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 $\theta$

Rises without gain/loss of heat

Warm
Pressure $p_0$
Potential temperature $\theta$
1st Law of Thermodynamics

\[ dq = c_p dT - \alpha dp \]

- \( q \): heat
- \( c_p \): specific heat
- \( \alpha \): inverse of density

With no gain or loss of heat:

\[ \frac{dT}{dp} = \frac{\alpha}{c_p}. \]
IDEAL GAS LAW

\[ p = \rho RT \]

- \( \rho \): density
- \( R \): gas constant

Rewrite this as

\[ \alpha = \frac{RT}{\rho}. \]
POTENTIAL TEMPERATURE ODE

• Putting these together gives

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

• Solve with \((p_0, \theta)\) 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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