CMAQ bias-correction for AQM v7.0.7 data

NOAA/PSL

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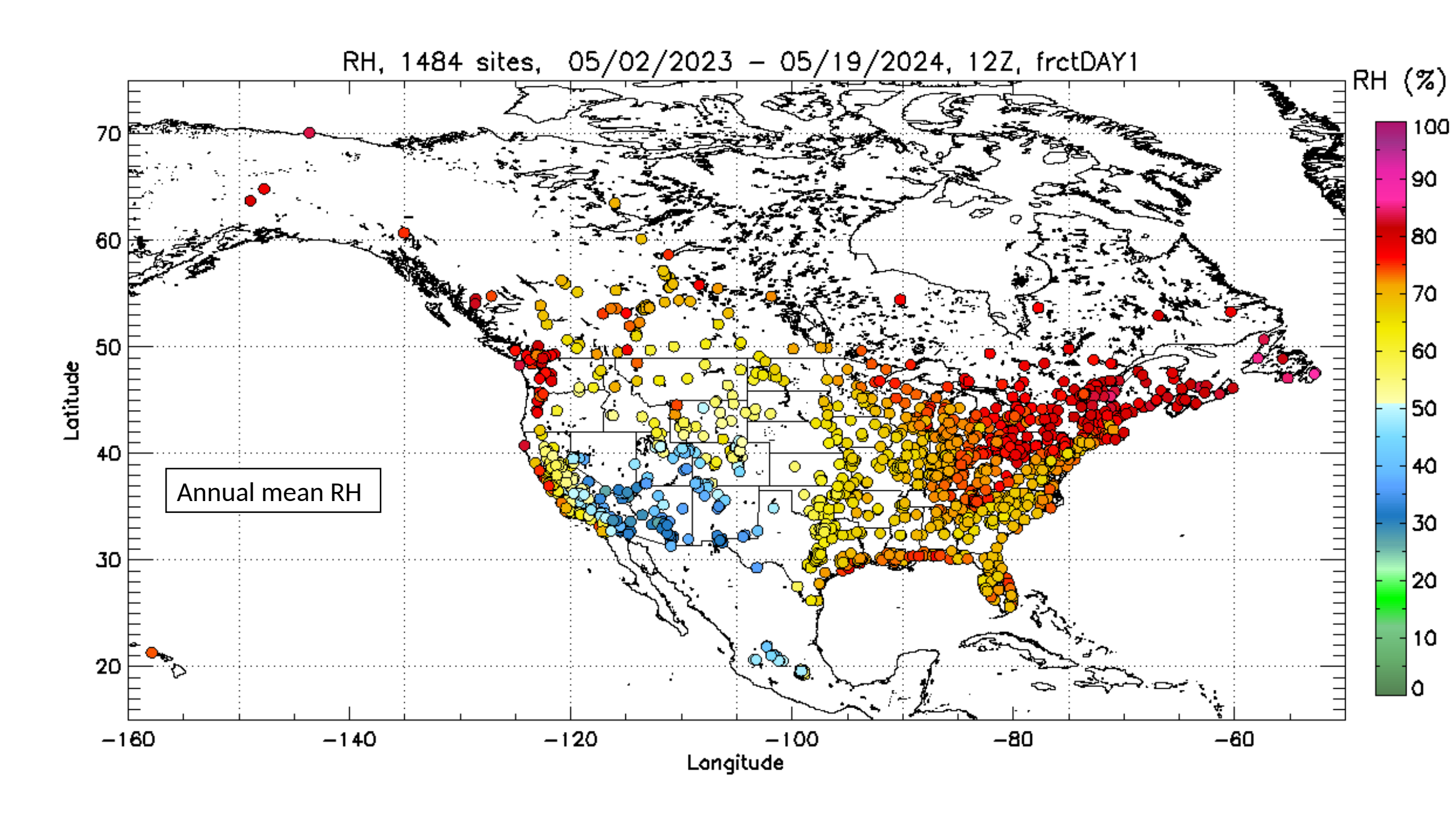
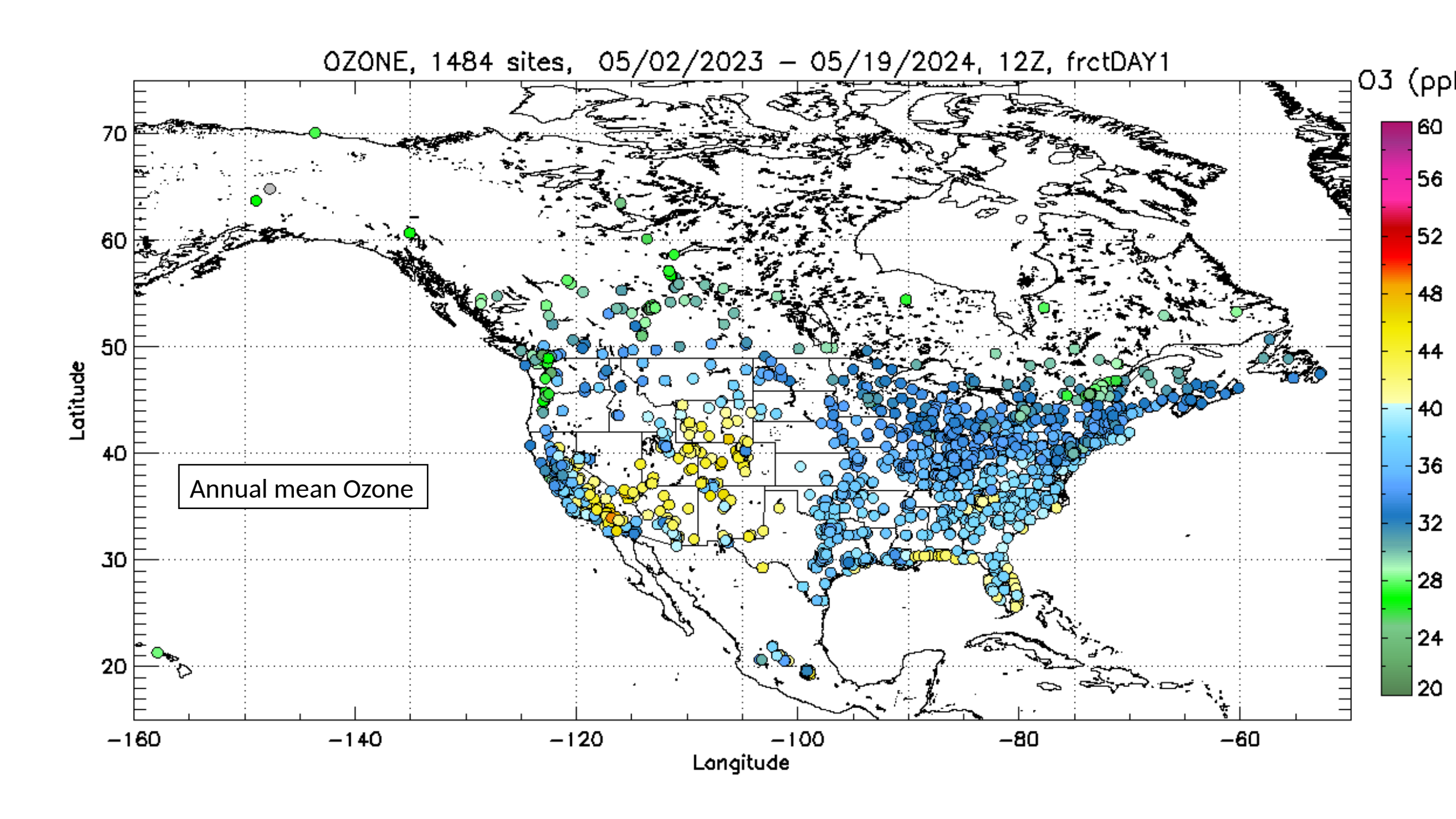
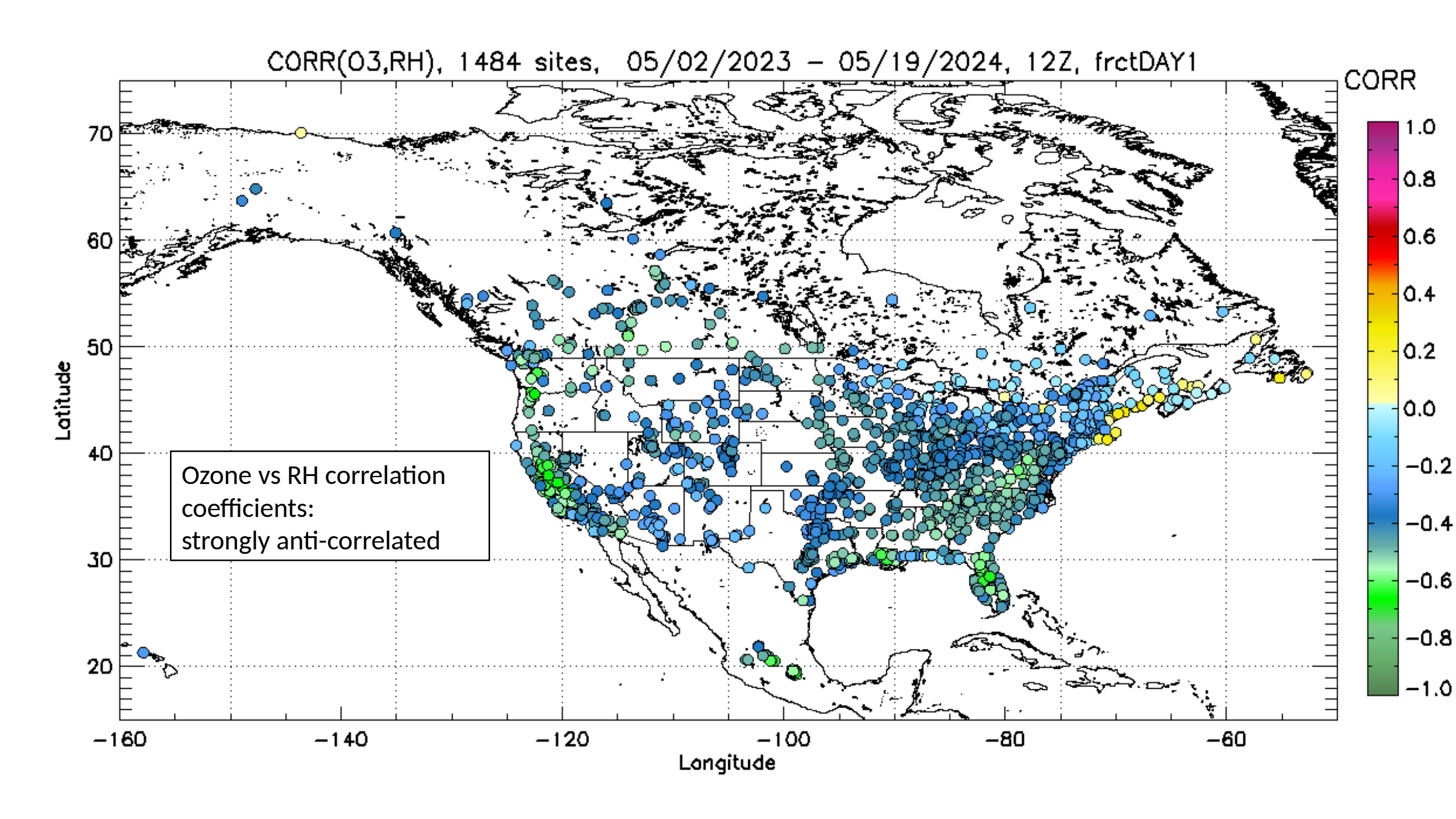
Humidity as a new predictor for ozone

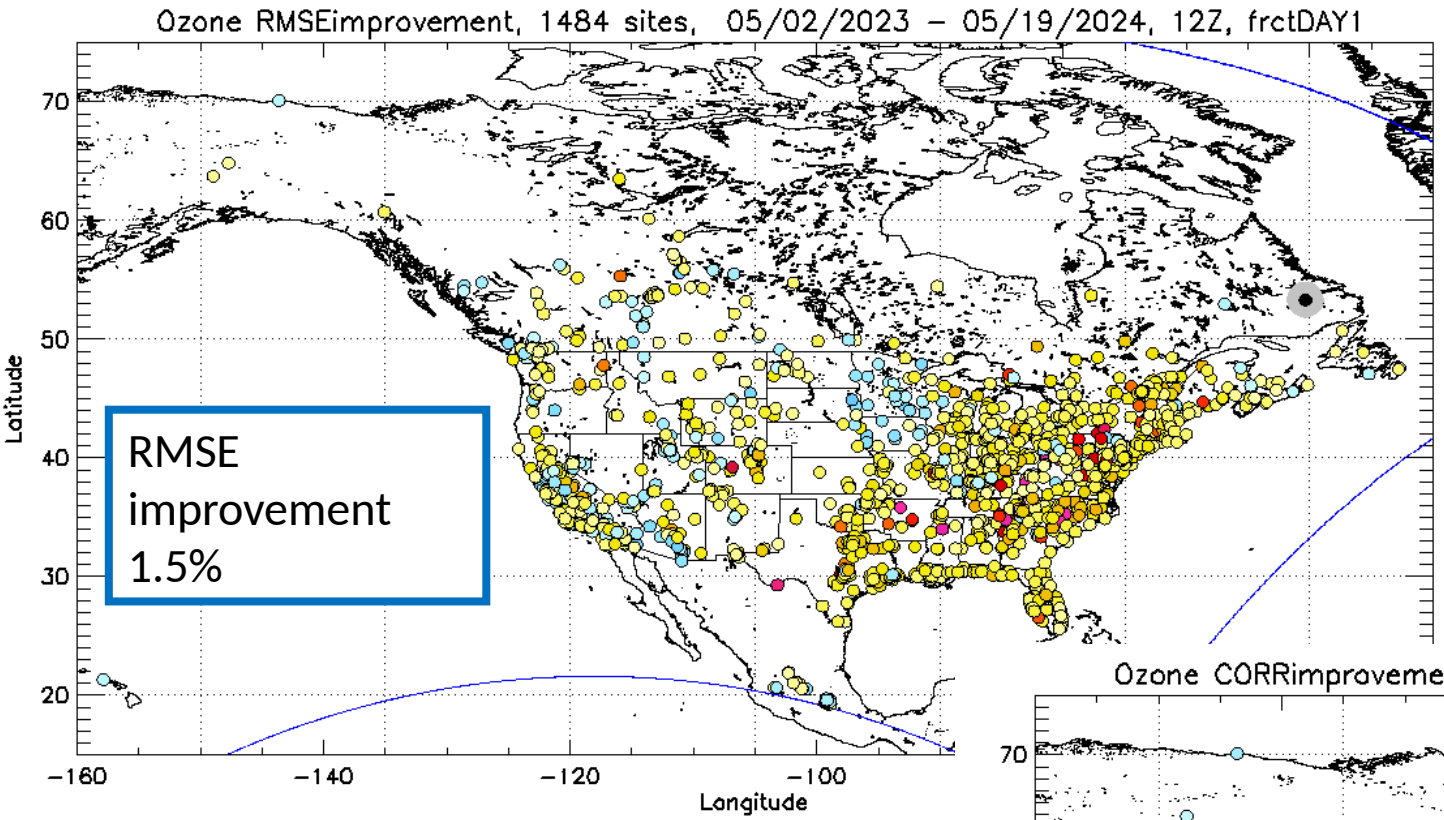
- AQMv7 bias correction currently uses 7 predictors:

  Ozone, Hpbl, Dswrf, Temp2m, Wdir10, Wspd10, Nox;
- Tested new predictor, 2m Relative Humidity (RH), at the 1484 AirNOW site locations;
- The following slides show a consistent skill improvement in the 2022 - 2024 time frame, both annually and seasonally;
- The largest improvement is in regions with higher humidity;
- RH as a predictor for $PM_{2.5}$ does not show a consistent improvement.


RH, 1484 sites, 05/02/2023 – 05/19/2024, 12Z, frctDAY1
RH (%)
100
90
80
70
60
50
40
30
20
10
0
Annual mean RH
Latitude
70
60
50
40
30
20
Longitude
−160
−140
−120
−100
−80
−60

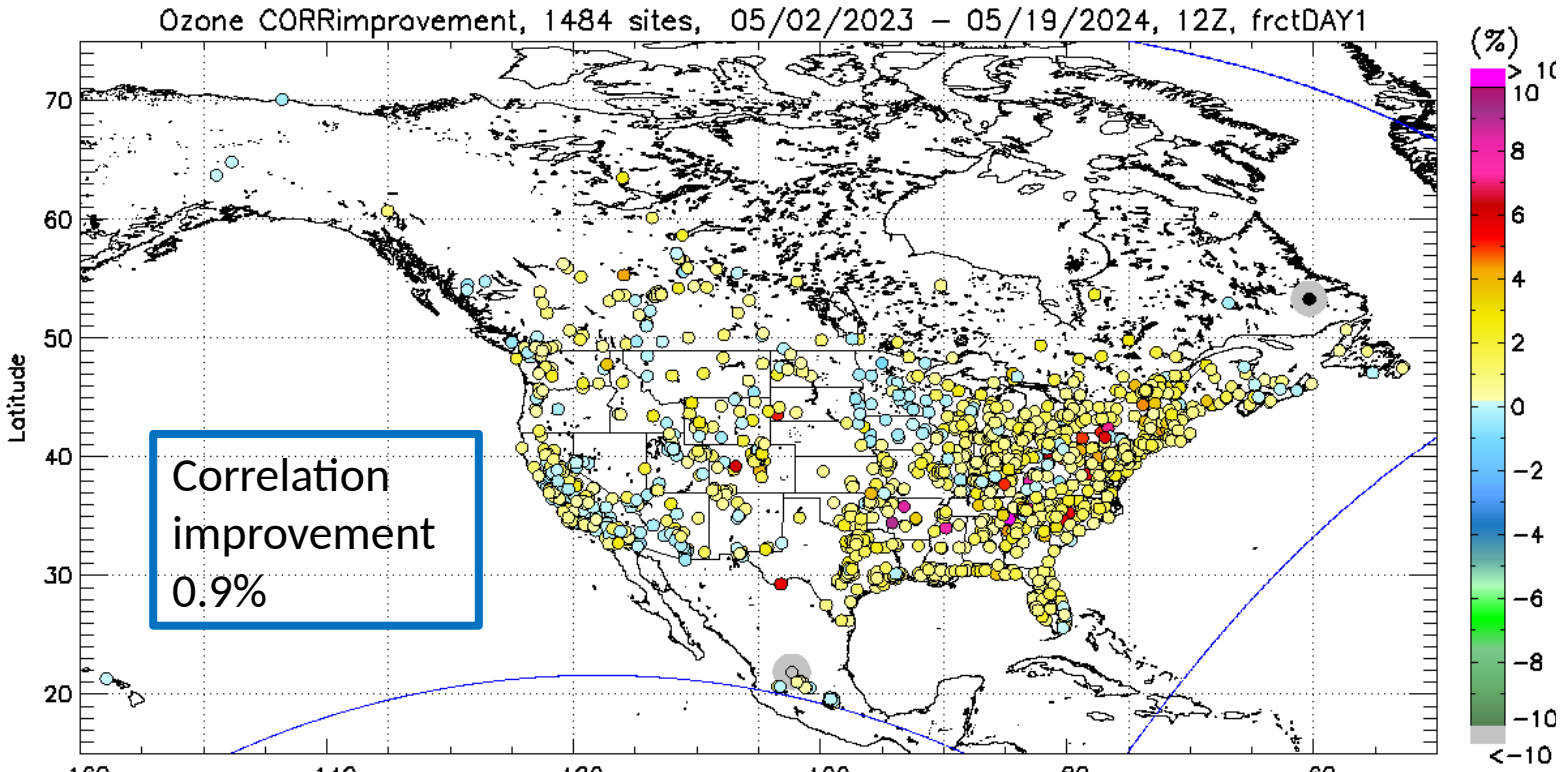

OZONE, 1484 sites, 05/02/2023 – 05/19/2024, 12Z, frctDAY1
O3 (ppb
60
56
52
48
44
40
36
32
28
24
20
Annual mean Ozone
Latitude
70
60
50
40
30
20
−160
−140
−120
−100
−80
−60
Longitude


CORR(O3,RH), 1484 sites, 05/02/2023 – 05/19/2024, 12Z, frctDAY1
CORR
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
Latitude
70
60
50
40
30
20
Longitude
−160
−140
−120
−100
−80
−60
Ozone vs RH correlation coefficients:
strongly anti-correlated



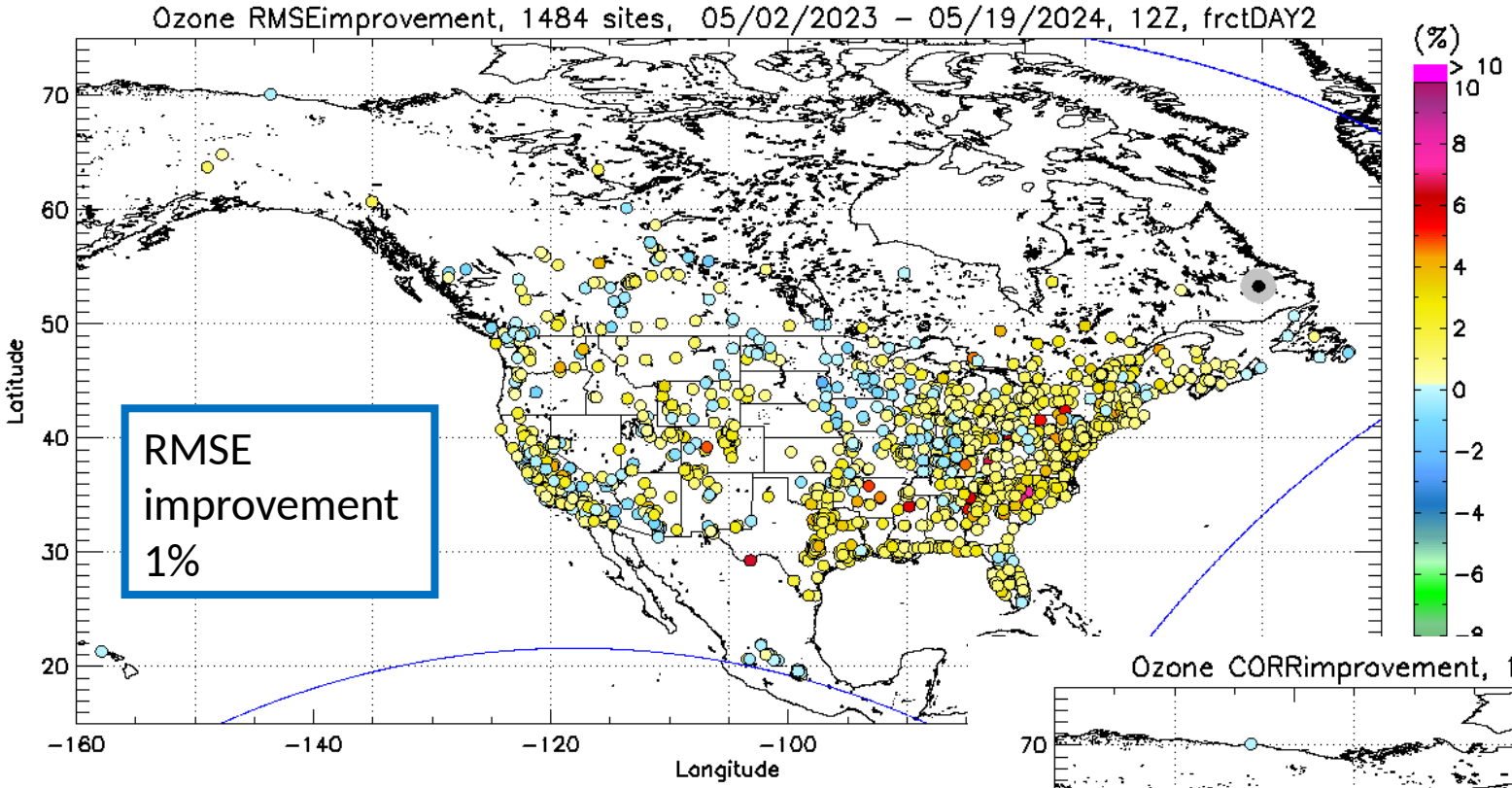
RMSE improvement 1.5%

Annual Improvements in % RH (8 predictors) vs no RH (7 predictors) frct day 1



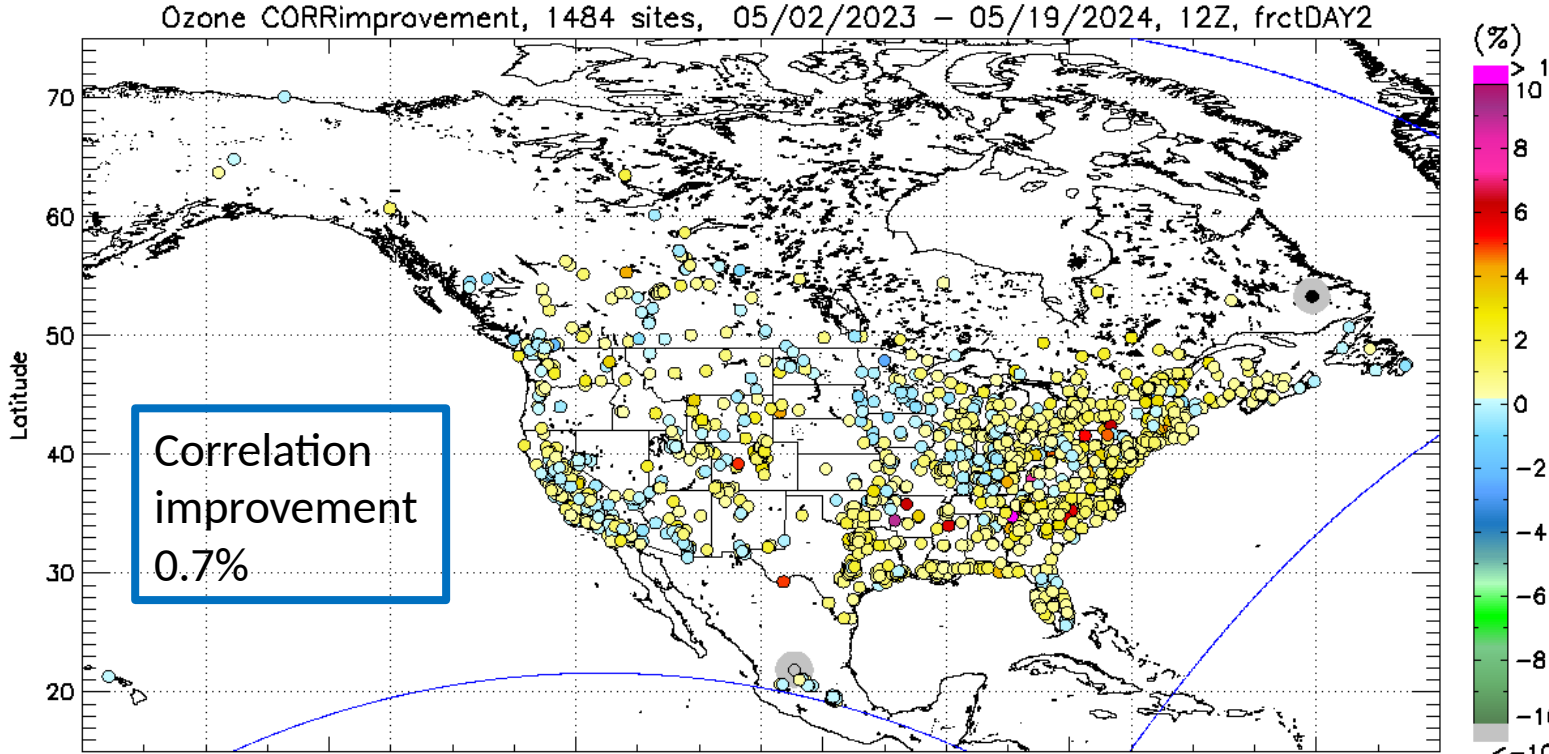
Correlation improvement 0.9%

Operational predictor set plus RH, equal predictor weights

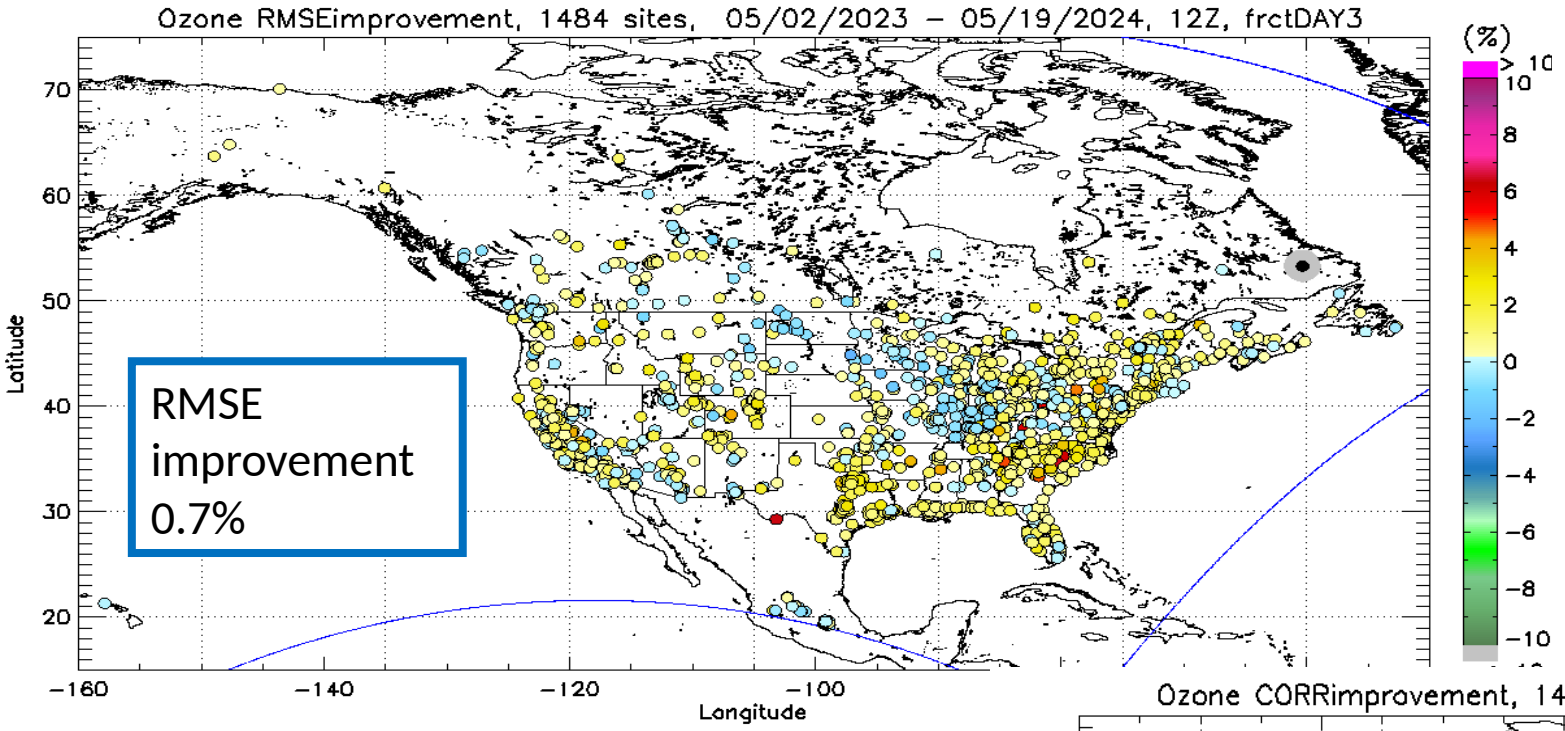


RMSE improvement 1%

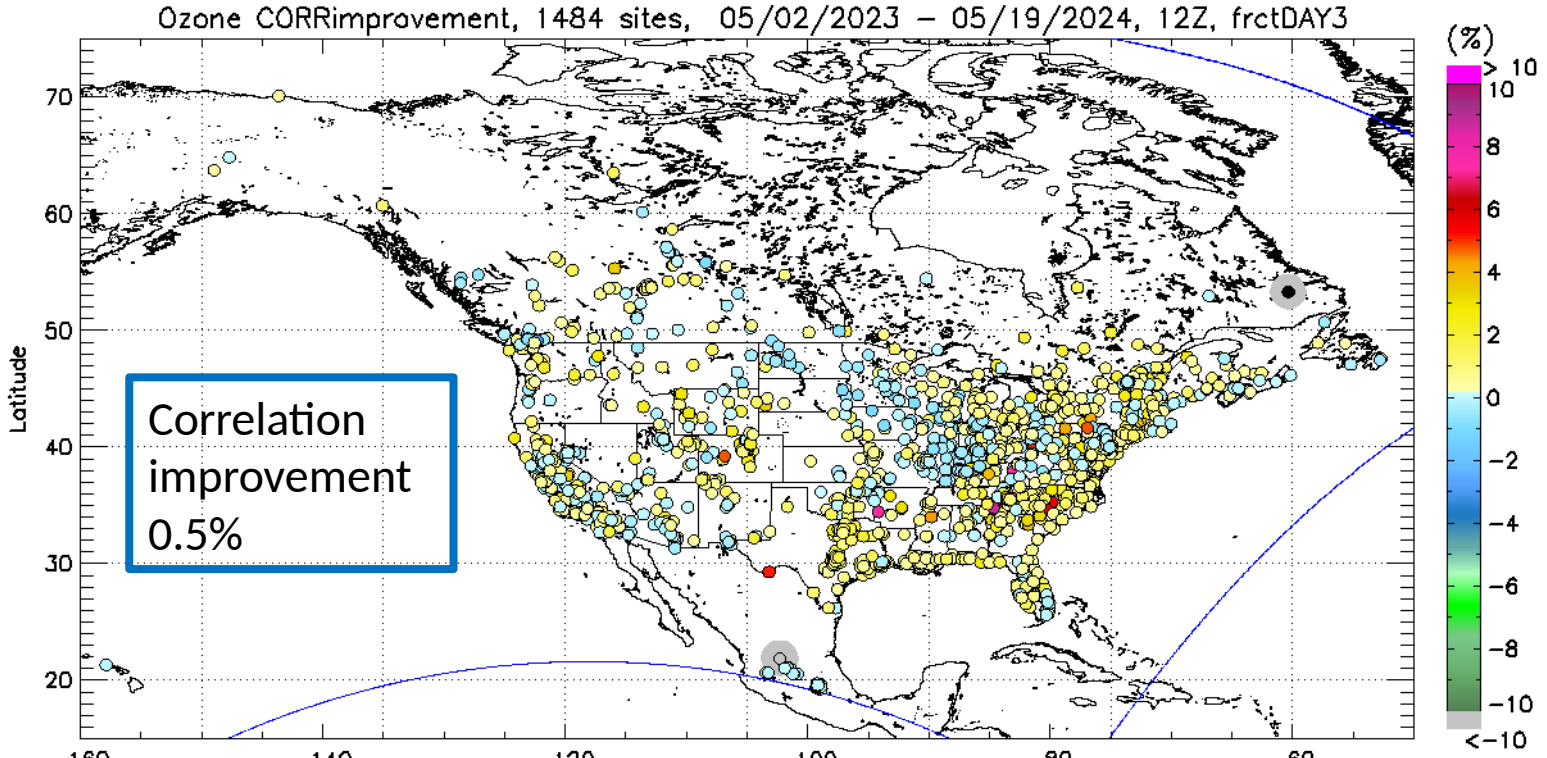
Annual Improvements frct day 2 in %

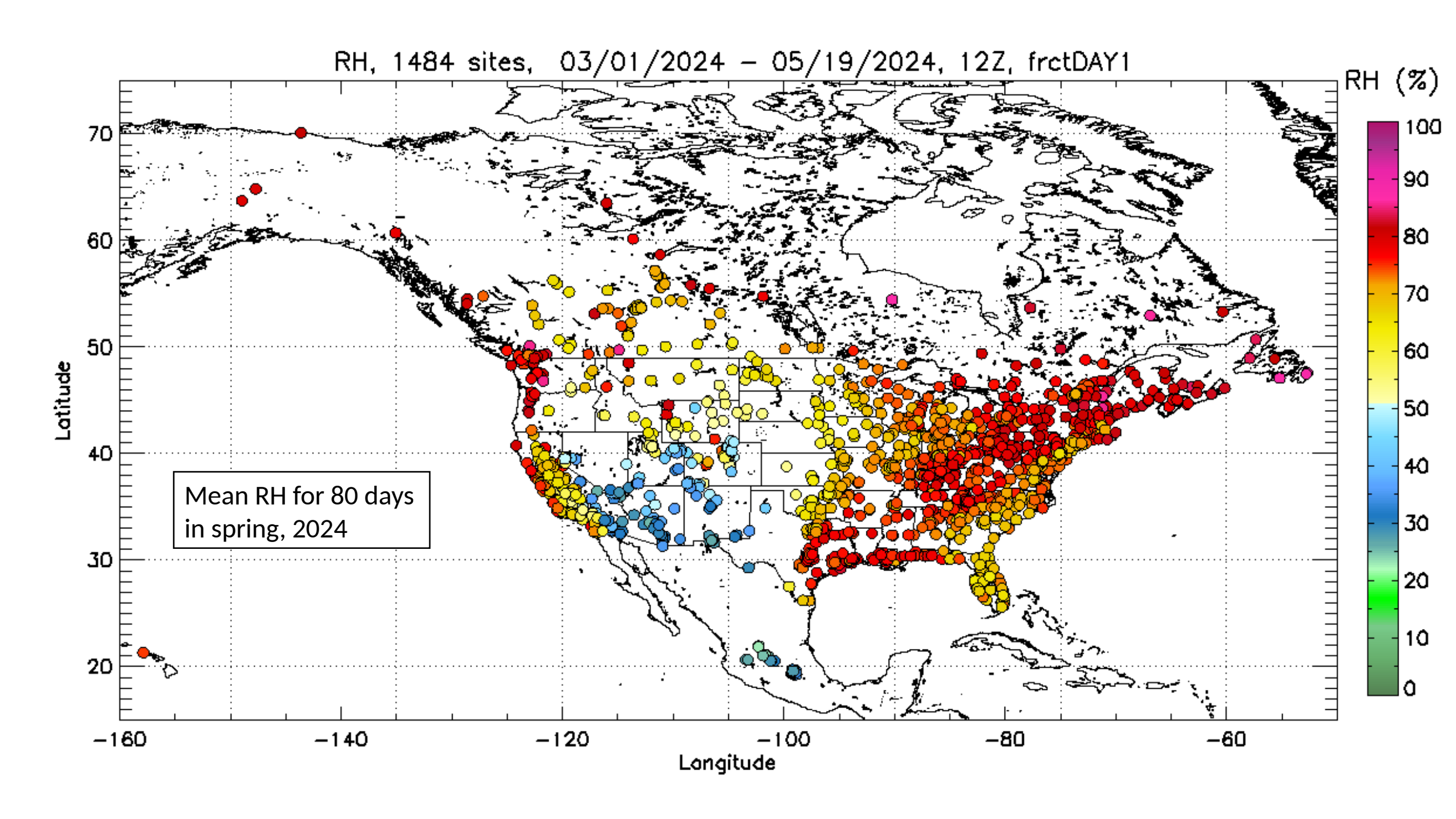


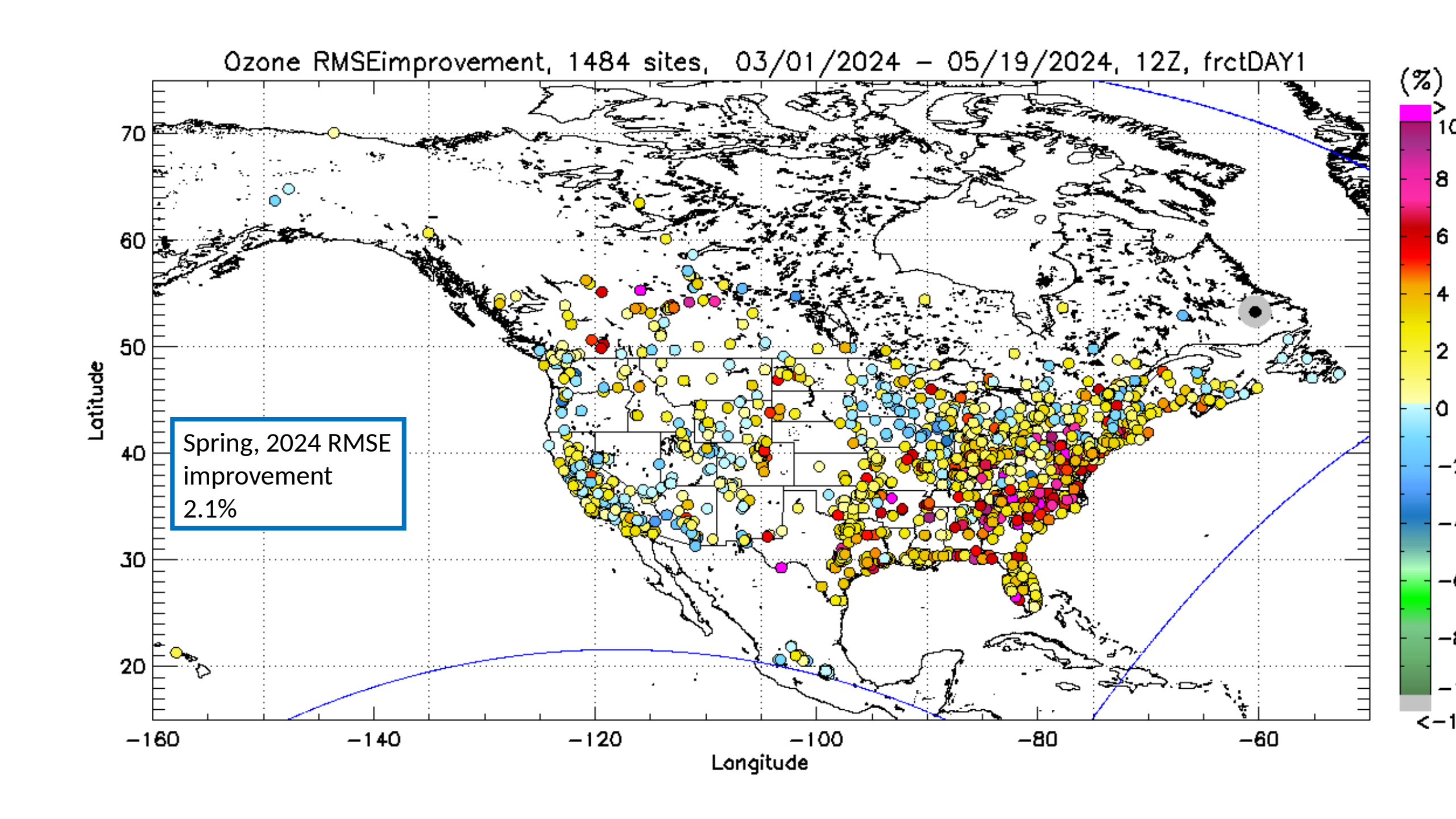
Correlation improvement 0.7%



Annual Improvements frct day 3 in %

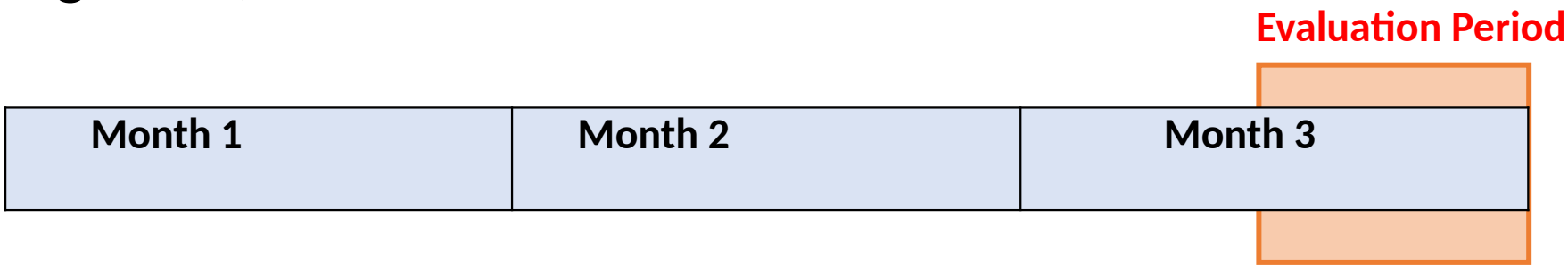



RH, 1484 sites, 03/01/2024 – 05/19/2024, 12Z, frctDAY1
RH (%)
100
90
80
70
60
50
40
30
20
10
0
Latitude
70
60
50
40
30
20
Longitude
−160
−140
−120
−100
−80
−60
Mean RH for 80 days
in spring, 2024

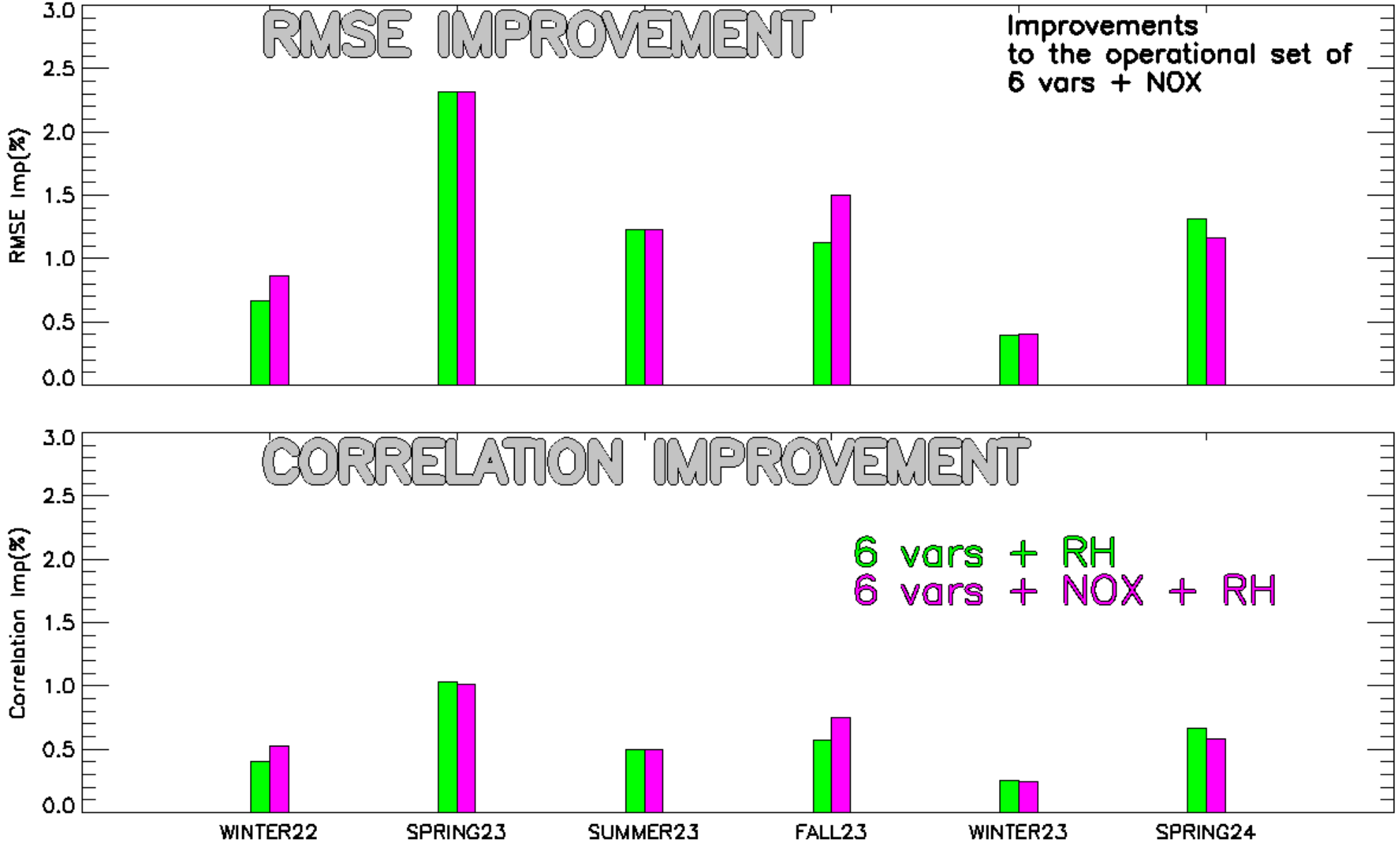

Ozone RMSEimprovement, 1484 sites, 03/01/2024 – 05/19/2024, 12Z, frctDAY1
(%)
>10
8
6
4
2
0
<−1
Latitude
70
60
50
40
30
20
Longitude
−160
−140
−120
−100
−80
−60
Spring, 2024 RMSE improvement 2.1%

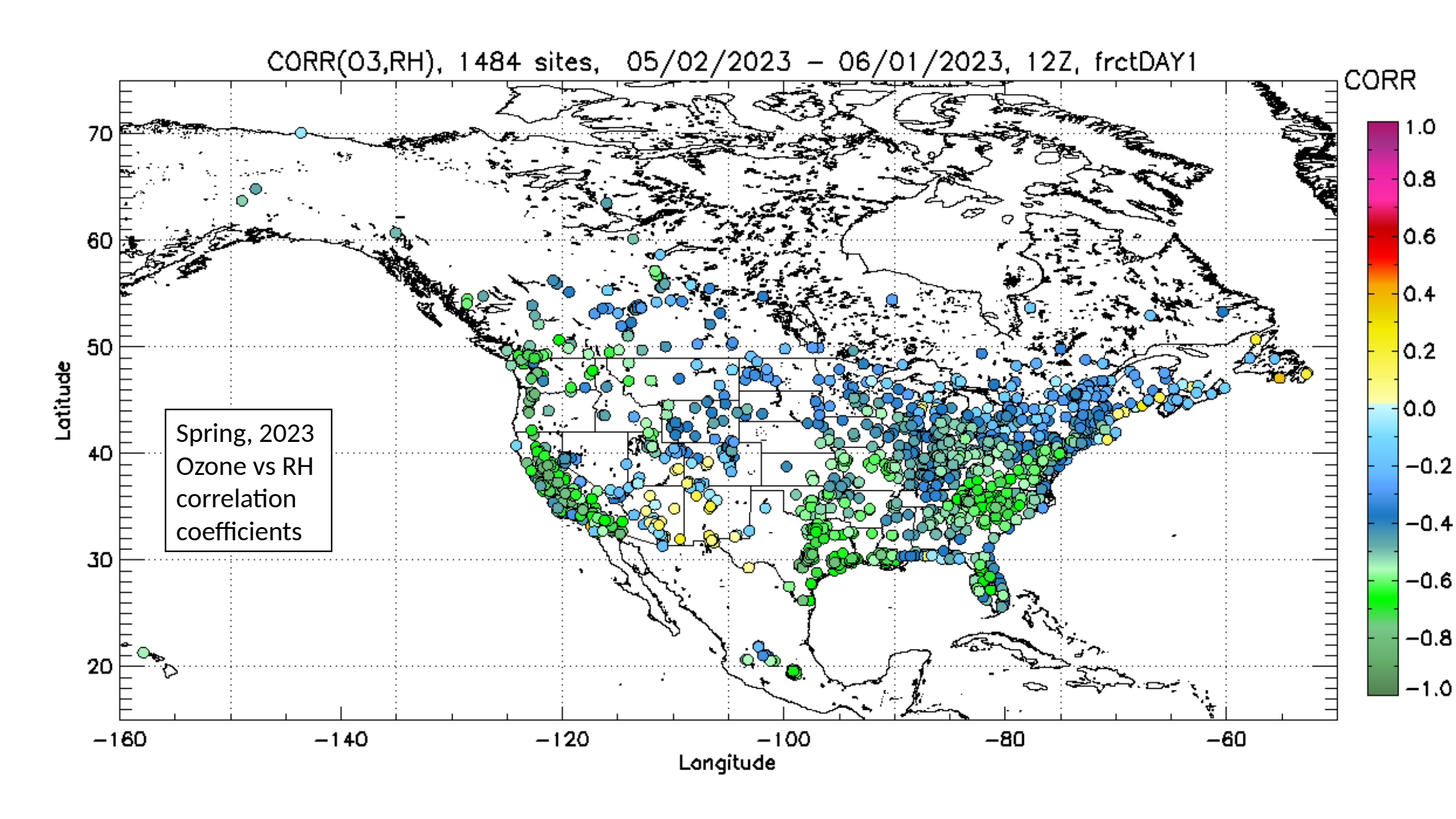
6 seasons test

- Winter 2022-2023, 22DJF
- Spring 2023, 23MAM
- Summer 2023, 23JJA
- Fall 2023, 23SON
- Winter 2023-2024, 23DJF
- Spring 2024, 24MAM

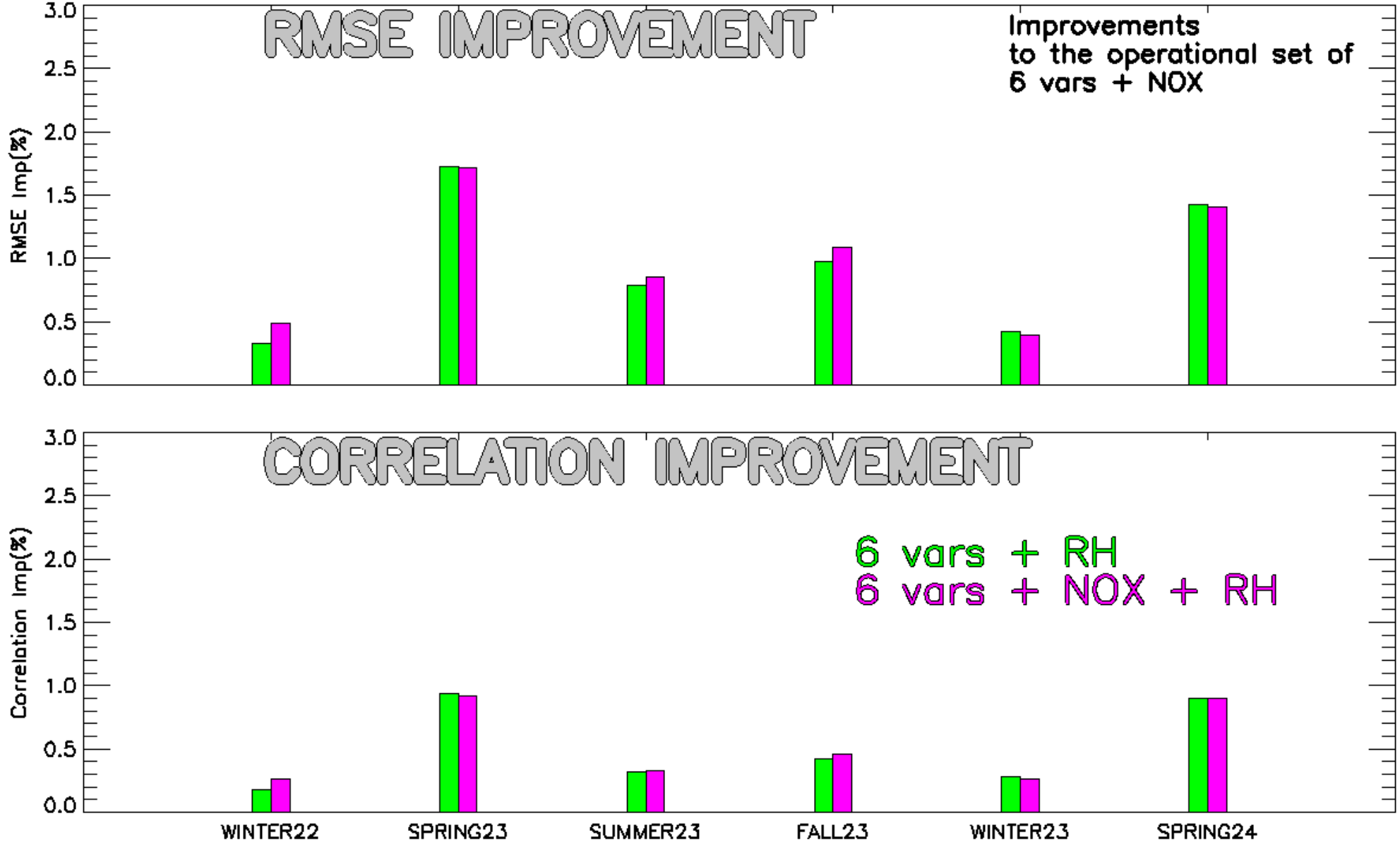


OZONE, 15 days evaluation period

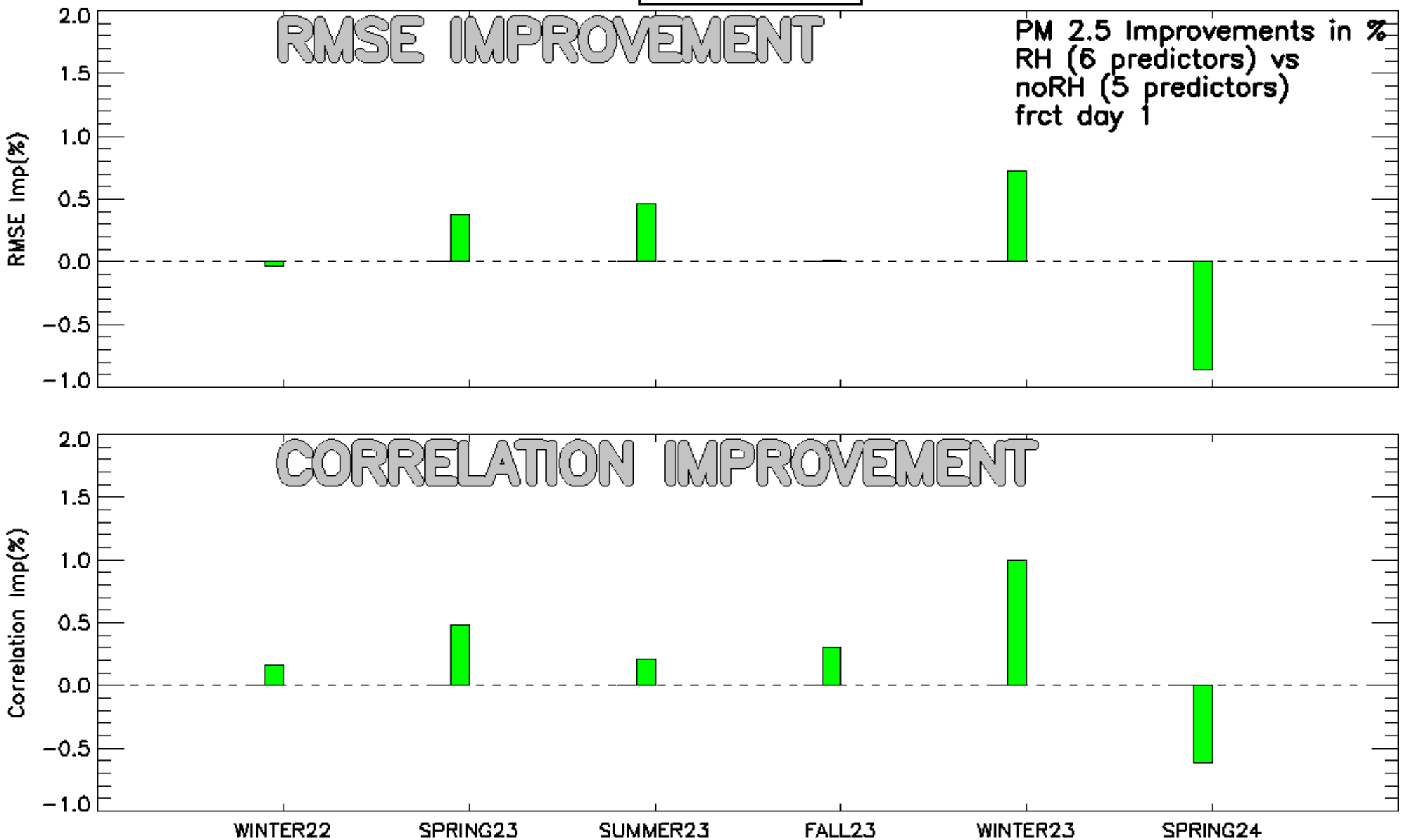



CORR(O3,RH), 1484 sites, 05/02/2023 – 06/01/2023, 12Z, frctDAY1
CORR
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
Latitude
70
60
50
40
30
20
Longitude
−160
−140
−120
−100
−80
−60
Spring, 2023
Ozone vs RH
correlation
coefficients

OZONE, 90 days evaluation period



$PM_{2.5}$


RMSE IMPROVEMENT
PM 2.5 Improvements in %
RH (6 predictors) vs
noRH (5 predictors)
frct day 1
RMSE Imp(%)
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
CORRELATION IMPROVEMENT
Correlation Imp(%)
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
WINTER22
SPRING23
SUMMER23
FALL23
WINTER23
SPRING24

Conclusions

- Ozone and RH are negatively correlated, both spatially and temporally;
- Using RH as a new predictor for ozone bias-correction gives ~2% RMSE and ~1% correlation improvements;
- Improvements vary by season, showing the highest improvement in spring;
- The improvements are the largest over the eastern US;
- Improvement of $PM_{2.5}$ forecast skill by including RH as a predictor is smaller and less consistent.
- Further tests are being run using water vapor deficit as the analog search variable instead of RH.