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Atmospheric CO_2 Concentrations Derived from Flask Samples Collected at U.S.S.R.-Operated Sampling Sites

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December 1991

КОНЦЕНТРАЦИЯ АТМОСФЕРНОГО УГЛЕРОДА, ИЗМЕРЕННАЯ ПО БАЛЛОННЫМ ОБРАЗЦАМ, ОТОБРАННЫМ НА СОВЕТСКИХ СТАНЦИЯХ ОТБОРА ПРОБ

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Environmental Sciences Division

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ABSTRACT

BROUNSHTEIN, A. M., E. V. FABER, and A. A. SHASHKOV. 1991. Atmospheric CO_2 Concentrations Derived from Flask Samples Collected at U.S.S.R.-Operated Sampling Sites. ORNL/CDIAC-51, NDP-033. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee. 62 pp. doi: 10.3334/CDIAC/atg.ndp033

This document presents daily atmospheric CO_2 concentrations from four U.S.S.R.-operated sampling sites (Teriberka Station, Ocean Station Charlie, Bering Island, and Kotelny Island). The period of record varies by station with the earliest measurements dating back to 1983 and recent estimates from early 1991. These CO_2 concentrations are derived from air samples collected in 1.5-L stainless steel electropolished flasks and later analyzed at the Main Geophysical Observatory (St. Petersburg, U.S.S.R.) using a nondispersive infrared gas analyzer. Measurements not meeting wind direction, wind speed, inter-flask agreement, and climate condition criteria were either discarded or flagged. All measurements have been corrected for drift biases introduced during flask storage.

These atmospheric CO_2 concentrations are considered indicative of regional background air conditions and are directly traceable to the World Meteorological Organization's primary CO_2 standards. These measurements support the rising trend in atmospheric CO_2 concentrations measured at other monitoring sites around the world and may be compared with similar measurements made by various monitoring programs at other northern latitude sites.

These atmospheric CO_2 concentrations are available free-of-charge as a numeric data package (NDP) from the Carbon Dioxide Information Analysis Center (CDIAC). The NDP consists of this document and a magnetic tape (or floppy diskette) containing machine-readable data files for each station, a descriptive file, and computer codes to access the data files. The document presents the atmospheric CO_2 concentrations in graphical and tabular form, describes the sampling methods, defines limitations and restrictions of the data, and describes the information on the magnetic media.

РЕЗЮМЕ

Броунштейн, А. М., Е. В. Фабер, и А. А. Шашков, "Концентрации атмосферного углерода, измеренные по баллонным образцам, отобранным на советских станциях отбора проб." ОРНЛ/СДИАС-51, НДП-033. Окриджская Национальная Лаборатория, Ок Ридж, Теннесси, 62 стр.

В настоящем отчёте представлены ежедневные концентрации CO_2, полученные на четырех советских станциях (станция Териберка, океаническая станция Чарли, станция на острове Беринга, и станция на острове Котельном). Измерения на каждой станции производились в течение различных периодов времени. Самые ранние измерения датируются 1983 годом, а последние измерения были произведены в начале 1991 года. Эти концентрации CO_2 определялись по образцам воздуха, собранным в полуторалитровые электрически отполированные баллоны из нержавеющей стали; они позднее анализировались с помощью недисперсионного инфракрасного газового анализатора в Главной Геофизической Обсерватории (Санкт Петербург, СССР). Не использовались или были соответственно отмечены измерения, которые не отвечали заданному направлению и скорости ветра, согласованным стандартам для баллонов, а также определенным погодным условиям. Все измерения были откорректированы на смещения, происходящие в процессе хранения баллонов.

Эти атмосферные концентрации CO_2 считаются характерными для региональных воздушных условий. Качество измерений CO_2 соответствует стандартам, установленным Всемирной Метеорологический Организацией. Эти измерения подтверждают тенденцию к росту содержаний CO_2, отмеченную на других станциях во многих странах мира. Они близки по значениям к измерениям, произведенным на других станциях, расположенных в северных широтах.

Данные о содержании CO_2 в атмосфере могут быть получены бесплатно в виде пакета числовых данных (NDP) от Центра Анализа Данных по Двуокиси Углерода (CDIAC). Пакет числовых данных состоит из настоящего отчета, и магнитной ленты (или дискеты), содержащей файлы с данными по каждой станции, файл описаний и программычтения данных. Отчет содержит данные о концентрациях CO_2 в атмосфере в виде графиков и таблиц, описывает методы отбора проб, определяет пределы точности данных, и описывает данные на магнитном носителе. Также прилагаются копии статей, имеющих отношение к обсуждаемому предмету.

PART 1

INFORMATION ABOUT THE DATA PACKAGE

1. NAME OF THE NUMERIC DATA PACKAGE

Atmospheric CO_2 Concentrations Derived from Flask Samples Collected At U.S.S.R.-Operated Sampling Sites

2. CONTRIBUTORS

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3. KEYWORDS

Carbon dioxide concentrations; Union of Soviet Socialist Republics; flask sampling; infrared gas analyzer.

4. BACKGROUND INFORMATION

Increasing concentrations of carbon dioxide (CO_2) in the atmosphere over the past several decades have been well established from measurements taken at monitoring sites around the world (Keeling et al. 1989; Conway et al. 1988; Komhyr et al. 1985; Pearman and Beardsmore 1984). These increases are believed to be due primarily to anthropogenic sources, principally fossil fuel combustion and deforestation. The potential impacts these increases in atmospheric CO_2 and other greenhouse gas concentrations will have on global vegetation, climate, and sea levels have also been studied, but many aspects of these potential impacts remain uncertain. In order to project future CO_2 levels and impacts from increased CO_2 concentrations, it is imperative to quantify the anthropogenic sources and the natural sources and sinks of CO_2. The atmospheric CO_2 concentrations presented in this document help in understanding the natural sources and sinks of CO_2 and represent part of the U.S.S.R.'s efforts to assist in determining the distribution of CO_2 in the atmospheric boundary layer.

5. SOURCE AND SCOPE OF THE DATA

This document presents daily atmospheric CO_2 concentrations from four U.S.S.R.-operated sampling sites: Teriberka Station, Ocean Station Charlie, Bering Island, and Kotelny Island (Fig. 1). The period of record varies by station (Teriberka Station, March 1988–March 1991; Ocean Station Charlie, January 1983–October 1990; Bering Island, May 1985–March 1991; and Kotelny Island, August 1986–January 1991). These CO_2 concentrations are derived from air samples collected in 1.5-L stainless steel

ORNL DWG 91M-13875

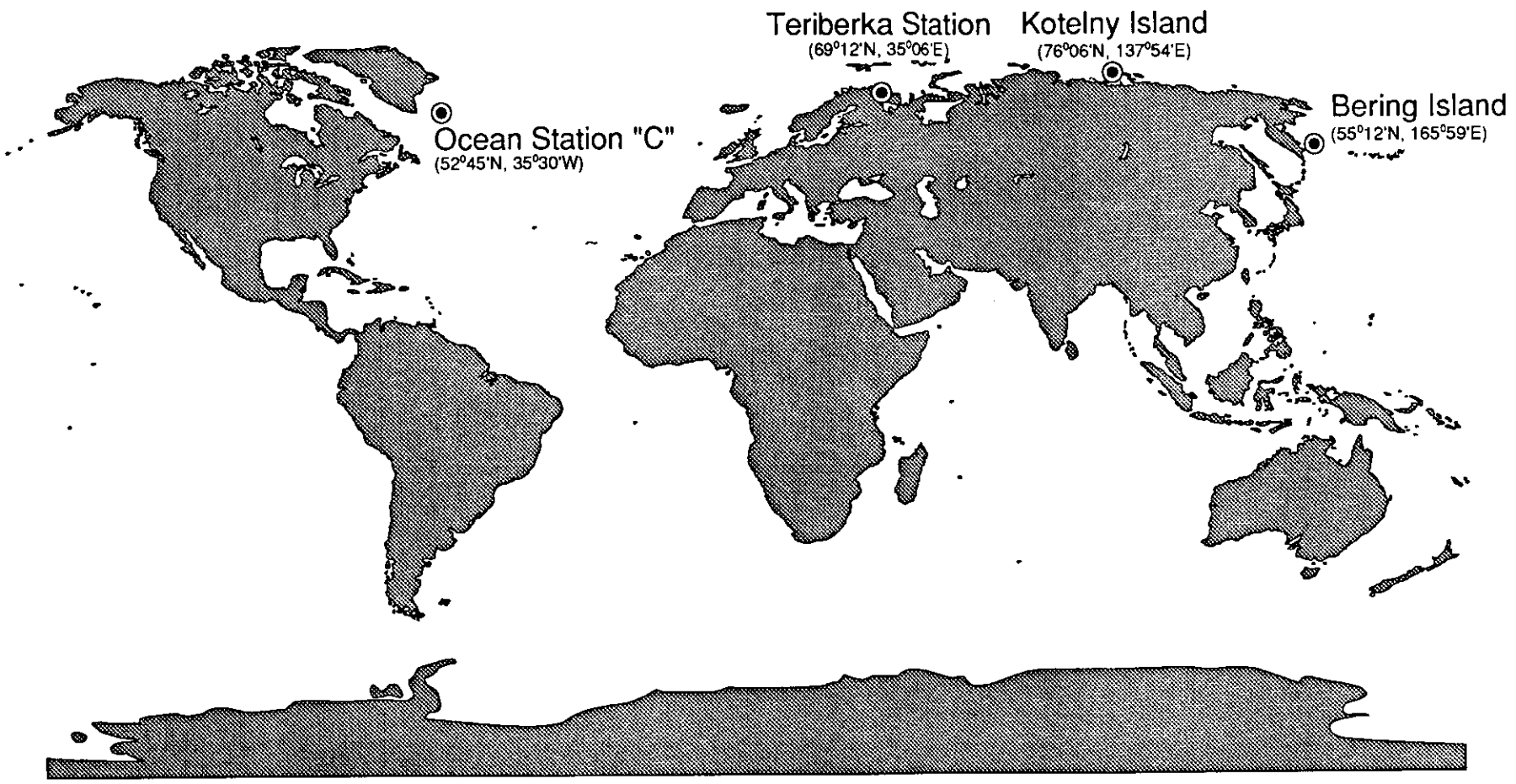

Figure 1. Location of the U.S.S.R.-operated flask sampling sites.

electropolished flask pairs and later analyzed at the Main Geophysical Observatory (MGO–St. Petersburg, U.S.S.R.) using a nondispersive infrared gas analyzer.

The atmospheric CO_2 concentrations measured at all four sites have increased over the period of record (Figs. 2–5 and Tables 1–4). Annual mean atmospheric CO_2 concentrations, calculated from available individual flask measurements for the four sites, have increased from 352.38 parts per million by volume (ppmv) in 1988 to 354.97 ppmv in 1990 for Teriberka Station, 343.52 ppmv in 1983 to 355.68 ppmv in 1990 for Ocean Station Charlie, 345.19 ppmv in 1986 to 354.93 ppmv in 1990 for Bering Island, and 351.96 ppmv in 1987 to 356.05 ppmv in 1990 for Kotelny Island. These growth trends are consistent with measurements from other CO_2 monitoring sites (Conway et al. 1988, Keeling et al. 1989). The atmospheric CO_2 measurements from each site also show a pronounced annual seasonal oscillation due to photosynthetic depletion during the growing season (Figs. 2–5). The amplitudes of these seasonal oscillations are quite large (10–30 ppmv) and are consistent with measurements from other northern latitude locations. These atmospheric CO_2 concentrations are considered indicative of regional background air conditions and are directly traceable to World Meteorological Organization (WMO) primary CO_2 standards.

Sampling Sites

Teriberka Station (69° 12′ N, 35° 06′ E; elevation 40 m above msl) — The coastal tundra peninsula site at Teriberka was established in 1988, and MGO began collecting flask samples in March of 1988.

Ocean Station Charlie (52° 45′ N, 35° 30′ W; elevation 5 m above msl) — This open ocean site in the North Atlantic, also known as Ocean Station "C," was established in 1968 and was operated in cooperation with National Oceanic and Atmospheric Administration's (NOAA) National Weather Service through 1973. The MGO collected flask samples at the site from January 1983 through October 1990.

Bering Island (55° 12′ N, 165° 59′ E; elevation 13 m above msl) — The station at Bering Island was established in 1985. Measurements obtained from this coastal site are generally indicative of maritime air masses. However, according to Shashkov (personal communication), this site is more susceptible to local vegetative influences than any of the other sites mentioned here.

Kotelny Island (76° 06′ N, 137° 54′ E; elevation 5 m above msl) — The coastal tundra station at Kotelny Island was established in 1985, and MGO began collecting flasks in February of that year. The northerly location of this site complements the existing global network of NOAA's Climate Monitoring and Diagnostics Laboratory (CMDL—formerly GMCC), and allows comparison with CMDL and Atmospheric Environment Service (AES—Downsview, Ontario, Canada) monitoring efforts at Alert, Northwest Territories (83° N, 62° W).

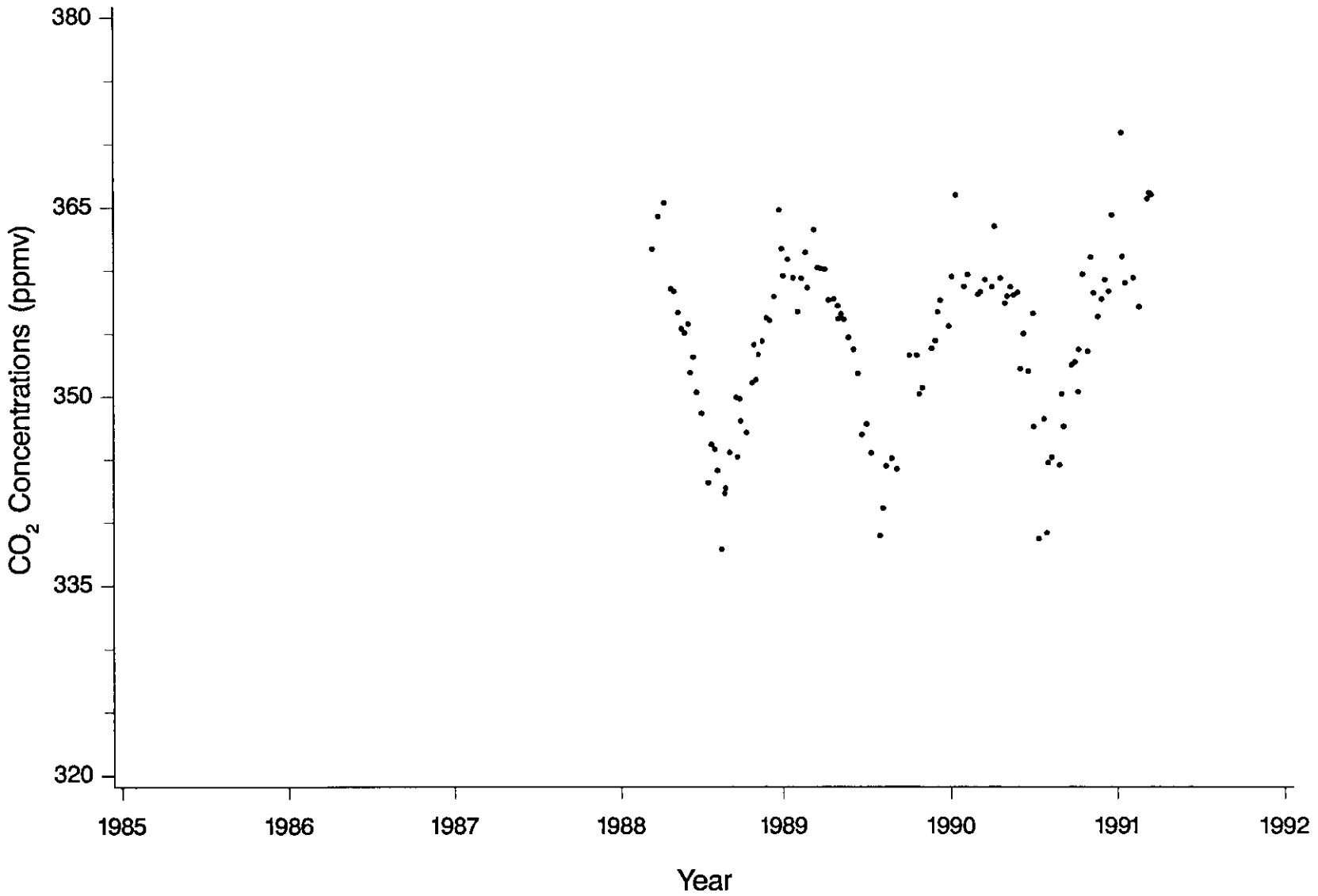

Figure 2. Atmospheric carbon dioxide concentrations from Teriberka Station.

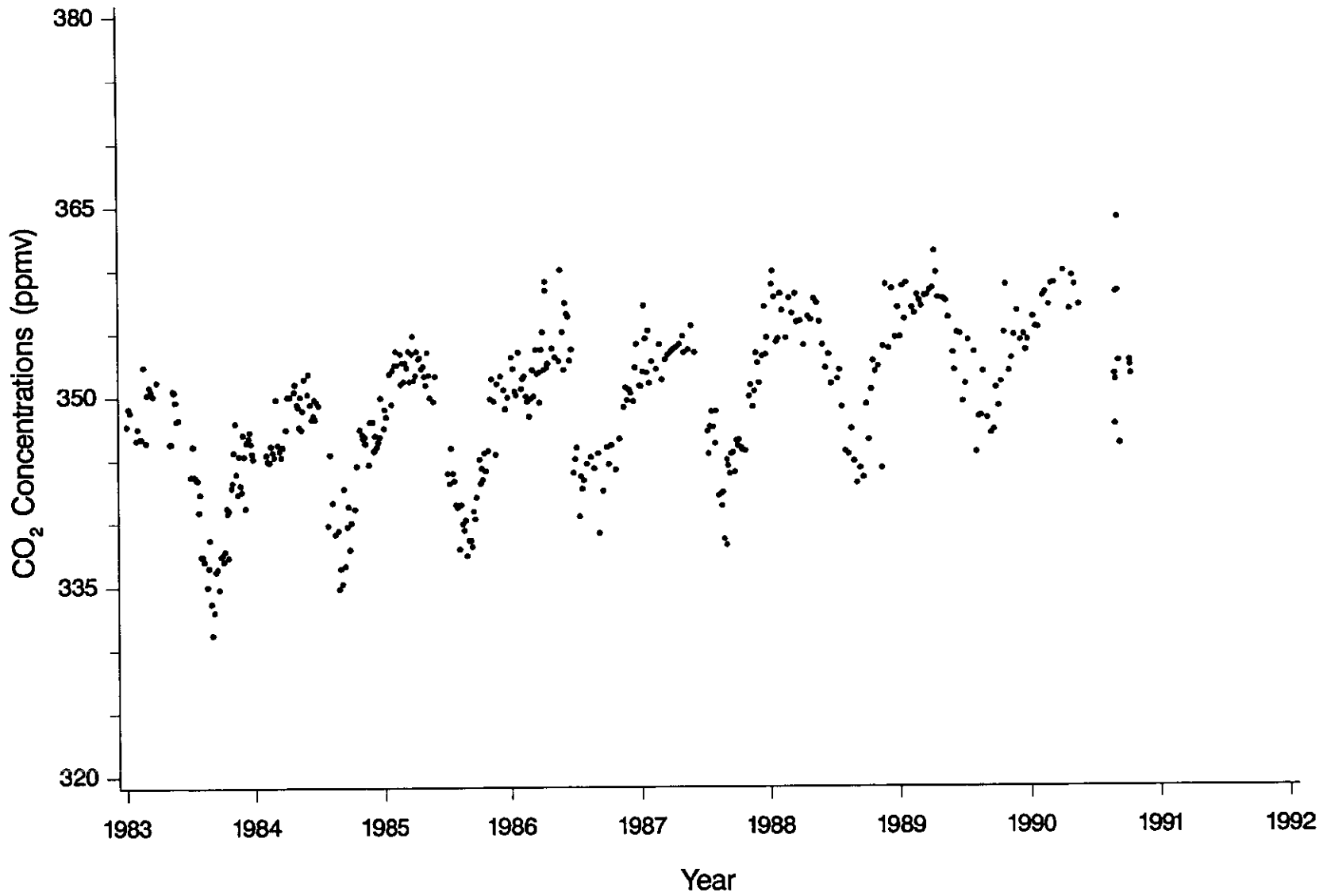

Figure 3. Atmospheric carbon dioxide concentrations from Ocean Station Charlie.

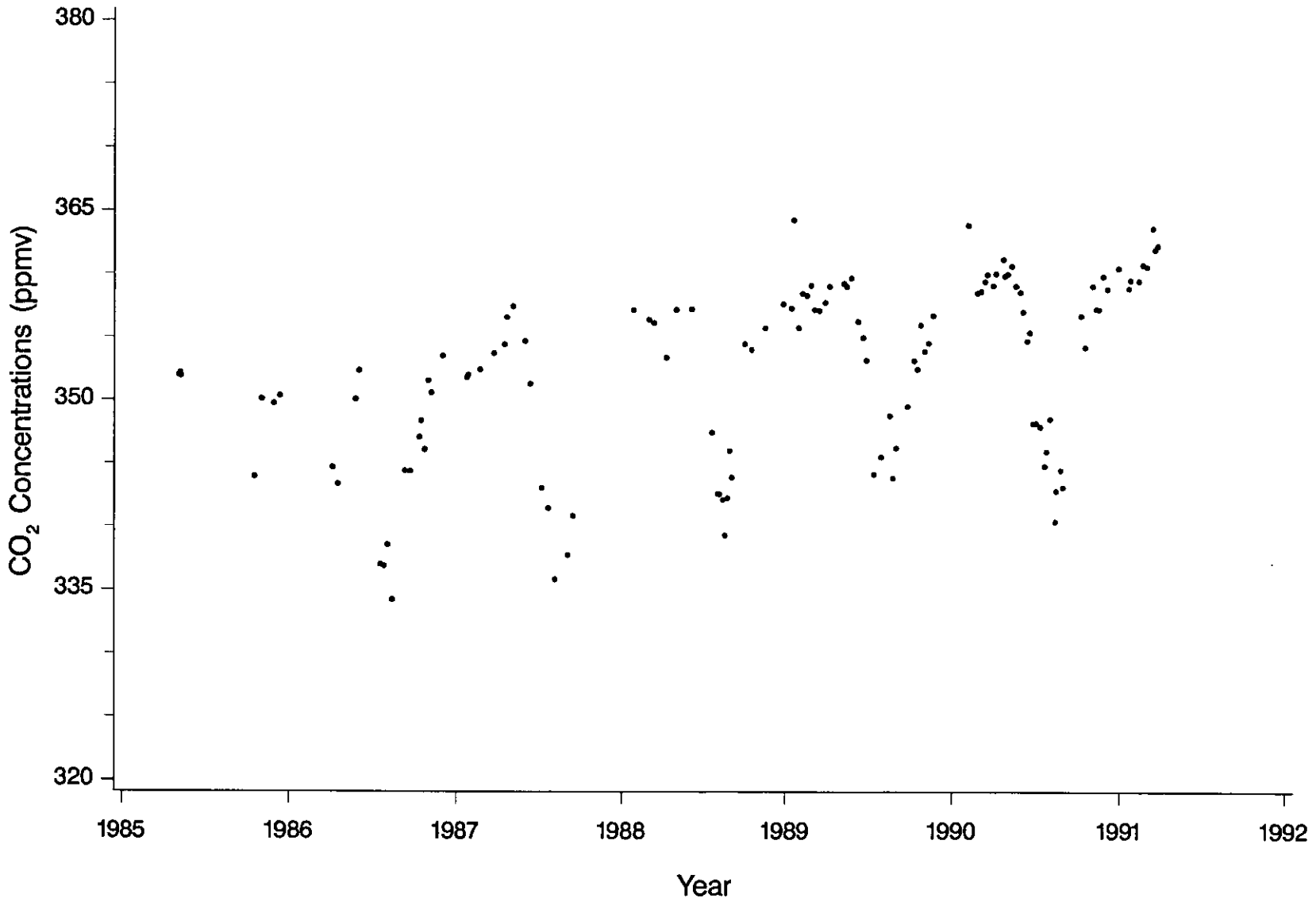

Figure 4. Atmospheric carbon dioxide concentrations from Bering Island.

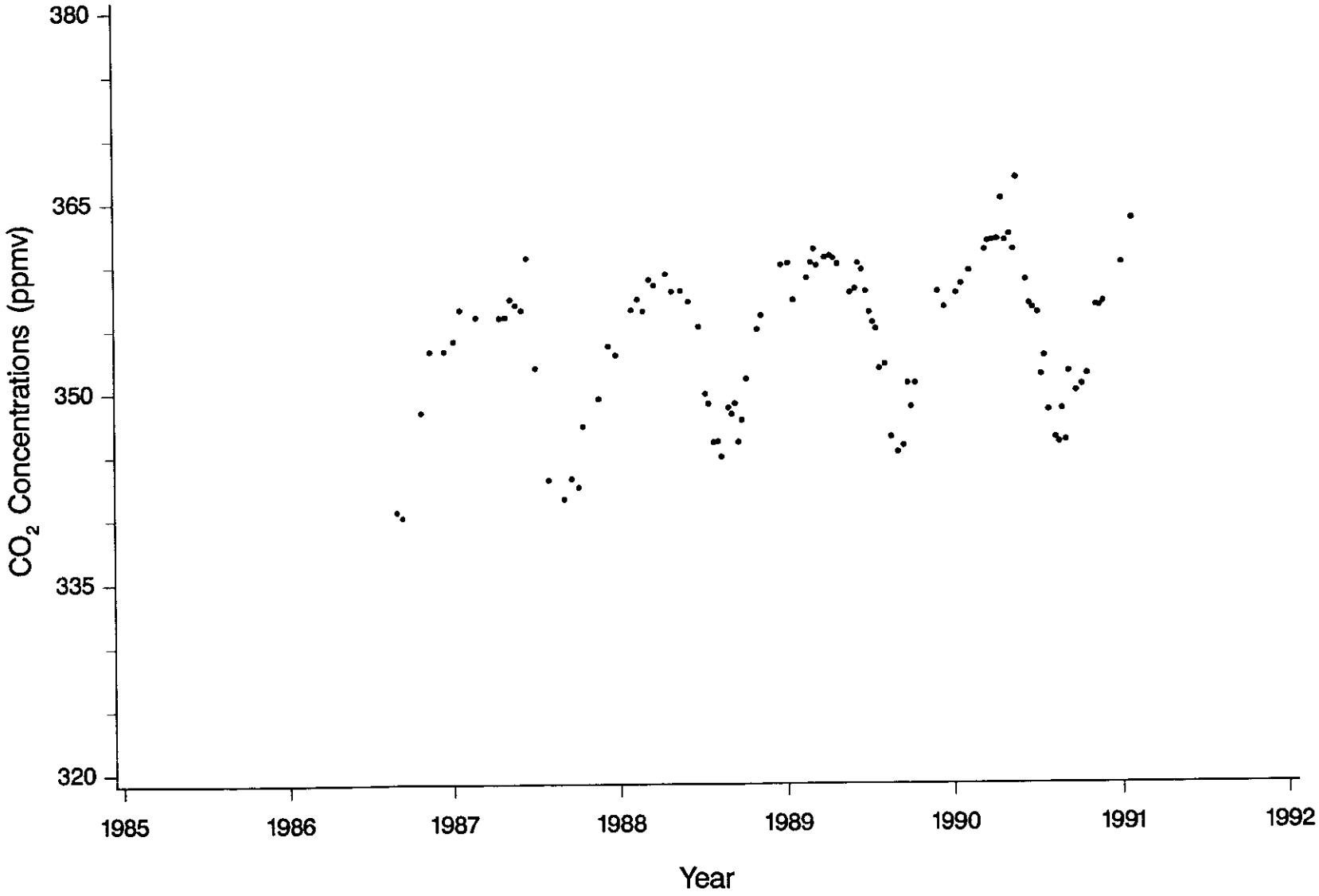

Figure 5. Atmospheric carbon dioxide concentrations from Kotelny Island.

Table 1. Daily atmospheric carbon dioxide concentrations from Teriberka Station

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1988	3	10	70	88.19178	361.7723	-99.9	M
1988	3	24	84	88.23014	364.3500	-99.9	M
1988	4	6	97	88.26575	365.4437	-99.9	M
1988	4	21	112	88.30685	358.6126	0.6	+
1988	4	28	119	88.32603	358.4029	4.2	S
1988	5	7	128	88.35068	356.7139	-99.9	M
1988	5	14	135	88.36986	355.4376	0.2	+
1988	5	21	142	88.38904	355.1093	1.2	S
1988	5	29	150	88.41096	355.7964	0.0	+
1988	6	2	154	88.42192	351.9357	1.8	S
1988	6	9	161	88.44110	353.1870	0.1	+
1988	6	16	168	88.46027	350.3800	0.6	+
1988	6	26	178	88.48767	348.7152	-99.9	M
1988	7	10	192	88.52603	343.1898	0.2	+
1988	7	17	199	88.54521	346.2271	0.2	+
1988	7	24	206	88.56438	345.8492	1.4	S
1988	7	30	212	88.58082	344.1600	5.0	S
1988	8	8	221	88.60548	337.8961	0.8	+
1988	8	15	228	88.62466	342.3476	0.4	+
1988	8	17	230	88.63014	342.7645	0.2	+
1988	8	27	240	88.65753	345.6046	2.1	S
1988	9	11	255	88.69863	349.9905	0.6	+
1988	9	14	258	88.70685	345.2387	0.3	+
1988	9	20	264	88.72329	349.8692	1.2	S
1988	9	22	266	88.72877	348.1104	0.1	+
1988	10	5	279	88.76438	347.1909	0.2	+
1988	10	19	293	88.80274	351.1316	22.1	S
1988	10	23	297	88.81370	354.1490	0.1	+
1988	10	28	302	88.82740	351.3982	1.6	S
1988	11	3	308	88.84384	353.3780	0.8	+
1988	11	13	318	88.87123	354.4375	5.4	S
1988	11	23	328	88.89863	356.2879	0.7	+
1988	12	1	336	88.92055	356.0865	0.1	+

Table 1 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1988	12	11	346	88.94795	357.9639	0.7	+
1988	12	23	358	88.98082	364.8877	5.5	S
1988	12	28	363	88.99452	361.7948	0.1	+
1989	1	1	1	89.00274	359.6349	3.5	S
1989	1	11	11	89.03014	360.9590	0.1	+
1989	1	23	23	89.06301	359.4818	1.9	S
1989	2	2	33	89.09041	356.7979	3.1	S
1989	2	10	41	89.11233	359.4421	0.4	+
1989	2	19	50	89.13699	361.5091	1.2	S
1989	2	23	54	89.14795	358.6868	10.6	S
1989	3	9	68	89.18630	363.3146	1.5	S
1989	3	17	76	89.20822	360.2806	0.5	+
1989	3	23	82	89.22466	360.2411	0.5	+
1989	4	2	92	89.25205	360.1626	0.9	+
1989	4	10	100	89.27397	357.7080	0.2	+
1989	4	21	111	89.30411	357.7908	0.6	+
1989	4	30	120	89.32877	357.2578	0.1	+
1989	5	1	121	89.33151	356.2248	93.4	S
1989	5	7	127	89.34795	356.6069	0.2	+
1989	5	13	133	89.36438	356.1779	0.5	+
1989	5	23	143	89.39178	354.7372	−99.9	M
1989	6	3	154	89.42192	353.7820	0.7	+
1989	6	12	163	89.44658	351.8801	11.7	S
1989	6	21	172	89.47123	347.0147	3.1	S
1989	7	1	182	89.49863	347.8533	0.3	+
1989	7	11	192	89.52603	345.5625	0.4	+
1989	7	30	211	89.57808	338.9950	2.0	S
1989	8	6	218	89.59726	341.1759	1.7	S
1989	8	13	225	89.61644	344.5200	0.7	+
1989	8	25	237	89.64932	345.1245	0.0	+
1989	9	5	248	89.67945	344.2955	0.1	+
1989	10	3	276	89.75616	353.3273	0.2	+
1989	10	19	292	89.80000	353.3310	0.1	+
1989	10	24	297	89.81370	350.2544	0.1	+

Table 1 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1989	10	31	304	89.83288	350.7337	0.2	+
1989	11	20	324	89.88767	353.8597	-99.9	M
1989	11	28	332	89.90959	354.4741	1.2	S
1989	12	3	337	89.92329	356.7701	-99.9	M
1989	12	9	343	89.93973	357.7060	0.2	+
1989	12	27	361	89.98904	355.6470	0.2	+
1990	1	3	3	90.00822	359.5834	13.3	S
1990	1	12	12	90.03288	366.0835	0.5	+
1990	1	30	30	90.08219	358.7963	1.3	S
1990	2	7	38	90.10411	359.7541	-99.9	M
1990	3	2	61	90.16712	358.1809	0.3	+
1990	3	7	66	90.18082	358.3757	1.8	S
1990	3	17	76	90.20822	359.3345	6.4	S
1990	4	1	91	90.24932	358.7771	-99.9	M
1990	4	7	97	90.26575	363.5852	35.2	S
1990	4	20	110	90.30137	359.4734	1.8	S
1990	4	30	120	90.32877	357.4742	-99.9	M
1990	5	5	125	90.34247	358.0224	0.5	+
1990	5	12	132	90.36164	358.7647	4.7	S
1990	5	19	139	90.38082	358.1290	3.6	S
1990	5	27	147	90.40274	358.3379	0.0	+
1990	6	2	153	90.41918	352.2552	5.4	S
1990	6	9	160	90.43836	355.0450	0.0	+
1990	6	19	170	90.46575	352.0539	-99.9	M
1990	6	30	181	90.49589	356.6615	1.0	+
1990	7	1	182	90.49863	347.6556	0.3	+
1990	7	12	193	90.52877	338.7347	6.7	S
1990	7	24	205	90.56164	348.2545	0.0	+
1990	7	30	211	90.57808	339.2066	6.2	S
1990	8	2	214	90.58630	344.7842	-99.9	M
1990	8	10	222	90.60822	345.2046	-99.9	M
1990	8	27	239	90.65479	344.6077	0.1	+
1990	9	1	244	90.66849	350.2526	-99.9	M
1990	9	5	248	90.67945	347.6685	0.1	+

Table 1 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1990	9	23	266	90.72877	352.5553	3.5	S
1990	10	8	281	90.76986	350.4151	0.2	+
1990	10	1	274	90.75068	352.7963	5.2	S
1990	10	9	282	90.77260	353.7914	0.4	+
1990	10	18	291	90.79726	359.7770	3.6	S
1990	10	29	302	90.82740	353.6321	-99.9	M
1990	11	5	309	90.84658	361.1340	0.8	+
1990	11	11	315	90.86301	358.2954	3.8	S
1990	11	20	324	90.88767	356.3990	0.7	+
1990	11	28	332	90.90959	357.7909	2.6	S
1990	12	5	339	90.92877	359.3357	0.2	+
1990	12	13	347	90.95068	358.4157	0.1	+
1990	12	20	354	90.96986	364.4951	0.1	+
1991	1	10	10	91.02740	371.0215	-99.9	M
1991	1	12	12	91.03288	361.1901	3.2	S
1991	1	18	18	91.04932	359.0805	0.1	+
1991	2	5	36	91.09863	359.4954	-99.9	M
1991	2	18	49	91.13425	357.1838	0.6	+
1991	3	8	67	91.18356	365.7804	0.3	+
1991	3	12	71	91.19452	366.2656	0.0	+
1991	3	17	76	91.20822	366.1100	1.5	S

[a] -99.9 denotes missing values.
[b] For explanation, see section 12.

Table 2. Daily atmospheric carbon dioxide concentrations from Ocean Station Charlie

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1983	1	2	2	83.00548	347.7000	0.9	+
1983	1	7	7	83.01918	349.1000	1.3	S
1983	1	11	11	83.03014	348.8000	-99.9	M
1983	1	30	30	83.08219	346.6000	-99.9	M
1983	2	2	33	83.09041	347.5000	-99.9	M
1983	2	8	39	83.10685	346.7000	0.1	+
1983	2	15	46	83.12603	346.7000	-99.9	M
1983	2	20	51	83.13973	352.4000	0.7	+
1983	2	27	58	83.15890	346.4000	-99.9	M
1983	3	2	61	83.16712	350.2000	-99.9	M
1983	3	8	67	83.18356	350.8000	-99.9	M
1983	3	13	72	83.19726	350.5000	0.8	+
1983	3	19	78	83.21370	350.1000	0.2	+
1983	3	30	89	83.24384	351.2000	-99.9	M
1983	5	6	126	83.34521	346.3000	-99.9	M
1983	5	10	130	83.35616	346.3000	7.5	S
1983	5	15	135	83.36986	350.5000	-99.9	M
1983	5	18	138	83.37808	350.4000	0.3	+
1983	5	21	141	83.38630	349.6000	1.6	S
1983	5	25	145	83.39726	348.1000	-99.9	M
1983	5	29	149	83.40822	348.2000	0.0	+
1983	7	2	183	83.50137	343.7000	-99.9	M
1983	7	7	188	83.51507	346.1000	0.4	+
1983	7	10	191	83.52329	343.7000	0.9	+
1983	7	16	197	83.53973	343.5000	-99.9	M
1983	7	19	200	83.54795	343.4000	0.2	+
1983	7	23	204	83.55890	340.9000	-99.9	M
1983	7	26	207	83.56712	342.3000	1.3	S
1983	7	29	210	83.57534	337.4000	0.3	+
1983	8	2	214	83.58630	337.4000	1.8	S
1983	8	6	218	83.59726	337.0000	1.8	S
1983	8	15	227	83.62192	335.0000	1.3	S
1983	8	19	231	83.63288	336.5000	1.0	+

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1983	8	22	234	83.64110	338.7000	1.2	S
1983	8	26	238	83.65205	333.7000	2.1	S
1983	8	29	241	83.66027	331.2000	5.2	S
1983	9	3	246	83.67397	333.0000	1.1	S
1983	9	8	251	83.68767	336.2000	0.5	+
1983	9	13	256	83.70137	336.4000	0.7	+
1983	9	18	261	83.71507	334.8000	0.8	+
1983	9	24	267	83.73151	337.4000	0.1	+
1983	9	28	271	83.74247	337.5000	1.2	S
1983	10	2	275	83.75342	337.0000	0.5	+
1983	10	5	278	83.76164	337.8000	-99.9	M
1983	10	11	284	83.77808	341.2000	1.1	S
1983	10	13	286	83.78356	340.8000	2.2	S
1983	10	16	289	83.79178	337.3000	2.5	S
1983	10	17	290	83.79452	341.0000	0.5	+
1983	10	26	299	83.81918	342.8000	1.6	S
1983	10	29	302	83.82740	343.2000	-99.9	M
1983	11	1	305	83.83562	345.6000	-99.9	M
1983	11	6	310	83.84932	347.9000	0.6	+
1983	11	9	313	83.85753	343.9000	-99.9	M
1983	11	13	317	83.86849	342.3000	1.3	S
1983	11	17	321	83.87945	345.3000	0.2	+
1983	11	21	325	83.89041	343.0000	2.0	S
1983	11	25	329	83.90137	342.5000	2.7	S
1983	11	29	333	83.91233	347.0000	0.0	+
1983	12	2	336	83.92055	345.3000	0.7	+
1983	12	5	339	83.92877	341.2000	1.3	S
1983	12	9	343	83.93973	346.4000	2.1	S
1983	12	15	349	83.95616	346.7000	0.2	+
1983	12	18	352	83.96438	347.2000	1.3	S
1983	12	21	355	83.97260	346.3000	0.0	+
1983	12	24	358	83.98082	345.5000	3.1	S
1983	12	27	361	83.98904	345.1000	1.1	S
1984	2	2	33	84.09041	345.4000	2.0	S

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1984	2	6	37	84.10137	344.9000	2.0	S
1984	2	11	42	84.11507	344.8000	3.9	S
1984	2	15	46	84.12603	346.1000	2.0	S
1984	2	20	51	84.13973	345.6000	2.0	S
1984	2	24	55	84.15068	345.2000	3.3	S
1984	2	29	60	84.16438	349.8000	2.5	S
1984	3	5	65	84.17808	346.2000	1.2	S
1984	3	10	70	84.19178	345.7000	0.9	+
1984	3	15	75	84.20548	345.2000	2.2	S
1984	3	17	77	84.21096	346.0000	0.6	+
1984	3	19	79	84.21644	346.0000	0.3	+
1984	3	28	88	84.24110	347.4000	-99.9	M
1984	4	2	93	84.25479	350.0000	1.8	S
1984	4	8	99	84.27123	350.0000	2.8	S
1984	4	20	111	84.30411	350.4000	0.2	+
1984	4	22	113	84.30959	351.0000	1.5	S
1984	4	28	119	84.32603	349.4000	1.1	S
1984	5	1	122	84.33425	349.2000	0.9	+
1984	5	4	125	84.34247	347.6000	1.2	S
1984	5	7	128	84.35068	350.0000	0.9	+
1984	5	10	131	84.35890	347.4000	1.2	S
1984	5	14	135	84.36986	348.9000	0.4	+
1984	5	18	139	84.38082	351.4000	0.0	+
1984	5	28	149	84.40822	350.2000	-99.9	M
1984	5	31	152	84.41644	351.8000	1.0	+
1984	6	5	157	84.43014	349.4000	0.1	+
1984	6	10	162	84.44384	348.2000	1.8	S
1984	6	14	166	84.45479	348.5000	-99.9	M
1984	6	17	169	84.46301	349.8000	0.3	+
1984	6	20	172	84.47123	348.2000	-99.9	M
1984	6	24	176	84.48219	349.6000	-99.9	M
1984	6	30	182	84.49863	349.3000	-99.9	M
1984	7	27	209	84.57260	339.8000	0.6	+
1984	8	2	215	84.58904	345.4000	1.9	S

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1984	8	9	222	84.60822	341.6000	1.7	S
1984	8	16	229	84.62740	339.1000	0.9	+
1984	8	25	238	84.65205	339.4000	3.0	S
1984	8	27	240	84.65753	334.8000	1.6	S
1984	8	31	244	84.66849	336.4000	2.6	S
1984	9	5	249	84.68219	335.2000	5.7	S
1984	9	10	254	84.69589	342.7000	-99.9	M
1984	9	13	257	84.70411	336.6000	3.3	S
1984	9	19	263	84.72055	339.7000	0.8	+
1984	9	22	266	84.72877	341.3000	0.9	+
1984	9	26	270	84.73973	337.9000	0.6	+
1984	9	30	274	84.75068	340.0000	3.7	S
1984	10	10	284	84.77808	341.1000	2.2	S
1984	10	16	290	84.79452	344.5000	0.6	+
1984	10	25	299	84.81918	347.4000	0.2	+
1984	11	1	306	84.83836	347.0000	0.5	+
1984	11	3	308	84.84384	346.7000	0.4	+
1984	11	6	311	84.85205	346.8000	0.3	+
1984	11	9	314	84.86027	346.3000	-99.9	M
1984	11	18	323	84.88493	344.6000	0.1	+
1984	11	22	327	84.89589	348.0000	1.3	S
1984	11	28	333	84.91233	348.0000	0.0	+
1984	12	2	337	84.92329	345.7000	1.8	S
1984	12	5	340	84.93151	346.9000	0.1	+
1984	12	9	344	84.94247	346.0000	0.1	+
1984	12	13	348	84.95342	346.4000	-99.9	M
1984	12	18	353	84.96712	346.8000	2.3	S
1984	12	20	355	84.97260	349.9000	-99.9	M
1984	12	30	365	85.00000	347.5000	-99.9	M
1985	1	2	2	85.00548	349.0000	1.8	S
1985	1	6	6	85.01644	348.4000	1.0	+
1985	1	16	16	85.04384	351.8000	0.1	+
1985	1	22	22	85.06027	349.4000	-99.9	M
1985	1	25	25	85.06849	352.1000	-99.9	M

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1985	2	1	32	85.08767	352.5000	-99.9	M
1985	2	4	35	85.09589	353.6000	0.5	+
1985	2	8	39	85.10685	352.5000	0.6	+
1985	2	18	49	85.13425	353.4000	0.0	+
1985	2	20	51	85.13973	351.0000	1.6	S
1985	2	24	55	85.15068	352.7000	0.4	+
1985	2	28	59	85.16164	351.2000	1.4	S
1985	3	5	64	85.17534	352.7000	0.1	+
1985	3	10	69	85.18904	352.3000	0.7	+
1985	3	15	74	85.20274	353.6000	0.4	+
1985	3	19	78	85.21370	351.2000	0.0	+
1985	3	26	85	85.23288	353.4000	-99.9	M
1985	3	28	87	85.23836	354.8000	0.9	+
1985	4	1	91	85.24932	351.3000	-99.9	M
1985	4	6	96	85.26301	351.7000	1.7	S
1985	4	10	100	85.27397	353.6000	-99.9	M
1985	4	15	105	85.28767	353.0000	1.0	+
1985	4	19	109	85.29863	353.1000	0.7	+
1985	4	24	114	85.31233	352.2000	0.7	+
1985	4	29	119	85.32603	352.4000	0.1	+
1985	5	2	122	85.33425	351.6000	1.4	S
1985	5	7	127	85.34795	350.9000	0.3	+
1985	5	11	131	85.35890	353.5000	-99.9	M
1985	5	16	136	85.37260	351.7000	-99.9	M
1985	5	20	140	85.38356	349.9000	-99.9	M
1985	5	31	151	85.41370	349.6000	0.8	+
1985	6	5	156	85.42740	351.6000	0.2	+
1985	7	10	191	85.52329	343.9000	1.4	S
1985	7	15	196	85.53699	343.1000	1.7	S
1985	7	19	200	85.54795	345.9000	0.6	+
1985	7	24	205	85.56164	343.9000	3.0	S
1985	7	28	209	85.57260	343.3000	1.7	S
1985	8	2	214	85.58630	341.4000	0.1	+
1985	8	6	218	85.59726	341.2000	0.6	+

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1985	8	11	223	85.61096	337.9000	1.9	S
1985	8	16	228	85.62466	341.4000	3.0	S
1985	8	20	232	85.63562	339.9000	0.3	+
1985	8	24	236	85.64658	339.4000	0.3	+
1985	8	28	240	85.65753	340.2000	0.2	+
1985	9	1	244	85.66849	337.4000	1.3	S
1985	9	7	250	85.68493	338.6000	1.1	S
1985	9	12	255	85.69863	338.6000	0.9	+
1985	9	15	258	85.70685	338.1000	1.0	+
1985	9	20	263	85.72055	340.9000	0.3	+
1985	9	24	267	85.73151	340.3000	1.2	S
1985	9	28	271	85.74247	342.0000	-99.9	M
1985	10	7	280	85.76712	345.0000	-99.9	M
1985	10	10	283	85.77534	343.1000	1.0	+
1985	10	13	286	85.78356	344.3000	-99.9	M
1985	10	16	289	85.79178	343.4000	0.2	+
1985	10	20	293	85.80274	345.5000	0.2	+
1985	10	24	297	85.81370	344.1000	-99.9	M
1985	11	1	305	85.83562	345.7000	0.6	+
1985	11	6	310	85.84932	349.8000	0.9	+
1985	11	11	315	85.86301	351.4000	1.1	S
1985	11	16	320	85.87671	349.6000	-99.9	M
1985	11	21	325	85.89041	345.4000	1.0	+
1985	11	25	329	85.90137	351.0000	0.8	+
1985	12	5	339	85.92877	351.6000	0.2	+
1985	12	14	348	85.95342	350.5000	-99.9	M
1985	12	18	352	85.96438	349.0000	1.5	S
1985	12	25	359	85.98356	349.9000	3.2	S
1986	1	4	4	86.01096	353.1000	0.2	+
1986	1	9	9	86.02466	352.2000	1.1	S
1986	1	14	14	86.03836	350.4000	3.0	S
1986	1	18	18	86.04932	350.1000	0.9	+
1986	1	24	24	86.06575	353.5000	2.3	S
1986	2	1	32	86.08767	350.6000	3.0	S

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1986	2	5	36	86.09863	351.4000	0.1	+
1986	2	9	40	86.10959	351.6000	0.1	+
1986	2	14	45	86.12329	350.0000	1.1	S
1986	2	18	49	86.13425	349.6000	0.7	+
1986	2	23	54	86.14795	348.4000	0.5	+
1986	2	27	58	86.15890	349.8000	0.0	+
1986	3	4	63	86.17260	352.1000	0.4	+
1986	3	8	67	86.18356	350.0000	-99.9	M
1986	3	14	73	86.20000	353.7000	0.7	+
1986	3	18	77	86.21096	351.8000	0.3	+
1986	3	24	83	86.22740	349.5000	2.6	S
1986	3	24	83	86.22740	351.9000	0.6	+
1986	3	29	88	86.24110	353.7000	0.4	+
1986	4	2	92	86.25205	355.1000	0.4	+
1986	4	6	96	86.26301	352.1000	0.1	+
1986	4	10	100	86.27397	358.4000	0.7	+
1986	4	10	100	86.27397	359.1000	0.6	+
1986	4	14	104	86.28493	352.3000	0.1	+
1986	4	16	106	86.29041	352.6000	0.9	+
1986	4	28	118	86.32329	353.8000	0.4	+
1986	5	7	127	86.34795	353.1000	0.2	+
1986	5	18	138	86.37808	352.8000	0.3	+
1986	5	23	143	86.39178	360.0300	-99.9	M
1986	5	28	148	86.40548	355.1000	-99.9	M
1986	6	1	152	86.41644	352.1000	-99.9	M
1986	6	5	156	86.42740	357.4100	-99.9	M
1986	6	9	160	86.43836	356.5500	-99.9	M
1986	6	13	164	86.44932	356.3200	-99.9	M
1986	6	17	168	86.46027	352.8300	-99.9	M
1986	6	22	173	86.47397	353.7100	-99.9	M
1986	6	27	178	86.48767	343.9400	-99.9	M
1986	7	2	183	86.50137	345.0100	-99.9	M
1986	7	6	187	86.51233	345.9100	-99.9	M
1986	7	14	195	86.53425	340.4800	-99.9	M
1986	7	18	199	86.54521	343.6600	-99.9	M

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1986	7	22	203	86.55616	342.6600	-99.9	M
1986	7	26	207	86.56712	343.3300	-99.9	M
1986	8	4	216	86.59178	344.6300	5.4	S
1986	8	15	227	86.62192	345.1700	0.8	+
1986	8	24	236	86.64658	344.2800	0.1	+
1986	9	4	247	86.67671	345.4700	0.8	+
1986	9	7	250	86.68493	339.1500	0.2	+
1986	9	18	261	86.71507	342.4900	0.8	+
1986	9	29	272	86.74521	345.9500	0.6	+
1986	10	4	277	86.75890	344.6100	0.5	+
1986	10	10	283	86.77534	346.1100	0.1	+
1986	10	22	295	86.80822	344.1600	2.7	S
1986	11	2	306	86.83836	346.6100	1.1	S
1986	11	14	318	86.87123	349.1300	0.4	+
1986	11	20	324	86.88767	350.6700	-99.9	M
1986	11	24	328	86.89863	349.6700	-99.9	M
1986	11	29	333	86.91233	350.5000	-99.9	M
1986	12	3	337	86.92329	350.2200	-99.9	M
1986	12	11	345	86.94521	349.5800	-99.9	M
1986	12	16	350	86.95890	352.2600	-99.9	M
1986	12	20	354	86.96986	354.1300	-99.9	M
1986	12	29	363	86.99452	350.8400	-99.9	M
1987	1	2	2	87.00548	350.7700	-99.9	M
1987	1	7	7	87.01918	351.9400	-99.9	M
1987	1	11	11	87.03014	357.1800	-99.9	M
1987	1	15	15	87.04110	354.5600	-99.9	M
1987	1	19	19	87.05205	351.8600	-99.9	M
1987	1	23	23	87.06301	355.1900	-99.9	M
1987	1	26	26	87.07123	351.0300	2.4	S
1987	2	2	33	87.09041	352.7600	0.4	+
1987	2	15	46	87.12603	352.1500	0.3	+
1987	2	24	55	87.15068	354.1000	0.4	+
1987	3	3	62	87.16986	351.3100	3.1	S
1987	3	12	71	87.19452	352.9000	0.6	+

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1987	3	20	79	87.21644	353.2900	0.8	+
1987	3	28	87	87.23836	353.5400	0.6	+
1987	4	3	93	87.25479	353.7200	0.2	+
1987	4	12	102	87.27945	353.8800	0.4	+
1987	4	21	111	87.30411	354.1300	0.2	+
1987	4	30	120	87.32877	354.7400	0.3	+
1987	5	3	123	87.33699	353.4400	3.0	S
1987	5	15	135	87.36986	353.6800	0.1	+
1987	5	24	144	87.39452	355.5900	2.0	S
1987	6	2	153	87.41918	353.4600	0.9	+
1987	7	7	188	87.51507	347.1900	-99.9	M
1987	7	10	191	87.52329	345.4100	-99.9	M
1987	7	14	195	87.53425	347.5800	-99.9	M
1987	7	19	200	87.54795	348.7500	-99.9	M
1987	7	23	204	87.55890	347.5200	-99.9	M
1987	7	29	210	87.57534	346.2300	-99.9	M
1987	7	31	212	87.58082	348.8000	-99.9	M
1987	8	8	220	87.60274	342.1100	-99.9	M
1987	8	15	227	87.62192	342.2500	-99.9	M
1987	8	17	229	87.62740	341.3000	-99.9	M
1987	8	20	232	87.63562	342.3800	-99.9	M
1987	8	24	236	87.64658	338.6600	-99.9	M
1987	8	31	243	87.66575	338.1800	-99.9	M
1987	9	1	244	87.66849	344.9300	-99.9	M
1987	9	4	247	87.67671	344.4700	-99.9	M
1987	9	9	252	87.69041	343.8400	-99.9	M
1987	9	13	256	87.70137	345.4200	-99.9	M
1987	9	18	261	87.71507	345.5000	-99.9	M
1987	9	24	267	87.73151	343.9700	-99.9	M
1987	9	28	271	87.74247	346.4500	-99.9	M
1987	10	2	275	87.75342	346.0300	-99.9	M
1987	10	5	278	87.76164	346.5100	-99.9	M
1987	10	11	284	87.77808	345.9000	-99.9	M
1987	10	15	288	87.78904	345.7200	-99.9	M

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1987	10	23	296	87.81096	345.6400	-99.9	M
1987	11	4	308	87.84384	349.9700	-99.9	M
1987	11	8	312	87.85479	350.8600	-99.9	M
1987	11	14	318	87.87123	349.1300	-99.9	M
1987	11	19	323	87.88493	350.3700	-99.9	M
1987	11	23	327	87.89589	353.4000	-99.9	M
1987	11	28	332	87.90959	352.6100	-99.9	M
1987	12	2	336	87.92055	351.0200	-99.9	M
1987	12	11	345	87.94521	353.1600	-99.9	M
1987	12	18	352	87.96438	357.0700	-99.9	M
1987	12	21	355	87.97260	353.2900	-99.9	M
1987	12	24	358	87.98082	354.6200	-99.9	M
1988	1	7	7	88.01918	358.8400	-99.9	M
1988	1	10	10	88.02740	359.9000	-99.9	M
1988	1	14	14	88.03836	357.8200	-99.9	M
1988	1	20	20	88.05479	354.2800	0.1	+
1988	1	25	25	88.06849	354.5300	4.3	S
1988	1	31	31	88.08493	358.1100	1.9	S
1988	2	5	36	88.09863	356.7800	0.9	+
1988	2	16	47	88.12877	354.5900	0.8	+
1988	2	25	56	88.15342	357.7600	0.5	+
1988	3	4	64	88.17534	356.5400	1.2	S
1988	3	13	73	88.20000	358.0900	-99.9	M
1988	3	17	77	88.21096	355.8500	1.3	S
1988	3	27	87	88.23836	355.9300	0.0	+
1988	4	6	97	88.26575	354.0200	3.3	S
1988	4	19	110	88.30137	356.2800	1.3	S
1988	4	27	118	88.32329	356.0300	0.5	+
1988	5	6	127	88.34795	357.6900	0.3	+
1988	5	14	135	88.36986	357.3500	-99.9	M
1988	5	21	142	88.38904	355.8700	0.7	+
1988	5	30	151	88.41370	354.0300	0.7	+
1988	6	7	159	88.43562	352.2100	6.1	S
1988	6	16	168	88.46027	353.2900	0.7	+

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1988	6	23	175	88.47945	350.9500	1.4	S
1988	7	10	192	88.52603	351.3300	3.2	S
1988	7	16	198	88.54247	352.0400	5.6	S
1988	7	22	204	88.55890	349.1000	4.2	S
1988	8	1	214	88.58630	345.6000	2.6	S
1988	8	10	223	88.61096	345.3700	0.1	+
1988	8	18	231	88.63288	347.3700	0.6	+
1988	8	25	238	88.65205	344.8100	2.1	S
1988	9	2	246	88.67397	343.0900	2.5	S
1988	9	11	255	88.69863	344.2600	5.4	S
1988	9	20	264	88.72329	343.5200	0.4	+
1988	9	29	273	88.74795	349.3200	1.6	S
1988	10	5	279	88.76438	346.5100	-99.9	M
1988	10	12	286	88.78356	350.4900	3.2	S
1988	10	17	291	88.79726	352.7500	0.2	+
1988	10	23	297	88.81370	351.9200	0.5	+
1988	11	1	306	88.83836	352.3400	1.7	S
1988	11	11	316	88.86575	344.2400	9.9	S
1988	11	15	320	88.87671	353.8900	0.4	+
1988	11	22	327	88.89589	358.8100	0.9	+
1988	12	1	336	88.92055	353.7400	0.3	+
1988	12	10	345	88.94521	358.4700	2.3	S
1988	12	20	355	88.97260	354.6000	0.4	+
1988	12	27	362	88.99178	356.9800	0.0	+
1989	1	4	4	89.01096	354.6600	1.4	S
1989	1	10	10	89.02740	358.6700	0.6	+
1989	1	16	16	89.04384	356.0600	0.9	+
1989	1	21	21	89.05753	358.9100	-99.9	M
1989	2	6	37	89.10137	356.9600	0.1	+
1989	2	13	44	89.12055	356.5100	0.1	+
1989	2	20	51	89.13973	357.9800	0.6	+
1989	2	26	57	89.15616	357.5400	0.0	+
1989	3	4	63	89.17260	357.0800	0.2	+
1989	3	13	72	89.19726	357.9100	0.4	+

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1989	3	20	79	89.21644	357.9500	1.4	S
1989	3	27	86	89.23562	358.3300	2.0	S
1989	4	4	94	89.25753	358.5100	0.8	+
1989	4	10	100	89.27397	361.4400	2.4	S
1989	4	15	105	89.28767	359.7300	0.4	+
1989	4	20	110	89.30137	357.7600	0.7	+
1989	5	4	124	89.33973	357.6700	0.1	+
1989	5	12	132	89.36164	357.5000	0.3	+
1989	5	18	138	89.37808	356.1600	3.8	S
1989	5	31	151	89.41370	353.3700	0.1	+
1989	6	3	154	89.42192	352.0000	1.2	S
1989	6	11	162	89.44384	354.9600	0.2	+
1989	6	19	170	89.46575	354.8600	1.2	S
1989	6	27	178	89.48767	349.5000	1.1	S
1989	7	4	185	89.50685	350.9000	10.5	S
1989	7	12	193	89.52877	354.3700	-99.9	M
1989	7	29	210	89.57534	353.4100	2.0	S
1989	8	4	216	89.59178	345.5000	0.4	+
1989	8	11	223	89.61096	348.3000	1.7	S
1989	8	18	230	89.63014	348.4000	6.2	S
1989	8	24	236	89.64658	351.8800	1.7	S
1989	9	4	247	89.67671	348.1800	1.3	S
1989	9	14	257	89.70411	346.9900	0.2	+
1989	9	22	265	89.72603	347.2600	1.3	S
1989	9	28	271	89.74247	350.6000	2.5	S
1989	10	5	278	89.76164	349.1500	7.3	S
1989	10	12	285	89.78082	351.0600	1.2	S
1989	10	21	294	89.80548	354.9600	3.9	S
1989	10	26	299	89.81918	358.7600	3.5	S
1989	11	4	308	89.84384	351.9100	2.6	S
1989	11	11	315	89.86301	352.9300	1.4	S
1989	11	18	322	89.88219	354.7600	2.1	S
1989	11	27	331	89.90685	356.6700	1.1	S
1989	12	6	340	89.93151	354.3500	0.2	+

Table 2 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1989	12	16	350	89.95890	354.8100	0.4	+
1989	12	21	355	89.97260	353.5700	1.0	+
1989	12	26	360	89.98630	354.3800	0.7	+
1990	1	10	10	90.02740	356.2000	0.1	+
1990	1	17	17	90.04658	355.4100	0.7	+
1990	1	24	24	90.06575	355.3600	0.6	+
1990	2	6	37	90.10137	357.8400	0.5	+
1990	2	13	44	90.12055	358.1500	0.1	+
1990	2	23	54	90.14795	357.1300	1.2	S
1990	3	2	61	90.16712	358.8100	-99.9	M
1990	3	11	70	90.19178	358.8800	0.5	+
1990	4	7	97	90.26575	359.8400	-99.9	M
1990	4	24	114	90.31233	356.8000	0.3	+
1990	5	1	121	90.33151	359.4500	0.5	+
1990	5	8	128	90.35068	358.7300	0.3	+
1990	5	20	140	90.38356	357.1300	0.1	+
1990	8	28	240	90.65753	351.6600	17.2	S
1990	8	29	241	90.66027	347.6500	1.9	S
1990	8	30	242	90.66301	351.1900	0.4	+
1990	8	31	243	90.66575	358.1300	3.8	S
1990	9	5	248	90.67945	358.2300	3.2	S
1990	9	6	249	90.68219	364.0700	12.9	S
1990	9	8	251	90.68767	352.6900	1.8	S
1990	9	10	253	90.69315	346.1400	3.4	S
1990	10	9	282	90.77260	352.7300	-99.9	M
1990	10	10	283	90.77534	352.3400	4.5	S
1990	10	12	285	90.78082	351.6500	-99.9	M

[a]-99.9 denotes missing values.
[b]For explanation, see section 12.

Table 3. Daily atmospheric carbon dioxide concentrations from Bering Island

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1985	5	5	125	85.34247	352.0087	0.3	+
1985	5	8	128	85.35068	352.1820	0.4	+
1985	5	9	129	85.35342	351.9028	0.3	+
1985	10	18	291	85.79726	343.9582	0.8	+
1985	11	2	306	85.83836	350.1032	16.5	S
1985	11	28	332	85.90959	349.7524	1.2	S
1985	12	11	345	85.94521	350.3658	0.7	+
1986	4	6	96	86.26301	344.6842	7.4	S
1986	4	17	107	86.29315	343.3580	8.2	S
1986	5	24	144	86.39452	350.0654	4.1	S
1986	5	31	151	86.41370	352.3483	11.7	S
1986	7	17	198	86.54247	336.9973	2.7	S
1986	7	25	206	86.56438	336.8864	0.8	+
1986	8	2	214	86.58630	338.5426	0.4	+
1986	8	12	224	86.61370	334.2328	1.7	S
1986	9	9	252	86.69041	344.4024	0.2	+
1986	9	21	264	86.72329	344.3815	0.0	+
1986	10	11	284	86.77808	347.0679	0.1	+
1986	10	15	288	86.78904	348.3655	0.5	+
1986	10	23	296	86.81096	346.0952	0.8	+
1986	10	31	304	86.83288	351.5342	0.5	+
1986	11	6	310	86.84932	350.5974	0.3	+
1986	12	1	335	86.91781	353.5011	0.1	+
1987	1	24	24	87.06575	351.7958	1.2	S
1987	1	27	27	87.07397	351.9944	15.5	S
1987	2	23	54	87.14795	352.4107	0.4	+
1987	3	26	85	87.23288	353.6932	0.6	+
1987	4	18	108	87.29589	354.3982	1.3	S
1987	4	23	113	87.30959	356.5487	0.8	+
1987	5	6	126	87.34521	357.4050	0.2	+
1987	6	1	152	87.41644	354.6648	0.2	+
1987	6	12	163	87.44658	351.2843	1.0	+
1987	7	7	188	87.51507	343.0519	1.7	S

Table 3 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1987	7	22	203	87.55616	341.4562	1.8	S
1987	8	6	218	87.59726	335.8210	0.1	+
1987	9	4	247	87.67671	337.7358	7.2	S
1987	9	16	259	87.70959	340.8494	3.2	S
1988	1	25	25	88.06849	357.1493	2.2	S
1988	2	29	60	88.16438	356.3924	0.3	+
1988	3	11	71	88.19452	356.1270	0.3	+
1988	4	7	98	88.26849	353.3957	2.5	S
1988	4	28	119	88.32603	357.1824	0.2	+
1988	5	31	152	88.41644	357.2324	1.0	+
1988	7	13	195	88.53425	347.4661	2.4	S
1988	7	26	208	88.56986	342.6151	-99.9	M
1988	7	30	212	88.58082	342.6045	0.9	+
1988	8	7	220	88.60274	342.1474	0.6	+
1988	8	12	225	88.61644	339.3333	0.6	+
1988	8	18	231	88.63288	342.2764	0.1	+
1988	8	23	236	88.64658	346.0418	0.3	+
1988	8	28	241	88.66027	343.9216	0.6	+
1988	9	28	272	88.74521	354.5205	5.0	S
1988	10	14	288	88.78904	354.0664	1.2	S
1988	11	15	320	88.87671	355.7936	0.2	+
1988	12	25	360	88.98630	357.6900	0.2	+
1989	1	12	12	89.03288	357.3532	0.8	+
1989	1	17	17	89.04658	364.3748	-99.9	M
1989	1	28	28	89.07671	355.8073	1.0	+
1989	2	6	37	89.10137	358.5409	0.1	+
1989	2	16	47	89.12877	358.3649	-99.9	M
1989	2	25	56	89.15342	359.1776	0.2	+
1989	3	5	64	89.17534	357.2526	0.0	+
1989	3	16	75	89.20548	357.1678	0.2	+
1989	3	28	87	89.23836	357.8220	0.2	+
1989	4	7	97	89.26575	359.1032	0.4	+
1989	5	9	129	89.35342	359.3459	0.2	+
1989	5	15	135	89.36986	359.1026	0.3	+

Table 3 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1989	5	25	145	89.39726	359.7715	0.3	+
1989	6	9	160	89.43836	356.3283	-99.9	M
1989	6	20	171	89.46849	355.0557	-99.9	M
1989	6	27	178	89.48767	353.2427	0.6	+
1989	7	14	195	89.53425	344.2155	2.4	S
1989	7	30	211	89.57808	345.5864	3.6	S
1989	8	18	230	89.63014	348.8604	1.2	S
1989	8	25	237	89.64932	343.9075	9.7	S
1989	9	1	244	89.66849	346.3085	3.1	S
1989	9	26	269	89.73699	349.6056	-99.9	M
1989	10	10	283	89.77534	353.2289	1.9	S
1989	10	17	290	89.79452	352.5594	5.6	S
1989	10	24	297	89.81370	356.0684	0.4	+
1989	11	2	306	89.83836	353.9846	1.4	S
1989	11	10	314	89.86027	354.6247	0.3	+
1989	11	20	324	89.88767	356.8147	-99.9	M
1990	2	4	35	90.09589	364.0089	1.2	S
1990	2	24	55	90.15068	358.6266	4.3	S
1990	3	4	63	90.17260	358.7524	-99.9	M
1990	3	13	72	90.19726	359.5387	0.2	+
1990	3	18	77	90.21096	360.0880	1.0	+
1990	3	30	89	90.24384	359.2148	0.7	+
1990	4	5	95	90.26027	360.1699	0.4	+
1990	4	21	111	90.30411	361.3129	-99.9	M
1990	4	24	114	90.31233	359.9719	0.1	+
1990	4	30	120	90.32877	360.1317	0.1	+
1990	5	9	129	90.35342	360.7726	7.4	S
1990	5	18	138	90.37808	359.1818	0.1	+
1990	5	27	147	90.40274	358.6940	-99.9	M
1990	6	2	153	90.41918	357.1232	-99.9	M
1990	6	11	162	90.44384	354.8248	3.9	S
1990	6	16	167	90.45753	355.4955	3.3	S
1990	6	24	175	90.47945	348.2778	0.7	+
1990	6	30	181	90.49589	348.2972	2.0	S

Table 3 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1990	7	9	190	90.52055	348.0010	0.4	+
1990	7	19	200	90.54795	344.8939	2.3	S
1990	7	23	204	90.55890	346.0435	0.8	+
1990	7	31	212	90.58082	348.6257	0.3	+
1990	8	12	224	90.61370	340.4719	-99.9	M
1990	8	14	226	90.61918	342.9178	-99.9	M
1990	8	24	236	90.64658	344.5576	1.6	S
1990	8	29	241	90.66027	343.1998	0.5	+
1990	10	7	280	90.76712	356.8058	-99.9	M
1990	10	16	289	90.79178	354.3132	0.2	+
1990	11	1	305	90.83562	359.1737	1.1	S
1990	11	9	313	90.85753	357.3509	4.8	S
1990	11	15	319	90.87397	357.3137	0.1	+
1990	11	24	328	90.89863	359.9406	0.9	+
1990	12	3	337	90.92329	358.9246	-99.9	M
1990	12	27	361	90.98904	360.5894	0.9	+
1991	1	19	19	91.05205	358.9949	0.5	+
1991	1	23	23	91.06301	359.6366	-99.9	M
1991	2	11	42	91.11507	359.5731	0.2	+
1991	2	20	51	91.13973	360.8660	0.1	+
1991	3	1	60	91.16438	360.7054	4.5	S
1991	3	14	73	91.20000	363.7607	-99.9	M
1991	3	19	78	91.21370	362.0581	5.2	S
1991	3	25	84	91.23014	362.3650	0.2	+

[a]-99.9 denotes missing values.
[b]For explanation, see section 12.

Table 4. Daily atmospheric carbon dioxide concentrations from Kotelny Island

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1986	8	25	237	86.64932	340.5809	1.0	+
1986	9	8	251	86.68767	340.1341	0.5	+
1986	10	25	298	86.81644	348.4273	1.0	+
1986	11	14	318	86.87123	353.2512	0.9	+
1986	12	15	349	86.95616	353.2665	0.3	+
1987	1	4	4	87.01096	354.0584	-99.9	M
1987	1	18	18	87.04932	356.5290	-99.9	M
1987	2	22	53	87.14521	355.9475	0.0	+
1987	4	16	106	87.29041	355.8923	0.2	+
1987	4	28	118	87.32329	355.9558	0.2	+
1987	5	9	129	87.35342	357.3590	-99.9	M
1987	5	20	140	87.38356	356.9074	0.4	+
1987	6	2	153	87.41918	356.4849	1.5	S
1987	6	14	165	87.45205	360.6186	-99.9	M
1987	7	2	183	87.50137	351.9015	4.6	S
1987	7	30	211	87.57808	343.0600	2.6	S
1987	9	2	245	87.67123	341.5705	-99.9	M
1987	9	19	262	87.71781	343.1580	-99.9	M
1987	10	5	278	87.76164	342.4727	0.1	+
1987	10	15	288	87.78904	347.2796	0.4	+
1987	11	19	323	87.88493	349.4753	0.4	+
1987	12	10	344	87.94247	353.6228	0.1	+
1987	12	26	360	87.98630	352.9272	1.8	S
1988	1	29	29	88.07945	356.4753	0.2	+
1988	2	11	42	88.11507	357.3348	0.1	+
1988	2	23	54	88.14795	356.3872	0.1	+
1988	3	8	68	88.18630	358.8807	1.0	+
1988	3	18	78	88.21370	358.4423	-99.9	M
1988	4	13	104	88.28493	359.3121	1.0	+
1988	4	26	117	88.32055	357.9312	0.1	+
1988	5	15	136	88.37260	357.9970	0.4	+
1988	6	1	153	88.41918	357.1308	0.1	+
1988	6	23	175	88.47945	355.1498	0.4	+

Table 4 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1988	7	7	189	88.51781	349.8244	1.9	S
1988	7	14	196	88.53699	349.0429	0.2	+
1988	7	25	207	88.56712	345.9922	0.9	+
1988	8	3	216	88.59178	346.0629	0.3	+
1988	8	10	223	88.61096	344.8497	0.5	+
1988	8	26	239	88.65479	348.7240	1.7	S
1988	9	2	246	88.67397	348.2234	0.9	+
1988	9	9	253	88.69315	349.0632	10.8	S
1988	9	16	260	88.71233	346.0192	0.4	+
1988	9	24	268	88.73425	347.7463	2.0	S
1988	10	4	278	88.76164	350.9937	0.7	+
1988	10	29	303	88.83014	354.9047	1.1	S
1988	11	7	312	88.85479	356.0161	0.2	+
1988	12	21	356	88.97534	360.0302	0.4	+
1989	1	6	6	89.01644	360.1633	0.0	+
1989	1	17	17	89.04658	357.2434	0.3	+
1989	2	15	46	89.12603	358.9968	-99.9	M
1989	2	24	55	89.15068	360.2092	0.1	+
1989	3	3	62	89.16986	361.2546	0.9	+
1989	3	9	68	89.18630	359.9661	0.1	+
1989	3	27	86	89.23562	360.6040	0.1	+
1989	4	7	97	89.26575	360.7449	-99.9	M
1989	4	15	105	89.28767	360.5509	0.5	+
1989	4	24	114	89.31233	360.0846	0.2	+
1989	5	21	141	89.38630	357.8182	1.7	S
1989	6	1	152	89.41644	358.1173	1.5	S
1989	6	8	159	89.43562	360.1188	0.5	+
1989	6	16	167	89.45753	359.6200	0.2	+
1989	6	25	176	89.48219	357.8952	0.8	+
1989	7	3	184	89.50411	356.2464	0.0	+
1989	7	10	191	89.52329	355.4412	0.1	+
1989	7	17	198	89.54247	354.9360	-99.9	M
1989	7	24	205	89.56164	351.7869	-99.9	M
1989	8	5	217	89.59452	352.1374	2.5	S

Table 4. (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1989	8	18	230	89.63014	346.3802	4.5	S
1989	9	2	245	89.67123	345.1773	0.4	+
1989	9	14	257	89.70411	345.6986	0.1	+
1989	9	24	267	89.73151	350.6383	-99.9	M
1989	10	1	274	89.75068	348.7624	0.1	+
1989	10	10	283	89.77534	350.6250	0.2	+
1989	11	29	333	89.91233	357.8687	1.0	+
1989	12	14	348	89.95342	356.6385	1.4	S
1990	1	9	9	90.02466	357.7467	0.7	+
1990	1	20	20	90.05479	358.4698	0.2	+
1990	2	6	37	90.10137	359.5152	0.0	+
1990	3	12	71	90.19452	361.1419	8.3	S
1990	3	19	78	90.21370	361.8302	-99.9	M
1990	3	29	88	90.24110	361.9250	0.2	+
1990	4	8	98	90.26849	361.9854	0.1	+
1990	4	17	107	90.29315	365.2133	2.5	S
1990	4	24	114	90.31233	361.8921	0.2	+
1990	5	4	124	90.33973	362.3727	6.6	S
1990	5	12	132	90.36164	361.1644	1.0	+
1990	5	19	139	90.38082	366.8332	-99.9	M
1990	6	8	159	90.43562	358.7668	1.1	S
1990	6	16	167	90.45753	356.8861	1.1	S
1990	6	23	174	90.47671	356.5542	0.0	+
1990	7	4	185	90.50685	356.1694	0.0	+
1990	7	11	192	90.52603	351.2653	3.4	S
1990	7	18	199	90.54521	352.7562		0.4
1990	7	26	207	90.56712	348.4670	0.4	+
1990	8	10	222	90.60822	346.2921	0.1	+
1990	8	17	229	90.62740	345.9276	0.6	+
1990	8	24	236	90.64658	348.5647	0.2	+
1990	9	1	244	90.66849	346.0757	0.6	+
1990	9	8	251	90.68767	351.5134	1.0	+
1990	9	24	267	90.73151	349.9736	-99.9	M
1990	10	6	279	90.76438	350.4672	0.2	+

Table 4 (continued)

Sample year	Sample month	Sample day	Day of year	Decimal year	CO_2 concentration (ppmv)	Flask difference[a]	Flag[b]
1990	10	17	290	90.79452	351.3250	0.1	+
1990	11	6	310	90.84932	356.7489	-99.9	M
1990	11	14	318	90.87123	356.7050	1.5	S
1990	11	23	327	90.89589	357.0435	1.6	S
1991	1	3	3	91.00822	360.1134	1.1	S
1991	1	25	25	91.06849	363.5959	-99.9	M

[a]-99.9 denotes missing values.
[b]For explanation, see section 12.

Sampling Methods

Aside from differences in the types of flasks used, the sampling techniques used at the U.S.S.R.-operated sites are virtually identical to those used by NOAA/CMDL in their flask sampling network. The NOAA/CMDL sampling methods have been described in detail by Komhyr et al. (1985) and Conway et al. (1988).

Air is collected at the four sites, generally four times per month, in pairs of 1.5-L stainless steel electropolished flasks using a portable sampling apparatus. A small, diaphragm-type plastic pump forces air through the flasks at a minimum rate of 5 L/min. Two flasks, previously filled with a dry gas of known CO_2 concentration and connected in series, are flushed for 5 min at approximately 5 L/min with ambient air and then pressurized to 1.2-1.5 times ambient atmospheric pressure. The air is not dried during sample collection, and attempts are made to obtain samples during conditions of optimal wind speed, wind direction, and time of day (see data selection criteria).

After collecting the air samples, the flasks are mailed to the central laboratory at MGO once per month for CO_2 determinations using a URAS-2T nondispersive infrared gas analyzer. The air samples are not dried before shipment to St. Petersburg. The delay between collecting the air sample and subsequent analysis at MGO varies and ranges from 2 months for Teriberka Station to 6 months for Kotelny Island. The air samples are dried cryogenically at MGO before analysis using a Cry-Cooler system that was provided by the AES and installed in October 1990. Before that time, air samples were dried using a dry ice-in-ethanol water vapor trap.

The URAS-2T nondispersive infrared gas analyzer is calibrated using CO_2-in-synthetic air reference gases. The concentration values assigned to the standard gases are traceable to the primary standards maintained by the WMO Central CO_2 Laboratory (CCL) operated by C. D. Keeling at the Scripps Institution of Oceanography (SIO). A set of four tertiary standards and four working gases were provided to MGO by NOAA/CMDL in 1981. One of these working gases was accidentally lost in 1983. All gases were calibrated against SIO and NOAA/CMDL gas standards in 1981. In 1988 and 1989, these reference gases were compared to a set of three NOAA/CMDL CO_2-in-air gas standards and in 1990 to a CO_2-in-air gas standard provided by AES. None of the reference gases used by MGO have CO_2 concentrations exceeding 356 ppmv. As a result, a linear extrapolation procedure must be applied to calculate concentration values for air samples with concentrations higher than 356 ppmv.

The data presented here in ppmv are based on manometric calibrations at CCL in 1982. This scale is generally referred to as the SIO X83 mole fraction scale. Greater details about the sampling methods used at the four U.S.S.R.-operated sites are provided in Brounshtein et al. (1988a-c)

Data Selection Criteria

To obtain measurements indicative of regional background air conditions, attempts are made to collect air samples at specific times during the day and during conditions of optimal wind speed and direction. Measurements not meeting wind direction, wind speed, inter-flask agreement, and climate condition criteria have been either discarded or flagged. In order for a sample to be considered indicative of background air, wind direction must be seaward, wind speed must be $\geq$16 mi/hr, and flask pairs must agree within 1 ppmv. If

the above criteria are met for a flask pair, an average flask pair concentration value is calculated. If the flask difference is greater than 1 ppmv, a single value is accepted if this value falls within 2 standard deviations when plotted on a smoothed concentration curve using a forward selection stepwise linear regression smoothing routine developed by N. B. A. Trivett of AES (personal communication).

Drift Corrections

Komhyr et al. (1985) indicated the greatest possible cause of sample deterioration in the NOAA/CMDL flask sampling program was the increase of CO_2 concentration in flasks stored for significant lengths of time before sample analysis. Komhyr et al. (1985) observed increases of several parts per million particularly, in moist air samples stored at room temperatures above 25°C.

The samples collected at the U.S.S.R.-operated sites are frequently stored for considerable periods of time before sample analysis. Samples collected at Bering and Kotelny Islands have been stored for periods exceeding 100 days before analysis at MGO. C. D. Keeling compared the atmospheric CO_2 concentrations from Bering and Kotelny Islands to those from Alert and found that the Soviet stations show consistently higher concentrations (~2 ppmv). Subsequent experiments eliminated the possibility of higher concentrations due to errors in the standard gas concentrations and suggested the elevated concentrations may be due to lengthy storage in stainless steel flasks.

Since flask drift error is largely a function of the storage time and the relative humidity at the time of sample collection, it is possible to correct these atmospheric CO_2 concentrations for the biases introduced by flask drifting. All the data presented here have been adjusted for potential drifts in CO_2 concentrations due to lengthy storage in stainless steel flasks. These adjustments have been made using the formula:

$$dC = -t(0.23*e - 0.51)$$

where dC is the correction added to the measured concentration value, t is the time in days between air sample collection and analysis, and e is the water vapor partial pressure in the air sample expressed in millibars.

6. APPLICATIONS OF THE DATA

Despite the brevity of the data records, these measurements provide data necessary for understanding recent trends in regional tropospheric CO_2 concentrations and support the increasing trend in atmospheric CO_2 concentrations observed at other northerly monitoring sites. These measurements may also prove useful to global carbon cycle modelers testing the ability of their models to reproduce measured features of northern latitude CO_2 distributions. Since these measurements are directly traceable to WMO standards, these atmospheric CO_2 concentration measurements may be compared with similar measurements by other monitoring programs (e.g., AES, NOAA/CMDL, or SIO) at northern latitude sites (e.g., Alert, Northwest Territories; Cold Bay, Alaska; Point Barrow, Alaska; and Shemya, Alaska) or with measurements obtained in the U.S.S.R. by spectral analysis (Brounshtein et al. 1976). These monitoring sites broaden the global network of

stations attempting to obtain CO_2 measurements indicative of background air conditions and provide essential coverage for a region of the world that to date has been sparsely monitored. These measurements may prove extremely useful since the northern latitudes are considered more susceptible to potential CO_2-induced climate changes.

7. LIMITATIONS AND RESTRICTIONS OF THE DATA

The daily atmospheric CO_2 concentration records for the four sites presented here do not have sufficient length to identify any long-term trends in atmospheric CO_2 concentrations over the U.S.S.R.; however, these records do support the general trend in rising atmospheric CO_2 concentrations shown by longer records from other northern latitude sites. The remoteness of these four sites makes them ideal for obtaining air samples indicative of background air conditions; however, the monitoring sites at Kotelny and Bering Island are subject to occasional local vegetative influences.

Air samples stored in 1.5-L stainless steel electropolished flasks are subject to drift, especially when stored for extended periods of time. Since flasks used at these four sites for sample collection are all shipped to MGO for analysis and may be stored for several months, errors introduced by flask drifting do occur. Measurements of CO_2 concentrations from Kotelny Island are typically 2 ppmv higher than those at Alert (Shashkov, personal communication). This discrepancy is believed to be due to flask drifting. Attempts are being made to reduce storage times. Other systematic attempts to resolve flask drift errors, including coating the inside of the flasks and drying the air samples, have been tried unsuccessfully.

Concentration values higher than 356 ppmv should be used with caution since a linear extrapolation procedure is used to calculate concentration values for air samples with concentrations higher than this level. The use of this extrapolation procedure is necessary because none of the reference gases used by MGO have CO_2 concentrations exceeding 356 ppmv.

8. REFERENCES

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9. QUALITY ASSURANCE OF THE U.S.S.R. FLASK SAMPLING DATA

An important part of the numeric data package (NDP) process at the Carbon Dioxide Information Analysis Center (CDIAC) is the quality assurance (QA) of data before distribution. To guarantee data of the highest possible quality, CDIAC conducts extensive QA reviews. Reviews involve examining the data for completeness, reasonableness, and accuracy. Although they have common objectives, these reviews must be tailored to each data set, often through extensive programming efforts. Although time-consuming, the QA process is an important component in the value-added concept of assuring accurate, usable CO_2 data for researchers.

These data were provided to CDIAC by Dr. Alexander Shashkov. The data were provided as four flat ASCII text files, one for each station. The following summarizes the conversions and checks that CDIAC performed on the original files:

1. Although each of the four original files contained identical variables, the column alignment of each file differed. To standardize the file formats, each flat ASCII file was read using a SAS* retrieval code and rewritten as flat ASCII files with identical formats.

2. All data were plotted to check for obvious outliers. Although some values appeared to be possible outliers (Figs. 2–5), no values were rejected, flagged, or removed from the data files provided to CDIAC.

In summary, CDIAC's principal role in working with these data files was standardizing the file formats and plotting the data. No changes were made to any of the CO_2 concentration values or flag codes provided by Dr. Alexander Shashkov.

10. HOW TO OBTAIN THE PACKAGE

The daily atmospheric CO_2 concentrations from the four sites previously described are provided in tabular form (Tables 1-4) for requesters who may not need automated data or data for the entire period of record. These data are available in machine-readable form, upon request, on 9-track magnetic tape or floppy diskette from CDIAC.

Requests for a magnetic tape should include any specific instructions for transmitting the data required by the user to access the data (i.e., 1600 or 6250 BPI density tape, labeled or non-labeled tapes, ASCII or EBCDIC characters, and block size or record length constraints). Requests not accompanied by specific instructions will be filled on 9-track, 6250 BPI, standard-labeled tapes with characters written in EBCDIC and files formatted as shown in Sect. 11.

Requesters wishing to receive the machine-readable data files on floppy diskettes will receive DOS ASCII text files on IBM formatted floppy diskettes. Requests for floppy diskettes should specify diskette size (either 5.25 or 3.5 inch) and density (high or low) preferences.

Requests should be addressed to:

Carbon Dioxide Information Analysis Center
Oak Ridge National Laboratory
Post Office Box 2008
Oak Ridge, Tennessee 37831-6335, U.S.A.

Telephone: (615) 574-0390
FTS 624-0390
FAX: (615) 574-2232

BITNET eMail: CDP@ORNLSTC
OMNET: CDIAC
INTERNET: CDP@STC10.CTD.ORNL.GOV

PART 2

INFORMATION ABOUT THE MAGNETIC TAPE

11. CONTENTS OF THE MAGNETIC TAPE

The following is a list of files distributed on magnetic tape (or floppy diskette) by CDIAC along with this documentation.

File number and description	File size (kB)	Logical records	Record format[a]	Block size	Record length
1. General descriptive information file	7.750	126	FB	8000	100
2. FORTRAN IV data retrieval code to read and print the daily atmospheric CO_2 concentration data files (files 4–7)	5.022	62	FB	8000	80
3. SAS[b] input/output routine to read and print the daily atmospheric CO_2 concentration data files (files 4–7)	0.972	12	FB	8000	80
4. Daily atmospheric CO_2 concentration data for Teriberka Station	5.612	122	FB	4500	45
5. Daily atmospheric CO_2 concentration data for Ocean Station Charlie	20.010	435	FB	4500	45
6. Daily atmospheric CO_2 concentration data for Bering Island	5.750	125	FB	4500	45
7. Daily atmospheric CO_2 concentration data for Kotelny Island	4.922	107	FB	4500	45
Total size and records	50.038	989			

[a]FB = fixed block.
[b]SAS is the registered trademark of SAS Institute, Inc., Cary, North Carolina 27511-8000.

12. DESCRIPTIVE FILE ON THIS TAPE

The following is a listing of the first file provided on the magnetic tape distributed by CDIAC. This file provides variable descriptions, formats, units, and other pertinent information about each file associated with this NDP.

TITLE OF THE DATA SET

Atmospheric CO_2 concentrations derived from flask samples collected at U.S.S.R.-operated sampling sites.

CONTRIBUTORS

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SOURCE AND SCOPE OF THE DATA

Daily atmospheric CO_2 concentrations from four U.S.S.R.-operated sampling sites (Teriberka Station, Ocean Station Charlie, Bering Island, and Kotelny Island) are provided. The period of record varies by station with the earliest measurements dating back to 1983 and recent estimates from early 1991. These CO_2 concentrations are derived from air samples collected in 1.5-L stainless steel electropolished flasks and later analyzed at the Main Geophysical Observatory (St. Petersburg, U.S.S.R.) using a nondispersive infrared gas analyzer. Measurements not meeting wind direction, wind speed, inter-flask agreement, and climate condition criteria have been either discarded or flagged. All measurements have been corrected for drift biases introduced during flask storage. These atmospheric CO_2 concentrations are considered indicative of regional background air conditions and are directly traceable to World Meteorological Organization primary CO_2 standards.

DATA FORMAT

Seven files are provided on this magnetic tape, including this descriptive file, one FORTRAN IV retrieval program, one SAS input/output routine, and four data files containing atmospheric CO_2 concentrations from the four Soviet stations.

The data files are each formatted as

```
      INTEGER SAMPYR, SAMPMO, SAMPDA, DAYYR
      REAL TIME, CONC, DIFF
      CHARACTER FLAG
      READ(5,100,END=99) SAMPYR,SAMPMO,SAMPDA,DAYYR,TIME,
     1                   CONC,DIFF,FLAG
  100 FORMAT(5X,3(I2,1X),I3,1X,F8.4,1X,F8.4,1X,F5.1,3X,A1)
```

where

SAMPYR	is the year the flask sample was collected;
SAMPMO	is the month the flask sample was collected;
SAMPDA	is the day of the month the flask sample was collected;
DAYYR	is the day of the year the flask sample was collected;
TIME	is the year and fraction of year expressed as a single decimal value;
CONC	is the average CO_2 concentration (ppmv). If DIFF is > 1 ppmv, the lesser of the flask pair is chosen provided it is within 2 standard deviations of the plotted smooth curve. If one of the two samples is lost the same criteria is applied to the remaining sample concentration value. If DIFF is $\leq$1 ppmv, the mean of the flask pair is used.
DIFF	is the absolute value of the difference (ppmv) between the flask pair concentrations;
FLAG	is a flag describing the nature of DIFF. It is assigned a '+' if DIFF is less than or equal to 1, an 'S' if DIFF is greater than 1, and an 'M' if CONC is derived from a single flask.

Missing values for the variable DIFF are represented by -99.9. All the data (CONC) presented here have been adjusted for potential drifts in CO_2 concentrations due to lengthy storage in stainless steel flasks. These adjustments have been made using the formula:

$$dC = -t(0.23*e - 0.51)$$

where dC is the correction added to the measured concentration value, t is the time in days between air sample collection and analysis, and e is the water vapor partial pressure in the air sample expressed in millibars.

Stated in tabular form, the contents include the following.

Variable	Variable type	Variable width	Starting column	Ending column
SAMPYR	Numeric	I2	6	7
SAMPMO	Numeric	I2	9	10
SAMPDA	Numeric	I2	12	13
DAYYR	Numeric	I3	15	17
TIME	Numeric	F8.4	19	26
CONC	Numeric	F8.4	28	35
DIFF	Numeric	F5.1	37	41
FLAG	Character	A1	45	45

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13. LISTING OF THE FORTRAN IV DATA RETRIEVAL PROGRAM

The following is a listing of the FORTRAN IV data retrieval program provided on magnetic tape (File 2) by CDIAC to read and print the daily atmospheric CO_2 concentration data for Teriberka Station, Ocean Station Charlie, Bering Island, and Kotelny Island (files 4–7 on the magnetic tape; see Tables 5–8 for a partial listing of these data files). The job control language (JCL) statements shown below are not provided in the file on the magnetic tape. The JCL statements required will vary for each individual requesting these data. The JCL statements shown below are provided to illustrate the statements that would be required by an individual at Oak Ridge National Laboratory (ORNL) who has requested these data on a 9-track, 6250 BPI, standard-labeled tape with characters written in EBCDIC and is attempting to read the tape on an IBM mainframe (e.g., IBM 3090).

```
//UID033 JOB (12345),'USER ADDRESS'
// EXEC FORTVCLG
//FORT.SYSIN DD *
C
C*****************************************************************************
C FORTRAN PROGRAM TO READ AND PRINT THE DATA FILES CONTAINING
C ATMOSPHERIC CO2 CONCENTRATIONS FROM USSR-OPERATED FLASK
C SAMPLING SITES -- TERIBERKA STATION, OCEAN STATION "C", BERING
C ISLAND, AND KOTELNY ISLAND
C*****************************************************************************
C
      INTEGER SAMPYR,SAMPMO,SAMPDA,DAYYR
      REAL TIME,CONC,DIFF
      CHARACTER FLAG
C
C*****************************************************************************
C INITIALIZE A COUNTER FOR THE NUMBER OF RECORDS READ & WRITTEN
C*****************************************************************************
C
      NREC=0
C
C*****************************************************************************
C READ ONE OF THE FOUR DATA FILES CONTAINING THE ATMOSPHERIC
C CO2 CONCENTRATIONS
C*****************************************************************************
C
 1    CONTINUE
      READ(5,100,END=99) SAMPYR,SAMPMO,SAMPDA,DAYYR,TIME,
     1     CONC,DIFF,FLAG
100   FORMAT(5X,3(I2,1X),I3,1X,F8.4,1X,F8.4,1X,F5.1,3X,A1)
C
C*****************************************************************************
C PRINT A DESCRIPTIVE HEADER AT THE TOP OF EACH PAGE USING
```

```
C THE COUNTER
C*************************************************************************
C
      IF(MOD(NREC,45).EQ.0)WRITE(6,101)
 101   FORMAT(1H1,'SAMPLE',2X,'SAMPLE',2X,'SAMPLE',2X,'JULIAN',
     1 2X,'DECIMAL',6X,'CO2',10X,'FLASK',5X,'FLAG',/,2X,'YEAR',
     2 3X,'MONTH',5X,'DAY',4X,'DATE',5X,'YEAR',3X,'CONCENTRATION',
     3 2X,'DIFFERENCE',2X,'CODE',/)
        WRITE(6,102) SAMPYR,SAMPMO,SAMPDA,DAYYR,TIME,
     1        CONC,DIFF,FLAG
102     FORMAT(3X,I2,6X,I2,6X,I2,5X,I3,3X,F8.4,5X,F8.4,6X,F5.1,7X,A1)
C
C*************************************************************************
C INSERT A BLANK LINE BETWEEN EACH 5 LINES OF OUTPUT
C*************************************************************************
C
      NREC=NREC+1
C
      IF(MOD(NREC,5).EQ.0) WRITE(6,103)
 103   FORMAT(1X)
C
      GO TO 1
 99   CONTINUE
      STOP
      END
//GO.FT05F001 DD UNIT=TAPE62,VOL=SER=TAPEVOL,DISP=(,PASS),
// LABEL=(7,SL),DCB=(RECFM=FB,LRECL=45,BLKSIZE=4500),
// DSN=TAB.NDP033.KOTELNYI.DATA
//GO.FT06F001 DD *
```

14. LISTING OF THE SAS INPUT/OUTPUT RETRIEVAL PROGRAM

The following is a listing of the SAS data retrieval program provided on magnetic tape (file 3) by CDIAC to read and print the daily atmospheric CO_2 data for Teriberka Station, Ocean Station Charlie, Bering Island, and Kotelny Island (files 4–7 on the magnetic tape; see Tables 5–8 for a partial listing of these data files). The job control language (JCL) statements shown below are not provided in the file on the magnetic tape. The JCL statements required will vary for each individual requesting these data. The JCL statements shown below are provided to illustrate the statements that would be required by an individual at ORNL who has requested these data on a 9-track, 6250 BPI, standard-labeled tape with characters written in EBCDIC and is attempting to read the tape on an IBM mainframe (e.g., IBM 3090).

```
//UIDCO2 JOB (12345,TAPE,IO20),'USER ADDRESS',TIME=(1,30)
//STEP1 EXEC SAS,SASRGN=4096K,WORK=1600
//OUT DD UNIT=TAPE62,VOL=SER=TAPEVOL,DISP=(,PASS),
// DSN=TAB.NDP033.BERINGIS.DATA,LABEL=(6,SL)
//FT06F001 DD SYSOUT=A
//SYSIN DD *
DATA USSR;
INFILE OUT;
INPUT SAMPYR 6-7 SAMPMO 9-10 SAMPDA 12-13 DAYYR 15-17 TIME 19-26
      CONC 28-35 DIFF 37-41 FLAG $ 45;
PROC PRINT;
RUN;
```

Table 5. Sample listing of the data file containing the CO_2 concentrations from Teriberka Station

88	3	10	70	88.19178	361.7723	-99.9	M
88	3	24	84	88.23014	364.3500	-99.9	M
88	4	6	97	88.26575	365.4437	-99.9	M
88	4	21	112	88.30685	358.6126	0.6	+
88	4	28	119	88.32603	358.4029	4.2	S
88	5	7	128	88.35068	356.7139	-99.9	M
88	5	14	135	88.36986	355.4376	0.2	+
88	5	21	142	88.38904	355.1093	1.2	S
88	5	29	150	88.41096	355.7964	0.0	+
88	6	2	154	88.42192	351.9357	1.8	S
88	6	9	161	88.44110	353.1870	0.1	+
88	6	16	168	88.46027	350.3800	0.6	+
88	6	26	178	88.48767	348.7152	-99.9	M
88	7	10	192	88.52603	343.1898	0.2	+
88	7	17	199	88.54521	346.2271	0.2	+
88	7	24	206	88.56438	345.8492	1.4	S
88	7	30	212	88.58082	344.1600	5.0	S
88	8	8	221	88.60548	337.8961	0.8	+
88	8	15	228	88.62466	342.3476	0.4	+
88	8	17	230	88.63014	342.7645	0.2	+
88	8	27	240	88.65753	345.6046	2.1	S
88	9	11	255	88.69863	349.9905	0.6	+
88	9	14	258	88.70685	345.2387	0.3	+
88	9	20	264	88.72329	349.8692	1.2	S
88	9	22	266	88.72877	348.1104	0.1	+
88	10	5	279	88.76438	347.1909	0.2	+
88	10	19	293	88.80274	351.1316	22.1	S
88	10	23	297	88.81370	354.1490	0.1	+
88	10	28	302	88.82740	351.3982	1.6	S
88	11	3	308	88.84384	353.3780	0.8	+
88	11	13	318	88.87123	354.4375	5.4	S
88	11	23	328	88.89863	356.2879	0.7	+
88	12	1	336	88.92055	356.0865	0.1	+
88	12	11	346	88.94795	357.9639	0.7	+
88	12	23	358	88.98082	364.8877	5.5	S
88	12	28	363	88.99452	361.7948	0.1	+
89	1	1	1	89.00274	359.6349	3.5	S
89	1	11	11	89.03014	360.9590	0.1	+
89	1	23	23	89.06301	359.4818	1.9	S
89	2	2	33	89.09041	356.7979	3.1	S
89	2	10	41	89.11233	359.4421	0.4	+
89	2	19	50	89.13699	361.5091	1.2	S
89	2	23	54	89.14795	358.6868	10.6	S
89	3	9	68	89.18630	363.3146	1.5	S
89	3	17	76	89.20822	360.2806	0.5	+
89	3	23	82	89.22466	360.2411	0.5	+

Table 6. Sample listing of the data file containing the CO_2 concentrations from Ocean Station Charlie

83	1	2	2	83.00548	347.7000	0.9	+
83	1	7	7	83.01918	349.1000	1.3	S
83	1	11	11	83.03014	348.8000	-99.9	M
83	1	30	30	83.08219	346.6000	-99.9	M
83	2	2	33	83.09041	347.5000	-99.9	M
83	2	8	39	83.10685	346.7000	0.1	+
83	2	15	46	83.12603	346.7000	-99.9	M
83	2	20	51	83.13973	352.4000	0.7	+
83	2	27	58	83.15890	346.4000	-99.9	M
83	3	2	61	83.16712	350.2000	-99.9	M
83	3	8	67	83.18356	350.8000	-99.9	M
83	3	13	72	83.19726	350.5000	0.8	+
83	3	19	78	83.21370	350.1000	0.2	+
83	3	30	89	83.24384	351.2000	-99.9	M
83	5	6	126	83.34521	346.3000	-99.9	M
83	5	10	130	83.35616	346.3000	7.5	S
83	5	15	135	83.36986	350.5000	-99.9	M
83	5	18	138	83.37808	350.4000	0.3	+
83	5	21	141	83.38630	349.6000	1.6	S
83	5	25	145	83.39726	348.1000	-99.9	M
83	5	29	149	83.40822	348.2000	0.0	+
83	7	2	183	83.50137	343.7000	-99.9	M
83	7	7	188	83.51507	346.1000	0.4	+
83	7	10	191	83.52329	343.7000	0.9	+
83	7	16	197	83.53973	343.5000	-99.9	M
83	7	19	200	83.54795	343.4000	0.2	+
83	7	23	204	83.55890	340.9000	-99.9	M
83	7	26	207	83.56712	342.3000	1.3	S
83	7	29	210	83.57534	337.4000	0.3	+
83	8	2	214	83.58630	337.4000	1.8	S
83	8	6	218	83.59726	337.0000	1.8	S
83	8	15	227	83.62192	335.0000	1.3	S
83	8	19	231	83.63288	336.5000	1.0	+
83	8	22	234	83.64110	338.7000	1.2	S
83	8	26	238	83.65205	333.7000	2.1	S
83	8	29	241	83.66027	331.2000	5.2	S
83	9	3	246	83.67397	333.0000	1.1	S
83	9	8	251	83.68767	336.2000	0.5	+
83	9	13	256	83.70137	336.4000	0.7	+
83	9	18	261	83.71507	334.8000	0.8	+
83	9	24	267	83.73151	337.4000	0.1	+
83	9	28	271	83.74247	337.5000	1.2	S
83	10	2	275	83.75342	337.0000	0.5	+
83	10	5	278	83.76164	337.8000	-99.9	M
83	10	11	284	83.77808	341.2000	1.1	S
83	10	13	286	83.78356	340.8000	2.2	S
83	10	16	289	83.79178	337.3000	2.5	S

Table 7. Sample listing of the data file containing the CO_2 concentrations from Bering Island

85	5	5	125	85.34247	352.0087	0.3	+
85	5	8	128	85.35068	352.1820	0.4	+
85	5	9	129	85.35342	351.9028	0.3	+
85	10	18	291	85.79726	343.9582	0.8	+
85	11	2	306	85.83836	350.1032	16.5	S
85	11	28	332	85.90959	349.7524	1.2	S
85	12	11	345	85.94521	350.3658	0.7	+
86	4	6	96	86.26301	344.6842	7.4	S
86	4	17	107	86.29315	343.3580	8.2	S
86	5	24	144	86.39452	350.0654	4.1	S
86	5	31	151	86.41370	352.3483	11.7	S
86	7	17	198	86.54247	336.9973	2.7	S
86	7	25	206	86.56438	336.8864	0.8	+
86	8	2	214	86.58630	338.5426	0.4	+
86	8	12	224	86.61370	334.2328	1.7	S
86	9	9	252	86.69041	344.4024	0.2	+
86	9	21	264	86.72329	344.3815	0.0	+
86	10	11	284	86.77808	347.0679	0.1	+
86	10	15	288	86.78904	348.3655	0.5	+
86	10	23	296	86.81096	346.0952	0.8	+
86	10	31	304	86.83288	351.5342	0.5	+
86	11	6	310	86.84932	350.5974	0.3	+
86	12	1	335	86.91781	353.5011	0.1	+
87	1	24	24	87.06575	351.7958	1.2	S
87	1	27	27	87.07397	351.9944	15.5	S
87	2	23	54	87.14795	352.4107	0.4	+
87	3	26	85	87.23288	353.6932	0.6	+
87	4	18	108	87.29589	354.3982	1.3	S
87	4	23	113	87.30959	356.5487	0.8	+
87	5	6	126	87.34521	357.4050	0.2	+
87	6	1	152	87.41644	354.6648	0.2	+
87	6	12	163	87.44658	351.2843	1.0	+
87	7	7	188	87.51507	343.0519	1.7	S
87	7	22	203	87.55616	341.4562	1.8	S
87	8	6	218	87.59726	335.8210	0.1	+
87	9	4	247	87.67671	337.7358	7.2	S
87	9	16	259	87.70959	340.8494	3.2	S
88	1	25	25	88.06849	357.1493	2.2	S
88	2	29	60	88.16438	356.3924	0.3	+
88	3	11	71	88.19452	356.1270	0.3	+
88	4	7	98	88.26849	353.3957	2.5	S
88	4	28	119	88.32603	357.1824	0.2	+
88	5	31	152	88.41644	357.2324	1.0	+
88	7	13	195	88.53425	347.4661	2.4	S
88	7	26	208	88.56986	342.6151	-99.9	M
88	7	30	212	88.58082	342.6045	0.9	+
88	8	7	220	88.60274	342.1474	0.6	+

Table 8. Sample listing of the data file containing the CO_2 concentrations from Kotelny Island

86	8	25	237	86.64932	340.5809	1.0	+
86	9	8	251	86.68767	340.1341	0.5	+
86	10	25	298	86.81644	348.4273	1.0	+
86	11	14	318	86.87123	353.2512	0.9	+
86	12	15	349	86.95616	353.2665	0.3	+
87	1	4	4	87.01096	354.0584	-99.9	M
87	1	18	18	87.04932	356.5290	-99.9	M
87	2	22	53	87.14521	355.9475	0.0	+
87	4	16	106	87.29041	355.8923	0.2	+
87	4	28	118	87.32329	355.9558	0.2	+
87	5	9	129	87.35342	357.3590	-99.9	M
87	5	20	140	87.38356	356.9074	0.4	+
87	6	2	153	87.41918	356.4849	1.5	S
87	6	14	165	87.45205	360.6186	-99.9	M
87	7	2	183	87.50137	351.9015	4.6	S
87	7	30	211	87.57808	343.0600	2.6	S
87	9	2	245	87.67123	341.5705	-99.9	M
87	9	19	262	87.71781	343.1580	-99.9	M
87	10	5	278	87.76164	342.4727	0.1	+
87	10	15	288	87.78904	347.2796	0.4	+
87	11	19	323	87.88493	349.4753	0.4	+
87	12	10	344	87.94247	353.6228	0.1	+
87	12	26	360	87.98630	352.9272	1.8	S
88	1	29	29	88.07945	356.4753	0.2	+
88	2	11	42	88.11507	357.3348	0.1	+
88	2	23	54	88.14795	356.3872	0.1	+
88	3	8	68	88.18630	358.8807	1.0	+
88	3	18	78	88.21370	358.4423	-99.9	M
88	4	13	104	88.28493	359.3121	1.0	+
88	4	26	117	88.32055	357.9312	0.1	+
88	5	15	136	88.37260	357.9970	0.4	+
88	6	1	153	88.41918	357.1308	0.1	+
88	6	23	175	88.47945	355.1498	0.4	+
88	7	7	189	88.51781	349.8244	1.9	S
88	7	14	196	88.53699	349.0429	0.2	+
88	7	25	207	88.56712	345.9922	0.9	+
88	8	3	216	88.59178	346.0629	0.3	+
88	8	10	223	88.61096	344.8497	0.5	+
88	8	26	239	88.65479	348.7240	1.7	S
88	9	2	246	88.67397	348.2234	0.9	+
88	9	9	253	88.69315	349.0632	10.8	S
88	9	16	260	88.71233	346.0192	0.4	+
88	9	24	268	88.73425	347.7463	2.0	S
88	10	4	278	88.76164	350.9937	0.7	+
88	10	29	303	88.83014	354.9047	1.1	S
88	11	7	312	88.85479	356.0161	0.2	+
88	12	21	356	88.97534	360.0302	0.4	+

15. VERIFICATION OF DATA TRANSPORT

The data files can be read using the FORTRAN or SAS input/output routines provided. Users should verify that the data have been correctly transported to their systems by generating some or all of the statistics presented in Tables 9–12. These statistics were generated in SAS (PROC MEANS) but can be duplicated in other statistical packages or languages. If the statistics generated by the user differ from those presented here, the data sets may have been corrupted in transport.

These statistics are presented only as a tool to ensure proper reading of the data sets. They are not to be construed as summarizing the atmospheric CO_2 concentration data files.

Table 9. Characteristics of numeric variables for the data file containing the CO_2 concentrations from Teriberka Station

Variable	Number of observations	Minimum value	Maximum value	Mean
SAMPYR	122	88.0000000	91.0000000	89.1721311
SAMPMO	122	1.0000000	12.0000000	6.5901639
SAMPDA	122	1.0000000	31.0000000	14.7704918
DAYYR	122	1.0000000	363.0000000	184.2213115
TIME	122	88.1917800	91.2082200	89.6768473
CONC	122	337.8961000	371.0215000	354.5012148
DIFF	122	-99.9000000	93.4000000	-12.1434426

Table 10. Characteristics of numeric variables for the data file containing the CO_2 concentrations from Ocean Station Charlie

Variable	Number of observations	Minimum value	Maximum value	Mean
SAMPYR	435	83.0000000	90.0000000	85.9862069
SAMPMO	435	1.0000000	12.0000000	6.6137931
SAMPDA	435	1.0000000	31.0000000	15.2827586
DAYYR	435	2.0000000	365.0000000	185.4850575
TIME	435	83.0054800	90.7808200	86.4943851
CONC	435	331.2000000	364.0700000	349.0945977
DIFF	435	-99.9000000	17.2000000	-27.0167816

Table 11. Characteristics of numeric variables for the data file containing the CO_2 concentrations from Bering Island

Variable	Number of observations	Minimum value	Maximum value	Mean
SAMPYR	125	85.0000000	91.0000000	88.4240000
SAMPMO	125	1.0000000	12.0000000	6.3280000
SAMPDA	125	1.0000000	31.0000000	16.6720000
DAYYR	125	12.0000000	361.0000000	177.9600000
TIME	125	85.3424700	91.2301400	88.9115617
CONC	125	334.2328000	364.3748000	352.4123184
DIFF	125	-99.9000000	16.5000000	-12.0072000

Table 12. Characteristics of numeric variables for the data file containing the CO_2 concentrations from Kotelny Island

Variable	Number of observations	Minimum value	Maximum value	Mean
SAMPYR	107	86.0000000	91.0000000	88.6168224
SAMPMO	107	1.0000000	12.0000000	6.4766355
SAMPDA	107	1.0000000	30.0000000	14.6168224
DAYYR	107	3.0000000	360.0000000	180.5514019
TIME	107	86.6493200	91.0684900	89.1114836
CONC	107	340.1341000	366.8332000	354.3405579
DIFF	107	-99.9000000	10.8000000	-15.0168224

The following is a listing of the SAS program used to generate the statistics described in the Tables 9–12.

```
DATA USSR;
INFILE IN;
INPUT SAMPYR 6-7 SAMPMO 9-10 SAMPDA 12-13 DAYYR 15-17 TIME 19-26
      CONC 28-35 DIFF 37-41 FLAG $ 45;
PROC MEANS DATA=USSR N MAX MIN MEAN;
RUN;
```

INTERNAL DISTRIBUTION

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2. M. P. Farrell
3. P. Kanciruk
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6-155. CDIAC
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