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

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Introduction

NASA initiated an interagency ozone lidar observation network under the name TOLNet 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.

Stations

Table 1. Summary of the TOLNet lidars.

Name	JPL TMO (Table Mountain tropospheric Ozone) DIAL	TOPAZ (Tunable Optical Profiler for Aerosol and oZone) lidar	RO_3QET (Rocket-city O3 Quality Evaluation in theTroposphere) lidar	GSFC TROPOZ (TROPospheric OZone) DIAL	LMOL (Langley Mobile Ozone Lidar)
Affiliation	NASA/JPL	NOAA/ESRL	UAH	NASA/GSFC	NASA/LaRC
Host location	Wrightwood, CA	Boulder, CO	Huntsville, AL	Greenbelt, MD	Hampton, VA
Set-up	Fixed-location	Mobile	Fixed-location	Mobile	Mobile
Transmitter type	Quadruple Nd:YAG pumped Raman laser	Quadruple Nd:YLF pumped Ce:LiCAF laser (tunable wavelength)	Quadruple Nd:YAG pumped Raman laser	Quadruple Nd:YAG pumped Raman laser	Quadruple Nd:YLF pumped Ce:LiCAF laser (tunable wavelength)
Wavelength (nm)	289, 299	Typically 287, 291, 294	283, 289, 299	289, 299	Typically 285, 291 (527 for aerosol)
Receiver size (cm)	91, 5, 5	50	40, 10, 2.5	41, 2.5, 2.5	40
Measurable range (km AGL)	0.1-23	0-3	0.1-12	0.2-12 (day) 0.2-19 (night)	0.1-4
Reference	[4]	[5]	[3, 6]	[7]	[8]

Measurements

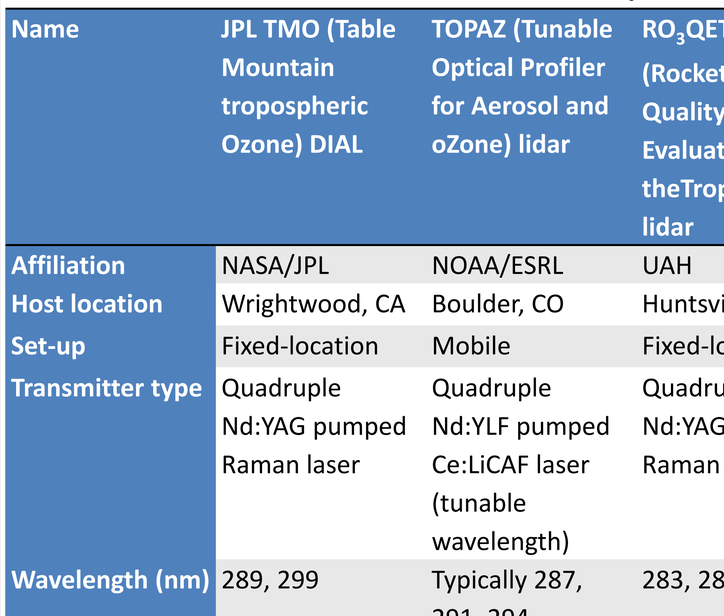
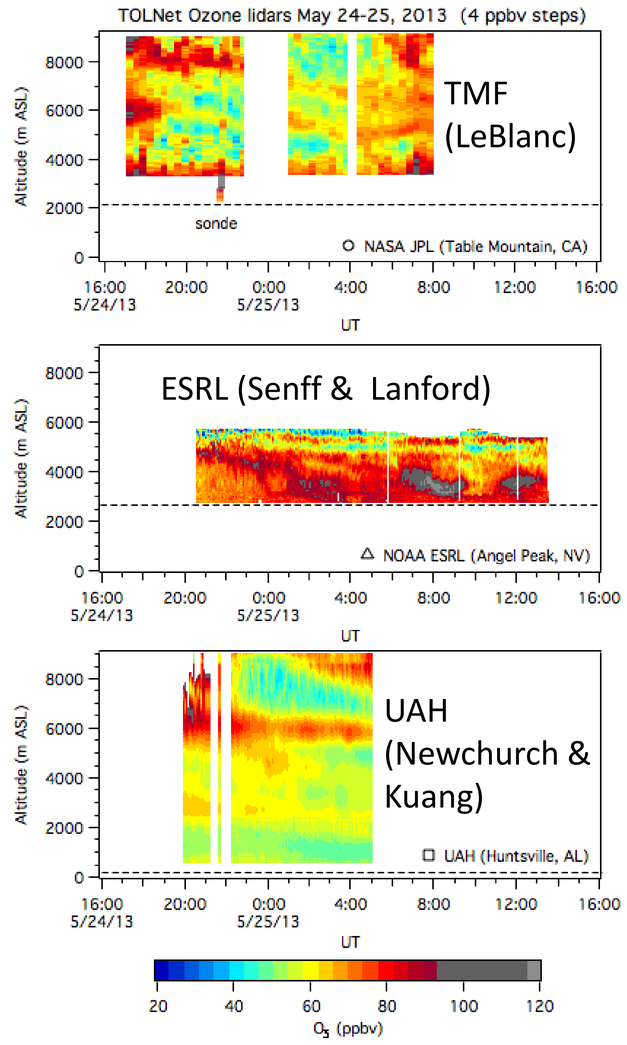
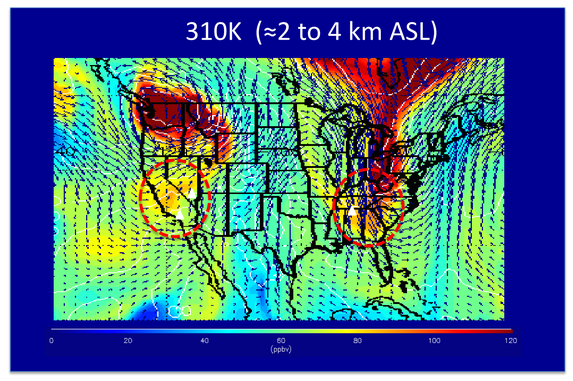


Figure 1. The effect of transport and mixing processes on the relationship between column and surface ozone observed with lidar during Discover-AQ/FRAPPE. In 66% of all cases observed at BAO, 1500 m AGL O_3 column and surface values agree within 10 ppbv, almost exclusively occurred after midday LT. For the remaining observations (34%), column O_3 mostly exceeds the surface values.

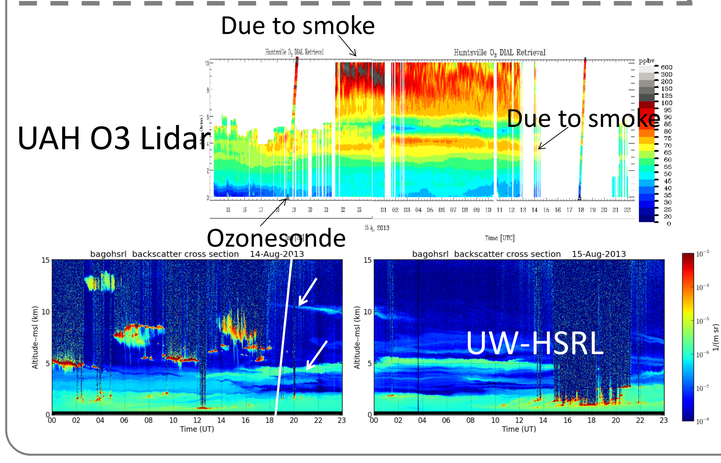
Measurements





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

Figure 2. Multiple-station measurements of two stratospheric intrusions on May 24, 2013. (note the ESRL observation was made at Las Vegas.)



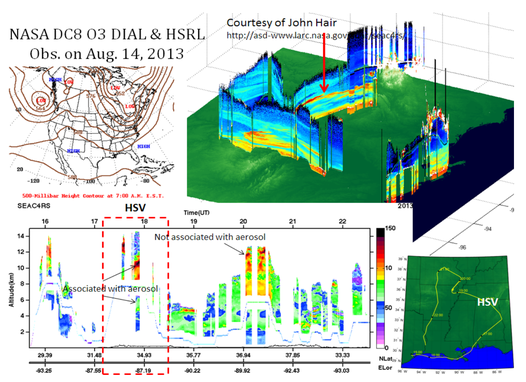
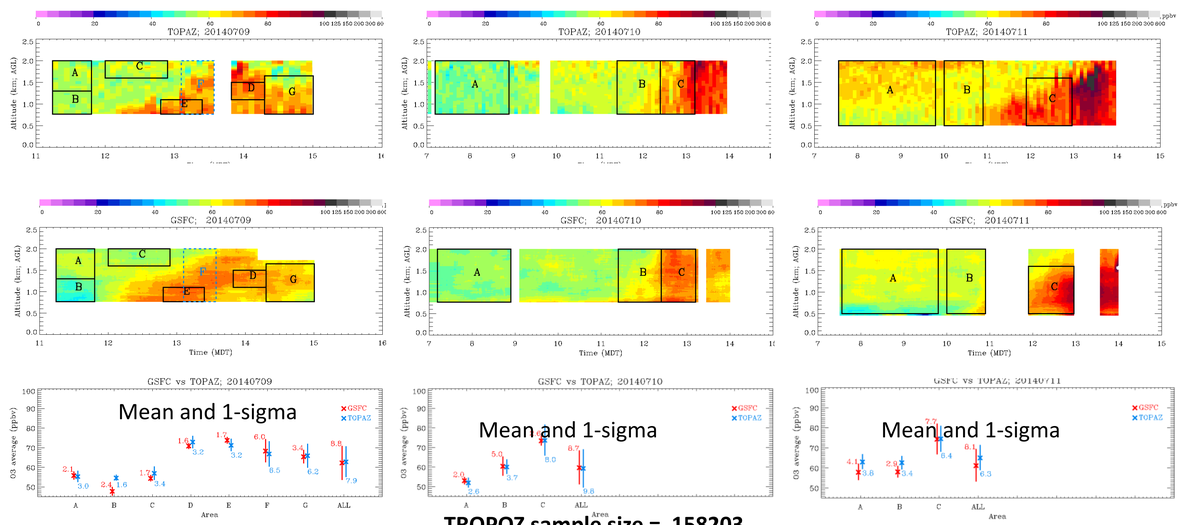


Figure 3. Ozone enhancement associated with smoke transport measured by the ozone DIAL and HSRL on August 14, 2013.

Data Accuracy Assessment



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

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

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

Figure4. TOLNet lidar intercomparison during DIACOVER-AQ campaign at BAO in July 2014.

Summary and Conclusions

1. A main objective of TOLNet is to provide high-resolution lidar data at multiple stations to modeling and satellite teams for validating and improving the fidelity of tropospheric ozone measurements by NASA's next-generation geostationary instruments.
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/.