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ACROSS NORTH AMERICA TRACER EXPERIMENT (ANATEX)

VOLUME II: AIRCRAFT-BASED SAMPLING

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CONTENTS

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Abstract. Aircraft-based sampling was an integral part of ANATEX. The data are useful for establishing the initial tracer path and for providing vertical tracer distributions. Because there were few, if any, ground-level sampling sites near the sources, the aircraft sampling was done within about 450 km of the two release sites (Glasgow, MT and St. Cloud, MN) and between altitudes near the ground to 2800 m above ground. One or two aircraft sampled 26 of the 33 Glasgow plumes. Usually one flew above the other to obtain vertical tracer profiles. The GGW plume was traversed at least once for 23 of the 26 releases sampled, with 30% of all the samples near GGW containing excess tracer. One aircraft sampled 16 St. Cloud plumes, with tracer concentrations above background reported for all 16 releases. Fifty percent of all the samples of the STC plume contained excess tracer. The instrumentation, operations, and data quality assurance are discussed. The complete archived dataset, consisting of aircraft position data, tracer data, and meteorological data, is included in the report. In addition, data summaries for all flights are displayed in a tabular format.

1. INTRODUCTION

The ANATEX field experiment was designed to produce a comprehensive database for the evaluation and verification of long-range atmospheric transport and dispersion models. Perfluorocarbon tracer gases (PFTs) were released for 3-h periods near the surface every 2½ days from Glasgow, MT (GGW) and St. Cloud, MN (STC) between January 5 and March 26, 1987. Perfluorotrimethylcyclohexane (PTCH) was released from GGW and ortho-perfluorodimethylcyclohexane (oPDCH) from STC. Perfluoromethylcyclohexane (PMCH) was also released from STC with every other release. PFT concentrations were obtained from ground-level air samples taken in the United States and Canada at distances of about 500 km to 3000 km downwind of GGW (the primary sites), from Bermuda and from several sites along the west coasts of Europe and North America (the remote sites), from aircraft within about 450 km of the release sites, and on towers at distances nearly 1600 km downwind. Figure 1 shows the locations of the ground-level samplers in the United States and Canada and the regions in which the aircraft sampled. A complete description of the experiment, the primary ground-level air sampler analysis and results, and archived meteorological data is found in Draxler and Heffter (1989). Results of the tower and remote ground-level sites are found in Heffter and Draxler (1989b). Daily surface synoptic maps with superimposed ground-level PFT concentrations are given in Draxler (1988).

This report describes the ANATEX aircraft program. The main purpose of the aircraft data is to provide 3-dimensional data on initial transport and dispersion. PFT data in the vertical may be critical to understanding the ground-level data farther downwind, especially since tracer was frequently released into strong surface-based inversions. Aircraft samples were also valuable for collecting tracer initially heading away from the ground-level sampling network, thus establishing a link if the tracer later returned.

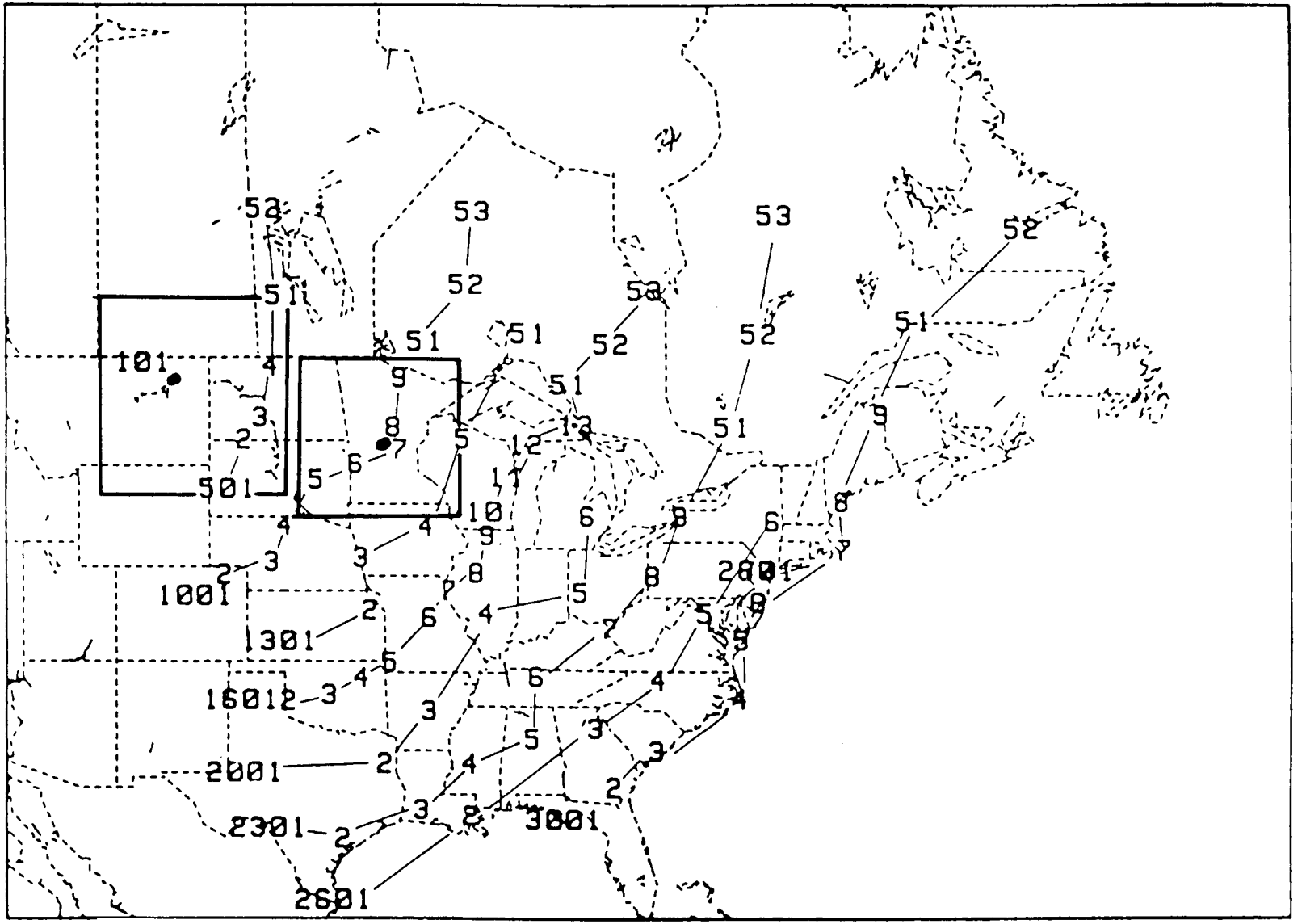

Figure 1. ANATEX ground-level sampler locations and regions for aircraft sampling near the release sites. The GGW and STC release sites are indicated by a dot.

Details on aircraft instrumentation, operations, PFT analysis and results, and the archived data are discussed here.

2. INSTRUMENTATION

Two aircraft were based at Miles City, MT, about 225 km SSE of GGW and one aircraft was based in the Minneapolis, MN area, about 100 km SE of STC. Sequential air samplers (SAS) on all three aircraft could automatically collect up to 20 samples which were later sent to a laboratory for perfluorocarbon tracer analysis. In addition, one aircraft at each release site had a 2-trap air-sampler/PFT analyzer for "real-time" tracer plume detection. All aircraft were equipped with a Loran-C navigation system. Some meteorological and other environmental measurements were also made from the aircraft.

The primary GGW aircraft was equipped with a Rosemount temperature sensor, a dew point hygrometer, and a pressure transducer. These devices, along with the Loran-C system, were interfaced with a data acquisition system consisting of a Pacific Northwest Laboratory (PNL) designed data logger coupled to a Hewlett-Packard 9816 microcomputer. Raw data and event signals from the 2-trap analyzer and SAS were recorded onto micro floppy disks for post-flight data reduction (Lee et al., 1989).

The STC aircraft was equipped with instruments to measure static and dynamic pressure, temperature, dew point, solar radiation, SO_2, and O_3. These instruments, along with Loran-C information and 2-trap output, were interfaced through a model DAS-64 data acquisition system manufactured by Particle Measuring Systems, Inc. Data on fast analog channels were sampled every 0.5 seconds, and every 5 seconds on slow analog channels. Data were recorded on magnetic tape cartridges via Algo, Inc. recorders every 5 seconds.

2.1 Sequential Air Sampler (SAS)

The perfluorocarbons used as tracers in ANATEX are extremely stable non-toxic compounds, measurable at very low concentrations by gas chromatography (GC) and electron capture detection (ECD). The tracer is recovered from a sampling tube by thermal desorption before chromatographic separation and electron capture counting. Air concentration is calculated from this recovered tracer.

The SAS used in the aircraft was designed by the NOAA Air Resources Laboratory (ARL) and the Department of Energy's Environmental Measurements Laboratory, and built by the engineering/electronics division of the National Weather Service. It weighs about 14 kg, is about 25 x 29 x 41 cm in size and contains 21 glass sampling tubes, 20 for samples and one extra tube downstream of the others to seal the sampling chamber. The 21 tubes in the SAS for one flight are referred to as a "string" of tubes. A pre-assigned string number was used for bookkeeping purposes since the string was kept intact throughout its use in sampling and in laboratory analysis. The sampling tubes are about 5 cm in length and 4 mm in diameter and a plastic cap seals both ends. The center third of the tube is packed with Ambersorb, which traps all PFTs in the air flowing through the tube. An internal pump pulls air from the intake port through one of the 20 sampling tubes and through the 21st tube; then the air

exits through the exhaust port. The intake and exhaust lines must be at the same pressure for the SAS to maintain a constant mass flow through the sampler. A constant mass flow is required through the sampler because, in the laboratory, PFT volume is based on PFT mass at STP. At higher altitudes where the air is less dense, more air must flow through the sampling tube to maintain a constant mass flow rate. The pressure drop is measured across a critical orifice in the flow between the intake and exhaust ports. The pressure drop is maintained at a constant value to control the air flow. The flow rate can be preset over the range 0.1 L/min to 0.5 L/min with a specific critical orifice. For ANATEX the maximum 0.5 L/min was chosen. Differences in pre- and post-experimental instrument flow calibrations were at most 10%. Details of the flow rates and their uncertainties are discussed later in section 4.1.3 and section 4.5.

The controls on the SAS are limited to setting sample duration and delay start time, power on/off and start/stop switches. The sample duration and delay start time can be set at intervals of 0.1 h between 0.1 and 999.9 h, and 0.1 and 99.9 h, respectively. The SAS is designed for automatic operation but could be operated manually. For ANATEX, operation with sampling times 0.1 or 0.2 h were used. Sometimes 0.2 h samples were taken until the plume was located and then 0.1 h samples were taken for better resolution. The 0.5 L/min flow rate implies 3 or 6 liter samples for the 0.1 and 0.2 h sampling times, respectively. Usually sampling began when the start/stop switch was set to start, instead of setting a delay start time. Before each flight the 21 sampling tubes were manually inserted into the unit, then removed after the flight to be sent to the laboratory for tracer analysis as described for the ground-level samples (Crawford and Start, 1989). The time between collection and analysis for the aircraft-based samples ranged from about 1½ to 18 months. Effects of this delay on concentration uncertainty are discussed in section 4.5.

2.2 Two-Trap Sampler/Analyzer

The purpose of the 2-trap analyzer, which collects and measured PFTs in ambient air on a "real-time" basis, was to enable on-board scientists to adjust the flight path to optimize plume traversal.

2.2.1 GGW primary aircraft

The two-trap analyzer consists of an adsorption trap module, with two adsorption traps, interfaced with a gas chromatograph to sequentially collect and measure PFTs in ambient air. Its characteristics and operational features have been described previously (Allwine et al., 1985). Under conditions employed during ANATEX, samples were collected and analyzed over a 12-min operational cycle. Material collected on one of the traps during the first 6 min of the cycle was measured following thermal desorption and injection into the carrier gas stream of the gas chromatograph. Coincident with sample injection, the second trap was positioned for sample collection. Lee et al. (1989) give 2-trap analyzer results for the flights on March 4, 1987.

2.2.2 STC aircraft

An older version of the Brookhaven National Laboratory (BNL) 2-trap analyzer consisted of two adsorbent traps, packed with the same material used

in the ground-level sampler and the aircraft SAS, and an in situ ECD chromatograph. While one trap was sampling at 1 L/min for 5 min, the other was heated to recover and analyze the collected PFTs. Since the traps reversed position every 5 min, no tracer was lost. A newer version of this real-time analyzer was built in 1983 for the fall CAPTEX experiment (Ferber et al., 1986); improvements allowed the separation of 3 PFTs. The unit was able to measure ambient levels of PMCP (perfluoromethylcyclopentane) and PMCH, indicative of the limit of detection of about 10 fL (D'Ottavio et al., 1986; Dietz et al., 1989). One fL (femtoliter) is 10^{-15} L.

2.3 Environmental Measurements

The primary GGW and STC aircraft both measured temperature and dew point. These data are included in the data listing in Appendix A for easy reference. The STC aircraft also measured solar radiation, SO_2 and O_3, which are available upon request from: R.L. Gunter, NOAA/ARL/Geophysical Monitoring for Climatic Change, Air Quality Group, 325 Broadway, Boulder, CO 80303.

3. OPERATIONS

PNL operated its Cessna 320 twin-engine aircraft for GGW sampling (the "primary" GGW aircraft) and directed the operation of a contractor twin-engine aircraft (the "contract" GGW aircraft) which usually "shadowed" the primary aircraft by flying 500 to 1000 ft higher. They flew at speeds of about 200 km/h. Aircraft at GGW were available for all 33 releases, but due to maintenance problems or poor weather conditions, sampling was done only for about three-fourths of the releases. Sampling at STC was done from the NOAA Beechcraft King Air, a twin-engine aircraft, for 16 of the 17 releases for which it was available. It usually sampled while flying about 250 km/h. Sampling this many releases from both sites exceeded our original expectations for an experiment of this magnitude and complexity.

Experimental operations generally consisted of the following. ARL scientists designed flight paths based on regional meteorological conditions, surface winds at the release site, 06 GMT and 18 GMT soundings at the GGW and STC National Weather Service (NWS) stations, and predicted tracer trajectories using forecast wind fields from the NWS National Meteorological Center Nested Grid Model. Sampling usually occurred soon after the release, but for several nighttime releases during conditions of strong surface-based inversions with light winds, sampling was delayed until the next day, when the plume mixed high enough for aircraft sampling. The aircraft frequently flew perpendicular to the plume, back-and-forth along a line at the same or different altitudes. Sometimes a second sampling flight was conducted after refueling, dependent, in part, on the weather conditions, plume speed, and the total flight hours available. In addition to automatic data logging, on-board personnel manually recorded on a "data sheet" whether tracer was detected by the 2-trap analyzer during periods corresponding to the SAS samples. Personnel on both GGW aircraft also recorded the aircraft position (latitude, longitude and altitude) corresponding to each sample start and end position on the data sheet during each flight. Personnel on the STC aircraft recorded the aircraft position on the data sheet after the flight using data automatically logged during the flight.

Table 1 summarizes the aircraft sampling flights, or sorties, by release and by source giving sampling time in terms of hours from the start of the release, and mean distance and azimuth from the release site. Sometimes during a sortie, sampling was stopped for a short time, then started again; Table 1 only gives the overall sampling time. Figure 2 is a box plot of sampling distances from the release. Sampling at GGW covered a wider range of downwind distances than at STC: 80% of the samples at GGW were within about 60 to 325 km of the release site whereas 80% of the STC samples were within about 60 to 250 km of the release site.

4. SAS PFT CONCENTRATION AND QUALITY ASSURANCE

Although the same PFTs were analyzed by the laboratories for both the ground and SAS aircraft samples, subsequent analysis and quality assurance procedures differed for two important reasons. First of all, with much less air sampled in an individual sampling tube from the aircraft, 3 or 6 L vs. 72 L at ground-level sites, measurements of background levels of PTCH and oPDCH were not generally possible as samples were at or below GC-analyzer detection limits. Secondly, concentrations in the plumes sampled from aircraft were typically about 2 orders of magnitude greater than the ground-level samples, 100 to 1000 fL/L vs. 1 to 10 fL/L. At high concentrations of the primary tracers, some of the other analyzed PFTs used for quality assurance with ground-level samples were also above ambient background levels because they were present at a small fraction in the released tracer. These factors limited the quality assurance procedures and made it impossible to define an objective uncertainty since no unambiguous reference tracer was available. However, given the large concentrations in the plume it was usually quite clear whether a sample was collected in the plume.

4.1 Concentration

A computer program was developed to compute PFT concentrations and for data quality assurance. The program plotted the time series of 6 analyzed PFT computed concentrations (PMCP, PMCH, oc-PDCH, mt-PDCH, pt-PDCH, and PTCH (c = cis, t = trans, m = meta, p = para)) for each aircraft flight on a computer screen. (For simplicity oc-PDCH, mt-PDCH, and pt-PDCH will be referred to as oPDCH, mPDCH, and pPDCH, respectively.) In this way, background measurements of PFTs that were not deliberately released (mPDCH and pPDCH at both release sites and PMCH at GGW) that deviated from the known ambient background and anomalies in the other PFTs for a given sample were prominent. Concentration was computed in units of dfL/L since the laboratories reported PFT volume in dfL. A description of the PFT analysis system is given in Dietz et al. (1989).

4.1.1 Sample contamination

Analysis of the concentration time series showed three different forms of contamination. One was an apparent uniform contamination of the entire string of sampling tubes in the sampler for a given flight; another was individual sample tube contamination, and the third was cross-contamination due to other PFTs present in the released tracer (see section 4.1.2). For all types of contamination the levels were such that the primary interference

Table 1. Aircraft sampling flights by release: approximate time in hours after the start of release, mean downwind distance (km) and mean direction from release site (deg), RLS = release.

			GLASGOW					
			Sortie A			Sortie B		
RLS #	RLS Date	RLS Time (GMT)	time	dist	dir	time	dist	dir
1	Jan 5	17						
2	Jan 8	5	17.0-19.0	220	100			
3	Jan 10	17	4.5- 6.5	90	80			
4	Jan 13	5	11.5-15.0	320	110			
5	Jan 15	17	23.5-27.5	395	90			
6	Jan 18	5						
7	Jan 20	17	4.0- 6.5*	90	80			
8	Jan 23	5	13.5-15.5*	95	360			
9	Jan 25	17						
10	Jan 28	5	5.0- 8.0*	70	315			
11	Jan 30	17	4.0- 7.0*	65	25			
12	Feb 2	5	4.0- 6.5	270	125			
13	Feb 4	17	4.0- 6.5	70	80			
14	Feb 7	5	5.0- 8.0*	230	95			
15	Feb 9	17						
16	Feb 12	5	5.5- 8.0*	125	310			
17	Feb 14	17	4.0- 7.0*	45	60			
18	Feb 17	5	12.5-15.0*	140	55			
19	Feb 19	17	5.0- 7.0	30	275	22.5-26.5	350	115
20	Feb 22	5	12.5-15.5*	185	350			
21	Feb 24	17	4.5- 7.5*	100	260			
22	Feb 27	5	10.5-14.5	210	345			
23	Mar 1	17	3.5- 7.0*	75	110	23.5-26.5	265	170
24	Mar 4	5	5.5- 9.5*	150	90	12.0-15.0*	260	90
25	Mar 6	17	4.0- 8.0	120	100			
26	Mar 9	5	5.0- 7.5*	135	305			
27	Mar 11	17	5.0- 7.5*	95	305			
28	Mar 14	5						
29	Mar 16	17						
30	Mar 19	5	17.5-19.5*	120	230	36.0-39.5	185	165
31	Mar 21	17						
32	Mar 24	5	11.0-14.0*	250	155	17.0-19.5*	345	160
33	Mar 26	17	3.5- 7.0*	190	125			

*Both GGW aircraft.

Table 1. Con't.

ST. CLOUD

RLS #	RLS Date	RLS Time (GMT)	Sortie A time	Sortie A dist	Sortie A dir	Sortie B time	Sortie B dist	Sortie B dir
1	Jan 5	17						
2	Jan 8	5						
3	Jan 10	17						
4	Jan 13	5	15.0-19.0	105	60	21.5-24.5	170	120
5	Jan 15	17	3.5- 7.5	150	160	10.5-12.5	170	155
6	Jan 18	5	11.0-15.0	190	110	17.0-19.0	300	115
7	Jan 20	17	4.5- 8.5	115	95			
8	Jan 23	5	4.0- 8.0	160	155			
9	Jan 25	17	23.5-26.5	275	30			
10	Jan 28	5	4.0- 7.5	165	140			
11	Jan 30	17	4.0- 7.5	170	135			
12	Feb 2	5						
13	Feb 4	17						
14	Feb 7	5						
15	Feb 9	17						
16	Feb 12	5						
17	Feb 14	17						
18	Feb 17	5	12.5-16.5	150	230	33.5-37.5	90	265
19	Feb 19	17	5.5- 9.0	65	30	21.5-25.5	195	40
20	Feb 22	5	12.5-16.0	290	135			
21	Feb 24	17	3.5- 7.5	205	340			
22	Feb 27	5						
23	Mar 1	17						
24	Mar 4	5						
25	Mar 6	17						
26	Mar 9	5						
27	Mar 11	17						
28	Mar 14	5						
29	Mar 16	17						
30	Mar 19	5	3.5- 7.5	140	290			
31	Mar 21	17	4.0- 8.0	220	300			
32	Mar 24	5	9.5-11.5	210	225	12.5-14.5	225	225
33	Mar 26	17	4.0- 8.0	75	90	9.5-13.5	150	75

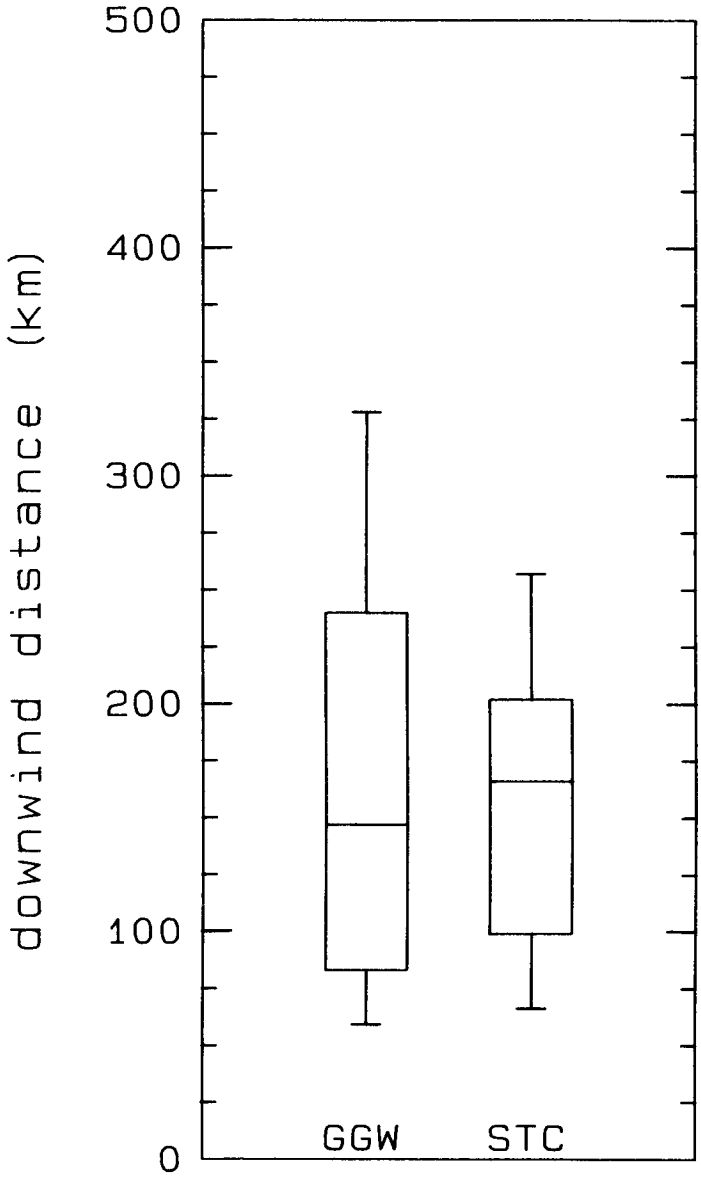

Figure 2. Sampling downwind distance boxplots for both GGW and STC. Plots show 10th, 25th, 50th, 75th, and 90th percentiles.

occurred near ambient background levels rather than the high concentration distinct in plumes.

The first step in the analysis was to remove the contamination over the entire string from the individual PFT volumes reported for each sample. The overall contamination volume was estimated from the tracer volumes reported for sampling tubes that were not used during the flight (blanks). If there were no blanks but the samples appeared to be contaminated, the contamination was estimated from the prior flight and the following flight contamination. Contamination for the entire string was apparent for PMCH, oPDCH and mPDCH for many flights, particularly from STC. Contamination of mPDCH was below background levels, but PMCH and oPDCH contamination levels were sometimes up to a few times background. The greater contamination levels of the STC samples may have occurred because the aircraft was based in a much more industrial area than at GGW. All sampling tubes would have been briefly exposed to the ambient environment while the SAS was loaded before each flight.

PMCH contamination of individual sampling tubes was observed for samples from both release sites. The contaminated samples were usually apparent for all the GGW and the STC nighttime releases when PMCH was not deliberately released. Typically PMCH and PMCP were both contaminated. For STC daytime releases when PMCH was released, if oPDCH and PMCH were both above background, it was impossible to determine if the PMCH was contaminated. PMCH concentrations are not reported when the contamination was observed. This occurred in about 8% and 5% of the GGW and STC samples, respectively. The contamination could be from residual tracer remaining in the tubes used in previous experiments.

4.1.2 Tracer cross-contamination

The aircraft SAS PFT data of interest are PTCH from GGW, oPDCH from STC, and PMCH from the STC daytime releases. Trace amounts of oPDCH and PMCH in the GGW tracer and PMCH in the nighttime STC tracer are termed "cross-contaminants." For instance, if oPDCH is measured from the GGW aircraft, the amount from STC is the measured tracer minus that coming from GGW. mPDCH and pPDCH are also cross-contaminants because they were in both the GGW and STC tracers. Cross-contamination must be known either to obtain the primary PFT concentrations or for quality assurance.

Table 2 gives a mean GGW tracer cross-contamination in terms of percent PTCH for the primary PFTs analyzed by the two laboratories, BNL and the ARL Field Research Division (FRD). The values were obtained from the ratios of the PFT to PTCH from the aircraft samples that were well within the PTCH plume. Though the tracer released was almost all PTCH, the data showed at most about 0.1% PMCH and oPDCH, depending on the laboratory. The laboratory differences are likely due to GC analysis/integration or calibration differences because the contamination levels in the released tracer were assumed to be uniform throughout the entire experiment. mPDCH cross-contamination of BNL data was about 0.5%. Figure 3 shows two cumulative concentration distributions of mPDCH for samples analyzed by BNL. The original higher mPDCH concentrations are reduced to that shown by the dashed line when the cross-contamination is removed.

Table 2. Cross-contamination of primary PFTs in GGW releases.

PFT	Percentage of PTCH	
	BNL*	FRD**
PMCH	.028	.14
oPDCH	.13	.031

*Brookhaven National Laboratory
**NOAA/ARL Field Research Division

Similarly for STC, Table 3 gives the cross-contamination in terms of percent oPDCH released based on the nighttime data. The same PMCH cross-contamination was assumed to occur in the day release tracer since daytime STC release data could not be used because PMCH and oPDCH were released in nearly equal amounts. mPDCH cross-contamination of BNL data was about 17%. Figure 4 shows two cumulative concentration distributions of mPDCH for samples analyzed by BNL. The highest mPDCH values are nearly all removed after accounting for the amount in the release and the final distribution looks almost identical to that in Fig. 3 at GGW where essentially no mPDCH was present. Other differences in the distributions will be discussed later.

Table 3. Cross-contamination of primary PFTs in STC releases.

PFT	Percentage of oPDCH	
	BNL*	FRD**
PMCH	2.7	7.9

*Brookhaven National Laboratory
**NOAA/ARL Field Research Division

4.1.3 Sample air volume

The initial assumption was that the flow rate through the sampler remained constant from sample to sample during one flight because altitude changes during a flight were relatively small and no extreme flow deviations were expected with the SAS sampler. Under this assumption, the air sample volume was simply the product of the flow rate (0.5 L/min) and the sample duration (min). pPDCH was the reference PFT used to verify the air volume for samples analyzed by BNL. Of the analyzed PFTs, pPDCH was the best choice as a reference because it was the smallest cross-contaminant in the tracer for both release sites.

For most of the GGW flights, the constant flow assumption of 0.5 L/min appeared valid because the calculated pPDCH concentrations were essentially at background. However, for about one-fourth of the flights that were analyzed

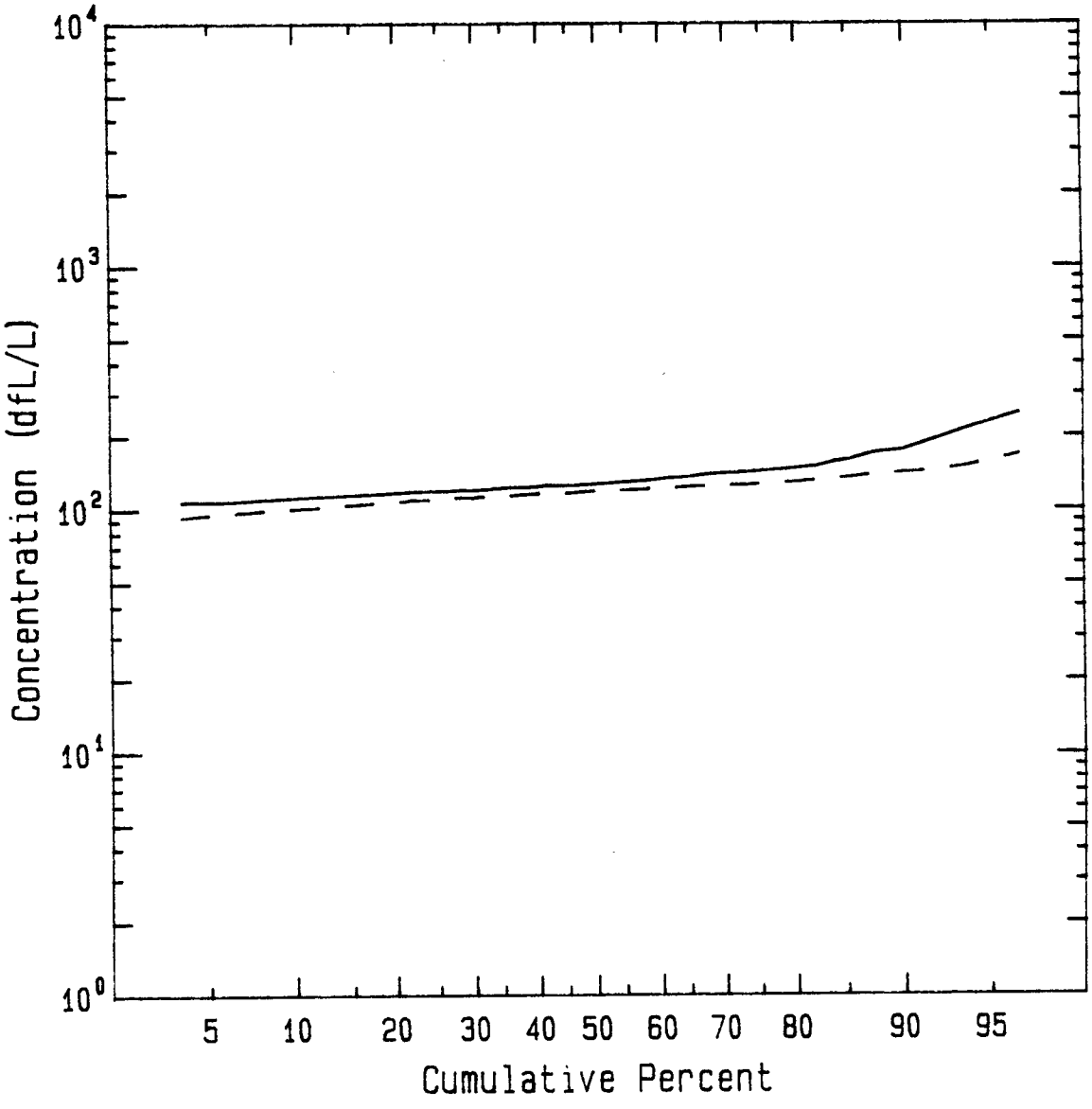

Figure 3. mPDCH cumulative concentration distribution for BNL-analyzed data at GGW. Solid line is the result with a constant flow of 0.5 L/min. Dashed line is the result after removing cross-contamination and using a better flow basis.

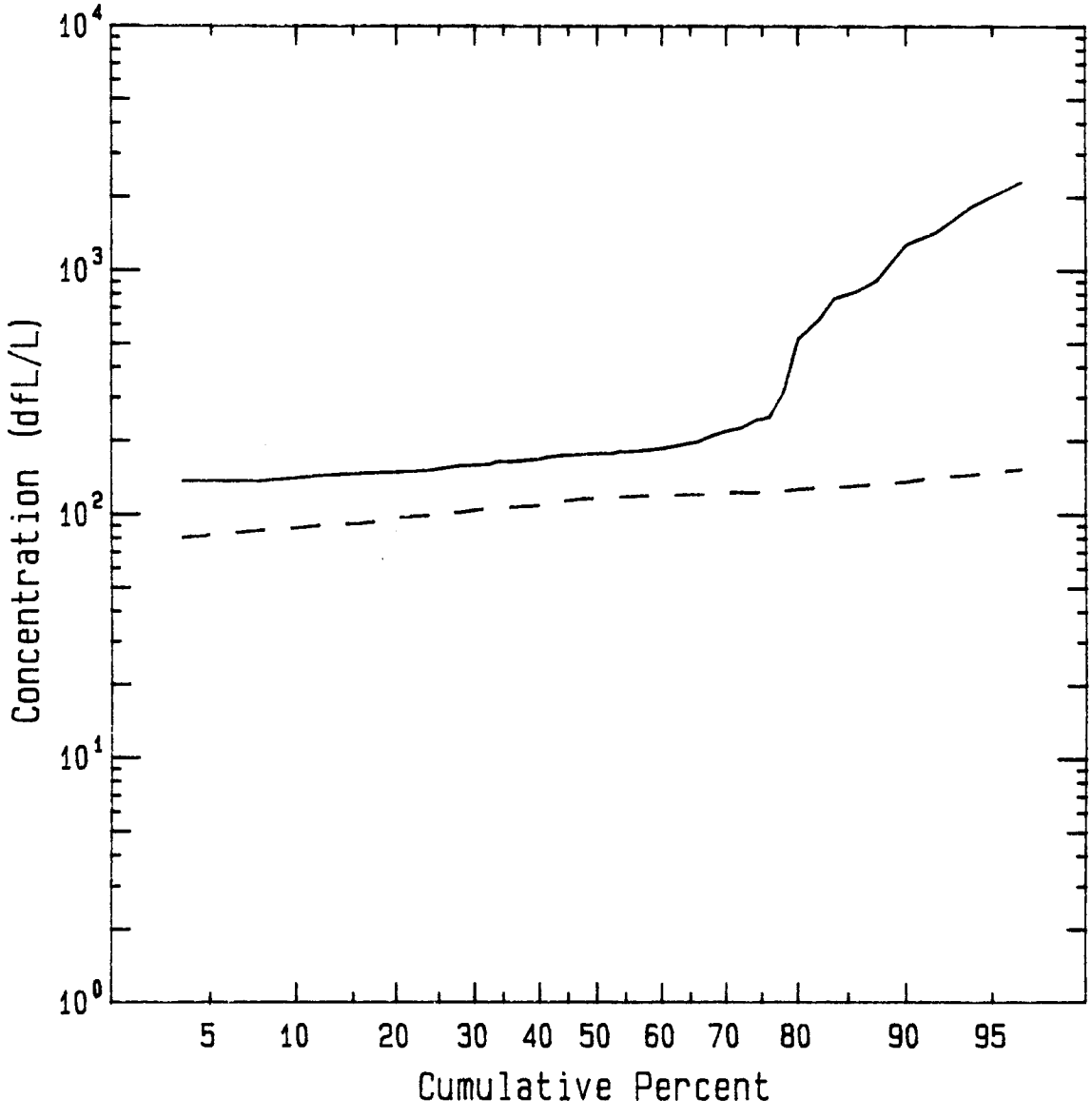

Figure 4. As Fig. 3, but at STC.

by BNL, the flow appeared to be constant, but higher, up to a maximum of about 0.8 L/min. For the high flow cases, the air volume sampled was computed by dividing the known pPDCH background (4.5 fL/L) into an estimated baseline pPDCH volume for that flight.

Similarly at STC, the flow appeared to be constant but generally somewhat higher than 0.5 L/min. For the STC flights with BNL-analyzed data, the flow rates ranged from 0.55 to 0.7 L/min.

pPDCH was not used as a reference for samples analyzed by FRD because the reported pPDCH values were consistently lower than those analyzed by BNL. Air volume computation based on pPDCH gave values far below what would be acceptable. Analysis differences in the other PDCH isomers were also observed. The pPDCH differences from the two laboratories are evident in the cumulative concentration distributions shown in Fig. 5 for GGW. Concentrations shown in the figure were calculated assuming 0.5 L/min constant flow and did not account for contamination nor was the pPDCH from the release removed. No other analyzed PFT could be used as a reference because the others were released (PMCH, oPDCH, and PTCH). Hence a constant flow rate of 0.5 L/min was assumed. Since the ideal constant flow appeared valid for most of the BNL data, it is probably a reasonable assumption that the sequential air sampler worked in a similarly satisfactory manner for the samples analyzed by FRD.

4.1.4 PTCH

Figures 6 and 7 show the cumulative PTCH volume distributions for GGW and STC, respectively, where the volumes have been normalized to a release of 100% PTCH. Both figures show a difference between the two laboratories at the lower end of the distributions. The FRD analysis-integration procedure included an interferant of about 100 dfL, independent of the sample duration (or air sample volume), while the BNL procedure did not. Above background tracer plumes at GGW are clearly evident for volumes greater than about 200 to 300 dfL. No clear PTCH plume samples are apparent at STC. Although the theoretical limit of detection is 35 dfL PTCH for the BNL analysis (Dietz et al., 1989), under actual operating conditions, volumes up to 200 to 300 dfL may have significant uncertainty (personal communication with R. Dietz, BNL, 1989). PTCH background is not measurable because aircraft samples would then have about 10 or 20 dfL PTCH for 3 or 6 L air samples, respectively. The laboratory analysis systems are simply not capable of resolving these low levels. With the difficulty in the low-level PTCH analysis and since plume concentrations are almost certainly much higher than background, we set samples having PTCH volumes less than 300 dfL to background, or zero excess concentration, and defined plume as that above 300 dfL.

4.1.5 Summary and results

The concentration (C) of a particular PFT for each aircraft sample is

$$C = (V - R - T - K) / (F * D). \quad (1)$$

The numerator may be considered as the net PFT volume, where V is the measured tracer volume from the laboratory analysis; R is the volume of the PFT attributed to cross-contamination; T is the threshold volume for PTCH only (300 dfL); and K is the contaminant volume, if any, the same for all samples

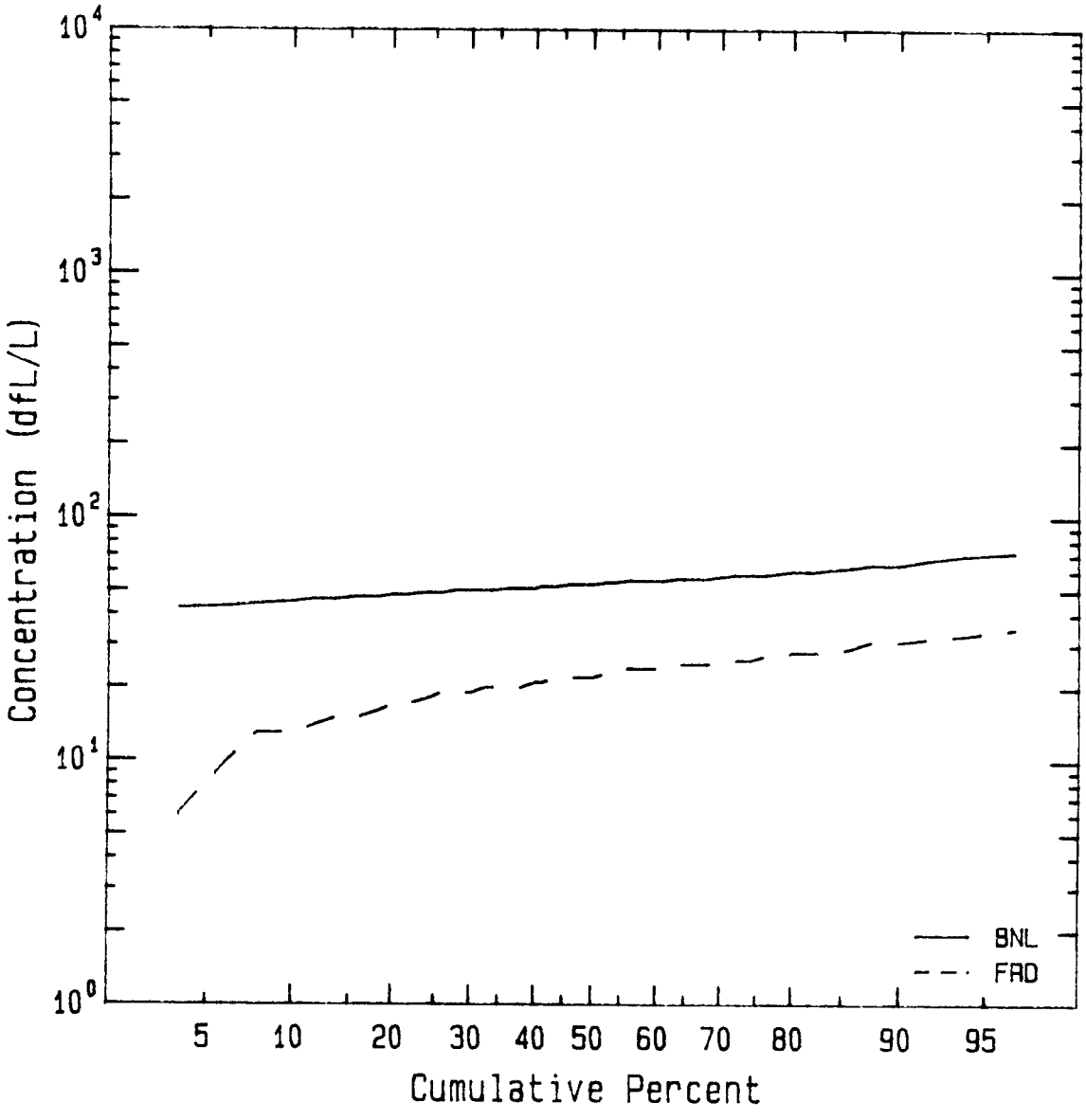

Figure 5. pPDCH cumulative concentration distribution for BNL (solid line) and FRD (dashed line) at GGW.

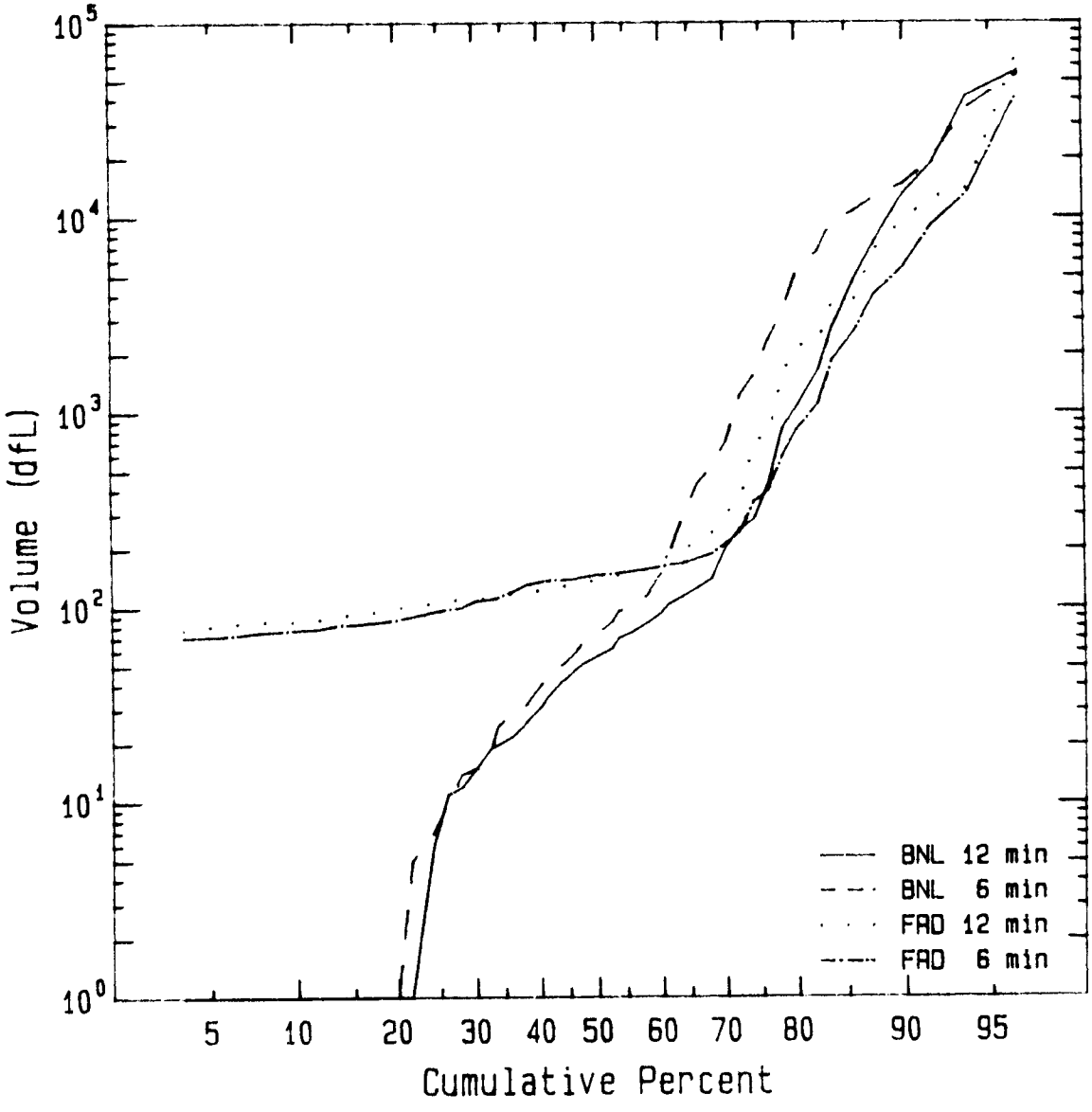

Figure 6. PTCH cumulative volume distribution for all GGW data by laboratory (BNL and FRD) and by sample duration.

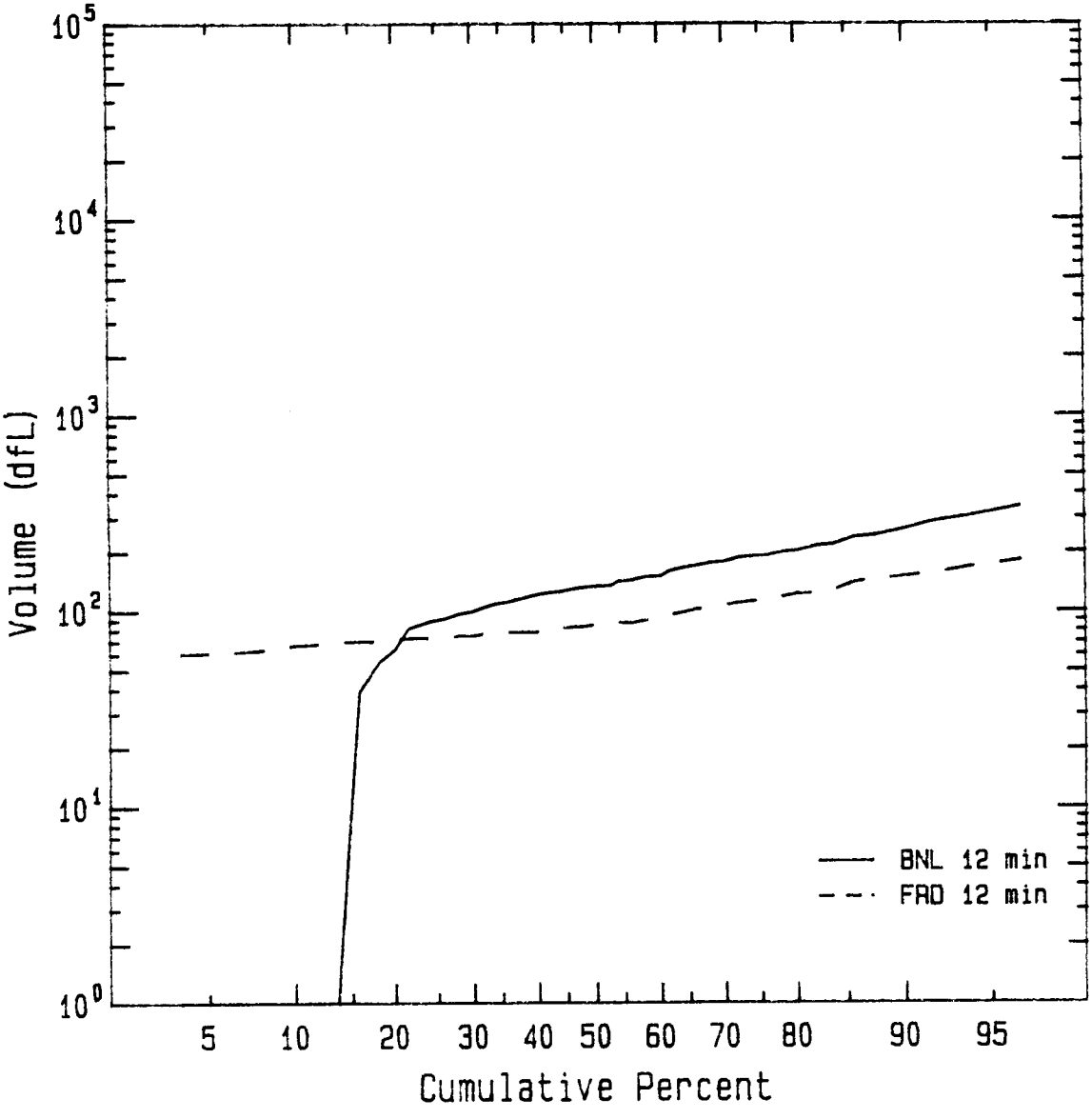

Figure 7. As Fig. 6, but for STC.

in a string. The denominator is the calculated air sample volume--the product of F, the flow rate through the sampling tube, and D, the sample duration. The flow rate for all samples during one aircraft flight is either the ideal constant flow rate or is a constant flow based on pPDCH. Details of these parameters were discussed in previous sub-sections to section 4.1.

In both Figs. 3 and 4, differences between the two cumulative concentration distributions shown in each figure are also due to using calculated flow rates rather than the ideal constant flow assumption. An earlier discussion noted the differences at the high end because of cross-contamination.

Cumulative concentration distributions of the resulting concentrations of PMCH, oPDCH and PTCH for GGW and STC using BNL-analyzed data are shown in Figs. 8 and 9, respectively. These figures are used for quality assurance by noting the slope of the distribution near ambient background and then comparing the background to known ambient levels. They show how many samples were collected in the tracer plume. If the distributions reflected constant ambient background concentrations, they would be flat, except for PTCH because of the 300 dfL threshold, then slope rapidly upward, indicating excess above background. However, analysis uncertainty and flow variations are reflected in the slight increases in background slopes in the figures. The much greater slope in the oPDCH compared to PMCH in both figures indicates greater uncertainty near the oPDCH background, a factor of 10 lower than PMCH. For comparison with the known background, we defined the concentration at the 40% cumulative concentration (30% for oPDCH at STC) to be the best estimate from the data of background, since it is clearly not excess and it is well above occasional steep slopes occurring at the very low end of the distributions due to analysis uncertainty. Table 4 compares the 40th percentile cumulative concentration for PMCH and the three analyzed PDCH isomers by release site and by laboratory to the ambient background concentration. PTCH is not included because it is not measurable at background in the aircraft samples. Comparisons with the ambient levels are fairly good, though as discussed earlier, FRD-reported PDCH values tended to be lower than those reported by BNL. Figure 8 also shows that about 30% of the GGW samples contained PTCH plume and possibly small fractions contained oPDCH and PMCH, although as stated above, the large slope of the oPDCH distribution suggests large uncertainties. Figure 9 shows about 50% oPDCH, 30% PMCH, and a few percent PTCH at STC.

Table 4. 40th percentile PFT concentrations compared to ambient background (dfL/L)

PFT	Glasgow		St. Cloud		ambient background
	BNL	FRD	BNL	FRD	
PMCH	40	34	35	47	36
oPDCH	4	3	10*	6*	3
mPDCH	116	75	109	81	125
pPDCH	48	21	47	23	45

*30th percentile

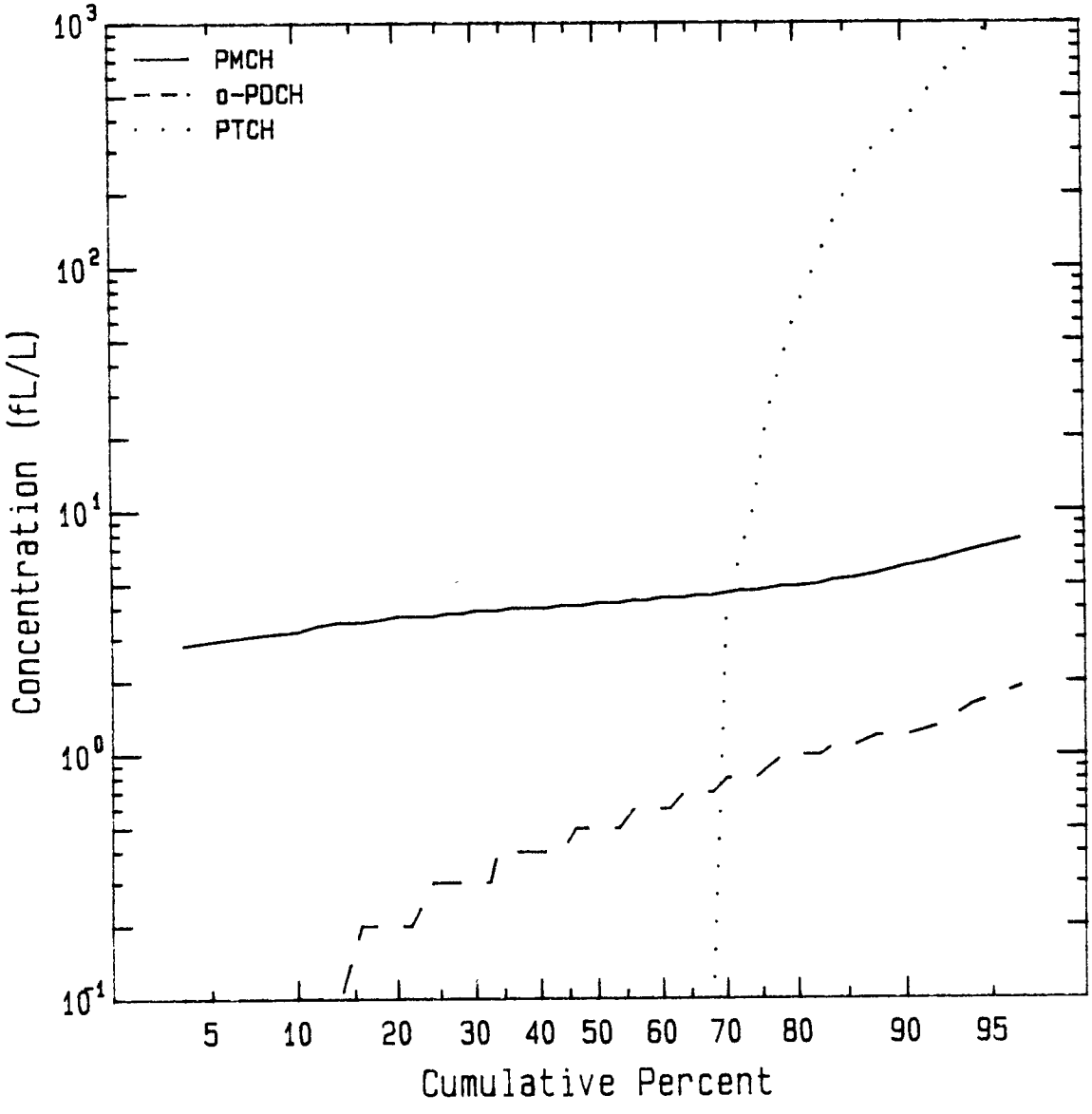

Figure 8. Cumulative concentration distributions of the three primary tracers. Results are from BNL analysis of GGW aircraft samples.

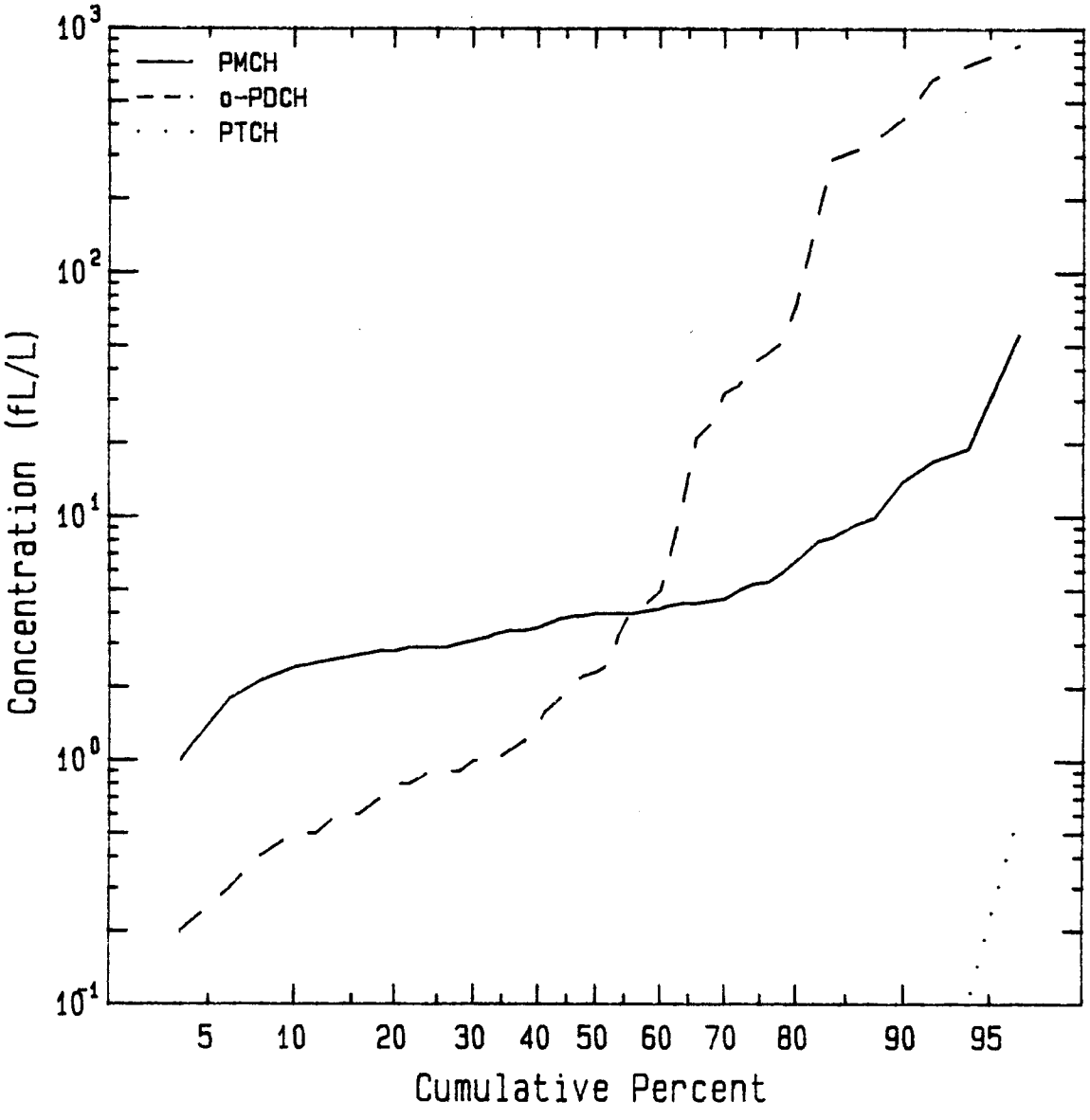

Figure 9. As Fig. 8, but for STC.

4.2 Excess Concentration

The excess concentration (X) is defined similar to that reported for ground-level samples except for no uncertainty term

$$X = C - B. \qquad (2)$$

The excess concentration (fL/L) is the calculated concentration (C) from Eq. 1 minus the background (B), where B is 3.6 fL/L PMCH, 0.3 fL/L oPDCH and 0 fL/L PTCH.

Analysis of oPDCH near background levels has large uncertainties because of the small amount of oPDCH collected (Dietz et al., 1989). These uncertainties coupled with the generally high plume concentrations suggest reporting oPDCH in units of fL/L. On the other hand, background measurements of PMCH were possible because the background (3.5 fL/L) is much higher compared to PTCH and oPDCH. However, due to greater uncertainty (see section 4.5) and with relatively high plume concentrations, samples having excess less than 5 fL/L were assigned an excess of zero.

Excess concentration boxplots for PMCH, oPDCH, and PTCH at GGW and STC using all the data are shown in Fig. 10. Clearly the tracer released closer to the aircraft was predominant, i.e., PTCH at GGW; oPDCH and, to a lesser extent, PMCH at STC. About 50% of the samples at STC contained oPDCH and about 30% at GGW contained PTCH.

4.3 Error Flags

The error flag associated with each reported tracer concentration indicates if FRD flagged the sample during the analysis because of an unknown chemical interferant. BNL did not report this quantity. A flag of "0" indicates a BNL sample or a good FRD sample; a "1" indicates the interference.

4.4 SAS Efficiency/Contamination (Tube 21)

Since air from all the sampling tubes in the SAS flows through tube 21 before leaving the sampler, the tracer on tube 21 is either that which was not collected in the 20 sampling tubes or contamination from the sampling chamber, the tube itself, or from the downstream end of the SAS. For the primary ANATEX tracers, in general, no more than a few percent of the sum of the tracer volumes in all the sampling tubes was observed on tube 21. This suggests that nearly all the tracer in the air flowing through the individual sampling tubes was collected.

4.5 Uncertainty

The uncertainty associated with each reported tracer concentration cannot be objectively determined. Uncertainties in the PFT volume analyzed by the laboratories, the cross-contamination, the PTCH threshold, the uniform contamination, the flow rate, and the time between sample collection and analysis all contribute to the overall uncertainty. In general, the uncertainty in the analyzed PFT volumes as determined by the laboratories is about 10% when the tracer volume sampled was less than 400 fL and about 6% for greater volumes of tracer. The contamination removed during the analysis

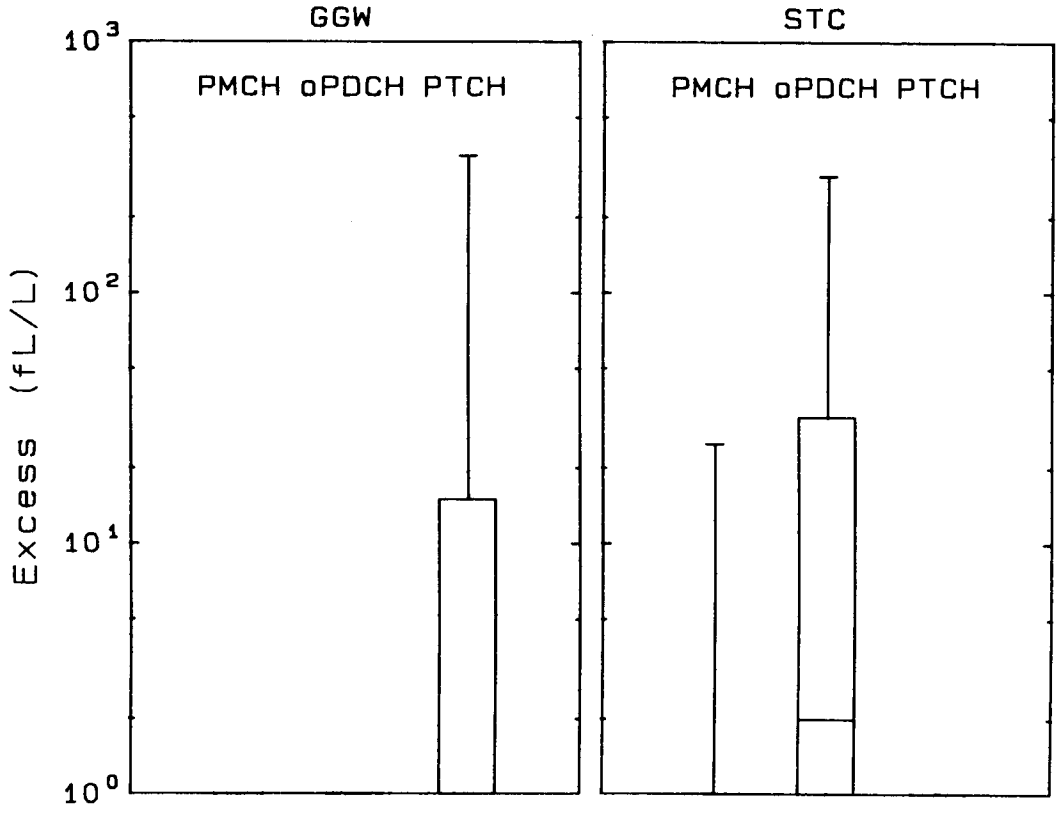

Figure 10. Excess concentration boxplots for PMCH, oPDCH, and PTCH at GGW and STC using all data. Plots show 10th, 25th, 50th, 75th, and 90th percentiles when excess is greater than 1 fL/L.

procedure was a small fraction of the tracer volumes. Uncertainty in flow rates for BNL-analyzed data should be relatively low because pPDCH was used as a reference; uncertainty for FRD-analyzed data could likely be higher because pPDCH could not be used as a reference (section 4.1.3). Measured differences of up to 10% between pre- and post-experimental SAS flow calibrations (section 2.1) would then have little or no effect on BNL-analyzed data, but for FRD-analyzed data would imply a corresponding ±5% concentration uncertainty. Ideally all samples should have been analyzed soon after the experiment. However, some were not analyzed for about 1½ years (section 2.1). Although it is not known if tracer desorbed from the Ambersorb in the sampling tubes over these large lapse times, we suspect desorption would be small, especially in comparison to the high tracer concentrations usually measured from the aircraft. Sampling tubes not exposed, but stored for similarly long periods, showed no tracer had adsorbed on the Ambersorb.

With the aircraft data, most of the primary tracer excess concentrations are large; it was usually quite clear if the aircraft was sampling in the plume. Samples with concentrations near background were not measurable for PTCH, and for oPDCH have high uncertainty since the oPDCH sample volumes were near the limit of detection of the GC. However, using the method for determining concentration described earlier and reporting excess in units of fL/L should result in relatively low uncertainty for the low-level plume samples. PMCH uncertainty may be higher, in part because of contamination in individual tubes. In addition, the PMCH/oPDCH mixture released for the daytime STC releases was not uniform (Heffter and Draxler, 1989a). The short duration aircraft samples near the release site sometimes indicated much more of one of the tracers.

4.6 PFT Data

Out of 1500 aircraft samples processed (20 sampling tubes per flight times 75 flights), 1304 (87%) are included in the archived data. The remaining 13% are not included for the following reasons: all data from two flights were lost due to apparent operator error on the contract aircraft at GGW; 112 sampling tubes were not used due to such problems as ending the flight because of inclement weather, mechanical problems, or timing constraints; 29 samples from STC were not included because the sample either began before take-off or ended after landing; data from a few samples were not available due to problems with a GC; and the sampler flow rate was apparently constricted enough for a few samples that the flow could not be determined.

The PFT data (PTCH for GGW and oPDCH for STC) for all the flights are displayed in Appendix B using a tabular format. These are given as an aid to visualize the complex spatial/temporal dataset for each flight. Corresponding approximate altitude and downwind distance and direction are also given. If both aircraft flew near GGW, data from both are shown.

5. ARCHIVED DATA

The GGW and STC data are archived on an MS-DOS diskette and sorted chronologically by flight in two separate files: AC-GGW.DAT and AC-STC.DAT. Aircraft position, PMCH, oPDCH, and PTCH excess concentration and flags, temperature and dew point are given. Missing temperature and dew point are

indicated by -999; -9 indicates missing values for all other parameters. The data are also included in Appendix A for easy reference.

Copies of the data may be obtained by written request to:

Terry Clark
NOAA/ARL Atmospheric Sciences Modeling
Division
Environmental Research Center
Research Triangle Park, NC 27711

Each archived SAS sample excess concentration is identified by flight, tracer release, aircraft, laboratory, and sample start date/time. The flight number uniquely identifies each flight by one aircraft flying one sortie. It is used to easily distinguish between two different aircraft flying at the same time or between two sorties flown by one aircraft for a given tracer release. GGW has 50 flights; STC has 22. Up to 20 air samples were collected during each flight. Refer to Table 1 for a list of all the sorties. Note that the two sorties at STC for release 32 are archived as one flight because of the relatively short time between the sorties and the SAS was loaded with 20 sampling tubes only before the first sortie; about half the samples were collected in each sortie. Table 1 also gives the release number, date, and time. Odd-numbered releases occurred during the day and even-numbered releases occurred at night. Code numbers for the aircraft and analysis laboratory are also given for each flight. The three aircraft are STC (1), primary GGW (2), and contract GGW (3). The two laboratories are BNL (1) and FRD (2). For GGW when both aircraft flew together, the data for the primary aircraft are given first, then the contract aircraft.

The aircraft position data give sample start and end time (GMT), latitude, longitude, mean terrain height, and altitude in meters (msl) and millibars. For STC and GGW, altitude was reported in pressure (mb) and height (m), respectively, because of different instrumentation on the aircraft. The other altitude parameter was computed by integrating the hydrostatic equation given sea level pressure and station elevation. Although the aircraft generally flew no lower than 150 m above the ground, comparison of altitude and mean terrain shows that aircraft at GGW were sometimes flying within 150 m of the mean terrain or, for a few SAS samples, slightly below mean terrain. This may be due to several factors. First, the aircraft did fly close to the ground during several flights. Second, the archived mean terrain may not always be a good reference when flying close to the ground. Terrain data at a resolution of 0.5 min latitude by 0.5 min longitude were averaged to a one-quarter degree latitude by one-quarter degree longitude grid. The mean terrain given in the archive is the nearest mean terrain value to the aircraft latitude/longitude position. If the aircraft were following the terrain, it could possibly go below the mean terrain. Finally, altitude differences between that automatically logged in the primary GGW aircraft and that manually recorded were usually small, less than 100 m. These differences would be more important when the aircraft flew close to the ground. It should also be noted that the STC aircraft usually began each flight by flying a vertical profile up to at least the top of the boundary layer. Sometimes the SAS was started near the beginning of the profile, sometimes after the profile.

The dew point data should be used qualitatively, for instance to aid in identifying air mass boundaries, because of the difficulty in its measurement, particularly at temperatures below 0°C. For about 30% of the SAS sample data at both GGW and STC the mean dew point is greater than the mean temperature. However, about one-third of these at GGW and one-half at STC are within 1°C. Differences in instrument response time and accuracy may explain some of the suspect data. On the STC aircraft the temperature sensor is accurate to 0.1°C and has a response time of 1 sec; the dew point sensor has an accuracy of 1.0°C and a response time of 5 sec. Both the primary GGW and STC aircraft use the optical condensation hygrometer as the dew point instrument. The condensate surface is electronically maintained in vapor pressure equilibrium with the surrounding air and surface condensation then detected optoelectronically. The dew point temperature is then that temperature at which the rate of condensate equals the rate of evaporation. At temperatures below 0°C, ice forms on the mirror surface and the surface temperature is interpreted as the frost point temperature. More time is required to form a stable frost layer than a dew layer because the mirror temperature first senses the dew point and then slowly rises to the frost point as the condensate freezes. Under conditions of near saturation, the condensation hygrometer gives poor performance, especially for frost point measurements.

The following describes the archive data organization, and record format:

FILE ORGANIZATION:

2 FILES (1 each for GGW and STC)

DATA ORGANIZATION:

RECORD = DATA FOR 1 SAS SAMPLE
(record length=118)

FILE 1 (GGW)

```
REC:  FLIGHT 1 RELEASE 2 SORTIE A AIRCRAFT 2 SAMPLE 1
REC:  FLIGHT 1 RELEASE 2 SORTIE A AIRCRAFT 2 SAMPLE 2
 .     .     .
 .     .     .
 .     .     .
REC:  FLIGHT 2 RELEASE 3 SORTIE A AIRCRAFT 2 SAMPLE 1
 .     .     .
 .     .     .
 .     .     .
REC:  FLIGHT 5 RELEASE 7 SORTIE A AIRCRAFT 2 SAMPLE 1
 .     .     .
 .     .     .
 .     .     .
REC:  FLIGHT 6 RELEASE 7 SORTIE A AIRCRAFT 3 SAMPLE 1
 .     .     .
 .     .     .
 .     .     .
REC:  FLIGHT 50 RELEASE 33 SORTIE A AIRCRAFT 3 LAST SAMPLE OF FLIGHT
```

FILE 2 (STC)

```
REC:  FLIGHT 1 RELEASE 4 SORTIE A SAMPLE 1
 .     .     .
 .     .     .
 .     .     .
REC:  FLIGHT 2 RELEASE 4 SORTIE B SAMPLE 1
 .     .     .
 .     .     .
 .     .     .
REC:  FLIGHT 22 RELEASE 33 SORTIE B LAST SAMPLE OF FLIGHT
```

RECORD FORMAT:

START COLUMN	FIELD LENGTH	FIELD DESCRIPTION
1	I2	Flight number
3	1X	
4	I2	Release number
6	1X	
7	I6	Sampling date (YRMODY)
13	1X	
14	I1	Aircraft number
15	1X	
16	I1	Laboratory number
17	1X	
18	I6	Start time (HHMMSS, GMT)
24	1X	
25	I4	Start latitude (°N*100)
29	1X	
30	I5	Start longitude (°W*100)
35	1X	
36	I4	Start mean terrain (m)
40	1X	
41	I4	Start altitude (m, msl)
45	1X	
46	I5	Start altitude (mb*10)
51	1X	
52	I6	End time (HHMMSS, GMT)
58	1X	
59	I4	End latitude (°N*100)
63	1X	
64	I5	End longitude (°W*100)
69	1X	
70	I4	End mean terrain (m)
74	1X	
75	I4	End altitude (m, msl)
79	1X	
80	I5	End altitude (mb*10)
85	1X	
86	I5	PMCH excess (fL/L)
91	1X	
92	I1	PMCH flag
93	1X	
94	I5	oPDCH excess (fL/L)
99	1X	
100	I1	oPDCH flag
101	1X	
102	I5	PTCH excess (fL/L)
107	1X	
108	I1	PTCH flag
109	1X	
110	I4	Temperature (°C*10)
114	1X	
115	I4	Dew point (°C*10)

Note: For field length, I2 means two integers; I3, three integers, etc.
1X means 1 space.

6. ACKNOWLEDGMENTS

We wish to thank the many people who contributed to the production of the ANATEX aircraft data archive. In particular, we thank R. Lee (Pacific Northwest Labs.), and D. Wellman and L. Gunter (NOAA/ARL/Geophysical Monitoring for Climatic Change) for their success as on-board scientists for the GGW and STC flights, respectively, and the ARL/Field Research Division staff who managed the hundreds of sampling tubes and created the aircraft position database. We appreciate the expertise of R. Dietz (Brookhaven National Laboratory) and G. Start (FRD) for the tracer analysis. Finally, we wish to thank the pilots who were willing to fly at low altitudes to measure the tracer.

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Appendix A - Archived Data

Archived data for GGW and STC are given. The following are included for each SAS sample:

F	= flight
R	= release
DATE	= sampling start date (YRMODY)
A	= aircraft (1=STC, 2=primary GGW, 3=contract GGW)
L	= laboratory (1=BNL, 2=FRD)
TIME	= start/end time (HHMMSS, GMT)
LAT	= start/end latitude (°N*100)
LON	= start/end longitude (°W*100)
E	= start/end mean terrain elevation (m)
HT	= start/end altitude (m, msl)
P	= start/end altitude (mb*10)
PMCH-F	= excess (fL/L) and flag (0=OK, 1=interference)
oPDCH-F	= excess (fL/L) and flag (0=OK, 1=interference)
PTCH-F	= excess (fL/L) and flag (0=OK, 1=interference)
T	= temperature (°C*10)
TD	= dew point (°C*10)

Missing = -9 or -999

GGW

					START						END										
F	R	DATE	A	L	TIME	LAT	LON	E	HT	P	TIME	LAT	LON	E	HT	P	PMCH-F	oPDCH-F	PTCH-F	T	TD
1	2	870108	2	1	221230	4785	10485	769	1036	8996	221830	4792	10472	677	1036	8996	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	221830	4792	10472	677	1036	8996	222430	4810	10460	679	1036	8996	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	222430	4810	10460	679	1036	8996	223030	4840	10442	618	1036	8996	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	223030	4840	10442	618	1036	8996	223630	4849	10425	630	1036	8996	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	223630	4849	10425	630	1036	8996	224230	4865	10413	692	1097	8930	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	224230	4865	10413	692	1097	8930	224830	4885	10401	636	1097	8930	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	224830	4885	10401	636	1097	8930	225430	4899	10407	668	1097	8930	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	225430	4899	10407	668	1097	8930	230030	4886	10391	636	1067	8963	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	230030	4886	10391	636	1067	8963	230630	4865	10381	673	1067	8963	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	230630	4865	10381	673	1067	8963	231230	4843	10371	660	1067	8963	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	231230	4843	10371	660	1067	8963	231830	4822	10362	645	1067	8963	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	231830	4822	10362	645	1067	8963	232430	4802	10350	642	975	9063	0 0	0 0	28 0	-999	-999
1	2	870108	2	1	232430	4802	10350	642	975	9063	233030	4780	10337	682	884	9164	0 0	0 0	7 0	-999	-999
1	2	870108	2	1	233030	4780	10337	682	884	9164	233630	4761	10329	751	884	9164	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	233630	4761	10329	751	884	9164	234230	4741	10319	751	884	9164	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	234230	4741	10319	751	884	9164	234830	4723	10310	761	945	9096	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	234830	4723	10310	761	945	9096	235430	4704	10300	796	945	9096	0 0	0 0	0 0	-999	-999
1	2	870108	2	1	235430	4704	10300	796	945	9096	30	4693	10312	796	1189	8831	0 0	0 0	0 0	-999	-999
1	2	870109	2	1	30	4693	10312	796	1189	8831	630	4688	10344	757	1372	8636	0 0	0 0	0 0	-999	-999
1	2	870109	2	1	630	4688	10344	757	1372	8636	1230	4686	10373	826	1250	8765	0 0	1 0	0 0	-999	-999
2	3	870110	2	1	213800	4900	10600	881	975	9008	214400	4881	10584	815	975	9008	0 0	0 0	0 0	-999	-999
2	3	870110	2	1	214400	4881	10584	815	975	9008	215000	4869	10568	815	975	9008	0 0	0 0	0 0	-999	-999
2	3	870110	2	1	215000	4869	10568	815	975	9008	215600	4854	10551	778	1036	8942	0 0	0 0	2273 0	-999	-999
2	3	870110	2	1	215600	4854	10551	778	1036	8942	220200	4837	10537	691	975	9008	0 0	0 0	481 0	-999	-999
2	3	870110	2	1	220200	4837	10537	691	975	9008	220800	4820	10520	691	975	9008	0 0	0 0	0 0	-999	-999
2	3	870110	2	1	220800	4820	10520	691	975	9008	221400	4807	10498	678	1097	8876	0 0	0 0	0 0	-999	-999
2	3	870110	2	1	221400	4807	10498	678	1097	8876	222000	4813	10512	653	1128	8843	0 0	0 0	0 0	-999	-999
2	3	870110	2	1	222000	4813	10512	653	1128	8843	222600	4825	10522	691	1067	8909	0 0	0 0	0 0	-999	-999
2	3	870110	2	1	222600	4825	10522	691	1067	8909	223200	4847	10548	778	1067	8909	0 0	0 0	0 0	-999	-999
2	3	870110	2	1	223200	4847	10548	778	1067	8909	223800	4848	10546	778	1128	8843	0 0	0 0	0 0	-999	-999
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22	18	870217	3	2	193700	4914	10509	735	1189	8791	194300	4896	10510	733	1036	8956	0	0	0	0	0	0	-999	-999
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24	19	870220	3	1	154400	4655	10562	848	914	9155	155600	4680	10504	757	914	9155	0	0	1	0	0	0	-999	-999
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25	20	870222	2	2	172400	4975	10822	917	914	9058	173330	4976	10778	811	914	9058	0	0	0	0	0	0	-25	-40
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29	22	870227	3	1	152000	4832	10671	674	853	9206	153200	4875	10693	773	914	9139	-9 0	1 0	0 0	-999	-999
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F	R	DATE	A	L	TIME	LAT	LON	E	HT	P	TIME	LAT	LON	E	HT	P	PMCH-F	oPDCH-F	PTCH-F	T	TD
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					START						END										
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15	19	870220	1	2	155518	4795	9214	439	1689	8351	160718	4768	9184	466	1371	8683	0 0	0 0	0 0	-79	-100
15	19	870220	1	2	161918	4722	9202	469	1372	8682	163118	4683	9218	340	1371	8683	0 0	0 0	0 0	-68	-89
15	19	870220	1	2	163118	4683	9218	340	1371	8683	164318	4721	9260	405	1374	8680	-9 0	0 0	0 0	-73	-83
15	19	870220	1	2	164318	4721	9260	405	1374	8680	165518	4764	9286	414	1396	8657	0 0	0 0	0 0	-89	-80
15	19	870220	1	2	165518	4764	9286	414	1396	8657	170718	4792	9304	402	1796	8241	5 0	2 0	0 0	-94	-85
15	19	870220	1	2	170718	4792	9304	402	1796	8241	171918	4734	9312	408	2437	7608	0 0	0 0	0 0	-94	-89
15	19	870220	1	2	171918	4734	9312	408	2437	7608	173118	4669	9320	382	2465	7582	0 0	0 0	0 0	-96	-101
15	19	870220	1	2	173118	4669	9320	382	2465	7582	174318	4604	9330	333	2464	7583	-9 0	0 0	0 0	-98	-100
15	19	870220	1	2	174318	4604	9330	333	2464	7583	175518	4539	9339	296	1802	8235	0 0	0 0	0 0	-97	-102
15	19	870220	1	2	175518	4539	9339	296	1802	8235	180718	4487	9342	271	649	9479	-9 0	1 0	0 0	-33	-69
16	20	870222	1	2	174825	4392	9149	286	2137	7831	180025	4375	9100	327	2146	7822	0 0	0 0	0 0	-126	-143
16	20	870222	1	2	180025	4375	9100	327	2146	7822	181225	4350	9050	317	919	9095	0 0	26 0	0 0	-83	-101
16	20	870222	1	2	181225	4350	9050	317	919	9095	182425	4355	9100	317	929	9084	0 0	104 0	0 0	-46	-55
16	20	870222	1	2	182425	4355	9100	317	929	9084	183625	4375	9130	296	660	9384	0 0	58 0	0 0	-43	-44
16	20	870222	1	2	183625	4375	9130	296	660	9384	184825	4361	9150	301	648	9398	0 0	146 0	0 0	-38	-31
16	20	870222	1	2	184825	4361	9150	301	648	9398	190025	4327	9195	355	647	9399	0 0	214 0	0 0	-16	-29
16	20	870222	1	2	190025	4327	9195	355	647	9399	191225	4296	9228	335	648	9398	0 0	24 0	0 0	-20	-31
16	20	870222	1	2	191225	4296	9228	335	648	9398	192425	4326	9180	338	683	9359	0 0	29 0	0 0	-18	-32
16	20	870222	1	2	192425	4326	9180	338	683	9359	193625	4363	9144	296	674	9369	0 0	189 0	0 0	-14	-32
16	20	870222	1	2	193625	4363	9144	296	674	9369	194825	4395	9099	270	668	9375	0 0	45 0	0 0	-14	-36
16	20	870222	1	2	194825	4395	9099	270	668	9375	200025	4379	9116	256	637	9411	0 0	22 0	0 0	-13	-33
16	20	870222	1	2	200025	4379	9116	256	637	9411	201225	4351	9156	301	660	9385	0 0	91 0	0 0	-13	-34
16	20	870222	1	2	201225	4351	9156	301	660	9385	202425	4380	9185	314	636	9412	0 0	117 0	0 0	-12	-32
16	20	870222	1	2	202425	4380	9185	314	636	9412	203625	4409	9227	367	676	9367	0 0	8 0	0 0	-14	-29
16	20	870222	1	2	203625	4409	9227	367	676	9367	204825	4439	9275	313	1250	8737	0 0	5 0	0 0	-31	-28
16	20	870222	1	2	204825	4439	9275	313	1250	8737	210025	4474	9328	283	776	9254	0 0	4 0	0 0	-49	-44
17	21	870224	1	2	204100	4523	9337	272	2439	7620	205300	4587	9340	315	3628	6549	0 0	0 0	0 0	-141	-155
17	21	870224	1	2	205300	4587	9340	315	3628	6549	210500	4654	9346	383	2441	7618	0 0	0 0	0 0	-143	-168
17	21	870224	1	2	210500	4654	9346	383	2441	7618	211700	4715	9349	400	1581	8477	0 0	0 0	0 0	-58	-95
17	21	870224	1	2	211700	4715	9349	400	1581	8477	212900	4734	9417	401	1105	8985	-9 0	0 0	0 0	-41	-73
17	21	870224	1	2	212900	4734	9417	401	1105	8985	214100	4752	9479	415	1093	8998	0 0	0 0	0 0	-32	-38
17	21	870224	1	2	214100	4752	9479	415	1093	8998	215300	4760	9560	426	1091	9001	0 0	0 0	0 0	-32	-35
17	21	870224	1	2	215300	4760	9560	426	1091	9001	220500	4780	9620	373	1103	8988	0 0	0 0	0 0	-37	-32
17	21	870224	1	2	220500	4780	9620	373	1103	8988	221700	4775	9600	373	1236	8843	0 0	0 0	0 0	-48	-39
17	21	870224	1	2	221700	4775	9600	373	1236	8843	222900	4764	9556	389	1275	8801	0 0	0 0	0 0	-37	-30
17	21	870224	1	2	222900	4764	9556	389	1275	8801	224100	4757	9509	426	1255	8822	0 0	0 0	0 0	-28	-21

STC

					START						END										
F	R	DATE	A	L	TIME	LAT	LON	E	HT	P	TIME	LAT	LON	E	HT	P	PMCH-F	oPDCH-F	PTCH-F	T	TD
17	21	870224	1	2	224100	4757	9509	426	1255	8822	225300	4737	9430	401	1271	8805	6 0	20 0	0 0	-35	-38
17	21	870224	1	2	225300	4737	9430	401	1271	8805	230500	4724	9369	405	1261	8816	-9 0	2 0	0 0	-38	-46
17	21	870224	1	2	230500	4724	9369	405	1261	8816	231700	4722	9386	405	1274	8802	5 0	1 0	0 0	-42	-42
17	21	870224	1	2	232900	4740	9454	404	1284	8791	234100	4761	9518	453	1257	8820	16 0	100 0	0 0	-25	-43
17	21	870224	1	2	234100	4761	9518	453	1257	8820	235300	4770	9576	373	1109	8981	5 0	3 0	0 0	-14	-18
17	21	870224	1	2	235300	4770	9576	373	1109	8981	500	4758	9510	426	1112	8978	6 0	17 0	0 0	-9	-20
17	21	870225	1	2	500	4758	9510	426	1112	8978	1700	4744	9447	404	1115	8974	21 0	190 0	0 0	-17	-32
17	21	870225	1	2	1700	4744	9447	404	1115	8974	2900	4742	9450	404	836	9284	0 0	3 0	0 0	-19	-37
18	30	870319	1	2	83300	4502	9362	290	1989	7951	84500	4547	9436	331	3032	6974	-9 0	0 0	0 0	-38	-51
18	30	870319	1	2	84500	4547	9436	331	3032	6974	85700	4592	9514	425	393	9659	0 0	0 0	0 0	-45	-68
18	30	870319	1	2	85700	4592	9514	425	393	9659	90900	4620	9594	379	983	8997	0 0	212 0	0 0	-8	-16
18	30	870319	1	2	90900	4620	9594	379	983	8997	92100	4662	9605	411	953	9029	0 0	67 0	0 0	-7	-5
18	30	870319	1	2	92100	4662	9605	411	953	9029	93300	4661	9601	411	1288	8669	0 0	2 0	0 0	4	-1
18	30	870319	1	2	93300	4661	9601	411	1288	8669	94500	4622	9620	321	1294	8662	0 0	6 0	0 0	18	26
18	30	870319	1	2	94500	4622	9620	321	1294	8662	95700	4587	9635	319	1169	8795	0 0	1 0	0 0	-14	6
18	30	870319	1	2	95700	4587	9635	319	1169	8795	100900	4635	9614	321	964	9017	5 0	146 0	0 0	-12	12
18	30	870319	1	2	100900	4635	9614	321	964	9017	102100	4685	9585	411	1253	8706	0 0	12 0	0 0	-6	15
18	30	870319	1	2	102100	4685	9585	411	1253	8706	103300	4635	9615	411	1280	8677	0 0	12 0	0 0	6	29
18	30	870319	1	2	103300	4635	9615	411	1280	8677	104500	4600	9630	411	1281	8676	0 0	1 0	0 0	-9	15
18	30	870319	1	2	104500	4600	9630	411	1281	8676	105700	4650	9605	411	1114	8854	0 0	62 0	0 0	-10	20
18	30	870319	1	2	105700	4650	9605	411	1114	8854	110900	4685	9585	411	1478	8469	0 0	17 0	0 0	-15	15
18	30	870319	1	2	110900	4685	9585	411	1478	8469	112100	4650	9605	411	1860	8080	0 0	0 0	0 0	8	34
18	30	870319	1	2	112100	4650	9605	411	1860	8080	113300	4625	9575	411	2155	7789	0 0	0 0	0 0	-18	19
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18	30	870319	1	2	114500	4590	9509	418	2142	7801	115700	4557	9456	354	2471	7487	0 0	0 0	0 0	-15	20
18	30	870319	1	2	115700	4557	9456	354	2471	7487	120900	4523	9404	306	1500	8446	0 0	0 0	0 0	-9	12
19	31	870321	1	2	205800	4701	9654	287	1271	8647	211000	4727	9598	369	1271	8648	0 0	1 0	0 0	-9	-21
19	31	870321	1	2	211000	4727	9598	369	1271	8648	212200	4705	9626	358	651	9323	0 0	0 0	0 0	26	-12
19	31	870321	1	2	212200	4705	9626	358	651	9323	213400	4683	9673	276	644	9331	32 0	17 0	0 0	34	1
19	31	870321	1	2	213400	4683	9673	276	644	9331	214600	4637	9683	292	661	9312	219 0	128 0	0 0	38	4
19	31	870321	1	2	214600	4637	9683	292	661	9312	215800	4600	9676	312	673	9298	328 0	194 0	0 0	41	3
19	31	870321	1	2	215800	4600	9676	312	673	9298	221000	4624	9676	292	1239	8681	-9 0	0 0	0 0	32	20
19	31	870321	1	2	221000	4624	9676	292	1239	8681	222200	4672	9683	276	948	8994	20 0	10 0	0 0	7	10
19	31	870321	1	2	222200	4672	9683	276	948	8994	223400	4636	9677	292	963	8978	126 0	76 0	0 0	23	9
19	31	870321	1	2	223400	4636	9677	292	963	8978	224600	4600	9669	312	966	8975	83 0	49 0	0 0	29	14
19	31	870321	1	2	224600	4600	9669	312	966	8975	225800	4601	9640	298	1122	8806	0 0	1 0	0 0	34	15
19	31	870321	1	2	225800	4601	9640	298	1122	8806	231000	4625	9597	379	1116	8813	102 0	45 0	0 0	22	20
19	31	870321	1	2	231000	4625	9597	379	1116	8813	232200	4673	9590	414	1125	8803	100 0	54 0	0 0	13	11
19	31	870321	1	2	232200	4673	9590	414	1125	8803	233400	4706	9573	454	1158	8767	0 0	1 0	0 0	13	1
19	31	870321	1	2	233400	4706	9573	454	1158	8767	234600	4687	9638	296	1257	8662	25 0	15 0	0 0	11	12
19	31	870321	1	2	234600	4687	9638	296	1257	8662	235800	4671	9704	280	1296	8621	45 0	26 0	0 0	8	16
19	31	870321	1	2	235800	4671	9704	280	1296	8621	1000	4657	9747	329	1429	8482	13 0	4 0	0 0	-2	10
19	31	870322	1	2	1000	4657	9747	329	1429	8482	2200	4678	9681	276	1439	8471	0 0	2 0	0 0	-9	2
19	31	870322	1	2	2200	4678	9681	276	1439	8471	3400	4697	9671	269	944	8998	34 0	19 0	0 0	3	8
20	32	870324	1	2	145130	4470	9409	303	1939	7977	150330	4455	9477	305	1046	8901	0 0	0 0	0 0	84	17
20	32	870324	1	2	150330	4455	9477	305	1046	8901	151530	4445	9544	327	1039	8908	0 0	0 0	0 0	94	44
20	32	870324	1	2	151530	4445	9544	327	1039	8908	152730	4444	9605	405	1136	8804	0 0	0 0	0 0	81	48
20	32	870324	1	2	152730	4444	9605	405	1136	8804	153930	4430	9670	543	1133	8807	0 0	0 0	0 0	77	52
20	32	870324	1	2	153930	4430	9670	543	1133	8807	155130	4405	9720	492	1129	8812	0 0	5 0	0 0	65	52
20	32	870324	1	2	160330	4380	9730	445	1155	8784	161530	4360	9670	445	772	9201	0 0	5 0	0 0	57	66
20	32	870324	1	2	173400	4376	9666	469	1204	8731	174600	4385	9640	465	1051	8896	0 0	0 0	0 0	68	55
20	32	870324	1	2	174600	4385	9640	465	1051	8896	175800	4357	9704	450	1047	8900	0 0	0 0	0 0	70	65
20	32	870324	1	2	175800	4357	9704	450	1047	8900	181000	4387	9685	469	1118	8823	0 0	0 0	0 0	67	67
20	32	870324	1	2	181000	4387	9685	469	1118	8823	182200	4430	9683	492	1303	8627	0 0	0 0	0 0	58	69
20	32	870324	1	2	182200	4430	9683	492	1303	8627	183400	4434	9624	543	1292	8638	0 0	0 0	0 0	61	62
20	32	870324	1	2	183400	4434	9624	543	1292	8638	184600	4441	9562	327	1292	8638	0 0	0 0	0 0	67	69
20	32	870324	1	2	184600	4441	9562	327	1292	8638	185800	4449	9502	306	885	9077	-9 0	1 0	0 0	85	75
20	32	870324	1	2	185800	4449	9502	306	885	9077	191000	4468	9429	314	1156	8783	0 0	0 0	0 0	77	66
21	33	870326	1	2	211110	4511	9333	267	2038	7899	212310	4534	9348	279	771	9225	0 0	1 0	0 0	-24	-36
21	33	870326	1	2	212310	4534	9348	279	771	9225	213510	4573	9357	315	775	9221	57 0	1468 0	0 0	-1	-25
21	33	870326	1	2	213510	4573	9357	315	775	9221	214710	4533	9340	279	792	9202	8 0	75 0	0 0	0	-7
21	33	870326	1	2	214710	4533	9340	279	792	9202	215910	4562	9320	283	767	9230	0 0	2 0	0 0	4	-3
21	33	870326	1	2	215910	4562	9320	283	767	9230	221110	4550	9322	283	793	9201	0 0	0 1	-9 0	6	-1
21	33	870326	1	2	221110	4550	9322	283	793	9201	222310	4548	9324	283	797	9196	0 0	2 0	0 0	4	0
21	33	870326	1	2	222310	4548	9324	283	797	9196	223510	4576	9315	293	772	9224	0 0	12 0	0 0	4	1
21	33	870326	1	2	223510	4576	9315	293	772	9224	224710	4532	9330	272	761	9237	10 0	90 0	0 0	4	3

STC

					START						END									
F	R	DATE	A	L	TIME	LAT	LON	E	HT	P	TIME	LAT	LON	E	HT	P	PMCH-F	qPDCH-F	PTCH-F	T	TD
21	33	870326	1	2	224710	4532	9330	272	761	9237	225910	4550	9322	283	534	9492	0 0	1 0	0 0	14	7
21	33	870326	1	2	225910	4550	9322	283	534	9492	231110	4596	9303	317	548	9476	21 0	260 0	0 0	27	16
21	33	870326	1	2	231110	4596	9303	317	548	9476	232310	4594	9310	317	1076	8891	0 0	1 0	0 0	15	11
21	33	870326	1	2	232310	4594	9310	317	1076	8891	233510	4548	9323	283	1083	8883	44 0	1092 0	0 0	-21	-3
21	33	870326	1	2	233510	4548	9323	283	1083	8883	234710	4540	9329	283	1393	8553	0 0	2 0	0 0	-37	-7
21	33	870326	1	2	234710	4540	9329	283	1393	8553	235910	4587	9310	286	1378	8569	56 0	1615 0	0 0	-50	-17
21	33	870326	1	2	235910	4587	9310	286	1378	8569	1110	4594	9306	317	1708	8228	0 0	3 0	0 0	-50	-12
21	33	870327	1	2	1110	4594	9306	317	1708	8228	2310	4547	9322	283	1697	8240	0 0	1 0	0 0	-54	-22
21	33	870327	1	2	2310	4547	9322	283	1697	8240	3510	4502	9350	290	801	9192	8 0	1 0	0 0	-29	-9
22	33	870327	1	2	24530	4534	9306	278	783	9199	25730	4574	9259	310	800	9180	621 0	295 0	0 0	0	3
22	33	870327	1	2	25730	4574	9259	310	800	9180	30930	4574	9186	379	784	9198	583 0	351 0	0 0	5	2
22	33	870327	1	2	30930	4574	9186	379	784	9198	32130	4597	9179	347	809	9170	0 0	3 0	0 0	13	11
22	33	870327	1	2	32130	4597	9179	347	809	9170	33330	4586	9238	310	798	9182	172 0	1014 0	0 0	6	5
22	33	870327	1	2	33330	4586	9238	310	798	9182	34530	4618	9247	361	805	9175	31 0	68 0	0 0	5	-4
22	33	870327	1	2	34530	4618	9247	361	805	9175	35730	4575	9214	326	791	9190	322 0	620 0	0 0	5	-4
22	33	870327	1	2	35730	4575	9214	326	791	9190	40930	4531	9188	347	783	9199	15 0	90 0	0 0	6	5
22	33	870327	1	2	40930	4531	9188	347	783	9199	42130	4572	9213	326	1411	8523	0 0	2 0	0 0	-17	-3
22	33	870327	1	2	42130	4572	9213	326	1411	8523	43330	4620	9244	361	1413	8520	0 0	6 0	0 0	-42	-22
22	33	870327	1	2	43330	4620	9244	361	1413	8520	44530	4663	9280	404	1539	8390	0 0	1 0	0 0	-49	-29
22	33	870327	1	2	44530	4663	9280	404	1539	8390	45730	4630	9255	360	1540	8389	0 0	4 0	0 0	-56	-34
22	33	870327	1	2	45730	4630	9255	360	1540	8389	50930	4583	9230	326	1548	8380	5 0	7 0	0 0	-55	-29
22	33	870327	1	2	50930	4583	9230	326	1548	8380	52130	4599	9234	301	1694	8231	0 0	0 0	0 0	-61	-34
22	33	870327	1	2	52130	4599	9234	301	1694	8231	53330	4648	9252	333	1152	8797	0 0	4 0	0 0	-59	-35
22	33	870327	1	2	53330	4648	9252	333	1152	8797	54530	4604	9229	301	1095	8858	67 0	19 0	0 0	-24	-11
22	33	870327	1	2	54530	4604	9229	301	1095	8858	55730	4561	9204	377	1092	8861	0 0	1 0	0 0	-19	-8
22	33	870327	1	2	55730	4561	9204	377	1092	8861	60930	4529	9272	280	1114	8837	0 0	0 0	0 0	-33	-4
22	33	870327	1	2	60930	4529	9272	280	1114	8837	62130	4494	9332	267	792	9189	0 0	0 0	0 0	-34	-15

Appendix B - Data Summary

The SAS PFT data (PTCH for GGW and oPDCH for STC) for all the flights are displayed in a tabular format. Downwind distance (D, km), angle with respect to the release site (A, deg), and excess concentration (fL/L) and height above ground (m) are given for 1 or 2 aircraft (C1, H1; C2, H2). The data are printed as a function of time, which is given below the box. The sampling date and release number are given at the left side of the box. The time after the start of the release (h) is shown above the box for 1 sample near the beginning of each flight. If the aircraft flew a back-and-forth type pattern or flew at different downwind distances for part or all of the flight, the segments are divided by the vertical lines.

In a simplified format these tables describe the complex spatial/temporal tracer patterns measured. The data in the tables clearly show if the plume was traversed during the flight, if concentrations at different altitudes were measured, if 2 aircraft flew near GGW, and indicate other general features such as plume size. Details in the data archive should also be obtained for the following reasons:

(1) The flightpath may not be a simple back-and-forth pattern.

(2) When 2 aircraft were flying near GGW, they were usually together, but at different altitudes. An asterisk (*) indicates they were not together for part or all of the flight. The distance and angle are given for only 1 aircraft.

(3) Although the GGW and STC aircraft flew about 200 and 250 km/h, respectively, distance travelled between the SAS sample start and end positions do not always imply these speeds, particularly if the aircraft were turning or changing altitude during a sample. Crosswind integrated concentrations based on these speeds without referring to the flightpath may lead to incorrect conclusions.

(4) For some GGW releases (18-21, 23) when both aircraft flew together (or one aircraft made two flights associated with a release), data from the two aircraft (or two flights), were analyzed by the two different laboratories. Due to differences in the laboratory analyses discussed in section 4, these data should be compared cautiously.

** GGW **

RLS 2 +18

D	140	140	150	160	170	180	190	190	200	200	210	220	230	250	260	280	290	300	290	280
A	105	105	95	85	75	75	65	65	75	85	85	95	95	105	105	115	115	115	115	125
C1	0	0	0	0	0	0	0	0	0	0	0	28	7	0	0	0	0	0	0	0
C2																				
H1	300	400	400	400	400	400	400	400	400	400	400	400	300	200	100	200	200	300	500	500
H2																				

870108 23 GMT 0 GMT

RLS 3 +5

D	70	70	70	80	90	110	110	100	90	80	80	70	70	80	90	100	100	100	100	
A	35	55	65	85	95	105	105	95	85	75	75	65	65	75	95	95	85	65	55	
C1	0	0	2300	480	0	0	0	0	0	0	0	4	110	0	0	0	480	6700	600	
C2																				
H1	100	200	200	300	300	400	400	400	300	300	300	300	200	200	200	100	100	100	100	
H2																				

870110 22 GMT 23 GMT

RLS 4 +12

D	350	330	320	300	300	300	300	300	320	330	360	360	340	320	310	300	330							
A	115	115	110	95	95	85	85	95	105	115	115	115	115	105	105	95	95							
C1	34	15	46	52	25	0	0	0	0	0	0	0	0	0	0	0	0							
C2																								
H1	200	200	200	300	200	200	600	600	600	500	400	800	800	900	900	900	900							
H2																								

870113 17 GMT 18 GMT 19 GMT

RLS 4 +16

D												300	300	320										
A												95	95	110										
C1												0	0	0										
C2																								
H1												200	300	300										
H2																								

870113 21 GMT

RLS 5 +24

D	400	410	410	410	410	410	410	420	420	420	410	410	410	410	400	380	350	320	290					
A	75	75	75	75	85	85	95	95	105	95	95	85	85	75	80	75	85	85	90					
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
C2																								
H1	200	200	200	200	200	100	100	0	100	200	200	300	300	300	300	300	200	100	100					
H2																								

870116 17 GMT 18 GMT 19 GMT 20 GMT

RLS 7 +4

D	100	90	80	80	80	80	80	80	80	100	120	140	140	120	110	100	90	80	70	70	70	70	100	
A	100	80	55	55	50	35	45	65	75	95	110	115	115	105	105	95	95	85	75	65	35	75	105	
C1	0	30	1300	380	0	0	0	4	6	0	0	0	0	0	0	0	0	0	0	0				
C2		1100		530		0	0	0	550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
H1	400	300	300	300	300	400	500	500	500	600	600	500	500	500	500	500	500	500	400	400				
H2		100		100		100	200	200	300	300	400	300	300	300	300	200	200	200	100		100	200	200	

870120 21 GMT 22 GMT

** GGW **

RLS 8 +14

D	20	30	50	70	90	80	70	70	100	100	100	110	130	120	110	110	120	130	130	140				
A	55	335	315	315	315	330	345	10	5	345	335	325	325	335	355	5	15	25	35	45				
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
C2	0	0	0	0	0	0	0	44	200	110	0	0	0	0	25	1700	3500	2100	41	0				
H1	400	400	400	400	400	400	400	400	200	300	300	300	400	400	500	400	500	400	400	500				
H2	200	200	200	200	200	200	200	200	100	100	100	100	300	300	300	300	300	300	300	300				

870123 19 GMT 20 GMT

RLS 10 +5

D	60	60	70	80	80	70	80	90	80	60	40	40	60
A	285	325	5	35	35	0	325	315	325	335	295	250	205
C1	0	0	0	0	0	0	0	0	0	0	0	0	0
C2	0	0	0	0	0	0	0	21	0	0	0	0	0
H1	800	700	700	600	500	500	600	500	500	500	800	600	800
H2	600	600	500	400	400	400	400	400	400	300	400	400	400

870128 10 GMT 11 GMT 12 GMT

RLS 11 +4

D	40	40	60	60	50	50	60	80	90	80	60	50	50	50	60	80	70	70	70	90	80	70	80	80		
A	55	0	325	335	5	35	55	65	75	65	55	45	15	0	335	325	345	5	15	50	35	15	5	355		
C1	0	120	0	0	350	80	0	0	0	0	0	0	0	0	0	0	0	0	0			0				
C2	9900	180	0	0	3800	5000	100	0	0	0	0	0	63	0	0					0	0	0	300	98		
H1	200	200	300	300	200	200	300	400	500	600	500	400	400	400	500	400	400	300	300			400				
H2	200	200	200	200	200	200	200	300	300	300	300	200	200	300	300					400	300	300	300	300		

870130 21 GMT 22 GMT 23 GMT

RLS 12 +4

D	280	280	280	290	290	280	270	280	280	280	270	260	260	260	250	240										
A	125	120	105	105	105	115	125	125	135	125	125	115	115	125	135	135										
C1	0	21	160	0	0	57	93	0	0	3	120	0	0	11	17	0										
C2																										
H1	400	400	500	500	500	400	400	400	400	500	600	1100	1200	1200	1100	1100										
H2																										

870202 9 GMT 10 GMT 11 GMT

RLS 13 +5

D	70	60	60	70	90	80	70	80	60	70	70	60	60	70	80	80	70	60	60	70						
A	115	95	75	55	45	45	55	75	95	120	115	95	75	60	45	45	55	75	95	115						
C1	0	0	180	710	0	0	9400	9300	4	0	0	0	2800	0	0	0	75	1200	0	0						
C2																										
H1	400	300	200	300	300	100	100	100	100	200	400	300	200	300	300	100	100	100	100	200						
H2																										

870204 22 GMT 23 GMT

RLS 14 * +5

D	190	190	190	190	190	180	200	200	190	190	180	180	180	190	190	260	260	260	260	270	400	390				
A	95	85	75	65	75	85	105	105	95	100	95	90	85	75	65	75	85	95	95	105	105	115				
C1	0	56	19	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	8						
C2	230	200	0		0	0	0	0			180	0	0			26	100	79	10	0	0	0				
H1	500	500	600	600	700	700	700	600	600	600	500	500	600	600	600	500	500	600	500	500						
H2	400	400	400		500	500	600	600			400	400	400			400	400	400	500	500	400	400				

870207 10 GMT 11 GMT 12 GMT

** GGW **

RLS 16 *

D	120	100	100	100	100	110	120	130	140	130	120	110	120	130	150	160	180	200	210	230		
A	315	345	0	355	335	325	315	315	305	315	325	325	315	315	310	305	295	295	295	285		
C1	0	0	0	0	0	0	0	0	0	0	0	M	0	0	0	0	0	0	0	0		
C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
H1	300	300	300	300	300	300	300	400	300	300	300	300	300	400	300	400	400	400	400	400		
H2	300	300	200	200	300	300	300	300	300	300	300	300	300	300	300	200	200	300	200	0		

870212 — 11 GMT — 12 GMT

RLS 17

D	30	50	70	60	40	30	40	60	70	60	40	30	30	50	60	40	30	50	70	60		
A	85	5	0	5	25	65	105	125	125	125	105	75	35	5	0	25	75	115	95	55		
C1	360	1700	2	0	1000	2300	290	430	90	30	1600	4900	410	0	0	0	0	0	0	0		
C2	3500	8	0	33	4300	640	15	0		230	440	7800	11	0	0	420	1400	22	0	0	31	
H1	300	200	200	200	200	200	200	400	600	500	400	400	300	400	500	500	600	700		800	700	
H2	100	0	0	0	0	0	100	100		300	200	200	200	200	300	300	400	400	500	600	500	

870214 — 21 GMT — 22 GMT — 23 GMT

RLS 18 *

D	130	130	160	170	160	150	130	110	110	110	120	140	150	150	140	130	120	110	100	110	110	
A	25	80	45	35	40	35	45	55	65	55	55	45	35	35	45	55	55	65	85	95	105	
C1		0	7	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
C2	25	9	7	8	8	9	6	2	4	5	3	4	7	7	6	4	4	2	2	2		
H1		400	400	300	300	300	300	200	200	300	300	300	300	300	400	400	300	300	500	400	300	
H2	200	200	200	100	100	100	100	100	100	100	100	100	100	200	200	200	200	100	100	200		

870217 — 18 GMT — 19 GMT — 20 GMT

RLS 19

D	40	30	20	10	30	30	20	20	30	40	50	60	40	40	30	10	20	30	20			
A	105	75	55	345	285	285	315	45	75	105	125	135	115	95	65	35	305	285	295			
C1	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
C2																						
H1	100	100	100	200	300	400	300	300	300	300	300	300	300	200	100	100	200	300	400			
H2																						

870219 — 22 GMT — 23 GMT

RLS 19

D	210	210	220	240	280	310	350	370	380	390	400	420	450	450	440	420	400	380	370	360		
A	155	135	125	115	105	95	95	95	100	105	105	115	115	115	115	105	105	95	95	85		
C1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0		
C2																						
H1	100	100	100	200	200	200	300	300	300	300	300	200	200	200	300	300	300	300	300	300		
H2																						

870220 — 16 GMT — 17 GMT — 18 GMT — 19 GMT

RLS 20

D	190	170	150	150	150	150	160	160	180	200	220	240	240	230	220	220	220	180	180	180		
A	315	335	345	0	355	350	335	335	335	335	335	335	335	340	345	345	355	5	5	5		
C1	0	22	290	30	84	130	160	380	75	0	0	0	0	0	0	0	0	350	0	300		
C2	0	0	0	180	180	76	0	0	44	52	54	160			0	0	0	0	0	0	110	
H1	200	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	400	300	300	300		
H2	100	100	100	200	200	200	200	200	200	200	200	100		100	100	100	200	200	100	100		

870222 — 18 GMT — 19 GMT — 20 GMT

RLS 21 +5

D		130	110	110	120	120	110	120	130	110	80	70		80	70	80	80			
A		235	255	275	295	285	265	250	235	225	245	275		295	265	255	255			
C1		0	0	0	0	0	0	0	0	0	65	1700		2	120	0	0			
C2		0	0	0	0	0	0	0	0	0	1100	0		0	140	0	0			
H1		400	400	400	300	300	400	400	400	400	400	400		400	400	400	400			
H2		100	100	100	100	100	100	100	100	200	200	200		300	300	300	400			

870224 22 GMT 23 GMT 0 GMT

RLS 22 +11

D	30	70	120	180	230	250	240	240	240	240	240	240	250	280	300	290	260	220	190	150
A	295	325	325	325	335	340	350	360	10	5	5	355	335	335	335	345	345	345	335	335
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C2																				
H1	200	100	200	200	100	200	200	200	200	100	100	100	200	200	200	200	200	100	100	100
H2																				

870227 16 GMT 17 GMT 18 GMT 19 GMT

RLS 23 +4

D		110	90	70	80	100	90	60	40	60	80	80	60	50	40	70	80	80	70	60	70
A		135	115	85	55	45	35	35	90	135	145	145	135	130	105	115	135	135	115	105	120
C1		1	0	0	0	0	0	0	0	1400	0	0	0	640	0	68	0	0	0	0	0
C2		0	0	0	0	0	0	0	0	1900	0	0	0	870	0	140	69	0	1600	0	7
H1		500	500	500	500	500	500	400	500	500	600	700	700	700	600	900	900	1000	800	0000	1200
H2		200	300	300	200	200	200	100	200	200	300	400	400	400	300	600	800	700	700	700	900

870301 21 GMT 22 GMT 23 GMT

RLS 23 +24

D	170	180	190	210	220	240	260	270	290	310	340	370	390	390	360	320	270	230	180	120
A	185	185	185	175	175	175	175	175	165	165	165	165	155	160	155	160	155	155	155	165
C1	25	54	24	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C2																				
H1	100	100	200	200	200	200	200	100	200	200	200	200	100	100	100	200	200	300	300	300
H2																				

870302 17 GMT 18 GMT 19 GMT

RLS 24 +6

D	160	150	150	160	160	150	150	160	150	150	150	160	150	150	160	160	150	150	160	150	
A	115	95	85	65	65	75	100	105	105	90	75	65	75	85	105	105	85	75	70	65	
C1	0	0	0	0	0	0	0	0	0	0	0	0	10	290	0	0	16	13	0	0	
C2	0	0	8	0	0	29	0	0	0	33	0		5	710	97	0	53	1600	83	10	1400
H1	700	700	700	700	700	700	700	700	700	800	700	500	400	400	400	500	600	600	500	500	
H2	400	400	500	400	400	500	400	400	400	400	300		200	300	300	200	300	300	200	200	300

870304 11 GMT 12 GMT 13 GMT 14 GMT

RLS 24 * +13

D	270	260	260	260	270	260	260	260	260	260	260	260	260	260	260	260	260	260	270	260	260	190
A	95	95	85	75	75	80	75	85	85	95	95	95	90	85	75	75	85	75	80	85	85	
C1	72	770	150	0	0	0	220	380	380	420	140	47	0	0	0	0	0	0	180	0		
C2	41	350	840	11	15	180	320	310	42	20		280	210	41	140	210	370	320	310	410	350	
H1	400	400	400	400	400	300	200	200	300	200	500	500	500	400	500	600	400	300	200	100		
H2	200	200	200	300	300	100	100	100	100	100		200	200	200	200	200	100	100	200	200	200	

870304 18 GMT 19 GMT

** GGW **

RLS 25 +4

D	140	120	110	120	120	110	120	140	140	120	110	120	120	110	120	140	140	120	110	120
A	125	105	85	65	70	85	105	125	115	105	75	65	65	90	105	125	125	105	85	55
C1	0	700	690	0	0	920	4	0	0	1400	0	0	0	850	0	0	0	0	1000	0
C2																				
H1	200	200	200	300	500	500	500	400	200	200	200	300	500	500	500	300	100	200	200	200
H2																				

870306 21 GMT 22 GMT 23 GMT 0 GMT

RLS 26 +5

D	130	120	130	140	130	140	150	170	160	150	140	130	120	120
A	265	285	305	305	295	305	320	325	325	315	305	295	285	275
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C2	0	690	540	1500	140	0	0	0	0	0	0	0	0	0
H1	700	700	700	600	700	700	600	700	700	600	600	700	700	700
H2	400	400	400	400	400	400	300	400	400	300	300	400	400	400

870309 10 GMT 11 GMT 12 GMT

RLS 27 * +5

D	130	110	100	90	80	70	60	50	50	70	90	90	80	70	70	70	90	100	120	140	140	160
A	270	285	305	315	325	335	325	305	285	275	285	285	295	315	325	325	315	305	305	295	305	295
C1	0	650	1300	29	0	0	0	0	0	0	0	0	1200	39	0	0	0	180	2100	1500		
C2	0	1500	280	16	0	0	0	0	0	0	0				1800	540	14			81	1800	2400
H1	200	200	200	100	100	200	200	200	200	300	200	200	200	200	200	200	200	100	100			
H2	200	200	200	200	200	100	200	200	300	300	200				200	200	200			200	200	100

870311 22 GMT 23 GMT 0 GMT

RLS 3017 *

D	200	180	150	140	130	120	110	100	80	80	90	100	100	100	100	100	110	110	130	150	90	100	110
A	165	175	185	195	205	215	225	235	245	245	245	245	255	255	245	235	215	205	185	185	265	255	235
C1	0	0	0	0	0	0	0	0	0	64	0	0	28	950	0	0	0	0	0	0			
C2				0	0	0	0	27	98	0	0	0	10	960	250	0	0	0	0	220	430	30	0
H1	200	200	200	100	200	200	200	100	100	100	100	100	100	100	100	100	200	300	300	300			
H2				200	200	200	200	100	100	100	100	100	100	100	100	100	100	200	200	100	100	100	100

8703182 GMT 23 GMT

RLS 30 +38

D	210	210	220	200	160	130	120	150	200	230	230	210	180	140	120	150	190	210	220	220
A	175	185	195	195	185	175	155	145	145	150	155	165	165	155	155	145	145	155	155	165
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C2																				
H1	400	400	300	300	300	400	400	300	300	300	400	400	300	300	300	300	300	300	200	200
H2																				

870320 17 GMT 18 GMT 19 GMT 20 GMT

RLS 32 * +11

D	240	240	250	270	280	240	250	260	270	280	270	260	260	250	240	240
A	175	185	155	145	145	165	155	155	145	150	145	155	155	155	185	170
C1	0	0	290	240	0	0	380	650	680	940	1000	440	730	350	280	8400
C2	0	0	280	270	120	350	640	640	1400	1100	0	0	0	0	0	0
H1	300	300	200	200	100	200	200	100	100	100	100	200	200	200	200	200
H2	200	200	200	200	100	300	300	200	200	200	200	100	200	300	500	500

870324 16 GMT 17 GMT 18 GMT

** GGW **

RLS 32 * +17

D	300	330	340	330	320	320	330	340	340	340	330	320	320	310	320	340	370	380	370	360			
A	155	145	145	155	155	155	155	145	145	145	155	155	155	165	155	155	155	155	155	155			
C1	100	230	9	110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
C2	66	210	7	0	12	190	57	0	0	0	0	0	0	0	0	0	10	73	5	0			
H1	200	200	200	200	300	300	300	200	200	200	300	300	300	300	300	200	200	100	200	200			
H2	100	0	0	0	0	100	200	200	200	200	200	200	200	200	200	200	100	100	100				

870324 22 GMT 23 GMT 0 GMT

RLS 33 +4

D	190	180	180	190	190	180	180	200	200	180	180	180	190	200	190	180	180	180	180	180			
A	145	125	120	105	105	120	125	145	145	135	115	110	95	95	95	110	115	115	125	135			
C1	0	0	0	0	0	0	0	0	0	0	130	0	0	0	0	0	0	5	340	0300			
C2	0	0	0	0	0	2	74	0	0	110	470	4	0			3	50	230	2600	350	0		
H1	800	800	800	900	1200	1100	1100	1100	800	800	800	900	900	700	500	400	400	400	400	300			
H2	500	500	500	600	600	500	500	500	500	500	500	400	300			300	300	200	200	200	200		

870326 21 GMT 22 GMT 23 GMT

RLS 4 +15

D	40	20	60	80	90	90	120	170	200	210	190	150	130	110	80	70	80	70	70
A	125	45	40	55	75	65	45	35	25	15	25	35	55	75	75	55	25	25	75
C1	4	2100	920	27	5	10	46	18	2	1	2	34	20	4	520	740	39	74	1200
H1	200	200	200	200	200	200	100	100	100	100	100	200	200	200	200	200	100	100	200

870113 20 GMT 21 GMT 22 GMT 23 GMT

RLS 4 +22

D	80	110	130	140	130	140	150	170	210	230	250	240	230	210	170
A	105	105	125	140	125	115	95	85	95	115	125	135	135	125	115
C1	4	36	24	50	1	92	10	2	42	340	350	52	720	820	0
H1	200	200	200	200	200	200	200	200	200	200	200	200	200	200	300

870114 3 GMT 4 GMT 5 GMT

RLS 5 +4

D	80	70	60	60	50	80	120	150	150	140	150	170	200	230	240	240	230	230
A	175	175	135	115	155	195	195	185	175	160	135	125	135	145	160	170	165	155
C1	43	32	1400	2	890	2	2	1	4	57	6	2	2	2	1	2	1	2
H1	300	300	300	400	500	400	500	500	400	500	500	400	400	400	500	500	500	500

870115 21 GMT 22 GMT 23 GMT

RLS 5 +11

D	180	160	150	180	190	190	180	160	130
A	115	135	155	155	155	165	185	155	150
C1	1	2	3	24	4	1	3	4	2
H1	200	200	200	200	200	300	200	200	200

870116 4 GMT 5 GMT

RLS 6 +11

D	210	210	190	170	170	180	200	200	190	170	170	180	190	180	170	180	200	220
A	125	125	115	95	95	105	115	115	105	95	95	105	115	105	95	85	95	105
C1	260	320	430	710	1	680	350	1	1	500	34	360	8	310	210	2	430	47
H1	300	300	300	300	300	300	300	600	900	1000	700	500	600	500	500	400	400	400

870118 16 GMT 17 GMT 18 GMT 19 GMT

RLS 6 +17

D	260	300	330	350	350	340	300	260	210
A	105	95	95	105	105	115	115	125	125
C1	290	34	1	6	0	0	0	0	0
H1	400	200	200	200	300	300	300	300	700

870118 22 GMT 23 GMT

RLS 7 +5

D	40	40	60	40	40	40	50	90	140	170	180	190	190	170	170	170	150	120
A	130	50	30	50	125	125	70	70	75	90	105	115	115	95	85	90	105	120
C1	22	0	0	0	5	5	0	0	0	190	170	0	2	860	0	1000	22	0
H1	300	300	300	300	400	500	500	500	400	300	300	400	400	400	400	500	600	700

870120 22 GMT 23 GMT 0 GMT 1 GMT

RLS 8 +5

D	130	180	200	190	190	190	190	170	140	120	140	170	190	180	150	120	120	120	130
A	150	145	145	150	165	170	160	155	160	160	145	130	125	130	140	160	180	180	155
C1	1	1	1	1	4	1	1	0	0	0	0	1	1	0	0	0	0	0	95
H1	900	500	400	400	400	400	400	400	400	400	500	500	500	600	600	600	600	600	600

870123 10 GMT 11 GMT 12 GMT

RLS 9 +24

D	220	270	300	300	320	340	320	280	250	260	260	
A	20	15	20	30	40	45	45	45	40	25	20	
C1	1	1	0	0	1	1	1	0	0	0	1	
H1	400	500	700	600	600	500	700	900	700	400	300	

870126 17 GMT 18 GMT 19 GMT

RLS 10 +5

D	170	160	160	170	160	160	170	170	160	160	160	160	180	180	150	
A	150	135	115	110	115	135	155	155	140	120	125	140	155	160	150	
C1	0	1	1	1	0	16	1	0	52	0	0	47	1	1	290	
H1	400	400	500	400	400	400	400	400	300	400	500	500	500	500	600	

870128 10 GMT 11 GMT 12 GMT

RLS 11 +4

D	160	170	160	170	180	170	160	160	160	160	170	170	170	170	160	160	160	170
A	160	150	135	115	110	115	130	145	140	125	115	130	145	155	145	135	120	110
C1	2	0	1	0	22	0	18	1	100	27	0	0	0	0	0	120	670	2
H1	600	200	200	300	400	400	500	600	700	800	1000	1100	1100	600	300	300	300	500

870130 21 GMT 22 GMT 23 GMT 0 GMT

RLS 18 +13

D	120	150	190	220	220	180	140	110	100	130	180	180	140	100	90	110	160	170	140
A	185	200	215	230	235	230	220	205	215	235	245	245	240	225	215	230	240	245	235
C1	0	1	1	0	1	0	0	1	7	51	1	0	53	10	0	25	41	1	0
H1	900	400	200	200	300	400	500	600	500	800	900	800	800	700	600	500	500	900	0

870217 18 GMT 19 GMT 20 GMT 21 GMT

** STC **

RLS 18 +34

D	80	110	140	150	130	90	40	50	90	130	120	80	70	110	130	100	50	10	50
A	190	220	235	250	265	270	285	310	300	290	280	270	270	285	290	295	300	235	150
C1	0	1	1	0	0	0	1	0	0	1	23	17	0	5	0	9	1	0	0
H1	400	400	400	400	400	300	300	300	300	500	700	700	600	500	600	600	600	600	0

870218 15 GMT 16 GMT 17 GMT 18 GMT

RLS 19 +6

D	50	50	50	70	90	70	50	50	70	90	70	50	50	80	80
A	20	335	355	45	55	40	355	355	40	55	40	0	10	55	80
C1	M	1	300	330	0	430	60	0	540	0	350	0	0	0	0
H1	300	400	500	500	700	800	900	1000	1100	1300	1400	1600	1700	1700	1700

870219 23 GMT 0 GMT 1 GMT

RLS 19 +22

D	50	90	160	230	280	300	300	230	210	230	260	240	180	110	70	80	
A	90	35	20	15	15	25	30	40	40	25	20	20	25	35	75	125	
C1	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	1	
H1	1600	1900	1900	1700	1400	1200	1100	1000	1000	1000	1200	1700	2100	2100	1800	900	

870220 15 GMT 16 GMT 17 GMT

RLS 20 +13

D	300	340	350	320	300	300	320	320	310	300	310	310	290	240	200	140	
A	130	125	130	130	135	140	145	145	135	130	125	130	135	135	135	140	
C1	0	26	100	58	150	210	24	29	190	45	22	91	120	8	5	4	
H1	1800	1200	600	500	400	300	300	300	400	400	400	400	300	300	600	700	

870222 18 GMT 19 GMT 20 GMT

RLS 21 +4

D	60	90	150	190	210	230	250	270	260	240	220	190	190	220	250	250	220	210
A	90	35	20	5	350	345	335	330	330	335	345	0	5	345	335	335	345	350
C1	0	0	0	0	0	0	0	0	0	0	20	2	1	100	3	17	190	3
H1	2700	2700	1600	900	700	700	700	800	900	900	800	900	900	800	800	700	700	0

870224 21 GMT 22 GMT 23 GMT 0 GMT

RLS 30 +4

D	40	50	120	170	180	180	170	170	180	180	180	180	180	180	130	50	20	
A	155	285	295	300	305	300	285	290	300	300	300	300	300	300	300	290	210	
C1	0	0	210	67	2	6	1	150	12	12	1	62	17	0	0	0	0	0
H1	2200	1300	300	600	700	900	900	700	700	900	900	800	900	1300	1600	1700	1900	1700

870319 9 GMT 10 GMT 11 GMT

** STC **

RLS 31 +4

D	240	230	240	230	210	210	230	230	210	190	170	170	200	210	240	270	260	250
A	315	320	310	300	285	285	295	295	285	285	290	305	320	315	305	295	295	305
C1	1	0	17	130	190	0	10	76	49	1	45	54	1	15	26	4	2	19
H1	900	600	300	400	400	700	800	700	700	700	800	700	700	800	1000	1100	1100	900

870321 21 GMT 22 GMT 23 GMT 0 GMT

RLS 32 +10

D	110	140	180	200	230	320
A	190	210	225	230	230	230
C1	0	0	0	0	5	5
H1	1200	700	700	700	600	500

870324 15 GMT 16 GMT

RLS 32 +12

D	270	290	300	270	230	190	150	110
A	220	225	225	230	230	225	215	195
C1	0	0	0	0	0	0	1	0
H1	700	600	600	700	800	900	800	700

870324 17 GMT 18 GMT

RLS 33 +5

D	70	50	50	70	80	70	80	70	70	80	100	80	70	80	90	80	70	
A	120	90	90	95	90	95	85	90	100	75	60	75	100	80	65	75	115	
C1	1	1500	75	2	0	2	12	90	1	260	1	1100	2	1600	3	1	1	
H1	1100	500	500	500	500	500	500	500	400	200	500	800	1000	1100	1200	1400	1000	

870326 22 GMT 23 GMT 0 GMT

RLS 33 +10

D	100	150	180	170	140	150	170	170	150	150	160	150	150	150	160	160	140	100
A	90	80	80	75	65	70	90	90	70	50	40	60	75	60	60	75	95	115
C1	300	350	3	1000	68	620	90	2	6	1	4	7	0	4	19	1	0	0
H1	500	400	400	500	500	500	500	800	1100	1100	1200	1200	1300	1100	800	800	800	700

870327 3 GMT 4 GMT 5 GMT 6 GMT

A D D E N D U M

NOAA Technical Memorandum ERL ARL-177
Across North America Tracer Experiment (ANATEX)
Vol. II: Aircraft-Based Sampling

Some terrain elevations listed in Appendix A for STC flights 16, 17, 18, and 20 are incorrect. The corrected elevations are included in the following list. The archived MS-DOS file AC-STC.DAT includes these corrections.

STC

					START						END										
F	R	DATE	A	L	TIME	LAT	LON	E	HT	P	TIME	LAT	LON	E	HT	P	PMCH-F	oPDCH-F	PTCH-F	T	TD
16	20	870222	1	2	174825	4392	9149	286	2137	7831	180025	4375	9100	327	2146	7822	0 0	0 0	0 0	-126	-143
16	20	870222	1	2	180025	4375	9100	327	2146	7822	181225	4350	9050	317	919	9095	0 0	26 0	0 0	-83	-101
16	20	870222	1	2	181225	4350	9050	317	919	9095	182425	4355	9100	317	929	9084	0 0	104 0	0 0	-46	-55
16	20	870222	1	2	182425	4355	9100	317	929	9084	183625	4375	9130	256	660	9384	0 0	58 0	0 0	-43	-44
16	20	870222	1	2	183625	4375	9130	256	660	9384	184825	4361	9150	301	648	9398	0 0	146 0	0 0	-38	-31
16	20	870222	1	2	184825	4361	9150	301	648	9398	190025	4327	9195	355	647	9399	0 0	214 0	0 0	-16	-29
16	20	870222	1	2	190025	4327	9195	355	647	9399	191225	4296	9228	335	648	9398	0 0	24 0	0 0	-20	-31
16	20	870222	1	2	191225	4296	9228	335	648	9398	192425	4326	9180	338	683	9359	0 0	29 0	0 0	-18	-32
16	20	870222	1	2	192425	4326	9180	338	683	9359	193625	4363	9144	296	674	9369	0 0	189 0	0 0	-14	-32
16	20	870222	1	2	193625	4363	9144	296	674	9369	194825	4395	9099	270	668	9375	0 0	45 0	0 0	-14	-36
16	20	870222	1	2	194825	4395	9099	270	668	9375	200025	4379	9116	256	637	9411	0 0	22 0	0 0	-13	-33
16	20	870222	1	2	200025	4379	9116	256	637	9411	201225	4351	9156	301	660	9385	0 0	91 0	0 0	-13	-34
16	20	870222	1	2	201225	4351	9156	301	660	9385	202425	4380	9185	314	636	9412	0 0	117 0	0 0	-12	-32
16	20	870222	1	2	202425	4380	9185	314	636	9412	203625	4409	9227	367	676	9367	0 0	8 0	0 0	-14	-29
16	20	870222	1	2	203625	4409	9227	367	676	9367	204825	4439	9275	313	1250	8737	0 0	5 0	0 0	-31	-28
16	20	870222	1	2	204825	4439	9275	313	1250	8737	210025	4474	9328	283	776	9254	0 0	4 0	0 0	-49	-44
17	21	870224	1	2	204100	4523	9337	272	2439	7620	205300	4587	9340	315	3628	6549	0 0	0 0	0 0	-141	-155
17	21	870224	1	2	205300	4587	9340	315	3628	6549	210500	4654	9346	383	2441	7618	0 0	0 0	0 0	-143	-168
17	21	870224	1	2	210500	4654	9346	383	2441	7618	211700	4715	9349	400	1581	8477	0 0	0 0	0 0	-58	-95
17	21	870224	1	2	211700	4715	9349	400	1581	8477	212900	4734	9417	401	1105	8985	-9 0	0 0	0 0	-41	-73
17	21	870224	1	2	212900	4734	9417	401	1105	8985	214100	4752	9479	415	1093	8998	0 0	0 0	0 0	-32	-38
17	21	870224	1	2	214100	4752	9479	415	1093	8998	215300	4760	9560	453	1091	9001	0 0	0 0	0 0	-32	-35
17	21	870224	1	2	215300	4760	9560	453	1091	9001	220500	4780	9620	332	1103	8988	0 0	0 0	0 0	-37	-32
17	21	870224	1	2	220500	4780	9620	332	1103	8988	221700	4775	9600	352	1236	8843	0 0	0 0	0 0	-48	-39
17	21	870224	1	2	221700	4775	9600	352	1236	8843	222900	4764	9556	389	1275	8801	0 0	0 0	0 0	-37	-30
17	21	870224	1	2	222900	4764	9556	389	1275	8801	224100	4757	9509	426	1255	8822	0 0	0 0	0 0	-28	-21
17	21	870224	1	2	224100	4757	9509	426	1255	8822	225300	4737	9430	401	1271	8805	6 0	20 0	0 0	-35	-38
17	21	870224	1	2	225300	4737	9430	401	1271	8805	230500	4724	9369	405	1261	8816	-9 0	2 0	0 0	-38	-46
17	21	870224	1	2	230500	4724	9369	405	1261	8816	231700	4722	9386	405	1274	8802	5 0	1 0	0 0	-42	-42
17	21	870224	1	2	232900	4740	9454	404	1284	8791	234100	4761	9518	453	1257	8820	16 0	100 0	0 0	-25	-43
17	21	870224	1	2	234100	4761	9518	453	1257	8820	235300	4770	9576	373	1109	8981	5 0	3 0	0 0	-14	-18
17	21	870224	1	2	235300	4770	9576	373	1109	8981	500	4758	9510	426	1112	8978	6 0	17 0	0 0	-9	-20
17	21	870225	1	2	500	4758	9510	426	1112	8978	1700	4744	9447	404	1115	8974	21 0	190 0	0 0	-17	-32
17	21	870225	1	2	1700	4744	9447	404	1115	8974	2900	4742	9450	404	836	9284	0 0	3 0	0 0	-19	-37
18	30	870319	1	2	83300	4502	9362	290	1989	7951	84500	4547	9436	331	3032	6974	-9 0	0 0	0 0	-38	-51
18	30	870319	1	2	84500	4547	9436	331	3032	6974	85700	4592	9514	425	393	9659	0 0	0 0	0 0	-45	-68
18	30	870319	1	2	85700	4592	9514	425	393	9659	90900	4620	9594	379	983	8997	0 0	212 0	0 0	-8	-16
18	30	870319	1	2	90900	4620	9594	379	983	8997	92100	4662	9605	411	953	9029	0 0	67 0	0 0	-7	-5
18	30	870319	1	2	92100	4662	9605	411	953	9029	93300	4661	9601	411	1288	8669	0 0	2 0	0 0	4	-1
18	30	870319	1	2	93300	4661	9601	411	1288	8669	94500	4622	9620	321	1294	8662	0 0	6 0	0 0	18	26
18	30	870319	1	2	94500	4622	9620	321	1294	8662	95700	4587	9635	319	1169	8795	0 0	1 0	0 0	-14	6
18	30	870319	1	2	95700	4587	9635	319	1169	8795	100900	4635	9614	321	964	9017	5 0	146 0	0 0	-12	12
18	30	870319	1	2	100900	4635	9614	321	964	9017	102100	4685	9585	427	1253	8706	0 0	12 0	0 0	-6	15
18	30	870319	1	2	102100	4685	9585	427	1253	8706	103300	4635	9615	321	1280	8677	0 0	12 0	0 0	6	29
18	30	870319	1	2	103300	4635	9615	321	1280	8677	104500	4600	9630	308	1281	8676	0 0	1 0	0 0	-9	15
18	30	870319	1	2	104500	4600	9630	308	1281	8676	105700	4650	9605	411	1114	8854	0 0	62 0	0 0	-10	20
18	30	870319	1	2	105700	4650	9605	411	1114	8854	110900	4685	9585	427	1478	8469	0 0	17 0	0 0	-15	15
18	30	870319	1	2	110900	4685	9585	427	1478	8469	112100	4650	9605	411	1860	8080	0 0	0 0	0 0	8	34
18	30	870319	1	2	112100	4650	9605	411	1860	8080	113300	4625	9575	405	2155	7789	0 0	0 0	0 0	-18	19
18	30	870319	1	2	113300	4625	9575	405	2155	7789	114500	4590	9509	418	2142	7801	0 0	0 0	0 0	-21	20
18	30	870319	1	2	114500	4590	9509	418	2142	7801	115700	4557	9456	354	2471	7487	0 0	0 0	0 0	-15	20
18	30	870319	1	2	115700	4557	9456	354	2471	7487	120900	4523	9404	306	1500	8446	0 0	0 0	0 0	-9	12
20	32	870324	1	2	145130	4470	9409	303	1939	7977	150330	4455	9477	305	1046	8901	0 0	0 0	0 0	84	17
20	32	870324	1	2	150330	4455	9477	305	1046	8901	151530	4445	9544	327	1039	8908	0 0	0 0	0 0	94	44
20	32	870324	1	2	151530	4445	9544	327	1039	8908	152730	4444	9605	405	1136	8804	0 0	0 0	0 0	81	48
20	32	870324	1	2	152730	4444	9605	405	1136	8804	153930	4430	9670	492	1133	8807	0 0	0 0	0 0	77	52
20	32	870324	1	2	153930	4430	9670	492	1133	8807	155130	4405	9720	525	1129	8812	0 0	5 0	0 0	65	52
20	32	870324	1	2	160330	4380	9730	484	1155	8784	161530	4360	9670	439	772	9201	0 0	5 0	0 0	57	66
20	32	870324	1	2	173400	4376	9666	469	1204	8731	174600	4385	9640	465	1051	8896	0 0	0 0	0 0	68	55
20	32	870324	1	2	174600	4385	9640	465	1051	8896	175800	4357	9704	450	1047	8900	0 0	0 0	0 0	70	65
20	32	870324	1	2	175800	4357	9704	450	1047	8900	181000	4387	9685	469	1118	8823	0 0	0 0	0 0	67	67
20	32	870324	1	2	181000	4387	9685	469	1118	8823	182200	4430	9683	492	1303	8627	0 0	0 0	0 0	58	69
20	32	870324	1	2	182200	4430	9683	492	1303	8627	183400	4434	9624	543	1292	8638	0 0	0 0	0 0	61	62
20	32	870324	1	2	183400	4434	9624	543	1292	8638	184600	4441	9562	327	1292	8638	0 0	0 0	0 0	67	69
20	32	870324	1	2	184600	4441	9562	327	1292	8638	185800	4449	9502	306	885	9077	-9 0	1 0	0 0	85	75
20	32	870324	1	2	185800	4449	9502	306	885	9077	191000	4468	9429	314	1156	8783	0 0	0 0	0 0	77	66