University of British Columbia, Vancouver
GEOS 300 - Microscale Weather and Climate
Knox, updated January 10, 2023

Answers to Study Questions - Lecture 2

1. The term $\frac{\partial \rho_v}{\partial t}$ describes the change in absolute humidity $\partial \rho_v$ in time ∂t and as such is the change in storage within the 'volume'. Its unit is partial density of water vapour ($\mathrm{g\,m^{-3}}$) divided by time (in s), i.e. $\underline{\mathrm{g\,m^{-3}\,s^{-1}}}$

2. The term $u\frac{\partial \rho_v}{\partial x}$ describes transport of a humidity gradient along the x-axis by the wind. Its unit is wind speed ($\mathrm{m\,s^{-1}}$) times partial density of water vapour ($\mathrm{g\,m^{-3}}$) divided by distance (in m), i.e. again $\underline{\mathrm{g\,m^{-3}\,s^{-1}}}$

3. Horizontally homogeneous conditions mean $\frac{\partial \rho_v}{\partial x} = 0$ and $\frac{\partial \rho_v}{\partial y} = 0$. So the conservation equation simplifies to:

$$0 = \frac{\partial \rho_v}{\partial t} + w\frac{\partial \rho_v}{\partial z} \tag{1}$$

or

$$\frac{\partial \rho_v}{\partial t} = -w\frac{\partial \rho_v}{\partial z} \tag{2}$$

Inserting $\frac{\partial \rho_v}{\partial z} = -1\,\mathrm{g\,m^{-3}\,m^{-1}}$ and $w = 0.1\,\mathrm{m\,s^{-1}}$ results in:

$$\frac{\partial \rho_v}{\partial t} = 0.1\,\mathrm{g\,m^{-3}\,s^{-1}}. \tag{3}$$

So the 'volume' becomes more humid over time.