IBM **Research**
Australia

Fine Scale Hail Hazard Prediction using the WRF Model

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Outline

- Motivation
- Case Overview
- Modeling Strategy
- Validation
- Sensitivity Experiments
- Conclusions

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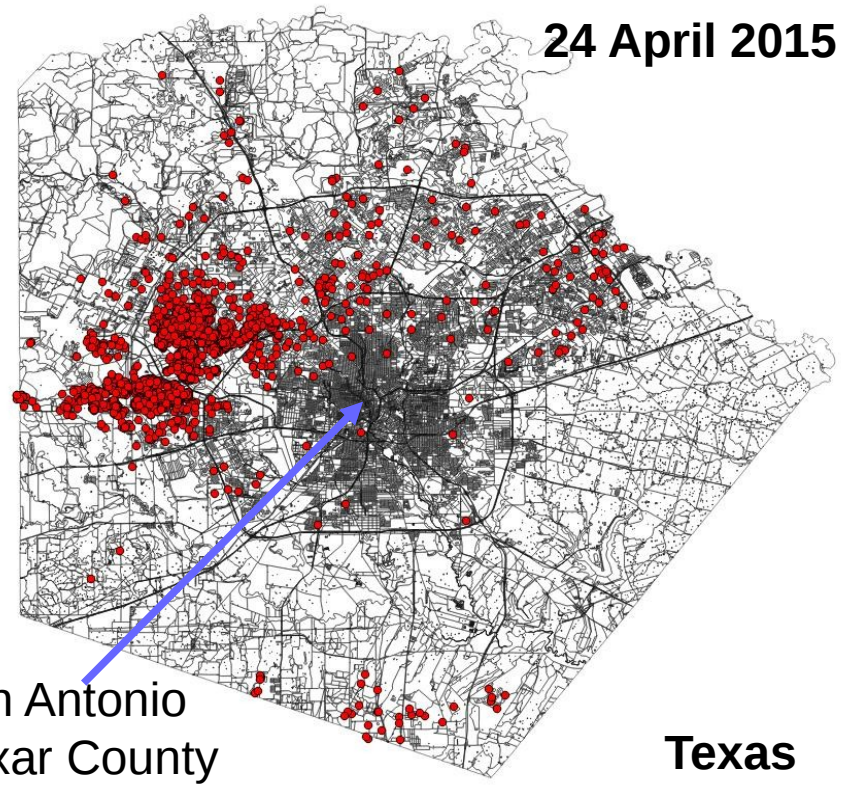
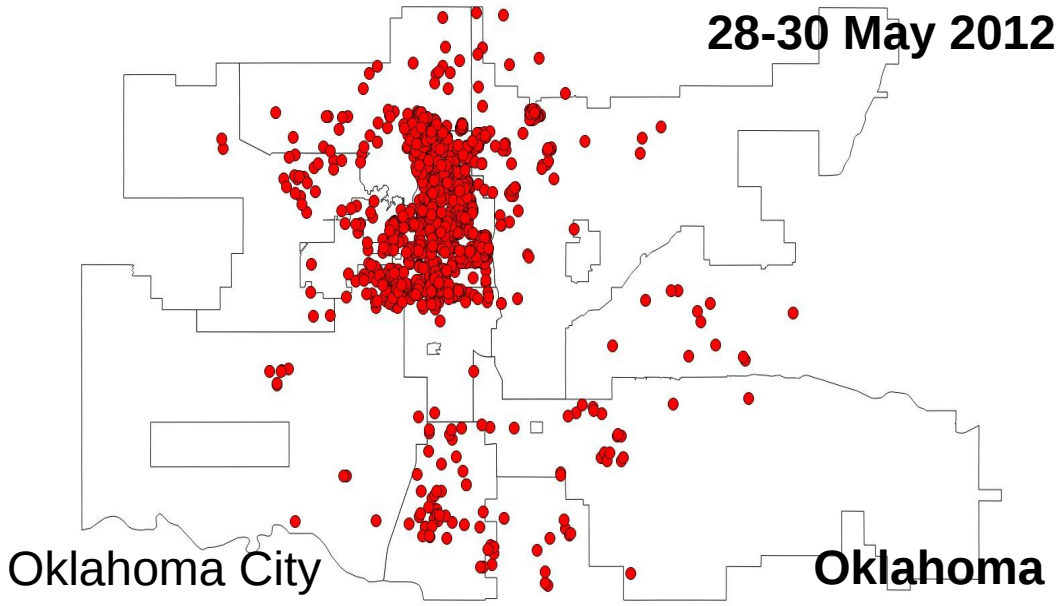
Motivation





Hail Observed

Loss (USD): 0.5 billion (Oklahoma) / 100 Million (Texas)

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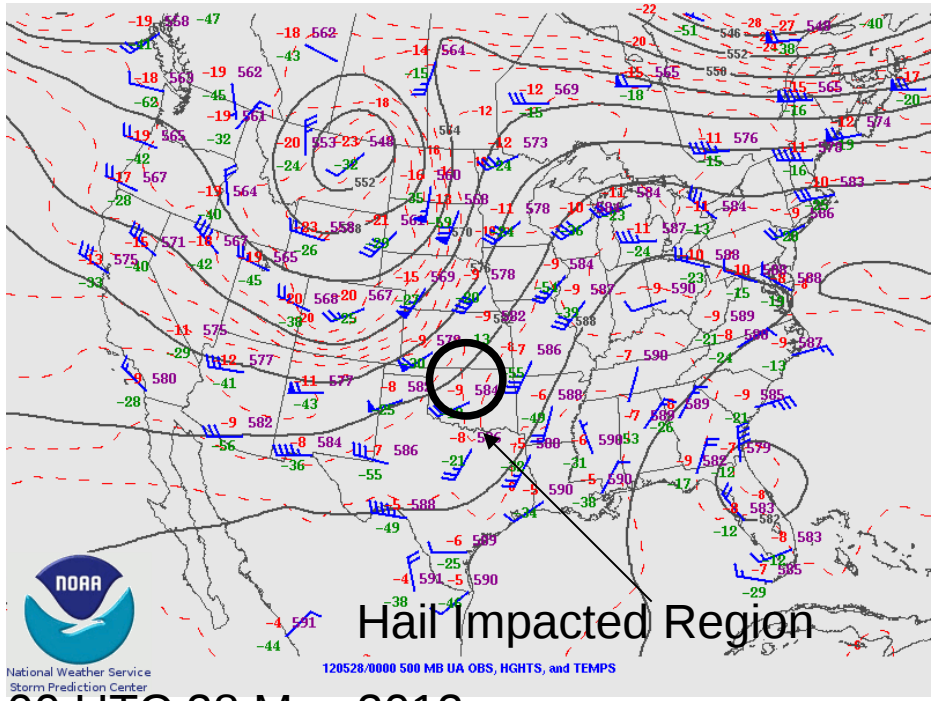
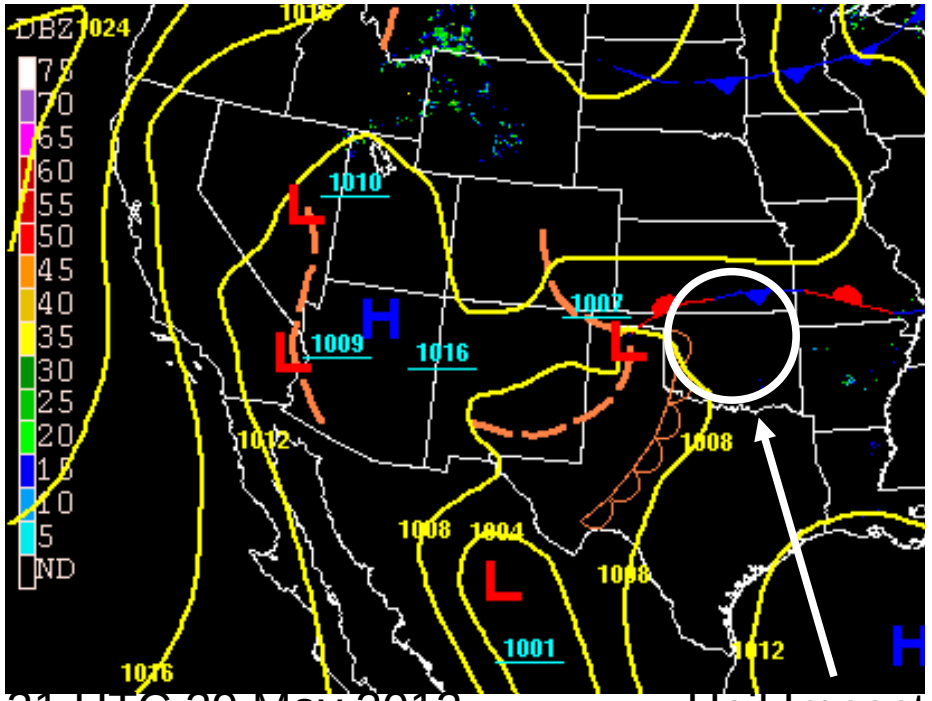
Overview: 28 – 30 May 2012 Oklahoma Storms

500 hPa Ht (dam) + Isotherms



00 UTC 28 May 2012

RADAR Refl.(dbZ) + MSLP (hPa)



21 UTC 29 May 2012

All 3 storms:
Weak
-synoptic forcing
-MSLP gradient
Dry Line.
MCS

Hail Impacted Region

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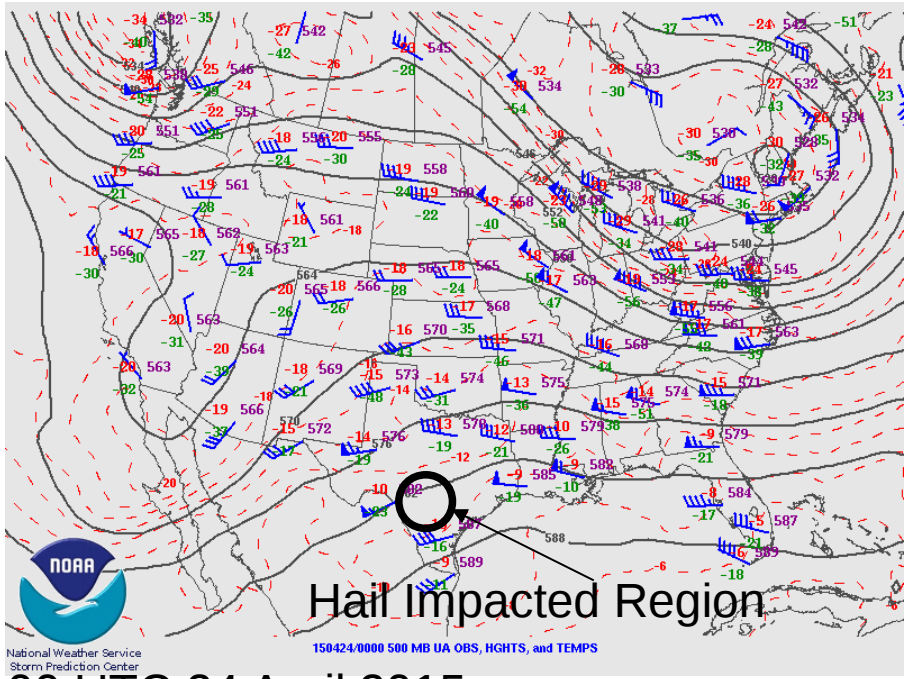
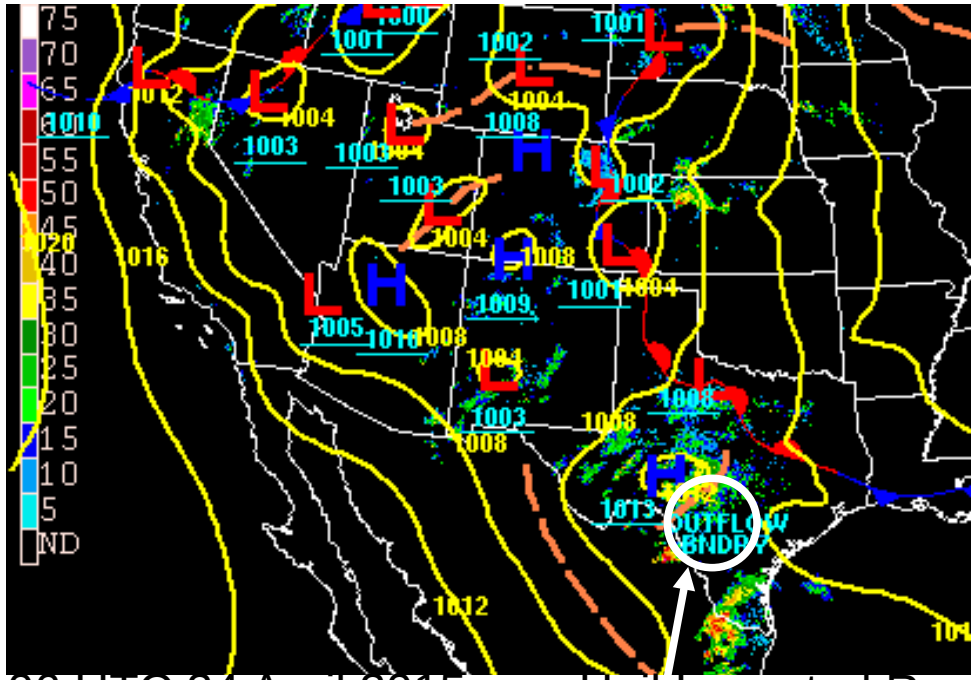
Overview: 24 April 2015 San Antonio Storm

500 hPa Ht (dam) + Isotherms



00 UTC 24 April 2015

RADAR Refl.(dbZ) + MSLP (hPa)



06 UTC 24 April 2015 Hail Impacted Region

The storm:
Weak
-synoptic forcing
-MSLP gradient
Outflow Boundary
Not a MCS

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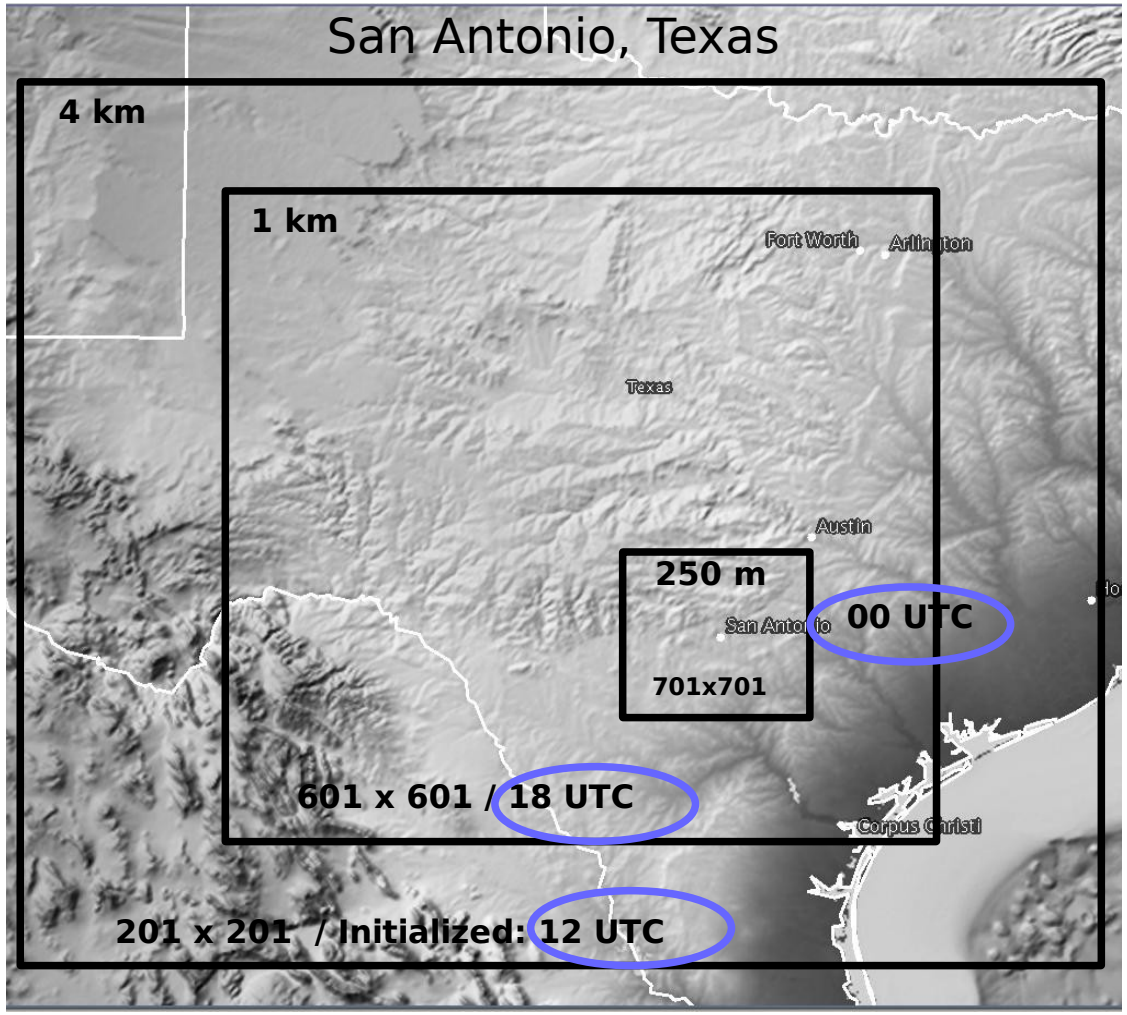
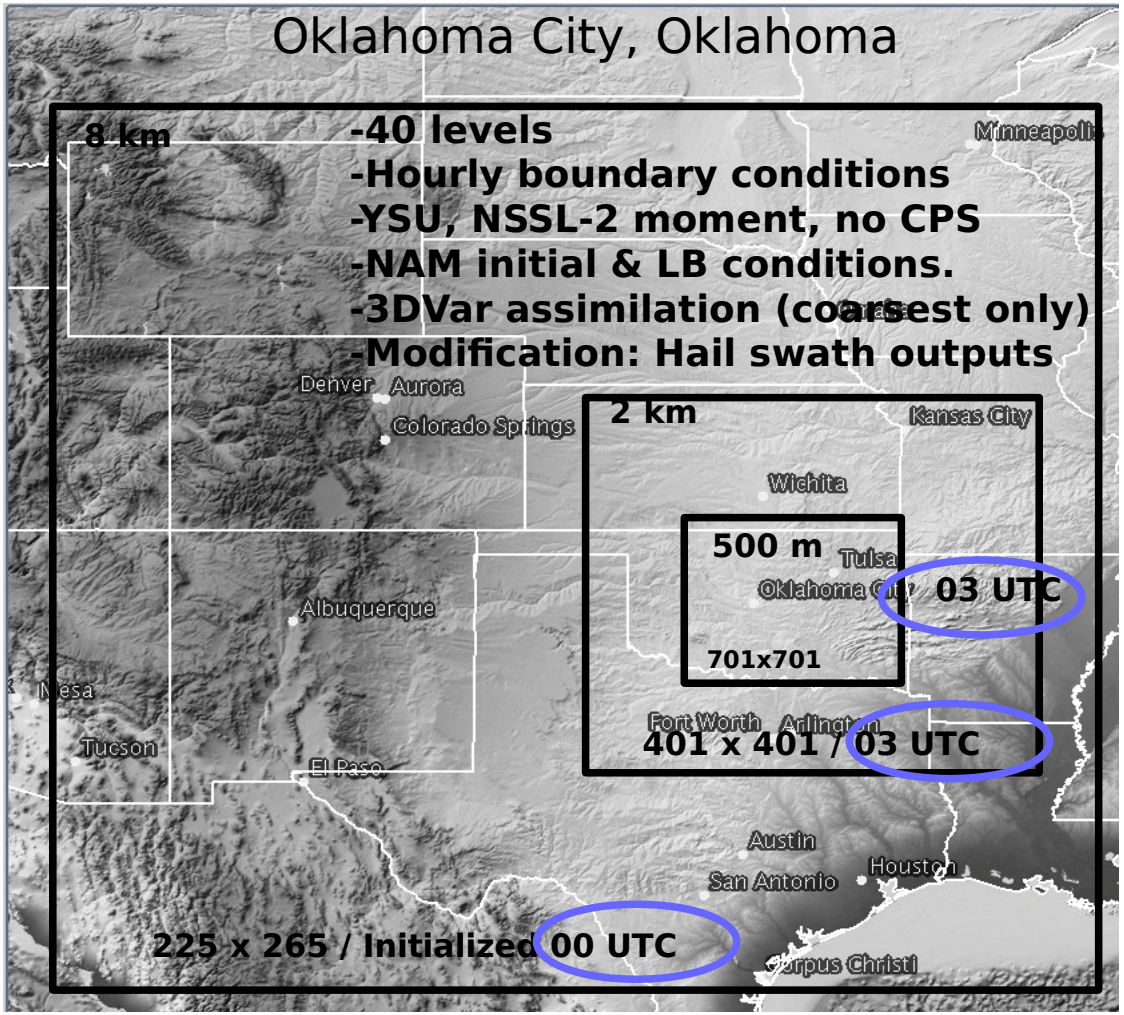
Modeling Strategy





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Verification Metrics

FCST \ OBS	YES	NO
YES	Hits (a)	False Alarms (b)
NO	Misses (c)	Correct Negatives(d)

Probability of Detection (POD):
Probability of False Detection (POFD):

POD = a/(a+c)
POFD = b/(b+d)

POD: What fraction of the OBSERVED hail events were correctly forecast ?

POFD: What fraction of the NOT OBSERVED hail events were incorrectly forecast ?

OBS: Hail YES/NO events at point locations.
FORECAST: Last 24-h / 12-h swath of hail mixing ratio for OK/TX storms converted to hail YES/NO events.

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Verification: POD

2012: Oklahoma City, Oklahoma

Resolution	28 May	29 May	30 May
8 km	1.00	0.99	0.59
2 km	0.97	0.99	0.94
500 m	0.88	0.99	0.00

High POD for OK storms but the 30 May storm showed complex small scale interactions (Bluestein 2014).

2015: San Antonio, Texas

Resolution	24 April
4 km	0.00
1 km	0.01
250 m	0.83

Smaller storm and fine resolution helps.

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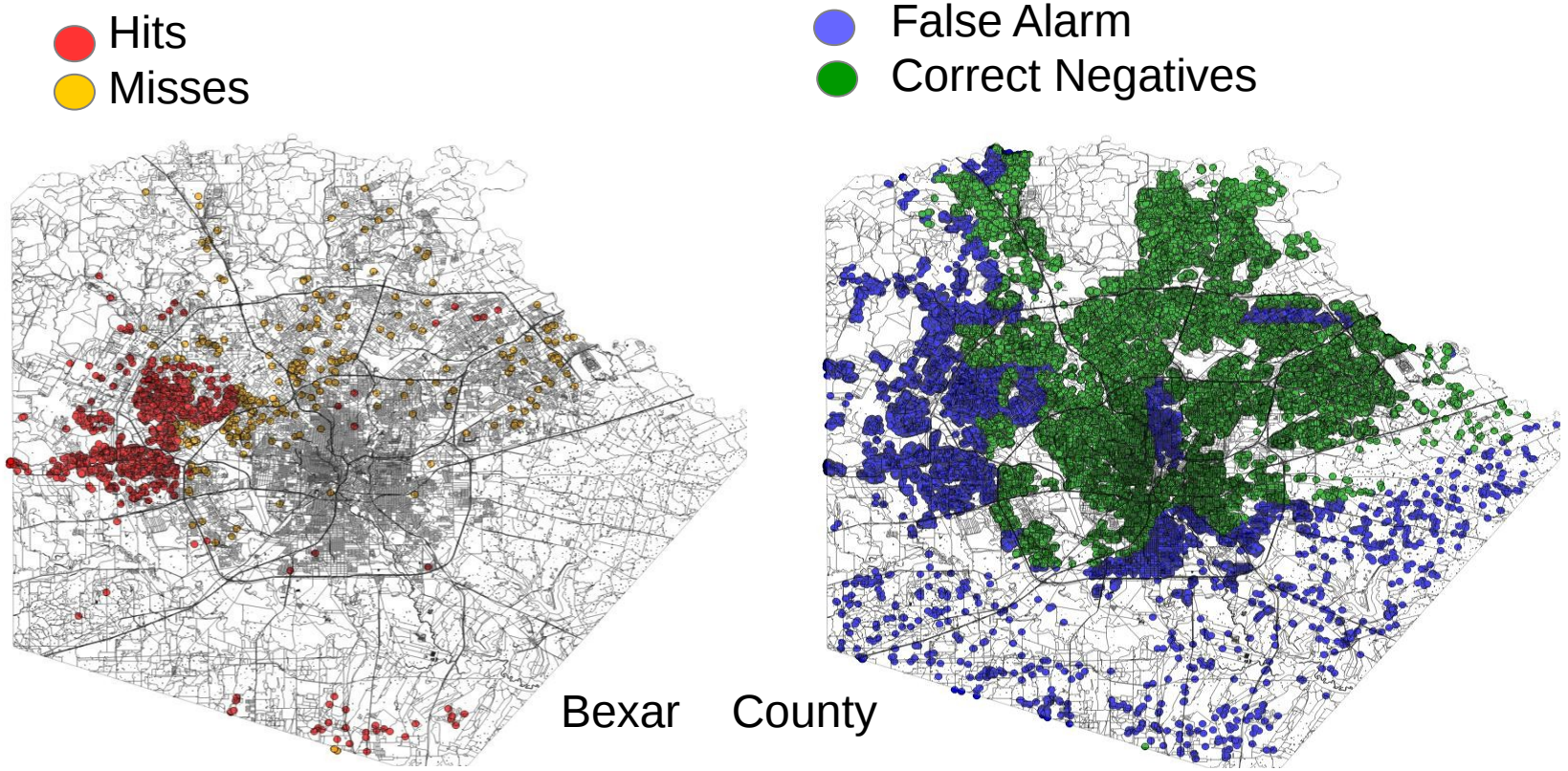
Verification: POD & POFD

Grid	POD	POFD
4 km	0.00	0.04
1 km	0.01	0.02
250 m	0.83	0.35



NAM IC & LBCs, 24 April 2015: San Antonio, Texas

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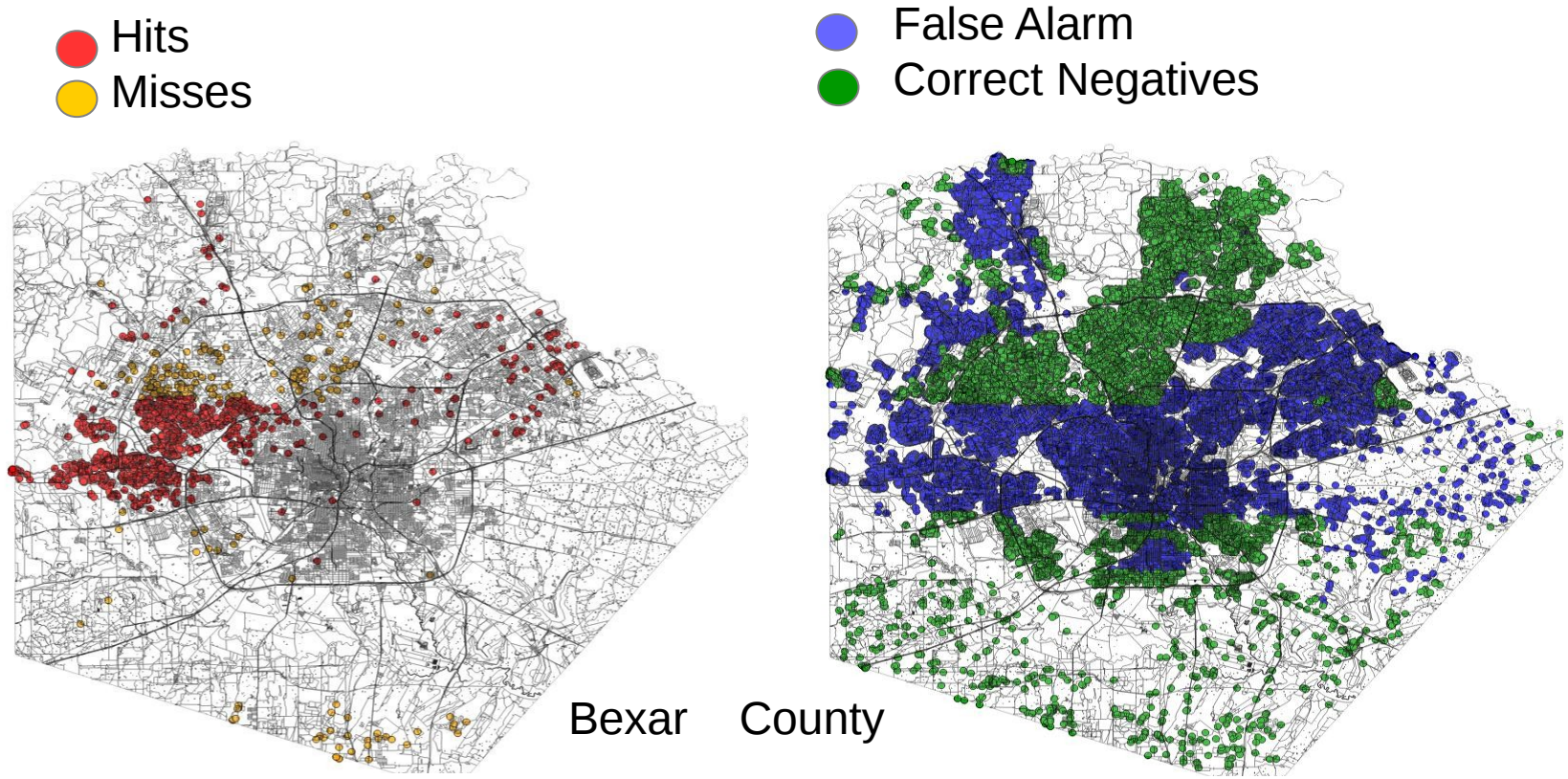
Sensitivity: RAP IC & LBCs

Grid	POD	POFD
4 km	0.00	0.05
1 km	0.01	0.15
250 m	0.9	0.57



24 April 2015: San Antonio, Texas

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Sensitivity (NAM): Initialization Time

Grid/Start Time	POD	POFD
4 km / 00 UTC	0.00	0.04
1 km / 03 UTC	0.01	0.02
250 m/ 03 UTC	0.83	0.35

Grid/Start Time	POD	POFD
4 km 00 UTC	0.00	0.0
1 km / 00 UTC	0.00	0.0
250 m / 00 UTC	0.14	0.09

24 April 2015: San Antonio, Texas

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Sensitivity (NAM): Data Assimilation

Probability of Detection

Date / Resolution	With	Without
24 April 2015 / 250 m	0.83	0.07
28 May 2012 / 500 m	0.88	0.03
29 May 2012 / 500 m	0.99	0.00
30 May 2012 / 500 m	0.00	0.99

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Conclusions & Future Work

The **hindcasts** showed high:
POD scores for all storms.
POD and low POFD for the TX storm.

Sensitivity Experiments:
For TX storm, the RAP IC and LBCs gave high(low) POD(POFD).
The 3DVar assimilation resulted in high POD scores for many of the storms.
Hindcast accuracy favorably impacted by using delayed initialization of the fine meshes.

Thus, the fine scale hail modeling system is **robust** and produces reasonable hail information.

Future Work:
Estimation of property loss from hindcasted hail information.
Test robustness of the hail modeling system by applying to other geographies.

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IBM Research Presentations (14 January 2016)

18th Conference on Atmospheric Chemistry

698: Impacts of an Unknown Daytime HONO Source on the Mixing Ratio and Budget of HONO, and Hydroxyl, Hydroperoxyl and Organic Peroxy Radicals, in the Coastal Regions of China

23rd Conf. on Probability and Statistics in the Atmospheric Sciences

14.5: Verification of High-resolution WRF-ARW Forecasts for Vermont Utility Applications

30th Conference on Hydrology

538: Modulation of Urban Heat Island and Heat Waves under Current and Future Climate

20th Conf. on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface (IOAS-AOLS)

676: An Integrated Modeling, Observing and Visualization System for the Study of the Ecology of Lake George in the Jefferson Project

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