NOAA Technical Memorandum ERL ARL-232

DATA REPORT: LONGEZ (N3R) PARTICIPATION IN THE 1999 SHOALING WAVES EXPERIMENT (SHOWEX) SPRING PILOT STUDY

Gennaro H. Crescenti
Timothy L. Crawford

Field Research Division
Idaho Falls, Idaho

Edward J. Dumas

Atmospheric Turbulence and Diffusion Divsion
Oak Ridge, Tennessee

Air Resources Laboratory
Silver Spring, Maryland
September 1999

UNITED STATES DEPARTMENT OF COMMERCE

William M. Daley
Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

D. JAMES BAKER
Under Secretary for Oceans and Atmosphere/Administrator

Environmental Research Laboratories

James L. Rasmussen
Director

Table of Contents

		Page
	Notice	ii
	List of Figures	v
	List of Tables	vii
	List of Abbreviations and Acronyms	viii
	List of Symbols	ix
	Abstract	x
1	Introduction	1
2	Description of the LongEZ, Sensors and Data Acquisition System	2
	2.1 LongEZ	2
	2.2 *In Situ* and Remote Sensors	2
	2.3 Data Acquisition System	5
3	Data	6
	3.1 In-Flight Data Collection	6
	3.2 Post-Flight Data Processing	9
4	Flight Summaries	12
	4.1 Flight 1: 01 MAR 99 (MON)	12
	4.2 Flight 2: 02 MAR 99 (TUE)	12
	4.3 Flight 3: 02 MAR 99 (TUE)	12
	4.4 Flight 4: 03 MAR 99 (WED)	16
	4.5 Flight 5: 04 MAR 99 (THU)	16
	4.6 Flight 6: 04 MAR 99 (THU)	16
	4.7 Flight 7: 05 MAR 99 (FRI)	16
	4.8 Flight 8: 05 MAR 99 (FRI)	16
	4.9 Flight 9: 06 MAR 99 (SAT)	16
	4.10 Flight 10: 07 MAR 99 (SUN)	17
	4.11 Flight 11: 07 MAR 99 (SUN)	17
	4.12 Flight 12: 08 MAR 99 (MON)	17
	4.13 Flight 13: 08 MAR 99 (MON)	17
	4.14 Flight 14: 09 MAR 99 (TUE)	18
	4.15 Flight 15: 10 MAR 99 (WED)	18

4.16 Flight 16: 11 MAR 99 (THU) 18
4.17 Flight 17: 11 MAR 99 (THU) 18
4.18 Flight 18: 12 MAR 99 (FRI) 18
4.19 Flight 19: 13 MAR 99 (SAT) 19
4.20 Flight 20: 16 MAR 99 (TUE) 19
4.21 Flight 21: 17 MAR 99 (WED) 19
4.22 Flight 22: 17 MAR 99 (WED) 19
4.23 Flight 23: 18 MAR 99 (THU) 20

Acknowledgments 21

References 22

Appendix A: Marker Files 24

Appendix B: LongEZ Flight Paths 64

List of Figures

		Page
Figure 1.	The LongEZ at the Wright Brother's Memorial in Kill Devil Hills, NC	1
Figure 2.	Schematic of the LongEZ with sensors	4
Figure 3.	Meteorological time series from FRF pier during SHOWEX	15
Figure 4.	Flight 1, Monday, 1 March 1999	64
Figure 5.	Flight 2, Tuesday, 2 March 1999	65
Figure 6.	Flight 3, Tuesday, 2 March 1999	66
Figure 7.	Flight 4, Wednesday, 3 March 1999	67
Figure 8.	Flight 5, Thursday, 4 March 1999	68
Figure 9.	Flight 6, Thursday, 4 March 1999	69
Figure 10.	Flight 7, Friday, 5 March 1999	70
Figure 11.	Flight 8, Friday, 5 March 1999	71
Figure 12.	Flight 9, Saturday, 6 March 1999	72
Figure 13.	Flight 10, Sunday, 7 March 1999	73
Figure 14.	Flight 11, Sunday, 7 March 1999	74
Figure 15.	Flight 12, Monday, 8 March 1999	75
Figure 16.	Flight 13, Monday, 8 March 1999	76
Figure 17.	Flight 14, Tuesday, 9 March 1999	77
Figure 18.	Flight 15, Wednesday, 10 March 1999	78
Figure 19.	Flight 16, Thursday, 11 March 1999	79
Figure 20.	Flight 17, Thursday, 11 March 1999	80

Figure 21. Flight 18, Friday, 12 March 1999 81

Figure 22. Flight 19, Saturday, 13 March 1999 82

Figure 23. Flight 20, Tuesday, 16 March 1999 83

Figure 24. Flight 21, Wednesday, 17 March 1999 84

Figure 25. Flight 22, Wednesday, 17 March 1999 85

Figure 26. Flight 23, Thursday, 18 March 1999 86

List of Tables

Page

Table 1. The LongEZ dimensional and performance specifications 3

Table 2. ORG data file specifications 7

Table 3. Listing from HEADER.TXT used during SHOWEX 8

Table 4. Empirical calibration constants used for wind velocity corrections 10

Table 5. Aircraft variables available in NCR and NCP netCDF data files 10

Table 6. Meteorological variables available in NCR and NCP netCDF data files 11

Table 7. Summary of LongEZ flights 13

Table 8. Data availability for SHOWEX 14

List of Abbreviations and Acronyms

A/D	Analog-to-Digital
ARA	Airborne Research Australia
ASCII	American Standard Code
ATDD	Atmospheric Turbulence and Diffusion Division
BAT	Best Aircraft Turbulence
DGPS	Differential Global Positioning System
DLS	Down-Looking Scatterometer
DSP	Design Stagnation Point
EOPACE	Electro-Optica Propagation Assessment in Coastal Environments
FFA	First Flight Airport
FRD	Field Research Division
FRF	Field Research Facility
GPS	Global Positioning System
IBL	Internal Boundary Layer
IR	Infrared
IRGA	Infrared Gas Analyzer
IRQ	Interrupt Request
ISA	Industry Standard Architecture
MFP	Mobile Flux Platform
MQI	Dare County Regional Airport
NASA	National Aeronautic and Space Administration
NCAR	National Center for Atmospheric Research
netCDF	Network Common Data Format
OSU	Oregon State University
PAR	Photosynthetically Active Radiation
PC	Personal Computer
PCI	Peripheral Component Interconnect
PPS	Pulse Per Second
PRT	Precision Resistence Temperature
RAM	Random Access Memory
REM	Remote
SAR	Synthetic Aperture Radar
SCSI	Small Computer System Interface
SIMM	Single In-line Memory Module
TANS	Trimble Advanced Navigation System
VGA	Video Graphics Array

List of Symbols

α_0	Angle of Attack at Zero Lift
ϵ_h	Heading Offset for Relative Velocity
ϵ_p	Pitch Offset for Relative Velocity
ϵ_q	Adjustment to Dynamic Pressure
ϵ_r	Roll Offset for Relative Velocity
K_α	Pitch Calibration Constant
K_β	Yaw Calibration Constant
K_{up}	Upwash Factor
R_t	Temperature Recovery Factor

Abstract

The Shoaling Waves Experiment (SHOWEX) Spring pilot study took place at the U. S. Army Corps of Engineers Field Research Facility (FRF) located in Duck, North Carolina during a three week period in March 1999 . The primary objective of SHOWEX was to measure the spatial and temporal variation of the mean wind, surface stress, and spectral wave fields in the coastal shoaling zone. These data are to be used to develop new models for the drag coefficient and momentum transfer between waves and the atmosphere. The LongEZ experimental research aircraft (N3R) flew 23 missions (75 flight hours) under a variety atmospheric and wave field conditions. Flight legs included parallel and perpendicular runs with respect to the coastline at various altitudes and numerous slant and spiral soundings. The LongEZ also acquired meteorological information on the boundary layer structures over Albermarle and Currituck Sounds. In addition, several flights were flown over Lake Mattamuskeet to document internal boundary layer development.

1 Introduction

Existing parameterizations of the surface wind stress in the coastal shoaling zone usually fail because of their inability to properly account for changes of surface wave characteristics such as height, steepness, period, phase speed, breaking, and age. Accurate model simulation of the surface stress and turbulence above the air-sea interface is important for a number of applications including understanding wave growth and decay. Until recently, detailed spatial and temporal observations did not exist to adequately examine the coupling of the atmosphere and ocean in the coastal shoaling zone. However, a boundary-layer research aircraft was used in a pilot study during November 1997 off the coast of North Carolina to investigate the spatial variation of both marine boundary layer and surface wave field (Mahrt et al., 1999; Sun et al., 1999; Vogel et al., 1999). An ongoing series of experiments have and will continue to address these issues by acquiring the necessary observations from a combination of research aircraft and surface-based sensors. This report focuses on data from the second pilot study. In particular, we discuss the data collected by the LongEZ research aircraft (N3R).

The Shoaling Waves Experiment (SHOWEX) Spring pilot study was successfully conducted during a three week period in March 1999 at the U. S. Army Corps of Engineers Field Research Facility (FRF) located in Duck, North Carolina. The collaborative effort included scientists from NOAA's Field Research Division (FRD) and Atmospheric Turbulence and Diffusion Division (ATDD), Oregon State University (OSU), the National Center for Atmospheric Research (NCAR), and the National Aeronautic and Space Administration (NASA). The SHOWEX scientific research team collaborated with scientists and engineers participating in the Electro-Optica Propagation Assessment in Coastal Environments (EOPACE) project to study aerosols generated by plumes associated with breaking waves in the surf zone.

The LongEZ (Fig. 1) successfully acquired the data needed to meet the SHOWEX objectives. A total of 23 missions (75 flight hours) were flown under various atmospheric and wave field conditions. LongEZ flight legs included parallel and perpendicular runs at various altitudes with respect to the coastline as well as numerous slant and spiral soundings. The LongEZ also acquired meteorological information on the boundary layer structures over Albermarle and Currituck Sounds. Several flights were flown over Lake Mattamuskeet in an attempt to further understand internal boundary layer development. The LongEZ is capable of acquiring high-fidelity turbulence measurements in the surface layer and simultaneously documenting the characteristics of the surface wave field. This unique air-sea data set will help better quantify the coupling between the atmosphere and ocean. This paper summarizes the data acquired by the LongEZ during the SHOWEX Spring pilot study.

Figure 1. The LongEZ at the Wright Brother's Memorial in Kill Devil Hills, NC.

2 Description of the LongEZ, Sensors and Data Acquisition System

The LongEZ is an experimental airplane that has been used extensively to acquire data for a variety of air quality and environmental research projects (e.g., Doran et al., 1992; Crawford et al., 1993, 1996; Brooks et al., 1997; Dobosy et al., 1997; Sun et al., 1997; Oechel et al., 1998). This aircraft has proven to be especially powerful in studying the spatial variability of air-surface exchange. The instrument suite and data acquisition system are used to measure mean properties of the atmosphere as well as turbulent fluxes of heat, moisture, momentum, carbon dioxide, ozone, and other quantities. Remote sensors such as laser altimeters and a Ka-band radar were recently added to determine wave field properties of the ocean. The following subsections briefly describe the aircraft, instrumentation, and data acquisition system used in SHOWEX.

2.1 LongEZ

The LongEZ was designed by Burt Rutan in the early 1980's as a high-performance sport aircraft. Built entirely from a composite structure of fiberglass and epoxy over rigid foam, the LongEZ is a safe and reliable aircraft with exceptional performance. The forward lifting surface (canard) is designed to prevent the main wing from stalling. The design combines vertical winglets, laminar flow wings, and a pusher engine. It is ideally suited for making high-fidelity turbulence measurements with minimal flow distortion at low altitudes and slow aircraft speeds. A distinct advantage of the pusher design is that it allows for the mounting of instruments on the aircraft nose which minimizes contamination due to propeller-induced turbulence, and engine vibration and exhaust. Some basic aircraft specifications of the LongEZ are listed in Table 1.

2.2 *In Situ* and Remote Sensors

Various *in situ* and remote sensors have been mounted on the LongEZ (Fig. 2) for the measurement of atmospheric and wave field properties. The Best Aircraft Turbulence (BAT) probe is the centerpiece of the atmospheric measurement system (Crawford and Dobosy, 1992; Hacker and Crawford, 1999). The BAT probe was the result of a collaboration of scientists and engineers from NOAA and Airborne Research Australia (ARA) of Adelaide, Australia. Additional information is available at http://www.noaa.inel.gov/frd/BAT.

The BAT housing consists of a 15-cm diameter carbon-fiber hemisphere mounted on a tapered carbon-fiber cone. The hemisphere and housing are mounted on the nose of the aircraft. Nine pressure ports are symmetrically located on the hemisphere. Static and differential pressure are measured by four solid-state pressure sensors that have a frequency response of about 1 kHz and an accuracy of ±0.05 hPa. Wind velocities relative to the aircraft are computed from the pressure distributions observed over the array of pressure ports. In addition, air temperature measurements are acquired by redundant fast-response 0.13 mm micro-bead thermistors. One thermistor is mounted on the hemisphere inside the design stagnation point (DSP) ports. The second thermistor is located in the auxiliary port on the bottom of the probe. The time response of these temperature sensors is about 0.07 sec. Additionally, a precision resistence temperature (PRT) probe is included

for slow response measurements. The pressure and temperature sensors along with their respective electronics are housed within the BAT probe. This allows the sensors to be interfaced in close proximity to signal conditioning electronics with no significant loss or contamination. Further, the sensors are heated to reduce temperature related drift.

Table 1
LongEZ dimensional and performance specifications.

Engine	Lycoming O-360 160 HP
Seats	2
Electrical	65 Amp @ 12 VDC
Fuselage Length	5.0 m
Fuselage Length (with probe)	5.6 m
Wing Span	8.5 m
Wing Area	10 m^2
Canard Span	3.7 m
Canard Chord	0.38 m
Propeller Diameter	1.80 m
Weight (empty)	430 kg
Payload	370 kg
Fuel Capacity (normal)	200 kg
Fuel Capacity (with aux tank)	300 kg
Range (normal)	3300 km
Range (extended)	3800 km
Ceiling	8000 m
Endurance	10 - 18 hr
Cruise Speed	90 m s^{-1}
Stall Speed	25 - 30 m s^{-1}
Fuel Use @ 50 m s^{-1}	11 kg hr^{-1}
Fuel Use @ 90 m s^{-1}	20 kg hr^{-1}

Global positioning system (GPS) technology is integrated into the BAT data acquisition system. By using differential GPS (DGPS) correction techniques (i.e., collecting data from a fixed station at a known location), aircraft position and horizontal velocity can be computed at a rate of 10 Hz to within ±3 m and ± 2 cm s^{-1}, respectively. Aircraft attitude is measured using a Trimble Advanced Navigation System (TANS) vector GPS. The TANS consists of four antennas mounted on the BAT probe housing, the wings, and the rear of the cockpit. Using carrier-phase techniques, the position of three antennas is measured relative to the master antenna. Resulting measurements of attitude (aircraft pitch, roll, and heading) are acquired at 10 Hz and have an accuracy of 0.05°. All GPS data acquired at 10 Hz are mixed with accelerometer data (accelerometers are mounted in the BAT probe and the rear of the airplane) which are collected at 50 Hz to extend their frequency response as described by Crawford and Dobosy, 1992.

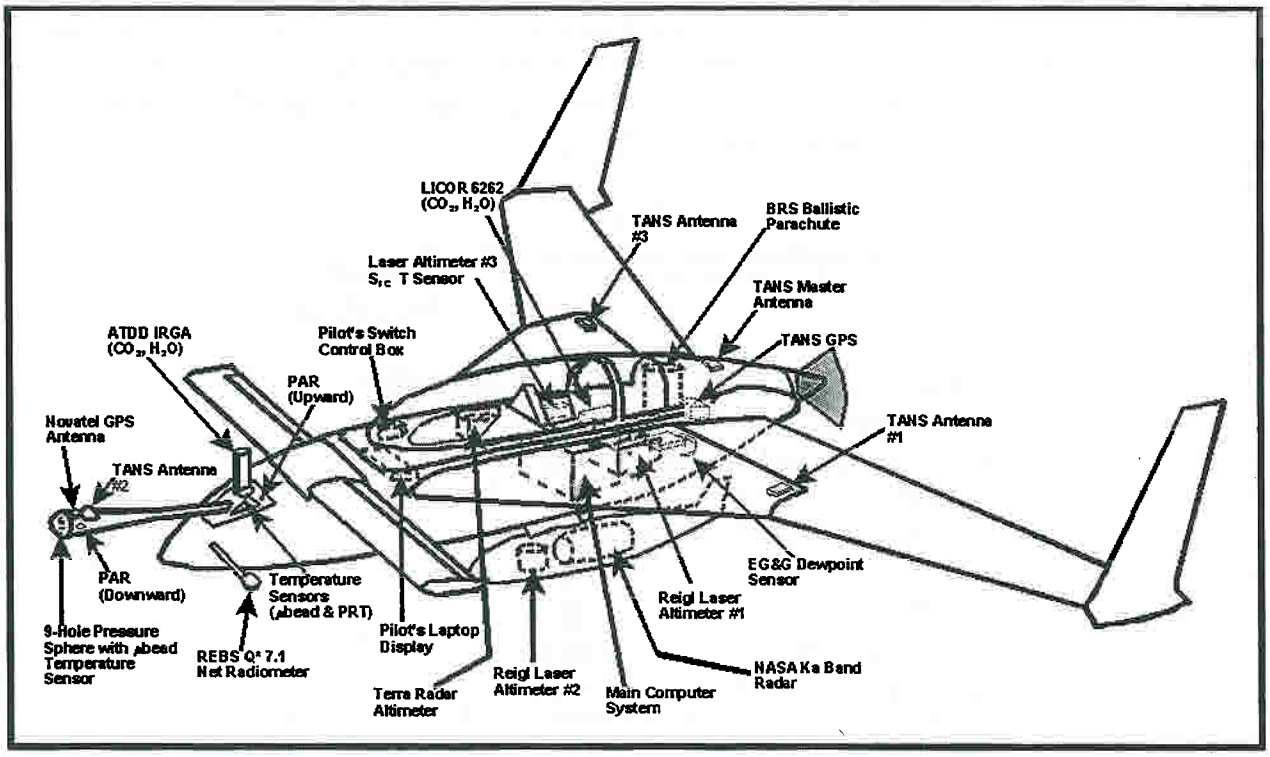


Figure 2. Schematic of the LongEZ with sensors.

A open-path infrared gas analyzer (IRGA), designed and built by ATDD, measures turbulent fluctuations in water vapor (H_2O) and carbon dioxide (CO_2) at frequencies up to 50 Hz. Three sets of two-each radiometric sensors mounted on the LongEZ measure both upwelling and downwelling (with respect to the aircraft) radiation. A Radiation and Energy Balance Systems Inc. Q*7.1 net radiometer provides measurements of both long and shortwave radiation. Upward looking and downward looking (with respect to the aircraft) LI-COR Inc. photosynthetically active radiation (PAR) sensors measure the incoming and reflected portion of the visible solar spectrum, respectively. An upward and downward looking (with respect to the aircraft) Everest Interscience Inc. 4000.4GL infrared (IR) radiometer are used to measure sky and surface temperature, respectively. Dew point temperature is measured by an EdgeTech Model 200 chilled mirror sensor.

An array of three Riegl LD90-3400VHS laser altimeters are used to determine ocean wave characteristics such as wave height, slope, spectra and phase speed. The laser array consists of three downward looking lasers mounted in an equilateral triangle with 1-m separation. Two are mounted under either wing. The third is mounted in a pod below the aircraft (Fig. 2). The lasers measure distance to ±2 mm at 50 Hz (i.e., at a nominal ground speed of 50 m s^{-1} with 1-m spatial resolution).

A low-power Ka-band radar developed by NASA is also mounted in the pod. The radar provides estimates of mean surface slope over wave scales from 0.01 to 1 m based on back-scattered power. The addition of the laser altimeters and Ka-band radar is a special configuration used for SHOWEX and other similar air-sea interaction field studies.

2.3 Data Acquisition System

The Mobile Flux Platform (MFP) data acquisition system consists of several components, including a personal computer (PC), two remote A/D modules (REM), an Iomega 100 MB Zip drive for onboard data storage, a portable flat-panel display, and control box for the pilot.

The PC motherboard consists of an Intel Pentium 133 MHZ CPU, an Iwill P55TU small computer system interface (SCSI), 32 MB of random access memory (RAM) in the form of two 16 MB single in-line memory module (SIMM) chips, five industry standard architecture (ISA) slots, and three peripheral component interconnect (PCI) slots. The cards plugged into the ISA bus include a video graphics array (VGA) display adapter, an 8-port RS-232 serial interface, an RS-422 serial interface, and a NovAtel 3150 GPS interface. Data from the TANS vector GPS, NovAtel GPS, and the laser altimeters are acquired by the PC via the RS-232 serial interface. For SHOWEX, none of the PCI slots were utilized.

The BAT-REM module was developed by ARA to provide high speed, high resolution, multi-channel data logging. Numerous software algorithms for data acquisition and manipulation are implemented on the REM module. Each REM module consists of two 8-channel A/D boards with 16-bit resolution. The analog input voltage ranges from -5 to +5 volts, translating to a digital resolution of 0.15259 mv. Each of the A/D channels is signal-conditioned by an 8-pole 30 Hz low-pass (anti-alias) filter. The digital signals are transmitted at a rate of 50 Hz to the PC via an RS-422 interface. During SHOWEX, the MFP included two REM modules for a total of 32 A/D channels. The first was contained in the tapered carbon fiber cone to the rear of the pressure port dome. The second was located in the PC case.

The NovAtel 3150 GPS interface provides the primary time reference for the MFP system. The clock utilized by the NovAtel interface is synchronized with the time transmitted by the GPS satellites. The clock outputs a one pulse per second (PPS) signal to interrupt request (IRQ) 5 on the ISA bus of the PC. The interrupt is also used to synchronize flow of data transmitted to the PC from the REM modules and other sensors.

The Zip drive with SCSI interface is used for primary onboard data storage. The SCSI interface provides the necessary data transfer speed.

The pilot can observe the status of the MFP in flight using a color flat-panel VGA (640 x 480 resolution) monitor. The pilot's switch box contains an instrument power switch, a PC power switch, a file write switch, an event button, and a marker switch. In addition, two LED lights are used to indicate power and system status.

3 Data

3.1 In-Flight Data Collection

The data acquisition programs run on top of the MS-DOS 6.22 operating system. They are written in C and consist of nine modules, each designed to execute particular tasks. The data acquisition software reads and interprets the digital data, time synchronizes and performs some housekeeping routines, and writes the data to a 100 MB Zip disk. The raw data consist of four files which typically total 70 MB for a 4-hour flight. These files have the same 8-digit root name which is based on the PC clock when the data acquisition system is started. The convention is: month (2 digits), day (2 digits), hour (2 digits), and minute (2 digits). For example, the filename with the root name of 03161322 was opened on March 16 at 1322 UTC. Each file is a unique 3-character suffix: ORG, NOV, TAN, and MKR.

The ORG file contains binary data acquired by the REM modules and all other sensors written in 1 s blocks (sometimes referred to as scan numbers). Also, this file contains information regarding device and channel assignments, measurement frequencies, engineering units, ranges, voltage scale factors and offsets, and preliminary calibration coefficients provided by an ASCII file (HEADER.TXT). The ORG data file specifications are listed in Table 2 while much of the information contained in the HEADER.TXT file is listed in Table 3.

The channel name (or label; Table 3) is a character string describing the measured variable. The device number is used to assign a logical channel with a physical device. The assignments listed below were used during SHOWEX:

0	ISA bus device channel 0 - NovAtel GPS data
1	Serial device channel 1 - TANS data
2	Serial device channel 2 - Laser input #1
3	Serial device channel 3 - Laser input #2
4	Serial device channel 4 - Laser input #3
5	Serial device channel 5 - Not used
6	Serial device channel 6 - Not used
7	Serial device channel 7 - Not used
8	Serial device channel 8 - Not used
10	REM device #1
11	REM device #2

Table 2
ORG data file specifications.

Field	Bytes	Data Type	Description
title	80	character array	experiment title
date	10	character array	ORG file creation date (MM/DD/YYYY)
nochan	2	integer	number of channel groups (i)
scans	2	integer	number of 1 s data blocks
GRP(i,1)	2	integer	storage frequency for channel group i
GRP(i,2)	2	integer	no. channels for channel group i of type CHAR
GRP(i,3)	2	integer	no. channels for channel group i of type SHORT
GRP(i,4)	2	integer	no. channels for channel group i of type LONG
label(j)	12	character array	channel name label for logical channel j
device(j)	2	integer	physical device number for logical channel j
phy(j)	2	integer	physical channel for logical channel j
freq(j)	2	integer	data storage frequency for logical channel j
units(j)	12	character array	engineering unit label for logical channel j
calpwr	2	integer	no. polynomial calibration coefficients
a0	2	integer	a0 coefficient for mv to engineering unit conversion
a1	2	integer	a1 coefficient for mv to engineering unit conversion
a2	2	integer	a2 coefficient for mv to engineering unit conversion
a3	2	integer	a3 coefficient for mv to engineering unit conversion
a4	2	integer	a4 coefficient for mv to engineering unit conversion
a5	2	integer	a5 coefficient for mv to engineering unit conversion
min(j)	4	float	minimum engineering unit value for channel j
max(j)	4	float	maximum engineering unit value for channel j
scalefactor(j)	4	float	multiplier portion of count to mv conversion
addoffset(j)	4	float	offset portion of count to mv conversion
cFormat(j)	2	integer	variable type (CHAR=1, SHORT=2, LONG=3)
fillValue(j)	4	float	fill value for channel j (values -1, 0, or +1)
lname(j)	100	character array	long channel name label for logical channel j

The physical channel is used to associate the logical channel with a physical channel on a particular device. The frequency defines the rate at which the data are provided to the data acquisition system. A 12-character string is used to assign the respective engineering units for a particular channel.

Table 3
Listing from HEADER.TXT used during SHOWEX.

Label	Dev	Cha	Frq	Units	a0	a1	Min	Max	Scale Fac	Offset
NLat	0	0	10	deg	0.000000	1.0000000	-90.0	90.0	0.0000305	0.000
NLon	0	1	10	deg	0.000000	1.0000000	-180.0	180.0	0.0000305	0.000
NAlt	0	2	10	m	0.000000	1.0000000	-235.0	6277.0	0.1000000	3000.000
Nu	0	3	10	$m\ s^{-1}$	0.000000	1.0000000	-200.0	200.0	0.0100000	0.000
Nv	0	4	10	$m\ s^{-1}$	0.000000	1.0000000	-200.0	200.0	0.0100000	0.000
Nw	0	5	10	$m\ s^{-1}$	0.000000	1.0000000	-100.0	100.0	0.0100000	0.000
GPSTime	0	6	1	s	0.000000	1.0000000	0.0	604800.0	0.1000000	0.000
Tpitch	1	0	10	deg	0.000000	1.0000000	-20.0	20.0	0.0100000	0.000
Troll	1	1	10	deg	0.000000	1.0000000	-80.0	80.0	0.0100000	0.000
Thdg	1	2	10	deg	0.000000	1.0000000	0.0	360.0	0.0100000	180.000
L1Dist	2	0	50	m	0.000000	1.0000000	0.0	400.0	0.0100000	0.000
L1Amp	2	1	50	counts	0.000000	1.0000000	0.0	256.0	1.0000000	0.000
L1Retn	2	2	50	counts	0.000000	1.0000000	0.0	127.0	1.0000000	0.000
L2Dist	3	0	50	m	0.000000	1.0000000	0.0	400.0	0.0100000	0.000
L2Amp	3	1	50	counts	0.000000	1.0000000	0.0	256.0	1.0000000	0.000
L2Retn	3	2	50	counts	0.000000	1.0000000	0.0	127.0	1.0000000	0.000
L3Dist	4	0	50	m	0.000000	1.0000000	0.0	400.0	0.0100000	0.000
L3Amp	4	1	50	counts	0.000000	1.0000000	0.0	256.0	1.0000000	0.000
L3Retn	4	2	50	counts	0.000000	1.0000000	0.0	127.0	1.0000000	0.000
Px	10	0	50	mb	16.592450	0.0033110	0.0	33.1	0.1523000	-21.627
Py	10	1	50	mb	-0.062700	0.0062640	-31.4	31.3	0.1523000	-25.891
Pz	10	2	50	mb	0.060500	0.0062700	-31.3	31.4	0.1523000	-31.526
Ps	10	3	50	mb	514.667400	0.1064450	0.0	1046.9	0.1523000	-26.196
Ax	10	4	50	$m\ s^{-2}$	0.232958	0.0034430	-17.0	17.4	0.1523000	-22.997
Ay	10	5	50	$m\ s^{-2}$	0.071810	-0.0037140	-18.6	18.5	0.1523000	-32.135
Az	10	6	50	$m\ s^{-2}$	9.535680	0.0037340	-9.1	28.2	0.1523000	-28.632
Tp1	10	7	50	°C	0.000000	0.0060000	-30.0	30.0	0.1523000	-33.658
Tp2	10	8	50	°C	0.000000	0.0060000	-30.0	30.0	0.1523000	-18.733
Tbar1	10	9	1	°C	0.000000	0.0100000	-50.0	50.0	0.1523000	-20.408
HatchDelP	10	10	50	mb	18.706400	-0.0083600	-23.1	60.5	0.1523000	-21.779
Net	10	11	1	$W\ m^{-2}$	0.000000	0.1222000	-200.0	1200.0	0.1523000	-20.713
PAR_UP	10	12	1	$\mu M\ m^{-2}\ s^{-1}$	119.400000	0.4975000	0.0	2487.4	0.1523000	-29.394
PAR_DN	10	13	1	$\mu M\ m^{-2}\ s^{-1}$	152.928000	0.5184000	0.0	2592.0	0.1523000	-22.540
F_H20	10	14	50	$g\ m^{-3}$	13.700000	0.0030510	-3.1	30.5	0.1523000	-21.779
F_CO2	10	15	50	$mg\ m^{-3}$	600.700000	0.0679000	261.2	940.2	0.1523000	-22.084
Radar_A	11	2	50	volts	0.000000	0.0010000	-5.1	5.1	0.1476000	-25.830
Radar_B	11	3	50	volts	0.000000	0.0010000	-5.1	5.1	0.1476000	-22.140
Radar_C	11	4	50	volts	0.000000	0.0010000	-5.1	5.1	0.1476000	-29.520
Radar_D	11	5	50	volts	0.000000	0.0010000	-5.1	5.1	0.1476000	-26.568
Tdew	11	6	1	°C	-60.244000	0.0288250	-47.1	57.7	0.1476000	-26.125
SfcT	11	7	50	°C	0.000000	0.1000000	-40.0	100.0	0.1476000	-29.668
Axb	11	8	50	$m\ s^{-2}$	-0.013810	-0.0004800	-2.4	2.4	0.1476000	-28.634
Ayb	11	9	50	$m\ s^{-2}$	0.031504	-0.0004800	-2.4	2.4	0.1476000	-27.011
Azb	11	10	50	$m\ s^{-2}$	-0.130770	0.0040140	-20.0	20.0	0.1476000	-31.291
Arol	11	11	50	s^{-2}	0.000727	-0.0006329	-10.0	10.0	0.1476000	-23.764

Most of the variables are defined as 2-byte integers (SHORT). However, the latitude (NLat), longitude (NLon), and the GPS time (GPSTime), which require high resolution and/or large range, are stored as 4-byte integers (LONG). The scale factor and offset are used to convert the counts returned by a REM module to millivolts, or for assigning a fixed number of decimal places to the data for those devices that already report values in engineering units.

The NOV file contains binary satellite pseudo-range data acquired by the aircraft during flight. These data, when combined with satellite pseudo-range data acquired from a ground station

of known location and elevation, are used to generate differentially corrected positions and velocities for the aircraft. The TAN file contains GPS data in ASCII format. These data are used primarily for troubleshooting.

The MKR file contains ASCII data listing specific times and locations during the flight when the marker switch was toggled to an "on" or "off" position. When the marker switch is turned "on", a value of "-1", the scan number (i.e., number of elapsed seconds since the start of data acquisition), current latitude, and current longitude are written to the MKR file. Similarly, a value of "0" is written with the time and location information when the marker switch is turned off. The event switch is used to mark a single event during flight (e.g., flying past the end of a pier). An event is recorded in the MKR file with the designation of "EVT" along with the scan number, latitude and longitude. The MKR file is usually edited at the end of the flight to include a summary of the weather conditions, flight plan, problems encountered, and other notes that may be helpful during data analysis. Appendix A contains the listings of the marker files from all flights during SHOWEX.

3.2 Post-Flight Data Processing

The final data are obtained through a series of post-processing routines. In the initial step, the aircraft position and velocity data in the NOV file are differentially corrected using GPS data acquired at a ground-station of known location and elevation. This is done using programs written by M. Elizabeth Cannon of the University of Calgary and modified by ATDD for our purposes. The final product of these programs is a file with the same root name and the extension of OUT. It contains an ASCII listing of GPS time, latitude, longitude, altitude, and the horizontal and vertical velocity of the aircraft with respect to the Earth.

Small cleanup operations are then performed on the ORG file. These include removing spikes and spurious data from the various time series. Next, calibrations are updated as needed. For example, fast-response sensors such as the micro-bead thermistors can experience drift in their calibrations. In order to obtain an accurate calibration, a regression of the micro-bead thermistor data is performed against the slow-response PRT probe. Since the calibration data is contained in every data file collected during the experiment, the calibration may be updated for each flight. Additionally, if a sensor is changed or fails during flight, the calibration can be updated to reflect the condition. The OUT and ORG files are then combined and converted into a single file in network common data format (netCDF). This combined file contains all of the raw data. It again has the same root name and is given the extension NCR (netCDF Raw). The final step (and the most complex) produces the basic scientific variables in standard units. Again, this is a netCDF file given the extension NCP (netCDF Processed).

Table 4 lists several empirical calibration constants used to correct wind velocity data acquired by the LongEZ. Details about the nature of these values can be found in Leise and Masters (1991). Tables 5 and 6 list both the aircraft performance and meteorological variables available in both the NCR and NCP data files acquired during SHOWEX. The respective engineering units and storage frequency are also given.

Table 4

Empirical calibration constants used for wind velocity corrections.

Calibration Constant	Value	Description
R_t	0.820	Temperature Recovery Factor
K_α	0.255	Pitch Calibration Constant
K_β	0.222	Yaw Calibration Constant
K_{up}	0.101	Upwash Factor
α_0	-3.61	Angle of Attack at Zero Lift
ϵ_q	0.9988	Adjustment to Dynamic Pressure
ϵ_p	0.02	Pitch Offset for Relative Velocity
ϵ_r	1.2	Roll Offset for Relative Velocity
ϵ_h	0.4	Heading Offset for Relative Velocity

Table 5

Aircraft performance variables available in NCR and NCP netCDF data files.

Variable	Units	Freq (Hz)	Description
GPSTime	s	1	GPS Time
NLat	deg	10	Latitude
NLon	deg	10	Longitude
NAlt	m	10	Altitude
Nu	$m\ s^{-1}$	10	Eastward Ground Speed
Nv	$m\ s^{-1}$	10	Northward Ground Speed
Nw	$m\ s^{-1}$	10	Vertical Ground Speed
GndSpeed	$m\ s^{-1}$	1	Ground Speed
AirSpeed	$m\ s^{-1}$	1	Air Speed
TPitch	deg	10	Pitch
TRoll	deg	10	Roll
THdg	deg	10	Heading
Ax	$m\ s^{-2}$	50	Longitudinal Acceleration at BAT Probe
Ay	$m\ s^{-2}$	50	Lateral Acceleration at BAT Probe
Az	$m\ s^{-2}$	50	Vertical Acceleration at BAT Probe
Axb	$m\ s^{-2}$	50	Longitudinal Acceleration at Center of Gravity
Ayb	$m\ s^{-2}$	50	Lateral Acceleration at Center of Gravity
Azb	$m\ s^{-2}$	50	Vertical Acceleration at Center of Gravity
Aroll	s^{-2}	50	Roll

Table 6
Meteorological variables available in NCR and NCP netCDF data files.

Variable	Units	Freq (Hz)	Description
U	$m\ s^{-1}$	50	Eastward Wind Velocity
V	$m\ s^{-1}$	50	Northward Wind Velocity
W	$m\ s^{-1}$	50	Vertical Wind Velocity
Px	mb	50	Longitudinal Differential Pressure
Py	mb	50	Lateral Differential Pressure
Pz	mb	50	Vertical Differential Pressure
Ps	mb	50	Static Pressure
Tp1	°C	50	Air Temperature (micro-bead) (primary)
Tp2	°C	50	Air Temperature (micro-bead) (secondary)
TBar	°C	1	Air Temperature (PRT)
Tdew	°C	1	Dew Point Temperature
F_H2O	$g\ m^{-3}$	50	Absolute Humidity
F_CO2	$mg\ m^{-3}$	50	Carbon Dioxide Concentration
RhoD	$kg\ m^{-3}$	50	Dry Air Density
Net	$W\ m^{-2}$	1	Net Radiation (short and longwave)
PAR_UP	$\mu M\ m^{-2}\ s^{-1}$	1	Upward Photosynthetically Active Radiation
PAR_DN	$\mu M\ m^{-2}\ s^{-1}$	1	Downward Photosynthetically Active Radiation
IRT_UP	°C	1	Upward Infrared Temperature (sky)
IRT_DN	°C	50	Downward Infrared Temperature (surface)
L1Dist	m	50	Altitude (Laser #1)
L1Dist	m	50	Altitude (Laser #2)
L1Dist	m	50	Altitude (Laser #3)
L1Amp	counts	50	Signal Amplitude (Laser #1)
L2Amp	counts	50	Signal Amplitude (Laser #2)
L3Amp	counts	50	Signal Amplitude (Laser #3)
L1Retn	counts	50	Number of Returned Readings (Laser #1)
L2Retn	counts	50	Number of Returned Readings (Laser #2)
L3Retn	counts	50	Number of Returned Readings (Laser #3)
Radar_A	mv	50	Transmit Power Monitor Voltage
Radar_B	mv	50	High Gain Receiver Output Voltage
Radar_C	mv	50	Low Gain Receiver Output Voltage
Radar_D	mv	50	Radar Status and Control

4 Flight Summaries

In order to assess changes in atmospheric turbulence and the ocean wave field through the shoaling region, repeated transects were flown both perpendicular and parallel to the coastline over the Atlantic Ocean at various altitudes. Slant and/or spiral soundings were also conducted during each flight to assess the vertical structure of the atmospheric boundary layer. A total of 23 missions (75 flight hours) were flown under various atmospheric and wave field conditions during a three week period in March 1999. Many of these flights were in the vicinity of the US Army Corps of Engineers Field Research Facility (FRF) pier located in Duck, North Carolina. The LongEZ also acquired meteorological information about the boundary layer structures over the Albermarle and Currituck Sounds. Several flights were flown over Lake Mattamuskeet in an attempt to further understand internal boundary layer (IBL) development.

The LongEZ utilized two different airports during SHOWEX. The first several flights were based out of Dare County Regional Airport (MQI) in Manteo. Hanger space was available at MQI to shelter the LongEZ from severe weather. Most of the flights, however, were flown in and out of First Flight Airport (FFA) in Kill Devil Hills. Table 7 is a summary listing of the LongEZ flights during SHOWEX. Note that the flight hours were determined by a Hobbs meter, which keeps track of time from when the aircraft engine is started until it is shutdown. An overview of the meteorological conditions acquired by a NOAA automated (C-MAN) station on the FRF pier are shown in Figure 3. The following subsections contain a brief summary of each flight.

4.1 Flight 1: 01 MAR 99 (MON)

This was a test flight to verify the proper operation of the various sensors and data acquisition system. The weather was dominated by sunny skies with westerly winds (260 deg) at 11 m s^{-1} and an air temperature of 10 °C. Differential GPS corrections were not applied to this data set because the ground- station was not yet in operation.

4.2 Flight 2: 02 MAR 99 (TUE)

This was a second test flight in the morning for further verification on the proper operation of the sensors and data acquisition system. Sunny skies once again dominated the region with west-southwesterly winds (250 deg) at 5 m s^{-1} and an air temperature of 8 °C. Once again, differential GPS corrections were not applied.

4.3 Flight 3: 02 MAR 99 (TUE)

This afternoon flight consisted of slant soundings to and from the FRF pier and numerous perpendicular flight legs with respect to the coastline at low altitudes (~ 10 to 50 m). Weather conditions consisted of sunny skies with southwesterly winds (230 deg) at 5 m s^{-1} and an air temperature of 12 °C. GPS differential corrections were applied to this flight, as well as all subsequent SHOWEX flights.

Table 7
Summary of LongEZ flights.

FL	Date	Day	Start/End Time (UTC)		FL Hr	Arrive	Depart	File Name	Comments
1	01 MAR 99	MON	2114	2145	0.5	MQI	MQI	03012111	test flight
2	02 MAR 99	TUE	1507	1524	0.3	MQI	MQI	03021454	test flight
3	02 MAR 99	TUE	1816	2113	3.0	MQI	MQI	03021809	perpendicular legs
4	03 MAR 99	WED	1333	1728	3.9	MQI	MQI	03031328	perpendicular legs
5	04 MAR 99	THU	1427	1717	3.3	MQI	FFA	03041425	parallel legs
6	04 MAR 99	THU	1734	1857	2.5	MQI	FFA	03041729	perpendicular legs
7	05 MAR 99	FRI	1320	1558	3.1	FFA	FFA	03051312	parallel legs
8	05 MAR 99	FRI	1711	2045	3.7	FFA	FFA	03051709	perpendicular legs
9	06 MAR 99	SAT	1314	1658	3.5	FFA	FFA	03061308	parallel, perpendicular legs
10	07 MAR 99	SUN	1317	1800	4.7	FFA	FFA	03071303	parallel legs, butterfly
11	07 MAR 99	SUN	1843	2132	3.8	FFA	FFA	03071833 03071941	butterfly (2)
12	08 MAR 99	MON	1450	1818	3.5	FFA	FFA	03081413	Albermarle Sound, butterfly
13	08 MAR 99	MON	1855	2121	2.5	FFA	FFA	03081853	Currituck Sound, butterfly
14	09 MAR 99	TUE	1409	1618	2.1	FFA	FFA	03091344 03091436	Currituck Sound, butterfly
15	10 MAR 99	WED	1819	2125	3.2	FFA	FFA	03101811 03101940	parallel legs
16	11 MAR 99	THU	1335	1715	3.7	FFA	FFA	03111315	parallel legs
17	11 MAR 99	THU	1812	2142	3.8	FFA	MQI	03111810 03112051	Lake Mattamuskeet
18	12 MAR 99	FRI	1609	1917	3.5	FFA	FFA	03121556	Lake Mattamuskeet
19	13 MAR 99	SAT	1612	1943	3.5	FFA	FFA	03131533	Lake Mattamuskeet
20	16 MAR 99	TUE	1719	2051	3.6	FFA	FFA	03161717	parallel legs
21	17 MAR 99	WED	1113	1640	5.7	FFA	FFA	03171048 03171442	SAR Overpass, parallel legs
22	17 MAR 99	WED	1750	2206	4.4	FFA	FFA	03171748 03172003	Currituck Sound, calibration maneuvers
23	18 MAR 99	THU	1359	1656	2.9	FFA	FFA	03181338	parallel, perpendicular legs

Table 8

Data availability for SHOWEX.

Variable / Flight	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
U	✘	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
V	✘	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
W	✘	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Tp1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Tp2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
TBar	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Tdew	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
F_H2O	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✘	✘	✘	✘	✘	✔	✔	✔
F_CO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘
Ps	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
RhoD	✘	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Net	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
IRT_UP	✔	✔	✔	✔	✔	✔	✔	✔	✔	✘	✘	✘	✘	?	?	?	?	?	?	?	?	?	?
IRT_DN	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	?	?	?	?	?	?	?	?	?	?
PAR_UP	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PAR_DN	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
L1Dist	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
L1Dist	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
L1Dist	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
L1Amp	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
L2Amp	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
L3Amp	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
L1Retn	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
L2Retn	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
L3Retn	✘	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Radar_A	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
Radar_B	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
Radar_C	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
Radar_D	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘

✔ valid data

✘ missing/invalid data

? suspect data

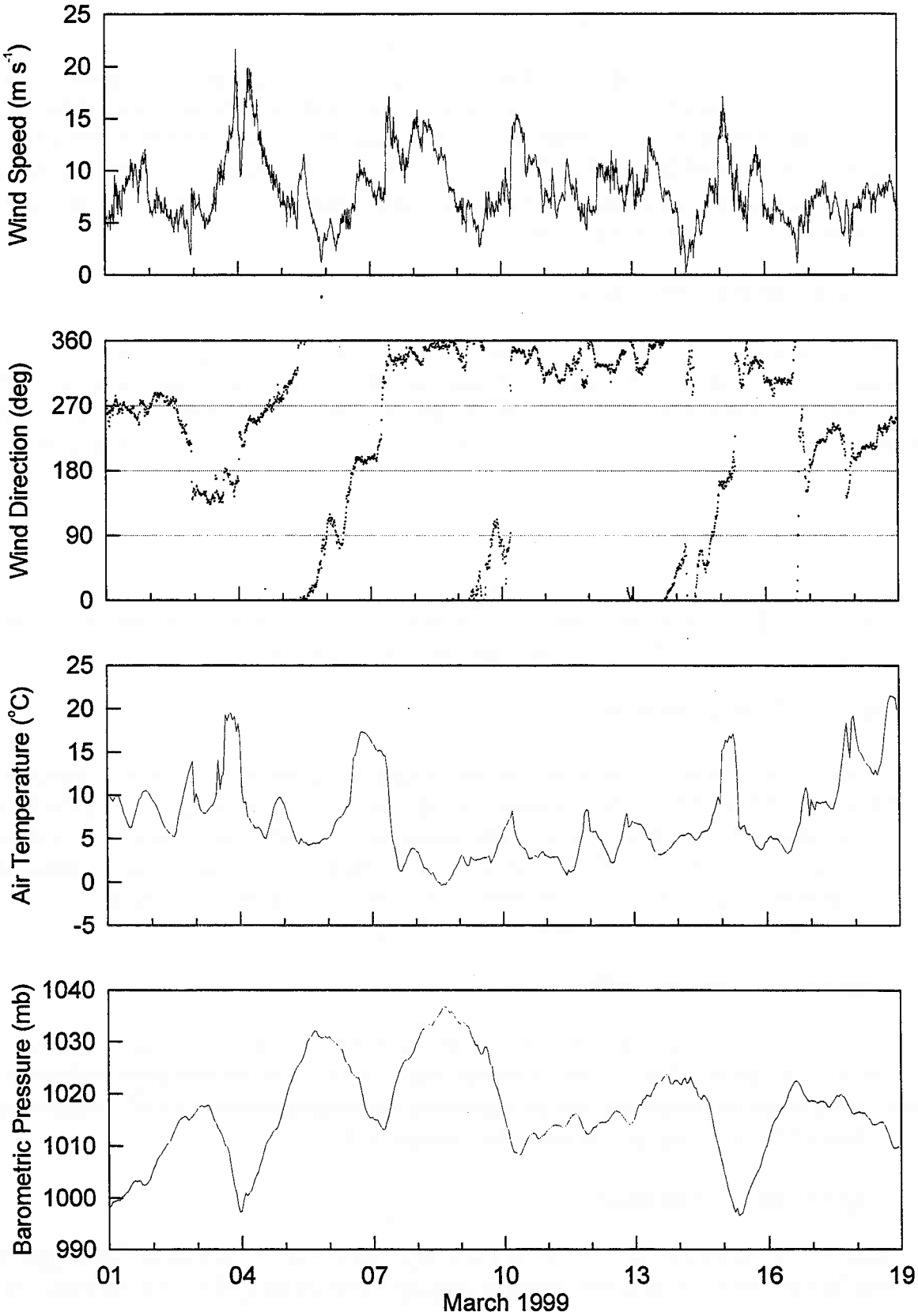


Figure 3. Meteorological time series from FRF pier during SHOWEX.

4.4 Flight 4: 03 MAR 99 (WED)

The LongEZ conducted a spiral profile ascending out of MQI and a slant sounding down to the FRF pier. Numerous perpendicular flight legs were conducted at various levels (10 to 400 m) from the coast out to about 12 km to examine IBL structure. A slant sounding from the FRF pier was conducted at the end of the mission. Prefrontal conditions dominated the weather during this flight. The region experienced sunny skies with warm air temperatures of about 15 °C. Winds were from the south-southeast (160 deg) at 10 m s^{-1}.

4.5 Flight 5: 04 MAR 99 (THU)

This mission consisted of numerous parallel flight legs at low altitudes (10 m) with respect to the coastline. These legs were conducted along the shoreline out to a distance of 20 km. Slant soundings were conducted before and after the parallel flight legs. The weather was dominated by post-frontal conditions. Skies were clear with an air temperature of 6 °C. Winds were from the west (270 deg) at 11 m s^{-1}.

4.6 Flight 6: 04 MAR 99 (THU)

This second flight of the day focused on the IBL. Several perpendicular flight legs were conducted until the MFP computer crashed. Skies remained clear with an air temperature of 8 °C. Winds remained westerly (270 deg) but decreased slightly to 10 m s^{-1}.

4.7 Flight 7: 05 MAR 99 (FRI)

This mission consisted of numerous parallel flight legs in the morning at low altitudes (10 m) with respect to the coastline. These legs were conducted along the shoreline out to a distance of 10 km. Two perpendicular flight legs were also included in the mission. Slant soundings were conducted at the start of the flight. The computer system crashed near the end of the mission during one of the parallel flight legs. The weather was dominated by sunny skies and cooler air temperatures of 4 °C. Winds were from the north (10 deg) at 7 m s^{-1}.

4.8 Flight 8: 05 MAR 99 (FRI)

Numerous perpendicular legs were flown during the afternoon across the Currituck Peninsula at various altitudes (60 to 300 m). Slant soundings were conducted at the beginning and end of the mission. Skies remained sunny with the air temperature increasing slightly to 5 °C. Winds veered to the north-northeast (30 deg) and decreased in velocity to 4 m s^{-1}.

4.9 Flight 9: 06 MAR 99 (SAT)

Multiple parallel flight legs were included in this mission as well as four perpendicular runs. These parallel runs were flown at low levels at varying distances away from the coastline. Slant

soundings were included before and after the flight legs. Skies were partly to mostly cloudy as an advancing cold front approached the area. Winds were from the south (180 deg) at 6 m s^{-1} with an air temperature of 15 °C.

The upward looking IR radiometer was switched with the downward looking IR sensor because due to instrument failure at the end of the flight.

4.10 Flight 10: 07 MAR 99 (SUN)

This morning flight included numerous legs parallel to the coastline. In addition, a butterfly pattern was included. This pattern is a series of slant and spiral soundings separated by horizontal flight legs at low (10 m) and high (500 m) altitudes. The weather was dominated by post-frontal conditions with an air temperature of 2 °C. Winds were from the north-northwest (330 deg) at 12 m s^{-1}. Slant soundings were included at the beginning and the end of this mission.

4.11 Flight 11: 07 MAR 99 (SUN)

The afternoon flight was similar to the previous mission flown that morning. Two butterfly patterns were flown at 1 and 10 km from the coastline. The high-level horizontal flight leg of the butterfly was flown at an altitude of 1 km. Several parallel legs were included. Slant soundings were also performed at the start and end of the mission. Winds remained north-northwesterly (340) at 11 m s^{-1} with a slight increase in air temperature to 3 °C.

The data acquisition PC suffered a crash in mid-flight resulting in a loss of about 8 min of data. The laser altimeter and Ka-band radar mounted in the pod under the LongEZ were severely damaged during landing. These sensors were not available for the remainder of the study.

4.12 Flight 12: 08 MAR 99 (MON)

Two butterfly patterns were flown over Albermarle Sound in the morning to examine the structure and evolution of the IBL. Two legs perpendicular to the coastline were also included in this mission. The weather was dominated by clear skies and cold air temperatures of about 0 °C. Winds were from the north (350 deg) at 11 m s^{-1}.

4.13 Flight 13: 08 MAR 99 (MON)

This afternoon flight consisted a butterfly pattern aligned with Currituck Sound. Two low-level legs perpendicular to the shore were also included. Slant soundings at the start and end of the mission were included. Clear skies and cold temperatures (1 °C) persisted. Winds remained from the north (0 deg) but decreased in speed to 8 m s^{-1}.

4.14 Flight 14: 09 MAR 99 (TUE)

An abbreviated butterfly pattern was flown parallel with Currituck Sound. Several low-level legs were included along Currituck Sound. Slant soundings were included at the start and end of the mission. Overcast (stratocumulus) skies and cold temperatures (3 °C) dominated the region. Winds were from the north-northeast (30 deg) at 6 m s^{-1}.

The data acquisition PC suffered a crash in mid-flight resulting in a loss of about 6 min of data.

4.15 Flight 15: 10 MAR 99 (WED)

This flight consisted of numerous parallel flight legs off the coastline and an abbreviated butterfly pattern. Slant soundings were also included at the start and end of the mission. Overcast (stratocumulus) skies remained over the area with cold air temperatures of 3 °C. Winds were from the north-northwest (340 deg) at 11 m s^{-1}.

The data acquisition PC suffered a crash in mid-flight resulting in a loss of about 5 min of data.

4.16 Flight 16: 11 MAR 99 (THU)

Numerous legs parallel to the coastline were included in this morning flight. Two perpendicular legs and slant soundings were also included. Mostly sunny skies with north-northwesterly winds (330 deg) at 8 m s^{-1} and an air temperature of 2 °C.

4.17 Flight 17: 11 MAR 99 (THU)

This afternoon flight was flown over Lake Mattamuskeet in an attempt to understand IBL development and evolution. Numerous low-level (15 m) legs were flown across the lake at varying distances away from its northern shoreline. Slant soundings were included in the vicinity of FFA and the lake. Skies remained clear with air temperatures warming to 6°C. Winds were from the north-northwest (340 deg) at 6 m s^{-1} at the FRF pier.

The data acquisition PC suffered a crash in mid-flight resulting in a loss of about 4.5 min of data.

4.18 Flight 18: 12 MAR 99 (FRI)

This flight was a repeat of the previous mission with multiple low-level legs over Lake Mattamuskeet. Slant soundings were included in the vicinity of FFA and the lake. Clear skies still dominated the region with air temperatures of 6 °C. Winds were from the north-northwest (340 deg) at 8 m s^{-1} at the FRF pier.

4.19 Flight 19: 13 MAR 99 (SAT)

This was yet another repeat of the previous two missions over Lake Mattamuskeet. In addition low-level runs at various distances from the northern lake shore, a stack flight pattern perpendicular to the northern shore was conducted at various altitudes (20 to 300 m). Slant soundings were included in the vicinity of FFA and the lake. Mostly sunny skies were present with some high cirrus clouds. Winds at the FRF pier were from the north (0 deg) at 8 m s^{-1} and an air temperature of 4 °C. However, winds over the lake were calm since the surface of the lake appeared to be very smooth.

4.20 Flight 20: 16 MAR 99 (TUE)

After a two-day layoff (due to rain), the LongEZ conducted a mission which included numerous low-level parallel legs at varying distances from the coastline. Two perpendicular flight legs were included in the mission. Slant soundings were also included at the start and end of the flight. Clear skies were observed with an air temperature of 9 °C. Winds during the first hour of the flight are northeasterly (50 deg) at 2 m s^{-1} but then veer quickly to west-southwesterly (240 deg) at 5 m s^{-1}.

The IRGA began to experience problems due to a faulty power supply. Measurements H_20 and CO_2 concentration were invalid for this flight an all subsequent flights.

4.21 Flight 21: 17 MAR 99 (WED)

The first half of this flight was dedicated to acquiring data for verification of a satellite-based synthetic aperture radar (SAR). This low-level box pattern was flown approximately parallel and perpendicular to the mean wind. Spiral soundings were included with the flight plan for this SAR overpass mission. The second half of the flight was dedicated to numerous parallel legs off the coastline. Slant soundings were included at the beginning with this flight. Skies were clear and air temperatures rose to about 10 °C. Winds were from the west-southwest (240 deg) at 7 m s^{-1}.

The data acquisition PC suffered a crash in mid-flight resulting in a loss of about 14 min of data.

4.22 Flight 22: 17 MAR 99 (WED)

The second flight of the day was dedicated to an IBL investigation of Currituck Sound. Numerous parallel and perpendicular legs were flown with respect to the Sound. In addition, calibration maneuvers (wind box, wind circles, pitch and yaw) were conducted near the end of the flight. Mostly sunny skies dominated the region with warm temperatures reaching 17 °C. Winds were from the southwest (220 deg) at the beginning of the flight but backed to south-southeasterly (160 deg) towards the end of the flight. Wind speeds ranged from 4 to 7 m s^{-1}.

The data acquisition PC suffered a crash in mid-flight resulting in a loss of about 15 min of data.

4.23 Flight 23: 18 MAR 99 (THU)

This final flight consisted of numerous parallel and perpendicular legs with respect to the coastline at various altitudes near the FRF pier. Clear skies remained over the area with warm temperatures of 16 °C. Winds were from the west-southwest (240 deg) at 8 m s^{-1}.

Acknowledgments

This research program was supported by the Office of Naval Research (N00014-97-F-0123). The authors wish to thank Ronald Dobosy and Richard Eckman for their suggestions and help on the various data processing techniques and issues. The authors wish to thank our colleagues Jielun Sun and Larry Mahrt for their tremendous support and cooperation. We would also like to extend our thanks to Jeff French for providing a critical review of this document.

References

Brooks, S. B., T. L. Crawford, and W. C. Oechel, 1997: Measurement of carbon dioxide emissions plumes from Prudhoe Bay, Alaska oil fields. *J. Atmos. Chem.*, **27**, 197-207.

Crawford, T. L., and R. J. Dobosy, 1992: A sensitive fast-response probe to measure turbulence and heat flux from any airplane. *Bound.-Layer Meteor.*, **59**, 257-278.

Crawford, T. L., R. T. McMillen, T. P. Meyers, and B. B. Hicks, 1993: Spatial and temporal variability of heat, water vapor, carbon dioxide, and momentum air-sea exchange in a coastal environment. *J. Geophys. Res.*, **98**, 12869-12880.

Crawford, T. L., R. J. Dobosy, R. T. McMillen, C. A. Vogel, and B. B. Hicks, 1996: Air-surface exchange measurement in heterogeneous regions: extending tower observations with spatial structure observed from small aircraft. *Global Change Biology*, **2**, 275-285.

Dobosy, R. J., T. L. Crawford, J. I. MacPherson, R. L. Desjardins, R. D. Kelly, S. P. Oncley, and D. H. Lenschow, 1997: Intercomparison among four flux aircraft at BOREAS in 1994. *J. Geophys. Res.*, **102**, 29101-29111.

Doran, J. C., F. J. Barnes, R. L. Coulter, T. L. Crawford, D. D. Baldocchi, L. Balick, D. R. Cook, D. Cooper, R. J. Dobosy, W. A. Dugas, L. Fritschen, R. L. Hart, L. Hipps, J. M. Hubbe, W. Gao, R. Hicks, R. R. Kirkham, K. E. Kunkel, T. J. Martin, T. P. Meyers, W. Porch, J. D. Shannon, W. J. Shaw, E. Swiatek, and C. D. Whiteman, 1992: The Boardman Regional Flux Experiment. *Bull. Amer. Meteor. Soc.*, **73**, 1785-1795.

Hacker, J. M., and T. L. Crawford, 1999: The BAT-probe: The ultimate tool to measure turbulence from any kind of aircraft (or sailplane). *J. of Technical Soaring*, **XXIII**, 43-46.

Leise, J. A., and J. M. Masters, 1991: Wind measurement from aircraft. Unpublished Tech. Rep., NOAA Aircraft Operations Center, Miami, FL, 182 pp.

Mahrt, L., D. Vickers, J. Sun, T. Crawford, C. Vogel, and E. Dumas, 1999: Coastal zone boundary layers. Preprint, *13th Symposium on Boundary Layers and Turbulence*, Dallas, TX, Amer. Meteor. Soc., 403-406.

Oechel, W. C., G. L. Vourlitis, S. Brooks, T. L. Crawford, and E. Dumas, 1998: Intercomparison among chamber, tower, and aircraft net CO_2 and energy fluxes measured during the Arctic System Science Land-Atmosphere-Ice Interactions (ARCSS-LAII) Flux Study. *J. Geophys. Res.*, **103**, 28993-29003.

Sun, J., D. H. Lenschow, L. Mahrt, T. L. Crawford, K. J. Davis, S. P. Oncley, J. I. MacPherson, Q. Wang, R. J. Dobosy, and R. J. Desjardins, 1997: Lake-induced atmospheric circulations during BOREAS. *J. Geophys. Res.*, **102**, 29155-29166.

Sun, J., L. Mahrt, D. Vickers, J. Wong, T. Crawford, C. Vogel, E. Dumas, P. Mourad, and D. Vandemark, 1999: Air-sea interaction in the coastal shoaling zone. Preprint, *13th Symposium on Boundary Layers and Turbulence*, Dallas, TX, Amer. Meteor. Soc., 343-345.

Vogel, C. A., T. L. Crawford, J. Sun, and L. Mahrt, 1999: Spatial variation of the atmospheric surface drag coefficient within a coastal shoaling zone. Preprint, *13th Symposium on Boundary Layers and Turbulence*, Dallas, TX, Amer. Meteor. Soc., 347-348.

Appendix A: Marker Files

The MKR file contains an ASCII data listing specific times and locations during the flight when the marker switch was toggled to an "on" or "off" position. When the marker switch is turned "on" during the flight, a value of "-1" along with the number of scans (i.e., number of elapsed seconds since the start of data acquisition), time, latitude and longitude are written to the MKR file. Similarly, a value of "0" is written with the time and location information when the marker switch is turned off. The event switch is used to mark a specific occurrence of significance during flight (e.g., flying past the end of a pier). An event is recorded in the MKR file with the designation of "EVT" along with the number of scans, time, latitude and longitude. The MKR file is usually edited at the end of the flight to include a summary of the weather conditions, flight plan, problems encountered, and other notes that may be helpful during data analysis.

When either the marker or event switch is toggled, a 3-character string is written in the first three columns of the time and location record. The default character string is XXX. However, during post-flight data processing, the string is replaced with a 1 to 3-character string which represents a specific flight pattern or event. The following listed below were used in the marker files for SHOWEX.

ERR	Error
EVT	Event
FL	Flux (level) Leg
FLE	Flux (level) Leg (eastward)
FLN	Flux (level) Leg (northward)
FLS	Flux (level) Leg (southward)
FLW	Flux (level) Leg (westward)
FRY	Ferry
PFA	Profile Sounding Ascending
PFD	Profile Sounding Descending
PTC	Pitch Calibration Maneuver
ROL	Roll Calibration Maneuver
SA	Slant Sounding Ascending
SAE	Slant Sounding Ascending (eastward)
SAN	Slant Sounding Ascending (northward)
SAS	Slant Sounding Ascending (southward)
SAW	Slant Sounding Ascending (westward)
SD	Slant Sounding Descending
SDE	Slant Sounding Descending (eastward)
SDN	Slant Sounding Descending (northward)
SDS	Slant Sounding Descending (southward)
SDW	Slant Sounding Descending (westward)
TXI	Taxi
VNT	Ventilation (static)
WBE	Wind Box Maneuver (eastward)
WBN	Wind Box Maneuver (northward)
WBS	Wind Box Maneuver (southward)
WBW	Wind Box Maneuver (westward)
WCL	Wind Circle Left (counterclockwise)
WCR	Wind Circle Right (clockwise)
XXX	Default Character String
YAW	Yaw Calibration Maneuver

SHOWEX 99 Spring Experiment, Duck NC

Flight: 01
Date: 01 MAR 99 (Monday)
Duration: 0.5 Hours
Pilot: TLC

Weather: Cold front passage day before, clear skies and breezy in the morning, winds from the NNW at 6 m/s, shallow stratocumulus in the afternoon from moisture due to previous day's rain. Temperature about 10-12 C.

Summary: Test flight to check data system.

Problems: None

Marker for D:\03012111.ORG OPENED at 162866

```
XXX -1 00391 21:20:56  35 55.0 -75 42.0 marker trial
     0 00594 21:24:19  35 55.4 -75 41.6
XXX -1 00748 21:26:53  35 54.5 -75 44.8 marker trial
     0 01102 21:32:47  36 00.9 -75 50.4
XXX -1 01107 21:32:52  36 01.0 -75 50.2 marker trial
     0 01248 21:35:13  36 01.8 -75 44.5
XXX -1 01330 21:36:35  36 00.2 -75 42.1 marker trial
     0 01660 21:42:05  35 54.9 -75 42.0
```

Marker for D:\03012111.ORG CLOSED at 164722

Total scans : 01856
Missed Ints : 00000
BAT Dropouts: -000.005%
NOV Dropouts: 001.643%
TAN Dropouts: 005.194%

SHOWEX 99 Spring Experiment, Duck NC

Flight: 02
Date: 02 MAR 99 (Tuesday)
Duration: 0.3 Hours
Pilot: TLC

Weather: Clear skies with temperatures about 13-14 C and winds from the SE.

Summary: Test flight to check data system.

Problems: None

Marker for D:\03021454.ORG OPENED at 227216

```
XXX -1 00216 15:10:31  35 55.0 -75 41.7 marker trial
     0 00224 15:10:39  35 54.9 -75 41.6
XXX -1 00301 15:11:56  35 55.2 -75 41.7 marker trial
     0 00307 15:12:02  35 55.4 -75 41.8
XXX -1 00439 15:14:14  35 57.0 -75 45.5 marker trial
     0 00534 15:15:49  35 57.9 -75 48.1
XXX -1 00903 15:21:58  35 55.4 -75 41.8 marker trial
     0 00906 15:22:01  35 55.4 -75 41.8

Marker for D:\03021454.ORG CLOSED at 228269

Total scans : 01053
Missed Ints : 00000
BAT Dropouts: -000.006%
NOV Dropouts: 008.946%
TAN Dropouts: 000.114%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 03
    Date: 02 MAR 99 (Tuesday)
Duration: 3.0 Hours
   Pilot: TLC

Weather: Clear skies with temperatures about 13-14 C and strong winds from
         the SE.

Summary: Numerous perpendicular runs conducted at numerous levels.  Several
         slant soundings included in flight.

Problems: The parallel runs were abandoned because way points were incorrect.

Marker for D:\03021809.ORG OPENED at 238540

VNT -1 00029 18:16:08  35 55.0 -75 42.1 ventilation
     0 00065 18:16:44  35 55.0 -75 42.1
TXI -1 00831 18:29:30  36 11.0 -75 45.2 taxi
     0 00861 18:30:00  36 11.3 -75 44.1
FLW -1 02081 18:50:20  36 14.0 -75 29.0 W 10 m
     0 02576 18:58:35  36 10.9 -75 45.0
FLE -1 02719 19:00:58  36 10.8 -75 45.0 E 15 m
     0 03198 19:08:57  36 14.6 -75 26.7
FLW -1 03340 19:11:19  36 15.1 -75 24.3 W 50 m
     0 04023 19:22:42  36 10.9 -75 45.0
SAN -1 04176 19:25:15  36 11.1 -75 44.6 N slant sounding up
     0 04554 19:31:33  36 20.6 -75 46.5
SDS -1 04557 19:31:36  36 20.6 -75 46.6 S slant sounding down
     0 04984 19:38:43  36 09.2 -75 43.3
FLE -1 05262 19:43:21  36 10.7 -75 45.6 E 110 m
     0 05530 19:47:49  36 13.0 -75 35.6
```

```
FLW -1 05689 19:50:28  36 13.5 -75 33.2 W 110 m
     0 06314 20:00:53  36 09.0 -75 52.0
FLE -1 06431 20:02:50  36 09.3 -75 52.4 E 50 m
     0 06873 20:10:12  36 12.8 -75 35.8
FLW -1 07032 20:12:51  36 13.3 -75 33.4 W 50 m
     0 07466 20:20:05  36 10.6 -75 46.7
FLE -1 07618 20:22:37  36 10.2 -75 47.9 E 50 m
     0 07955 20:28:14  36 12.8 -75 35.3
FLW -1 08116 20:30:55  36 13.4 -75 32.8 W 50 m
     0 08552 20:38:11  36 10.7 -75 46.1
FLE -1 08687 20:40:26  36 10.7 -75 47.2 E 50 m
     0 08998 20:45:37  36 12.9 -75 35.5
FLW -1 09146 20:48:05  36 13.2 -75 33.1 W 50 m
     0 09557 20:54:56  36 10.7 -75 45.7
SA  -1 09638 20:56:17  36 10.9 -75 46.0 sounding to 1500 m
     0 10056 21:03:15  36 00.3 -75 38.5
SD  -1 10063 21:03:22  36 00.1 -75 38.3 down sounding
     0 10453 21:09:52  35 54.9 -75 41.6
TXI -1 10460 21:09:59  35 54.9 -75 41.6 taxi
     0 10475 21:10:14  35 55.0 -75 41.6
VNT -1 10599 21:12:18  35 55.0 -75 42.1 ventilation
     0 10632 21:12:51  35 55.0 -75 42.1

Marker for D:\03021809.ORG CLOSED at 249178

Total scans : 10638
Missed Ints : 00000
BAT Dropouts: -000.005%
NOV Dropouts: 002.755%
TAN Dropouts: 001.406%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 04
    Date: 03 MAR 99 (Wednesday)
Duration: 3.9 Hours
   Pilot: TLC

Weather: Mostly sunny skies with stiff SE winds (160 deg) at start of flight
         switching to SSW (210 deg) by the end of the flight.  Cold front
         approaching area.

Summary: Numerous perpendicular legs towards and away from the coast at
         several levels.  Parallel legs to the coast also included in flight.

Problems: None

Marker for D:\03031328.ORG OPENED at 307986

VNT -1 00005 13:33:10  35 55.0 -75 42.1 ventilation
```

```
     0 00043 13:33:48  35 55.0 -75 42.1
TXI -1 00251 13:37:16  35 55.3 -75 41.7 taxi
     0 00262 13:37:27  35 55.1 -75 41.6
PFA -1 00343 13:38:48  35 56.3 -75 40.5 spiral profile to 1500 m at MQI
     0 00778 13:46:03  36 00.7 -75 39.2
SD  -1 00791 13:46:16  36 01.2 -75 39.1 slant sounding to pier
     0 01282 13:54:27  36 16.0 -75 49.5
FLE -1 01549 13:58:54  36 10.5 -75 46.8 E 11 m
     0 02067 14:07:32  36 14.4 -75 29.8
FLW -1 02202 14:09:47  36 14.6 -75 28.4 W 8 m
     0 02714 14:18:19  36 10.4 -75 46.4
FLE -1 02812 14:19:57  36 10.7 -75 46.2 E 15 m
     0 03321 14:28:26  36 14.1 -75 29.8
FLW -1 03456 14:30:41  36 14.1 -75 28.6 W 15 m
     0 03959 14:39:04  36 10.7 -75 46.2
FLN -1 04116 14:41:41  36 09.9 -75 44.2 N off pier
     0 04313 14:44:58  36 15.9 -75 46.6
FLS -1 04438 14:47:03  36 17.4 -75 46.5 S off pier
     0 04907 14:54:52  36 07.2 -75 40.8
FLW -1 05175 14:59:20  36 11.5 -75 42.8 W 20 m
EVT    05233 15:00:18  36 11.0 -75 44.7 pier
     0 05585 15:06:10  36 07.1 -75 55.5
FLE -1 05673 15:07:38  36 07.4 -75 54.6 E 50 m
     0 06270 15:17:35  36 12.1 -75 38.4
FLW -1 06422 15:20:07  36 13.6 -75 36.5 W 100 m
     0 07061 15:30:46  36 07.3 -75 55.6
FLE -1 07234 15:33:39  36 07.6 -75 55.7 E 200 m
     0 07721 15:41:46  36 12.6 -75 37.6
FLW -1 07895 15:44:40  36 14.4 -75 34.3 W 400 m
     0 08691 15:57:56  36 08.0 -75 54.7
FLE -1 08748 15:58:53  36 07.7 -75 53.9 E 400 m
     0 09183 16:06:08  36 12.5 -75 37.9
FLW -1 09328 16:08:33  36 12.7 -75 35.9 W 200 m
     0 10063 16:20:48  36 05.6 -75 53.5
FLE -1 10158 16:22:23  36 06.6 -75 51.8 E 100 m
     0 10552 16:28:57  36 12.7 -75 38.0
FLW -1 10695 16:31:20  36 13.2 -75 36.0 W 50 m
     0 11346 16:42:11  36 08.5 -75 55.0
FLE -1 11431 16:43:36  36 08.4 -75 53.3 E 70 m
     0 11853 16:50:38  36 12.3 -75 37.6
FLW -1 11995 16:53:00  36 13.0 -75 35.9 W 50 m
     0 12645 17:03:50  36 08.4 -75 54.9
SA  -1 12662 17:04:07  36 08.2 -75 55.3 slant sounding, pier to MQI, 1700 m
     0 13237 17:13:42  36 01.8 -75 41.4
TXI -1 13886 17:24:31  35 55.0 -75 41.9 taxi
     0 13890 17:24:35  35 54.9 -75 42.0
VNT -1 14034 17:26:59  35 55.1 -75 41.5 ventilation
     0 14070 17:27:35  35 55.1 -75 41.5

Marker for D:\03031328.ORG CLOSED at 322059
```

Total scans : 14073
Missed Ints : 00000
BAT Dropouts: -000.004%
NOV Dropouts: 002.444%
TAN Dropouts: 001.673%

SHOWEX 99 Spring Experiment, Duck NC

Flight: 05
Date: 04 MAR 99 (Thursday)
Duration: 3.3 Hours
Pilot: TLC

Weather: Post-frontal conditions, clear skies and strong westerly (250 deg) winds at 10-14 m/s. Cooler temperatures 4-6 C.

Summary: Numerous perpendicular legs at several levels. Slant sounding down to the pier. One round trip at target-track at 10 m. Parallel runs at 0.5, 1, 2, 4, and 10 km.

Problems: Problems with data acquisition system which crashed in flight shortly after takeoff. System was rebooted with new ZIP disk, no problems after that.

Marker for D:\03041425.ORG OPENED at 397635

```
SD  -1 00007 14:27:21  36 00.5 -75 36.4 slant sounding
     0 00531 14:36:05  36 11.7 -75 45.2
FLE -1 00647 14:38:01  36 10.9 -75 45.0 E 20 m
     0 01227 14:47:41  36 15.8 -75 20.3
FLW -1 01344 14:49:38  36 16.7 -75 18.2 W 20 m
     0 02572 15:10:06  36 09.4 -75 49.6
FLN -1 02900 15:15:34  36 05.7 -75 41.9 at pier S to N
     0 03399 15:23:53  36 17.8 -75 46.8
FLS -1 03457 15:24:51  36 18.0 -75 45.3 pier +1 km N to S
     0 03899 15:32:13  36 05.9 -75 41.4
FLN -1 03960 15:33:14  36 06.2 -75 40.4 pier +2 km S to N
     0 04433 15:41:07  36 17.1 -75 44.9
FLS -1 04491 15:42:05  36 16.9 -75 43.6 pier +4 km N to S
     0 04878 15:48:32  36 06.3 -75 39.7
FLN -1 05038 15:51:12  36 07.1 -75 35.2 pier +10 km S to N
     0 05512 15:59:06  36 18.1 -75 39.9
FLS -1 05641 16:01:15  36 18.5 -75 40.2 pier +10 km N to S
     0 06091 16:08:45  36 05.7 -75 35.8
FLN -1 06292 16:12:06  36 05.5 -75 29.7 pier +20 km S to N
     0 06911 16:22:25  36 20.7 -75 34.7
FLS -1 07011 16:24:05  36 21.1 -75 35.4 pier +20 km N to S
     0 07503 16:32:17  36 07.4 -75 30.2
FLN -1 08068 16:41:42  36 07.8 -75 39.9 pier +4 km S to N
     0 08462 16:48:16  36 17.2 -75 43.8
```

```
FLS -1 08545 16:49:39  36 16.4 -75 44.8 pier +2 km N to S
     0 08876 16:55:10  36 06.9 -75 41.3
FLN -1 08945 16:56:19  36 06.8 -75 42.1 pier +1 km S to N
     0 09353 17:03:07  36 16.6 -75 45.4
FLS -1 09465 17:04:59  36 17.0 -75 46.1 pier +0 km N to S
     0 09875 17:11:49  36 05.6 -75 41.9
VNT -1 10155 17:16:29  36 00.8 -75 40.3 ventilation
     0 10199 17:17:13  36 00.8 -75 40.3

Marker for D:\03041425.ORG CLOSED at 407843

Total scans : 10208
Missed Ints : 00000
BAT Dropouts: -000.005%
NOV Dropouts: 002.556%
TAN Dropouts: 003.510%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 06
    Date: 04 MAR 99 (Thursday)
Duration: 2.5 Hours
   Pilot: TLC

Weather: Post-frontal conditions, clear skies and strong westerly winds
         at 10 m/s.  Temperatures cooler 4-6 C.

Summary: Perpendicular runs, internal boundary layer flight.

Problems: Problem with data acquisition system, crashed in flight, reboot
          failed.

Marker for D:\03041729.ORG OPENED at 408844

VNT -1 00001 17:34:04  36 00.9 -75 40.3 ventilation
     0 00039 17:34:42  36 00.9 -75 40.3
TXI -1 00166 17:36:49  36 01.3 -75 40.2 taxi
     0 00174 17:36:57  36 01.2 -75 40.3
SD  -1 00441 17:41:24  35 58.0 -75 36.6 slant sounding 1500 m down to pier
     0 01124 17:52:47  36 11.2 -75 44.9
FLE -1 01449 17:58:12  36 09.0 -75 52.8 E 60 m
ERR    01918 18:06:02                   GPS Time Reset!
     0 02107 18:09:11  36 14.8 -75 27.0
FLW -1 02255 18:11:39  36 15.0 -75 25.0 W 90 m
     0 03341 18:29:45  36 09.1 -75 54.2
FLE -1 03503 18:32:27  36 08.4 -75 53.9 E 150 m
     0 03956 18:40:00  36 13.0 -75 36.1
FLW -1 04120 18:42:44  36 13.3 -75 33.4 W 300 m
     0 04951 18:56:35  36 08.5 -75 55.5
Data system crash
```

Marker for D:\03041729.ORG CLOSED at 416636

Total scans : 07790
Missed Ints : 00002
BAT Dropouts: -000.031%
NOV Dropouts: 004.576%
TAN Dropouts: 001.330%

SHOWEX 99 Spring Experiment, Duck NC

Flight: 07
Date: 05 MAR 99 (Friday)
Duration: 3.1 Hours
Pilot: TLC

Weather: Clear skies and strong northerly winds at 10 m/s. Temperatures from 10-12 C.

Summary: Slant sounding followed by 12 parallel and 2 perpendicular flux transects.

Problems: Moved to First Flight (FFA) but the ground power unit (GPU) did not work. System booted with aircraft power which prohibited ground calibrations. Data acquisition system crashed towards end flight.

Marker for D:\03051312.ORG OPENED at 479982

```
SD  -1 00427 13:26:48  35 56.5 -75 36.6 FFA 5 km to pier
     0 01153 13:38:54  36 12.6 -75 45.2
FLS -1 01618 13:46:39  36 12.5 -75 45.5 S surf zone
     0 01850 13:50:31  36 05.8 -75 42.3
FLN -1 02017 13:53:18  36 04.0 -75 41.2 N surf zone
     0 02581 14:02:42  36 16.5 -75 47.3
FLE -1 03011 14:10:00  36 11.0 -75 44.6 Pier to E
     0 03447 14:17:08  36 13.6 -75 32.3
FLW -1 04343 14:32:04  36 07.6 -75 43.0 E to Pier
     0 04747 14:38:48  36 16.8 -75 46.5
FLN -1 04866 14:40:47  36 16.6 -75 45.2 parallel N +0 km
     0 05240 14:47:01  36 05.7 -75 41.6
FLS -1 05333 14:48:34  36 06.0 -75 40.7 parallel S +0 km
     0 05812 14:56:33  36 16.7 -75 44.7
FLN -1 05887 14:57:48  36 16.7 -75 43.3 parallel N +0.5 km
     0 06255 15:03:56  36 06.1 -75 39.2
FLS -1 06434 15:06:55  36 08.0 -75 36.5 parallel S +0.5 km
     0 06866 15:14:07  36 18.0 -75 39.9
FLN -1 07048 15:17:09  36 18.2 -75 39.9 parallel N +1 km
     0 07429 15:23:30  36 07.2 -75 36.2
FLS -1 07575 15:25:56  36 05.2 -75 39.3 parallel S +1 km
     0 08100 15:34:41  36 17.1 -75 43.5
FLN -1 08179 15:36:00  36 16.4 -75 44.8 parallel N +2 km
```

```
     0 08551 15:42:12  36 05.7 -75 40.7
FLS -1 08676 15:44:17  36 04.4 -75 41.1 parallel S +2 km
     0 09204 15:53:05  36 16.9 -75 45.2
FLN -1 09329 15:55:10  36 17.2 -75 46.3 parallel N +10 km
Data system crash

Marker for D:\03051312.ORG CLOSED at 489897

Total scans : 09914
Missed Ints : 00001
BAT Dropouts: -000.011%
NOV Dropouts: 005.352%
TAN Dropouts: 003.156%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 08
    Date: 05 MAR 99 (Friday)
Duration: 3.7 Hours
   Pilot: EJD

Weather: High overcast skies and northeasterly winds.  Temperature about
         10-12 C.

Summary: Numerous east-west legs for IBL.  The flight focus on Currituck
         Peninsula, 7 passes at 60 m, which is the lowest possible level,
         then 7 passes at 1000 ft, and 7 passes at 200 ft.  Two slant
         soundings were conducted at the beginning and end of the mission.

Problems: None

Marker for D:\03051709.ORG OPENED at 493864

VNT -1 00009 17:11:12  36 00.8 -75 40.3 ventilation
     0 00033 17:11:36  36 00.8 -75 40.3
SA  -1 00458 17:18:41  36 02.6 -75 42.4 slant sounding sfc - 1500 m
     0 00828 17:24:51  36 04.6 -75 54.2
SD  -1 00832 17:24:55  36 04.7 -75 54.3 slant sounding 1500 m - sfc
     0 01374 17:33:57  36 03.3 -75 59.7
FLE -1 01486 17:35:49  36 04.7 -75 56.8 150 m
     0 01856 17:41:59  36 09.8 -75 47.5
FLW -1 01981 17:44:04  36 09.4 -75 47.9 60 m
     0 02270 17:48:53  36 04.7 -75 57.0
FLE -1 02428 17:51:31  36 04.8 -75 56.8 60 m
     0 02802 17:57:45  36 09.3 -75 47.3
FLW -1 02925 17:59:48  36 09.4 -75 47.5 60 m
     0 03228 18:04:51  36 04.7 -75 57.0
FLE -1 03381 18:07:24  36 04.8 -75 56.8 60 m
     0 03748 18:13:31  36 09.6 -75 47.4
FLW -1 03882 18:15:45  36 09.5 -75 47.6 60 m
```

```
     0 04183 18:20:46  36 04.8 -75 57.1
FLE -1 04361 18:23:44  36 04.8 -75 56.9 60 m
     0 04719 18:29:42  36 09.7 -75 47.4
FLW -1 04850 18:31:53  36 09.6 -75 47.6 60 m
     0 05146 18:36:49  36 04.7 -75 57.0
FLE -1 05315 18:39:38  36 04.8 -75 56.9 150 m
     0 05666 18:45:29  36 09.6 -75 47.4
FLW -1 05809 18:47:52  36 09.5 -75 47.5 300 m
     0 06115 18:52:58  36 03.7 -75 56.4
FLE -1 06202 18:54:25  36 04.8 -75 56.8 300 m
     0 06561 19:00:24  36 09.4 -75 47.3
FLW -1 06690 19:02:33  36 09.5 -75 47.5 300 m
     0 06991 19:07:34  36 04.6 -75 56.9
FLE -1 07163 19:10:26  36 04.9 -75 57.0 300 m
     0 07516 19:16:19  36 09.5 -75 47.3
FLW -1 07651 19:18:34  36 09.0 -75 48.2 300 m
     0 07955 19:23:38  36 04.6 -75 56.8
FLE -1 08155 19:26:58  36 05.0 -75 57.0 300 m
     0 08509 19:32:52  36 09.6 -75 47.3
FLW -1 08641 19:35:04  36 09.5 -75 47.6 60 m
     0 08943 19:40:06  36 04.6 -75 56.9
FLE -1 09098 19:42:41  36 04.8 -75 56.9 60 m
     0 09452 19:48:35  36 09.7 -75 47.4
FLW -1 09589 19:50:52  36 09.6 -75 47.6 60 m
ERR    09597 19:51:01                   GPS Time Reset!
     0 09893 19:55:57  36 04.5 -75 56.9
FLE -1 10069 19:58:53  36 04.7 -75 56.8 60 m
     0 10421 20:04:45  36 09.5 -75 47.2
FLW -1 10556 20:07:00  36 09.5 -75 47.6 60 m
     0 10866 20:12:10  36 04.8 -75 57.1
FLE -1 11033 20:14:57  36 05.1 -75 57.0 60 m
     0 11382 20:20:46  36 09.6 -75 47.4
FLW -1 11489 20:22:33  36 09.3 -75 48.0 60 m
     0 11816 20:28:00  36 04.5 -75 56.9
SA  -1 11934 20:29:58  36 05.4 -75 58.3 slant sounding sfc - 900 m
     0 12176 20:34:00  36 04.9 -75 50.5

Marker for D:\03051709.ORG CLOSED at 506727

Total scans .: 12862
Missed Ints : 00001
BAT Dropouts: -000.013%
NOV Dropouts: 003.702%
TAN Dropouts: 001.448%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 09
    Date: 06 MAR 99 (Saturday)
Duration: 3.5 Hours
```

Pilot: TLC

Weather: Partly to mostly cloudy, southerly winds about 5 m/s, more humid with temperatures about 15-17 C.

Summary: Numerous parallel legs and 4 east-west legs. Slant soundings at near-shore and 10 km off-shore. Due to the drop-out problem of the new IR radiometer, the new IR radiometer was replaced by the old IR radiometer at the end of the day, pointing downward.

Problems: None

Marker for D:\03061308.ORG OPENED at 566017

```
VNT -1 00354 13:19:30  36 00.7 -75 40.4 ventilation, low pass RY 2 @ FFA
     0 00368 13:19:44  36 01.2 -75 40.2
SD  -1 01235 13:34:11  35 59.2 -75 36.1 slant sounding to pier
     0 01724 13:42:20  36 15.1 -75 46.8
FLW -1 01989 13:46:45  36 10.9 -75 45.0 E to W
     0 02350 13:52:46  36 13.7 -75 32.4
FLE -1 02519 13:55:35  36 14.2 -75 30.5 W to E
     0 02956 14:02:52  36 10.9 -75 45.0
FLN -1 03184 14:06:40  36 07.8 -75 43.5 S to N in surf
     0 03478 14:11:34  36 16.6 -75 47.3
FLS -1 03669 14:14:45  36 18.6 -75 48.0 N to S in surf
     0 04181 14:23:17  36 06.0 -75 42.4
FLN -1 04321 14:25:37  36 05.1 -75 41.8 S to N +0.5 km
     0 04697 14:31:53  36 16.9 -75 46.8
FLS -1 04893 14:35:09  36 18.7 -75 46.8 N to S +0.5 km
     0 05406 14:43:42  36 06.0 -75 42.2
FLN -1 05555 14:46:11  36 06.8 -75 41.7 S to N +1 km
     0 05873 14:51:29  36 16.8 -75 45.5
FLS -1 06011 14:53:47  36 16.3 -75 44.5 N to S +1 km
     0 06432 15:00:48  36 06.1 -75 40.8
FLN -1 06513 15:02:09  36 07.0 -75 39.4 S to N +2 km
     0 06850 15:07:46  36 17.3 -75 43.5
FLS -1 06982 15:09:58  36 18.9 -75 40.2 N to S +4 km
     0 07486 15:18:22  36 07.0 -75 36.0
FLN -1 07629 15:20:45  36 06.6 -75 39.7 S to N +2 km
     0 07968 15:26:24  36 17.2 -75 43.6
FLS -1 08037 15:27:33  36 17.0 -75 44.8 N to S +1 km
     0 08487 15:35:03  36 06.1 -75 41.0
FLN -1 08627 15:37:23  36 05.0 -75 40.6 S to N +1 km
     0 09022 15:43:58  36 16.8 -75 45.5
FLS -1 09178 15:46:34  36 17.7 -75 46.2 N to S just off pier
     0 09660 15:54:36  36 06.0 -75 42.1
FLN -1 09774 15:56:30  36 05.3 -75 41.8 S to N in surf
     0 10148 16:02:44  36 16.2 -75 46.5
    -1 10269 16:04:45  36 16.6 -75 47.4
     0 10669 16:11:25  36 06.6 -75 42.9
FLE -1 10892 16:15:08  36 10.9 -75 45.1 E
```

```
     0 11239 16:20:55  36 13.9 -75 32.4
FLW -1 11408 16:23:44  36 14.1 -75 31.1 W
     0 11817 16:30:33  36 10.9 -75 45.1
SA  -1 11885 16:31:41  36 11.2 -75 44.5 slant sounding to FFA
     0 12166 16:36:22  36 05.0 -75 40.7
TXI -1 12397 16:40:13  36 00.9 -75 40.3 taxi
     0 12401 16:40:17  36 00.9 -75 40.4

Marker for D:\03061308.ORG CLOSED at 579502

Total scans : 13485
Missed Ints : 00000
BAT Dropouts: 000.127%
NOV Dropouts: 003.675%
TAN Dropouts: 002.918%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 10
    Date: 07 MAR 99 (Sunday)
Duration: 4.7 Hours
   Pilot: TLC

Weather: A few stattered clouds, strong north winds at 10-15 m/s, cool
         temperatures about 3 C.

Summary: Butterfly at start and end, then parallel legs.

Problems: None

Marker for D:\03071303.ORG OPENED at 047850

VNT -1 00040 13:18:09  36 00.8 -75 40.3 ventilation
     0 00135 13:19:44  36 00.8 -75 40.3
TXI -1 00456 13:25:05  36 01.5 -75 40.4 taxi
     0 00459 13:25:08  36 01.5 -75 40.5
SDN -1 01286 13:38:55  35 49.5 -75 32.3 N down slant sounding from 1800 m 1
     0 02559 14:00:08  36 15.8 -75 46.9
FLS -1 02767 14:03:36  36 17.8 -75 47.5 S in surf                         2
     0 03128 14:09:37  36 06.0 -75 42.1
SAN -1 03284 14:12:13  36 03.5 -75 40.8 N up slant profile                3
     0 03981 14:23:50  36 17.2 -75 47.0
PFD -1 03986 14:23:55  36 17.3 -75 47.0 down profile                      4
     0 04168 14:26:57  36 16.5 -75 47.1
FLS -1 04184 14:27:13  36 16.0 -75 47.1 near Surf S
     0 04478 14:32:07  36 06.2 -75 42.2
SAN -1 04646 14:34:55  36 04.8 -75 41.6 slant pro up to N
     0 05251 14:45:00  36 16.5 -75 47.8
SDS -1 05306 14:45:55  36 16.7 -75 47.0 near surf slant pro down to S
     0 05614 14:51:03  36 05.6 -75 42.3
```

```
FLN -1 05724 14:52:53  36 06.0 -75 42.2 PS to PN
     0 06254 15:01:43  36 17.4 -75 46.3
FLS -1 06331 15:03:00  36 16.7 -75 45.4 N1 to S1
     0 06646 15:08:15  36 05.6 -75 41.2
FLN -1 06749 15:09:58  36 05.4 -75 40.6 S2 to N2
     0 07326 15:19:35  36 17.8 -75 44.6
FLS -1 07412 15:21:01  36 16.7 -75 43.1 N3 to S3
     0 07726 15:26:15  36 05.7 -75 39.6
FLN -1 07916 15:29:25  36 06.1 -75 35.7 S4 to N4
     0 08491 15:39:00  36 18.1 -75 39.9
FLS -1 08765 15:43:34  36 19.4 -75 33.6 N5 to S5
     0 09045 15:48:14  36 09.2 -75 30.4
SAN -1 09217 15:51:06  36 06.3 -75 28.9 S5 to N5 slant up
     0 10060 16:05:09  36 22.3 -75 33.5
XXX -1 10157 16:06:46  36 20.0 -75 34.9 cloud base 900 m, top 1200 m
     0 10464 16:11:53  36 08.5 -75 30.7
FLN -1 10615 16:14:24  36 05.4 -75 28.7 S5 to N5
     0 11365 16:26:54  36 19.8 -75 34.0
SDS -1 11621 16:31:10  36 22.4 -75 34.9 N5 to S5 Down
ERR    11897 16:35:47                   GPS Time Reset!
     0 11973 16:37:03  36 09.6 -75 31.1
FLN -1 12070 16:38:40  36 10.0 -75 31.3 S5 to N5
     0 12565 16:46:55  36 20.5 -75 34.6
FLS -1 12661 16:48:31  36 20.9 -75 34.6 N5 to S5 up to 900 m
     0 12963 16:53:33  36 09.9 -75 30.5
FLS -1 13041 16:54:51  36 07.9 -75 31.8 S5 to S4 down
     0 13196 16:57:26  36 06.5 -75 35.9
FLN -1 13197 16:57:27  36 06.5 -75 35.9 S4 to N4
     0 13737 17:06:27  36 18.1 -75 39.9
FLS -1 13923 17:09:33  36 15.3 -75 42.5 N3 to S3
     0 14234 17:14:44  36 04.4 -75 39.4
FLN -1 14323 17:16:13  36 03.4 -75 40.2 S2 to N2
     0 14936 17:26:26  36 17.7 -75 44.6
FLS -1 15064 17:28:34  36 17.3 -75 45.4 N1 to S1
     0 15404 17:34:14  36 05.8 -75 41.2
FLN -1 15494 17:35:44  36 05.7 -75 42.0 PS to PN
     0 15962 17:43:32  36 16.6 -75 45.7
FLS -1 16039 17:44:49  36 16.0 -75 47.0 surf S
     0 16356 17:50:06  36 05.5 -75 42.2
SA  -1 16373 17:50:23  36 04.9 -75 41.8 pier to FFA
     0 16533 17:53:03  35 60.0 -75 38.0
TXI -1 16843 17:58:13  36 01.2 -75 40.3 taxi
     0 16853 17:58:23  36 01.3 -75 40.2

Marker for D:\03071303.ORG CLOSED at 064839

Total scans : 16988
Missed Ints : 00001
BAT Dropouts: -000.010%
NOV Dropouts: 001.927%
TAN Dropouts: 002.252%
```

SHOWEX 99 Spring Experiment, Duck NC

Flight: 11
Date: 07 MAR 99 (Sunday)
Duration: 3.8 Hours
Pilot: EJD

Weather: A few stattered clouds, NW wind (340 deg) at 12 m/s, strong turbulence, cool temperatures of about 3 C.

Summary: Slant sounding to 1800 m, butterfly to 900 m at start and end, then parallel legs.

Problems: The pod, Laser #2 and the Ka-band radar were damaged on landing and The pod and these sensors were removed for the duration of the experiment.

Marker for D:\03071833.ORG OPENED at 067402

```
VNT -1 00009 18:43:30  36 00.8 -75 40.3 ventilation
     0 00055 18:44:16  36 00.8 -75 40.3
SA  -1 00225 18:47:06  36 01.5 -75 40.1 profile sfc - 1800 m
     0 00617 18:53:38  36 09.6 -75 43.3
SD  -1 00687 18:54:48  36 09.8 -75 41.6 profile 1800 m - sfc
     0 01251 19:04:12  36 06.2 -75 42.6
FLN -1 01253 19:04:14  36 06.3 -75 42.6 15 m S-N 1 km
     0 01685 19:11:26  36 16.3 -75 46.5
SAS -1 01826 19:13:47  36 16.0 -75 46.2 slant 15 m - 1800 m N-S
     0 02143 19:19:04  36 06.0 -75 42.0
PFD -1 02163 19:19:24  36 05.4 -75 41.5 spiral Dn 1800 m - 15 m over S point
     0 02555 19:25:56  36 05.9 -75 42.4
SAN -1 02569 19:26:10  36 06.2 -75 42.5 slant 15 m - 1800 m S-N
     0 03059 19:34:20  36 16.4 -75 46.5
Data system crash
```

Marker for D:\03071833.ORG CLOSED at 070739

Total scans : 03336
Missed Ints : 00001
BAT Dropouts: -000.035%
NOV Dropouts: 006.903%
TAN Dropouts: 001.406%

SHOWEX 99 Spring Experiment, Duck NC

Flight: 11
Date: 07 MAR 99 (Sunday)
Duration: 3.8 Hours
Pilot: EJD

Weather: A few stattered clouds, NW wind (340 deg) at 12 m/s, strong turbulence, cool temperatures of about 3 C.

Summary: Slant sounding to 1800 m, butterfly to 900 m at start and end, then parallel legs.

Problems: The pod, Laser #2 and the Ka-band radar were damaged on landing and The pod and these sensors were removed for the duration of the experiment.

Marker for D:\03071941.ORG OPENED at 070975

```
FLS -1 00112 19:44:46  36 15.5 -75 46.3 1800 m N-S
     0 00394 19:49:28  36 05.9 -75 41.6
SDN -1 00485 19:50:59  36 06.0 -75 42.4 slant 1800 m - 15 m S-N
     0 00953 19:58:47  36 16.3 -75 46.4
PFA -1 00964 19:58:58  36 16.5 -75 46.5 spiral Up 15 m - 1800 m over N point
     0 01217 20:03:11  36 15.4 -75 47.0
SDS -1 01315 20:04:49  36 15.4 -75 45.8 slant 1800 m - 15 m N-S
     0 01595 20:09:29  36 05.6 -75 42.0
PFA -1 01598 20:09:32  36 05.5 -75 42.0 spiral up 15 m - 1800 m over S point
     0 01819 20:13:13  36 05.7 -75 41.8
FLN -1 01839 20:13:33  36 06.0 -75 42.2 1800 m S-N
     0 02302 20:21:16  36 16.5 -75 46.4
PFD -1 02343 20:21:57  36 17.4 -75 46.6 spiral dn 1800 m - 15 m over N point
     0 02771 20:29:05  36 15.2 -75 45.5
FLS -1 02774 20:29:08  36 15.1 -75 45.5 15 m N-S
     0 03099 20:34:33  36 04.0 -75 40.7
SAN -1 03309 20:38:03  36 04.0 -75 40.3 slant 15 m - 1800 m S-N
     0 03714 20:44:48  36 09.7 -75 30.8
SDS -1 03863 20:47:17  36 09.1 -75 28.9 slant 1800 m - 15 m N-S
     0 04400 20:56:14  36 07.1 -75 36.9
FLN -1 04422 20:56:36  36 07.6 -75 36.7 15 m S-N
     0 04899 21:04:33  36 17.8 -75 40.0
SAS -1 04998 21:06:12  36 17.5 -75 40.4 slant 15 m - 1800 m N-S
     0 05305 21:11:19  36 07.1 -75 36.0
PFD -1 05308 21:11:22  36 07.0 -75 36.0 spiral dn 1800 m - 15 m over S point
     0 05732 21:18:26  36 06.2 -75 36.4
SAN -1 05734 21:18:28  36 06.2 -75 36.4 slant 15 m - 1800 m S-N
     0 06303 21:27:57  36 17.8 -75 39.9
FLS -1 06458 21:30:32  36 17.8 -75 40.2 1800 m N-S
     0 06754 21:35:28  36 07.2 -75 36.1
SDN -1 06888 21:37:42  36 04.8 -75 35.0 slant 1800 m - 15 m S-N
     0 07541 21:48:35  36 17.7 -75 40.0
PFA -1 07544 21:48:38  36 17.7 -75 40.0 spiral up 15 m - 1800 m over N point
     0 07807 21:53:01  36 16.8 -75 39.6
SDS -1 07910 21:54:44  36 17.1 -75 39.6 slant 1800 m - 15 m N-S
     0 08201 21:59:35  36 06.4 -75 35.6
PFA -1 08202 21:59:36  36 06.4 -75 35.6 spiral up 15 m - 1800 m over S point
     0 08401 22:02:55  36 06.3 -75 35.4
FLN -1 08452 22:03:46  36 07.3 -75 36.2 1800 m S-N
```

```
     0 08911 22:11:25  36 17.7 -75 40.4
PFD -1 08916 22:11:30  36 17.8 -75 40.4 spiral dn 1800 m - 15 m over N point
     0 09145 22:15:19  36 17.0 -75 39.4
FLS -1 09147 22:15:21  36 16.9 -75 39.4 15 m N-S
     0 09407 22:19:41  36 07.3 -75 36.6

Marker for D:\03071941.ORG CLOSED at 080935

Total scans : 09960
Missed Ints :
BAT Dropouts:
NOV Dropouts:
TAN Dropouts:


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 12
    Date: 08 MAR 99 (Monday)
Duration: 3.5 Hours
   Pilot: TLC

Weather: Clear skies and cold with strong northerly winds at about
         10-15 m/s.

Summary: Two butterflys and pier east and west.

Problems: Laser #2 and Ka-band radar not working.

Marker for D:\03081413.ORG OPENED at 139825

VNT -1 00006 14:50:30  36 00.8 -75 40.3 ventilation
     0 00055 14:51:19  36 00.8 -75 40.3
TXI -1 00404 14:57:08  36 00.9 -75 40.1 taxi
     0 00407 14:57:11  36 00.9 -75 40.0
SAE -1 00740 15:02:44  36 00.6 -75 39.0 FFA to E up
     0 01283 15:11:47  36 13.8 -75 50.5
SDW -1 01719 15:19:03  36 08.1 -76 04.7 EW slant dn pro
     0 01911 15:22:15  36 06.3 -76 11.7
XXX -1 02318 15:29:02  36 08.8 -76 02.1
     0 02321 15:29:05  36 08.8 -76 02.0
PFD -1 02326 15:29:10  36 08.9 -76 01.9 down spiral at E
     0 02659 15:34:43  36 08.4 -76 01.7
SAW -1 02734 15:35:58  36 08.3 -76 03.8 EW slant up pro
     0 03018 15:40:42  36 05.9 -76 13.8
FLE -1 03300 15:45:24  36 04.9 -76 16.1 WE flx at 600 m
     0 03698 15:52:02  36 08.4 -76 03.3
SDW -1 03840 15:54:24  36 08.9 -76 03.2 EW slant dn pro
     0 04227 16:00:51  36 04.3 -76 16.0
PFA -1 04468 16:04:52  36 03.8 -76 15.7 W spiral up
     0 04625 16:07:29  36 05.1 -76 15.7
```

```
SDE -1 04630 16:07:34  36 05.1 -76 15.6 WE slant dn pro
     0 05083 16:15:07  36 09.0 -76 02.6
FLW -1 05539 16:22:43  36 07.0 -76 03.6 EW flx at 600 m
     0 05799 16:27:03  36 04.9 -76 12.8
XXX -1 06213 16:33:57  36 08.4 -76 03.7
     0 06215 16:33:59  36 08.5 -76 03.6
FLW -1 06550 16:39:34  36 05.3 -76 01.6 EW flx at sfc
     0 06761 16:43:05  36 01.0 -76 07.5
SAE -1 06903 16:45:27  36 00.3 -76 08.5 WE slant up pro
     0 07229 16:50:53  36 05.5 -76 02.1
SAW -1 07493 16:55:17  36 05.5 -76 01.1 EW slant up pro
     0 07786 17:00:10  35 59.7 -76 09.0
FLE -1 07996 17:03:40  36 00.0 -76 09.2 WE flx at 600 m
     0 08305 17:08:49  36 05.3 -76 01.3
SDW -1 08446 17:11:10  36 06.2 -76 00.1 EW slant dn pro
     0 08801 17:17:05  35 59.7 -76 09.5
SDE -1 09007 17:20:31  35 58.5 -76 11.0 WE slant dn pro
     0 09412 17:27:16  36 04.8 -76 02.0
FLW -1 09588 17:30:12  36 05.5 -76 00.7 EW flx at 600 m
     0 09823 17:34:07  36 00.6 -76 07.7
FLE -1 10021 17:37:25  36 00.1 -76 08.7 WE flx at sfc
     0 10305 17:42:09  36 05.1 -76 01.6
SA  -1 10311 17:42:15  36 05.2 -76 01.4 ES4 to pier up & dn
EVT    10598 17:47:02  36 08.9 -75 54.2 top of profile
     0 11408 18:00:32  36 14.0 -75 31.1
FLW -1 11435 18:00:59  36 13.8 -75 32.1 pier W
     0 11785 18:06:49  36 10.9 -75 45.0
TXI -1 12287 18:15:11  36 01.3 -75 40.2 taxi
     0 12290 18:15:14  36 01.3 -75 40.2
VNT -1 12412 18:17:16  36 00.8 -75 40.3 ventilation
     0 12483 18:18:27  36 00.8 -75 40.3

Marker for D:\03081413.ORG CLOSED at 152309

Total scans : 12484
Missed Ints : 00000
BAT Dropouts: -000.005%
NOV Dropouts: 000.092%
TAN Dropouts: 001.479%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 13
    Date: 08 MAR 99 (Monday)
Duration: 2.5 Hours
   Pilot: EJD

Weather: Clear skies and cold with stong northerly winds at about
         10-15 m/s.
```

Summary: One butterfly along the river and Currituck penninsula east and west IBL runs.

Problems: Laser #2 and Ka-band radar not working.

Marker for D:\03081853.ORG OPENED at 154503

VNT	-1	00004	18:55:06	36	00.9	-75	40.3	ventilation
	0	00023	18:55:25	36	00.9	-75	40.3	
SA	-1	00192	18:58:14	36	01.4	-75	40.2	profile sfc - 1500 m
	0	00534	19:03:56	36	04.4	-75	49.1	
SD	-1	00593	19:04:55	36	03.9	-75	51.4	profile 1500 m - sfc
	0	01151	19:14:13	36	00.5	-75	53.8	
FLN	-1	01203	19:15:05	36	01.2	-75	53.0	15 m S-N
	0	01579	19:21:21	36	09.7	-75	59.3	
SAS	-1	01694	19:23:16	36	09.4	-75	59.3	slant profile 15 m - 1200 m N-S
	0	02077	19:29:39	35	59.5	-75	51.9	
PFD	-1	02142	19:30:44	35	58.2	-75	52.4	spiral dn @ S 1200 m - 15 m
	0	02691	19:39:53	35	60.0	-75	52.6	
SAN	-1	02698	19:40:00	36	00.1	-75	52.7	slant profile 15 m - 900 m S-N
	0	03019	19:45:21	36	07.0	-75	57.1	
FLS	-1	03267	19:49:29	36	09.5	-75	59.3	900 m N-S
	0	03588	19:54:50	36	00.8	-75	52.5	
SDN	-1	03722	19:57:04	35	59.4	-75	51.5	slant profile 900 m - 15 m S-N
	0	04191	20:04:53	36	09.7	-75	59.3	
PFA	-1	04192	20:04:54	36	09.7	-75	59.3	spiral up @ N 15 m - 900 m
	0	04392	20:08:14	36	09.0	-75	59.1	
SDS	-1	04394	20:08:16	36	08.9	-75	59.1	slant profile 900 m - 15 m N-S
	0	04766	20:14:28	35	58.9	-75	51.2	
PFA	-1	04767	20:14:29	35	58.9	-75	51.1	spiral up @ S 15 m - 900 m
	0	05040	20:19:02	35	59.6	-75	51.4	
FLN	-1	05075	20:19:37	36	00.2	-75	52.2	750 m S-N
	0	05512	20:26:54	36	09.7	-75	59.2	
PFD	-1	05588	20:28:10	36	09.3	-75	59.7	spiral dn @ N 750 m - 15 m
	0	06045	20:35:47	36	08.9	-75	58.8	
FLS	-1	06059	20:36:01	36	08.6	-75	58.5	15 m N-S
	0	06349	20:40:51	36	01.0	-75	52.6	
FLE	-1	06712	20:46:54	36	05.1	-75	56.8	W-E 60 m
	0	07056	20:52:38	36	09.6	-75	47.4	
FLW	-1	07154	20:54:16	36	09.7	-75	47.4	E-W 60 m
	0	07411	20:58:33	36	04.7	-75	55.5	
SA	-1	07451	20:59:13	36	03.5	-75	55.2	slant profile 15 m - 1200 m
	0	07748	21:04:10	36	03.1	-75	45.6	
SD	-1	07779	21:04:41	36	03.4	-75	44.6	slant profile 1200 m - 15 m
	0	08298	21:13:20	35	58.5	-75	43.6	
TXI	-1	08653	21:19:15	36	01.2	-75	40.2	taxi
	0	08678	21:19:40	36	01.1	-75	40.3	
VNT	-1	08748	21:20:50	36	00.8	-75	40.3	ventilation
	0	08768	21:21:10	36	00.8	-75	40.3	

Marker for D:\03081853.ORG CLOSED at 163276

```
Total scans : 08773
Missed Ints : 00000
BAT Dropouts: -000.005%
NOV Dropouts: 003.617%
TAN Dropouts: 001.824%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 14
    Date: 09 MAR 99 (Tuesday)
Duration: 2.1 Hours
   Pilot: TLC

Weather: Low clouds, NE wind (20 deg) at 5 m/s, cool temperatures, about 3 C.

Summary: Abbreviated Butterfly @ start and end, then parallel legs west of
         Duck over Currituck sound.

         WP-U 36 13.0 N, 75 47.0 W
          W-D 36  7.7 N, 75 44.5 W

Problems: System crash at start, no serious problems thereafter.  Laser #2
          and Ka-band radar not working.

Marker for D:\03091344.ORG OPENED at 223765

VNT -1 00004 14:09:28  36 00.9 -75 40.3 ventilation
     0 00058 14:10:22  36 00.9 -75 40.3
TXI -1 00399 14:16:03  36 00.7 -75 40.4 taxi
     0 00415 14:16:19  36 01.2 -75 40.3
SA  -1 01002 14:26:06  35 59.9 -75 37.8 pro FFA to D
     0 01452 14:33:36  36 10.4 -75 45.6
Data system crash

Marker for D:\03091344.ORG CLOSED at 225352

Total scans : 01586
Missed Ints : 00001
BAT Dropouts: 000.067%
NOV Dropouts: 001.620%
TAN Dropouts: 001.614%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 14
    Date: 09 MAR 99 (Tuesday)
Duration: 2.1 Hours
   Pilot: TLC
```

Weather: Low clouds, NE wind (20 deg) at 5 m/s, cool temperatures, about 3 C.

Summary: Abbreviated Butterfly @ start and end, then parallel legs west of Duck over Currituck sound.

WP-U 36 13.0 N, 75 47.0 W
W-D 36 7.7 N, 75 44.5 W

Problems: System crash at start, no serious problems thereafter. Laser #2 and Ka-band radar not working.

Marker for D:\03091436.ORG OPENED at 225562

SD	-1	00003	14:39:24	36	14.4	-75	47.1	slant down from 600 m
	0	00218	14:42:59	36	08.0	-75	44.9	
SA	-1	00326	14:44:47	36	07.5	-75	44.8	slant up to 600 m
	0	00586	14:49:07	36	14.1	-75	47.2	
FL	-1	00791	14:52:32	36	14.2	-75	46.8	parallel +0.5 km
	0	00986	14:55:47	36	08.3	-75	44.9	
FL	-1	01145	14:58:26	36	07.9	-75	44.8	parallel +0.5 km
	0	01370	15:02:11	36	13.8	-75	46.5	
FL	-1	01512	15:04:33	36	13.1	-75	47.0	parallel +1 km
	0	01714	15:07:55	36	07.8	-75	45.5	
FL	-1	01867	15:10:28	36	07.3	-75	45.9	parallel +2 km
	0	02088	15:14:09	36	12.7	-75	47.9	
FL	-1	02244	15:16:45	36	12.7	-75	49.4	parallel +4 km
	0	02458	15:20:19	36	06.8	-75	46.9	
FL	-1	02525	15:21:26	36	07.4	-75	46.0	parallel +2 km
	0	02736	15:24:57	36	12.9	-75	48.4	
FL	-1	02873	15:27:14	36	13.2	-75	47.8	parallel +1 km
	0	03068	15:30:29	36	07.8	-75	45.3	
FL	-1	03203	15:32:44	36	07.8	-75	44.8	parallel +0.5 km
	0	03425	15:36:26	36	13.5	-75	46.5	
FL	-1	03519	15:38:00	36	13.5	-75	47.6	parallel +1 km
	0	03732	15:41:33	36	07.8	-75	45.2	
FL	-1	03869	15:43:50	36	07.9	-75	46.0	parallel +2 km
	0	04076	15:47:17	36	13.0	-75	48.4	
FL	-1	04159	15:48:40	36	12.1	-75	49.4	parallel +4 km
	0	04345	15:51:46	36	07.2	-75	46.7	
SA	-1	04510	15:54:31	36	06.0	-75	46.5	slant up to 600 m
	0	04781	15:59:02	36	12.7	-75	49.4	
SA	-1	04948	16:01:49	36	14.1	-75	50.0	slant up to 1500 m at FFA
	0	05400	16:09:21	36	02.5	-75	43.1	
TXI	-1	05707	16:14:28	36	01.1	-75	40.3	taxi
	0	05720	16:14:41	36	01.2	-75	40.2	
VNT	-1	05845	16:16:46	36	00.8	-75	40.3	ventilation
	0	05888	16:17:29	36	00.8	-75	40.3	

Marker for D:\03091436.ORG CLOSED at 231455

Total scans : 05893

Missed Ints : 00000
BAT Dropouts: -000.006%
NOV Dropouts: 001.539%
TAN Dropouts: 001.369%

SHOWEX 99 Spring Experiment, Duck NC

Flight: 15
Date: 10 MAR 99 (Wednesday)
Duration: 3.2 Hours
Pilot: TLC

Weather: Low clouds, north wind at 10 m/s, cool temperatures, about 3 C. There is a bit of an on-shore flow.

Summary: Two abbreviated Butterfly @ middle then parallel legs E of Duck, surf zone about 100 m and 2 transects down center made. Parallel run was conducted to off-shore distance of 8 km. Two simplified butterfly soundings were done at the shore-line and 8 km off-shore. A surf-zone run was included.

Problems: System crash half way into flight, no serious problems thereafter. Laser #2 and Ka-band radar not working.

Marker for D:\03101811.ORG OPENED at 325112

```
VNT -1 00003 18:18:34  36 00.8 -75 40.3 ventilation
     0 00061 18:19:32  36 00.8 -75 40.3
SD  -1 00149 18:21:00  36 00.9 -75 40.3 down profile FFA to pier
     0 00179 18:21:30  36 01.5 -75 40.4
VNT -1 00521 18:27:12  36 02.1 -75 36.1 ventilation
     0 00838 18:32:29  36 08.7 -75 42.7
SAN -1 00842 18:32:33  36 08.7 -75 42.8 up profile S to N near pier
     0 01034 18:35:45  36 13.2 -75 45.1
SAS -1 01212 18:38:43  36 14.1 -75 46.1 up profile N to S near pier
     0 01418 18:42:09  36 07.4 -75 42.2
FLN -1 01570 18:44:41  36 03.9 -75 41.1 SP to NP
     0 02142 18:54:13  36 16.9 -75 46.2
FLS -1 02206 18:55:17  36 16.2 -75 47.2 NP to SP just off pier
     0 02516 19:00:27  36 06.1 -75 42.5
FLN -1 02682 19:03:13  36 06.2 -75 42.7 in surf zone
     0 03164 19:11:15  36 16.8 -75 47.5
FLS -1 03256 19:12:47  36 17.3 -75 45.6 N2 to S2 +1 km
     0 03623 19:18:54  36 05.4 -75 41.3
FLN -1 03722 19:20:33  36 05.6 -75 40.5 S2 to N2 +2 km
     0 04263 19:29:34  36 16.8 -75 44.6
FLS -1 04342 19:30:53  36 16.5 -75 43.0 N3 to S3 +4 km
     0 04650 19:36:01  36 06.1 -75 39.5
```

Marker for D:\03101811.ORG CLOSED at 329945

```
Total scans : 04832
Missed Ints : 00001
BAT Dropouts: 000.333%
NOV Dropouts: 004.089%
TAN Dropouts: 004.071%
```

SHOWEX 99 Spring Experiment, Duck NC

```
  Flight: 15
    Date: 10 MAR 99 (Wednesday)
Duration: 3.2 Hours
   Pilot: TLC
```

Weather: Low clouds, north wind at 10 m/s, cool temperatures, about 3 C. There is a bit of an on-shore flow.

Summary: Two abbreviated Butterfly @ middle then parallel legs E of Duck, surf zone about 100 m and 2 transects down center made. Parallel run was conducted to off-shore distance of 8 km. Two simplified butterfly soundings were done at the shore-line and 8 km off-shore. A surf-zone run was included.

Problems: System crash half way into flight, no serious problems thereafter. Laser #2 and Ka-band radar not working.

Marker for D:\03101940.ORG OPENED at 330147

```
FLN -1 00002 19:42:28  36 06.1 -75 36.0 S4 to N4 +8 km
     0 00569 19:51:55  36 18.0 -75 39.9
SAN -1 00710 19:54:16  36 18.9 -75 40.3 up profile S to N @ +8 km
     0 01007 19:59:13  36 09.4 -75 36.0
SAS -1 01212 20:02:38  36 08.2 -75 37.1 up profile N to S @ +8 km
     0 01625 20:09:31  36 15.9 -75 40.3
FLS -1 01899 20:14:05  36 19.6 -75 39.9 N4 to S4
     0 02277 20:20:23  36 06.5 -75 35.5
FLN -1 02462 20:23:28  36 05.8 -75 39.7 S3 to N3
     0 02963 20:31:49  36 17.1 -75 43.5
FLS -1 03040 20:33:06  36 16.6 -75 44.8 N2 to S2
     0 03362 20:38:28  36 05.9 -75 41.2
FLN -1 03499 20:40:45  36 03.8 -75 40.9 S1 to N1
     0 04083 20:50:29  36 16.8 -75 45.4
FLS -1 04165 20:51:51  36 15.9 -75 45.7 NP to SP
     0 04470 20:56:56  36 06.1 -75 42.2
FLN -1 04634 20:59:40  36 05.7 -75 42.3 S to N off pier
     0 05112 21:07:38  36 16.9 -75 47.4
FLS -1 05193 21:08:59  36 16.6 -75 47.4 N to S in surf
     0 05510 21:14:16  36 06.5 -75 42.9
SAS -1 05514 21:14:20  36 06.4 -75 42.8 up S to FFA
     0 05662 21:16:48  36 01.9 -75 40.3
TXI -1 05865 21:20:11  36 01.2 -75 40.3 taxi
```

```
     0 05876 21:20:22  36 01.3 -75 40.2
VNT -1 06141 21:24:47  36 00.8 -75 40.3 ventilation
     0 06160 21:25:06  36 00.8 -75 40.3

Marker for D:\03101940.ORG CLOSED at 336309

Total scans : 06162
Missed Ints : 00000
BAT Dropouts: -000.006%
NOV Dropouts: 002.345%
TAN Dropouts: 002.994%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 16
    Date: 11 March 99 (Thursday)
Duration: 3.7 Hours
   Pilot: TLC

Weather: Sunny, temperature of 8 C with NW wind (310) at 8 m/s.

Summary: Parallel runs and target run.

Problems: Laser #2 and Ka-band radar not working.

Marker for D:\03111315.ORG OPENED at 394463

TXI -1 00203 13:37:45  36 00.9 -75 40.4 taxi
     0 00213 13:37:55  36 01.2 -75 40.3
SD  -1 00538 13:43:20  35 54.6 -75 35.9 slant 1200 m - 15 m FFA-PS
     0 01097 13:52:39  36 06.1 -75 42.5
XXX -1 01098 13:52:40  36 06.2 -75 42.5
     0 01485 13:59:07  36 14.1 -75 46.1
XXX -1 01673 14:02:15  36 15.7 -75 46.4
     0 01965 14:07:07  36 06.9 -75 42.5
XXX -1 02282 14:12:24  36 06.1 -75 42.3
EVT    02513 14:16:15  36 11.0 -75 44.7
     0 02817 14:21:19  36 17.6 -75 47.6
XXX -1 03084 14:25:46  36 17.0 -75 47.6
EVT    03290 14:29:12  36 11.0 -75 44.9
     0 03449 14:31:51  36 06.3 -75 42.7
XXX -1 03546 14:33:28  36 06.9 -75 42.3
     0 03954 14:40:16  36 15.9 -75 45.7
XXX -1 04073 14:42:15  36 16.3 -75 44.8
     0 04428 14:48:10  36 05.4 -75 41.4
XXX -1 04510 14:49:32  36 05.7 -75 40.7
     0 05020 14:58:02  36 17.0 -75 44.7
XXX -1 05115 14:59:37  36 16.6 -75 43.0
     0 05490 15:05:52  36 05.1 -75 39.3
XXX -1 05643 15:08:25  36 05.4 -75 35.2
```

```
     0 06215 15:17:57  36 17.8 -75 40.1
XXX -1 06330 15:19:52  36 18.7 -75 40.3
     0 06715 15:26:17  36 07.1 -75 34.8
XXX -1 06943 15:30:05  36 05.2 -75 34.6
     0 07317 15:36:19  36 12.7 -75 38.9
XXX -1 07567 15:40:29  36 16.1 -75 39.2
     0 07902 15:46:04  36 06.0 -75 35.4
XXX -1 08065 15:48:47  36 04.1 -75 39.0
     0 08643 15:58:25  36 17.4 -75 43.4
XXX -1 08716 15:59:38  36 16.7 -75 44.6
     0 09065 16:05:27  36 06.1 -75 40.6
XXX -1 09167 16:07:09  36 05.1 -75 41.0
     0 09669 16:15:31  36 16.5 -75 45.4
XXX -1 09809 16:17:51  36 17.1 -75 45.9
     0 10165 16:23:47  36 06.1 -75 42.1
XXX -1 10287 16:25:49  36 04.6 -75 41.4
     0 10774 16:33:56  36 15.4 -75 46.9
XXX -1 10861 16:35:23  36 15.4 -75 47.0
EVT    11007 16:37:49  36 11.2 -75 45.1
EVT    11014 16:37:56  36 11.0 -75 45.0
     0 11180 16:40:42  36 06.3 -75 42.7
XXX -1 11464 16:45:26  36 11.0 -75 44.5
     0 11819 16:51:21  36 13.5 -75 32.3
XXX -1 12016 16:54:38  36 13.7 -75 31.5
     0 12433 17:01:35  36 10.9 -75 44.9
ERR    12482 17:02:25                   BAT time new
SA  -1 12496 17:02:38  36 09.7 -75 44.3 pier-FFA profile
     0 12706 17:06:08  36 03.9 -75 41.5
TXI -1 13050 17:11:52  36 01.2 -75 40.2 taxi
     0 13060 17:12:02  36 01.3 -75 40.2
VNT -1 13201 17:14:23  36 00.8 -75 40.3 ventilation
     0 13243 17:15:05  36 00.8 -75 40.3

Marker for D:\03111315.ORG CLOSED at 407709

Total scans : 13246
Missed Ints : 00000
BAT Dropouts: 000.018%
NOV Dropouts: 001.163%
TAN Dropouts: 002.080%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 17
    Date: 11 MAR 99 (Thursday)
Duration: 3.8 Hours
   Pilot: EJD

Weather: Sunny, NNW wind at 5 m/s, cool temperatures, about 1 C.
```

Summary: Flew parallel patterns over Lake Matamuskeet (35 SW of FFA).

Problems: Laser #2 and Ka-band radar not working.

Marker for D:\03111810.ORG OPENED at 411098

```
VNT -1 00005 18:11:42  36 00.8 -75 40.4 ventilation
     0 00022 18:11:59  36 00.8 -75 40.3
SA  -1 00138 18:13:55  36 01.7 -75 40.1 profile sfc - 1500 m
     0 00981 18:27:58  35 35.6 -75 48.8
SD  -1 00990 18:28:07  35 35.4 -75 49.1 profile 1500 m - sfc
     0 01645 18:39:02  35 31.9 -76 11.0
FL  -1 01837 18:42:14  35 33.3 -76 06.4 150 m shore run
     0 02076 18:46:13  35 31.7 -76 13.2
FLW -1 02195 18:48:12  35 31.1 -76 12.3 0.9 km, 15 m E-W
     0 02343 18:50:40  35 33.3 -76 07.6
FL  -1 02985 19:01:22  35 30.3 -76 10.4
     0 03116 19:03:33  35 31.5 -76 05.9
FLE -1 03187 19:04:44  35 32.2 -76 06.5 1.8 km, 15 m W-E
     0 03352 19:07:29  35 30.1 -76 11.5
FLE -1 03475 19:09:32  35 29.2 -76 10.9 3.7 km, 15 m W-E
     0 03627 19:12:04  35 31.2 -76 05.8
FLW -1 03773 19:14:30  35 29.6 -76 06.3 7.4 km, 15 m E-W
     0 03922 19:16:59  35 28.2 -76 11.1
FLE -1 04078 19:19:35  35 28.7 -76 11.2 7.4 km, 15 m W-E
     0 04228 19:22:05  35 30.4 -76 06.3
FLW -1 04363 19:24:20  35 31.3 -76 05.5 3.7 km, 15 m E-W
     0 04542 19:27:19  35 29.2 -76 11.0
FLE -1 04651 19:29:08  35 30.2 -76 11.2 1.8 km, 15 m W-E
     0 04807 19:31:44  35 31.6 -76 05.5
FLW -1 04936 19:33:53  35 31.8 -76 06.1 0.9 km, 15 m E-W
     0 05124 19:37:01  35 31.0 -76 12.3
FLE -1 05322 19:40:19  35 31.6 -76 11.7 0.9 km, 15 m W-E
     0 05429 19:42:06  35 33.0 -76 08.1
SA  -1 05448 19:42:25  35 33.4 -76 07.7 profile sfc - 1500 m @ E
     0 05876 19:49:33  35 32.0 -76 04.8
SD  -1 06730 20:03:47  35 31.7 -76 05.7 profile 1500 m - sfc @ E
     0 07238 20:12:15  35 32.0 -76 06.8
FLW -1 07240 20:12:17  35 32.0 -76 06.9 1.8 km, 15 m E-W
     0 07390 20:14:47  35 30.1 -76 11.6
FLE -1 07454 20:15:51  35 29.2 -76 10.7 3.7 km, 15 m W-E
     0 07598 20:18:15  35 31.2 -76 05.9
FLW -1 07697 20:19:54  35 29.9 -76 05.4 5.6 km, 15 m E-W
     0 07857 20:22:34  35 28.3 -76 10.5
FLE -1 07982 20:24:39  35 28.3 -76 10.7 5.6 km, 15 m W-E
     0 08150 20:27:27  35 30.7 -76 05.2
FLW -1 08247 20:29:04  35 31.7 -76 06.4 3.7 km, 15 m E-W
     0 08411 20:31:48  35 29.2 -76 11.0
FLE -1 08484 20:33:01  35 30.4 -76 11.2 1.8 km, 15 m W-E
     0 08625 20:35:22  35 32.0 -76 06.3
FLW -1 08763 20:37:40  35 31.6 -76 07.6 1.8 km, 15 m E-W
```

```
     0 08893 20:39:50  35 30.1 -76 11.5
FLE -1 08964 20:41:01  35 29.0 -76 10.8 3.7 km, 15 m W-E
     0 09118 20:43:35  35 31.2 -76 05.9
FLW -1 09210 20:45:07  35 29.9 -76 06.0 5.6 km, 15 m E-W
     0 09353 20:47:30  35 28.3 -76 10.4
Data system crash

Marker for D:\03111810.ORG CLOSED at 420616

Total scans : 09517
Missed Ints : 00001
BAT Dropouts: -000.016%
NOV Dropouts: 003.845%
TAN Dropouts: 001.606%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 17
    Date: 11 MAR 99 (Thursday)
Duration: 3.8 Hours
   Pilot: EJD

Weather: Sunny, NNW wind at 5 m/s, cool temperatures, about 1 C.

Summary: Flew parallel patterns over Lake Matamuskeet (35 SW of FFA).

Problems: Laser #2 and Ka-band radar not working.

Marker for D:\03112051.ORG OPENED at 420812

FLE -1 00024 20:53:55  35 28.2 -76 10.6 5.6 km, 90 m W-E
     0 00178 20:56:29  35 30.3 -76 05.4
FLW -1 00265 20:57:56  35 31.4 -76 06.1 3.7 km, 90 m E-W
     0 00431 21:00:42  35 29.2 -76 11.0
FLE -1 00533 21:02:24  35 30.1 -76 11.4 1.8 km, 90 m W-E
     0 00680 21:04:51  35 32.3 -76 06.4
SA  -1 00682 21:04:53  35 32.3 -76 06.4 profile sfc - 1500 m @ E
     0 01430 21:17:21  35 33.6 -75 53.5
SD  -1 01607 21:20:18  35 35.4 -75 47.4 slant profile 1500 m - sfc to MQI
     0 02428 21:33:59  35 56.6 -75 46.9
TXI -1 02796 21:40:07  35 55.3 -75 41.9 taxi
     0 02829 21:40:40  35 55.2 -75 42.0
VNT -1 02854 21:41:05  35 55.2 -75 42.0 ventilation
     0 02876 21:41:27  35 55.2 -75 42.0

Marker for D:\03112051.ORG CLOSED at 423694

Total scans : 02882
Missed Ints : 00000
BAT Dropouts: -000.005%
```

NOV Dropouts: 007.988%
TAN Dropouts: 001.017%

SHOWEX 99 Spring Experiment, Duck NC

Flight: 18
Date: 12 MAR 99 (Friday)
Duration: 3.5 Hours
Pilot: EJD

Weather: Clear skies, N wind 5-10 m/s, cool temperatures, about 8 C.

Summary: Lake Mattamuskeet flight at 1.8, 3.7, and 5.6 km parallel to N shore to study the internal boundary layer off-shore. Water temperature at the Mattamuskeet National Wildlife Refuge was measured with two simple thermometers. The lake temperature is very homogeneous, about 7 C. Close to the shore line the temperature rises to 9 C. The lake is very shallow, the deepest part is about 1.5 m.

Problems: IRGA changed from AC2 to AC3 this flight. Laser #2 and Ka-band radar not working.

Marker for D:\03121556.ORG OPENED at 490142

```
VNT -1 00006 16:09:07  36 00.8 -75 40.3 ventilation
     0 00095 16:10:36  36 00.8 -75 40.3
SA  -1 00317 16:14:18  36 01.6 -75 40.1 slant profile sfc - 1800 m
     0 00718 16:20:59  35 50.6 -75 41.5
SD  -1 01126 16:27:47  35 35.0 -75 49.8 slant profile 1800 m - sfc
     0 01798 16:38:59  35 30.5 -76 13.2
FLE -1 01881 16:40:22  35 31.6 -76 11.9 0.9 km dog-leg track 30 m W-E
     0 02012 16:42:33  35 33.0 -76 07.0
FLW -1 02343 16:48:04  35 31.8 -76 06.0 1.8 km, 30 m E-W
     0 02527 16:51:08  35 30.1 -76 11.7
FLE -1 02598 16:52:19  35 29.1 -76 10.8 3.7 km, 30 m W-E
     0 02753 16:54:54  35 31.3 -76 05.8
FLW -1 02875 16:56:56  35 30.1 -76 05.3 5.6 km, 30 m E-W
     0 03043 16:59:44  35 28.3 -76 10.4
FLE -1 03171 17:01:52  35 28.2 -76 10.6 5.6 km, 30 m W-E
     0 03341 17:04:42  35 30.7 -76 05.1
FLW -1 03408 17:05:49  35 31.3 -76 06.1 3.7 km, 30 m E-W
     0 03573 17:08:34  35 29.1 -76 11.0
FLE -1 03662 17:10:03  35 30.3 -76 11.5 1.8 km, 30 m W-E
     0 03810 17:12:31  35 32.1 -76 06.4
SA  -1 03827 17:12:48  35 32.5 -76 05.9 profile sfc - 1500 m @ E
     0 04235 17:19:36  35 30.8 -76 04.1
SD  -1 04304 17:20:45  35 29.7 -76 05.2 profile 1500 m - sfc @ E
     0 05110 17:34:11  35 31.7 -76 06.6
FLW -1 05123 17:34:24  35 31.6 -76 07.0 1.8 km, 30 m E-W
     0 05280 17:37:01  35 29.7 -76 11.8
```

```
FLE -1 05343 17:38:04  35 29.0 -76 10.5 3.7 km, 30 m W-E
     0 05491 17:40:32  35 31.3 -76 05.9
FLW -1 05578 17:41:59  35 30.0 -76 05.2 5.6 km, 30 m E-W
     0 05745 17:44:46  35 28.2 -76 10.4
FLE -1 05844 17:46:25  35 28.1 -76 10.6 5.6 km, 100 m W-E
     0 06011 17:49:12  35 30.5 -76 05.2
FLW -1 06088 17:50:29  35 31.2 -76 06.0 3.7 km, 100 m E-W
     0 06263 17:53:24  35 28.9 -76 11.0
FLE -1 06359 17:55:00  35 30.3 -76 11.4 1.8 km, 100 m W-E
     0 06510 17:57:31  35 32.3 -76 06.4
SA  -1 06516 17:57:37  35 32.4 -76 06.3 slant profile 90 - 1400 m
     0 06951 18:04:52  35 32.4 -76 07.8
SD  -1 06983 18:05:24  35 32.0 -76 08.7 slant profile 1400 - 90 m
     0 07551 18:14:52  35 31.6 -76 06.5
FLW -1 07554 18:14:55  35 31.6 -76 06.6 1.8 km, 30 m E-W
     0 07710 18:17:31  35 30.1 -76 11.5
FLE -1 07792 18:18:53  35 29.1 -76 10.3 3.7 km, 30 m W-E
     0 07933 18:21:14  35 31.2 -76 05.9
FLW -1 08011 18:22:32  35 30.0 -76 05.7 5.6 km, 30 m E-W
     0 08164 18:25:05  35 28.2 -76 10.4
FLE -1 08294 18:27:15  35 28.1 -76 10.2 5.6 km, 30 m W-E
     0 08449 18:29:50  35 30.4 -76 05.5
FLW -1 08507 18:30:48  35 31.0 -76 06.0 3.7 km, 30 m E-W
     0 08672 18:33:33  35 29.1 -76 10.9
FLE -1 08765 18:35:06  35 30.2 -76 11.2 1.8 km, 30 m W-E
     0 08890 18:37:11  35 31.8 -76 07.0
FLW -1 09121 18:41:02  35 31.5 -76 07.7 1.8 km, 100 m E-W
     0 09245 18:43:06  35 30.0 -76 11.5
FLE -1 09313 18:44:14  35 29.1 -76 10.5 3.7 km, 100 m W-E
     0 09471 18:46:52  35 31.8 -76 05.9
FLW -1 09571 18:48:32  35 30.1 -76 05.3 5.6 km, 100 m E-W
ERR    09655 18:49:57                   BAT time new
     0 09737 18:51:18  35 28.1 -76 10.3
SA  -1 09807 18:52:28  35 29.3 -76 10.6 slant profile 90 - 2000 m
     0 10295 19:00:36  35 33.9 -75 54.1
SD  -1 10566 19:05:07  35 40.5 -75 45.1 slant profile 2000 m - sfc
Data system crash

Marker for D:\03121556.ORG CLOSED at 501531

Total scans : 11389
Missed Ints : 00000
BAT Dropouts: 002.293%
NOV Dropouts: 003.780%
TAN Dropouts: 001.281%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 19
    Date: 13 MAR 99 (Saturday)
```

Duration: 3.5 Hours
Pilot: TLC

Weather: High clouds, clear below 3000 m, light and variable NNW wind, cool cool temperatures. Not much wind, lake was very smooth.

Summary: Lake Mattamuskeet flight perpindicular and parallel to north shore. In addition to the traditional parallel runs at 1, 2, and 4 km off northern shore, a stack flight pattern along a perpendicular to shore track was done at 20, 40, 80, 160, and 320 m. Navigation difficult on parallel runs due to poor way points.

Problems: Laser #2 and Ka-band radar not working.

Marker for D:\03131533.ORG OPENED at 576703

```
VNT -1 00009 16:11:51  36 00.8 -75 40.3 ventilation
     0 00050 16:12:32  36 00.8 -75 40.3
TXI -1 00105 16:13:27  36 00.9 -75 40.3 taxi
     0 00125 16:13:47  36 01.3 -75 40.2
SDS -1 01552 16:37:34  35 35.2 -75 50.1
     0 02225 16:48:47  35 33.8 -76 14.1
FLS -1 02487 16:53:09  35 33.4 -76 07.8 N to S @ 20 m
     0 02634 16:55:36  35 28.8 -76 07.3
FLN -1 02778 16:58:00  35 28.9 -76 07.4 S to N @ 40 m
     0 02944 17:00:46  35 33.9 -76 08.6
FLS -1 03088 17:03:10  35 34.7 -76 08.6 N to S @ 80 m
     0 03298 17:06:40  35 28.3 -76 07.5
FLN -1 03487 17:09:49  35 28.5 -76 07.2 S to N @ 160 m
     0 03708 17:13:30  35 35.0 -76 07.3
FLS -1 03920 17:17:02  35 35.6 -76 07.0 N to S @ 320 m
EVT    03987 17:18:09  35 33.5 -76 06.8
EVT    04134 17:20:36  35 29.2 -76 06.8
     0 04161 17:21:03  35 28.4 -76 06.8
FLS -1 04310 17:23:32  35 27.4 -76 06.9 N to S @ 320 m
EVT    04365 17:24:27  35 28.9 -76 07.1
ERR    04528 17:27:11                  GPS Time Reset!
     0 04565 17:27:48  35 34.5 -76 07.1
FLN -1 04714 17:30:17  35 35.6 -76 06.9 S to N @ 160 m
EVT    04938 17:34:01  35 29.0 -76 07.0
     0 04950 17:34:13  35 28.7 -76 07.1
FLN -1 05162 17:37:45  35 27.2 -76 06.5 S to N @ 80 m
     0 05439 17:42:22  35 35.1 -76 07.0
FLS -1 05604 17:45:07  35 35.6 -76 06.6 N to S @ 40 m
EVT    05669 17:46:12  35 33.5 -76 07.0
EVT    05824 17:48:47  35 29.0 -76 07.1
     0 05832 17:48:55  35 28.7 -76 07.1
FLN -1 06039 17:52:22  35 28.3 -76 06.8 S to N @ 20 m
EVT    06218 17:55:21  35 33.6 -76 07.3
     0 06272 17:56:15  35 35.1 -76 07.3
PFA -1 06418 17:58:41  35 32.2 -76 06.6 spiral profile
```

```
     0 07107 18:10:10  35 29.7 -76 08.9
FLW -1 07390 18:14:53  35 32.5 -76 05.4 N shore +50 m
     0 07665 18:19:28  35 31.6 -76 14.0
FLE -1 07738 18:20:41  35 31.3 -76 14.4 N shore +500 m
     0 07978 18:24:41  35 32.9 -76 06.5
FLW -1 08072 18:26:15  35 31.9 -76 07.1 N shore +1 km
     0 08257 18:29:20  35 29.5 -76 12.6
FLE -1 08425 18:32:08  35 29.7 -76 12.4 N shore +1 km
     0 08623 18:35:26  35 32.5 -76 06.6
FLW -1 08770 18:37:53  35 32.5 -76 06.3 N shore +2 km
     0 08982 18:41:25  35 29.7 -76 13.0
FLE -1 09049 18:42:32  35 30.3 -76 12.7 N shore +4 km
     0 09245 18:45:48  35 33.1 -76 06.9
FLW -1 09337 18:47:20  35 33.1 -76 06.3 N shore +4 km
     0 09565 18:51:08  35 31.7 -76 13.1
FLE -1 09645 18:52:28  35 31.2 -76 12.4 N shore +2 km
     0 09839 18:55:42  35 33.2 -76 06.5
FLW -1 09899 18:56:42  35 32.2 -76 06.3 N shore +1 km
     0 10106 19:00:09  35 29.6 -76 12.7
FLE -1 10188 19:01:31  35 30.5 -76 12.7 N shore +1 km
     0 10395 19:04:58  35 33.3 -76 06.9
FLW -1 10492 19:06:35  35 33.3 -76 06.5 N shore +50 m
     0 10712 19:10:15  35 31.8 -76 13.1
SAN -1 10819 19:12:02  35 30.1 -76 11.2
     0 11046 19:15:49  35 27.7 -76 04.2
SDN -1 11631 19:25:34  35 45.6 -75 42.8
     0 12084 19:33:07  36 00.8 -75 40.4
TXI -1 12110 19:33:33  36 01.1 -75 40.2 taxi
     0 12122 19:33:45  36 01.3 -75 40.2
VNT -1 12624 19:42:07  36 00.8 -75 40.3 ventilation
     0 12664 19:42:47  36 00.8 -75 40.3

Marker for D:\03131533.ORG CLOSED at 589372

Total scans : 12668
Missed Ints : 00001
BAT Dropouts: 000.009%
NOV Dropouts: 002.347%
TAN Dropouts: 001.595%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 20
    Date: 16 MAR 99 (Tuesday)
Duration: 3.6 Hours
   Pilot: TLC

Weather: Clear, west wind 3 m/s switching to south 5 m/s, 9 C and warming.

Summary: Two perpindicular & many parallel east of Duck Pier.  Two
```

soundings, one close to the shore and one at 20 km off-shore was done.

Problems: IRGA not working. Laser #2 and Ka-band radar not working.

Marker for D:\03161717.ORG OPENED at 235155

```
VNT -1 00004 17:19:18  36 00.8 -75 40.3 ventilation
     0 00171 17:22:05  36 00.8 -75 40.4
TXI -1 00193 17:22:27  36 00.9 -75 40.3 taxi
     0 00292 17:24:06  36 00.3 -75 41.5
SA  -1 00528 17:28:02  35 59.3 -75 38.1 slant sounding 1200 m FFA to pier
ERR    00768 17:32:03                   GPS Time Reset!
     0 01006 17:36:01  36 11.1 -75 43.9
SDS -1 01018 17:36:13  36 11.3 -75 44.0 slant sounding 1200 m headed S
     0 01343 17:41:38  36 17.9 -75 47.1
SDN -1 01388 17:42:23  36 17.5 -75 47.6 slant sounding 1200 m headed N
     0 01827 17:49:42  36 06.1 -75 41.3
FLE -1 02226 17:56:21  36 10.9 -75 45.1
     0 02575 18:02:10  36 13.7 -75 32.7
FLW -1 02746 18:05:01  36 13.9 -75 31.6
     0 03123 18:11:18  36 10.9 -75 45.1
FLN -1 03385 18:15:40  36 06.5 -75 42.8 over east edge of surf
EVT    03549 18:18:24  36 11.0 -75 44.9
     0 03748 18:21:43  36 16.6 -75 47.4
FLS -1 03892 18:24:07  36 17.5 -75 47.3 about 0.7 km off shore
     0 04320 18:31:15  36 06.3 -75 42.4
FLN -1 04493 18:34:08  36 05.2 -75 41.9
     0 04900 18:40:55  36 16.5 -75 46.1
FLS -1 05027 18:43:02  36 17.5 -75 45.4
     0 05473 18:50:28  36 05.9 -75 41.5
FLN -1 05546 18:51:41  36 06.5 -75 40.7
     0 05914 18:57:49  36 17.0 -75 44.8
FLS -1 05991 18:59:06  36 17.4 -75 43.4
     0 06413 19:06:08  36 06.5 -75 39.8
FLN -1 06541 19:08:16  36 07.3 -75 36.4
     0 06901 19:14:16  36 18.0 -75 40.3
FLS -1 07055 19:16:50  36 20.2 -75 40.9
     0 07538 19:24:53  36 07.6 -75 35.7
FLN -1 07738 19:28:13  36 05.3 -75 35.4
     0 08156 19:35:11  36 16.6 -75 39.7
FLS -1 08329 19:38:04  36 18.9 -75 40.2
     0 08777 19:45:32  36 07.3 -75 36.2
FLN -1 08923 19:47:58  36 06.0 -75 39.6
     0 09328 19:54:43  36 17.2 -75 43.4
FLS -1 09402 19:55:57  36 16.7 -75 44.5
     0 09790 20:02:25  36 06.1 -75 40.9
FLN -1 09901 20:04:16  36 05.3 -75 41.4
     0 10310 20:11:05  36 16.6 -75 45.1
FLS -1 10436 20:13:11  36 17.1 -75 45.8
     0 10832 20:19:47  36 06.3 -75 42.3
```

```
FLN -1 10954 20:21:49  36 05.3 -75 41.9
     0 11365 20:28:40  36 16.4 -75 47.1
FLS -1 11462 20:30:17  36 17.0 -75 47.6
EVT    11693 20:34:08  36 10.9 -75 44.9
ERR    11765 20:35:21                   GPS Time Reset!
     0 11860 20:36:56  36 06.6 -75 42.8
SAS -1 11863 20:36:59  36 06.5 -75 42.8 slant sounding to FFA
     0 12126 20:41:22  36 00.4 -75 37.1
TXI -1 12515 20:47:51  36 01.0 -75 40.3 taxi
     0 12527 20:48:03  36 00.9 -75 40.3
VNT -1 12643 20:49:59  36 00.8 -75 40.3 ventilation
     0 12670 20:50:26  36 00.8 -75 40.3

Marker for D:\03161717.ORG CLOSED at 247830

Total scans : 12673
Missed Ints : 00002
BAT Dropouts: 000.904%
NOV Dropouts: 002.550%
TAN Dropouts: 003.768%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 21
    Date: 17 MAR 99 (Wednesday)
Duration: 5.7 Hours
   Pilot: TLC

Weather: Clear, WSW wind 3 m/s, temperature rising from 8 to 18 C.

Summary: SAR pattern then parallel legs E & S of Duck Pier.

SAR Way Points   A = 36 10 N, 75 10 W
                 B = A + 56 km @ 150
                 C = A + 83 km @ 150
                 D = C + 37 km @  60
                 E = D + 28 km @ 330
                 F = E + 74 km @ 240
                 G = F + 28 km @ 150

Problems: Data system crashed between SAR and Parallel runs.  IRGA power
          supply replaced, H2O channel working but not CO2.  Laser #2 and
          Ka-band radar not working.

Marker for D:\03171048.ORG OPENED at 299585

VNT -1 00004 11:13:08  36 00.8 -75 40.3 static
     0 00029 11:13:33  36 00.8 -75 40.3
TXI -1 00157 11:15:41  36 00.8 -75 40.4 taxi
     0 00173 11:15:57  36 01.1 -75 40.3
```

```
FLE -1 00446 11:20:30  36 01.9 -75 33.9 FFA to A
     0 01022 11:30:06  36 09.6 -75 11.8
PFA -1 01031 11:30:15  36 09.7 -75 11.5 spiral up
     0 01585 11:39:29  36 07.7 -75 08.1
PFD -1 01585 11:39:29  36 07.7 -75 08.1 altitude dump
     0 01851 11:43:55  36 09.1 -75 12.8
FLS -1 01851 11:43:55  36 09.1 -75 12.8 A to B
     0 02965 12:02:29  35 47.1 -74 45.8
PFA -1 02969 12:02:33  35 47.0 -74 45.7 spiral up
     0 03347 12:08:51  35 45.6 -74 44.8
PFD -1 03347 12:08:51  35 45.6 -74 44.8 altitude dump
     0 03567 12:12:31  35 47.9 -74 45.6
FLS -1 03567 12:12:31  35 47.9 -74 45.6 B to C
     0 04089 12:21:13  35 36.3 -74 34.4
FLE -1 04143 12:22:07  35 36.3 -74 32.5 C to D
     0 04677 12:31:01  35 48.4 -74 16.1
FLN -1 04720 12:31:44  35 49.4 -74 16.4 D to E
     0 05229 12:40:13  35 59.9 -74 26.4
FLW -1 05272 12:40:56  35 59.9 -74 27.5 E to F
     0 06875 13:07:39  35 33.7 -75 03.5
FLS -1 06913 13:08:17  35 32.7 -75 03.3 F to G
     0 07333 13:15:17  35 23.2 -74 52.8
FLE -1 07395 13:16:19  35 23.6 -74 50.4 G to C
     0 07898 13:24:42  35 35.4 -74 34.7
FLS -1 07944 13:25:28  35 36.6 -74 34.7 C to B
     0 08456 13:34:00  35 47.2 -74 45.5
PFA -1 08465 13:34:09  35 47.4 -74 45.7 spiral profile
     0 08876 13:41:00  35 46.5 -74 42.8
PFD -1 08876 13:41:00  35 46.5 -74 42.8 altitude dump
     0 09048 13:43:52  35 46.1 -74 47.3
FLN -1 09048 13:43:52  35 46.1 -74 47.3 B to A
ERR    09792 13:56:17                   GPS Time Reset!
     0 10118 14:01:43  36 10.1 -75 10.2
FLW -1 10184 14:02:49  36 10.4 -75 12.1 A to FFA
     0 11128 14:18:33  36 01.2 -75 39.5
SAN -1 11197 14:19:42  36 02.8 -75 40.3 slant profile N
ERR    11716 14:28:22                   GPS Time Reset!
     0 11980 14:32:46  36 09.4 -75 44.1
Data system crash

Marker for D:\03171048.ORG CLOSED at 311572

Total scans : 11985
Missed Ints : 00002
BAT Dropouts: 000.003%
NOV Dropouts: 004.458%
TAN Dropouts: 002.640%


SHOWEX 99 Spring Experiment, Duck NC
```

Flight: 21
Date: 17 MAR 99 (Wednesday)
Duration: 5.7 Hours
Pilot: TLC

Weather: Clear, WSW wind 3 m/s, temperature rising from 8 to 18 C.

Summary: SAR pattern then parallel legs E & S of Duck Pier.

SAR Way Points
A = 36 10 N, 75 10 W
B = A + 56 km @ 150
C = A + 83 km @ 150
D = C + 37 km @ 60
E = D + 28 km @ 330
F = E + 74 km @ 240
G = F + 28 km @ 150

Problems: Data system crashed between SAR and Parallel runs. IRGA power supply replaced, H2O channel working but not CO2. Laser #2 and Ka-band radar not working.

Marker for D:\03171442.ORG OPENED at 312422

```
FLE -1 00137 14:49:18  36 04.2 -75 44.8 target run E at 75 m
     0 00405 14:53:46  36 07.0 -75 34.1
FLW -1 00559 14:56:20  36 06.8 -75 31.6 target run W at 75 m
     0 01002 15:03:43  36 04.6 -75 44.8
FLN -1 01308 15:08:49  36 00.4 -75 39.0 S to N in surf at 15 m
     0 01653 15:14:34  36 09.0 -75 44.1
FLS -1 01824 15:17:25  36 09.6 -75 44.1 N to S +0.5 km at 15 m
     0 02216 15:23:57  35 59.3 -75 38.1
FLN -1 02276 15:24:57  35 59.2 -75 37.0 S to N +0.9 km at 15 m
     0 02671 15:31:32  36 08.7 -75 43.3
FLS -1 02781 15:33:22  36 08.2 -75 42.0 N to S +1.8 km at 15 m
     0 03092 15:38:33  35 59.9 -75 36.9
FLN -1 03166 15:39:47  36 00.5 -75 35.5 S to N +3.7 km at 15 m
     0 03555 15:46:16  36 09.7 -75 42.3
SAS -1 03691 15:48:32  36 11.3 -75 43.0 N to S sounding up to 800 m
     0 04009 15:53:50  36 02.7 -75 37.7
SDS -1 04211 15:57:12  35 59.7 -75 35.5 N to S sounding down to sfc
     0 04531 16:02:32  36 07.7 -75 40.6
FLS -1 04697 16:05:18  36 09.4 -75 41.4 N to S +3.7 km at 15 m
     0 05043 16:11:04  36 00.5 -75 35.9
FLN -1 05131 16:12:32  36 00.2 -75 37.2 S to N +1.8 km at 15 m
     0 05502 16:18:43  36 09.3 -75 43.3
FLS -1 05587 16:20:08  36 09.4 -75 44.1 N to S +0.9 km at 15 m
     0 05959 16:26:20  35 60.0 -75 37.6
FLN -1 06079 16:28:20  35 59.0 -75 37.4 S to N +0.5 km at 15 m
     0 06463 16:34:44  36 08.4 -75 43.5
FLS -1 06601 16:37:02  36 09.6 -75 44.4 N to S in surf at 15 m
Data system crash
```

Marker for D:\03171442.ORG CLOSED at XXXXXX

Total scans :
Missed Ints :
BAT Dropouts:
NOV Dropouts:
TAN Dropouts:

SHOWEX 99 Spring Experiment, Duck NC

Flight: 22
Date: 17 MAR 99 (Wednesday)
Duration: 4.4 Hours
Pilot: EJD

Weather: Clear, WSW wind 3 m/s, temperature rising from 8 to 18 C.

Summary: Parallel pattern W of Duck pier along Currituck penninsula shore. Parallel runs at three off-shore distances. 10 passes perpendicular to the coast line of the peninsula to off-shore 5 km at 120 m.

Parallel Way Points:
N = 36 22 N, 75 55.5 W
S = 36 17 N, 75 53.5 W
E = 165 DEG 4.6 km FROM N
W = 75 DEG 4.6 km FROM E
N1 = 75 DEG 0.6 km FROM N
N2 = 75 DEG 0.9 km FROM N
N3 = 75 DEG 1.8 km FROM N
S1 = 75 DEG 0.6 km FROM S
S2 = 75 DEG 0.9 km FROM S
S3 = 75 DEG 1.8 km FROM S

Problems: Data system crashed halfway through flight. IRGA power supply replaced, H2O channel working but not CO2. Laser #2 and Ka-band radar not working.

Marker for D:\03171748.ORG OPENED at 323405

```
VNT -1 00006 17:50:10  36 00.8 -75 40.3 ventilation
     0 00026 17:50:30  36 00.8 -75 40.3
TXI -1 00131 17:52:15  36 00.8 -75 40.4 taxi
     0 00171 17:52:55  36 03.7 -75 40.9
SA  -1 00510 17:58:34  36 00.5 -75 45.5 profile sfc - 1200 m
     0 00823 18:03:47  36 09.0 -75 48.9
SD  -1 00845 18:04:09  36 09.6 -75 49.1 profile 1200 m - sfc
ERR    01398 18:13:23                   GPS Time Reset!
     0 01475 18:14:40  36 26.7 -75 59.8
FLS -1 01773 18:19:38  36 21.8 -75 55.5 N-S shore run 150 m
     0 01952 18:22:37  36 17.1 -75 52.9
FLN -1 02131 18:25:36  36 18.1 -75 53.0 S1-N1 15 m
```

```
     0 02275 18:28:00  36 22.0 -75 55.4
FLS -1 02405 18:30:10  36 21.8 -75 55.1 N1-S1 15 m
     0 02581 18:33:06  36 17.2 -75 52.9
FLN -1 02710 18:35:15  36 17.4 -75 52.8 S2-N2 15 m
     0 02860 18:37:45  36 21.8 -75 55.0
FLS -1 03027 18:40:32  36 22.1 -75 54.6 N3-S3 15 m
     0 03212 18:43:37  36 17.3 -75 52.3
FLN -1 03339 18:45:44  36 17.4 -75 52.4 S3-N3 15 m
     0 03510 18:48:35  36 22.5 -75 54.6
FLS -1 03667 18:51:12  36 21.9 -75 54.8 N2-S2 15 m
     0 03840 18:54:05  36 17.2 -75 52.8
FLN -1 04003 18:56:48  36 17.7 -75 53.1 S1-N1 15 m
     0 04151 18:59:16  36 21.9 -75 55.4
FLS -1 04310 19:01:55  36 21.9 -75 55.4 N1-S1 15 m
     0 04489 19:04:54  36 17.3 -75 52.9
FLN -1 04632 19:07:17  36 17.6 -75 52.8 S2-N2 15 m
     0 04785 19:09:50  36 21.9 -75 55.2
FLS -1 04988 19:13:13  36 21.8 -75 54.3 N3-S3 15 m
     0 05166 19:16:11  36 17.4 -75 52.3
FLN -1 05273 19:17:58  36 17.3 -75 52.4 S2-N2 15 m
     0 05458 19:21:03  36 22.8 -75 54.7
FLS -1 05564 19:22:49  36 22.1 -75 54.9 N1-S1 15 m
     0 05755 19:26:00  36 17.2 -75 52.7
FLN -1 05880 19:28:05  36 17.3 -75 52.9 S1-N1 15 m
     0 06049 19:30:54  36 22.0 -75 55.4
FLS -1 06209 19:33:34  36 21.9 -75 55.3 N2-S2 15 m
     0 06394 19:36:39  36 17.2 -75 52.8
FLN -1 06549 19:39:14  36 17.4 -75 52.8 S3-N3 15 m
     0 06711 19:41:56  36 21.9 -75 55.1
FLS -1 06850 19:44:15  36 22.3 -75 54.3 N3-S3 15 m
     0 07045 19:47:30  36 17.4 -75 52.2
Data system crash

Marker for D:\03171748.ORG CLOSED at 331254

Total scans : 07847
Missed Ints : 00002
BAT Dropouts: -000.030%
NOV Dropouts: 003.926%
TAN Dropouts: 001.678%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 22
    Date: 17 MAR 99 (Wednesday)
Duration: 4.4 Hours
   Pilot: EJD

Weather: Clear, WSW wind 3 m/s, temperature rising from 8 to 18 C.
```

Summary: Parallel pattern W of Duck pier along Currituck penninsula shore. Parallel runs at three off-shore distances. 10 passes perpendicular to the coast line of the peninsula to off-shore 5 km at 120 m.

Parallel Way Points:

N =	36 22 N, 75 55.5 W
S =	36 17 N, 75 53.5 W
E =	165 DEG 4.6 km FROM N
W =	75 DEG 4.6 km FROM E
N1 =	75 DEG 0.6 km FROM N
N2 =	75 DEG 0.9 km FROM N
N3 =	75 DEG 1.8 km FROM N
S1 =	75 DEG 0.6 km FROM S
S2 =	75 DEG 0.9 km FROM S
S3 =	75 DEG 1.8 km FROM S

Problems: Data system crashed halfway through flight. IRGA power supply replaced, H2O channel working but not CO2. Laser #2 and Ka-band radar not working.

Marker for D:\03172003.ORG OPENED at 331512

FLN	-1	00170	20:08:01	36 17.2	-75 52.9	S1-N1 15 m
	0	00333	20:10:44	36 21.9	-75 55.4	
FLE	-1	00550	20:14:21	36 20.0	-75 54.4	W-E 120 m
	0	00642	20:15:53	36 21.5	-75 51.2	
FLW	-1	00840	20:19:11	36 21.5	-75 51.0	E-W 120 m
	0	00964	20:21:15	36 20.5	-75 54.5	
FLE	-1	01113	20:23:44	36 20.9	-75 54.8	W-E 120 m
	0	01207	20:25:18	36 21.9	-75 51.1	
FLW	-1	01353	20:27:44	36 21.6	-75 50.7	E-W 120 m
	0	01477	20:29:48	36 20.5	-75 54.3	
FLE	-1	01580	20:31:31	36 19.9	-75 54.1	W-E 120 m
	0	01667	20:32:58	36 21.4	-75 51.1	
FLW	-1	01812	20:35:23	36 21.3	-75 50.4	E-W 120 m
	0	01938	20:37:29	36 20.5	-75 54.3	
FLE	-1	02030	20:39:01	36 20.0	-75 54.3	W-E 120 m
	0	02118	20:40:29	36 21.5	-75 51.3	
FLW	-1	02271	20:43:02	36 21.3	-75 51.0	E-W 120 m
	0	02385	20:44:56	36 20.7	-75 54.4	
FLE	-1	02452	20:46:03	36 19.7	-75 54.1	W-E 120 m
	0	02552	20:47:43	36 21.8	-75 51.0	
FLW	-1	02716	20:50:27	36 21.6	-75 50.7	E-W 120 m
	0	02847	20:52:38	36 20.6	-75 54.6	
FLE	-1	02895	20:53:26	36 19.9	-75 54.0	W-E 120 m
EVT		03023	20:55:34	36 22.3	-75 49.9	west ocean shore
EVT		03038	20:55:49	36 22.6	-75 49.4	east ocean shore
	0	03039	20:55:50	36 22.6	-75 49.4	
FLW	-1	03183	20:58:14	36 21.7	-75 50.6	E-W 120 m
	0	03315	21:00:26	36 20.6	-75 54.6	
SA	-1	03407	21:01:58	36 18.9	-75 52.7	profile sfc - 1800 m
	0	03872	21:09:43	36 07.9	-75 42.4	

```
PTC -1 04097 21:13:28  36 03.5 -75 47.5 pitchcal 120 - 60 kts
     0 04330 21:17:21  35 58.6 -75 52.9
PTC -1 04331 21:17:22  35 58.6 -75 52.9 pitchcal 60 - 120 kts
     0 04636 21:22:27  35 51.7 -75 59.2
WBE -1 04762 21:24:33  35 53.7 -75 59.7 windbox W-E
     0 04883 21:26:34  35 56.7 -75 56.5
WBN -1 04925 21:27:16  35 57.8 -75 56.6 windbox S-N
     0 05046 21:29:17  35 59.9 -75 59.7
WBW -1 05093 21:30:04  35 59.4 -76 00.9 windbox E-W
     0 05215 21:32:06  35 56.0 -76 02.7
WBS -1 05261 21:32:52  35 54.7 -76 02.1 windbox N-S
     0 05386 21:34:57  35 52.6 -75 57.2
WCL -1 05430 21:35:41  35 52.6 -75 55.5 wind circle left
     0 05552 21:37:43  35 52.6 -75 54.8
WCR -1 05587 21:38:18  35 53.7 -75 54.5 wind circle right
     0 05741 21:40:52  35 53.8 -75 53.7
YAW -1 05786 21:41:37  35 55.0 -75 52.6 yaw left (1/4, 1/2, 3/4, 1 ball)
     0 05872 21:43:03  35 57.7 -75 51.6
YAW -1 05899 21:43:30  35 58.6 -75 51.8 yaw right (1/4, 1/2, 3/4, 1 ball)
     0 05981 21:44:52  36 00.9 -75 51.2
PTC -1 05997 21:45:08  36 01.3 -75 50.8 pitch up/dn slow
     0 06095 21:46:46  36 03.9 -75 48.5
PTC -1 06098 21:46:49  36 04.0 -75 48.4 pitch up/dn medium
     0 06177 21:48:08  36 06.3 -75 47.1
PTC -1 06213 21:48:44  36 07.4 -75 46.5 pitch up/dn fast
     0 06263 21:49:34  36 09.0 -75 46.0
SD  -1 06337 21:50:48  36 08.8 -75 47.1 profile 1800 - 300 m
     0 06860 21:59:31  36 00.8 -75 43.8
VNT -1 07218 22:05:29  36 00.8 -75 40.3 ventilation
     0 07245 22:05:56  36 00.8 -75 40.3

Marker for D:\03172003.ORG CLOSED at 338764

Total scans : 07252
Missed Ints : 00000
BAT Dropouts: -000.005%
NOV Dropouts: 017.292%
TAN Dropouts: 001.434%


SHOWEX 99 Spring Experiment, Duck NC

  Flight: 23
    Date: 18 MAR 99 (Thursday)
Duration: 2.9 hours
   Pilot: TLC

Weather: Clear, WSW wind at 5 m/s, temperature rising from 14 to 20 C.

Summary: Parallel legs E & S of Duck Pier.
```

Problems: IRGA power supply replaced, H2O channel working but not CO2.
Laser #2 and Ka-band radar not working.

Marker for D:\03181338.ORG OPENED at 395937

```
VNT -1 00011 13:59:07  36 00.8 -75 40.4 ventilation
     0 00056 13:59:52  36 00.8 -75 40.4
TXI -1 00124 14:01:00  36 01.4 -75 40.2 taxi
     0 00127 14:01:03  36 01.4 -75 40.2
FLN -1 00360 14:04:56  35 59.1 -75 38.1 stack N @ 15 m near shore
     0 00756 14:11:32  36 09.2 -75 44.2
FLS -1 00807 14:12:23  36 09.3 -75 43.2 stack S @ 15 m shore +1.8 km
     0 01182 14:18:38  35 59.7 -75 36.6
FLN -1 01282 14:20:18  35 59.6 -75 38.2 stack N @ 120 m near shore
     0 01642 14:26:18  36 09.1 -75 43.9
FLS -1 01700 14:27:16  36 09.3 -75 42.7 stack S @ 120 m shore +1.8 km
     0 02061 14:33:17  35 59.8 -75 36.9
FLN -1 02152 14:34:48  35 59.7 -75 38.3 stack N @ 275 m near shore
     0 02550 14:41:26  36 08.5 -75 43.7
FLS -1 02675 14:43:31  36 07.9 -75 41.5 stack S @ 275 m shore +1.8 km
     0 02932 14:47:48  36 00.3 -75 37.1
FLN -1 03082 14:50:18  35 58.4 -75 35.6 stack N @ 200 m shore +1.8 km
     0 03537 14:57:53  36 09.2 -75 42.7
FLS -1 03618 14:59:14  36 08.2 -75 43.5 stack S @ 200 m near shore
     0 03946 15:04:42  35 59.4 -75 38.1
FLN -1 04009 15:05:45  36 00.4 -75 37.3 stack N @ 120 m shore +1.8 km
     0 04370 15:11:46  36 09.5 -75 43.2
FLS -1 04443 15:12:59  36 08.7 -75 43.8 stack S @ 120 m near shore
     0 04823 15:19:19  35 59.1 -75 38.1
FLN -1 04901 15:20:37  36 00.5 -75 37.6 stack N @ 15 m shore +1.8 km
     0 05225 15:26:01  36 09.2 -75 43.0
FLS -1 05280 15:26:56  36 08.8 -75 44.0 stack S @ 15 m
     0 05646 15:33:02  35 59.2 -75 38.3
FLE -1 06009 15:39:05  36 04.7 -75 44.3 stack E @ 75 m
     0 06243 15:42:59  36 06.3 -75 35.5
FLW -1 06392 15:45:28  36 07.1 -75 32.6 stack W @ 150 m
     0 06806 15:52:22  36 04.3 -75 44.6
FLE -1 06955 15:54:51  36 04.2 -75 45.7 stack E @ 300 m
     0 07170 15:58:26  36 06.3 -75 35.3
FLW -1 07363 16:01:39  36 07.5 -75 31.0 stack W @ 600 m
     0 07795 16:08:51  36 04.0 -75 44.4
FLE -1 07949 16:11:25  36 04.2 -75 45.1 stack E @ 600 m
     0 08179 16:15:15  36 06.7 -75 34.2
FLW -1 08346 16:18:02  36 07.7 -75 29.8 stack W @ 300 m
     0 08890 16:27:06  36 04.2 -75 44.3
FLE -1 09051 16:29:47  36 04.7 -75 44.5 stack E @ 150 m
     0 09260 16:33:16  36 06.1 -75 35.4
FLW -1 09405 16:35:41  36 06.9 -75 32.2 stack W @ 75 m
     0 09822 16:42:38  36 04.5 -75 44.4
TXI -1 10271 16:50:07  36 01.0 -75 40.3 taxi
     0 10289 16:50:25  36 00.9 -75 40.4
```

```
VNT -1 10358 16:51:34  36 00.8 -75 40.3 ventilation
     0 10386 16:52:02  36 00.8 -75 40.3

Marker for D:\03181338.ORG CLOSED at 406575

Total scans : 10638
Missed Ints : 00000
BAT Dropouts: 000.064%
NOV Dropouts: 000.911%
TAN Dropouts: 000.995%
```

Appendix B: LongEZ Flight Paths

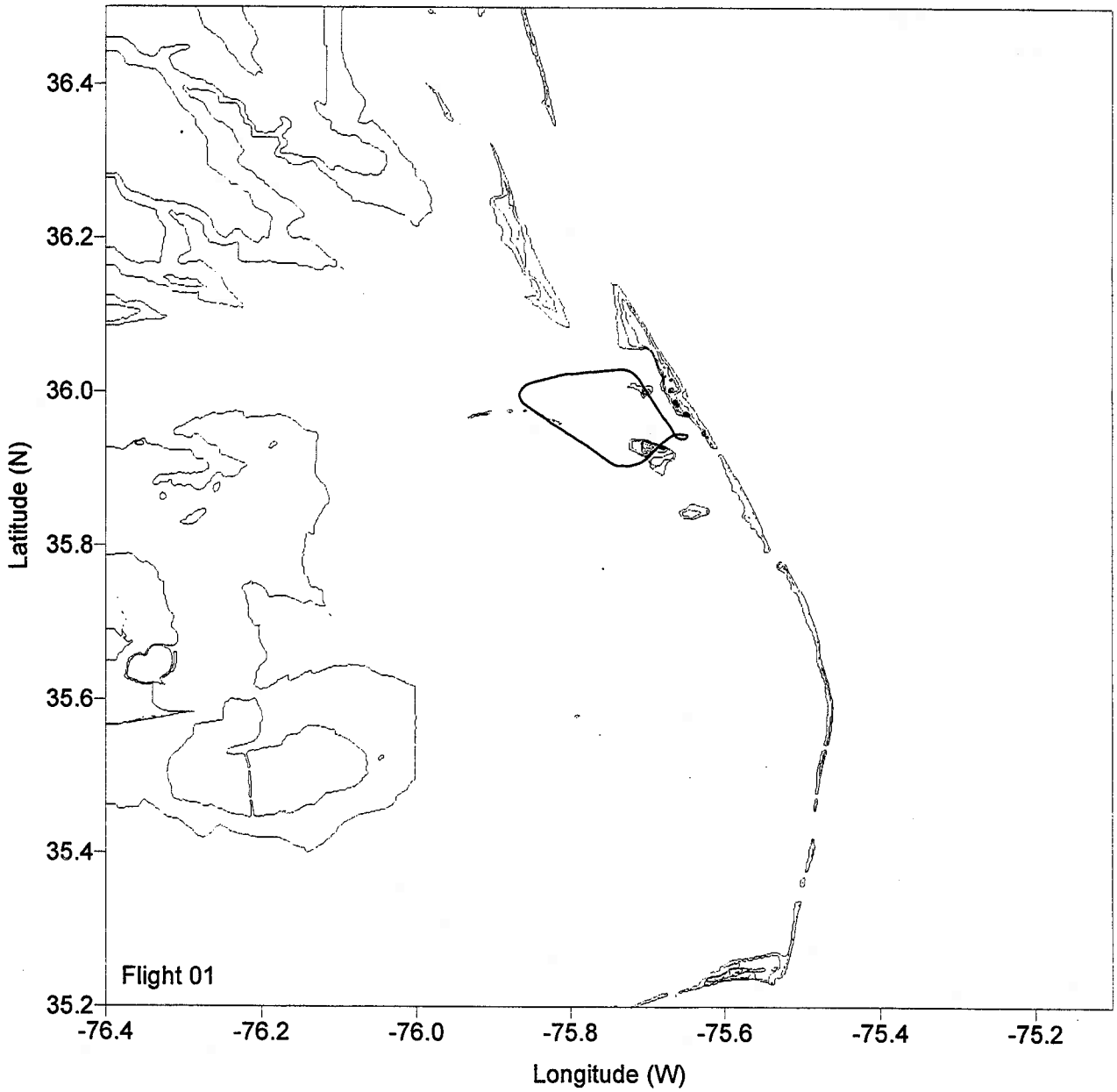


Figure 4. Flight 1, Monday, 1 March 1999.

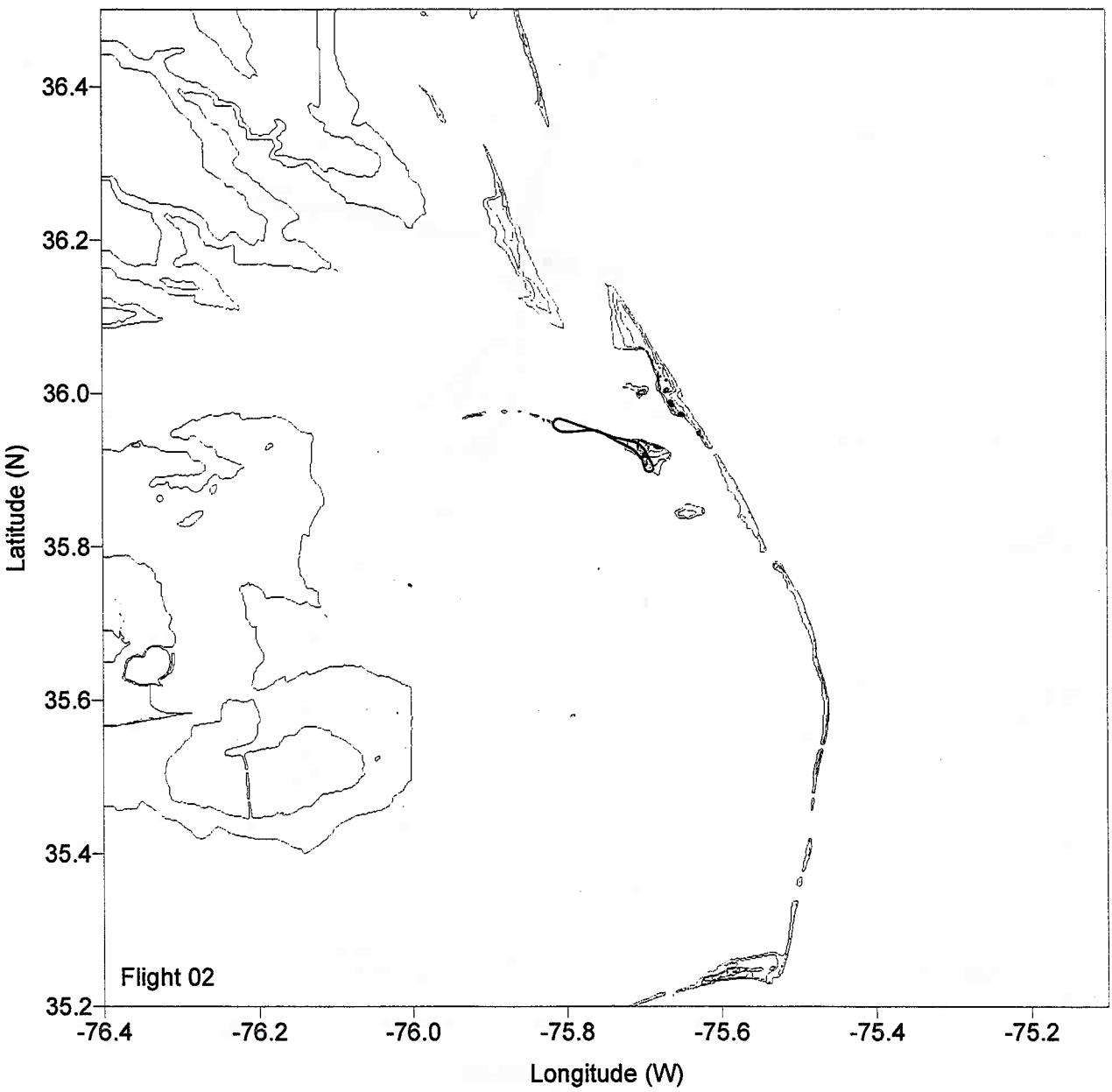


Figure 5. Flight 2, Tuesday, 2 March 1999.

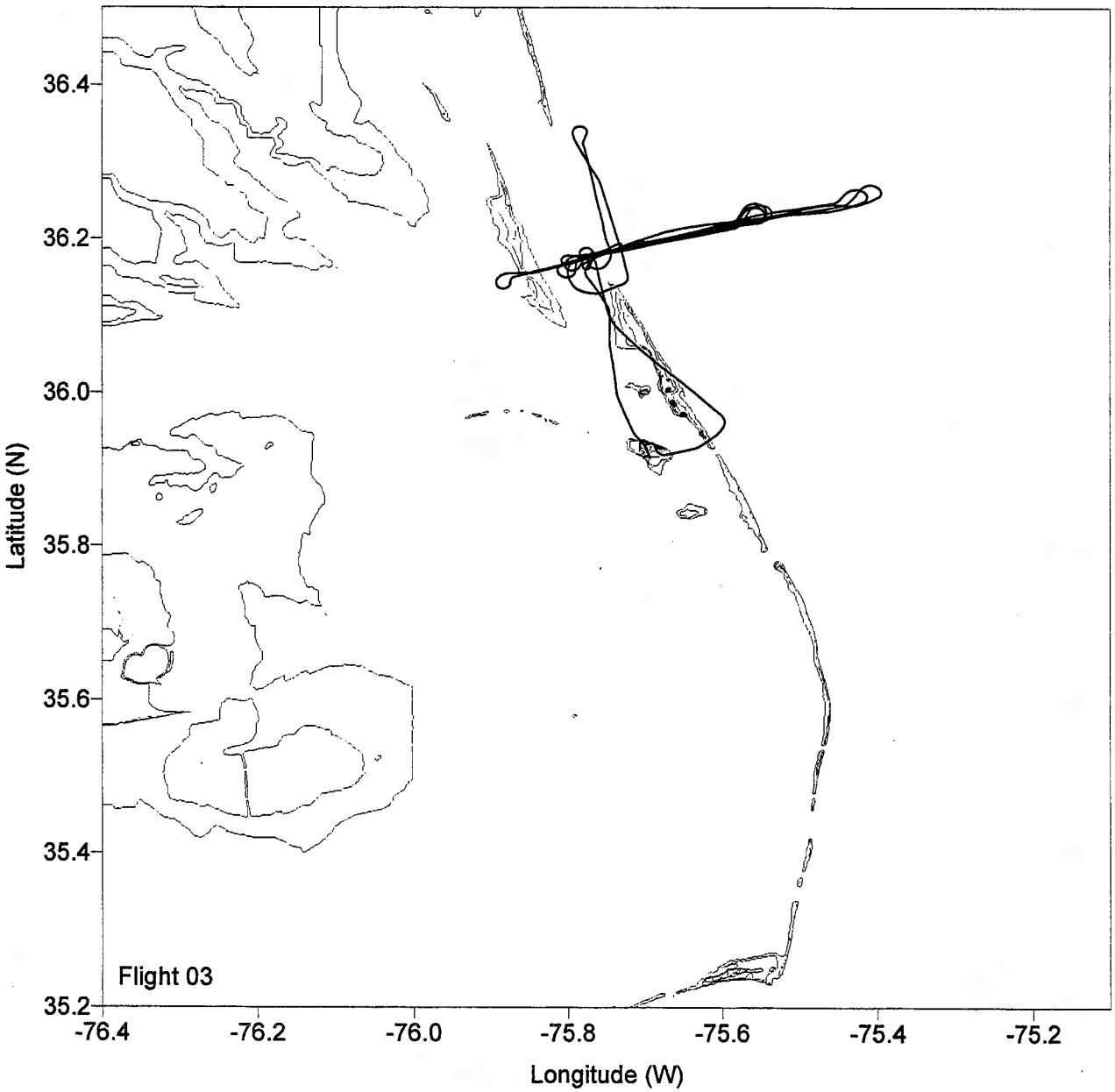


Figure 6. Flight 3, Tuesday, 2 March 1999.

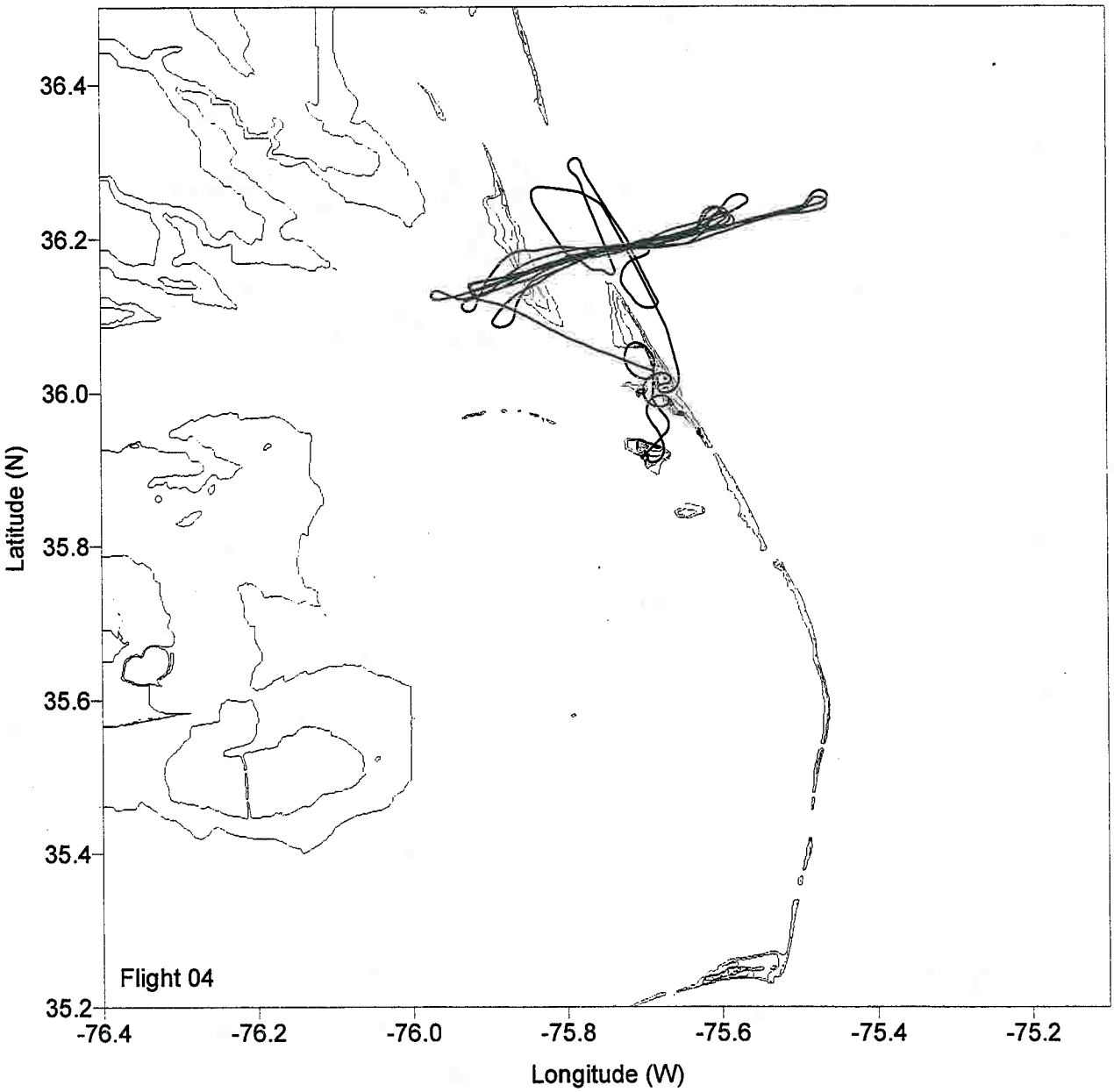


Figure 7. Flight 4, Wednesday, 3 March 1999.

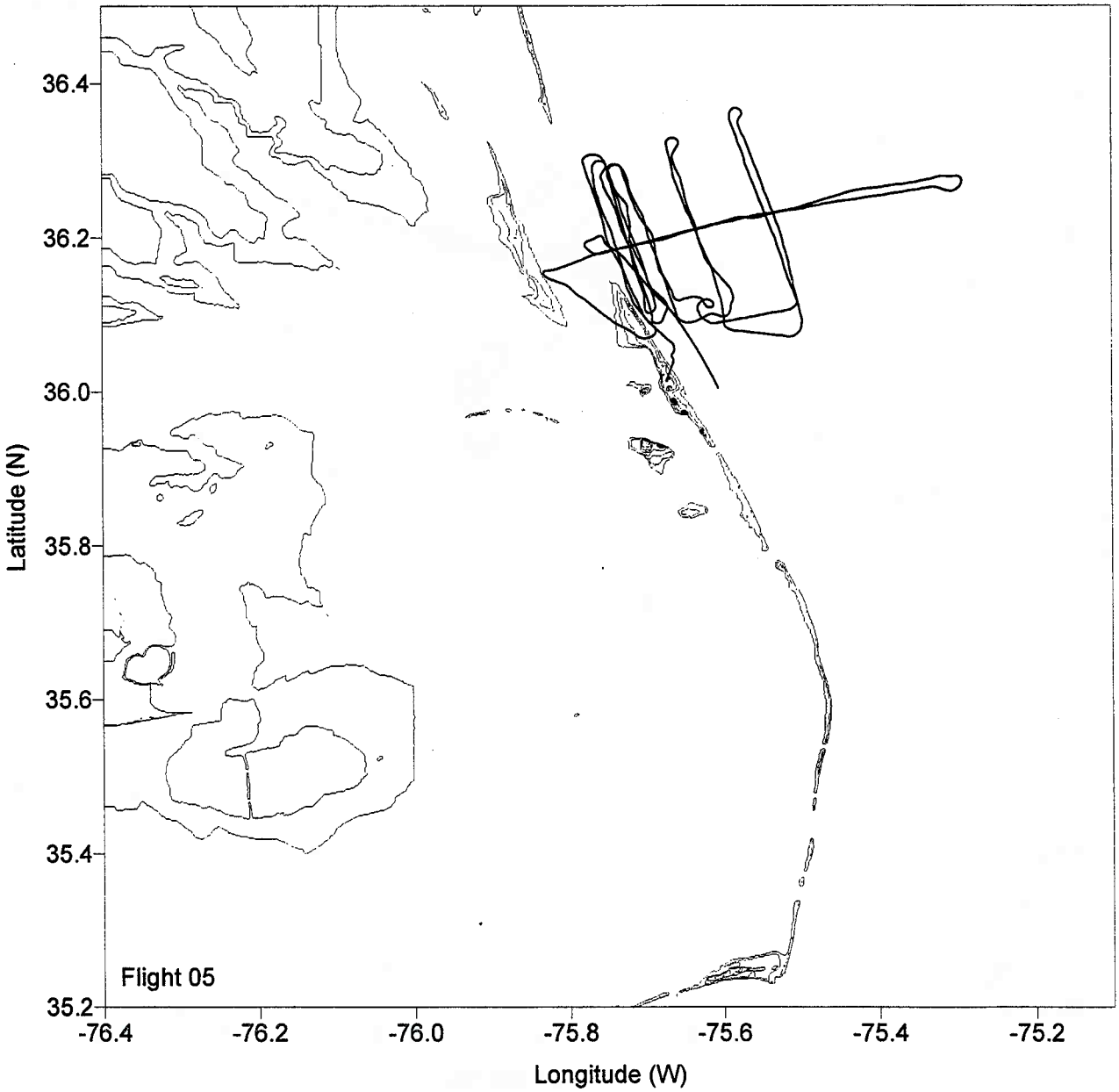


Figure 8. Flight 5, Thursday, 4 March 1999.

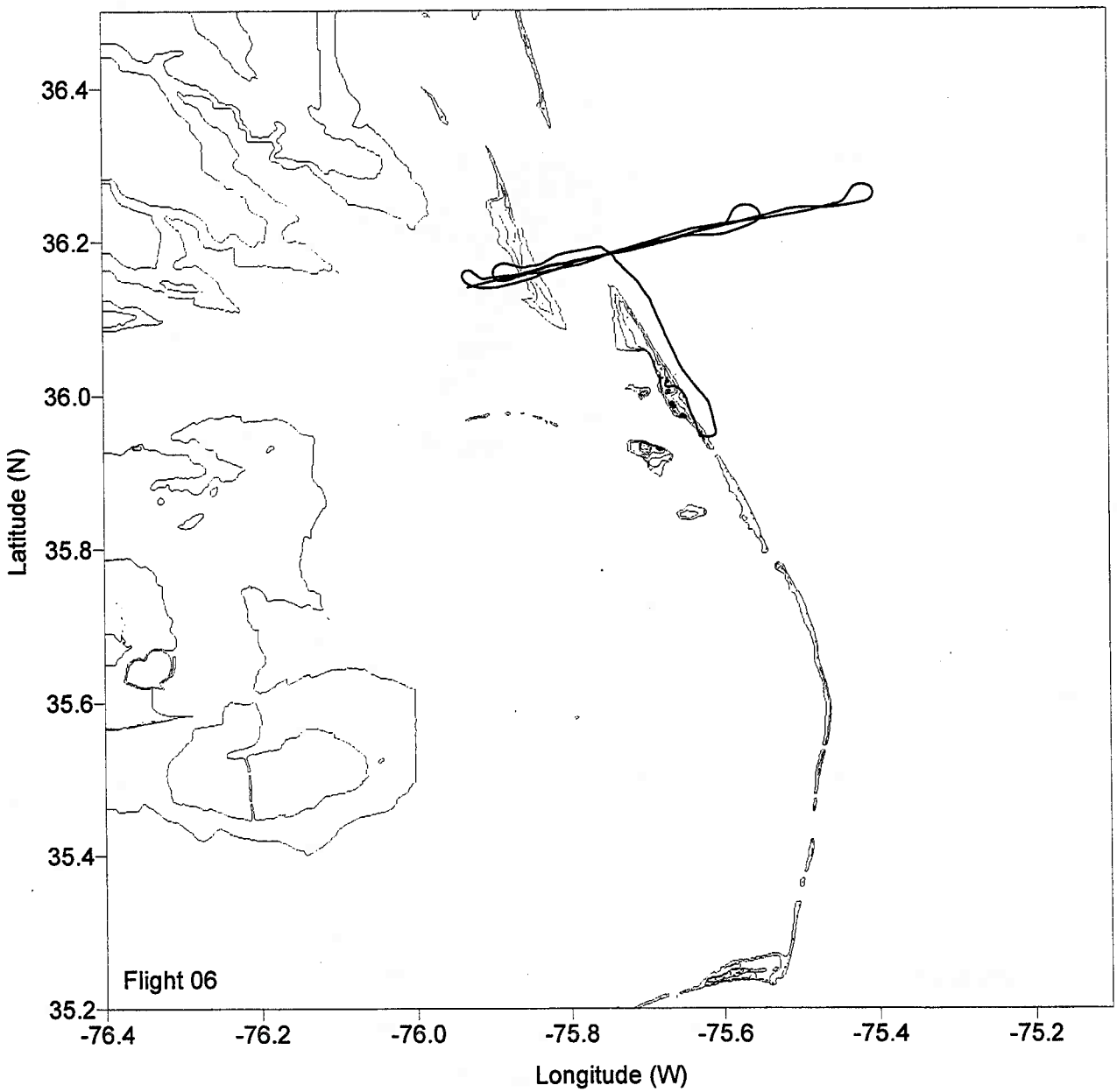


Figure 9. Flight 6, Thursday, 4 March 1999.

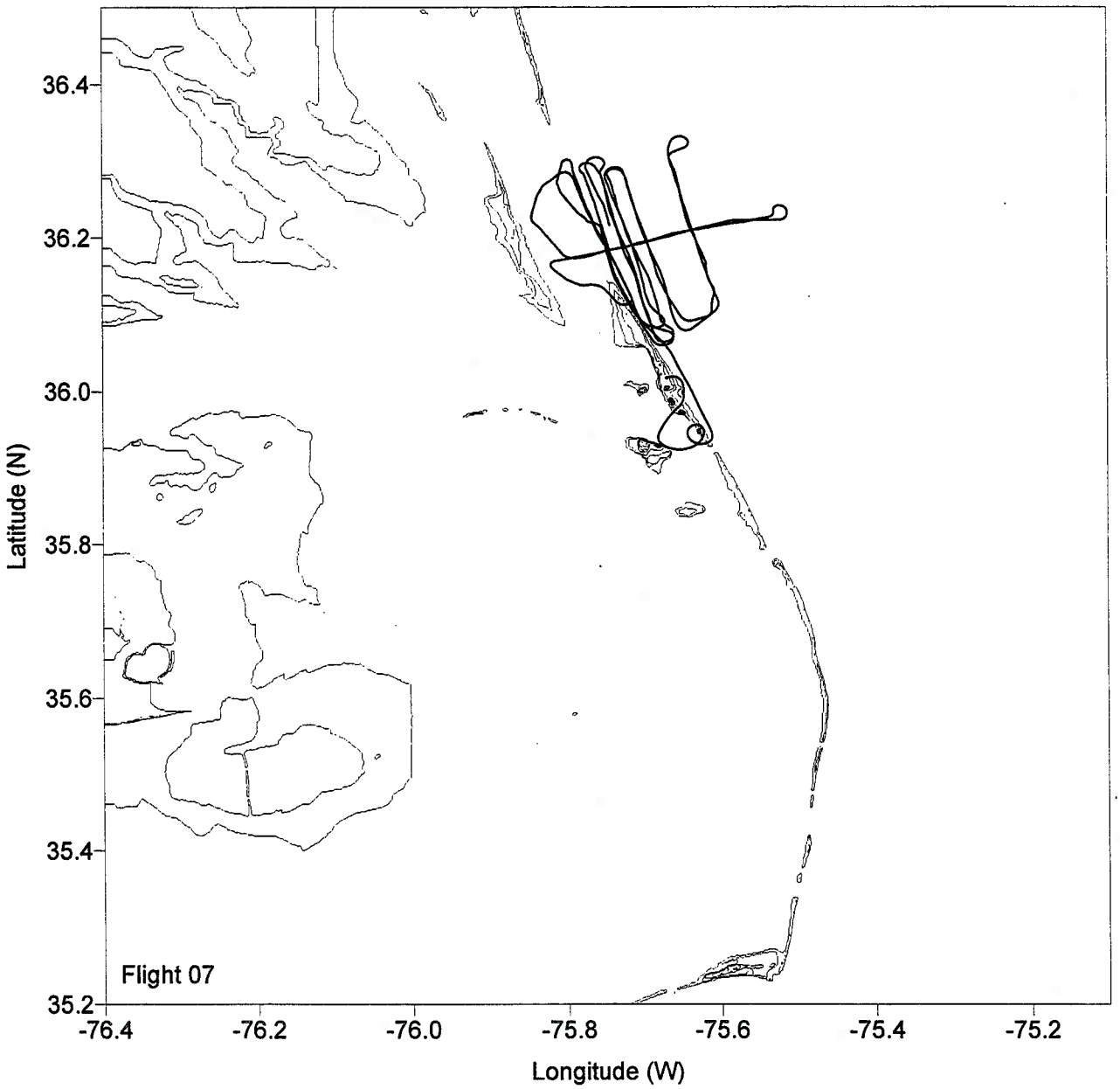


Figure 10. Flight 7, Friday, 5 March 1999.

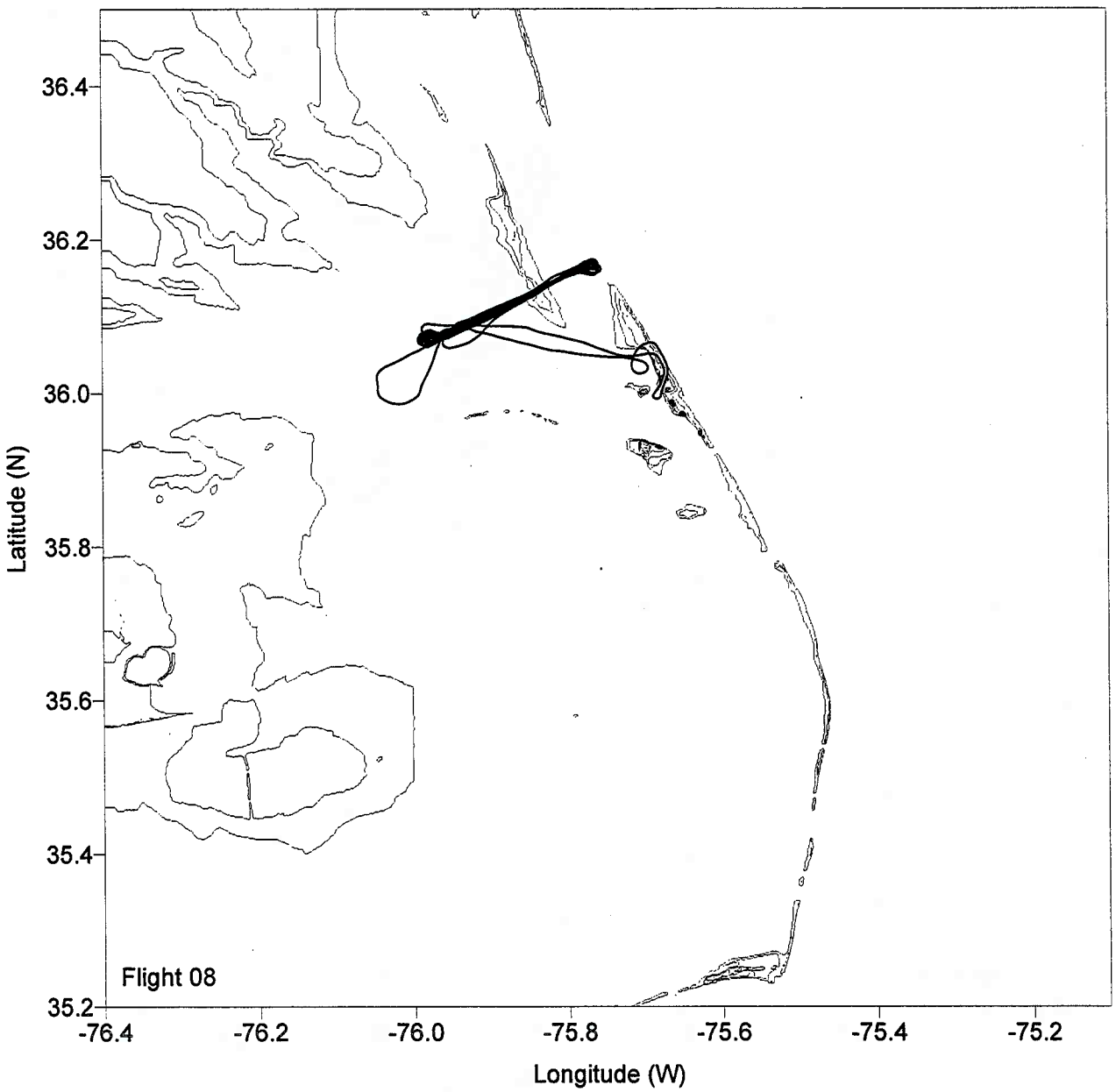


Figure 11. Flight 8, Friday, 5 March 1999.

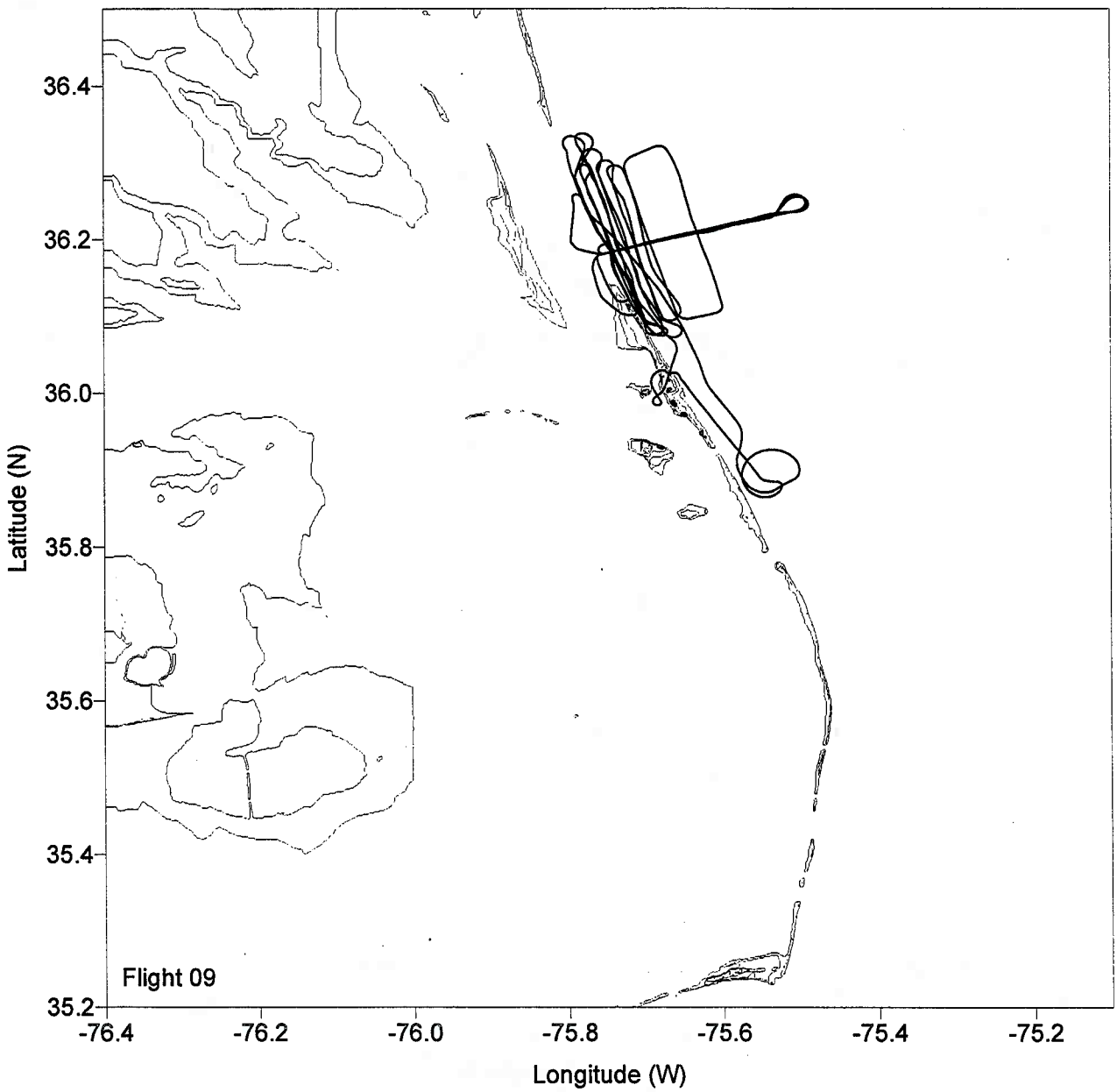


Figure 12. Flight 9, Saturday, 6 March 1999.

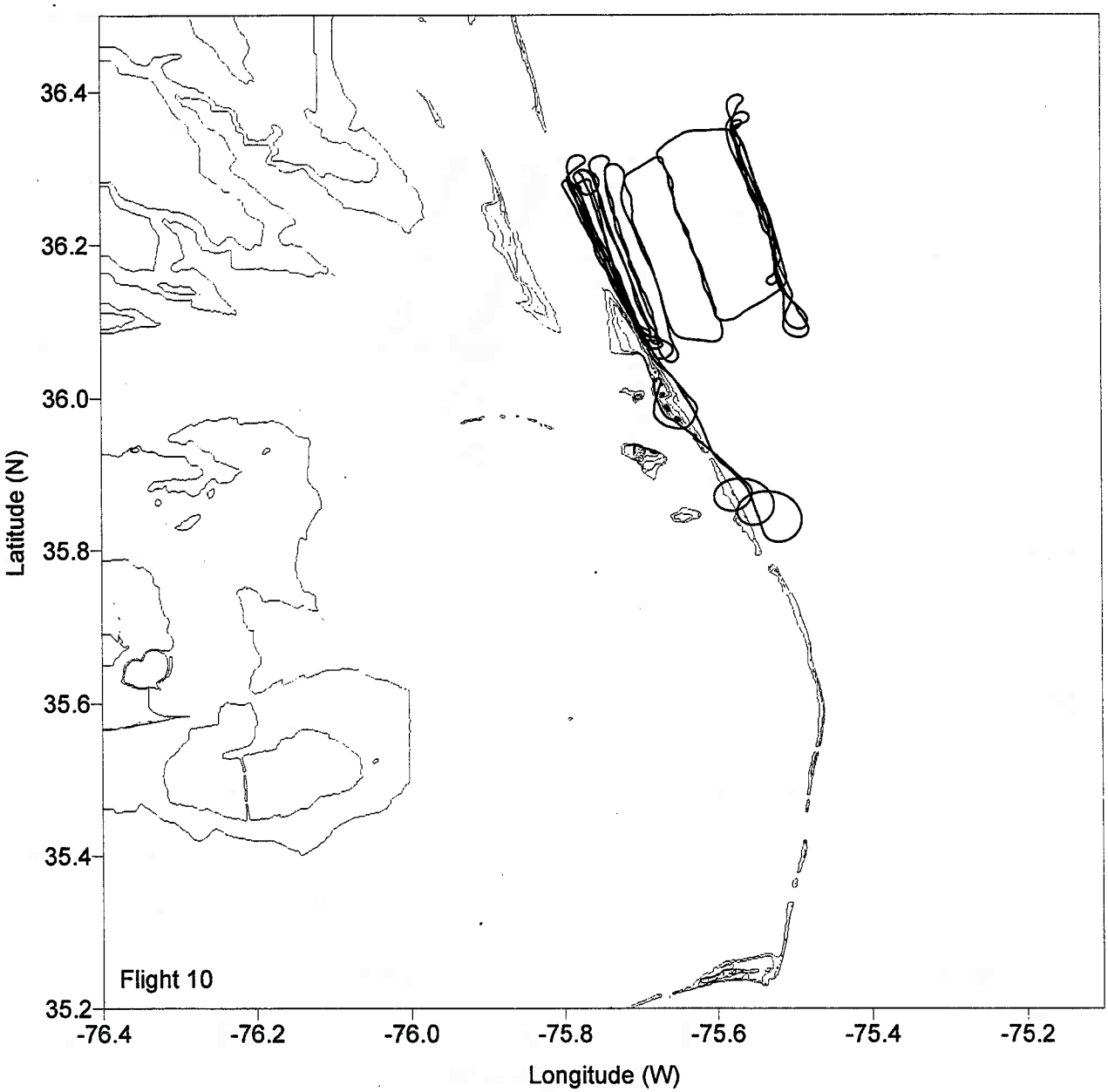


Figure 13. Flight 10, Sunday, 7 March 1999.

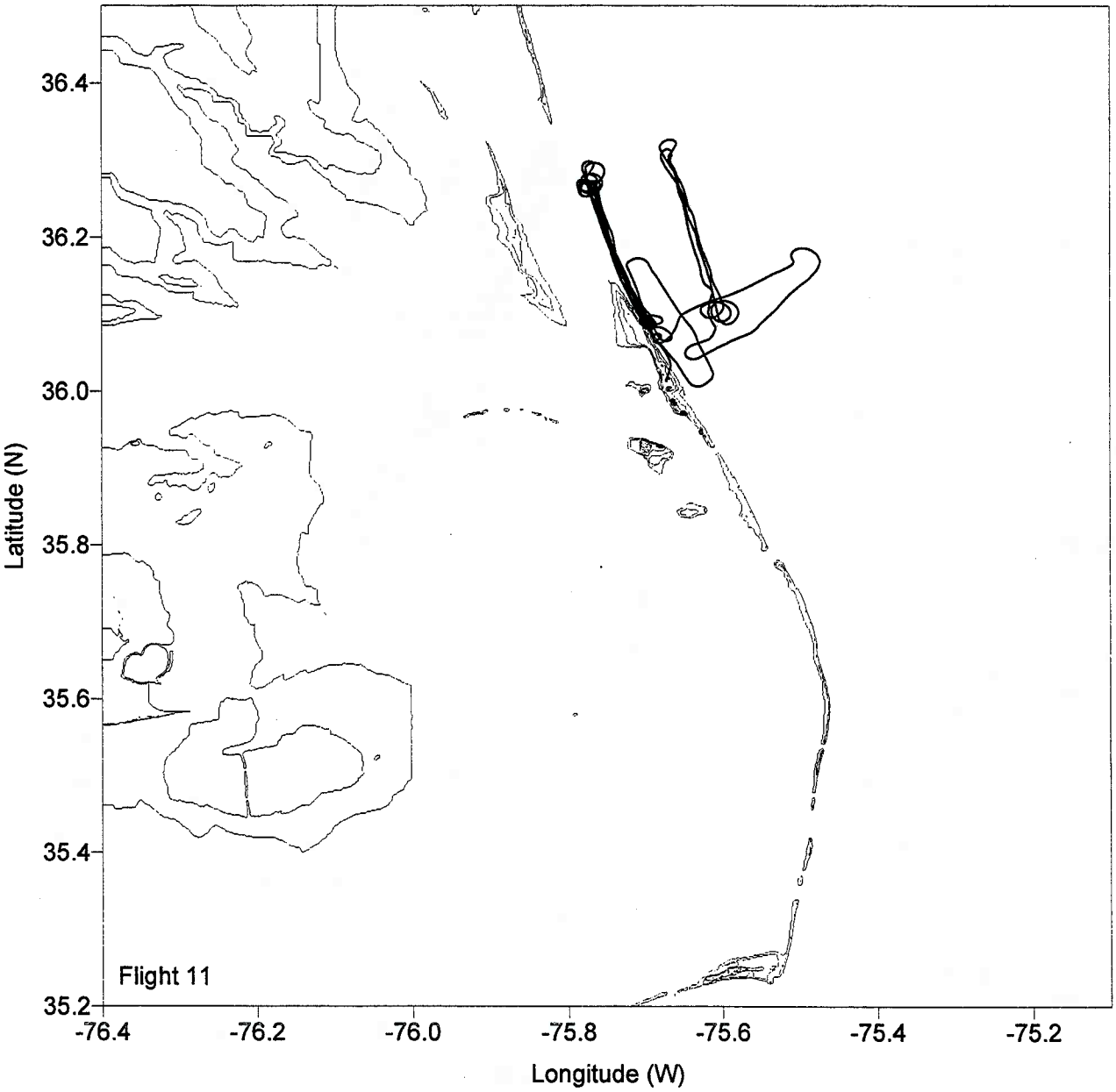


Figure 14. Flight 11, Sunday, 7 March 1999.

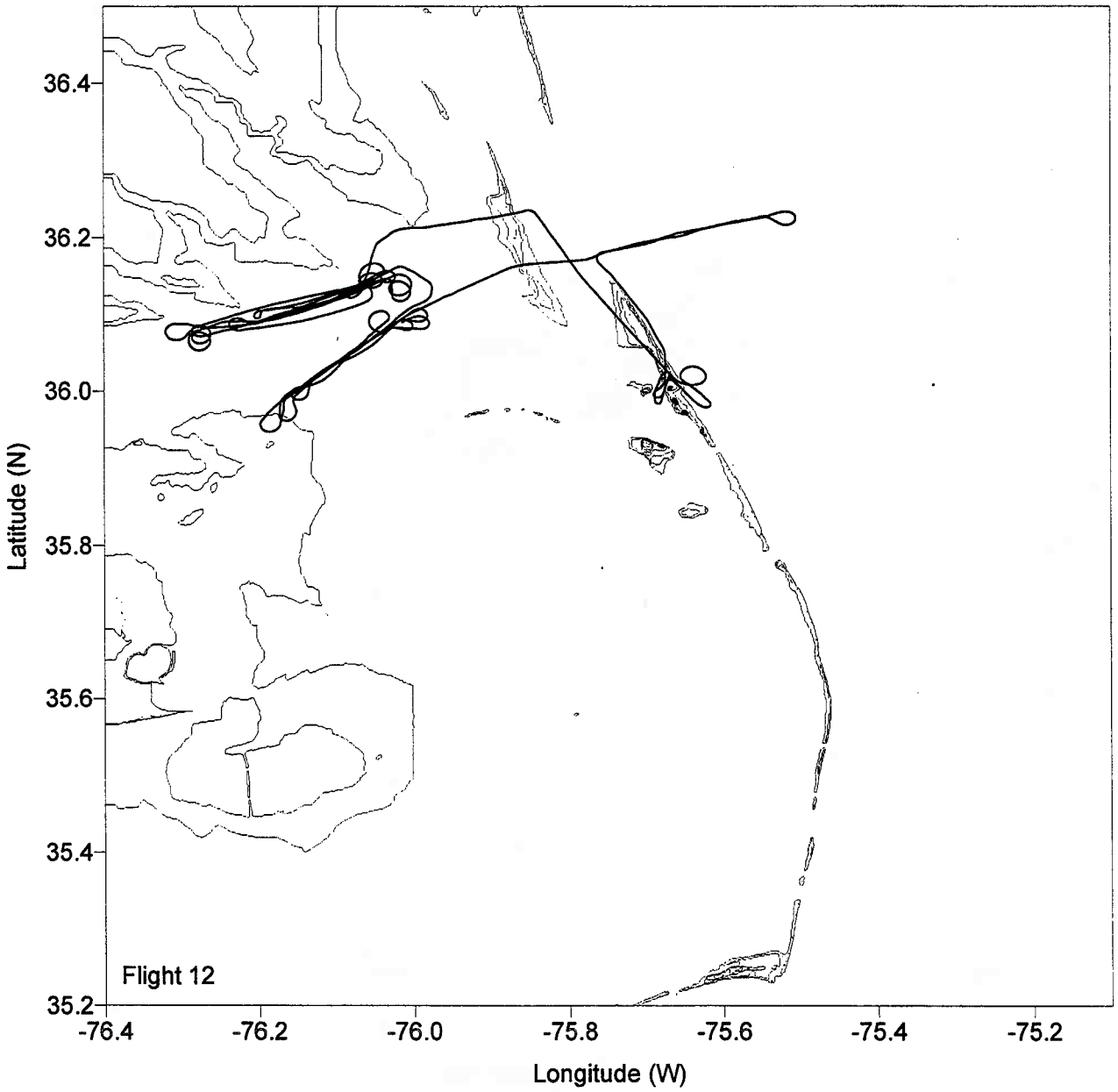


Figure 15. Flight 12, Monday, 8 March 1999.

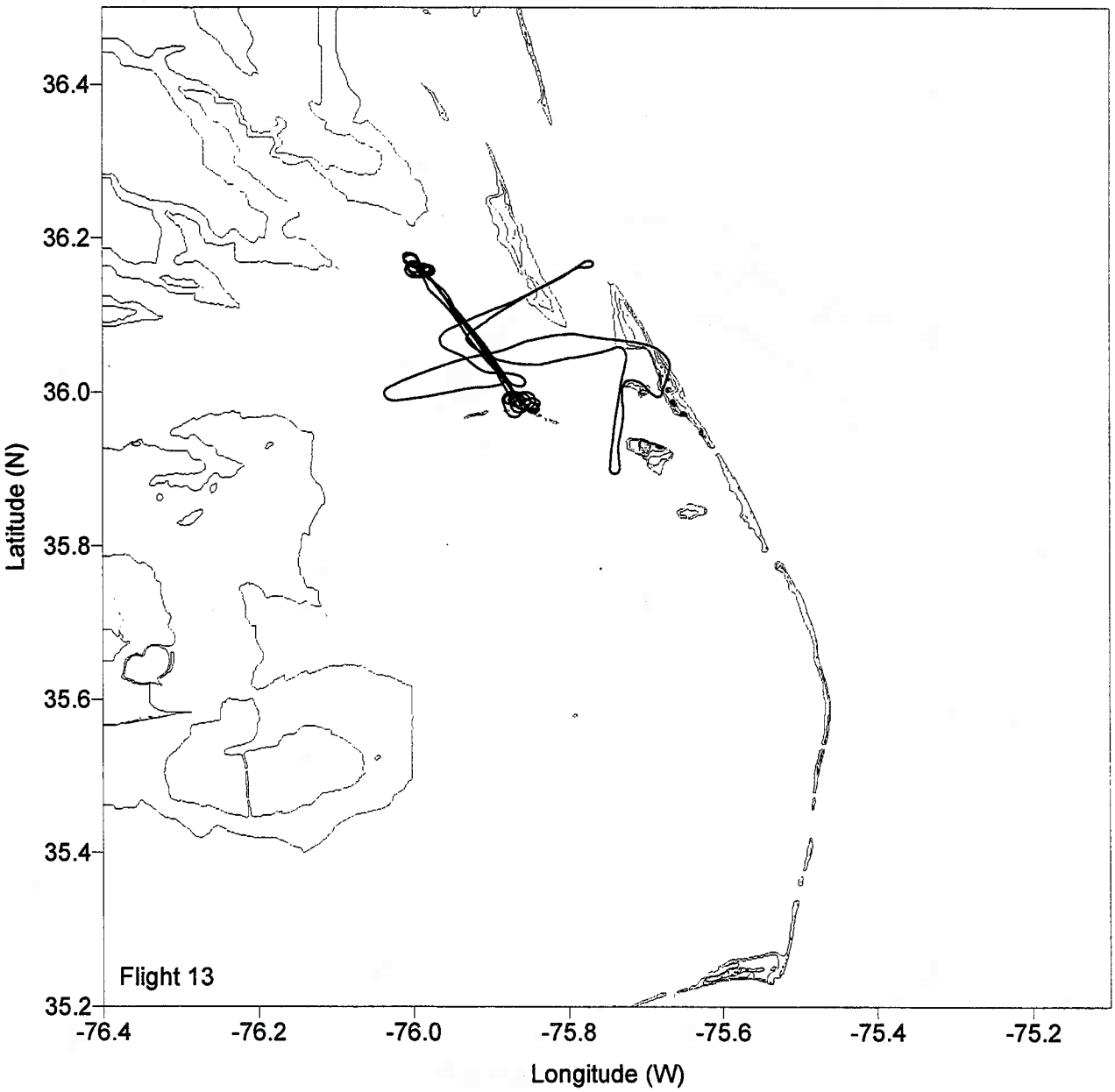


Figure 16. Flight 13, Monday, 8 March 1999.

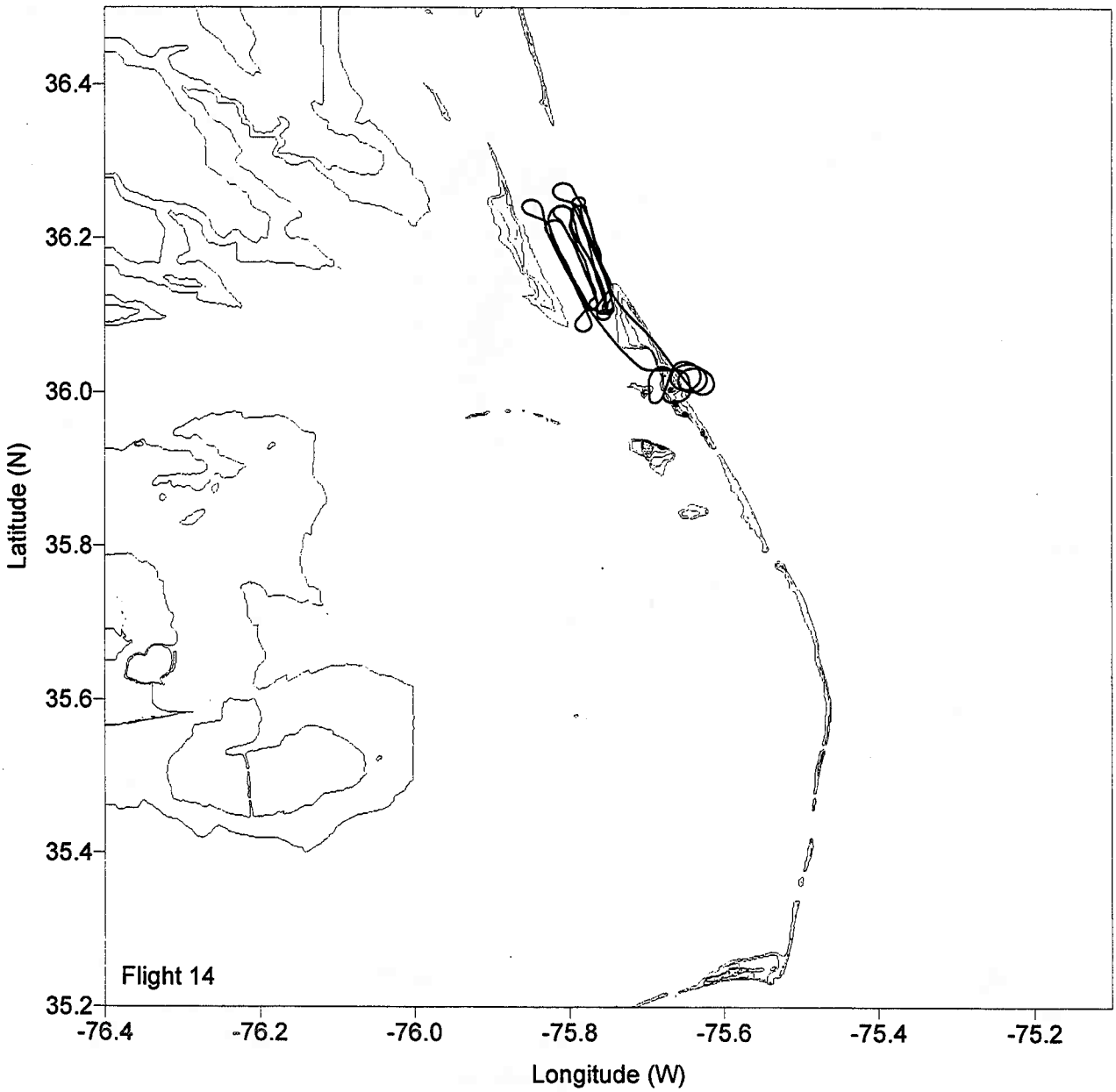


Figure 17. Flight 14, Tuesday, 9 March 1999.

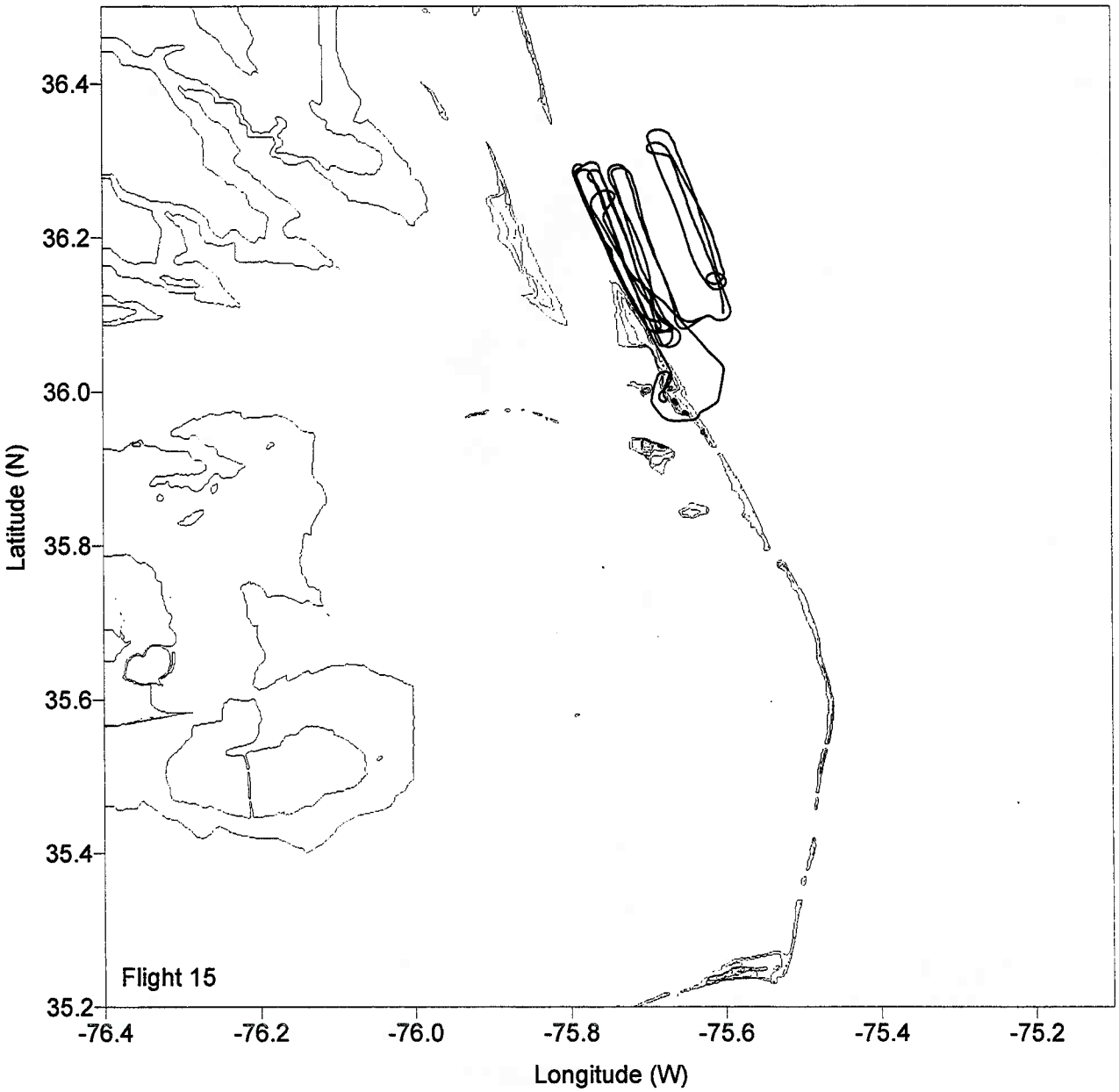
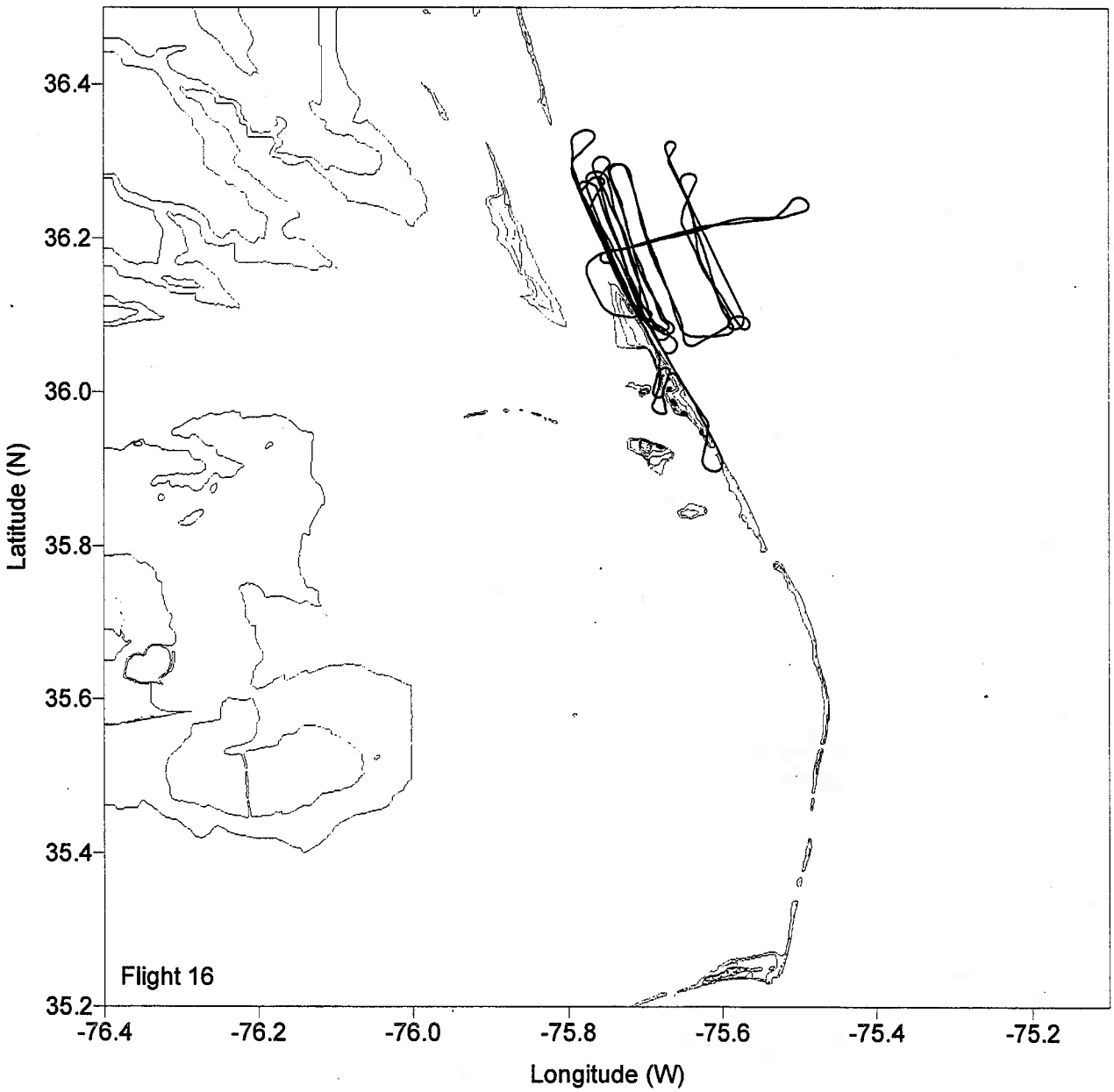


Figure 18. Flight 15, Wednesday, 10 March 1999.



Flight 19. Flight 16, Thursday, 11 March 1999.

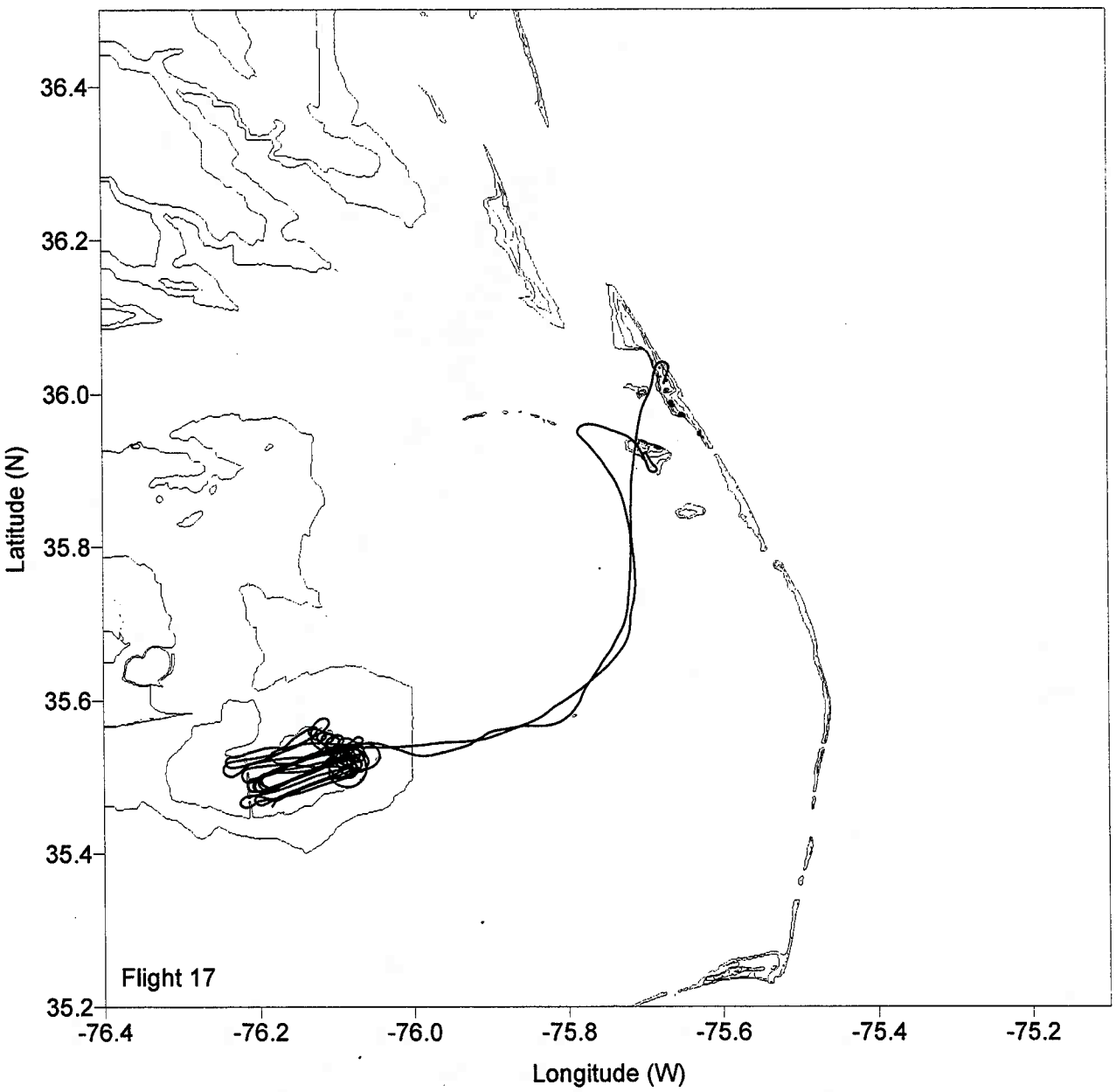


Figure 20. Flight 17, Thursday, 11 March 1999.

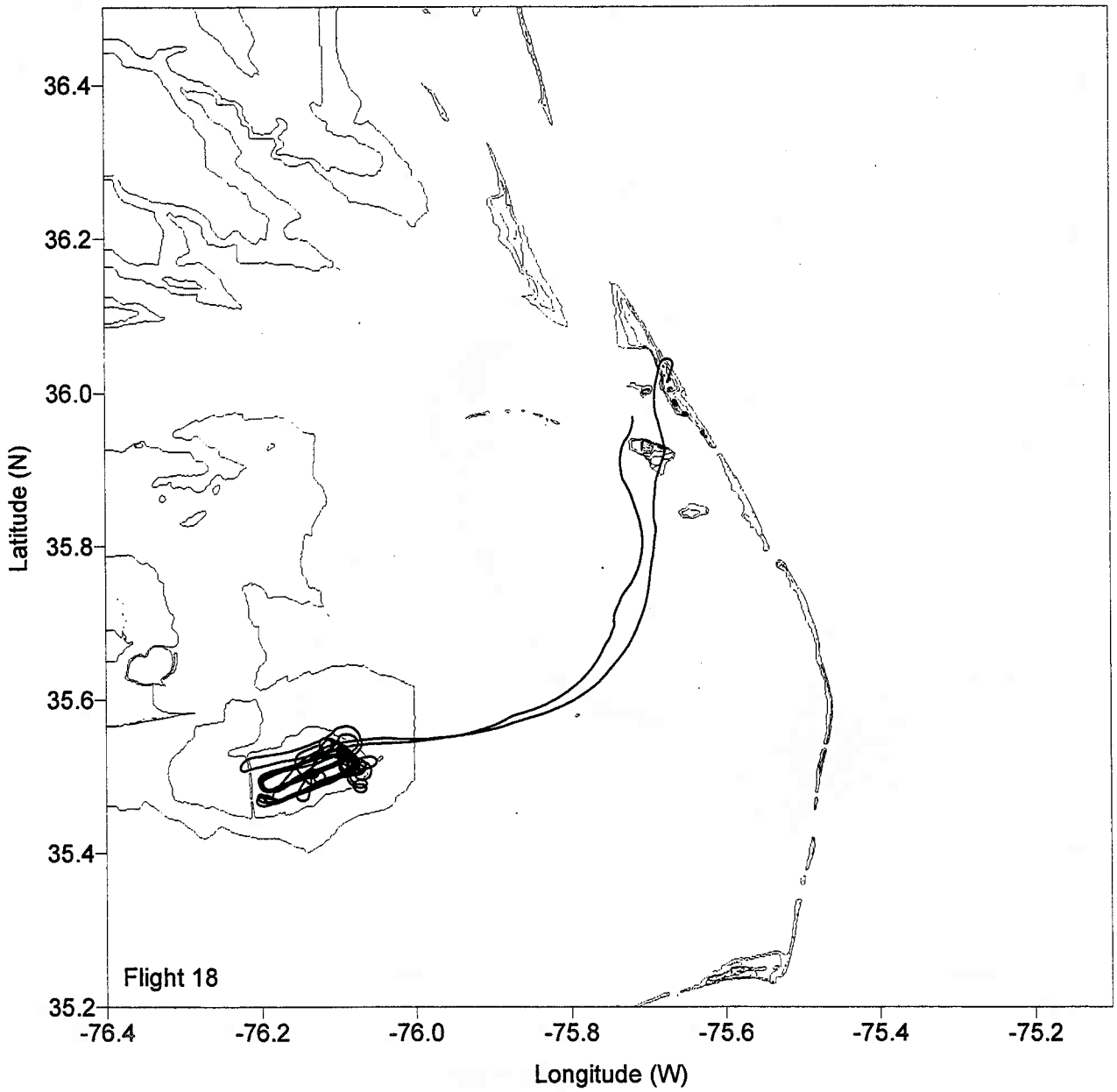


Figure 21. Flight 18, Friday, 12 March 1999.

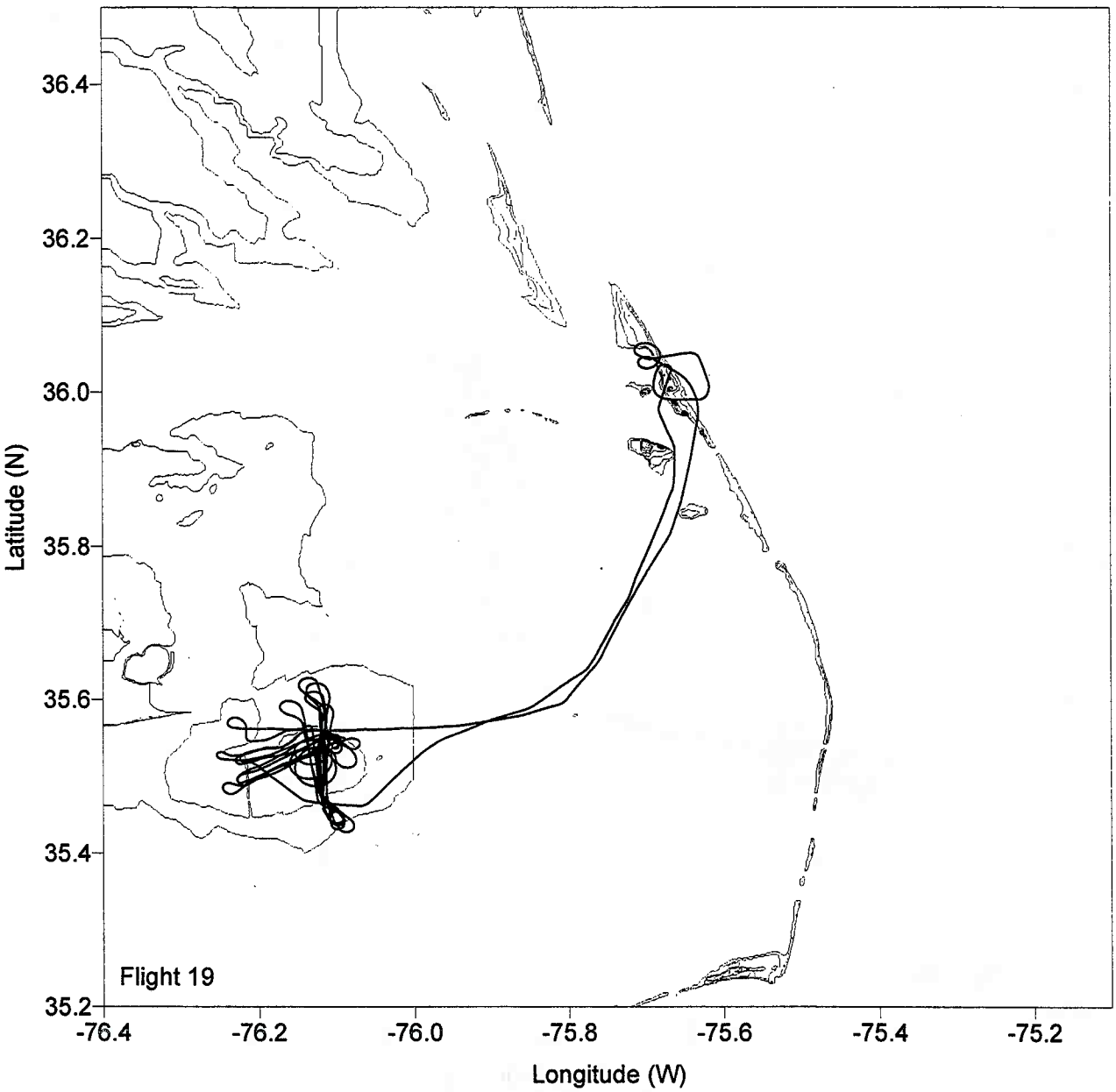


Figure 22. Flight 19, Saturday, 13 March 1999.

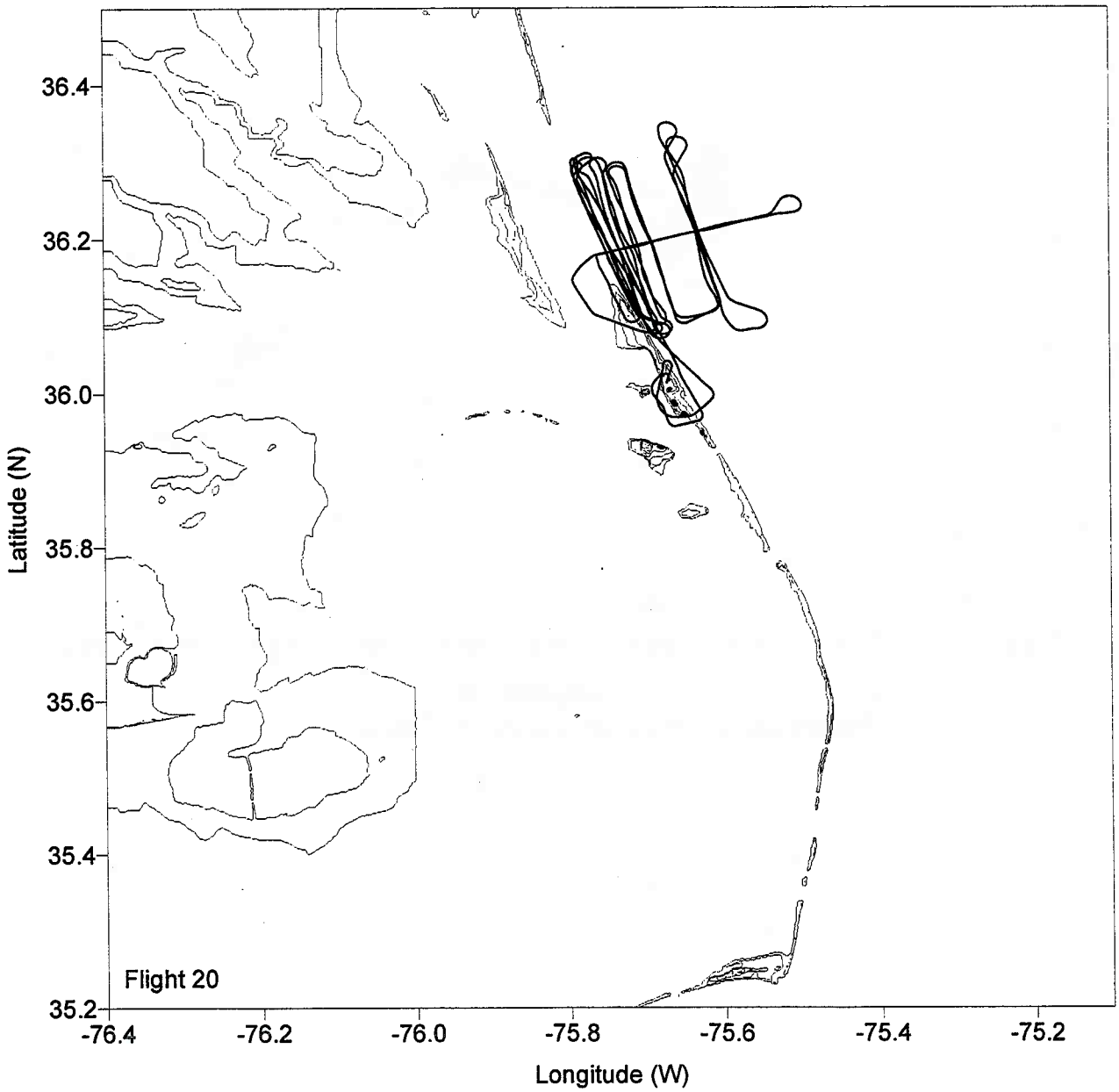


Figure 23. Flight 20, Tuesday, 16 March 1999.

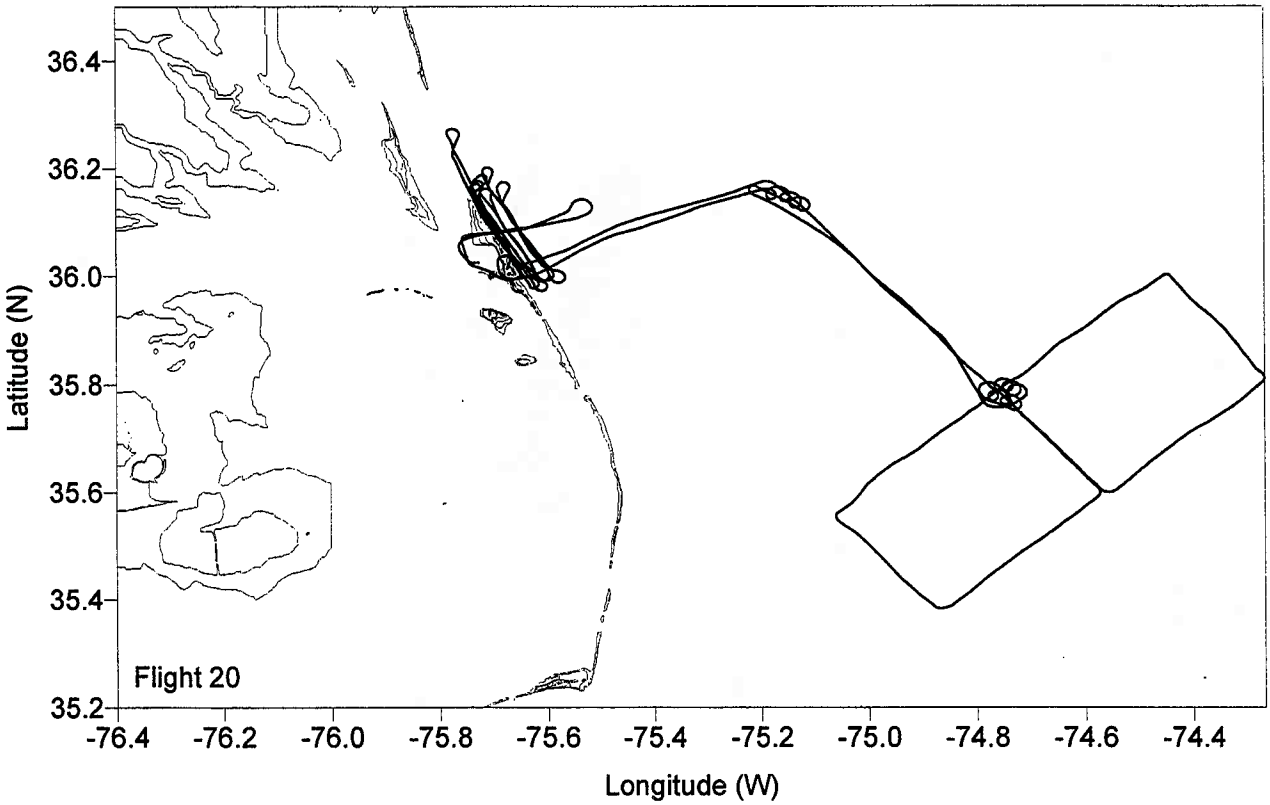


Figure 24. Flight 21, Wednesday, 17 March 1999.

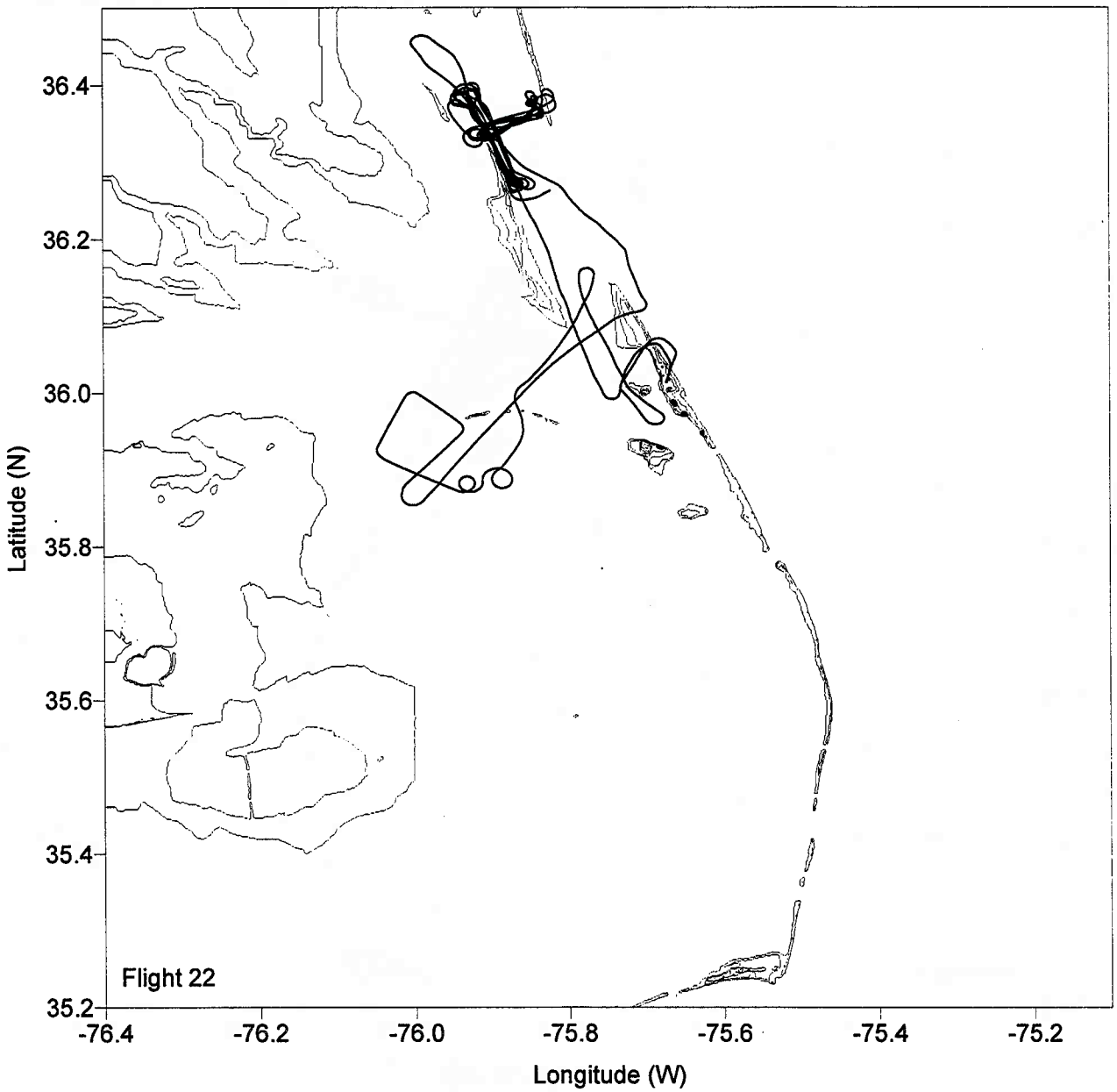


Figure 25. Flight 22, Wednesday, 17 March 1999.

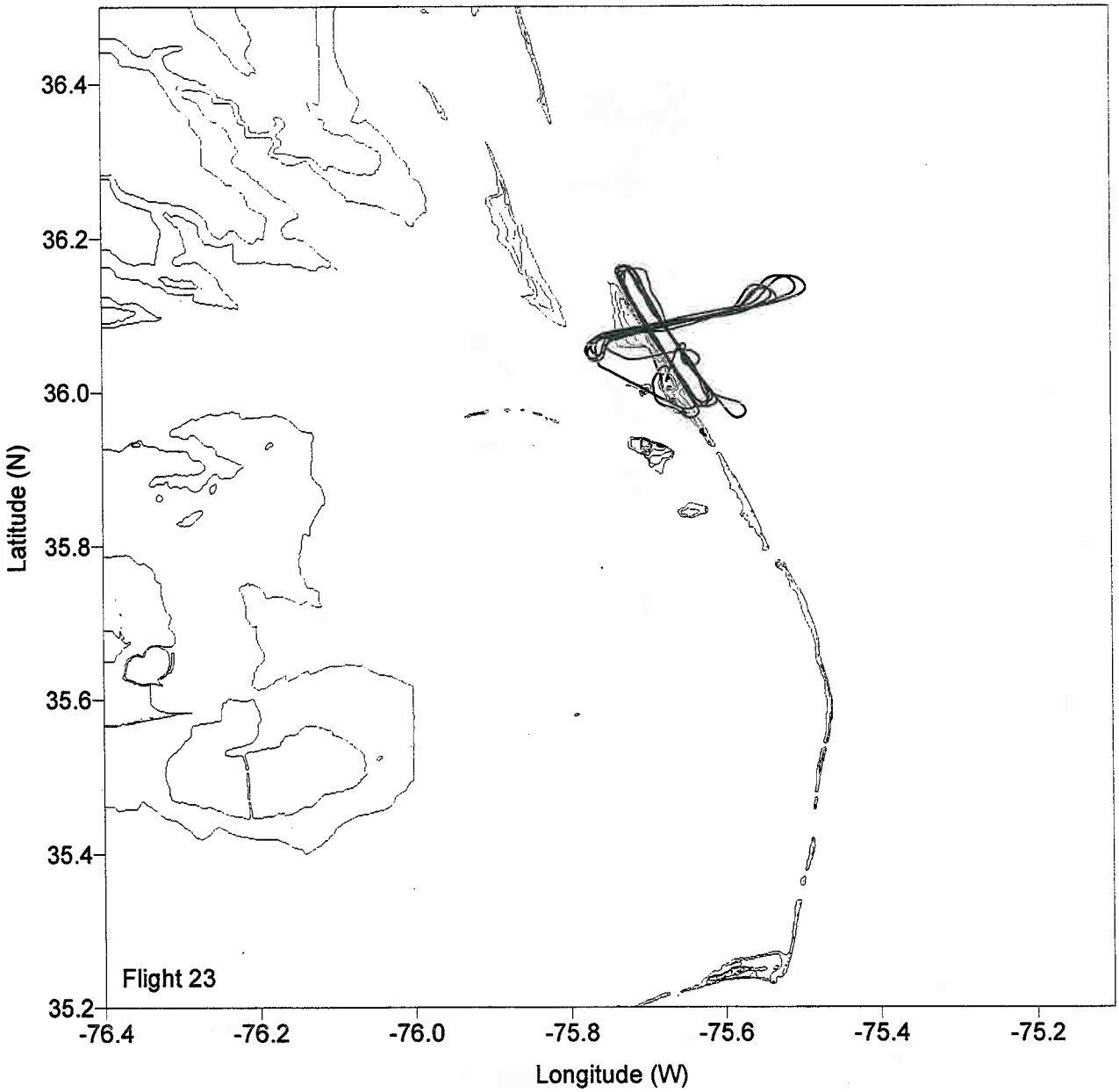


Figure 26. Flight 23, Thursday, 18 March 1999.