Move More Atmospheric Sci. Fundamentals into Years 1 & 2 in University

	Job Track	Grad-school Track
Yr. 4 Senior	**Tech**: Air quality, synoptics & fcst, severe wx., local/ mtn. winds., **People**: commun., teamwork, web design & progr., proj.capstone	**DifEq-based**: synop-dyn., thermo., cld.phys., NWP, etc.
Yr. 3 Junior		**Skills**: ODEs, PDEs, Lin.Alg., adv. phys., fluid dyn., database
Yr. 2 Sophomore	**Algebra-based**: dyn., synoptics, global circ., PBL, climate, instruments, optics. **Skills**: computer programming	
Yr.1 Freshman	**Algebra-based**: atm., radiation, heat, water, stability, clouds, precip., remote. **Skills**: Matlab/Excel, stats.	

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} Algebra-based (Yr. 1 and Yr. 2)

Algebra-based Atmos. Sci. - Examples

Hydrostatic Eq.

$$\frac{\Delta P}{\Delta z} = -\rho \cdot |g|$$

Radar Eq.

$$dBZ = 10\left[\log\left(\frac{P_R}{P_T}\right) + 2\log\left(\frac{R}{R_1}\right) - 2\log\left|\frac{K}{L_a}\right| - \log(b)\right]$$

Frontogenesis (kinematic)

$$\text{Frontal Strength} = FS = \frac{\Delta\theta}{\Delta x}$$

$$\underbrace{\frac{\Delta(FS)}{\Delta t}}_{\text{Strengthening}} = \underbrace{-\left(\frac{\Delta\theta}{\Delta x}\right)\cdot\left(\frac{\Delta U}{\Delta x}\right)}_{\text{Confluence}} \underbrace{-\left(\frac{\Delta\theta}{\Delta y}\right)\cdot\left(\frac{\Delta V}{\Delta x}\right)}_{\text{Shear}} \underbrace{-\left(\frac{\Delta\theta}{\Delta z}\right)\cdot\left(\frac{\Delta W}{\Delta x}\right)}_{\text{Tilting}}$$

Omega Eq. (Trenberth)

$$W_{mid} \cong \frac{-2\cdot\Delta z}{f_c}\left[U_{TH}\frac{\overline{\Delta\zeta_g}}{\Delta x} + V_{TH}\frac{\overline{\Delta\zeta_g}}{\Delta y} + V_{TH}\frac{\beta}{2}\right]$$

Thermo. 1st Law

$$\left.\frac{\Delta T}{\Delta t}\right|_{x,y,z} = \underbrace{-\left[U\cdot\frac{\Delta T}{\Delta x} + V\cdot\frac{\Delta T}{\Delta y}\right]}_{\text{advection}} \underbrace{-0.1\frac{\text{K}}{\text{h}}}_{\text{radiation}}$$

$$\underbrace{-\frac{\Delta F_{z\ turb}(\theta)}{\Delta z}}_{\text{turbulence}} + \underbrace{\frac{L_v}{C_p}\cdot\frac{\Delta m_{condensing}}{m_{air}\cdot\Delta t}}_{\text{latent heat}}$$

Thermal Wind Relationship

$$\frac{\Delta U_g}{\Delta z} \approx \frac{-|g|}{T_v\cdot f_c}\cdot\frac{\Delta T_v}{\Delta y}$$

$$\frac{\Delta V_g}{\Delta z} \approx \frac{|g|}{T_v\cdot f_c}\cdot\frac{\Delta T_v}{\Delta x}$$

Q vectors

$$Q_x = -\frac{\Re}{P}\cdot\left[\left(\frac{\Delta U_g}{\Delta x}\cdot\frac{\Delta T}{\Delta x}\right) + \left(\frac{\Delta V_g}{\Delta x}\cdot\frac{\Delta T}{\Delta y}\right)\right]$$

$$Q_y = -\frac{\Re}{P}\cdot\left[\left(\frac{\Delta U_g}{\Delta y}\cdot\frac{\Delta T}{\Delta x}\right) + \left(\frac{\Delta V_g}{\Delta y}\cdot\frac{\Delta T}{\Delta y}\right)\right]$$

Recommendation

- Cover more atmos. sci. earlier, using **algebra**-based approach.

Critique

- **Pros**: Same physics, terms, units, interpretation, application. Allows easy computation. Can be used with complex topics.
- **Cons**: Cannot derive many of the eqs.

Resources (free, online)

http://www.eos.ubc.ca/books/Practical_Meteorology/

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