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

C. J. Senff, A. O. Langford, R. J. Alvarez II, A. Choukulkar, Wm. A. Brewer, A. M. Weickmann, G. Kirgis, S. P. Sandberg, R. M. Hardesty, R. Delgado, R. Long, S. S. Brown, E. Olson

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

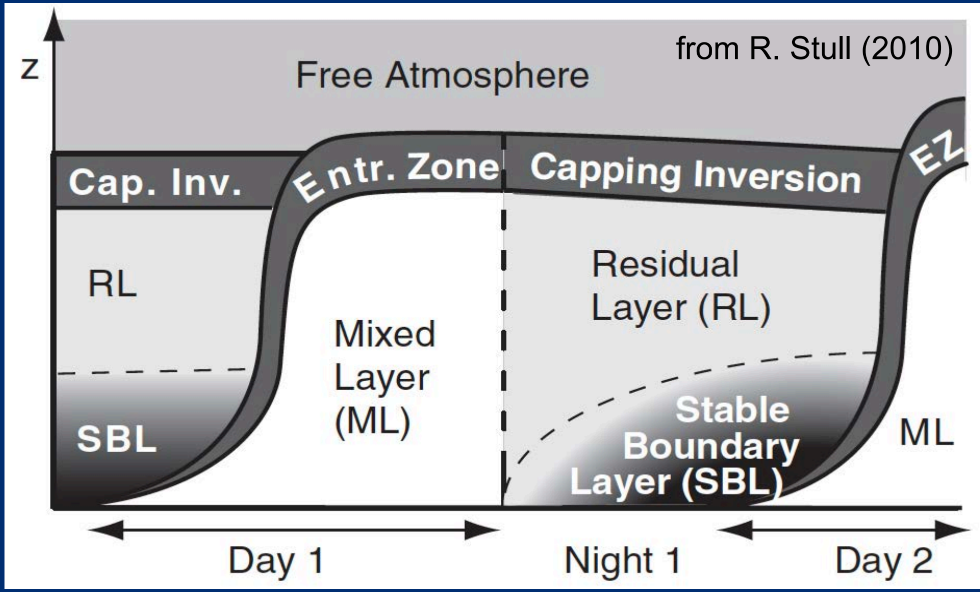
AGU Fall Meeting, 15 Dec 2014

DiscoverAQ objective:

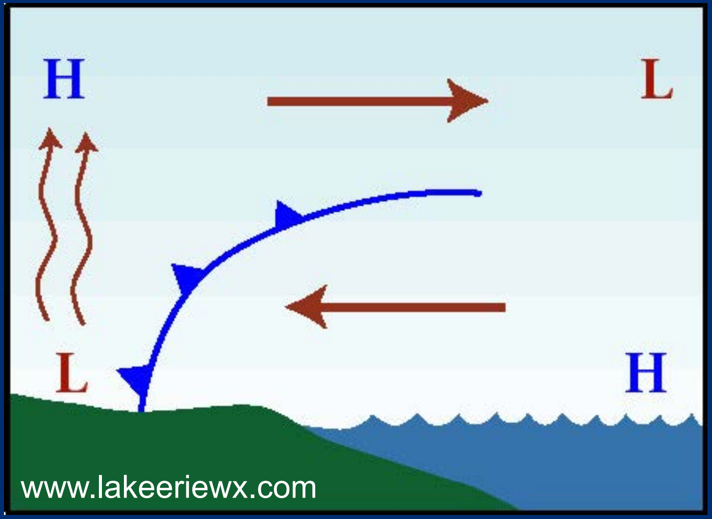
Characterize relationship between surface and column observations of AQ-relevant trace gases and aerosols

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

BL structure & mixing



Horizontal advection
(e.g. sea breeze, tstorm outflow, LLJ)



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

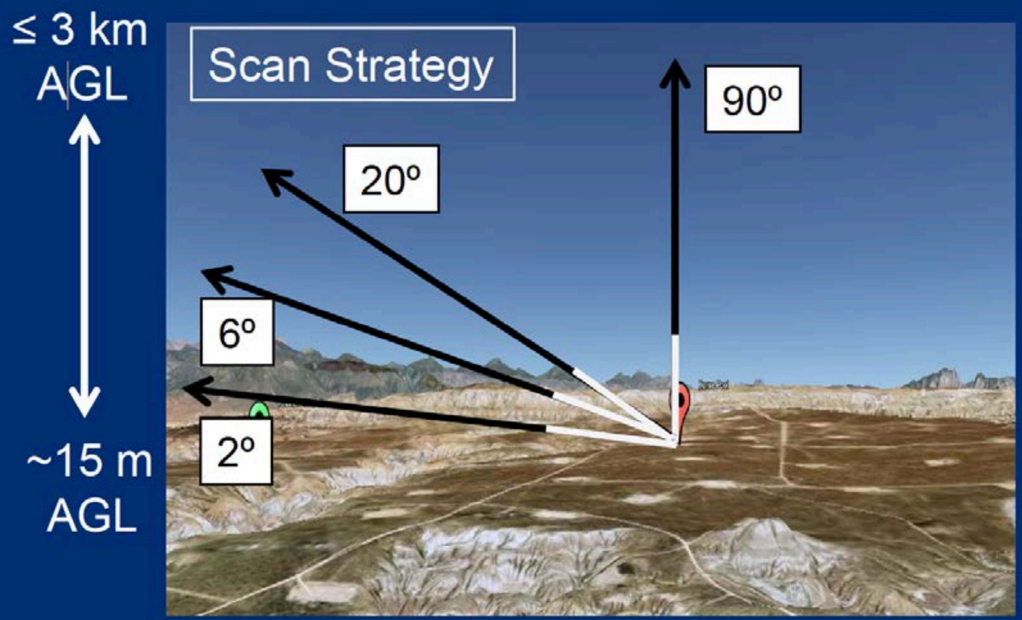
DAQ Colorado 2014/FRAPPE, BAO Tower
9 Jul – 18 Aug 2014, ~240 hours

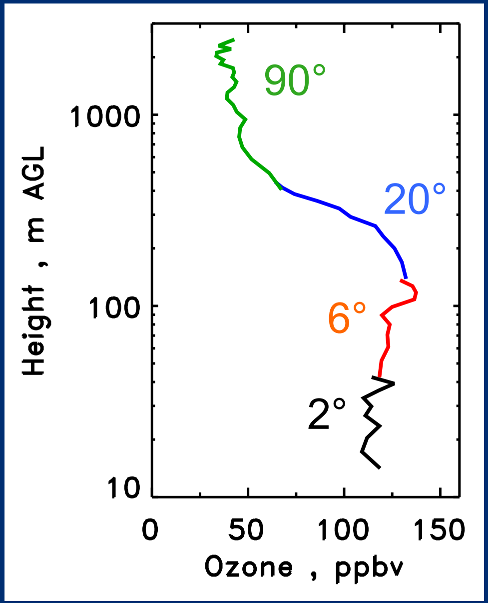
Tropospheric Ozone Lidar Network (www-air.larc.nasa.gov/missions/TOLNet/)

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

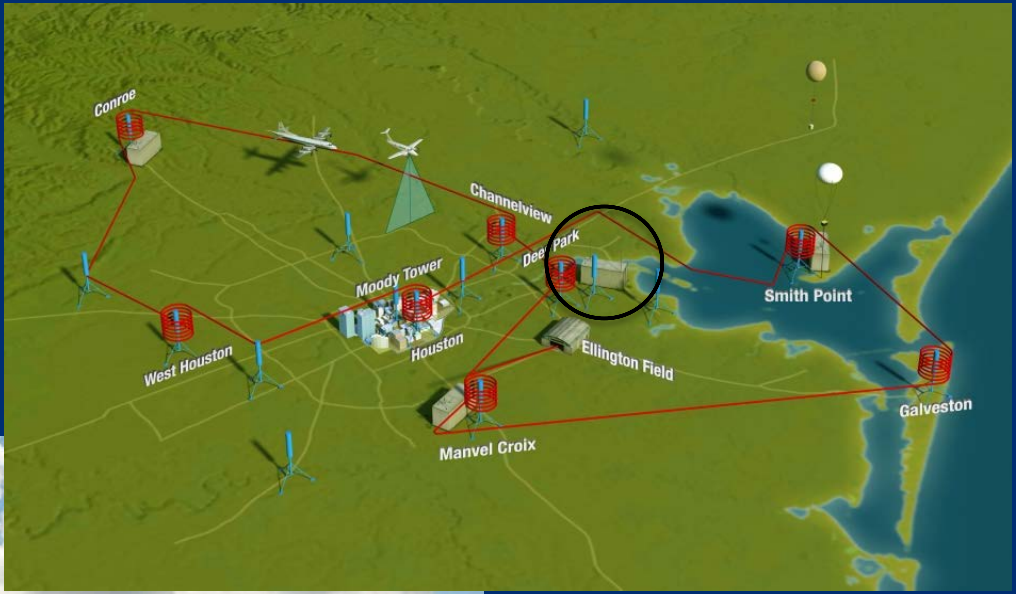


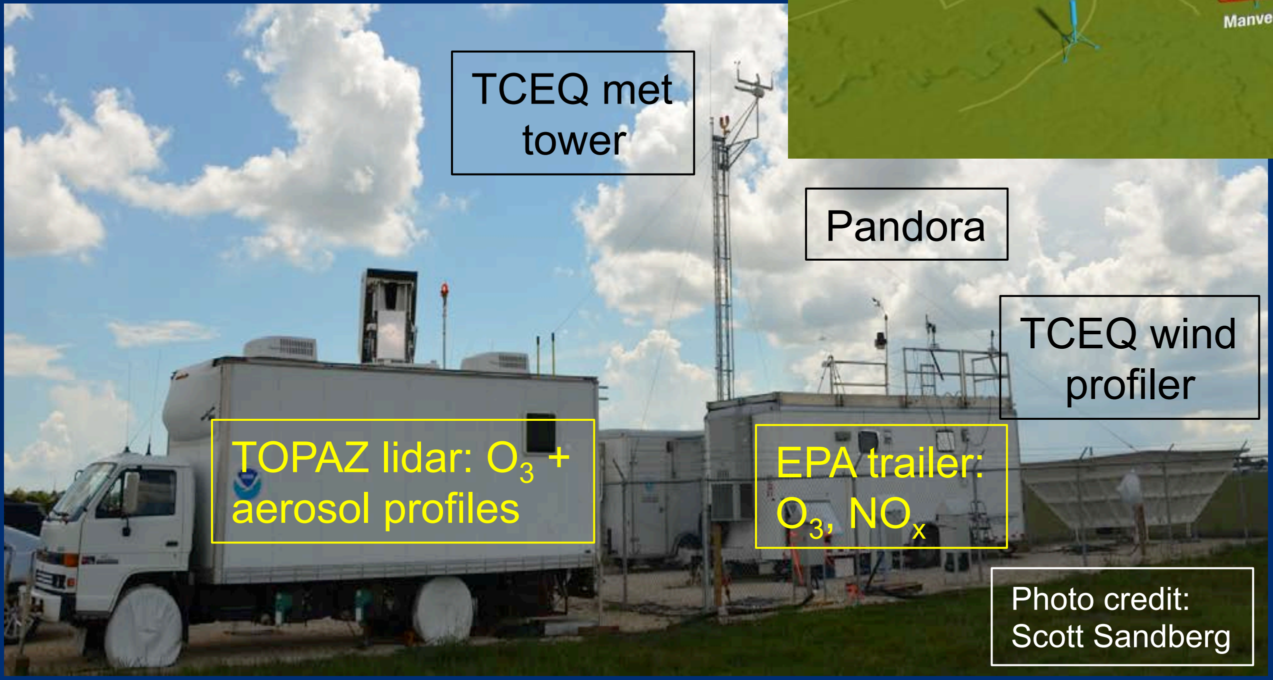


Composite vertical profiles every 5 min

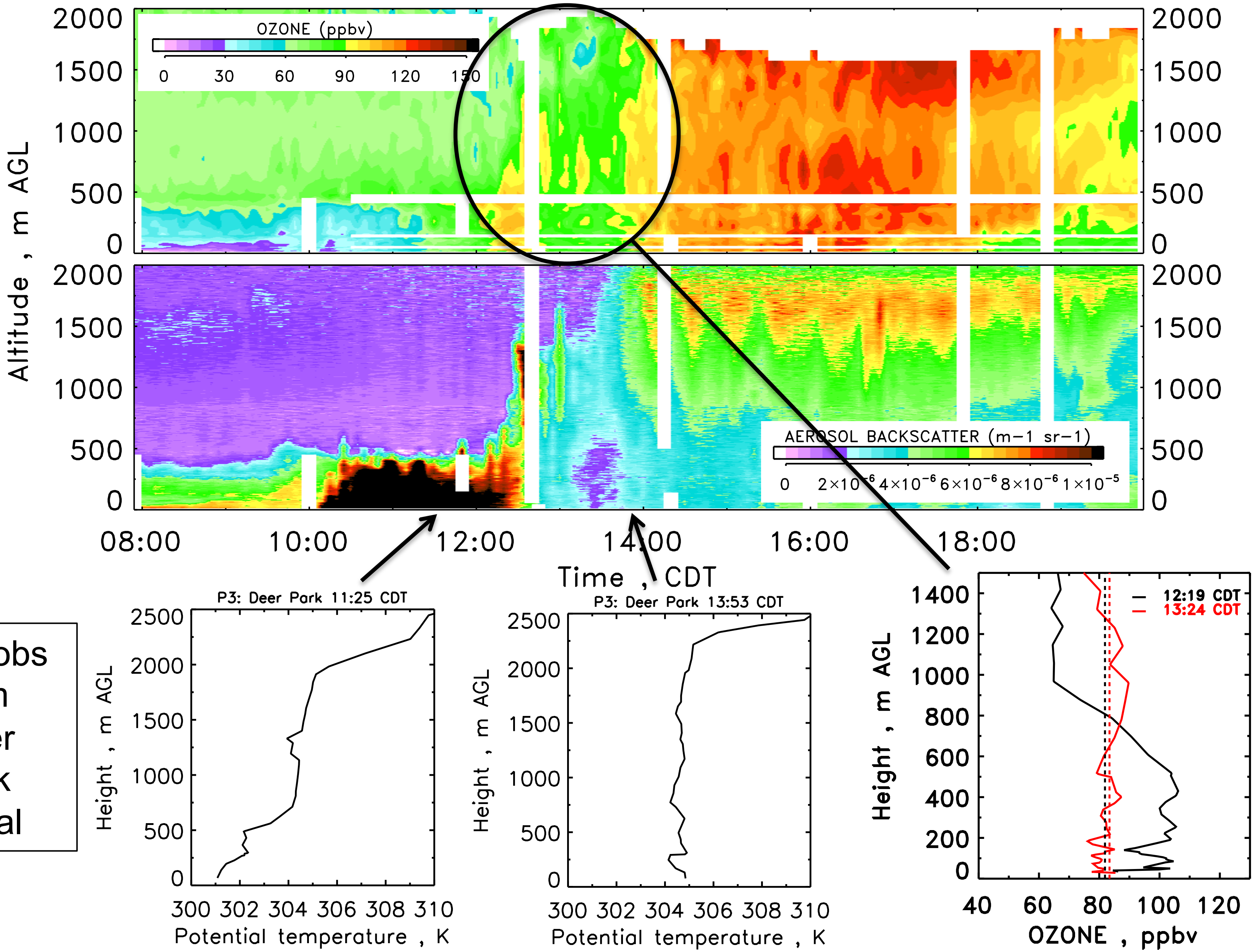
TOPAZ Ozone Lidar at DAQ Houston

- La Porte Airport
- 29 Aug – 27 Sep 2013



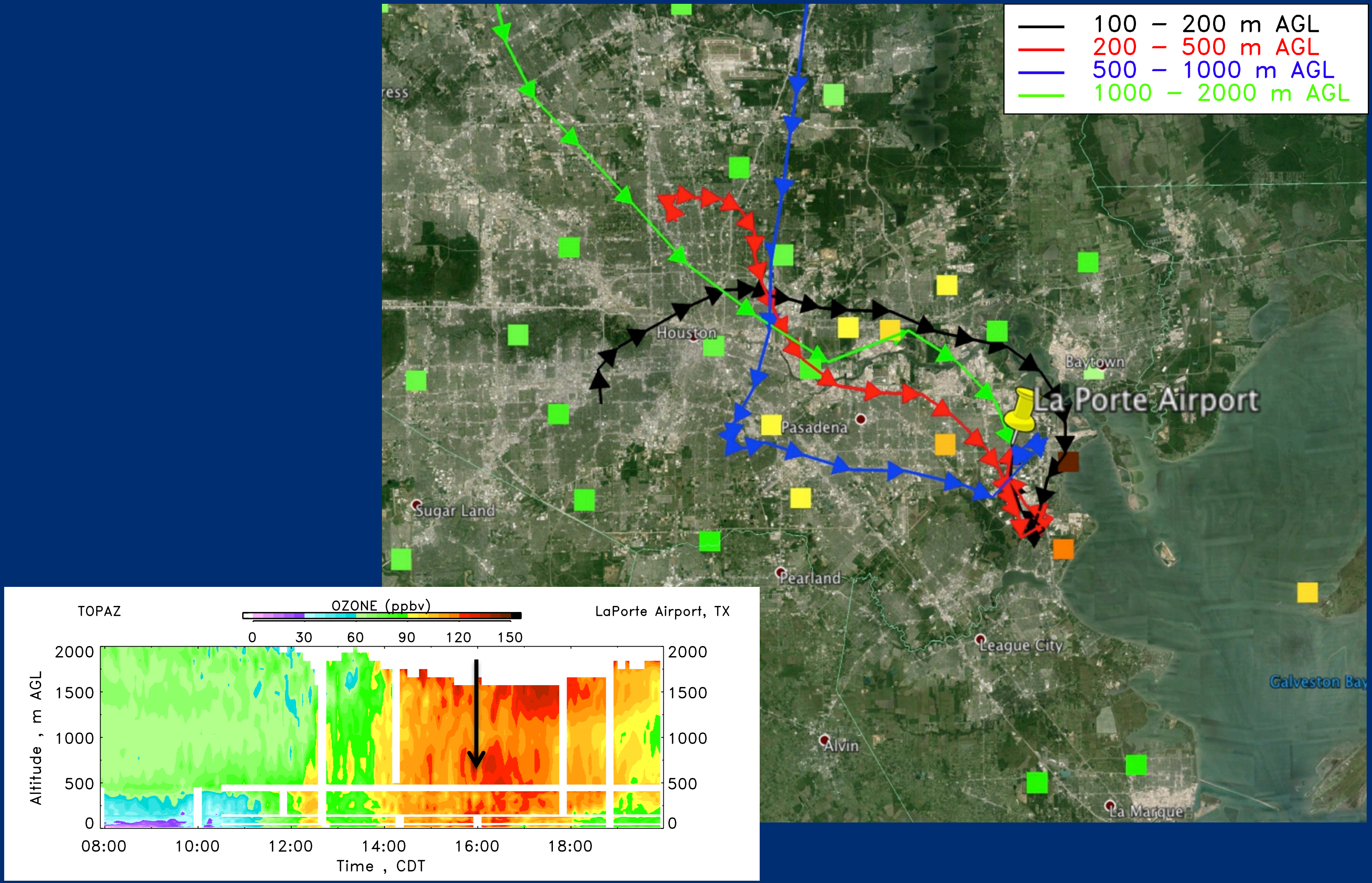


Evolution of O_3, aerosol, and mixing height on 25 Sep 2013

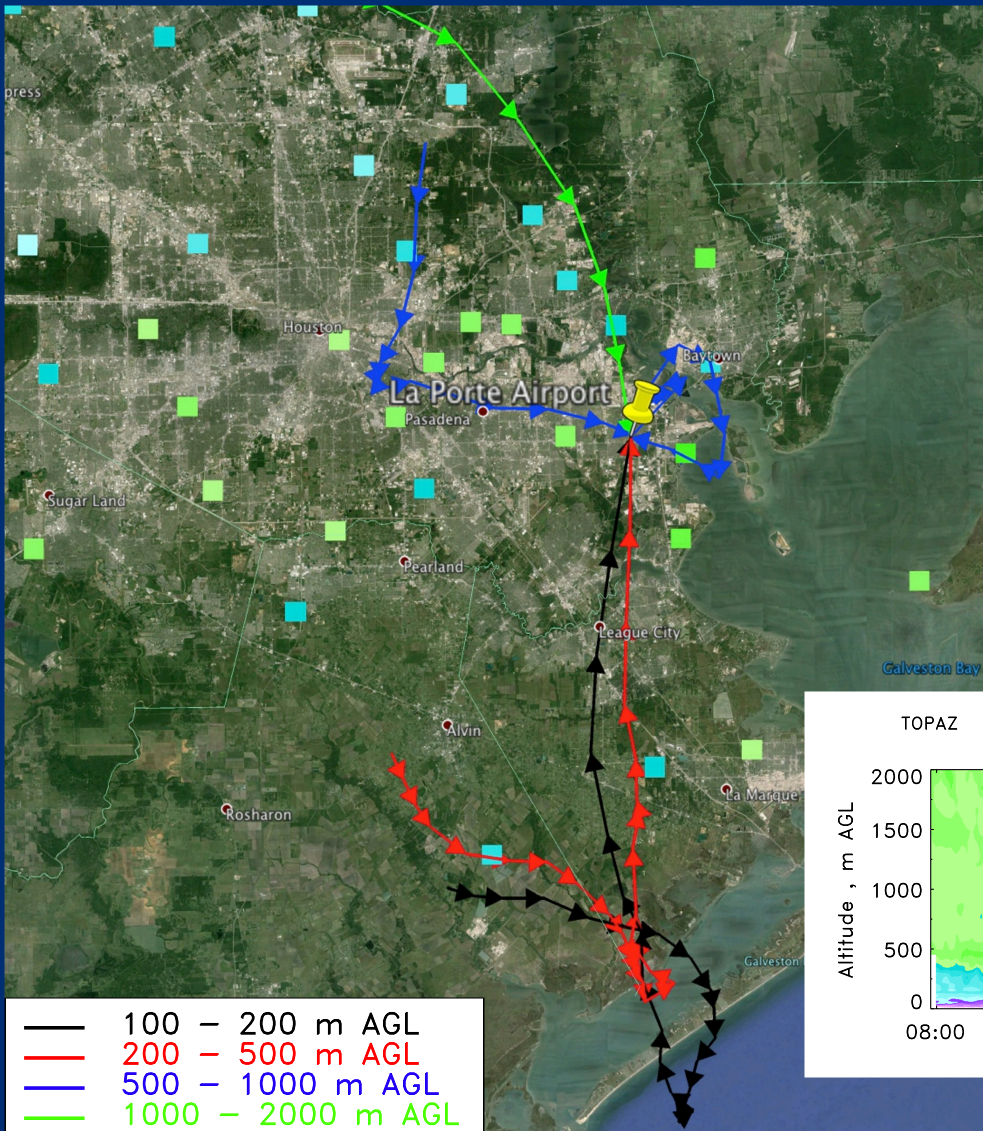


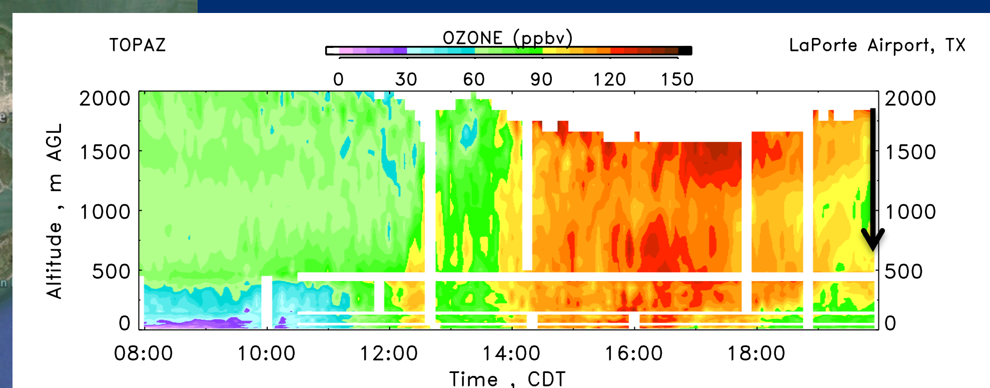
P3 obs from Deer Park spiral

Wind profiler 12-hour back trajectories from La Porte Airport on 25 Sep 2013 **16:00 CDT**

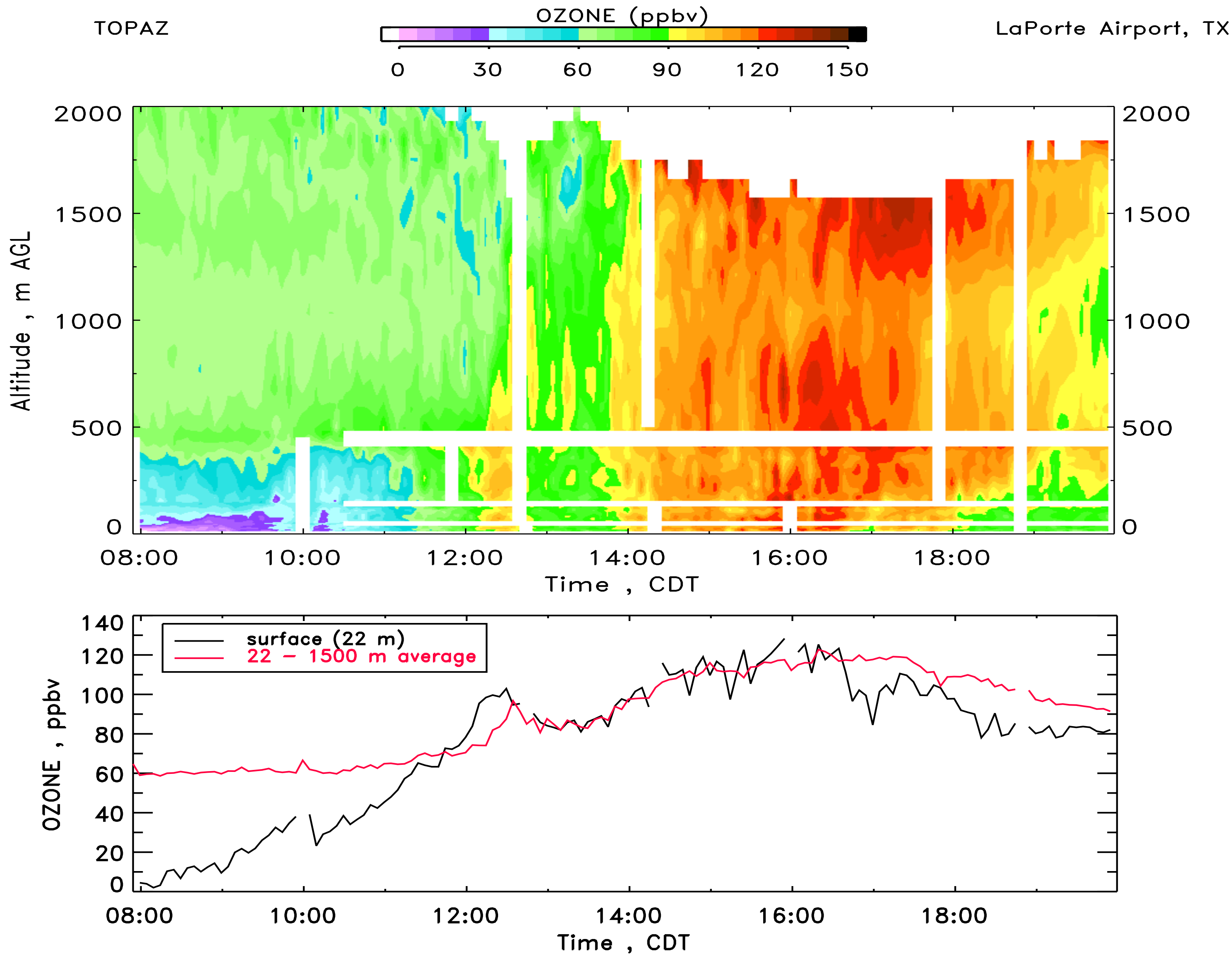


Wind profiler 12-hour back trajectories from La Porte Airport on 25 Sep 2013 **20:00 CDT**



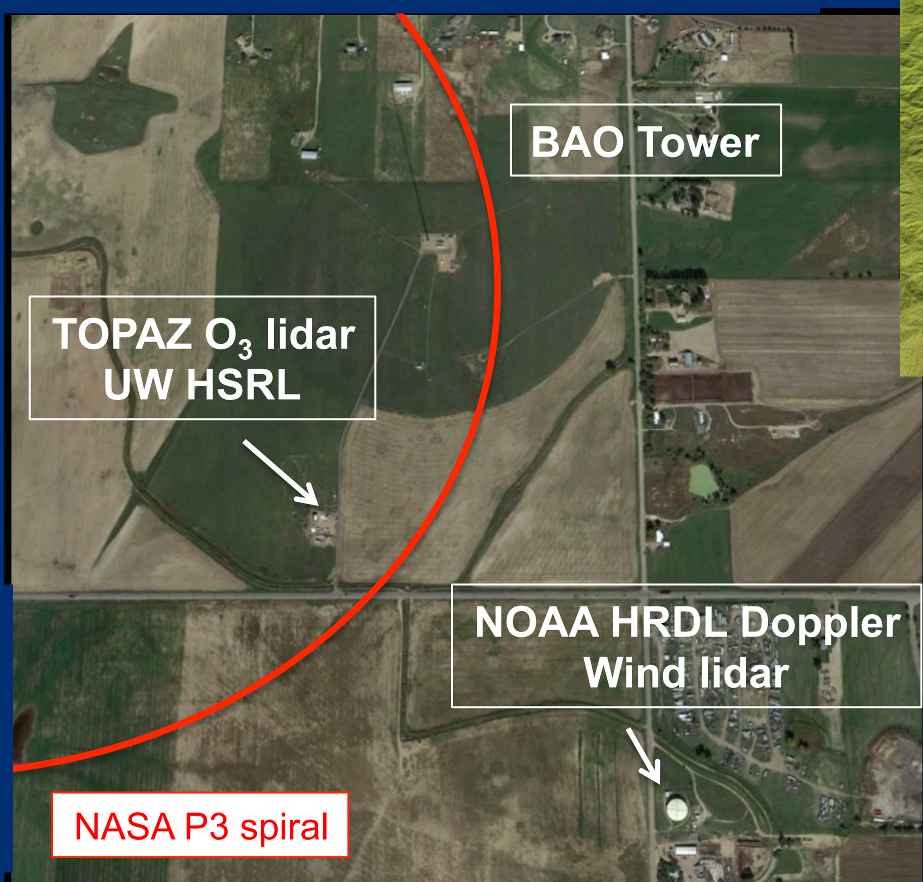


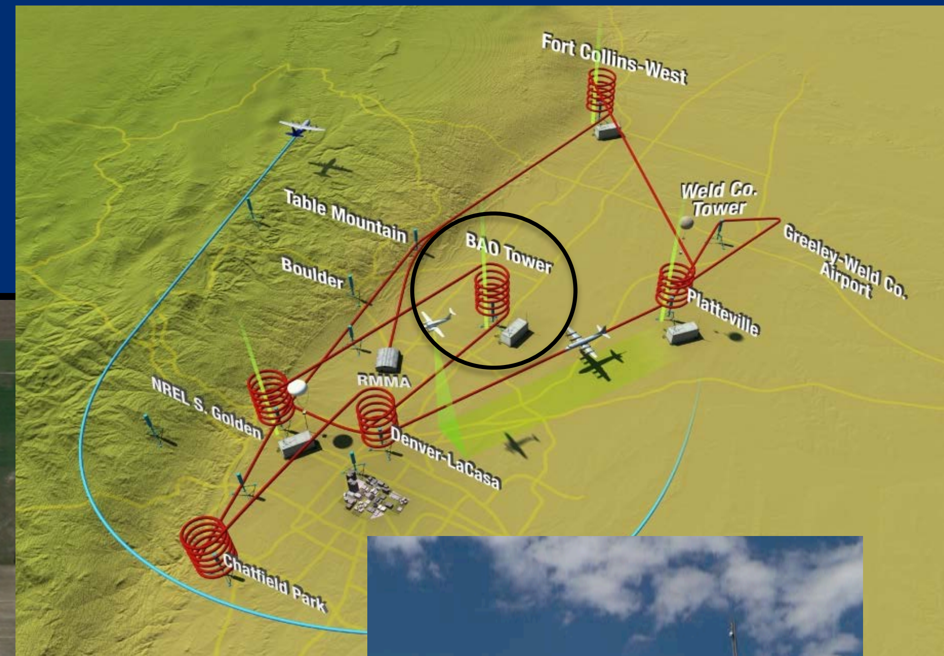
Surface vs. column O_3: 25 Sep 2013



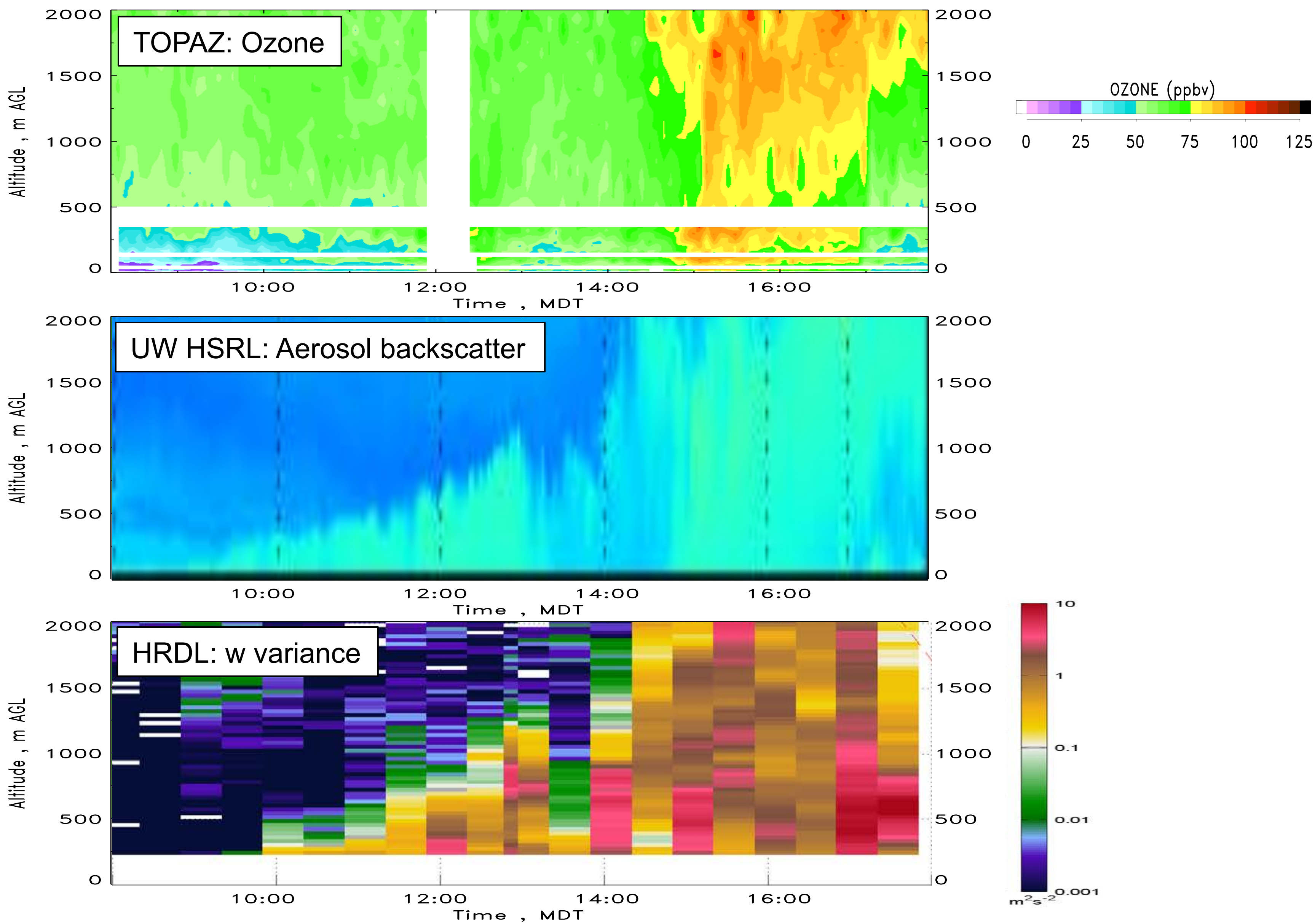
TOPAZ Ozone Lidar at DAQ Colorado / FRAPPE

- BAO Tower
- 9 Jul – 18 Aug 2014



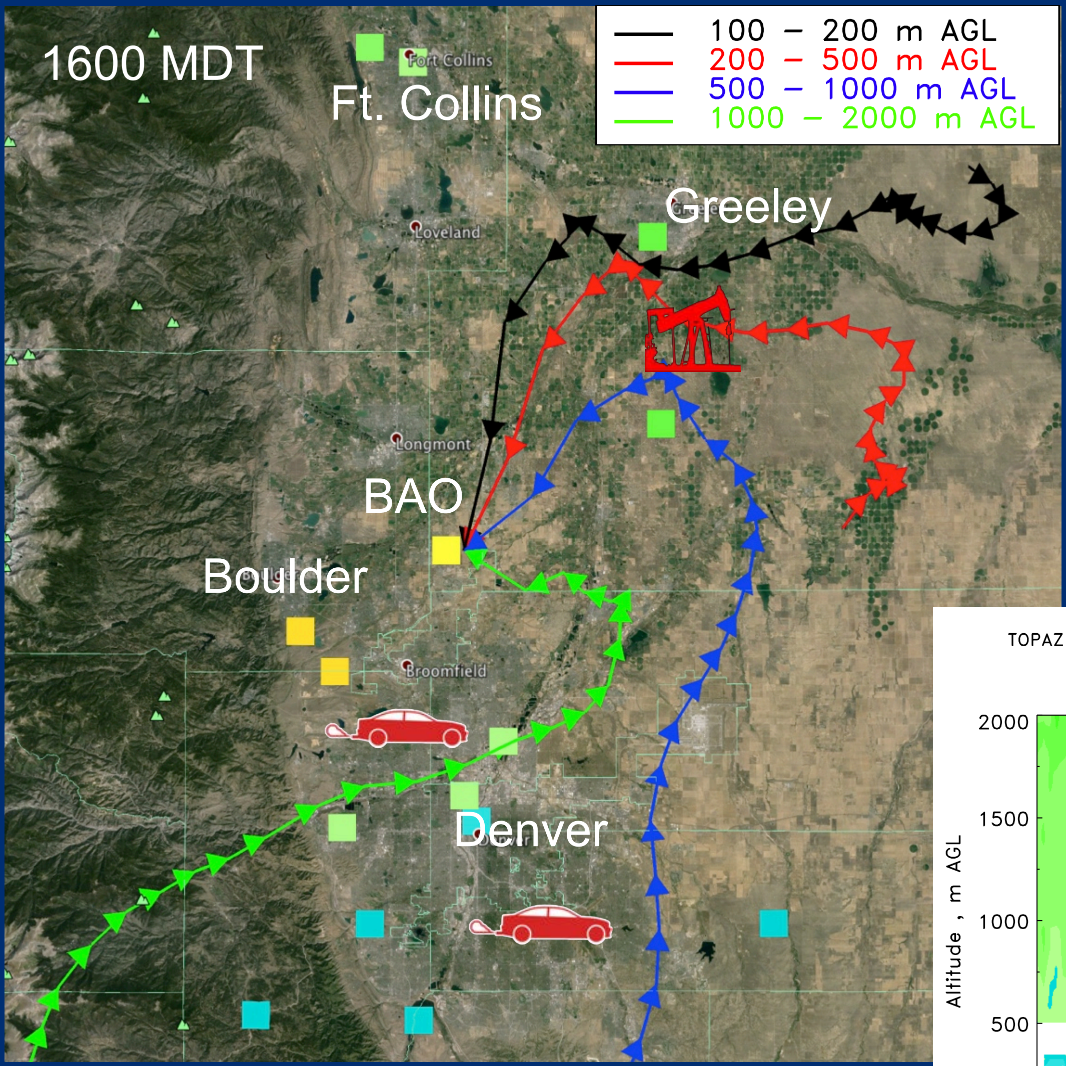


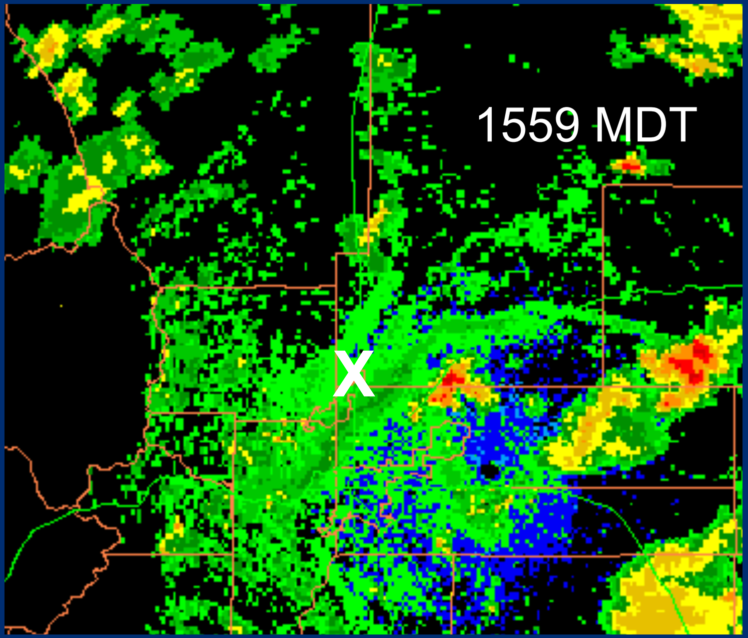
Evolution of O_3, aerosol, and mixing height on 8 Aug 2014

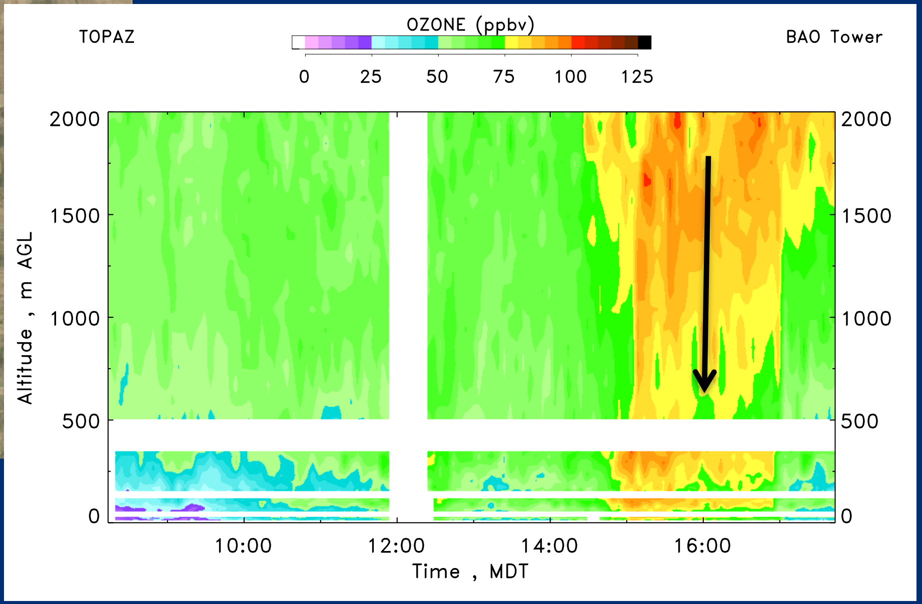


8 Aug 2014

HRDL 12-hour back trajectories from BAO

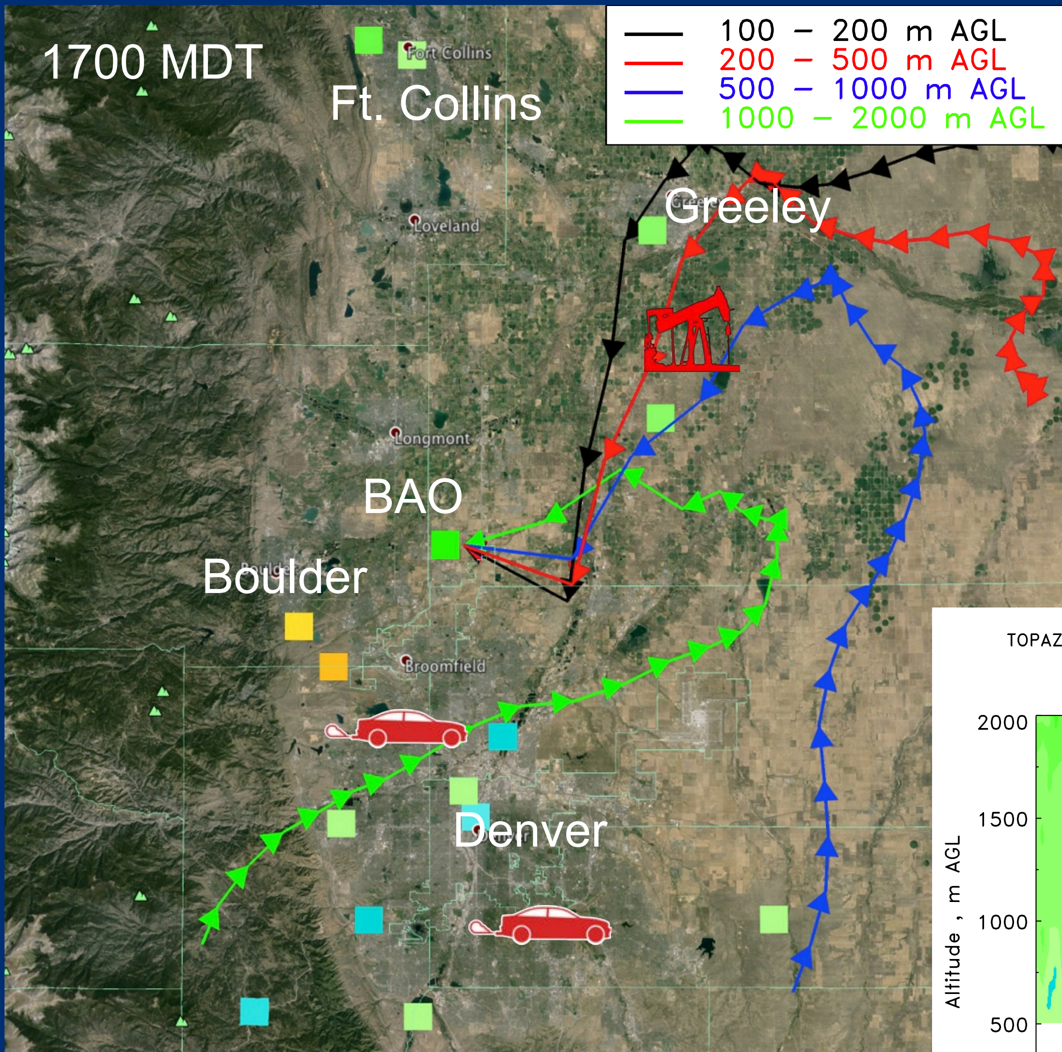


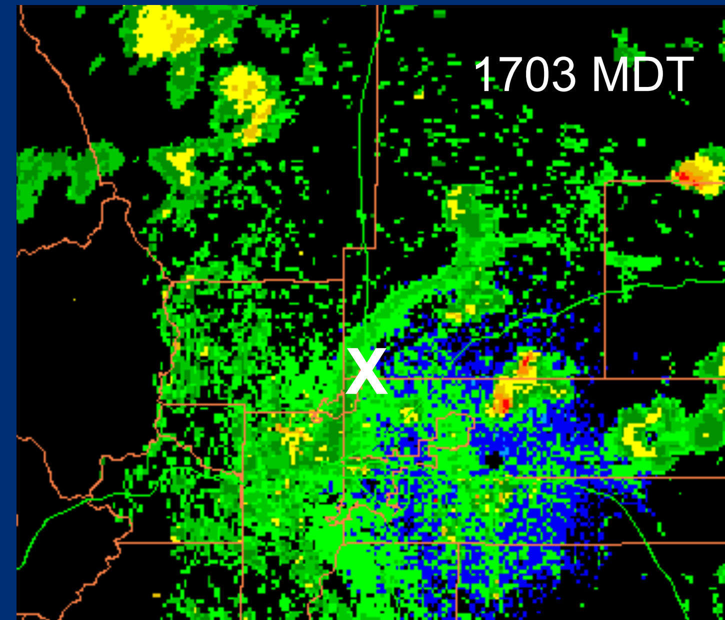


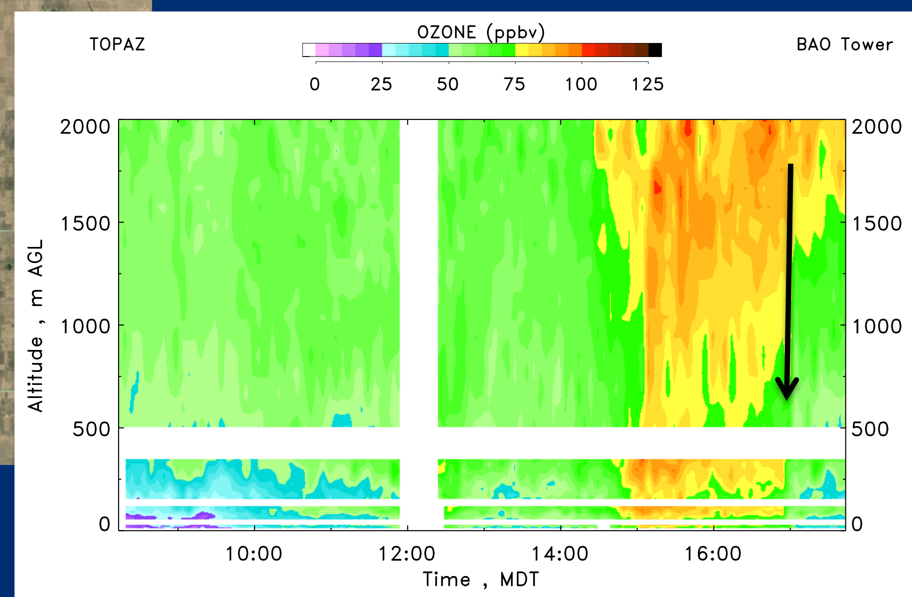


8 Aug 2014

HRDL 12-hour back trajectories from BAO

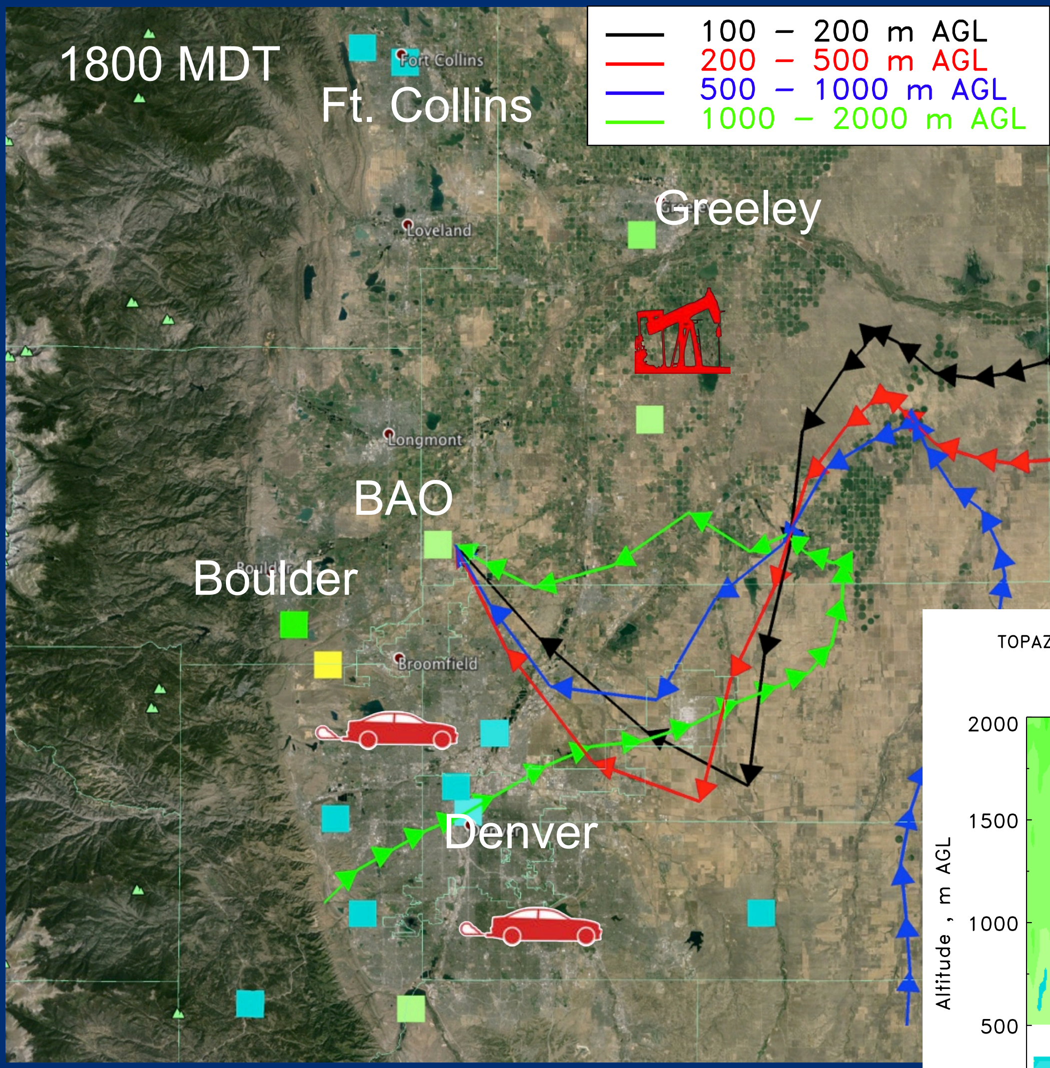


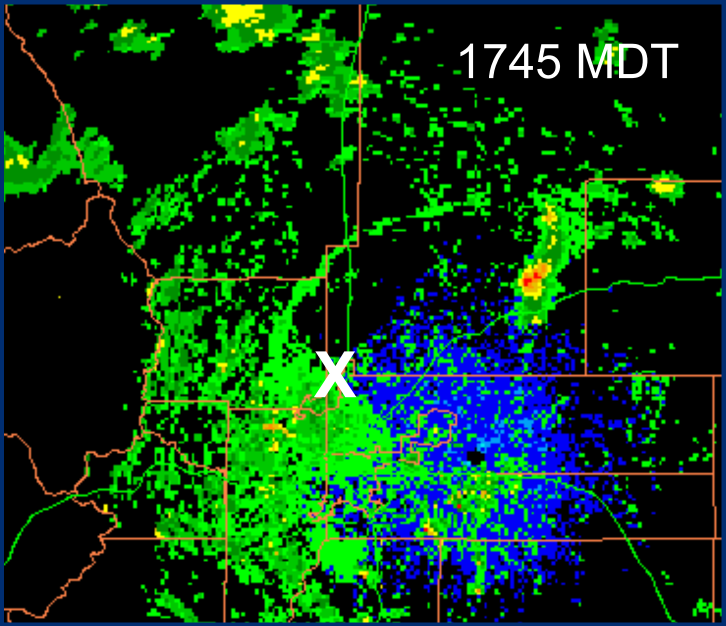


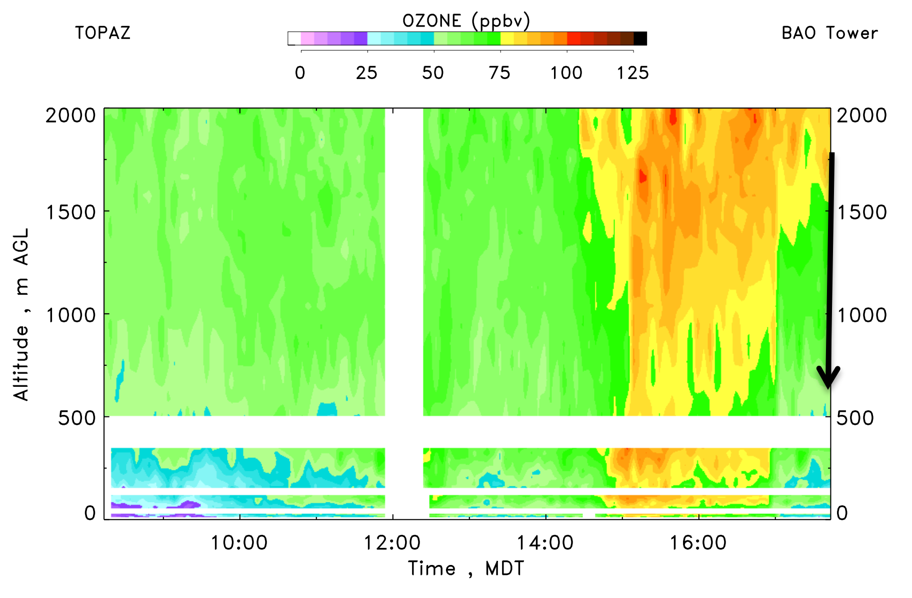


8 Aug 2014

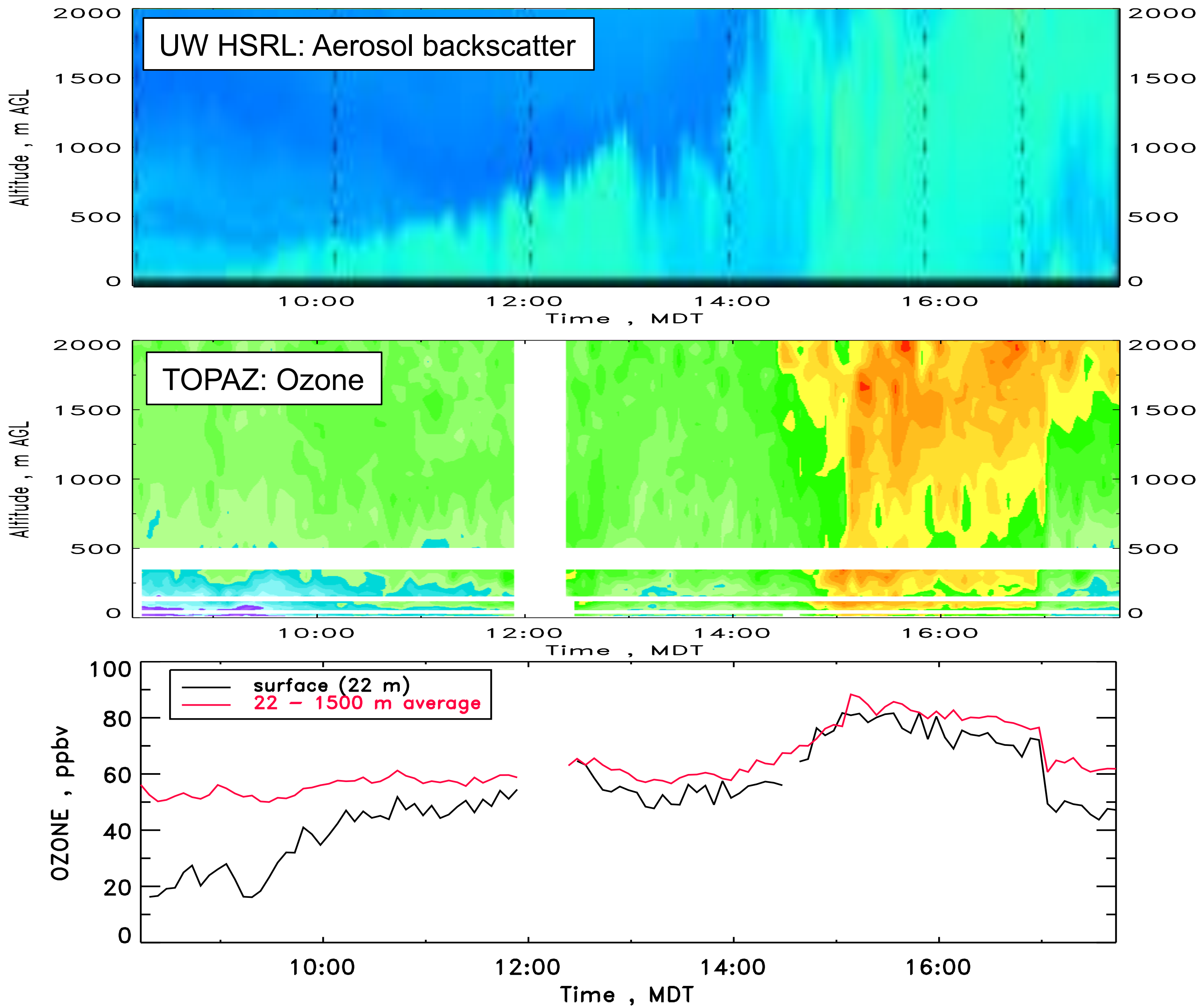
HRDL 12-hour back trajectories from BAO







Surface vs. column O_3: 8 Aug 2014



Summary

- 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