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.

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 O3 column and surface values agree within 10 ppbv, almost exclusively occurred after midday LT. For the remaining observations (34%), column O3 mostly exceeds the surface values.

Table 1. Summary of the TOLNet lidars.

<table>
<thead>
<tr>
<th>Name</th>
<th>JPL TMO (Table Mountain tropospheric Ozone) DIAL</th>
<th>TOPAZ (tunable Optical Profiler for Aerosol and Ozone) lidar</th>
<th>RO DIAL (Rocket-city O3 Quality Evaluation in the Troposphere) lidar</th>
<th>GSFC TROPOZ (Tropospheric Ozone) DIAL</th>
<th>LAMO (Langley Mobile Ozone Lidar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affiliation</td>
<td>NASA/JPL</td>
<td>NOAA/ESRL</td>
<td>UAH</td>
<td>NASA/GSFC</td>
<td>NASA/LaRC</td>
</tr>
<tr>
<td>Host location</td>
<td>Wrightwood, CA</td>
<td>Boulder, CO</td>
<td>Huntsville, AL</td>
<td>Greenbelt, MD</td>
<td>Hampton, VA</td>
</tr>
<tr>
<td>Set-up</td>
<td>Mobile</td>
<td>Fixed-location</td>
<td>Mobile</td>
<td>Mobile</td>
<td>Mobile</td>
</tr>
<tr>
<td>Receiver size (cm)</td>
<td>91, 5, 7</td>
<td>50</td>
<td>40, 10, 2, 5</td>
<td>41, 2, 5, 2</td>
<td>40</td>
</tr>
<tr>
<td>Measurable range (km AGL)</td>
<td>0-23</td>
<td>0-3</td>
<td>0.1-12</td>
<td>0.2-12 (day)</td>
<td>0.1-4</td>
</tr>
<tr>
<td>Mean and 1-sigma</td>
<td>Mean and 1-sigma</td>
<td>Mean and 1-sigma</td>
<td>Mean and 1-sigma</td>
<td>Mean and 1-sigma</td>
<td></td>
</tr>
<tr>
<td>Diff of mean</td>
<td>Diff of mean</td>
<td>Diff of mean</td>
<td>Diff of mean</td>
<td>Diff of mean</td>
<td></td>
</tr>
</tbody>
</table>

Data Accuracy Assessment

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/.

Stations

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.

Figure 4. TOLNet lidar intercomparison during DIACOVER-AQ campaign at BAO in July 2014.

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