TITLE: Aerosol Backscatter Studies Supporting LAWS

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SIGNIFICANT ACCOMPLISHMENTS TO DATE:

1. Aerosol backscatter algorithm development.

A. Optimized Royal Signals and Radar Establishment (RSRE), United Kingdom (UK), Laser True Airspeed System (LATAS) algorithm for low backscatter conditions. Algorithm converts backscatter intensity measurements from focused continuous-wave (CW) airborne Doppler lidar into backscatter coefficients.

B. Evaluated performance of optimized algorithm under marginal backscatter signal conditions.

2. CO_2 backscatter climatologies. Statistically analyzed 10.6 micron CO_2 aerosol backscatter climatologies compiled by RSRE, Wave Propagation Laboratory/NOAA (Boulder, CO), and Jet Propulsion Laboratory (Pasadena, CA). Climatologies reveal "clean background" aerosol mode near 10^{-10} $kg^{-1}m^2sr^{-1}$ (mixing ratio units) through middle and upper troposphere, "convective mode" associated with planetary boundary layer convective activity, and "stratospheric mode" associated with volcanically-generated aerosols. Properties of clean background mode are critical to design and simulation studies of Laser Atmospheric Wind Sounder (LAWS), a MSFC Facility Instrument on the Earth Observing System (Eos).

3. Backscatter - water vapor studies. Previous intercomparisons suggested correlation between aerosol backscatter at CO_2 wavelength and water vapor. Field measurements of backscatter profiles with MSFC ground-based Doppler lidar system (GBDLS) were initiated in late FY88 to coincide with independent program of local rawinsonde releases and overflights by Multispectral Atmospheric Mapping Sensor (MAMS), a multi-channel infrared radiometer capable of measuring horizontal and vertical moisture distributions. Design and performance simulation studies for LAWS would benefit from the existence of a relationship between backscatter and water vapor.

FOCUS OF CURRENT RESEARCH AND PLANS FOR FY 89:

1. Backscatter algorithm development.

A. Refine LATAS algorithm to improve performance under marginal signal conditions.

B. Provide expertise to RSRE during debugging phase following installation of LATAS on new research aircraft; analyze forthcoming measurements; update UK climatology.

2. Global Backscatter Experiment (GLOBE) data base. Participate in implementation of GLOBE data base on desk-top computer; incorporate and periodically update CO_2 backscatter climatologies.

3. GLOBE survey flight preparations. Provide expertise on implementation of surface acoustic wave (SAW) spectrum analyzer to MSFC 9.1 and 10.6 micron CW backscatter lidars; apply LATAS algorithm to analysis of measurements from these systems during debug and field phases.

4. Backscatter - water vapor studies. Continue contemporaneous backscatter measurement program begun in late FY88. Define empirical relationship between backscatter and water vapor using (1) aforementioned field measurements and (2) carefully selected backscatter and water vapor measurement sets from, e.g., Joint Airport Weather Studies experiment and from VISSR Atmospheric Sounder (VAS) data archives.

PUBLICATIONS:

Bowdle, D.A., J. Rothermel, J.M. Vaughan, D.W. Brown and M.J. Post, 1988: Aerosol backscatter measurements at 10.6 micrometers with airborne and ground-based CO_2 Doppler lidars over the Colorado High Plains, 1, Lidar intercomparison. Submitted to *J. Geophys. Res.-Atmospheres.*

Bowdle, D.A., J. Rothermel, J.M. Vaughan and M.J. Post, 1988: Aerosol backscatter measurements at 10.6 micrometers with airborne and ground-based CO_2 Doppler lidars over the Colorado High Plains, 2, Backscatter structure. Submitted to *J. Geophys. Res.-Atmospheres.*

Rothermel, J., D.A. Bowdle, J.M. Vaughan and M.J. Post, 1988: Evidence of a tropospheric aerosol backscatter background mode. Submitted to *Nature.*

Rothermel, J., D.A. Bowdle, J.M. Vaughan, D.W. Brown and A.A. Woodfield, 1988: Calculation of aerosol backscatter from airborne CW focused CO_2 Doppler lidar measurements, 1, Algorithm description. Submitted to *J. Geophys. Res.-Atmospheres.*

Rothermel, J., D.A. Bowdle and J.M. Vaughan, 1988: Calculation of aerosol backscatter from airborne CW focused CO_2 Doppler lidar measurements, 2, Algorithm performance. Submitted to *J. Geophys. Res.-Atmospheres.*

Rothermel, J., D.A. Bowdle and J.M. Vaughan, 1988: Aerosol backscatter variability at 10.6 microns over Colorado High Plains during JAWS experiment. Presented, 3rd Conf. Sat. Meteor. Ocean., 1-5 Feb., Anaheim, CA, sponsored by Amer. Meteor. Soc.

Vaughan, J.M., R. Callan, D.A. Bowdle and J. Rothermel, 1988: Spectral analysis, digital integration, and measurement of low backscatter in coherent laser radar. Submitted to *Appl. Optics.*