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 TITLE: Global Backscatter Assessment

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INVESTIGATOR: David A. Bowdle, University of Alabama, Huntsville

SIGNIFICANT ACCOMPLISHMENTS IN THE PAST YEAR:

The activities described below have been performed as part of the GLOBE Backscatter Experiment (GLOBE), an international/interagency program coordinated by NASA to support NASA's Laser Atmospheric Wind Sounder (LAWS).

Global Backscatter Model The focus of this effort is the development of a global-scale model of aerosol backscatter for LAWS design and performance studies. The model is being developed in stages, the first of which is the determination of a design baseline backscatter magnitude. This objective is being attained assuming a global-scale background aerosol with an invariant geometric mean backscatter mixing ratio. Background parameters are derived from aerosol data sets with global-scale spatial and/or temporal coverage, using objective statistical decomposition and/or *a priori* stratification based on supplementary data. Backscatter coefficients at the LAWS design wavelength (currently envisioned to be 9.11 μm) are derived from background aerosol physical, chemical, and optical data, or from direct backscatter measurements at other wavelengths, using background conversion factors. Results to date confirm the background hypothesis to first order. Background backscatter magnitudes appear to be near the expected design threshold for LAWS. Critical uncertainties in the analysis involve lidar calibration procedures, conversion factors, sampling statistics, inter-hemispheric variability, and the effects of massive aerosol injection from volcanoes and dust storms.

Aerosol Data Analysis Direct measurements of aerosol backscatter at 10.6 μm from the Royal Signals and Radar Establishment (RSRE) and the Wave Propagation Laboratory (WPL) were selected for special study. This Investigator assisted in the optimization of the RSRE backscatter data processing code under low backscatter conditions, performed detailed analyses of collocated intercomparisons between the two lidars, and assisted in the analysis of the long-term backscatter climatologies from the two lidars. The intercomparison studies showed sufficient agreement to warrant the climatology study. Both climatologies showed similar background backscatter magnitudes, despite large spatial separation, further confirming the background hypothesis.

GLOBE Special Issue Timely presentation of GLOBE research results to the global geophysical community is required: 1) to ensure a rigorous scientific review of the GLOBE results and their impact on LAWS, 2) to ensure that the community bases its response to LAWS on appropriate evidence, 3) to support aerospace contractor studies for LAWS, and 4) to support national scientific and administrative reviews of LAWS. This objective is being met by a special GLOBE issue of the Journal of Geophysical Research - Atmospheres, for which this Investigator is Lead Guest Editor. The special issue was approved by the GLOBE Scientific Working Group (SWG) in September 1987, a Call for Papers was issued in October 1987, and paper submission was completed in July 1988. Approximately 20 papers are currently being considered for the special issue. Publication is expected in late winter, in time to support critical phases of the LAWS development effort.

Mission Planning Evaluation and screening of existing aerosol data and designing of new aerosol research in support of GLOBE must be consistent with the background aerosol concept if they are to be useful to the LAWS development activity. In the earlier phases of GLOBE, this investigator was instrumental in the design of the GLOBE research effort, using this concept. This activity gradually evolved into evaluation of prospective instrumentation for GLOBE, detailed design of GLOBE field experiments (particularly the 1989 Pacific survey flight on the NASA DC-8), continuing technical liaison with the various GLOBE investigators, and documentation of the overall GLOBE research program.

Eos Proposals Two proposals based on LAWS were submitted to NASA's Earth Observing System (Eos): 1) as Principal Investigator on a LAWS Team Member proposal, involving an extension of the GLOBE backscatter modeling work, and 2) as Co-Investigator on an Interdisciplinary proposal, involving dust plume mapping and dust transport modeling.

Meetings and Communication Regular meetings of the GLOBE SWG are required for updates and critical reviews of the GLOBE data base and the various research elements of the GLOBE program. Six of these meetings have been held since the inception of GLOBE in 1986, including three within the past twelve months. This Investigator has organized and coordinated the technical sessions for these meetings, coordinated and prepared full meeting documentation, including proceedings and technical assessments, and also prepared periodic newsletters between meetings. This activity will continue during the next year with full SWG meetings approximately every six months.

FOCUS OF CURRENT RESEARCH AND PLANS FOR NEXT YEAR:

Background Backscatter Analysis Analysis is continuing on backscatter data sets from the RSRE and WPL lidars. Analysis is beginning on backscatter data from the JPL CO₂ lidar and on aerosol scattering coefficient data from the Mauna Loa Observatory climatology. The focus of these studies will be on the spatial and temporal variability of the background, physical mechanisms for generating and maintaining the background, and the use of surrogate (tracer) data (such as water vapor from rawinsondes and infrared imagers) in extending the global coverage of the background model. Other data will be incorporated as they become available.

Field Experiments Planning is underway for the Mauna Loa Aerosol Backscatter Intercomparison Experiment (MABIE) during late Fall 1988. This experiment will involve many of the instruments that will be used on the NASA DC-8 in the Spring 1989 Pacific Survey flight. MABIE-1988 will be used for instrument shakedown, sampling protocol development, and interim backscatter data supply from low backscatter conditions in the free troposphere over the central Pacific. The Survey flight will provide critical backscatter data over a wide range of meteorological and geographical settings. This Investigator will participate in the planning, coordination, execution, and data analysis phases of both of these experiments, as well as in the calibration of the MSFC continuous-wave CO₂ Doppler lidar to be used in these efforts.

GLOBE Data Base A centralized, user-friendly GLOBE data base, with rapid access capability, is required to support aerospace contractor studies on LAWS, and also to perform in-house performance simulations for prospective LAWS design concepts. The data base has matured from the conceptual phase (SWG meeting, September 1987), to the preliminary design phase (Spring 1988). Detailed design will be completed in late summer 1988, and implementation will commence in Fall 1988. The data base will utilize a microcomputer version of the ORACLE relational data base manager on a dedicated IBM AT, with optical disk storage.

PUBLICATIONS - JOURNAL:

Bowdle, D.A., and D.E. Fitzjarrald, 1989: "The GLOBal Backscatter Experiment (GLOBE): measurement and modeling." To be submitted to special GLOBE issue of J. Geophys. Res.

Bowdle, D.A., J. Rothermel, J.M. Vaughan, D.W. Brown, and M.J. Post, 1989: "Aerosol backscatter measurements with airborne and ground-based CO₂ Doppler lidars over the Colorado High Plains, 1, lidar intercomparison." Submitted to special GLOBE issue of J. Geophys. Res.

Bowdle, D.A., J. Rothermel, J.M. Vaughan, and M.J. Post, 1989: "Aerosol backscatter measurements with airborne and ground-based CO₂ Doppler lidars over the Colorado High Plains, 2, backscatter structure." Submitted to special GLOBE issue of J. Geophys. Res.

Patterson, E.M., and D.A. Bowdle, "Use of aerosol microphysical measurements to model IR backscatter in support of GLOBE." Submitted to special GLOBE issue of J. Geophys. Res.

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, 1989: "Calculation of aerosol backscatter from airborne CW focused CO₂ Doppler lidar measurements, 1, Algorithm description." Submitted to special GLOBE issue of J. Geophys. Res.

Rothermel, J., D.A. Bowdle, and J.M. Vaughan, 1989: "Calculation of aerosol backscatter from airborne CW focused CO₂ Doppler lidar measurements, 2, Algorithm performance." Submitted to special GLOBE issue of J. Geophys. Res.

Vaughan, J.M., D.A. Bowdle, R. Callan, and J. Rothermel, 1989: "Spectral analysis, digital integration, and measurement of low backscatter in coherent laser radar." Submitted to Appl. Opt.

PUBLICATIONS - CONFERENCE:

*Fourth Conference on Coherent Laser Radar:
Technology and Applications, Aspen, CO, July 25-31, 1987*

Bowdle, D.A.: "A global-scale model of aerosol backscatter at CO₂ wavelengths"

Bowdle, D.A. and D. E. Fitzjarrald: "The GLOBal Backscatter Experiment (GLOBE) program" (invited paper)

Bowdle, D.A., W. D. Jones, A. D. Clarke, S. A. Johnson, and D. E. Fitzjarrald: "Mauna Loa Aerosol Backscatter Intercomparison Experiment (MABIE)"

Patterson, E.M., and D.A. Bowdle: "Use of aerosol microphysical measurements to model IR backscatter in support of GLOBE"

Rothermel, J., J.M. Vaughan, and D.A. Bowdle: "Algorithm to calculate aerosol backscatter from airborne CW focused CO₂ Doppler lidar measurements"

Vaughan, J.M., D.W. Brown, J. Rothermel, and D.A. Bowdle: "Measurements of aerosol backscatter at CO₂ wavelengths with the airborne Laser True Airspeed System (LATAS)"

*Symposium on Aerosols and Climate
International Association of Meteorology and Atmospheric Physics
International Union of Geodesy and Geophysics
Vancouver, British Columbia, August 11-18, 1987*

Bowdle, D.A., J. Rothermel, and J.M. Vaughan: "Micro-scale to global-scale variability of atmospheric aerosol backscatter at 10.6 micrometers wavelength"

*Third Conference on Satellite Meteorology and Oceanography
Anaheim, California, February 1-5, 1988*

Bowdle, D.A., 1988: "The GLOBal Backscatter Experiment (GLOBE) measurement and modeling program"

PUBLICATIONS - OTHER:

- Bowdle, D.A., and D.E. Fitzjarrald (Eds.), 1988: GLOBE Survey Flight Program Test Plan.** In preparation.
- Bowdle, D.A., W.D. Jones, A.D. Clarke, S.A. Johnson, and D.E. Fitzjarrald, 1987: "Mauna Loa Aerosol Backscatter Intercomparison Experiment (MABIE)",** in Geophysical Monitoring for Climatic Change, No. 15, Summary Report 1986, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Research Laboratories, Boulder CO, December 1987. 137-139.
- Vaughan, J.M., D.W. Brown, P.H. Davies, R. Foord, J. Cannel, C. Nash, A.A. Woodfield, D.A. Bowdle, and J. Rothermel, 1987: Atmospheric Backscatter at 10.6 um: A Compendium of Measurements Made Outside the United Kingdom by the Airborne LATAS Coherent Laser Radar Velocimeter. RSRE Report 87002,** Royal Signals and Radar Establishment, Great Malvern, United Kingdom, May 1987.

PUBLICATIONS - GLOBE SWG

Proceedings

- Bowdle, D.A.(Ed), 1987: Proceedings: Third Meeting of the GLOBE Scientific Working Group, Guntersville, Alabama, May 4-6, 1987,** Birch and Davis Associates, Silver Springs, Maryland, 223 pp.
- Bowdle, D.A. (Ed), 1988: Proceedings: Fifth Meeting of the GLOBE Scientific Working Group, Oakland, California, February 8-10, 1988,** Birch and Davis Associates, Silver Springs, Maryland, 190 pp.

Summaries

- Bowdle, D.A., 1987: Summary of Third GLOBE Meeting, Guntersville, Alabama, May 4-5, 1987,** University of Alabama at Huntsville, Huntsville, Alabama, 9 pp.
- Bowdle, D.A., and D.E. Fitzjarrald (Eds), 1988: Technical Session Summaries, Fifth Meeting for the GLOBal Backscatter Experiment (GLOBE), Oakland, California, February 8-10, 1988,** Birch and Davis Associates, Silver Springs, Maryland, 9pp.

Newsletters

- Bowdle, D.A., 1987: GLOBE Newsletter, Vol. 1, No. 1,** June 1, 1987, University of Alabama at Huntsville, Huntsville, Alabama, 6 pp.
- Bowdle, D.A., 1987: GLOBE Newsletter, Vol. 1, No. 2,** December 15, 1987, University of Alabama at Huntsville, Huntsville, Alabama, 6 pp.