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Towed Thermistor Chain Observations in JASIN

by

R. J. Baumann, C. A. Paulson
and J. Wagner

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Observations of temperature and pressure between 10 and 70 m depth were taken with a towed thermistor chain during late August and early September, 1978, about 400 km northwest of Scotland as a part of the JASIN Experiment. The chain was usually towed at a speed of 3 m/s around a 15-km square centered at 59°N, 12°30'W. On two occasions tows were made around five-km squares as part of coordinated observations involving several ships. The observations were averaged over sequential 30-second intervals and

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isotherm depths were interpolated from the averaged observations. Cross-sections of temperature and isotherm depth are presented. Spectra of the depth of the lowest and highest isotherm of each cross-section are also presented.

TOWED THERMISTOR CHAIN

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INTRODUCTION

This report presents measurements of temperature in the upper ocean obtained by use of a towed thermistor chain. The measurements were taken as part of the Joint Air-Sea Interaction (JASIN) Experiment conducted during the summer of 1978. A summary of the scientific and operational plans for JASIN has been given by Pollard (1978). More detailed accounts are given in documents published by the Royal Society (1977, 1978).

INSTRUMENTATION

The thermistor chain consisted of sensors, electrical conductors, plastic fairing, a strain member and a 450 kg lead-filled depressor. The thermistors were manufactured by Thermometrics (Model P-85). They were molded into sections of fairing together with bridge/amplifiers. Power and signals were transmitted by electrical conductors running through the tail sections of the fairing. The thermistors were spaced at intervals of 2 m over a section of chain 50 m in length. Four pressure sensors were also installed on the chain at 15 m intervals. The pressure sensors were manufactured by Kulite and were installed in tail sections together with bridge/amplifiers in a fashion similar to the thermistor electronics. Signals from the sensors were recorded, processed and displayed by use of a minicomputer system manufactured by Digital Equipment Corporation (PDP 11/05). A more complete description of the thermistor chain system is given by Spoering and Paulson (1980).

OBSERVATIONS

The thermistor chain was towed by the R/V ATLANTIS II in an area about 400 km northwest of Scotland. The locations of the tows are tabulated and plotted in the section entitled Tow Tracks. A summary of the tow parameters is given in Table 1. The first digit of the run number designates the number of the deployment of the chain. With the exception of the first deployment, the chain was always towed counterclockwise around a square. The letter following the deployment number designates the side of the square, i.e. N indicates a tow leg toward the west on the north side of the box. The digits following the dash in the run number designates the leg, one leg per side of the square except for the first deployment. The first deployment was separated into three legs. The middle leg contained a front which separated regions of nearly constant thermal properties. The square around which tows were made was usually 15 km on a side surrounding the Fixed Intensive Array. However, on two occasions tows were conducted in cooperation with other ships. The first occasion was around a five-km square containing the drifting buoy P1 and the second occasion was around a five-km square containing the mooring H2. The instrumented section of the chain extended from about 20 to 70 m depth in all tows except the last which was 10 m shallower. The tow speed was usually about 3 m/s. The tow speeds tabulated in Table 1 were determined from LORAN C and satellite navigational fixes.

TABLE 1. Thermistor chain tows during JASIN-78.

Run	Date	Start time (GMT)	Tow speed (m/s)	Duration Time (min)	Duration Distance (km)
1-1	24-AUG-78	1611	3.36	128.0	25.8
1-2	"	1819	3.07	64.0	11.8
1-3	"	1923	3.19	128.0	24.5
2W-1	25-AUG-78	1213	2.95	75.0	13.3
2S-2	"	1331	2.93	72.5	12.7
2E-3	"	1446	2.88	91.0	15.7
2N-4	"	1620	3.41	73.0	14.9
2W-5	"	1738	2.99	72.5	13.0
2S-6	"	1853	3.07	80.0	14.7
2E-7	"	2016	2.74	85.0	14.0
2N-8	"	2145	3.01	70.0	12.6
3N-1	27-AUG-78	1215	2.97	73.0	13.0
3W-2	"	1332	2.89	85.0	14.7
3S-3	"	1459	2.97	77.5	13.8
3E-4	"	1620	2.93	77.5	13.6
3N-5	"	1742	3.21	77.0	14.8
3W-6	"	1902	3.22	67.5	13.0
3S-7	"	2012	3.02	78.5	14.2
3E-8	"	2133	3.10	72.5	13.5

Run	Date	Start time (GMT)	Tow speed (m/s)	Duration Time (min)	Duration Distance (km)
4N-1	29-AUG-78	1209	3.04	37.5	6.8
4W-2	"	1249	2.92	28.5	5.0
4S-3	"	1320	2.91	26.5	4.6
4E-4	"	1349	3.02	27.5	5.0
Computer failure		1433	----	72.0	---
4E-5	"	1545	3.09	23.5	4.4
4N-6	"	1611	2.93	25.5	4.5
4W-7	"	1639	2.86	27.5	4.7
4S-8	"	1709	2.64	28.5	4.5
4E-9	"	1740	3.00	25.5	4.6
4N-10	"	1807	2.76	27.5	4.6
4W-11	"	1837	2.90	27.5	4.8
4S-12	"	1907	2.77	27.5	4.6
4E-13	"	1937	2.70	27.5	4.5
4N-14	"	2007	2.86	27.5	4.7
4W-15	"	2037	2.85	29.5	5.0
4S-16	"	2109	2.84	27.5	4.7
4E-17	"	2139	2.66	23.5	3.8
4N-18	"	2210	2.91	30.5	5.3
4W-19	"	2243	3.00	26.5	4.8
4S-20	"	2312	2.91	27.5	4.8
4E-21	"	2342	2.70	27.5	4.5
4N-22	30-AUG-78	0012	2.78	29.5	4.9
4W-23	"	0044	2.79	27.5	4.6
4S-24	"	0114	2.85	27.5	4.7
4E-25	"	0144	2.73	27.5	4.5
4N-26	"	0214	2.78	28.5	4.8
4W-27	"	0245	2.70	27.5	4.5
4S-28	"	0315	2.83	27.5	4.7
4E-29	"	0345	2.78	29.5	4.9
4N-30	"	0417	2.61	27.5	4.3
5N-1	31-AUG-78	1153	3.02	72.0	13.0
5W-2	"	1308	3.16	69.5	13.2
5S-3	"	1419	3.19	78.5	15.0
5E-4	"	1540	2.89	86.0	14.9
5N-5	"	1710	3.03	90.0	16.4
5W-6	"	1843	3.04	72.5	13.2
5S-7	"	1958	2.86	85.5	14.7
5E-8	"	2126	2.97	84.5	15.1

Run	Date	Start time (GMT)	Tow speed (m/s)	Duration Time (min)	Duration Distance (km)
6W-1	2-SEP-78	1139	2.73	28.5	4.7
6S-2	"	1212	2.50	32.5	4.9
6E-3	"	1247	2.74	27.5	4.5
6N-4	"	1317	2.53	29.5	4.5
6W-5	"	1349	2.39	28.5	4.1
6S-6	"	1420	2.96	27.5	4.9
6E-7	"	1451	2.52	24.5	3.7
6N-8	"	1518	2.46	32.5	4.8
6W-9	"	1553	2.74	27.5	4.5
6S-10	"	1624	2.69	25.5	4.1
6E-11	"	1653	2.66	26.5	4.2
6N-12	"	1722	2.40	36.5	5.3
6W-13	"	1801	2.87	27.0	4.6
6S-14	"	1832	2.86	26.0	4.5
6E-15	"	1901	2.46	31.5	4.6
6N-16	"	1935	2.51	34.5	5.2
6W-17	"	2012	2.84	23.5	4.0
6S-18	"	2038	2.71	27.5	4.5
6E-19	"	2109	2.31	31.5	4.4
6N-20	"	2143	2.68	30.5	4.9
6W-21	"	2217	2.57	20.5	3.2
6S-22	"	2240	2.45	33.5	4.9
6E-23	"	2316	2.38	31.5	4.5
6N-24	"	2356	2.98	20.0	3.6
6W-25	3-SEP-78	0019	2.80	22.5	3.8
6S-26	"	0044	2.58	33.5	5.2
6E-27	"	0120	2.55	26.5	4.1
6N-28	"	0148	2.59	28.5	4.4
6W-29	"	0218	2.52	29.5	4.5
6S-30	"	0250	2.71	30.5	5.0
6E-31	"	0324	2.84	21.5	3.7
6N-32	"	0348	2.69	29.5	4.8
6W-33	"	0421	2.60	31.5	4.9
6S-34	"	0455	2.80	28.5	4.8
6E-35	"	0526	2.58	28.5	4.4
7S-1	4-SEP-78	0803	3.23	64.0	12.4
7E-2	"	0910	3.03	74.5	13.5
7N-3	"	1027	2.86	93.5	16.0
7W-4	"	1203	3.27	68.5	13.4
7S-5	"	1314	2.93	85.0	14.9
7E-6	"	1443	2.85	81.0	13.9
7N-7	"	1607	3.29	70.5	13.9
7W-8	"	1719	2.74	81.0	13.3

ANALYSIS

The temperature observations were low-pass filtered by computing sequential 30 s averages. Filtering removes variations caused by surface gravity waves and ship heave. The filtered observations are shown in the section entitled Temperature Cross-Sections.

Isotherm depths were determined by linear interpolation between the filtered temperature observations. The depths of isotherms in intervals of 0.2°C are shown in the section entitled Isotherm Cross-Sections.

Spectra of the shallowest and deepest isotherm on each leg were computed and are presented in the section entitled Spectra of Highest and Lowest Isotherms.

Spectra of the depth of the thermistor chain at three locations on the chain are shown in Figure 1. The spectra were computed from low-pass filtered (30 s averages) measurements of pressure during Run 1-1. The magnitude of vertical oscillations of the chain is usually greatest near the bottom. The magnitude of the spectra can be compared with spectra of isotherm depth shown in the section entitled Isotherm Cross-Sections. The magnitude of the isotherm spectra are usually more than two orders of magnitude greater than spectra of depth. We therefore conclude that variations in depth of the chain have a negligible effect on spectra of isotherm depth determined from the low-pass filtered temperature measurements.

More details on analysis procedures can be found in Spoering and Paulson (1980).

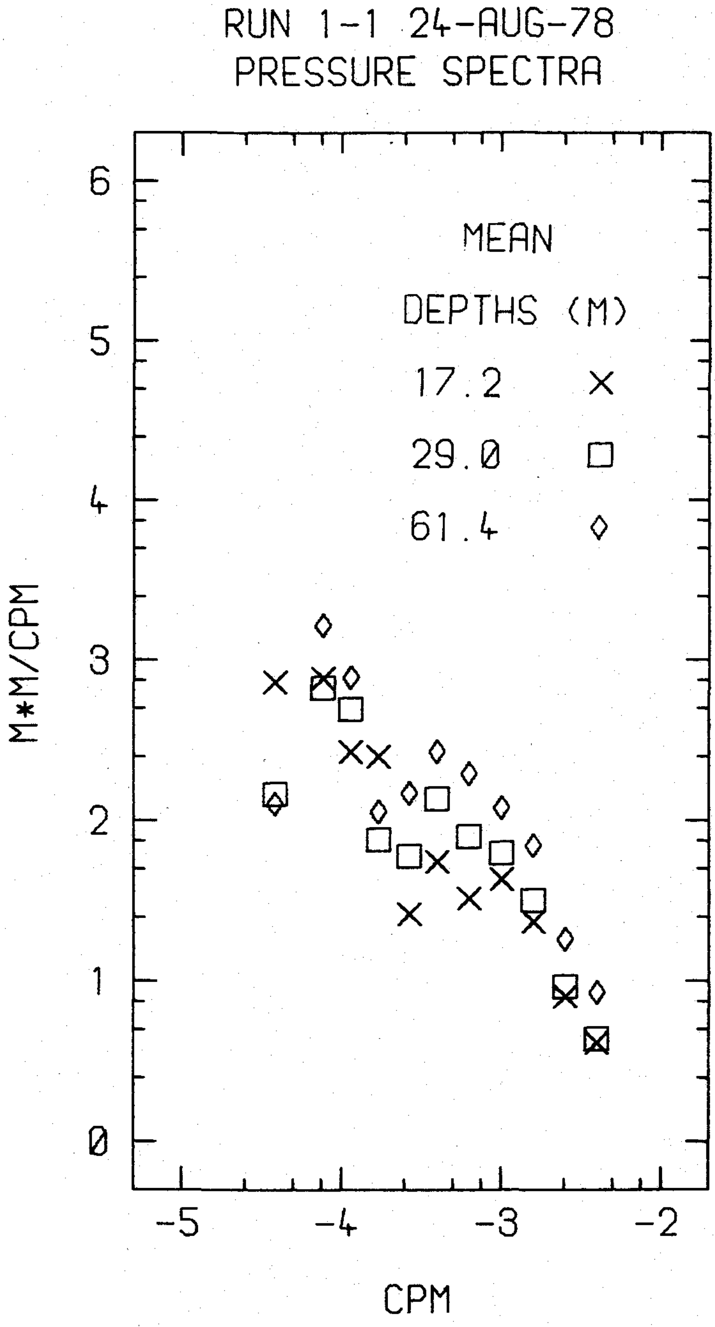

Figure 1. Spectra of depth measured at three locations on the towed thermistor chain during Run 1-1. The mean depths of the pressure sensors are indicated. The pressure records were low-pass (30 s averages) filtered prior to computing spectra.

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TOW TRACKS

On the following pages there is a tabulation of positions during each of the tows followed by plots, one for each run. The tabulated positions are plotted (x) on the plots. The positions were determined by use of LORAN C and navigational satellite. The local coordinates, x and y, are in kilometers north and east, respectively, of a point at the center of the Fixed Intensive Array (59°N, 12.5°W). The locations of moorings B1, B2, B3 and H2 are shown in several plots.

RUN 1 24-AUG-78

TIME	LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	LOCAL COORDINATES X	LOCAL COORDINATES Y
1609	59	3.80	12	26.09	3.75	7.05
1635	59	3.54	12	31.76	-1.69	6.57
1655	59	3.37	12	35.48	-5.25	6.26
1701	59	3.26	12	36.84	-6.55	6.05
1727	59	3.04	12	42.42	-11.90	5.64
1811	59	2.74	12	51.71	-20.80	5.09
1840	59	2.67	12	58.21	-27.02	4.96
1904	59	2.52	13	2.87	-31.49	4.68
1934	59	2.45	13	8.48	-36.86	4.55
2006	59	2.22	13	14.56	-42.69	4.12
2041	59	1.98	13	21.52	-49.35	3.68
2101	59	1.88	13	25.52	-53.19	3.49
2120	59	1.77	13	29.63	-57.12	3.29

RUN 2 25-AUG-78

TIME	LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	LOCAL COORDINATES X	LOCAL COORDINATES Y
1203	59	4.09	12	40.60	-10.15	7.59
1221	59	2.48	12	40.25	-9.82	4.60
1304	58	58.32	12	39.54	-9.14	-3.12
1331	58	55.75	12	38.80	-8.43	-7.89
1447	58	55.60	12	24.68	5.10	-8.17
1520	58	58.68	12	24.80	4.98	-2.45
1547	59	1.20	12	25.11	4.68	2.23
1620	59	4.26	12	25.53	4.28	7.91
1652	59	3.58	12	32.08	-1.99	6.65
1731	59	3.46	12	40.05	-9.63	6.42
1733	59	3.46	12	41.05	-10.59	6.42
1741	59	2.89	12	41.19	-10.72	5.37
1755	59	1.36	12	41.21	-10.74	2.53
1815	58	59.50	12	40.72	-10.27	-0.93
1853	58	55.75	12	40.28	-9.85	-7.89
2016	58	56.44	12	24.38	5.38	-6.61
2118	59	1.82	12	24.26	5.50	3.38
2145	59	4.31	12	24.81	4.97	8.00
2255	59	4.79	12	37.99	-7.65	8.89

RUN 3 27-AUG-78

TIME	LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	LOCAL COORDINATES X	LOCAL COORDINATES Y
1209	59	3.97	12	22.69	7.00	7.37
1254	59	4.01	12	31.33	-1.27	7.45
1317	59	4.00	12	35.60	-5.36	7.43
1332	59	3.91	12	38.14	-7.80	7.26
1404	59	1.05	12	37.80	-7.47	1.95
1434	58	58.11	12	37.44	-7.13	-3.51
1459	58	55.82	12	36.80	-6.51	-7.76
1520	58	55.96	12	32.82	-2.70	-7.50
1549	58	56.01	12	27.15	2.73	-7.41
1620	58	56.38	12	21.75	7.90	-6.72
1651	58	59.38	12	22.10	7.57	-1.15
1743	59	4.22	12	22.93	6.77	7.83
1837	59	3.48	12	33.49	-3.34	6.46
1900	59	3.18	12	38.30	-7.95	5.91
1910	59	2.20	12	38.23	-7.88	4.08
1934	58	59.57	12	37.90	-7.57	-0.80
2009	58	56.01	12	37.53	-7.21	-7.41
2011	58	55.81	12	37.27	-6.96	-7.78
2032	58	55.74	12	33.54	-3.39	-7.91
2059	58	55.74	12	28.31	1.62	-7.91
2133	58	55.79	12	21.65	8.00	-7.82
2218	59	0.16	12	21.61	8.04	0.30
2252	59	3.69	12	21.89	7.77	6.85

RUN 4 29,30-AUG-78

TIME	LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	LOCAL COORDINATES X	LOCAL COORDINATES Y
1126	58	53.91	12	20.44	9.16	-11.31
1142	58	53.88	12	17.20	12.26	-11.36
1148	58	54.26	12	16.91	12.54	-10.66
1210	58	56.08	12	17.42	12.05	-7.28
1246	58	55.86	12	24.27	5.49	-7.69
1250	58	55.75	12	24.52	5.25	-7.89
1318	58	52.84	12	24.30	5.46	-13.29
1330	58	52.72	12	22.14	7.53	-13.52
1348	58	52.82	12	18.83	10.70	-13.33
1404	58	54.29	12	18.98	10.56	-10.60
1417	58	55.65	12	19.10	10.44	-8.08
1545	58	53.02	12	19.49	10.07	-12.96
1609	58	55.42	12	19.60	9.96	-8.50
1637	58	55.63	12	24.72	5.06	-8.11
1653	58	54.16	12	24.95	4.84	-10.84
1706	58	52.95	12	24.83	4.95	-13.09
1735	58	52.89	12	20.00	9.58	-13.20
1740	58	53.04	12	19.27	10.28	-12.92
1754	58	54.41	12	19.44	10.12	-10.38
1803	58	55.31	12	19.50	10.06	-8.71
1807	58	55.65	12	19.53	10.03	-8.08
1835	58	55.85	12	24.36	5.40	-7.71
1904	58	53.13	12	24.40	5.36	-12.75
1934	58	53.10	12	19.20	10.35	-12.81
2004	58	55.71	12	18.95	10.59	-7.96
2034	58	55.89	12	24.31	5.45	-7.63
2106	58	52.94	12	24.13	5.62	-13.11
2136	58	52.77	12	18.81	10.72	-13.42
2207	58	55.41	12	18.05	11.45	-8.52
2240	58	55.42	12	24.07	5.68	-8.50
2309	58	52.61	12	24.07	5.68	-13.72
2339	58	52.40	12	18.61	10.91	-14.11
2409	58	55.01	12	18.23	11.28	-9.26
2441	58	55.21	12	23.78	5.96	-8.89
2511	58	52.51	12	24.17	5.58	-13.91
2541	58	52.22	12	18.85	10.68	-14.44
2611	58	54.86	12	18.42	11.09	-9.54
2642	58	55.18	12	23.78	5.96	-8.95
2712	58	52.57	12	24.10	5.65	-13.79
2742	58	52.49	12	18.78	10.75	-13.94
2814	58	55.36	12	18.47	11.05	-8.61
2844	58	55.63	12	23.34	6.38	-8.11

RUN 5 31-AUG-78

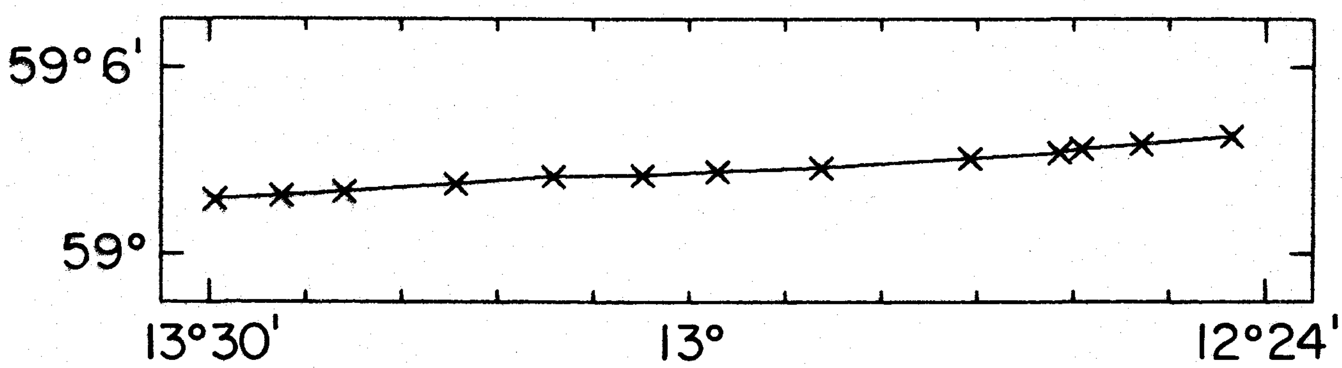
TIME	LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	LOCAL COORDINATES X	LOCAL COORDINATES Y
1152	59	3.79	12	23.91	5.83	7.04
1223	59	3.54	12	29.68	0.31	6.57
1308	59	3.05	12	38.19	-7.85	5.66
1419	58	55.81	12	37.60	-7.28	-7.78
1537	58	55.67	12	22.01	7.65	-8.04
1709	59	4.23	12	20.82	8.79	7.85
1841	59	3.41	12	38.19	-7.85	6.33
1956	58	55.96	12	37.72	-7.40	-7.50
2124	58	55.58	12	21.96	7.70	-8.21
2254	59	4.21	12	21.69	7.96	7.82

RUN 6 2,3-SEP-78

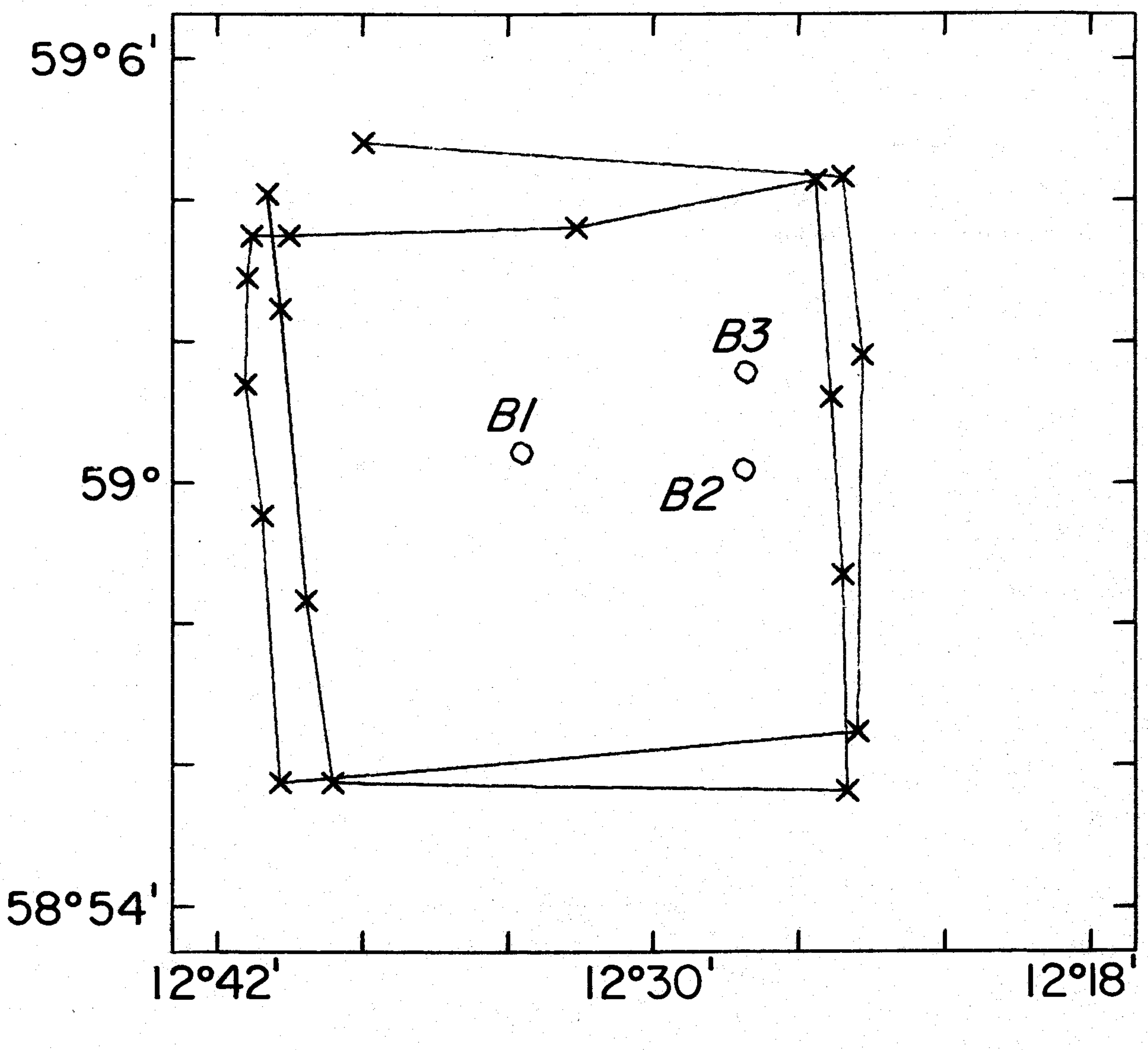
TIME	LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	LOCAL COORDINATES X	LOCAL COORDINATES Y
1121	59	26.90	12	28.08	1.84	49.94
1138	59	26.90	12	31.56	-1.49	49.94
1147	59	26.19	12	31.62	-1.55	48.62
1208	59	24.25	12	31.62	-1.55	45.02
1244	59	24.06	12	26.00	3.83	44.67
1314	59	26.72	12	25.93	3.90	49.61
1346	59	27.01	12	30.97	-0.93	50.15
1421	59	24.31	12	30.96	-0.92	45.13
1447	59	24.46	12	26.14	3.70	45.41
1515	59	26.72	12	25.62	4.20	49.61
1550	59	27.05	12	30.97	-0.93	50.22
1620	59	24.39	12	31.04	-1.00	45.28
1649	59	24.39	12	26.16	3.68	45.28
1720	59	27.00	12	25.16	4.64	50.13
1759	59	27.01	12	31.02	-0.98	50.15
1831	59	24.04	12	31.02	-0.98	44.63
1900	59	24.20	12	25.83	3.99	44.93
1933	59	26.81	12	25.38	4.43	49.78
2010	59	26.66	12	31.18	-1.13	49.50
2036	59	24.27	12	31.17	-1.12	45.06
2106	59	23.94	12	26.12	3.72	44.45
2141	59	26.54	12	25.60	4.22	49.27
2213	59	26.36	12	30.95	-0.91	48.94
2237	59	24.39	12	31.51	-1.45	45.28
2313	59	23.97	12	26.05	3.78	44.50
2347	59	26.58	12	25.92	3.91	49.35
2417	59	26.59	12	31.51	-1.45	49.37
2442	59	24.33	12	31.73	-1.66	45.17
2518	59	24.33	12	25.92	3.91	45.17
2547	59	26.72	12	26.15	3.69	49.61
2617	59	26.90	12	31.00	-0.96	49.94
2650	59	24.22	12	31.24	-1.19	44.97
2721	59	24.46	12	26.00	3.83	45.41
2746	59	26.75	12	25.82	4.00	49.66
2818	59	27.13	12	31.17	-1.12	50.37
2853	59	24.19	12	31.22	-1.17	44.91
2924	59	24.38	12	25.79	4.03	45.26
2955	59	26.95	12	25.23	4.57	50.04

RUN 7 4-SEP-78

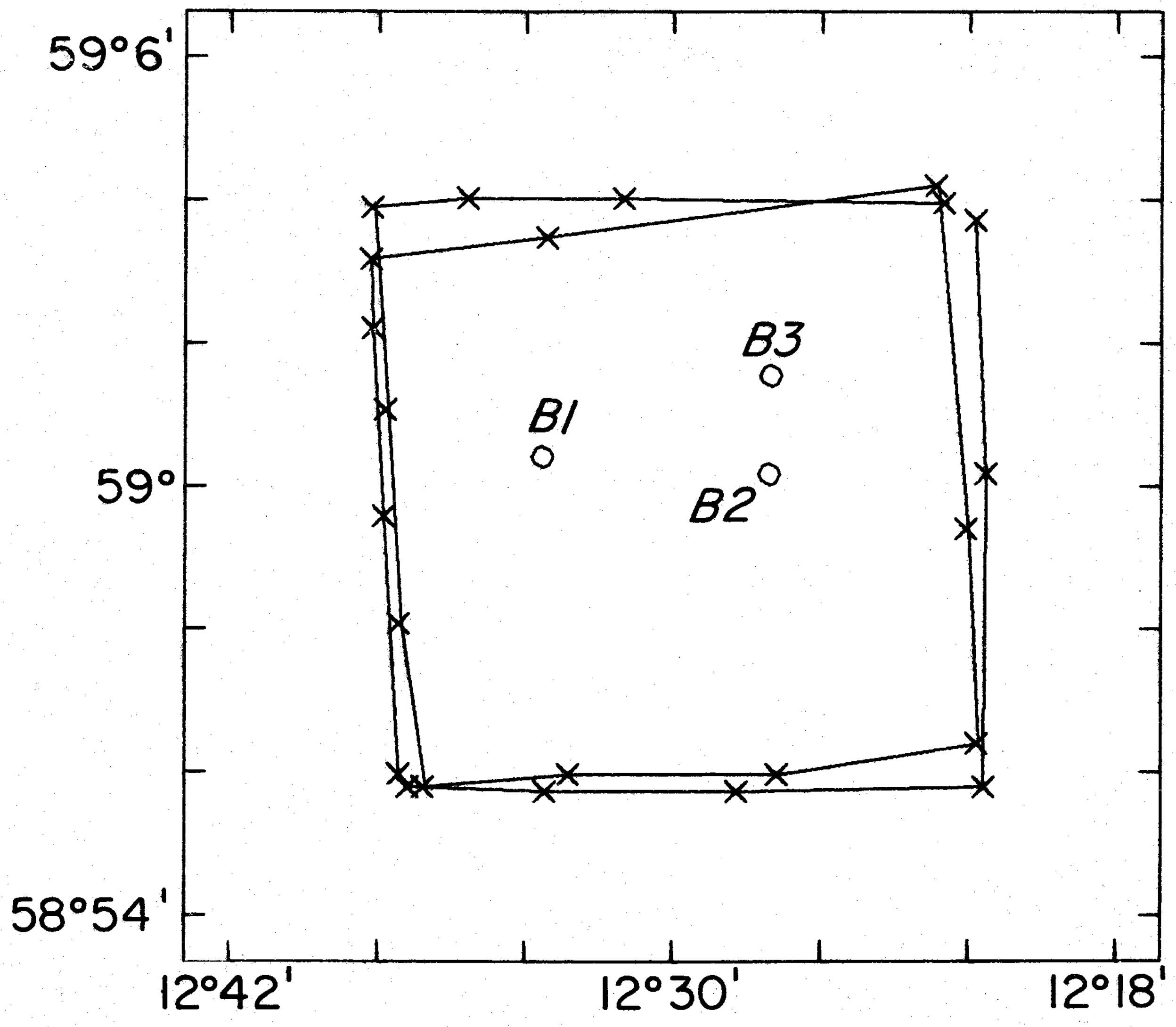
TIME	LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	LOCAL COORDINATES X	LOCAL COORDINATES Y
754	58	55.88	12	37.00	-6.71	-7.65
907	58	56.49	12	22.26	7.41	-6.52
1024	59	3.99	12	20.85	8.77	7.41
1200	59	3.55	12	38.00	-7.66	6.59
1311	58	56.05	12	38.31	-7.96	-7.33
1439	58	56.13	12	22.17	7.50	-7.18
1604	59	3.93	12	23.20	6.51	7.30
1718	59	3.99	12	38.45	-8.09	7.41
1847	58	56.10	12	38.40	-8.05	-7.24



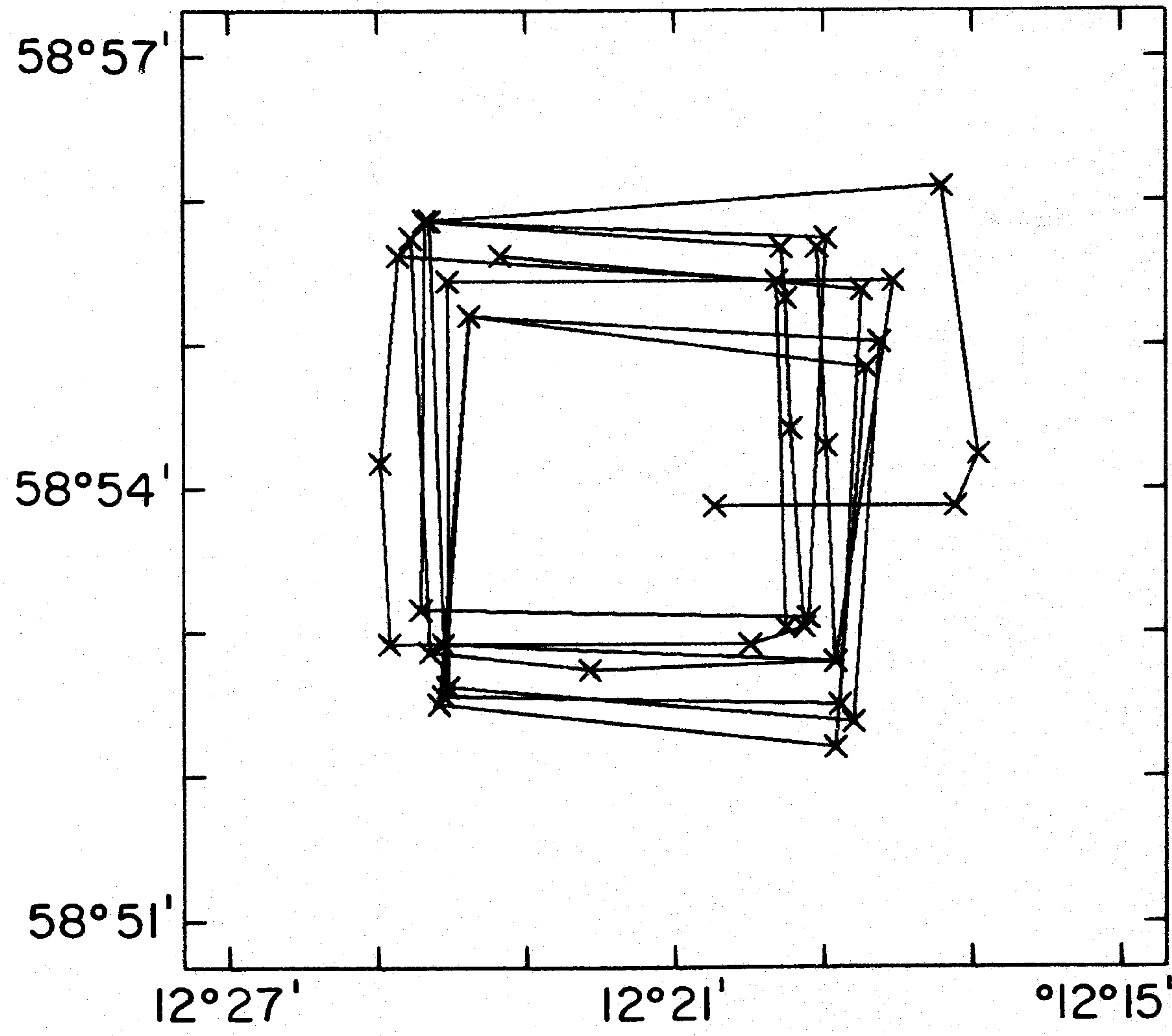
TOW TRACK RUN 1 24-AUG-78



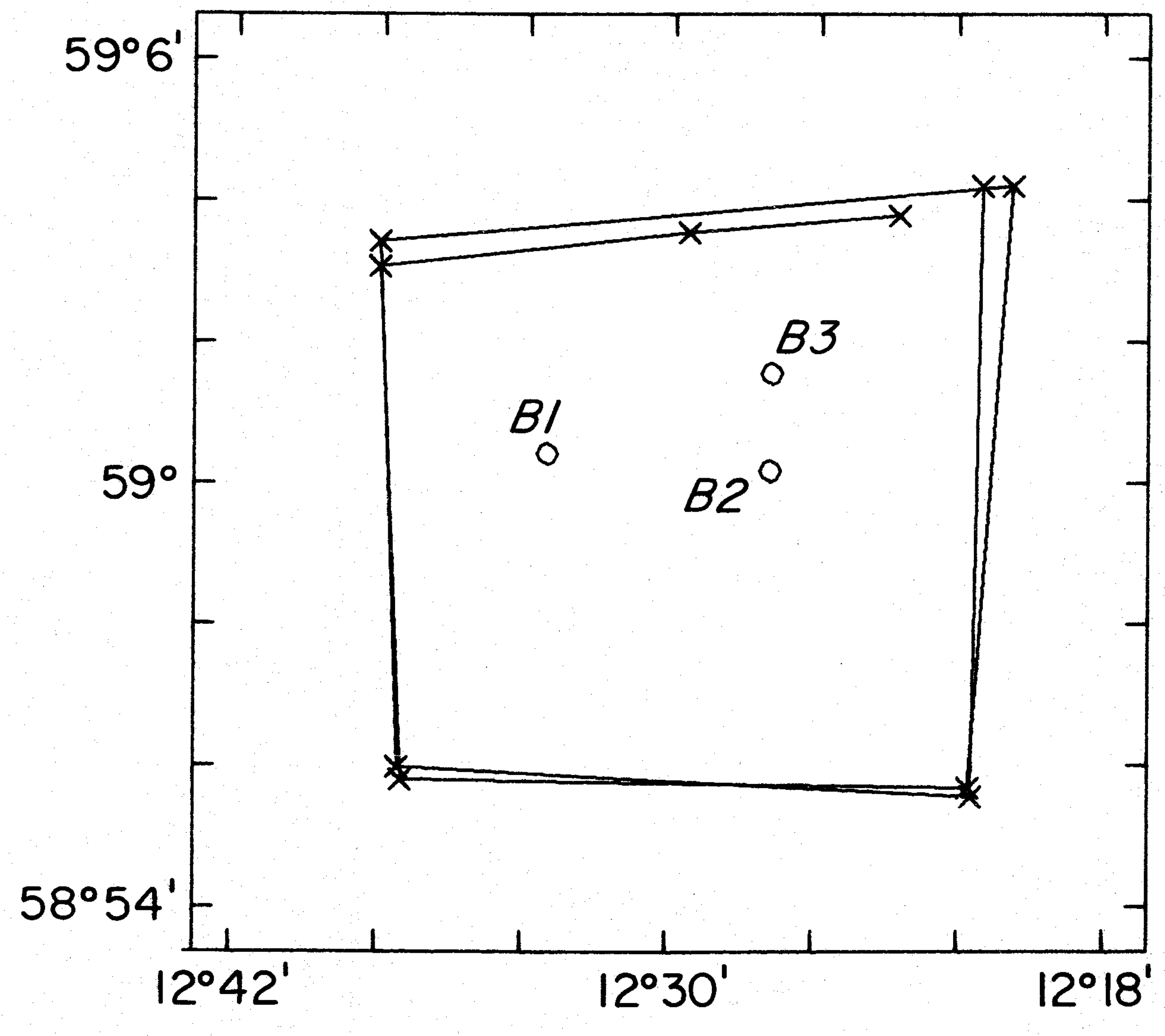
TOW TRACK RUN 2 25-AUG-78



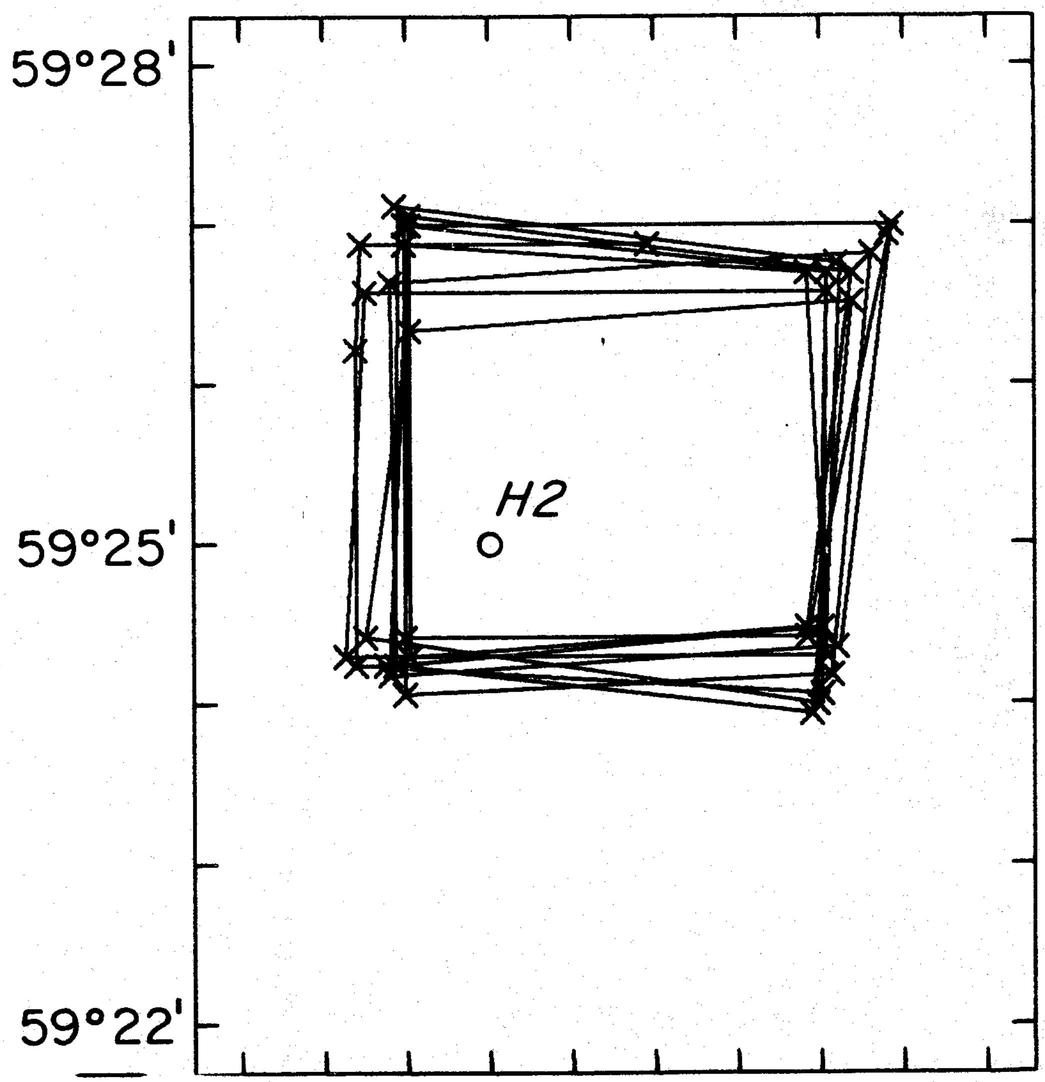
TOW TRACK RUN 3 27-AUG-78



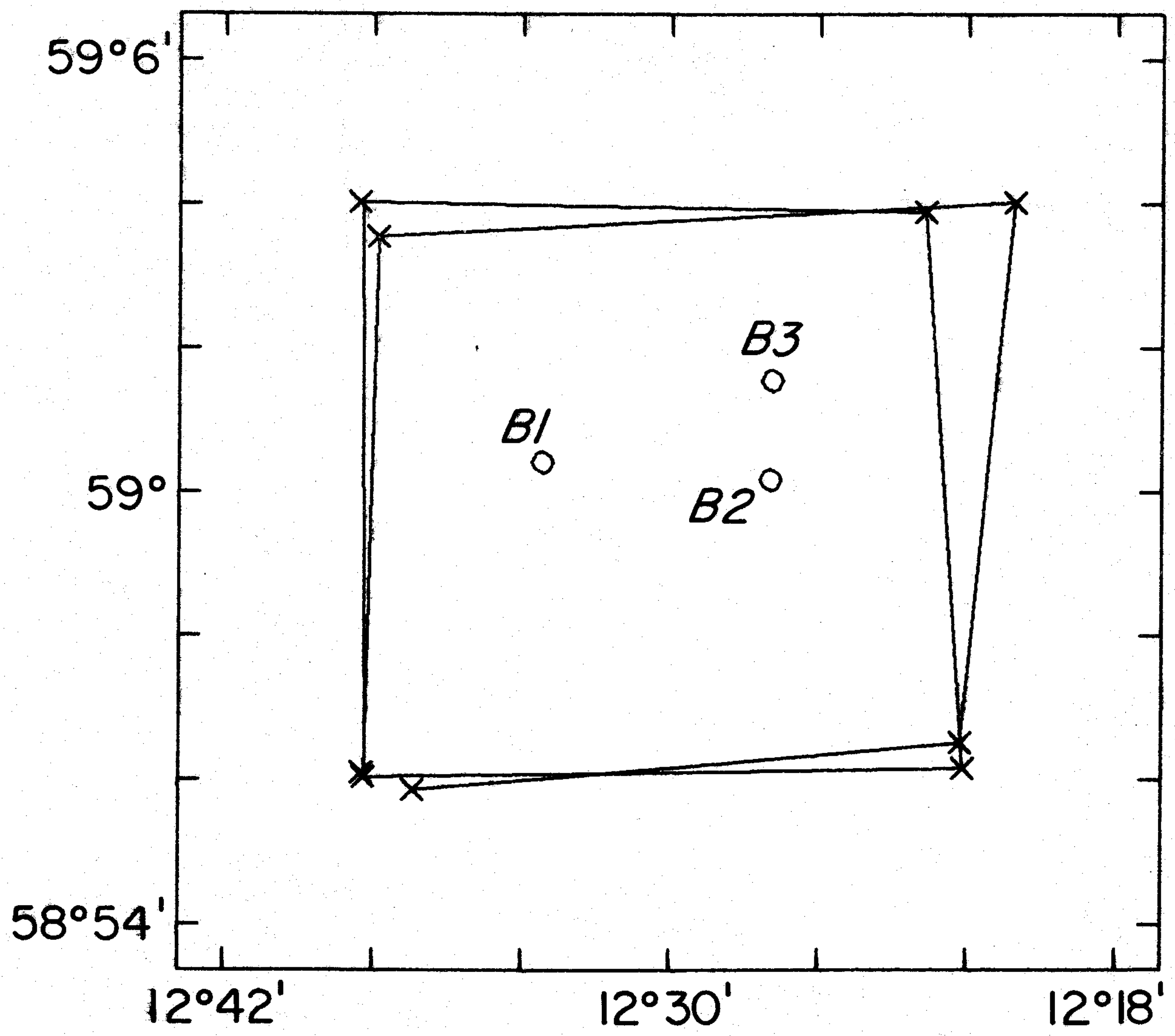
TOW TRACK RUN 4 29,30-AUG-78



TOW TRACK RUN 5 31-AUG-78



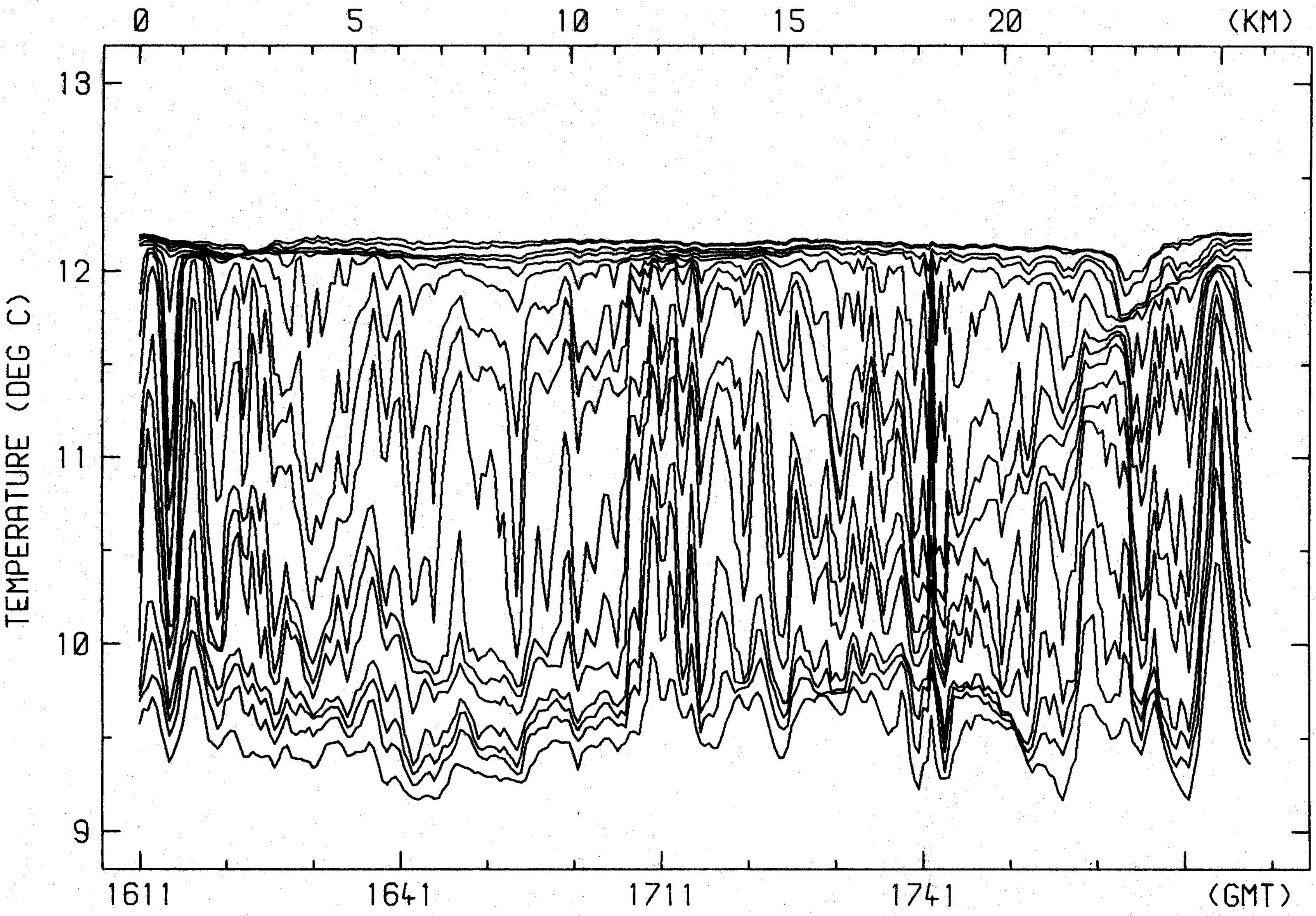
TOW TRACK RUN 6 2,3-SEP-78



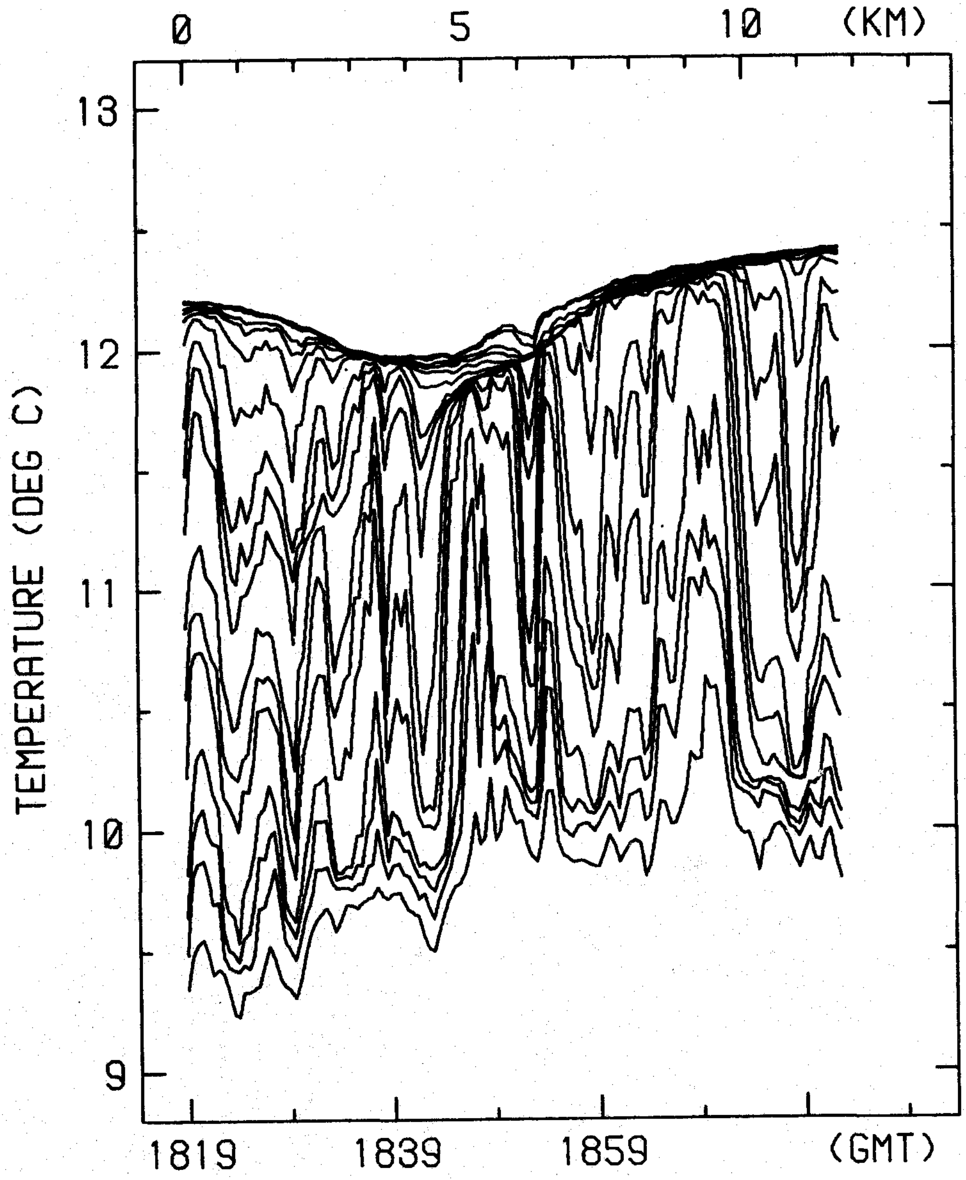
TOW TRACK RUN 7 4-SEP-78

TEMPERATURE CROSS-SECTIONS

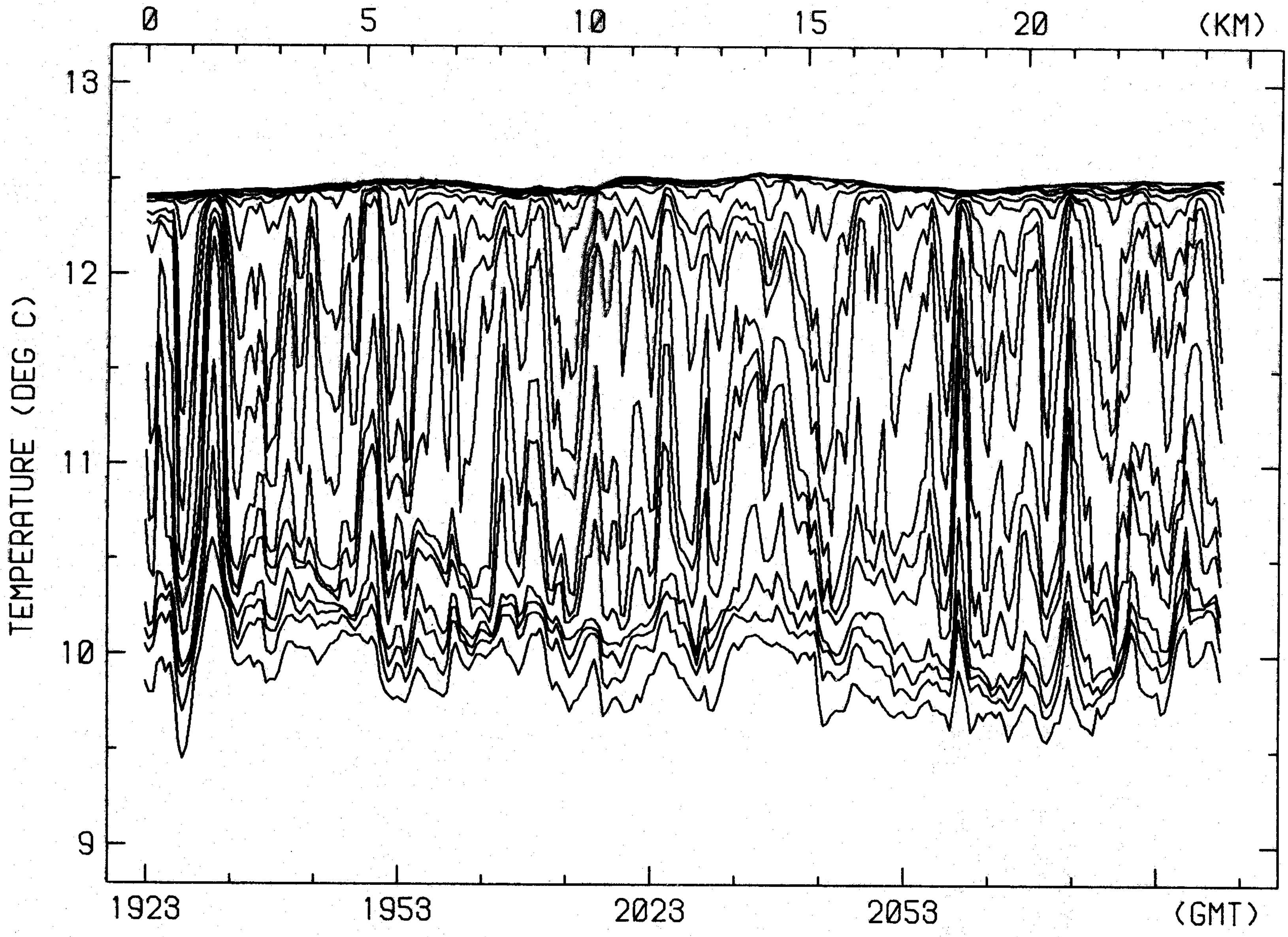
On the following pages there are plots, one for each leg, of low-pass filtered temperature as a function of time and distance along the leg. The filtering was accomplished by computing sequential 30 s averages. The mean depth of each sensor is given.



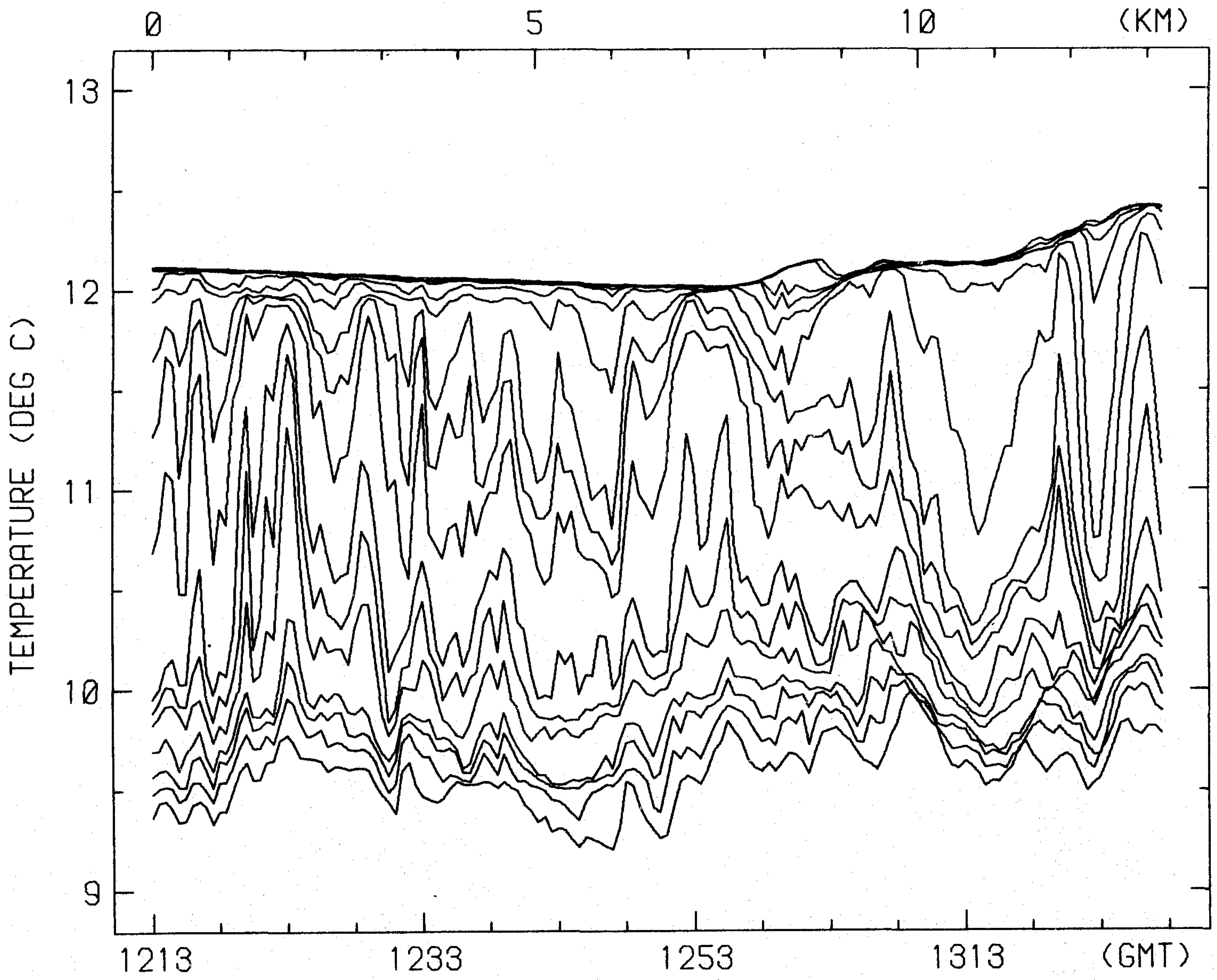
RUN 1-1 24-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.2,20.2,26.0,28.0,32.0,36.0,40.0
42.0,44.0,48.1,50.1,52.1,56.2,58.3,60.3,64.5



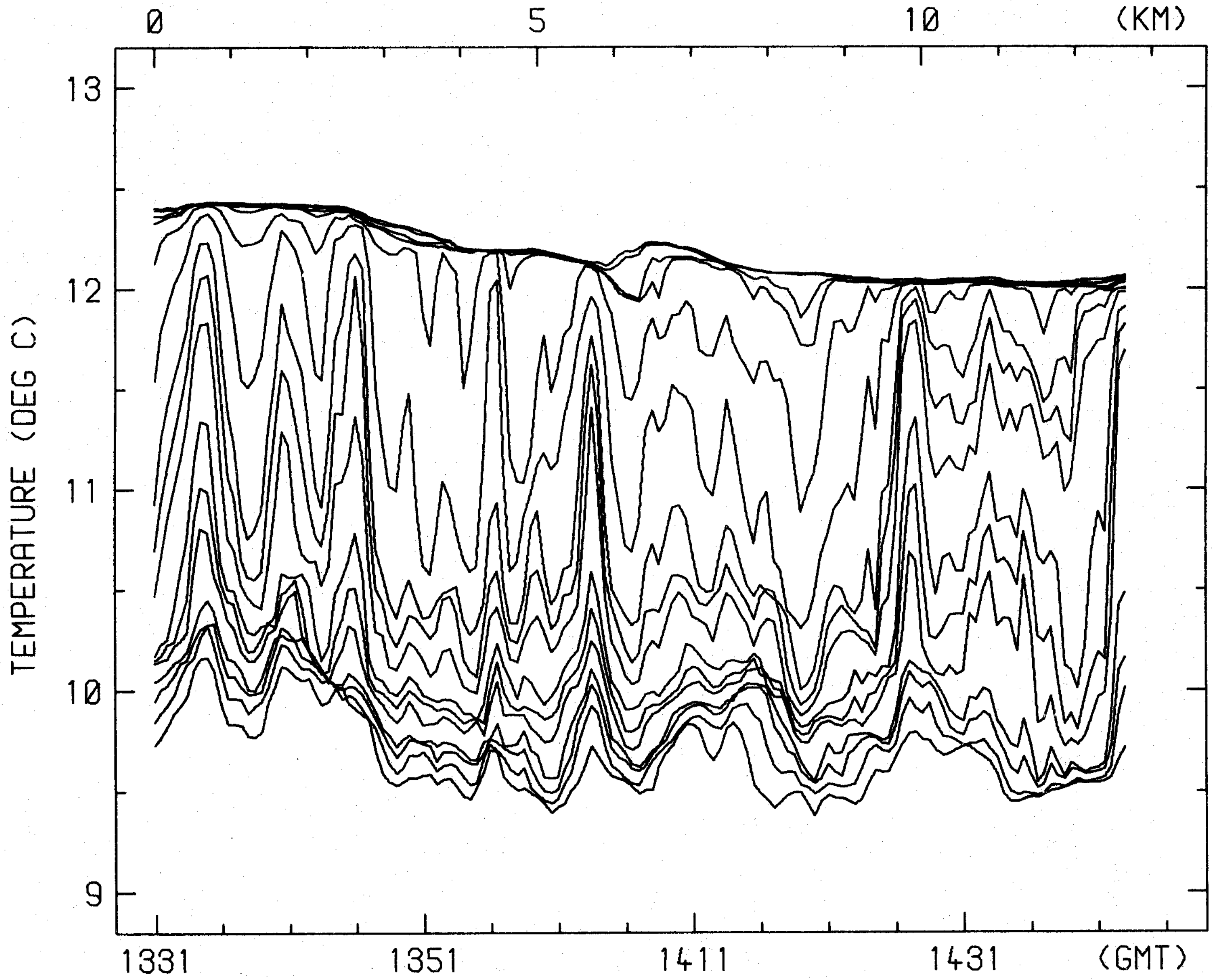
RUN 1-2 24-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.2,20.2,26.0,28.0,32.0,36.0,40.0
42.0,44.0,48.1,50.1,52.1,56.2,58.3,60.3,64.5



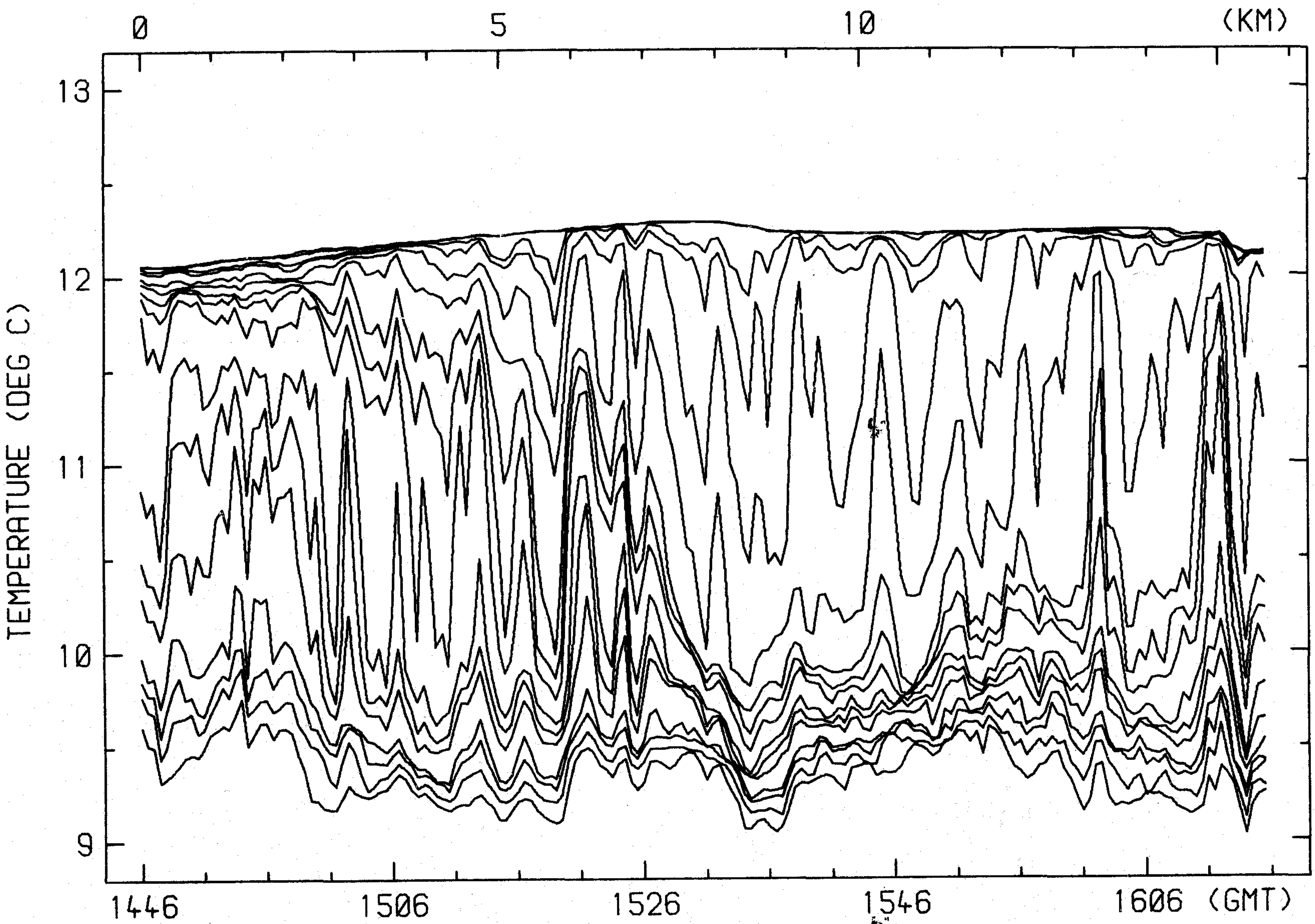
RUN 1-3 24-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.2,20.2,26.0,28.0,32.0,36.0,40.0
42.0,44.0,48.1,50.1,52.1,56.2,58.3,60.3,64.5



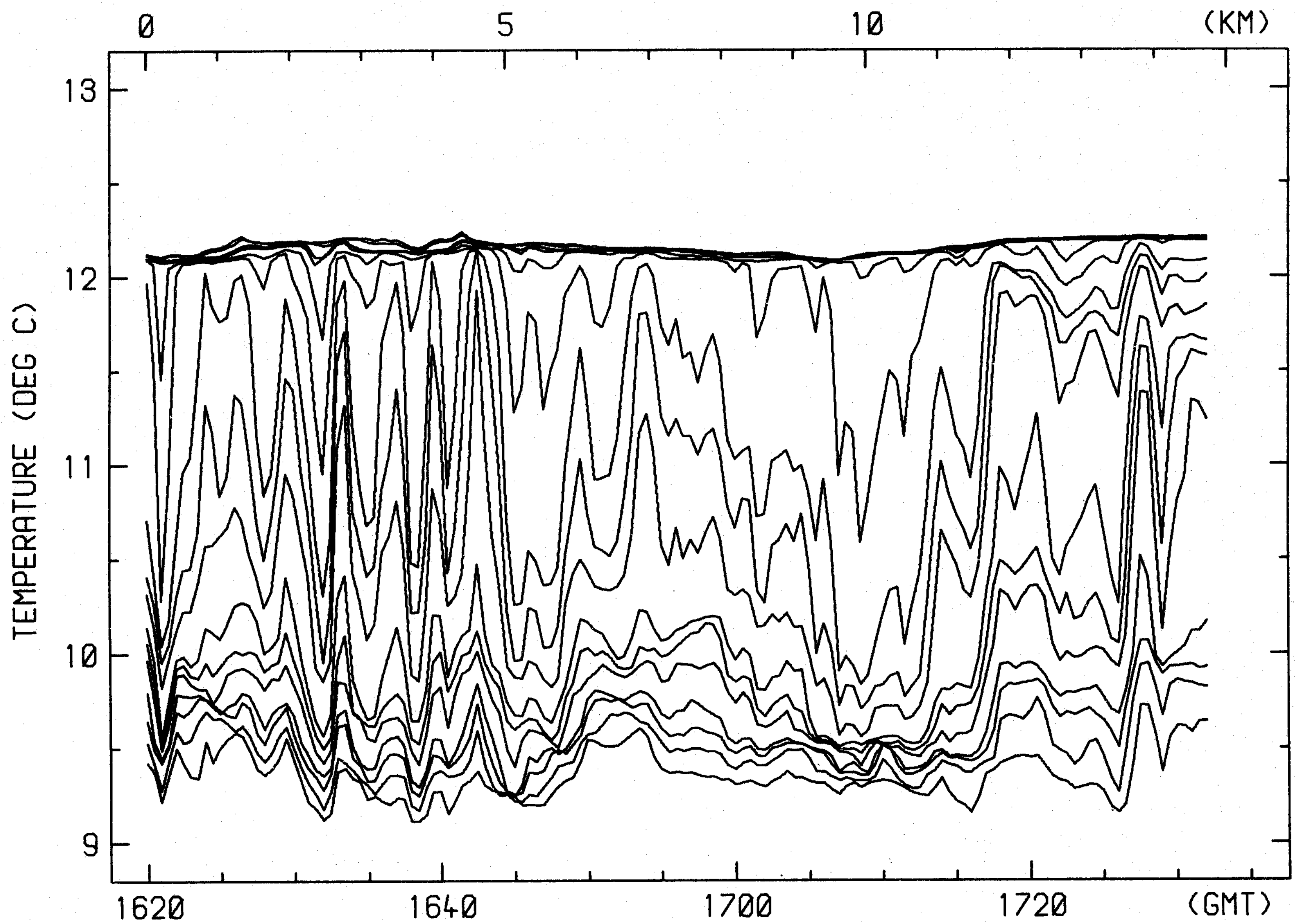
RUN 2W-1 25-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,20.5,26.5,28.5,32.5,36.5,40.6
42.6,44.6,48.7,50.7,52.8,56.9,59.0,61.0,65.2



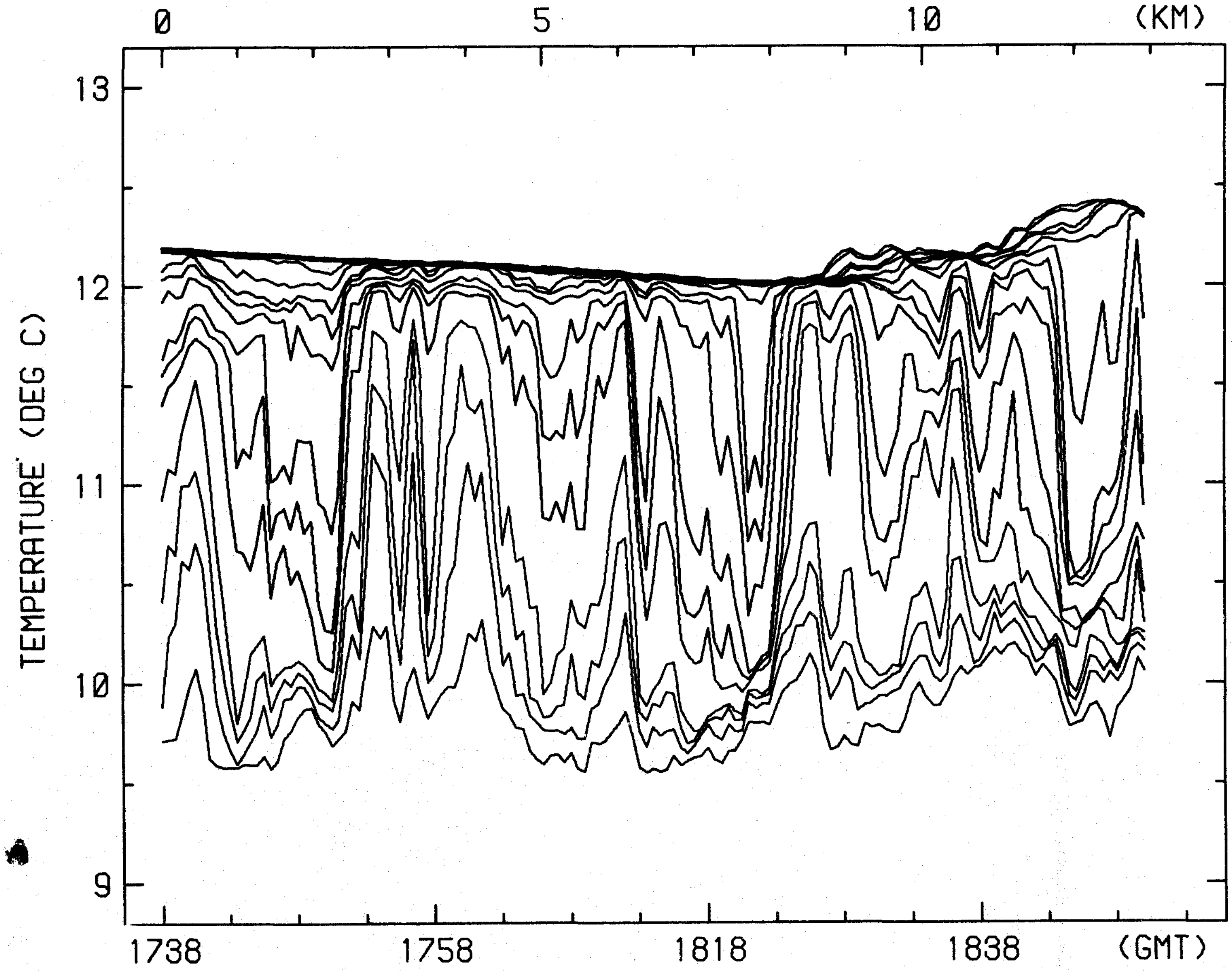
RUN 2S-2 25-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,20.5,26.5,28.5,32.5,36.5,40.6
42.6,44.6,48.7,50.7,52.8,56.9,59.0,61.0,65.2



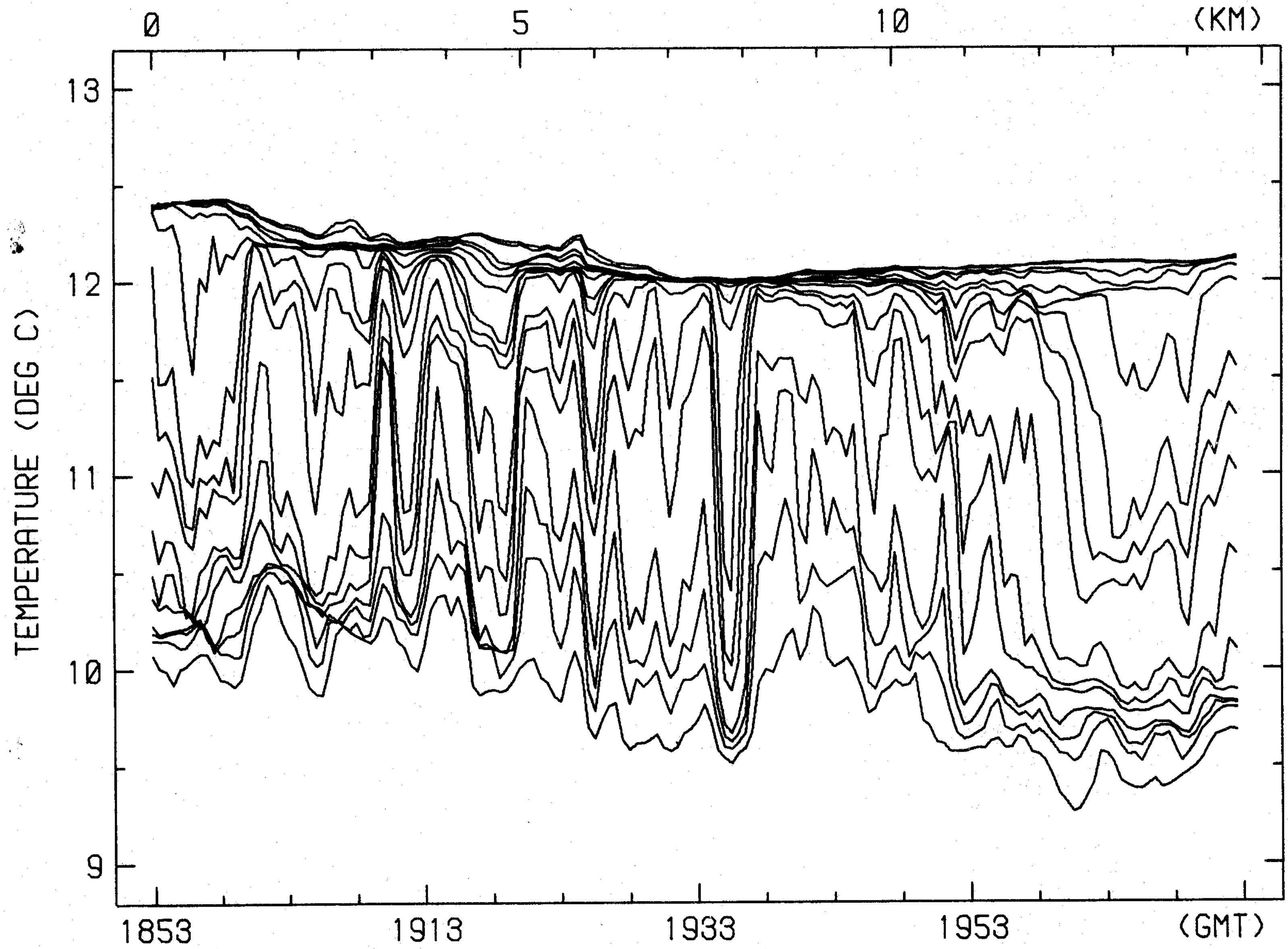
RUN 2E-3 25-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,20.5,26.5,28.5,32.5,36.5,40.6
42.6,44.6,48.7,50.7,52.8,56.9,59.0,61.0,65.2



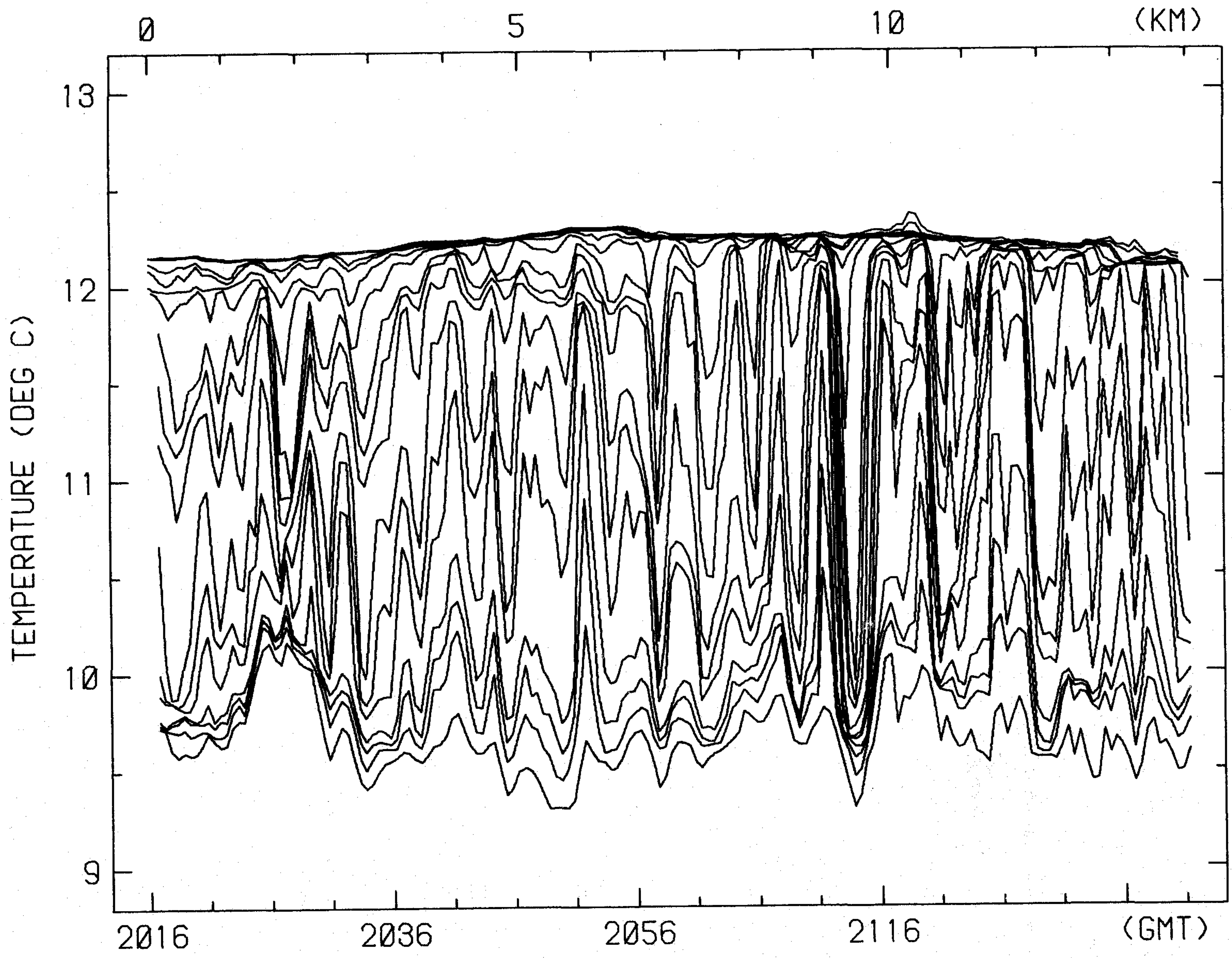
RUN 2N-4 25-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,20.5,26.5,28.5,32.5,36.5,40.6
42.6,44.6,48.7,50.7,52.8,56.9,59.0,61.0,65.2



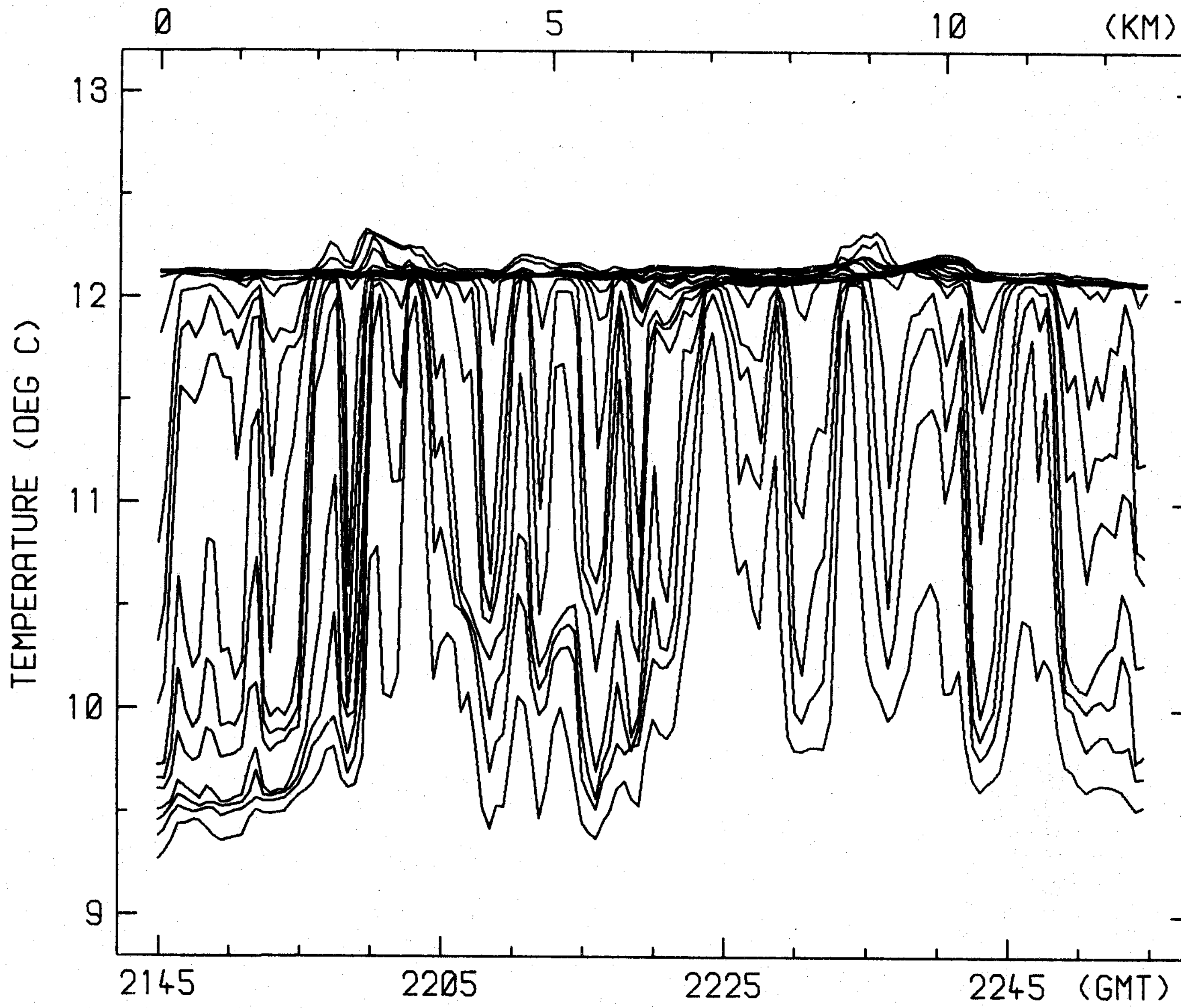
RUN 2W-5 25-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS(M) 18.6,20.5,26.5,28.5,32.5,36.5,40.6
42.6,44.6,48.7,50.7,52.8,56.9,59.0,61.0,65.2



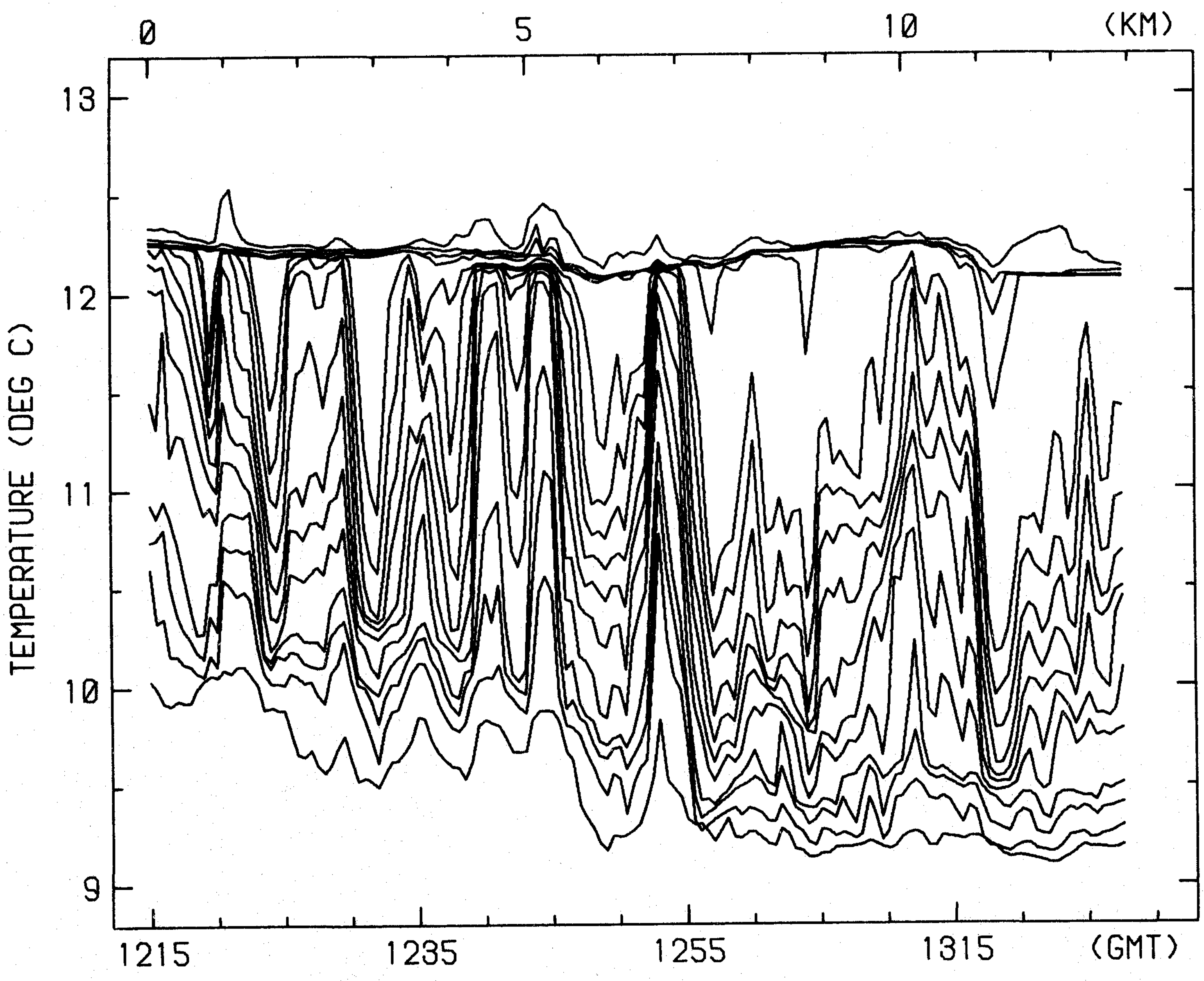
RUN 2S-6 25-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS(M) 18.6,20.5,26.5,28.5,32.5,36.5,40.6
42.6,44.6,48.7,50.7,52.8,56.9,59.0,61.0,65.2



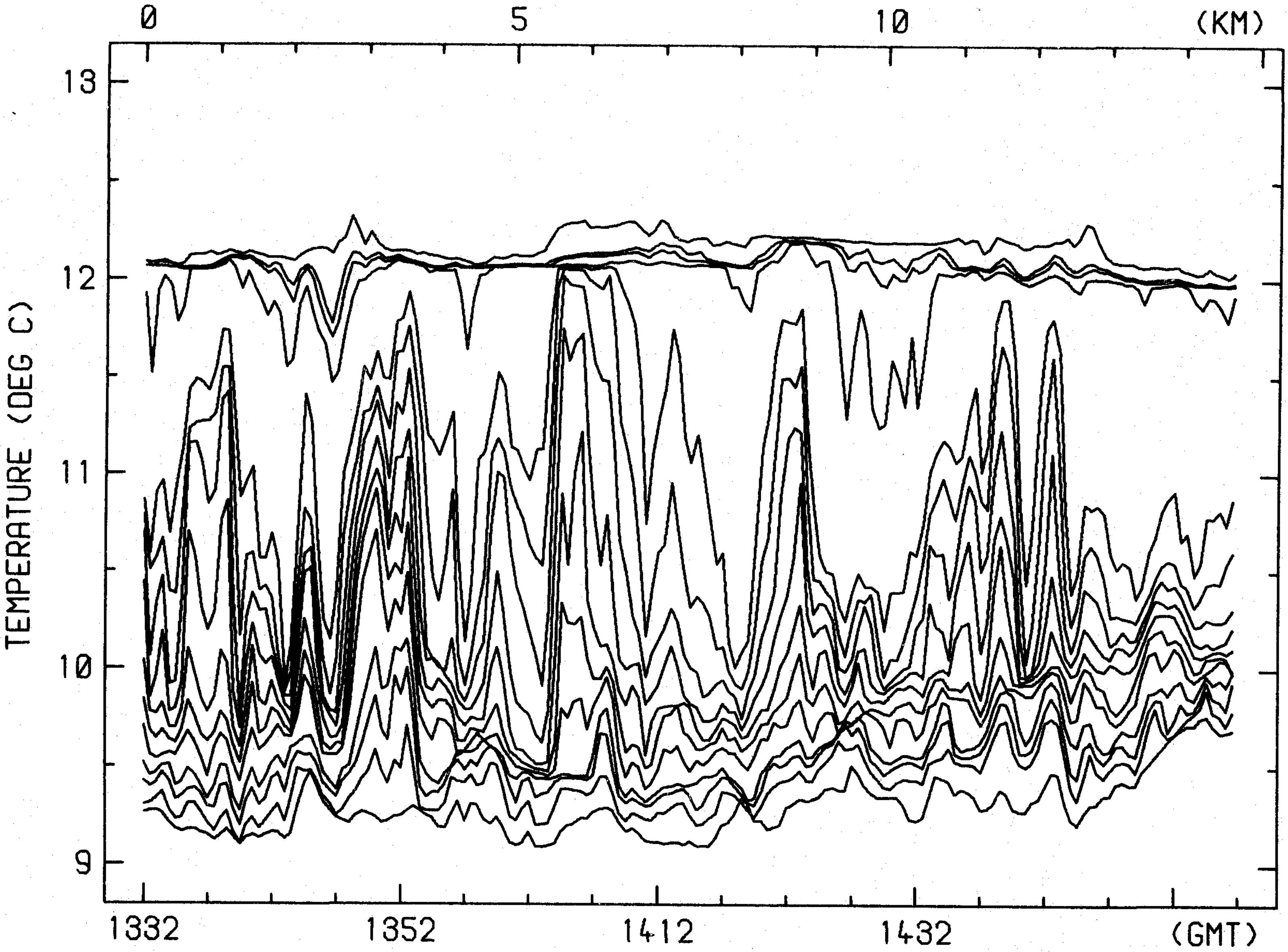
RUN 2E-7 25-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS(M) 18.6,20.5,26.5,28.5,32.5,36.5,40.6
42.6,44.6,48.7,50.7,52.8,56.9,59.0,61.0,65.2



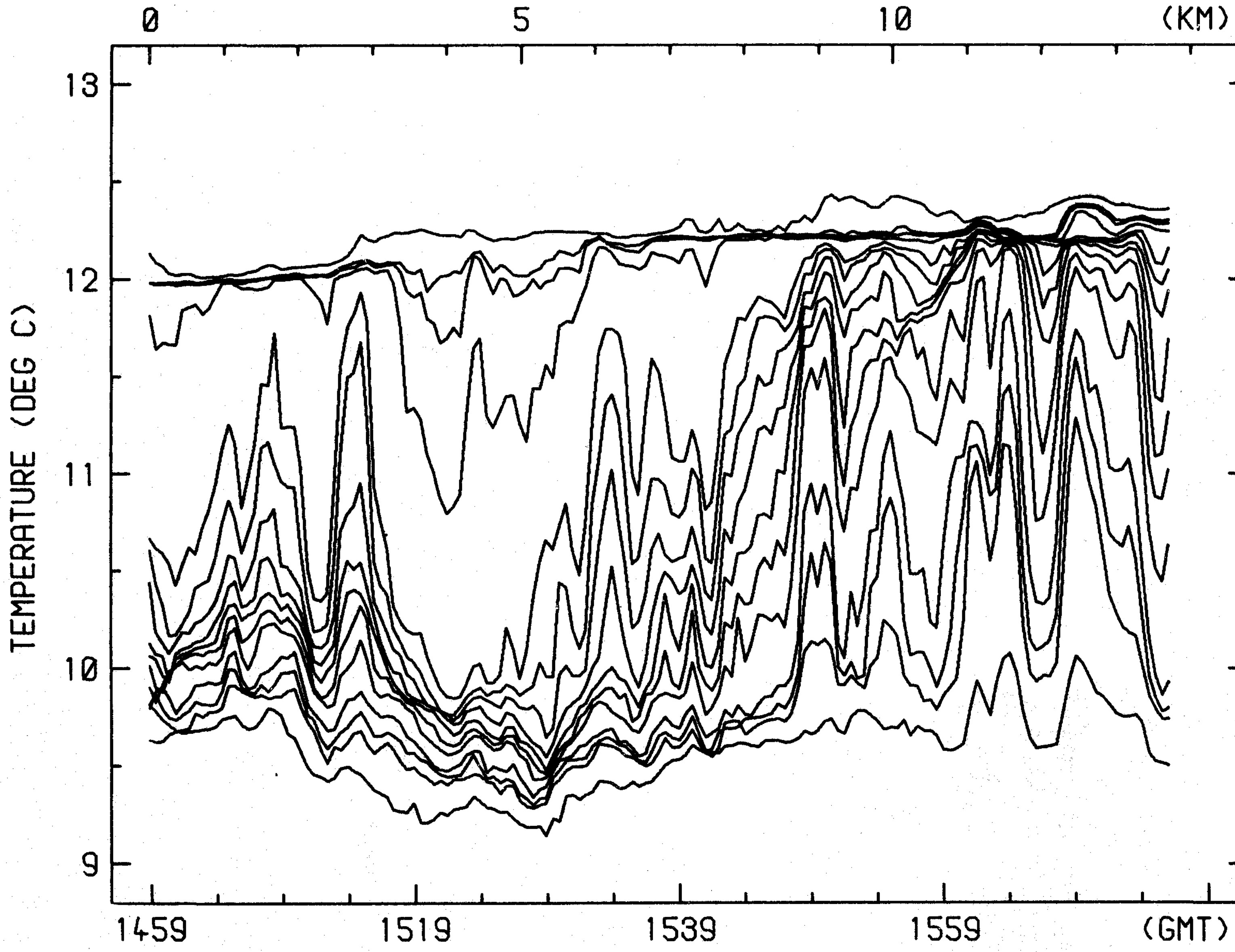
RUN 2N-8 25-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS(M) 18.6,20.5,26.5,28.5,32.5,36.5,40.6
42.6,44.6,48.7,50.7,52.8,56.9,59.0,61.0,65.2



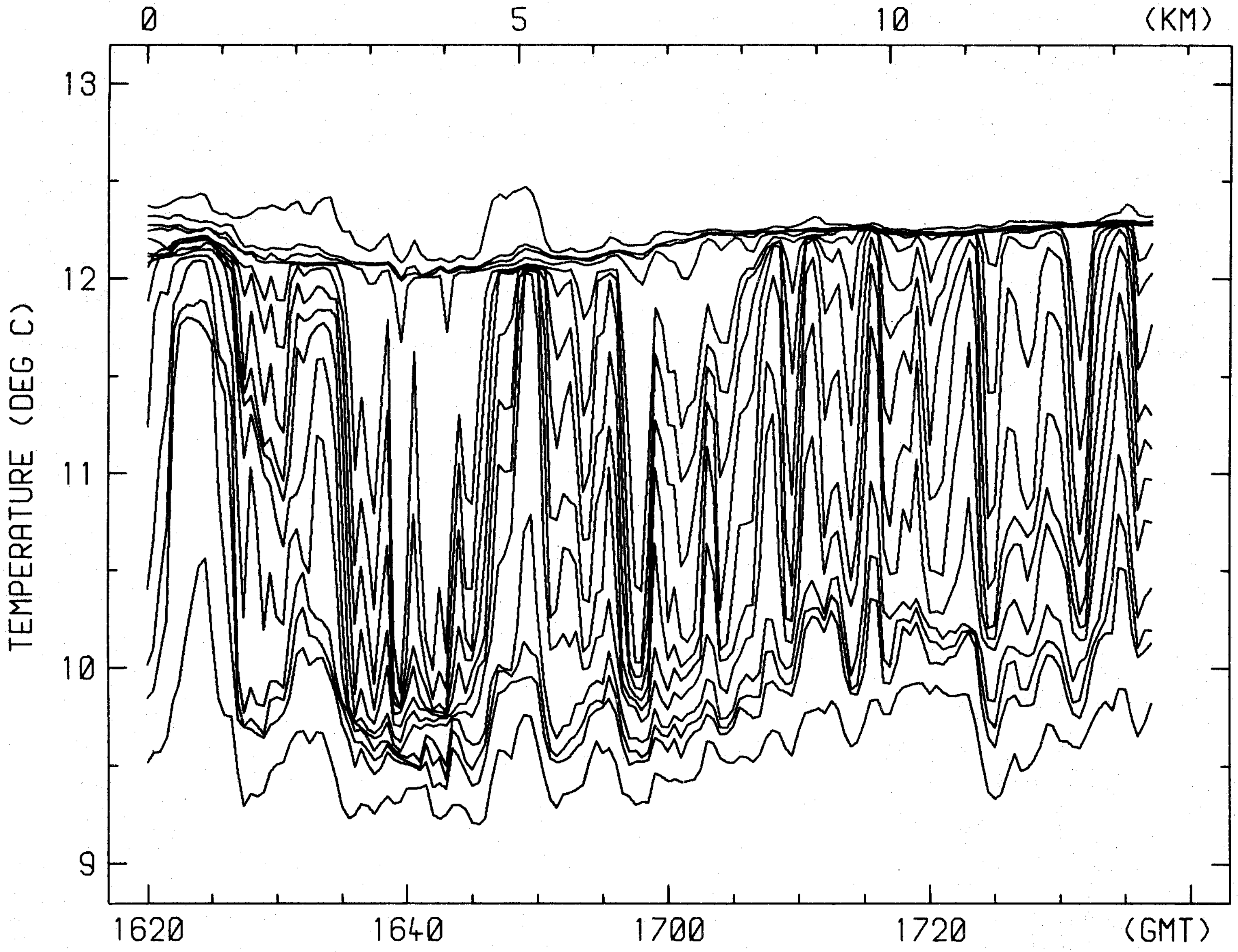
RUN 3N-1 27-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,26.5,28.5,32.5,40.6,42.6
44.6,46.7,48.7,50.7,52.8,56.9,59.0,61.0,69.3



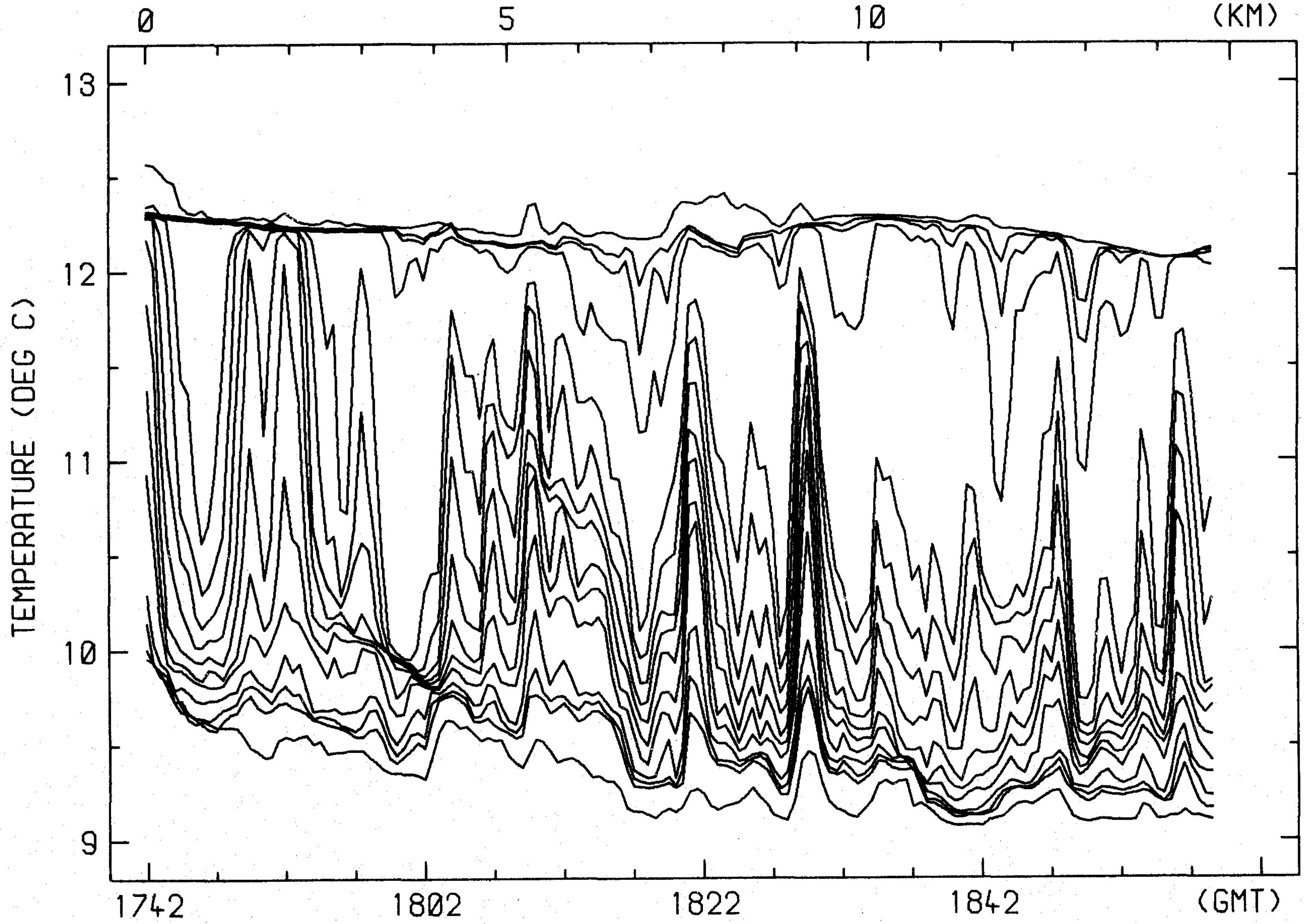
RUN 3W-2 27-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,26.5,28.5,32.5,40.6,42.6
44.6,46.7,48.7,50.7,52.8,56.9,59.0,61.0,69.3



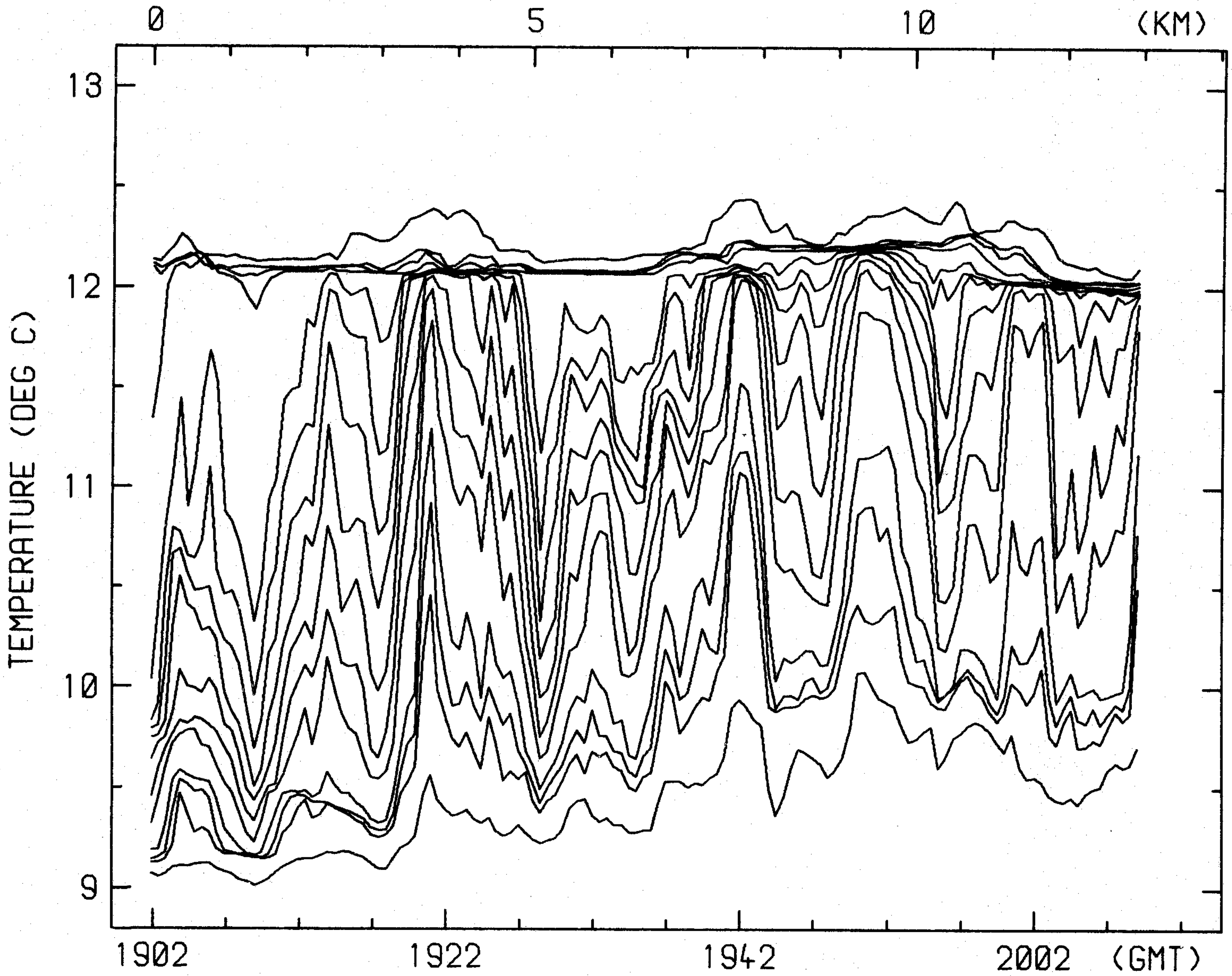
RUN 3S-3 27-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6, 26.5, 28.5, 32.5, 40.6, 42.6
44.6, 46.7, 48.7, 50.7, 52.8, 56.9, 59.0, 61.0, 69.3



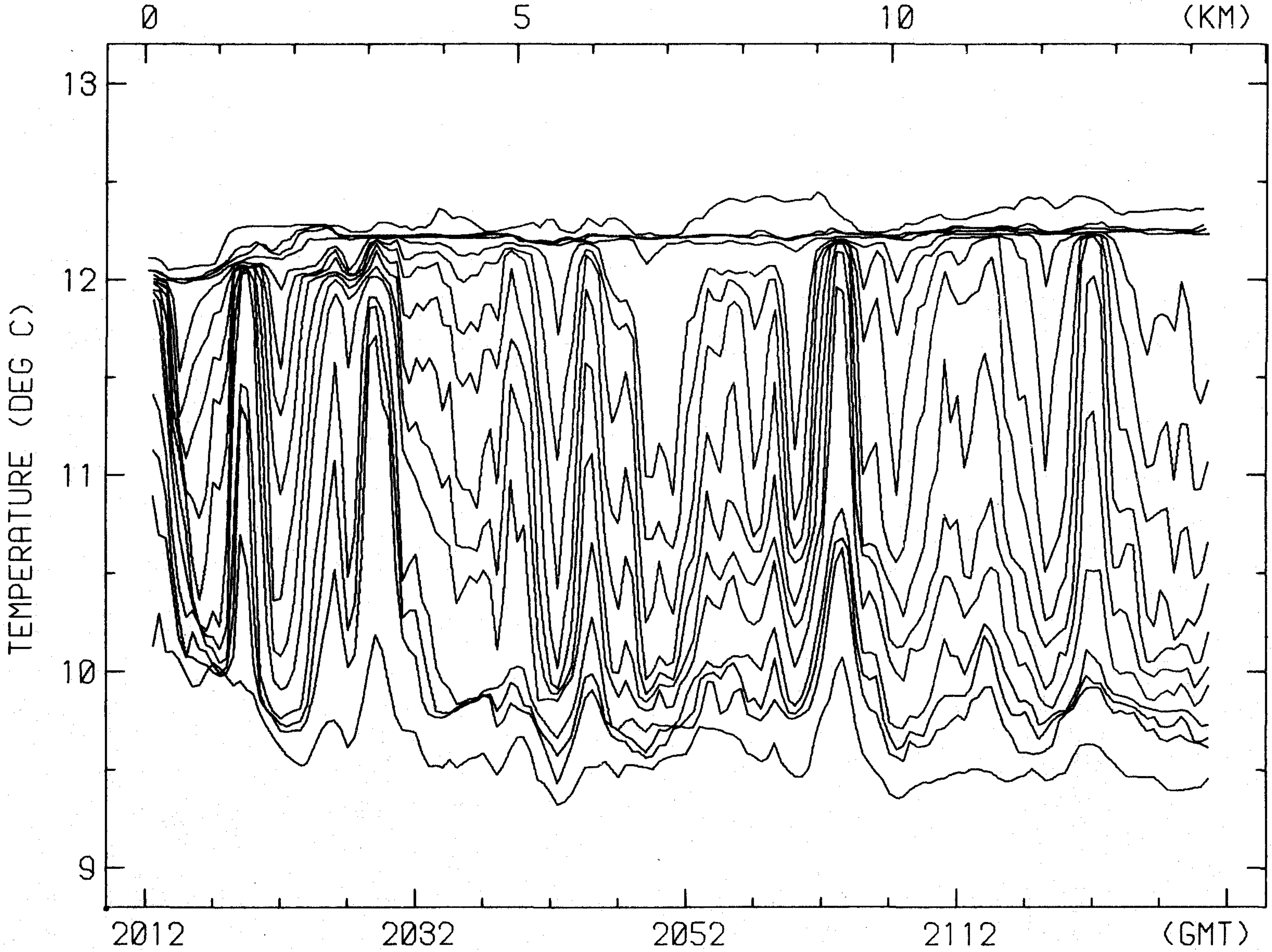
RUN 3E-4 27-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,26.5,28.5,32.5,40.6,42.6
44.6,46.7,48.7,50.7,52.8,56.9,59.0,61.0,69.3



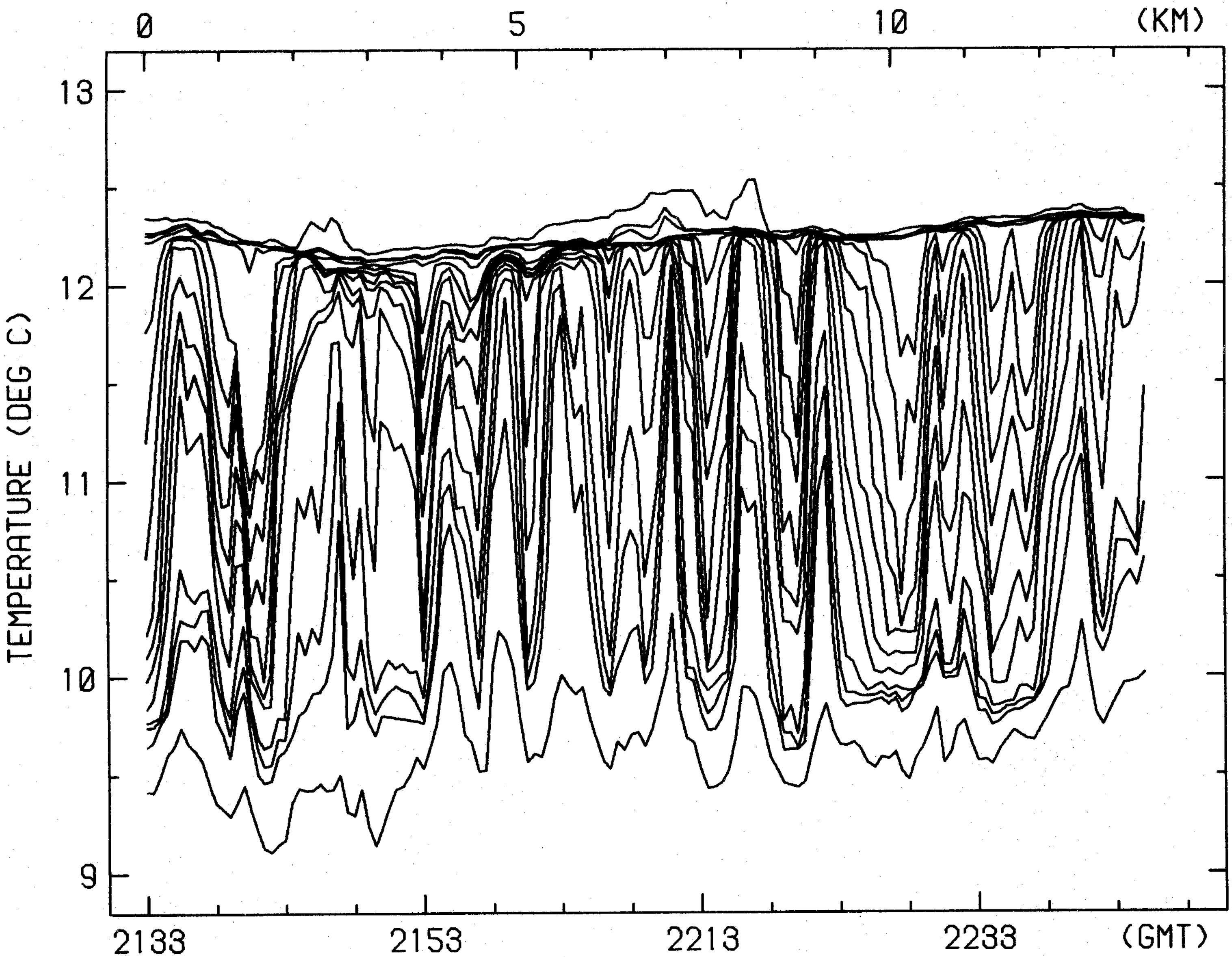
RUN 3N-5 27-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,26.5,28.5,32.5,40.6,42.6
44.6,46.7,48.7,50.7,52.8,56.9,59.0,61.0,69.3



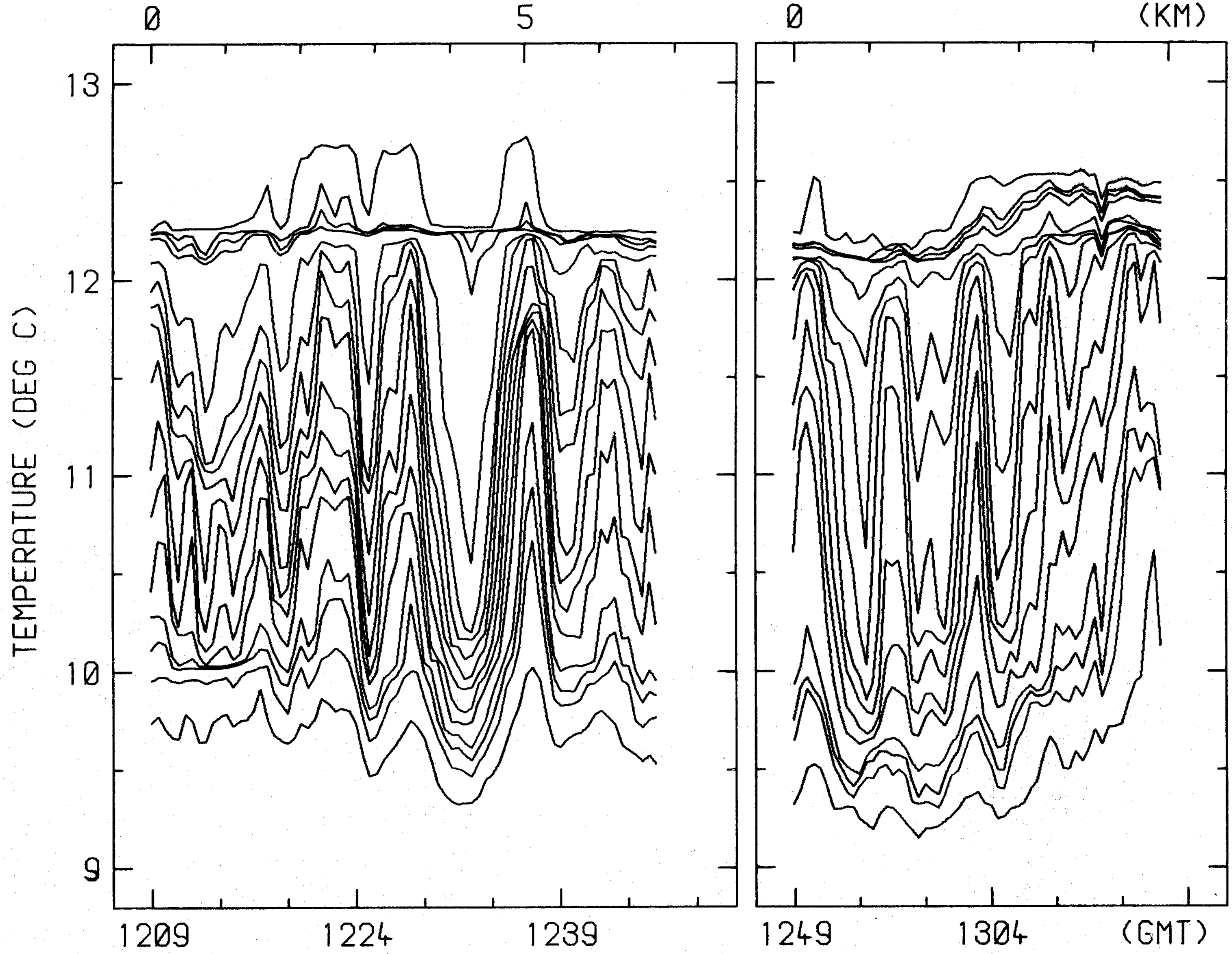
RUN 3W-6 27-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6, 26.5, 28.5, 32.5, 40.6, 42.6
44.6, 46.7, 48.7, 50.7, 52.8, 56.9, 59.0, 61.0, 69.3



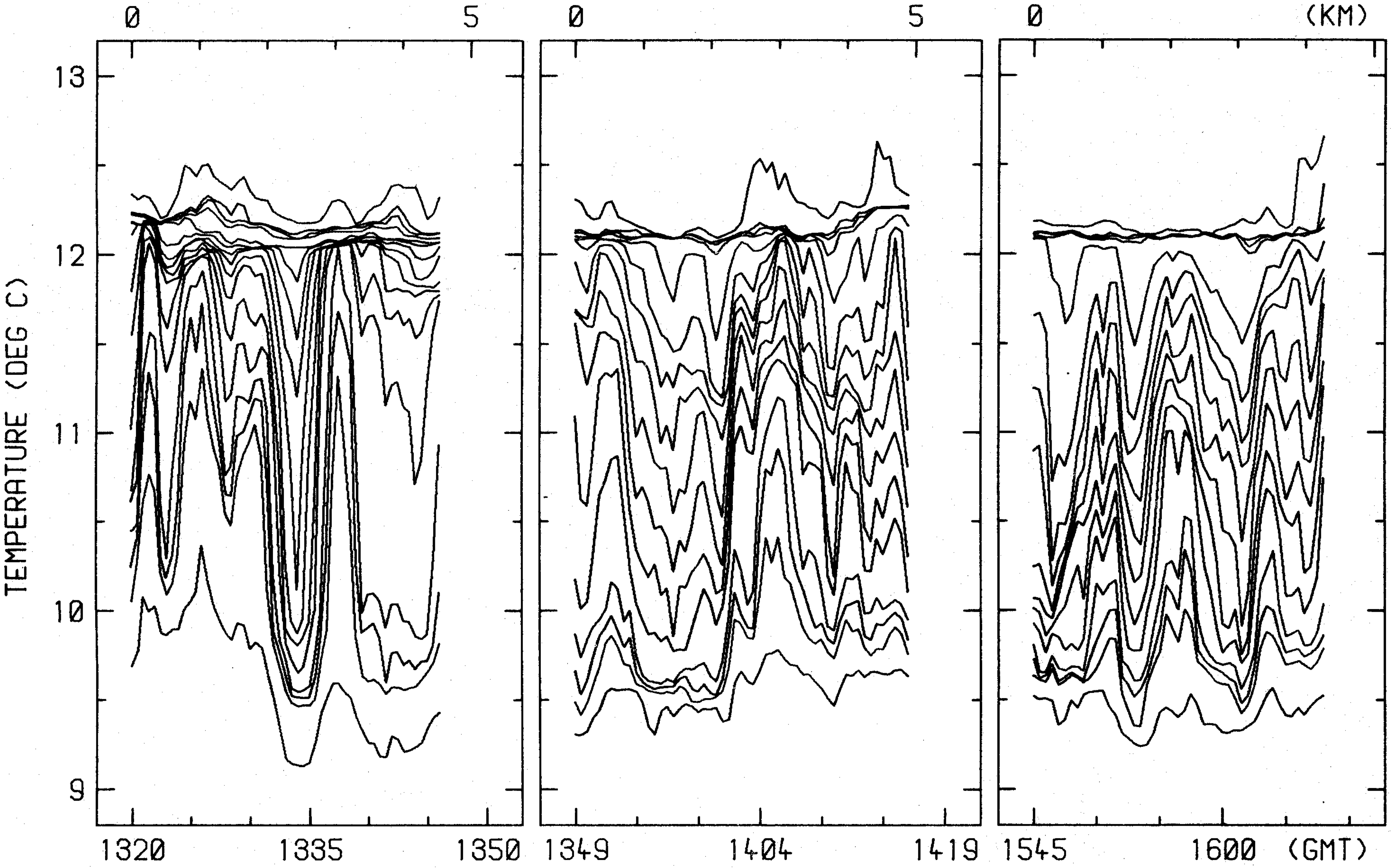
RUN 3S-7 27-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,26.5,28.5,32.5,40.6,42.6
44.6,46.7,48.7,50.7,52.8,56.9,59.0,61.0,69.3



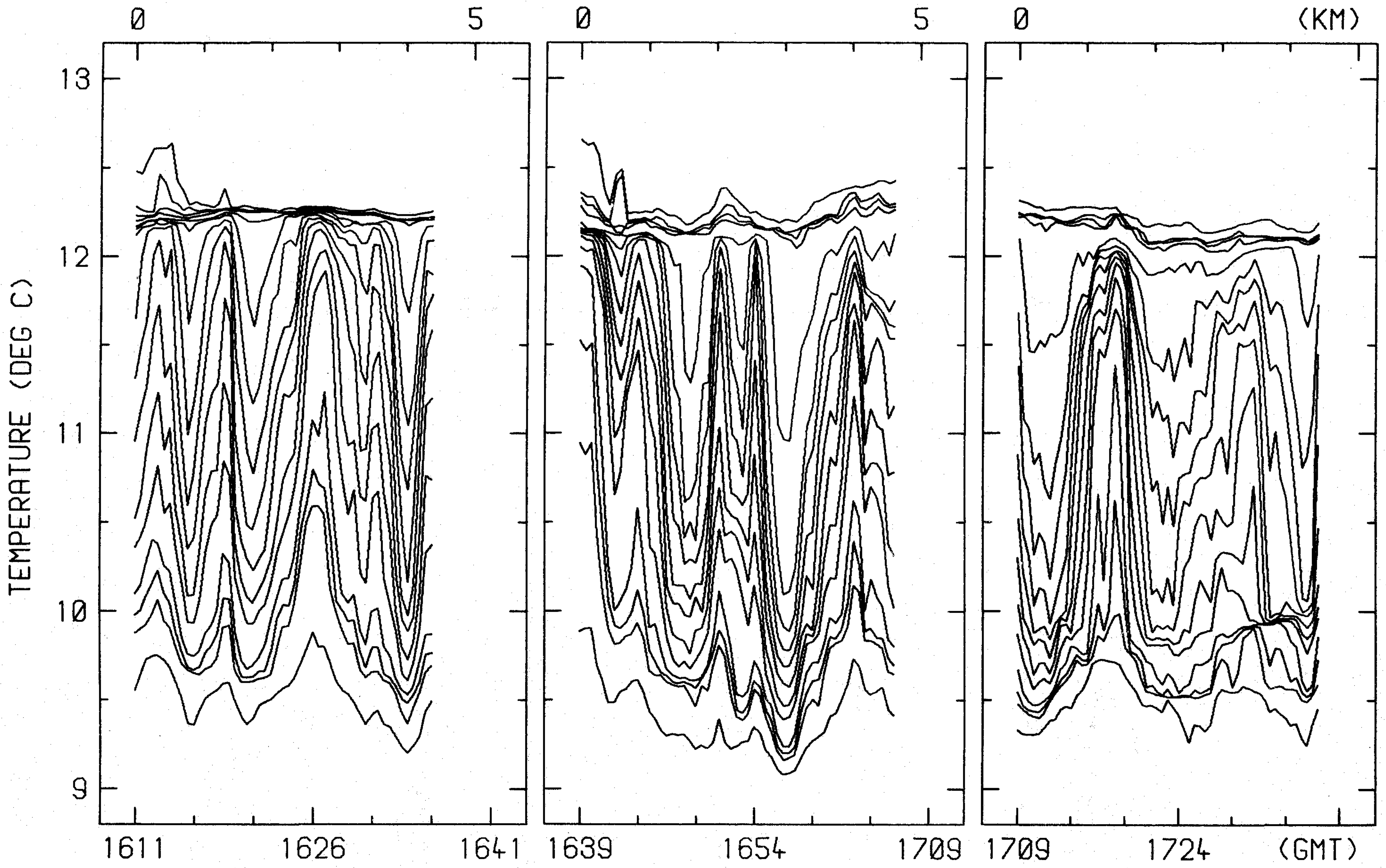
RUN 3E-8 27-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,26.5,28.5,32.5,40.6,42.6
44.6,46.7,48.7,50.7,52.8,56.9,59.0,61.0,69.3



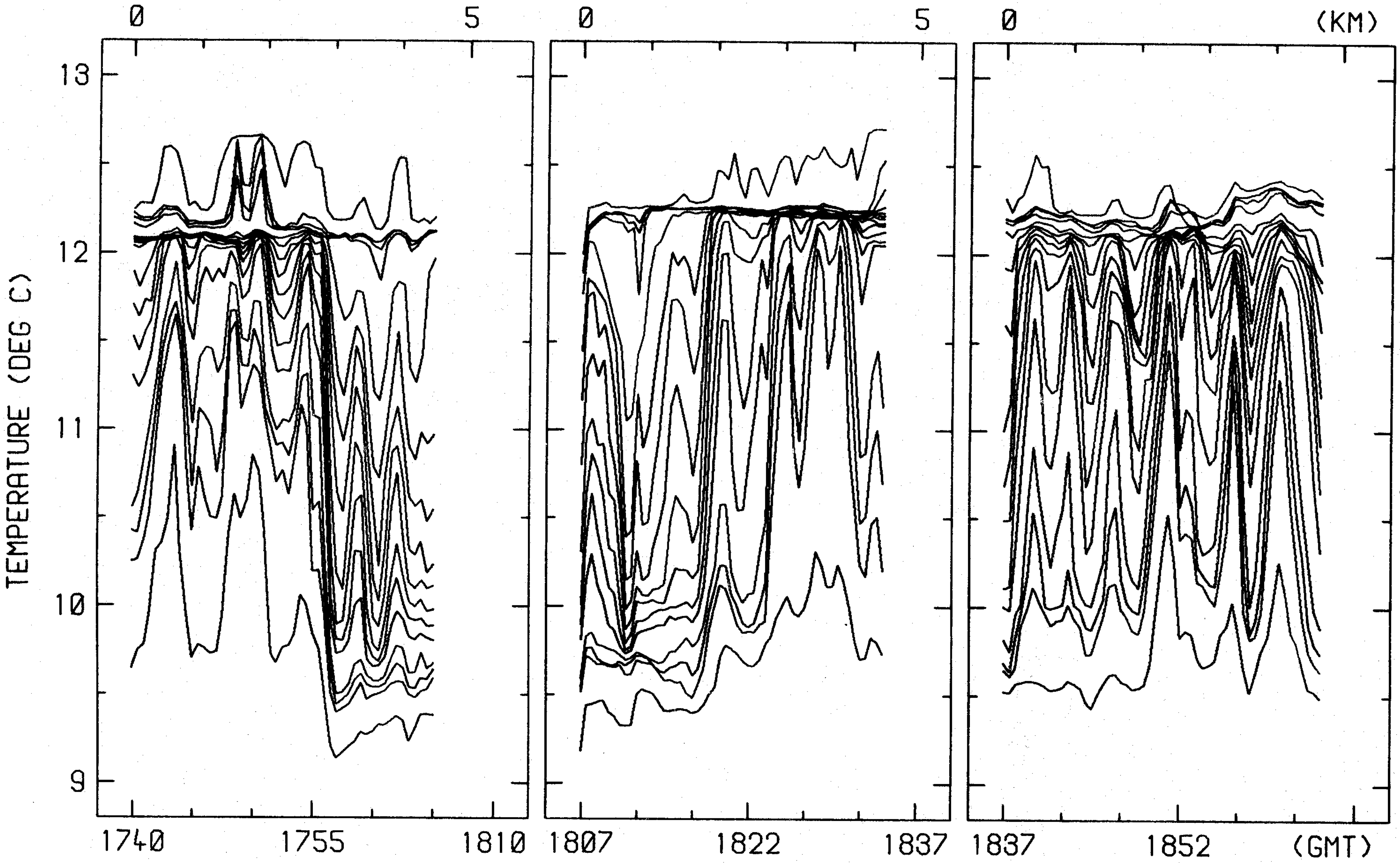
RUNS 4N-1, 4W-2 29-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.9,24.9,26.9,28.9,37.0,41.1,43.1
45.1,47.2,49.2,51.3,53.4,57.5,59.5,61.6,69.9



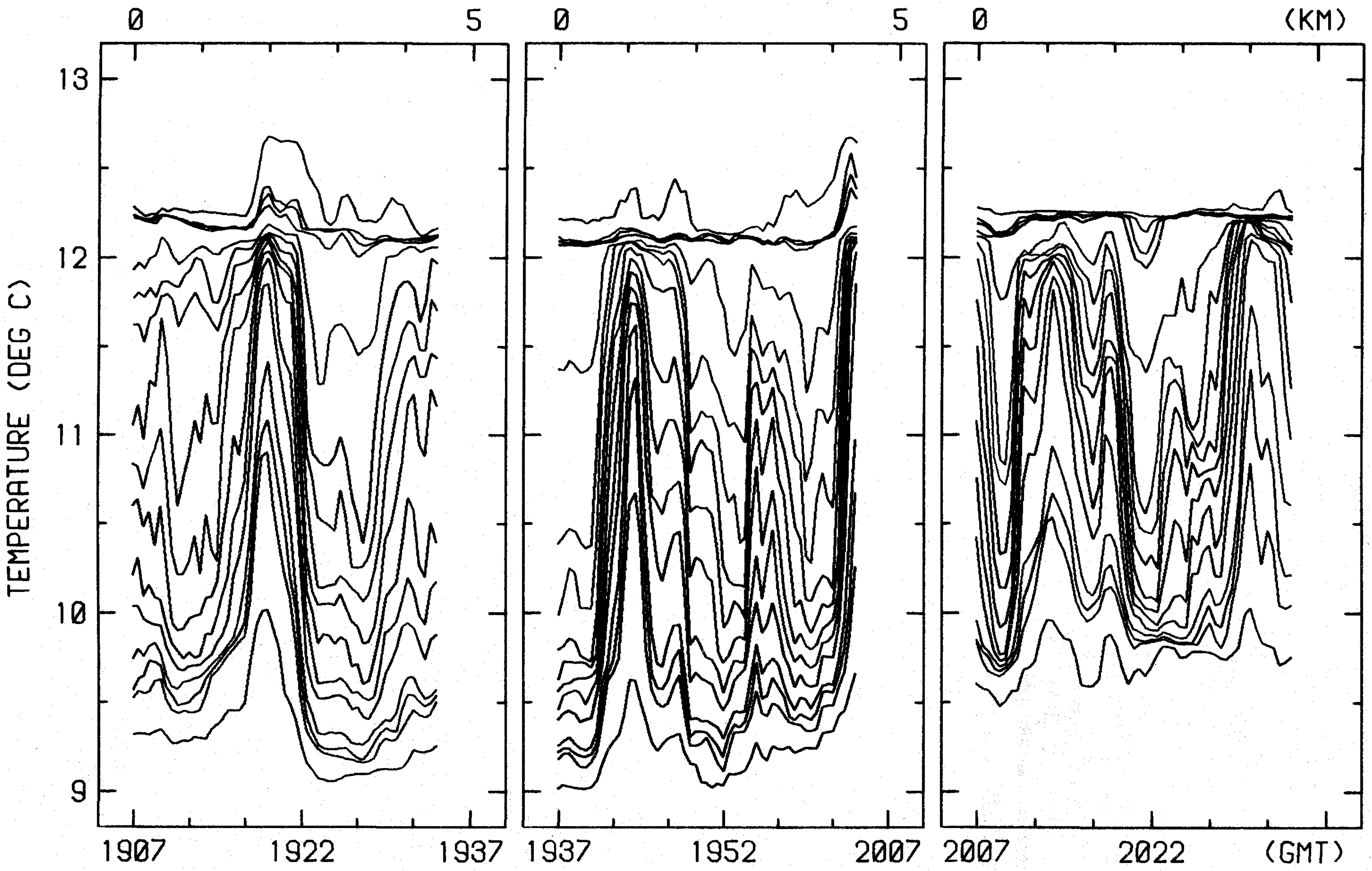
RUNS 4S-3, 4E-4, 4E-5 29-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.9,24.9,26.9,28.9,37.0,41.1,43.1
45.1,47.2,49.2,51.3,53.4,57.5,59.5,61.6,69.9



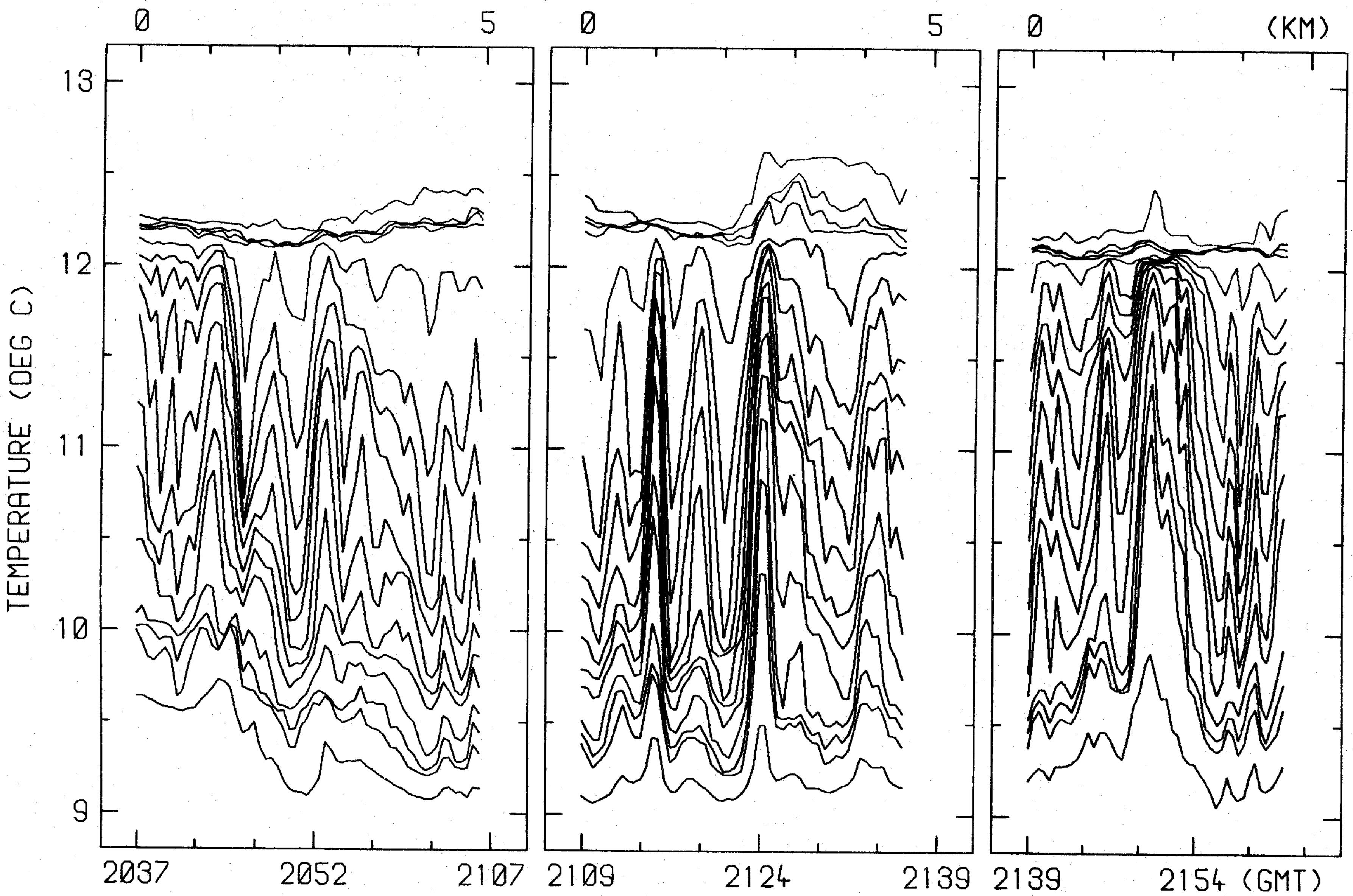
RUNS 4N-6, 4W-7, 4S-8 29-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.9, 24.9, 26.9, 28.9, 37.0, 41.1, 43.1
45.1, 47.2, 49.2, 51.3, 53.4, 57.5, 59.5, 61.6, 69.9



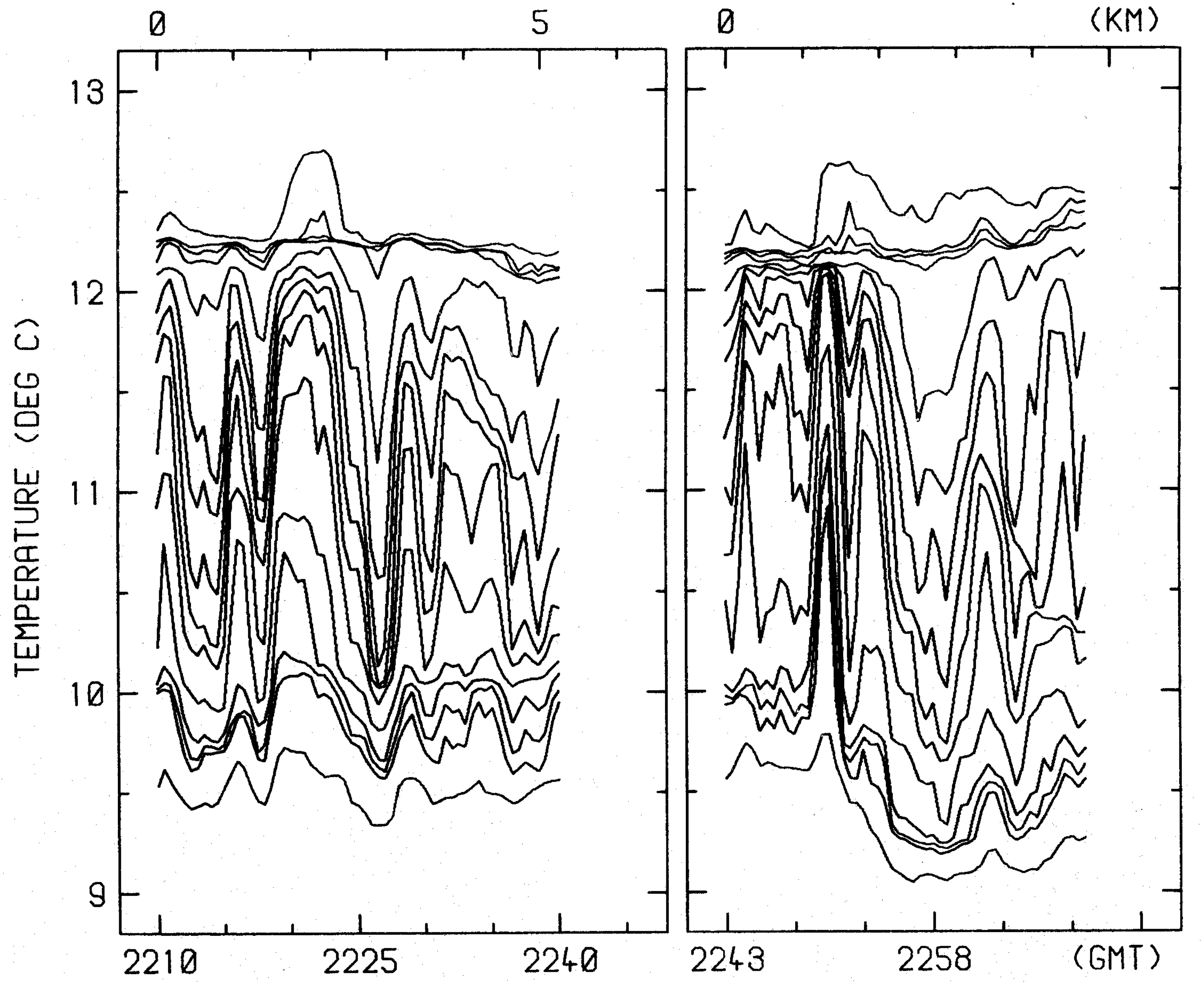
RUNS 4E-9, 4N-10, 4W-11 29-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.9,24.9,26.9,28.9,37.0,41.1,43.1
45.1,47.2,49.2,51.3,53.4,57.5,59.5,61.6,69.9



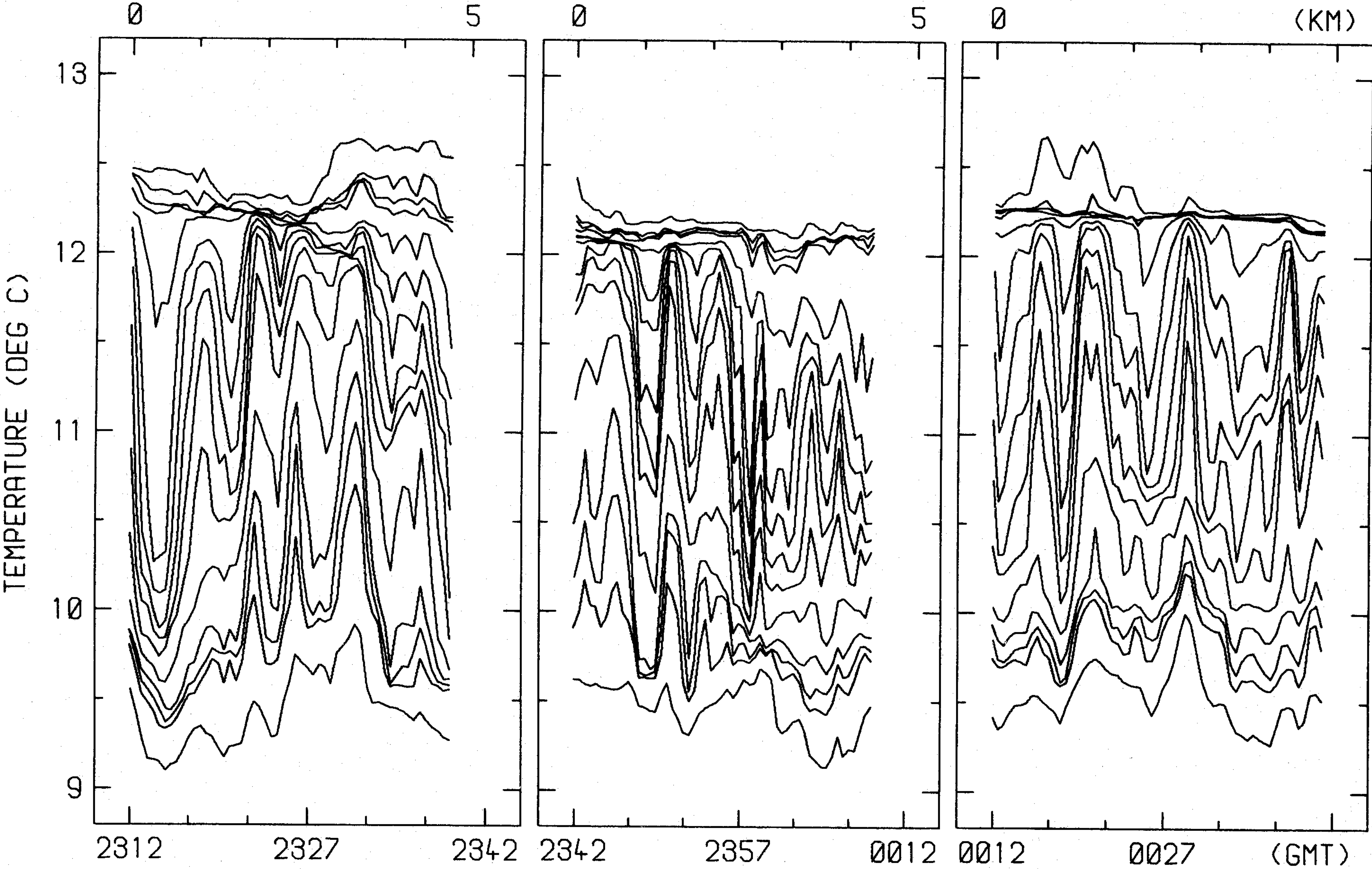
RUNS 4S-12, 4E-13, 4N-14 29-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.9,24.9,26.9,28.9,37.0,41.1,43.1
45.1,47.2,49.2,51.3,53.4,57.5,59.5,61.6,69.9



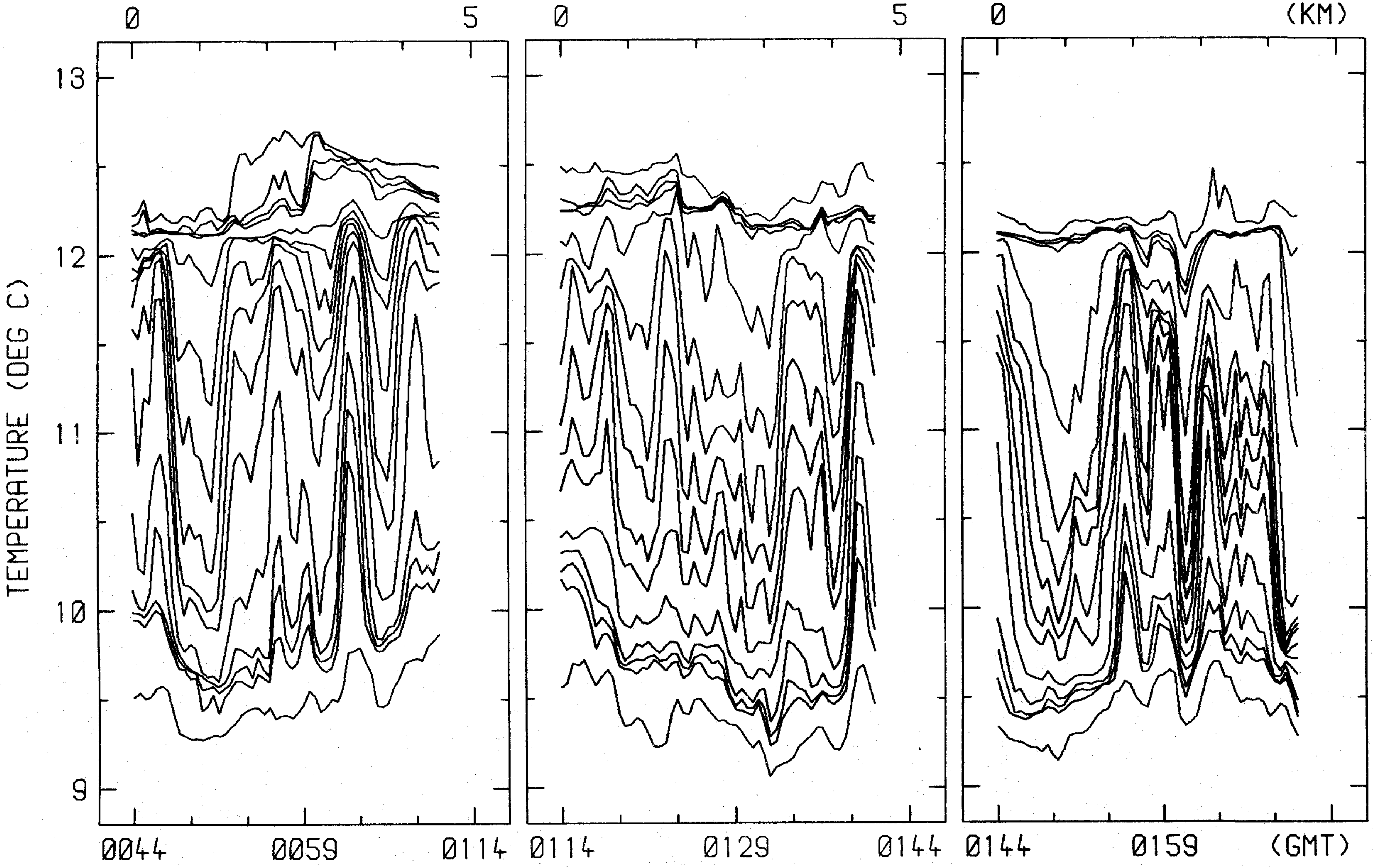
RUNS 4W-15, 4S-16, 4E-17 29-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.9, 24.9, 26.9, 28.9, 37.0, 41.1, 43.1
45.1, 47.2, 49.2, 51.3, 53.4, 57.5, 59.5, 61.6, 69.9



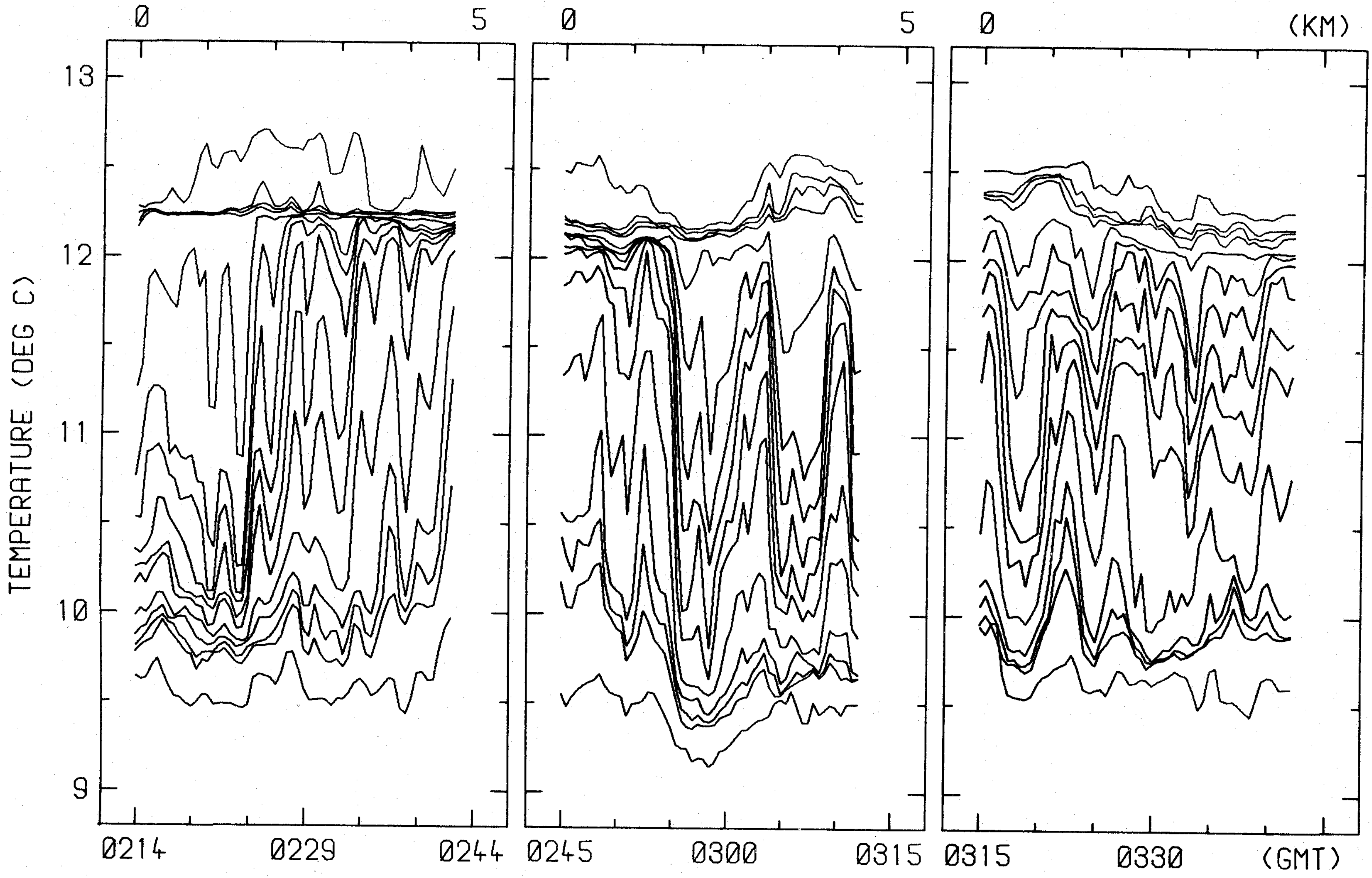
RUNS 4N-18, 4W-19 29-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.9, 24.9, 26.9, 28.9, 37.0, 41.1, 43.1
45.1, 47.2, 49.2, 53.4, 57.5, 59.5, 61.6, 69.9



RUNS 4S-20, 4E-21, 4N-22 29,30-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.9,24.9,26.9,28.9,37.0,41.1,43.1
45.1,47.2,49.2,53.4,57.5,59.5,61.6,69.9



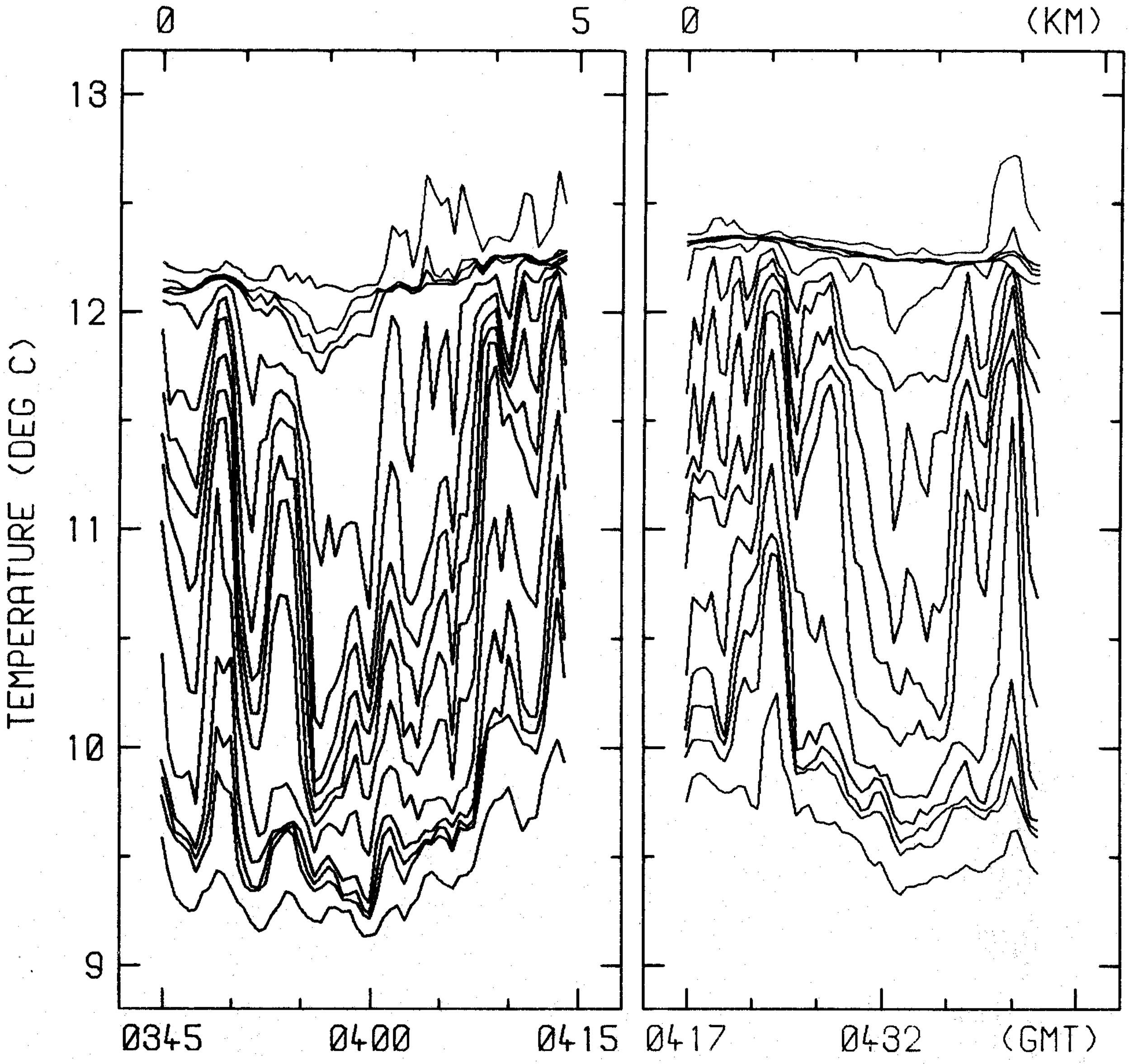
RUNS 4W-23, 4S-24, 4E-25 30-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.9,24.9,26.9,28.9,37.0,41.1,43.1
45.1,47.2,49.2,53.4,57.5,59.5,61.6,69.9



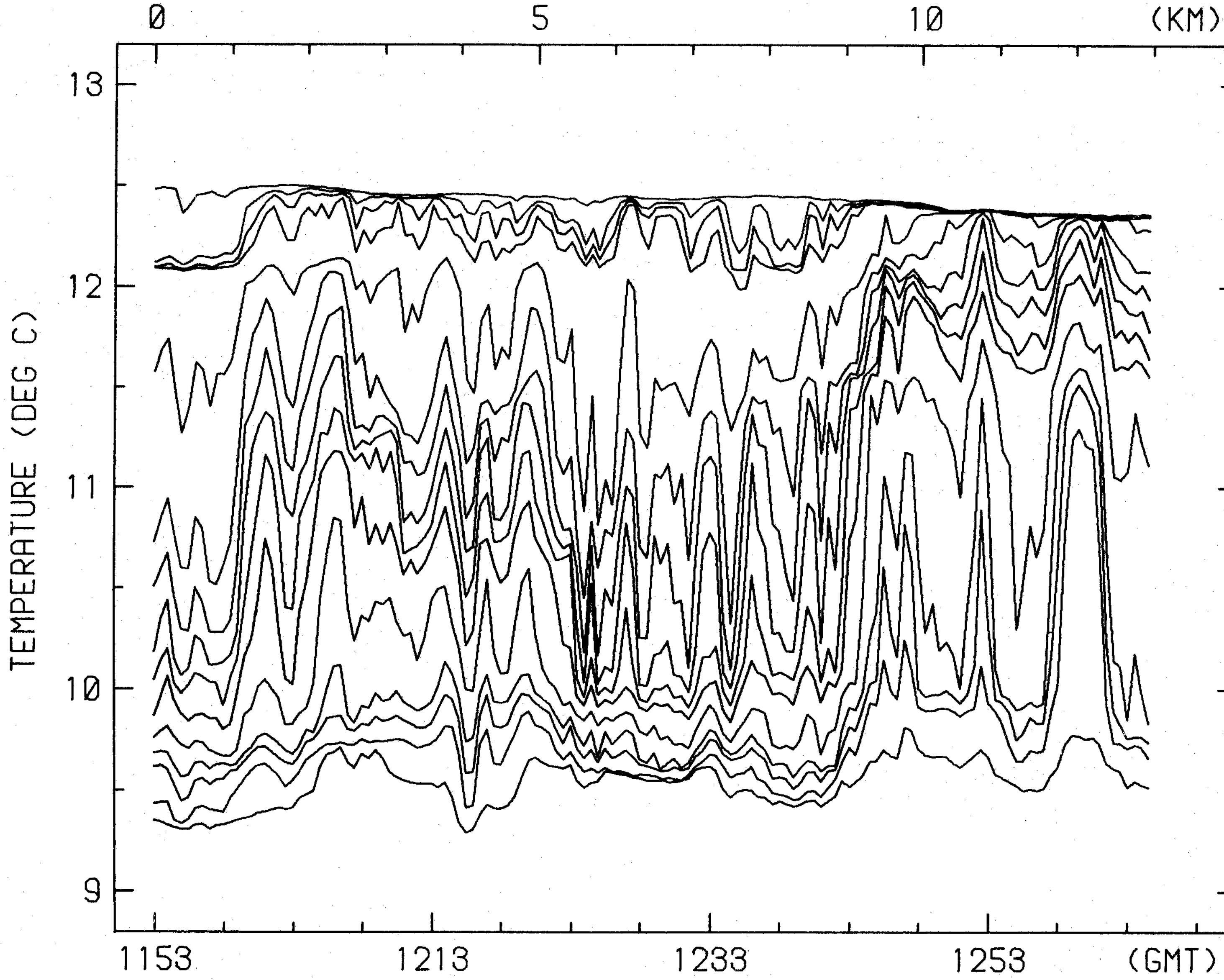
RUNS 4N-26, 4W-27, 4S-28 30-AUG-78 TEMPERATURE VS TIME/DISTANCE

DEPTHS (M) 18.9,24.9,26.9,28.9,37.0,41.1,43.1

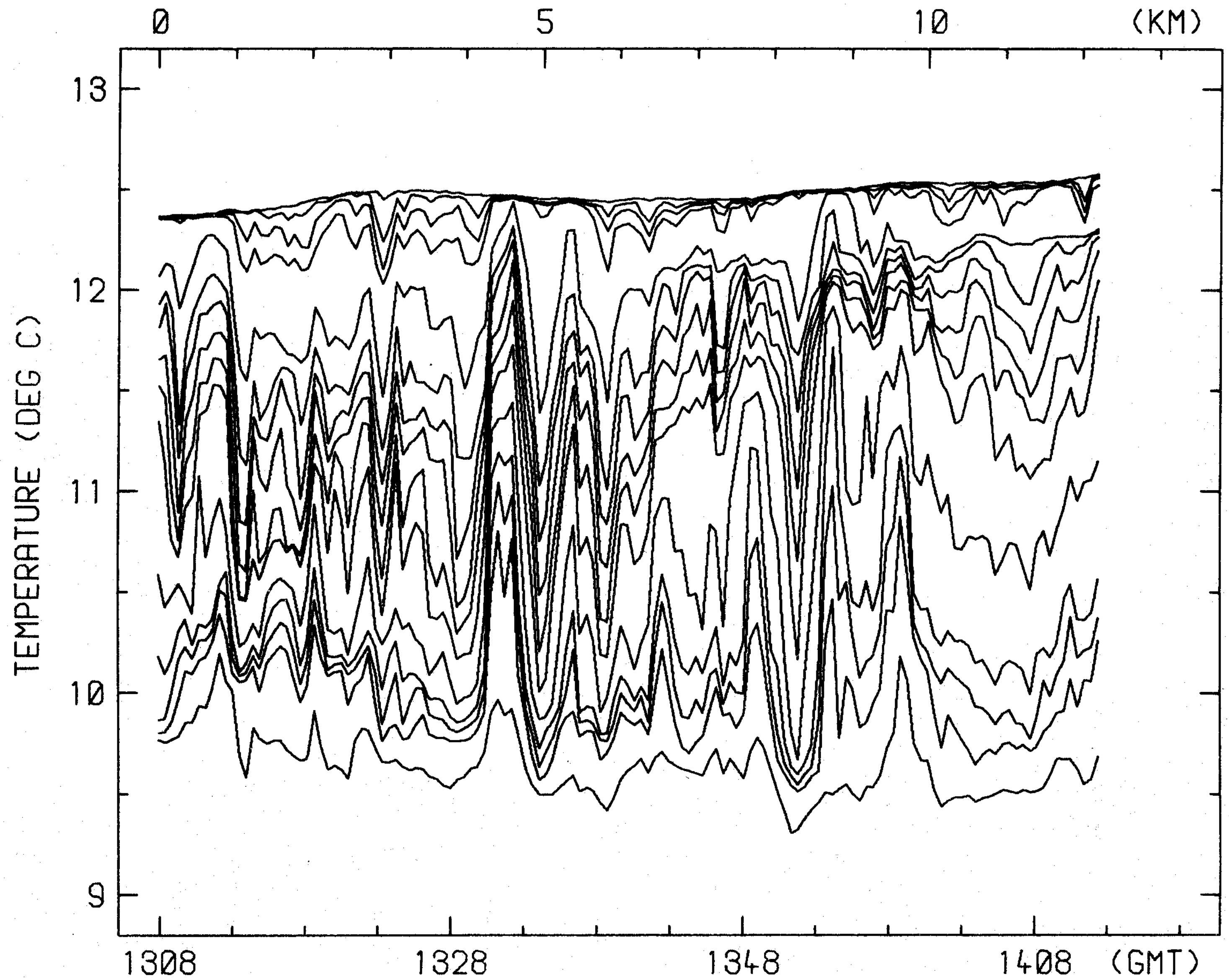
45.1,47.2,49.2,53.4,57.5,59.5,61.6,69.9



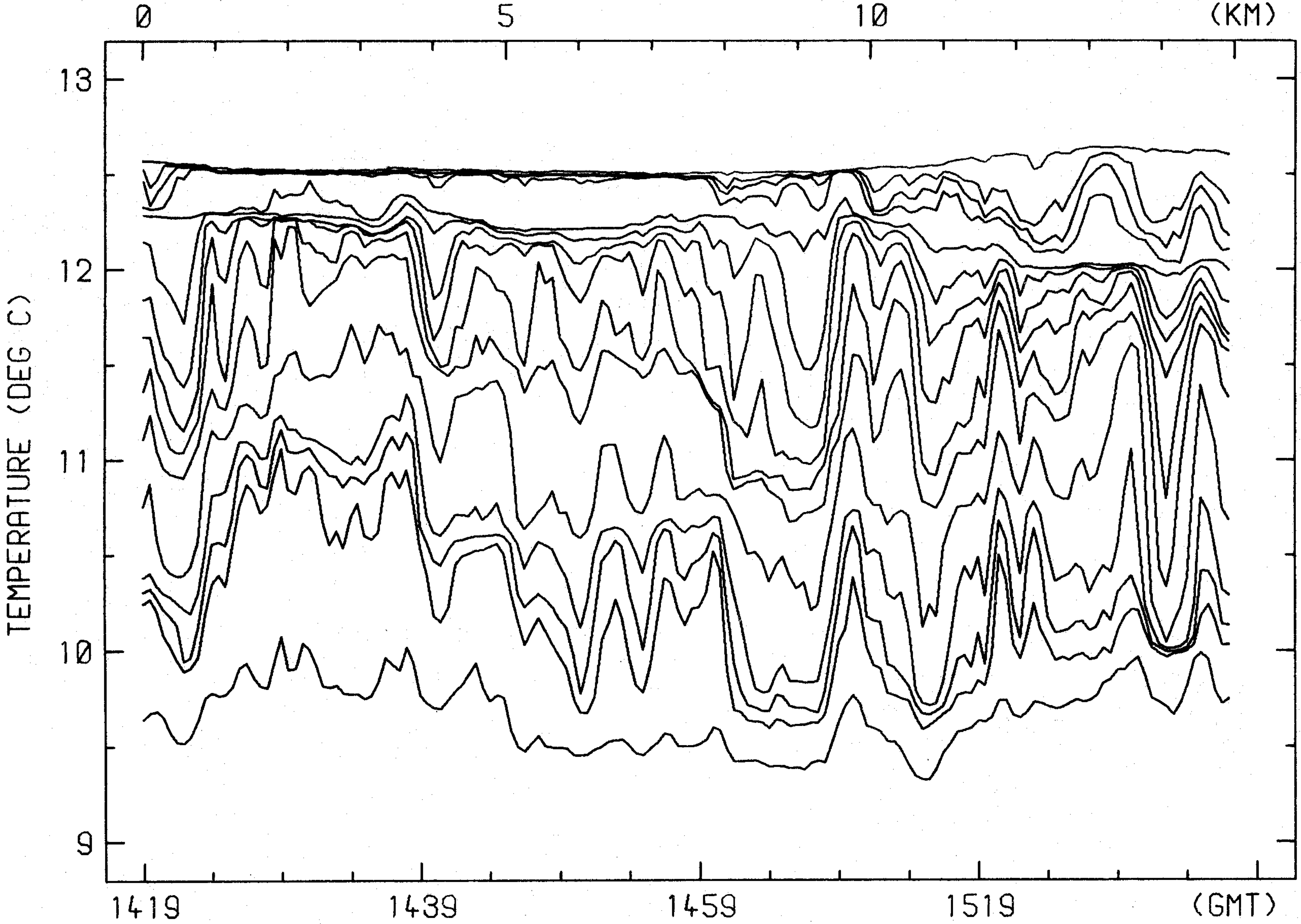
RUNS 4E-29, 4N-30 30-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.9, 24.9, 26.9, 28.9, 37.0, 41.1, 43.1
45.1, 47.2, 49.2, 53.4, 57.5, 59.5, 61.6, 69.9



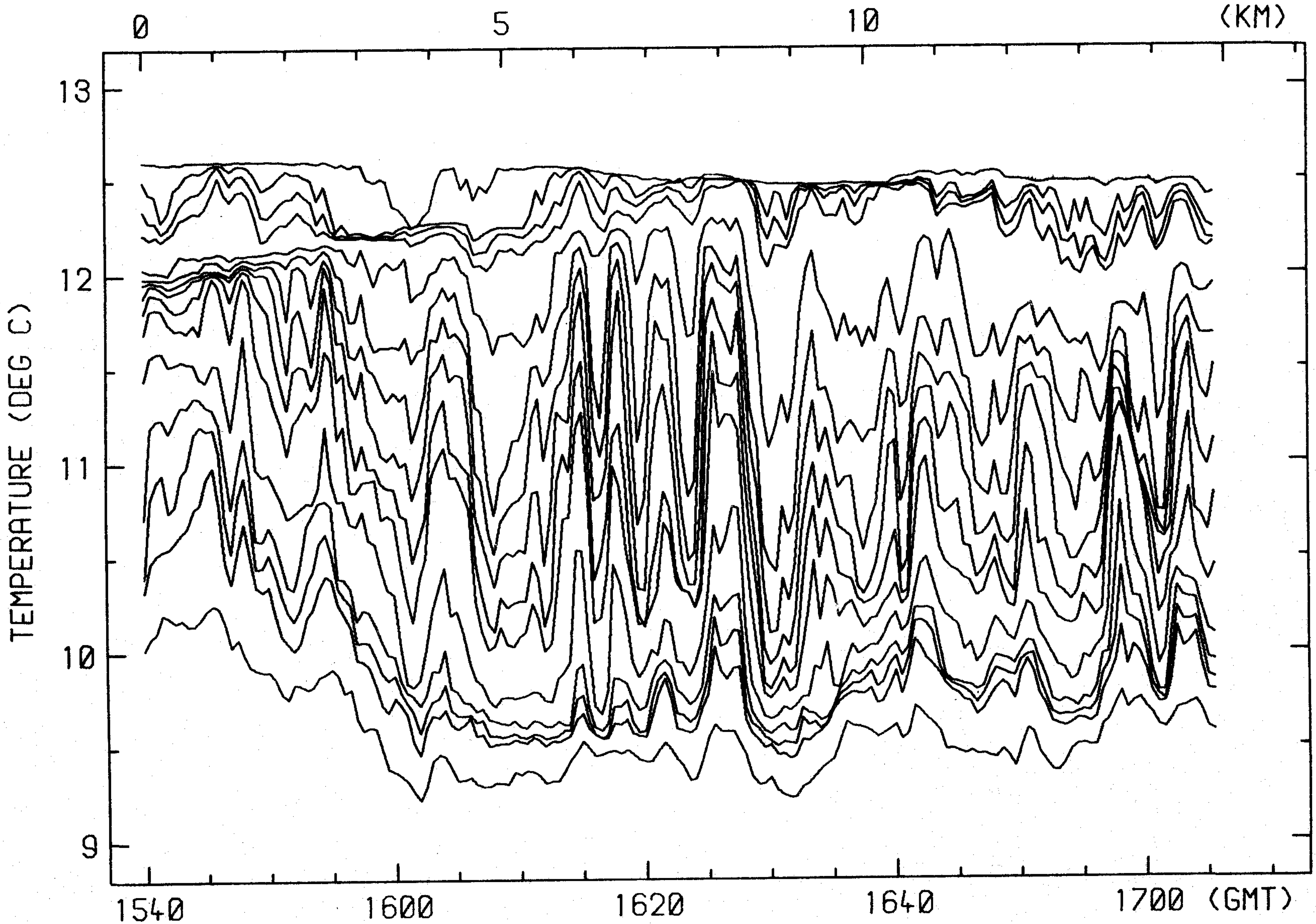
RUN 5N-1 31-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,24.5,26.5,28.5,36.5,40.6,42.6
44.6,46.7,48.7,52.8,56.9,59.0,61.0,69.3



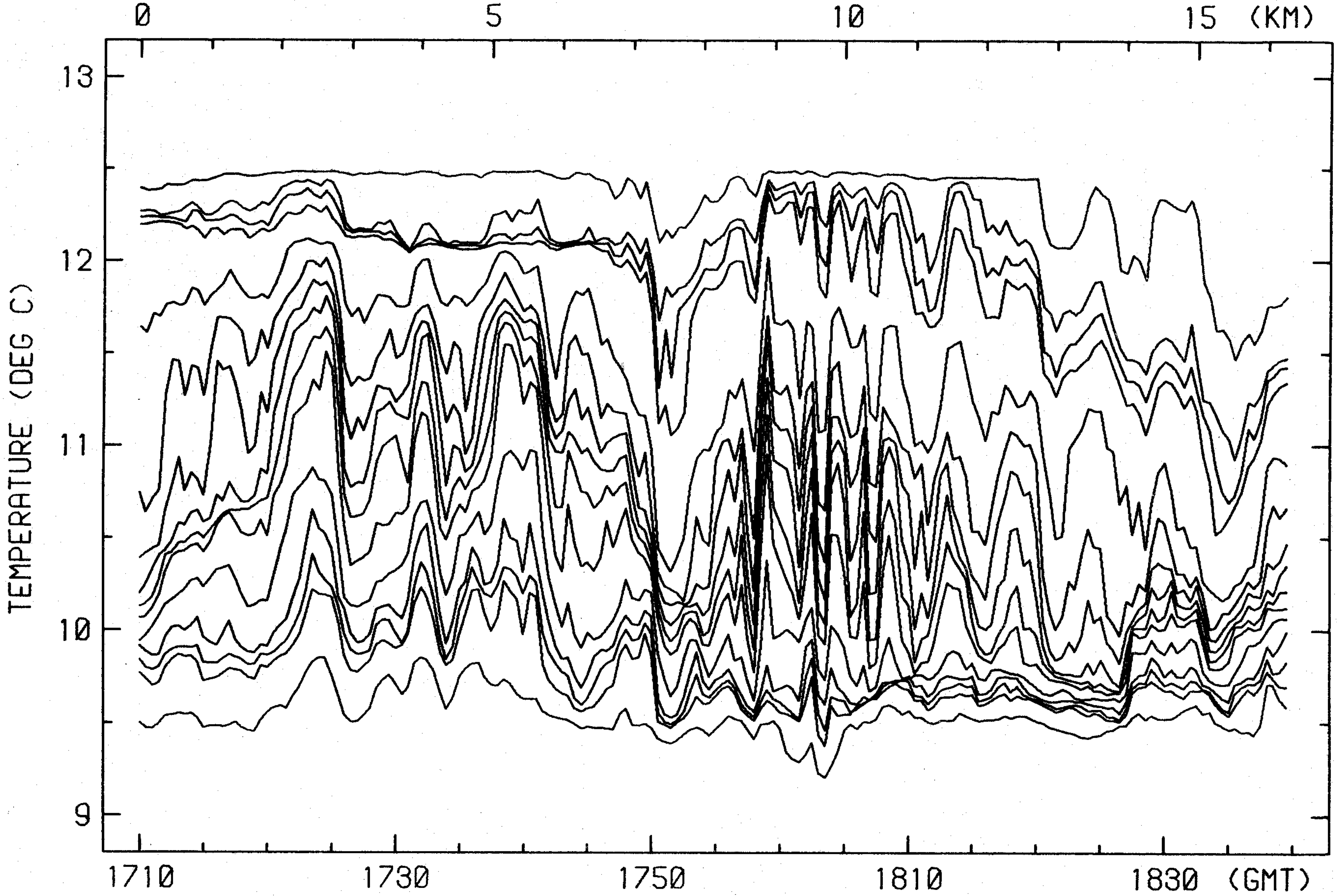
RUN 5W-2 31-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,24.5,26.5,28.5,36.5,40.6,42.6
44.6,46.7,48.7,52.8,56.9,59.0,61.0,69.3



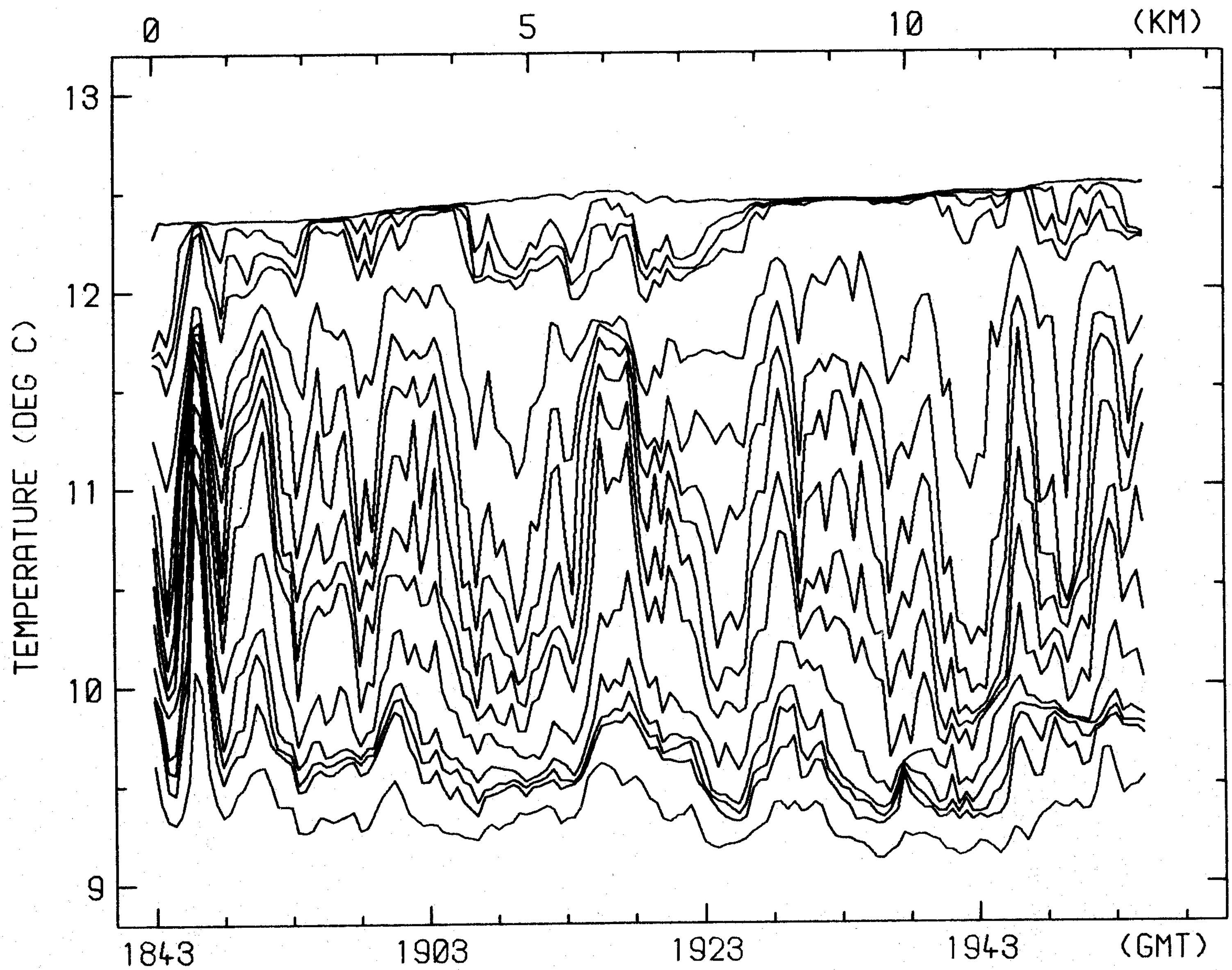
RUN 5S-3 31-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,24.5,26.5,28.5,36.5,4Ø.6,42.6
44.6,46.7,48.7,52.8,56.9,59.Ø,61.Ø,69.3



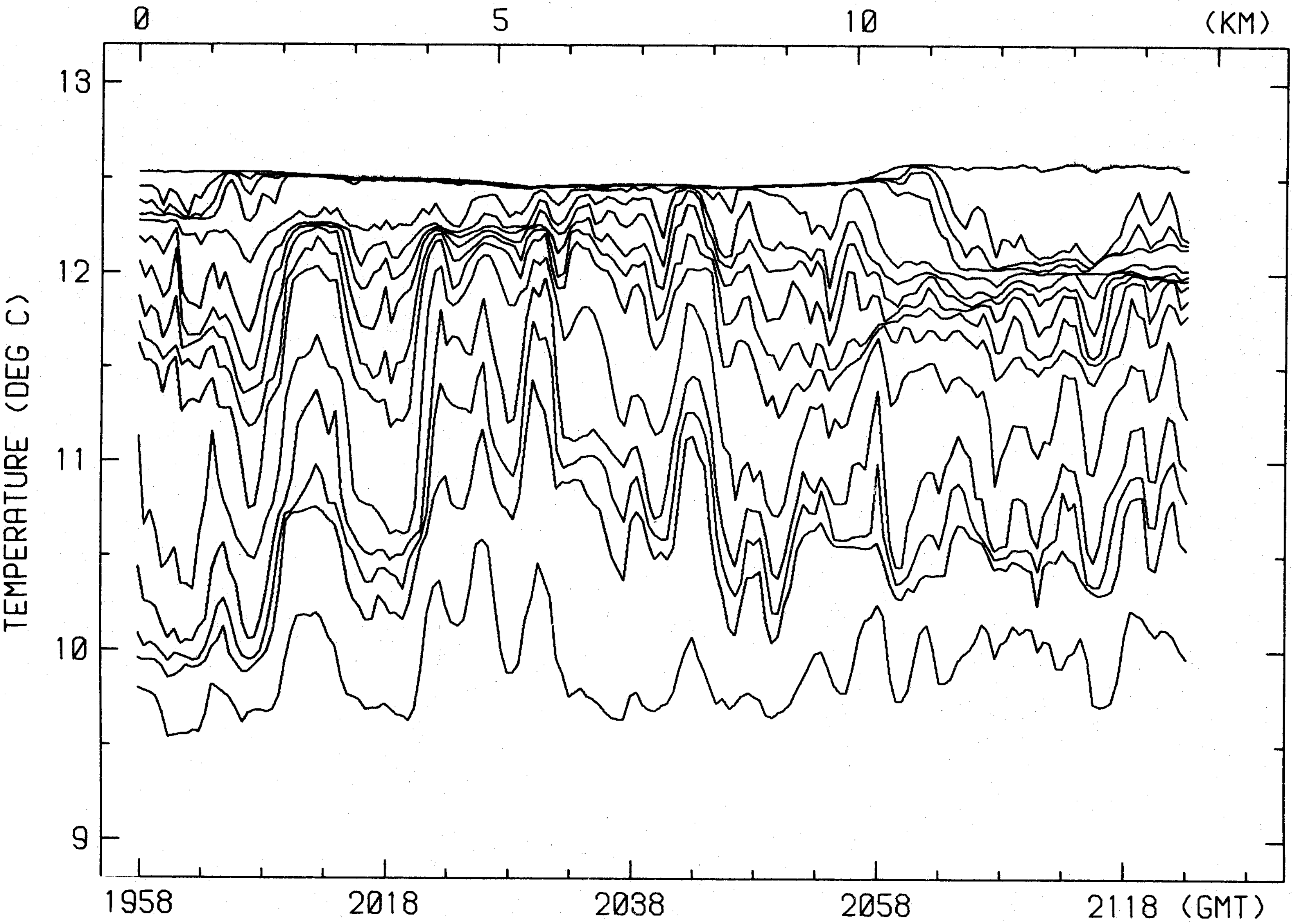
RUN 5E-4 31-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,24.5,26.5,28.5,36.5,40.6,42.6
44.6,46.7,48.7,52.8,56.9,59.0,61.0,69.3



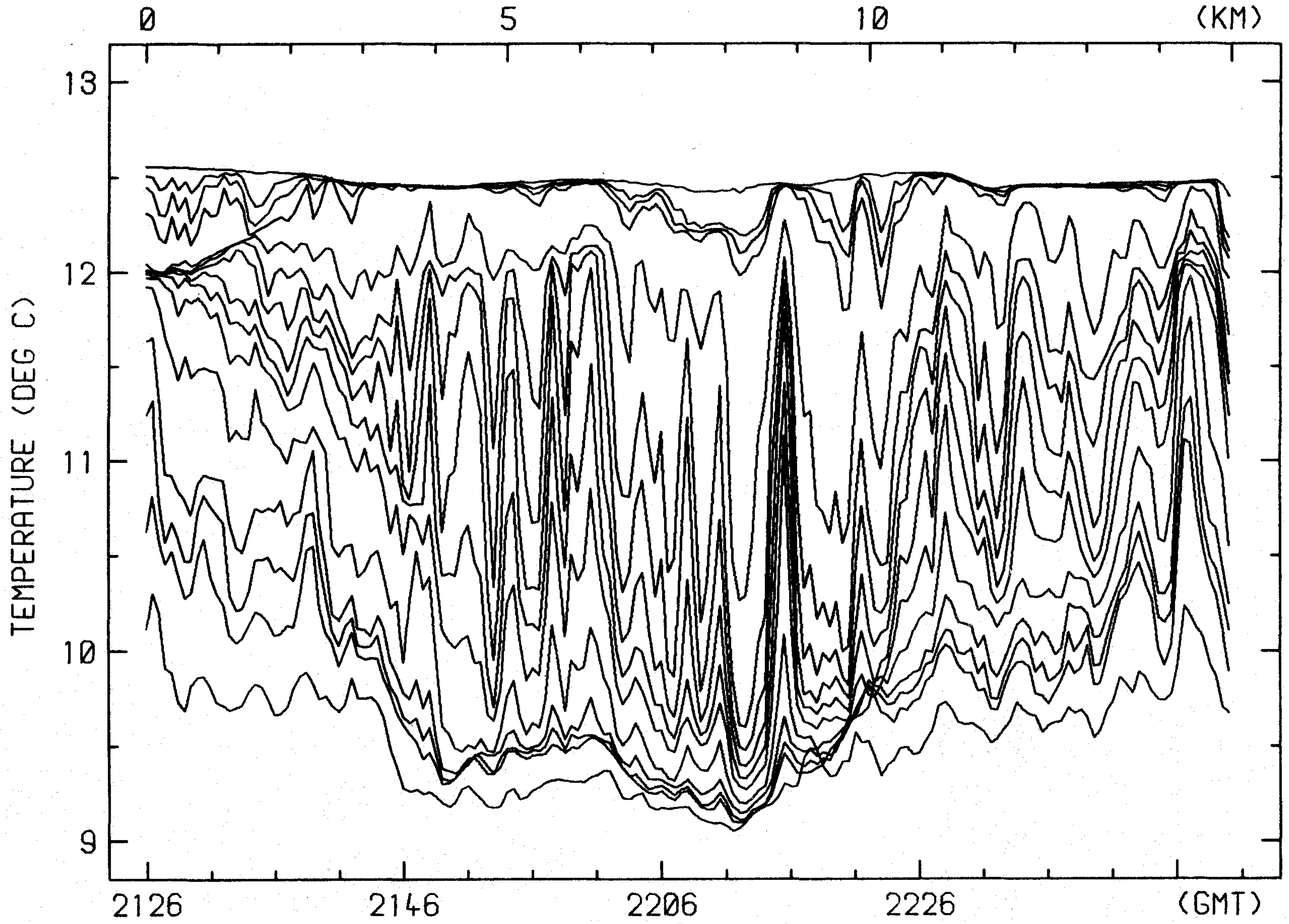
RUN 5N-5 31-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,24.5,26.5,28.5,36.5,40.6,42.6
44.6,46.7,48.7,52.8,56.9,59.0,61.0,69.3



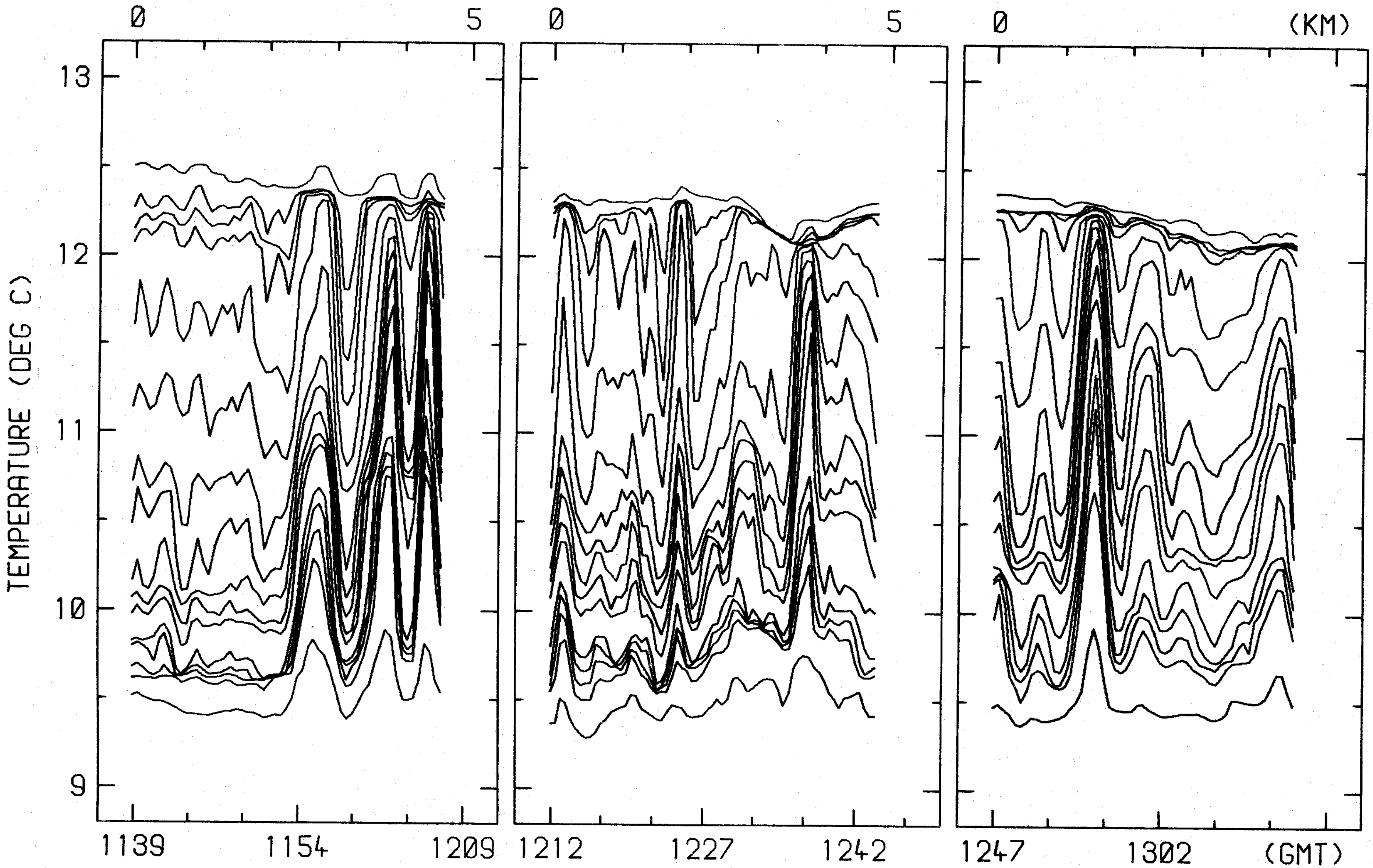
RUN 5W-6 31-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6, 24.5, 26.5, 28.5, 36.5, 40.6, 42.6
44.6, 46.7, 48.7, 52.8, 56.9, 59.0, 61.0, 69.3



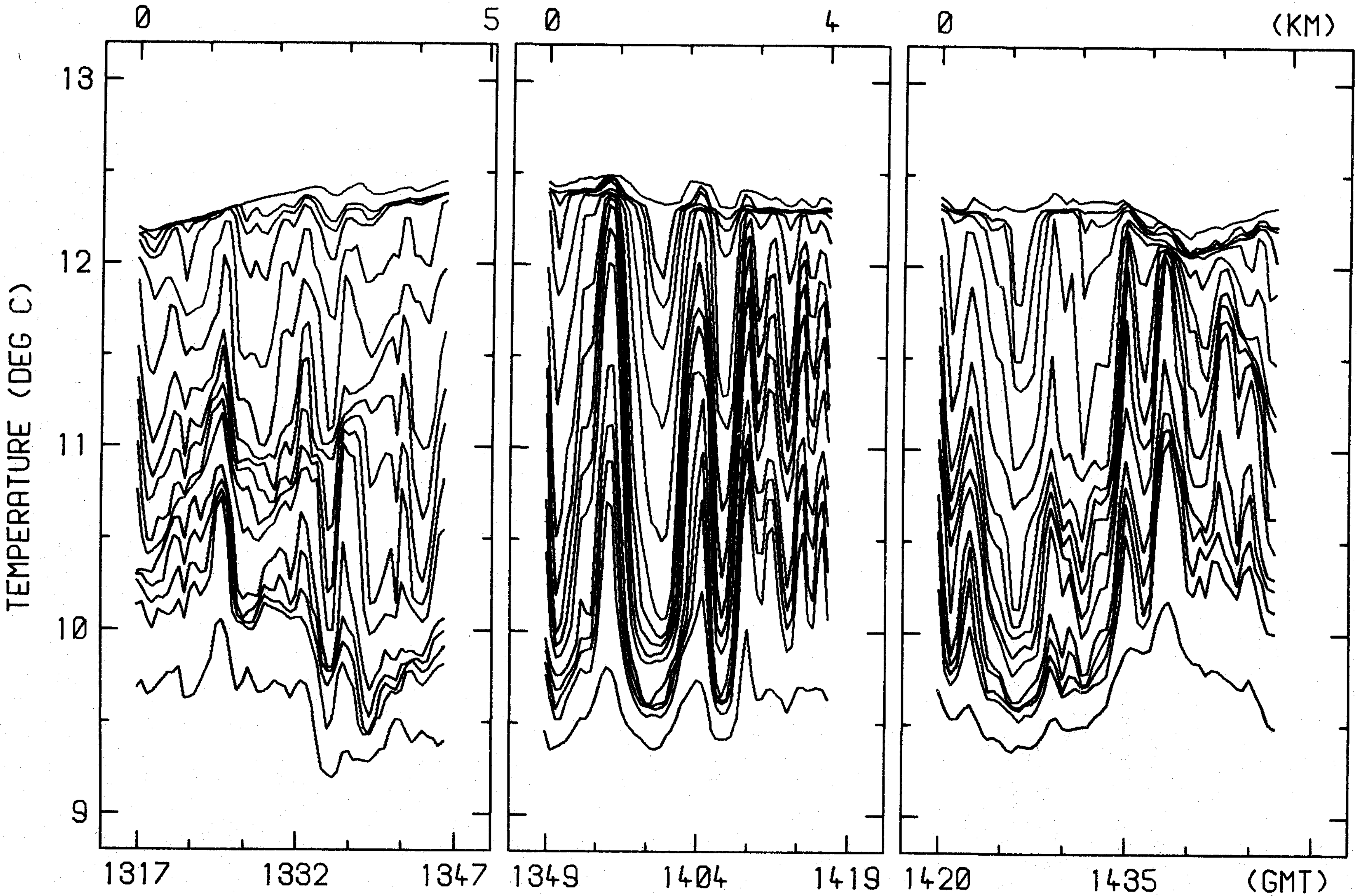
RUN 5S-7 31-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6, 24.5, 26.5, 28.5, 36.5, 40.6, 42.6
44.6, 46.7, 48.7, 52.8, 56.9, 59.0, 61.0, 69.3



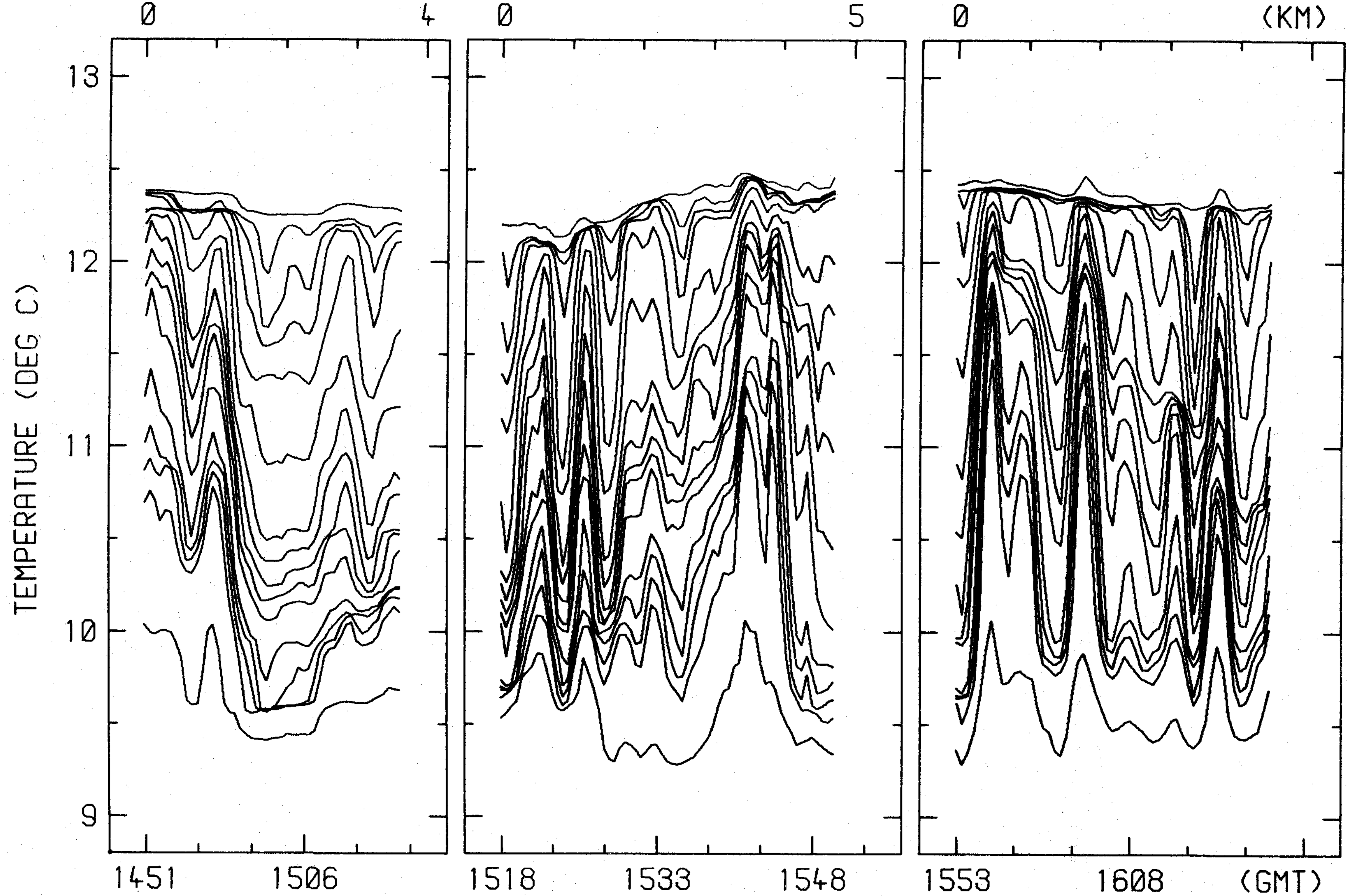
RUN 5E-8 31-AUG-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 18.6,24.5,26.5,28.5,36.5,40.6,42.6
44.6,46.7,48.7,52.8,56.9,59.0,61.0,69.3



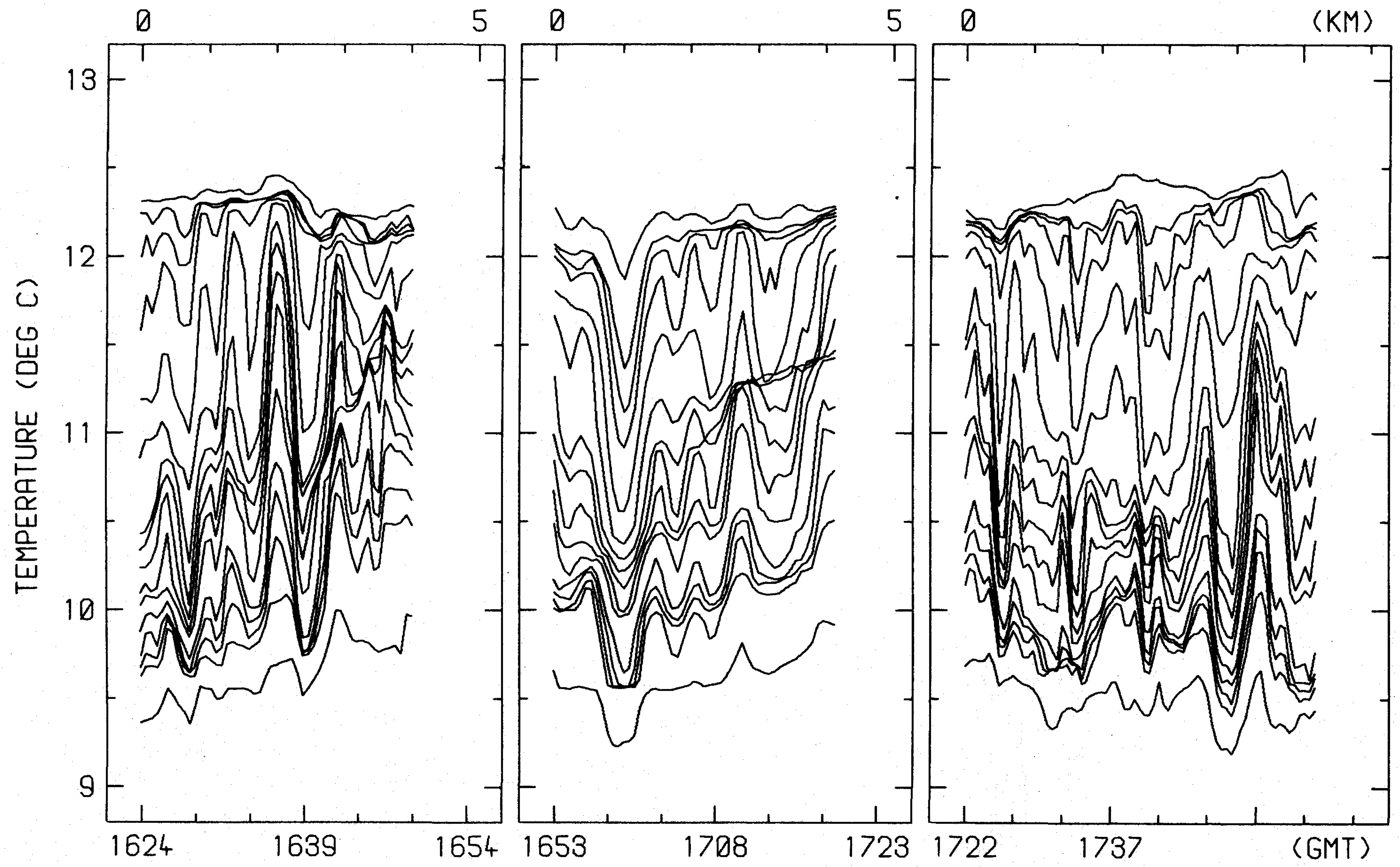
RUNS 6W-1, 6S-2, 6E-3 2-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1,25.2,27.2,29.2,33.3,37.4,41.5
43.5,45.6,47.6,49.7,53.8,55.9,58.0,60.0,70.4



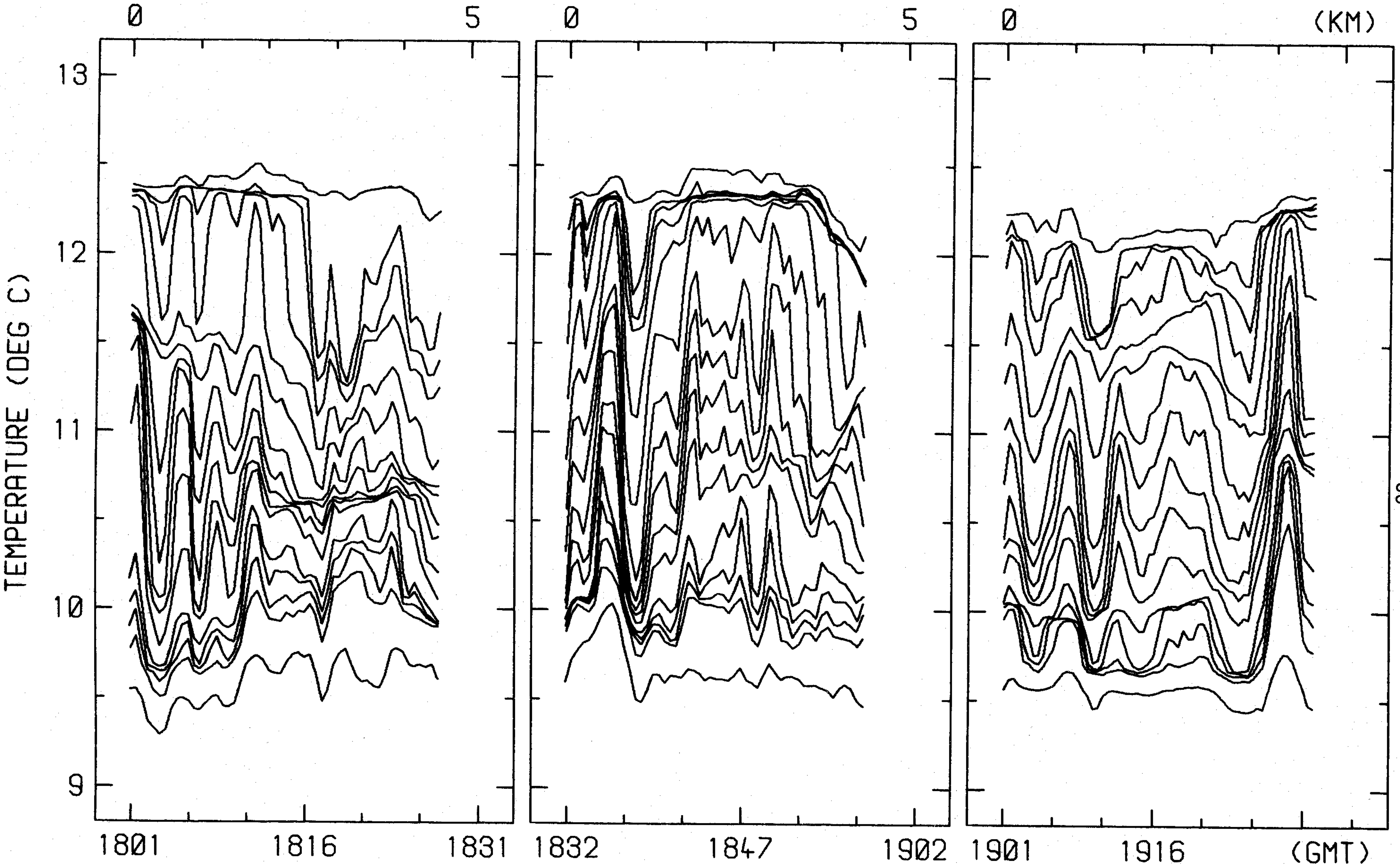
RUNS 6N-4, 6W-5, 6S-6 2-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1,25.2,27.2,29.2,33.3,37.4,41.5
43.5,45.6,47.6,49.7,53.8,55.9,58.0,60.0,70.4



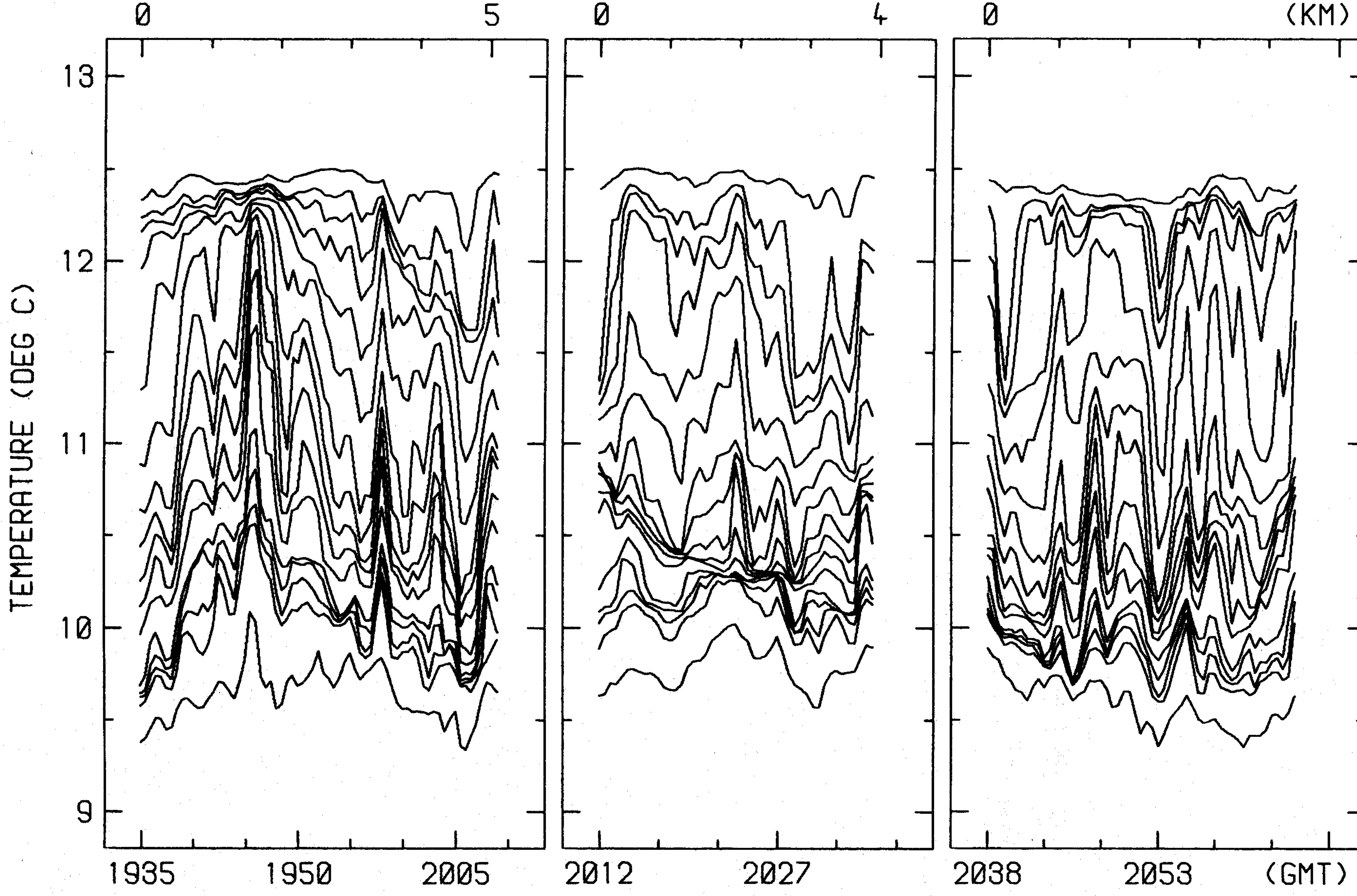
RUNS 6E-7, 6N-8, 6W-9 2-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1,25.2,27.2,29.2,33.3,37.4,41.5
43.5,45.6,47.6,49.7,53.8,55.9,58.0,60.0,70.4



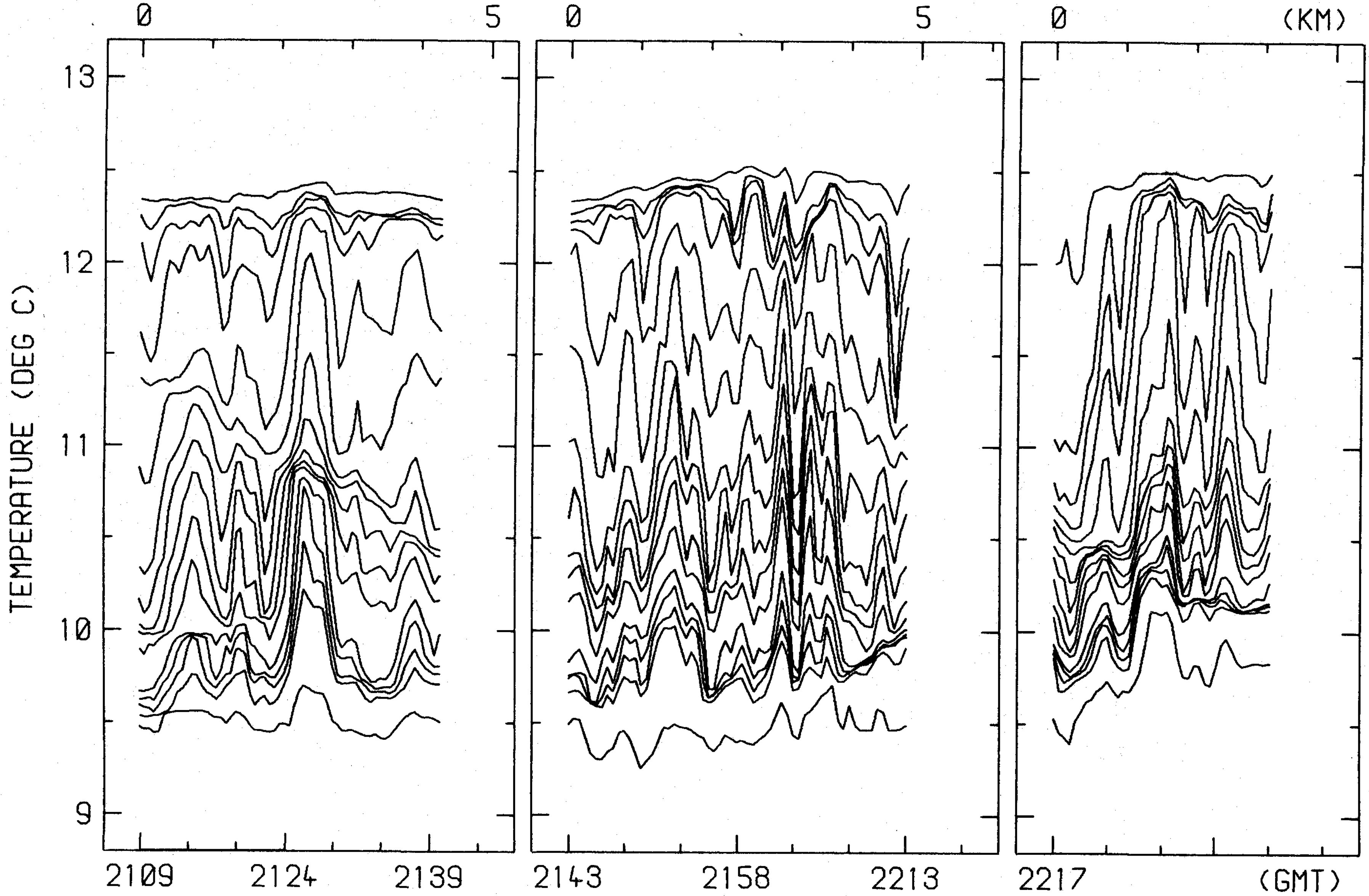
RUNS 6S-10, 6E-11, 6N-12 2-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1, 25.2, 27.2, 29.2, 33.3, 37.4, 41.5
43.5, 45.6, 47.6, 49.7, 53.8, 55.9, 58.0, 60.0, 70.4



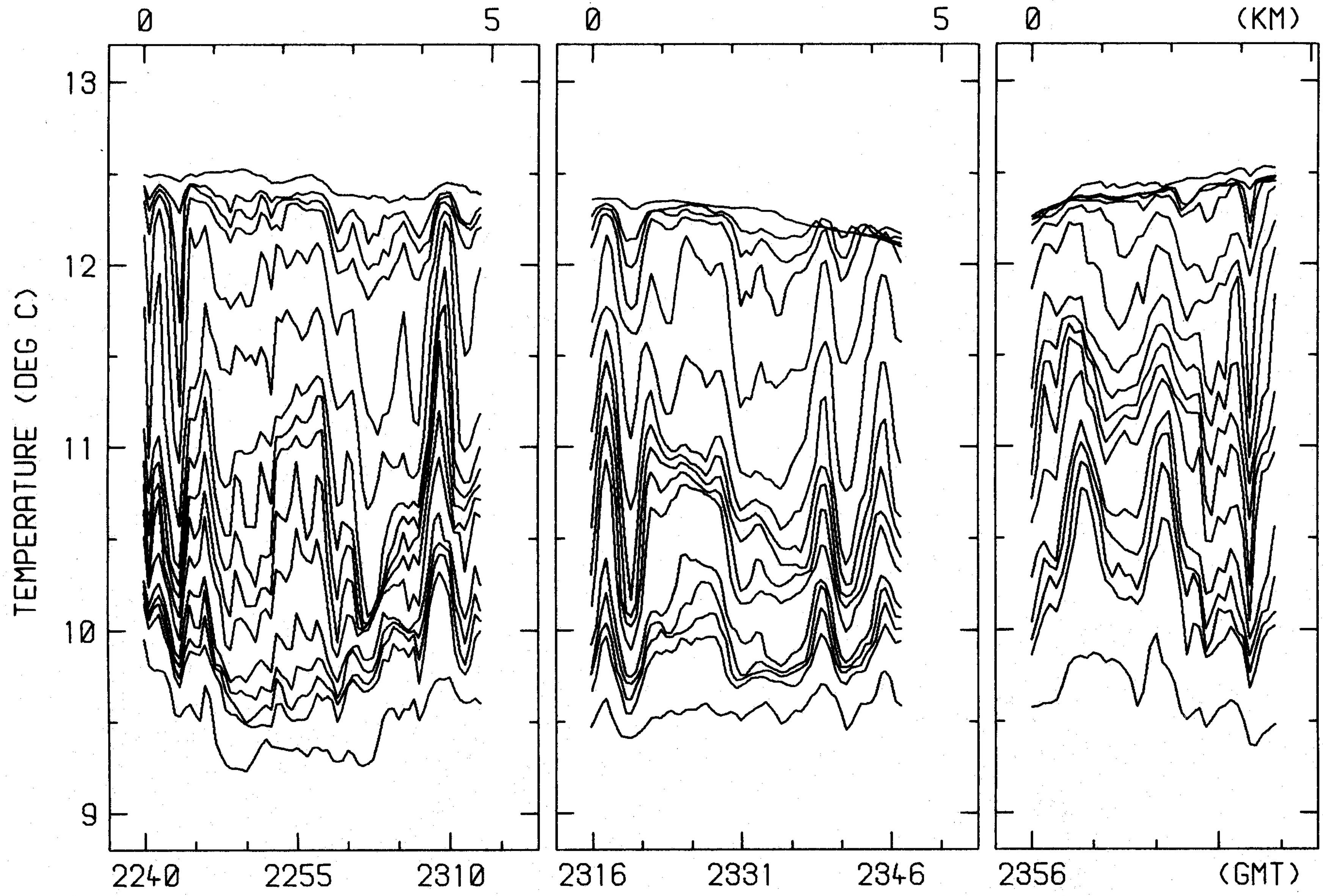
RUNS 6W-13, 6S-14, 6E-15 2-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1,25.2,27.2,29.2,33.3,37.4,41.5
43.5,45.6,47.6,49.7,53.8,55.9,58.0,60.0,70.4



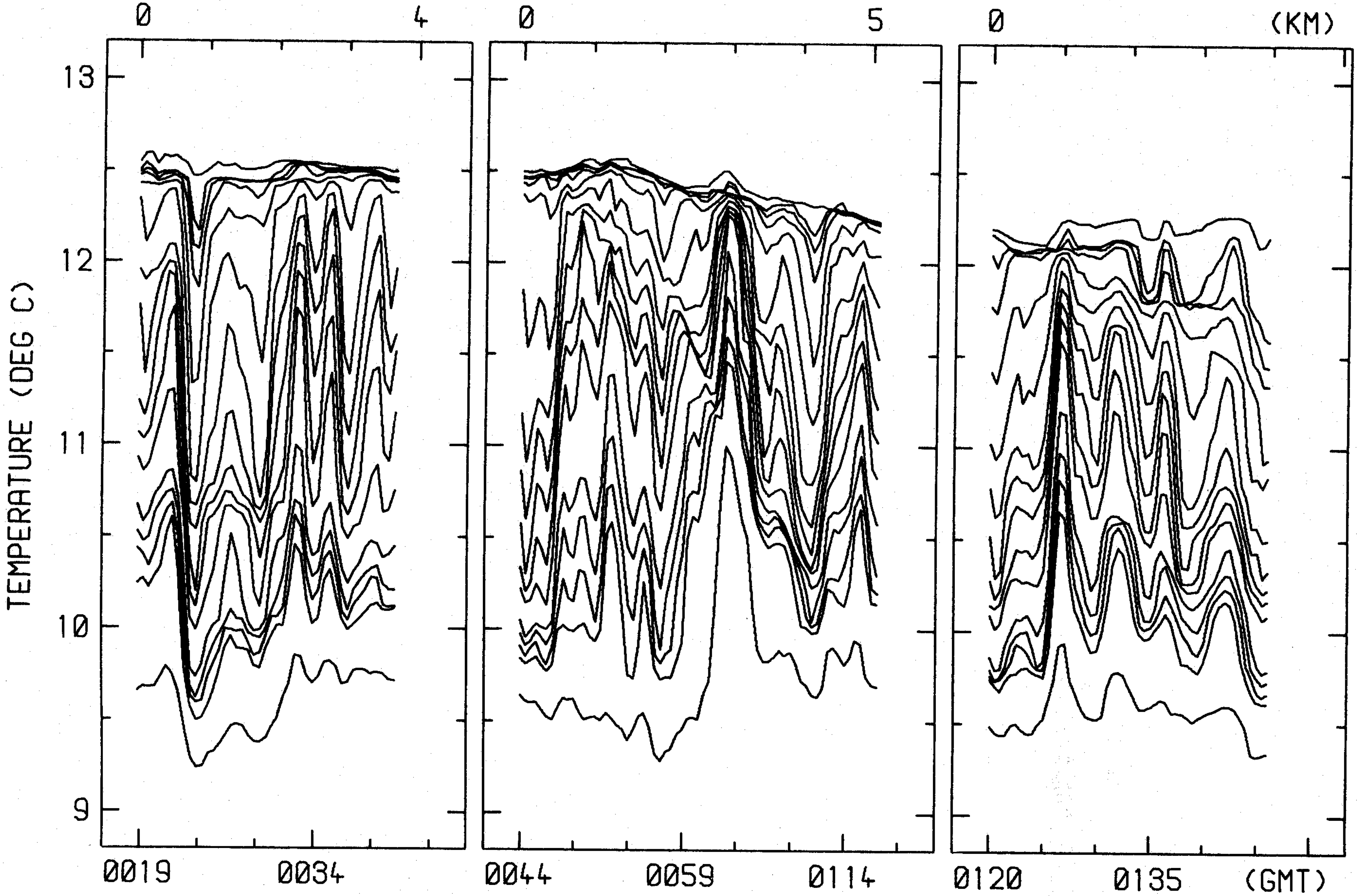
RUNS 6N-16, 6W-17, 6S-18 2-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1,25.2,27.2,29.2,33.3,37.4,41.5
43.5,45.6,47.6,49.7,53.8,55.9,58.0,60.0,70.4



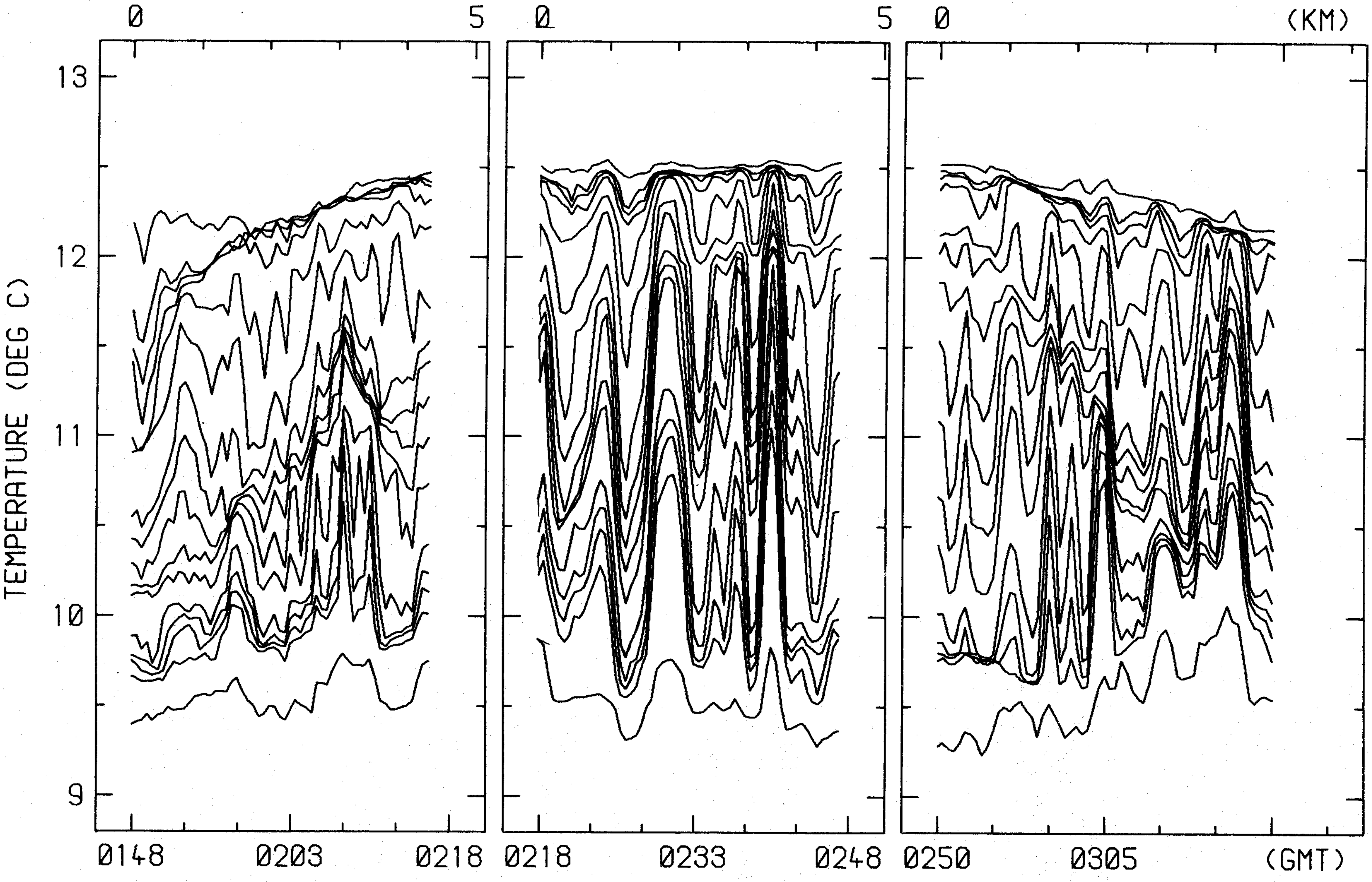
RUNS 6E-19, 6N-20, 6W-21 2-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1,25.2,27.2,29.2,33.3,37.4,41.5
43.5,45.6,47.6,49.7,53.8,55.9,58.0,60.0,70.4



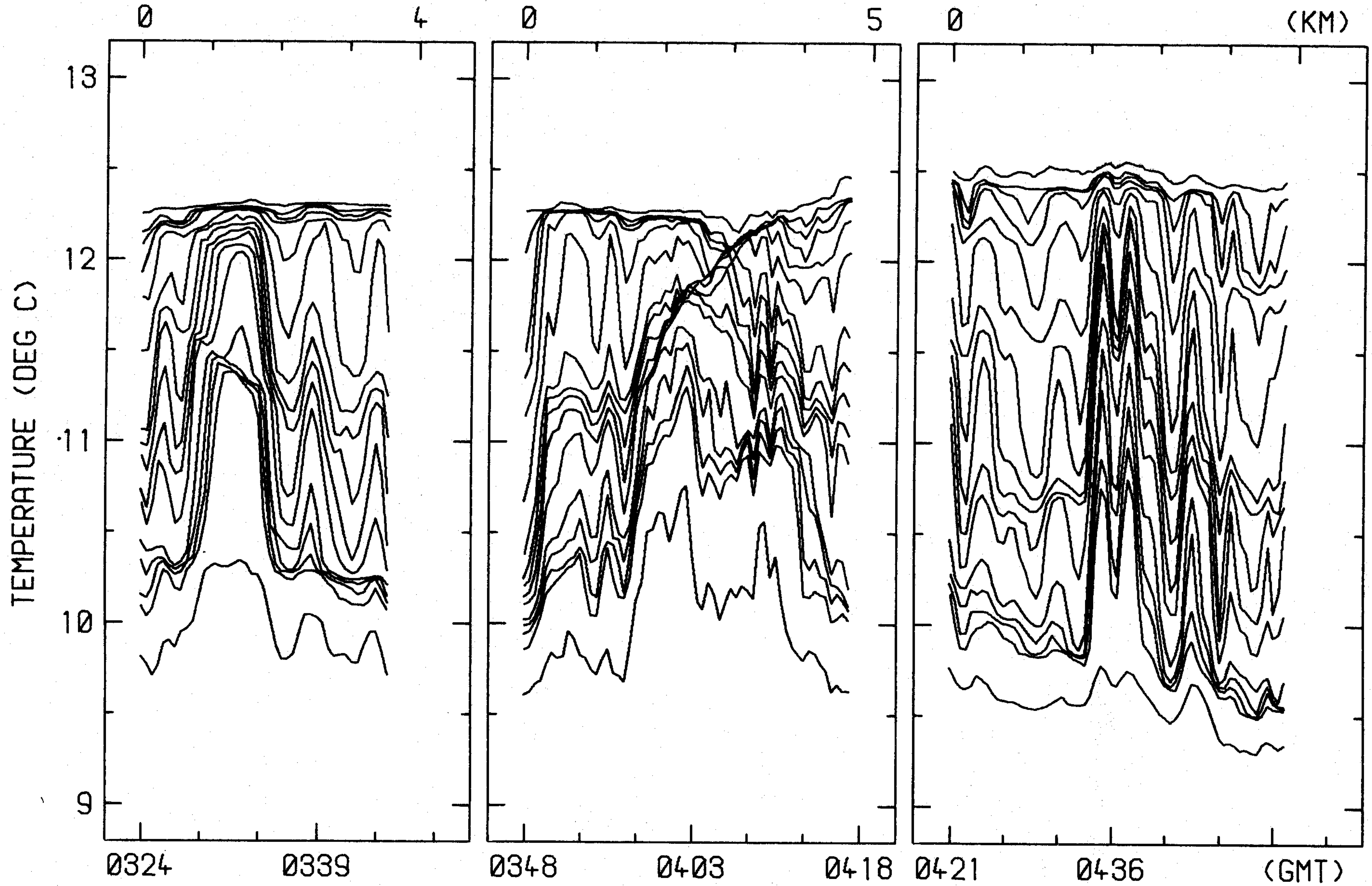
RUNS 6S-22, 6E-23, 6N-24 2-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1,25.2,27.2,29.2,33.3,37.4,41.5
43.5,45.6,47.6,49.7,53.8,55.9,58.0,60.0,70.4



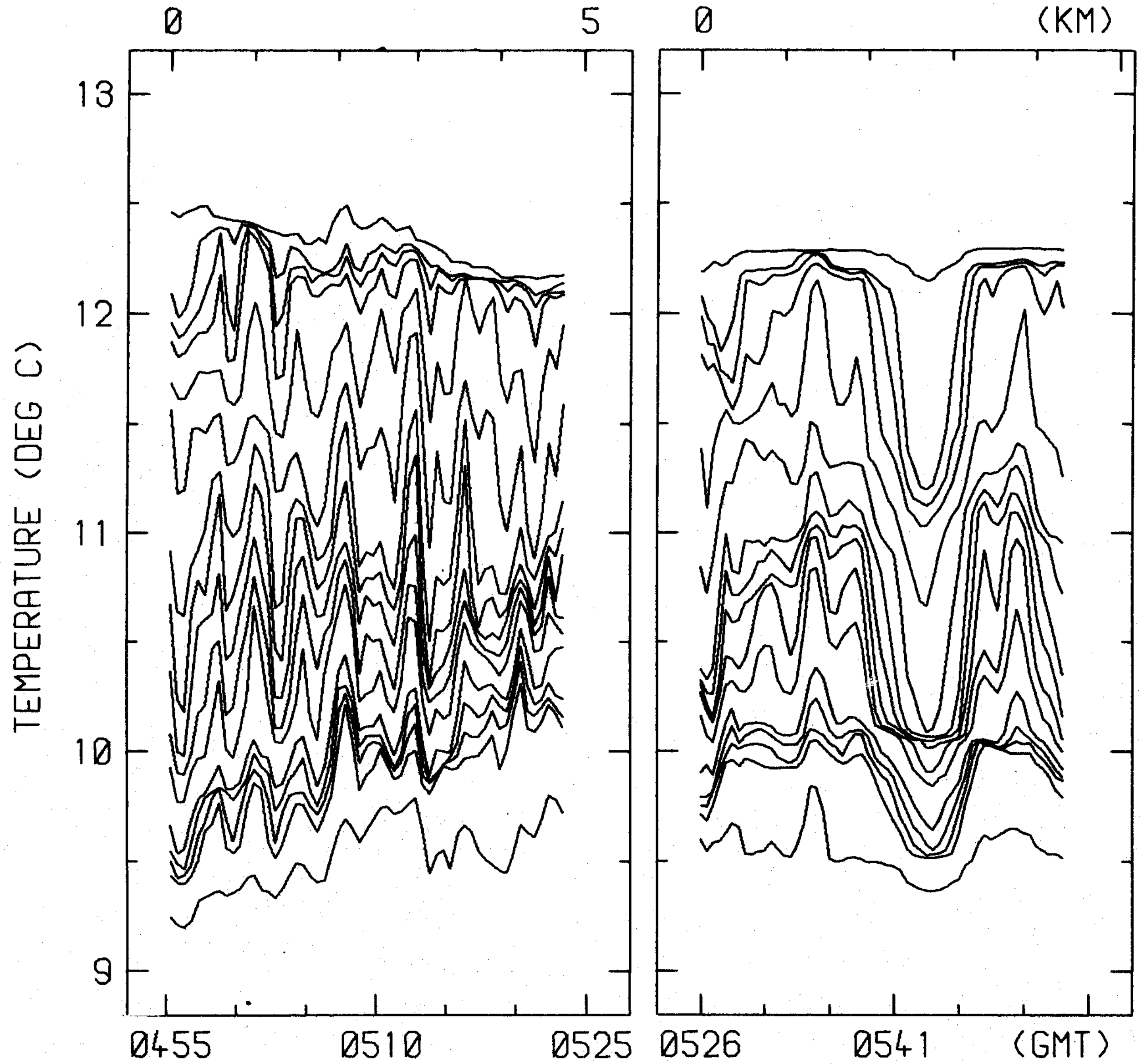
RUNS 6W-25, 6S-26, 6E-27 3-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1,25.2,27.2,29.2,33.3,37.4,41.5
43.5,45.6,47.6,49.7,53.8,55.9,58.0,60.0,70.4



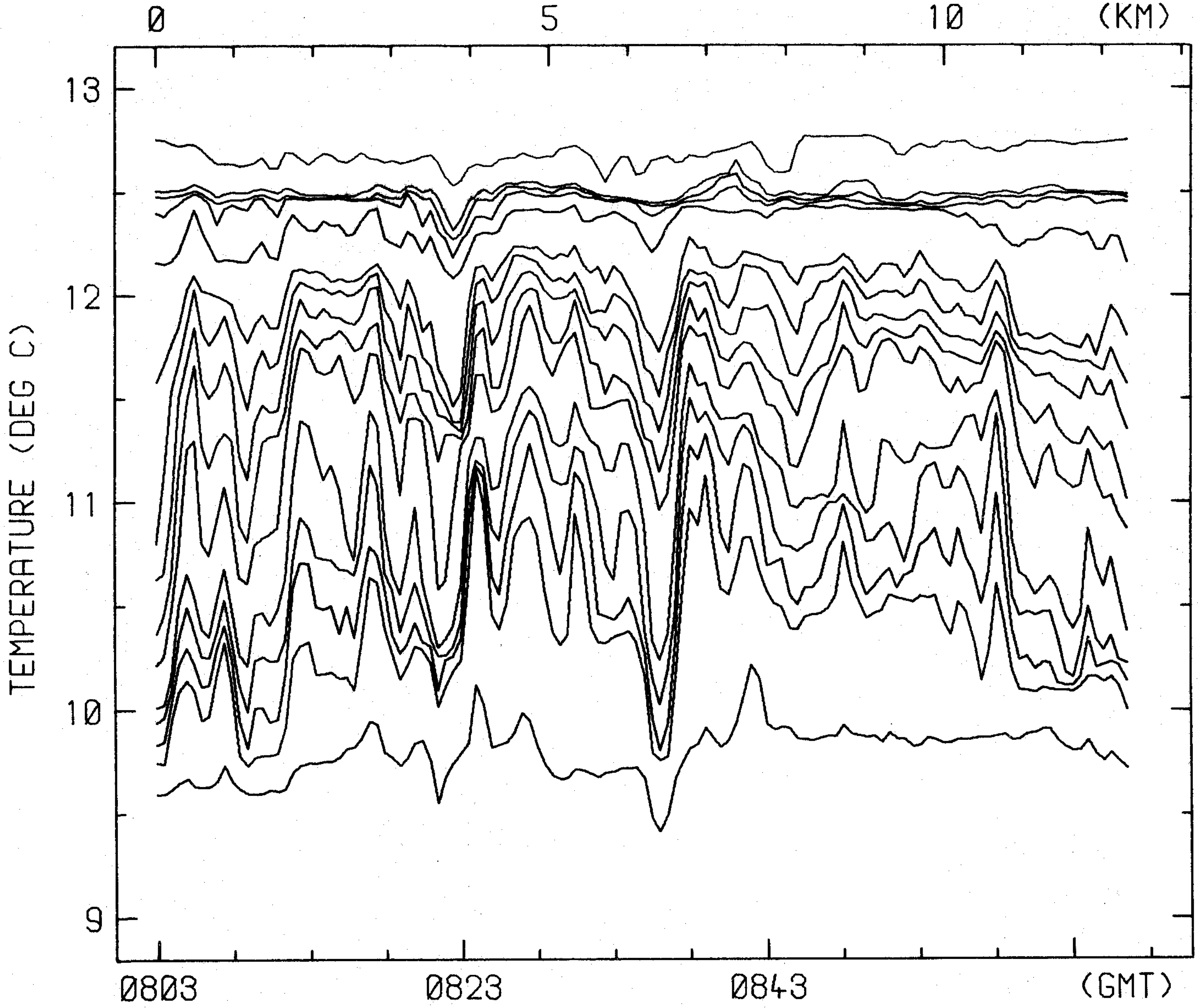
RUNS 6N-28, 6W-29, 6S-30 3-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1, 25.2, 27.2, 29.2, 33.3, 37.4, 41.5
43.5, 45.6, 47.6, 49.7, 53.8, 55.9, 58.0, 60.0, 70.4



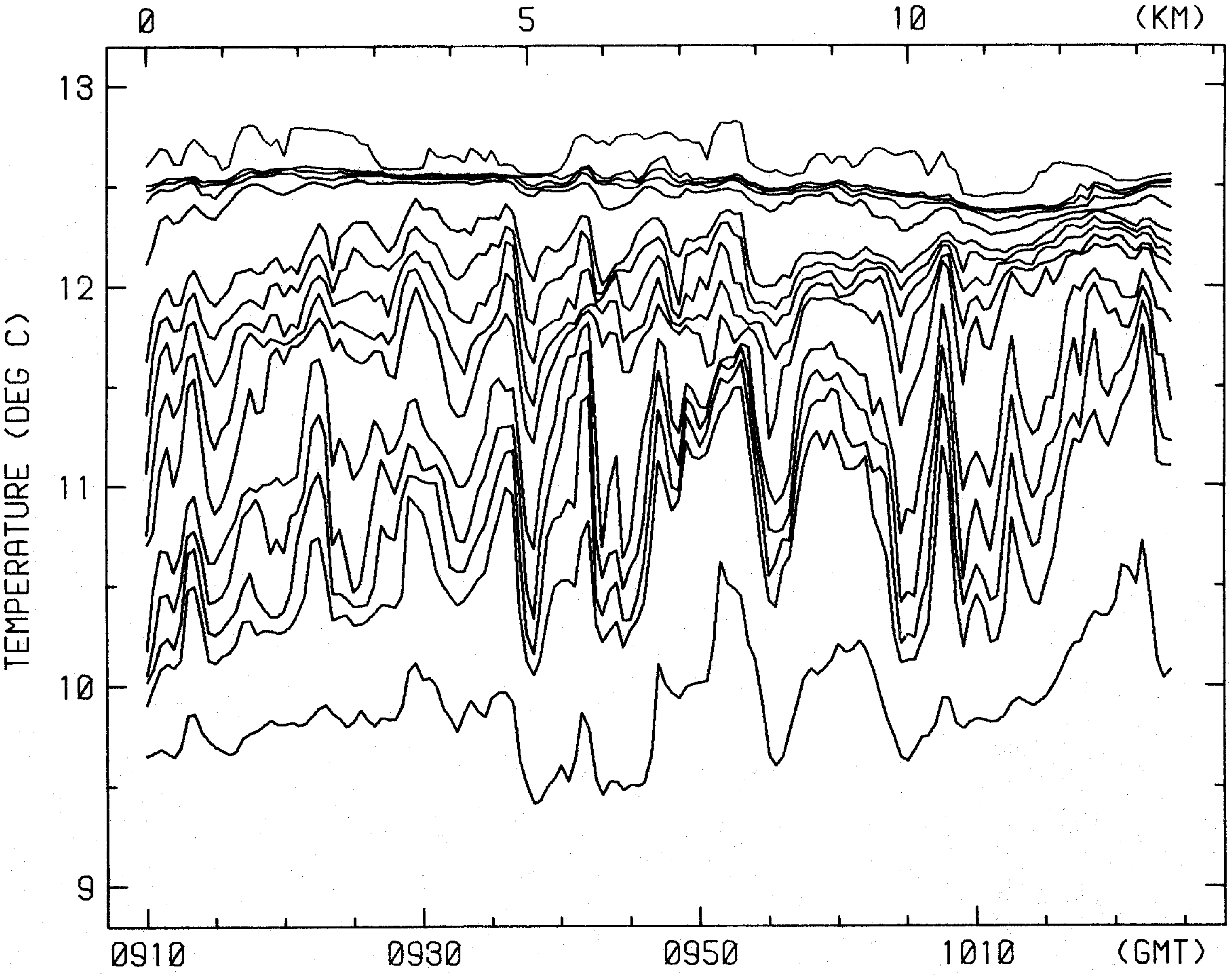
RUNS 6E-31, 6N-32, 6W-33 3-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1, 25.2, 27.2, 29.2, 33.3, 37.4, 41.5
43.5, 45.6, 47.6, 49.7, 53.8, 55.9, 58.0, 60.0, 70.4



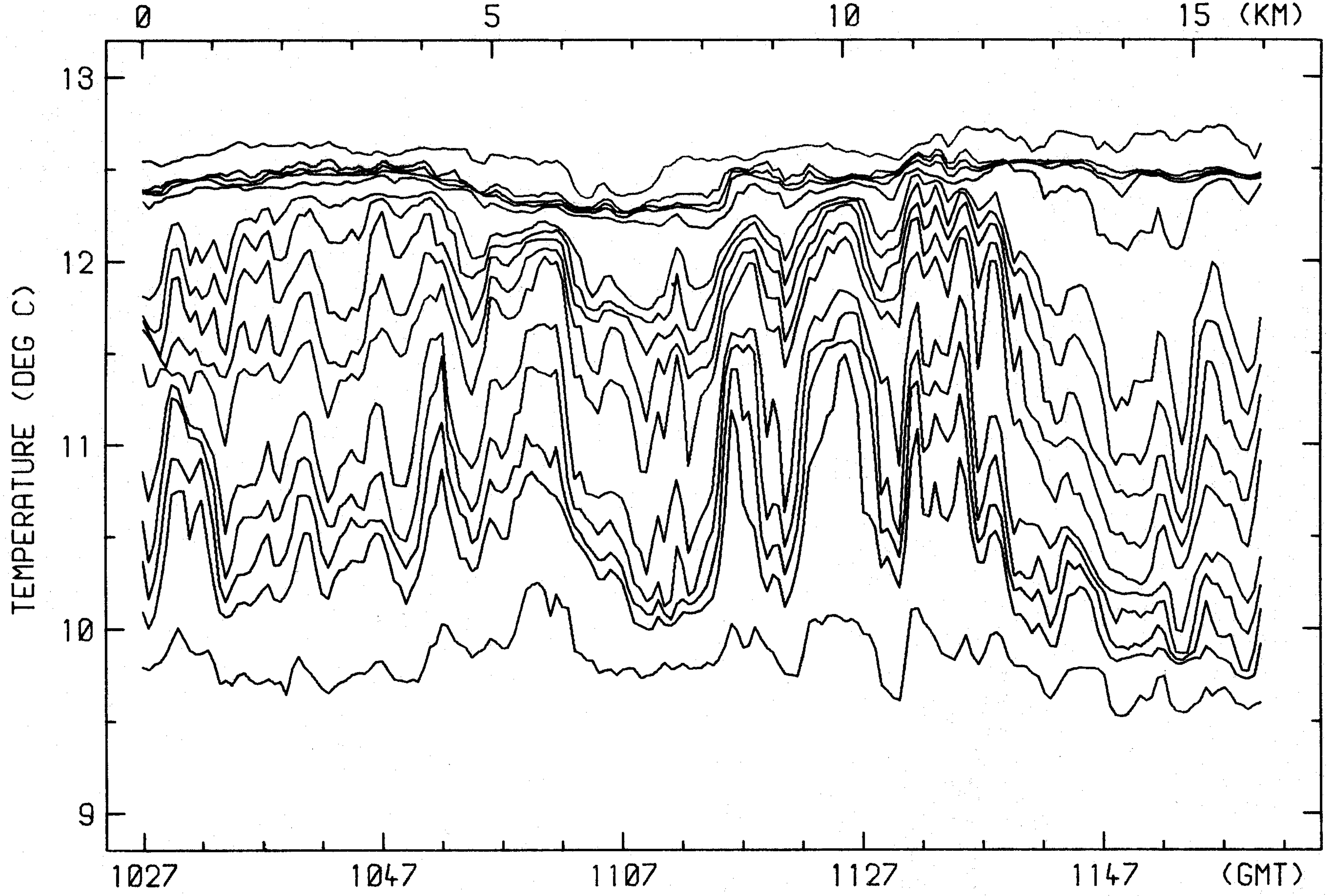
RUNS 6S-34, 6E-35 3-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 19.1,25.2,27.2,29.2,33.3,37.4,41.5
43.5,45.6,47.6,49.7,53.8,55.9,58.0,60.0,70.4



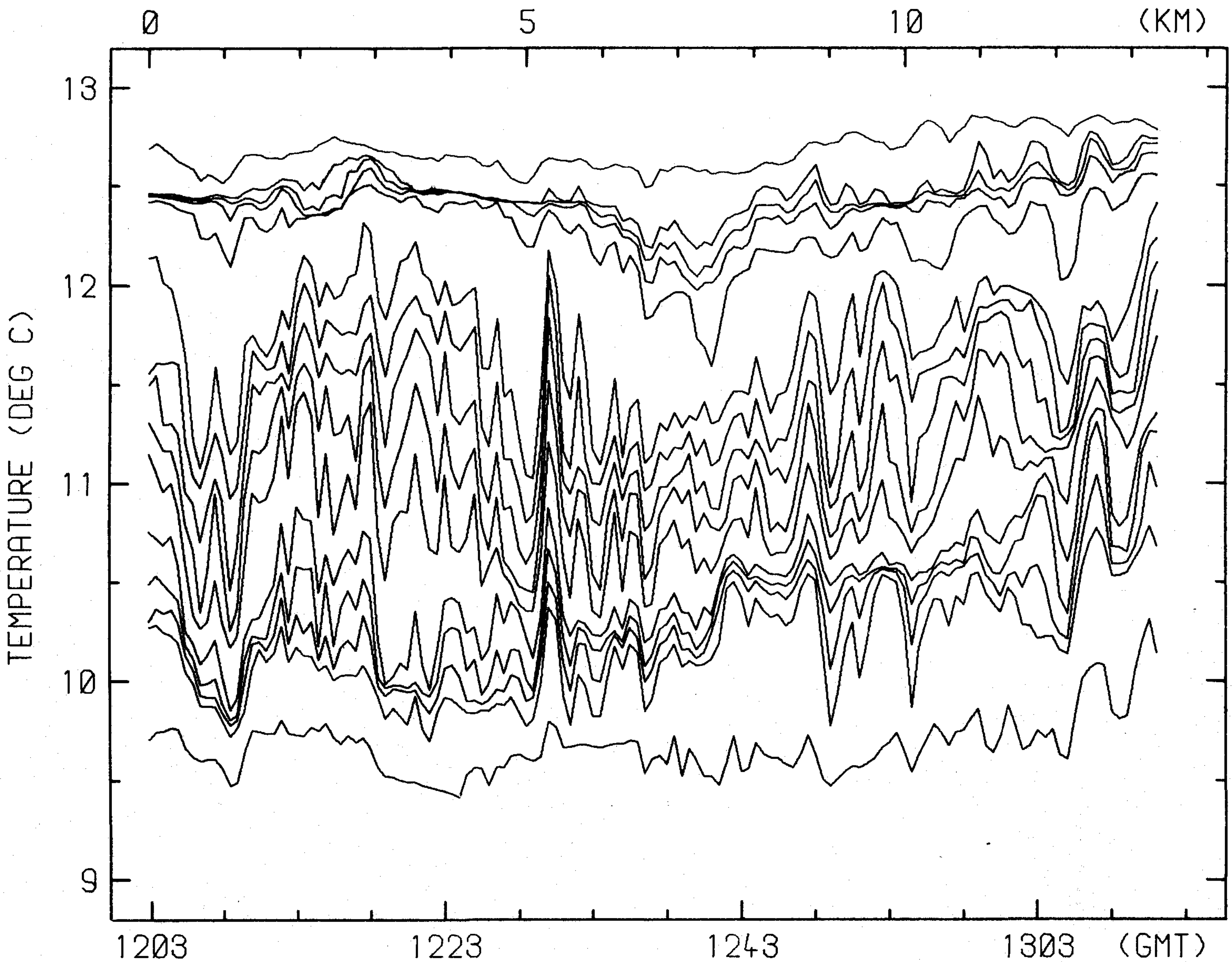
RUN 7S-1 4-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 7.9,13.8,15.8,17.8,21.8,29.9,31.9
34.0,36.0,38.0,42.1,44.2,46.2,48.3,58.6



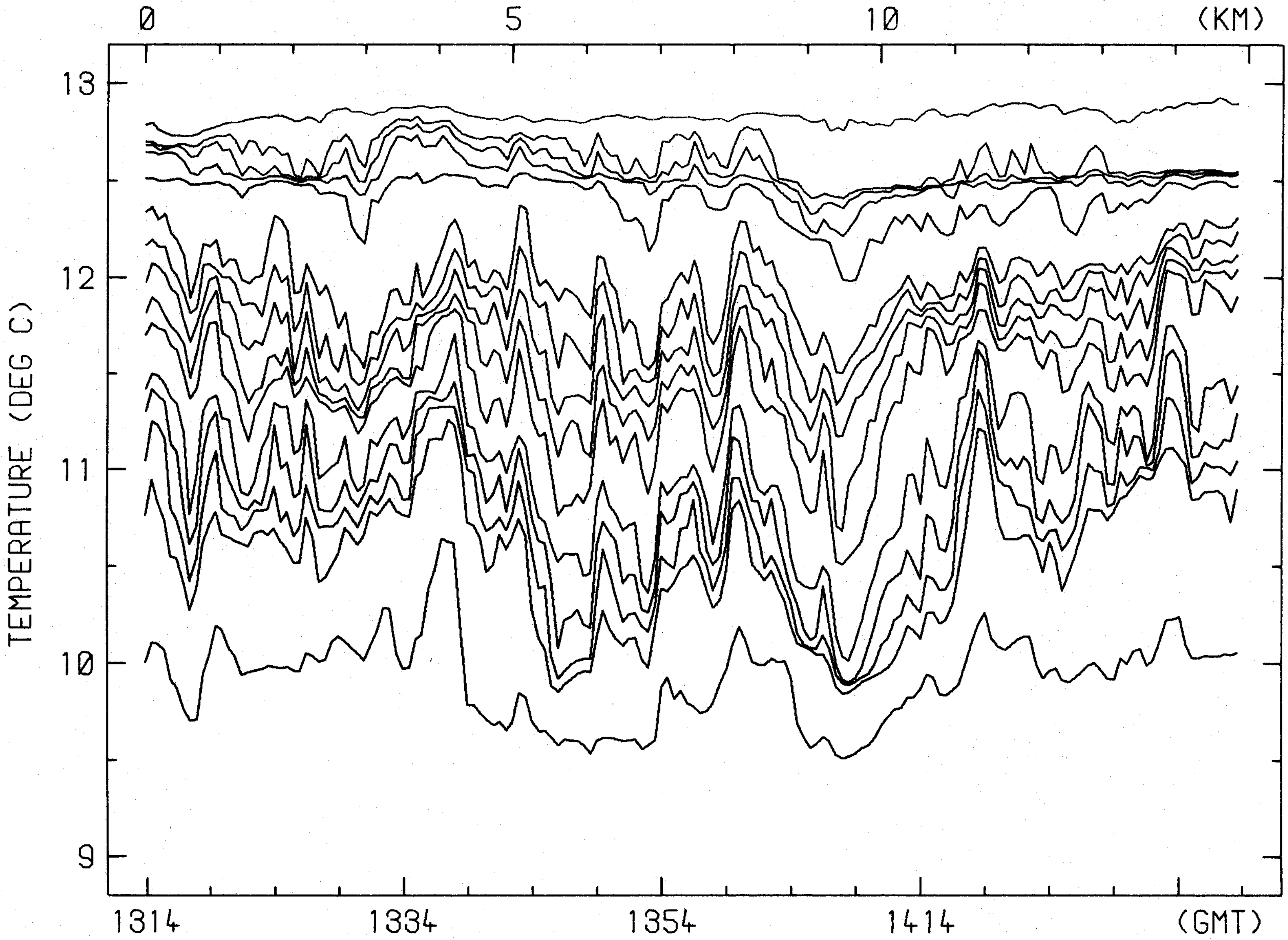
RUN 7E-2 4-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 7.9, 13.8, 15.8, 17.8, 21.8, 29.9, 31.9
34.0, 36.0, 38.0, 42.1, 44.2, 46.2, 48.3, 58.6



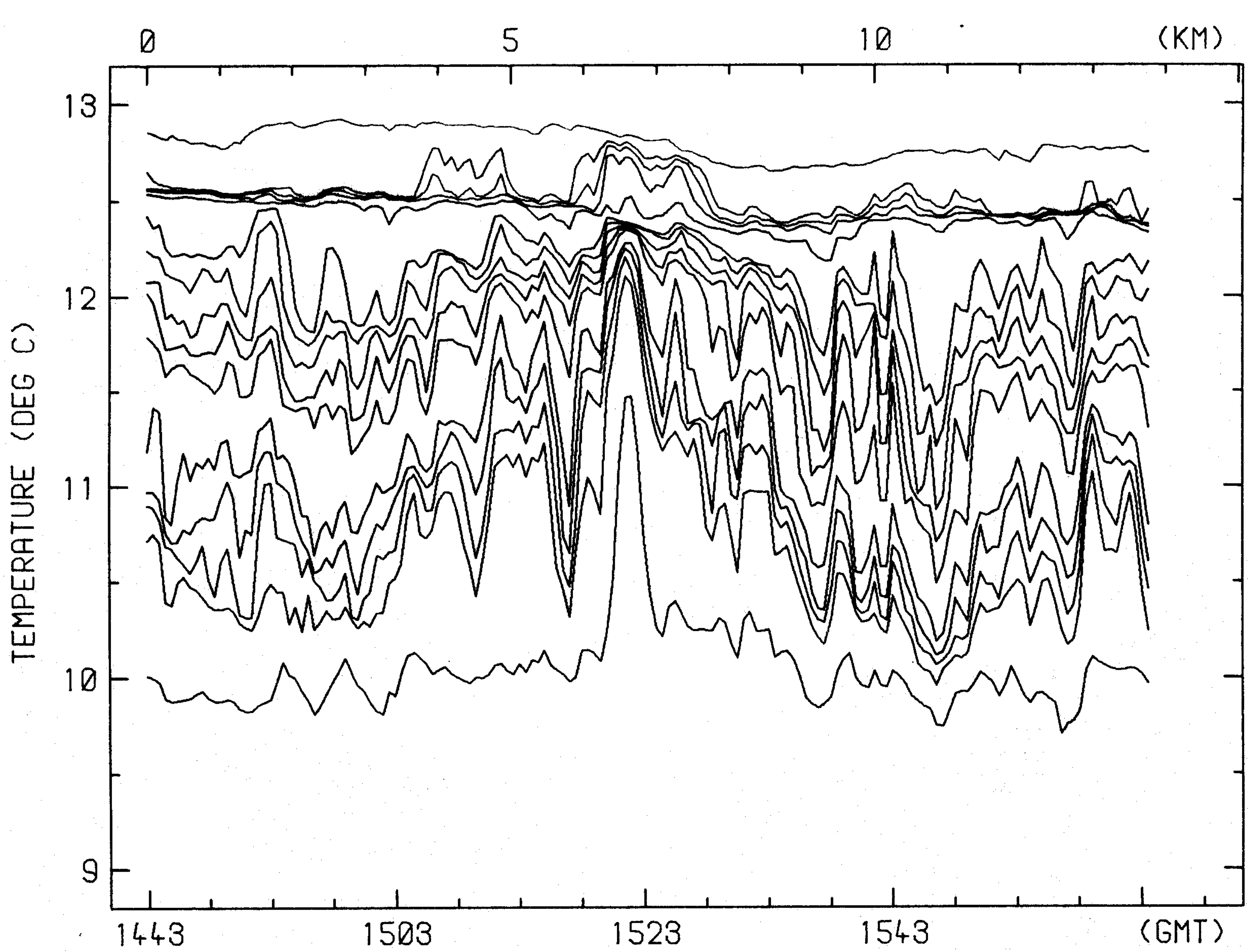
RUN 7N-3 4-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 7.9,13.8,15.8,17.8,21.8,29.9,31.9
34.0,36.0,38.0,42.1,44.2,46.2,48.3,58.6



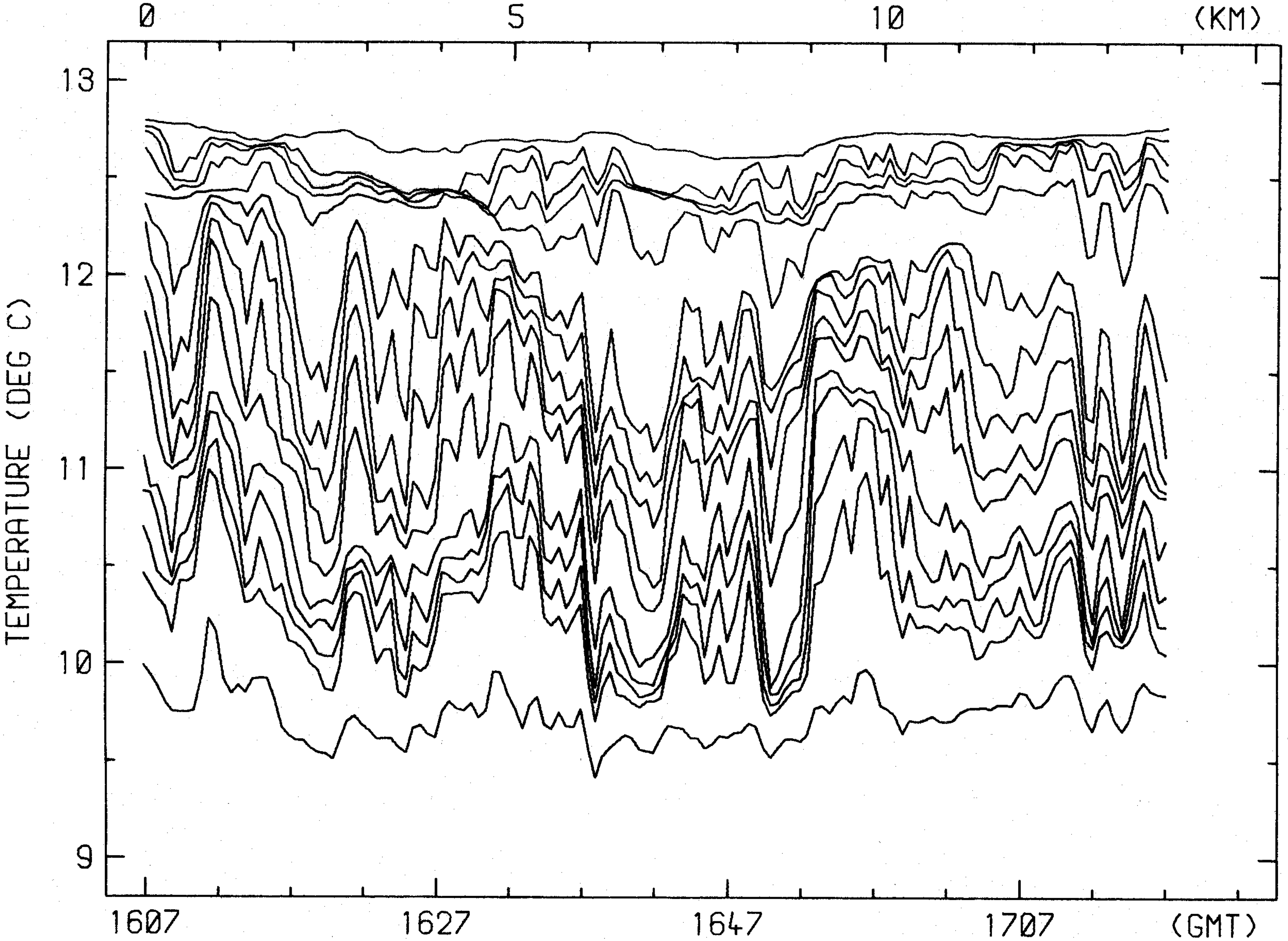
RUN 7W-4 4-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 7.9, 13.8, 15.8, 17.8, 21.8, 29.9, 31.9
34.0, 36.0, 38.0, 42.1, 44.2, 46.2, 48.3, 58.6



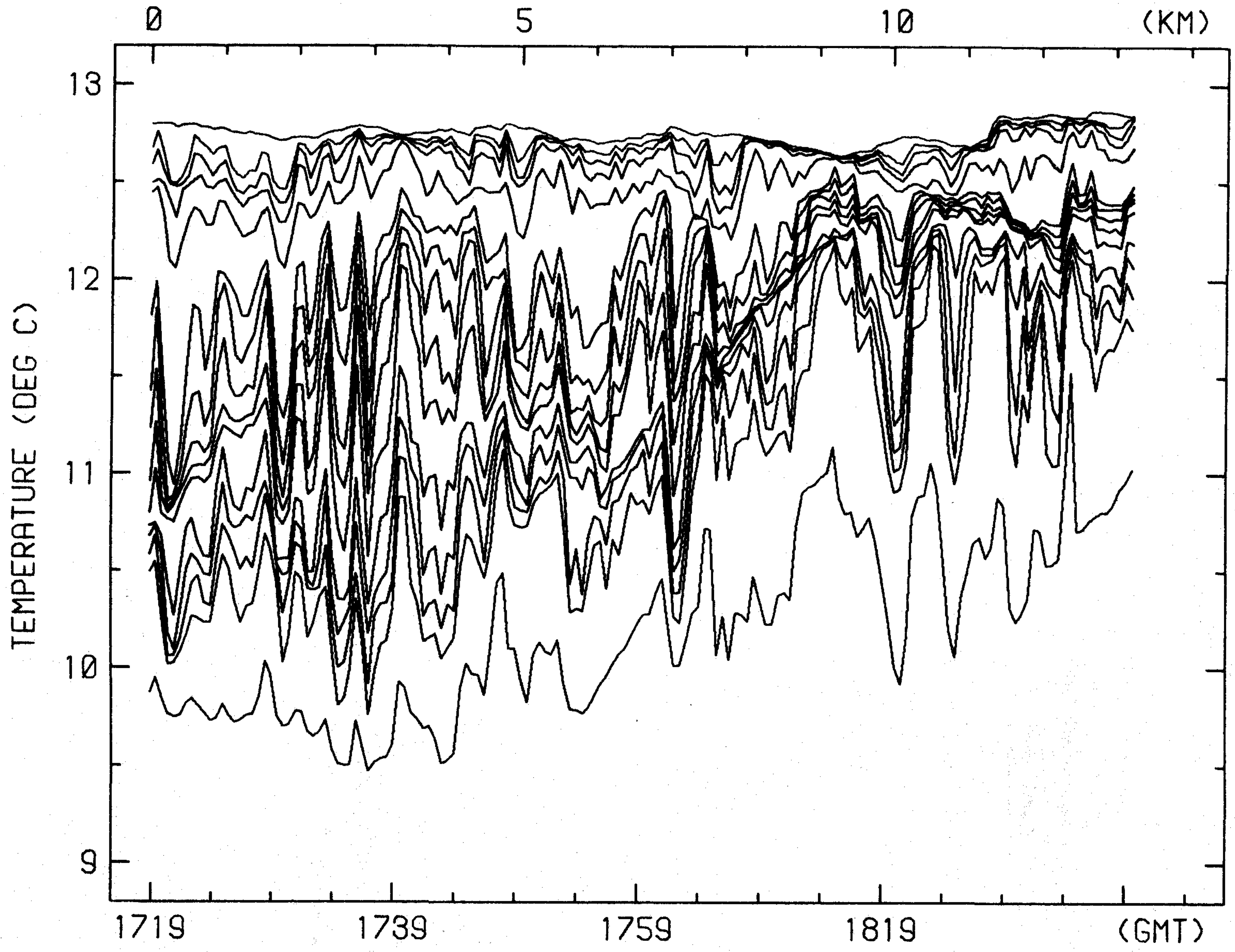
RUN 7S-5 4-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 7.9,13.8,15.8,17.8,21.8,29.9,31.9
34.0,36.0,38.0,42.1,44.2,46.2,48.3,58.6



RUN 7E-6 4-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 7.9,13.8,15.8,17.8,21.8,29.9,31.9
34.0,36.0,38.0,42.1,44.2,46.2,48.3,58.6



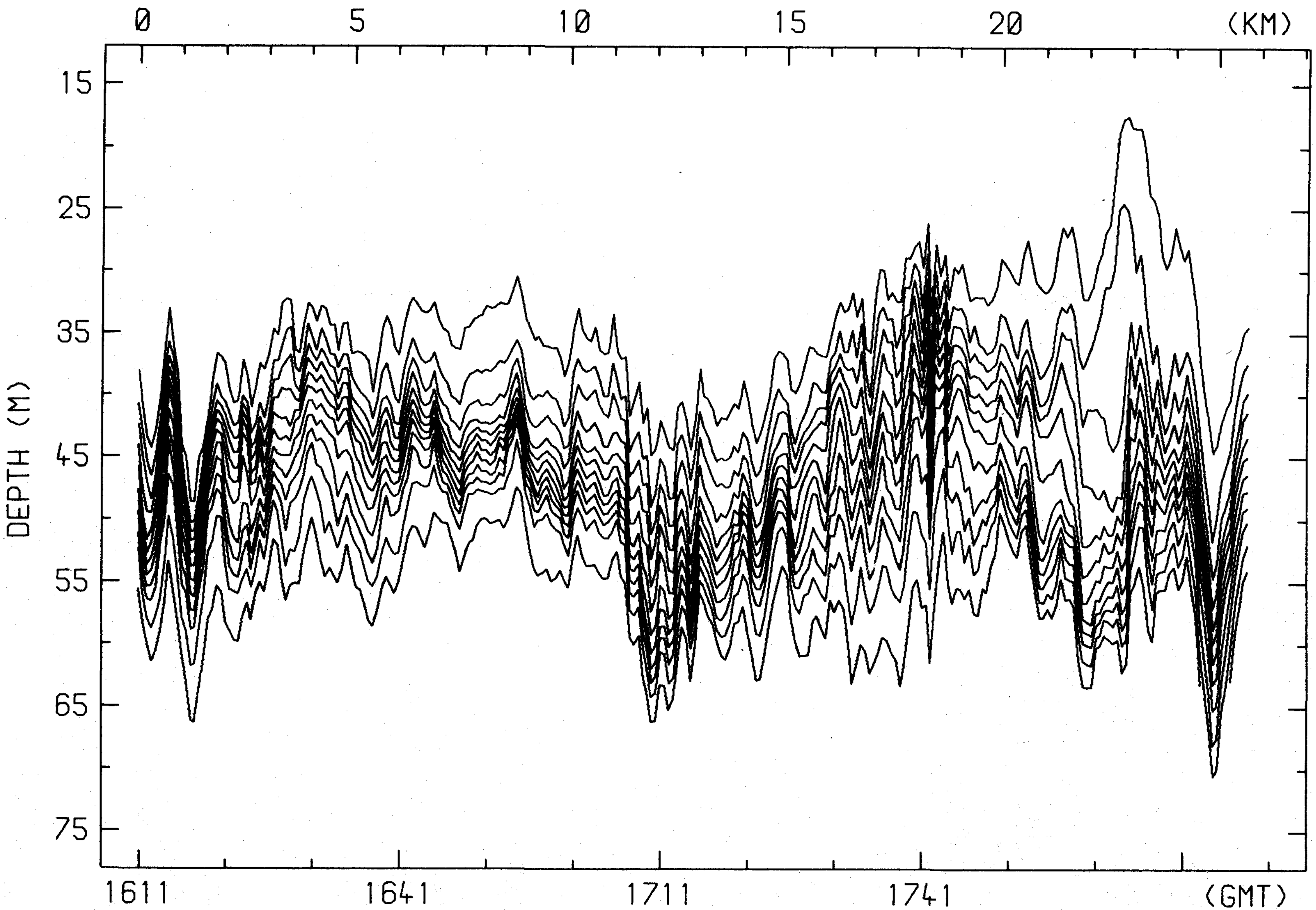
RUN 7N-7 4-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 7.9,13.8,15.8,17.8,21.8,29.9,31.9
34.0,36.0,38.0,42.1,44.2,46.2,48.3,58.6



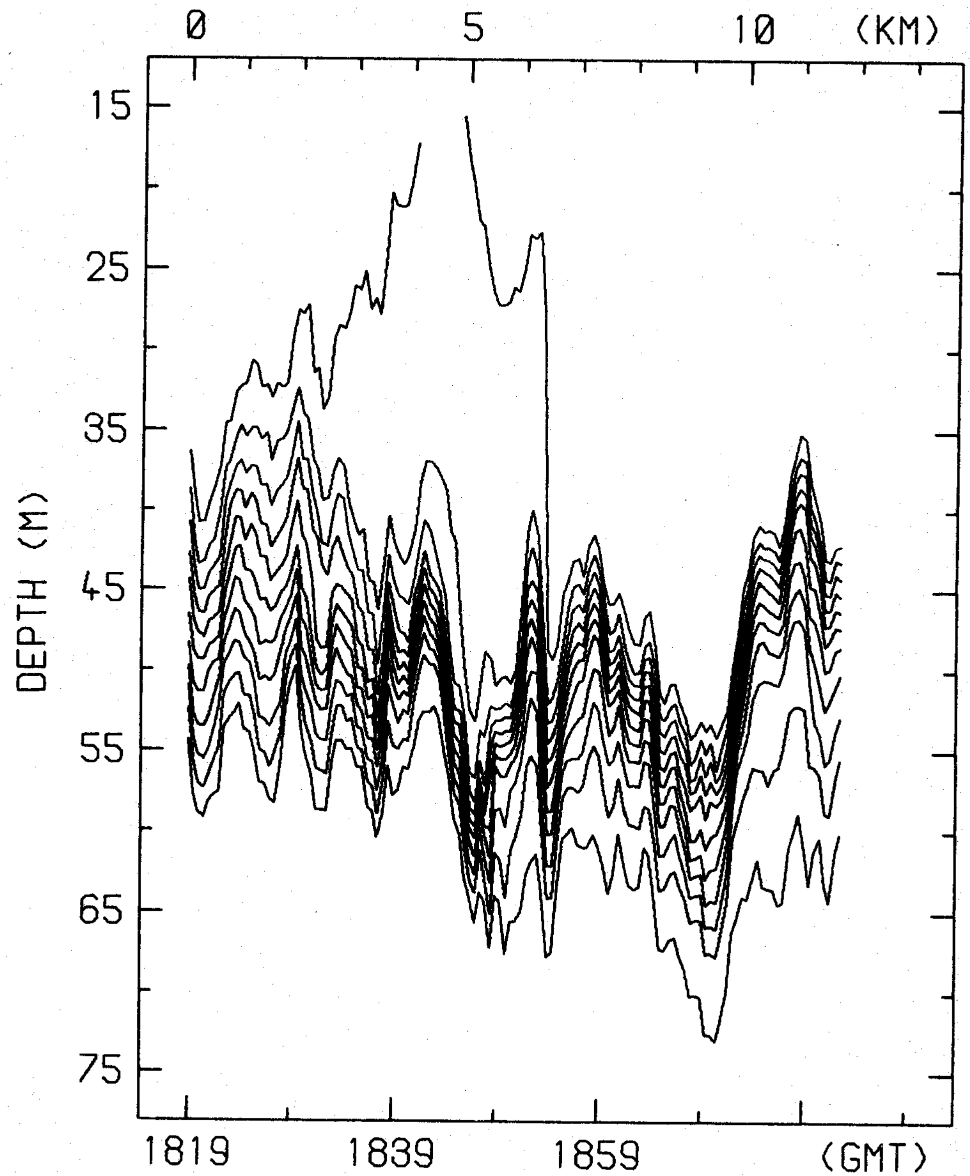
RUN 7W-8 4-SEP-78 TEMPERATURE VS TIME/DISTANCE
DEPTHS (M) 7.9,13.8,15.8,17.8,21.8,29.9,31.9
34.0,36.0,38.0,42.1,44.2,46.2,48.3,58.6

ISOTHERM CROSS-SECTIONS

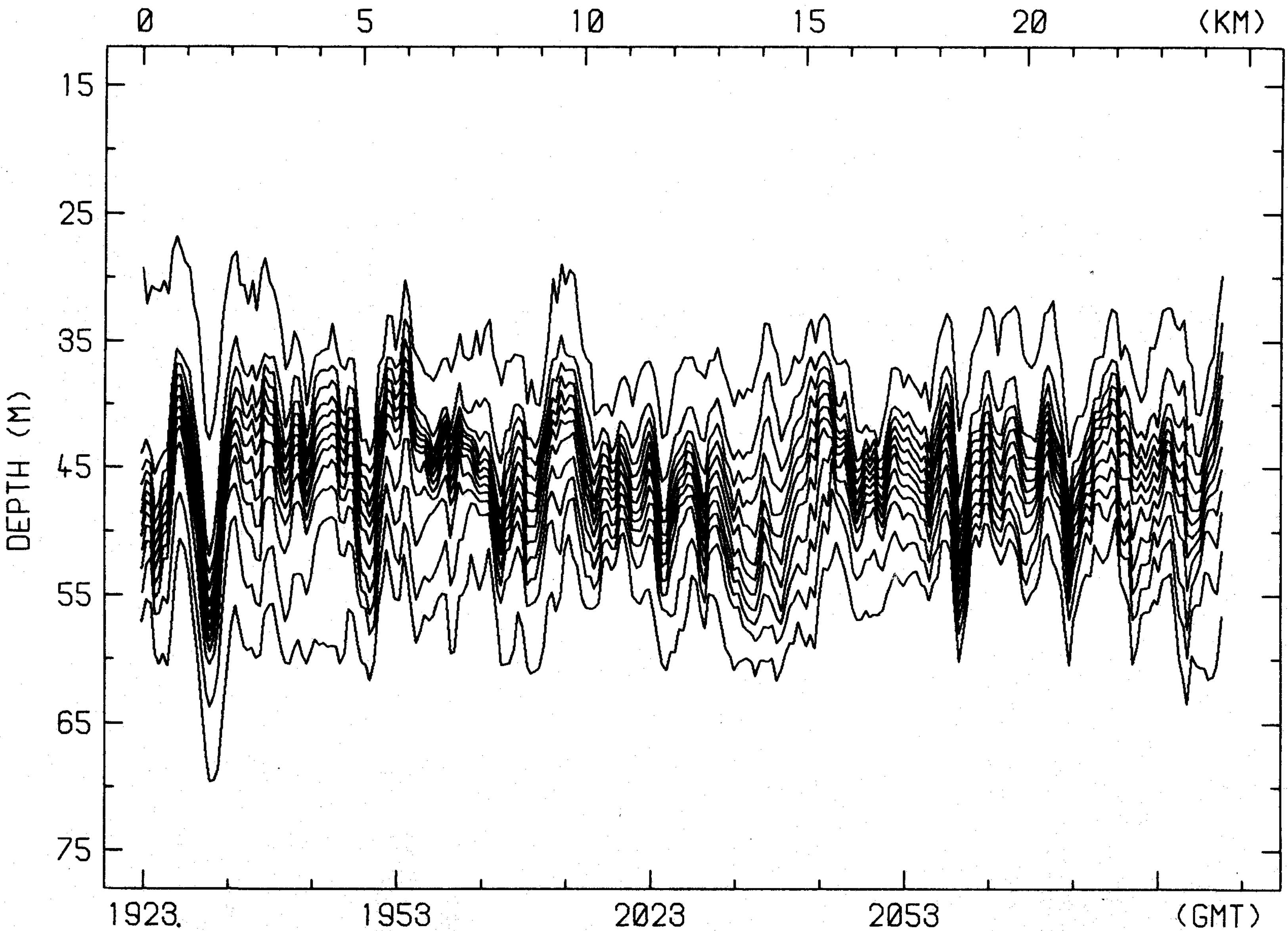
On the following pages there are plots of isotherms at 0.2°C intervals which were obtained by linear interpolation between the low-pass filtered temperature observations shown in the previous section. Isotherms which were not at least 80% complete were not plotted. Isotherms which were incomplete, but had no more than 20% of the record missing, were completed by linear extrapolation from adjacent isotherms.



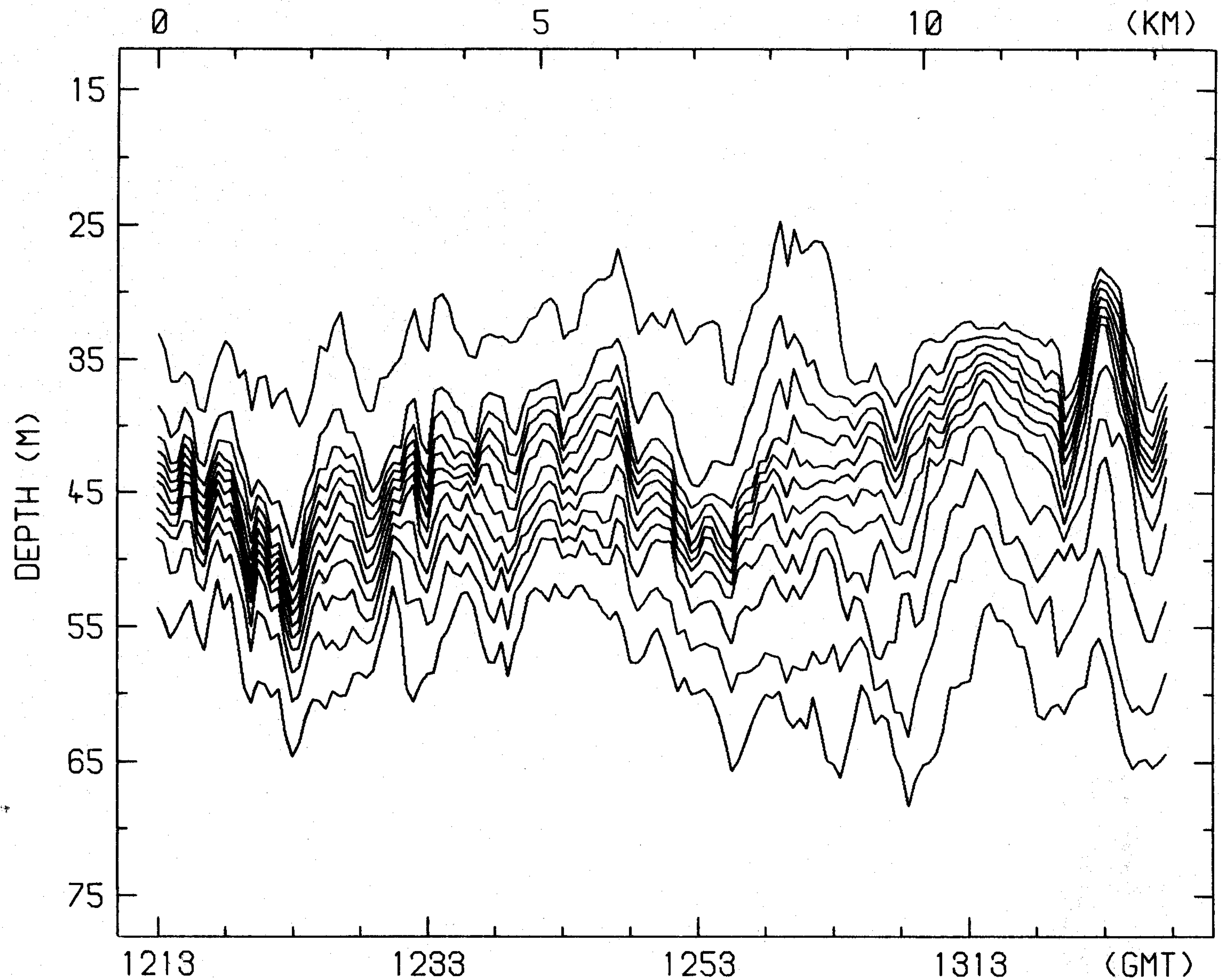
RUN 1-1 24-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4,11.2
11.0,10.8,10.6,10.4,10.2,10.0,9.8



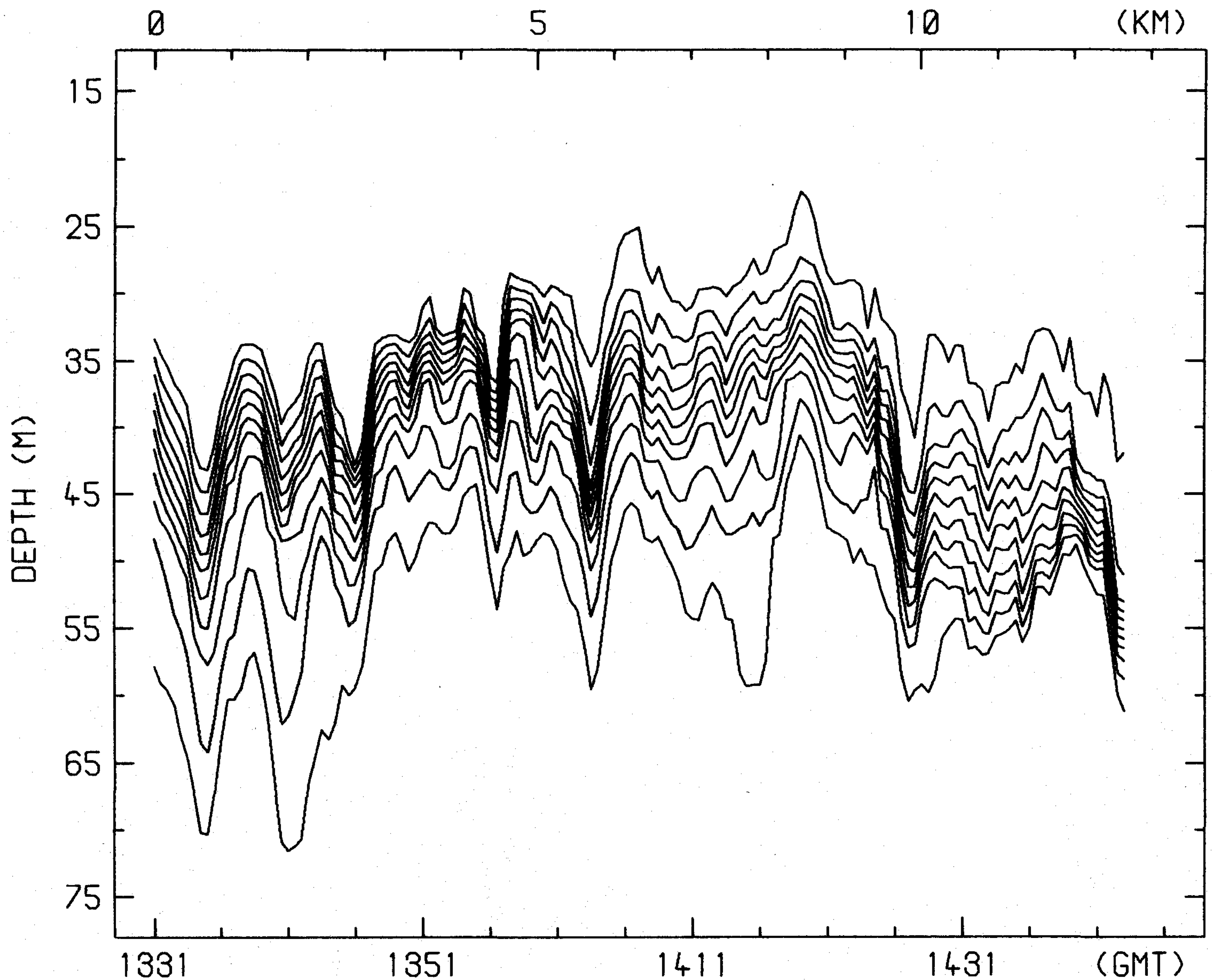
RUN 1-2 24-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4,11.2
11.0,10.8,10.6,10.4,10.2,10.0



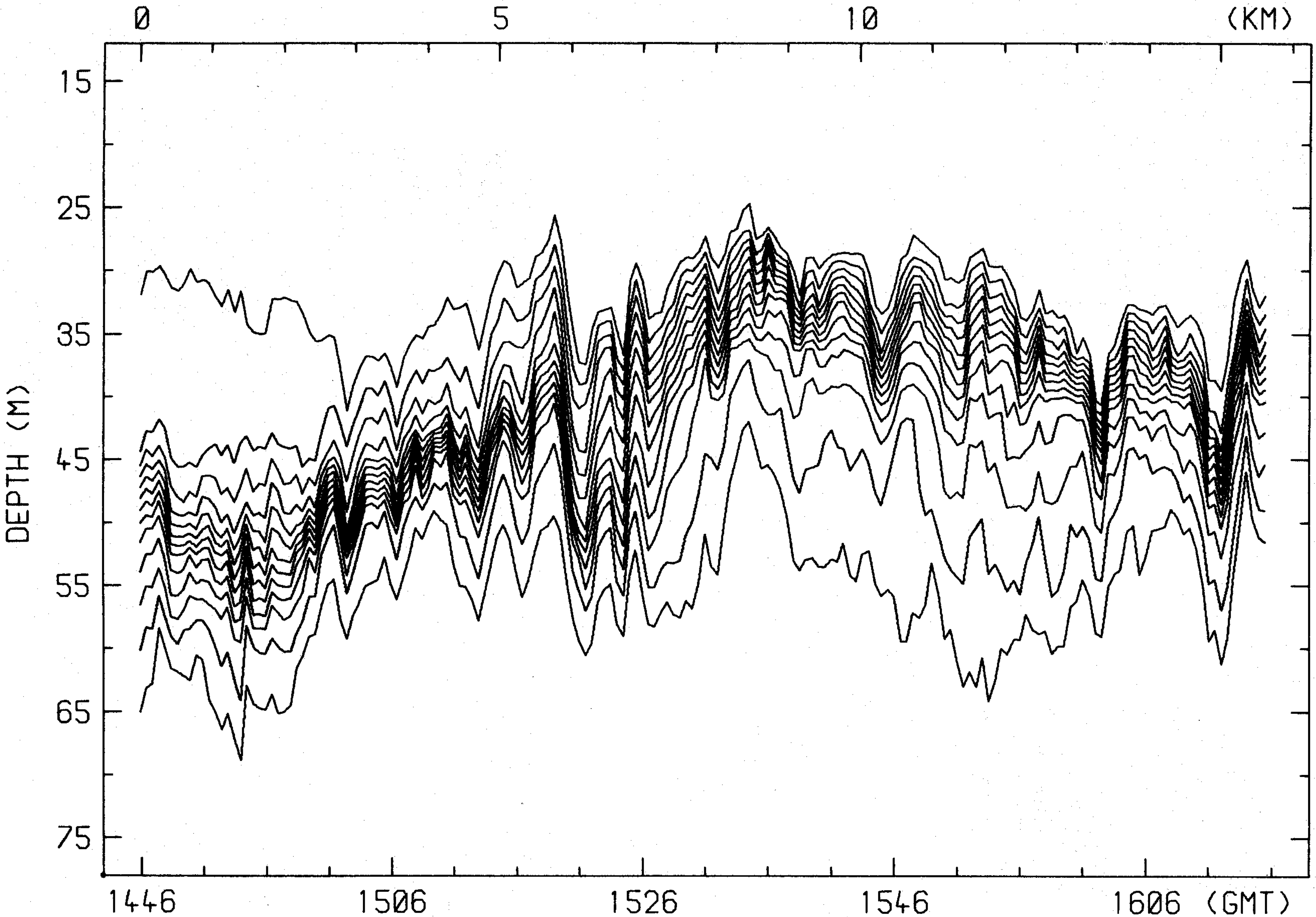
RUN 1-3 24-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4, 12.2, 12.0, 11.8, 11.6
11.4, 11.2, 11.0, 10.8, 10.6, 10.4, 10.2



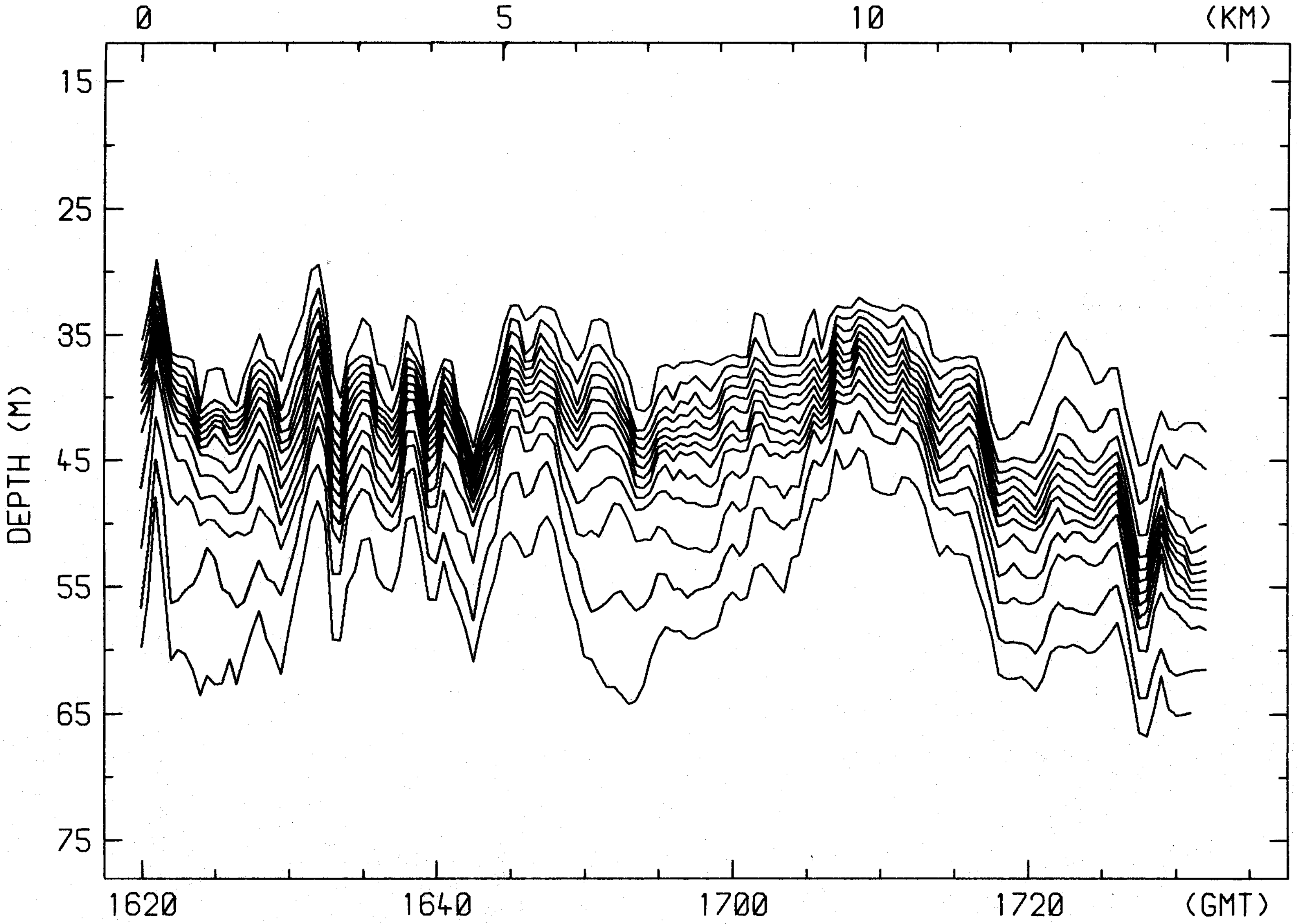
RUN 2W-1 25-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4,11.2
11.0,10.8,10.6,10.4,10.2,10.0,9.8



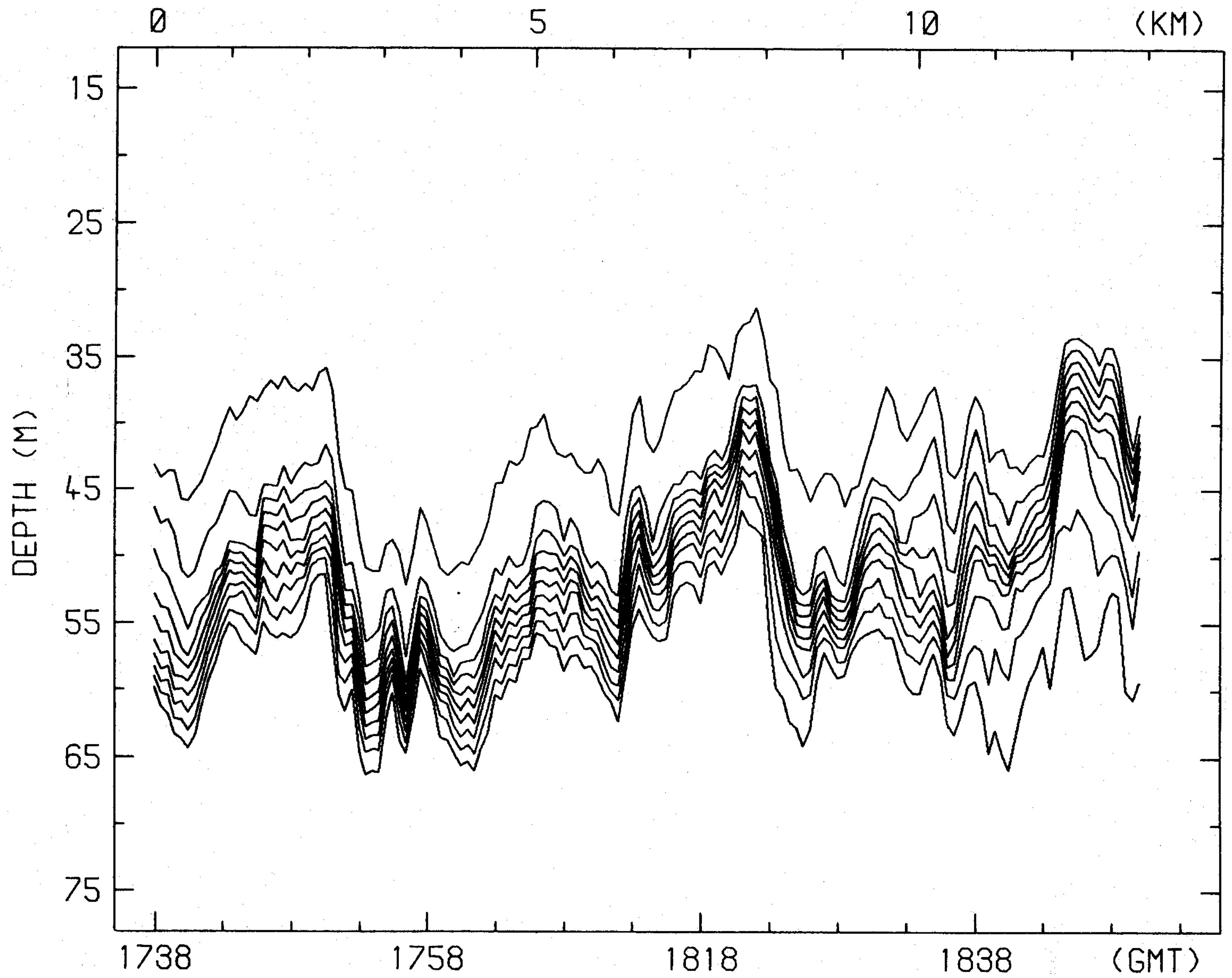
RUN 2S-2 25-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4,11.2
11.0,10.8,10.6,10.4,10.2,10.0



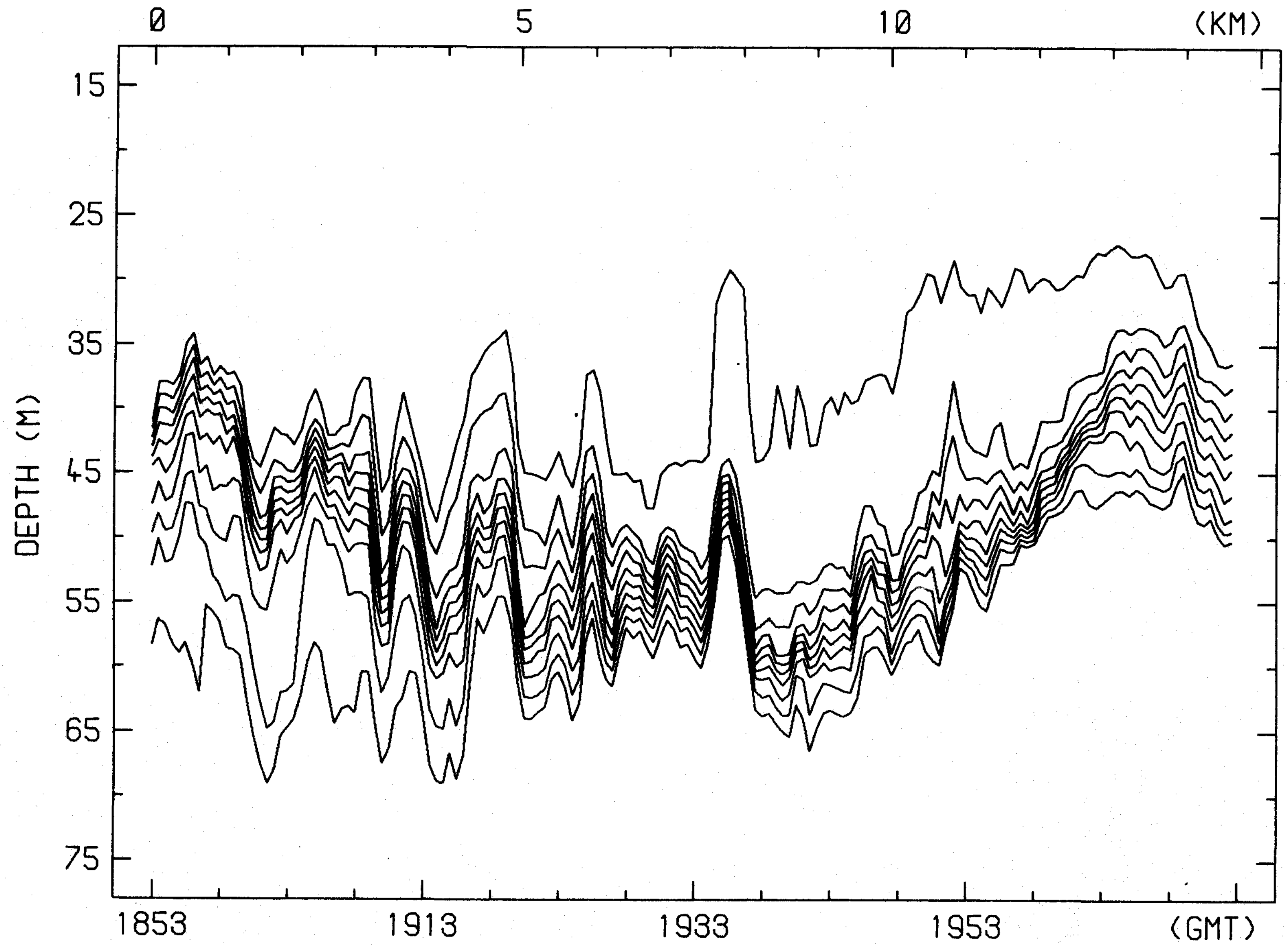
RUN 2E-3 25-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4,11.2
11.0,10.8,10.6,10.4,10.2,10.0,9.8,9.6



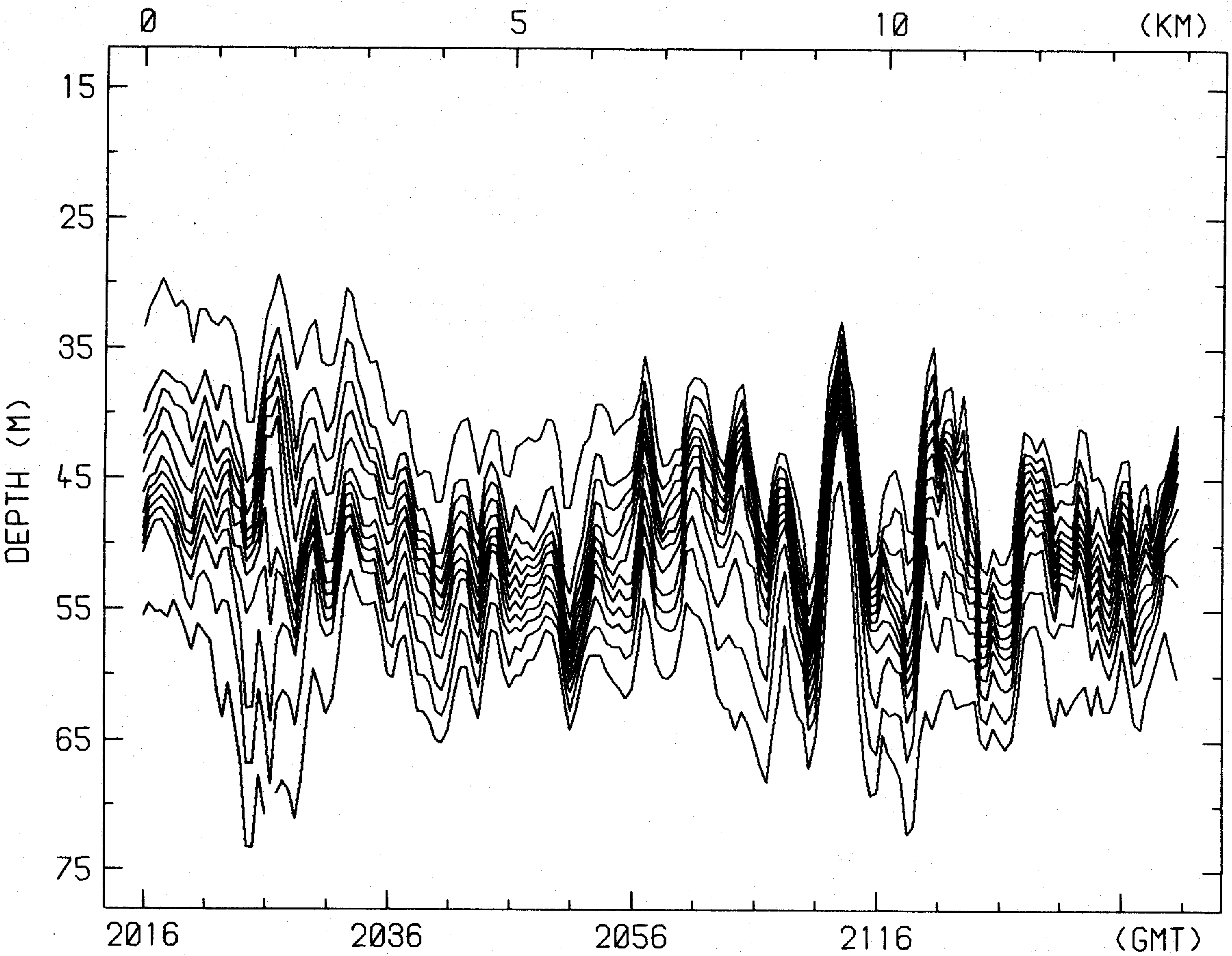
RUN 2N-4 25-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4,11.2
11.0,10.8,10.6,10.4,10.2,10.0,9.8,9.6



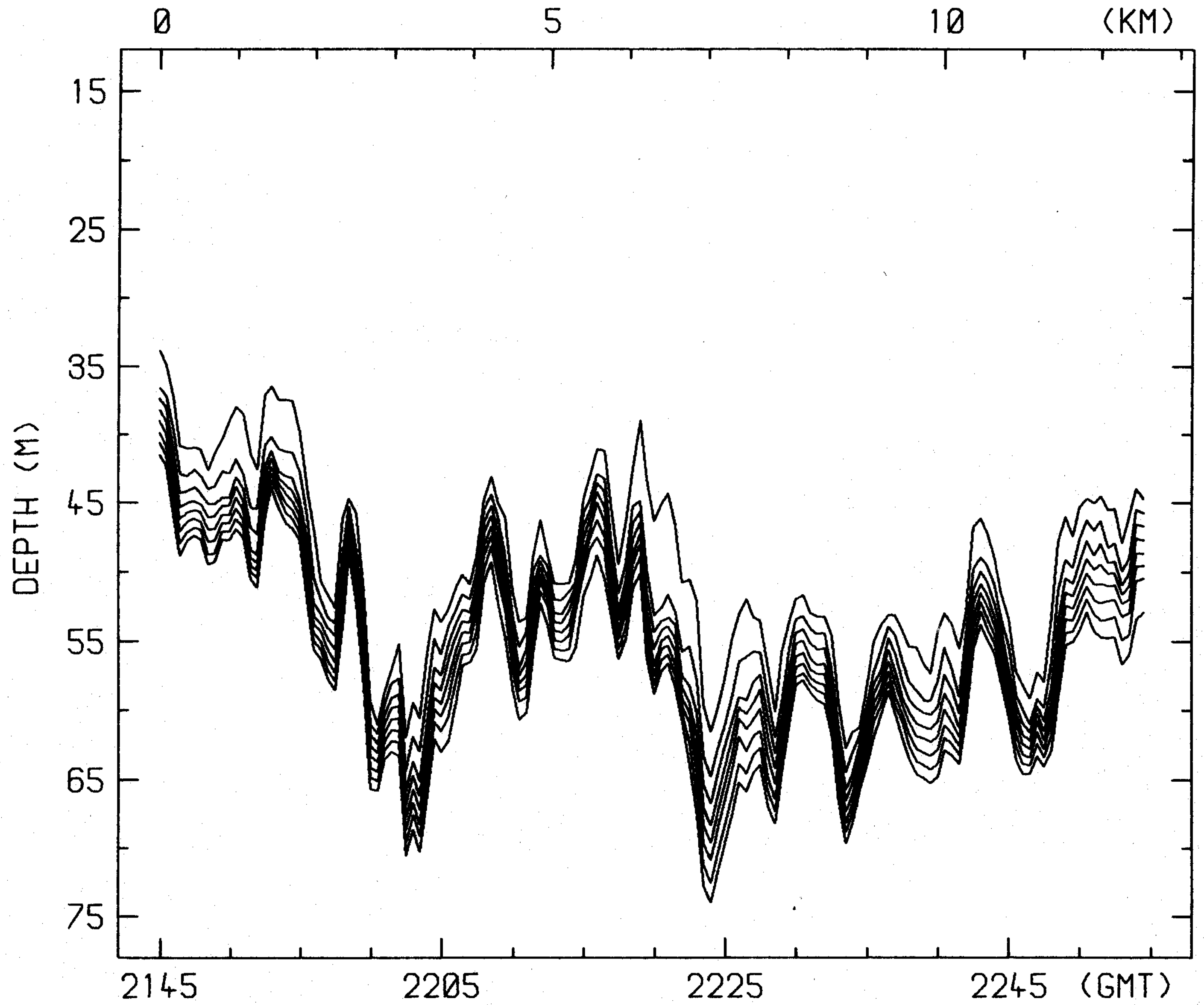
RUN 2W-5 25-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4
11.2,11.0,10.8,10.6,10.4,10.2



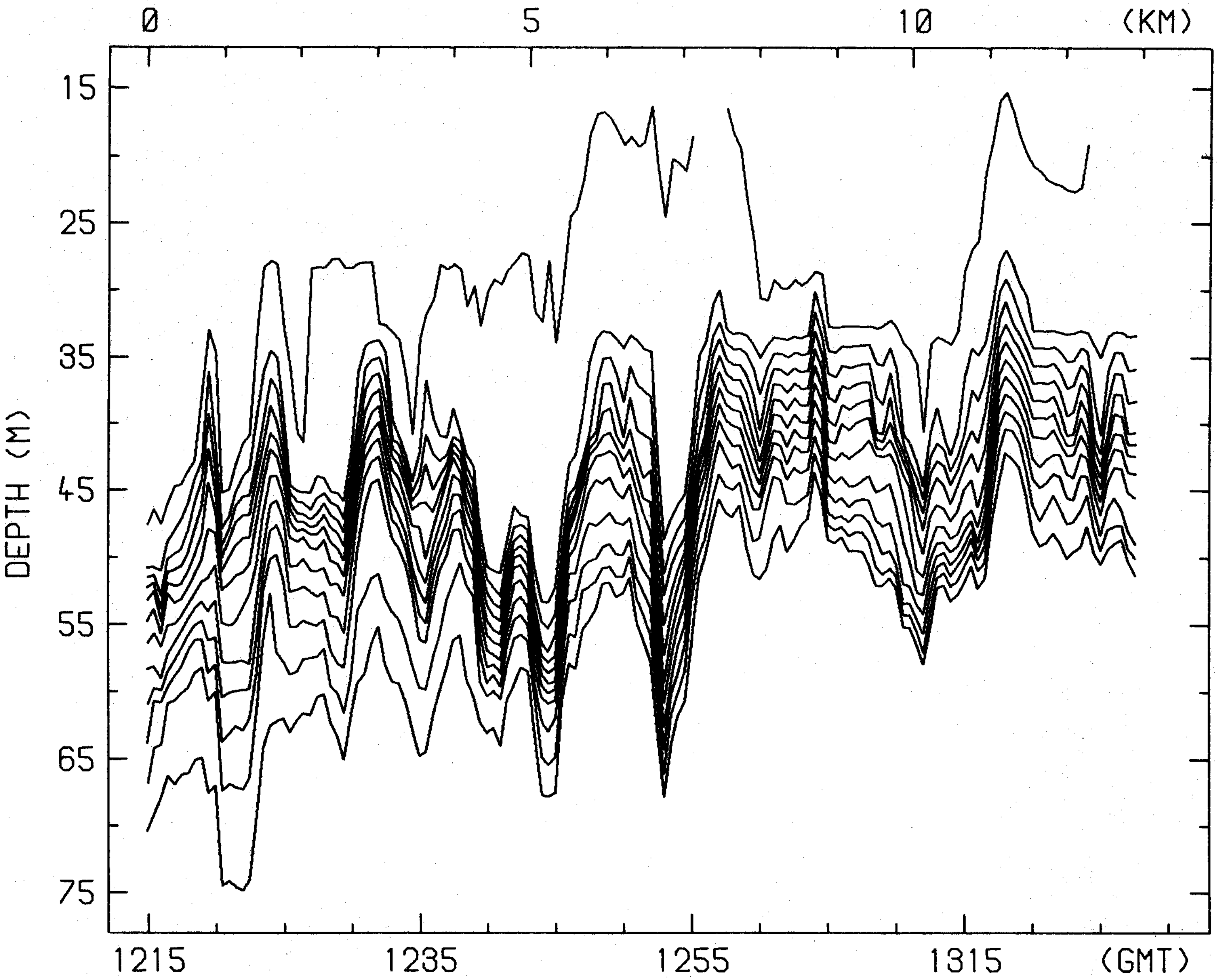
RUN 2S-6 25-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4
11.2,11.0,10.8,10.6,10.4,10.2



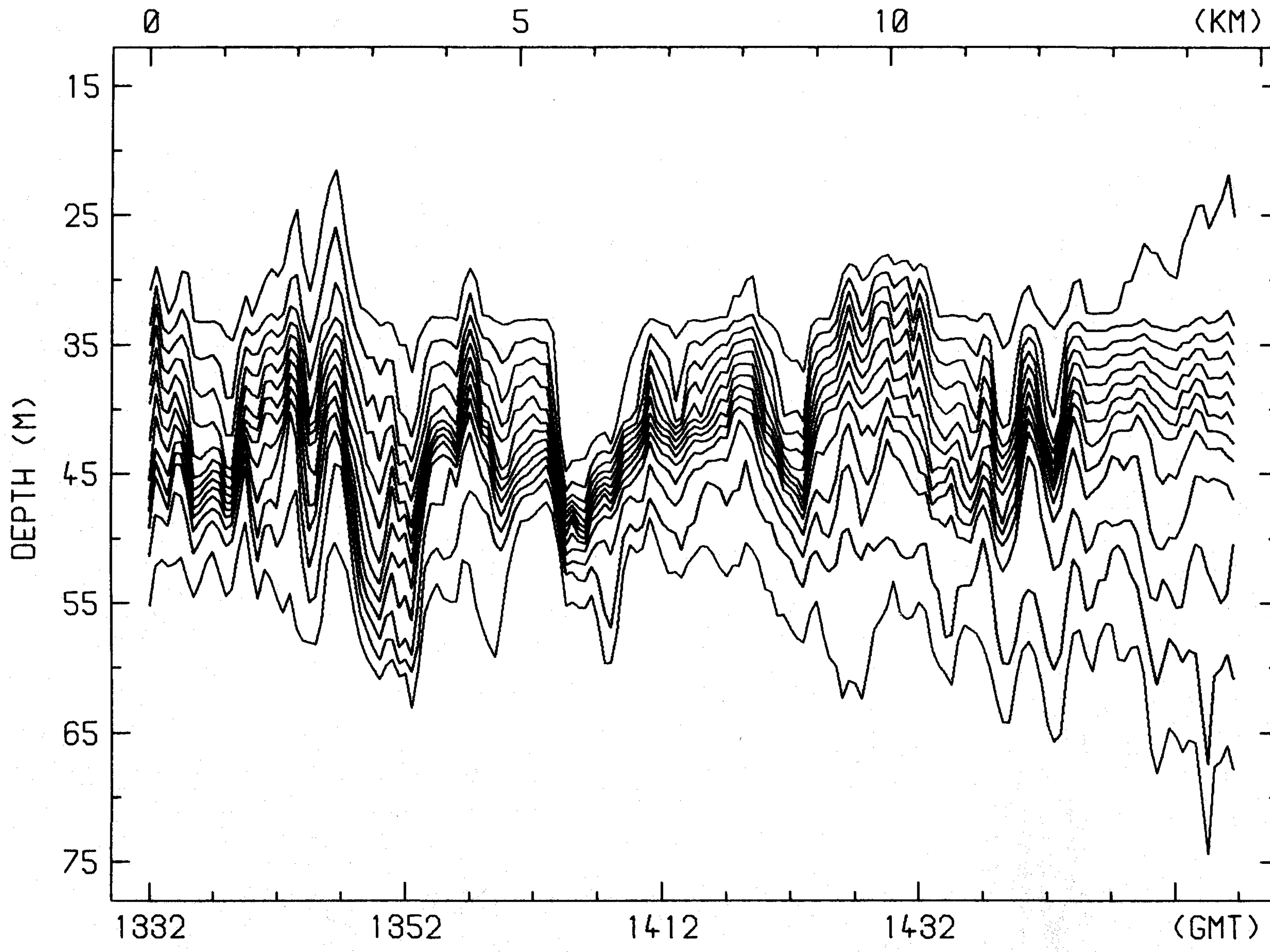
RUN 2E-7 25-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4
11.2,11.0,10.8,10.6,10.4,10.2,10.0,9.8



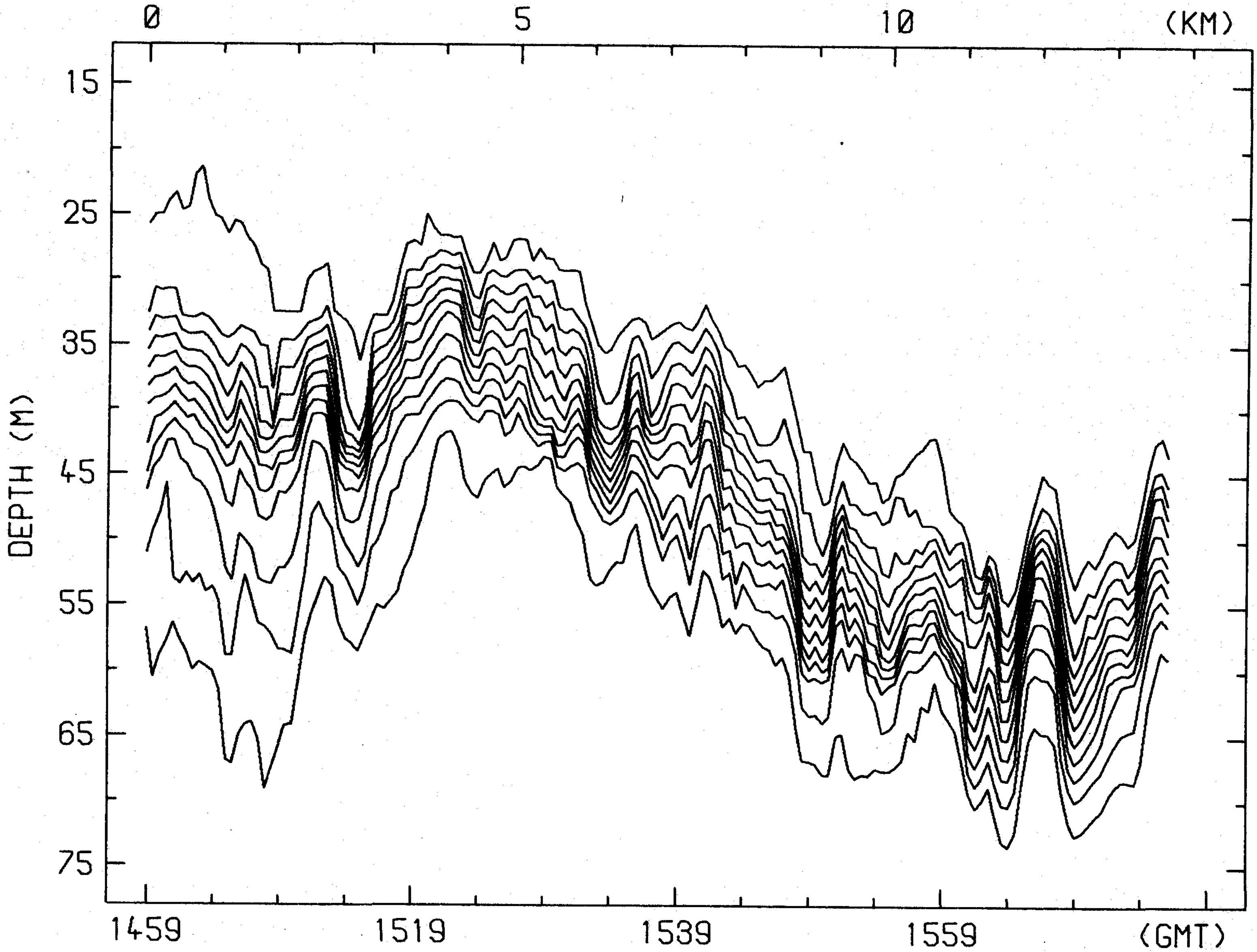
RUN 2N-8 25-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0, 11.8, 11.6, 11.4
11.2, 11.0, 10.8, 10.6



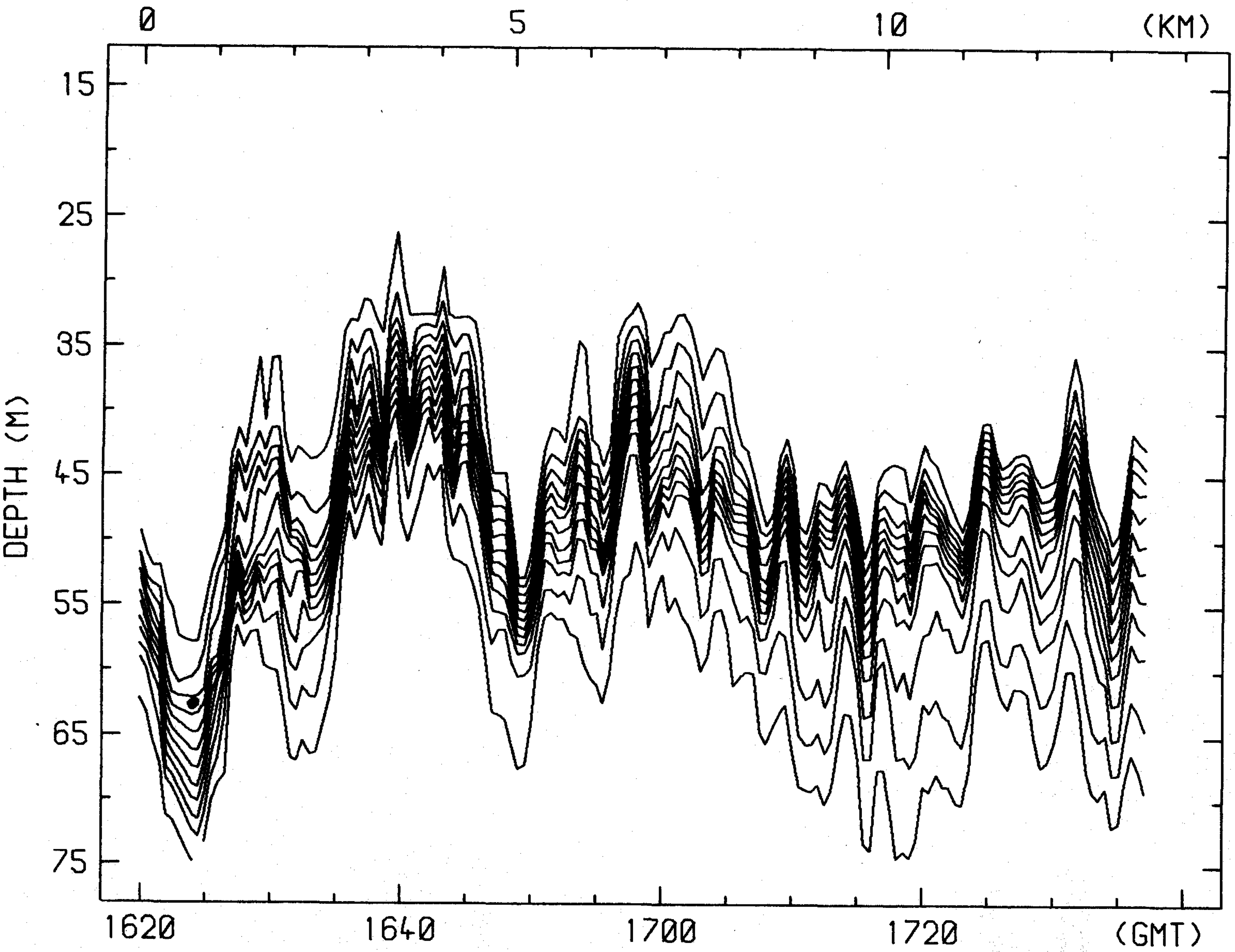
RUN 3N-1 27-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.2, 12.0, 11.8, 11.6, 11.4
11.2, 11.0, 10.8, 10.6, 10.4, 10.2, 10.0



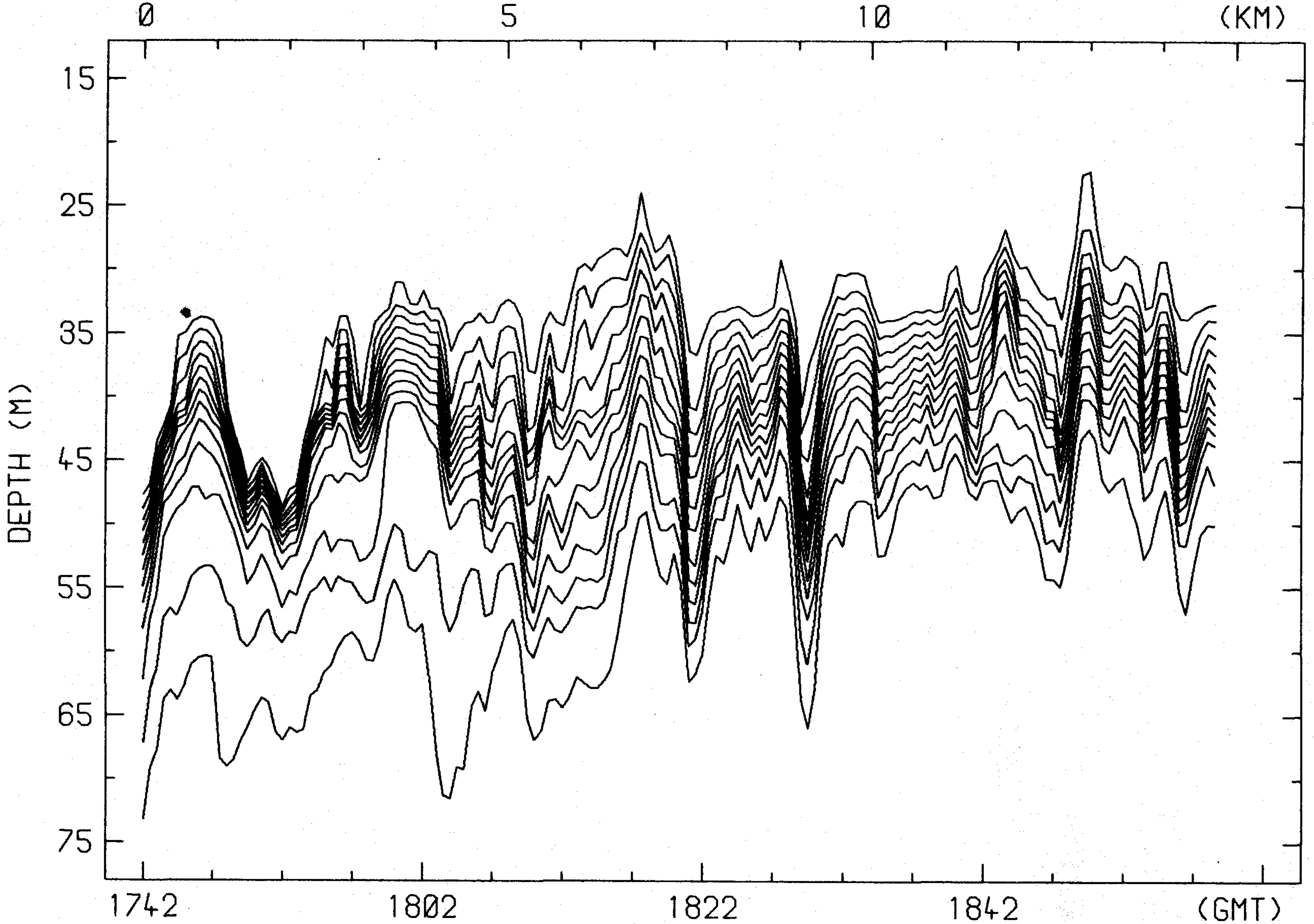
RUN 3W-2 27-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4,11.2
11.0,10.8,10.6,10.4,10.2,10.0,9.8,9.6



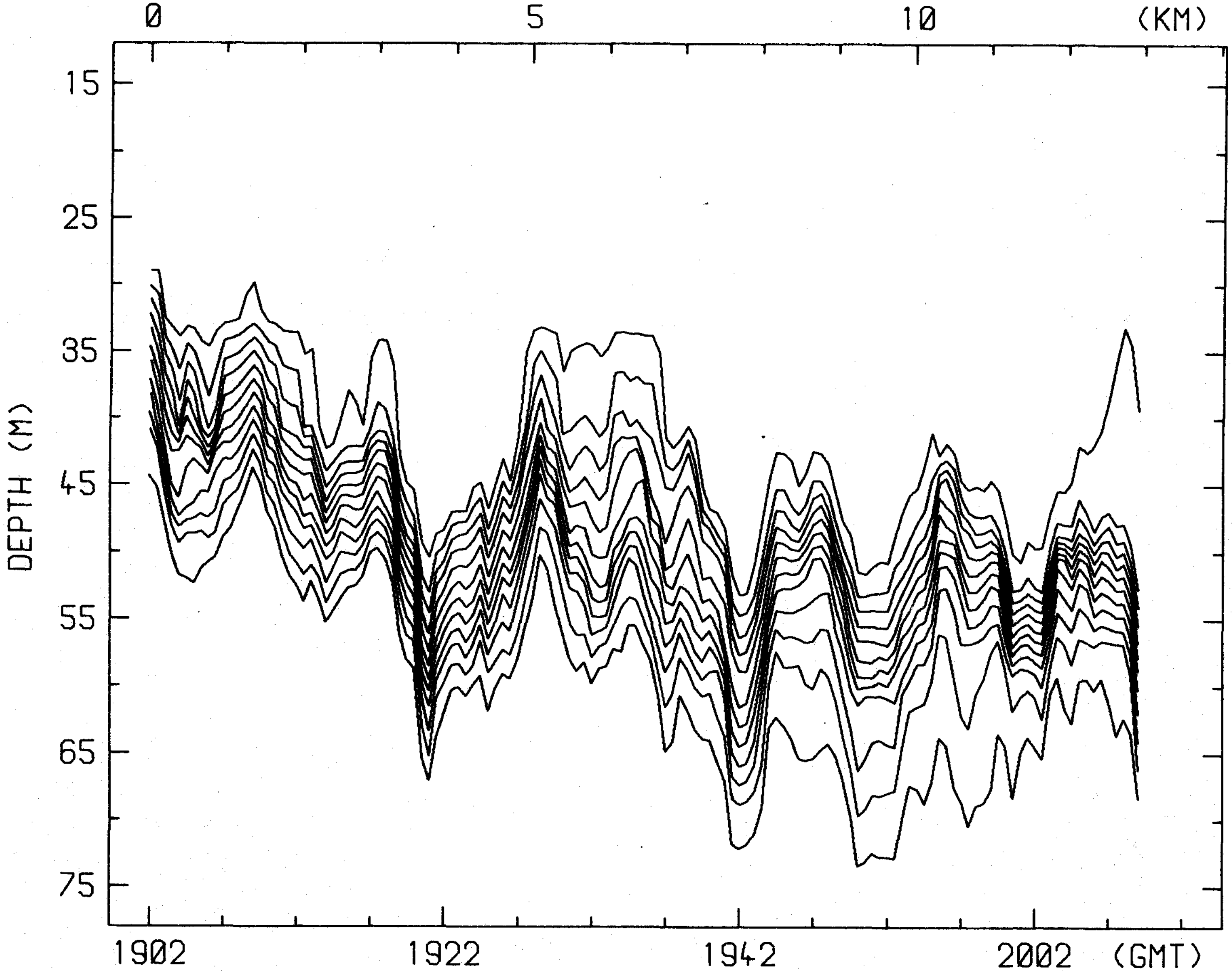
RUN 3S-3 27-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0, 11.8, 11.6, 11.4, 11.2
11.0, 10.8, 10.6, 10.4, 10.2, 10.0, 9.8



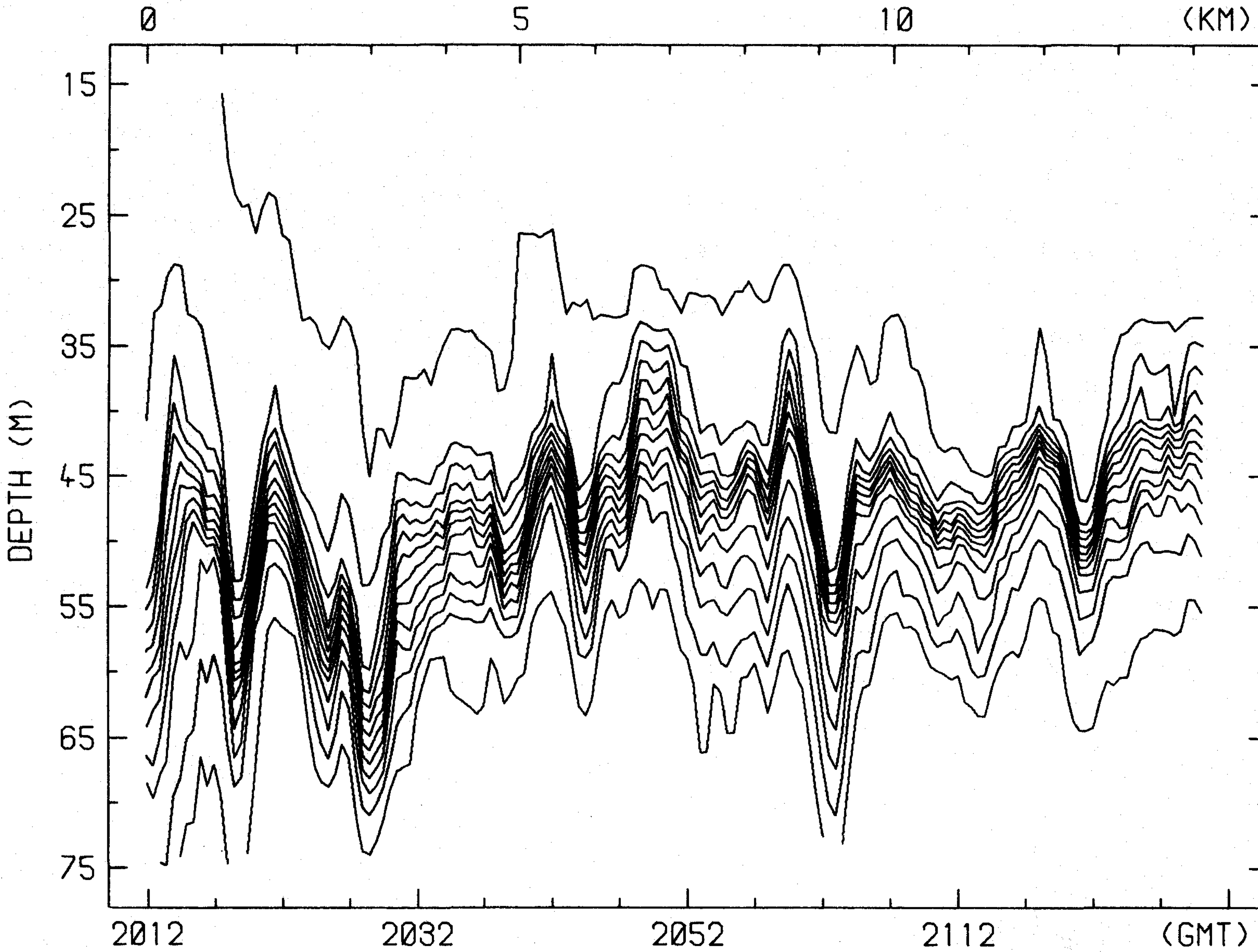
RUN 3E-4 27-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0, 11.8, 11.6, 11.4, 11.2
11.0, 10.8, 10.6, 10.4, 10.2, 10.0, 9.8



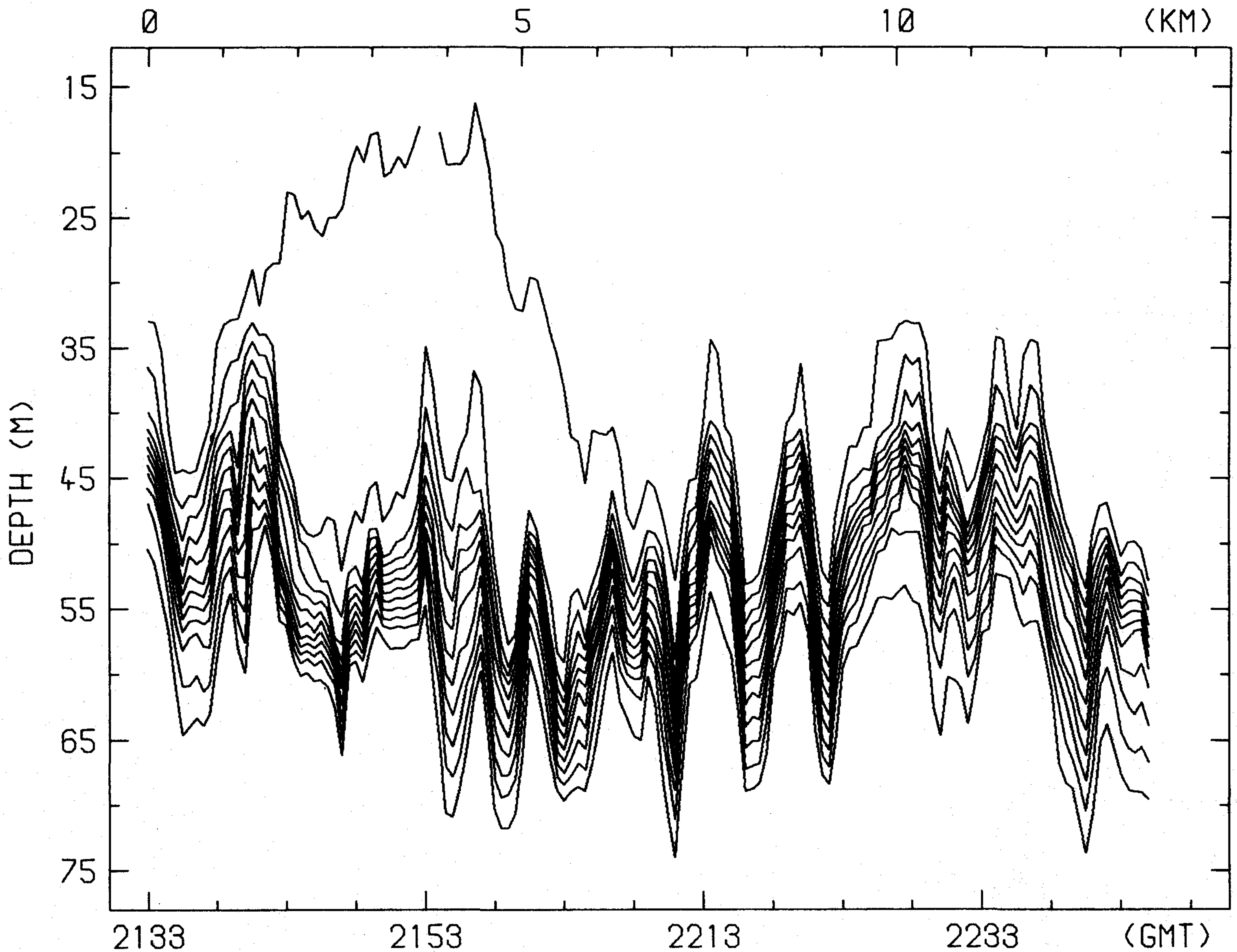
RUN 3N-5 27-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4,11.2
11.0,10.8,10.6,10.4,10.2,10.0,9.8,9.6



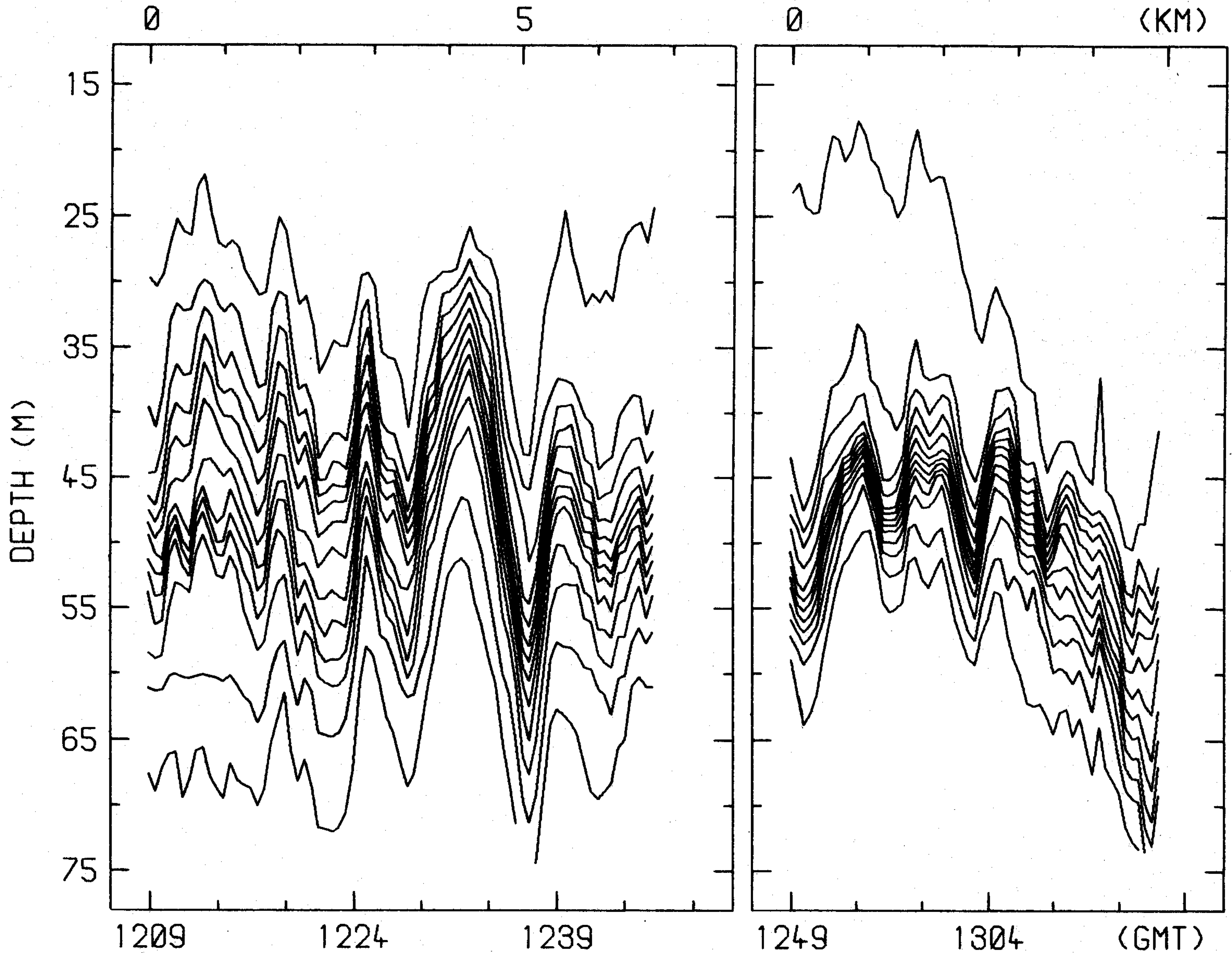
RUN 3W-6 27-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.0,11.8,11.6,11.4,11.2
11.0,10.8,10.6,10.4,10.2,10.0,9.8



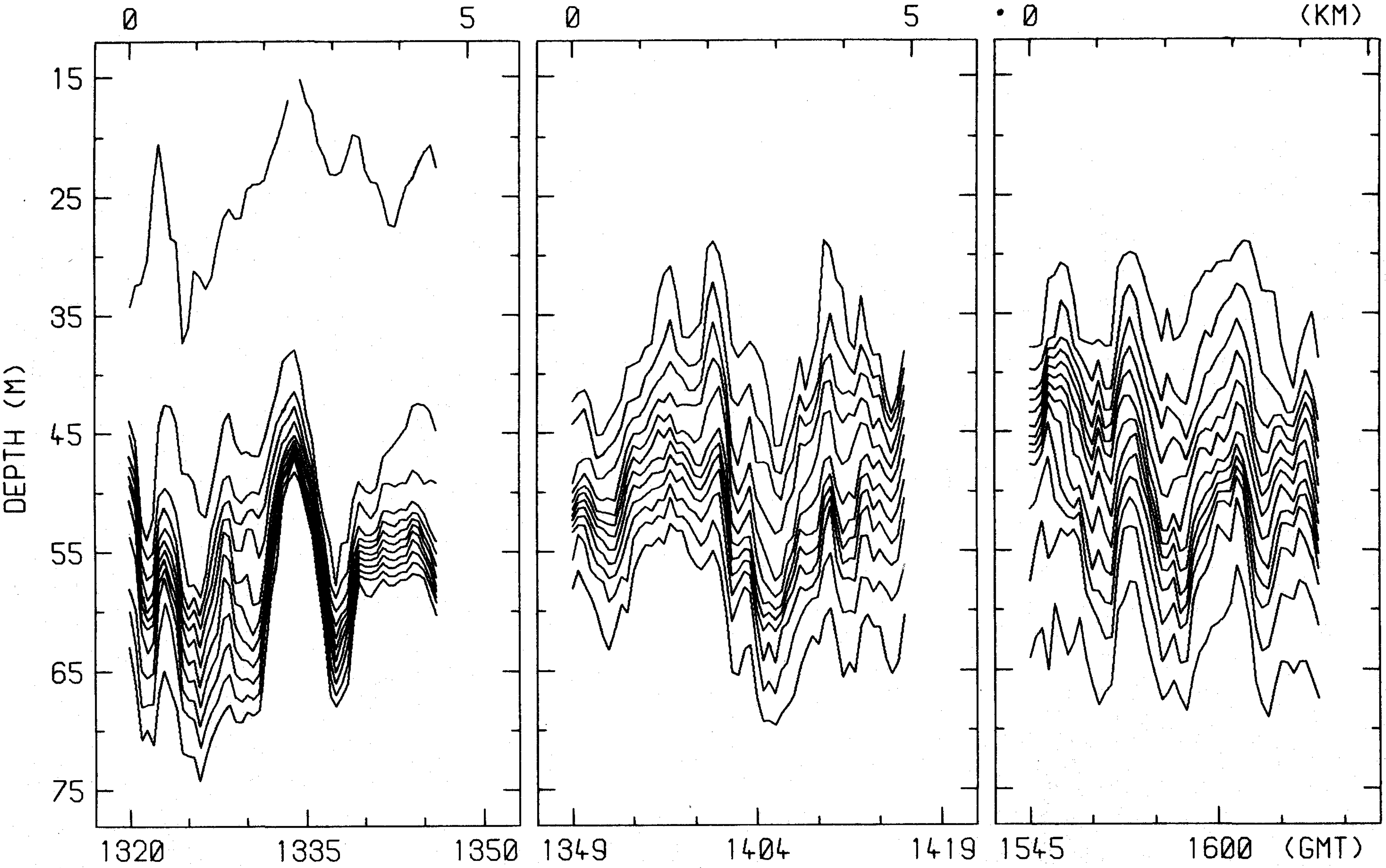
RUN 3S-7 27-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.2,12.0,11.8,11.6,11.4,11.2
11.0,10.8,10.6,10.4,10.2,10.0,9.8



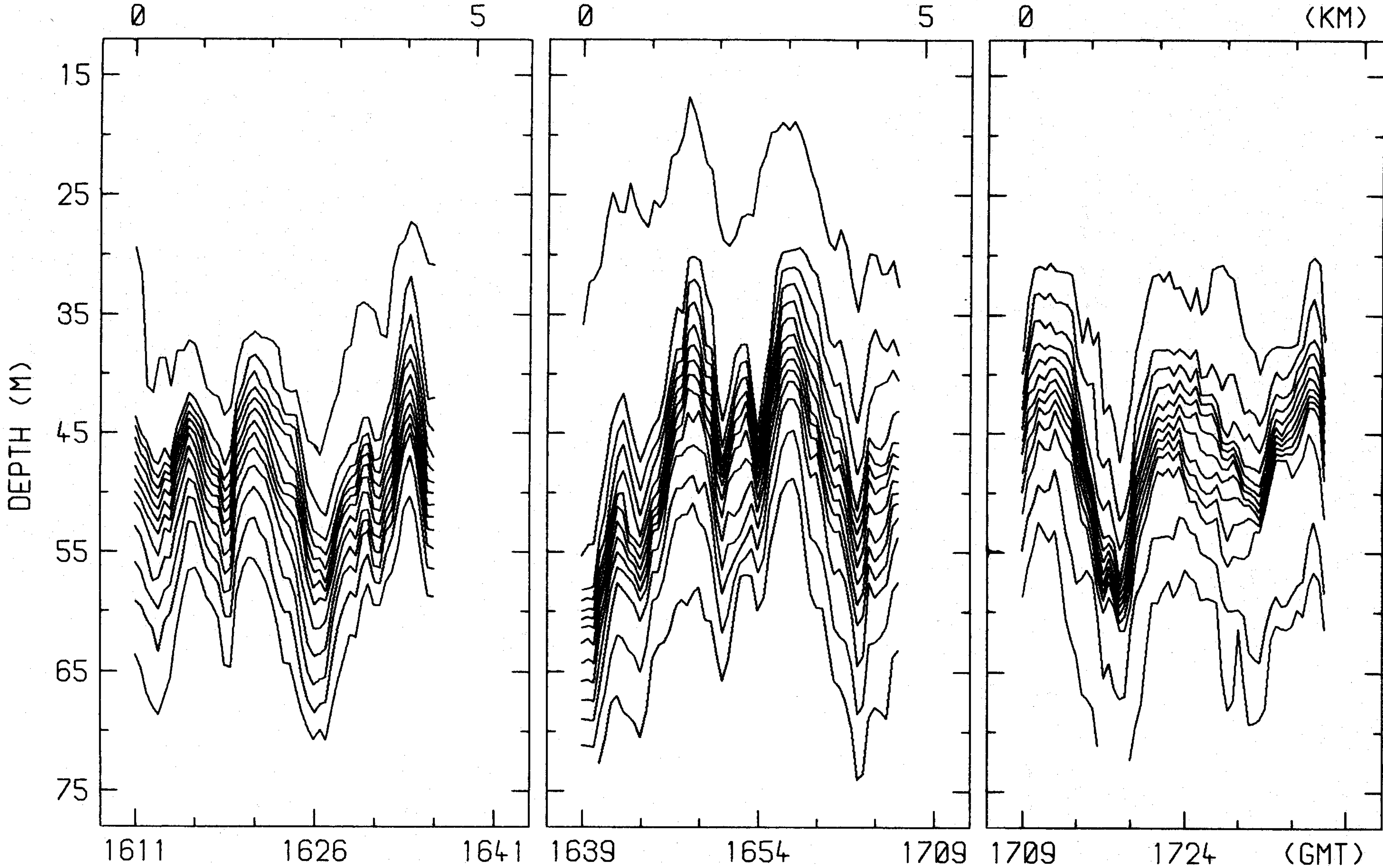
RUN 3E-8 27-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.2,12.0,11.8,11.6,11.4,11.2
11.0,10.8,10.6,10.4,10.2,10.0



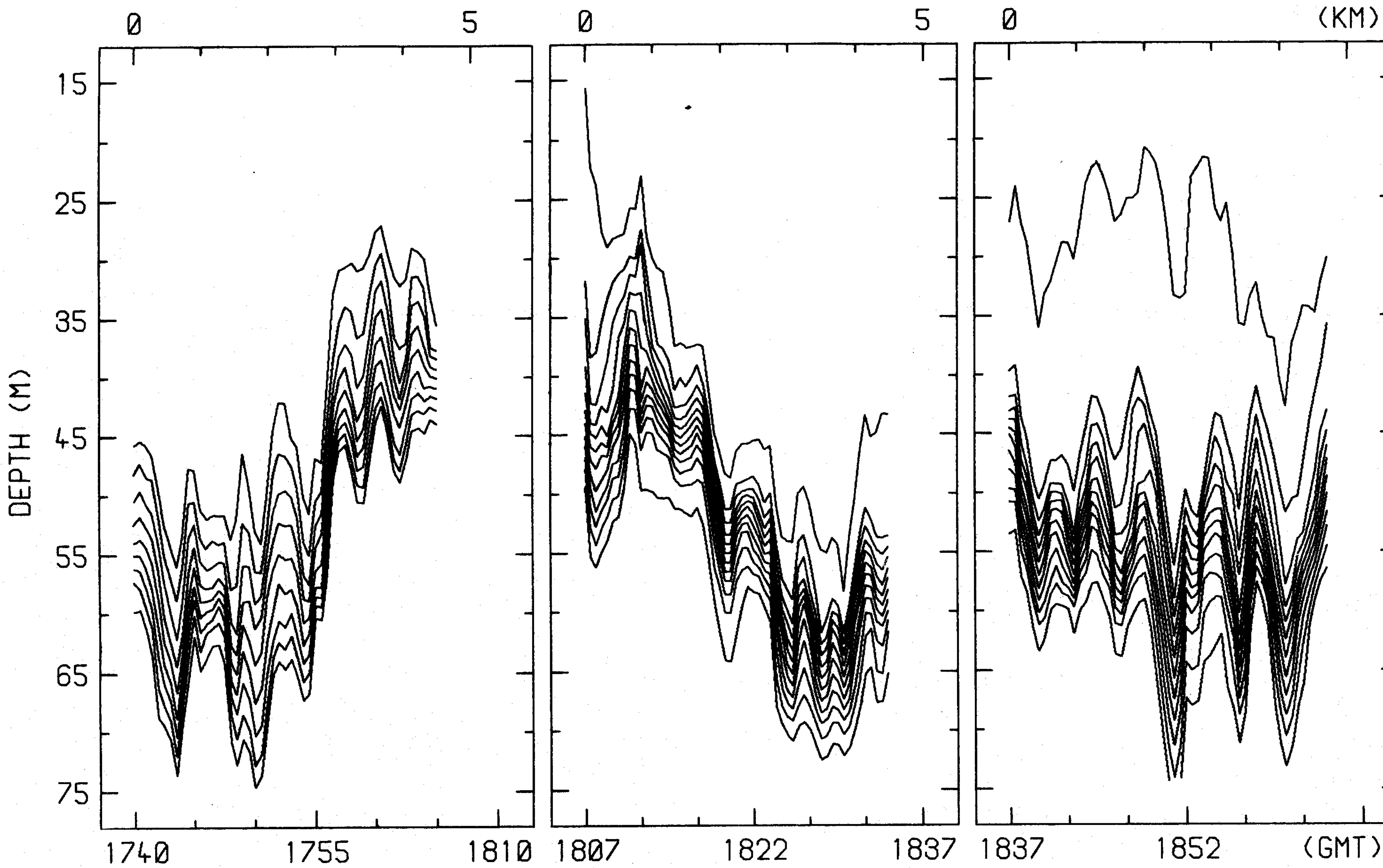
RUNS 4N-1, 4W-2 29-AUG-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
4N-1 12.2 TO 9.8; 4W-2 12.2 TO 9.8



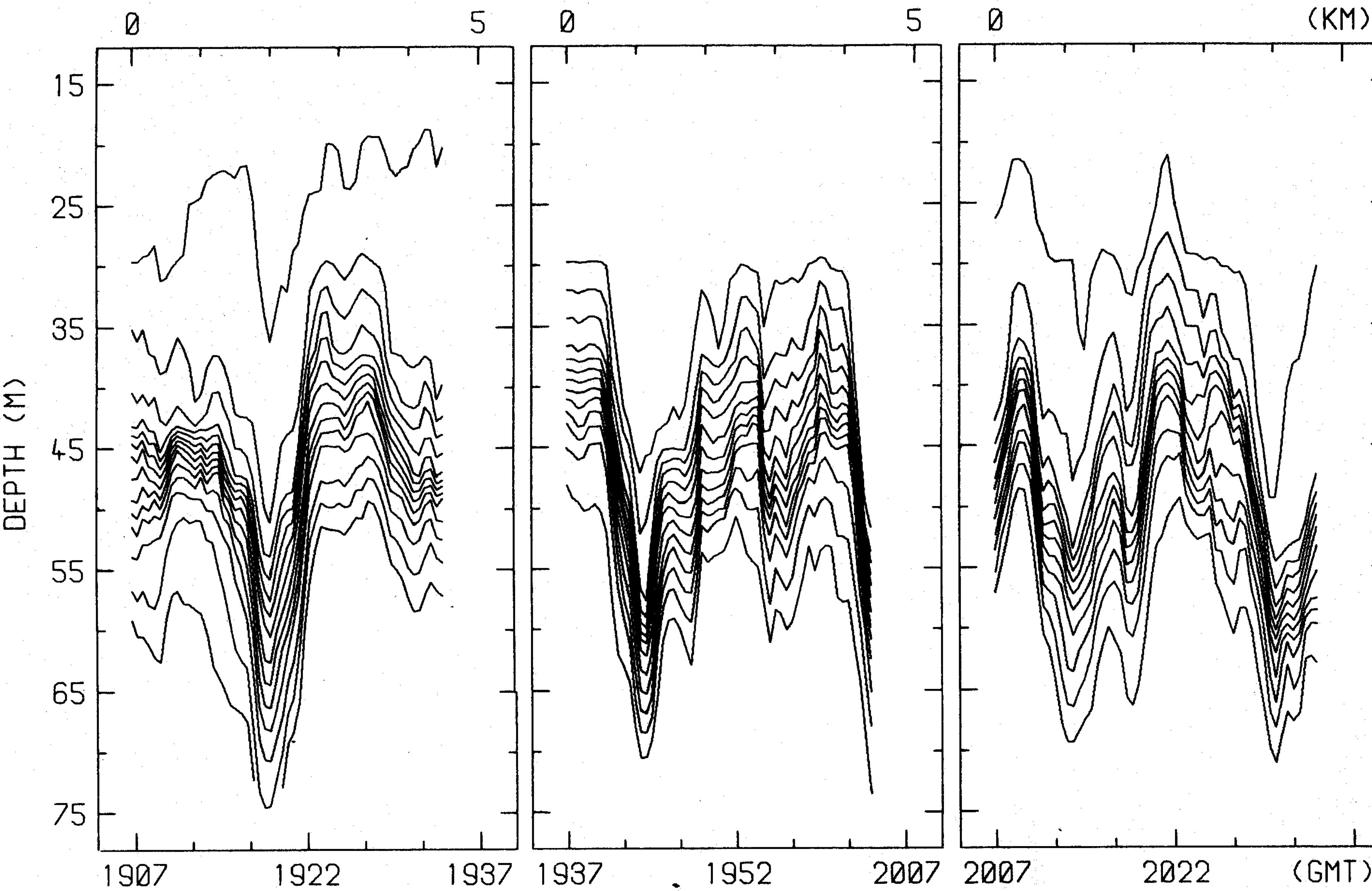
RUNS 4S-3, 4E-4, 4E-5 29-AUG-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
4S-3 12.2 TO 10.0; 4E-4 12.0 TO 9.8; 4E-5 12.0 TO 9.6



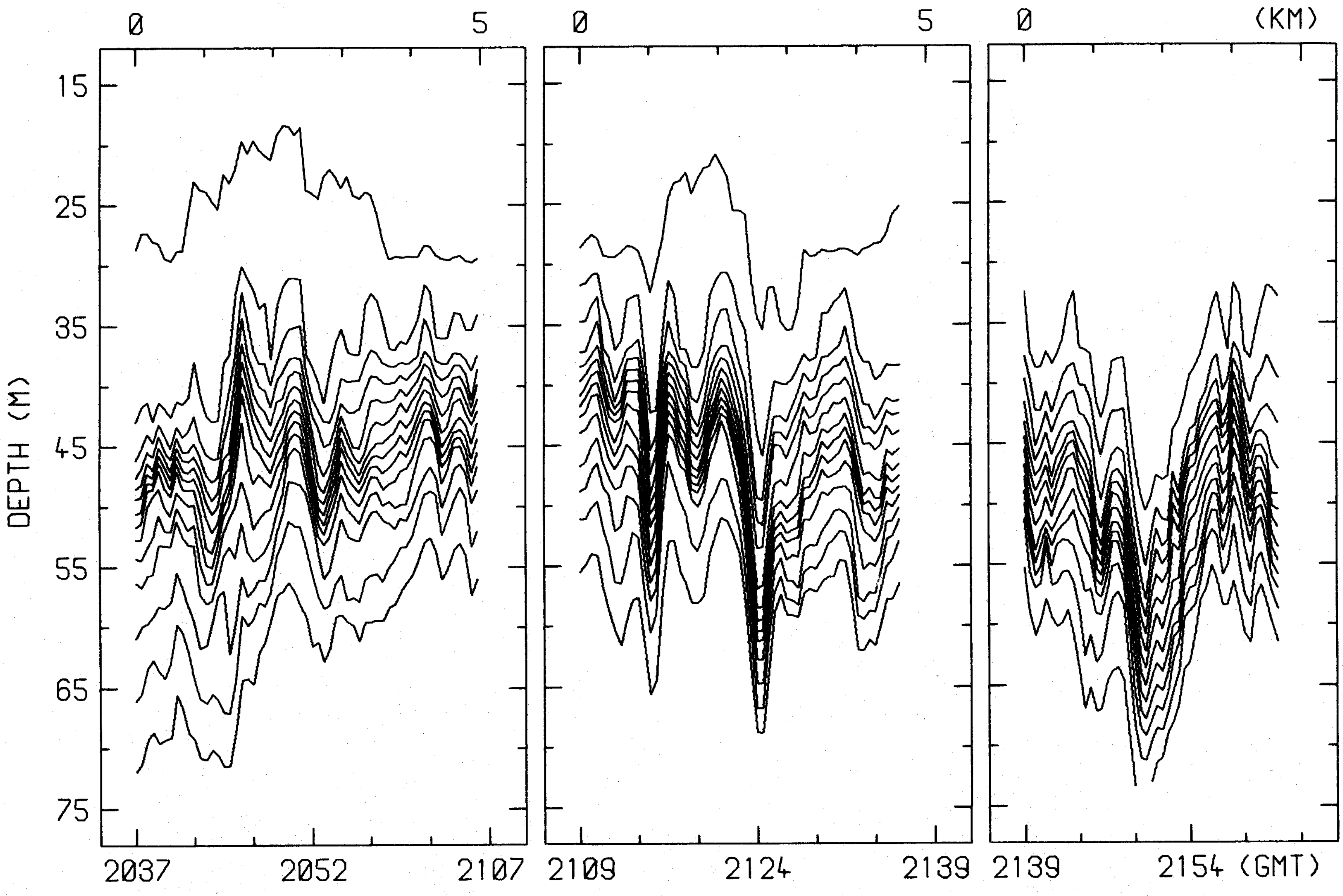
RUNS 4N-6, 4W-7, 4S-8 29-AUG-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
4N-6 12.2 TO 9.8; 4W-7 12.2 TO 9.6; 4S-8 12.0 TO 9.6



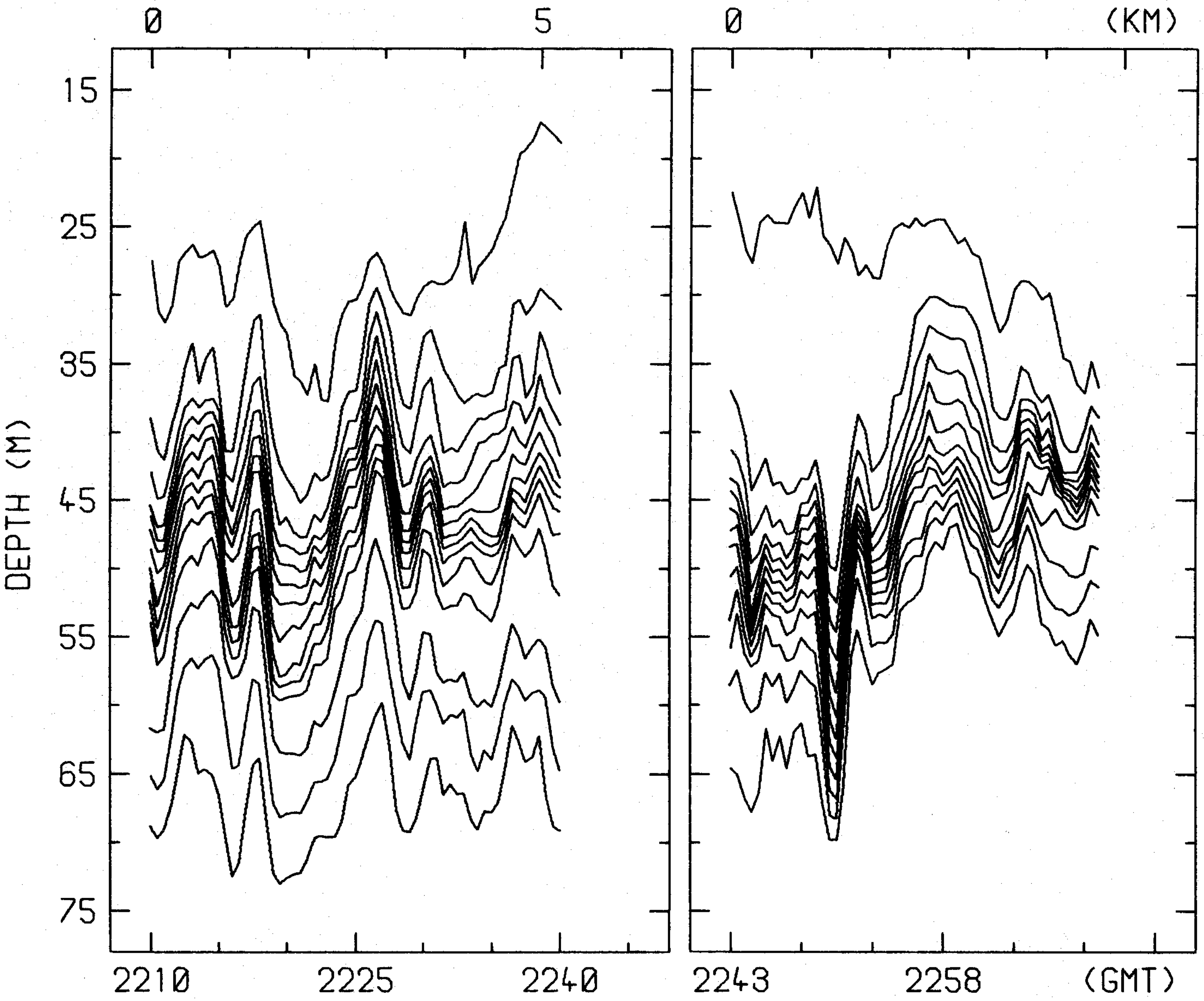
RUNS 4E-9, 4N-10, 4W-11 29-AUG-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
4E-9 12.0 TO 10.4; 4N-10 12.2 TO 10.0; 4W-11 12.2 TO 10.0



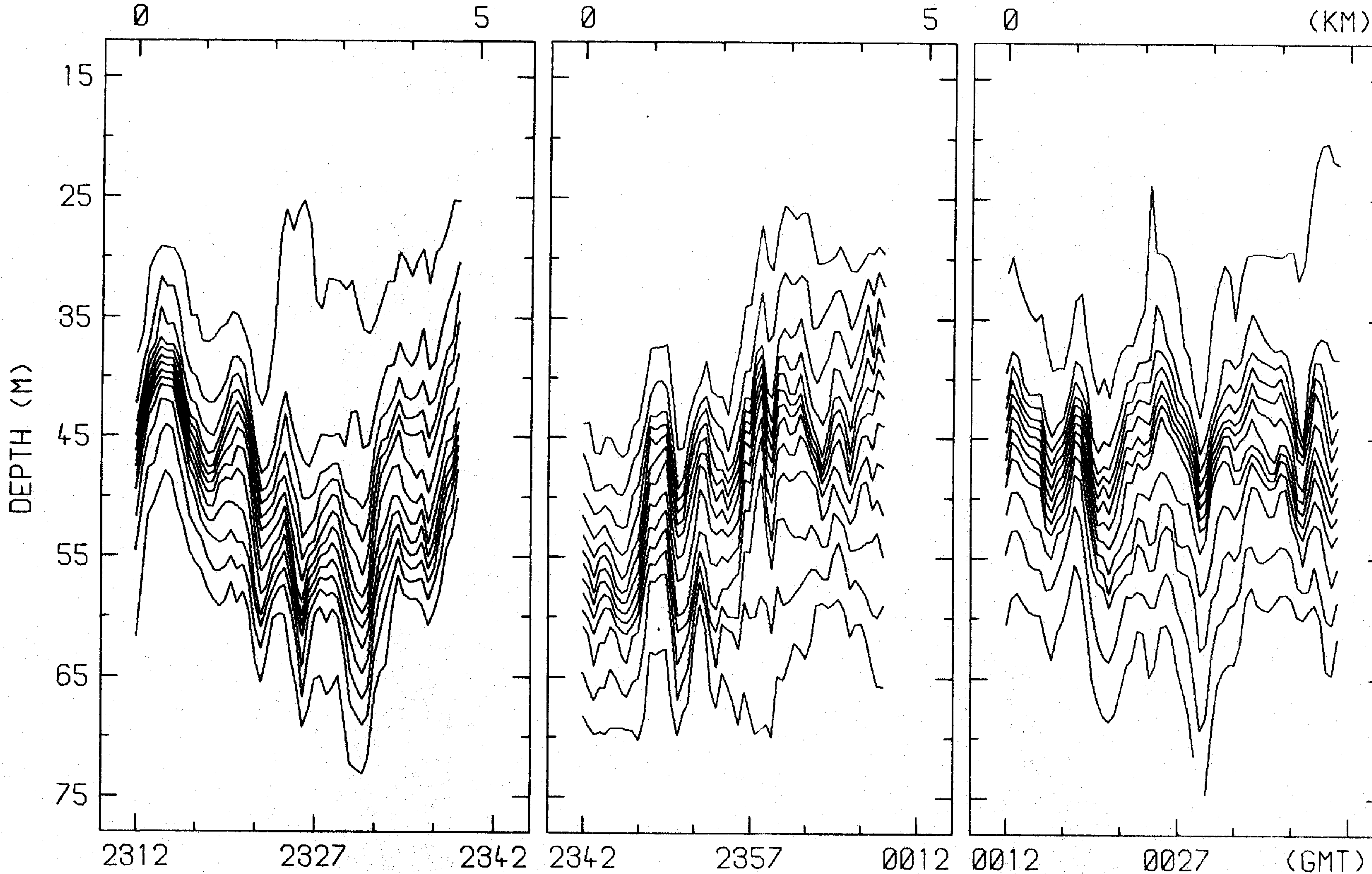
RUNS 4S-12, 4E-13, 4N-14 29-AUG-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
4S-12 12.2 TO 9.6; 4E-13 12.0 TO 9.6; 4N-14 12.2 TO 10.0



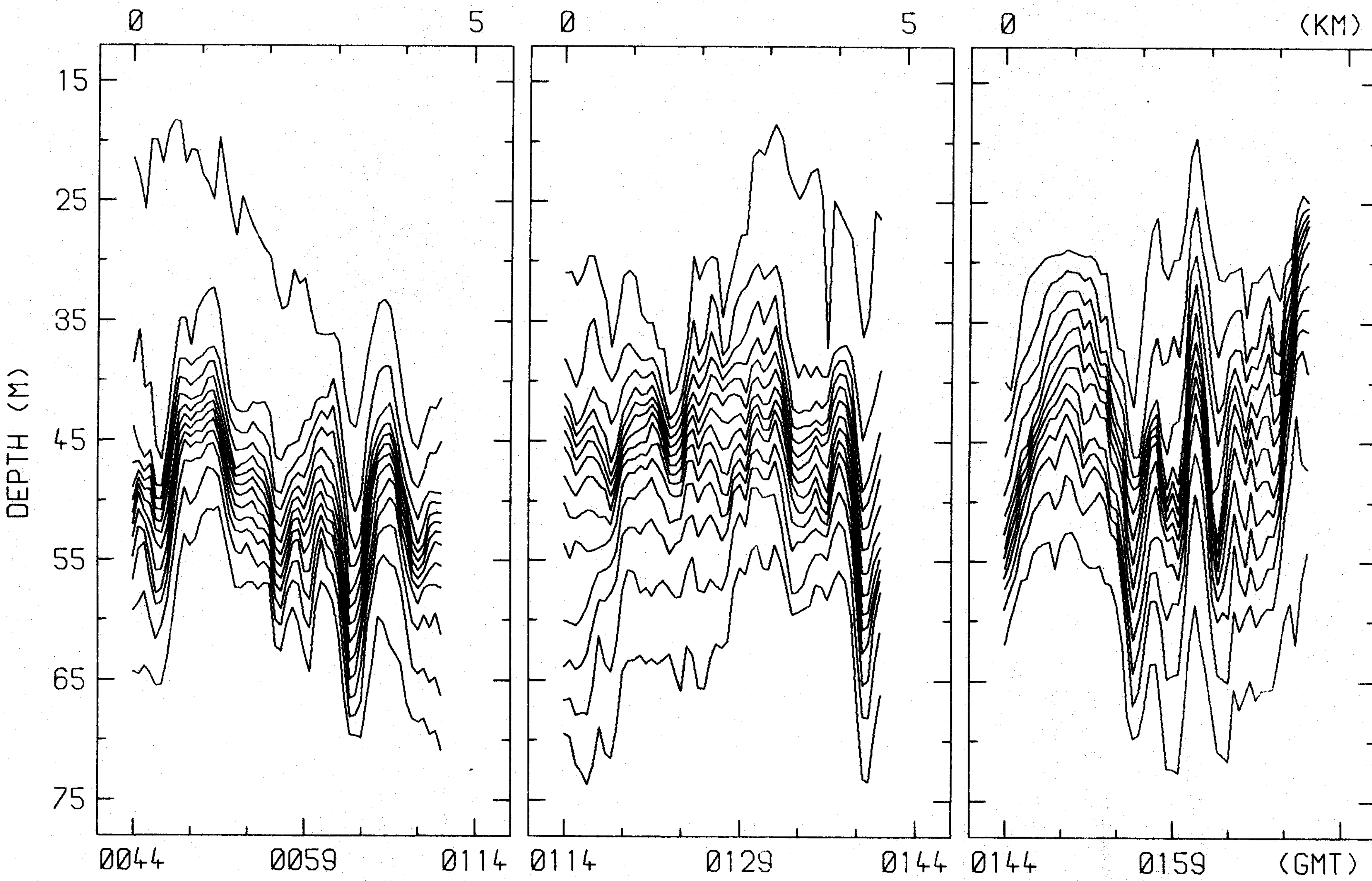
RUNS 4W-15, 4S-16, 4E-17 29-AUG-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
4W-15 12.2 TO 9.6; 4S-16 12.2 TO 9.6; 4E-17 12.0 TO 9.6



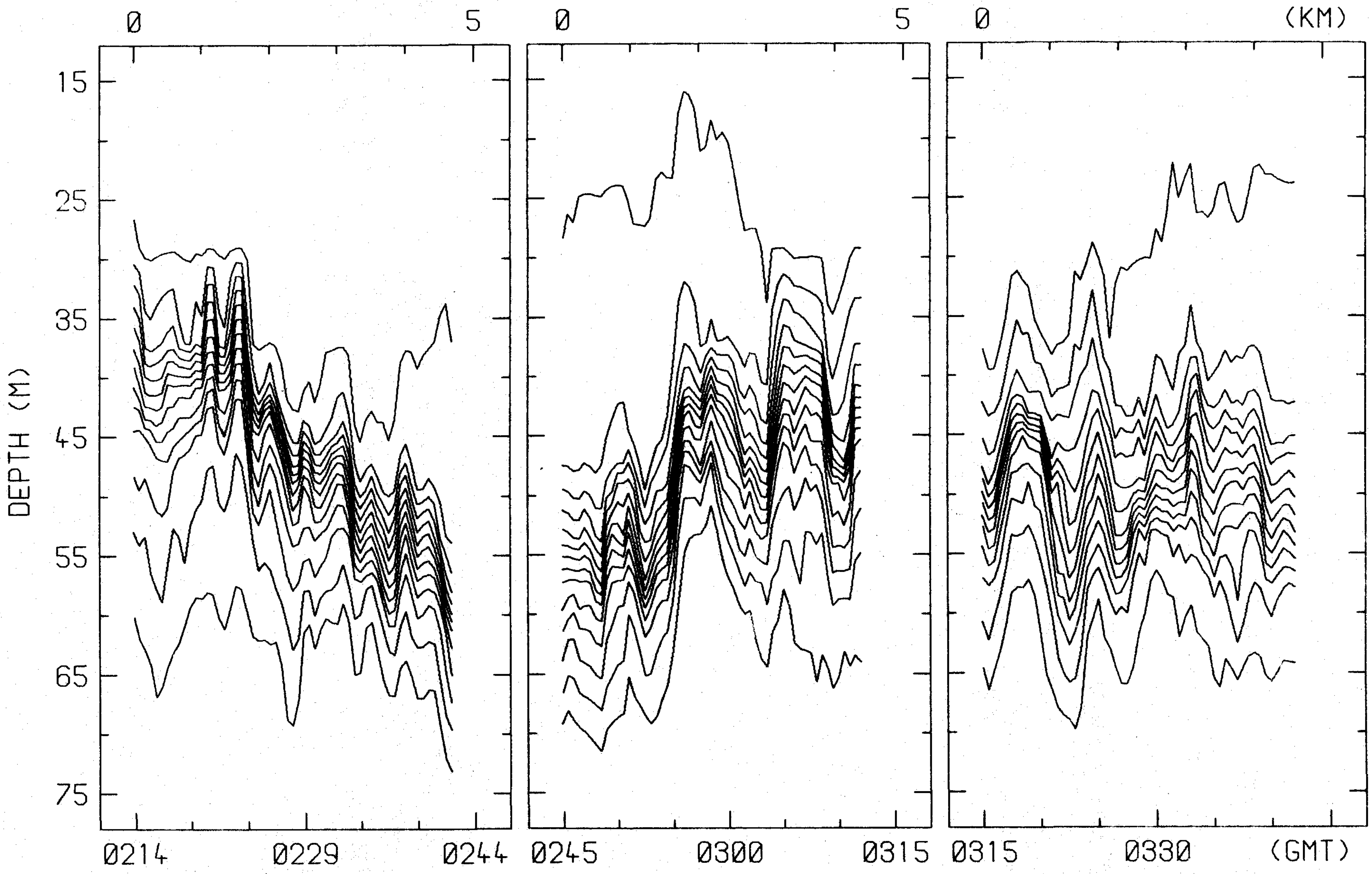
RUNS 4N-18, 4W-19 29-AUG-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
4N-18 12.2 TO 9.6; 4W-19 12.2 TO 9.8



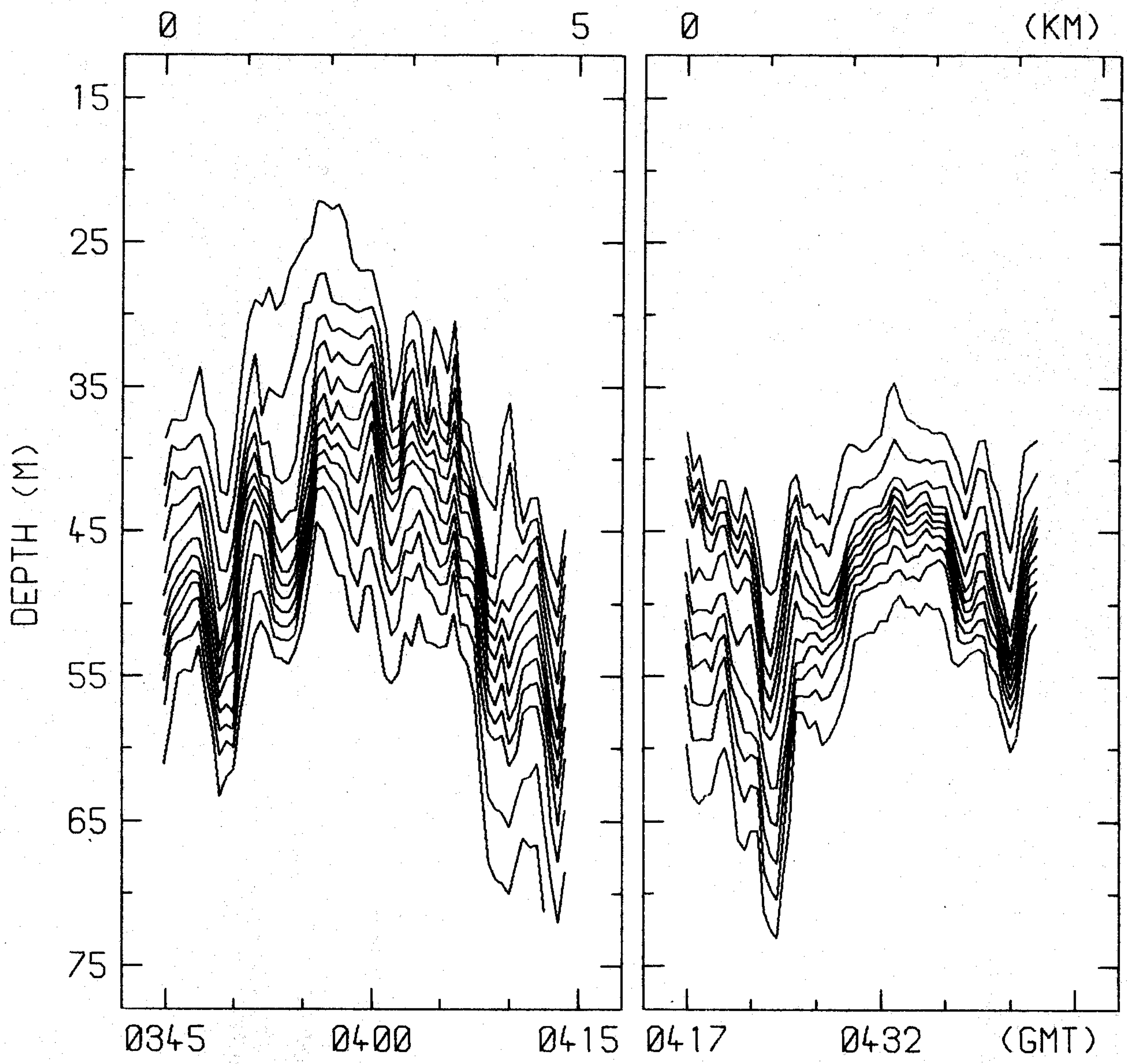
RUNS 4S-20, 4E-21, 4N-22 29,30-AUG-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
4S-20 12.2 TO 9.8; 4E-21 12.0 TO 9.6; 4N-22 12.2 TO 9.8



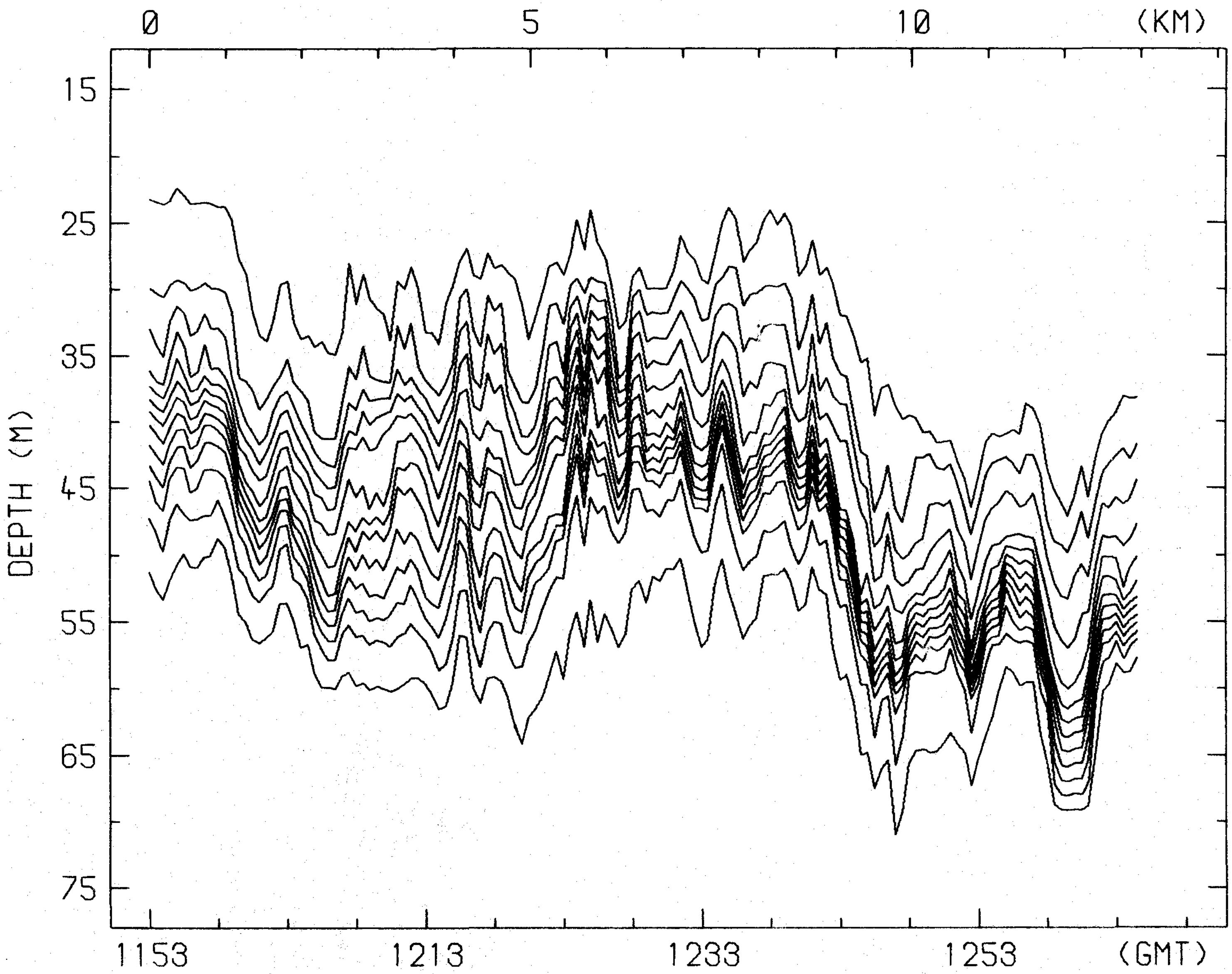
RUNS 4W-23, 4S-24, 4E-25 30-AUG-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
4W-23 12.2 TO 9.8; 4S-24 12.2 TO 9.6; 4E-25 12.0 TO 9.6



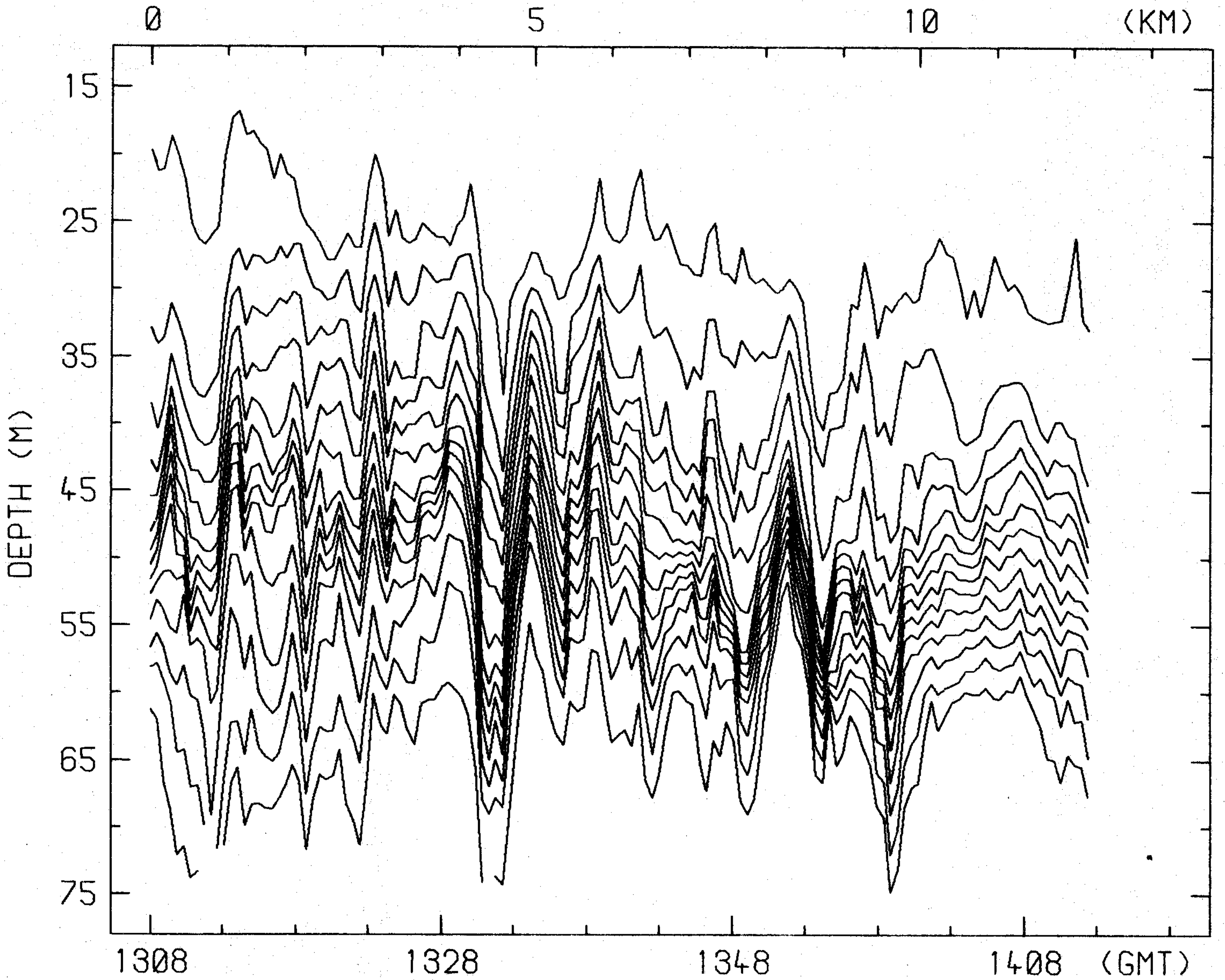
RUNS 4N-26, 4W-27, 4S-28 30-AUG-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
4N-26 12.2 TO 9.8; 4W-27 12.2 TO 9.6; 4S-28 12.2 TO 9.8



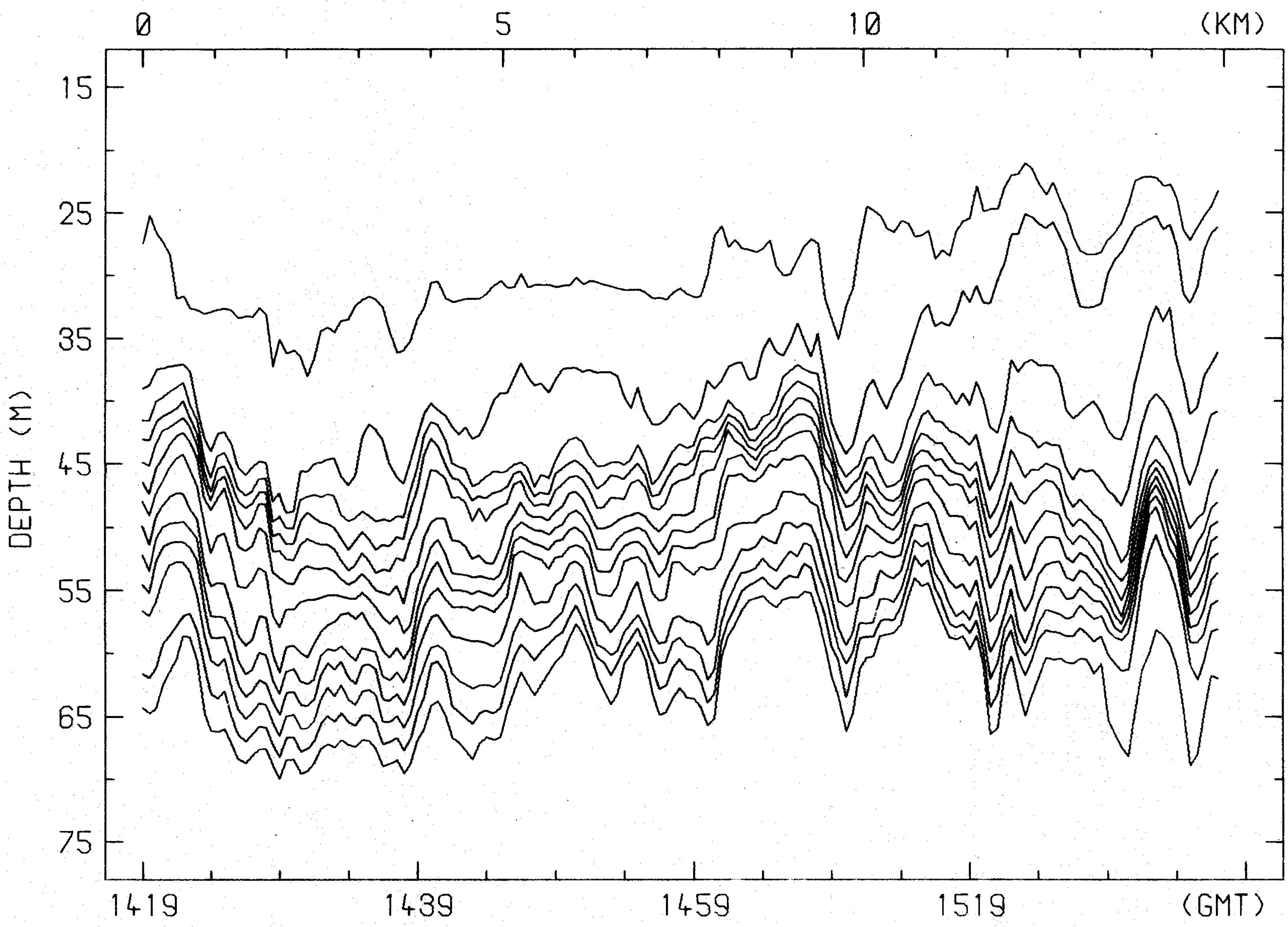
RUNS 4E-29, 4N-30 30-AUG-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
4E-29 12.0 TO 9.8; 4N-30 12.0 TO 10.0



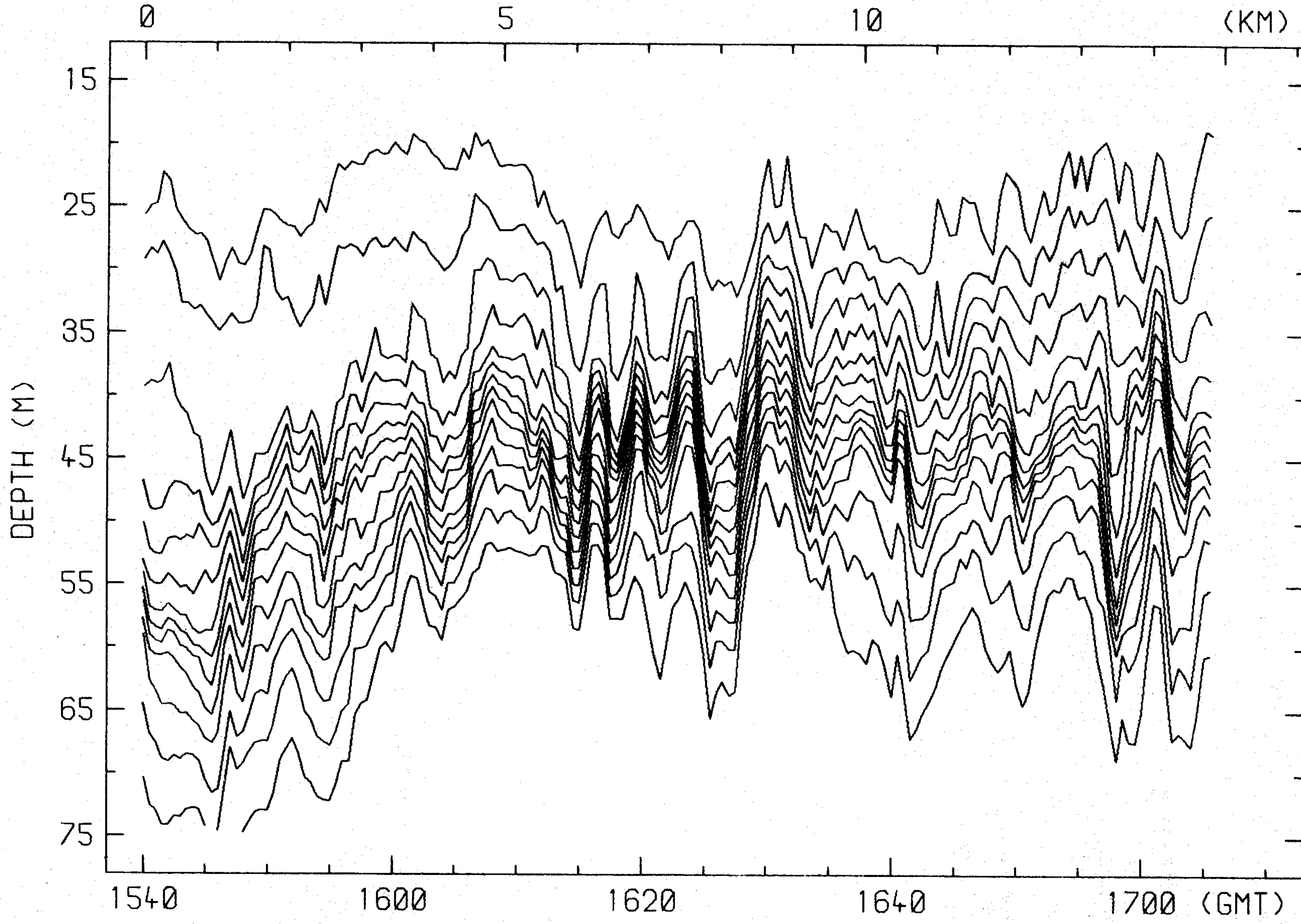
RUN 5N-1 31-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.2,12.0,11.8,11.6,11.4
11.2,11.0,10.8,10.6,10.4,10.2,10.0,9.8



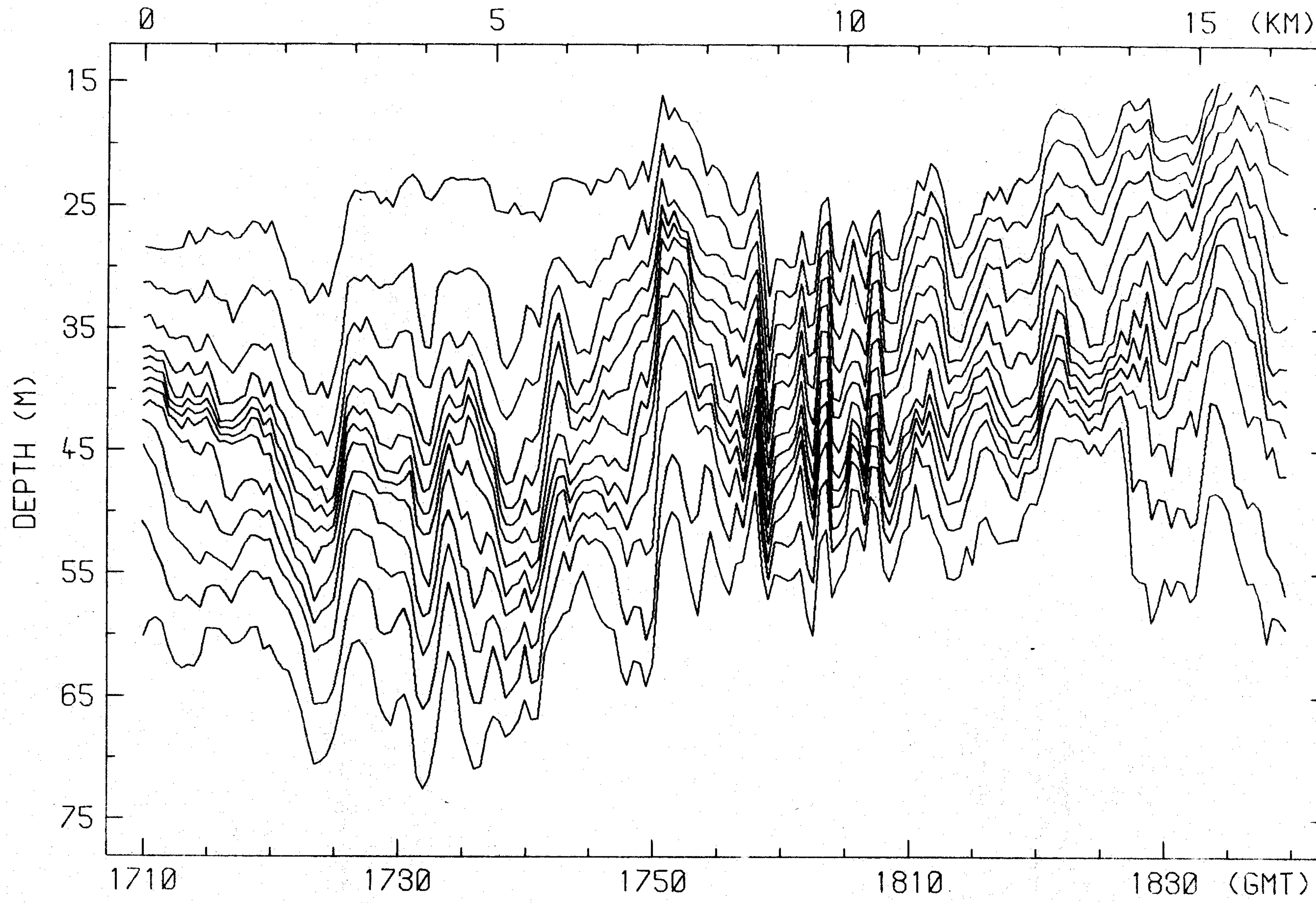
RUN 5W-2 31-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4,12.2,12.0,11.8,11.6,11.4
11.2,11.0,10.8,10.6,10.4,10.2,10.0,9.8



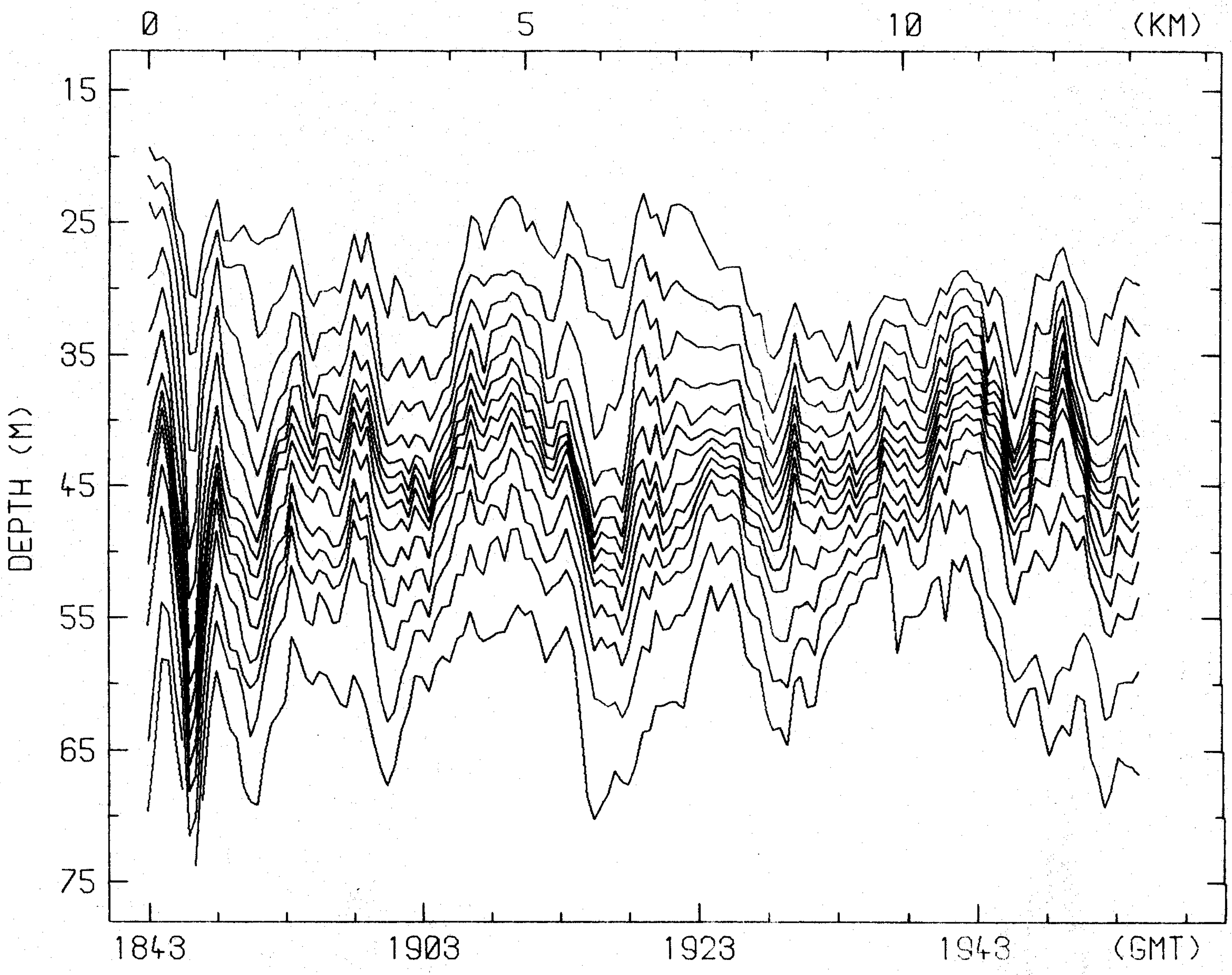
RUN 5S-3 31-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4,12.2,12.0,11.8,11.6,11.4
11.2,11.0,10.8,10.6,10.4,10.2,10.0



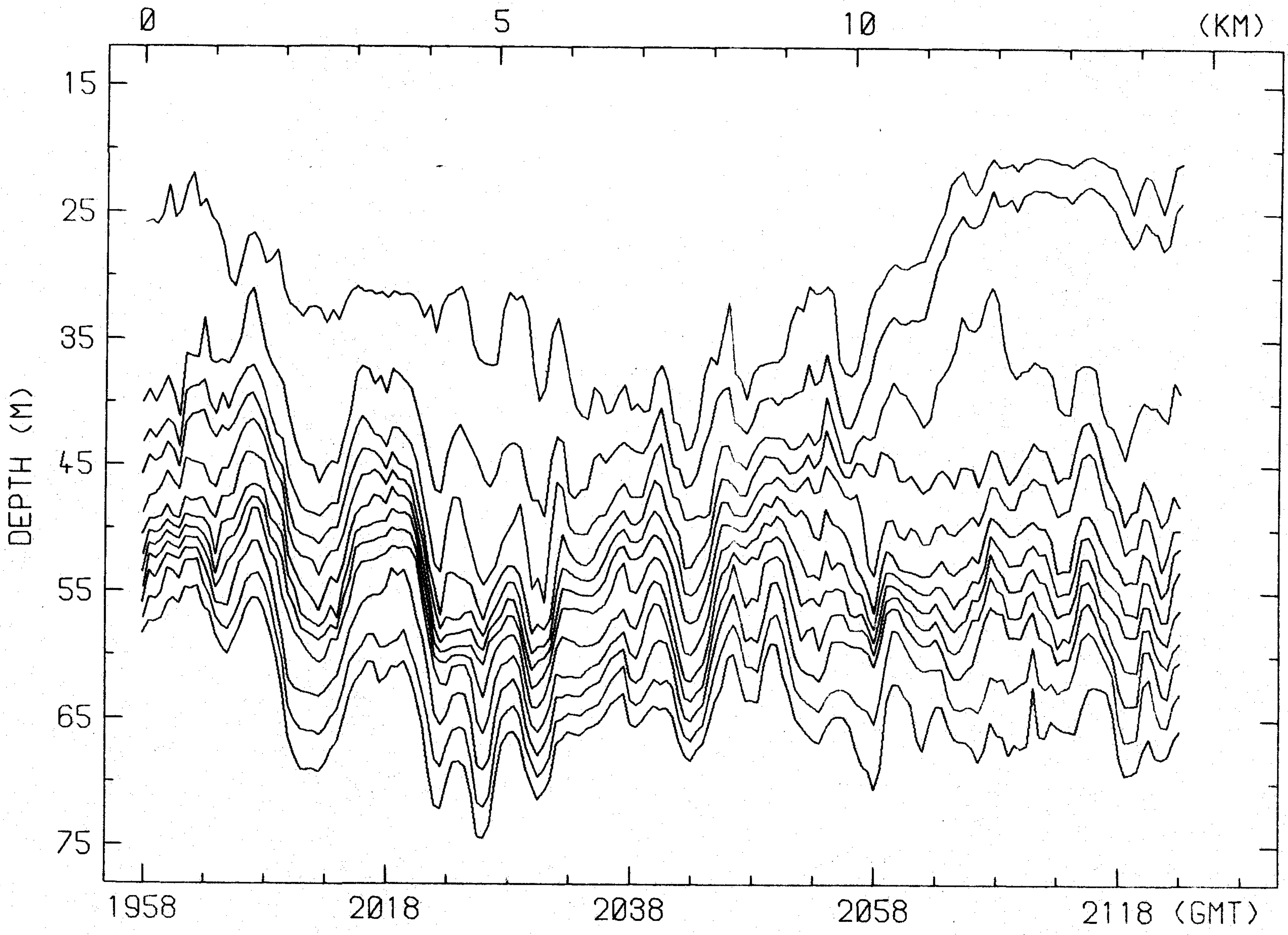
RUN 5E-4 31-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4,12.2,12.0,11.8,11.6,11.4
11.2,11.0,10.8,10.6,10.4,10.2,10.0,9.8



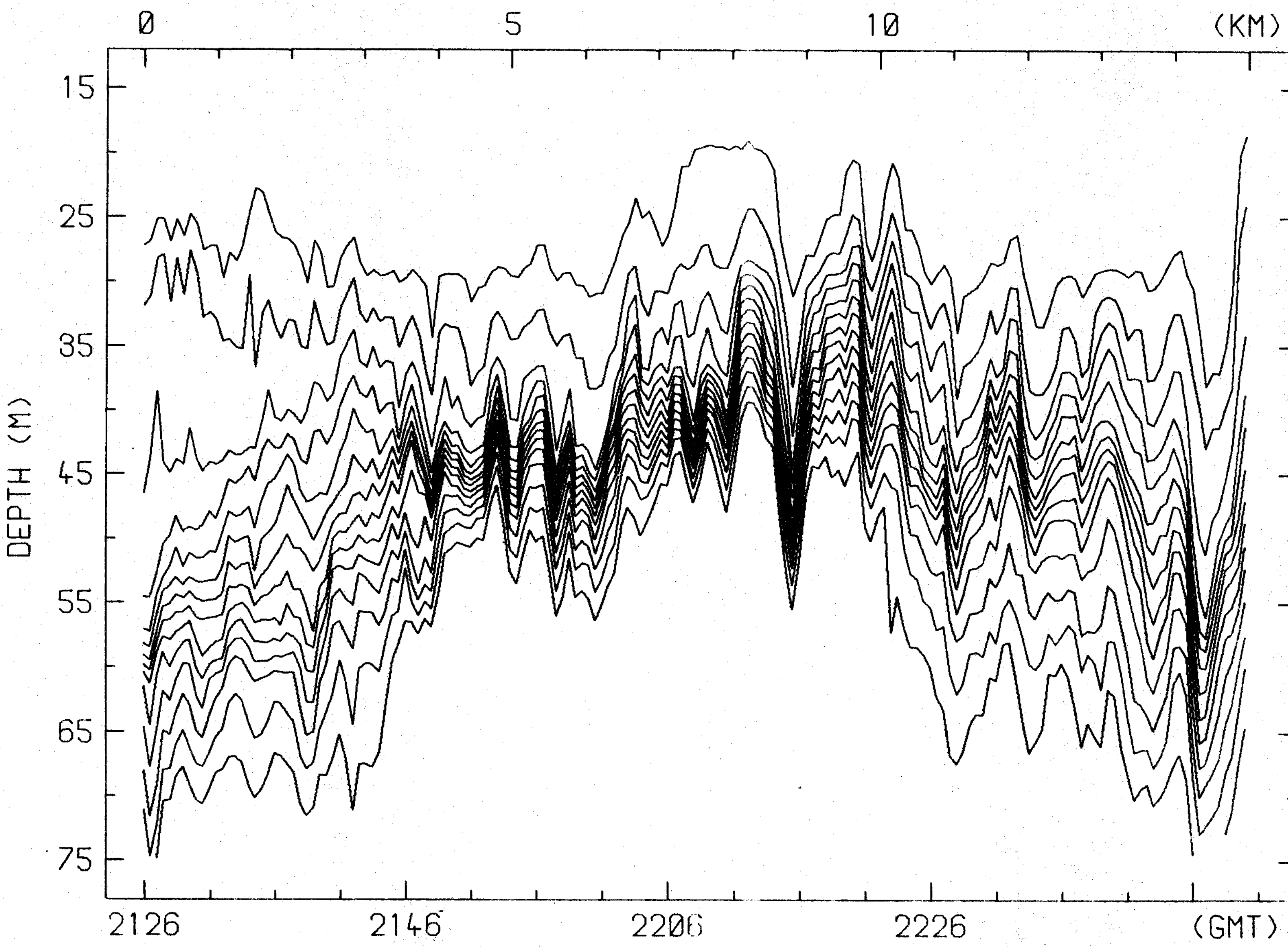
RUN 5N-5 31-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.2,12.0,11.8,11.6,11.4
11.2,11.0,10.8,10.6,10.4,10.2,10.0,9.8



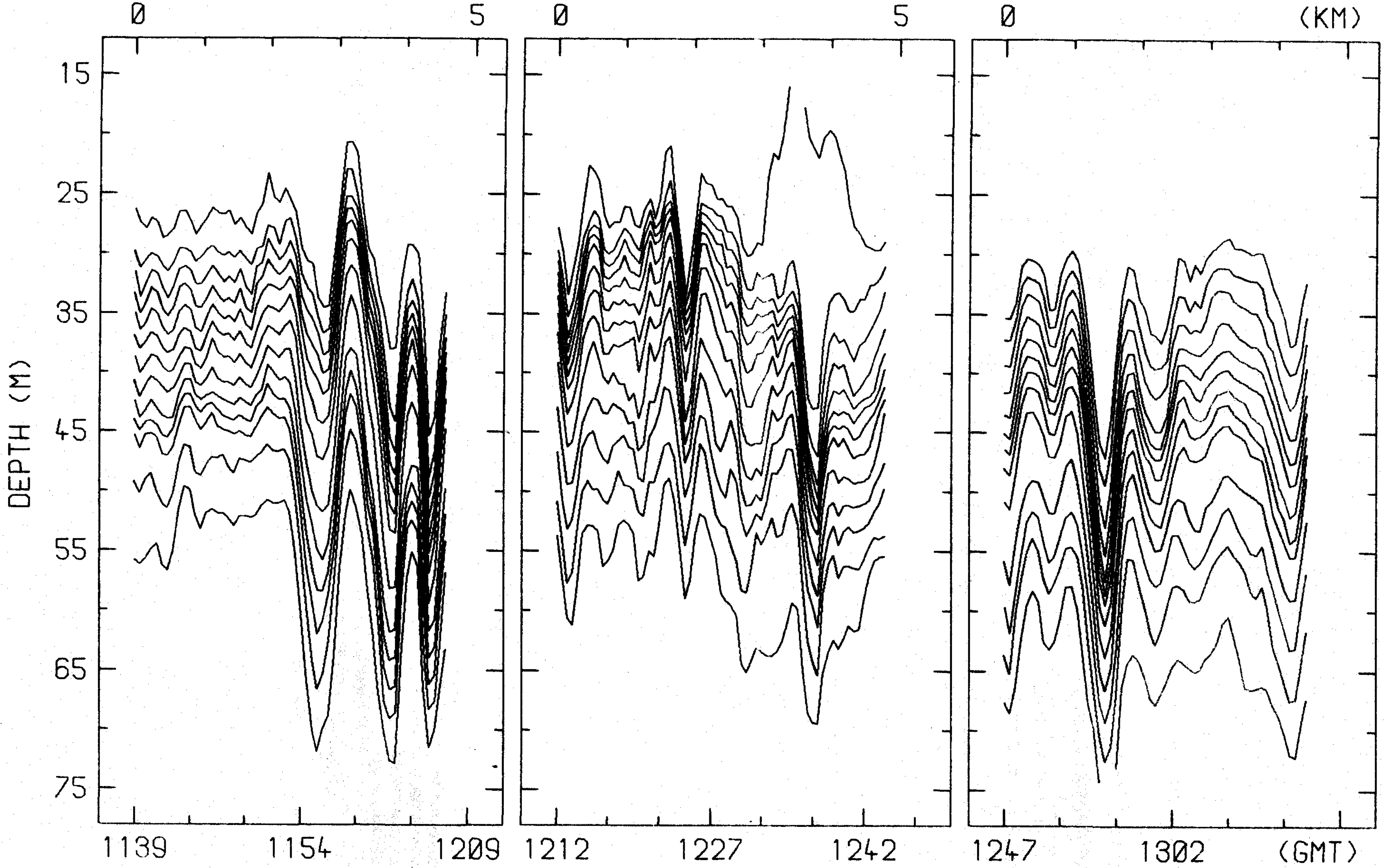
RUN 5W-6 31-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.2,12.0,11.8,11.6,11.4
11.2,11.0,10.8,10.6,10.4,10.2,10.0,9.8,9.6



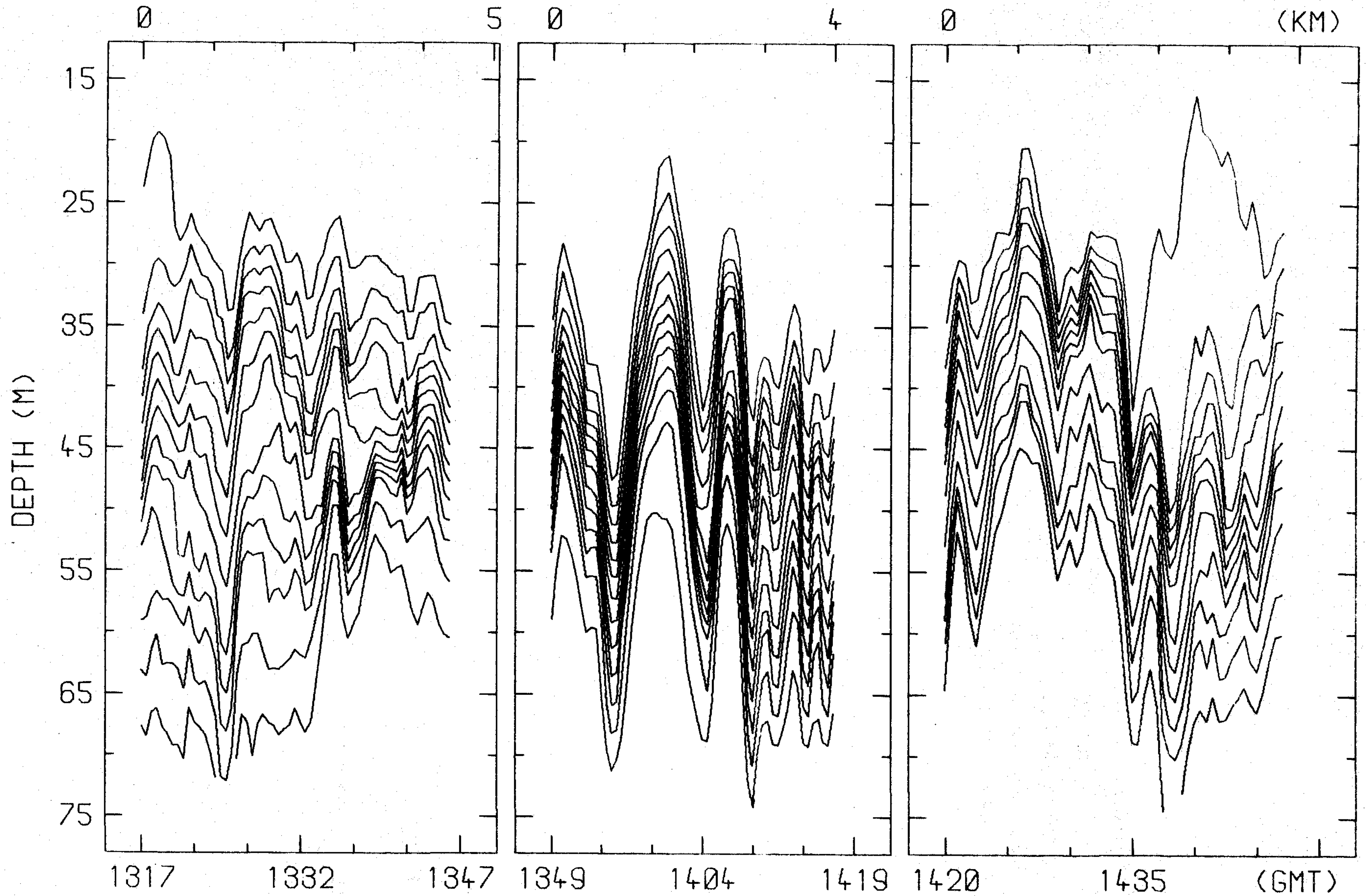
RUN 5S-7 31-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4, 12.2, 12.0, 11.8, 11.6
11.4, 11.2, 11.0, 10.8, 10.6, 10.4, 10.2



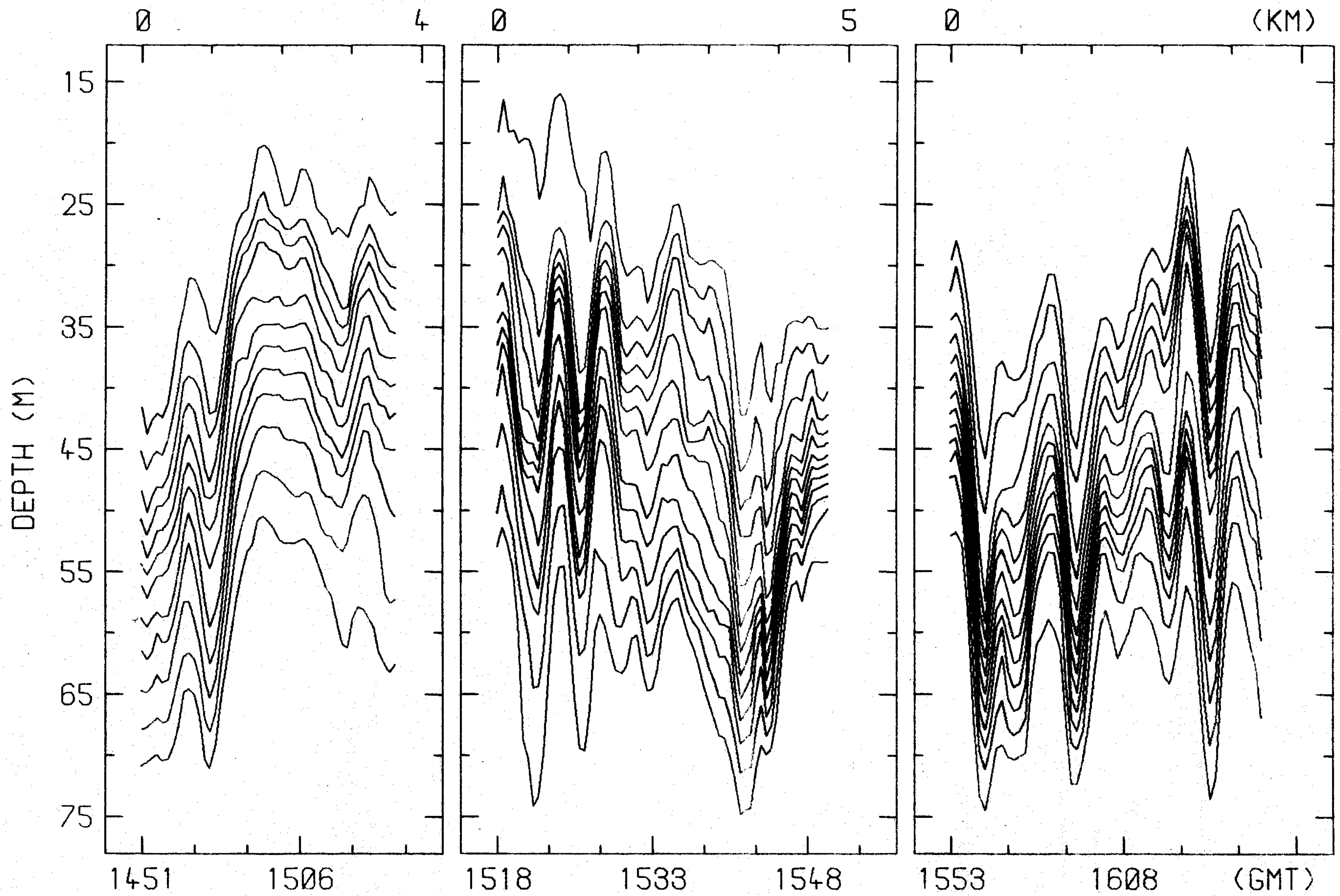
RUN 5E-8 31-AUG-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4,12.2,12.0,11.8,11.6,11.4
11.2,11.0,10.8,10.6,10.4,10.2,10.0,9.8



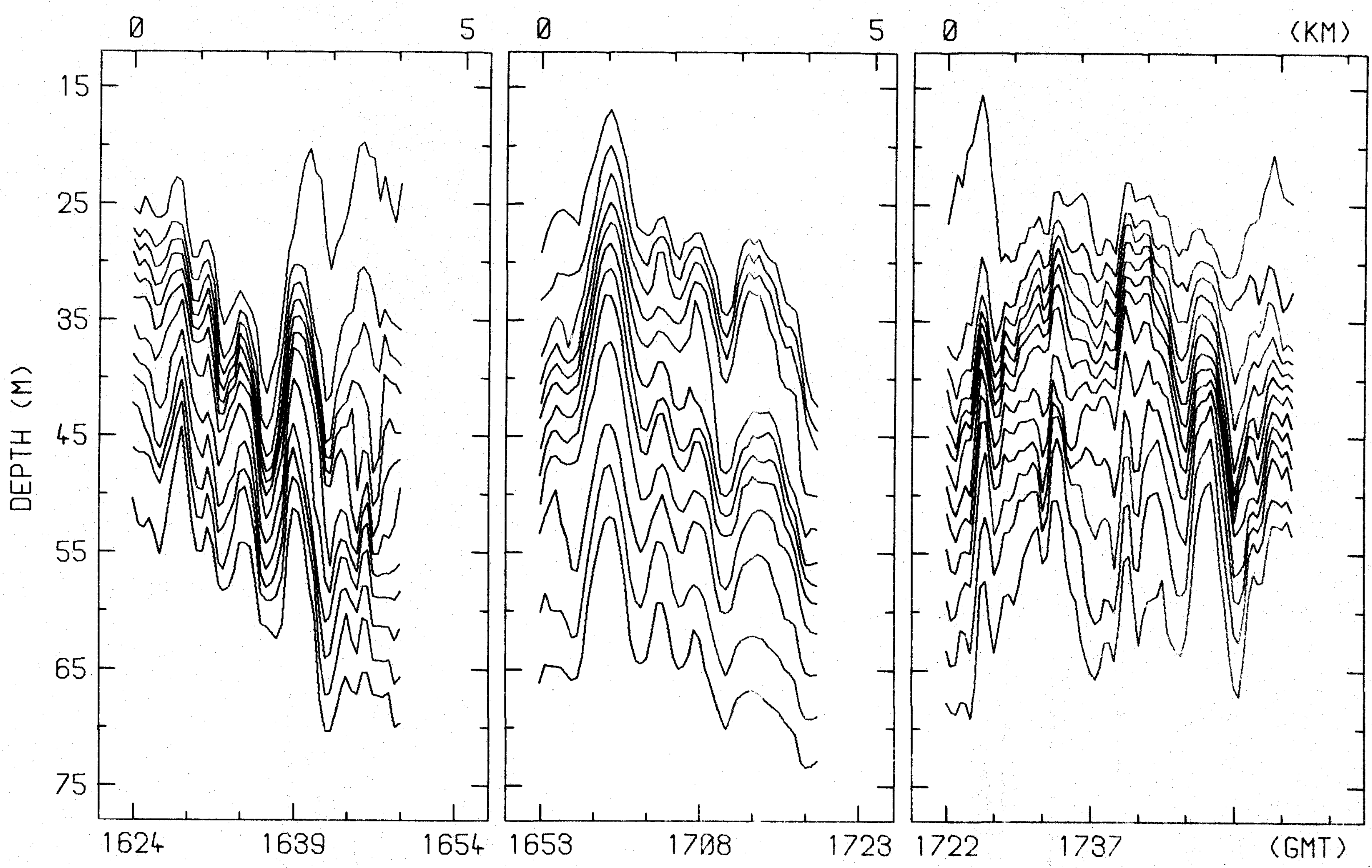
RUNS 6W-1, 6S-2, 6E-3 2-SEP-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 6W-1 12.2 TO 9.8; 6S-2 12.2 TO 9.8; 6E-3 12.0 TO 9.6



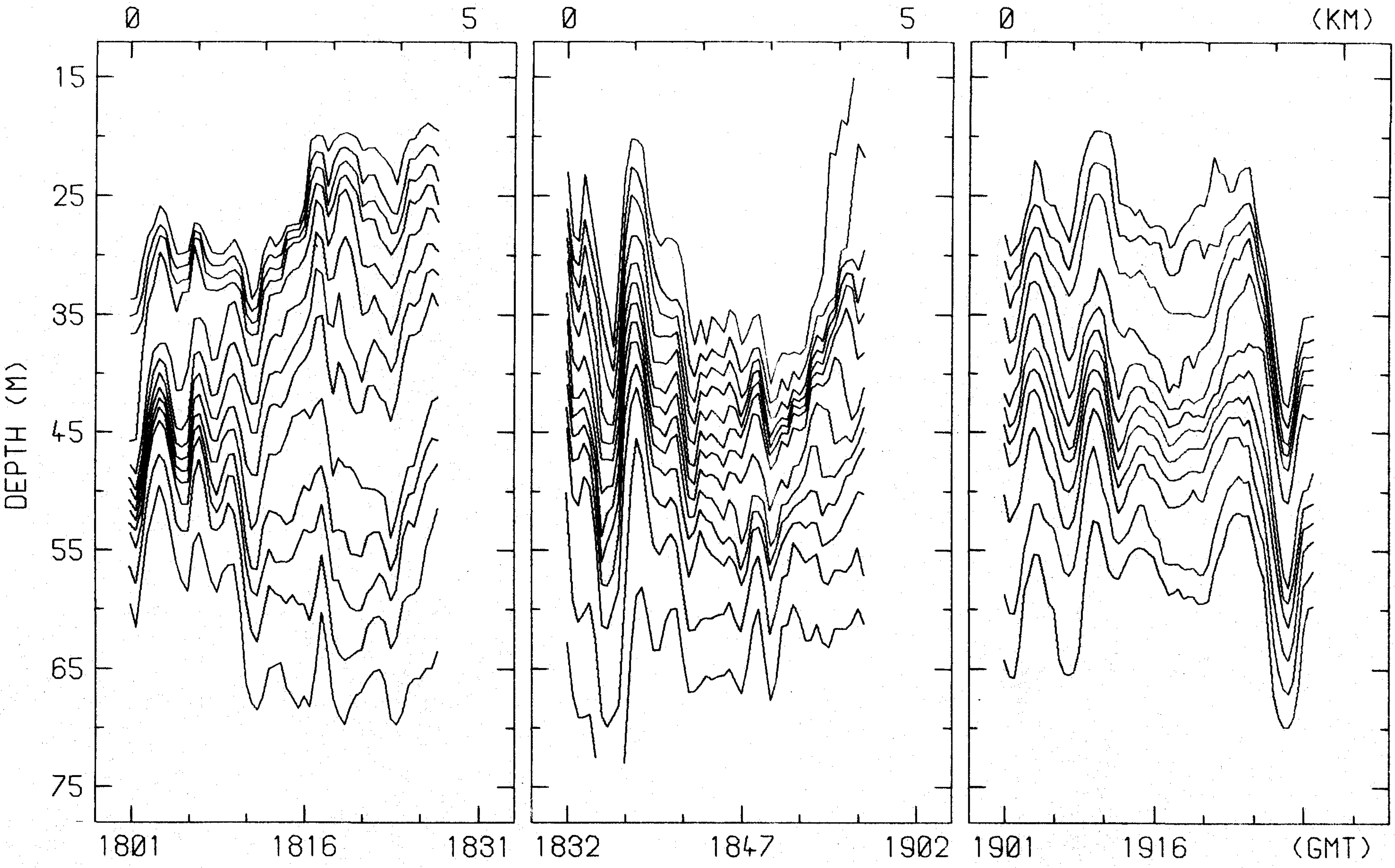
RUNS 6N-4, 6W-5, 6S-6 2-SEP-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 6N-4 12.2 TO 9.8; 6W-5 12.2 TO 9.8; 6S-6 12.2 TO 10.0



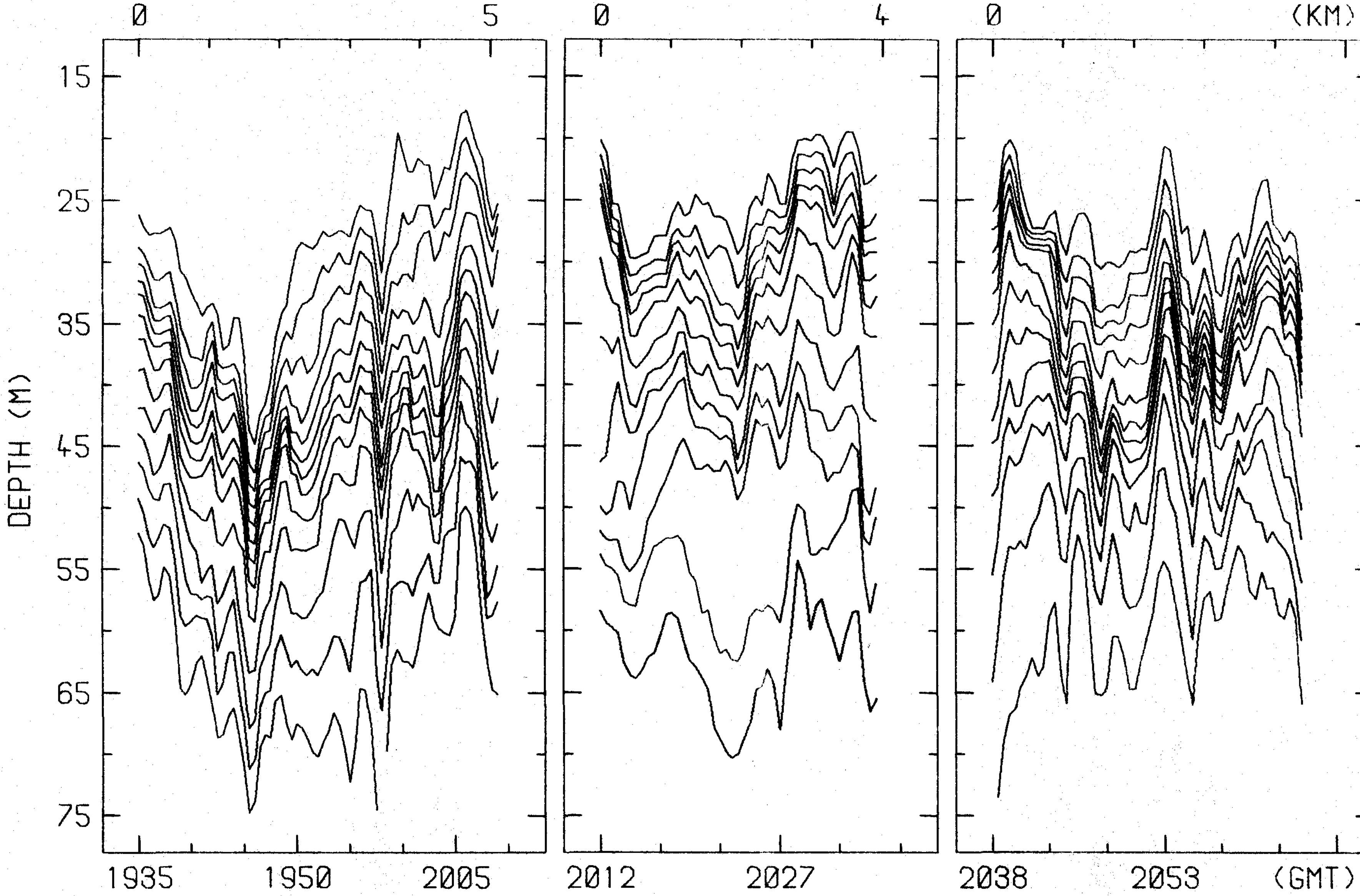
RUNS 6E-7, 6N-8, 6W-9 2-SEP-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 6E-7 12.2 TO 10.0; 6N-8 12.2 TO 9.8; 6W-9 12.2 TO 9.8



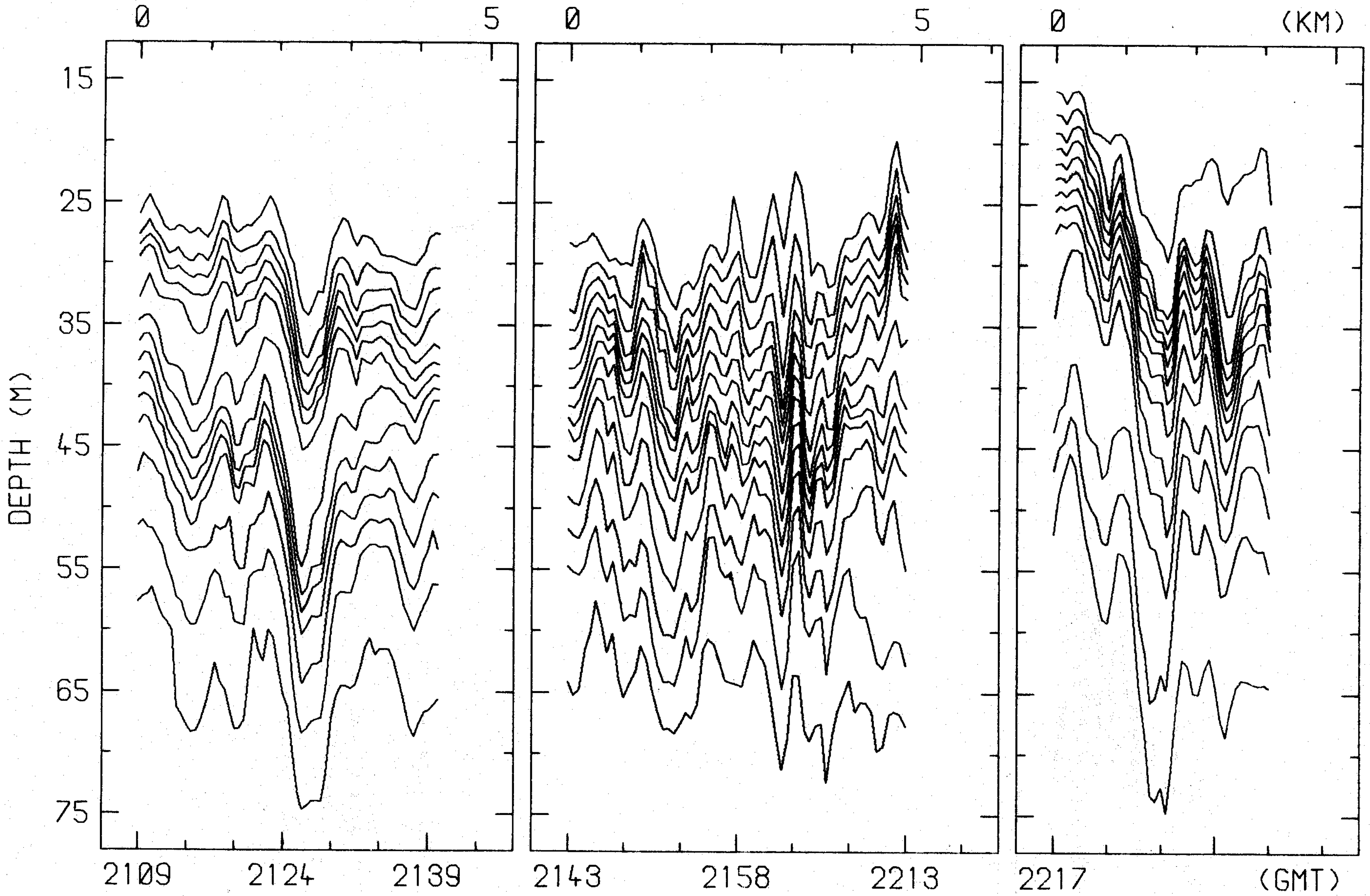
RUNS 6S-10, 6E-11, 6N-12 2-SEP-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
6S-10 12.2 TO 10.0; 6E-11 12.0 TO 9.8; 6N-12 12.2 TO 9.8



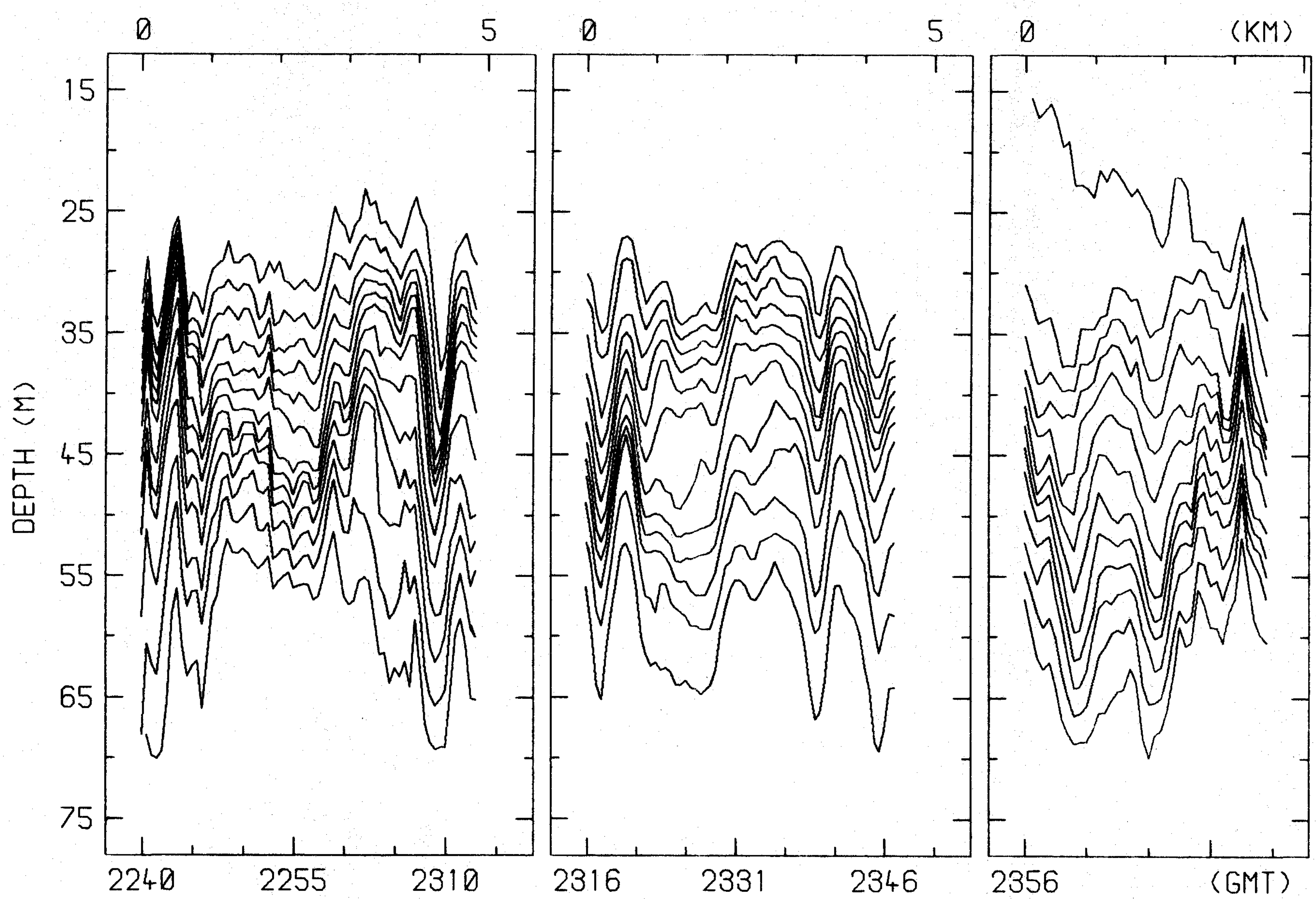
RUNS 6W-13, 6S-14, 6E-15 2-SEP-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
6W-13 12.2 TO 9.8; 6S-14 12.2 TO 9.8; 6E-15 12.0 TO 9.8



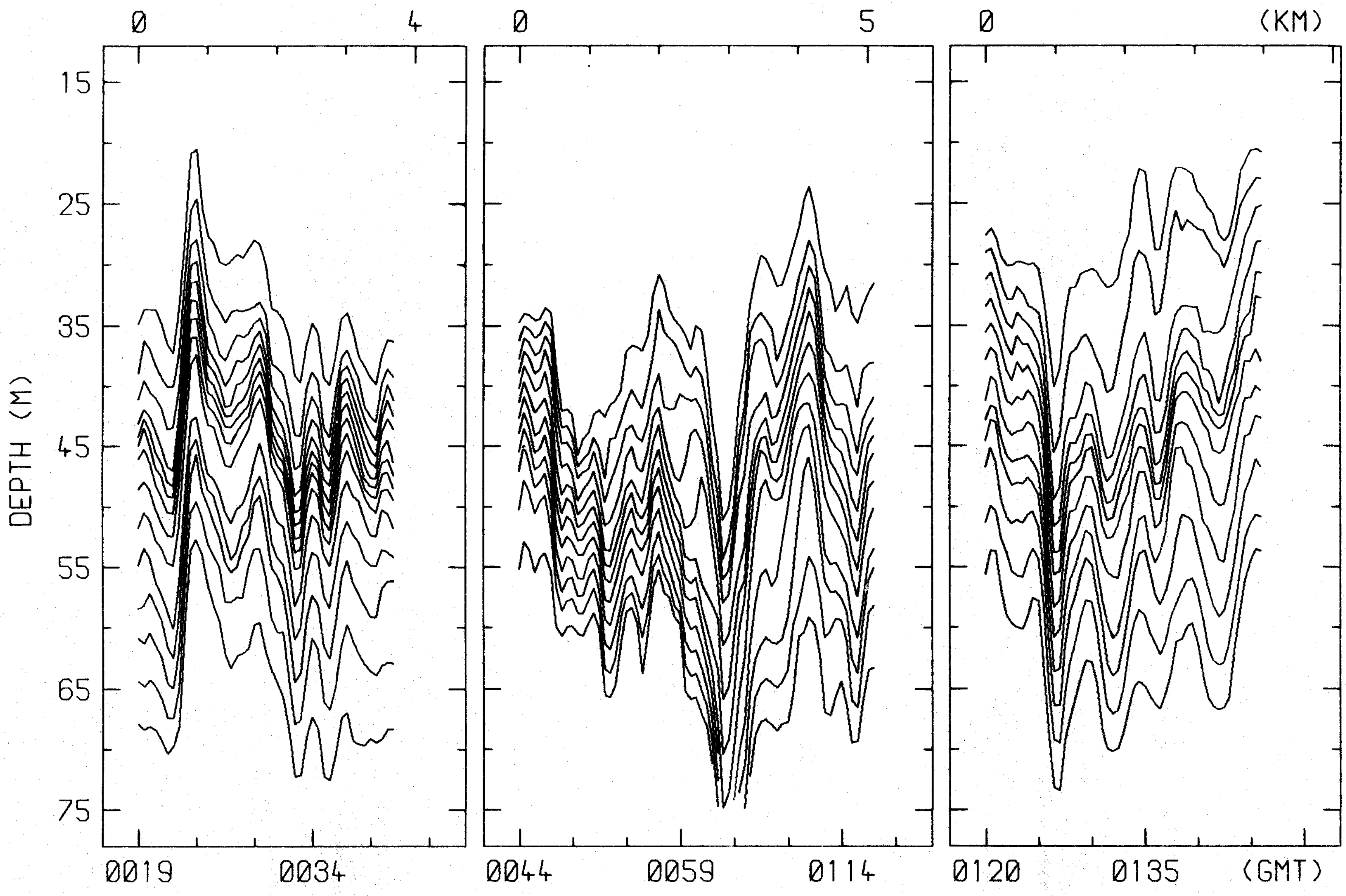
RUNS 6N-16, 6W-17, 6S-18 2-SEP-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
6N-16 12.2 TO 9.8; 6W-17 12.2 TO 10.0; 6S-18 12.2 TO 9.8



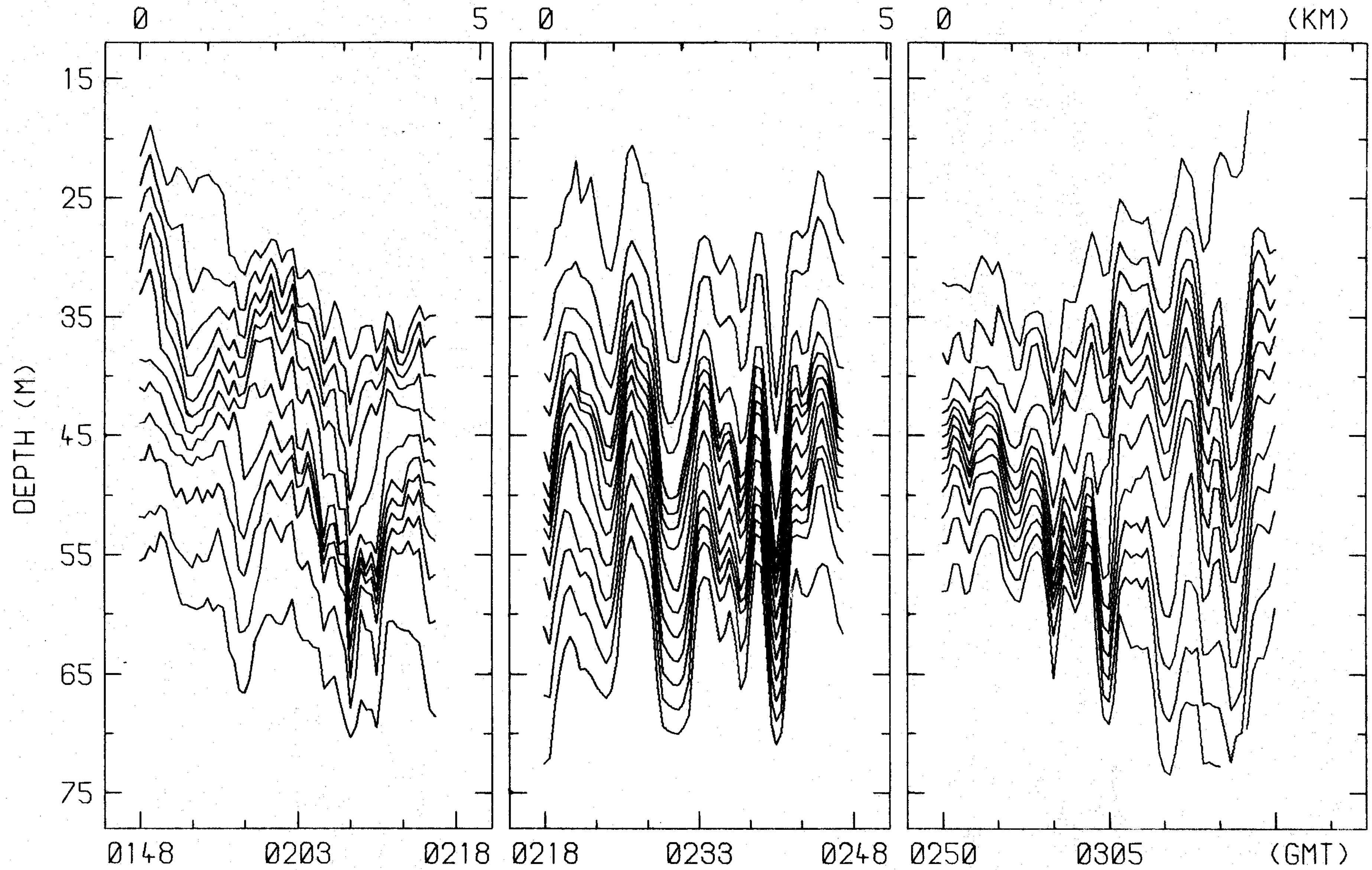
RUNS 6E-19, 6N-20, 6W-21 2-SEP-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
6E-19 12.2 TO 9.6; 6N-20 12.2 TO 9.6; 6W-21 12.4 TO 10.0



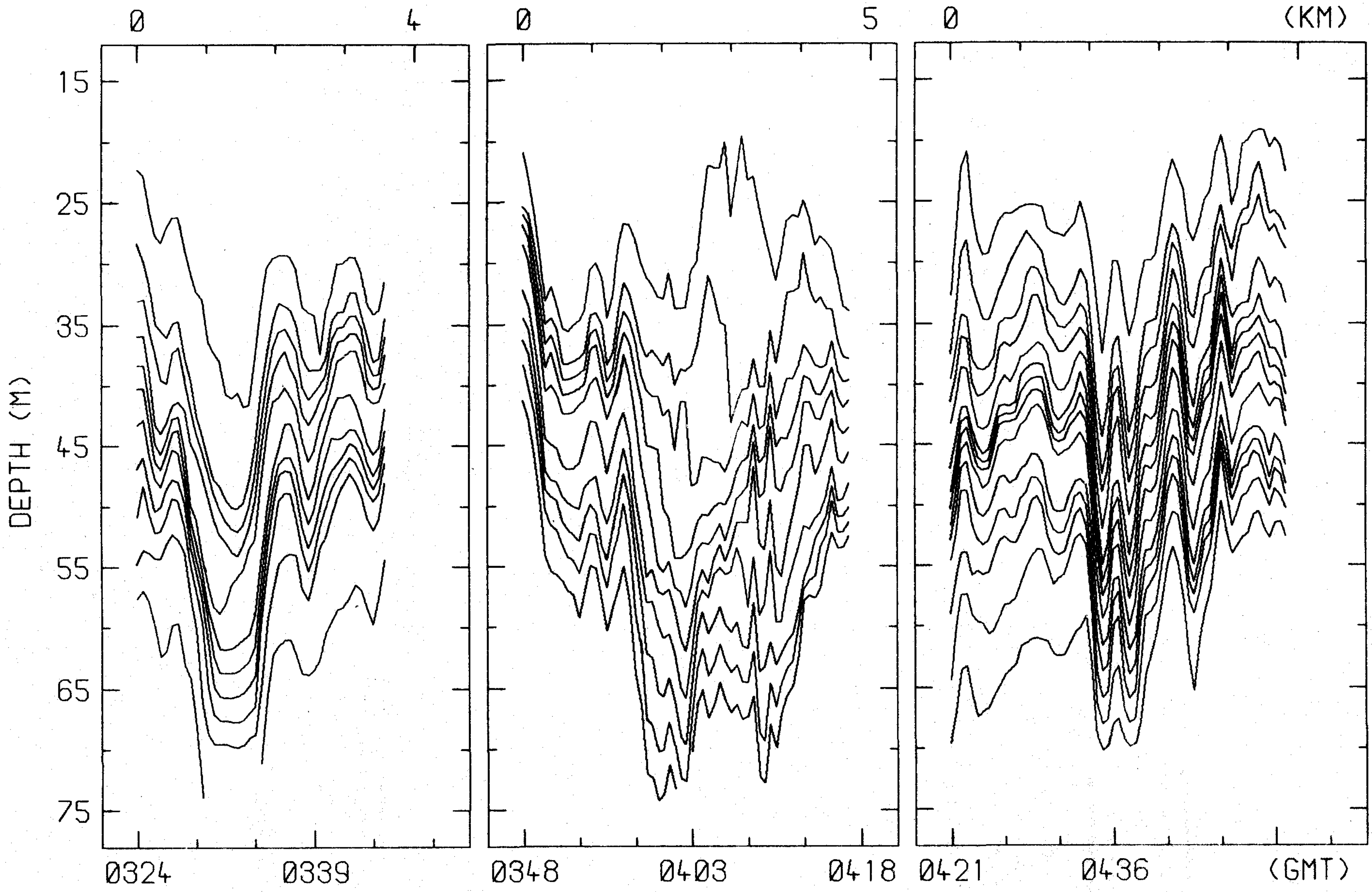
RUNS 6S-22, 6E-23, 6N-24 2-SEP-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
6S-22 12.2 TO 9.8; 6E-23 12.0 TO 9.8; 6N-24 12.4 TO 10.0



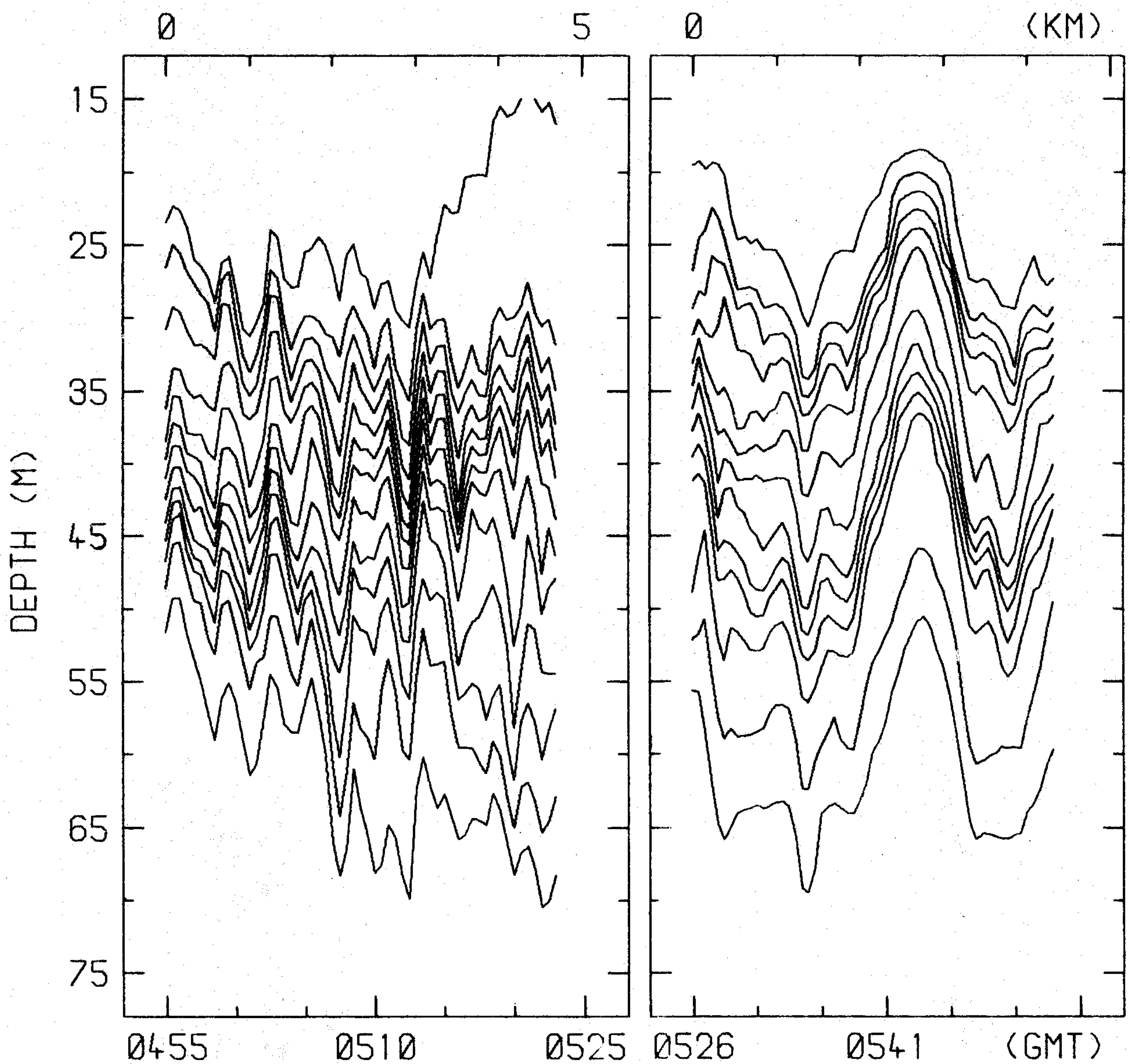
RUNS 6W-25, 6S-26, 6E-27 3-SEP-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
6W-25 12.4 TO 9.8; 6S-26 12.2 TO 10.0; 6E-27 12.0 TO 9.8



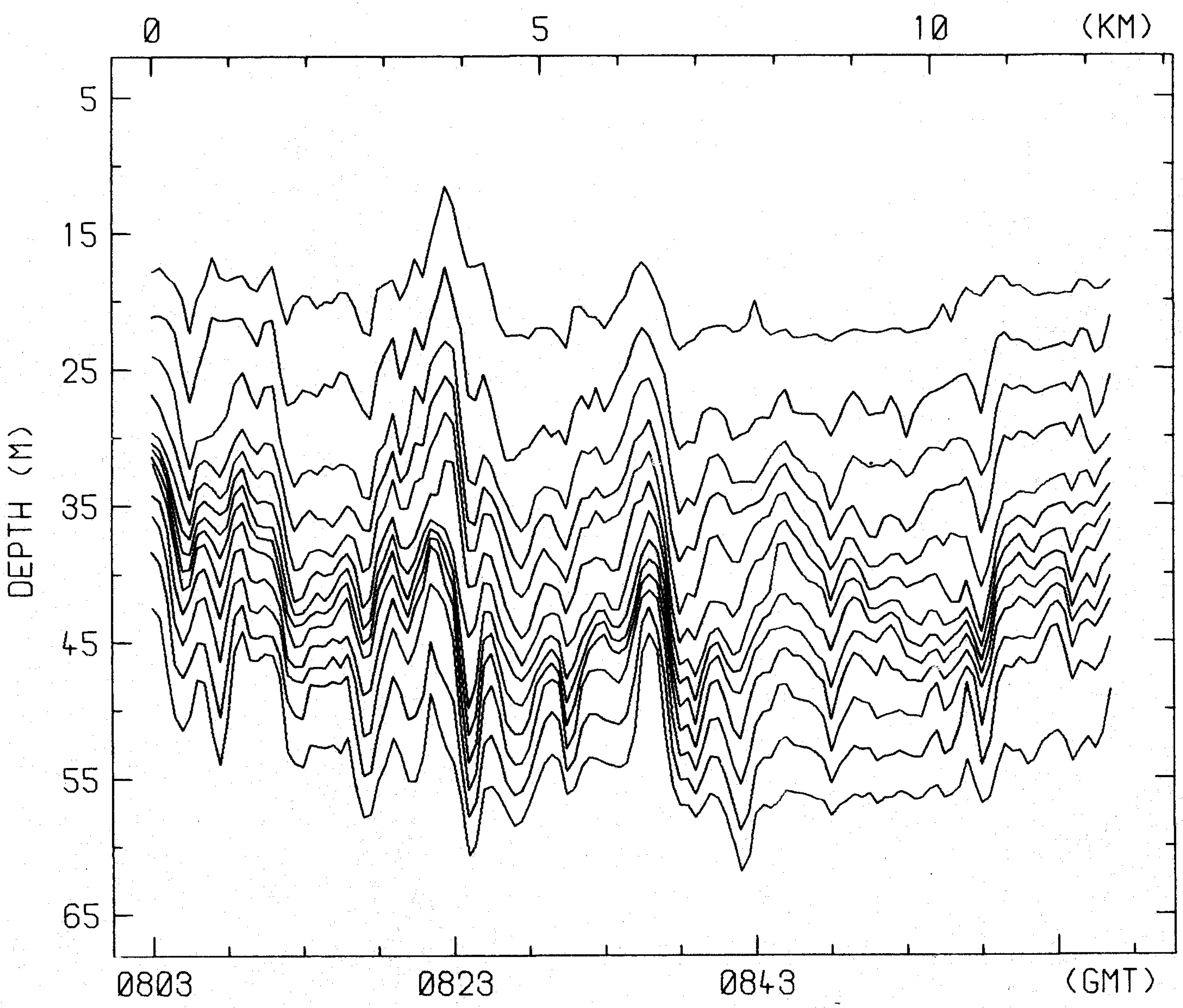
RUNS 6N-28, 6W-29, 6S-30 3-SEP-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
6N-28 12.0 TO 9.8; 6W-29 12.4 TO 9.8; 6S-30 12.2 TO 9.8



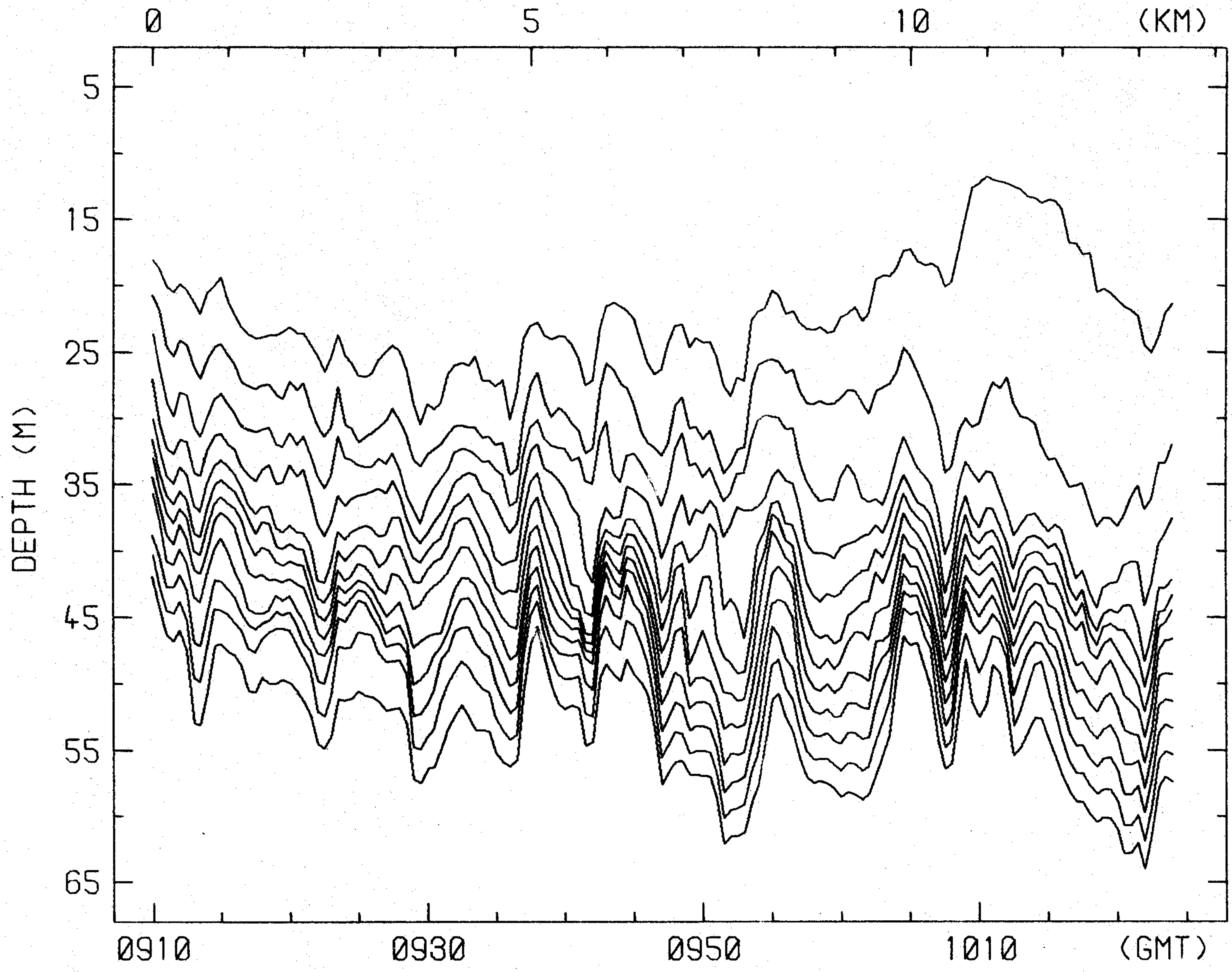
RUNS 6E-31, 6N-32, 6W-33 3-SEP-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
6E-31 12.2 TO 10.2; 6N-32 12.2 TO 10.4; 6W-33 12.4 TO 9.8



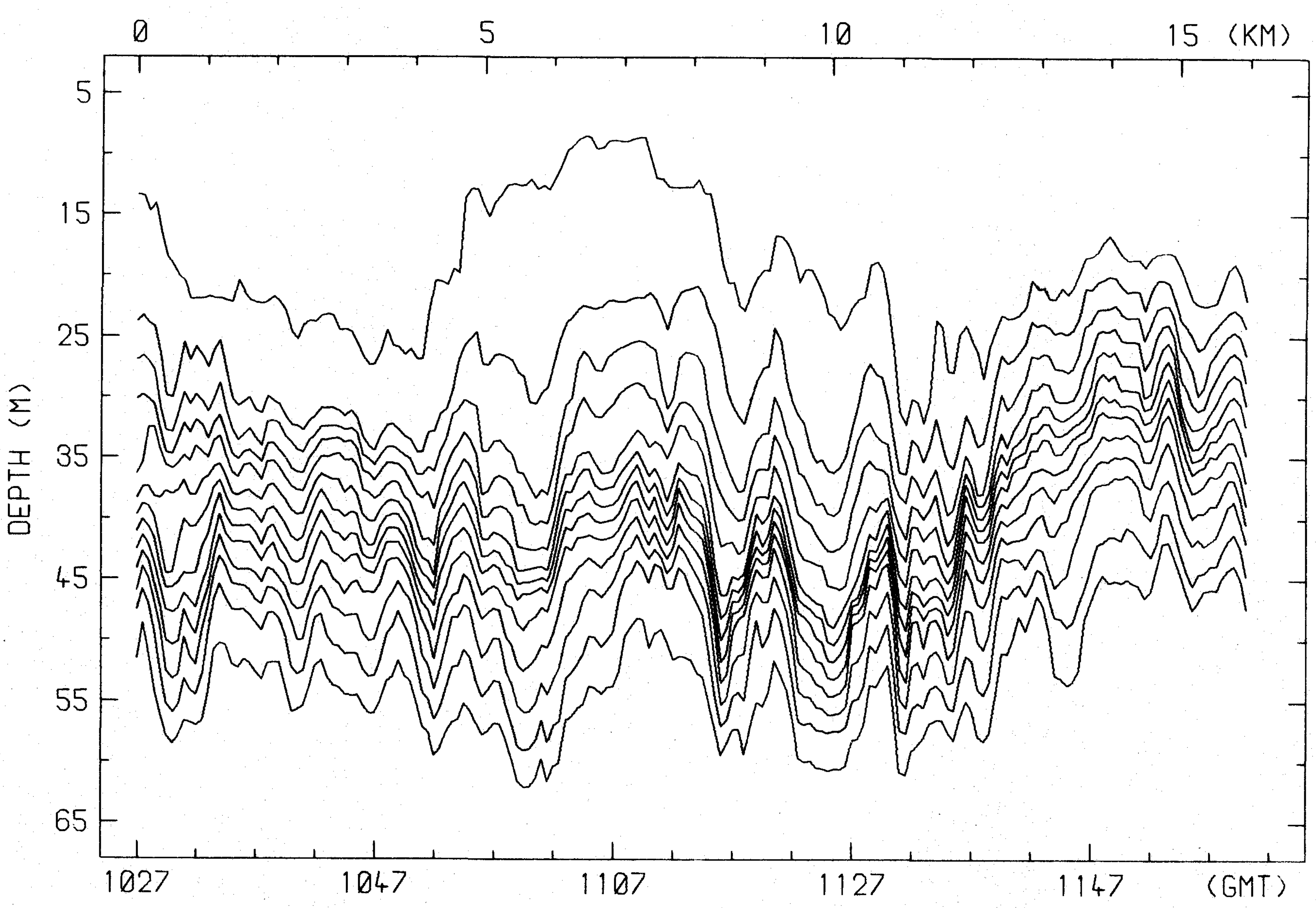
RUNS 6S-34, 6E-35 3-SEP-78
EDITED ISOTHERM DEPTH VS TIME/DISTANCE ISOTHERMS (DEG C)
6S-34 12.2 TO 9.8; 6E-35 12.2 TO 9.8



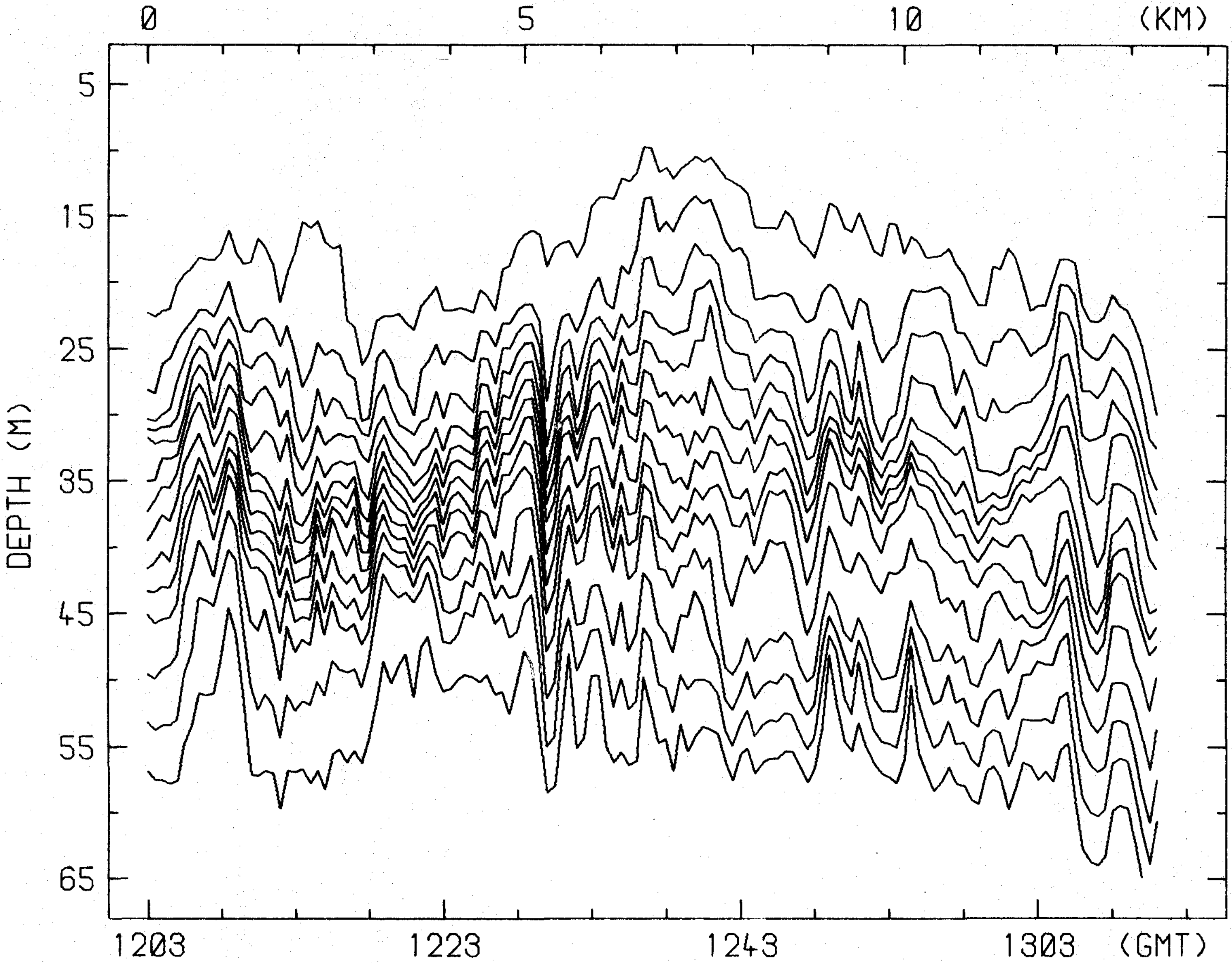
RUN 7S-1 4-SEP-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4, 12.2, 12.0, 11.8, 11.6
11.4, 11.2, 11.0, 10.8, 10.6, 10.4, 10.2, 10.0



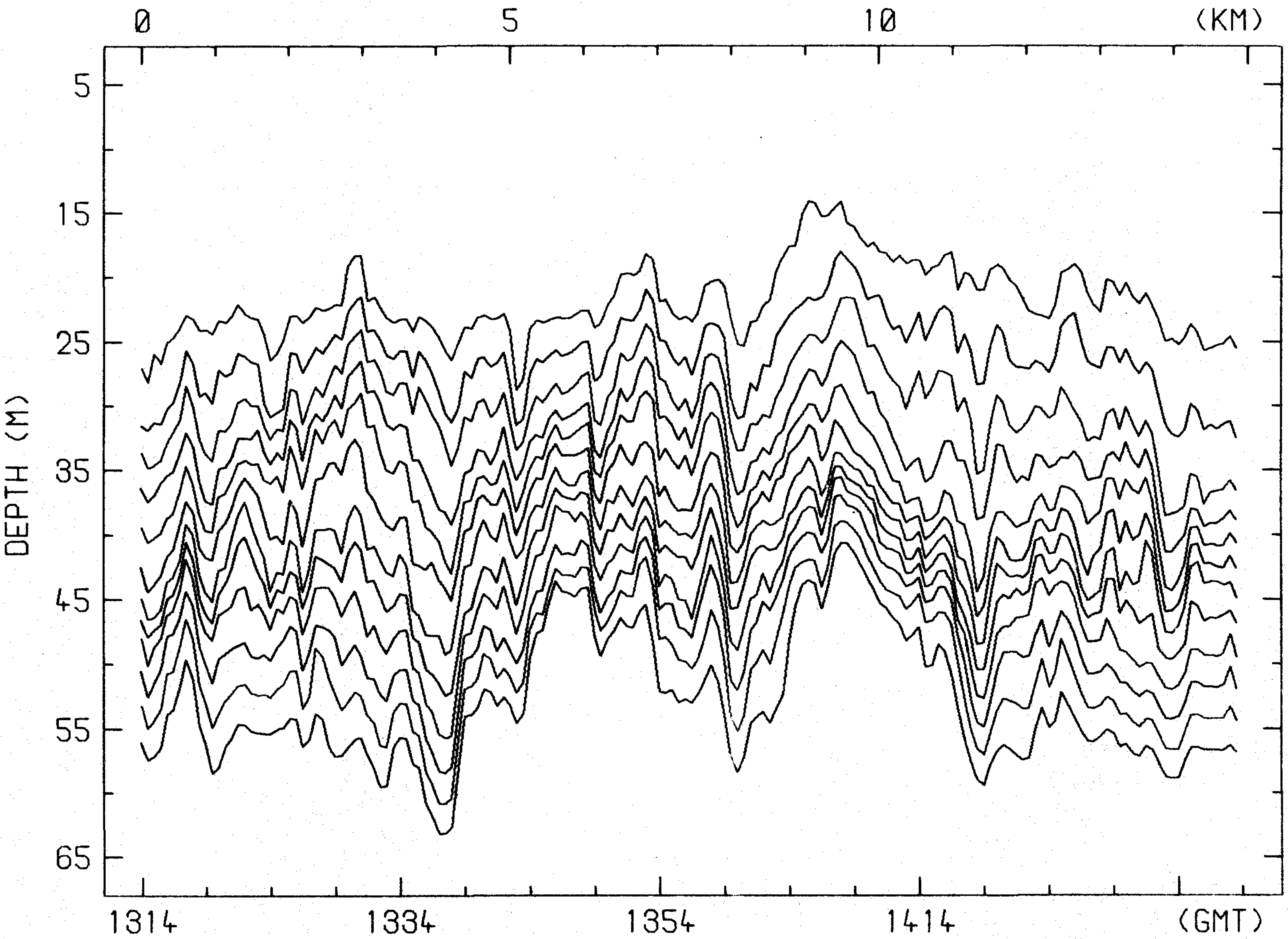
RUN 7E-2 4-SEP-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4,12.2,12.0,11.8,11.6
11.4,11.2,11.0,10.8,10.6,10.4,10.2



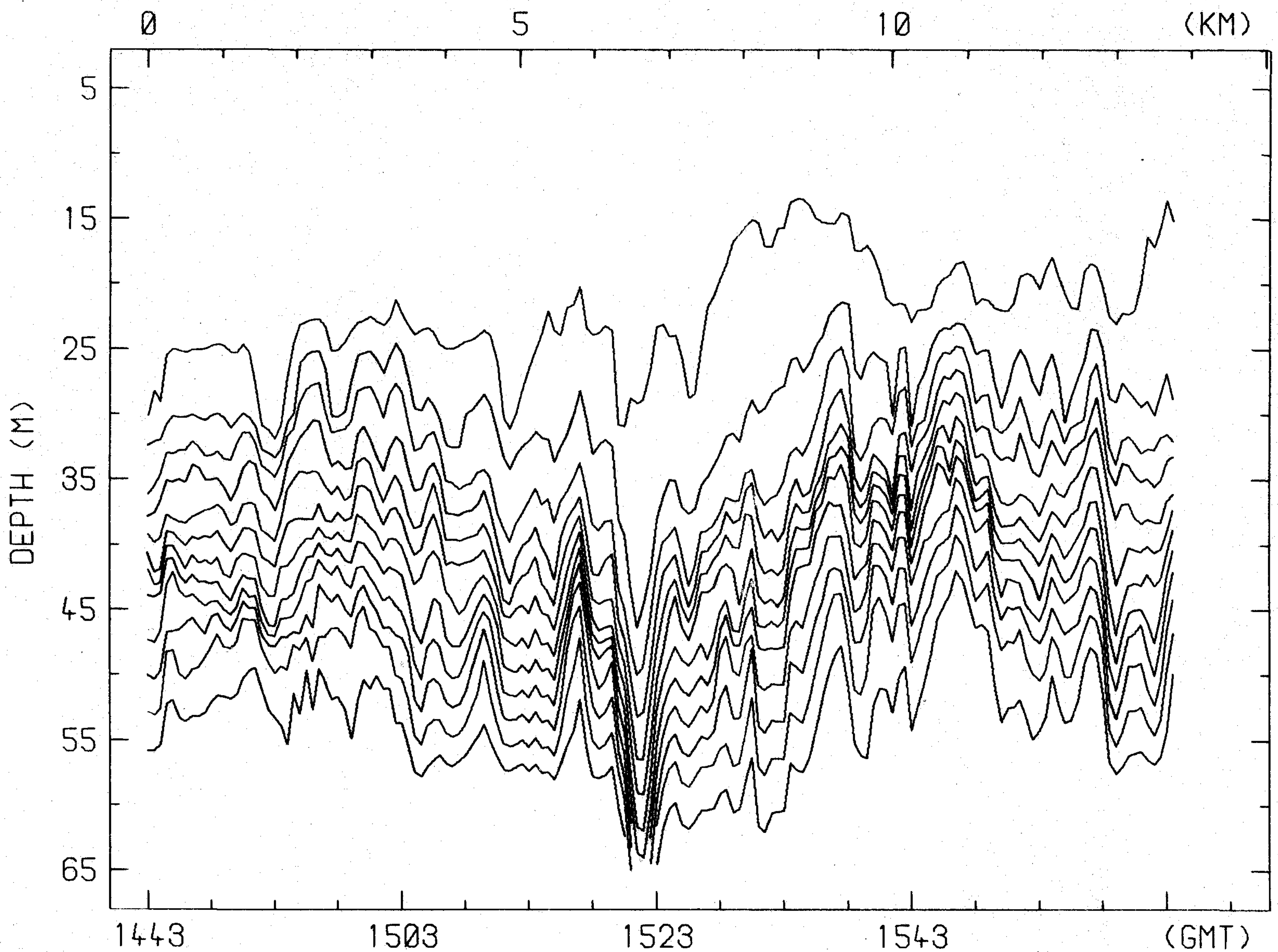
RUN 7N-3 4-SEP-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4,12.2,12.0,11.8,11.6
11.4,11.2,11.0,10.8,10.6,10.4,10.2,10.0



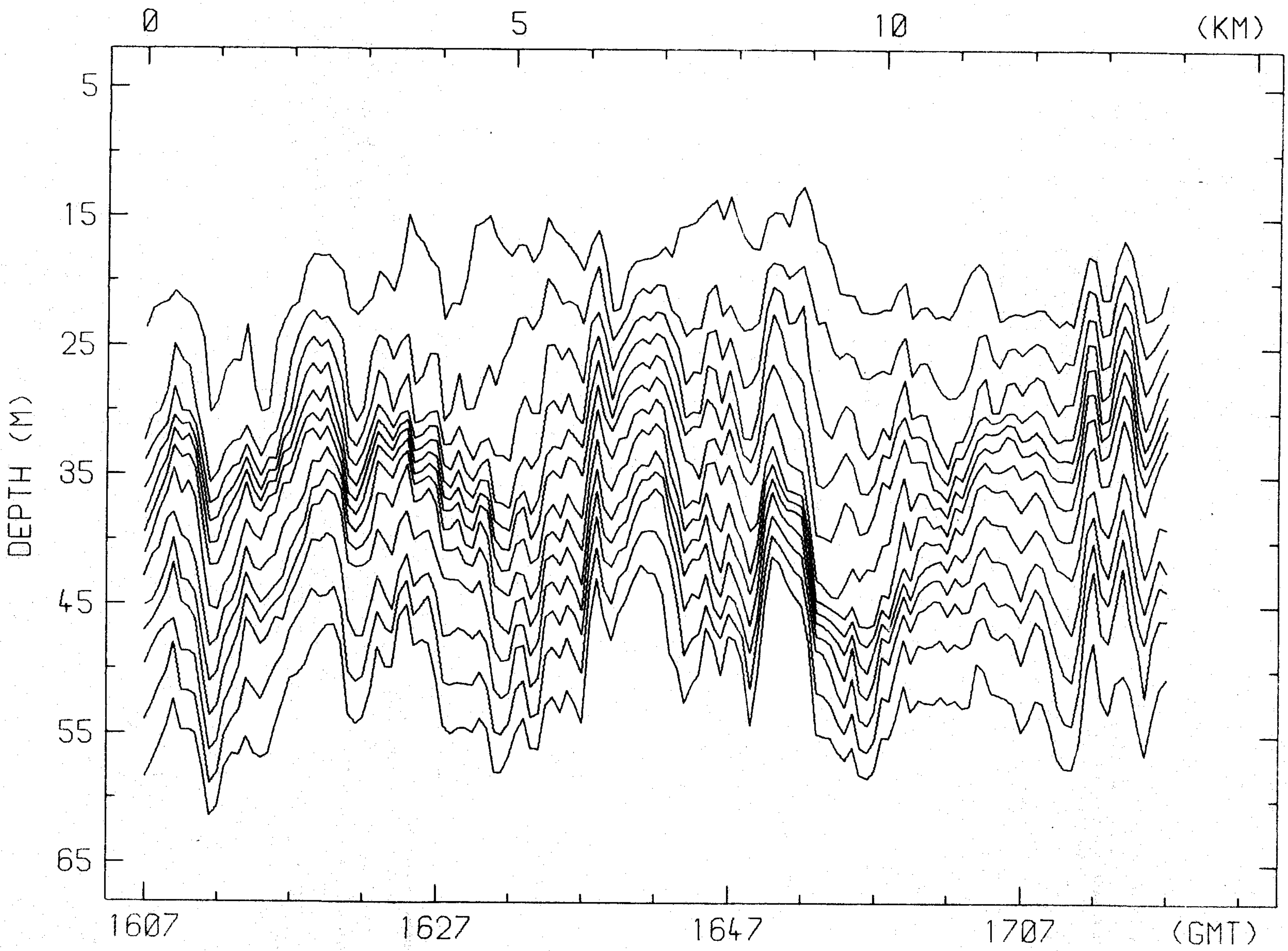
RUN 7W-4 4-SEP-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4,12.2,12.0,11.8,11.6
11.4,11.2,11.0,10.8,10.6,10.4,10.2,10.0,9.8



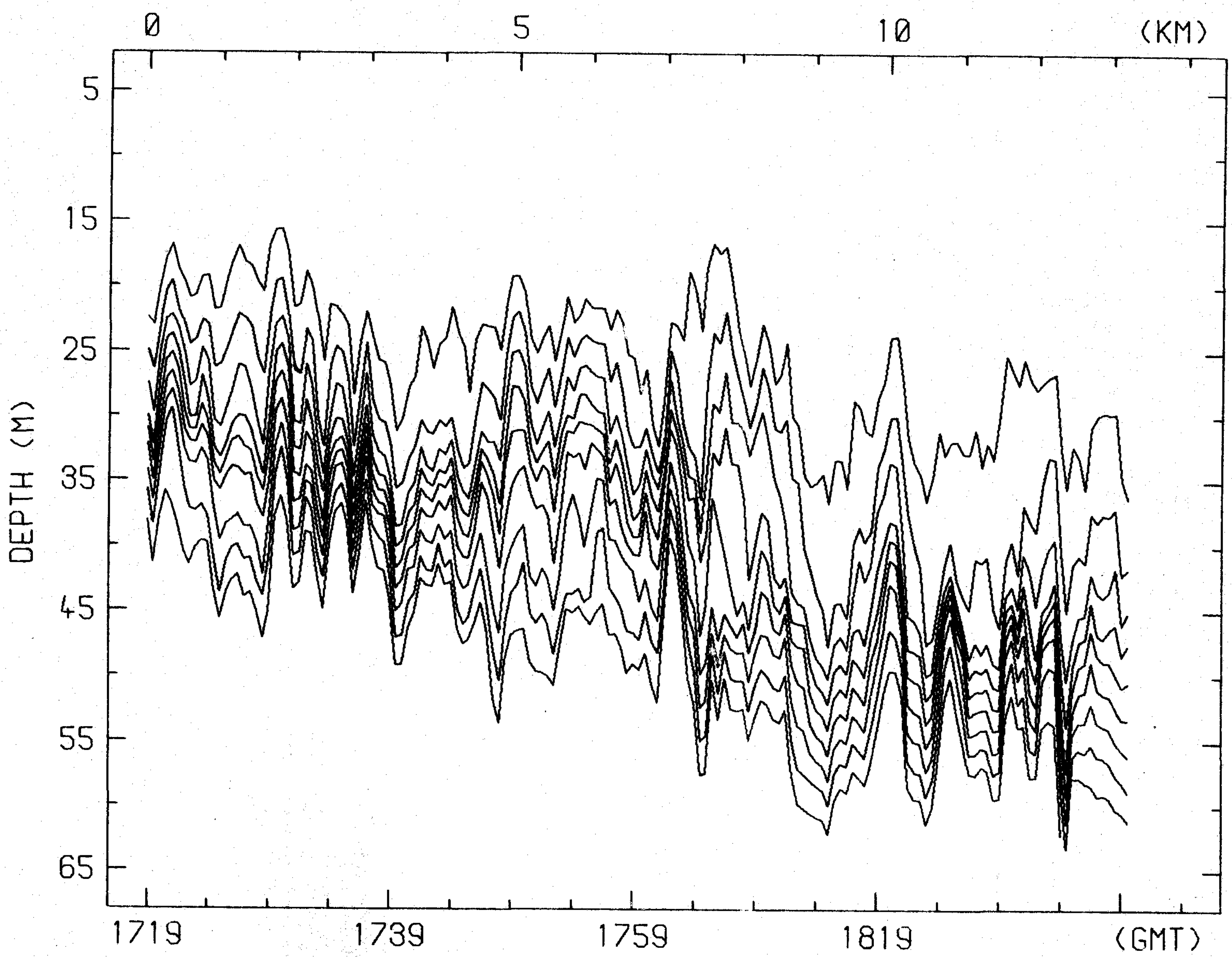
RUN 7S-5 4-SEP-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4,12.2,12.0,11.8,11.6
11.4,11.2,11.0,10.8,10.6,10.4,10.2



RUN 7E-6 4-SEP-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4,12.2,12.0,11.8,11.6
11.4,11.2,11.0,10.8,10.6,10.4,10.2



RUN 7N-7 4-SEP-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4,12.2,12.0,11.8,11.6
11.4,11.2,11.0,10.8,10.6,10.4,10.2,10.0

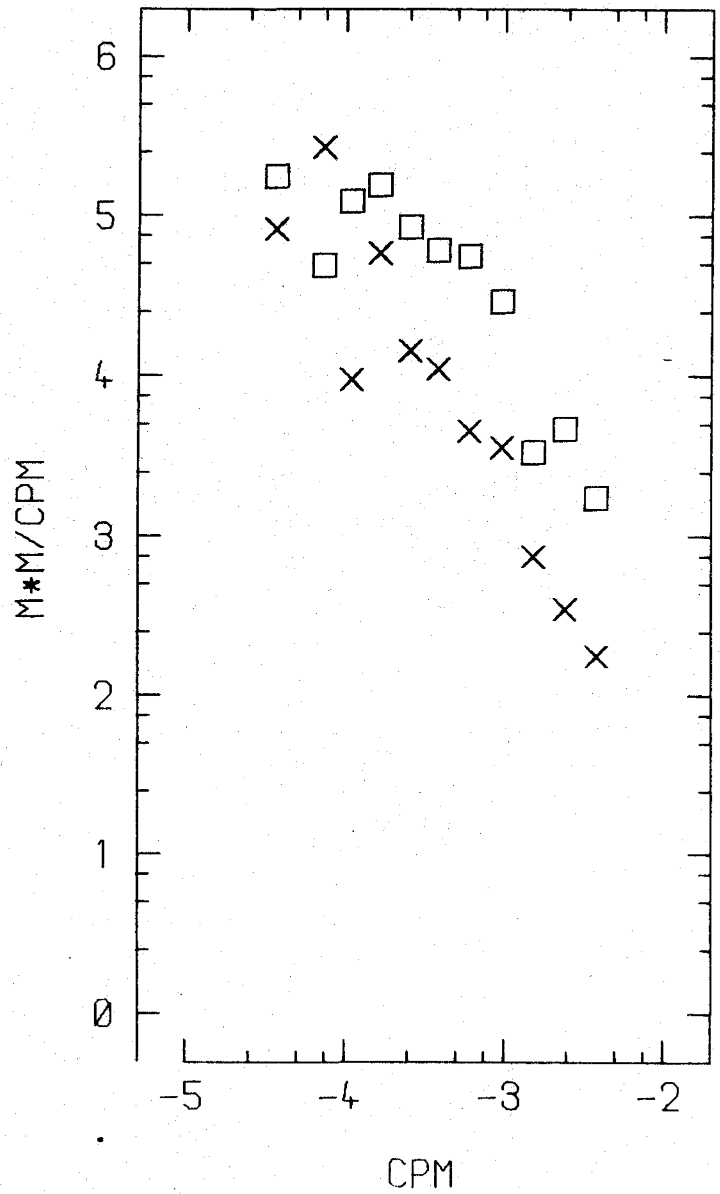


RUN 7W-8 4-SEP-78 EDITED ISOTHERM DEPTH VS TIME/DISTANCE
ISOTHERMS (DEG C) 12.4,12.2,12.0,11.8,11.6
11.4,11.2,11.0,10.8

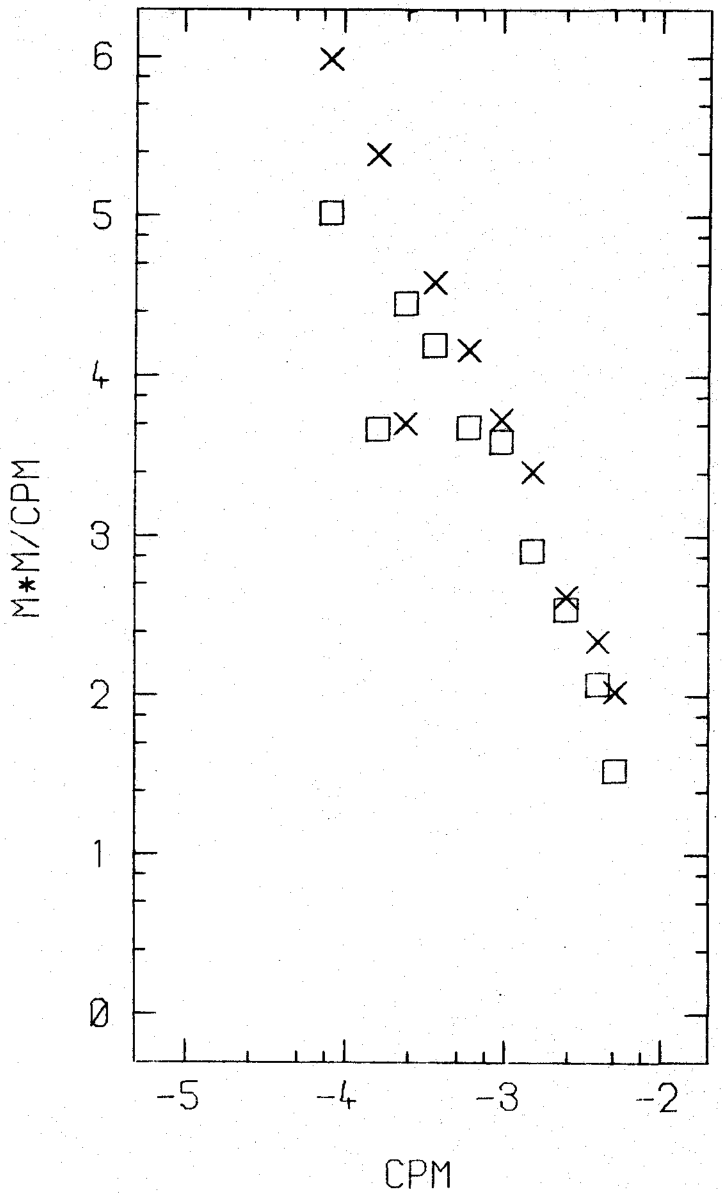
SPECTRA OF HIGHEST AND LOWEST ISOTHERMS

Spectra of the depth of the shallowest and deepest isotherms from each leg are plotted on the following pages. The symbol x designates the shallowest isotherm (highest temperature) and □ designates the deepest isotherm. The time-series of low-pass filtered isotherm depth were prewhitened by taking first differences prior to computing Fourier coefficients. The spectra were then recolored and smoothed by averaging over non-overlapping frequency bands, five per decade, equally spaced on a logarithmic scale.

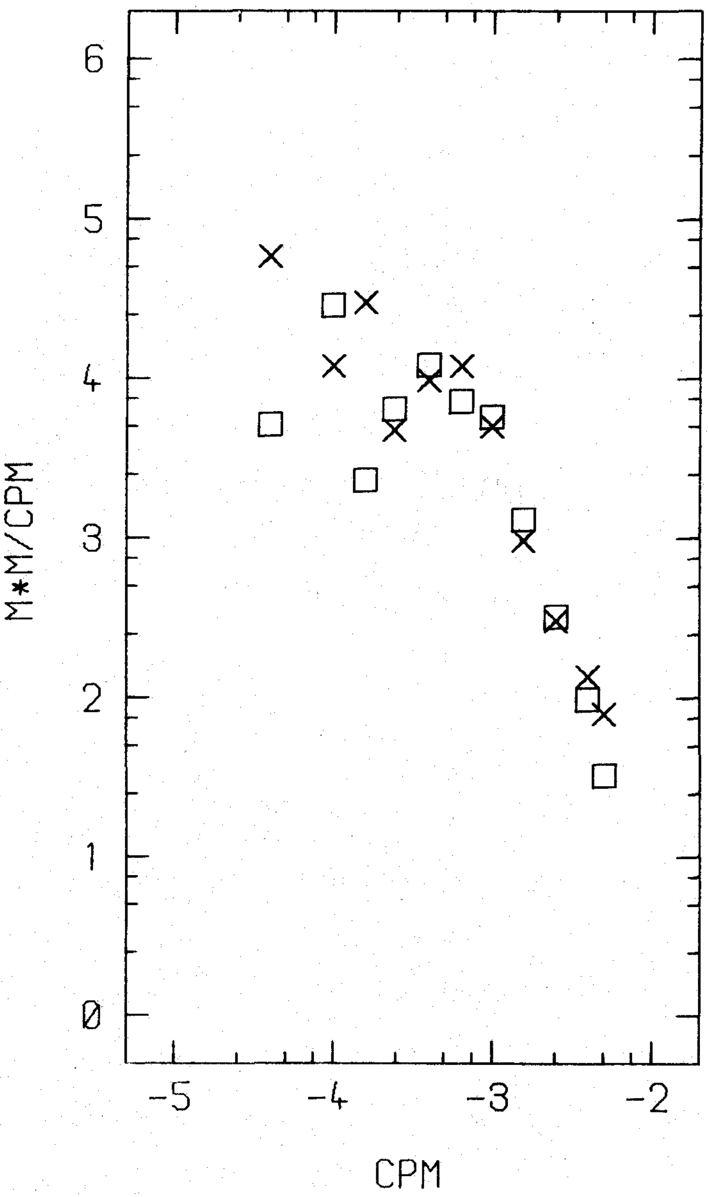
RUN 1-1 24-AUG-78
ISOTHERMS (DEG C) 12.0, 9.8



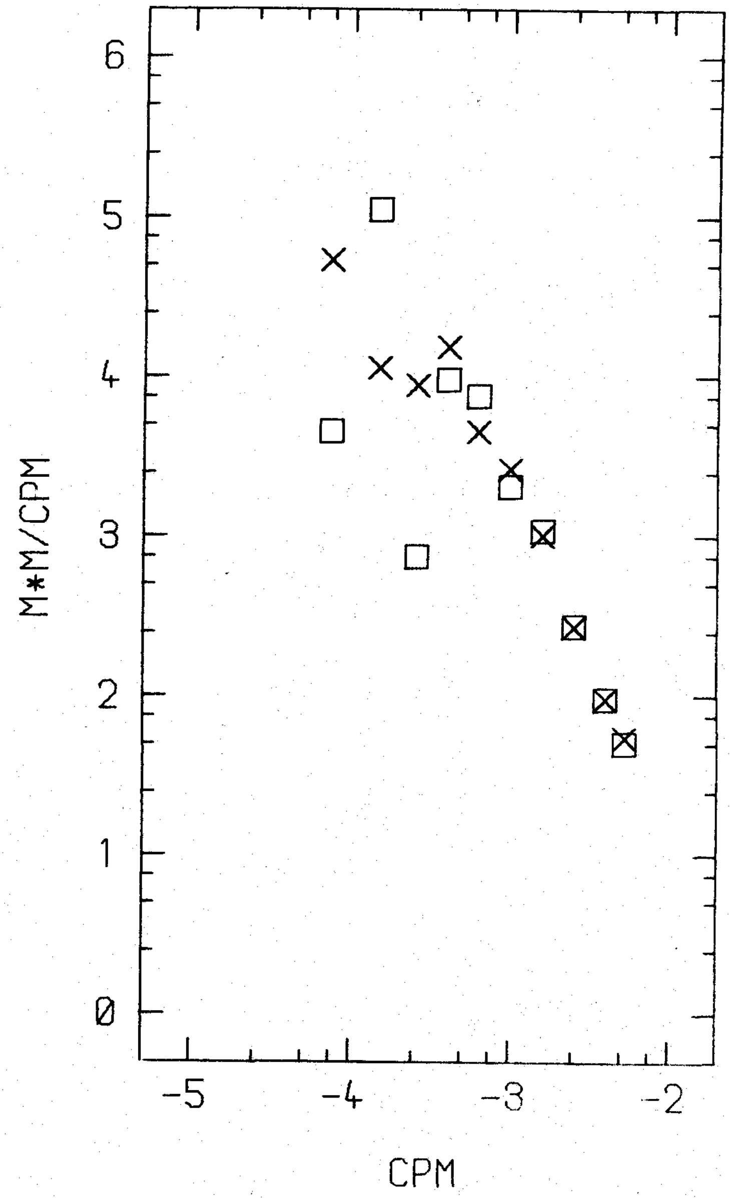
RUN 1-2 24-AUG-78
ISOTHERMS (DEG C) 12.0, 10.0



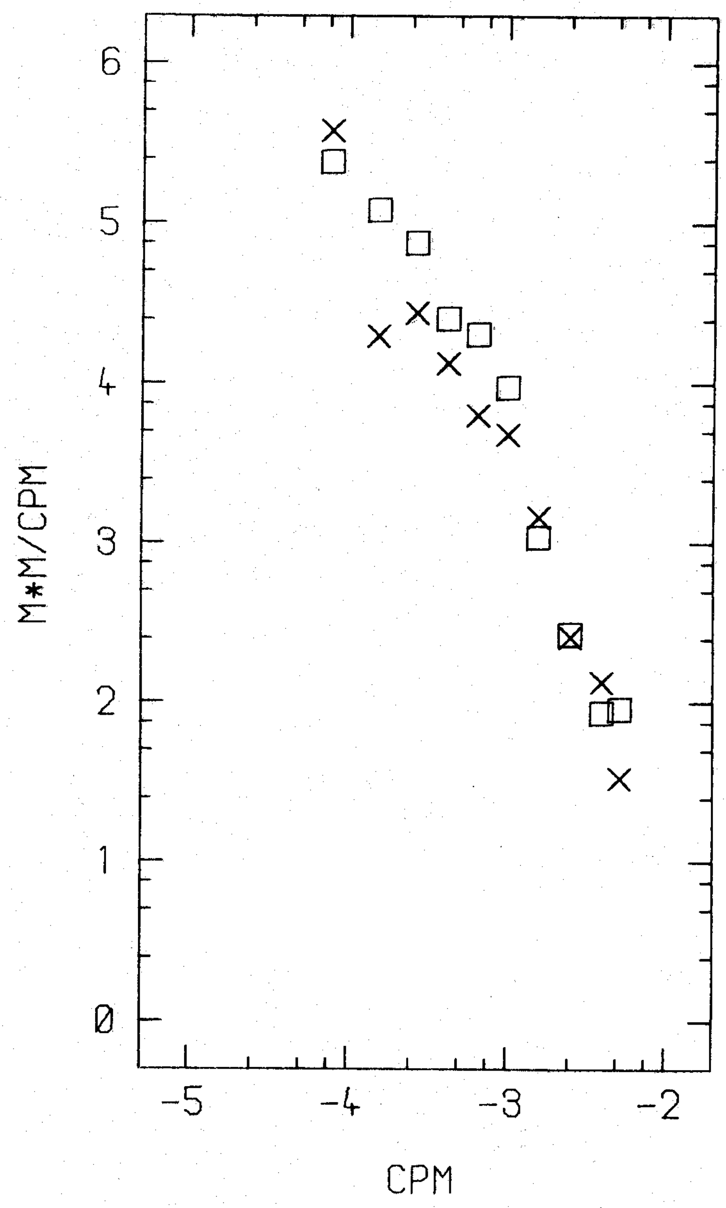
RUN 1-3 24-AUG-78
ISOTHERMS (DEG C) 12.4, 10.2



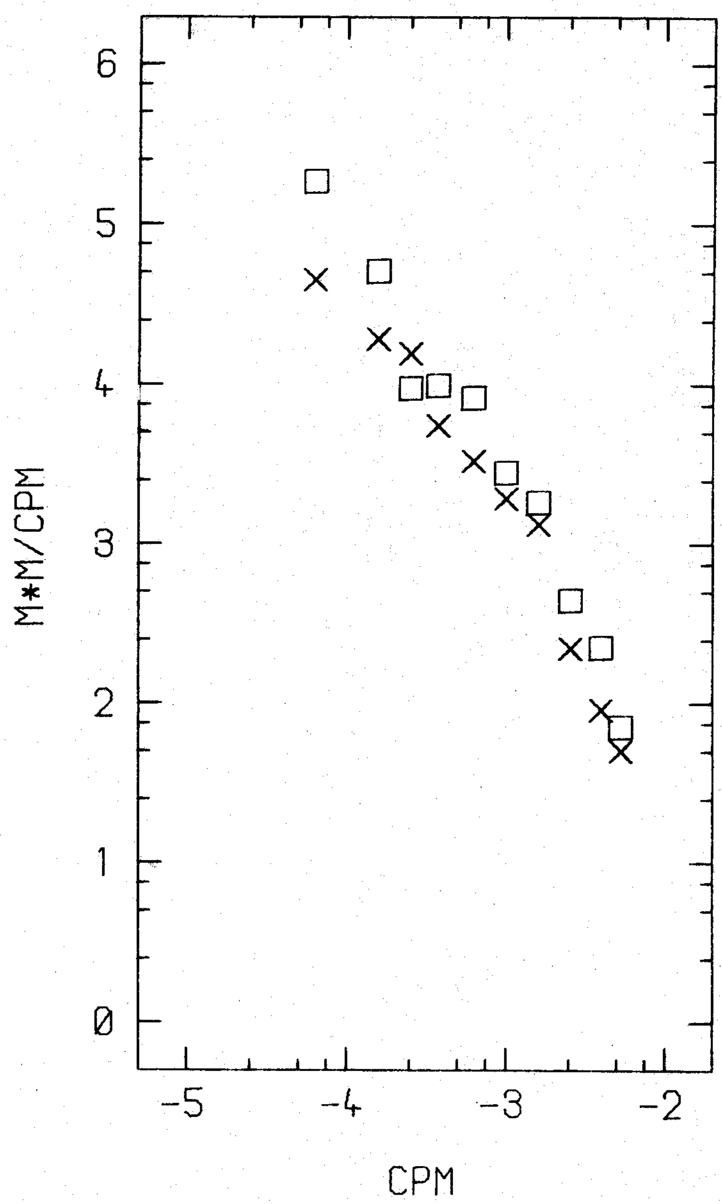
RUN 2W-1 25-AUG-78
ISOTHERMS (DEG C) 12.0, 9.8

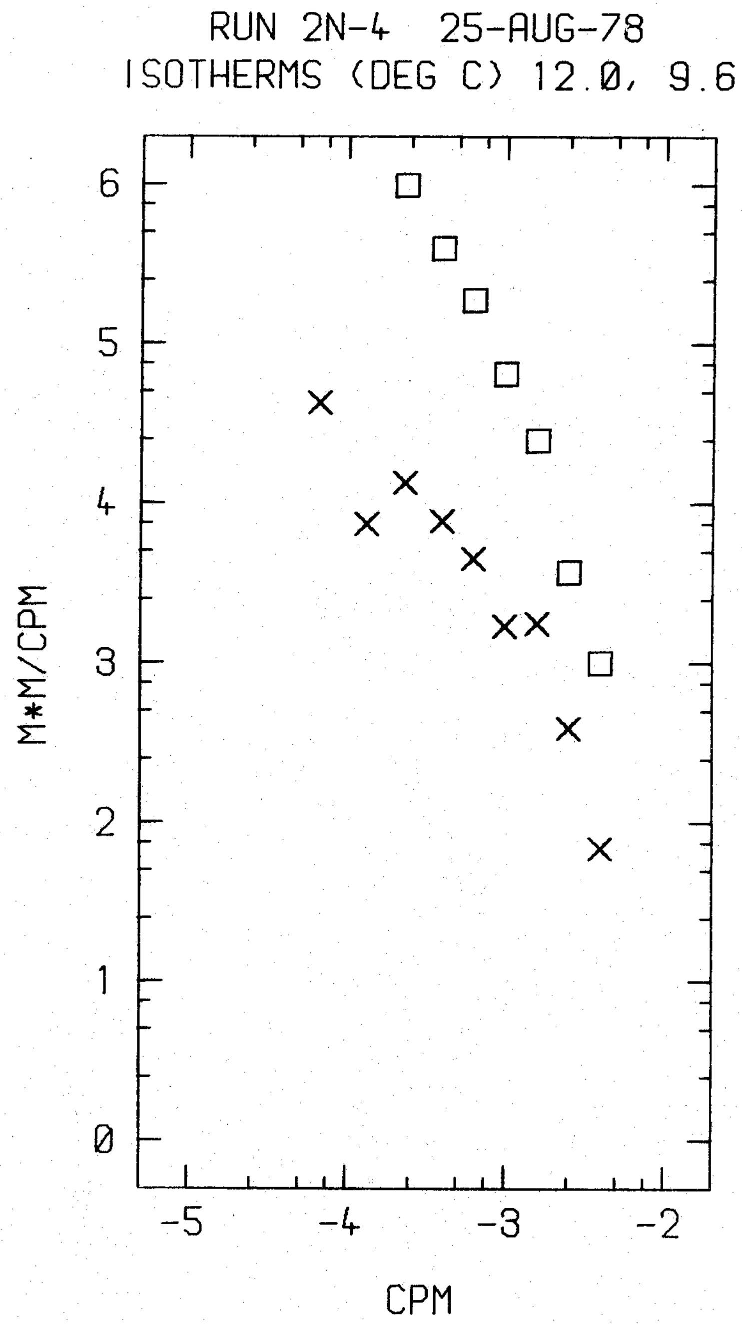


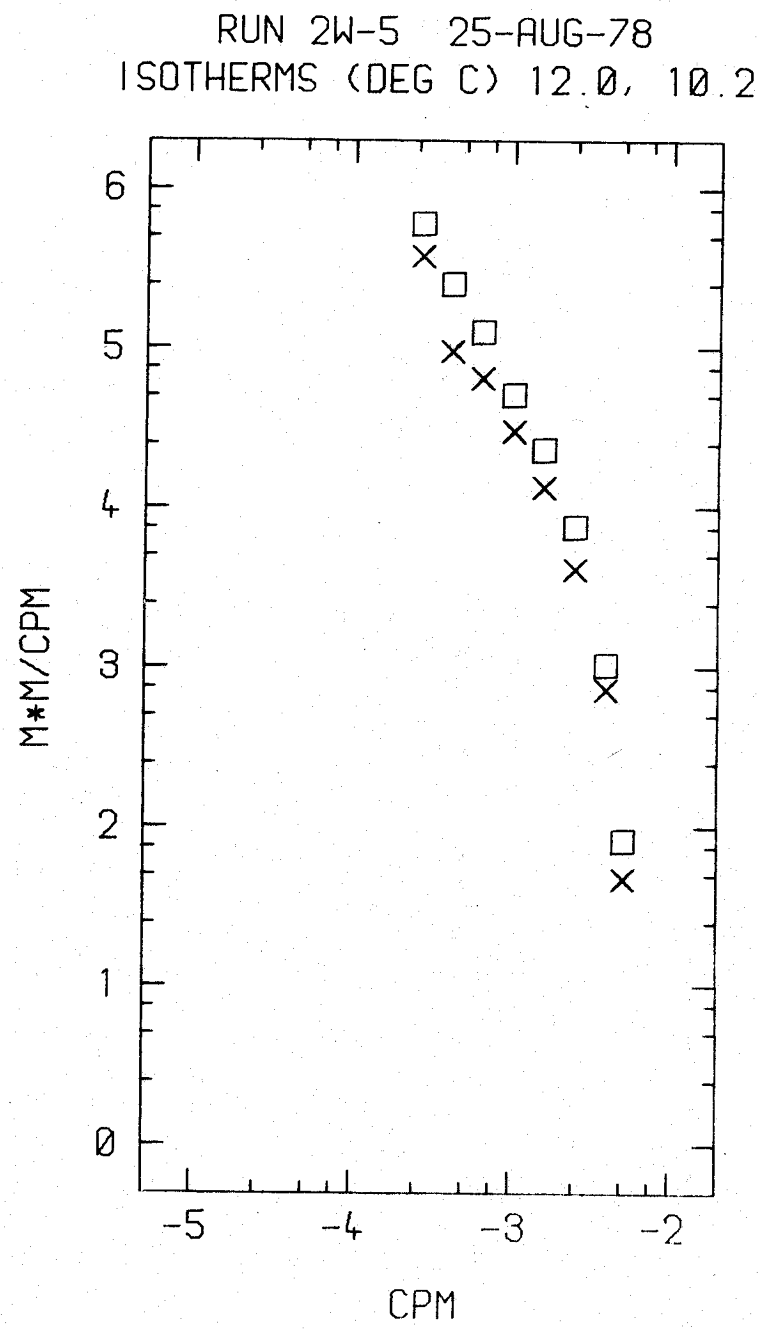
RUN 2S-2 25-AUG-78
ISOTHERMS (DEG C) 12.0, 10.0

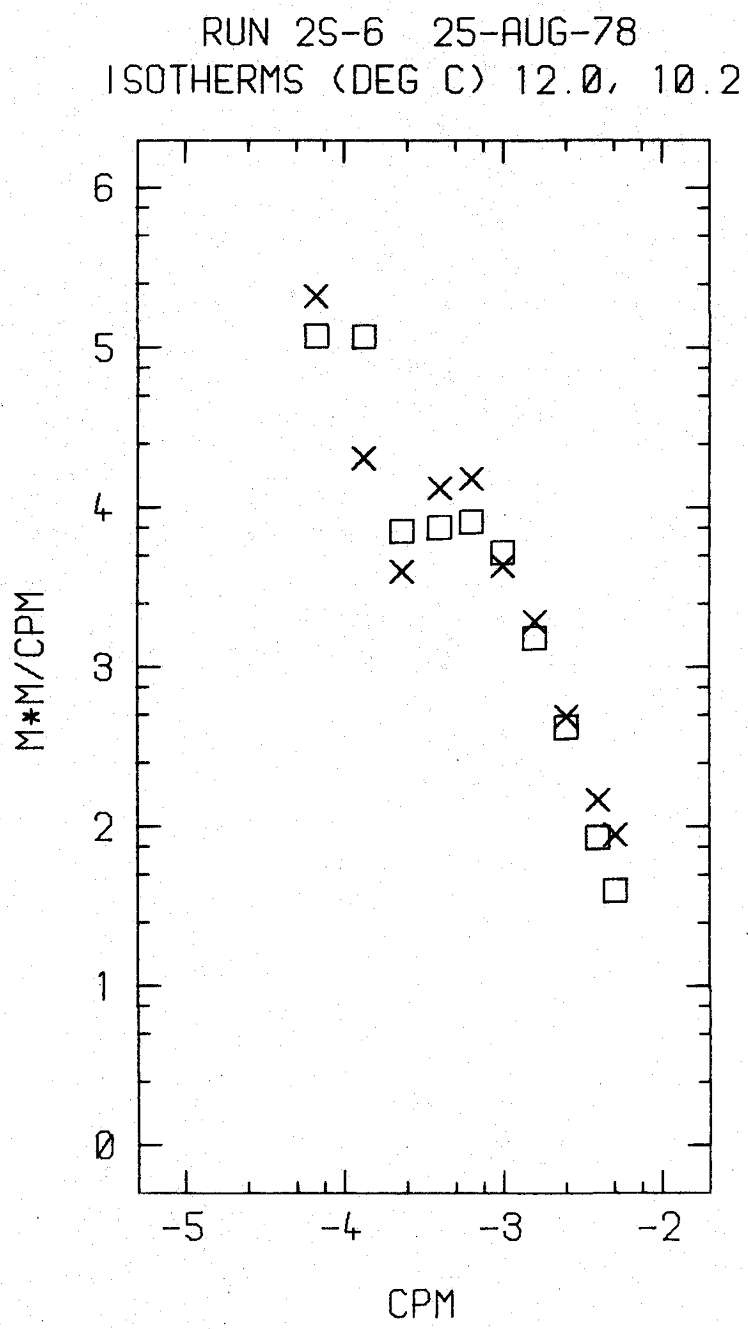


RUN 2E-3 25-AUG-78
ISOTHERMS (DEG C) 12.0, 9.6

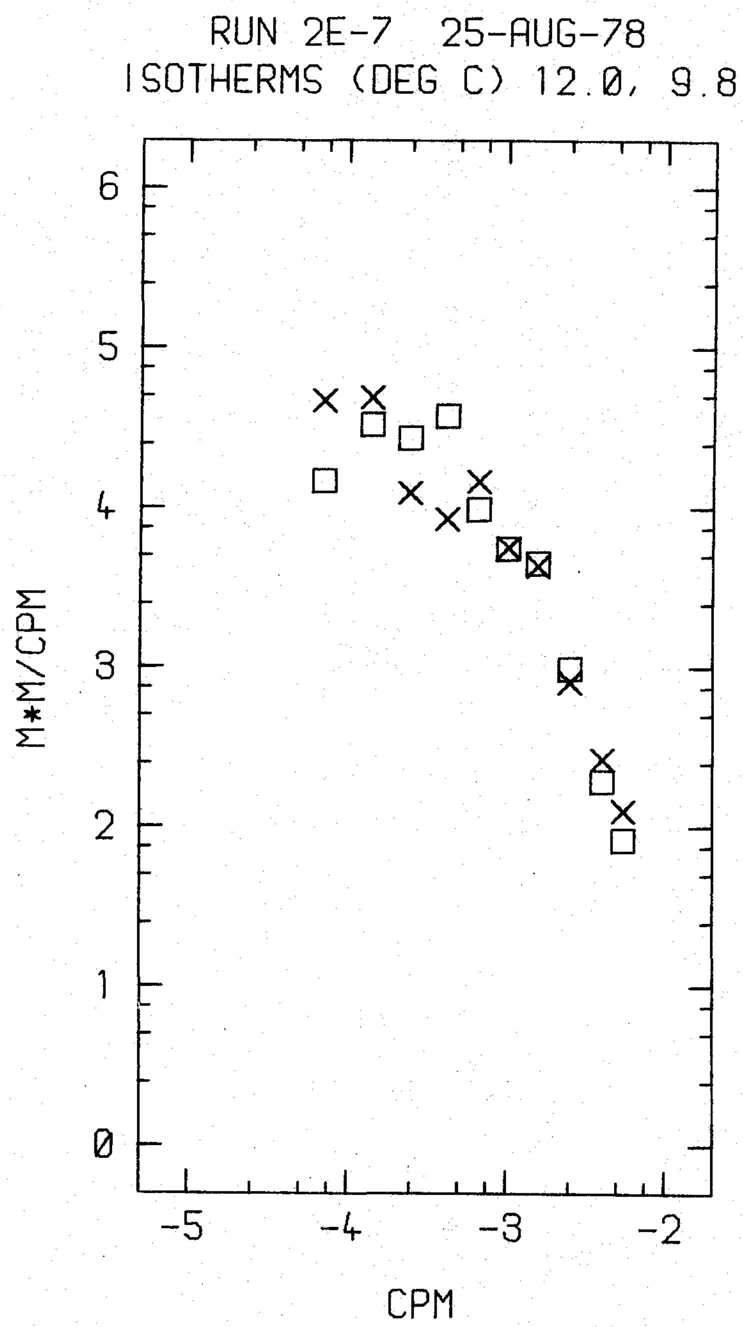



RUN 2N-4 25-AUG-78
ISOTHERMS (DEG C) 12.0, 9.6
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2

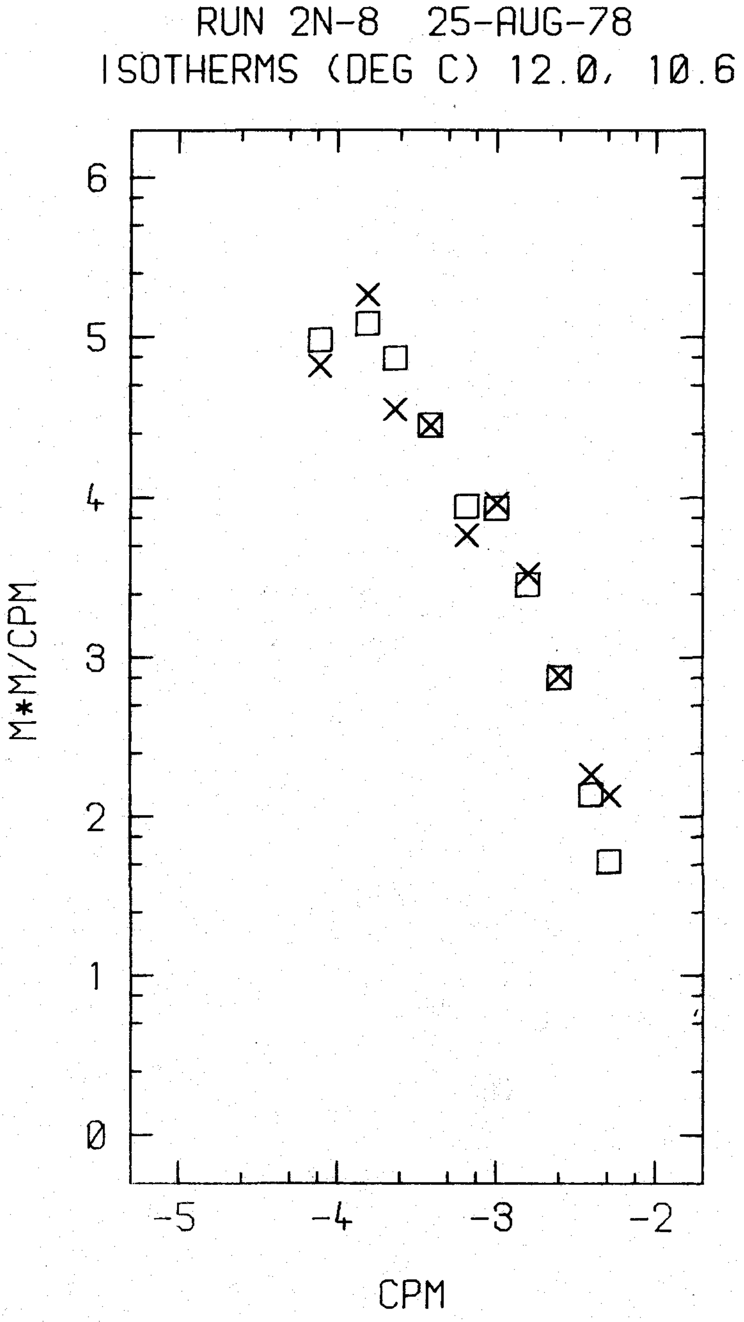

RUN 2W-5 25-AUG-78
ISOTHERMS (DEG C) 12.0, 10.2
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2

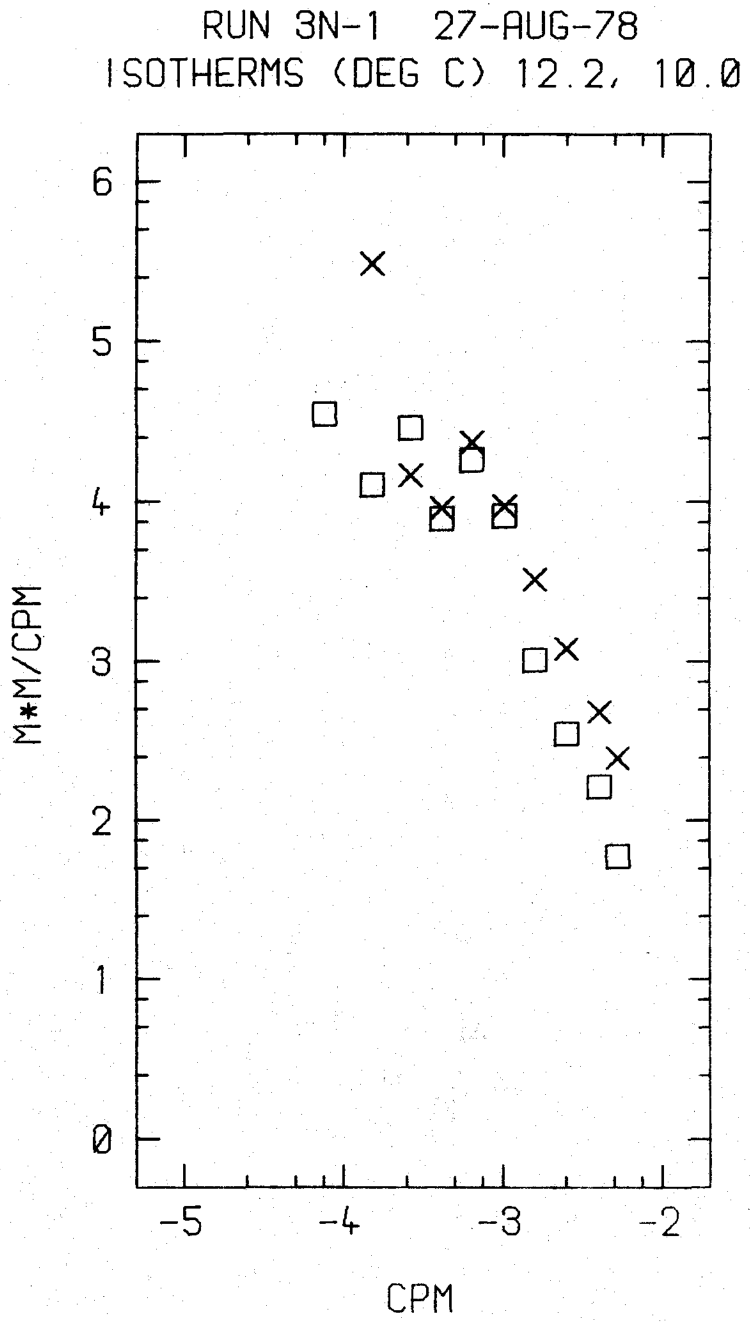


RUN 2S-6 25-AUG-78
ISOTHERMS (DEG C) 12.0, 10.2
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2

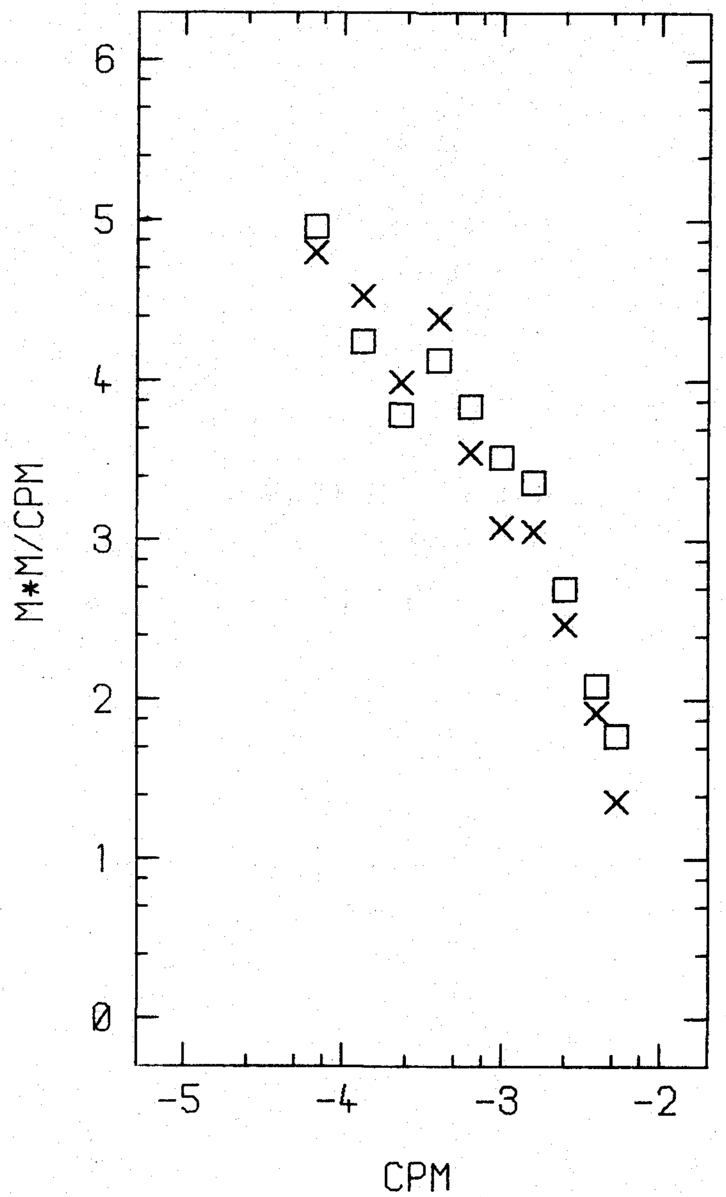


RUN 2E-7 25-AUG-78
ISOTHERMS (DEG C) 12.0, 9.8
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2

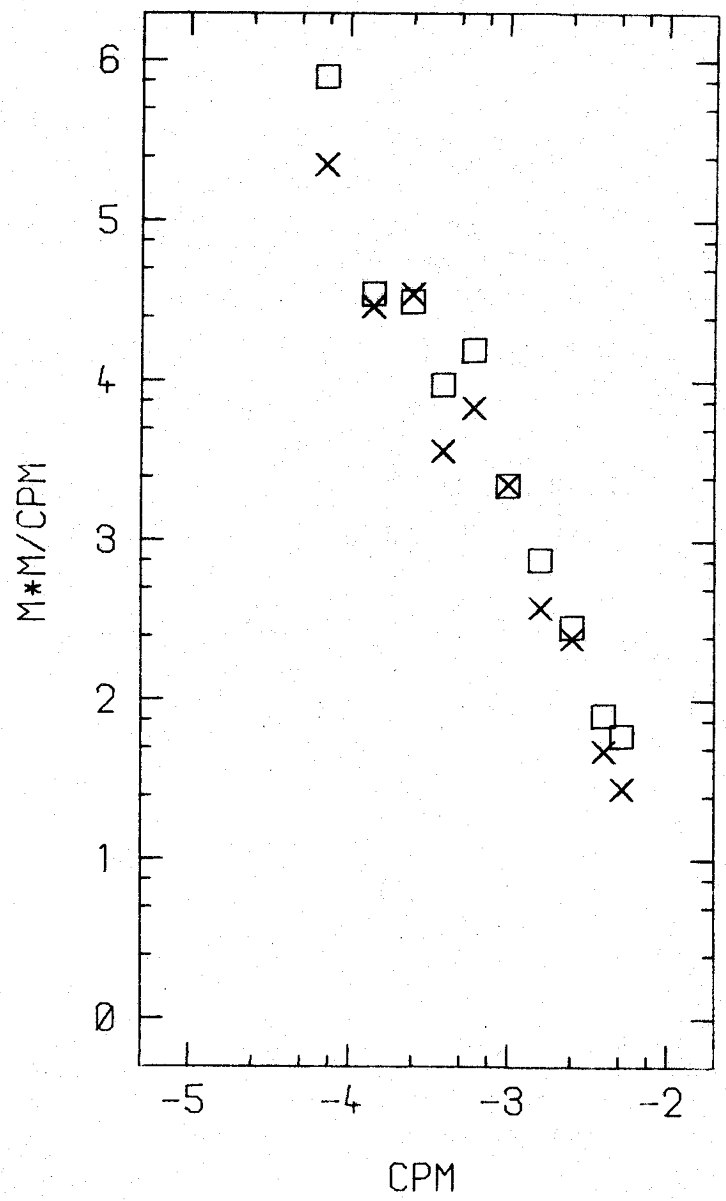

RUN 2N-8 25-AUG-78
ISOTHERMS (DEG C) 12.0, 10.6
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2


RUN 3N-1 27-AUG-78
ISOTHERMS (DEG C) 12.2, 10.0
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2

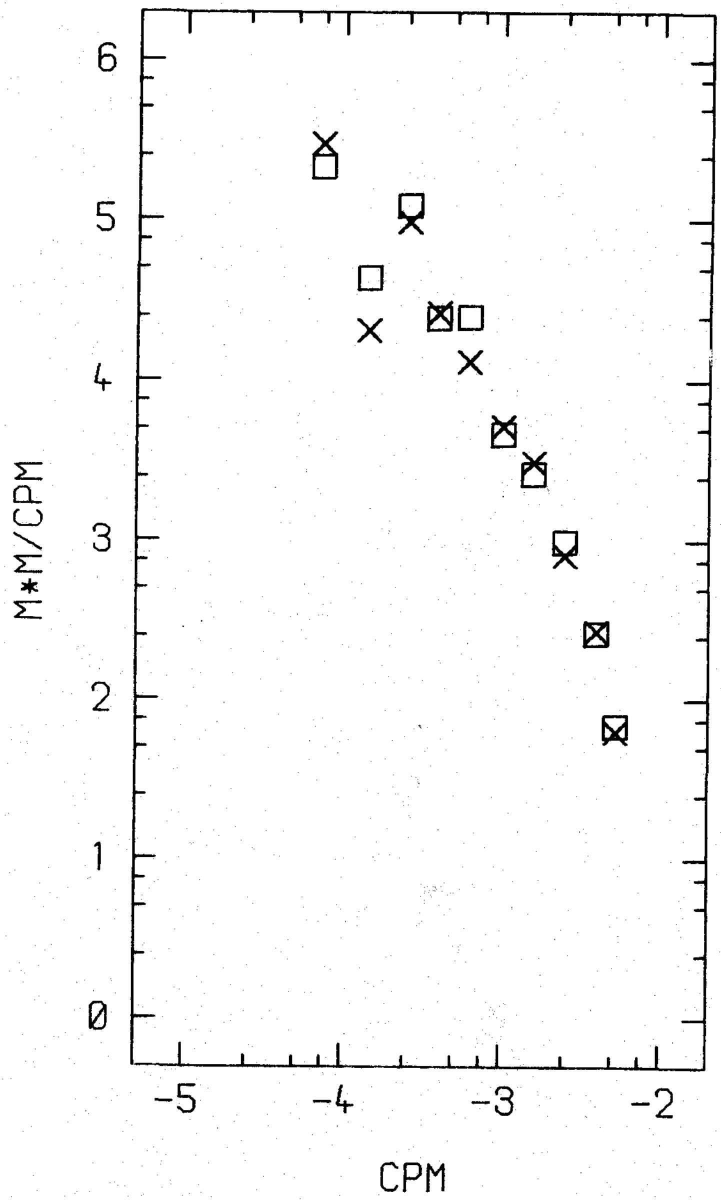
RUN 3W-2 27-AUG-78
ISOTHERMS (DEG C) 12.0, 9.6



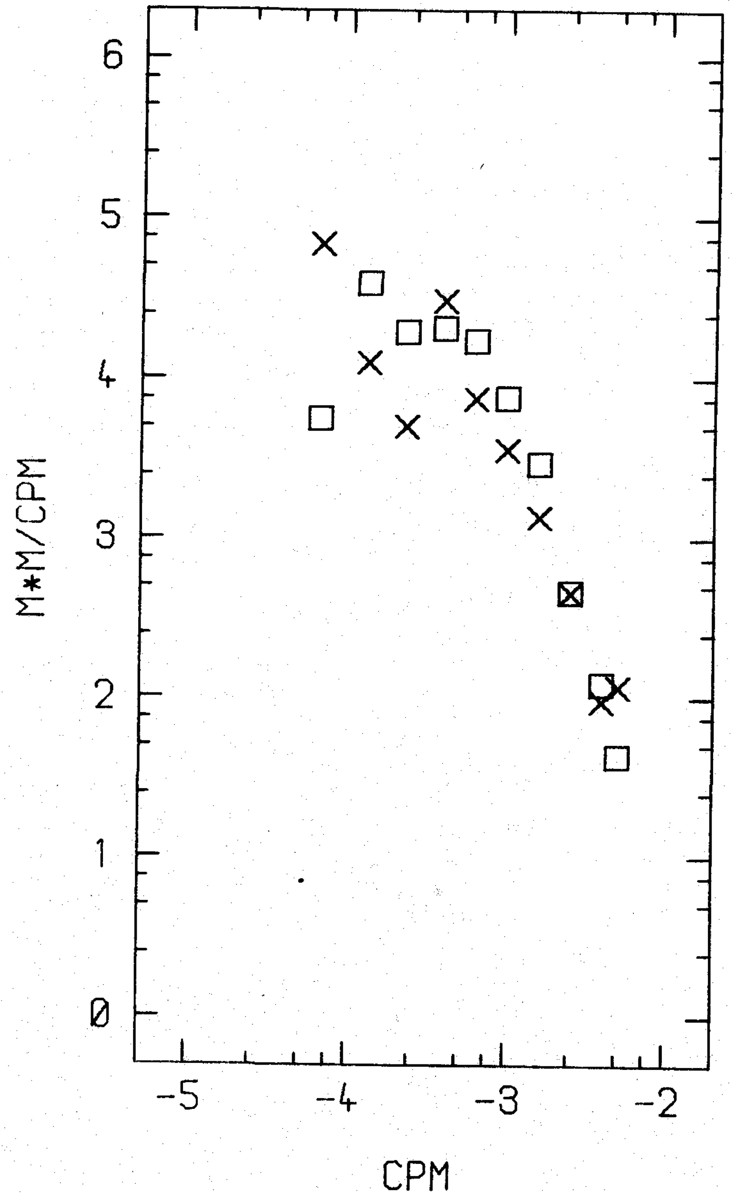
RUN 3S-3 27-AUG-78
ISOTHERMS (DEG C) 12.0, 9.8

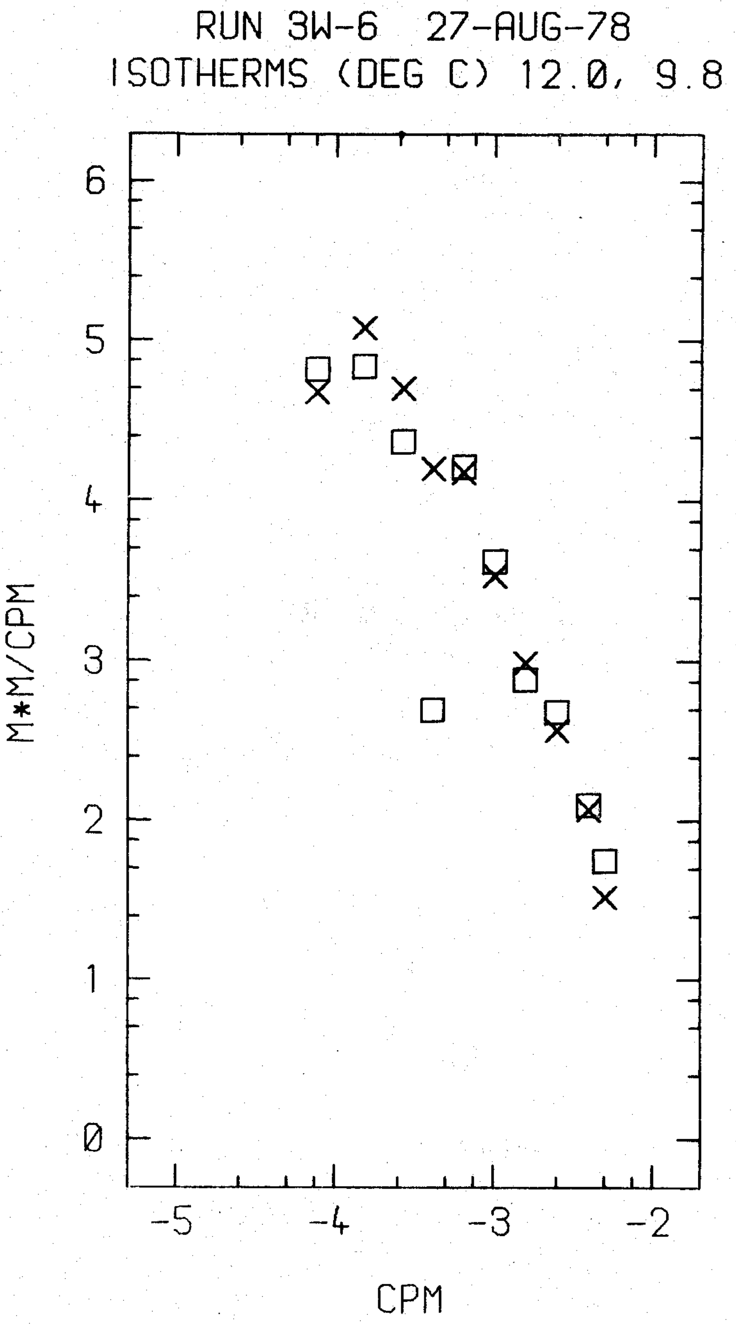


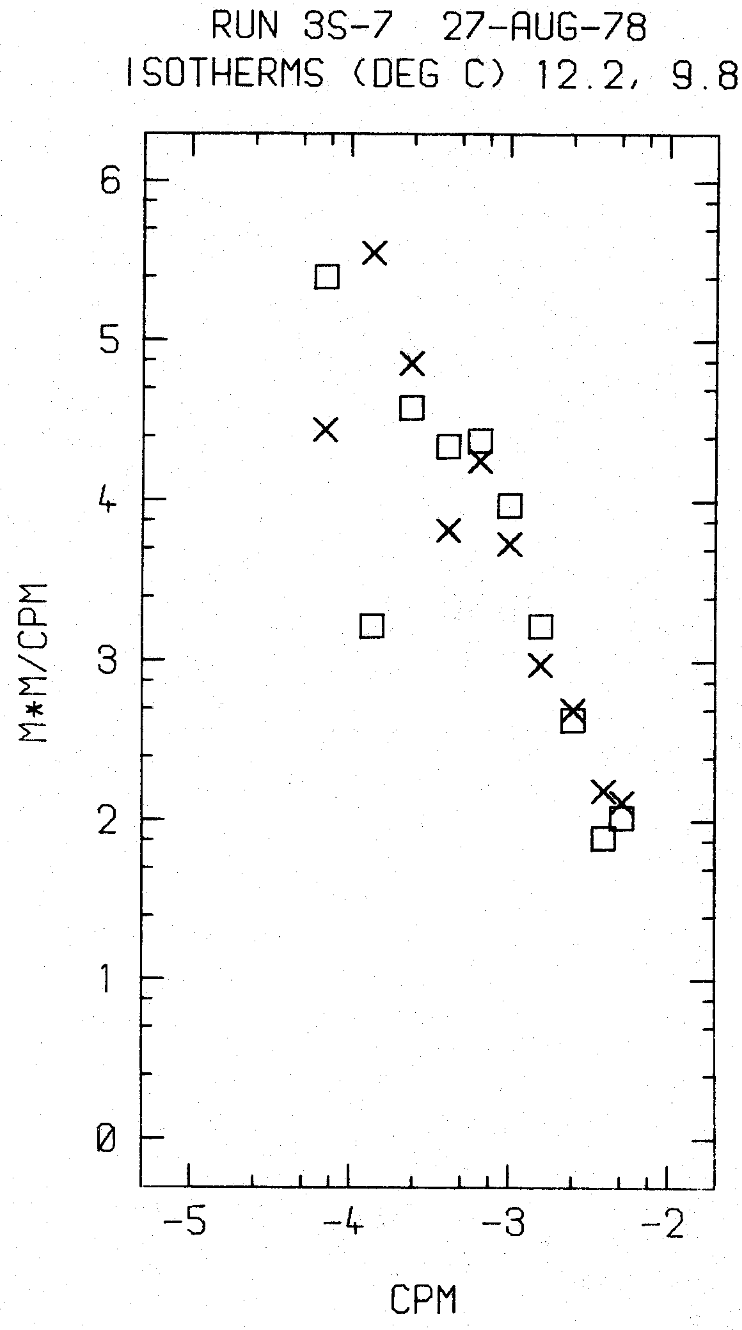
RUN 3E-4 27-AUG-78
ISOTHERMS (DEG C) 12.0, 9.8



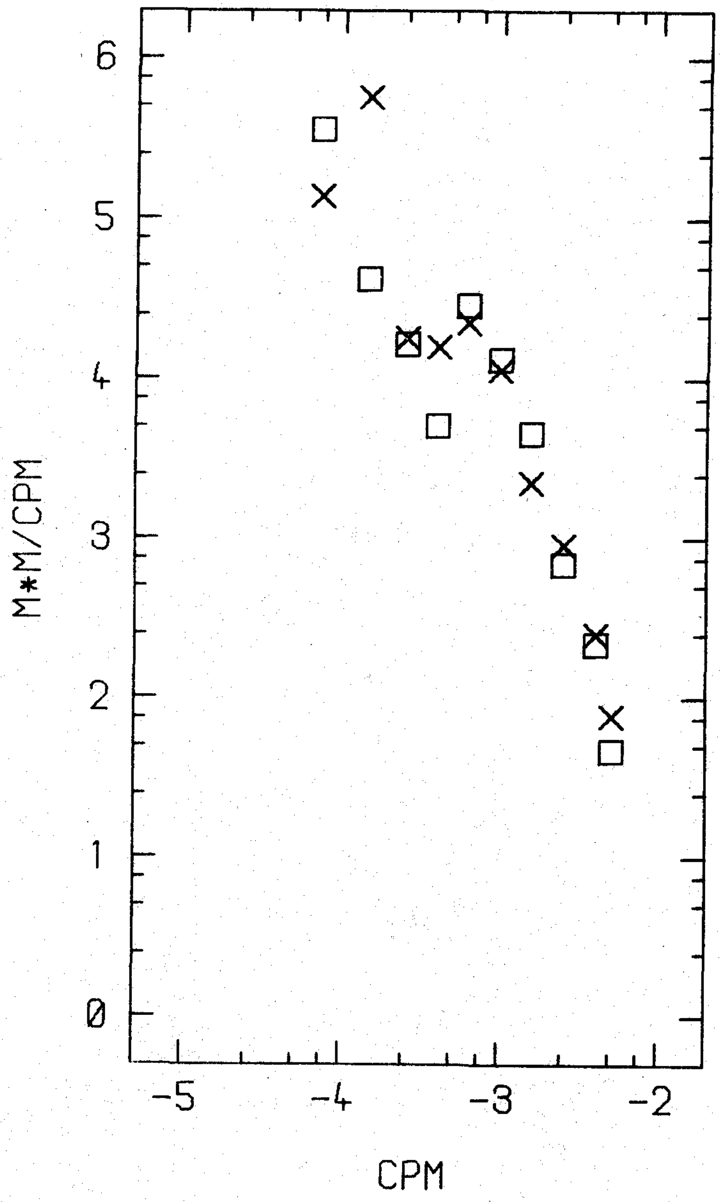
RUN 3N-5 27-AUG-78
ISOTHERMS (DEG C) 12.0, 9.6



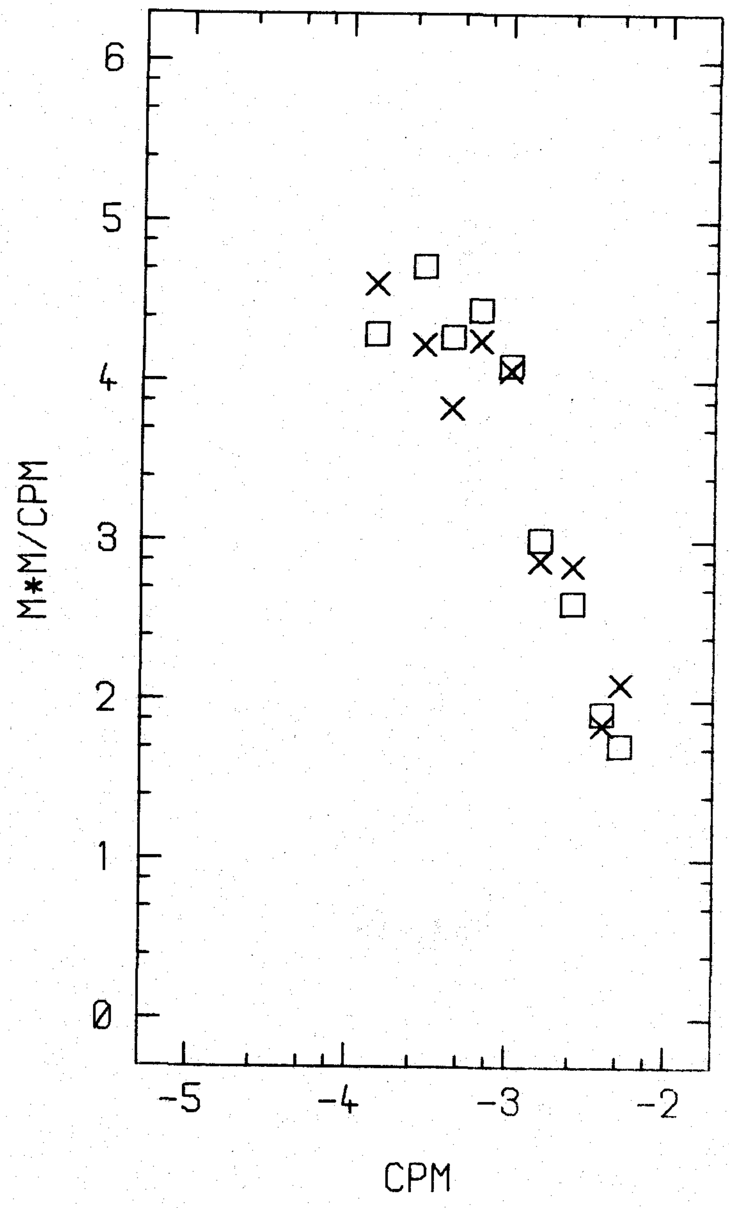

RUN 3W-6 27-AUG-78
ISOTHERMS (DEG C) 12.0, 9.8
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2

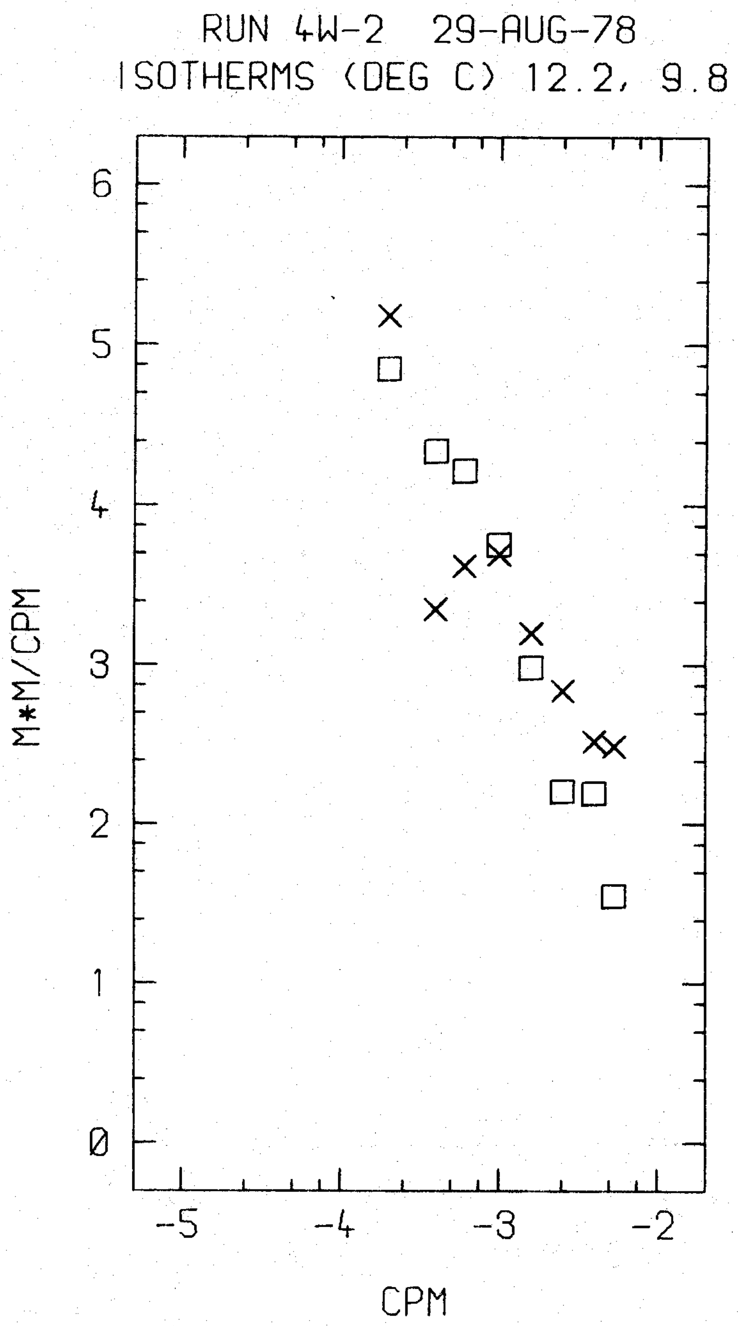

RUN 3S-7 27-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2

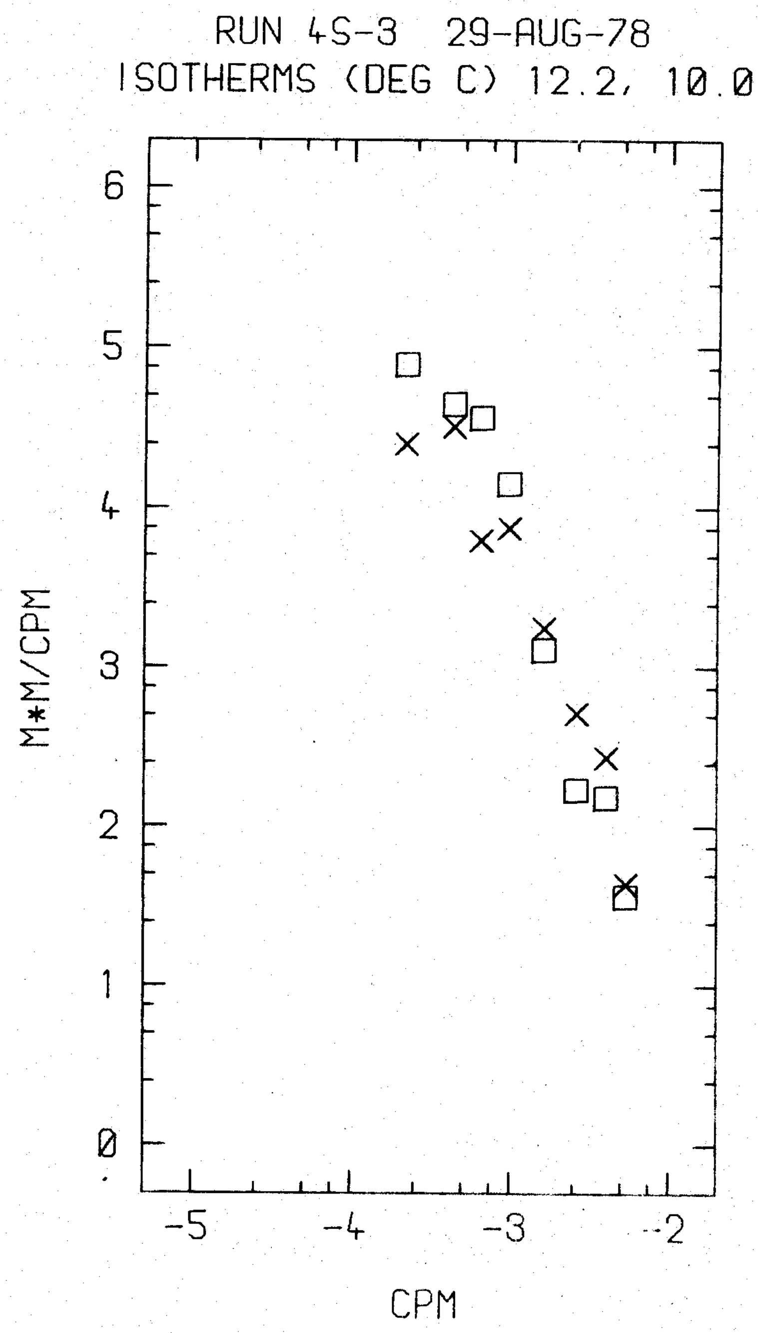
RUN 3E-8 27-AUG-78
ISOTHERMS (DEG C) 12.2, 10.0



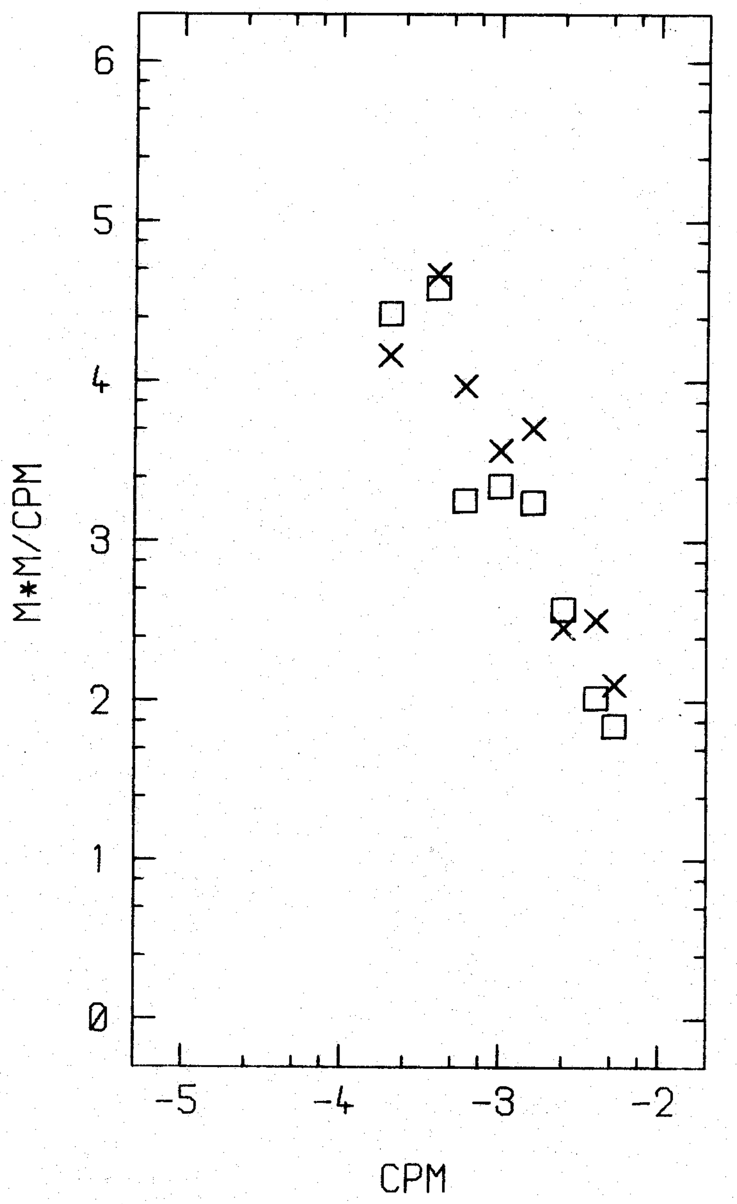
RUN 4N-1 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8



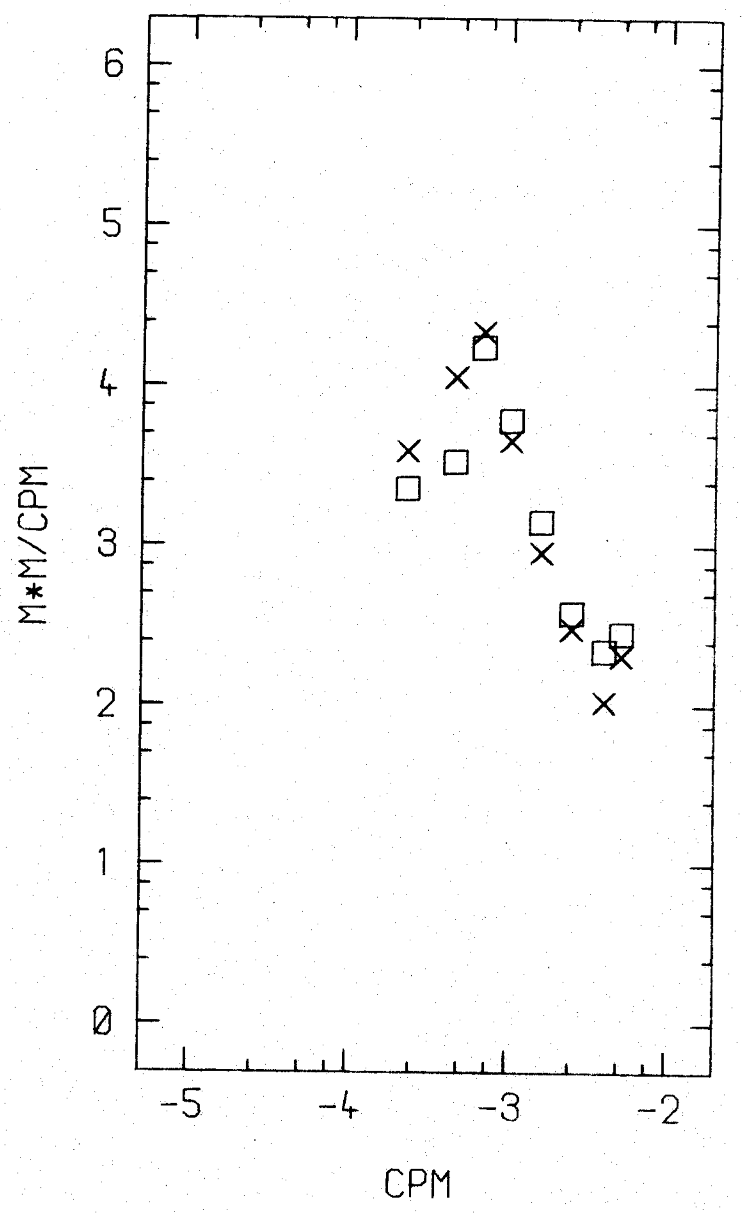

RUN 4W-2 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2

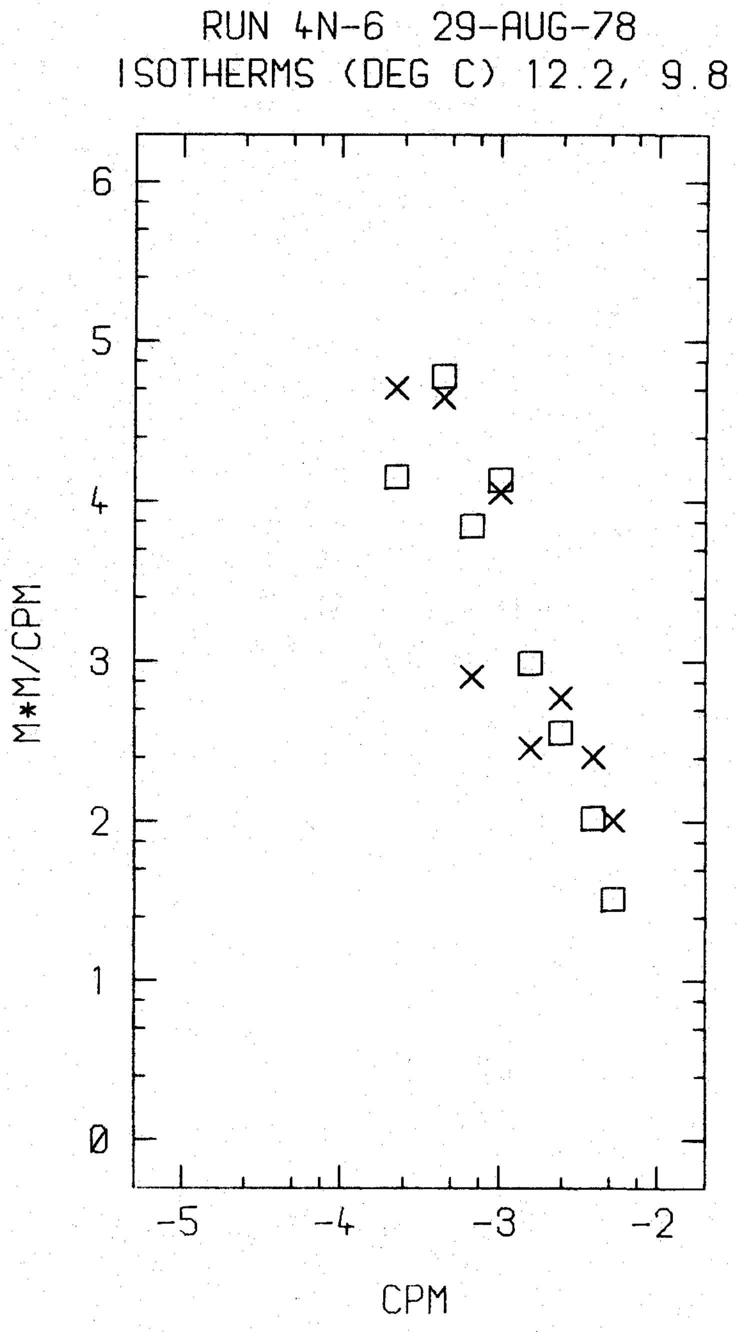

RUN 4S-3 29-AUG-78
ISOTHERMS (DEG C) 12.2, 10.0
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2

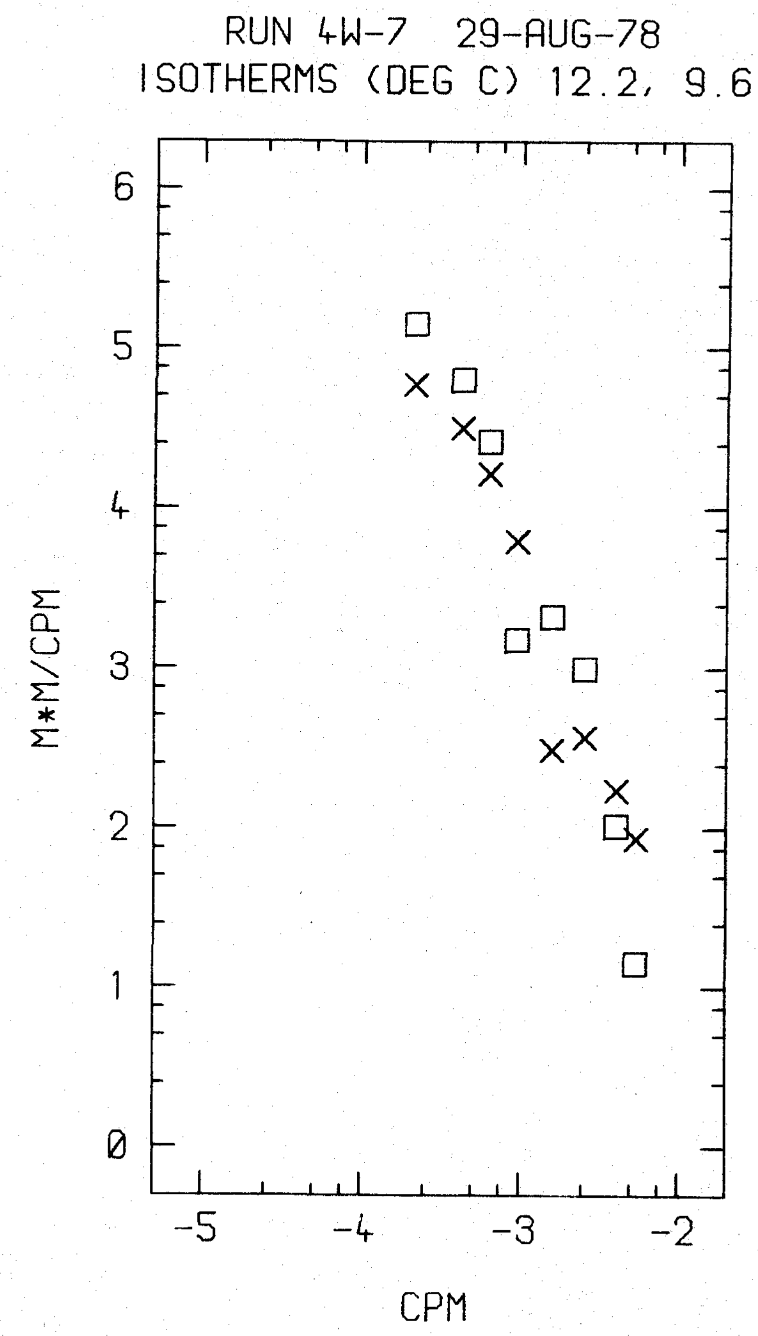
RUN 4E-4 29-AUG-78
ISOTHERMS (DEG C) 12.0, 9.8



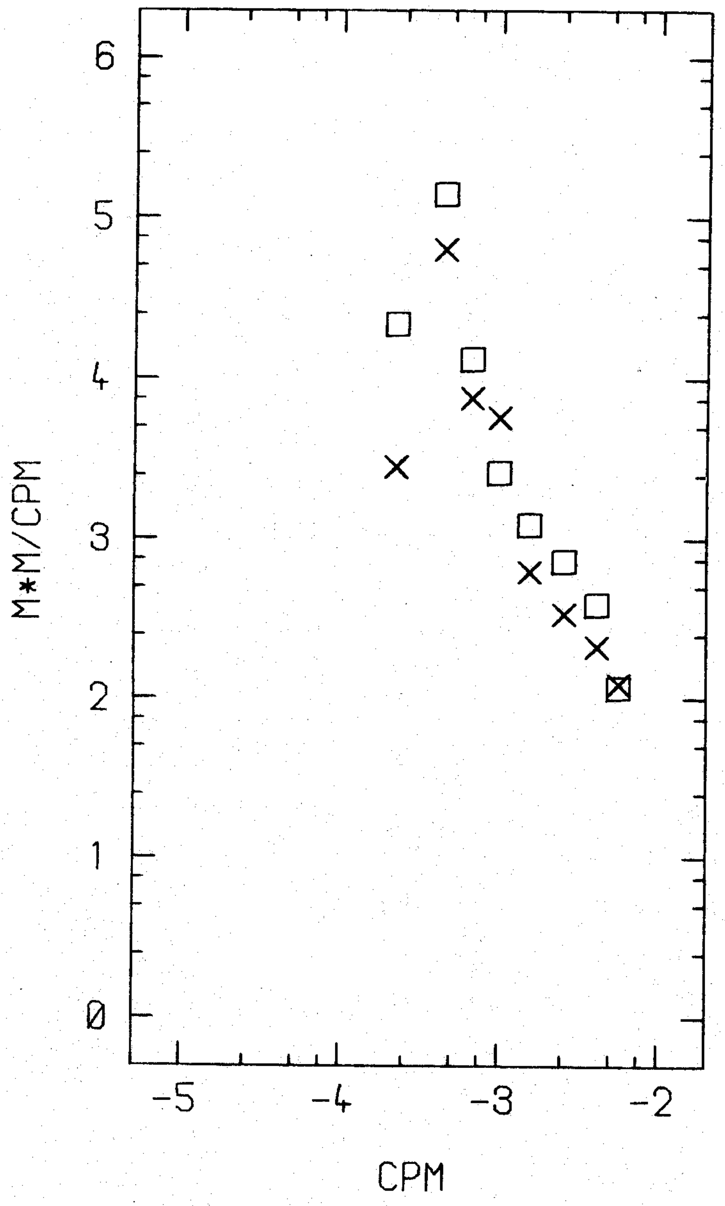
RUN 4E-5 29-AUG-78
ISOTHERMS (DEG C) 12.0, 9.6



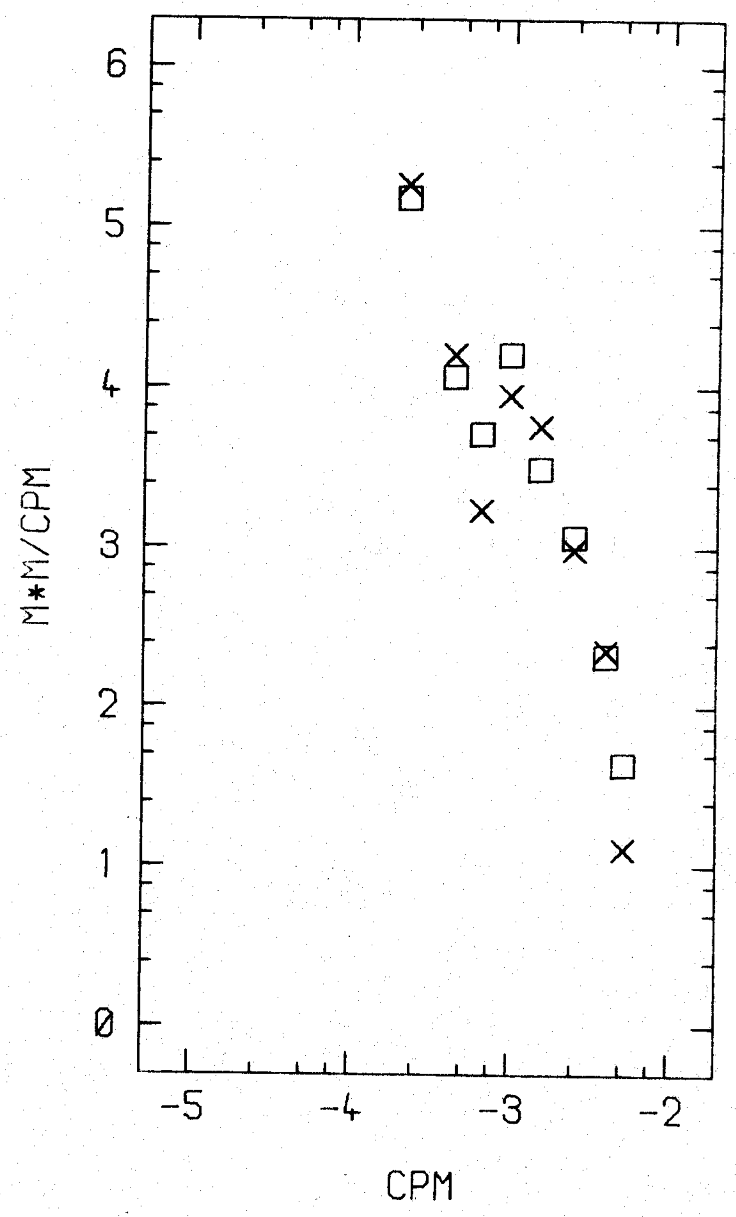

RUN 4N-6 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2


RUN 4W-7 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.6
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2

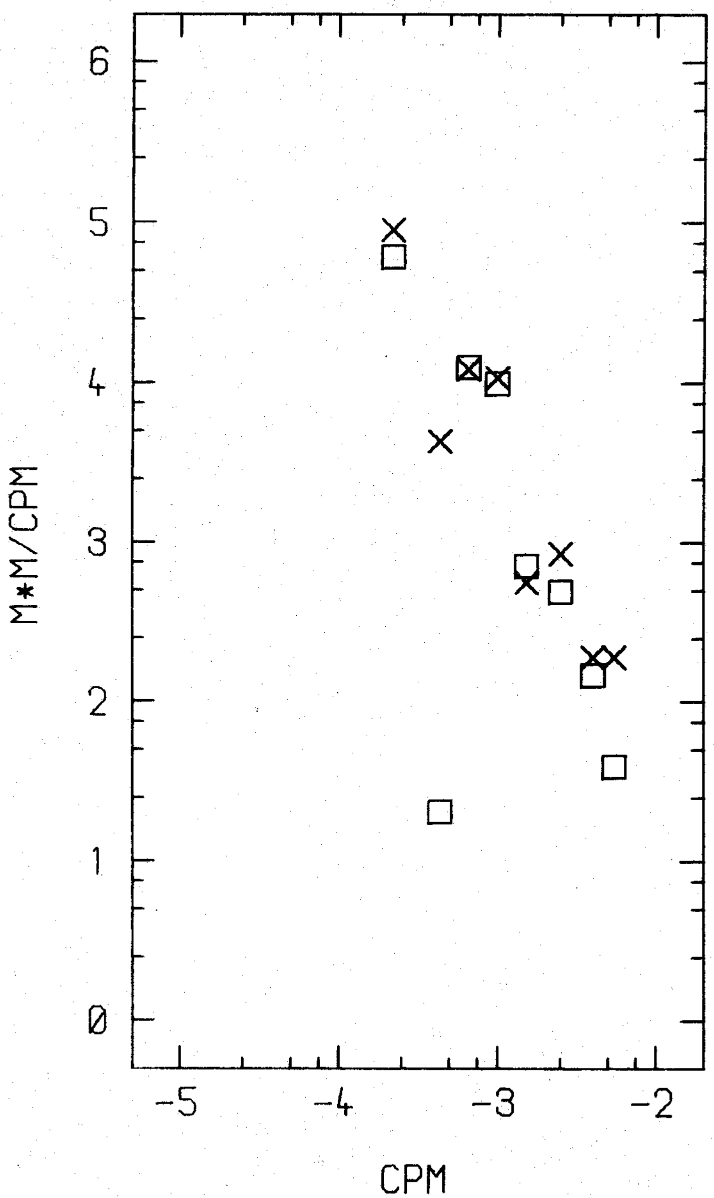
RUN 4S-8 29-AUG-78
ISOTHERMS (DEG C) 12.0, 9.6



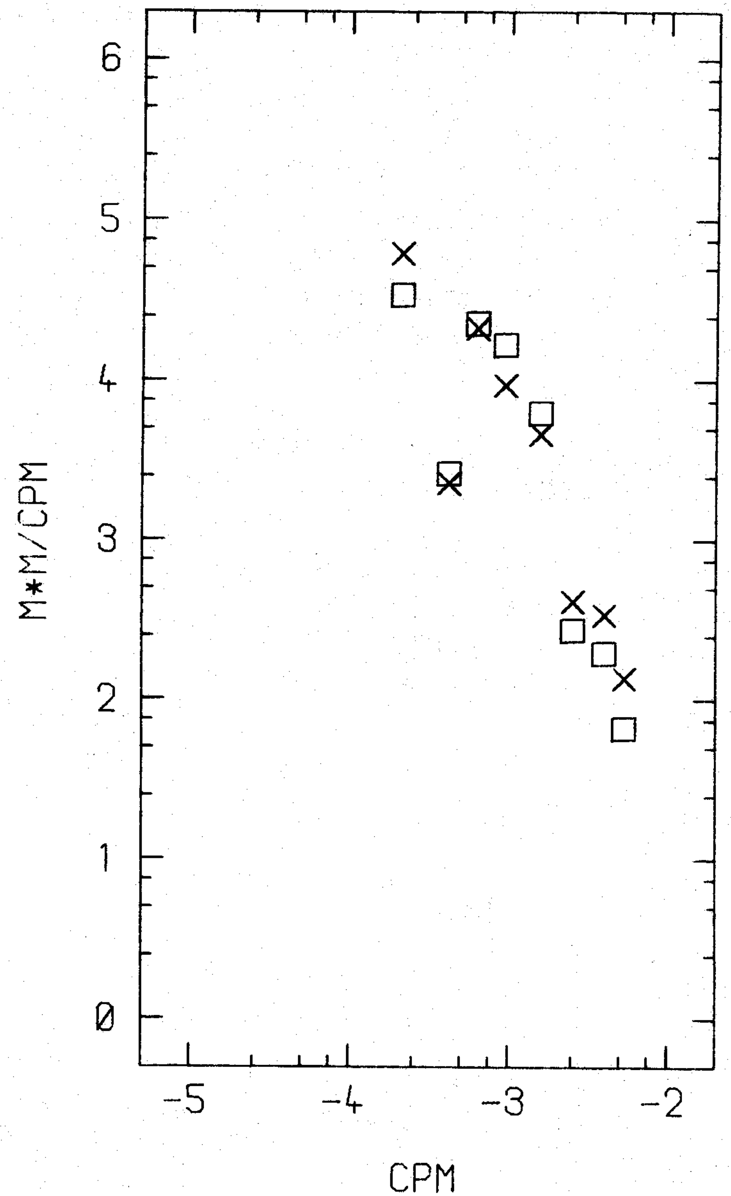
RUN 4E-9 29-AUG-78
ISOTHERMS (DEG C) 12.0, 10.4



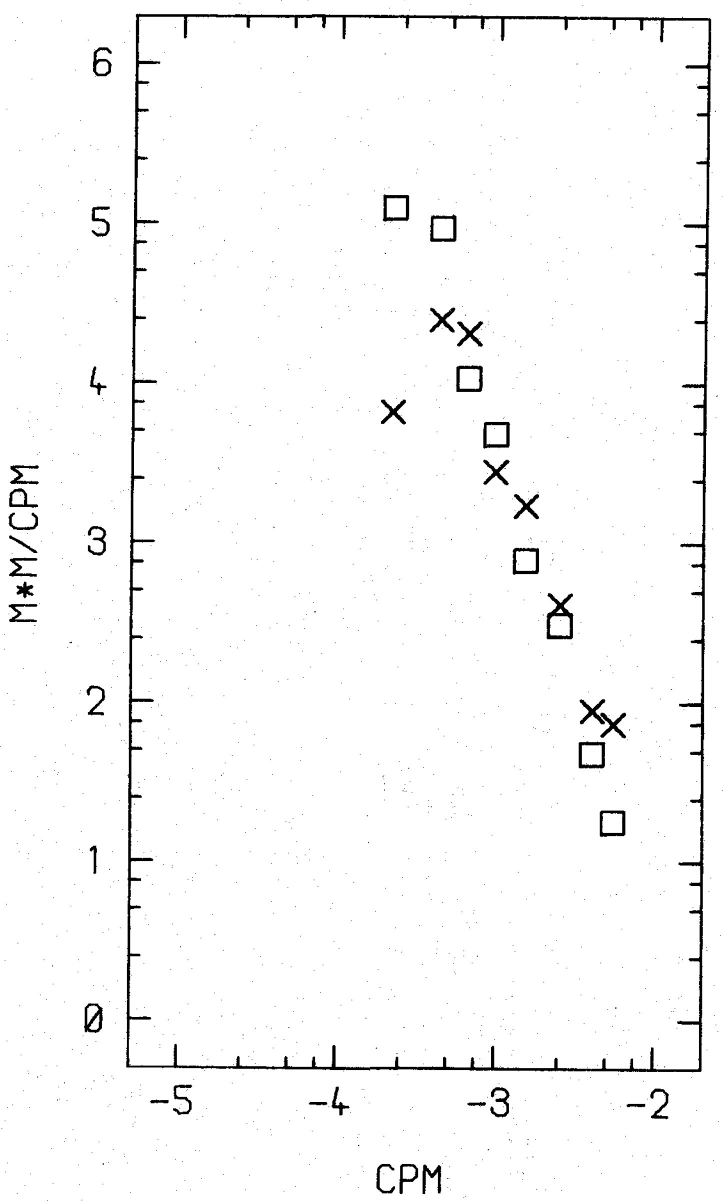
RUN 4N-10 29-AUG-78
ISOTHERMS (DEG C) 12.2, 10.0



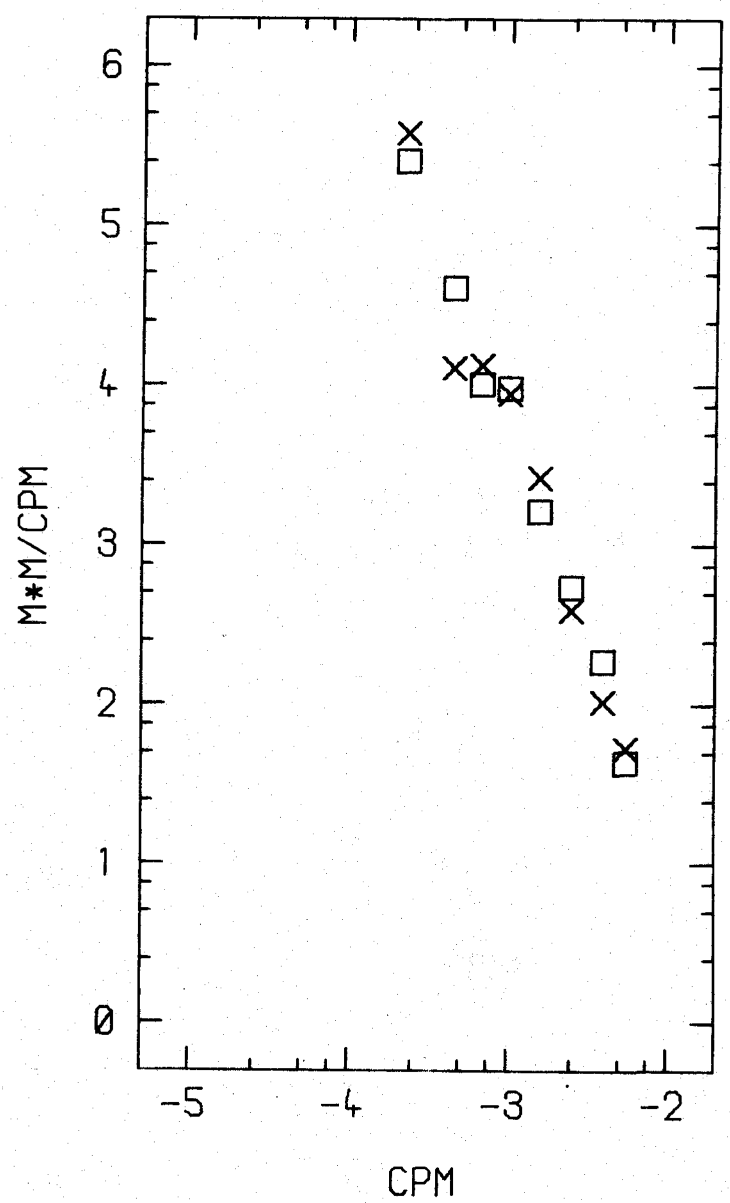
RUN 4W-11 29-AUG-78
ISOTHERMS (DEG C) 12.2, 10.0



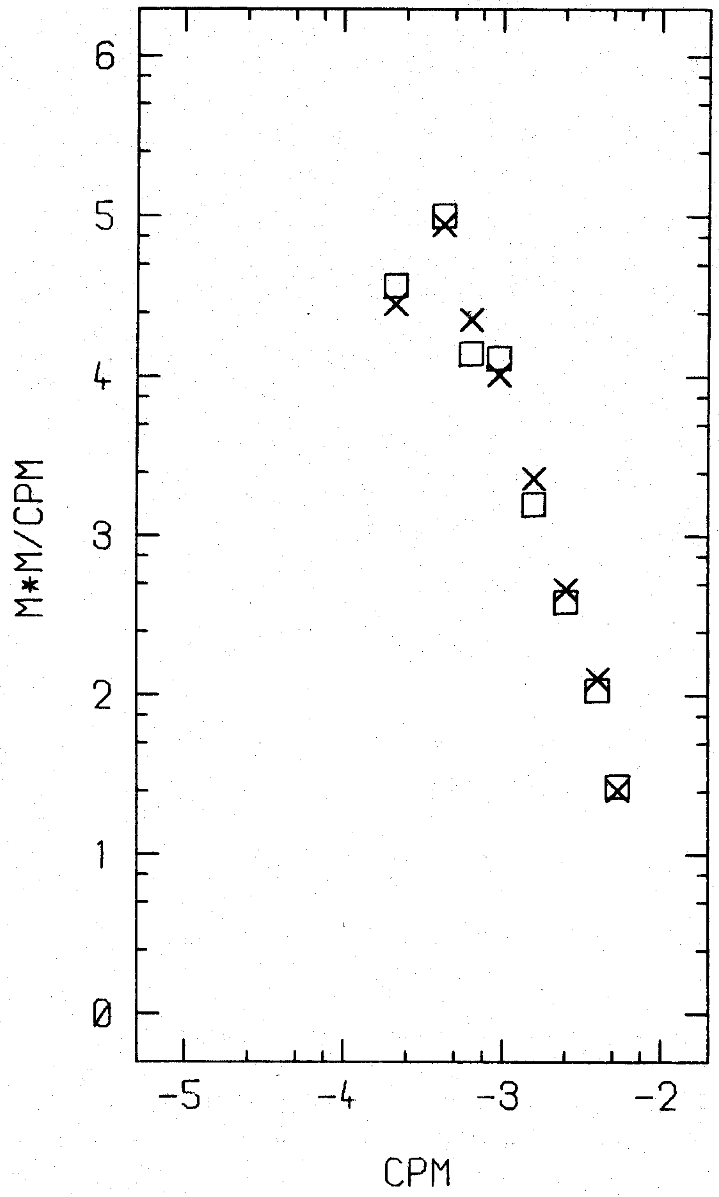
RUN 4S-12 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.6



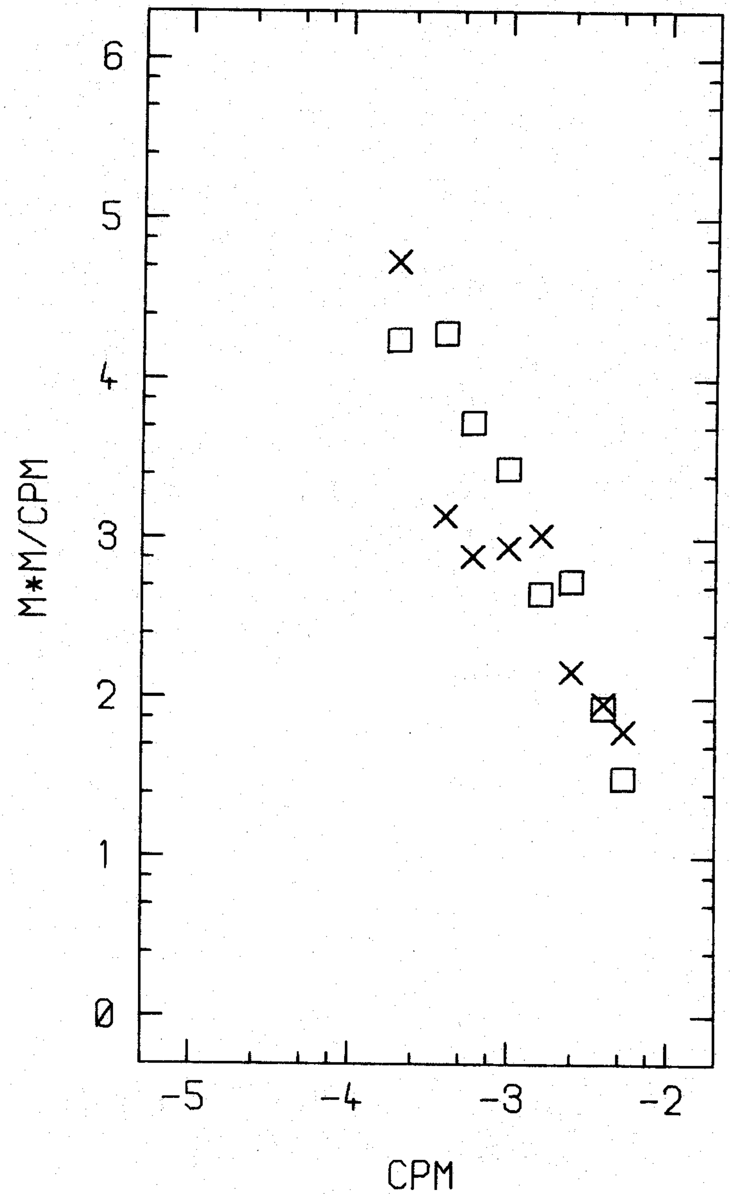
RUN 4E-13 29-AUG-78
ISOTHERMS (DEG C) 12.0, 9.6

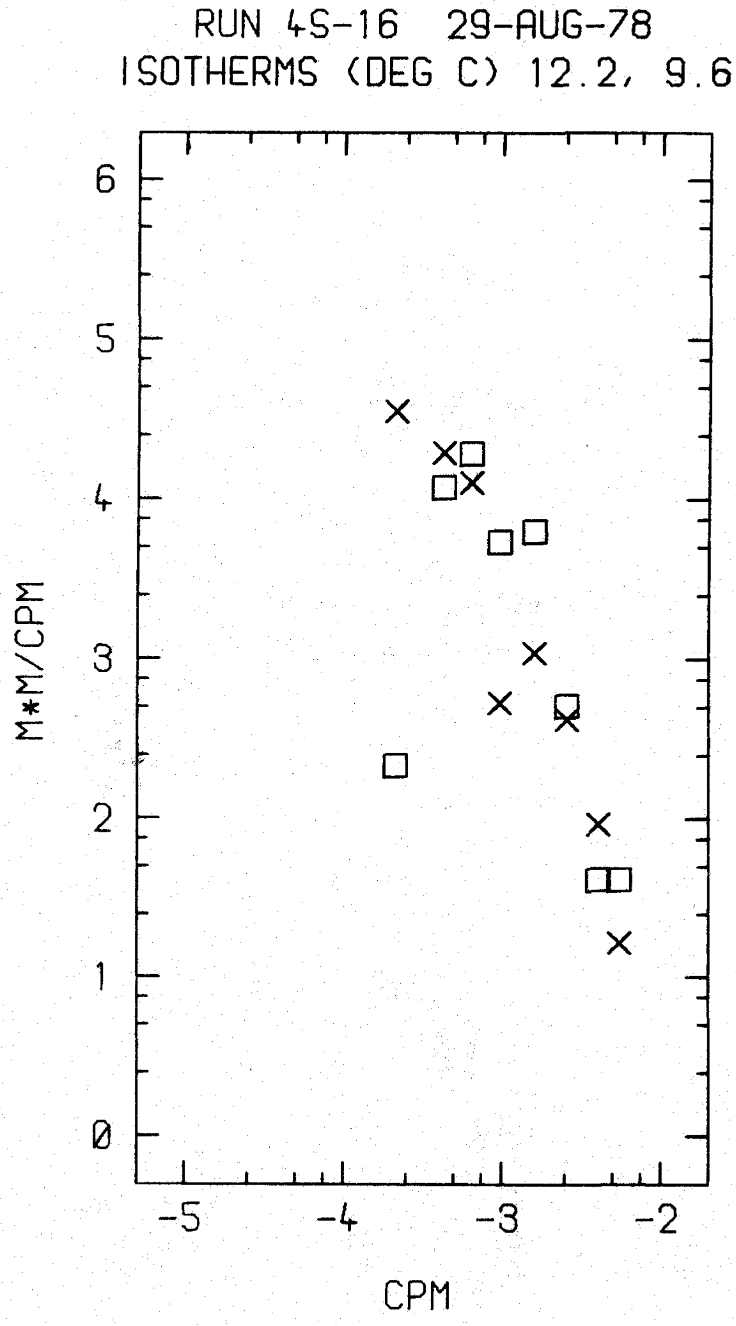


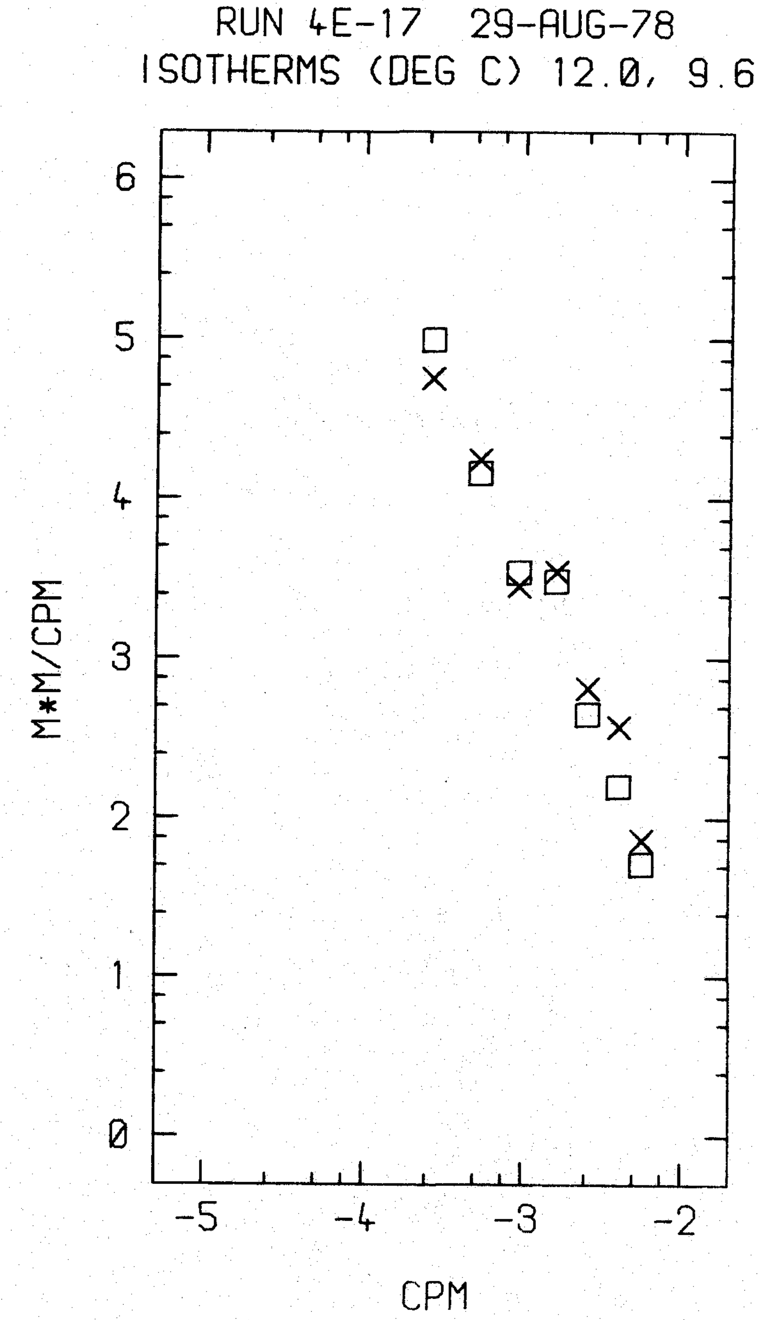
RUN 4N-14 29-AUG-78
ISOTHERMS (DEG C) 12.2, 10.0

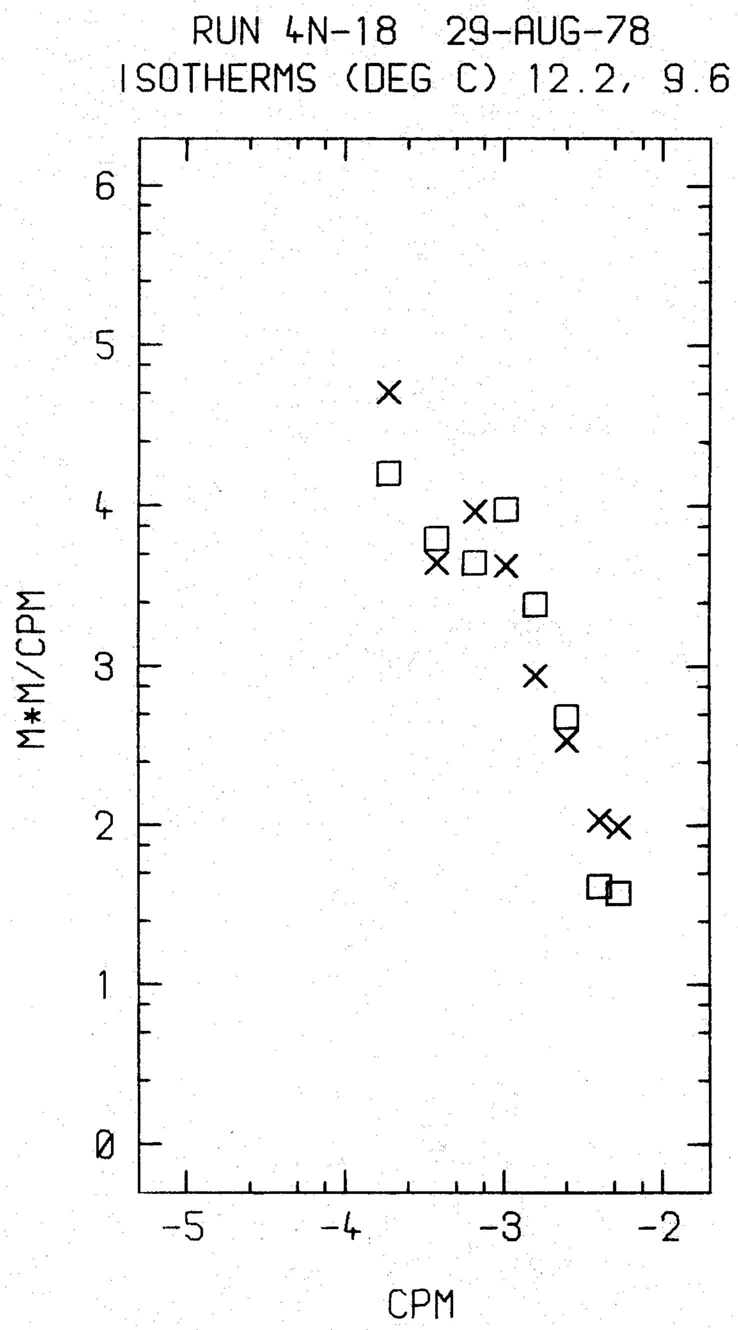


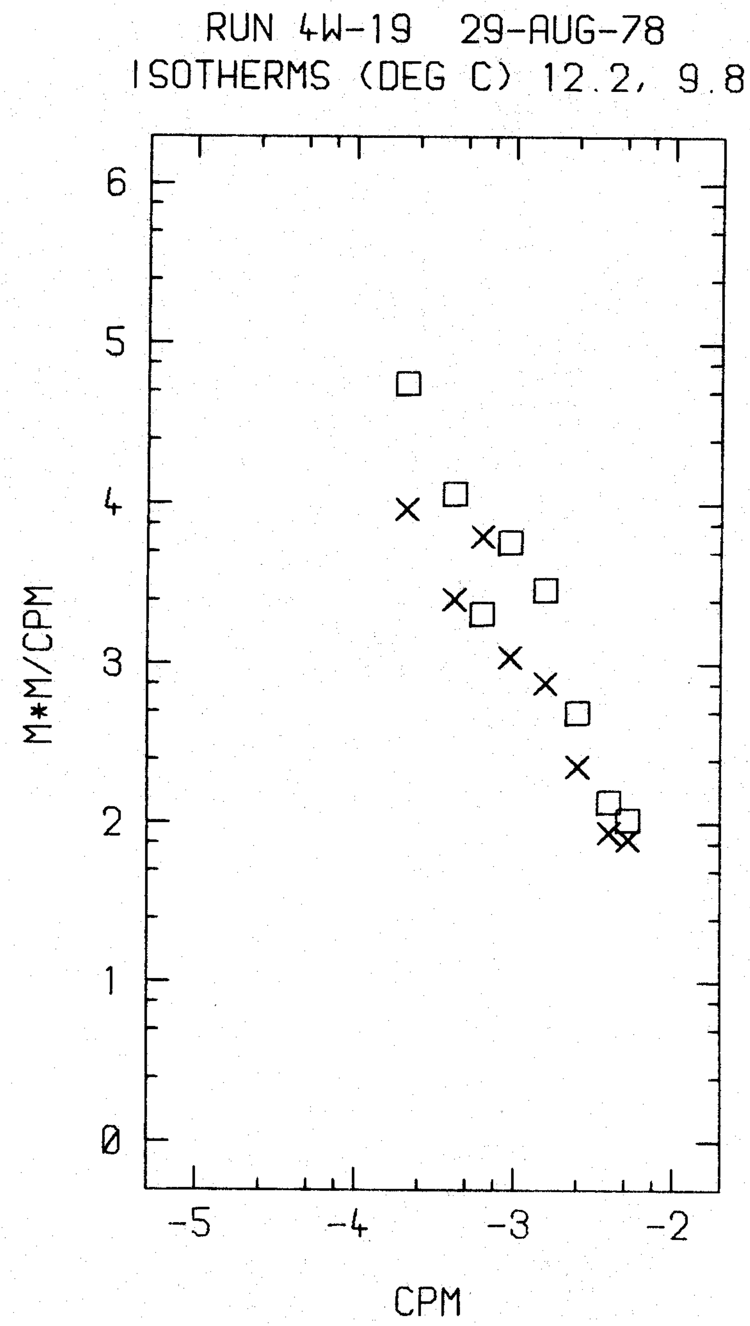
RUN 4W-15 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.6



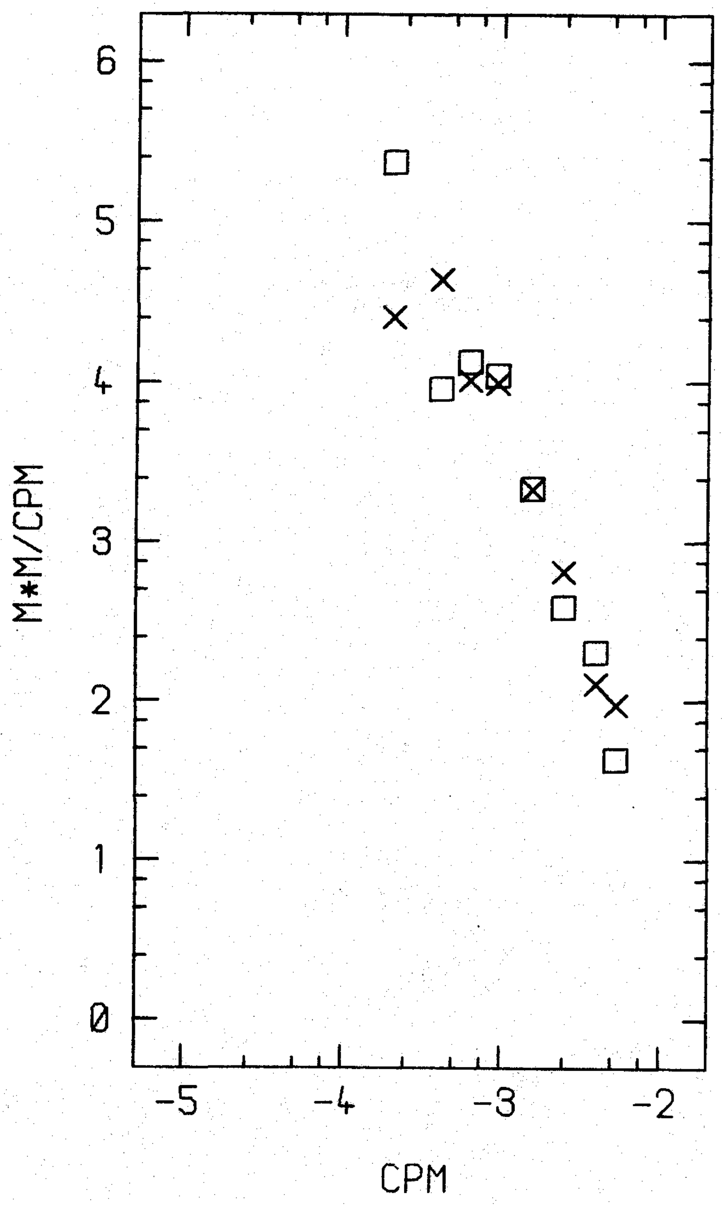

RUN 4S-16 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.6
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2


RUN 4E-17 29-AUG-78
ISOTHERMS (DEG C) 12.0, 9.6
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2

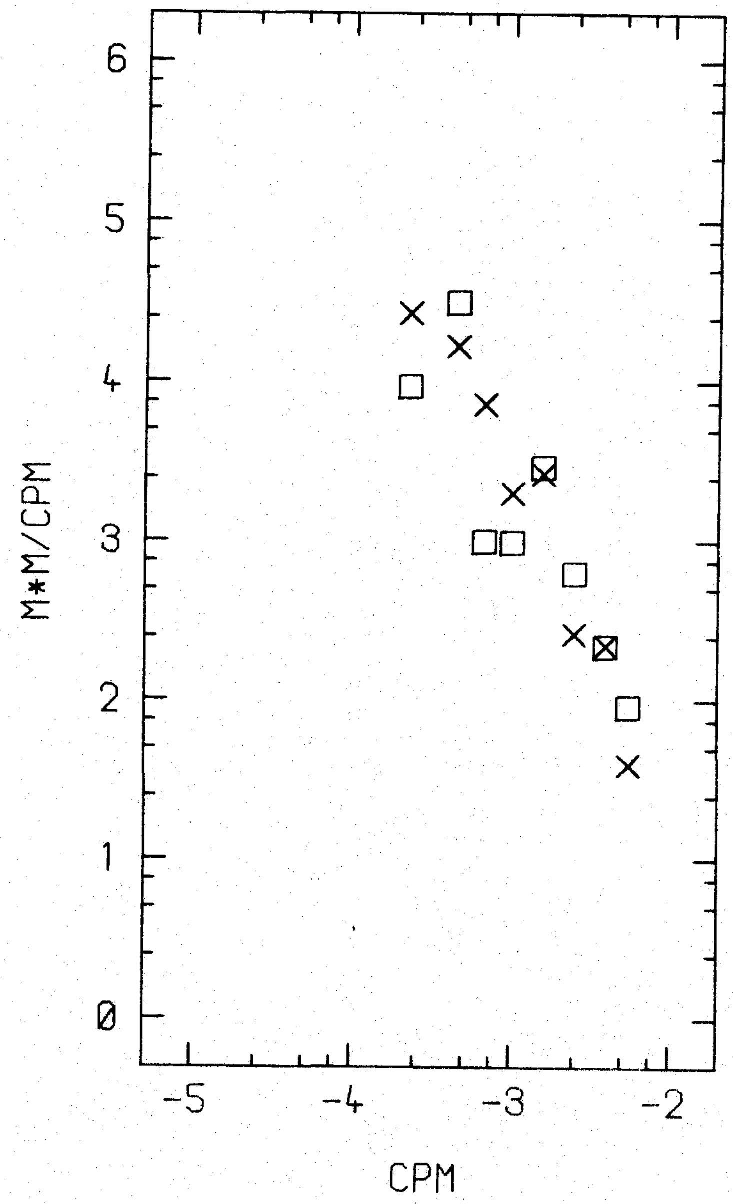

RUN 4N-18 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.6
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2


RUN 4W-19 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2

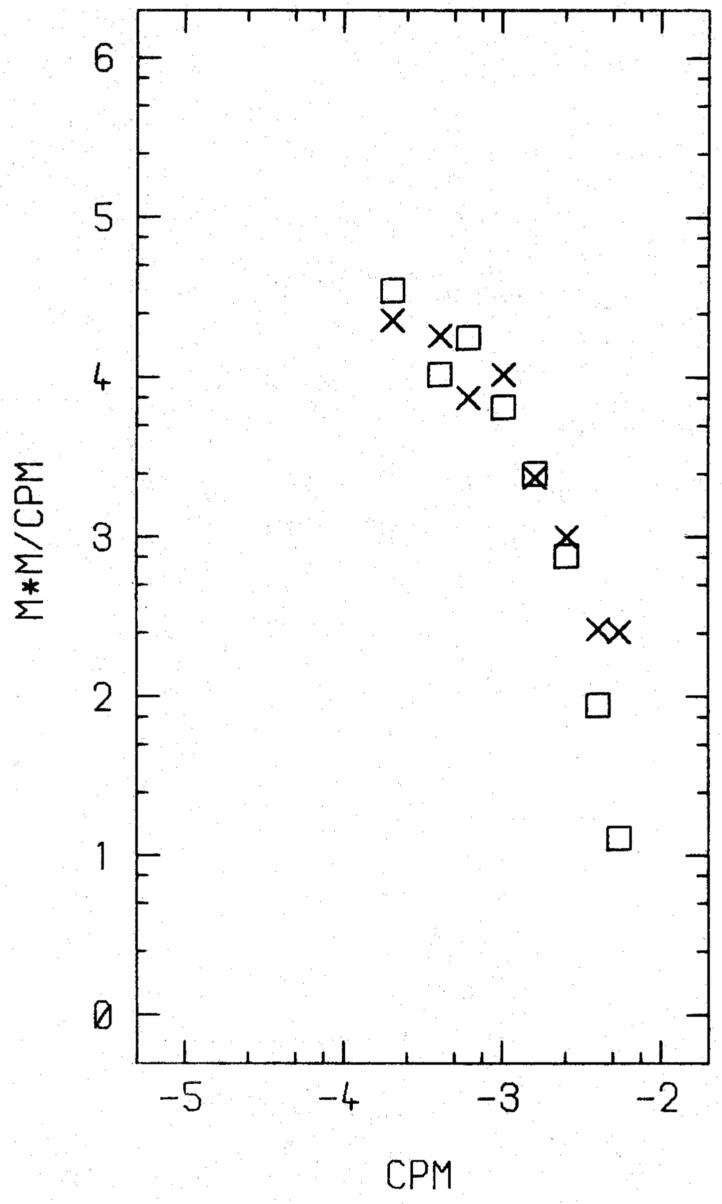
RUN 4S-20 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8



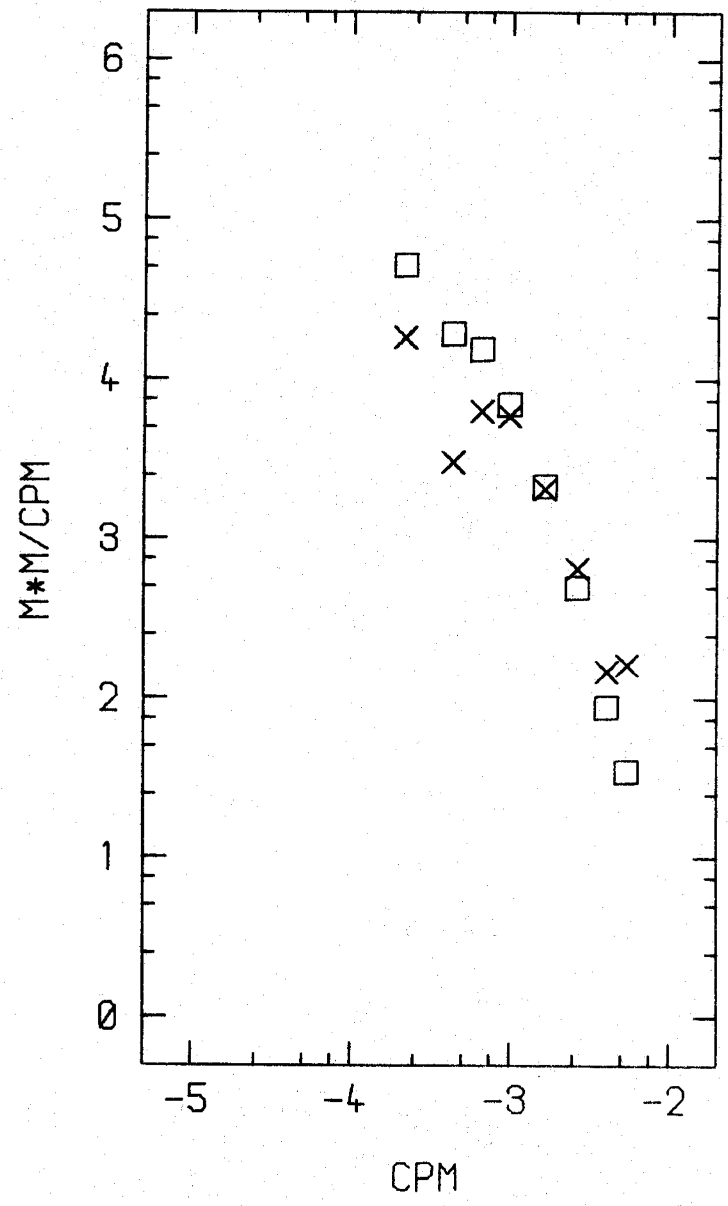
RUN 4E-21 29-AUG-78
ISOTHERMS (DEG C) 12.0, 9.6



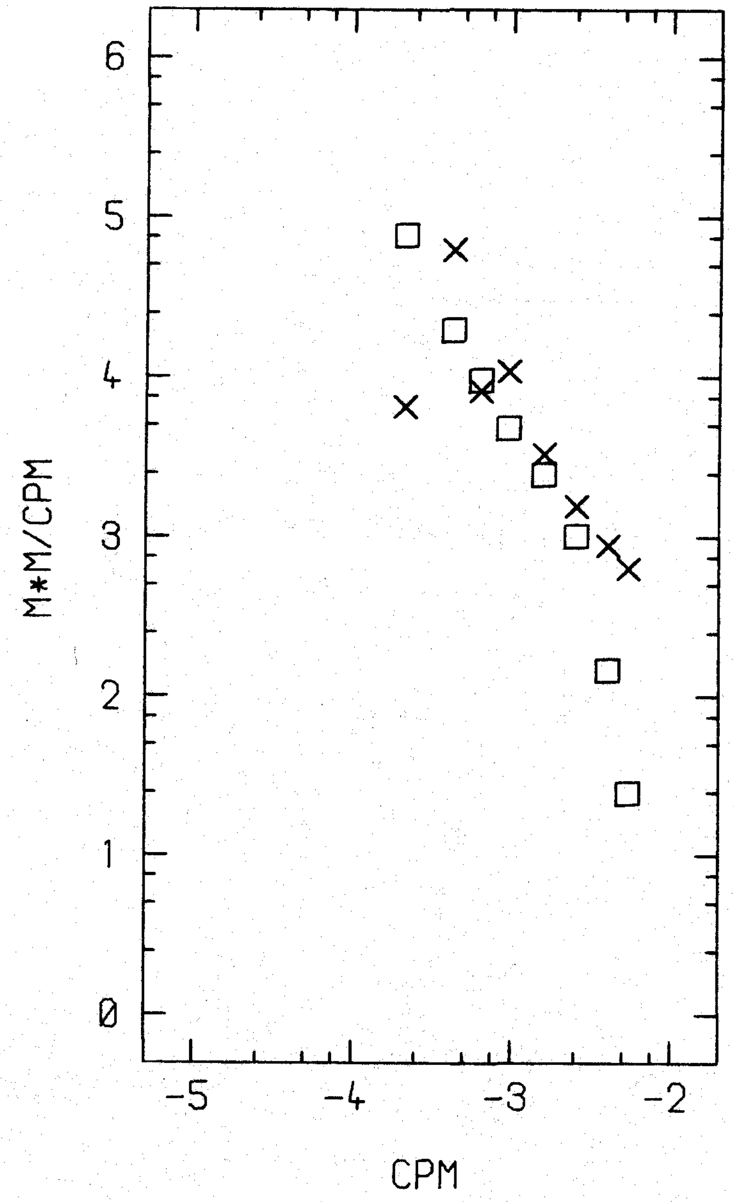
RUN 4N-22 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8



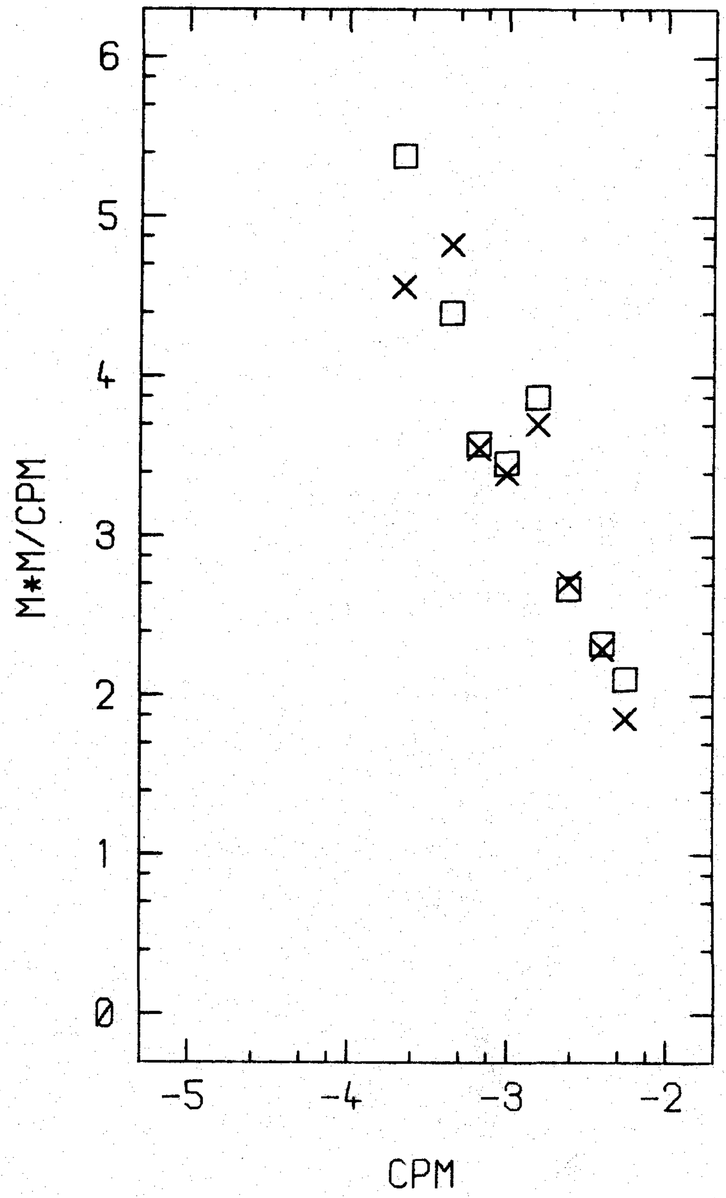
RUN 4W-23 29-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8



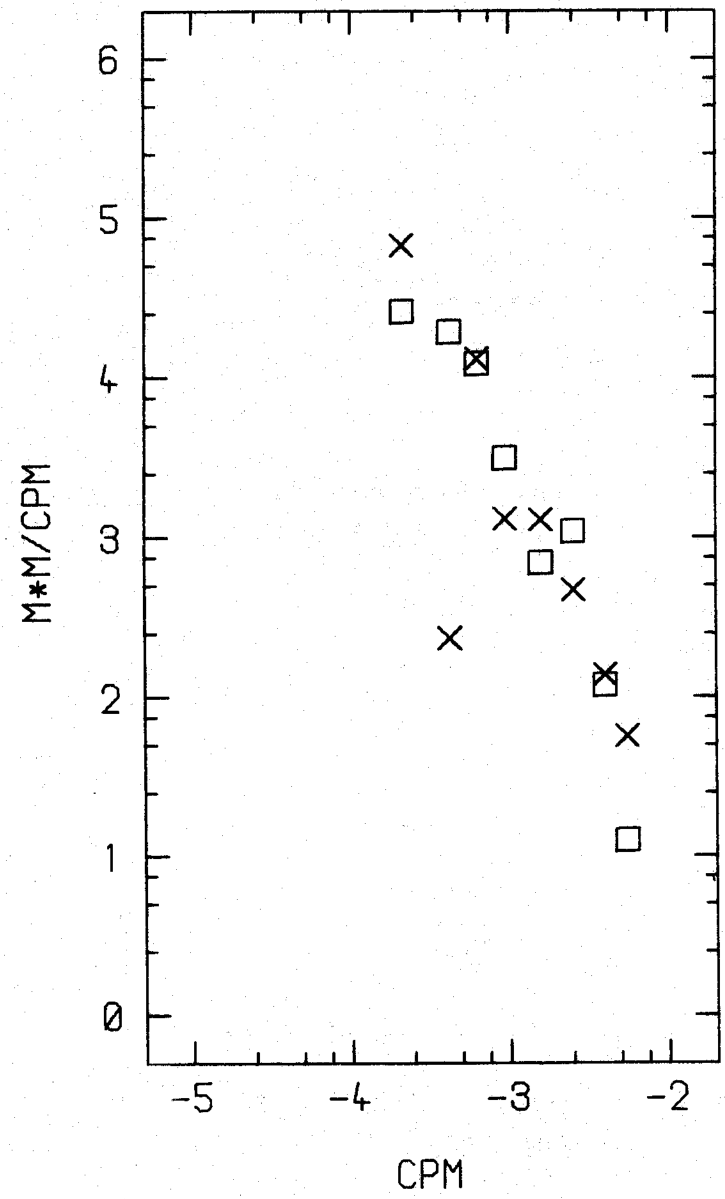
RUN 4S-24 30-AUG-78
ISOTHERMS (DEG C) 12.2, 9.6



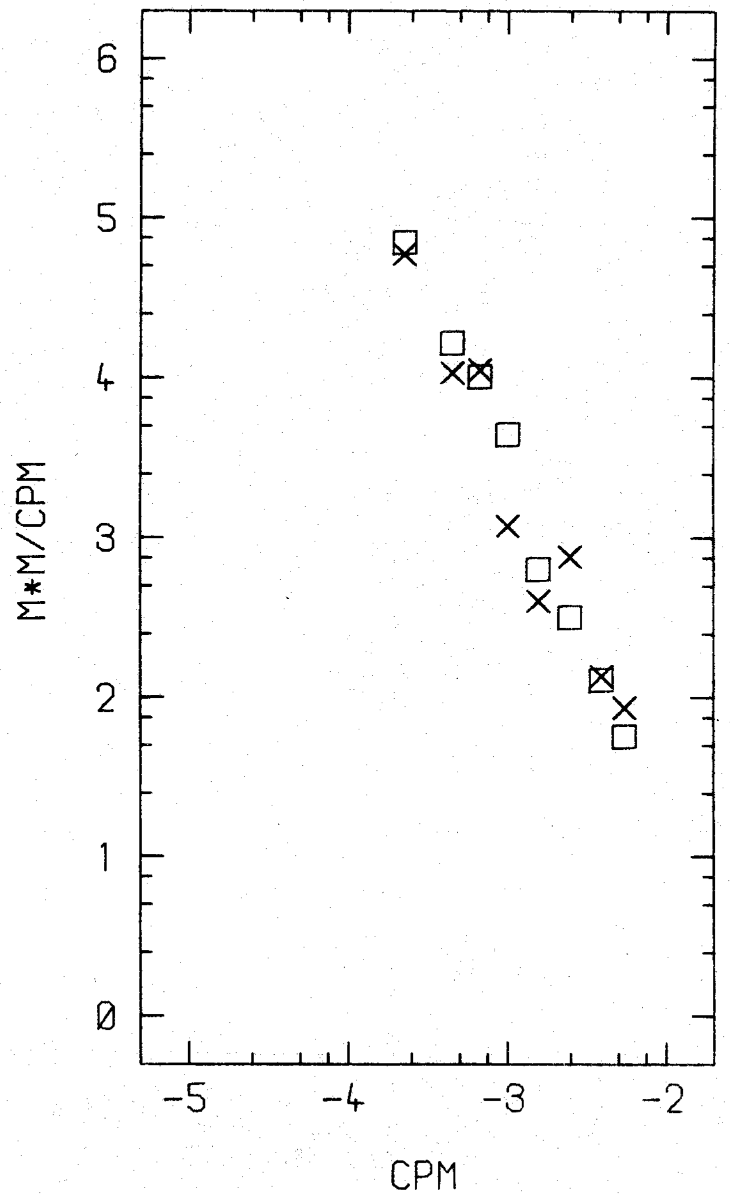
RUN 4E-25 30-AUG-78
ISOTHERMS (DEG C) 12.0, 9.6

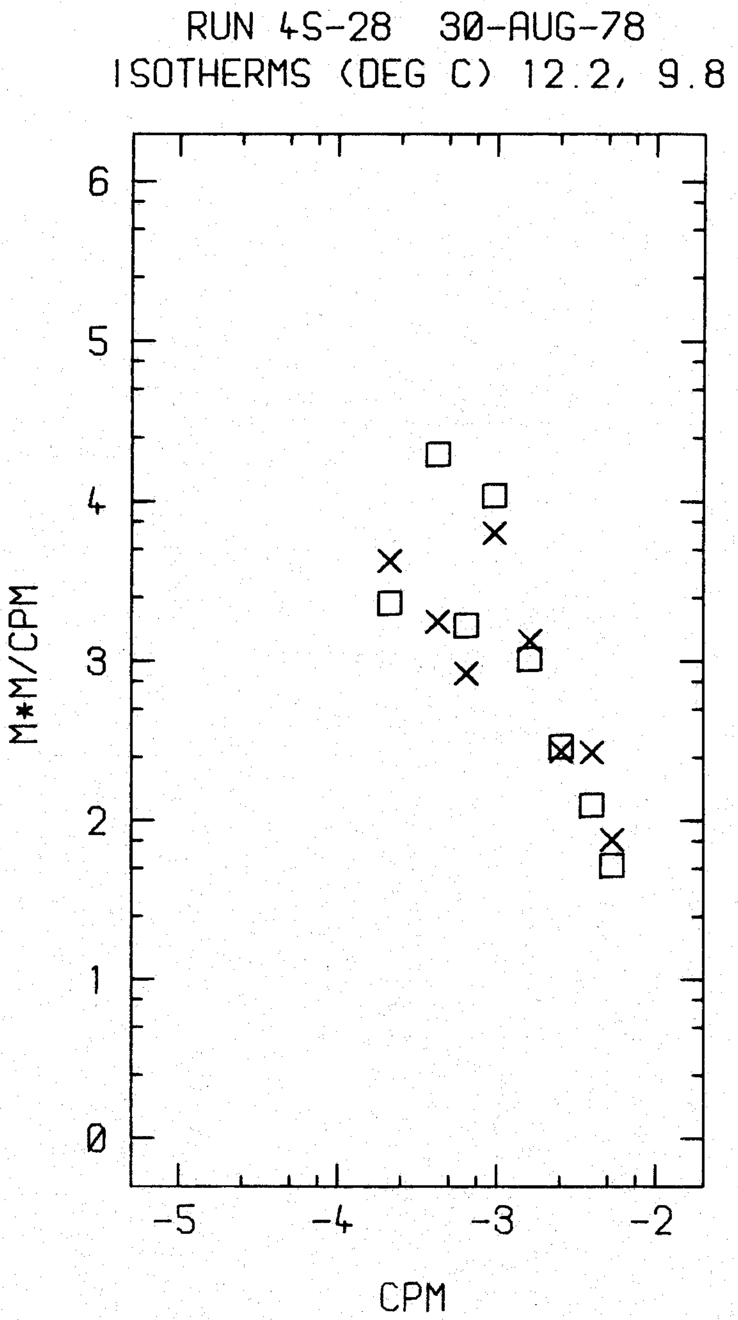


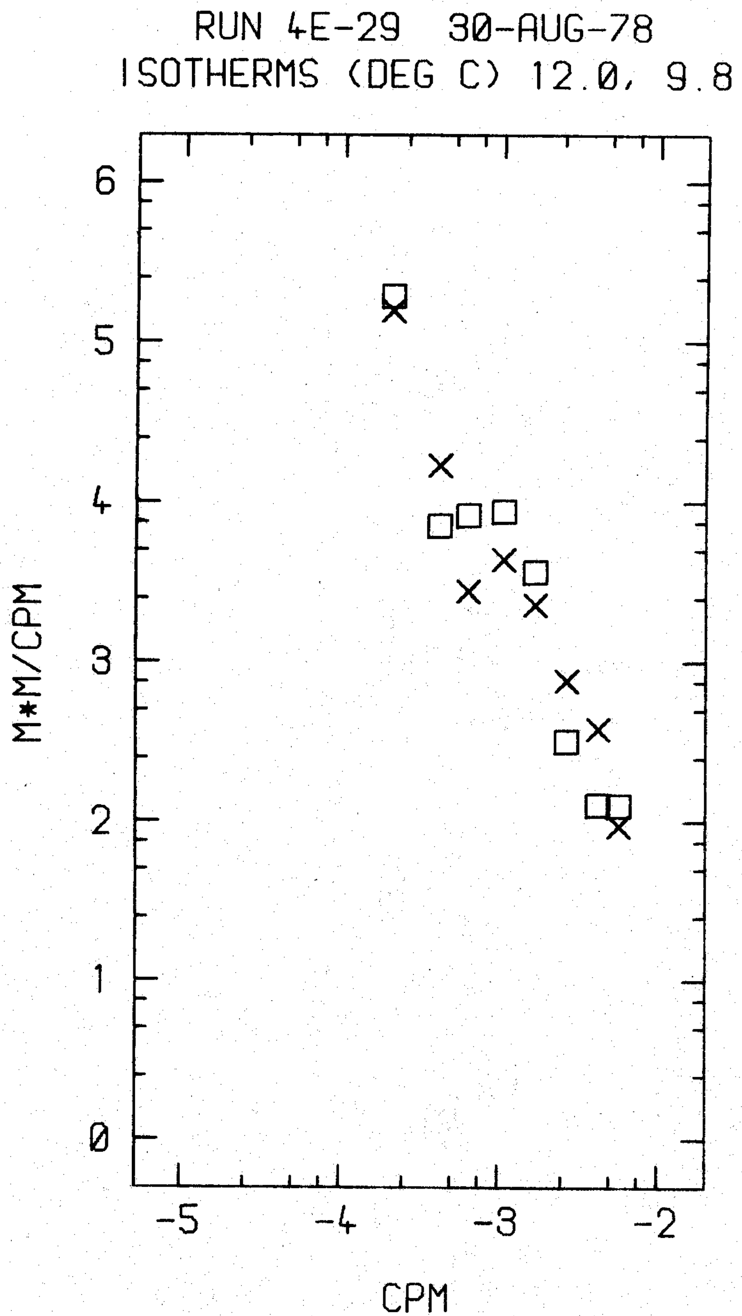
RUN 4N-26 30-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8



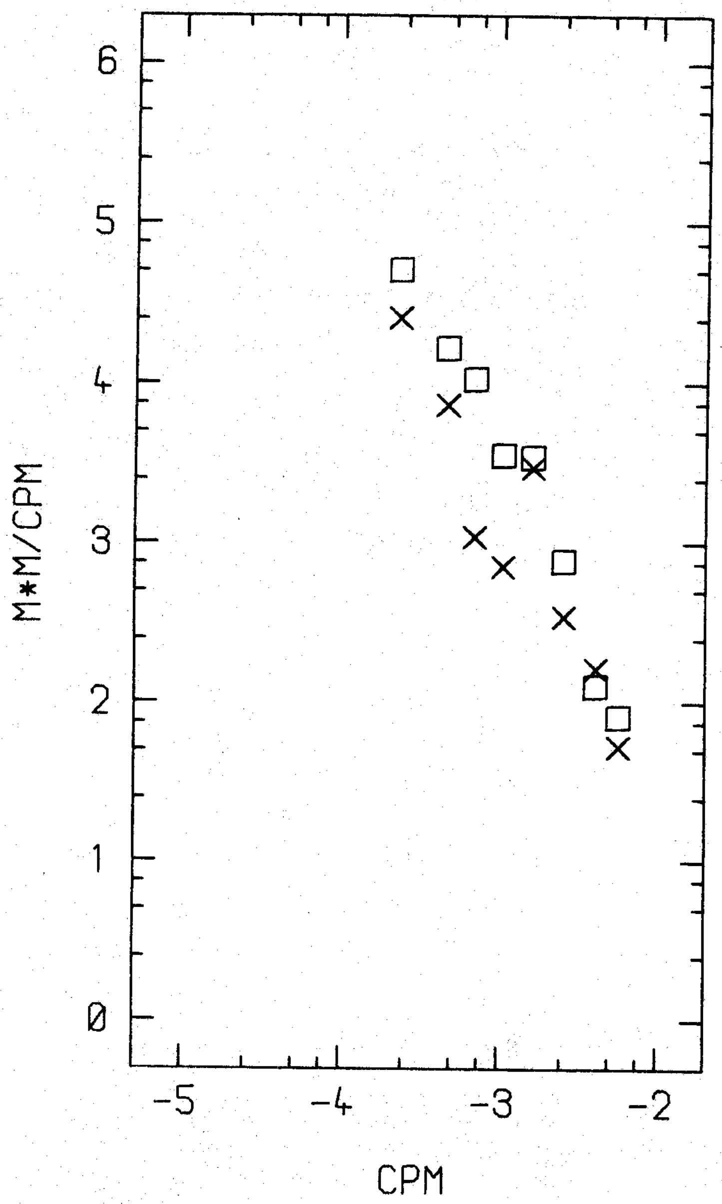
RUN 4W-27 30-AUG-78
ISOTHERMS (DEG C) 12.2, 9.6



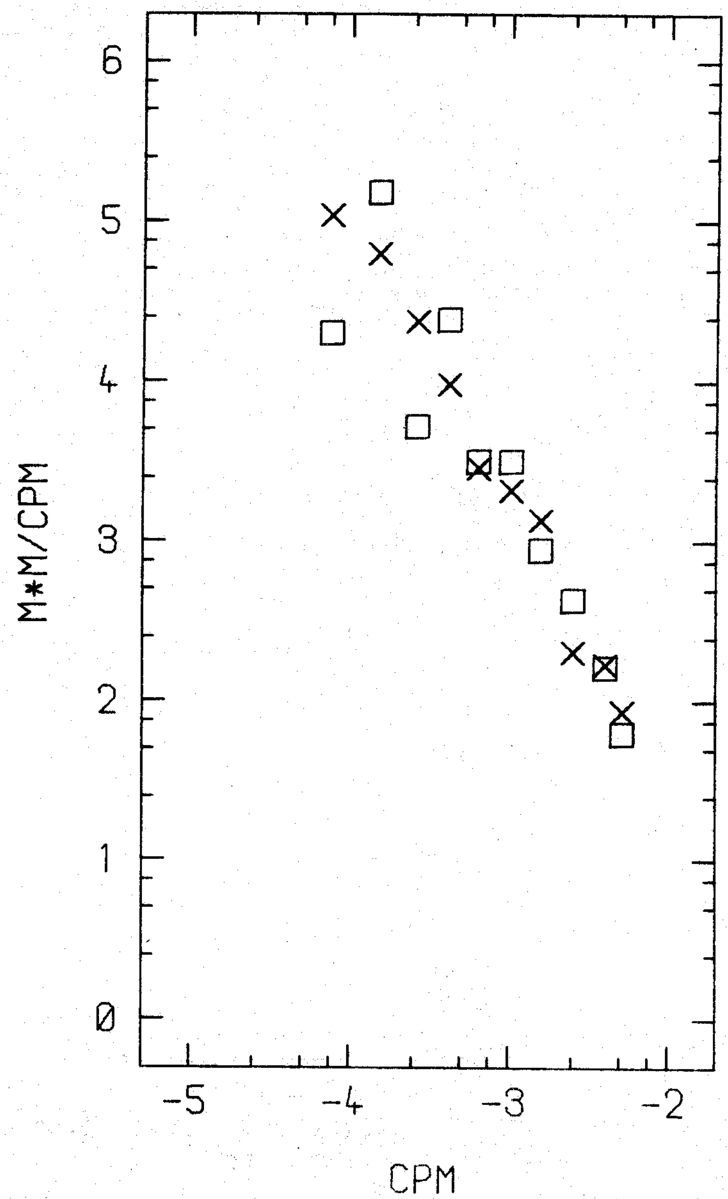

RUN 4S-28 30-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2

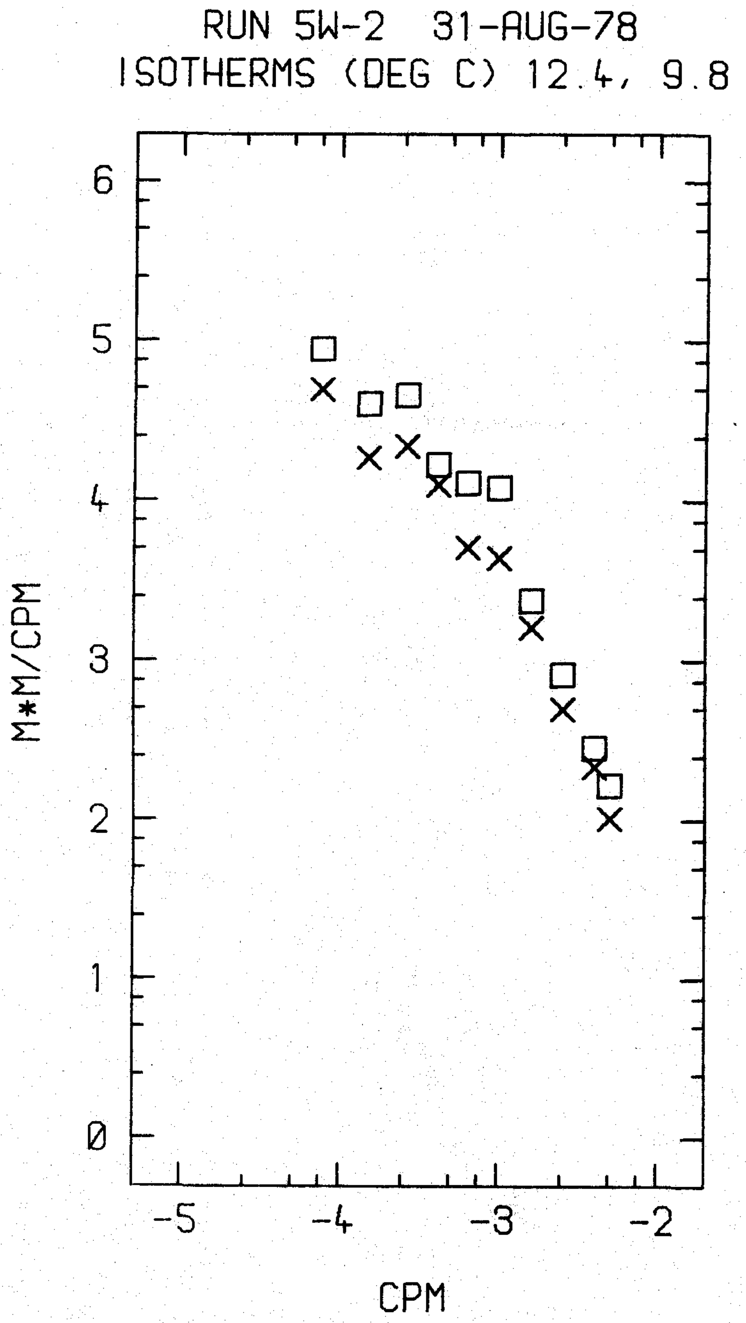

RUN 4E-29 30-AUG-78
ISOTHERMS (DEG C) 12.0, 9.8
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2

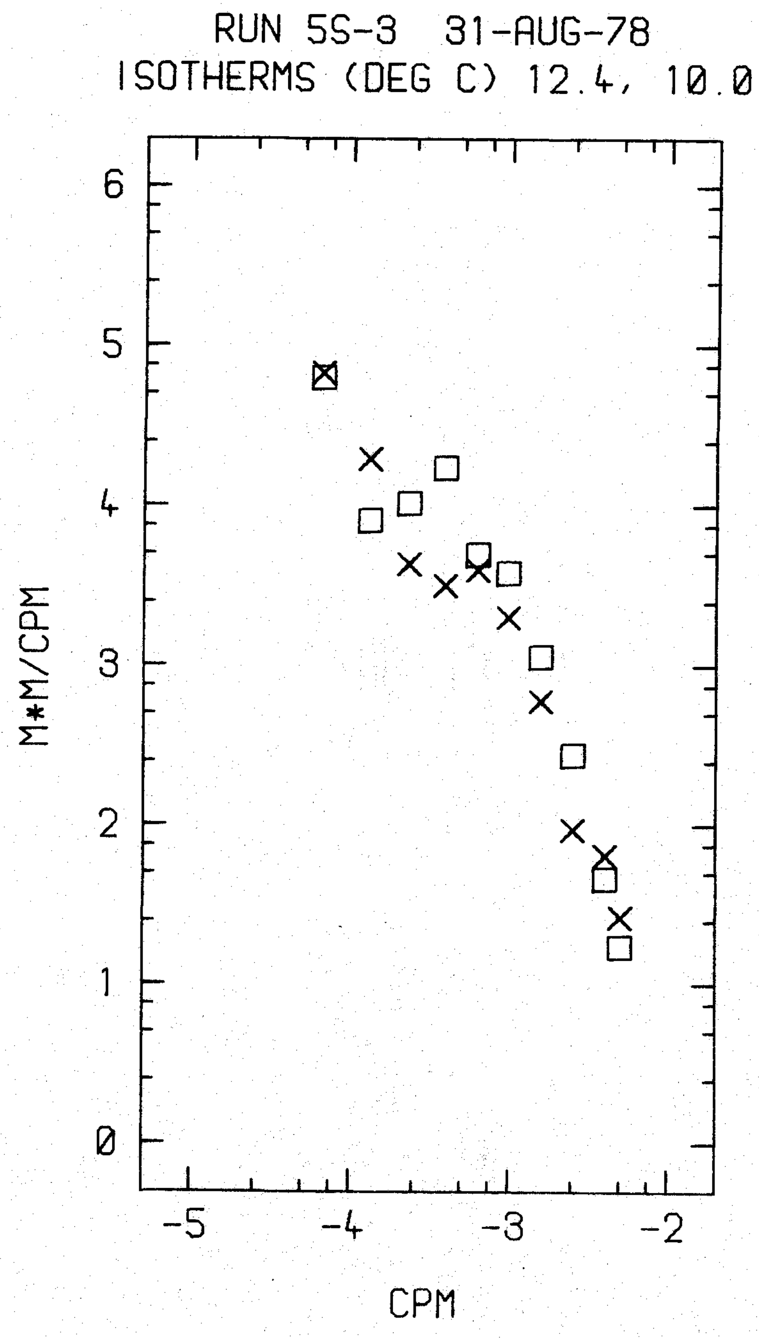
RUN 4N-30 30-AUG-78
ISOTHERMS (DEG C) 12.0, 10.0



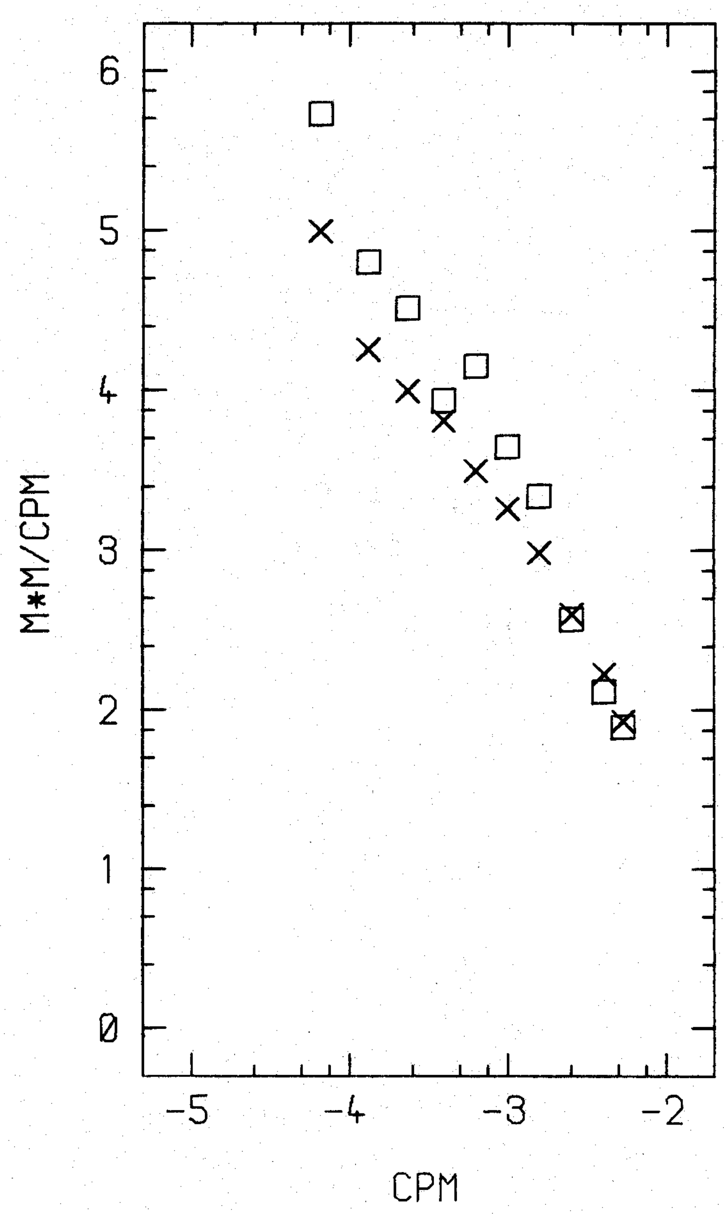
RUN 5N-1 31-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8



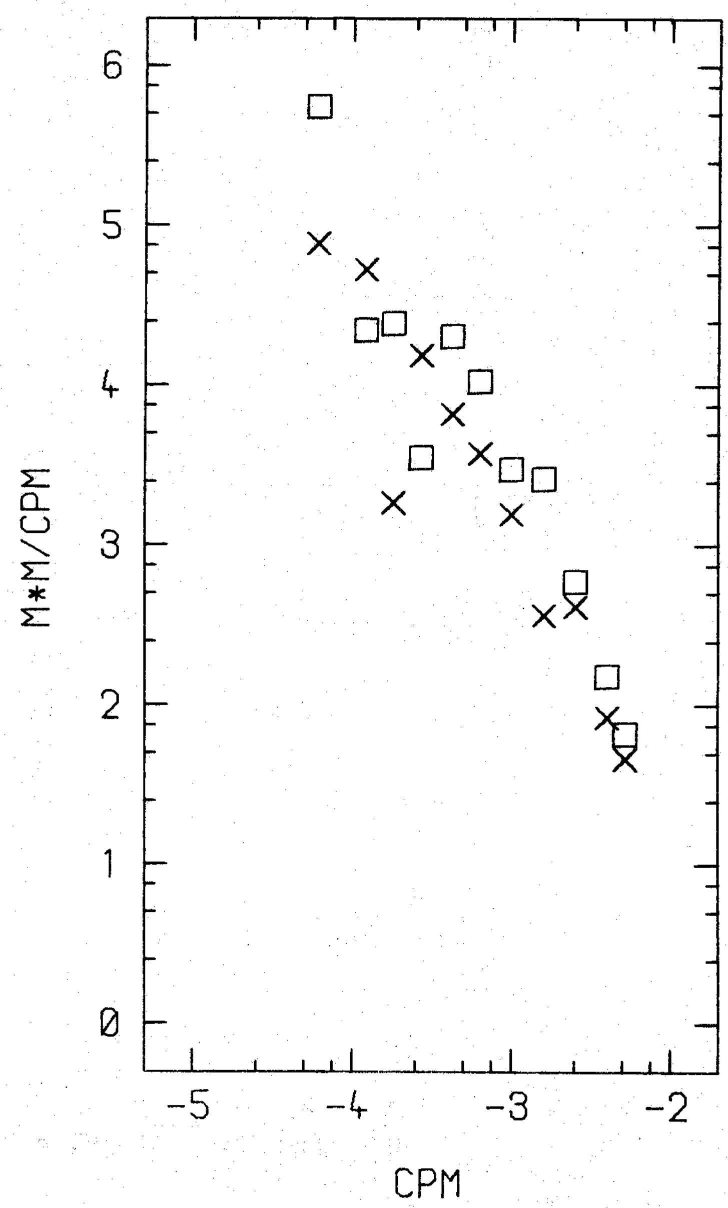

RUN 5W-2 31-AUG-78
ISOTHERMS (DEG C) 12.4, 9.8
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2


RUN 5S-3 31-AUG-78
ISOTHERMS (DEG C) 12.4, 10.0
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2

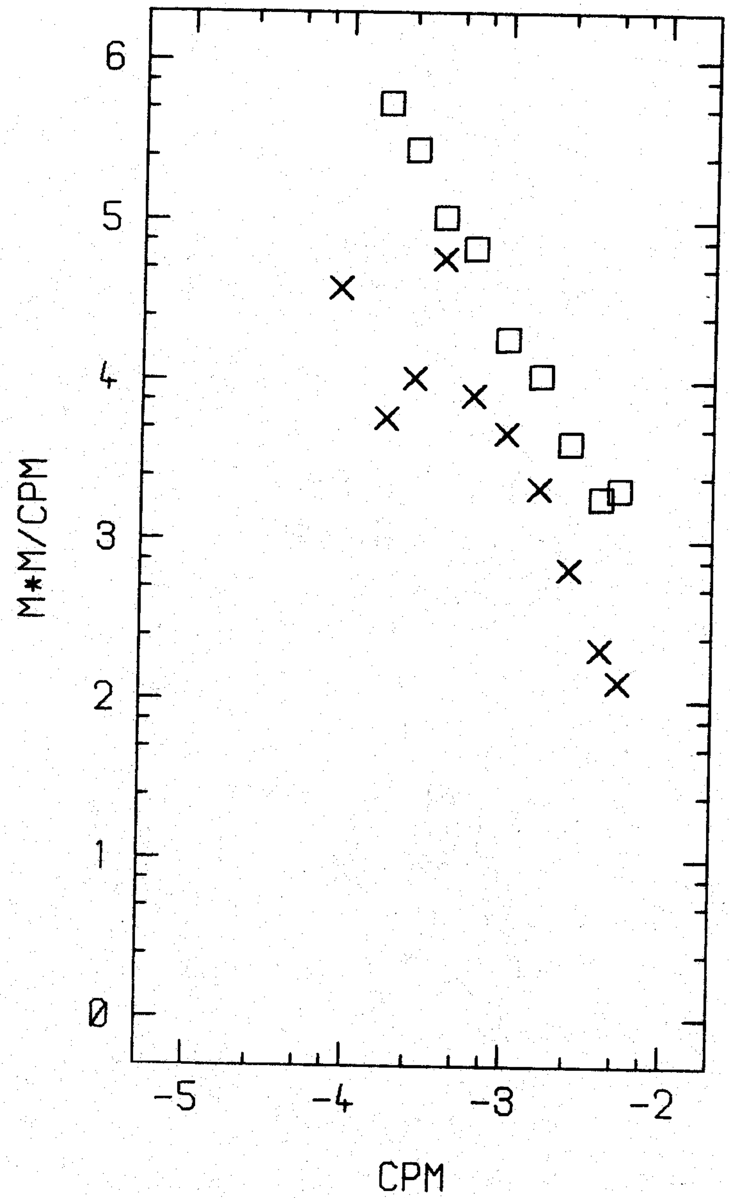
RUN 5E-4 31-AUG-78
ISOTHERMS (DEG C) 12.4, 9.8



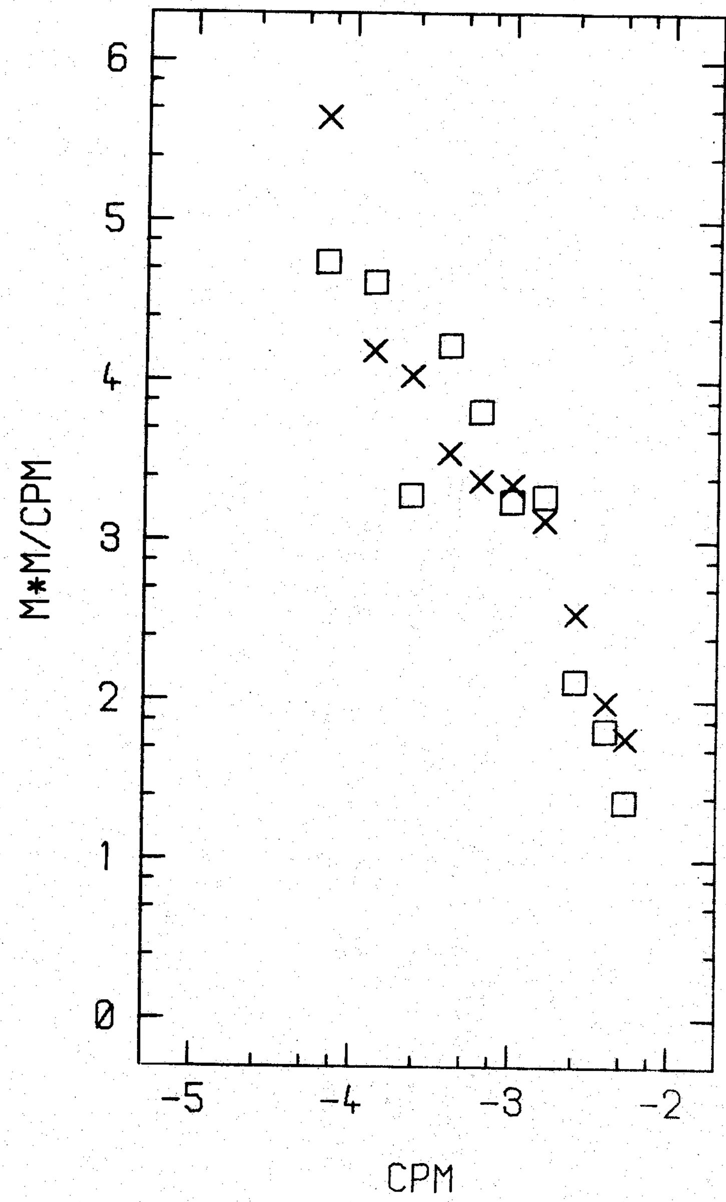
RUN 5N-5 31-AUG-78
ISOTHERMS (DEG C) 12.2, 9.8



RUN 5W-6 31-AUG-78
ISOTHERMS (DEG C) 12.2, 9.6



RUN 5S-7 31-AUG-78
ISOTHERMS (DEG C) 12.4, 10.2



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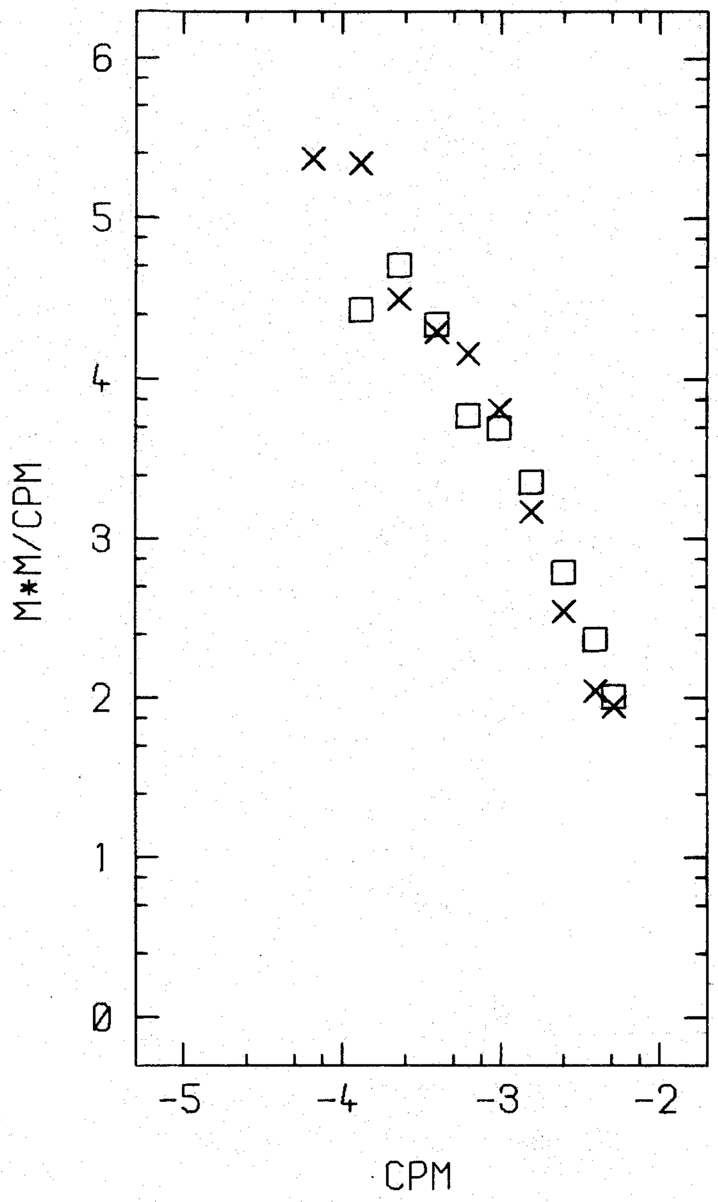
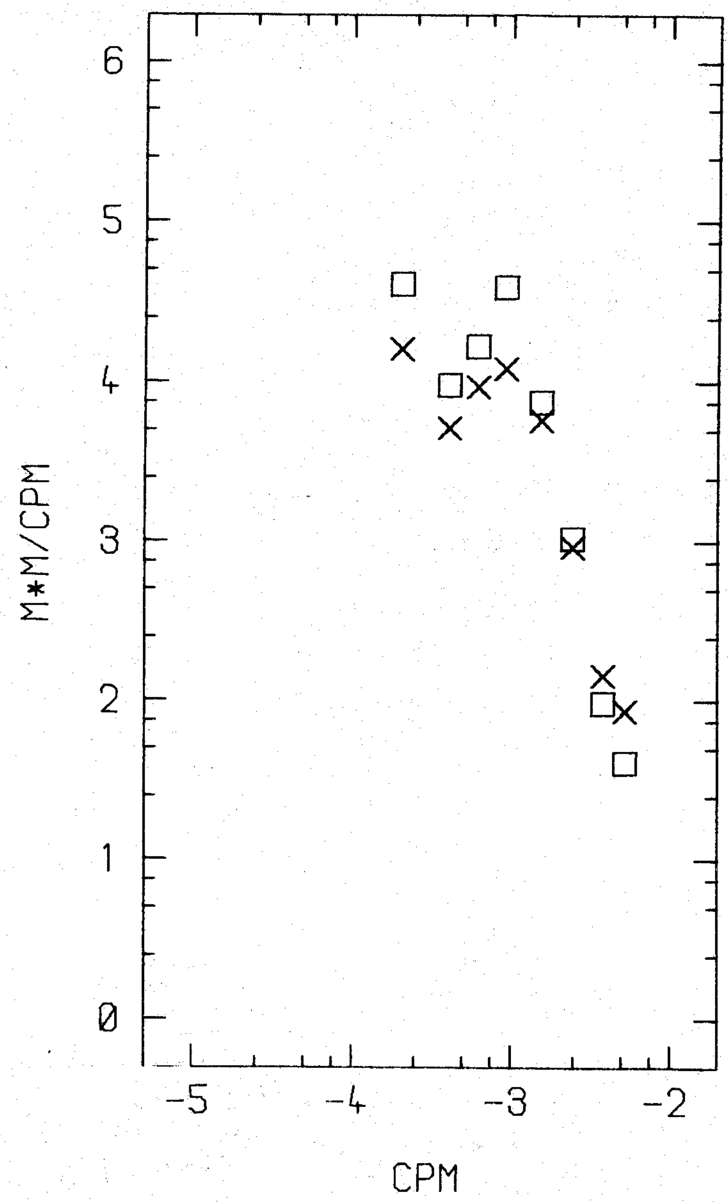
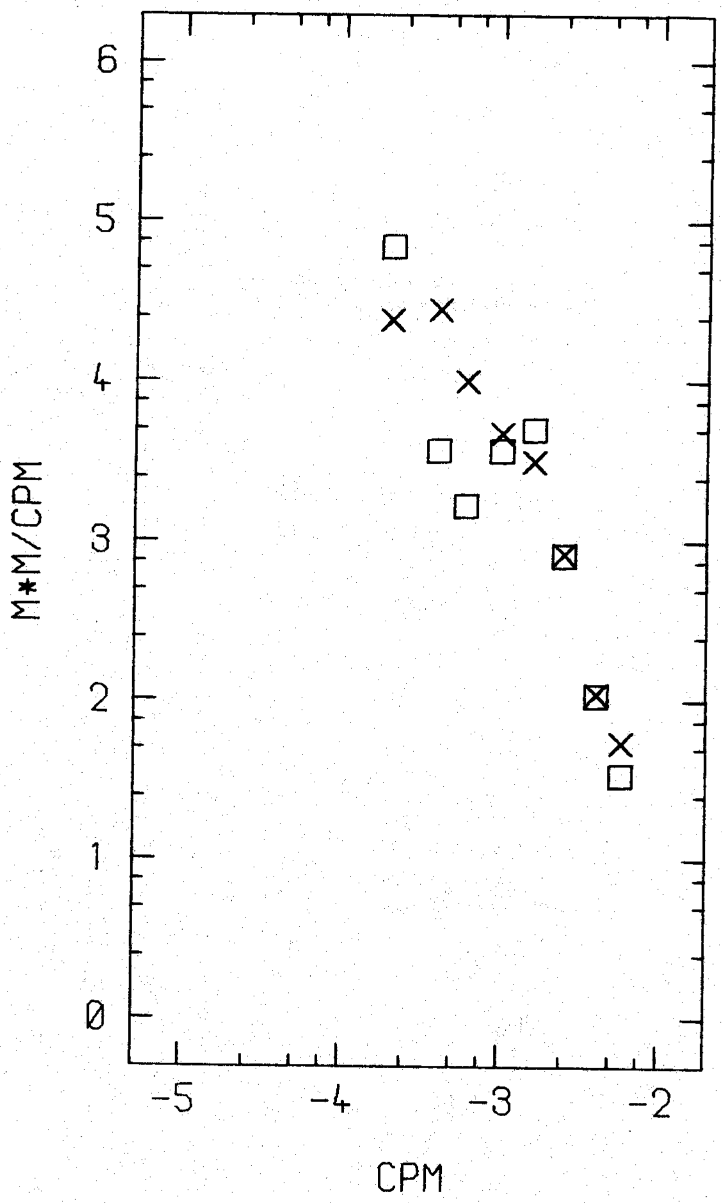
ISOTHERMS (DEG C) 12.4, 9.8



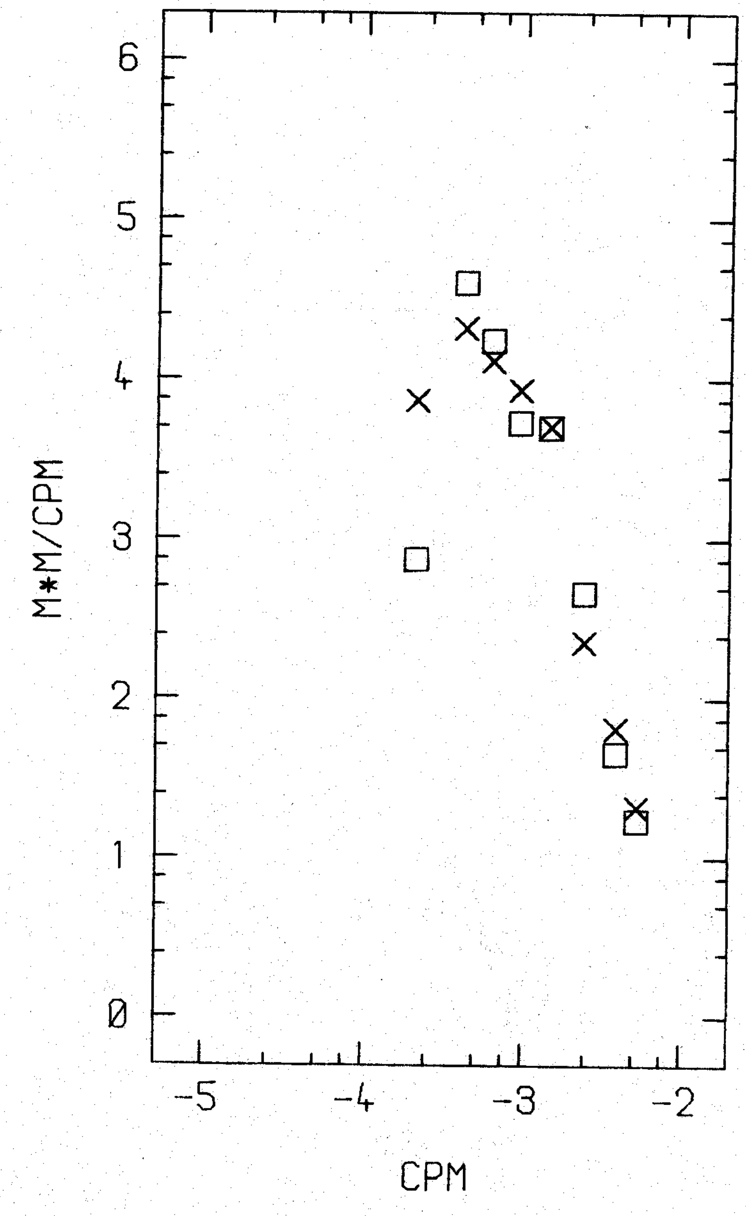
RUN 6W-1 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8

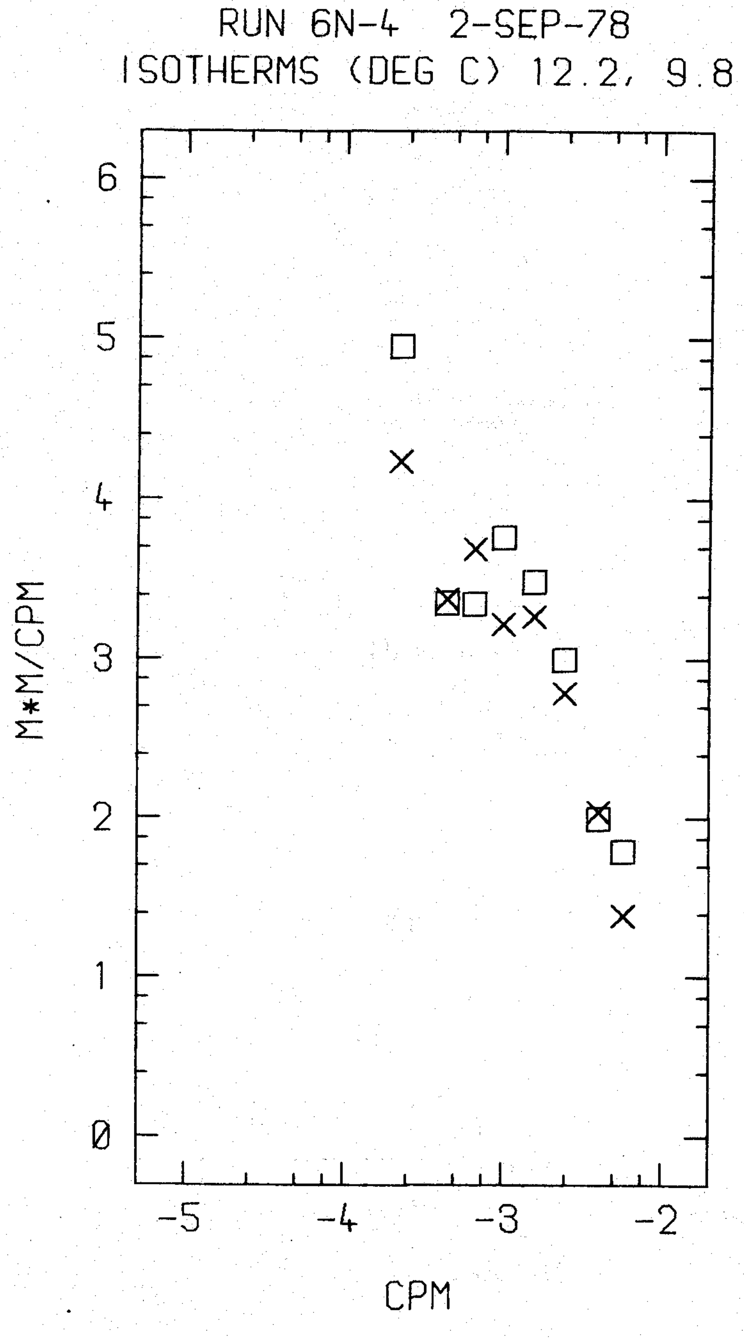


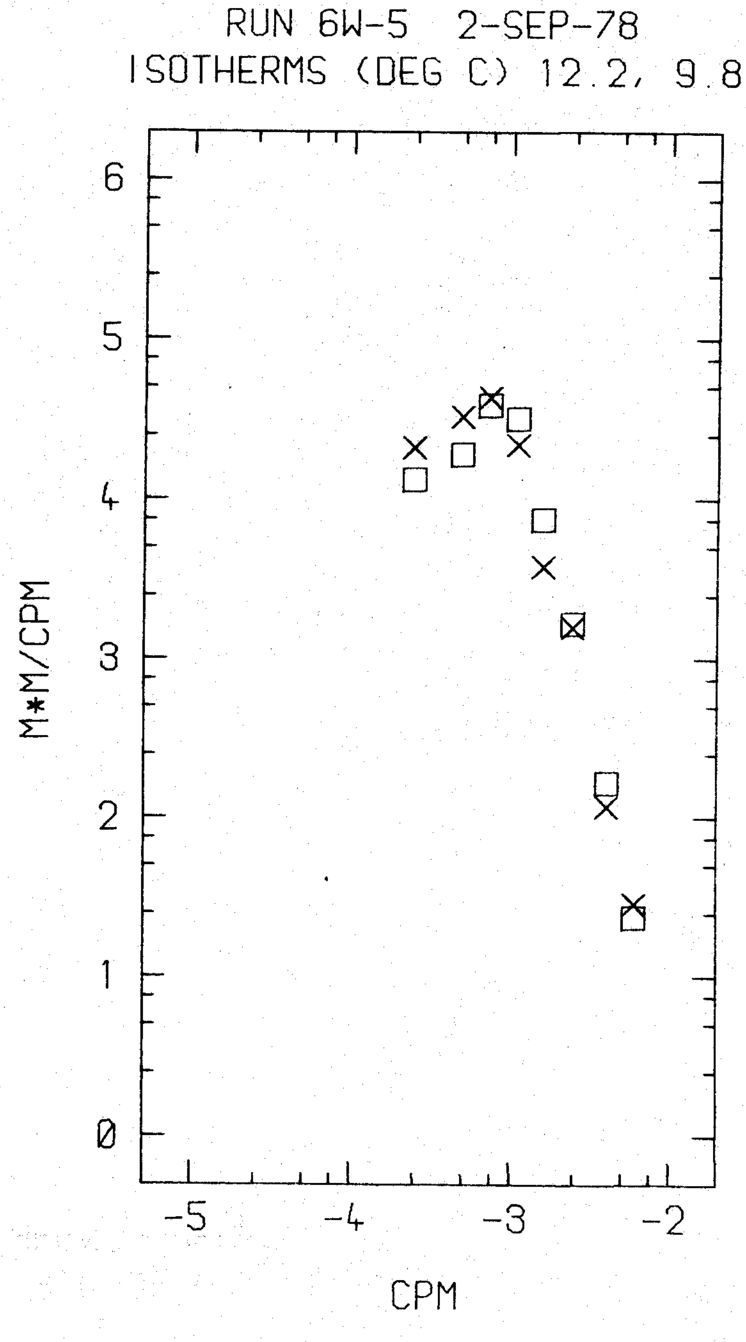
RUN 6S-2 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8



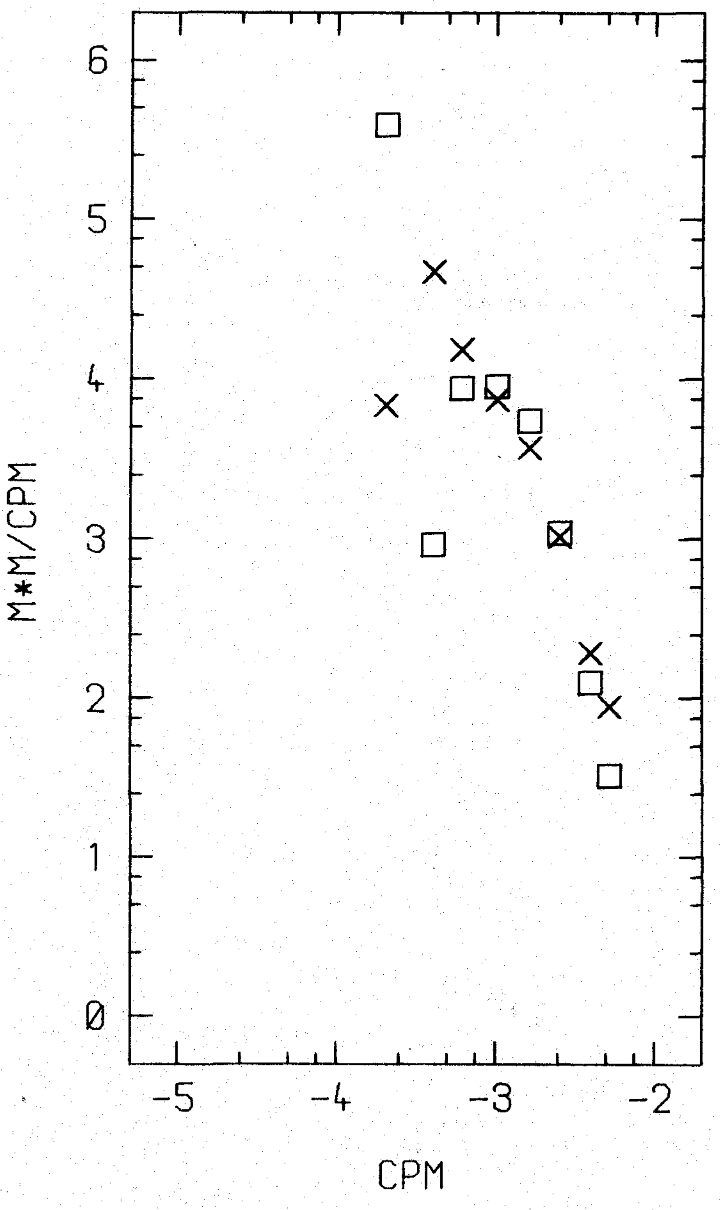
RUN 6E-3 2-SEP-78
ISOTHERMS (DEG C) 12.0, 9.6



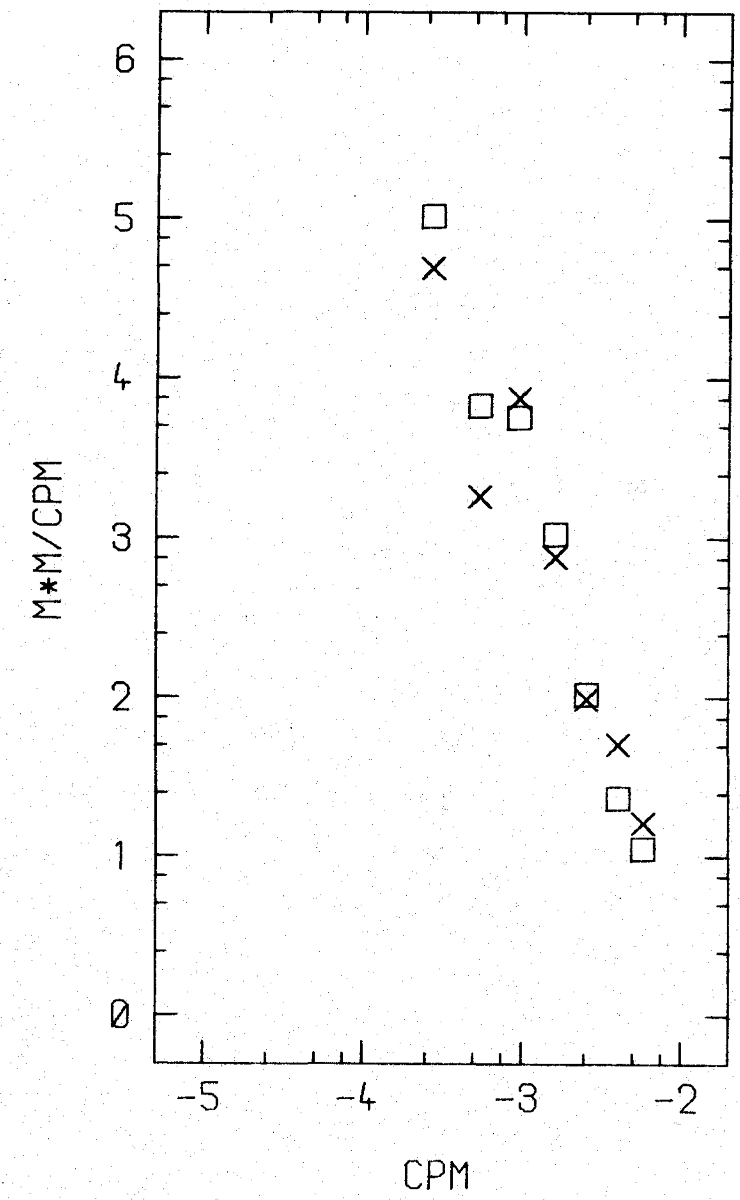

RUN 6N-4 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2


RUN 6W-5 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8
M*M/CPM
CPM
6
5
4
3
2
1
0
-5
-4
-3
-2

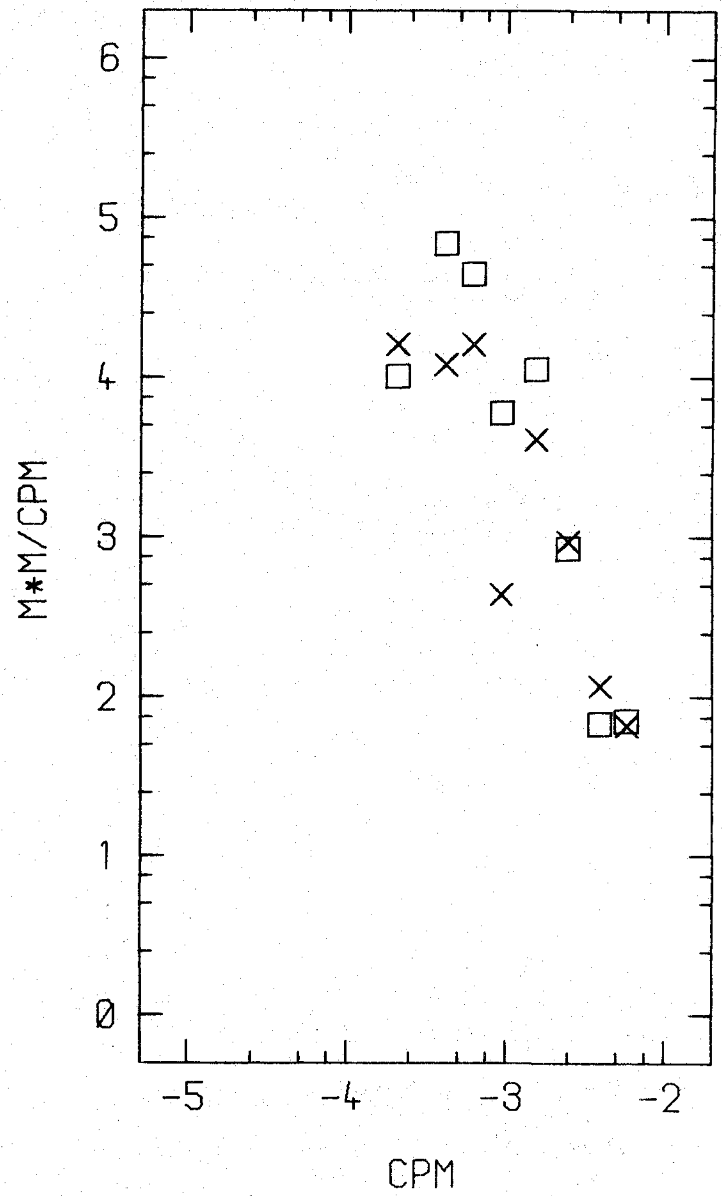
RUN 6S-6 2-SEP-78
ISOTHERMS (DEG C) 12.2, 10.0



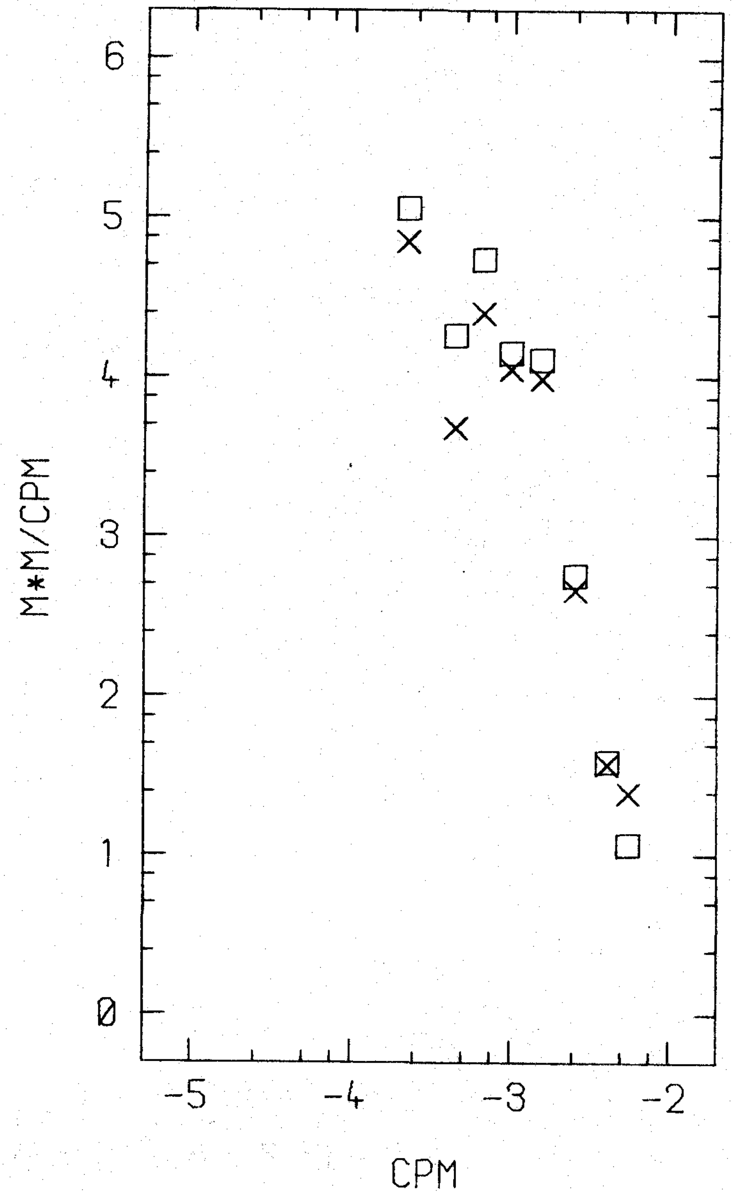
RUN 6E-7 2-SEP-78
ISOTHERMS (DEG C) 12.2, 10.0



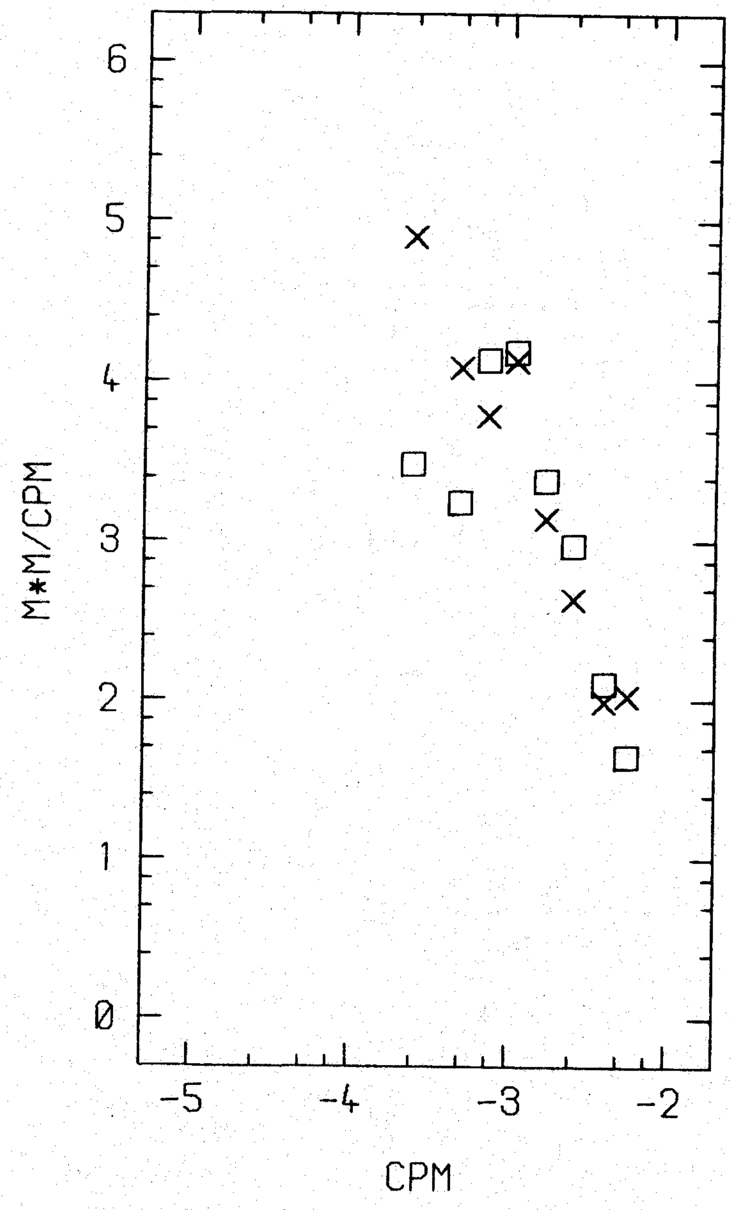
RUN 6N-8 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8



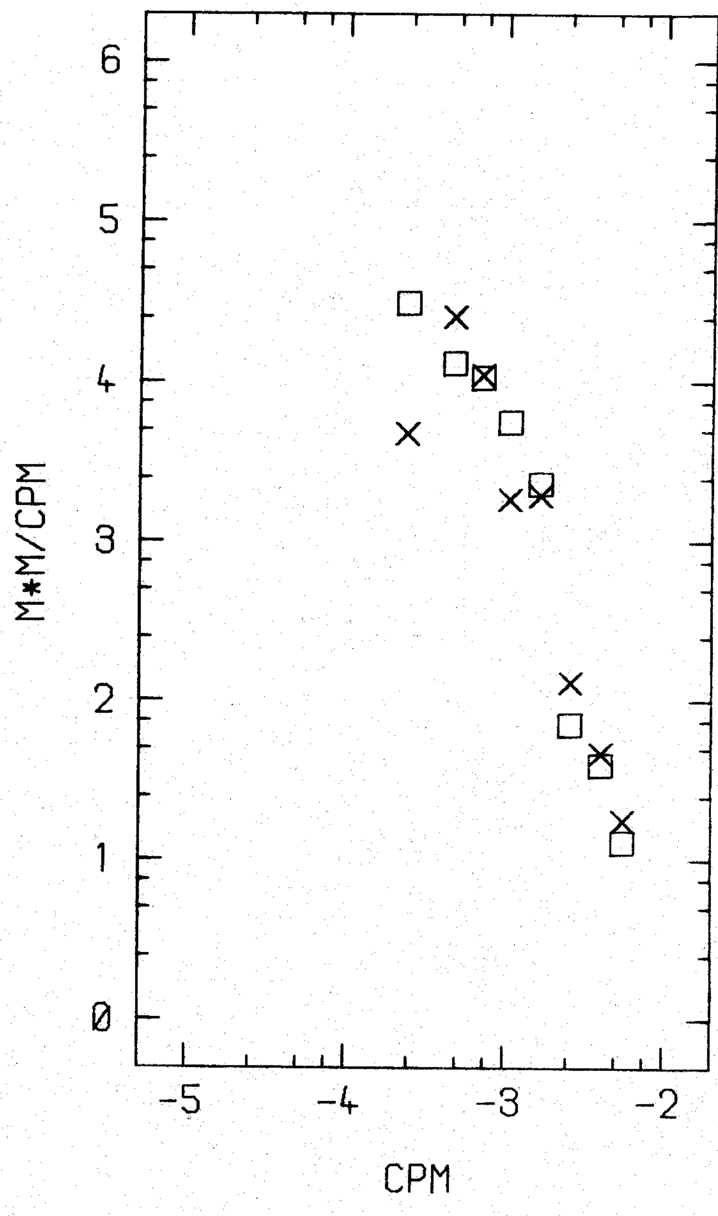
RUN 6W-9 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8



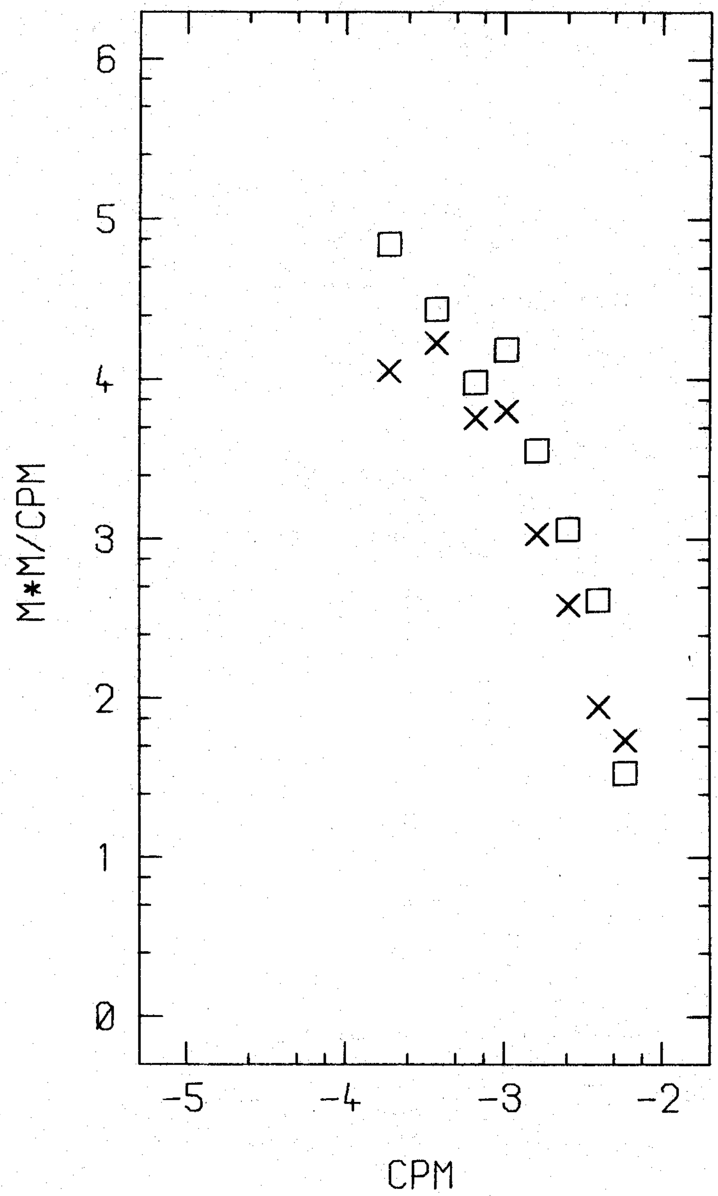
RUN 6S-10 2-SEP-78
ISOTHERMS (DEG C) 12.2, 10.0



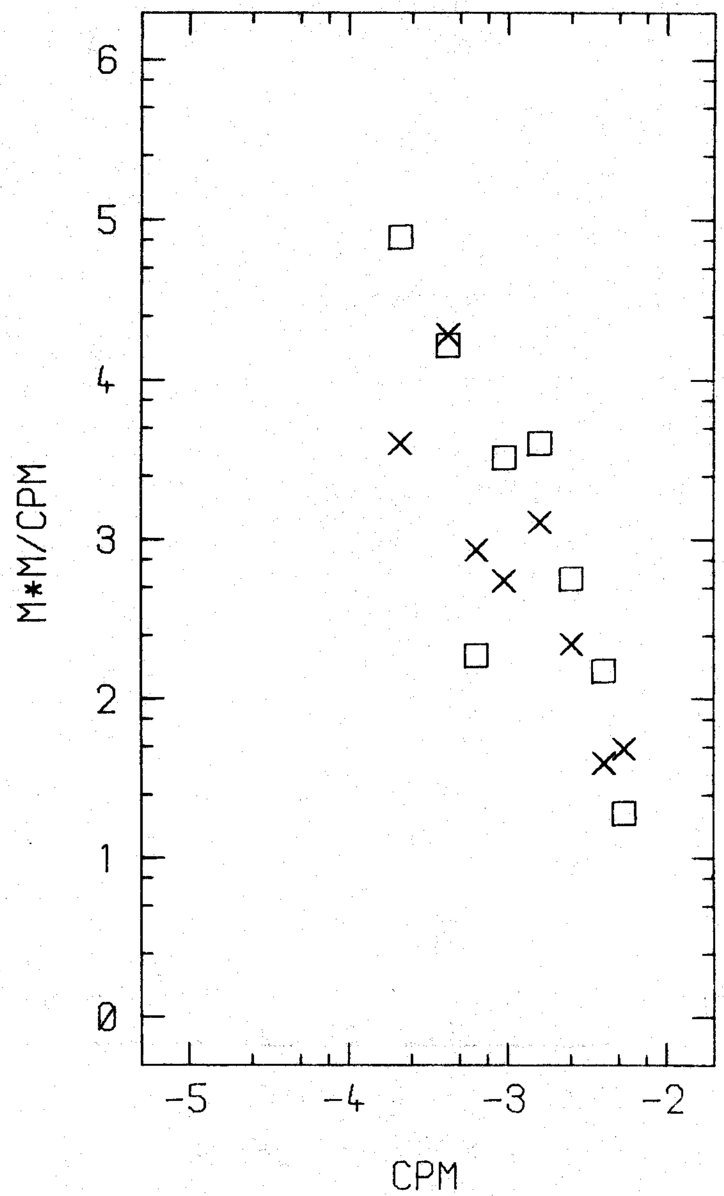
RUN 6E-11 2-SEP-78
ISOTHERMS (DEG C) 12.0, 9.8

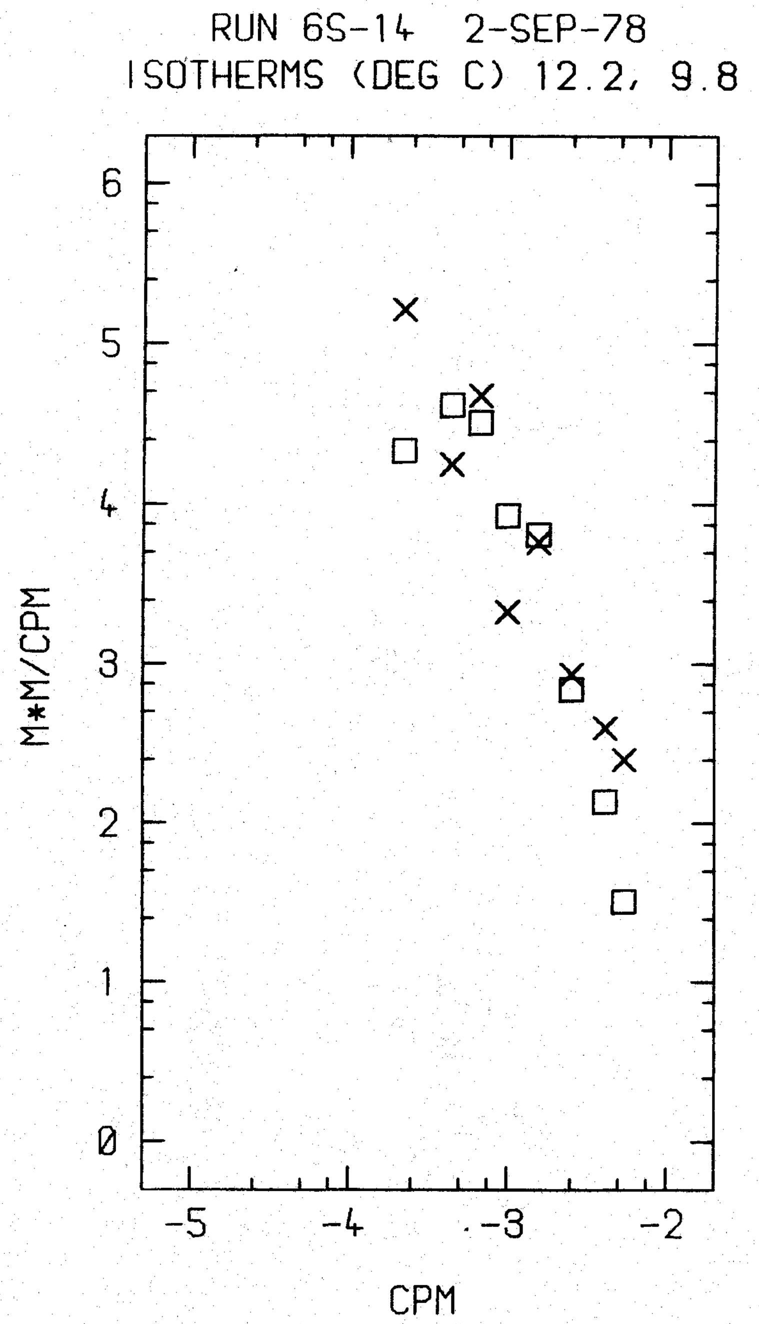


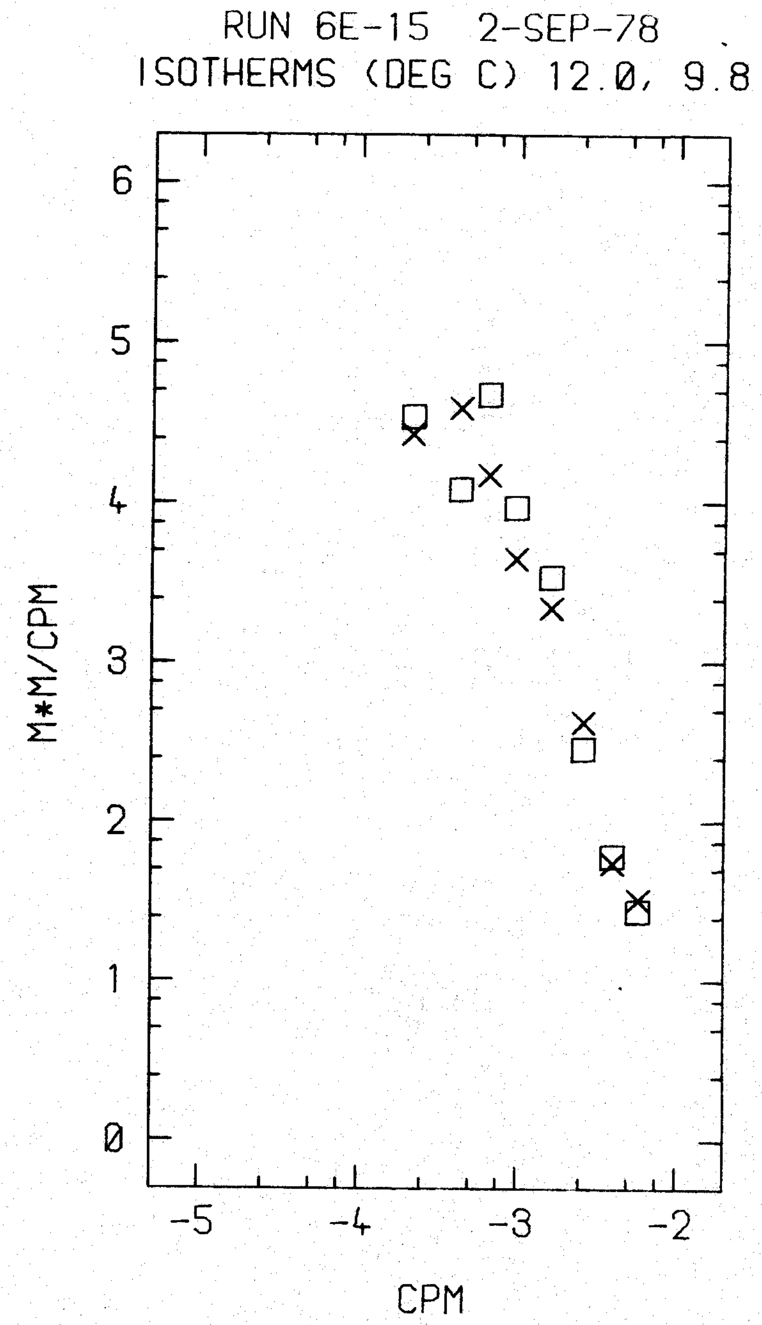
RUN 6N-12 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8



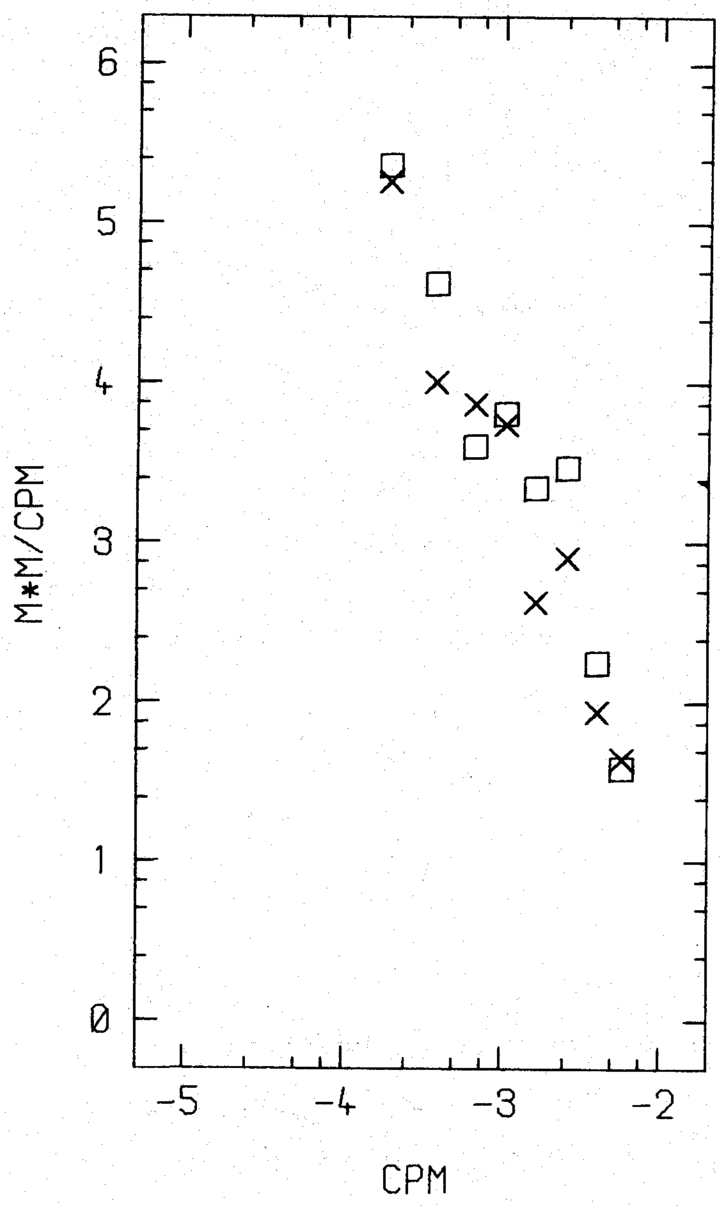
RUN 6W-13 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8



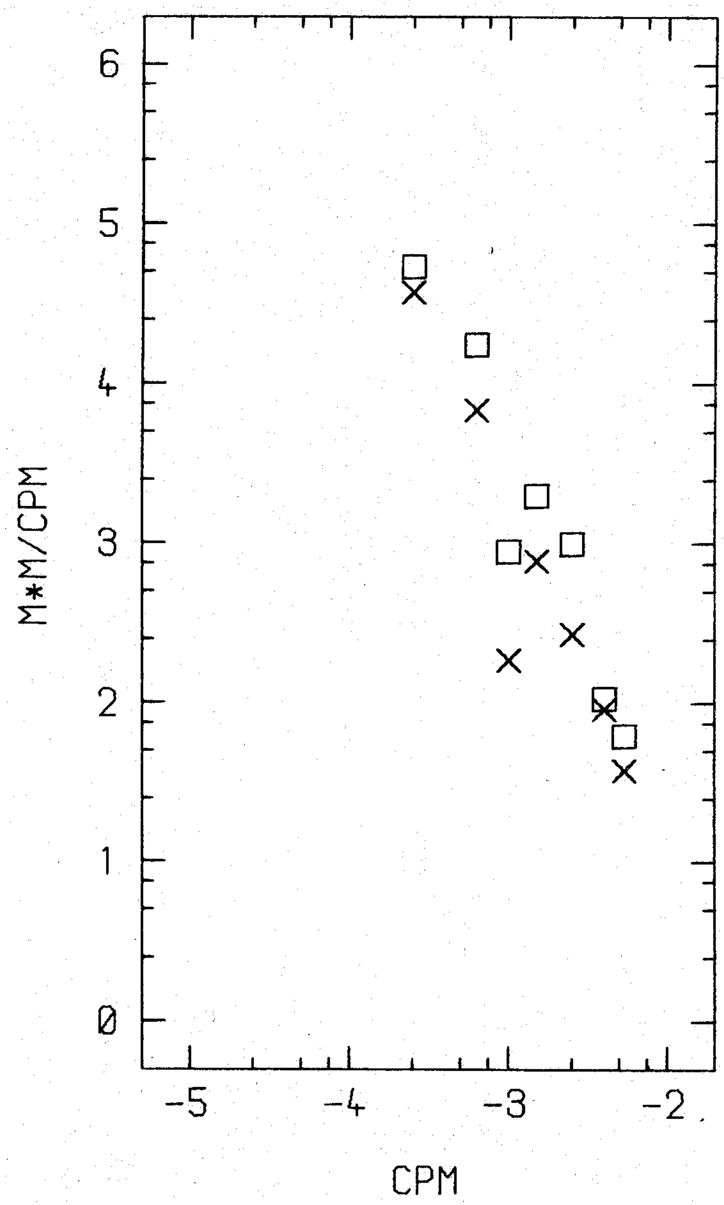

RUN 6S-14 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8
M*M/CPM
0
1
2
3
4
5
6
-5
-4
-3
-2
CPM


RUN 6E-15 2-SEP-78
ISOTHERMS (DEG C) 12.0, 9.8
M*M/CPM
0
1
2
3
4
5
6
-5
-4
-3
-2
CPM

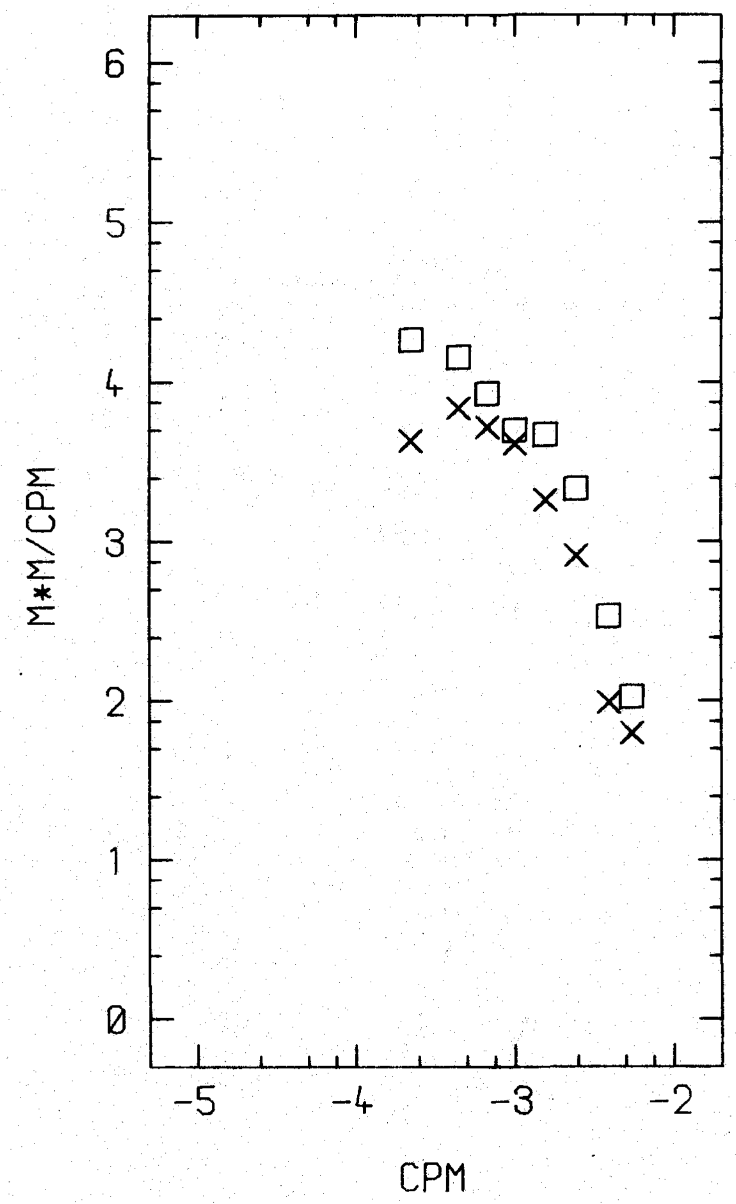
RUN 6N-16 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8



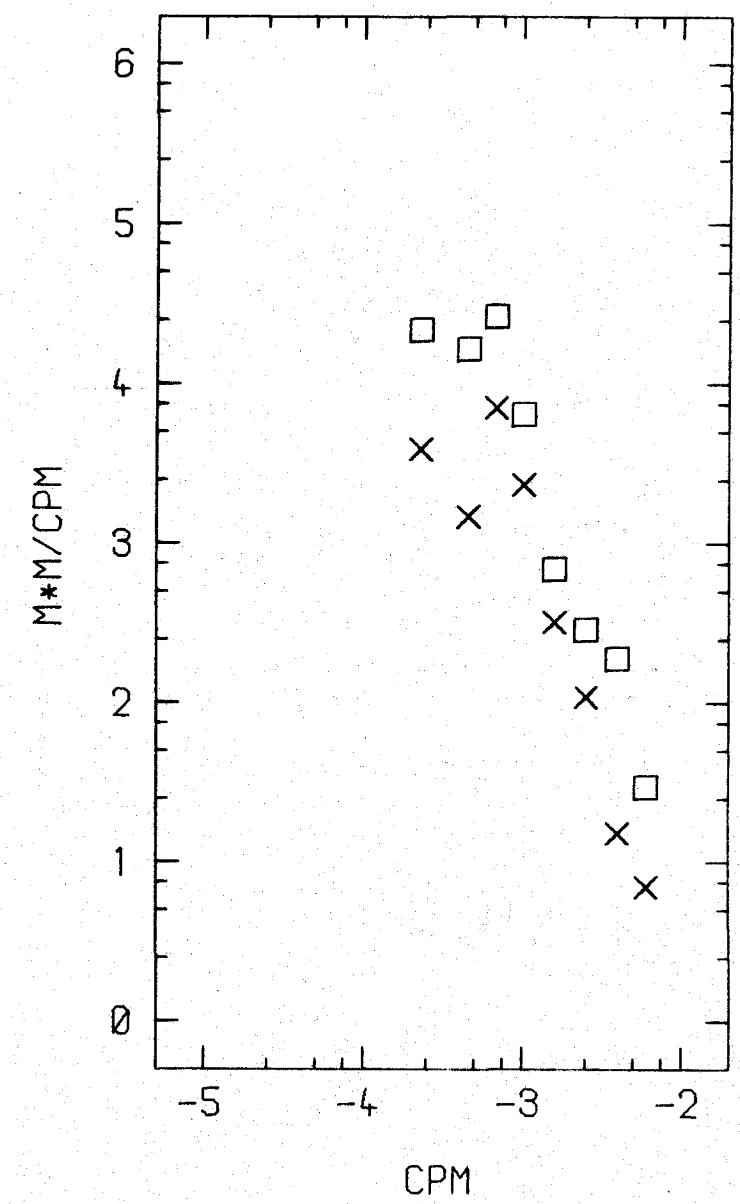
RUN 6W-17 2-SEP-78
ISOTHERMS (DEG C) 12.2, 10.0



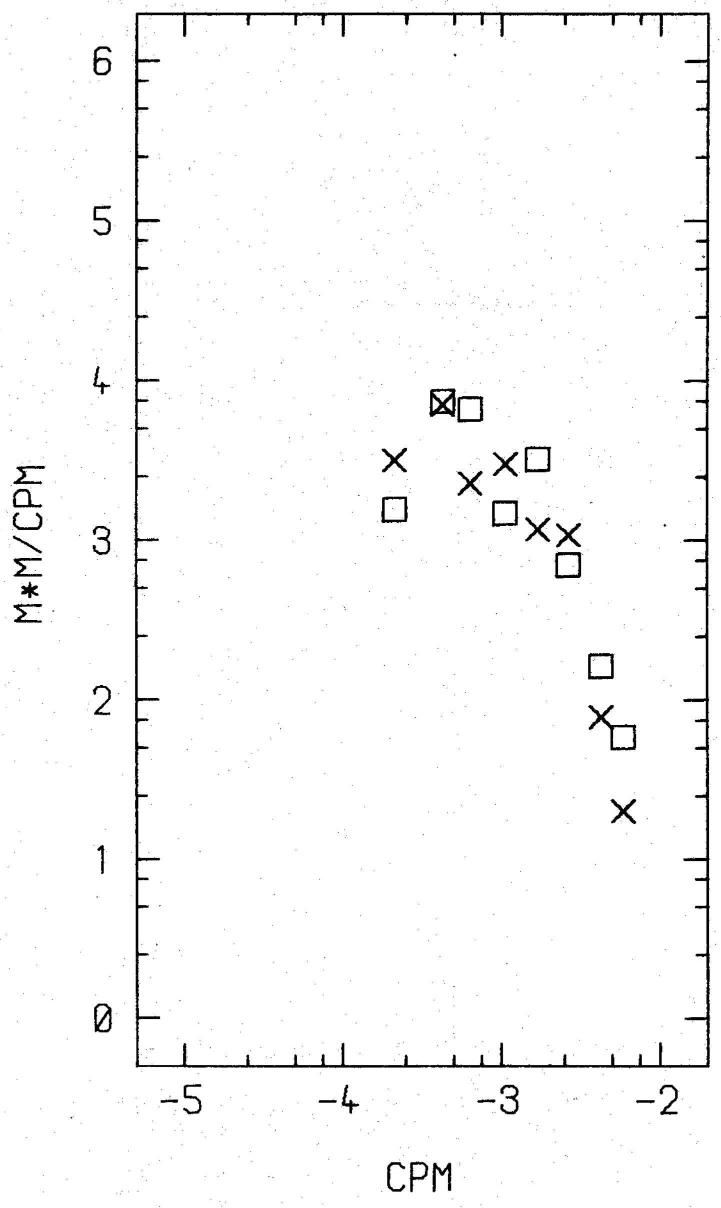
RUN 6S-18 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8



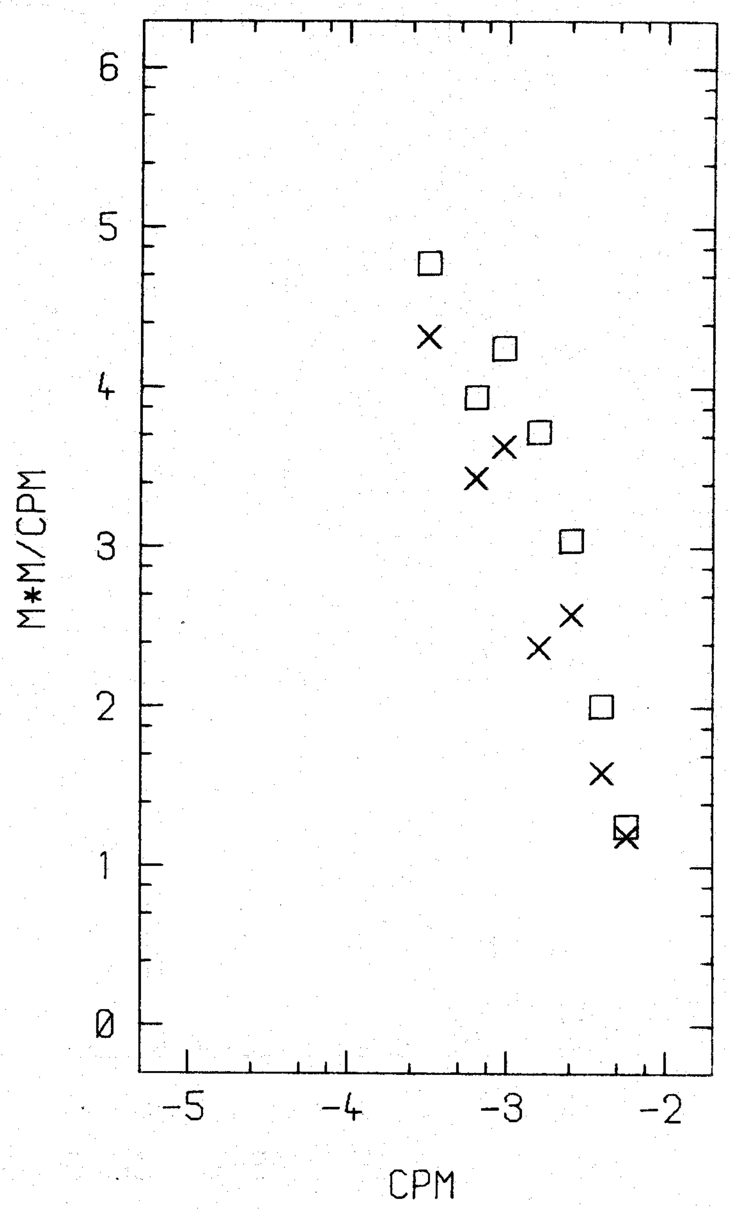
RUN 6E-19 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.6



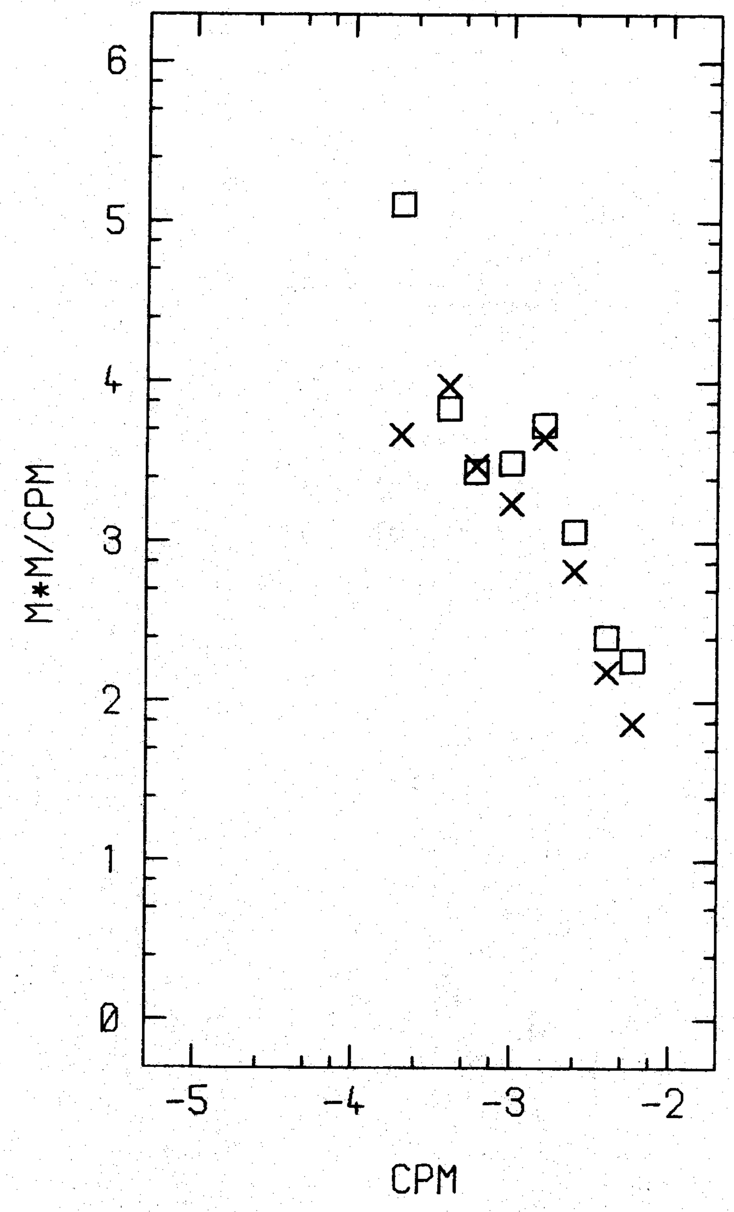
RUN 6N-20 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.6



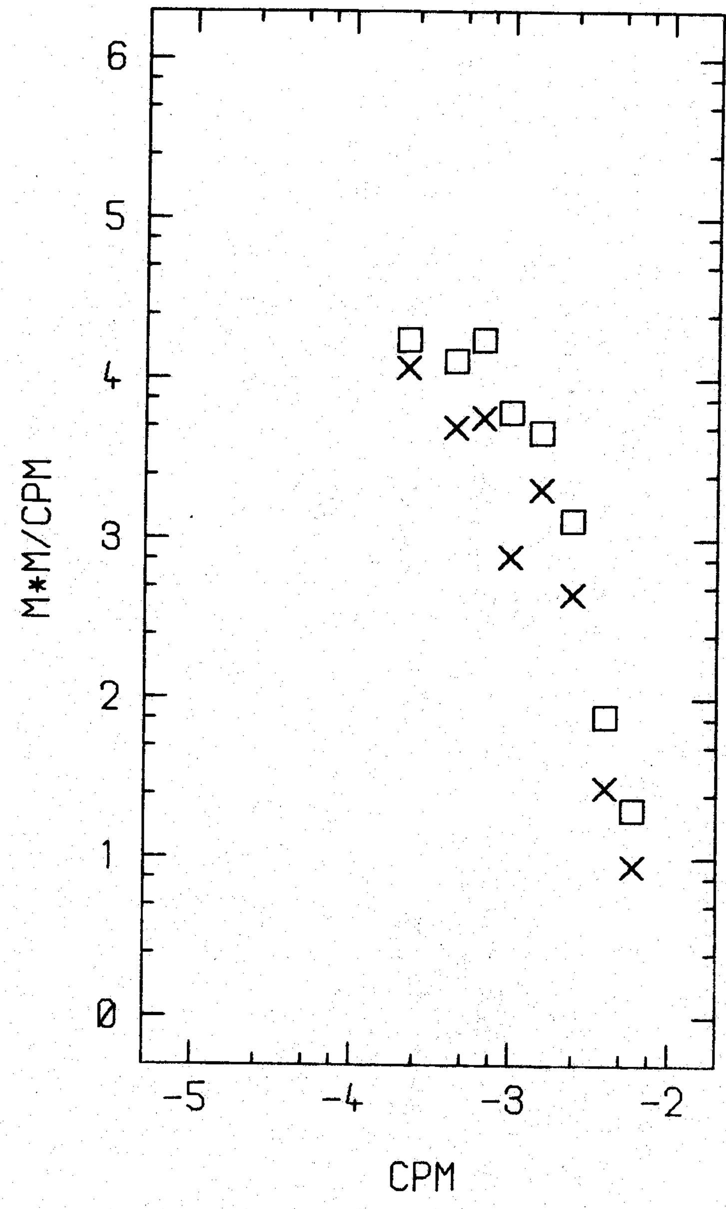
RUN 6W-21 2-SEP-78
ISOTHERMS (DEG C) 12.4, 10.0



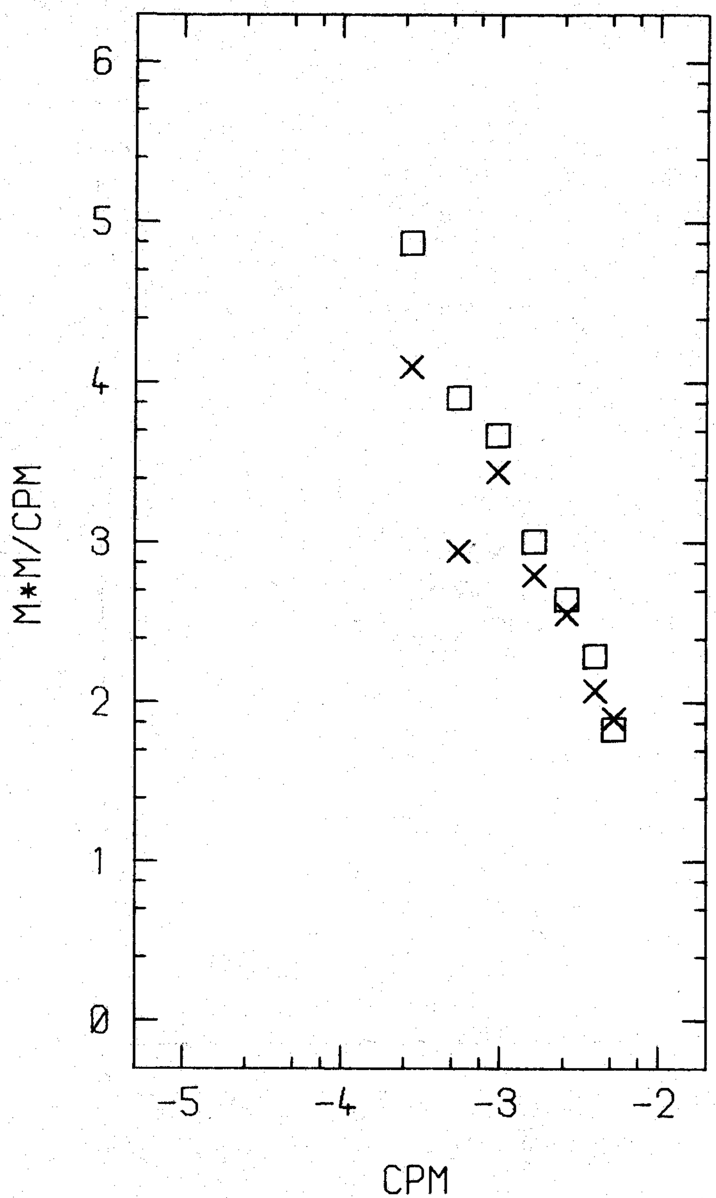
RUN 6S-22 2-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8



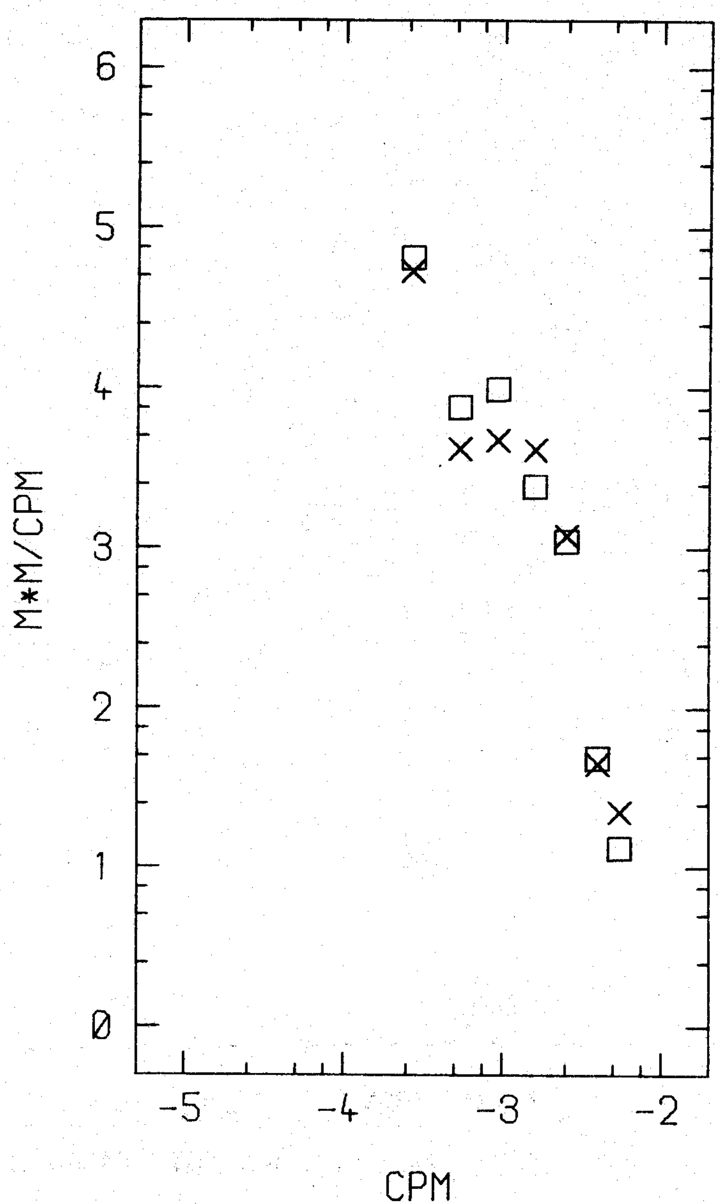
RUN 6E-23 2-SEP-78
ISOTHERMS (DEG C) 12.0, 9.8

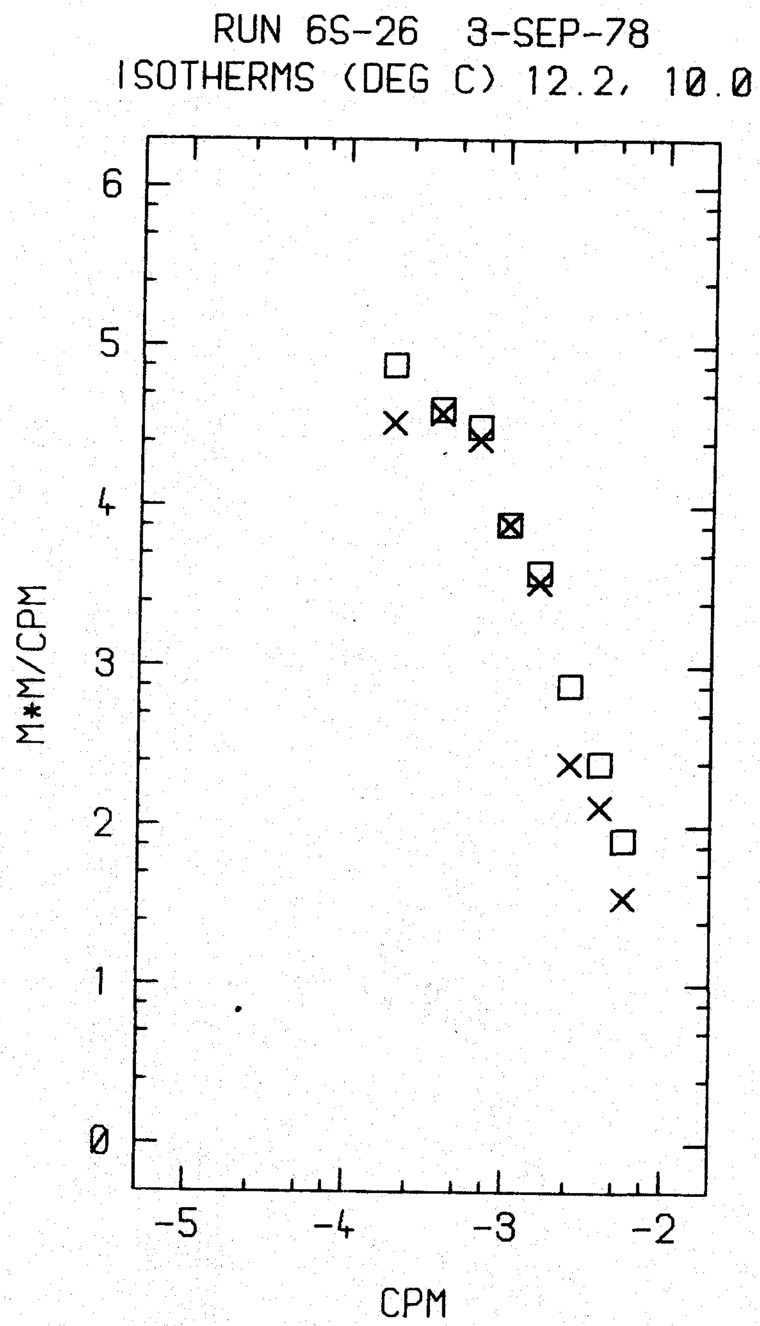


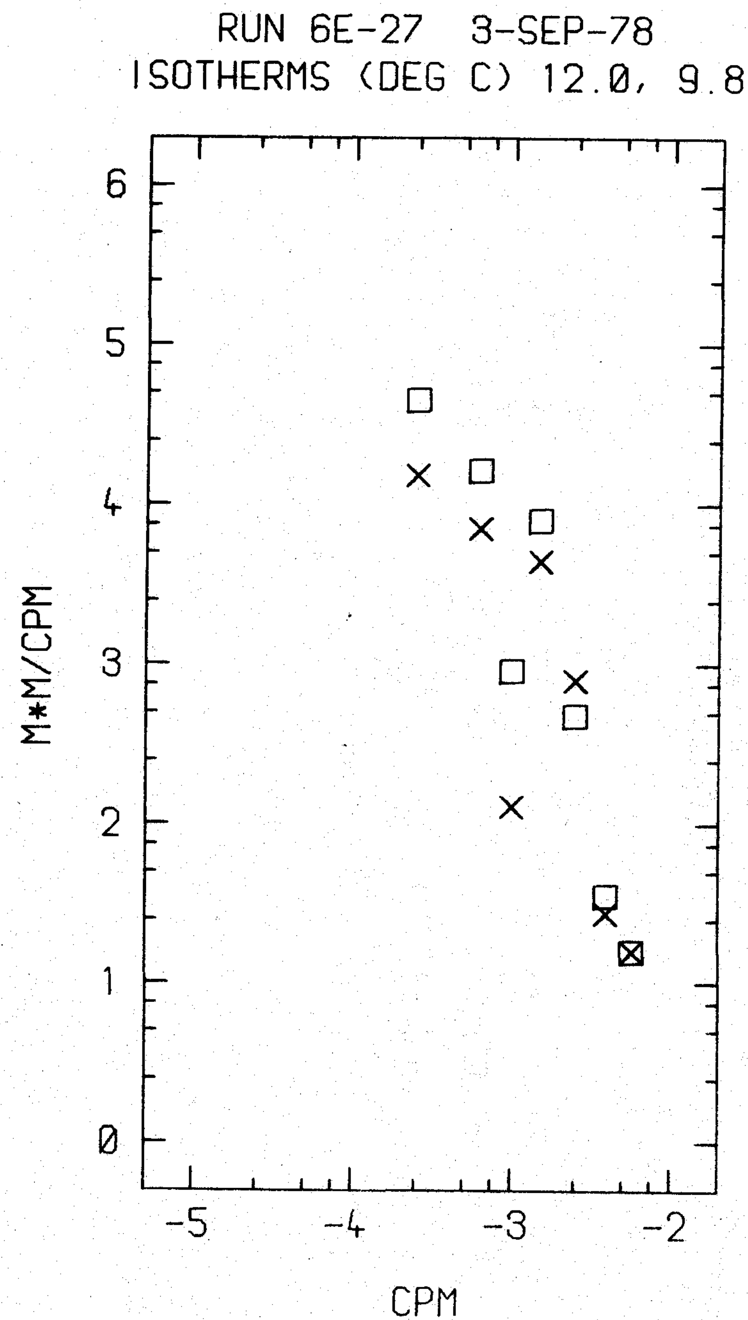
RUN 6N-24 2-SEP-78
ISOTHERMS (DEG C) 12.4, 10.0



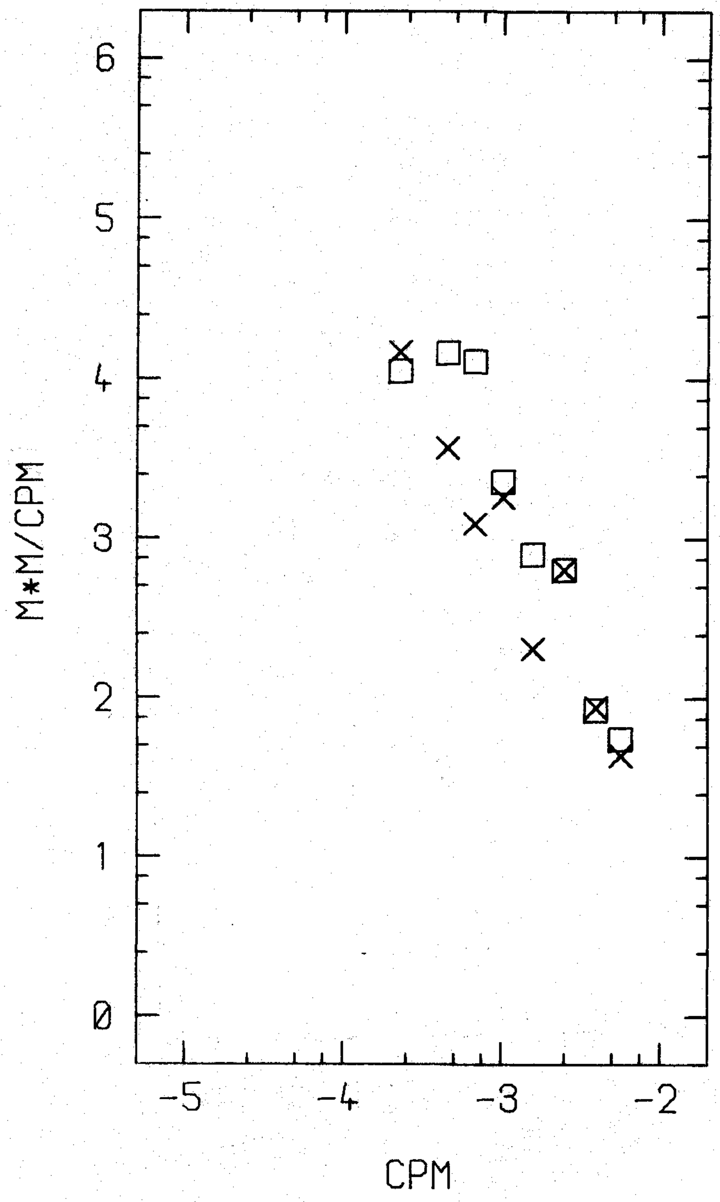
RUN 6W-25 3-SEP-78
ISOTHERMS (DEG C) 12.4, 9.8



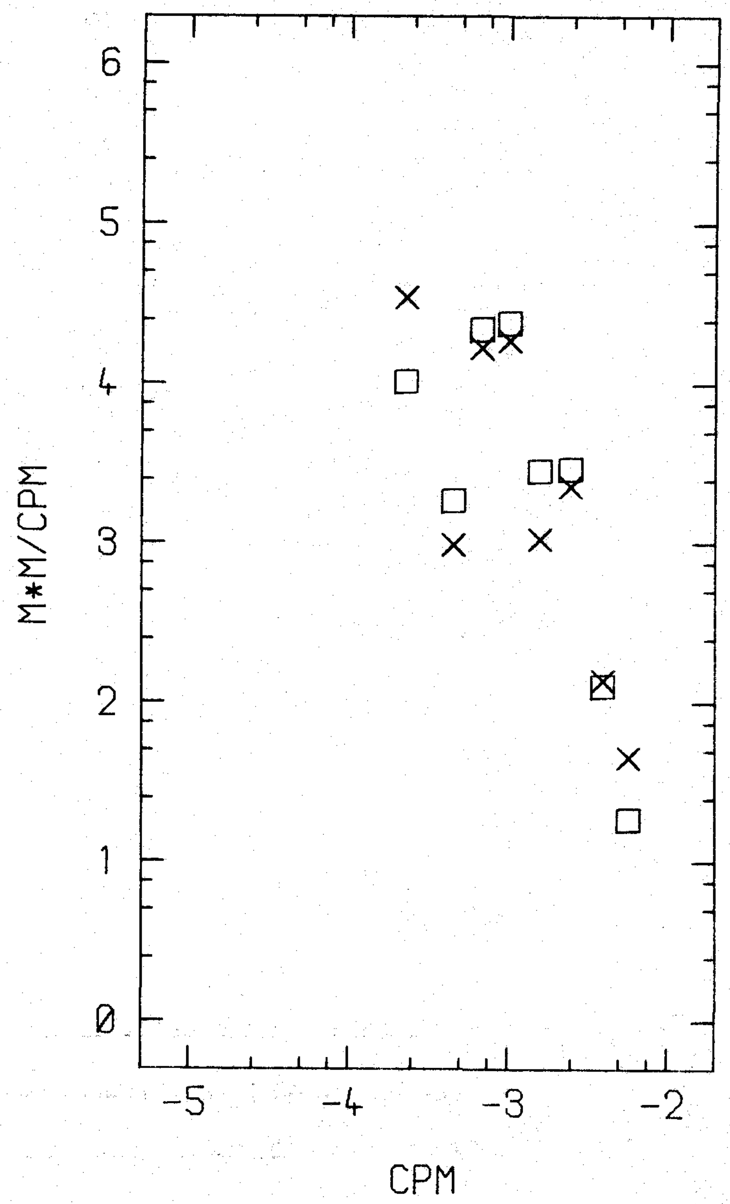

RUN 6S-26 3-SEP-78
ISOTHERMS (DEG C) 12.2, 10.0
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2


RUN 6E-27 3-SEP-78
ISOTHERMS (DEG C) 12.0, 9.8
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2

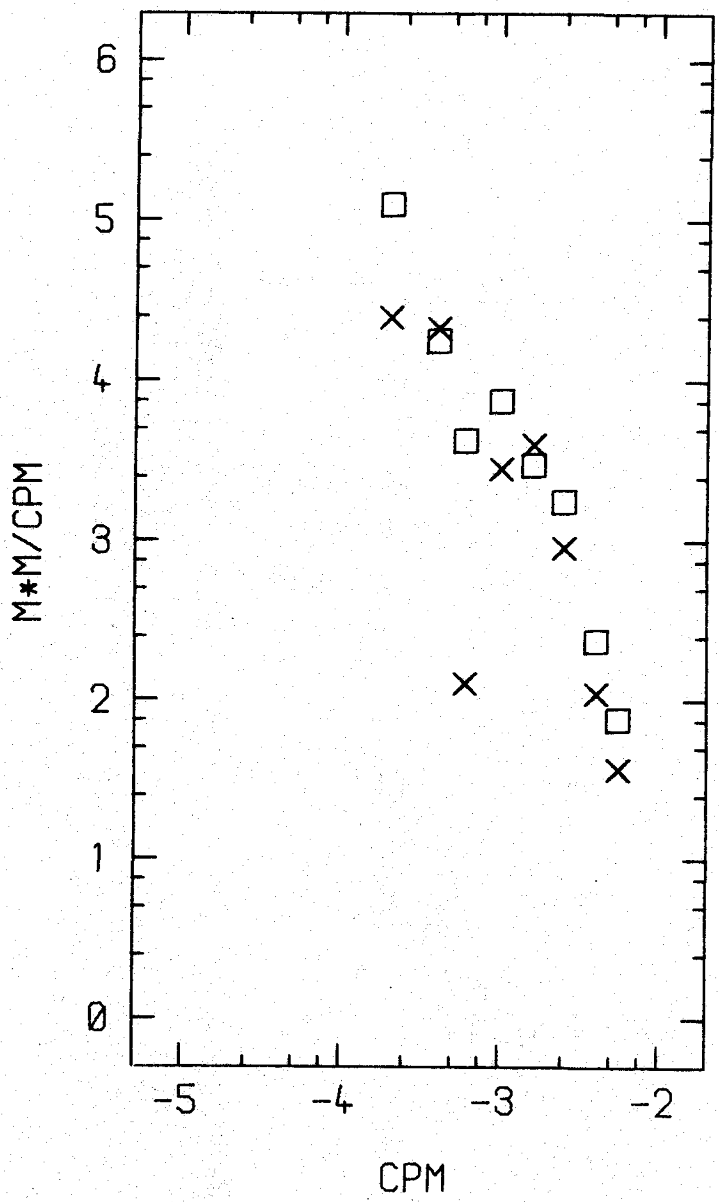
RUN 6N-28 3-SEP-78
ISOTHERMS (DEG C) 12.0, 9.8



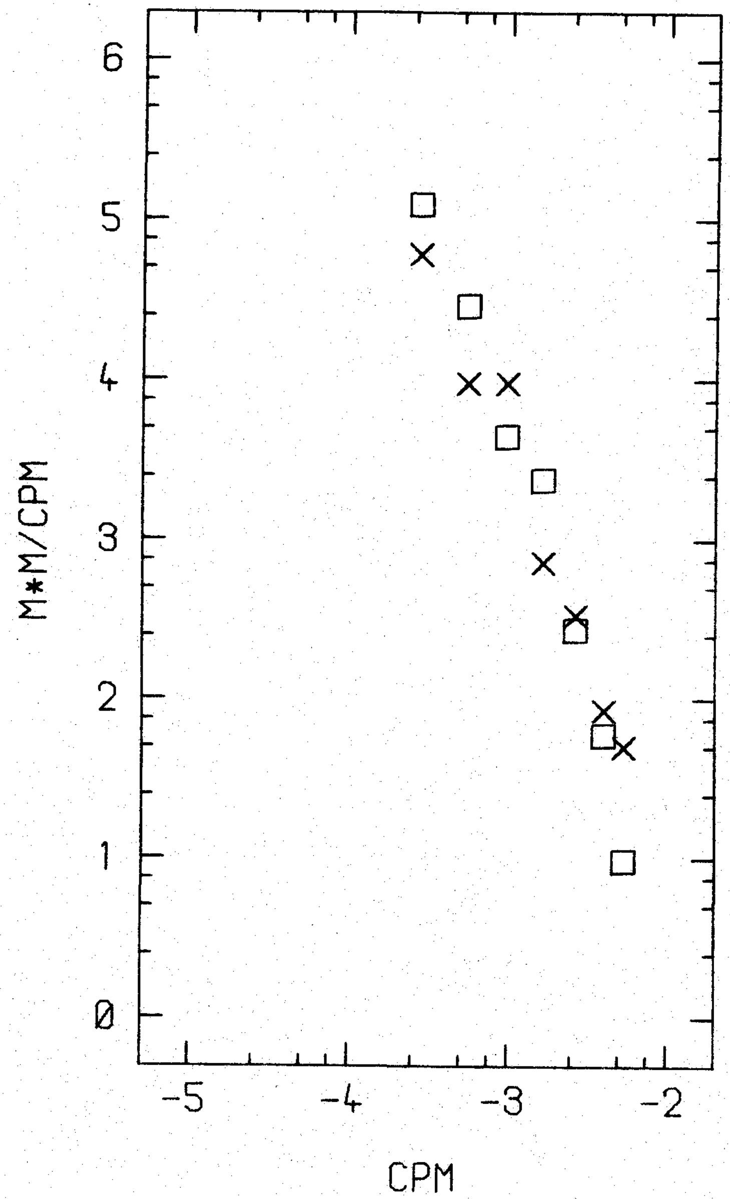
RUN 6W-29 3-SEP-78
ISOTHERMS (DEG C) 12.4, 9.8



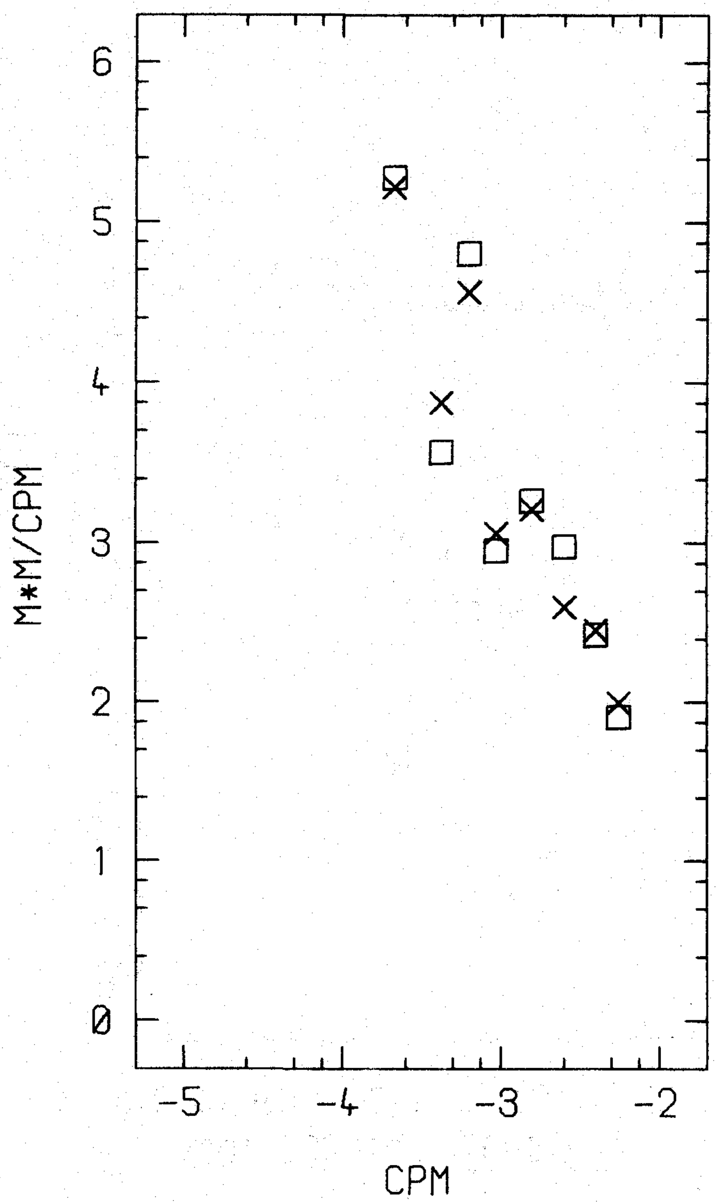
RUN 6S-30 3-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8



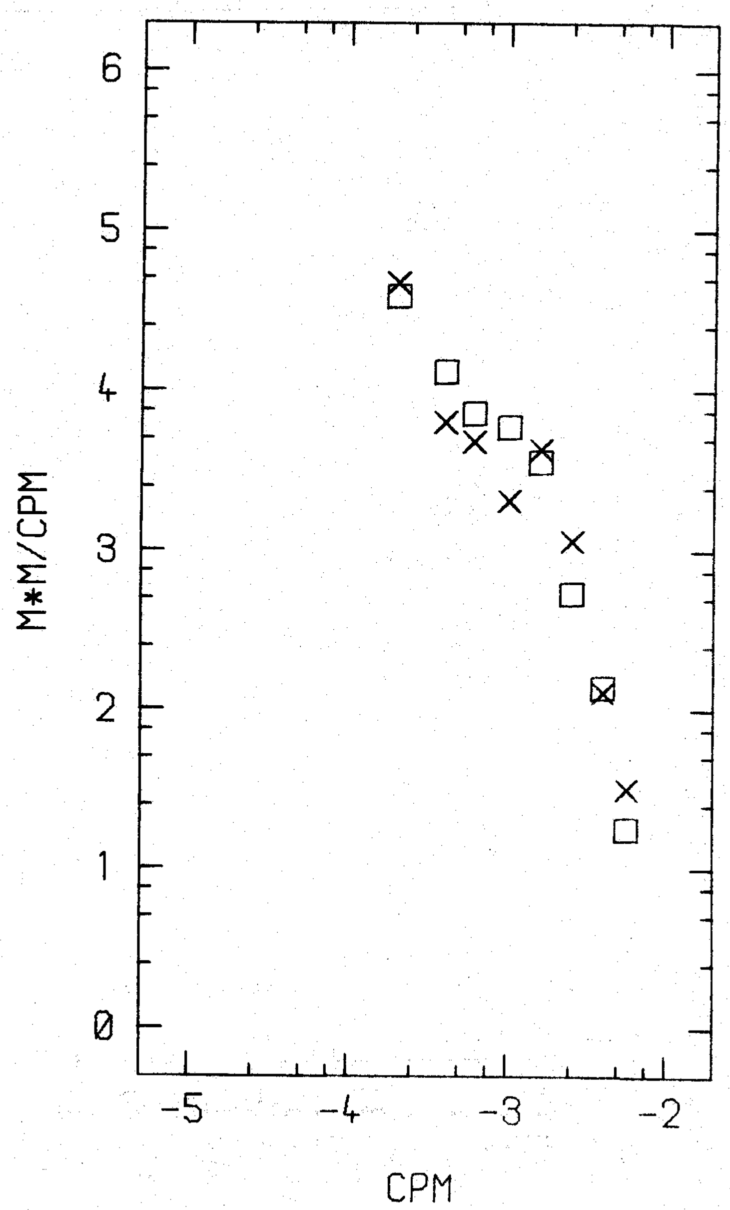
RUN 6E-31 3-SEP-78
ISOTHERMS (DEG C) 12.2, 10.2



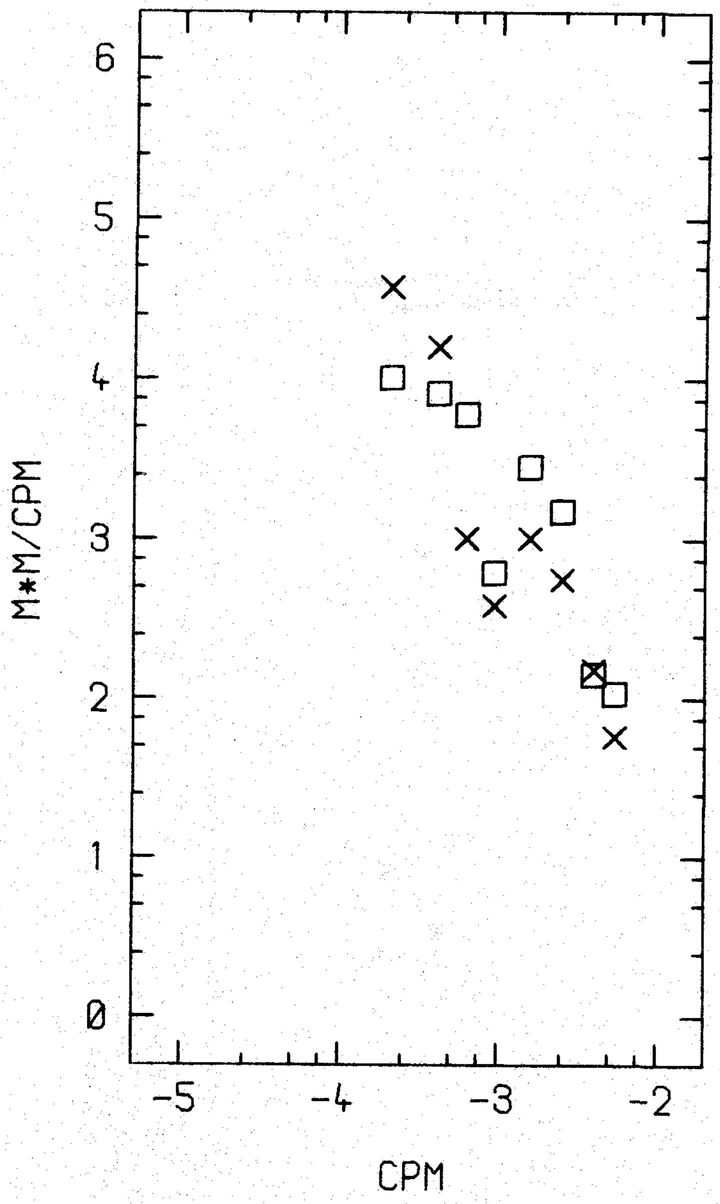
RUN 6N-32 3-SEP-78
ISOTHERMS (DEG C) 12.2, 10.4



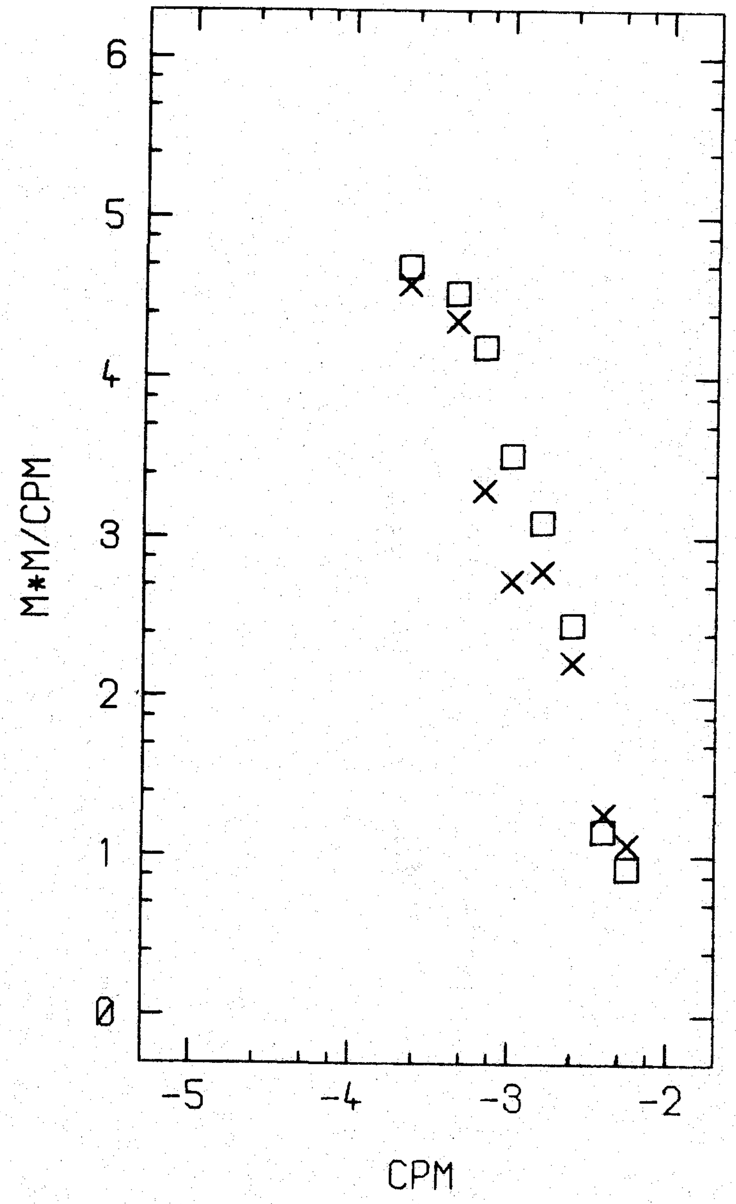
RUN 6W-33 3-SEP-78
ISOTHERMS (DEG C) 12.4, 9.8

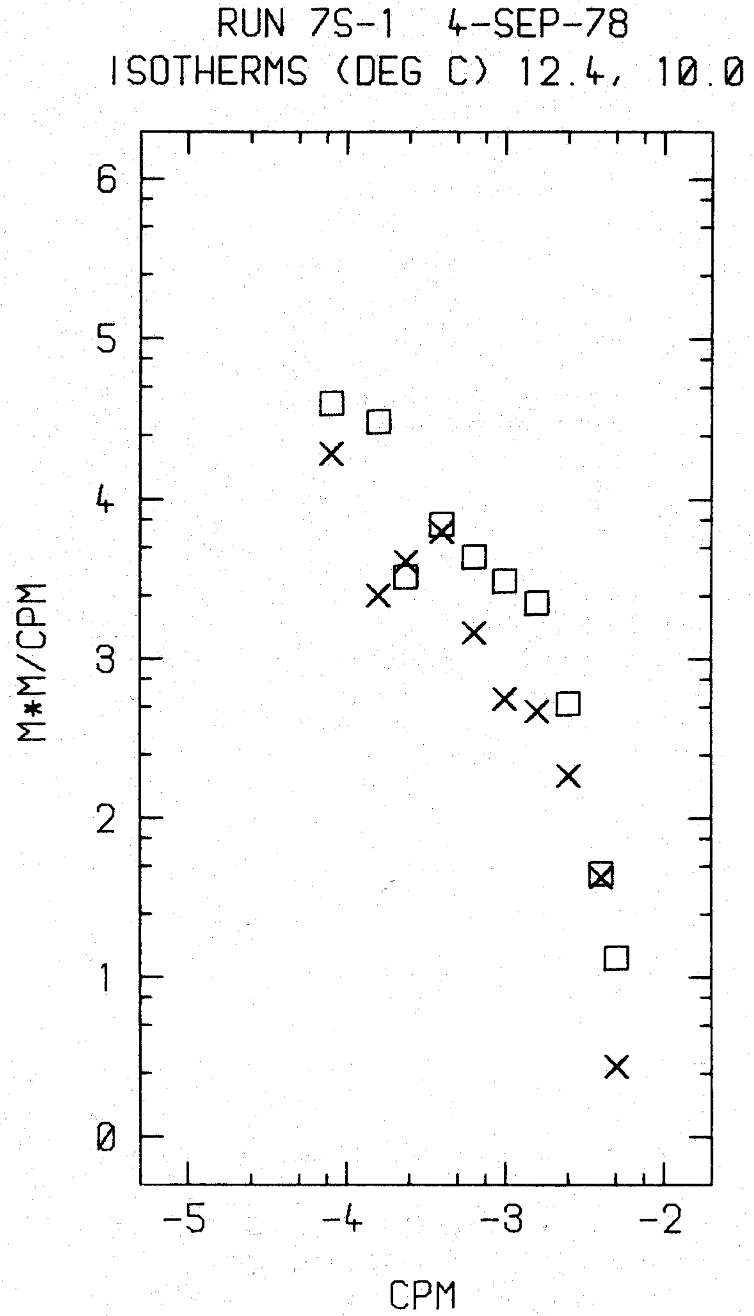


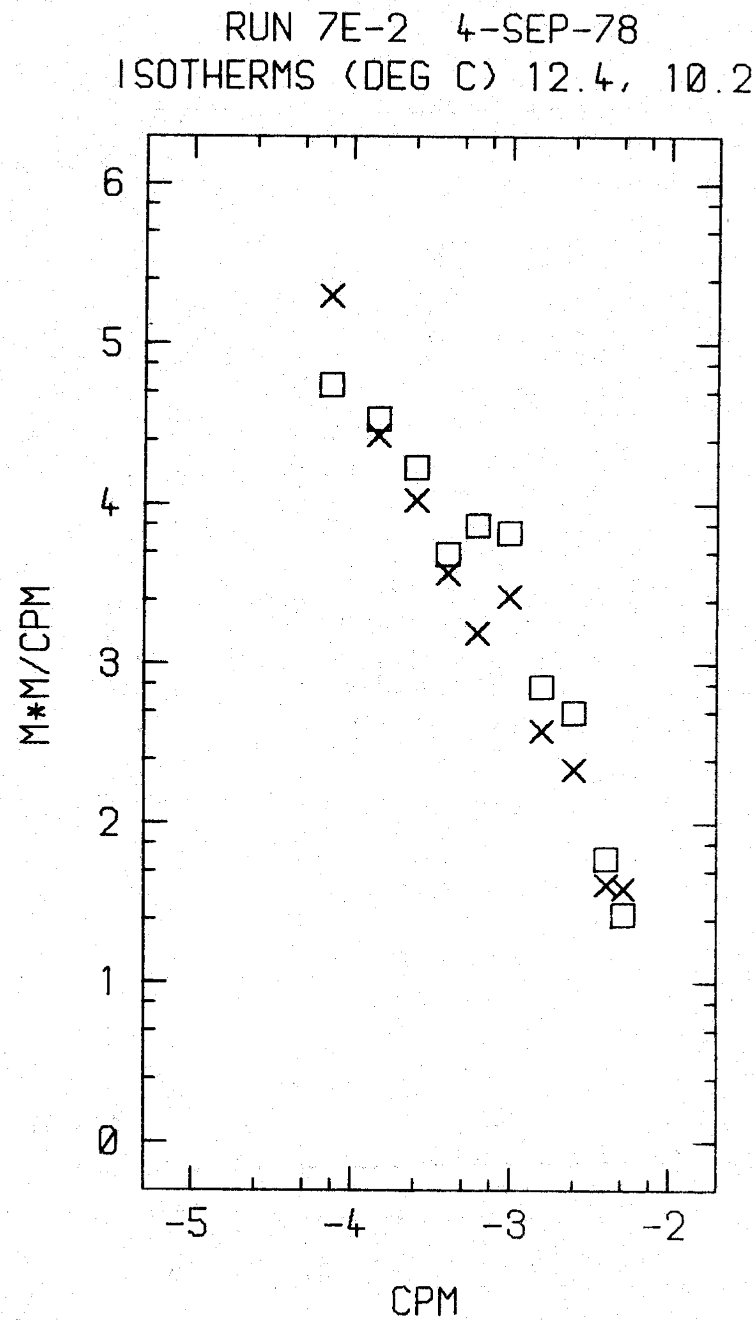
RUN 6S-34 3-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8



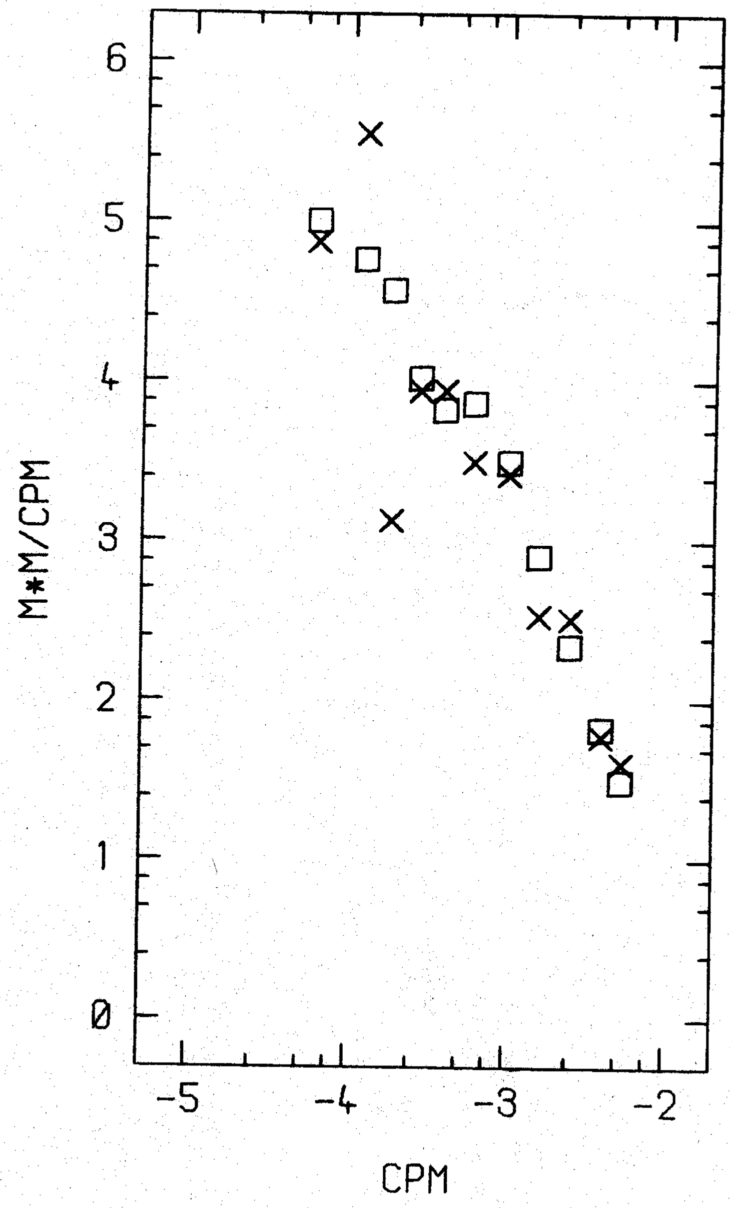
RUN 6E-35 3-SEP-78
ISOTHERMS (DEG C) 12.2, 9.8



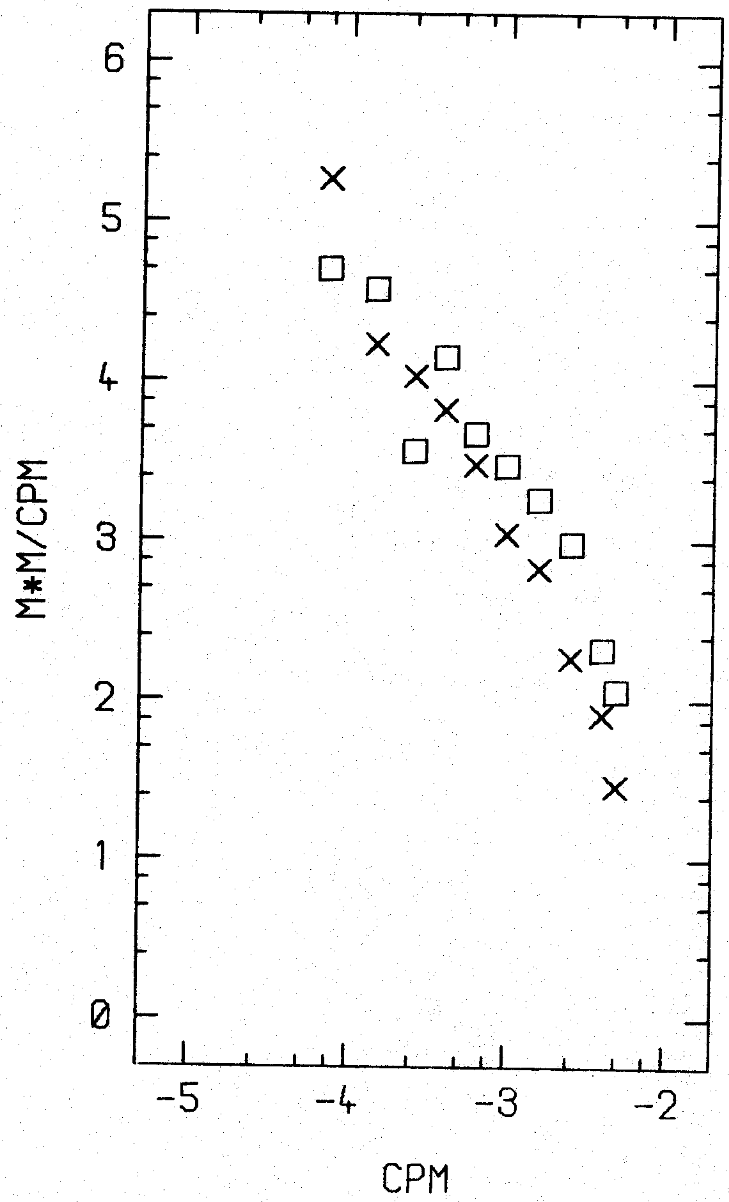

RUN 7S-1 4-SEP-78
ISOTHERMS (DEG C) 12.4, 10.0
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2


RUN 7E-2 4-SEP-78
ISOTHERMS (DEG C) 12.4, 10.2
M*M/CPM
CPM
0
1
2
3
4
5
6
-5
-4
-3
-2

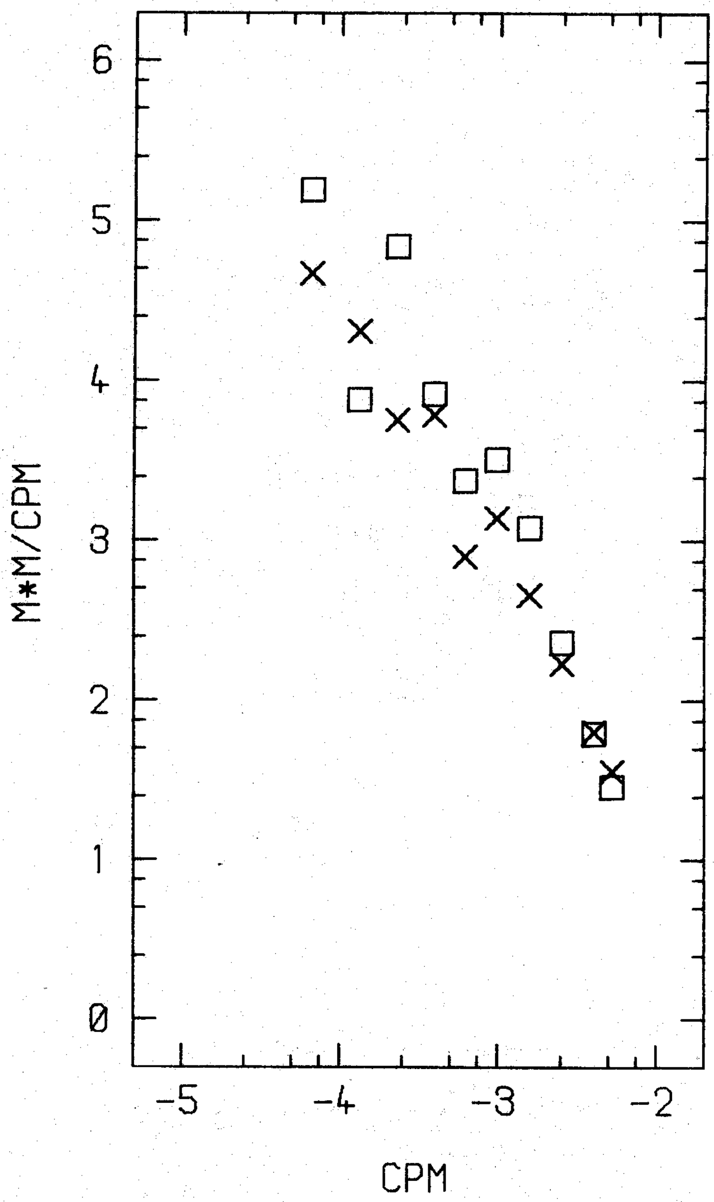
RUN 7N-3 4-SEP-78
ISOTHERMS (DEG C) 12.4, 10.0



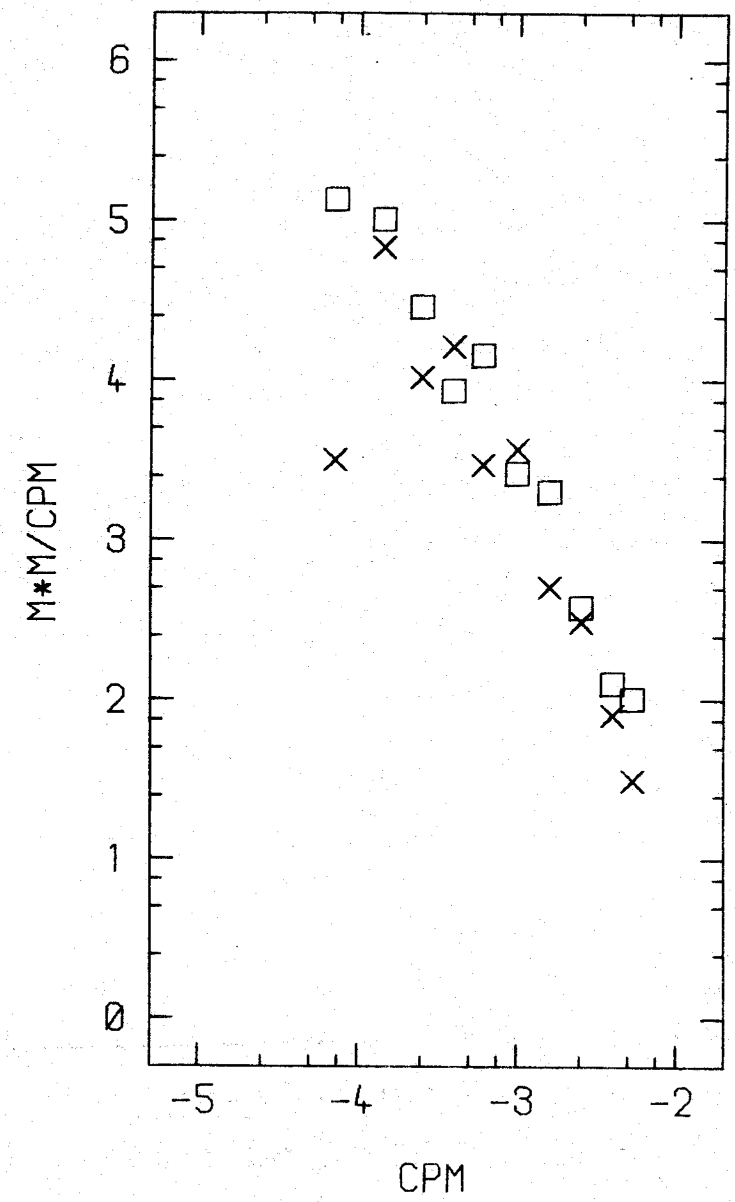
RUN 7W-4 4-SEP-78
ISOTHERMS (DEG C) 12.4, 9.8



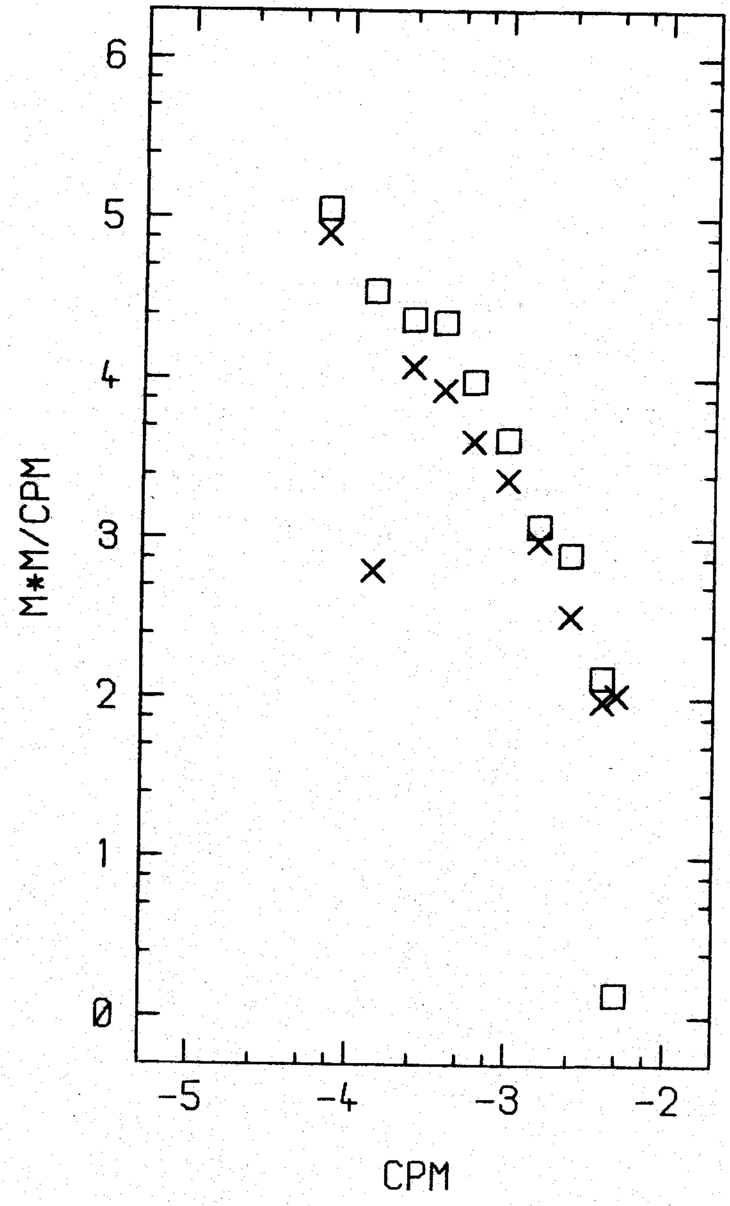
RUN 7S-5 4-SEP-78
ISOTHERMS (DEG C) 12.4, 10.2



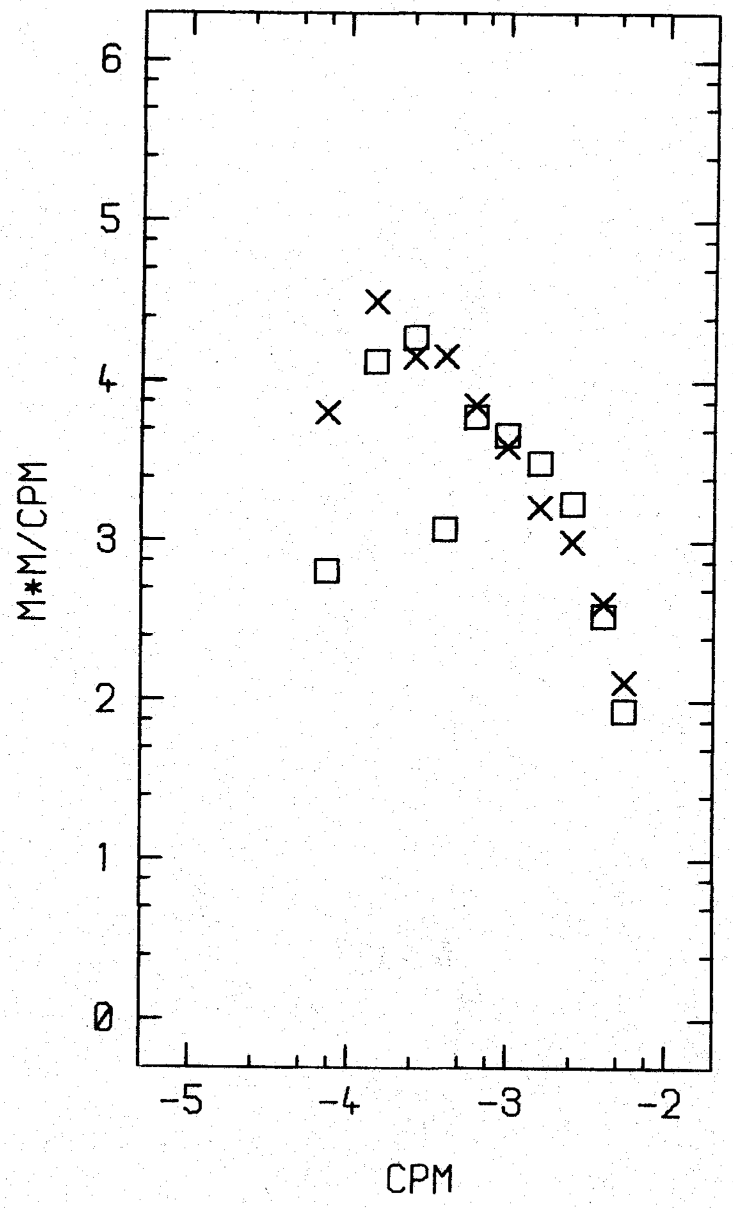
RUN 7E-6 4-SEP-78
ISOTHERMS (DEG C) 12.4, 10.2



RUN 7N-7 4-SEP-78
ISOTHERMS (DEG C) 12.4, 10.0



RUN 7W-8 4-SEP-78
ISOTHERMS (DEG C) 12.4, 10.8



APPENDIX A

Configuration of the Chain Under Tow

The purpose of this Appendix is to derive an expression for the shape of the chain under tow. The derived shape serves as the basis for interpolating the depths of the sensors between pressure measurements and for smoothing variations in the pressure records caused by errors in the measurements.

We simplify the problem by considering the equilibrium case in which accelerations are neglected and the shape is independent of time. The problem then becomes similar to the problem of the "hanging chain", treatments of which are given in many textbooks (e.g., Sokolnikoff and Redheffer, 1958, pp. 40-42).

A schematic diagram of the chain under tow is shown in Figure A1. The x-z coordinate system has its origin at the bottom of the chain in the center of the dead-weight depressor (bomb). The forces acting on the chain at $x = z = 0$ are G_B, the gravitational force on the bomb; D_B, the drag force on the bomb; T $(s = 0)$, the upward tension in the chain, where s is the distance along the chain from $x = z = 0$. The forces acting on an element of the chain, δs, at an arbitrary point s on the chain are: $W(s)\delta s$, the gravitational force, where $W(s)$ has dimensions of force per unit length; $D(s)\delta s$, the drag force, where $D(s)$ also has dimensions of force per unit length; $T(s + \delta s/2)$ the upward tensile force; and $T(s - \delta s/2)$, the downward tensile force. The buoyancy forces are incorporated into the gravitational forces, G_B and W. The tensile force may be decomposed into vertical and horizontal components as shown where $\theta(s)$ is the angle between the chain and the horizontal.

If the chain is in equilibrium, we may, as shown in Figure A1, separately equate the horizontal and vertical forces acting on the chain at any point along the chain:

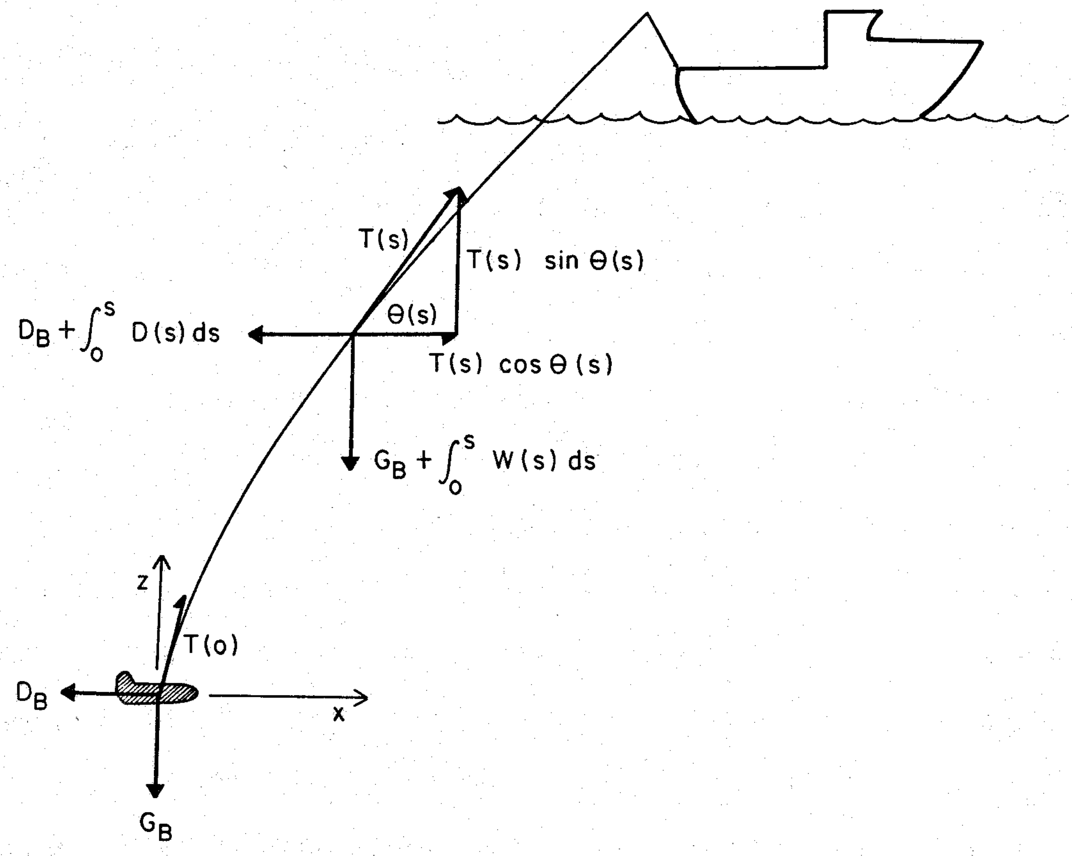


Figure A1. Schematic diagram illustrating the forces acting on the towed thermistor chain.

$$D_B + \int_0^s D(s)\,ds = T(s)\cos\theta(s)$$

$$G_B + \int_0^s W(s)\,ds = T(s)\sin\theta(s) \qquad (A1)$$

We now assume that D(s) and W(s) are independent of s. This is essentially true for W(s) and is approximately true for D(s) providing θ(s) does not differ too far from 90°. The equations (A1) are then integrated to obtain:

$$D_B + sD = T(s)\cos\theta(s) \qquad (A2)$$

$$G_B + sW = T(s)\sin\theta(s) \qquad (A3)$$

T(s) can be eliminated from (A2) to obtain:

$$\tan\theta(s) = \frac{G_B + sW}{D_B + sD}$$

It is now possible to solve for θ(s), x(s) and z(s). θ(s) is obtained directly from (A3) and x(s) and z(s) are given by:

$$x(s) = \int_0^s \cos\theta(s')\,ds'$$

$$z(s) = \int_0^s \sin\theta(s')\,ds' \qquad (A4)$$

Consider first the expression for z(s). Substituting from (A3) into (A4) yields:

$$z(s) = \int_0^s \frac{(G_B + s'W)\,ds'}{[(G_B + s'W)^2 + (D_B + s'D)^2]^{\frac{1}{2}}}$$

which can be rewritten

$$z(s) = \int_0^s \frac{(G_B + s'W)\,ds'}{(a + bs' + cs'^2)^{\frac{1}{2}}} \qquad (A5)$$

where $a \equiv {G_B}^2 + D^2$

$b \equiv 2G_BW + 2\ D_BD$

$c \equiv W^2 + D^2$

Integrating (A5) yields:

$$z(s) = (\frac{G_B}{\sqrt{c}} - \frac{bW}{2c^{3/2}}\ [\sinh^{-1}\ (\frac{2cs + b}{\sqrt{d}})$$

$$- \sinh^{-1}\ (\frac{b}{\sqrt{d}})] \qquad \text{(A7)}$$

$$+ \frac{W}{c}\ [(A + bs + cs^2)^{\frac{1}{2}} - \sqrt{a}]$$

where

$$d = 4ac - b^2$$

An expression for x(s) can be obtained by a procedure similar to that used to obtain (A7). From (A3) and (A4) we obtain

$$x(s) = \int_0^s \frac{(D_B + s'D)ds'}{(a = b\ s' + cs'^2)^{\frac{1}{2}}} \qquad \text{(A8)}$$

where a, b and c have the definitions given in (A6). If one replaces G_B and W in (A5) with D_B and D respectively, the equation becomes identical to (A8). The integration of (A8) therefore yields an expression of the same form as (A7) with G_B and W replaced by D_B and D:

$$x(s) = (\frac{D_B}{\sqrt{c}} - \frac{bD}{2c^{3/2}})\ [\sinh^{-1}\ (\frac{2cs + b}{\sqrt{d}})$$

$$- \sinh^{-1}\ (\frac{b}{\sqrt{d}})] \qquad \text{(A9)}$$

$$+ \frac{D}{c}\ [(a + bs + cs^2)^{\frac{1}{2}} - \sqrt{a}\,]$$

The drag forces, D_B and D, are assumed to be proportional to ρU^2 where ρ is the density of the water and U is the tow velocity:

$$D_B = C_B A_B \rho U^2$$
$$D = C A \rho U^2 \qquad (A10)$$

where C_B and C are the drag coefficients for the depressor and the faired chain, respectively. A_B and A are the corresponding cross-sectional areas where A has dimensions of area per unit length.

The drag coefficient for the depressor was assumed equal to one. This value can be compared with the value for a circular disk equal 0.55 in the range of Reynolds numbers likely to be encountered (Batchelor, 1967, p. 341). A larger value was assumed for the depressor because, although it is streamlined, it has protruding fins, cable attachments and handling rings and may at times present a larger cross-sectional area to the flow than assumed. It turns out that the shape of the chain is not critically dependent on the assumed value of C_B. If one decreases C_B by 50% at a tow speed of 3 m/s, the computed change in depth 95 m below the surface is only 0.3 m. The Reynolds number for the bomb at a tow speed of 3 m/s is 6.7×10^5.

The drag coefficient for the faired chain was taken equal to 0.13 as suggested by the manufacturer. For comparison, bluff bodies have drag coefficients about equal 0.5. The value C = 0.13 yielded chain shapes in good agreement with the pressure measurements on the chain. The uncertainties of the calculated depths of the thermistors are estimated not to exceed $\pm$ 1 m. The Reynolds number for the fairing is 6×10^4 at a tow speed of 3 m/s.

Chain shapes calculated by use of (A7) and (A9) are shown in Figure A2. For a given tow speed, the shape depends only the the distance along the chain from the depressor. The parameters used to obtain the curves shown

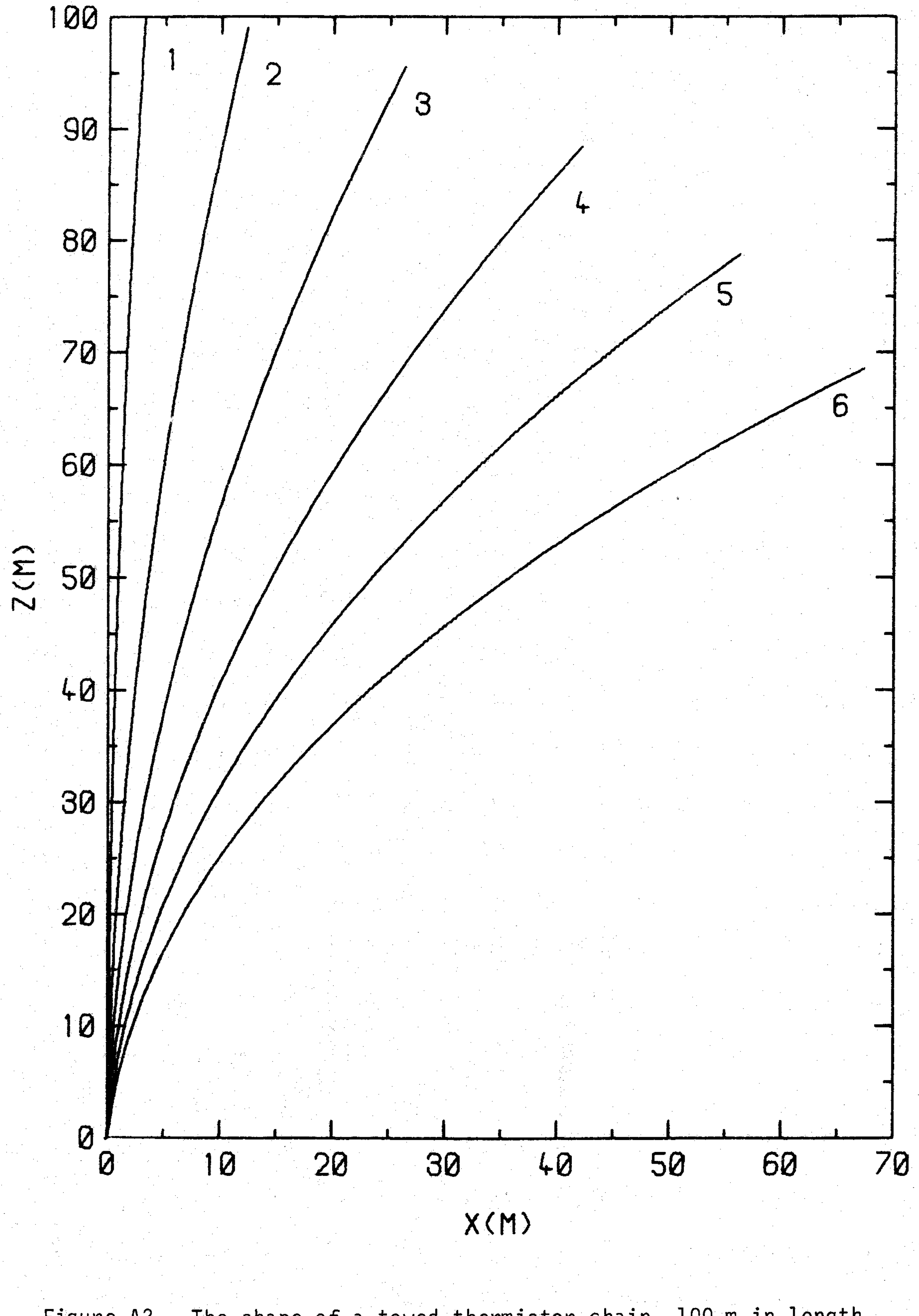


Figure A2. The shape of a towed thermistor chain, 100 m in length, for tow speeds ranging from 1 to 6 m/s. The drag force on the chain is assumed proportional to s, the distance along the chain.

in Figure A2 were:

$$G_B = 4{,}120 \text{ Newtons}$$
$$W = 7 \text{ Newtons/m} \qquad \text{(A11)}$$
$$C_B A_B \rho = 12.3 \text{ Newtons/m}^2\text{s}^{-2}$$
$$CA\rho = 2.6 \text{ Newtons/m}^3\text{s}^{-2}$$

The above parameters are the best estimates for the chain.

An additional model for the shape of the chain was developed to compare two different assumptions for the drag force on the chain. In the previous development we assumed the drag, D, proportional to s, the distance along the chain from the depressor. Alternatively, we assume that D is proportional to z, the vertical space coordinate. The equation corresponding to (A3) is:

$$\frac{dz}{dx} = \tan\theta(s) = \frac{G_B + sW}{D_B + zD} \qquad \text{(A12)}$$

To ease the integration of (A12) we assume that W is negligible, from which follows:

$$x = \left(D_B + \frac{D}{2}z\right)\frac{z}{G_B} \qquad \text{(A13)}$$

We may also derive s(z) as follows:

$$\frac{dz}{ds} = \sin\theta(s)$$

$$s = \int_0^z \frac{1}{\sin\theta(s)}\,dz'$$

$$s = \int_0^z \frac{\left[G_B^{\,2} + (D_B + Dz')^2\right]^{\frac{1}{2}}}{G_B}\,dz'$$

$$s = \int_0^z (e + fz' + gz'^2)^{\frac{1}{2}}\,dz'$$

where

$$e \equiv 1 + \frac{{D_B}^2}{{G_B}^2}\,, \quad f \equiv \frac{2D_B D}{{G_B}^2}\,, \quad g \equiv \frac{D^2}{{G_B}^2}$$

Integrating we obtain:

$$s = \frac{(2gz + f)\sqrt{Z} - f\sqrt{e}}{4g}$$

$$+ \frac{1}{2k\sqrt{g}}\left[\sinh^{-1}\left(\frac{2gz+f}{\sqrt{q}}\right) - \sinh^{-1}\left(\frac{f}{\sqrt{q}}\right)\right]$$

where

$$Z = e + fz + gz^2$$

$$q = 4\,eg - f^2$$

$$k = \frac{4g}{q}$$

The two models are compared in Figures A3 and A4. In Figure A3 the shape of the chain given by the second model ($D \propto z$) is plotted for various tow speeds. In Figure A4 the shape of the chain given by the first model ($D \propto s$) is plotted for the same tow speeds. The parameters used in constructing the cruves shown in Figures A3 and A4 are identical to those used in generating the curves shown in Figure A2 except that W, the gravitational minus buoyancy force, is assumed zero in Figures A3 and A4. The difference between the two models for a tow speed of 3 m/s amounts to only 0.3 m difference in z at s = 70 m. We therefore conclude that the calculated shape of the chain is not critically dependent on the model for the tow speeds employed in JASIN. For faster tow speeds the differences may become significant. For example, at a tow speed of 5 m/s the difference in z when s = 100 m is 4 m.

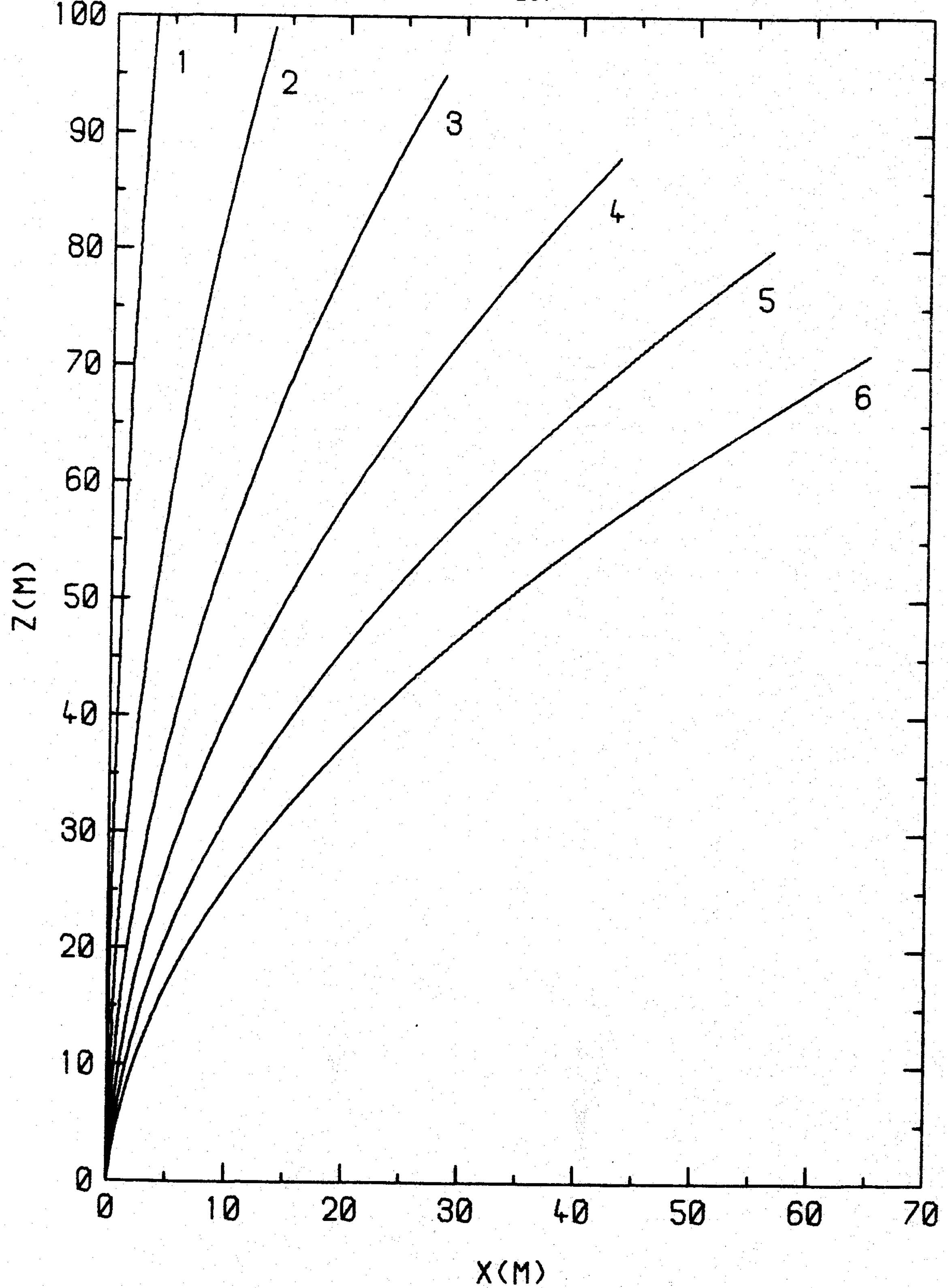


Figure A3. The shape of a towed thermistor chain, 100 m in length, for tow speeds ranging from 1 to 6 m/s. The chain is assumed to be weightless in water and the drag force is assumed proportional to z.

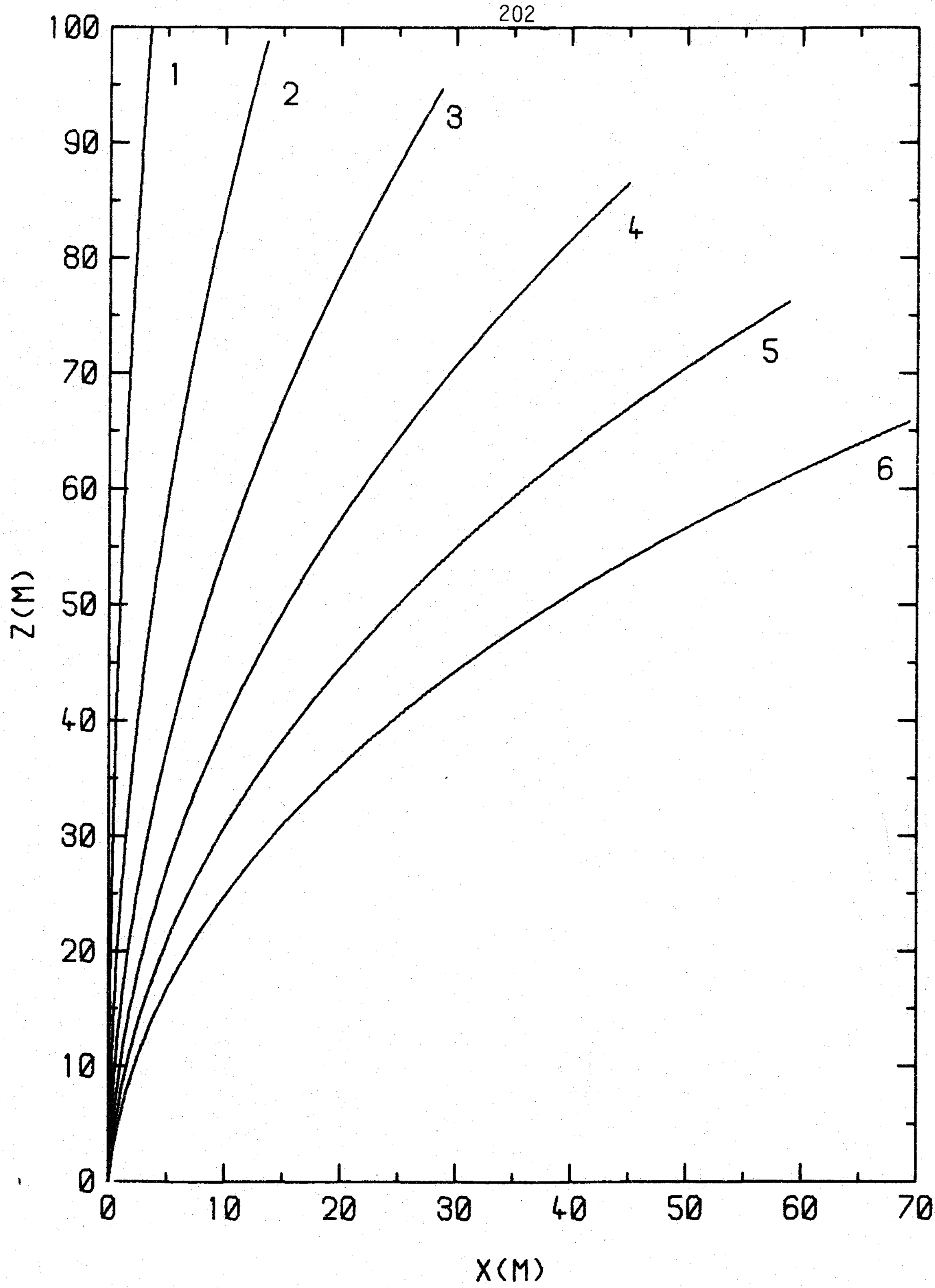


Figure A4. The shape of a towed thermistor chain, 100 m in length, for tow speeds ranging from 1 to 6 m/s. The chain is assumed to be weightless in water and the drag force is assumed proportional to s, the distance along the chain.

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