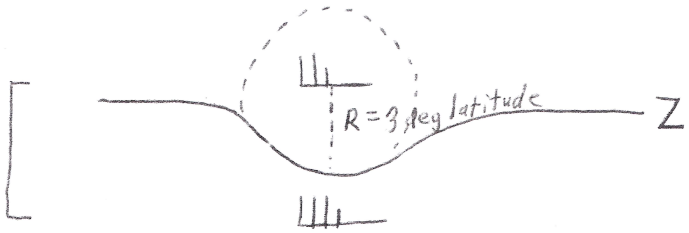
8) Vorticity

$\frac{\pi}{4}$

For the map below, answer the following questions. Show all calculations in an ordered, neat, detailed manner. You are at 45^{o} N latitude, the top observation is 25 kts, and the bottom observation is 35 kts. Assume the spacing between the wind observations is $\Delta n = 2$ deg, and the radius is $R = 3$ deg. Don't forget to convert all values to metric units.

$\Delta n = 2$ deg latitude



R not drawn to scale. Actual trough would have more curvature.

$\Delta n = 2\,\text{deg} = 222000\,\text{m}$

$R = 3\,\text{deg} = 333000\,\text{m}$

$|\vec{V}|_{top} = 25\,\text{kts} = 12.9\,\text{ms}^{-1}$

$|\vec{V}|_{bottom} = 35\,\text{kts} = 18.0\,\text{ms}^{-1}$

a) Compute $\frac{|\vec{V}|}{R} \approx \frac{(|\vec{V}|_{top} + |\vec{V}|_{bottom})/2}{R}$ (2 pts)

$\approx \frac{(12.9\,\text{ms}^{-1} + 18.0\,\text{ms}^{-1})/2}{333000\,\text{m}}$

$\approx +4.64 \times 10^{-5}\,\text{s}^{-1}$

b) Is this cyclonic curvature relative vorticity or anticyclonic curvature relative vorticity? (1 pt)

cyclonic

c) Compute $-\frac{\partial |\vec{V}|}{\partial n} \approx -\frac{|\vec{V}|_{top} - |\vec{V}|_{bottom}}{\Delta n}$. **(watch out for extra negative sign)** (2 pts)

$\approx -\frac{(12.9\,\text{ms}^{-1} - 18.0\,\text{ms}^{-1})}{222000\,\text{m}} \approx +2.3 \times 10^{-5}\,\text{s}^{-1}$

d) Is this cyclonic shear relative vorticity or anticyclonic shear relative vorticity? (1 pt)

cyclonic

e) Compute ζ. (2 pts)

$\zeta = \frac{|\vec{V}|}{R} - \frac{\partial |\vec{V}|}{\partial n} = a + c = +6.9 \times 10^{-5}\,\text{s}^{-1}$

f) Compute ζ_a. (2 pts)

$f = 2\Omega \sin\left(\frac{\pi}{4}\right) = 2(7.292 \times 10^{-5}\,\text{s}^{-1})(0.707107) = 1.03 \times 10^{-4}\,\text{s}^{-1}$

$\zeta_a = \zeta + f = (6.9 \times 10^{-5}\,\text{s}^{-1}) + (1.03 \times 10^{-4}\,\text{s}^{-1}) = 1.7 \times 10^{-4}\,\text{s}^{-1}$