USING ATMOSPHERIC DATA TO DETERMINE HOW WELL A SEPARABLE ODE MODELS THE VERTICAL MOTION OF A DRY AIR PARCEL

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ODE FOR ENGINEERS

POTENTIAL TEMPERATURE

Cool

Pressure $p < p_0$

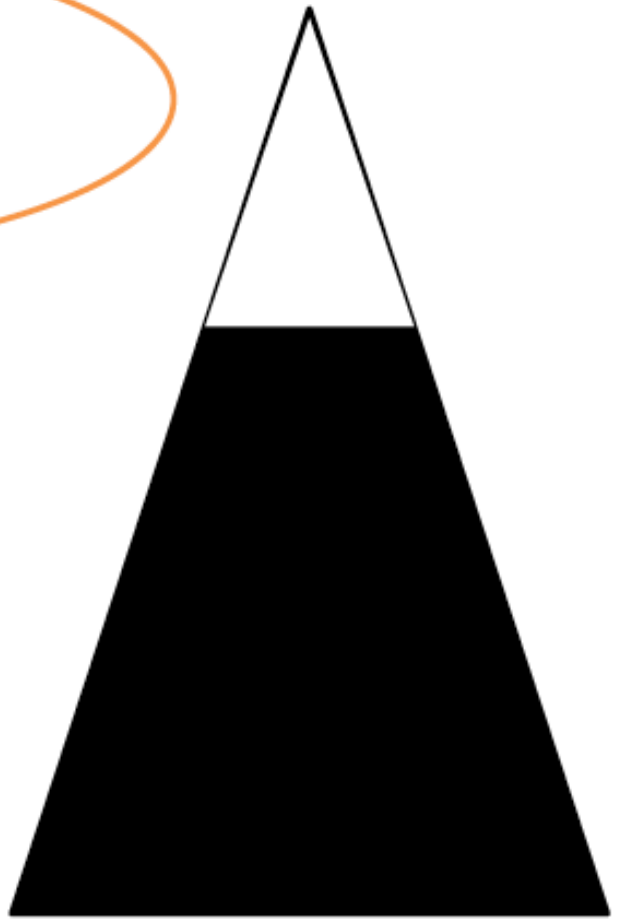
Potential temperature θ

Rises without gain/loss of heat

Warm

Pressure p_0

Potential temperature θ



1ST LAW OF THERMODYNAMICS

$$dq = c_p dT - \alpha dp$$

- q: heat
- c_p: specific heat
- α: inverse of density

With no gain or loss of heat:

$$\frac{dT}{dp} = \frac{\alpha}{c_p}.$$

IDEAL GAS LAW

$$p = \rho RT$$

- ρ: density
- R: gas constant

Rewrite this as

$$\alpha = \frac{RT}{p}.$$

POTENTIAL TEMPERATURE ODE

- Putting these together gives

$$\frac{dT}{dp} = \frac{R}{c_p}\frac{T}{p}.$$

- Solve with (p_0, θ) as the pressure and temperature at the ground:

$$\theta = T\left(\frac{p_0}{p}\right)^{\frac{R}{c_p}}$$

THE ASSIGNMENT

- Solve the Separable IVP
- Compare Model Potential Temps with Actual Calculations
- Identify Issues

MY ROLE

- PROVIDE DATA
- INSTRUCTIONS/SYNTAX for R
- GUIDANCE ON SCATTERPLOT ISSUES

THE REALITY

- Is the ODE Separable?
- ALGEBRA!!!
- Oceanographic Data easier to access than Atmospheric Data
  - No heat exchange means density change
  - Density not removed
  - Scatterplot NOT LINEAR

THE FUTURE

- Convert .nc files
- Keep Oceanographic Data
- More ODE Class Time on Data Concepts
- Curriculum Change

Thank You

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