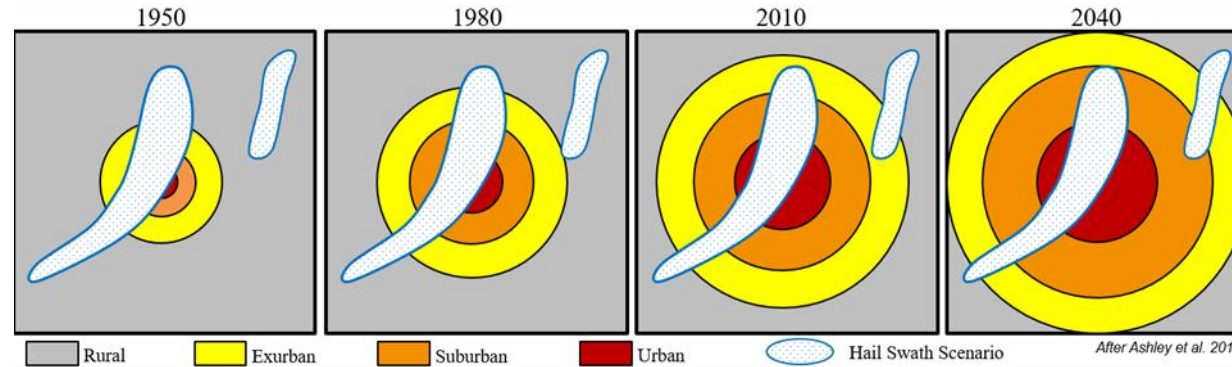


Simulating Historical and Potential Future Hail Impacts on Exposure Surfaces



Stephen M. Strader, Ph.D.; Associate Professor; Villanova University

Walker S. Ashley, Ph.D.; Professor; Northern Illinois University

Logan Bundy; Ph.D. Candidate, Northern Illinois University



Northern Illinois
University



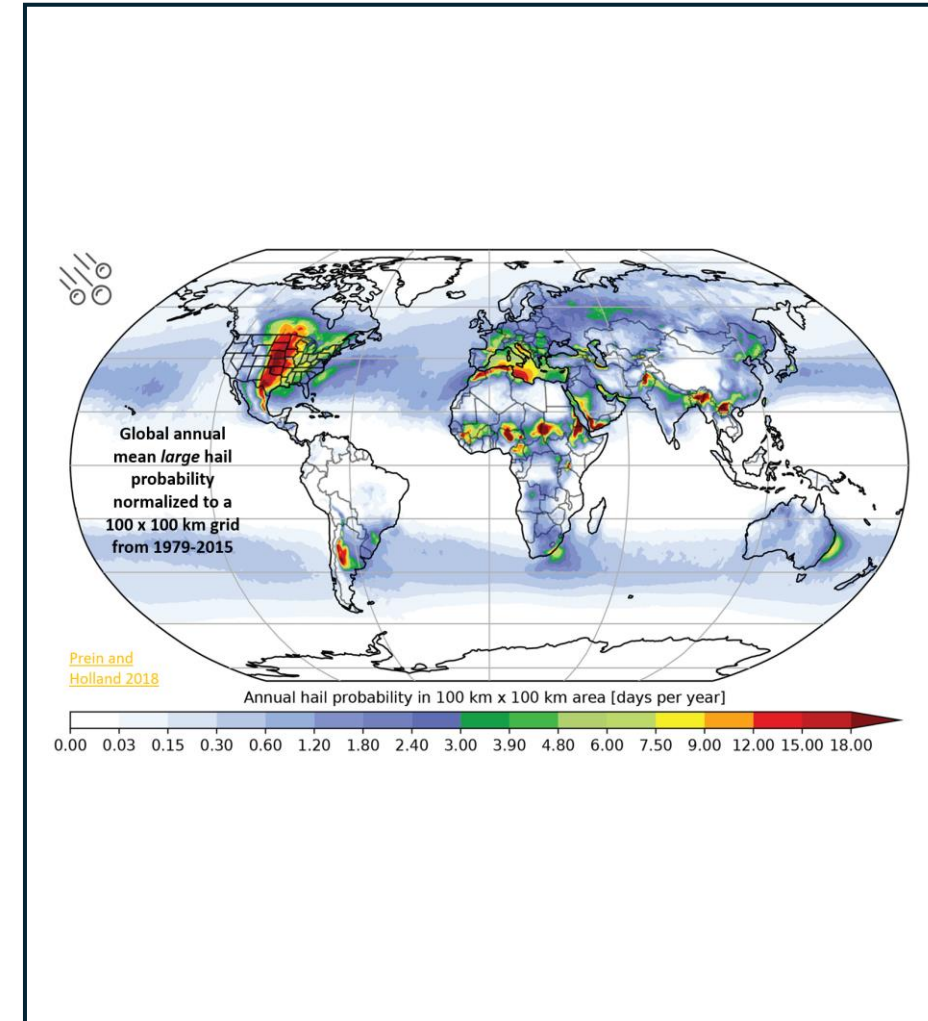
WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON



The Emerging and Escalating Challenge of SCSs

- **70%** of global insured losses driven by SCSs *(Aon)*
- SCS losses are increasing at an annual rate of **9 to 10%**, which $> 2X$ all perils *(Aon, Insurance NewsNet)*
- Last few years, **\$60bn yr⁻¹** in SCS losses with **hail** comprising over **50%** of those losses *(Insurance Information Institute, Gallagher Re)*
- **Hail** the costliest of SCSs *(Zurich)*

Is hail really a secondary peril?



Need and Relevance

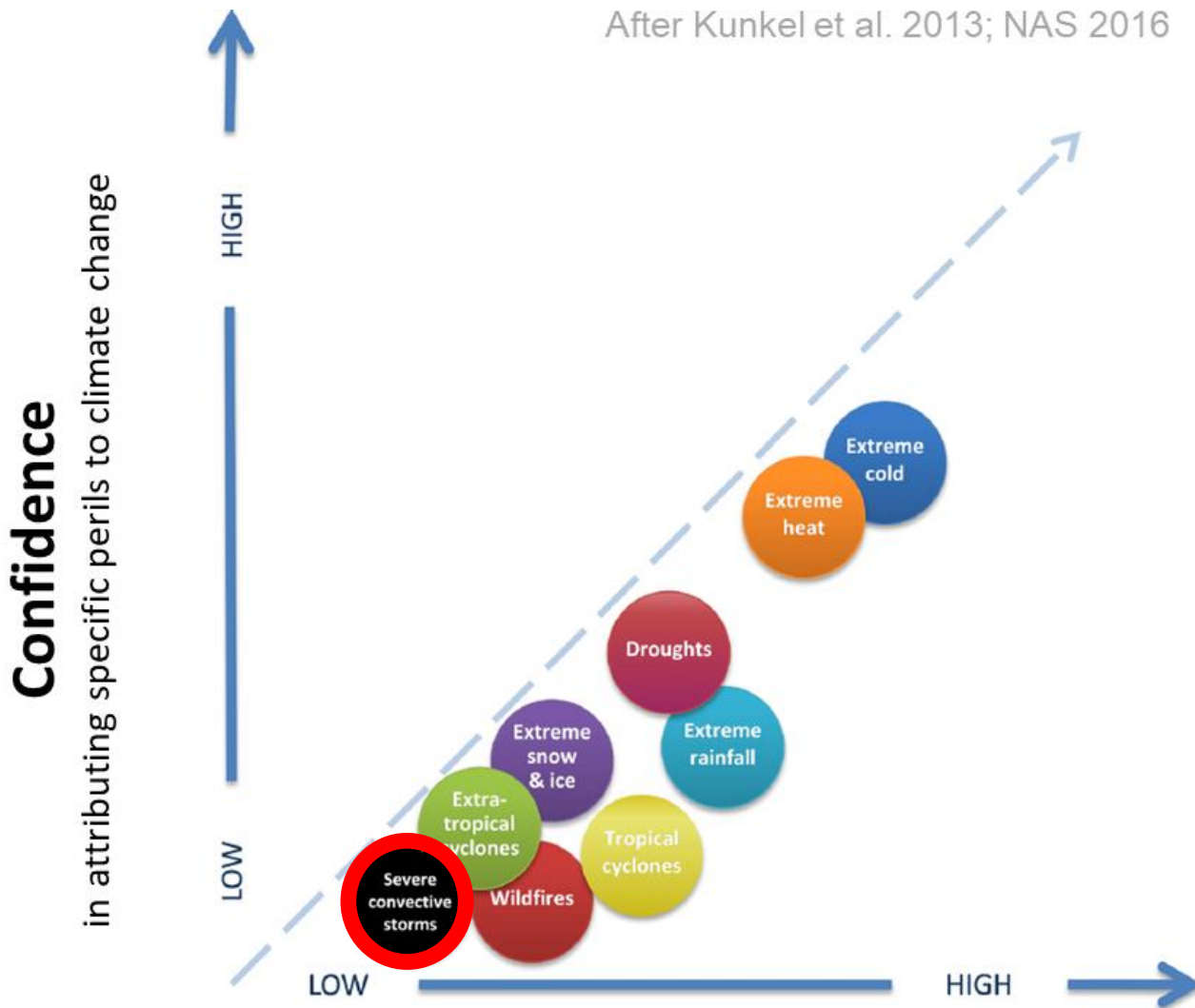
Root Causes



Need and Relevance



After Kunkel et al. 2013; NAS 2016

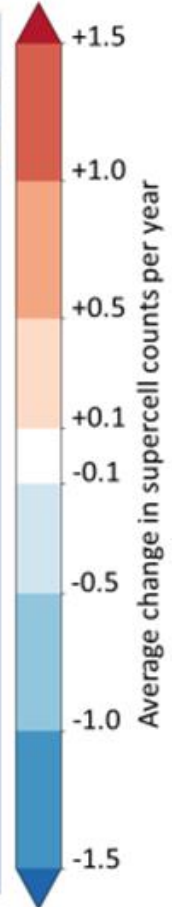
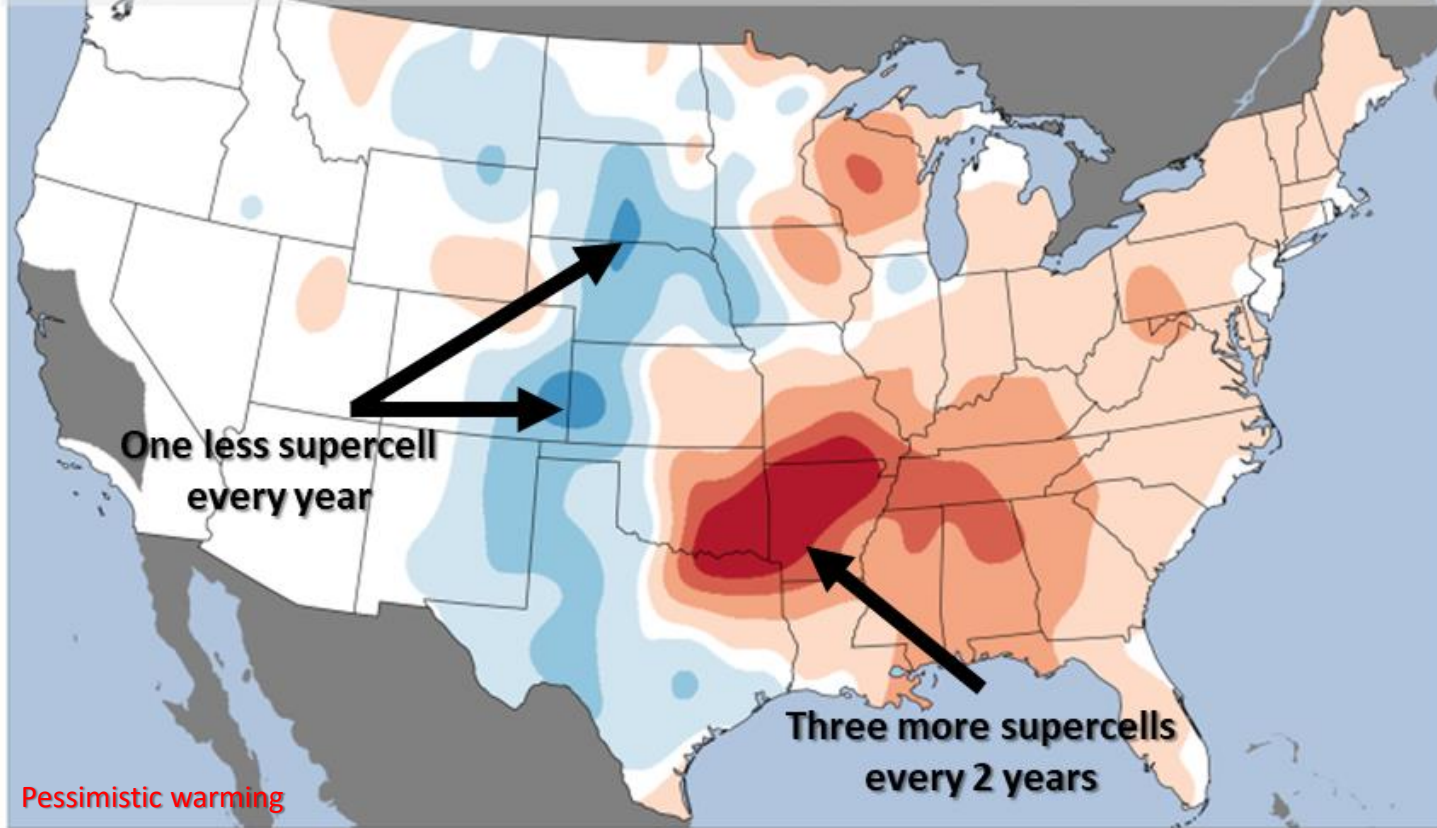


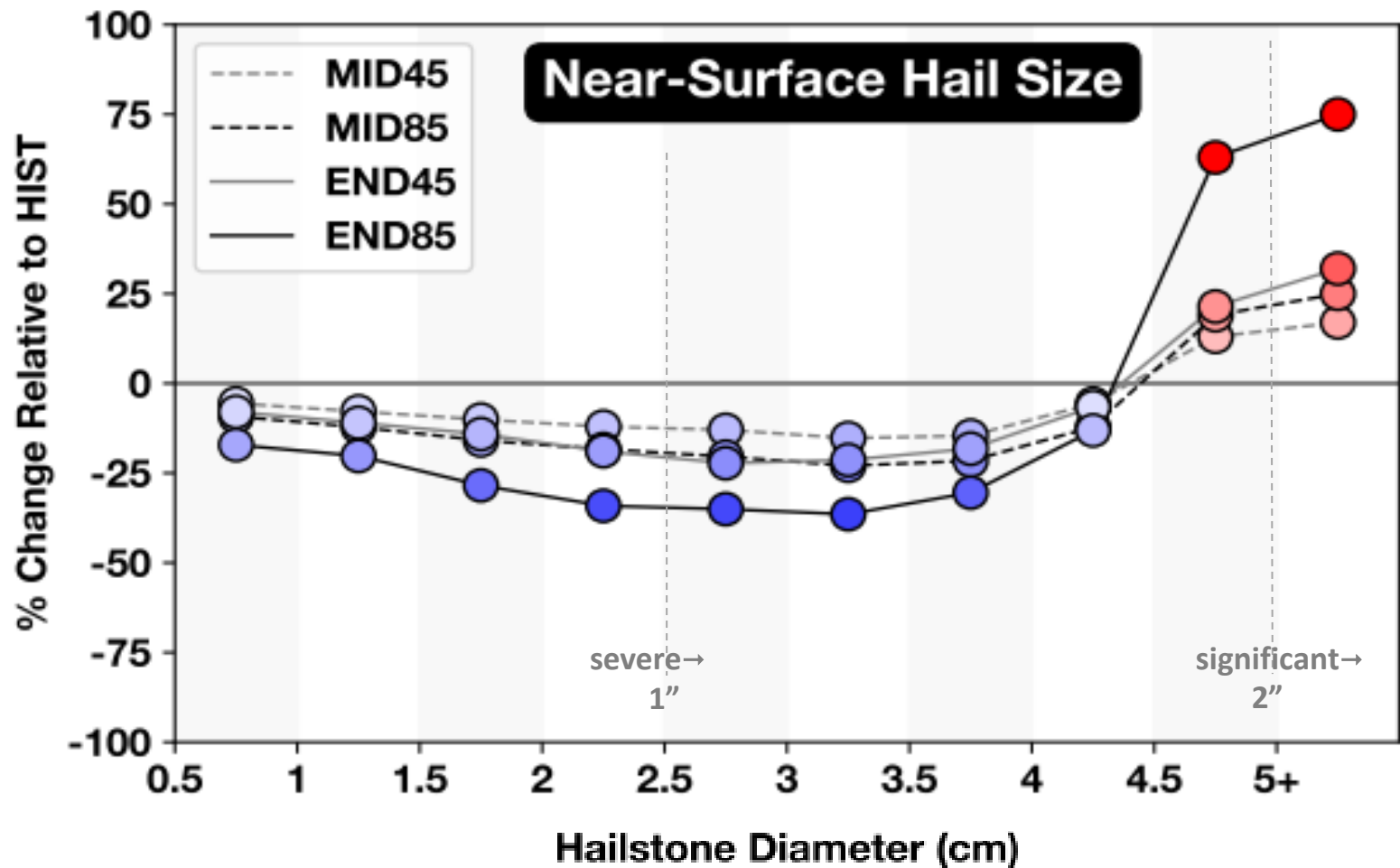
Understanding
of effect of climate change on peril type

Future of Significant Hail-producing Storms



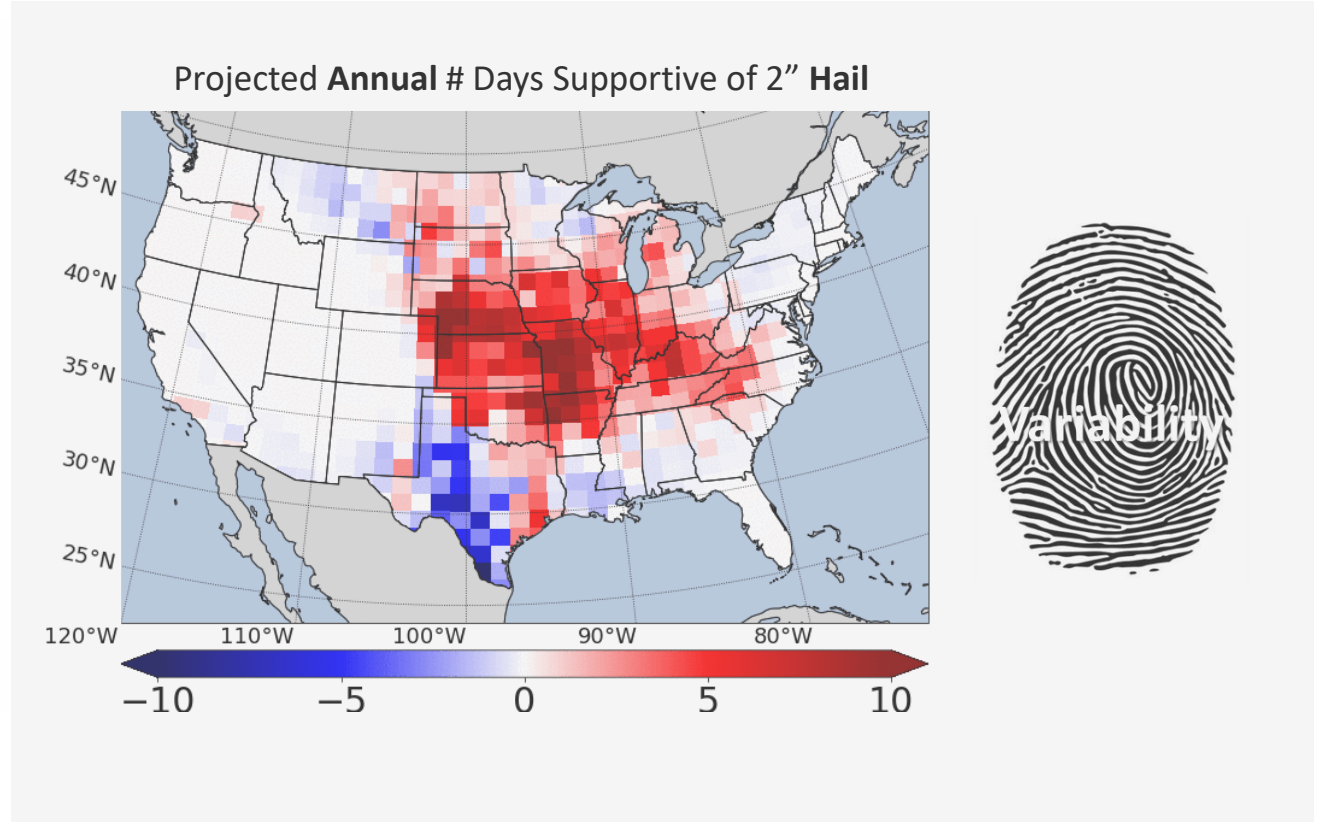
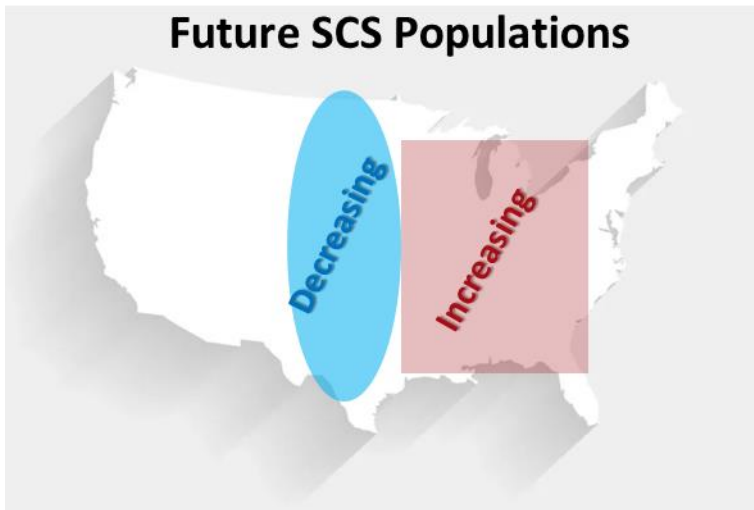
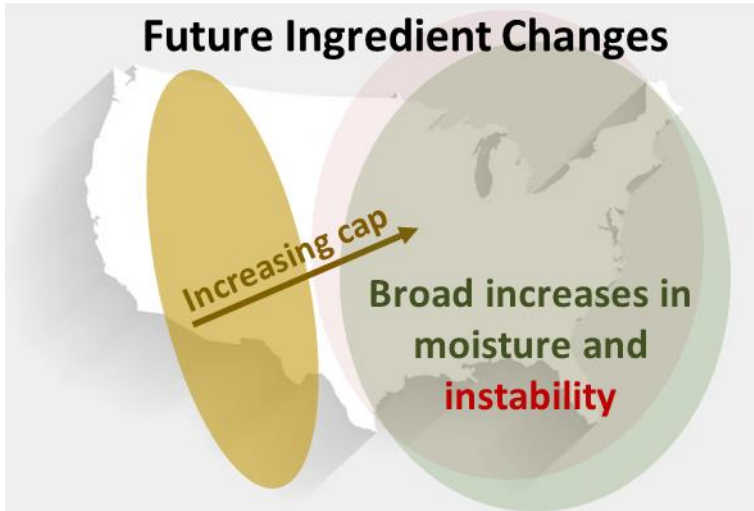
Yearly supercell counts at the end of the century (RCP 8.5) compared to present day





*Fewer small hailstones reaching the surface, with a favored distribution toward **larger** hail sizes.*

Need and Relevance



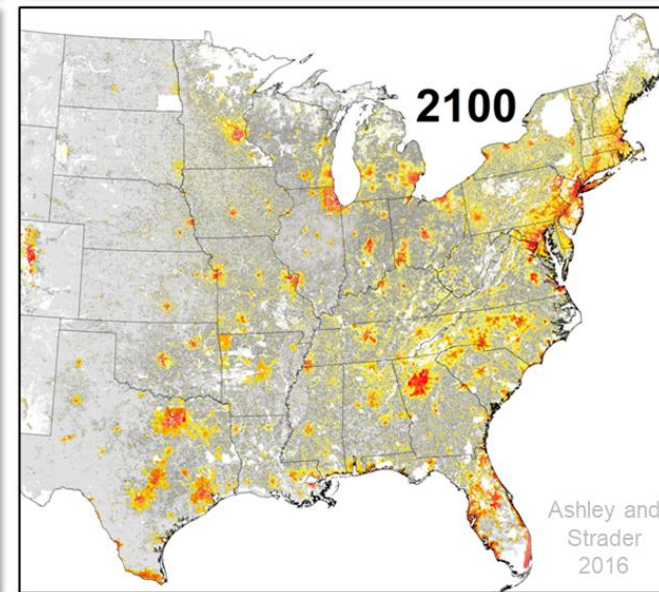
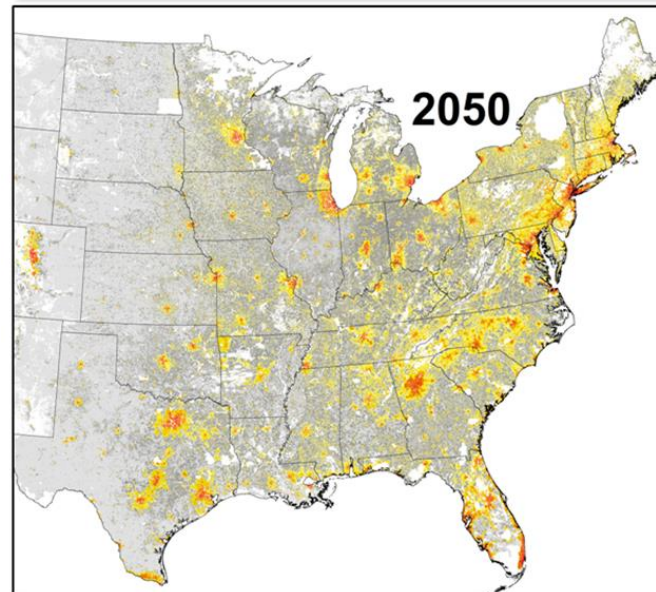
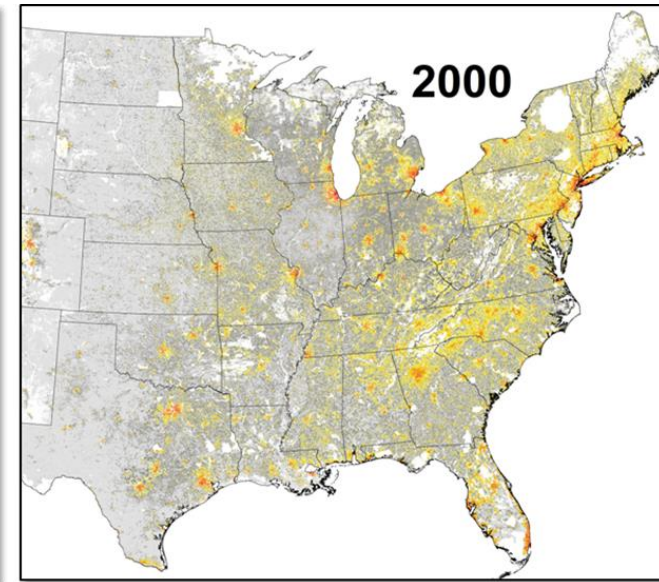
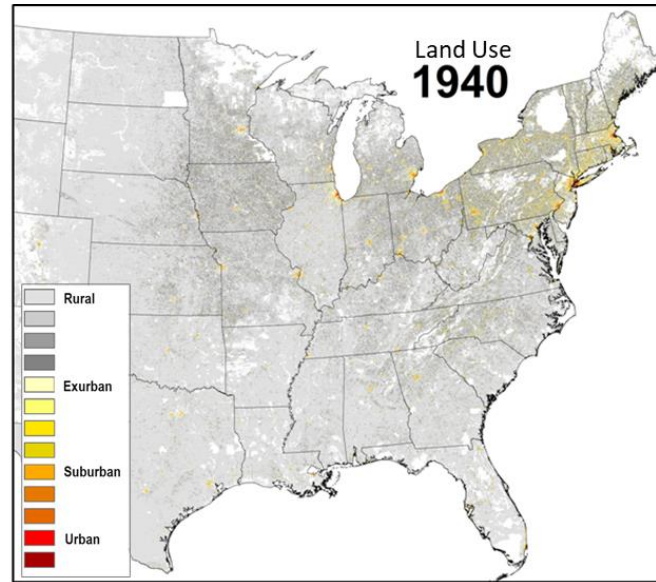
Population more than doubled the past 80 years

Since 1950, housing increased nearly 350%

Transitioned development character

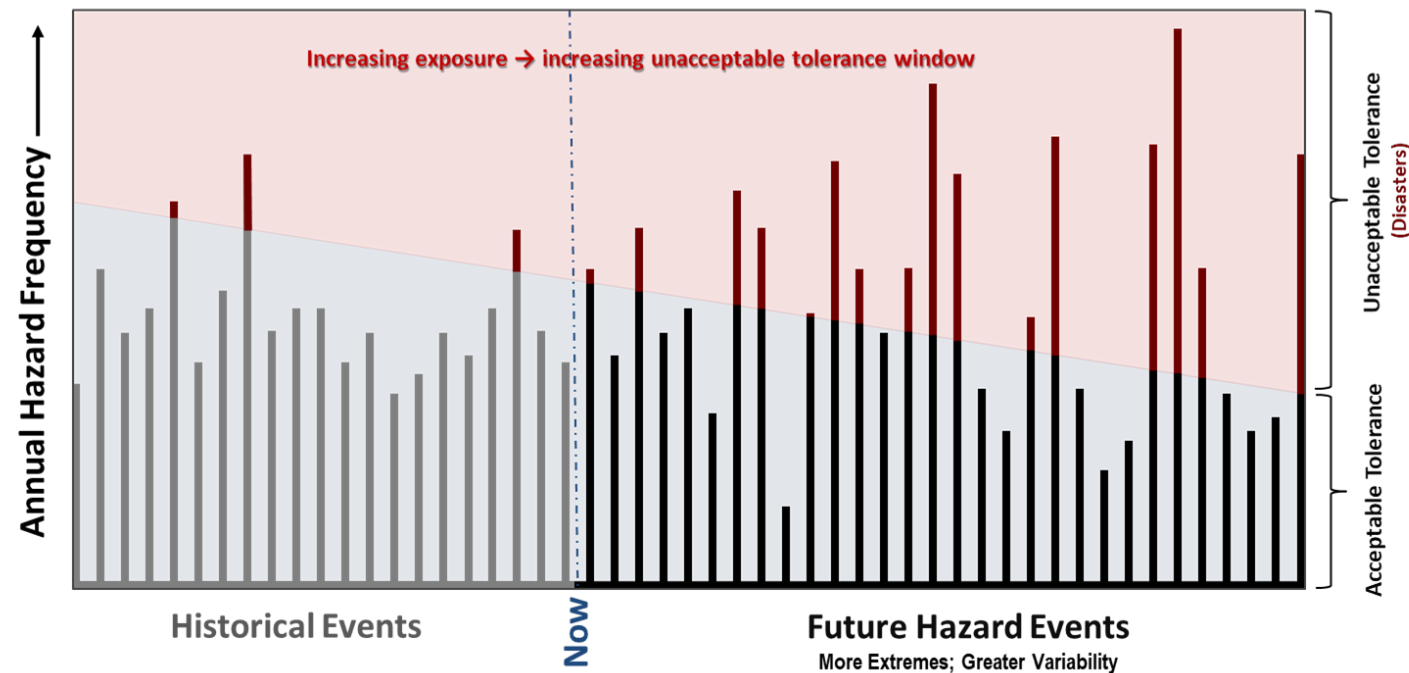
Urban footprint 5X

in 1940, 2.5% of land developed; by 2100, 18%



Project Goals

- Leverage existing (**and new!**) tools and datasets—e.g., Monte Carlo tool, observations, and simulations—to understand how the hail disaster landscape has—**and will**—change
- Explore how changes in climate system *and* built-environment will shape future hail losses **over different time horizons**



Hail Risk Menu



• Obs

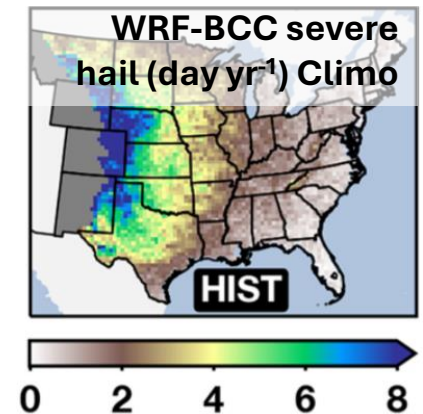
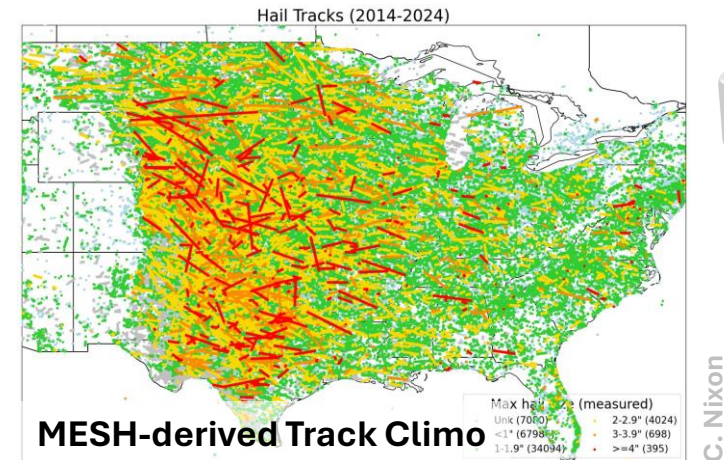
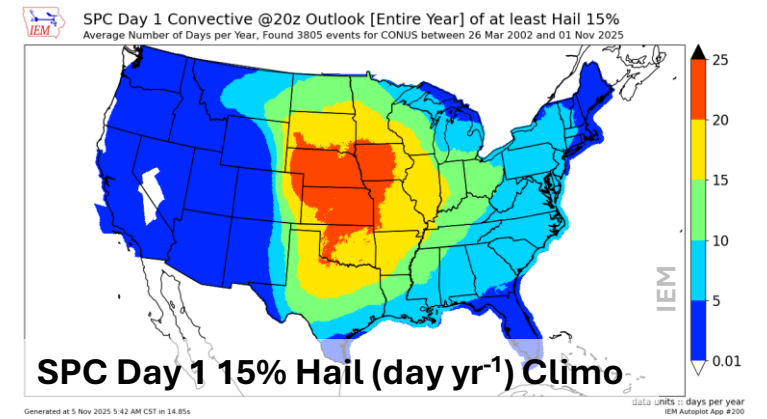
- SPC hail outlook risk climatology
- Storm Event Database / practically perfect
- MESH (Bundy and Gensini CIRCS effort)
- ICECHIP swath details

• Sim output – implicit/ingredients

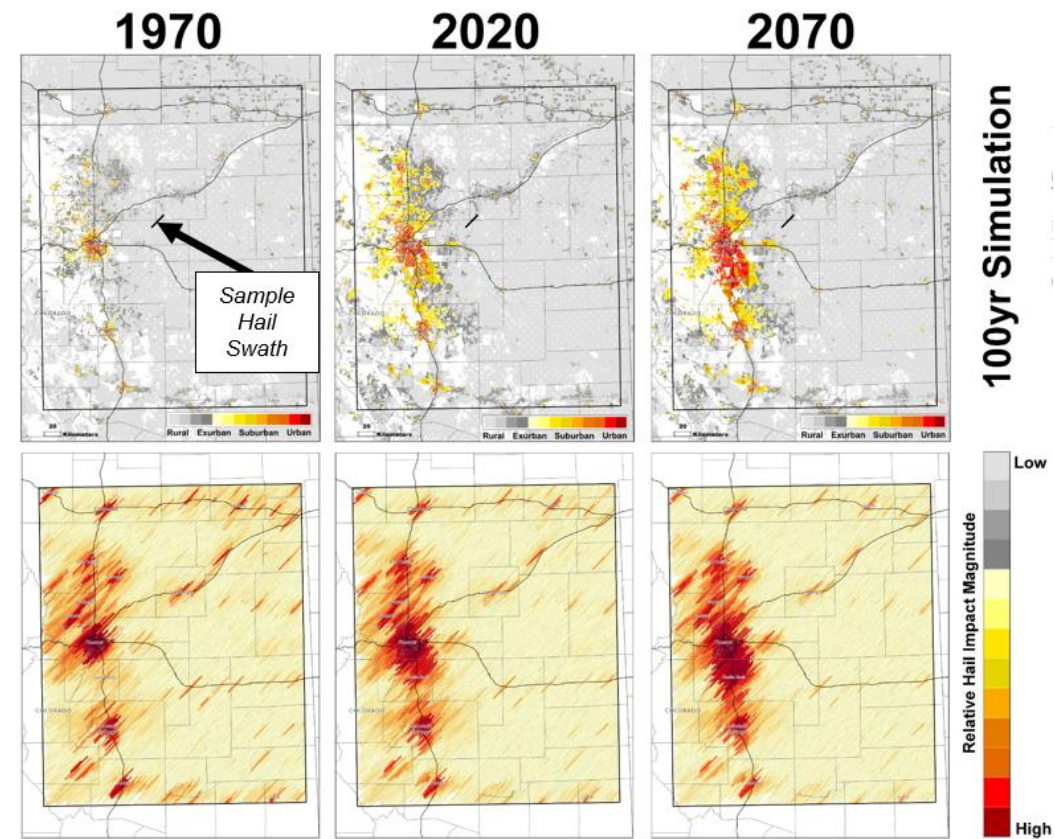
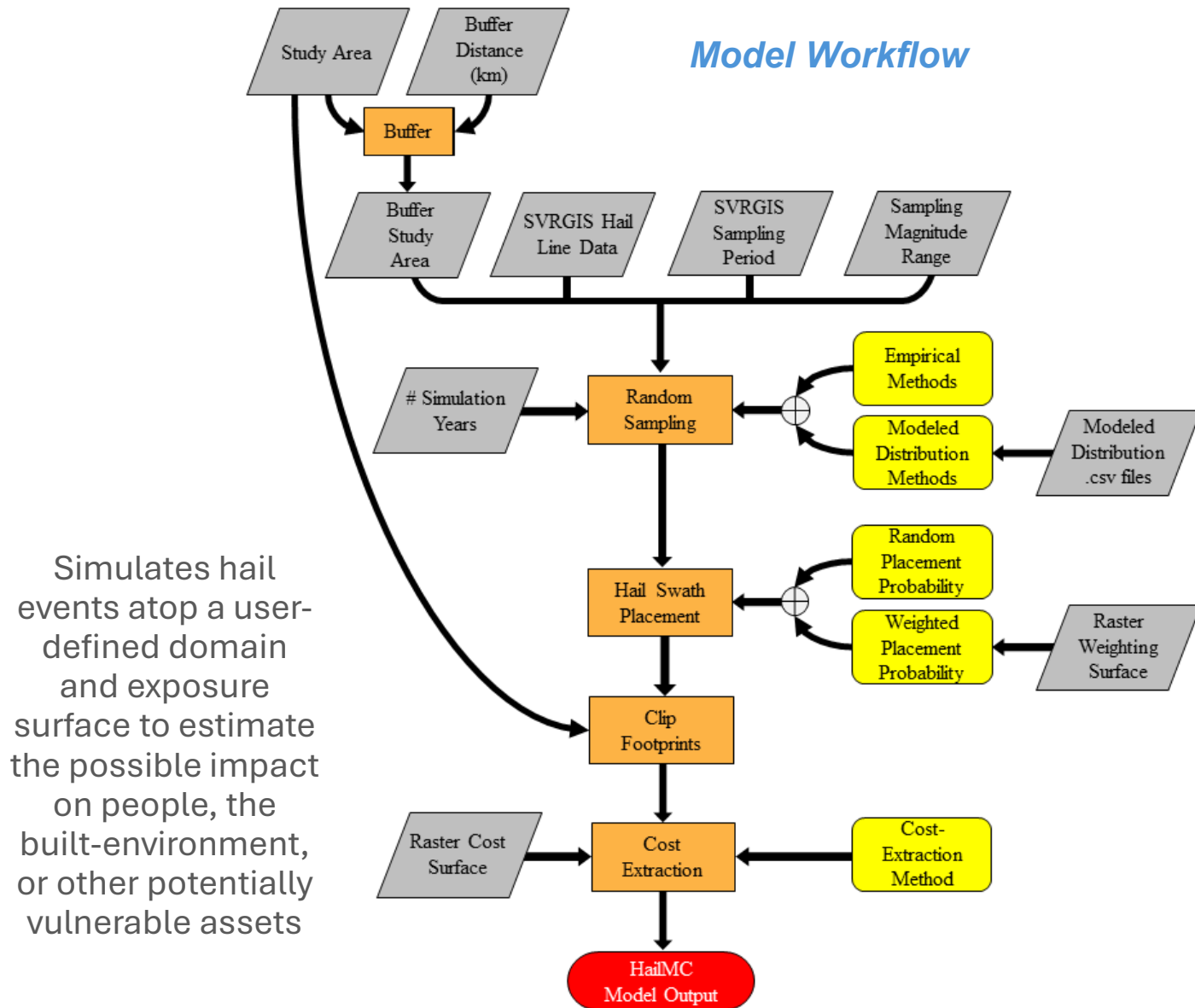
- Reanalyses: ERA5
- CMIP GCM suites
- WRF-BCC, CORDEX-NA, CONUS404

• Sim output – explicit storms/perils

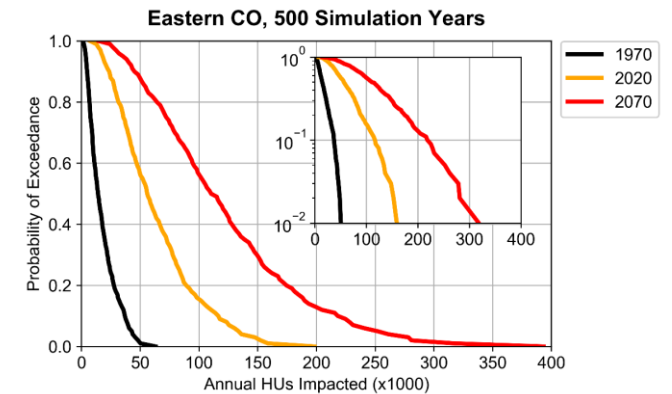
- WRF-BCC
- CONUS2 (Wright et al. CIRCS effort)
- CONUS404 / PGW
- CIRCS-specific generated simulations



Hail Impact Monte Carlo Model



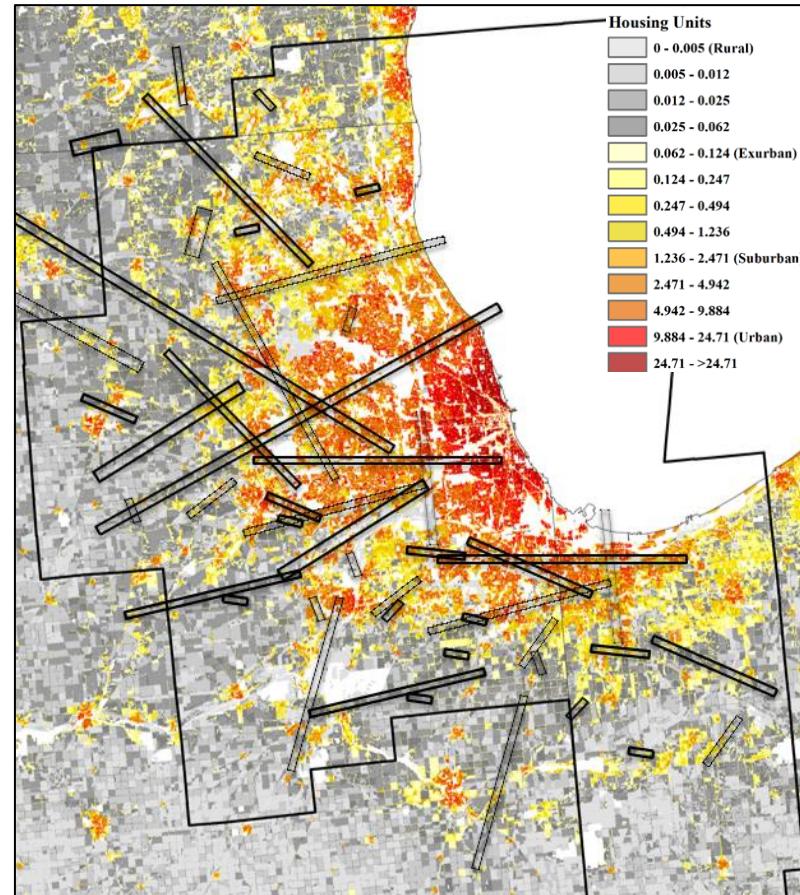
Sample HailMC sims atop housing unit density for 1970, 2020, and 2070



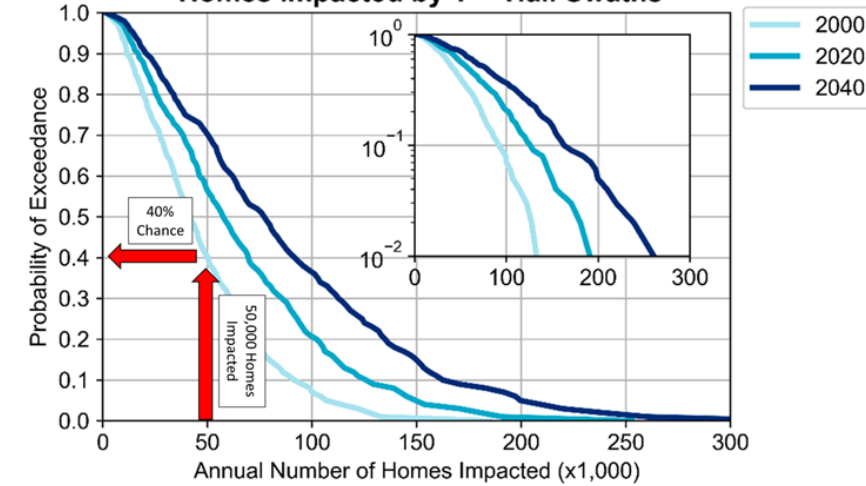
Objectives

1. Assess the influence and possible consequences of a **changing climate** on hail impact potential
2. Assess the influence and possible consequences of a **changing built-environment or other exposure surface** on hail impact potential
3. Develop a more complete understanding of how hail disasters have and may potentially change in the future

Sample Study Domain



Annual Probability of the Total Number of Homes Impacted by 1"+ Hail Swaths

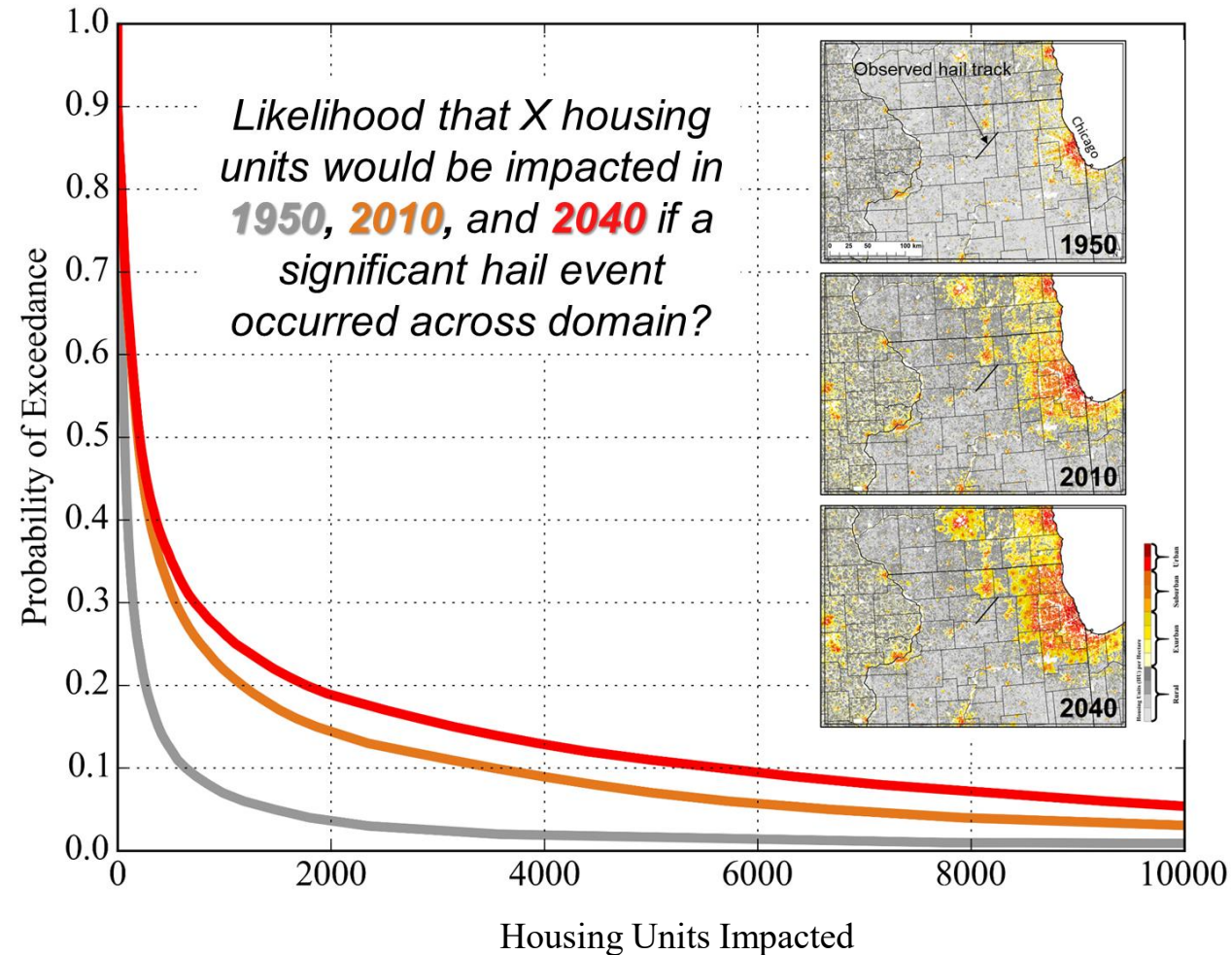


Modeled total annual number of homes (housing units; x1,000) affected by 1"+ hail swaths by development year

Impact Year	Median	Mean	Std. Dev.	95 th Percentile	99 th Percentile
2000	64.1	68.4	60.1	187.2	234.3
2020	75.9	80.5	50.8	200.9	245.7
2040	80.3	85.2	70.7	228.0	310.6

Project Outcomes and Deliverables

- **Difference:** Our focus is on **change**, not a singular slice in time; not a black box; can modify to examine user-defined hypotheticals
- **Outcomes:**
 - Employ existing datasets to assess a user's current and potential exposure should the book and/or risk change
 - Ultimately, generate a better understanding of drivers of hail losses ... i.e., **who is in the driver seat: climate or exposure?**
 - Determine geographies where hail impact potential has and will change the most
- **Products:** POE curves, maps of disaster variables, statistics on potential exposure and losses, etc. You dream it, we can deliver it.



Impact

- **Incorporate** both climate mode/change-driven effects and societal growth
 - **Quantify** future hail loss potential on a variety of exposed entities
 - **Identify** areas where resilience building efforts are in need
 - **Adjust** policies, exposure, premiums, etc., to reduce potential impacts on bottom line
-
- Future work could be expanded to other perils:
 - Tornado Impact Monte Carlo Model (TorMC)
 - Wind Impact Monte Carlo Model (WindMC)
 - Wildland Fires
 - Flooding
 - Tropical Storms



© Walker Ashley



Northern Illinois University



WISCONSIN UNIVERSITY OF WISCONSIN-MADISON



CIRCS

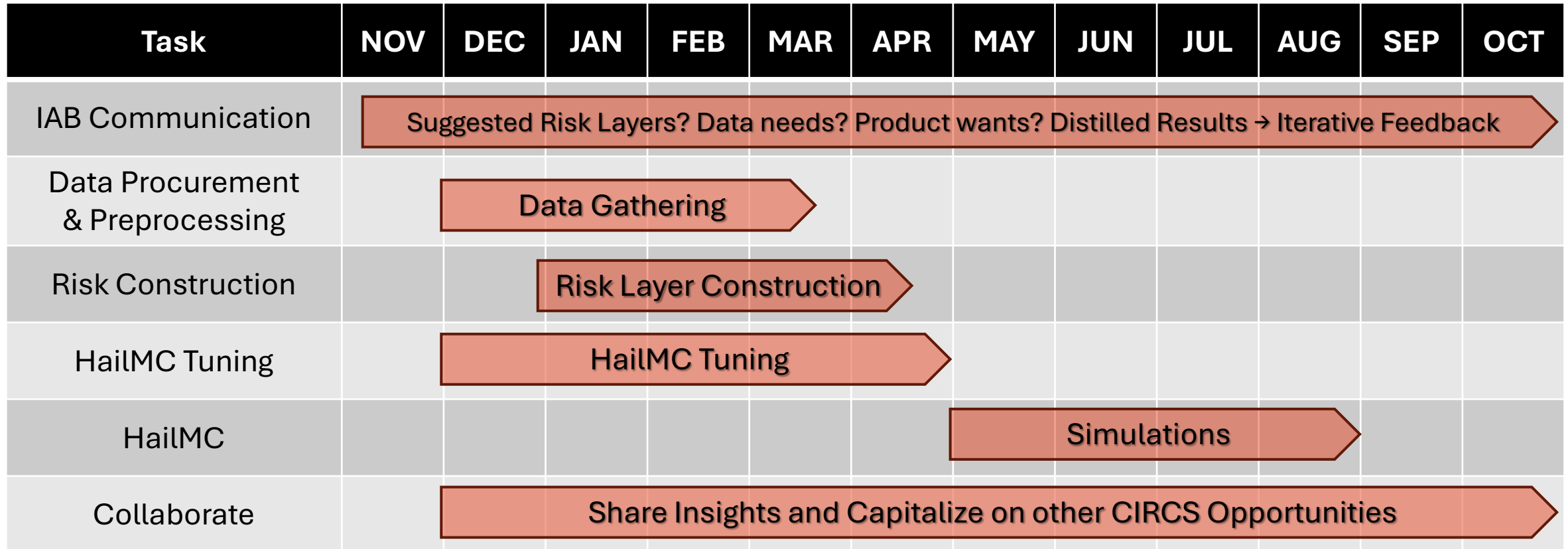


NOAA



NSF

Project Timeline



Project Budget

- **Personnel: \$120,500**

- Co-PIs Strader and Ashley (summer mo)
- NIU Ph.D. Candidate (Bundy; 12 mo)
- Villanova M.S. Student (TBD; 12 mo)
- NIU Undergraduate Students (TBD; hourly)

- **Materials and Supplies: \$30,000**

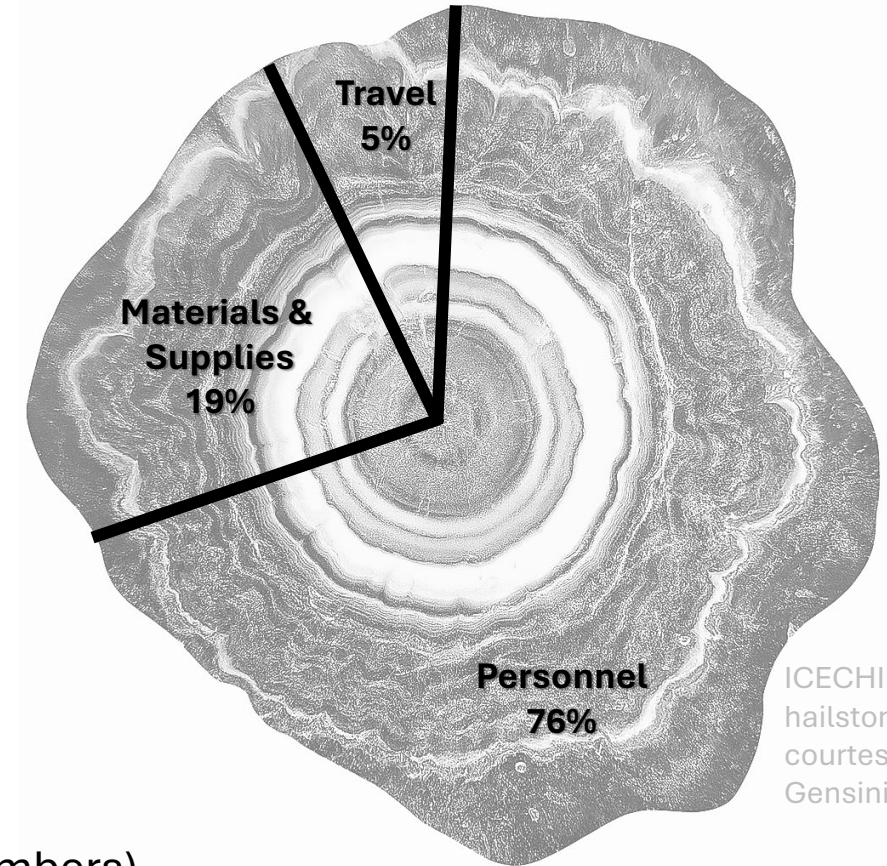
- Workstation builds
- Data storage array
- Page charges
- NIU compute time *gratis* (tens of thousands \$)

- **Travel: \$9,000**

- Workshop/professional development attendance for students
- CIRCS annual meeting attendance (all team members)
- AMS SLS Conference attendance and presentation (all team members)

- **Other: \$0**

- **Total: \$159,500**



ICECHIP
hailstone slice
courtesy of V.
Gensini