National Aeronautics and Space Administration

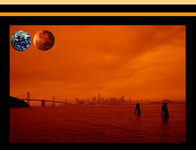
2020 Wildfire Plumes Observed by Satellite and Ground Sensors at San Francesco Bay

Hazem Mahmoud l University of Texas at San Antonio
Mentor: Dr. Qian Tan (ARC-SGG)
Atmospheric Science Branch

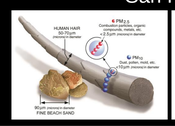
ABSTRACT

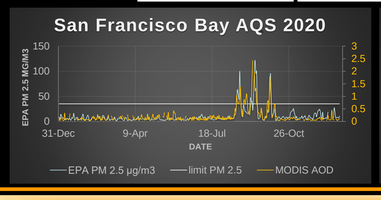
The main purpose of this research is to study the spreading of the 2020 wildfire plumes in the San Francisco Bay Area. Last year's fire plumes have caused severe impact on regional air quality and public health over large part of the west coast. We studied fire plumes with two datasets: aerosol optical depth (AOD) retrieved from MODIS sensor onboard two NASA satellites (Terra and Aqua), and surface PM2.5 measurements from US EPA. Satellite can monitor fire plumes from a top-down view, including active fire location, emission amount, spreading of the fire plume in both horizontal and vertical directions. EPA records air quality using the ground network of in-situ sensors. In general the two points of view are consistent with each other. But in the peak of the 2020 fire season, we found an episode where the AOD and PM2.5 are out-of-phase for two days. We explored the possible mechanism for this shift with available meteorological measurements, including both ground measurements and sounding data. By tracking the evolution of the sounding data, we concluded a heated near surface inversion layer might shield the region from aloft fire plumes for two days before they touch down and severely downgraded the air quality over the whole Bay area.

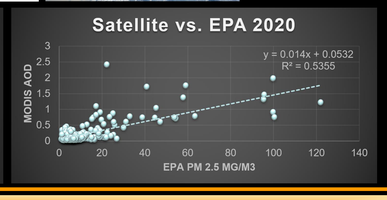
OBJECTIVES



San Francisco Sep 9th 2020

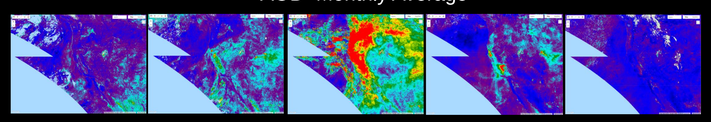






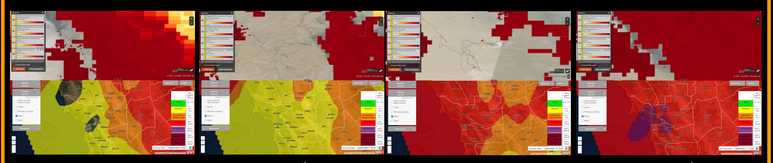
BACKGROUND

AOD Monthly Average



July August September October November

AOD vs. EPA PM 2.5



Sep 8th Sep 9th Sep 10th Sep 11th

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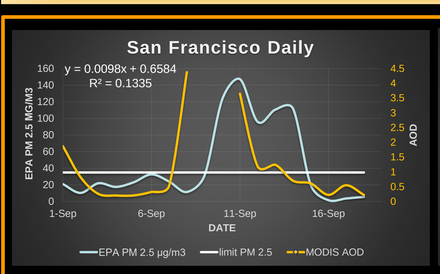
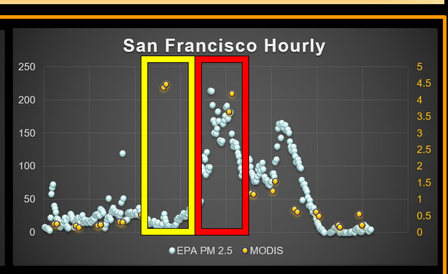
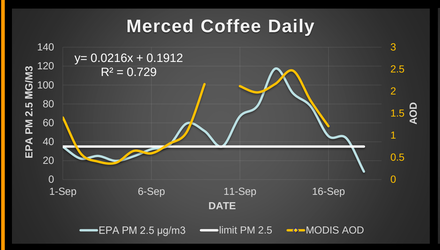
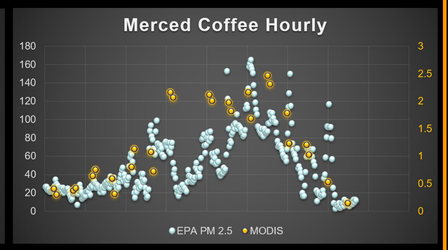
HORIZONTAL CORRELATION



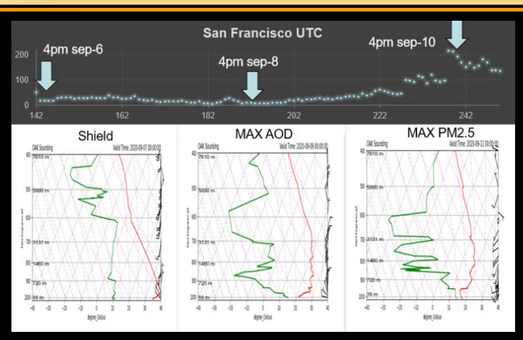


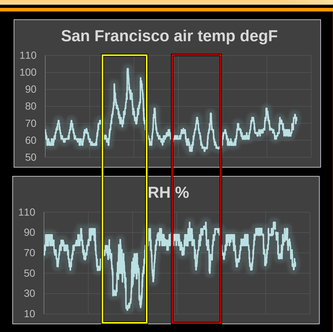


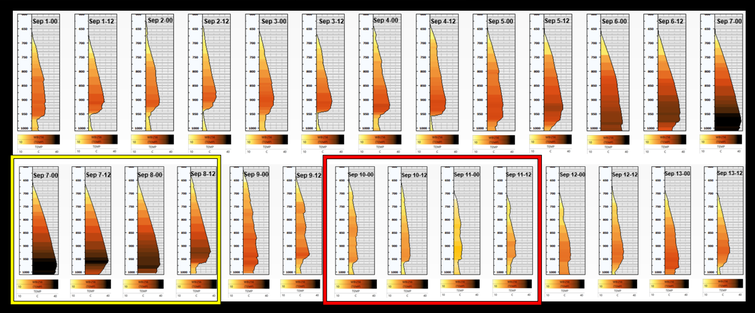


Daily and Hourly comparison between PM 2.5 and MODIS AOD

POSSIBLE EXPLANATION

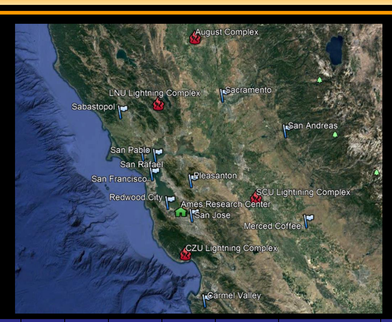






Inversion layer tracking using Skew T Log P plot and meteorological data

RESULTS



	Lat	Long	EPA Days	Satellite days	EPA Dates SEP-2020	Satellite Dates SEP-2020	1/2 deg	Elevation meters MSL	Regression R²
San Rafael	37.97	-122.52	5	6	10-14	8-13	-122.8,37.7,-122.3,38.2	3	0.217
San Pablo	37.96	-122.36	5	6	10-14	8-13	-122.6,37.7,-122.1,38.2	20	0.1359
San Francisco	**37.77**	**-122.4**	**5**	**6**	**10-14**	**8-13**	**-122.7,37.5,-122.1,38.0**	**5**	**0.1335**
Redwood	37.48	-122.2	5	7	10-14	8-14	-122.5,37.2,-122.0,37.7	3	0.3782
San Jose	37.35	-121.89	5	7	11-15	8-14	-122.1,37.1,-121.6,37.6	31	0.1972
Pleassanton	37.7	-121.9	8	7	7-14	8-14	-122.2,37.5,-121.7,38.0	101	0.3815
Sebastopol	38.4	-122.82	5	8	10-14	7-15	-122.1,38.2,-121.6,38.7	78	0.7256
San Andreas	38.2	-120.68	10	10	8-17	7-18	-120.9,38.0,-120.4,38.5	280	0.1385
Merced-Coffee	**37.28**	**-120.43**	**11**	**9**	**7-17**	**8-16**	**-120.7,37.0,-120.2,37.5**	**86**	**0.729**
Sacramento	38.57	-121.49	11	9	4-17	4-15	-121.7,38.4,-121.2,38.8	13	0.4798
Caramel Valley	36.48	-121.73	6	6	10-15	8-13	-120.0,36.2,-121.5,36.7	131	0.4803

10 selected locations around San Francisco bay results

CONCLUSIONS

- There is a regular very high correlation between AOD and PM 2.5
- The blanket effect in the first half of September 2020 caused the lag between the ground sensor and satellite measurement due to the thickening in the inversion layer which trapped the wildfire plumes to move vertically.
- The Satellite AOD observes Wildfire plumes around 2 days earlier than the EPA ground station.
- The elevation of the ground station is an important factor for correlation with satellite data.
- The vertical correlation using the skew T log P plot was the most important key to understand the inversion layer through the atmosphere.
- The Heat Shield prevented the Plumes from spreading to ground sensor

ACKNOWLEGMENTS

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*All photos and figures are credited to NASA, EPA and CALFIRE

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