Rocky Mountain High

(ozone, that is)

A look at three consecutive ozone exceedance days in Rocky Mountain National Park

June 11-13, 2018

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NOAA ESRL Chemical Sciences Division and *CIRES, U. of Colorado

Rocky Mountain National Park historical compliance with the ozone NAAQS

Year	NAAQS (ppbv)	No. exceedances	Max MDA8 (ppbv)	4th highest MDA8 (ppbv)	CO acres burned (NIFC)
2008	75	4	81	76	141,964
2009	75	0	75	68	50,456
2010	75	6	82	77	44,020
2011	75	8	80	77	161,167
2012	**75**	**14**	**90**	**81**	**286,887**
2013	75	3	83	75	195,145
2014	75	0	70	69	24,949
2015	75	0	72	69	22,602
2016	70	3	80	69	129,495
2017	70	1	74	67	111,667

(Long's Peak monitor: 40.278° N, -105.546° W, 2742 m asl)

Rocky Mountain National Park

(*preliminary data through June 15, 2018)

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2018*	**70**	**5**	**91**	**71**	

(Long's Peak monitor: 40.278° N, -105.546° W, 2742 m asl)

Rocky Mountain National Park

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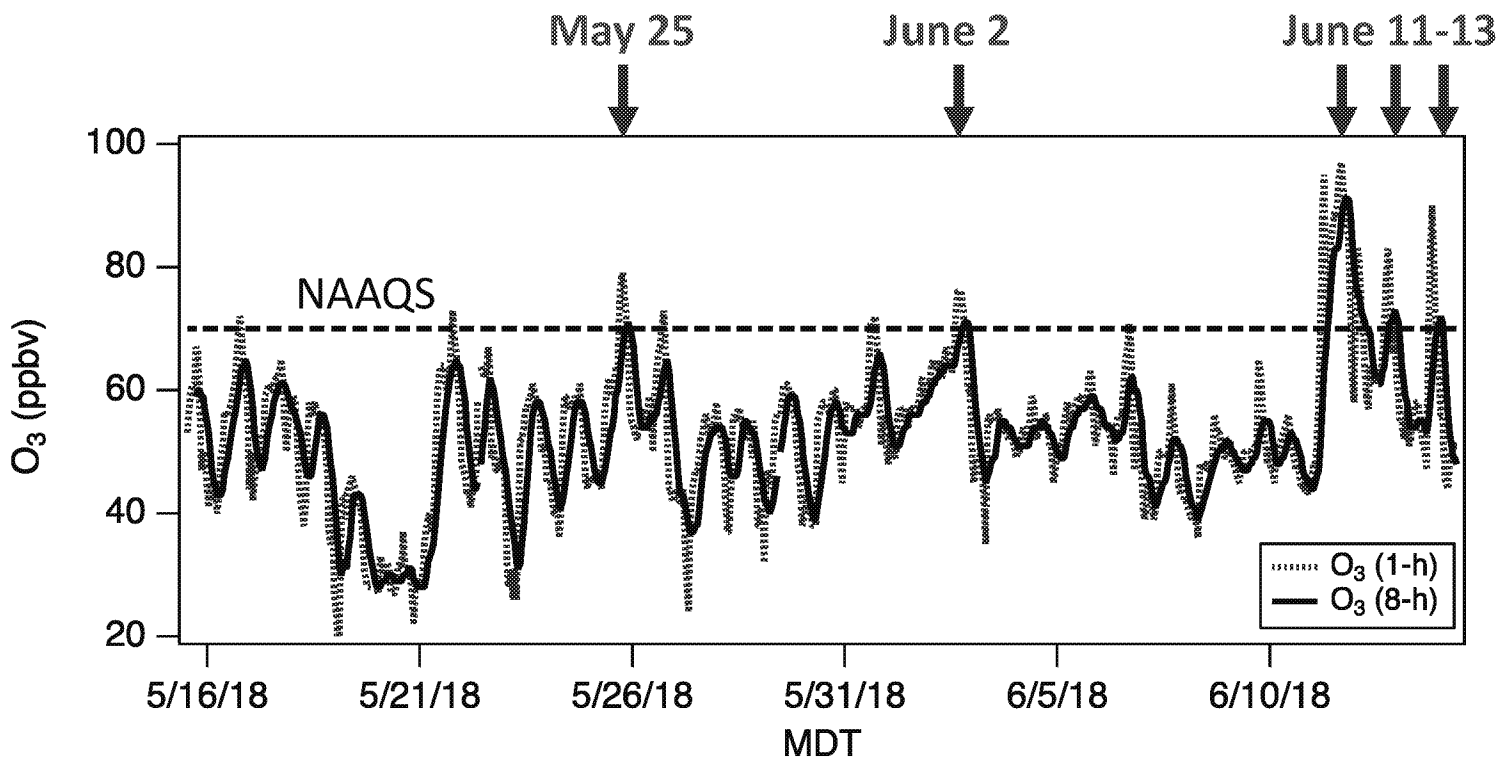
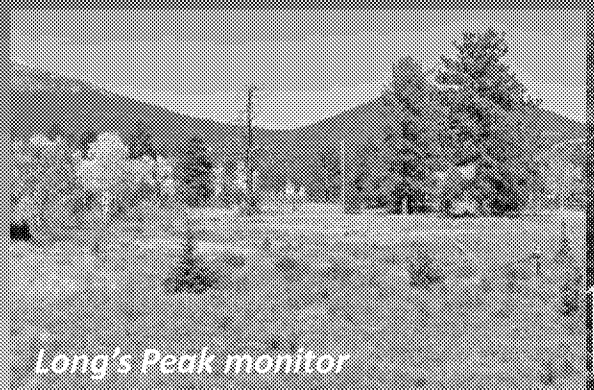
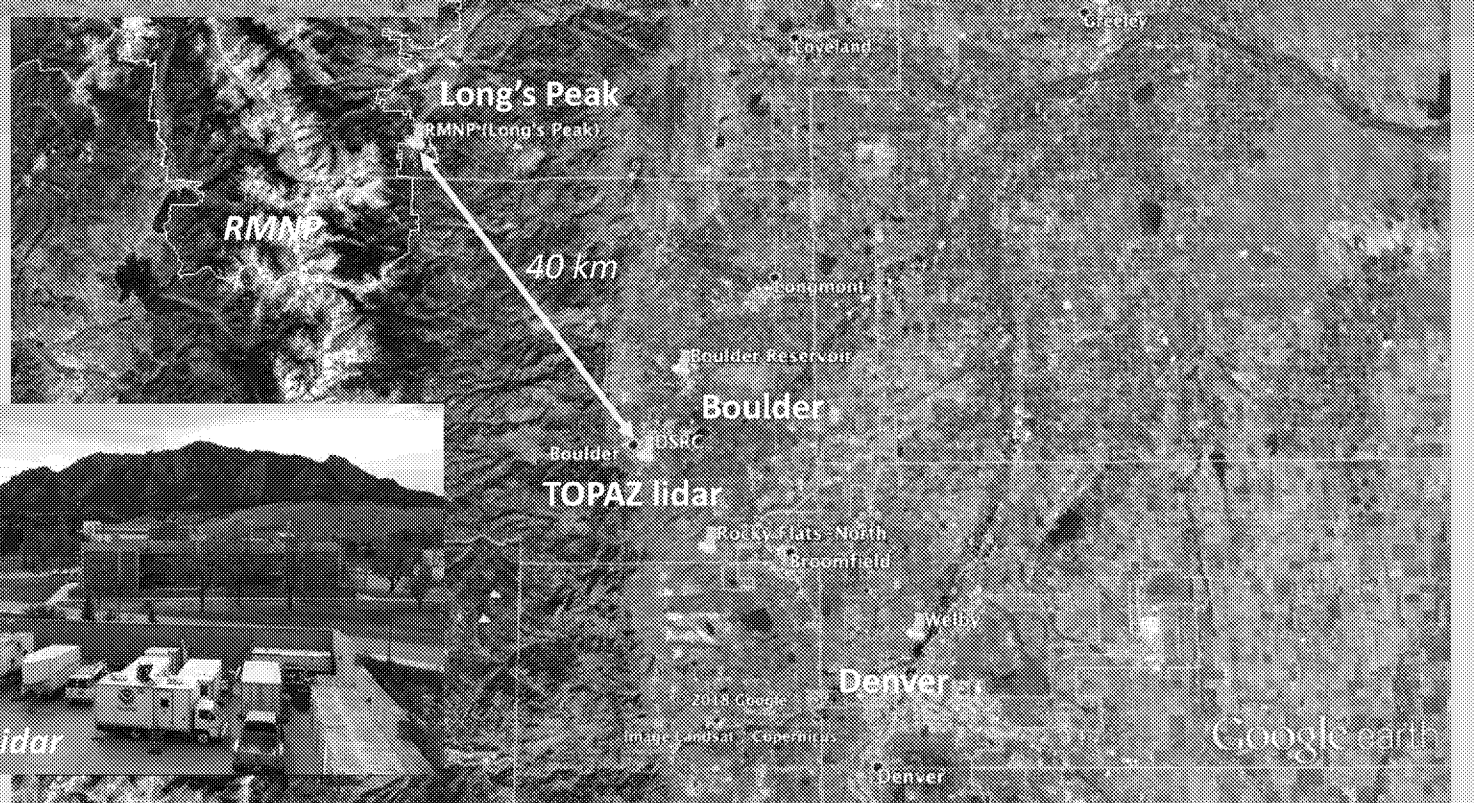
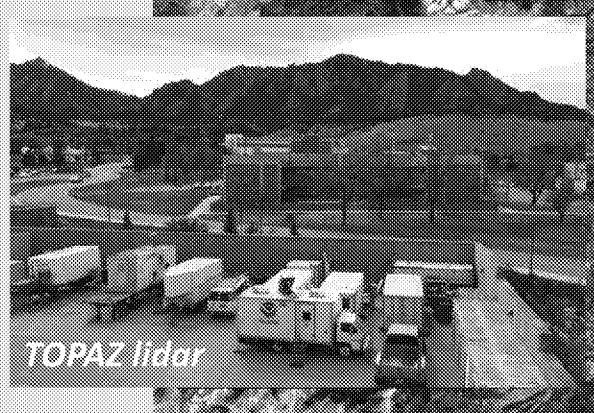


(Long's Peak monitor: 40.278° N, -105.546° W, 2742 m asl)

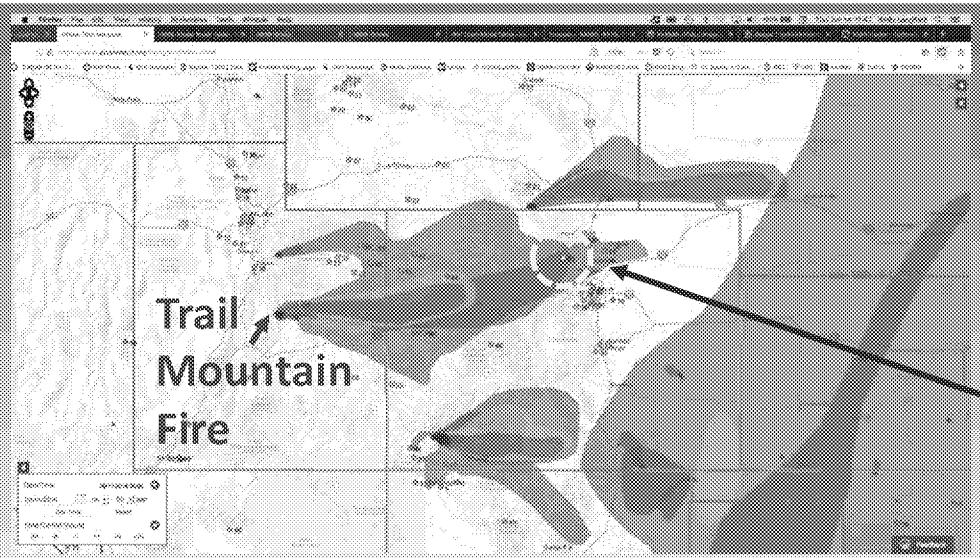
Measurement sites

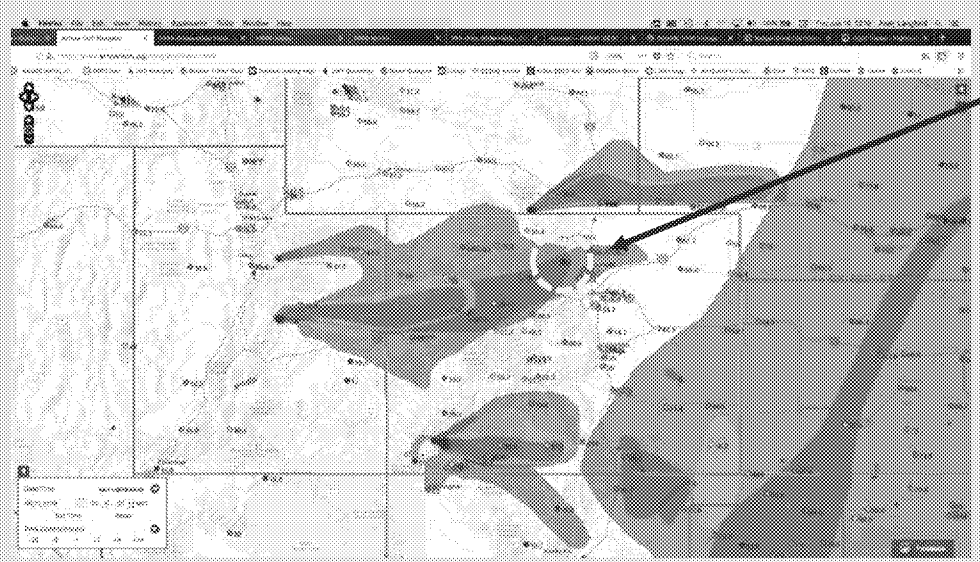


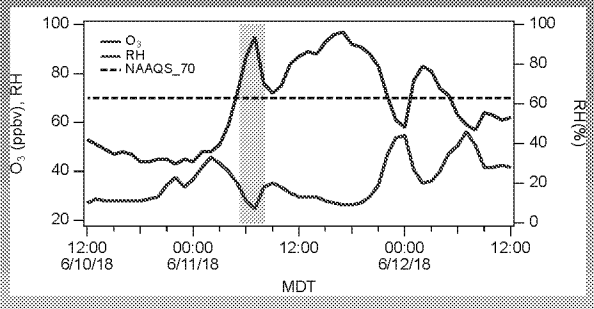




High ozone and dry air appear in RMNP before sunrise on Monday (June 11)







95 ppbv O_3 and 7% RH at RMNP at 0500-0600 MDT.

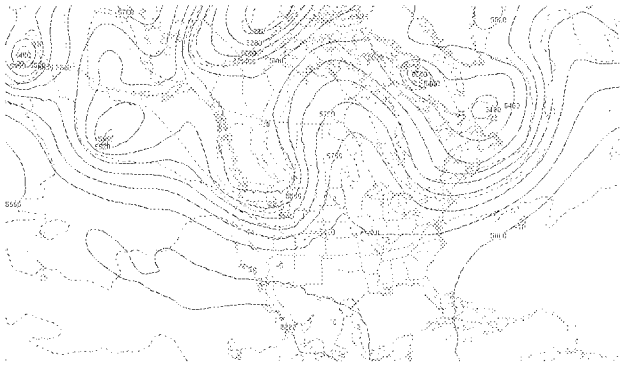
All other monitors in CO and UT show <60 ppbv O_3 and >20% RH

STT, Fire, or ????

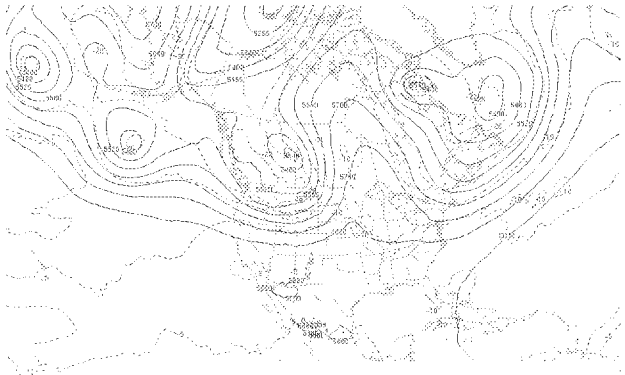
(Maps from AirNow Navigator)

Tropopause fold develops on the SW flank of upper level trough on June 10-11

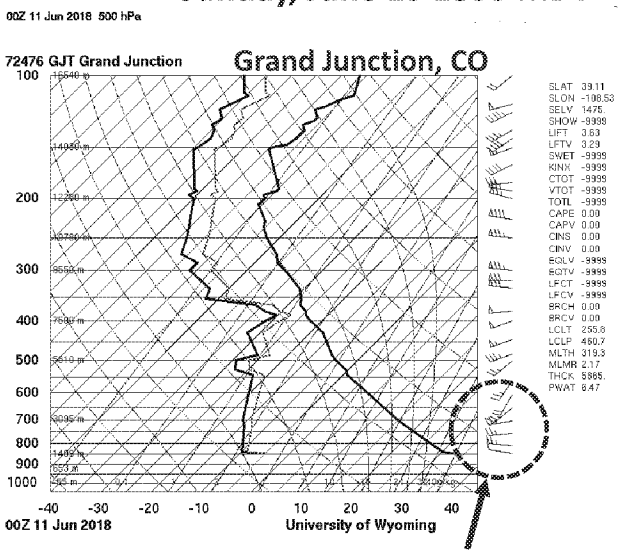
Upper level trough moves across the northwestern U.S.

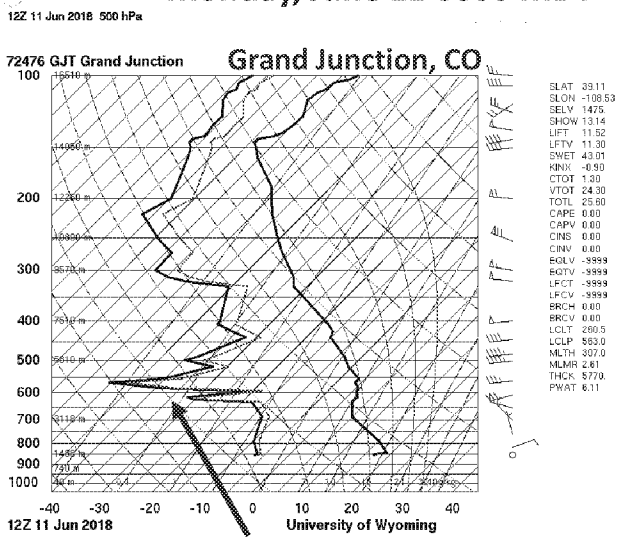


Sunday, June 10 1800 MDT



Monday, June 11 0600 MDT



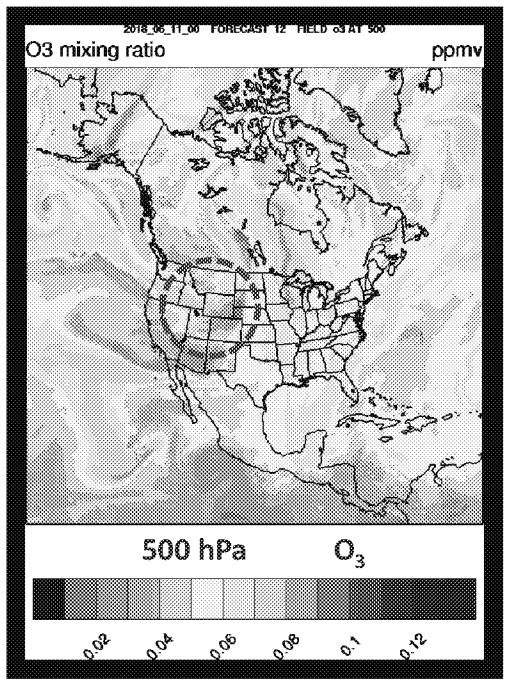


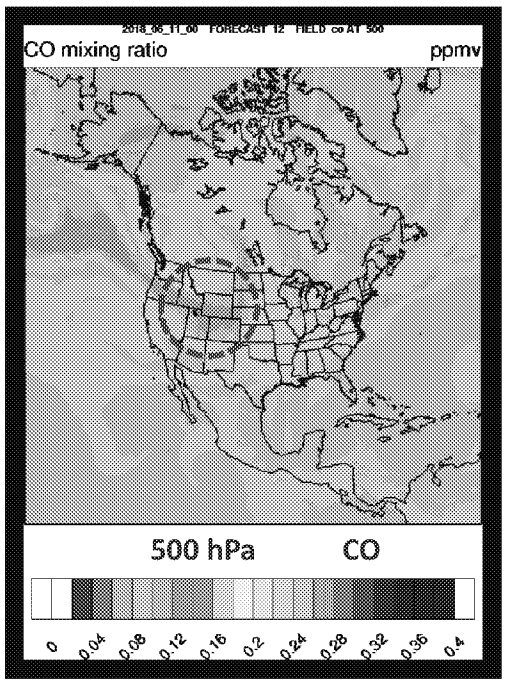
High surface winds beneath the jet on Sunday evening

(Plots from U Wyoming)

Stratospheric intrusion follows Monday morning

NOAA RAP-Chem model also shows high CO consistent with entrained Asian pollution





Monday, June 11 0600 MDT

•13 km Forecast model based on the Weather Research and Forecasting (WRF) coupled with chemistry via the RACM chemical mechanism including MOSAIC/VBS for better prediction of secondary organic aerosols (SOA). Forecasts include:

•MEGAN biogenic emissions, NEI and RETRO/EDGAR anthropogenic emissions,
•Chemical deposition,
•Convective and turbulent chemical transport, Photolysis,
•Advective chemical transport performed simultaneously with the meteorology ("online"),
•Lateral chemical boundary conditions obtained from RAQMS model real time forecasts. **https://rapidrefresh.noaa.gov/RAPchem**

High winds and dry air associated with the stratospheric intrusion fanned the flames on Sunday

The **Trail Mountain Wildfire** began when the Trail Mountain Prescribed Fire 15 miles northwest of Orangeville, UT escaped across Cottonwood Canyon Road to East Mountain Wednesday, June 6. The escaped fire initially burned 300 acres. **Late Sunday, June 10, wind gusts of 55 miles per hour grounded all aircraft and pushed the fire northeast into Meetinghouse Canyon**. The fire covered 6497 acres by late Monday.

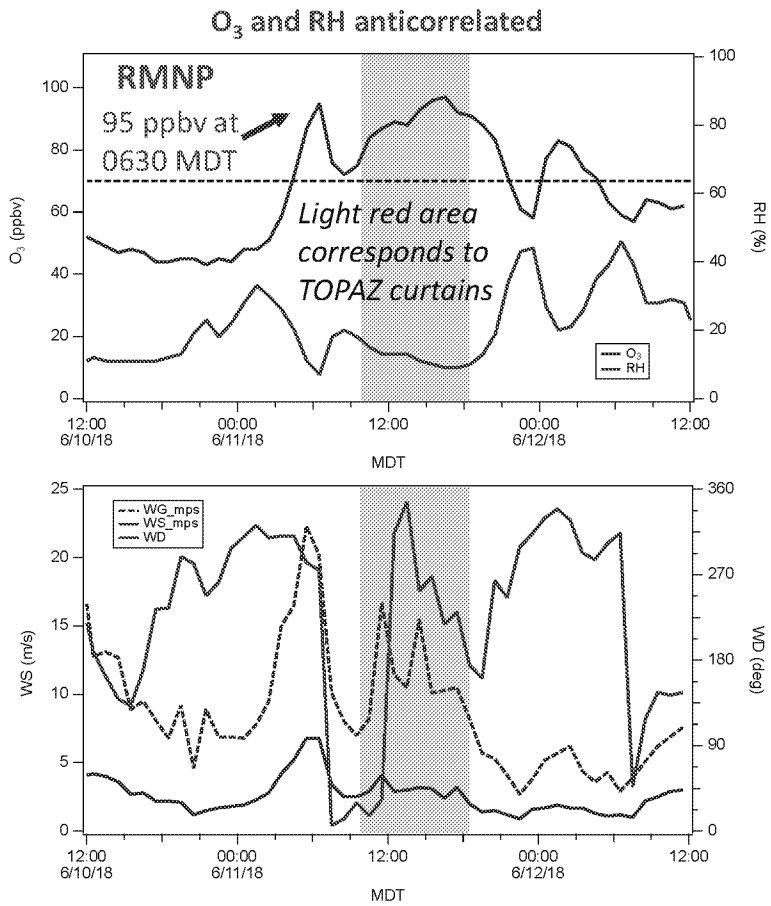
Stratospheric intrusions, the Santa Ana winds, and wildland fires in Southern California

A. O. Langford[1], R. B. Pierce[2], and P. J. Schultz[1,3]

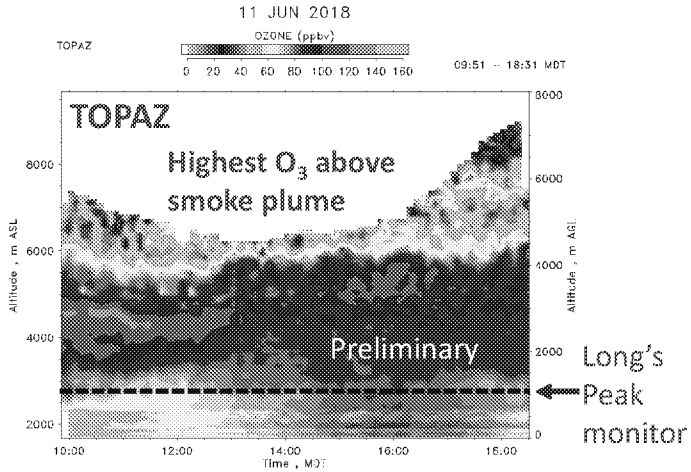
[1]NOAA Earth System Research Laboratory, Boulder, Colorado, USA, [2]NOAA/NESDIS Center for Satellite Application and Research, Cooperative Institute for Meteorological Satellite Studies, Madison, Wisconsin, USA, [3]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, Colorado, USA

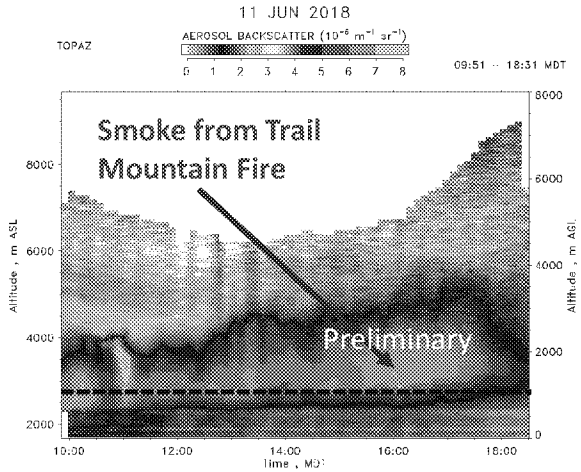
Citation:
Langford, A. O., R. B. Pierce, and P. J. Schultz (2015), Stratospheric intrusions, the Santa Ana winds, and wildland fires in Southern California, *Geophys. Res. Lett.*, *42*, 6091–6097, doi:10.1002/2015GL064964.

Day 1: June 11, 2018



Highest ozone during gusty northerly winds

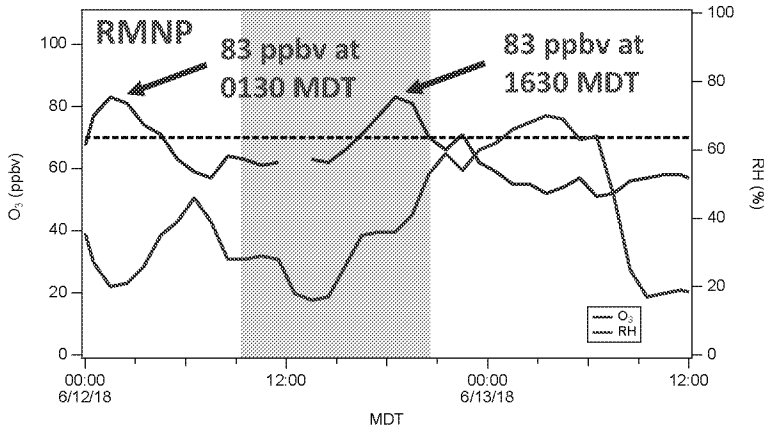


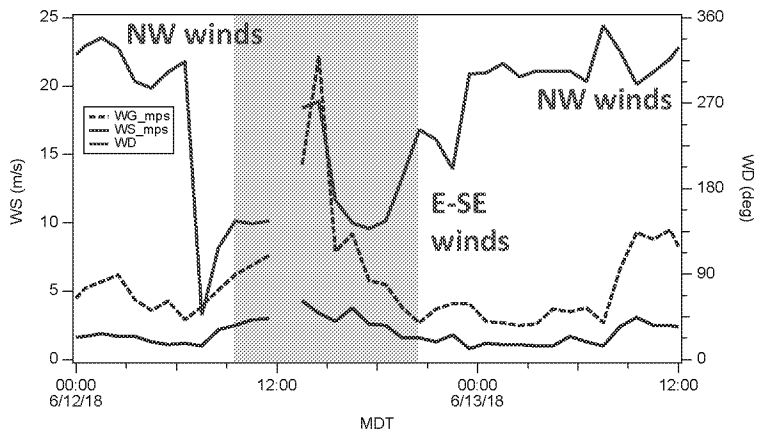


Strong stratospheric influence at RMNP

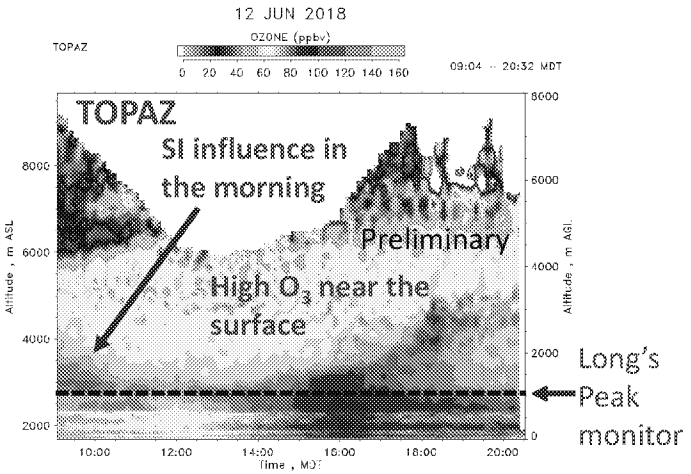
Day 2: June 12, 2018

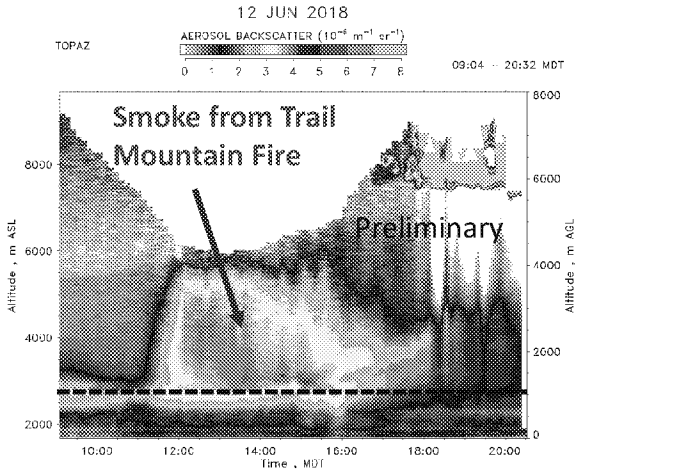
O_3 and RH anticorrelated in AM





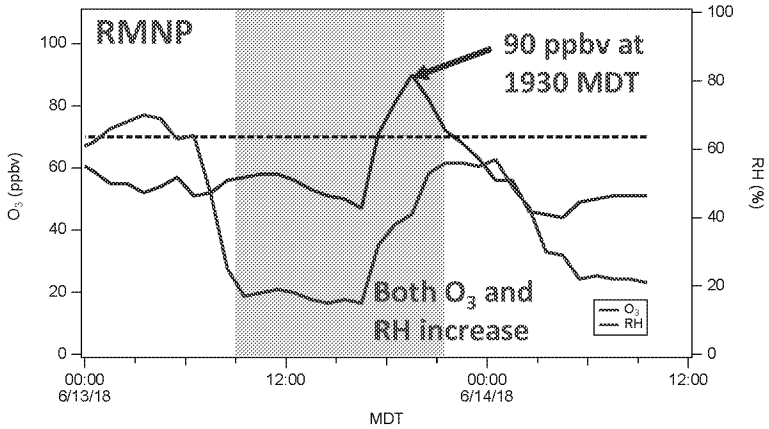
Upslope transport creates second O_3 peak in late afternoon

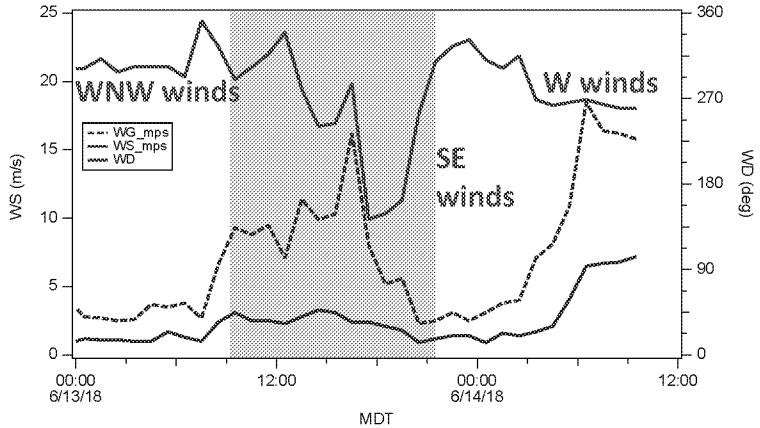




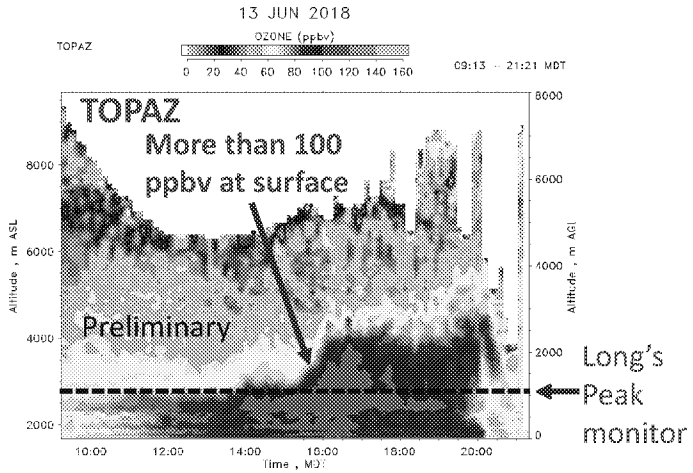
SI and regional production with possible fire influences

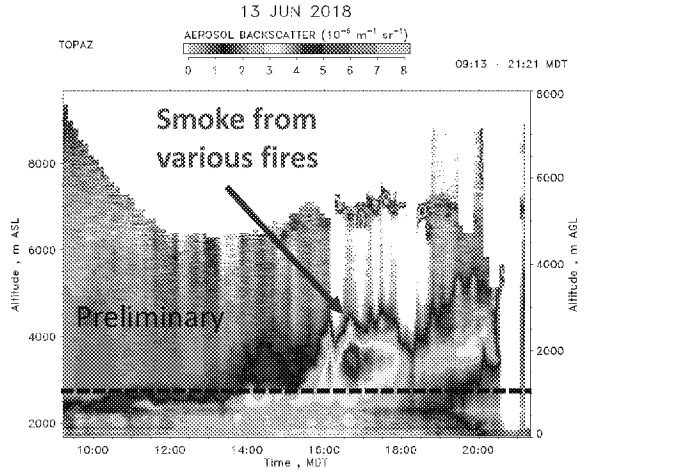
Day 3: June 13, 2018





Upslope transport creates afternoon O_3 peak

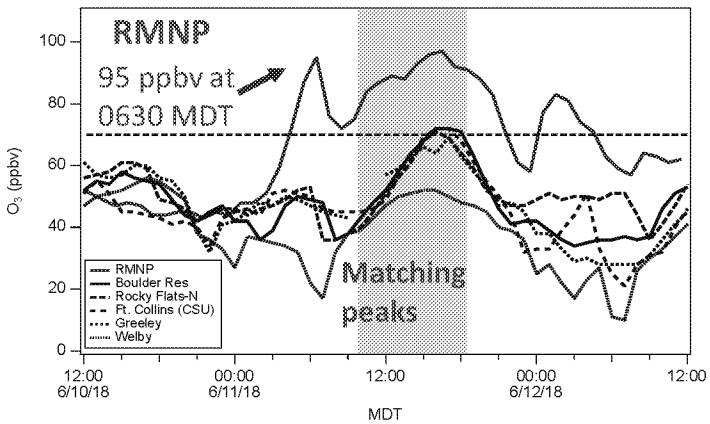


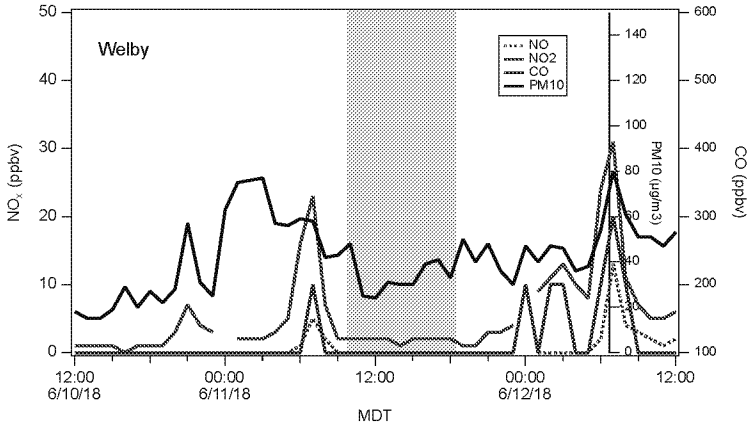


Regional production with possible fire influences

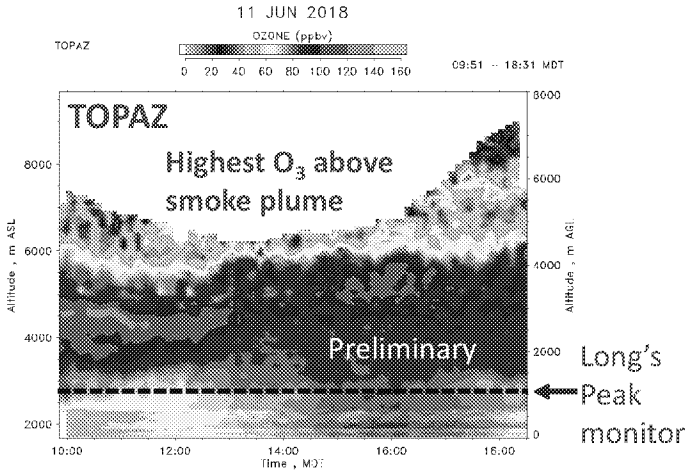
Day 1: June 11, 2018

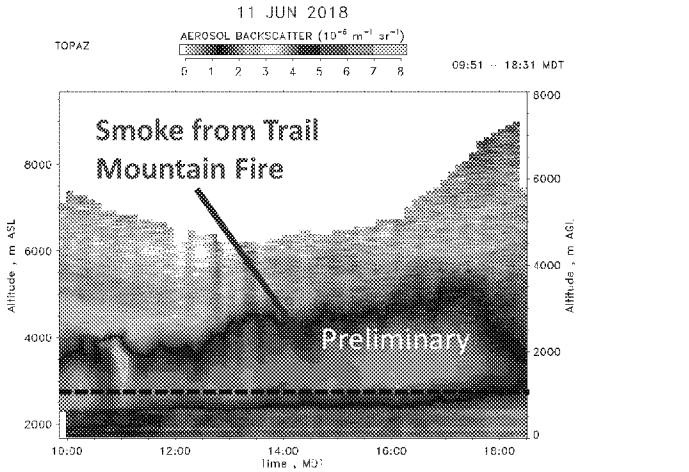
Second O_3 peak also appears at low elevation sites





Little NOx or CO enhancement at Welby during day

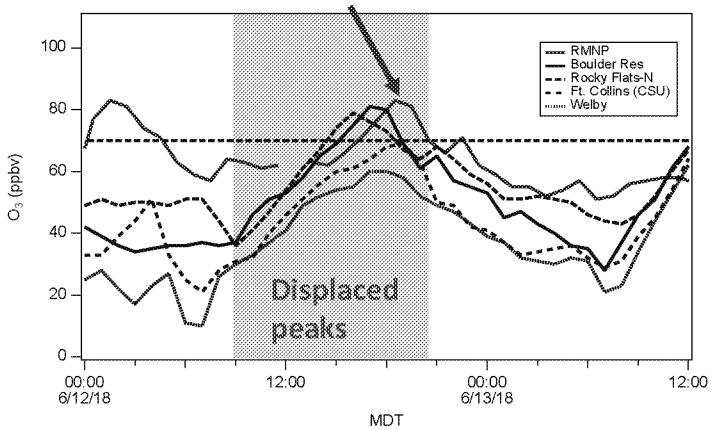


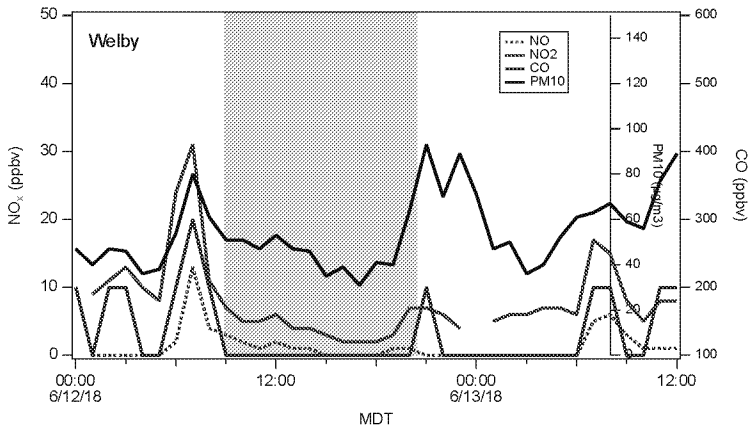


No obvious fire influence

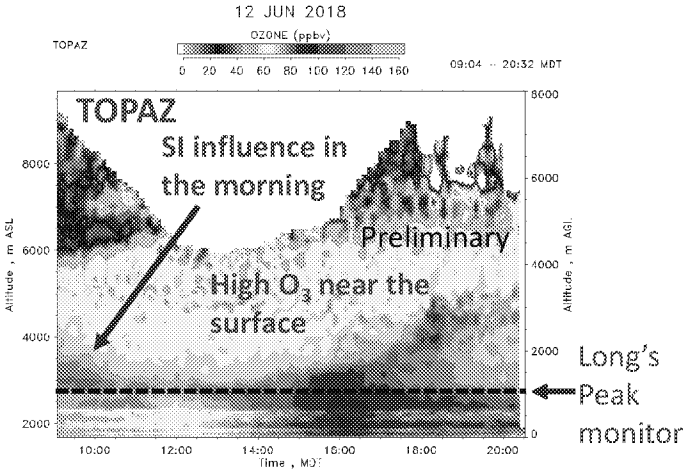
Day 2: June 12, 2018

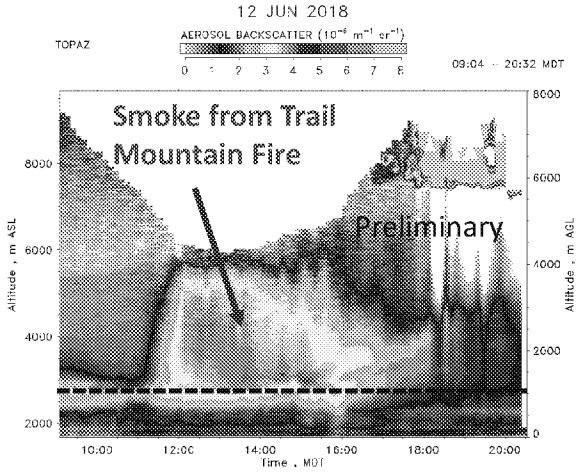
Afternoon peak lags lower elevation sites





Modest NOx and PM10 at Welby during day

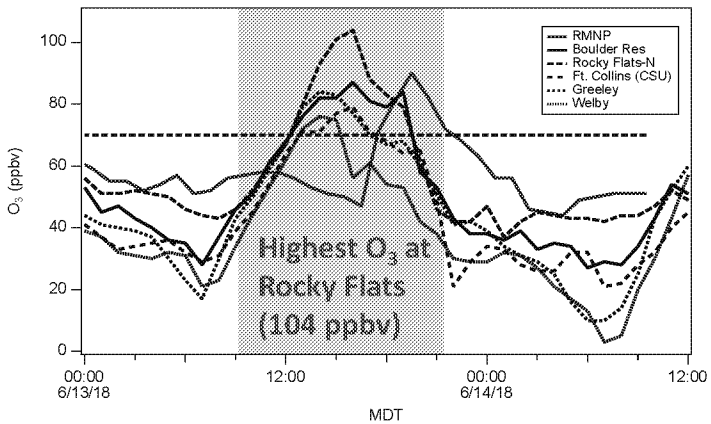


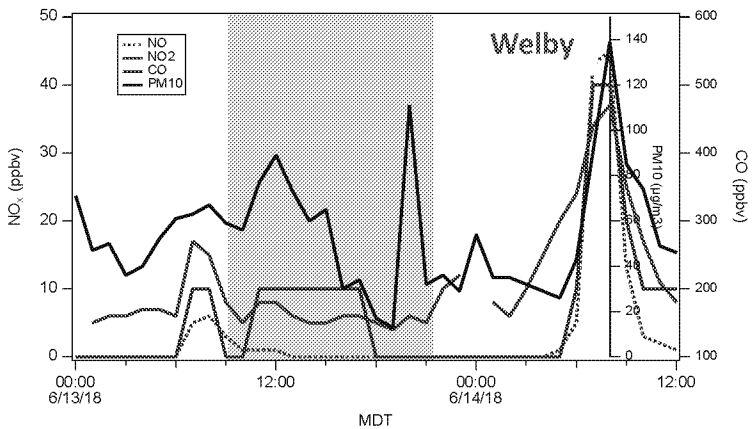


SI and regional production with possible fire influence

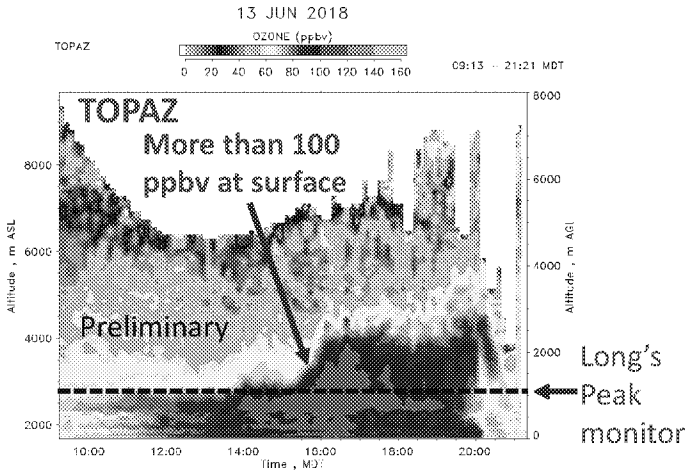
Day 3: June 13, 2018

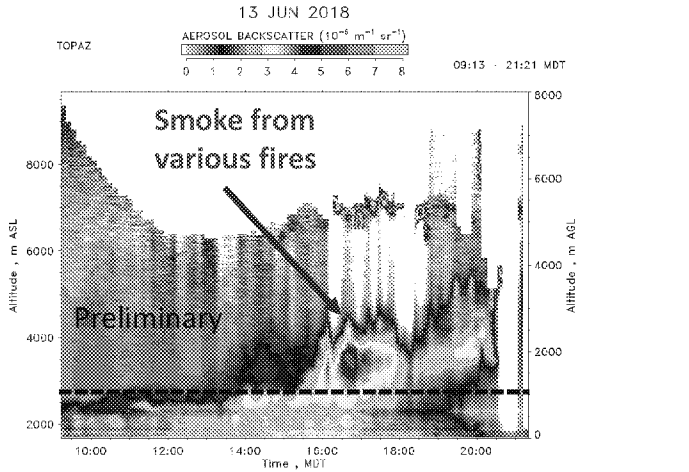
Ozone at RMNP lags low elevation sites





Elevated NOx, CO, and PM10 at Welby





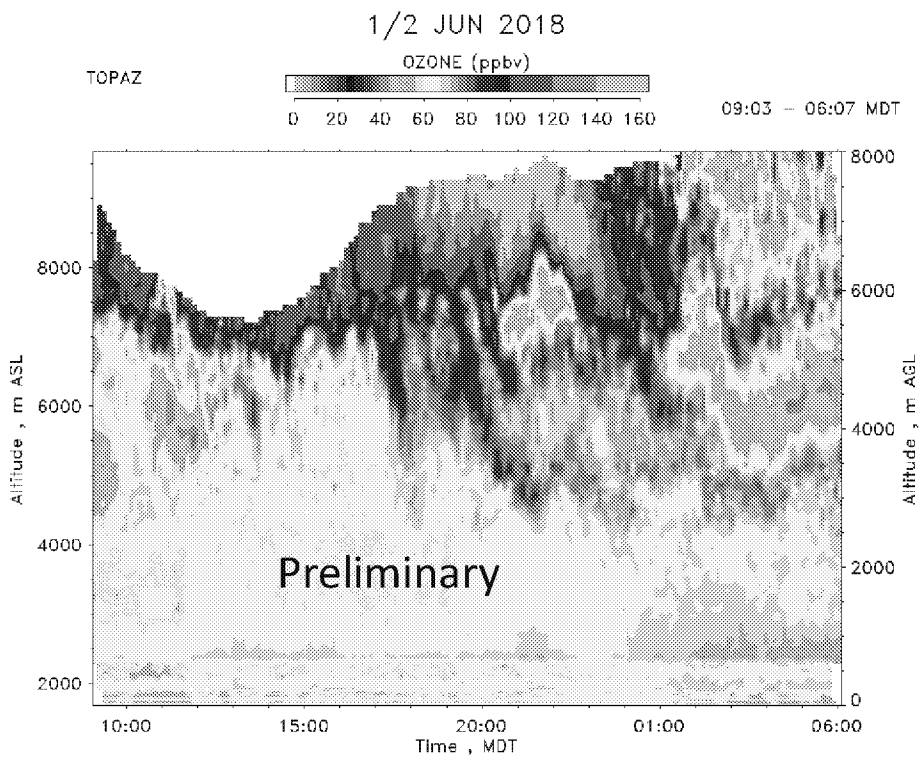
Regional production with likely fire influence

Rocky Mountain National Park
High ozone events 2018

Date	MDA8 (ppbv)	max 1-h (ppbv)	Time of 1-h max (MDT)	Stratospheric influence?	Fire influence?
May 25	71	79	19:00	?	?
June 2	71	76	16:00	Y	N
June 11	91	95	07:00	Y	Y?
June 12	73	83	19:00	Y	Y?
June 13	72	90	20:00	N	Y?

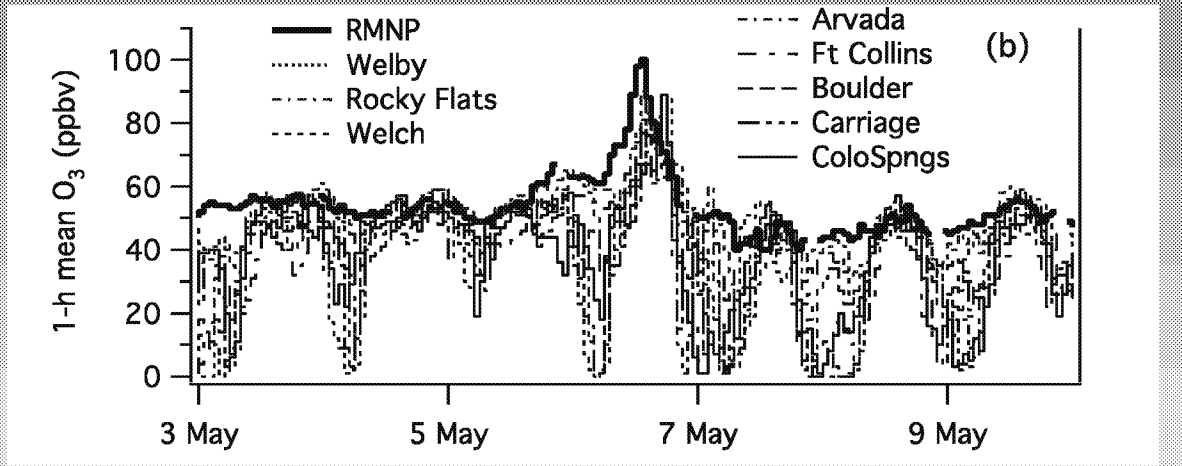
(Long's Peak monitor: 40.278° N, -105.546° W, 2742 m asl)

June 1-2, 2018


1/2 JUN 2018
TOPAZ
OZONE (ppbv)
0 20 40 60 80 100 120 140 160
09:03 – 06:07 MDT
Altitude , m ASL
8000
6000
4000
2000
Altitude , m AGL
8000
6000
4000
2000
0
10:00
15:00
20:00
01:00
06:00
Time , MDT
Preliminary

Comparison to archetypical event of May 6, 1999

May 6, 1999:	Max 1-h of 100 ppbv	MDA8 of 85 ppbv
June 11, 2018:	Max 1-h of 95 ppbv	MDA8 of 91 ppbv



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Stratospheric contribution to high surface ozone in Colorado during springtime

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Received 30 March 2009; revised 8 May 2009; accepted 19 May 2009; published 16 June 2009.

Conclusions

- Stratosphere-to-troposphere transport (STT) was the main source of high O_3 at RMNP on June 11.
- STT and upslope transport from Front Range Urban Corridor contributed to the high O_3 at RMNP on June 12.
- Upslope transport from the Front Range Urban Corridor was the main source of high O_3 at RMNP on June 13. Fire emissions were probably a significant contributing factor to the high O_3 along the urban corridor.