Variable definitions

Variable Symbol	Variable Name	Metric Units MKSA
IWV	Integrated water vapor amount for the whole column of the atmosphere above a point on the ground	$\frac{kg}{m^2}$
PW	Precipitable water, the height of a 1 m^2 column of water that would come about from condensing all of the IWV into liquid water	m
$\overrightarrow{IVT}$	Integrated Water Vapor Transport Vector	$\frac{kg}{m\ s}$
ρ_w	Water vapor density	$\frac{kg}{m^3}$
ρ_{Dry}	Density of dry air at temperature *T* and pressure *P* calculated from the ideal gas equation using the dry gas constant (no water vapor)	$\frac{kg}{m^3}$
ρ	Density of moist air at virtual temperature T_v and pressure *P* calculated from the ideal gas equation using the dry gas constant (water vapor accounted for with virtual temperature to take into account the molecular weight of water vapor)	$\frac{kg}{m^3}$
$\rho_{BulkWater}$	Density of bulk water, nominally 1000 $\frac{kg}{m^3}$	$\frac{kg}{m^3}$
w	Water vapor mixing ratio=$\frac{\rho_w}{\rho_{Dry}}$ is ratio of water vapor and dry air	$\frac{kg}{kg}$
q	Specific humidity=$\frac{\rho_w}{\rho}$ is ratio of water vapor and dry air	$\frac{kg}{kg}$
$\vec{v}$	Wind vector. It transports water vapor among other things	$\frac{m}{s}$
u	West to east wind component, known as the zonal component	$\frac{m}{s}$
v	South to north wind component, known as the meridional component	$\frac{m}{s}$

Water vapor analysis in the atmosphere

Integrated Water Vapor *IWV*:

$$IWV = \int_{0}^{TOA} \rho_w(z)\, dz = -\frac{1}{g}\int_{P_s}^{0} q(z)\, dP$$

$$\rho_w(z) = \rho_{Dry}(z)\, w(z) = \rho(z)\, q(z)$$

$$q(z) = \frac{w(z)}{1 + w(z)}$$

Precipitable Water Vapor *PW*:

$$PW = \frac{IWV}{\rho_{BulkWater}}$$

Integrated Water Vapor Transport Vector $\overrightarrow{IVT}$:

$$\overrightarrow{IVT} = \int_{0}^{TOA} \rho_w(z)\, \vec{v}(z) dz = -\frac{1}{g}\int_{P_s}^{0} q(z)\, \vec{v}(z) dP$$

$$\rho_w(z) = \rho_{Dry}(z)\, w(z) = \rho(z)\, q(z)$$

$$q(z) = \frac{w(z)}{1 + w(z)}$$

$$\vec{v}(z) = (u(z), v(z))$$

Wind as a vector and scalar quantity

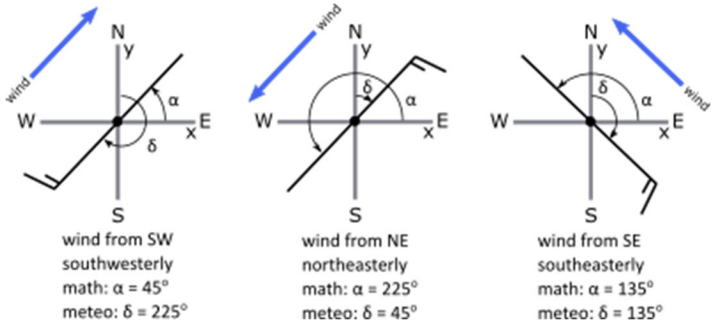

Figure 1. Meteorological, δ, and math, α, angle definitions. A positive u wind blows from west to east, δ=270 deg, and is called a westerly wind. A positive v wind blows from south to north, δ=180 deg, and is called a southerly wind. Usually the wind is drawn only from the flag to the origin, but was extended to show the math angle. From https://www.e-education.psu.edu/meteo300/node/719.

Vector relationships for wind: https://confluence.ecmwf.int/pages/viewpage.action?pageId=133262398

$$u = -|\vec{v}| \sin(\delta)$$

$$v = -|\vec{v}| \cos(\delta)$$

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

$$\delta = mod\left(180 + \frac{180}{\pi} atan2(v, u), 360\right)$$