Research Summary Report

Evaluation of Airborne Doppler Lidar Wind Measurements

John J. Carroll
Department of Land, Air and Water Resources
University of California
Davis, California 95616
(916) 752-3245

FY-84 Accomplishments:

The primary thrust of this investigation continues to be the verification of the doppler lidar wind measurment system. It was intended that in situ measurements on a 500 meter tall tower would be used to check the lidar determined winds (flight 4), followed by other tests applied to the extensive data sets of flights 19 and 21. In fact, we have not been able to derive self consistent wind fields for any of these data. After checking for possible software errors in the processing programs at MSFC and at Davis, we have not been able to solve the inconsistency problem. The source of the errors appears to be the uncertainty in the calculation of the contribution of the aircraft motion to the lidar measured line of sight speed. Given that typical wind speeds are usually less than 20 knots whereas the aircraft travels at a minimum of 250 knots, most of the measured doppler speed is due to the aircraft motion. An error in either the ground speed or track angle results in an error in the calculated contribution of the aircraft motion to the line of sight speed. When the calculated aircraft induced component is subtracted from the measured doppler speed, this error is added to the contribution of the real wind. While the percentual error in the aircraft induced

doppler speed is small relative to the aircraft speed, it is large relative to the wind speed.

The aircraft motion information is derived from the inertial navigation system (INS) in which errors of a knot in ground speed and a degree in track angle are not uncommon. For each one knot error in ground speed, the doppler derived wind speed will have an error between 0.05 and 1.0 knots in speed and up to 6° in direction depending on the wind direction relative to the flight path. For a track angle error of only 0.8 degrees, wind speed errors of up to 35% and direction errors in excess of 20° can be encountered with a mean wind of 10 knots. Again the error is dependent on the angle between the aircraft path and the wind direction. If wind field mapping with this technique is to be successful, errors in the aircraft motion must be less than 0.3 knots in speed and less than 0.1° in direction.

Current Research:

We are presently investigating possible techniques for estimating the aircraft motion errors from the aircraft data themselves. If this can be done, even for only certain very restricted circumstances, it would be useful for the design of future flight plans and experiments. We are also examining the suggestion of Dr. Fitzjarrald that ground returns be used in future flights to directly measure the aircraft contribution to the doppler measured speeds and make the subtraction of the aircraft induced component independent of the INS.

Plans for FY-85:

The current project will end by summer 1984. Our future plans are

to participate in the FY-85 flight program on the assumption that the problems identified here can be resolved. We will also be preparing a proposal to use this technique to obtain a detailed study of terrain modified sea breeze circulations from data obtained during the FY-85 flight program.

Publications:

On the accuracy of wind measurements using an airborne doppler lidar submitted to Jl of Atmos. and Oceanic Technology.