Transitioning to a new NowCast Method

Technical Slides for CETESB

Provided by EPA – OAQPS

David Mintz, Susan Stone, Phil Dickerson, Alison Davis

July 15, 2013

Overview

- Background
- Analysis
- Examples
- Recommendation
- Next Steps
- Health FAQ

Background

- Previous Nowcast method (Conroy method) was developed in 2003
  - Designed so "current conditions" represent the 24-hour $PM_{2.5}$ standard as closely as possible.
  - At the time the current method was developed, EPA and our partners had little experience reporting PM2.5 values to the public. We also had less information at that time about shorter-term $PM_{2.5}$ health effects.
  - As a result, this method is slow to respond when air quality changes rapidly.

- Many stakeholders have requested that the Nowcast be updated to be more responsive to rapidly changing air quality conditions, such as those we see during fires. EPA has analyzed millions of data points and has developed a new Nowcast method (Reff method).

The new method should

- Represent a shorter average (target 3-hour) when air quality is changing rapidly.
  (A 3-hour average from continuous monitors is more stable than a 1-hour average.)
- Reflect a longer-term average when air quality is stable
- Work in the U.S. and other locations
- Allow us to caution the public at the right time

A new method is born

- Adam Reff (OAQPS) designed a method to meet those characteristics
- It is an average of the previous 12 hours
- If air quality is less variable, then the hours are weighted more evenly (approaching a 12-hour average)
- If air quality is more variable, then recent hours are weighted more heavily (approaching an average of the most recent 3-hours)

Computing the NowCast with the New Method

1. Compute the concentration range (max-min) over the last 12 hours. This tells us how much the air has changed.

Example 12-hour period
50 80 75 90 82 53 64 74 21 10 16 13
Range = 90-10 = 80 ug/m3

2. Divide the range by the maximum concentration in the 12-hour period

Scaled rate of change is 80/90.

3. Compute the weight factor by subtracting the scaled rate of change from 1. The weight factor must be between .5 and 1. The minimum limit approximates a 3-hour average. If the weight factor is less than .5 then set it equal to .5.

Weight factor is 1 – 80/90 = .11 → less than .5, so use .5

4. Multiply each hourly concentration by the weight factor raised to the power of how many hours ago the concentration was measured (for the current hour, the factor is raised to the zero power)

$13*(.5)^0 + 16*(.5)^1 + 10*(.5)^2 + 21*(.5)^3 + 74*(.5)^4 + \ldots$

5. Compute the NowCast by summing these products and dividing by the sum of the weight factors raised to the power of how many hours ago the concentration was measured.

$$\frac{13*(.5)^0 + 16*(.5)^1 + 10*(.5)^2 + 21*(.5)^3 + 74*(.5)^4 + \ldots}{(.5)^0 + (.5)^1 + (.5)^2 + (.5)^3 + (.5)^4 + \ldots}$$

= 17.4 ug/m3

How is missing data handled?

- To compute a valid NowCast, you must have at least two of the most recent 3 hours
  - If you are missing a single hour, there will be no interruption in the reported NowCast
  - If you are missing two of three hours, there will be at least one missing NowCast value

I = data
X= NO data

Hourly data	I	I	I	X	I	I	I	I	I
NowCast			I	I	I	I	I	I	I

Hourly data	I	I	I	X	X	I	I	I	I
NowCast			I	I	X	X	I	I	I

Hourly data	I	I	I	X	I	X	I	I	I
NowCast			I	I	I	X	I	I	I

- The weighting of the values does not change
  - That is, each hourly concentration is multiplied by the weight factor raised to the power of how many hours ago the concentration was measured
  - The example to the right shows the calculation if we were missing the next to last value in the 12-hour period

Example 12-hour period

50 80 75 90 82 53 64 74 21 10 ~~16~~ 13

$$\frac{13*(.5)^0 + \sout{16*(.5)^1} + 10*(.5)^2 + 21*(.5)^3 + 74*(.5)^4 + \ldots}{(.5)^0 + \sout{(.5)^1} + (.5)^2 + (.5)^3 + (.5)^4 + \ldots}$$

Analysis

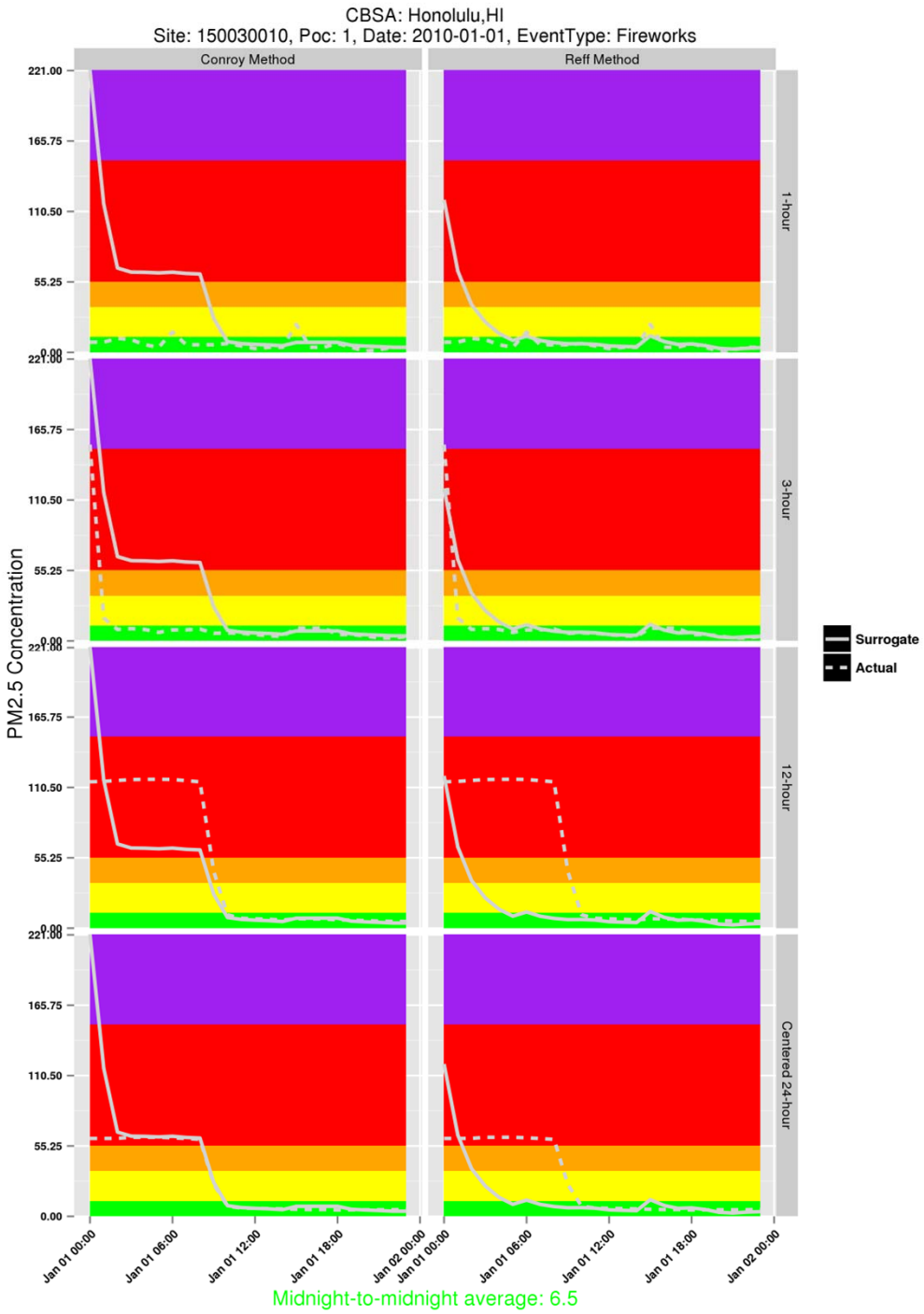
- Compared the previous method (Conroy) to new method (Reff)
- Examined how the methods respond to different patterns of:
  - Rapidly changing air quality (associated with flagged exceptional events)
  - Rapidly changing air quality (not flagged)
  - Stable air quality
- Examined how often they match the respective AQI category
- Examined how those matches vary regionally in the U.S.

Situations we examined…

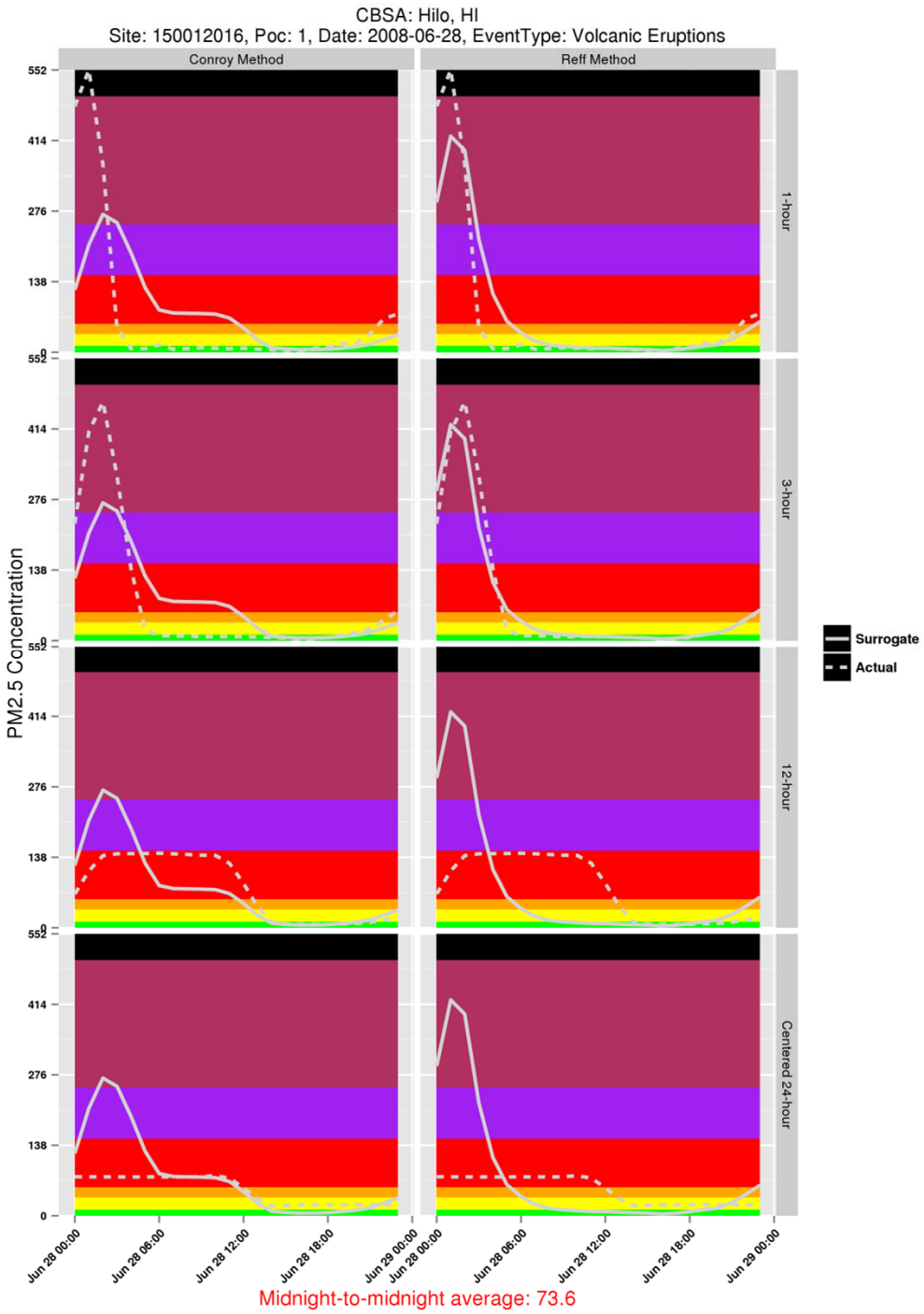
Conditions	Event	City	Date
Variable	Prescribed Fire	Chicago, IL	3-27-2012
Variable	Prescribed Fire	Tallahassee, FL	8-11-2008
Variable	High Winds	El Paso, TX	3-18-2012
Variable	High Winds	Las Cruces, NM	3-18-2012
Variable	Wildfire	Fairbanks, AK	7-30-2009
Variable	Wildfire	Las Cruces, NM	4-4-2011
Variable	Fireworks	Honolulu, HI	1-1-2010
Variable	Fireworks	Omaha, NE	7-4-2010
Variable	Volcanic Eruptions	Hilo, HI	6-28-2008
Variable	-	Salt Lake City, UT	3-30-2010
Variable	-	Portland, OR	11-12-2011
Variable	-	Klamath Falls, OR	9-24-2009
Stable	-	Philadelphia, PA	1-7-2008
Stable	-	New York, NY	1-6-2008
Stable	-	Chattanooga, TN	7-17-2008
Stable	-	Pittsburgh, PA	7-17-2008

Let’s look at a few examples

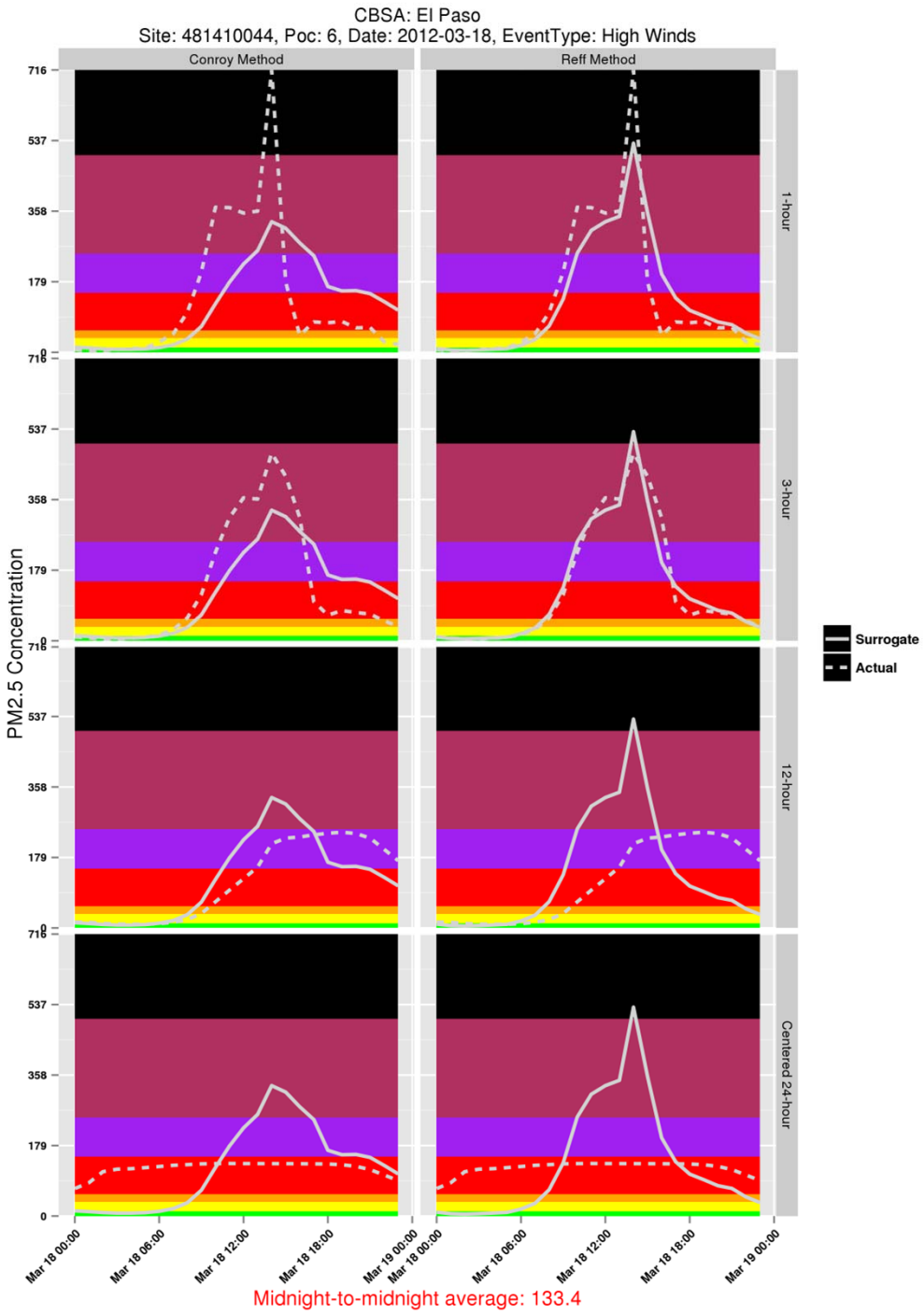
- Variable (flagged events)
- Variable (not flagged)
- Stable (to show that it works with stable data)



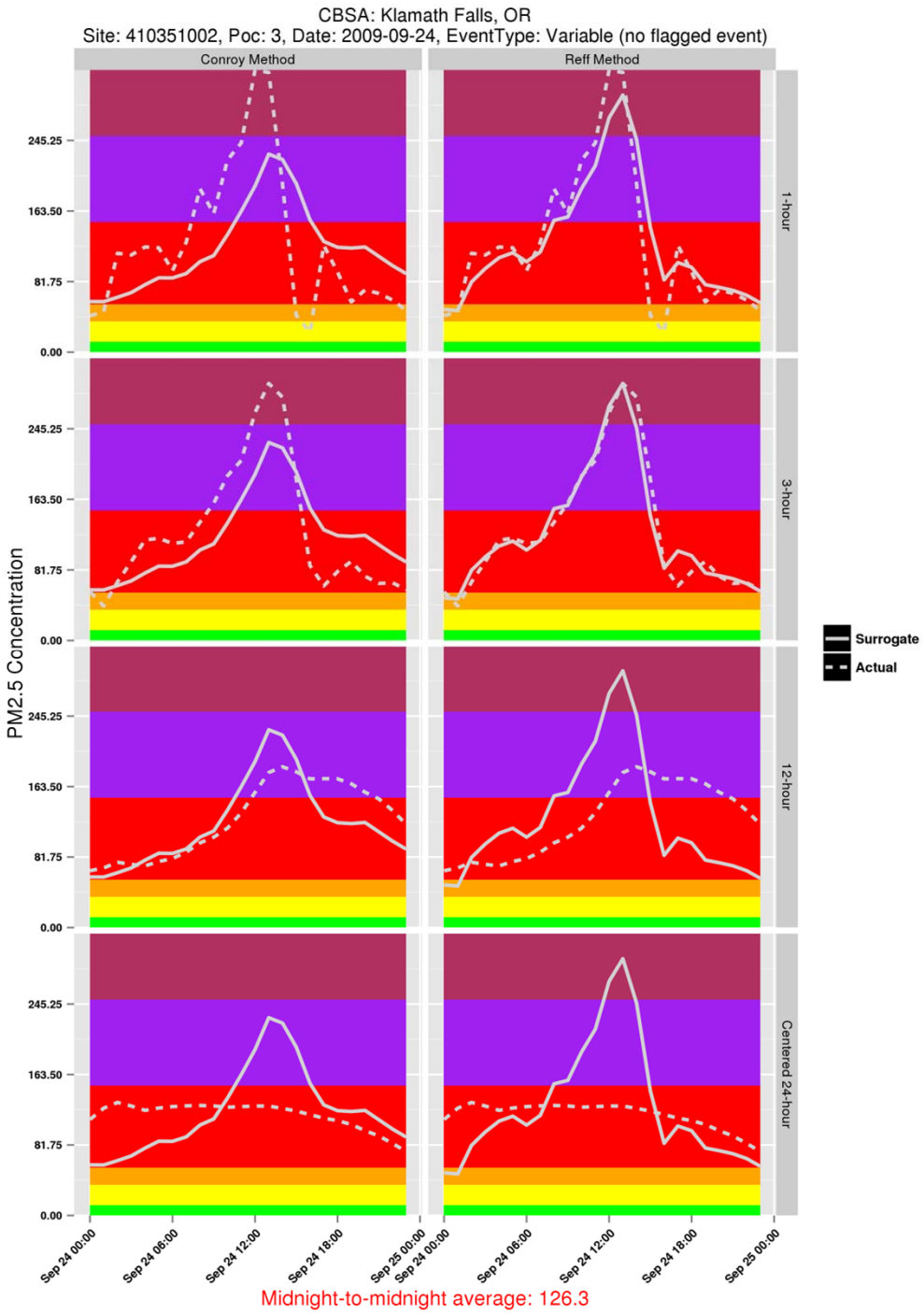
- This is the day after a fireworks event.
- The 24-hour average (midnight to midnight) is green.
- The Previous (Conroy) method gets to green at 10am. The new (Reff) method gets to green before 6am.



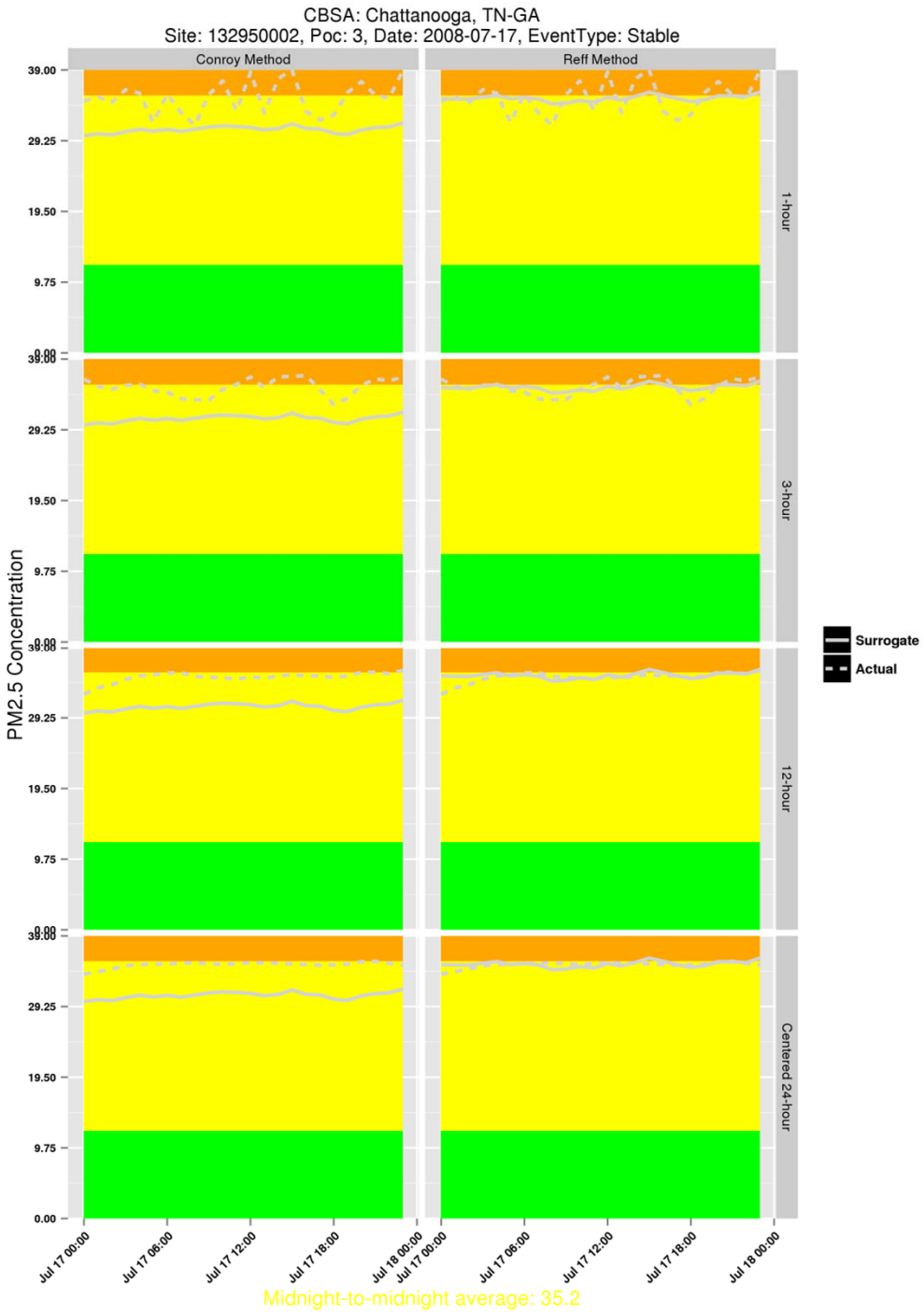
- This is like the previous example (goes low, stays low).
- The new (Reff) method begins reporting lower values several hours ahead of the previous (Conroy) method.
- The 24-hour average (midnight to midnight) is red, yet most of the day would be reported as yellow or green based on the new (Reff) method.



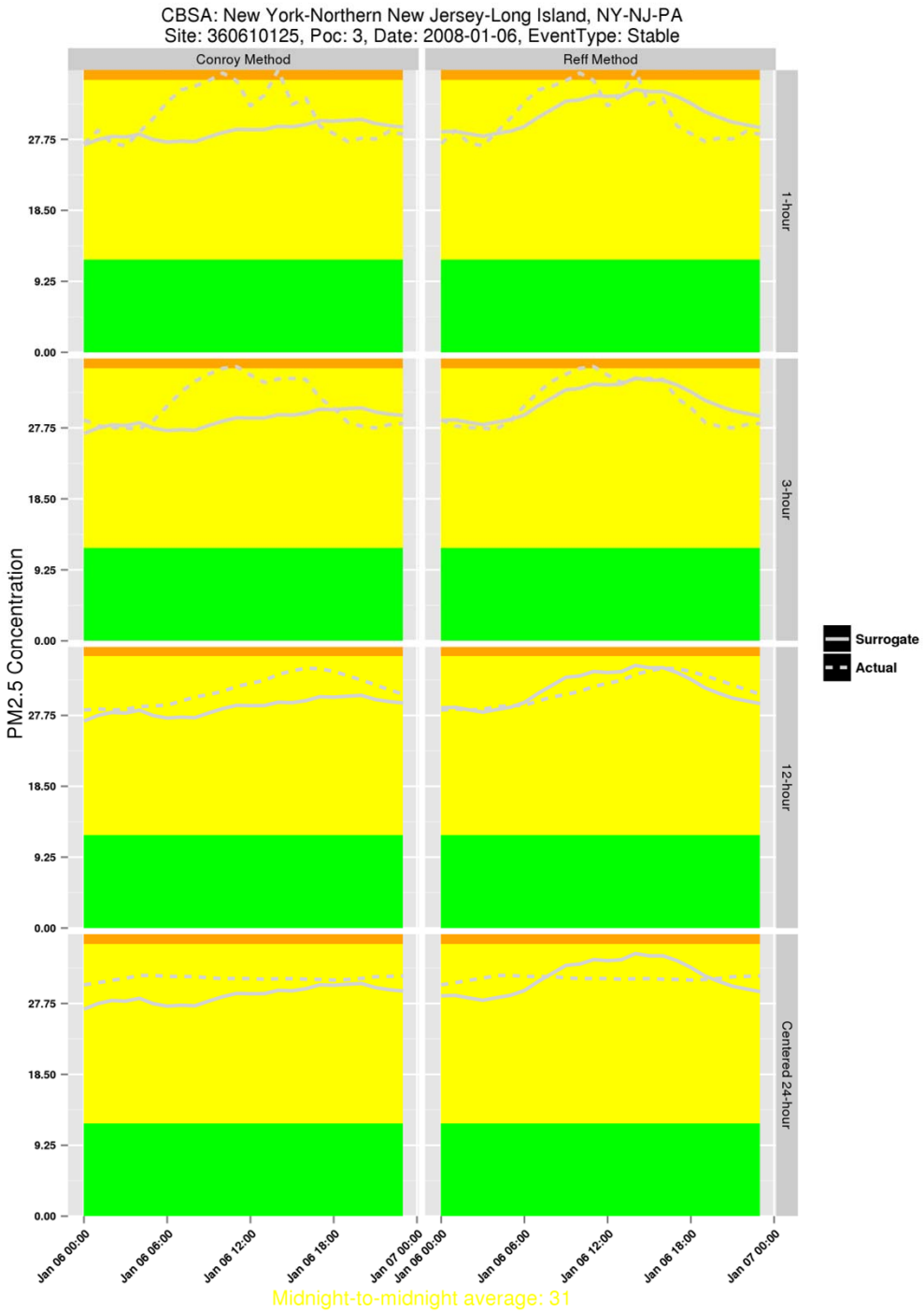
- This example shows a spike in the middle of the day resulting from a high wind event.
- The 24-hour average (midnight to midnight) is red, yet there are 8 hours (9am to 5pm) when the NowCast would report higher categories (purple or maroon).



- This is like the previous example – a spike in the middle of the day, but the values are not flagged.
- The 24-hour average (midnight to midnight) is red, yet there are 7 hours (8am to 3pm) when the NowCast based on the new (Reff) method would report higher categories (purple or maroon).



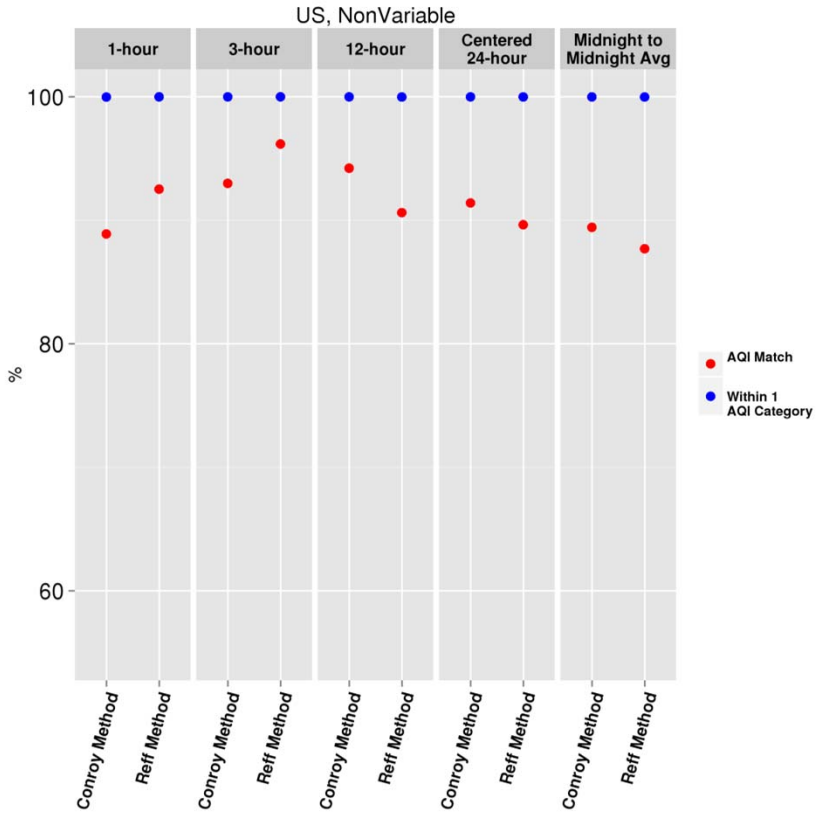
- This is an example of relatively stable air quality.
- The new (Reff) method tracks the 12-hour average as we'd expect.

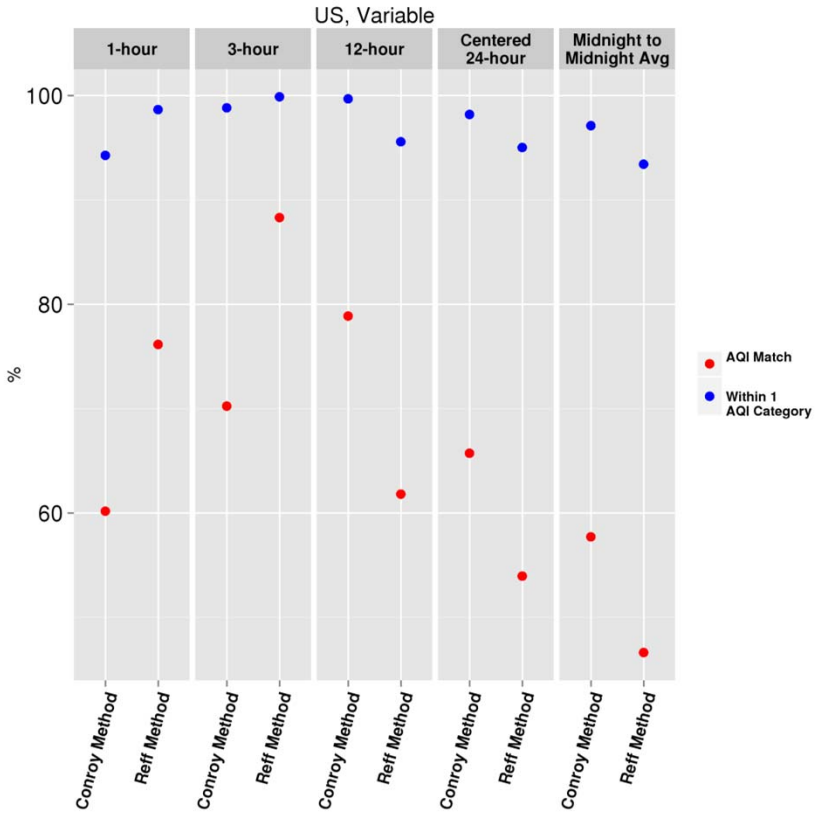


- This is another example of relatively stable air quality.
- The new (Reff) method tracks the 12-hour average as we'd expect.

How well do the methods match AQI categories?

U.S. data, 2008-2012
(24 million data points)





On **non-variable** days, we'd expect the new (Reff) method to track the longer-term averages, and it seems to do that well (almost as well as the Conroy method).

On **variable** days, we want the new (Reff) Method to track the 3-hour average, and it does that considerably better than the previous (Conroy) method.

Recommendation

- After evaluating each method, we agreed that the new (Reff) method best matches the desired characteristics:
  - Responds to rapid changes in air quality
  - Yet still reflects a longer-term average when air quality is stable
  - Will work in any location and for any air quality situation
  - Allows us to caution people in time for them to reduce their 24-hour
  - Appropriately balances the “public right-to-know” and the “exposure reduction” functions of the AQI based on what we know about the health effects of 24-hour exposures
  - Improves credibility of the AQI because it more closely matches what people see

- As a bonus:
  - Because it can be adapted to track various averaging times, it can potentially be used for PM10, ozone, and any other AQI pollutants for which we may need a surrogate in the future
  - A single method = less cost to implement and maintain in AirNow and also AirNow-I

Health FAQ

The AQI is a 24-hour index; how can a NowCast accurately represent that?

- While the AQI is a 24-hour index; we want to give people tools to reduce their exposures to protect their health. To do that, they need to take action.
- So we use the NowCast to approximate the 24-hour AQI in any given hour. This gives people the power to take action. They can use this information to reduce their exposure – even reducing exposures if PM is high only during a few hours a day will help reduce a person's 24-hour exposure.
- New NowCast will mean our current conditions maps will align more closely with what people are seeing/experiencing. We believe this will increase individual action to reduce exposure.