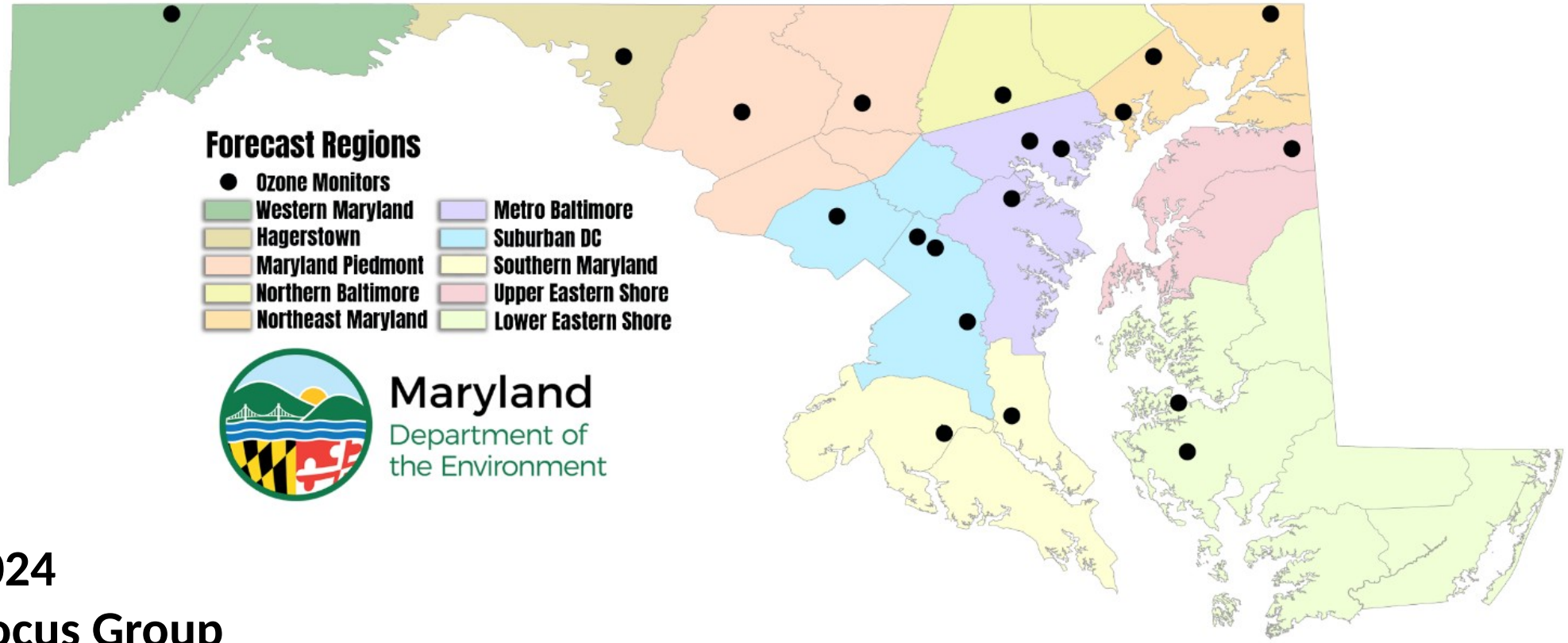
Maryland
Department of
the Environment

Maryland's 2024 Ozone Season NOAA Feedback



James Boyle
Joel Dreessen
October 9-10, 2024
AQ Forecaster Focus Group

Overview

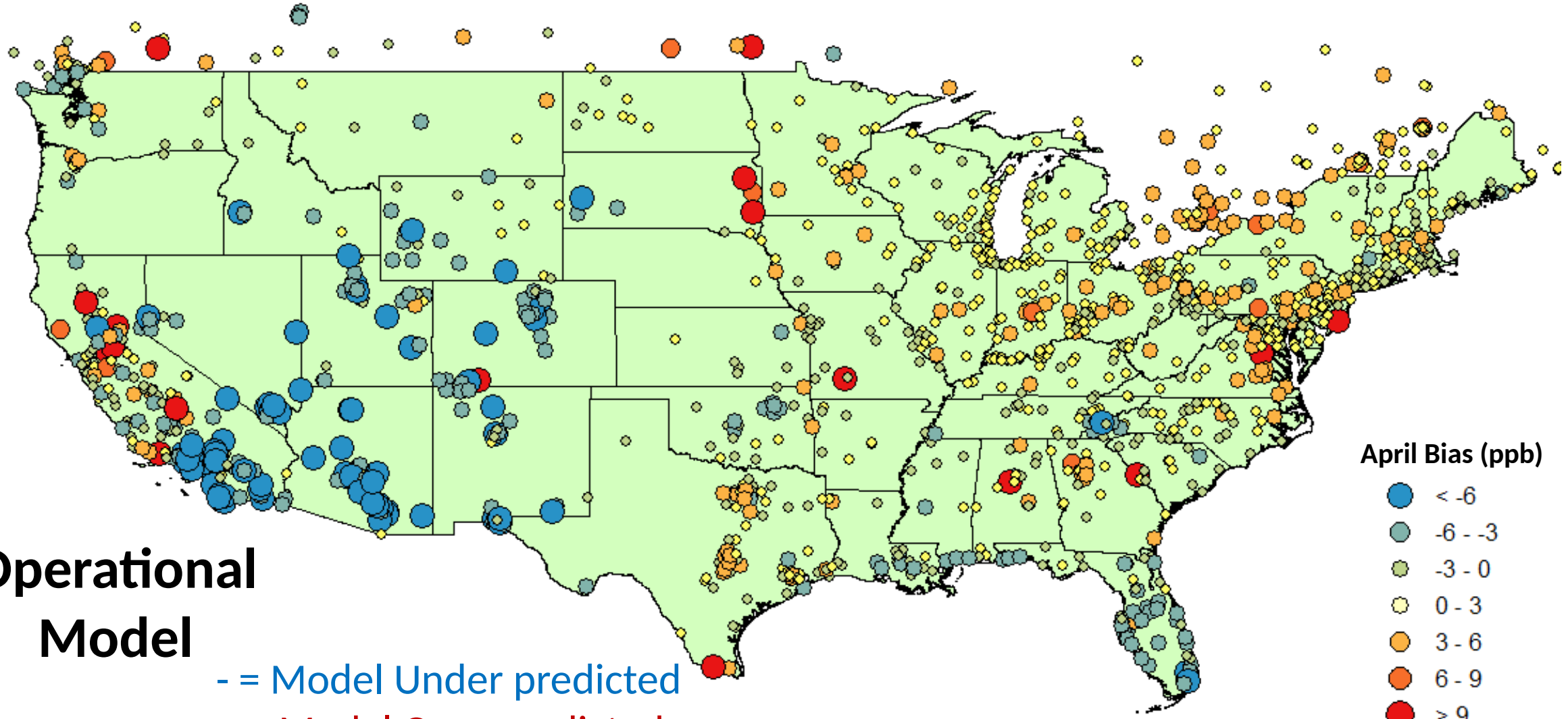
- National
  - Ozone: Monthly Forecast Bias
  - Ozone: Seasonal Bias
    - 2024 vs 2023
  - Ozone: Correct AQI Category

- Maryland
  - Operational versus Bias Corrected
  - False Alarms/Misses/Hits
    - Specific Examples
  - Model Bias at Low O_3 Concentrations
  - Low Model Bias at High O_3 Concentrations

Monthly BIAS – 8hr Ozone

April: 2024

12Z: Day 2



Operational Model

- = Model Under predicted

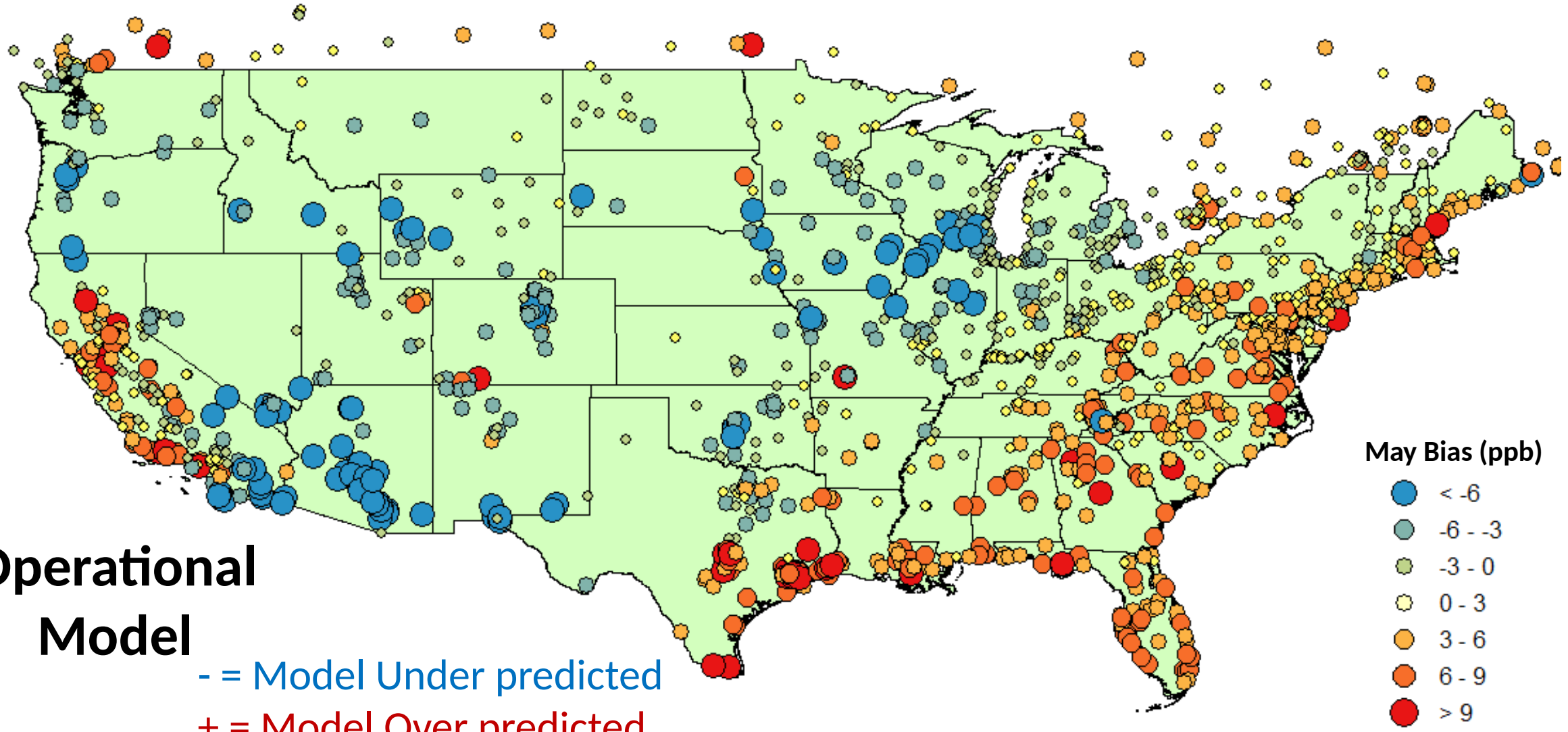
+ = Model Over predicted

*2024 data is preliminary

Monthly BIAS – 8hr Ozone

May: 2024

12Z: Day 2



Operational Model

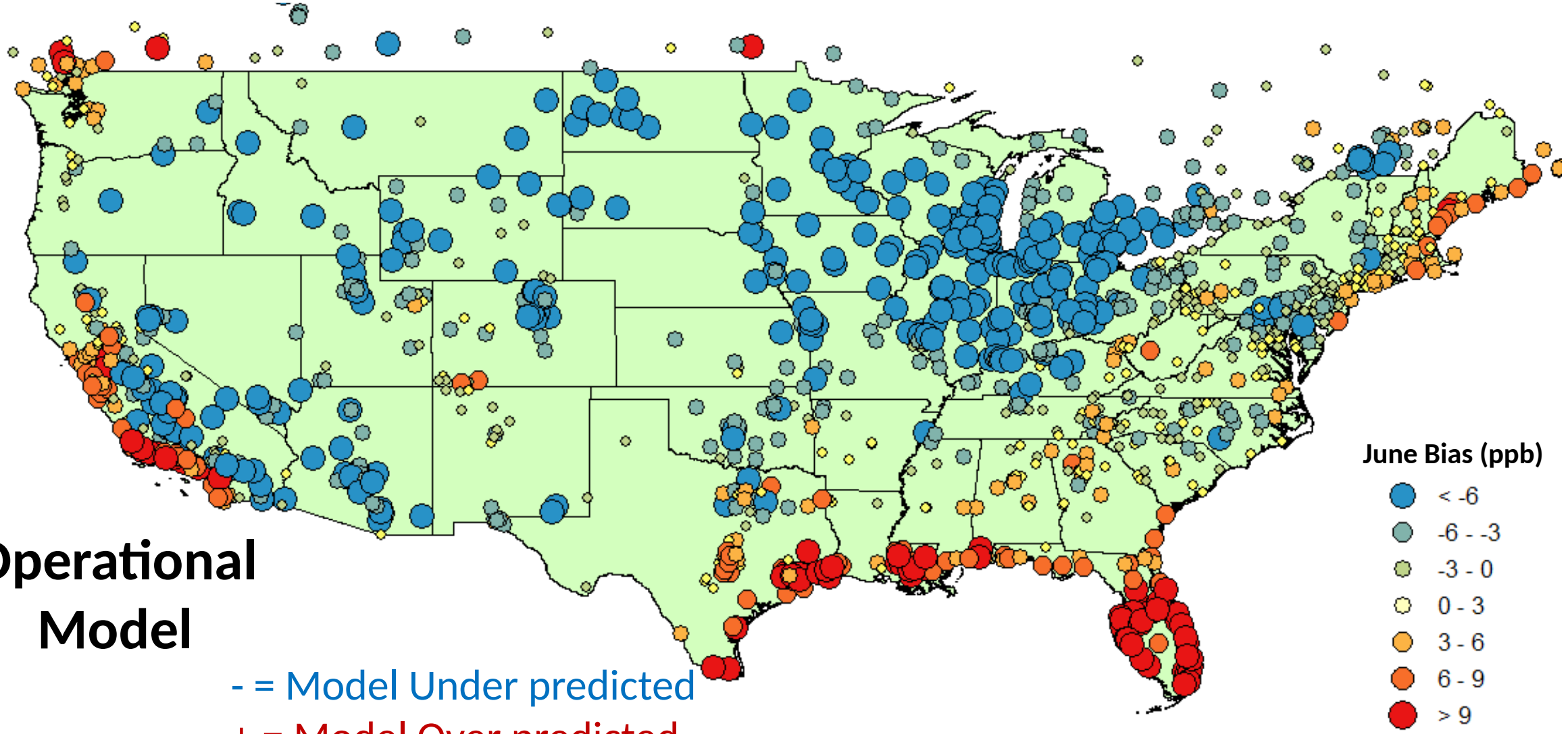
- = Model Under predicted

+ = Model Over predicted

Monthly BIAS – 8hr Ozone

June: 2024

12Z: Day 2



Operational Model

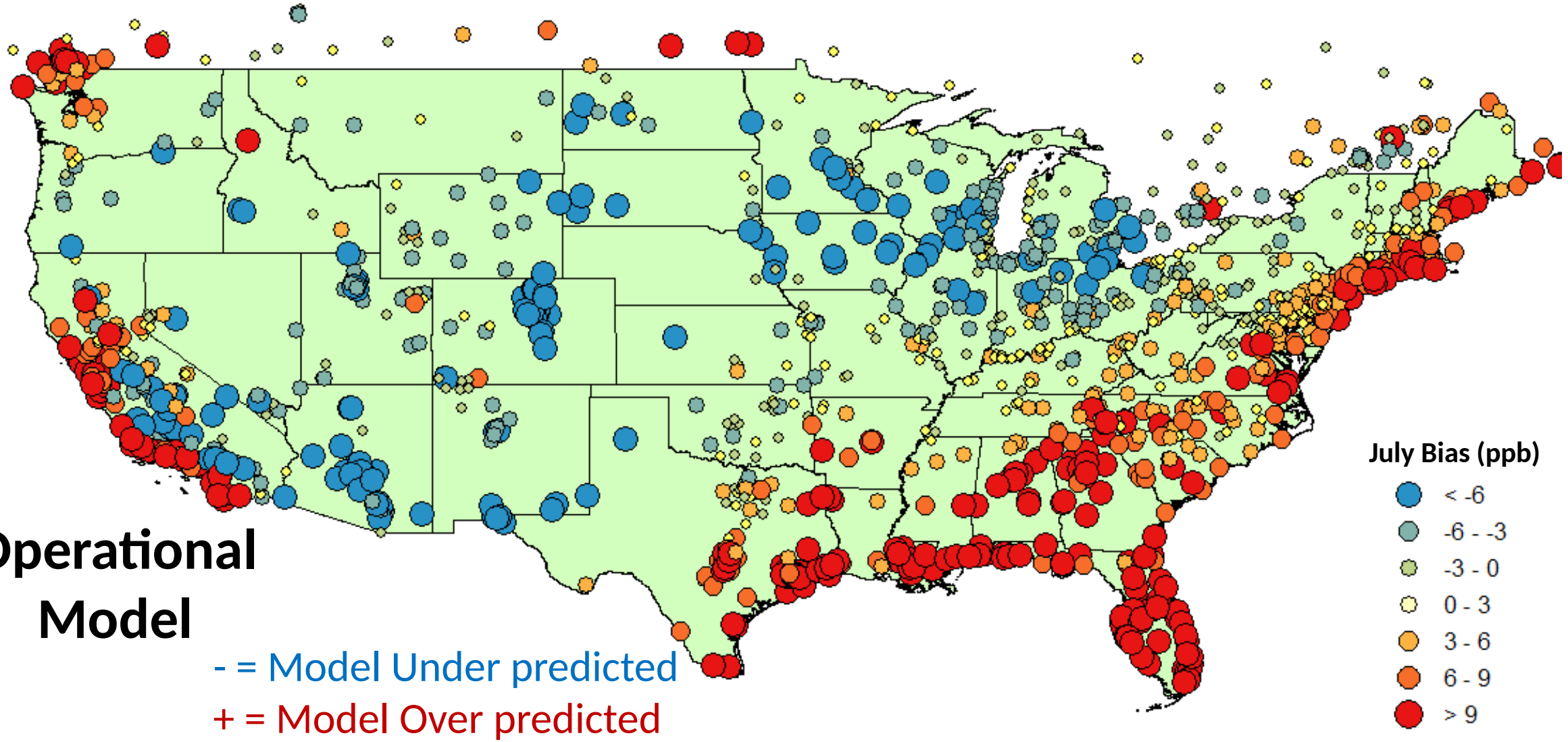
- = Model Under predicted

+ = Model Over predicted

Monthly BIAS – 8hr Ozone

July: 2024

12Z: Day 2



Operational Model

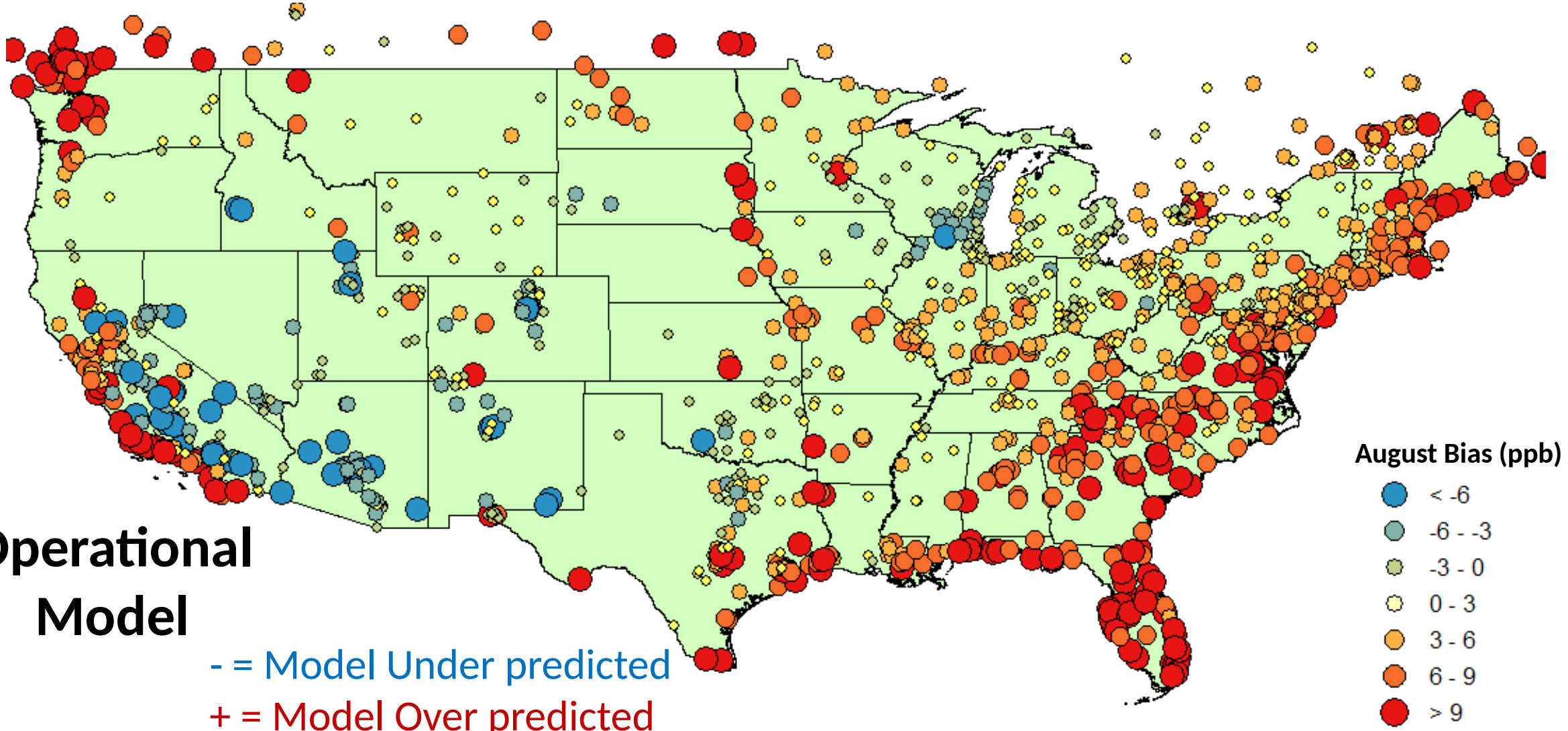
- = Model Under predicted

+ = Model Over predicted

Monthly BIAS – 8hr Ozone

August: 2024

12Z: Day 2



Operational Model

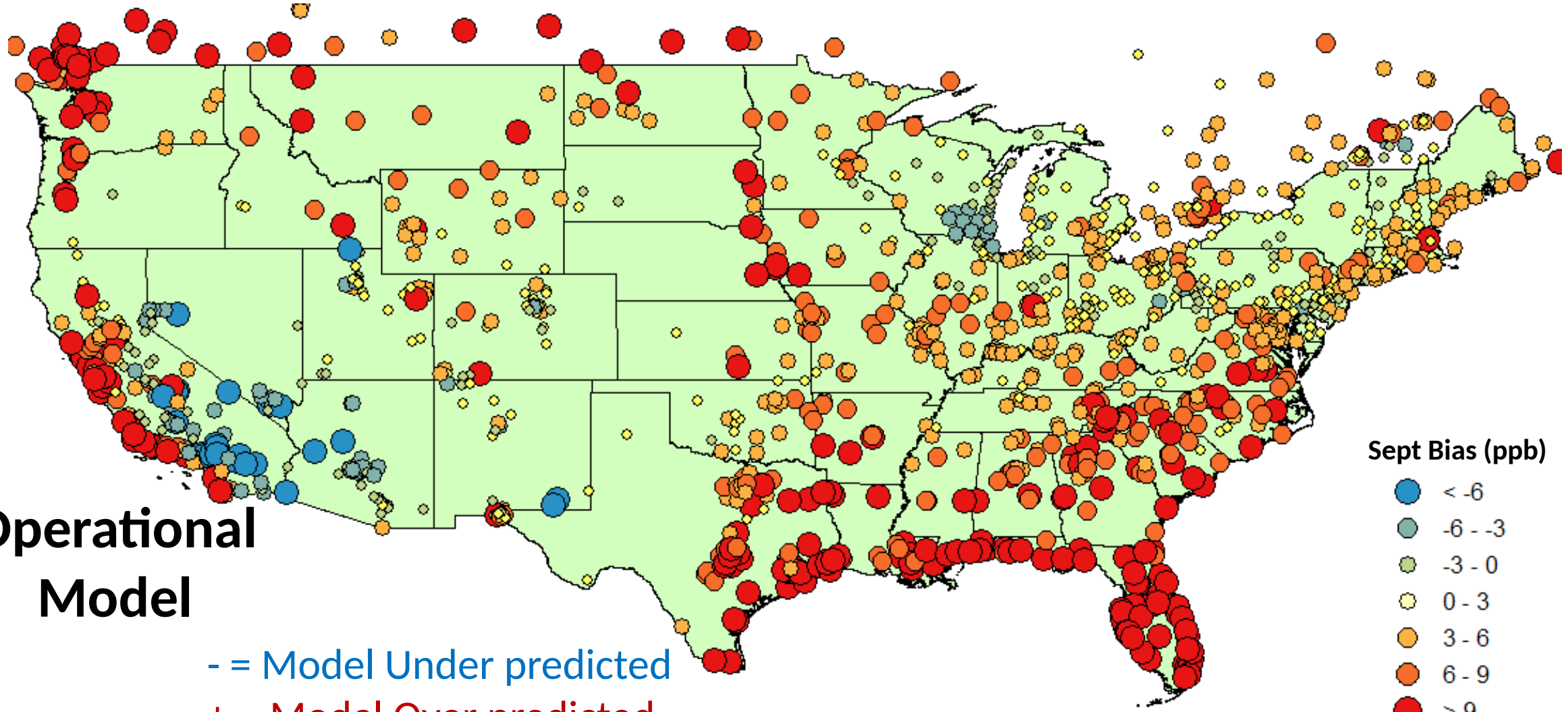
- = Model Under predicted

+ = Model Over predicted

Monthly BIAS – 8hr Ozone

Sept*: 2024

12Z: Day 2



Operational Model

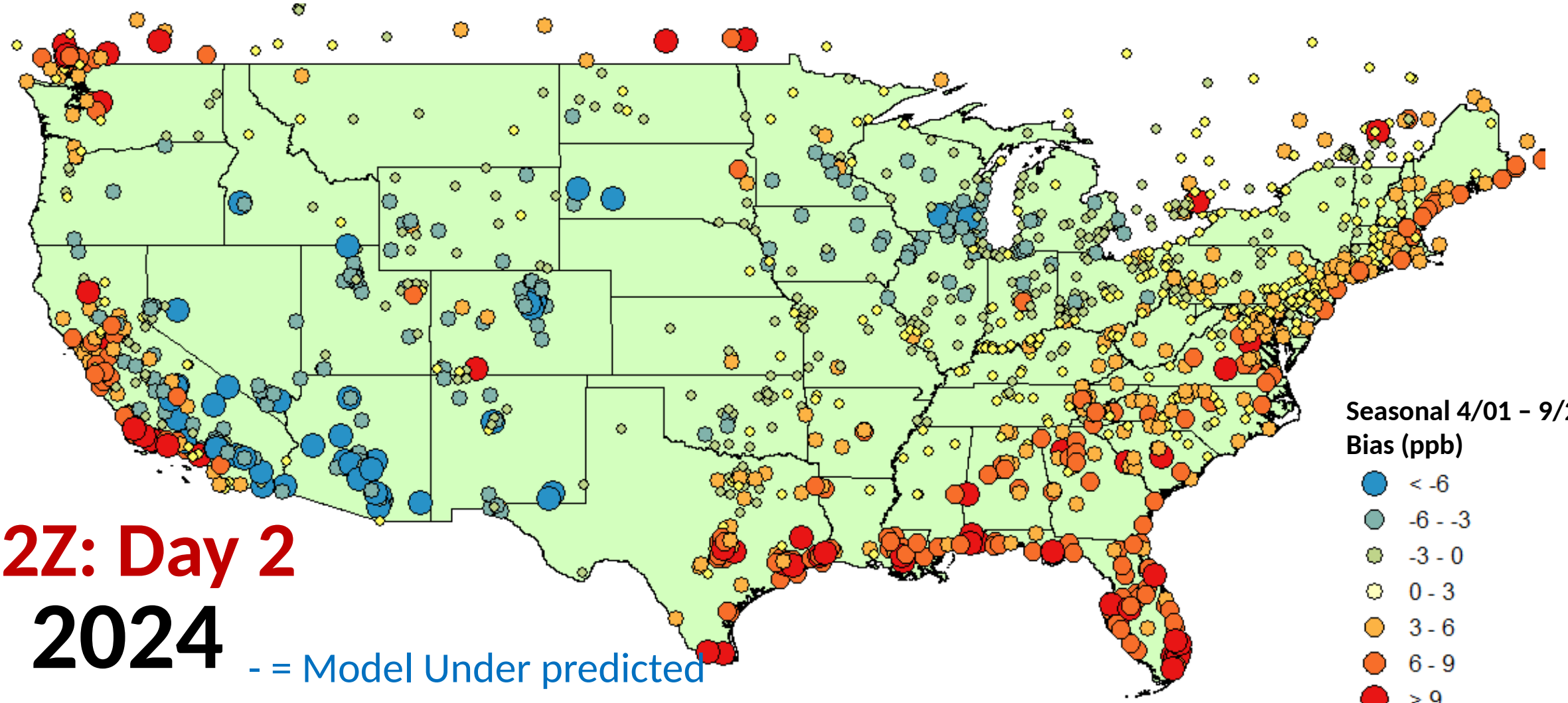
\- = Model Under predicted

\+ = Model Over predicted

**Valid for Sept 1st – Sept 20th*

Seasonal BIAS – 8hr Ozone

Operational



12Z: Day 2

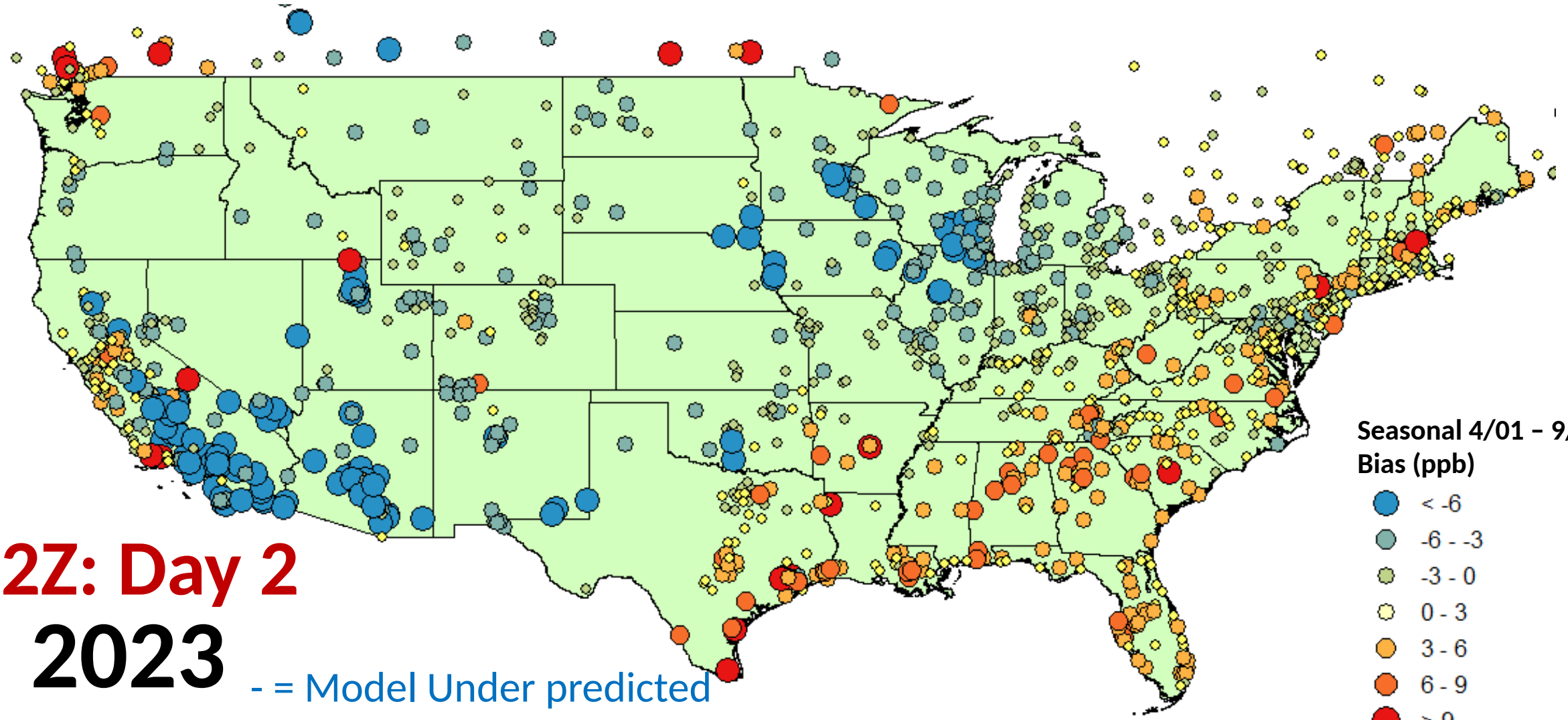
2024

- = Model Under predicted

+ = Model Over predicted

Seasonal BIAS – 8hr Ozone

Operational



12Z: Day 2

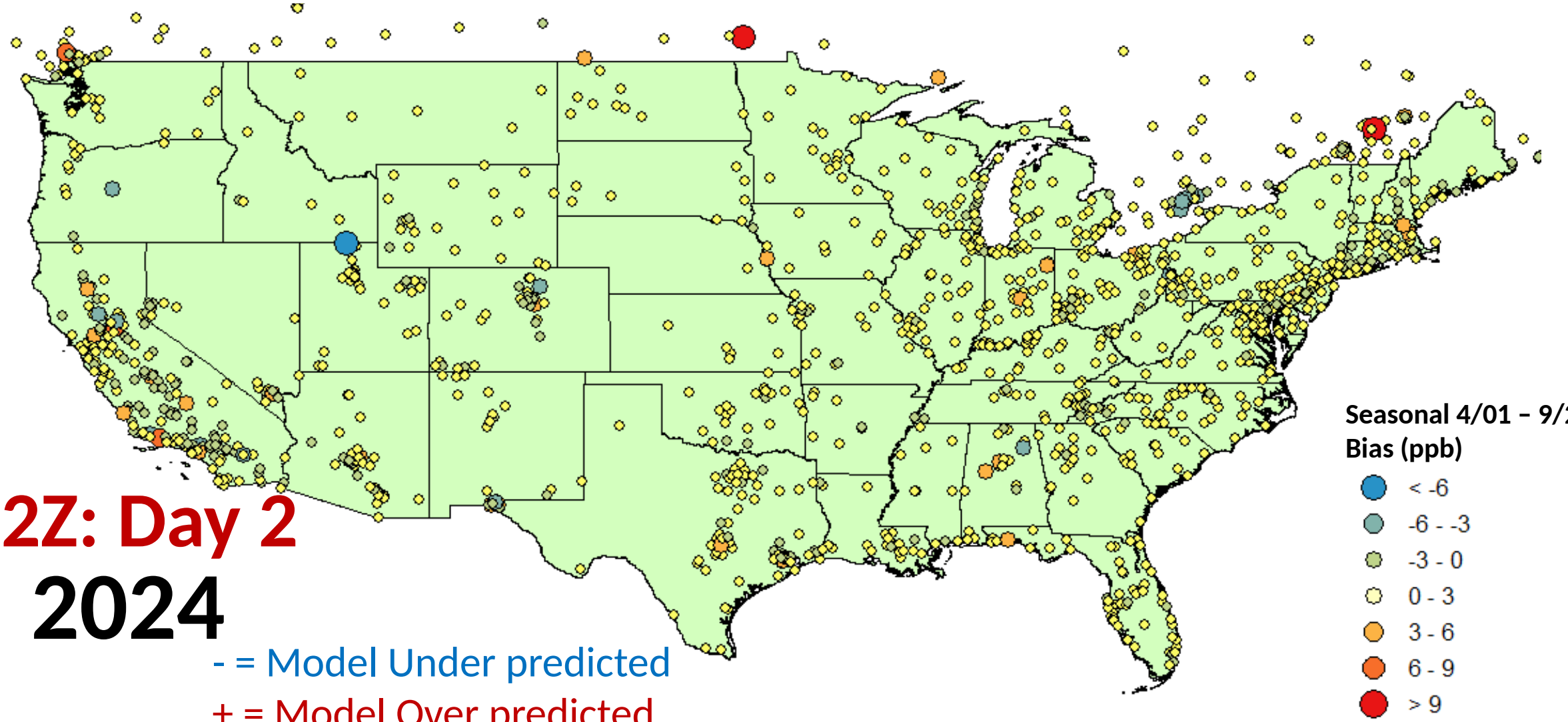
2023

\- = Model Under predicted

\+ = Model Over predicted

Seasonal BIAS – 8hr Ozone

Bias Corrected



12Z: Day 2

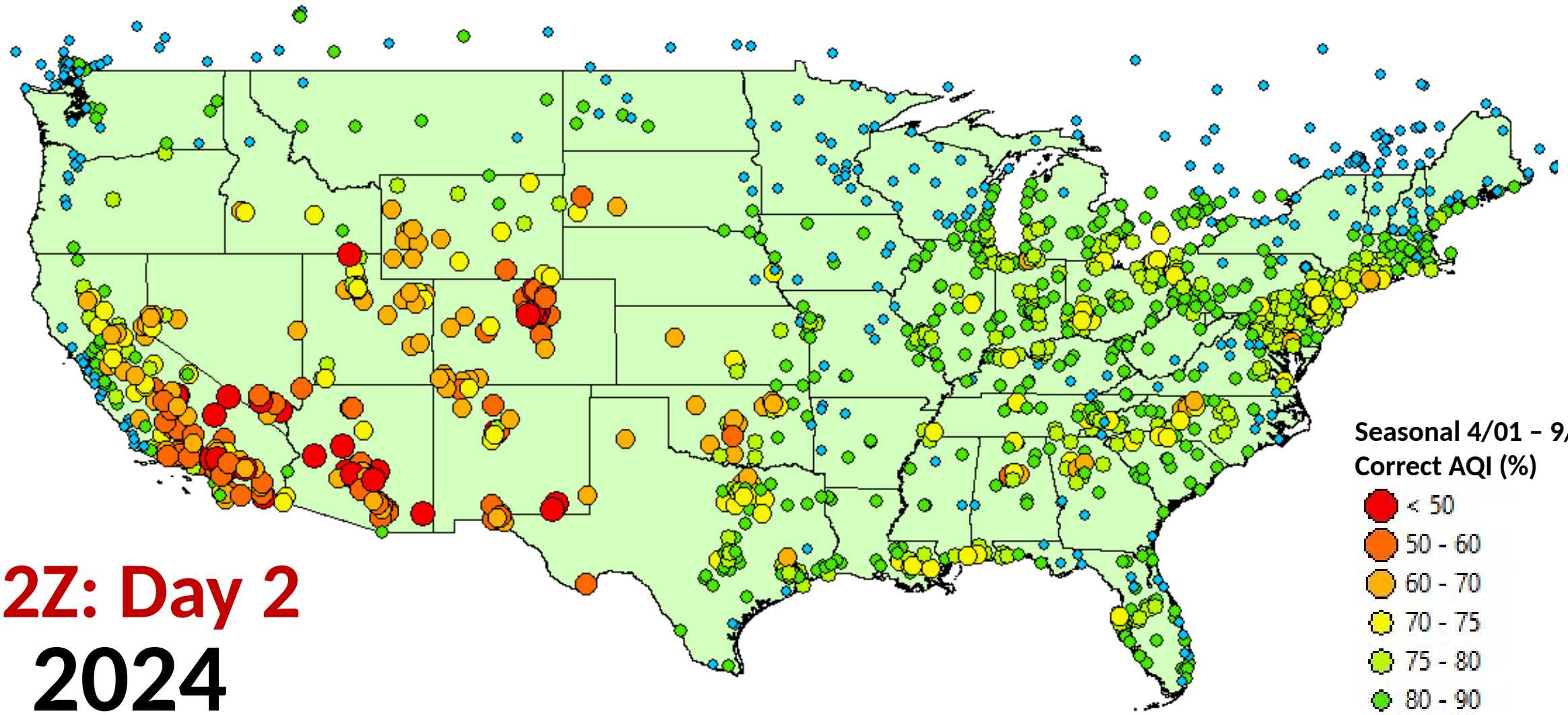
2024

- = Model Under predicted

+ = Model Over predicted

Seasonal Correct AQI Category: Ozone

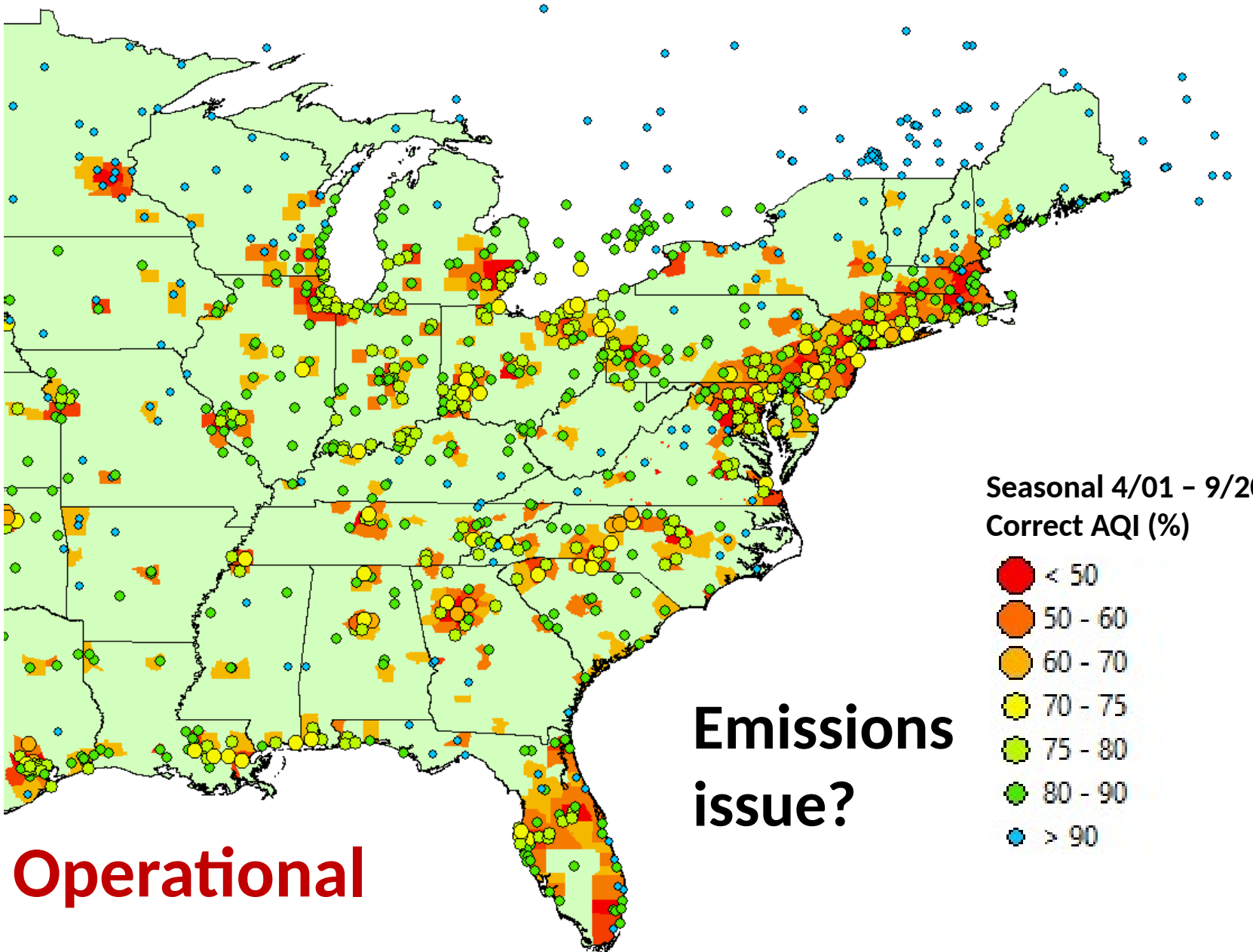
Operational



12Z: Day 2

2024

Seasonal Correct AQI Category: Ozone

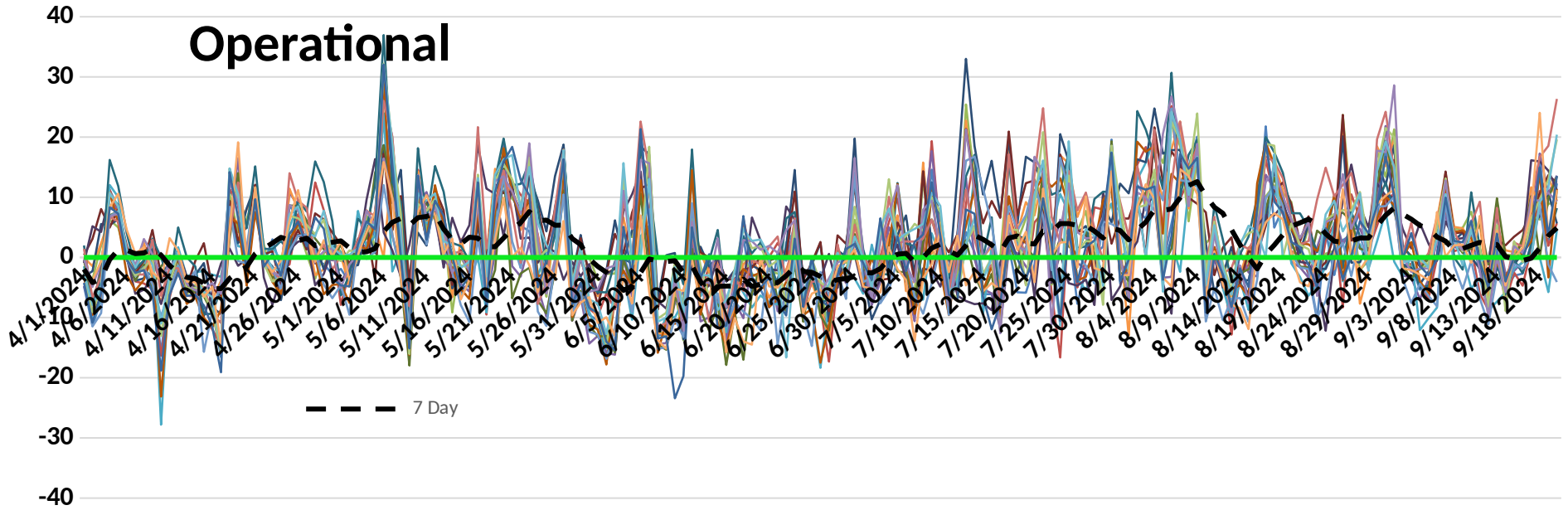


2024

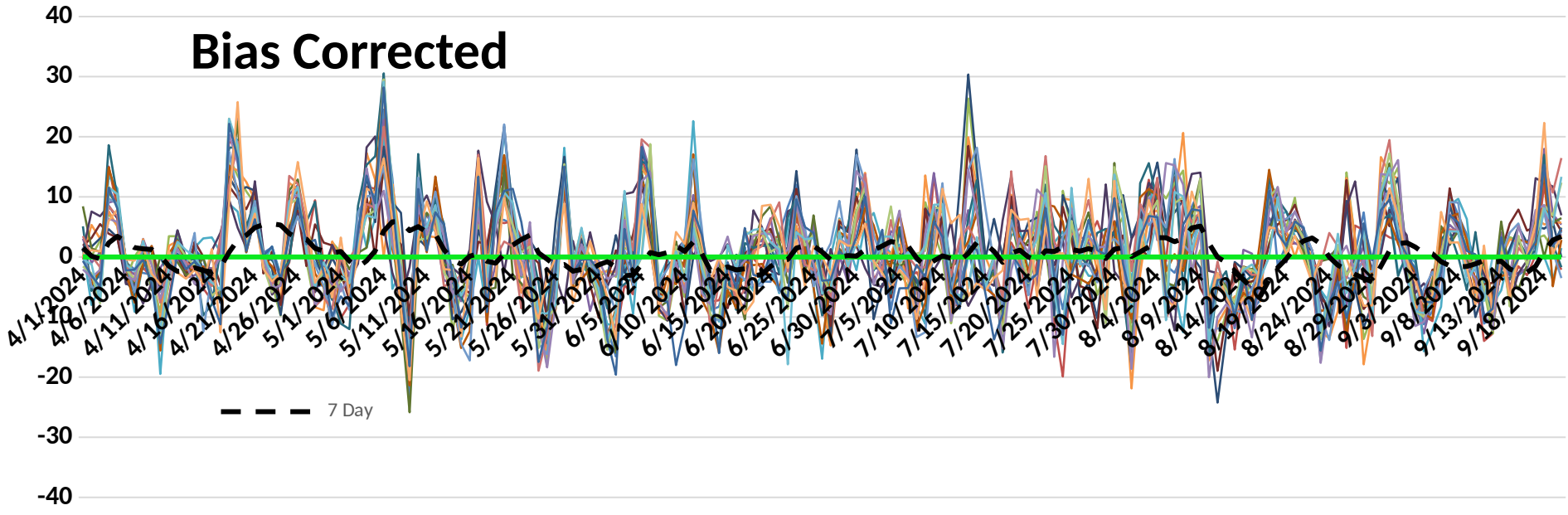
12Z: Day 2 Operational

Emissions issue?

NOAA DAY-2 MARYLAND ERRORS (Model - Observations)



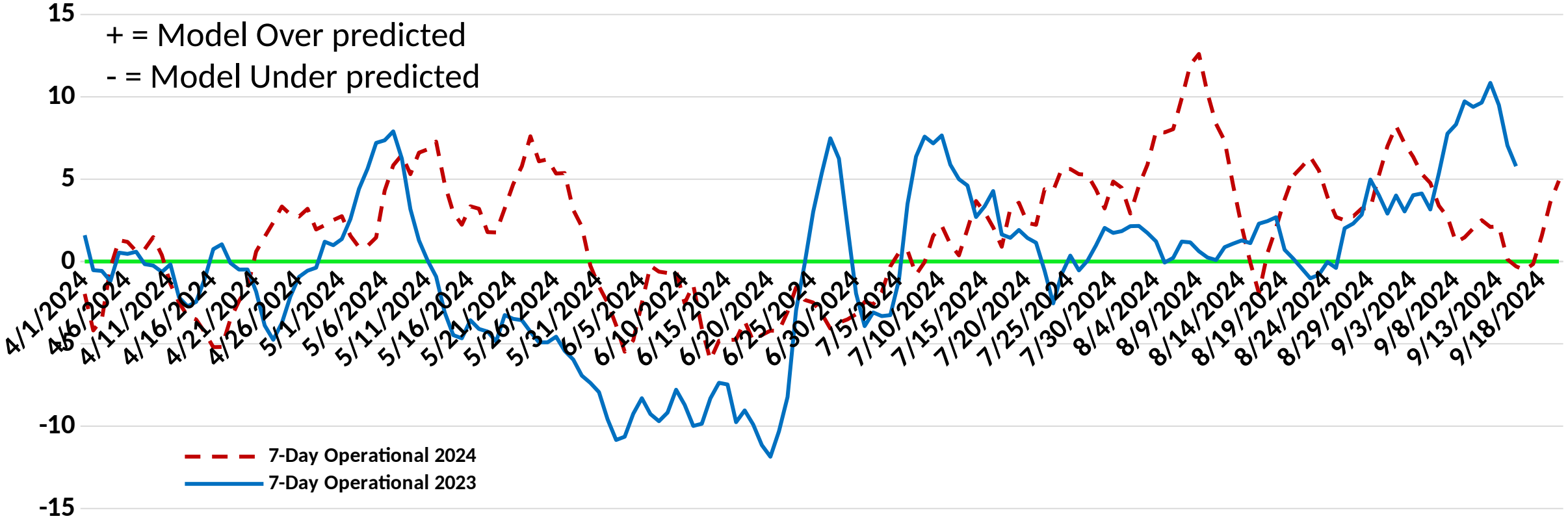
April: 0
May: 3.18
June: -2.93
July: 2.74
August: 5.62
Sept*: 2.88
All: 1.89



April: 1.16
May: 0.95
June: -0.29
July: 0.86
August: 0.04
Sept*: 0.03
All: 0.49

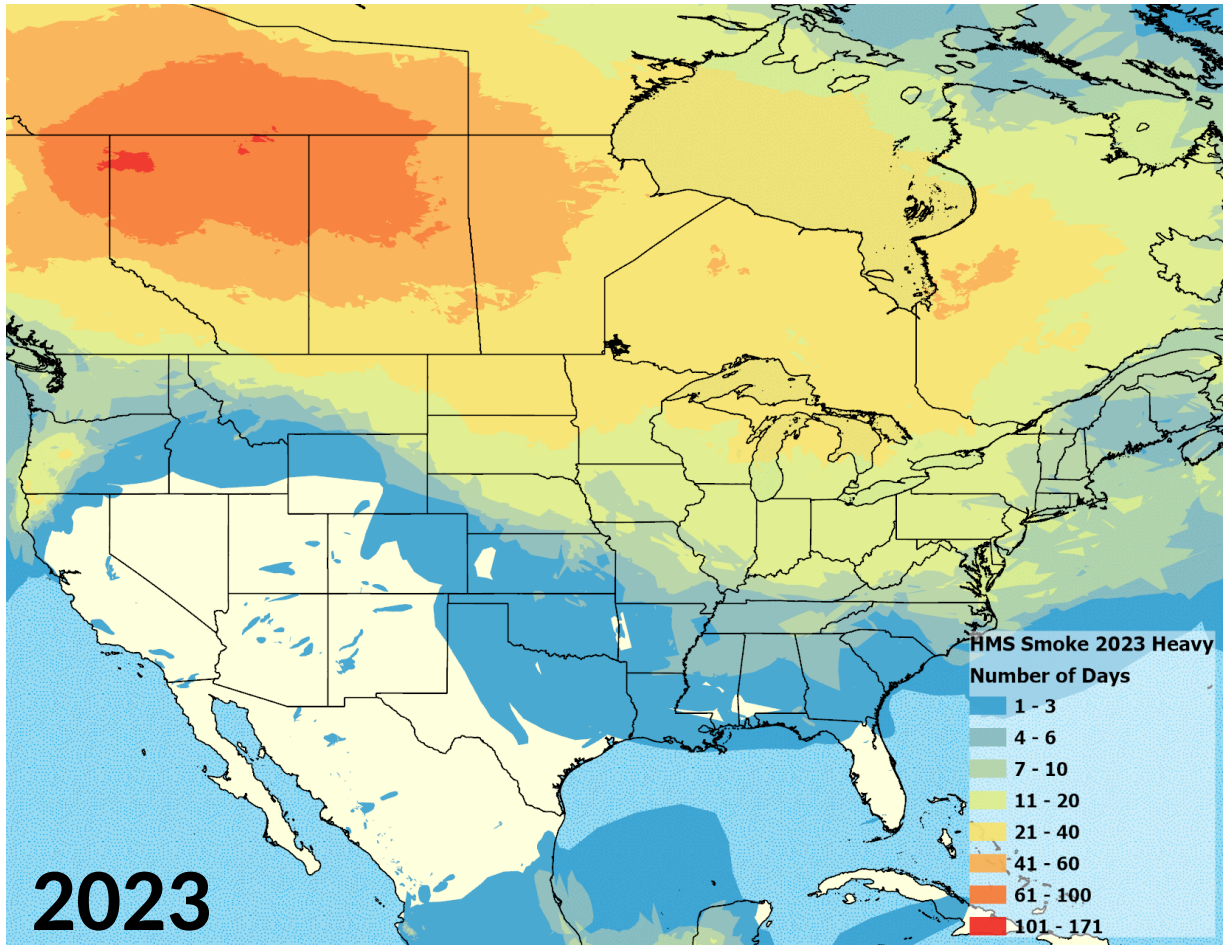
NOAA DAY-2 MARYLAND ERRORS (Model - Observations)

Operational 2024 vs 2023

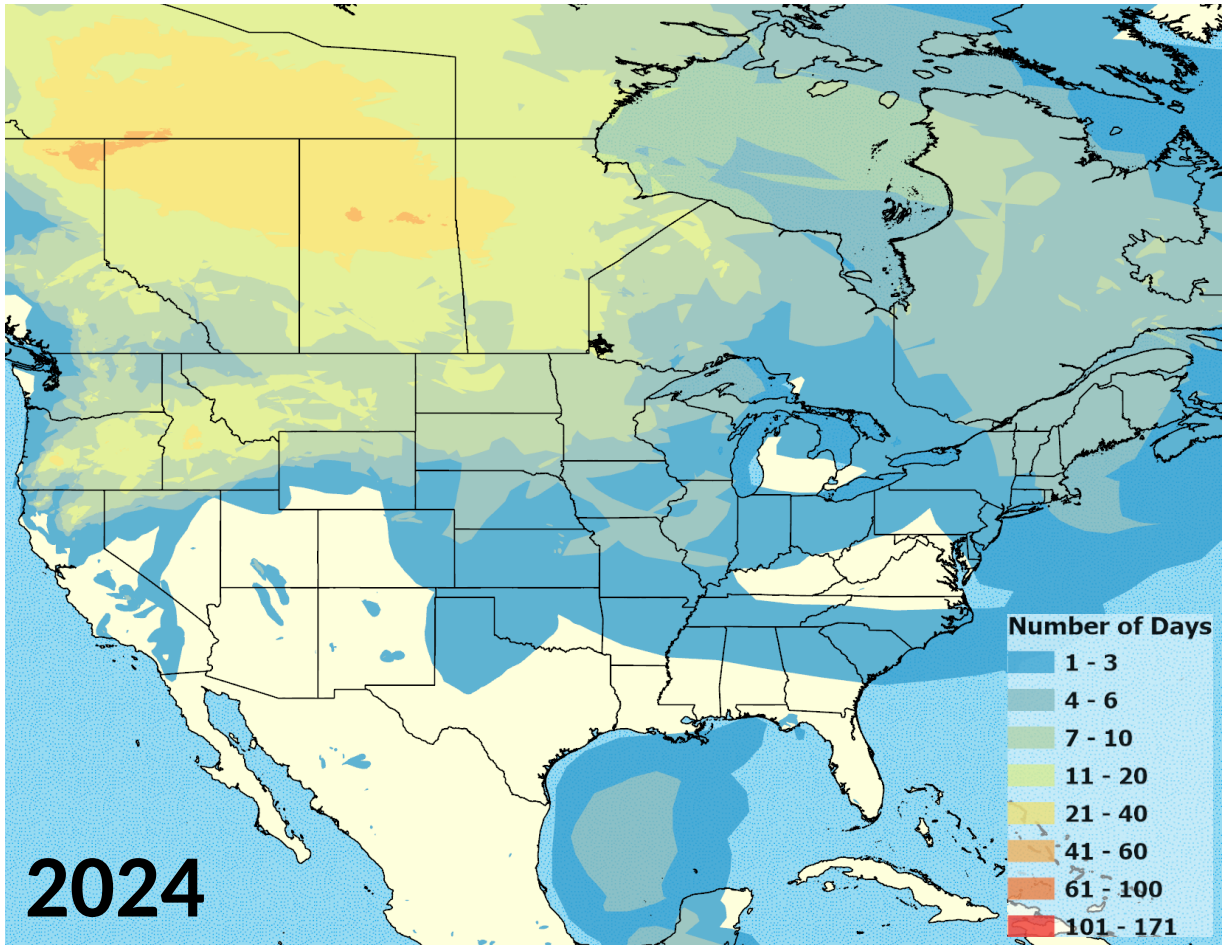


- Seasonal ebbs and flows comparable (generally neutral 1st half and broad overprediction 2nd)
- Significant improvement in June – mid-July timeframe…

HMS Heavy Smoke Days: April – Sept 2023 vs 2024



- What smoke there was, was diffuse across the Mid-Atlantic leading to less impacts on the overall model performance.



Maryland Ozone Exceedance Statistics

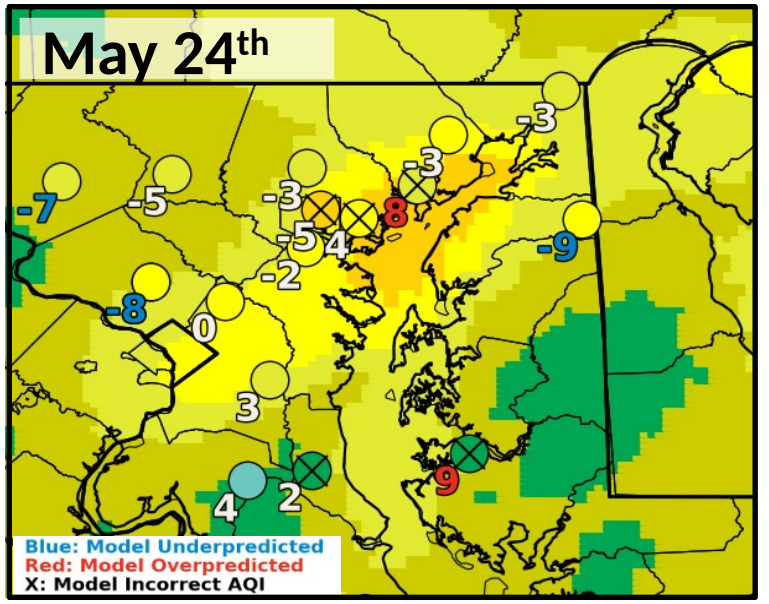
Operational 12Z: Day 2

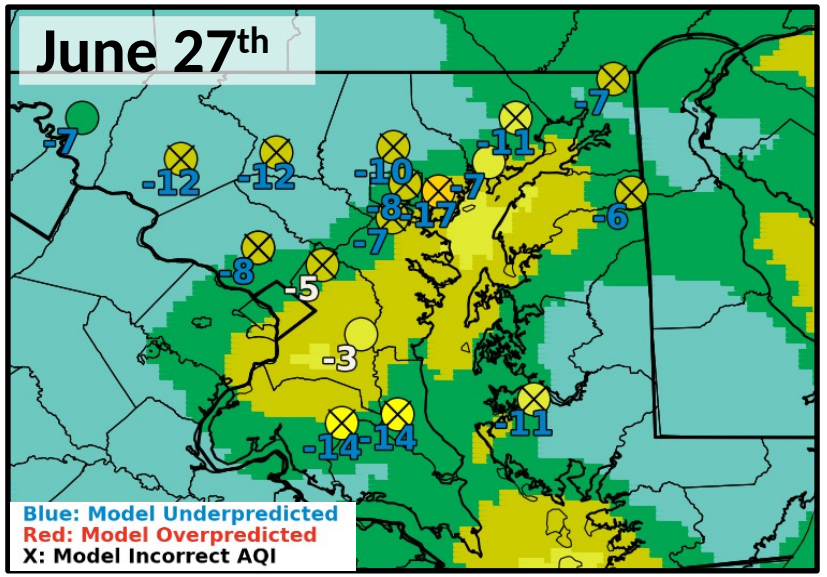
Maryland Stats	
Hit	7
Miss	6
False Alarm	9

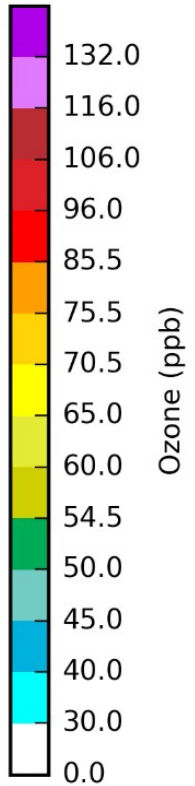
Bias Corrected 12Z: Day 2

Maryland Stats	
Hit	3
Miss	10
False Alarm	1

Ozone Exceedance Days: **13**

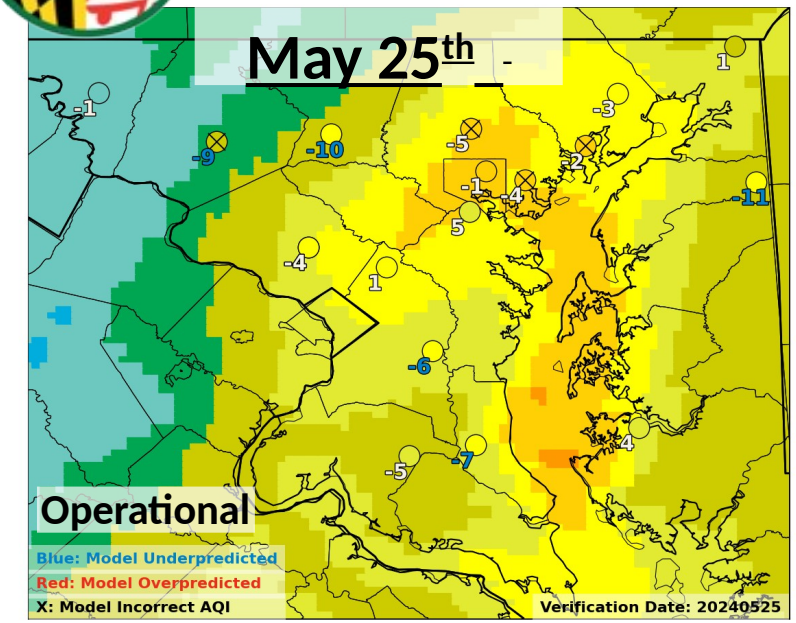


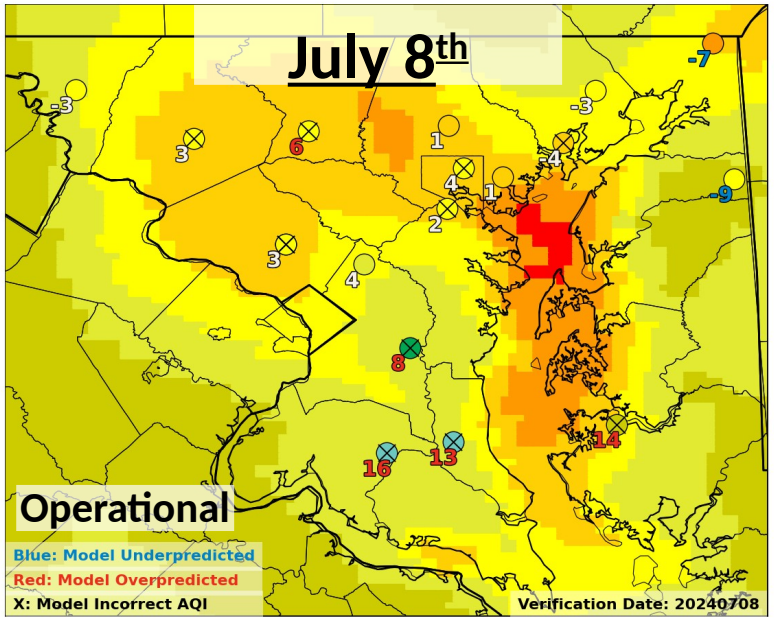


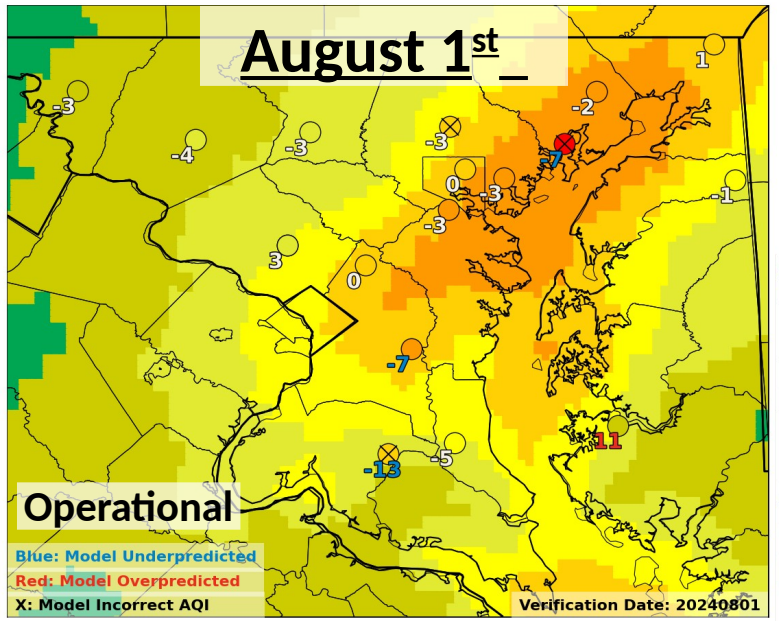


Maryland Ozone Exceedance Statistics

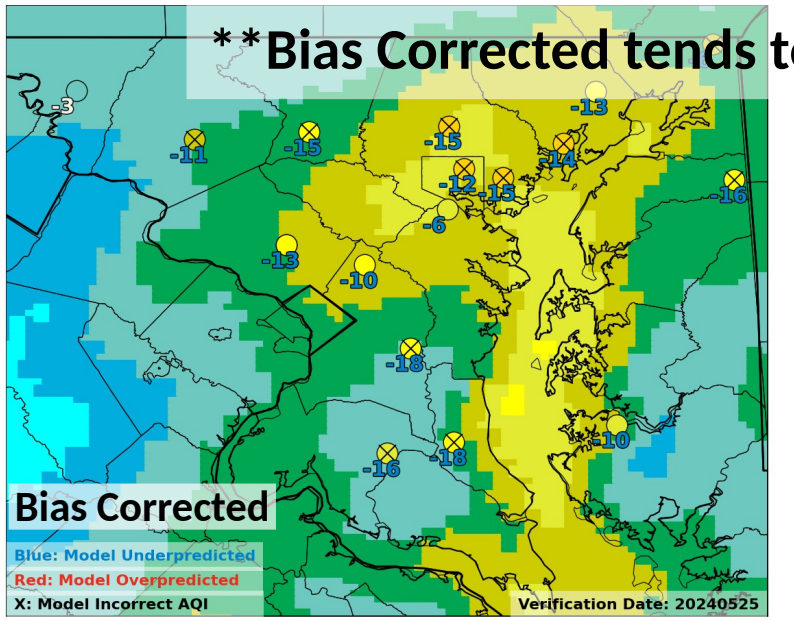
Hits

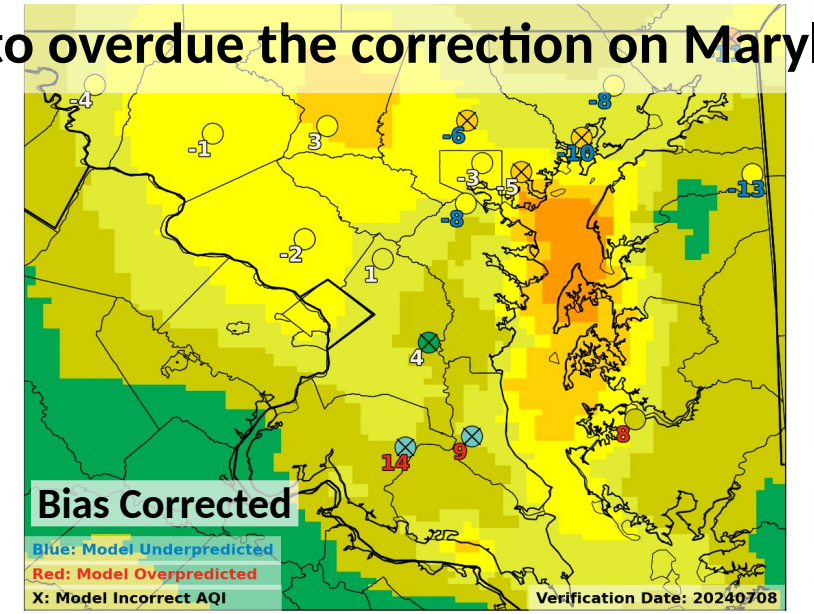


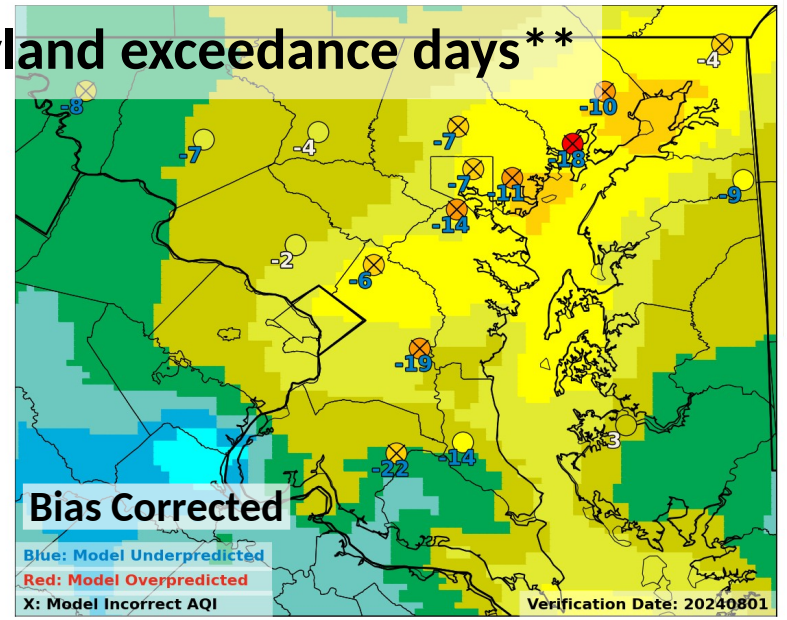


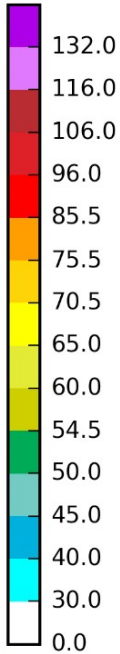


Bias Corrected tends to overdue the correction on Maryland exceedance days





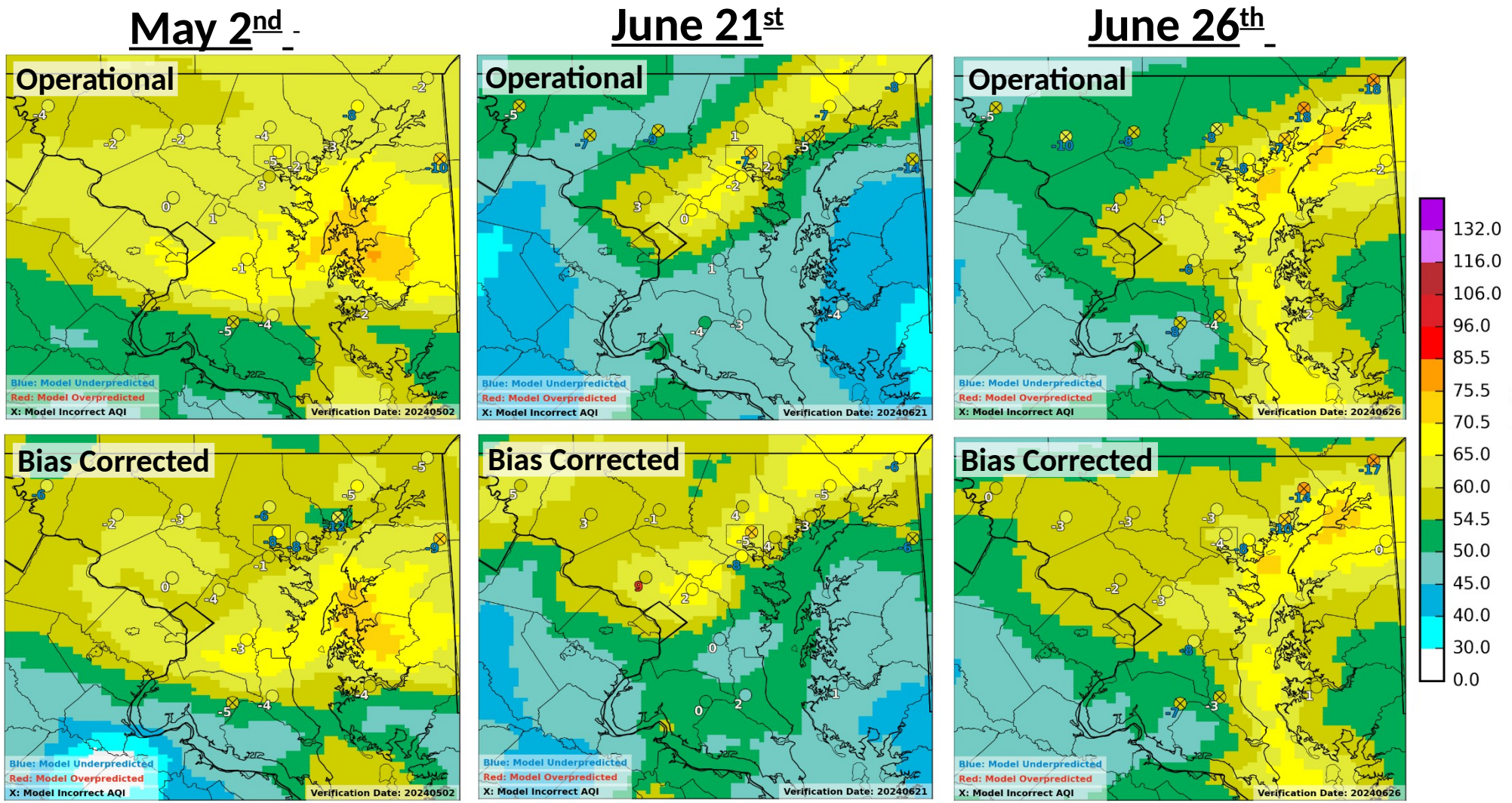




Maryland Ozone Exceedance Statistics

12Z : Day 2 Misses

- Numerous near misses: primarily model resolution and/or meteorologically linked
- Both models were comparable, BC showed improvements in Piedmont Region

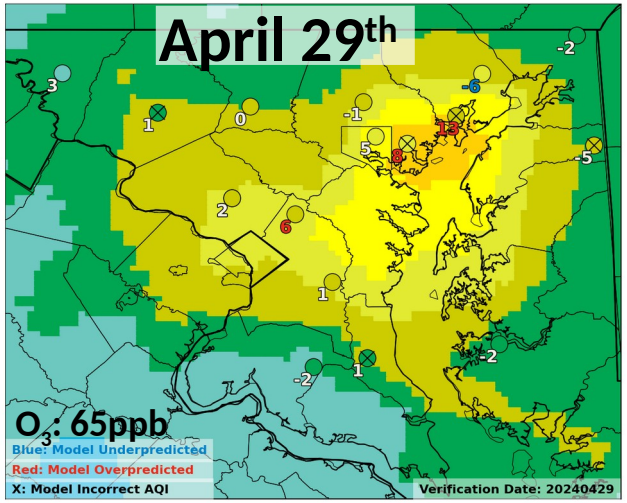


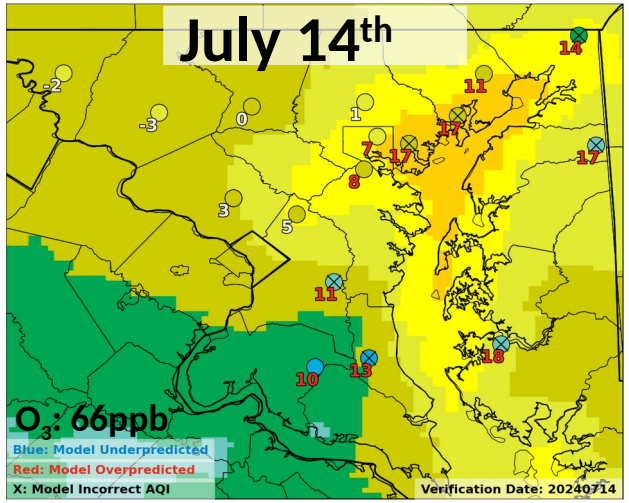
Maryland Ozone Exceedance Statistics

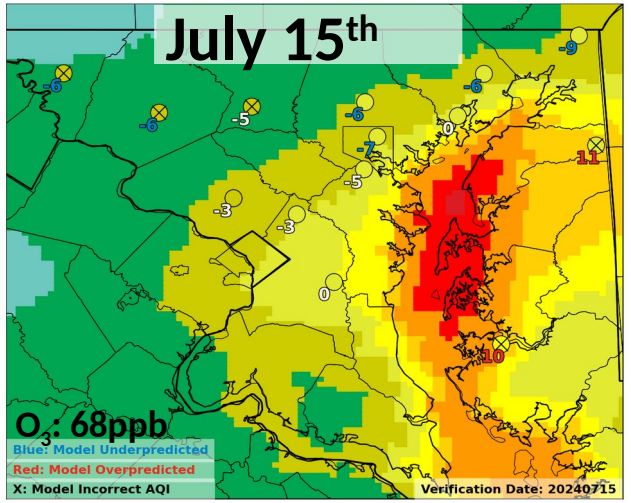
Operational
12Z : Day 2

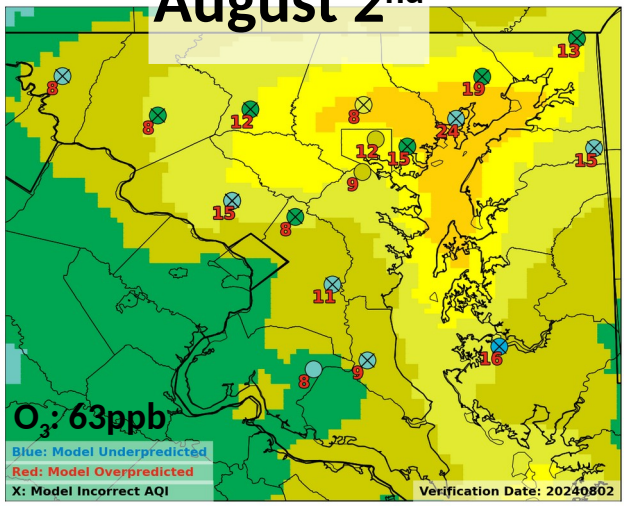
False Alarms

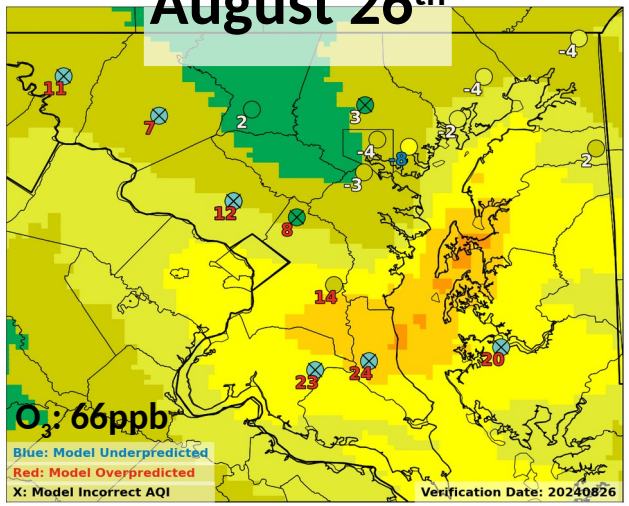
- More common during the end of the ozone season
- 5/9 FA within 6ppb of USG…

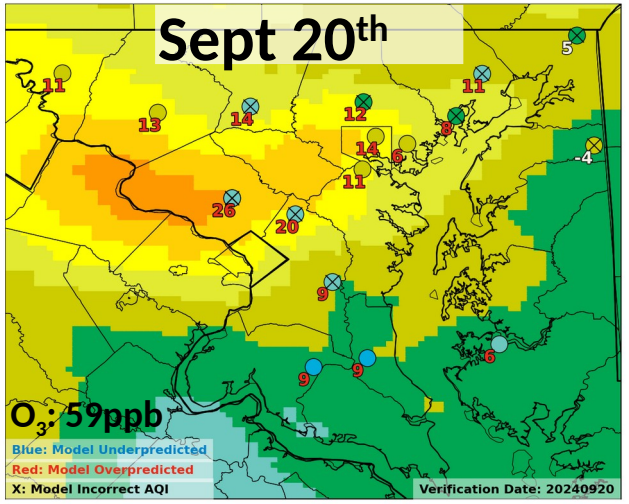


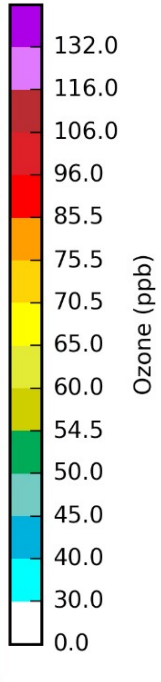










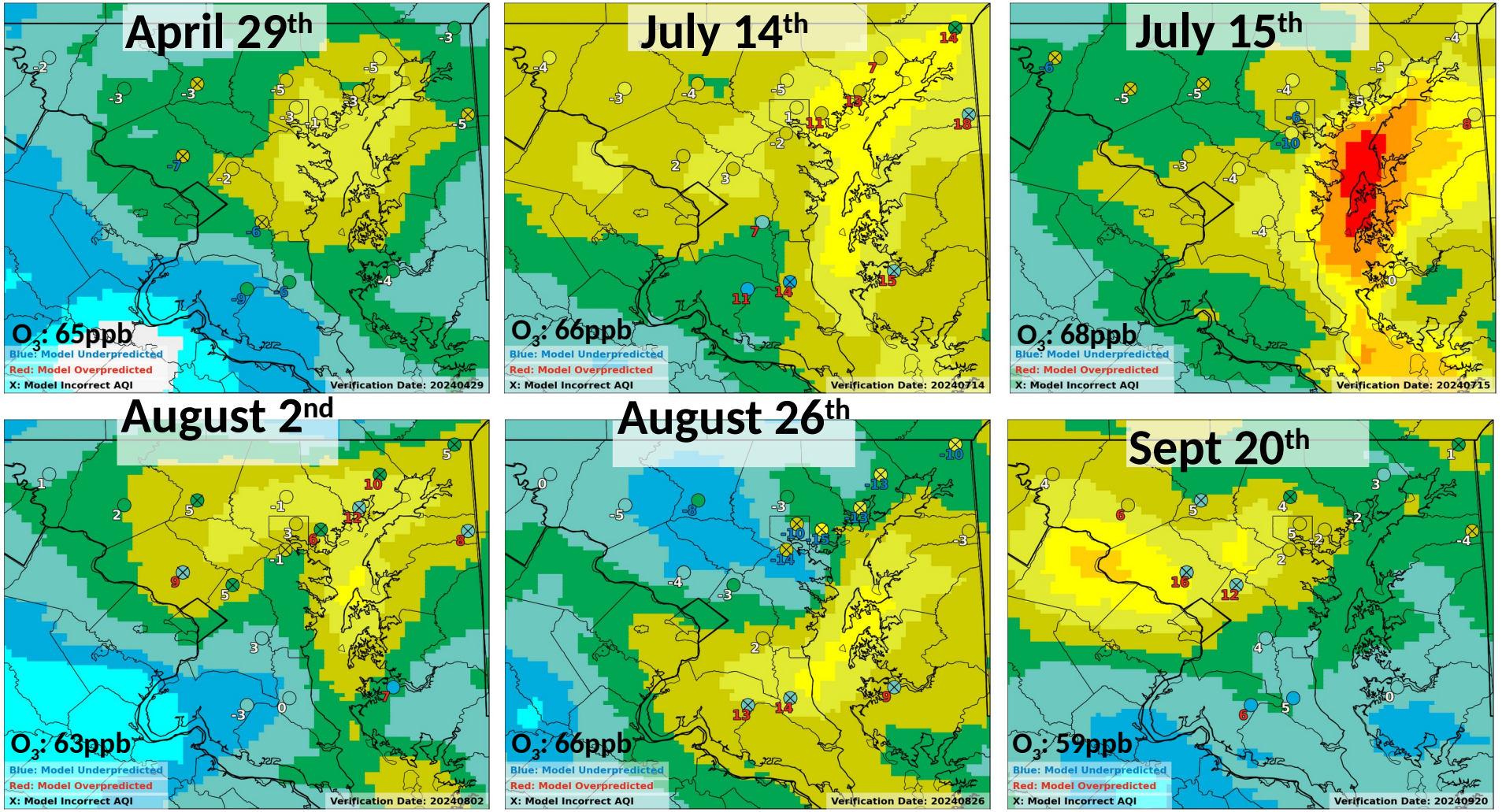


Maryland Ozone Exceedance Statistics

Bias Corrected
12Z : Day 2

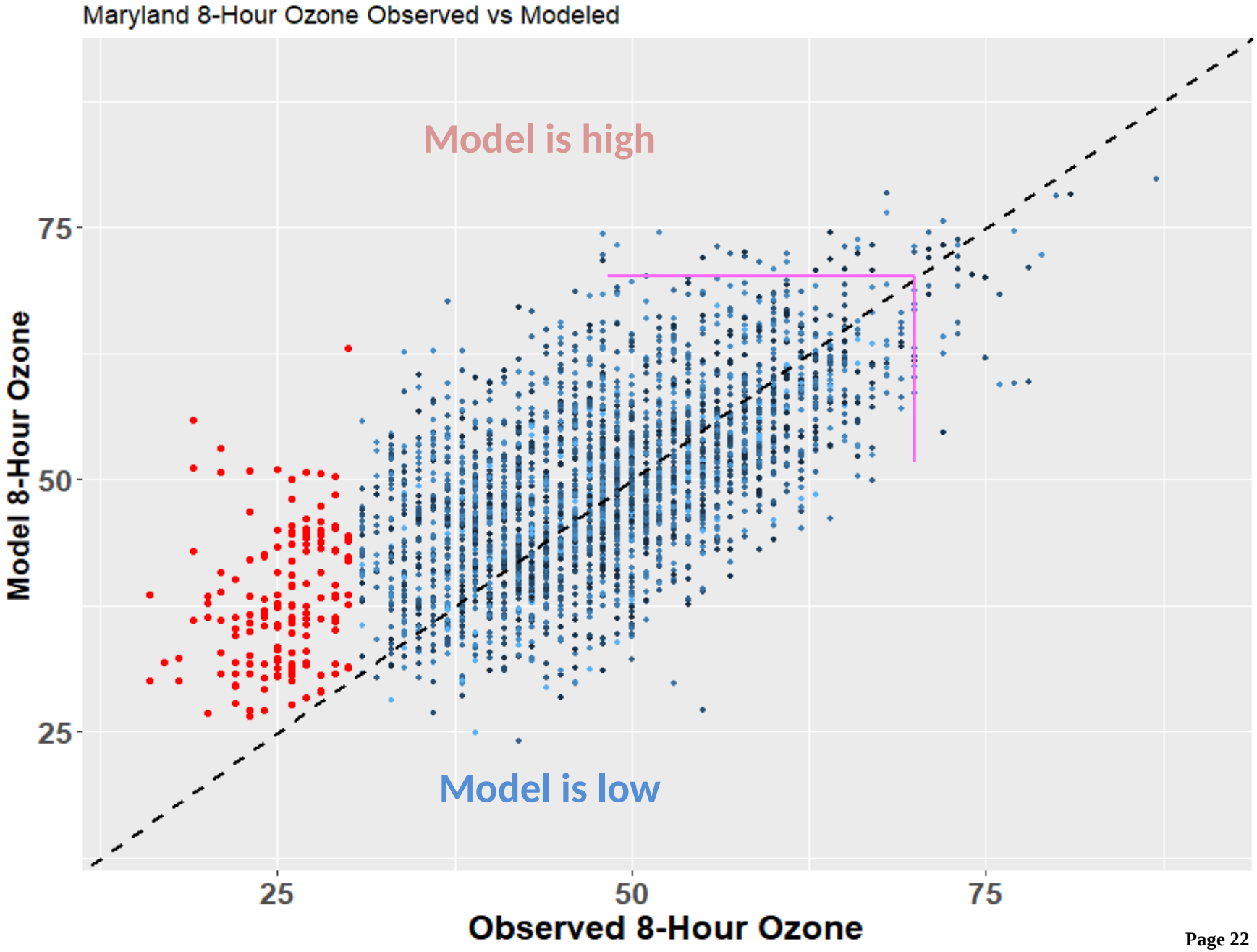
False Alarms

- Bias correction shows improvement on late season false alarms



Model Error Assessment

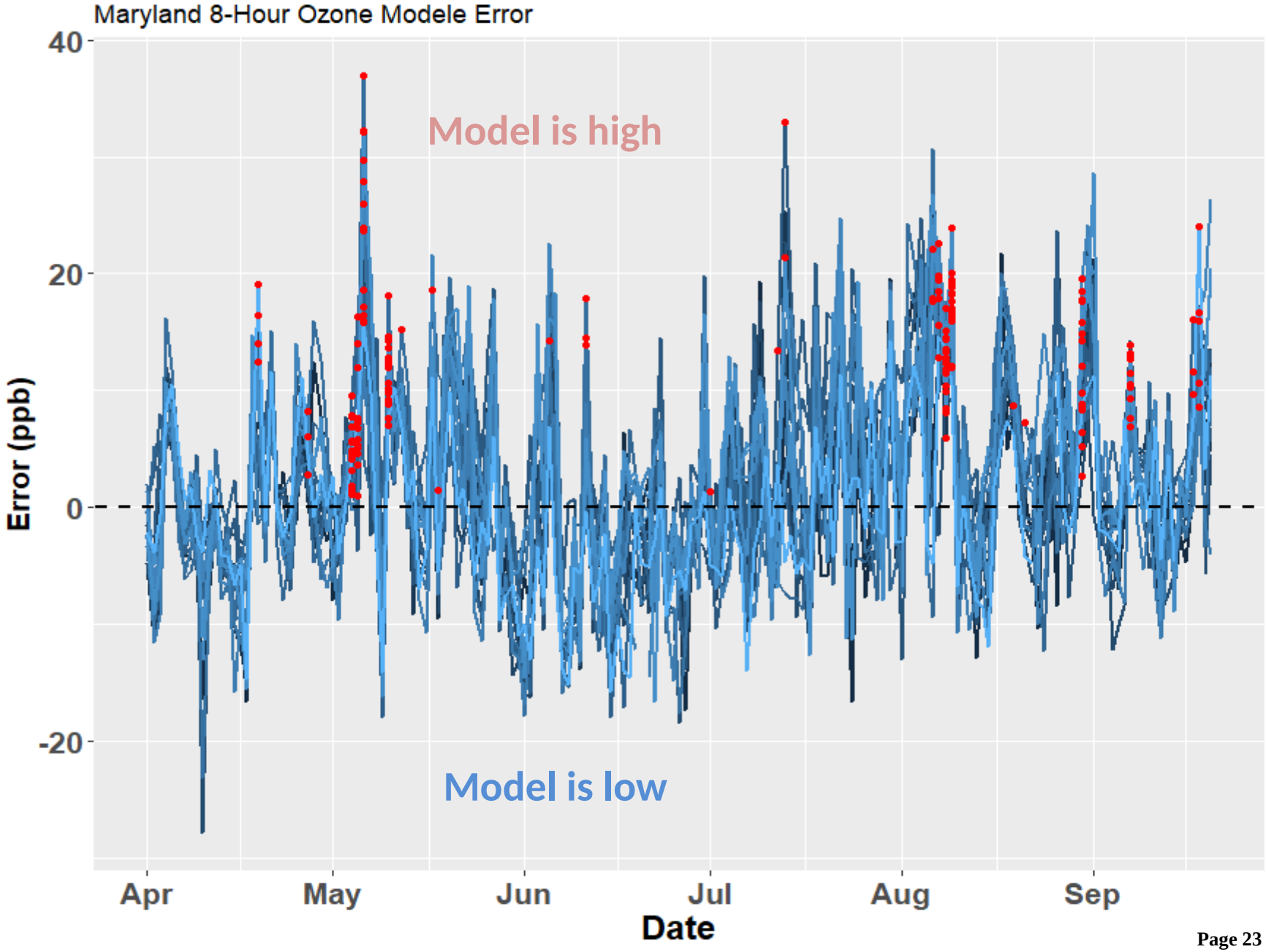
- Not a lot of points above 70 for either the model or observations
- Look for outlier patterns
- Noticeable overprediction at lowest tail of forecasts
- **Red Points**



Positive Model Bias at Low O3 Concentrations

MD8AO Concentrations < 31ppb

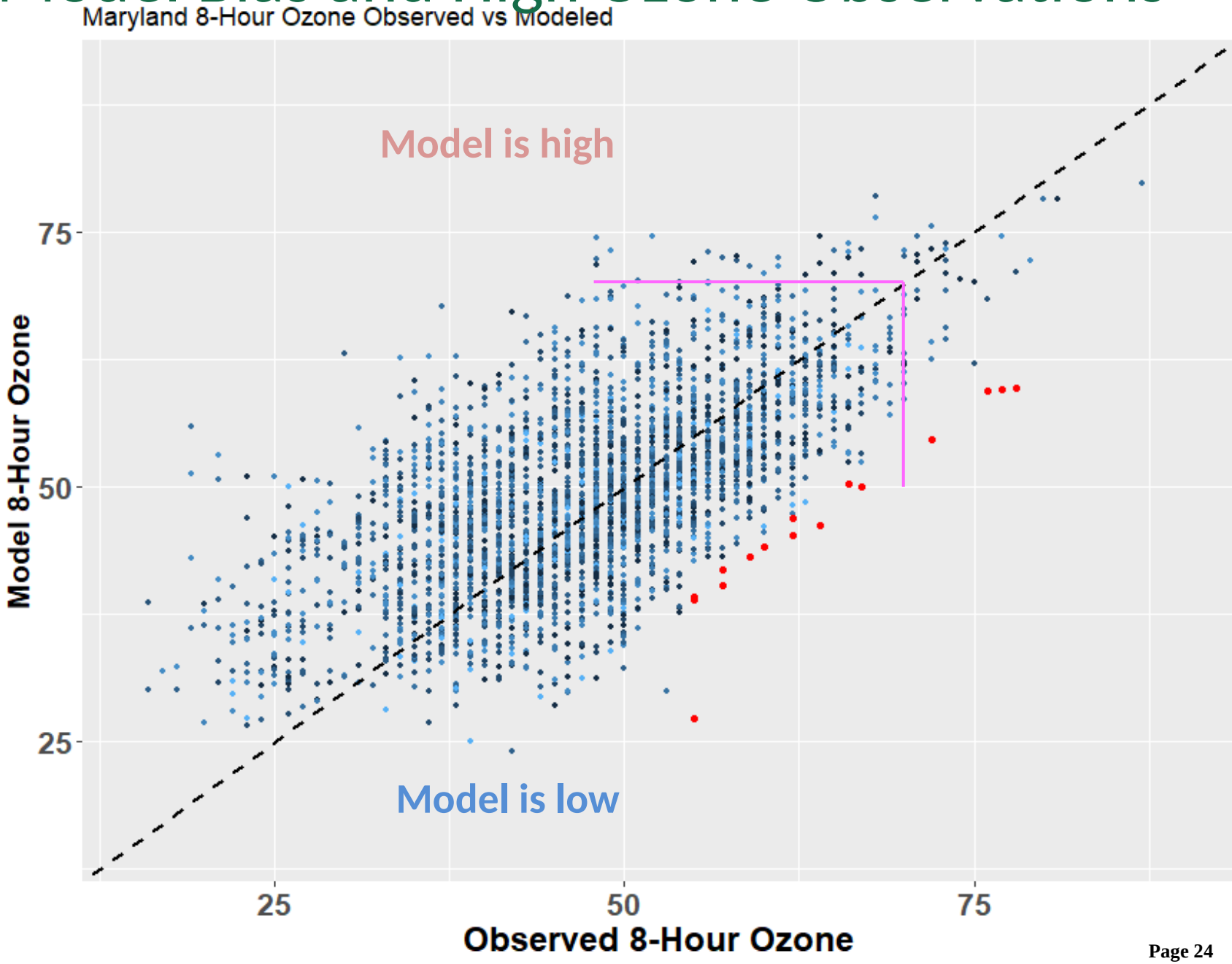
- 21 of 23 days of low concentration but over-prediction by the operational model were associated with rain
- 2 of the 23 days were due to tropical and/or marine air off the ocean



Large Negative Model Bias and High Ozone Observations

MD8AO Concentrations > 55 ppb &
Model error <=-15 ppb

- Highly local phenomenon or features not appropriately captured at 12km scale
- 6/27 – Essex (Baltimore) only had issues…likely due to complexities of scale and emissions (91°F)



Conclusions

- We're at the point where the only significant improvements would be by 1 or all of 3 things:
  1. Better representation of smoke and smoke chemistry
  2. Better representation of local emissions
  3. Finer model resolution

- When you look at the seasonal average it does a good job. The bias is right around zero but the day-to-day variability makes it sometimes difficult to use

- Operational model did a decent job predicting MD ozone exceedances
  - Slightly over done late season, bias correction fixes this generally

- Bias correction shows seasonal bias near zero however is a fine line between improving false alarms and missing ozone exceedances.

- General rule of thumb, trust the operational model more during the first half of the season and bias corrected in the second half but day-to-day understanding of each model performance is key.

- Suggestions:
  - Suggest emissions and met files be made available to assess seasonal biases for continued/deeper feedback towards model improvement

Dates with high model bias at low O3 concentrations

“2024-04-19 EDT" – Rainfall, particularly over northern areas of Maryland (some large errors here)

"2024-04-27 EDT" – Rainfall, midday whole state (good test case of met or emissions) (smaller errors here)

"2024-05-04 EDT" "2024-05-05 EDT" "2024-05-06 EDT" – Rainfall period across network

"2024-05-10 EDT" "2024-05-12 EDT" – Rainfall. One site 5/12 (Edgewood – very specific rainfall pattern…good test)

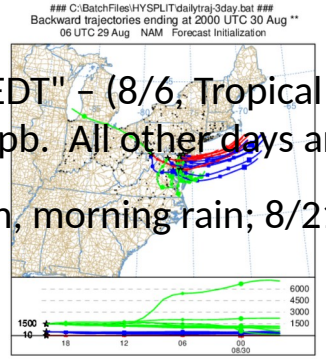
"2024-05-17 EDT" "2024-05-18 EDT" (5/17 – Piney Run only, Heavy Rainfall there)(5/18, Rockville, Heaviest Rain there)

"2024-06-05 EDT" Rain

"2024-06-11 EDT" (Rain south Bay only. Errant monitors are Edgewood, Aldino, FairHill, no rain there) Very light rain there per BWI TDWR

"2024-07-01 EDT“ – Very small error here, but fits search criterion

"2024-07-12 EDT" "2024-07-13 EDT" – Rain period across eastern half of Maryland; 7/13 Horn Point had one of the highest errors all season – Rain!!



"2024-08-06 EDT" "2024-08-07 EDT" "2024-08-08 EDT" "2024-08-09 EDT" – (8/6, Tropical Air Boundary – “southern monitors not clean enough” – Also Edgewood had a thunderstorm but MD8AO was >31ppb. All other days are rain related.

"2024-08-19 EDT" "2024-08-21 EDT“ (8/19 Scattered cells in afternoon, morning rain; 8/21 Windy and cool…not a big deal)

"2024-08-30 EDT" No Rain here, just cool easterly winds!

"2024-09-07 EDT" – Light rain but widespread

"2024-09-17 EDT" "2024-09-18 EDT“ – 9/18 Hagerstown (24ppb error!!); Rain both days

Dates with low model bias and high Observations

"2024-04-10 EDT"

"2024-04-15 EDT" Scattered Storms- Millington wasn't hit

"2024-06-01 EDT" "2024-06-02 EDT" (6/1; No rain. 5 stations > 15ppb error, 85 F high, stagnant (Saturday, high clouds increasing, but plenty of sun) Northern monitors in MD, Transport?!

"2024-06-07 EDT"

"2024-06-17 EDT" Frederick – Downwind of DC??

"2024-06-22 EDT" – HU-Castnet Site(76)…but HUB was 67!! Highly local or features not appropriately captured

"2024-06-26 EDT" "2024-06-27 EDT" 6/26 – FH & Aldino had issues (BB?); 6/27 – Essex Only had issues…likely due to complexities of scale and emissions (91F)

"2024-07-24 EDT"