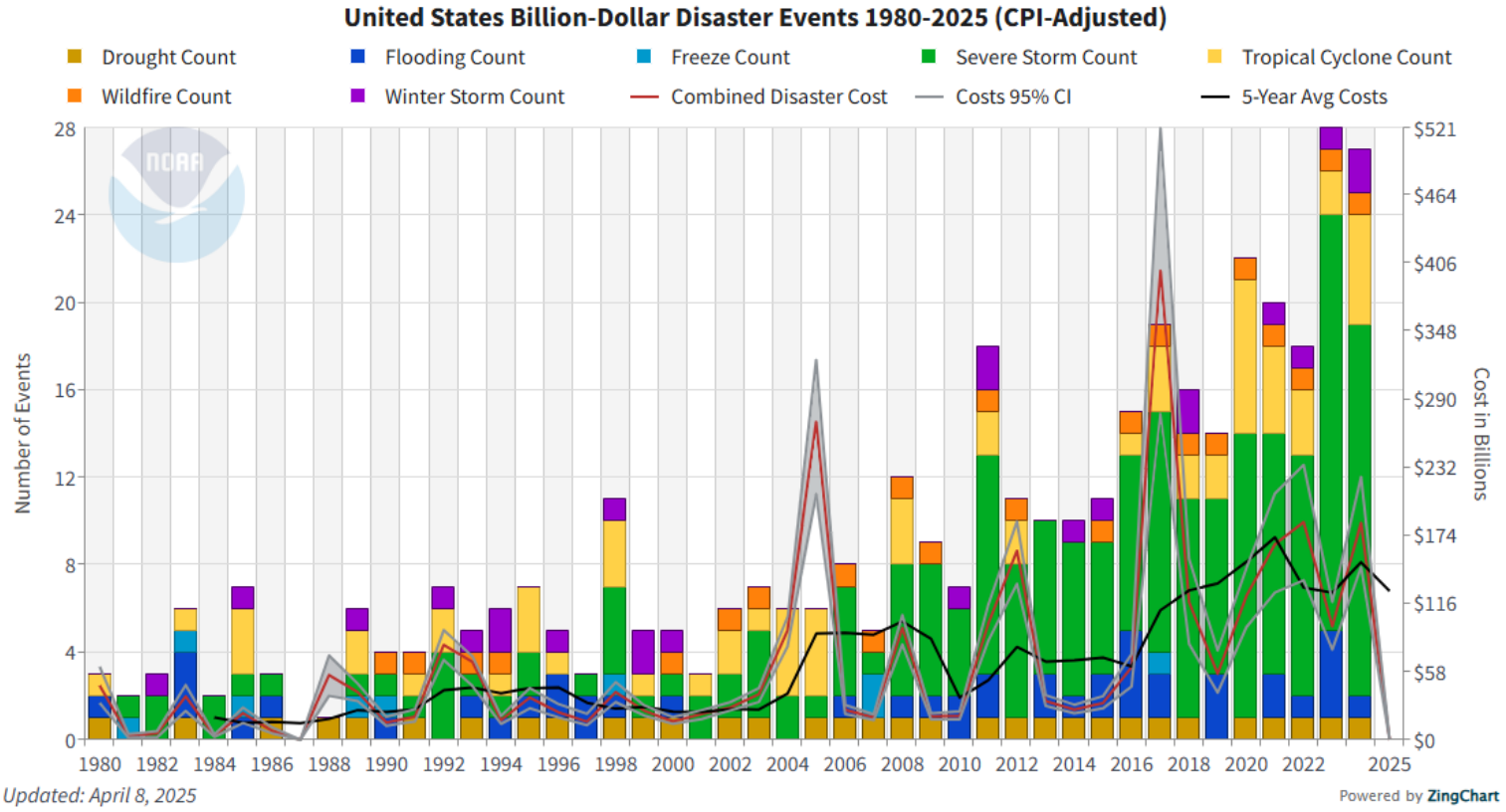
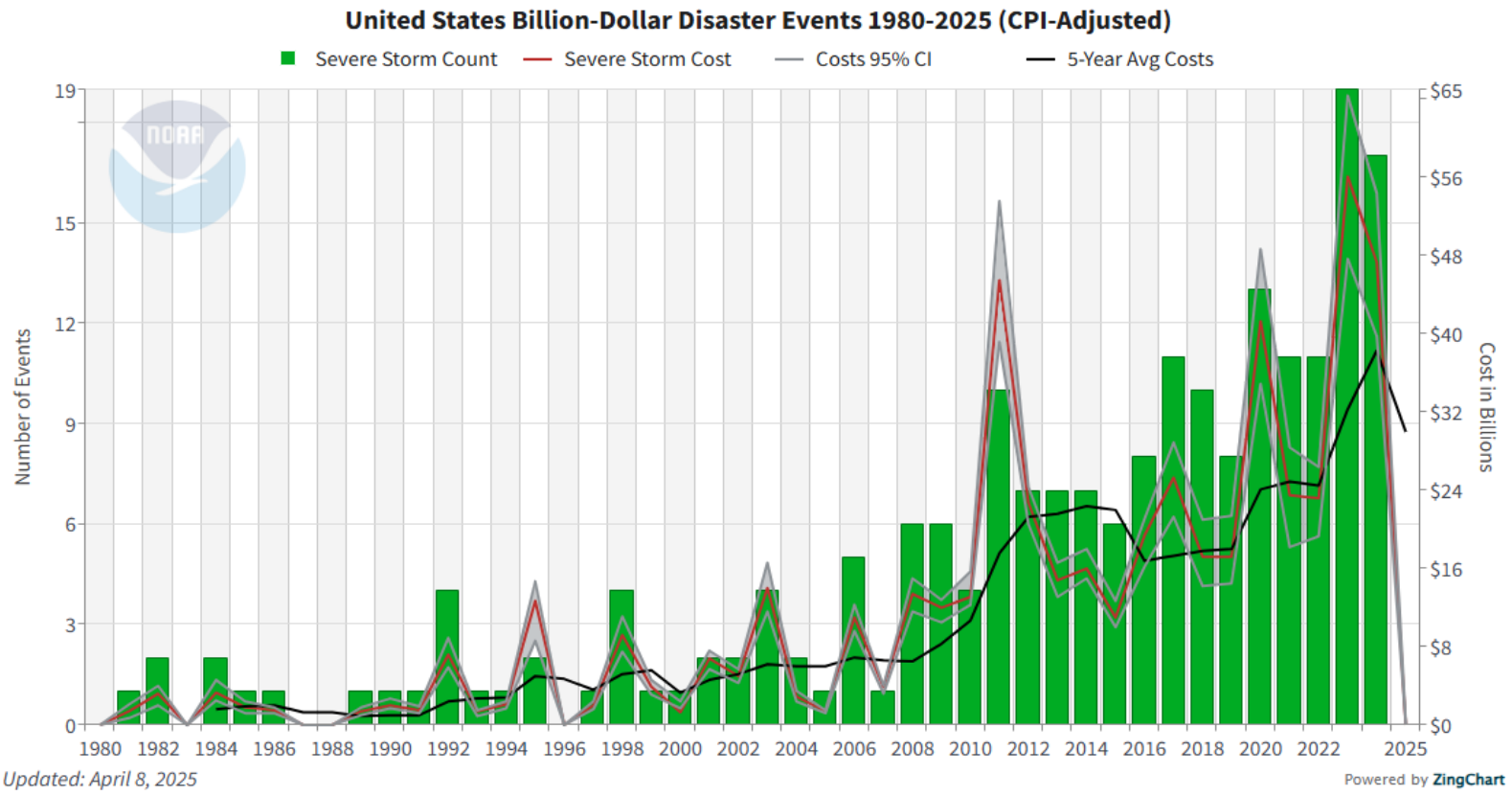
A Hail of a Good Time: Understanding Forecast Storms

August 1st, 2025

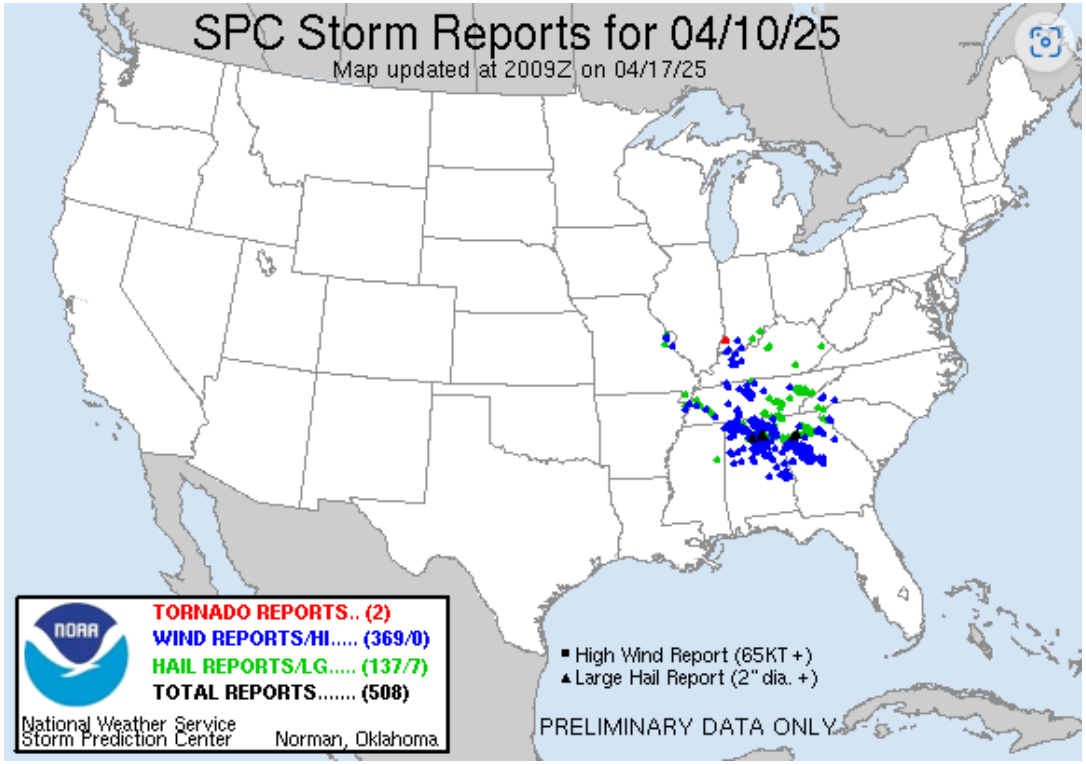
Climate Disasters

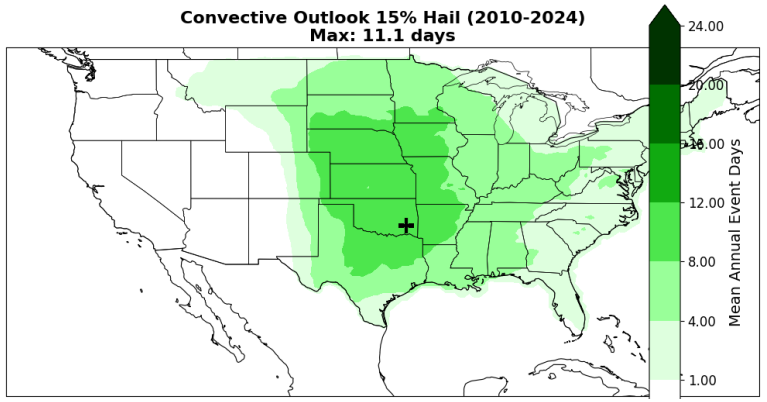


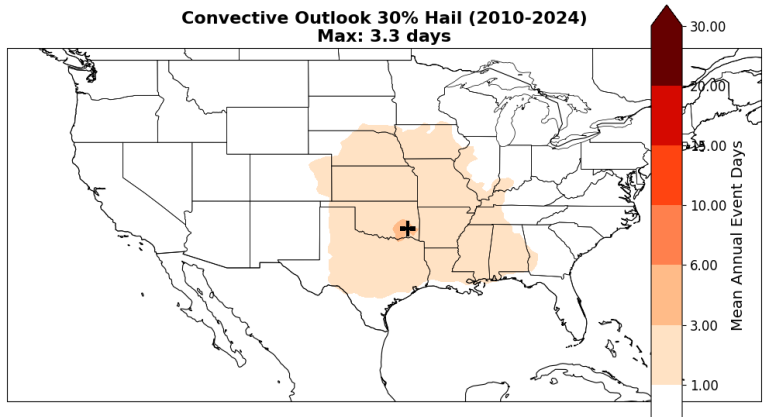
Severe Convective Storms

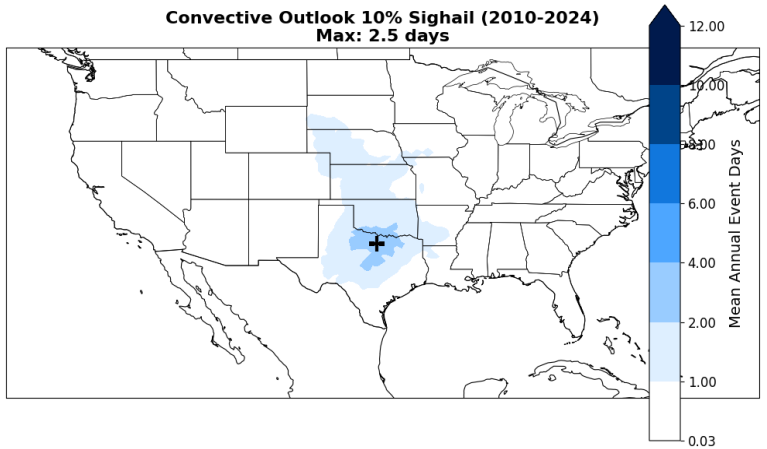


Convective Outlook (Short Intro)

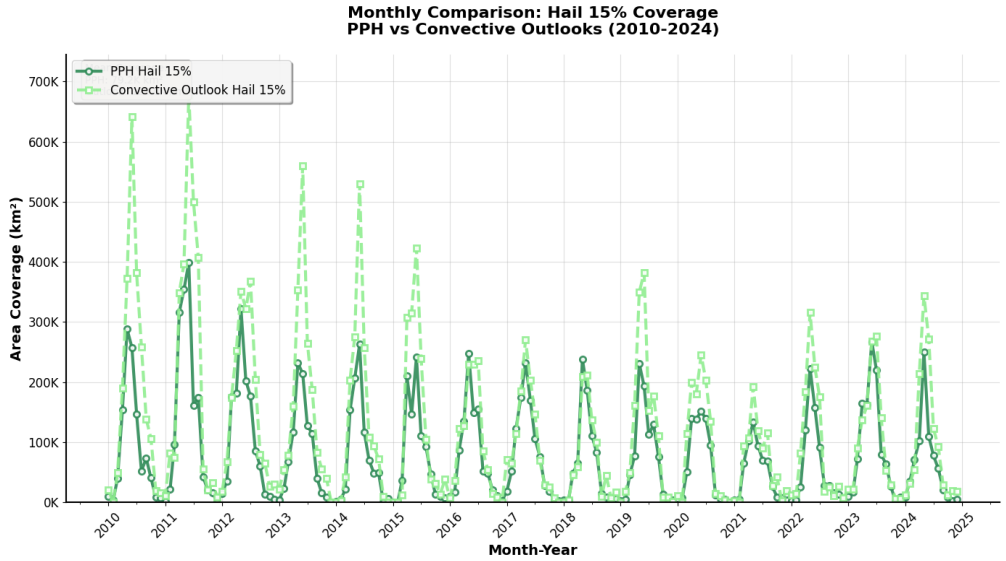


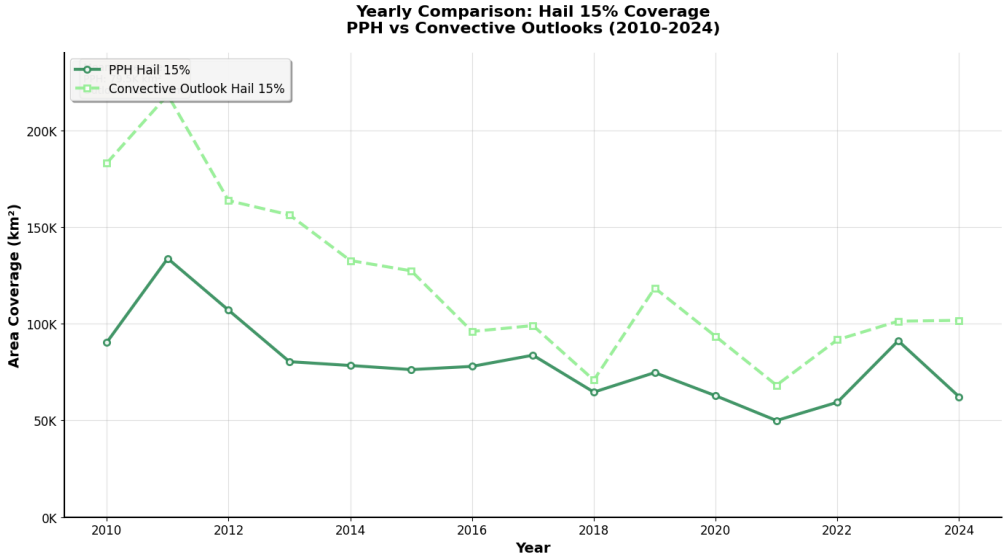

Convective Outlook 15% Hail (2010-2024)
Max: 11.1 days
24.00
20.00
16.00
12.00
8.00
4.00
1.00
Mean Annual Event Days


Convective Outlook 30% Hail (2010-2024)
Max: 3.3 days
30.00
20.00
15.00
10.00
6.00
3.00
1.00
Mean Annual Event Days

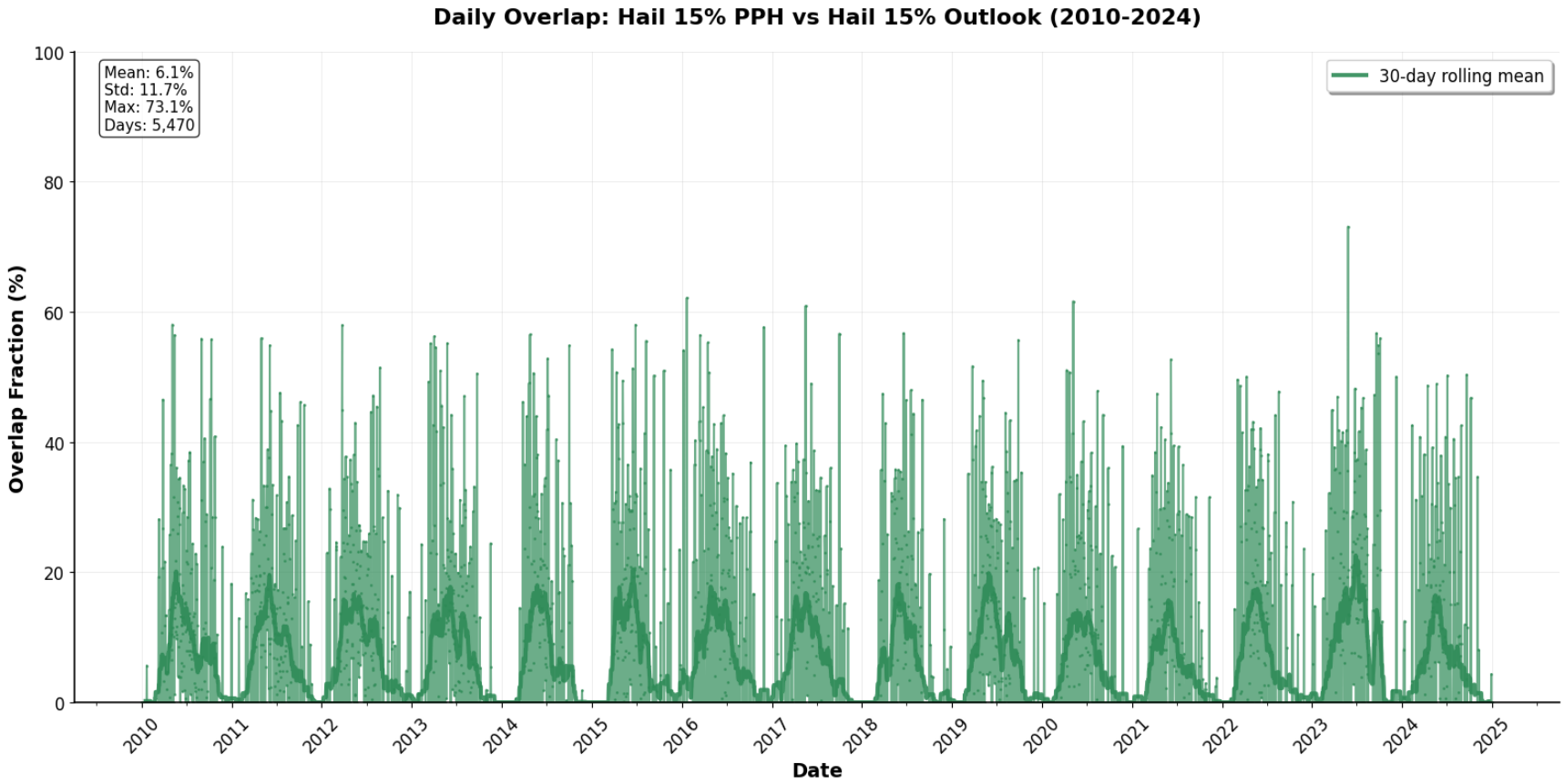

Convective Outlook 10% Sighail (2010-2024)
Max: 2.5 days
12.00
10.00
8.00
6.00
4.00
2.00
1.00
0.03
Mean Annual Event Days

Area coverage

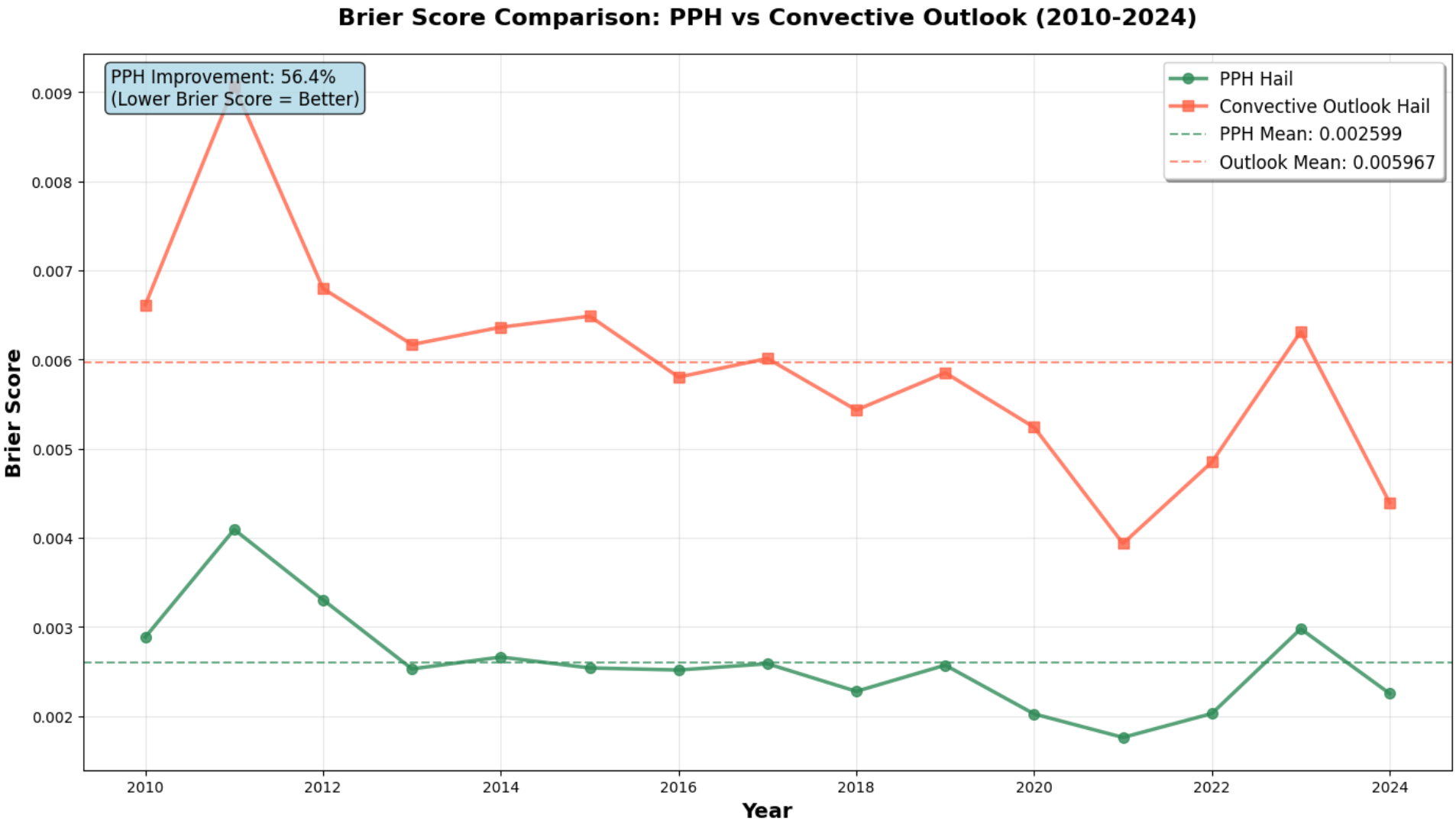


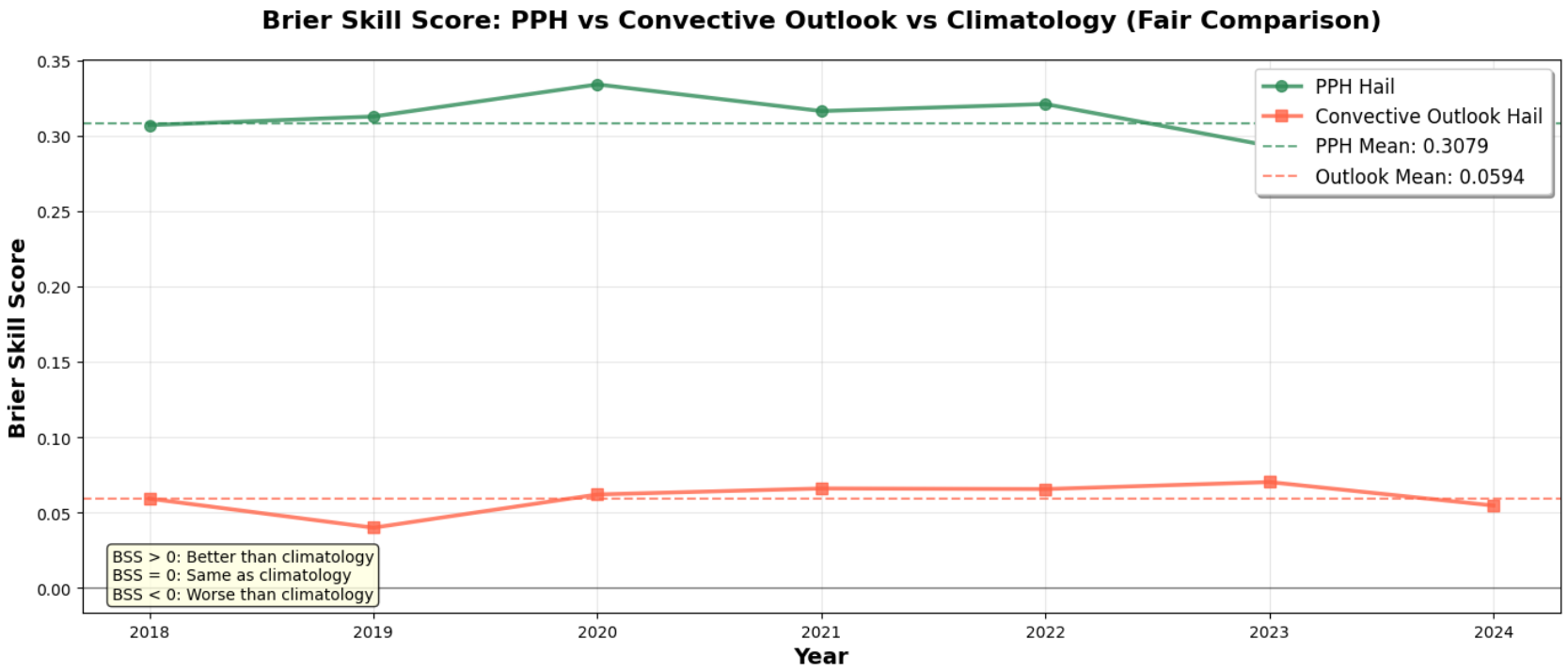


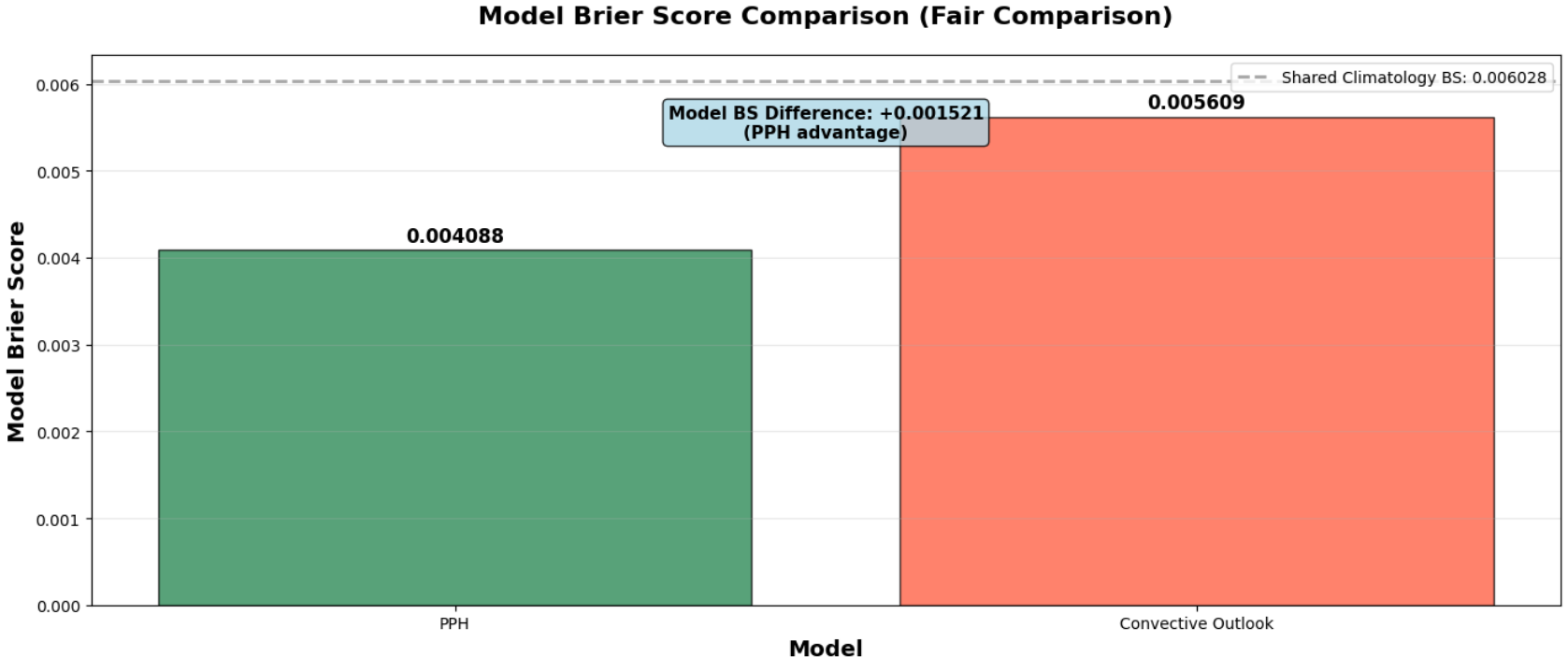
Brier Skill Score

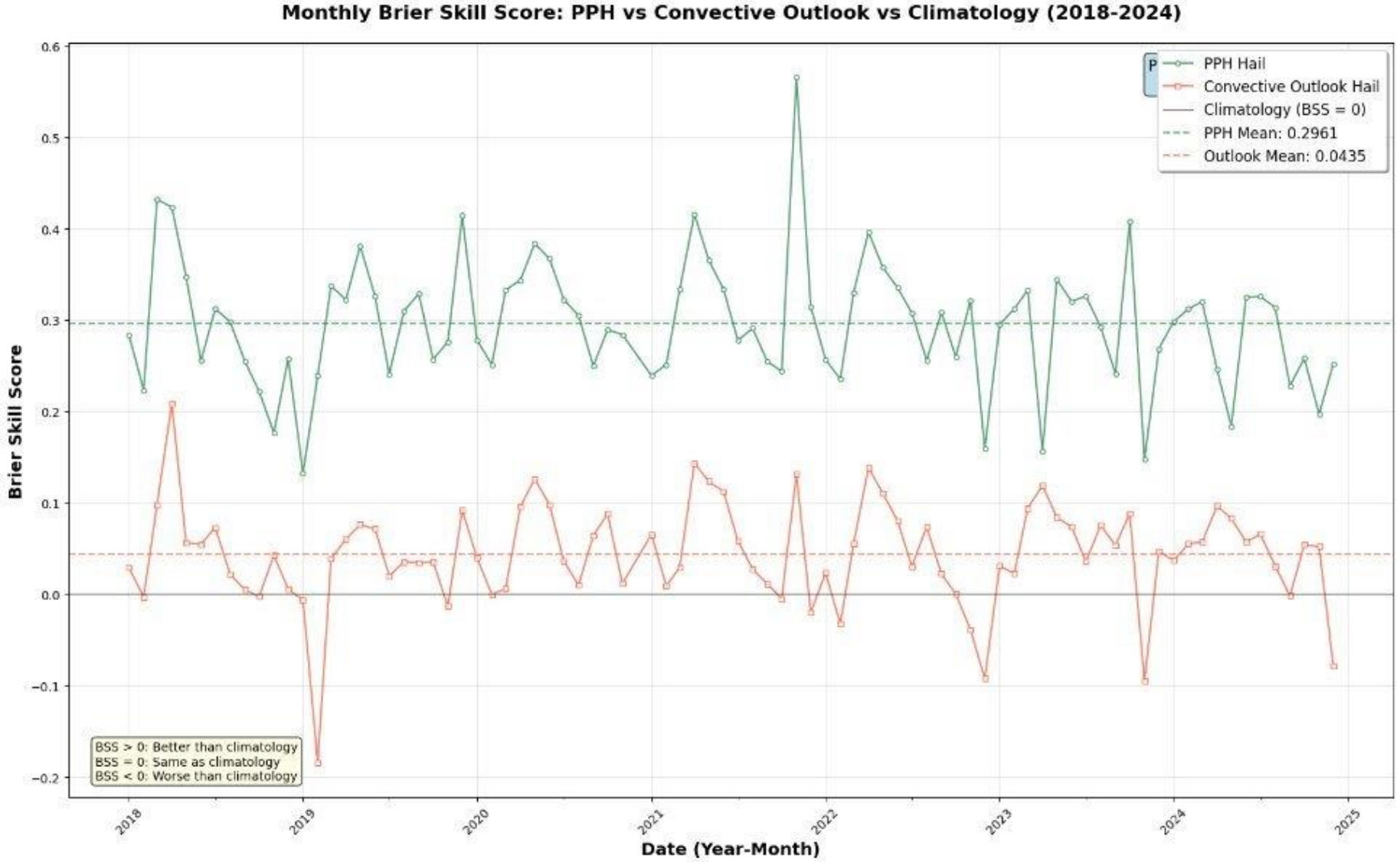

Daily Overlap: Hail 15% PPH vs Hail 15% Outlook (2010-2024)
Mean: 6.1%
Std: 11.7%
Max: 73.1%
Days: 5,470
30-day rolling mean
Overlap Fraction (%)
0
20
40
60
80
100
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date

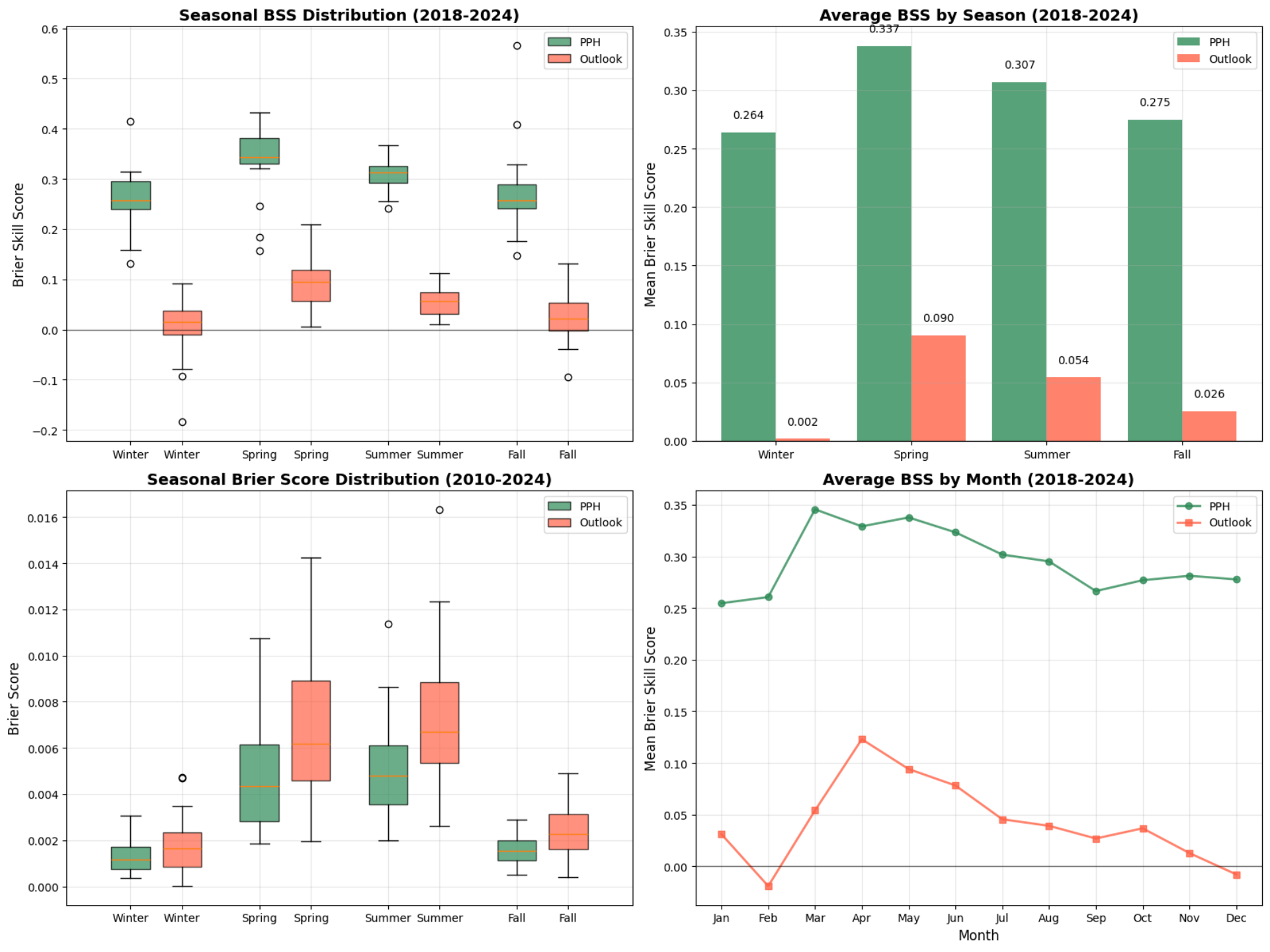
Severe Convective Storms



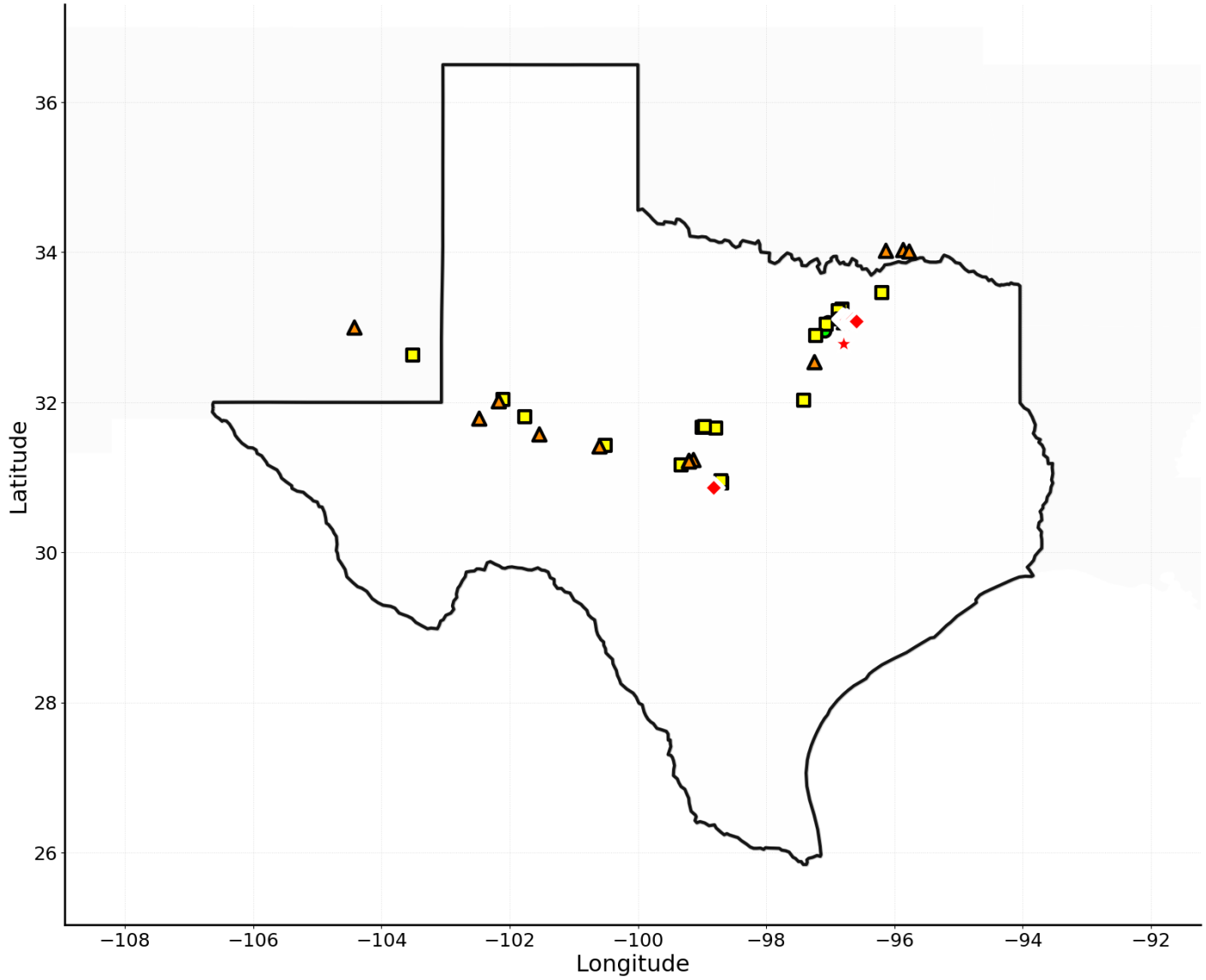

Brier Skill Score: PPH vs Convective Outlook vs Climatology (Fair Comparison)
PPH Hail
Convective Outlook Hail
PPH Mean: 0.3079
Outlook Mean: 0.0594
BSS > 0: Better than climatology
BSS = 0: Same as climatology
BSS < 0: Worse than climatology
Brier Skill Score
Year
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
2018
2019
2020
2021
2022
2023
2024


Model Brier Score Comparison (Fair Comparison)
Shared Climatology BS: 0.006028
Model BS Difference: +0.001521
(PPH advantage)
0.005609
0.004088
Model Brier Score
Model
PPH
Convective Outlook
0.006
0.005
0.004
0.003
0.002
0.001
0.000


Monthly Brier Skill Score: PPH vs Convective Outlook vs Climatology (2018-2024)
PPH Hail
Convective Outlook Hail
Climatology (BSS = 0)
PPH Mean: 0.2961
Outlook Mean: 0.0435
BSS > 0: Better than climatology
BSS = 0: Same as climatology
BSS < 0: Worse than climatology
Brier Skill Score
Date (Year-Month)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
2018
2019
2020
2021
2022
2023
2024
2025


Seasonal BSS Distribution (2018-2024)
Brier Skill Score
PPH
Outlook
Winter
Winter
Spring
Spring
Summer
Summer
Fall
Fall
Average BSS by Season (2018-2024)
Mean Brier Skill Score
0.264
0.002
0.337
0.090
0.307
0.054
0.275
0.026
Seasonal Brier Score Distribution (2010-2024)
Brier Score
Average BSS by Month (2018-2024)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Texas Hail Reports
May 19, 2023



PPH FORECAST CONTOURS
- 0.05 probability
- 0.10 probability
- 0.15 probability
- 0.30 probability
- 0.60 probability

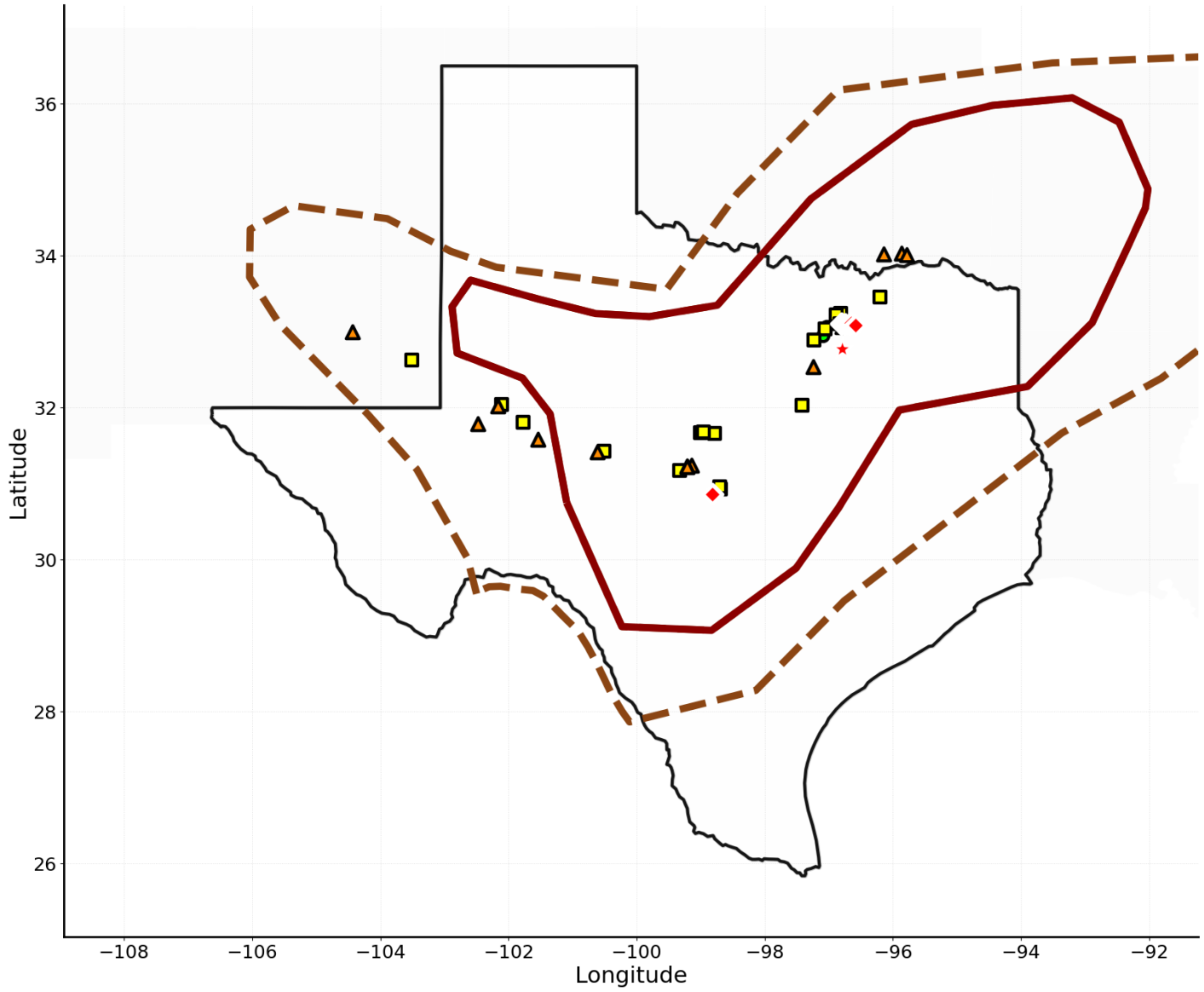
MESH RADAR GRID (35% transparent)
- Small (0.1-0.75")
- Penny (0.75-1")
- Quarter (1-1.75")
- Golf Ball (1.75-2.5")
- Large (>2.5")

SPC OUTLOOK
- 5%% Hail
- 15%% Hail

STORM REPORTS
- Small (<0.75") (2)
- Penny (0.75-1") (17)
- Quarter (1-1.75") (17)
- Golf Ball (1.75-2.75") (6)

REFERENCE
- Dallas

Texas Hail Reports + Convective Outlooks
May 19-20



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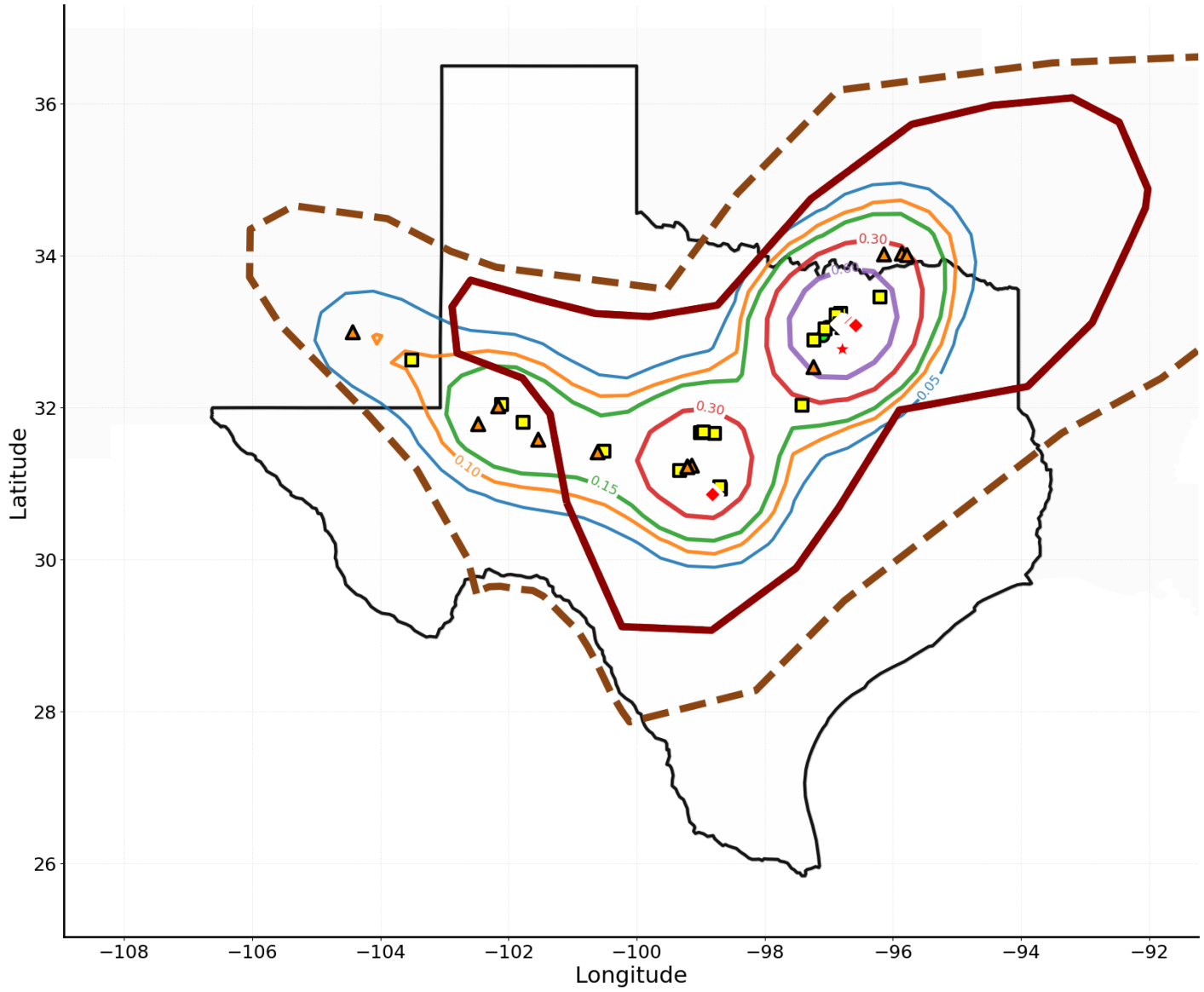
UNC INSTITUTE FOR RISK MANAGEMENT AND INSURANCE INNOVATION

Texas Hail Analysis Storm + Convective Outlook + PPH
May 19-20, 2023



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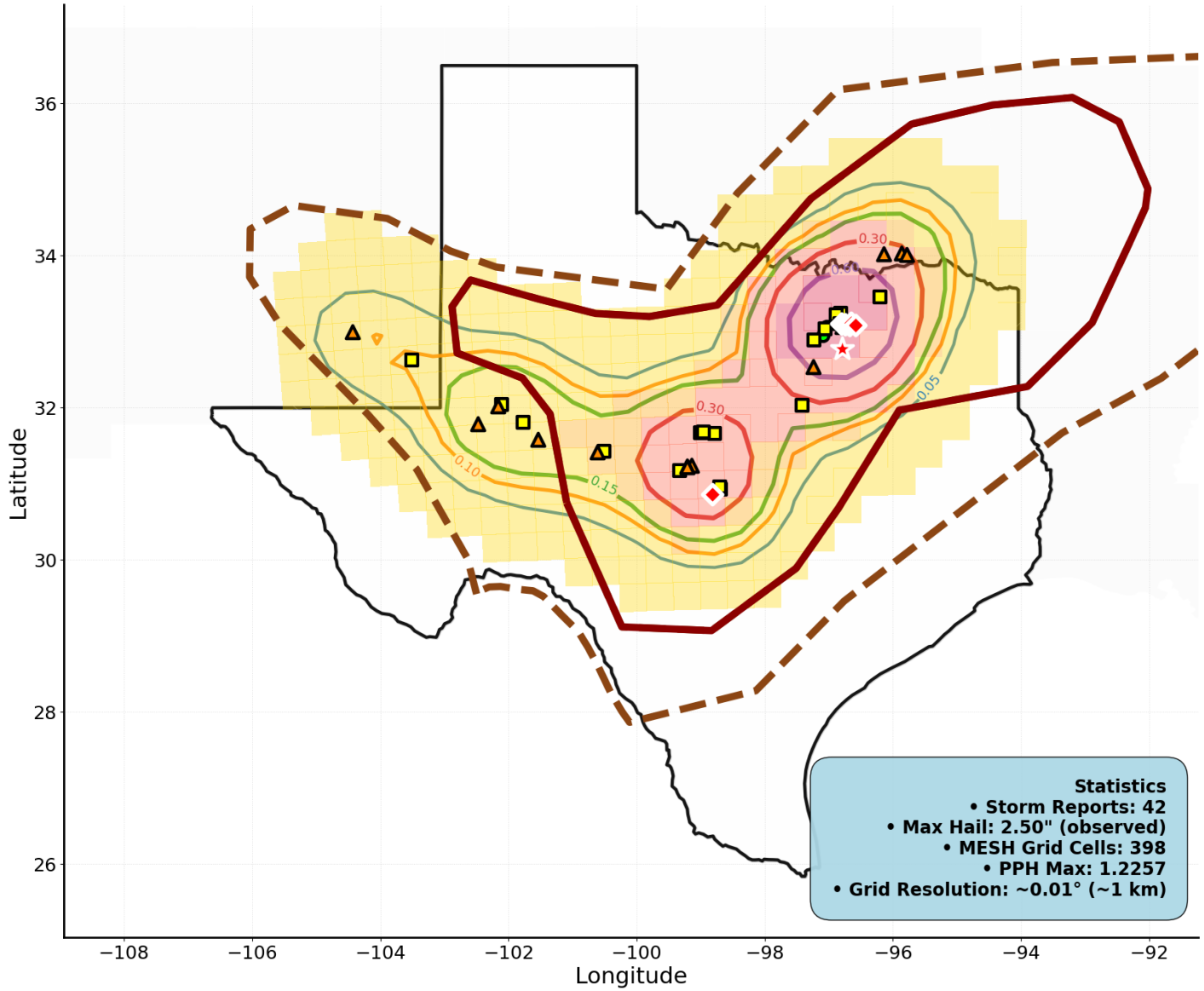
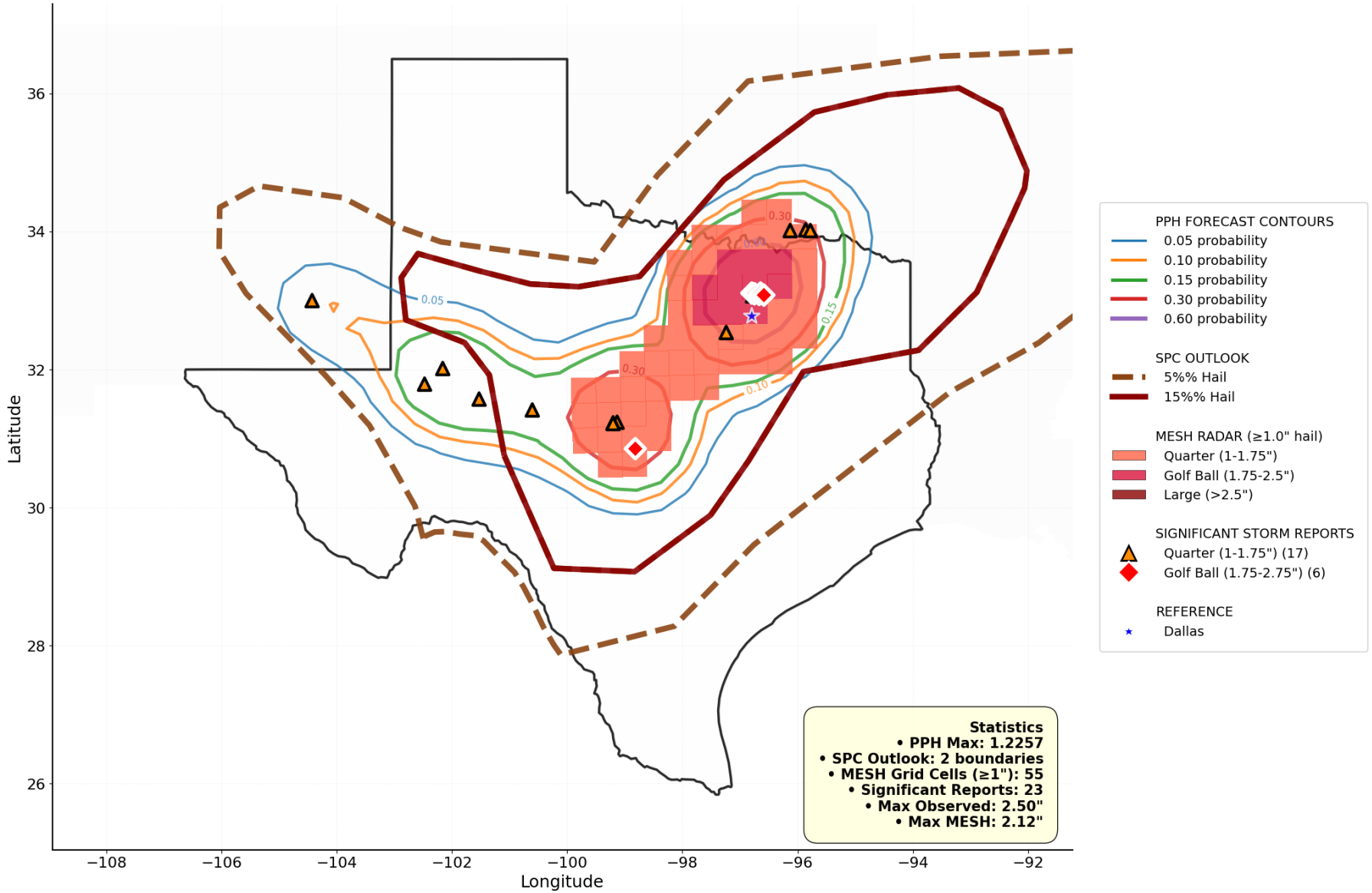
UNC INSTITUTE FOR RISK MANAGEMENT AND INSURANCE INNOVATION

Texas Hail
Storm Reports + Convective Outlooks + PPH + Radar MESH
May 19-20, 2023



UNC INSTITUTE FOR RISK MANAGEMENT AND INSURANCE INNOVATION

Texas Hail
PPH + Outlook + MESH + Significant Reports
Significant Hail
May 19-20, 2023



Why are we doing this ? / Next Steps

Estimate damages

$$\mathrm{TIV}_{\mathrm{Loss}}(d,\phi,\lambda) = F\Big(\underbrace{\{P_{g,\sigma}(d,\phi,\lambda)\}_{g\in\{211,212,215,218\},\ \sigma\in\{1.5,\,2,\,2.5,\,3\}}}_{16\,\text{convective-outlook probabilities}},\ \mathrm{MESH}(d,\phi,\lambda),\ \mathrm{Dist}_{\mathrm{NCEI}}(d,\phi,\lambda),\ \overline{\mathrm{Age}}(d,\phi,\lambda),\ \overline{\mathrm{Roof}}(d,\phi,\lambda),\ \mathrm{Tax}(d,\phi,\lambda)\Big)$$

Variable definitions

- **d** Date (day, month, year).
- **ϕ, λ** Latitude and longitude of the grid cell centre.
- $P_{g,\sigma}(d,\phi,\lambda)$ Convective-outlook probability on NAM grid **g** ∈ {211, 212, 215, 218} after Gaussian smoothing scale **σ** ∈ {1.5, 2, 2.5, 3}.
- **MESH** Radar-derived *Maximum Estimated Size of Hail* at (d,ϕ,λ).
- $\mathrm{Dist}_{\mathrm{NCEI}}$ – Great-circle distance from (ϕ,λ) to the nearest NCEI severe-weather report valid on **d**.
- $\overline{\mathrm{Age}}$ Average building age in the cell.
- $\overline{\mathrm{Roof}}$ Average roof type (encoded numerically or one-hot and then averaged).
- **Tax** Average tax-appraised property value in the cell.

$F : \mathbb{R}^{16+5} \to [0, 100]$ is the model(e.g. random forest, diffusion-based model, etc) that maps the 16-element probability vector and the 5 additional predictors to an expected percentage loss of *total insured value* (TIV).