1. A weather map shows the following distribution for barometric pressure in the vicinity of 58° N latitude. The isobars are approximately 100 miles apart, as shown. Calculate the velocity of the expected geostrophic wind. Indicate both speed and direction. Be careful to work the calculations in a consistent set of units.

\[\begin{array}{c|c}
1010 \text{ mb} & \text{100 miles} \\
1009 \text{ mb} & \\
1008 \text{ mb} & \\
1007 \text{ mb} & \\
\end{array}\]

2. If a large lake is located in the area covered by the weather map above, what is the magnitude and direction of the expected wind drift at the surface of the lake?

3. A deep, relatively clear lake has a measured, weighted-average light extinction coefficient (i.e., the overall extinction coefficient for all wavelengths of light) of \(K = 0.125 \text{ m}^{-1}\). What is the depth in meters of 1% light penetration depth (the depth where light level is 1% of the surface incident light)? You can neglect any additional light absorption due to the surface films mentioned in the notes (i.e., \(\beta = 0\)).

4. Consider a stratified lake where the epilimnion temperature is 22° C and the hypolimnion temperature is 3° C. We know it takes work to mix the denser deep water with the less dense surface water. Suppose we could exchange the positions of two 1.00 m³ "cubes" of water separated by 6.00 m of depth, as shown below. What is the total energy input, in joules, required to either push the surface cube down five meters, or else raise the deeper cube up five meters? (Same answer either way.) **Hint:** Focus on the difference in water density, hence water mass and water weight, between the upper water and the lower water. The distance moved is 6.00 m.