Pressure Gradient Acceleration

The acceleration that results from the unequal distribution of pressure along each of the coordinate axes is called the "pressure gradient acceleration."

Conceptually, it is strongest in areas in which the isobars are closest together.

Here are the pressure gradient accelerations on each of the coordinate axes. But usually, we partition this acceleration into a "horizontal" and a "vertical" pressure gradient acceleration.

$$a_x = -\frac{1}{\rho}\frac{\Delta p}{\Delta x}$$

$$a_y = -\frac{1}{\rho}\frac{\Delta p}{\Delta y}$$

$$a_z = -\frac{1}{\rho}\frac{\Delta p}{\Delta z}$$

The pressure gradient acceleration acts to accelerate air parcels from higher values of pressure to lower values of pressure, at right angles to the isobars, with a greater magnitude where the isobars are closest together. As in the

case for all accelerations, the unit for pressure gradient acceleration is m s^{-2}.

Upper air maps are drawn to show distribution of heights (e.g., 500 mb height map). How do meteorologists and oceanographers relate atmospheric and oceanic motion to maps of heights?

Consider the magnitude (absolute value) of the pressure gradient acceleration along the x axis:

$$|a_x| = \left|\frac{1}{\rho}\frac{\Delta p}{\Delta x}\right| \qquad (1)$$

The hydrostatic law is

$$|\Delta p| = |\rho g \Delta z| \qquad (2)$$

Substitute the value for Δp in (2) into (1) to get

$$|a_x| = \left|g\frac{\Delta z}{\Delta x}\right| \qquad (3)$$

which states that horizontal pressure gradient acceleration along the x axis can be approximated by the height gradient. For example, if the difference, for example, in 500 mb heights is 50 m over 100 km, the acceleration due to pressure gradient can be approximated by substitution into equation (3).

Comparable expressions can be obtained for the horizontal pressure gradient acceleration approximation on height maps for the y axis in the rectangular coordinate system and the s and n axis in the natural coordinate system.