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2018 Ozone Season CMAQ Model Feedback

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CMAQ Model Performance Methodology (same as previous years)

- 12Z Operational NOAA CMAQ model run was used exclusively (except for missing data) for this study.

- Day 1 (today's forecast) and Day 2 (tomorrow's forecast) CMAQ NOAA model maximum 8-hour concentrations are extracted for every day since March 31st at all monitor sites that are used by South Carolina for ozone forecast verification.

- Differences between Day 2 and Day 1 CMAQ forecasts are used to remove model biases when producing day-to-day forecasts, and this same methodology is used for CMAQ performance testing in South Carolina.

CMAQ Model Performance Methodology (same as previous years*)

- **“NOAA Value”** - **Day 2 max 8-hour CMAQ predicted value at monitored location**

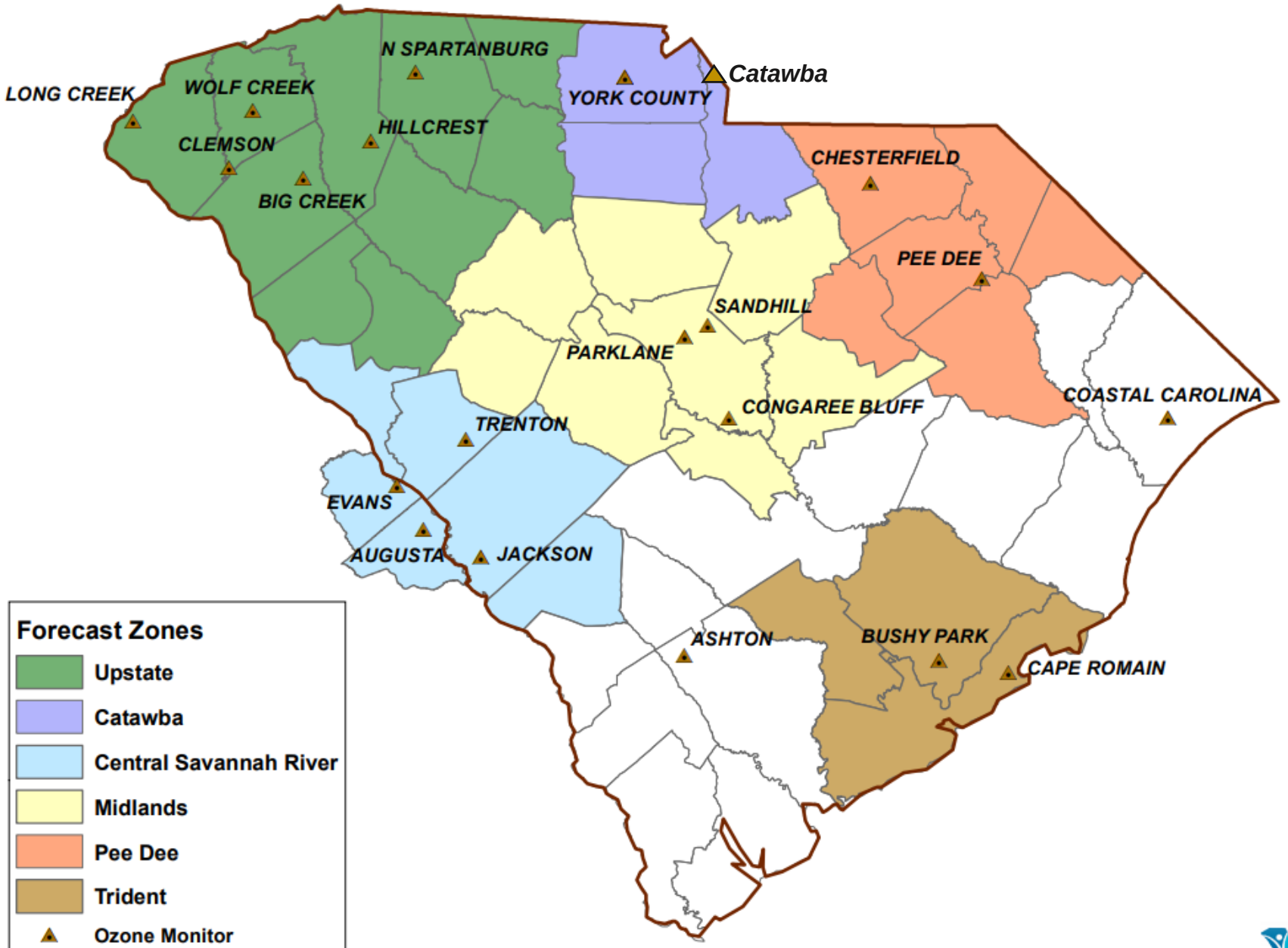
- **“NOAA Diff”** {CMAQ bias adjusted/corrected value at the monitored location}
  [(day 2 max 8-hour CMAQ prediction) – (day 1 max 8-hour CMAQ prediction)] + (Day 1 max 8-hour observation)

- Data Categories for Statistics:
  - “NOAA Value”, “NOAA Diff”, and South Carolina DHEC forecasts and errors
  - Monitor site-specific (22) and zone maximums (6 forecast zones)
  - O3 Season, Spring (April 1 – June 15) and Summer (June 16 – Sept 15) seasons

- *Missing NOAA CMAQ data for 12Z model run from July 12th. Used 06Z from July 12th as replacement data.

- *Removed July 8-11 Upstate data due to erroneous monitor readings.

Ground-Level Ozone - Forecast Zones and Monitors



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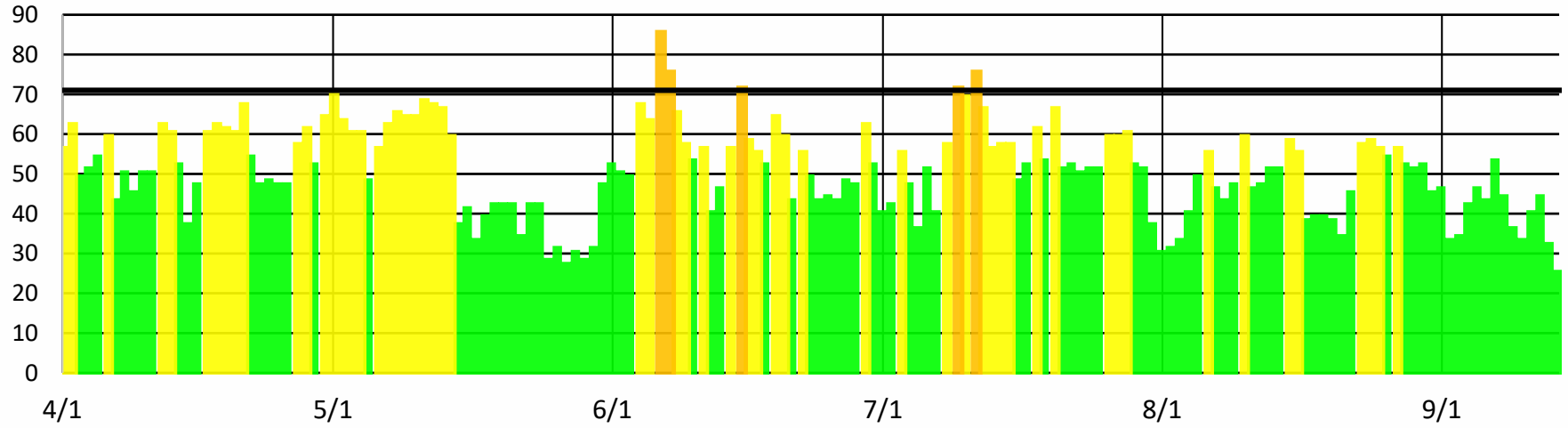
2018 Season Daily Max Observed Ozone



Date (exceedance)	Day of Week	Augusta, GA 8hr Max ppb	York 8hr Max ppb	Catawba 8hr Max ppb	Sandhill 8hr Max ppb
6/6	Wed	85	----	----	----
6/7	Thu	----	75	----	----
6/15	Fri	----	----	71	----
7/9	Mon	----	----	----	71
7/11	Wed	----	----	75	----

5 Monitor Exceedances in 2018

Date	Day of Week	Monitor Exceeded 70 ppb	Observed Max ppb	SC Forecast Max ppb	NOAA Value Max ppb	NOAA Diff Max ppb
6/6	Wed	Augusta, GA	85	65	54	50
6/7	Thu	York	75	71	59	73
6/15	Fri	Catawba	71	71	62	67
7/9	Mon	Sandhill	71	56	62	61
7/11	Wed	Catawba	75	71	67	70

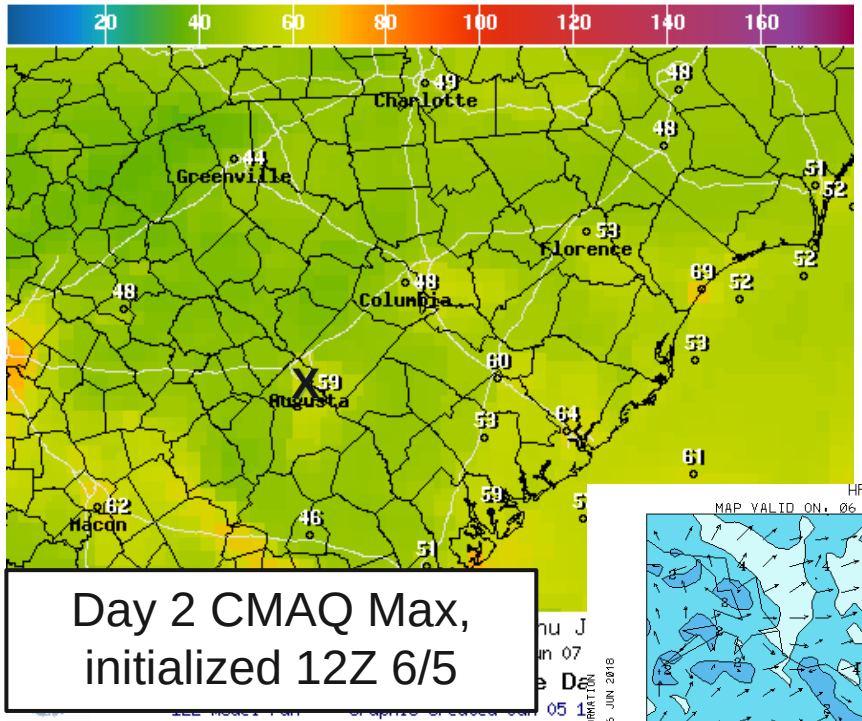
NOAA CMAQ False Alarms in 2018

- **"NOAA Value" – None.** However, the model did not predict any exceedances at our monitored locations in 2018.

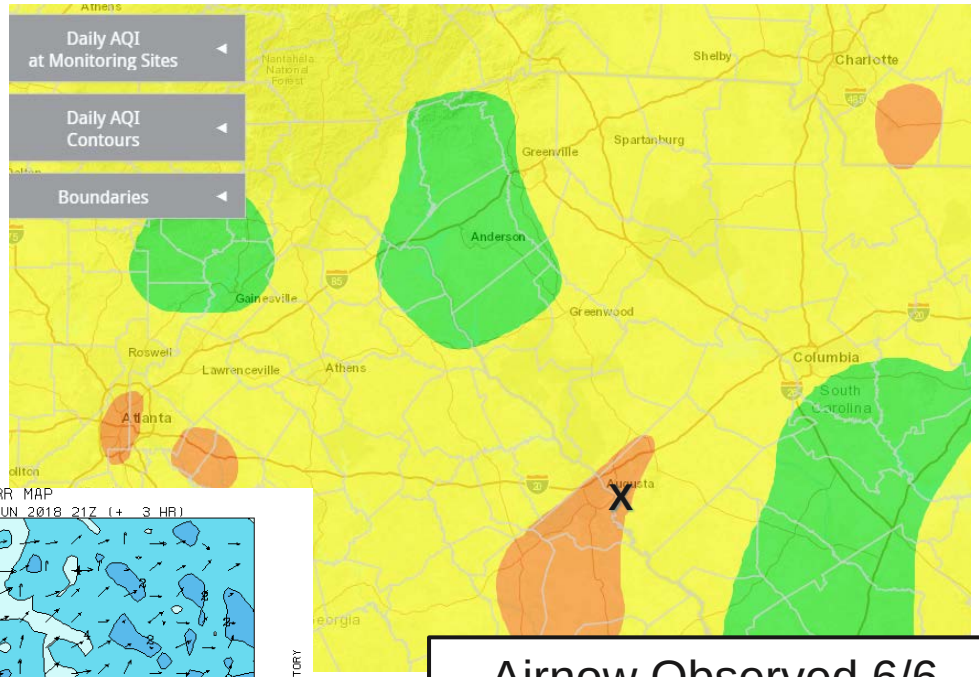
- **"NOAA Diff" – 8 False Alarm Days Total (4/18, 5/12, 5/13, 6/5, 6/7, 6/8, 7/10, and 7/11)**

Times when SCDHEC issued a false alarm ozone action day is shown below						
Date	Day of Week	Highest Monitor	Observed Max ppb	SC Forecast Max ppb	NOAA Value Max ppb	NOAA Diff Max ppb
5/12	Sat	Jackson	66	71	59	72
5/13	Sun	Jackson	66	72	60	67
6/7	Thu	Augusta, GA	64	72	63	86
7/11	Wed	Parklane	62	75	64	68

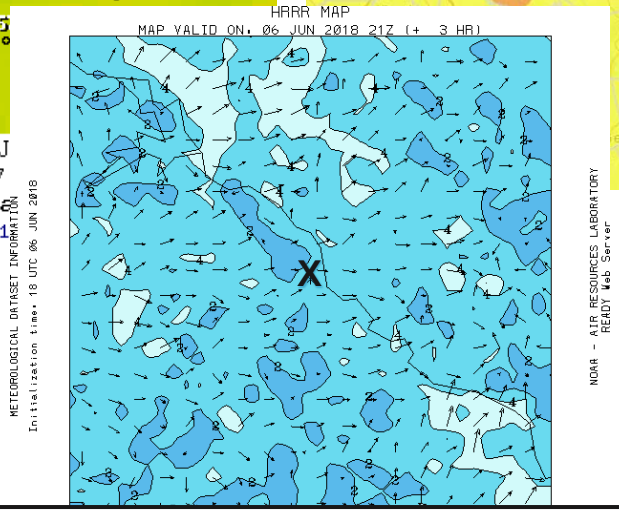
Example: Augusta, SC Exceedance - June 6th, 2018



Day 2 CMAQ Max, initialized 12Z 6/5



Airnow Observed 6/6



Surface Wind Speed/Vectors 21Z 6/6…. Showing very light winds

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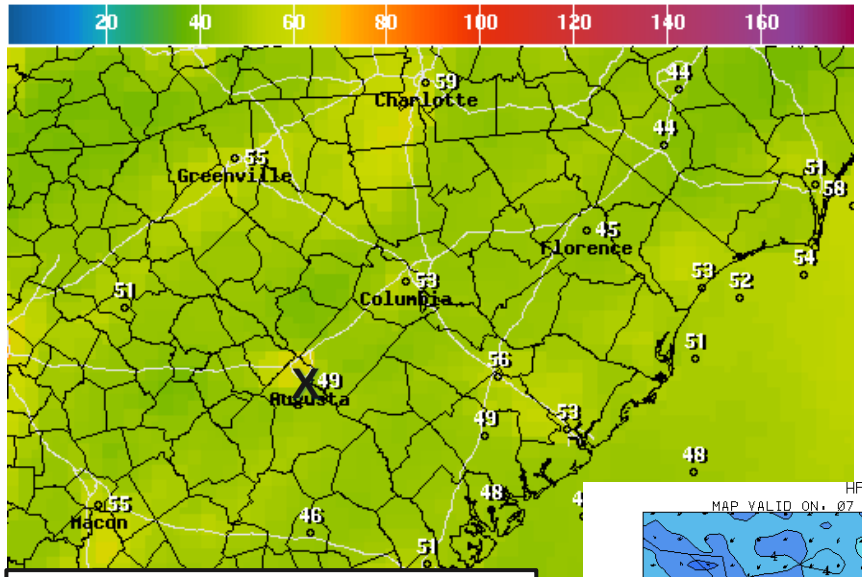
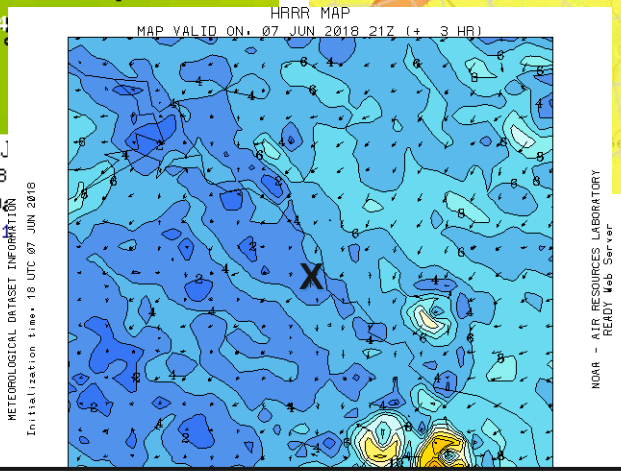
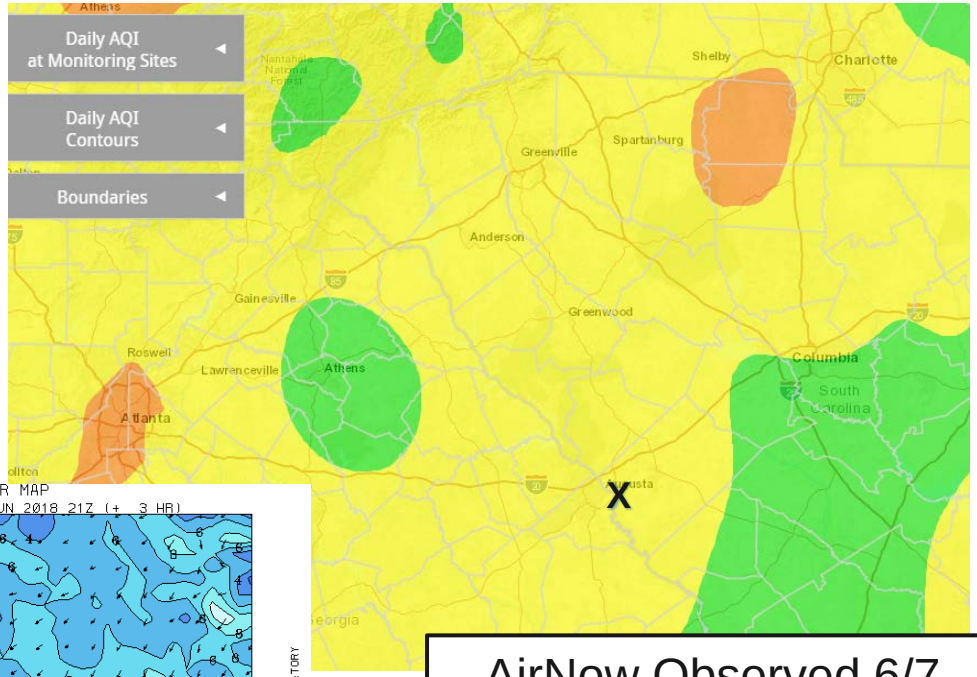
Example: Augusta, SC SCDHEC False Alarm - June 7th, 2018



Day 2 CMAQ Max, initialized 12Z 6/6





AirNow Observed 6/7

Surface Wind Speed/Vectors 21Z 6/7…. Showing a slight increase in surface wind from northeast direction. NOAA Diff and SCDHEC false alarm!

CMAQ Model Performance for SC 2018

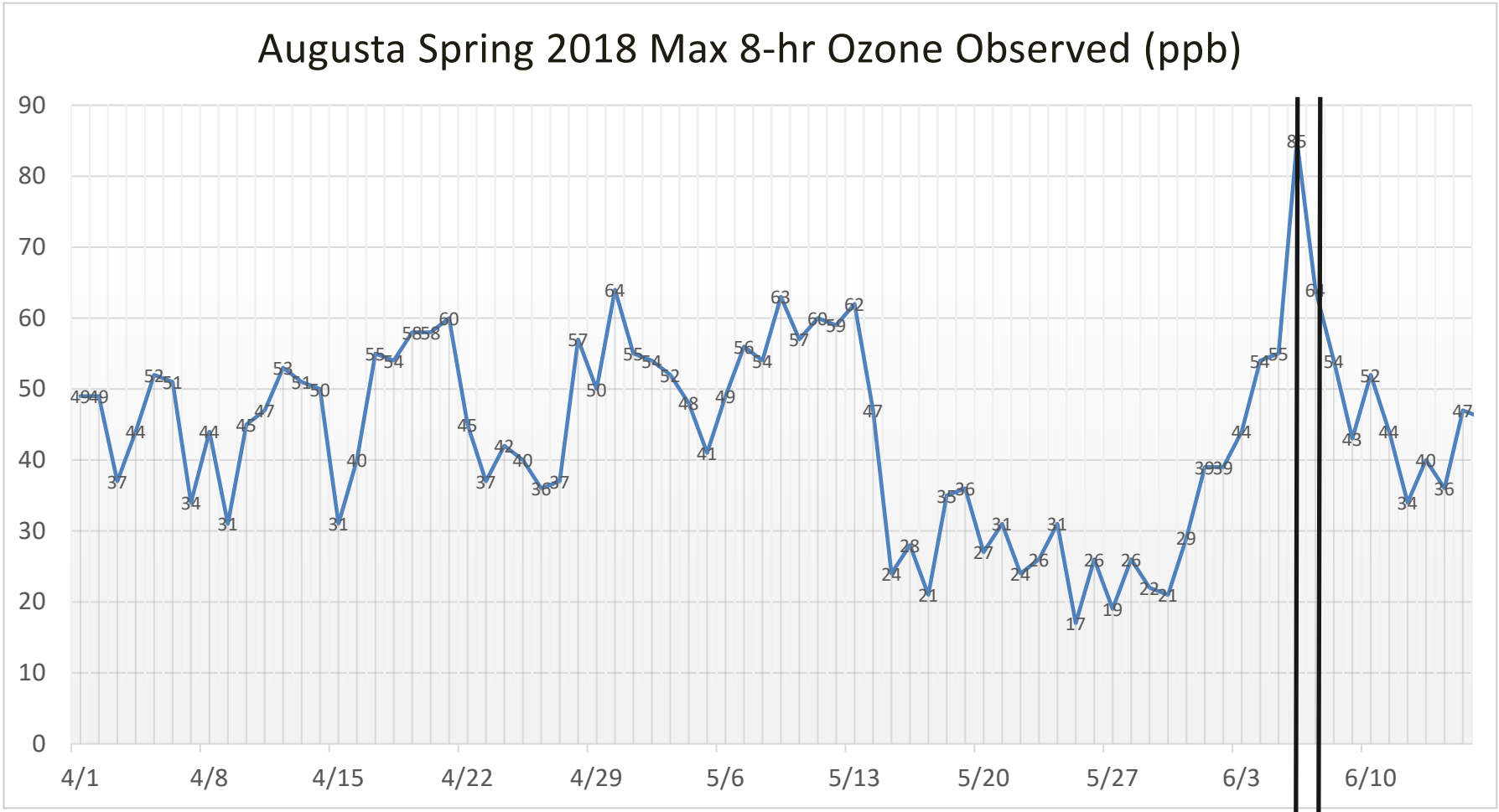
Forecast Bias (PPB)	Midlands / Columbia (Sandhill)			Upstate (Spartanburg)			Central Savannah (Augusta, GA)		
	BAQ	NOAA		BAQ	NOAA		BAQ	NOAA	
		Value	Diff		Value	Diff		Value	Diff
2018 Ozone Season (Apr 1 – Sept 15)	3.2	0.0	1.5	3.1	-0.8	4.4	3.6	1.7	6.0
Spring (Apr 1 – June 15)	2.4	-2.1	1.4	2.2	-3.0	3.5	2.8	-1.1	4.6
Summer (June 16 – Sept 15)	3.9	1.8	1.7	3.8	1.2	5.3	4.3	4.3	7.3

Forecast Bias Color Key	<2	2-5	>5

CMAQ Model Performance for SC 2018

Forecast Bias (PPB)	Pee Dee / Florence (Pee Dee)			Catawba / Rock Hill (York)			Trident / Charleston (Bushy Park)		
	BAQ	NOAA		BAQ	NOAA		BAQ	NOAA	
		Value	Diff		Value	Diff		Value	Diff
2018 Ozone Season (Apr 1 – Sept 15)	1.0	-1.0	1.3	3.0	-0.3	1.2	3.4	7.5	1.2
Spring (Apr 1 – June 15)	-0.1	-2.8	0.7	1.5	-2.5	1.1	2.7	4.5	0.8
Summer (June 16 – Sept 15)	2.0	0.6	1.8	4.3	1.7	1.3	4.0	10.2	1.5

Forecast Bias Color Key	<2	2-5	>5



Ozone Observation > 70ppb on 6/6 (85ppb), NOAA Diff False Alarm 6/7

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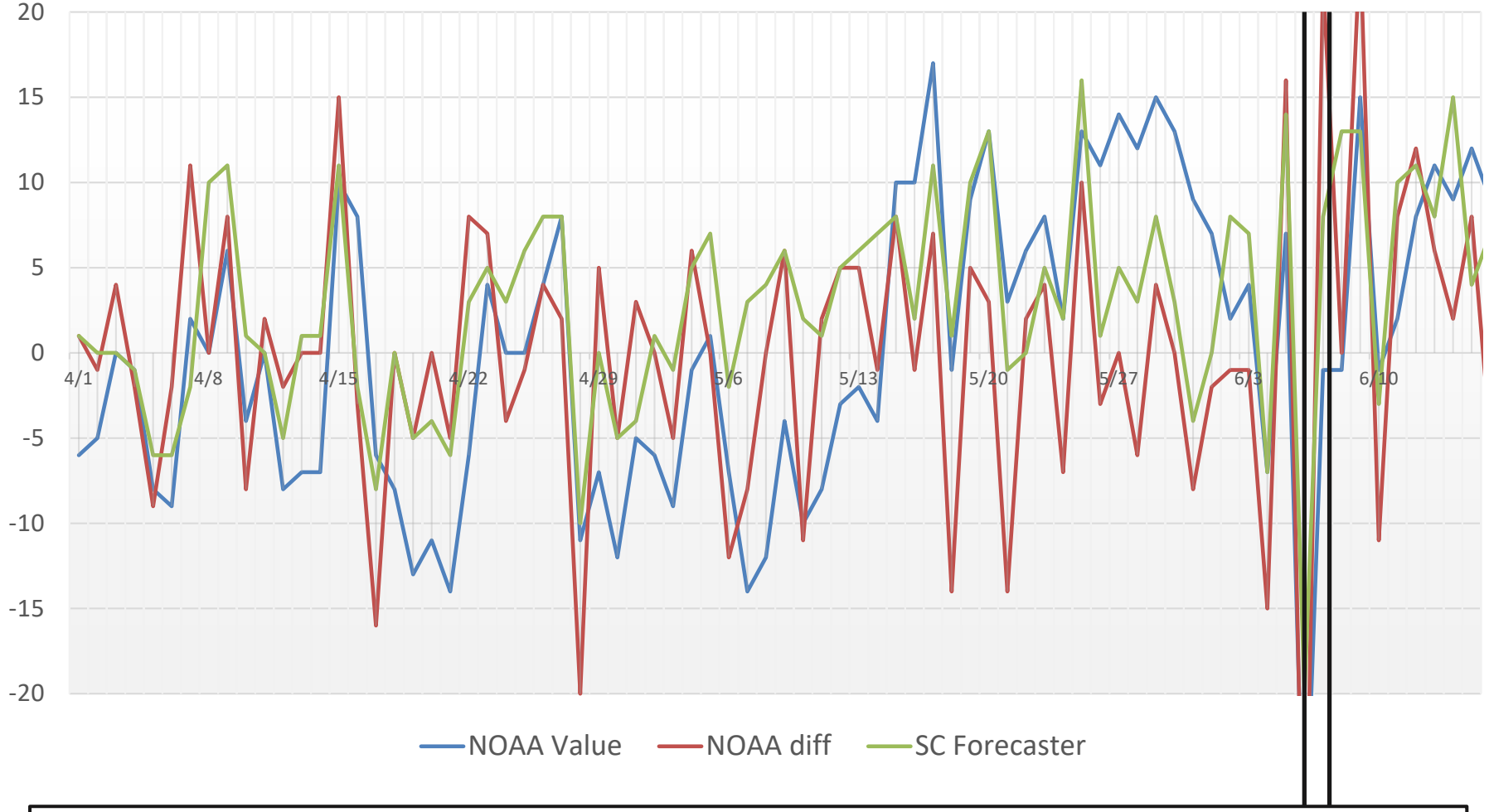
Augusta Spring 2018 Forecast Errors (ppb)



Ozone Observation > 70ppb on 6/6 (85ppb), NOAA Diff False Alarm 6/7

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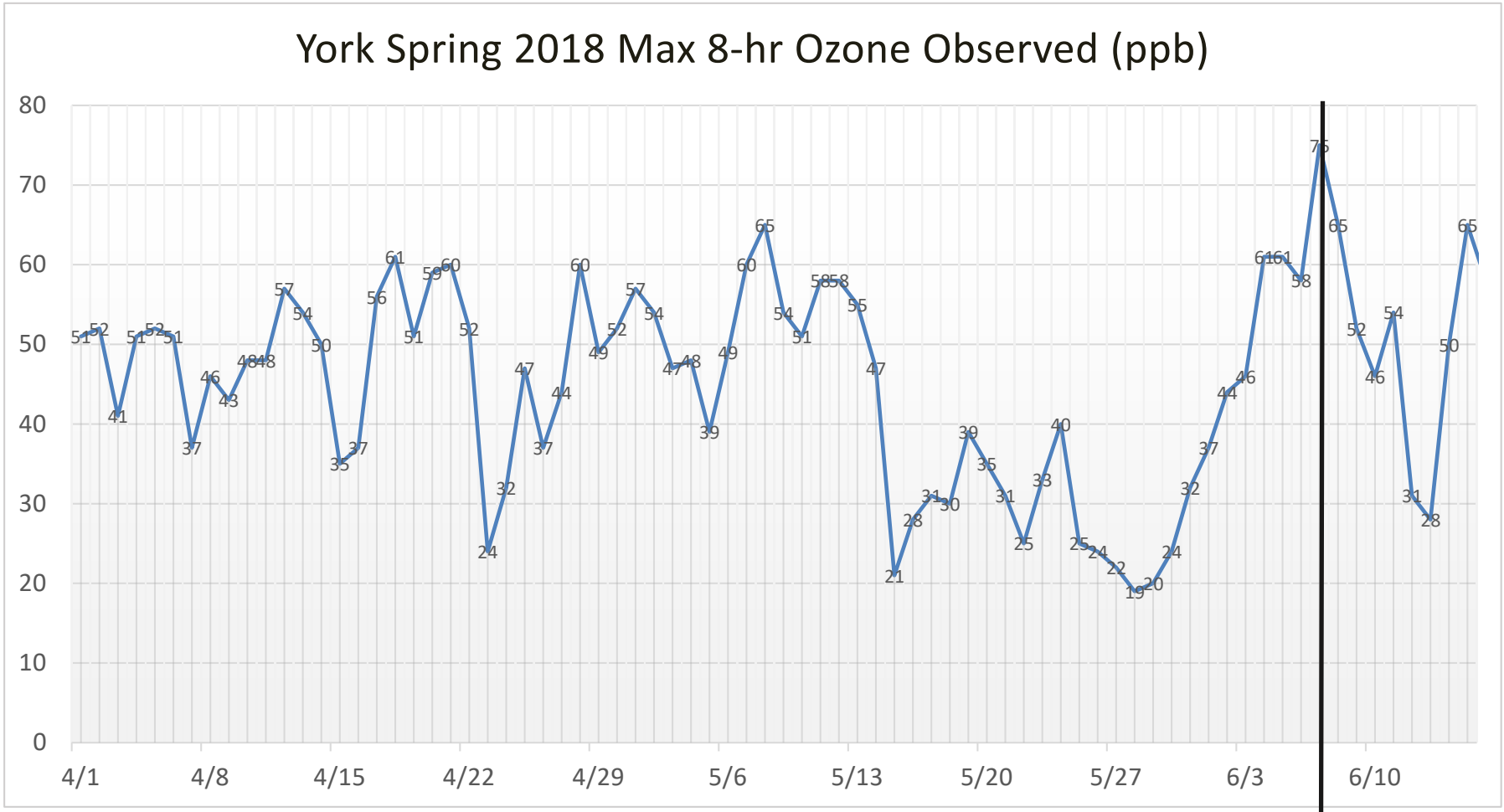
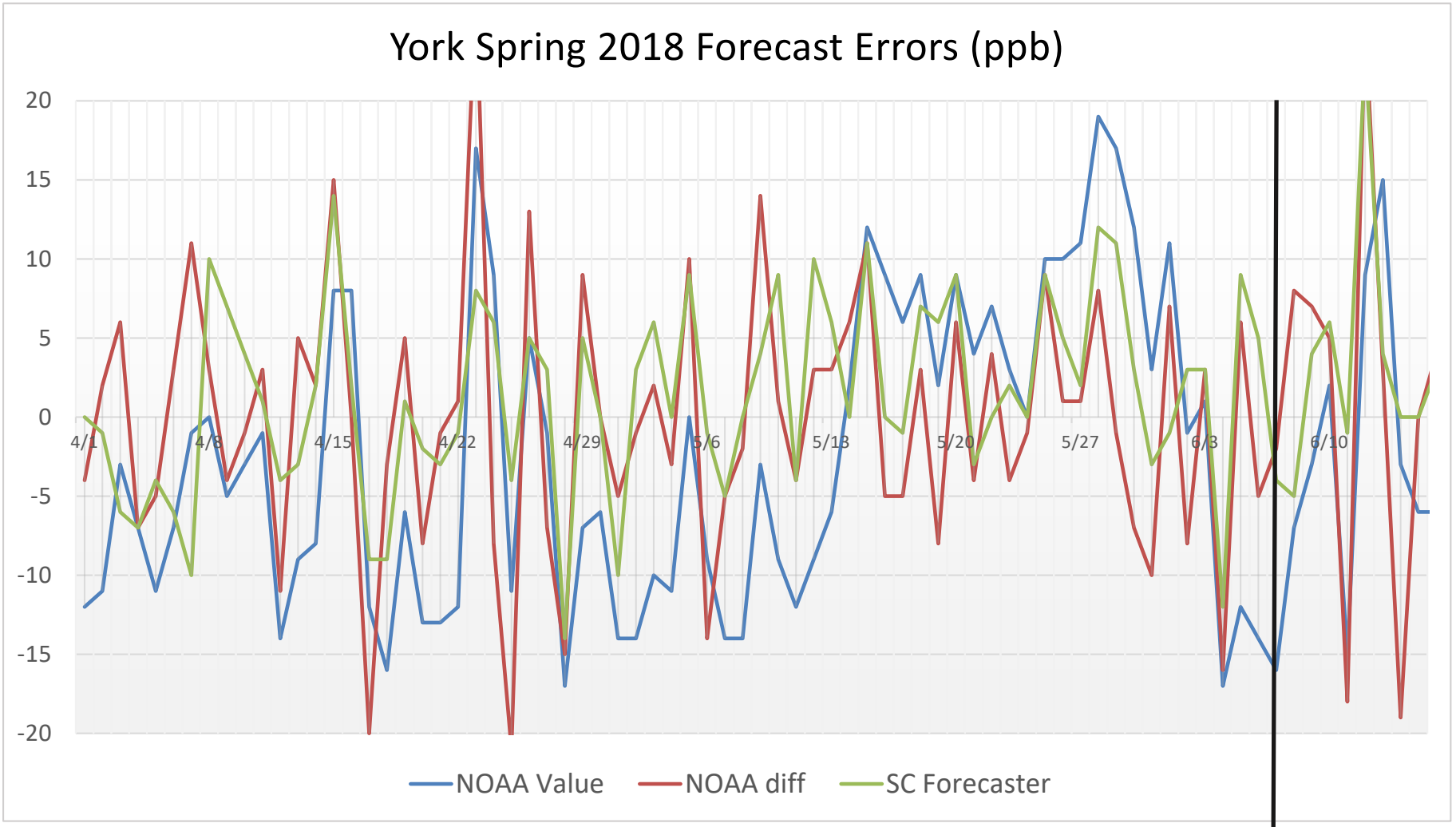


Ozone Observation > 70ppb on 6/7 (75ppb)



Ozone Observation > 70ppb on 6/7 (75ppb)

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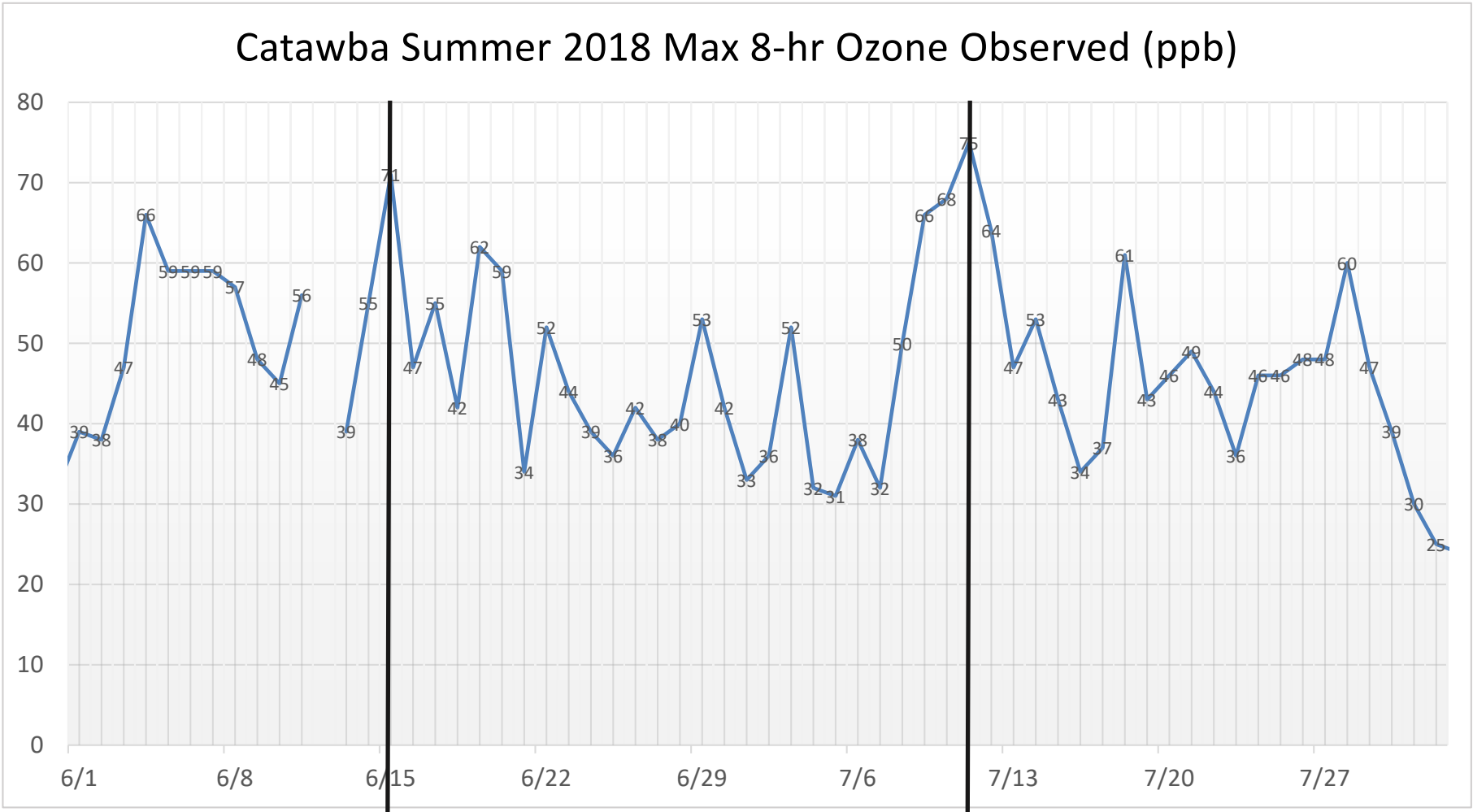
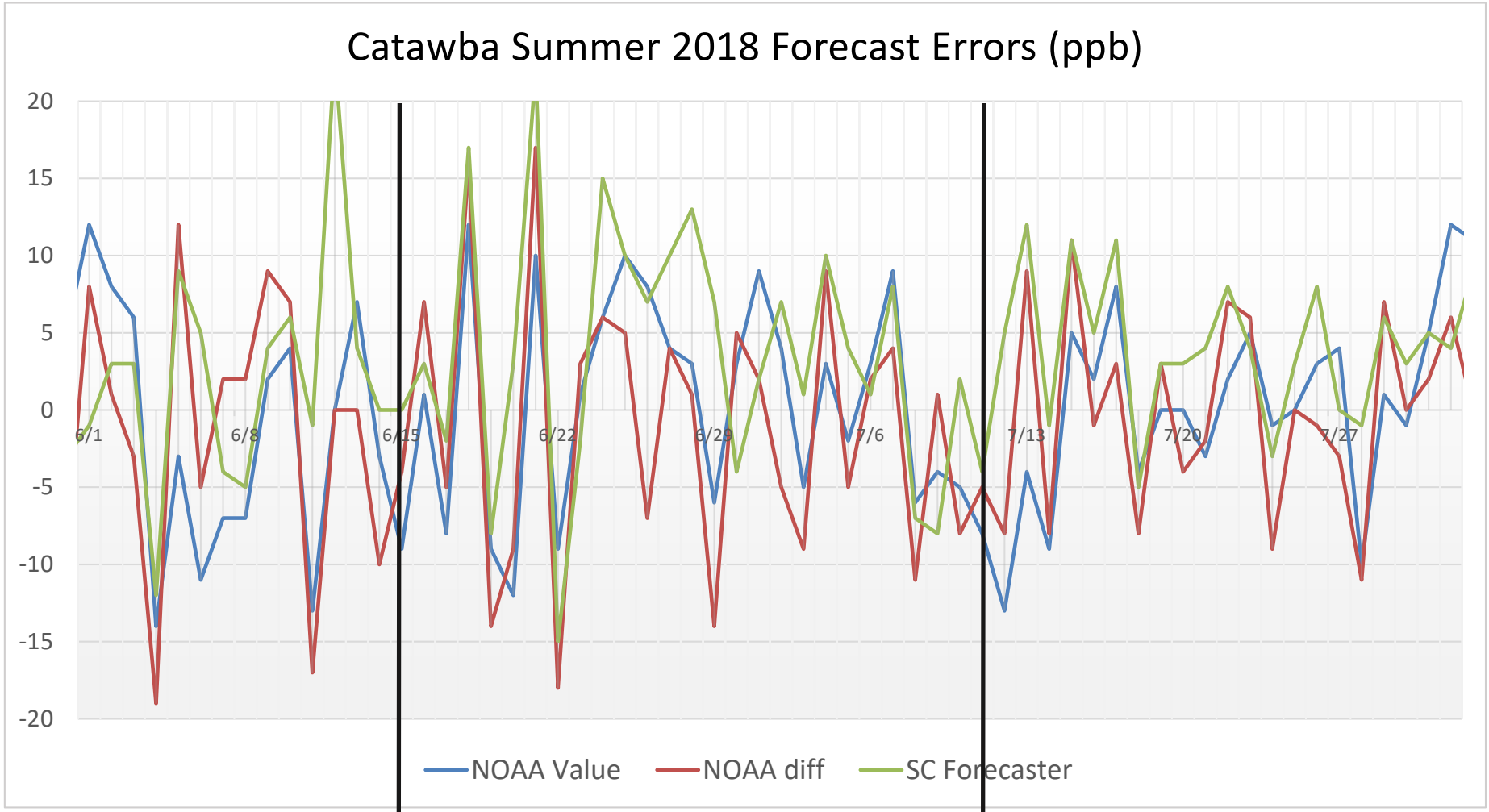


Ozone Observation > 70ppb on 6/15 (71ppb) and 7/11 (75ppb)



Ozone Observation > 70ppb on 6/15 (71ppb) and 7/11 (75ppb)

Summary of SC Comments on NOAA Operational CMAQ Guidance

- "NOAA Value" (Day 2 CMAQ actual value) forecasts generally better than previous years, except in coastal areas.

- "NOAA Value" continues to over-predict more often during Summer months (June-August). NOAA CMAQ struggles with a moist environment. The bias was much closer to zero in April and May with a slight under-prediction (except over-prediction along the coast), but there was a slight over-prediction across the entire state during Summer months.

- "NOAA Diff" approach should remove systematic biases. This approach worked reasonably well for the coast in 2018, but the approach performed poorly in Upstate and Central Savannah River Area this year.

- SC forecasters use the "NOAA Diff" methodology to develop a day 2 forecast.

Summary of SC Comments on NOAA Operational CMAQ Guidance

- The data shown in this presentation are preliminary.
- For graphical display, SCDHEC prefers smoothing algorithms due to coarse resolution of the model.
- Definitive contours between color thresholds would be preferable.
- Suggestion to generate forecasts out 72 hours (or longer).
- Operational CMAQ output is good guidance. Thanks!

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Thank you!

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