

NOAA Technical Memorandum OAR ARL-250

**PROCESSING OF SURFACE CONCENTRATION DATA FROM TRACER RELEASES
IN MVP SESSIONS 1, 2, 3, AT CAPE CANAVERAL, FLORIDA**

K. Shankar Rao

Atmospheric Turbulence and Diffusion Division
Oak Ridge, Tennessee

Air Resources Laboratory
Silver Spring, Maryland
April 2003



**UNITED STATES
DEPARTMENT OF COMMERCE**

**Donald L. Evans
Secretary**

**NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION**

**VADM Conrad C. Lautenbacher, Jr.
Under Secretary for Oceans
and Atmosphere/Administrator**

Oceanic and Atmospheric
Research Laboratories

Daniel L. Albritton
Acting Director

NOTICE

Mention of a commercial company or product is for information purposes only and does not constitute an endorsement by NOAA's Oceanic and Atmospheric Research Laboratories. Use for publicity or advertising purposes, of information from this publication concerning proprietary products or the tests of such products, is not authorized.

ATDD Contribution File No. 02/01

TABLE OF CONTENTS

| | |
|---|------|
| NOTATION | iv |
| LIST OF FIGURES | v |
| LIST OF TABLES | viii |
| ABSTRACT | 1 |
| 1. INTRODUCTION | 1 |
| 2. MVP TRACER EXPERIMENTS AT CCAS | 2 |
| 3. PROCESSING OF SURFACE TRACER DATA | 4 |
| 3.1 Analysis Procedure | 4 |
| 3.2 Session 1 | 6 |
| 3.2.1 Surface release | 6 |
| 3.2.2 Elevated release | 7 |
| 3.3 Session 2 | 19 |
| 3.3.1 Surface release | 24 |
| 3.3.2 Elevated release | 32 |
| 3.4 Session 3 | 41 |
| 3.4.1 Surface release | 41 |
| 3.4.2 Elevated release | 50 |
| 4. DISCUSSION AND CONCLUSIONS | 62 |
| 5. ACKNOWLEDGEMENTS | 68 |
| 6. REFERENCES | 69 |
| APPENDIX I Computer Programs for Tracer Data Processing | 70 |
| APPENDIX II Surface Concentration Data Files | 81 |

NOTATION

| | |
|-----------------|---|
| ATDD | Atmospheric Turbulence and Diffusion Division |
| C | Sampled tracer concentration (ppt) |
| A | Averaged tracer concentration (ppt) |
| CCAS | Cape Canaveral Air Station |
| EDT | Eastern Daylight Time = UTC - 4.0 hr |
| EST | Eastern Standard Time = UTC - 5.0 hr |
| FGA | Fast Gas Analyzer |
| GPS | Global Positioning System |
| KSC | Kennedy Space Center |
| Lat/Lon | Latitude/Longitude |
| HYPACT | HYbrid Particle And Concentration Transport model |
| MVP | (Atmospheric Dispersion) Model Validation Program |
| NOAA | National Oceanic and Atmospheric Administration |
| OAR | Oceanic and Atmospheric Research |
| ppt | parts per trillion |
| RAMS | Regional Atmospheric Modeling System |
| REEDM | Rocket Exhaust Effluent Diffusion Model |
| SF ₆ | Sulfur hexafluoride |
| USAF | United States Air Force |
| UTC | Universal Time Convention |
| VAFB | Vandenberg Air Force Base |

LIST OF FIGURES

| <u>Figure</u> | | <u>Pages</u> |
|---------------|---|--------------|
| 1. | Cape Canaveral and vicinity of interest for MVP tracer experiments. Merritt Island, and the local rivers and highways are shown. Tower 110 is used as reference point for analysis of tracer sampling data. | 3 |
| 2. | Traverses of tracer-sampling platforms used in MVP Test 110. The label at top left inside each figure gives the Test number and the platform label: (a) Vans 1 and 2; (b) Vans 3 and 4; (c) Vans 5 and 6; (d) Aircraft A and B. | 8-11 |
| 3. | Traverses of Van 1 in Test 110 at different times during sampling period 14.21–15.38 hr, and the common Eulerian track (solid line). | 12 |
| 4. | Variations of processed concentrations and their average value over the time period 14.88–15.38 hr versus travel distance along the Eulerian track for Van 1 in Test 110. | 13 |
| 5. | Traverses of Van 3 in Test 110 at different times and the common Eulerian tracks (solid lines) during sampling periods: (a) 13.90–14.35 hr, and (b) 14.50–15.18 hr. | 14 |
| 6. | Traverses of tracer-sampling platforms used in MVP Test 117. The label at top left inside each figure gives the Test number and the platform label: (a) Vans 1 and 2; (b) Vans 3 and 4; (c) Vans 5 and 6; (d) Aircraft A and B. | 15-18 |
| 7. | Traverses of Van 2 in Test 117 at different times during sampling period 10.36–12.23 hr, and the common Eulerian track (solid line). | 20 |
| 8. | Traverses of Van 3 in Test 117 at different times and the common Eulerian tracks (solid lines) during sampling periods: (a) 10.28–11.64 hr, and (b) 11.82–12.42 hr | 21 |
| 9. | Variations of processed concentrations and their average value over the time period 10.41–10.91 hr versus travel distance along the Eulerian track for Van 3 in Test 117. | 22 |
| 10. | Traverses of Van 4 in Test 117 at different times during sampling periods 10.91–11.71 hr and 12.10–12.27 hr, and the common Eulerian tracks (solid lines). | 23 |
| 11. | Traverses of Van 6 in Test 117 at different times during sampling period 11.05–11.31 hr, and the common Eulerian track (solid line). | 23 |

LIST OF FIGURES (contd.)

| <u>Figure</u> | | <u>Pages</u> |
|---------------|---|--------------|
| 12. | Traverses of tracer-sampling platforms used in MVP Test 209. The label at top left inside each figure gives the Test number and the platform label: (a) Vans 1 and 2; (b) Vans 3 and 4; (c) Vans 5 and 6; (d) Aircraft A and B. | 25-28 |
| 13. | Traverses of Van 1 in Test 209 at different times and the common Eulerian tracks (solid lines) during sampling periods: (a) 16.75–17.24 hr, (b) 17.28–17.72 hr, (c) 17.81–18.31 hr, (d) 18.37–18.67 hr, and (e) 18.72–19.08 hr. | 29-31 |
| 14. | Traverses of Van 3 in Test 209 at different times during sampling period 18.01–18.88 hr, and the common Eulerian track (solid line). | 33 |
| 15. | Traverses of Van 6 in Test 209 at different times during sampling period 18.32–19.00 hr, and the common Eulerian track (solid line). | 33 |
| 16. | Variations of processed concentrations and their average value over the time period 18.01–18.51 hr versus travel distance along the Eulerian track for Van 3 in Test 209. | 34 |
| 17. | Traverses of tracer-sampling platforms used in MVP Test 216. The label at top left inside each figure gives the Test number and the platform label: (a) Vans 1 and 2; (b) Vans 3 and 4; (c) Vans 5 and 6; (d) Aircraft A and B. | 35-38 |
| 18. | Traverses of Vans 3 and 5 in Test 216 at different times during sampling period 13.22–13.49 hr, and the common Eulerian track (solid line). | 39 |
| 19. | Variations of processed concentrations and their average value over the time period 13.22–13.49 hr versus travel distance along the Eulerian track for Vans 3 and 5 in Test 216. | 40 |
| 20. | Traverses of Van 4 in Test 216 at different times during sampling period 14.48–15.38 hr, and the common Eulerian track (solid line). | 42 |
| 21. | Traverses of Van 6 in Test 216 at different times during sampling period 13.74–14.22 hr, and the common Eulerian track (solid line). | 42 |
| 22. | Traverses of tracer-sampling platforms used in MVP Test 306. The label at top left inside each figure gives the Test number and the platform label: (a) Vans 1 and 2; (b) Vans 3 and 4; (c) Vans 5 and 6; (d) Aircraft A and B. | 43-46 |
| 23. | Traverses of Van 1 in Test 306 at different times and the common Eulerian tracks (solid lines) for sampling periods: (a) 10.09–11.03 hr, (b) 11.12–11.85 hr, and (c) 11.95–12.79 hr. | 47-48 |

LIST OF FIGURES (contd.)

| <u>Figure</u> | | <u>Pages</u> |
|---------------|---|--------------|
| 24. | Traverses of Van 3 in Test 306 at different times during sampling period 10.18–12.28 hr, and the common Eulerian track (solid line). | 49 |
| 25. | Traverses of Van 4 in Test 306 at different times and the common Eulerian tracks (solid lines) during sampling periods: (a) 10.53–10.97 hr, (b) 11.14–11.54 hr, (c) 11.54–12.08 hr, and (d) 12.47–12.92 hr. | 51-52 |
| 26. | Traverses of Van 5 in Test 306 at different times and the common Eulerian tracks (solid lines) during sampling periods: (a) 10.29–10.78 hr, (b) 10.83–11.32 hr, (c) 11.43–11.96 hr, and (d) 12.13–12.66 hr. | 53-54 |
| 27. | Traverses of Van 6 in Test 306 at different times and the common Eulerian tracks (solid lines) during sampling periods: (a) 10.46–10.99 hr, (b) 11.11–11.67 hr, and (c) 12.33–12.79 hr. | 55-56 |
| 28. | Variations of processed concentrations and their average value over the time period 12.33–12.79 hr versus travel distance along the Eulerian track for Van 6 in Test 306. | 57 |
| 29. | Traverses of tracer-sampling platforms used in MVP Test 304. The label at top left inside each figure gives the Test number and the platform label: (a) Vans 1 and 2; (b) Vans 3 and 4; (c) Vans 5 and 6; (d) Aircraft A and B. | 58-61 |
| 30. | Traverses of Van 1 in Test 304 at different times during sampling period 10.96–12.72 hr, and the common Eulerian track (solid line). | 63 |
| 31. | Traverses of Van 3 in Test 304 at different times during sampling period 10.48–12.33 hr, and the common Eulerian track (solid line). | 63 |
| 32. | Variations of processed concentrations and their average value over the time period 12.28–12.72 hr versus travel distance along the Eulerian track for Van 1 in Test 304. | 64 |
| 33. | Traverses of Van 5 in Test 306 at different times and the common Eulerian tracks (solid lines) during sampling periods (a) 10.55–11.52 hr, and (b) 11.58–12.29 hr. | 65 |
| 34. | Traverses of Van 6 in Test 304 at different times during sampling period 11.00–12.64 hr, and the common Eulerian track (solid line). | 66 |

LIST OF TABLES

| <u>Table</u> | | <u>Page</u> |
|--------------|---|-------------|
| 1. | Tracer Release Information for Selected MVP Tracer Tests. | 5 |
| 2. | Processed Tracer Concentration Data File 110C1ALL.DAT. | 81 |
| 3. | Time-Averaged Concentration Data File 110A1-2.DAT. | 82 |
| 4. | Surface Concentration Data Files of the Tests Processed from MVP Session 1. | 83 |
| 5. | Surface Concentration Data Files of the Tests Processed from MVP Session 2. | 84 |
| 6. | Surface Concentration Data Files of the Tests Processed from MVP Session 3. | 85 |

PROCESSING OF SURFACE CONCENTRATION DATA FROM TRACER RELEASES IN MVP SESSIONS 1, 2, 3 AT CAPE CANAVERAL, FLORIDA

K. Shankar Rao

ABSTRACT. Near-instantaneous concentration measurements by mobile vans of SF₆ tracer gas released from different locations and heights at Cape Canaveral, FL, during Sessions 1, 2, 3 of the Model Validation Program (MVP) field experiments were processed to derive single-pass and time-average surface concentrations at virtual receptors located on common tracks. The three sessions were conducted during different seasons of 1995 and 1996. The tracer was sampled using continuous fast gas analyzers installed in two aircraft as well as six passenger vans moving on available roadways downwind of the tracer release (source) locations. The tracer measurements and associated meteorological data were stored in the MVP archive housed at ATDD. Two tracer tests, one with an elevated release and the other with a near-surface release, were selected for each session for the data analyses described in this report.

Several computer software programs were developed to read and process the raw data from the MVP archive, to interpolate the mobile van-sampled "Lagrangian" concentrations to receptors located on a common fixed "Eulerian" track, and to calculate and store the single-pass and half-hour average concentrations at these receptors. This report describes the procedure used to derive the time-space history of the concentration field and half-hour average concentrations for six tracer tests. The processed concentration data for the six tests were stored in the MVP archive in a separate directory.

This report illustrates and explains how the raw tracer data were processed to derive the surface concentration fields and time-averaged concentrations. This document, including the computer programs listed in Appendix I, is intended to demonstrate and guide potential users in processing the archived MVP data for other tracer tests for their research and related applications.

1. INTRODUCTION

The Atmospheric Dispersion Model Validation Program (MVP) was sponsored by the Launch Program Office of the Air Force Space and Missile Systems Center (SMC/CL). Its primary mission is to test, improve, and validate the performance of the Rocket Exhaust Effluent Diffusion Model (REEDM), which is used by the U.S. Air Force to predict the atmospheric dispersion of very large buoyant clouds resulting from rocket launches in order to minimize their environmental impacts (Kamada *et al.*, 1997; Start and Kamada, 2001). The MVP was designed to collect, archive, and analyze on-site launch cloud and tracer dispersion data to evaluate and improve the performance of REEDM (see Eckman *et al.*, 1996) and other atmospheric plume dispersion codes (Hosker *et al.*, 1993), such as RAMS/HYPACT (e.g., Evans and Tremback,

1996), for use at the rocket launch ranges on the east and west coasts in the U.S. In addition, MVP will also extend our knowledge about pollutant transport and turbulent diffusion phenomena in coastal settings. The data and results from this program will be of great benefit in various applications since much of our nation's population, business and commerce are located near the coastlines, and it is essential to assure the public that its health, safety, and economic interests are being safeguarded.

In contrast to most previous atmospheric dispersion studies, which obtained data at fixed *in situ* samplers at the ground-level (e.g., Rao *et al.*, 1991a), the MVP collected extensive meteorological, tracer releases, and concentration sampling data throughout the atmospheric boundary layer and above to altitudes of 1200 m MSL (Start and Kamada, 2001). Two highlights of these activities are: (1) the first set of SF₆ releases from a hovering blimp, which were tracked and sampled during seasonally varying meteorological conditions, and (2) the first use of multiple, narrow-band infrared cameras to measure along and crosswind dispersion rates for elevated, otherwise invisible, SF₆ puffs (Abernathy *et al.*, 1999). Fast-response gas analyzers mounted on mobile vans and aircraft were used extensively to monitor both ground and elevated releases.

This report presents the methodology of processing the near-instantaneous surface concentration measurements for six tracer tests selected from the three MVP sessions at Cape Canaveral, FL. The plots and analyses given in this report are intended for use in obtaining the concentration data necessary for developing and evaluating models of pollutant transport and dispersion in coastal environments, and for aiding interested researchers in the processing of archived MVP tracer data sampling for other tests.

2. MVP TRACER EXPERIMENTS AT CCAS

The Cape Canaveral Air Station (CCAS) and Kennedy Space Center (KSC) region is located on the eastern shore of the central Florida peninsula. High temperatures and moisture characterize this marshy subtropical region. In summertime, the contrast in sensible heat flux from water to land is strong enough to drive a sea breeze by mid-morning. The latent heat flux dominates the surface energy budget, since much of the solar energy is expended in evaporating water. The rapidity of sea breeze onset and its strength largely depend on the soil moisture, largely determined by the recency of rains.

Local terrain height at CCAS varies just tens of meters from the MSL over the surrounding domain, and does not significantly influence the local winds or turbulence. However, the surface canopies at the launch sites vary greatly, so that local flows vary with wind direction. Westward advecting flow encounters several transitions from land to inland waterway to land to marshy wetlands and onto the vegetated Florida mainland, as shown in Figure 1. These thermal and dynamic transitions alter the horizontal and vertical flow fields and turbulence throughout the diurnal cycle. The easterly sea breeze at CCAS opposes the westerly zonal flow. This creates forceful convergence zones, complex boundary layers cumulus afternoon thunderstorms (Start and Hoover, 1995; Kamada *et al.*, 1997). The interaction of the strong sea breeze front and

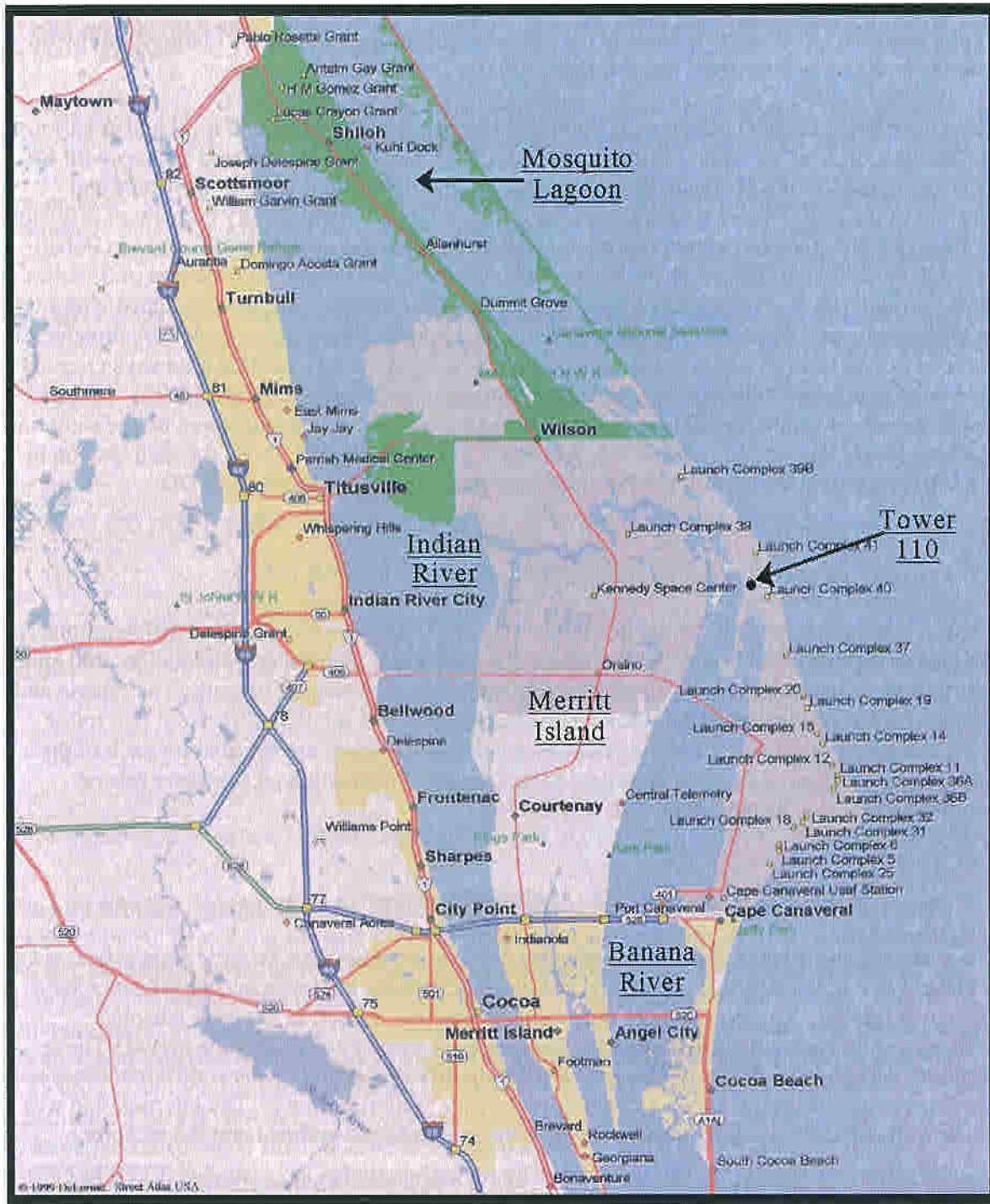


Figure 1. Cape Canaveral and vicinity of interest for MVP tracer experiments. Merritt Island, and the local rivers and highways are shown. Tower 110 is used as reference point for analysis of tracer sampling data.

updrafts produced by the horizontal convergence zone over Merritt Island between mainland and Cape Canaveral (see Figure 1) leads to the formation of north-south band of large cumuli with bases near 600 m height (Start and Kamada, 2001).

Short duration puffs and continuous plumes of SF₆ were released at ground level and at various elevations aloft from an airship (blimp) over the CCAS/KSC region. Infrared sensors with SF₆ filters were used to image the invisible tracer puffs and plumes to document the shape and location of the initial tracer source and to record the tracer plume trajectory and rate of diffusion in the near field. One or two aircraft equipped with SF₆ fast gas analyzers (FGA) and Global Positioning System (GPS) receivers tracked the dispersing puff/plume to distances of 25 miles or more. Ground-level concentrations were measured by six mobile vans, also equipped with FGA and GPS receivers. Based on the wind direction and release height, these vans were directed to move back and forth (for data replication) on specific segments of available roadways crossing the plume path where non-zero surface concentrations were expected. These nearly instantaneous concentration data files for all tests were distinguished and stored by the sampling platform label (Van 1 = 1, ..., Van 6 = 6, Aircraft 1 = A, and Aircraft 2 = B) for each session in the MVP data archive (in `pub/MVP/data/TracrObs` directory) housed at ATDD.

3. PROCESSING OF SURFACE TRACER DATA

The tracer experiments in the three MVP Sessions at CCAS were conducted at different times of the year to capture some aspects of the seasonal variations in atmospheric circulations and study their influence upon the transport and turbulent diffusion of airborne effluents. The release and meteorological conditions of the sessions are discussed in this section. Data from two tracer tests, one a near-surface release and the other an elevated release, are selected for each of the three sessions for processing as described in this report. Information on the tracer release conditions for the selected tests is listed in Table 1.

3.1 Analysis Procedure

The surface concentration data for the selected MVP tracer tests (see Table 1) were processed at ATDD. For a given test, this processing consisted of plotting the traverses of each van over a given time period. This was done to determine its location as well as to verify adequate replication of measurements over nearly the same track during a specific time period. These "Lagrangian" concentrations observed over slightly differing spatial paths at different times were then interpolated to receptors on a common stationary "Eulerian" track. The interpolation was linear with respect to spatial distance between the point of measurement and the receptor.

For the processed tests, plots of individual traverses of each van at different times in a sampling period as well as their common track are presented below. Several computer programs were developed for processing the nearly instantaneous concentration sampling data stored in the MVP archive. These programs are listed in Appendix I. The latitude/longitude GPS coordinates of the vans were converted to Cartesian coordinates X (distance east) and Y (distance north) and used in the traverse plots. Meteorological tower 110 was utilized as the reference point O

($X_o=50$ km, $Y_o=30$ km) for this conversion. The processed concentration files were stored in the **SfcCon** and **SfcConAv** directories (under **pub/MVP/data/TracrObs/Processd** directory) in the MVP archive.

Table 1. Tracer Release Information for Selected MVP Tracer Tests.

| Tracer Test Number | Julian Day Date | Release Time Period Local Time GMT | Source Location Lat/Lon (deg) Height (m MSL) |
|--------------------|-------------------------|--|--|
| 110 | 204 23 July 1995 | 13:30 - 14:57 EDT 17:30 - 18:57 GMT | SLC 37 28.5325, - 80.5665 1 |
| 117 | 208 27 July 1995 | 10:00 - 12:00 EDT 14:00 - 16:00 GMT | Tower 110 28.5675, - 80.5870 150 |
| 209 | 310 6 November 1995 | 16:22 - 18:56 EST 21:22 - 23:56 GMT | SLC 37 BH roof 28.5296, - 80.5679 20 |
| 216 | 314 10 November 1995 | 12:55 - 15:17 EST 17:55 - 20:17 GMT | 300 m S of SLC 37 28.5270, - 80.5680 457 |
| 304 | 119 28 April 1996 | 10:00 - 12:00 EDT 14:00 - 16:00 GMT | SLC 37 28.5333, - 80.5668 305 |
| 306 | 120 29 April 1996 | 09:45 - 12:30 EDT 13:45 - 16:30 GMT | UCS 26 28.4600, - 80.5917 8 |

Directory **SfcCon** contains the files of surface tracer concentration (in parts per trillion) data processed by ATDD. Each file gives the temporal and spatial variation of concentrations of each van, i.e., the spatial variation (on a common Eulerian track, defined by its coordinates XE and YE in km) of concentrations at discrete sampling times over a selected time period. The file naming notation is as follows: a file named 110C3-1A.DAT denotes Test 110, concentration data of Van 3, and Eulerian track 1. The suffix A distinguishes the file for time period A (13.90–14.35 EDT) from the file for time period B (14.81–15.18 EDT), both for track 1. Most concentration files do not have such suffixes. Some files include data of a van for all times for the same reference track; such files are designated as *ALL.DAT or *AL.DAT; e.g., file 216C35AL.DAT includes concentration data for all sampling times for Vans 3 and 5 for Test 216.

Average concentrations over an approximately half-hour time period are derived from the processed concentrations described above, and stored in the **SfcConAv** directory. Some average concentrations are for less than 30-min time periods, while a few are for more; this averaging

period, which is determined by the available van sampling times, is indicated in each file. The file naming notation is similar to that described above, except that "A" (to indicate average concentrations) replaces the letter "C".

3.2 Session 1 (17 July - 1 August, 1995)

The local meteorology during MVP Sessions 1 to 3 was described by Parks (1998). In summer, the diurnal terrestrial heat engine often leads to cumulus formation and thunderstorms over the CCAS/KSC region. The later tend to generate mesoscale turbulence, which dissipates most of the atmospheric gradients effectively. Thunderstorms or rain showers developed or moved into the study area almost every day. The synoptic scale winds during the period oscillated between the prevailing easterlies and prevailing westerlies over a period of a few days. Atlantic sea breeze and local breezes off the Indian and Banana River lagoons were often seen. Beginning and ending times and depth of these breezes were driven by the strength of the offshore wind component. In general, a stronger offshore wind component caused the local breezes to begin later and end earlier, and have a shallower circulation. Thunderstorms developed primarily in the convergence zones associated with these breezes. At times, the thunderstorm outflows seemed to complicate the wind fields. It should be emphasized that the general comments given above on the relationships of the dynamics to the meteorological factors were educated conjectures based on limited observations, and not rigorously established from the MVP data set, theory, or numerical simulations.

During the period 17 through 31 July 1995, there were 21 plumes plus 9 large puff releases of SF₆ tracer gas at CCAS. The tracer was often released in clear daytime skies above the more turbulent lower portion of the sea breeze. This probably led to fast-moving narrow ribbons of tracer that slowed only at the upwind edge of the cumulus convergence zone. Ribbons that entered the convergence zone were often disrupted by thermal updrafts and cumulus induced circulations (Start and Hoover, 1995). The disruptions were often so strong that SF₆ was not detected downwind of the convergence zone at all, or only as a widely dispersed horizontal distribution. Diffusion during morning pre-sea breeze releases was quite modest. The post-storm and evening diffusion tended to be generally weak as well. Data were collected during onshore, offshore, and sea breeze transition flow conditions. There was only one tracer release (Test 105) in Session 1 that had no tracer measurements by the vans or aircraft.

3.2.1 Surface release

Test 110 was selected as the surface release case for Session 1. The tracer was released at a height of 1 m on the blimp mast at SLC 37 (see Table 1) at a mean rate of 33.83 kg/hr into the shallow sea breeze layer. The release duration was 1.45 hr starting at 13:30 EDT. A sea breeze began near noon and reached the Shuttle Landing Facility (SLF) just after 14:00 EDT, when winds shifted from SW to E. During the test, the weather was partly cloudy with mean winds of about 4 m/s from the east (80° true). No aircraft was available for airborne sampling. Vans tracked the tracer plume to the Florida mainland. Ground-level sampling on Merritt Island measured large concentrations. The number of plume-hit sampling files are listed in parentheses:

Van 1 (7), Van 2 (0), Van 3 (13), Van 4 (3), and Van 6 (3). Van 5 and aircraft A and B did not operate. The traverses of the various sampling platforms, plotted by Start (2000), are shown in Figure 2.

Figure 3 presents six traverses of Van 1, denoted by symbols 1 to 6, which represent the sampling start times during the period 14.21–15.38 hr. It can be seen that traverses 1 to 5 and most of 6 approximately overlap. An “Eulerian” track common to all six van traverses was fitted by the solid line in Figure 3. The measured “Lagrangian” concentrations of Van 1 are then linearly interpolated to stationary “Eulerian” receptors located on the common track to derive a detailed time – space history of the concentration field. The latter is stored in two separate files. File 110C1-1.DAT includes the concentrations for sampling times 14.21 hr and 14.79 hr, and file 110C1-2.DAT includes the concentrations at 4 sampling times during the period 14.88–15.38 hr. This is done for convenience to calculate two (approximate) half-hour average concentrations, which are stored as 110A1-1.DAT and 110A1-2.DAT. The averaging time periods and the number of van traverses used for averaging are indicated in each file. Examples of processed and time-averaged surface concentration data files are listed in Appendix II. Figure 4 shows variations of processed concentrations and their average value over the time period 14.88–15.38 hr versus travel distance along the Eulerian track for Van 1.

Figure 5(a) presents the traverses of Van 3 at six sampling times during the period 13.90–14.35 hr, and Track3A (solid line) denotes the common Eulerian track. Figure 5(b) shows the traverses for the same van at seven sampling times during the period 14.50–15.18 hr. It can be seen that traverses 1 and 2 in this plot are markedly different from the other five traverses in this plot. The common track for these five traverses during the period 14.81–15.18 hr is denoted as Track3B (solid line) in this figure. The sampled concentration fields for Track3A and Track3B are stored separately as 110C3-1A.DAT and 110C3-1B.DAT, and the averaged concentrations are stored as 110A3-1A.DAT and 110A3-1B.DAT.

3.2.2 Elevated release

Test 117 was selected as the elevated release case for Session 1. The tracer was released at an altitude of 150 m MSL above meteorological tower 110 (see Table 1) at a mean rate of 21.74 kg/hr into the sea breeze flow. The purpose was to examine tracer interactions, transport and diffusion in the lower sea breeze region. The release duration was 2.00 hr starting from 10:00 EDT. The prevailing winds were onshore throughout the day. The deep flow from the SE brought rain showers, and set up a convergence zone and thunderstorms on Merritt Island. The mean wind during the release was about 4 m/s from 140 and the tracer was steadily transported to NW. Vans and aircraft tracked this plume over KSC and N. Merritt Island to NE of Titusville. The number of plume-hit sampling files are listed in the parentheses: Van 1 (1), Van 2 (11), Van 3 (16), Van 4 (8), Van 6 (3), and Aircraft 1 (22). Van 5 and Aircraft 2 did not operate. The traverses of the various sampling platforms, plotted by Start (2000), are shown in Figure 6. Figure 7 presents eleven traverses of Van 2, denoted by symbols 1 to 9 plus A and B for the various sampling times during the period 10.36 – 12.23 hr. It can be seen that most of the traverses overlap several others, and a common Eulerian track (shown by the solid line) can be fitted to pass through all the points. In order to form a number of half-hour average

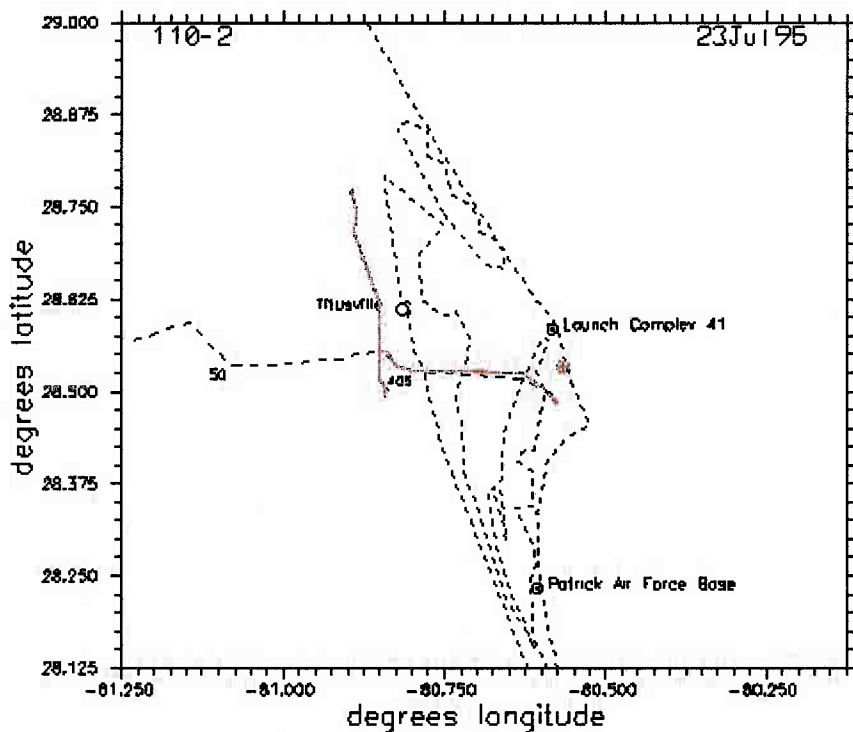
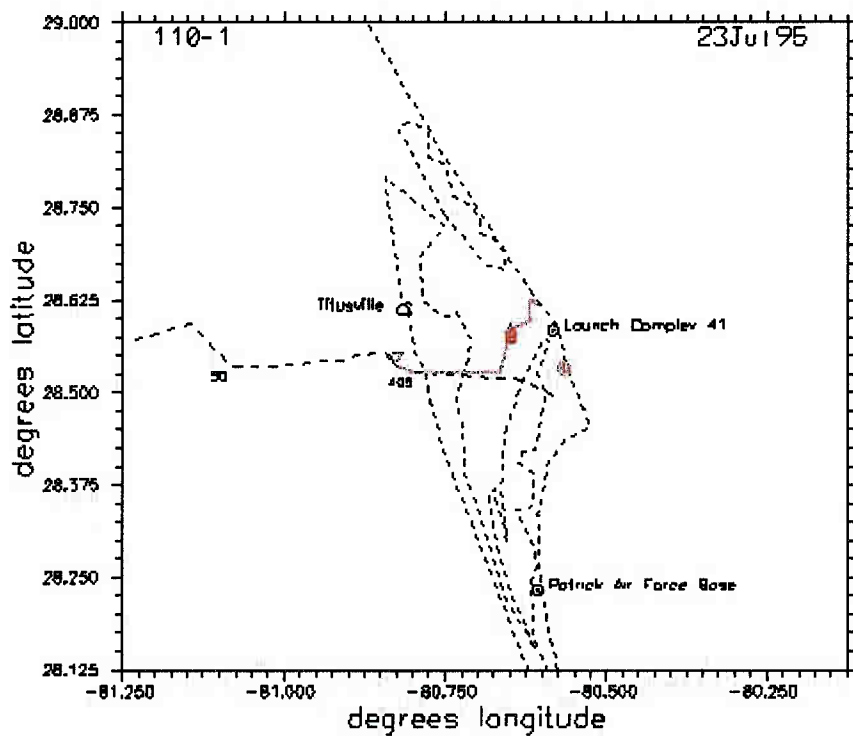


Figure 2. Traverses of tracer-sampling platforms used in MVP Test 110. The label at the top left inside of each figure gives the Test number and the platform label: (a) Vans 1 and 2.

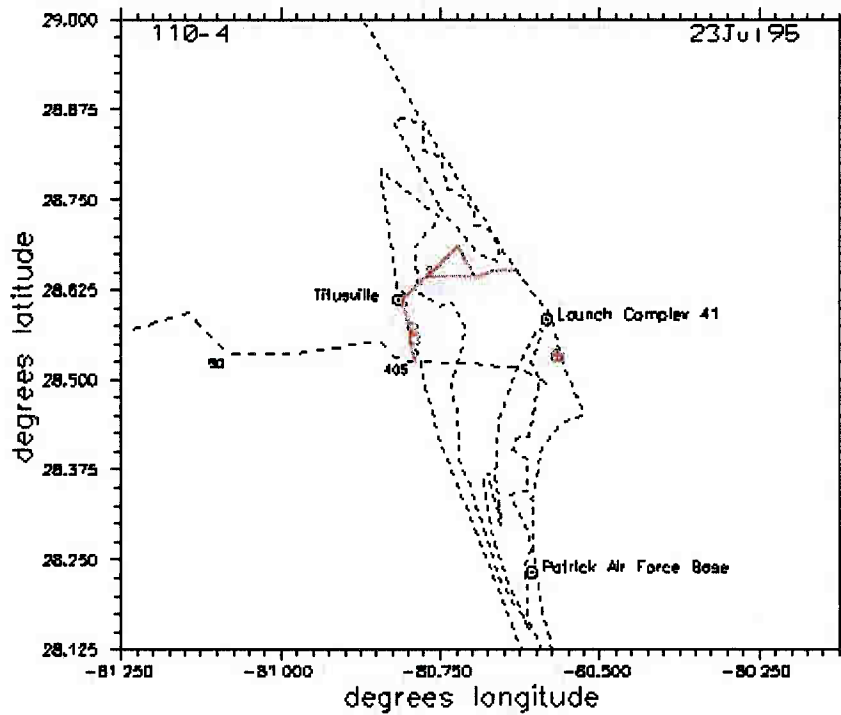
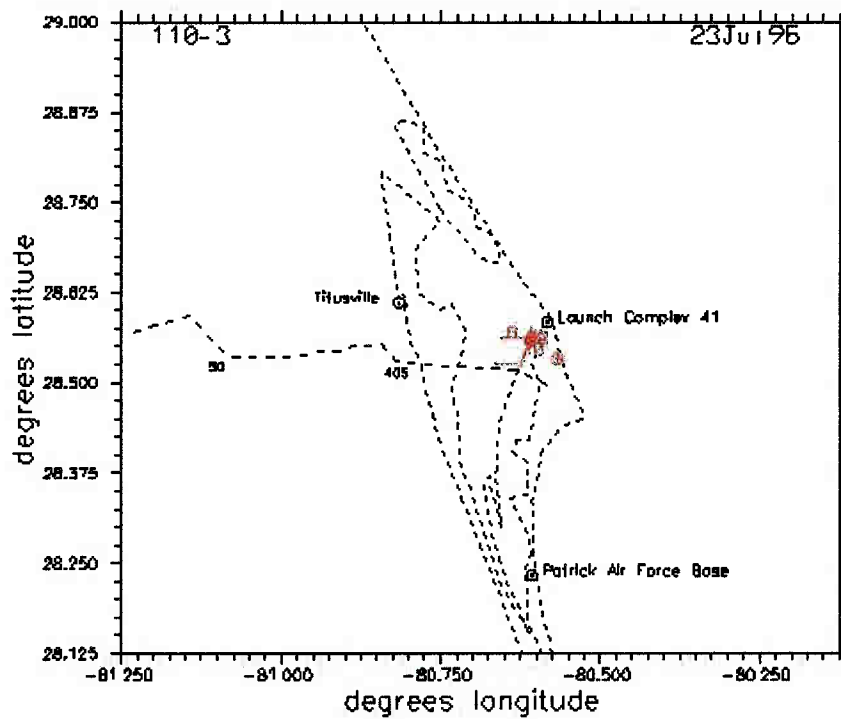


Figure 2. Continued: (b) Vans 3 and 4

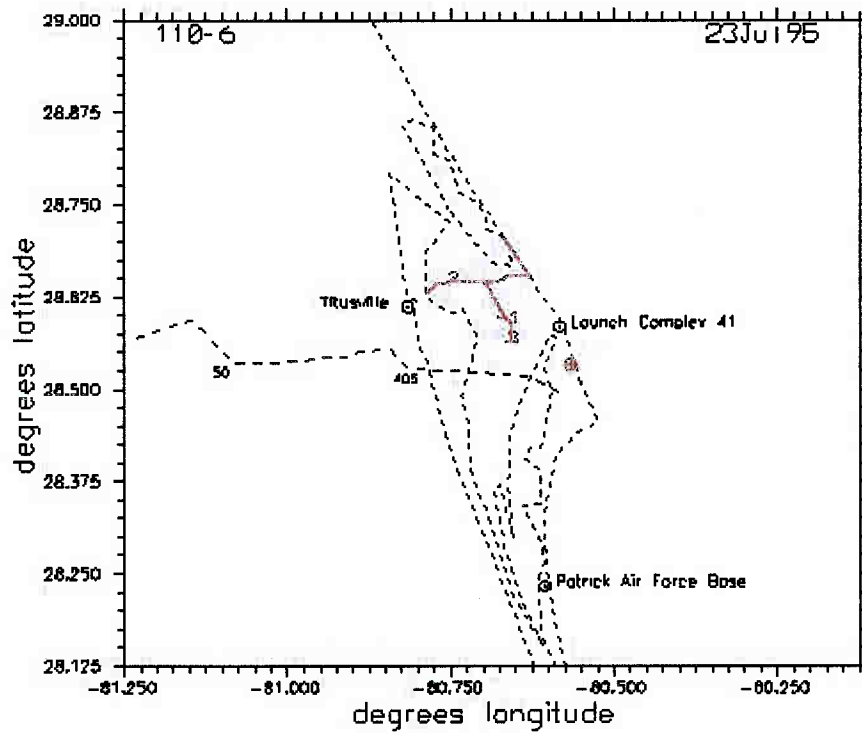
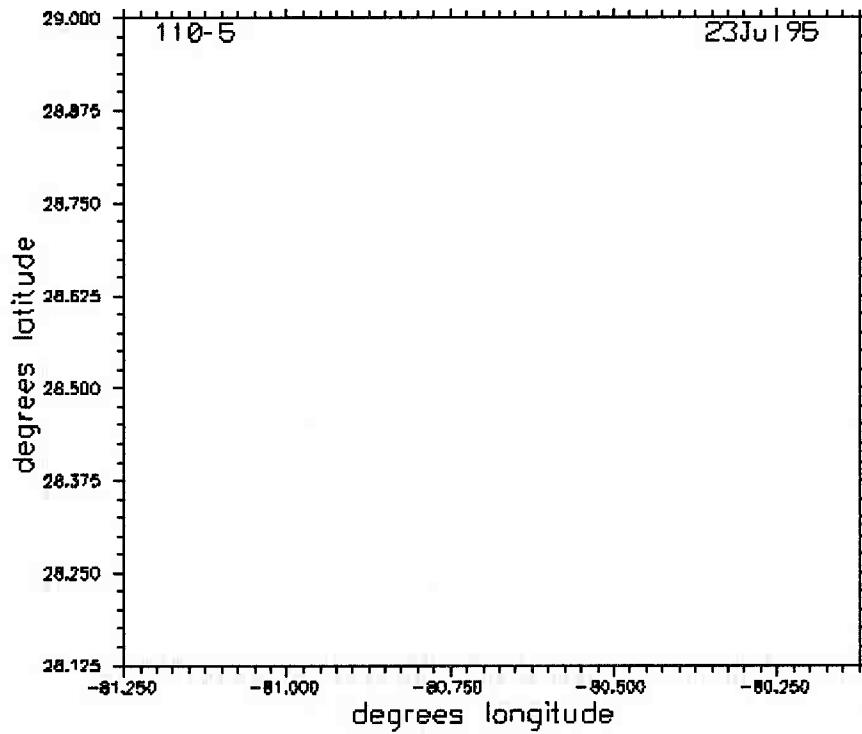


Figure 2. Continued: (c) Vans 5 and 6.

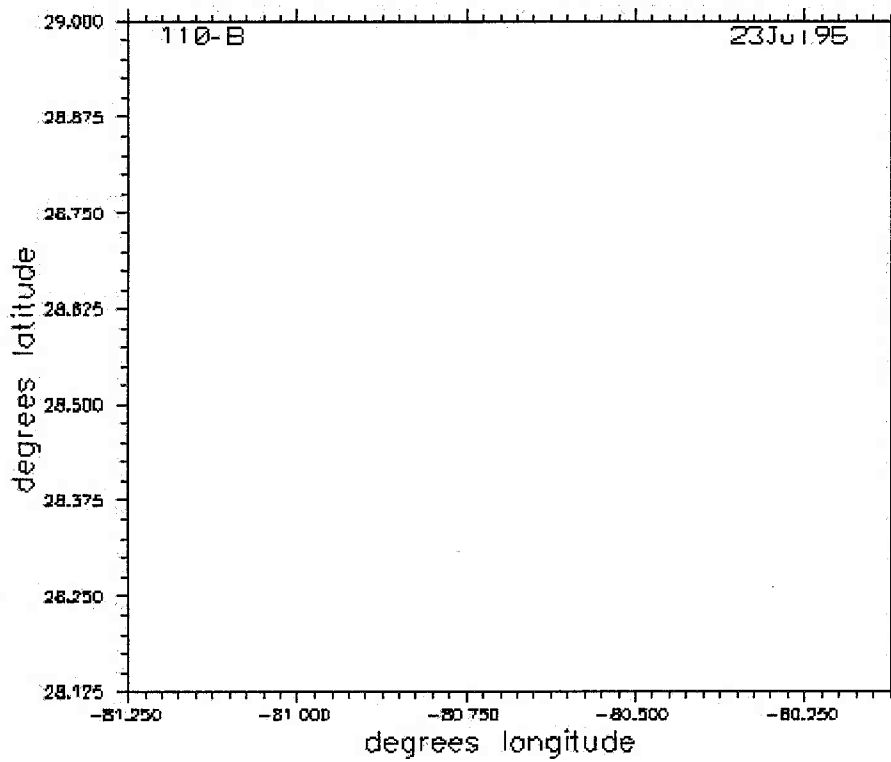
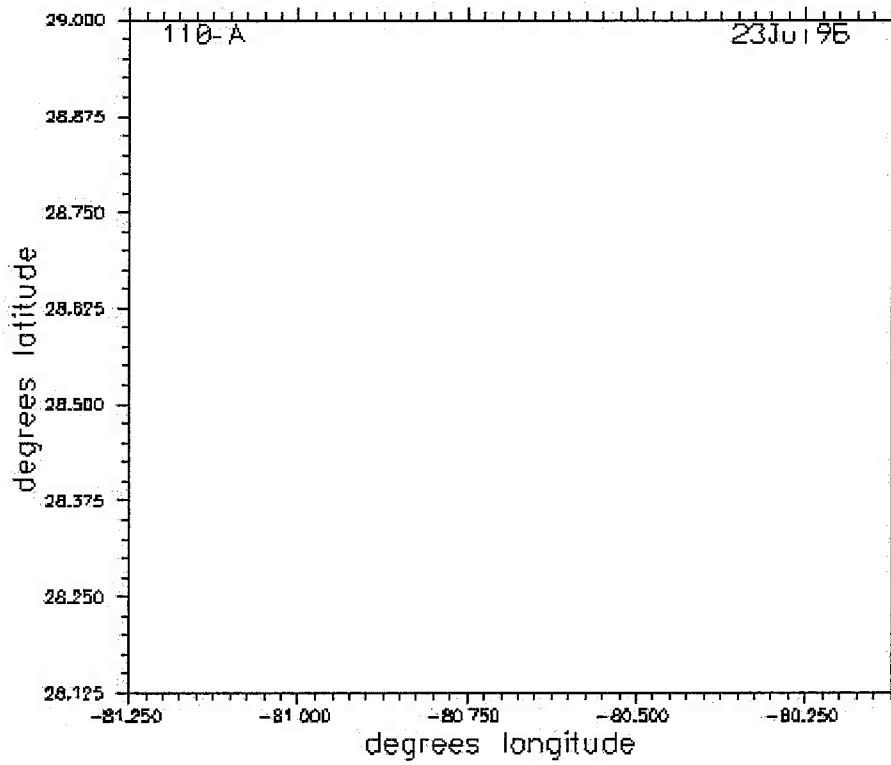


Figure 2. Continued: (d) Aircraft A and B.

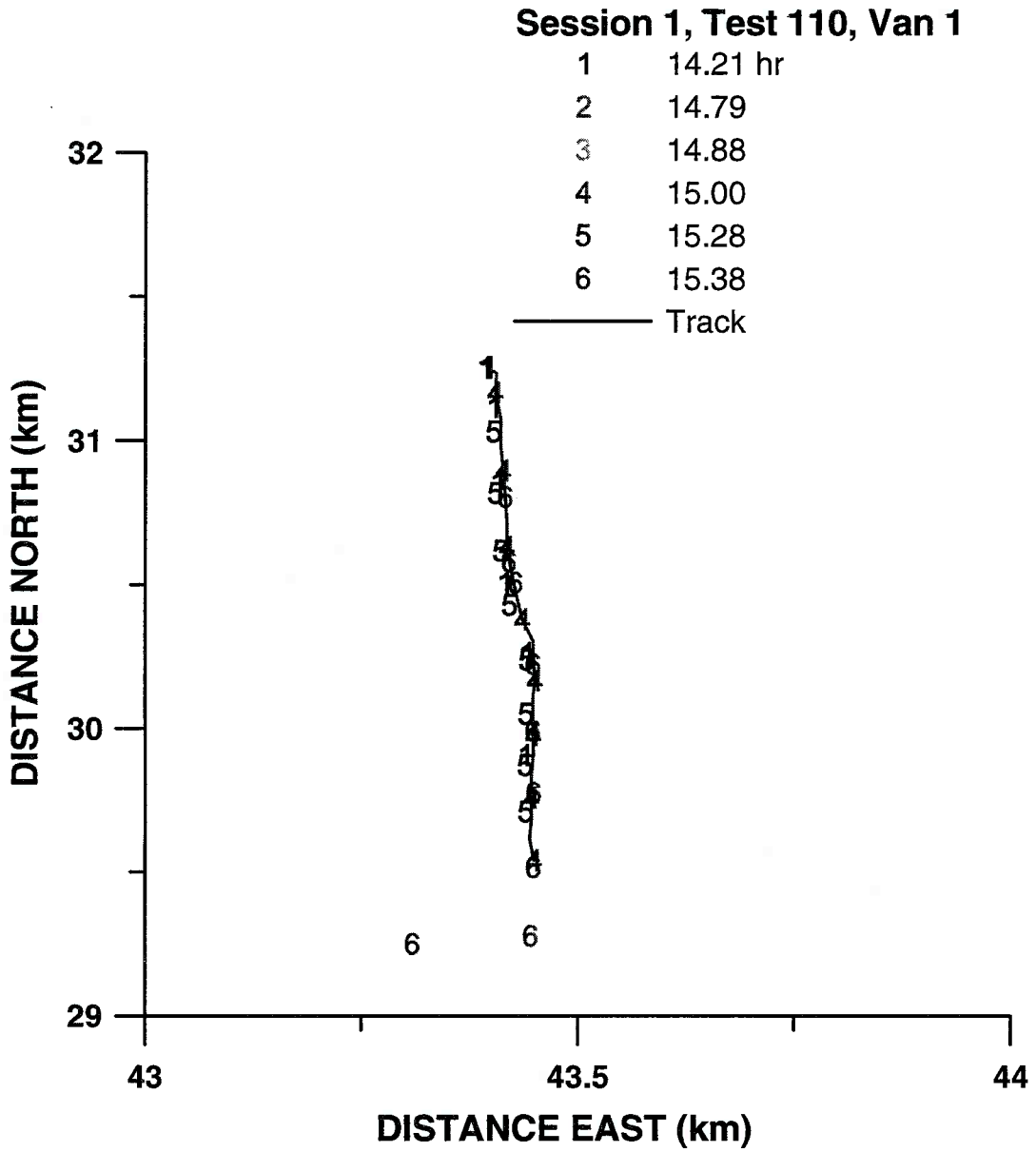


Figure 3. Traverses of Van 1 in Test 110 at different times during sampling period 14.21 - 15.38 hr, and the common Eulerian track (solid line).

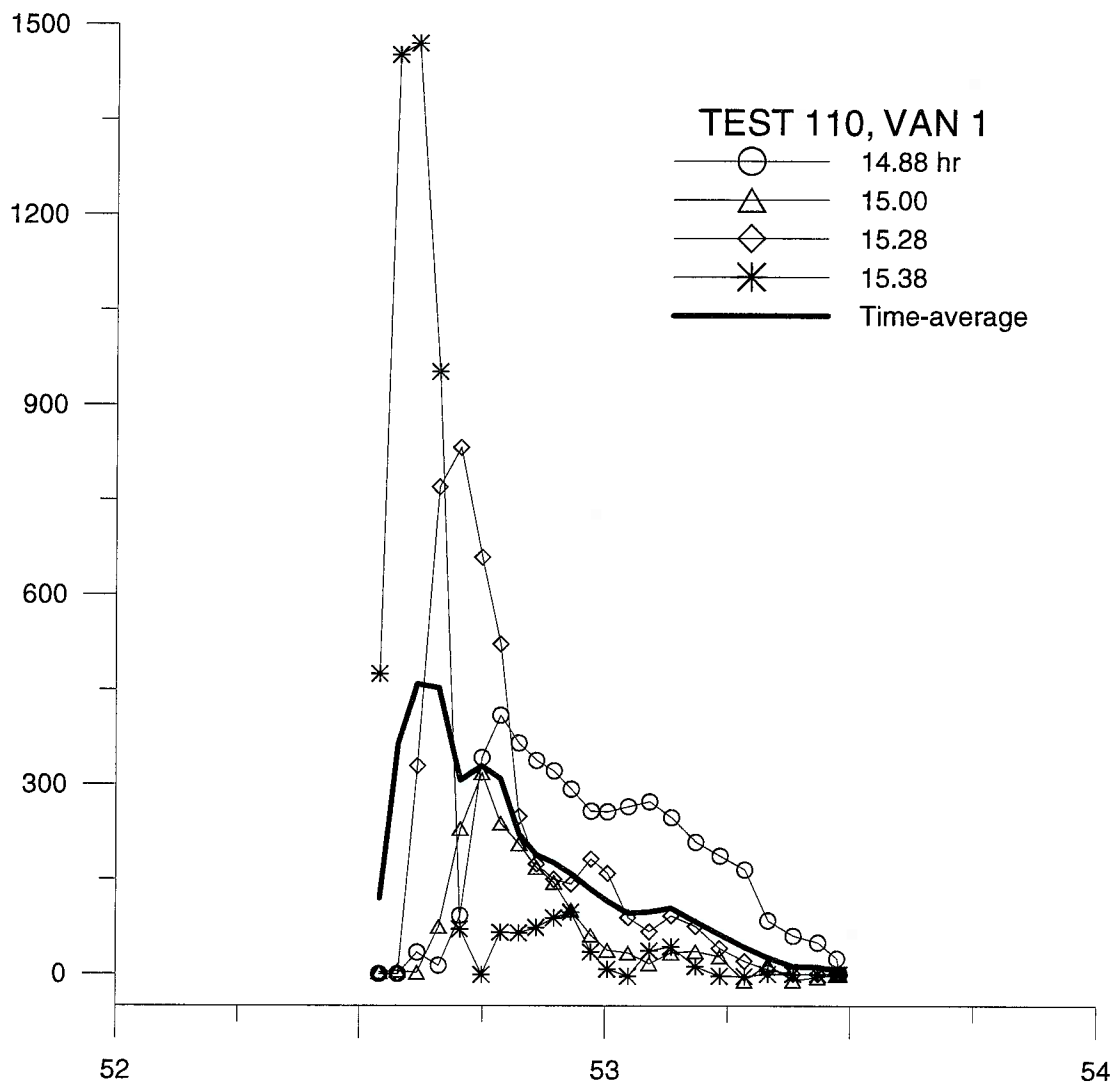


Figure 4. Variations of processed concentrations and their average value over the time period 14.88 - 15.38 hr versus travel distance along the Eulerian track for Van 1 in Test 110.

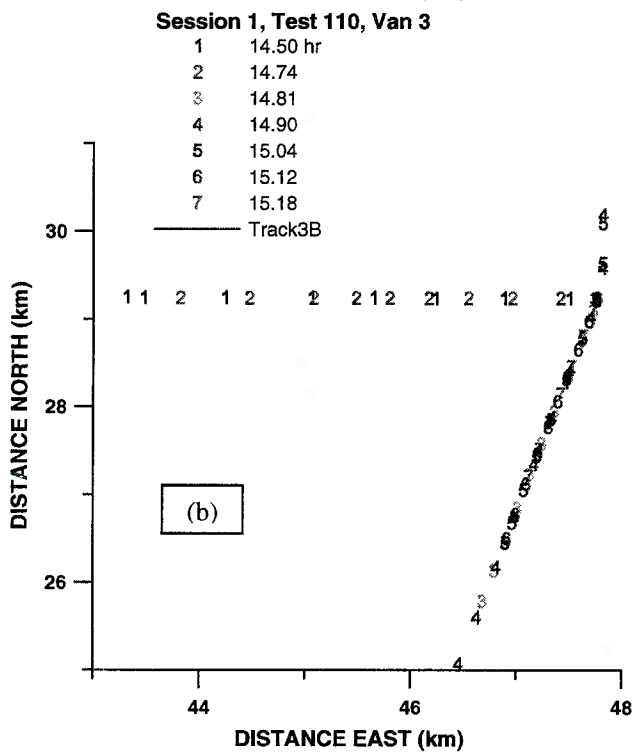
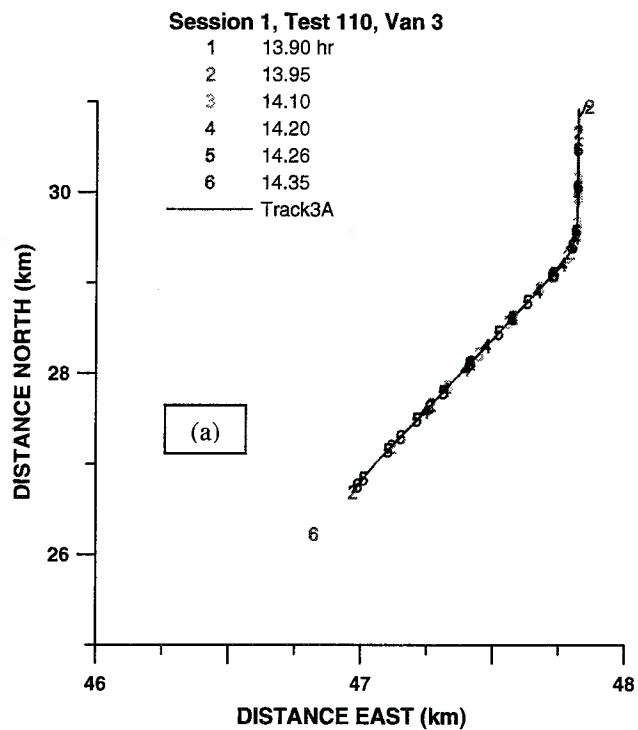


Figure 5. Traverses of Van 3 in Test 110 at different times and the common Eulerian tracks (solid lines) during sampling periods (a) 13.90 - 14.35 hr, and (b) 14.50 - 15.18 hr.

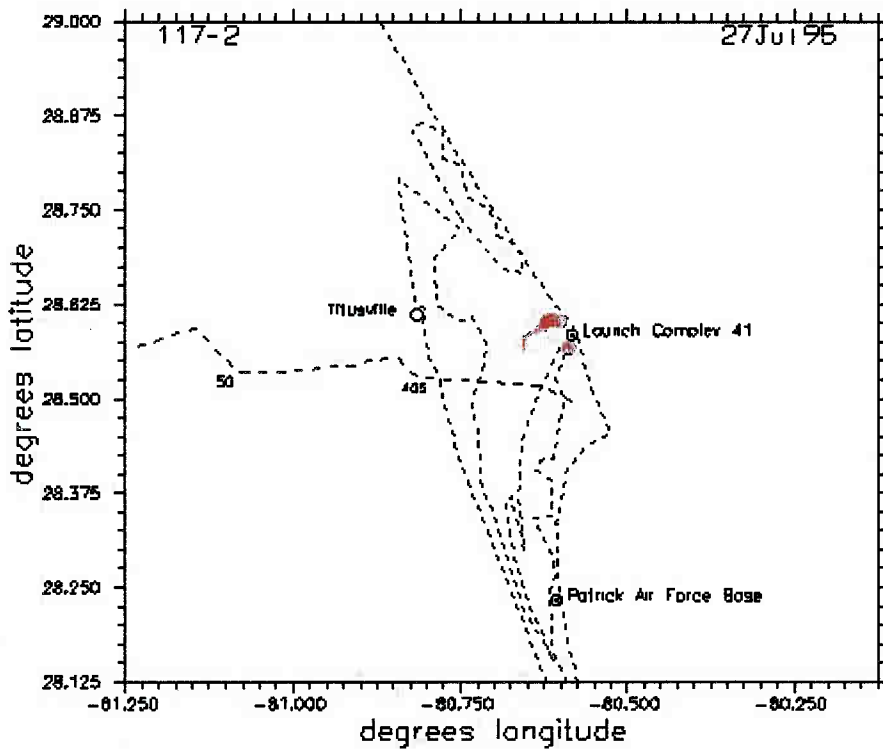
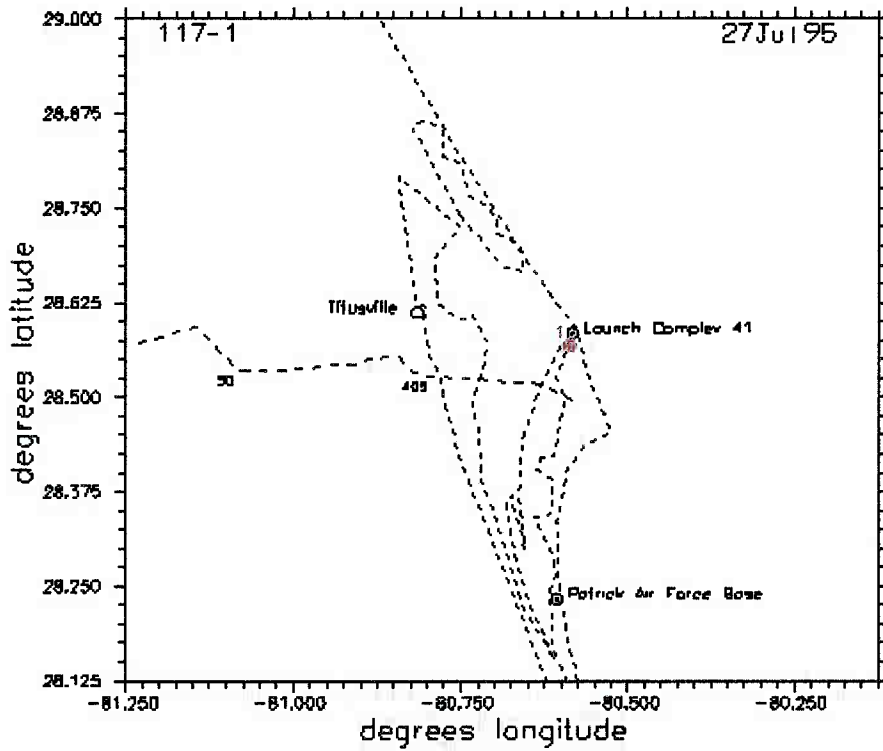


Figure 6. Traverses of tracer-sampling platforms used in MVP Test 117. The label at the top left inside of each figure gives the Test number and the platform label: (a) Vans 1 and 2.

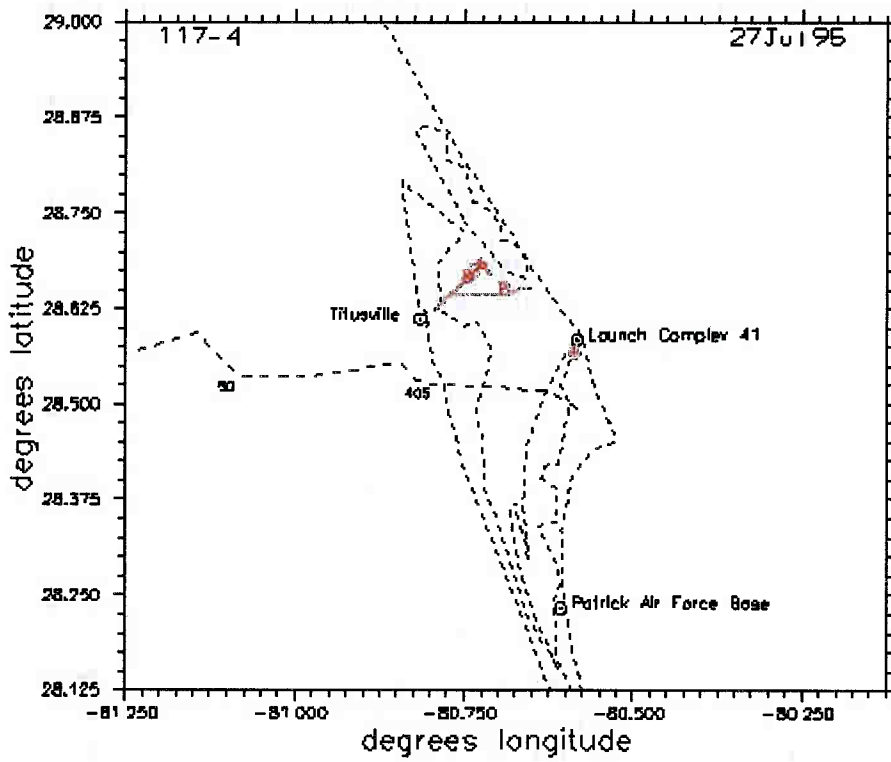
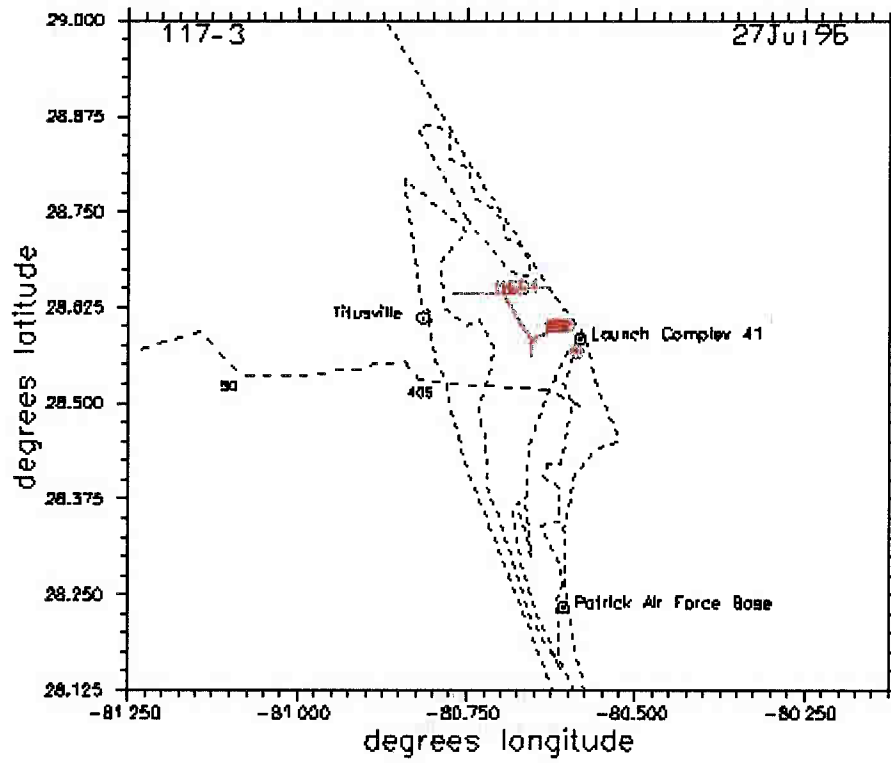


Figure 6. Continued: (b) Vans 3 and 4.

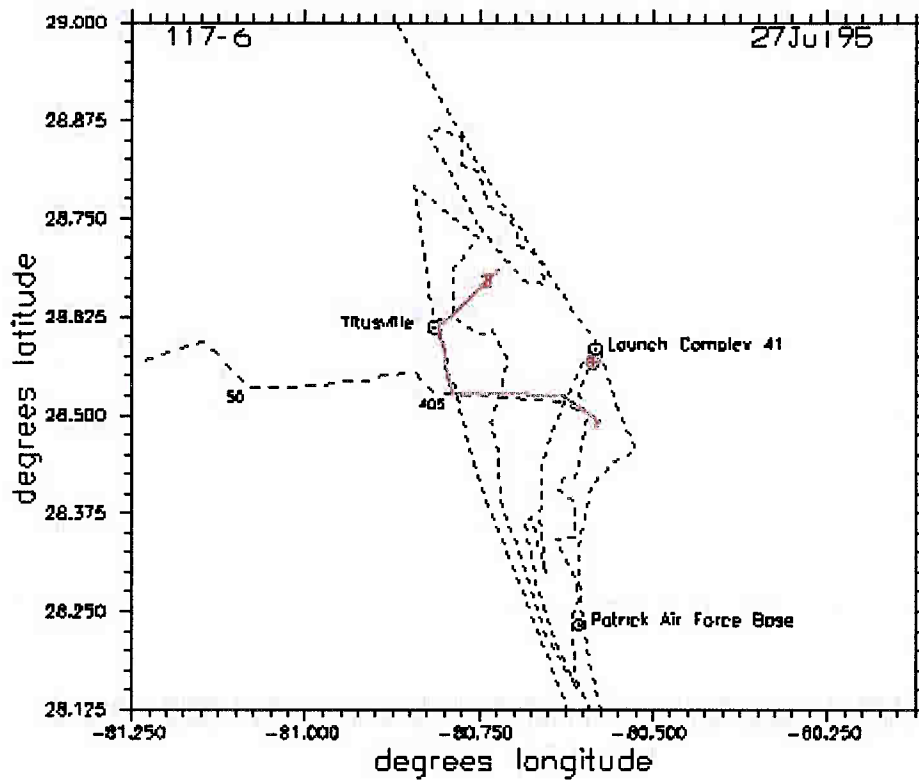
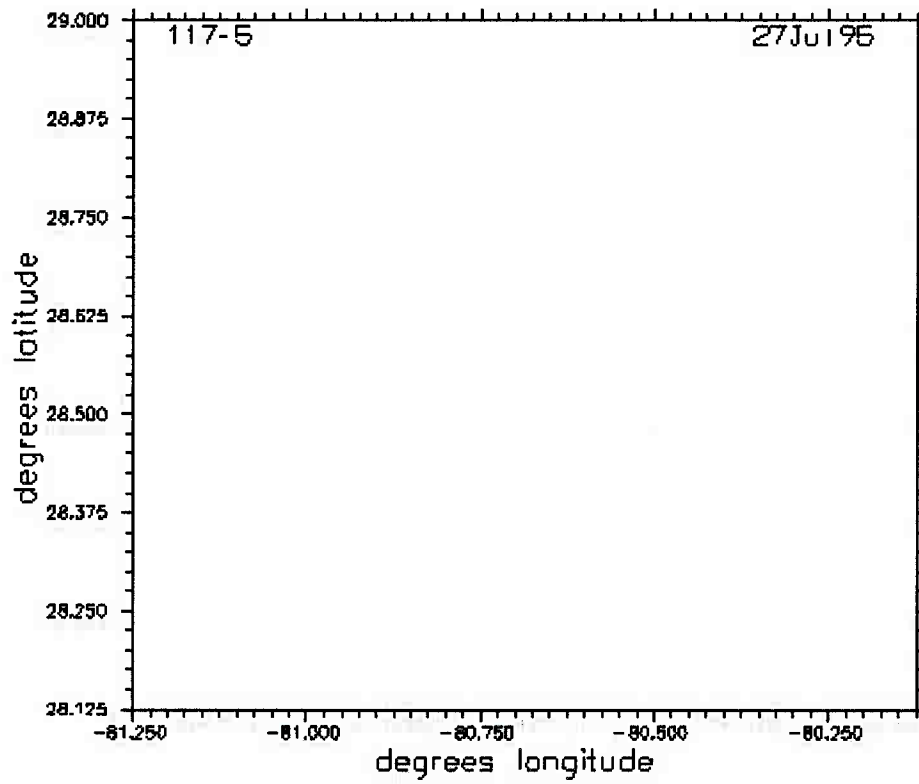


Figure 6. Continued: (c) Vans 5 and 6.

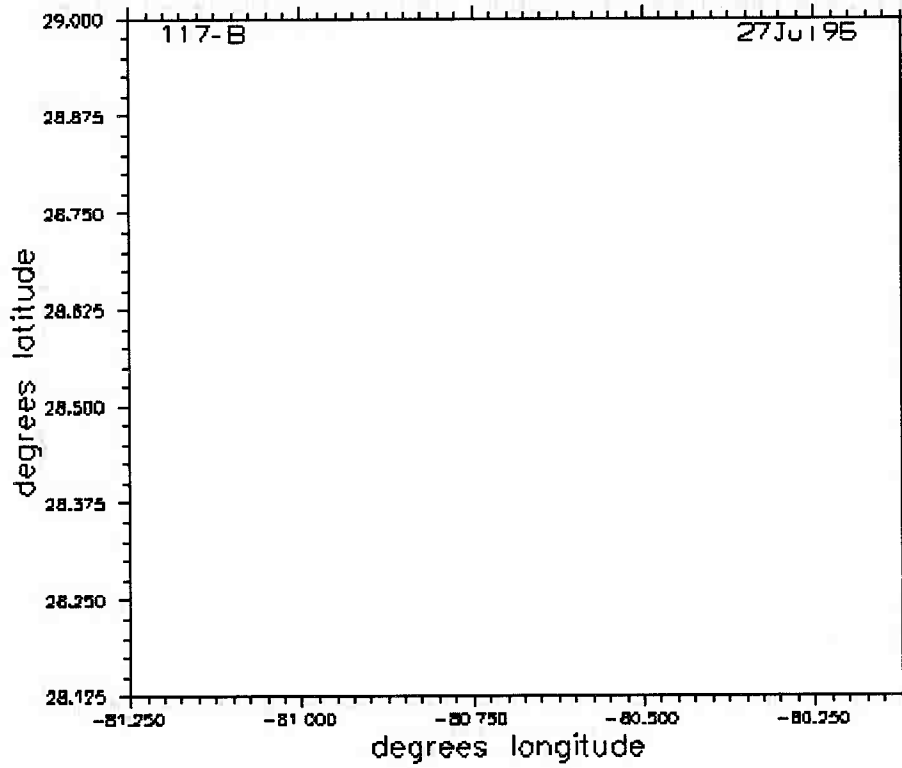
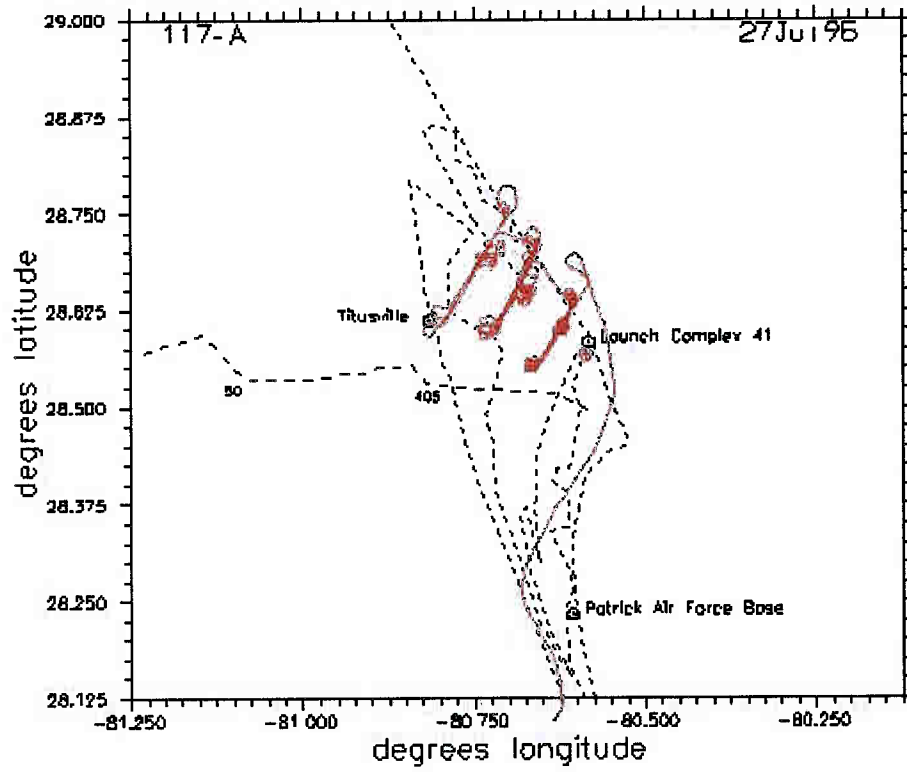


Figure 6. Continued: (d) Aircraft A and B.

concentrations, six groups are formed from the traverses, as follows: traverses 2 to 5 (10.60–11.11 hr), 4 to 7 (10.97–11.46 hr), 5 to 8 (11.11–11.68 hr), 6 to 9 (11.36–11.80 hr), 7 to A (11.46–12.02 hr), and 8 to B (11.68–12.23 hr). The sampled concentration fields for these six groups are stored separately in files 117C2-1.DAT to 117C2-6.DAT. The corresponding averaged concentrations are stored in files 117A2-1.DAT to 117A2-6.DAT. Since some of the traverses appear in more than one group, the calculated average concentrations are not entirely independent of each other. However, this grouping increases the number of observed average concentrations available for comparison to the model predictions.

Figure 8(a) shows twelve traverses of Van 3, denoted by 1 to 9 plus A to C, for various sampling times during the period 10.28–11.64 hr. The solid line shows the track common to all traverses. In order to increase the number of half-hour average concentrations, eight groups are formed from these 12 traverses, as follows: traverses 1 to 5 (10.28–10.77 hr), 2 to 6 (10.41–10.91 hr), 3 to 7 (10.53–11.03 hr), 4 to 8 (10.62–11.15 hr), 5 to 9 (10.77–11.29 hr), 6 to 10 (10.91–11.40 hr), 7 to 11 (11.03–11.53 hr), and 8 to 12 (11.15–11.64 hr). The processed concentrations for these eight groups and the corresponding averaged concentrations are stored separately, following the file notation described above. The temporal and spatial variation of the concentration field for all 12 traverses are also stored as 117C3AAL.DAT. Figure 8(b) presents traverses D to G (11.82–12.42 hr) for Van 3. The concentration field for these four traverses is stored as 117C3BAL.DAT. All traverses, except part of D, are represented by the common track (solid line) shown. The concentration field and the averaged concentration for traverses E to G (11.99–12.42 hr) are stored as 117C3-9.DAT and 117-A3-9.DAT, respectively. Figure 9 shows variations of processed concentrations and their average value over the time period 10.41–10.91 hr versus travel distance along the Eulerian track for Van 3.

Figure 10 presents eight traverses of Van 4. The first 6 traverses for time period 10.91–11.71 hr are represented by the straight solid line named Track A. Traverses 7 and 8 are represented by the solid line denoted as Track B. For averaging, three groups are formed: traverses 1 to 4 (10.91–11.38 hr), 3 to 6 (11.18–11.71 hr), and 7 and 8 (12.1–12.27 hr). The sampled concentration fields and averaged concentration of each group, referred to its Eulerian track, are calculated and stored separately. The concentration field for all six traverses is also stored. Figure 11 shows three traverses of Van 6 during the sampling period 11.05–11.31 hr and their common track (solid line). The averaging time for the calculated concentration (117A6-1.DAT) is only 0.26 hr in this case.

3.3 Session 2 (1 - 18 November, 1995)

Session 2 of MVP tracer releases at Cape Canaveral was conducted in the autumn of 1995, because thunderstorms were not as likely to occur as in summer. Stable nighttime conditions with significant surface-based inversions were expected, and dispersion under a variety of wind conditions could be explored. Ground level concentrations from elevated tracer releases during early morning hours did not become noticeable until the inversion lifted above the release height. Without intense local heating, evaporation rates were small, cumuli were mostly absent, and synoptic forces became more evident. Tracer released into the post-frontal northwesterlies

Session 1, Test 117, Van 2

| | |
|---|----------|
| 1 | 10.36 hr |
| 2 | 10.60 |
| 3 | 10.76 |
| 4 | 10.97 |
| 5 | 11.11 |
| 6 | 11.36 |
| 7 | 11.46 |
| 8 | 11.68 |
| 9 | 11.80 |
| A | 12.02 |
| B | 12.23 |

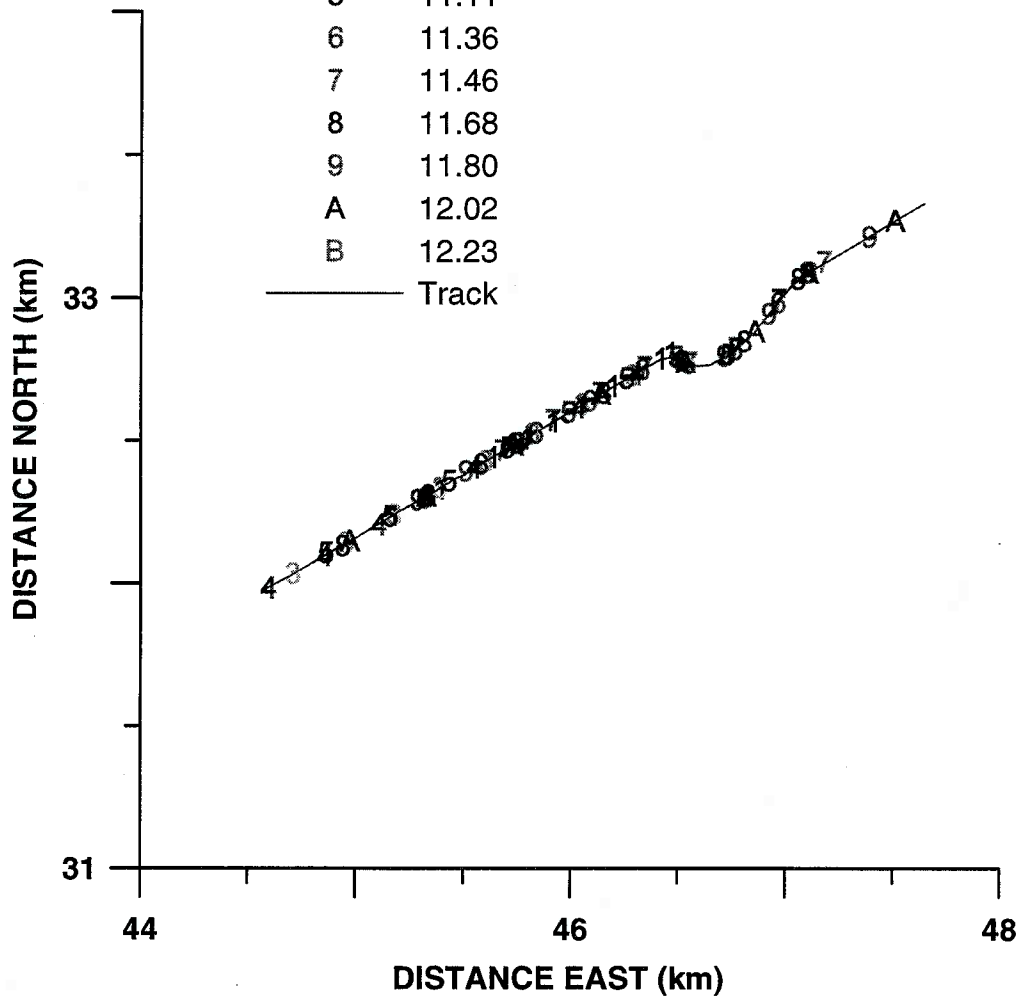


Figure 7. Traverses of Van 2 in Test 117 at different times during sampling period 10.36 - 12.23 hr, and the common Eulerian track (solid line).

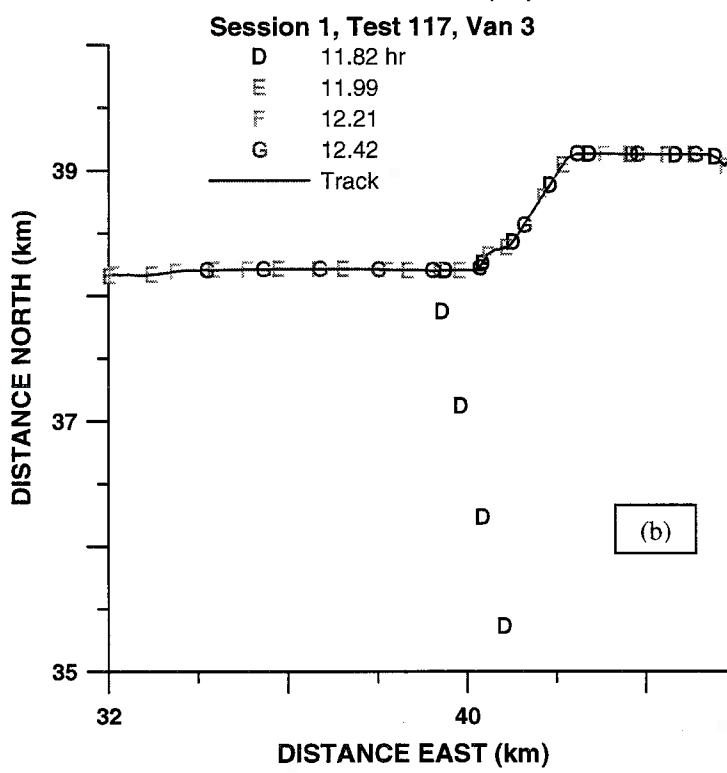
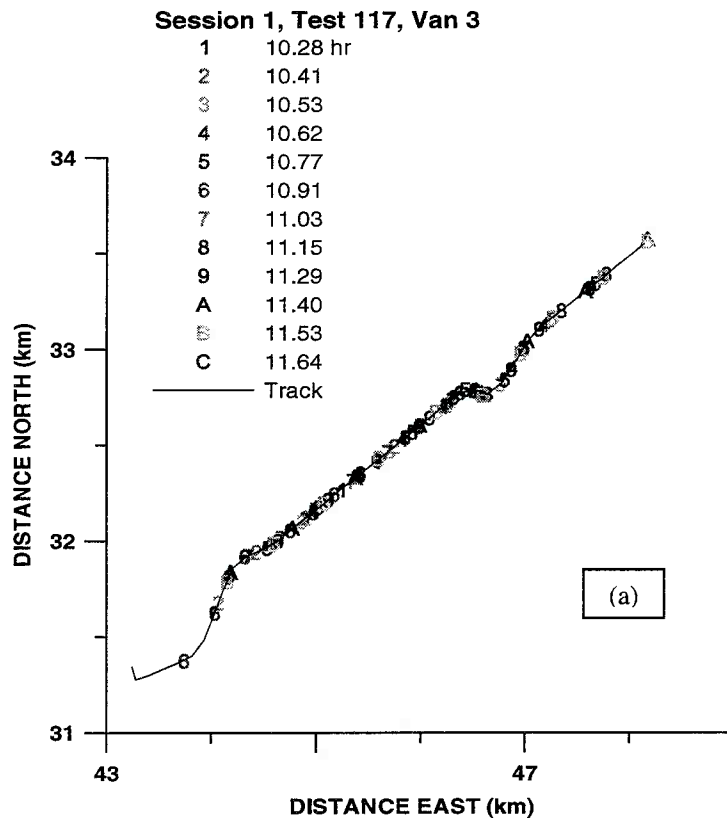


Figure 8. Traverses of Van 3 in Test 117 at different times and the common Eulerian tracks (solid lines) during sampling periods: (a) 10.28 - 11.64 hr, and (b) 11.82 - 12.42 hr.

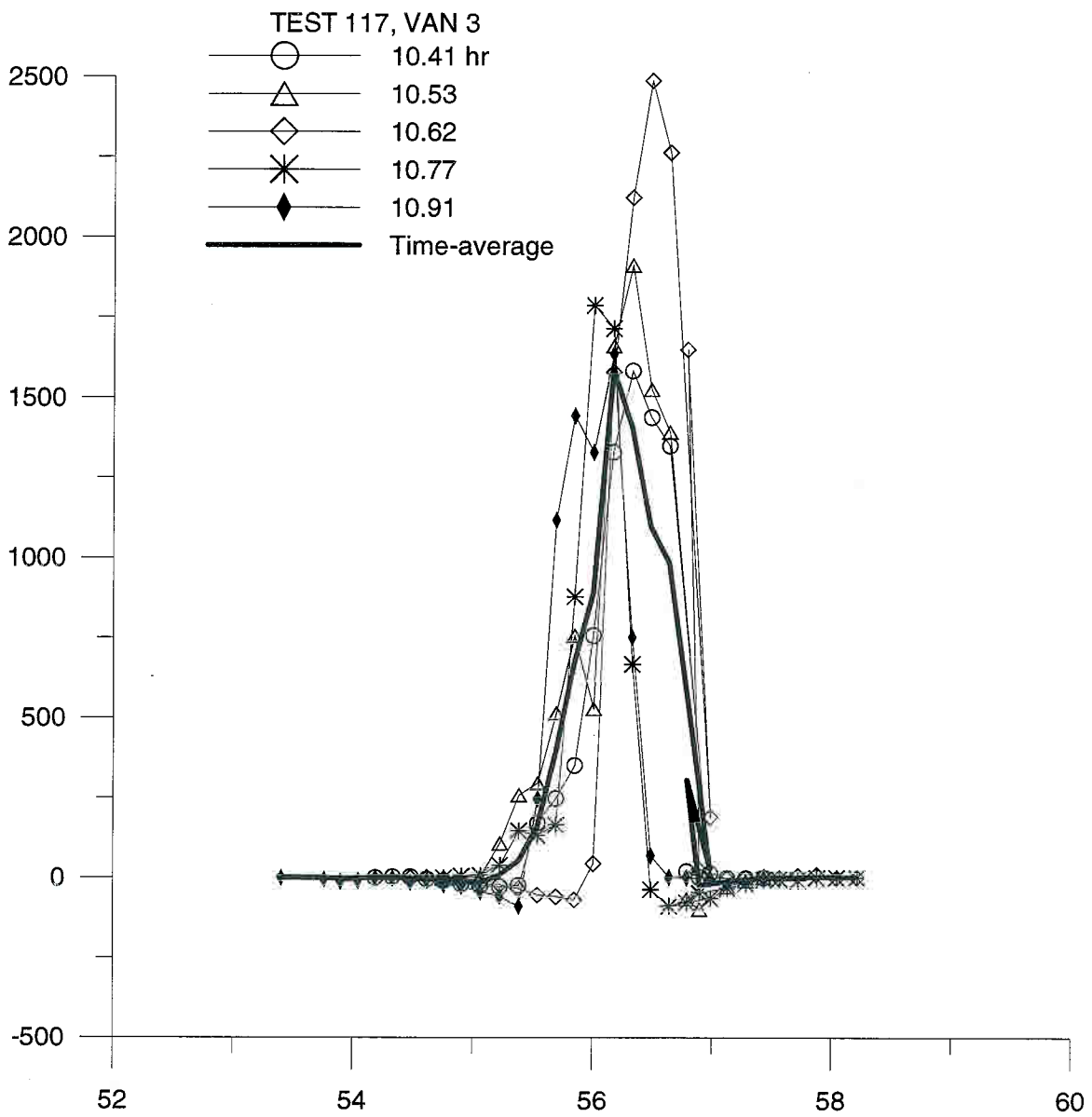


Figure 9. Variations of processed concentrations and their average value over the time period 10.41 - 10.91 hr versus travel distance along the Eulerian track for Van 3 in Test 117.

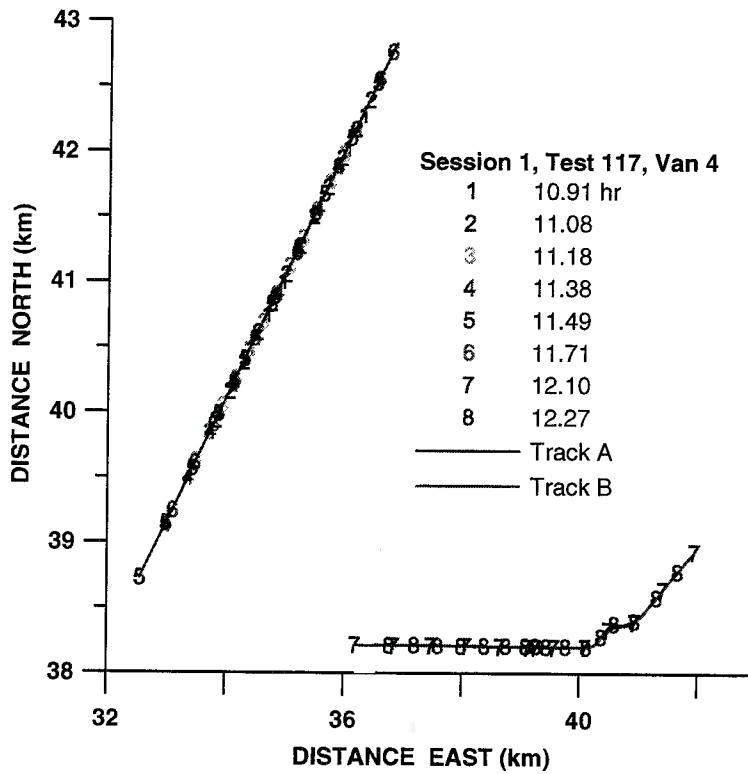


Figure 10. Traverses of Van 4 in Test 117 at different times during sampling periods 10.91 - 11.71 hr and 12.10 - 12.27 hr, and the common Eulerian tracks (solid lines).

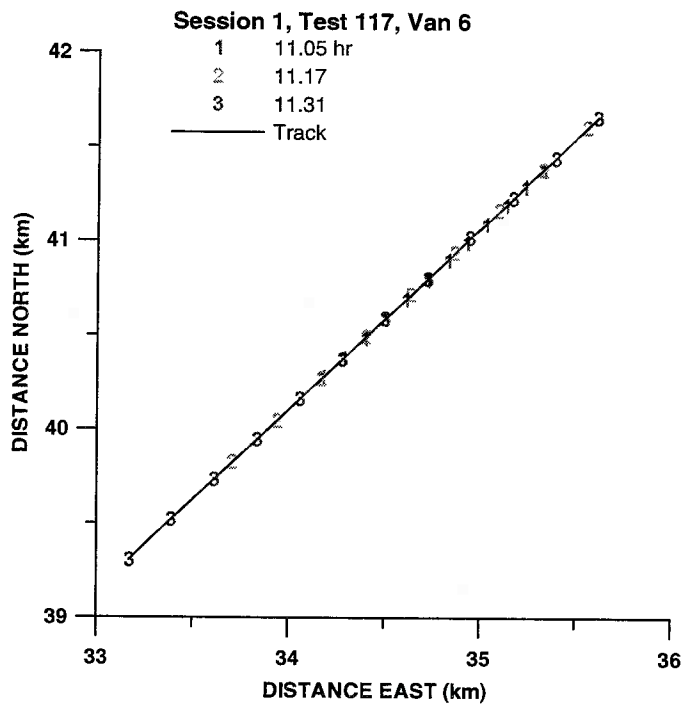


Figure 11. Traverses of Van 6 in Test 117 at different times during sampling period 11.05 - 11.31 hr, and the common Eulerian track (solid line).

tended to form fast-moving narrow plumes. Surface fluxes and convergence zones were weak, and the westward incursion of the sea breeze front would occur so late that the diurnally dominant winds were often northwesterly (Start and Kamada, 2001). During Session 2, tracer material was released as 16 ground plumes, 12 elevated plumes, and 7 sets of elevated puffs.

3.3.1 Surface release

Test 209 was selected as the near-surface release case for Session 2. The tracer was released at a mean rate of 20.57 kg/hr at a height of 20 m on the roof of the Blockhouse at SLC 37 (see Table 1). The release duration was 2.567 hr starting from 16:22 EST. The winds were steady at 4 m/s from the NE (50). Cape rawinsondes at 15:00 and 18:40 EST indicated a sea breeze depth of over 600 m. The test objective was to examine transport and diffusion along the Banana River, across S. Merritt Island, and out to I-95 on the mainland, with a focus on the lower atmospheric boundary layer. A very strong and steady tracer footprint was noted on Merritt Island. Both vans and aircraft tracked the plume across Merritt Island and the city of Cocoa on the mainland. The number of plume-hit sampling files for each platform are listed in parentheses: Van 1 (68), Van 2 (54), Van 3 (18), Van 4 (10), Van 5 (8), Van 6 (12), and Aircraft 1 (24). Aircraft 2 did not operate. The traverses or tracks of the various sampling platforms are shown in Figure 12. This was considered one of the best tracer tests for a near surface release.

Figures 13(a) to (e) present 38 traverses of Van 1 for the sampling periods 16.75–17.24 hr, 17.28–17.72 hr, 17.81–18.31 hr, 18.17–18.67 hr, and 18.72–19.08 hr, respectively. The various sampling times in these figures are denoted by the symbols 1 to 8. An “Eulerian” track common to all overlapping van traverses is shown by the solid line in each figure. The sampled concentrations of Van 1 were interpolated to stationary “Eulerian” receptors located on these common tracks to derive detailed time – space history of the concentration field. The latter was stored in ten separate files, 209C1-1.DAT to 209C1-10.DAT, each file containing three tracks over a different sampling period of approximately half-hour duration. This was done for calculating the half-hour average concentrations, which were stored in files 209A1-1.DAT to 109A1-10.DAT.

Figure 14 presents 7 traverses of Van 3 at various sampling times during the sampling period 18.01–18.88 hr. The solid line denotes the common track. The sampled concentration field 24 for all 7 traverses was stored in 209C3ALL.DAT. These data were separated and stored in three files for different but overlapping sampling periods: 18.01–18.51 hr, 18.22–18.70 hr, and 18.38–18.88 hr. In addition to the average concentrations over these three sampling periods, the average concentrations over different, non-overlapping sampling periods during the time interval 19.12–21.09 hr were calculated. The supporting processed concentration files were not saved and the van traverses were not shown.

Figure 15 shows the traverses for Van 6 at five sampling times during the sampling period 18.32–19.00 hr, and their common track (solid line). The average concentrations over two periods, 18.32–18.82 hr and 18.51–19.00 hr, were calculated and stored as 209A6-1.DAT and 209A6-2.DAT. In addition, the average concentrations calculated over different non-overlapping sampling periods during the time interval 19.00–20.97 hr for Van 6 were also stored,

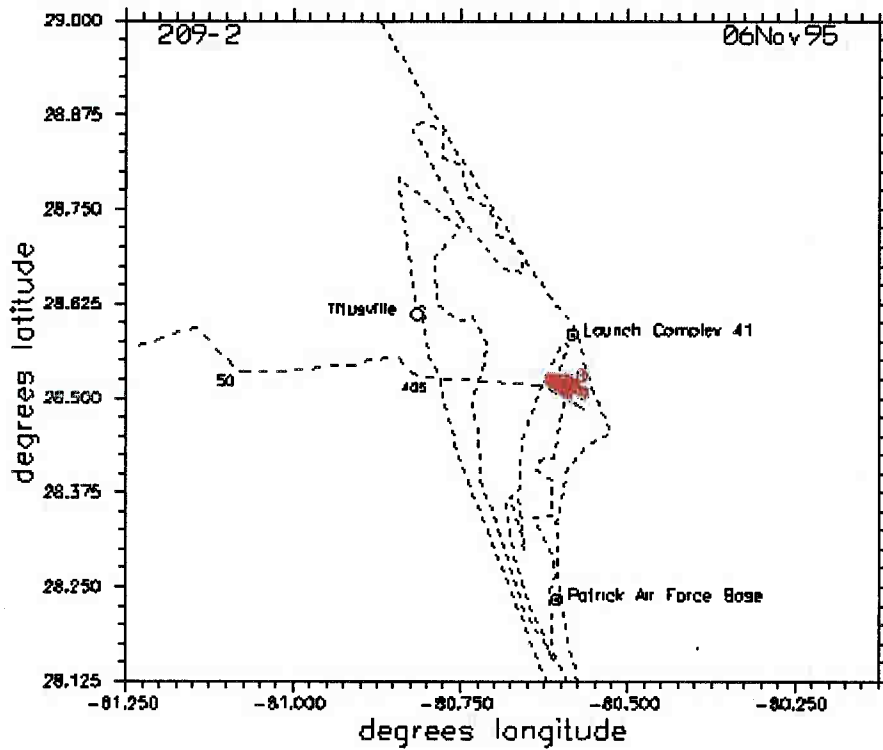
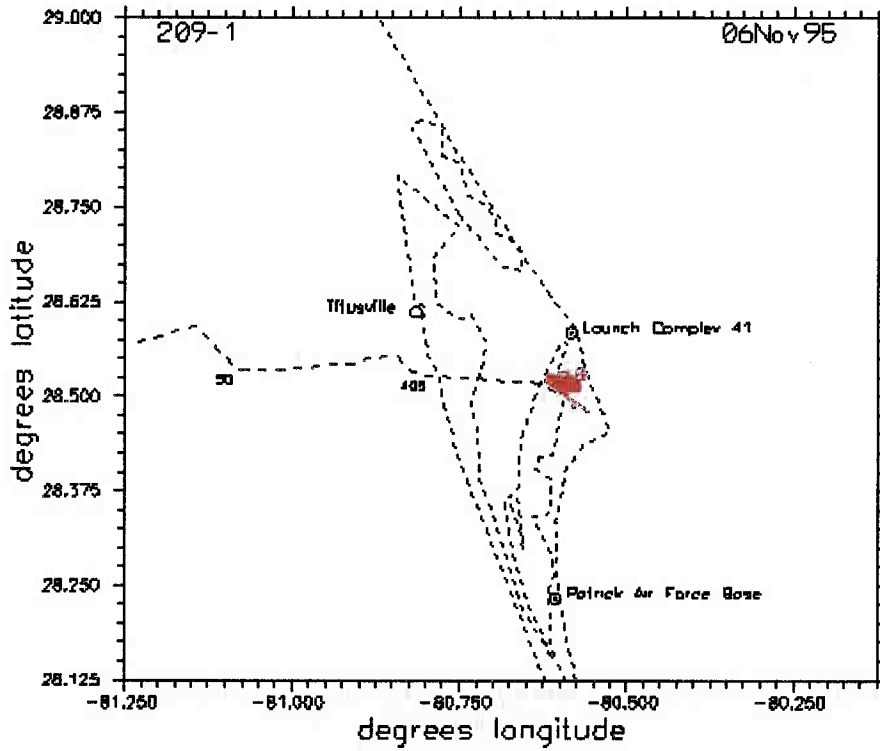


Figure 12. Traverses of tracer-sampling platforms used in MVP Test 209. The label at the top left inside of each figure gives the Test number and the platform label: (a) Vans 1 and 2.

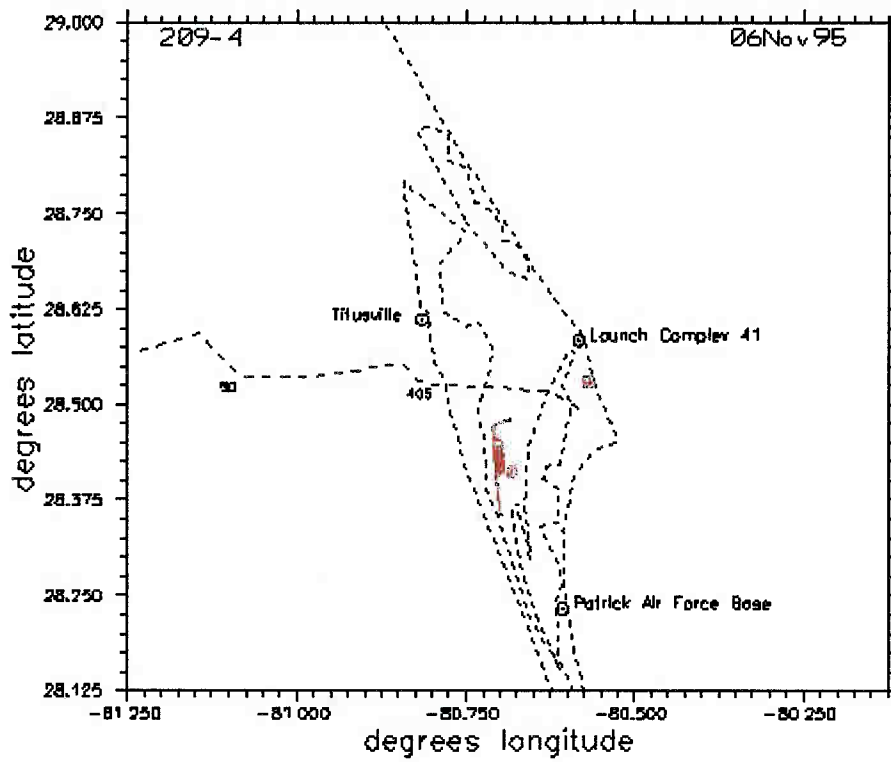
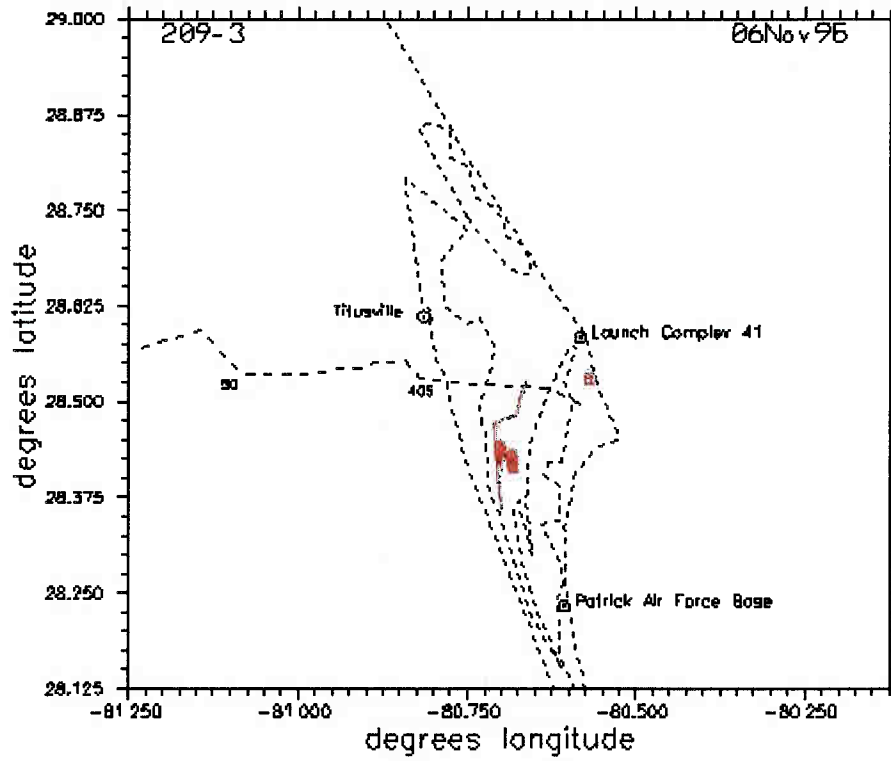


Figure 12. Continued: (b) Vans 3 and 4.

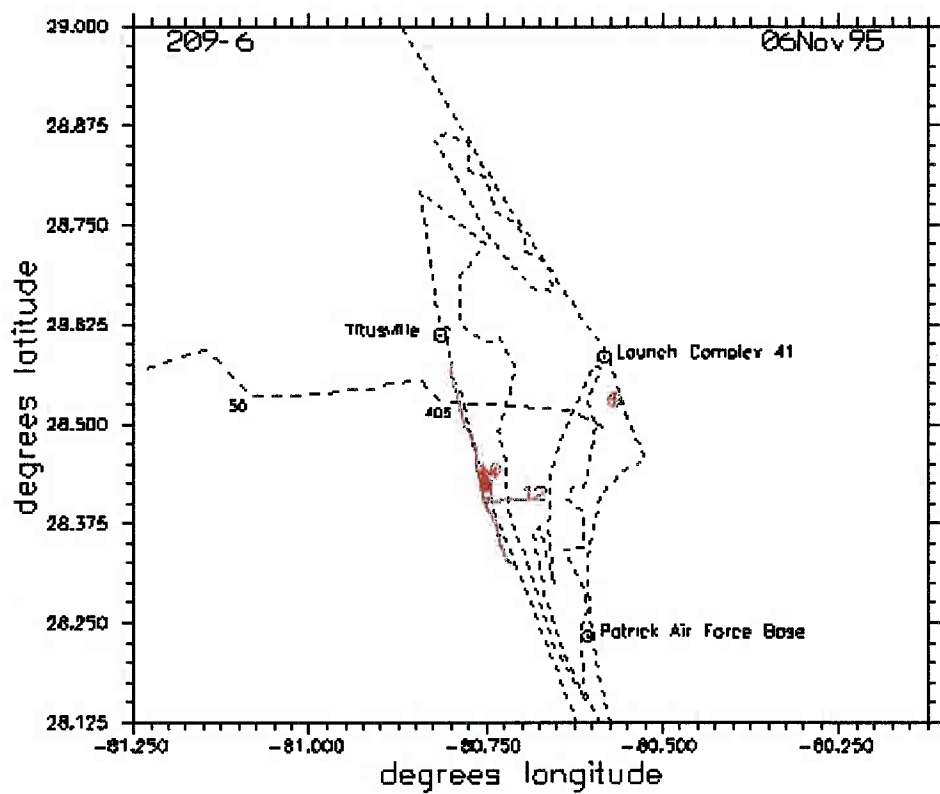
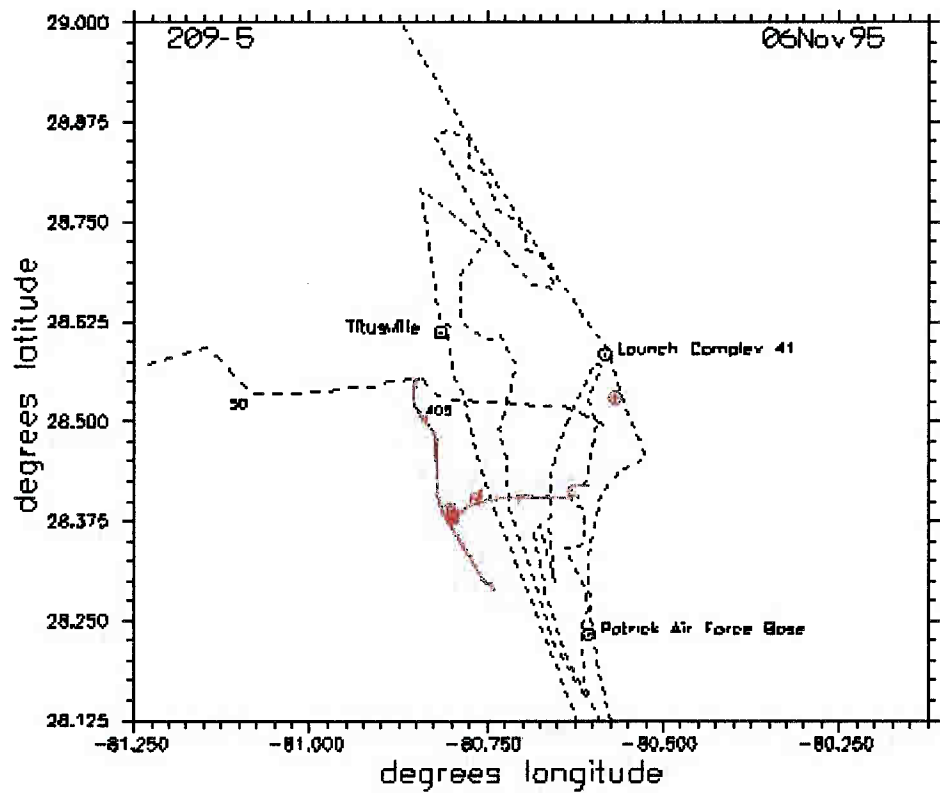


Figure 12. Continued: (c) Vans 5 and 6.

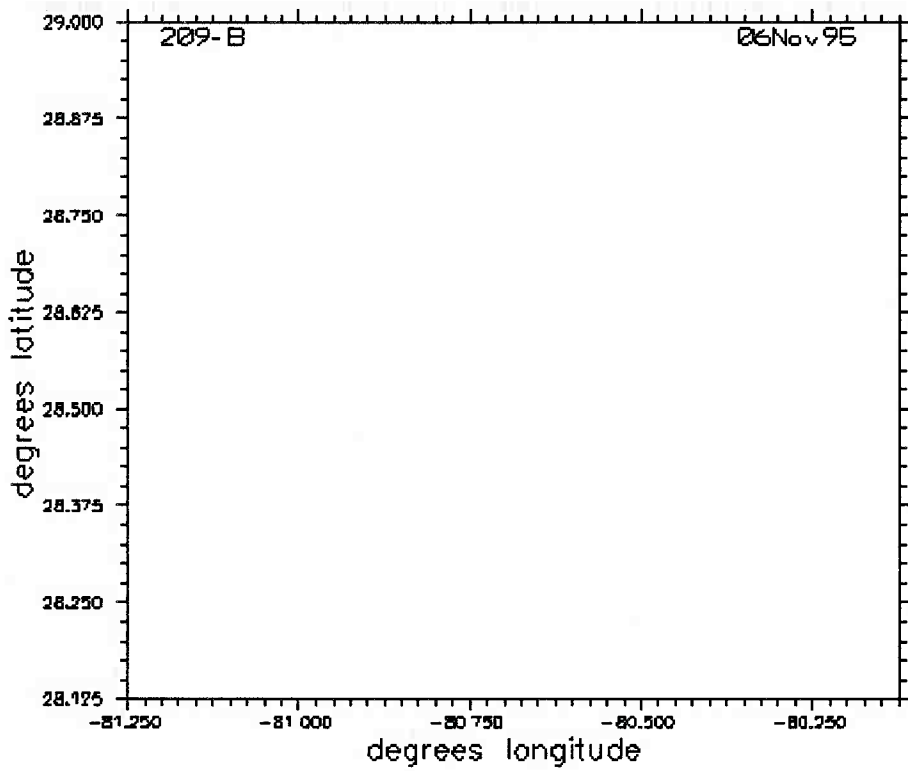
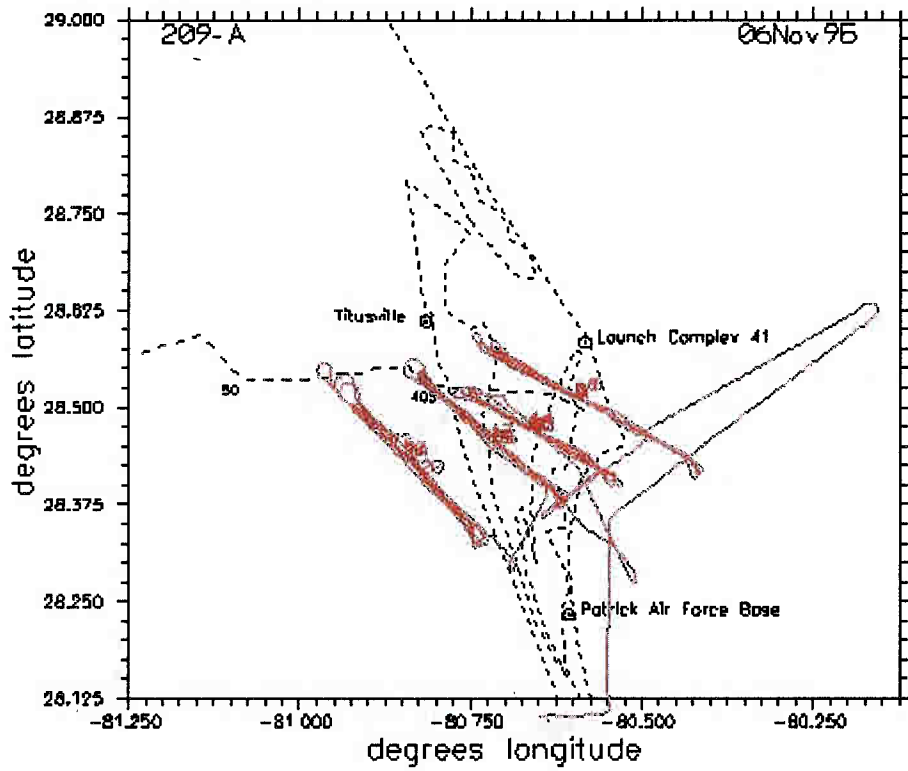


Figure 12. Continued: (d) Aircraft A and B.

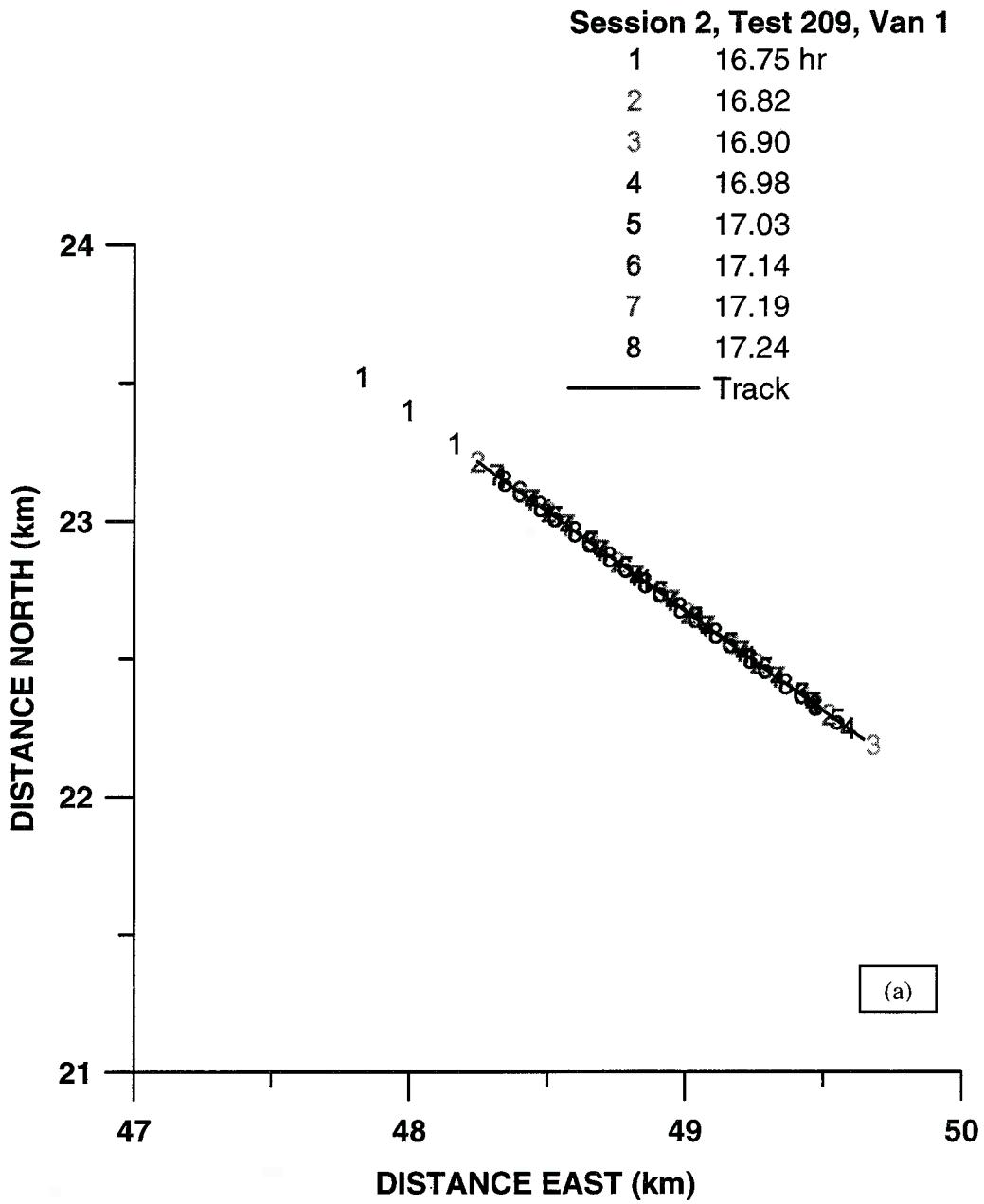


Figure 13. Traverses of Van 1 in Test 209 at different times and the common Eulerian tracks (solid lines) during sampling periods. (a) 16.75 - 17.24 hr.

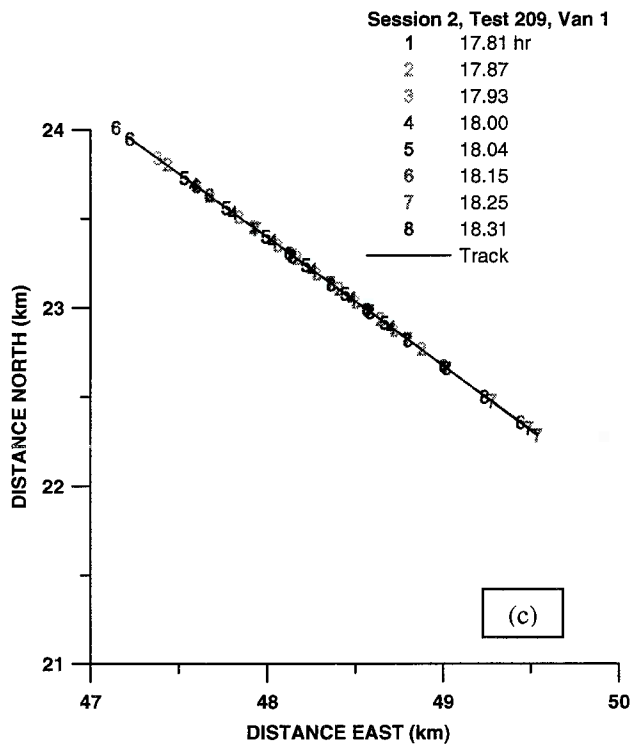
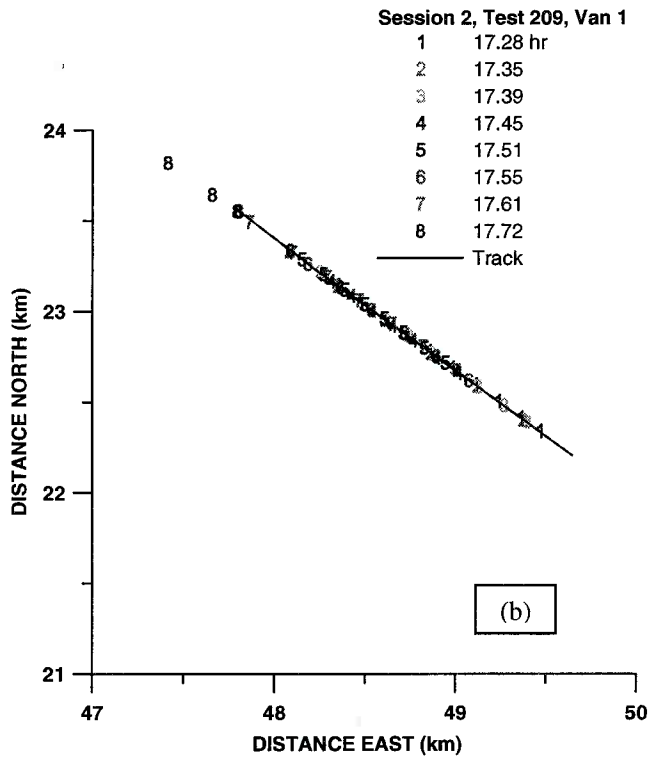


Figure 13. Continued: (b) 17.28 - 17.72 hr. and (c) 17.81 - 18.31 hr.

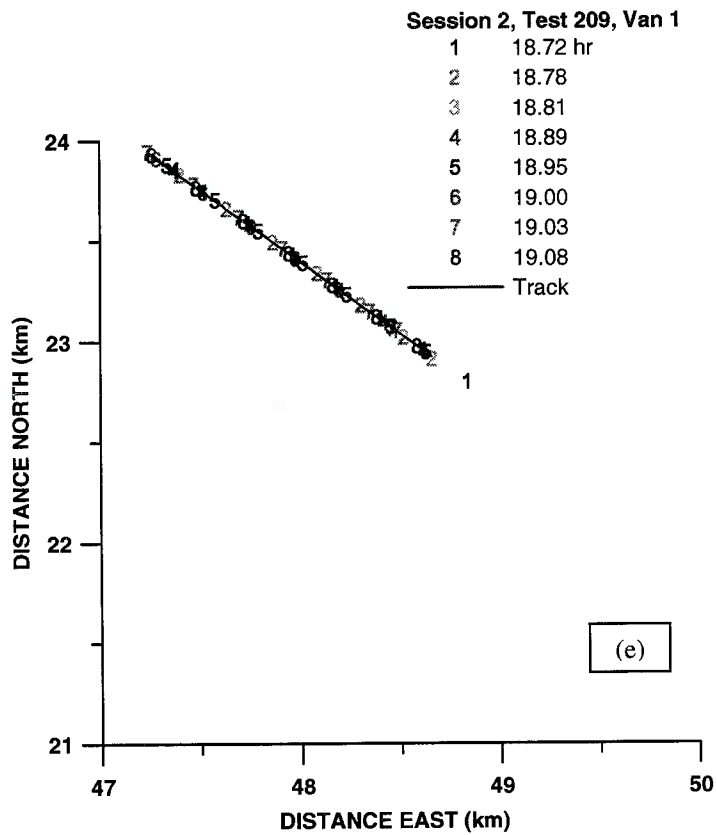
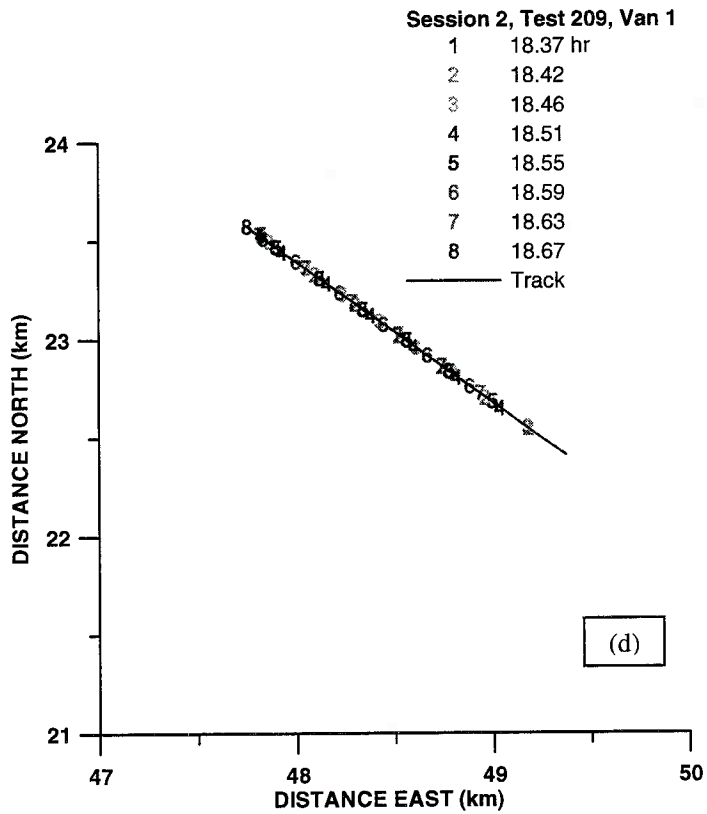


Figure 13. Continued: (d) 18.37 - 18.67 hr. and (e) 18.72 - 19.08 hr.

without saving the processed concentration fields or showing plots of van traverses. Half-hour average concentrations could not be formed from Van 2 tracer measurements due to discontinuities. Van 4 had only 2 traverses and Van 5 had none during the tracer release period. So these data were not processed further. Figure 16 shows the variations of processed concentrations and their average value over the time period 18.01–18.51 hr versus travel distance along the Eulerian track for Van 3.

3.3.2 Elevated release

Test 216 was selected as the elevated release case for Session 2. The tracer was released about 300 m south of the Blockhouse at SLC 37 (see Table 1) at 457 m (1500 ft) MSL altitude, which was just below the cloud base. The duration of the release was 2.367 hr starting from 12:55 EST at a mean rate of 19.81 kg/hr. The objective of the test was to release the tracer into the middle of the daytime mixing layer and examine diffusion during cloudy, onshore flow conditions. The 915 MHz wind profiler at the False Cape showed uniform winds of about 10 m/s from the east below the tracer release height during this period. Tower winds at 54 ft height were generally north of east at 5 - 7.5 m/s. Aircraft tracked the plume west along the NASA parkway to obtain good vertical profiles of the tracer over east and west of Merritt Island. The vans sampled at the surface where only small concentrations were measured, because the plume was mostly trapped in the layer aloft. The number of plume-hit sampling files are as listed in parentheses: Van 1 (0), Van 2 (0), Van 3 (2), Van 4 (3), Van 5 (2), Van 6 (3), and Aircraft 1 (18). Aircraft 2 did not operate. The traverses or tracks of the various sampling platforms, plotted by Start (2000), are shown in Figure 17.

Figure 18 shows 2 traverses each for Van 3 and Van 5 during the sampling period 13.22–13.49 hr. These two vans were sampling on the same plume transect, traveling in opposite directions for replication. The four traverses overlap each other, and can be fitted by a common Eulerian track (solid line). The interpolated concentrations for the four sampling times were stored as 216C3&5.DAT and the average concentration (over 0.27 hr) was saved as 216A3&5.DAT. Figure 19 shows the variations of processed concentrations and their average value over the time period 13.22–13.49 hr versus travel distance along the Eulerian track for Vans 3 and 5.

Figure 20 presents 3 traverses of Van 4. Only two of them (14.58 hr and 15.38 hr) overlap each other, and their average concentration over 0.8 hr on the common track (solid line) was calculated and stored. Figure 21 shows 3 traverses of Van 6. Only parts of these traverses overlap each other, and this segment was fitted with a common track (solid line). The average concentrations for the time period 13.74–14.22 hr calculated at the samplers fixed over this track were stored as 216A6-1.DAT.

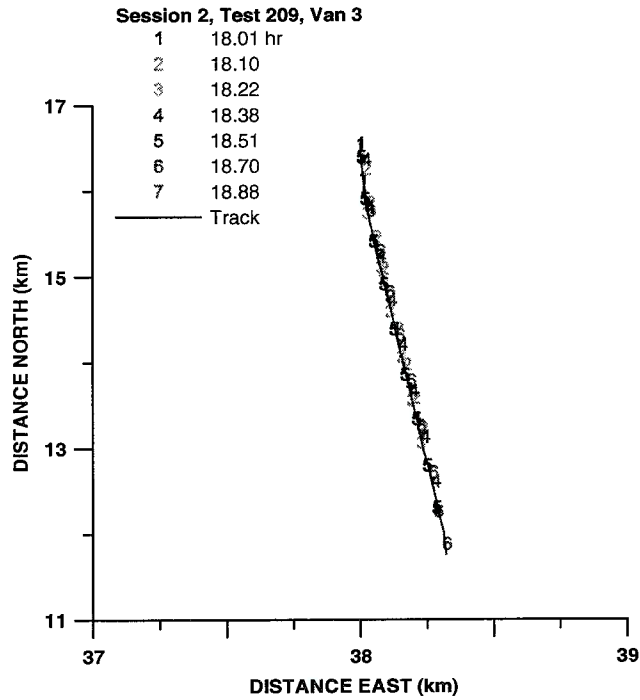


Figure 14. Traverses of Van 3 in Test 209 at different times during sampling period 18.01 - 18.88 hr, and the common Eulerian track (solid line).

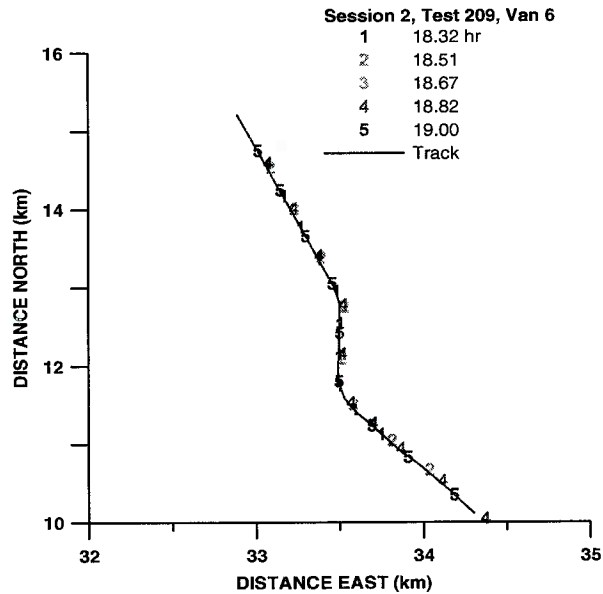


Figure 15. Traverses of Van 6 in Test 209 at different times during sampling period 18.32 - 19.00 hr versus travel distance along the Eulerian track for Van 3 in Test 209.

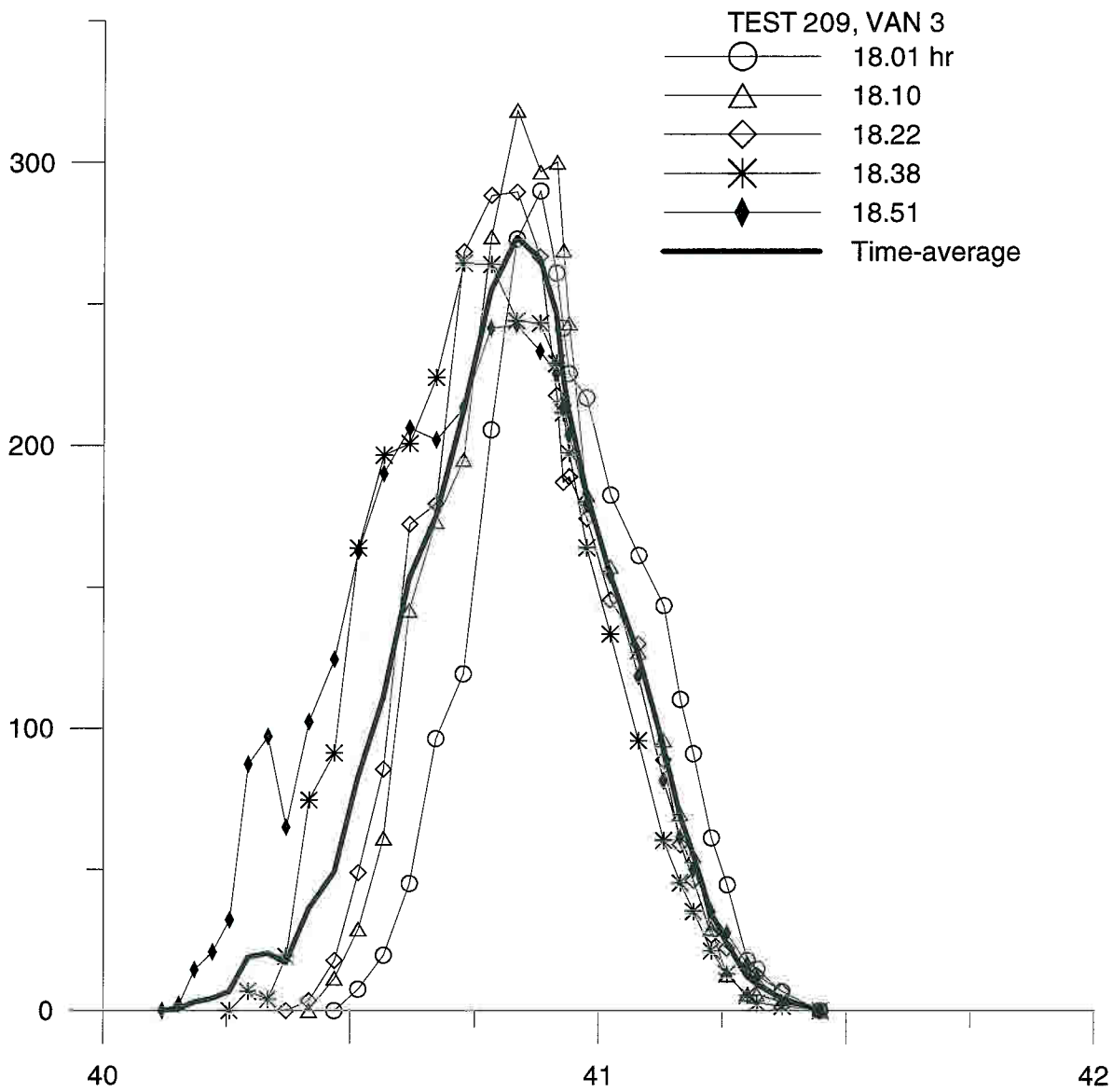


Figure 16. Variations of processed concentrations and their average value over the time period 18.01 - 18.51 hr versus travel distance along the Eulerian track for Van 3 in Test 209.

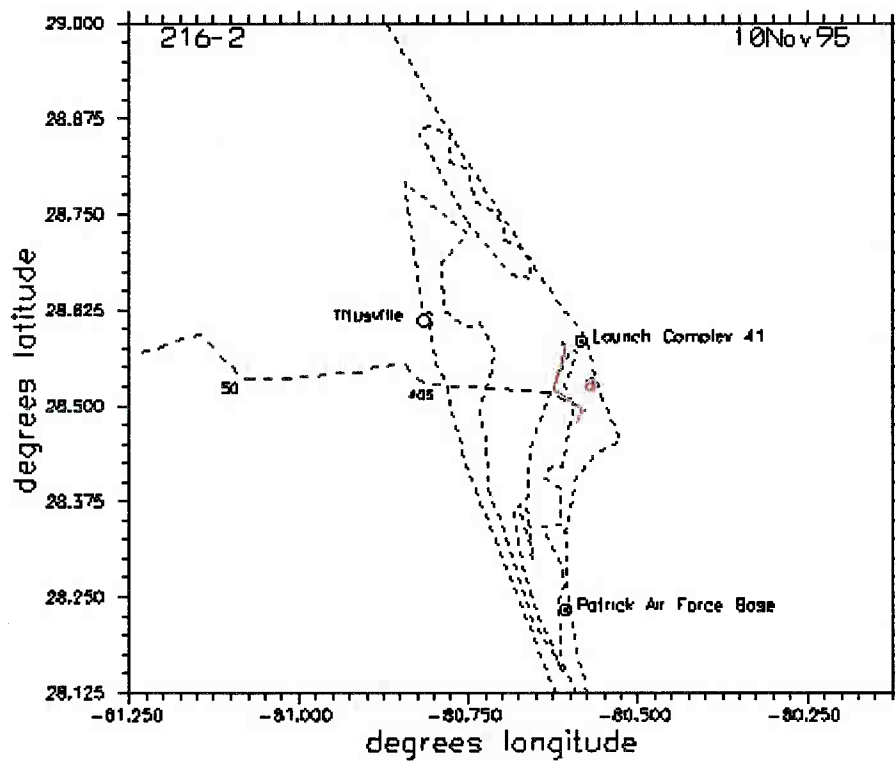
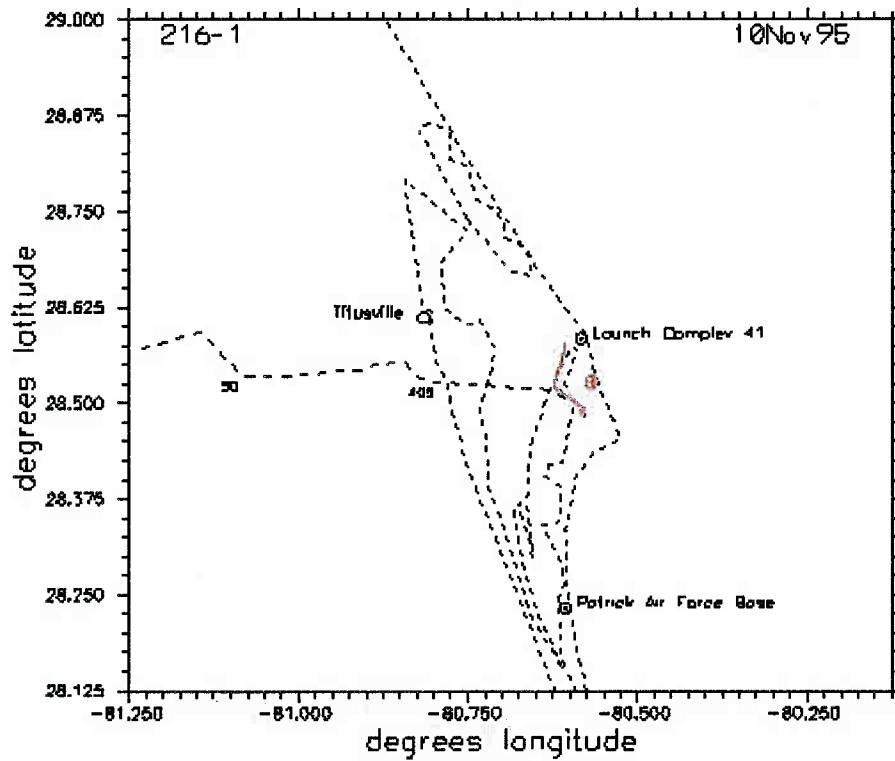


Figure 17. Traverses of tracer-sampling platforms used in MVP Test 216. The label at the top left inside of each figure gives the Test number and the platform label: (a) Vans 1 and 2.

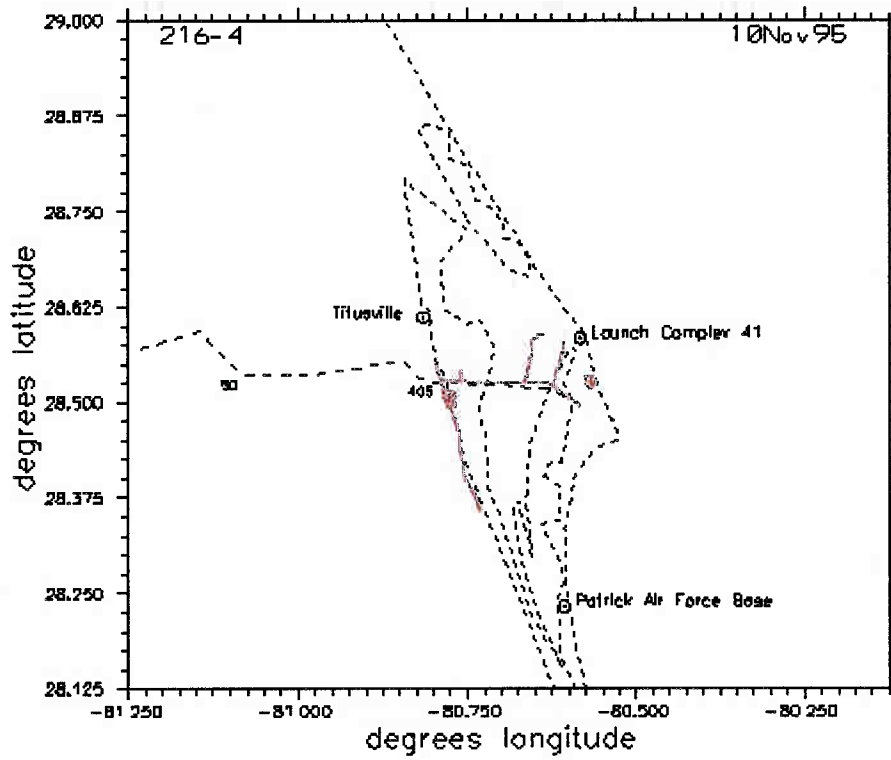
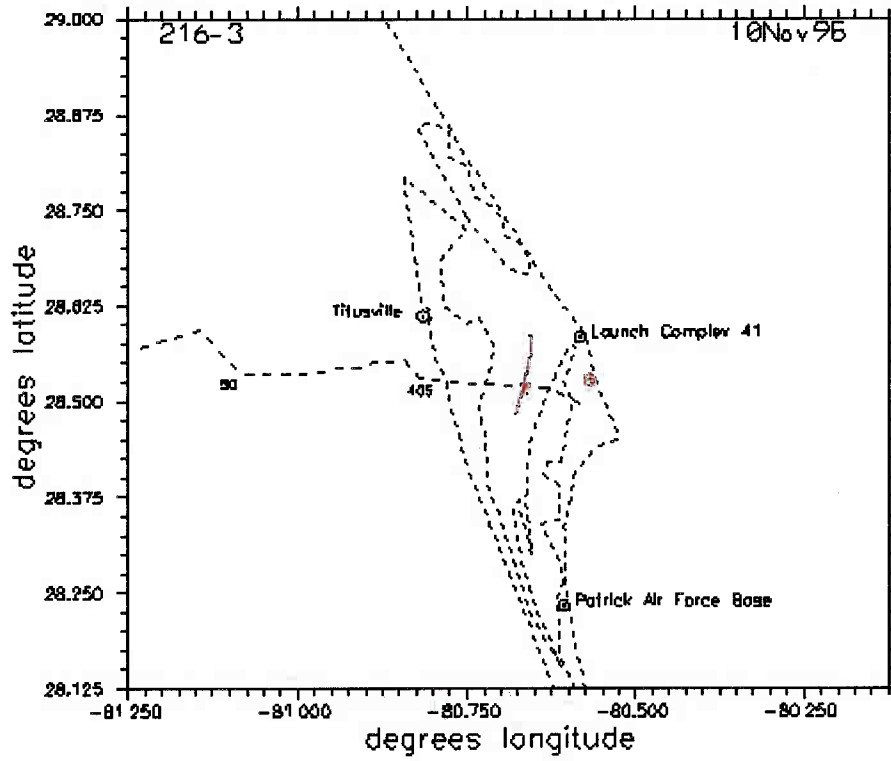


Figure 17. Continued: (b) Vans 3 and 4.

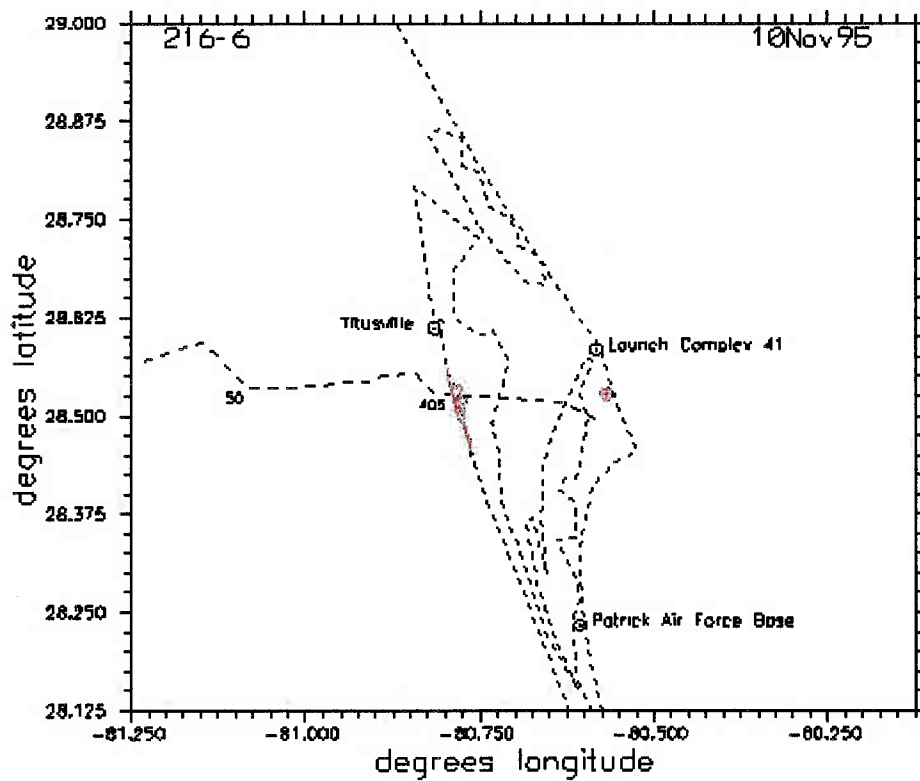
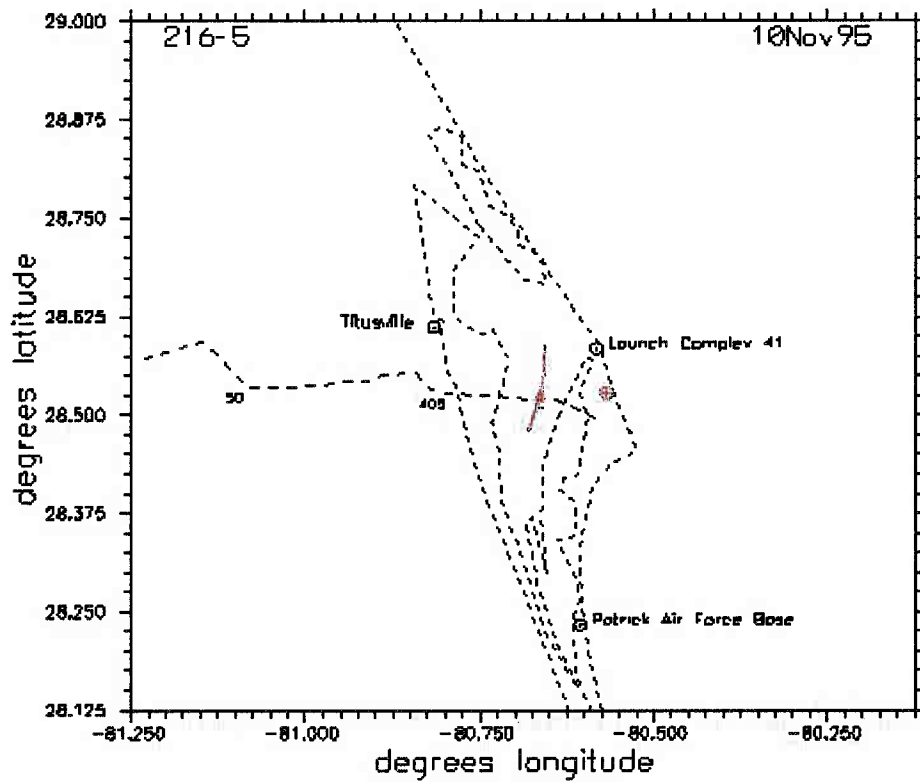


Figure 17. Continued: (c) Vans 5 and 6.

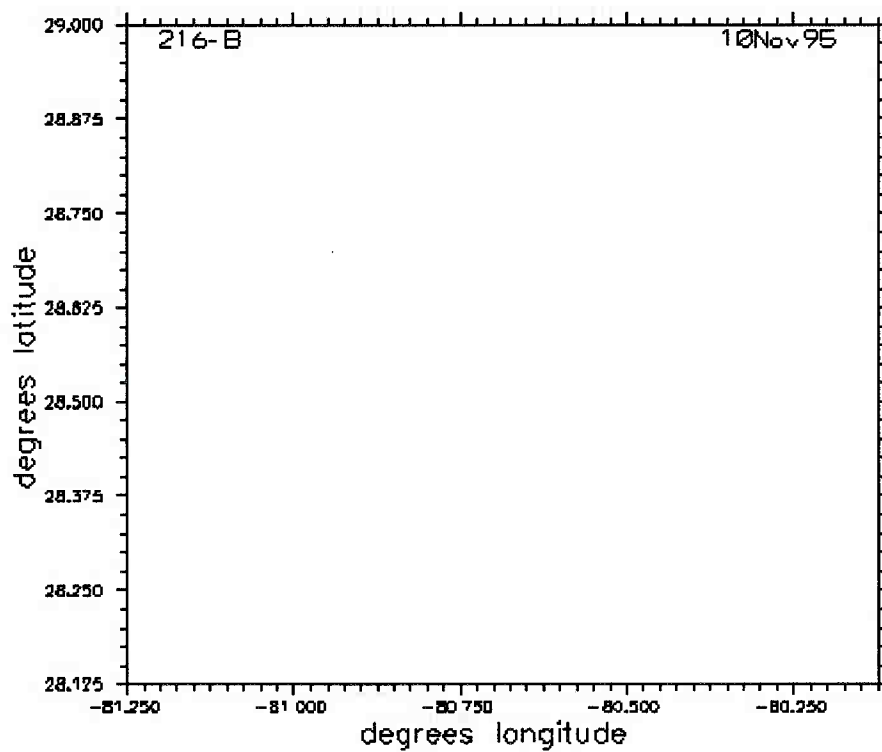
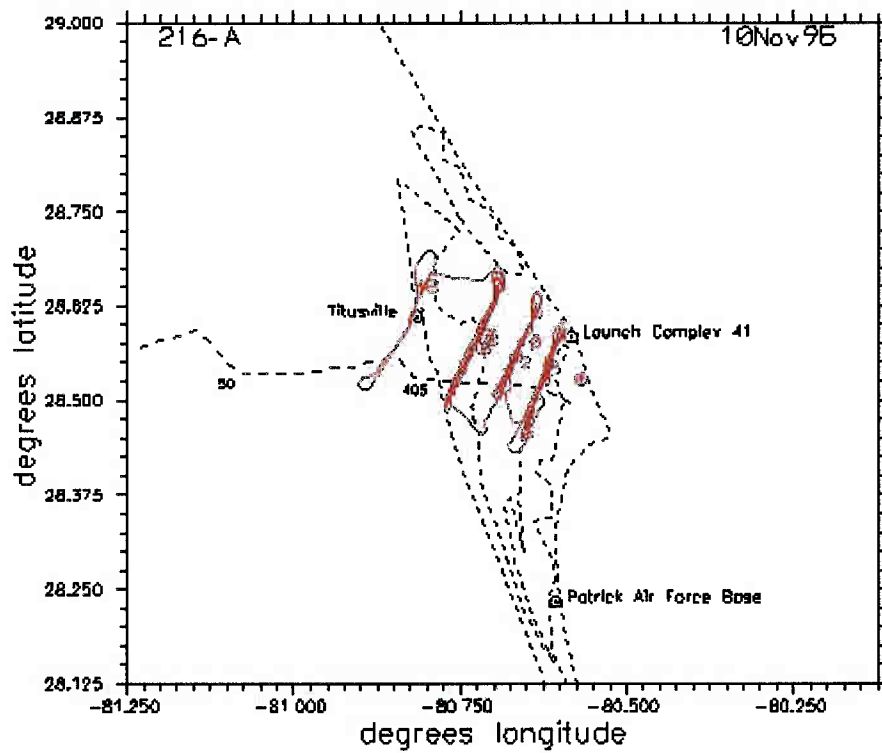


Figure 17. Continued: (d) Aircraft A and B.

Session 2, Test 216, Van 3 & 5

- 1 13.22 hr
- 2 13.34
- 3 13.37
- 4 13.49

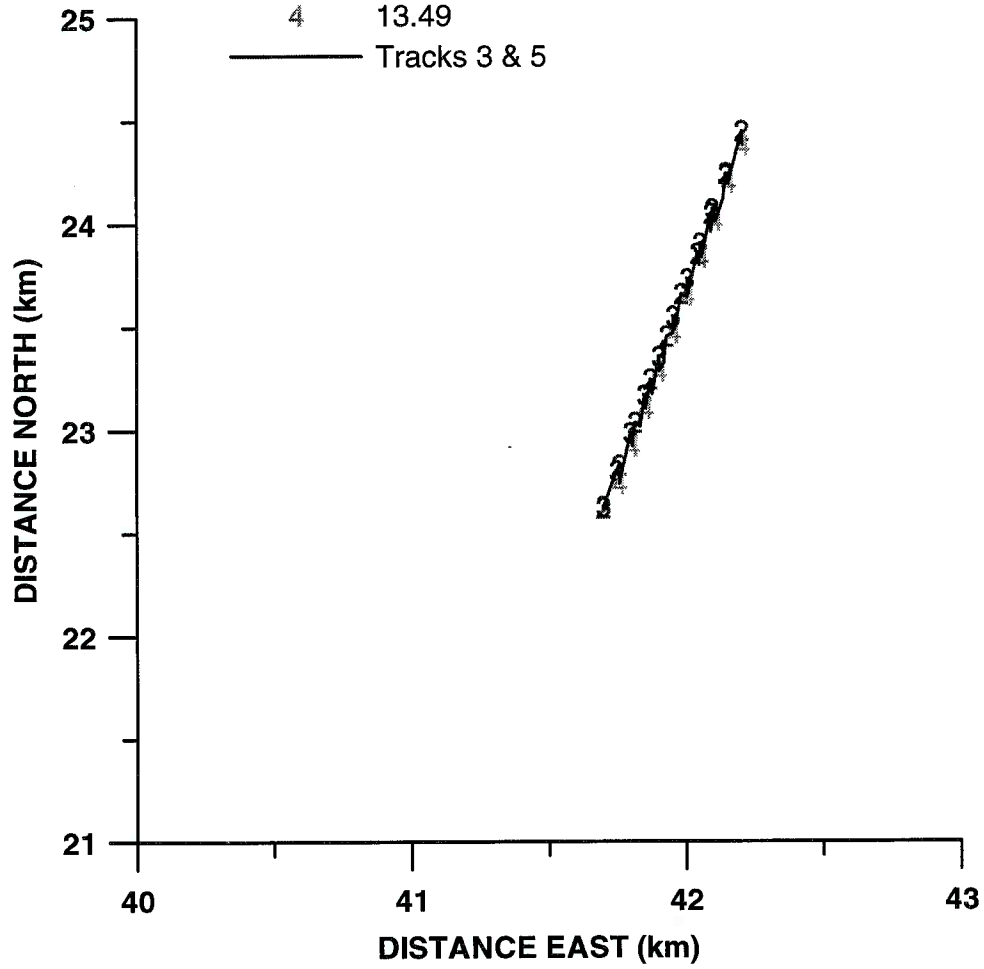


Figure 18. Traverses of Vans 3 and 5 in Test 216 at different times during sampling period 13.22 - 13.49 hr, and the common Eulerian track (solid line).

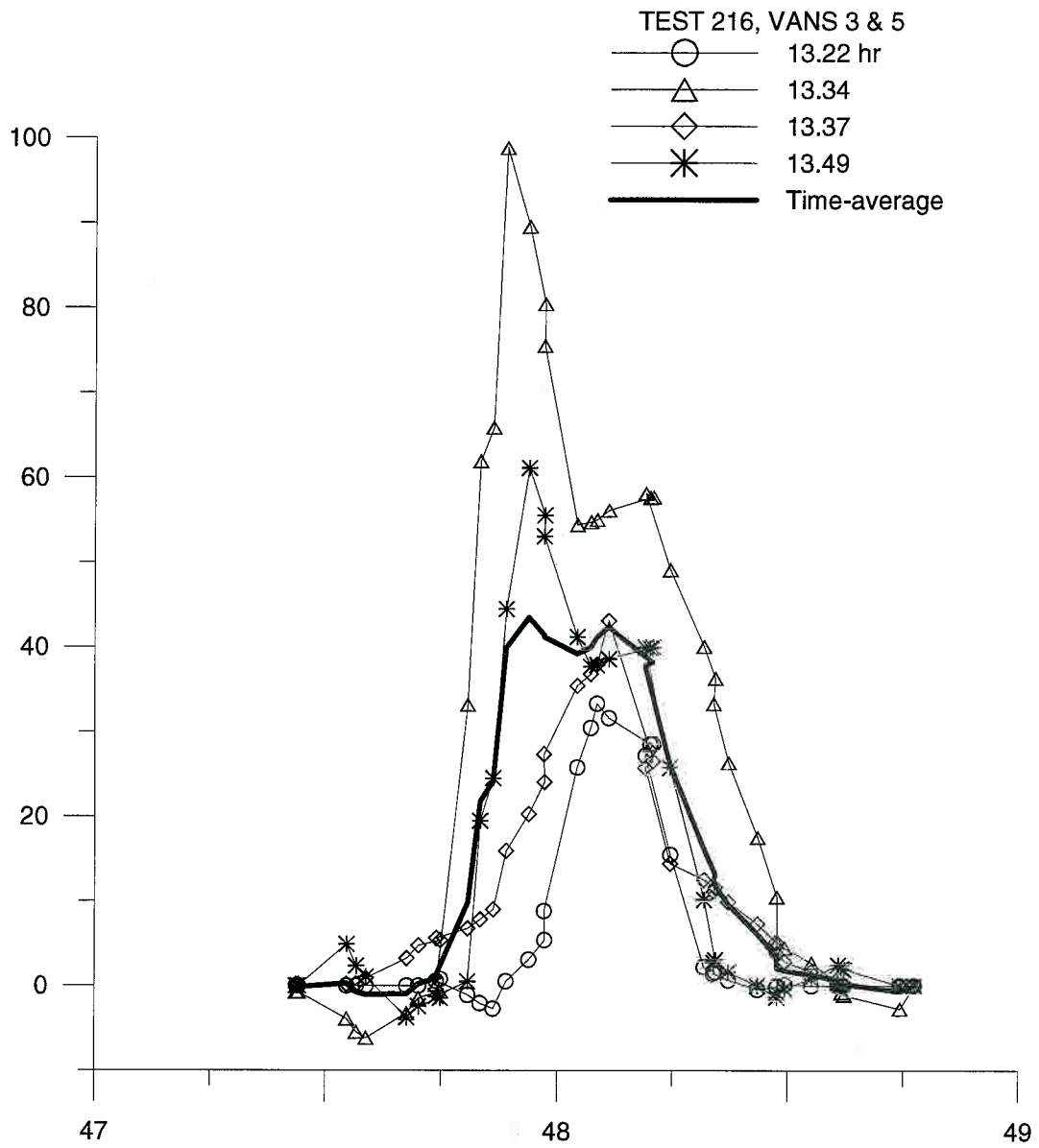


Figure 19. Variations of processed concentrations and their average value over

3.4 Session 3 (26 April - 9 May, 1996)

Session 3 of MVP tracer releases at Cape Canaveral was conducted in the spring of 1996, because weather conditions would be between those of summer and fall. Skies tend to be mostly fair with moderate convection; fronts would be weak with minimal precipitation, and good operating conditions for aircraft and blimp. Good nighttime stable conditions and modest sea breeze flow during the day could be expected with little chance of thunderstorms or strong convergence zones. These conditions would lead to layer-trapped dispersion and moderate over-water subsidence. Even weaker sea breezes might yield broader plumes than the fast moving, ribbon-like plumes found during summer. Tracer was released during day, night, and transition periods in order to examine transport and diffusion under a variety of atmospheric conditions. Two acoustic sounders were operated to gather additional meteorological data during the session. During Session 3, the tracer tests consisted of 17 elevated plumes, 4 ground-level plumes, and 6 sets of elevated puffs.

3.4.1 Surface release

Test 306 was selected as the near-surface release case for Session 3. The tracer was released at a mean rate of 16.39 kg/hr at a height of 8 m at UCS-26 (see Table 1), which is 2 miles north of the Range Operations Control Center near the Banana River and 100 m north of Tower 403. The release duration was 2.75 hr starting from 9:45 EDT. Wind profilers and rawinsondes during the period showed uniform SSE winds at 10 - 13 m/s up to several hundred meters height. The skies were partly cloudy, and the boundary layer flow was capped by a weak temperature inversion at 1200 m MSL. The blimp was grounded due to excessive wind speed, which led to near surface tracer release. The wind was from 170 at 4 m/s near the source. The plume was steadily transported NW, and was found at the surface and aloft. The vans and aircraft had no trouble tracking it to N. Merritt Island. The number of plume-hit sampling files are listed in parentheses: Van 1 (28), Van 2 (6), Van 3 (9), Van 4 (16), Van 5 (29), Van 6 (15), and Aircraft 1 (16). Aircraft 2 did not operate. The traverses of the various sampling platforms are shown in Figure 22. This was considered one of the best tests for a near-surface tracer release.

Figures 23(a) to (c) present 28 traverses of Van 1 for the sampling periods 10.09–11.03, 11.12–11.85, and 11.95–12.79 hr, respectively. The symbols 1 to 9 and A denote the sampling times in these figures. An "Eulerian" track was fitted to all overlapping van traverses as shown by the solid line in each figure. The sampled concentrations of Van 1 were interpolated to stationary receptors distributed on these common tracks to derive detailed time-space history of the concentration field. The latter was stored in five approximately half-hour time blocks (10.19–10.55, 10.64–11.12, 11.26–11.76, 11.85–12.36, 12.36–12.79 hr) in files 306C1-1.DAT to 306C1-5.DAT. The average concentrations calculated over these five time periods were stored as 306A1-1.DAT to 306A1-5.DAT.

For Van 2, no half-hour average concentrations could be formed for the 6 traverses (not shown). Figure 24 shows 9 traverses of Van 3 for the period 10.18–12.28 hr and their common track. The resulting concentration fields were stored as 306C3ALL.DAT, 306C3-1.DAT, 306C3-2.DAT and 306C3-3.DAT, with the last three files covering the periods 10.18–10.70, 11.07–

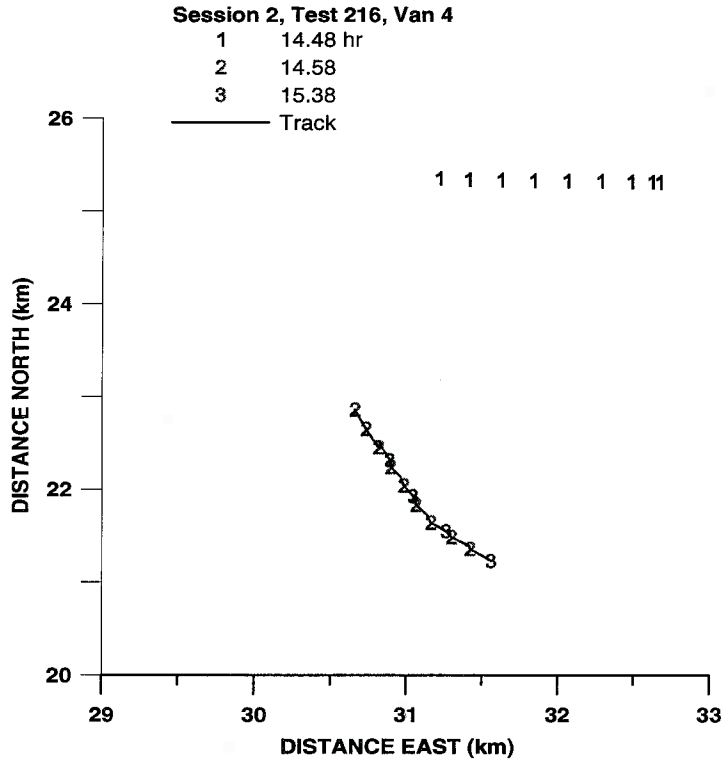


Figure 20. Traverses of Van 4 in Test 216 at different times during sampling period 14.48 - 15.38 hr, and the common Eulerian track (solid line).

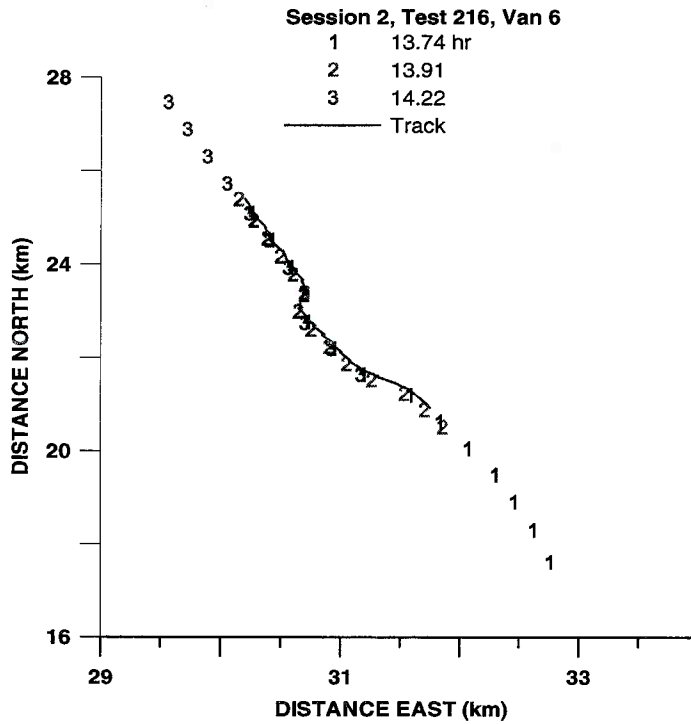


Figure 21. Traverses of Van 6 in Test 216 at different times during sampling period 13.74 - 14.22 hr, and the common Eulerian track (solid line).

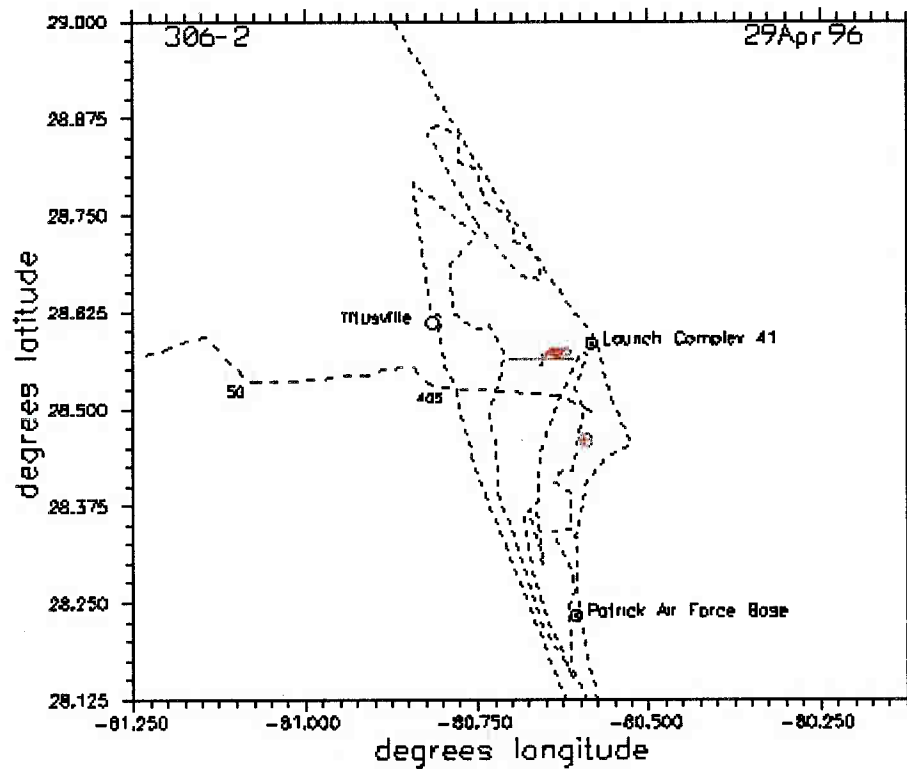
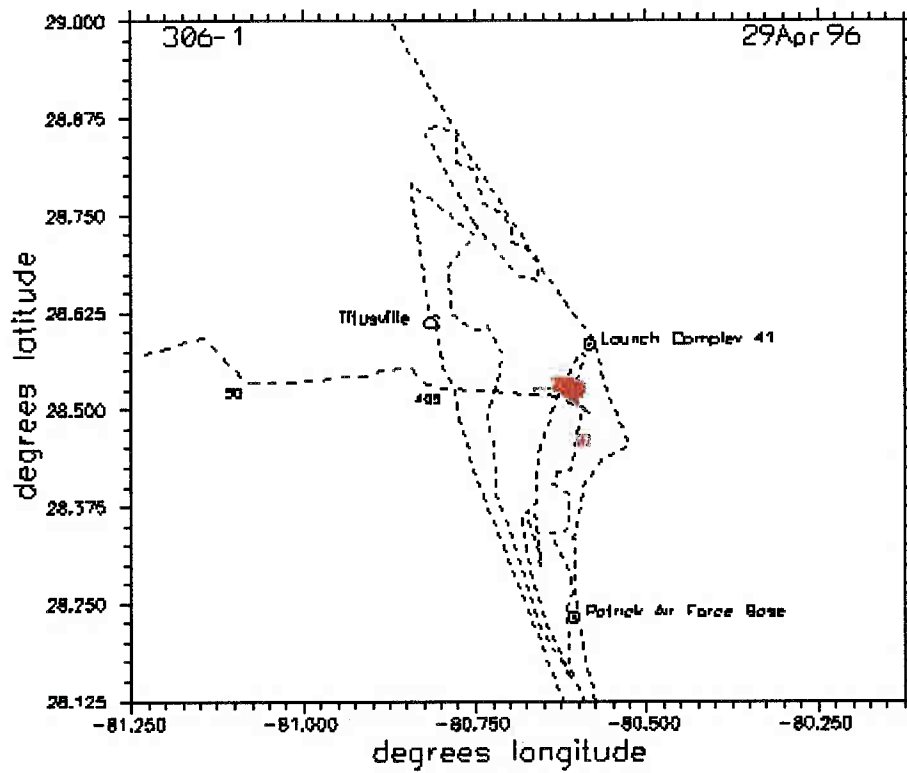


Figure 22. Traverses of tracer-sampling platforms used in MVP Test 306. The label at the top left inside of each figure gives the Test number and the platform label. (a) Vans 1 and 2.

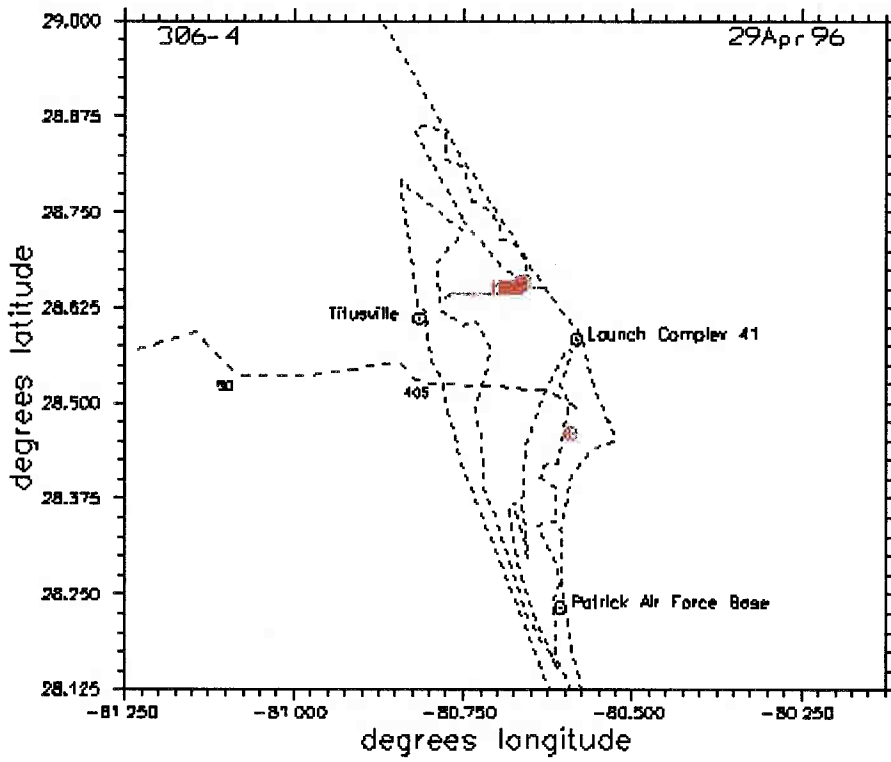
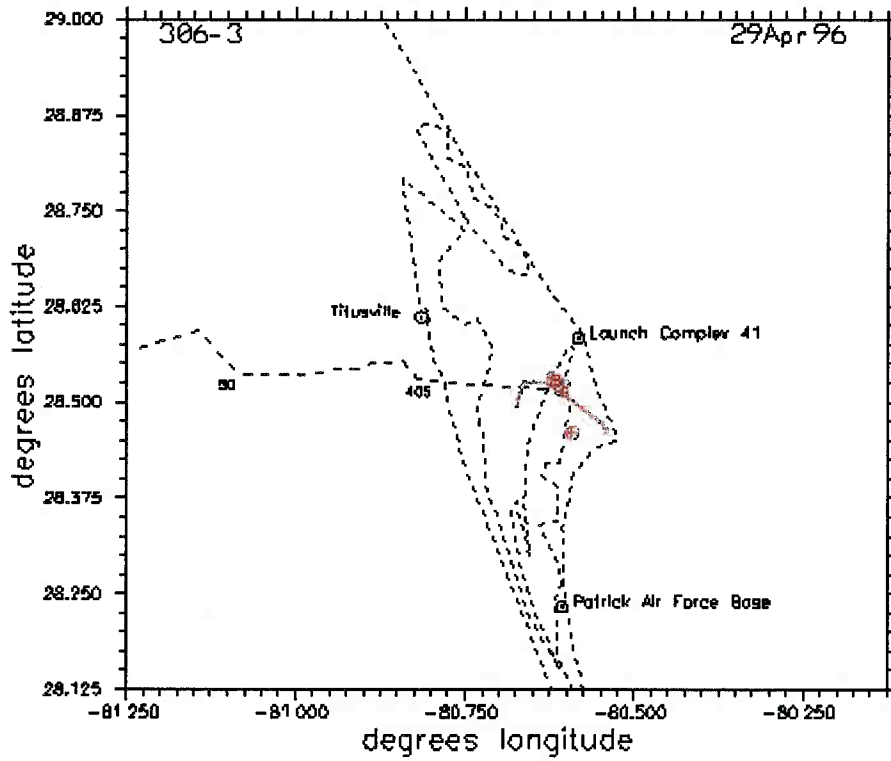


Figure 22. Continued: (b) Vans 3 and 4.

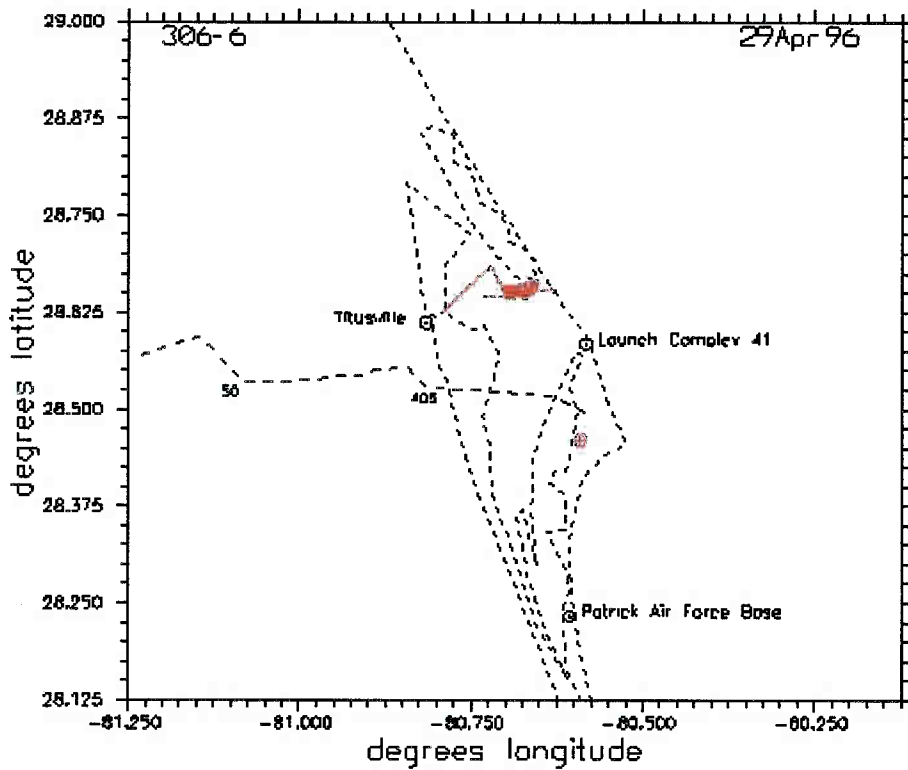
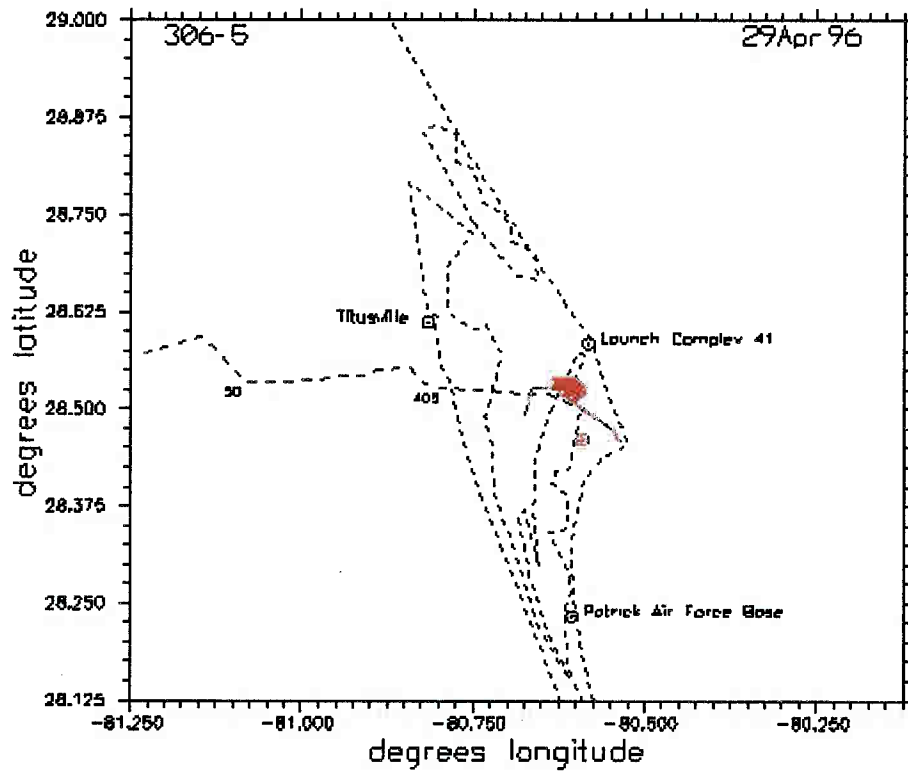


Figure 22. Continued: (c) Vans 5 and 6.

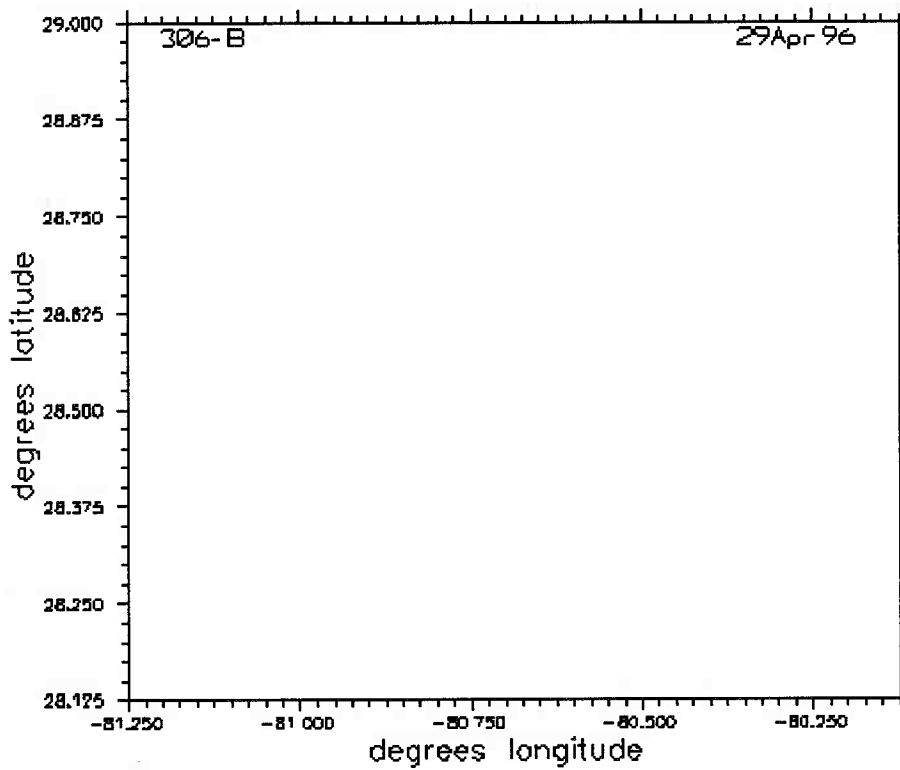
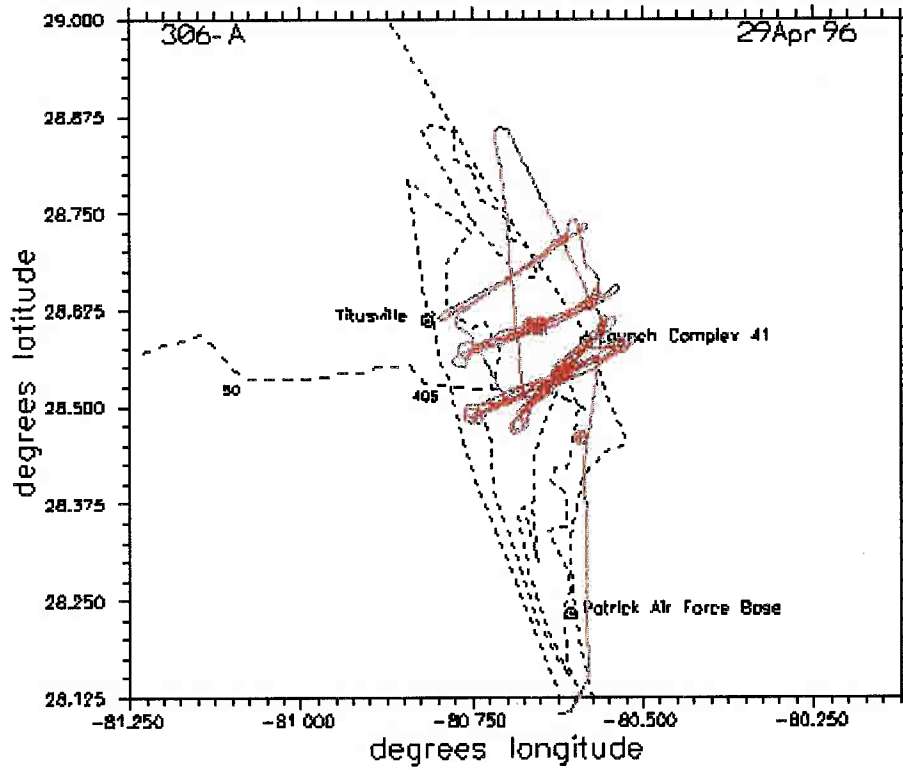


Figure 22. Continued: (d) Aircraft A and B.

Session 3, Test 306, Van 1

| | |
|---|----------|
| 1 | 10.09 hr |
| 2 | 10.27 |
| 3 | 10.35 |
| 4 | 10.55 |
| 5 | 10.64 |
| 6 | 10.73 |
| 7 | 10.78 |
| 8 | 10.86 |
| 9 | 10.94 |
| A | 11.03 |

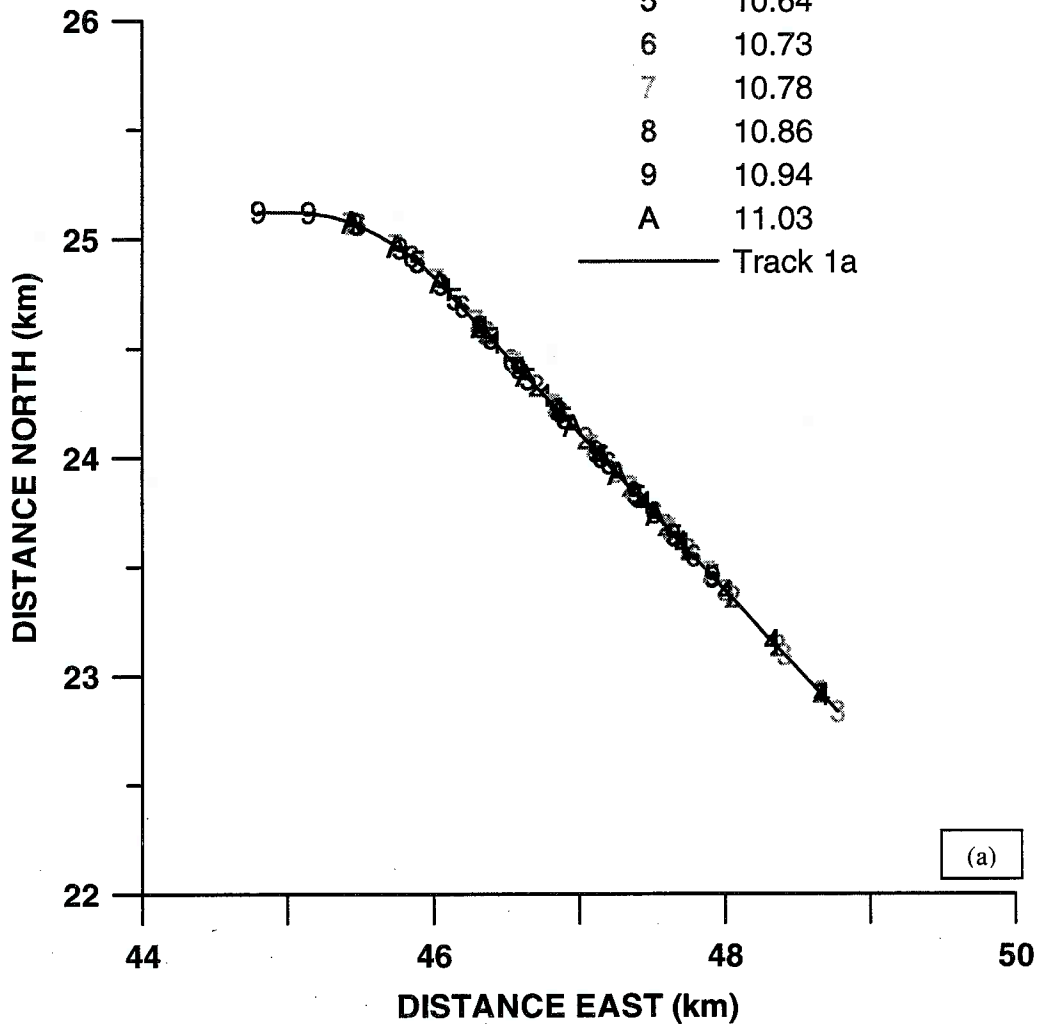


Figure 23. Traverses of Van 1 in Test 306 at different times and the common Eulerian tracks (solid lines) for sampling periods: (a) 10.09 - 11.03 hr.

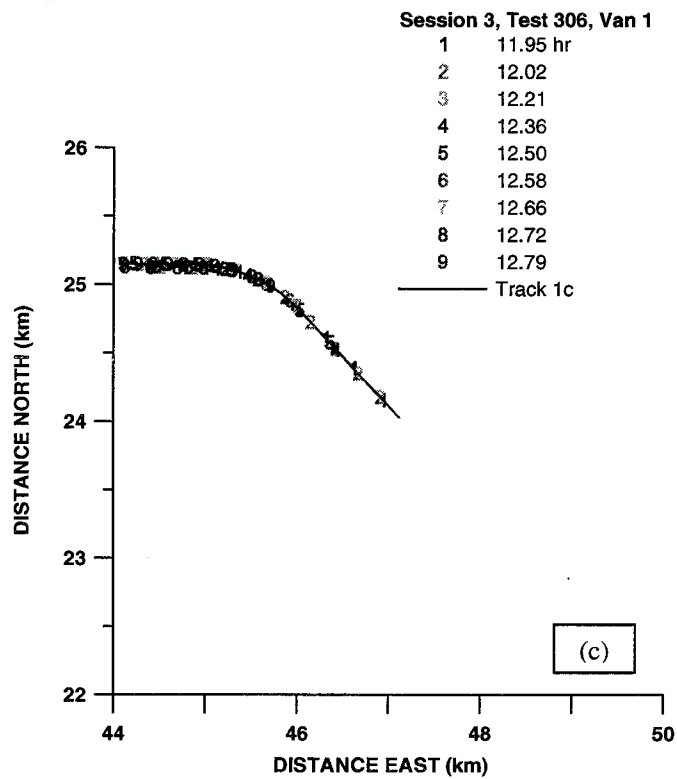
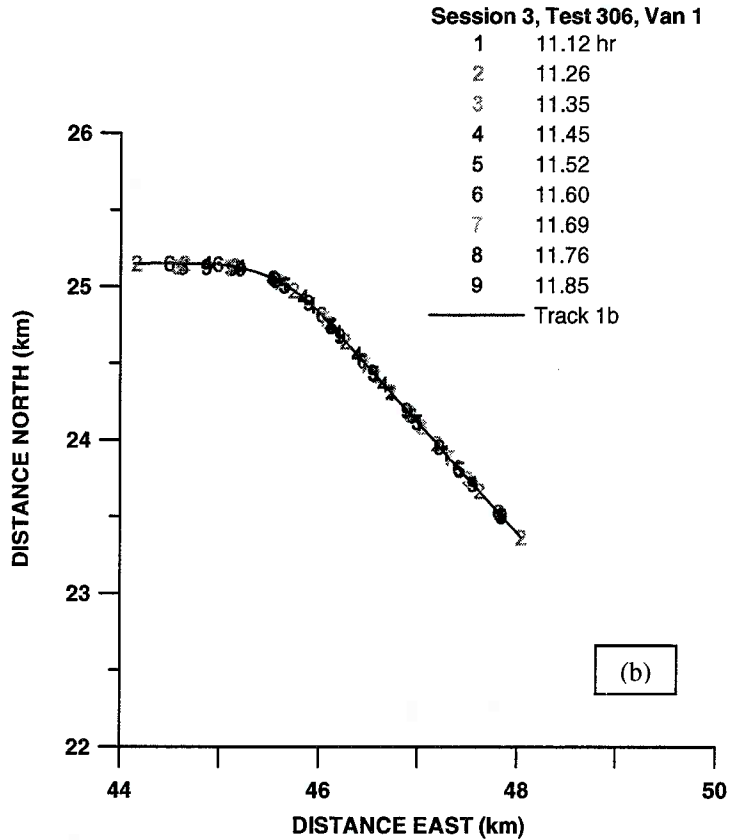


Figure 23. Continued: (b) 11.12 - 11.85 hr, and (c) 11.95 - 12.97 hr.

Session 3, Test 306, Van 3

| | |
|---|----------|
| 1 | 10.18 hr |
| 2 | 10.52 |
| 3 | 10.70 |
| 4 | 11.07 |
| 5 | 11.22 |
| 6 | 11.61 |
| 7 | 11.74 |
| 8 | 12.17 |
| 9 | 12.28 |

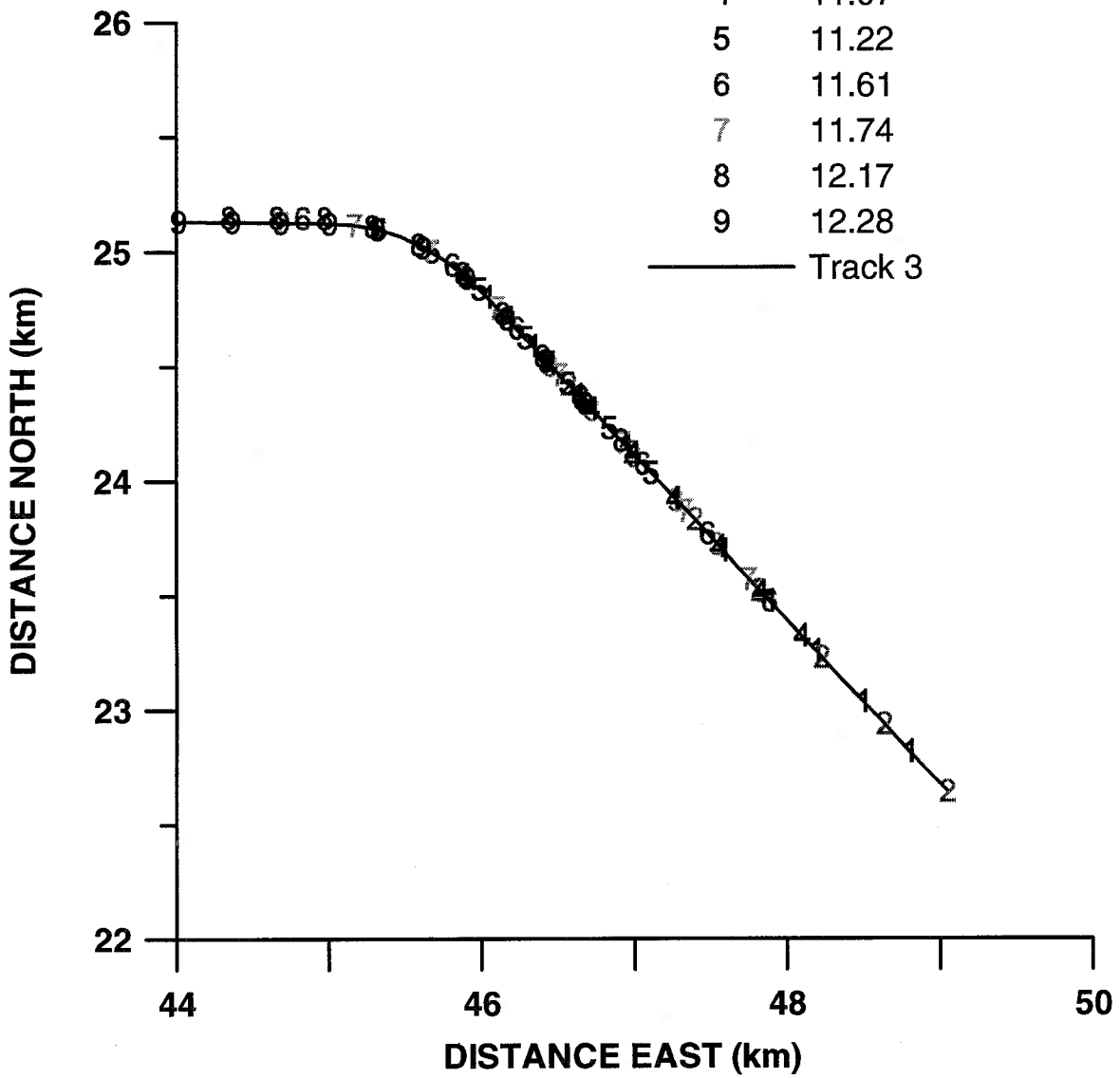


Figure 24. Traverses of Van 3 in Test 306 at different times during sampling period 10.18 - 12.28 hr, and the common Eulerian track (solid line).

11.61, and 11.74–12.28 hr. The average concentrations calculated for these periods were stored as 306A3-1.DAT to 306A3-3.DAT. Figures 25(a) to (d) present 16 traverses of Van 4 for the sampling periods 10.53–10.97, 11.14–11.54, 11.54–12.08, and 12.47–12.92 hr, respectively. Their concentration fields were stored in files 306C4-1.DAT to 306C4-4.DAT, and the average concentrations calculated over these four time periods were stored as 306A4-1.DAT to 306A4-4.DAT.

Figures 26(a) to (d) present 28 traverses of Van 5 for the sampling periods 10.29–10.78, 10.83–11.32, 11.43–11.96, and 12.13–12.66 hr, respectively. The corresponding concentration fields were stored in files 306C5-1.DAT to 306C5-4.DAT, and the average concentrations calculated over these four time periods were stored as 306A5-1.DAT to 306A5-4.DAT. Figures 27(a) to (c) show 12 traverses of Van 6 for the sampling periods 10.46–10.99, 11.11–11.67, and 12.33–12.79 hr, respectively. The average concentrations calculated from these files were stored as 306A6-1.DAT to 306A6-3.DAT. The variations of processed concentrations and their average value over the time period 12.33–12.79 hr versus travel distance along the Eulerian track for Van 6 are presented in Figure 28.

3.4.2 Elevated release

Test 304 was selected as the elevated release case for Session 3. The tracer was released from the blimp over SLC 37 (see Table 1) at an altitude of 305 m (1000 ft) MSL. The duration of the release was 2.00 hr starting from 10:00 EDT at a mean rate of 17.60 kg/hr. The objective of the test was to release the tracer just above the surface flow layer with likely sea breeze influences, so that the morning ground heating over Merritt Island would mix it to the ground level. The profiler and rawinsonde winds were nearly uniform at about 8 m/s from the ESE to SE in the atmospheric layer below the release height. Broken cumulus clouds at about 750 m altitude covered about 70% of the sky. Vans and aircraft tracked the plume NW across Merritt Island, and found moderate to strong concentrations in places. Plume subsidence was taking place as the tracer flowed west over the Banana River. Aircraft found dilute amounts of tracer above the release altitude only at a far downwind distance, where the plume apparently became wide and diffuse. The number of plume-hit sampling files are listed in parentheses: Van 1 (10), Van 2 (7), Van 3 (18), Van 4 (10), Van 5 (22), Van 6 (7), and Aircraft 1 (17). Aircraft 2 did not operate. The traverses of the various sampling platforms, plotted by Start (2000), are shown in Figure 29.

Figure 30 shows 10 traverses (denoted by the symbols 1 to 9 and A) of Van 1 during the sampling period 10.96–12.72 hr. The solid line indicates the common track overlapping all van traverses. The sampled concentrations of Van 1 were interpolated to stationary receptors located on this track to derive detailed time – space history of the concentration field, which was stored as 304C1ALL.DAT, 304C1-1.DAT, and 304C1-2.DAT. The last two files, with 4 traverses each, cover the sampling periods 11.38–11.90 and 12.28–12.72 hr.

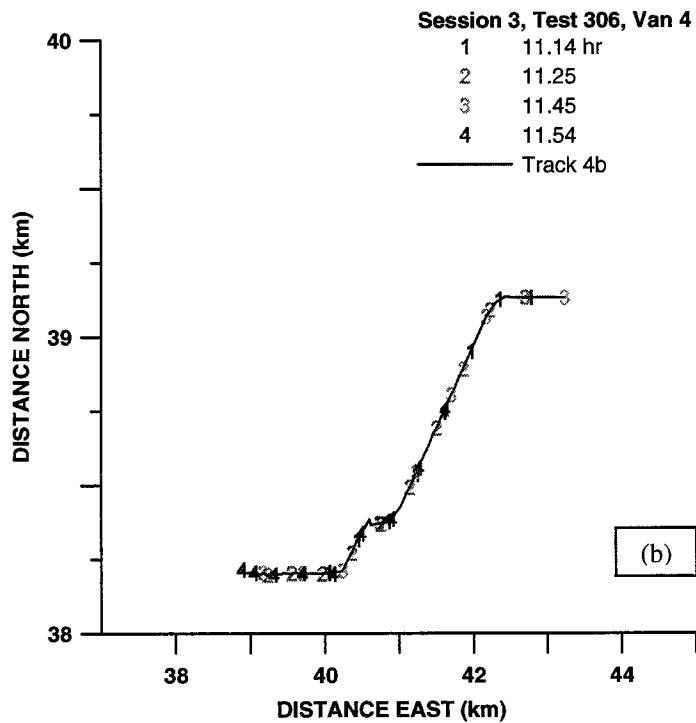
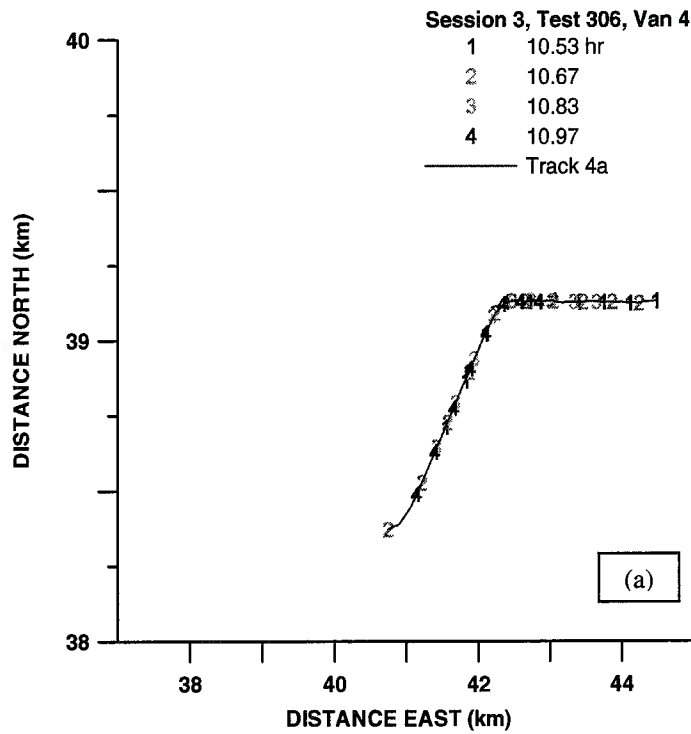


Figure 25. Traverses of Van 4 in Test 306 at different times and the common Eulerian tracks (solid lines) during sampling periods: (a) 10.53 - 10.97 hr, and (b) 11.14 - 11.54.

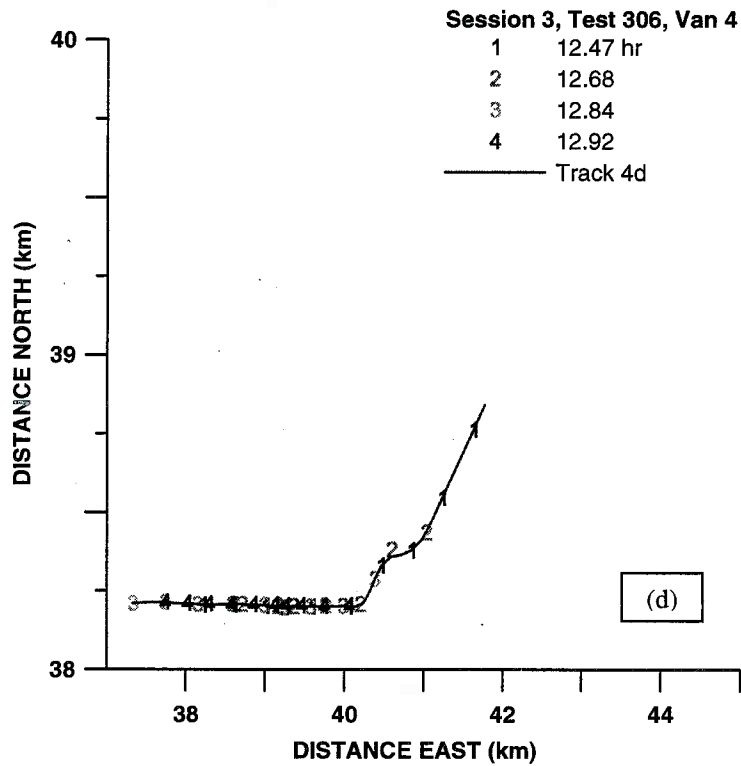
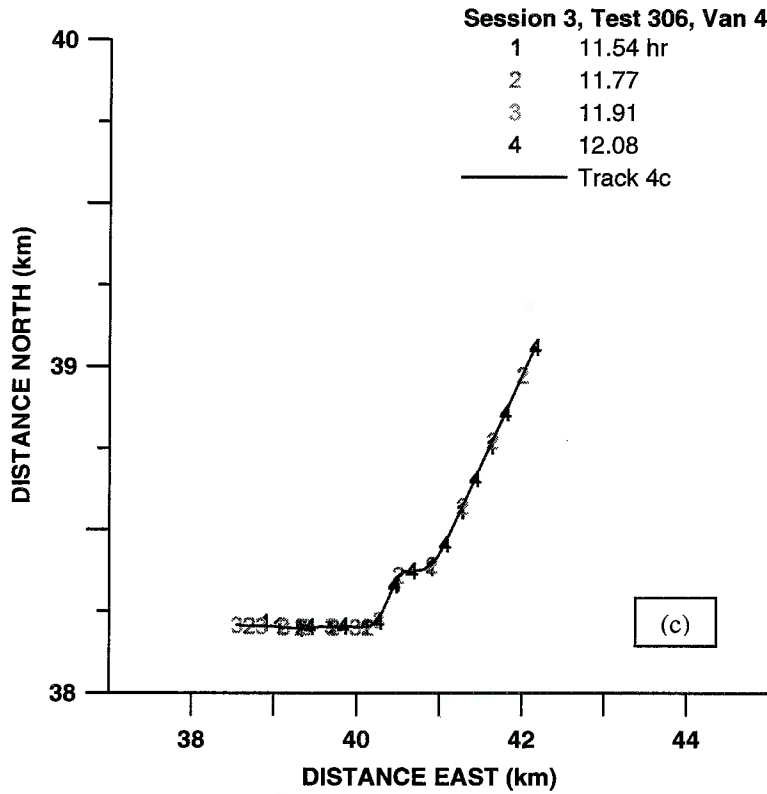


Figure 25. Continued: (c) 11.54 - 12.08, and (d) 12.47 - 12.92.

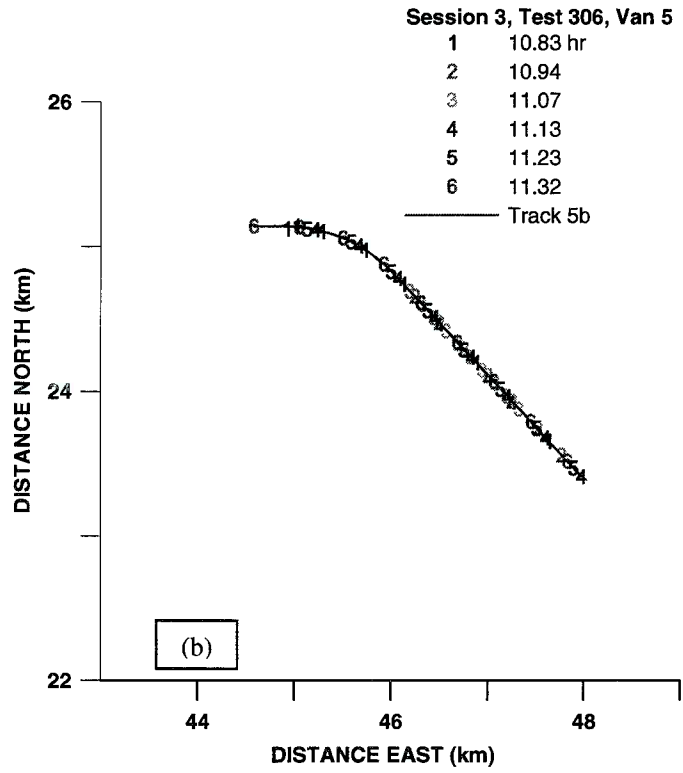
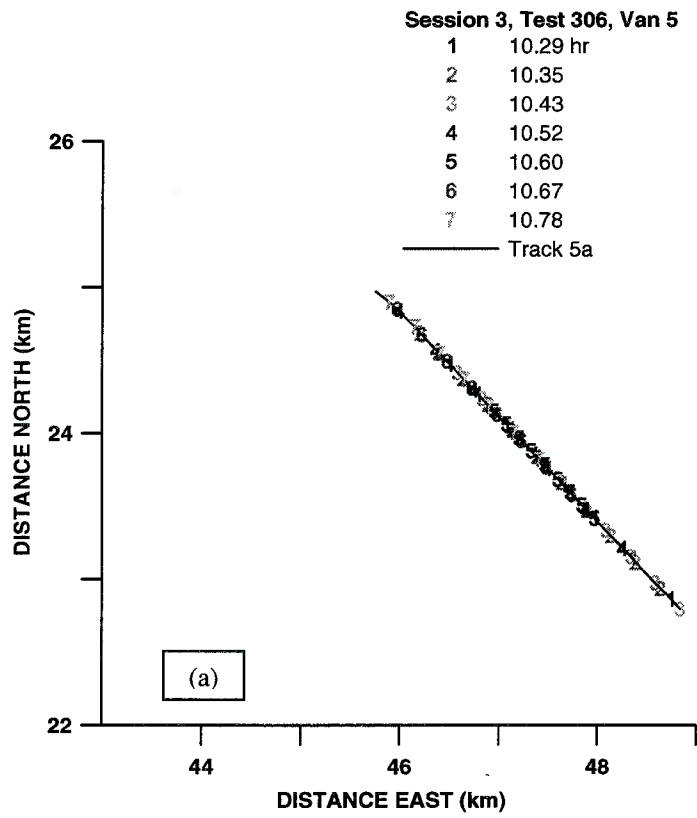


Figure 26. Traverses of Van 5 in Test 306 at different times and the common Eulerian tracks (solid lines) during sampling periods: (a) 10.53 - 10.97 hr, and (b) 11.11 - 11.67 hr.

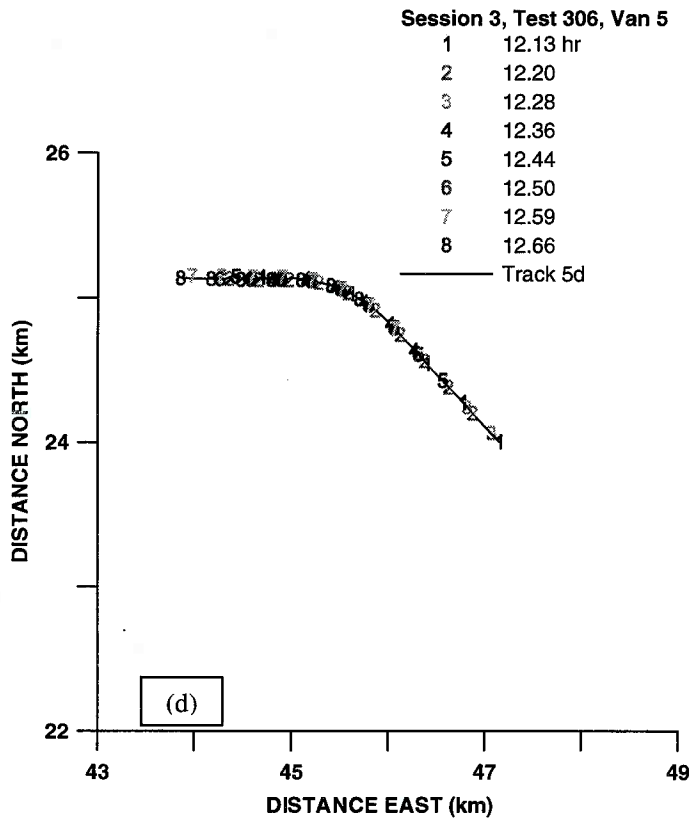
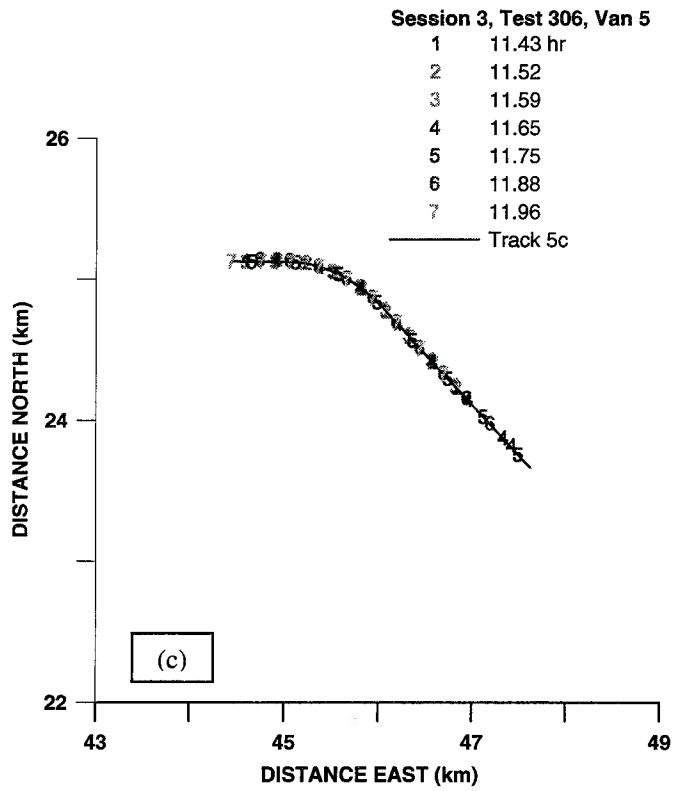


Figure 26. Continued: (c) 11.43 - 11.96 hr, and (d) 12.13 - 12.66 hr.

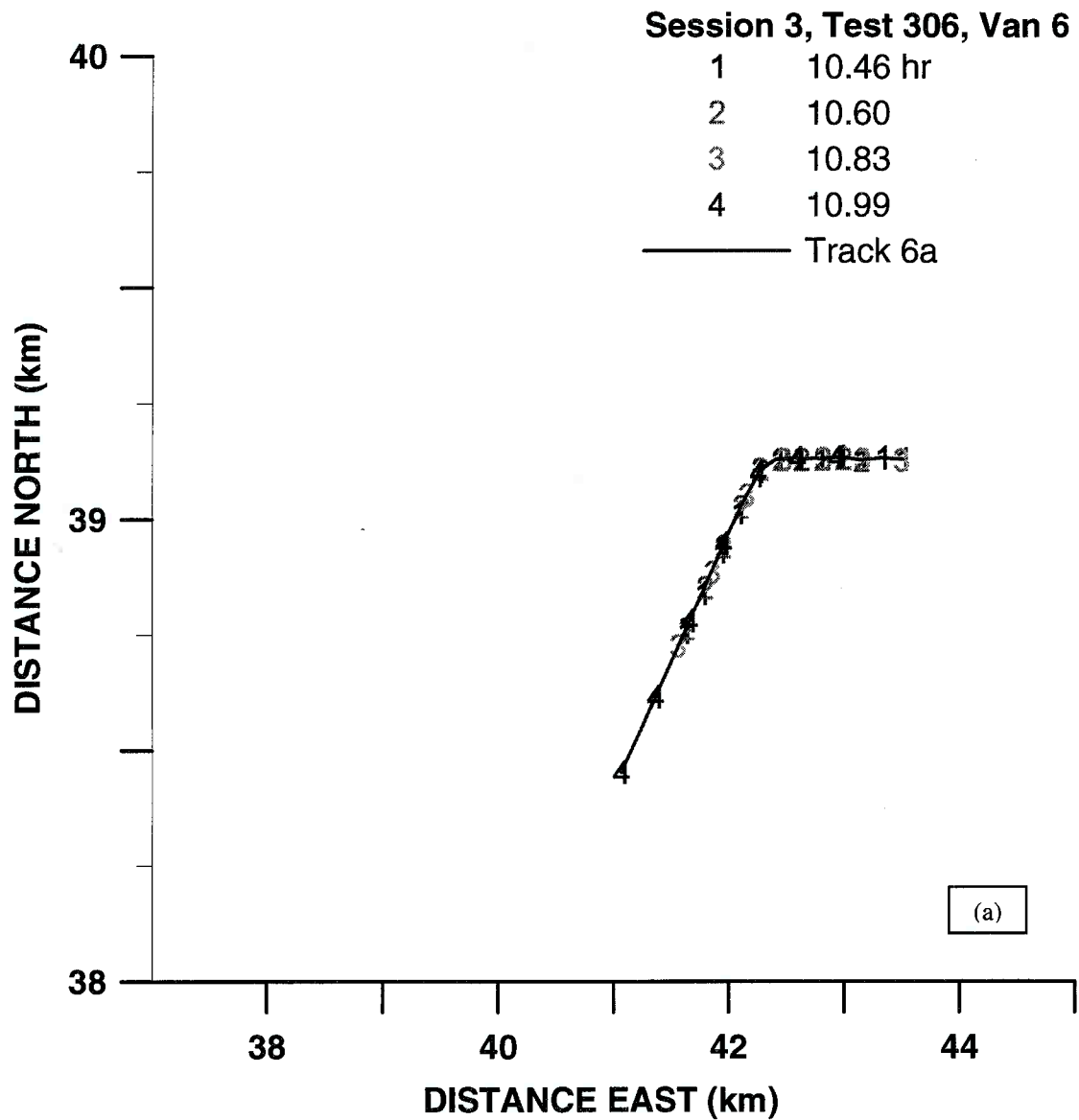


Figure 27. Traverses of Van 6 in Test 306 at different times and the common Eulerian tracks (solid lines) during sampling periods: (a) 10.46 - 10.99 hr.

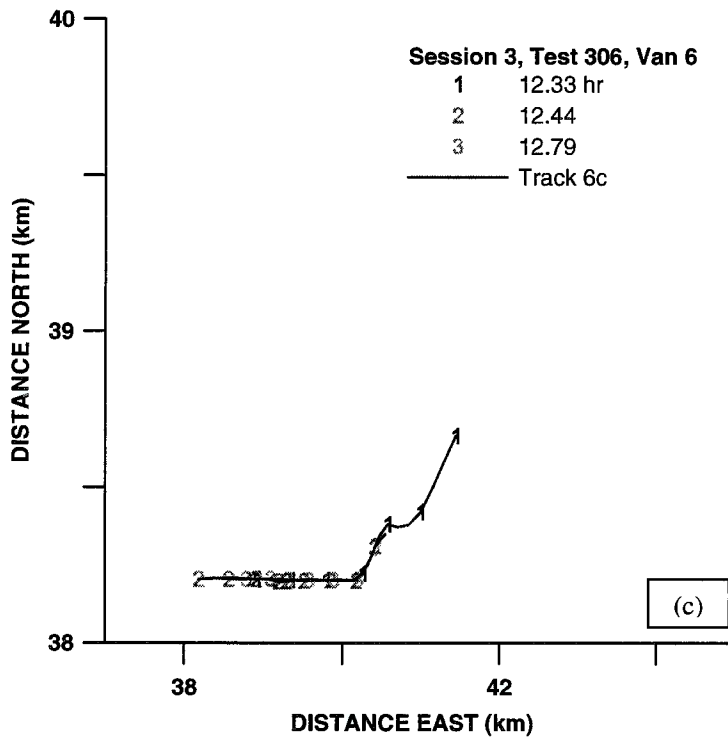
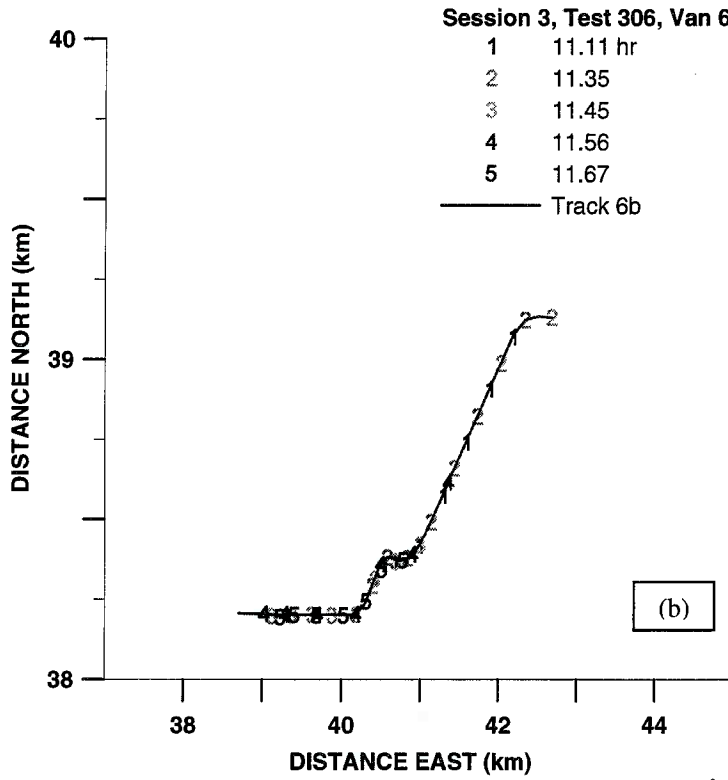


Figure 27. Continued: (b) 11.11 - 11.67 hr, and (c) 12.33 - 12.79 hr.

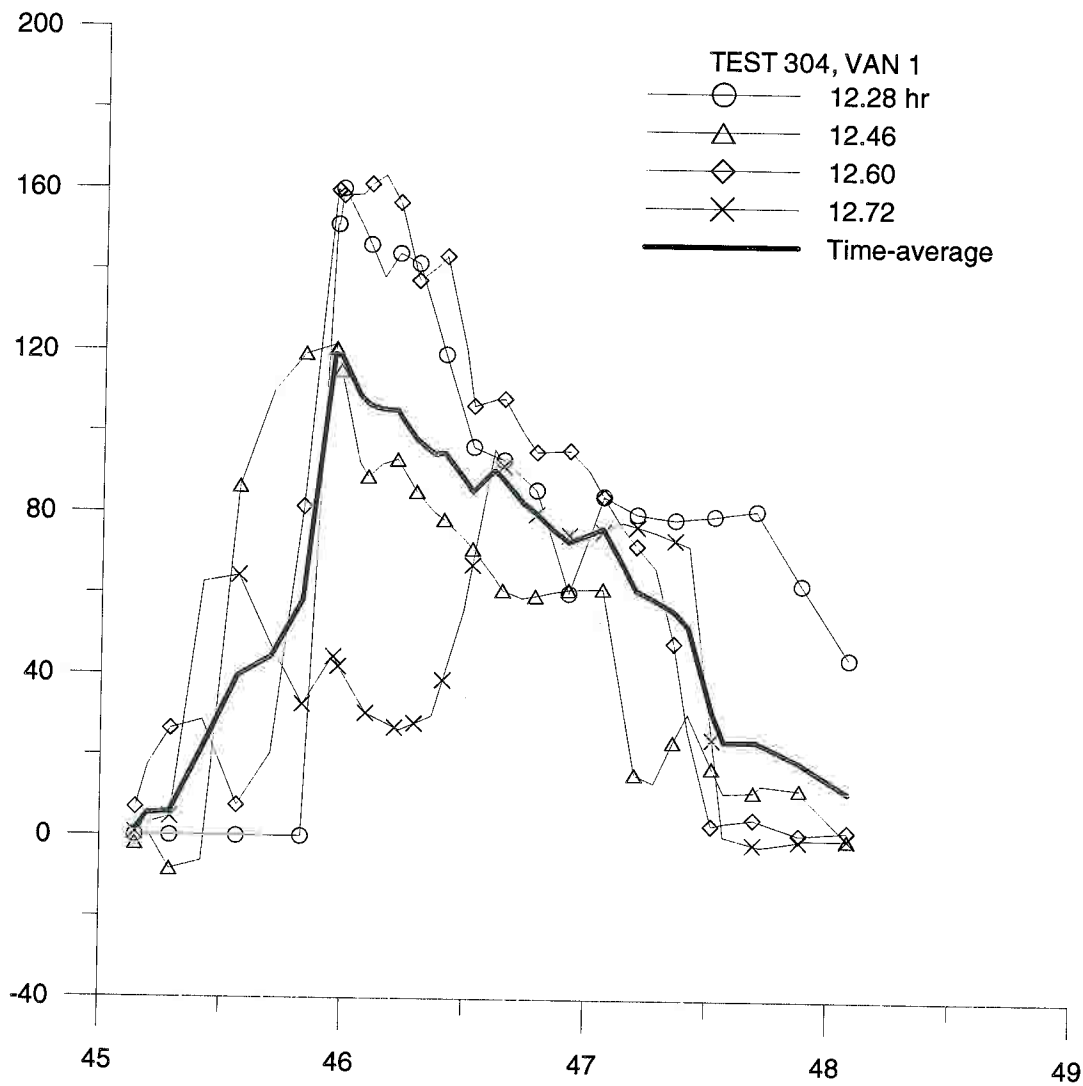


Figure 28. Variations of processed concentrations and their average value over the time period 12.33 - 12.79 hr versus travel distance along the Eulerian track for Van 6 in Test 306.

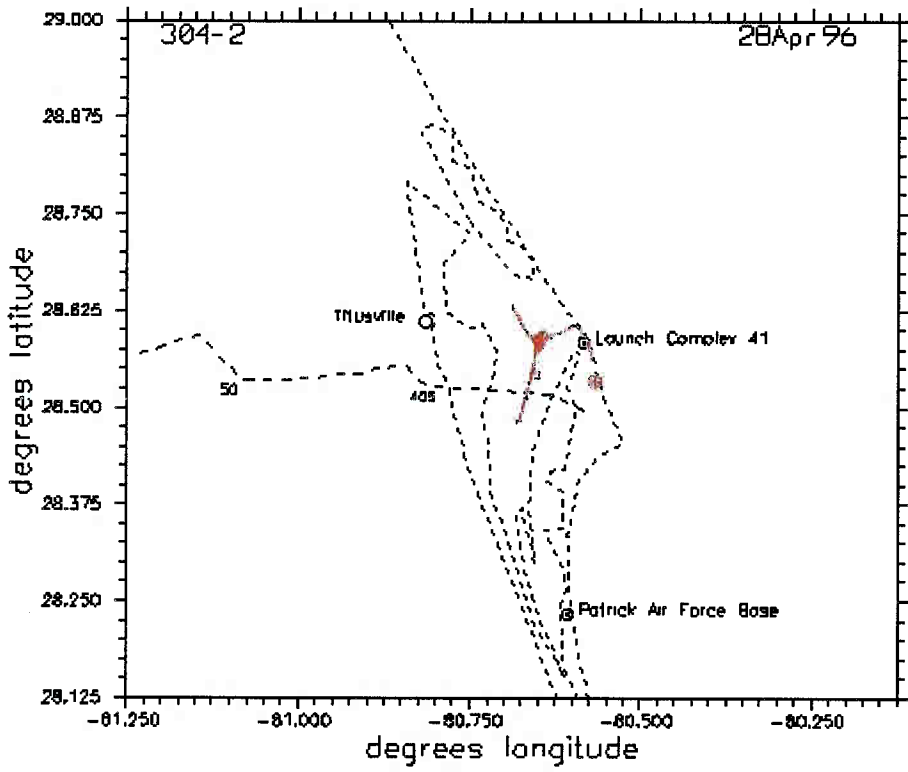
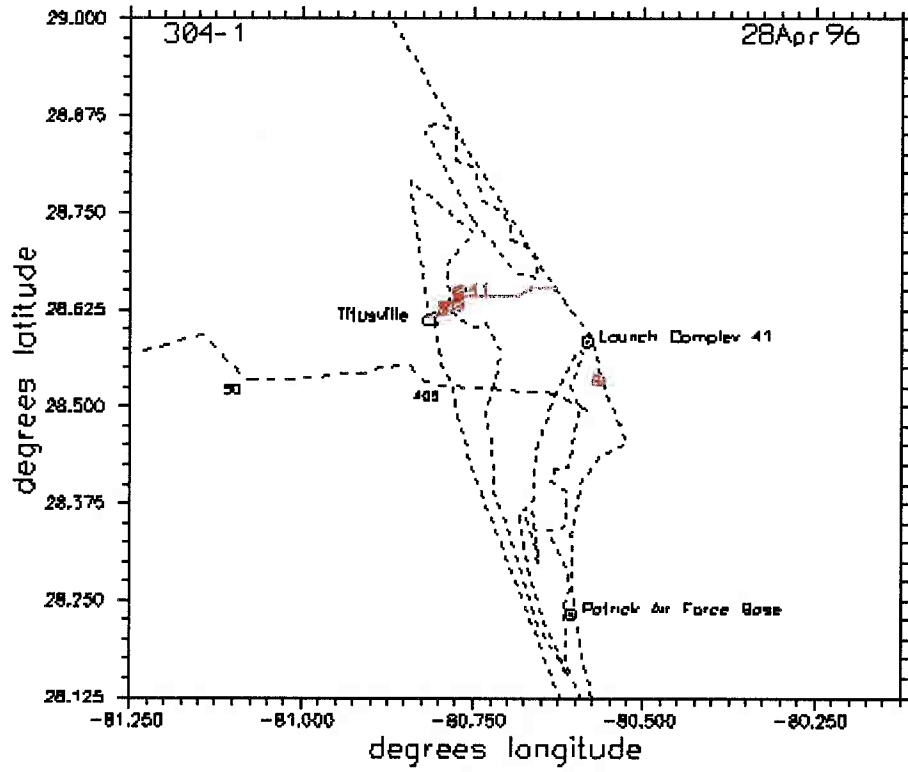


Figure 29. Traverses of tracer-sampling platforms used in MVP Test 304. The label at the top left inside of each figure gives the Test number and the platform label: (a) Vans 1 and 2.

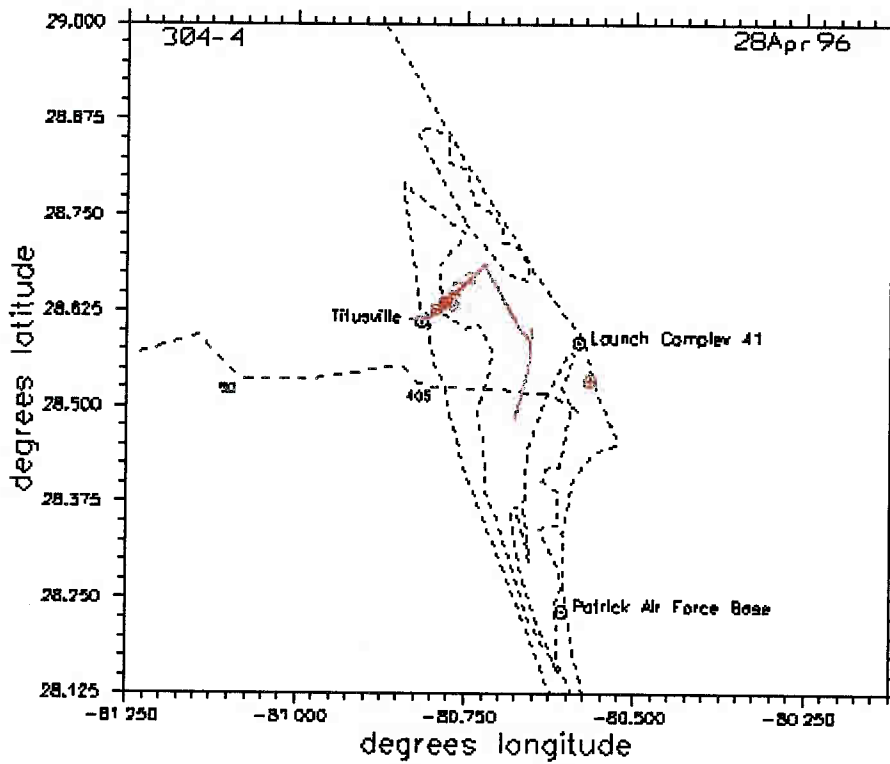
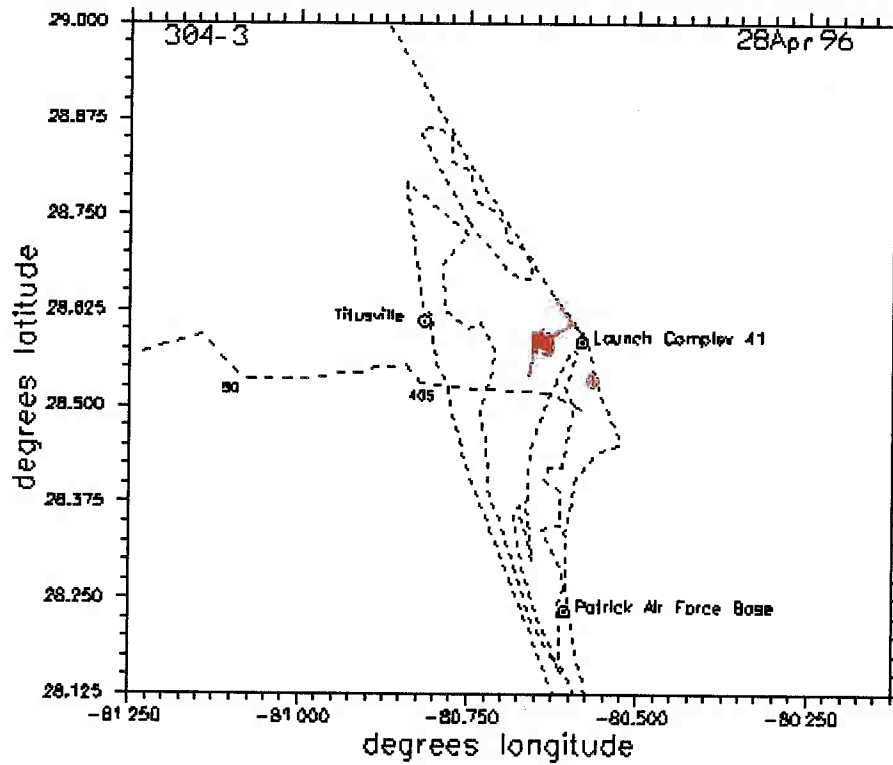


Figure 29. Continued: (b) Vans 3 and 4.

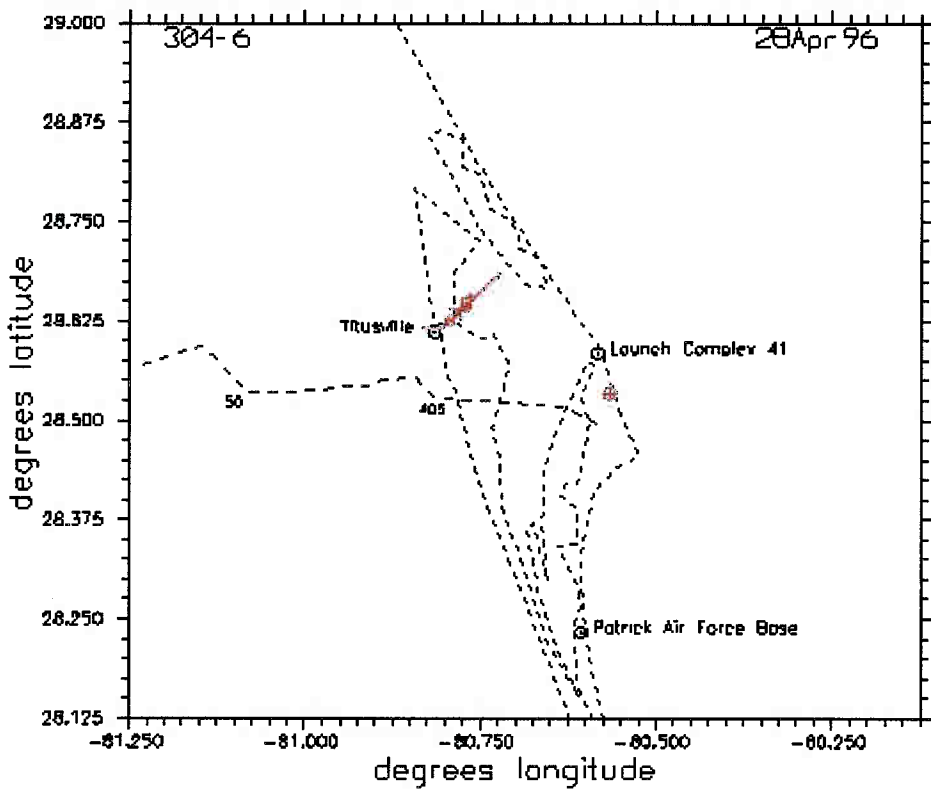
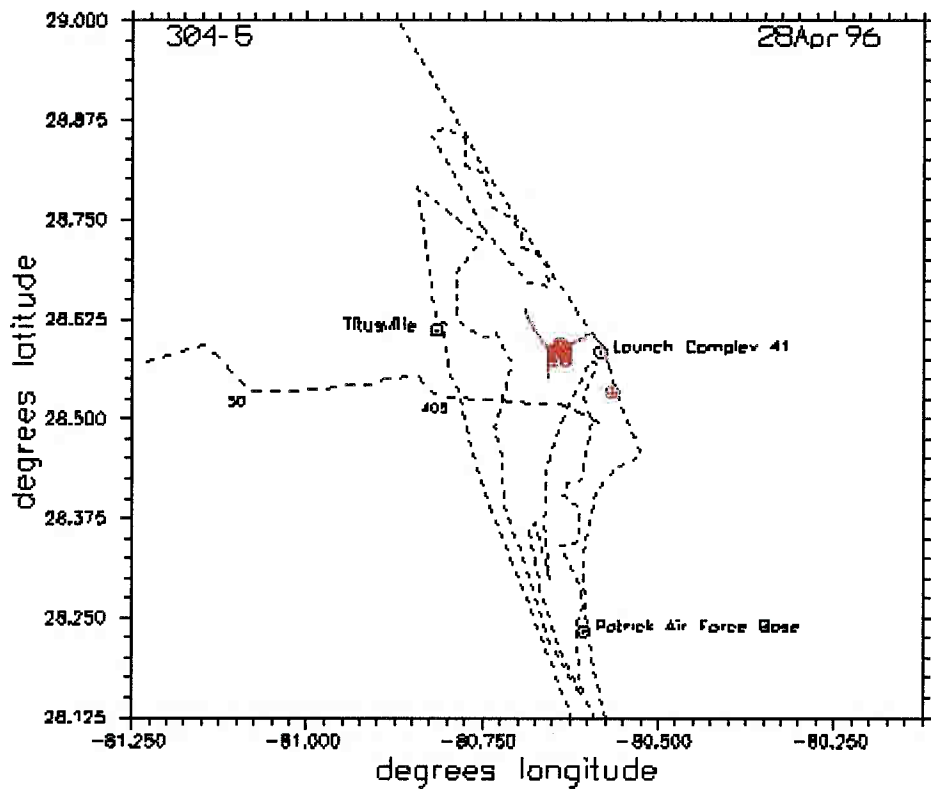


Figure 29. Continued: (c) Vans 5 and 6.

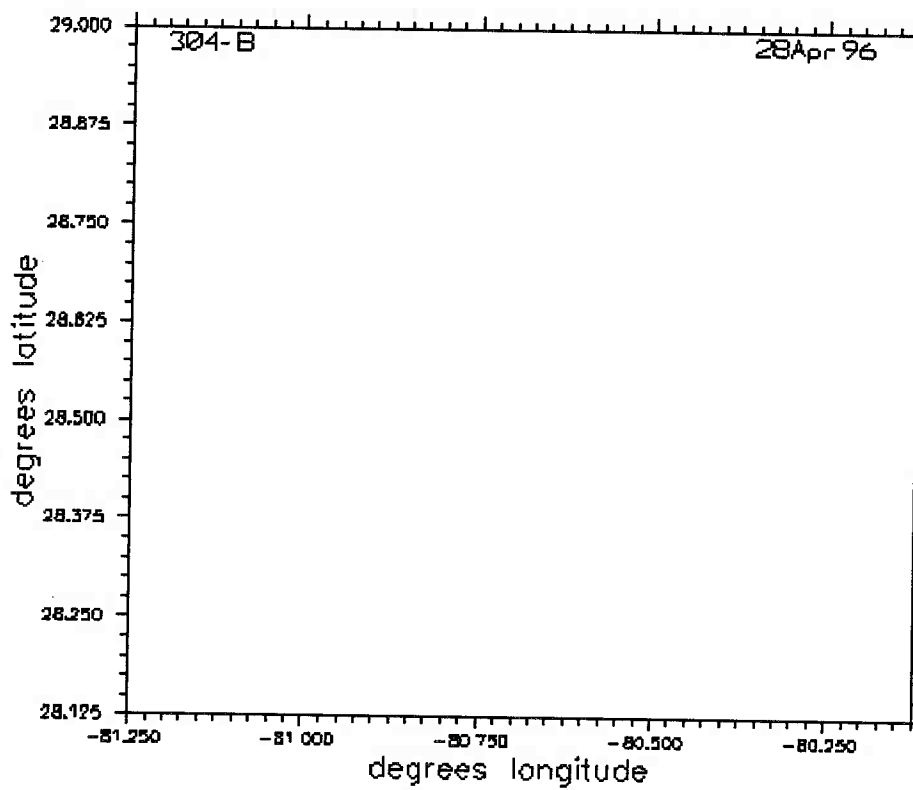
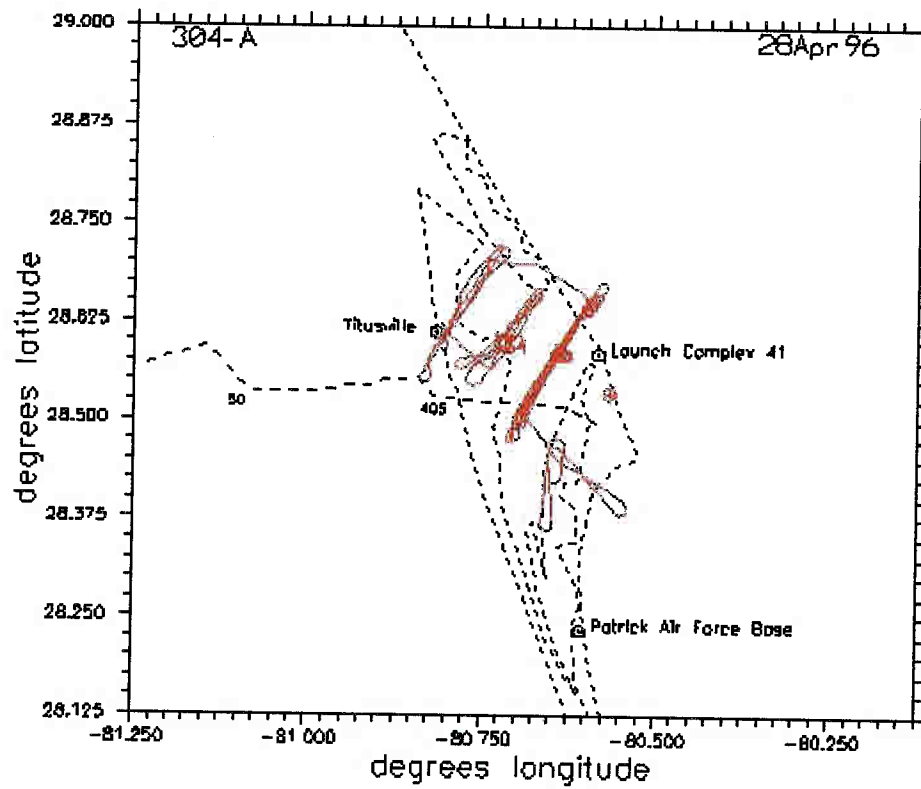


Figure 29. Continued: (d) Aircraft A and B.

The average concentrations calculated for these two periods were stored as 304A1-1.DAT and 304A1-2.DAT. The sampled concentration field for 6 traverses (not shown) of Van 2 during the time period 10.67–12.08 hr was stored in 304C2ALL.DAT. No half-hour average concentrations were calculated since half of the common track was E–W and the other half N–S. Figure 31 shows 18 traverses of Van 3 from 10.48–12.33 hr and their common track. The resulting concentration fields were stored as 304C3ALL.DAT, 304C3-1.DAT, 304C3- 2.DAT and 304C3-3.DAT. The last three files cover the sampling periods 10.75–11.31, 11.31–11.81, and 11.86–12.33 hr, respectively. The average concentrations calculated over these periods were stored as 304A3-1.DAT to 304A3-3.DAT. The variations of processed concentrations and their average value over the time period 12.28–12.72 hr versus travel distance along the Eulerian track for Van 1 are presented in Figure 32.

The concentration field for 9 traverses (not shown) of Van 4 during the sampling period 11.10–12.75 hr was stored as 304C4ALL.DAT. No half-hour average concentrations were computed since the van traverses and sampling times did not facilitate calculation of a continuous half-hour average value. Figure 33(a) shows 12 traverses of Van 5 for the sampling period 10.55–11.52 hr and their common track. The concentration field for all traverses was stored as 304C5ALL.DAT. The concentration field for the first 9 traverses (covering the period 10.55–11.23 hr) and the last 4 traverses (covering the period 11.23–11.52 hr) were stored separately in files 304C5-1.DAT and 304C5-2.DAT, respectively. Figure 33(b) presents 10 traverses of Van 5 for the sampling period 11.58–12.29 hr and their common track. Its concentration field was stored as 304C5-3.DAT. The average concentrations derived from the three concentration files (with averaging times of 0.28, 0.29 and 0.31 hr, respectively) were calculated and stored in 304A5-1.DAT to 304A5-3.DAT. Figures 34 shows 7 traverses of Van 6 for the sampling period 11.00–12.64 hr and their common track. The resulting concentration fields were stored as 304C6ALL.DAT, 304C6-1.DAT and 304C6-2.DAT. The average concentrations calculated from the last two files, covering the periods 11.17–11.67 and 11.41–11.93 hr, were stored as 304A6-1.DAT and 304A6-2.DAT.

4. DISCUSSION AND CONCLUSIONS

USAF's Model Validation Program (MVP) conducted three field experiment sessions at Cape Canaveral, Florida, during different seasons of 1995 and 1996. A series of tracer tests, which involved SF₆ releases at different locations and heights, were performed during each experiment. For each test, extensive meteorological and concentration sampling data were collected throughout the atmospheric boundary layer to altitudes of 1200 m MSL. In contrast to most previous atmospheric dispersion studies, which deployed a ground-level stationary tracer-sampling network (e.g., Rao *et al.*, 1991a), MVP utilized fast-response gas analyzers mounted on mobile vans and on aircraft to collect the concentration data.

This report described the processing of the MVP tracer surface sampling data stored in the MVP archives. The data analyses for six tracer tests, one elevated release and one near-surface release for each of the three MVP sessions at CCAS, were described in this report to illustrate the spatial

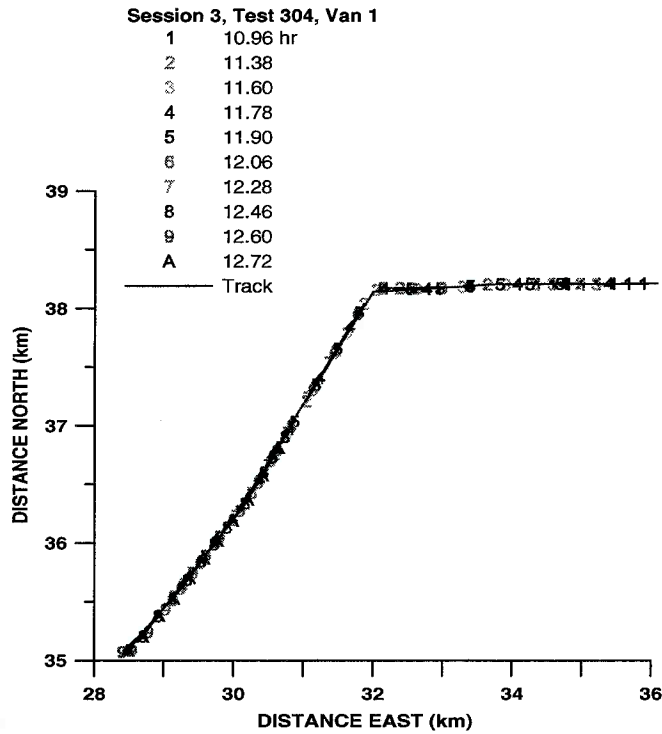


Figure 30. Traverses of Van 1 in Test 304 at different times during sampling period 10.96 - 12.72 hr, and the common Eulerian track (solid line).

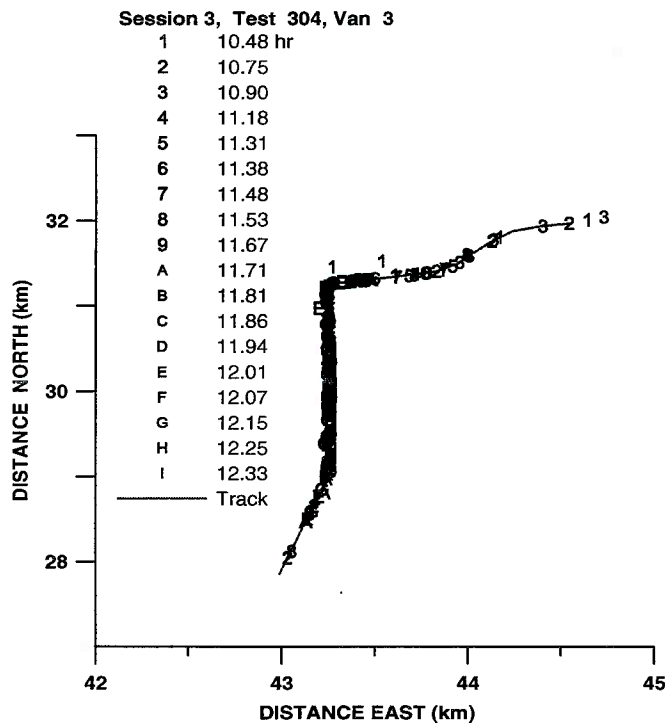


Figure 31. Traverses of Van 3 in Test 304 at different times during sampling period 10.48 - 12.33 hr, and the common Eulerian track (solid line).

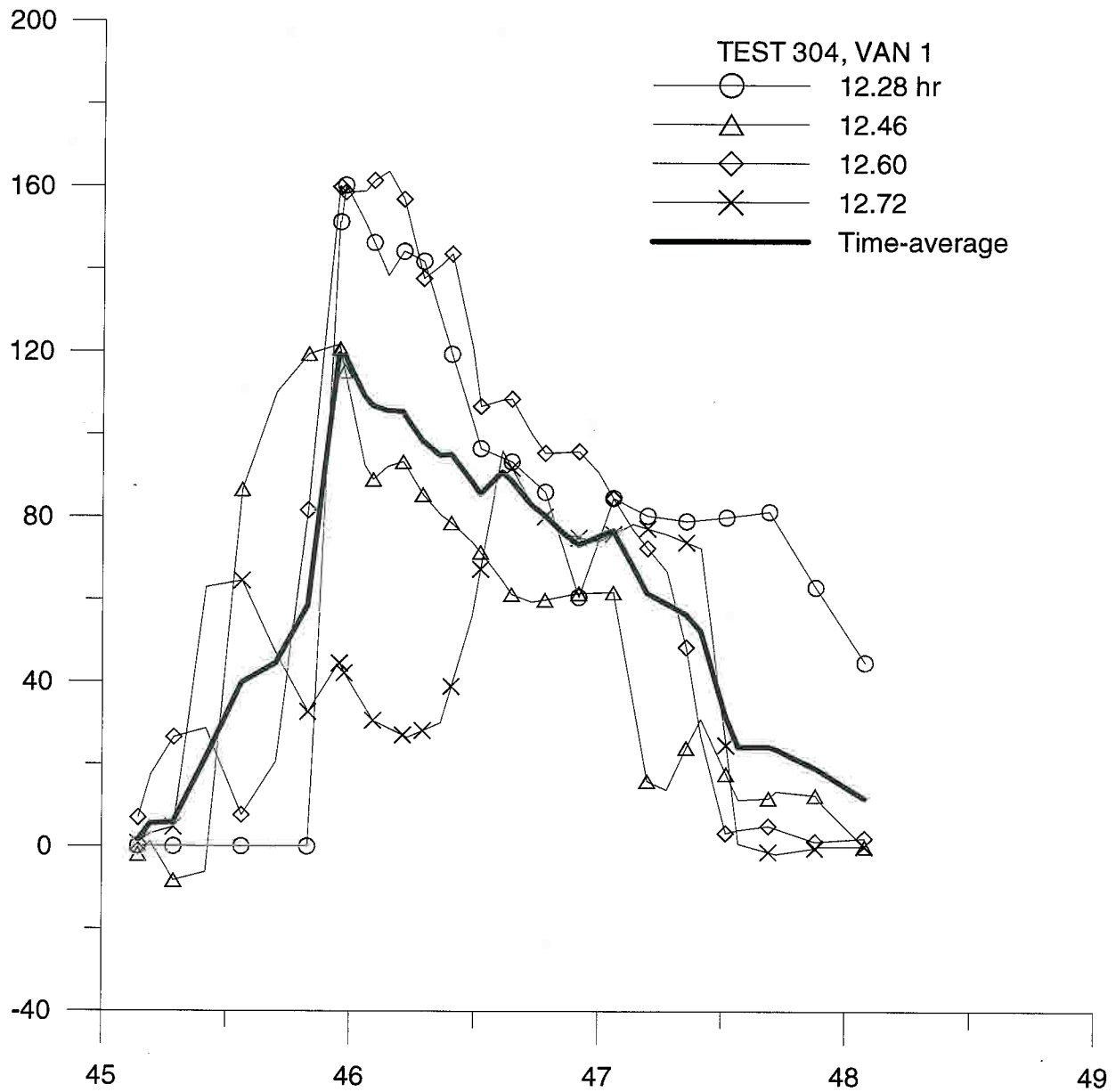


Figure 32. Variations of processed concentrations and their average value over the time period 12.28 - 12.72 hr versus travel distance along the Eulerian track for Van 1 in Test 304.

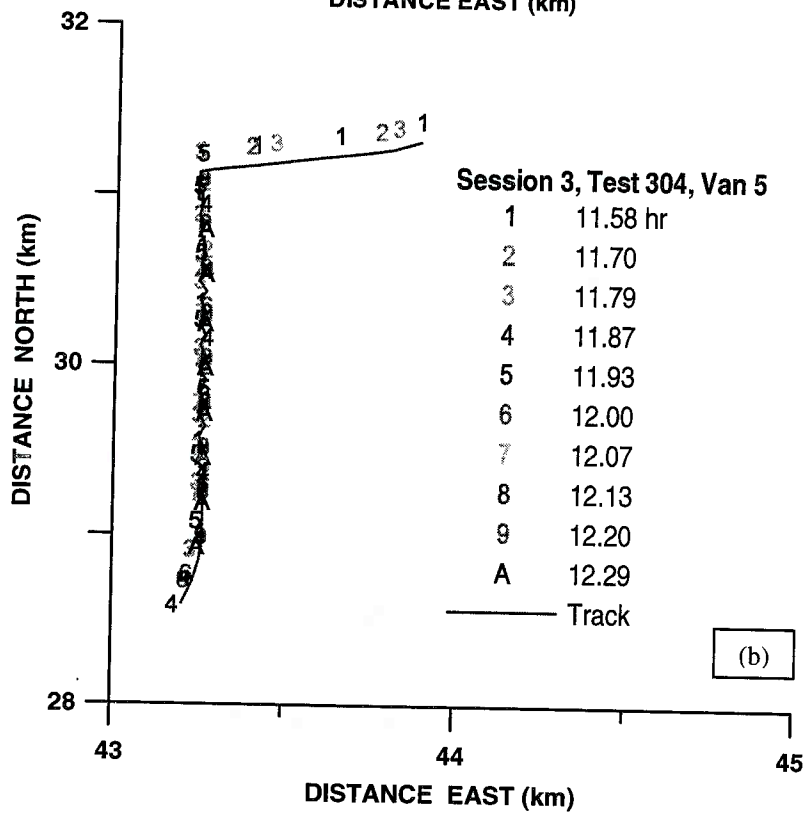
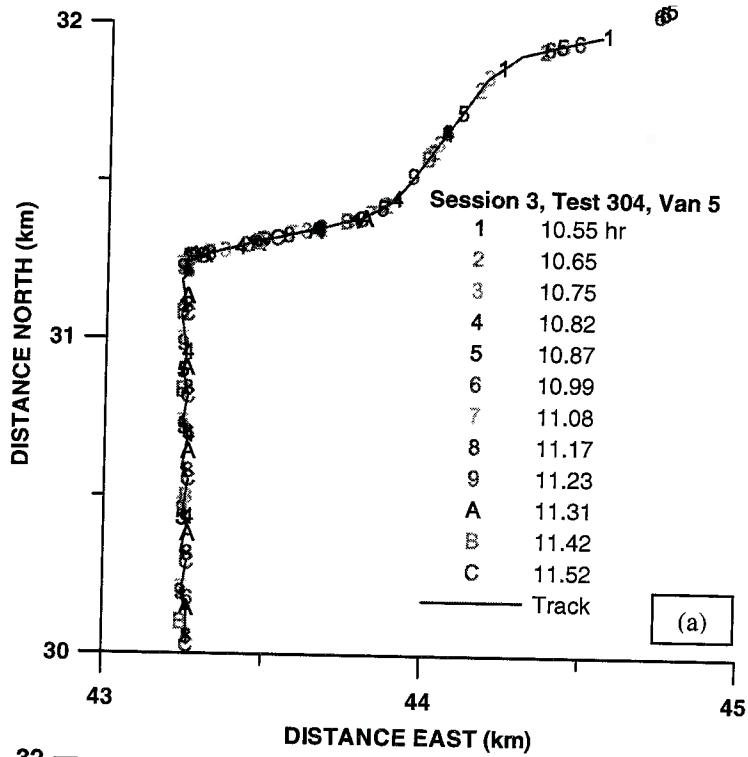


Figure 33. Traverses of Van 5 in Test 306 at different times and the common Eulerian tracks (solid lines) during sampling periods (a) 10.55 - 11.52 hr, and (b) 11.58 - 12.29 hr.

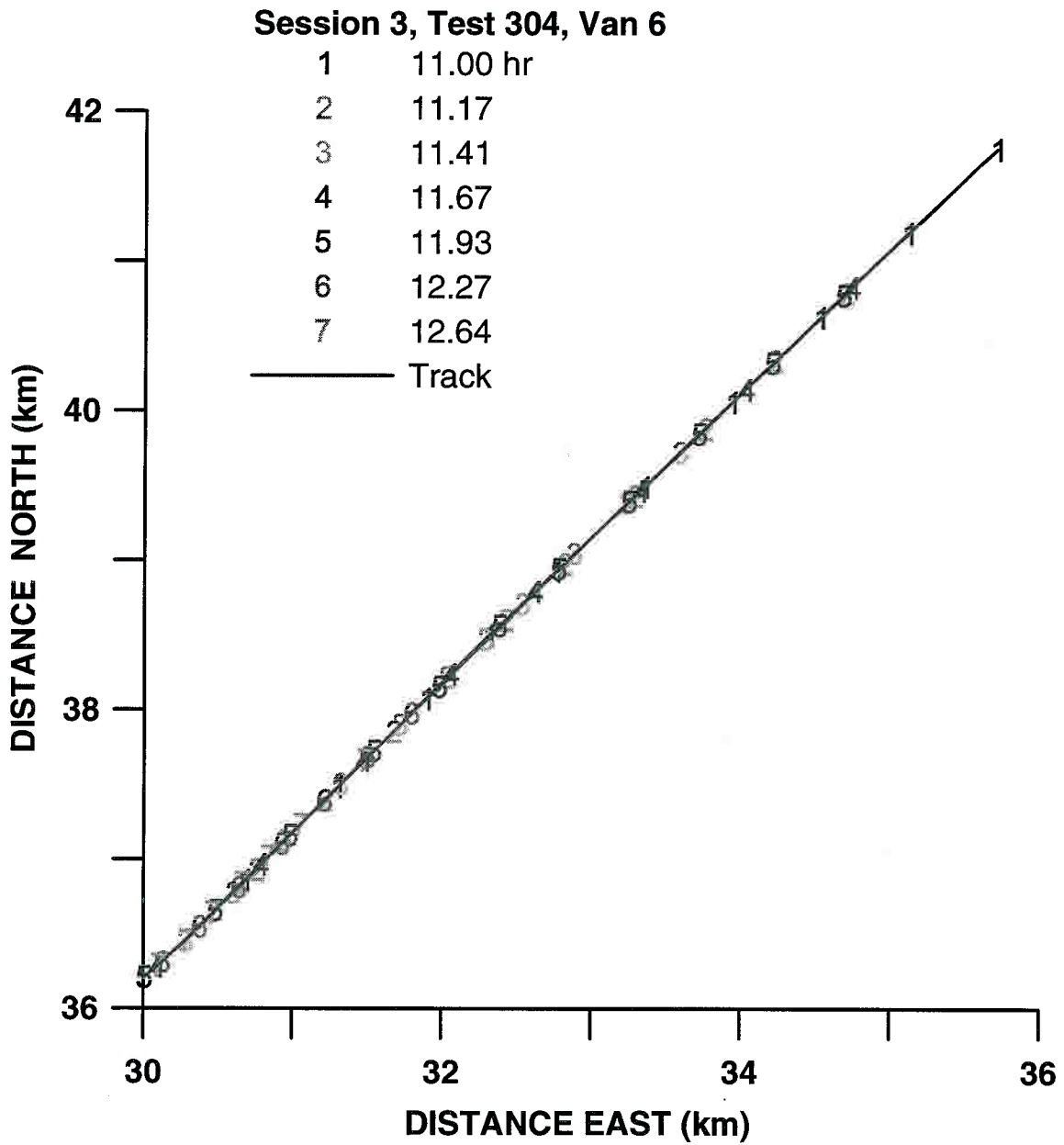


Figure 34. Traverses of Van 6 in Test 304 at different times during sampling period 11.00 - 12.64 hr, and the common Eulerian track (solid line).

and temporal averaging procedures developed to calculate the surface concentrations. The methodology consists of systematically plotting each van's traverses at different times in a sampling period, determining a fixed (Eulerian) track, which is common to multiple traverses of each van, interpolating the van-sampled (Lagrangian) near-instantaneous concentrations to receptors located on this common track, and calculating average concentrations over an approximately half-hour time period at each receptor by averaging the interpolated data at different sampling times in that period. For each van, the time-space history of single-pass as well as half-hour average concentrations were calculated and stored in separate directories in the MVP data archive.

Mobile sampling is ideally suited for elevated releases and large experimental domains with highly variable complex meteorological conditions, such as those encountered in the MVP, where fixed *in-situ* sampling would be impractical and prohibitively expensive. It is certain that mobile sampling, which has been facilitated by the development of GPS and FGA in recent years, would be increasingly used in tracer studies in future field experiments. However, little guidance is available for the collection and analysis of mobile surface sampling data. The methodology described in this report takes advantage of multiple replications of van traverses downwind of the tracer release location to compute spatial variations of time-average concentrations. While this procedure is somewhat tedious and time-consuming, it is more accurate than other types of averaging (e.g., over a spatial volume, regardless of measurement platform or related uncertainties) for calculating average observed concentrations that can be physically compared to model predictions.

Some of the calculated values in both the single-pass and time-average concentration files were negative. Negative concentrations are physically meaningless. The simplest correction for the negative concentrations (Start, 2001) is to set them to zero or to a small negative constant, in the absence of specific supporting information about the instrument operation at that time. This "uniform censoring" of data is somewhat arbitrary and may introduce some bias in the averaged concentrations (see, e.g., Rao *et al.*, 1991b). This bias can be considered as one of the factors contributing to the overall uncertainty in the sampling results. This type of correction was not applied to the processed data files for the tests described in this report, since it was felt such decisions should be left to the individual investigator.

The negative concentration values often result from a noisy baseline signal from the FGA instrument that is set close to a zero output voltage. As the instrument detector accumulates or loses contaminants, the baseline signal changes. Those changes that cause the instrument baseline to drift toward the negative side of zero voltage result in a greater likelihood of calculated negative concentrations. The signal variation may be real, but the absolute value of specific concentrations may be in error due to the switch in sign of output voltage. Small tracer concentration measurements need to rise substantially above the baseline noise level to be detected with confidence. Tracer concentration measurements of less than around 30 ppt have relatively large uncertainties, which are specific to each FGA during its particular date and time of operation.

According to Start (2001), when large concentrations of tracer were detected by the FGA, the instrument detector sometimes responds with a significant overshoot of the output signal in the

“negative” direction during its return to the detector background signal voltage. The degree of overshoot is related to the amount of contamination within the detector at the time. Sometimes those overshoots result in calculated negative concentrations. Test 110 (among the 6 tracer tests processed here) contained some significantly large negative concentrations. In most MVP tracer measurements however, unlike in Test 110, the magnitudes of the negative concentrations were small compared to the measured maximum (positive) concentrations.

The six tests processed here were selected from the three MVP sessions at CCAS to represent different seasons, tracer release heights and locations, and meteorological conditions. The MVP archive contains data files for many other tests conducted at CCAS and VAFB that should be of great interest to researchers for developing and evaluating models of complex local and mesoscale flow and dispersion in coastal regions. Many of these tests had specific objectives, such as investigation of dispersion patterns associated with local wind flows including sea and land breezes and convergence zones, plume dispersion under convective and under stable conditions, tracer releases above low-level inversions to determine if and where tracer was able to penetrate the inversion to reach ground-level receptors, elevated release along a cross-wind line to study along-wind diffusion, and tracer puff releases to investigate the near-field and far-field puff growth and relative diffusion.

The comprehensive MVP data archive, containing related reports and explanatory material, such as the supplemental tracer test and data collection descriptions provided by Start (2000) to help in understanding and screening the data, is a valuable resource for interested researchers. This archive, now housed at ATDD, is accessible to qualified users by issued password through ftp or Internet. In order to facilitate the use of the MVP tracer database, computer codes developed to process the surface tracer measurements, as described in this report, were included in Appendix I of this report. These codes can also be downloaded from the MVP archive.

5. ACKNOWLEDGEMENTS

This report was prepared under an agreement between NOAA’s Atmospheric Turbulence and Diffusion Division and the U.S. Air Force. The SF₆ tracer data processed in this report were collected, quality-checked, and archived by a team led by Mr. G. Start and Mr. R. Carter of NOAA Air Resources Laboratory’s Field Research Division. The author thanks Mr. G. Start, now of Evergreen Trust, Dr. R. Kamada of Kamada Science & Design, Drs. R. Abernathy and B. Lundblad of Aerospace Corporation, and Dr. R. Hosker of ATDD, for useful discussions and comments.

Ms. G. Ridenour of ATDD assisted with arrangement of the figures for the report. Ms. L. Gunter of ATDD aided Ms. G. Ridenour in preparing Figure 1. Figures 2, 6, 12, 17, 22, and 29 were reproduced from a CD-ROM prepared for MVP by Start (2000) and rearranged.

6. REFERENCES

Abernathy, R.N., I. A.Min, B. L. Lundblad, and W.S. Kempf, 1999: Tracer Puff Dispersion at Launch Sites. SMC-TR-99-25, Space and Missile Systems Center, Los Angeles AFB, CA, 12 pp.

Eckman, R. M., C. J. Nappo, and K. S. Rao, 1996: Rocket Exhaust Effluent Diffusion Model (REEDM) verification and sensitivity study. NOAA Tech. Memo. ERL ARL-214, ATDD, Oak Ridge, TN, 56 pp.

Evans, R. J. and C. J. Tremback, 1996: The implementation and evaluation of the Emergency Response Dose Assessment System (ERDAS) at Cape Canaveral Air Station/Kennedy Space Center. Preprints of the 9th Joint Conf. on Applications of Air Poll. Met. with A&WMA, Amer. Met. Soc., Boston, MA, 193-197.

Hosker, R. P., K. S. Rao, R M.Eckman, J. T. McQueen, and G. E. Start, 1993: An assessment of the dispersion models in the MARSS system used at the Kennedy Space Center. NOAA Tech. Memo. ERL ARL-205, ATDD, Oak Ridge, TN, 91 pp.

Kamada, R. F., G. E. Start, R. P. Hosker, J. T. Knudtson, and H. L. Lundblad, 1997: MVP: Elevated SF₆ puff/plume releases from 1 to 1200 m at Cape Canaveral, FL. Proceedings of the Sixth Topical Meeting on Emergency Preparedness and Response, Vol. 1, San Francisco, 43-46.

Parks, C. R., 1998: An overview of weather conditions during MVP tracer sessions at the Eastern Range. 98-370/9.3-01, ACTA, Torrance, CA, 29 pp; available in MVP archive.

Rao, K. S., R. S. Tangirala, and R. P. Hosker, 1991a: Tracer distributions in Brush Creek Valley drainage flow derived from 1984 ASCOT data. NOAA Tech. Memo. ERL ARL- 191, ATDD, Oak Ridge, TN, 55 pp.

Rao, S. T., J. Y. Ku, and K. S. Rao, 1991b: Analysis of toxic air contaminant data containing concentrations below the limit of detection. J. Air & Waste Management Assoc., 41, 442- 448.

Start, G. E. and D. Hoover, 1995: Model Validation Program, Cape Canaveral, Florida. draft report, NOAA ARL/FRD, Idaho Falls, ID.

Start, G. E., 2000: Guide to use of MVP tracer sampling data. file in CD-ROM with supplemental MVP tracer test and data measurement descriptions, Evergreen Trust, Idaho Falls, ID, 19 pp.

Start, G. E., 2001: Additional comments on MVP tracer sampling data uncertainties. Personal communication, 3 pp.

Start, G. E. and R. F. Kamada, 2001: Model Validation Project Summary Report MVP Field Sessions: 1 - 4 (1995 - 97) for Ground and Hovering Blimp Releases of SF₆ Tracer, Mobile Ground and Aerial Tracking, and Simultaneous Meteorological Data Collection. KSD-2001-01, USAF, Space and Missile Systems Center/CLNM, Los Angeles AFB, CA.

APPENDIX I

Computer Programs for Tracer Data Processing

The computer programs developed for processing the MVP surface-sampled tracer data (stored in the MVP data archive) as described in this report are listed here. Brief descriptions of these Fortran codes are given below.

RECPTOR.FOR

This program reads the surface sampled tracer data in the MVP archive and calculates the relative locations of the Cape Canaveral SF₆ receptors. Tower 110 (X₀,Y₀) is taken as the reference point of the receptor grid. The coordinates and concentration of only every tenth data sample are saved to reduce the number of observations at the same location.

RECYKSR.FOR

This program reads the Lagrangian (van-sampled) tracer concentration data output files produced by RECPTOR.FOR program and interpolates them to receptor points on a common (reference) Eulerian track. This program should be used only for non-horizontal sampling and reference tracks. Single-pass and half-hour average concentrations are calculated and stored at each receptor point on the reference track.

RECXKSR.FOR

This program reads the Lagrangian (van-sampled) tracer concentration data output files produced by RECPTOR.FOR program and interpolates them to receptor points on a common (reference) Eulerian track. This program should be used only for horizontal Eulerian sampling and reference tracks. Single-pass and half-hour average concentrations are calculated and stored at each receptor point on the reference track.

COORDES.FOR

This program calculates the relative locations of the Cape Canaveral SF₆ source(s) and receptors in Cartesian Coordinates in a rectangular grid. Tower 110 with coordinates X₀=50 km and Y₀=30 km is taken as the reference point.

LATLON.FOR

This program calculates the relative locations of the Cape Canaveral SF₆ receptors in latitude (deg) and longitude (deg) coordinates from input X (km) and Y (km) coordinates in a rectangular grid with Tower 110 (X₀=50 km, Y₀=30 km) as the reference point.

```

C   PROGRAM VERSION DATED: MAY 7, 2001
C   K.SHANKAR RAO, NOAA/ATDD, OAK RIDGE, TN 37831, USA
C   E-mail: rao@atdd.noaa.gov ; FAX: (865) 576-1327
C   *****
C   program RECPTOR
C
C   DOUBLE PRECISION LAT,LON, HOUR, C, CONVERT, CONST1,
1  CONST2, CONST3, XLAT, XLON, LAT1100, LON110
C   DIMENSION XR(3000), YR(3000), AVEC(3000), ALT(3000)
C   REAL LATR(3000), LONR(3000)
C   CHARACTER*12 PLUMIN
C   CHARACTER*12 PLUMOUT
C   CHARACTER*3 TAG/'DAT'/
C
C   X0=50.
C   Y0=30.
C   LAT110=28.5697D0
C   LON110=-80.5864D0
C   CONVERT=3.14157D0/180.D0
C   CONST1=6366.800D0
C   CONST2=CONVERT*CONST1
C
C   READ TRACER DATA AND CALCULATE AVERAGE CONCENTRATION FOR SAMPLES
C   AT SAME COORDINATES.
C
C   PLUMES.LST CONTAINS THE NAMES AND PATHS OF ALL INPUT TRACER RAW DATA
C   FILES (FROM MVP ARCHIVES): *.TNp, WHERE N IS VAN NUMBER (1 TO 6).
C   OPEN(10, FILE='PLUMES.LST', STATUS='OLD')
50  READ(10, '(A12)', END=2100) PLUMIN
C   WRITE(*, '(A12)') PLUMIN
C   OPEN(12, FILE=PLUMIN, STATUS='OLD')
C
C   PLUMOUT=PLUMIN
C   THE OUTPUT FILE HAS SAME NAME AS INPUT FILE EXCEPT FOR LAST
C   3 LETTERS: tNp OF FILE NAME ARE CHANGED TO: DAT
C   WRITE(PLUMOUT(10:12), '(A3)') TAG
C   ICOUNT=1
100  CSUM=0.0
C   K=0
150  READ(12, *, END=200) HOUR, LAT, LON, ALT1, N, DIF, C
C   IF(ICOUNT.EQ.1) THEN
C   TIME=HOUR
C   ENDIF
C
C   IF(K.GT.0) GO TO 190
C   CSUM=CSUM+C
C   K=K+1
C   XLAT=LAT
C   XLON=LON
C   GO TO 150
C
C   CONTINUE
190  IF(LAT.EQ.XLAT.AND.LON.EQ.XLON) THEN
C   CSUM=CSUM+C
C   K=K+1
C   GO TO 150

```

```

        END IF
        LATR(ICOUNT)=LAT
        LONR(ICOUNT)=LON
        ALT(ICOUNT)=ALT1
        AVEC(ICOUNT)=CSUM/K
        ICOUNT=ICOUNT+1
        GO TO 100
200    CONTINUE
C
C    PROCESS AND WRITE OUTPUT FILE
        ICOUNT=ICOUNT-1
        OPEN(20,FILE=PLUMOUT,STATUS='UNKNOWN')
        WRITE(20,'(F5.2)') TIME
C    CONVERT LAT/LON COORDINATES OF RECEPTORS (LATR,LONR)
C    TO CARTESIAN COORDINATES (XR,YR)
        DO 110 J=10,ICOUNT,10
        CONST3=DCOS(LATR(J)*CONVERT)
        YR(J)=Y0-(LAT110-LATR(J))*CONST2
        XR(J)=X0-(LON110-LONR(J))*CONST2*CONST3
C    WRITE OUTPUT: XR AND YR IN km, AND AVERAGE CONCENTRATION (ppt)
        WRITE(20,1100) J,XR(J),YR(J),AVEC(J)
110    CONTINUE
        WRITE(*,'(A12)') PLUMOUT
1100   FORMAT(I4,2F12.5,E12.4)
        CLOSE(12)
        CLOSE(20)
C
        GO TO 50
C
2100   CONTINUE
C
        STOP 999
        END
C*****
PROGRAM RECYKSR
C
        DIMENSION XE(500),YE(500),XL(500),YL(500),CL(500),CE(500,20),
1CAVE(500),TIME(20),CDUM(500)
        CHARACTER*19 LANG
C
C    LISTINP.DAT CONSISTS OF ALL SAMPLING DATA FILES (RECPTR.FOR
C    OUTPUTS) OF EACH VAN INCLUDED IN THE HALF-HOUR AVERAGE;
C    TRACKINP.DAT CONSISTS OF X,Y COORDINATES OF RECEPTORS ON THE
C    REFERENCE EULERIAN TRACK.
C
        OPEN (16,FILE='C:\MVP\LISTINP.DAT',STATUS='OLD')
        OPEN (15,FILE='C:\MVP\TRAKINP.DAT',STATUS='OLD')
C
C    EULERIAN OUTPUT FILES:
C    CONCOUT.DAT CONSISTS OF OUTPUT CONCENTRATIONS INTERPOLATED TO
C    EULERIAN RECEPTORS FOR EACH SAMPLING PERIOD; CAVEOUT.DAT CONTAINS
C    CALCULATED HALF-HOUR AVERAGE OUTPUT CONCENTRATIONS AT SAME RECEPTORS.
C    THE OUTPUT FILES ARE RENAMED TO IDENTIFY THE TEST,VAN,TRACK,AND TIME.
C    (THE OUTPUT FILE-NAMING NOTATION IS DESCRIBED IN THE README FILE
C    IN THE MVP DATA ARCHIVE (under /pub/MVP/data/TracerObs/Processd).
C

```



```

OPEN (20, FILE='C:\MVP\CONCOUT.DAT', STATUS='UNKNOWN')
OPEN (22, FILE='C:\MVP\CAVEOUT.DAT', STATUS='UNKNOWN')
C
C READ XE AND YE RECEPTOR POINTS FROM TRAKINP.DAT FILE ON UNIT 15.
K=1
9 READ (15, *, END=10) XE (K), YE (K)
K=K+1
GO TO 9
10 CONTINUE
C NEUL IS NUMBER OF EULERIAN RECEPTOR POINTS.
NEUL=K-1
CLOSE (15)
C
C FOR NON-HORIZONTAL EULERIAN REFERENCE TRACKS ONLY:
C ARRANGE EULERIAN Y CORDINATES (YE) IN ASCENDING ORDER.
CALL PIKSR3 (1, NEUL, YE, XE, CDUM)
C
DO 52 K=1, NEUL
CAVE (K)=0.
CDUM (K)=0.
52 CONTINUE
C
NFIL=0
C LANG IS THE GENERIC NAME FOR FILES IN LISTINP.DAT FILE ON UNIT 16.
99 READ (16, '(A19)', END=101) LANG
NFIL=NFIL+1
C NFIL IS THE NUMBER OF LAGRANGIAN DATA FILES
WRITE (*, '(A19)') LANG
C
C READ RECEPTOR COORDINATES (XL, YL) ON SAMPLING TRACK.
OPEN (18, FILE=LANG, STATUS='OLD')
NLAG=0
K=1
READ (18, '(F5.2)') TIME (NFIL)
20 CONTINUE
READ (18, *, END=25) NUM, XL (K), YL (K), CL (K)
C NLAG=NUMBER OF LAGRANGIAN POINTS IN EACH LANG FILE
NLAG=NLAG+1
K=K+1
GO TO 20
25 CONTINUE
C
C THE FOLLOWING INTERPOLATION IS USEFUL ONLY FOR NON-HORIZONTAL
C SAMPLING AND REFERENCE TRACKS.
C ARRANGE LAGRANGIAN Y CORDINATES (YL) IN ASCENDING ORDER.
CALL PIKSR3 (1, NLAG, YL, XL, CL)
C
C BEGIN INTERPOLATION OF CONCENTRATIONS TO EULERIAN TRACK
28 DO 50 K=1, NEUL
DO 55 J=1, NLAG-1
DIST=SQRT ((YL (J) - YE (K)) **2 + (XL (J) - XE (K)) **2)
IF (DIST.LT.0.01) THEN
CE (K, NFIL)=CL (J)
GO TO 50
ENDIF
34 IF (YL (J+1) .GT. YE (K) .AND. YE (K) .GT. YL (J)) THEN

```

```

        T1=(XL(J+1)-XE(K))**2+(YL(J+1)-YE(K))**2
        T2=(XL(J+1)-XL(J))**2+(YL(J+1)-YL(J))**2
        WT=SQRT(T1/T2)
        IF(WT.GT.1.0) THEN
            CE(K,NFIL)=0.5*(CL(J+1)+CL(J))
            GO TO 50
        ENDIF
C      LINEAR INTERPOLATION FOR EULERIAN CONCENTRATION
        CE(K,NFIL)=(1.-WT)*CL(J+1)+WT*CL(J)
        GO TO 50
    ENDIF
55  CONTINUE
C      END LOOP ON LAGRANGIAN POINTS
C
50  CONTINUE
C      END LOOP ON EULERIAN POINTS
C
        WRITE(*,*) NFIL
        GO TO 99
101  CONTINUE
C      END LOOP ON FILES IN LISTINP
C
C      CALCULATE AVERAGE CONCENTRATIONS AT RECEPTORS ON EULERIAN TRACK
        DO 111 NN=1,NFIL
        DO 111 K=1,NEUL
            CAVE(K)=CAVE(K)+CE(K,NN)/NFIL
111  CONTINUE
C
200  CONTINUE
C
C      WRITE OUTPUT FILES
        WRITE(20,910)
910  FORMAT(2X,'TEMPORAL & SPATIAL EVOLUTION OF CONCENTRATIONS (ppt):')
        WRITE(20,920) NFIL,(TIME(J),J=1,NFIL)
920  FORMAT(I3,' TRACKS ARE PROCESSED.'/'SAMPLING TIMES (Hrs.):',
118F6.2)
        WRITE(20,'(1X)')
        WRITE(22,922) NFIL,TIME(1),TIME(NFIL)
922  FORMAT('AVERAGE CONCENTRATION OF',I3,' TRACKS FROM ',F5.2,
1' TO ',F5.2,' Hrs. '/')
C      TEMPORAL EVOLUTION OF CONCENTRATION STORED IN CONCOUT FILE ON UNIT 20
        WRITE(20,925) (TIME(J),J=1,NFIL)
925  FORMAT(4X,'XE(km)',4X,'YE(km)',20(5X,F5.2,2X))
        DO 60 K=NEUL,1,-1
            WRITE(20,1000) XE(K),YE(K),(CE(K,NN),NN=1,NFIL)
1000 FORMAT(2F10.3,2X,18E12.4)
        60  CONTINUE
C      TEMPORAL AVERAGE OF CONCENTRATIONS STORED IN CAVEOUT FILE ON UNIT 22
        WRITE(22,927)
927  FORMAT(4X,'XE(km)',4X,'YE(km)',4X,'CAVE (ppt)')
        DO 65 K=NEUL,1,-1
            WRITE(22,1002) XE(K),YE(K),CAVE(K)
1002 FORMAT(2F10.3,2X,E12.4)
        65  CONTINUE
        STOP 999
    END

```

```

C
C *****
C SUBROUTINE PIKSR3 (M,N,ARR,BRR,CRR)
C *****
C THIS ROUTINE SORTS AN ARRAY ARR OF LENGTH N-M+1 INTO ASCENDING
C NUMERICAL ORDER, BY STRAIGHT INSERTION, WHILE MAKING THE
C CORRESPONDING REARRANGEMENT OF THE ARRAYS BRR AND CRR.
C
C ADAPTED FROM: PRESS ET AL.,1987: NUMERICAL RECIPES. P228.
C
C   DIMENSION ARR(100),BRR(100),CRR(100)
C PICK OUT EACH ELEMENT IN TURN.
C   M1 = M+1
C   DO 12 J = M1,N
C     A = ARR(J)
C     B = BRR(J)
C     C = CRR(J)
C LOOK FOR THE PLACE TO INSERT IT.
C   DO 11 I = J-1,1,-1
C     IF (ARR(I) .LE. A) GO TO 10
C     ARR(I+1) = ARR(I)
C     BRR(I+1) = BRR(I)
C     CRR(I+1) = CRR(I)
11 CONTINUE
C   I = 0
C   INSERT IT.
10 ARR(I+1) = A
C     BRR(I+1) = B
C     CRR(I+1) = C
12 CONTINUE
C   RETURN
C   END
C *****
C PROGRAM RECXKSR
C
C XE,YE....COORDINATES OF EULERIAN RECEPTORS
C XL,YL....COORDIANTES OF LAGRANGIAN RECEPTORS.
C
C DIMENSION XE(500),YE(500),XL(500),YL(500),CL(500),CE(500,20),
1CAVE(500),TIME(20),CDUM(500)
C
C CHARACTER*19 LANG
C
C LISTINP.DAT CONSISTS OF ALL SAMPLING DATA FILES (RECTOR.FOR
C OUTPUTS) OF EACH VAN INCLUDED IN THE HALF-HOUR AVERAGE;
C TRAKINP.DAT CONSISTS OF X,Y COORDINATES OF RECEPTORS ON THE
C REFERENCE EULERIAN TRACK.
C
C OPEN (16,FILE='C:\MVP\LISTINP.DAT',STATUS='OLD')
C OPEN (15,FILE='C:\MVP\TRAKINP.DAT',STATUS='OLD')
C
C EULERIAN OUTPUT FILES:
C CONCOUT.DAT CONSISTS OF OUTPUT CONCENTRATIONS INTERPOLATED TO
C EULERIAN RECEPTORS FOR EACH SAMPLING PERIOD; CAVEOUT.DAT CONTAINS
C CALCULATED HALF-HOUR AVERAGE OUTPUT CONCENTRATIONS AT SAME RECEPTORS.
C THE OUTPUT FILES ARE RENAMED TO IDENTIFY THE TEST,VAN,TRACK,AND TIME.

```

```

C      (THE OUTPUT FILE-NAMING NOTATION IS DESCRIBED IN THE README FILE
C      IN THE MVP DATA ARCHIVE (under /pub/MVP/data/TracerObs/Processd) .
C
C      OPEN(20,FILE='C:\MVP\CONCOUT.DAT',STATUS='UNKNOWN')
C      OPEN(22,FILE='C:\MVP\CAVEOUT.DAT',STATUS='UNKNOWN')
C
C      READ XE AND YE RECEPTOR POINTS FROM TRAKINP.DAT FILE ON UNIT 15.
C      K=1
C      9 READ(15,*,END=10) XE(K),YE(K)
C      K=K+1
C      GO TO 9
C      10 CONTINUE
C      NEUL IS NUMBER OF EULERIAN RECEPTOR POINTS.
C      NEUL=K-1
C      CLOSE(15)
C
C      FOR NEAR-HORIZONTAL REFERENCE TRACKS ONLY, ARRANGE
C      EULERIAN X COORDINATES (XE) IN ASCENDING ORDER.
C      CALL PIKSR3(1,NEUL,XE,YE,CDUM)
C
C      DO 52 K=1,NEUL
C      CAVE(K)=0.
C      CDUM(K)=0.
C      52 CONTINUE
C
C      NFIL=0
C      LANG IS THE GENERIC NAME FOR FILES IN LISTINP.DAT FILE ON UNIT 16.
C      99 READ(16,'(A19)',END=101) LANG
C      NFIL=NFIL+1
C      WRITE(*,'(A19)') LANG
C
C      READ XL AND YL RECEPTOR LOCATIONS.
C      OPEN(18,FILE=LANG,STATUS='OLD')
C      NLAG=0
C      K=1
C      READ(18,'(F5.2)') TIME(NFIL)
C      20 CONTINUE
C      READ(18,*,END=25) NUM,XL(K),YL(K),CL(K)
C      NLAG=NUMBER OF LAGRANGIAN POINTS IN EACH LANG FILE
C      NLAG=NLAG+1
C      K=K+1
C      GO TO 20
C      25 CONTINUE
C
C      THE FOLLOWING INTERPOLATION IS TO BE USED ONLY FOR NEAR-HORIZONTAL
C      SAMPLING AND REFERENCE TRACKS.
C      ARRANGE LAGRANGIAN X COORDINATES (XL) IN ASCENDING ORDER.
C      27 CALL PIKSR3(1,NLAG,XL,YL,CL)
C
C      BEGIN INTERPOLATION
C      28 DO 50 K=1,NEUL
C      DO 55 J=1,NLAG-1
C      DIST=SQRT((YL(J)-YE(K))**2+(XL(J)-XE(K))**2)
C      IF(DIST.LT.0.01) THEN
C      CE(K,NFIL)=CL(J)
C      GO TO 50

```

```

ENDIF
IF (XL(J+1) .GT. XE(K) .AND. XE(K) .GT. XL(J)) THEN
    T1=(XL(J+1)-XE(K))**2+(YL(J+1)-YE(K))**2
    T2=(XL(J+1)-XL(J))**2+(YL(J+1)-YL(J))**2
    WT=SQRT(T1/T2)
    IF (WT.GT.1.0) THEN
        CE(K,NFIL)=0.5*(CL(J+1)+CL(J))
        GO TO 50
    ENDIF
C    LINEAR INTERPOLATION FOR EULERIAN CONCENTRATION
    CE(K,NFIL)=(1.-WT)*CL(J+1)+WT*CL(J)
    GO TO 50
ENDIF
55 CONTINUE
C    END LOOP ON LAGRANGIAN POINTS
50 CONTINUE
C    END LOOP ON EULERIAN POINTS
C
    WRITE(*,*) NFIL
    GO TO 99
101 CONTINUE
C    END LOOP ON FILES IN LISTINP
C
C    CALCULATE AVERAGE PLUME CONCENTRATIONS
    DO 111 NN=1,NFIL
    DO 111 K=1,NEUL
    CAVE(K)=CAVE(K)+CE(K,NN)/NFIL
111 CONTINUE
C
200 CONTINUE
C
C    WRITE OUTPUT TO FILES
    WRITE(20,910)
910 FORMAT(2X,'TEMPORAL & SPATIAL EVOLUTION OF CONCENTRATIONS (ppt):')
    WRITE(20,920) NFIL,(TIME(J),J=1,NFIL)
920 FORMAT(I3,' TRACKS ARE PROCESSED.'/ 'SAMPLING TIMES (Hrs.):',
118F6.2)
    WRITE(20,'(1X)')
    WRITE(22,922)NFIL,TIME(1),TIME(NFIL)
922 FORMAT('AVERAGE CONCENTRATION OF',I3,' TRACKS FROM ',F5.2,
1' TO ',F5.2,' Hrs. '/')
C    TEMPORAL EVOLUTION OF CONCENTRATION STORED IN CON FILE ON UNIT 20
    WRITE(20,925) (TIME(J),J=1,NFIL)
925 FORMAT(4X,'XE(km)',4X,'YE(km)',20(5X,F5.2,2X))
    DO 60 K=NEUL,1,-1
    WRITE(20,1000) XE(K),YE(K),(CE(K,NN),NN=1,NFIL)
1000 FORMAT(2F10.3,2X,18E12.4)
60 CONTINUE
C    TEMPORAL AVERAGE OF CONCENTRATIONS STORED IN CAVE FILE ON UNIT 22
    WRITE(22,927)
927 FORMAT(4X,'XE(km)',4X,'YE(km)',4X,'CAVE (ppt)')
    DO 65 K=NEUL,1,-1
    WRITE(22,1002) XE(K),YE(K),CAVE(K)
1002 FORMAT(2F10.3,2X,E12.4)
65 CONTINUE
    STOP 999

```

```

END
C
C *****
C SUBROUTINE PIKSR3 (M,N,ARR,BRR,CRR)
C *****
C THIS ROUTINE SORTS AN ARRAY ARR OF LENGTH N-M+1 INTO ASCENDING
C NUMERICAL ORDER, BY STRAIGHT INSERTION, WHILE MAKING THE
C CORRESPONDING REARRANGEMENT OF THE ARRAYS BRR AND CRR.
C
C ADAPTED FROM: PRESS ET AL.,1987: NUMERICAL RECIPES. P228.
C
C   DIMENSION ARR(100),BRR(100),CRR(100)
C PICK OUT EACH ELEMENT IN TURN.
C   M1 = M+1
C   DO 12 J = M1,N
C     A = ARR(J)
C     B = BRR(J)
C     C = CRR(J)
C LOOK FOR THE PLACE TO INSERT IT.
C   DO 11 I = J-1,1,-1
C     IF (ARR(I) .LE. A) GO TO 10
C     ARR(I+1) = ARR(I)
C     BRR(I+1) = BRR(I)
C     CRR(I+1) = CRR(I)
11 CONTINUE
C   I = 0
C INSERT IT.
10 ARR(I+1) = A
C   BRR(I+1) = B
C   CRR(I+1) = C
12 CONTINUE
C   RETURN
C   END
C*****
C   program COORDES
C
C   DOUBLE PRECISION LAT,LON,CONVERT,CONST1,
C 1CONST2,CONST3,LAT110,LON110,LATS,LONS
C   DIMENSION XR(3000),YR(3000),ALT(3000)
C   REAL LATR(3000),LONR(3000)
C
C   X0=50.
C   Y0=30.
C   LAT110=28.5697D0
C   LON110=-80.5864D0
C   CONVERT=3.14157D0/180.D0
C   CONST1=6366.800D0
C   CONST2=CONVERT*CONST1
C
C   INPUT DATA FILE: READ AND STORE SOURCE AND/OR RECEPTOR COORDINATES:
C   LATR (LATITUDE, deg.), LONR (LONGITUDE, deg.), ALT1 (ALTITUDE, m).
C
C   INPUT SOURCE COORDINATES (LATS,LONS) FOR TRACER TEST:
C   THE SOURCE DATA GIVEN BELOW ARE ONLY FOR TEST 209.
C   LATS=28.529583D0
C   LONS=-80.567933D0

```

```

C
OPEN (12, FILE='COORDIN.DAT', STATUS='OLD')
ICOUNT=1
150 READ (12, *, END=200) LAT, LON, ALT1
LATR (ICOUNT) =LAT
LONR (ICOUNT) =LON
ALT (ICOUNT) =ALT1
ICOUNT=ICOUNT+1
GO TO 150
200 CONTINUE
C
C
WRITE OUTPUT DATA TO FILE AFTER CONVERTING (LAT, LON)
COORDINATES (deg.) TO (X, Y) COORDINATES TO (km) .
YS=Y0- (LAT110-LATS)*CONST2
XS=X0- (LON110-LONS)*CONST2*DCOS (LATS*CONVERT)
OPEN (20, FILE='COORDOUT.DAT', STATUS='UNKNOWN')
WRITE (20, 250) XS, YS
250 FORMAT (4X, 2F12.5)
C
ICOUNT=ICOUNT-1
DO 110 J=1, ICOUNT
CONST3=DCOS (LATR (J) *CONVERT)
YR (J) =Y0- (LAT110-LATR (J) ) *CONST2
XR (J) =X0- (LON110-LONR (J) ) *CONST2*CONST3
WRITE (20, 300) J, XR (J) , YR (J) , ALT (J)
110 CONTINUE
300 FORMAT (I4, 3F12.5)
C
CLOSE (12)
CLOSE (20)
C
STOP 999
END
C*****
program LATLON
C
DOUBLE PRECISION CONVERT, CONST1,
1CONST2, CONST3, LAT110, LON110
DIMENSION XR (3000), YR (3000)
REAL LATR (3000), LONR (3000)
C
X0=50.
Y0=30.
LAT110=28.5697D0
LON110=-80.5864D0
CONVERT=3.14157D0/180.D0
CONST1=6366.800D0
CONST2=CONVERT*CONST1
C
C
READ INPUT FILE OF RECEPTOR (X, Y) COORDINATES (km) DATA
OPEN (12, FILE='XYKM.DAT', STATUS='OLD')
ICOUNT=1
150 READ (12, *, END=200) X, Y
XR (ICOUNT) =X
YR (ICOUNT) =Y
ICOUNT=ICOUNT+1

```

```

GO TO 150
200 CONTINUE
C
ICOUNT=ICOUNT-1
OPEN(20,FILE='LATLONR.DAT',STATUS='UNKNOWN')
C CONVERT XR AND YR TO LATR AND LONR COORDINATES
DO 110 J=1,ICOUNT
LATR(J)=LAT110-(Y0-YR(J))/CONST2
CONST3=DCOS(LATR(J)*CONST2)
LONR(J)=LON110-(X0-XR(J))/(CONST2*CONST3)
C WRITE OUTPUT: J, LATR AND LONR IN DEGREES
WRITE(20,1100) J,LATR(J),LONR(J)
110 CONTINUE
1100 FORMAT(I4,2F12.4)
CLOSE(12)
CLOSE(20)
STOP 999
END

```


APPENDIX II

Surface Concentration Data Files

An example of surface tracer concentration data file, 110C1ALL.DAT, processed by ATDD is listed below in Table 2. These data are for MVP Test 110, Van 1 for all sampling times, for the same Eulerian track (shown by solid line in Fig. 3). The coordinates of the receptors located on this track are indicated by (XE, YE). An example of the half-hour average concentrations derived from these results is shown in 110A1-2.DAT file in Table 3. These time-averaged concentrations are for Test 110, Van 1 time period 2 (14.88 – 15.38 hr). The processed and time-averaged surface concentration data files for the six Tests discussed in this report can be found in the **SfcCon** and **SfcConAV** directories under **pub/MVP/data/TracrObs/Processd** directory in the MVP archive. The names of these files and the averaging time periods are listed in Tables 4, 5, and 6 for Sessions 1, 2, and 3, respectively.

Table 2. Processed Tracer Concentration Data File 110C1ALL.DAT.

TEMPORAL & SPATIAL EVOLUTION OF CONCENTRATIONS (ppt):

6 TRACKS ARE PROCESSED.

| SAMPLING TIMES (Hrs.): | | 14.21 | 14.79 | 14.88 | 15.00 | 15.28 | 15.38 |
|------------------------|--------|-------------|-------------|------------|-------------|------------|-------------|
| XE(km) | YE(km) | | | | | | |
| 43.394 | 31.256 | 0.7016E+03 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 43.405 | 31.232 | 0.4413E+03 | 0.1646E+01 | 0.2444E+02 | -0.1150E+01 | 0.0000E+00 | 0.0000E+00 |
| 43.404 | 31.167 | 0.4033E+03 | -0.2085E+01 | 0.4975E+02 | -0.4775E+01 | 0.0000E+00 | 0.0000E+00 |
| 43.410 | 31.072 | 0.3927E+03 | -0.3709E+01 | 0.6045E+02 | -0.1023E+02 | 0.0000E+00 | 0.0000E+00 |
| 43.410 | 30.983 | 0.4221E+03 | -0.1370E+02 | 0.8466E+02 | 0.1540E+02 | 0.7043E+01 | 0.0000E+00 |
| 43.413 | 30.896 | 0.6621E+03 | -0.1811E+02 | 0.1651E+03 | -0.1045E+02 | 0.2037E+02 | -0.3518E+01 |
| 43.415 | 30.806 | 0.1213E+04 | -0.2752E+02 | 0.1870E+03 | 0.2757E+02 | 0.4055E+02 | -0.3067E+01 |
| 43.417 | 30.717 | 0.1215E+04 | -0.3417E+02 | 0.2088E+03 | 0.3593E+02 | 0.7517E+02 | 0.1209E+02 |
| 43.417 | 30.631 | 0.7696E+03 | 0.9268E+01 | 0.2477E+03 | 0.3335E+02 | 0.9200E+02 | 0.4326E+02 |
| 43.423 | 30.545 | 0.6754E+03 | 0.6402E+02 | 0.2728E+03 | 0.1627E+02 | 0.6692E+02 | 0.3653E+02 |
| 43.429 | 30.461 | 0.7427E+03 | 0.7789E+02 | 0.2649E+03 | 0.3353E+02 | 0.8918E+02 | -0.3583E+01 |
| 43.435 | 30.379 | 0.5829E+03 | 0.8297E+02 | 0.2567E+03 | 0.3785E+02 | 0.1592E+03 | 0.7644E+01 |
| 43.448 | 30.302 | 0.4708E+03 | 0.8996E+02 | 0.2578E+03 | 0.6147E+02 | 0.1821E+03 | 0.3488E+02 |
| 43.448 | 30.231 | 0.7150E+03 | 0.7772E+02 | 0.2926E+03 | 0.1012E+03 | 0.1422E+03 | 0.9773E+02 |
| 43.450 | 30.167 | 0.1265E+04 | 0.2306E+03 | 0.3216E+03 | 0.1451E+03 | 0.1499E+03 | 0.8873E+02 |
| 43.448 | 30.107 | 0.1334E+04 | 0.2514E+03 | 0.3380E+03 | 0.1686E+03 | 0.1739E+03 | 0.7340E+02 |
| 43.448 | 30.044 | 0.1457E+04 | 0.2201E+03 | 0.3655E+03 | 0.2058E+03 | 0.2495E+03 | 0.6489E+02 |
| 43.448 | 29.978 | 0.1507E+04 | 0.3232E+03 | 0.4094E+03 | 0.2385E+03 | 0.5222E+03 | 0.6594E+02 |
| 43.448 | 29.911 | 0.1311E+04 | 0.3167E+03 | 0.3424E+03 | 0.3180E+03 | 0.6590E+03 | -0.8931E+00 |
| 43.446 | 29.836 | 0.1053E+04 | 0.5147E+03 | 0.9251E+02 | 0.2301E+03 | 0.8325E+03 | 0.7107E+02 |
| 43.446 | 29.760 | 0.3746E+03 | 0.1930E+03 | 0.1344E+02 | 0.7497E+02 | 0.7702E+03 | 0.9519E+03 |
| 43.446 | 29.683 | -0.9493E+02 | 0.4784E+02 | 0.3420E+02 | 0.2167E+01 | 0.3293E+03 | 0.1470E+04 |
| 43.444 | 29.616 | 0.1047E+02 | -0.1285E+02 | 0.0000E+00 | 0.5167E+01 | 0.0000E+00 | 0.1452E+04 |
| 43.449 | 29.542 | 0.0000E+00 | -0.8937E+01 | 0.0000E+00 | 0.2833E+01 | 0.0000E+00 | 0.4750E+03 |

Table 3. Time-Averaged Concentration Data File 110A1- 2.DAT

AVERAGE CONCENTRATION OF 4 TRACKS FROM 14.88 TO 15.38 Hrs.

| XE(km) | YE(km) | CAVE (ppt) |
|--------|--------|------------|
| 43.394 | 31.256 | 0.0000E+00 |
| 43.405 | 31.232 | 0.5823E+01 |
| 43.404 | 31.167 | 0.1124E+02 |
| 43.410 | 31.072 | 0.1256E+02 |
| 43.410 | 30.983 | 0.2678E+02 |
| 43.413 | 30.896 | 0.4288E+02 |
| 43.415 | 30.806 | 0.6302E+02 |
| 43.417 | 30.717 | 0.8300E+02 |
| 43.417 | 30.631 | 0.1041E+03 |
| 43.423 | 30.545 | 0.9813E+02 |
| 43.429 | 30.461 | 0.9601E+02 |
| 43.435 | 30.379 | 0.1154E+03 |
| 43.448 | 30.302 | 0.1341E+03 |
| 43.448 | 30.231 | 0.1584E+03 |
| 43.450 | 30.167 | 0.1763E+03 |
| 43.448 | 30.107 | 0.1885E+03 |
| 43.448 | 30.044 | 0.2214E+03 |
| 43.448 | 29.978 | 0.3090E+03 |
| 43.448 | 29.911 | 0.3296E+03 |
| 43.446 | 29.836 | 0.3066E+03 |
| 43.446 | 29.760 | 0.4526E+03 |
| 43.446 | 29.683 | 0.4590E+03 |
| 43.444 | 29.616 | 0.3643E+03 |
| 43.449 | 29.542 | 0.1195E+03 |

Table 4. Surface Concentration Data Files of Tests Processed from MVP Session 1.

(a) TEST 110, 23 JULY 1995, RELEASE HEIGHT 1 M, RELEASE TIME 13:30 - 14:57 EDT

| | AVERAGING PERIOD (EDT) | PROCESSED CONCENTRATIONS FILE | TIME-AVERAGED CONCENTRATIONS FILE |
|----|---------------------------|----------------------------------|--------------------------------------|
| 1. | 14.21 - 14.79 | 110C1-1.DAT | 110A1-1.DAT |
| 2. | 14.88 - 15.38 | 110C1-2.DAT | 110A1-2.DAT |
| 3. | 13.90 - 14.35 | 110C3-1A.DAT | 110A3-1A.DAT |
| 4. | 14.81 - 15.18 | 110C3-1B.DAT | 110A3-1B.DAT |

(b) TEST 117, 27 JULY 1995, RELEASE HEIGHT 150 M, RELEASE TIME 10:00 - 12:00 EDT

| | AVERAGING PERIOD (EDT) | PROCESSED CONCENTRATIONS FILE | TIME-AVERAGED CONCENTRATIONS FILE |
|-----|---------------------------|----------------------------------|--------------------------------------|
| 1. | 10.60 - 11.11 | 117C2-1.DAT | 117A2-1.DAT |
| 2. | 10.97 - 11.46 | 117C2-2.DAT | 117A2-2.DAT |
| 3. | 11.11 - 11.68 | 117C2-3.DAT | 117A2-3.DAT |
| 4. | 11.36 - 11.80 | 117C2-4.DAT | 117A2-4.DAT |
| 5. | 11.46 - 12.02 | 117C2-5.DAT | 117A2-5.DAT |
| 6. | 11.68 - 12.23 | 117C2-6.DAT | 117A2-6.DAT |
| 7. | 10.28 - 10.77 | 117C3-1.DAT | 117A3-1.DAT |
| 8. | 10.41 - 10.91 | 117C3-2.DAT | 117A3-2.DAT |
| 9. | 10.53 - 11.03 | 117C3-3.DAT | 117A3-3.DAT |
| 10. | 10.62 - 11.15 | 117C3-4.DAT | 117A3-4.DAT |
| 11. | 10.77 - 11.29 | 117C3-5.DAT | 117A3-5.DAT |
| 12. | 10.91 - 11.40 | 117C3-6.DAT | 117A3-6.DAT |
| 13. | 11.03 - 11.53 | 117C3-7.DAT | 117A3-7.DAT |
| 14. | 11.15 - 11.64 | 117C3-8.DAT | 117A3-8.DAT |
| 15. | 11.99 - 12.42 | 117C3-9.DAT | 117A3-9.DAT |
| 16. | 11.82 - 12.42 | 117C3BAL.DAT | 117A3BAL.DAT |
| 17. | 10.91 - 11.38 | 117C4-1.DAT | 117A4-1.DAT |
| 18. | 11.18 - 11.71 | 117C4-2.DAT | 117A4-2.DAT |
| 19. | 12.10 - 12.27 | 117C4-3.DAT | 117A4-3.DAT |
| 20. | 11.05 - 11.31 | 117C6ALL.DAT | 117A6-1.DAT |

Table 5. Surface Concentration Data Files of Tests Processed from MVP Session 2.

(a) TEST 209, 6 NOVEMBER 1995, RELEASE HEIGHT 20 M, RELEASE TIME 16:22 – 18:56 EST

| | AVERAGING PERIOD (EST) | PROCESSED CONCENTRATIONS FILE | TIME-AVERAGED CONCENTRATIONS FILE |
|-----|---------------------------|----------------------------------|--------------------------------------|
| 1. | 16.75 – 17.24 | 209C1-1.DAT | 209A1-1.DAT |
| 2. | 16.90 – 17.39 | 209C1-2.DAT | 209A1-2.DAT |
| 3. | 17.03 – 17.51 | 209C1-3.DAT | 209A1-3.DAT |
| 4. | 17.19 – 17.72 | 209C1-4.DAT | 209A1-4.DAT |
| 5. | 17.28 – 17.81 | 209C1-5.DAT | 209A1-5.DAT |
| 6. | 17.51 – 18.00 | 209C1-6.DAT | 209A1-6.DAT |
| 7. | 17.81 – 18.31 | 209C1-7.DAT | 209A1-7.DAT |
| 8. | 10.41 – 10.91 | 209C1-8.DAT | 209A1-8.DAT |
| 9. | 18.04 – 18.55 | 209C1-9.DAT | 209A1-9.DAT |
| 10. | 18.51 – 19.00 | 209C1-10.DAT | 209A1-10.DAT |
| 11. | 18.01 – 18.51 | 209C3-1.DAT | 209A3-1.DAT |
| 12. | 18.22 – 18.70 | 209C3-2.DAT | 209A3-2.DAT |
| 13. | 18.38 – 18.88 | 209C3-2A.DAT | 209A3-2A.DAT |
| 14. | 18.01 – 18.88 | 209C3ALL.DAT | - |
| 15. | 19.12 – 19.53 | - | 209A3-3.DAT |
| 16. | 19.53 – 19.94 | - | 209A3-4.DAT |
| 17. | 19.94 – 20.64 | - | 209A3-5.DAT |
| 18. | 20.64 – 21.09 | - | 209A3-6.DAT |
| 19. | 19.15 – 19.79 | 209C5-1.DAT | 209A5-1.DAT |
| 20. | 20.02 – 20.62 | 209C5-2.DAT | 209A5-2.DAT |
| 21. | 20.62 – 20.96 | 209C5-3.DAT | 209A5-3.DAT |
| 22. | 18.32 – 18.82 | 209C6-1.DAT | 209A6-1.DAT |
| 23. | 18.51 – 19.00 | 209C6-2.DAT | 209A6-2.DAT |
| 24. | 19.00 – 19.60 | 209C6-3.DAT | 209A6-3.DAT |
| 25. | 19.60 – 20.14 | 209C6-4.DAT | 209A6-4.DAT |
| 26. | 20.49 – 20.97 | 209C6-5.DAT | 209A6-5.DAT |

(b) TEST 216, 10 NOVEMBER 1995, RELEASE HEIGHT 457 M, RELEASE TIME 12:55 – 15:17 EST

| | AVERAGING PERIOD (EDT) | PROCESSED CONCENTRATIONS FILE | TIME-AVERAGED CONCENTRATIONS FILE |
|----|---------------------------|----------------------------------|--------------------------------------|
| 1. | 13.22 – 13.49 | 216C35AL.DAT | 216A35-1.DAT |
| 2. | 14.58 – 15.38 | 216C4-1.DAT | 216A4-1.DAT |
| 3. | 13.37 – 13.49 | 216C5ALL.DAT | - |
| 4. | 13.74 – 14.22 | 216C6ALL.DAT | 216A6-1.DAT |

Table 6. Surface Concentration Data Files of Tests Processed from MVP Session 3

(a) TEST 304, 28 APRIL 1996, RELEASE HEIGHT 305 M, RELEASE TIME 10:00 - 12:00 EDT

| | AVERAGING PERIOD (EDT) | PROCESSED CONCENTRATIONS FILE | TIME-AVERAGED CONCENTRATIONS FILE |
|-----|---------------------------|----------------------------------|--------------------------------------|
| 1. | 11.38 - 11.90 | 304C1-1.DAT | 304A1-1.DAT |
| 2. | 12.28 - 12.72 | 304C1-2.DAT | 304A1-2.DAT |
| 3. | 10.96 - 12.72 | 304C1ALL.DAT | - |
| 4. | 10.67 - 12.08 | 304C2ALL.DAT | - |
| 5. | 10.75 - 11.31 | 304C3-1.DAT | 304A3-1.DAT |
| 6. | 11.31 - 11.81 | 304C3-2.DAT | 304A3-2.DAT |
| 7. | 11.86 - 12.33 | 304C3-3.DAT | 304A3-3.DAT |
| 8. | 10.48 - 12.33 | 304C3ALL.DAT | - |
| 9. | 11.10 - 12.75 | 304C4ALL.DAT | - |
| 10. | 10.55 - 11.23 | 304C5-1.DAT | 304A5-1.DAT |
| 11. | 11.23 - 11.52 | 304C5-2.DAT | 304A5-2.DAT |
| 12. | 11.58 - 12.29 | 304C5-3.DAT | 304A5-3.DAT |
| 13. | 10.55 - 11.52 | 304C51AL.DAT | - |
| 14. | 11.17 - 11.67 | 304C6-1.DAT | 304A6-1.DAT |
| 15. | 11.41 - 11.93 | 304C6-2.DAT | 304A6-2.DAT |
| 16. | 11.00 - 12.64 | 304C6ALL.DAT | - |

(b) TEST 306, 29 APRIL 1996, RELEASE HEIGHT 8 M, RELEASE TIME 09:45 - 12:30 EDT

| | AVERAGING PERIOD (EDT) | PROCESSED CONCENTRATIONS FILE | TIME-AVERAGED CONCENTRATIONS FILE |
|-----|---------------------------|----------------------------------|--------------------------------------|
| 1. | 10.09 - 10.55 | 306C1-1.DAT | 306A1-1.DAT |
| 2. | 10.64 - 11.12 | 306C1-2.DAT | 306A1-2.DAT |
| 3. | 11.26 - 11.76 | 306C1-3.DAT | 306A1-3.DAT |
| 4. | 11.85 - 12.36 | 306C1-4.DAT | 306A1-4.DAT |
| 5. | 12.36 - 12.79 | 306C1-5.DAT | 306A1-5.DAT |
| 6. | 10.18 - 10.70 | 306C3-1.DAT | 306A3-1.DAT |
| 7. | 11.07 - 11.61 | 306C3-2.DAT | 306A2-2.DAT |
| 8. | 11.74 - 12.28 | 306C3-3.DAT | 306A3-3.DAT |
| 9. | 10.18 - 12.28 | 306C3ALL.DAT | - |
| 10. | 10.53 - 10.97 | 306C4-1.DAT | 306A4-1.DAT |
| 11. | 11.14 - 11.54 | 306C4-2.DAT | 306A4-2.DAT |
| 12. | 11.54 - 12.08 | 306C4-3.DAT | 306A4-3.DAT |
| 13. | 12.47 - 12.92 | 306C4-4.DAT | 306A3-4.DAT |
| 14. | 10.29 - 10.78 | 306C5-1.DAT | 306A5-1.DAT |
| 15. | 10.83 - 11.32 | 306C5-2.DAT | 306A5-2.DAT |
| 16. | 11.43 - 11.96 | 306C5-3.DAT | 306A5-3.DAT |
| 17. | 12.13 - 12.66 | 306C5-4.DAT | 306A5-4.DAT |
| 18. | 10.46 - 10.99 | 306C6-1.DAT | 306A6-1.DAT |
| 19. | 11.11 - 11.67 | 306C6-2.DAT | 306A6-2.DAT |
| 20. | 12.33 - 12.79 | 306C6-3.DAT | 306A6-3.DAT |