Connecticut Department of Energy and Environmental Protection

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

May 25-26, 2016 Ozone Exceptional Event Analysis for Connecticut using Satellite Data

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HAQAST
November 2017

Connecticut Department of Energy and Environmental Protection

Fort McMurray Wildfire

On May 1, 2016, a wildfire began southwest of Fort McMurray, Alberta, Canada. On May 3, it swept through the community, destroying approximately 2,400 homes and buildings and forcing the largest wildfire evacuation in Albertan history. The fire spread across approximately 590,000 hectares (1,500,000 acres) before it was declared to be under control on July 5, 2016.

November 2017 Update

- **Notification Letter to EPA Region 1, for May 2016 Potential Exceptional Event**
  - Submitted on September 28, 2016
  - Originally included May 25-28 and all Connecticut monitors
- **EPA Response to CT Exceptional Event Request**
  - Established deadline of May 31, 2017 for submittal of final demonstration
  - Required a 30-day public comment period before final submission
- **Notice of Intent to Submit an Exceptional Event Demonstration to EPA and Opportunity for Public Comment**
  - For the four most critical monitors on May 25-26th
  - Issued on April 18th, 2017 and notification sent to stakeholders
  - Comments due by 4:30 PM on May 19, 2016
- **Response from EPA Region 1, May 19, 2016 - No comments were received from the public**
- **Technical Support Document for Exceptional Event Analysis - Final Submission to EPA Region 1, May 23, 2017**
- **EPA Concurrence Letter and TSD Approving the CT Exceptional Event Demonstration EPA Region 1, July 31, 2017**
- **EPA Concurrence Letter and TSD Approving the MA Exceptional Event Demonstrations EPA Region 1, September 19, 2017**
- **EPA Concurrence Letter and TSD Approving the RI Exceptional Event Demonstrations EPA Region 1, September 19, 2017**

Attainment Status Affected

- May 25-26 had the most impact on 2016 Design Values in Connecticut;
- Only four of the most affected monitors were chosen for exclusion.

May 25-29, 2016 Ozone					
	5/25/2016	5/26/2016	5/27/2016	5/28/2016	5/29/2016
Greenwich/O3	89	91	63	82	59
Danbury/O3	82	99	81	81	73
Stratford/O3	89	76	59	70	47
Westport/O3	87	90	61	81	58
East Hartford/O3	75	93	70	81	66
Middletown/O3	80	91	67	79	61
Stafford/O3	74	82	70	73	56
Cornwall/O3	81	91	78	65	69
New Haven - Criscuolo Park/O3	63	84	65	73	54
Groton Fort Griswold/O3	87	80	54	60	51
Abington/O3	76	83	68	67	52
Madison/O3	89	86	56	63	48

Attainment Status Affected

Comparison of 2016 Design Values with and without May 25 and 26, 2016 Data, and Corresponding 2017 Critical 4th High Values at the Four Sites Proposed for Exclusion. Critical 4th high is the value at which the monitor will exceed the NAAQS (in parenthesis) for the 2017 season.

	Previous Values					Revised Values Excluding May 25-26, 2016		
Site Name	4th high 2014	4th high 2015	4th high 2016	2014-2016 DV	2017 Critical 4th High Value (NAAQS Standard)	4th high 2016	2014-2016 DV	2017 Critical 4th High Value (NAAQS Standard)
Abington	67	70	74	70	69 (70)	67	68	76 (70)
Westport	81	87	87	85	81 (84)	81	83	87 (84)
Cornwall	68	76	78	74	74 (75)	74	72	78 (75)
East Hartford	77	75	75	75	78 (75)	72	74	81 (75)

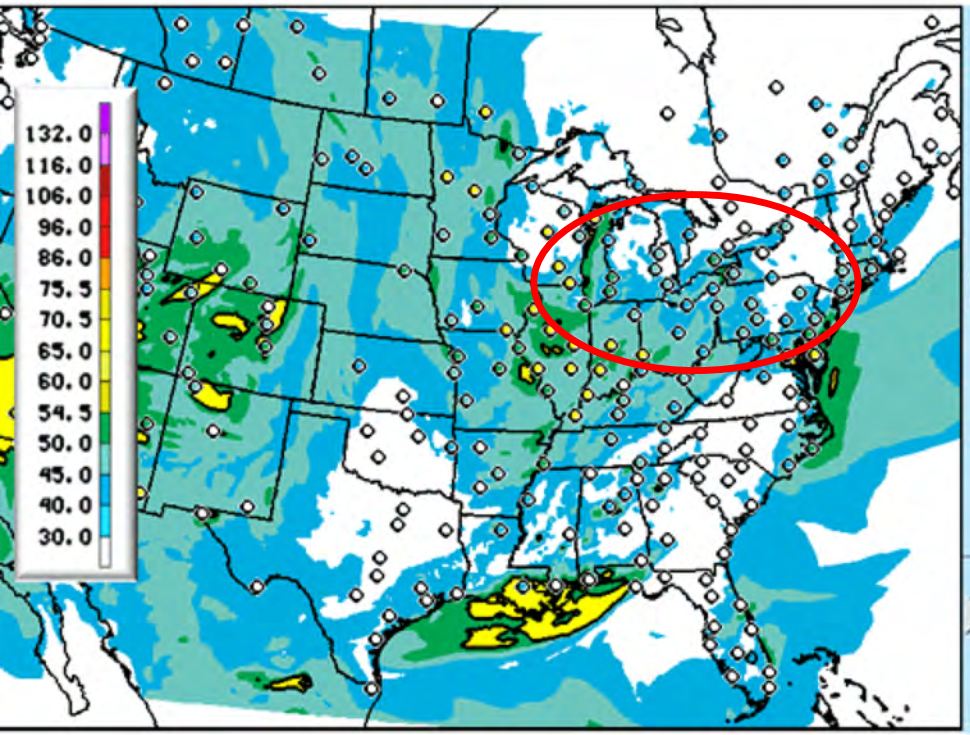
Site Name	To Date: Prelim 2017 DVs	2015 NAAQS 70 ppb Violations	2008 NAAQS 75 ppb Violations	1997 NAAQS 84 ppb Violations	Next Possible NAAQS in Violation (key monitors for 1997 NAAQS are highlighted in yellow)
SWCT Portion of NYC Area					A close call for 2017!
Danbury	77	X	X		Four 95+ ppb days violate 1997 NAAQS.
Greenwich	79	X	X		Four 92+ ppb days violate 1997 NAAQS.
Madison	82	X	X		Two more 94+ ppb days violate 1997 NAAQS.
Middletown	79	X	X		Four 97+ ppb days violate 1997 NAAQS.
New Haven	77	X	X		Four 99+ ppb days violate 1997 NAAQS.
Stratford	83	X	X		One more 86+ ppb day violates 1997 NAAQS.
Westport	83	X	X		One more 87+ ppb day violates 1997 NAAQS.

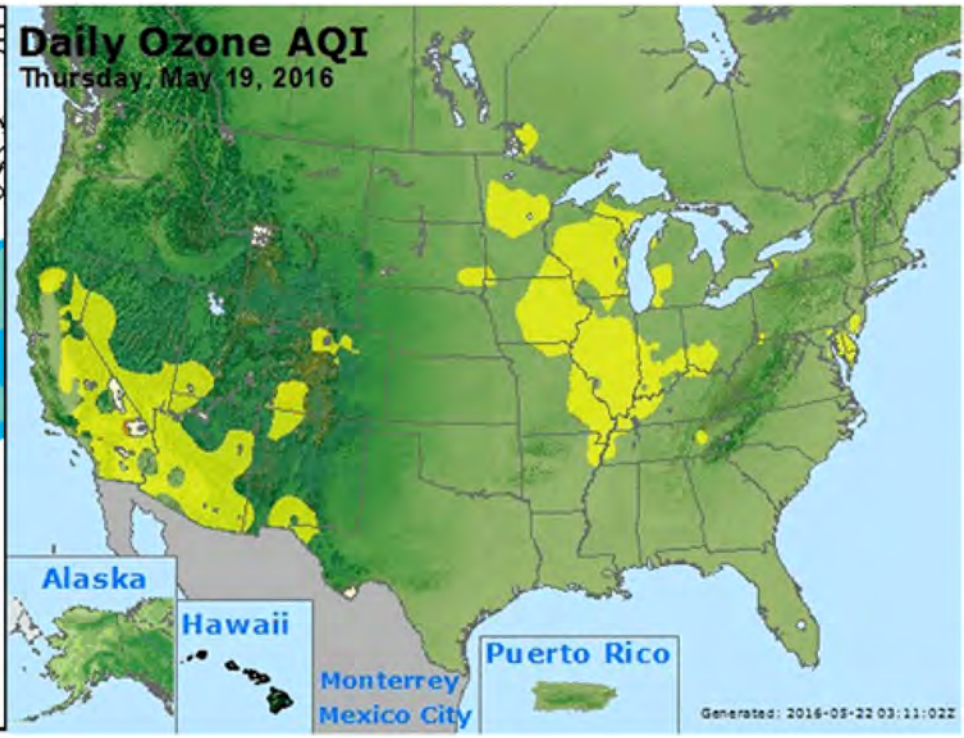
Available Tools for Analysis

- NOAA Model Forecasts and Airnow AQI maps;
- NESDIS analyzed smoke plume coverage;
- MODIS Satellite with AOD estimations;
- eIDEA-VIIRS Satellite Analysis
- Calipso satellite aerosol analysis;
- Airnowtech Navigator trajectory analysis;
- Hysplit trajectory analysis;

NOAA Model vs. the Observed AQI

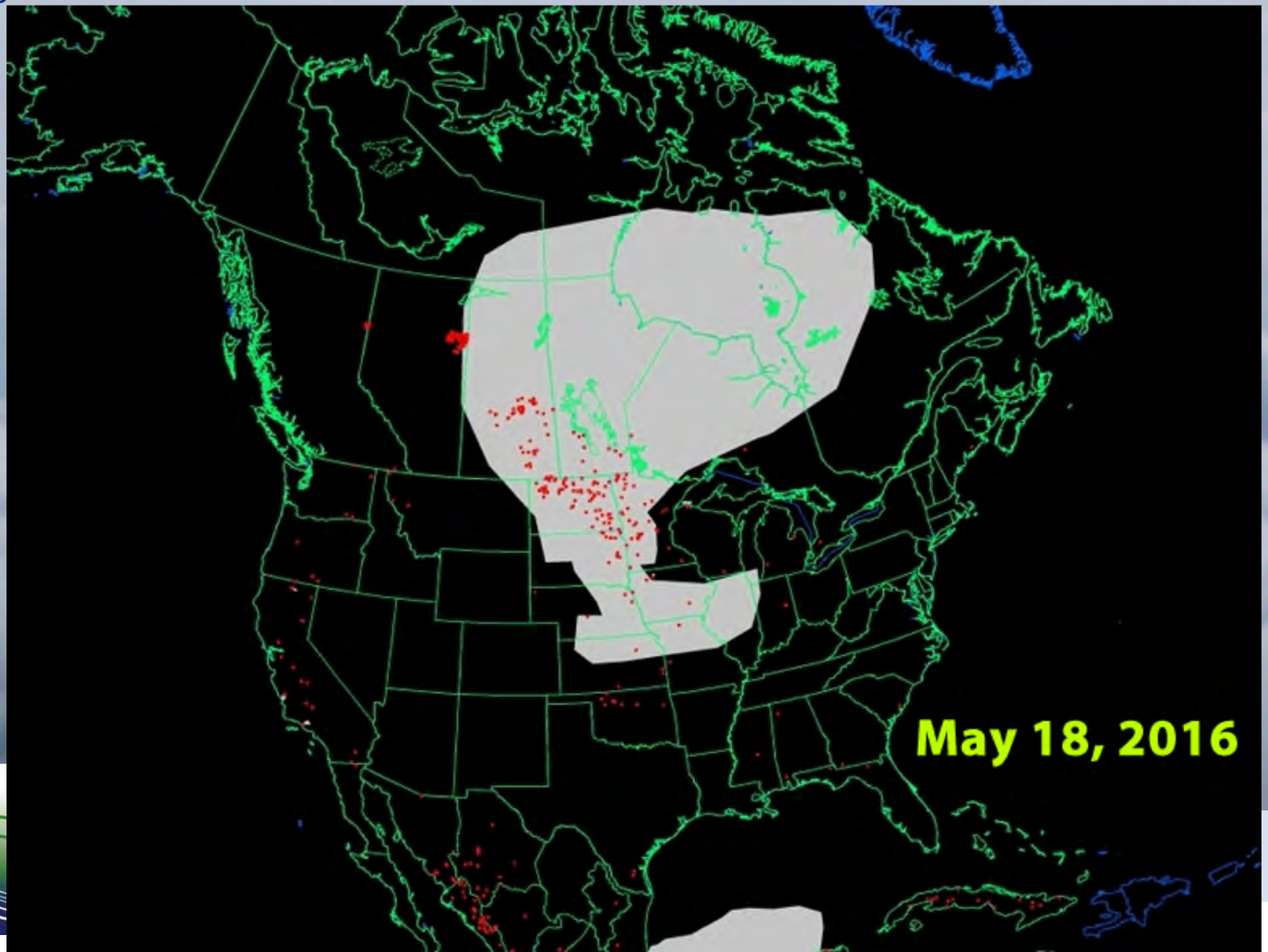
Note the large area where the NOAA model under-predicted the ozone. This is a strong indicator that that it is a smoke enhanced event. The NOAA operational model does not assimilate gaseous smoke emissions into the real-time input.



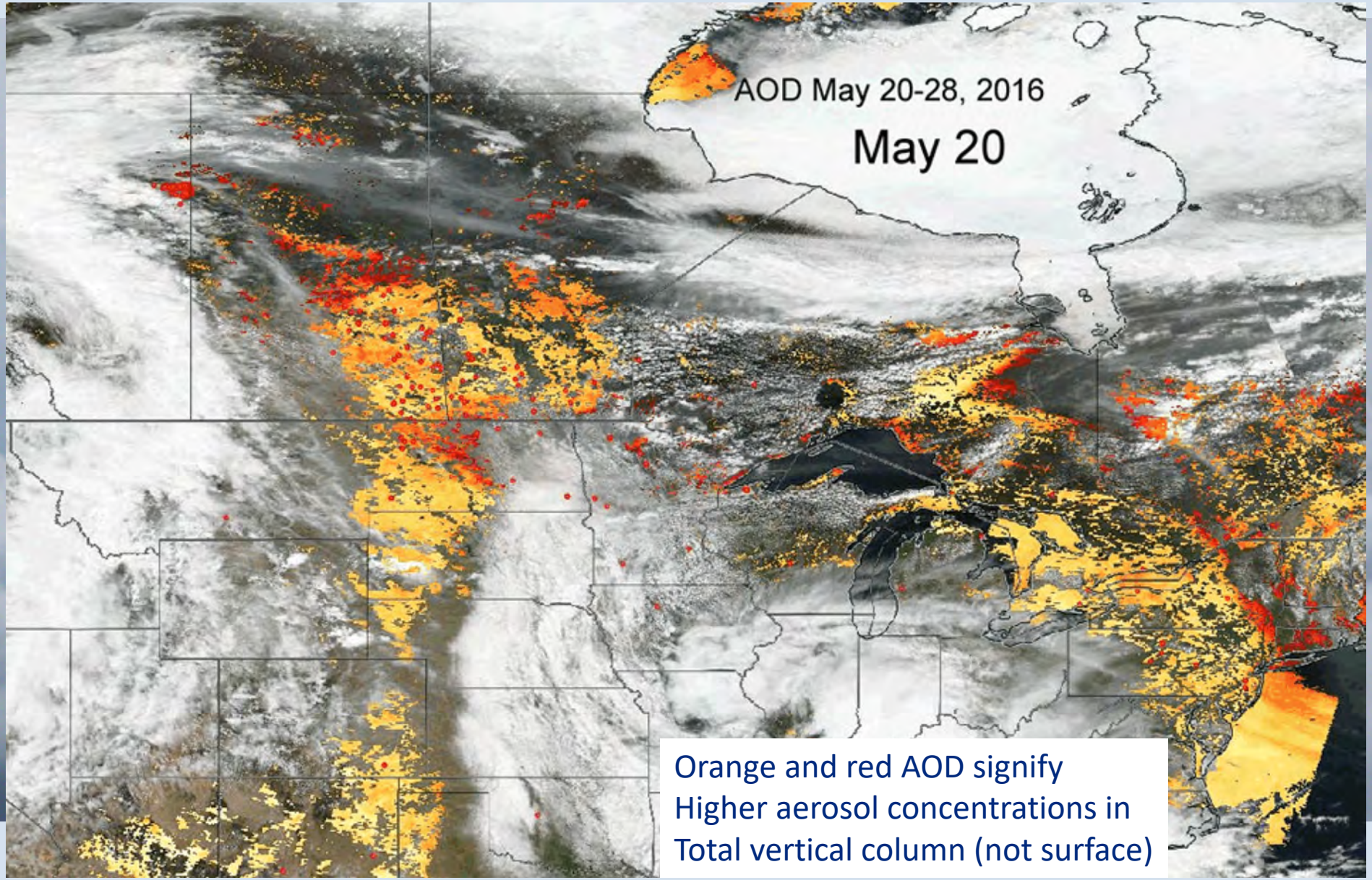


Smoke Plume Animation from May 18th- May 25th

- HMS analyzed smoke plumes are useful for tracking transport, but rely on visible satellite images.

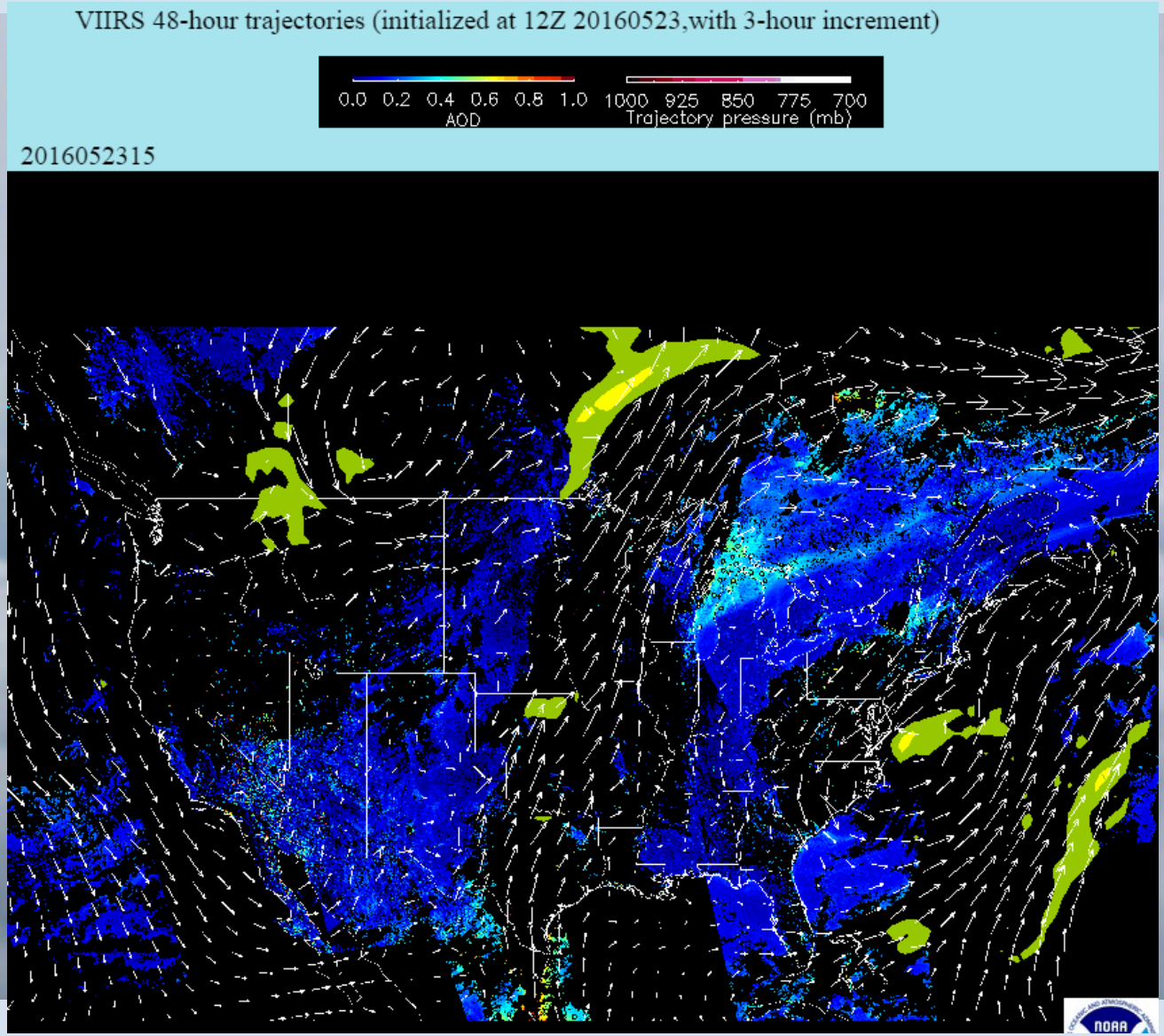


May 20-28 MODIS AOD Satellite Animation



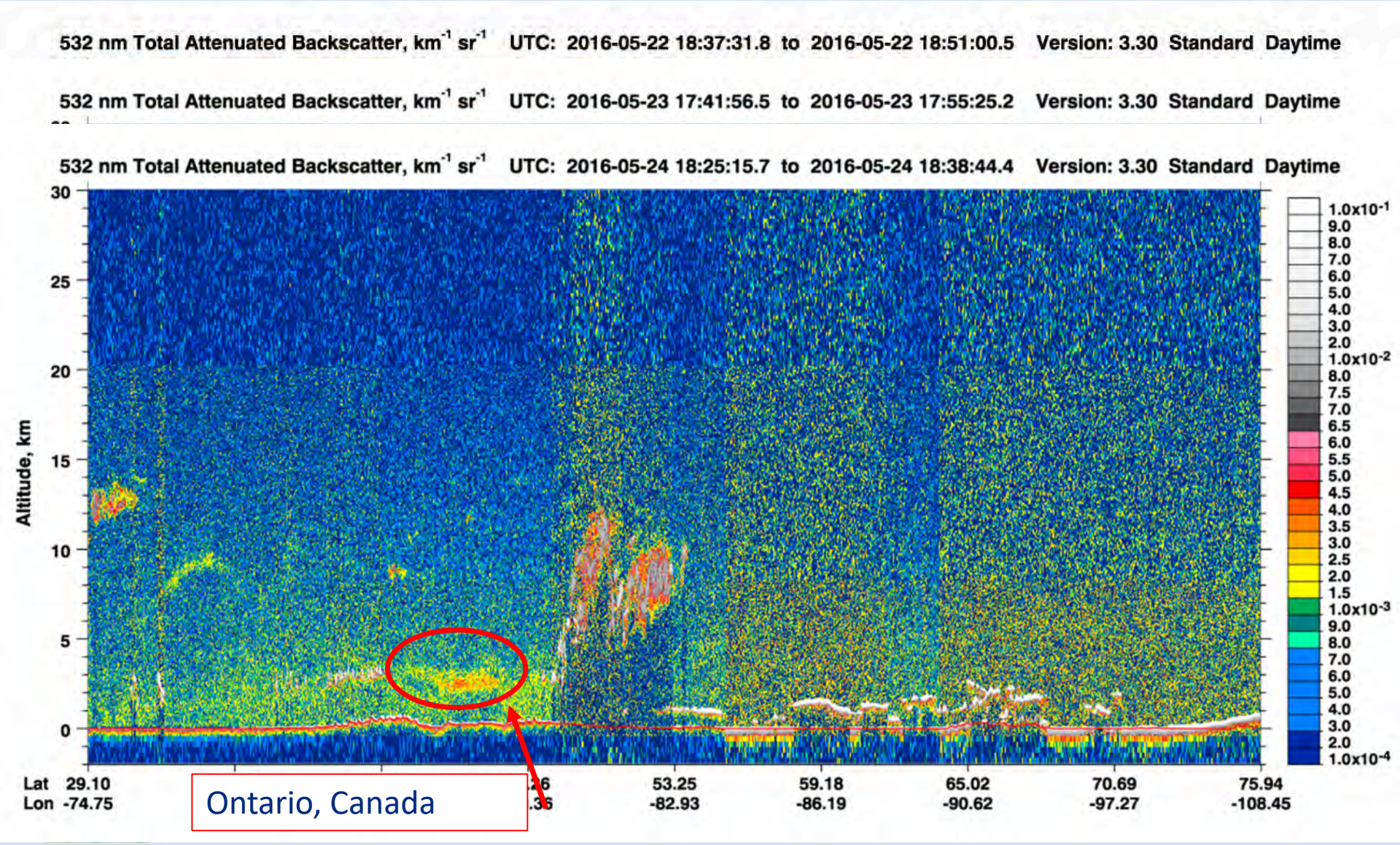
- MODIS Aqua/Terra sensors produce column AOD estimates that are useful for tracking aerosol plumes.

VIIRS Modeled Trajectories, May 23-25



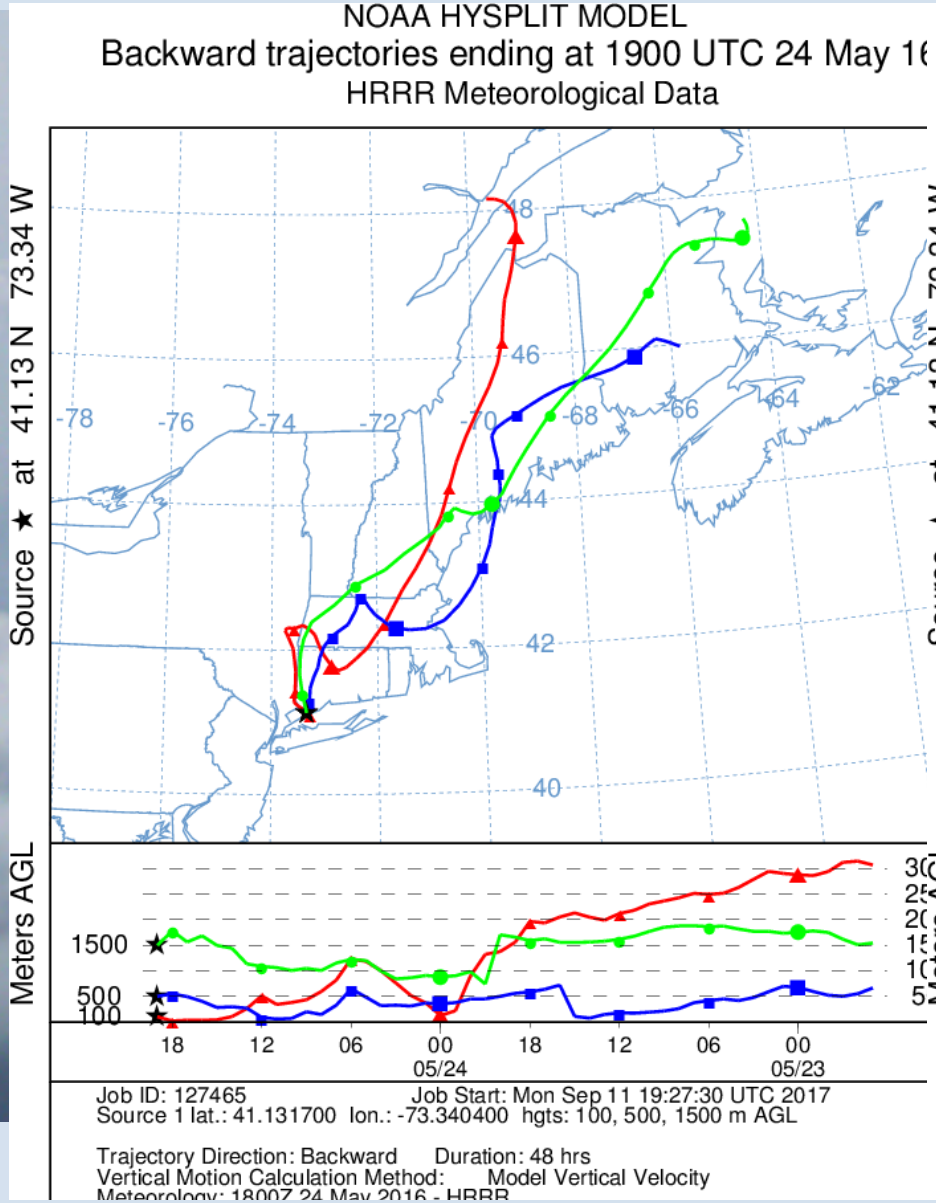
- VIIRS also estimates column AOD and the eIDEA website provides transport animations. This plot shows an aerosol area over the upper Great lakes on May 23rd being transported to CT on May 25th.

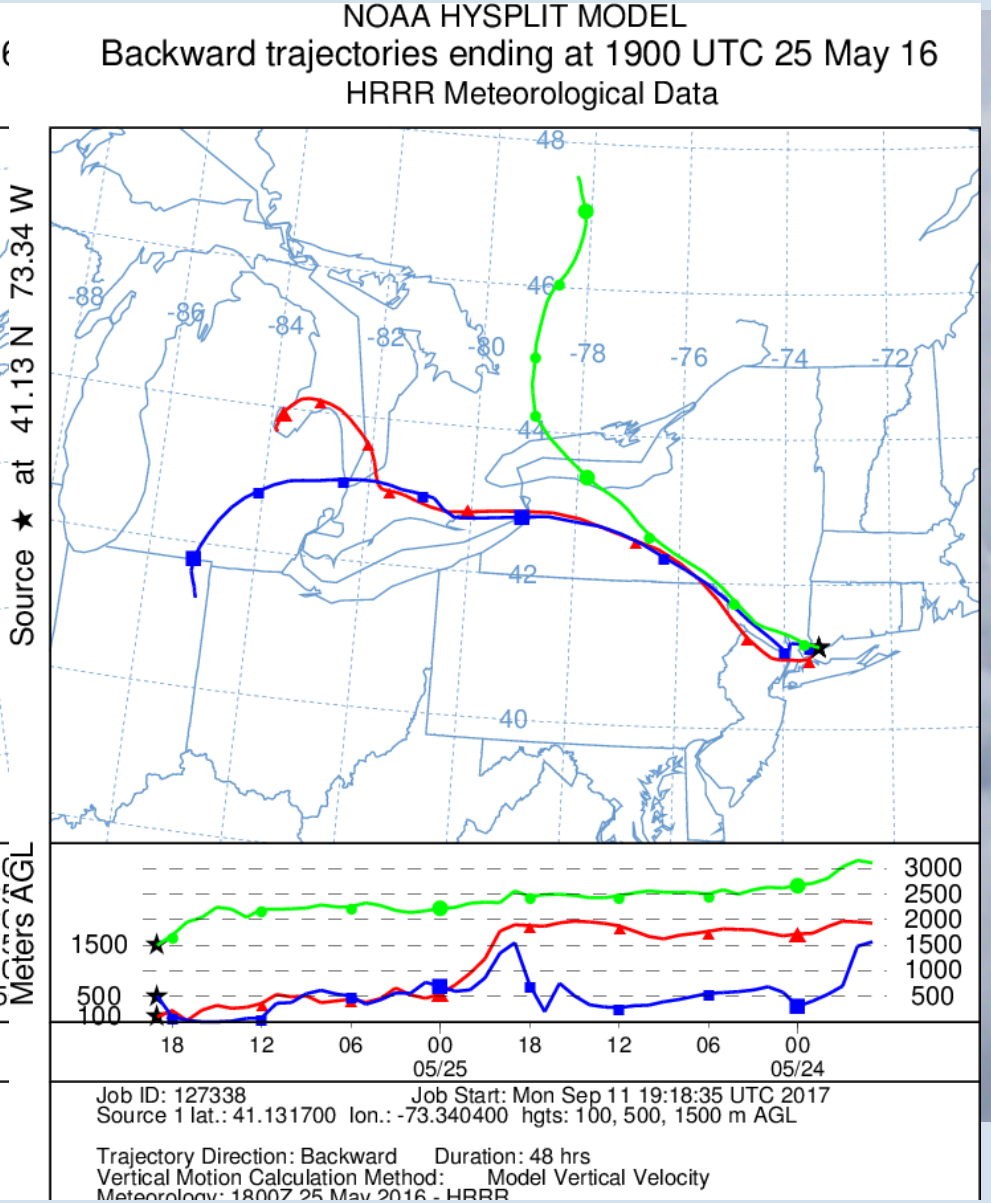
Calipso LIDAR, May 22-24, 2016



- Calipso images are produced for narrow swaths but can show the location and altitude of aerosol plumes on a daily basis.

May 24 -25 Back Trajectories (HRRR)

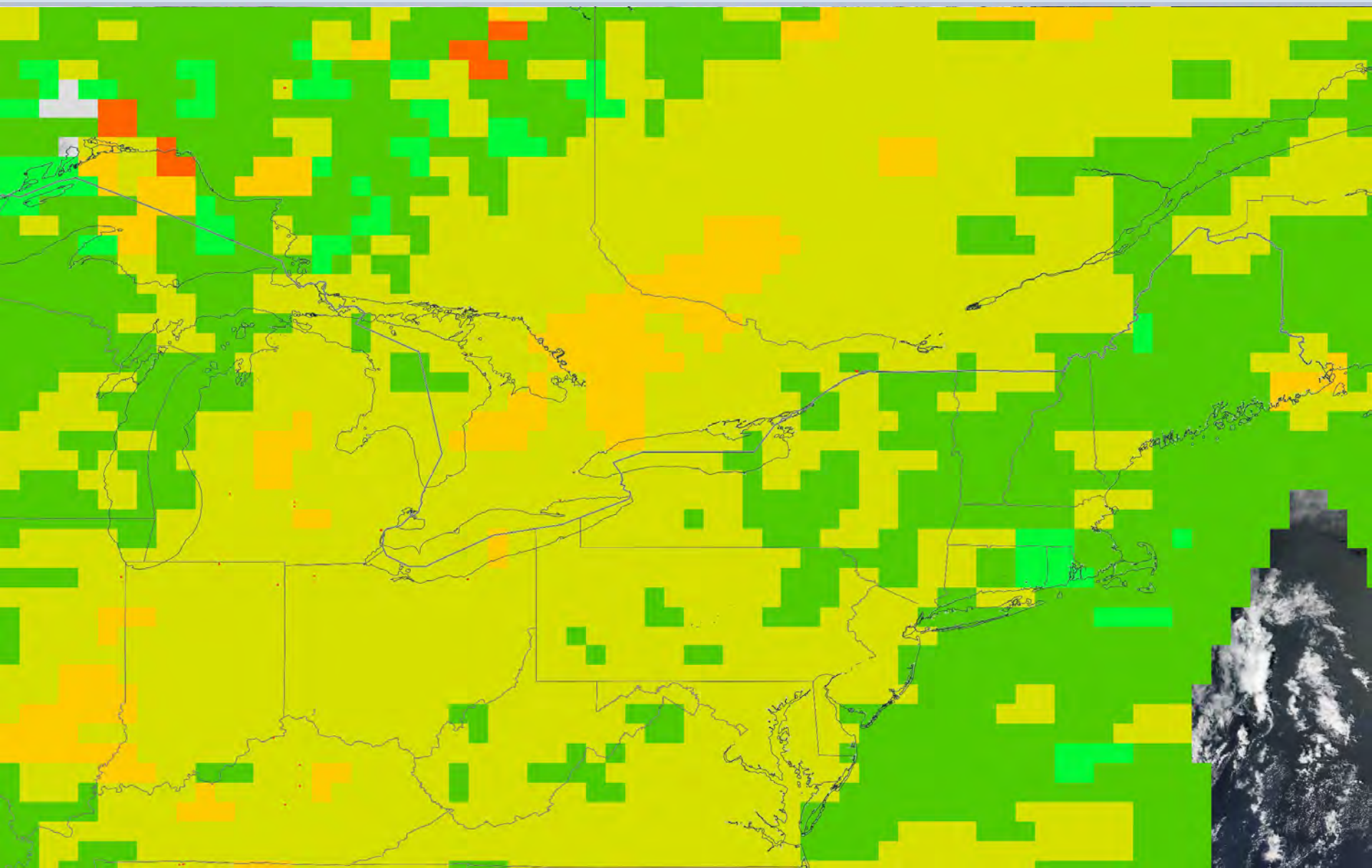




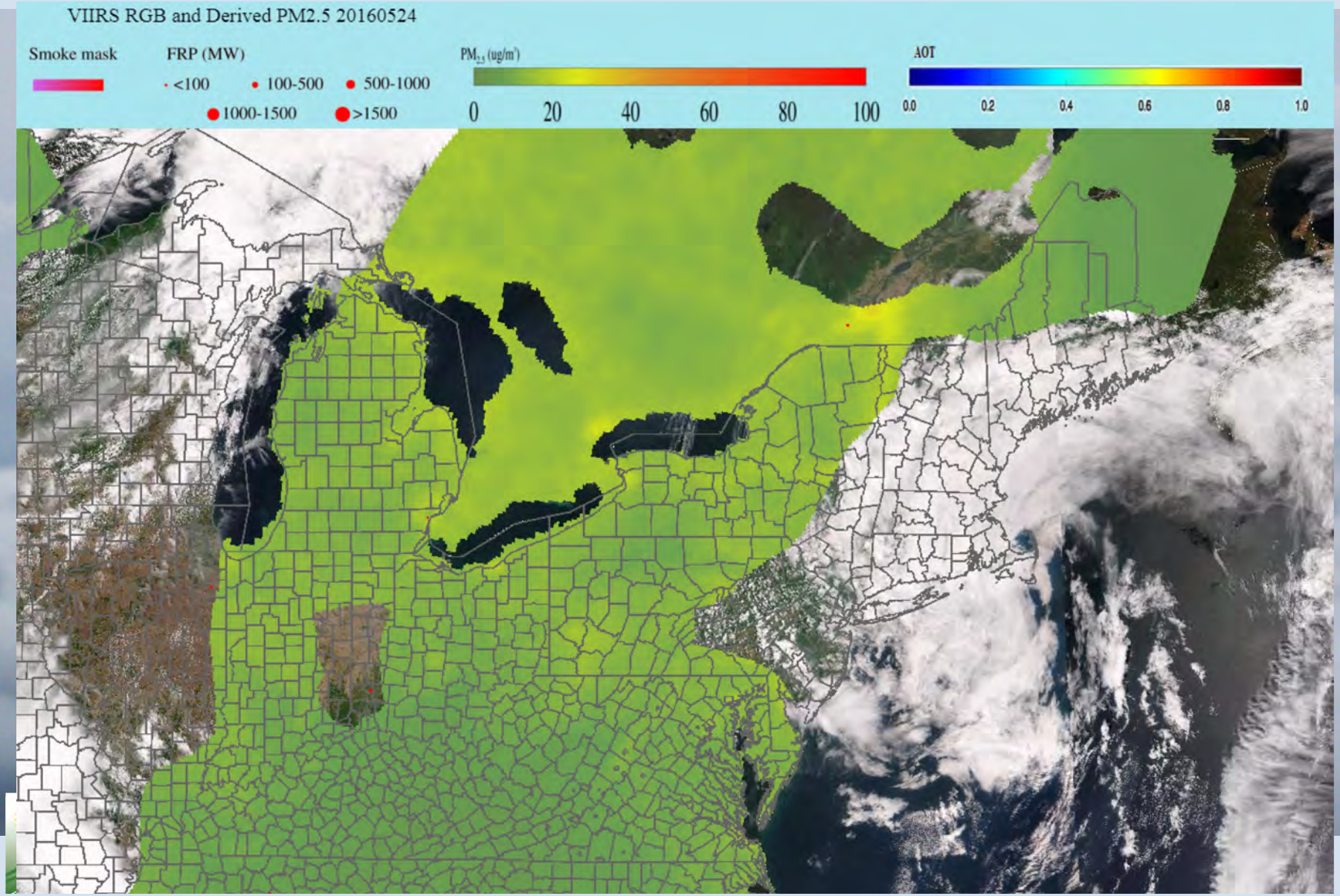
- By May 25th, the back trajectories move to the Michigan region, which is generally a 'clean' air mass.

May 24, MODIS 2017 Visible, AOD and CO

- MODIS plots show elevated AOD and CO just to the west of Connecticut .



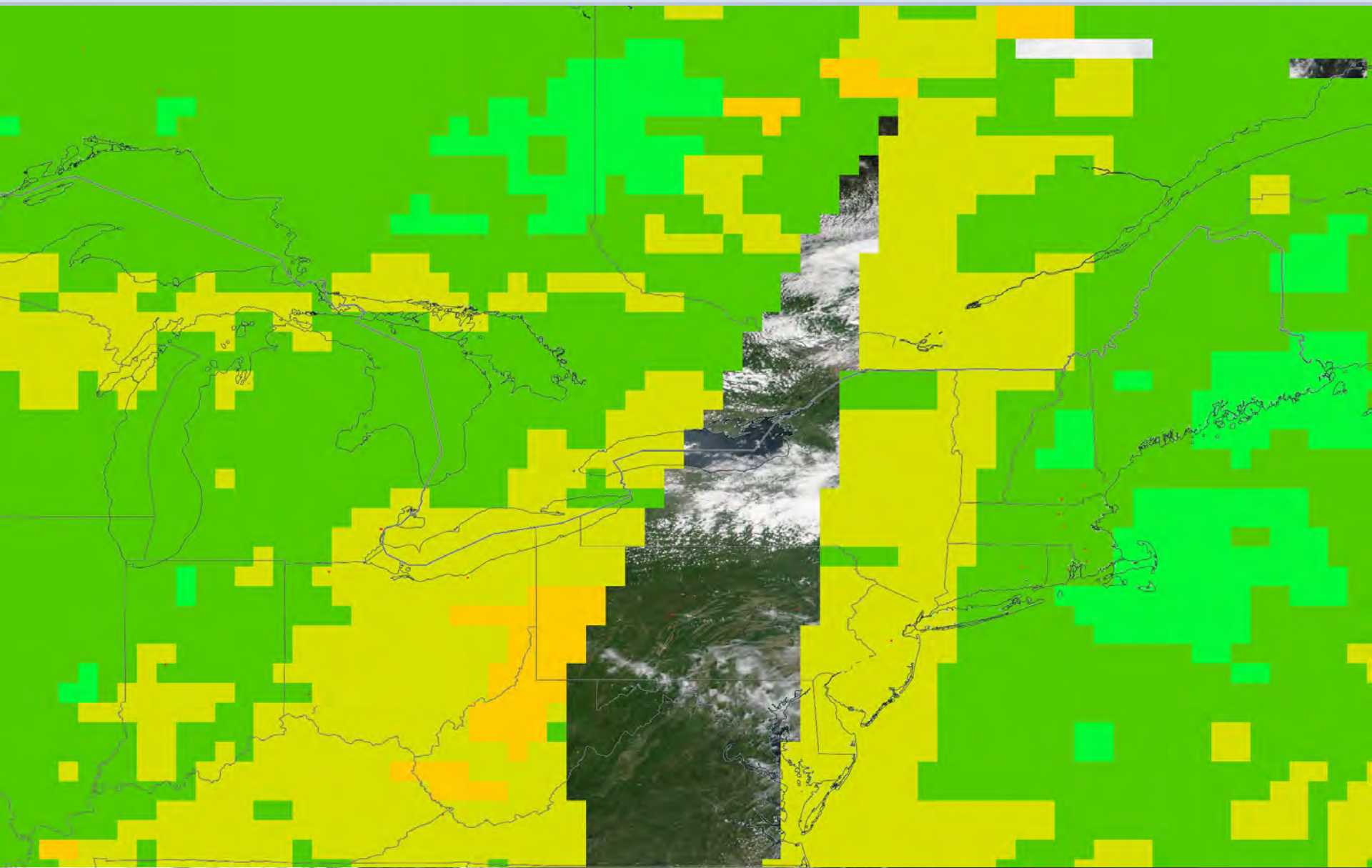
May 24, 2017 VIIRS Smoke, AOT and PM2.5



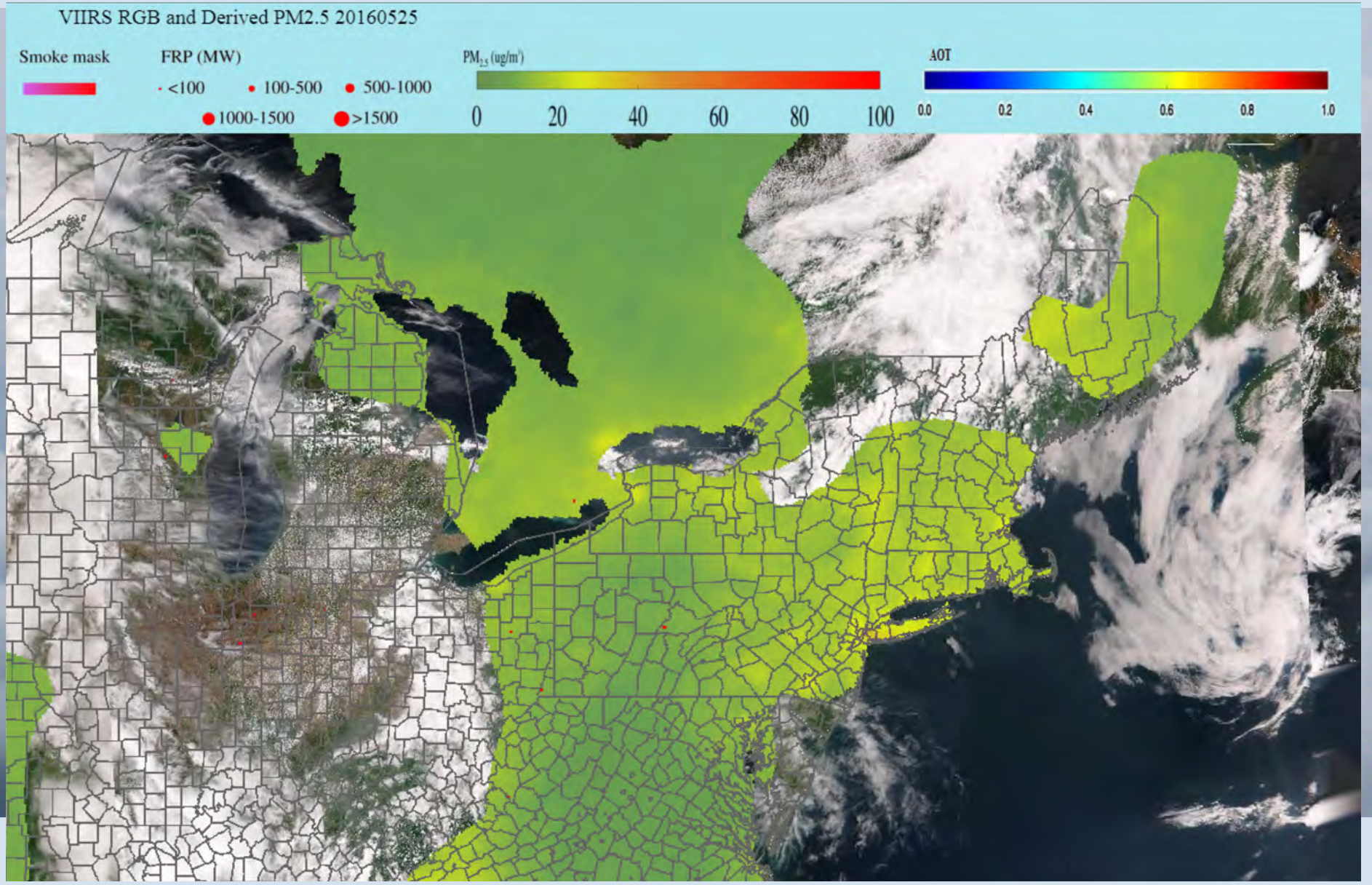
- VIIRS AOT is elevated over the same region and estimates elevated surface PM2.5 over the Great Lakes .

May 25, MODIS 2017 Visible, AOD and CO

- MODIS plots show elevated AOD and CO moving east to New England.



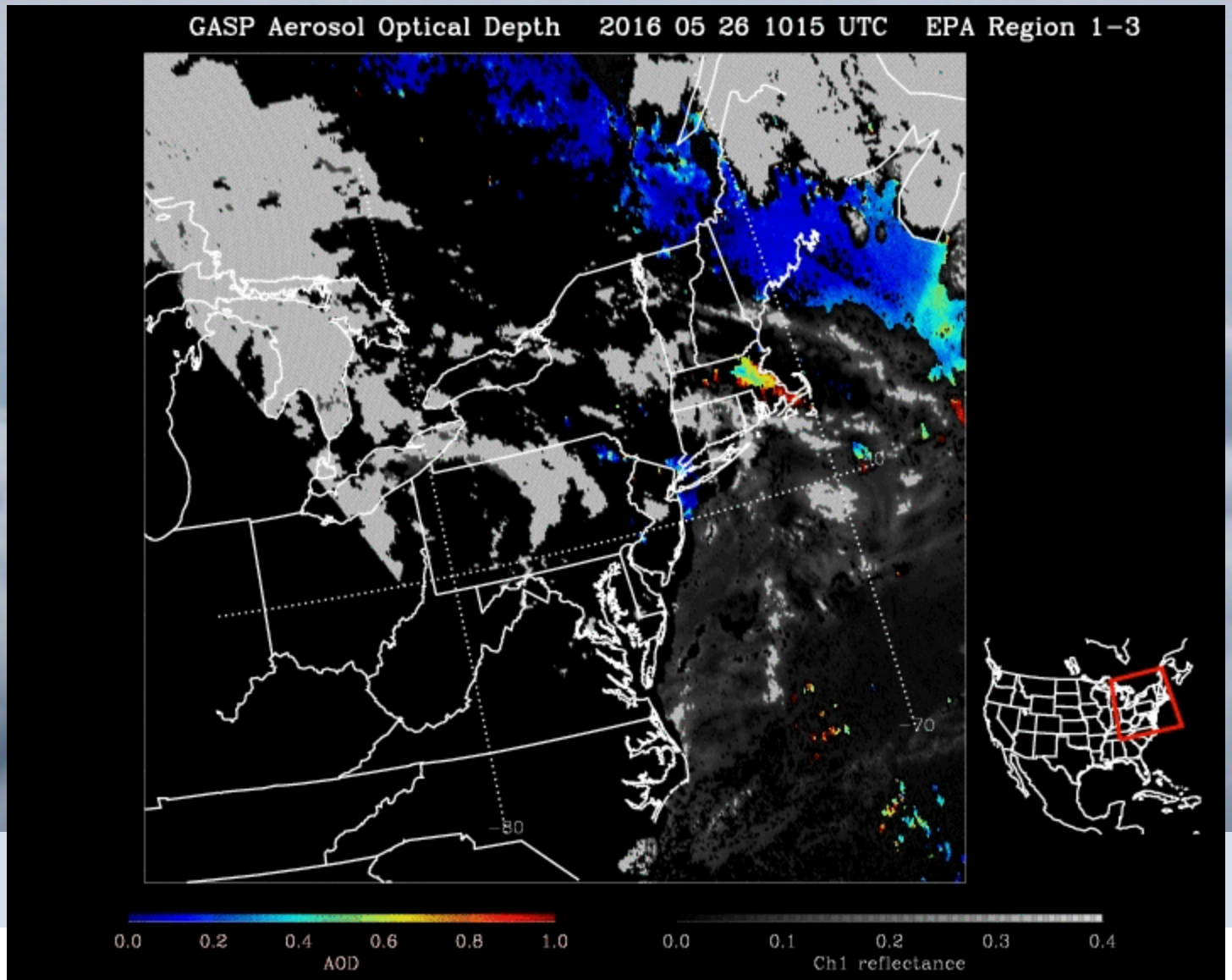
May 25, 2017 VIIRS Smoke, AOT and PM2.5



- VIIRS AOT and PM2.5 show similar trends as MODIS.

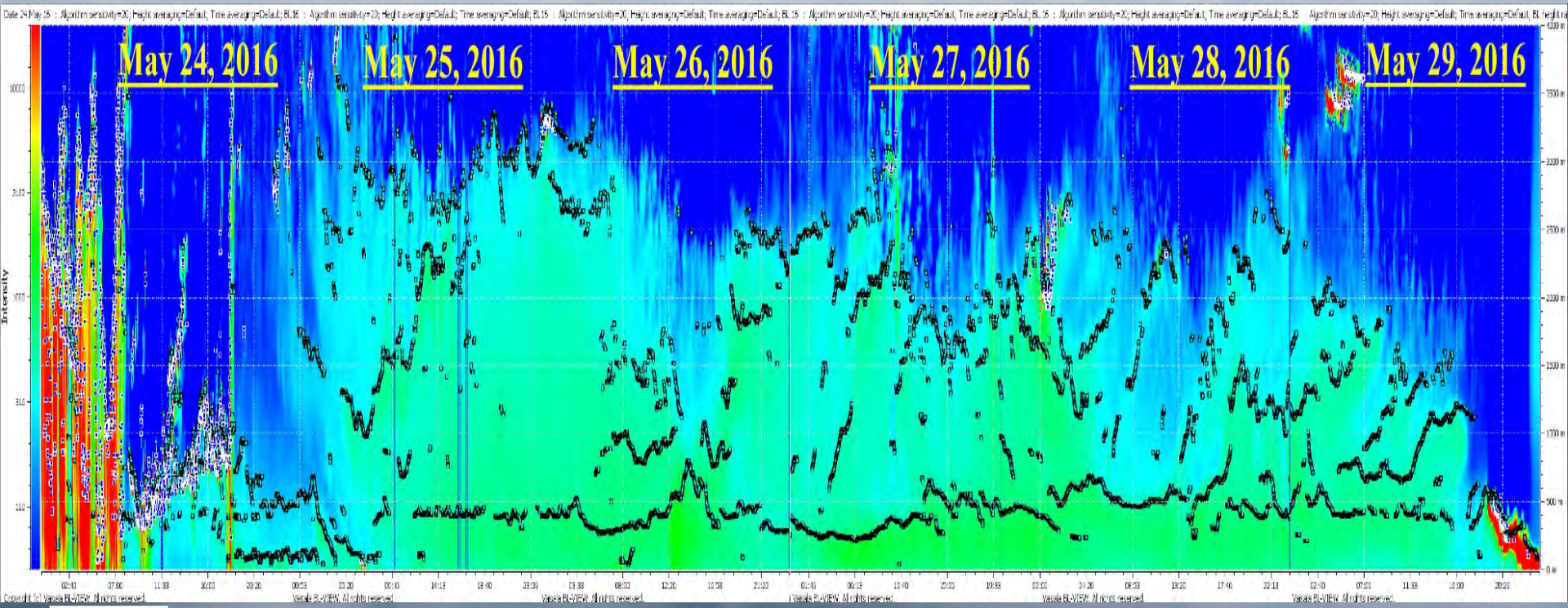
GASP AOD Products

This resolution is relatively coarse but will be much improved with the GOES-16 ABI product and later with TEMPO.



New Haven Ceilometer Back Scatter Aerosols

- Thick aerosol layer moves over New Haven after 6:00 am LST on May 25th with the upper boundary layer exceeding 3000 meters during the afternoon. The aerosol plume remains until a cold frontal passage on May 29th.



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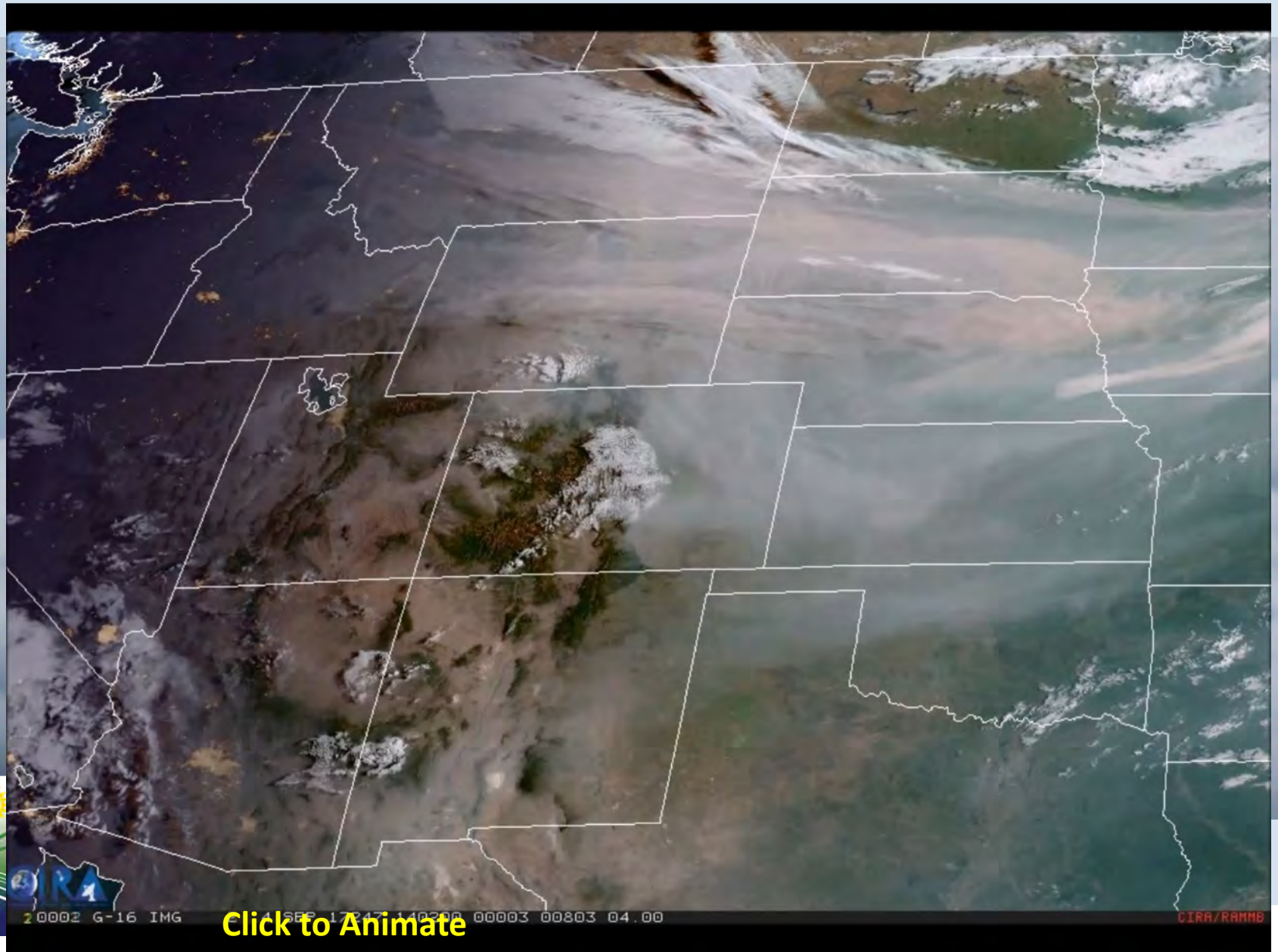
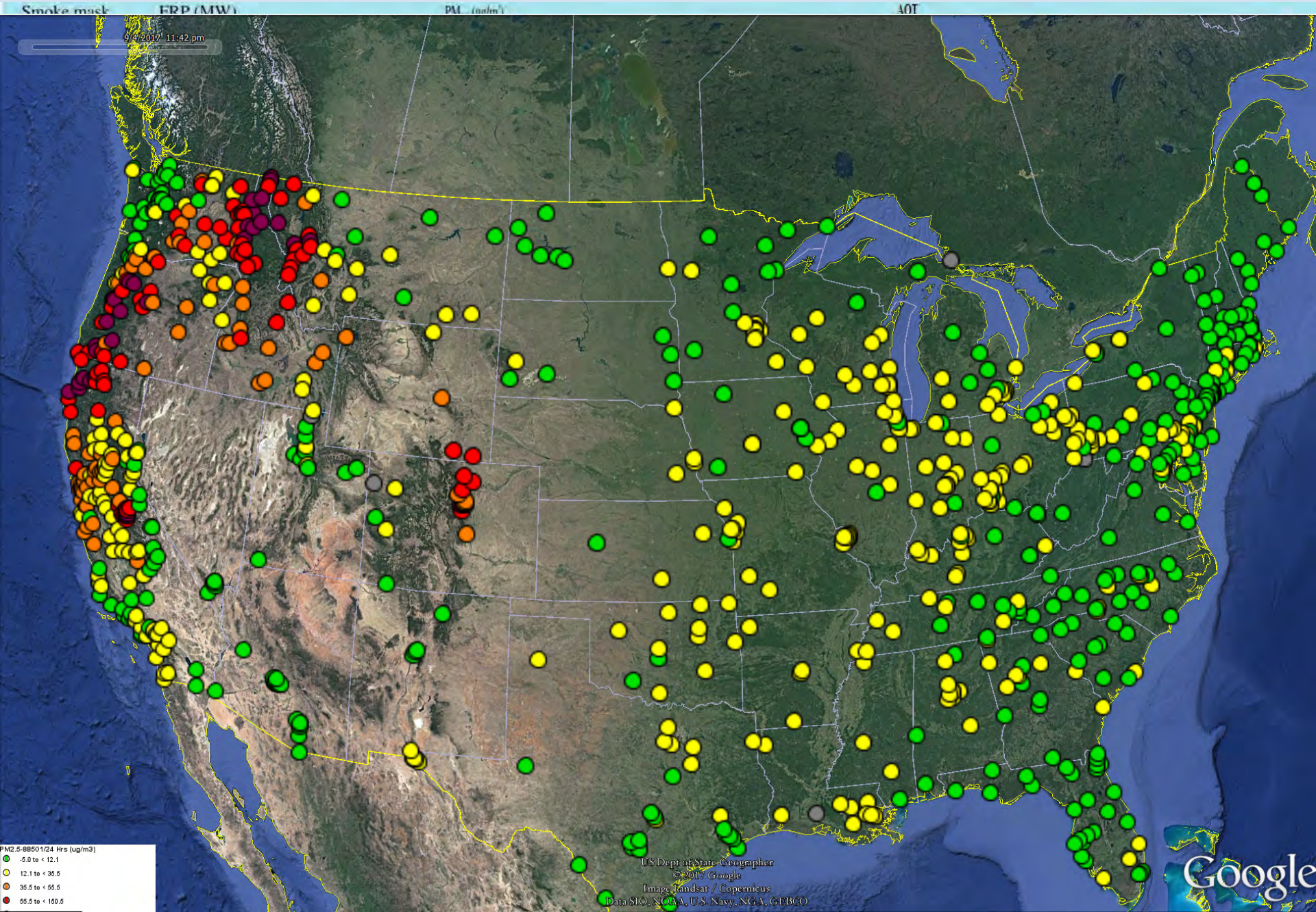
Recent Western North American Fires

- Stunning images from the GOE-16 Satellite on September 4, 2017.



September 4, 2017 Western North American Fires



Conclusion

- There is no doubt that the Fort McMurray wildfire plume directly affected ozone production in the States surrounding the Great Lakes and that ozone, as well as residual pollutants from the plume, was transported to the southeast to enhance ozone production in the northeast States beginning on May 25, 2016
- Satellite images and data were a valuable part of the exceptional events demonstration.

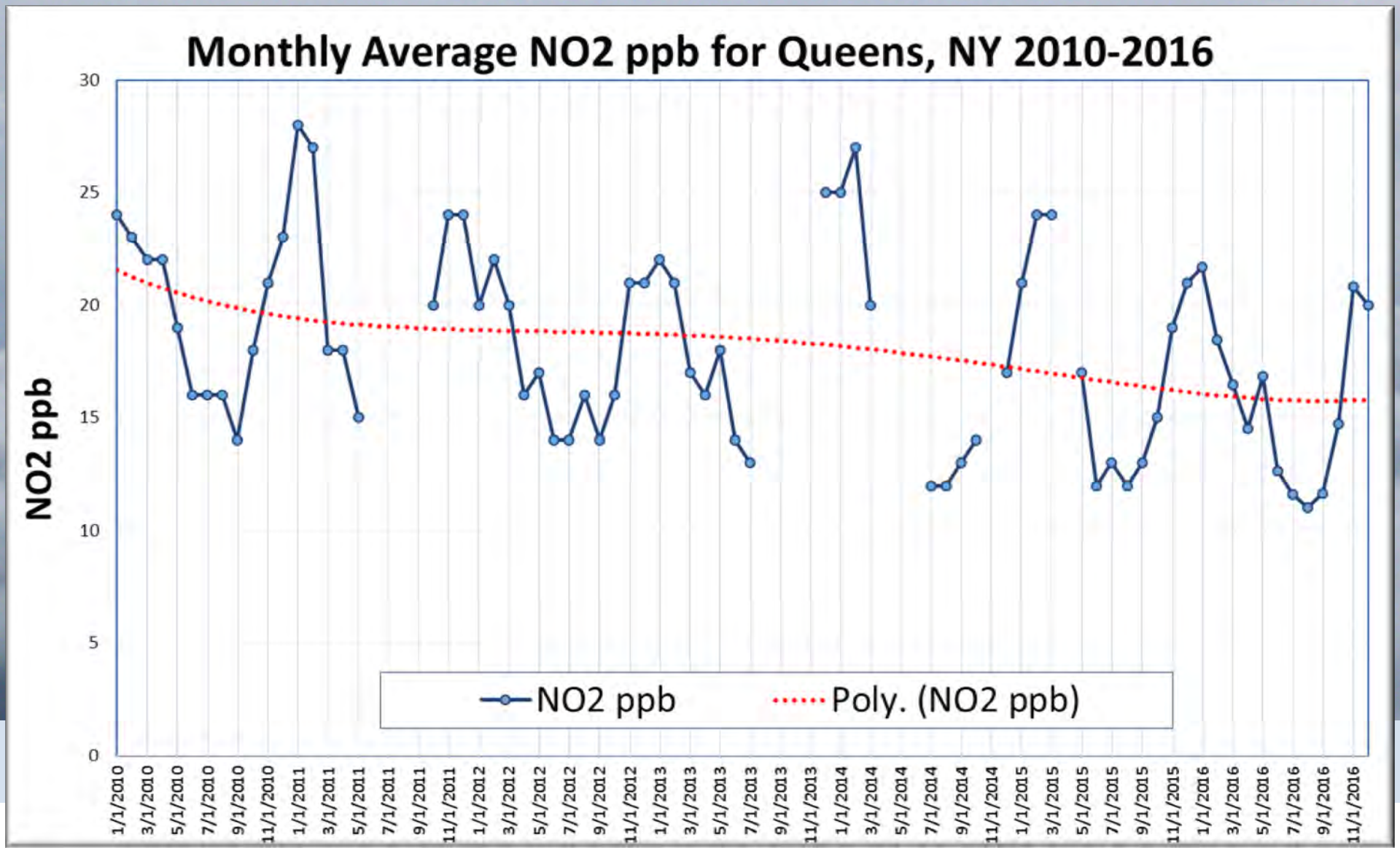
Extra Slides to Follow

Calculating FNR from Monitored Data

- I looked at monthly averaged CHOH and NO2 trends at the Queens NY monitor to determined long-term trends;
- CHOH was monitored every 6 days, while NO2 was monitored on an hourly basis;
- Although hourly CHOH would be preferred, I was able to nevertheless plot the monthly trends;
- I also calculated the FNR using the monthly averages, realizing the limitations;

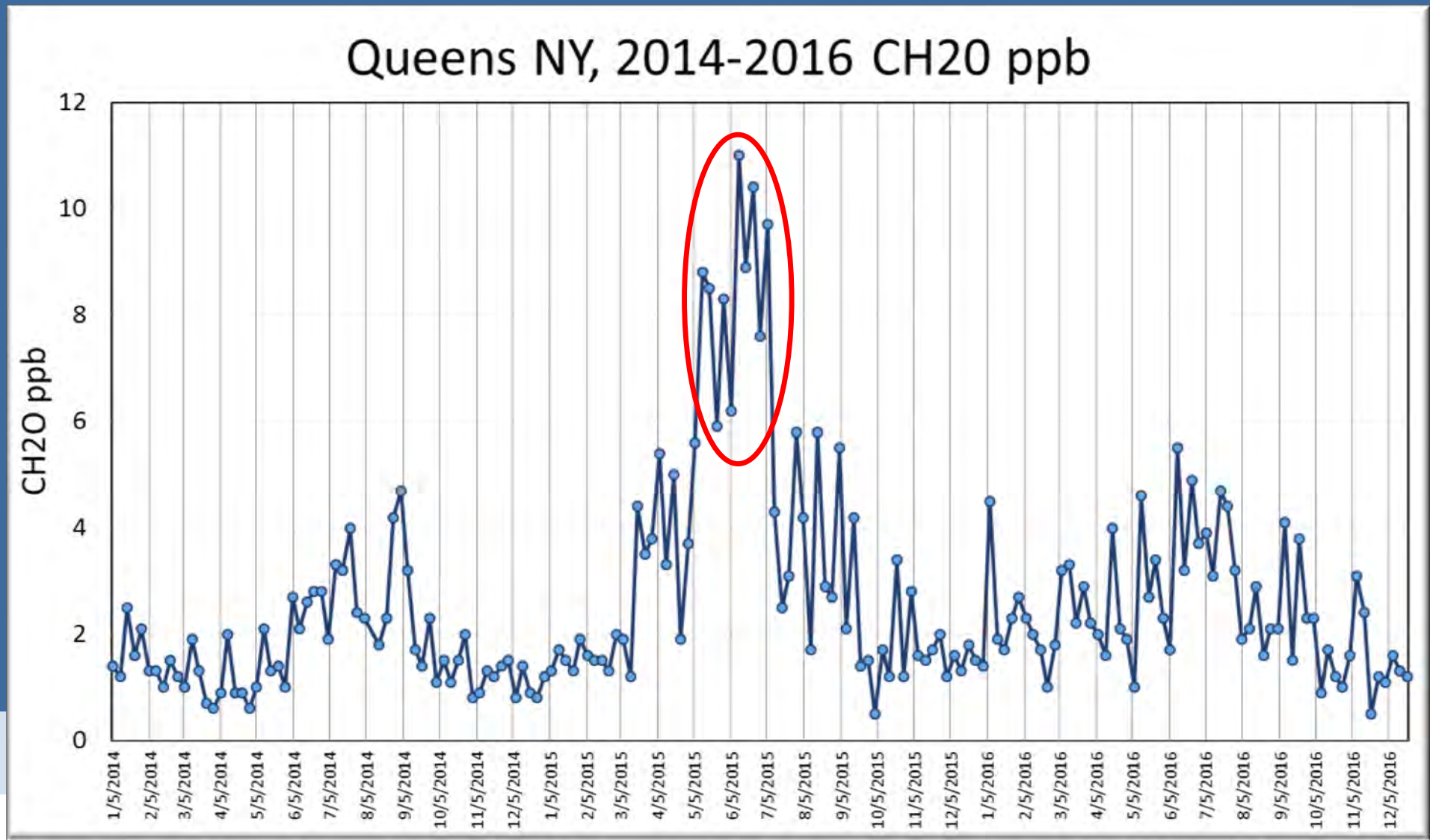
Monthly NO2 Averages 2010-2016

- Note the general downward trend in the monthly NO2 averages



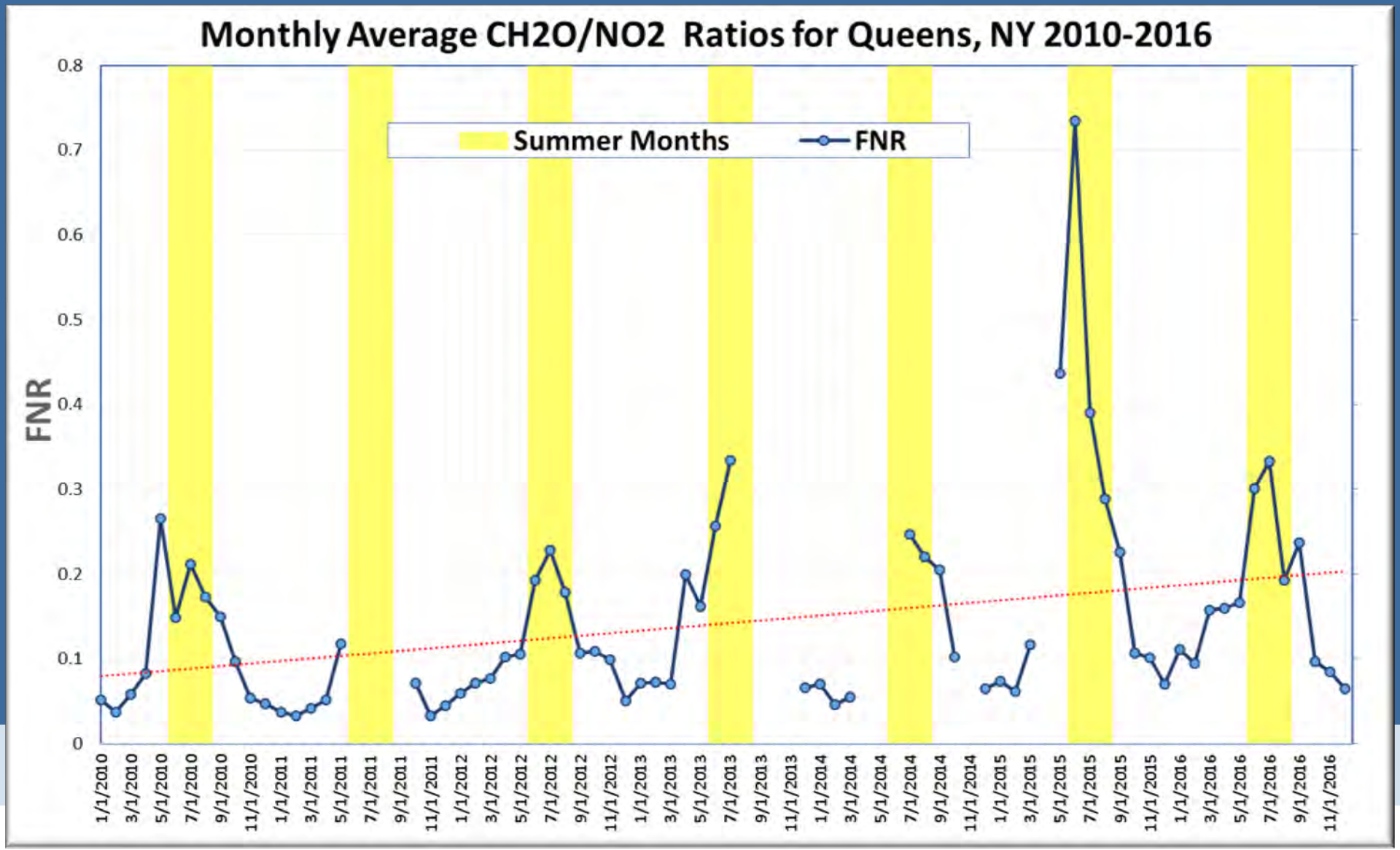
Daily CH2O Queens NY, 2014-2016

- Every 6-day CH2O observations at Queens are generally below 6 ppb except for May- June 2015, which are likely enhanced from wildfire smoke.



FNR using the Monthly Averages

- May-July 2015 produced an outlier ratio that exaggerated the upward linear trend line.



June 11, 2015, 2015 Satellite AOD