turbulence length scales

$$\nu_t = (k^{\frac{1}{2}} l) S_{\mathrm{M}} + \nu,$$

$$\kappa_t = (k^{\frac{1}{2}} l) S_{\mathrm{T}} + \kappa,$$

- Second equation for a generic length scale is introduced (similar to TKE eq.)

$$\psi = (c_\mu^0)^p k^m l^n.$$