**Gulf Stream Extension (North Atlantic Current, NAC)** I have picked section A01, which runs from Greenland to England. See end of document for the neutral density plots.

Estimate the near-surface current speed with surface geostrophic balance:

$$\begin{aligned} u_s &= -\frac{g}{f}\frac{\partial \zeta}{\partial y} \\ v_s &= \frac{g}{f}\frac{\partial \zeta}{\partial x}, \end{aligned}$$

where $f = 2\Omega \sin\varphi = 2 \times 7.27 \times 10^{-5} \times \sin(55°)$, $g = 9.81ms^{-2}$, and $\zeta$ is the sea surface height (SSH) anomaly. For section A01, the current transects it such that the flow is largely meridional. Therefore, we can approximate the current speed with only the meridional component.

Using a horizontal distance of about 200km to represent the NAC, and an SSH anomaly difference of 0.8m across this distance, substitute into the above to calculate the current speed:

$$\begin{aligned} v &= \frac{9.81}{2 \times 7.27 \times 10^{-5} \times \sin(55°)} \frac{0.8}{200000} \\ &= 0.3 \text{ ms}^{-1} \text{ (1 s.f.)} \end{aligned}$$

Estimate the buoyancy gradient at 500 m depth with the neutral density section:

$$\begin{aligned} b &= \frac{-g\ (\rho - \rho_0)}{\rho_0} \\ &= \frac{-9.81\ (1028 - 1025)}{1025} \\ &= \frac{-9.81 \times 2.8}{1025} \\ &= -0.029 \text{ ms}^{-2} \text{ (2 s.f.)} \end{aligned}$$

$$\begin{aligned} b &= \frac{-g\ (\rho - \rho_0)}{\rho_0} \\ &= \frac{-9.81\ (1027.6 - 1025)}{1025} \\ &= \frac{-9.81 \times 2.7}{1025} \\ &= -0.025 \text{ ms}^{-2} \text{ (2 s.f.)} \end{aligned}$$

The buoyancy gradient at 500m depth is:

$$\frac{\partial b}{\partial x} = \frac{-0.029 + 0.025}{200000} = -2 \times 10^{-8} \text{s}^{-2}$$

Level of no motion:

$$-f\frac{\partial v_g}{\partial z} = -\frac{\partial b}{\partial x} = -2 \times 10^{-8} \tag{1}$$

$$\int_{v=0.3}^{v=0} 2 \times 7.27 \times 10^{-5} \times \sin(55^\circ) dv_g = \int_0^z 2 \times 10^{-8} dz \tag{2}$$

$$\Rightarrow 2 \times 7.27 \times 10^{-5} \times \sin(55^\circ) \times 0.3 = 2 \times 10^{-8}\ z$$
$$\therefore z = 1800m\ (2 \text{ s.f.})$$

The total transport of this current (in Sverdrups) between the level of no motion and the surface:

$$\begin{aligned}\text{transport in sverdrups} &= \text{current area} \times \text{current speed} \times 10^{-6} \\ &= (1800 \times 200000) \times \frac{0.3}{2} \times 10^{-6} \\ &= 54\ Sv\end{aligned}$$

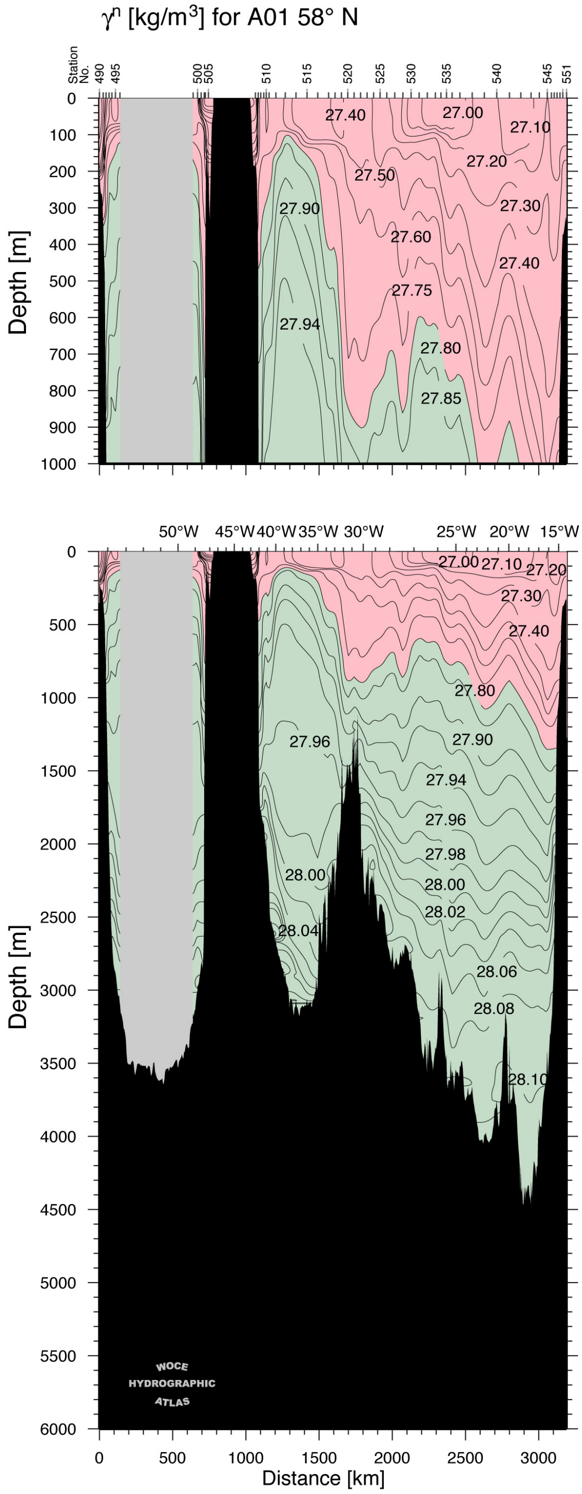


Figure 1: Neutral density plots for section A01