USA Hail Reporting: The Good, The Bad, and the Ugly

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COLORADO CLIMATE CENTER

NSF

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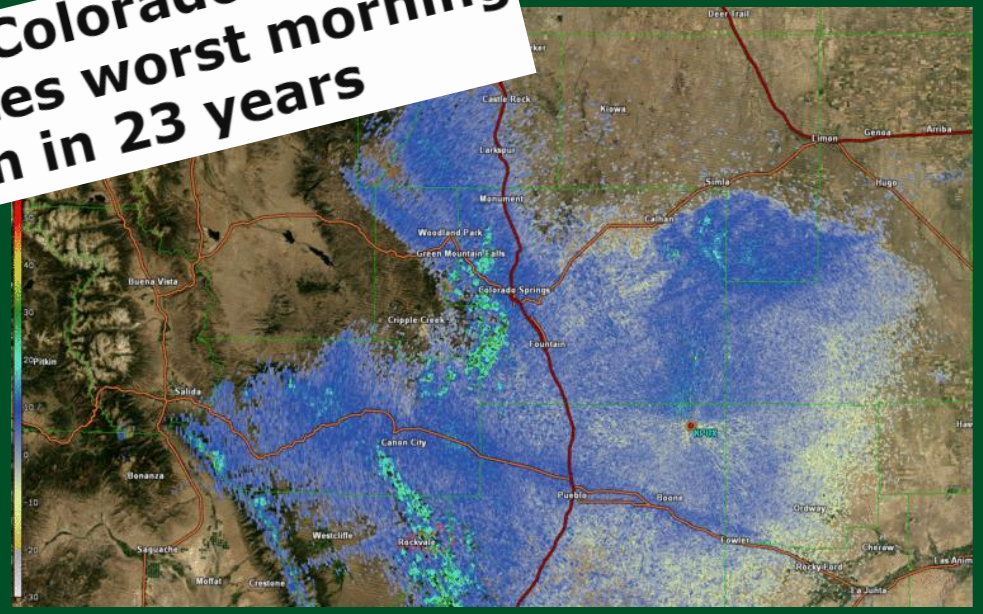
ATMOSPHERIC SCIENCE

COLORADO STATE UNIVERSITY

Southern Colorado experiences worst morning hail storm in 23 years



Denver7

It's official: Colorado has a new largest hailstone on record

Russ Schumacher

PHOTOS: Softball-sized hail pounds El Paso County causing death and damage

The Gazette

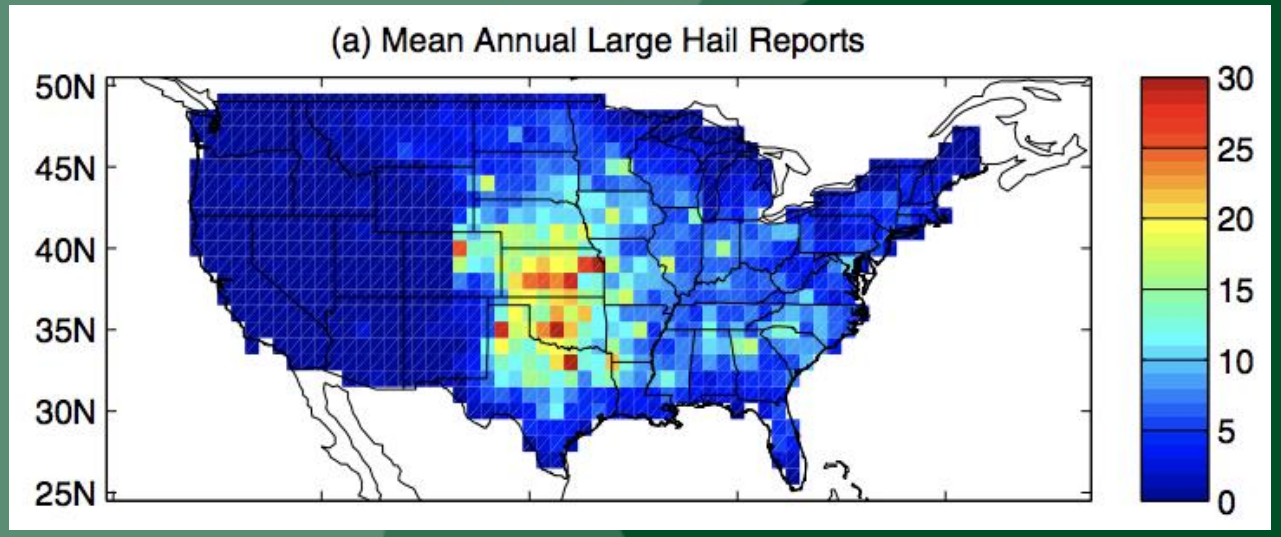
BUSINESS

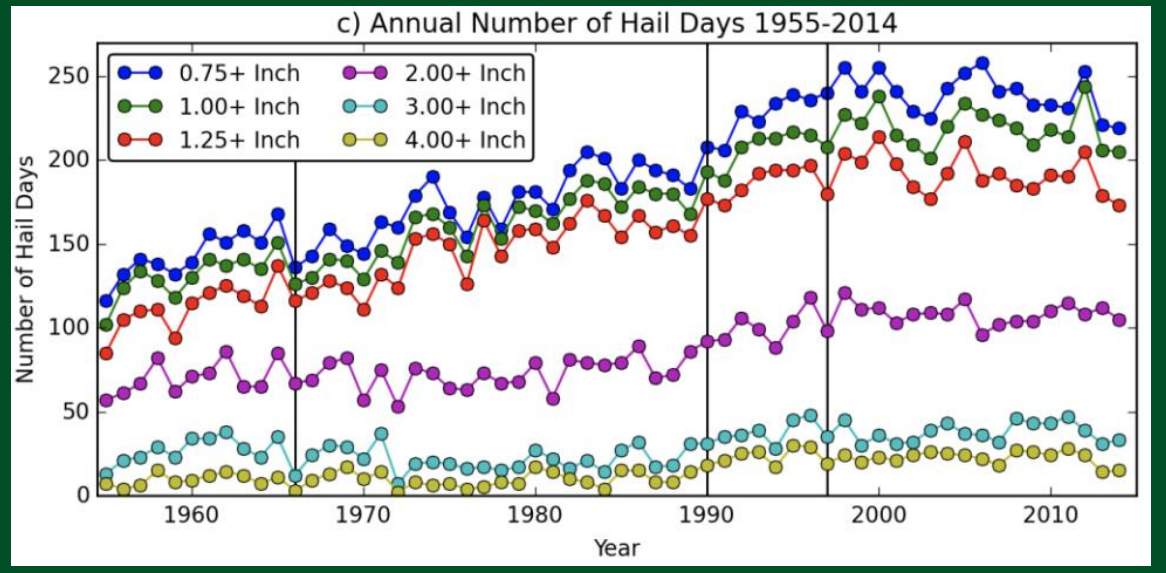
Hailstorms aren't more common in Colorado than before, they are just costing more as the state grows

Colorado has experienced three of its eight costliest hail storms in the last three years

The Good

- The U.S. has the densest and most complete database for hail (and other hazards) in the world with >150,000 reports in official Storm Prediction Center database for 1.0”+ since 1997





Allen and Tippett (2015)

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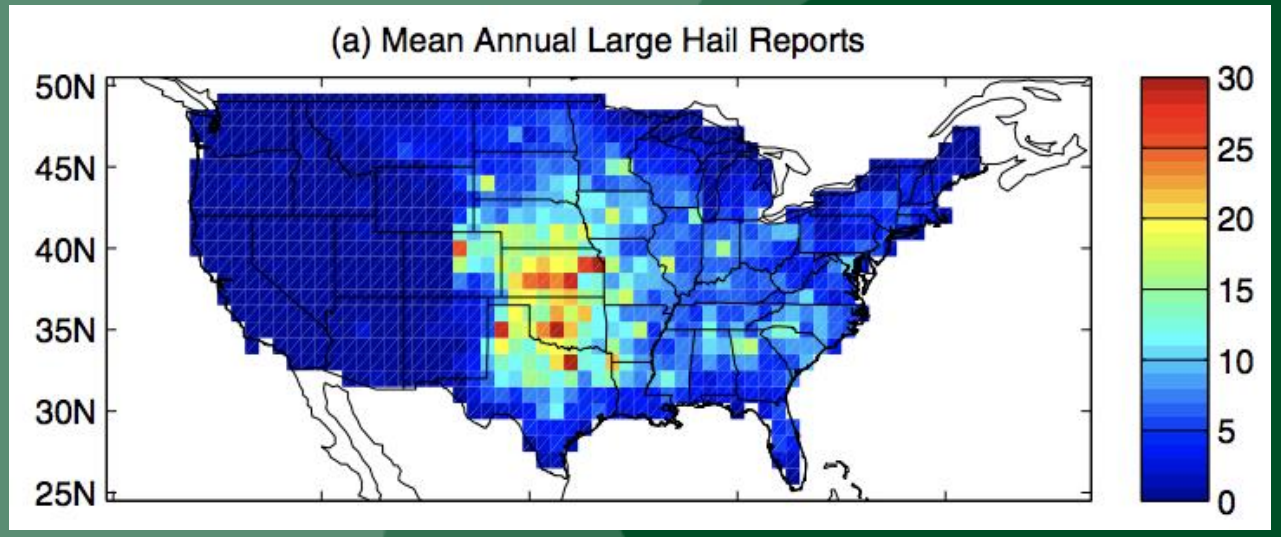
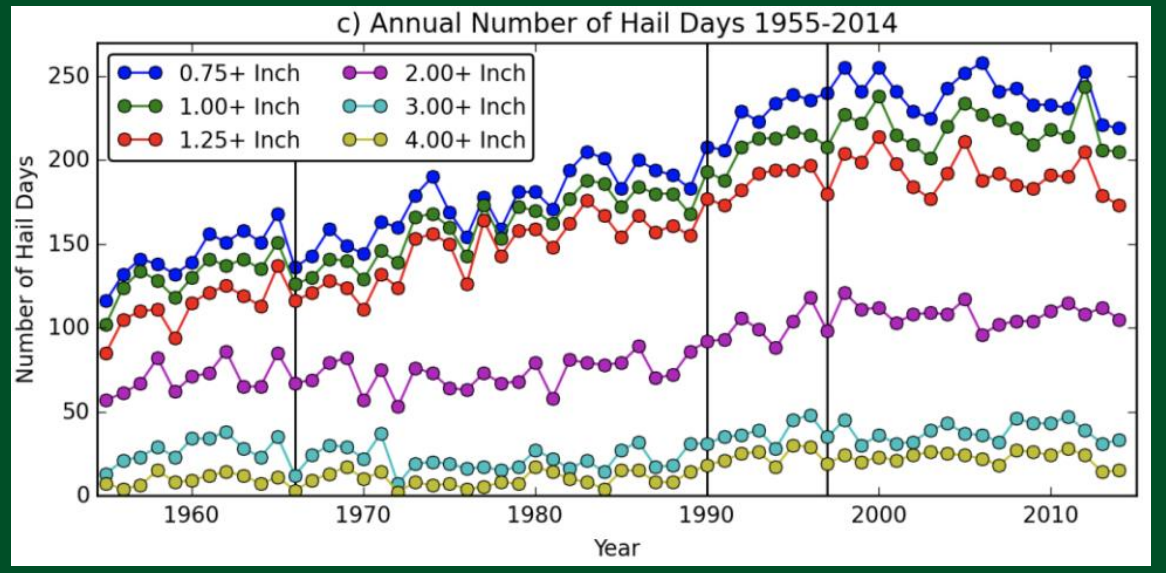
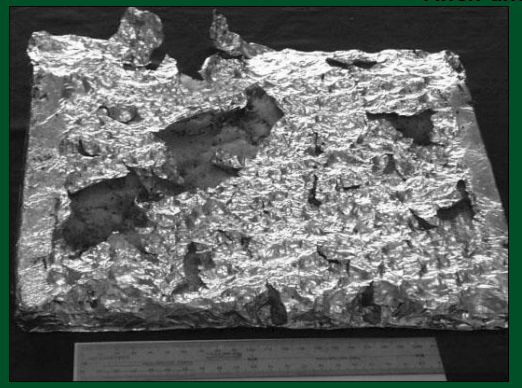




Allen and Tippett (2015)

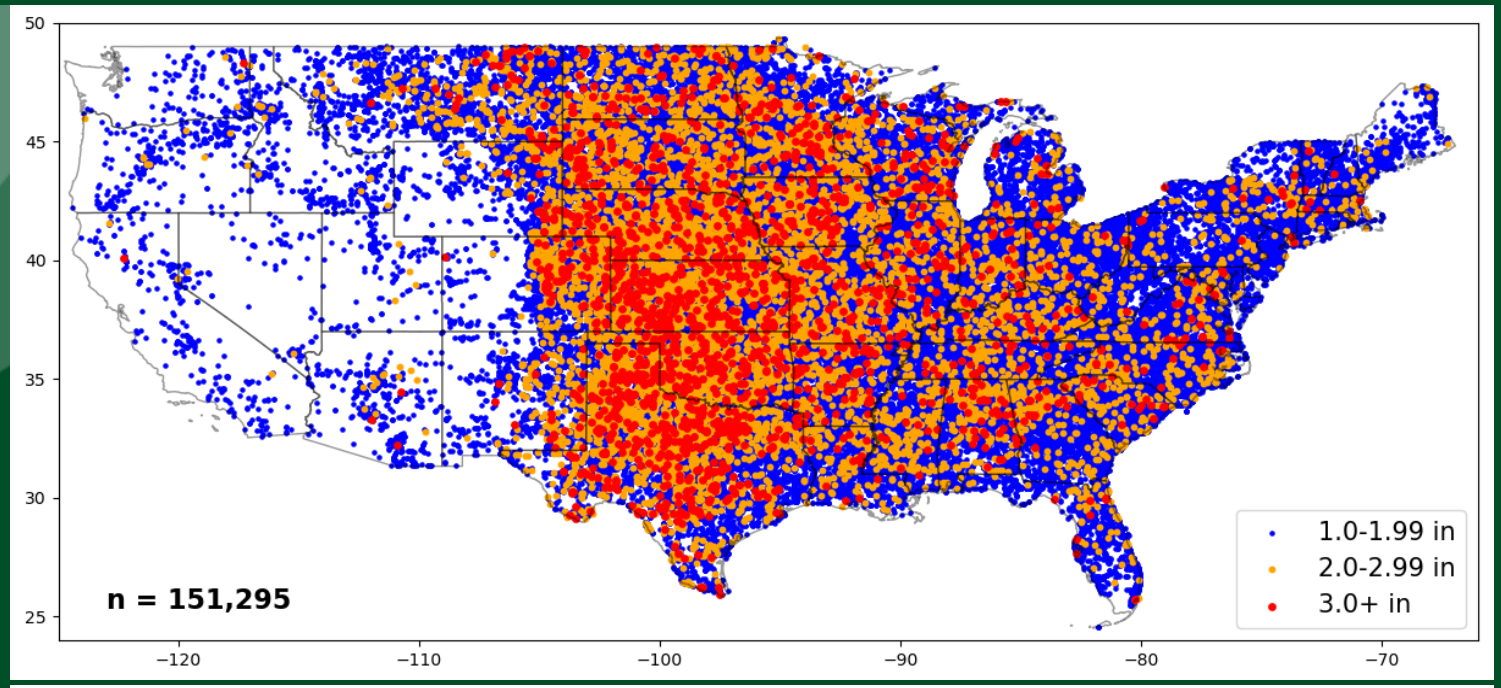
- CoCoRaHS is becoming another large database of hail reports, especially for sub-severe hail

- >40,000 hail reports with 4,500 hail pad photos since 1998

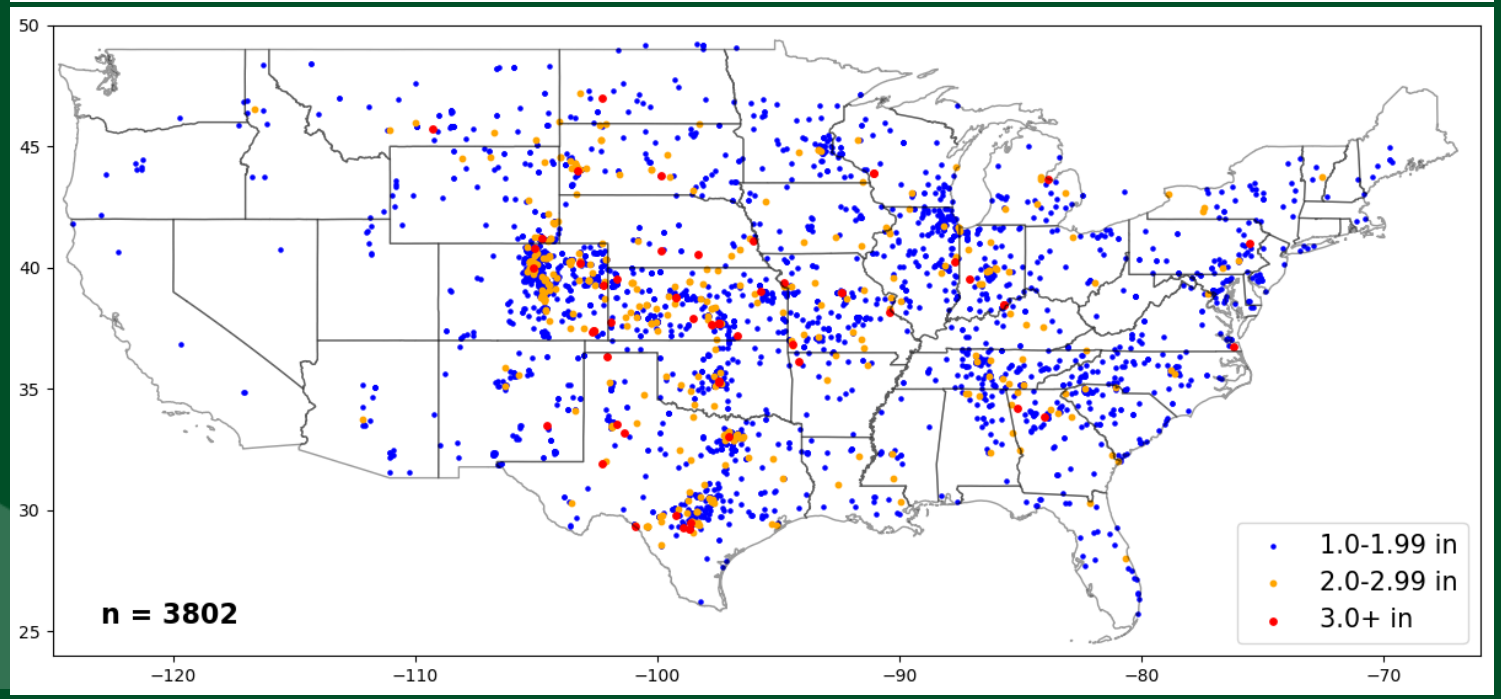


The Good

SPC (1997-2018)



CoCoRaHS (1998-2019)
1.0”+



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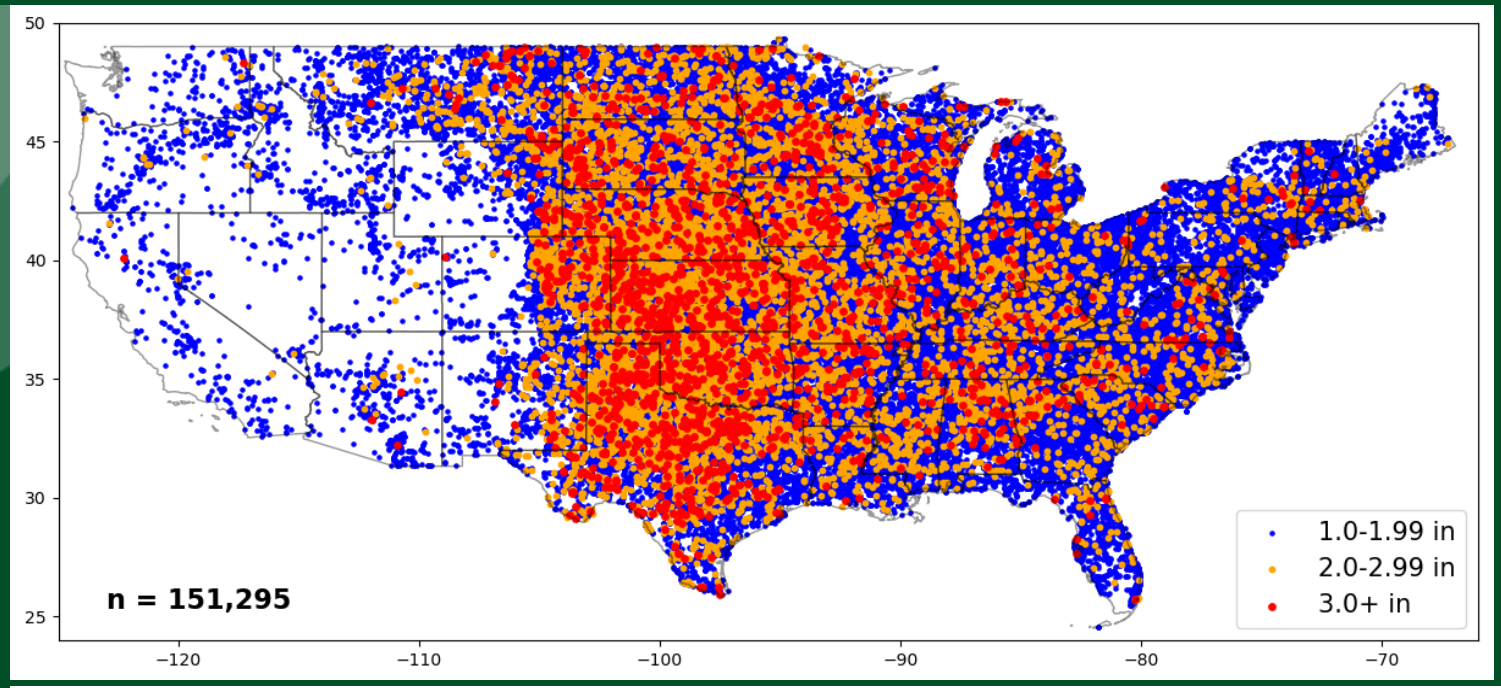
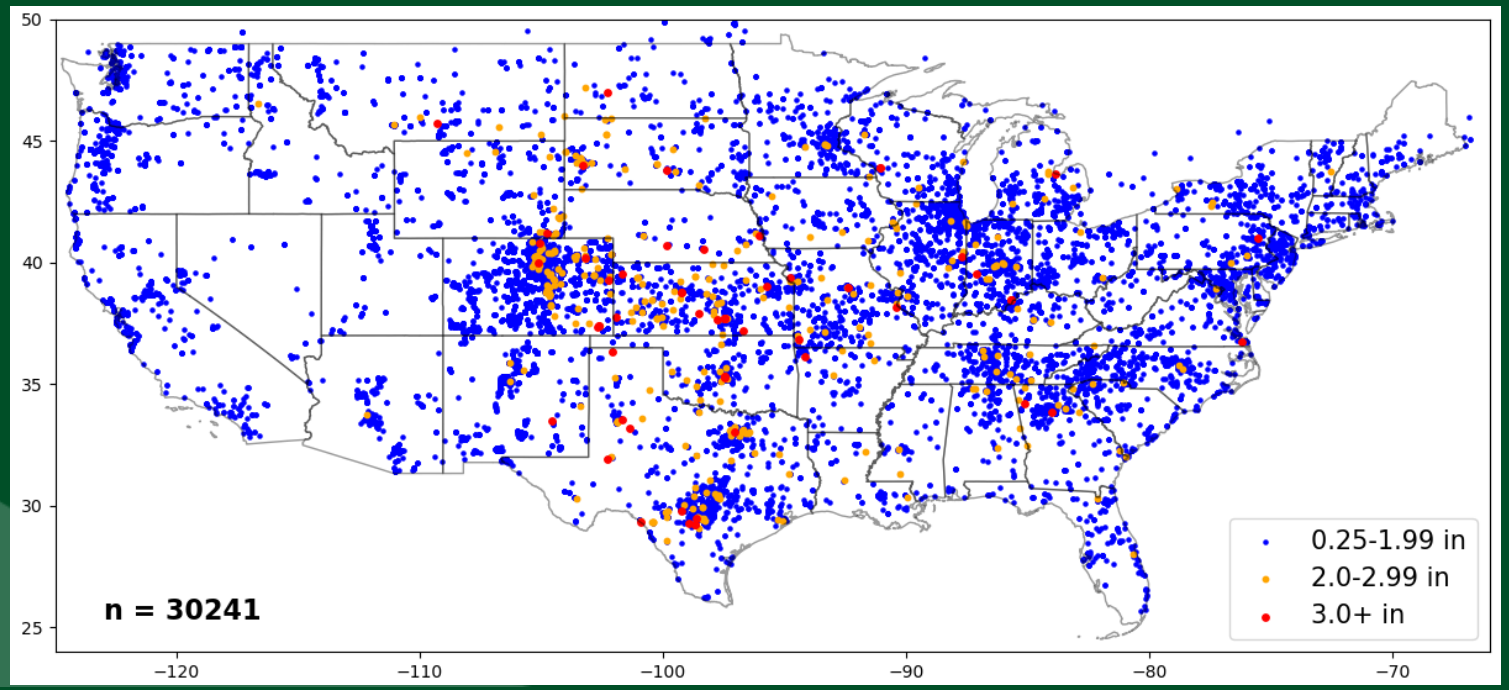
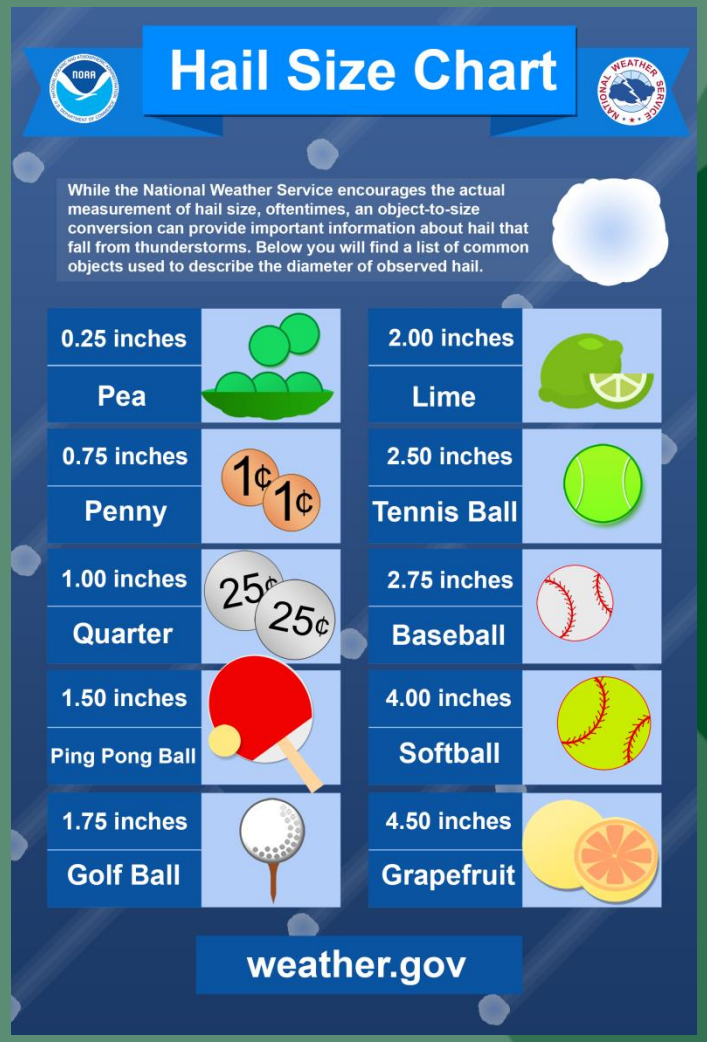


CoCoRaHS (1998-2019)
0.25”+



The Bad

Size Sorting



- SPC data has strong bias toward reference objects
- People generally do not use a ruler or caliper when making measurements
- Field projects such as SHAVE (Ortega et al. 2009) and HailSTONE (Blair et al. 2017) took effort to measure hail with precision
- CoCoRaHS can help by providing caliper measurements

The Bad

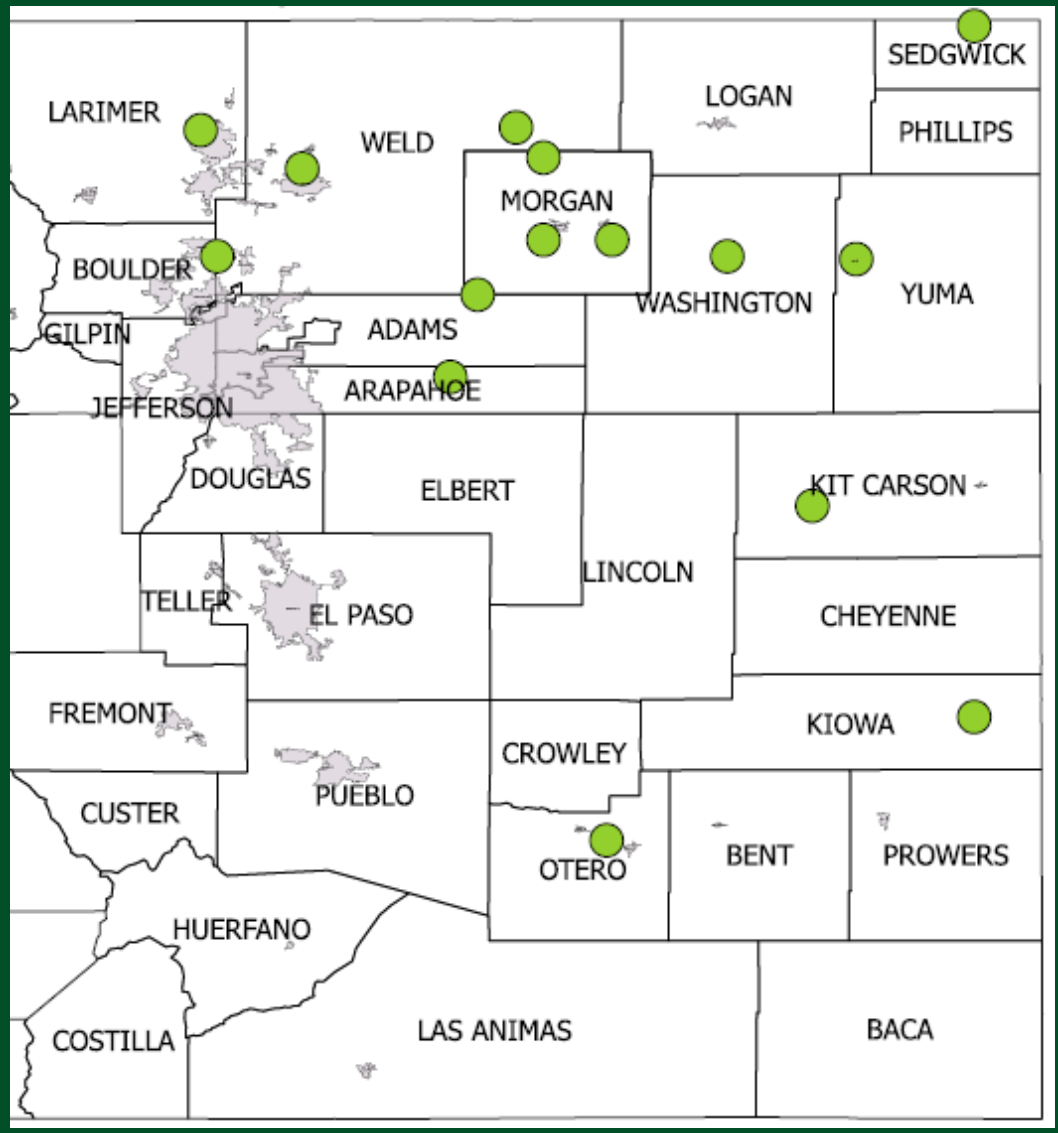
"Severe" threshold

- "Severe" hail increased from 0.75" to 1.0" by National Weather Service in 2010 after stakeholders and media suggest that hailstones smaller than 1.0" pose too small a risk to property and society

"It's not necessarily the size of the stone that matters. It's the amount of them and how hard they are."
~ Interviewee #6

"The ones that have the winds with them . . . are the ones that seem like they do the most damage. [It] can be smaller hail, the size of a dime or pea-sized but boy, if the wind there is with it, it destroys things fast. You can have bigger ones that are, you know, come straight down and they don't do near the damage." ~ Interviewee #15

Farmer Interviews



Childs et al. (2020b, accepted)

The Bad

Reporters

- Trained spotters and public often overlap and may not be trained in the same way
- A few CoCoRaHS reports get into the SPC database
- Public reports often come with a picture, but doesn't get logged as 'social media'

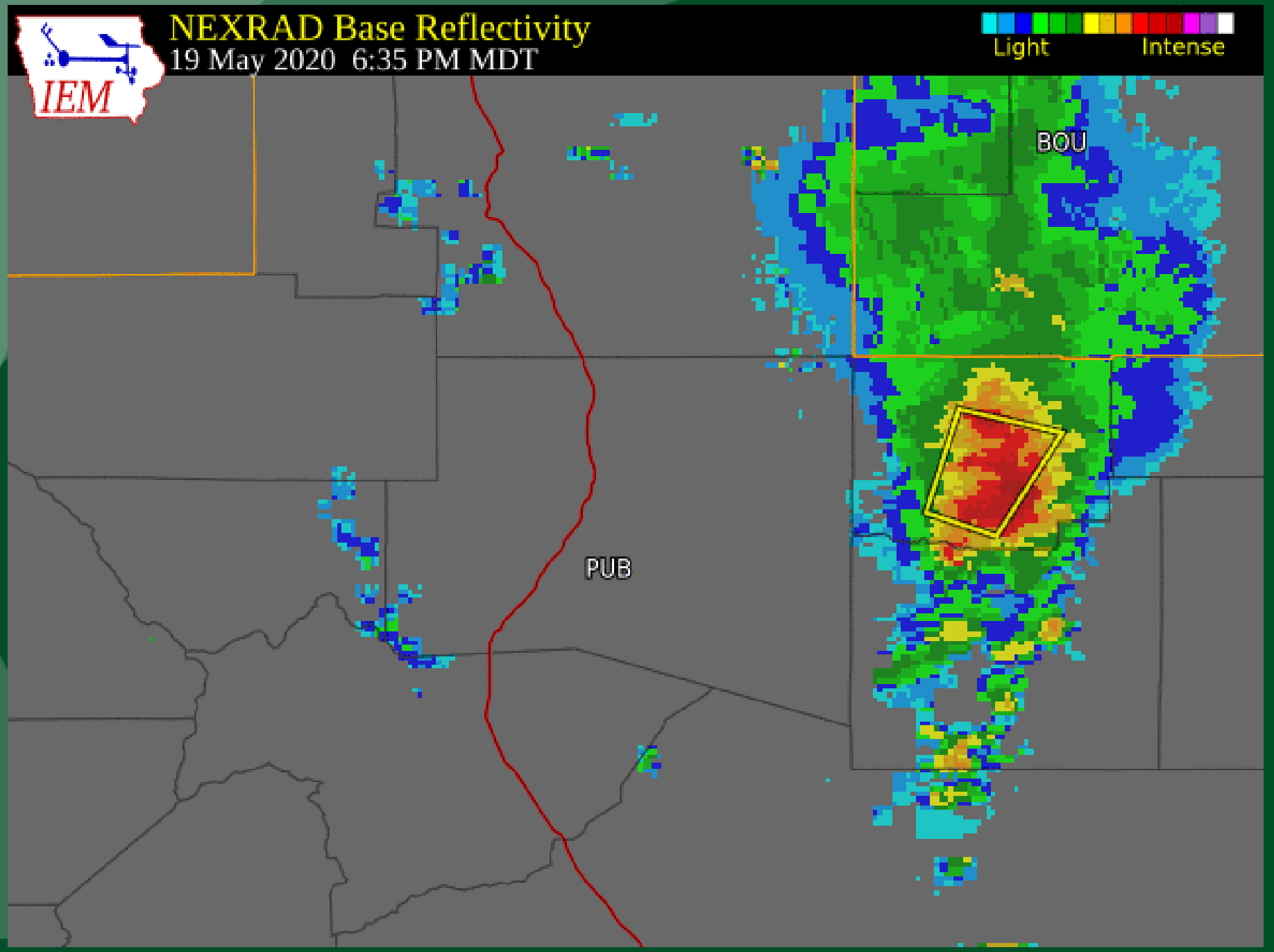
Colorado Severe Hail Source Reports (1998-2017)

SOURCE CATEGORY	INCLUDED CATEGORIES	REPORTS	%
Trained Spotter	Trained Spotter	3550	66.4%
Public	General Public	665	12.4%
Unknown	Unknown (Missing)	238	4.5%
Law Enforcement	Law Enforcement	154	2.9%
Storm Chaser	Storm Chaser	149	2.8%
Amateur Radio	Amateur Radio	143	2.7%
NWS Emplovee	NWS Emplovee (Off Duty)	112	2.1%
CoCoRaHS/SHAVE	CoCoRaHS, SHAVE Project	81	1.5%
Emergency Management	911 Call Center, Emergency Manager	76	1.4%
Weather Stations	ASOS, AWOS, COOP Observer, COOP Station, Mesonet	65	1.2%
Broadcast Media	Broadcast Media	39	0.7%
Government Official	County Official, Government Official, State Official	18	0.3%
NWS Storm Survey	Official NWS Observations	15	0.3%
Fire/Rescue	Fire Department/Rescue	12	0.2%
Federal Agencies	Department of Highways, Other Federal Agency, Park/Forest Service, Post Office	12	0.2%
Newspaper	Newspaper	9	0.2%
Social Media	Social Media	7	0.1%

Childs and Schumacher (2018)

The Ugly

Population Bias



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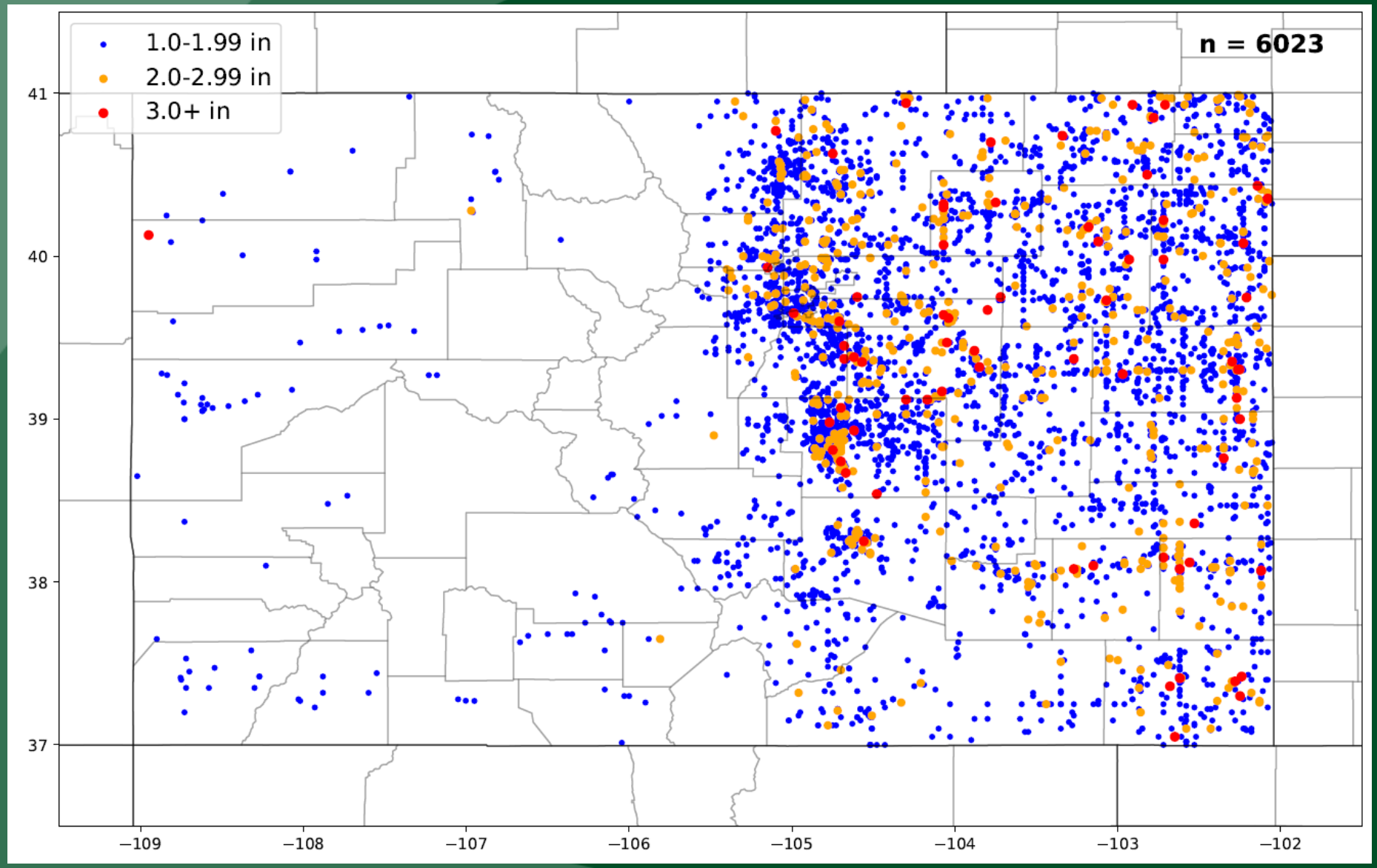
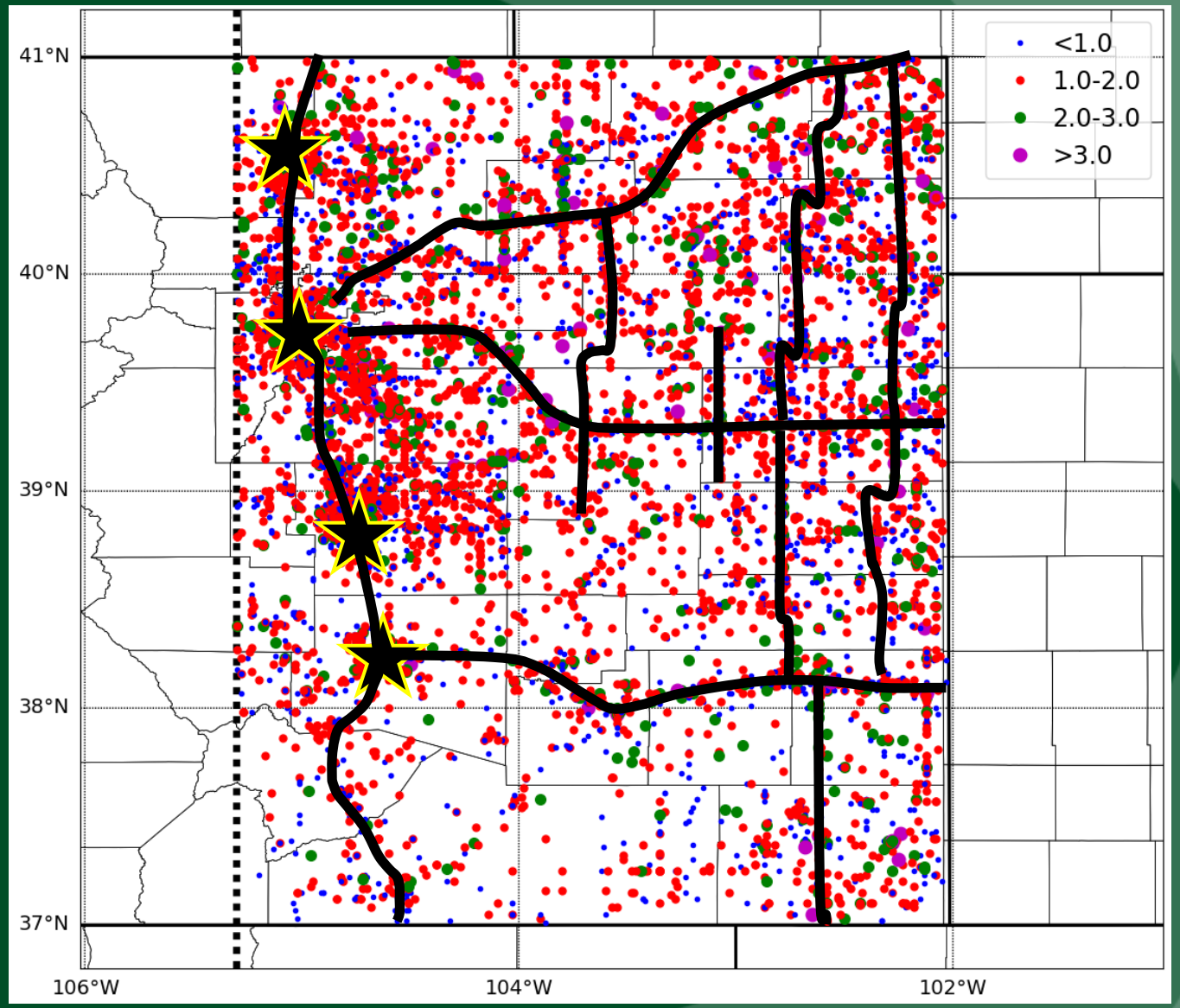


The Ugly

Population Bias

- Hail reports highly correlated to population centers, major roadways



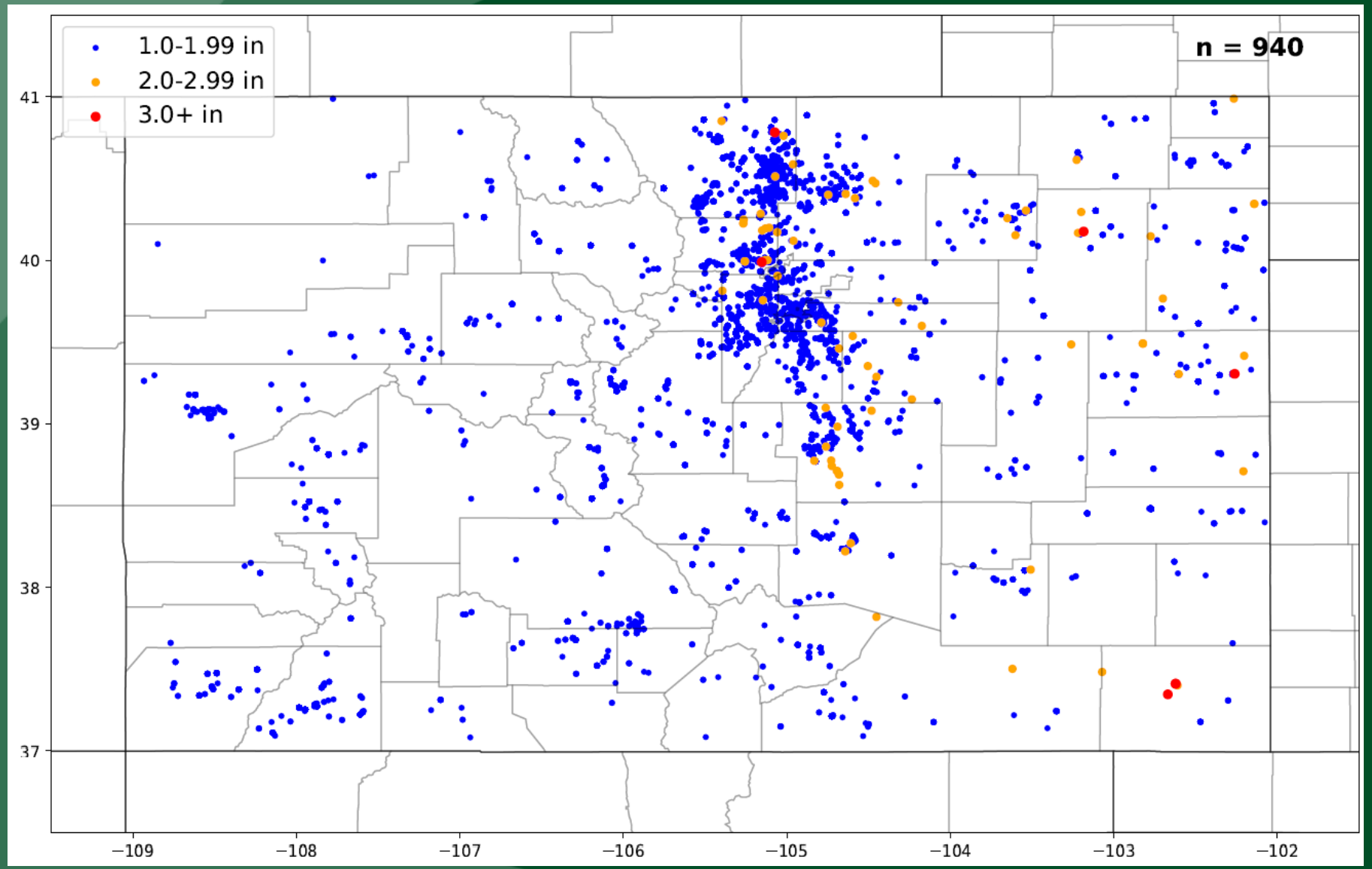
Childs and Schumacher (2018)

The Ugly

Population Bias

- Much fewer reports in eastern Plains, more in western CO

CoCoRaHS (1998-2019)



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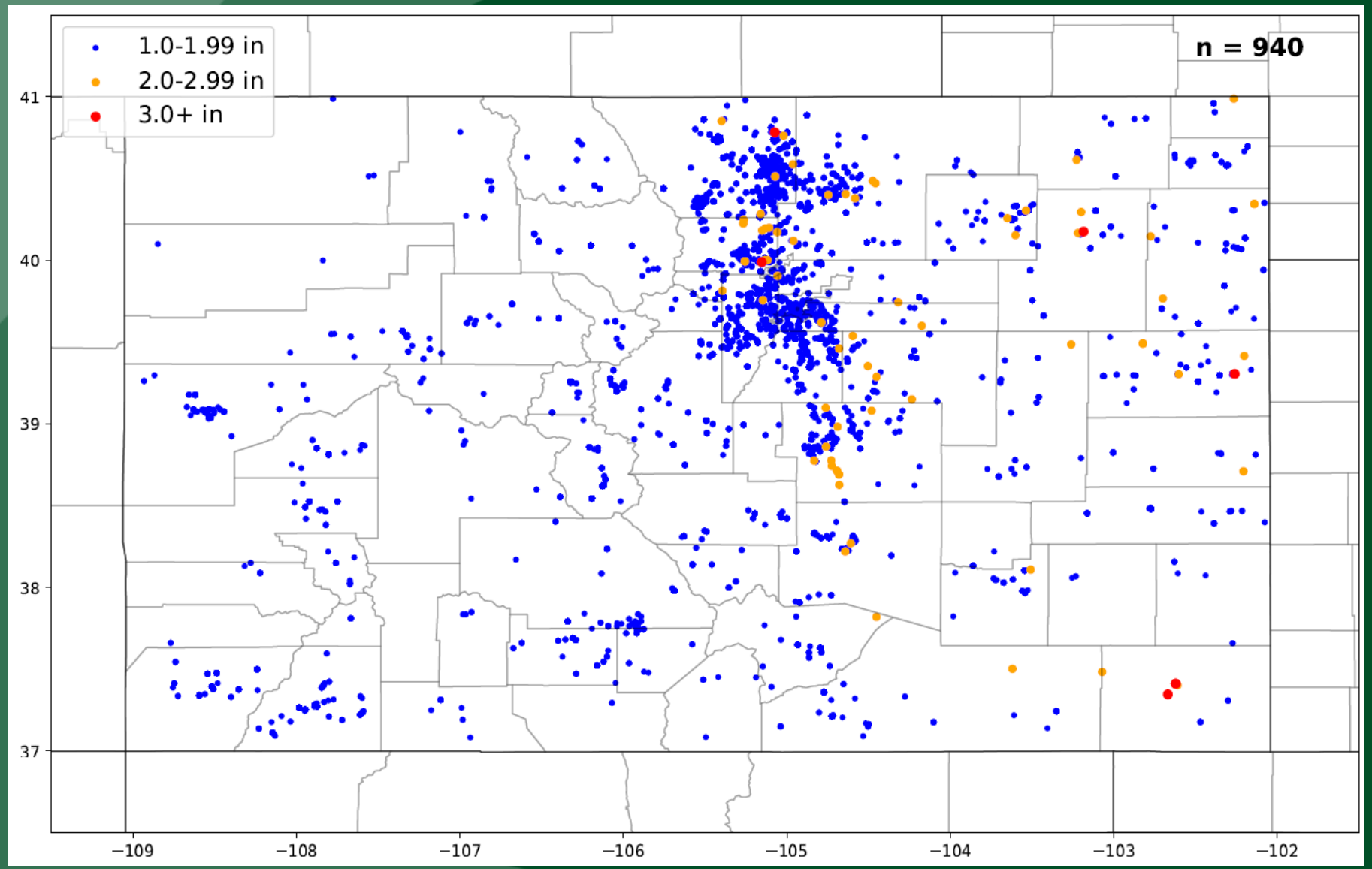


Why Does This Matter?

How is human exposure from tornadoes and severe hail expected to change across eastern Colorado by the end of this century?

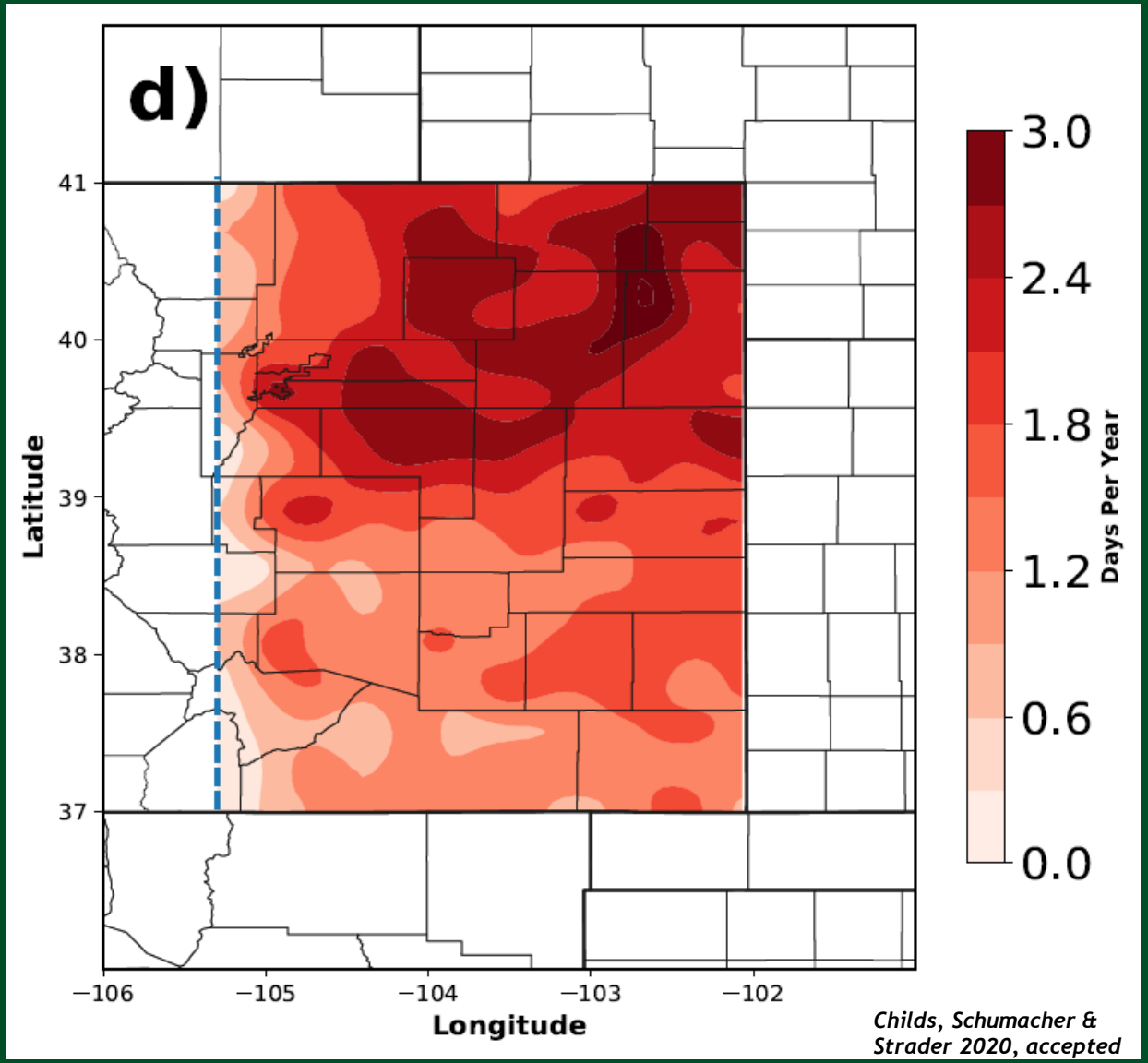
(a) Meteorology / Climate (b) Population Dynamics

TWO CONTRIBUTING FACTORS

“Synthetic” Hail Reports

-Use high-resolution weather model output of variables that can be used as proxies for hail reports, and compare threshold exceedances of these variables in future vs. historical climate scenarios

Up to 3 more days of severe hail per year by 2100, maximized in north-central Colorado



Big Ideas

- U.S. SPC hail database is dense but has biases and inhomogeneities due to changes in reporting procedures, population bias, etc.
- CoCoRaHS hail reports have less population bias due to station reporting and contain important sub-severe hail reports
- CoCoRaHS hail report database is currently too small to make robust conclusions about trends
- Having accurate and long-term hail data is critical for projecting future changes in hail climatology due to climate change and population effects

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https://sites.google.com/rams.colostate.edu/sjchilds/home