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COPENHAGEN RADIOCARBON MEASUREMENTS VIII GEOGRAPHIC VARIATIONS IN ATMOSPHERIC C^{14} ACTIVITY

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The following list covers measurements of bomb-produced C^{14} in series of cereals and grasses collected on the northern hemisphere from 1956 through 1966. Samples were measured in order to determine the yearly addition of bomb produced C^{14} at a single locality, and to detect possible geographic variations in the distribution and uptake of bomb-generated C^{14} in terrestrial plant material during years with greatly varying additions of bomb C^{14}. Measurements are given in the Δ scale (Lamont VIII), i.e. per mil deviations from 0.95 times the activity of the NBS oxalic-acid standard (the natural C^{14} level).

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SAMPLE DESCRIPTIONS

A. Post-bomb rise in C^{14} activity in Denmark

Danish cereals 1956 to 1966

Samples of cereals which grew in locations ca. 10 mi N of Copenhagen (55° 50′ N Lat; 12° 30′ E Long), Denmark, in area with rather little industry. Collected on dates close to June 1 or July 1; in latter case only new ears of cereals were assayed. Results from July 1 each year are plotted in Fig. 1. *Comment:* measurements on samples from 1956 through 1959 have previously been reported in ΔC^{14} scale (Tauber, 1960). Rise in C^{14} activity is similar to that reported from other stations in middle latitudes (Lamont VIII; Cambridge IV, VI; Saskatchewan III, IV; Yale VII; Münnich and Vogel, 1963; Nydal, 1963; Stockholm V; Uppsala II, VI; UCLA IV, V; Monaco II). In 1958 and 1959 a latitudinal effect in the rise of C^{14} was suggested (Tauber, 1961). This effect has not been borne out clearly in subsequent years in these latitudes, and the amplitude and extent of such an effect may depend on meteorological factors that vary from year to year. At European longitudes the polar front, thus, had an extreme northern position during the whole summer of 1959, while it oscillated over a much wider latitudinal range in the following years.

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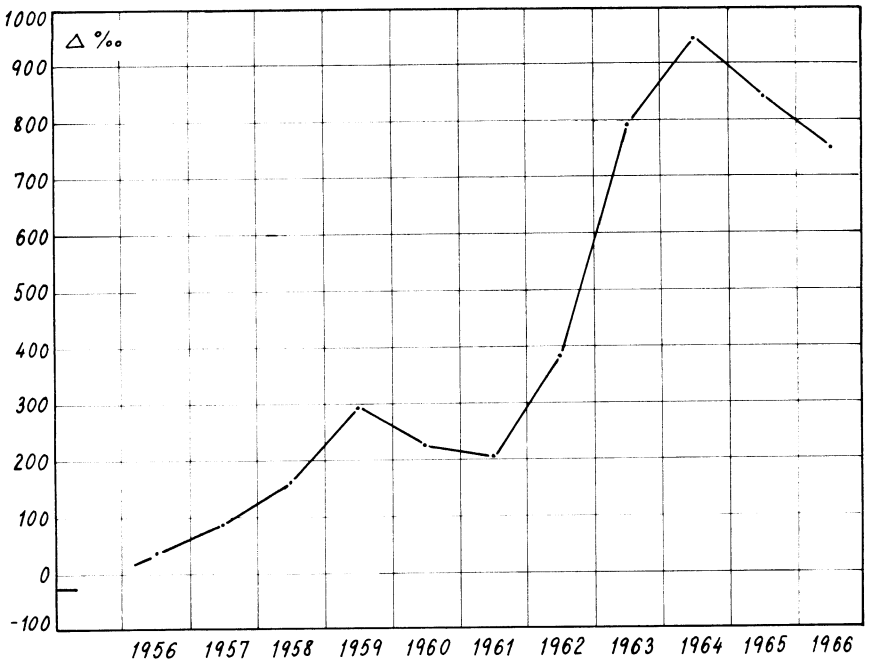

Fig. 1. Per mil C^{14} excess over natural C^{14} level (Δ) in Danish cereals (55° 50′ N Lat; 12° 30′ E Long) on July 1 each year from 1956 through 1966. The activity on July 1 is not the absolute peak value of that year.

	δC^{14}‰	δC^{13}‰	Δ‰
K-612. Frederiksdal 1956	**35 ± 8**	**–26.2**	**37 ± 8**
Ears of barley, coll. July 1, 1956.			
K-611. Sorgenfri 1957	**82 ± 7**	**–26.5**	**85 ± 7**
Ears of barley, coll. July 1, 1957.			
K-613. Virum 1958	**165 ± 7**	**–24.5**	**164 ± 7**
Grains of wheat, exact date of collection not known.			
K-610. Frederiksdal 1959	**292 ± 7**	**–25.5**	**293 ± 7**
Ears of rye, coll. July 1, 1959.			
K-615. Vedbaek 1959	**293 ± 9**	**–26.1**	**295 ± 9**
Ears of rye, coll. July 1, 1959.			
K-641. Naerum 1960	**222 ± 8**	**–25.2**	**223 ± 8**
Ears of oats, coll. July 2, 1960.			
K-643. Virum 1960	**233 ± 8**	**(–26)**	**235 ± 10**
Ears of barley, coll. July 2, 1960.			

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	δC^{14}‰	δC^{13}‰	Δ‰
K-642. Naerum 1961	**205 ± 8**	**−27.9**	**212 ± 8**
Ears of oats, coll. July 1, 1961.			
K-644. Naerum 1961	**197 ± 8**	**(−26)**	**199 ± 10**
Ears of barley, coll. July 1, 1961.			
K-645. Naerum 1962	**336 ± 8**	**−27.7**	**343 ± 8**
Green parts of oats, coll. June 5, 1962.			
K-646. Naerum 1962	**377 ± 8**	**−27.9**	**385 ± 8**
Ears of barley, coll. July 1, 1962.			
K-660. Naerum 1963	**666 ± 9**	**(−26)**	**669 ± 11**
Green parts of barley, coll. June 1, 1963.			
K-661. Naerum 1963	**790 ± 9**	**−26.2**	**794 ± 9**
Ears of barley, coll. July 1, 1963.			
K-668. Naerum 1964	**882 ± 9**	**(−26)**	**886 ± 11**
Green parts of barley, coll. June 1, 1964.			
K-667. Naerum 1964	**938 ± 8**	**−26.9**	**945 ± 8**
Ears of oats, coll. July 1, 1964.			
K-692. Naerum 1965	**794 ± 9**	**(−26)**	**798 ± 11**
Green parts of barley, coll. June 1, 1965.			
K-693. Naerum 1965	**840 ± 9**	**(−26)**	**844 ± 11**
Ears of barley, coll. July 1, 1965.			
K-694. Naerum 1966	**722 ± 9**	**(−26)**	**725 ± 11**
Green parts of barley, coll. June 1, 1966.			
K-695. Naerum 1966	**748 ± 9**	**(−26)**	**752 ± 11**
Ears of barley, coll. June 28, 1966.			

B. Grass samples 1960

Grass samples from 40°N to 80°N

Samples of green parts of grasses and cereals collected between July 2 and Aug. 1, 1960, on both sides of Atlantic Ocean in latitudes from 40°N to 80°N. Samples in this and next series were collected in order to trace a possible geographic variation in atmospheric C^{14} concentration in Northern Hemisphere in a year with a minimal addition of bomb-generated C^{14} (see Fig. 1). *Comment:* atmospheric C^{14} concentrations proved to be remarkably uniform within these latitudes in 1960. Average value for all samples in this series is $\Delta = 247$‰.

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	δC^{14}‰	δC^{13}‰	Δ‰
K-648. Svalbard 78°N	**234 ± 6**	**–30.5**	**248 ± 6**

Grass from Cape Linné (78° 04′ N Lat, 13° 38′ E Long), Svalbard. Coll. July 23, 1960.

K-649. Finnmarken 70°N	**250 ± 8**	**(–25)**	**250 ± 10**

Grass from Nesseby (70° 09′ N Lat, 28° 55′ E Long), Finnmarken, Norway. Coll. July 4, 1960.

K-650. Trondheim 63°N	**241 ± 8**	**(–25)**	**241 ± 10**

Ears of wheat from N of Trondheim (63° 24′ N Lat, 10° 22′ E Long), Norwey. Coll. July 6, 1960.

K-651. Naerum 56°N	**237 ± 6**	**–25.6**	**238 ± 6**

Grass from Naerum (55° 50′ N Lat, 12° 30′ E Long), Denmark. Coll. July 22, 1960.

K-652. Bern 47°N	**252 ± 8**	**(–25)**	**252 ± 10**

Ears of wheat from Grauholz (46° 56′ N Lat, 7° 26′ E Long), Bern, Switzerland. Coll. July 16, 1960.

K-653. Abruzzi 42°N	**250 ± 8**	**(–25)**	**250 ± 10**

Ears of wheat from 1040 m above sealevel at Castel di Sangro (41° 48′ N Lat, 14° 02′ E Long), Abruzzi, Italy. Coll. July 7, 1960.

K-657. Thule 77°N	**250 ± 8**	**–25.8**	**252 ± 8**

Grass from 10 km E of Thule Air Base (76° 32′ N Lat, 68° 40′ W Long), West Greenland. Coll. Aug. 1, 1960.

K-658. Itivnera 64°N	**235 ± 9**	**–26.9**	**240 ± 9**

Grass from Itivnera (64° 23′ N Lat, 50° 23′ W Long), West Greenland. Coll. July 2, 1960.

K-659. Churchill 59°N	**241 ± 9**	**–29.1**	**251 ± 9**

Grass from Churchill (58° 40′ N Lat, 94° 10′ W Long), Manitoba, Canada. Coll. July 18, 1960.

Grass samples from 0° to 40°N

Samples of green parts of grasses, and a sample of banana leaves, collected between July 3 and Aug. 17, 1960, in latitudes from 0° to 40°N, for comparison with samples from more northern latitudes. *Comment:* atmospheric C^{14} concentrations scattered considerably more in these latitudes than between 40°N and 80°N. Activities appear to some extent to be lower in locations with a dominance of winds from S, and higher in locations with wind components from N. Average value for all samples in series is $\Delta = 219$‰. This is significantly lower than for previous series. Decrease may partly have been caused by advection of air from South-

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ern Hemisphere; a latitudinal effect in transfer of bomb-produced C^{14} from middle latitudes could therefore only be small in 1960. The δC^{13} values, except for one sample (K-675), are all outside normal range of terrestrial plant material (−20 to −30‰). These anomalous values might have been caused by a recycling of CO_2 between ocean and atmosphere at these latitudes, or by a release of CO_2 from soil carbonates. However, in that case the δC^{14} values should have been more suppressed, since only a small fraction of bomb-produced C^{14} had entered into ocean surface water in 1960 (Broecker and Olson, 1960), or could have been included in soil carbonates. The unusual isotopic fractionation is rather due to changes in ratio of assimilation of carbon to respiration in the plants, caused by the extreme microclimatic conditions that prevail directly above the soil in warm and dry areas. The only sample in this series that has normal $C^{13}/^{12}$ ratio, thus, is banana leaves, which will not have been exposed to these microclimatic extremes. A temperature dependence of the C^{13}/C^{12} ratios in marine plankton has previously been noted by Sackett *et al.* (1965).

	δC^{14}‰	δC^{13}‰	Δ‰
K-654. Kaduna 11°N	**255 ± 8**	**−13.7**	**225 ± 8**

Grass from Kaduna (10° 34′ N Lat, 7° 22′ E Long), Nigeria. Coll. July 14, 1960.

K-655. Enugu 6°N	**242 ± 8**	**−11.4**	**207 ± 8**

Grass from Enugu (6° 28′ N Lat, 7° 24′ E Long), Nigeria. Coll. July 23, 1960.

K-684. Nora-Pula 39°N	**232 ± 9**	**−15.0**	**207 ± 8**

Grass from Nora-Pula (39° 01′ N Lat, 9° 01′ E Long), Sardinia, Italy. Coll. July 24, 1960.

K-656. Wad Medani 14°N	**251 ± 8**	**−13.0**	**221 ± 8**

Grass from Wad Medani (14° 24′ N Lat, 33° 30′ E Long), Sudan. Coll. July 8, 1960.

K-677. Karachi 25°N	**220 ± 8**	**−13.9**	**193 ± 8**

Grass from Zoological Garden in Karachi (24° 50′ N Lat, 67° 13′ E Long), Pakistan. Coll. Aug. 17, 1960.

K-678. Chinsura 23°N	**235 ± 8**	**−19.1**	**220 ± 8**

Grass from Chinsura (22° 55′ N Lat, 88° 24′ E Long), 40 km N of Calcutta, India. Coll. July 10, 1960.

K-679. Ilan Hsien 25°N	**260 ± 9**	**−11.4**	**226 ± 9**

Maize from coastal field at Ilan Hsien outside of Taipei (25° 02′ N Lat, 121° 26′ E Long), Taiwan. Coll. July 14, 1960.

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	δC^{14}‰	δC^{13}‰	Δ‰
K-680. Seoul 38°N	**258 ± 9**	**−13.9**	**230 ± 9**

Grass taken outside of Seoul (37° 36′ N Lat, 127° 02′ E Long), Korea. Coll. Aug. 1, 1960.

K-681. Honolulu 21°N	**270 ± 8**	**−11.3**	**236 ± 8**

Grass taken 500 m above sealevel at Forest Ridge Way outside of Honolulu (21° 20′ N Lat, 157° 51′ W Long), Hawaii. Coll. July 24, 1960.

K-682. Mexico City 19°N	**236 ± 9**	**−14.4**	**210 ± 9**

Grass taken outside of Mexico City (19° 25′ N Lat, 99° 07′ W Long), Mexico. Coll. Aug. 2, 1960.

K-683. Coral Gables 26°N	**234 ± 9**	**−11.4**	**200 ± 9**

Grass from Coral Gables (25° 44′ N Lat, 80° 16′ W Long), Florida, U.S.A. Coll. July 3, 1960.

K-676. Panama 9°N	**245 ± 9**	**−17.1**	**225 ± 9**

Grass taken at Pacific side of Canal Zone (9° 0′ N Lat, 79° 25′ W Long), Panama. Coll. July 15, 1960.

K-675. Las Palmas 28°N	**242 ± 8**	**−24.6**	**241 ± 8**

Banana leaves from plantation outside of Las Palmas (28° 07′ N Lat, 15° 32′ W Long), Gran Canaria, Canary Islands. Coll. July 22, 1960.

C. Grass samples 1961

European series 37°N to 70°N

Samples of green parts of grasses collected from June 1 through June 13, 1961, on every second degree of latitude between 37°N and 70°N. Samples are assumed to reflect the average C^{14} activity of the ground level troposphere a few weeks prior to sampling. Series approximates a synchronous profile through Europe in a year with a minimal addition of bomb-produced C^{14}. Samples were taken away from areas with heavy industry, away from main roads, and outside towns and villages; they are named after nearest locality. *Comment:* apart from a small local Suess effect over Central Europe (44°N to 54°N), C^{14} activities scatter within statistics. Geographic variations within this sector thus were less than 1‰ in 1961. Series of grass samples from 1960 and 1961 suggest that geographic variations in atmospheric C^{14} in the pre-bomb state were also below 1‰.

	δC^{14}‰	δC^{13}‰	Δ‰
K-621. Tromsø 70°N	**193 ± 6**	**−29.0**	**203 ± 6**

Grass taken 2 km S of Tromsø (69° 38′ N Lat, 19° 0′ E Long), Norway. Coll. June 8, 1961.

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	δC^{14}‰	δC^{13}‰	Δ‰
K-622. Innhavet 68°N	**203 ± 6**	**−27.5**	**209 ± 6**

Grass from Innhavet (68° 0′ N Lat, 16° 01′ E Long), Norway. Coll. June 7, 1961.

K-623. Mosjöen 66°N	**202 ± 6**	**−26.9**	**207 ± 6**

Grass taken 20 km N of Mosjöen (66° 0′ N Lat, 13° 29′ E Long), Norway. Coll. June 6, 1961.

K-624. Steinkjer 64°N	**198 ± 8**	**(−27)**	**203 ± 10**

Grass taken outside of Steinkjer (64° 0′ N Lat, 11° 30′ E Long), Norway. Coll. June 5, 1961.

K-625. Dovre 62°N	**194 ± 8**	**(−27)**	**199 ± 10**

Grass from Dovre (62° 0′ N Lat, 9° 15′ E Long), Norway. Coll. June 5, 1961.

K-626. Lilleström 60°N	**192 ± 8**	**(−27)**	**197 ± 10**

Grass from Lilleström (60° 0′ N Lat, 11° 02′ E Long), Norway. Coll. June 4, 1961.

K-627. Jörlanda 58°N	**209 ± 6**	**−28.0**	**216 ± 8**

Grass from Jörlanda (58° 0′ Lat, 11° 50′ E Long), Sweden. Coll. June 3, 1961.

K-628. Kagerup 56°N	**205 ± 6**	**−28.0**	**212 ± 8**

Grass from Kagerup (56° 0′ N Lat, 12° 17′ E Long), Denmark. Coll. June 1, 1961.

K-629. Pansdorf 54°N	**180 ± 8**	**−26.9**	**185 ± 8**

Grass from Pansdorf (54° 0′ N Lat, 10° 43′ E Long), Germany. Coll. June 3, 1961.

K-630. Bad Salzgitter 52°N	**188 ± 8**	**(−27)**	**193 ± 10**

Grass taken 5 km SW of Bad Salzgitter (52° 0′ N Lat, 10° 14′ E Long), Germany. Coll. June 4, 1961.

K-631. Karlstadt 50°N	**197 ± 8**	**(−27)**	**202 ± 10**

Grass taken 6 km NE of Karlstadt (50° 0′ N Lat, 9° 50′ E Long), Germany. Coll. June 5, 1961.

K-632. Starnberg 48°N	**189 ± 8**	**(−27)**	**194 ± 10**

Grass from Starnberg (48° 0′ N Lat, 11° 21′ E Long), Germany. Coll. June 6, 1961.

K-633. Primolano 46°N	**192 ± 8**	**−28.4**	**200 ± 8**

Grass taken 5 km NW of Primolano (46° 0′ N Lat, 11° 52′ E Long), Italy. Coll. June 7, 1961.

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	δC^{14}‰	δC^{13}‰	Δ‰
K-634. Riccione 44°N	**190 ± 6**	**–26.8**	**199 ± 6**

Grass from Riccione (44° 0′ N Lat, 12° 38′ E Long), Italy. Coll. June 10.

K-635. S. Salvo 42°N	**231 ± 6**	**–17.0**	**212 ± 6**

Grass taken 7 km SE of S. Salvo (42° 0′ N Lat, 14° 46′ E Long), Italy. Coll. June 10, 1961.

K-636. Sapri 40°N	**219 ± 6**	**–25.7**	**221 ± 6**

Grass taken 12 km SE of Sapri (40° 0′ N Lat; 15° 42′ E Long), Italy. Coll. June 11, 1961.

K-637. Ali Marina 38°N	**200 ± 6**	**–26.7**	**204 ± 6**

Grass from Ali Marina (38° 0′ N Lat, 15° 22′ E Long), Sicily, Italy. Coll. June 12, 1961.

K-638. Pachino 37°N	**233 ± 6**	**–13.2**	**204 ± 6**

Leaves of maize taken 3 km S of Pachino (36° 42′ N Lat, 15° 09′ E Long), Sicily, Italy. Coll. June 13, 1961.

D. Grass samples 1963

Scandinavian series June 1963

Samples of green parts of grasses collected from June 12 through June 17, 1963, on every second degree of latitude between 56°N and 70°N, in Scandinavia. Collected in order to detect possible geographic variations in atmospheric C^{14} activity in a year with a maximum addition of bomb-produced C^{14} (see Fig. 1.). Samples were taken with same precautions as in 1961 series. *Comment:* C^{14} activities scattered only slightly more than a normal statistical distribution. Even with an extreme addition of bomb-generated C^{14} a latitudinal effect has thus not been ascertained in this section (compare however Greenlandic series from 1963). Average activity of all samples in series is $\Delta = 699‰$ (compare K-660 and K-661, taken June 1 and July 1, 1963, respectively, in series of Danish cereals 1956 to 1966).

	δC^{14}‰	δC^{13}‰	Δ‰
K-671. Tromsø 70°N	**663 ± 6**	**–30.9**	**683 ± 6**

Grass taken 2 km S of Tromsø (69° 38′ N Lat, 19° 0′ E Long), Norway. Coll. June 17, 1963.

K-670. Innhavet 68°N	**681 ± 6**	**–29.2**	**695 ± 6**

Grass from Innhavet (68° 0′ N Lat, 16° 01′ E Long), Norway. Coll. June 16, 1963.

K-669. Mosjöen 66°N	**686 ± 8**	**–28.7**	**698 ± 8**

Grass taken 20 km N of Mosjöen (66° 0′ N Lat, 13° 29′ E Long), Norway. Coll. June 15, 1963.

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	δC^{14}‰	δC^{13}‰	Δ‰
K-666. Steinkjer 64°N	**684 ± 8**	**–27.5**	**692 ± 8**

Grass taken outside of Steinkjer (64° 0′ N Lat, 11° 30′ E Long), Norway. Coll. June 15, 1963.

K-665. Dovre 62°N	**704 ±8**	**–27.5**	**713 ± 8**

Grass from Dovre (62° 0′ N Lat, 9° 15′ E Long), Norway. Coll. June 14, 1963.

K-664. Lilleström 60°N	**711 ±8**	**–28.7**	**724 ± 8**

Grass from Lilleström (60° 0′ N Lat, 11° 02′ E Long), Norway. Coll. June 13, 1963.

K-663. Jörlanda 58°N	**683 ± 8**	**–28.8**	**696 ± 8**

Grass from Jörlanda (58° 0′ N Lat, 11° 50′ E Long), Sweden. Coll. June 12, 1963.

K-662. Kvistgaard 56°N	**685 ± 8**	**–26.7**	**691 ± 8**

Grass from Kvistgaard (56° 0′ N Lat, 12° 30′ E Long), Denmark. Coll. June 12, 1963.

Greenlandic series June 1963

Samples of green parts of grasses collected on June 21 and June 26, 1963, at latitudes of 64°N and 82°N in Greenland. Collected for comparison with Scandinavian series from same month. *Comment:* C^{14} activities were considerably lower than in Scandinavian series, although samples were taken later in month. Simultaneously there was marked decrease in activity from 64°N to 82°N in Greenland. Compared to Scandinavian series a geographic variation in C^{14} activity exceeding 14% of natural C^{14} level was present in high latitudes of Northern Hemisphere in 1963. Activities of K-686 and K-687 are far below activity at Copenhagen on June 1 (K-660). Delay thus is more than 1 month. Similar delay between northern Sweden and Svalbard in 1963 has previously been reported (Uppsala VI).

	δC^{14}‰	δC^{13}‰	Δ‰
K-686. Brønlund Fjord 82°N	**555 ± 6**	**–26.5**	**560 ± 6**

Grass from Jørgen Brønlund Fjord (82° 10′ N Lat, 30° 30′ W Long), Peary Land, North Greenland. Coll. June 26, 1963.

K-687. Kapisigdlit 64°N	**605 ± 6**	**–28.9**	**618 ± 6**

Grass taken at mouth of river Kapisigdlit (64° 26′ N Lat, 50° 12′ W Long), West Greenland. Coll. June 21, 1963.

Greenlandic series July 1963

Samples of green parts of grasses collected between July 5 and July 10, 1963, at latitudes from 61°N to 73°N in Greenland, for comparison

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with previous series from 1963. *Comment:* activities of Greenlandic samples are intermediate between C^{14} activities found at Copenhagen on June 1 and July 1, 1963 (compare K-660 and K-661 in series of Danish cereals 1956 to 1966). There is clear gradient in C^{14} activity from S to N. At European longitudes preferred position of the polar front in summers is over southern Scandinavia with frequent shifts towards N and S, while over the Atlantic the polar front is usually found far S of Greenland. Geographic variations in C^{14} activity found in 1963 are thus consistent with assumption that main transfer of C^{14} from stratosphere to troposphere takes place at tropopause gaps in middle latitudes, with a subsequent diffusion towards northern and southern latitudes.

	δC^{14}‰	δC^{13}‰	Δ‰
K-685. Mestersvig 72°N	**716 ± 8**	**−26.5**	**721 ± 8**

Grass taken 1 km away from airport at Mestersvig (72° 13′ N Lat, 23° 54′ W Long), East Greenland. Coll. July 19, 1963.

K-688. Kulusuk 65°N	**724 ± 8**	**−28.7**	**737 ± 8**

Grass from Kulusuk (65° 33′ N Lat, 37° 13′ W Long), East Greenland. Coll. July 5, 1963.

K-689. Narssaq 61°N	**765 ± 8**	**−28.0**	**776 ± 8**

Grass from Narssaq (60° 58′ N Lat, 46° 05′ W Long), West Greenland. Coll. July 9, 1963.

References

Date lists:

Cambridge IV	Godwin and Willis, 1961
Cambridge VI	Godwin and Willis, 1964
Lamont VIII	Broecker and Olson, 1961
Monaco II	Thommeret and Thommeret, 1966
Saskatchewan III	McCallum and Wittenberg, 1962
Saskatchewan IV	McCallum and Wittenberg, 1965
Stockholm V	Östlund and Engstrand, 1963
UCLA IV	Berger *et al.*, 1965
UCLA V	Berger and Libby, 1966
Uppsala II	Olsson, 1960
Uppsala VI	Olsson and Karlén, 1965
Yale VII	Stuiver and Deevey, 1962

Berger, R., Ferguson, G. J., and Libby, W. F., 1965, UCLA radiocarbon dates IV: Radiocarbon, v. 7, p. 336-371.

Berger, R., and Libby, W. F., 1966, UCLA radiocarbon dates V: Radiocarbon, v. 8, p. 467-497.

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.

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.

McCallum, K. J., and Wittenberg, J., 1962, University of Saskatchewan radiocarbon dates III: Radiocarbon, v. 4, p. 71-80.

https://doi.org/10.1017/S0033822200000540 Published online by Cambridge University Press

———— 1965, University of Saskatchewan radiocarbon dates IV: Radiocarbon, v. 7, p. 229-235.

Münnich, K. O., and Vogel, J. C., 1963, Investigations of meridional transport in the troposphere by means of carbon-14 measurements: Radioactive dating, I.A.E.A., Vienna 1963, p. 189-197.

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

Olsson, I., 1960, Uppsala natural radiocarbon measurements II: Am. Jour. Sci. Radioc. Supp., v. 2, p. 112-128.

Olsson, I. U., and Karlén, I., 1965, Uppsala radiocarbon measurements VI: Radiocarbon, v. 7, p. 331-335.

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

Sackett, W. M., Eckelmann, W. R., Bender, M. L., and Bé, A.W.H., 1965, Temperature dependence of carbon isotope composition in marine plankton and sediments: Science, v. 148, p. 235-237.

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

Tauber, H., 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.

Thommeret, J., and Thommeret, Y., 1966 Monaco radiocarbon measurements II: Radiocarbon, v. 8, p. 286-291.

https://doi.org/10.1017/S0033822200000540 Published online by Cambridge University Press