South Carolina Department of Health and Environmental Control

2017 Ozone Season CMAQ Model Feedback

Wes Behrend, SCDHEC Air Quality Forecaster

CMAQ Model Performance Methodology

- 12Z NOAA CMAQ model run was used exclusively 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

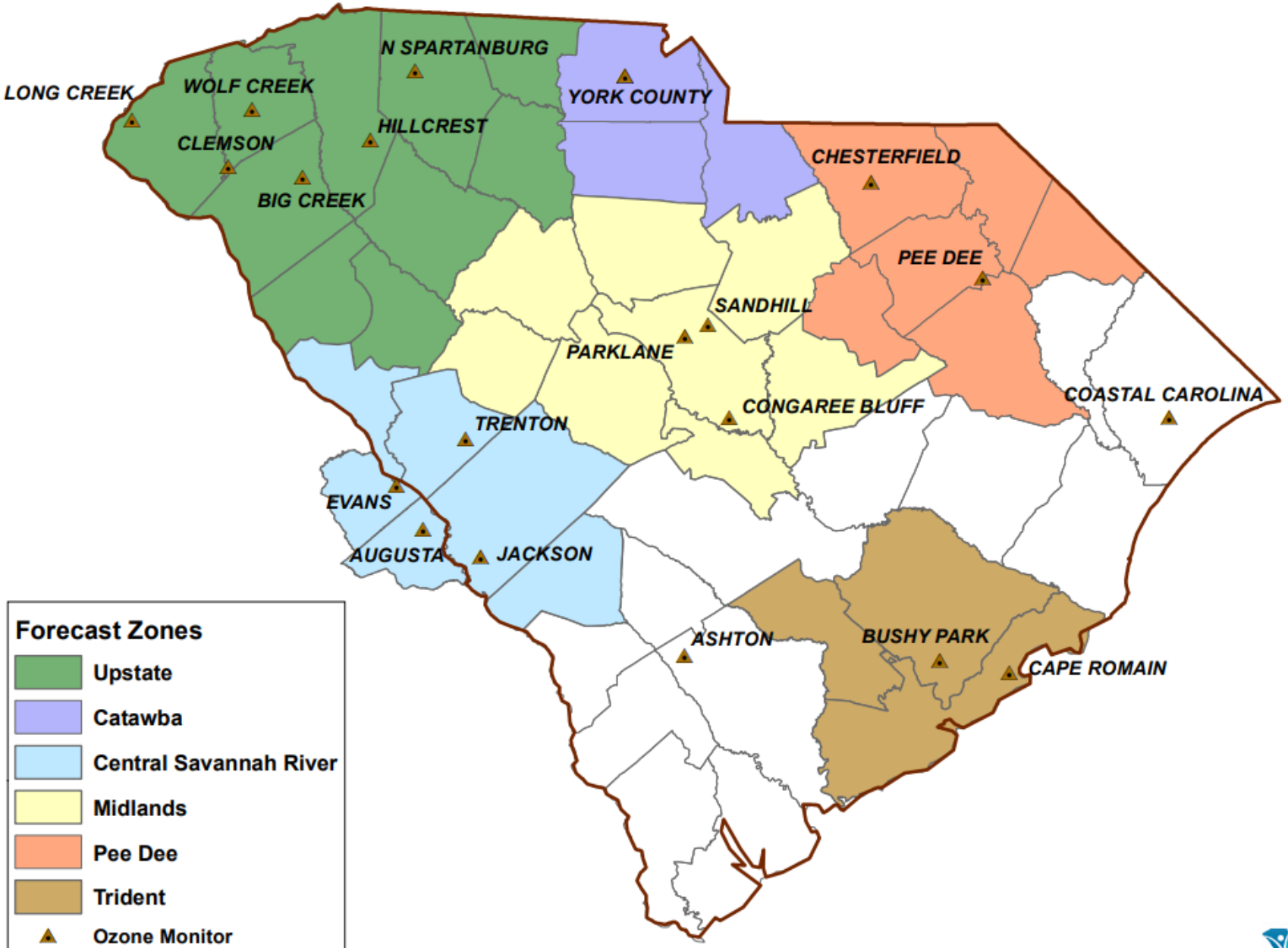
- **“NOAA Value”** - **Day 2 max 8-hour CMAQ predicted value at monitored location**

- **“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 (21) and zone maximums (6 forecast zones)
  - O3 Season, Spring (April 1 – June 15) and Summer (June 16 – Sept 6) seasons

- Missing NOAA CMAQ data on April 3rd, May 9th, May 10th, and June 15th due to SCDHEC Linux downtime.

Ground-Level Ozone - Forecast Zones and Monitors



3 Ozone Exceedance Days in 2017

Date	Day of Week	Sandhill Max ppb	Spartanburg Max ppb	Evans, GA Max ppb	York Max ppb	Cape Romain Max ppb
5/10/17	Wed	----	----	----	----	71
5/16/17	Tue	72	73	72	----	----
7/25/17	Tue	----	----	----	72	----

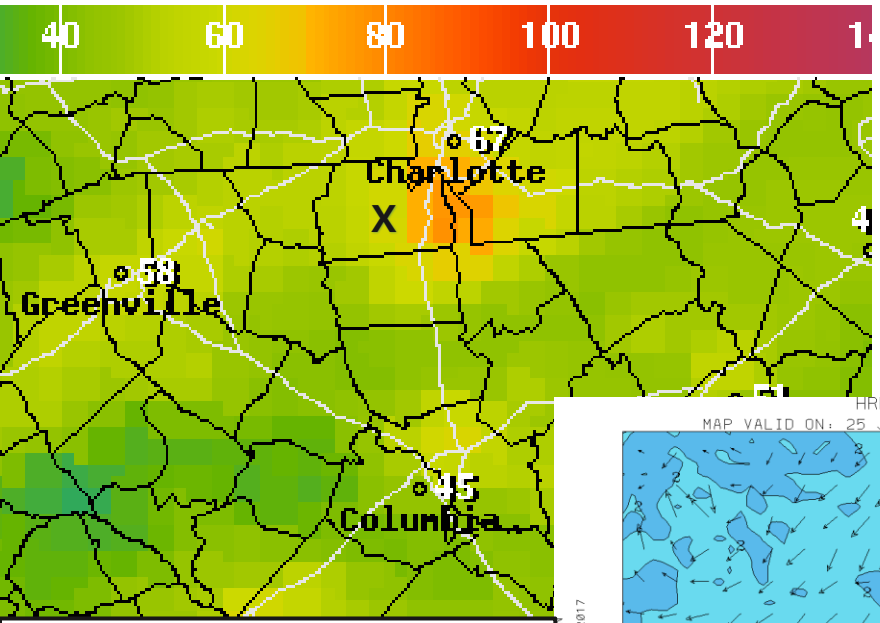
5 Monitor Exceedances in 2017

Date	Day of Week	Monitor Exceeded 70 ppb	Observed Max ppb	SC Forecast Max ppb	NOAA Value Max ppb	NOAA Diff Max ppb
5/10/17	Wed	Cape Romain	71	71	56*	69*
5/16/17	Tue	Sandhill	72	62	60	66
5/16/17	Tue	Spartanburg	73	69	57	66
5/16/17	Tue	Evans, GA	72	64	52	62
7/25/17	Tue	York	72	56	58	48

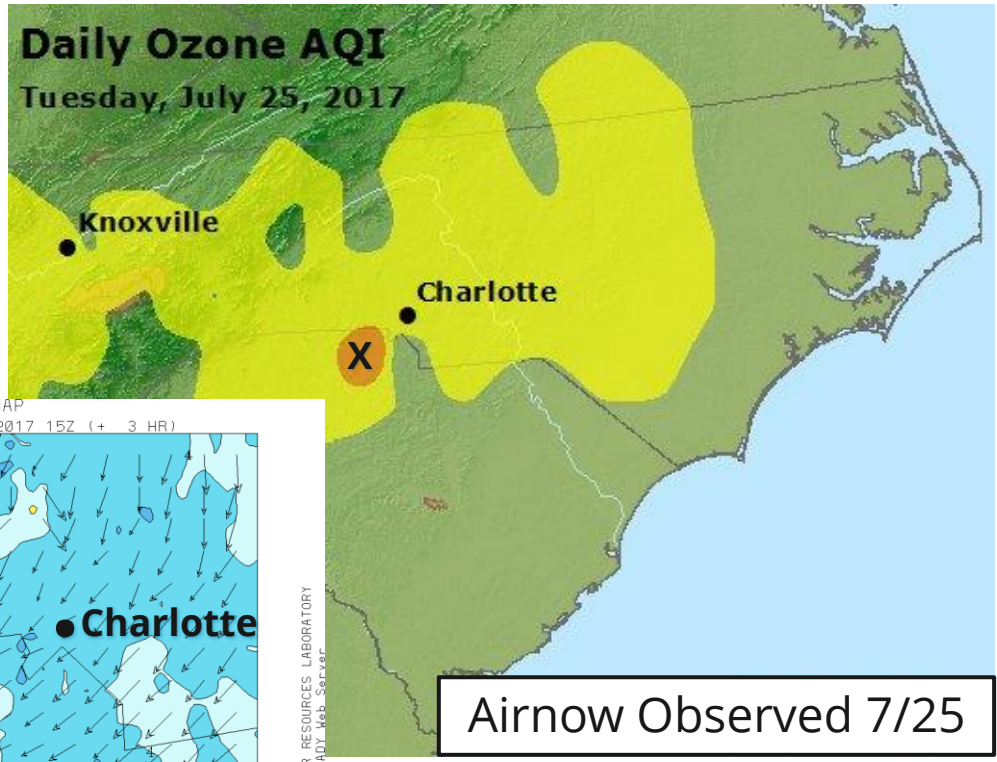
* Max based on the 6Z NOAA CMAQ model run.

South Carolina Department of Health and Environmental Control

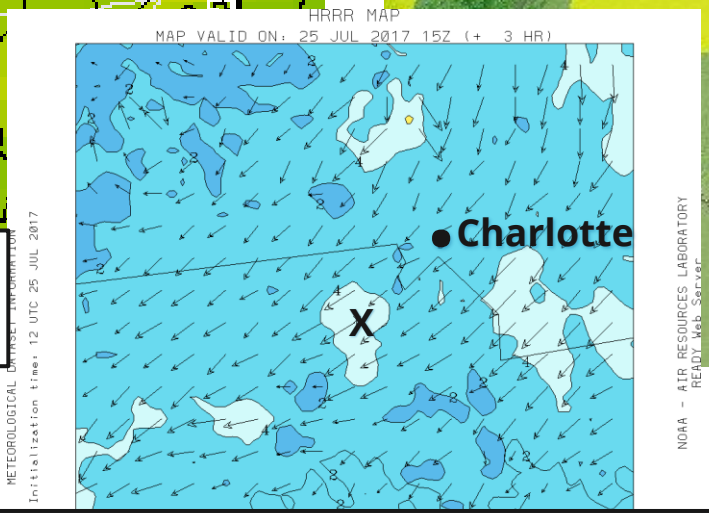
York Exceedance - July 25th, 2017



Day 2 CMAQ Max, initialized 12Z 7/24



Airnow Observed 7/25



Surface Wind Speed/Vectors 15Z 7/25

NOAA CMAQ False Alarms in 2017

Date	Day of Week	CMAQ Exceeded 70 ppb	Observed Max ppb	SC Forecast Max ppb	NOAA Value Max ppb	NOAA Diff Max ppb
6/3/17	Sat	Spartanburg	57	64	58	71
8/1/17	Tue	York	65	67	71	74
8/25/17	Fri	York	63	57	58	72

CMAQ Model Performance for SC 2017

Forecast Bias (PPB)	Midlands / Columbia (Sandhill)			Upstate (Spartanburg)			Central Savannah (Augusta, GA)		
	BAQ	NOAA		BAQ	NOAA		BAQ	NOAA	
		Value	Diff		Value	Diff		Value	Diff
2017 Ozone Season (Apr 1 – Sept 6)	3.1	1.5	-1.1	3.7	1.1	0.0	4.0	6.4	-0.5
Spring (Apr 1 – June 15)	1.8	-0.4	-1.0	2.2	-0.4	-0.4	2.1	3.4	-1.1
Summer (June 16 – Sept 6)	4.4	3.2	-1.2	5.1	2.4	0.3	5.7	9.0	0.1

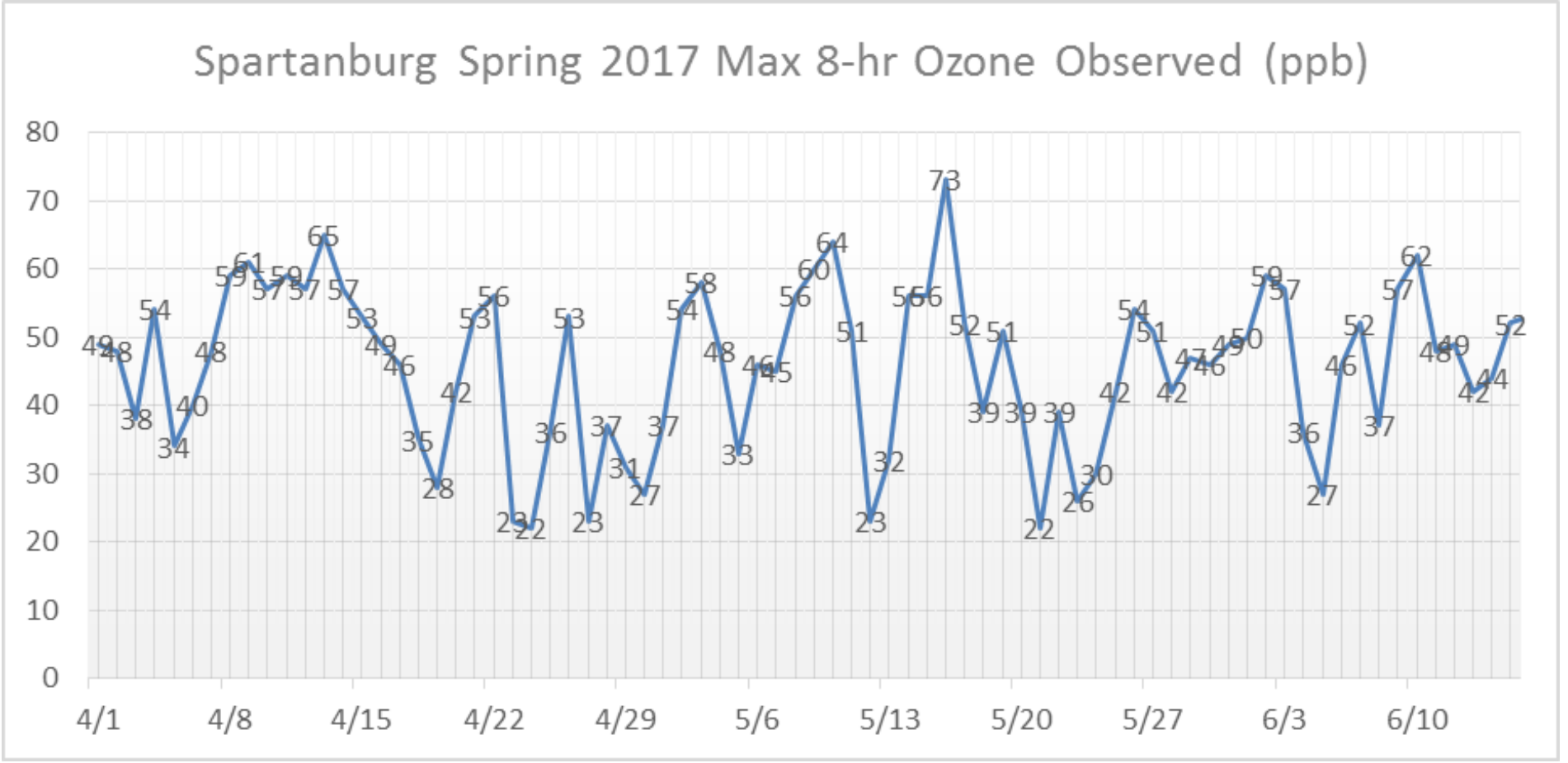
Forecast Bias Color Key	<2	2-5	>5

CMAQ Model Performance for SC 2017

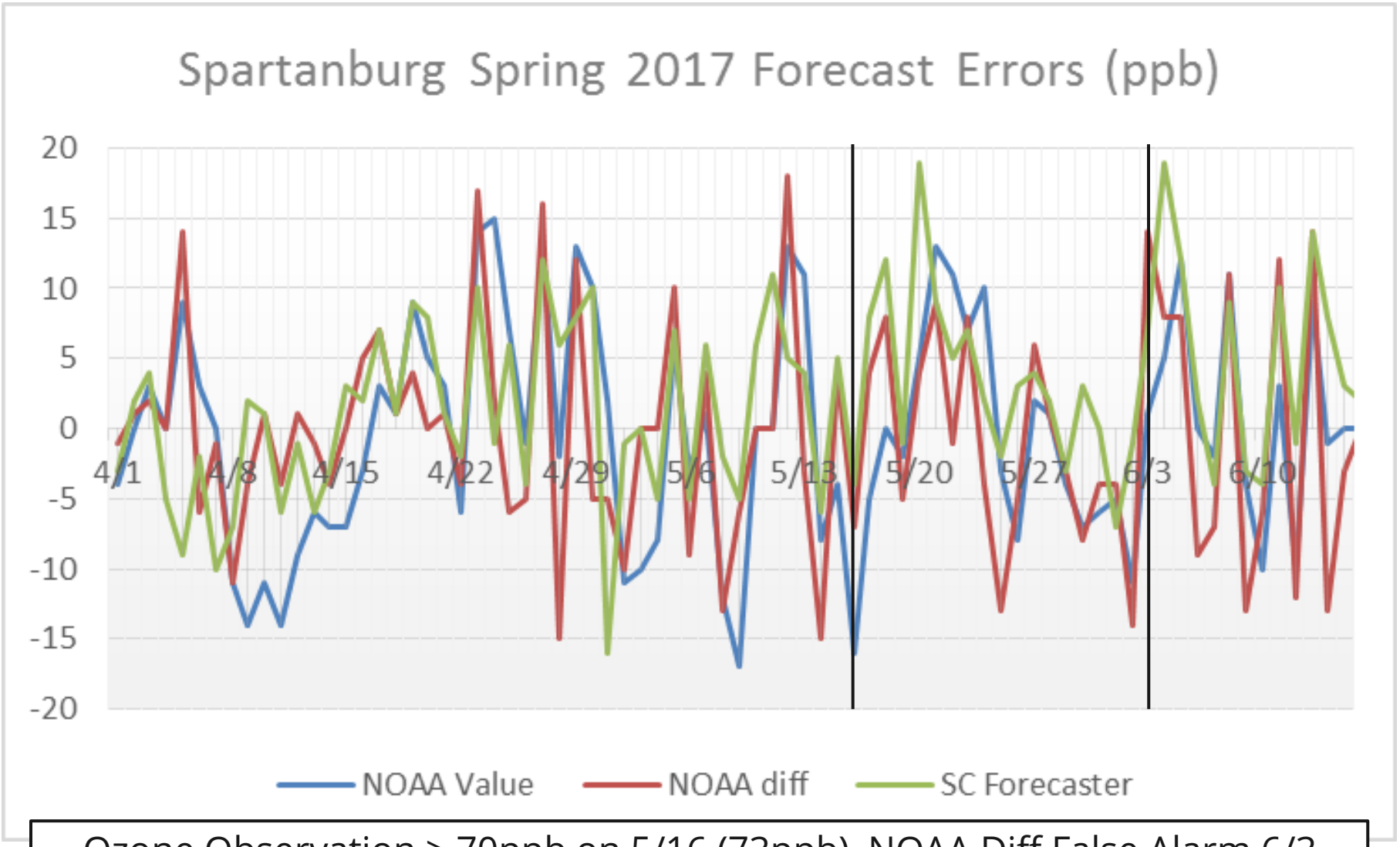
Forecast Bias (PPB)	Pee Dee / Florence (Pee Dee)			Catawba / Rock Hill (York)			Trident / Charleston (Bushy Park)		
	BAQ	NOAA		BAQ	NOAA		BAQ	NOAA	
		Value	Diff		Value	Diff		Value	Diff
2017 Ozone Season (Apr 1 – Sept 6)	2.6	2.8	-0.9	2.4	2.3	-0.5	3.9	8.5	-0.4
Spring (Apr 1 – June 15)	1.1	0.3	-0.8	1.7	1.1	-0.6	1.9	3.6	-0.6
Summer (June 16 – Sept 6)	3.9	4.9	-1.0	3.0	3.5	-0.5	5.7	12.9	-0.2

Forecast Bias Color Key	<2	2-5	>5

South Carolina Department of Health and Environmental Control

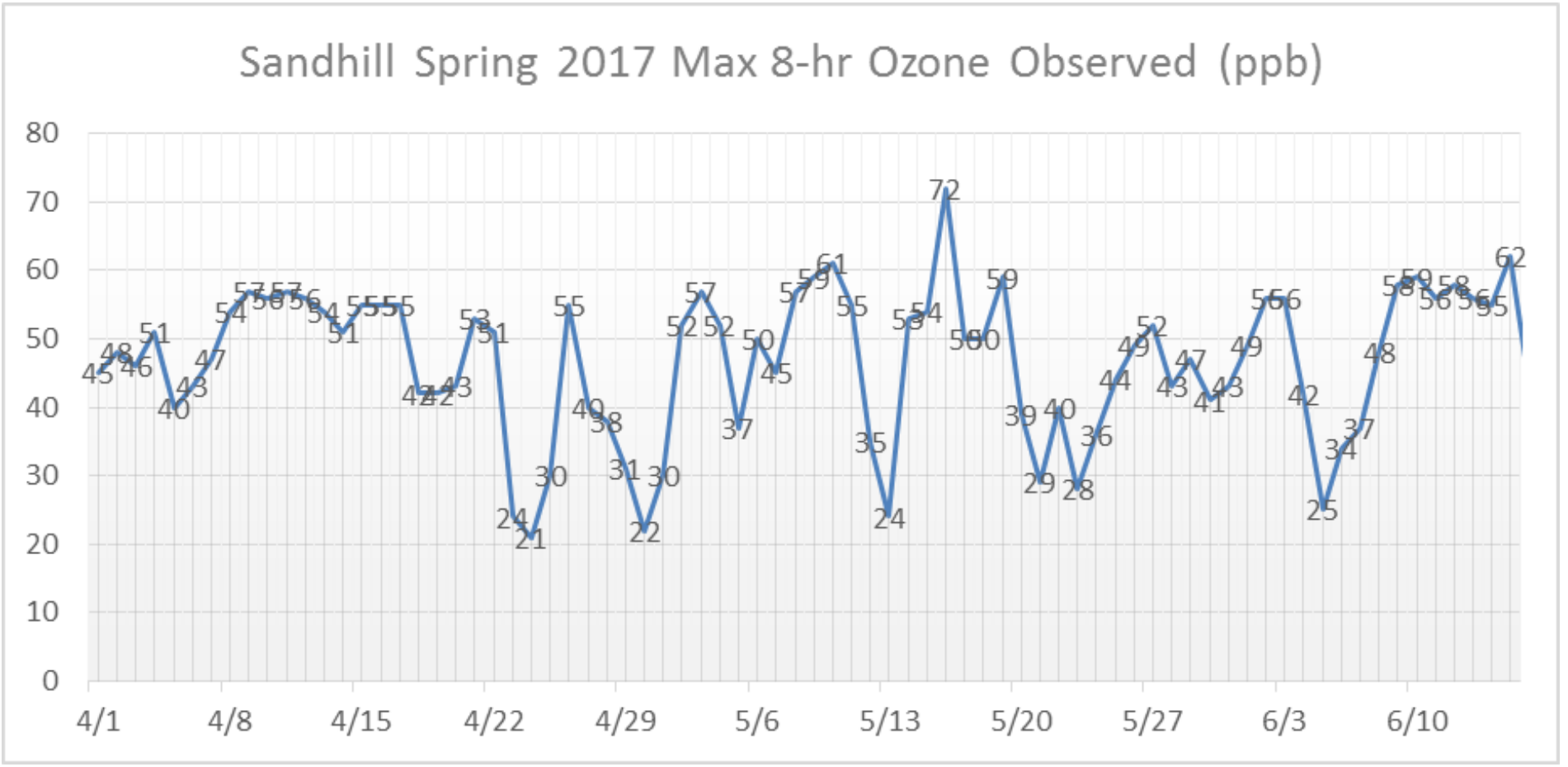


Ozone Observation > 70ppb on 5/16 (73ppb)

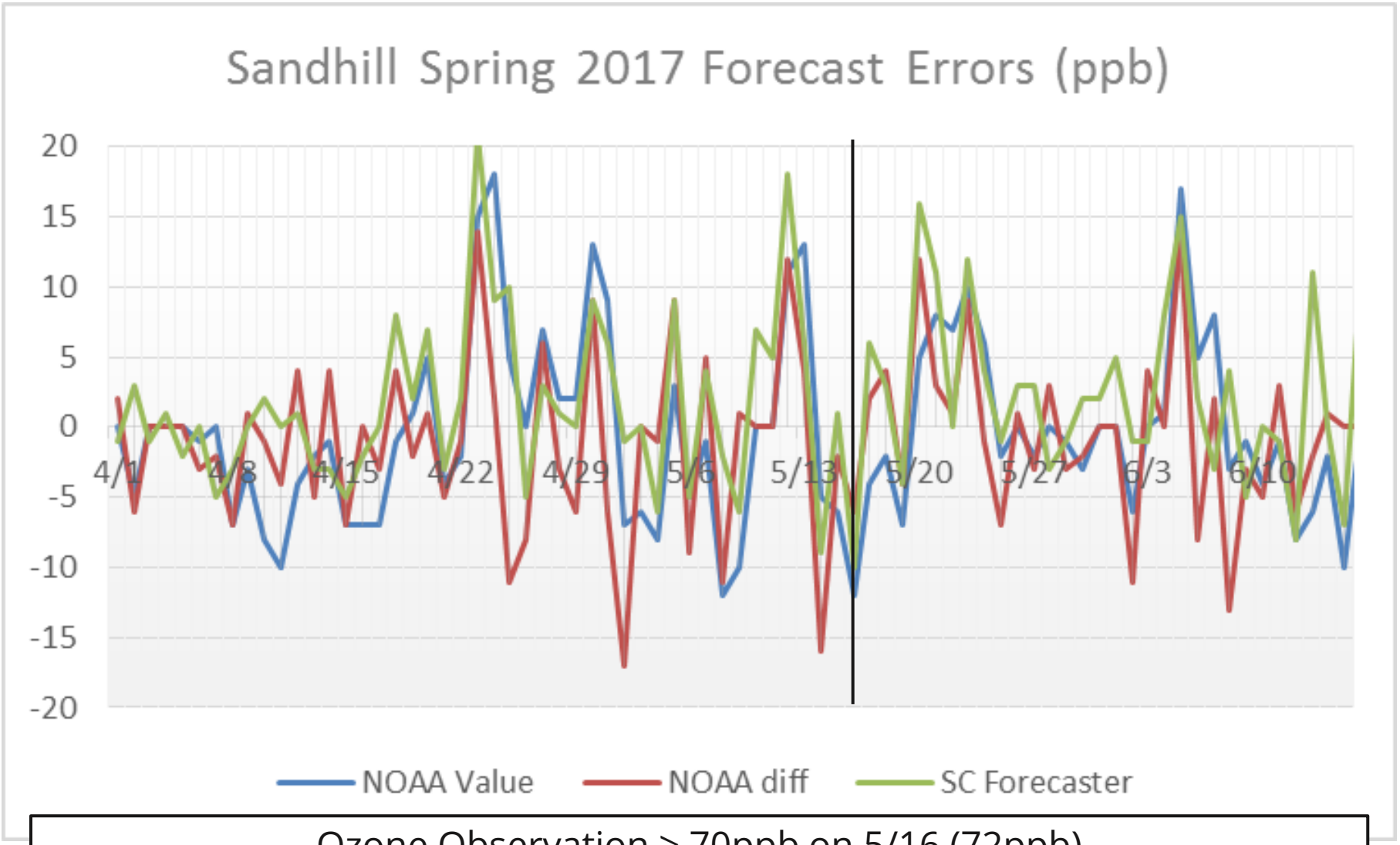


Ozone Observation > 70ppb on 5/16 (73ppb), NOAA Diff False Alarm 6/3

South Carolina Department of Health and Environmental Control



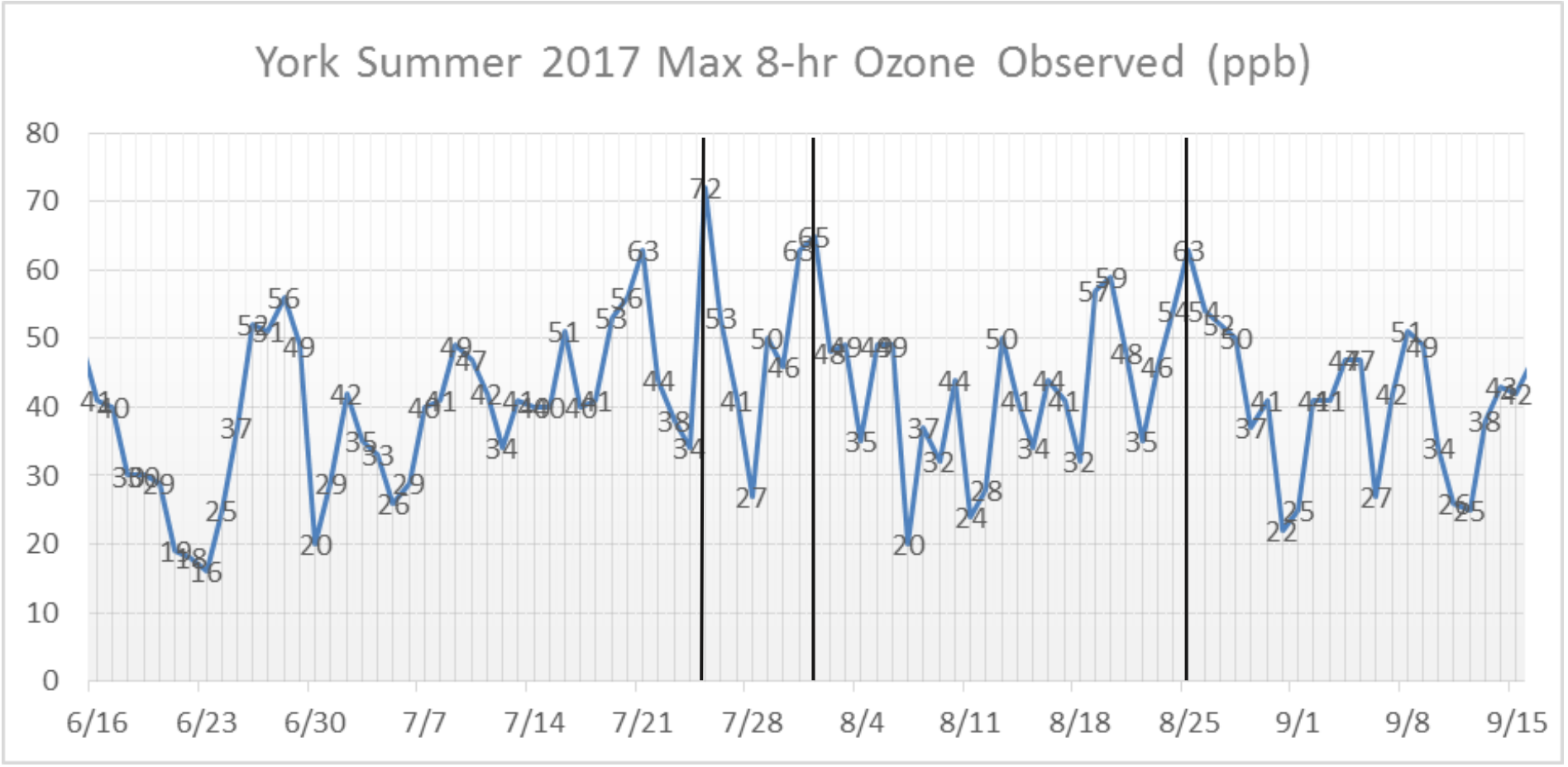
Ozone Observation > 70ppb on 5/16 (72ppb)



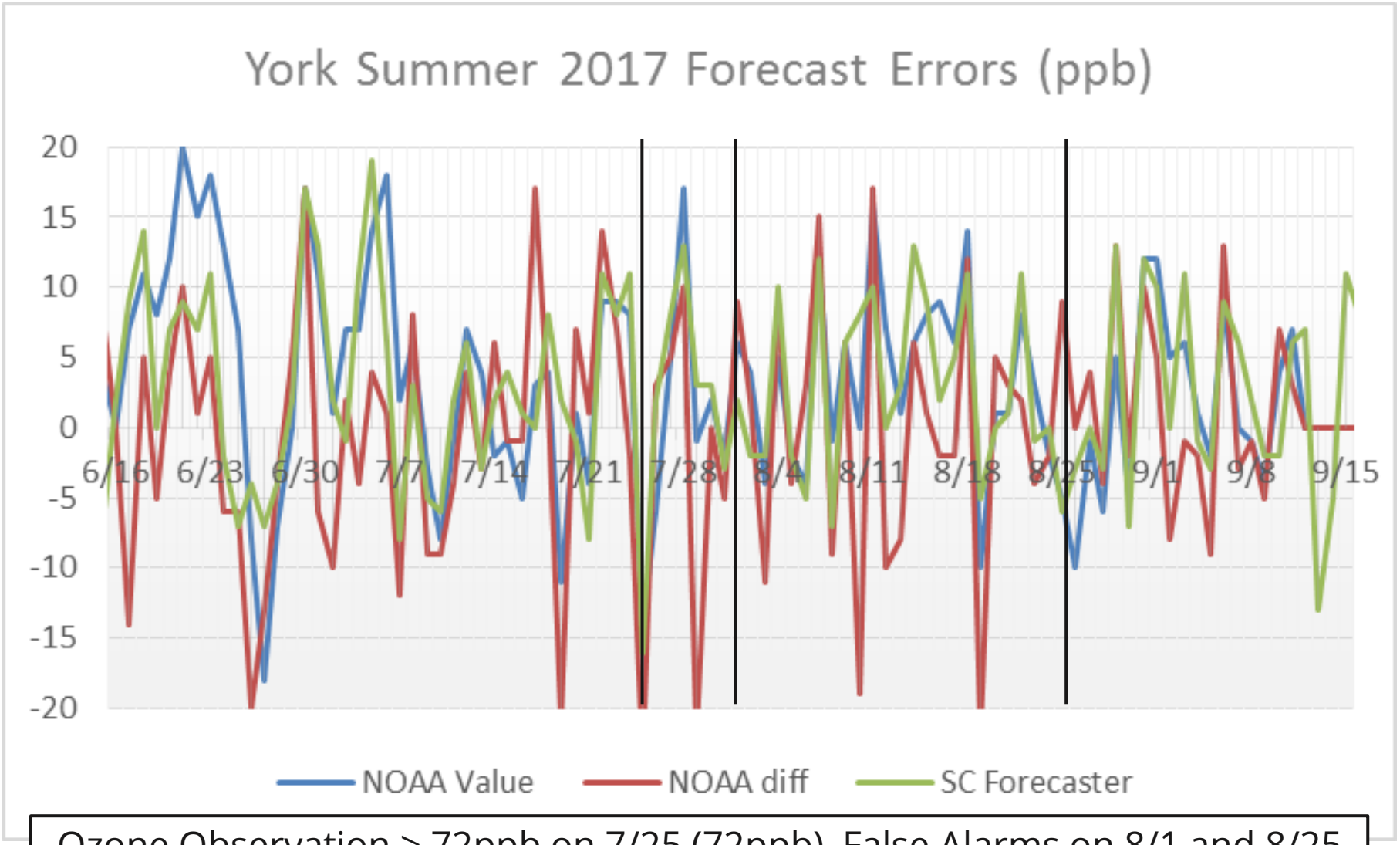
Ozone Observation > 70ppb on 5/16 (72ppb)

dhec Healthy People. Healthy Communities.

South Carolina Department of Health and Environmental Control

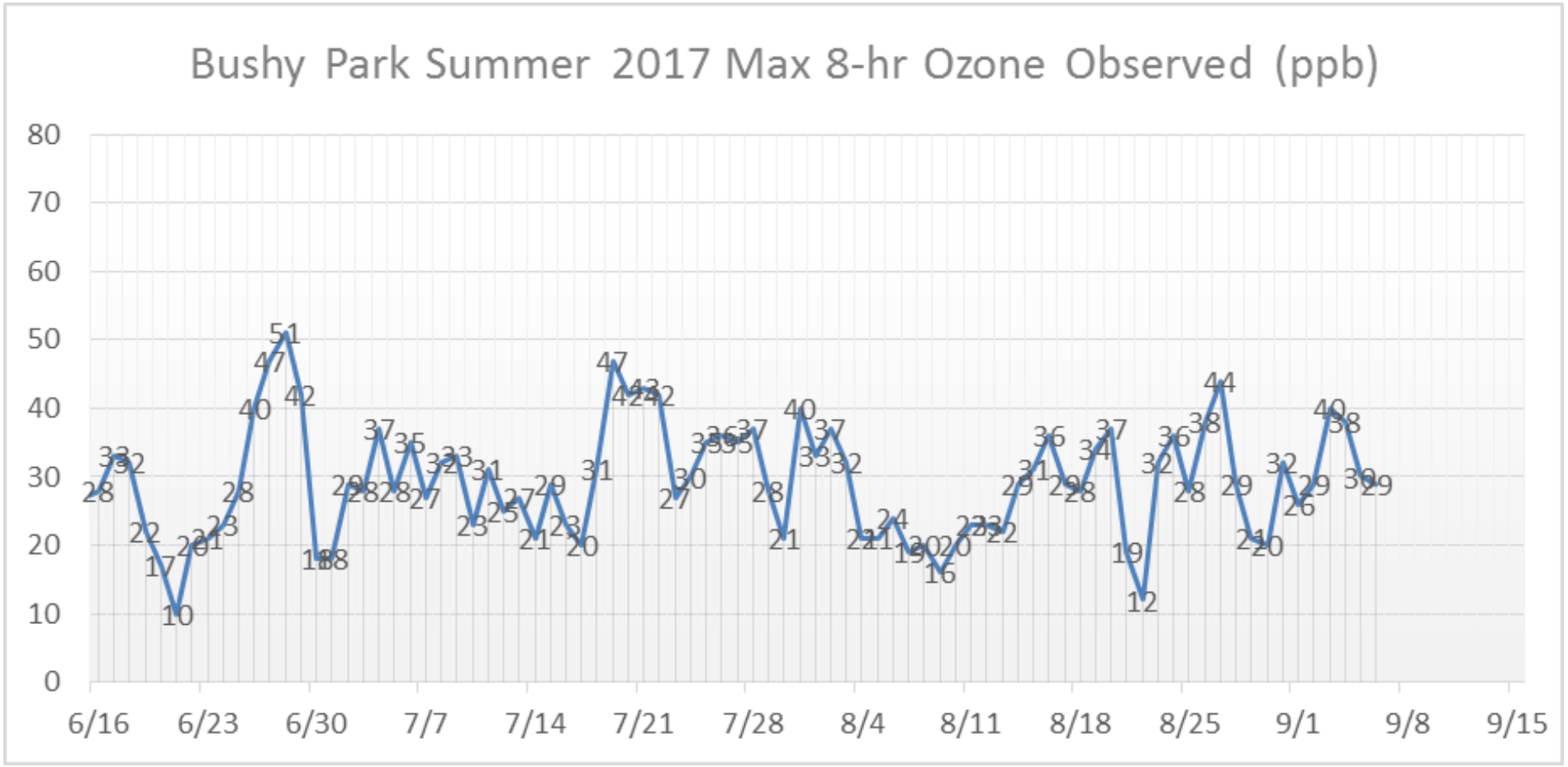


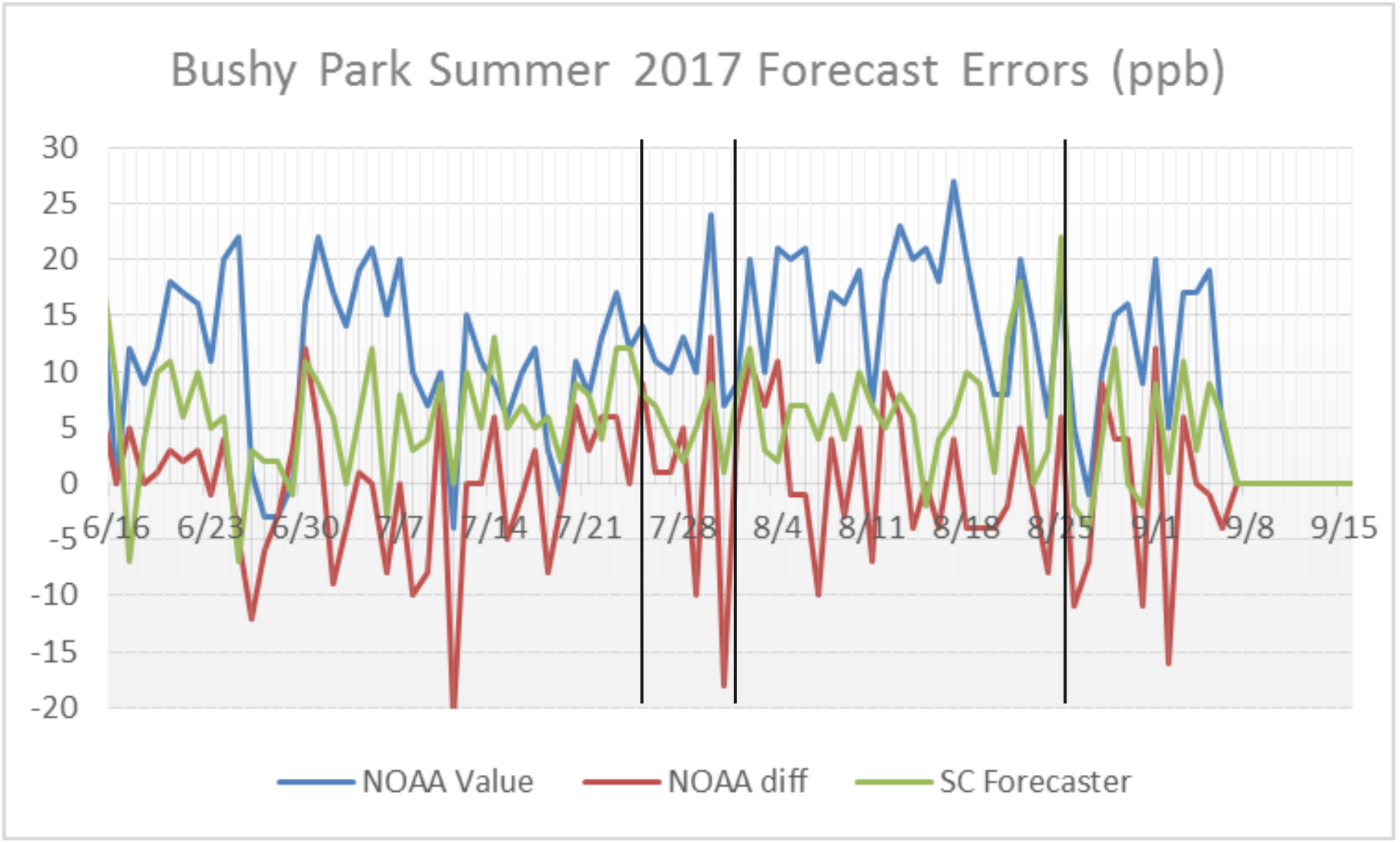
Ozone Observation > 72ppb on 7/25 (72ppb), False Alarms on 8/1 and 8/25



Ozone Observation > 72ppb on 7/25 (72ppb), False Alarms on 8/1 and 8/25

South Carolina Department of Health and Environmental Control




Bushy Park Summer 2017 Forecast Errors (ppb)
30
25
20
15
10
5
0
-5
-10
-15
-20
6/16
6/23
6/30
7/7
7/14
7/21
7/28
8/4
8/11
8/18
8/25
9/1
9/8
9/15
NOAA Value
NOAA diff
SC Forecaster

Summary of SC Comments on NOAA Operational CMAQ Guidance

- "NOAA Value" (Day 2 CMAQ actual value) forecasts generally over-predicted ozone concentrations, especially in rural areas and coastal areas.

- "NOAA Value" over-predicted more often during Summer months (June-August). NOAA CMAQ struggles with a moist environment and intense isolated convection. The bias was much closer to zero in April and May, but there was a slight over-prediction in rural areas during Spring months.

- "NOAA Diff" CMAQ forecast generally removes the day to day model bias on average, but this approach sometimes under-predicts ozone.

- 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.
- NOAA should fix “Daily 1Hr Ozone Max” and “Daily 8Hr Ozone Max” images on the NOAA Air Quality Forecast Guidance website.
- Suggestion to generate forecasts out 72 hours (or longer).
- Operational CMAQ output is excellent guidance. Thanks!

South Carolina Department of Health and Environmental Control

Thank you!

CMAQ Feedback Presented by

Wes Behrend

behrenwr@dhec.sc.gov

(803) 898-4216

CMAQ Feedback Produced by

Greg Quina

quinags@dhec.sc.gov

(803) 898-3405

Additional SC DHEC Air Quality Forecasters

Andrew Kingston
kingstap@dhec.sc.gov
(803) 898-0403

Bryan McAvoy
mcavoybp@dhec.sc.gov
(803) 898-1275

John Allard
allardjr@dhec.sc.gov
(803) 898-4088

Steve Smutz
smutzsw@dhec.sc.gov
(803) 898-7854