TOLNet – A Tropospheric Ozone Lidar Profiling Network for Satellite Validation and Process Studies

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7th IWAQFR

Introduction

NASA and NOAA initiated the Tropospheric Ozone Lidar Network TOILNet, an interagency ozone lidar observation network, to promote cooperative multiple-station ozone-lidar observations to provide highly time-resolved (few minutes) tropospheric-ozone vertical profiles useful for air-quality studies, model evaluation, and satellite validation.

Motivation:

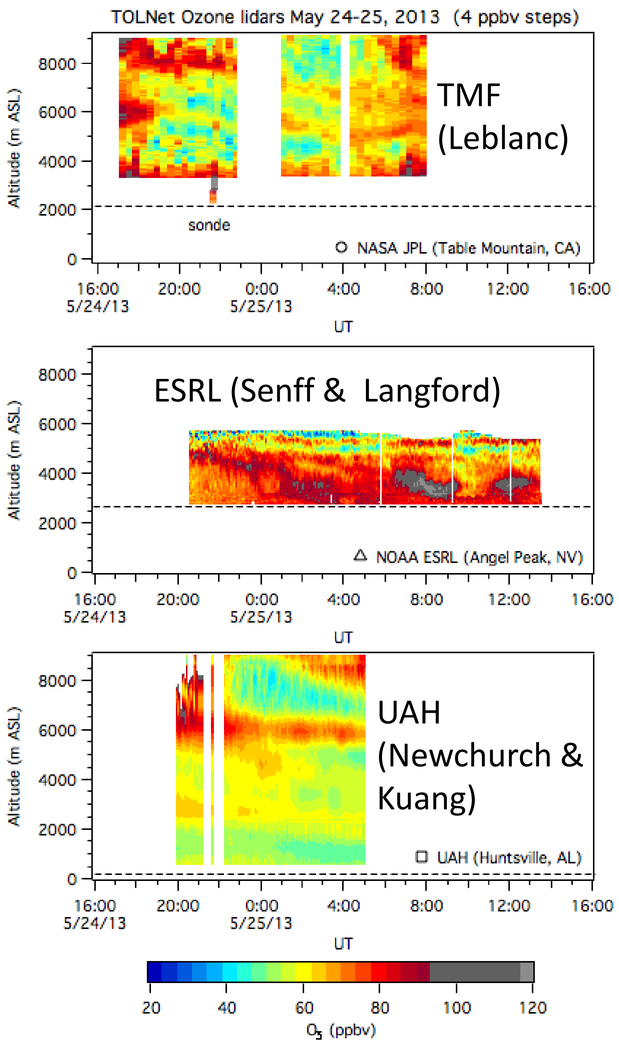
Prepare to make best use of next-generation-satellite tropospheric ozone observations by advancing the understanding of following processes:

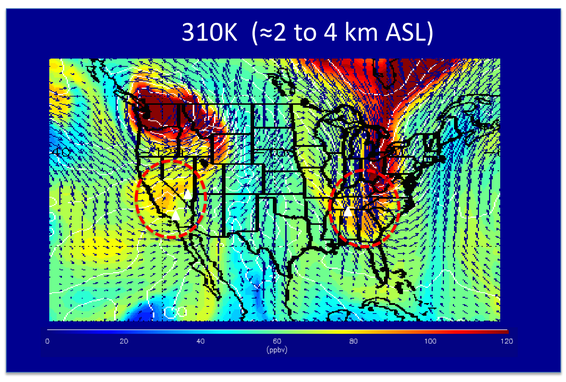
- Synoptic processes such as STE, long-range pollution transport, and large-scale stagnation [timescale: days to several hours].
- Mesoscale processes such as diurnal land/water boundary cycles, low-level jets, and orographic venting [timescale: hours].
- Local scale processes including exchange between the boundary layer and the free troposphere, episodic precursor emissions, and convection [timescale: sub-hourly].

Objectives:

- Provide coordinated high-resolution measurements of tropospheric ozone for air-quality/chemical/transport model improvement and satellite retrieval validation.
- Exploit synergies with EVS-1 DISCOVER-AQ, EVI-1 TEMPO, GEO-CAPE studies, and existing routine observations to advance understanding of processes controlling regional air quality and chemistry.
- Develop recommendations for lowering the cost and improving the robustness of ozone lidar systems.

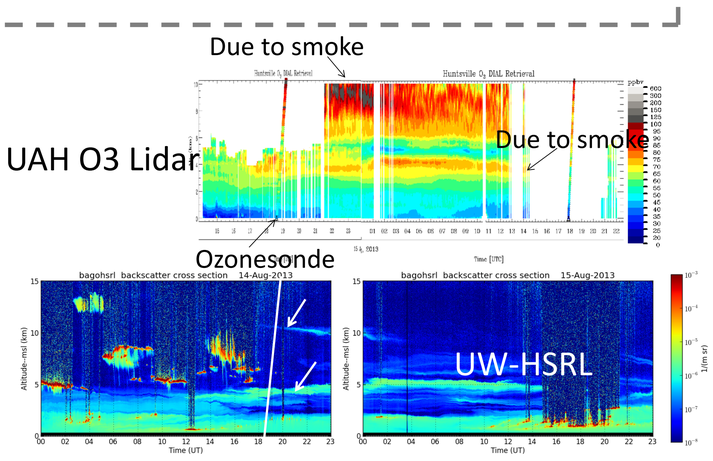
FT and STE Processes





May 24, 2013 12UT RAQMS 310-K ozone
Brad Pierce (NOAA/NESDIS)

Figure 1. Multiple-station measurements of two stratospheric intrusions on May 24, 2013. (note the ESRL observation was made at Las Vegas.)



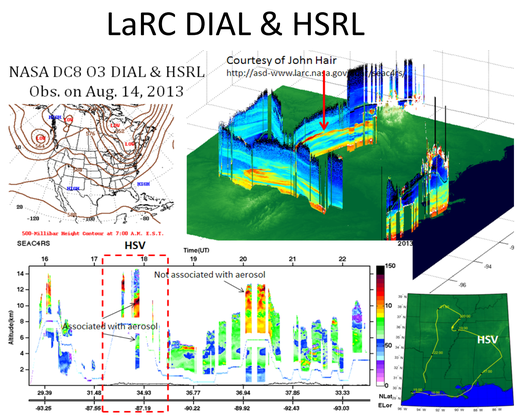


Figure 2. Ozone enhancement associated with smoke transport measured by the ozone DIAL and HSRL on August 14, 2013.

PBL Processes

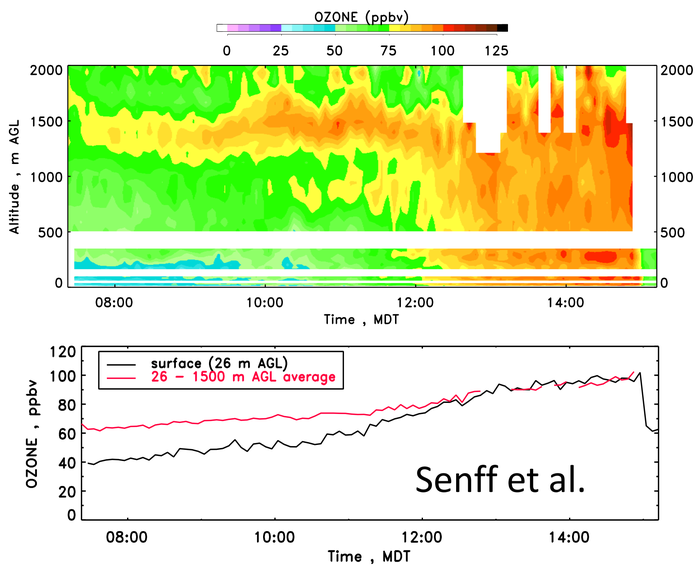


Figure 3. The effect of transport and mixing processes on the relationship between column and surface ozone observed with lidar during Discover-AQ/FRAPPE. In 66% of all cases observed at BAO, 1500 m AGL O_3 column and surface values agree within 10 ppbv, almost exclusively occurred after midday LT. For the remaining observations (34%), column O_3 mostly exceeds the surface values.

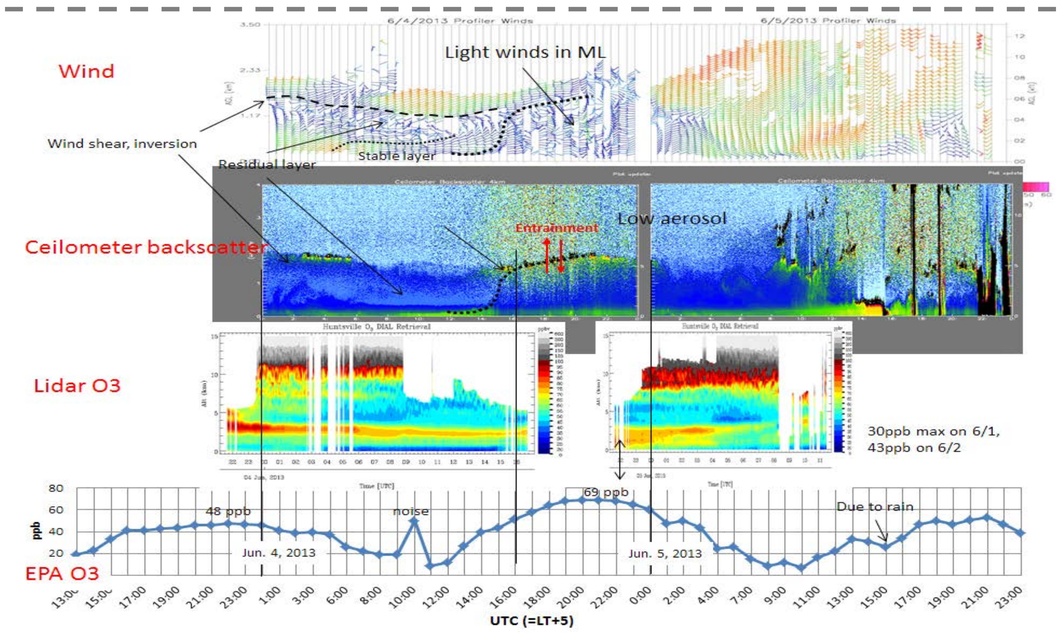
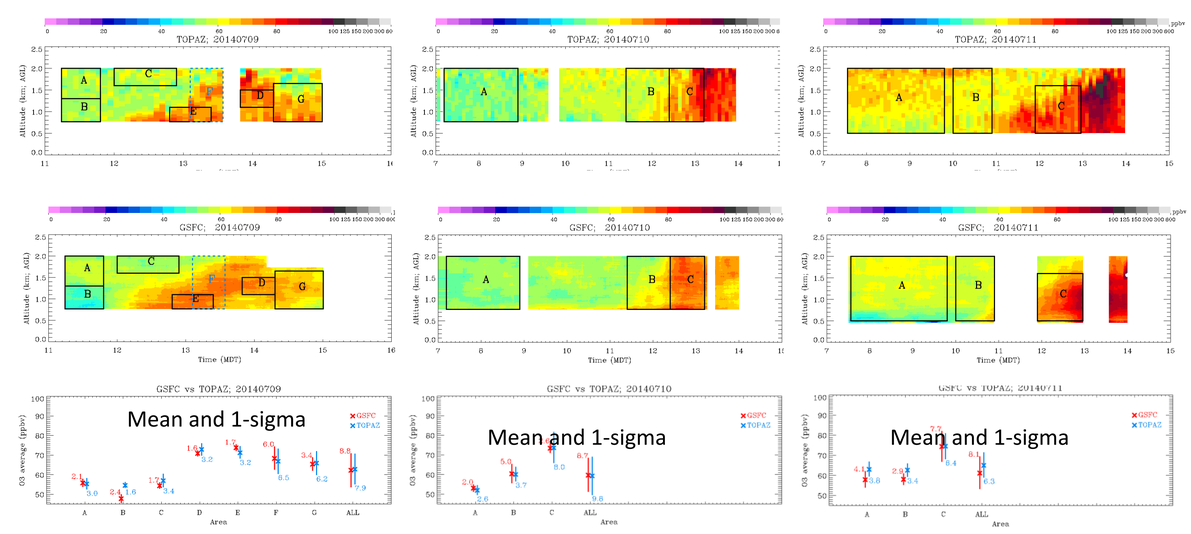


Figure 4. 915-MHz Wind profiler, ceilometer (Kevin Knupp/UAH), ozone lidar, and EPA surface hourly ozone (at the Airport Road Station, 10 km from the lidar lab) measurements at Huntsville for investigation of the PBL ozone enhancement on June 5, 2013.

Data Accuracy Assessment



NOAA/ESRL TOPAZ sample size = 30967
mean = 62.6 ppbv
std dev = 8.4 ppbv =13%

NASA/GSFC TROPOZ sample size = 158203
mean = 60.9 ppbv
std dev = 8.5 ppbv = 14%

Diff. of mean = 3%
Diff. of std dev = 1%

Figure 5. TOLNet lidar intercomparison during DISCOVER-AQ campaign at BAO in July 2014.

Summary and Conclusions

1. TOLNet provides high-resolution ozone lidar data to modeling and satellite teams for improving the fidelity of tropospheric ozone process measurement and understanding.
2. TOLNet lidars agree with ozonesonde free flights and tether flights, with CRDS on the BAO carriage, and with each other to within ~ 10% over a wide variety of conditions.
3. The TOLNet data are accessible at http://www-air.larc.nasa.gov/missions/TOLNet/.