FORM A: GACP ACCOMPLISHMENT REPORT

Name: David A. Bowdle

Institution: University of Alabama in Huntsville

TITLE: Characterization of Elevated Aerosol Layers as a Liaison to NASA's Aerosol Climatology Program from NASA's MACAWS, ACLAIM, SPARCLE, and ATMOS/CCOSM Programs

ABSTRACT: This letter proposal requests a three-year term of service on the Aerosol Science Team (AST) for NASA's Global Aerosol Climatology Program (GACP), as a scientific liaison from related NASA programs for the Multi-center Airborne Coherent Atmospheric Wind Sensor (MACAWS), the Airborne Coherent Lidar for Advanced Inflight Measurements (ACLAIM), the SPAce Readiness Coherent Lidar Experiment (SPARCLE), and the Atmospheric Trace Molecule Spectroscopy (ATMOS) sensor / Chemistry and Circulation Occultation Spectroscopy Mission (CCOSM). The proposal requests funding for participation in the AST and for data management in the characterization of elevated aerosol layers. The rest of the proposed research will be funded by the proposer's participation in MACAWS, ACLAIM, SPARCLE, and ATMOS/CCOSM.

GOALS: The long-term goal of this research is to develop semi-empirical models for aerosol backscatter statistics at selected laser wavelengths in the middle and upper troposphere. These models will provide inputs to Doppler lidar design studies for remote measurements of turbulence from aircraft and remote measurements of global wind fields from low earth orbit. The aerosol measurement and modeling studies for these prospective Doppler lidar systems will also provide useful inputs to the NASA GACP.

OBJECTIVES: The objective of the proposed research is to develop a climatology for elevated aerosol layers that originate in the planetary boundary layer (PBL). Relevant properties for these layers include aerosol physicochemical properties; their variability and correlation with meteorological features on meso- to synoptic spatial/temporal scales; plus their variability and frequency of occurrence on regional to global and seasonal to inter-annual spatial/temporal scales.

APPROACH: Baseline aerosol properties, and perturbations around those baseline values, will be derived from selected aerosol databases. Positive perturbations larger than empirically derived thresholds will usually be assumed to originate from elevated aerosol layers. Perturbations due to PBL aerosols will be identified using aerosol composition, wavelength dependence of aerosol optical properties, and collocated water vapor concentrations. PBL-sourced perturbations will be correlated with meteorological features that are diagnosed from global gridded meteorological data sets. Particular emphasis will be given to meteorological features that are associated with vertical transport, long-distance transport, and other strong dynamic activity. The PBL-sourced aerosol distributions and their meteorological contexts will be combined into a global climatology.

COMPLETED TASKS: The proposed research included activities that were specifically funded under this GACP proposal, and related activities that were funded separately from the MACAWS, ACLAIM, SPARCLE, and ATMOS liaison programs. GACP funding did not arrive until late April 1999. Therefore, GACP-sponsored tasks are only in the early start-up phase, and none of these tasks has been completed. Several GACP-related tasks have been wholly or partially completed during the nominal GACP contract year, under separate funding from the liaison programs. These tasks include:

- preliminary statistical analysis of modeled global sulfate distributions from the NCAR Community Climate Model, Version 3+ (CCM3+), using the proposed methodology

- meteorological analysis, and comparison of measured and modeled aerosol backscatter at 2 μm wavelength in clear air conditions, for lee-wave turbulence, convective boundary layer turbulence, and the quiescent free troposphere, during the first airborne field tests of the ACLAIM instrument near the Colorado Rocky Mountains in March/April 1998.
- recovery of broad-band spectral calibration coefficients, parameterization of particulate spectral optical properties, and exploration of novel analytical methods for particulate retrievals from solar occultations with ATMOS, a Fourier Transform Infrared (FTIR) spectrometer that flew on the Space Shuttle in 1985, 1992, 1993, and 1994

RESULTS:

- identified prominent background aerosol mode in NCAR sulfate model statistics
- excellent agreement between measured and modeled temporal trends for 2-μm aerosol backscatter
- established quantitative limits for broadband self-calibration in particulate retrievals from ATMOS

FUTURE PLANS:

- continue analysis of existing ACLAIM data, and participate in new ACLAIM field program
- develop ATMOS retrieval algorithm for particulate concentration, composition, and size
- acquire measured and modeled aerosol data sets from selected data providers
- convert compiled data sets into standard file formats and standard aerosol properties
- analyze statistical properties of aerosol data sets using proposed methodology
- evaluate relative importance of “nucleation and aging” versus “vertical transport and dilution”

FORM B: GACP SIGNIFICANT HIGHLIGHTS

Name: David A. Bowdle

Institution: University of Alabama in Huntsville

SIGNIFICANT HIGHLIGHTS: none submitted

FORM C: FUTURE PLANS

Name: David A. Bowdle

Institution: University of Alabama in Huntsville

Briefly describe your research plans for the second year of GACP: During the last few months, NASA has eliminated two of the aerosol-related instrument development projects (SPARCLE [cancellation imminent] and CCOSM [mission proposal not selected])for which I proposed to serve as a liaison to the GACP. The loss of those missions will deprive the GACP from future opportunities for unique "ground-truth" experiments and expanded aerosol databases. These losses will also modify the nature and scope of my GACP-related research, both externally funded and funded under GACP. Since GACP funds arrived only three months ago, the modified plan essentially represents the first year, and not the second year, of activity under this GACP proposal:

- acquire gridded aerosol data from selected chemical transport models, both GACP and others
- transform modeled data sets into standard file formats and standard aerosol properties
- analyze statistical properties of aerosol data sets using the proposed methodology

FORM D: GACP BIBLIOGRAPHY

Name: David A. Bowdle

Institution: University of Alabama in Huntsville

BIBLIOGRAPHY:

Papers, reports, and presentations refer to those published during GACP by the principal investigator, co-investigators, and other researchers supported by your agency for aerosol research. Include those in progress or planned. Note: the following listing includes publications prepared under GACP-related funding.

a. List of publications (including books, book chapters, and refereed papers), using AMS bibliographic citation form.

Published

Cutten, D.R., J.D. Spinhirne, R.T. Menzies, D.A. Bowdle, V. Srivastava, R.F. Pueschel, A.D. Clarke, and J. Rothermel, 1998: Intercomparison of pulsed lidar data with flight level CW lidar data and modeled backscatter from measured aerosol microphysics near Japan and Hawaii. *J. Geophys. Res.*, **103**, **D16**, 19,649-19,661.

In Progress

Bowdle, D.A., and M.A. Jarzembski: Aerosol backscatter measurement uncertainty with focused CO_2 Doppler lidars. In preparation for submission to *Appl. Opt.*

Bowdle, D.A., M.J. Newchurch, M.R. Gunson, A.Y. Chang, A. Eldering, and C.P. Rinsland: Atmospheric aerosol and cloud retrievals from ATMOS infrared transmittance spectra: Broadband calibration spectra. In preparation for submission to *Appl. Opt.*

Bowdle, D.A., and M.J. Newchurch: Atmospheric aerosol and cloud retrievals from ATMOS infrared transmittance spectra: Parameterization of particulate optical properties. In preparation for submission to *J. Geophys. Res.*

Bowdle, D.A., and J. Rothermel: Turbulent-scale aerosol backscatter variability in the middle and upper troposphere: Atmospheric and instrumental effects on backscatter measurements by focused CO_2 Doppler lidars. In preparation for submission to *J. Atmos. Oceanic Technol.*

Srivastava, V., J. Rothermel, A. D. Clarke, D. R. Cutten, M. A. Jarzembski, D. A. Bowdle, R. T. Menzies, J. D. Spinhirne, and E. W. McCaul, 1999: Backscatter modeling at 2.1 μm wavelength for space-based and airborne lidars using aerosol microphysics and lidar datasets. In preparation for submission to *Appl. Opt.*

b. List of printed technical reports and non-refereed papers.

In Progress

Soreide, D., D.A. Bowdle, S.M. Hannon, R.K. Bogue, and L.J. Ehrenberger: ACLAIM Flight Test Results. In preparation as NASA Technical Report. National Aeronautics and Space Administration, Washington, DC.

c. List of oral presentations or posters at professional society meetings and conferences.

Published/Presented

Bowdle, D.A., Hannon, S.M., and R.K. Bogue, 1999: Comparison of predicted and measured 2 μm aerosol backscatter from the 1998 ACLAIM flight tests. Presented at Tenth Biennial Conference on Coherent Laser Radar Technology and Applications, Timberline Lodge, Mount Hood, Oregon, June 28-July 2, 1999. Optical Society of America, Washington, DC.

Hannon, S.M., H.R. Bagley, D.C. Soreide, D.A. Bowdle, R.K. Bogue, and L.J. Ehrenberger, 1999: Airborne turbulence detection and warning: ACLAIM flight test results. Invited paper, In Technical Digest, Tenth Biennial Conference on Coherent Laser Radar Technology and Applications, Timberline Lodge, Mount Hood, Oregon, June 28-July 2, 1999. PP 20-23. Optical Society of America, Washington, DC.

Srivastava, V., J. Rothermel, M.A. Jarzembski, A.D. Clarke, D.R. Cutten, D.A. Bowdle, J.D. Spinhirne, and R.T. Menzies, 1999: Backscatter modeling at 2.1 micron wavelength for space-based and airborne lidars using aerosol physico-chemical and lidar datasets. In Technical Digest, Tenth Biennial Conference on

Coherent Laser Radar Technology and Applications, Timberline Lodge, Mount Hood, Oregon, June 28-July 2, 1999. PP 147-150. Optical Society of America, Washington, DC.