Where does the high springtime ozone in the Southwest come from?

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NOAA ESRL Global Monitoring Annual Conference 2018
Surface ozone often exceeds the NAAQS in parts of the rural West during late spring and early summer.

Jean O₃ monitor
35 km SW of Las Vegas
300 km NE of Los Angeles

Jean, Clark County, NV

Daily max 8-h ozone (MDA8)
Las Vegas Ozone Study (LVOS)

May 19 - June 29, 2013

TOPAZ lidar and *in situ* CO and O₃ on Angel Peak
45 km NW of Las Vegas at 2.7 km asl (8680 ft)

NAAQS exceeded in the Las Vegas Valley after high O₃ layers pass over Angel Peak
Fires, Asian, and Stratospheric Transport - Las Vegas Ozone Study (FAST-LVOS)

May 17 - June 30, 2017

Angel Peak
NOAA/ESRL/CSD mobile lab
(O₃, CO, CO₂, CH₄, NO, NO₂, NOₓ, N₂O, H₂O)

*Joe Neal
NOAA/ESRL/GMD ozonesondes

*NLVA-Jean-Barstow-Big Bear
Scientific Aviation Mooney (O₃, NO₂, CH₄, C₂H₆, H₂O)

*NLVA
NOAA/ESRL/CSD
TOPAZ lidar
Doppler lidar
CCDAQ profiler

*IOPs only

(O₃, T, RH, winds)

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Fires, Asian, and Stratospheric Transport - Las Vegas Ozone Study (FAST-LVOS)

GMAC 2018 AOL 4 of 9
**FAST-LVOS Measurements**  
(May 17 - June 30, 2017)

**TOPAZ (523 hours on 45 days)**

**µ-Doppler lidar (45 days)**

**Scientific Aviation**  
(90 hours/14 days)

**Ozonesondes (30 sondes/14 days)**

**Angel Peak in situ (41 days, 6 mobile)**

6 hour flight plan

ML up to 5 km!  
CSD

270 ppbv!  
GMD

**G. Kirgis**

**SA**
Example 1: Entrainment of Holcomb Fire plume

June 22, 2017

AirNow NOAA HYSPLIT -24 h

1000 PDT AP
Holcomb Fire

1800 PDT AP
Holcomb Fire

2.7 ± 0.5 km ASL

TOPAZ

Ozone 70-80 ppbv

Angel Peak

No visible smoke!

1503 acres near Big Bear: June 19 - July 13, 2017
Mixed layer captures O₃/CH₄-rich pollution plume transported over Sierra Nevada
Example 3: Entrainment of deep *Stratospheric* intrusion

Entrainment of UTLs air increased surface ozone to \(\approx 60-65\) ppbv in the Las Vegas Valley.

**June 11-12, 2017**

*GMAC 2018 AOL 08 of 9 (24 of 60 hours shown)*

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**Ozone sondes**

Wind-driven mixing

**GMD ozonesondes**

Ozonesondes have greater range and also measure T, RH, and winds

**In situ measurements**

Scientific Aviation flight track (flight cut short because of winds)
Summary

• Entrainment of transported $O_3$ (fires, Asian, CA, STT) directly observed.

• Deep mixed mixed layers entrain transport layers and vent locally produced $O_3$.

• Stratospheric intrusions can indirectly cause high surface $O_3$ by capping ML.