Ozone Lidar Observations for Air Quality Studies

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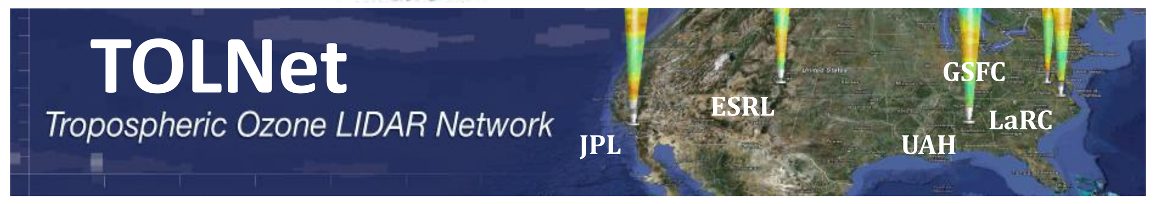
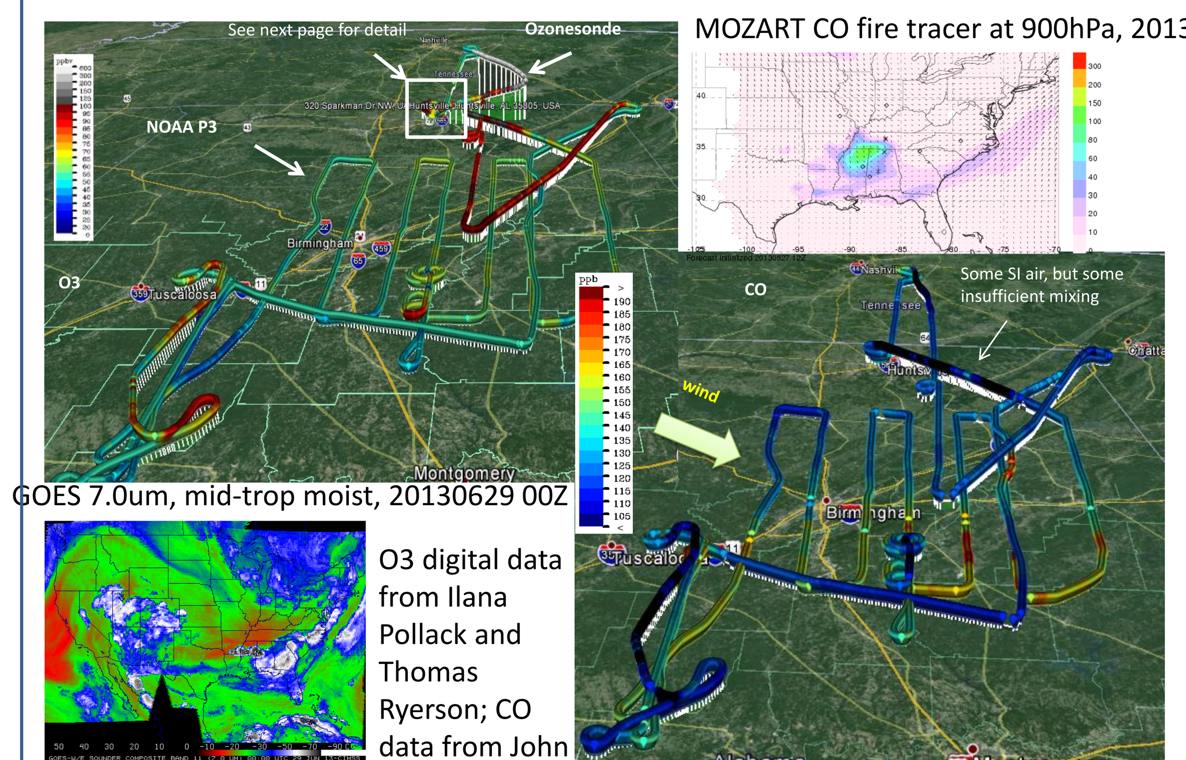


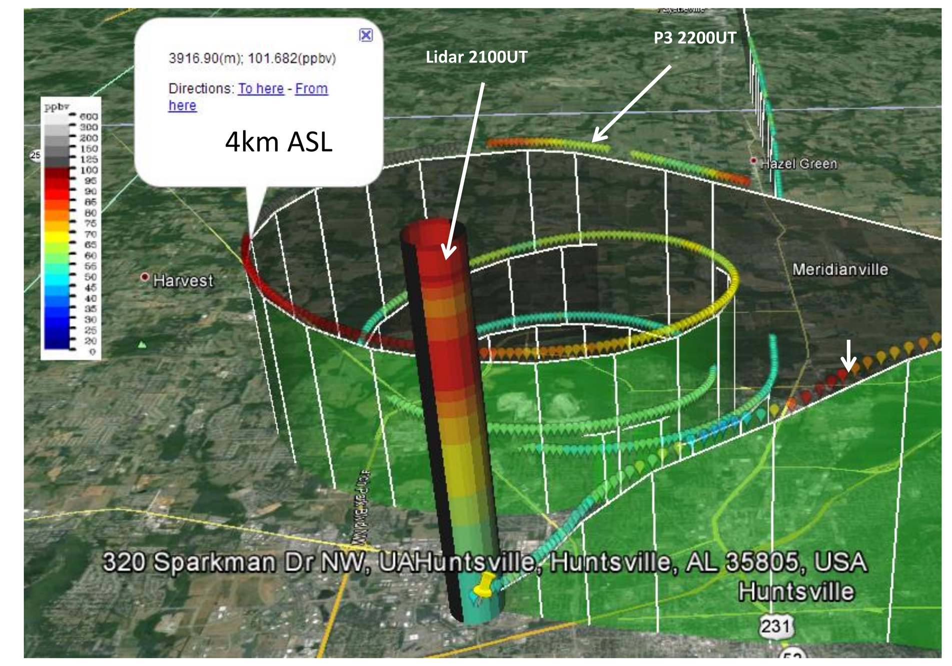
Tropospheric ozone lidars are well suited to measuring the high spatio-temporal variability of this important trace gas. Furthermore, lidar measurements in conjunction with balloon soundings, aircraft, and satellite observations provide substantial information about a variety of atmospheric chemical and physical processes. Examples of processes elucidated by ozone-lidar measurements are presented, and modeling studies using WRF-Chem, RAQMS, and DALES/LES models illustrate our current understanding and shortcomings of these processes.

A Complicated Case of June 29, 2013– Affected by both stratospheric source and smoke transport



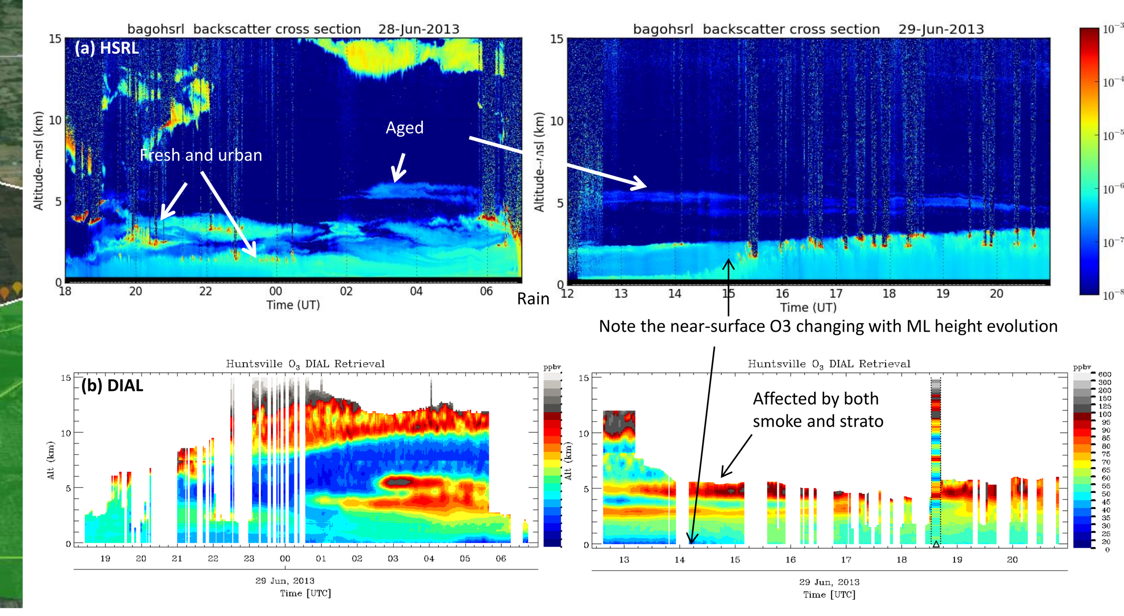
O3 digital data from Ilana Pollack and Thomas Ryerson; CO data from John S Holloway

A Closer Look of the O3 Profiling by Multiple Sensors



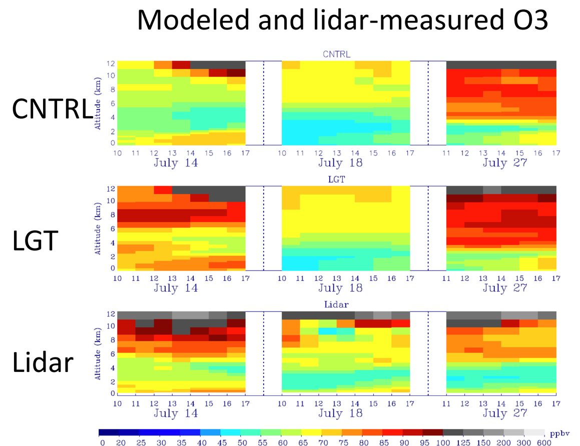
Comparison of the UAH O3 lidar, UAH ozonesonde, and NOAA P3 aircraft measurements

Collocated O3 DIAL and HSRL observations

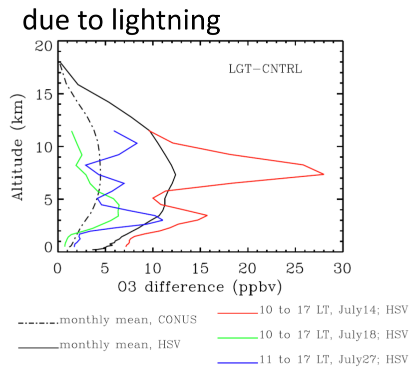


Lightning-induced tropospheric ozone enhancements

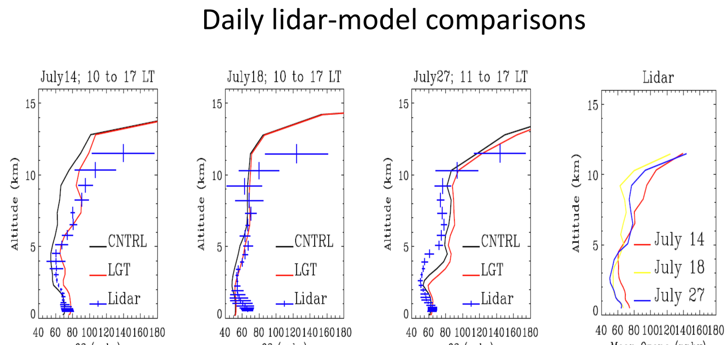
Modeled and lidar-measured O3



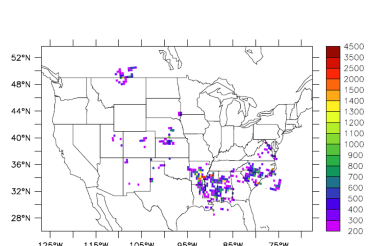
Model-simulated O3 enhancement due to lightning

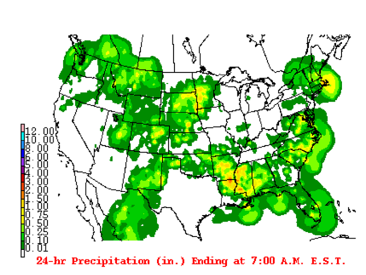


Daily lidar-model comparisons

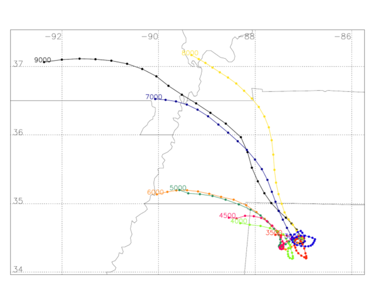


Lightning events occurring within upwind regions resulted in an ozone enhancement of 28 ppbv at 7.5 km AGL over Huntsville on July 14, 2011.



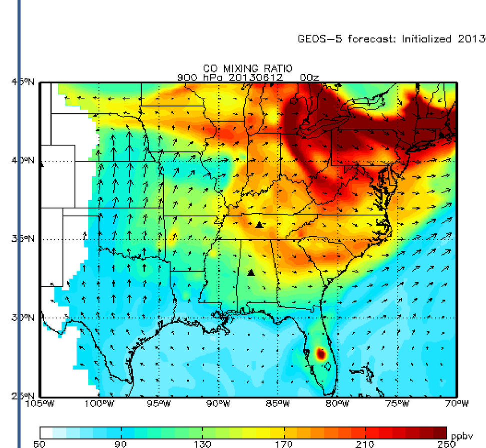


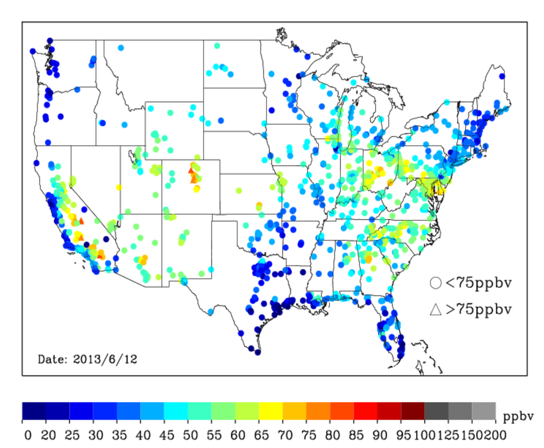
Total CG flashes (top-left) and total precipitation (top-right) ending at 1200 UTC, July 14, 2011.



Backward trajectories calculated using WRF 36 km wind fields, starting from 18 UTC, July 14, 2011, at Huntsville, AL, backward for 24 hours. Backward trajectories at 9000, 8000, 7000, 6000, 5000, 4500, 4000, 3500, and 3000 meters AGL.

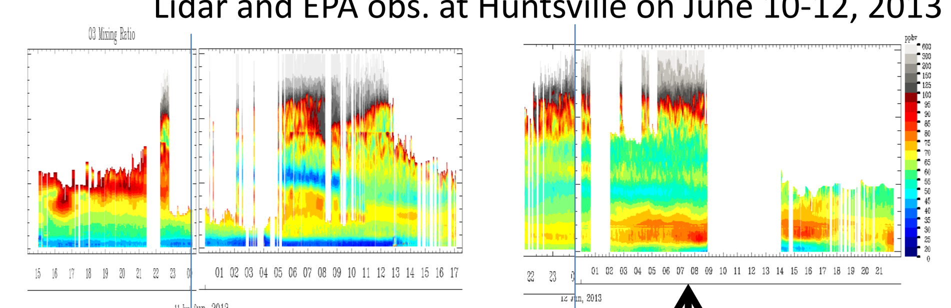
Influence of the Smoke Transport on the Surface, June 12, 2013

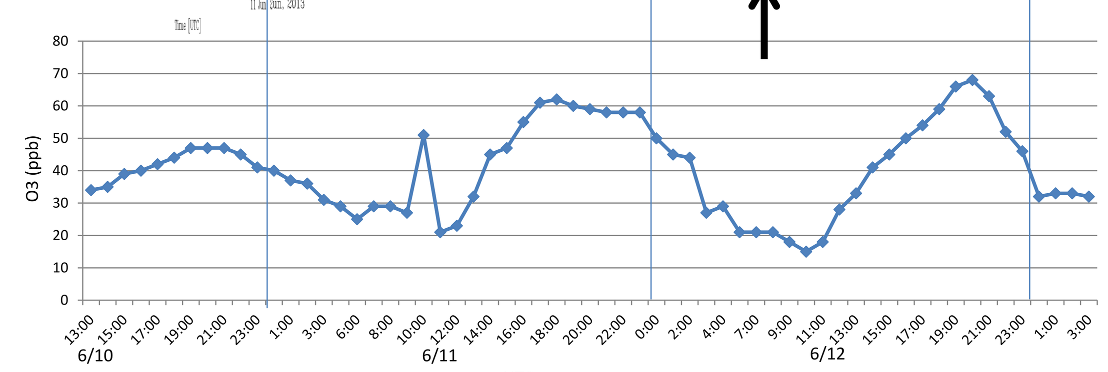




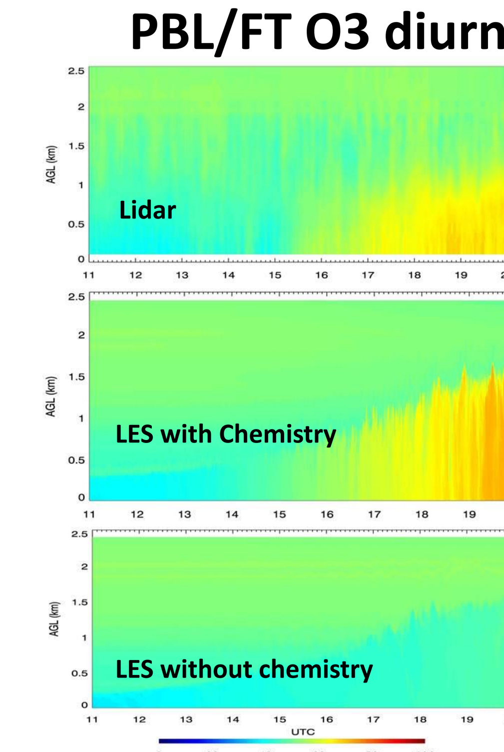
(**Left**) GEOS-5 900-hPa CO analysis field at 00Z and (**right**) the EPA daily maximum 8-hr average on June 12, 2013 showing the impact of smoke transport on eastern U.S.

Lidar and EPA obs. at Huntsville on June 10-12, 2013

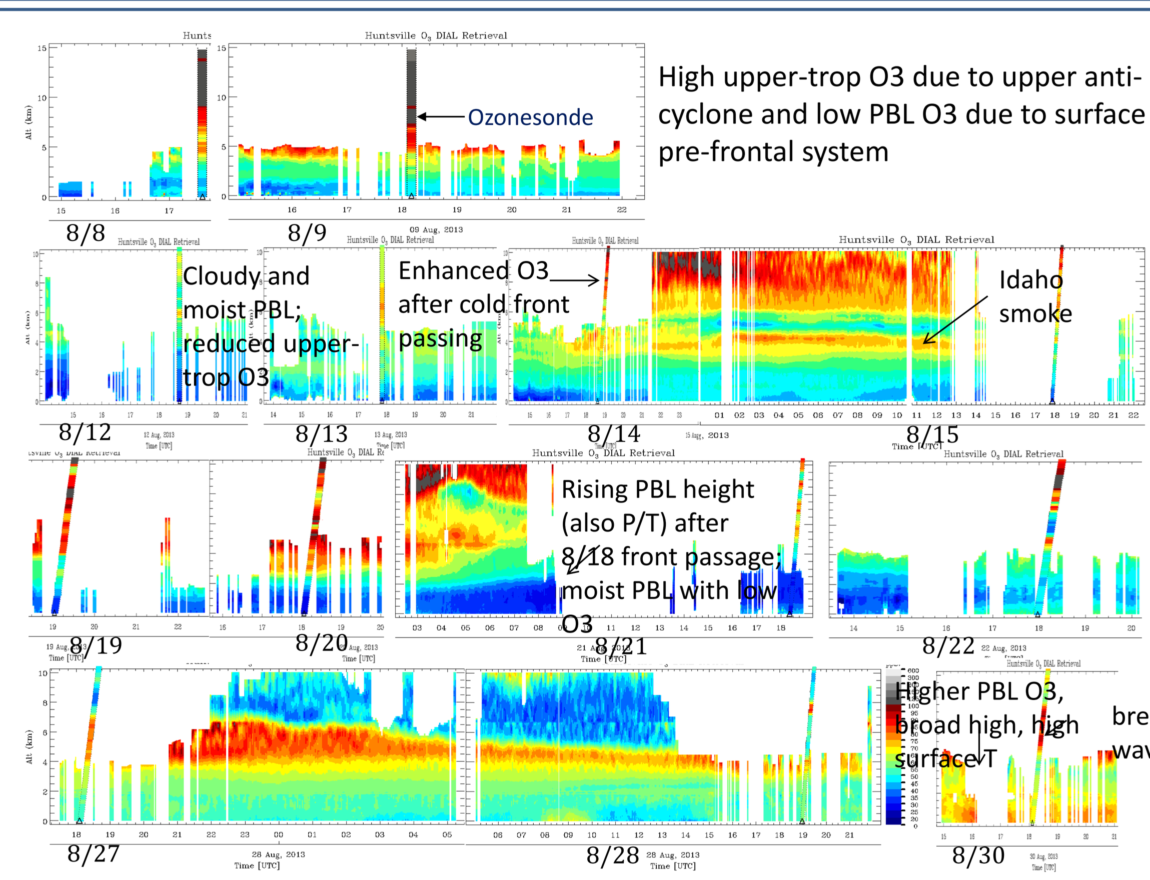




PBL/FT O3 diurnal variations



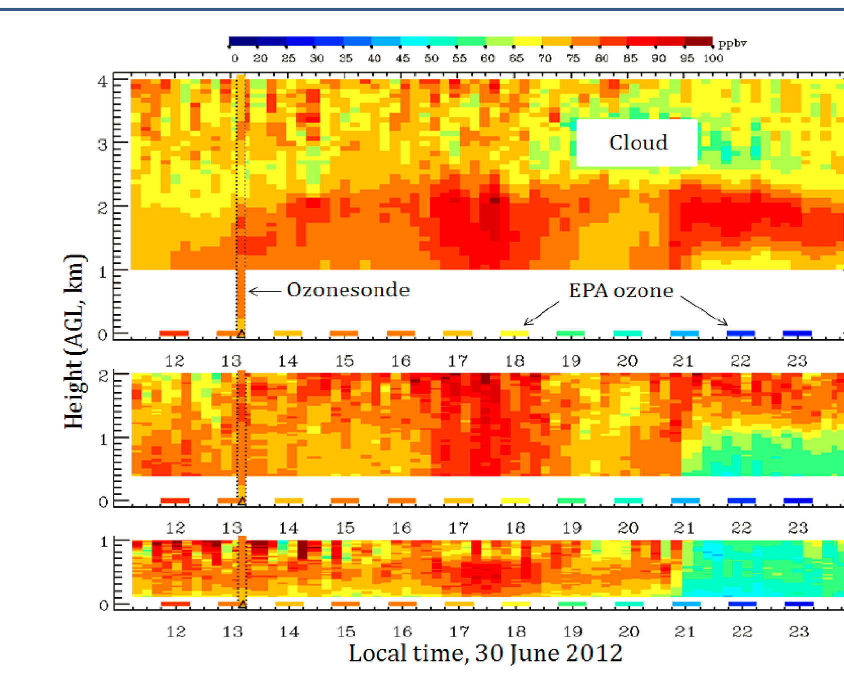
Suggesting the ozone diurnal variation on Sept. 6, 2013 at Huntsville is largely controlled by local emissions and chemical production.



High upper-trop O3 due to upper anti-cyclone and low PBL O3 due to surface pre-frontal system

(Left) Ozone Lidar & Ozonesonde Obs. at Huntsville for SEAC[4]RS in Aug. 2013

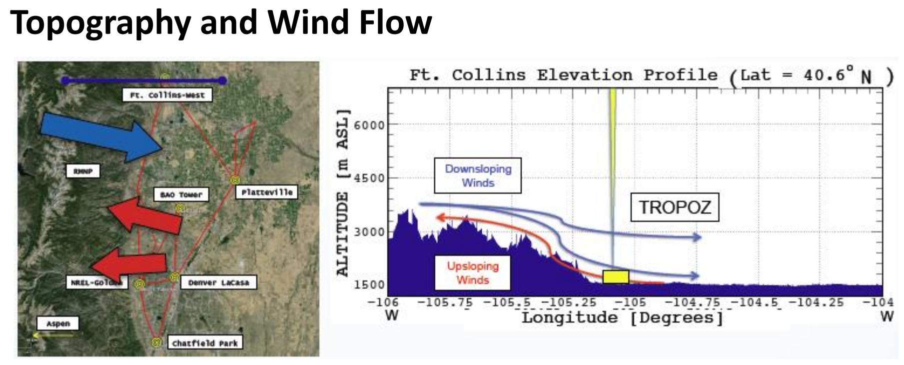
(Right) Ozone lidar measurements in the boundary layer (Kuang et al., 2013)



Ozone lidar retrievals (Channel 1 – bottom, Channel 2 – middle, and Channel 3 - top) compared with ozonesonde (marked by the black triangle at 13:10 launch time) and EPA (~ 16 km away from lidar station) hourly surface measurements **(Kuang et al., 2013).**

synoptic-scale recirculation of pollutants

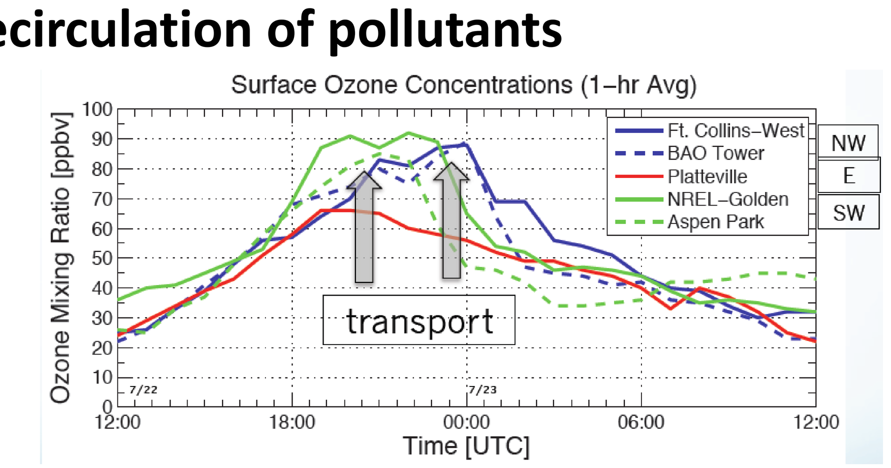
Topography and Wind Flow

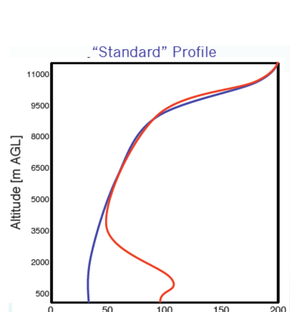


Climatology of the region indicates

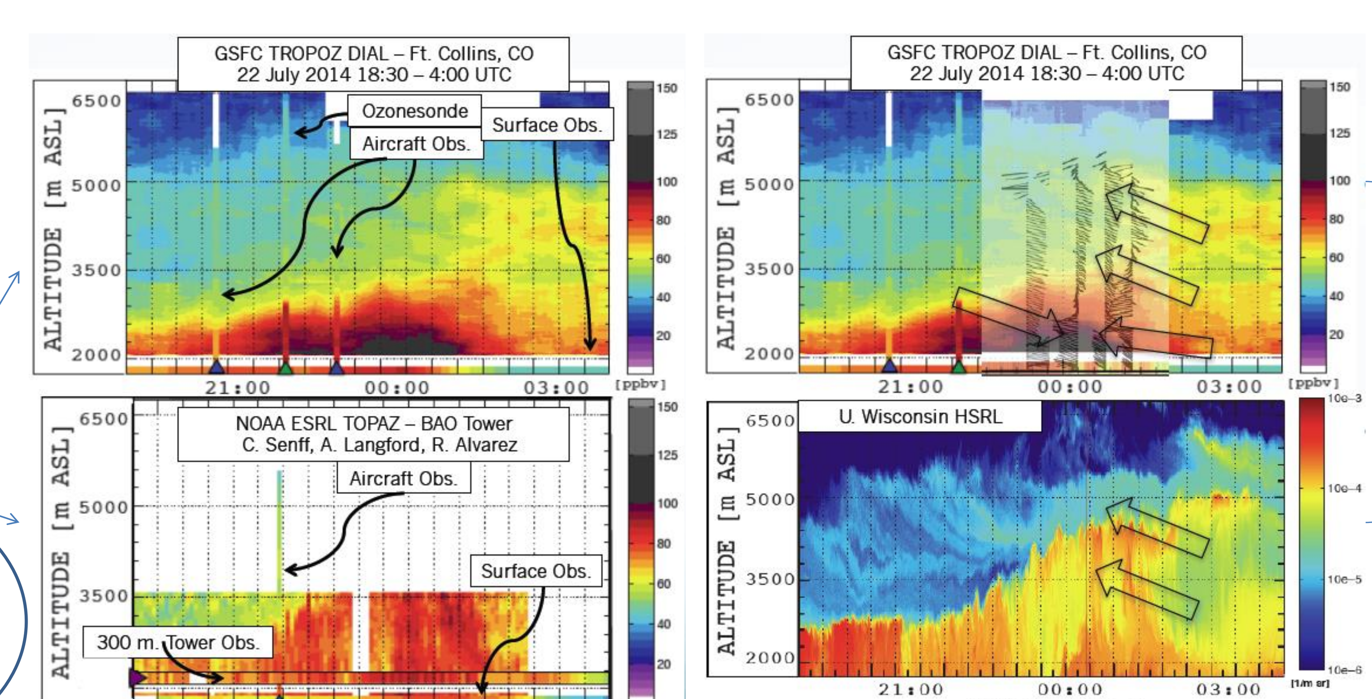
- Downsloping winds typically before 5:00 MDT
- Upsloping winds begin near 8:00 MDT due to convective effects
- Deep upslope flow has developed near 12:00 MDT in the domain (Possibly affecting high mountain elevation sites)
- Return to downsloping winds near 16:00 MDT

Surface Ozone Concentrations (1-hr Avg)





Both TROPOZ and TOPAZ ozone lidars show less polluted conditions after 0200UTC.



TROPOZ vs. HSRL

Both TROPOZ ozone lidar and HSRL wind lidar indicate polluted air mass aloft.

Wind lidar data helps to determine ozone transport.

Lower level flow convergence associated with a 20-30 ppb increase in ozone.

Aloft winds indicate southeasterly flow, while less polluted at surface.

TOLNet: http://www-air.larc.nasa.gov/missions/TOLNet/index.html

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