

Session 1

1. A ship is steaming northward at a rate of 10km/h. The surface pressure increases toward the northwest at the rate 5Pa/km. What is the pressure tendency recorded at a nearby island station if the pressure aboard the ship decreases at a rate 100Pa/3h.

2. Show that a homogeneous atmosphere (density independent of height) has a finite height that depends only on the temperature at the lower boundary. Compute this height and temperature profile for surface temperature $T_0 = 273\text{K}$ and surface pressure 1000hPa.

3. Show that:

a) $\underline{\nabla} * (\underline{a} \times \underline{b}) = \underline{b}(\underline{\nabla} \times \underline{a}) - \underline{a}(\underline{\nabla} \times \underline{b})$

b) $\underline{\nabla} \times (f\underline{a}) = f(\underline{\nabla} \times \underline{a}) + [(\underline{\nabla} f) \times \underline{a}]$

c) $\underline{a} \times (\underline{b} \times \underline{c}) = \underline{b}(\underline{a} * \underline{c}) - \underline{c}(\underline{a} * \underline{b})$

d) $\underline{\nabla} \times (\underline{\nabla} \times \underline{a}) = \underline{\nabla}(\underline{\nabla} * \underline{a}) - \Delta \underline{a}$

Homework 1

1. The temperature at a point 50 km north of a station is 3°C cooler than at the station. If the wind is blowing from northeast at 20m/s and the air is being heated by radiation at the rate of 1°C per hour, what is the local temperature change at the station?
2. Draw the plot of the difference between the geopotential height and height.

Hint:

$$\text{geopotential: } \Phi(h) = \int_0^h g(z) dz,$$

$$\text{geopotential height: } Z_g(h) = \frac{\Phi(h)}{g_0},$$

$$g(z) = \frac{GM}{(z + R)^2}, \quad g_0 = \frac{GM}{R^2}$$