TITLE: Analysis of Lidar, Radar, and Satellite Measurements on Severe Thunderstorms and Their Environments

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Significant Accomplishments to Date in FY-84:

Intercomparison of wind data from the airborne Doppler lidar, ground-based Doppler radars, the 444 m NSSL-KTVY tower, and rawinsonde has been completed. The vertical profile of wind in the PBL measured by the radars compared favorably with the profiles measured by the tower and rawinsonde while the one obtained from lidar data differed from the other three by as much as 3m/sec in wind speed and 38° in direction. The time dependence of differences in wind estimates from radar and lidar suggested that these discrepencies could be attributed to a Schuler resonance in the aircraft's inertial navigation system which caused an erroneous component of the aircraft's velocity vector to be subtracted from the lidar radial velocities, thus creating errors in the synthesized wind speed and direction. The vertical profile of turbulent fluctations of the horizontal wind detected by the different systems compared well. Also, spectra from the different sensing systems compared well in both magnitude and shape, suggesting that the lidar and radar detected similar turbulent structure.

This study has added to the documentation on the structure of the convective PBL. The vertically averaged winds over the PBL were found to be insensitive to baroclinicity, supporting the hypothesis of Arya and Wyngaard (1975). The computed momentum flux profiles were found to be in agreememt with those predicted by numerical models for the baroclinic, convective PBL. A consistent peak found near 4 km in all the

spectra computed from data collected on June 29, 1981 could be attributed to horizontally symmetric cells with horizontal wavelength 4 times the boundary layer height as theoretically shown by Kuettner (1971) for the case of weak wind shear.

Doppler lidar, aircraft, and surface mesonetwork data along two gust fronts were analyzed and examined. Wavelike patterns in the wind field appeared along one of the gust fronts. Doppler lidar data were analyzed at two levels in the area surrounding a growing, isolated, towering cumulus. The wind field was mainly convergent at both levels; the cloud was embedded within a line of convergence.

An observational study of a mesoscale area of convection in western Kansas has been completed, and it is hypothesized that the nocturnal thunderstorms were formed in response to lift (due to warm advection) of an elevated layer of conditional instability.

Focus of Current Research Activities:

Research is concluded and the final report is being prepared.

Plans for FY-85:

We look forward to participating in the FY '85 CV990 flights, data collection, and analyses.

Recommendations for New Research:

There is still an urgent need for the study of wind shear and the downburst phenomenon in connection with aircraft landing and take-off safety. Airborne Doppler lidar in conjunction with ground-based Doppler radars can be advantageously used for this study, and also for the study of the flow pattern in the vicinity of tornadoes, wall clouds, flanking lines, gust fronts, and pre-storm boundaries.

List of Publications Prepared since June 1983:

Bluestein, H.B., "An Observational Study of a Mesoscale area of Convection in Western Kansas" - submitted for publication in Monthly Weather Review.

Bluestein, H.B., E.W. McCaul, Jr., and D. Fitzjarrald, 1983: Airborne Doppler lidar and ground-based Doppler radar observations of a thunderstorm in Oklahoma. Preprints, 21st Conf. on Radar Meteorology (Edmonton), Amer. Meteor. Soc., 85-90. (cited previously)

Doviak, R.J., M. Eilts, and D. Fitzjarrald, "Remote and In-situ Observations of Atmospheric Winds and Turbulence Compared with Each Other and Theoretically Predicted Circulations" - Presented at the First Australian Conference on the Physics of Remote Sensing of Atmosphere and Ocean, Melbourne, Australia, 13-16 February 1984.

Eilts, M., 1983: "The Structure of the Convective Boundary Layer As Seen by Lidar and Doppler Radars". M.S. Thesis, University of Oklahoma, Norman, OK.

Eilts, M.D., A. Sundara-Rajan, and R.J. Doviak, "Boundary Layer Winds, Waves, and Turbulence Observed with Airborne Doppler Lidar and Ground-Based Dual Doppler Radars" - to be presented at the Twelfth International Laser Radar Conference to be held at Aux. En. Provence, France during 13-17 August 1984.

Eilts, M.D., R.J. Doviak and A. Sundara-Rajan, "The Structure of the Convective Atmospheric Boundary Layer As Revealed by Lidar and Doppler Radars" - submitted to Boundary-layer Meteorology.

Eilts, M.D., R.J. Doviak, and A. Sundara-Rajan, "Comparison of Winds, Waves, and Turbulence As Observed by Airborne Doppler Lidar, Ground Based Radars and Tall Tower" - submitted for publication in Radio Science.

McCaul, E.W., Jr., "Observations of Oklahoma convection using airborne Doppler lidar and Doppler radar", M.S. Thesis, University of Oklahoma, Norman, OK.

McCaul, E.W., Jr. and H. Bluestein, "Analysis of airborne Doppler lidar and ground-based Doppler radar observations of convection in Oklahoma" - to be submitted to J. Atmos. and Oceanic Tech.