DRA/ LANGLEY

DEPARTMENT OF GEOLOGY
SCHOOL OF SCIENCES AND HEALTH PROFESSIONS
OLD DOMINION UNIVERSITY
NORFOLK, VIRGINIA

TECHNICAL REPORT GSTR-84-12

FIELD TESTS OF THE REAL-DATA ACQUISITION SYSTEM FOR THE NASA-LaRC DIFFERENTIAL ABSORPTION LIDAR

By

Carolyn Butler

Submitted by Earl C. Kindle, Principal Investigator

Progress Report
For the period January 1, 1984 to June 31, 1984

Prepared for the
National Aeronautics and Space Administration
Langley Research Center
Hampton, Virginia 23665

Under
Research Grant NCC1-28
Edward Browell, Technical Monitor
Chemistry and Dynamics Branch

Submitted by the
Old Dominion University Research Foundation
P.O. Box 6369
Norfolk, Virginia 23508

September 1984

A data acquisition system (DAS) for the NASA/LaRC Differential Absorption Lidar (DIAL) was documented in ODU Technical Report GSTR-84-5. This DAS is a dual LSI 11/23 set-up where one computer retrieves data from the digitizers and other peripheral units, stores that data on magnetic tape, generates aerosol grayscales on a Trilog printer and passes data to the second computer. The second computer is dedicated to real-time displays of the data in a variety of modes from raw data to range resolved ozone profiles. The DIAL DAS also has several new features:

(1) a dual mag tape drive system which allows for continuous data acquisition during rewind operations
(2) both tape units can record in streamer mode (100 ips) if the data is buffered appropriately
(3) five new Transiac 12-bit digitizers and amplifiers to replace the Biomation 10-bit digitizers
(4) a Matrox QRGB-GRAPH Controller for video display with 256 X 512 pixel resolution
(5) a navigation interface which accepts both LORAN and OMEGA inputs (switch selectable) for latitude and longitude data
(6) a ADV11-C analog to digital converter with up to 10 volt range for digitization of laser energies and met data
(7) a TCU50-DYR time clock with capability to retain time of day and date for upto 3 months without external power

In order to implement these system improvements the DIAL DAS software had to be, for the most part, re-designed. I have written all my own MACRO subroutines to drive each of these peripheral units in order to save CPU time and memory and to customize them for our purposes. The resulting MASTER program which runs on LSI #1 uses nearly all of the 128k word memory available. The MASTER program and RT-11 monitor reside in the lower 32k of memory. Extended memory is used for data storage from the Transiacs (up to 4096 words per buffer) where it is buffered until written to magnetic tape. The SLAVE program which runs on LSI #2 uses only the lower 32k of memory.

The DIAL DAS hardware and software were first field tested in April 1984 during the Global Tropospheric Experiment's (GTE) Tropopause Fold Experiment (TPE). The TPE is one of a number of experimental objectives of the GTE. The TFE was conducted to measure the effects of a stratospheric incursion into the troposphere. On a number of different flights the NASA Electra flew across the fold. The DIAL system made simultaneous measurements of aerosols and ozone with dramatic increases of both species observed in the fold itself.

The DIAL DAS proved not only flight worthy but also did nearly everything it was designed to do. The problems encountered are outlined below.

(1) Due to the use of re-cycled tapes, dirt collected on the head of one of the Cipher tape drives which left us with only one tape drive for the remainder of the

flight. The tape drives are not easily accessible during flight so we were forced to circle back to position during rewind operations. This problem was avoided on future flights by periodic cleaning of both tape units and by using only new tapes.

(2) One of the Transiac units overheated minutes after the CAMAC crate power was turned on but since we carried spares this did not present a major problem. The problem turned out to be a temperature sensor on the unit that was bent too close to a very active, heat generating component. The sensor was bent in another direction and the problem went away.

(3) To allow for more cooling to occur in the Transiacs all the sides were removed from the amplifiers and digitizers. On later analysis of the data, discontinuties were found in the returns which turned out to be caused by "cross-talk" between amplifiers and the digitizers. The sides were all replaced and the problem was eliminated.

(4) The software was written so that the highest priority was to record the data on tape. During the TFE, however, CPU scheduling conflicts occurred occasionally between the mag tape interface (DILOG DQ130), formatted Fortran WRITE instructions to the Trilog T-100 and data transfer from the Transiacs. The problem was minimized during the experiment by starting output to the printer (which begins with a Fortran WRITE then proceeds to plot output) prior to recording data. On return to Langley, the DQ130 interface board was modified to make it a high priority device. The hardware modification now allows the mag tape routines to interrupt the Transiac data transfer routines. Since I have no control over the priority status of the Fortran WRITE statements a timing conflict occasionally occurs. This timing conflict results in the loss of, at most, 20 data shots before the problem is corrected and only occurs when the banner record (256 word record printed at start of grayscales) is printed on the Trilog -- if it happens at all.

(5) A software bug caused LSI #1 to fail intermittently. Attempts were made to trace the bug in between flights but to no avail. During flights the solution to such failures was to re-start both computers. On return to Langley the error was eventuallly found and corrected.

During the months of May and June items (3), (4) and (5) above were corrected. Additional hard copy aerosol grayscales with profile averaging were generated. An option to average upto 15 shots for the aerosol grayscales, in flight, was added to the program. An array transformation for a log amplifier was included in the program (but never implemented in the field). More versatility in choosing the area for background subtraction was incorporated into the program with the command BGLEN I where I is the number of words to average (see GSTR-84- 5 p.42).

By early June DIAL was back in the field preparing for

another GTE project. The Atlantic Boundary Layer Experiment (ABLE) was designed to study the marine boundary layer off the continental shelf. For two weeks flights were made over Barbados, W.I. with the DIAL system again measuring ozone and aerosols. One flight was made over Guyana to study the atmosphere over the dense tropical rain forests. This latter flight was a feasibility study for next year's mission to Brazil. The DIAL DAS functioned extremely well -- the hardware worked reliably; the software did all it was designed to do with no "bugs".