

## Wind Components

Wind is just the velocity of the air relative to the Earth's surface. It has both a direction and a speed, which means that wind is a vector quantity.

Wind speed is usually expressed in units of knots, kts, or meters per second, m/s. Since speed is a change of position with time, speed is positive when an air parcel is moving in a positive direction. For example, consider an air parcel that is moving east,

$$\frac{x_{final} - x_{initial}}{t_{final} - t_{initial}} = \frac{x_2 - x_1}{t_2 - t_1} > 0.$$

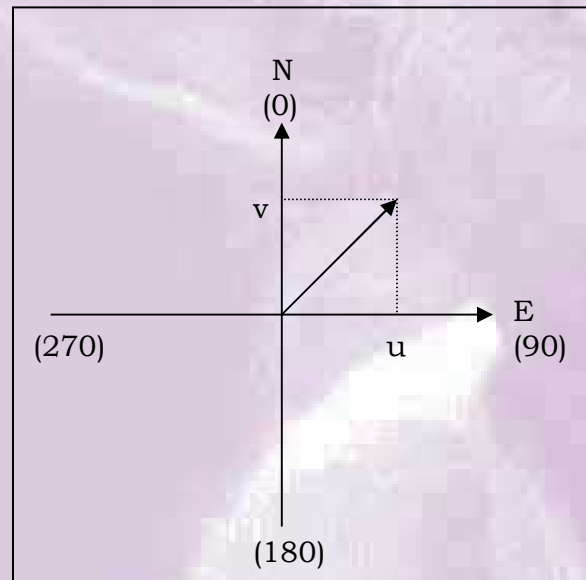


Since the x position increases to the east, the air parcel is moving in the positive x direction and the speed along the x-axis,  $u$ , is positive. The eastward component of the wind is also called the **zonal wind**. The wind component along the y-axis,  $v$ , is called the

**meridional wind**; it is positive when an air parcel is moving north, the positive y direction. The resultant wind speed is found using vector arithmetic,

$$|\vec{v}| = \sqrt{(u^2 + v^2)}.$$

Wind direction can be confusing because azimuth is defined differently in meteorology than in mathematics. In meteorology wind direction is always the direction from which the air is coming. A west wind is *from* the west. The direction of a wind from the North is 0 or 360 degrees; the direction of a wind from the east is 90 degrees, etc. Azimuth can be calculated from the arctan of  $u/v$ , but the quadrant must be considered to get the correct answer.



### Vertical Component of the Wind

The vertical component of the wind is defined in a similar fashion to the horizontal components,

$$u \equiv \frac{dx}{dt} \text{ and } v \equiv \frac{dy}{dt}.$$

When altitude,  $z$ , is the vertical co-ordinate:

$$w \equiv \frac{dz}{dt};$$

and when pressure,  $p$ , is the vertical co-ordinate:

$$\omega \equiv \frac{dp}{dt}.$$

Be careful with the sign of vertical velocity. Ascent corresponds to a positive value of  $w$ , but a negative value of  $\omega$  (since altitude increases upward and pressure increases downward).

Units of vertical velocity are also problematic. Typical values in SI units are several orders of magnitude from one. Thus, many use other units, such as cm/s for  $w$ . Commonly used units of  $\omega$  include: mb/dy, microbars/sec, and others.