Oakridge 2020 PM2.5 Exceptional Event EPA Concurrence Request

Submitted to: EPA, Region 10
By: Margaret Miller, Anthony Barnack, and Lance Giles
June 2021

Oregon DEQ
Air Quality Planning
700 NE Multnomah St.,
Suite #600
Portland, OR 97232
Phone: 503 229-5269
800 452-4011
Fax: 503 229-6762
www.oregon.gov/DEQ

DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

State of Oregon
Department of Environmental Quality

This report prepared by:

Oregon Department of Environmental Quality
700 NE Multnomah St., Suite #600
Portland, OR 97232
1-800-452-4011
www.oregon.gov/deq

Lane Regional Air Protection Agency
1010 Main St.
Springfield, Or 97477
1-541-736-1056
www.lrapa.org

Contact: Margaret Miller, AQ Planner
Margaret.miller@deq.state.or.us

Alternative formats (Braille, large type) of this document can be made available. Contact DEQ, Portland, at 503-229-5696, or toll-free in Oregon at 1-800-452-4011, ext. 5696.

Contents

EXECUTIVE SUMMARY **3**

Required Elements of the Exceptional Event Rule 5

INTRODUCTION **6**

1 CONCEPTUAL MODEL **6**

1.1 Overview 6
1.2 Transport Weather Conditions 7
Weather Trends 7
Historic Windstorm on September 7th and 8th 7
1.3 Source Area and Affected Region 10
1.3.1 Holiday Farm Fire *12*
1.3.2 Lionshead Fire *12*
1.3.3 Thielsen Fire *12*
1.3.4 Multiple Fires Smoke Event *12*
1.3.5 Methodology *13*
1.3.6 Oakridge Monitor Wildfire Smoke Impacted Days *14*

2 CLEAR CAUSAL RELATIONSHIP **19**

2.1 Meteorological data and time series 20
2.2 Satellite Data, Back Trajectories and Wind Roses 20
2.3 Alternative Source Hypotheses 20
2.3.1 Prescribed Burning *20*
2.3.2 Crop Residue & Agricultural Burning *20*
2.3.3 Residential Wood Combustion *20*
2.3.4 Outdoor Burning *21*
2.3.5 Vehicle Emissions *22*

3 COMPARISON TO HISTORICAL FLUCTUATIONS **22**

4 NOT REASONABLY CONTROLLABLE OR PREVENTABLE **24**

5 NATURAL EVENT OR HUMAN ACTIVITY UNLIKELY TO RECUR (NE/HAUR) **24**

6 MITIGATION **24**

7 INITIAL NOTIFICATION **27**

8 PUBLIC COMMENT **28**

9 SUMMARY **28**

APPENDIX A – HYSPLIT PROTOCOL **29**

APPENDIX B – WILDFIRE IMPACT FIGURES **32**

Tables

Table 1. Monitor values at Oakridge for which DEQ is requesting EPA concurrence 3
Table 2. Rank Percent of requested values, 2011-2020; June 1-Sept 30; Oakridge monitor 3
Table 3. Change in 3-year average of the 24-hour PM2.5 design value for 2020 4
Table 4. Changes in 3-year average of the 24-hour PM2.5 design value for 2020 4
Table 5. Summary of elements included in this demonstration. 5
Table 6.. Max and Min daily temperatures at Oakridge monitor on impacted days, 2020 21
Table 7. Statistics for 24-hr PM2.5 concentrations, June 1 – September 30, 2011 - 2020 22
Table 8. Wildfire response protocol: actions and agencies responsible. 25
Table 9. Exceptional Event Rule Procedure Requirements 27

Figures

Figure 1. Wildfire acres burned in Oregon, 2010-2020. 7
Figure 2. NW Average Temperatures 8
Figure 3. NW Mean Temperatures 9
Figure 4. NW Precipitation 9
Figure 5. NW Drought Map 10
Figure 6. Map of 2020 Oregon large wildfires. 11
Figure 7. September 10, 2020 - Western Oregon Wildfire Smoke Event 13
Figure 8. Time Series, 9/7/2020 14
Figure 9. Satellite Smoke and HYSPLIT Model Image, 9/7/2020 15
Figure 10. Time Series, 9/9/2020 16
Figure 11. Satellite Smoke and HYSPLIT Model Image, 9/9/2020 17
Figure 12. Time Series, 9/10/2020 18
Figure 13. Satellite Smoke and HYSPLIT Model Image, 9/10/2020 19
Figure 14. Historical Comparison of PM2.5 at Oakridge Monitor, All Concentrations 23
Figure 15. Historical Comparison of PM2.5 at Oakridge Monitor, Lower Concentrations 23
Figure 16. Time Series, 9/7/2020 32
Figure 17. Satellite Smoke and HYSPLIT Model Image, 9/7/2020 33
Figure 18. Time Series, 9/9/2020 34
Figure 19. Satellite Smoke and HYSPLIT Model Image, 9/9/2020 35
Figure 20. Time Series, 9/10/2020 36
Figure 21. Satellite Smoke and HYSPLIT Model Image, 9/10/2020 37
Figure 22. Time Series, 9/11/2020 38
Figure 23. Satellite Smoke and HYSPLIT Model Image, 9/11/2020 39
Figure 24. Time Series, 9/12/2020 40
Figure 25. Satellite Smoke and HYSPLIT Model Image, 9/12/2020 41
Figure 26. Time Series, 9/13/2020 42
Figure 27. Satellite Smoke and HYSPLIT Model Image, 9/13/2020 43
Figure 28. Time Series, 9/14/2020 44
Figure 29. Satellite Smoke and HYSPLIT Model Image, 9/14/2020 45
Figure 30. Time Series, 9/15/2020 46
Figure 31. Satellite Smoke and HYSPLIT Model Image, 9/15/2020 47
Figure 32. Time Series, 9/16/2020 48
Figure 33. Satellite Smoke and HYSPLIT Model Image, 9/16/2020 49
Figure 34. Time Series, 9/17/2020 50
Figure 35. Satellite Smoke and HYSPLIT Model Image, 9/17/2020 51
Figure 36. Time Series, 9/18/2020 52
Figure 37. Satellite Smoke and HYSPLIT Model Image, 9/18/2020 53

Executive Summary

To address high monitor values resulting from exceptional events not reasonably controllable or preventable, the U.S. Environmental Protection Agency promulgated the Exceptional Events Rule pursuant to Section 319 of the Clean Air Act. Major changes to the 2007 EER contained in the Code of Federal Regulations, Title 40, Parts 50 and 51 (40 CFR 50 and 51) were promulgated on October 3, 2016 (72 FR 13560) to clarify the scope of the rules, analyses, content, and organization for exceptional events demonstrations, and fire related definitions and demonstration components. The EER allows states to flag air quality data as exceptional and exclude those data from use in determining compliance with the National Ambient Air Quality Standards if EPA concurs with the state's demonstration that it satisfies the rule requirements.

Following the EER procedures, Oregon Department of Environmental Quality and Lane Regional Air Protection Agency flagged values at the Oakridge monitor and are requesting concurrence that certain flagged values are exceptional events. The PM2.5 flagged values close to or over 35 micrograms per cubic meter ($\mu g/m^3$) affect Oregon's compliance with the 24-hour limited maintenance plan criteria and NAAQS. ODEQ and LRAPA demonstrates in this report and requests EPA concurrence that these exceptional concentration values occurred as a result of wildfires, they were not reasonably controllable or preventable by the State of Oregon, not likely to reoccur, and they fully meet the EER criteria for excluding monitor values from the data used to determine compliance with NAAQS. At this point, we are only requesting concurrence for days that are of regulatory significance, and are providing information for days that may become regulatorily significant (RS) in the future.

Table 1 shows the key fires or fire complexes that are the likely major contributors to the event days in Oakridge associated with our request of EPA to concur with our findings. The 2020 wildfire season in Oregon was extensive and it is likely that other fires had an impact on the PM levels seen in Oakridge.

Table 1. Monitor values at Oakridge for which DEQ is requesting EPA concurrence

Date	24-hour average PM2.5 (µg/m3) EPA # 41-039-2013, POC 1	Most likely source
9/7/2020	43.0	Holiday Farm and Lionshead Fires
9/9/2020	189.5	Thielsen Fire
9/10/2020	173.0	Multiple Fires, Including Holiday Farm, and Thielsen Fires
9/11/2020	255.1	Multiple Fires, Including Holiday Farm, and Thielsen Fires
9/12/2020	576.6	Multiple Fires, Including Holiday Farm, and Thielsen Fires
9/13/2020	376.8	Multiple Fires, Including Holiday Farm, and Thielsen Fires
9/14/2020	280.5	Multiple Fires, Including Holiday Farm, and Thielsen Fires
9/15/2020	277.8	Multiple Fires, Including Holiday Farm, and Thielsen Fires
9/16/2020	209.3	Multiple Fires, Including Holiday Farm, and Thielsen Fires
9/17/2020	149.5	Multiple Fires, Including Holiday Farm, and Thielsen Fires
9/18/2020	39.7	Multiple Fires, Including Holiday Farm, and Thielsen Fires

In addition, Table 2 shows that the requested values are the highest values recorded at the respective monitors for summer days (June 1 to September 30) from 2011-2020. Exceptional events days from prior years that have been concurred by EPA were removed from the data set.

Table 2. Rank Percent of requested values, 2011-2020; June 1-Sept 30; Oakridge monitor

Monitor	Date	YR	FinePM	Flagged	Rank (N=450)	PCTL
OAK	9/12/2020	2020	576.6	RT	450	**100.0%**

OAK	9/13/2020	2020	376.8	RT	449	**99.8%**
OAK	9/14/2020	2020	280.5	RT	448	**99.6%**
OAK	9/15/2020	2020	277.8	RT	447	**99.3%**
OAK	9/11/2020	2020	255.1	RT	446	**99.1%**
OAK	9/16/2020	2020	209.3	RT	445	**98.9%**
OAK	9/9/2020	2020	189.5	IT	444	98.7%
OAK	9/10/2020	2020	173.0	IT	443	98.4%
OAK	9/17/2020	2020	149.5	IT	442	98.2%
OAK	8/21/2018	2018	62.0	IT	441	98.0%
OAK	9/7/2020	2020	43.0	IT	440	97.8%
OAK	9/18/2020	2020	39.7	IT	439	97.6%
OAK	8/20/2017	2017	33.3		438	97.3%
OAK	9/14/14	2014	32.2		437	97.1%
OAK	9/8/14	2014	31.1		436	96.9%
OAK	8/8/2017	2017	31.0		435	96.7%
OAK	8/15/2018	2018	27.5		434	96.4%
OAK	8/23/2017	2017	26.7		433	96.2%
OAK	7/4/2020	2020	26.0		432	96.0%
OAK	8/13/2015	2015	25.9		431	95.8%

An evaluation of the 3-year average of the 24-hour 98th percentile PM2.5 design value in 2020 for the Oakridge monitor, with and without the requested RS exceptional event days (see Table 3), shows that six days, 9/11/2020 through 9/16/2020, require removal from the dataset to lower the 3-year average design value to be equal to or below the 35 µg/m^3 standard (see Table 4).

Table 3. Change in 3-year average of the 24-hour PM2.5 design value for 2020

Year	2018	2019	2020
3-Year 98%-ile, all wildfire data included	30	35	87
3-Year 98%-ile, RS wildfire data removed	30	35	34

Table 4. Changes in 3-year average of the 24-hour PM2.5 design value for 2020

Monitor Reading Rank (highest to lowest)	24-hour average PM2.5 (µg/m^3)	Date	Data flag	Resulting 3-year average design value if daily value is removed from dataset (µg/m^3)	% of standard
342	576.6	9/12/2020	RT	81.0	131.4%
341	376.8	9/13/2020	RT	73.1	108.9%
340	280.5	9/14/2020	RT	37.6	7.4%
339	277.8	9/15/2020	RT	36.5	4.3%
338	255.1	9/11/2020	RT	36.1	3.1%
337	209.3	9/16/2020	RT	34.3*	-2.0%
336	189.5	9/9/2020	IT	34.0	-2.9%
335	173.0	9/10/2020	IT	33.9	-3.1%
334	149.5	9/17/2020	IT	32.9	-6.0%
333	43.0	9/7/2020	IT	32.6	-6.9%
332	39.7	9/18/2020	IT	32.1!	-8.3%

* Design value if 6 values removed

! Design value if all wildfire influenced values removed

Required Elements of the Exceptional Event Rule

The EER requires that demonstrations justifying data exclusion as exceptional event must include the following:

(a) A narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s);
(b) A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation;
(c) Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times to support the clear causal relationship requirement;
(d) A demonstration that the event was both not reasonably controllable and not reasonably preventable;
(e) A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event; and
(f) Documentation that the State followed the public comment process and conducted at least a 30-day comment period.

In addition, a state must submit the public comments with the demonstration and address in the demonstration those comments disputing or contradicting factual evidence provided in the demonstration (40 CFR 50.14).

We organized the demonstrations by sections that address each element of the EER (Table 5).

Table 5. Summary of elements included in this demonstration.

EER Element	Section	Summary
Conceptual Model	1	The conceptual model describes the affected area, meteorological conditions of the region, and the source causing the violation. It includes a discussion of how emissions from the wildfire event led to the violation at the Oakridge monitor.
Clear Causal Relationship	2	Data are presented to demonstrate that the event affected air quality and that there is a clear causal relationship between the event and the exceedances: (1) Meteorological evidence: transport of emissions to monitor (2) Satellite and back trajectory evidence: spatial relationship between source and monitor (3) Time series evidence: temporal description of event days (4) Alternative sources
Historical Concentrations	3	Analyses are provided comparing the event-influenced concentrations at Oakridge to historical concentrations.
Not Reasonably Controllable or Preventable	4	A wildfire event meets the EER for this element (40 CFR 50.14(b)(4))
Human Activity Unlikely to Recur at a Particular Location or a Natural Event	5	The criterion meets the EER definition that wildfires predominantly occurring on wildland are natural events.
Mitigation	6	Evidence presented of prompt public notification of the event, public education so that individuals could make behavioral changes to reduce exposure to unhealthy air, and implementation of appropriate measures to protect public health from the impacts of exceptional events.
Initial Notification	7	Demonstration of initial notification to EPA.
Public Comments	8	Documentation of the public comment process, public comments received and response to comments.

Introduction

The Oregon Department of Environmental Quality (ODEQ) and Lane Regional Air Protection Agency (LRAPA) request an exclusion of the wildfire measured exceedances of the 24-hour PM2.5 (fine particulate matter) National Ambient Air Quality Standards at Oakridge, Oregon for six days, 9/11/2020 through 9/16/2020. This demonstration provides evidence and narrative satisfying all the requirements set forth in the Exceptional Events Rule. The exceedances were the direct result of wildfire events that affected air quality at the Oakridge monitor.

The conceptual model describes the event and how the emissions from the events led to the exceedances on the monitor at AQS site# 410392013 on each day. It demonstrates that a clear causal relationship exists between the wildfire smoke events and the monitored exceedances. We compared the historical concentrations at the Oakridge monitor to the exceedance concentrations to support the clear causal relationship requirement. The wildfire event was both not reasonably controllable and not reasonably preventable, and it was a natural event. ODEQ and LRAPA provided prompt public notification of the event, provided for public education concerning actions that individuals may take to reduce exposures to unhealthy levels of air quality during the event, and provided for the implementation of appropriate measures to protect public health from the exceedances caused by the event. Public comments on the demonstration and ODEQ and LRAPA responses will be included in Section 8.

1 Conceptual Model

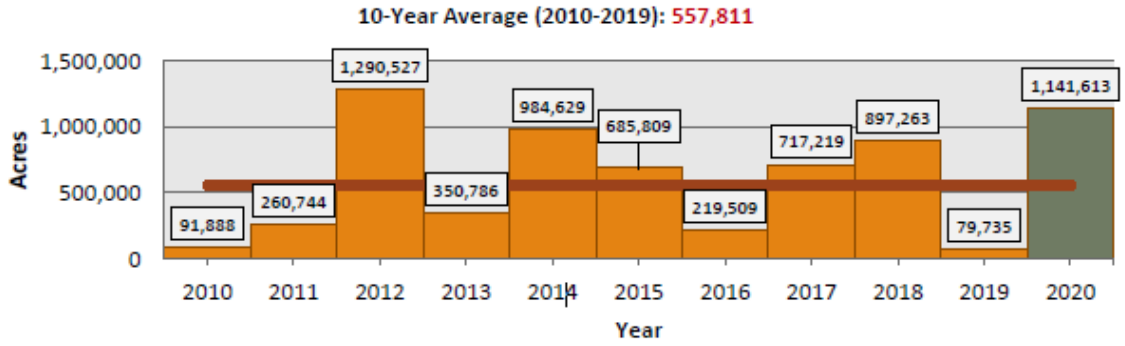
In September 2020, smoke from regional wildfires was transported to the Oakridge monitor. The Oakridge monitor recorded exceedances of the 24-hour PM2.5 NAAQS on 9/7/2020, 9/9/2020, and 9/10/2020 through 9/18/2020, for a total of 11 exceedances as a result of wildfire smoke. The conceptual model describes the source of the fine particulate matter that impacted the monitor, the transport weather conditions that brought aerosols to the monitor, the estimated emissions of the wildfire sources, and the timing and magnitude of the events impacts on the monitor.

1.1 Overview

Wildfires occur every year in the western United States during summer and fall. The 2020 wildfire season was, like most years, hot, dry, and smoky. Over 1.98 million acres burned in Oregon, Washington, and Idaho during the 2020 wildfire seaason. Oregon alone saw over 1.14 million acres burn.[1] From September 7th through the 18th, smoke from many of these fires was trapped in a multiday stagnation event. Smoke accumulated during that 12-day period and negatively affected the air quality throughout the northwestern United States. In addition, the larger wildfires that burned in 2020 were closer to human habitation than in previous years.

1 [1] Northwest Interagency Coordination Center. April 9, 2020. Northwest Annual Fire Report 2020. Portland, OR. https://gacc.nifc.gov/nwcc/content/pdfs/archives/2020_NWCC_Annual_Fire_Report.pdf (Accessed April 2020).

Figure 1. Wildfire acres burned in Oregon, 2010-2020.



1.2 Transport Weather Conditions

According to the 2020 Northwest Annual Fire Report,[2] Despite cool and wet periods early in fire season 2020, persistent warmth and very low rainfall in the second half of the summer boosted fire danger sufficiently to make many areas more susceptible to fires by late August and early September. While lightning was much less than average during fire season 2020, a few lightning-caused large fires helped set the stage for the fire outbreak that was caused by a historic windstorm in early September.

Weather Trends

The very dry trend observed in July and August 2020 across the region continued for the first half of September. Daily values of minimum relative humidity and corresponding overnight recoveries maintained a worsening trend from late August through mid-September, falling steadily below average.

Historic Windstorm on September 7th and 8th

On September 7th and 8th, a strong dry cold front moving south from Canada pushed across the NW geographic area bringing record breaking strong winds and low relative humidity to much of the region. As winds calmed behind the front, smoke from multiple large fires settled into western Oregon and Washington creating unhealthy air quality and poor visibility that spread over the next ten days and covered regions on both sides of the Cascades.

Strong winds diminished in the aftermath of the cold front, but the dry air and heavy smoke lingered until several Pacific frontal systems brought rain on September 18th, and again on the 24th. It was concentrated mainly in western Washington and most of northwest Oregon, where rainfall totals went well above normal for the month. However, eastern Washington, eastern Oregon, and southwest Oregon did not accumulate as much precipitation and rainfall totals remained below average for the month.

Air quality improved considerably with the arrival of the Pacific frontal systems. Despite the arrival of cold fronts, temperatures were above normal for September over the entire Northwest Geographic Area.

[2] Northwest Interagency Coordination Center. April 9, 2020. Northwest Annual Fire Report 2020. Portland, OR. https://gacc.nifc.gov/nwcc/content/pdfs/archives/2020_NWCC_Annual_Fire_Report.pdf (Accessed April 2020).

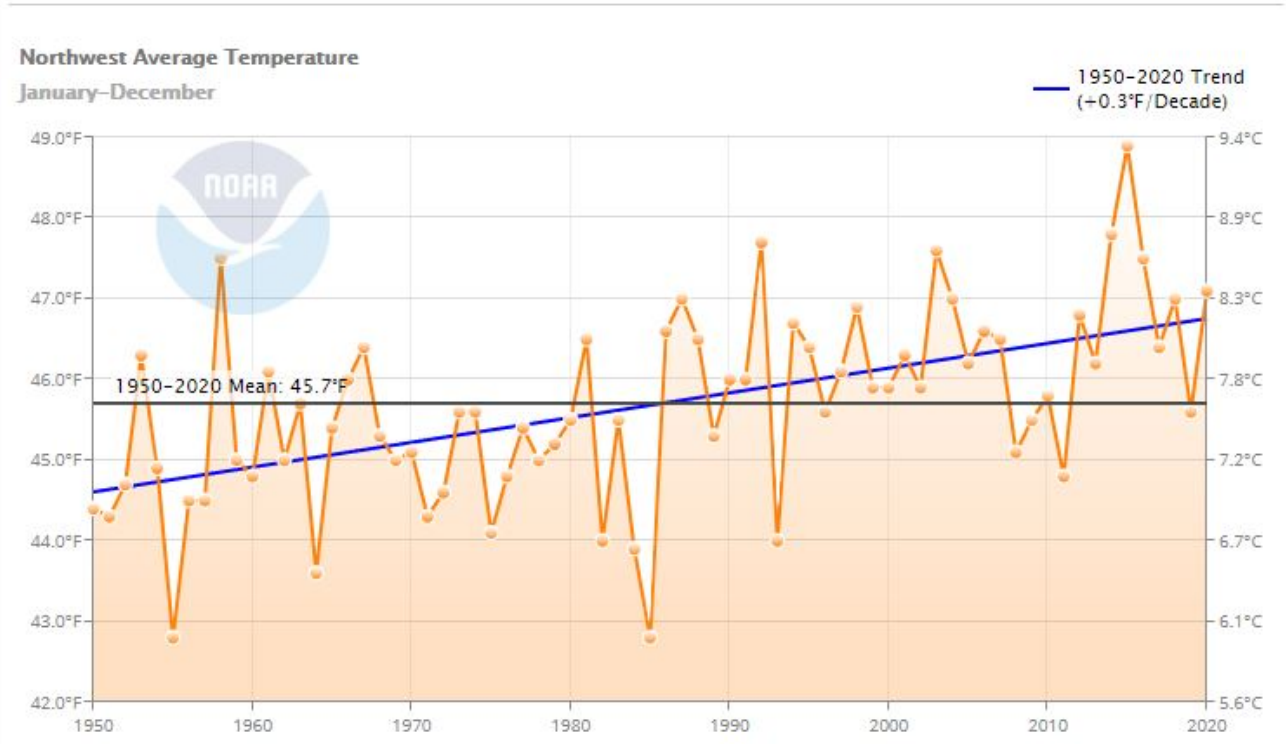
September Fire Activity

The Northwest Geographic Area was already busy at Preparedness Level 4 in early September 2020 with a dozen large incidents receiving support, in both Oregon and Washington. On September 7th and 8th, a dry cold front swept in from Canada with strong winds that accelerated the already busy fire activity in the Northwest. Eastern Washington and the Cascades of western and southern Oregon saw the greatest impacts from this cold front.

The resulting fast-moving firestorms in timber, brush, and grasses burned over 1.76 million acres on new and existing large fires across the geographic area from September 7th through 13th, during and shortly after the wind event. The event proved to be an unprecedented disaster for communities and there was significant resource loss in and near the Oregon Cascades.

Fire activity was well above average for the region for September both in terms of numbers of fires and acreage burned; 90% of acres burned in the geographic area in 2020 occurred during September. [3] Temperatures in the Northwest during the 2020 wildfire season were significantly higher than normal (Figures 2 and 3). PNW average precipitation (figure 4 and 5) was lower than average.

Figure 2. NW Average Temperatures



[3] Northwest Interagency Coordination Center. April 9, 2020. Northwest Annual Fire Report 2020. Portland, OR. https://gacc.nifc.gov/nwcc/content/pdfs/archives/2020_NWCC_Annual_Fire_Report.pdf (Accessed April 2020).

Figure 3. NW Mean Temperatures

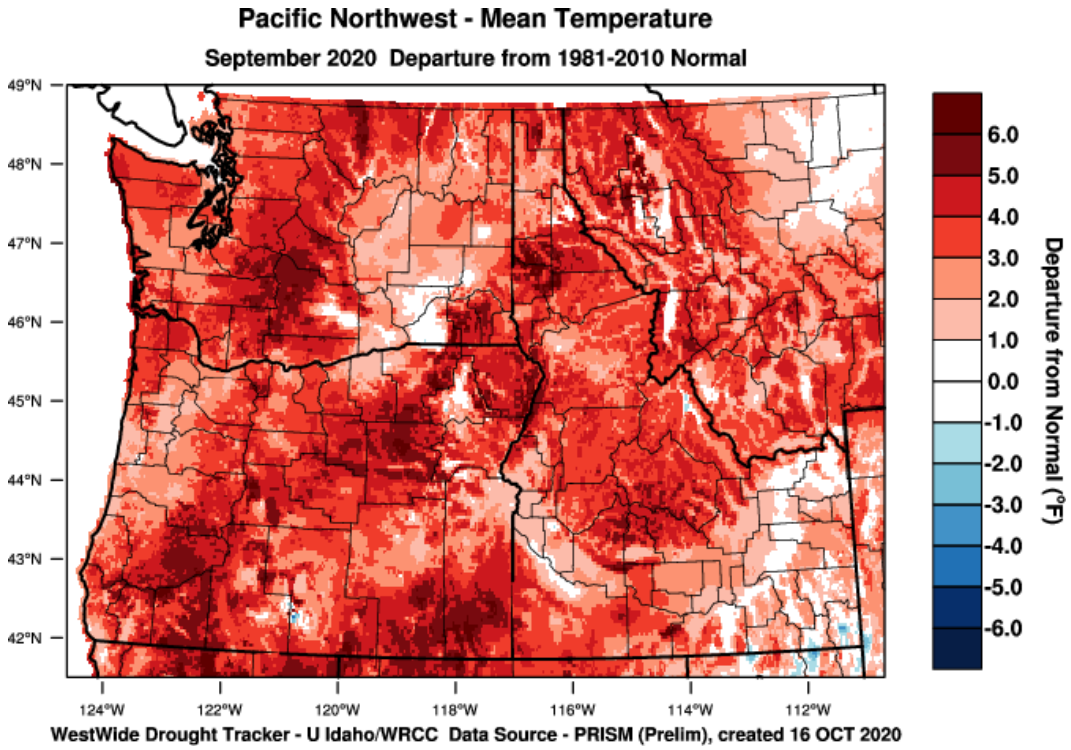


Figure 4. NW Precipitation

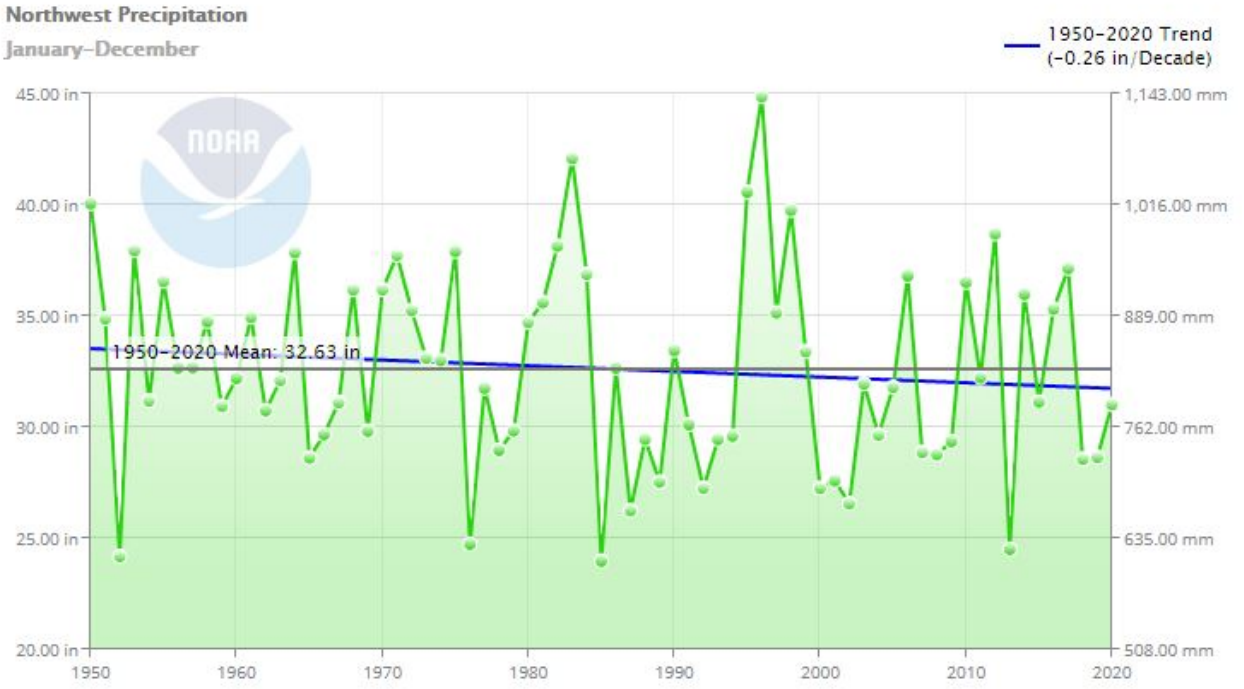
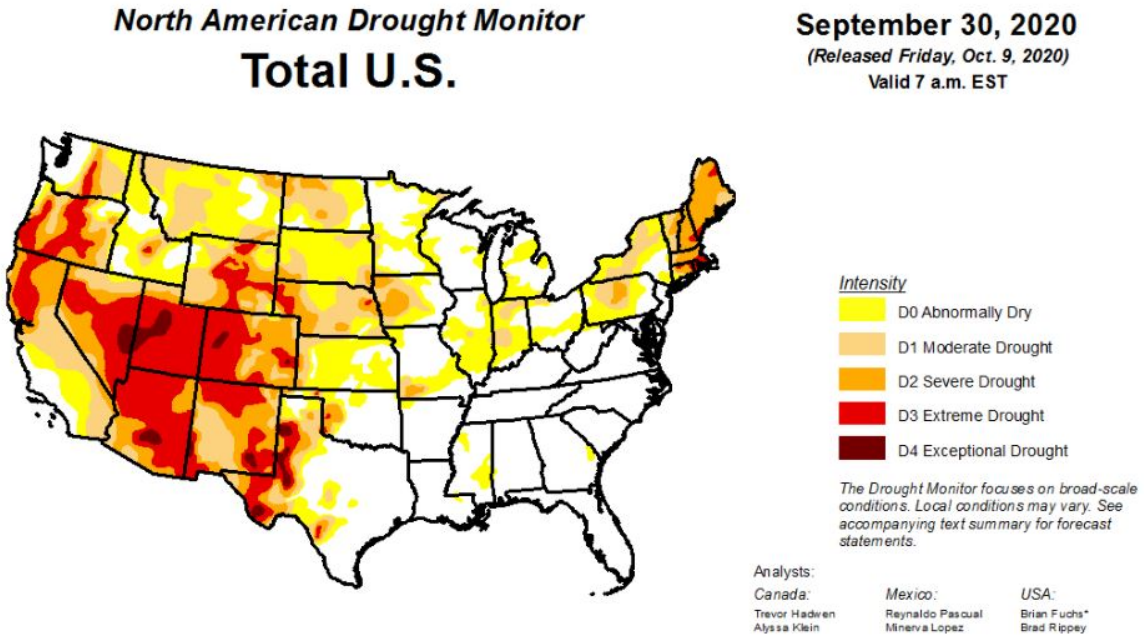


Figure 5. NW Drought Map



1.3 Source Area and Affected Region

Oakridge

The Oakridge community in Lane County, Oregon, has steadily improved air quality over the past 25+ years. Oakridge is a forest-oriented community (population 3,240[4]) in a valley of the Middle Fork Willamette River in the foothills of the Cascade Mountains about 45 miles southeast of Eugene-Springfield. Many of the homes are heated by wood as the primary or secondary heat source, or even sole source in some cases. As a result, the major contributor to the historical particulate air pollution has been home wood heating, especially on stagnant winter days when temperature inversions form over the small valley.

The Lane Regional Air Protection Agency has been monitoring in Oakridge for inhalable particulate matter (PM10 – particles 10 microns and smaller) since 1988 and for respirable particulate matter (PM2.5 – particles 2.5 microns and smaller) since 1999. The U.S. Environmental Protection Agency designated Oakridge as a moderate PM10 nonattainment area in 1994. The City of Oakridge, LRAPA, and the Oregon Environmental Quality Commission adopted the Oakridge PM10 attainment strategy in 1996 and submitted to EPA as part of the State Implementation Plan. EPA approved the plan in 1999. The Oakridge PM10 strategy focused primarily on control of residential wood combustion. The attainment strategy was successful in achieving the PM10 standards in Oakridge on schedule. In 2001, EPA published a finding of attainment for the Oakridge PM10 area.

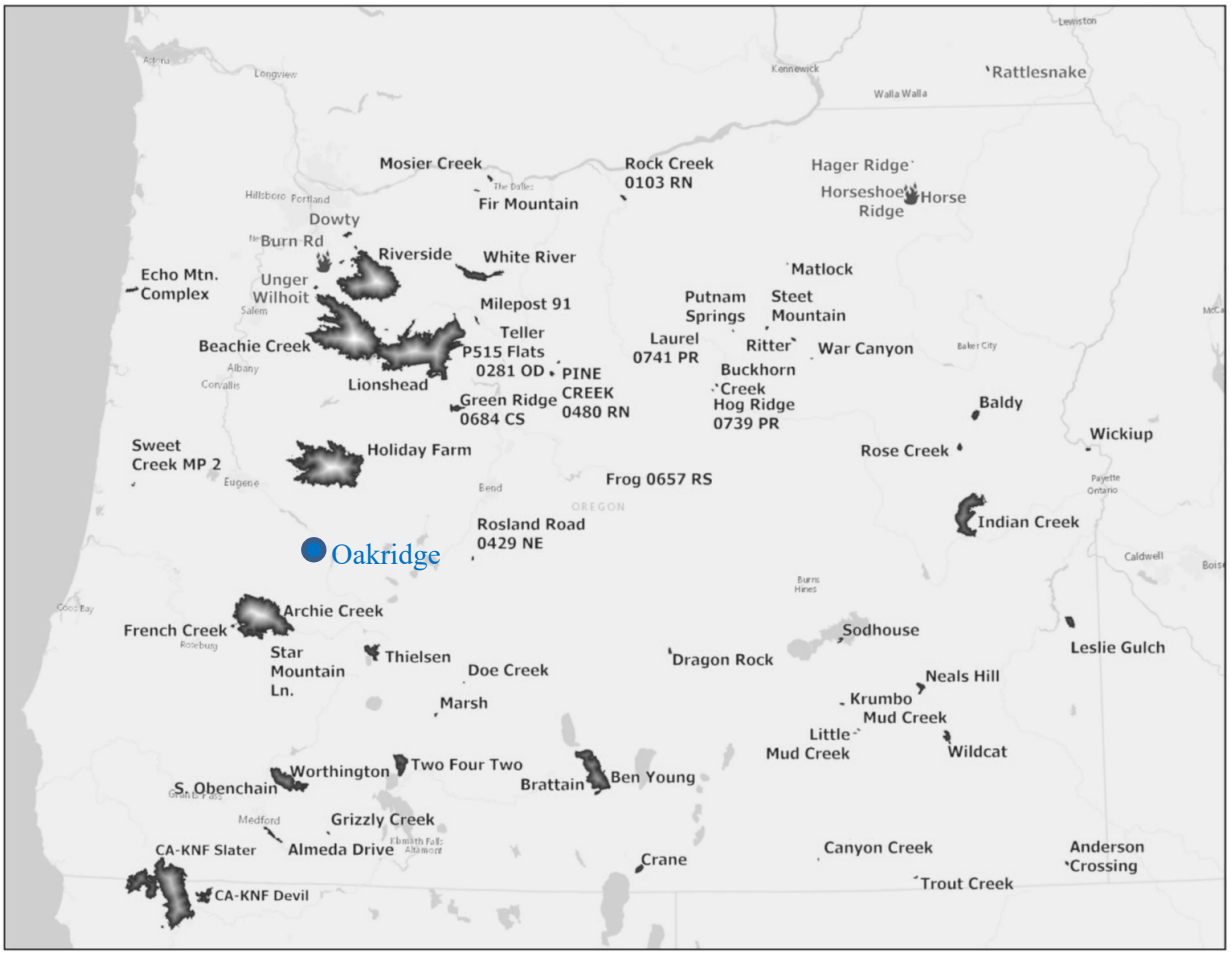
The 1996 Oakridge PM10 attainment plan was successful in not only meeting the PM10 standards on schedule, but also meeting the initial national PM2.5 standard of 65 micrograms per cubic meter (µg/m3) adopted by EPA in 1997. EPA adopted a more protective 24-hour national PM2.5 health standard of 35 µg/m3 in 2006, and Oakridge was identified as a PM2.5 nonattainment area by Oregon and EPA in 2009. LRAPA, the City of Oakridge, and other community stakeholders developed a

[4] *"Population and Housing Unit Estimates". United States Census Bureau. May 24, 2020. Retrieved May 27, 2020.*

comprehensive Oakridge PM2.5 attainment plan in 2012, and then adopted additional control strategies in the Updated Oakridge PM2.5 2016 Attainment Plan ("Plan"). The LRAPA Board of Directors adopted the Plan in November 2016 and Oregon EQC adopted it in January 2017. Implementation of the Plan resulted in attainment of the 35 µg/m3 PM2.5 health standard in 2014-2016. EPA approved the Plan and made a finding of attainment for the Oakridge PM2.5 area in February 2018.

In 2020, wildfire smoke events in Oakridge started on 9/7/2020 with smoke from the Holiday Farm fire and on 9/9/2020 with smoke from the Thielson Fire. From 9/10/2020 through 9/18/2020 the smoke from multiple fires mixed and settled over the western parts of Oregon, including the Willamette Valley and Oakridge. Following is a map of Oregon wildfires for the 2020 season (Figure 6).

Figure 6. Map of 2020 Oregon large wildfires.[5]



[5] Northwest Interagency Coordination Center. April 9, 2020. Northwest Annual Fire Report 2020. Portland, OR. https://gacc.nifc.gov/nwcc/content/pdfs/archives/2020_NWCC_Annual_Fire_Report.pdf (Accessed April 2020). P. 34.

1.3.1 Holiday Farm Fire

The Holiday Farm Fire began on September 7, 2020 at approximately 7:45 p.m. during a strong east wind event that passed through the area. The fire started approximately 3 miles west of McKenzie Bridge, OR. Pushed westward by strong winds, the fire moved through the communities of Blue River, Finn Rock, Nimrod, Vida and Leaburg, damaging and destroying homes, businesses and facilities in its path. The fire (as of 10/12/2020) encompassed 173,439 acres primarily in a mixed conifer forest. The fire burned a mosaic pattern through most of the area, and the majority burned with low and moderate severity.[6]

1.3.2 Lionshead Fire

Lightning sparked the Lionshead Fire on August 16, 2020 at 10:45 pm in Lionshead Canyon on the Confederated Tribes of Warm Springs Reservation approximately 14 miles west of the Warm Springs community. An historic windstorm on Monday, September 7, caused rapid fire spread west onto the Willamette, Deschutes, and Mt. Hood National Forests. The fire (as of 10/10/2020) encompassed 204,469 acres.[7]

1.3.3 Thielsen Fire

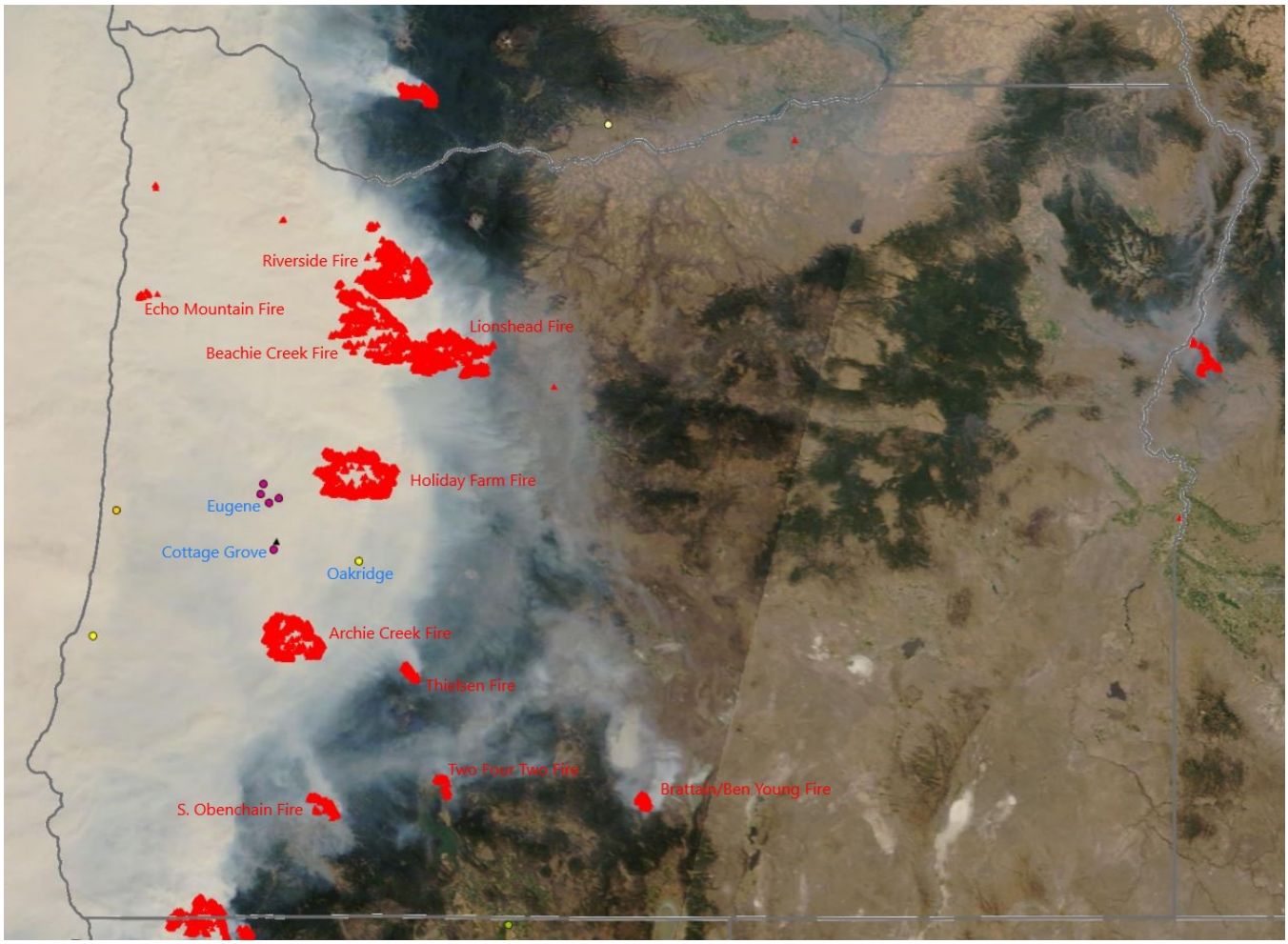
The Thielsen Fire was detected on September 8, 2020 at approximately 8:30 a.m. after lightning passed through the area. The fire was on the Diamond Ranger District of the Umpqua National Forest, approximately 5 miles north of Crater Lake National Park. It burned within one mile of the Diamond Lake Resort, along both sides of Oregon Highway 138, and a small portion of the Mount Thielsen Wilderness. The fire (as of 10/6/2020) encompassed 9,951 acres primarily in a mixed conifer forest. The fire burned a mosaic pattern through most of the area, and the majority burned with low and moderate severity.[8]

1.3.4 Multiple Fires Smoke Event

Starting on 9/10/2020 and continuing through 9/18/2020, smoke from the Holiday Farm, Lionshead, and Thielsen fires, combined with multiple other fires in Oregon (see Figure 7) to inundate the western half of the state, including the Oakridge area, with wildfire smoke. Smoke from the fires caused air quality levels in the region to climb to hazardous levels, at points going beyond the limits of the AQI scale and well above the NAAQS.

[6] 2020 – Burned Area Emergency Response Summary – Holiday Farm Fire, http://inciweb.nwcg.gov/photos/ORUPF/2020-09-27-1710-Western-Oregon-USFS-BAER/related_files/pict20201002-102952-0.pdf
[7] 2020 – Burned Area Emergency Response Summary – Lionshead Fire, http://inciweb.nwcg.gov/photos/ORUPF/2020-09-27-1710-Western-Oregon-USFS-BAER/related_files/pict20200923-142722-0.pdf
[8] 2020 – Burned Area Emergency Response Summary – Thielsen Fire, http://inciweb.nwcg.gov/photos/ORUPF/2020-09-27-1710-Western-Oregon-USFS-BAER/related_files/pict20200923-143740-0.pdf

Figure 7. September 10, 2020 - Western Oregon Wildfire Smoke Event



1.3.5 Methodology

Wind speed, wind direction and hourly PM2.5 readings were taken from monitors and plotted against the time of day for the previous evening and 24 hour period of the impacted day.

Satellite smoke images from MODIS Terra and MODIS Aqua satellites were examined for the day of the impacted monitor reading, for the central Oregon region. These satellites tend to pass over the area that covers Oakridge from 10 am to 1 pm of each day.

HYSPLIT back trajectories were calculated in AirNow-Tech, using the PM2.5-88502 parameter and 1-hour duration. The date and time was set to the time of day where the monitor reading was at its peak. Heights were set at 500 m, 1000 m, and 1500 m to capture near ground and higher altitude wind transport, and the model was usually run for 8-12 hour. See Appendix A for more details.

1.3.6 Oakridge Monitor Wildfire Smoke Impacted Days

9/7/2020

PM2.5 levels remained fairly low in the early morning of 9/7/2021 (< 20 µg/m3), but increased dramatically once the wind direction shifted in the late evening, pushing smoke from the Holiday Farm and Lionshead fires, north and northeast of Oakridge, into town. This is shown by HYPSLIT back trajectory model results for 9/7/2021. Peak PM2.5 levels were > 100 µg/m3.

Figure 8. Time Series, 9/7/2020

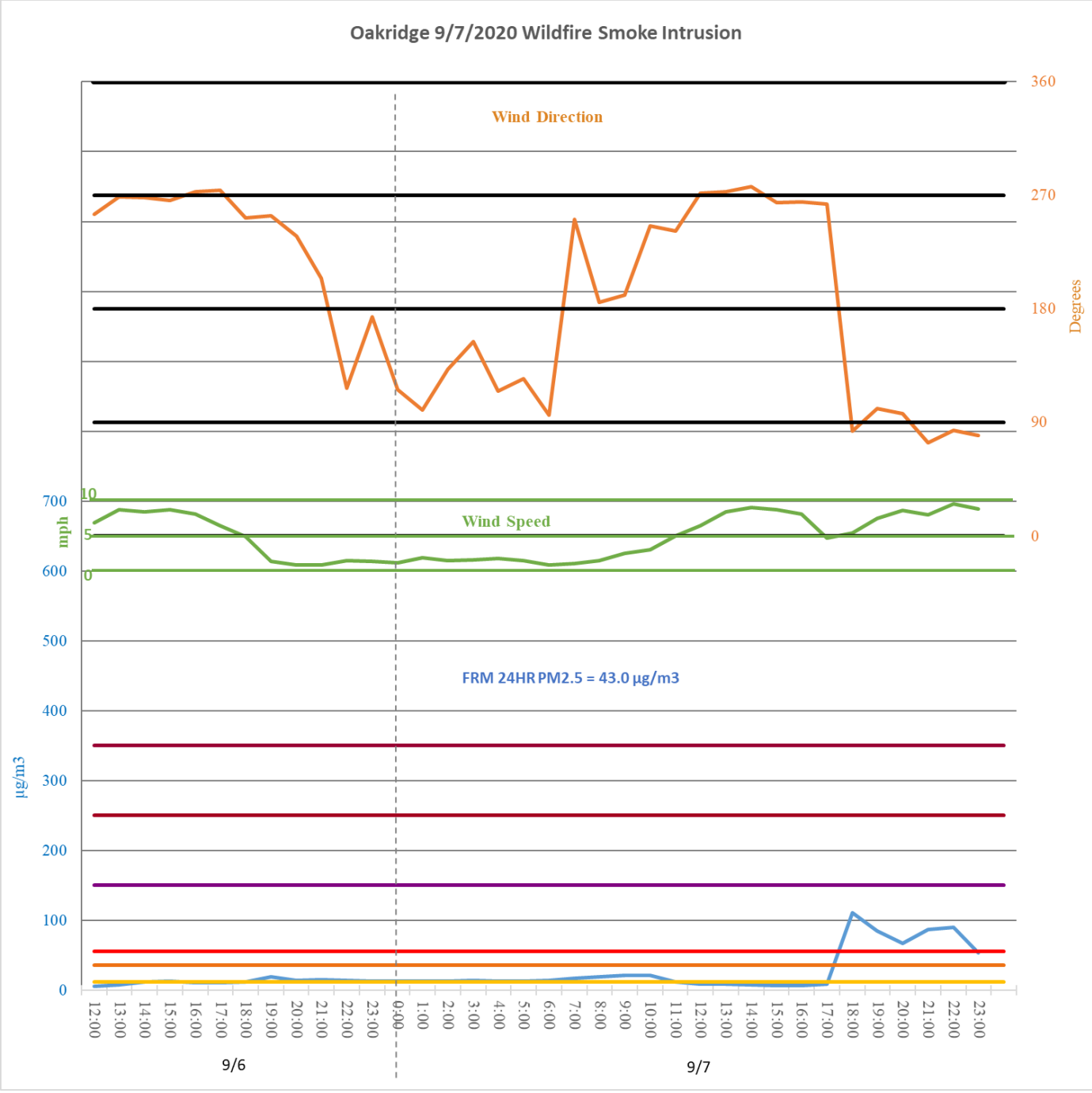
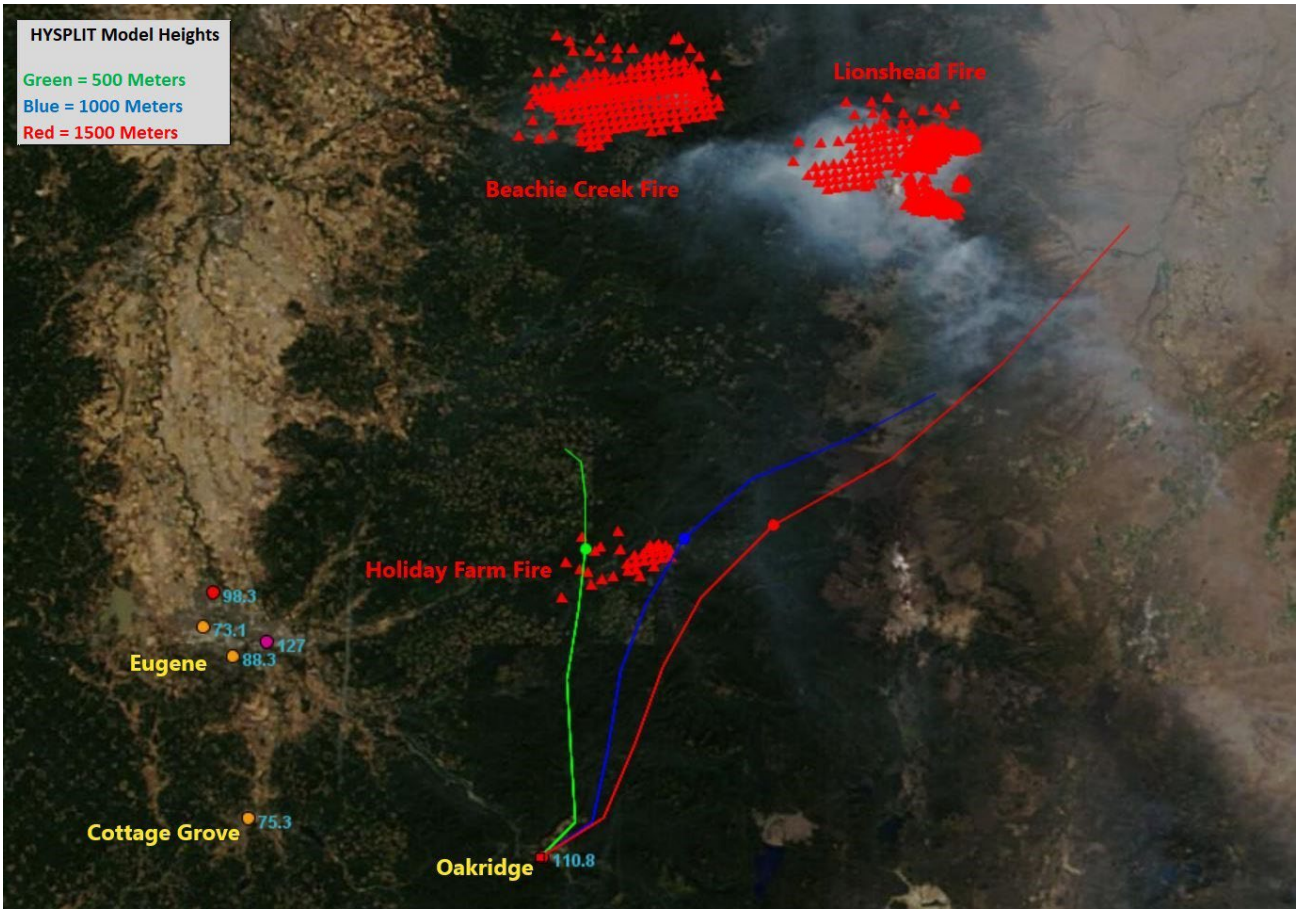


Figure 9. Satellite Smoke and back trajectory HYSPLIT Model Back Trajectory Image, 9/7/2020



9/9/2020

As other wildfires began, more sources of smoke affected the Willamette Valley and Oakridge. On 9/9/2020 smoke from the nearby Theilsen Fire combined with other fires to impact Oakridge. Data from this day is limited by power outages caused as the local power company, Lane Electric Co-op, shutdown power to the area as a safety precaution. PM2.5 data from the afternoon and evening hours show peak PM2.5 levels > 500 ug/m3. As the HYSPLIT model run shows (see Figure 11) smoke from the Thielsen fire was likely the major smoke source for 9/9/2020.

Figure 10. Time Series, 9/9/2020

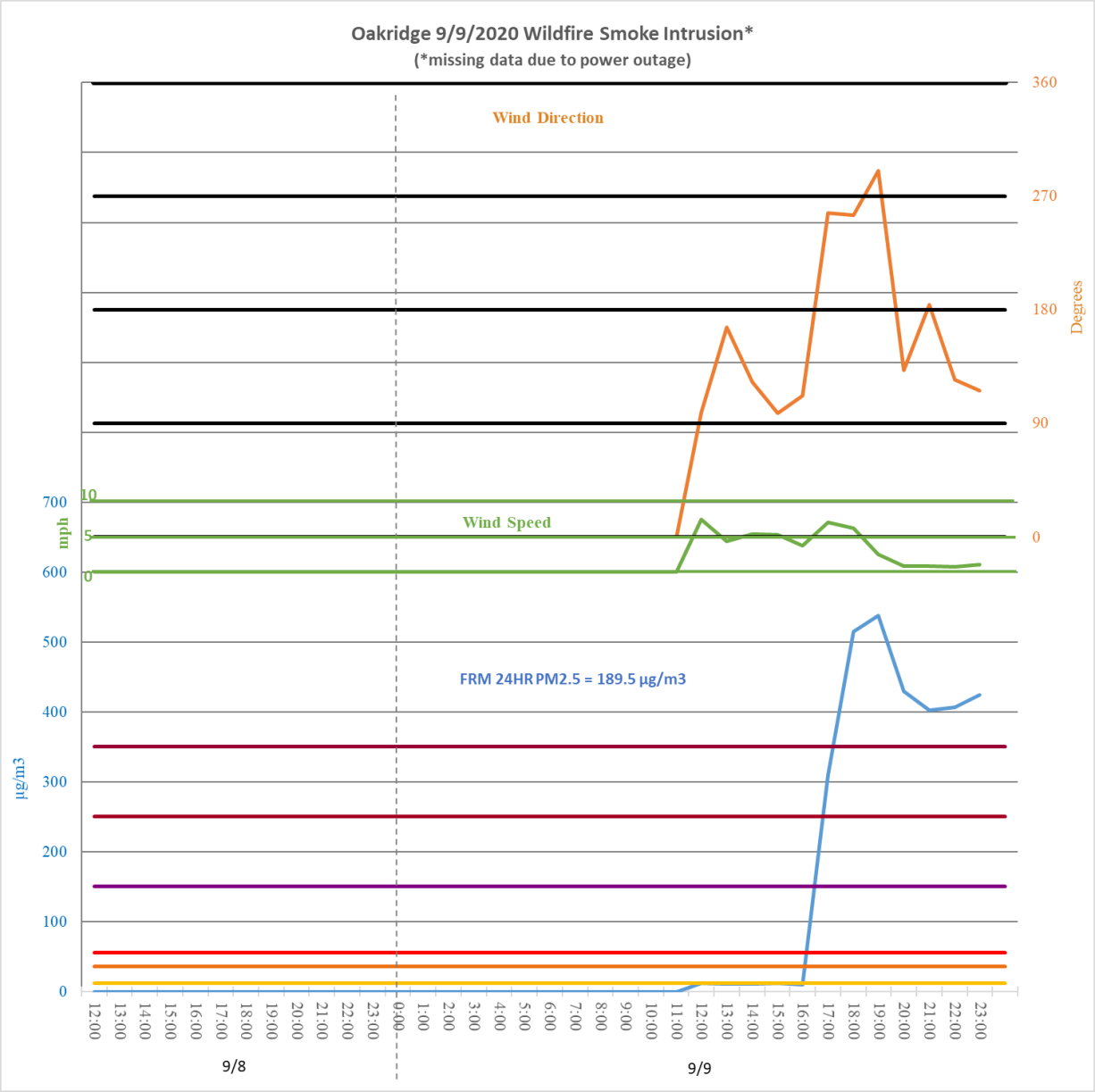
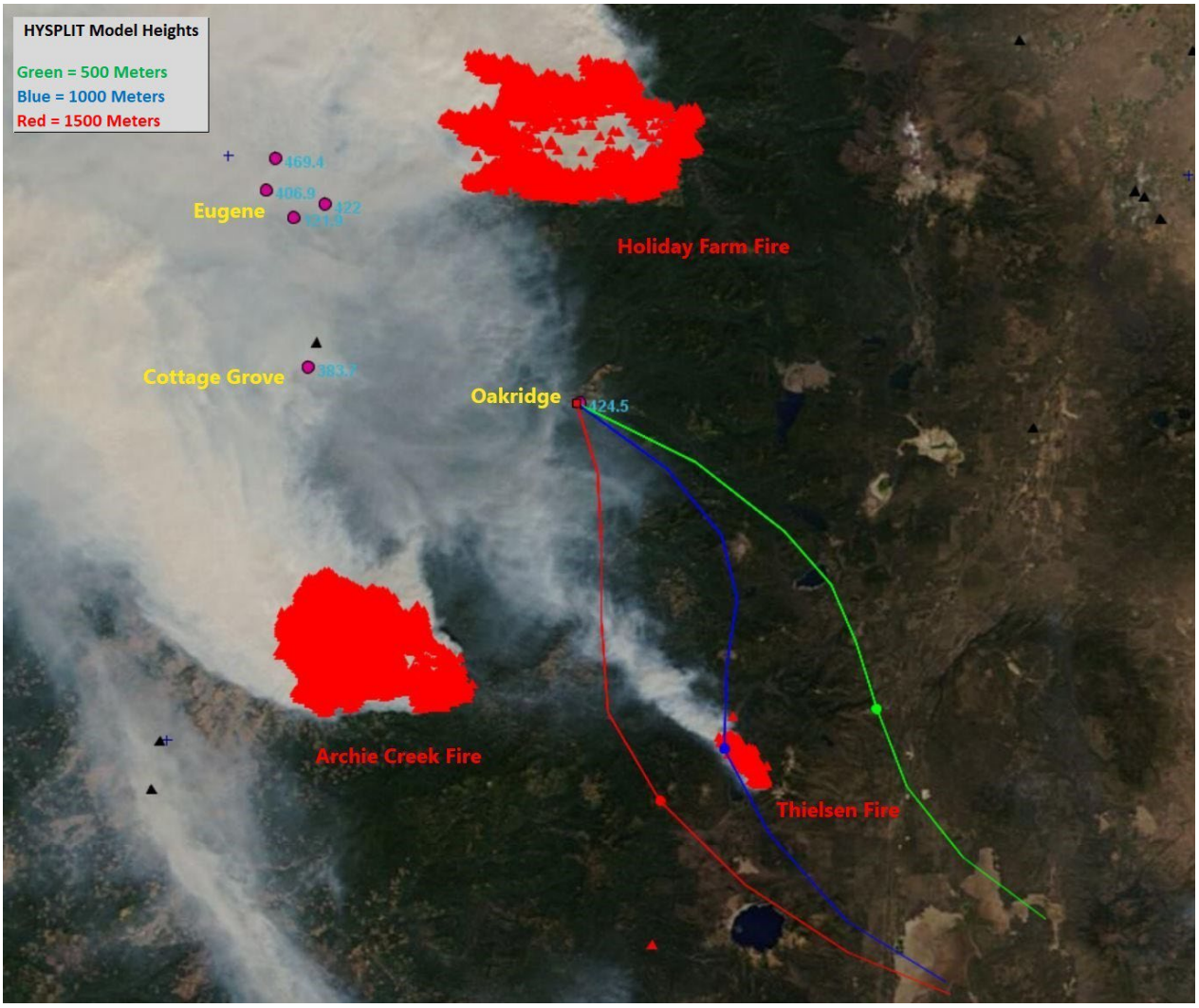


Figure 11. Satellite Smoke and back trajectory HYSPLIT Model Back Trajectory Image, 9/9/2020



9/10/2021 through 9/18/2020

From 9/10/2020 through 9/18/2020 the Holiday Farm, Lionshead, and Thielsen Fires combined with smoke from multiple other Oregon wildfires (see Figure 7) to inundate western Oregon with smoke causing exceedences of the NAAQS for PM2.5 in Oakridge. Figures 12 and 13 show the time series and MODIS satellite images with fire and HYSPLIT back trajectory overlay and is an example of the impact from the first day of the 8-day combined smoke event. The time series and images for all the dates of impact are located in Appendix B.

Figure 12. Time Series, 9/10/2020

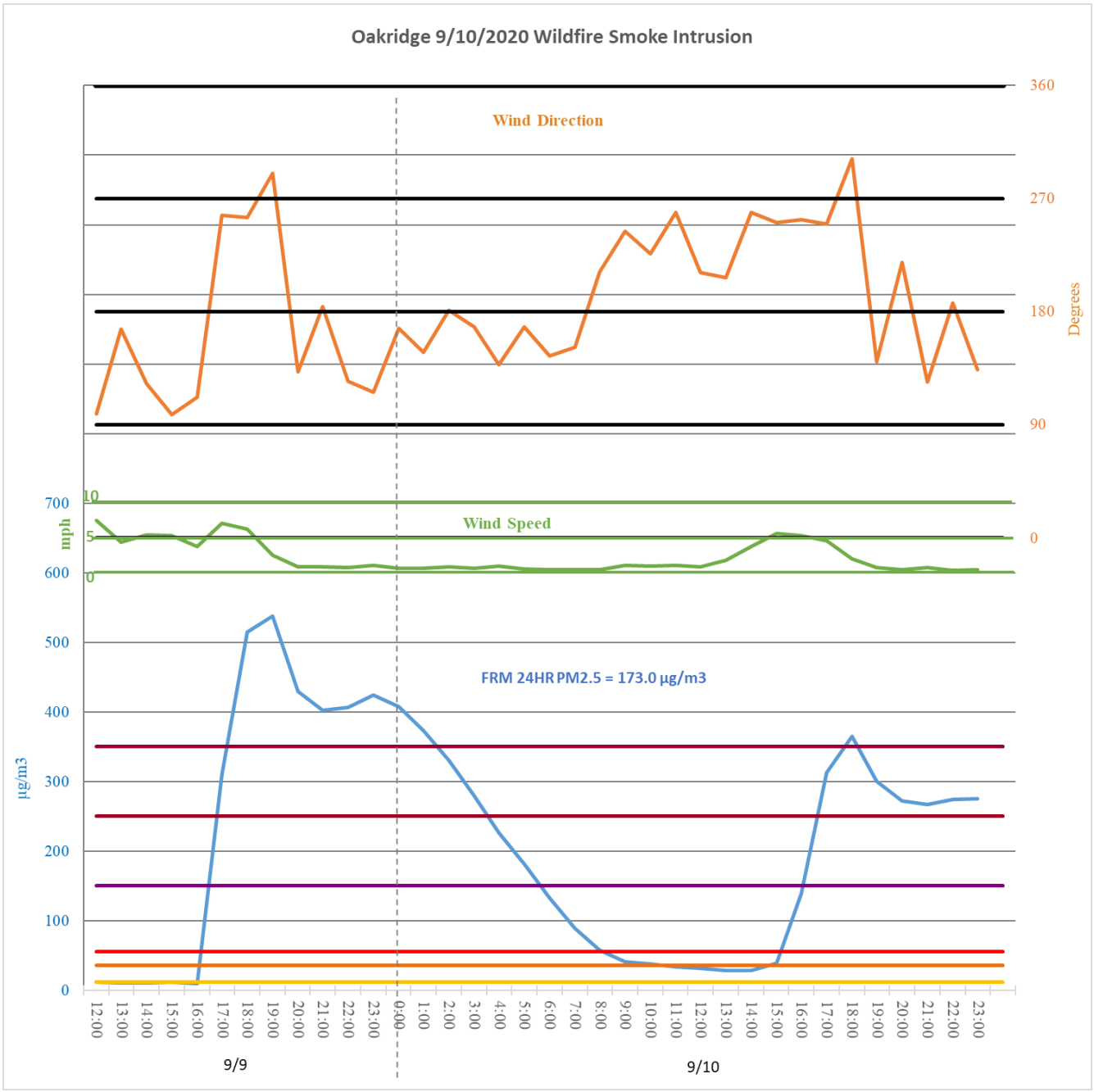
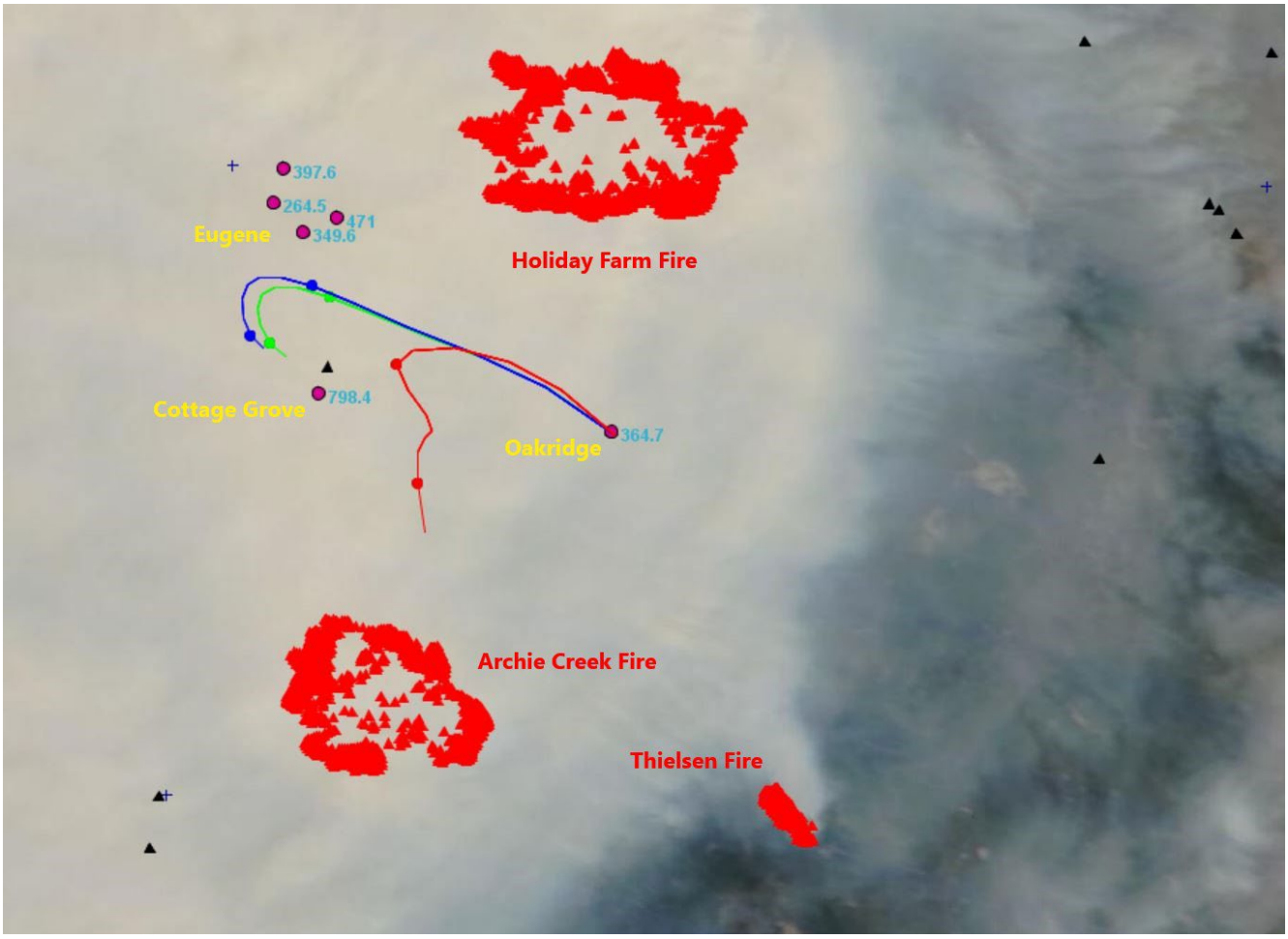


Figure 13. Satellite Smoke and back trajectory HYSPLIT Model Back Trajectory Image, 9/10/2020



2 Clear causal relationship

A clear causal relationship between a source and monitor is demonstrated with multiple strands of evidence linking the source of the event to the monitored exceedance. ODEQ and LRAPA provide a concise description of how the evidence for each day demonstrates the clear causal relationship. In addition, alternative sources of PM2.5 and PM10 are explored.

Specifically,

(1) Meteorological evidence (time series): transport of emissions to monitor
(2) Satellite, back trajectory, and/or wind rose evidence: spatial relationship between source and monitor
(3) Alternative sources

2.1 Meteorological data and time series

Meteorological data was gathered from the Oakridge monitoring site. Wind speed and wind direction at the moniting site as well as the hourly PM2.5 reading at the monitor to develop a three-tiered time series graph that shows the relationship of PM2.5 reading with wind speed and direction on the days of interest. We used that data to backtrack the wildfires that most likely contributed to the high readings of the days of interest. See appendix B for all time series.

2.2 Satellite Data, Back Trajectories and Wind Roses

We examined MODIS Terra and MODIS Aqua satellite photos provided through NASA's EOSDIS WorldView for smoke images related to monitor sites on the flagged wildfire days. MODIS satellite photos give visual evidence of the size and direction of the smoke plume on affected days.

HYSPLIT back trajectory and wind rose modeling were conducted through EPA's AirNowTech website. The HYSPLIT model shows the back trajectory from the monitor to show that smoke traveled from the direction of the wildfires in questions to the monitor. The HYSPLIT model also shows the trajectory of smoke at varying heights. See appendix B for satellite and HYSPLIT images.

2.3 Alternative Source Hypotheses

An important element of the clear causal relationship demonstration is to explore alternative hypotheses for sources of PM2.5 and PM10. Anthropogenic sources include prescribed fires, crop residue burning (CRB), residential wood combustion (RWC), open burning, and vehicle emissions. These anthropogenic sources maintain relatively steady emissions from year to year and are included in historical monitor values.

2.3.1 Prescribed Burning

Oregon Department of Forestry reported no prescribed burns in Oakridge for the impacted monitor days.

2.3.2 Crop Residue & Agricultural Burning

Crop residue burning is regulated in Oregon by the Oregon Department of Agriculture in conjunction with multi-agency smoke management efforts, including the Oregon Department of Forestry, Oregon Department of Environmental Quality, and the Oregon State Fire Marshal. ODA's field burning rules are listed in OAR 603-077, "Field Burning Rules," for the Willamette Valley only.[9] The open burning of all other agricultural waste is governed by OAR 340-264, "Rules for Open Burning."

Field burning in the Willamette Valley is only allowed northeast of Salem where the terrain is too difficult to manage in any other way. Field burning was not done in this area because it was adjacent to the Beachie Creek Fire and in Hazardous AQI conditions.

2.3.3 Residential Wood Combustion

[9] The Willamette Valley is extremely distant from the monitors in question, for those not familiar with the geography of Oregon.

Residential wood combustion can be a significant source of PM2.5 emissions in Oregon communities during the winter months. The temperatures in Oakridge on the dates in question were well above the temperatures at which anyone would be burning wood for residential heating purposes (see Table 6). RWC was not a likely source of PM2.5 emissions during this time period.

Table 6.. Max and Min daily temperatures at Oakridge monitor on impacted days, 2020

Oakridge							
Date	**PM2.5 µg/m3**	**Max Temp (F)**	**Min Temp (F)**	**Date**	**PM2.5 µg/m3**	**Max Temp (F)**	**Min Temp (F)**
9/7/2020	43.0	91.6	51.8	9/14/2020	280.5	73.4	47.5
9/9/2020	189.5	99.0	54.6	9/15/2020	277.8	79.1	45.8
9/10/2020	173.0	80.6	46.3	9/16/2020	209.3	76.0	45.5
9/11/2020	255.1	68.2	45.6	9/17/2020	149.5	74.9	51.2
9/12/2020	576.6	71.4	45.2	9/18/2020	39.7	66.4	56.5
9/13/2020	376.8	68.5	44.0				

2.3.4 Outdoor Burning

Open burning in Oregon is regulated by OAR 340-264.[10] Oregon

"Classifies all open burning into one of seven classes: Agricultural; Commercial; Construction; Demolition (which includes land clearing); Domestic (which includes burning commonly called "backyard burning" and burning of yard debris); Industrial; or Slash. Except for field burning within the Willamette Valley regulated through OAR 340 division 266 and slash burning administered by the forest practices smoke management plan of the Oregon Department of Forestry, this division prescribes requirements for and prohibitions of open burning for every location in the state. Generally, if a class of open burning is not specifically prohibited in a given location, then it is authorized subject to OAR 340-264-0050 and 340-264-0060 and the requirements and prohibitions of local jurisdictions and the State Fire Marshal."[11]

In addition, according to OAR 340-262-0900, "Materials Prohibited from Burning,"

No person may cause or allow any of the following materials to be burned in a solid fuel burning device, fireplace, a trash burner or any other device described in ORS 468A.485(4)(b):

(1)(a) Garbage; (b) Treated wood; (c) Plastic or plastic products; (d) Rubber or rubber products; (e) Animal carcasses; (f) Products that contain asphalt; (g) Waste petroleum products; (h) Paint; (i) Chemicals; (j) Products containing lead, mercury or other heavy or toxic metals; (k) Materials containing asbestos; and (l) Particleboard.

(2) Paper or paper products, except for paper used to kindle a fire.

The outdoor burning period in Oakridge is only allowed during the months of October, March through June 15 (LRAPA Section 47-015(2)(f)). Thus, open burning was prohibited on the impacted monitor days in question. Barrel burns are also prohibited year round in Lane County.

[10] Oregon Secretary of State website. "Rules for Open Burning." (Accessed 3/5/2019) https://secure.sos.state.or.us/oard/displayDivisionRules.action;JSESSIONID_OARD=cC9P1ta7Uus8P2xtYZlahJLghrbyYGUCt0sDOMyytWOQg9umWVQF!1318524005?selectedDivision=1568

[11] OAR 340-262-0010 (1).

According to the Oregon Department of Forestry, no prescribed burns or open burns were registered on any of the impacted days in Oakridge.

2.3.5 Vehicle Emissions

Vehicle emissions and road dust produce PM2.5 emissions and are included in the onroad mobile source category in the 2014 NEI. The annual PM2.5 emissions in this category are a small fraction of the emissions produced by wildfires, especially in rural areas like Oakridge, with few vehicles.

The Updated Oakridge-Westfir PM2.5 Attainment Plan (LRAPA 2016)[12] used the 2008 NEI as the basis for estimating PM2.5 in 2015. Road dust and mobile on road emissions account for up to 10% of PM2.5 on the worst winter days and less than 5% of PM2.5 on average days. Onroad mobile emissions did not likely contribute any significant PM2.5 to the elevated concentrations at the monitor in question on the impacted days.

3 Comparison to historical fluctuations

To support the clear causal relationship requirement of the EER, analyses are presented here comparing the event-influenced concentrations at Oakridge to historical concentrations. Evidence supports the conclusion that PM2.5 concentrations at the monitor on the flagged days were elevated due to wildfire smoke.

Figures 14 and 15 show the PM2.5 concentrations measured at Oakridge for 2016 through 2020. This data shows that during wildfire season (June through September) PM2.5 measurements typically remain below 30 ug/m3 with higher concentrations related to wildfire events. Higher numbers in the wintertime are attributed to residential wood combustion and wintertime inversions in our mountain valleys.

The exception is when there are wildland fire smoke incursions during the summer months. June through September data was analyzed for 2011 through 2019 to establish a background level. Table 7 shows that 2020 PM2.5 readings were exceptional, within the 2011-2020 years, at the Oakridge monitor.

Table 7. Statistics for 24-hr PM2.5 concentrations, June 1 – September 30, 2011 - 2020

Oakridge	2011-2019	2020
Minimum, ug/m3	0.2	1.1
Maximum, ug/m3	62.0*	576.6
Median, ug/m3	4.6	4.7
Mean, ug/m3	5.9	31.2
Std.Dev., ug/m3	5.7	87.3
N	349	98

*wildfire influenced from 2018, second high (33.3 ug/m3) was another wildfire influenced day in 2017

[12] LRAPA 2016. *Updated Oakridge-Westfir PM2.5 Attainment Plan.* Springfield, OR. https://www.oregon.gov/deq/EQCdocs/0117ItemEAttachC.pdf

Figure 14. Historical Comparison of PM2.5 at Oakridge Monitor, All Concentrations

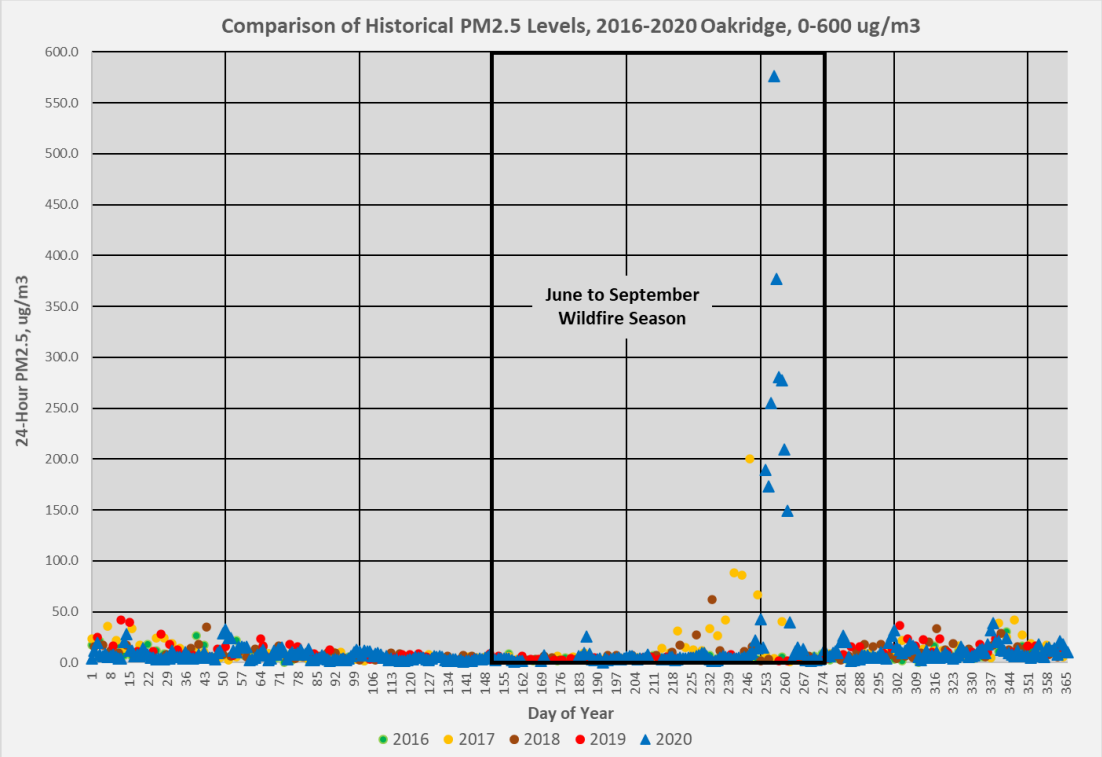
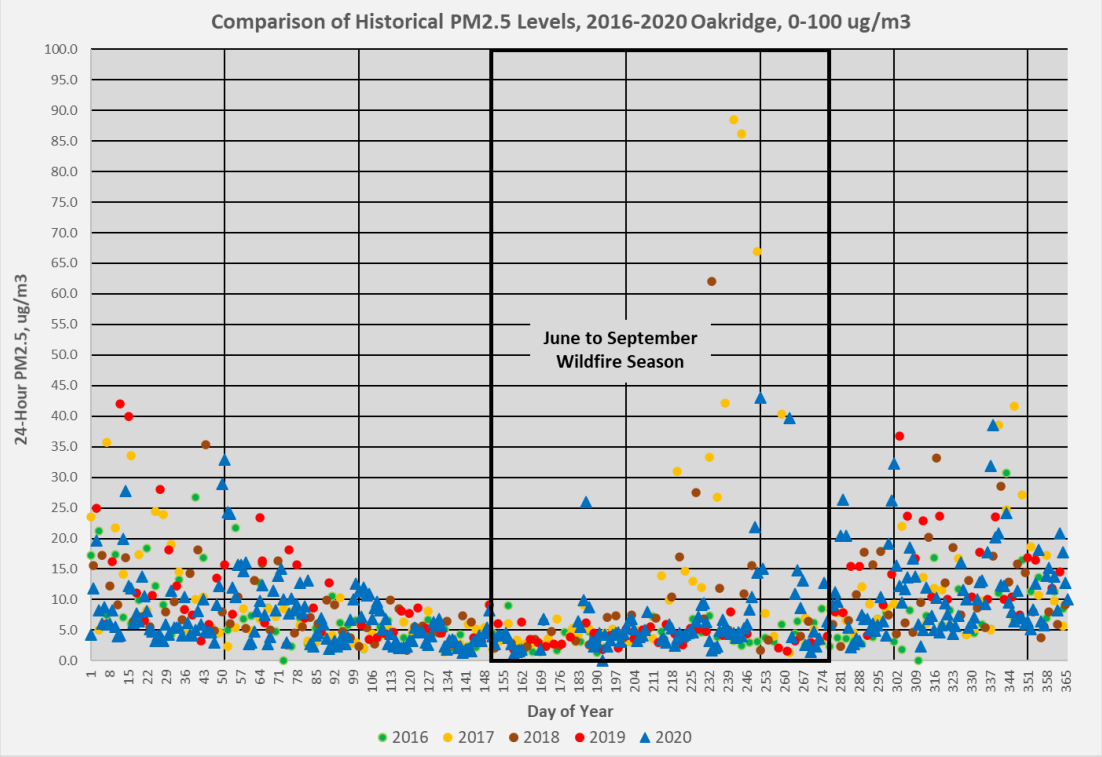


Figure 15. Historical Comparison of PM2.5 at Oakridge Monitor, Lower Concentrations



4 Not reasonably controllable or preventable

This EER element requires a demonstration that the event was neither reasonably controllable nor preventable, and this requirement has been met for wildfire events (40 CFR 50.14(b)(4)). ODEQ and LRAPA present sufficient evidence in this demonstration showing the source of the event was indeed wildfires (section 1, section 2). ODEQ and LRAPA contend that the events of September 2020 at Oakridge were both not reasonably controllable or preventable.

5 Natural Event or Human Activity unlikely to Recur (NE/HAUR)

The EER requires that agencies must document that the identified source of an exceptional event is either a natural event (NE) or a human activity unlikely to recur at the same location (HAURL) such as to affect the monitors in question again. EPA's 2016 Exceptional Events rule indicates that if an agency has adequately demonstrated that the source is a *natural event* or, if not natural, is a human activity unlikely recur at the same location and that there is a *clear causal relationship* between the identified source (s) and the affected monitor, then the HAURL/Natural Event criterion is also satisfied.

In the late summer of 2020, unusually low humidity and high temperatures in western Oregon dried out the thick layer of duff, branches and sticks, that lay on the forest floor. This set the stage for a rare and powerful wind event that erupted on September 7th, 2020, bringing dry, hot winds, up to 75 miles per hour, that quickly spread any fire that started or was already burning. Humidity was measured in the single digits, previously only seen in particularly dry areas in the height of summer.[13] The data included in Sections 1 and 2 demonstrate the clear causal relationship between the source of the smoke and monitor data for each day that ODEQ and LRAPA request concurrence. Thus, the NE/HAUR criterion is satisfied.

6 Mitigation

The EER requires states to take appropriate and reasonable actions to protect public health from exceedances or violations of the NAAQS (40CFR 51.930). DEQ presents evidence of prompt public notification of the event, public education so that individuals could make behavioral changes to reduce exposure to unhealthy air, and implementation of appropriate measures to protect public health from the impacts of exceptional events.

Control of wildland fires is coordinated under the National Interagency Fire Center. Their fire control policy states:

> Five federal agencies, including the Department of the Interior's Bureau of Land Management, Bureau of Indian Affairs, National Park Service, and U.S. Fish and Wildlife Service, along with the Department of Agriculture's Forest Service, manage and have primary fire program responsibilities on more than 676 million acres. The U.S. Fire Administration works with county and local fire departments; while the states are represented by the National Association of State Foresters. The state, county, and local jurisdictions provide primary fire protection on public and private lands covering additional hundreds of millions of acres across all 50 states.
>
> As partners, they work together on fire management issues covering the spectrum from safety and planning, to science, preparedness, operations, strategy development, logistics, intelligence,

[13] OSU Extension Fire Program, After the Fire report, After the Fire

emergency response, and more. They also collaborate on interagency strategies to manage wildfires, not only for single incidents but as a matter of policy.

In addition to the total effort of the various natural resource agencies, the specific USFS districts prepare fire management plans.[14]

Oregon DEQ, Lane Regional Air Pollution Authority, Oregon Health Authority, Oregon OSHA, Oregon Emergency Management, Oregon Department of Forestry, and the US Forest Service developed a wildfire response protocol which outlines the state, federal, and local response to dangerous smoke levels impacting Oregon communities.[15] The protocol defines which agency is responsible for which activity and provides a guide for the coordination of emergency communication during extreme smoke events.

The major areas of agency actions and the lead agencies responsible in the event of a severe smoke episode related to wildfire are presented in detail in Table 8.

Table 8. Wildfire response protocol: actions and agencies responsible.[16]

Action Needed	Lead Agency and Action Taken	Desired Outcome
1. Air Monitoring		
Measuring ambient air quality	Mostly DEQ as lead agency. Air Resource Advisors (ARA) may provide additional monitoring equipment via national cache resources and assist in deployment and data collection.	Ability to track ambient air quality levels in communities receiving the heaviest impact, and identify smoke-free areas where air quality is good.
Indoor air quality exposure	Oregon OSHA is lead agency to evaluate air quality concerns for workers. DEQ and OHA can provide advice to schools.	Ability to monitor indoor smoke levels in work environments and schools.
2. Smoke Forecasting and Modeling		
Smoke weather forecast	ODF is the lead agency, with back-up and assistance from NWS Meteorologists as requested. DEQ assists in coordination. National Weather Service can be contacted to provide "spot weather forecasts" for wildfire.	Provide advance notice of possible smoke movement and impacts, improve public notification, lower risk of public exposure to high smoke levels
Smoke modeling	ARAs can provide smoke modeling forecasts if requested.	Complementary to above
3. Issuing Health Warnings		

[14] For more details for fire management and community outreach practices during the 2017 fire season, see: USDA Forest Service and DOI Bureau of Land Management. *2017 Pacific Northwest Fire Narrative.* https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd572804.pdf (Accessed March 4, 2019)

[15] Oregon DEQ et al. 2018. *Oregon Wildfire Response Protocol for Severe Smoke Episodes.* V5.3. June 28, 2018. https://www.oregon.gov/deq/FilterDocs/WFresponse.pdf (Accessed March 4, 2019).

[16] Oregon DEQ et al. 2018. *Oregon Wildfire Response Protocol for Severe Smoke Episodes.* V5.3. (June 28, 2018) pages 5-6. https://www.oregon.gov/deq/FilterDocs/WFresponse.pdf (Accessed March 4, 2019).

Provide public with frequent smoke updates on potential health risk and recommended public health actions via the web and media	Coordination between the Incident Management Team, DEQ, LRAPA, ARA, OHA, county health departments, local government, tribes and 211 info. Assistance from federal land managers on fire status, and from ODF wildfire forecasting.	Frequent coofdinated updates provided to the public via Oregon Smoke Blog, DEQ, OHA, local govermnet websites, press releases and media outreach. 211 info is provided with up-to-date health-related information.
4. Website management		
Updating the Oregon Smoke Blog and social media (see description under section 6)	Blog initiated by federal land managers or DEQ, and updated by DEQ Public Affairs who will act as a "gate keeper" to avoid duplicative messaging and crowding of the smoke blog.	Provide the public with comprehensive "one-stop" website/social media on wildfire status, air quality levels, leath risk, cleaner air spaces, press releases and other critical info.
Updating DEQ, OHA, ODF and local websites	Managed by respective agency. Supplements the Oregon Smoke Blog website.	Complements the above website.
5. Public Actions		
Cancel or modify public events, outdoor and business activities	Decision made within affected jurisdiction, by local or tribal health authorities in consultation with DEQ, LRAPA, ARA, local public health, OHA, federal land managers, and possibly or OR-OSHA as needed.	Prompt action taken, via notification of media, 211 info, and posting info on Oregon Smoke Blog and other websites
Consult with schools on limited hours or closure. Decisions about protecting schools or other public buildings from smoke intrusion	Decision made within affected jurisdiction, by local or tribal health authorities in consultation with DEQ, LRAPA, ARA, local public health, OHA, or OR-OSHA as needed.	Identification of measures to protect schools and users of public buildings from smoke
Set up general population shelters	Red Cross may support the setup and management of general population shelters based on decisions by local health officials.	When determined necessary, general population shelters will be established and opened in coordination with local public health and emergency management.
Establish or identify public cleaner air spaces	Decisions made within affected jurisdiction, by local or tribal health authorities in consultation with DEQ, LRAPA, ARA, OHA, or OR-OSHA as needed.	When determined necessary, prompt action taken to set up or identify cleaner air spaces, using guidance for "Identifcation of Cleaner Air Spaces for Protection from Wildfire Smoke"[1]
Recommended evacuation/relocation of sensitive populations	Decision made at local level, by health officials and tribal/local government (Sheriff or local emergency management), OEM, in consultation with DEQ, LRAPA, ARA, OHA, federal land managers and possibly OR-OSHA	Prompt action taken if dangerous smoke levels are expected to persist for a prolonged period. Requires close communication with DEQ, OHA, federal land managers, OEM, OR-OSHA, 211 info, and possibly Red Cross, State Fire Marshal and State Police.

7 Initial Notification

The EER establishes specific procedural requirements that an air agency must follow to request data exclusion. Those requirements and ODEQ's actions to meet them are summarized in the table below.

Table 9. Exceptional Event Rule Procedure Requirements

Exceptional Event Rule Procedural Requirement	ODEQ Action/Intended Action
A State shall notify EPA of its intent to exclude one or more measured exceedances of an applicable ambient air quality standard as being due to an exceptional event by placing a flag in the appropriate field for the data record of concern which has been submitted to the AQS database... 40 CFR § 50.14(c)(2)(i).	ODEQ notified EPA that it placed flags on numerous monitor values originally thought to be affected by wildfires above the level of concern in Oregon for PM2.5 of 25µg/m3 and that we intended to request EPA concurrence to exclude some or all of them from the AQS database.
A State that has flagged data as being due to an exceptional event and is requesting exclusion of the affected measurement data shall, after notice and opportunity for public comment, submit a demonstration to justify data exclusion to EPA. EPA shall respond with a due date for demonstration submittal that considers the nature of the event and the anticipated timing of the associated regulatory decision. 40 CFR § (50.14(c)(3)(i)).	DEQ made this package available for public comment and subsequently submitted it to EPA by {TBD} so that it continues to demonstrate Oakridge is meeting the 24-hour PM2.5 standard.
With the submission of the demonstration, the air agency must document that the public comment process was followed. 40 CFR § (50.14(c)(3)(iv) and (v).	This document was available for a 30-day public comment from {Blank} to {Blank}. See Section 8 for Public comments.

DEQ posted notice of this exceptional events demonstration on {TBD} on the DEQ website. {Fill this information in later} comments were received.

8 Public Comment

{THIS SECTION WILL BE ADDED AFTER THE PUBLIC COMMENT PERIOD}

9 Summary

With the weight of evidence discussed throughout this report, Oregon DEQ and LRAPA have shown that the fires in western Oregon impacted the monitor at Oakridge. ODEQ and LRAPA therefore request EPA's concurrence for six days, 9/11/2021 through 9/16/2021, to be flagged RT and that these values not be used to calculate the relevant design values for the Oakridge State Implementation Plan and attainment status. We also request that Oakridge be redesignated an attainment area and the Oakridge Maintenance Plan be approved.

ODEQ and LRAPA are also submitting some dates for which EPA will not concur at the moment, but for which the information may become of regulatory significance in the future.

Appendix A – HYSPLIT Protocol

HYSPLIT back trajectory protocol for exceptional events in AirNow-Tech, developed by Anthony Barnack. Protocol instructions are based on the 2017 wildfire event but are still applicable for 2020 event.

Instructions:
Log onto Airnow Tech and go to the Navigator tab. You will need an account to log on.

1. Under the Parameter Tab Select:
   PM2.5-88502
   Duration 1 hr
   Display – parameter, HMS fire, and HMS smoke if you want

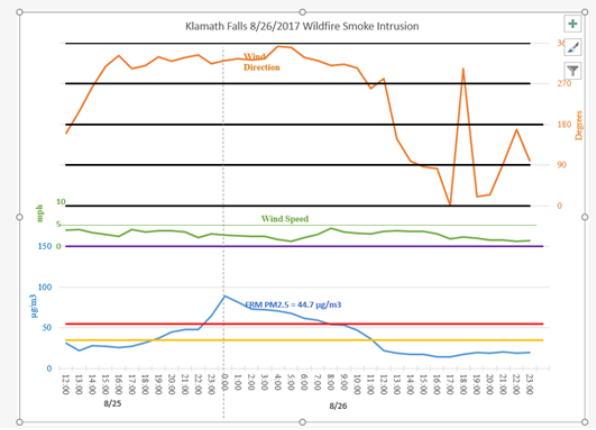
2. Under the Site Tab Select:
   By Parameter - PM2.5-88502
   By Duration – 1 HR

3. Under the Layers Tab Select:
   I usually add the states border. You can also add the MODIS satellite images if it helps.

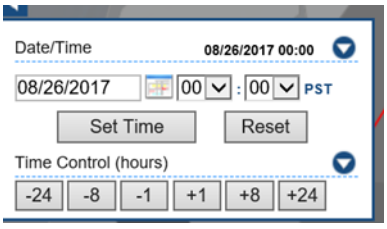
4. My maps – Leave as Standard

5. Setting the time and date on the map.
   I usually look at the time series to see what time of day the biggest impact was and the WD and WS at the time.

   For KFalls, 8/26/17, the impact was at 0:00 PST with winds from the NNW. This tells you when to set your map time and what fires you will be looking at.



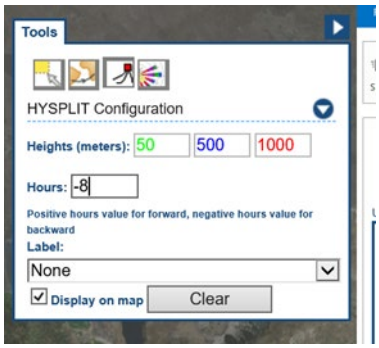
6. Set the map time



7. Under the lower arrow at the upper right is the tool box.

   Select the red box for Hysplit. I use 50, 500, and 1000 meters.
   You can do a back trajectory by putting negative hours in and clicking on the site. Forward trajectory is from the forest fire and positive hours.

   When ready click on the site or fire you want a trajectory for.



Notes:

I use the HMS smoke discussed in step 1 to see where the old smoke is and get an idea of where the smoke is heading. I turn it off to see the map. It usually takes many iterations of changing the trajectory hours to see where the impact came from.

This page left blank intentionally

Appendix B – Wildfire Impact Figures

Figure 16. Time Series, 9/7/2020

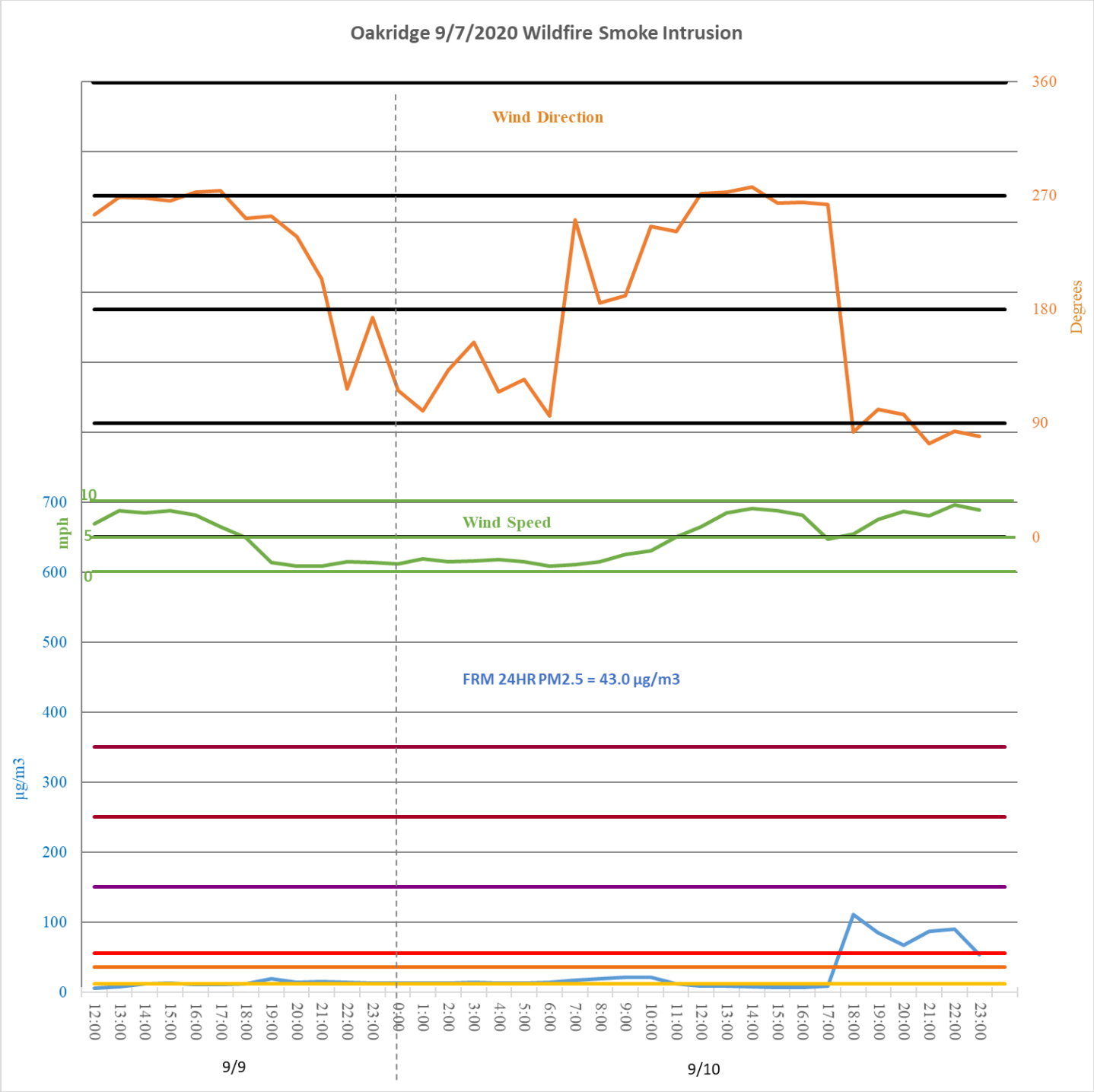


Figure 17. Satellite Smoke and back trajectory HYSPLIT Model Image, 9/7/2020

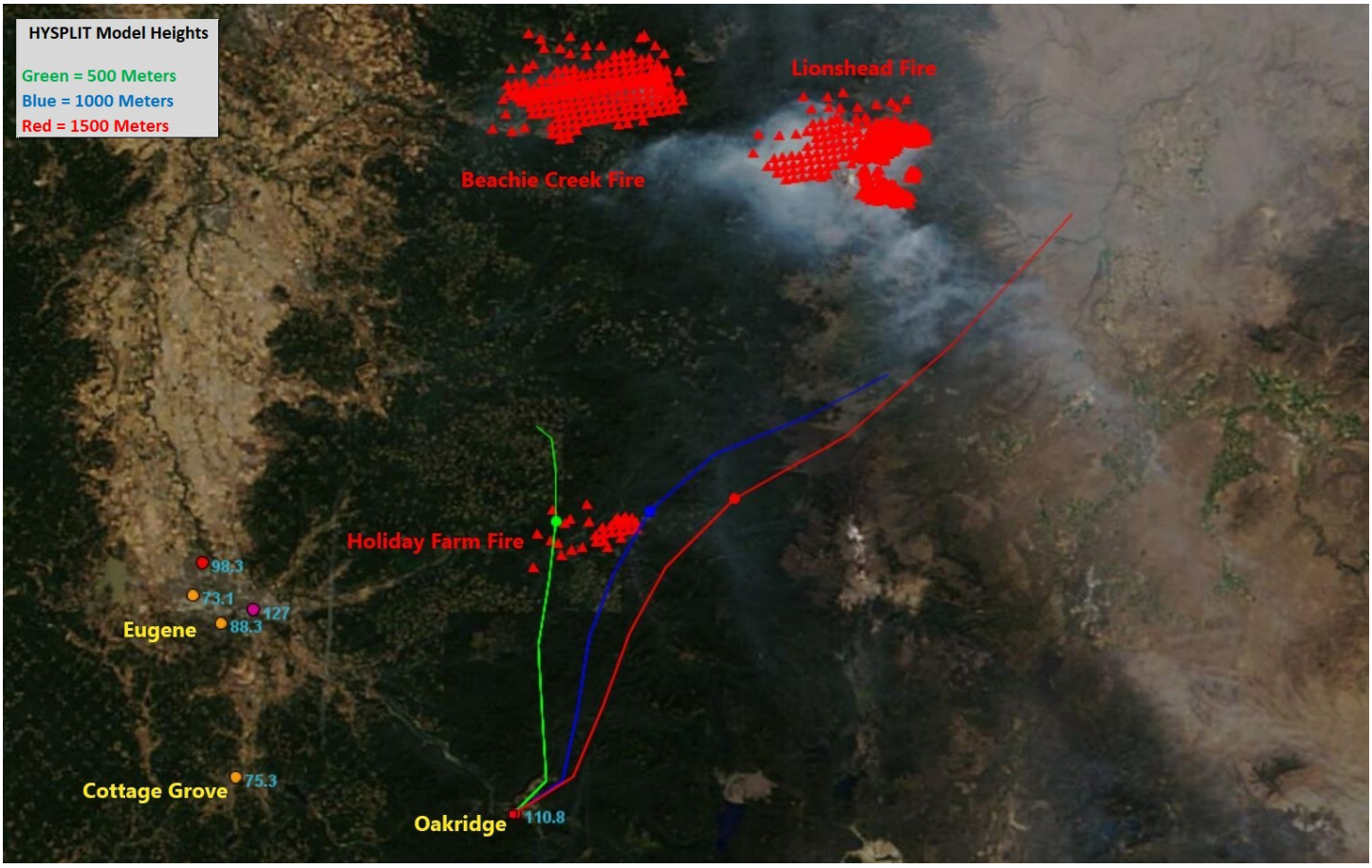


Figure 18. Time Series, 9/9/2020

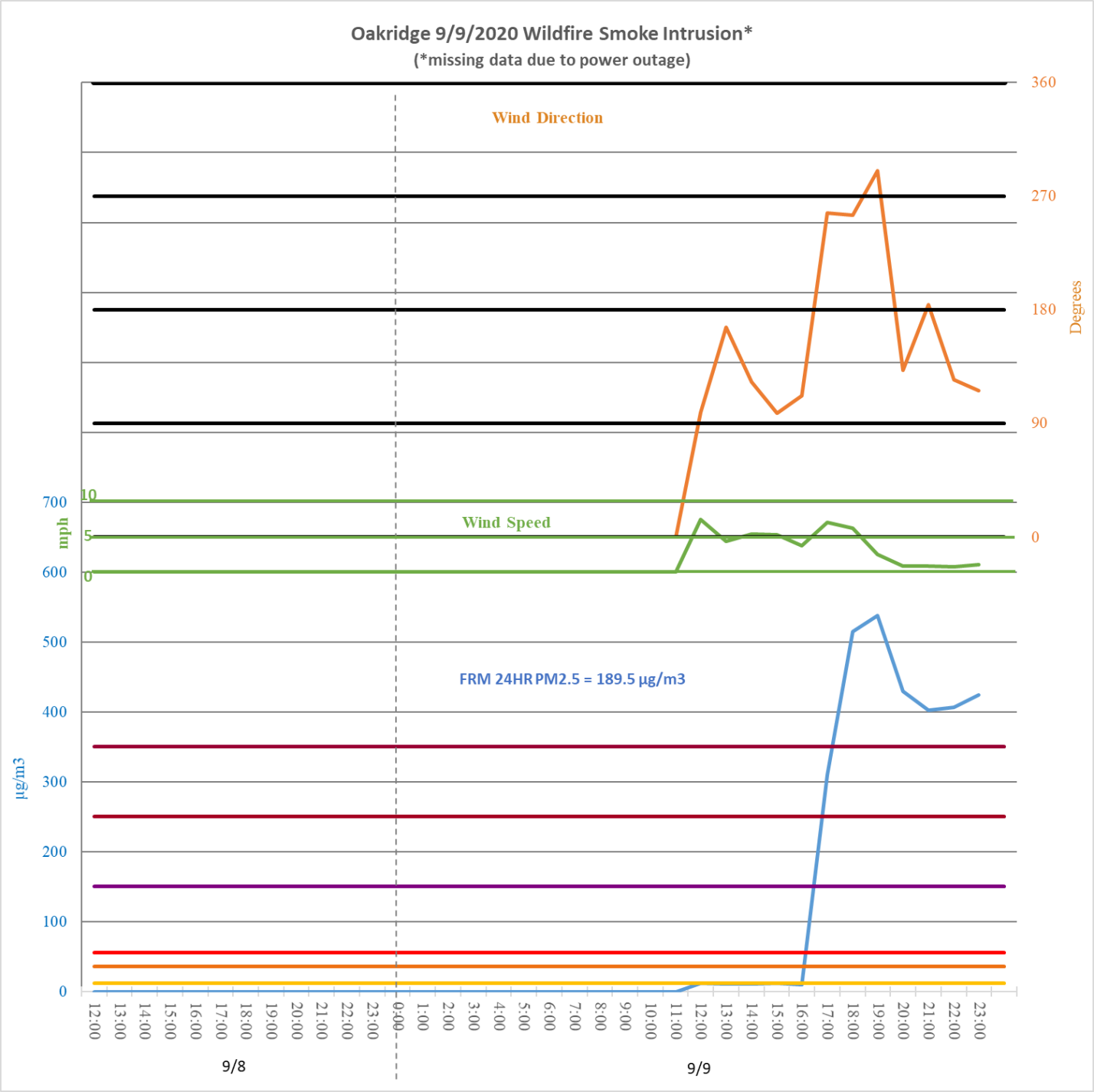


Figure 19. Satellite Smoke and back trajectory HYSPLIT Model Image, 9/9/2020

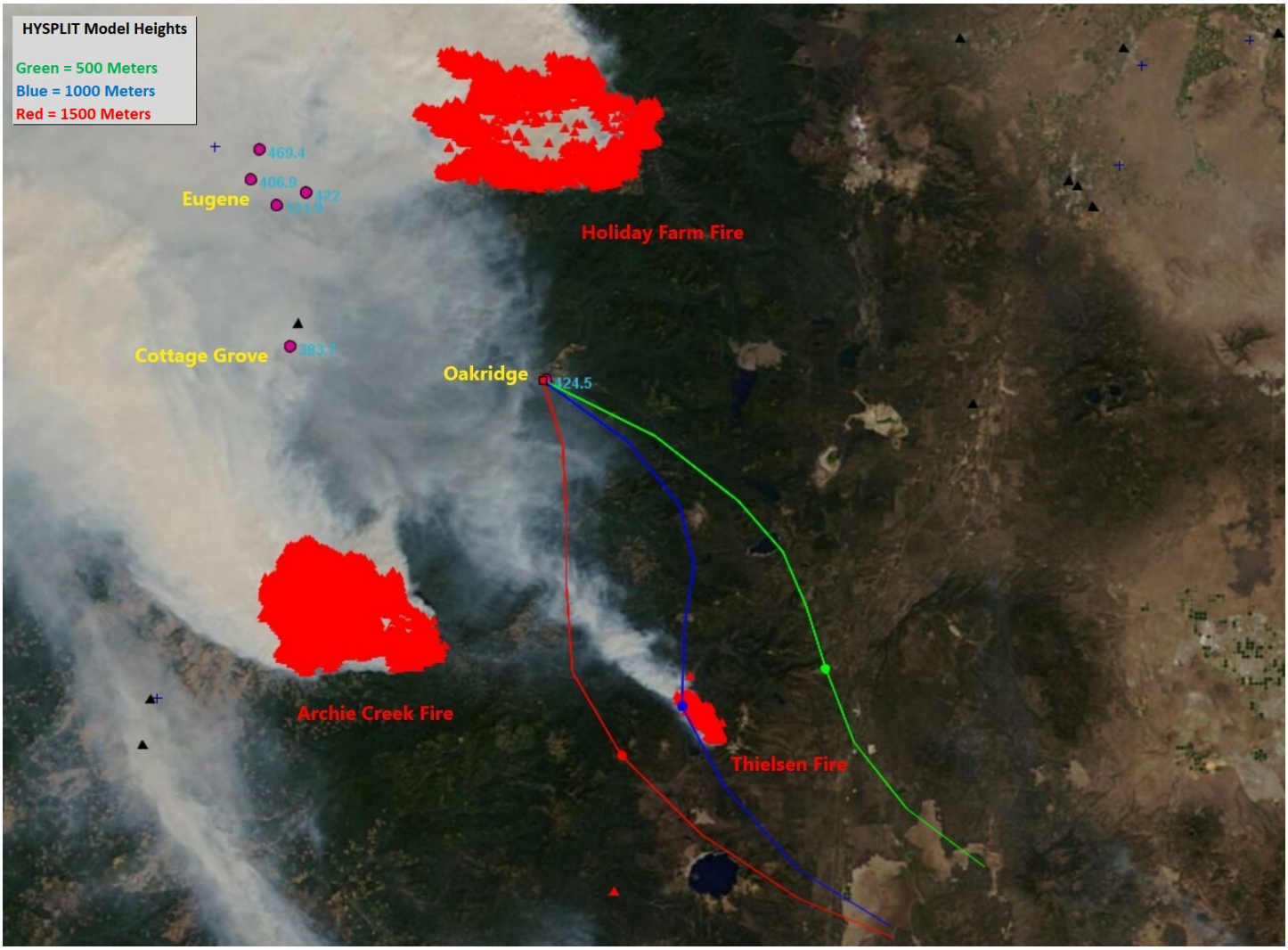


Figure 20. Time Series, 9/10/2020

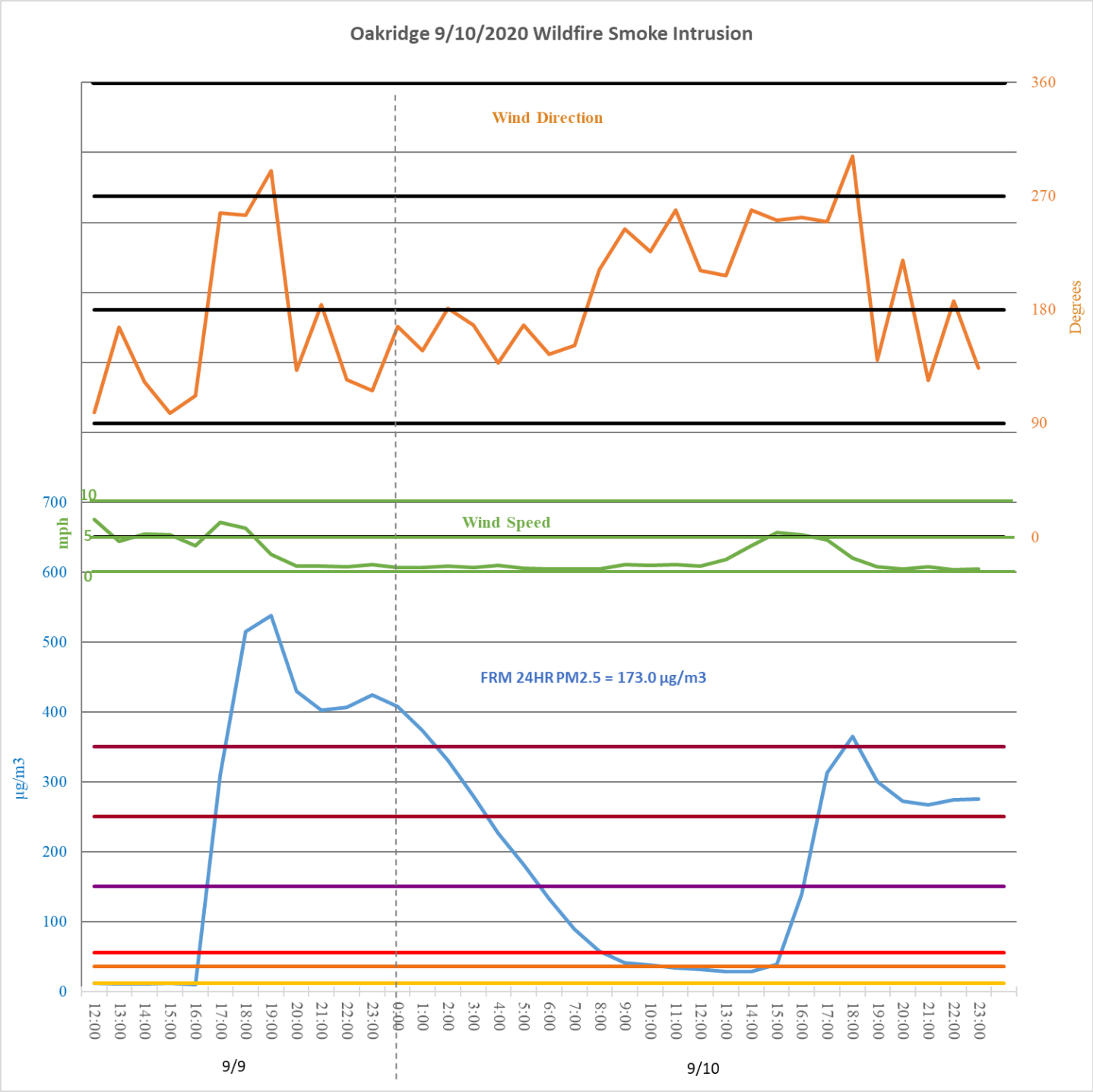


Figure 21. Satellite Smoke and back trajectory HYSPLIT Model Image, 9/10/2020

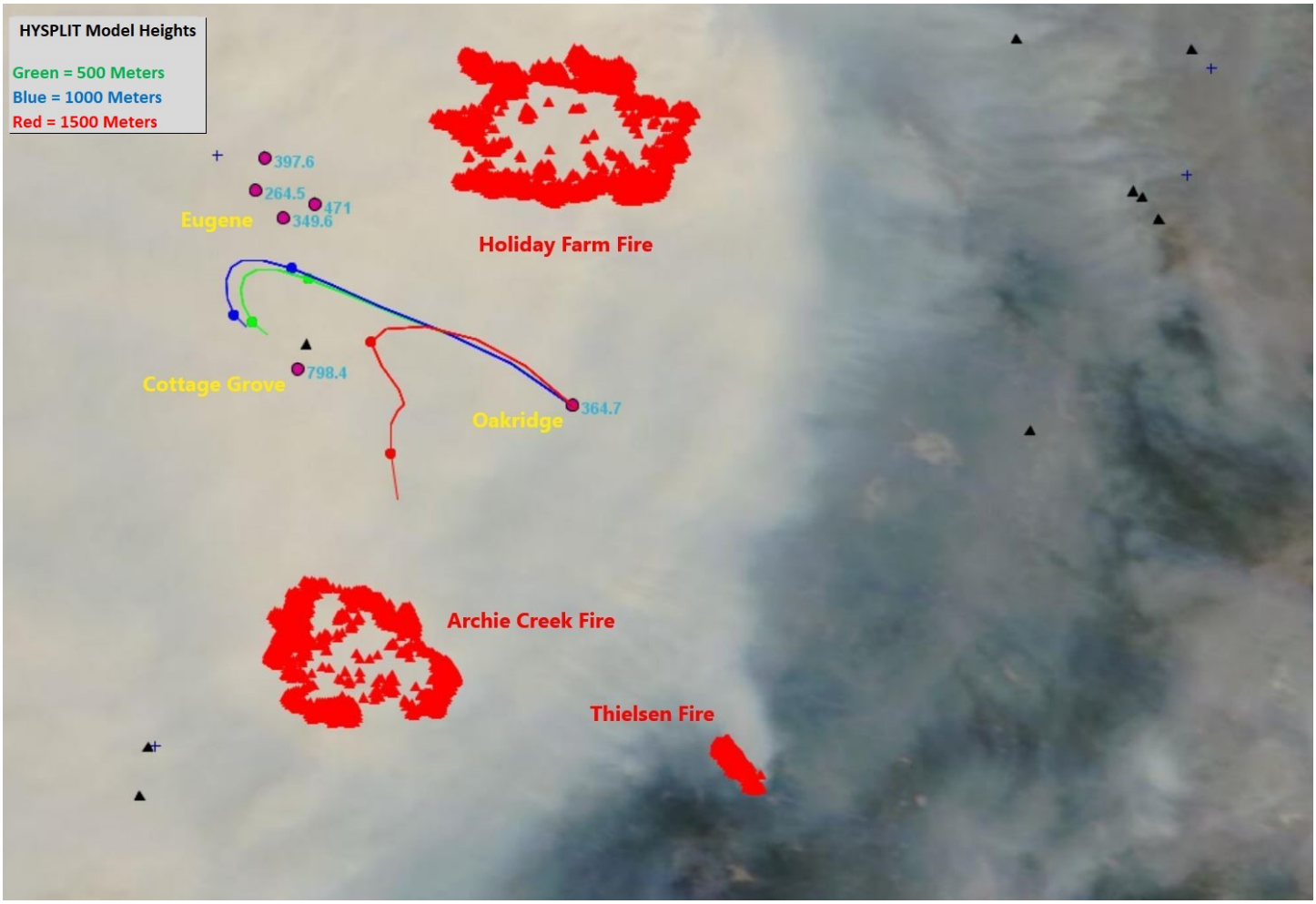


Figure 22. Time Series, 9/11/2020

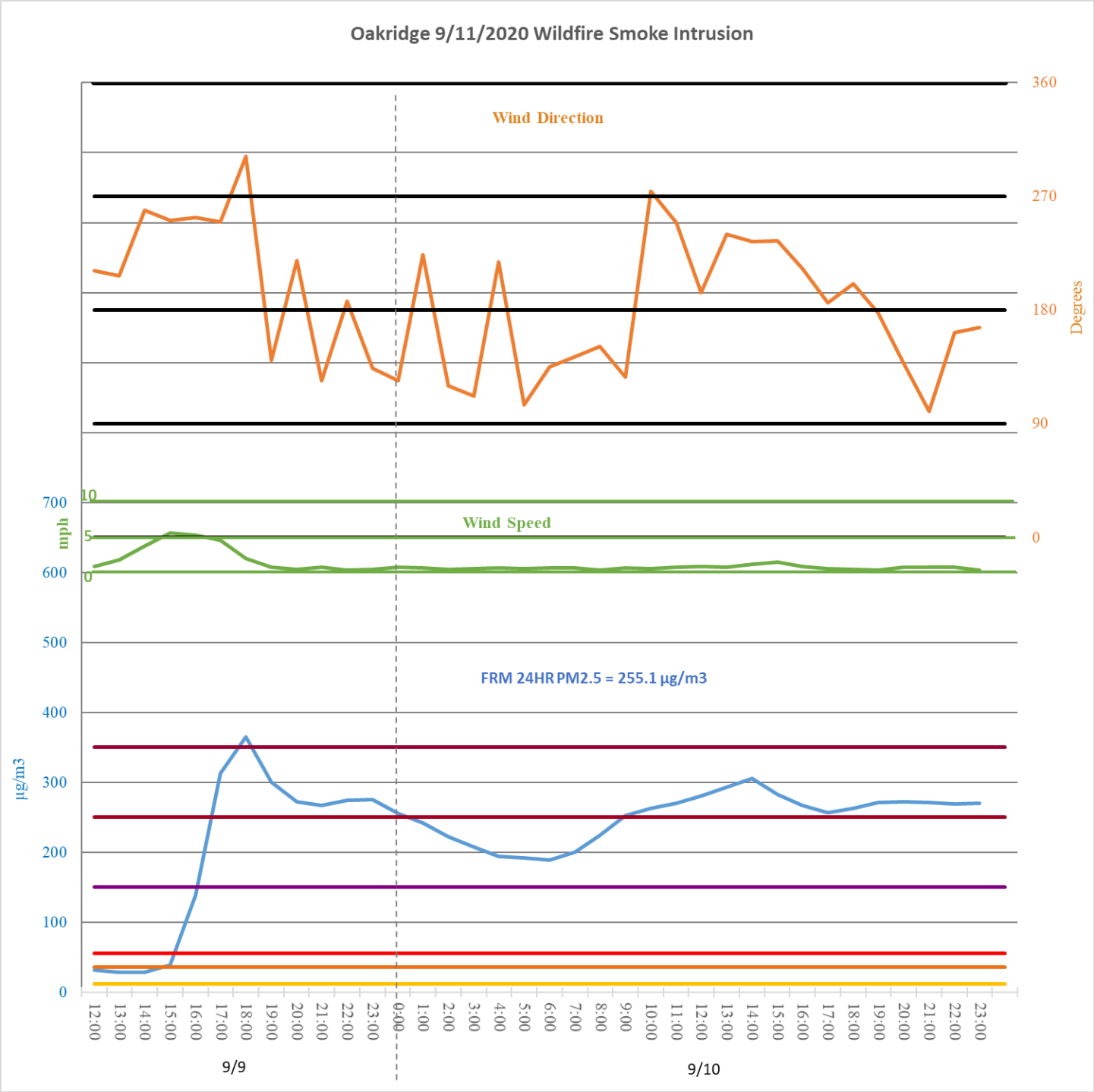


Figure 23. Satellite Smoke and back trajectory HYSPLIT Model Image, 9/11/2020

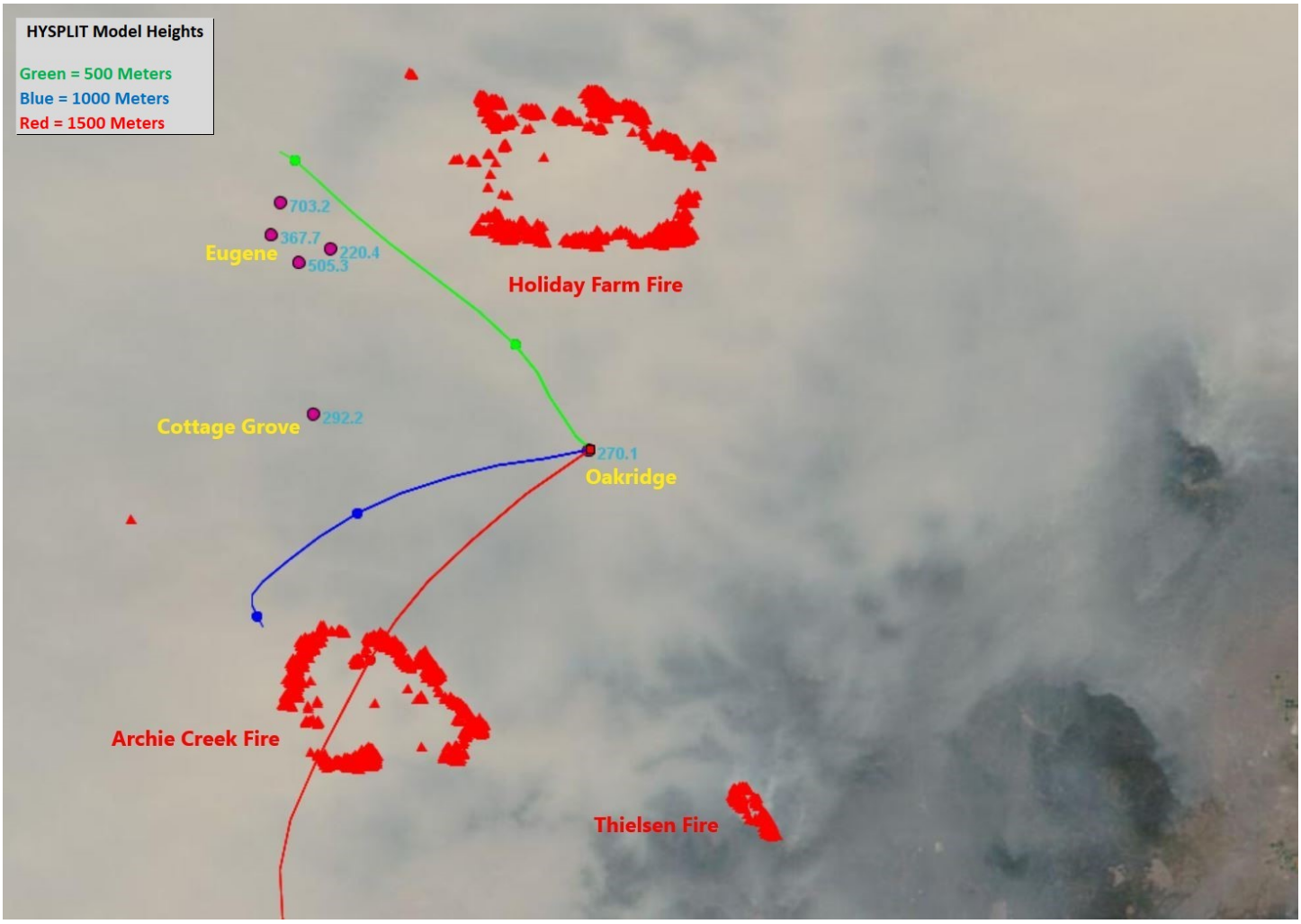


Figure 24. Time Series, 9/12/2020

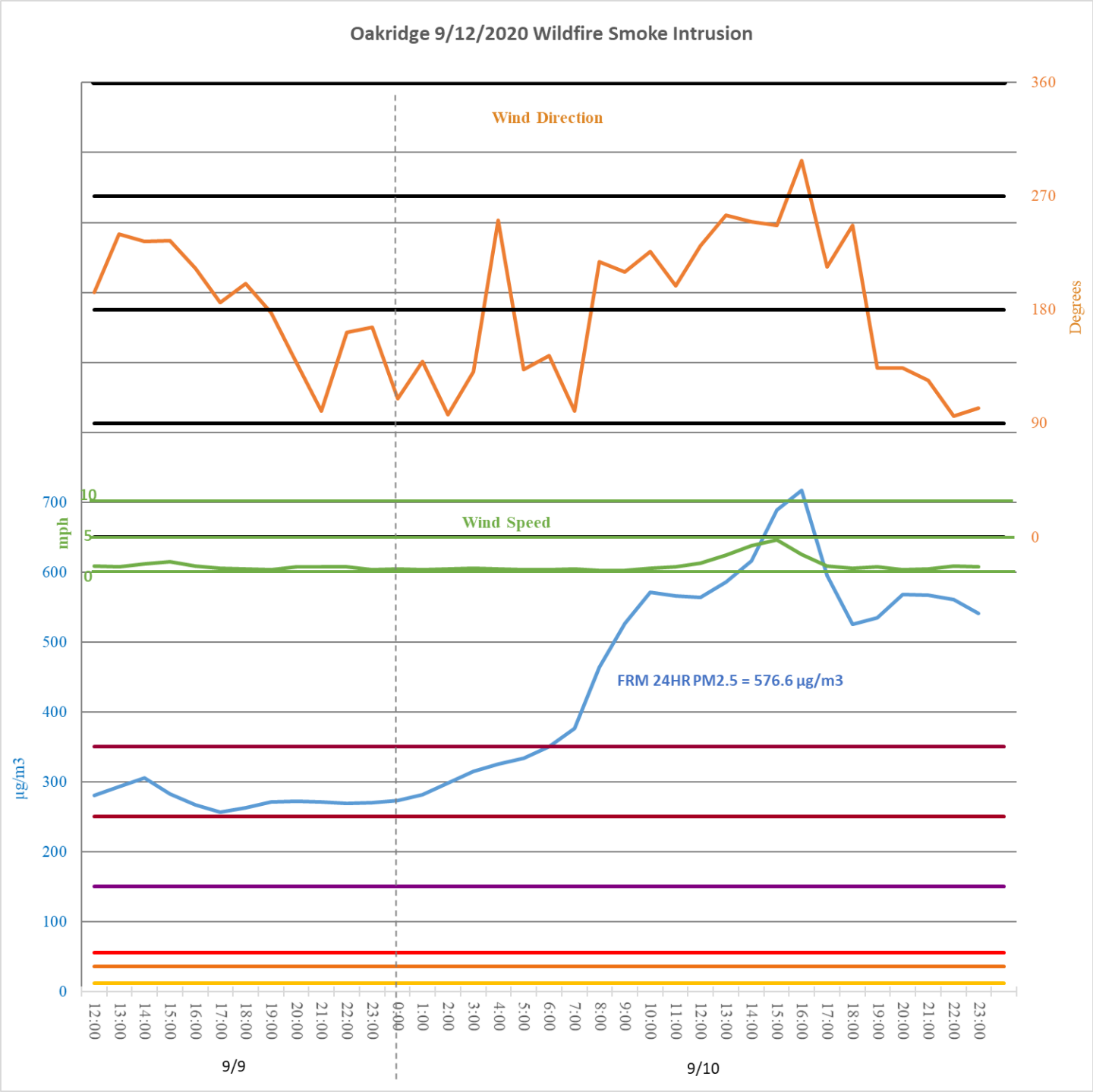


Figure 25. Satellite Smoke and back trajectory HYSPLIT Model Image, 9/12/2020

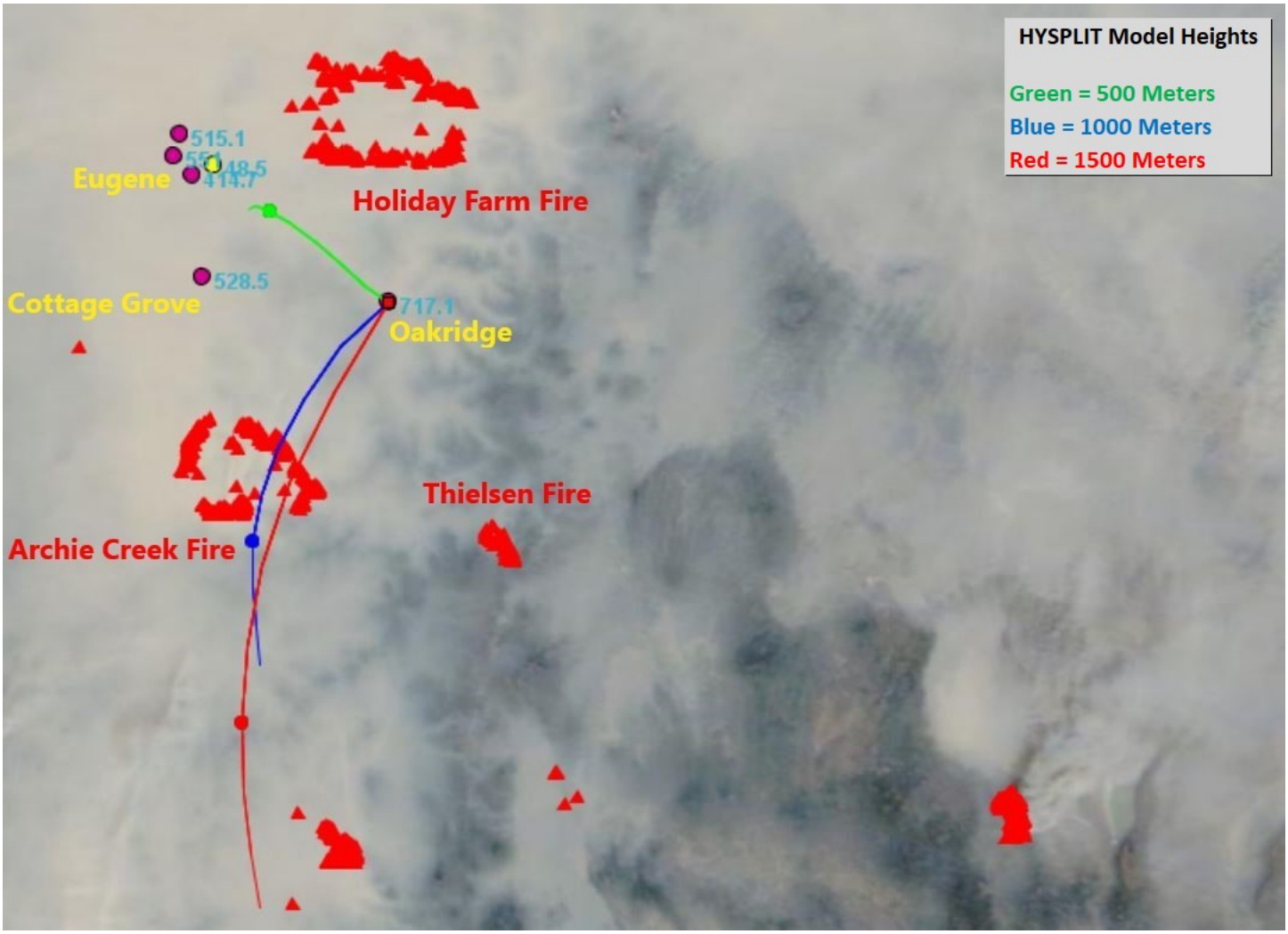


Figure 26. Time Series, 9/13/2020

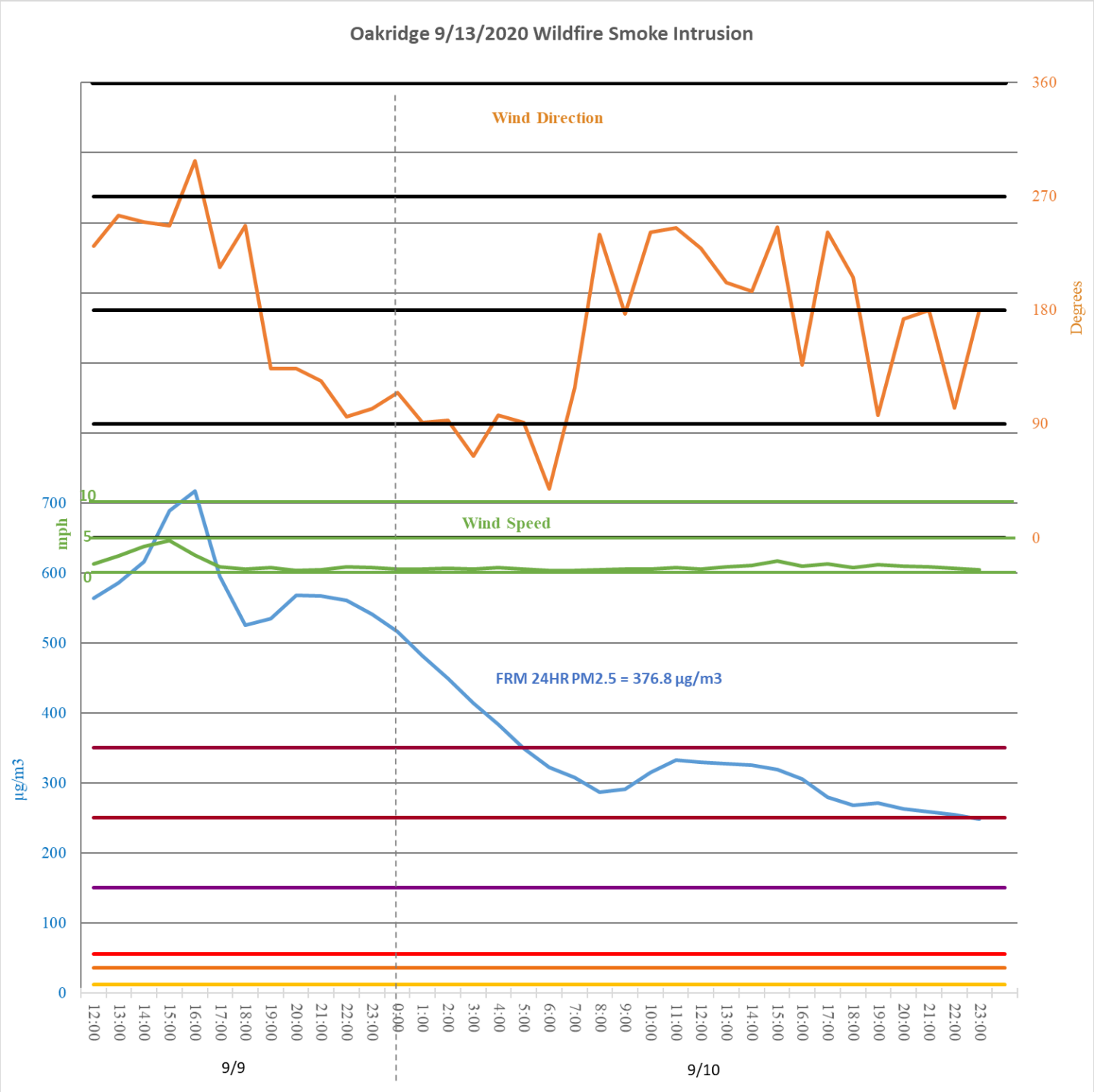


Figure 27. Satellite Smoke and back trajectory HYSPLIT Model Image, 9/13/2020

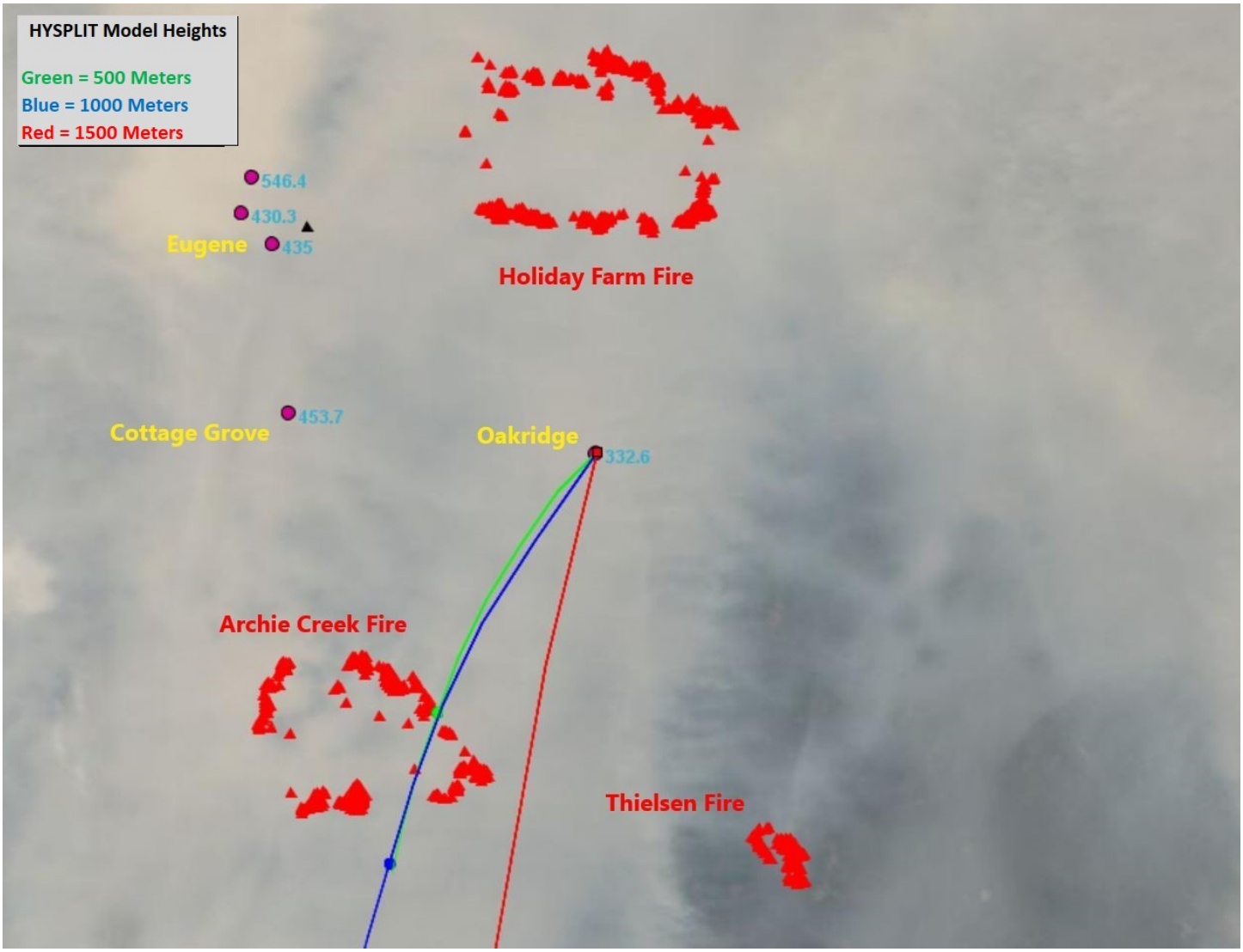


Figure 28. Time Series, 9/14/2020

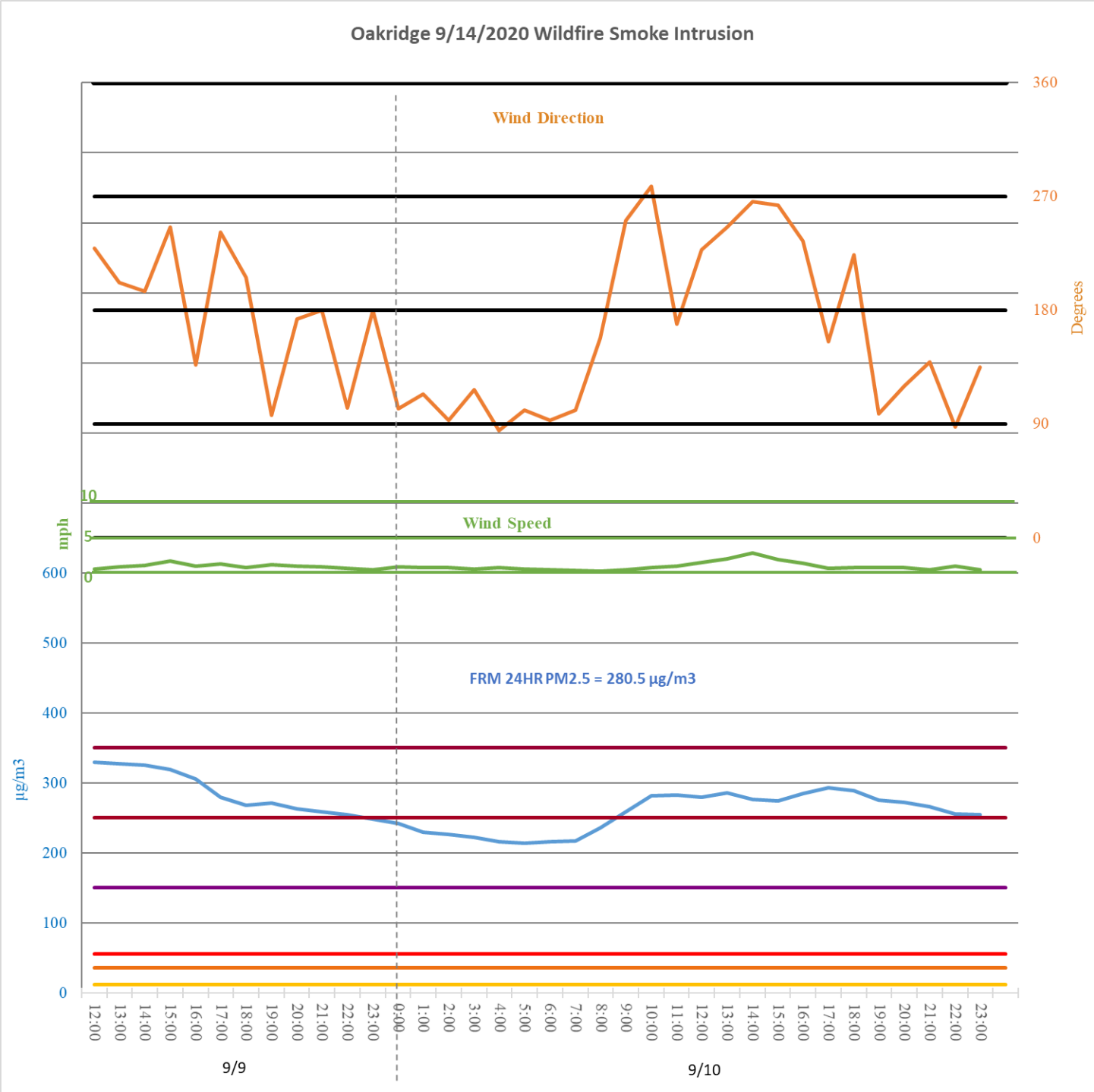


Figure 29. Satellite Smoke and back trajectory HYSPLIT Model Image, 9/14/2020

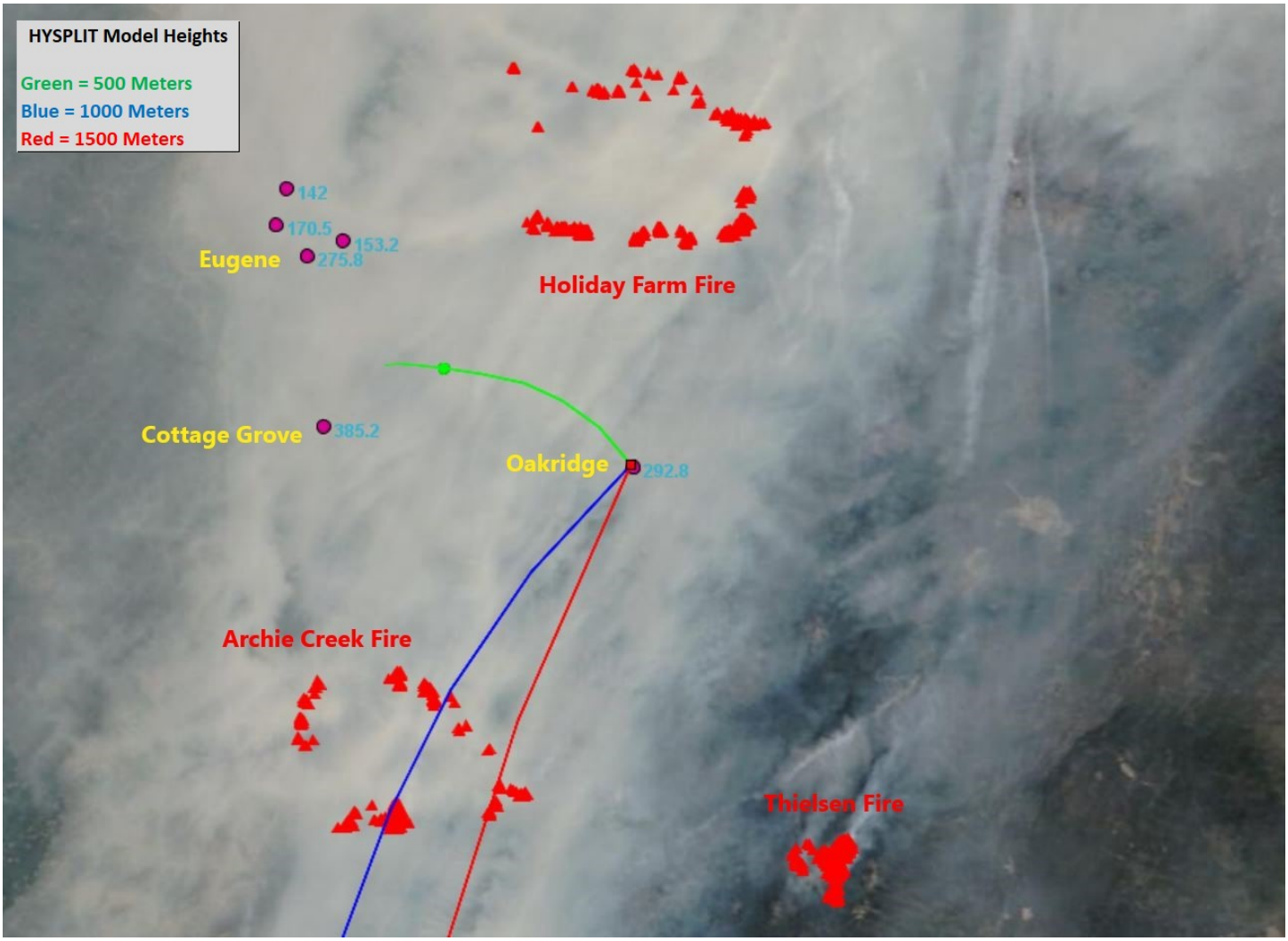


Figure 30. Time Series, 9/15/2020

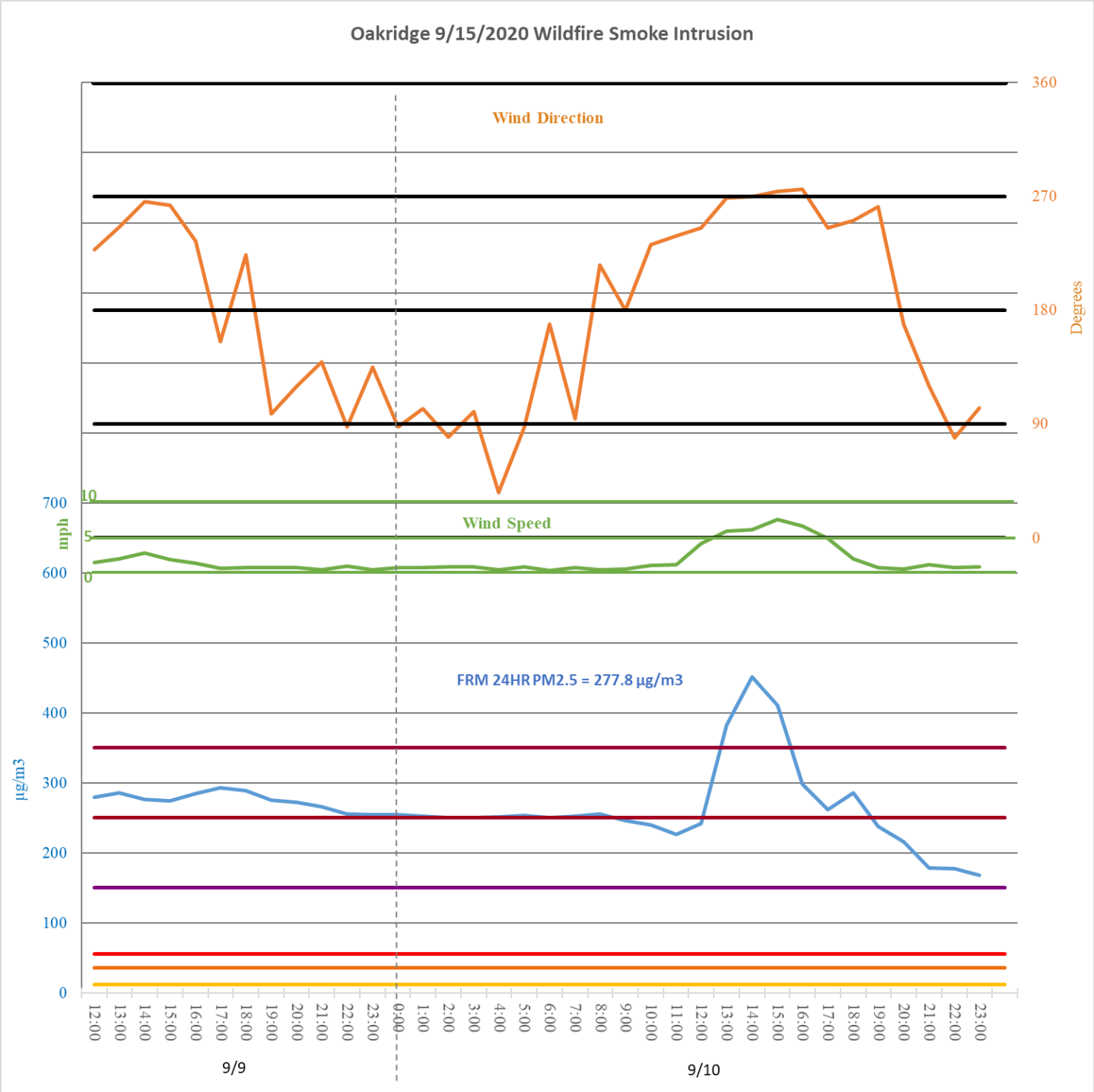


Figure 31. Satellite Smoke and back trajectory HYSPLIT Model Image, 9/15/2020

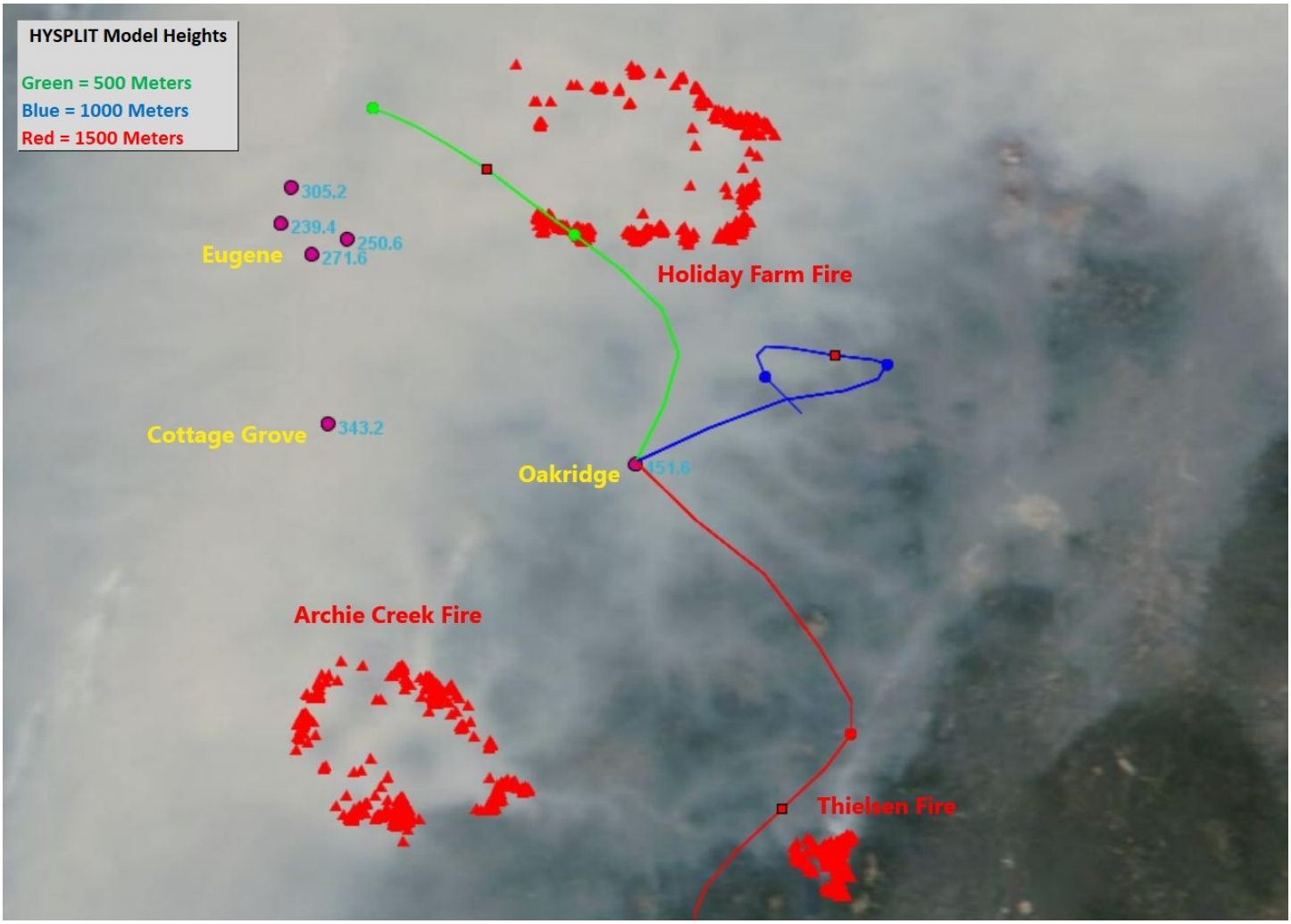


Figure 32. Time Series, 9/16/2020

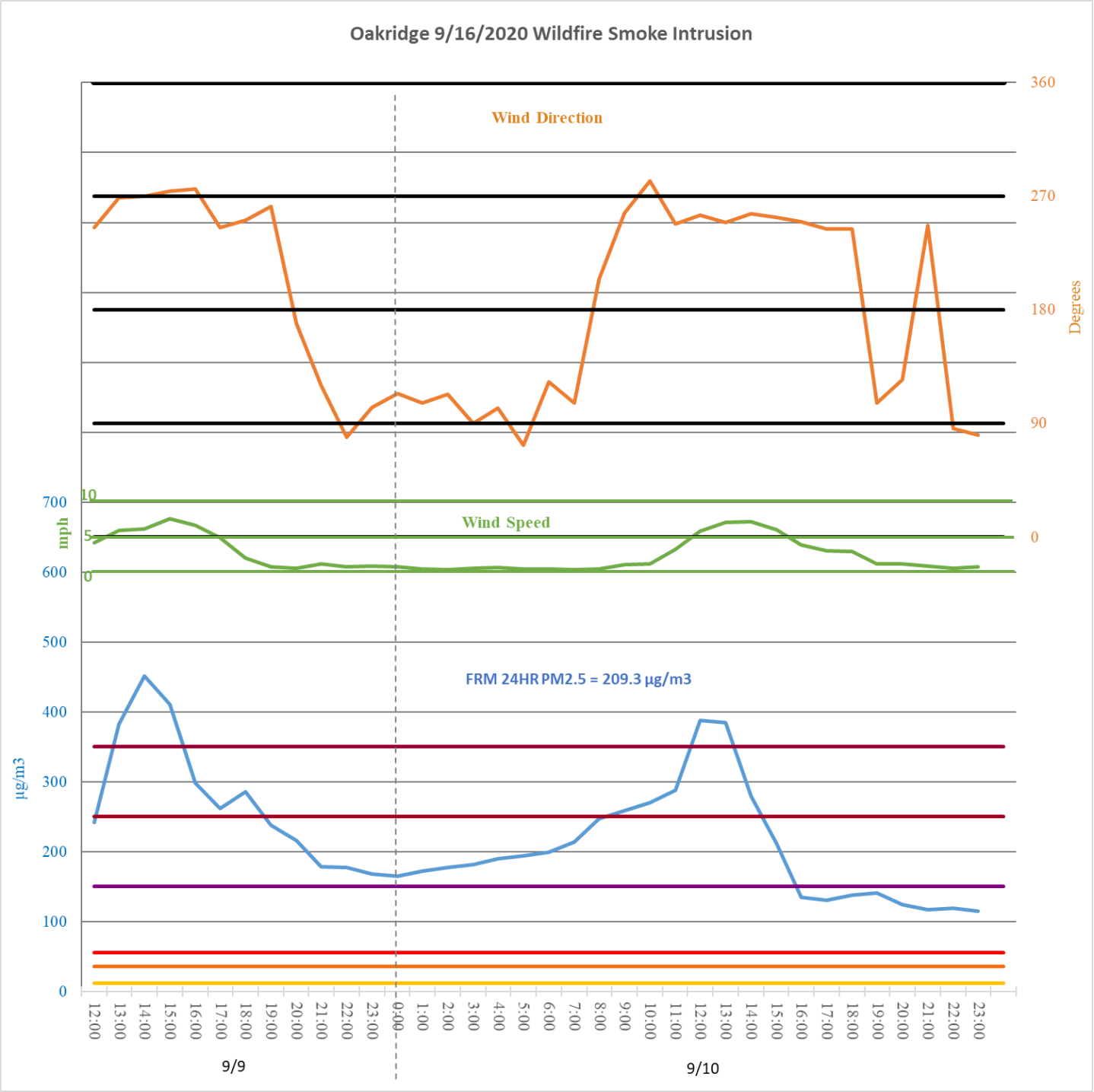


Figure 33. Satellite Smoke and back trajectory HYSPLIT Model Image, 9/16/2020

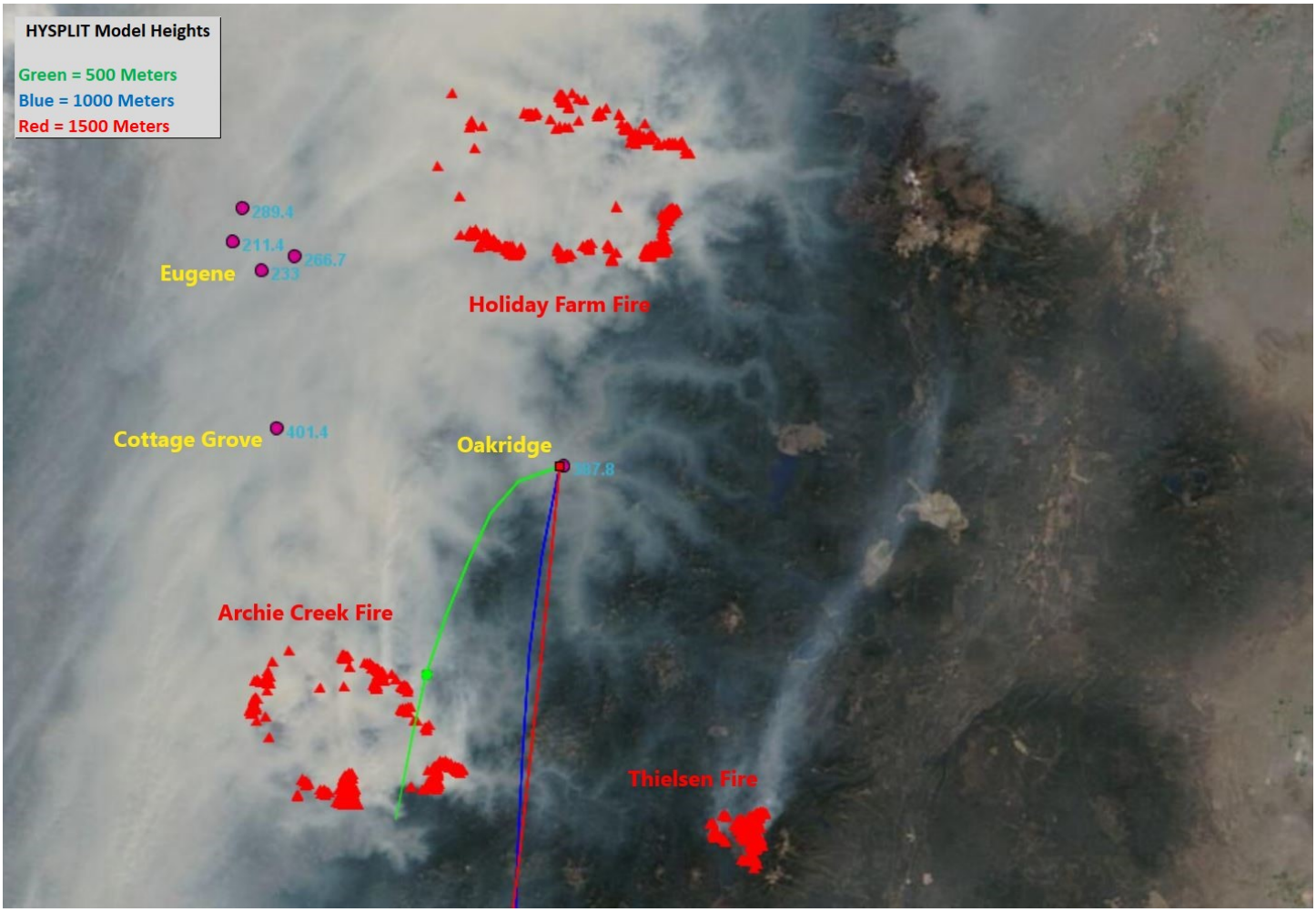


Figure 34. Time Series, 9/17/2020

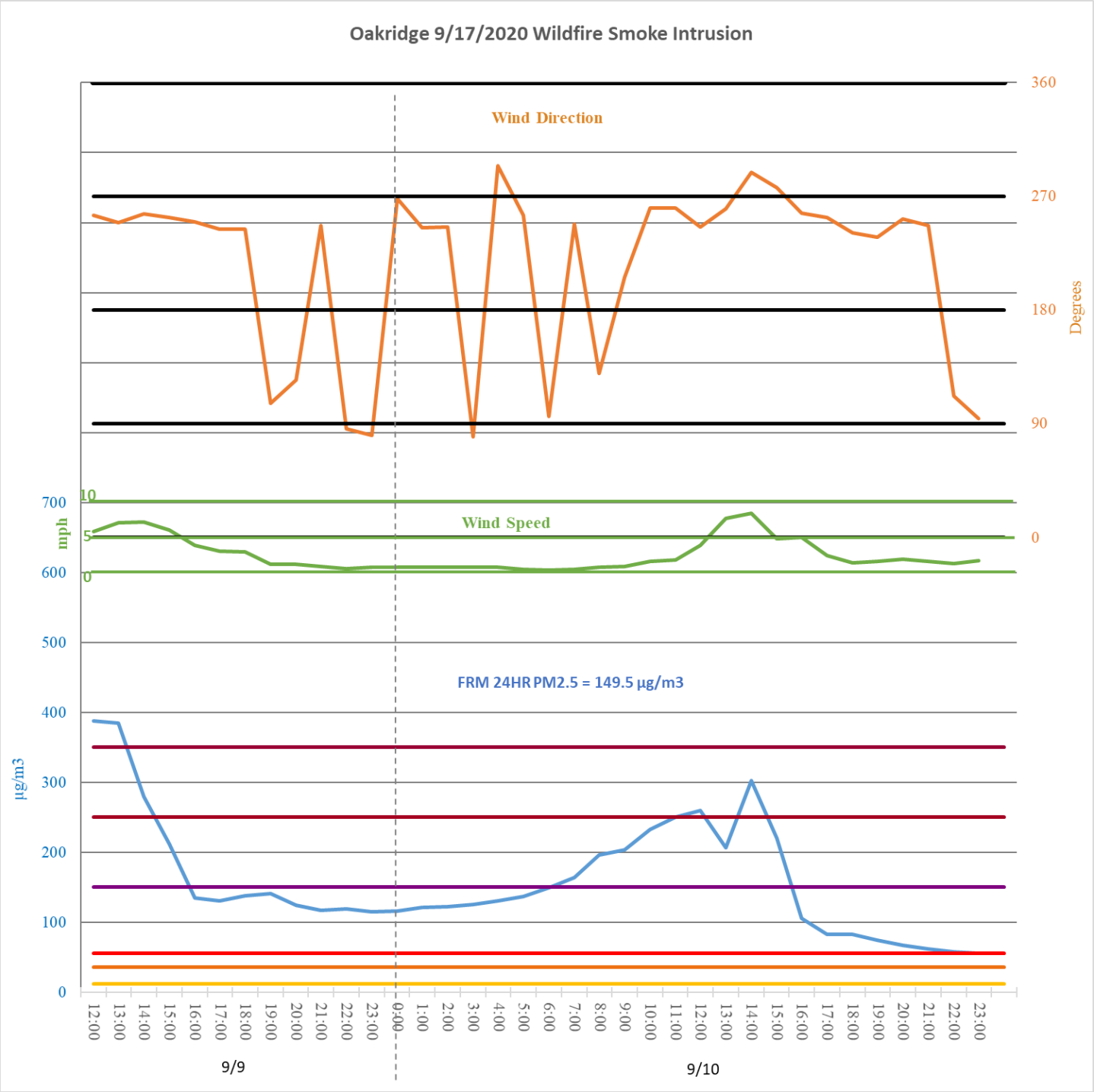


Figure 35. Satellite Smoke and back trajectory HYSPLIT Model Image, 9/17/2020

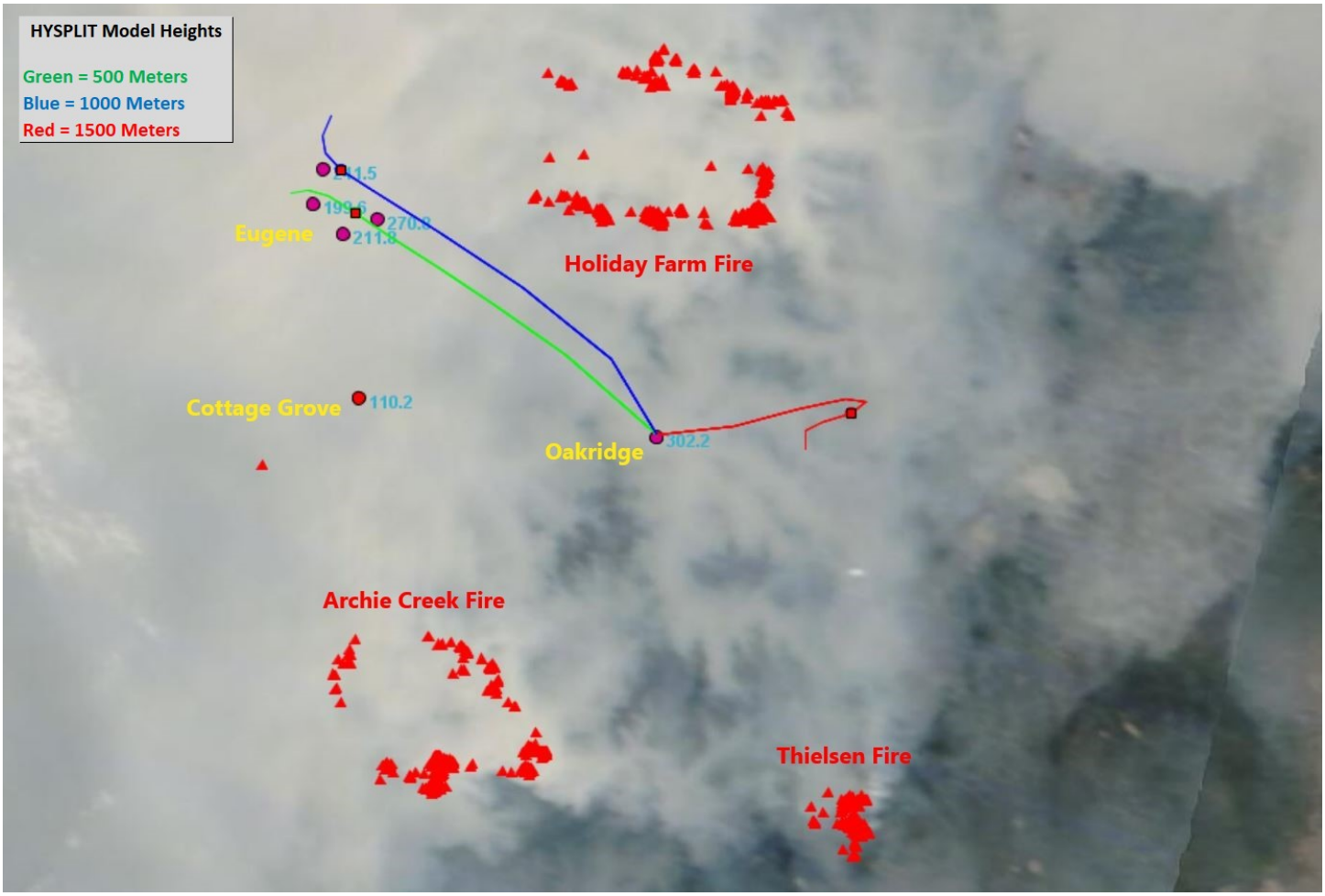


Figure 36. Time Series, 9/18/2020

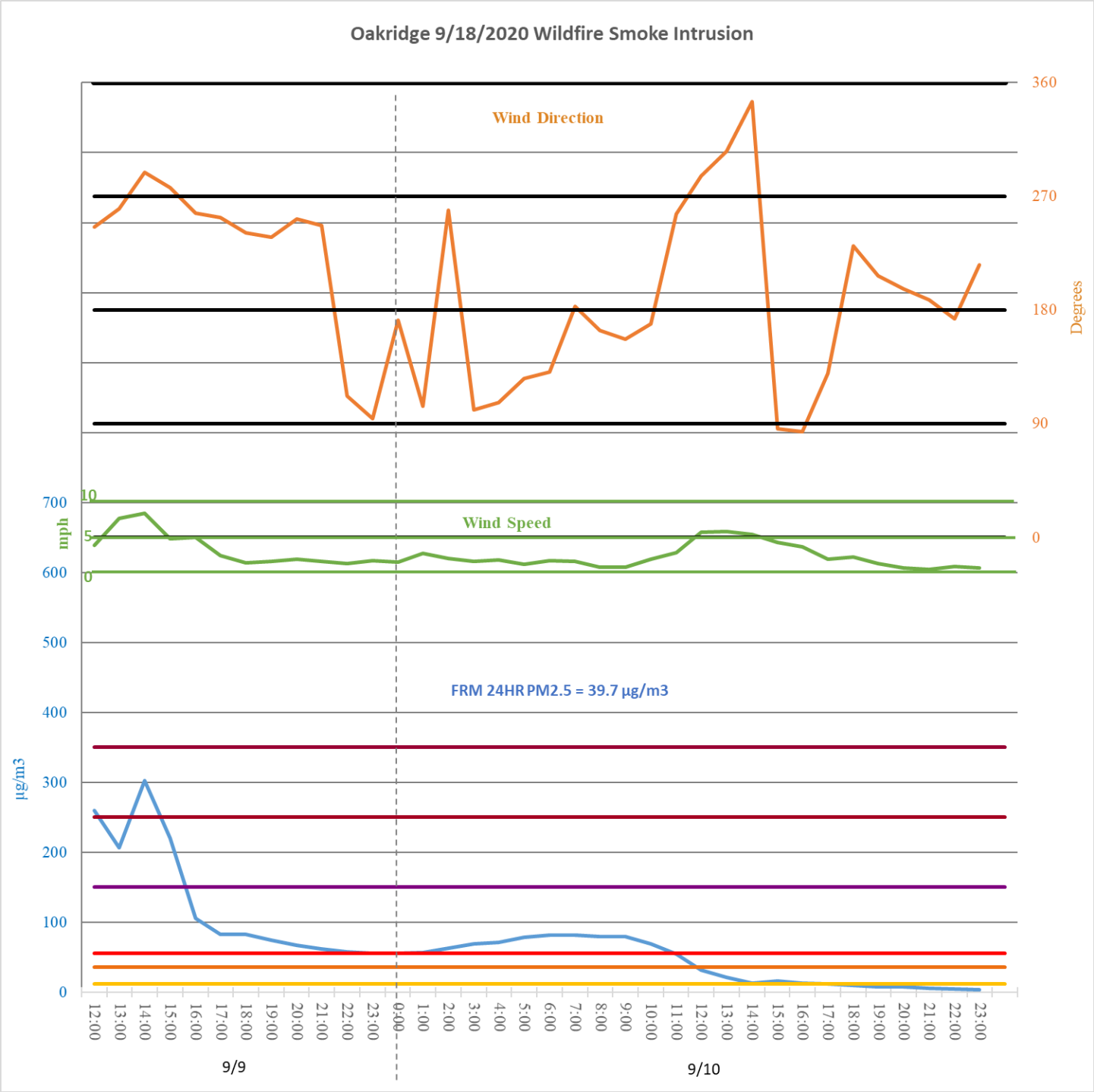


Figure 37. Satellite Smoke and back trajectory HYSPLIT Model Image, 9/18/2020