



TOKIO MARINE
TECHNOLOGIES

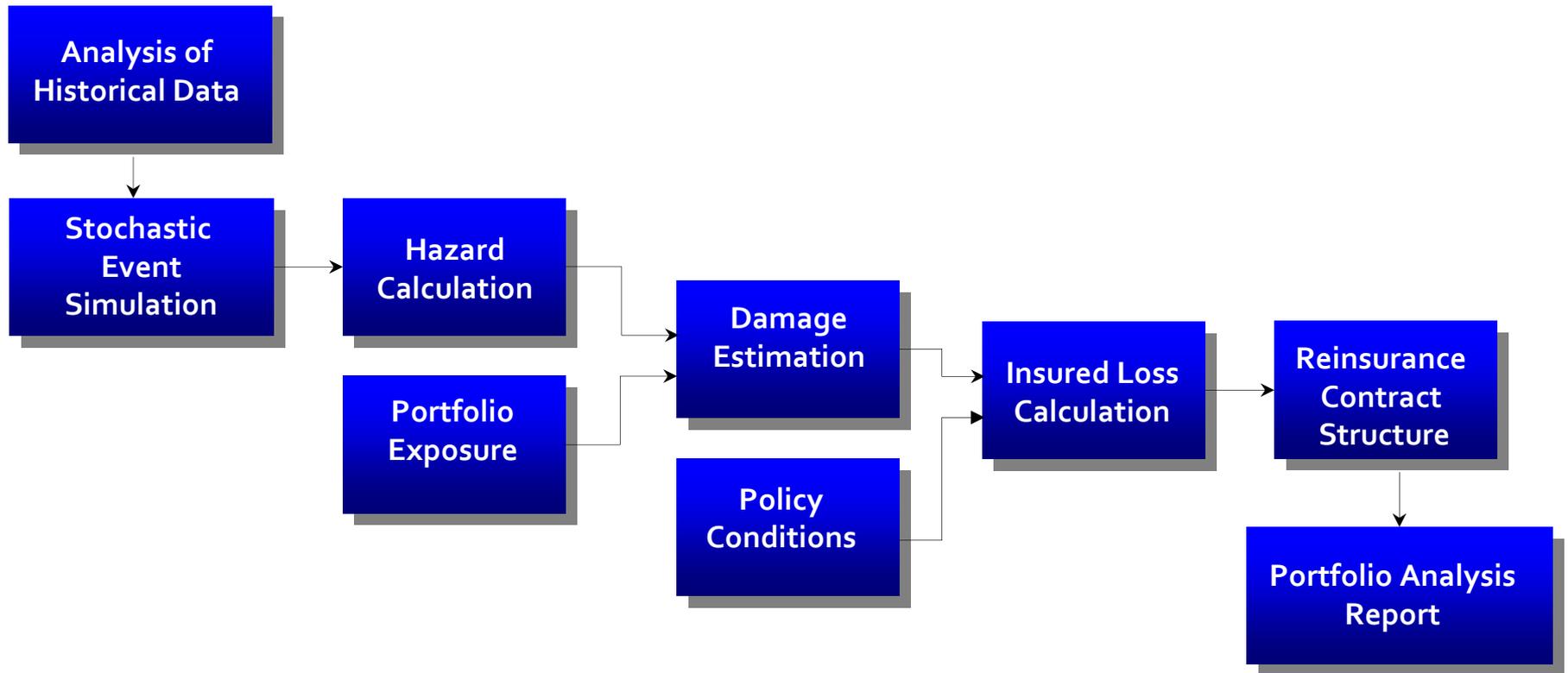
Modeling of Severe Weather Risks -- from Insurance/Reinsurance Perspectives

Jianming Yin, Ph.D.

2010 NWS National Severe Weather Workshop
March 4th-6th, Norman, OK

Tokio Marine Technologies LLC

Simulation Approach to Model Severe Weather Risks



What is Insurance/Reinsurance

+ Insurance

- > Transferring of the risk of a loss, from one entity to another, in exchange for a premium, to prevent a large, and possibly devastating loss

+ Reinsurance

- > The business of insuring an insurance company against suffering too great a loss from their insurance operations, and
- > Allowing an insurance company to lay off or pass on part of their liability to another insurer on a given insurance which they have accepted

NCDC/SPC Tornado/Hail/Wind Reports

+ NCDC/SPC database

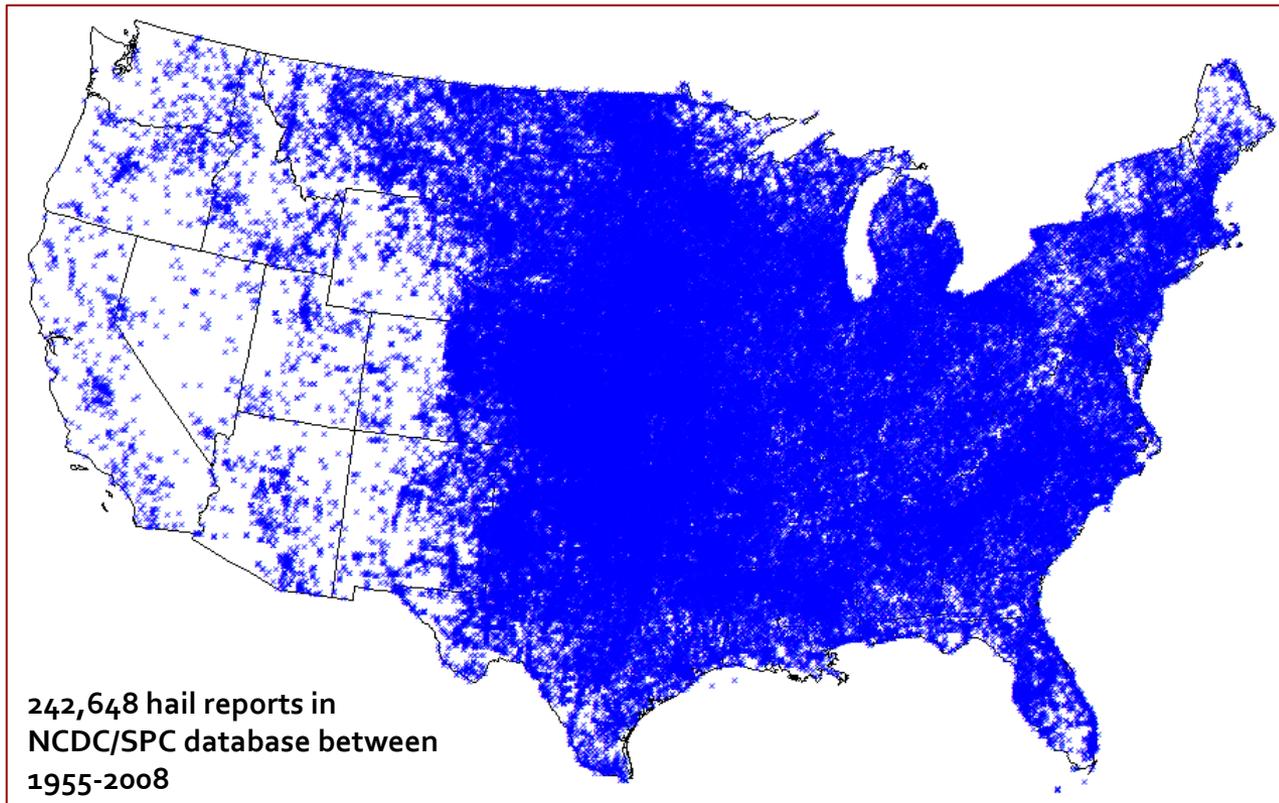
- > Storm reports are filed by US National Weather Service (NWS).
- > National Climatic Data Center (NCDC) compiles the information and publishes *Storm Data*.
 - Tornadoes in F-scale/EF-scale
 - Severe/Large hail, i.e., hail at least 0.75 inch in diameter
 - Severe convective winds exceeding 50 knots
- > Electronic databases are developed and maintained by NCDC and shared with Storm Prediction Center (SPC).

+ Severe hail data available from 1955-2008 with varying quality over time

- > Area on the ground impacted by hail with a temporal gap less than 15 minutes and spatial gap less than 10 miles

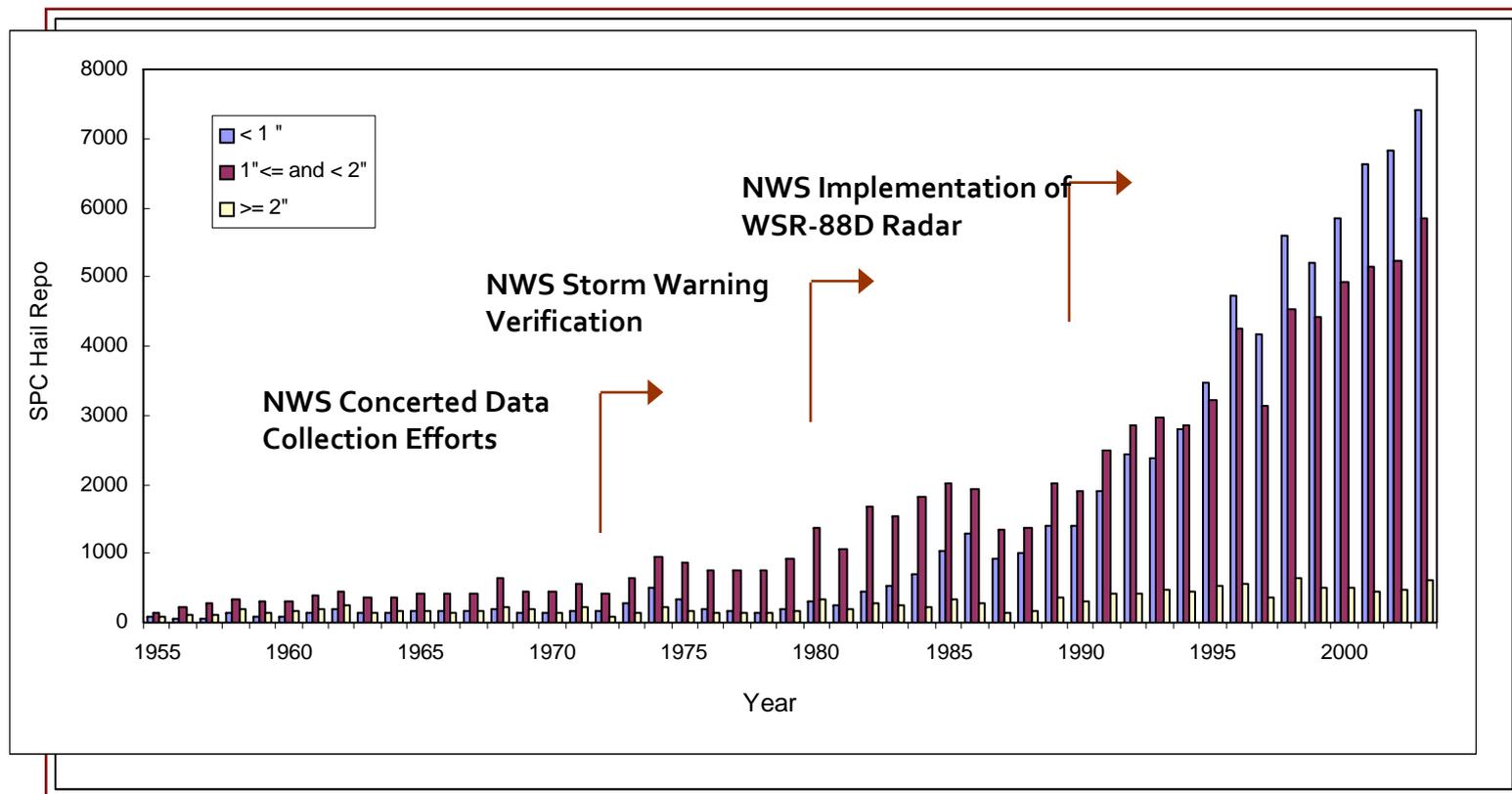
NCDC/SPC Severe Hail Reports 1955-2008

“The worldwide pattern of hail occurrence is characterized by a greater frequency in continental interiors of mid-latitudes, decreasing seaward, poleward, and equatorward.” -- Lemons, 1942



NCDC/SPC Severe Hail Reports by Year

The number of hail reports each year increases exponentially from less than 350 in 1955 to more than 13,000 in 2003.

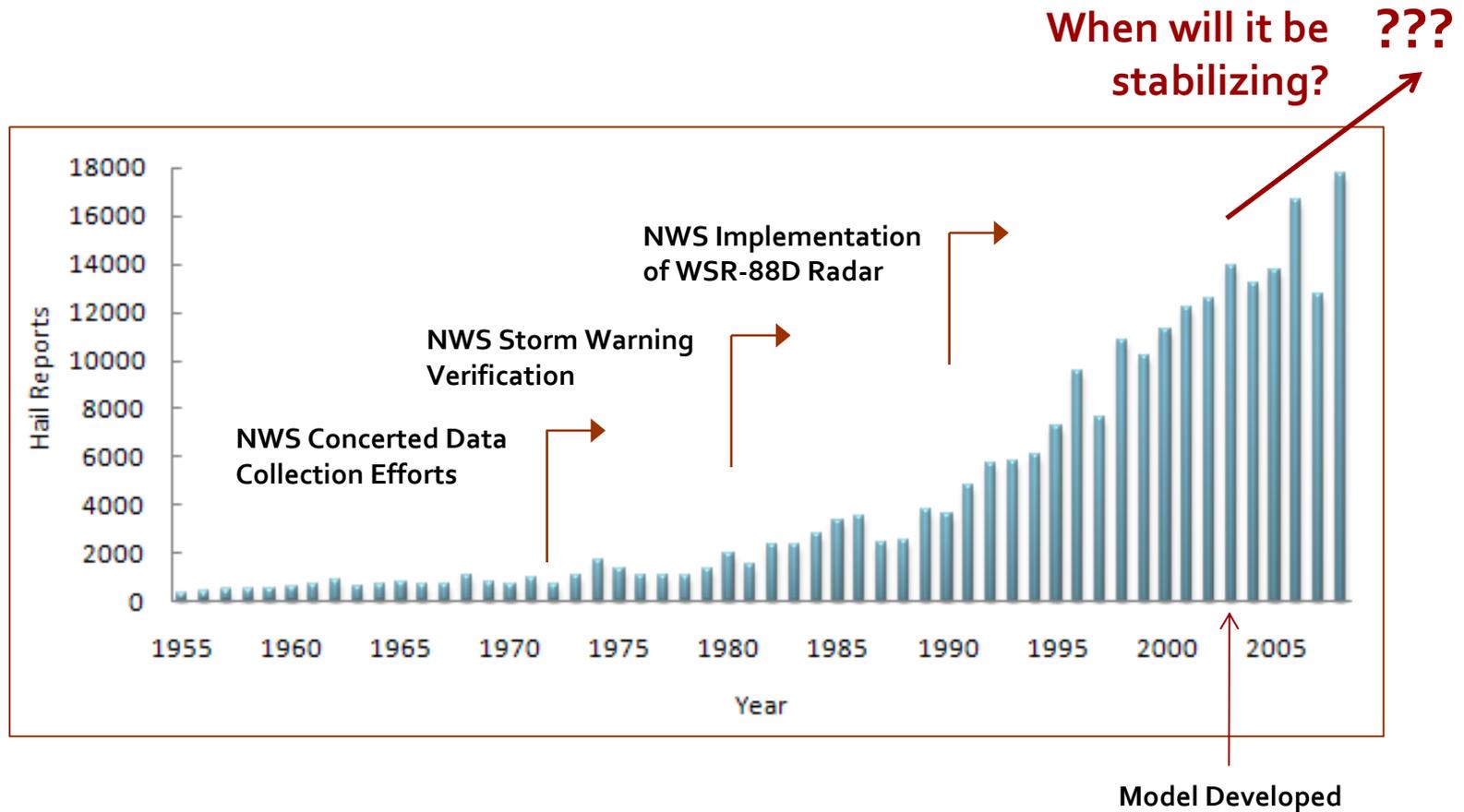


Concerns in NCDC/SPC Severe Hail Reports

- + **Climate change justifiable for or contributing partially to the increase in hail reports?**
- + **Inherent climatic variability due to the short time period of quality hail data?**



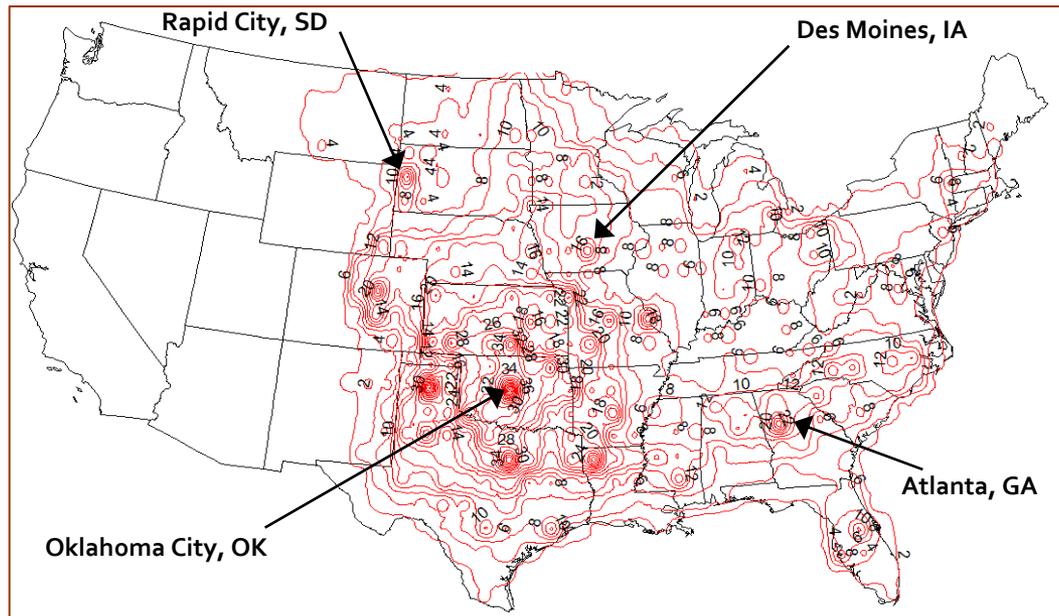
Challenge I – True Severe Hail Risk in the US



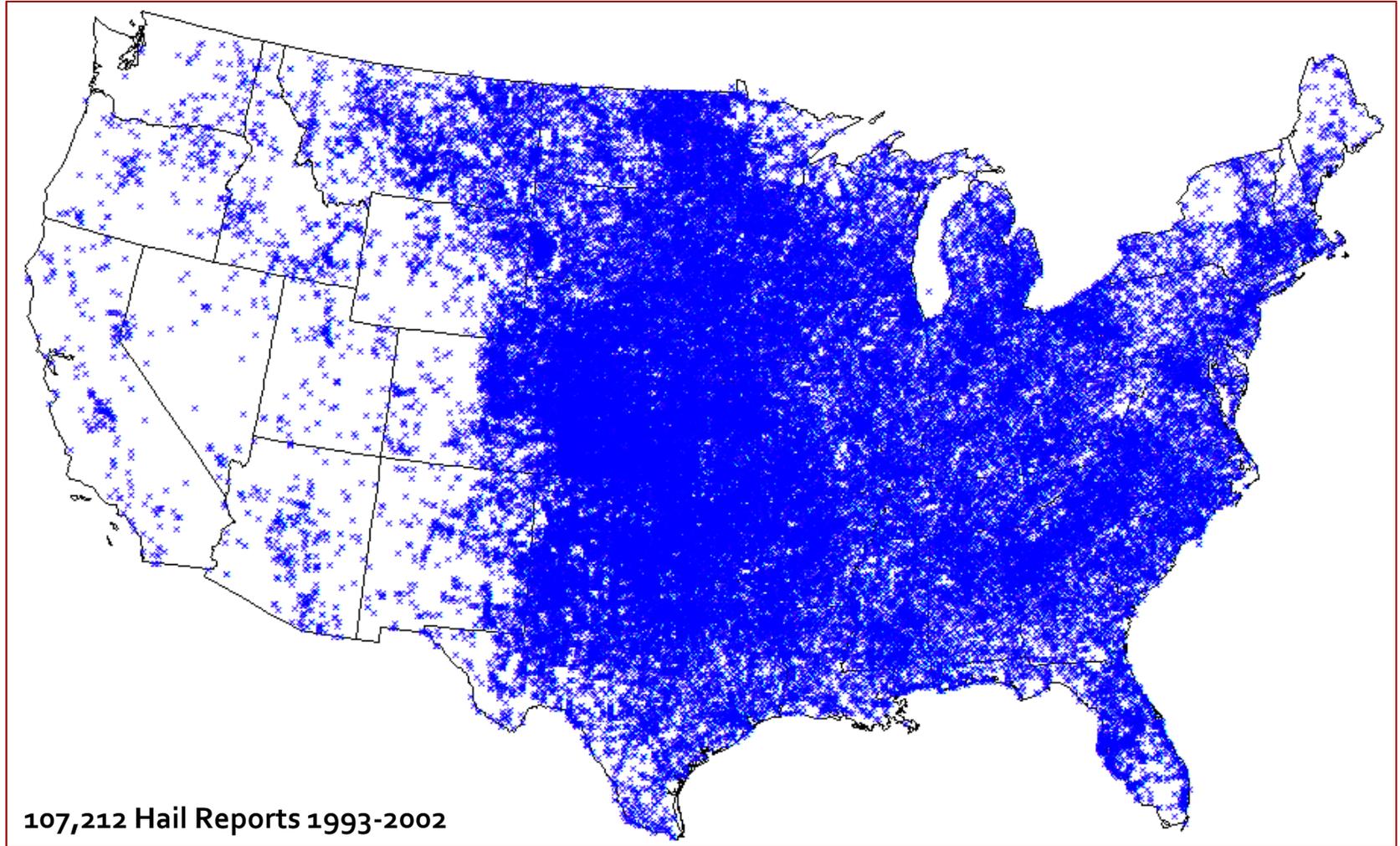
NCDC/SPC Severe Hail Reports by 1-Degree Grid

- + High variability in annual average hail reports in 1955-2003 by 1-degree latitude and longitude grid
- + Hail report peaks coinciding with urban areas
- + Hail report valleys occurring in rural areas between cities

NCDC/SPC Severe hail reports in 1955-2003



Severe Hail Reports from Different Time Periods

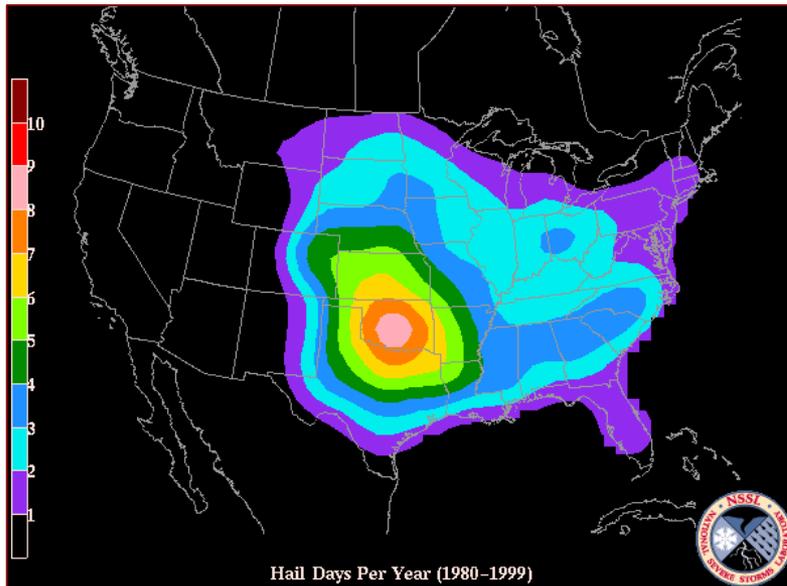


Climatology of US Severe Hail

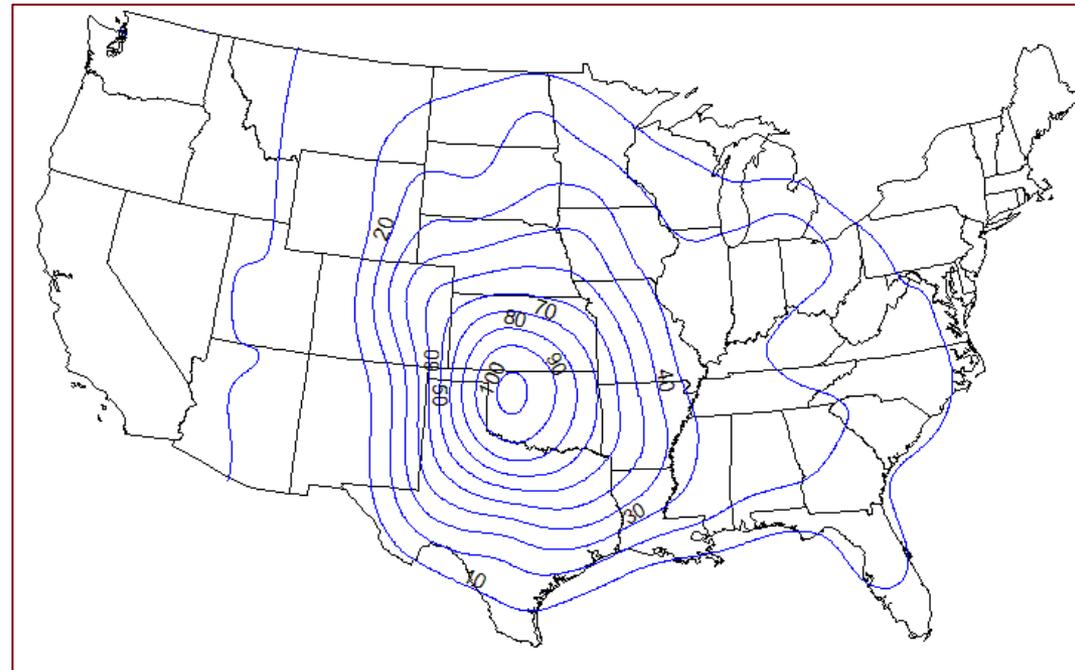
- + **Climatological explanations to the spatial variability in NCDC/SPC hail reports?**
- + **Underreporting bias in NCDC/SPC hail data especially in the earlier years**
 - > Use of the NCDC/SPC hail data in its current format will likely underestimate the true US hail risk.
 - > Empirical augmentation algorithms is needed to alleviate the underreporting bias before use for hail risk modeling.
- + **No theoretical hail climatology available for US hail risk modeling from property Re/Insurance perspectives**

Challenge II – True Climatology of US Severe Hail

NSSL Study on hail-day at 1-degree grid



TMTech 10,000-year simulation at 1-degree¹

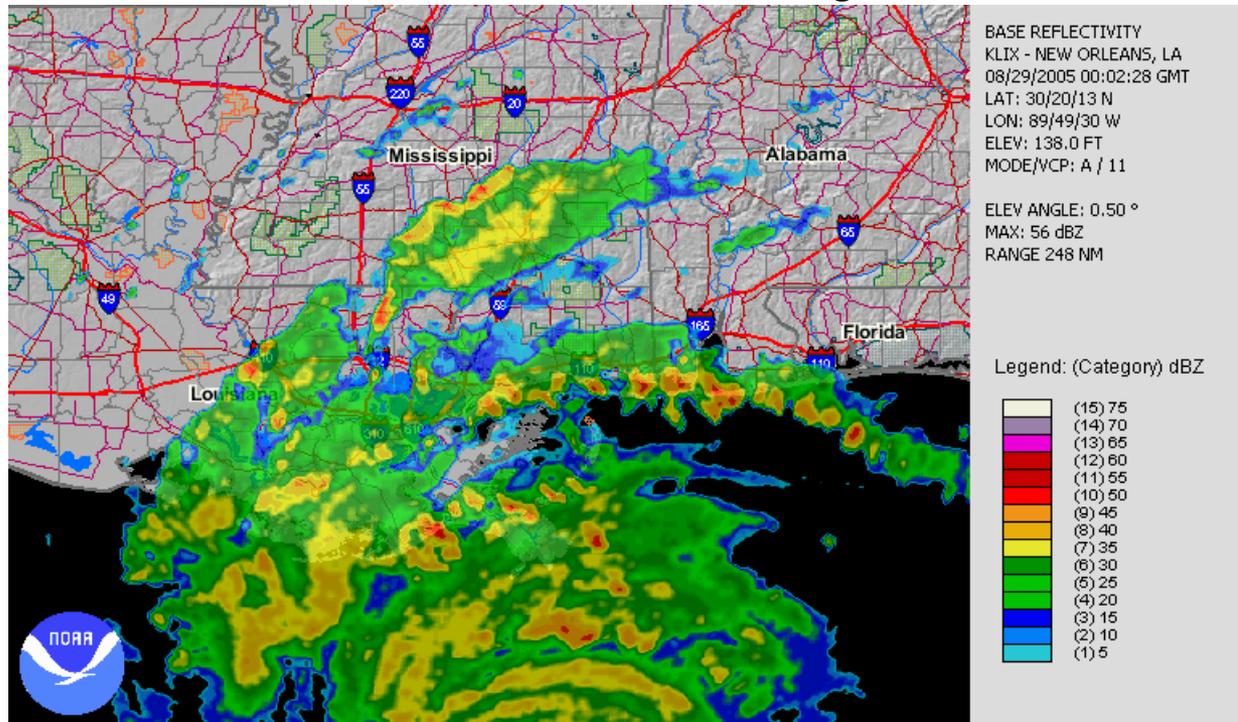


1. Jianming Yin et al., 2007: "Modeling hail risk in the contiguous United States for insurance loss estimation," Proceedings of the 12th International Conf. on Wind Engineering, Cairns, Australia, Vol. 2, pp1751-1758

Severe Weather Events

Reinsurance: to insure an insurance company against suffering too great a loss from their insurance operations...

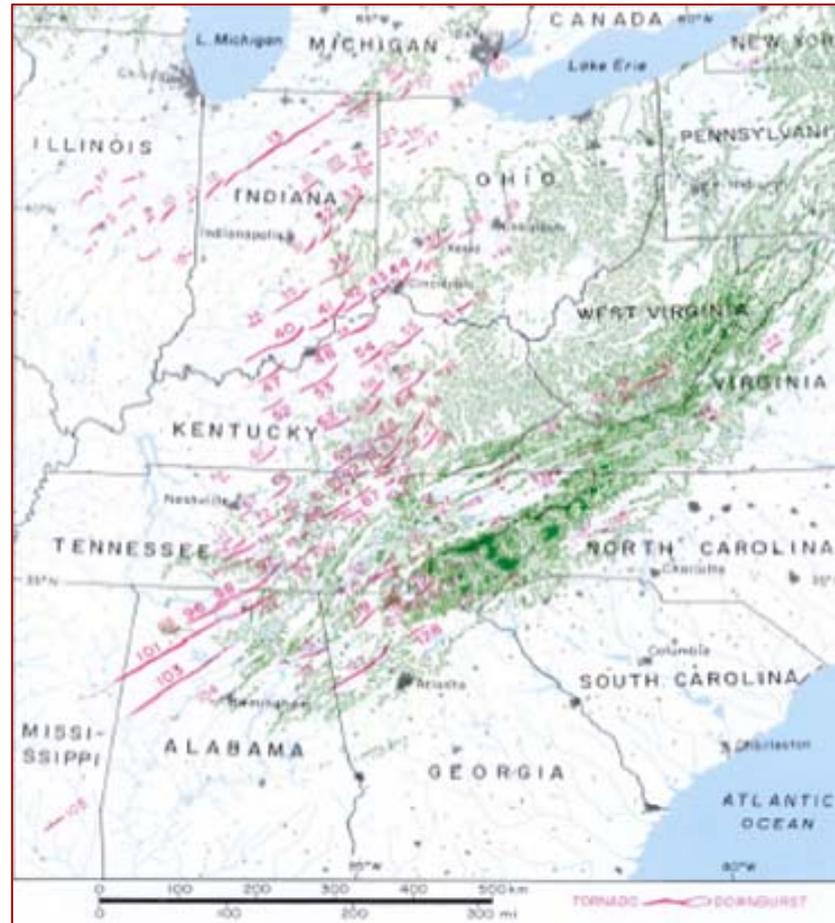
Hurricane Katrina 2005



Severe Thunderstorm Events for Reinsurance Contracts

- + **Severe convective weather producing system**
 - > A convective precipitation system that is usually associated with severe thunderstorm weather
- + **Severe thunderstorm event**
 - > Congregation of tornadoes, hailstorms at least 0.75 inch in diameter, winds exceeding 50 knots spawned by the same severe convective weather producing system within a continuous time period of up to 72 hours
 - > Two or more severe thunderstorm events may be counted when the severe weather producing system lasts more than 72 hours.

The 1974 Tornado Super Outbreak



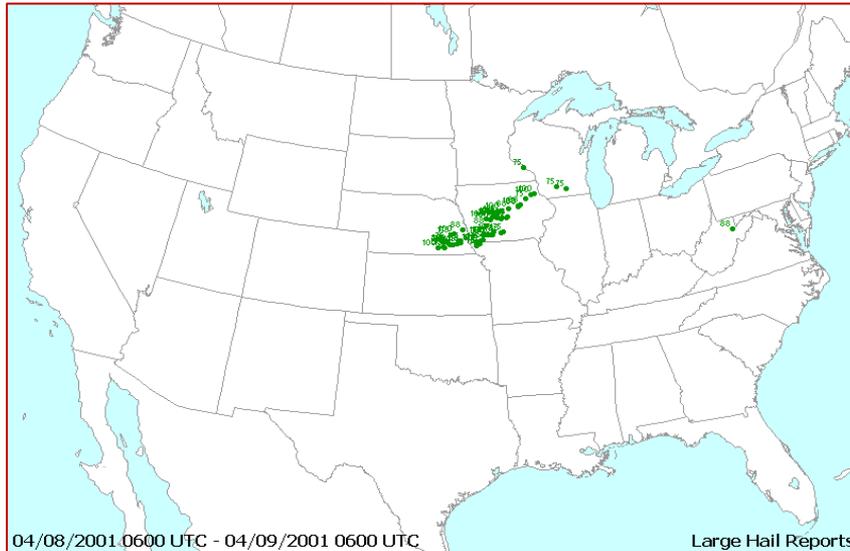
Risk Management Solutions (RMS), 2004: "Analysis and Reconstruction of the 1974 tornado super outbreak," special report.



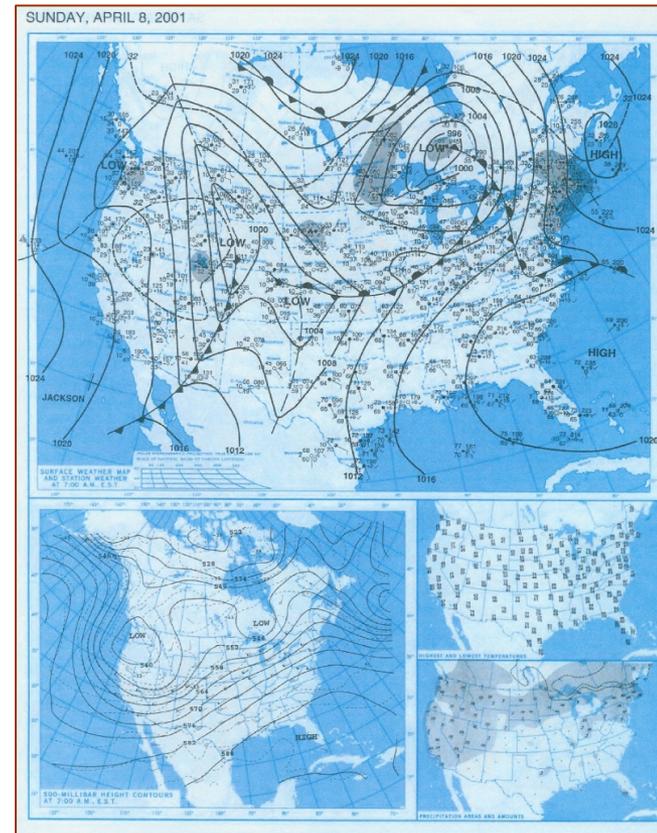
Daily Hail Reports and Weather Maps

Severe Thunderstorm Event: Tornadoes, hailstorms and winds spawned by the same severe weather producing system

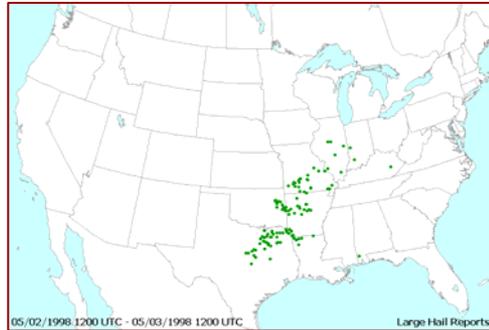
NCDC Daily severe hail reports



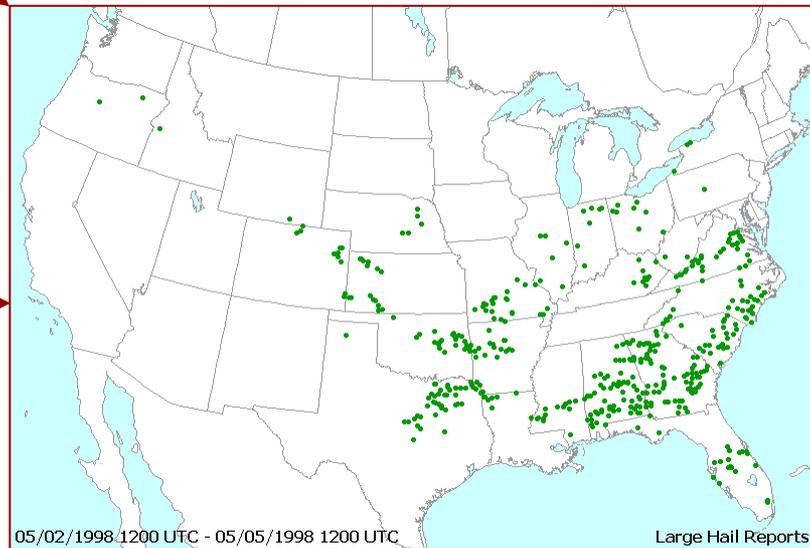
Daily weather map



Challenge III -- Identification of Events



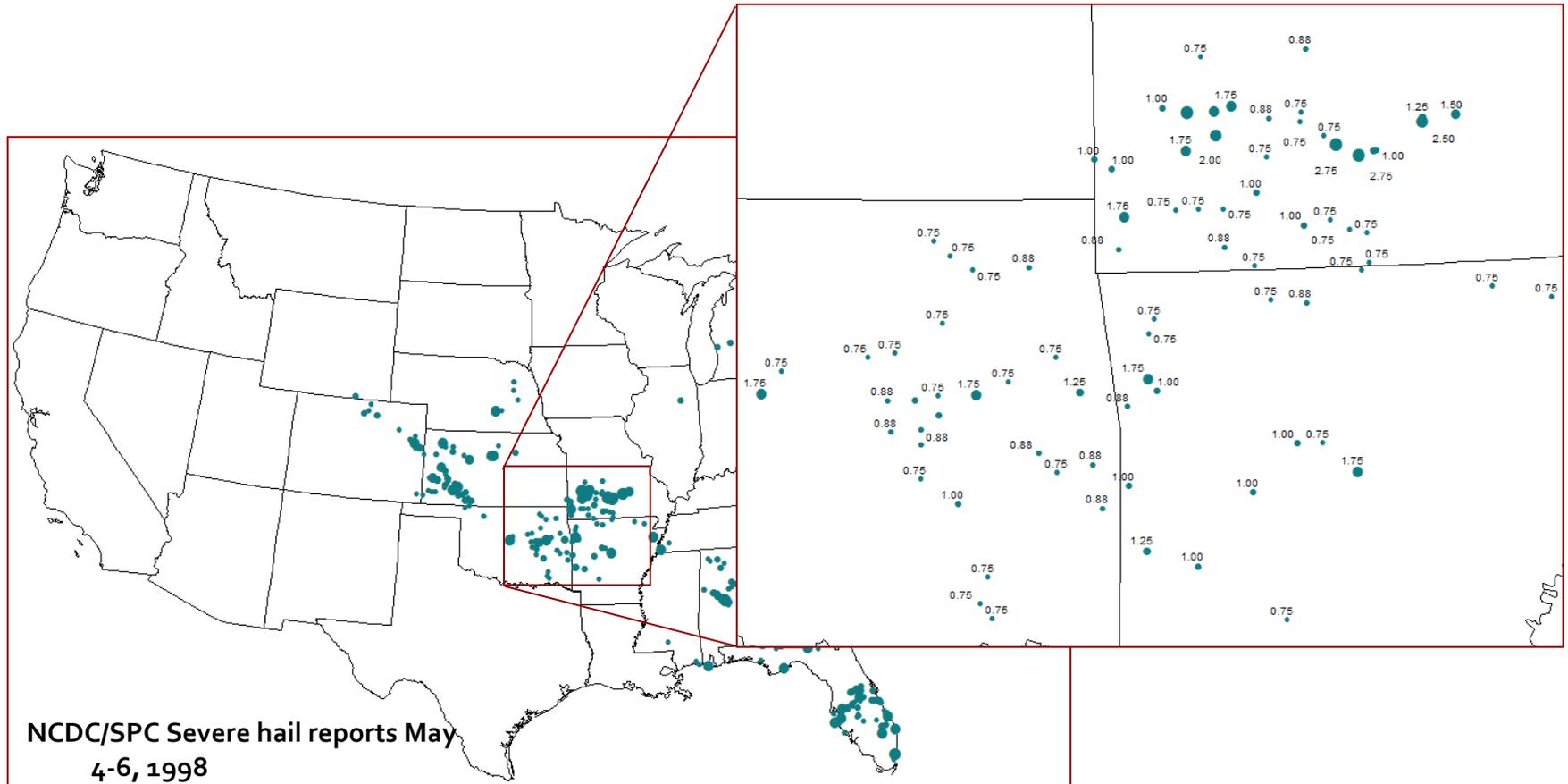
One event or two or more events???



Severe Thunderstorm Event: Tornadoes, hailstorms and winds spawned by the same severe weather producing system



Challenge IV -- Hailstorm Clustering and Intensity Correlation



Hail Damage to Buildings and Automobiles



The Western Sydney Hailstorm 2007

Challenge V – Missing Information Needed for Hail Hazard Assessment

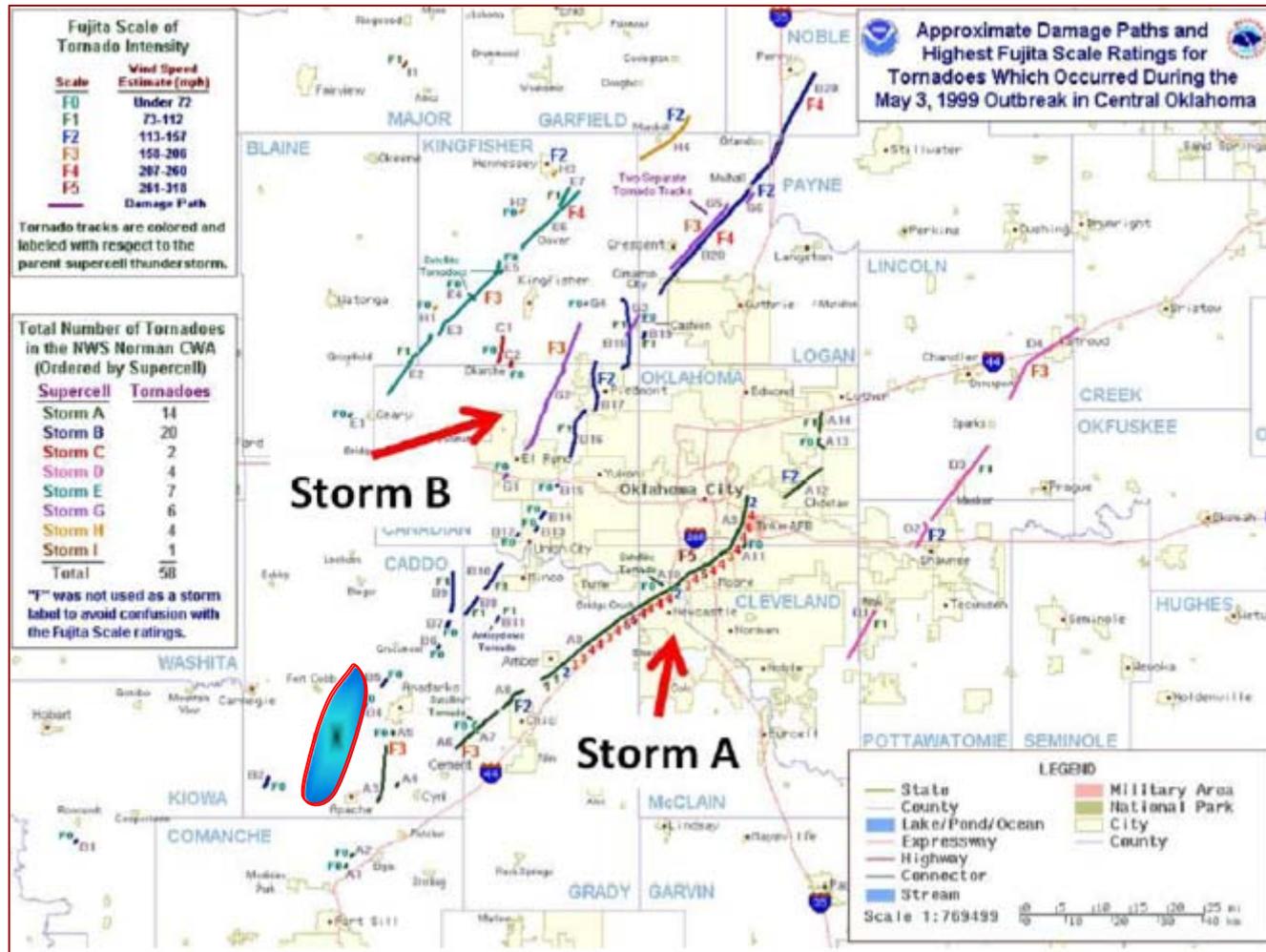
Hailstorm Parameters	NCDC/SPC Reports	Field Study
Year, Date, and Time	Yes	
Hailstorm Central Lat/Lon	Yes	
Hail Impact Area—Length/Width	No	Yes
Hail Intensity Variation	No	Yes
Maximum/Reported Hail Size	Yes	
Hailstone Size Distribution	No	Yes
Number of Hailstones Falling	No	Yes
Near Ground Wind Speed	No	Yes

Challenge VI -- Real-Time Storm Information

- + **Re/Insurance companies like to have loss number at the time of (real-time) or soon after the event occurring for risk management purpose.**
- + **How soon and what kind of storm information can we have?**



Illustration of Real-Time Storm Information



Recap

- + **True severe weather risk in the US**
- + **True climatology of severe weather risk in the US**
 - > Optimal trade-off between reports quality and amount of data
 - > Robust augmentation techniques to alleviate the data quality issue in earlier years
- + **Identification of severe weather events**
- + **Storm clustering and intensity correlation**
- + **Lack of storm information critical for risk modeling**
- + **(Near) Real-time storm information**



Questions and Comments