1. Temperature Advection. A strong north-south temperature gradient exists across Oklahoma with temperatures increasing toward the south at 8 degrees/100 km. A howling north wind of 20 m/s is bringing more cold air into Oklahoma.

   a. Under the prevailing clear sky conditions, at what rate (degrees per hour) will the temperature change at Oklahoma City?

   b. If the temperature at Oklahoma City starts at 25 C, how long (in hours) will it take for the temperature to drop to freezing?

2. Temperature Advection. Suppose the temperature above an observing station is dropping by 5 degrees per hour due only to vertical advection. If the vertical velocity above the station is 1.0 m/s,

   a. Find the environmental lapse rate (in degrees per kilometer) (i.e., the vertical temperature gradient). HINT: Use the vertical part of the 3-D advection equation given in class.

   b. If the east-west temperature gradient above the station is 5 degrees per 100 km, i.e., the temperature increase toward the east, what speed (in meters per second) and direction of the east-west wind would be required in order to keep the temperature above the station constant (i.e., to counteract the cooling caused by vertical advection)?

3. Continuity Equation. For the wind observations below,

   a. Compute the horizontal divergence (in sec\(^{-1}\)) at Oklahoma City.

   b. Assuming that the horizontal divergence is constant from the ground to 2 km, find the vertical velocity at 2 km. HINT: Use the mass continuity equation given below and integrate with respect to height, assuming that the vertical velocity is zero at the ground.

   c. Does your answer in part b make physical sense?

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   \text{Horizontal Divergence} = \delta = -\frac{dw}{dz}
   \]