



# Connecticut Department of Energy and Environmental Protection



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

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September 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.*

# September 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 25-26<sup>th</sup>
  - Issued on April 18<sup>th</sup>, 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 Exceptional Event Demonstration**  
EPA Region 1, July 31, 2017

# Attainment Status Affected

Table of recent design values for all Connecticut monitors. This includes the pre-exceptional event data exclusion requested for the four monitors. All monitors, except for Abington, are in violation of at least one NAAQS.

Site Name	AQS Code	DV2010	DV2011	DV2012	DV2013	DV2014	DV2015	Prelim DV2016
Greenwich	90010017	78	76	82	83	82	81	80
Danbury	90011123	81	80	83	81	78	76	78
Stratford	90013007	76	79	85	89	84	83	81
Westport	90019003	80	79	85	87	85	84	85
East Hartford	90031003	74	71	75	75	77	76	75
Cornwall (Mohawk Mt)	90050005		70	71	70	69	70	74
Middletown	90070007	77	77	80	81	81	80	79
New Haven	90090027	67	69	76	78	76	76	76
Madison	90099002	76	81	87	89	81	78	76
Groton Fort Griswold	90110124	76	76	81	84	79	75	72
Stafford	90131001	79	73	76	77	80	76	73
Abington	90159991					70	68	70
<b>DV Violations</b>			<b>70 ppb NAAQS</b>		<b>75 ppb NAAQS</b>		<b>84 ppb NAAQS</b>	

# Attainment Status Affected

- May 25-26 had the most impact on current design values

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 4<sup>th</sup> 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 4 <sup>th</sup> High Value (NAAQS Standard)	4th high 2016	2014-2016 DV	2017 Critical 4 <sup>th</sup> 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	2008 NAAQS	1997 NAAQS	Next Possible NAAQS in Violation (key monitors for 1997 NAAQS are highlighted in yellow)
		70 ppb	75 ppb	84 ppb	
		Violations	Violations	Violations	
SWCT Portion of NYC Area					
Westport	83	X	X		One more 87+ ppb day violates 1997 NAAQS.
Greater CT					
Cornwall	72	X			Four 78+ ppb days violate 2008 NAAQS.
East Hartford	72	X			Four 81+ ppb days violate 2008 NAAQS.
Abington	70				One more 76+ ppb day violates 2015 NAAQS.

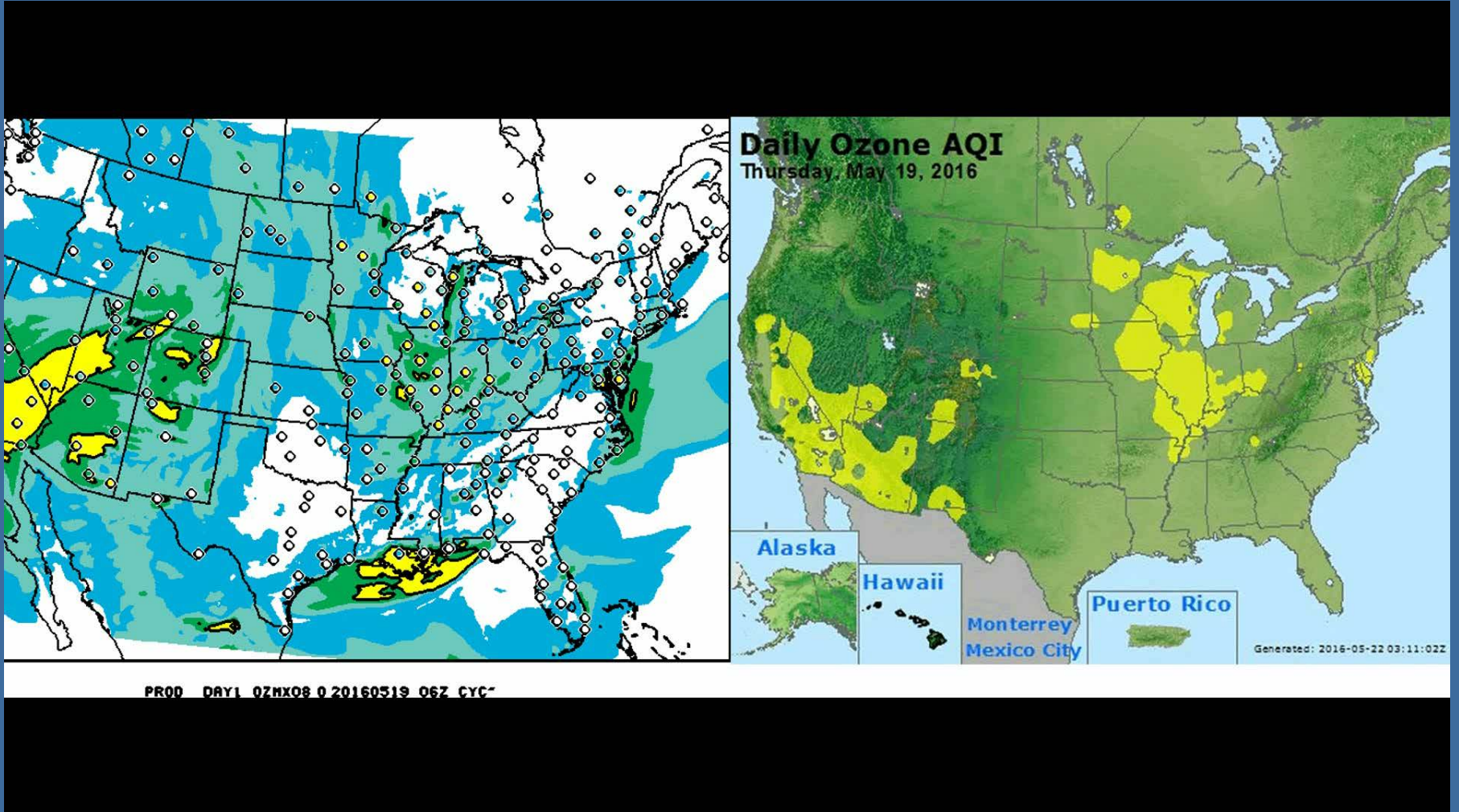
# Available Tools for Analysis

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

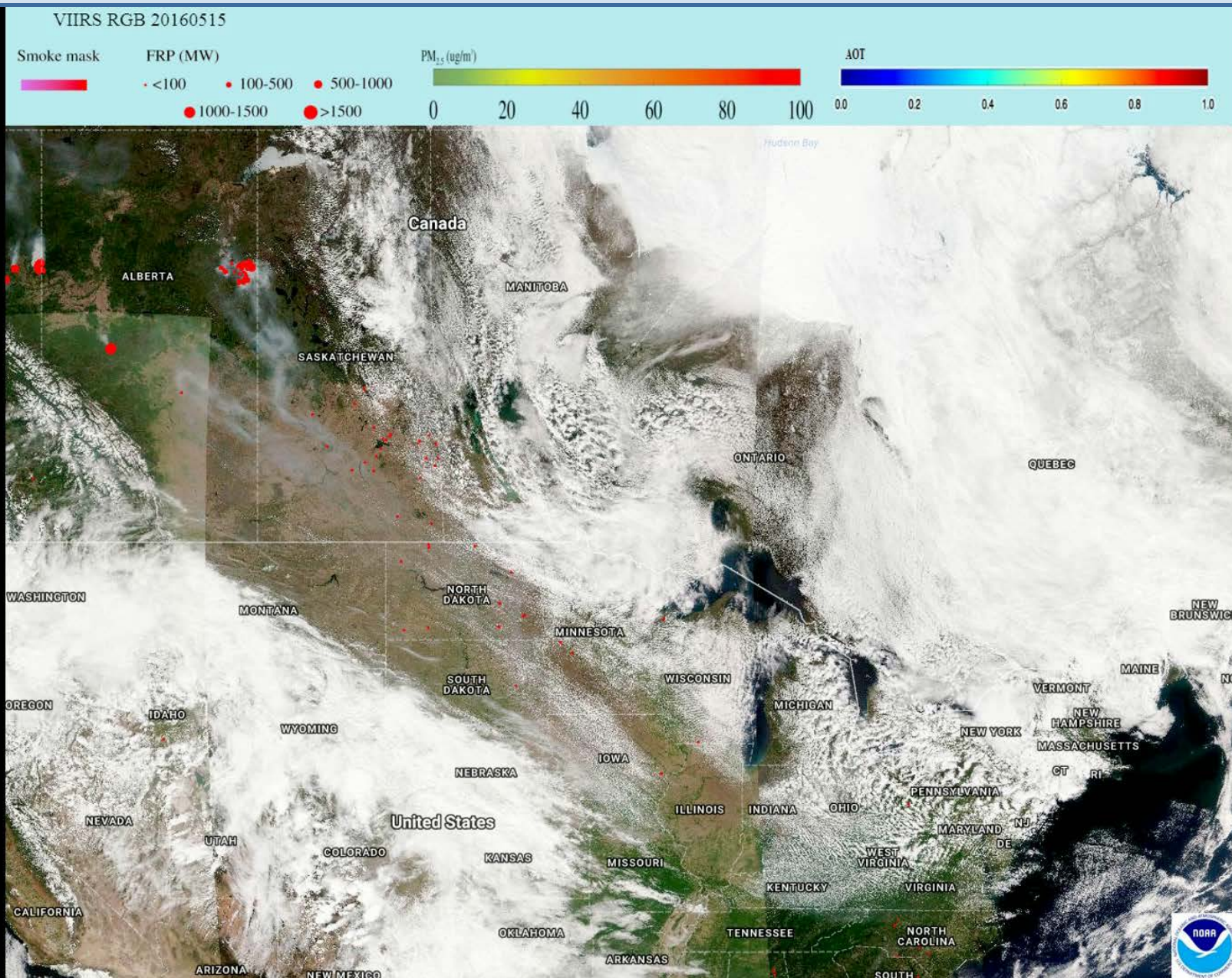




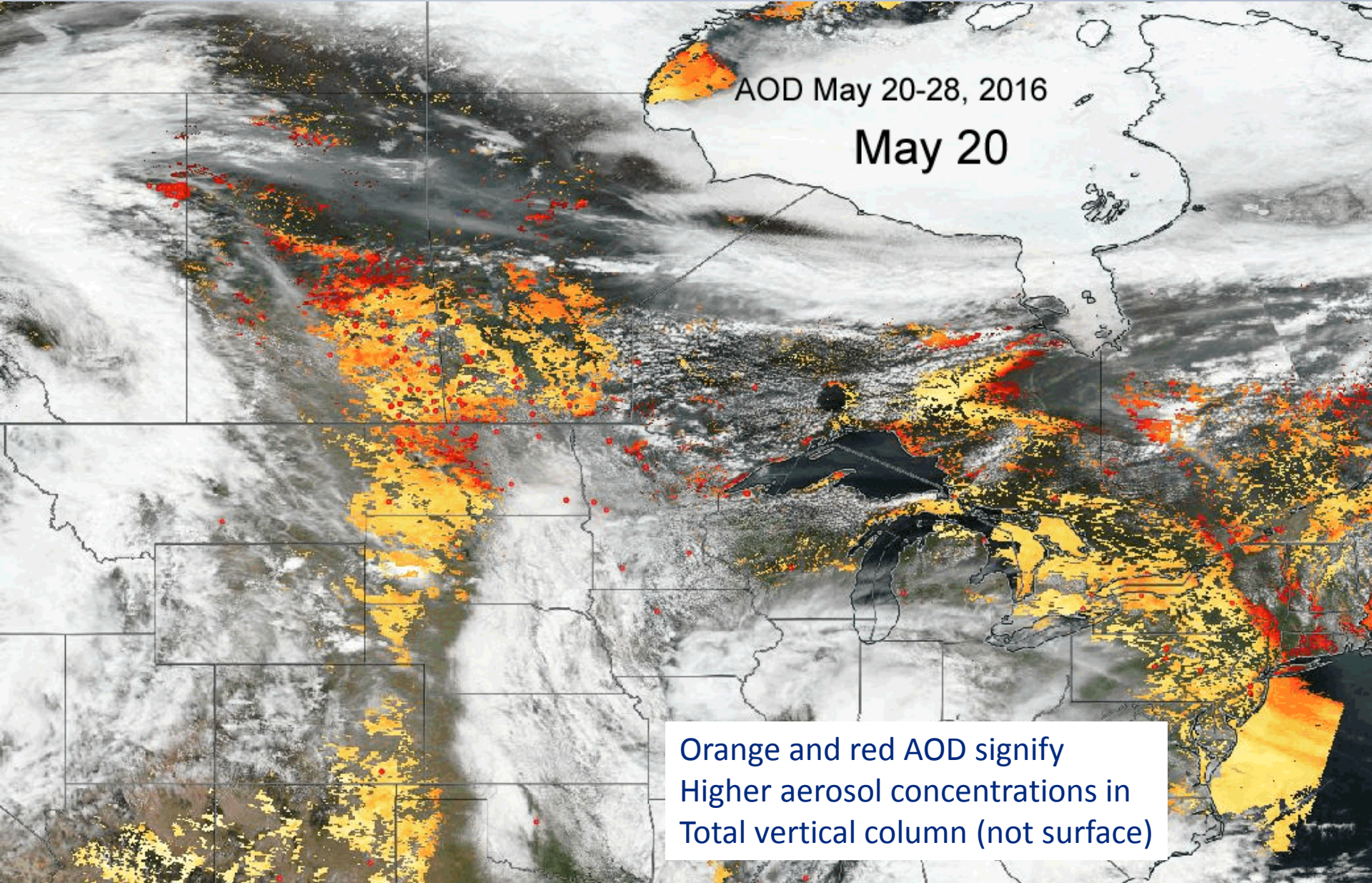
# NOAA Model vs. the AQI



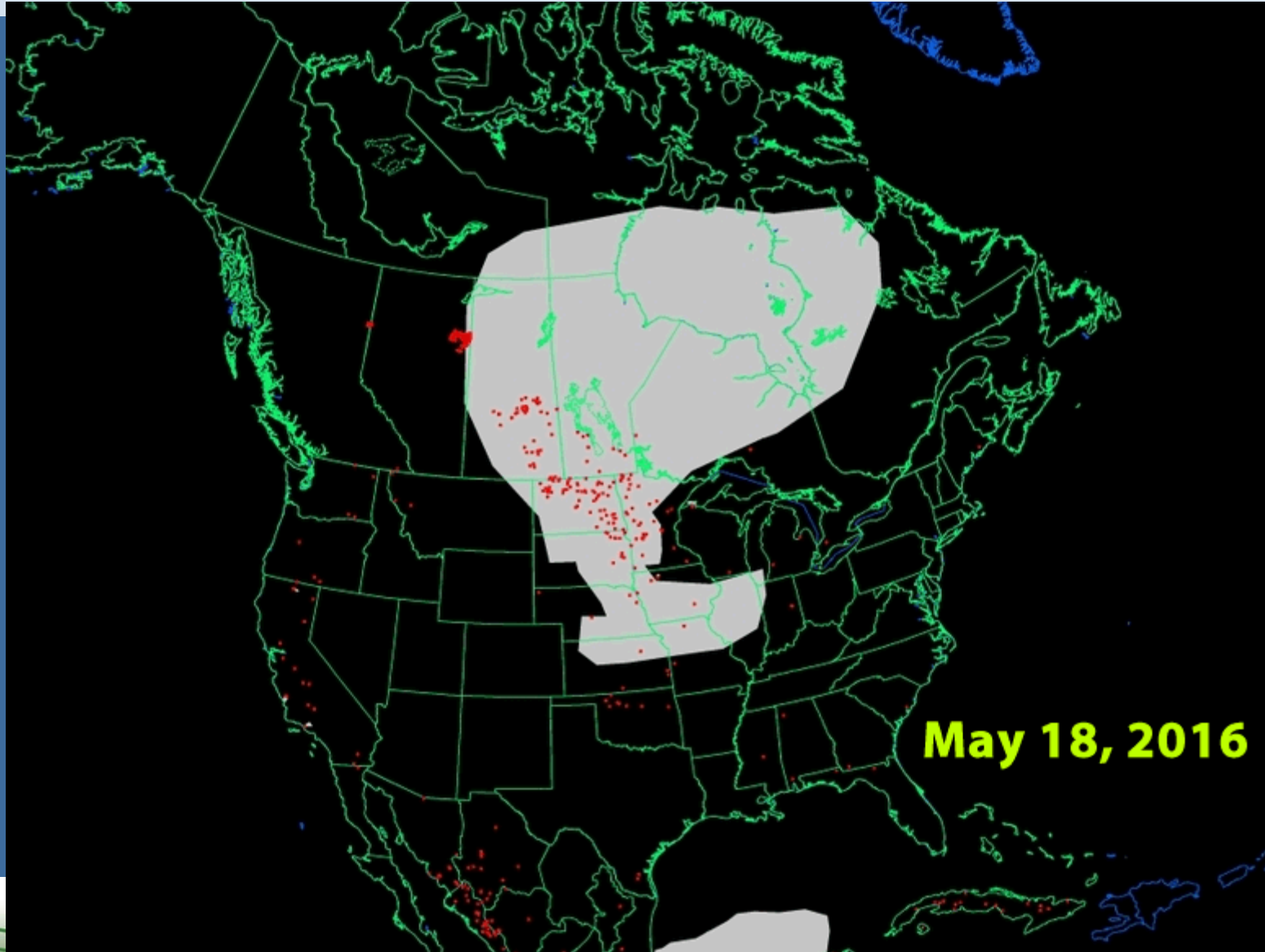
# Video of Wildfire Evolution May 15-26, 2016



# May 20-28 AOD Satellite Animation



# Smoke Plume Animation from May 18<sup>th</sup>- May 25<sup>th</sup>



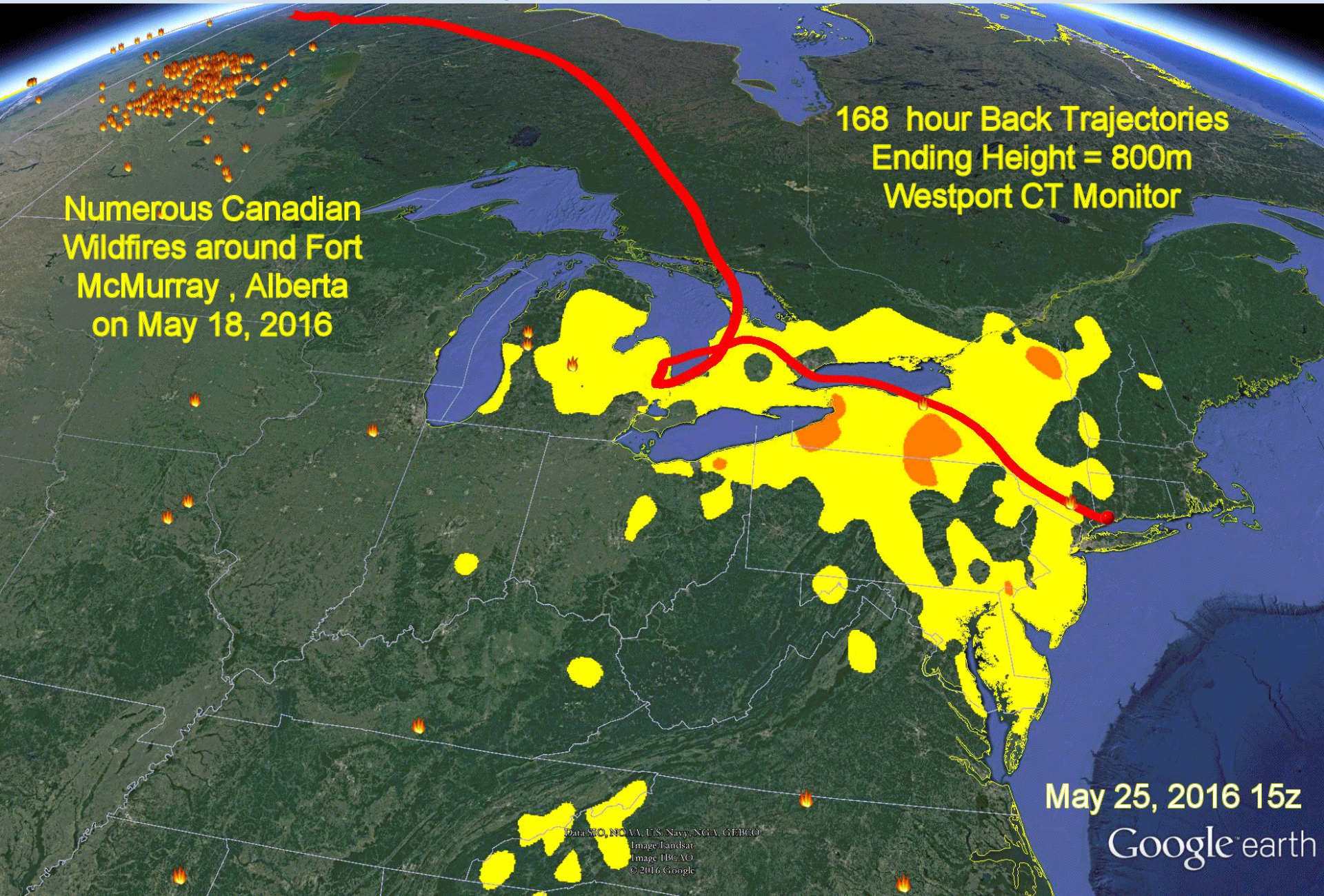
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# Back Trajectory Animation

Numerous Canadian Wildfires around Fort McMurray, Alberta on May 18, 2016

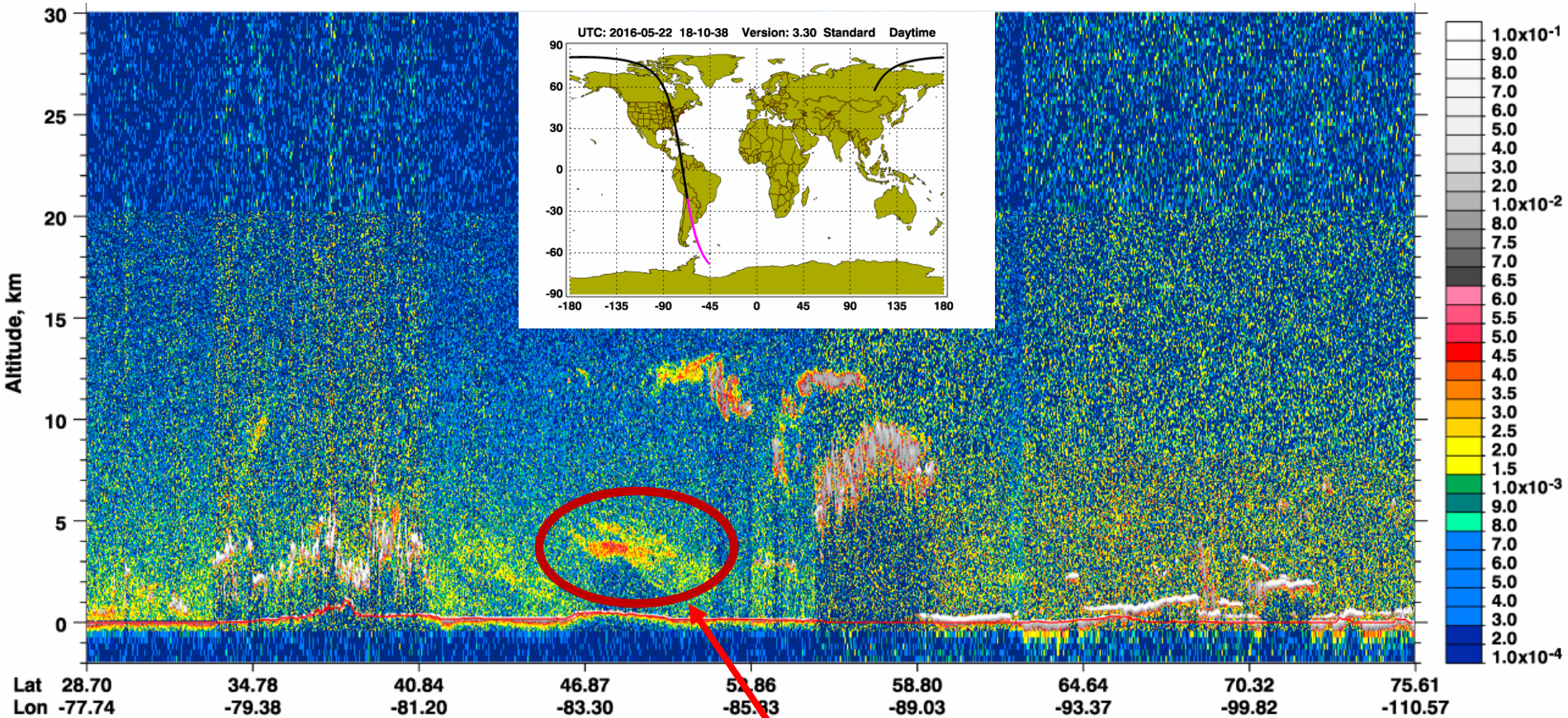
168 hour Back Trajectories  
Ending Height = 800m  
Westport CT Monitor

May 25, 2016 15z  
Google earth



# Calipso LIDAR 5/22/16

532 nm Total Attenuated Backscatter,  $\text{km}^{-1} \text{sr}^{-1}$  UTC: 2016-05-22 18:37:31.8 to 2016-05-22 18:51:00.5 Version: 3.30 Standard Daytime



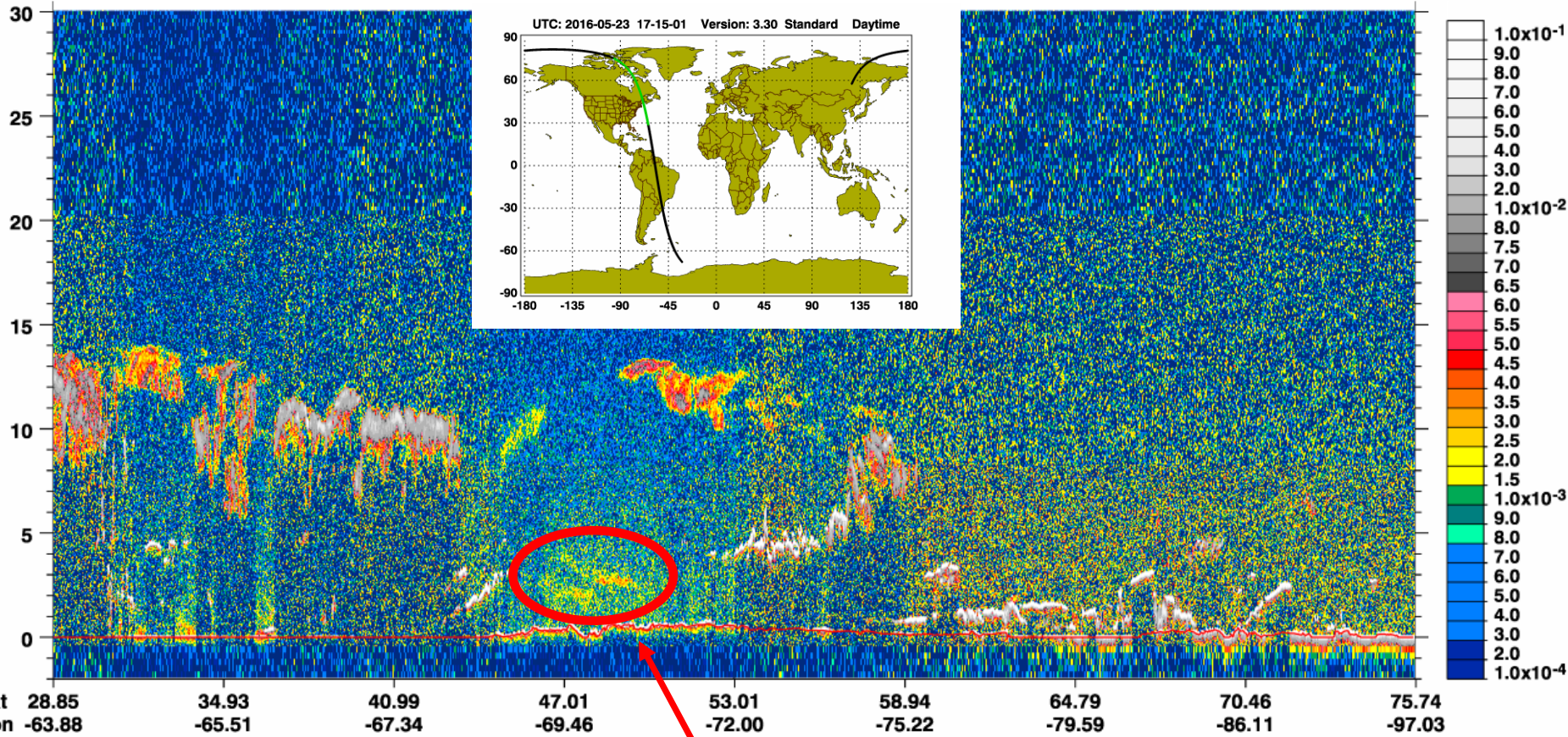
U.P. MI



Connecticut Department of Energy and Environmental Protection

# Calipso LIDAR 5/23/16

532 nm Total Attenuated Backscatter,  $\text{km}^{-1} \text{sr}^{-1}$  UTC: 2016-05-23 17:41:56.5 to 2016-05-23 17:55:25.2 Version: 3.30 Standard Daytime



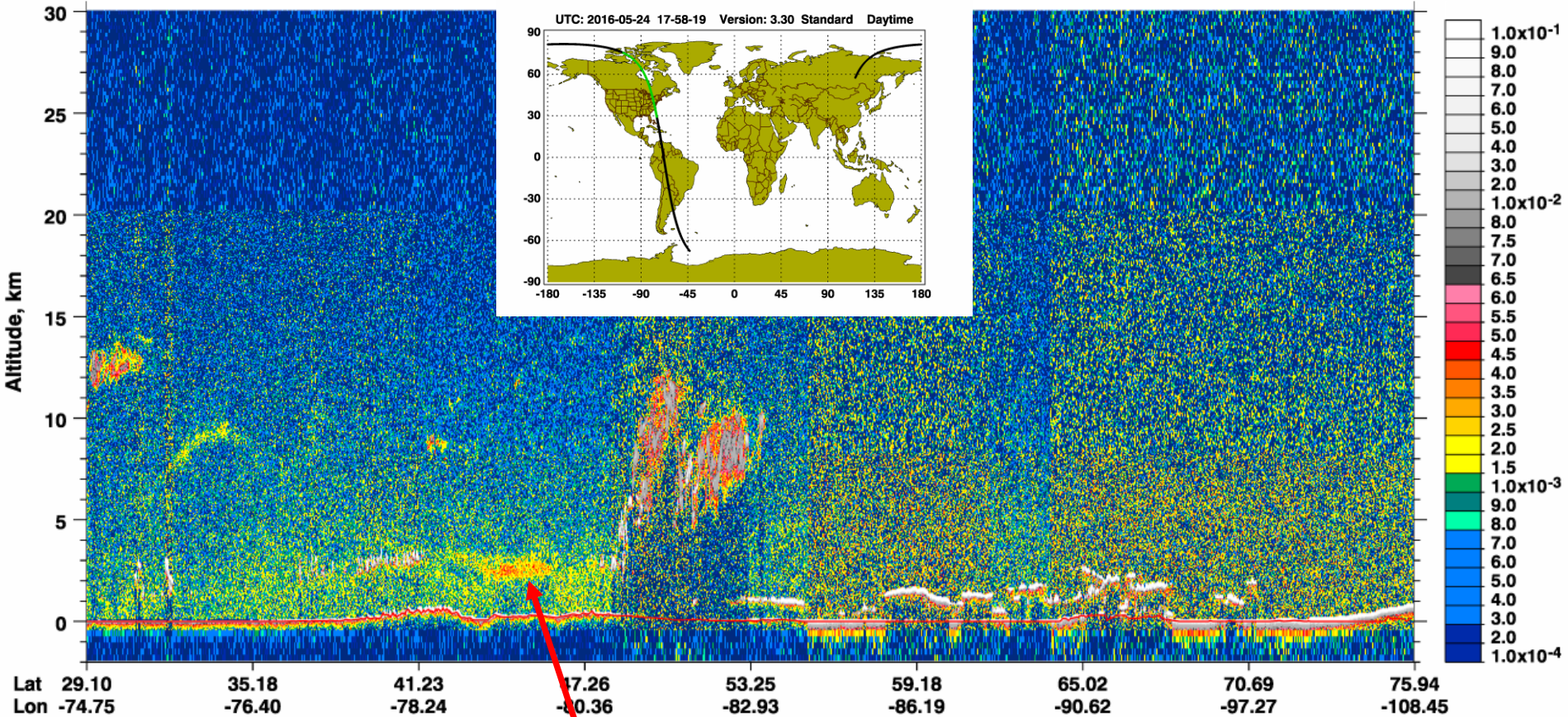
Quebec,  
Canada



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# Calipso LIDAR 5/24/16

532 nm Total Attenuated Backscatter,  $\text{km}^{-1} \text{sr}^{-1}$  UTC: 2016-05-24 18:25:15.7 to 2016-05-24 18:38:44.4 Version: 3.30 Standard Daytime



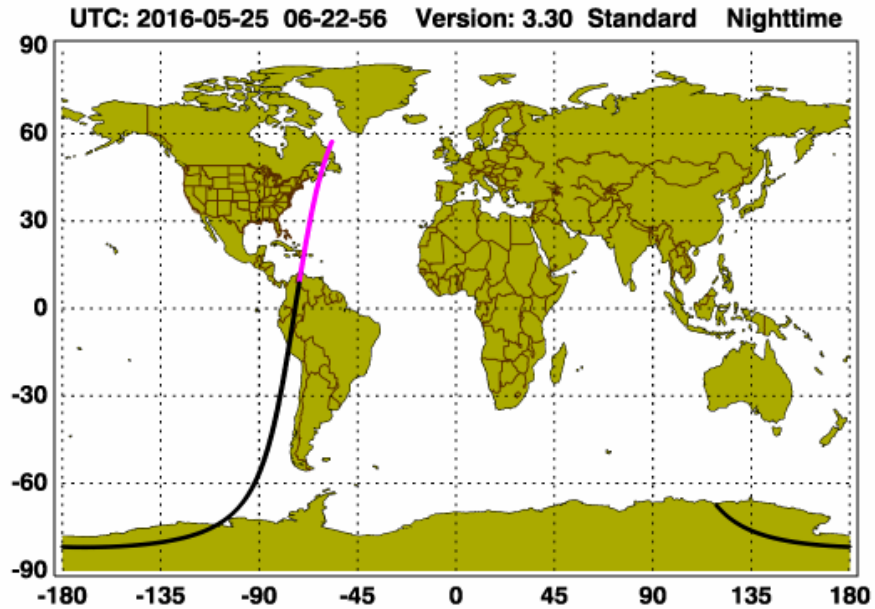
Ontario,  
Canada



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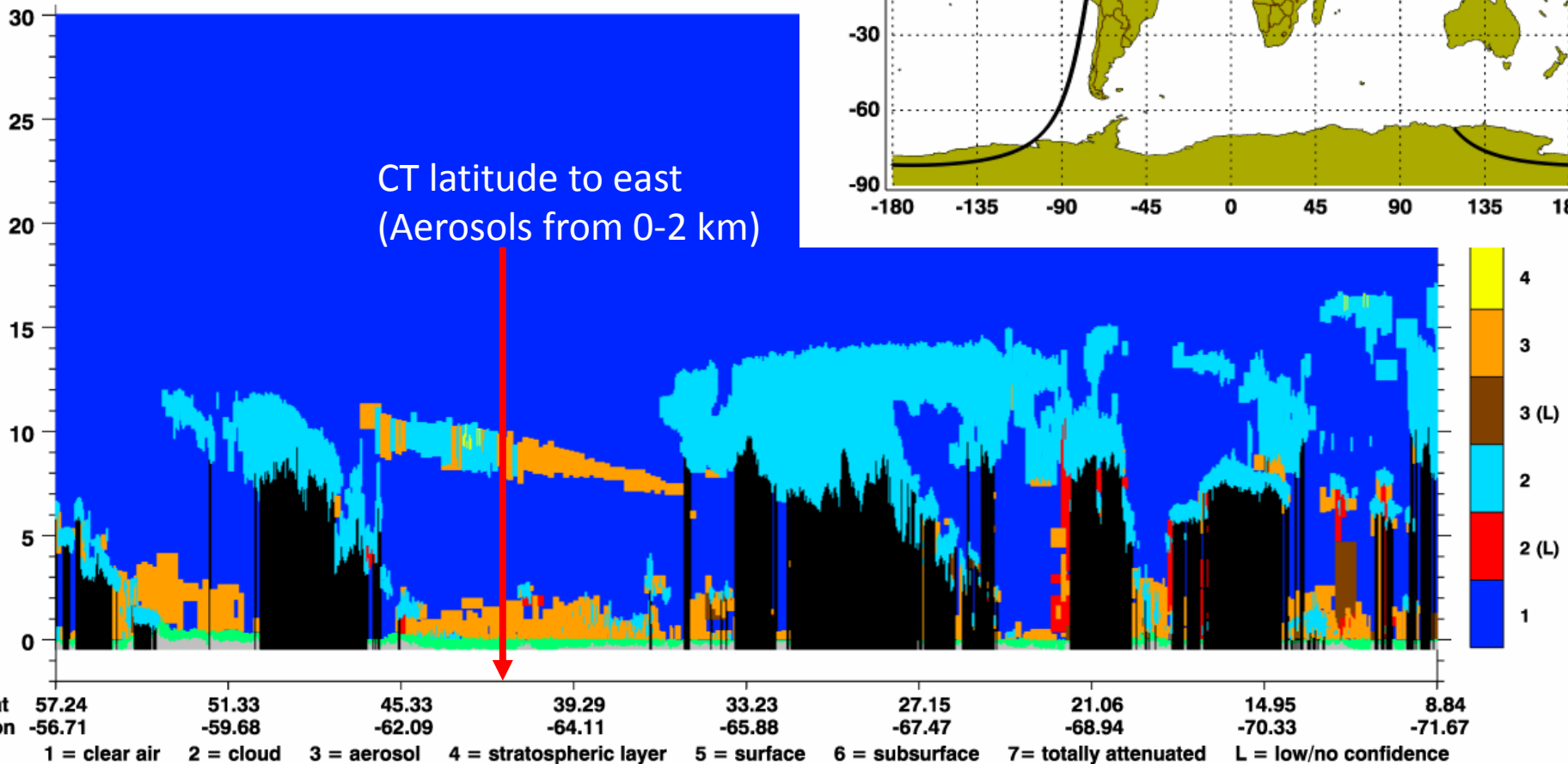


# Calipso Aerosol Cross Section May 25th



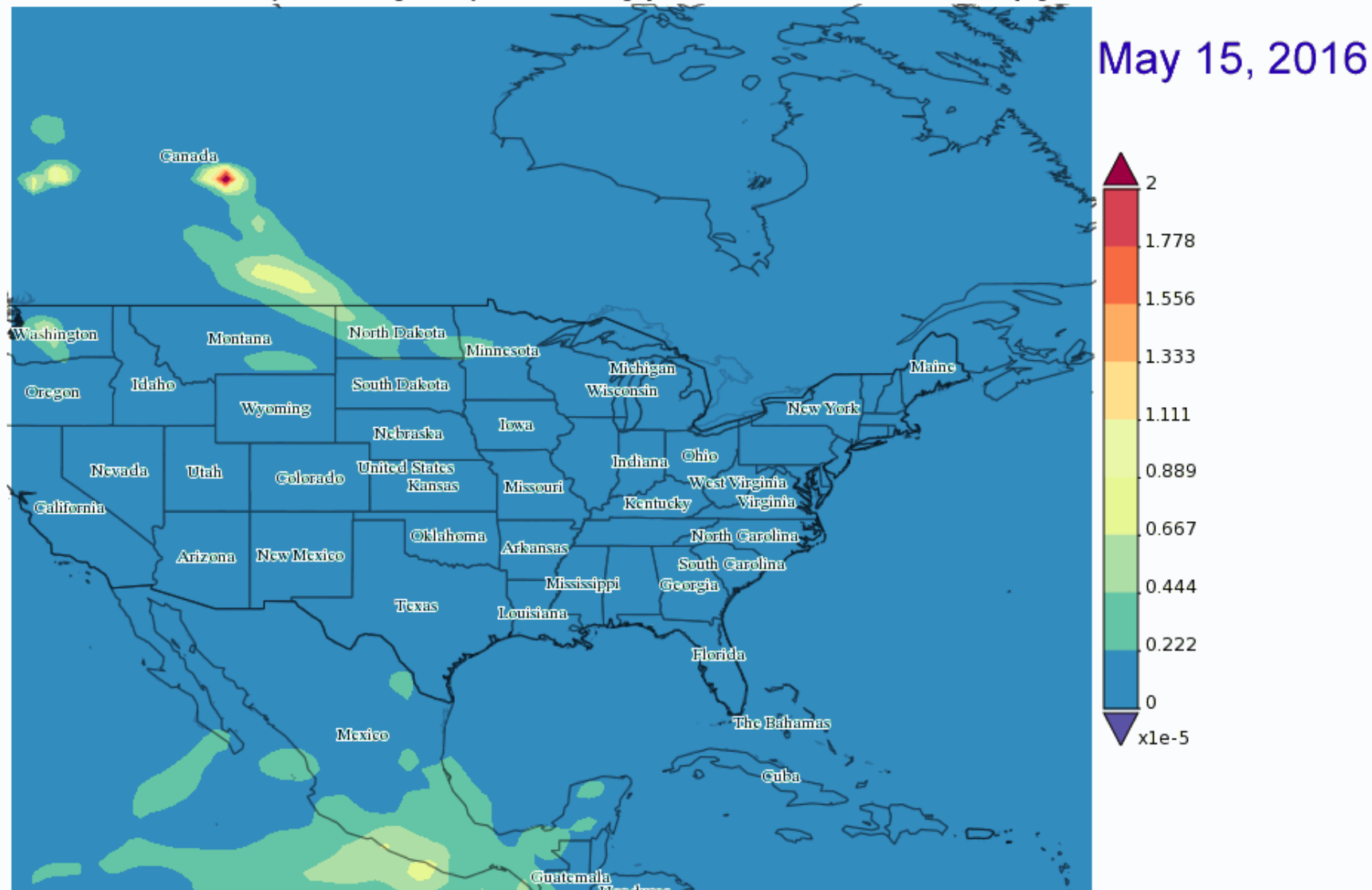
Vertical Feature Mask UTC: 2016-05-25 06:22:51.6 to 2016-

CT latitude to east  
(Aerosols from 0-2 km)



# May 16-26, 2016 OMI BC Animation

Black Carbon Column Mass Density, time average hourly 0.5 x 0.625 deg. [MERRA-2 Model M2T1NXAER v5.12.4] kg m<sup>-2</sup> 2016-05-16T00:00:00

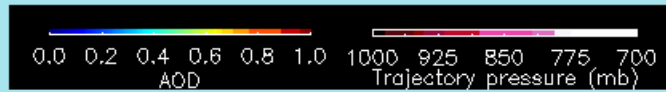


- Selected date range was 2016-05-16 00Z - 2016-05-26 23Z. Title reflects the date range of the granules that went into making this result.

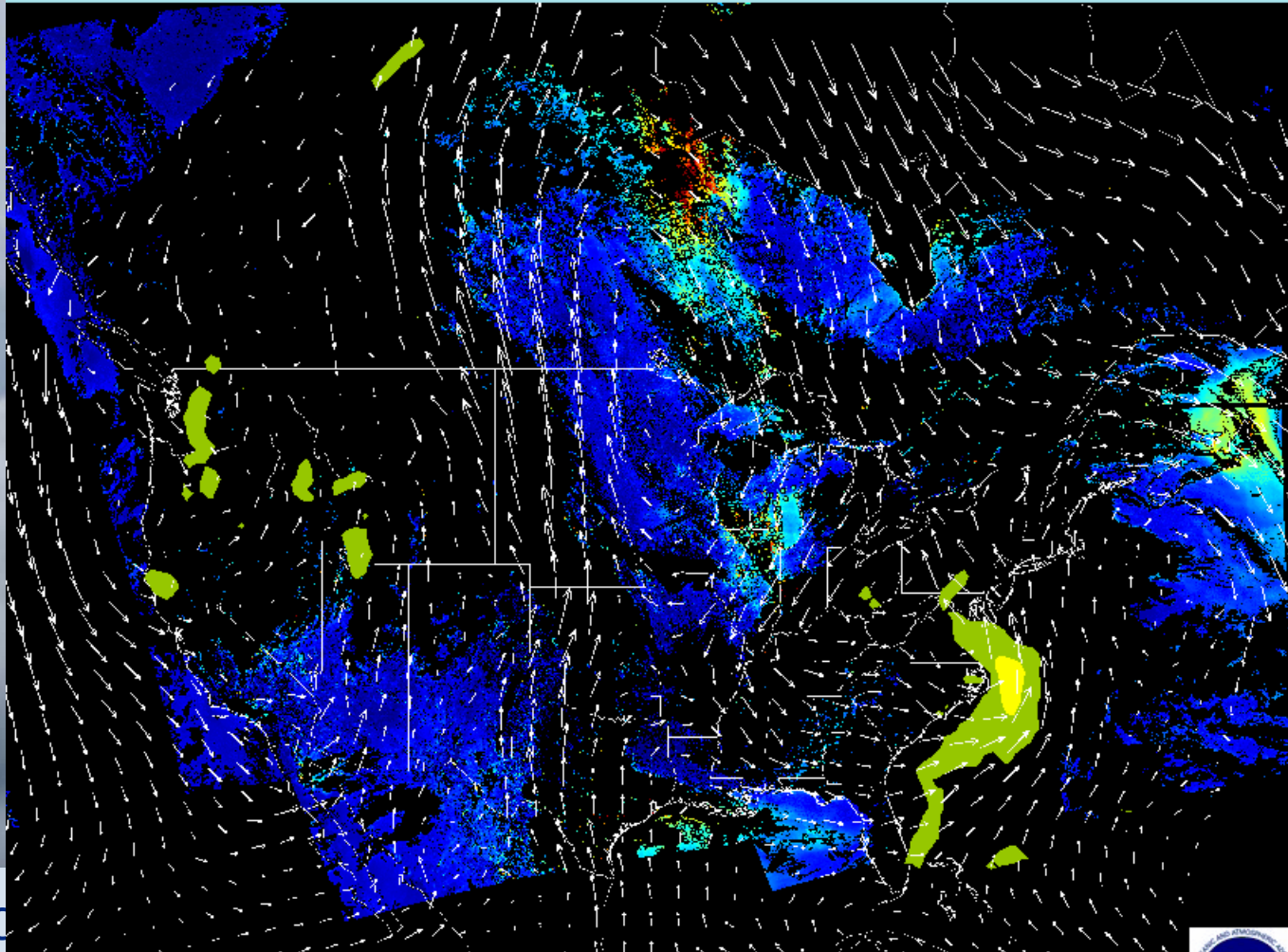


# VIIRS Modeled Trajectories, May 21-23

VIIRS 48-hour trajectories (initialized at 12Z 20160521, with 3-hour increment)

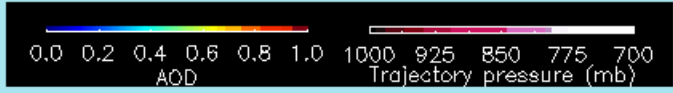


2016052115

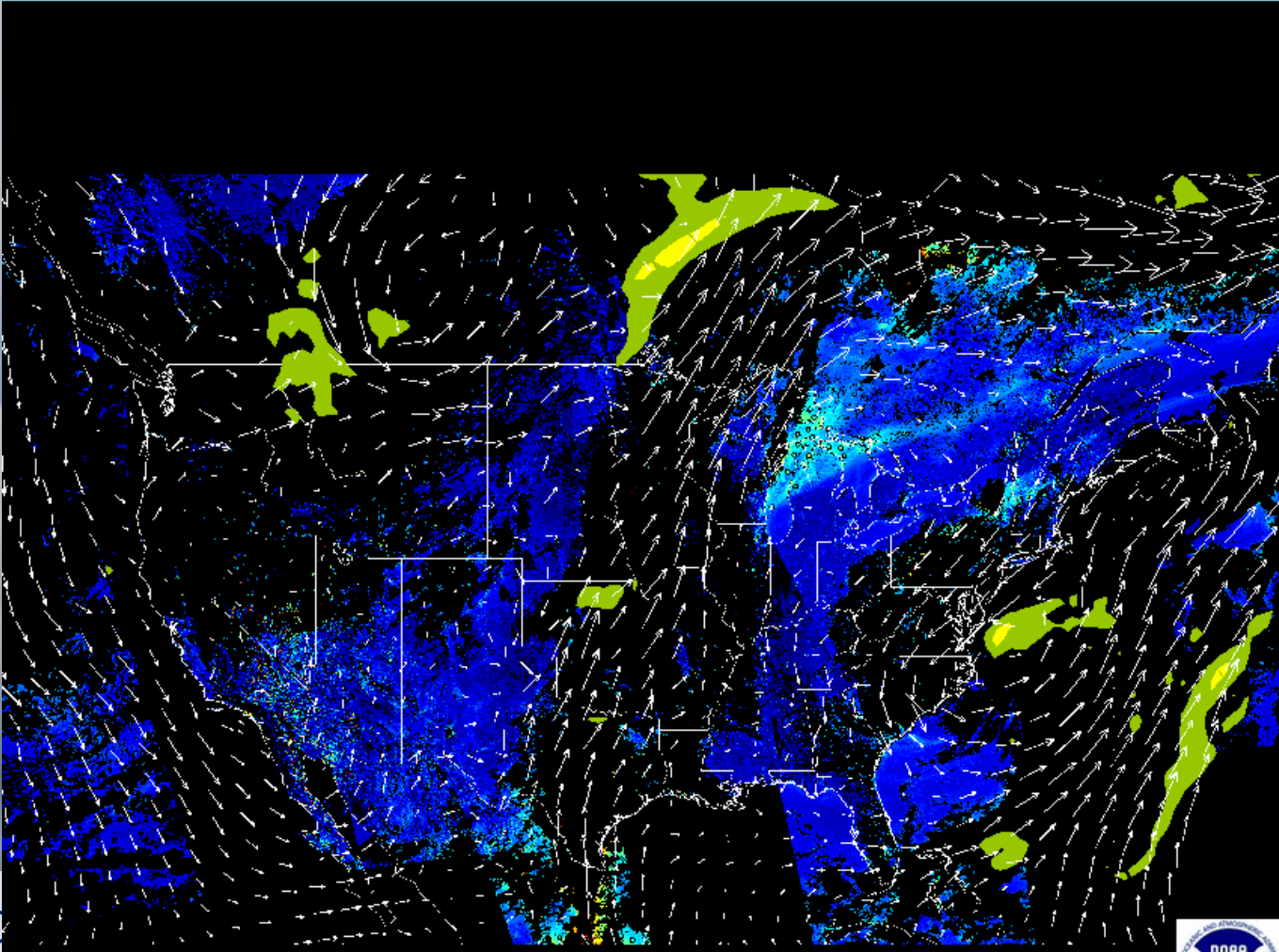


# VIIRS Modeled Trajectories, May 23-25

VIIRS 48-hour trajectories (initialized at 12Z 20160523, with 3-hour increment)



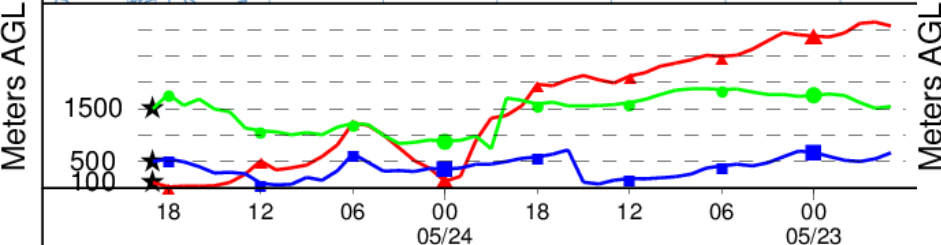
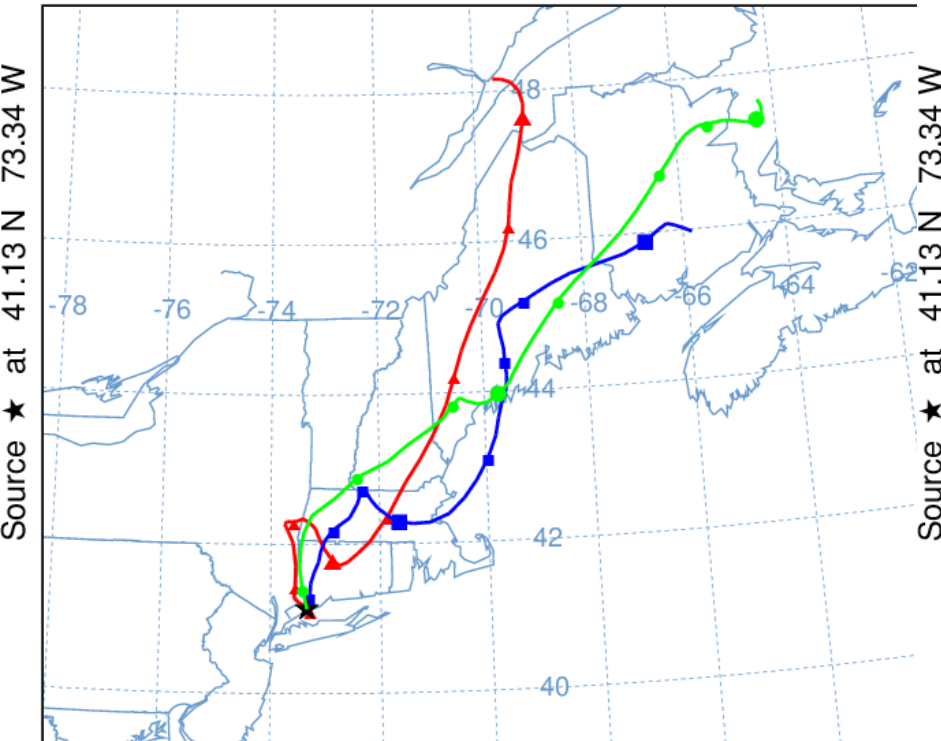
2016052315



# May 24 -25 Back Trajectories (HRRR)

NOAA HYSPLIT MODEL

Backward trajectories ending at 1900 UTC 24 May  
HRRR Meteorological Data

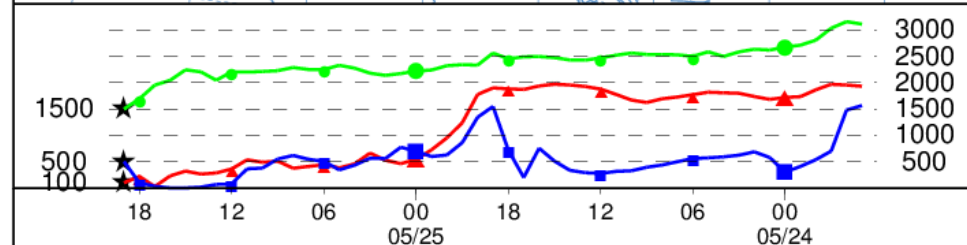
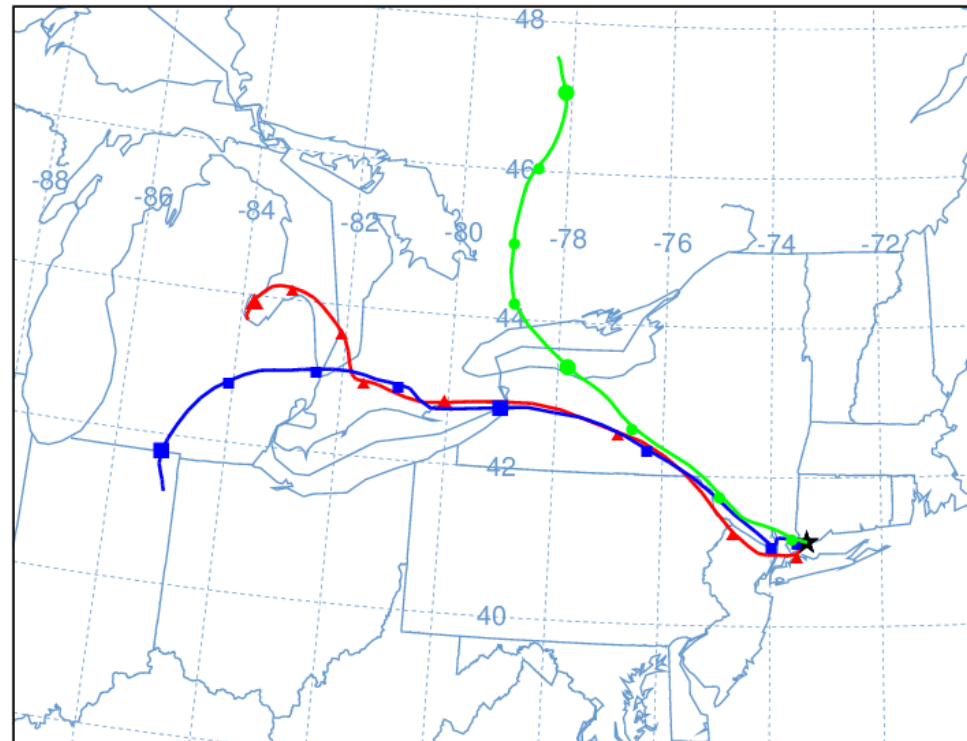


Job ID: 127465 Job Start: Mon Sep 11 19:27:30 UTC 2017  
Source 1 lat.: 41.131700 lon.: -73.340400 hgts: 100, 500, 1500 m AGL

Trajectory Direction: Backward Duration: 48 hrs  
Vertical Motion Calculation Method: Model Vertical Velocity  
Meteorology: 1800Z 24 May 2016 - HRRR

NOAA HYSPLIT MODEL

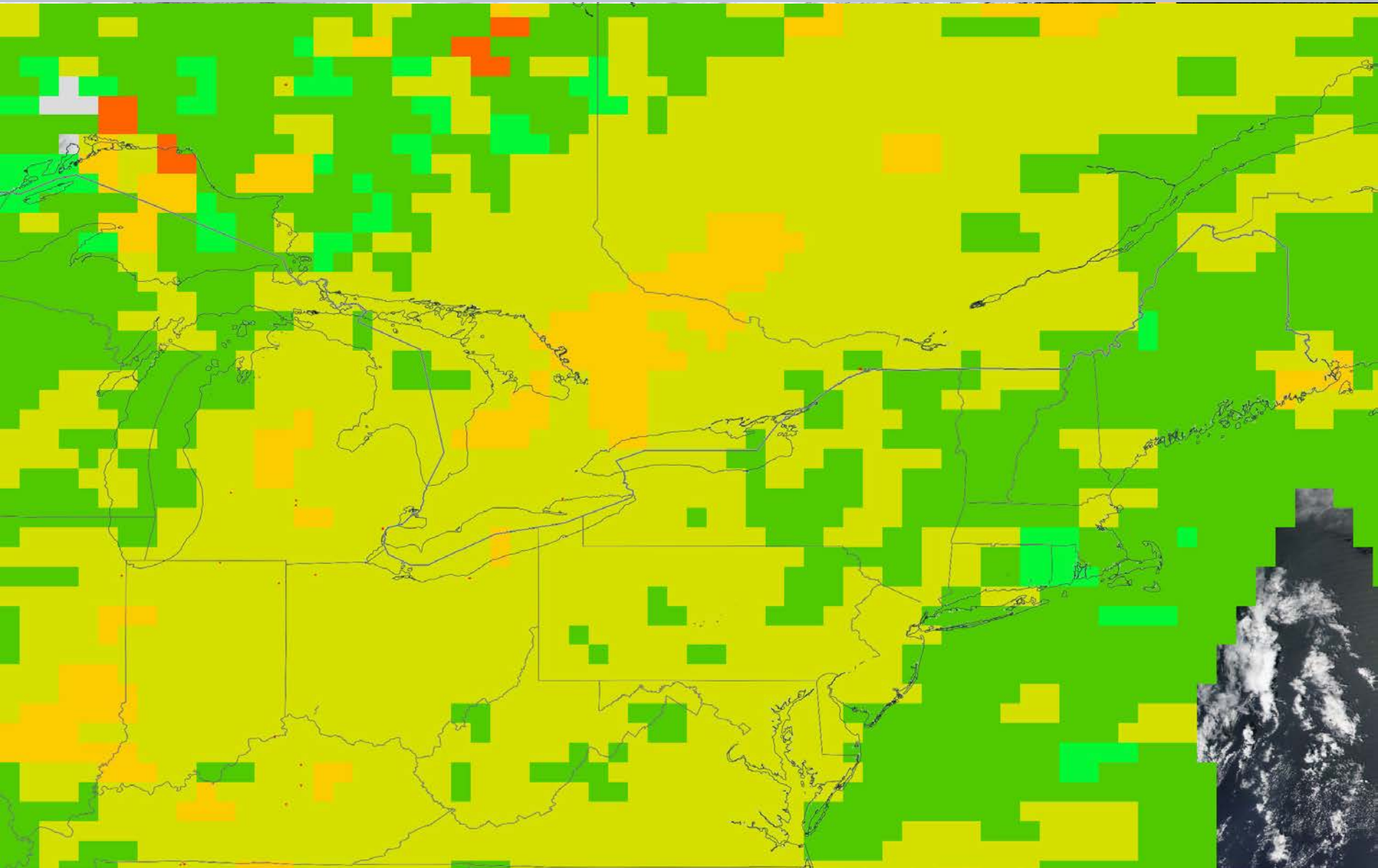
Backward trajectories ending at 1900 UTC 25 May 16  
HRRR Meteorological Data



Job ID: 127338 Job Start: Mon Sep 11 19:18:35 UTC 2017  
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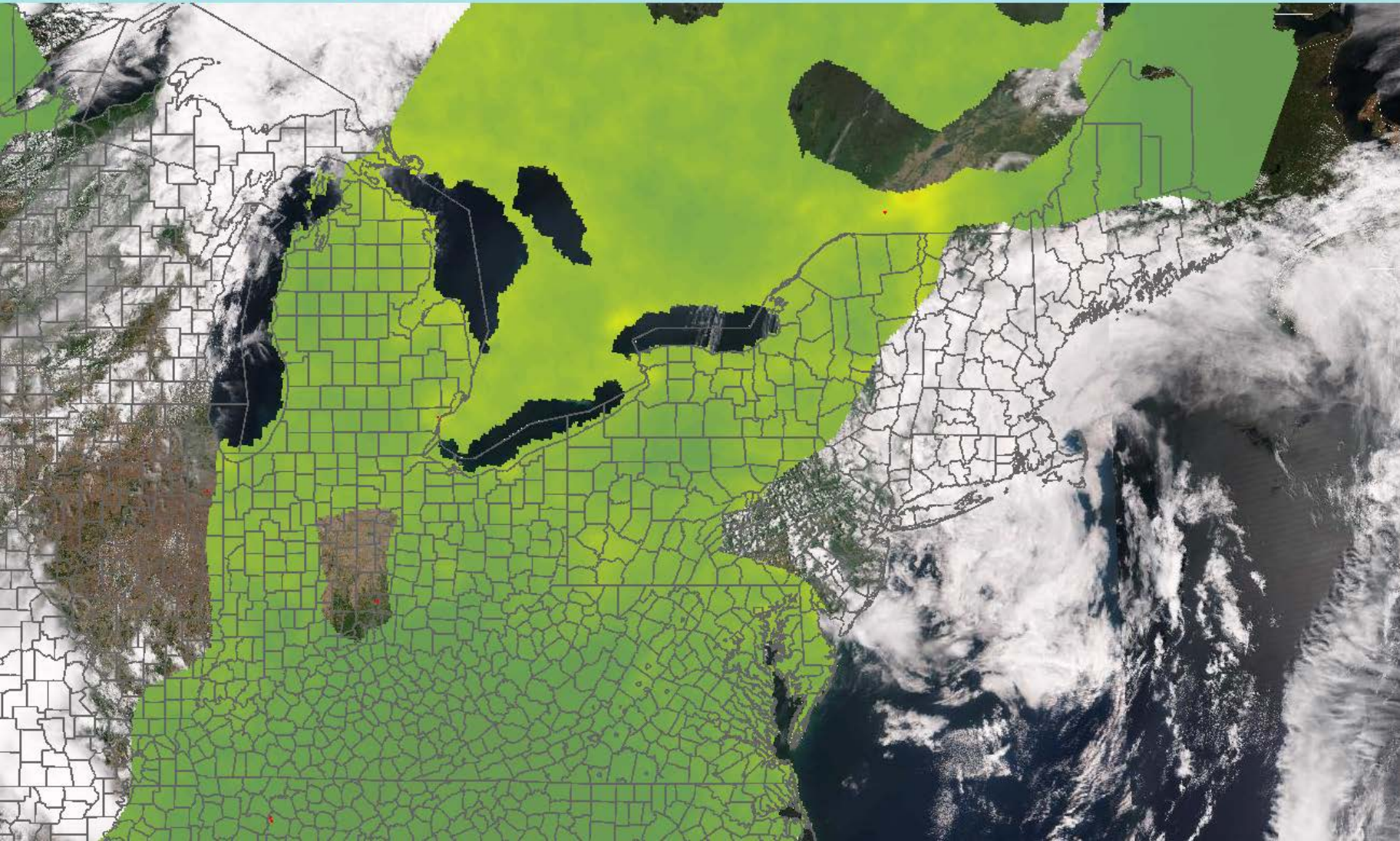
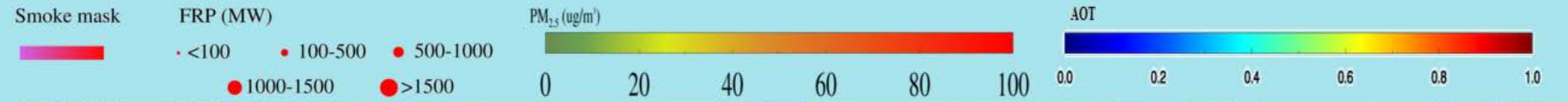
Trajectory Direction: Backward Duration: 48 hrs  
Vertical Motion Calculation Method: Model Vertical Velocity  
Meteorology: 1800Z 25 May 2016 - HRRR

# May 24, 2017 Visible, AOD and CO

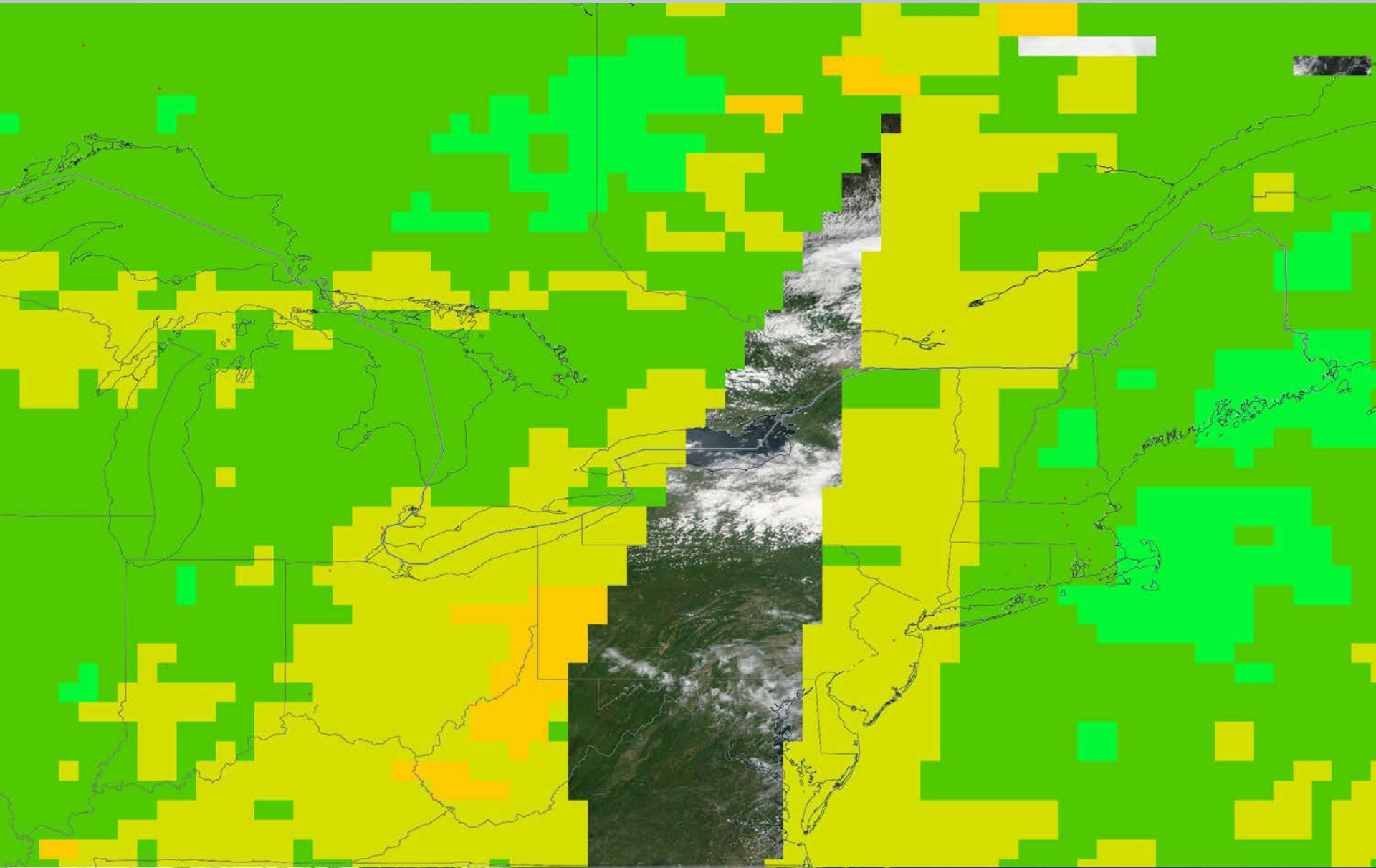


# May 24, 2017 Smoke, AOT and PM2.5

VIIRS RGB and Derived PM2.5 20160524



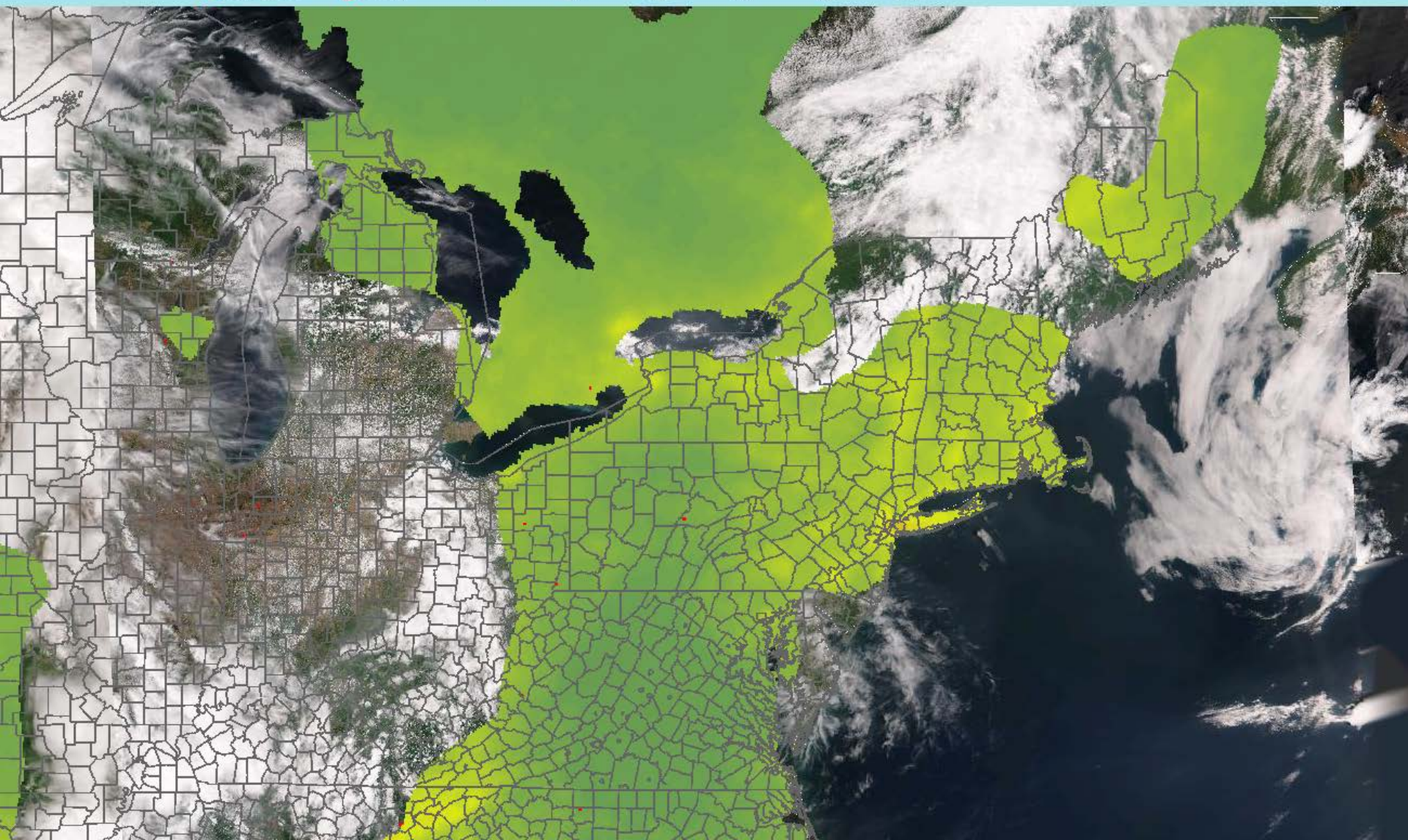
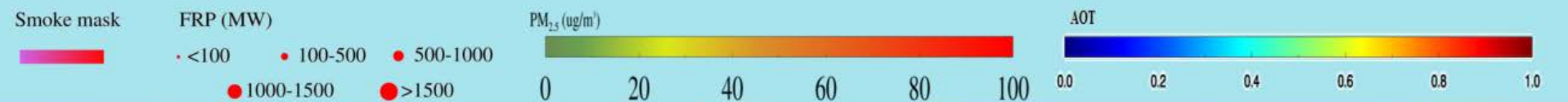
# May 25, 2017 Visible, AOD and CO



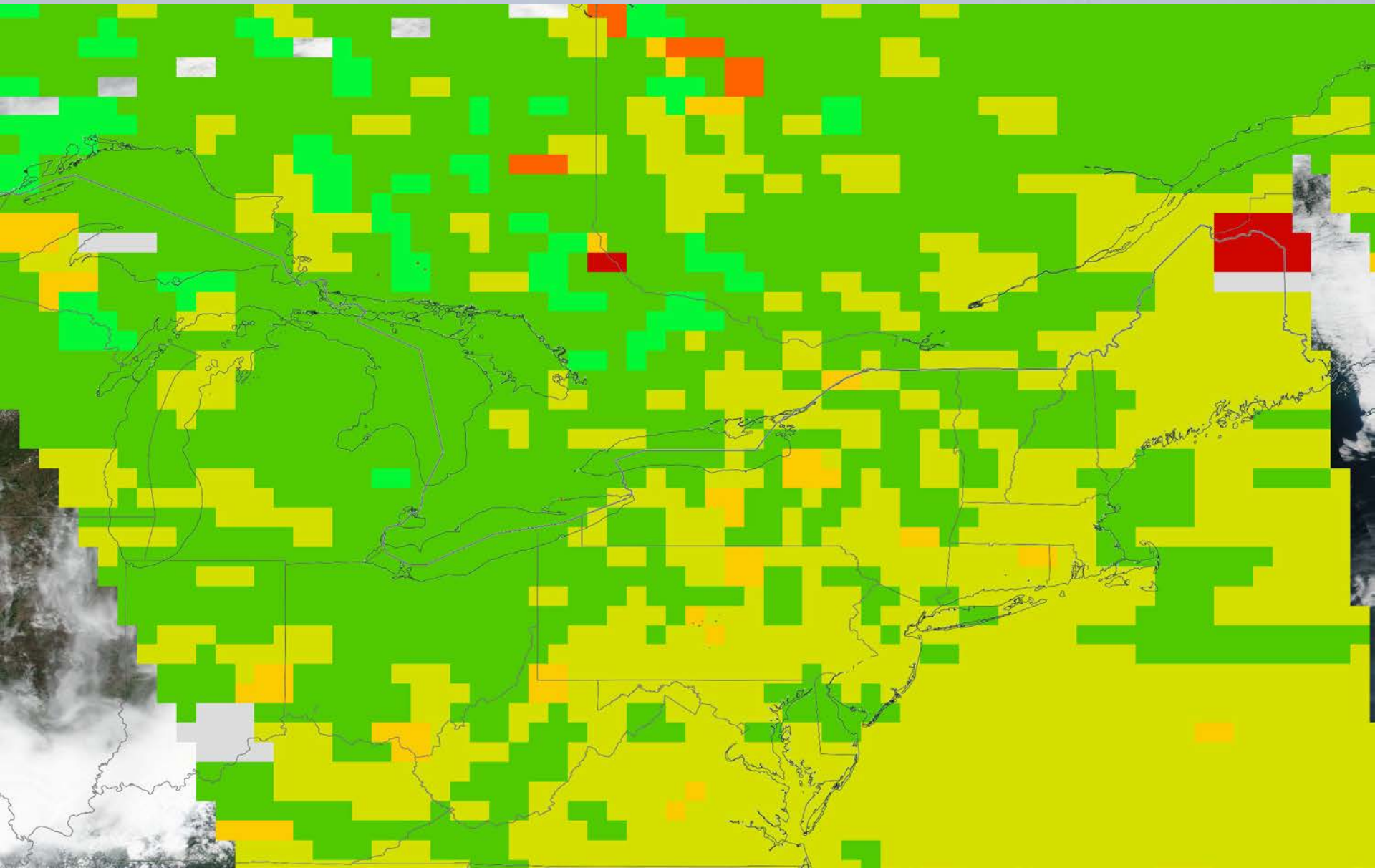


# May 25, 2017 Smoke, AOT and PM2.5

VIIRS RGB and Derived PM2.5 20160525

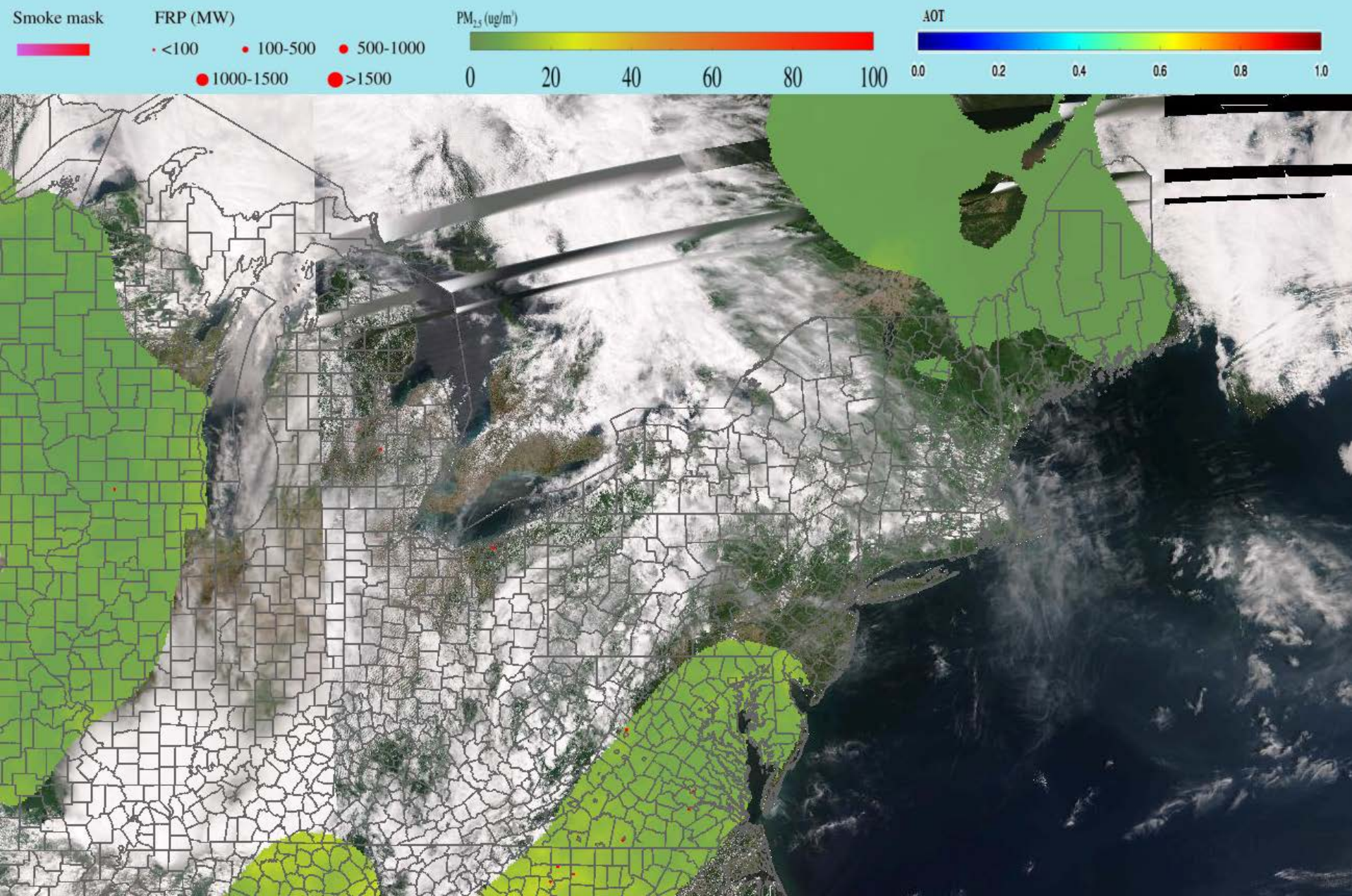


# May 26, 2017 Visible, AOD and CO

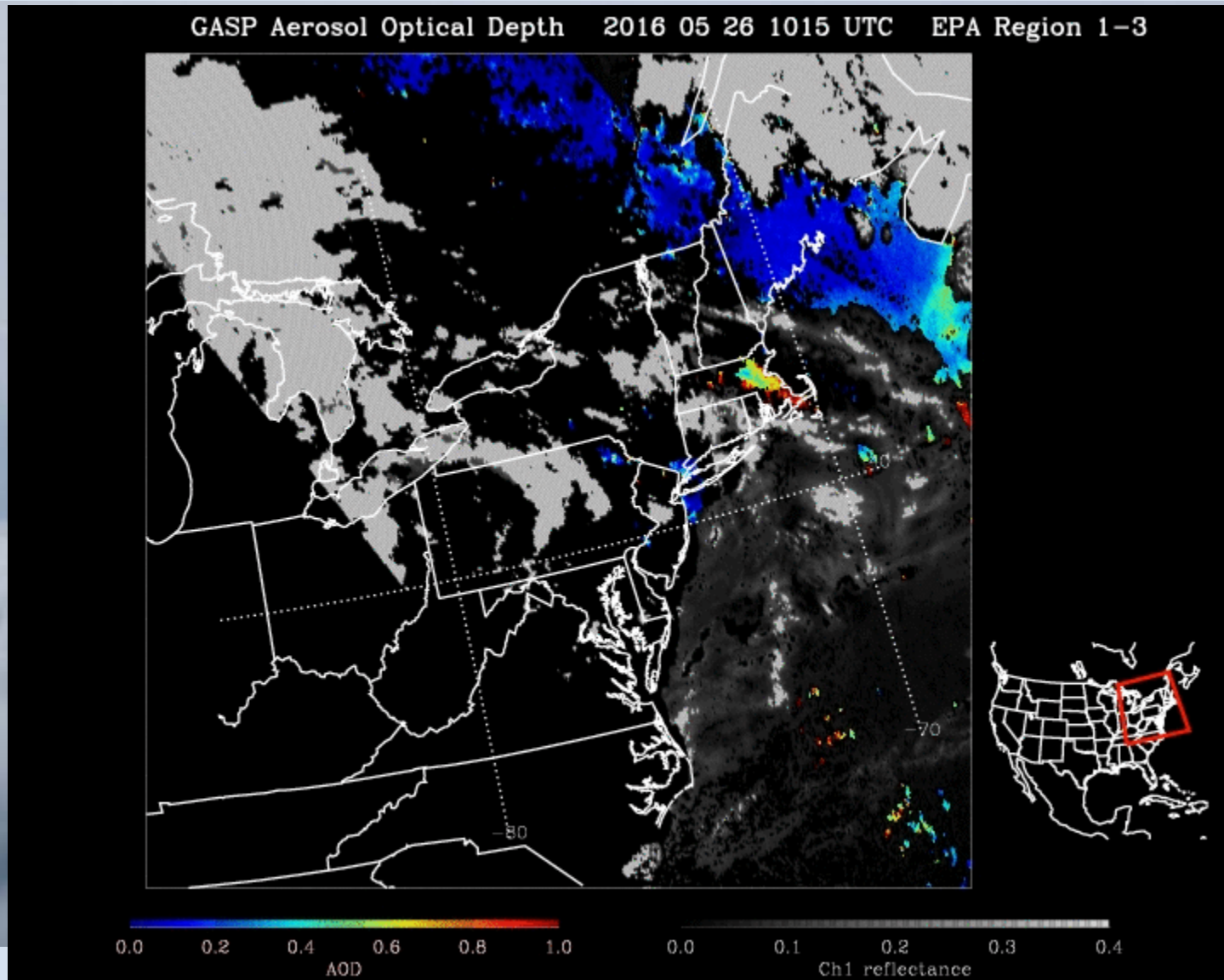


# May 26, 2017 Smoke, AOT and PM2.5

VIIRS RGB and Derived PM2.5 20160526



# GASP AOD Products

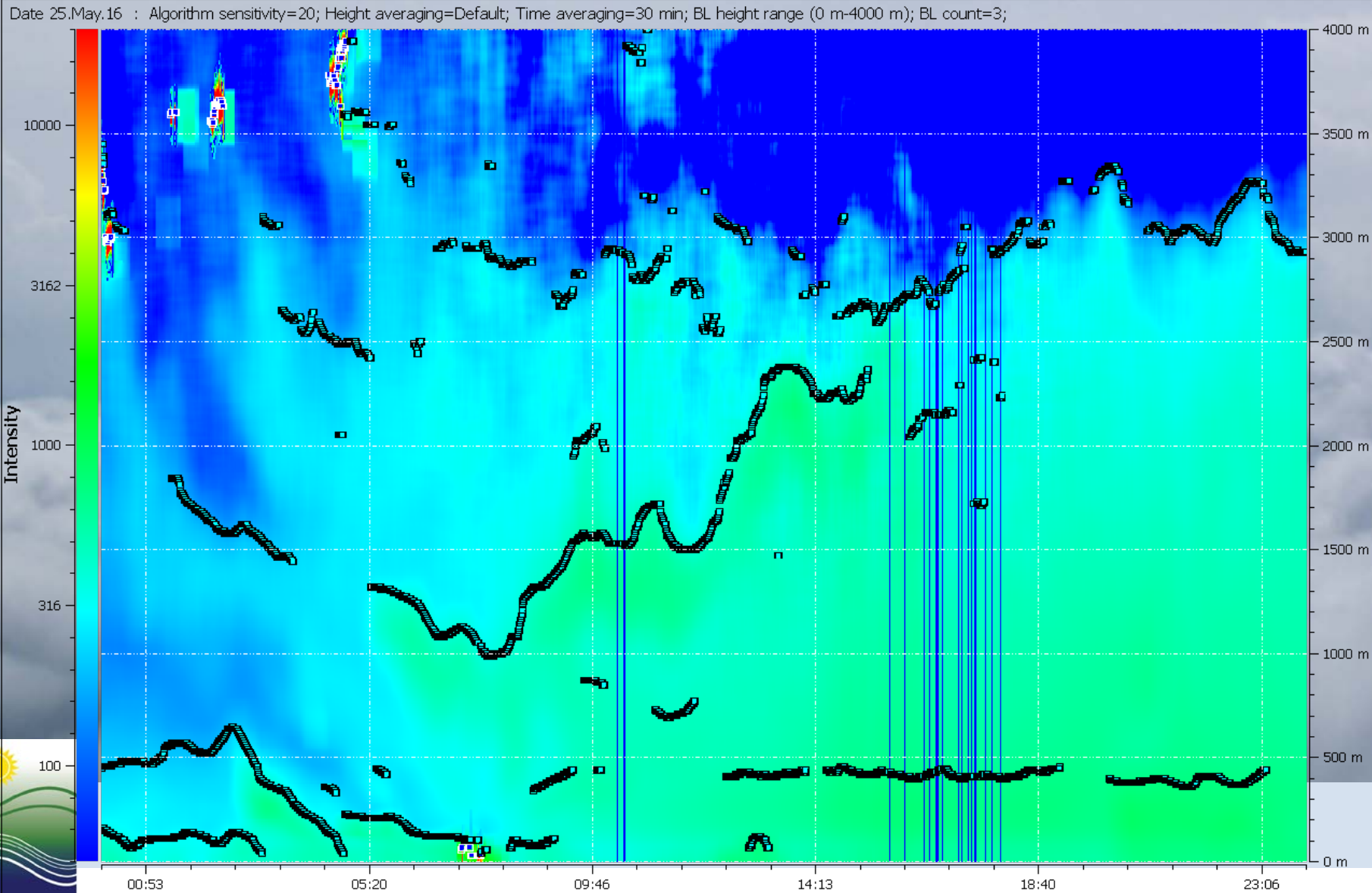


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# New Haven Ceilometer Back Scatter Aerosols

- Thick aerosol layer moves over New Haven after 6:00 am LST with mixing layer exceeding 3000 meters during the afternoon.



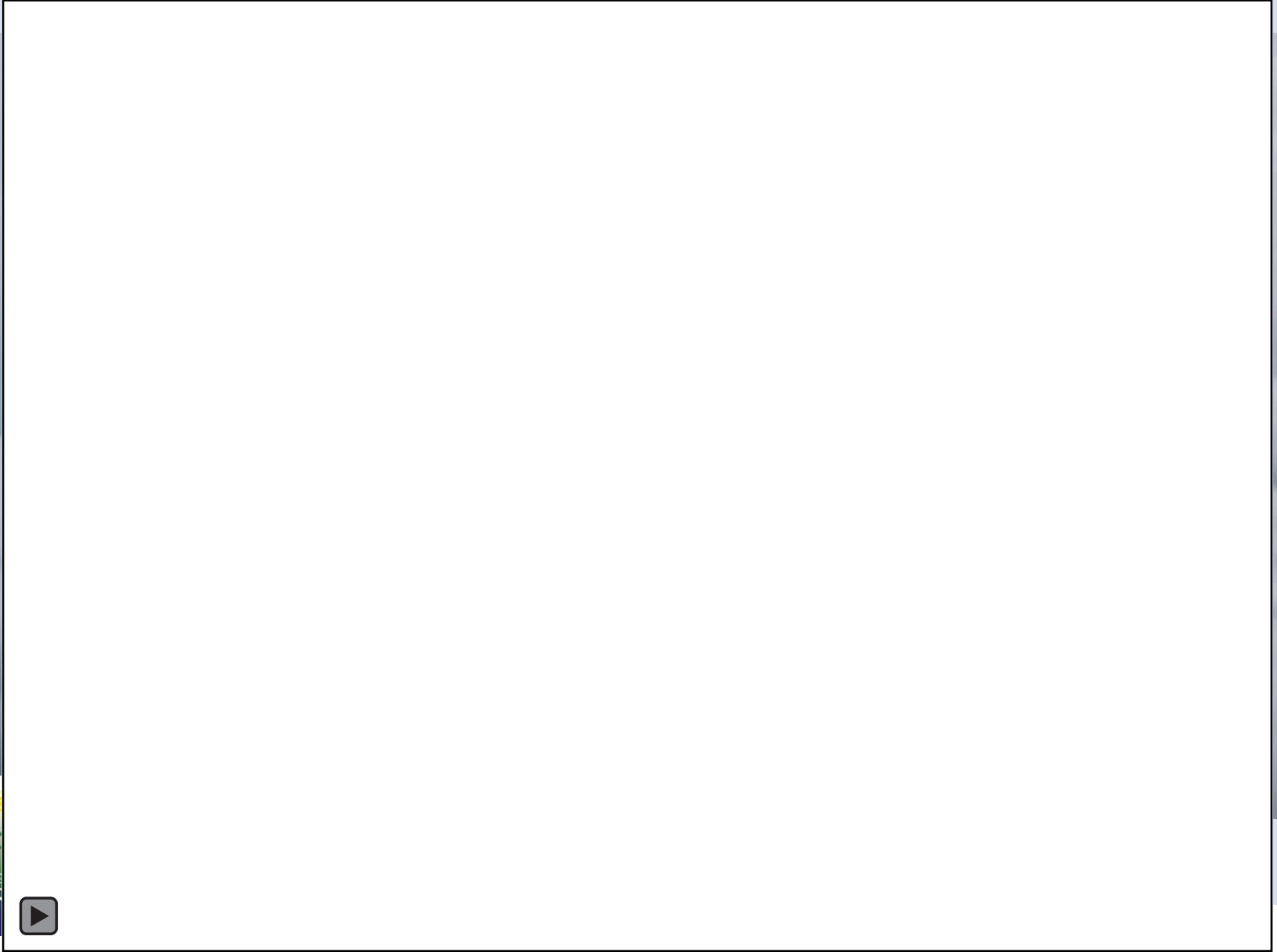
# Recent Western North American Fires

- Images from the VIIRS Satellite on September 4, 2017.

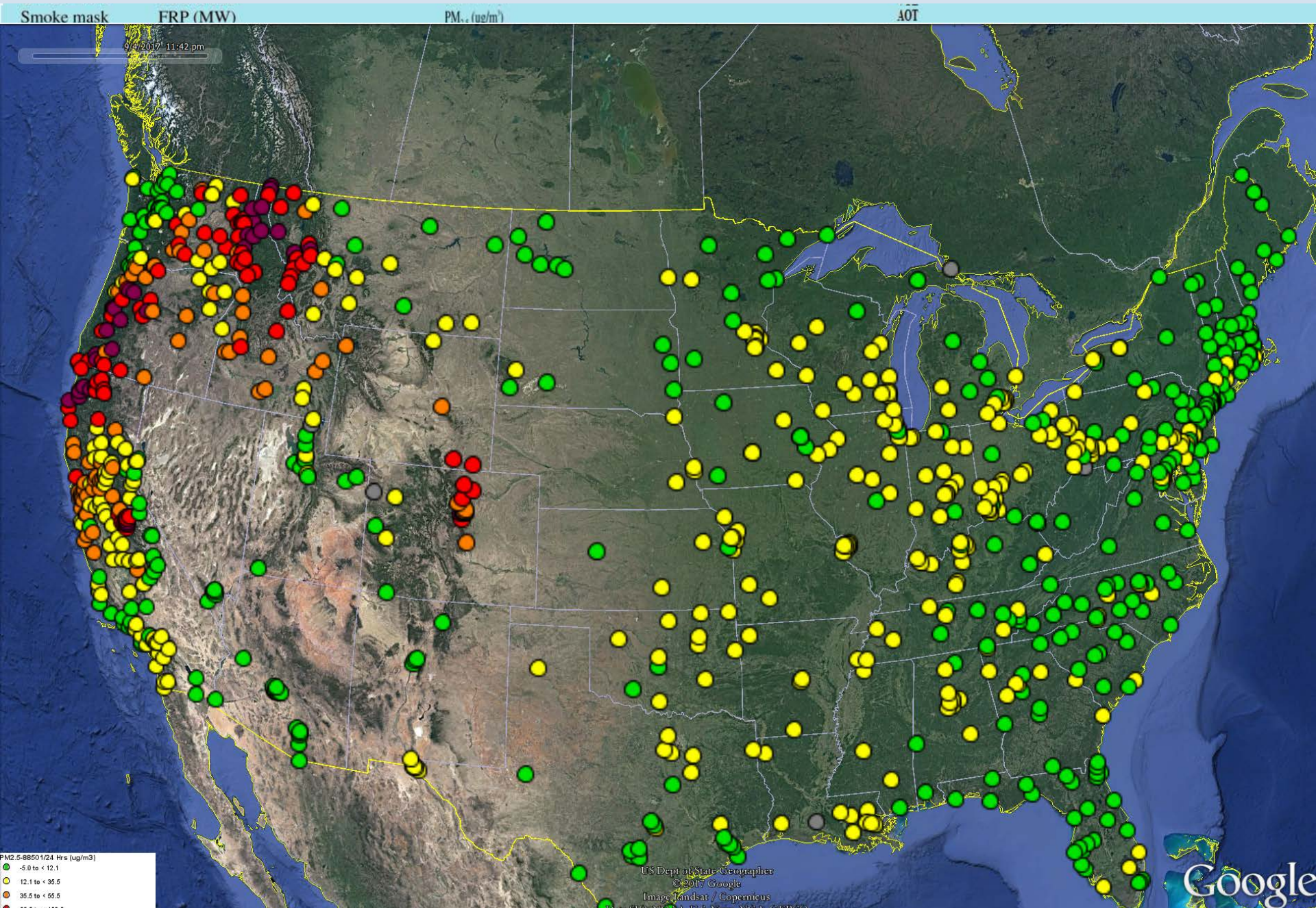


# Recent Western North American Fires

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



# Recent 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 was a valuable part of the exceptional events demonstration.

