[Radiocarbon, Vol. 7, 1965, P. 331-335]

UPPSALA RADIOCARBON MEASUREMENTS VI

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The following list covers the samples measured since 1962 at the Uppsala C^{14} laboratory to determine the increase of the C^{14}/C^{12} ratio due to explosion of nuclear devices.

The technique used is the same as that previously described by Olsson (1958). The collection of CO_2 from the air was initiated by Münnich and Vogel, who also submitted the first apparatus for the collection, which still is in use at Abisko. It consists of a stainless steel tray (900 cm^2) with electrical heating, automatically controlled with a bimetal switch. It is shielded against rain etc. by a roof and perforated walls. The second apparatus, on Spitsbergen, is similar to that from Heidelberg but equipped with double walls well insulated from each other and with the heating wire between the walls. The wire occupies nearly the whole bottom and part of the walls, thus preventing freezing even at very low temperatures. The tray, with 0.5 N CO_2-free NaOH, is usually exposed to air during three days and nights. The reference sample is 95% of the activity of the NBS oxalic-acid standard. Correction for deviations from the normal C^{13}/C^{12} ratio are applied. All results are given according to the Editorial Statement in Radiocarbon, 1961:

$$\Delta = \delta C^{14} - (2\delta C^{13}+50)\left(1+\frac{\delta C^{14}}{1000}\right)$$

ACKNOWLEDGMENTS

Sincere thanks are due to Prof. Gustav Sandberg, Uppsala, and to Telegrafstyret, Oslo for giving us help and allowing us to collect samples at Abisko and on Kapp Linné, Spitsbergen, respectively. Special thanks are due to Mr. Staffan Holmgren, Reino Rova, Ragnar Wiedersheim-Paul, Georg Baas, Miss Margareta Redin, Mr. Lennart Johansson (Abisko); Radiobestyrer Arild Halvorsen, Svein Rökke, Kåre Henrikson and their collaborators on Spitsbergen, who have been responsible for the collection of CO_2; to Dr. R. Ryhage and his co-workers for making the C^{13}/C^{12} determinations; to Prof. K. Siegbahn, who has made it possible to do this work at the institute; and to Statens Naturvetenskapliga Forskningsråd, which has given the laboratory the financial support necessary for this project. The authors are indebted to Miss Birgitta Wallin and Miss Maud Söderman who have assisted in the routine work since springtime 1963.

A. Abisko, Sweden

Abisko Naturvetenskapliga Station is a scientific research station belonging to Kungliga Vetenskapsakademien. The sampling apparatus (68° 20.5′ N Lat, 18° 49.3′ E Long) is situated 390 m above sealevel near the lake Torne Träsk in the mountain district of Sweden. The railway passing near is used by electrical trains (except an engine used at the railway station). The few houses and the tourist station 0.2 to 1.5 km away are heated either with oil or wood.

Due to the absence of a road connection only a few motor vehicles are used. Thus contamination of the locality by fossil fuels is minimal.

Dating no.	No.,	Year,	month,	day	$\delta C^{14}‰$	$\delta C^{13}‰$	$\Delta‰$
U-209.	UA-1,	1960,	May,	25 to 28.	252	–23.6	249 ± 9
U-301.	UA-63,	1962,	March,	15 to 18.	278	–26.0	281 ± 9
U-302.	UA-66,	1962,	April,	15 to 18.	330	–21.9	322 ± 9
U-306.	UA-68,	1962,	May,	5 to 8.	304	–25.4	305 ± 11
U-307.	UA-73,	1962,	July,	15 to 18.	382	–25.2	383 ± 10
U-310.	UA-77,	1962,	Aug,	15 to 18.	429	–23.2	423 ± 10
U-313.	UA-75,	1962,	Aug,	5 to 8.	418	–24.1	415 ± 10
U-315.	UA-80,	1962,	Sept,	15 to 18.	426	–24.2	423 ± 10
U-320.	UA-83,	1962,	Nov,	15 to 18.	397	–27.3	403 ± 10
U-321.	UA-86,	1962,	Dec,	15 to 18.	399	–22 8	393 ± 10
U-323.	UA-65,	1962,	April,	5 to 8.	305	–23.7	301 ± 9
U-324.	UA-88,	1963,	Jan,	15 to 18.	388	–29.5	400 ± 10
U-325.	UA-71,	1962,	June,	25 to 28.	404	–23.4	399 ± 10
U-326.	UA-93,	1963,	March,	15 to 18.	456	–25.8	458 ± 10
U-327.	UA-97,	1963,	May,	5 to 8.	626	–25.5	628 ± 12
U-328.	UA-100,	1963,	June,	17 to 20.	749	–25.2	750 ± 12
U-329.	UA-103,	1963,	July,	15 to 18.	876	–22.5	867 ± 13
U-332.	UA-98,	1963,	May,	15 to 18.	622	–25.5	623 ± 12
U-333.	UA-94,	1963,	March,	25 to 29.	498	–25.5	500 ± 11
U-334.	UA-91,	1963,	Feb,	15 to 18.	422	–24.4	420 ± 10
U-335.	UA-108,	1963,	Sept,	15 to 18.	993	–25.0	993 ± 13
U-336.	UA-106,	1963,	Aug,	15 to 18.	1012	–23.2	1005 ± 13
U-341.	UA-84,	1962,	Nov,	25 to 28.	405	–26.4	409 ± 11
U-342.	UA-111,	1963,	Nov,	5 to 8.	896	–25.9	900 ± 12
U-343.	UA-107,	1963,	Sept,	5 to 8.	961	–25.1	962 ± 15
U-344.	UA-115,	1963,	Dec,	15 to 18.	844	–26.0	848 ± 13
U-345.	UA-109,	1963,	Nov,	25 to 28.	889	–28.6	902 ± 14
U-346.	UA-126,	1964,	April,	5 to 8.	821	–25.2	822 ± 14
U-1304.	UA-112,	1963,	Nov,	15 to 18.	887	–24.9	886 ± 10
U-1305.	UA-118,	1963,	Jan,	15 to 18.	761	–25.5	763 ± 10
U-1306.	UA-122,	1964,	Feb,	15 to 18.	798	–25.8	801 ± 10

B. Kapp Linné, Spitsbergen

Kapp Linné is a radiostation and meteorologic station belonging to Telegrafstyret, Oslo, Norway. The sampling apparatus (78° 04′ N Lat, 13° 38′ E Long) is situated only a few meters above sealevel near the shore at the mouth of Isfjorden. The apparatus is placed on top of a small house rather far from the generators and their smoke.

Dating no.	No.,	Year,	month,	day	$\delta C^{14}‰$	$\delta C^{13}‰$	$\Delta‰$
U-303.	US-8,	1961,	Nov,	4 to 7.	235	–20.1	223 ± 9
U-304.	US-1,	1961,	Sept,	15 to 18.	247	–22.7	242 ± 10
U-305.	US-5,	1961,	Oct,	15 to 18.	240	–23.8*	(237 ± 11)
U-308.	US-14,	1962,	May,	15 to 18.	316	–24.8	315 ± 10
U-309.	US-13,	1962,	April,	15 to 18.	292	–26.6	296 ± 10
U-311.	US-9,	1961,	Dec,	15 to 18.	265	–23.6	262 ± 10
U-312.	US-12,	1962,	March,	15 to 18.	282	–19.8	268 ± 10
U-314.	US-11,	1962,	Feb,	16 to 19.	259	–26.1	262 ± 9
U-316.	US-15,	1962,	July,	15 to 18.	397	–22.8	391 ± 10
U-317.	US-16,	1962,	Aug,	14 to 18.	437	–24.0	434 ± 10
U-318.	US-17,	1962,	Sept,	15 to 18.	424	–23.7	420 ± 10
U-319.	US-18,	1962,	Oct,	15 to 21.	420	–23.2	414 ± 10
U-322.	US-10,	1962,	Jan,	15 to 18.	240	–25.6	242 ± 9
U-330.	US-25,	1963,	June,	11 to 14.	654	–23.0	648 ± 11

U-331.	US-24,	1963,	May,	15 to 18.	565	–26.3	569 ± 11
U-337.	US-21,	1963,	Jan,	15 to 18.	399	–24.9	399 ± 10
U-338.	US-29,	1963,	Sept,	16 to 20.	1001	–24.8	1001 ± 9
U-339.	US-28,	1963,	Aug,	15 to 18.	994	–21.9	981 ± 13
U-340.	US-27,	1963,	July,	15 to 18.	808	–23.1	801 ± 12
U-347.	US-32,	1964,	Feb,	15 to 18.	733	–28.8	747 ± 17
U-348.	US-30,	1963,	Dec,	16 to 19.	826	–31.2	849 ± 13
U-349.	US-33.	1964,	March,	15 to 18.	764	–31.2	786 ± 15
U-350.	US-34,	1964,	April,	15 to 18.	802	–26.8	809 ± 14
U-1301.	US-19,	1962,	Nov,	18 to 21.	393	–24.5	392 ± 6
U-1302.	US-22,	1963,	March,	16 to 19.	447	–25.8	449 ± 7
U-1303.	US-23,	1963,	April,	15 to 18.	479	–26.9	483 ± 12

* δC^{13} assumed

General Comment: from Figure 1 it is quite obvious that the increase in activity has been about 1/2 to 1 month later in Spitsbergen than Abisko during the

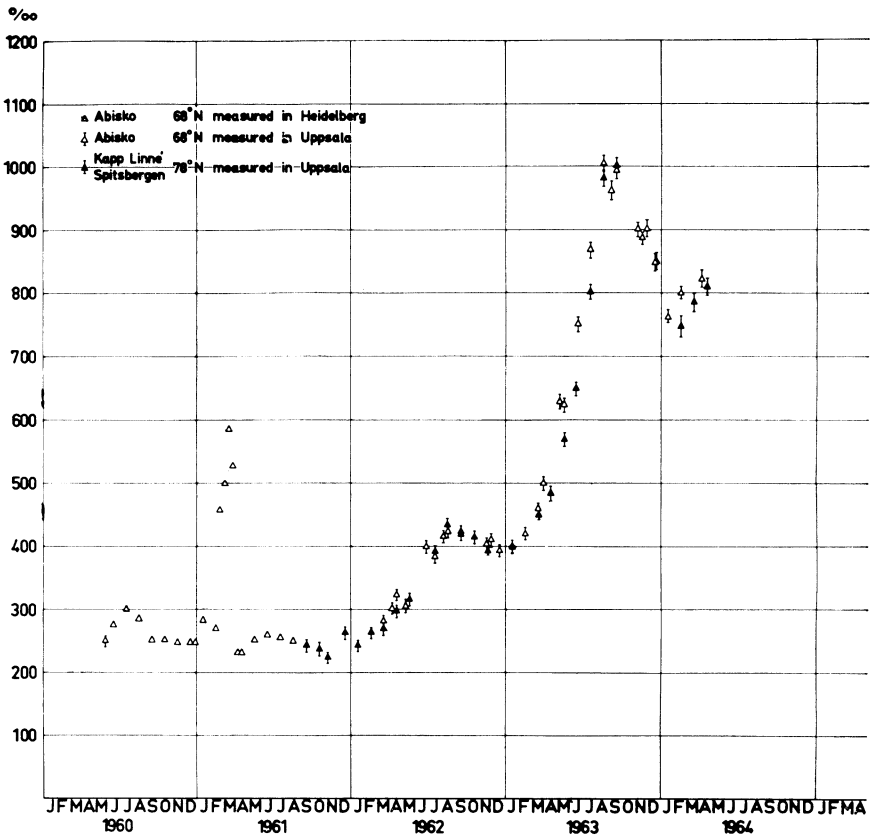

Fig. 1. The per mil C^{14} excess over natural concentration (Δ) at Abisko and Kapp Linné. Points given with statistical errors are determined at the Uppsala C^{14} lab. Points given without statistical errors are determined at the Heidelberg C^{14} lab. (Münnich and Vogel, 1963) but collected through the Uppsala lab.

years 1962, 1963 and 1964. In comparison with the results from Heidelberg (Münnich and Vogel, 1963) the values are somewhat lower in Abisko than in Central Europe during the spring 1962 although the values from 1961 and 1960 are higher in Sweden than in Central Europe. Some previous data from the Uppsala lab. are summarized in Olsson (1962). Measurements from other laboratories have been published by Rafter and Fergusson (1957), de Vries (1958), Münnich and Vogel (1958, 1963), Bien and Suess (1959), Broecker and Walton (1959), Broecker and others (1959), Broecker and Olson (1960, 1961), Hagemann and others (1959), Tauber (1960, 1961, 1962), Willis (1960), Godwin and Willis (1961, 1964), Vinogradov and others (1961), Fergusson (1963), Stuiver and Deevey (1962), Nydal (1963), Östlund and Engstrand (1963), Kigoshi (1964), and Münnich, Vogel, Broecker and Olsson (in preparation). The present measurements support the idea given by Hagemann and others (1959), that the mixing between the stratosphere and the troposphere may occur at different latitudes (and altitudes) from year to year, even though previous data on samples collected through the Uppsala lab. but measured at Heidelberg imply that the mixing occurs far in the north (Münnich and Vogel, 1963).

It could also be noted that the Abisko peak in March 1961, which has been questioned, is coincident in time with statistically less certain increases given by Godwin and Willis (1964) and by Östlund and Engstrand (1963); and also that the March value from Vermunt, Austria, is higher than the values from February and April. The possibility of contamination of the NaOH can not be excluded, however, since the solution used in March was prepared in February 1961 and the work with radioactive $BaCO_3$ for the half-life measurement was started Oct. 12, 1960.

References

Bien, G. S., and Suess, H. E., 1959, Increase of C^{14} in the atmosphere from artificial sources measured in a California tree: Z. Physik, v. 154, p. 172-174.

Broecker, W. S., and Walton, Alan, 1959, Radiocarbon from nuclear tests: Science, v. 130, p. 309-314.

Broecker, W. S., Schulert, Arthur, and Olson, E. A., 1959, Bomb carbon-14 in human beings: Science, v. 130, p. 331-332.

Broecker, W. S., and Olson, E. A., 1960, Radiocarbon from nuclear tests, II: Science, v. 132, p. 712-721.

———— 1961, Lamont radiocarbon measurements VIII: Radiocarbon, v. 3, p. 176-204.

Fergusson, G. J., 1963, Upper tropospheric carbon 14 levels during spring 1962: Jour. Geophys. Res., v. 68, p. 3933-3941.

Godwin, H., and Willis, E. H., 1961, Cambridge University natural radiocarbon measurements IV. Nuclear-weapon testing and the atmospheric radiocarbon concentration: Radiocarbon, v. 3, p. 77-80.

———— 1964, Cambridge University natural radiocarbon measurements VI: Radiocarbon, v. 6, p. 116-137.

Hagemann, French, Gray, James, Jr., Machta, Lester, and Turkevich, Anthony, 1959, Stratospheric carbon-14, carbon dioxide, and tritium: Science, v. 130, p. 542-552.

Kigoshi, Kunihiko, 1964, Recent variation of atmospheric contents of C-14 in Tokyo and transfer problem of atmospheric carbon dioxide: Jour. Rad. Res., v. 5, no. 2, p. 1-7.

Münnich, K. O., and Vogel, J. C., 1958, Durch Atomexplosionen erzeugter Radiokohlenstoff in der Atmosphäre: Naturwiss., v. 45, p. 327-329.

———— 1963, Investigation of meridional transport in the troposphere by means of carbon-14 measurements: Radioactive dating, I.A.E.A., Vienna 1963, p. 189-197.

Nydal, Reidar, 1963, Increase in radiocarbon from the most recent series of thermonuclear tests: Nature, v. 200, no. 4903, p. 212-214.

Olsson, I. U., 1958, A C^{14} dating station using the CO_2 proportional counting method: Arkiv för Fysik, v. 13, p. 37-60.

———— 1962, A study of some problems connected with C^{14} dating: Acta Universitatis Upsaliensis, Abstracts of Uppsala Dissertations in Science, v. 14, p. 1-6.

Östlund, H. G., and Engstrand, L. G., 1963, Stockholm natural radiocarbon measurements V: Radiocarbon, v. 5, p. 203-227.

Rafter, T. A., and Fergusson, G. J., 1957, The atom bomb effect: N.Z.J. Science and Technology, sec. B, v. 38, no. 8, p. 871-883.

Stuiver, Minze, and Deevey, E. A., 1962, Yale natural radiocarbon measurements VII: Radiocarbon, v. 4, p. 250-262.

Tauber, Henrik, 1960, Post-bomb rise in radiocarbon activity in Denmark: Science, v. 131, p. 921-922.

———— 1961, Latitudinal effect in the transfer of radiocarbon from stratosphere to troposphere: Science, v. 133, p. 461-462.

———— 1962, Latitudinal effect in the transport of radiocarbon from stratosphere to troposphere: Radioisotopes in the physical sciences and industry, I.A.E.A., Vienna 1962, p. 67-74.

Vinogradov, A. P., Devirts, A. L., and Dobkina, E. I., 1961: Dokladi Akademi naok SSSR, v. 137, p. 688-691.

de Vries, Hessel, 1958, Atomic bomb effect: Variation of radiocarbon in plants, shells and snails in the past 4 years: Science, v. 128, p. 250-251.

Willis, Eric, 1960, Atmospheric radiocarbon activity in 1959: Nature, v. 185, no. 4712, p. 552-553.