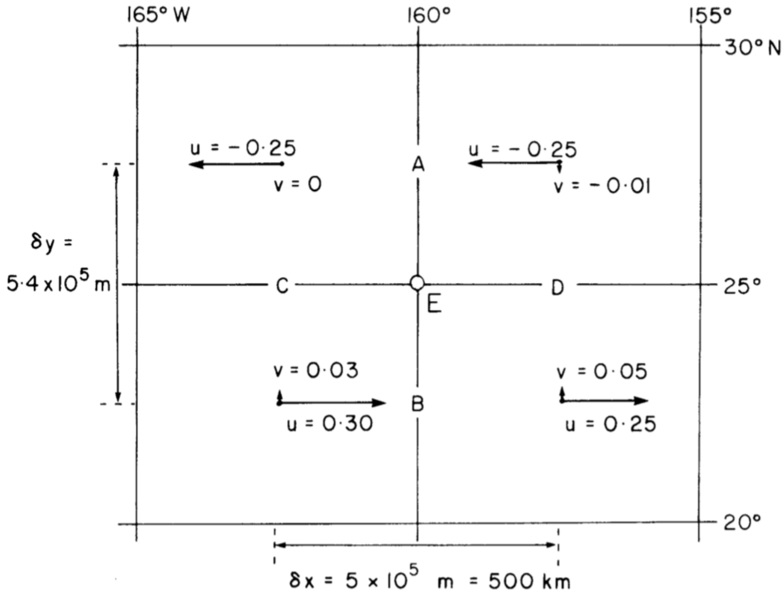
Homework 1

1. For a fluid volume, show that $\frac{\partial}{\partial t}\int_v \rho\, dV = \int_v \frac{\partial \rho}{\partial t} dV$.

2. Use the following configuration for a domain in the ocean, derive the vertical velocity *w* at 50 m (assuming incompressible fluids and *w=0* at surface) based on the continuity equation. Hint: you can obtain the horizontal velocity at points A, B, C and D first, and then use these values to compute the horizonal divergence at point E.



3. There are two sites in the ocean, A and B. The distributions of temperature (C°) and salinity (‰) with pressure (P, dbar) at these sites are shown in the following table.

	Site-A		Site-B	
P	S	T	S	T
0	35.10	28.50	33.50	2.50
20	34.99	28.45	33.50	3.74
40	34.88	28.35	34.25	4.02
60	34.78	24.55	34.55	4.10
80	34.68	22.75	34.65	4.15
100	34.60	20.55	34.74	4.20
200	34.45	15.50	34.90	4.30
250	34.35	13.00	35.10	4.35
500	34.25	6.58	35.23	4.25
1000	34.53	4.20	35.40	3.75

1) Calculate density with the linear Equation of State (EOS) as shown below, and plot the density profiles separately for A and B.

$$\rho = \rho_0 \left[1 - \beta_T (T - T_0) + \beta_S (S - S_0) + \beta_p (p - p_0) \right]$$

where $\rho_0 = 1027$ kg m^{-3}, β_T=0.15 kg m^{-3} C$^{\circ-1}$, β_S=0.78 kg m^{-3} ‰$^{-1}$, β_P=4.5 kg m^{-3} dbar^{-1}, and p_0=0 dbar。

2) Use the Thermodynamic Equation of Seawater – 2010 (TEOS2010) (matlab or python packages are available at Github, named as "Gibbs Sea Water (GSW)") to compute the density again, and plot the profiles on the figure drawn in 1) to make a comparison between the density distributions obtained from linear and nonlinear EOS.