N93-20101

Title: MULTI-CENTER AIRBORNE COHERENT ATMOSPHERIC WIND SENSOR (MACAWS)

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Background of the Investigation:
Funding began in April 1992. This effort involves development of a calibrated, pulsed, coherent CO_2 Doppler lidar, followed by a carefully-planned and -executed program of multi-dimensional wind velocity and aerosol backscatter measurements from the NASA DC-8 research aircraft. The lidar, designated as the Multi-center Airborne Coherent Atmospheric Wind Sensor (MACAWS), will be applicable to two research areas. First, MACAWS will enable specialized measurements of atmospheric dynamical processes in the planetary boundary layer and free troposphere in geographic locations and over scales of motion not routinely or easily accessible to conventional sensors. The proposed observations will contribute fundamentally to a greater understanding of the role of the mesoscale, helping to improve predictive capabilities for mesoscale phenomena and to provide insights into improving model parameterizations of sub-grid scale processes within large-scale circulation models. As such, it has the potential to contribute uniquely to major, multi-institutional field programs planned for the mid-1990's. Second, MACAWS measurements can be used to reduce the degree of uncertainty in performance assessments and algorithm development for NASA's prospective Laser Atmospheric Wind Sounder (LAWS), which has no space-based instrument heritage. Ground-based lidar measurements alone are insufficient to address all of the key issues.

To minimize costs, MACAWS is being developed cooperatively by the lidar remote sensing groups of the Jet Propulsion Laboratory, NOAA Wave Propagation Laboratory, and MSFC using existing lidar hardware and manpower resources. Several lidar components have already been exercised in previous airborne lidar programs (for example, MSFC Airborne Doppler Lidar System (ADLS) used in 1981,4 Severe Storms Wind Measurement Program; JPL Airborne Backscatter Lidar Experiment (ABLE) used in 1989,90 Global Backscatter Experiment Survey Missions). MSFC has been given responsibility for directing the overall program of instrument development and scientific measurement.

Significant Accomplishments in the Past Year:
None; this is a new effort.

Focus of Current Research and Plans for Next Year:
Three primary activities are being conducted during the remainder of this fiscal year. The first involves definition and acquisition of the MACAWS data system, which must orchestrate in real time all functions and subsystems, including: user interface; basic input/output of the transmitter/receiver; constant adjustment of germanium wedge scanner to compensate for changes in aircraft attitude and speed using inputs from a dedicated inertial navigation unit; acquisition and use of measurements from the DC-8 digital aircraft data system; calculation and display of moment estimates; and calculation and display of two-dimensional wind vectors for various scan patterns. The second activity involves development and execution of a flight qualification test plan for existing MSFC germanium optical windows through which the MACAWS lidar beam is to be directed to the atmosphere. Development of the plan involves cooperation with flight safety personnel at the NASA Ames Research Center. The third activity involves upgrading the aircraft software simulator to emulate with the DC-8 operating environ-

ment. The aircraft simulator is required for data system development and MACAWS performance simulation.

Instrument development is planned for FY92-5, with first flights on the NASA DC-8 in FY95. Activities planned at MSFC for the next fiscal year include: (1) continued coordination of overall MACAWS development, (2) development or refurbishment of lidar hardware subsystems and corresponding mechanical and electrical interfaces for which MSFC is directly responsible, and (3) refinement of science objectives and flight plans in cooperation with MACAWS co-investigators.

Publications:

An airborne Doppler lidar system of similar design but with more modest capability was first developed and demonstrated by MSFC researchers in the early 1980's. The following references provide examples of the scientific utility of such a system:

Bilbro, J.W., G.H. Fichtl, D.E. Fitzjarrald and M. Krause, "Airborne Doppler lidar wind field measurements," *Bull. Amer. Meteor. Soc.*, **65**, 348-359 (1984).

Bilbro, J.W., C.A. Dimarzio, D.E. Fitzjarrald, S.C. Johnson and W.D. Jones, "Airborne Doppler lidar measurements," *Appl. Opt.*, **25**, 3952-3960 (1986).

Blumen, W. and J.E. Hart, "Airborne Doppler lidar wind field measurements of waves in the lee of Mount Shasta," *J. Atmos. Sci.*, **45**, 1571-1583 (1988).

Carroll, J.J., "Analysis of airborne Doppler lidar measurements of the extended California sea breeze," *J. Atmos. Oceanic Tech.*, **6**, 820-831 (1989).

Emmitt, G.D., "Convective storm downdraft outflows detected by NASA/MSFC's 10.6 micron pulsed Doppler lidar system," *NASA CR-3898*, Marshall Space Flight Center, Huntsville, AL, 46 pp. (1985).

McCaul, E.W., Jr., H.B. Bluestein and R.J. Doviak, "Airborne Doppler lidar observations of convective phenomena in Oklahoma," *J. Atmos. Oceanic Tech.*, **4**, 479-497 (1987).