California Environmental Protection Agency
Air Resources Board

PQAO Training 2017

California Baseline Ozone Transport Study (CABOTS)

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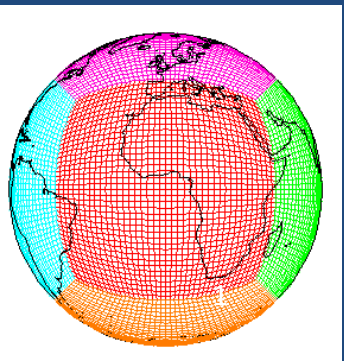
Participants:

ARB, NOAA, SJSU, UCD, NASA, US EPA, SJVAPCD, BAAQMD, USFS







Outline

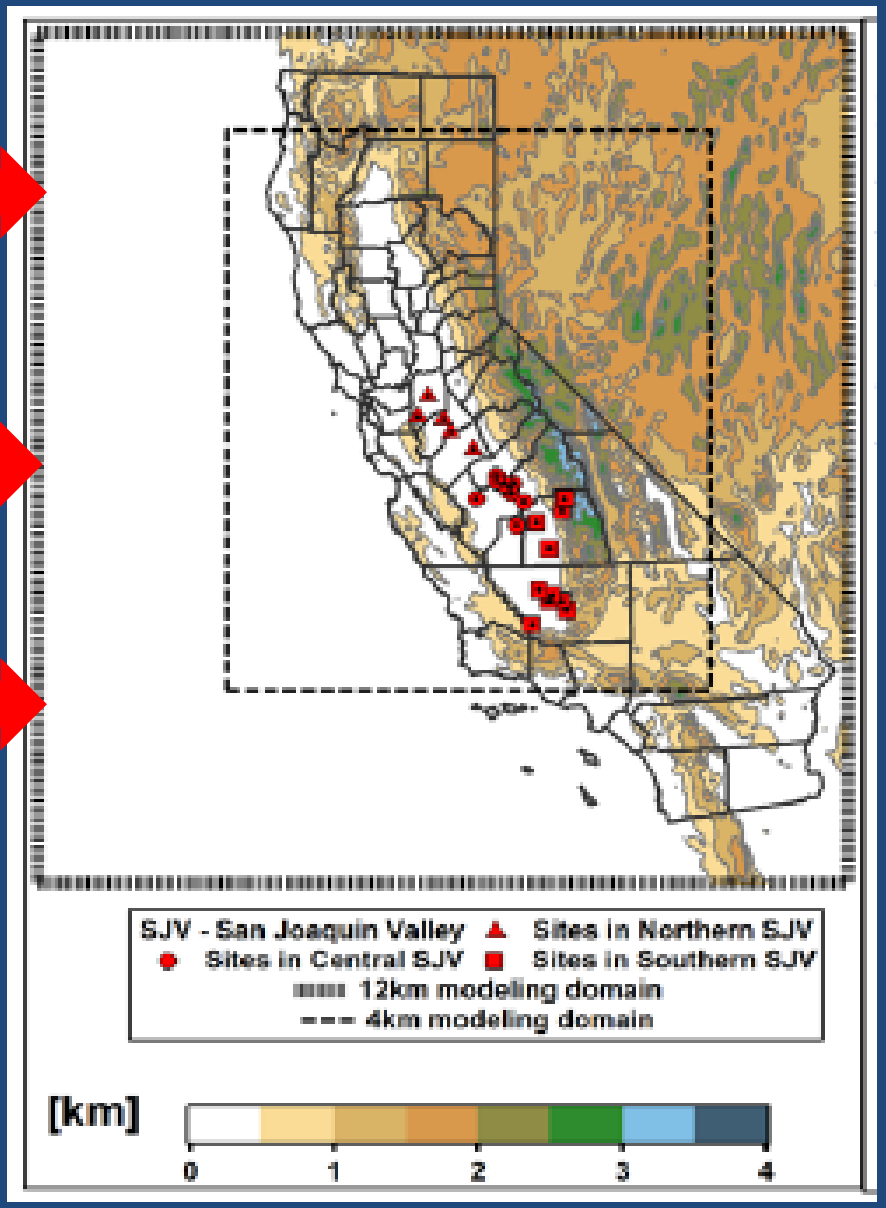
- Introduction
- Field Measurements
- Preliminary Results
- What's Next

Introduction: Background and Baseline Ozone

- U.S. Background O_3 (EPA) - Modeled
  - Ozone formed from sources or processes other than U.S. manmade emissions of NOx, VOC, CH4, and CO.
- Baseline O_3 (TF HTAP) - Measured
  - Observed ozone at a site when it is not influenced by recent, locally emitted or produced anthropogenic pollution
- Sources of Background/Baseline Ozone
  - Natural sources (e.g. stratospheric intrusion, lightning, wildfire)
  - Long-range Transboundary Air Pollution

Introduction:

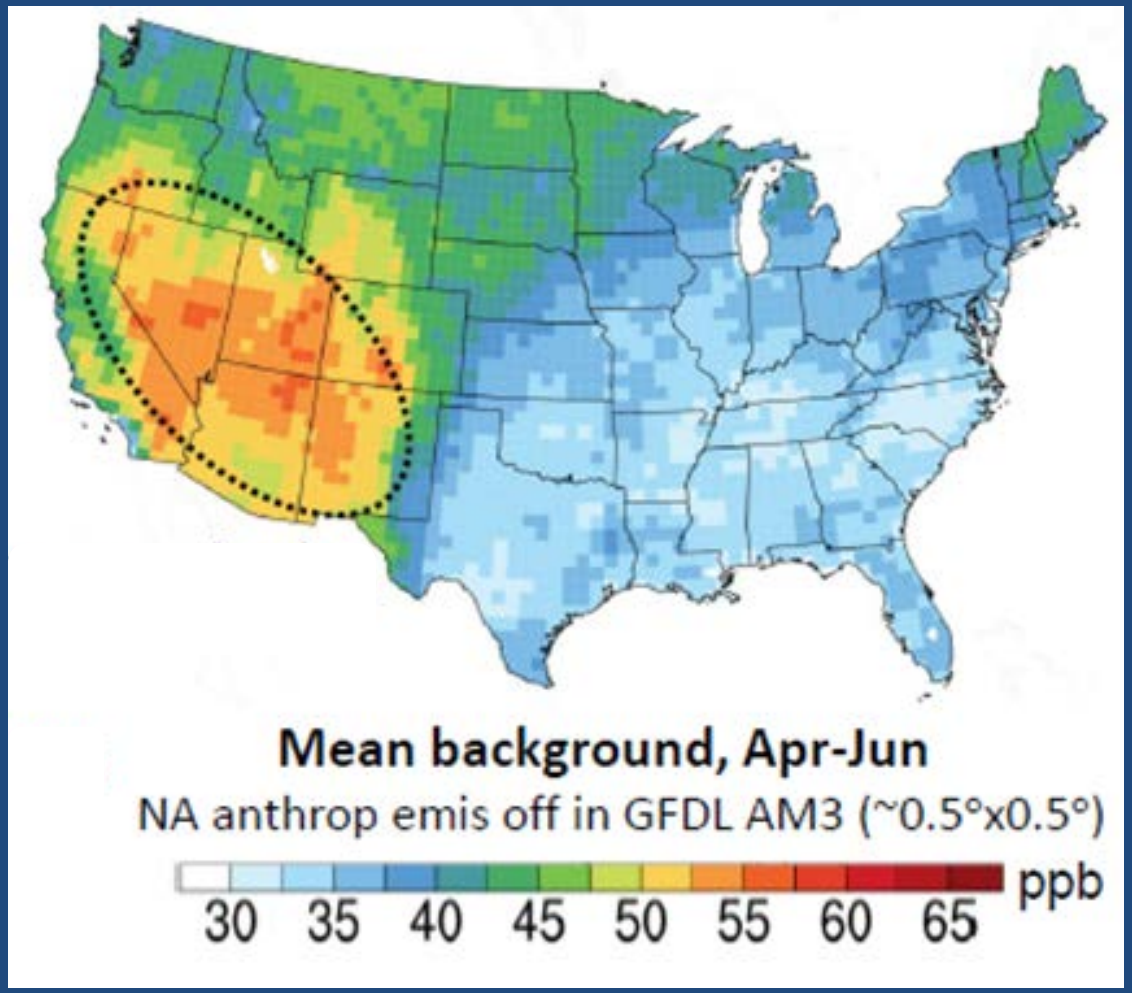
Boundary Conditions for Ozone modeling in California



- Chemical boundary conditions for the outer 12 km domain were extracted from the global chemical transport model MOZART-4.

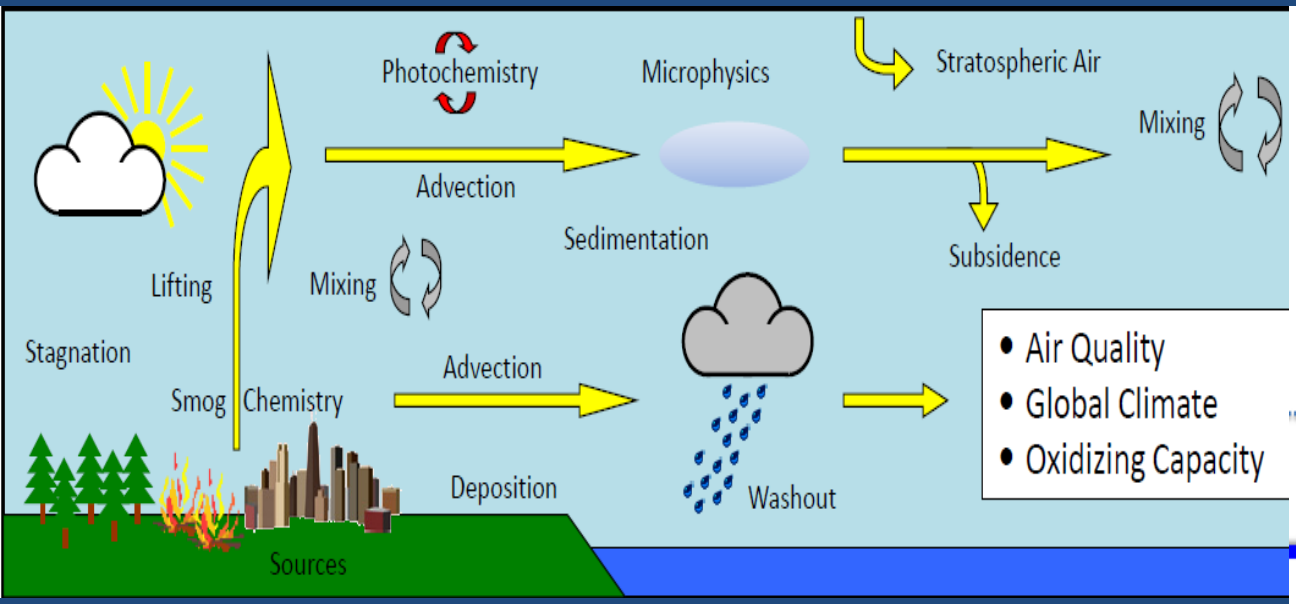
- Western Boundary Conditions – Baseline Ozone – Background Ozone

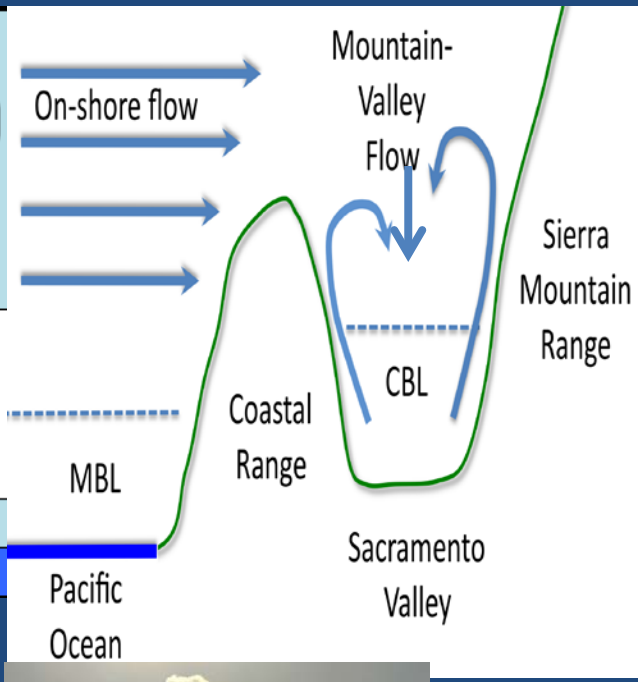
Introduction:
The Importance of Background Ozone in the Western US



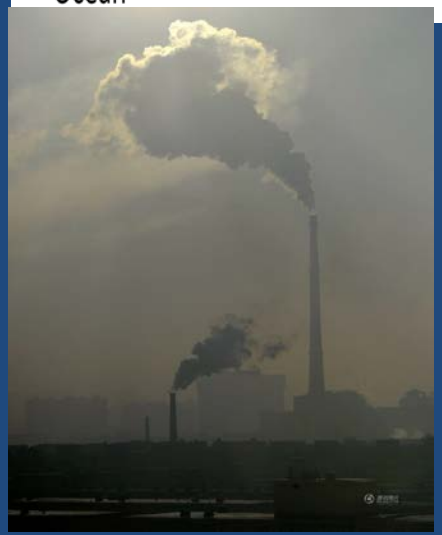
Lin, M., Transboundary Ozone Pollution Conference, April 2015

Introduction:
The Importance of 3-Dimensional Data





- Baseline ozone concentrations coming ashore to California increase with altitude in lower few km
- Transport of baseline ozone (e.g. winds change with height)
- Downward mixing of ozone aloft

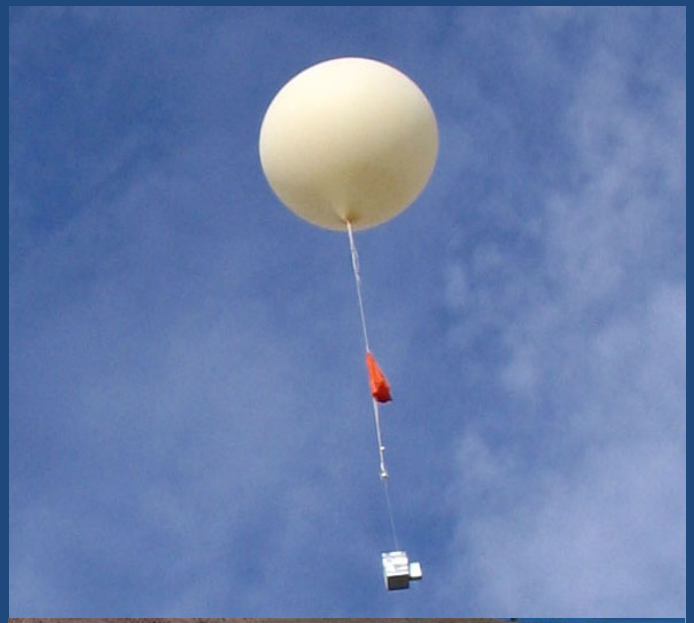


Objectives of CABOTS

- Data to better understand the content and daily variability of ozone vertical profiles as they enter the State from the Pacific ocean, and to evaluate how well global models reproduce boundary conditions used in our regional SIP modeling.
  - Contract #15RD007 with SJSU (PI: Professor Sen Chiao)
- Understand to what extent does baseline ozone (long-range transboundary and stratospheric ozone) aloft mix down to surface sites in the SJV and what is the impact.
  - Contract #15RD012 with NOAA (PIs: Drs. Andrew O. Langford and Christoph J. Senff)

SJSU Ozonesondes at Bodega Bay

- Near daily ozonesondes mid-May – mid Aug
- Products:
  - Baseline ozone
  - To validate modeled boundary conditions
  - To link with ozone measured in the SJV
- US EPA & BAAQMD fund 2nd sonde site at Half Moon Bay starting from mid July



Ozonesonde Measurements

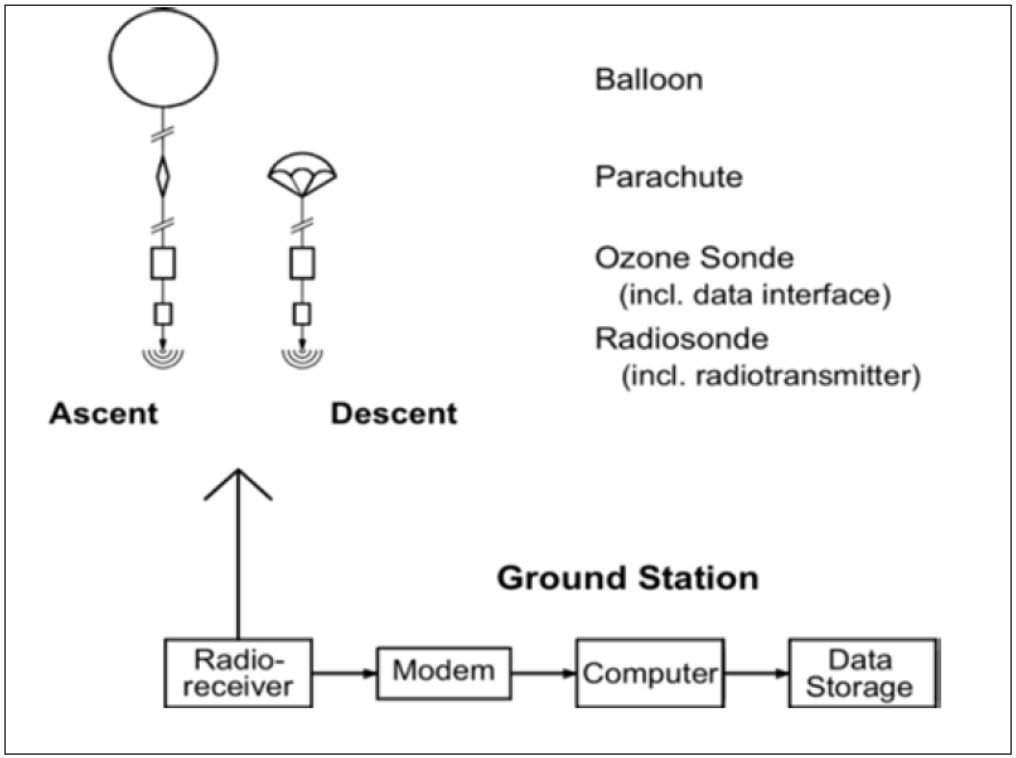
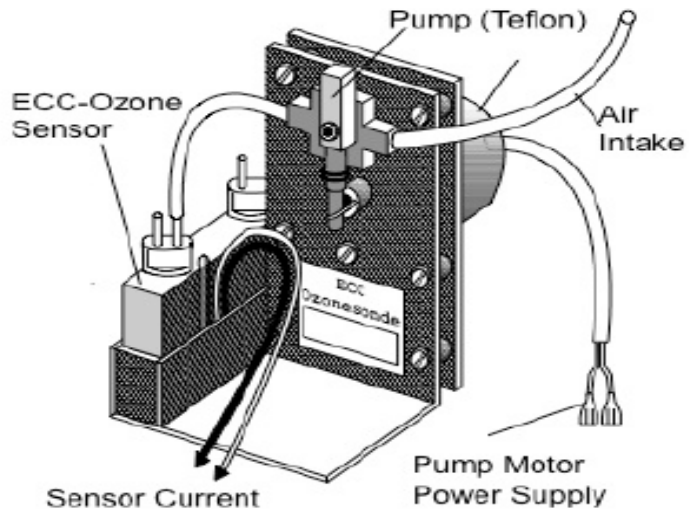


Figure 2: Set up of an ozone sounding system

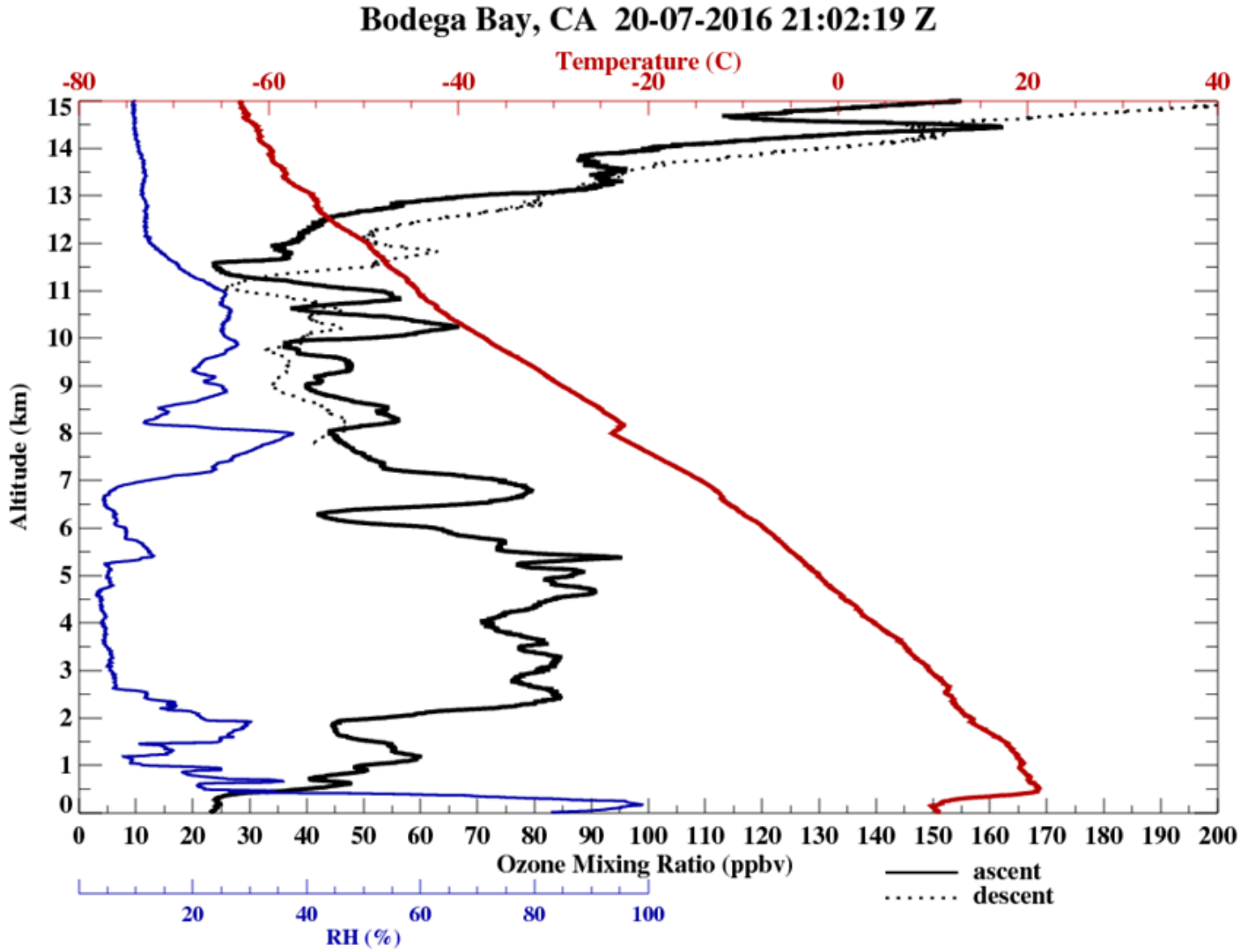
$2KI + O_3 + H_2O \rightarrow I_2 + O_2 + 2KOH$

I_2 is converted back to I^- at the cathode



- Ozonesonde is a balloon-borne instrument that measure ozone concentrations, T, RH, WS and WD, from the ground up to ~40 km.
- Ozone concentrations are obtained using electrochemical concentration cell (ECC) with typical uncertainty < ± 10%.

Example of Ozonesonde Profile



Ozonesonde Launch Summary

- Bodega Bay (5/6-8/17)
  - 86 total ozonesondes were launched
  - 80 total with data to at least 9 km
- Half Moon Bay (7/15-8/17)
  - 24 ozonesondes
- Ozonesonde measurement was compared with the surface ozone monitor before launching for quality assurance purpose.
  - Average difference is 1.4 ppb.

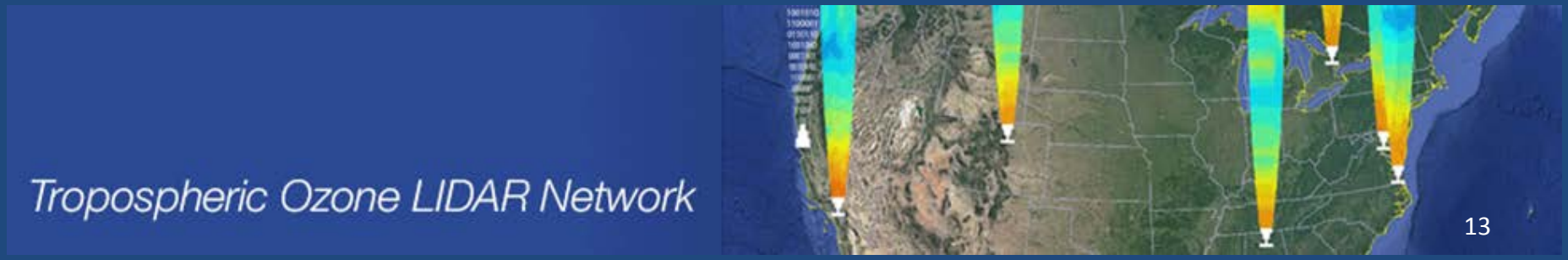
NOAA TOPAZ Ozone Lidar at Visalia Airport

- Collocated with SJVAPCD wind profiler
- Deployments: May 29 – June 18 and July 18 – Aug 7
- More than 8 hours per day continuous ozone vertical profile
- Products:
  - Continuous O_3 and aerosol vertical profiles to investigate the horizontal and vertical transport

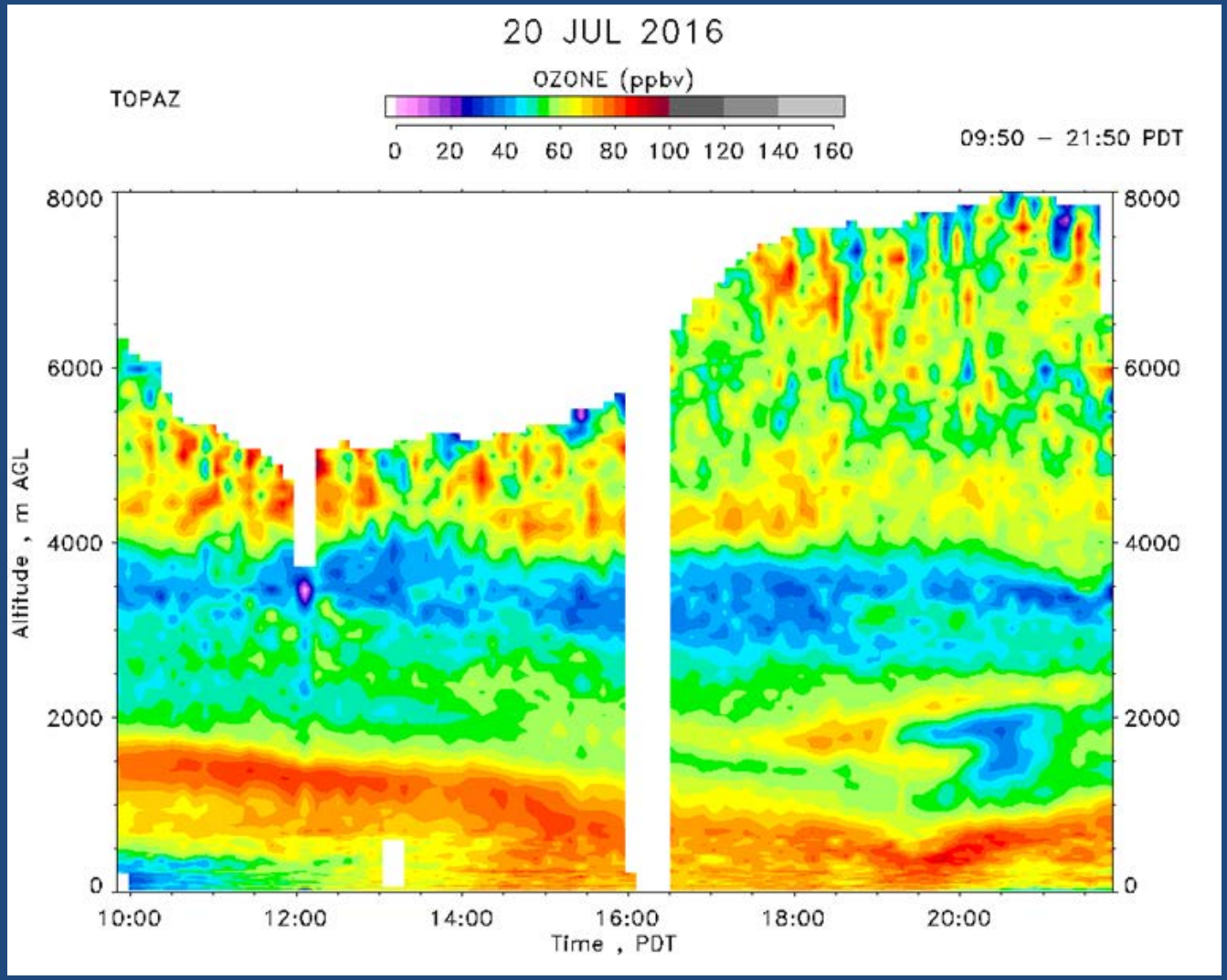
NOAA TOPAZ Ozone Lidar

- Uses a differential absorption lidar (DIAL) to measure ozone and aerosol backscatter profiles
- TOPAZ is part of the NASA Tropospheric Ozone Lidar Network (TOLNet) - ground-based profiling of tropospheric ozone.
- May be operated from an airborne platform.

- Deployed in numerous field campaigns such as the CalNex and Las Vegas Ozone Study (LVOS)



Example of TOPAZ Lidar Ozone Profile



- Accuracy: 5 – 15% (depends on range, signal-to-noise ratio, and ozone concentration)

Other Related Work

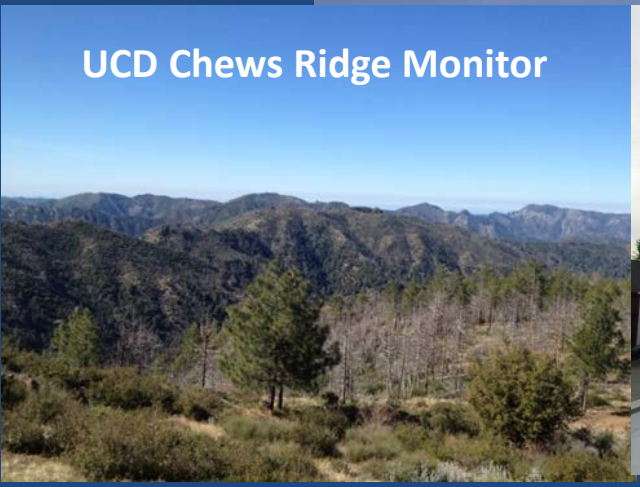
ARB APOB Flights

UCD Residual Layer Ozone Contract

NASA Ames – AJAX Program

NASA SARP flights

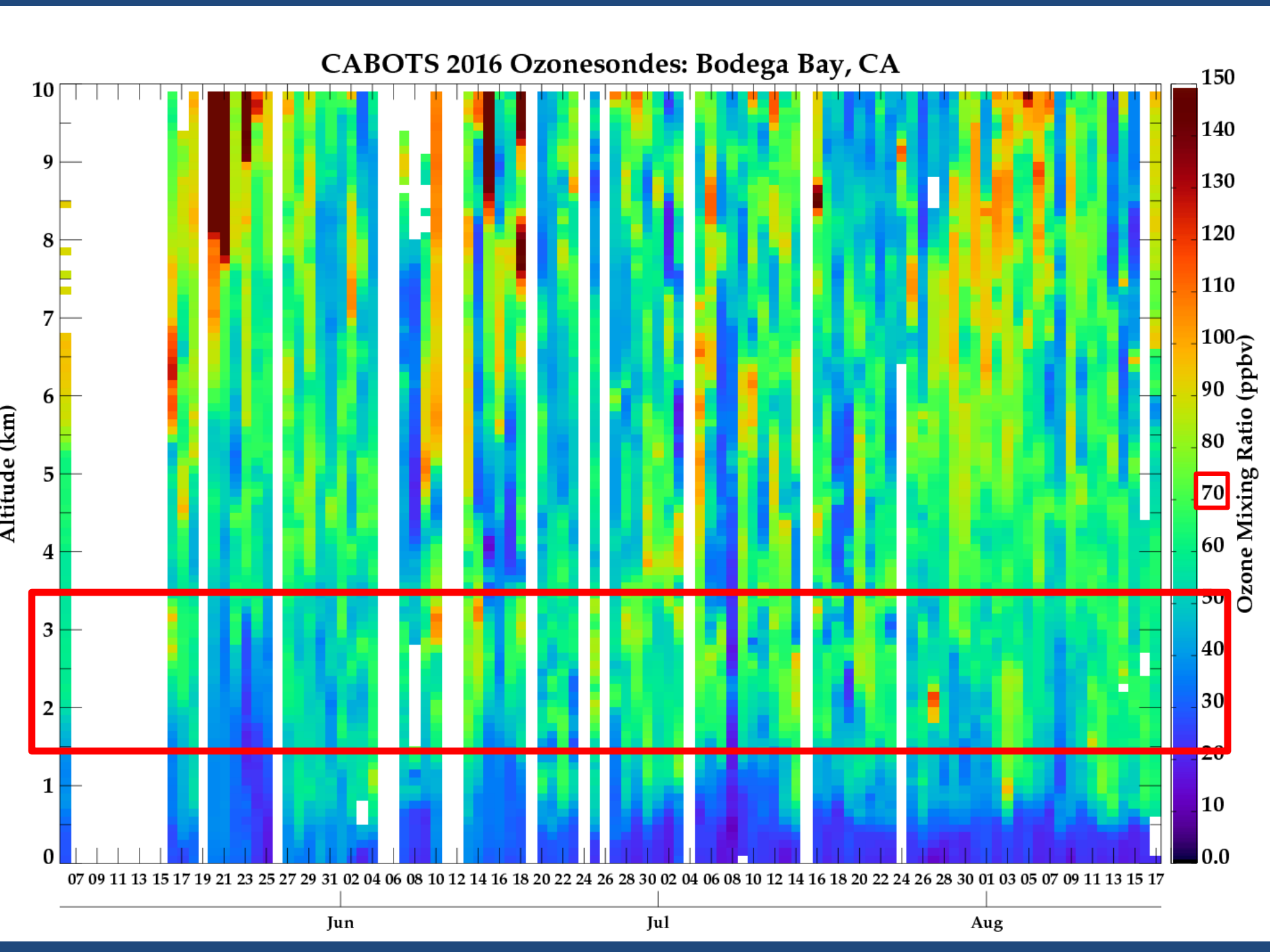
UCD Chews Ridge Monitor



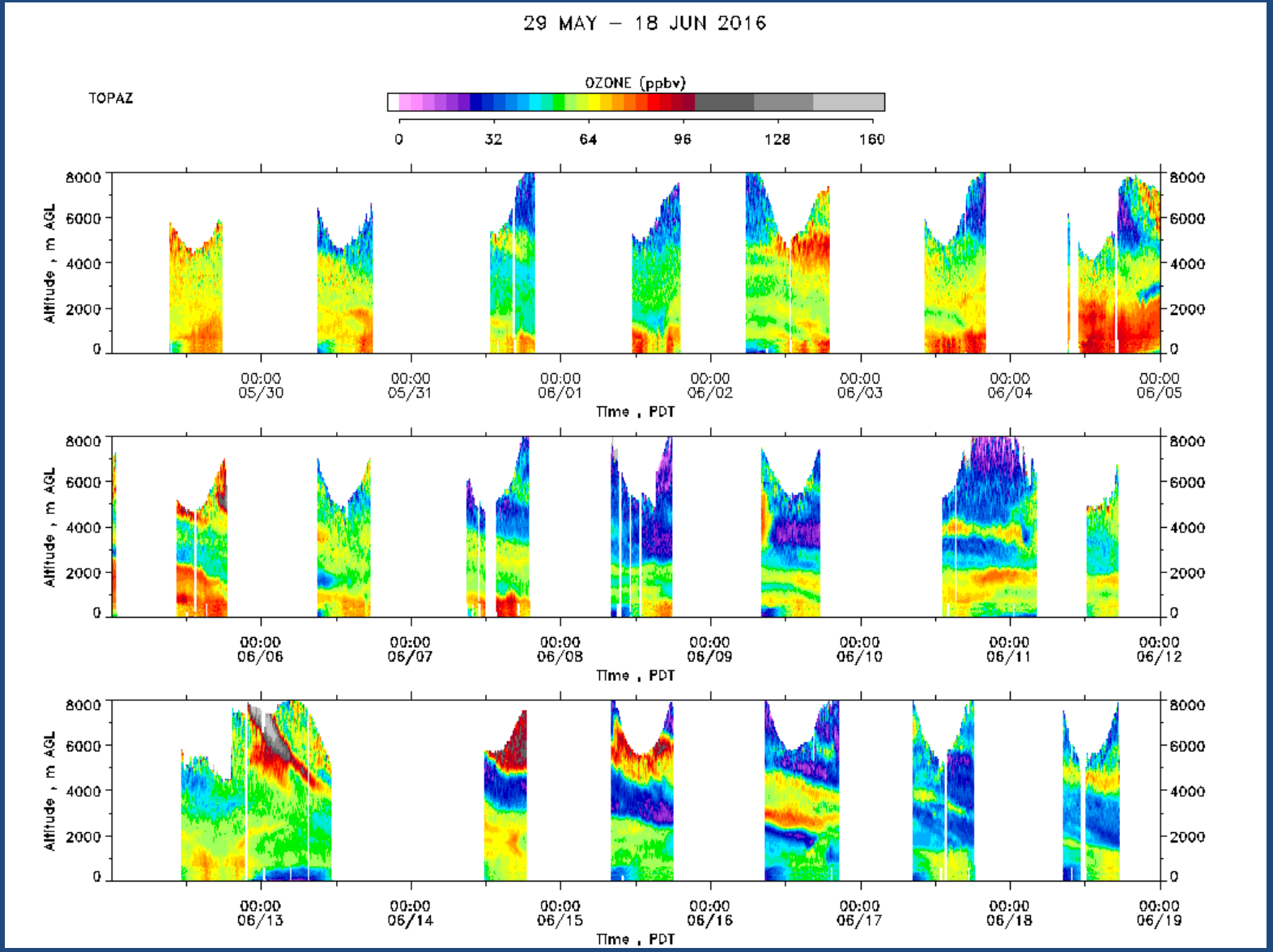
Routine Ozone Monitoring Sites

USFS Ozone Monitors in the Sierra

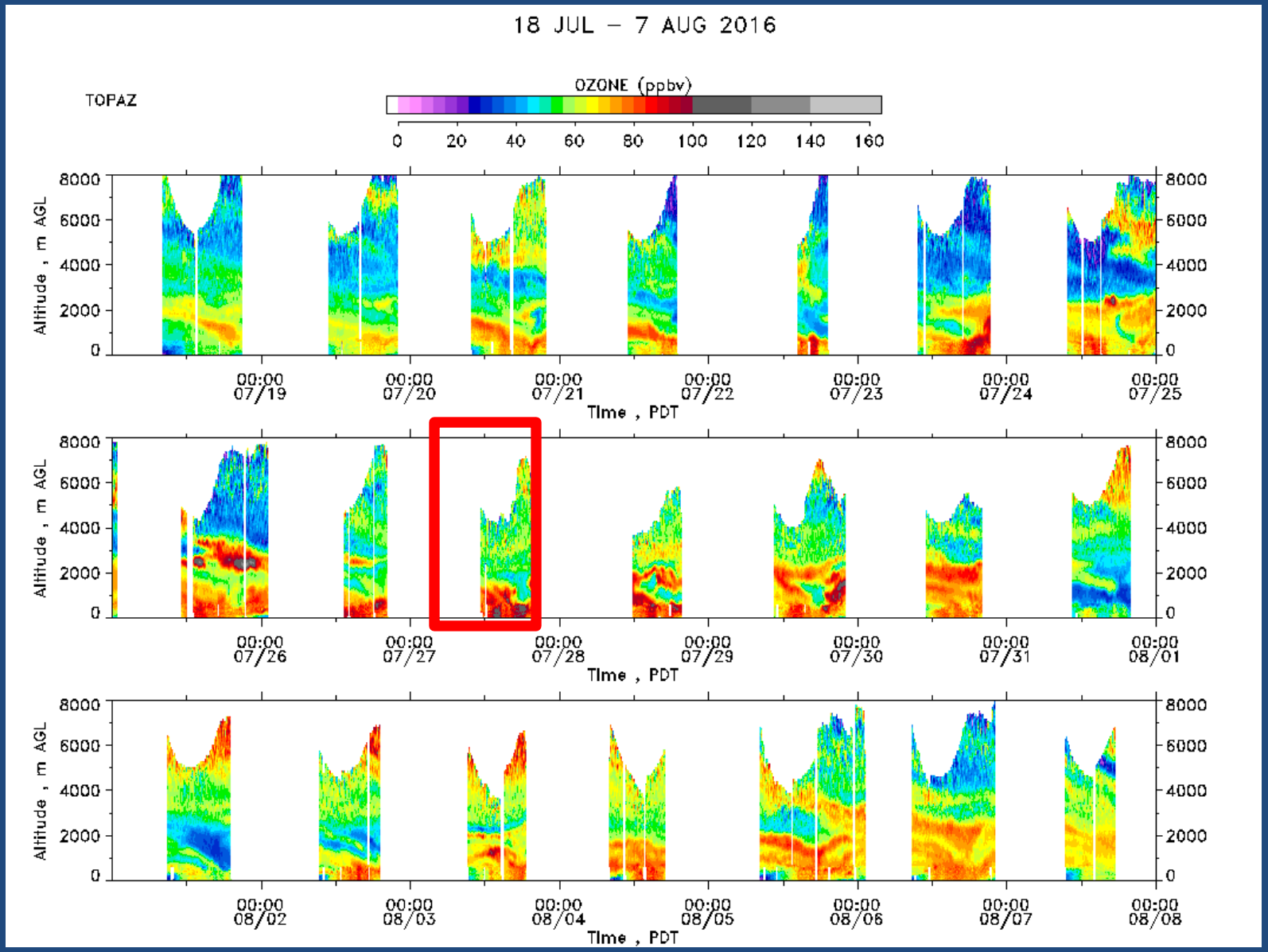
CABOTS Field Campaign Sites


CABOTS 2016 Ozonesondes: Bodega Bay, CA
Altitude (km)
0
1
2
3
4
5
6
7
8
9
10
07 09 11 13 15 17 19 21 23 25 27 29 31 02 04 06 08 10 12 14 16 18 20 22 24 26 28 30 02 04 06 08 10 12 14 16 18 20 22 24 26 28 30 01 03 05 07 09 11 13 15 17
Jun
Jul
Aug
Ozone Mixing Ratio (ppbv)
150
140
130
120
110
100
90
80
70
60
40
30
10
0.0

Ozone Lidar Profiles at Visalia Airport Spring 2016



Ozone Lidar Profiles at Visalia Airport Summer 2016



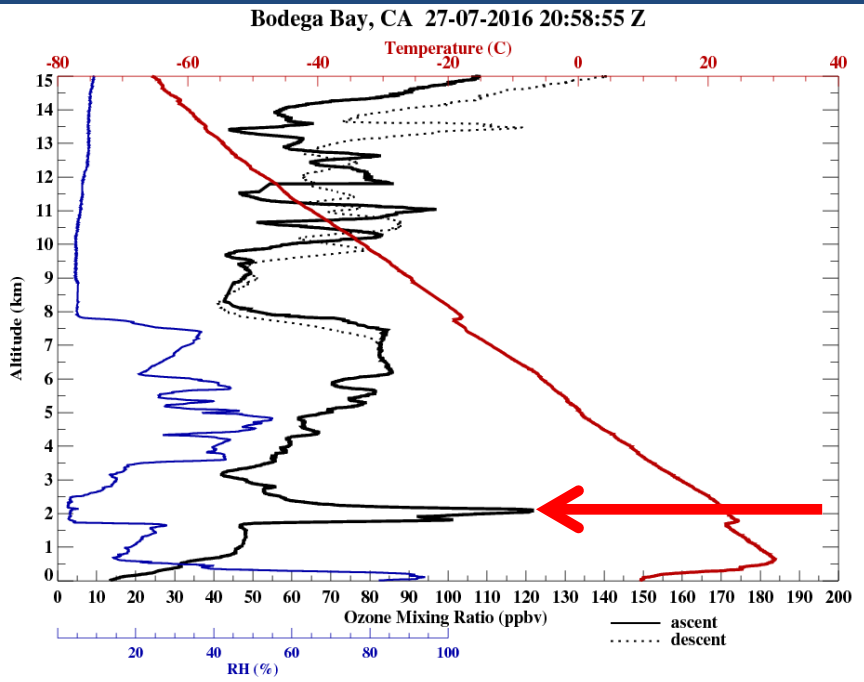
Impact of Wildfires on Ozone
- Soberanes Fire (July 22- October 15, 2016)

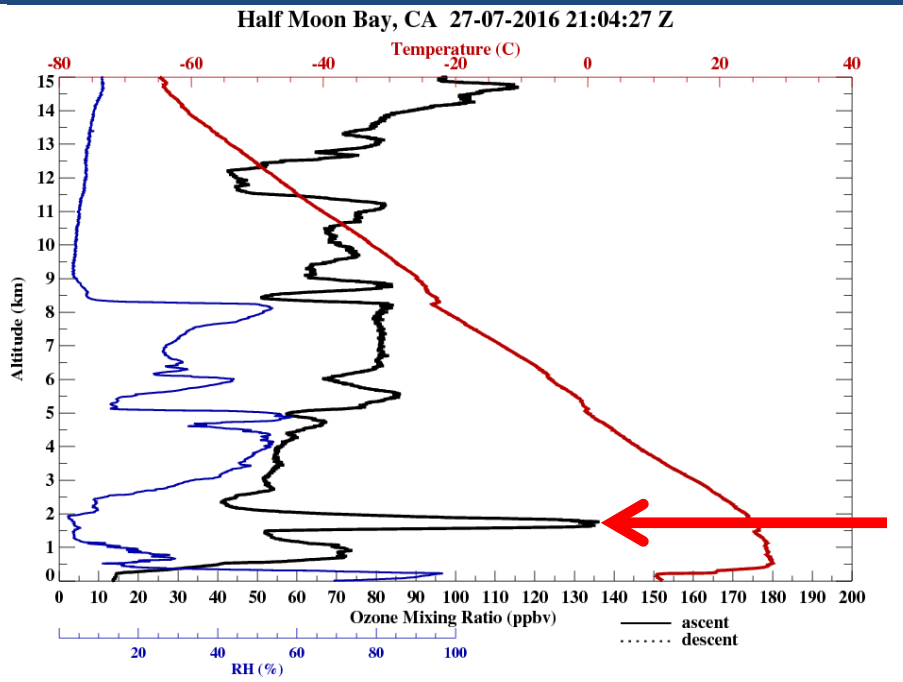
MODIS True Color: 29-July

Landsat OLI: 16-Sept

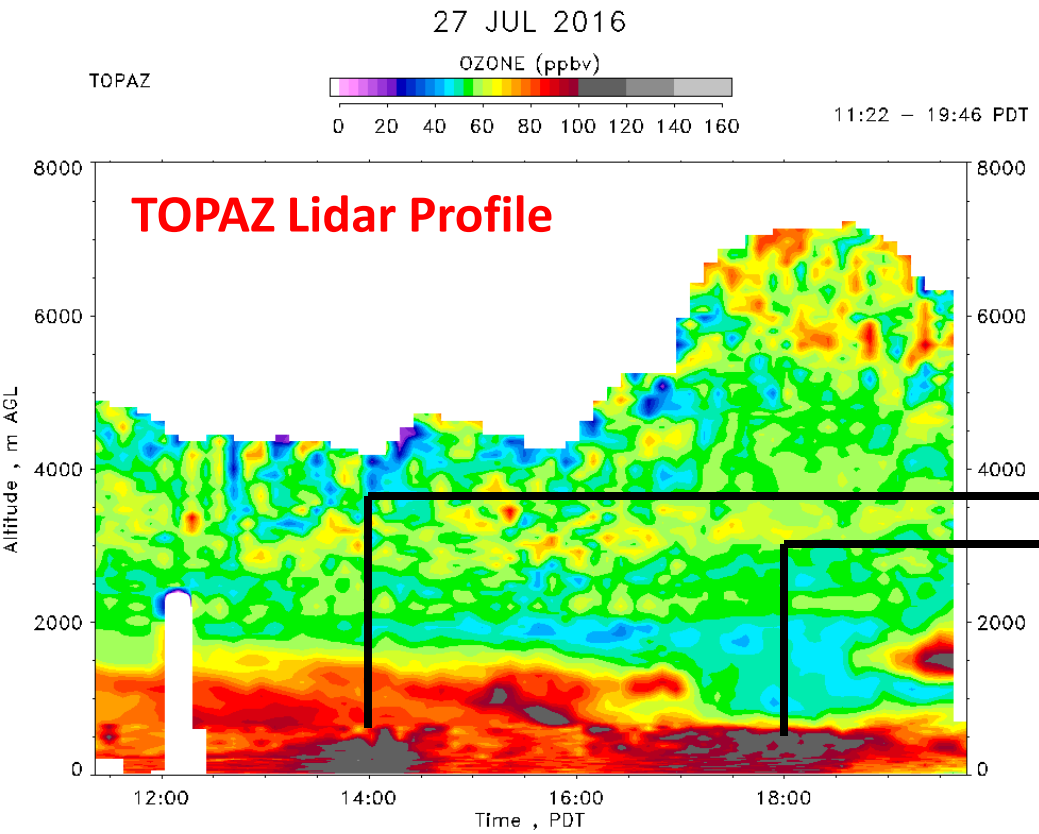
Smoke Plumes from the Soberanes Fire

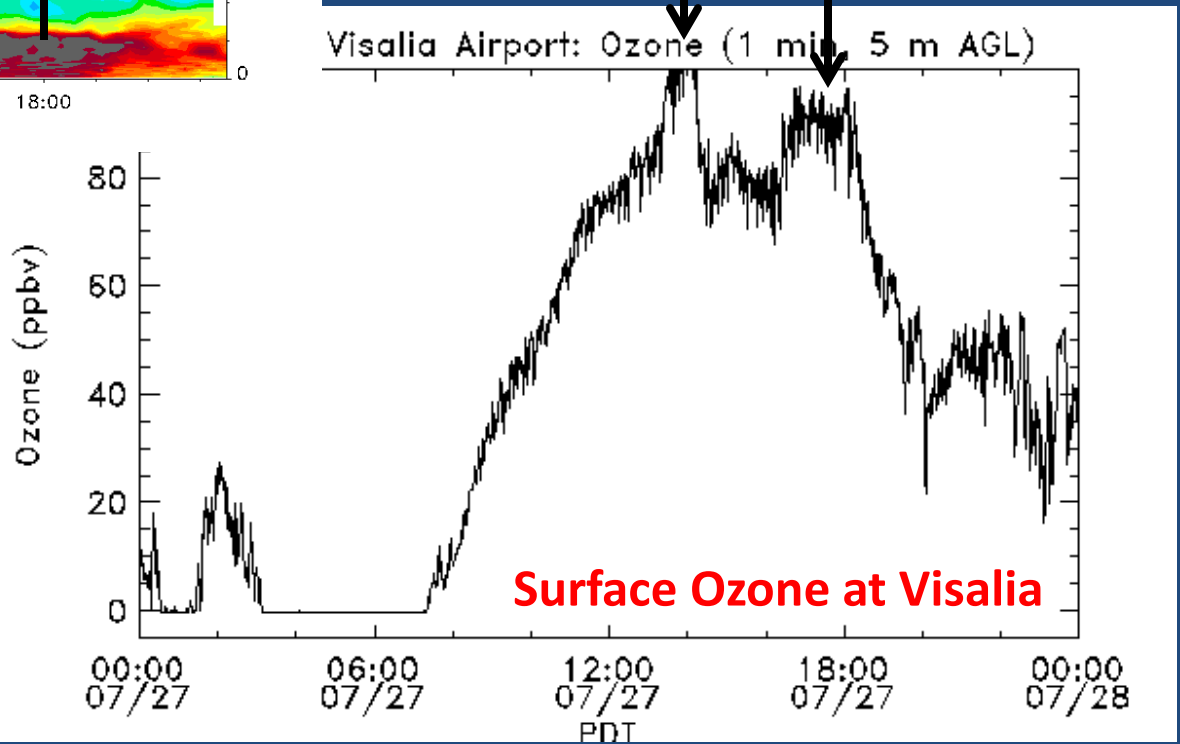
Ozonesonde Profiles at Bodega Bay and Half Moon Bay





Entrainment of Ozone From Aloft





Next Steps

- Data QA/QC and delivery from the PIs
- Detailed analysis and inter-comparison of data from different platforms; Develop conceptual model relating meteorology, emissions and air quality
- Compare measurements with modeling results; Evaluate and improve ozone boundary conditions (BCs) for air quality modeling