2020 Wildfire Plumes Observed by Satellite and Ground Sensors at San Francisco Bay

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Ames Research Center

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Summer 2021

UTSA

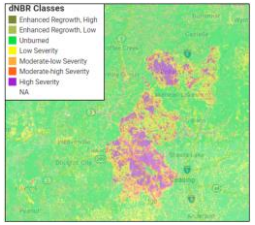
Earth Science Career Path

Geosphere

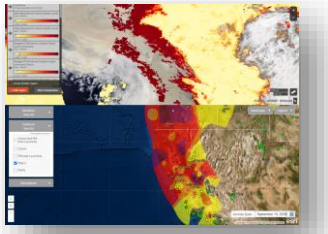
Hydrosphere

Biosphere

Atmosphere



Wildfire Impact on Vegetation



Wildfire Impact on Air Quality

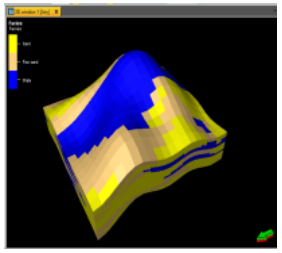
Glaciers Mass Balance

Climate Change

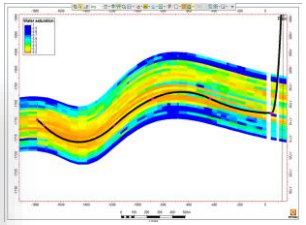
Earth Surface

Energy

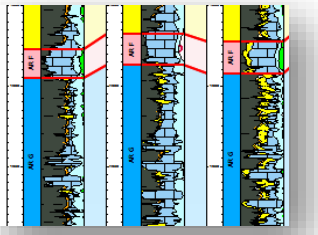
Reservoir 3D Modelling



Geo-steering



Borehole Geophysics

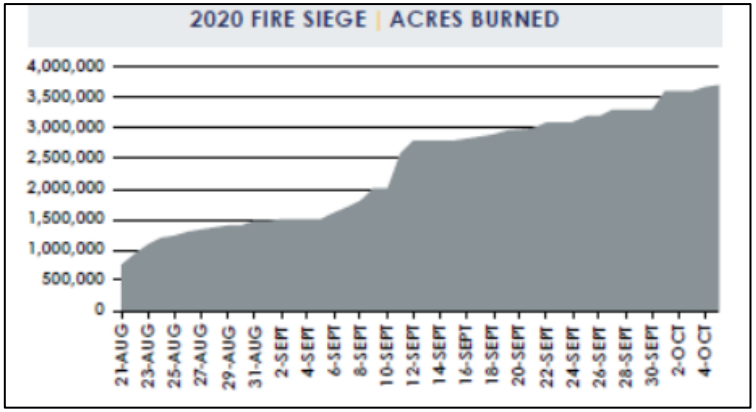


Agenda

- Challenges
- Background
- Methodology
- Findings
- Conclusions
- Acknowledgment

Top 6 Largest California Wildfires

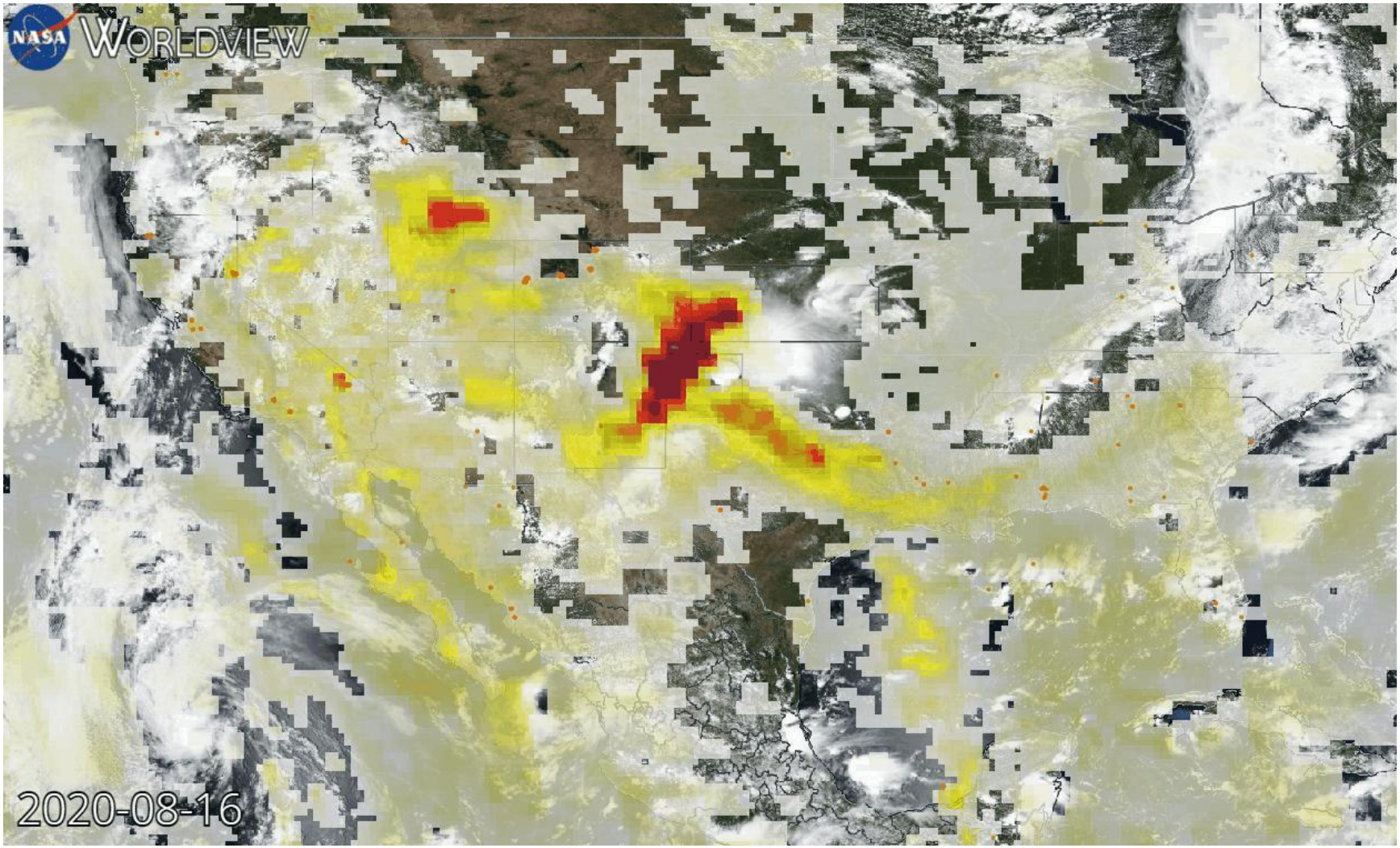
RANK	FIRE NAME (CAUSE)	DATE	COUNTY	ACRES	STRUCTURES DESTROYED	DEATHS
1	AUGUST COMPLEX *(Under Investigation)**	August 2020	Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake, & Colusa	1,032,648	54	0
2	MENDOCINO COMPLEX *(Under Investigation)**	July 2018	Colusa, Lake, Mendocino & Glenn	459,123	280	1
3	SCU LIGHTNING COMPLEX *(Under Investigation)**	August 2020	Stanislaus, Santa Clara, Alameda, Contra Costa, & San Joaquin	396,624	222	0
4	CREEK FIRE *(Under Investigation)**	September 2020	Fresno & Madera	374,466	856	0
5	LNU LIGHTNING COMPLEX *(Under Investigation)**	August 2020	Sonoma, Lake, Napa, Yolo & Solano	363,220	1,491	6
6	NORTH COMPLEX *(Under Investigation)**	August 2020	Butte, Plumas & Yuba	318,930	2,455	15



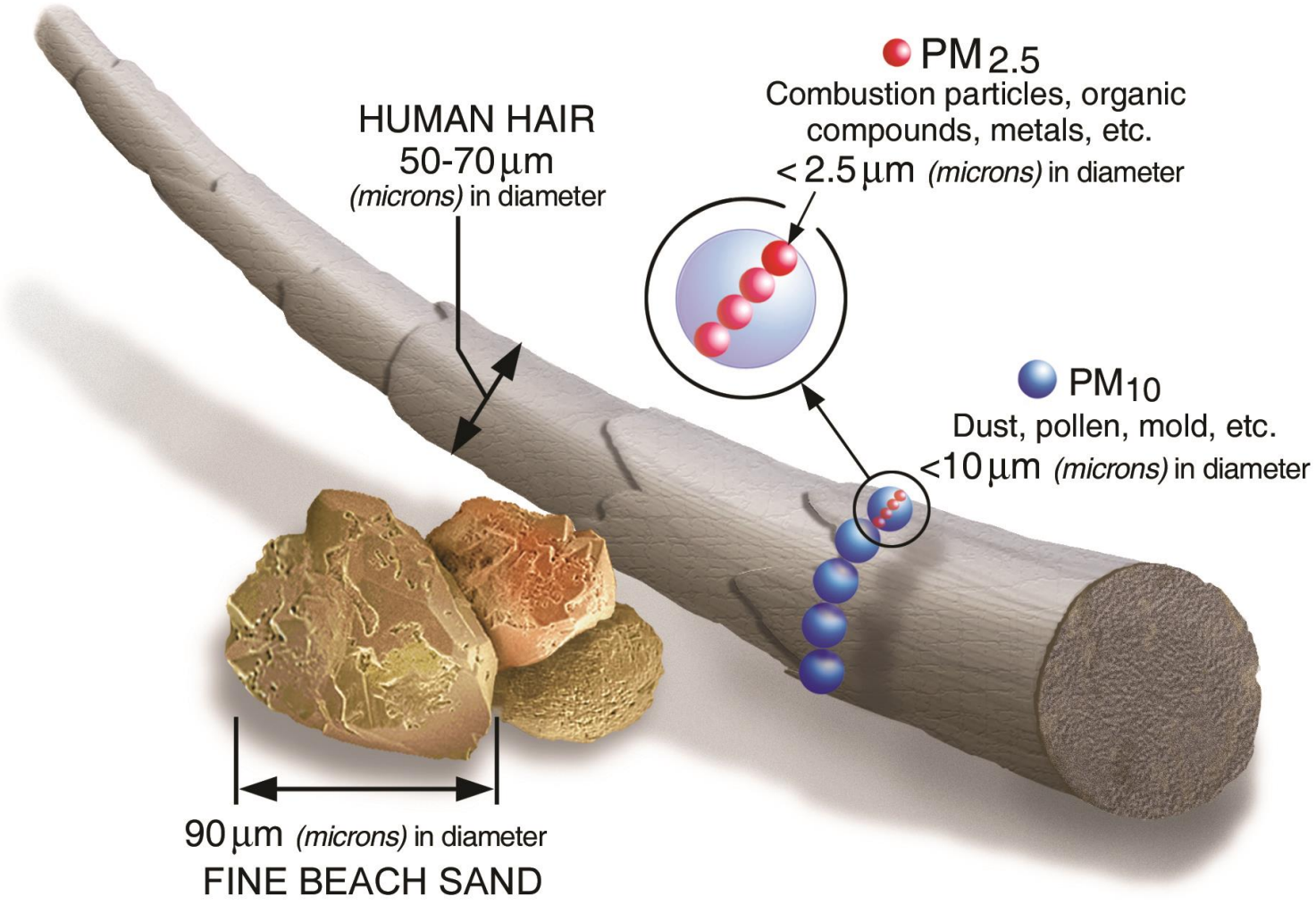
"*The 2020 Fire Season will be counted among the most severe since the founding of our nation*" – CALFIRE 2020 Report

San Francisco During Wildfire

Suomi Aerosol Index



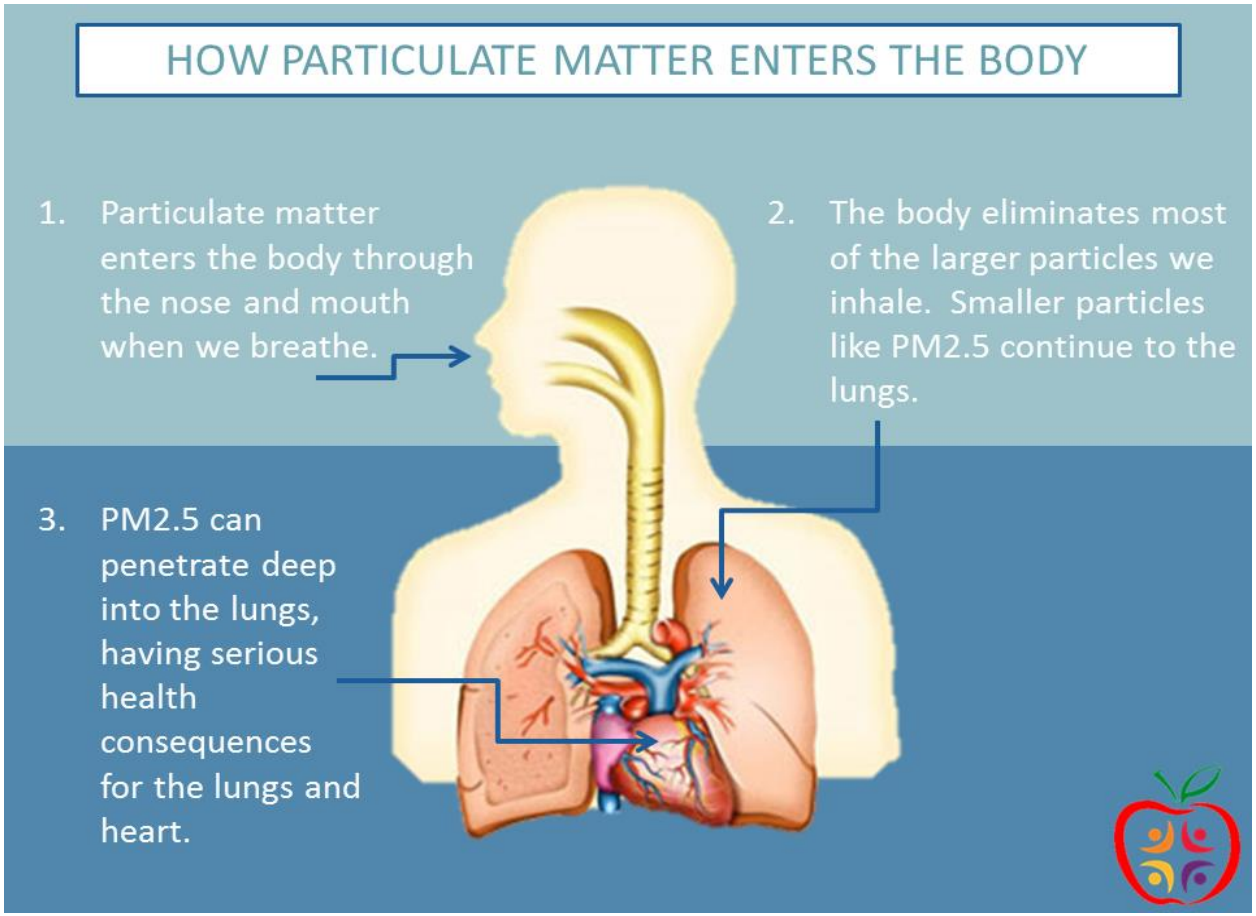
PM 2.5


HUMAN HAIR
50-70 µm
(microns) in diameter
PM2.5
Combustion particles, organic compounds, metals, etc.
< 2.5 µm (microns) in diameter
PM10
Dust, pollen, mold, etc.
<10 µm (microns) in diameter
90 µm (microns) in diameter
FINE BEACH SAND

EPA-USA

Why PM 2.5?


1 out of 8 deaths are due to air pollution
(WHO, 2014)


HOW PARTICULATE MATTER ENTERS THE BODY
1. Particulate matter enters the body through the nose and mouth when we breathe.
2. The body eliminates most of the larger particles we inhale. Smaller particles like PM2.5 continue to the lungs.
3. PM2.5 can penetrate deep into the lungs, having serious health consequences for the lungs and heart.

Methodology

Satellite AOD

EPA AQS PM 2.5

Meteorology Temp & RH

Weather Balloon Vertical Profile

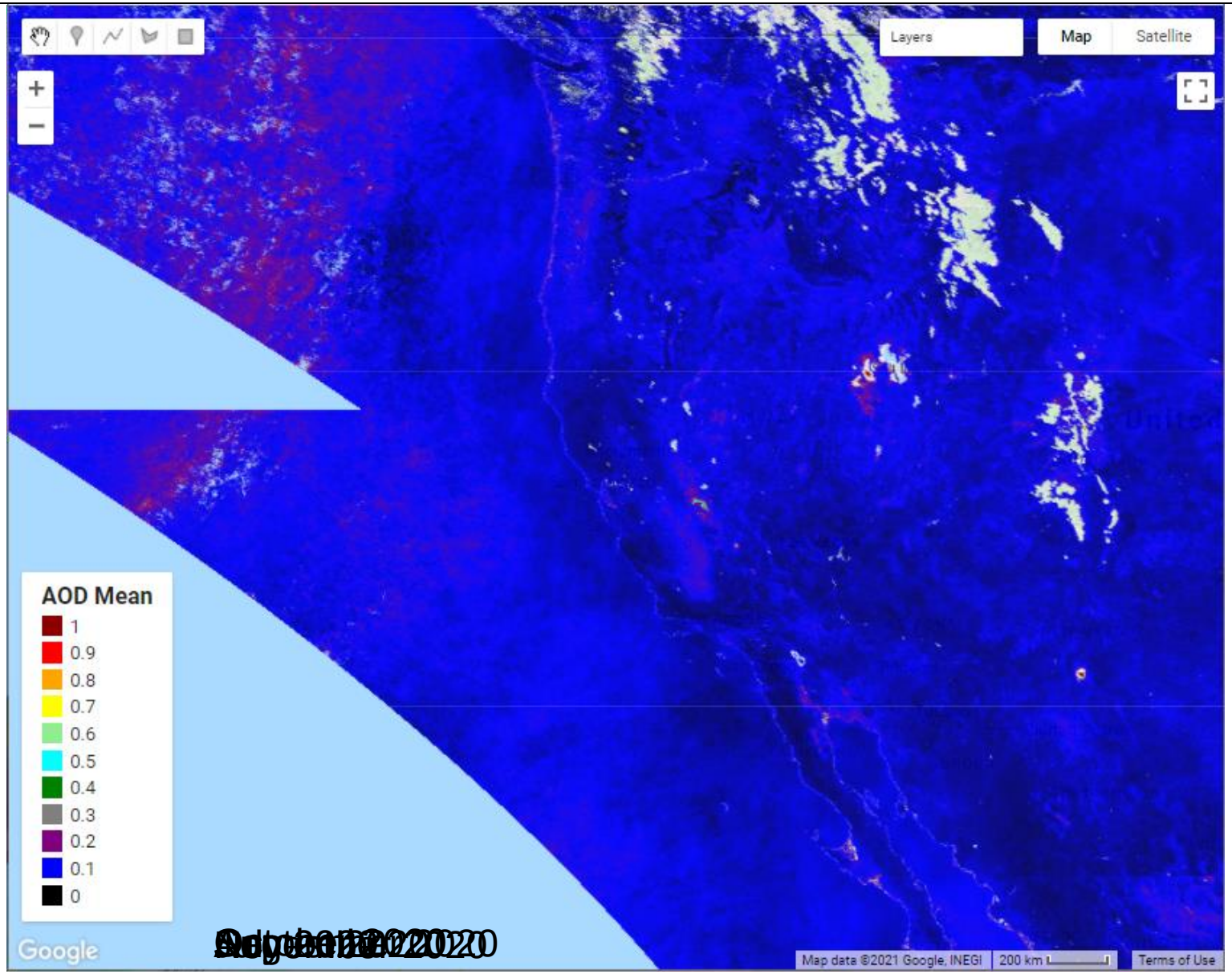
Collecting

Processing

Analyzing

Integrating

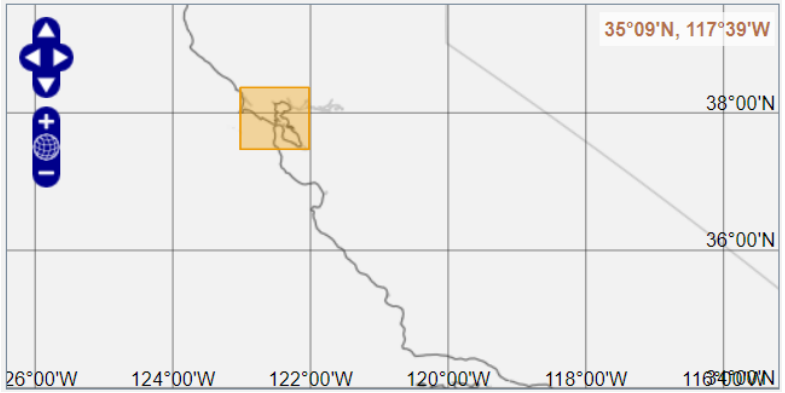
Monthly Mean Aerosol Optical Depth



Ground PM 2.5 Vs. Satellite AOD

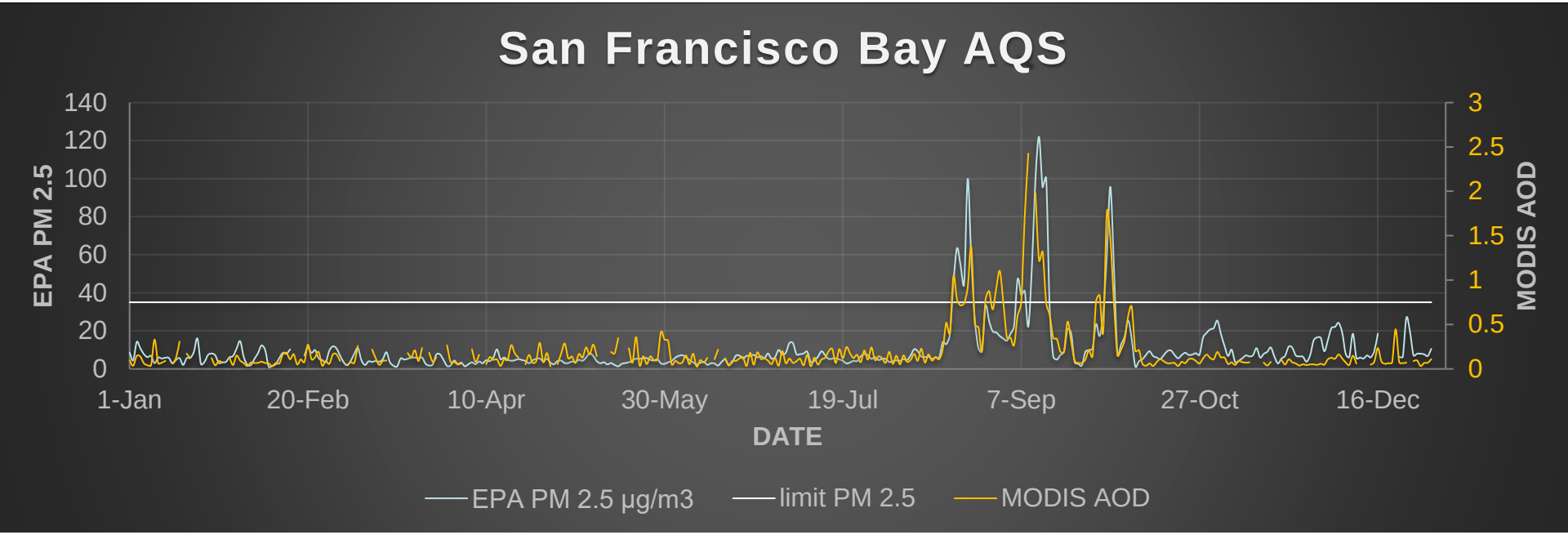
	$PM_{2.5}$ ($\mu g/m^3$) 24-hour
Good	0.0 – 12.0
Moderate	12.1 – 35.4
Unhealthy for Sensitive Groups	35.5 – 55.4
Unhealthy	(55.5 - 150.4)^3
Very unhealthy	(150.5 - (250.4)^3
Hazardous	(250.5 - (350.4)^3
Hazardous	(350.5 - 500.4)^3

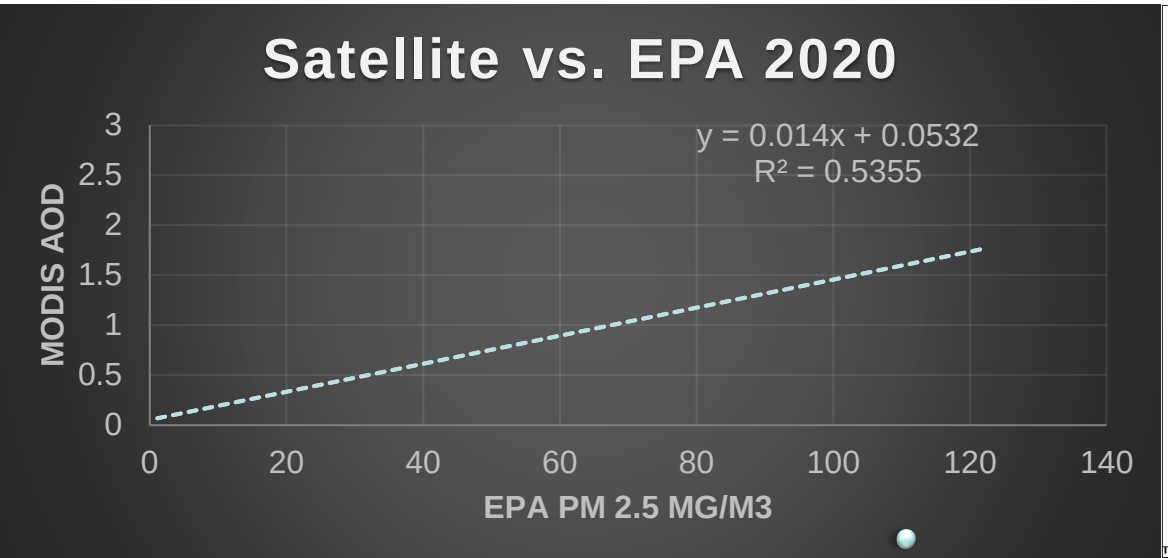
Hourly/Daily

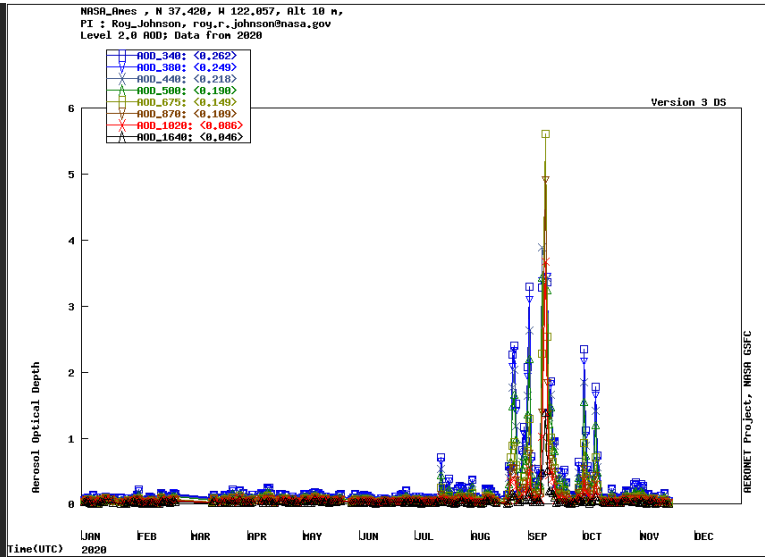


Daily
Daytime snapshot

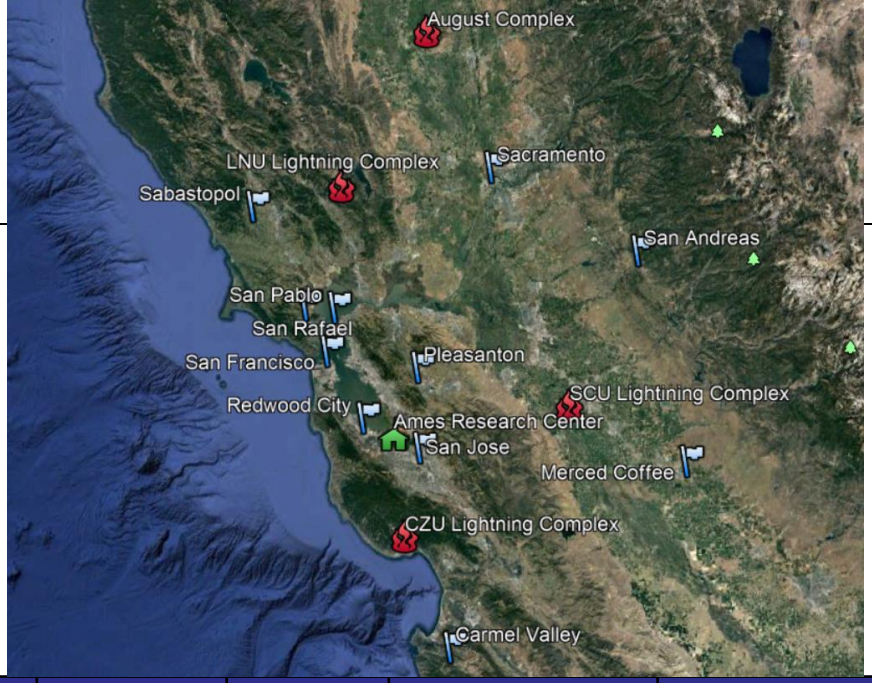
San Francisco Bay 2020



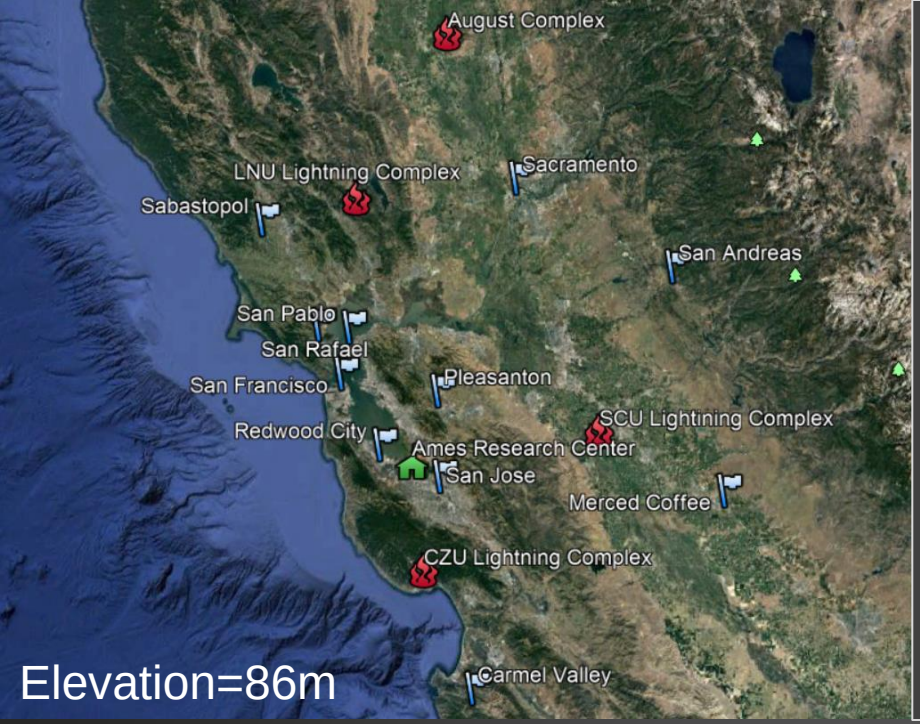


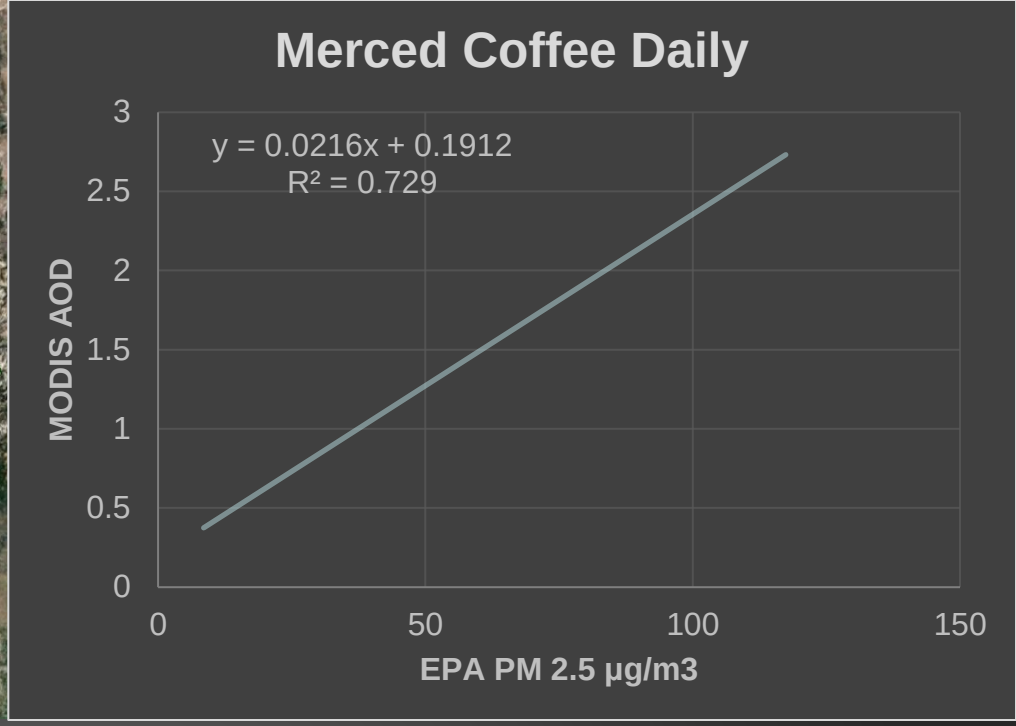


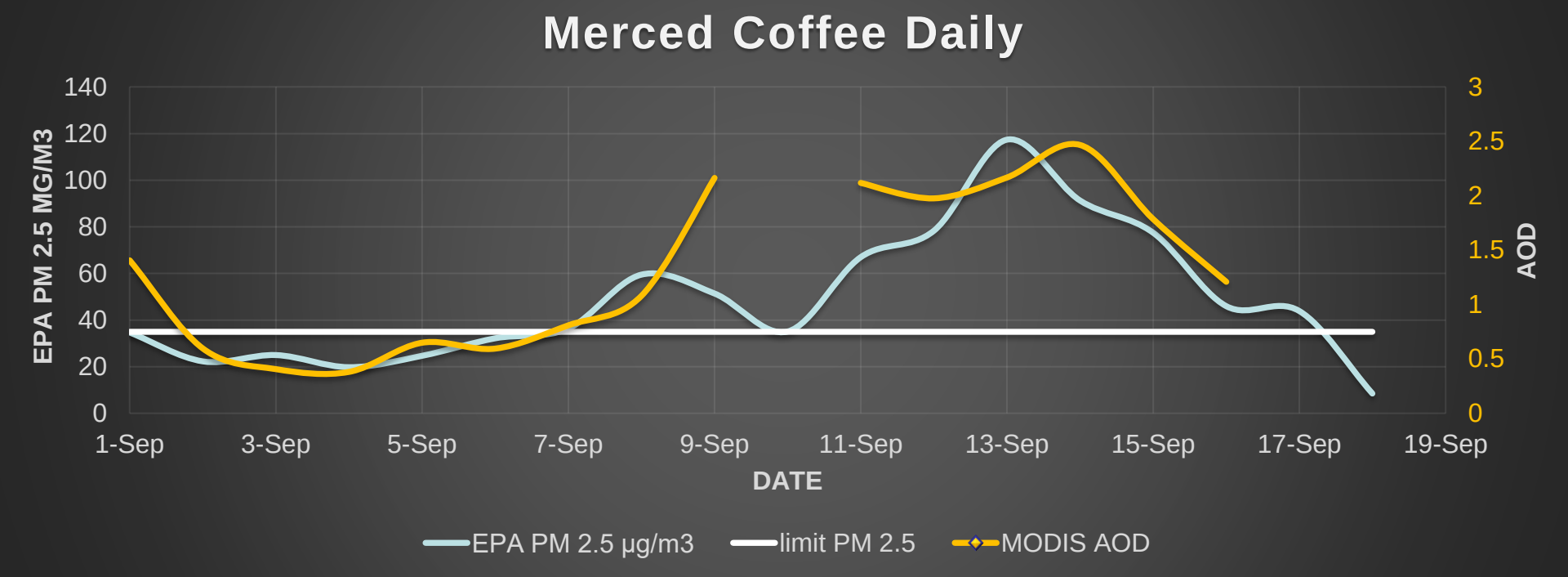
Summary

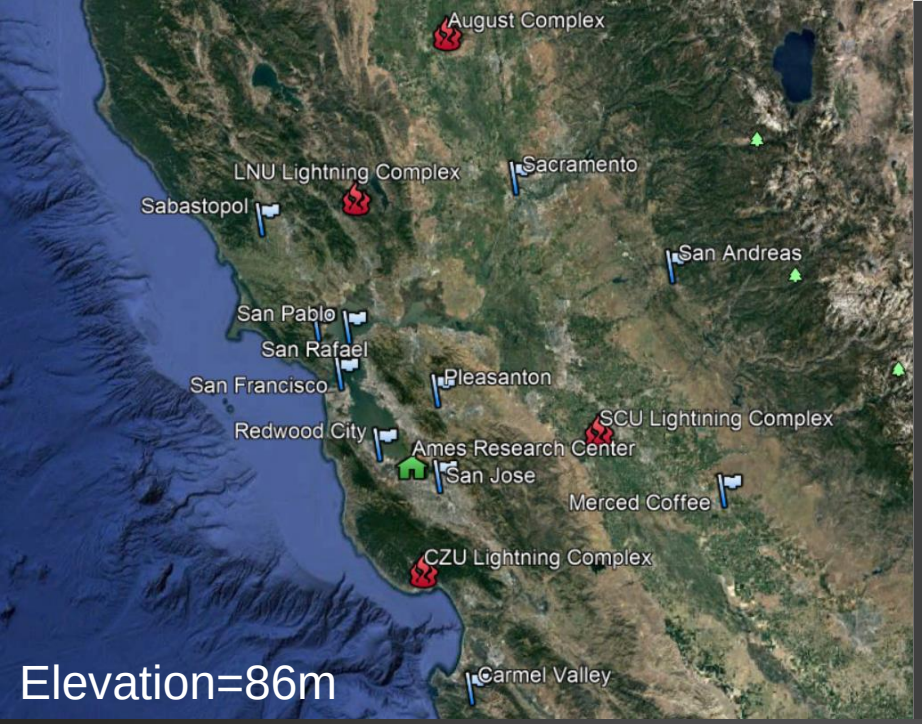


	Lat	Long	EPA Days	Satellite days	EPA Dates SEP-2020	Satellite Dates SEP-2020	1/2 deg	Elevation meters MSL	Regression R^2
San Rafael	37.97	-122.52	5	6	10-14	8-13	-122.77,37.72,-122.27,38.22	3	0.217
San Pablo	37.96	-122.36	5	6	10-14	8-13	-122.61,37.71,-122.11,38.21	20	0.136
San Francisco	37.77	-122.4	5	6	10-14	8-13	-122.65,37.52,-122.15,38.02	5	0.134
Redwood	37.48	-122.2	5	7	10-14	8-14	-122.45,37.23,-121.95,37.73	3	0.378
San Jose	37.35	-121.89	5	7	11-15	8-14	-122.14,37.10,-121.64,37.60	31	0.197
Pleassanton	37.7	-121.9	8	7	7-14	8-14	-122.15,37.45,-121.65,37.95	101	0.382
Sebastopol	38.4	-122.82	5	8	10-14	7-15	-122.07,38.15,-121.57,38.65	78	0.726
San Andreas	38.2	-120.68	10	10	8-17	7-18	-120.93,37.95,-120.43,38.45	280	0.139
Merced-Coffee	37.28	-120.43	11	9	7-17	8-16	-120.74,37.03,-120.24,37.53	86	0.729
Sacramento	38.57	-121.49	11	9	4-17	4-15	-121.68,38.35,-121.18,38.82	13	0.480
Caramel Valley	36.48	-121.73	6	6	10-15	8-13	-121.98,36.23,-121.48,36.73	131	0.480


August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
SCU Lightining Complex
Redwood City
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=86m


Merced Coffee Daily
y = 0.0216x + 0.1912
R² = 0.729
MODIS AOD
EPA PM 2.5 µg/m3
0
0.5
1
1.5
2
2.5
3
0
50
100
150


Merced Coffee Daily
EPA PM 2.5 MG/M3
AOD
DATE
140
120
100
80
60
40
20
0
3
2.5
2
1.5
1
0.5
0
1-Sep
3-Sep
5-Sep
7-Sep
9-Sep
11-Sep
13-Sep
15-Sep
17-Sep
19-Sep
EPA PM 2.5 µg/m3
limit PM 2.5
MODIS AOD


August Complex
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Ames Research Center
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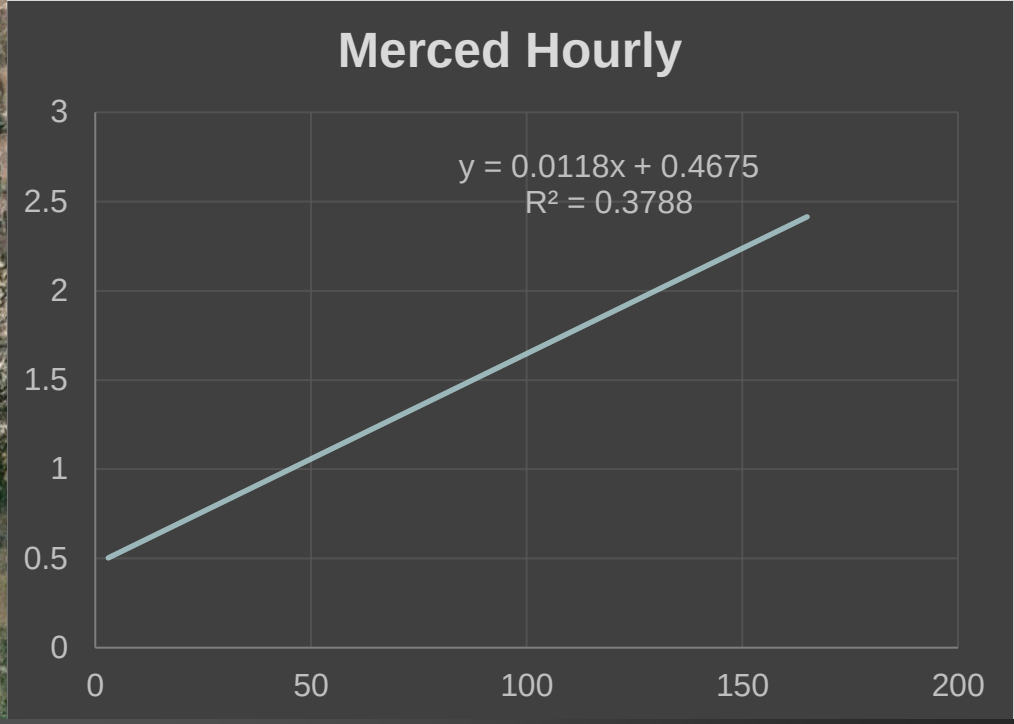
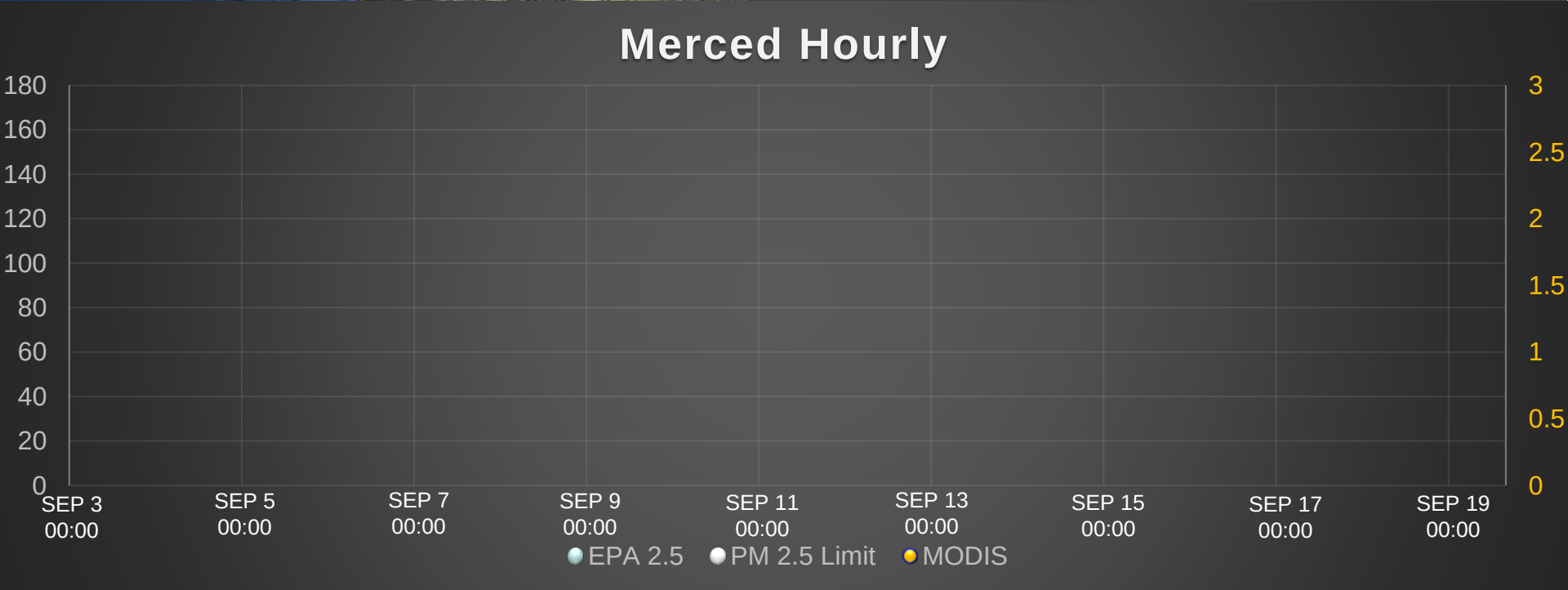
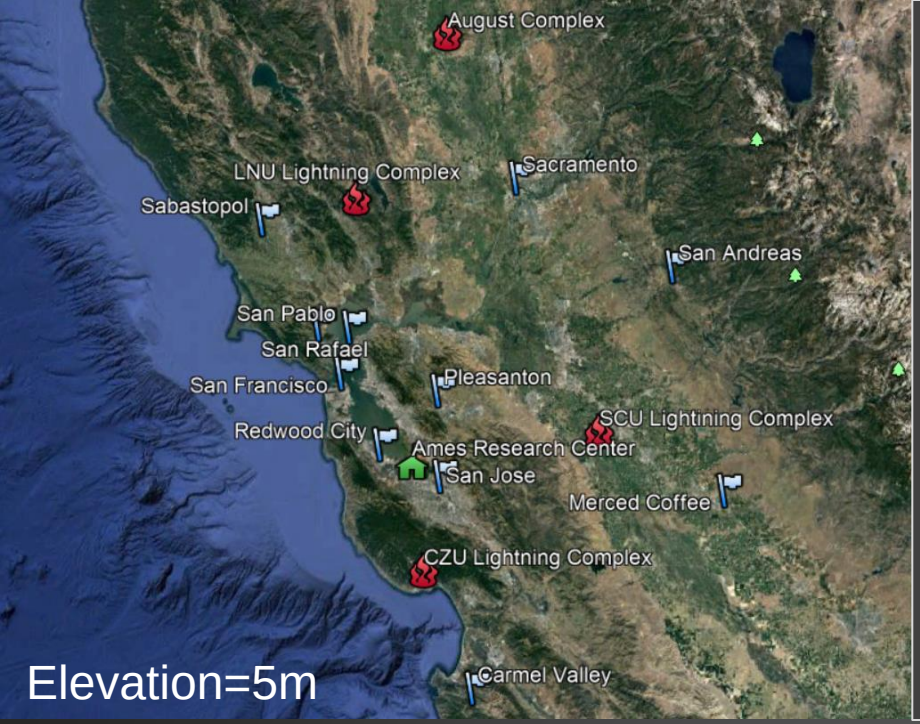
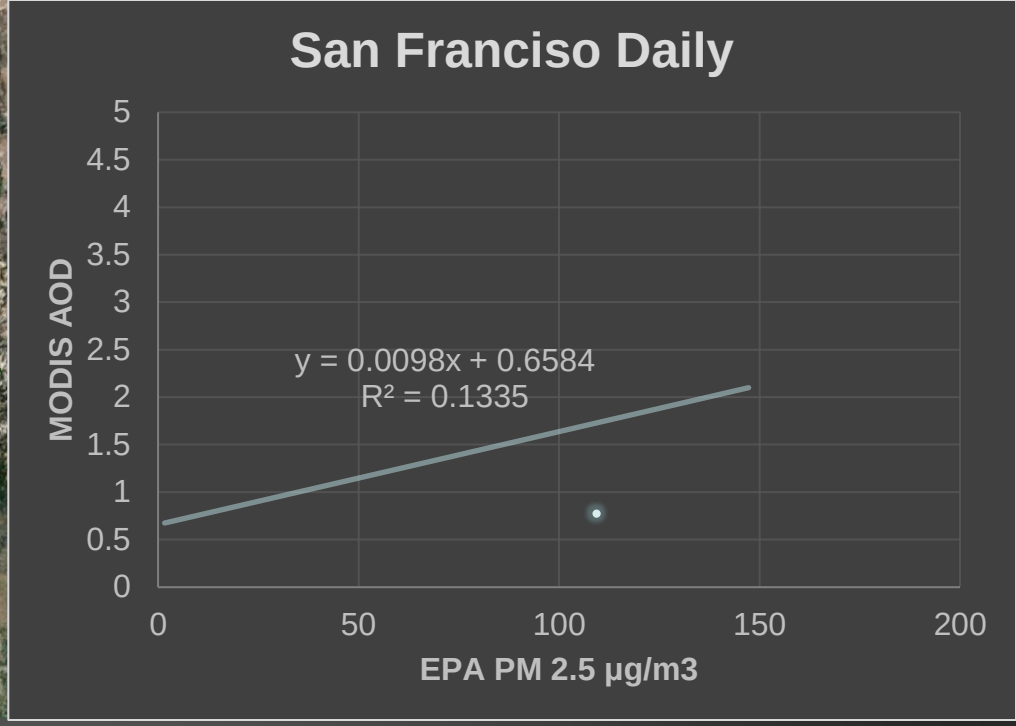
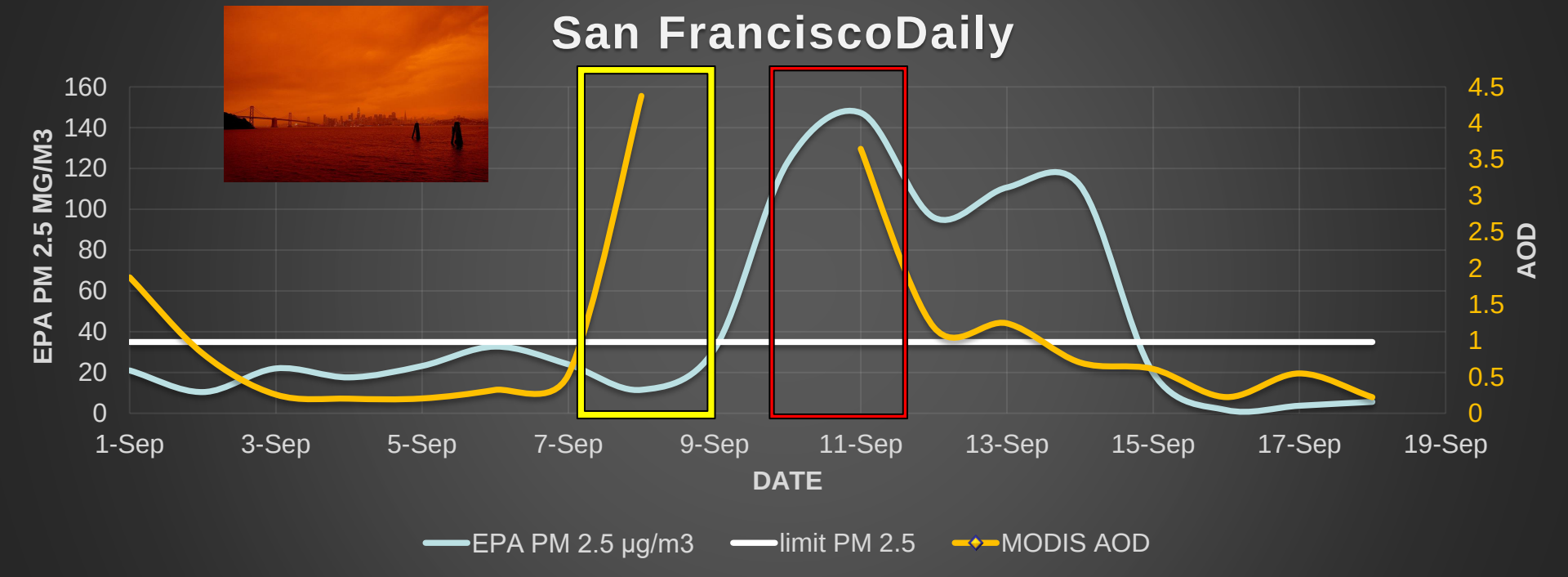
Carmel Valley
Elevation=86m

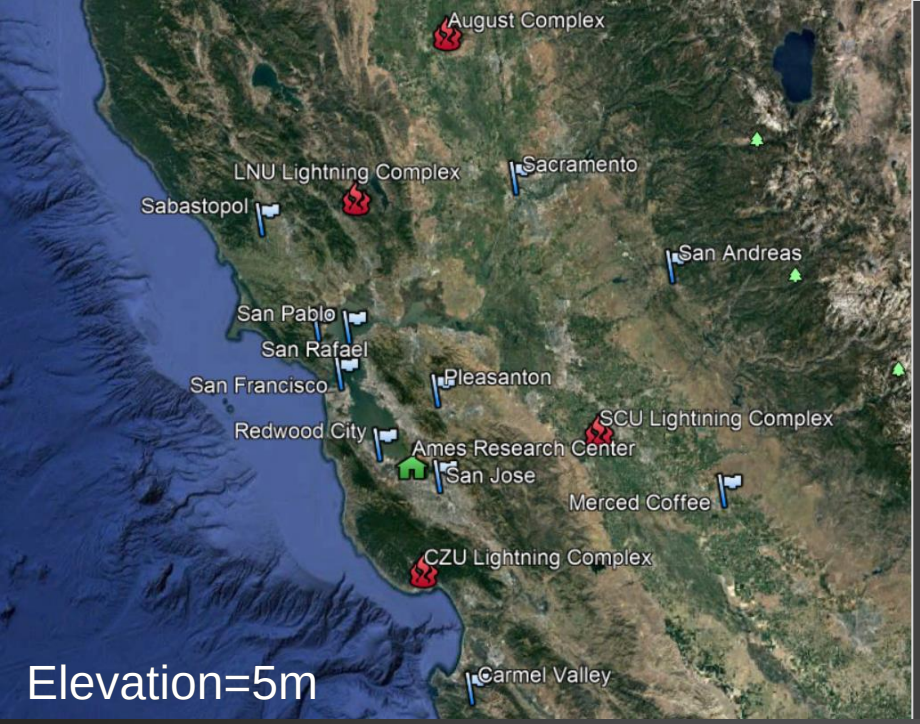

Merced Hourly
y = 0.0118x + 0.4675
R² = 0.3788
3
2.5
2
1.5
1
0.5
0
0
50
100
150
200

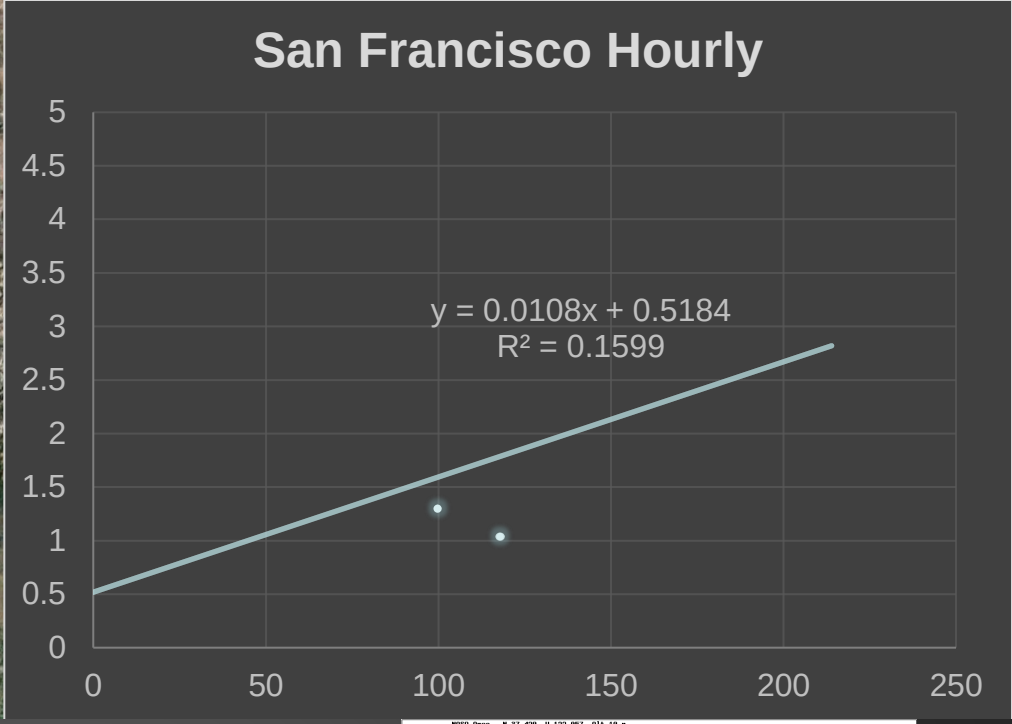

Merced Hourly
180
160
140
120
100
80
60
40
20
0
3
2.5
2
1.5
1
0.5
0
SEP 3 00:00
SEP 5 00:00
SEP 7 00:00
SEP 9 00:00
SEP 11 00:00
SEP 13 00:00
SEP 15 00:00
SEP 17 00:00
SEP 19 00:00
EPA 2.5
PM 2.5 Limit
MODIS

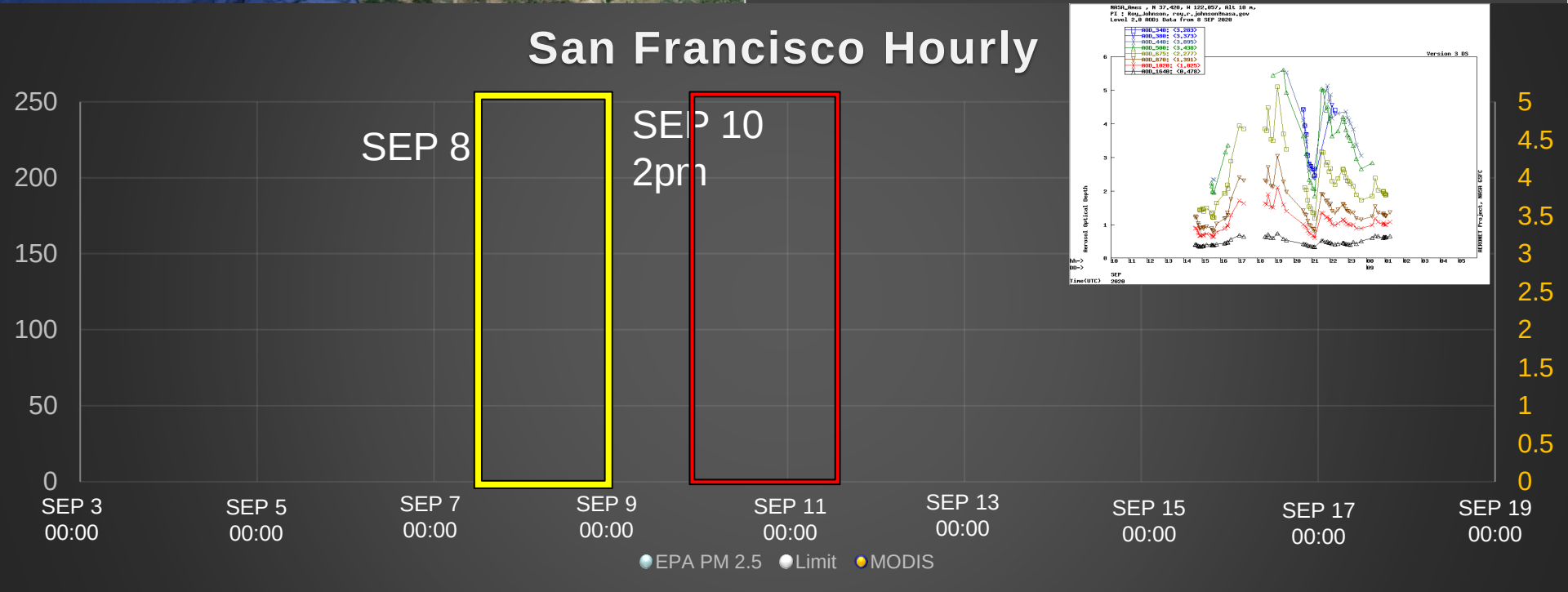

August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
SCU Lightining Complex
Redwood City
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=5m

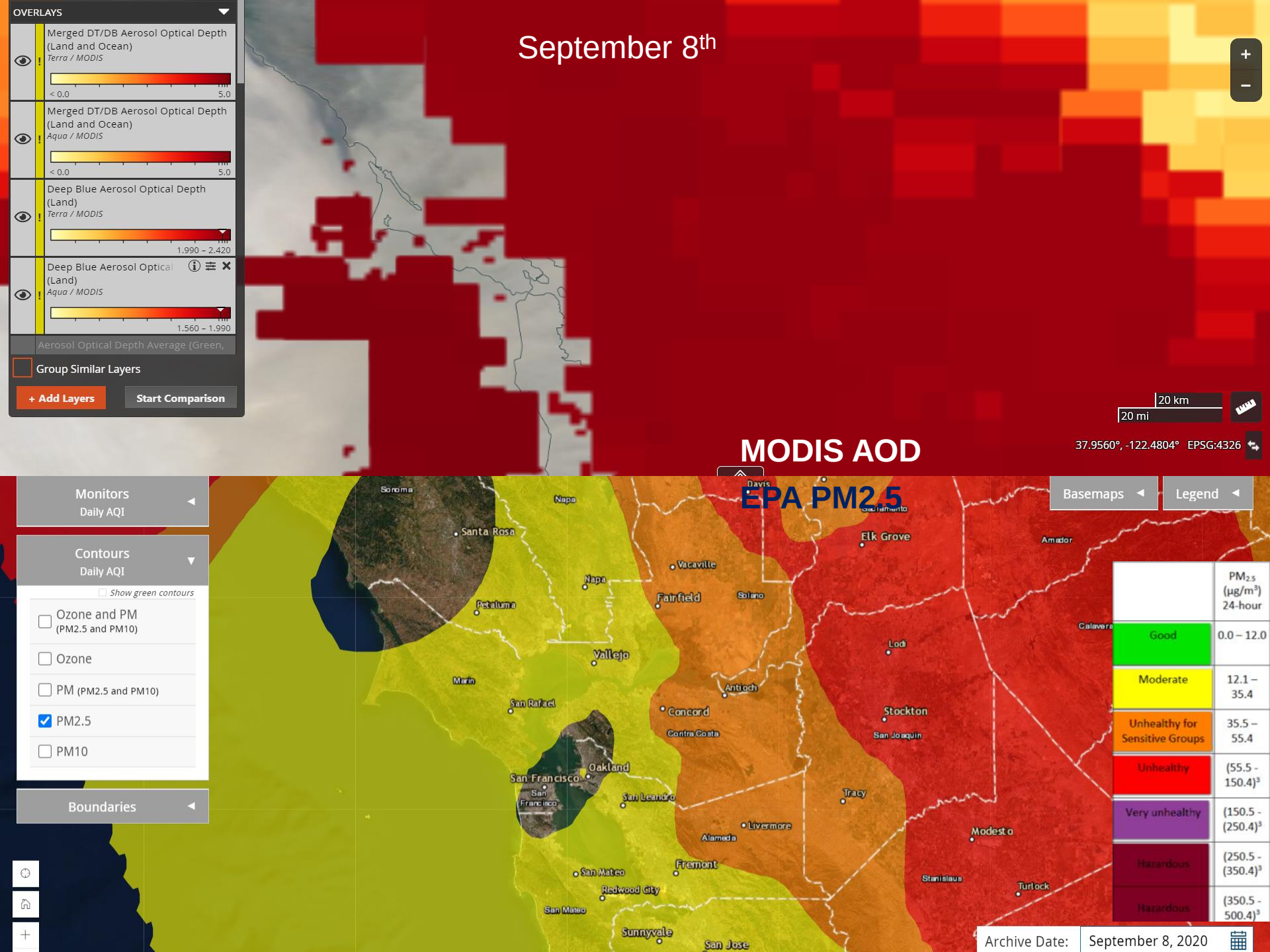

San Franciso Daily
MODIS AOD
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
y = 0.0098x + 0.6584
R² = 0.1335
0
50
100
150
200
EPA PM 2.5 µg/m3


San FranciscoDaily
EPA PM 2.5 MG/M3
160
140
120
100
80
60
40
20
0
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
AOD
1-Sep
3-Sep
5-Sep
7-Sep
9-Sep
11-Sep
13-Sep
15-Sep
17-Sep
19-Sep
DATE
EPA PM 2.5 µg/m3
limit PM 2.5
MODIS AOD


August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
SCU Lightining Complex
Redwood City
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=5m


San Francisco Hourly
y = 0.0108x + 0.5184
R² = 0.1599
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
50
100
150
200
250


San Francisco Hourly
SEP 8
SEP 10
2pm
250
200
150
100
50
0
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
SEP 3 00:00
SEP 5 00:00
SEP 7 00:00
SEP 9 00:00
SEP 11 00:00
SEP 13 00:00
SEP 15 00:00
SEP 17 00:00
SEP 19 00:00
EPA PM 2.5
Limit
MODIS


OVERLAYS
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Terra / MODIS
< 0.0
5.0
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Aqua / MODIS
< 0.0
5.0
Deep Blue Aerosol Optical Depth (Land)
Terra / MODIS
1.990 – 2.420
Deep Blue Aerosol Optical (Land)
Aqua / MODIS
1.560 – 1.990
Aerosol Optical Depth Average (Green,
Group Similar Layers
+ Add Layers
Start Comparison
September 8th
20 km
20 mi
37.9560°, -122.4804° EPSG:4326
MODIS AOD
EPA PM2.5
Monitors
Daily AQI
Contours
Daily AQI
Show green contours
Ozone and PM (PM2.5 and PM10)
Ozone
PM (PM2.5 and PM10)
PM2.5
PM10
Boundaries
Basemaps
Legend
PM2.5 (µg/m³) 24-hour
Good
0.0 – 12.0
Moderate
12.1 – 35.4
Unhealthy for Sensitive Groups
35.5 – 55.4
Unhealthy
(55.5 - 150.4)³
Very unhealthy
(150.5 - 250.4)³
Hazardous
(250.5 - 350.4)³
Hazardous
(350.5 - 500.4)³
Archive Date:
September 8, 2020
Sonoma
Napa
Santa Rosa
Petaluma
Vacaville
Fairfield
Solano
Vallejo
Marin
San Rafael
Concord
Contra Costa
Antioch
Oakland
San Francisco
San Leandro
Livermore
Alameda
Fremont
San Mateo
Redwood City
Sunnyvale
San Jose
Davis
Elk Grove
Amador
Lodi
Calaveras
Stockton
San Joaquin
Tracy
Modesto
Stanislaus
Turlock

September 9th

OVERLAYS

- Merged DT/DB Aerosol Optical Depth (Land and Ocean) *Terra / MODIS* — < 0.0 … 5.0
- Merged DT/DB Aerosol Optical Depth (Land and Ocean) *Aqua / MODIS* — < 0.0 … 5.0
- Deep Blue Aerosol Optical Depth (Land) *Terra / MODIS* — < 0.0 … 5.0
- Deep Blue Aerosol Optical (Land) *Aqua / MODIS* — < 0.0 … 5.0
- Aerosol Optical Depth Average (Green,

Group Similar Layers

+ Add Layers | Start Comparison

20 km
20 mi

38.1096°, -122.3241° EPSG:4326

MODIS AOD

EPA PM2.5

Monitors
Daily AQI

Contours
Daily AQI

Show green contours

- Ozone and PM (PM2.5 and PM10)
- Ozone
- PM (PM2.5 and PM10)
- PM2.5
- PM10

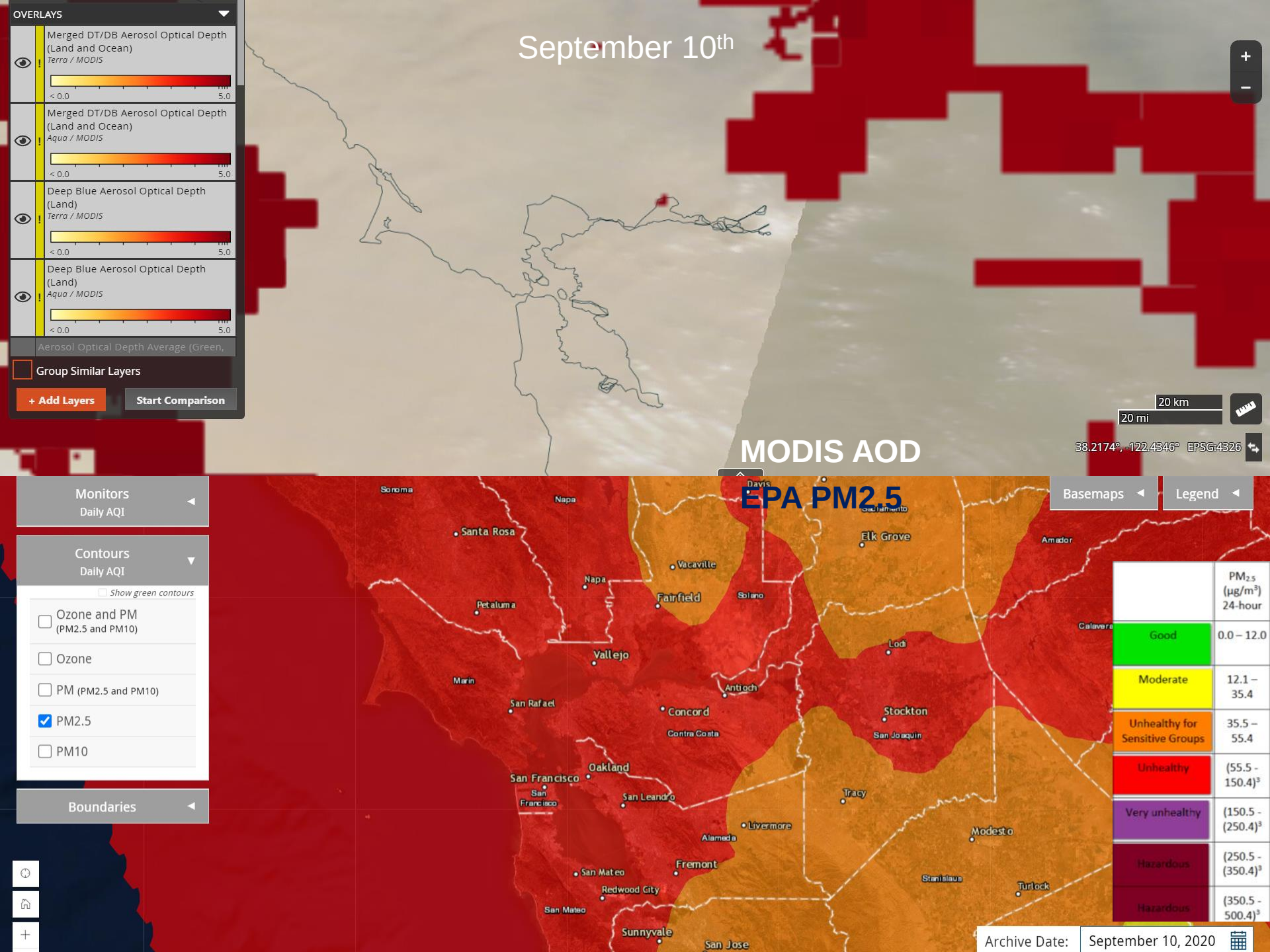
Boundaries

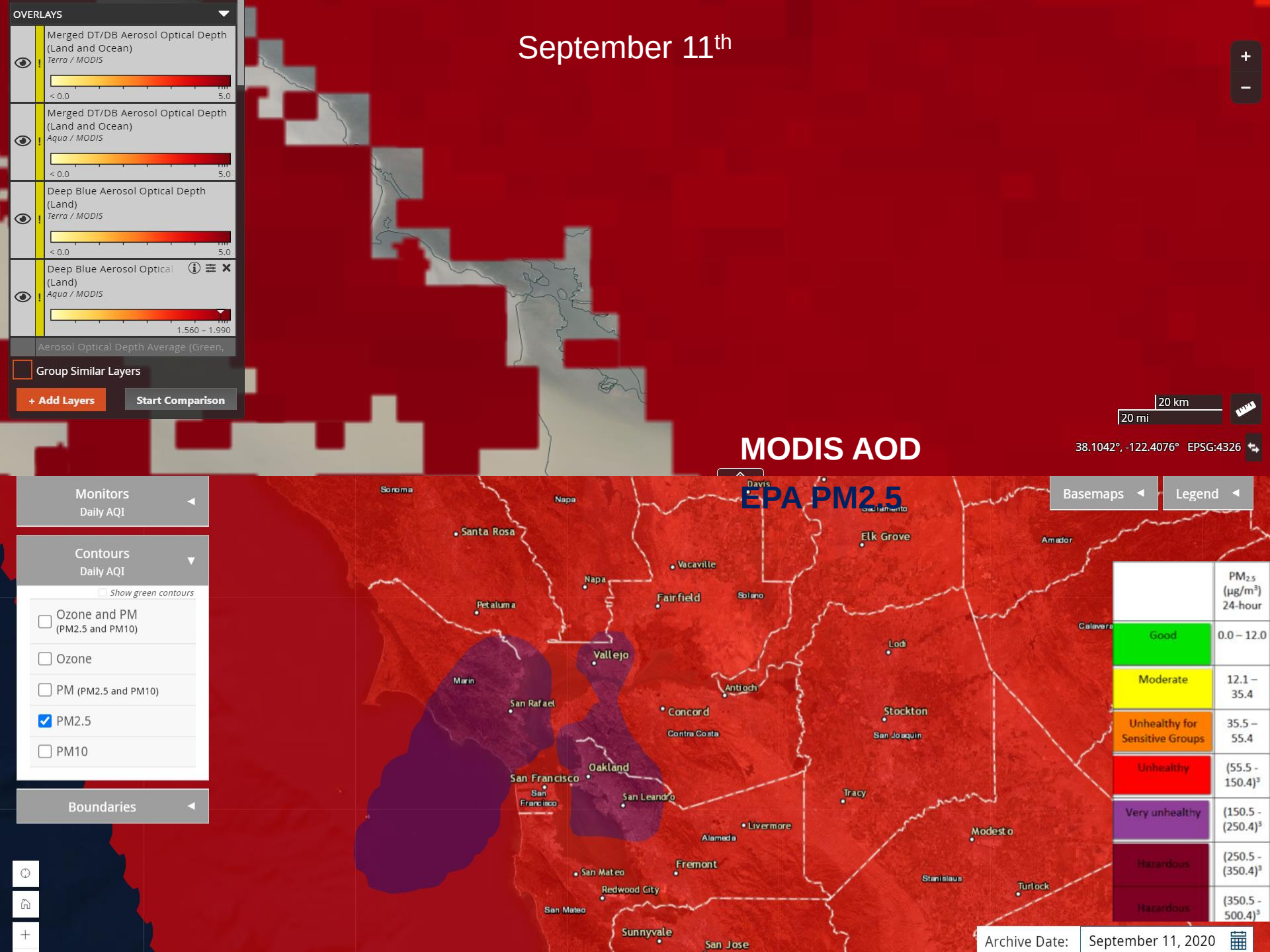
Basemaps | Legend

	$PM_{2.5}$ ($\mu g/m^3$) 24-hour
Good	0.0 – 12.0
Moderate	12.1 – 35.4
Unhealthy for Sensitive Groups	35.5 – 55.4
Unhealthy	(55.5 - 150.4)³
Very unhealthy	(150.5 - (250.4)³
Hazardous	(250.5 - (350.4)³
Hazardous	(350.5 - 500.4)³

Archive Date: September 9, 2020

Sonoma, Napa, Santa Rosa, Vacaville, Davis, Elk Grove, Amador, Napa, Fairfield, Solano, Petaluma, Calaveras, Lodi, Vallejo, Marin, Antioch, San Rafael, Concord, Stockton, Contra Costa, San Joaquin, Oakland, San Francisco, San Leandro, Tracy, Livermore, Alameda, Modesto, Fremont, San Mateo, Redwood City, Stanislaus, Turlock, Sunnyvale, San Jose

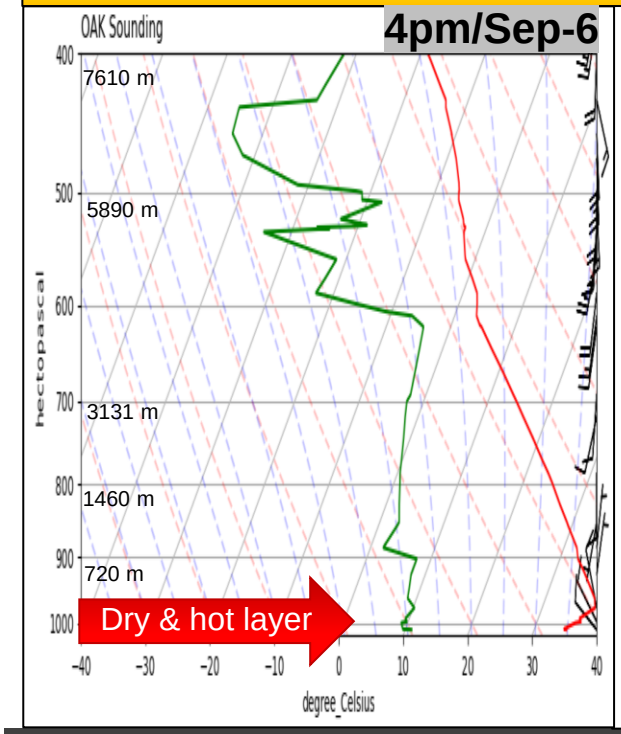

September 10th
OVERLAYS
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Terra / MODIS
< 0.0
5.0
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Aqua / MODIS
< 0.0
5.0
Deep Blue Aerosol Optical Depth (Land)
Terra / MODIS
< 0.0
5.0
Deep Blue Aerosol Optical Depth (Land)
Aqua / MODIS
< 0.0
5.0
Aerosol Optical Depth Average (Green,
Group Similar Layers
+ Add Layers
Start Comparison
20 km
20 mi
38.2174°, -122.4346° EPSG:4326
MODIS AOD
EPA PM2.5
Basemaps
Legend
Monitors
Daily AQI
Contours
Daily AQI
Show green contours
Ozone and PM (PM2.5 and PM10)
Ozone
PM (PM2.5 and PM10)
PM2.5
PM10
Boundaries
Sonoma
Napa
Santa Rosa
Vacaville
Petaluma
Fairfield
Solano
Vallejo
Marin
San Rafael
Concord
Contra Costa
Antioch
Davis
Elk Grove
Amador
Lodi
Calaveras
Stockton
San Joaquin
Oakland
San Francisco
San Leandro
Tracy
Livermore
Alameda
Modesto
Fremont
San Mateo
Redwood City
Stanislaus
Turlock
Sunnyvale
San Jose
PM2.5 (µg/m³) 24-hour
Good
0.0 – 12.0
Moderate
12.1 – 35.4
Unhealthy for Sensitive Groups
35.5 – 55.4
Unhealthy
(55.5 - 150.4)³
Very unhealthy
(150.5 - 250.4)³
Hazardous
(250.5 - 350.4)³
Hazardous
(350.5 - 500.4)³
Archive Date:
September 10, 2020

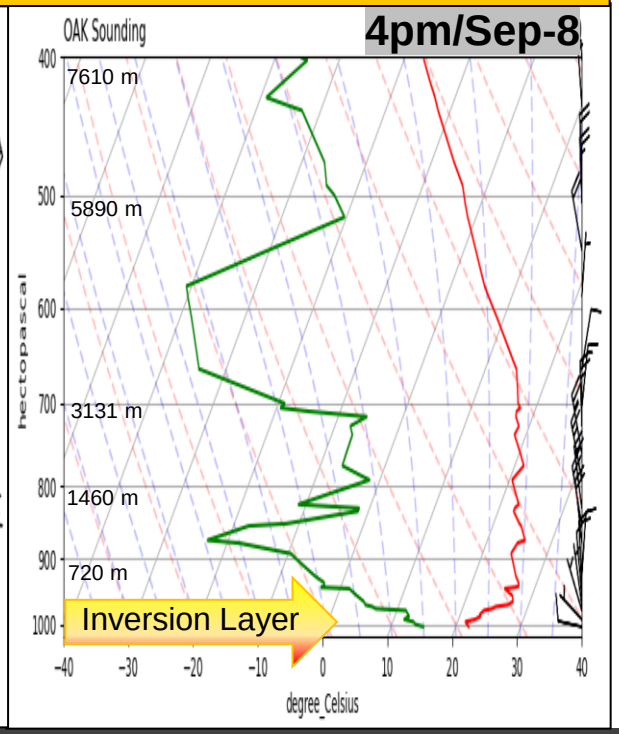

September 11th
OVERLAYS
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Terra / MODIS
< 0.0
5.0
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Aqua / MODIS
< 0.0
5.0
Deep Blue Aerosol Optical Depth (Land)
Terra / MODIS
< 0.0
5.0
Deep Blue Aerosol Optical (Land)
Aqua / MODIS
1.560 – 1.990
Aerosol Optical Depth Average (Green,
Group Similar Layers
+ Add Layers
Start Comparison
20 km
20 mi
38.1042°, -122.4076° EPSG:4326
MODIS AOD
EPA PM2.5
Basemaps
Legend
Monitors
Daily AQI
Contours
Daily AQI
Show green contours
Ozone and PM (PM2.5 and PM10)
Ozone
PM (PM2.5 and PM10)
PM2.5
PM10
Boundaries
Sonoma
Napa
Santa Rosa
Davis
Elk Grove
Amador
Vacaville
Napa
Fairfield
Solano
Petaluma
Calaveras
Lodi
Vallejo
Marin
Antioch
San Rafael
Concord
Stockton
Contra Costa
San Joaquin
Oakland
San Francisco
San Leandro
Tracy
Livermore
Alameda
Modesto
Fremont
San Mateo
Redwood City
Stanislaus
Turlock
Sunnyvale
San Jose
PM2.5 (µg/m³) 24-hour
Good
0.0 – 12.0
Moderate
12.1 – 35.4
Unhealthy for Sensitive Groups
35.5 – 55.4
Unhealthy
(55.5 - 150.4)³
Very unhealthy
(150.5 - (250.4)³
Hazardous
(250.5 - (350.4)³
Hazardous
(350.5 - 500.4)³
Archive Date:
September 11, 2020

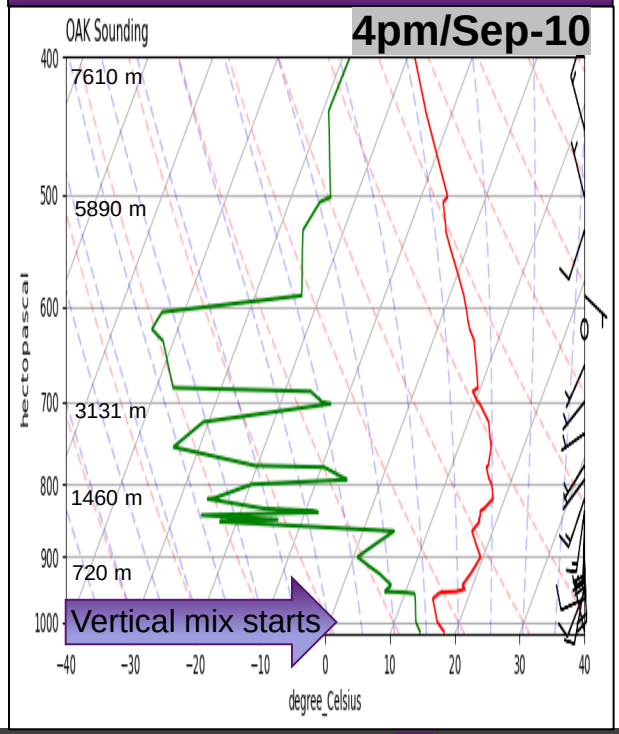
Evolution of the Vertical Layer in OAK

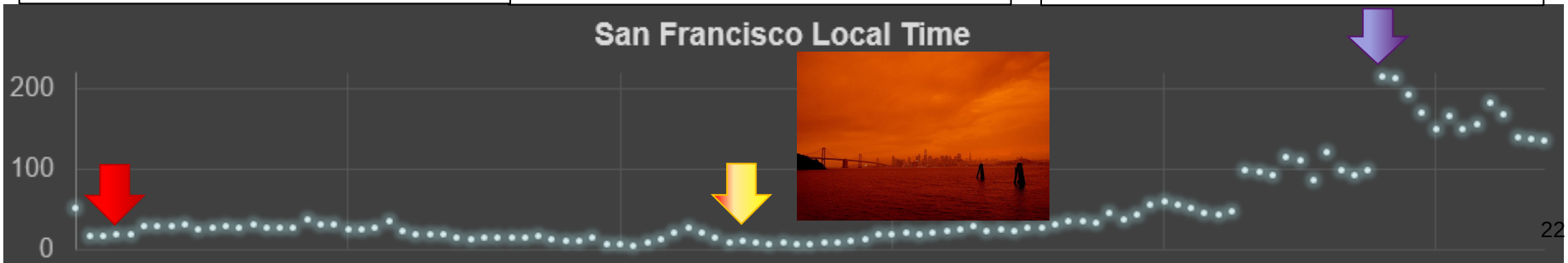
Satellite AOD is very high, surface PM 2.5 is moderate and below standard

Surface PM2.5 reached maximum and way beyond air quality standard

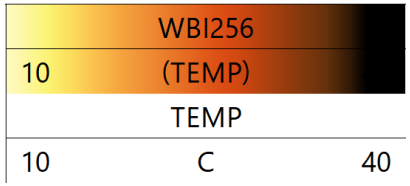


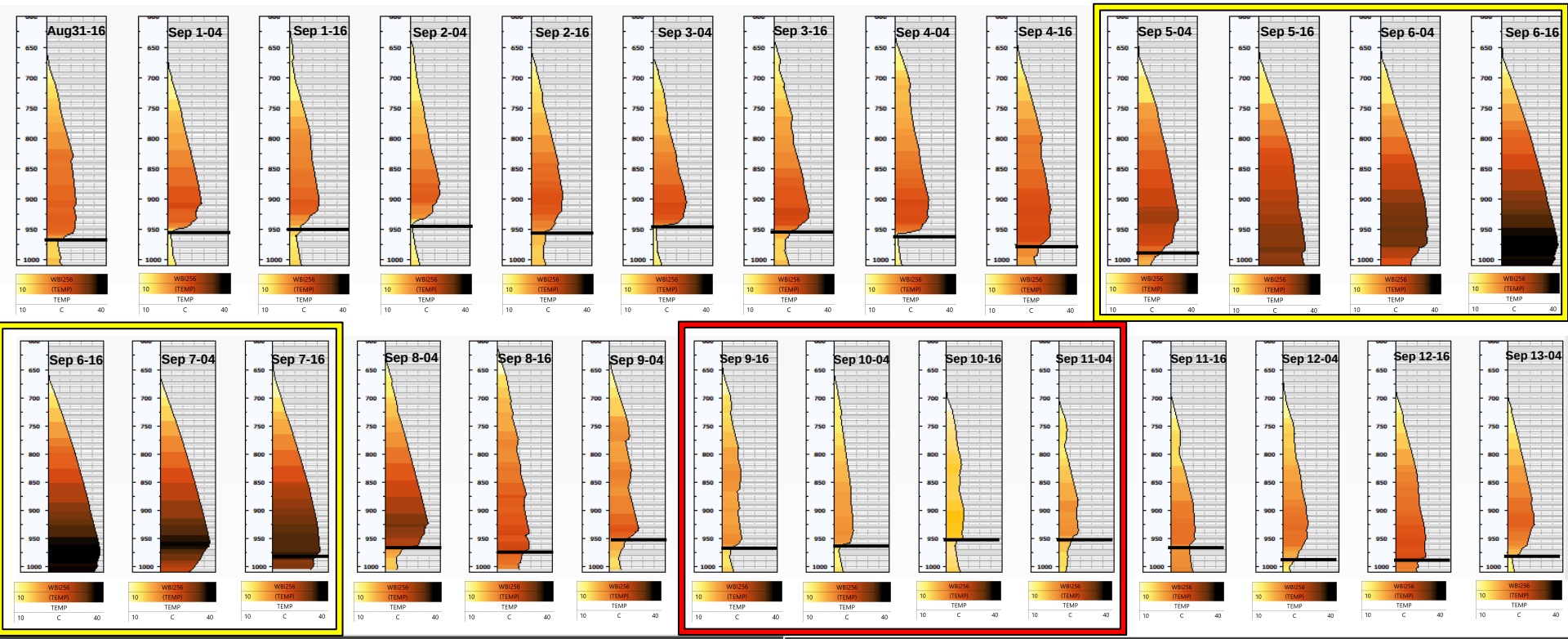


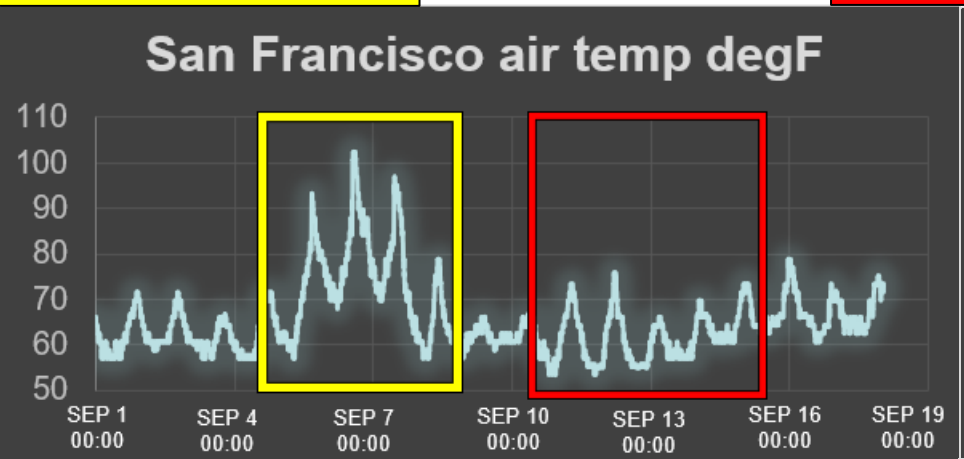


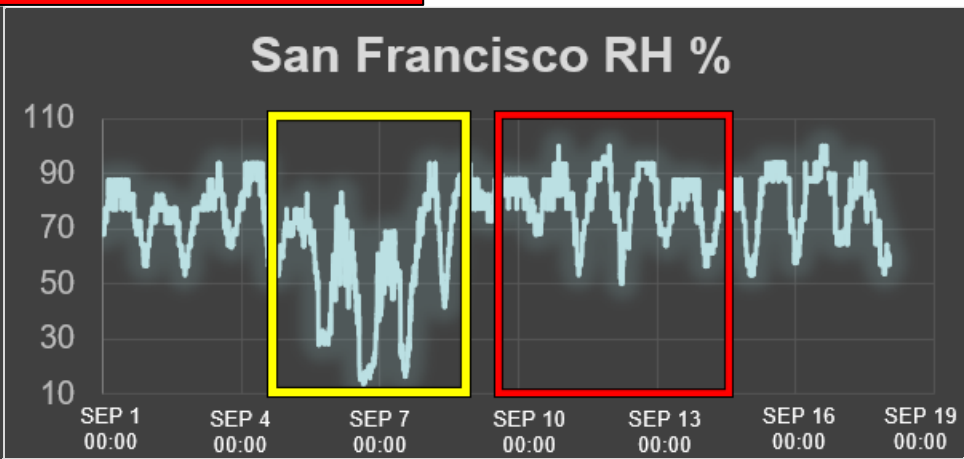


Inversion Layer Tracking





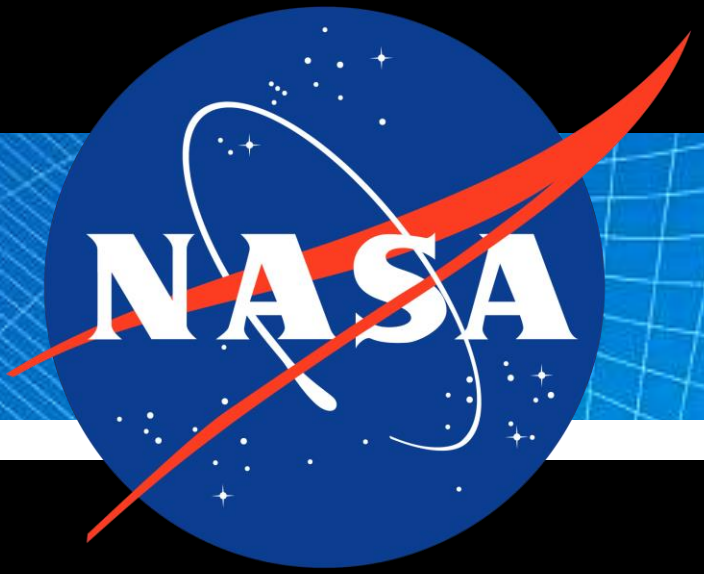




Conclusions

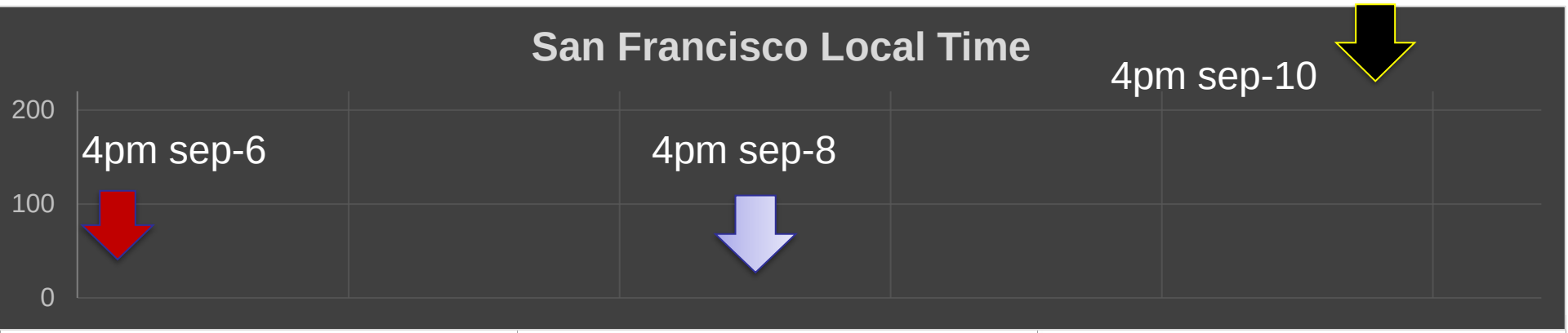
- Record high 2020 wildfires cause significant degradation of regional air quality in the west coast.
- Both retrieved AOD from satellite measurement and ground level PM 2.5 concentration show significantly higher value than other time during the year.
- Near the fire source region, the two parameters (PM2.5 & AOD) show close correlation and suggest satellite can be a good indication of ground level air quality.
- During the peak of the fire season, there is an episode when AOD from both satellite and AERONET reached its peak, while the ground level PM2.5 is still moderate and below the WHO standard. Two days later, PM 2.5 level reached its peak
- The evolution of the temperature vertical profile in the Bay Area suggested a growing inversion near the surface likely shield the region from transported fire plume for 1-2 days.
- Other factors need to be considered when using satellite AOD to estimate the impact of transported fire plumes on near surface air quality.

NATIONAL AERONAUTICS AND SPACE ADMINSTRATION

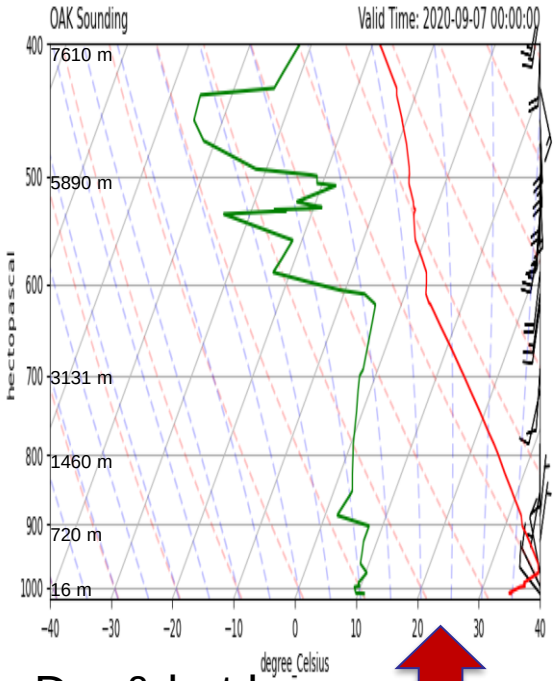


FOR THE BENEFIT OF ALL

Evolution of the Vertical Layer in OAK

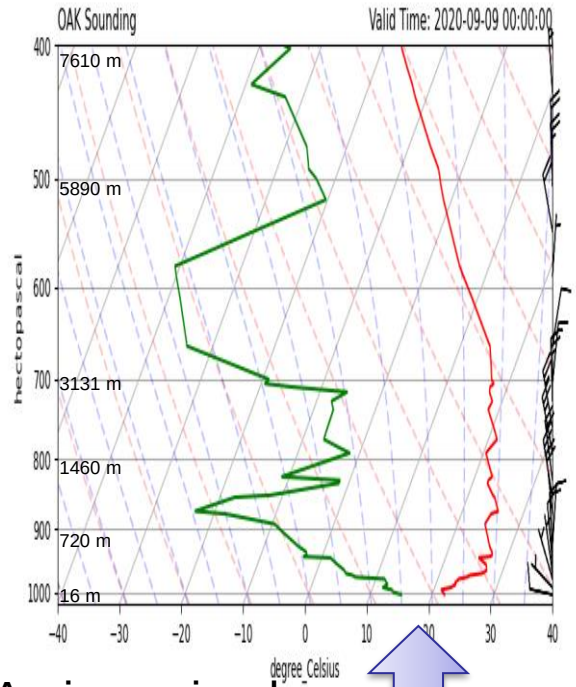


High Temperature and Dry



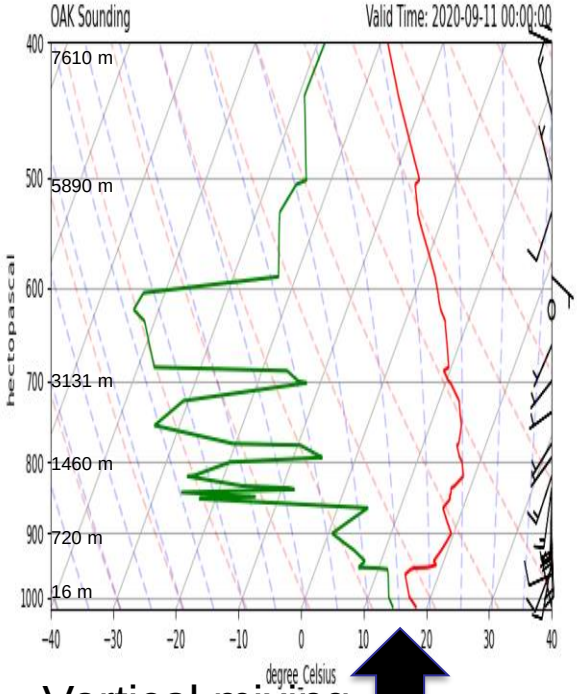
Dry & hot layer

AOD is high, PM 2.5 is moderate



An inversion layer

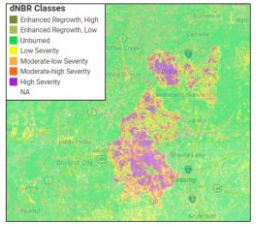
Surface PM 2.5 is high



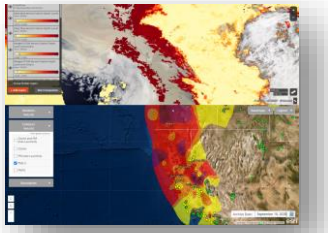
Vertical mixing

Earth Science Career Path

Glaciers Mass Balance



Wildfire Impact on Vegetation



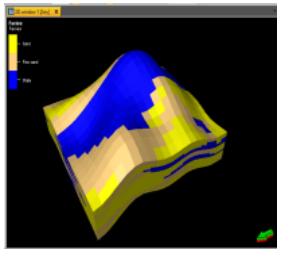
Wildfire Impact on Air Quality

Climate Change

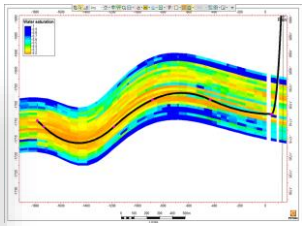
Earth Surface

Energy

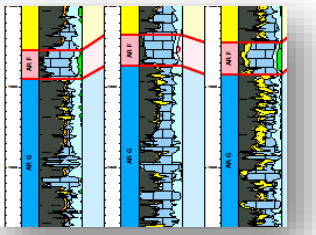
Reservoir 3D Modelling



Geo-steering



Borehole Geophysics

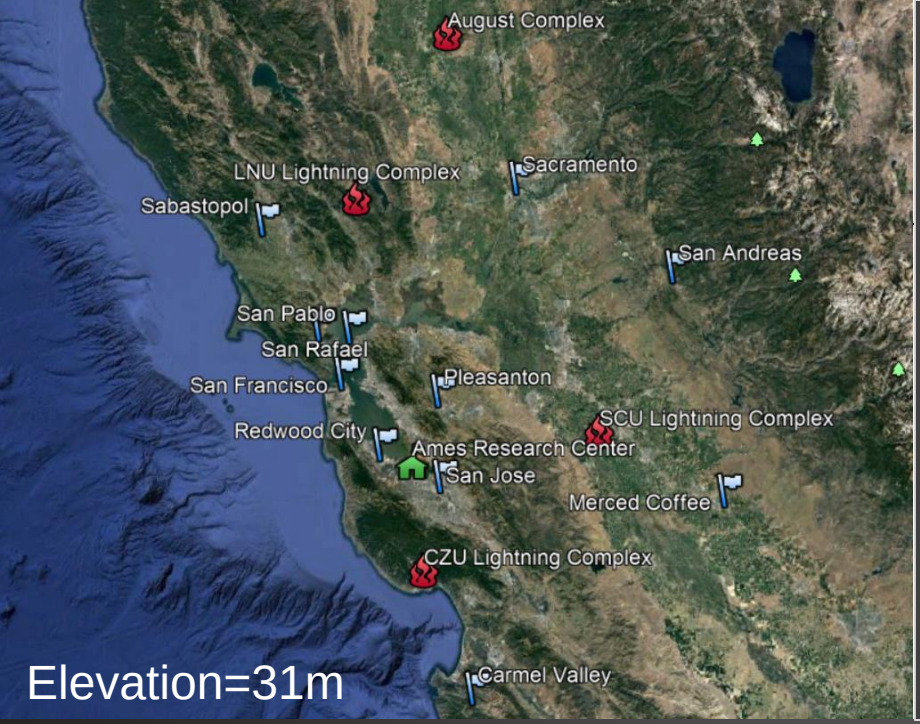


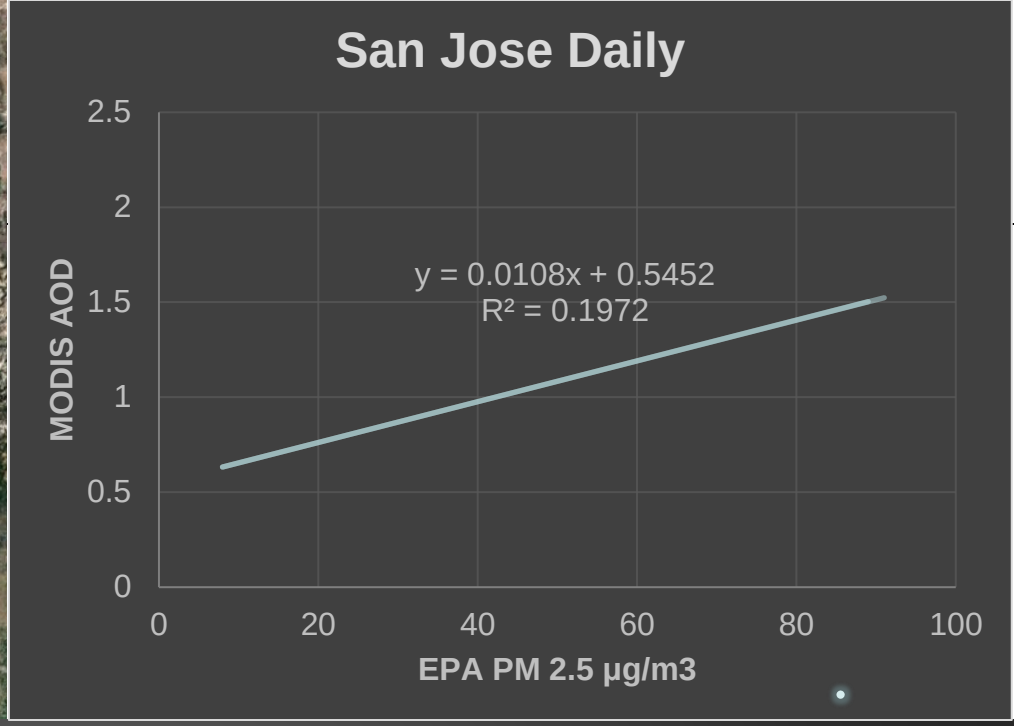
Geosphere

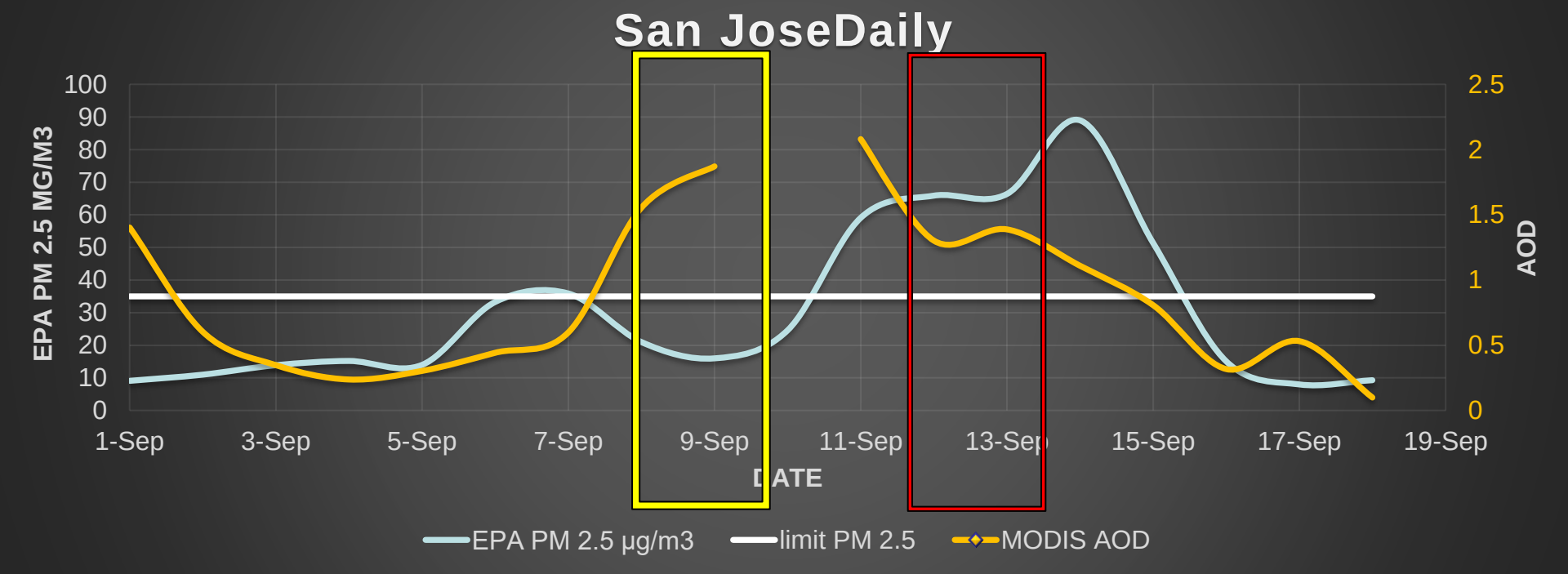
Hydrosphere

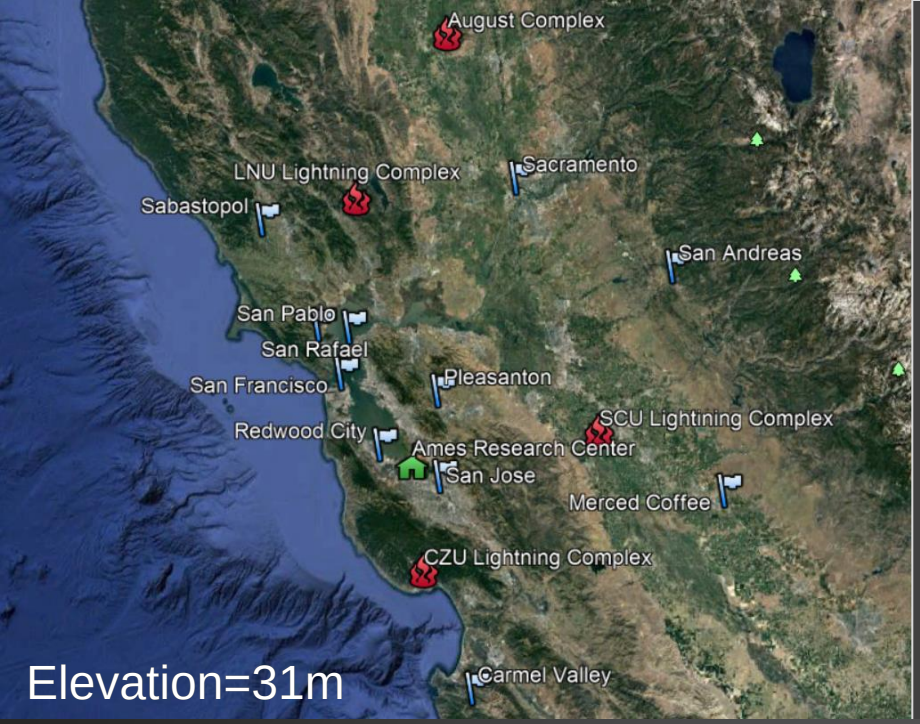
Biosphere

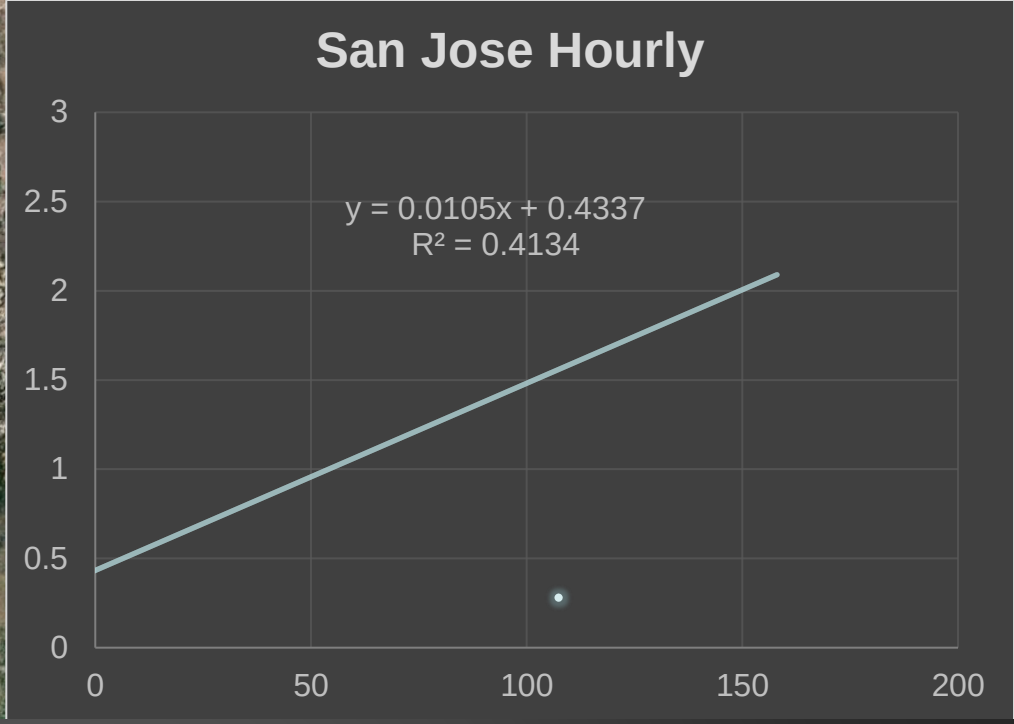
Atmosphere


August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
Redwood City
SCU Lightining Complex
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=31m


San Jose Daily
MODIS AOD
2.5
2
1.5
1
0.5
0
y = 0.0108x + 0.5452
R² = 0.1972
0
20
40
60
80
100
EPA PM 2.5 µg/m3

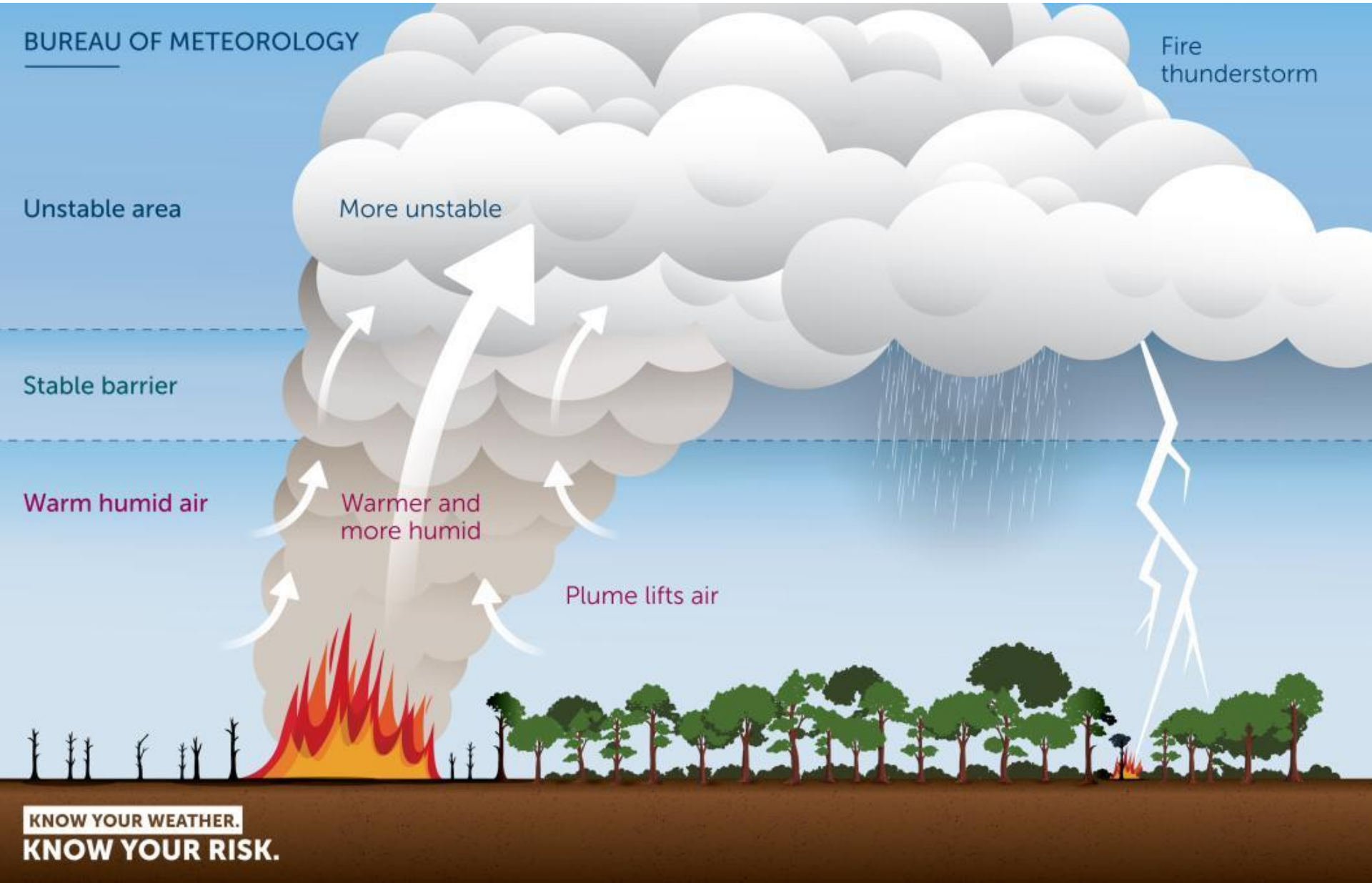

San JoseDaily
EPA PM 2.5 MG/M3
100
90
80
70
60
50
40
30
20
10
0
AOD
2.5
2
1.5
1
0.5
0
1-Sep
3-Sep
5-Sep
7-Sep
9-Sep
11-Sep
13-Sep
15-Sep
17-Sep
19-Sep
DATE
EPA PM 2.5 µg/m3
limit PM 2.5
MODIS AOD


August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
SCU Lightining Complex
Redwood City
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=31m


San Jose Hourly
y = 0.0105x + 0.4337
R² = 0.4134
3
2.5
2
1.5
1
0.5
0
0
50
100
150
200


San Jose Hourly
180
160
140
120
100
80
60
40
20
0
3
2.5
2
1.5
1
0.5
0
SEP 9
10am
SEP 11
6am
SEP 6
11am
SEP 2
00:00
SEP 4
03:00
SEP 6
06:00
SEP 8
13:00
SEP 10
14:00
SEP 12
17:00
SEP 14
17:00
SEP 16
21:00
SEP 18
14:00
EPA PM 2.5
Limit
MODIS

Introduction



September 7th

September 8th

8th

8th

8th

Smoke from wildfires shrouded the San Francisco Bay Area and blocked sunlight on September 9, 2020. Credit: Aaron Maizlish/Flickr/CC BY 2.0

Photo of a pyrocumulonimbus cloud over the Pacific Northwest taken from the cockpit of the NASA DC-8 aircraft on August 8, 2019, during the FIREX-AQ field campaign. Credit: Dr. David Peterson of the Naval Research Laboratory/ NOAA

https://demo.openwfm.org/sj/?zoom=7&pan=38.31,-119.23&job_id=wfc-from-web-2020-09-08_20-37-33-2020-09-08_23:00:00-48&domain=1&timestamp=2020-09-08%2023:00:00&startDate=2020-09-08%2014:00:00&endDate=2020-09-10%2000:00:00&rasters=PLUME_HEIGHT&opacity=0.5

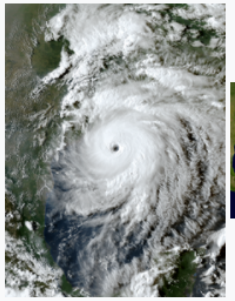
Hurricane Laura

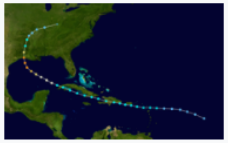
Main article: Hurricane Laura

On August 16, a tropical wave exited the west coast of Africa and entered the Atlantic. The wave combined with a broad area of low pressure located a few hundred miles west-southwest of the Cabo Verde Islands on August 18. Deep convection steadily increased and became better organized as the disturbance moved across the central tropical Atlantic, and by 00:00 UTC on August 20, the presence of a sufficiently well-defined low-level circulation indicated that Tropical Depression Thirteen developed about 980 mi (1,575 km) east-southeast of Antigua. By 12:00 UTC that same day, the cyclone organized further and strengthened into Tropical Storm Laura. However, moderate wind shear then prohibited further intensification.[93] The storm had a disorganized appearance in satellite imagery as it crossed the northern Leeward islands on August 21. It then became organized on August 22, while passing just south of the U.S. Virgin Islands and Puerto Rico.[94] Early on August 23, Laura made landfall about 25 mi (40 km) west of Santo Domingo, Dominican Republic, with winds of 50 mph (80 km/h). The storm weakened little as it moved across the mountainous terrain of Hispaniola. Laura made landfall near Uvero in Cuba's Santiago de Cuba Province with winds of 65 mph (100 km/h) at 02:00 UTC on August 4, before re-emerging into the Caribbean and striking near Playa de las Tunas in Pinar del Río Province at the same intensity about 22 hours later.[93]

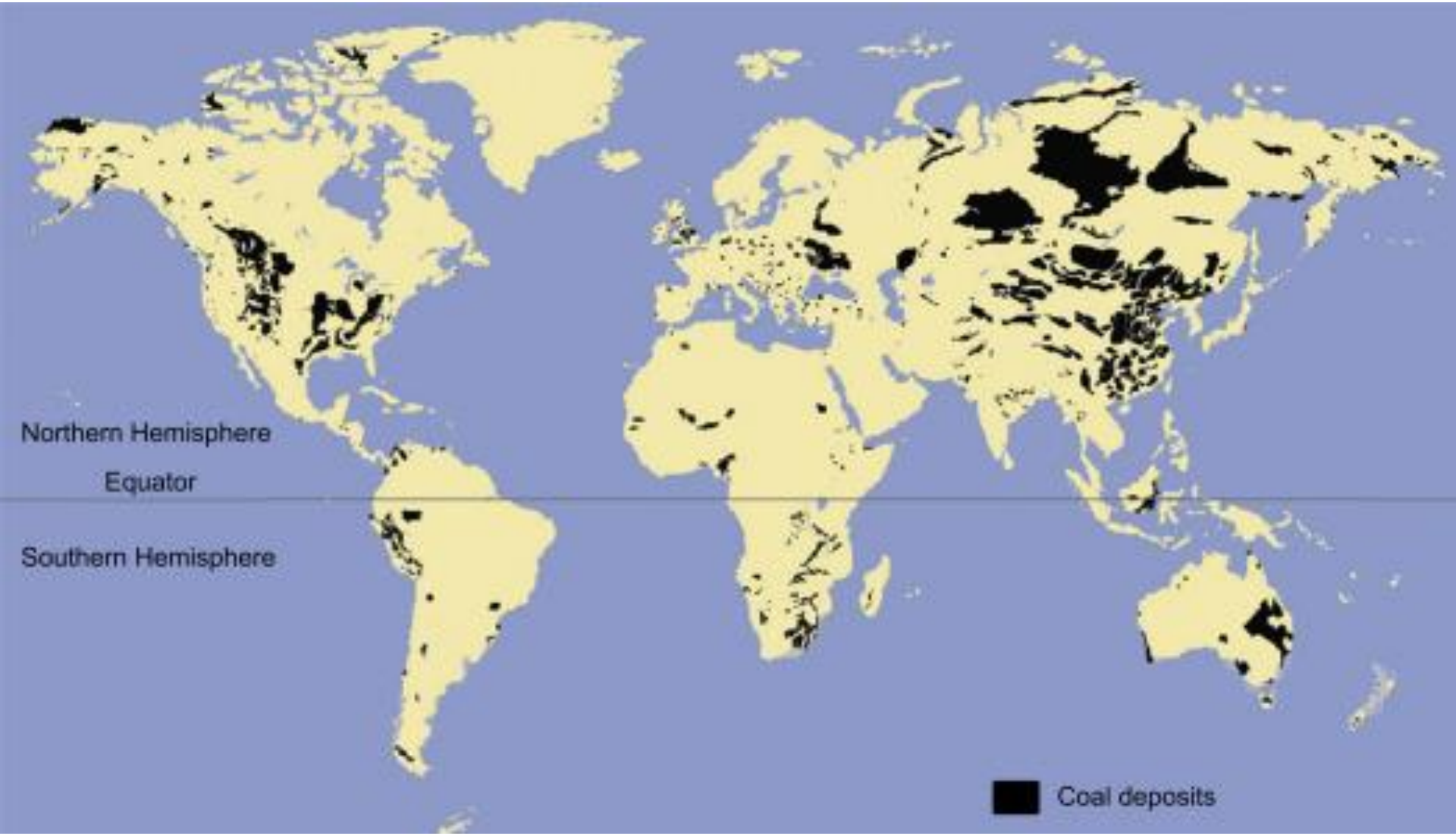
Laura entered the Gulf of Mexico later on August 25, where it became a hurricane around 12:00 UTC that day. Later, while situated over the central Gulf, Laura began a period of rapid intensification, and by 12:00 UTC on August 26, the storm became a major Category 3 hurricane. A mid-level low near Oklahoma caused the system to turn northwestward and then northward, and over the 24-hour period ending at 00:00 UTC on August 27, it intensified by

Category 4 hurricane (SSHWS)





Duration	August 20 – August 29
Peak intensity	150 mph (240 km/h) (1-min) 937 mbar (hPa)


Northern Hemisphere
Equator
Southern Hemisphere
Coal deposits

Data Display Controls

AERONET AOD Data Product:

AOD
Water Vapor
440-870 Angstrom
SDA Fine/Coarse AOD
SDA Fine Mode Fraction

AOD Level (2020): Level 1.0 Level 1.5 Level 2.0

Data Format: All points Daily averages

Triplet Variability (All Points Only): Off On

Related Product Availability for NASA_Ames (select each day below):

- Show Terra MODIS
- Show Aqua MODIS

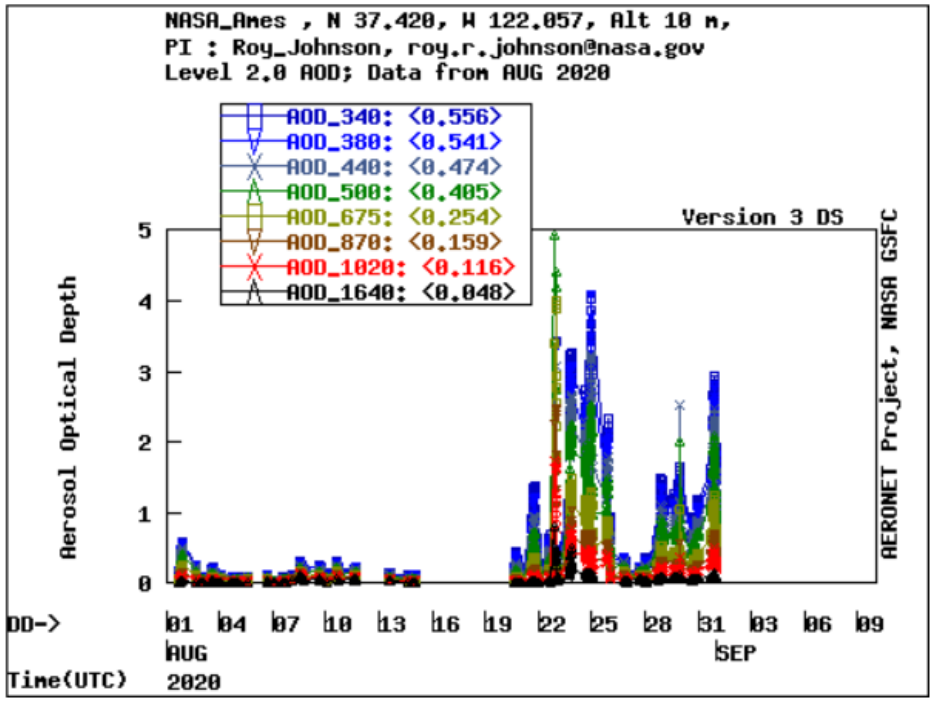
SELECT CHARTS FOR LARGER IMAGES

Choose year :	2007	2014	2015	2016	2017	2019	2020
Choose month of 2020 :	JAN	FEB	MAR	APR	MAY	JUN	JUL
	AUG	SEP	OCT	NOV			

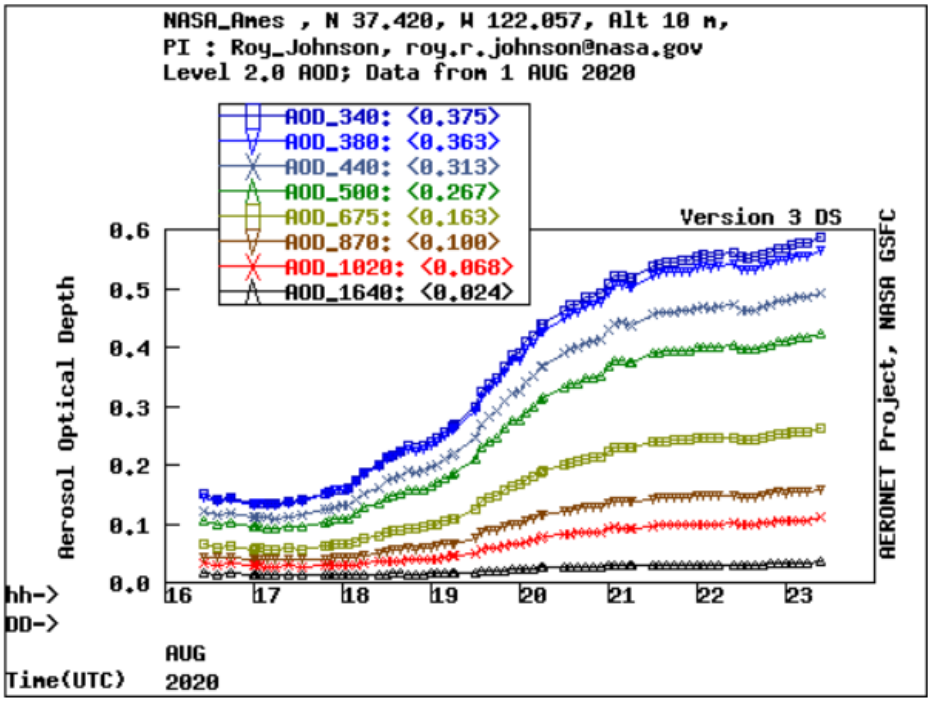
Choose day of AUG 2020

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30	31					

AOD Level 2.0 data from AUG of 2020



AOD Level 2.0 data from AUG 1 of 2020



AERONET DOWNLOAD

- AOD Level 1.0
- AOD Level 1.5
- AOD Level 2.0
- SDA Level 1.0
- SDA Level 1.5
- SDA Level 2.0
- More AERONET Downloadable Products...

AERONET DOWNLOAD

- AOD Level 1.0
- AOD Level 1.5
- AOD Level 2.0
- SDA Level 1.0
- SDA Level 1.5
- SDA Level 2.0
- More AERONET Downloadable Products...

https://aeronet.gsfc.nasa.gov/cgi-bin/data_display_aod_v3

Data Display Controls

AERONET AOD Data Product:

AOD
Water Vapor
440-870 Angstrom
SDA Fine/Coarse AOD
SDA Fine Mode Fraction

AOD Level (2020): ○ Level 1.0 ○ Level 1.5 ◉ Level 2.0

Data Format: ◉ All points ○ Daily averages

Triplet Variability (All Points Only): ◉ Off ○ On

Related Product Availability for NASA_Ames (select each day below):

- Show Terra MODIS
- Show Aqua MODIS

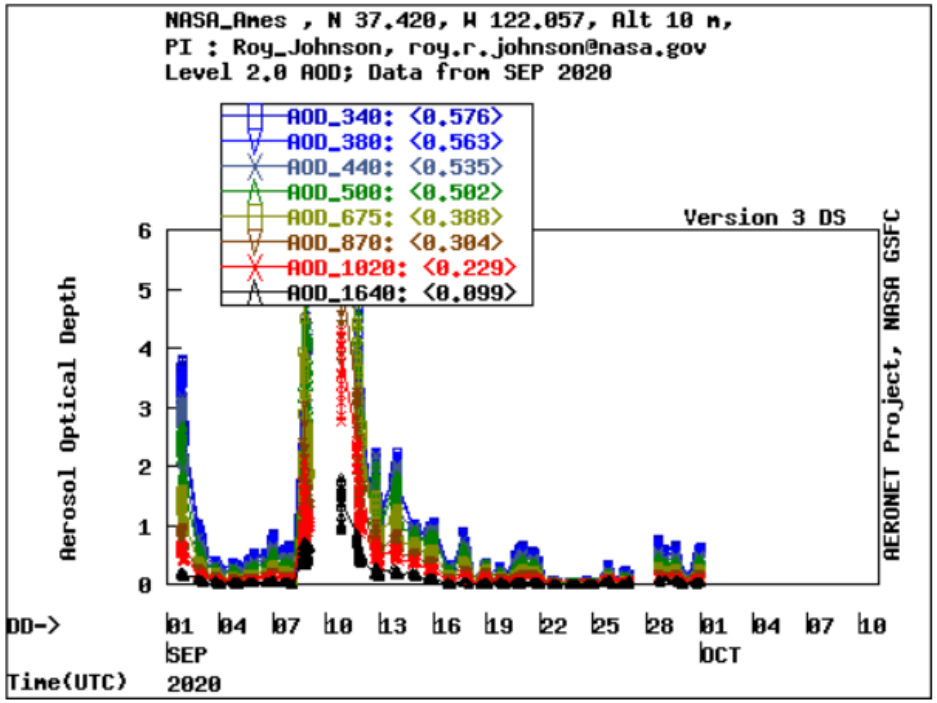
SELECT CHARTS FOR LARGER IMAGES

Choose year :	2007	2014	2015	2016	2017	2019	2020
Choose month of 2020 :	JAN	FEB	MAR	APR	MAY	JUN	JUL
	AUG	SEP	OCT	NOV			

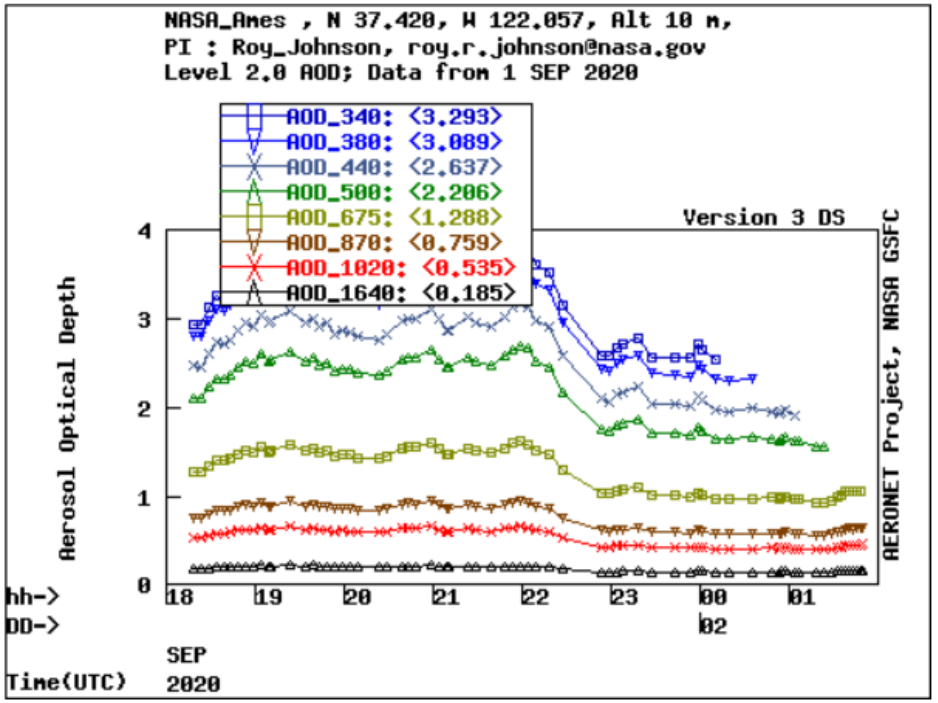
Choose day of SEP 2020

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30						

AOD Level 2.0 data from SEP of 2020



AOD Level 2.0 data from SEP 1 of 2020



AERONET DOWNLOAD

- AOD Level 1.0
- AOD Level 1.5
- AOD Level 2.0
- SDA Level 1.0
- SDA Level 1.5
- SDA Level 2.0
- More AERONET Downloadable Products...

AERONET DOWNLOAD

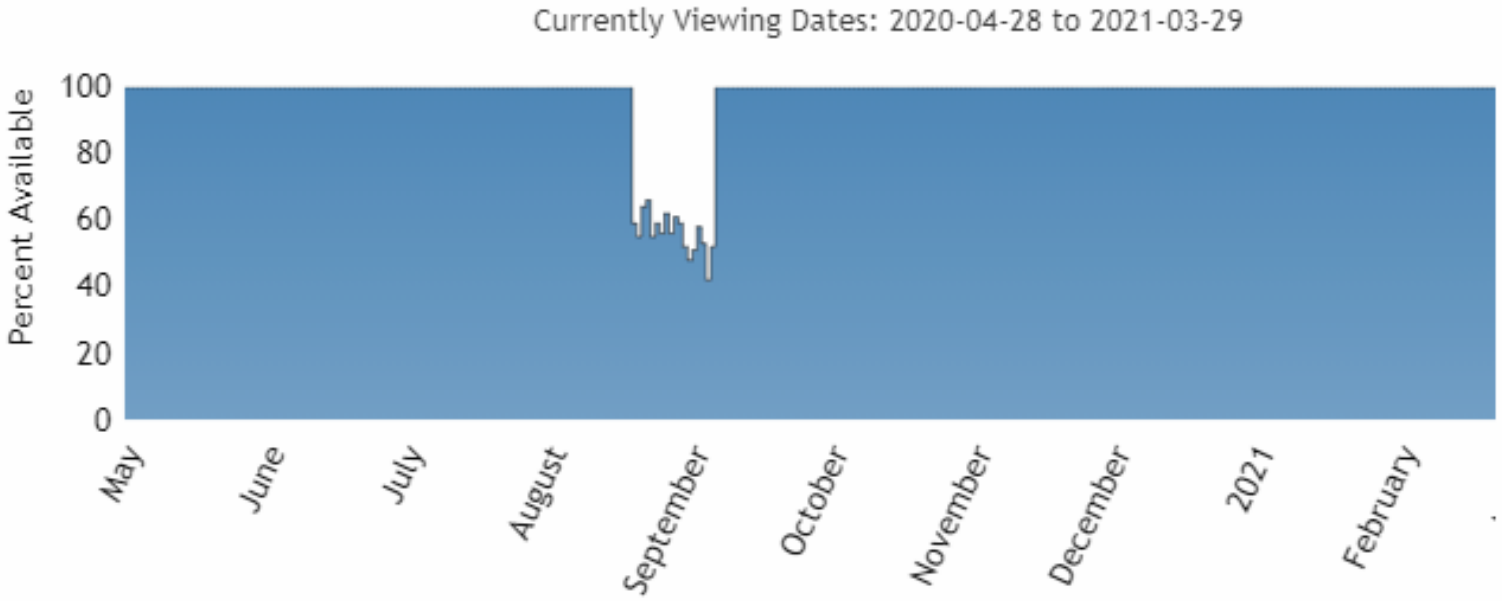
- AOD Level 1.0
- AOD Level 1.5
- AOD Level 2.0
- SDA Level 1.0
- SDA Level 1.5
- SDA Level 2.0
- More AERONET Downloadable Products...

MODIS Aqua

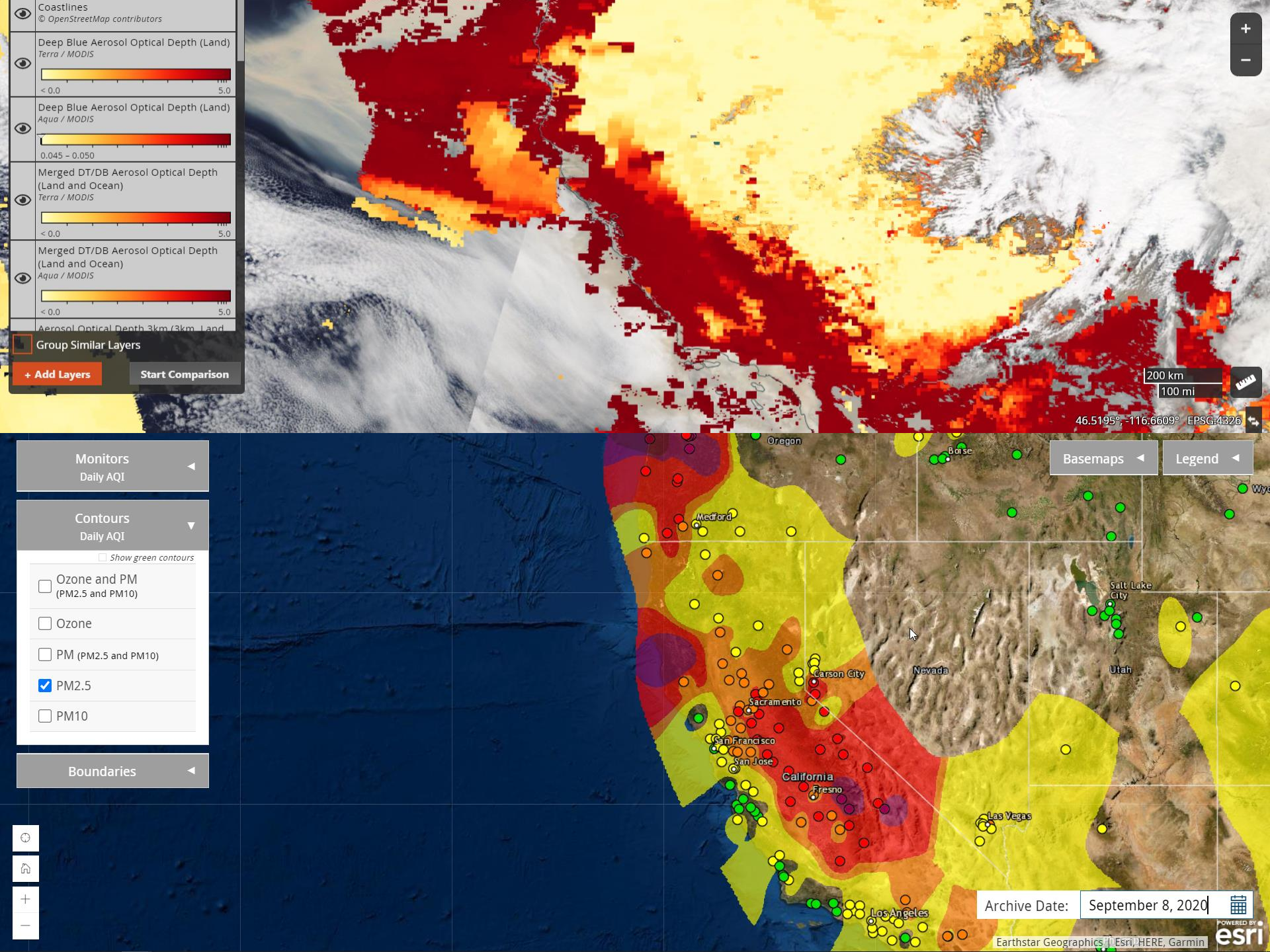
MYD04_3K - MODIS/Aqua Aerosol 5-Min L2 Swath 3km

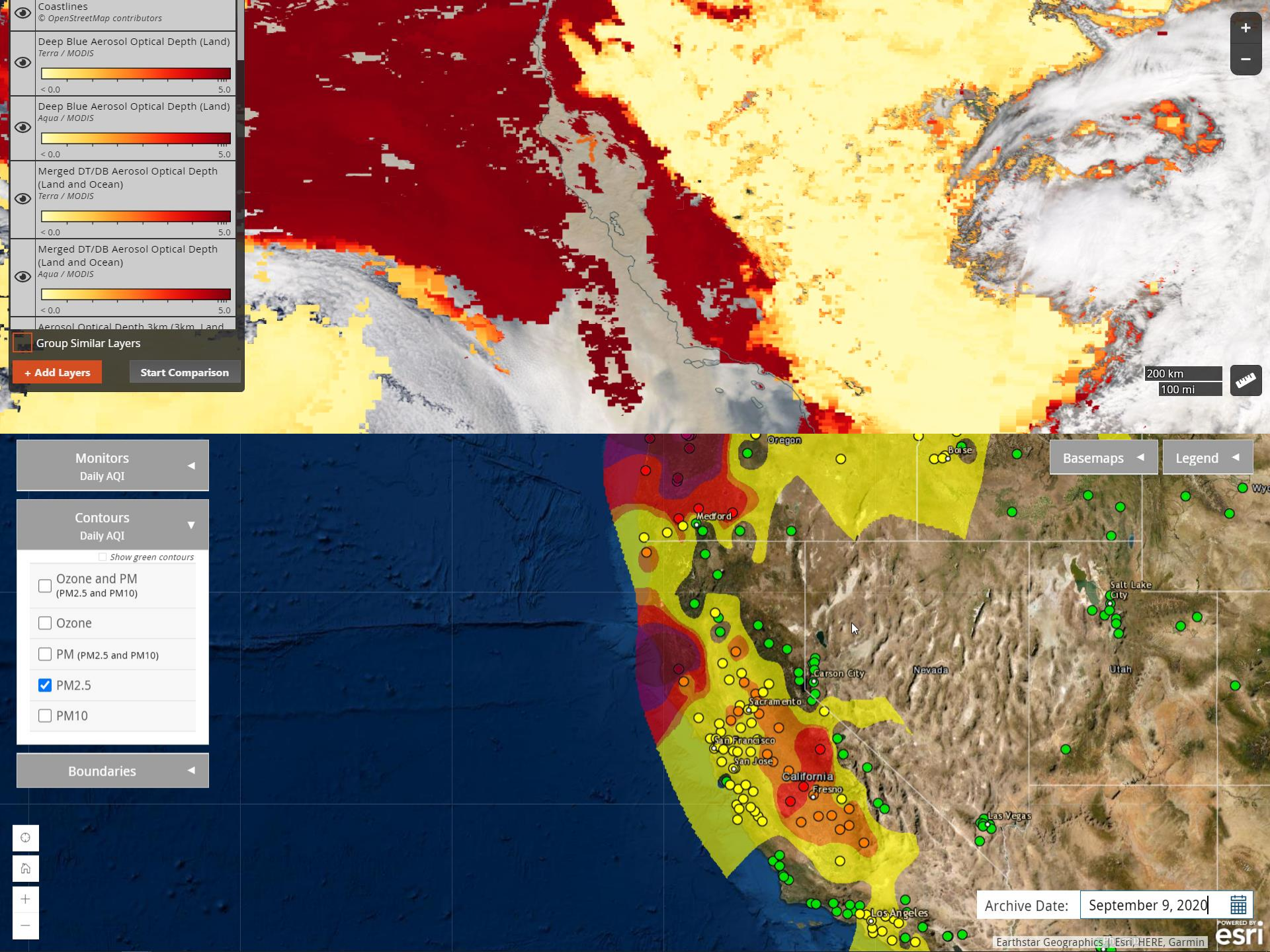
Overview | Product Information | Data Availability

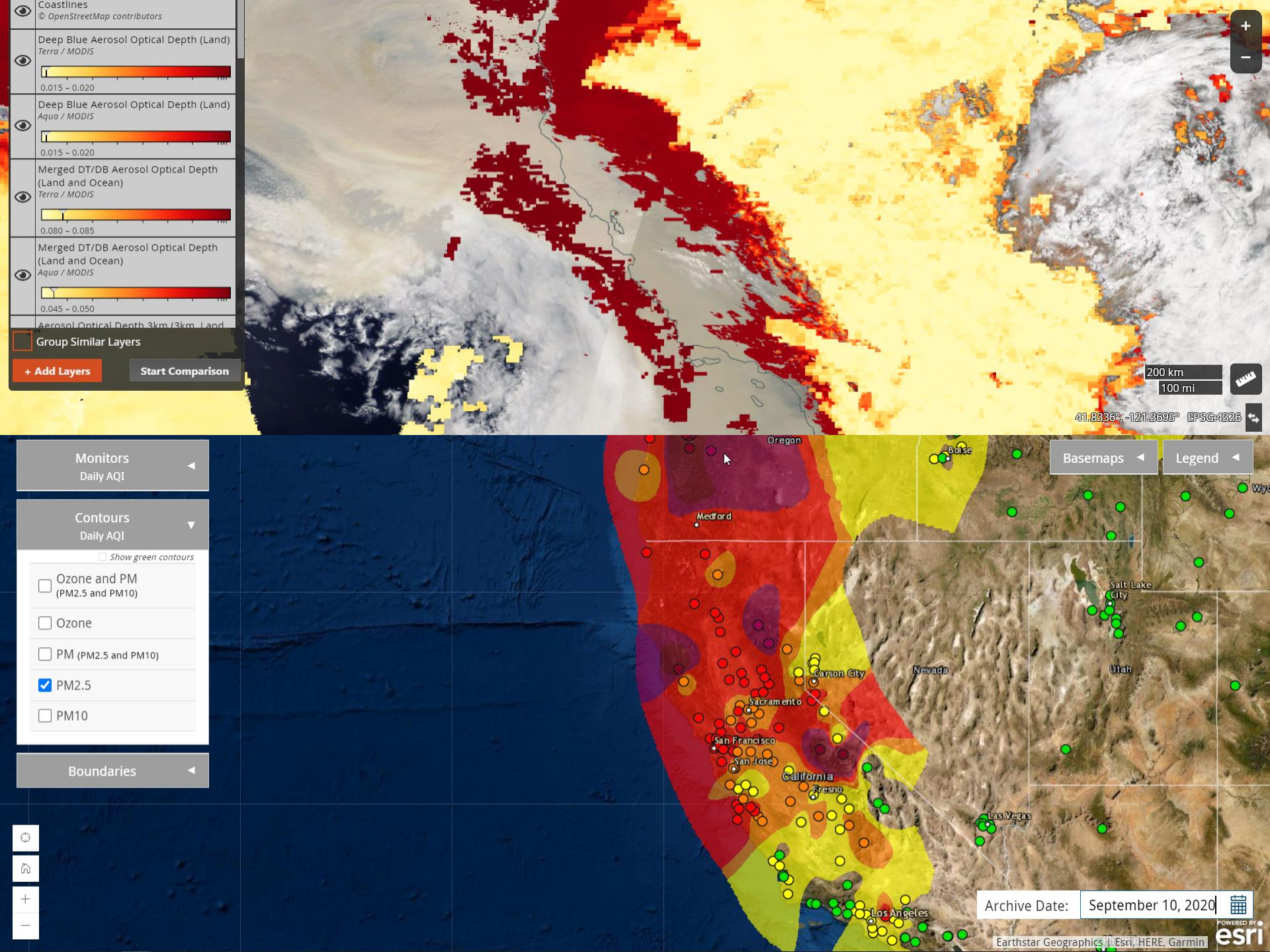
MYD04_3K archiveSet 61 Between 2002-07-04 and 2021-06-05

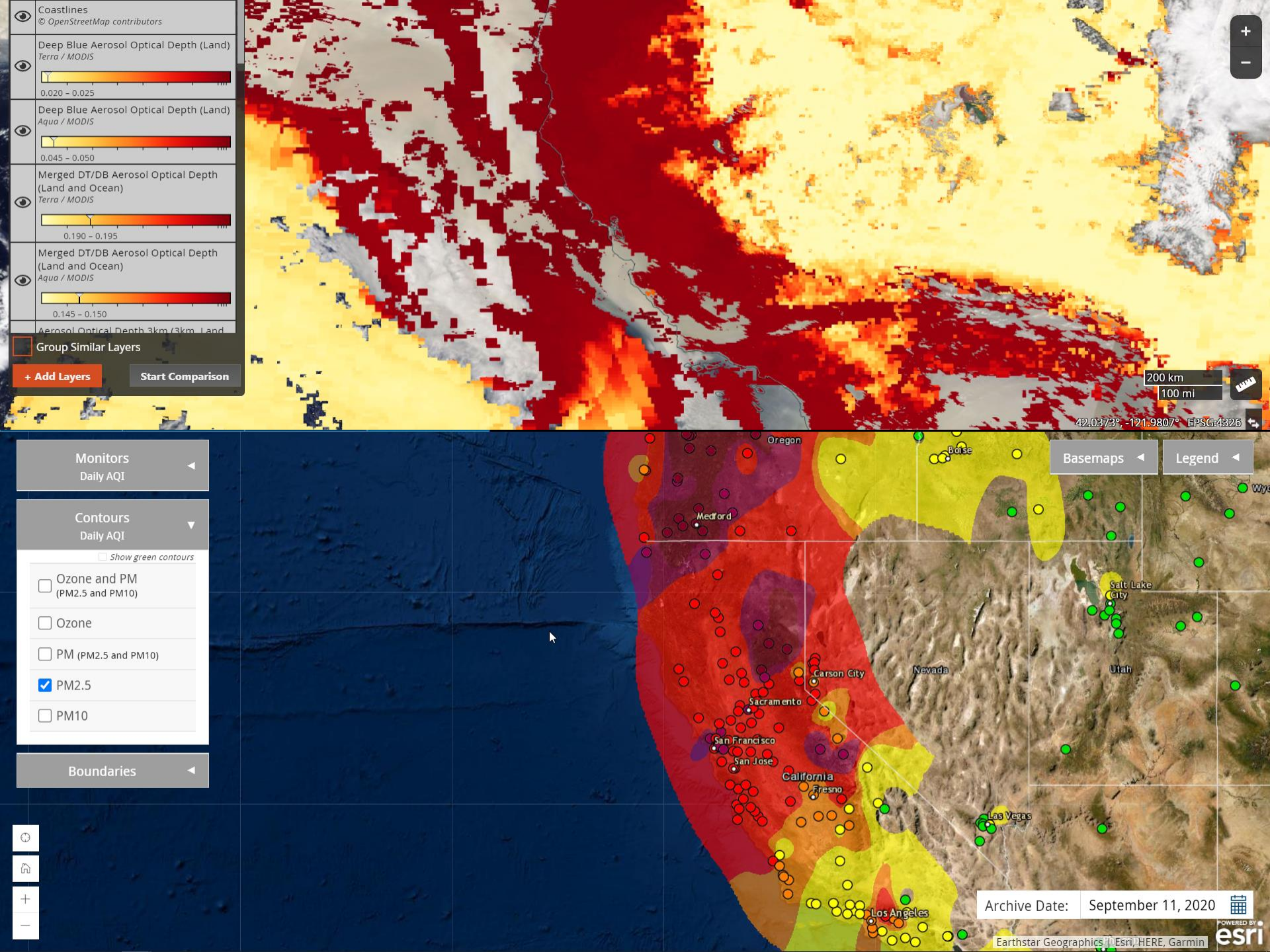


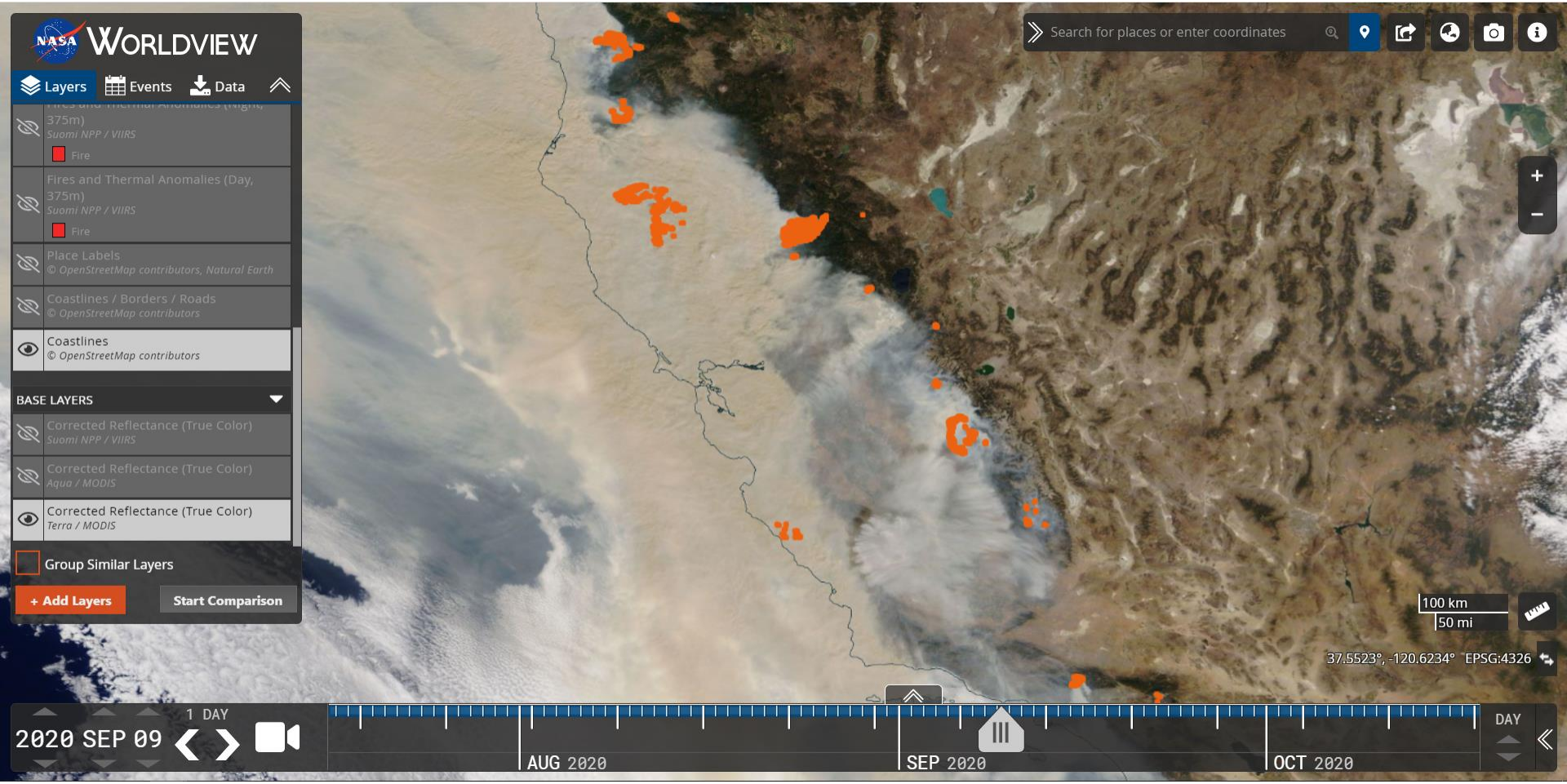
Click and drag the chart left or right to pan through dates.

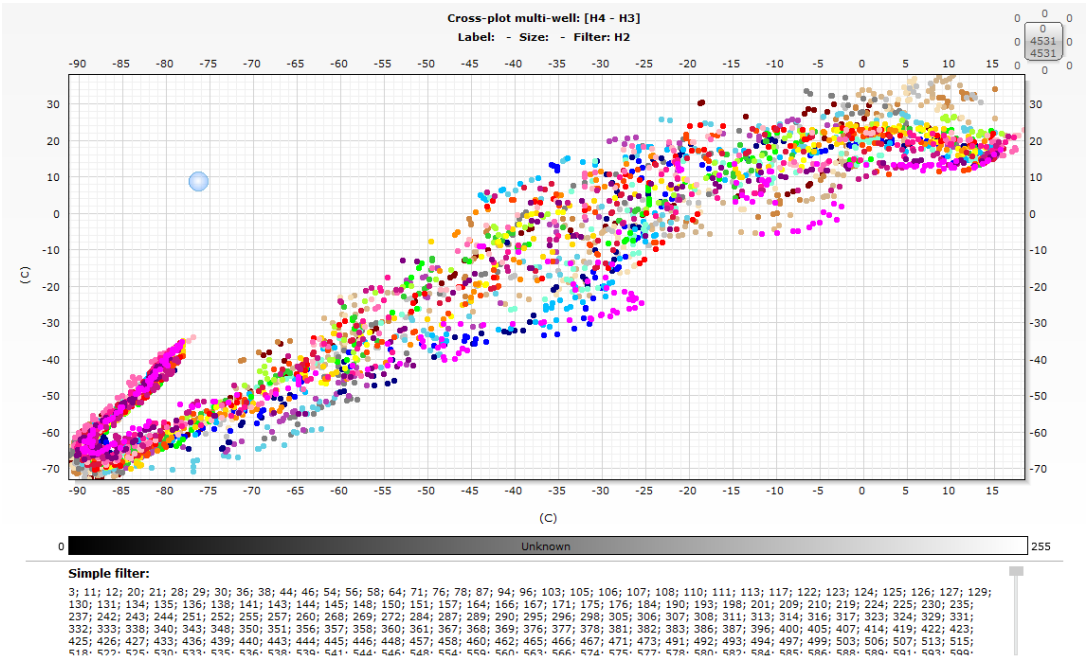

Coastlines
© OpenStreetMap contributors
Deep Blue Aerosol Optical Depth (Land)
Terra / MODIS
< 0.0
5.0
Deep Blue Aerosol Optical Depth (Land)
Aqua / MODIS
0.045 – 0.050
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Terra / MODIS
< 0.0
5.0
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Aqua / MODIS
< 0.0
5.0
Group Similar Layers
+ Add Layers
Start Comparison
200 km
100 mi
46.5195°, -116.6609° EPSG:4326
Monitors
Daily AQI
Contours
Daily AQI
Show green contours
Ozone and PM
(PM2.5 and PM10)
Ozone
PM (PM2.5 and PM10)
PM2.5
PM10
Boundaries
Basemaps
Legend
Oregon
Boise
Medford
Salt Lake City
Nevada
Utah
Carson City
Sacramento
San Francisco
San Jose
California
Fresno
Las Vegas
Los Angeles
Archive Date:
September 8, 2020
Earthstar Geographics | Esri, HERE, Garmin
POWERED BY esri

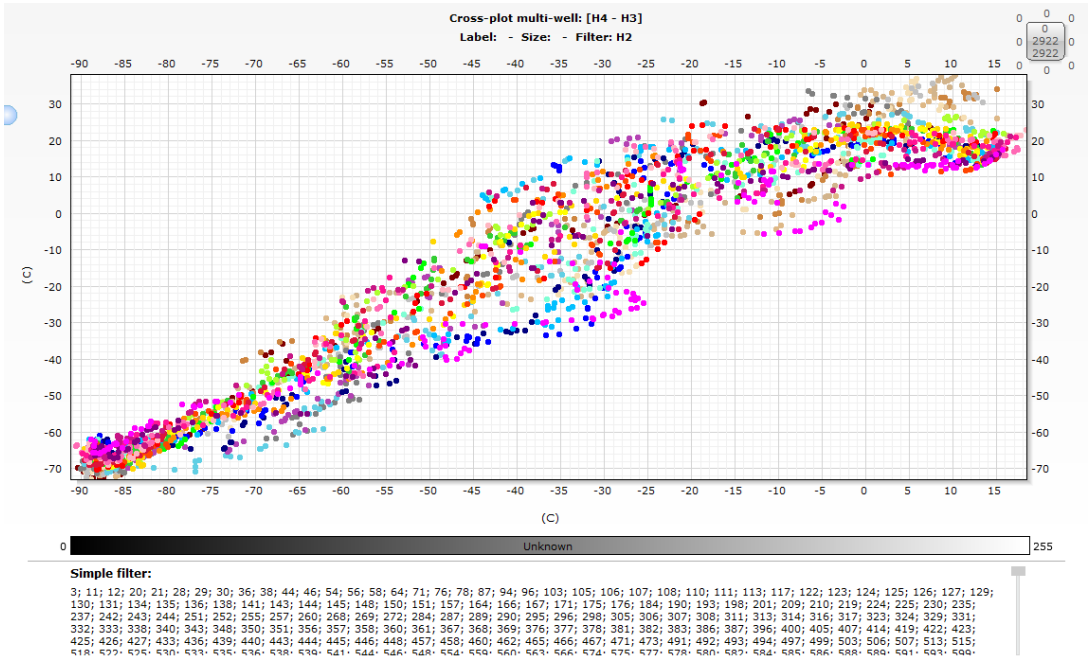

Coastlines
© OpenStreetMap contributors
Deep Blue Aerosol Optical Depth (Land)
Terra / MODIS
< 0.0
5.0
Deep Blue Aerosol Optical Depth (Land)
Aqua / MODIS
< 0.0
5.0
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Terra / MODIS
< 0.0
5.0
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Aqua / MODIS
< 0.0
5.0
Aerosol Optical Depth 3km (3km, Land
Group Similar Layers
+ Add Layers
Start Comparison
200 km
100 mi
Monitors
Daily AQI
Contours
Daily AQI
Show green contours
Ozone and PM
(PM2.5 and PM10)
Ozone
PM (PM2.5 and PM10)
PM2.5
PM10
Boundaries
Basemaps
Legend
Oregon
Boise
Medford
Salt Lake City
Carson City
Nevada
Utah
Sacramento
San Francisco
San Jose
California
Fresno
Las Vegas
Los Angeles
Archive Date:
September 9, 2020
Earthstar Geographics | Esri, HERE, Garmin
POWERED BY esri

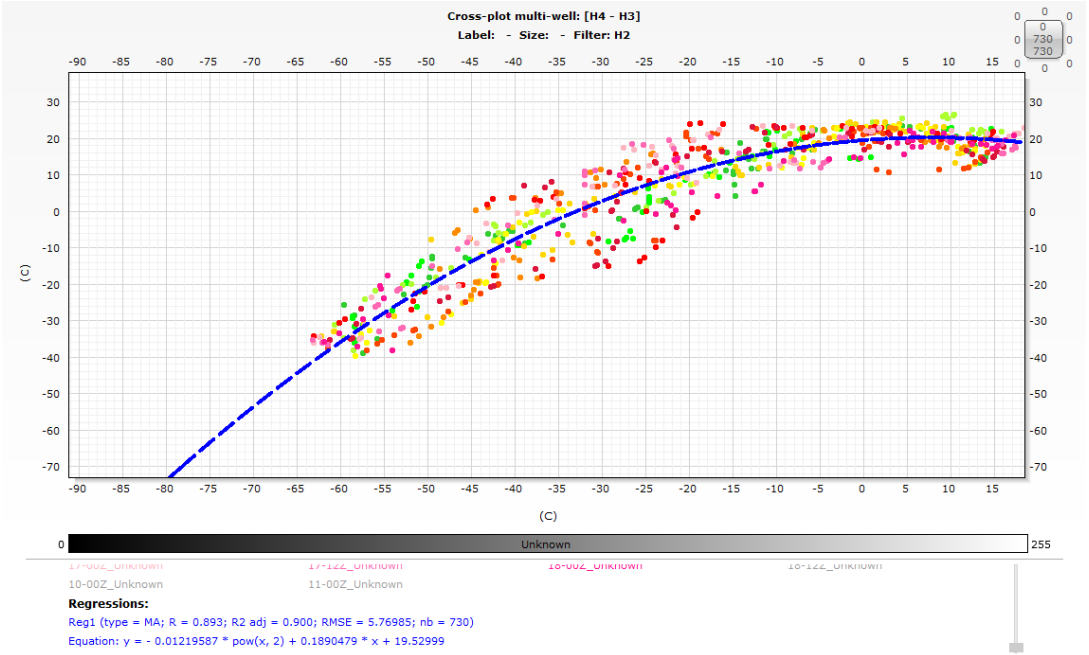

Coastlines
© OpenStreetMap contributors
Deep Blue Aerosol Optical Depth (Land)
Terra / MODIS
0.015 – 0.020
Deep Blue Aerosol Optical Depth (Land)
Aqua / MODIS
0.015 – 0.020
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Terra / MODIS
0.080 – 0.085
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Aqua / MODIS
0.045 – 0.050
Group Similar Layers
+ Add Layers
Start Comparison
200 km
100 mi
41.8336°, -121.3695° EPSG:4326
Monitors
Daily AQI
Contours
Daily AQI
Show green contours
Ozone and PM
(PM2.5 and PM10)
Ozone
PM (PM2.5 and PM10)
PM2.5
PM10
Boundaries
Basemaps
Legend
Oregon
Boise
Medford
Salt Lake City
Carson City
Nevada
Utah
Sacramento
San Francisco
San Jose
California
Fresno
Las Vegas
Los Angeles
Archive Date:
September 10, 2020
Earthstar Geographics | Esri, HERE, Garmin
POWERED BY esri

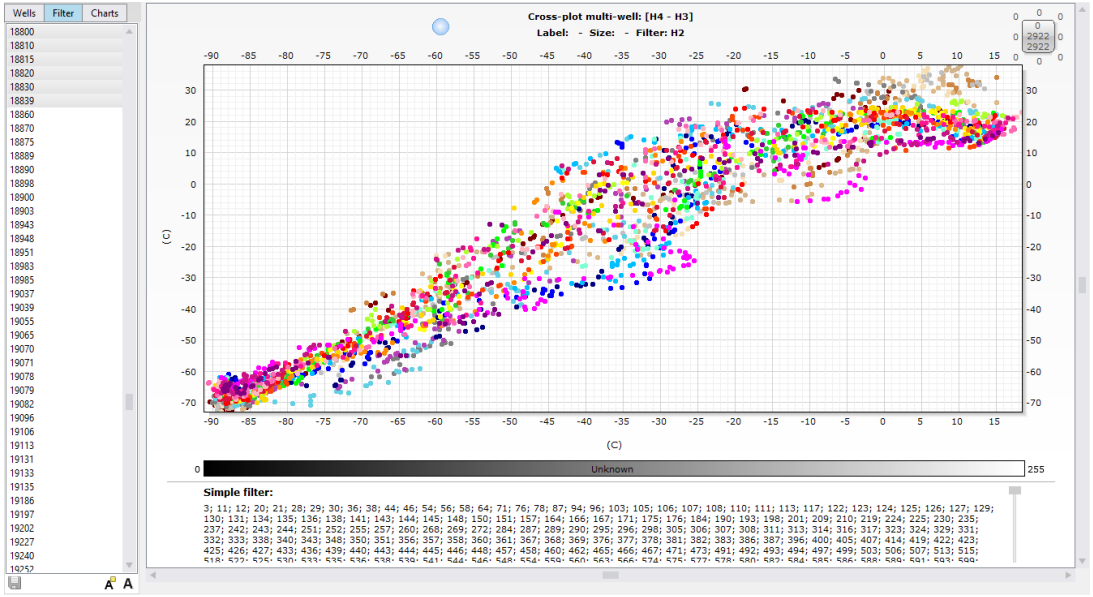

Coastlines
© OpenStreetMap contributors
Deep Blue Aerosol Optical Depth (Land)
Terra / MODIS
0.020 – 0.025
Deep Blue Aerosol Optical Depth (Land)
Aqua / MODIS
0.045 – 0.050
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Terra / MODIS
0.190 – 0.195
Merged DT/DB Aerosol Optical Depth (Land and Ocean)
Aqua / MODIS
0.145 – 0.150
Group Similar Layers
+ Add Layers
Start Comparison
200 km
100 mi
42.0373°, -121.9807° EPSG:4326
Monitors
Daily AQI
Contours
Daily AQI
Show green contours
Ozone and PM
(PM2.5 and PM10)
Ozone
PM (PM2.5 and PM10)
PM2.5
PM10
Boundaries
Basemaps
Legend
Oregon
Boise
Medford
Salt Lake City
Carson City
Nevada
Utah
Sacramento
San Francisco
San Jose
California
Fresno
Las Vegas
Los Angeles
Archive Date:
September 11, 2020
Earthstar Geographics | Esri, HERE, Garmin
esri

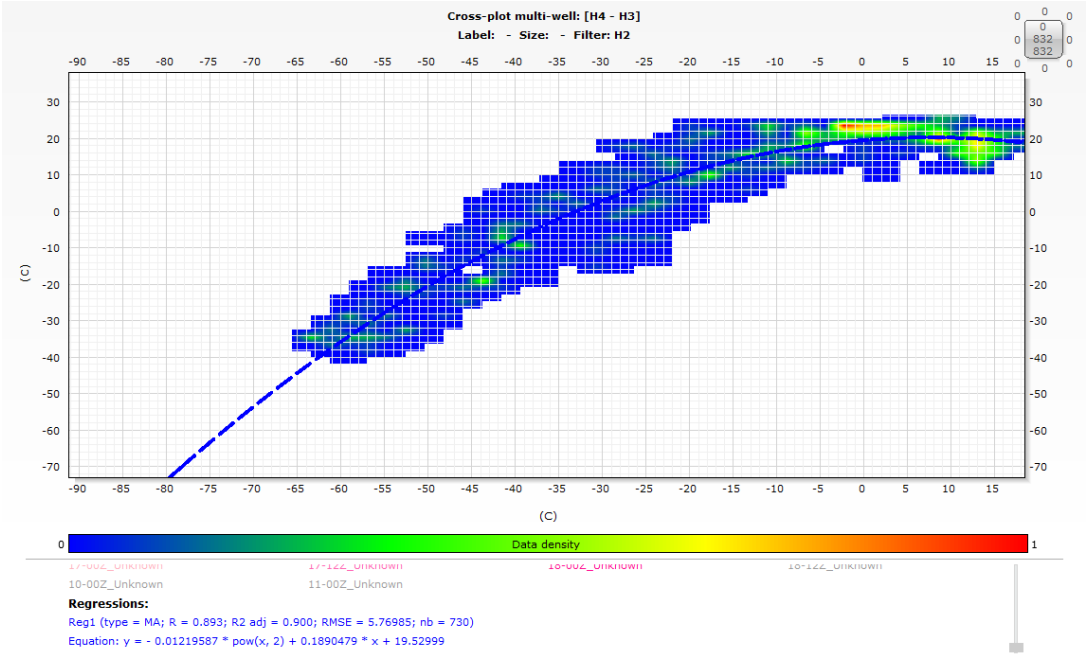

WORLDVIEW
Layers
Events
Data
Fires and Thermal Anomalies (Night, 375m)
Suomi NPP / VIIRS
Fire
Fires and Thermal Anomalies (Day, 375m)
Suomi NPP / VIIRS
Fire
Place Labels
© OpenStreetMap contributors, Natural Earth
Coastlines / Borders / Roads
© OpenStreetMap contributors
Coastlines
© OpenStreetMap contributors
BASE LAYERS
Corrected Reflectance (True Color)
Suomi NPP / VIIRS
Corrected Reflectance (True Color)
Aqua / MODIS
Corrected Reflectance (True Color)
Terra / MODIS
Group Similar Layers
+ Add Layers
Start Comparison
Search for places or enter coordinates
100 km
50 mi
37.5523°, -120.6234° EPSG:4326
1 DAY
2020 SEP 09
AUG 2020
SEP 2020
OCT 2020
DAY

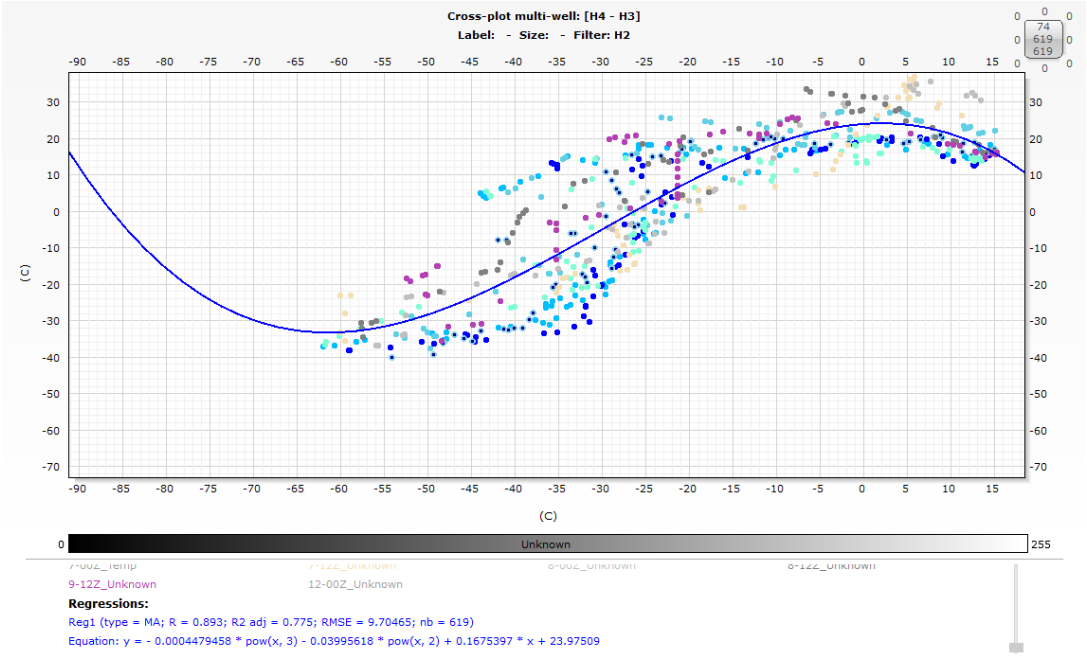

Cross-plot multi-well: [H4 - H3]
Label: - Size: - Filter: H2
(C)
(C)
Unknown
0
255
Simple filter:
3; 11; 12; 20; 21; 28; 29; 30; 36; 38; 44; 46; 54; 56; 58; 64; 71; 76; 78; 87; 94; 96; 103; 105; 106; 107; 108; 110; 111; 113; 117; 122; 123; 124; 125; 126; 127; 129;
130; 131; 134; 135; 136; 138; 141; 143; 144; 145; 148; 150; 151; 157; 164; 166; 167; 171; 175; 176; 184; 190; 193; 198; 201; 209; 210; 219; 224; 225; 230; 235;
237; 242; 243; 244; 251; 252; 255; 257; 260; 268; 269; 272; 284; 287; 289; 290; 295; 296; 298; 305; 306; 307; 308; 311; 313; 314; 316; 317; 323; 324; 329; 331;
332; 333; 338; 340; 343; 348; 350; 351; 356; 357; 358; 360; 361; 367; 368; 369; 376; 377; 378; 381; 382; 383; 386; 387; 396; 400; 405; 407; 414; 419; 422; 423;
425; 426; 427; 433; 436; 439; 440; 443; 444; 445; 446; 448; 457; 458; 460; 462; 465; 466; 467; 471; 473; 491; 492; 493; 494; 497; 499; 503; 506; 507; 513; 515;

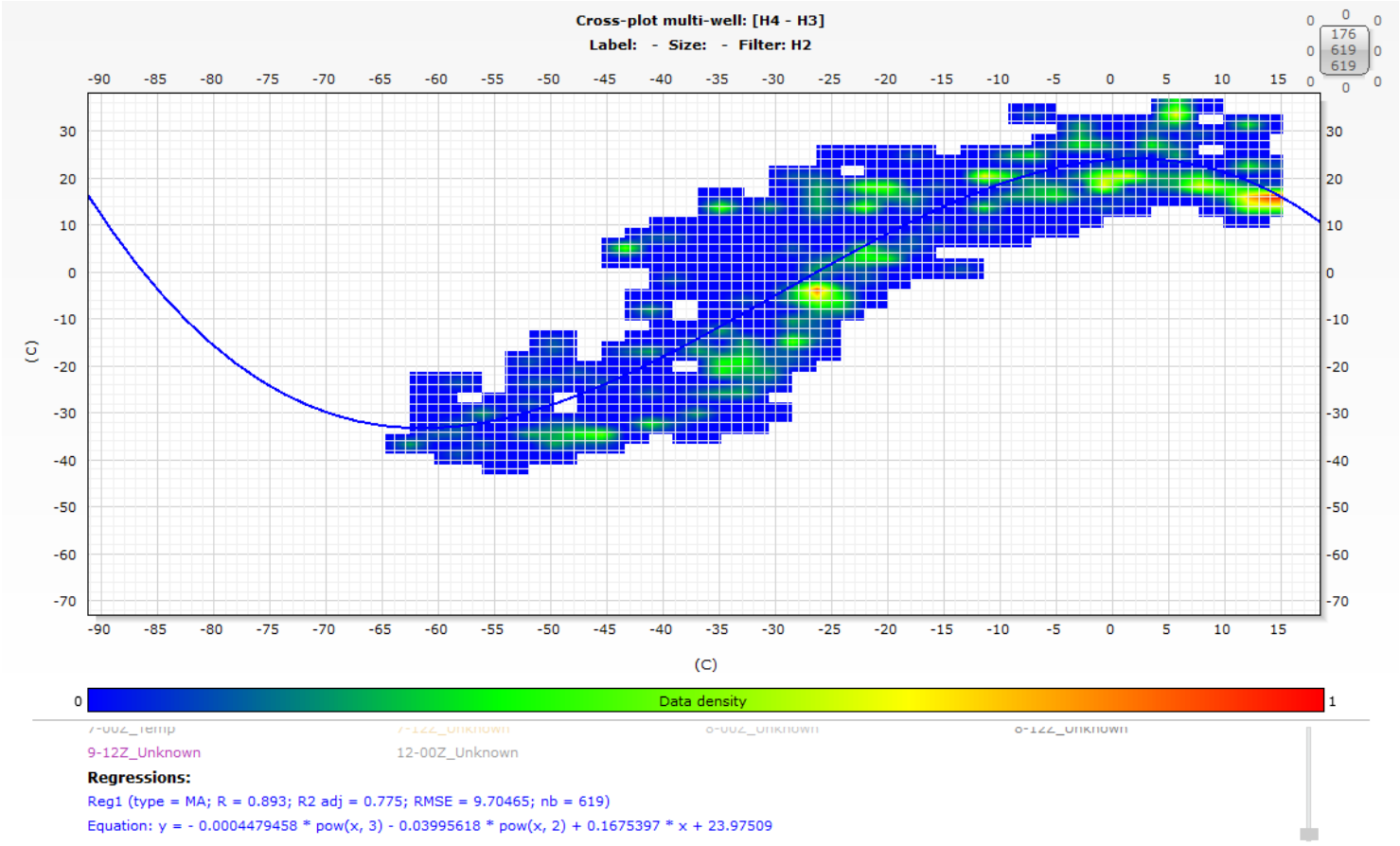

Cross-plot multi-well: [H4 - H3]
Label: - Size: - Filter: H2
2922
2922
(C)
(C)
Unknown
0
255
Simple filter:
3; 11; 12; 20; 21; 28; 29; 30; 36; 38; 44; 46; 54; 56; 58; 64; 71; 76; 78; 87; 94; 96; 103; 105; 106; 107; 108; 110; 111; 113; 117; 122; 123; 124; 125; 126; 127; 129;
130; 131; 134; 135; 136; 138; 141; 143; 144; 145; 148; 150; 151; 157; 164; 166; 167; 171; 175; 176; 184; 190; 193; 198; 201; 209; 210; 219; 224; 225; 230; 235;
237; 242; 243; 244; 251; 252; 255; 257; 260; 268; 269; 272; 284; 287; 289; 290; 295; 296; 298; 305; 306; 307; 308; 311; 313; 314; 316; 317; 323; 324; 329; 331;
332; 333; 338; 340; 343; 348; 350; 351; 356; 357; 358; 360; 361; 367; 368; 369; 376; 377; 378; 381; 382; 383; 386; 387; 396; 400; 405; 407; 414; 419; 422; 423;
425; 426; 427; 433; 436; 439; 440; 443; 444; 445; 446; 448; 457; 458; 460; 462; 465; 466; 467; 471; 473; 491; 492; 493; 494; 497; 499; 503; 506; 507; 513; 515;

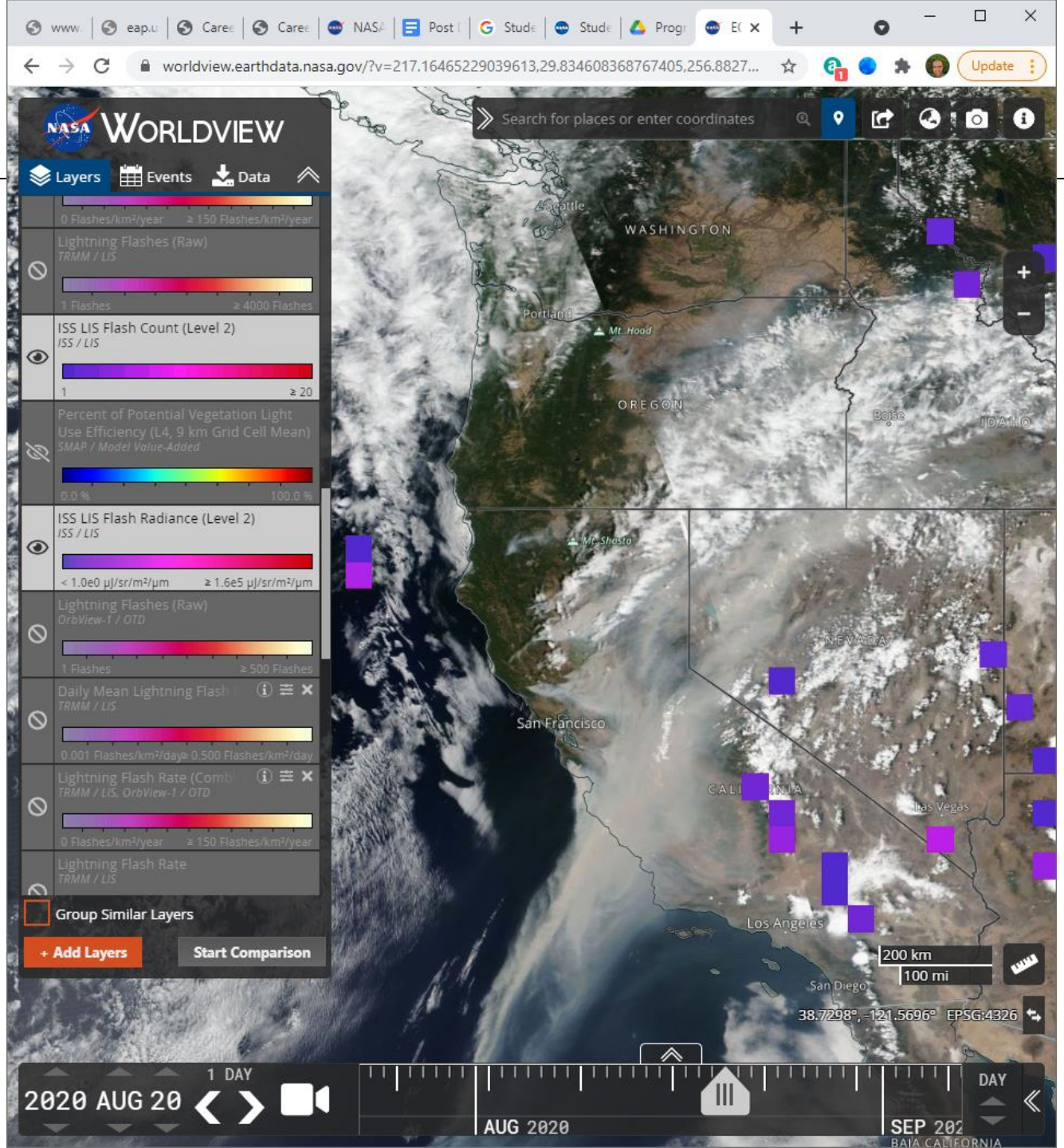

Cross-plot multi-well: [H4 - H3]
Label: - Size: - Filter: H2
(C)
(C)
0
Unknown
255
10-00Z_Unknown
11-00Z_Unknown
Regressions:
Reg1 (type = MA; R = 0.893; R2 adj = 0.900; RMSE = 5.76985; nb = 730)
Equation: y = - 0.01219587 * pow(x, 2) + 0.1890479 * x + 19.52999

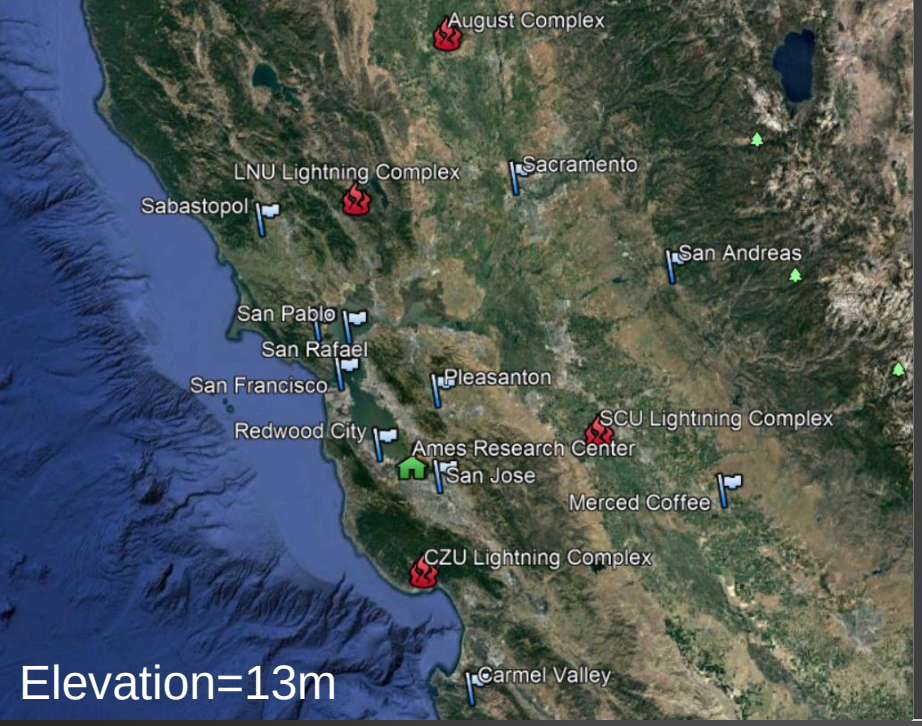

Wells
Filter
Charts
Cross-plot multi-well: [H4 - H3]
Label: - Size: - Filter: H2
(C)
(C)
Unknown
Simple filter:

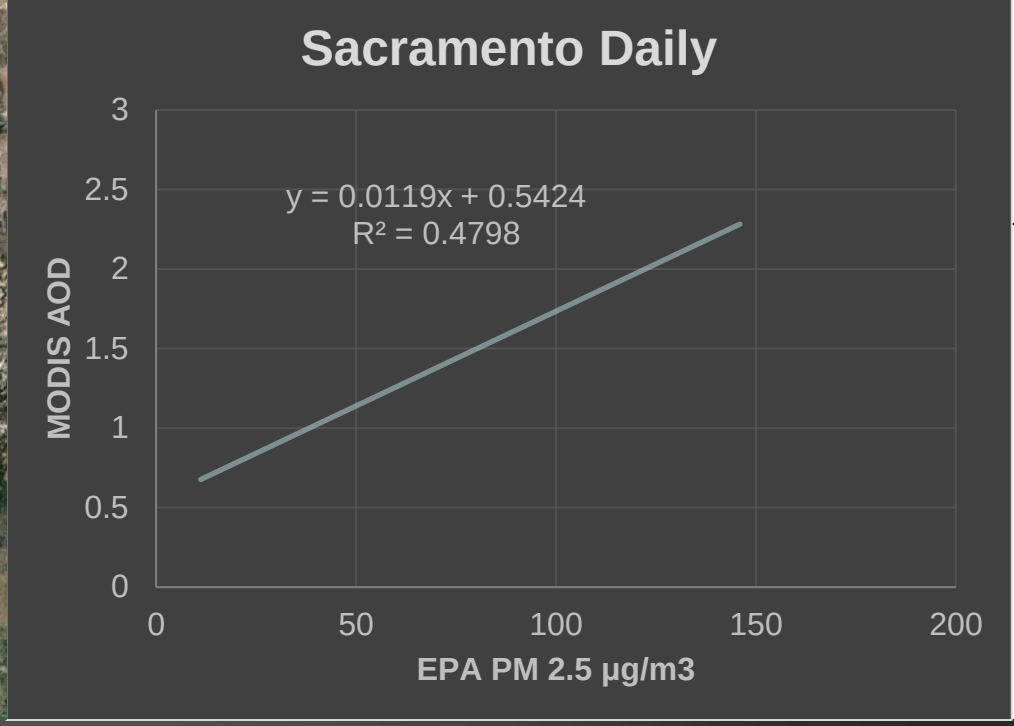

Cross-plot multi-well: [H4 - H3]
Label: - Size: - Filter: H2
(C)
(C)
Data density
10-00Z_Unknown
11-00Z_Unknown
Regressions:
Reg1 (type = MA; R = 0.893; R2 adj = 0.900; RMSE = 5.76985; nb = 730)
Equation: y = - 0.01219587 * pow(x, 2) + 0.1890479 * x + 19.52999

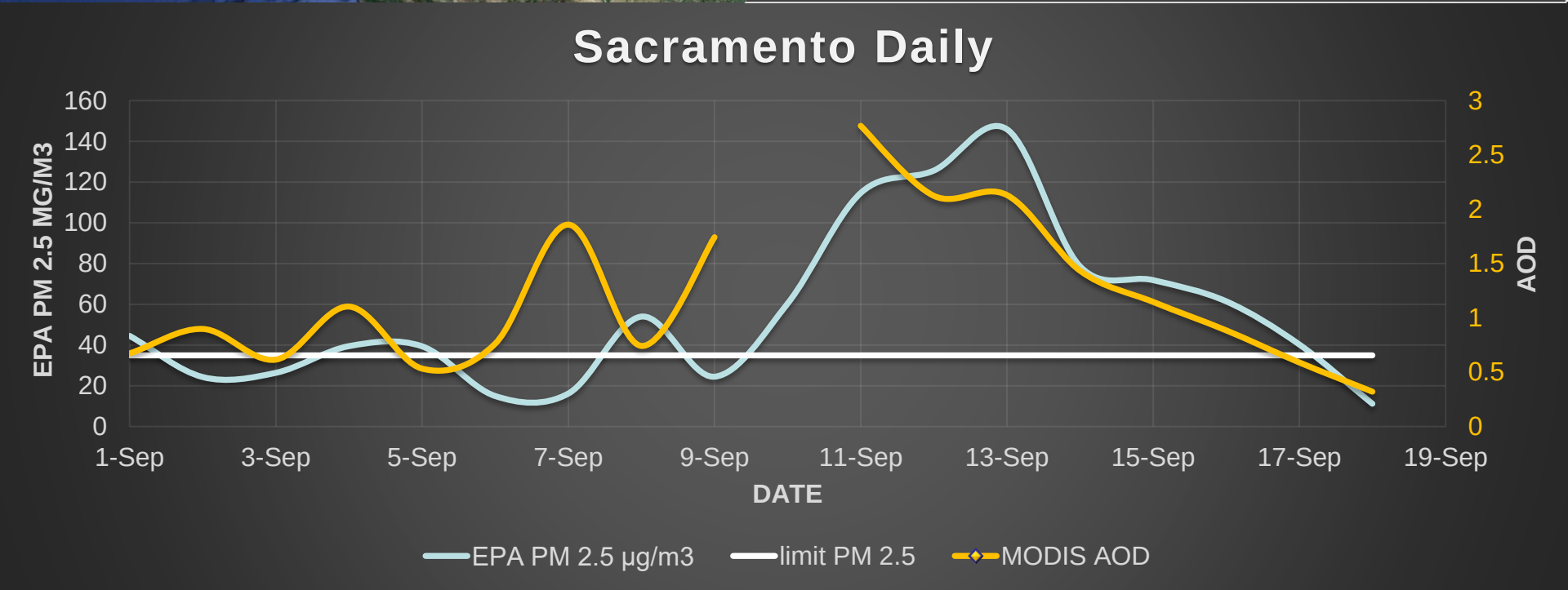

Cross-plot multi-well: [H4 - H3]
Label: - Size: - Filter: H2
0
74
619
619
(C)
Unknown
255
9-12Z_Unknown
12-00Z_Unknown
Regressions:
Reg1 (type = MA; R = 0.893; R2 adj = 0.775; RMSE = 9.70465; nb = 619)
Equation: y = - 0.0004479458 * pow(x, 3) - 0.03995618 * pow(x, 2) + 0.1675397 * x + 23.97509

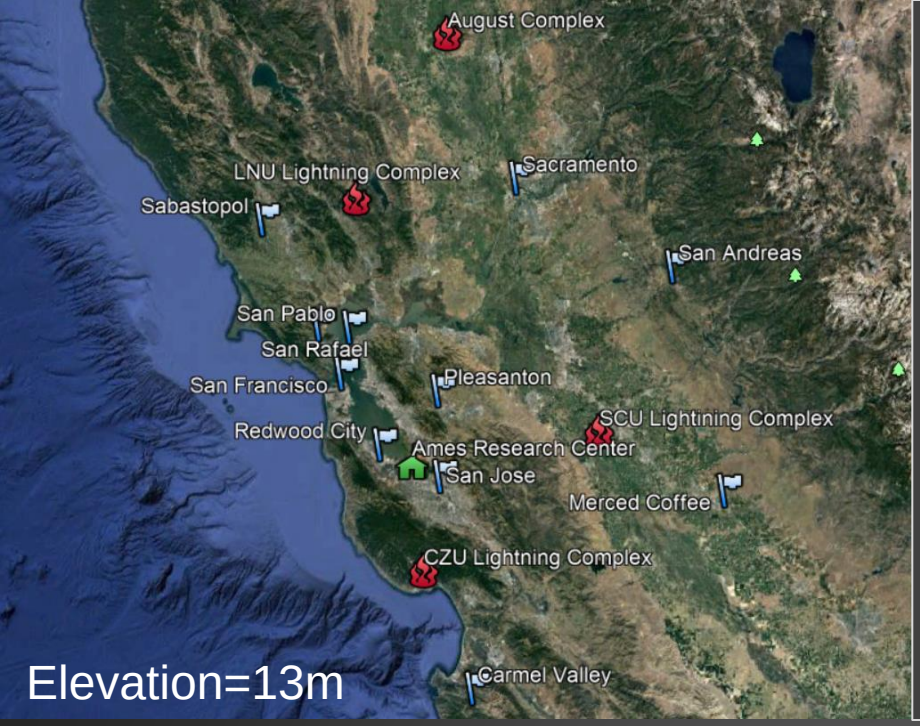

Cross-plot multi-well: [H4 - H3]
Label: - Size: - Filter: H2
0
176
619
619
0
-90 -85 -80 -75 -70 -65 -60 -55 -50 -45 -40 -35 -30 -25 -20 -15 -10 -5 0 5 10 15
30 20 10 0 -10 -20 -30 -40 -50 -60 -70
(C)
(C)
0
Data density
1
9-12Z_Unknown
12-00Z_Unknown
Regressions:
Reg1 (type = MA; R = 0.893; R2 adj = 0.775; RMSE = 9.70465; nb = 619)
Equation: y = - 0.0004479458 * pow(x, 3) - 0.03995618 * pow(x, 2) + 0.1675397 * x + 23.97509

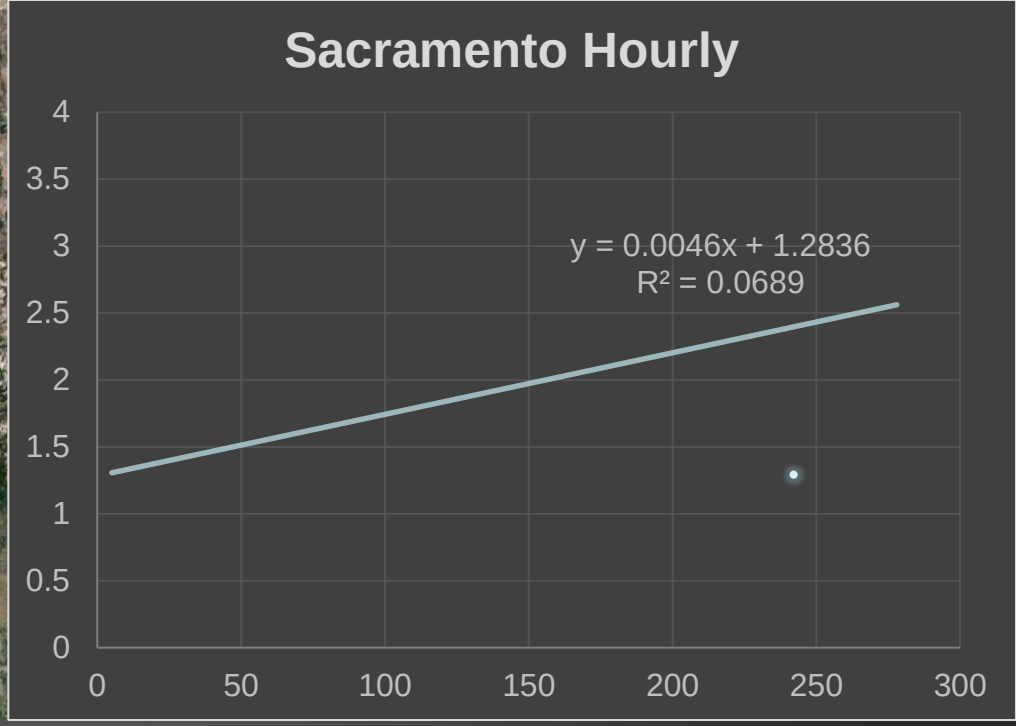

worldview.earthdata.nasa.gov/?v=217.16465229039613,29.834608368767405,256.8827...
Update
WORLDVIEW
Search for places or enter coordinates
Layers
Events
Data
0 Flashes/km²/year
≥ 150 Flashes/km²/year
Lightning Flashes (Raw)
TRMM / LIS
1 Flashes
≥ 4000 Flashes
ISS LIS Flash Count (Level 2)
ISS / LIS
1
≥ 20
Percent of Potential Vegetation Light Use Efficiency (L4, 9 km Grid Cell Mean)
SMAP / Model Value-Added
0.0 %
100.0 %
ISS LIS Flash Radiance (Level 2)
ISS / LIS
< 1.0e0 µJ/sr/m²/µm
≥ 1.6e5 µJ/sr/m²/µm
Lightning Flashes (Raw)
OrbView-1 / OTD
1 Flashes
≥ 500 Flashes
Daily Mean Lightning Flash
TRMM / LIS
0.001 Flashes/km²/day
≥ 0.500 Flashes/km²/day
Lightning Flash Rate (Comb
TRMM / LIS, OrbView-1 / OTD
0 Flashes/km²/year
≥ 150 Flashes/km²/year
Lightning Flash Rate
TRMM / LIS
Group Similar Layers
+ Add Layers
Start Comparison
Seattle
WASHINGTON
Portland
Mt. Hood
OREGON
Boise
IDAHO
Mt. Shasta
NEVADA
San Francisco
Las Vegas
Los Angeles
San Diego
200 km
100 mi
38.7298°, -121.5696° EPSG:4326
1 DAY
2020 AUG 20
AUG 2020
SEP 202
DAY
BAJA CALIFORNIA


August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
Redwood City
SCU Lightining Complex
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=13m


Sacramento Daily
y = 0.0119x + 0.5424
R² = 0.4798
MODIS AOD
EPA PM 2.5 µg/m3
0
0.5
1
1.5
2
2.5
3
0
50
100
150
200


Sacramento Daily
EPA PM 2.5 MG/M3
AOD
DATE
160
140
120
100
80
60
40
20
0
3
2.5
2
1.5
1
0.5
0
1-Sep
3-Sep
5-Sep
7-Sep
9-Sep
11-Sep
13-Sep
15-Sep
17-Sep
19-Sep
EPA PM 2.5 µg/m3
limit PM 2.5
MODIS AOD



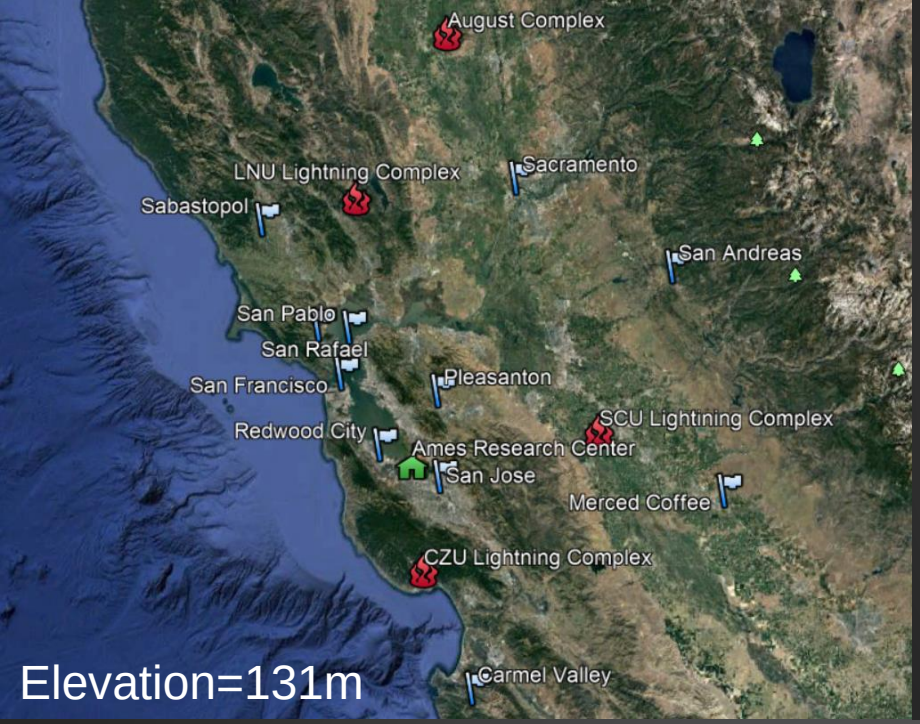


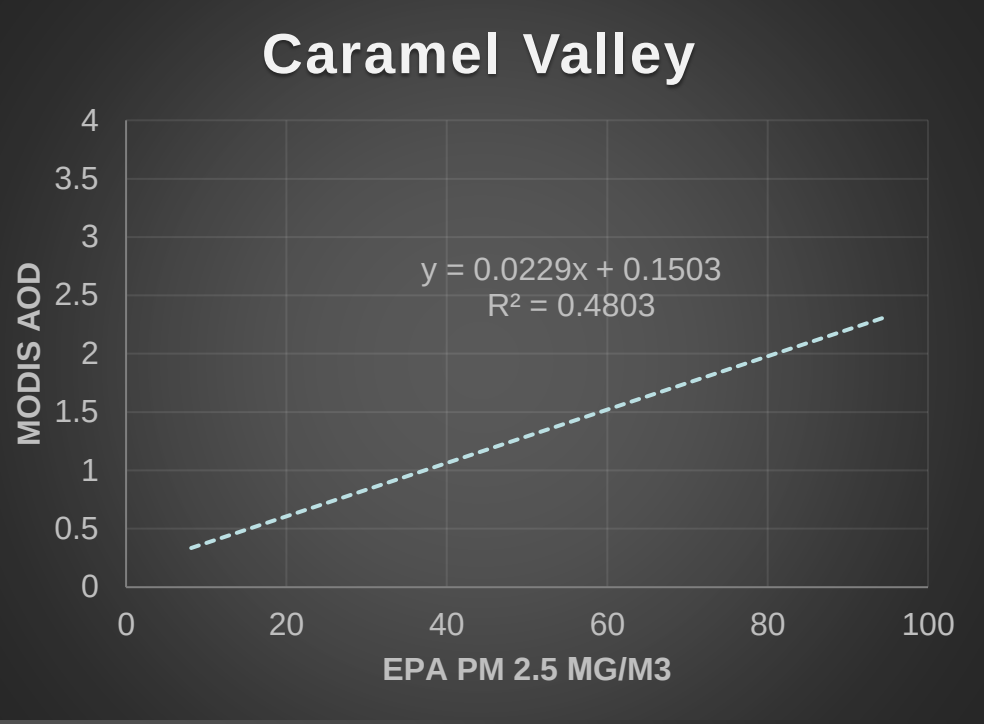
Sacramento Hourly

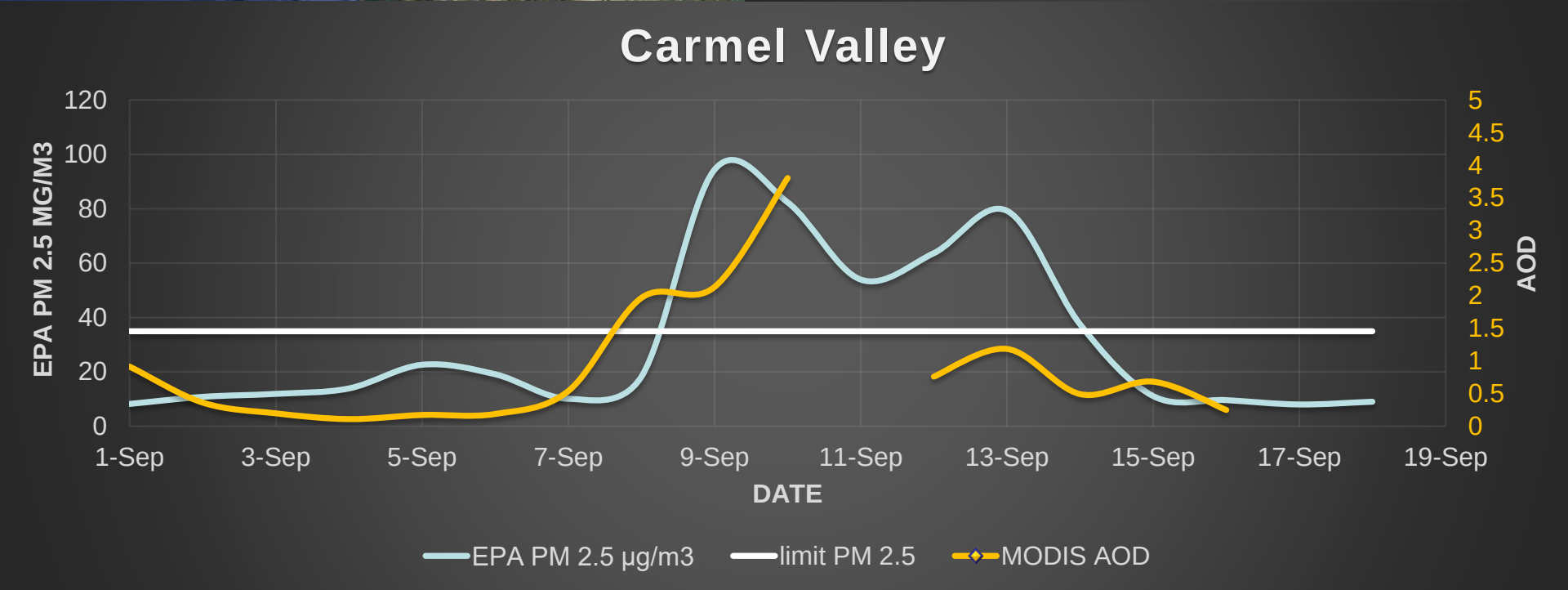
SEP 11
16-23

300
250
200
150
100
50
0

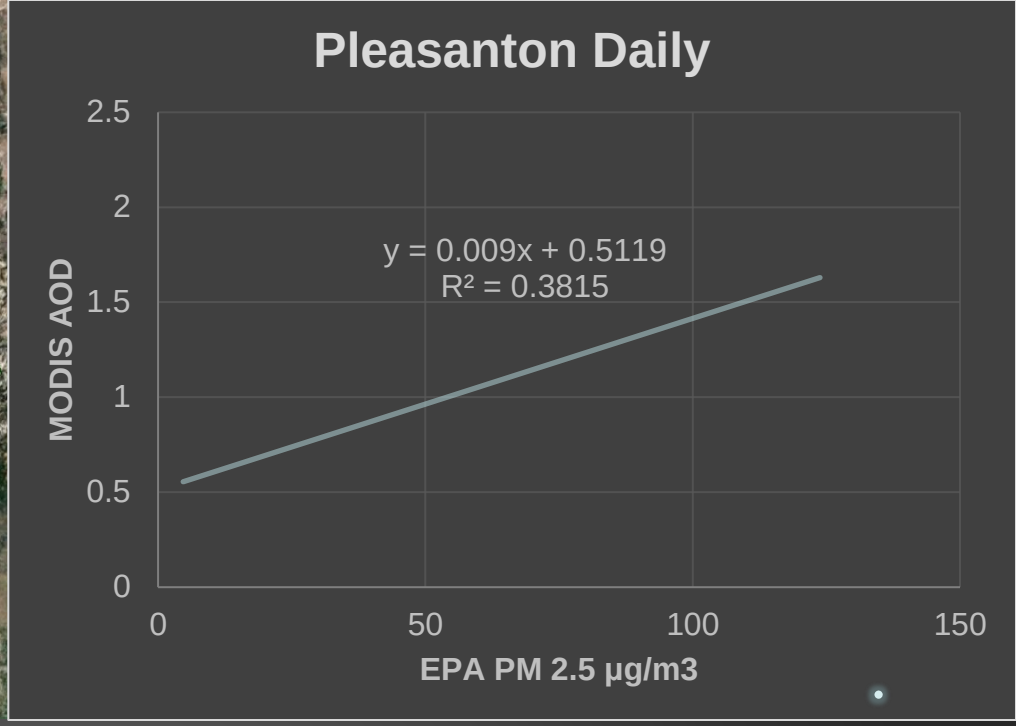
4
3.5
3
2.5
2
1.5
1
0.5
0

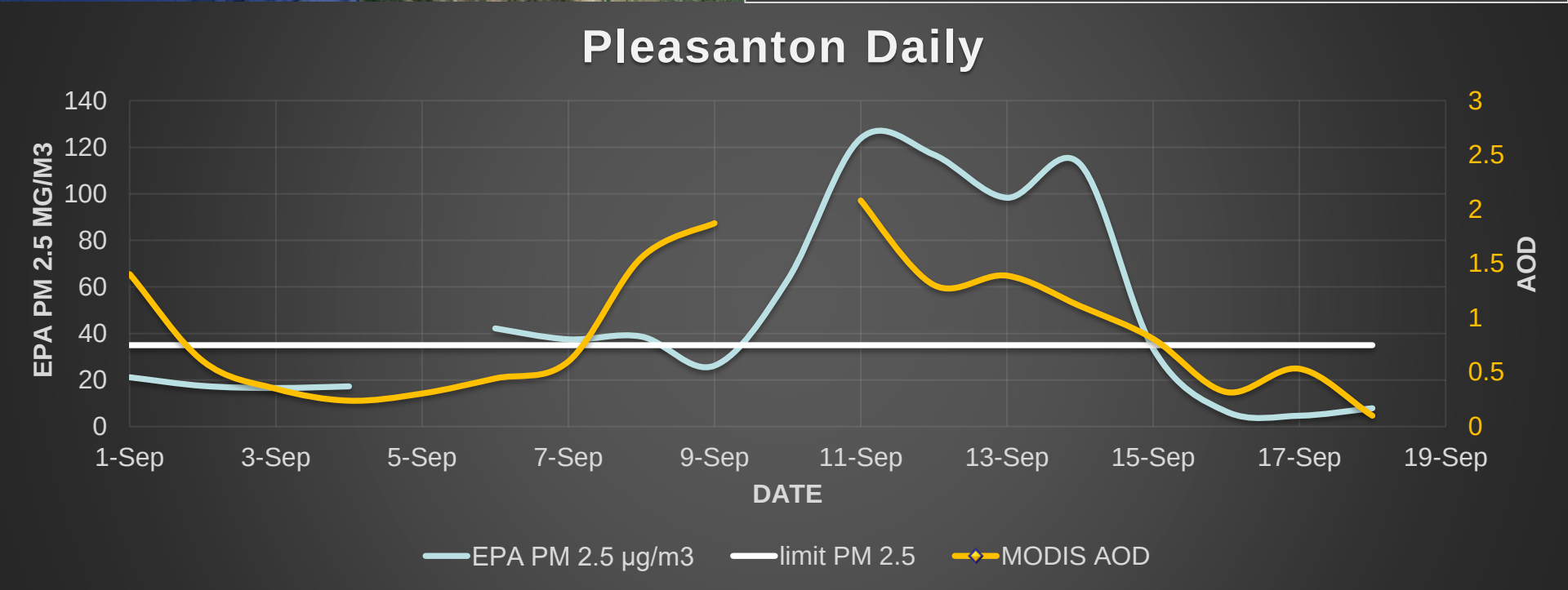

August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
Redwood City
SCU Lightining Complex
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=131m

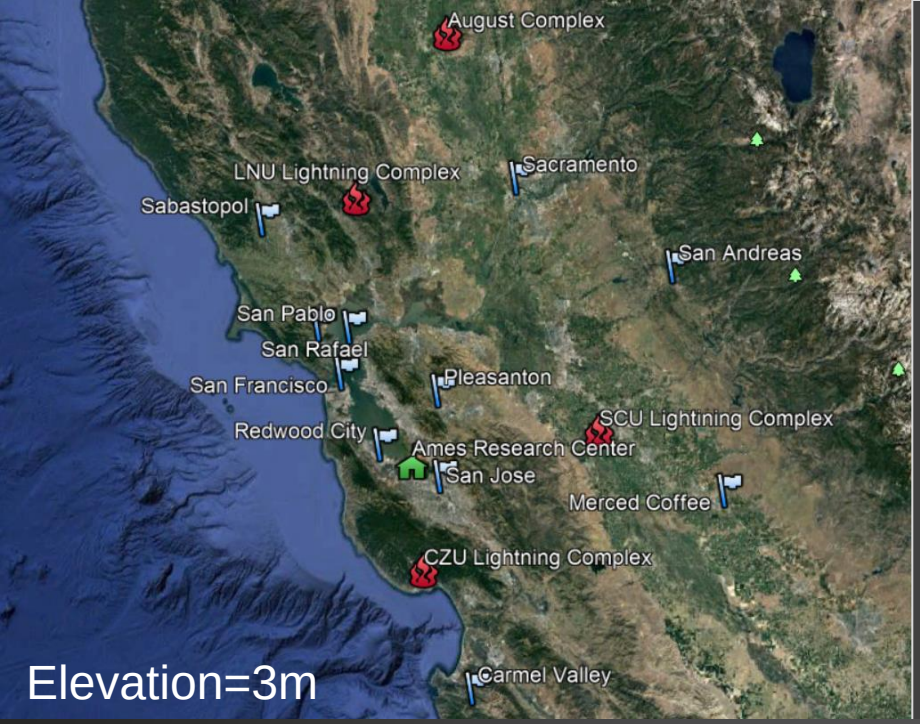

Caramel Valley
MODIS AOD
y = 0.0229x + 0.1503
R² = 0.4803
EPA PM 2.5 MG/M3
0
0.5
1
1.5
2
2.5
3
3.5
4
0
20
40
60
80
100

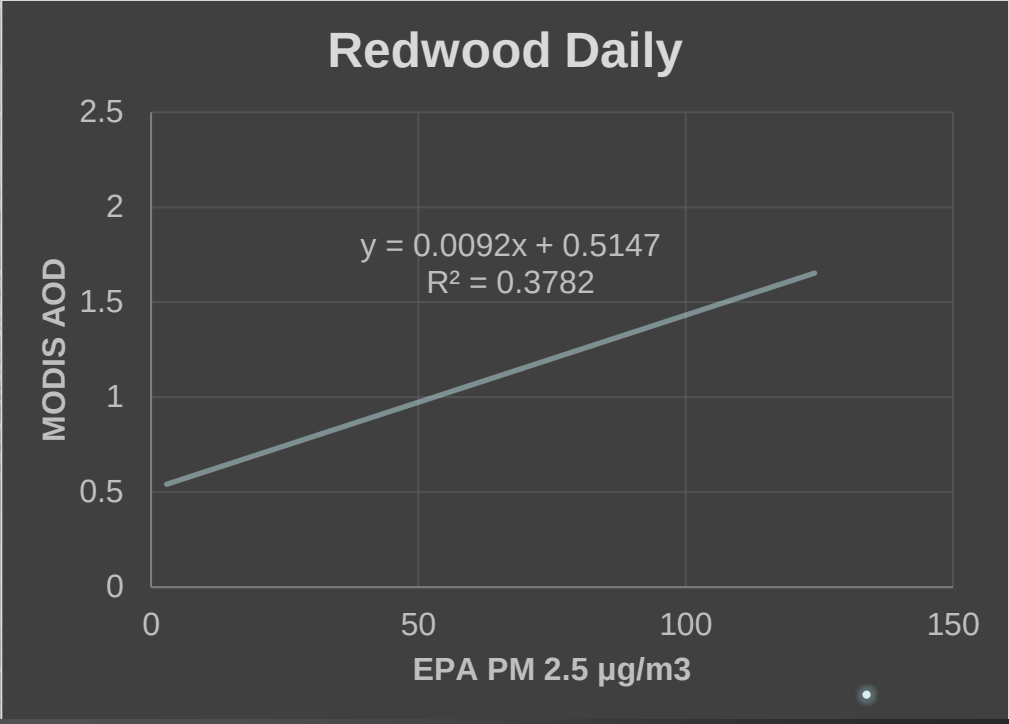

Carmel Valley
EPA PM 2.5 MG/M3
AOD
DATE
120
100
80
60
40
20
0
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1-Sep
3-Sep
5-Sep
7-Sep
9-Sep
11-Sep
13-Sep
15-Sep
17-Sep
19-Sep
EPA PM 2.5 µg/m3
limit PM 2.5
MODIS AOD

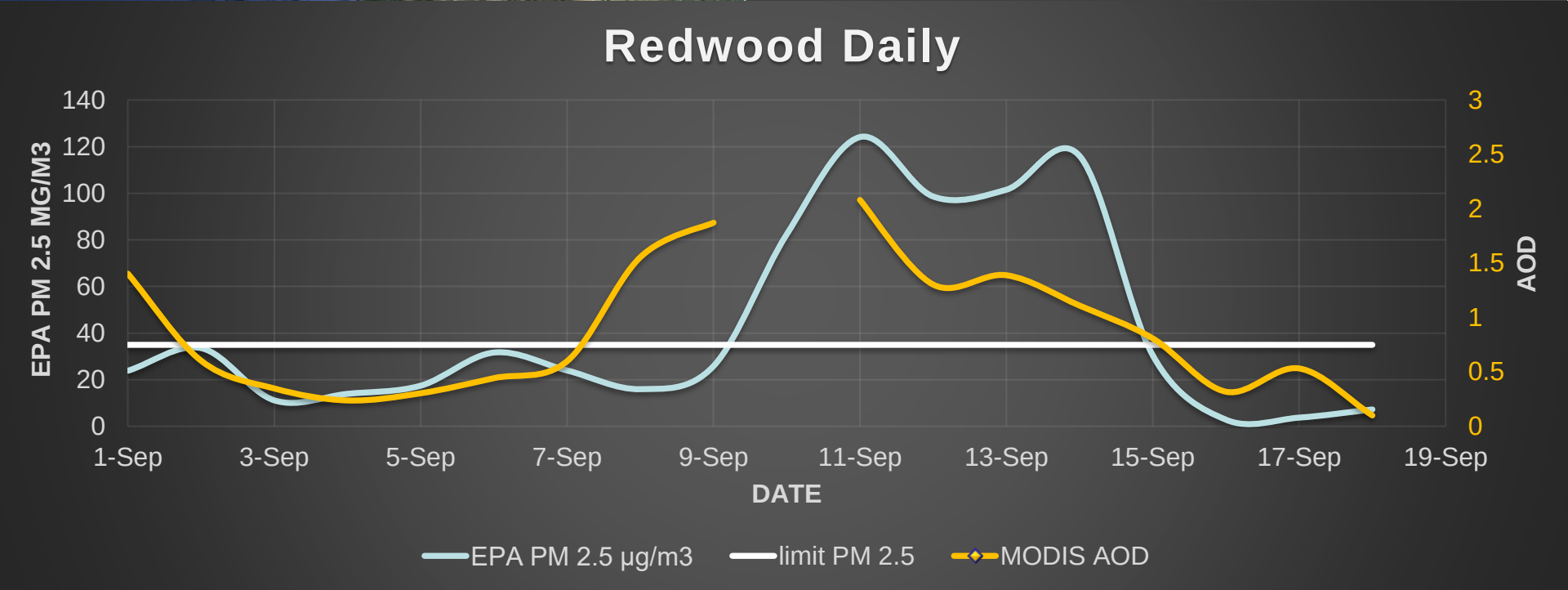

August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
SCU Lightining Complex
Redwood City
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=101m

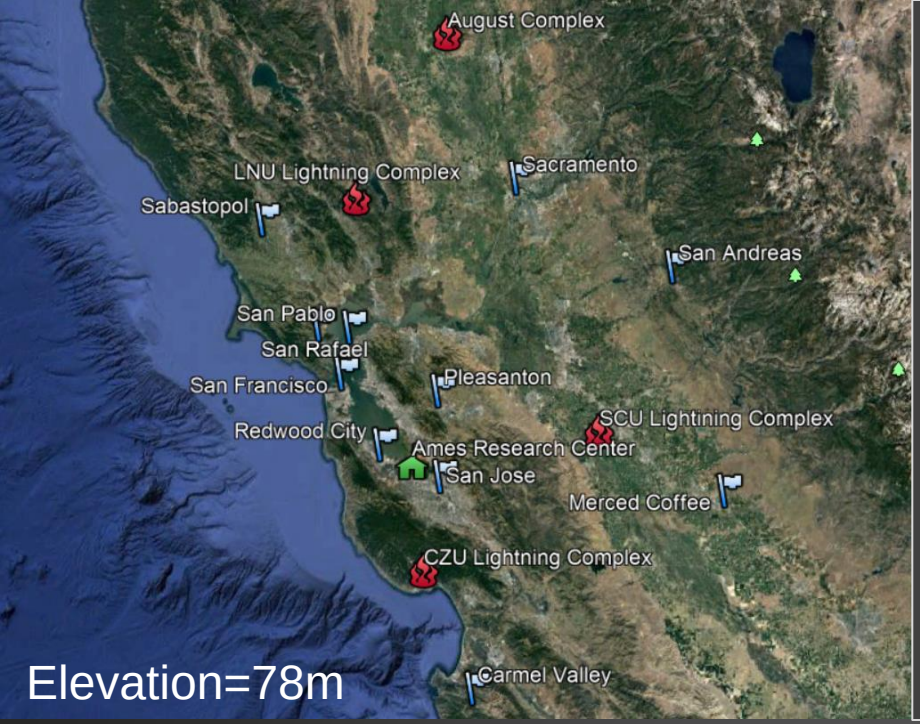

Pleasanton Daily
MODIS AOD
2.5
2
1.5
1
0.5
0
y = 0.009x + 0.5119
R² = 0.3815
0
50
100
150
EPA PM 2.5 µg/m3

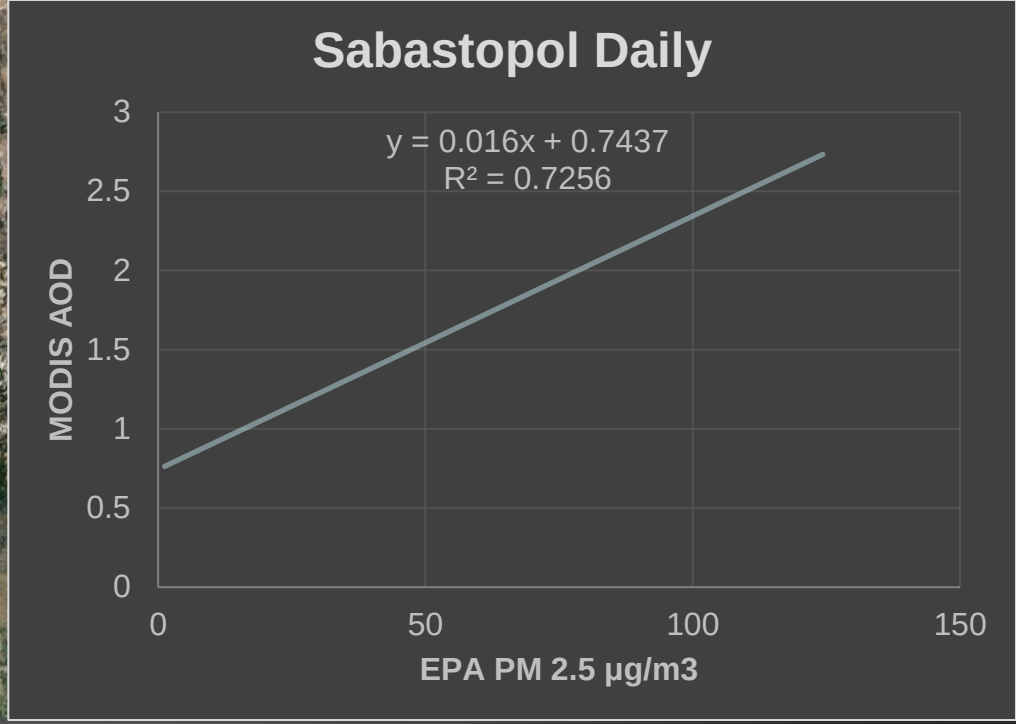

Pleasanton Daily
EPA PM 2.5 MG/M3
140
120
100
80
60
40
20
0
3
2.5
2
1.5
1
0.5
0
AOD
1-Sep
3-Sep
5-Sep
7-Sep
9-Sep
11-Sep
13-Sep
15-Sep
17-Sep
19-Sep
DATE
EPA PM 2.5 µg/m3
limit PM 2.5
MODIS AOD

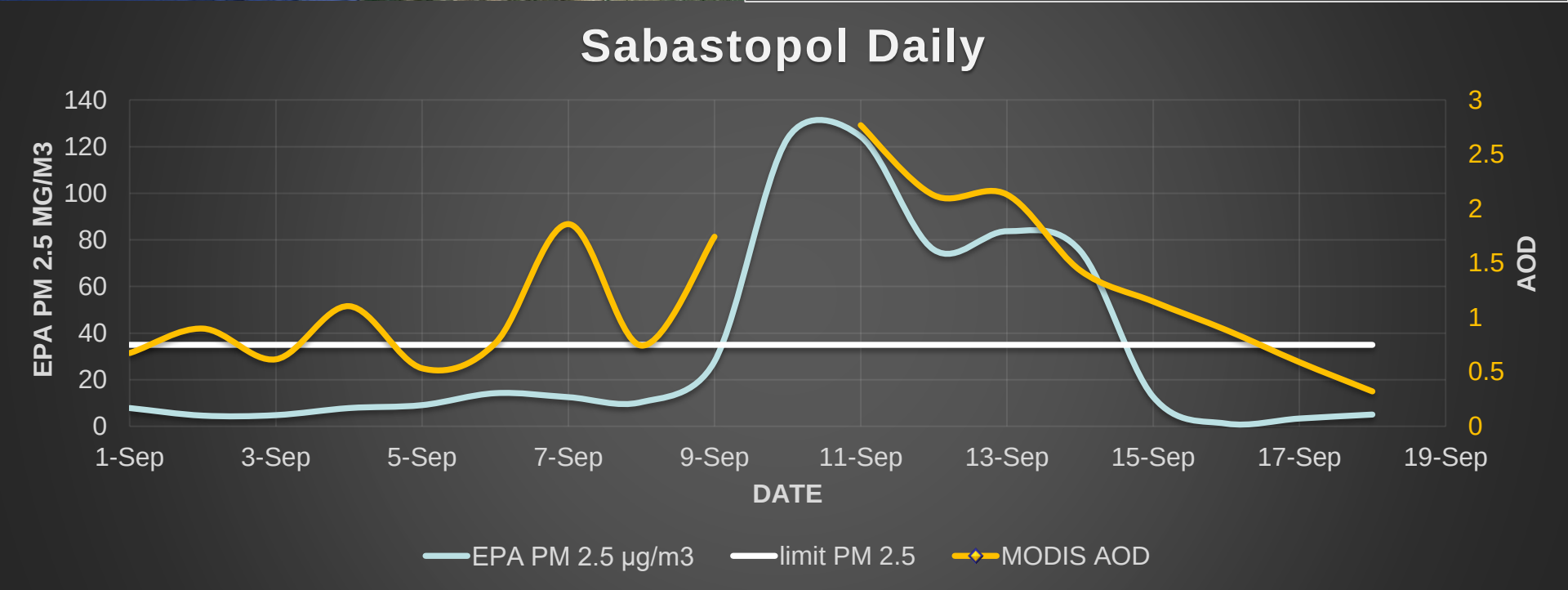

August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
SCU Lightining Complex
Redwood City
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=3m

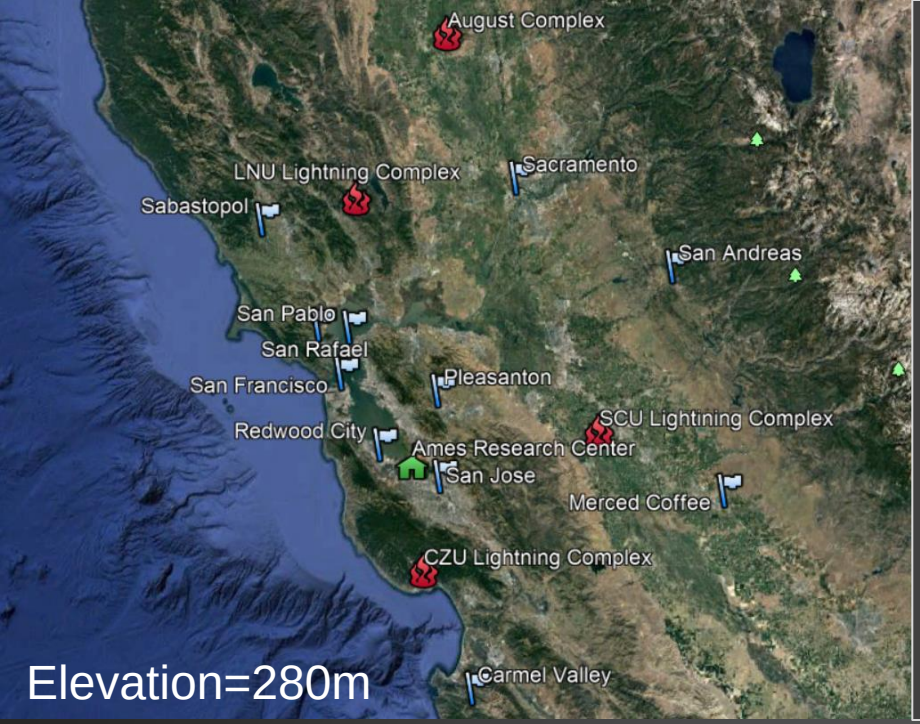

Redwood Daily
y = 0.0092x + 0.5147
R² = 0.3782
MODIS AOD
EPA PM 2.5 µg/m3
0
0.5
1
1.5
2
2.5
0
50
100
150

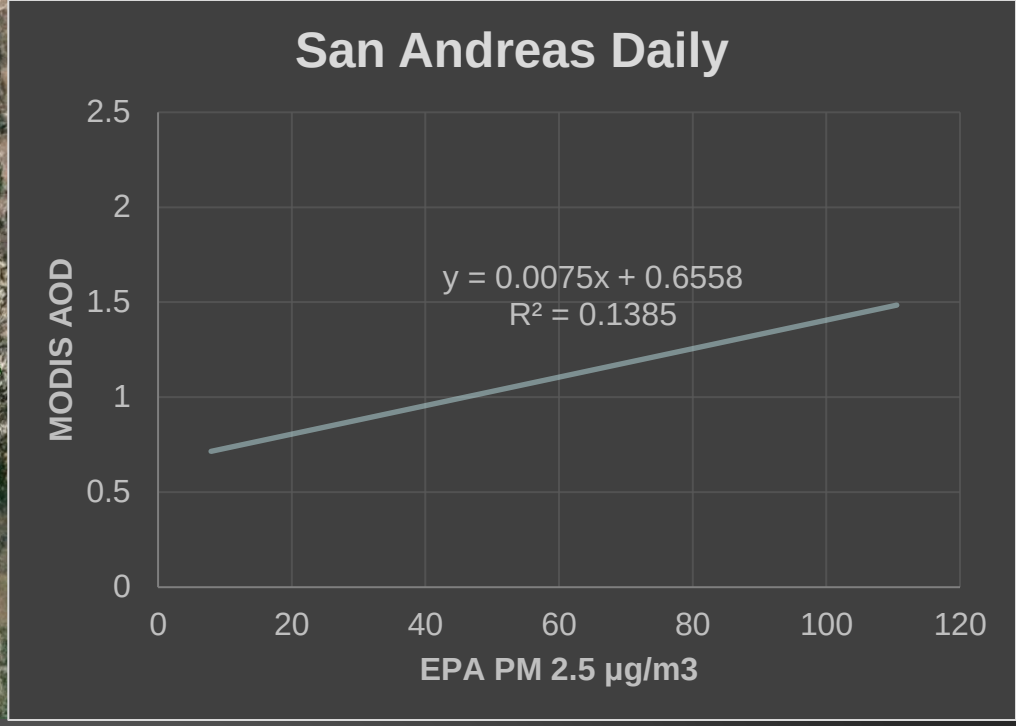

Redwood Daily
EPA PM 2.5 MG/M3
AOD
DATE
0
20
40
60
80
100
120
140
0
0.5
1
1.5
2
2.5
3
1-Sep
3-Sep
5-Sep
7-Sep
9-Sep
11-Sep
13-Sep
15-Sep
17-Sep
19-Sep
EPA PM 2.5 µg/m3
limit PM 2.5
MODIS AOD

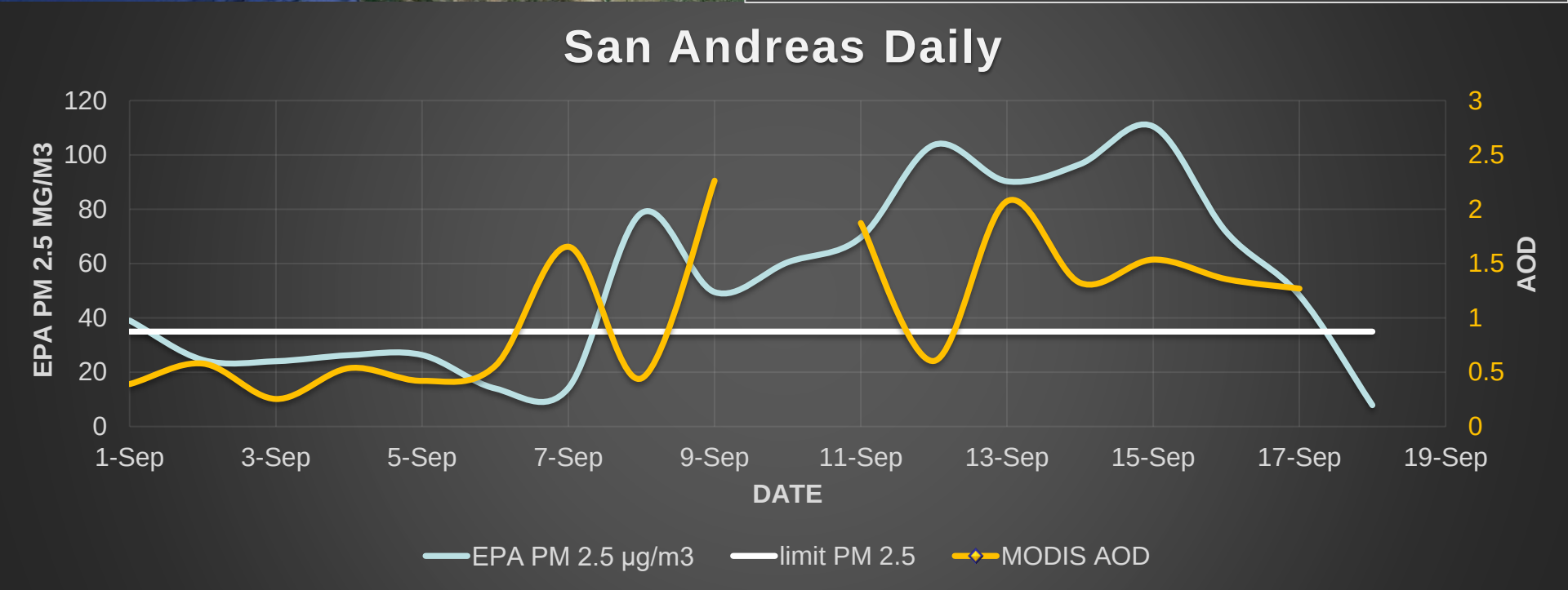

August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
SCU Lightining Complex
Redwood City
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=78m

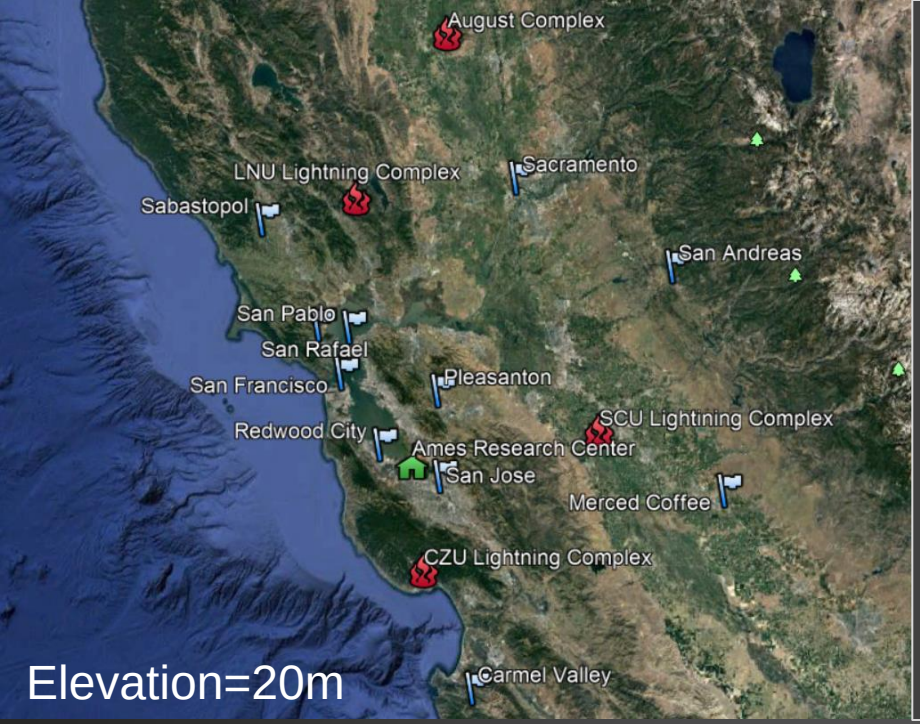

Sabastopol Daily
y = 0.016x + 0.7437
R² = 0.7256
MODIS AOD
EPA PM 2.5 µg/m3
0
0.5
1
1.5
2
2.5
3
0
50
100
150

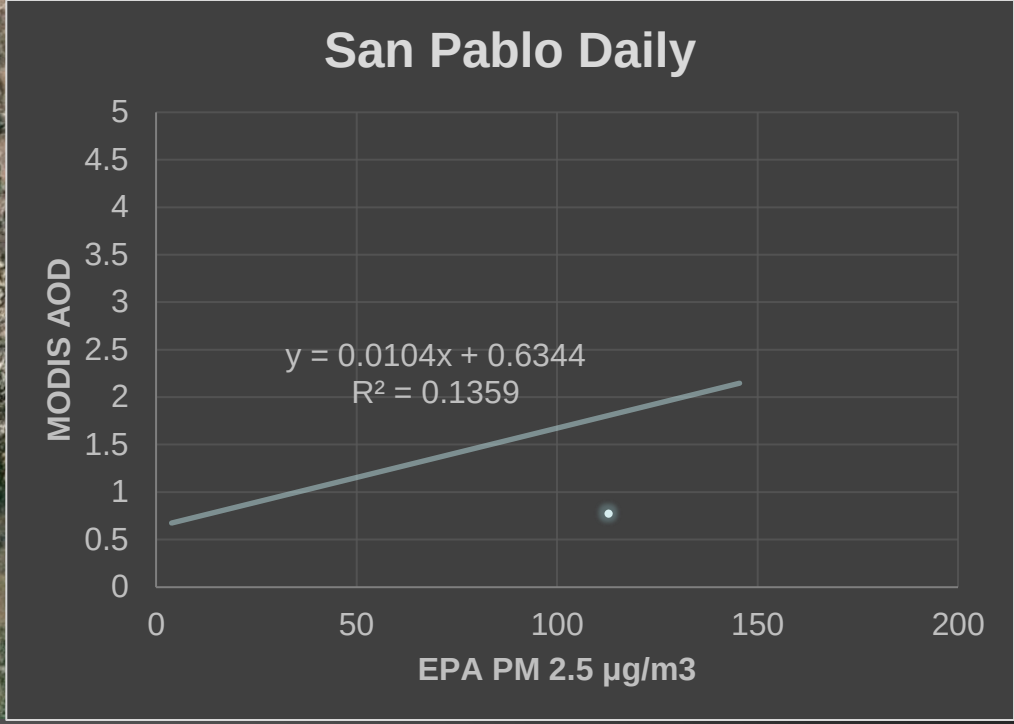

Sabastopol Daily
EPA PM 2.5 MG/M3
AOD
DATE
140
120
100
80
60
40
20
0
3
2.5
2
1.5
1
0.5
0
1-Sep
3-Sep
5-Sep
7-Sep
9-Sep
11-Sep
13-Sep
15-Sep
17-Sep
19-Sep
EPA PM 2.5 µg/m3
limit PM 2.5
MODIS AOD

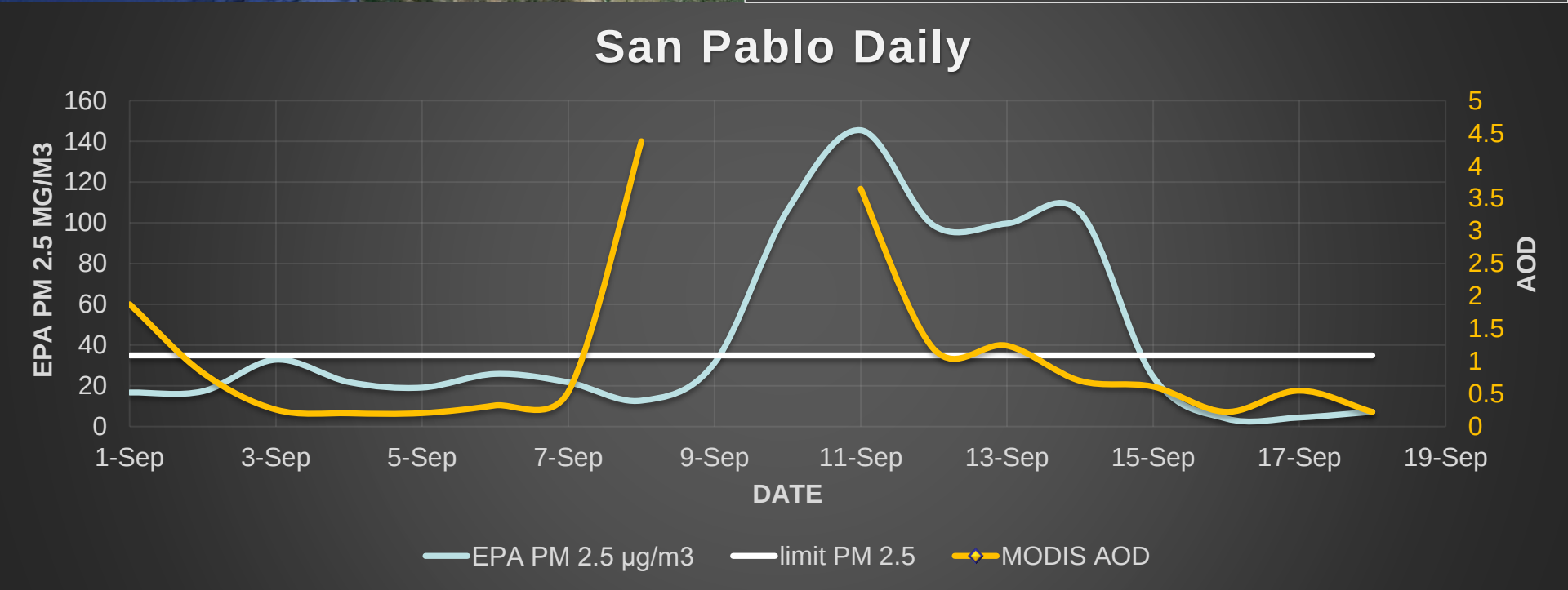

August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
Redwood City
SCU Lightining Complex
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=280m

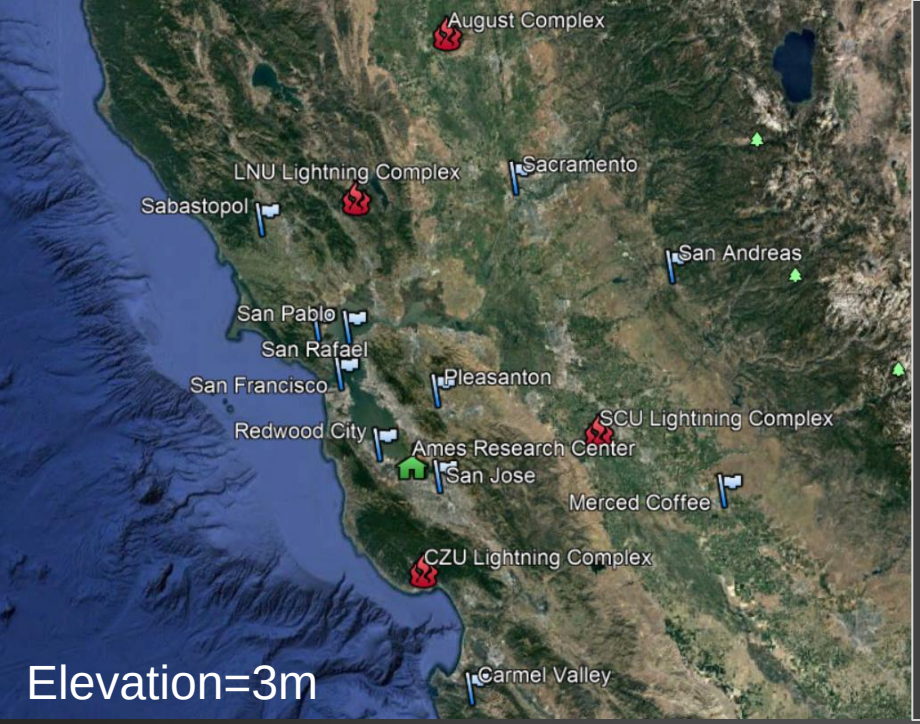

San Andreas Daily
MODIS AOD
2.5
2
1.5
1
0.5
0
y = 0.0075x + 0.6558
R² = 0.1385
0
20
40
60
80
100
120
EPA PM 2.5 µg/m3

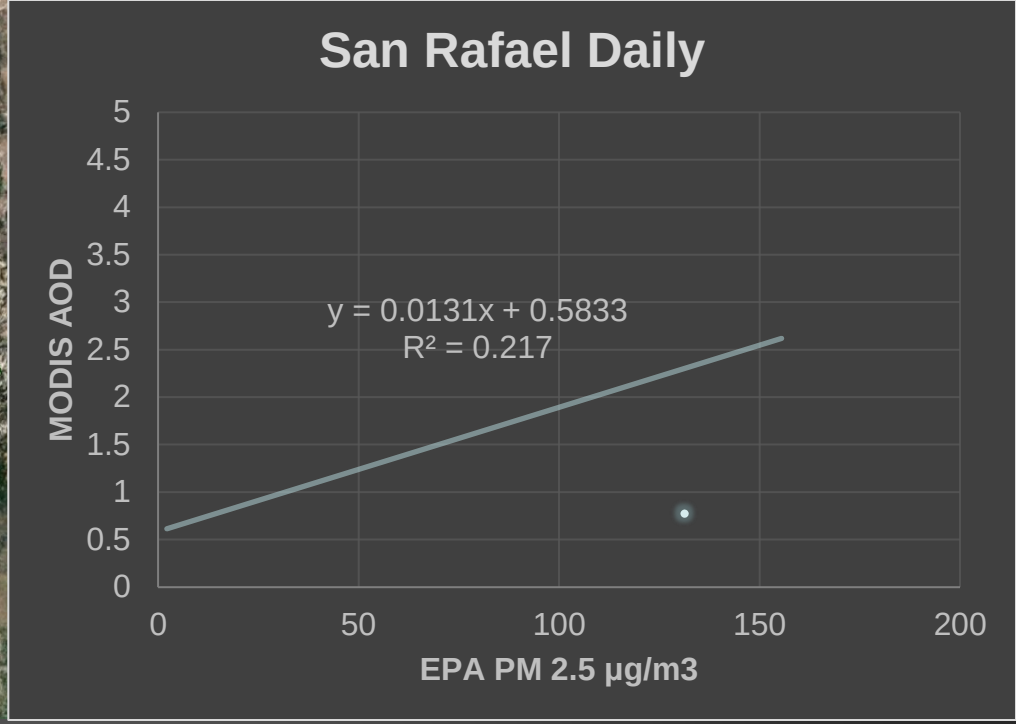

San Andreas Daily
EPA PM 2.5 MG/M3
120
100
80
60
40
20
0
3
2.5
2
1.5
1
0.5
0
AOD
1-Sep
3-Sep
5-Sep
7-Sep
9-Sep
11-Sep
13-Sep
15-Sep
17-Sep
19-Sep
DATE
EPA PM 2.5 µg/m3
limit PM 2.5
MODIS AOD

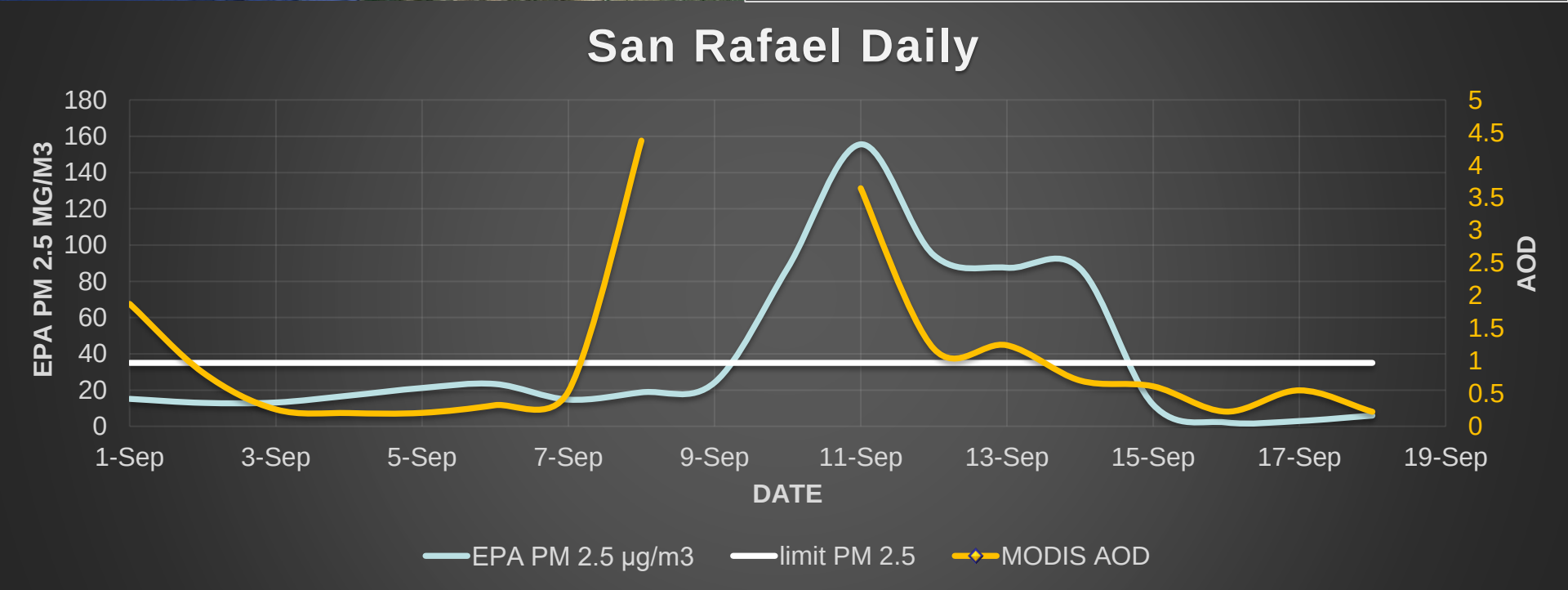

August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
Redwood City
SCU Lightining Complex
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=20m

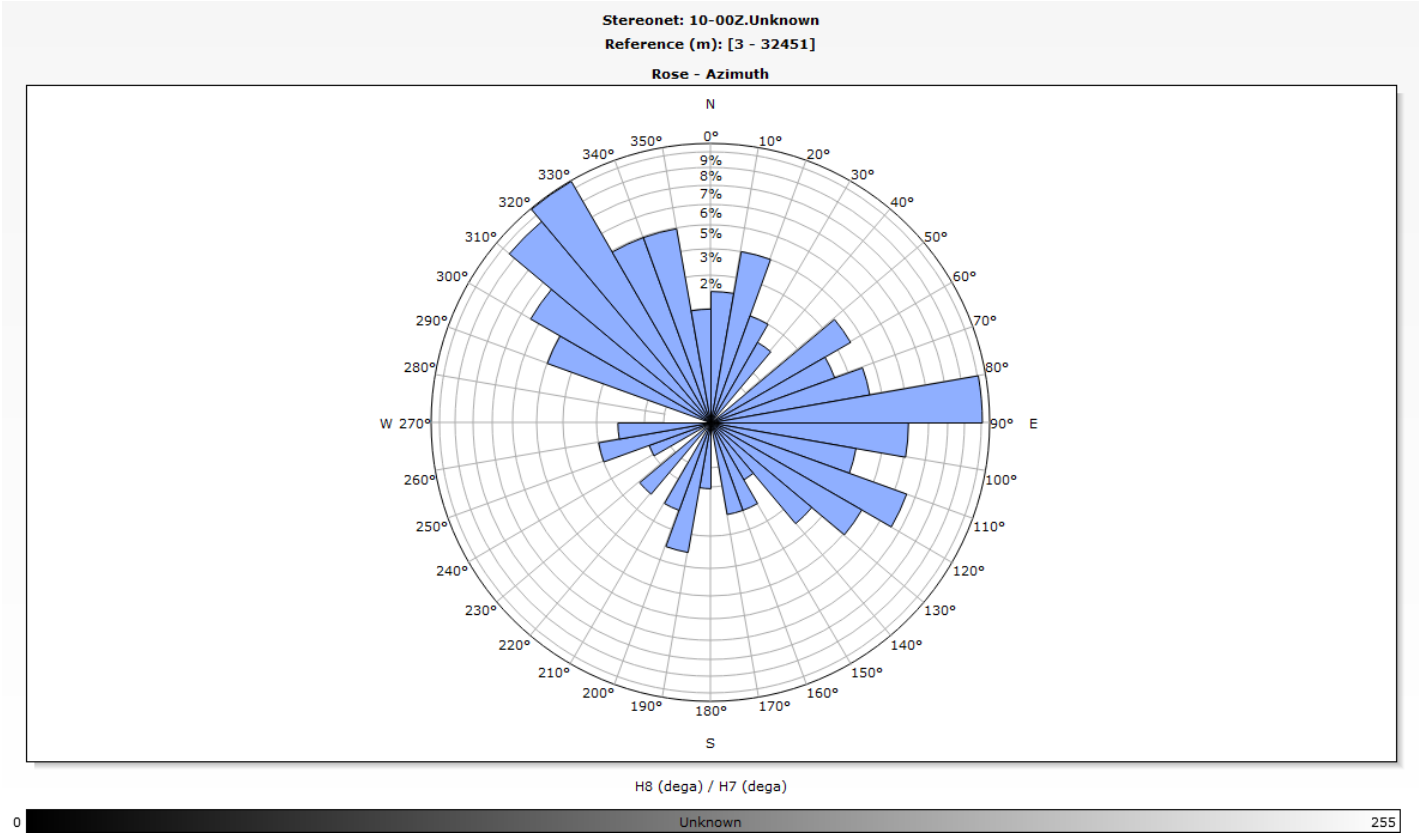

San Pablo Daily
MODIS AOD
y = 0.0104x + 0.6344
R² = 0.1359
EPA PM 2.5 µg/m3


San Pablo Daily
EPA PM 2.5 MG/M3
AOD
DATE
EPA PM 2.5 µg/m3
limit PM 2.5
MODIS AOD

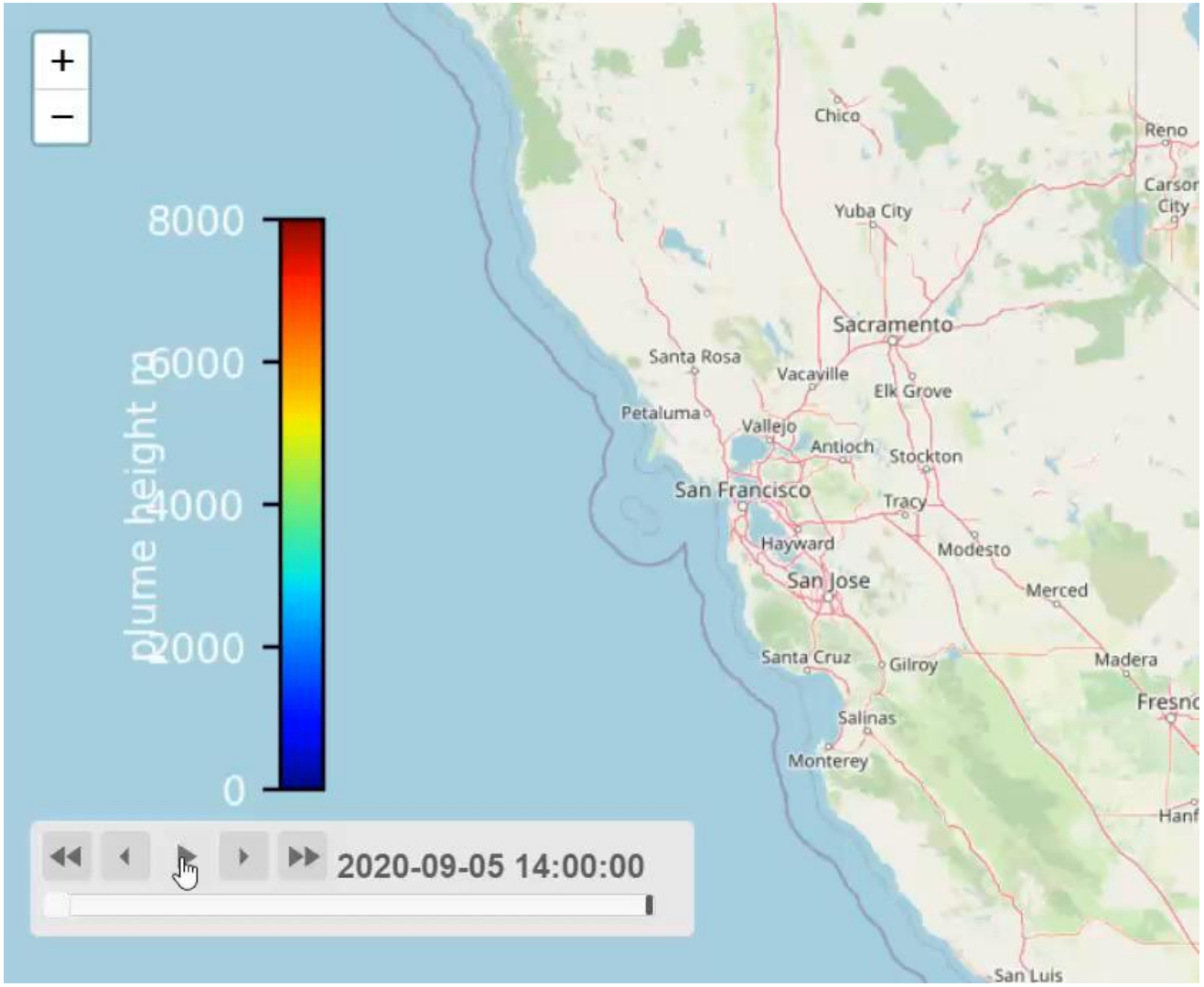

August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
SCU Lightining Complex
Redwood City
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley
Elevation=3m


San Rafael Daily
MODIS AOD
EPA PM 2.5 µg/m3
y = 0.0131x + 0.5833
R² = 0.217
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
50
100
150
200

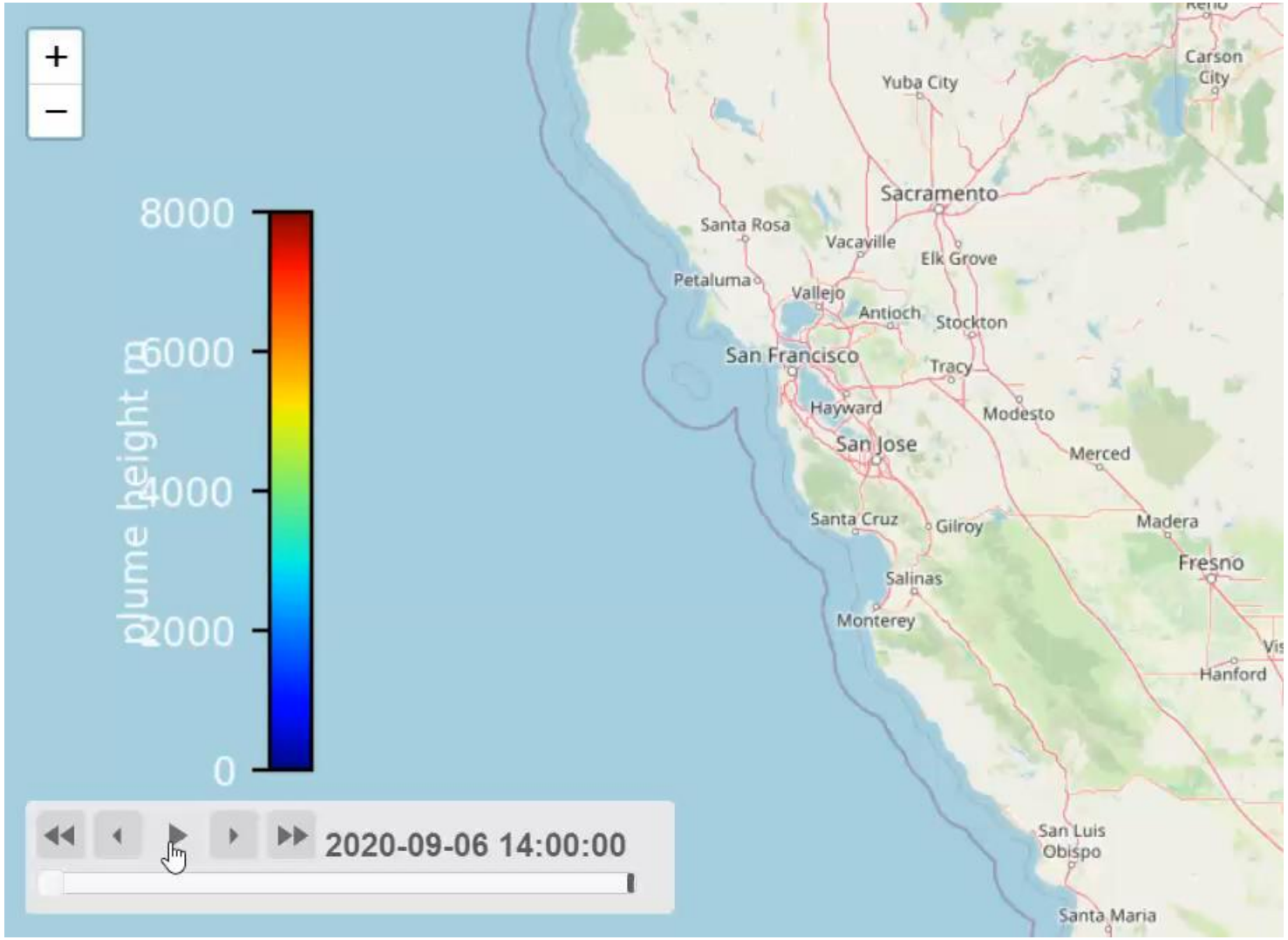

San Rafael Daily
EPA PM 2.5 MG/M3
AOD
DATE
1-Sep
3-Sep
5-Sep
7-Sep
9-Sep
11-Sep
13-Sep
15-Sep
17-Sep
19-Sep
EPA PM 2.5 µg/m3
limit PM 2.5
MODIS AOD


Stereonet: 10-00Z.Unknown
Reference (m): [3 - 32451]
Rose - Azimuth
N
0°
10°
20°
30°
40°
50°
60°
70°
80°
90°
E
100°
110°
120°
130°
140°
150°
160°
170°
180°
S
190°
200°
210°
220°
230°
240°
250°
260°
W 270°
280°
290°
300°
310°
320°
330°
340°
350°
9%
8%
7%
6%
5%
3%
2%
H8 (dega) / H7 (dega)
0
Unknown
255

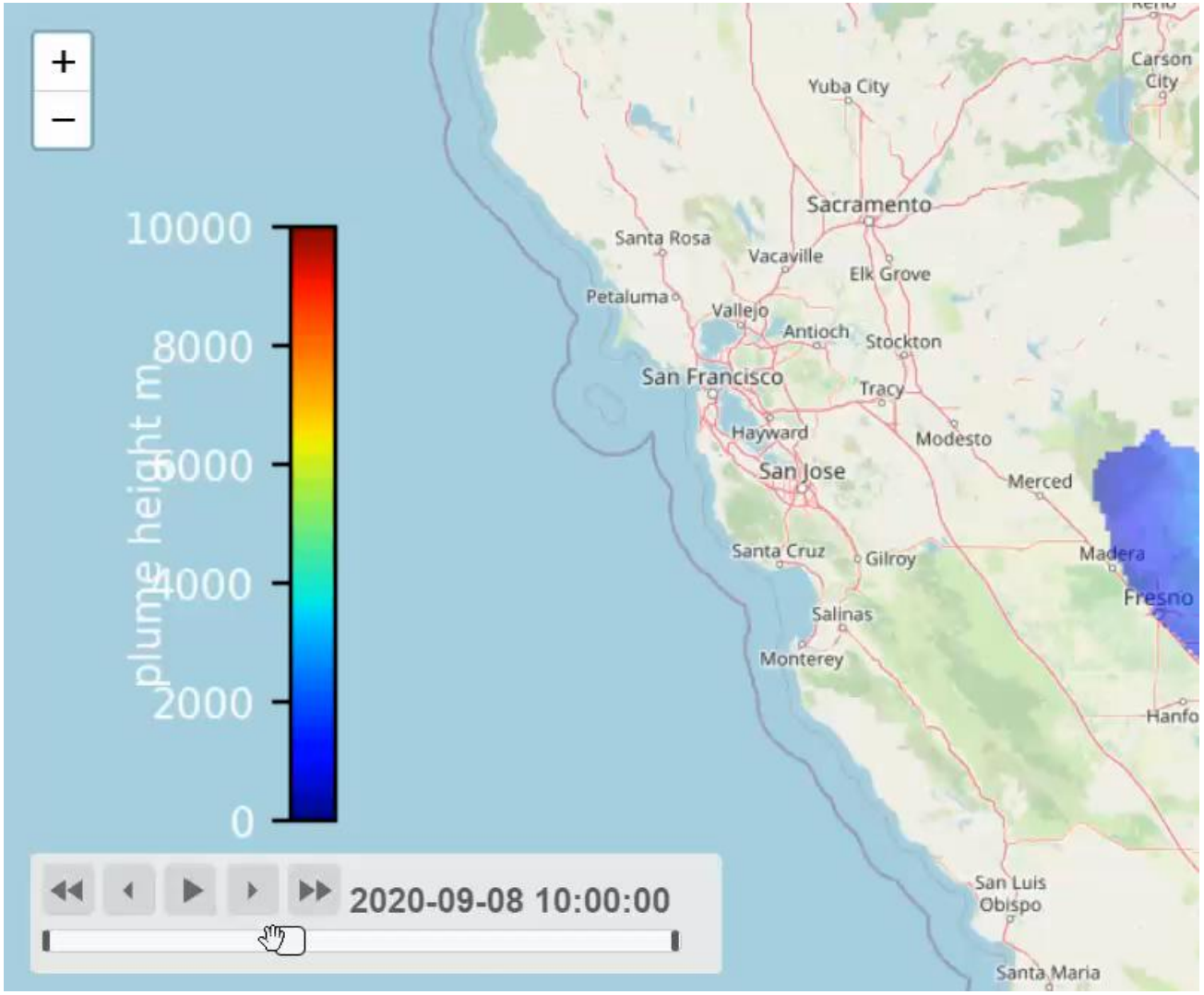
WFM Simulation SJ Fire



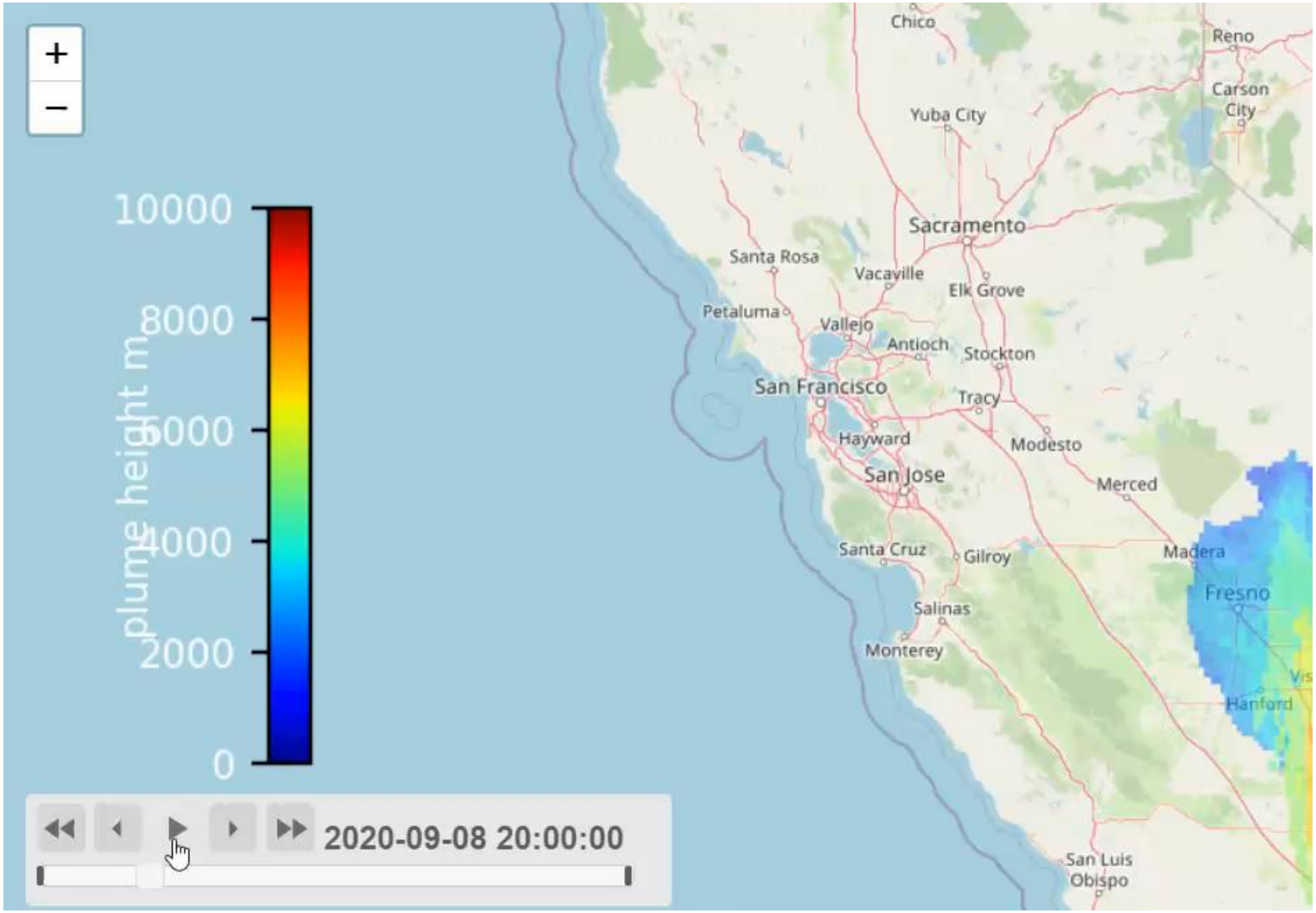
WFM Simulation SJ Fire



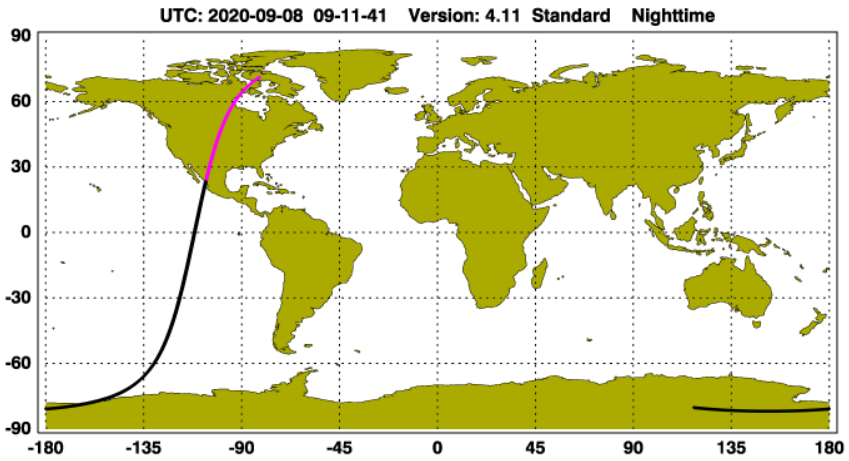
WFM Simulation Creek Fire

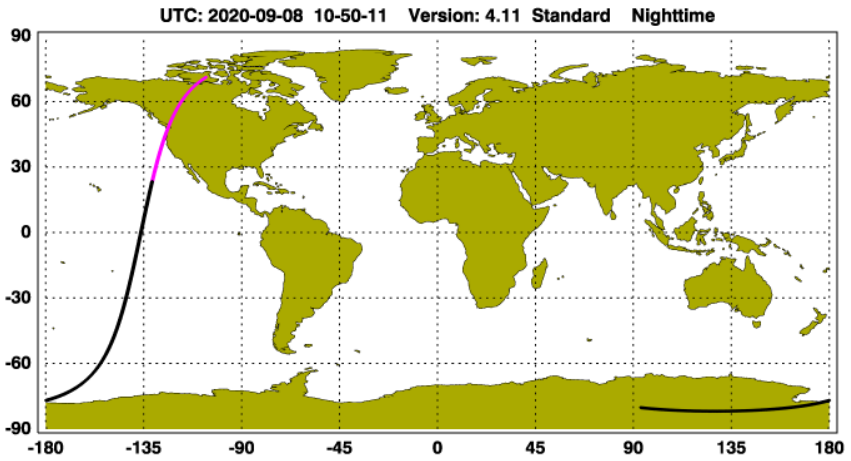


WFM Simulation Creek Fire

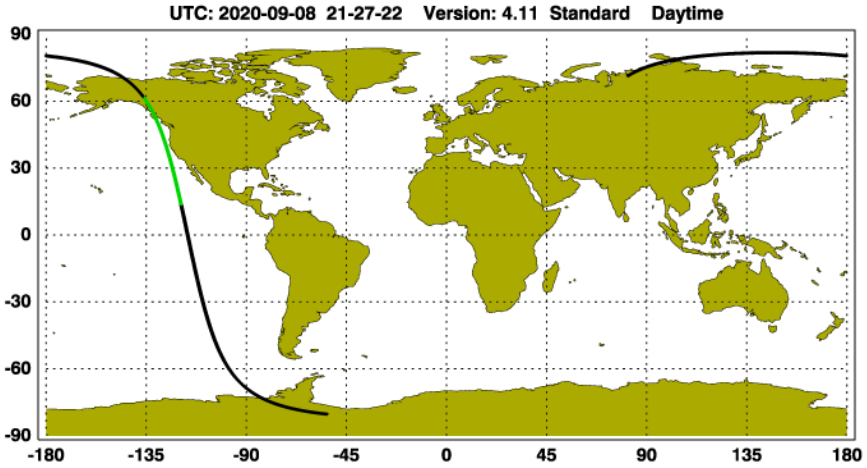


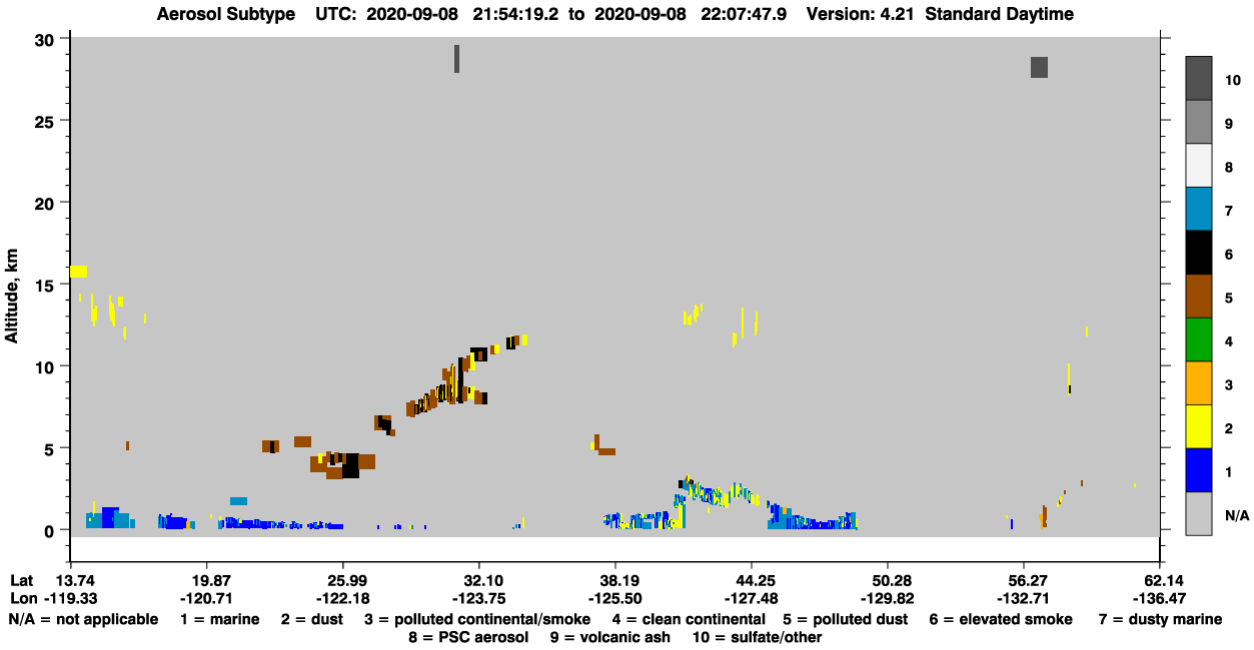
Sept – 08, night time, no nearby tracks.



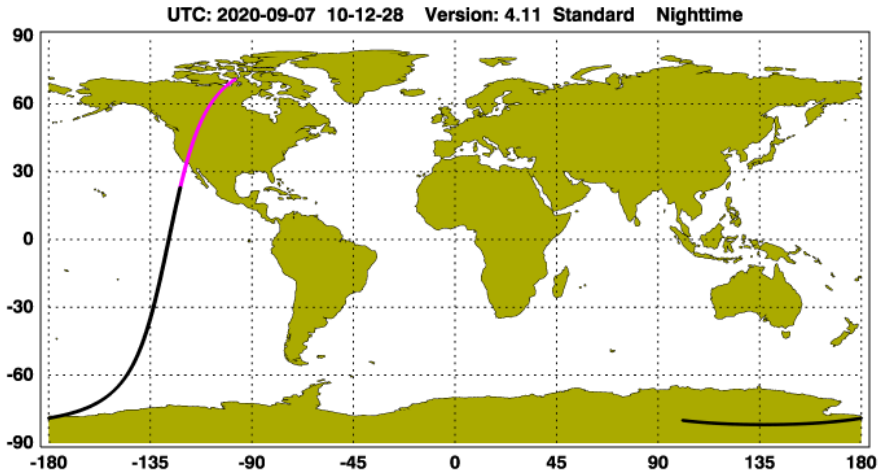


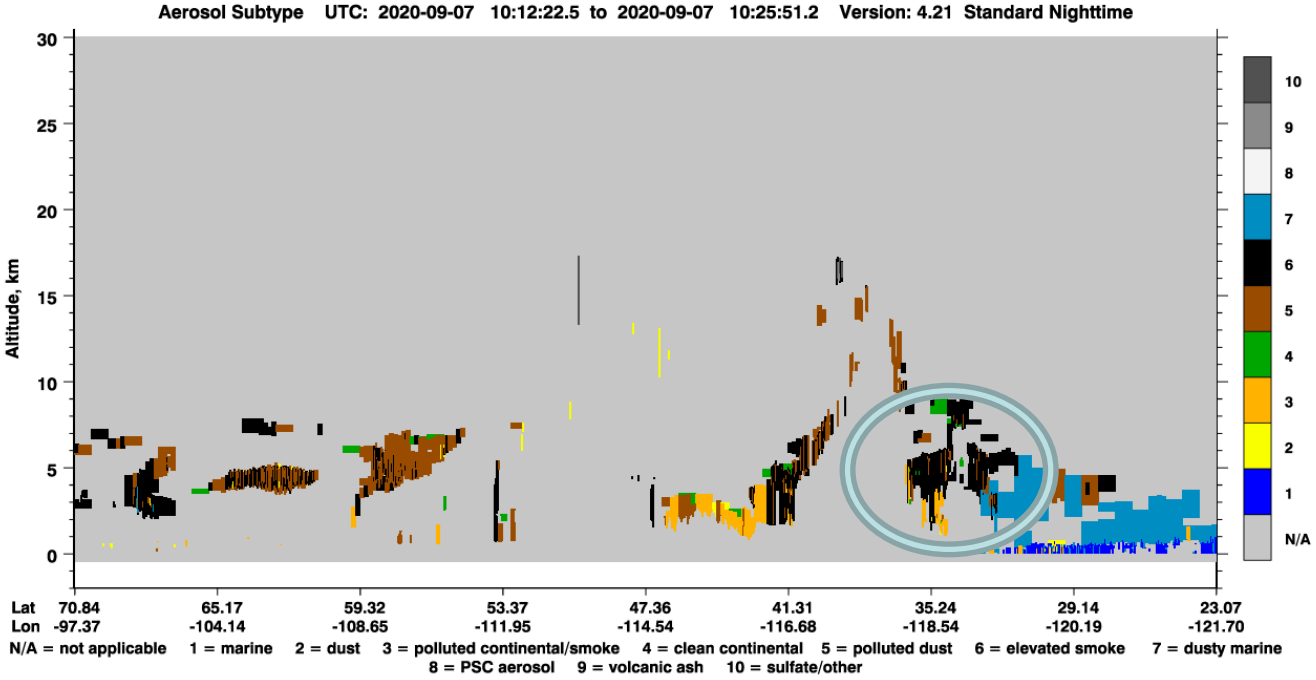
Sept-08, day time



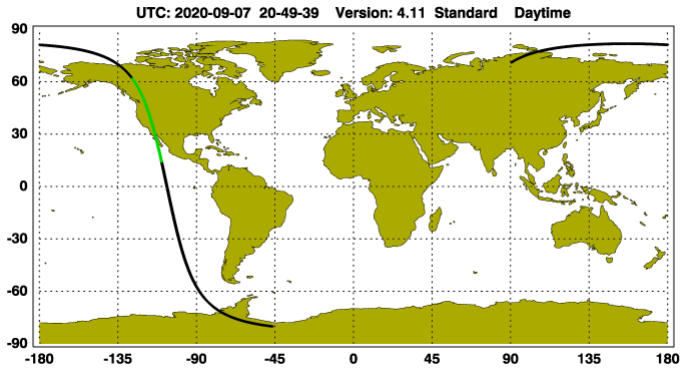


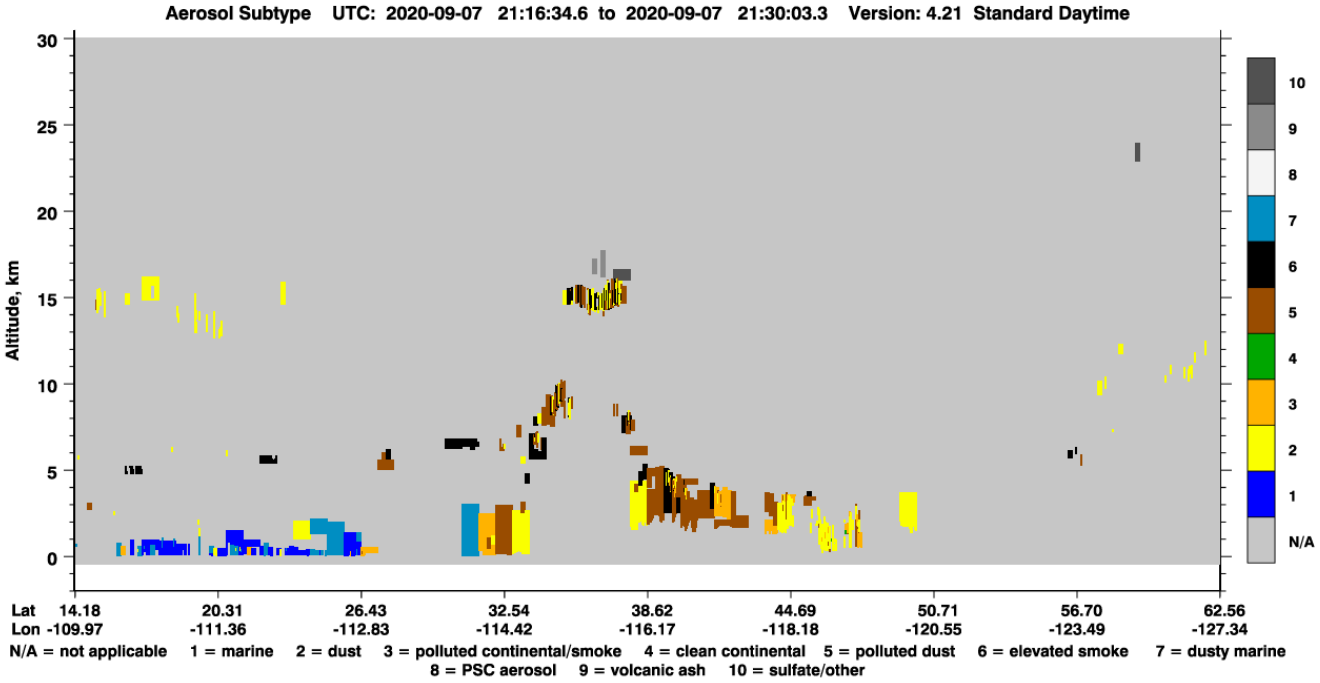
Sept – 07 night time



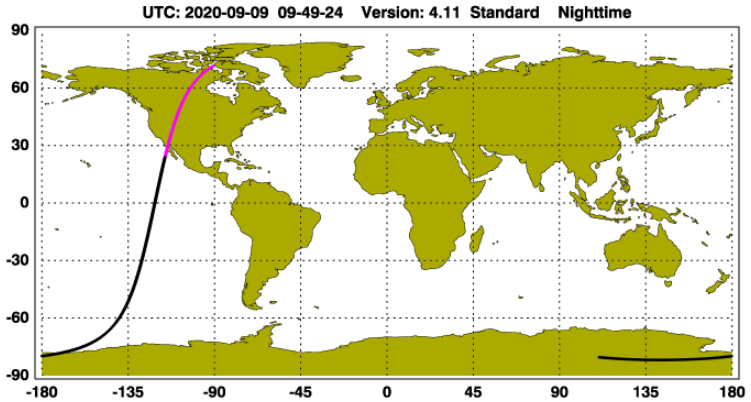


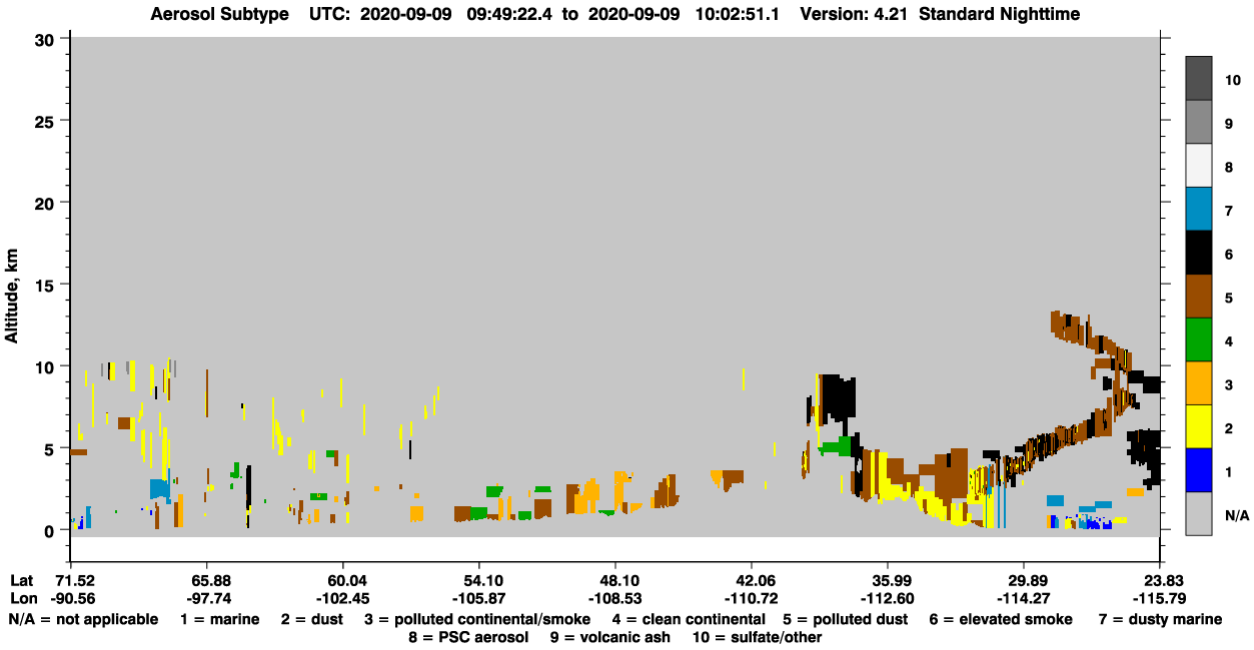
Sept -07 day time



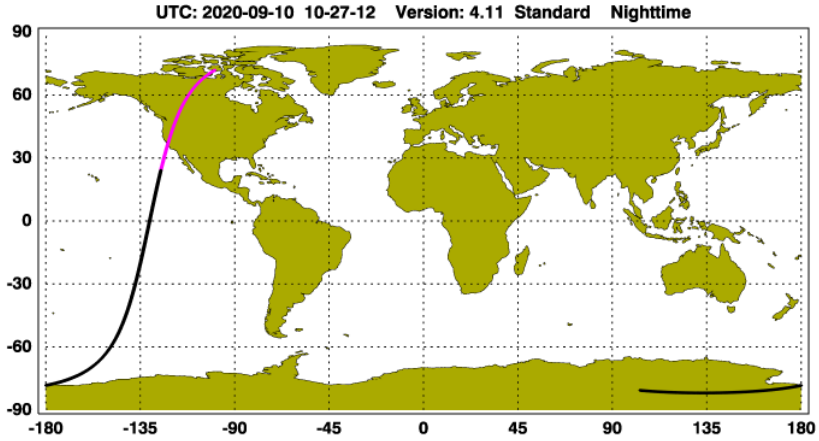


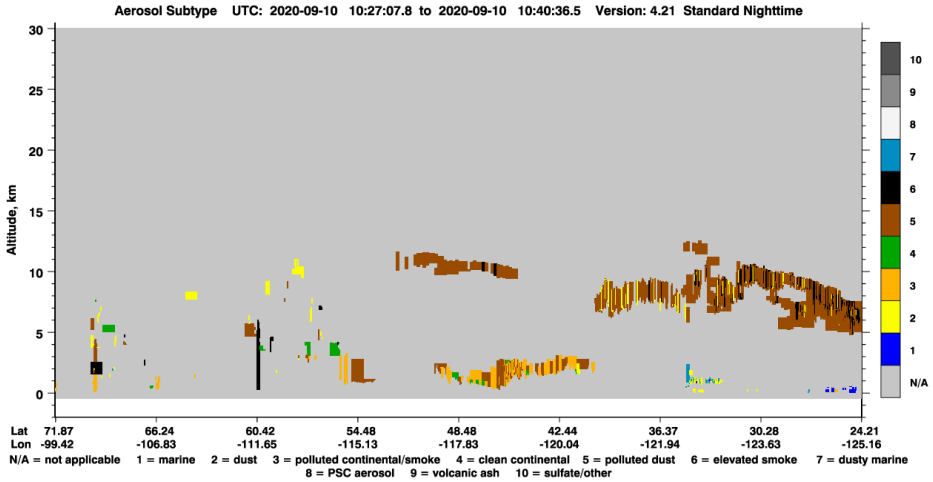
Sept – 09 night time

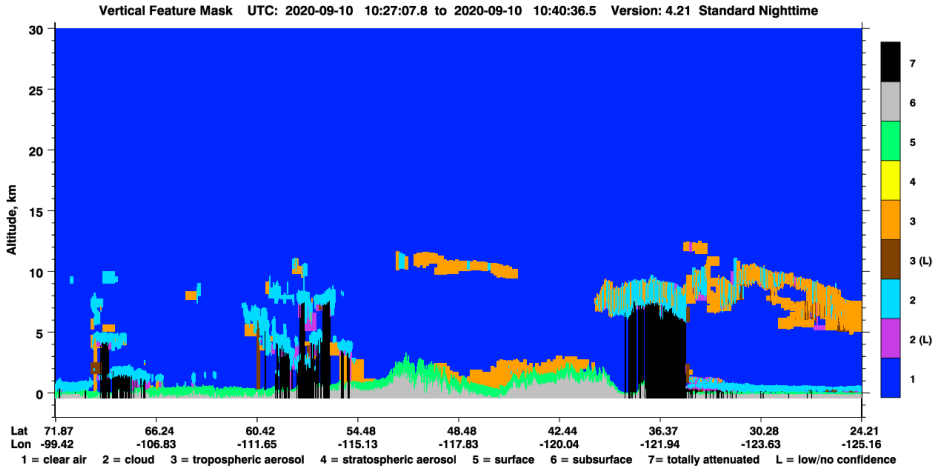




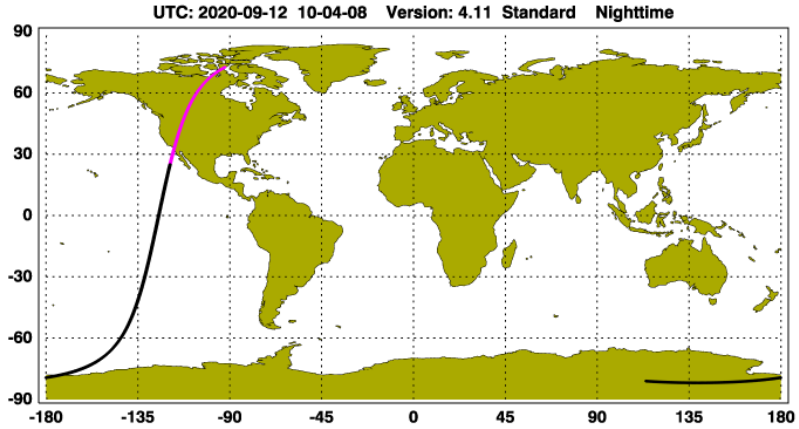
Sept -10

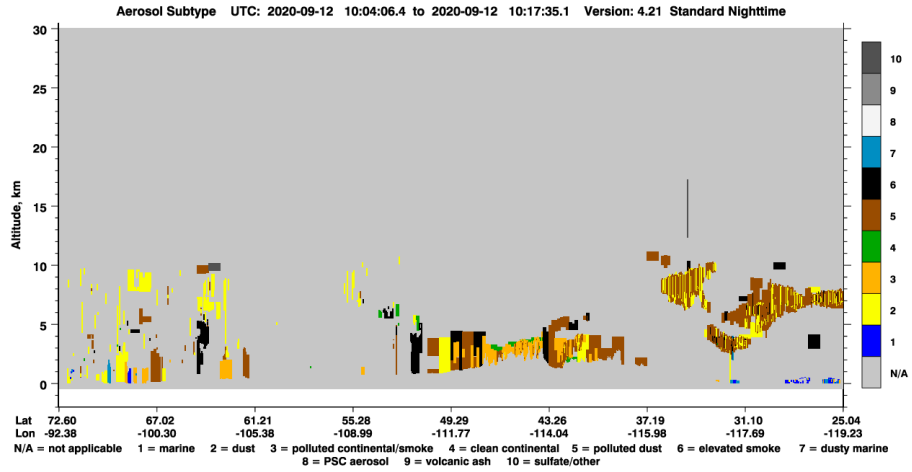

UTC: 2020-09-10 10-27-12 Version: 4.11 Standard Nighttime
90
60
30
0
-30
-60
-90
-180 -135 -90 -45 0 45 90 135 180

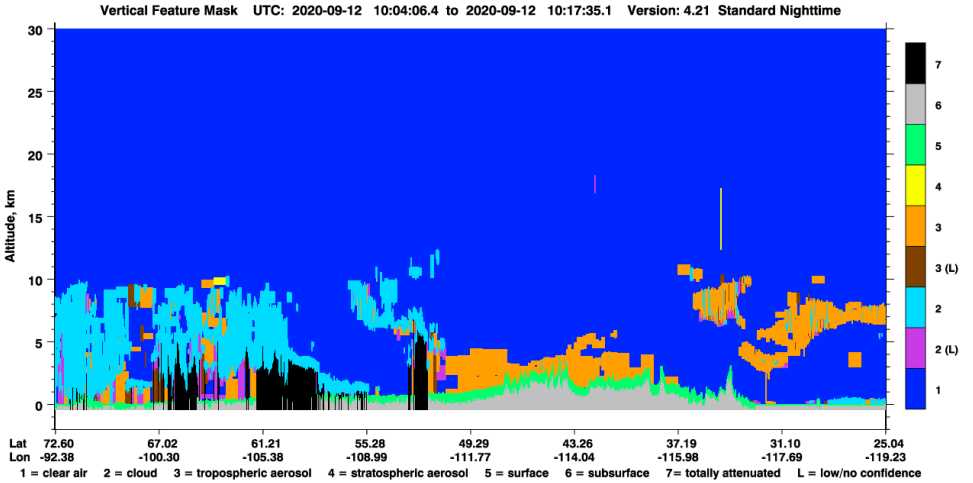

Aerosol Subtype UTC: 2020-09-10 10:27:07.8 to 2020-09-10 10:40:36.5 Version: 4.21 Standard Nighttime
Altitude, km
30
25
20
15
10
5
0
10
9
8
7
6
5
4
3
2
1
N/A
Lat 71.87 66.24 60.42 54.48 48.48 42.44 36.37 30.28 24.21
Lon -99.42 -106.83 -111.65 -115.13 -117.83 -120.04 -121.94 -123.63 -125.16
N/A = not applicable 1 = marine 2 = dust 3 = polluted continental/smoke 4 = clean continental 5 = polluted dust 6 = elevated smoke 7 = dusty marine
8 = PSC aerosol 9 = volcanic ash 10 = sulfate/other


Vertical Feature Mask UTC: 2020-09-10 10:27:07.8 to 2020-09-10 10:40:36.5 Version: 4.21 Standard Nighttime
Altitude, km
30
25
20
15
10
5
0
7
6
5
4
3
3 (L)
2
2 (L)
1
Lat 71.87 66.24 60.42 54.48 48.48 42.44 36.37 30.28 24.21
Lon -99.42 -106.83 -111.65 -115.13 -117.83 -120.04 -121.94 -123.63 -125.16
1 = clear air 2 = cloud 3 = tropospheric aerosol 4 = stratospheric aerosol 5 = surface 6 = subsurface 7= totally attenuated L = low/no confidence

Sept-12

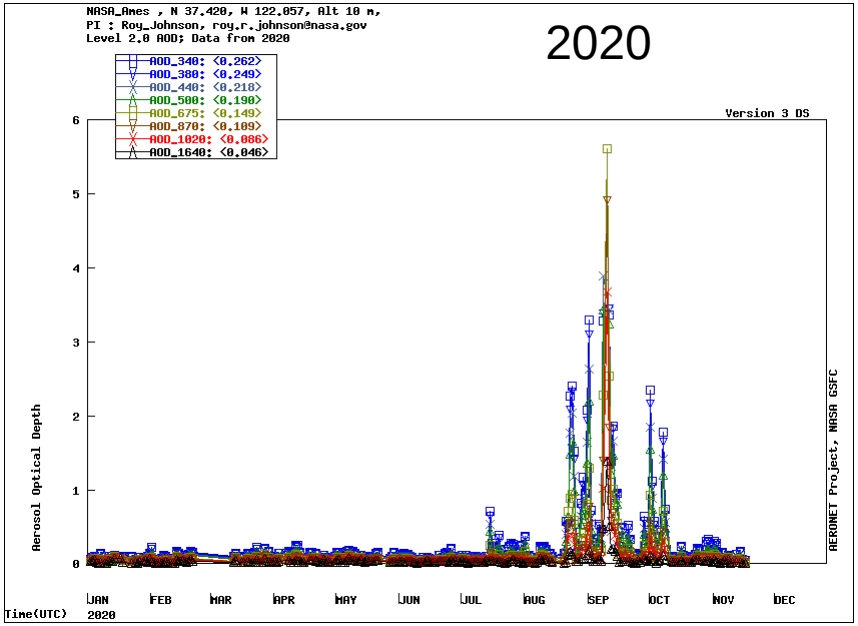

UTC: 2020-09-12 10-04-08 Version: 4.11 Standard Nighttime
90
60
30
0
-30
-60
-90
-180
-135
-90
-45
0
45
90
135
180

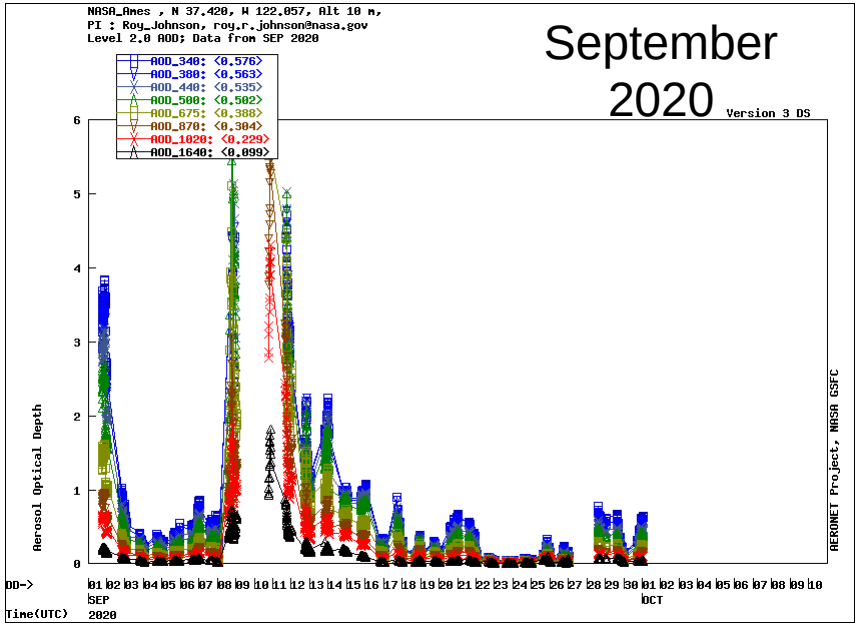

Aerosol Subtype UTC: 2020-09-12 10:04:06.4 to 2020-09-12 10:17:35.1 Version: 4.21 Standard Nighttime
Altitude, km
30
25
20
15
10
5
0
10
9
8
7
6
5
4
3
2
1
N/A
Lat 72.60 67.02 61.21 55.28 49.29 43.26 37.19 31.10 25.04
Lon -92.38 -100.30 -105.38 -108.99 -111.77 -114.04 -115.98 -117.69 -119.23
N/A = not applicable 1 = marine 2 = dust 3 = polluted continental/smoke 4 = clean continental 5 = polluted dust 6 = elevated smoke 7 = dusty marine
8 = PSC aerosol 9 = volcanic ash 10 = sulfate/other


Vertical Feature Mask UTC: 2020-09-12 10:04:06.4 to 2020-09-12 10:17:35.1 Version: 4.21 Standard Nighttime
Altitude, km
30
25
20
15
10
5
0
7
6
5
4
3
3 (L)
2
2 (L)
1
Lat 72.60 67.02 61.21 55.28 49.29 43.26 37.19 31.10 25.04
Lon -92.38 -100.30 -105.38 -108.99 -111.77 -114.04 -115.98 -117.69 -119.23
1 = clear air 2 = cloud 3 = tropospheric aerosol 4 = stratospheric aerosol 5 = surface 6 = subsurface 7= totally attenuated L = low/no confidence

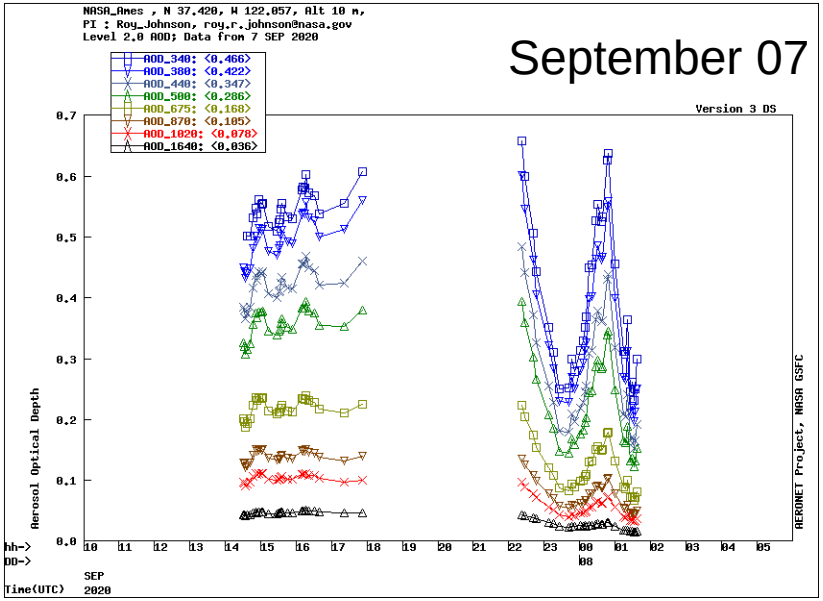
AERONET Observation

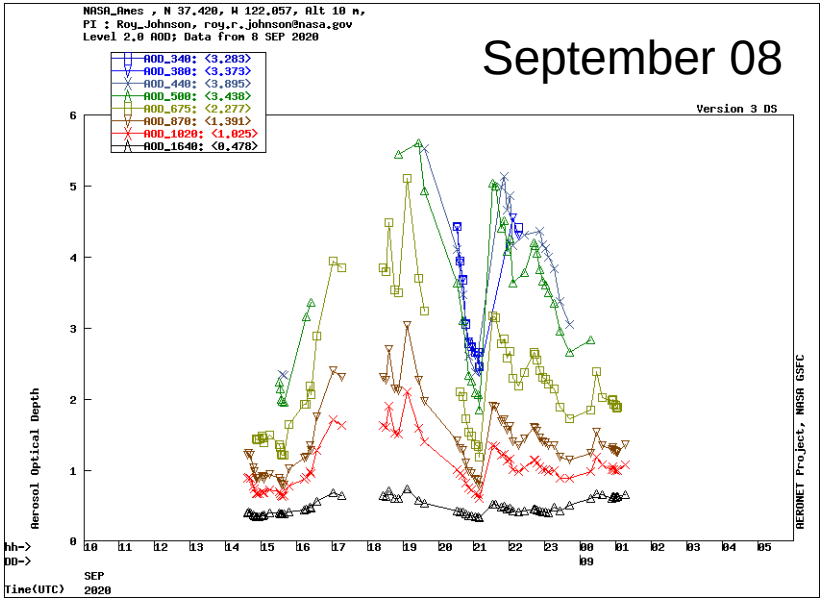
Fire season greatly perturb the otherwise clean environment



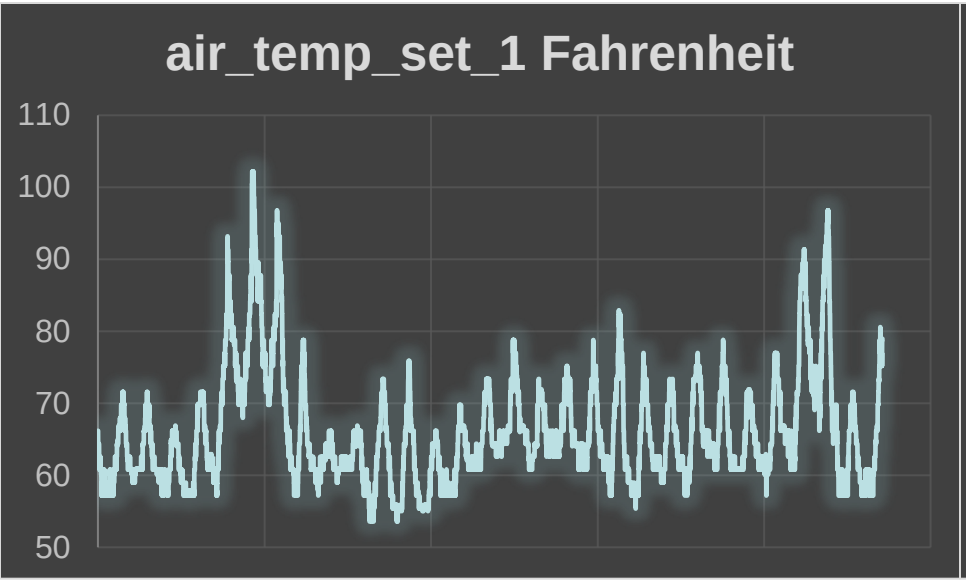


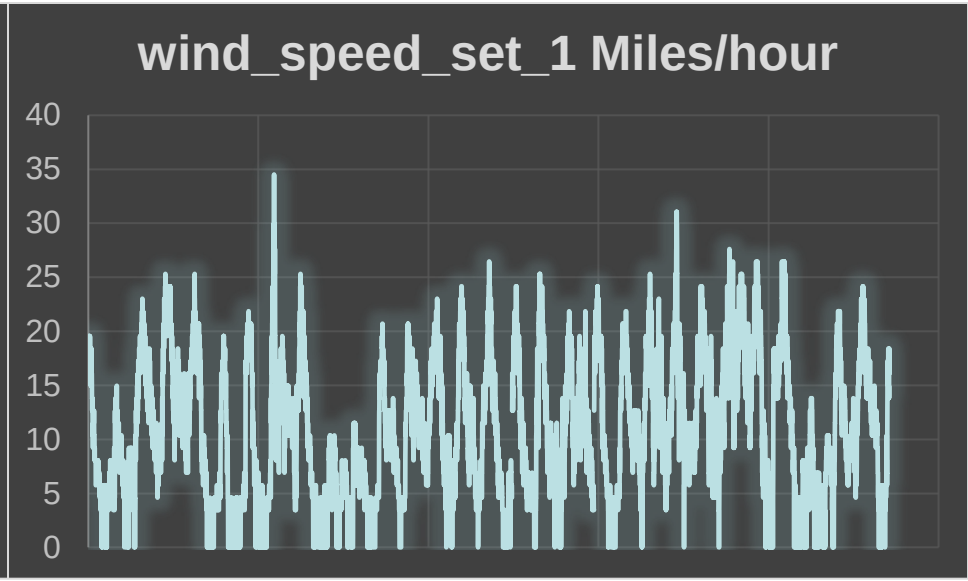
AERONET observation peaked on September 8

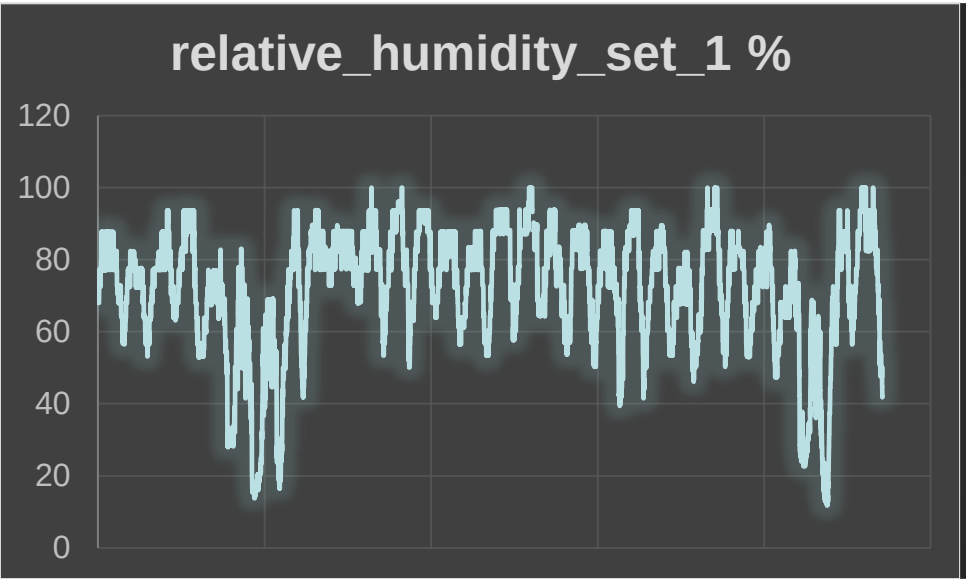


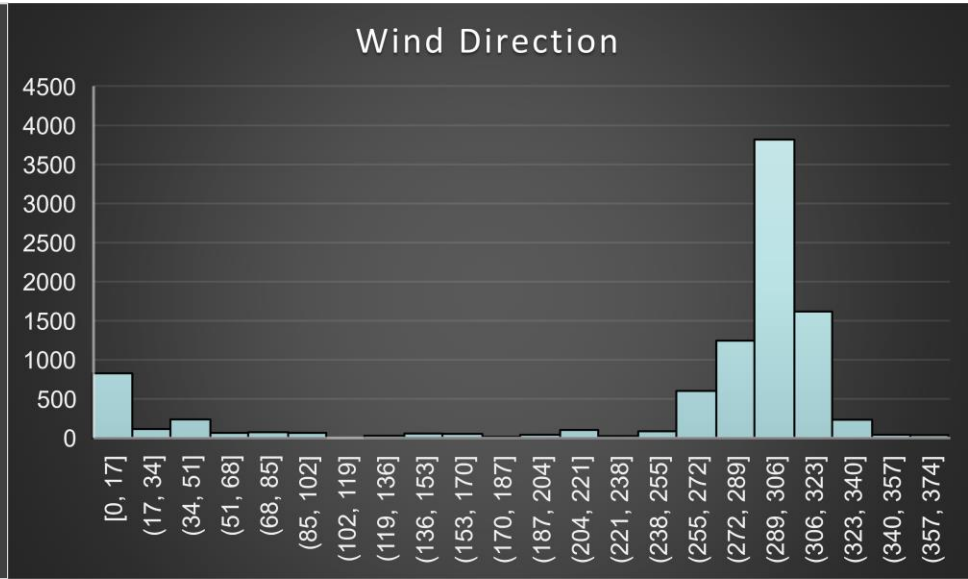


San Francisco

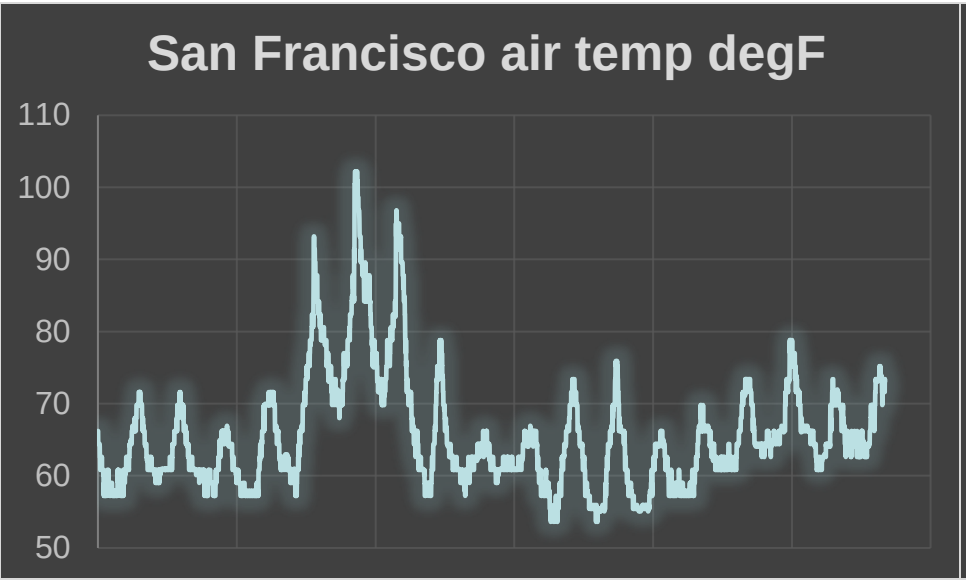


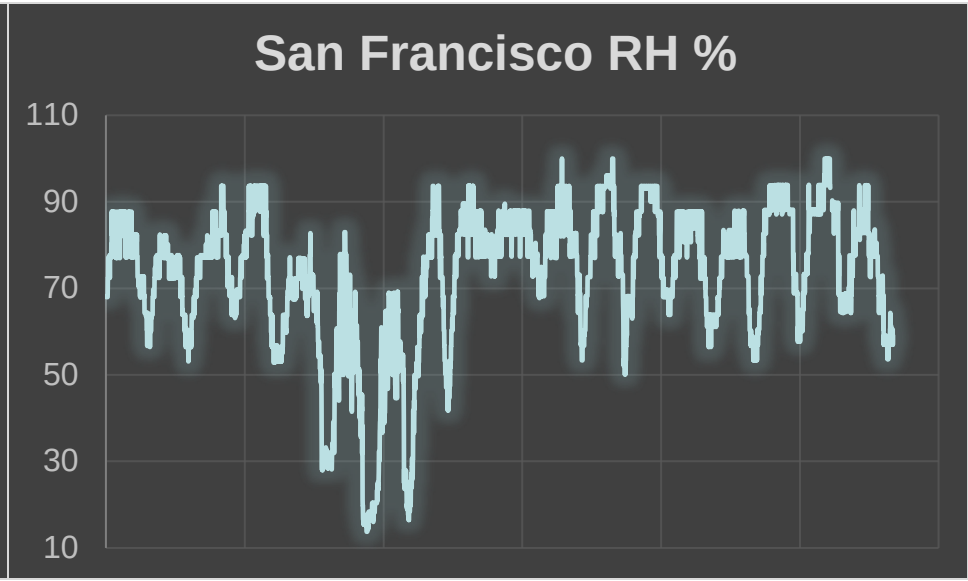


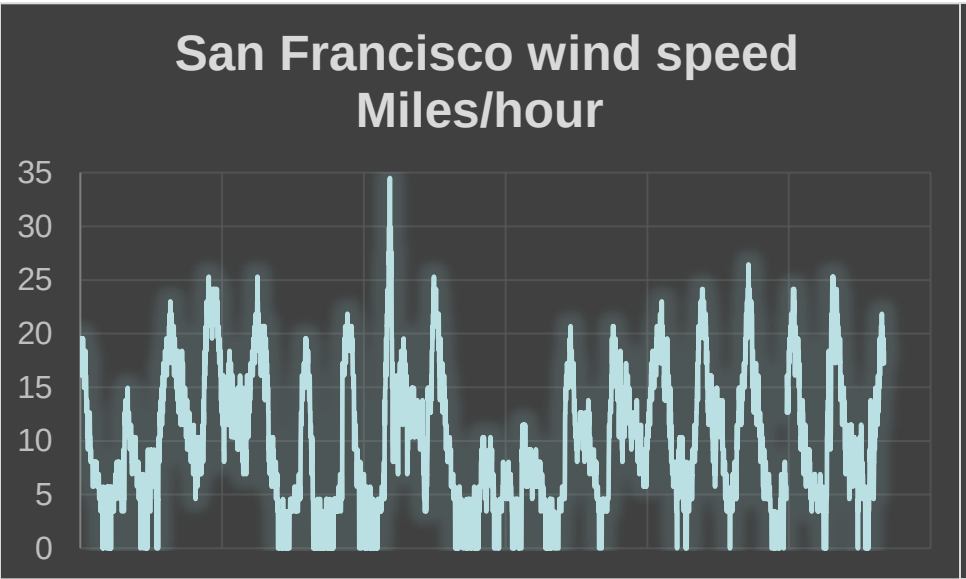


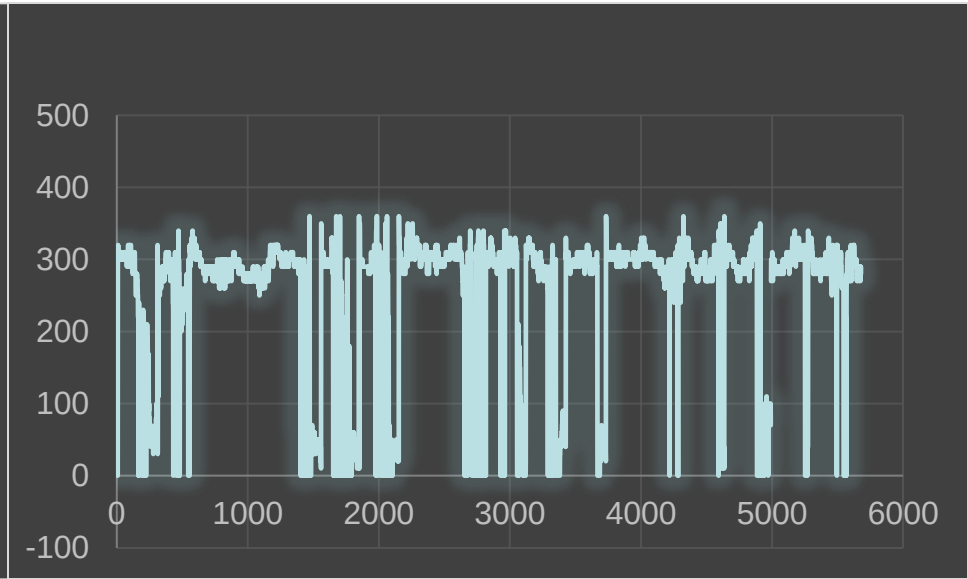


San Francisco

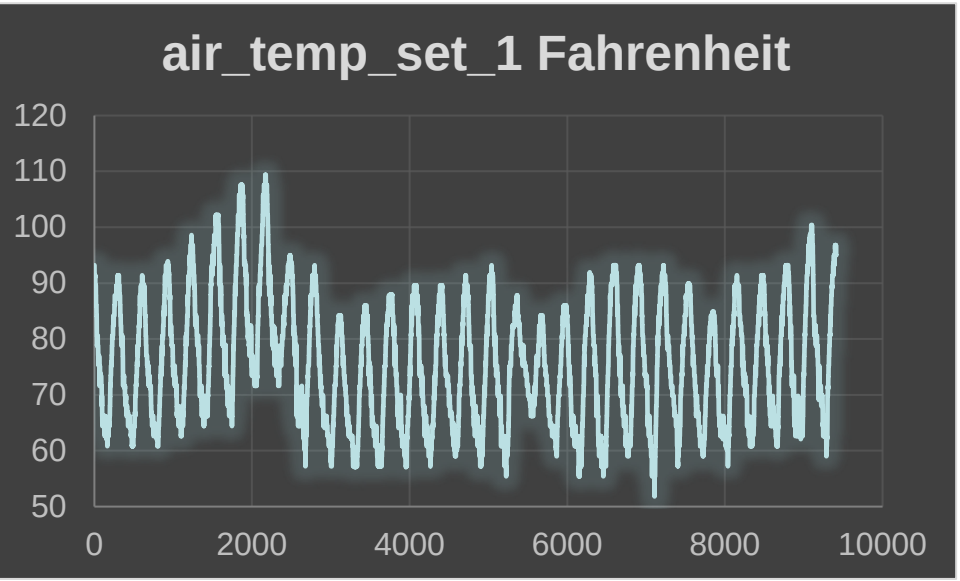


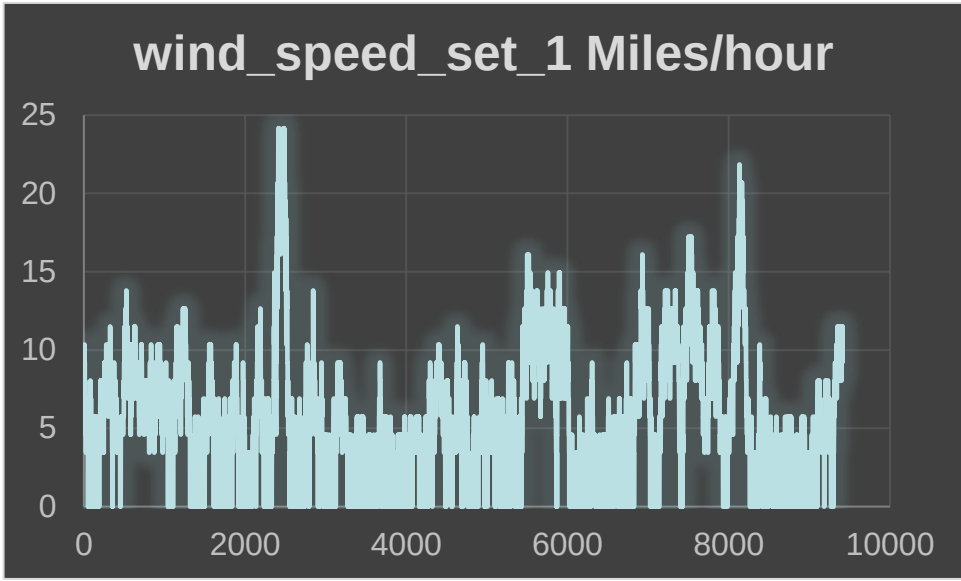


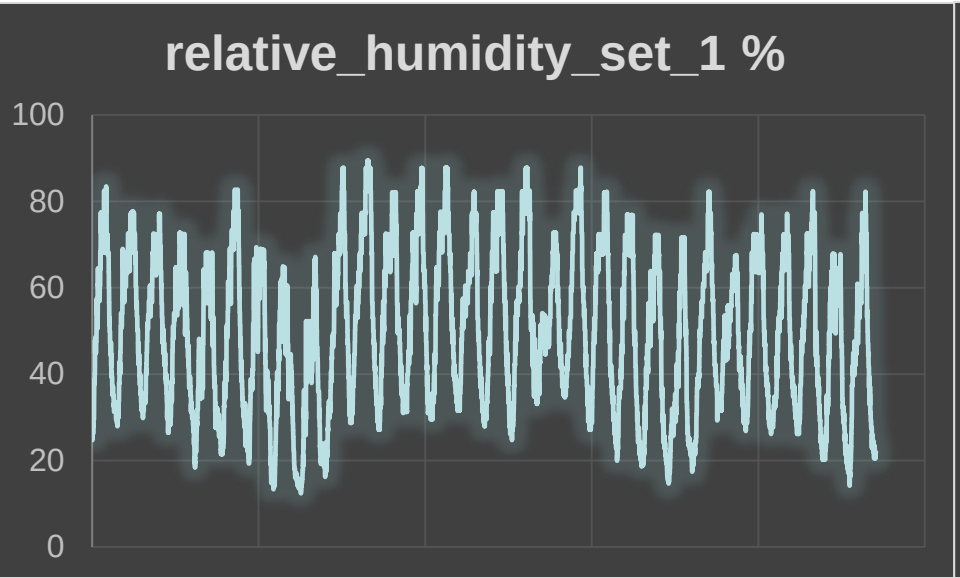


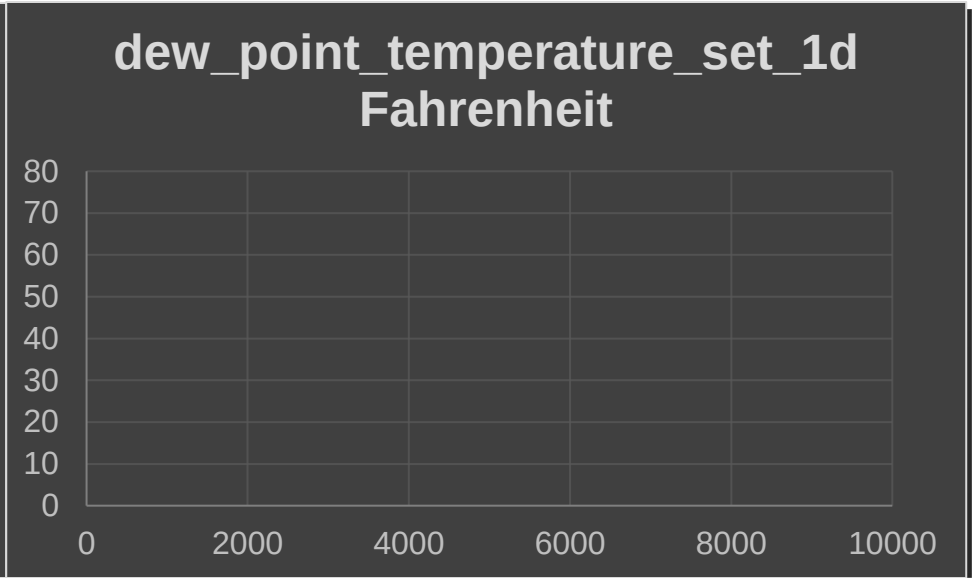


Merced Coffee









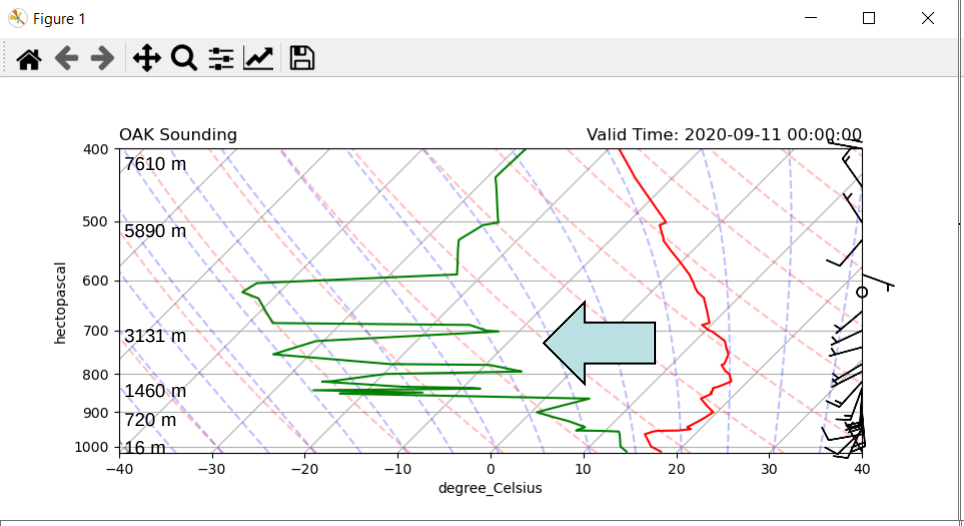


Figure 1
OAK Sounding
Valid Time: 2020-09-11 00:00:00
7610 m
5890 m
3131 m
1460 m
720 m
16 m
hectopascal
degree_Celsius

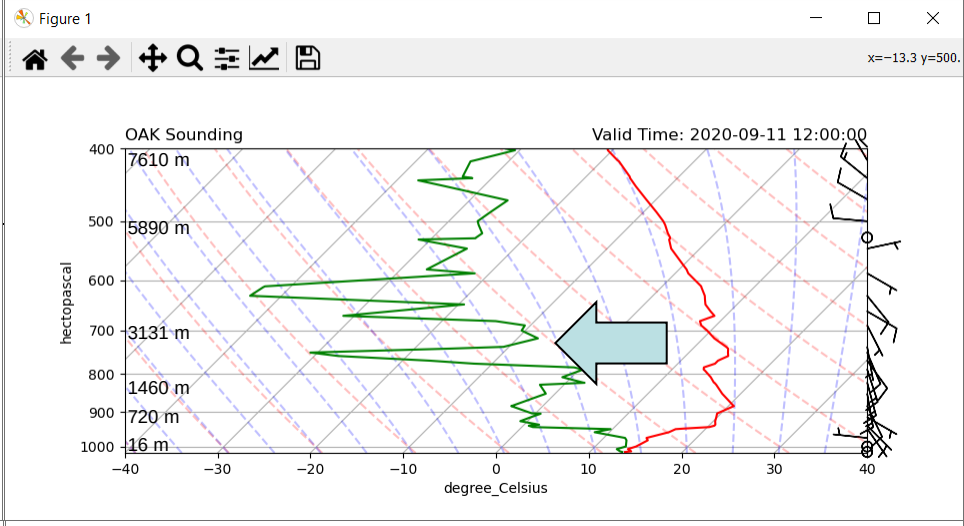


Figure 1
x=−13.3 y=500.
OAK Sounding
Valid Time: 2020-09-11 12:00:00
7610 m
5890 m
3131 m
1460 m
720 m
16 m
hectopascal
degree_Celsius

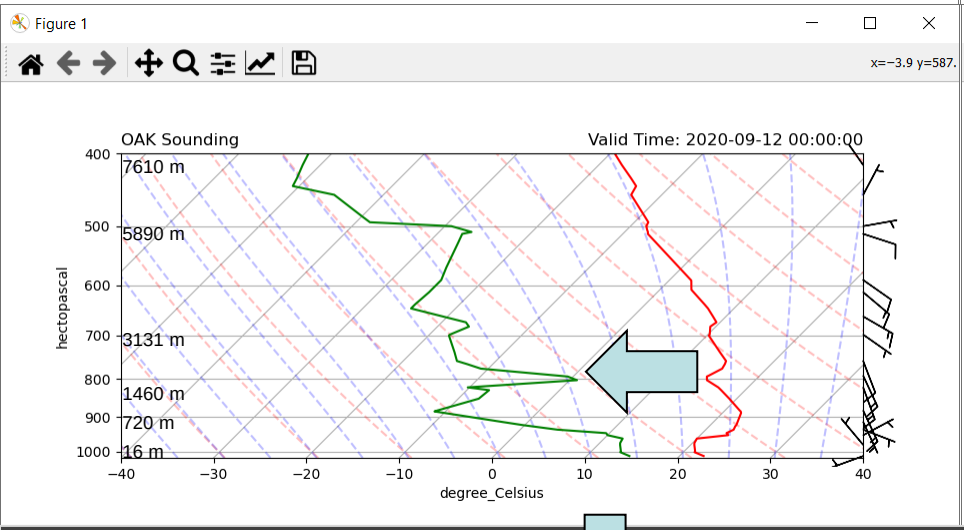


Figure 1
x=−3.9 y=587.
OAK Sounding
Valid Time: 2020-09-12 00:00:00
7610 m
5890 m
3131 m
1460 m
720 m
16 m
hectopascal
degree_Celsius

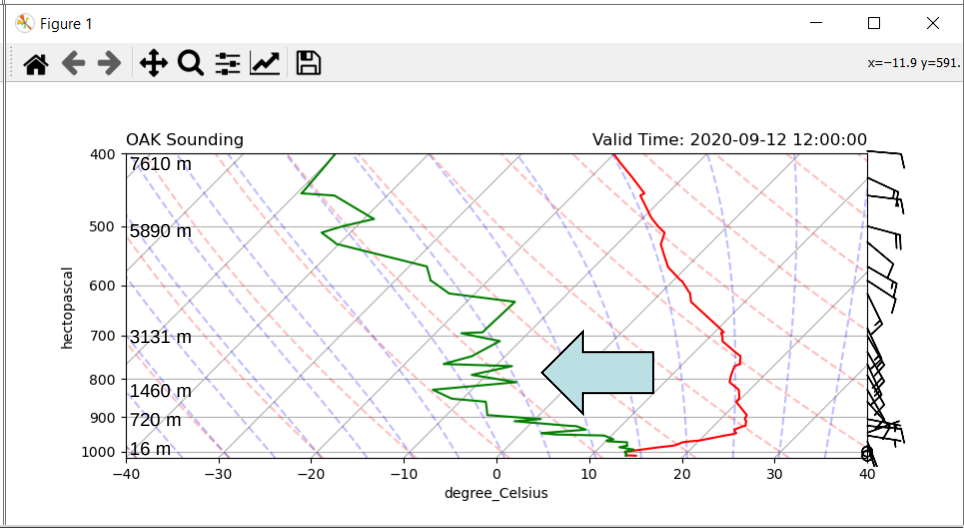


Figure 1
x=−11.9 y=591.
OAK Sounding
Valid Time: 2020-09-12 12:00:00
7610 m
5890 m
3131 m
1460 m
720 m
16 m
hectopascal
degree_Celsius

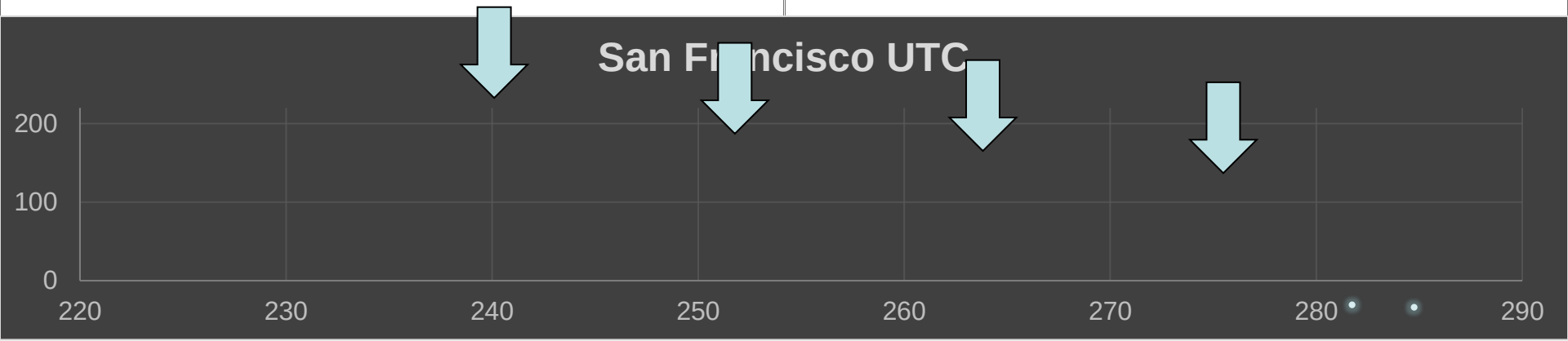

San Francisco UTC
200
100
0
220
230
240
250
260
270
280
290

Figure 1

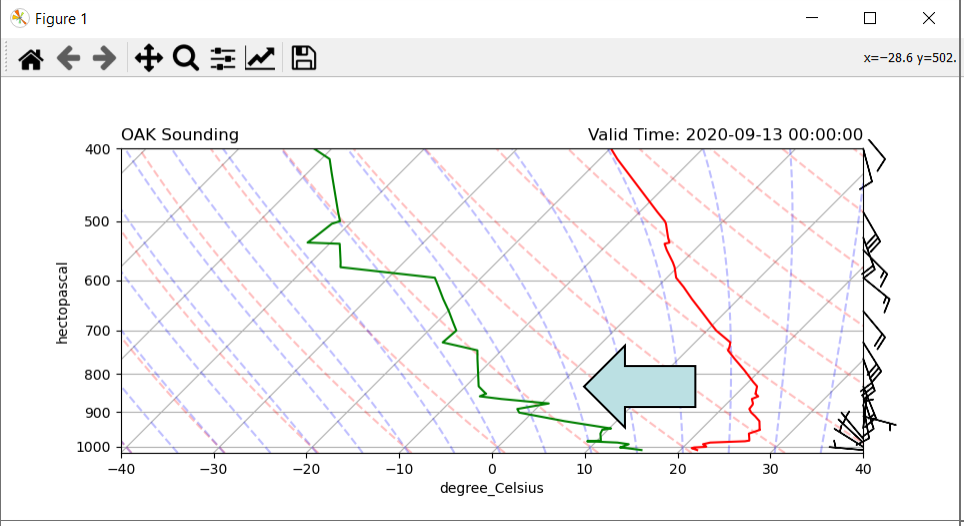


Figure 1

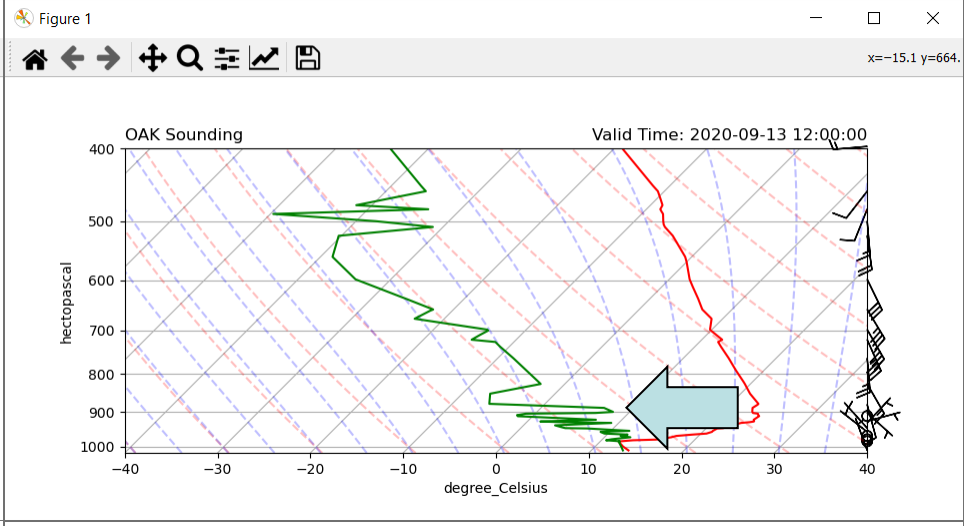


Figure 1

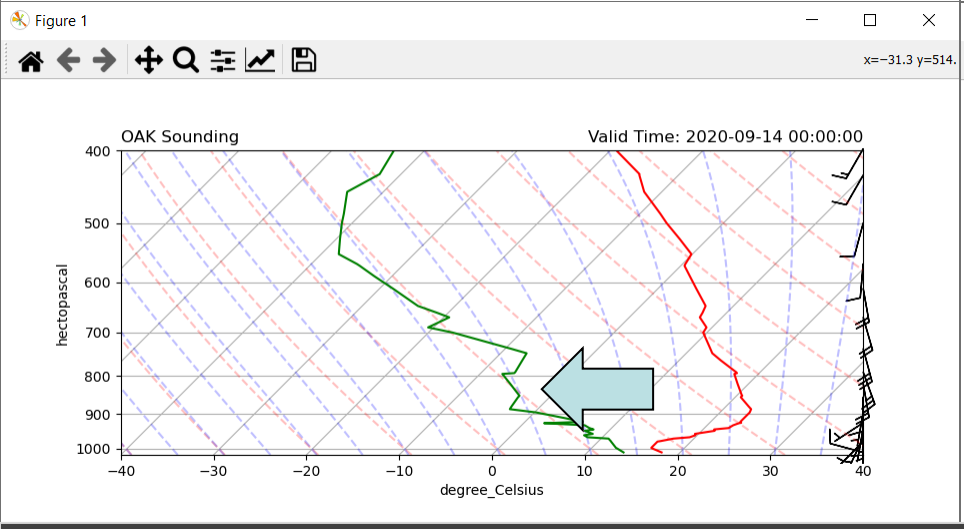
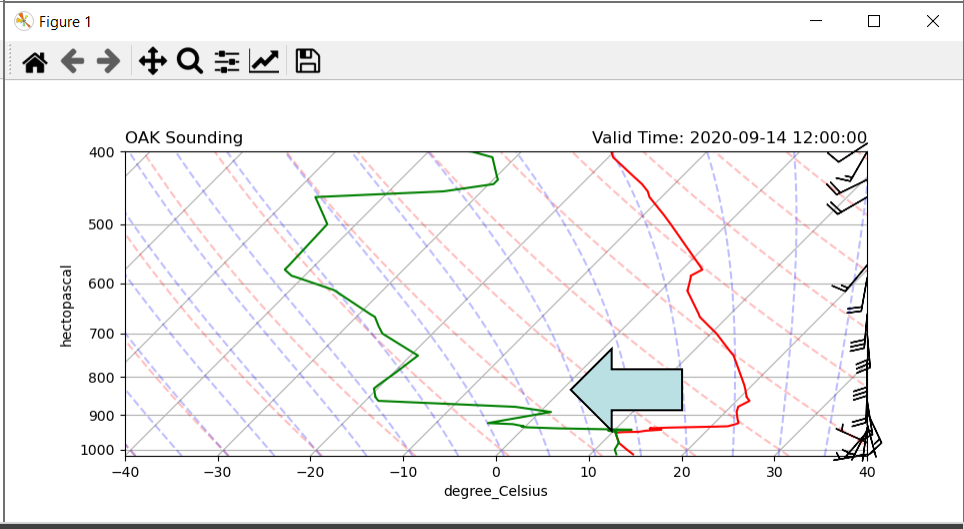
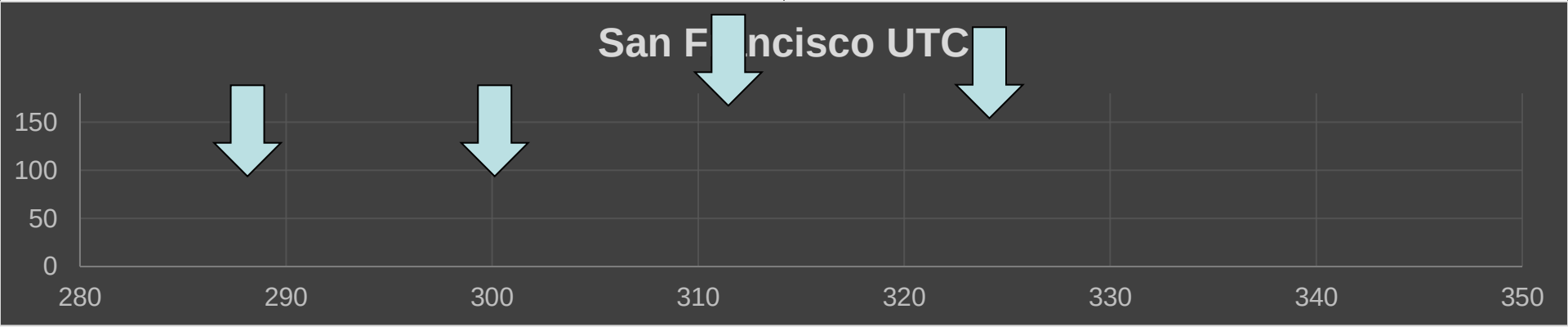


Figure 1





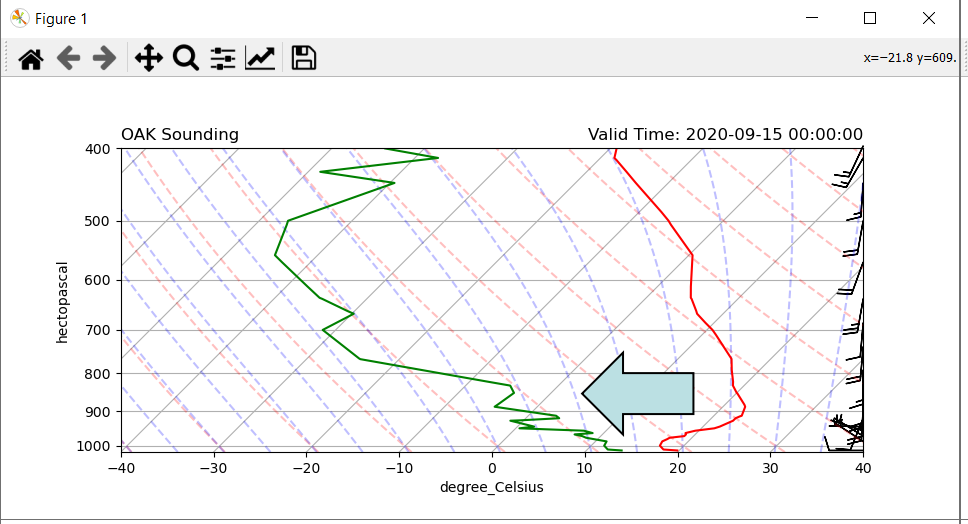


Figure 1
x=−21.8 y=609.
OAK Sounding
Valid Time: 2020-09-15 00:00:00
hectopascal
degree_Celsius

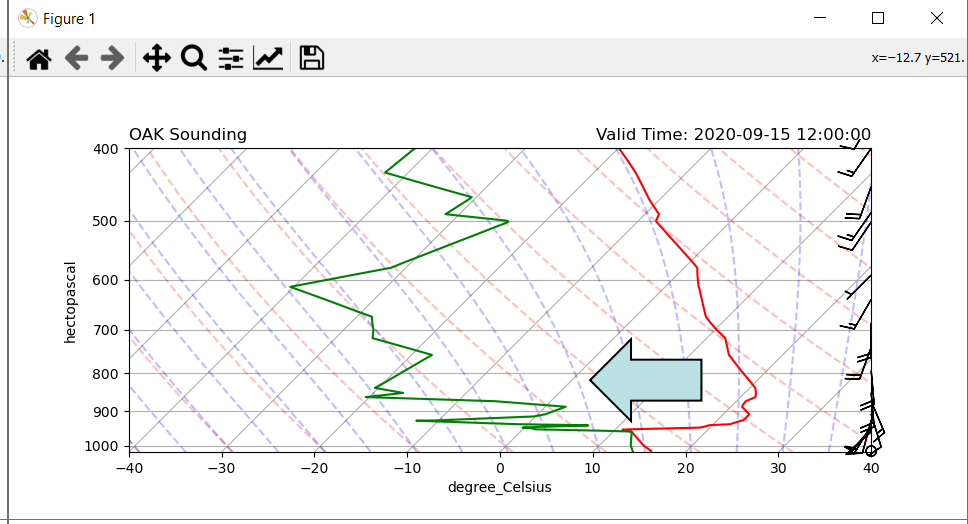


Figure 1
x=−12.7 y=521.
OAK Sounding
Valid Time: 2020-09-15 12:00:00
hectopascal
degree_Celsius

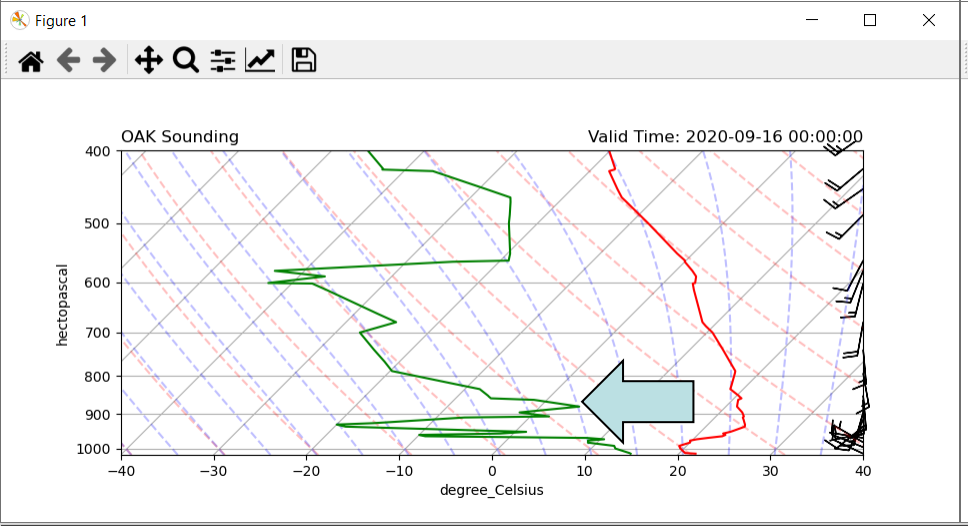


Figure 1
OAK Sounding
Valid Time: 2020-09-16 00:00:00
hectopascal
degree_Celsius

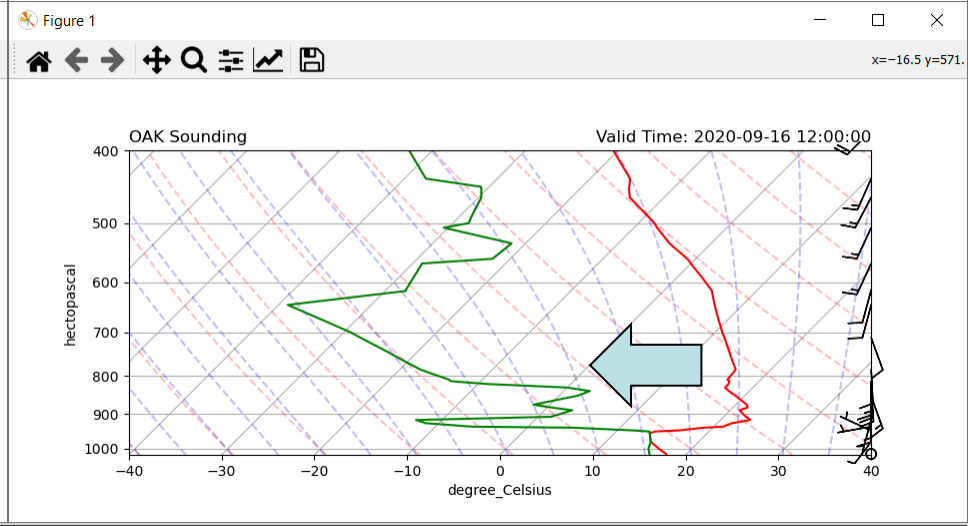
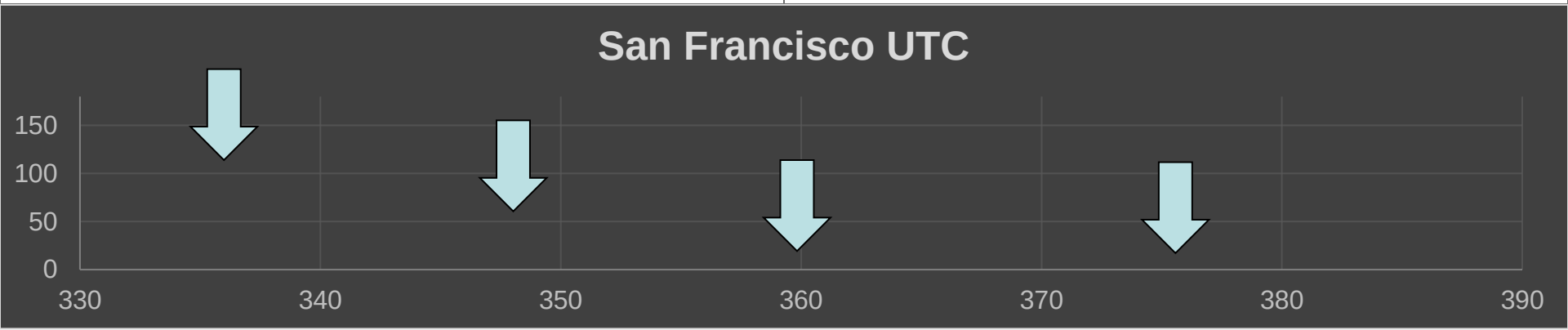


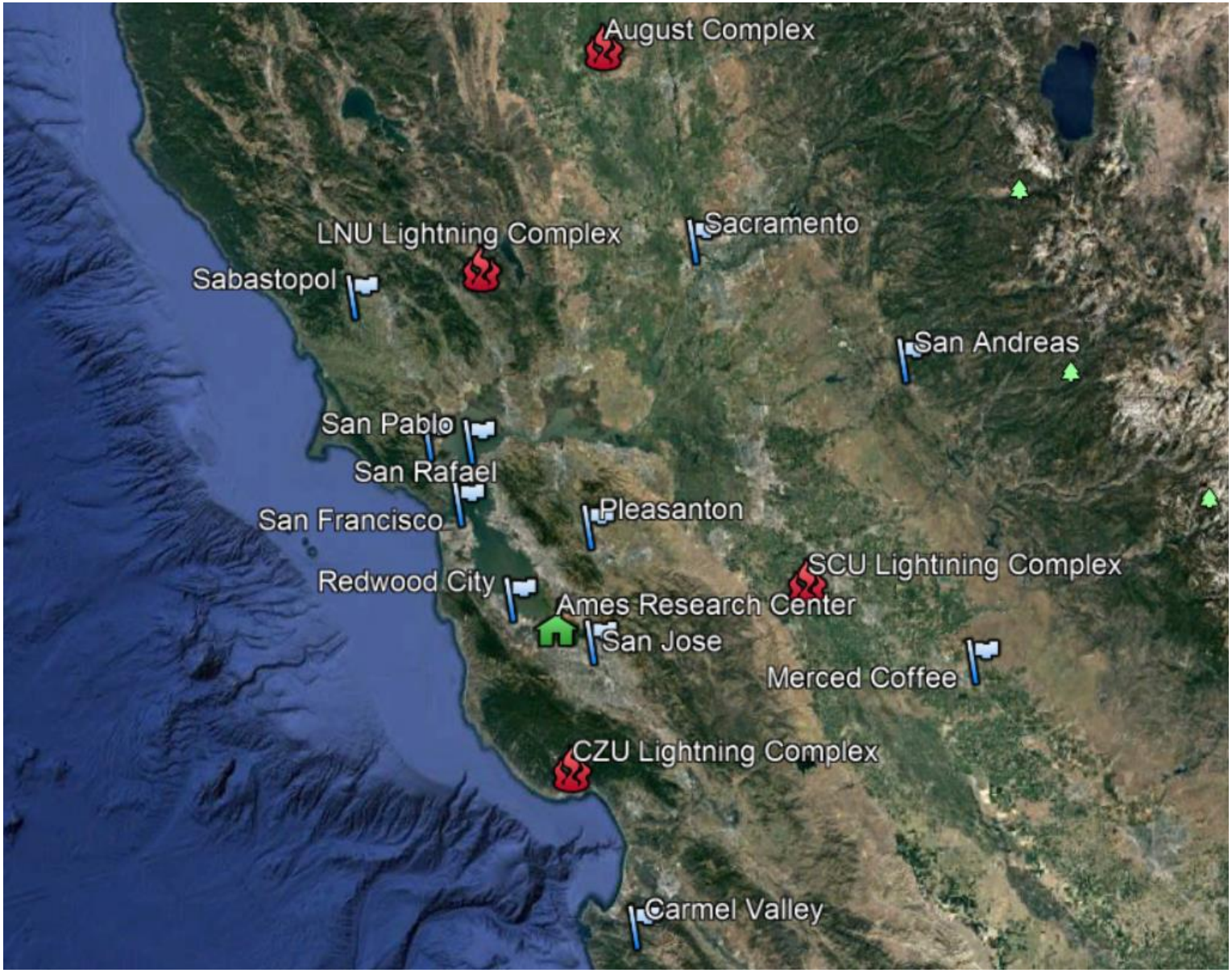
Figure 1
x=−16.5 y=571.
OAK Sounding
Valid Time: 2020-09-16 12:00:00
hectopascal
degree_Celsius


San Francisco UTC

Fire and Smoke Detection

- MODIS (MOD04A1/MYD04A1)
- 1km Resolution ; 1 degree x 1 degree
- Low Earth Orbit
- Aqua 2002-Terra 1999
- True Color Image (RGB) visible wavelength bands 1,4 & 3
- The Terra satellite has an approximate 10:30am local time satellite overpass whilst the Aqua satellite has an approximate 1:30pm local time overpass.

Study Area


August Complex
LNU Lightning Complex
Sacramento
Sabastopol
San Andreas
San Pablo
San Rafael
San Francisco
Pleasanton
SCU Lightning Complex
Redwood City
Ames Research Center
San Jose
Merced Coffee
CZU Lightning Complex
Carmel Valley

San Francisco

San Francisco After

November 1st 2020 after NFPA(National Fire Protection Association)

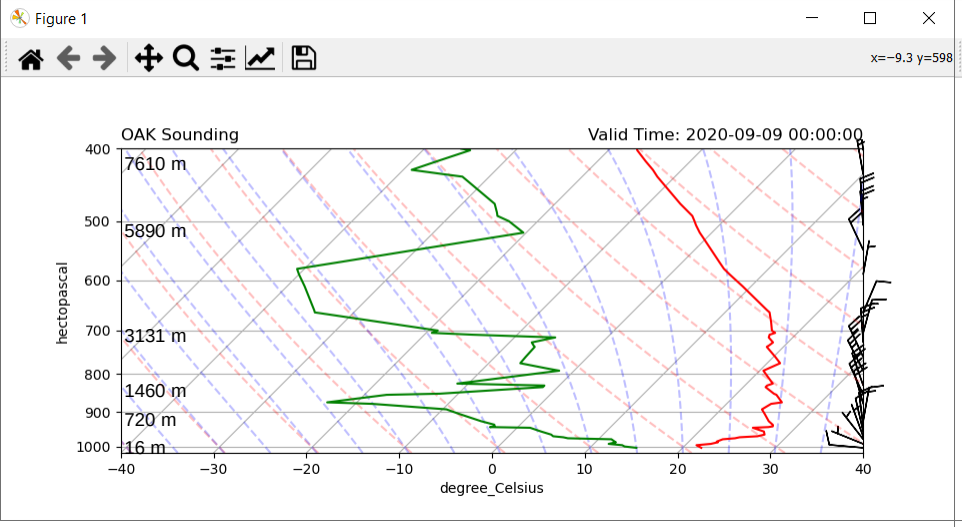


Figure 1
x=−9.3 y=598
OAK Sounding
Valid Time: 2020-09-09 00:00:00
7610 m
5890 m
3131 m
1460 m
720 m
16 m
hectopascal
degree_Celsius

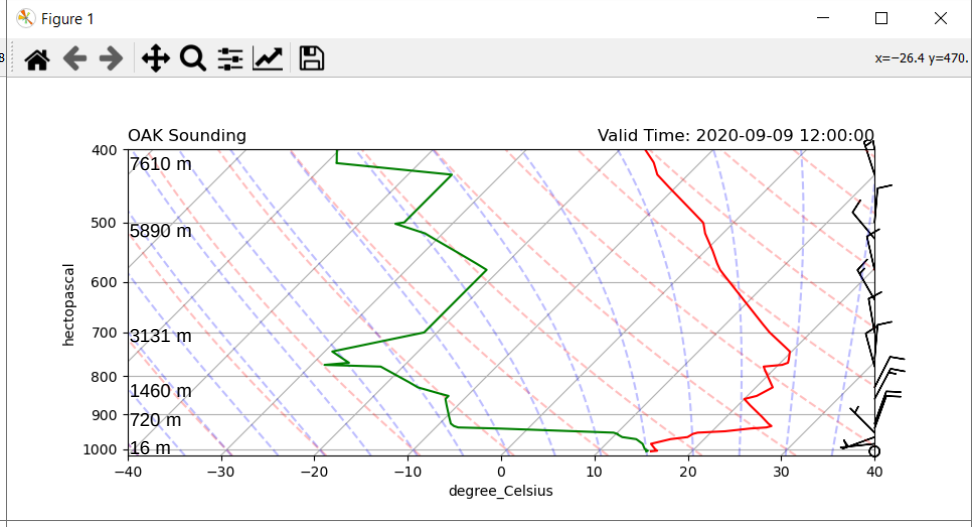


Figure 1
x=−26.4 y=470.
OAK Sounding
Valid Time: 2020-09-09 12:00:00
7610 m
5890 m
3131 m
1460 m
720 m
16 m
hectopascal
degree_Celsius

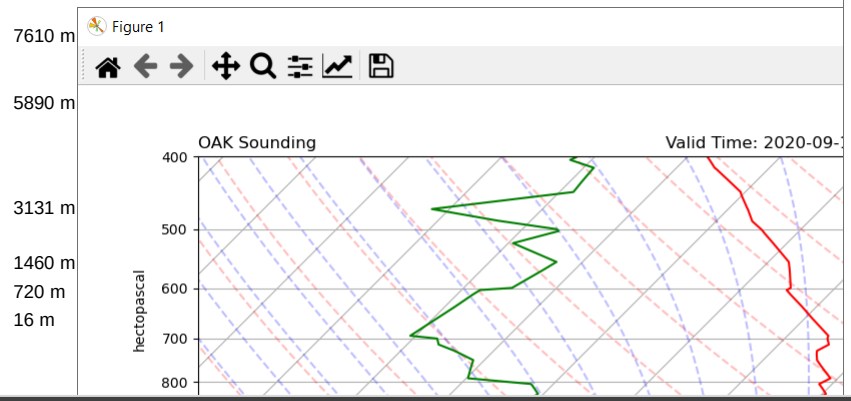


Figure 1
OAK Sounding
Valid Time: 2020-09-
7610 m
5890 m
3131 m
1460 m
720 m
16 m
hectopascal

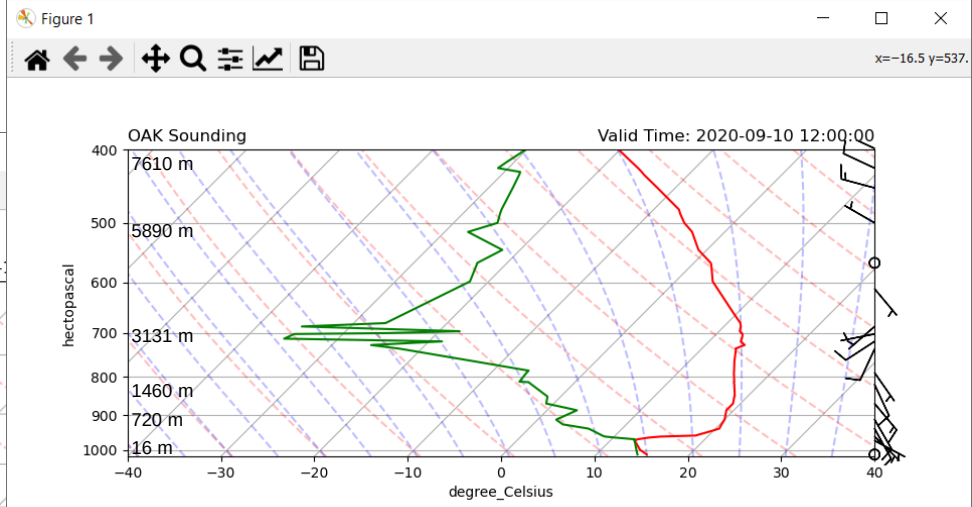


Figure 1
x=−16.5 y=537.
OAK Sounding
Valid Time: 2020-09-10 12:00:00
7610 m
5890 m
3131 m
1460 m
720 m
16 m
hectopascal
degree_Celsius

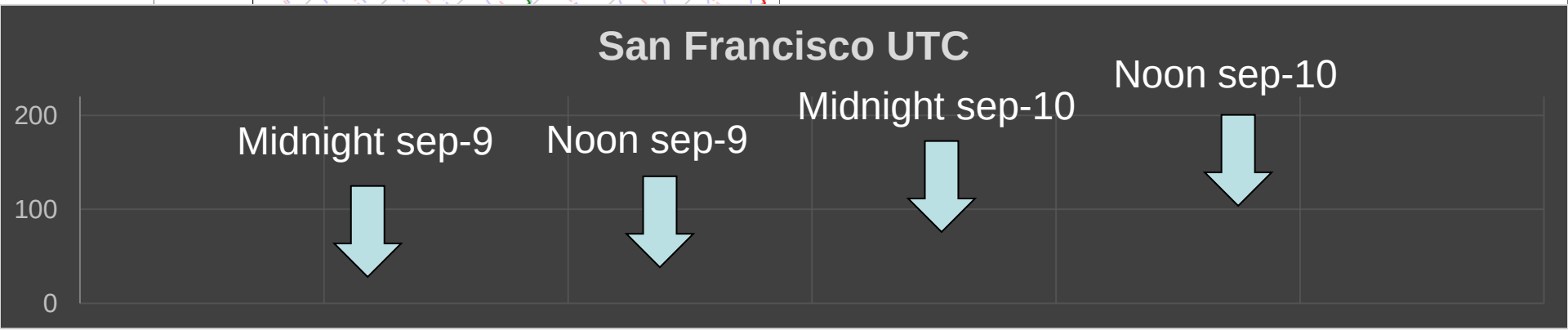

San Francisco UTC
Midnight sep-9
Noon sep-9
Midnight sep-10
Noon sep-10
200
100
0

Figure 1

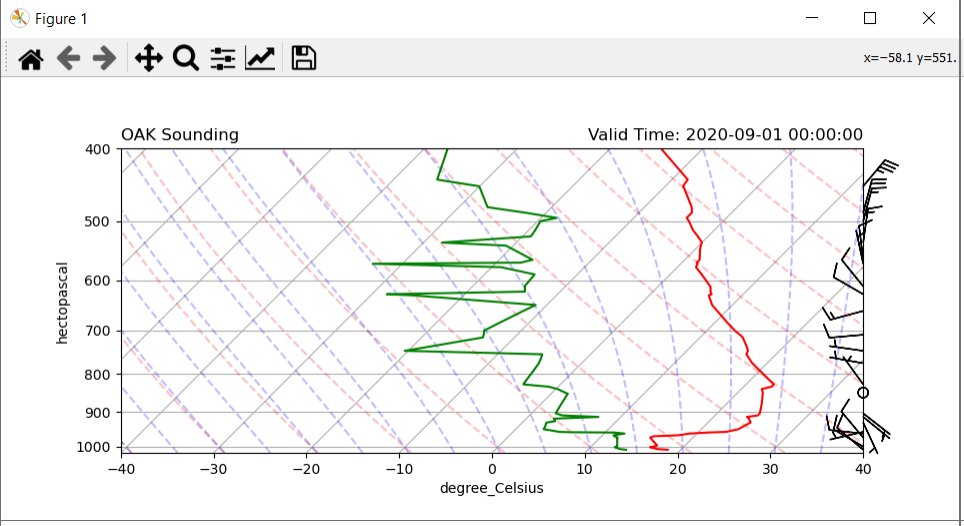


Figure 1

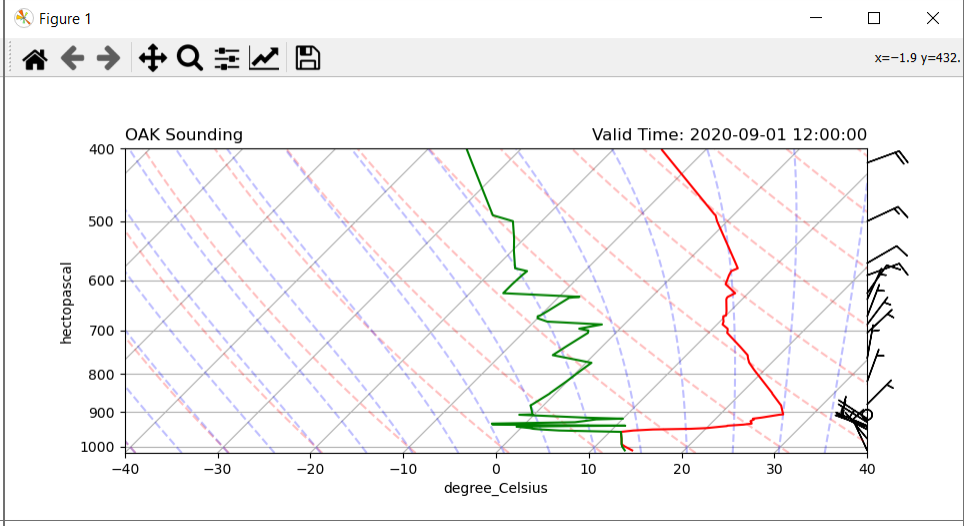


Figure 1

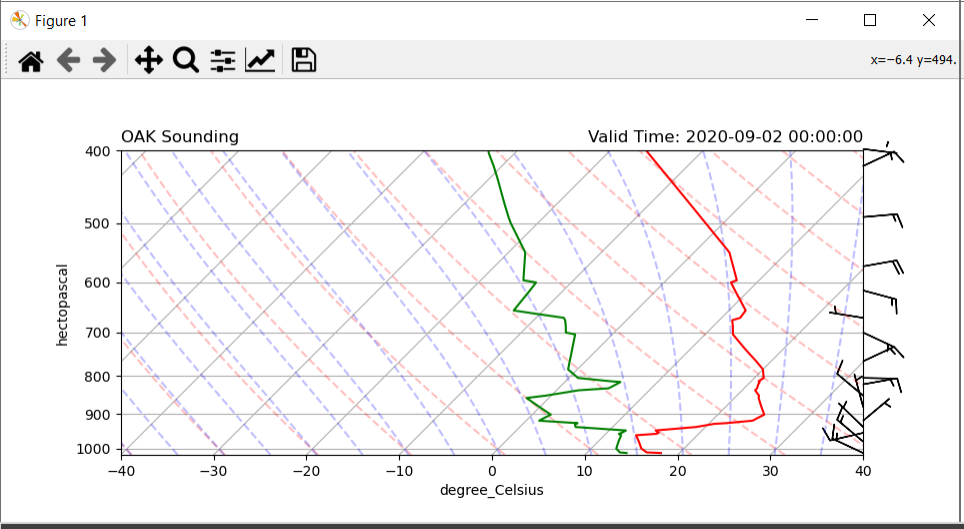
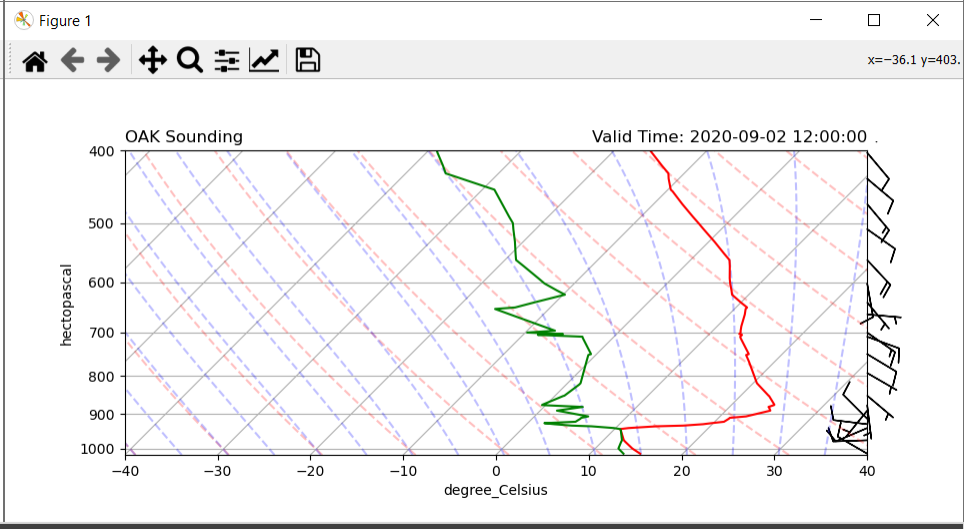


Figure 1



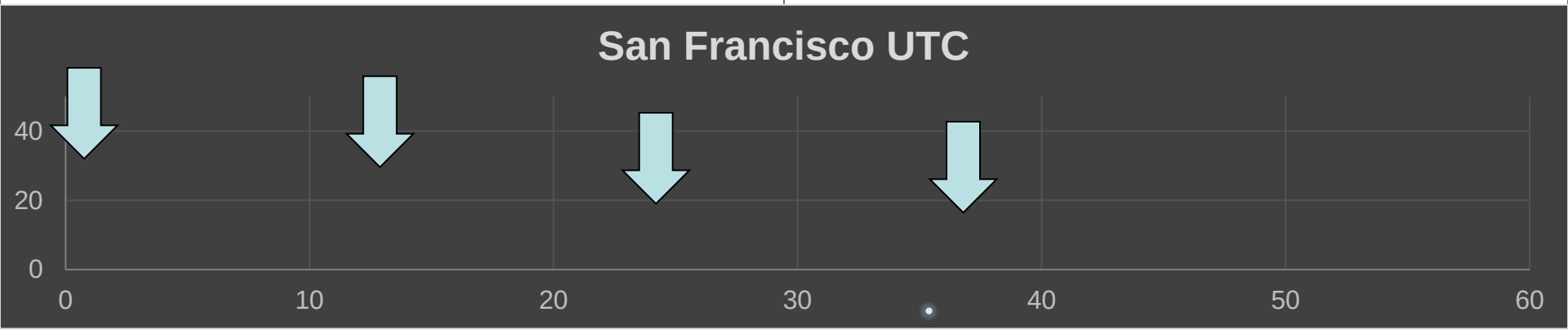


Figure 1

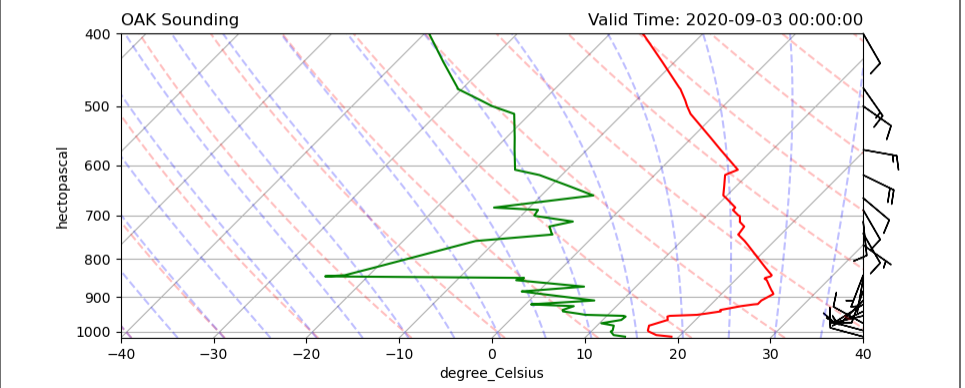


Figure 1

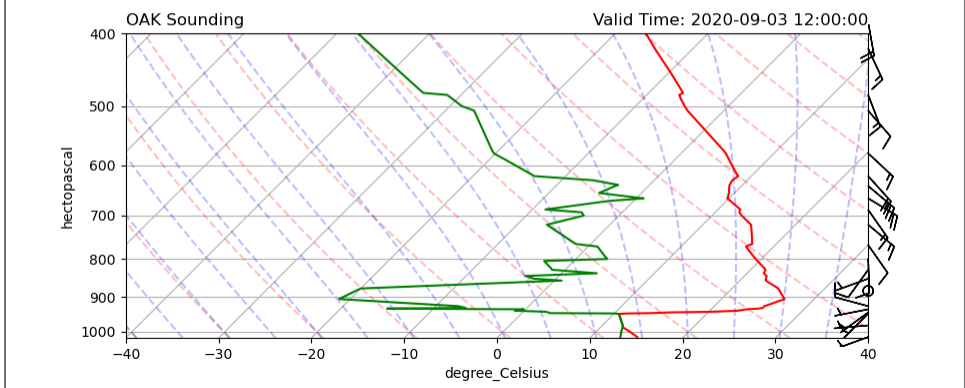


Figure 1

x=−21.7 y=602.

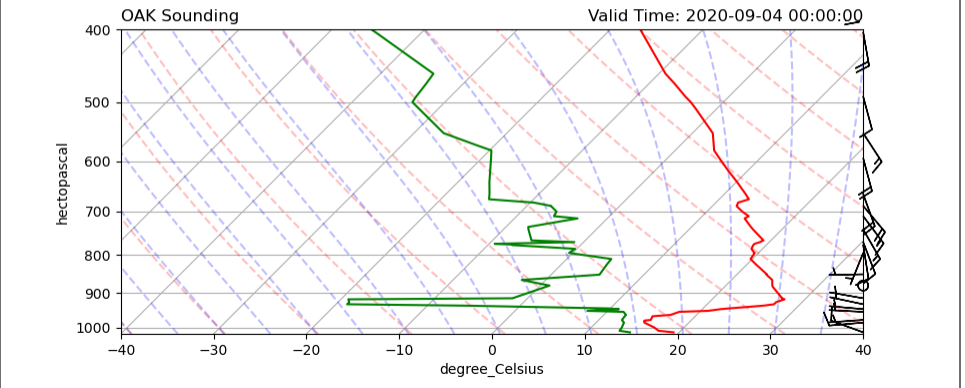
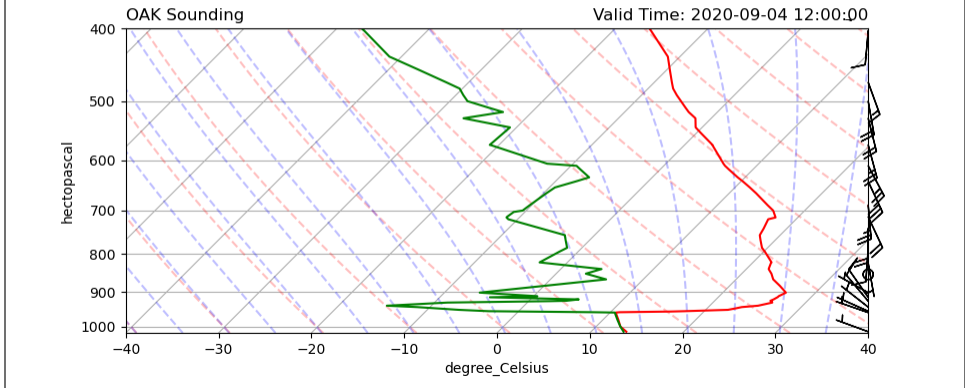


Figure 1



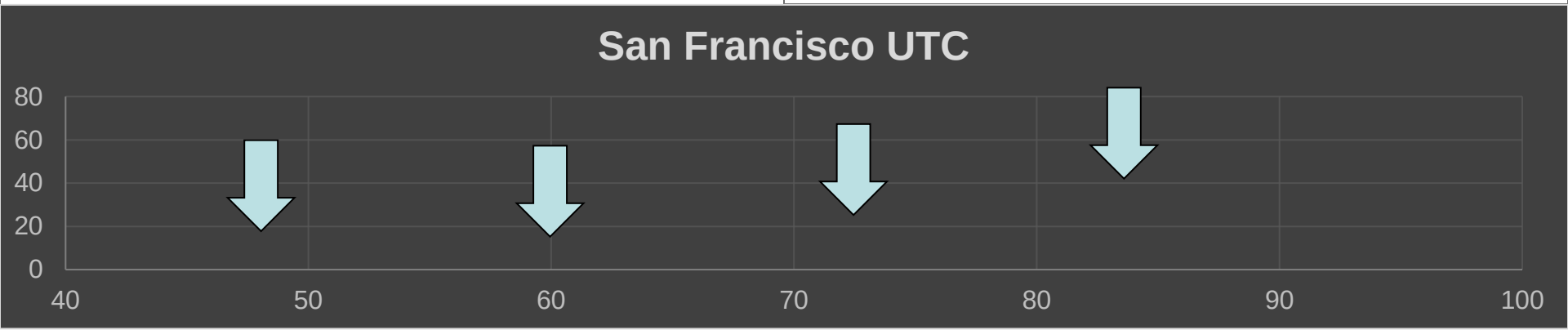


Figure 1

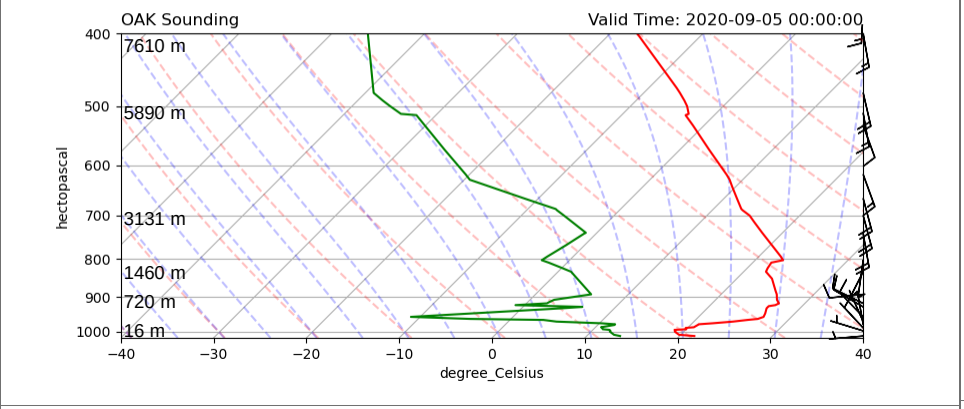


Figure 1

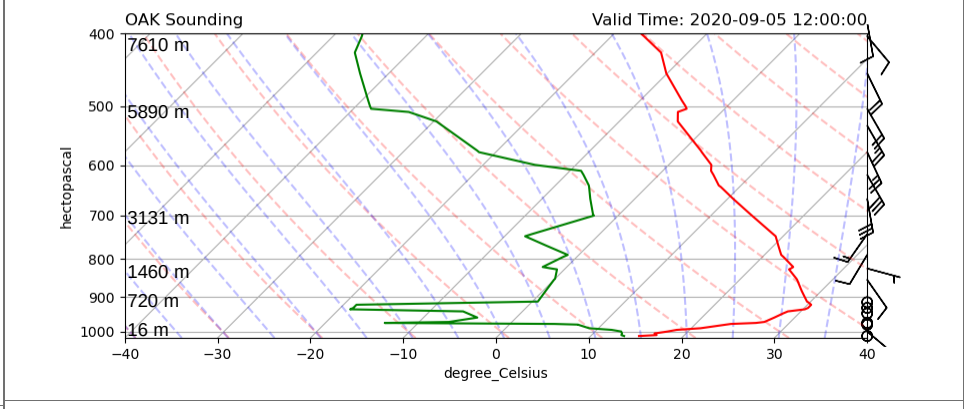


Figure 1

x=−36.0 y=462.

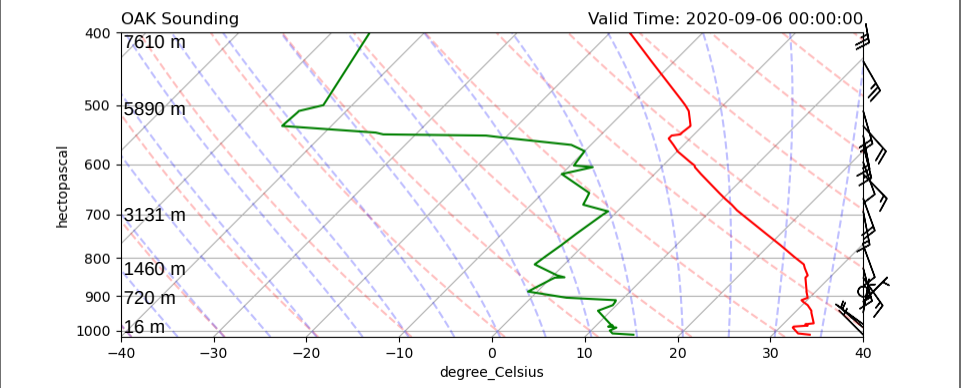
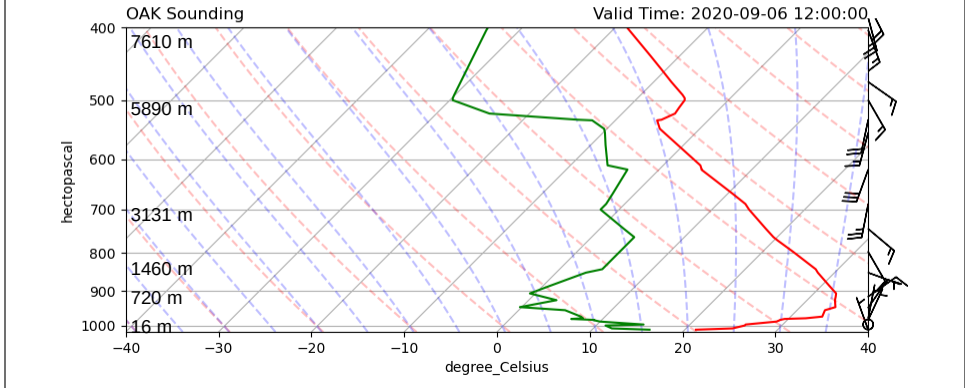


Figure 1

x=−26.7 y=511.



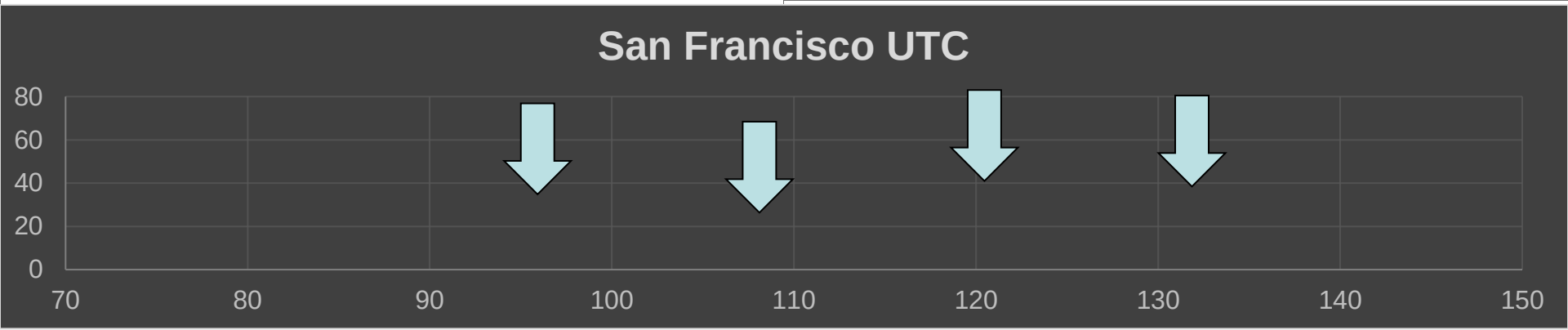


Figure 1

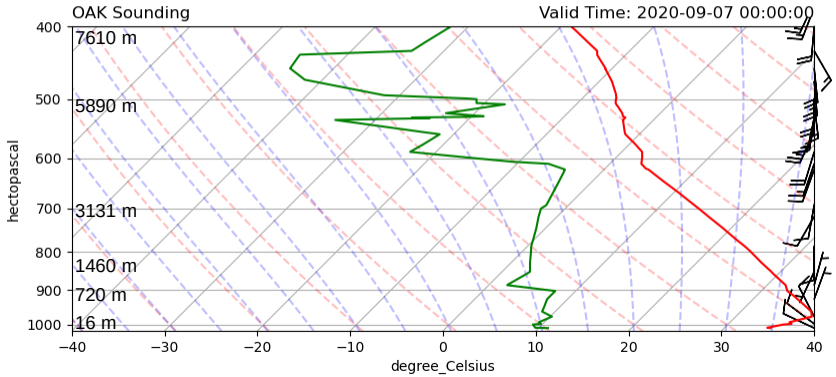


Figure 1

x=−12.7 y=611.

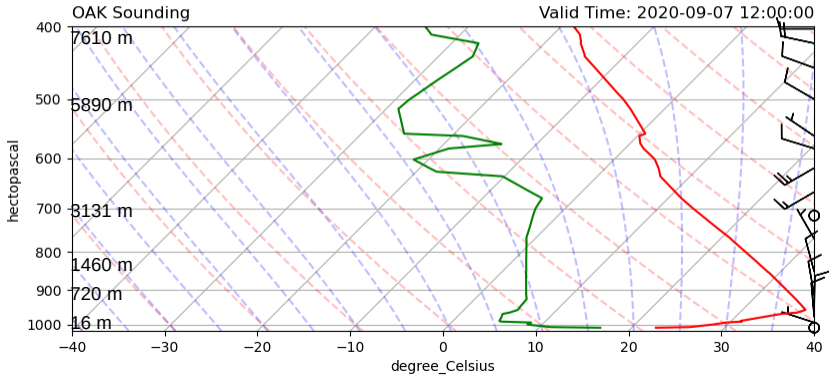


Figure 1

x=4.4 y=807.

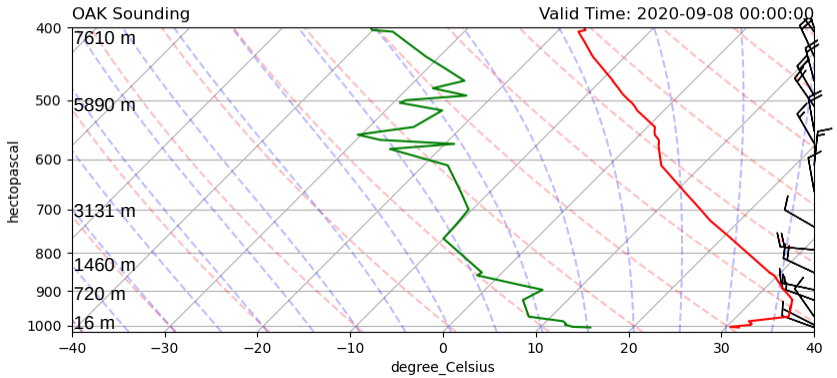


Figure 1