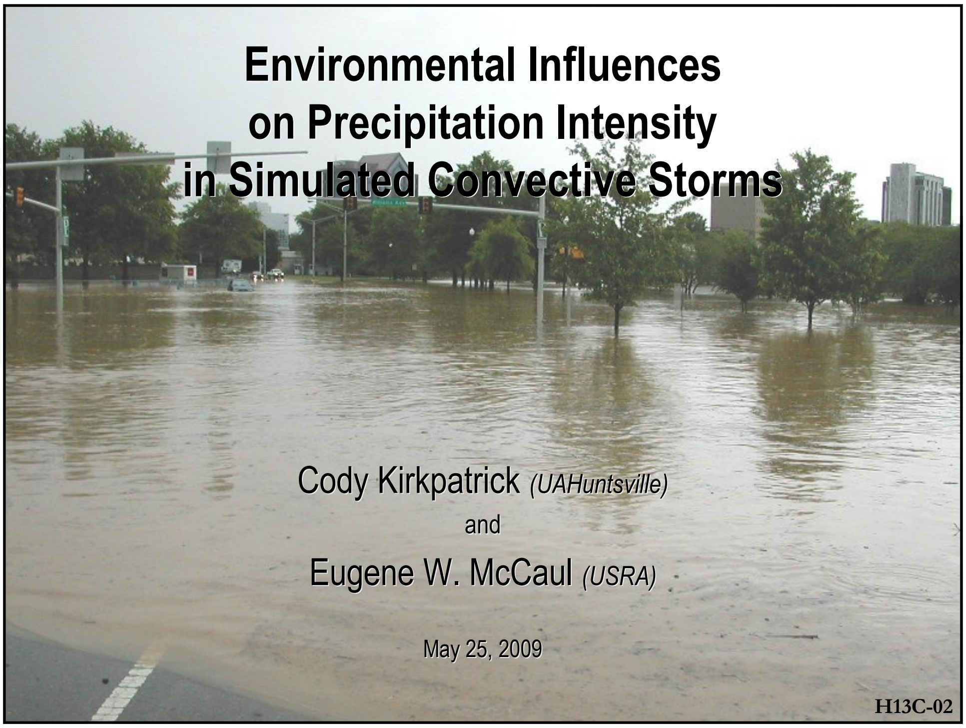

Environmental Influences on Precipitation Intensity in Simulated Convective Storms

Cody Kirkpatrick *(UAHuntsville)*

and

Eugene W. McCaul *(USRA)*

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Challenges of Precipitation Forecasting

- When and where are conditions supportive?
- Which individual storms will be heavy rain producers?
- Key physical principles
  - Precipitation efficiency
  - Updraft water vapor flux
  - Storm motion
  - (Usually, all of these are important.)

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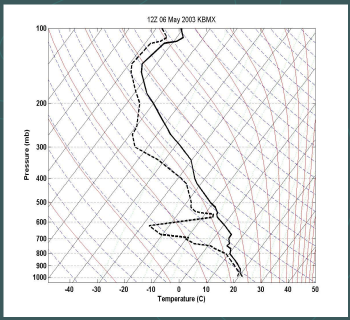
Challenges of Precipitation Forecasting

- Contributing environmental factors to heavy rainfall:
  - Moist, deep-layered air mass
  - Deep low-level warm layer
  - Strong inflow
- Relevant sounding para-meters:
  - High PW, CAPE
  - Low LCL, high LFC (within reason)
  - Strong shear (at least at low levels)



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The niche for this paper…

- Detailed study of the *environmental* influences on precipitation
  - Profiles of temperature, humidity, wind
  - Impacts of storm motion
- What we cannot study:
  - Hydrologic aspects
    - Topography, watersheds
    - Groundwater, streamflow, channel characteristics
  - These are *often as important as the storm itself.*

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Model dataset

- Simulations from the Convection Morphology Parameter Space Study (COMPASS)
  - **Broad spectrum** of convective environments and modes

Parameter	Possible Values
Bulk CAPE	800, 2000, 3200 J kg^{-1}
Semicircular hodo. radius	8, 12, 16 m s^{-1}
Shape of buoyancy profile	Two choices per CAPE
Shape of shear profile	Two choices per CAPE
LCL-LFC configuration	0.5-0.5, 0.5-1.6, 1.6-1.6 km
Precipitable water (PW)	Roughly 30 or 60 mm
RH above LFC	Constant, 90%

  - LCL-conserving thermal bubble, in a 75 km × 75 km homogeneous domain; single moment microphysics

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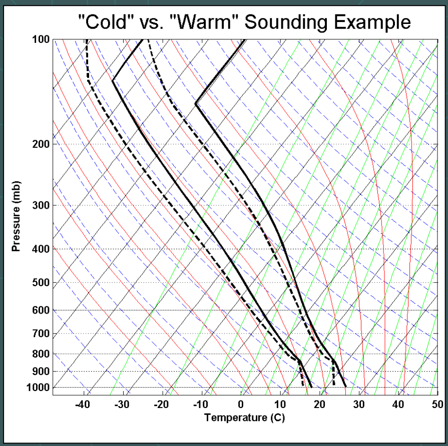
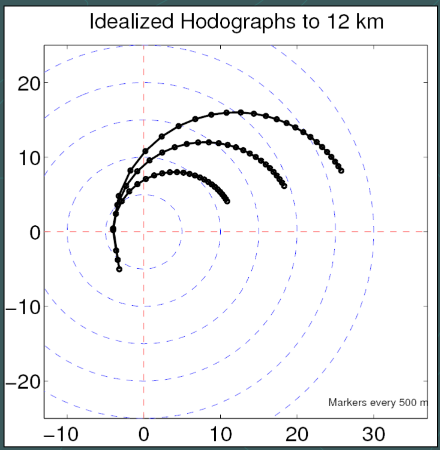
Sample profile configurations





Left: PW ~ 30 mm
Right: PW ~ 60 mm

Radii: 8, 12, 16 m s^{-1}
(U = -4 m s^{-1} at LCL)

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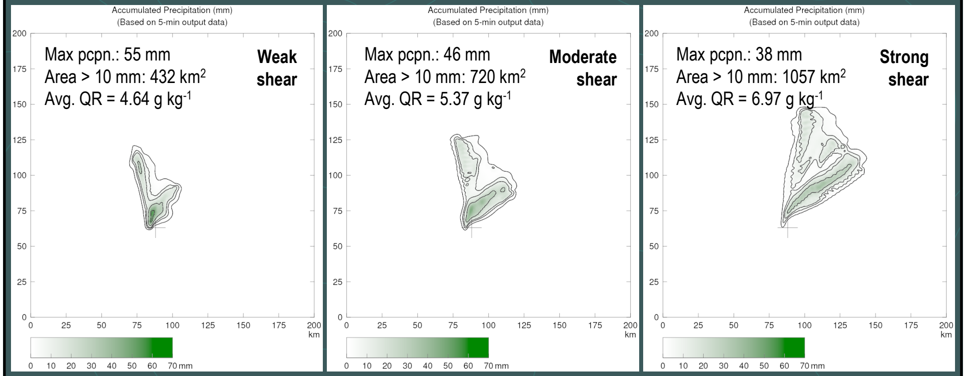
Effects of Environmental Wind Shear

- Increasing shear leads to larger precip. footprint
  - Faster storm motions; heaviest rain spread over larger area
  - QR also increased—more rain falling at the surface



Constant in these 3 simulations: CAPE = 2000 J kg^{-1}, concentrated buoyancy and shear, LCL = LFC = 1.6 km, PW ~ 30 mm

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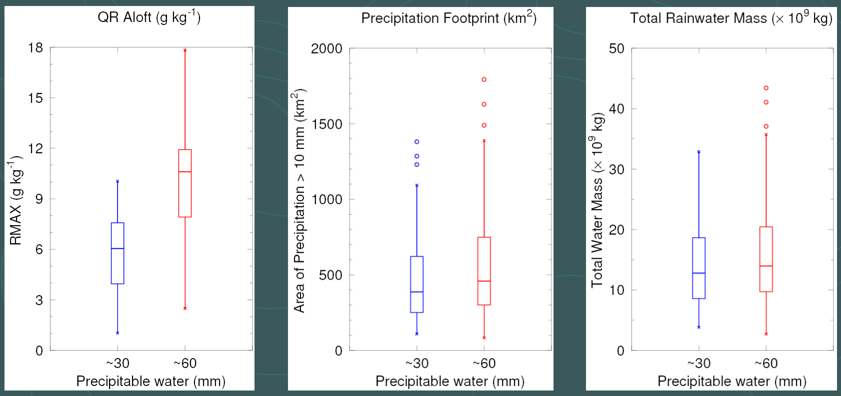
Effects of precipitable water

- In persistent storms, *surface* rainfall properties are nearly the same regardless of PW



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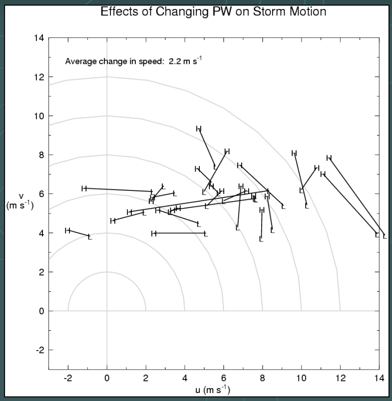
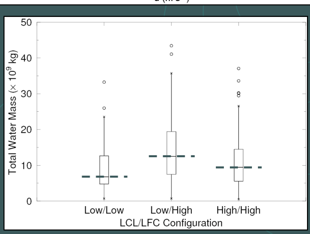
Other Influences

- Effects are nonlinear
  - Example: reducing PW can affect storm motion
  - LCL and LFC
    - Storm motions slightly faster when LFC is raised
    - Greater PE, so water mass distributed over a larger area
    - But, high LCL means more subcloud evaporation





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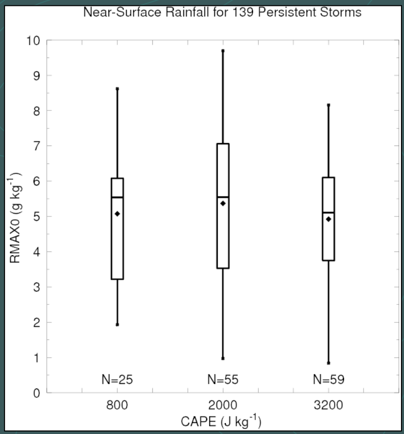
What does *not* influence precipitation?

- (Only the *persistent* updrafts are considered here)
- Low-CAPE storms that exist are just as likely to produce heavy rain as high-CAPE storms
- No statistically significant effects as CAPE is varied



- Caveat: CAPE does affect the *number* of storms

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Relationships to Climate Change

- "Trends" in storm behavior as certain parameters may become altered:
  - CAPE: little affect on amount of precip *from an individual updraft*
  - Shear: obvious importance, but competing effects
  - Others: LCL, LFC, PW
- Important to remember:

  Multiple aspects of the profile are important.

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Summary

- Environmental shear greatly impacts precipitation
  - Effects are dichotomous
  - Storms can produce more precip, but will move more quickly
- CAPE does *not* appear to influence an updraft's precipitation to a significant degree
- Further investigations possible:
  - Precip. and intra-storm processes
  - More study of shear vs. storm motion effects on precip

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