An Interagency Research Initiative for Ground-Based Lidar Profiling of Tropospheric Ozone and Aerosol

Mike Newchurch1, R. J. Alvarez2, Jay Al-Saadi3, John Burris4, Russell DeYoung5, John Hair2, Mike Hardesty2, Shi Kuang1, A. O. Langford2, Thierry Leblanc4, Stuart McDermid4, Tom McGee4, Brad Pierce2, Christoph Senff2, Jim Szykman8

1UAHuntsville, 2NOAA/ESRL, 3NASA/HQ, 4NASA/GSFC, 5NASA/LaRC, 6NASA/JPL, 7NOAA/NESDIS, 8USEPA

1. Introduction

An interagency research initiative for ground-based ozone and aerosol lidar profiling recently funded by NASA has important applications to air-quality studies in addition to the goal of serving the GEO-CAPE mission. Surface air-quality affects is affected by pollution aloft through various physical and chemical processes in the PBL. Unfortunately, the general lack of high-resolution observations aloft limits the evaluation of air-quality models. Our recent studies also suggest the models have limited capability to resolve the 1-2 km-thick ozone layers. The initiative will provide a prototype for high-resolution time/height measurements of ozone and aerosols from near surface to the top of the troposphere at a few stations (i.e., UAHuntsville, NASA/GSFC, NASA/LaRC, NASA/JPL, NOAA/ESRL) with particular focus on the PBL. These measurements can make significant contributions in evaluating air-quality models and improving their simulation and forecasting capabilities.

The purpose of this initiative is to (1) provide high-resolution time-height measurements of ozone and aerosols at a few sites near surface to upper troposphere for scientific investigations of air-quality processes and GEO-CAPE mission definition; (2) develop recommendations for lowering the cost and improving the robustness of such systems to better enable their possible use in future national networks to address the needs of NASA, NOAA, EPA and State/local AQ agencies.

2. Instrumentation

Figure 1. UAHuntsville Planned ground-based DIAL configuration.

Figure 2. LaRC ozone lidar configuration including tunable two wavelengths within 262-313 nm for O3 measurement and 527 nm for aerosol measurement. This ground-based system can be modified to a mobile system.

3. Science Addressed by the Lidar Measurements

(1) Provide high spatio-temporal observations of PBL and FT ozone and aerosol for use by the GEO-CAPE science team to study the character of the atmospheric structure that GEO-CAPE will observe and assess the fidelity with which a geo instrument can measure that structure.

(2) Discover new structures and processes at the PBL/FT boundary, especially in the diurnal variation of that interface.

(3) Foster use of these high-resolution ozone and aerosol observations to improve the processes in air-quality forecast and diagnostic models.

(4) Exploit synergy with DISCOVER-AQ, thermal profilers, MOZAIK/ IAGOS, regulatory surface monitors, and other networks.

(5) Improve our understanding of the relationship between ozone and aerosols aloft and surface ozone and PM values.

(6) Advance our understanding of processes controlling regional background atmospheric composition (including ST and long range transport) and their effect on surface air quality to prepare for the GEO-CAPE era.

4. Conclusions

(1) Ozone/aerosol lidar research initiative will address compelling science questions of regional/local processes controlling air quality:

- Laminar structures associated with long range pollutant transport and stratospheric influence;
- Residual O3 aloft and diurnal PBL pumping.

(2) These measurements will be used to:

- Measure the impact of ozone aloft on surface ozone over a diverse range of air-quality environments in the US;
- Evaluate air quality models to improve their simulation and forecasting capabilities;
- Provide high time-resolved observations to begin preparing for GEO-CAPE satellite mission observations expected early in the next decade;
- Inform future discussion about whether such measurements are needed routinely.

(3) Leveraging a significant current instrumentation and expertise provides a cost-effective way to obtain these research observations.

(4) Interagency interest and participation, and engagement of non-Federal partners to address high-priority research gaps, enhances the probability of effective outcomes.