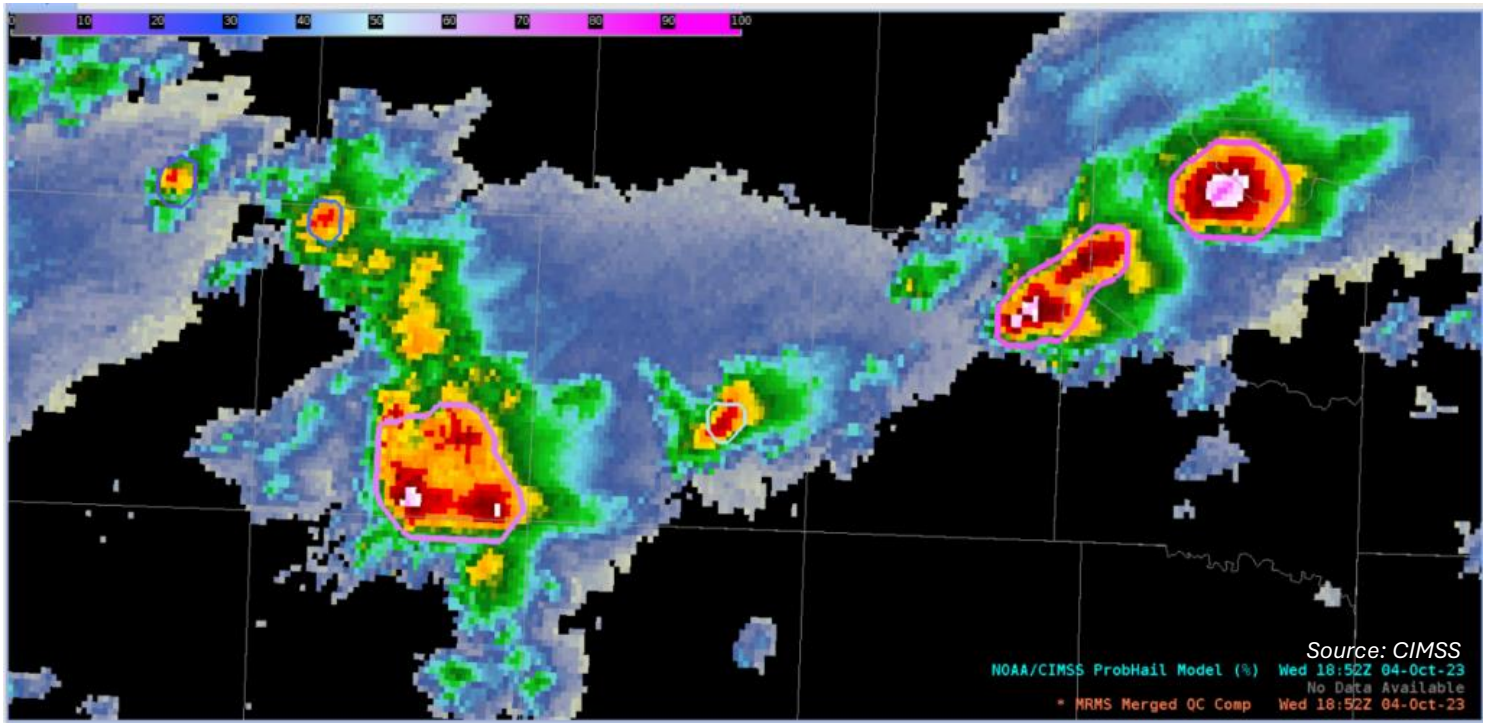
A library of remotely-sensed hail probabilities



Lead: Dr. Angela Rowe[1]

with Drs. Tristan L'Ecuyer[1], Justin Sieglaff[1], Lena Heuscher[1], John Cintineo[3], Daniel Wright[1], Victor Gensini[2]

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Need and Industrial Relevance

When and where did it hail?

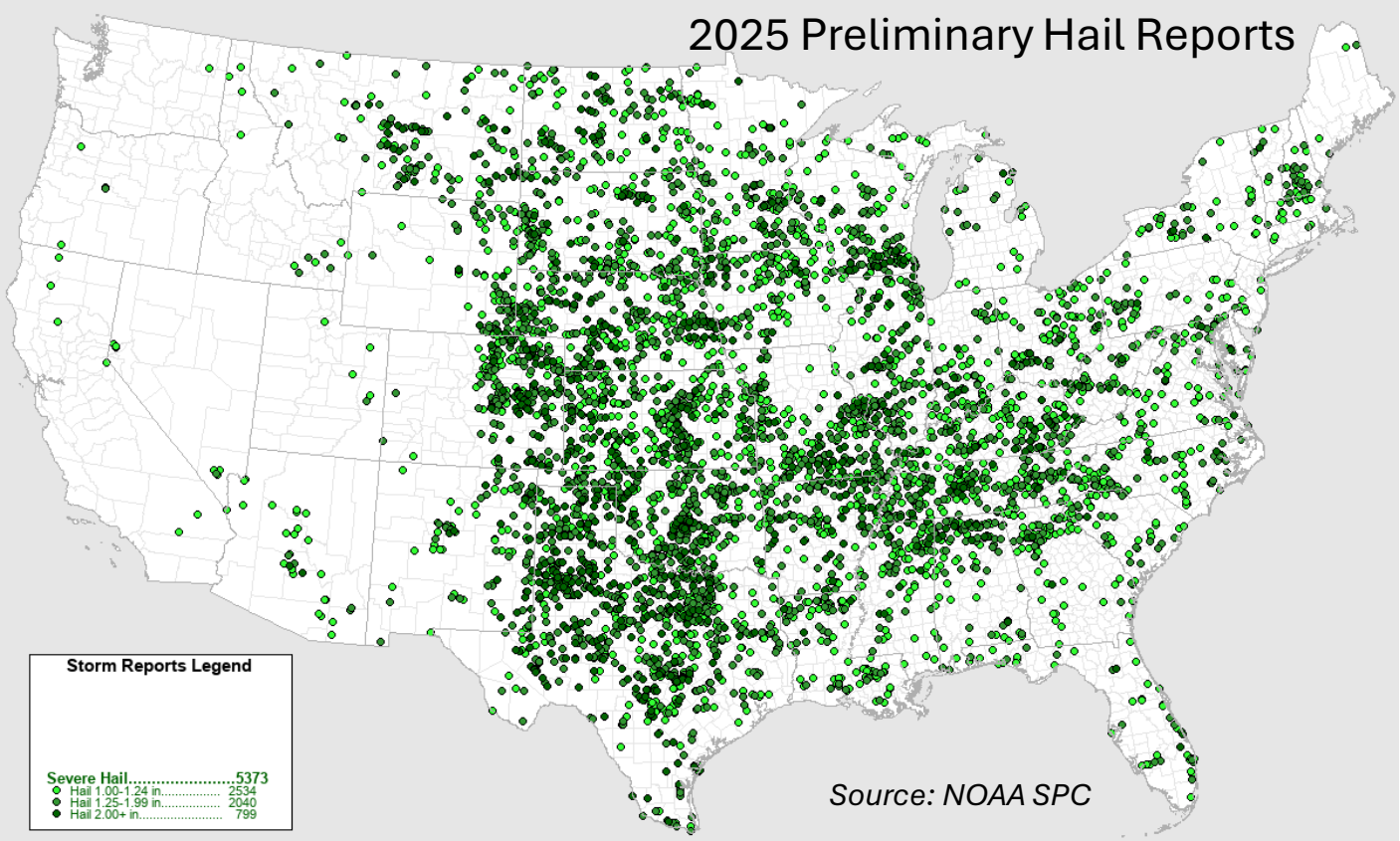
- Known limitations in storm report databases
- Ground-based remote sensing valuable but with limitations (e.g., known issues with MRMS MESH underestimating hail and empirical relationship sensitivity)

More than just *yes* or *no*?

- Probabilities

When and where are these datasets most reliable?

What atmospheric conditions supported a specific hail event?



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Project Vision

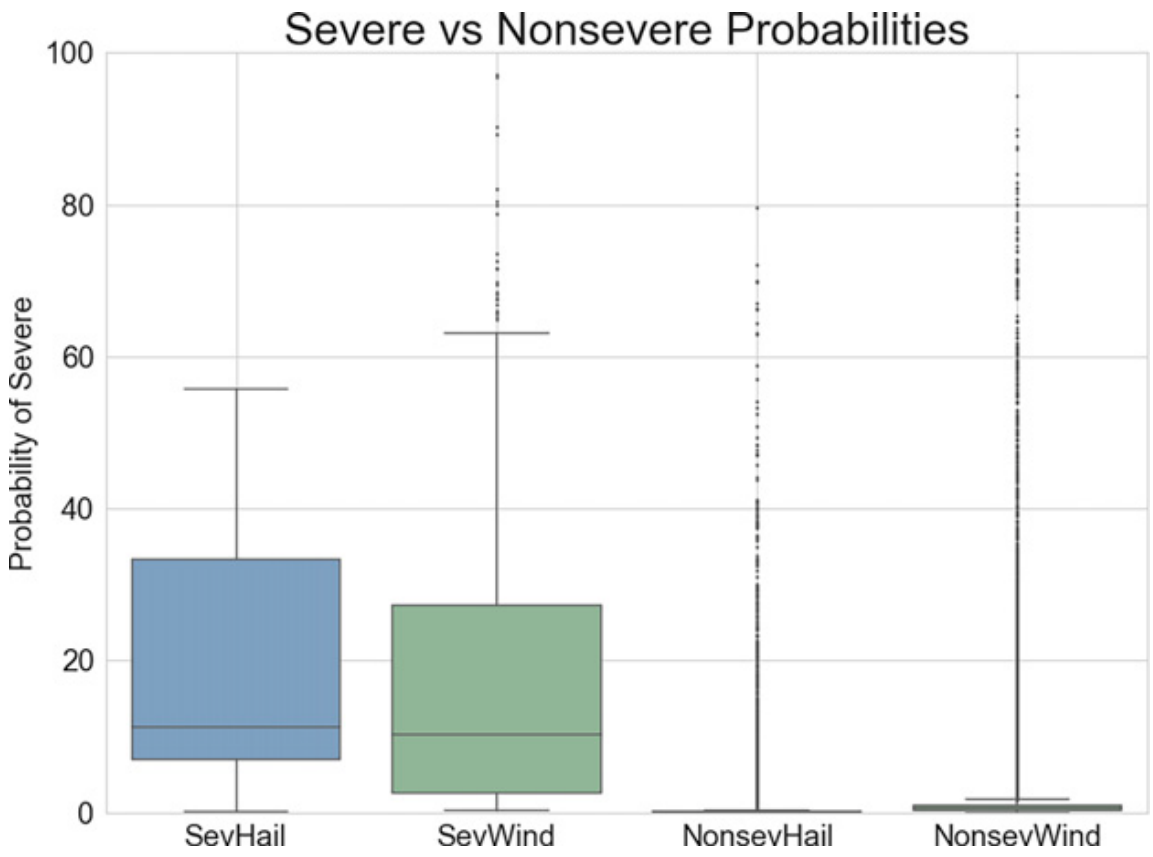
This project will provide a 10-year library of hail events

- ***Probabilities*** of hail with associated ***atmospheric conditions***

- Observational ***constraints for CIRCS modeling activities*** including inputs to stochastic catastrophe models

→Longer term expansion of capabilities for broader applications

→Severe wind, tornado



Source: Gard et al. 2022

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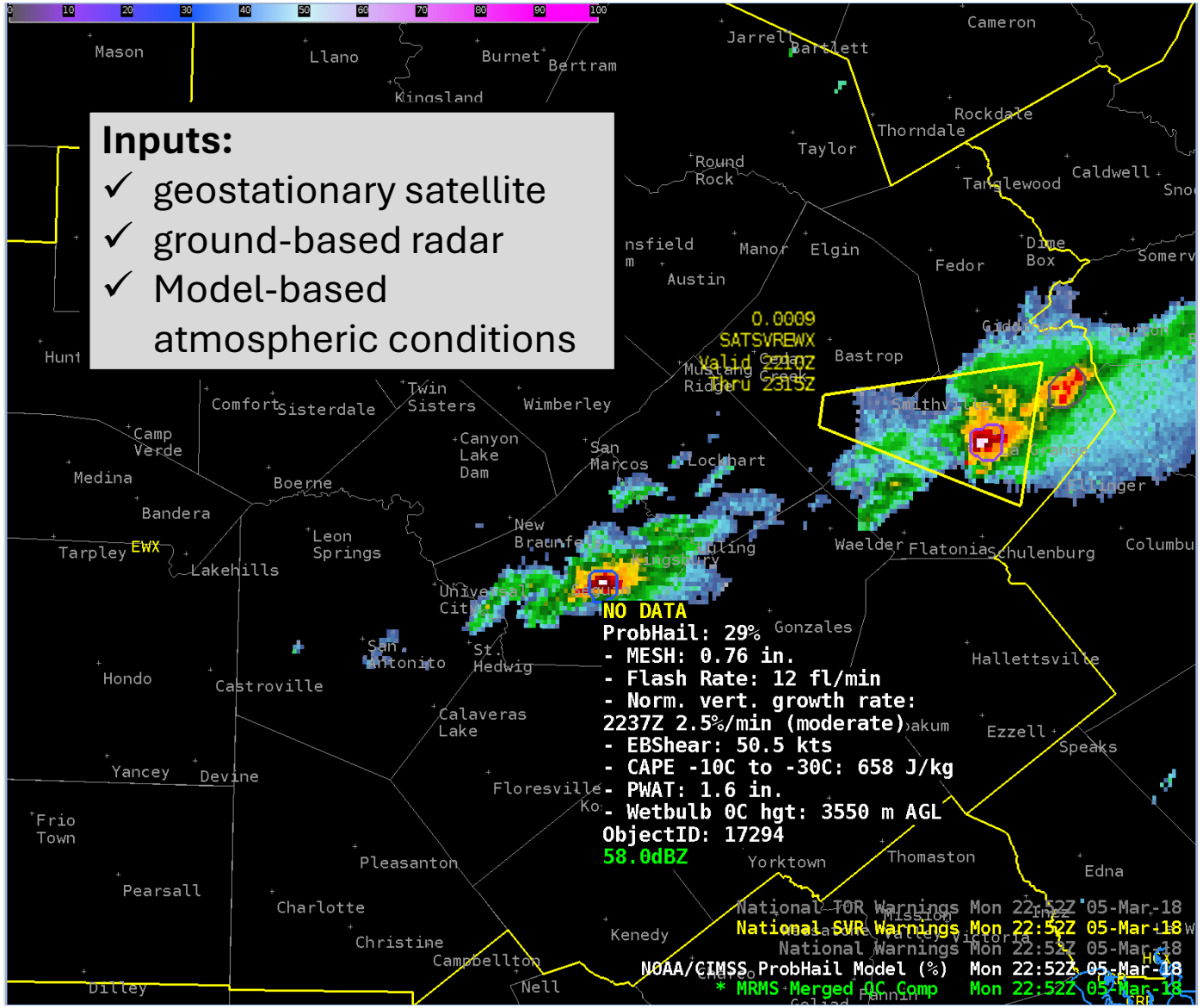
ProbSevere

Probability of Severe hazards model

- ***Large hail (≥ 1” diameter)***
- ***Damaging wind gust (≥ 50 kt)***
- ***Tornado***

- **UW-Madison:** AOS + NOAA Cooperative Institute for Meteorological Satellite Studies (CIMSS)
- **Multiplatform,** multiscale storm objective identification combined with machine learning-based techniques
- **Probabilities** of hazards from extracted **predictors**



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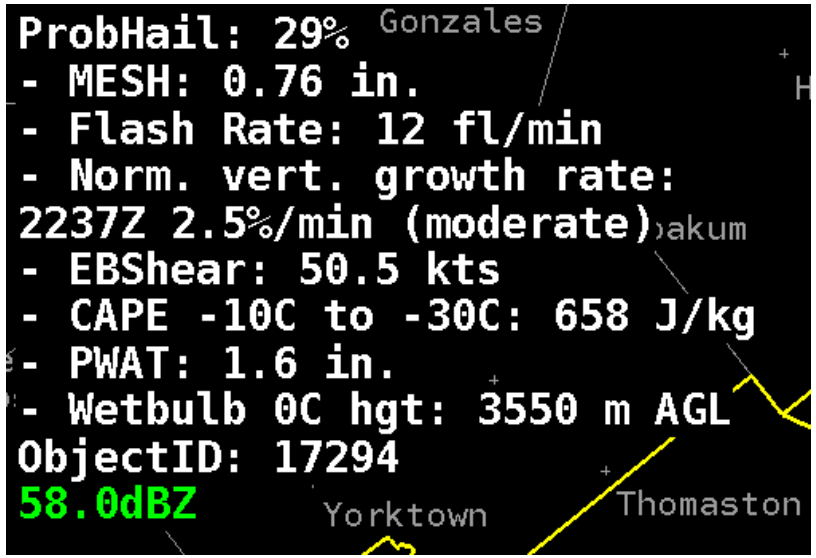
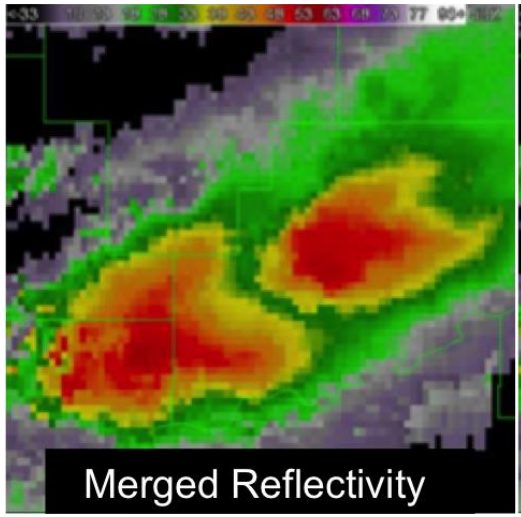
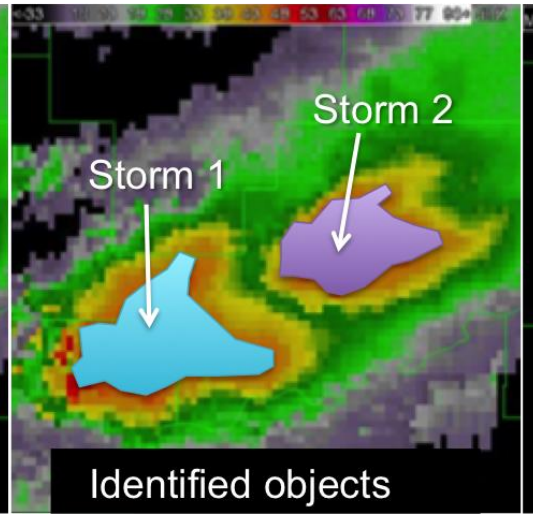
ProbHail (V3) Approach

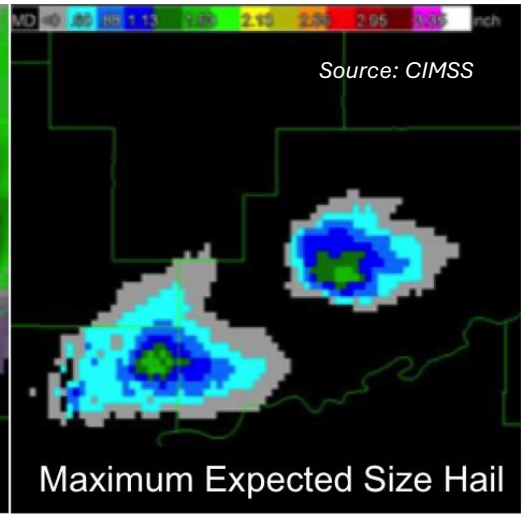
- Outputs **shapefiles** contoured around radar storm cells (but **can be overlaid on any field**) with model probability and each model predictor
- Storm tracking = duration!
- Current target: NOAA's severe local storm reports
- Probability for best performance has **regional variability**
- 42 predictors from input data sources, predictor importance points to **value in satellite input**

V3 Input data: MRMS, GOES ABI + GLM, Earth Networks Total Lightning Network (ENTLN), and HRRR









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Expected Outcomes / Deliverables

✓**Probabilistic hail event library** across the U.S., day and night, all year with context-based evaluation

→*Supporting other projects as observational input and verification, in usable formats and developer insight into interpretation of probabilities*

Step 1: Expand ProbHail dataset back through 2016 (MRMS and GOES ABI record)

→ 10 years of CONUS hail probabilities during convectively active days

→*Compliments and expands upon MESH including greater reliable coverage*

→*Includes information on which predictors most important for that hail prediction (HRRR-based atmospheric conditions including CAPE and shear; radar- and satellite-based inputs including MESH, lightning; etc.)*

→*Assessment for select cases (e.g., most likely vs marginal cases, large hail events)*

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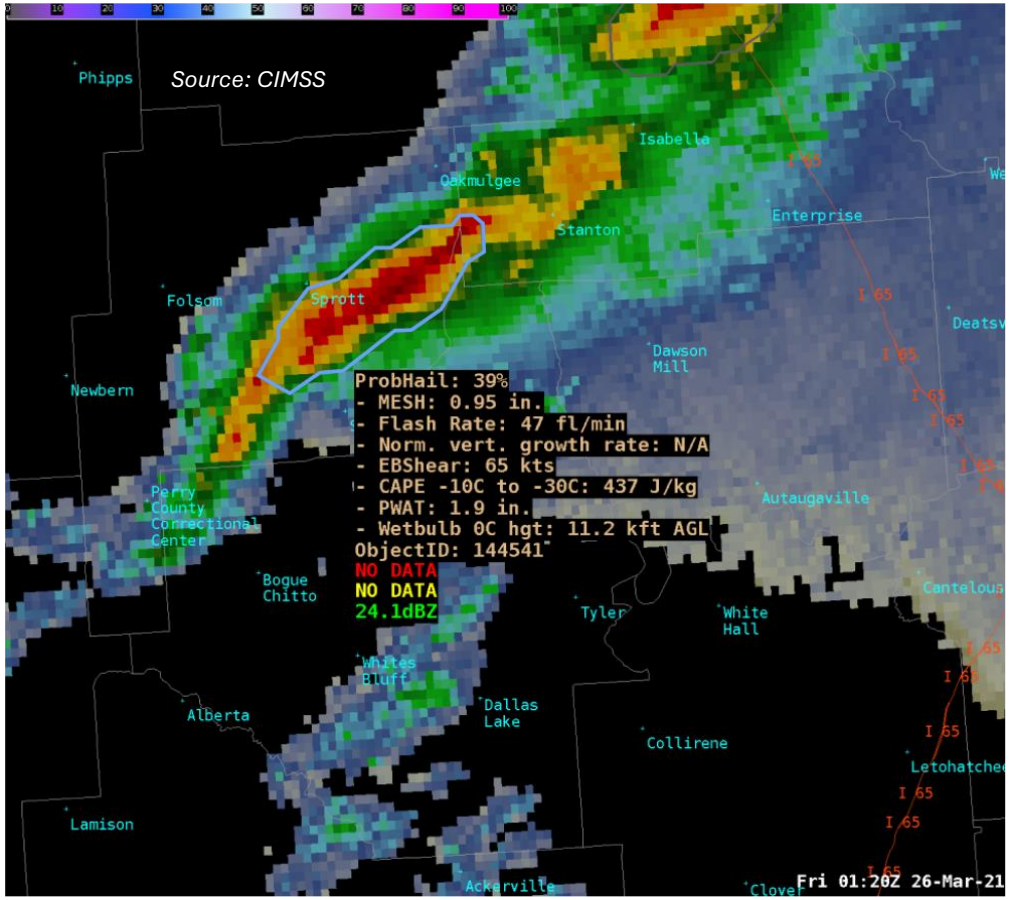
Project Impact

10-year library of probabilistic hail events

Opens opportunity for longer-term projects for additional improvements and applications:

- Inputs to CIRCS modeling activities (e.g., drive stochastic models)
- Distinguishing small severe (1-2”) from large severe hail (>2”, significant), currently constrained by storm report database categorization
- Testing spatially aware machine learning models (e.g., toward reducing influence of artifacts in MRMS)
- Understanding regional relationships between atmospheric conditions and hail probabilities, including for marginal cases
- Compound perils with ProbSevere wind, tornado



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Project Timeline

Year 1: Expand ProbHail back through 2016

- **Months 0-3:** Discussions with CIRCS model collaborators on required output format; Student familiarizes with ProbHail code with CIMSS collaborators, compiles input data in usable format for previous years
- **Months 4-12:** Reprocessing ProbHail for previous years, with periodic assessment of model output (months 8-12) for predefined select cases based on Storm Report validation dataset. Compiling output in shareable database for CIRCS user community

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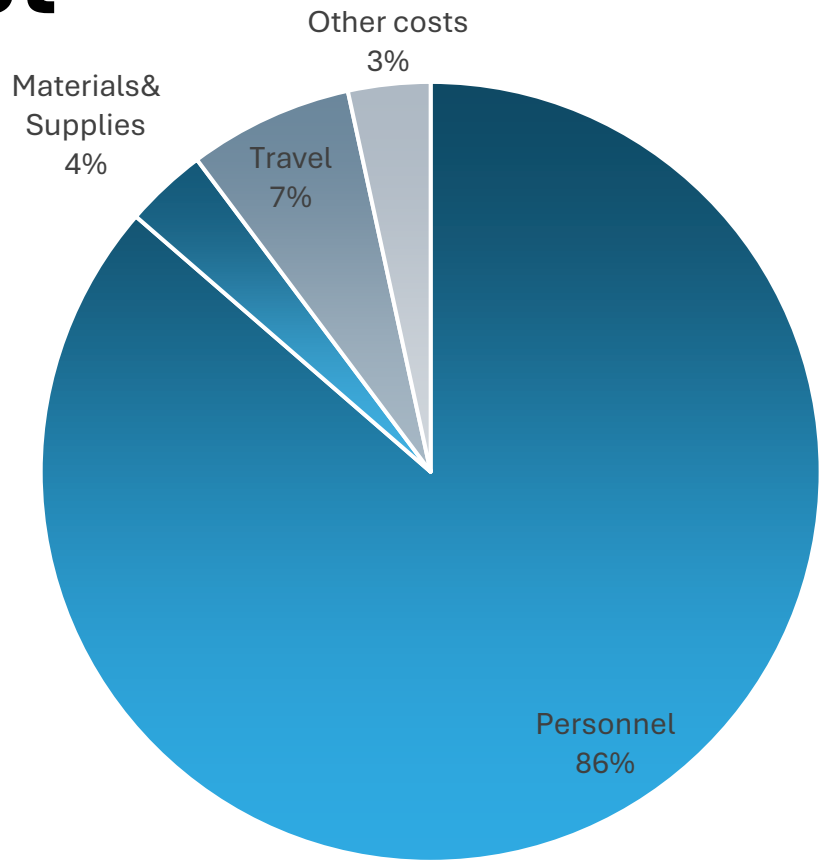
Project Budget

- **Personnel: ~$76K**
  - PI (Rowe)
  - Graduate student stipend + tuition
  - CIMSS ProbSevere researcher (Heuscher)
- **Materials and Supplies: $3K**
  - Computer for graduate student
  - Software fees
- **Travel: $6K**
  - Travel to CIRCS annual meeting
  - Conference attendance and presentation (AGU 2026)
- **Other: $3K**
  - Open-source publication fee
- **Total: $88K**



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