Ozone Transport and Mixing Processes in the Boundary Layer Observed with Lidar during Discover-AQ


- Motivation & instrument description
- DAQ Houston 25 Sep 2013: vertical mixing, sea breeze
- DAQ Colorado 8 Aug 2014: thunderstorm outflow
- Summary
**DiscoverAQ objective:**

Characterize *relationship between surface and column observations of AQ-relevant trace gases and aerosols*

→ Understand the processes controlling their vertical distribution and diurnal variation, especially in the highly variable BL.

BL structure & mixing

**Lidar** is ideal tool to study these processes because of its continuous profiling capabilities.
NOAA TOPAZ Ozone Lidar at Discover AQ

- Characterize the distribution of ozone in the lower atmosphere and study the processes responsible for the observed $O_3$ structure

DAQ Houston 2013, La Porte Airport
29 Aug – 27 Sep 2013, ~140 hours

Photo credit: Scott Sandberg

DAQ Colorado 2014/FRAPPE, BAO Tower
9 Jul – 18 Aug 2014, ~240 hours

Photo credit: Andy Langford

Tropospheric Ozone Lidar Network (www-air.larc.nasa.gov/missions/TOLNet/)
NOAA TOPAZ Ozone Lidar

(TOPAZ = Tunable Optical Profiler for Aerosol and OZone)

- Tunable UV ozone differential absorption lidar (DIAL)
- Ozone and aerosol backscatter profiles from ~15 m up to 3 km AGL

Scan Strategy:
- 2°
- 6°
- 20°
- 90°

Composite vertical profiles every 5 min
TOPAZ Ozone Lidar at DAQ Houston

- La Porte Airport
- 29 Aug – 27 Sep 2013

Photo credit: Scott Sandberg
Evolution of O$_3$, aerosol, and mixing height on 25 Sep 2013

P3 obs from Deer Park spiral
Wind profiler 12-hour back trajectories from La Porte Airport on 25 Sep 2013 16:00 CDT
Wind profiler 12-hour back trajectories from La Porte Airport on 25 Sep 2013 20:00 CDT
Surface vs. column O₃: 25 Sep 2013

LaPorte Airport, TX

TOPAZ

OZONE (ppbv)

0 30 60 90 120 150

0 500 1000 1500

0 2000

Altitude, m AGL

08:00 10:00 12:00 14:00 16:00 18:00

Time, CDT

0 200 400 600 800 1000 1200 1400

OZONE, ppbv

0 20 40 60 80 100 120 140

08:00 10:00 12:00 14:00 16:00 18:00

Time, CDT

surface (22 m)

22 - 1500 m average
TOPAZ Ozone Lidar at DAQ Colorado / FRAPPE

- BAO Tower
- 9 Jul – 18 Aug 2014
Evolution of $O_3$, aerosol, and mixing height on 8 Aug 2014

**TOPAZ: Ozone**

**UW HSRL: Aerosol backscatter**

**HRDL: w variance**
HRDL 12-hour back trajectories from BAO

1600 MDT
Ft. Collins
Greeley
Boulder
Denver

8 Aug 2014

Greeley

BAO

Boulder

Denver

1559 MDT

100 – 200 m AGL
200 – 500 m AGL
500 – 1000 m AGL
1000 – 2000 m AGL

TOPAZ

OZONE (ppbv)

0 25 50 75 100 125

BAO Tower

Time, MDT

0 500 1000 1500 2000

Altitude, m AGL
HRDL 12-hour back trajectories from BAO

1700 MDT
Ft. Collins

1703 MDT

BAO
Greeley
Denver

8 Aug 2014
HRDL 12-hour back trajectories from BAO

8 Aug 2014
Surface vs. column $O_3$: 8 Aug 2014

UW HSRL: Aerosol backscatter

TOPAZ: Ozone

Graph showing ozone concentrations over time.
Suppressed vertical mixing and resulting shallow mixing heights, as well as low-level advection of different air masses by the sea breeze or thunderstorm outflows can cause significant vertical gradients of ozone in the lower atmosphere.

Under these circumstances, it would be challenging to infer surface ozone (and other AQ trace gas and aerosol) concentrations from lower-atmosphere column observations.

Future work: Extend column vs surface ozone analysis to include entire data set gathered with TOPAZ ozone lidar during DiscoverAQ