$$\frac{\partial T}{\partial x}|_{yzt} = \lim_{dx \to 0}[T(x+dx,y,z,t) = T(x,y,z,t])$$

Notice: this value at constant z is not identical to that at constant p.

Vergence: >0 is "divergence" (flowing apart), <0 "convergence" (together)

- In 1D it is called "diffluence": $\frac{\partial u}{\partial x}$ or $\frac{\partial v}{\partial y}$. 2D con-/di- *vergence* is the sum.

Can you grok the "operator" $\frac{\partial}{\partial x}$? Anything to its LEFT is multiplied, anything to its RIGHT gets differentiated (operated on). $3\frac{\partial}{\partial x}(T) \neq T\frac{\partial}{\partial x}(3) = 0$ for instance!

Dot product of vectors:

Velocity: simple multiplication of unit vectors times flow *components* u,v,w

$\vec{V} = \hat{i}u + \hat{j}v + \hat{k}w = u\hat{i} + v\hat{j} + w\hat{k}$

"DEL" operator *nabla*: don't put the unit vectors to the right of the $\frac{\partial}{\partial}$ operator!

$\nabla = \hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}$

$-\vec{V} \cdot \nabla$ is pronounced "ADVECTION OF" (any **field** placed to the right, like T)

$-\nabla \cdot \vec{F}$ is pronounced "CONVERGENCE OF" (any **vector flux field F** to its right)

TRANSPORT is one **tendency** in an Eulerian (local) time derivative $\frac{\partial}{\partial t}$:

$$\frac{\partial q}{\partial t} = TRANSPORTS_q + (SOURCES - SINKS)_q$$

TRANSPORTS include large-scale transport by wind plus small-scale transport.

Small-scale **diffusion** involves the random swapping of neighboring molecules. Similar swapping of tiny puffs of air, which we don't care enough about to treat as "wind" patterns, is also treated the same way: as *eddy diffusion*. Notice that neighbor-swapping raises lower values and lowers higher values: it is **a flux down the gradient (from high to low values of the transported substance).**

Large-scale transport can be written as either FLUX CONVERGENCE or ADVECTION as written above. Why choose one or the other? **Advection** is easier to understand at a point: *look immediately upwind, what condition is the wind bringing and how fast?* **Flux convergence** is useful because it integrates precisely to zero (vanishes) over area or volume of the whole unbounded atmosphere, because it integrates precisely to the *boundary flux* for a limited region of space.