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SUMMARY

Artificial radioactivity in the environment in New Zealand and Rarotonga during 1988 continued to be at a trace level only, typical of recent years.

Average levels were: total beta activity in air, 0.08 mBq/m^3; strontium-90 deposition, 0.1 MBq/km^2; caesium-137 in milk, 0.18 Bq/gK; strontium-90 in milk, 0.041 Bq/gCa. No artificial radionuclides were detected on high-volume air filters.

Total beta activity deposition at Hokitika was higher than usual at 336 MBq/km^2, and this is thought to be due to heavy deposition of natural radioactivity during heavy spring rains. Strontium-90 deposition was the lowest since measurements began in 1960, and was virtually undetectable.

The report includes monitoring data for natural beryllium-7 including plots of variations in atmospheric concentration during 1987 and 1988.

CONTENTS

INTRODUCTION

The National Radiation Laboratory has been monitoring environmental radioactivity levels in the New Zealand and South Pacific regions since 1960, as described in earlier reports in this series[1,2]. Monitoring was initially conducted for radioactive fallout from nuclear weapons tests in the Northern Hemisphere, and then for fallout from the French testing programme in the Tuamotu Archipelago. When the French atmospheric testing programme was terminated in 1974 monitoring continued for residues from atmospheric tests and in order to detect any venting from the underground tests. Although these two factors are still primary interests, the emphasis is again changing towards the need to provide warning of any influx of artificial radioactivity into the New Zealand and South Pacific regions, from any source. The National Radiation Laboratory has now become part of international networks which have been set up to improve cooperation and information dissemination during nuclear emergencies, as discussed later in this report.

There is also now much scientific interest in apparent long term changes in atmospheric composition and theories concerning possible climatic effects. Data from the monitoring programme concerning natural radionuclides and trends in levels during the year are presented in detail in this report (and in subsequent issues) in order to make them available for workers in this area.

The environmental radioactivity monitoring programme comprises the following measurements:

Atmospheric radioactivity - total beta activity, fission product, and natural beryllium-7 (Be-7) levels are monitored with weekly sample collection at Kaitaia, Hokitika and Rarotonga;

Radioactive deposition - total beta activity deposition is monitored at Hokitika and Rarotonga, with weekly sample collection, while strontium-90 (Sr-90) deposition is monitored with monthly collections at Kaitaia, Hokitika and Rarotonga;

Radioactivity in milk - strontium-90 and caesium-137 (Cs-137) concentrations are monitored in dairy milk powders with monthly sample collection from three New Zealand regions: Auckland, Taranaki and Westland.

The rationale behind this monitoring programme, which was revised in 1986, has been discussed earlier[3,4]. Other earlier reports[1,2] gave information on terms of reference, reference levels, potential health hazard and technical information[3,5].

1988 MONITORING RESULTS

Monitoring results for 1988 are summarised in Tables 1-3, while atmospheric radioactivity and deposition rate fluctuations are illustrated in Figures 1-9. The precision of measurements is indicated by the 95% confidence limits tabulated with the results.

Atmospheric radioactivity

A new type of high-volume air filter was introduced during 1988 - "Microdon FA2311" - when the older type LM2030 ceased production. The filtering efficiency of FA2311 is similar to that of

LM2030, but with a lower flow rate of approximately 3 m^3/min. The filters were changed once per week, with a weekly volume sampled of approximately 28 000 m^3, and analysed by high-resolution gamma spectroscopy for artificial gamma-emitting radionuclides and natural Be-7, and by gas-flow proportional counting for total beta activity.

No artificial radionuclides were detected on air filters from any monitoring site during 1988 (limit of detection approximately 1 microbecquerel per m^3).

The total beta activity, due mainly to natural radionuclides such as lead-210 (Pb-210), ranged from < 0.04 - 0.22 mBq/m^3, with means at the three sites of 0.06 - 0.10 mBq/m^3 which were similar to those recorded in 1987[6].

Natural Be-7 levels ranged from 0.2 - 6.9 mBq/m^3, with an overall mean of 3.2 mBq/m^3. (Be-7 is not a beta emitter and so does not interfere with beta activity measurements).

The variation of Be-7 levels and total beta activity with time is illustrated in Figures 1-6, which show 5-week moving average values for each site during 1988 and for the latter 9 months of 1987. Beryllium-7 levels showed well-defined peaks during the spring/early summer period (September-November) at all sites except Hokitika in 1988. Earlier peaks during Autumn (February-April) were also evident during 1988. The mid-winter low Be-7 period was also observed at Hokitika during 1986[7].

Most Be-7 production (due to interaction of cosmic radiation with the atmosphere) occurs in the stratosphere and upper troposphere, and variations in Be-7 levels at ground level are due to four main factors: influx of stratospheric air into the troposphere; transport from the upper troposphere due to vertical mixing; horizontal transport from other latitudes due to circulation; and the degree of washout. The peak levels observed in spring and early summer may be due to the well known "spring influx" of stratospheric air, and also to the greater degree of vertical mixing in the warming atmosphere. Heavy rainfall at Hokitika during the spring of 1988 (see Figure 8) may have suppressed the Be-7 peak due to washout, although a 1986 study[7] indicated that there was (then) a sufficient reservoir of Be-7 in the atmosphere for depletion by rainfall not to be significant at Hokitika.

It will be interesting to observe trends in Be-7 levels during the future for evidence of effects of changes in atmospheric circulatory and meteorological phenomena. It is also planned to present data for Pb-210, a natural radionuclide of tropospheric origin, in future reports in this series.

Radioactive deposition

Deposition results are summarised in Table 2.

The total beta activity deposited in rain was measured weekly for the full year at Hokitika and for the second half year at Rarotonga. The deposited radioactivity was assumed to be mainly due to natural Pb-210, as discussed earlier[3,4].

The 1988 deposition at Hokitika was 336 ± 24 MBq/km^2, with 2743 mm of rainfall. At Rarotonga the deposition for June-December was 75 ± 24 MBq/km^2, with a rainfall for the period of 1278 mm.

Deposition data for the Hokitika area (including some early measurements at Greymouth, 40 km north) over the period 1967-1988 are graphed in Figure 7. These data indicate an increase in annual deposited radioactivity there during 1985-1988, with the 1988 level being the highest since 1975 when weapons tests ceased making a major contribution to the deposited radioactivity.

While the 1988 deposition at Hokitika was insignificant in comparison with those measured in the pre-1976 "fallout era", the slight increase recently has been noted and the trend over the next few years will be observed with interest. The phenomenon was not observed at Rarotonga where the annual deposition, estimated from the 7 months' data collection, was 115 MBq/km^2 which is similar to the average of 1975-1986 depositions of 137 MBq/km^2.

The increased beta activity deposition was not matched with more artificial fallout deposition - the Sr-90 deposition was lower than ever at Hokitika during 1988, as described below. This further supports the deposited beta activity being of natural origin.

The variation in weekly deposition at Hokitika during 1988 and 1987 is illustrated in Figures 8 and 9, together with rainfall data. In both years a significant peak in deposition was observed during the mid-September to mid-October period (day 260-300), and the higher total deposition for 1988 was due largely to the extra deposited at that time. The rainfall rate also peaked at that time but not at an unusual level.

Strontium-90 deposition for the year was the lowest recorded since monitoring began, at all sites: Kaitaia 0.1 MBq/km^2, Hokitika 0.1 MBq/km^2, Rarotonga < 0.1 MBq/km^2. The 3-site average, 0.1 MBq/km^2, was lower than those of 1987 (0.4 MBq/km^2) and 1986 (0.3 MBq/km^2)[6]. The apparent variability in these results reflects the fact that all are near the limit of detection and that the Laboratory has had to resort to analysis of bulked composite samples in order to detect any Sr-90 at all.

Radioactivity in milk

Caesium-137 levels in cows' milk were assessed by gamma spectroscopic analysis of 3-month aggregates of monthly samples. Results are shown in Table 3, with units of Bq per gram potassium (Bq/gK) and Bq per kilogram of milk powder (Bq/kg).

The 1988 Cs-137 level averages were: Auckland 0.07 Bq/gK; Taranaki 0.36 Bq/gK; Westland 0.13 Bq/gK. The three-region mean was 0.18 Bq/gK or 2.4 Bq/kg powder, similar to the 1987 mean of 0.19 Bq/gK[6].

Strontium-90 levels in cows' milk were measured by radiochemical analysis of 3-month aggregated samples. Results are shown in Table 3, with units of Bq per gram calcium (Bq/gCa) and Bq/kg powder.

The 1988 Sr-90 level averages were: Auckland 0.027 Bq/gCa; Taranaki 0.044 Bq/gCa; Westland 0.052 Bq/gCa. The three-region mean was 0.041 Bq/gCa or 0.5 Bq/kg, similar to the 1987 mean of 0.045 Bq/gCa[6].

CONCLUSION

Artificial radioactivity levels in the New Zealand and South Pacific environments, as indicated by measurements of atmospheric, deposited, and milk radioactivity, remained very low during 1988, consistent with an environment containing only traces of residual global weapons-test

fallout. These traces were insignificant in comparison with natural radioactivity levels: Be-7 concentrations in ground-level air averaged 40 times the total beta activity, with almost all of the latter also being due to naturally-occurring radionuclides.

Deposition of beta activity was heavier than usual at Hokitika during 1988, although Sr-90 deposition was light and consistent with the continuing downward trend in strontium fallout levels. It is assumed that the total beta result was due to a natural phenomenon which resulted in relatively heavy Pb-210 deposition at Hokitika during heavy spring rainfall.

There was no detectable influx of fresh fission products into the region during 1988.

OTHER WORK

A report on the natural radioactivity of New Zealand coals[8] and a study of radioactive emissions from the Huntly coal-fired Power Station[9] were completed during 1988.

The Russian satellite, Cosmos 1900, re-entered Earth's atmosphere in October 1988. The Laboratory prepared contingency plans for searching for radioactive debris in the extremely unlikely event that debris landed in New Zealand territory. As it happened the nuclear power unit was successfully boosted into a "parking orbit" before the satellite was destroyed by burn-up over the African continent.

There was a steady demand for export certificates during 1988. This was a result of most countries to which New Zealand exports foodstuffs requiring certification by the National Radiation Laboratory (as the country's competent authority on radiation issues) that the exports complied with the relevant import restrictions. During the year 397 certificates were issued.

A commercial radioactivity testing service is now provided by the Laboratory for customers who require advice on radioactivity levels. During 1988 158 samples were tested.

Imported foodstuffs continued to be monitored for radioactivity by the Department of Health. The Laboratory issued 170 import test certificates in 1988.

INTERNATIONAL LINKS

Following the Chernobyl nuclear reactor accident in 1986 the International Atomic Energy Agency (IAEA) and the World Health Organization (WHO) have each set up international networks of radiation protection and monitoring agencies in order to facilitate the transfer of information and assistance in any future nuclear emergencies.

The IAEA has established two international conventions: the "Convention on Early Notification of a Nuclear Accident", and the "Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency". New Zealand is now a signatory to both these conventions, with the National Radiation Laboratory as the designated contact point. They are intended to allow the rapid communication of radiological information, as well as requests for and offers of assistance, to the IAEA in Vienna during any nuclear emergency. From Vienna the information would be passed on to other convention signatories.

As New Zealand has no nuclear installations capable of causing environmental impacts beyond the country's boundaries, it is very unlikely to ever need to activate the Convention. The

prompt receipt of information from other countries would, however, be very helpful - one of the frustrations experienced following the Chernobyl accident was the difficulty in obtaining accurate and current information. Furthermore, New Zealand has limited resources of personnel and equipment for handling nuclear emergencies and any offers of assistance from New Zealand would accordingly be at a very low level.

The WHO has recently established a Global Environmental Radiation Monitoring Network (GERMON) to ensure that information is constantly available regarding the radioactivity status of the global environment. As the National Radiation Laboratory is already a WHO Collaborating Centre for Environmental Radioactivity Measurement it is likely to join the GERMON also in the near future.

These networks are constructive steps towards overcoming deficiencies in international information transfer which were highlighted during the Chernobyl affair. New Zealand's participation will ensure that as much information as possible is available to aid in advisory work. This may be particularly important for a country largely dependent on the export of primary agricultural produce in a world of increasing sensitivity to pollution issues.

ACKNOWLEDGEMENT

The assistance given by the staff of this and other Government Departments, especially the New Zealand Meteorological Service, and Managers of milk processing plants, is gratefully acknowledged. The Laboratory's Environmental Radioactivity and Chemistry Section organized the monitoring and analysed the samples. This report was written by the Section Head, Dr K M Matthews, who was assisted technically by Ms M Okey and Ms R M Larkin.

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4. "Environmental Radioactivity Annual Report", NRL-F/66 (1987). National Radiation Laboratory, Christchurch.

5. "Environmental Radioactivity Annual Report", NRL-F/64 (1985). National Radiation Laboratory, Christchurch.

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TABLE 1: Atmospheric radioactivity summary. Ranges and means of total beta activity (TBA) and Be-7 levels recorded during 1989.

	TBA (mBq/m^3)		Be-7 (mBq/m^3)	
	range	mean	range	mean
Kaitaia	<0.04 - 0.19	0.10	2.0 - 6.5	3.9
Hokitika	<0.04 - 0.22	0.09	0.5 - 5.5	2.9
Rarotonga	<0.04 - 0.16	0.06	0.2 - 6.9	2.8

TABLE 2: Deposited radioactivity summary. Strontium-90 and total beta activity (TBA) deposition and rainfall during 1988.

	Sr-90 MBq/km^2	TBA MBq/km^2	Rainfall mm
Kaitaia	0.1 ± 0.2		1438
Hokitika	0.1 ± 0.2	336 ± 24	2743
Rarotonga	<0.1	75 ± 24*	1278*

* June - December only

TABLE 3: Caesium-137 and strontium-90 levels in dairy milk during 1988. Results are expressed as Bq Cs-137 per gram potassium, Bq Sr-90 per gram calcium, and as Bq per kilogram of milk powder, for each quarter year.

Caesium-137

Qtr	Auckland		Taranaki		Westland	
	Bq/gK	Bq/kg	Bq/gK	Bq/kg	Bq/gK	Bq/kg
1	0.13 ± 0.02	2.0 ± 0.2	0.45 ± 0.03	6.5 ± 0.4	0.15 ± 0.01	2.4 ± 0.2
2	0.06 ± 0.01	0.8 ± 0.1	0.47 ± 0.02	4.5 ± 0.1	0.10 ± 0.01	0.9 ± 0.1
3	<0.04	<0.6	0.26 ± 0.02	3.1 ± 0.2	0.13 ± 0.01	1.6 ± 0.2
4	0.04 ± 0.01	0.6 ± 0.1	0.25 ± 0.02	3.9 ± 0.3	0.12 ± 0.01	1.9 ± 0.1
Mean	0.07	1.0	0.36	4.5	0.13	1.7

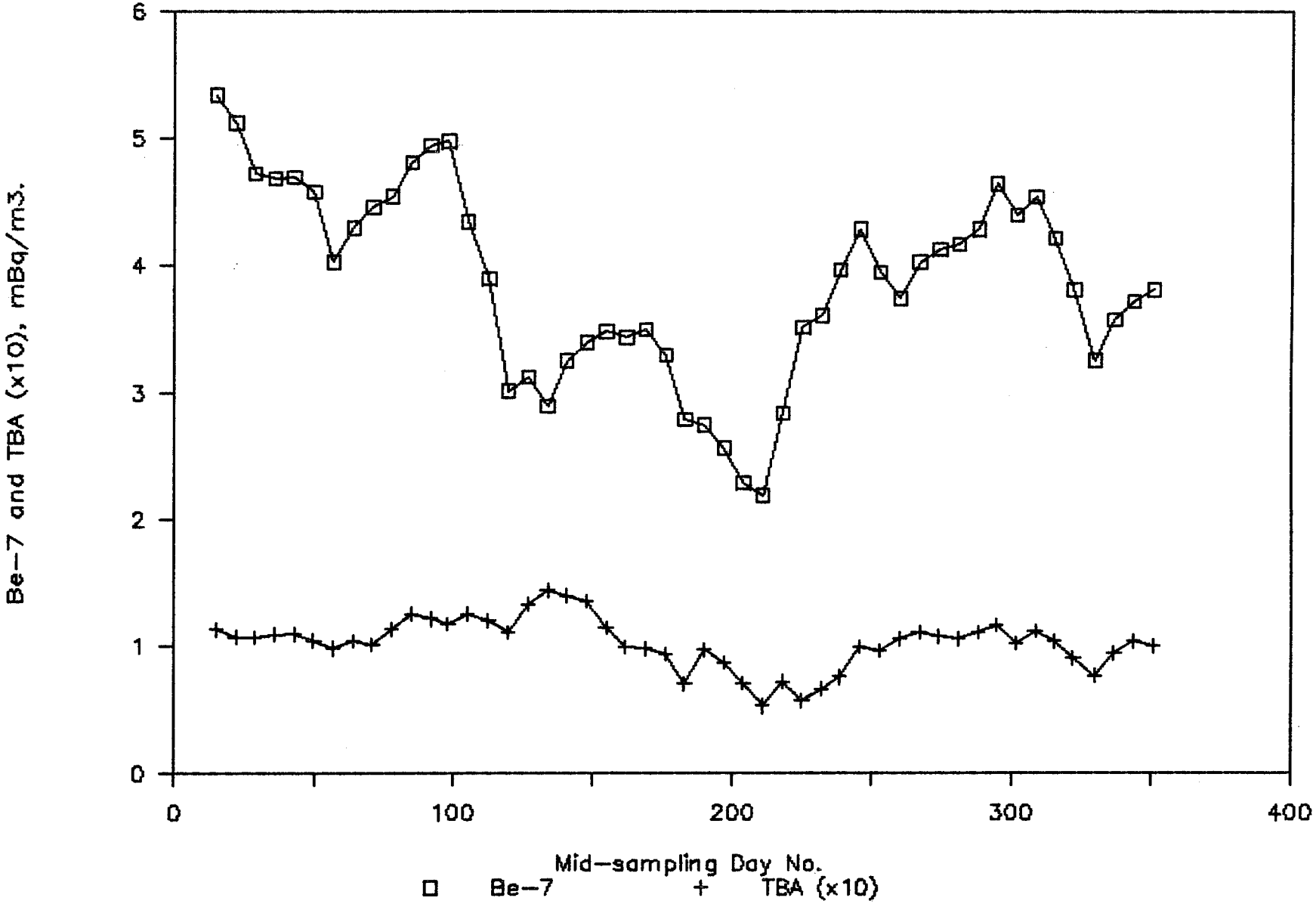
Strontium-90

Qtr	Auckland		Taranaki		Westland	
	Bq/gCa	Bq/kg	Bq/gCa	Bq/kg	Bq/gCa	Bq/kg
1	0.009 ± 0.009	0.12 ± 0.12	0.036 ± 0.006	0.45 ± 0.08	0.053 ± 0.007	0.67 ± 0.09
2	0.023 ± 0.018	0.30 ± 0.23	0.052 ± 0.007	0.63 ± 0.13	0.063 ± 0.011	0.83 ± 0.14
3	0.050 ± 0.006	0.62 ± 0.07	0.047 ± 0.006	0.56 ± 0.07	0.047 ± 0.008	0.57 ± 0.10
4	0.027 ± 0.005	0.36 ± 0.06	0.042 ± 0.006	0.48 ± 0.07	0.043 ± 0.006	0.55 ± 0.07
Mean	0.027	0.35	0.044	0.53	0.052	0.66

Figs. 1-6. The variation in Be-7 and total beta activity (TBA) concentrations in the atmosphere plotted against time (expressed as day number at the middle of each sampling period). One week sampling periods were used and 5-week moving averages are plotted. For scaling purposes TBA results were multiplied by 10. The 1987 data are for April - December only.

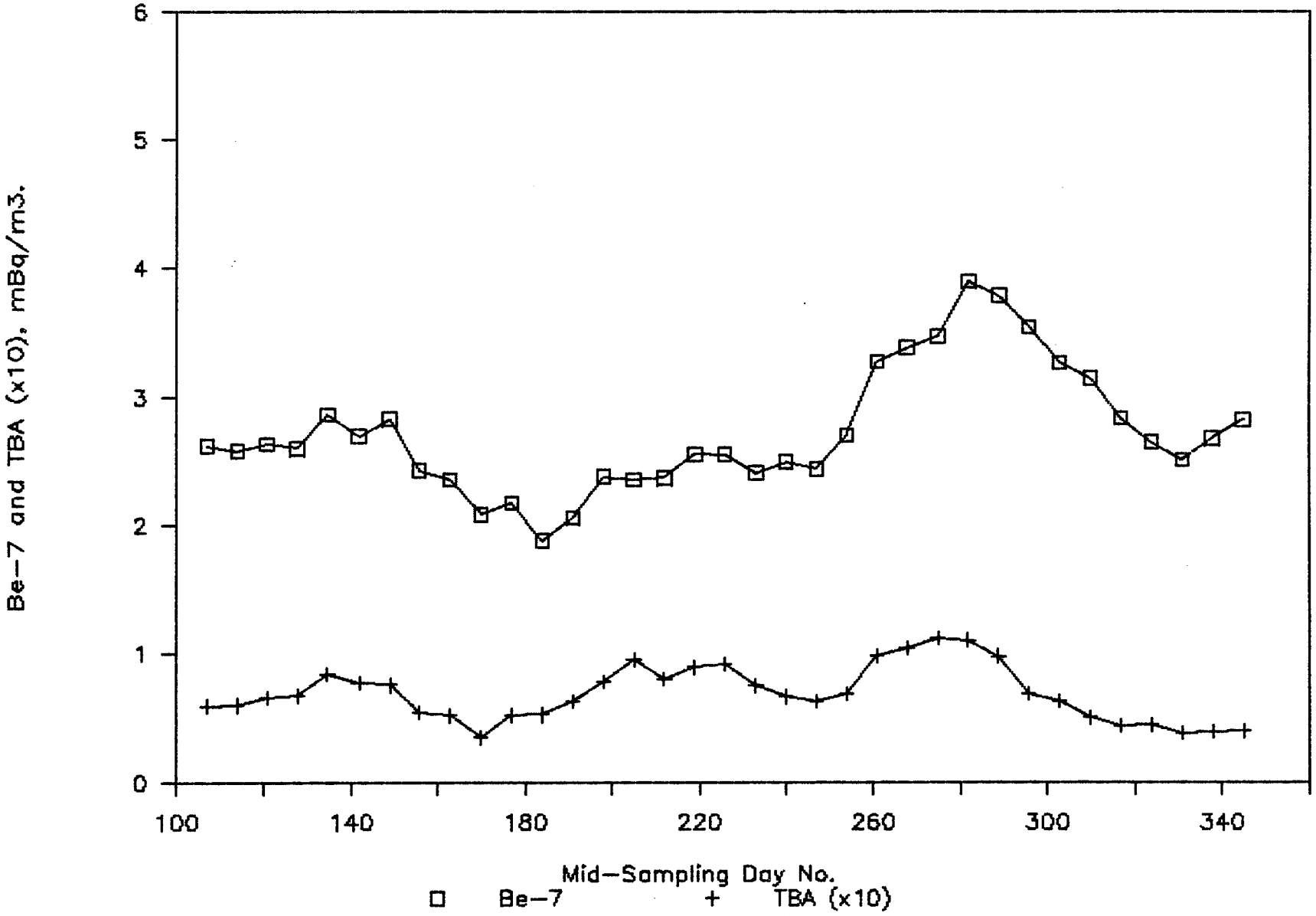
KAITAIA ATMOSPHERIC MONITORING 1988.

5 Week Moving Averages.



KAITAIA ATMOSPHERIC MONITORING 1987

5 Week Moving Averages



HOKITIKA ATMOSPHERIC MONITORING 1988

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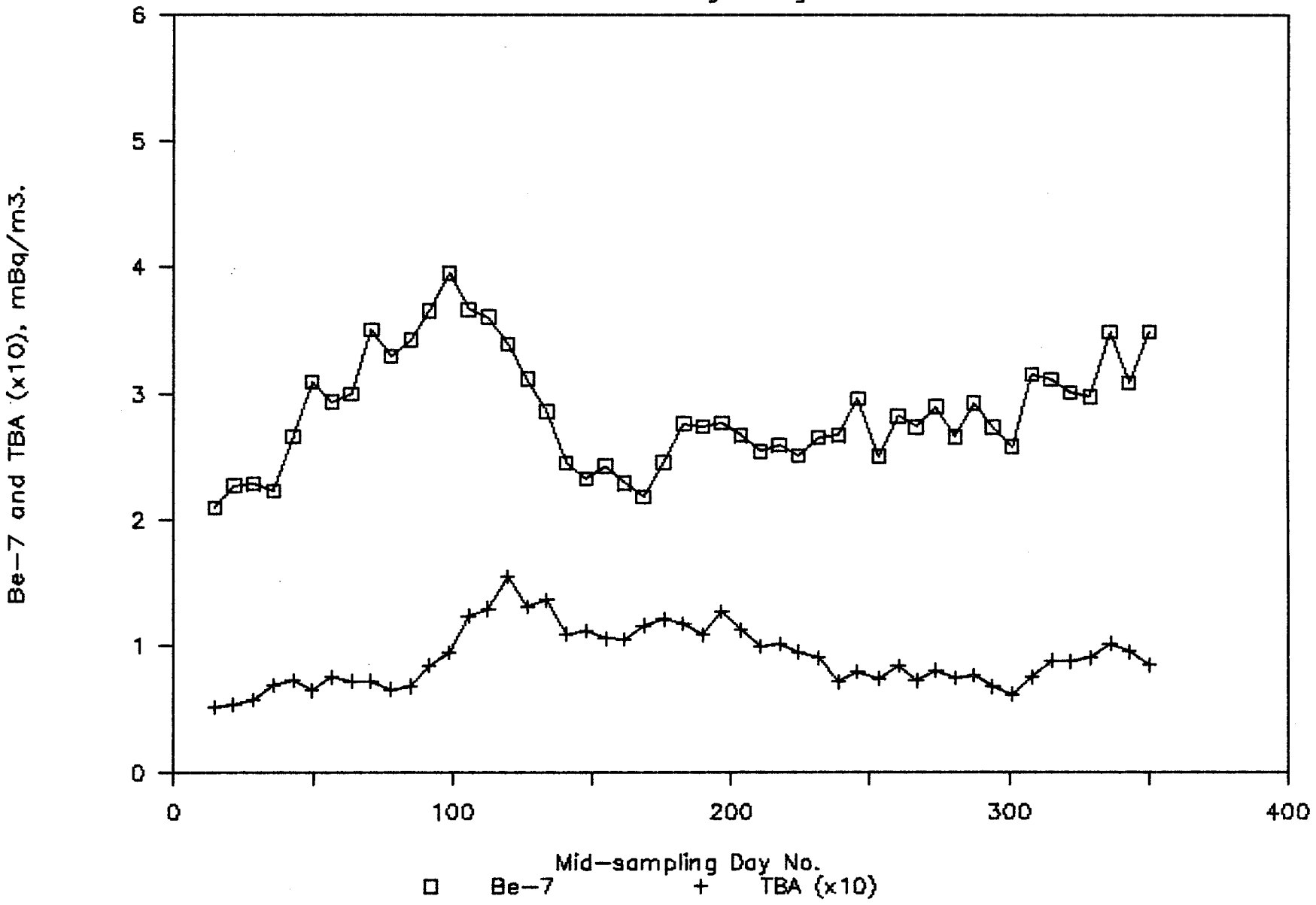

HOKITIKA ATMOSPHERIC MONITORING 1987

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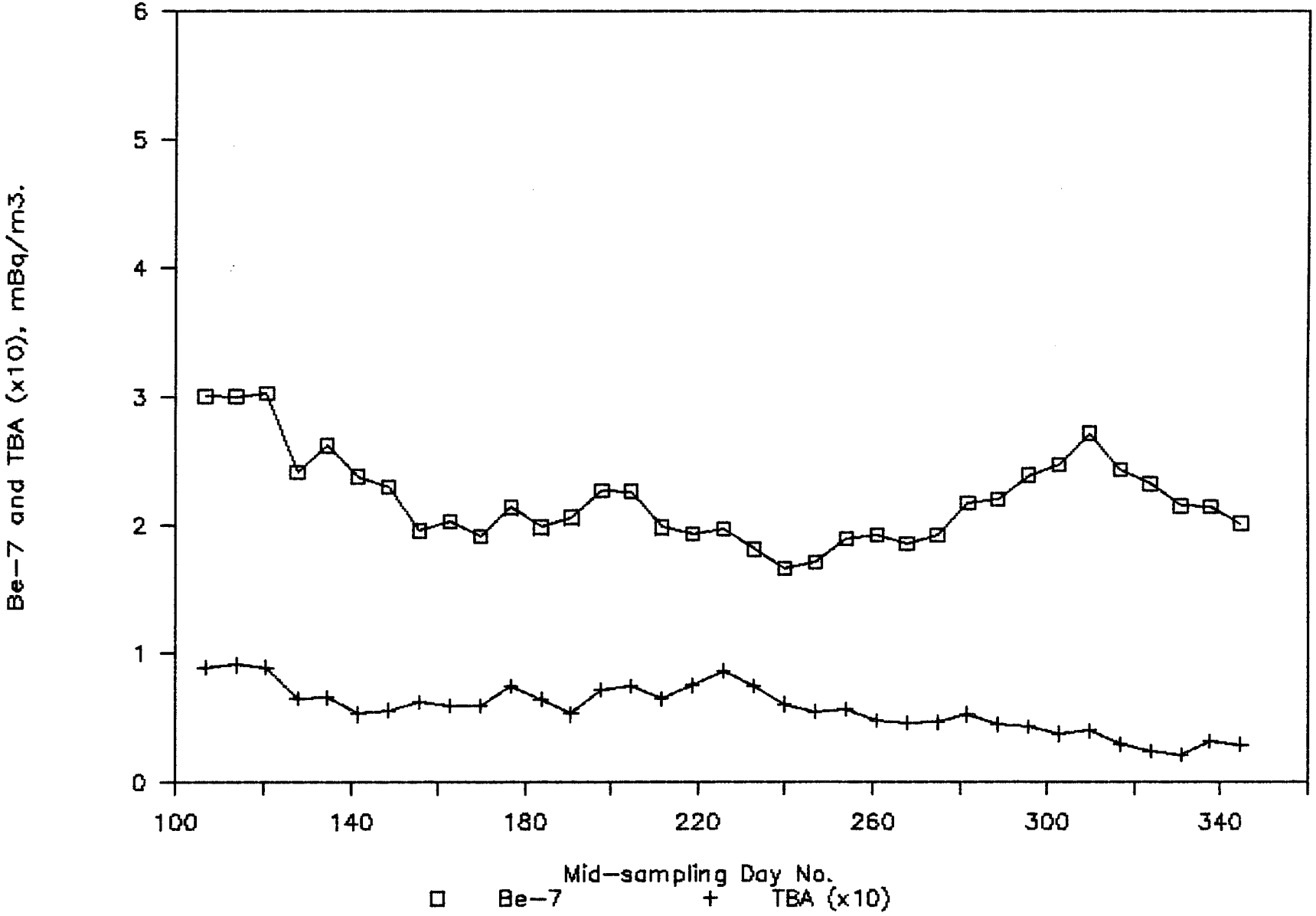
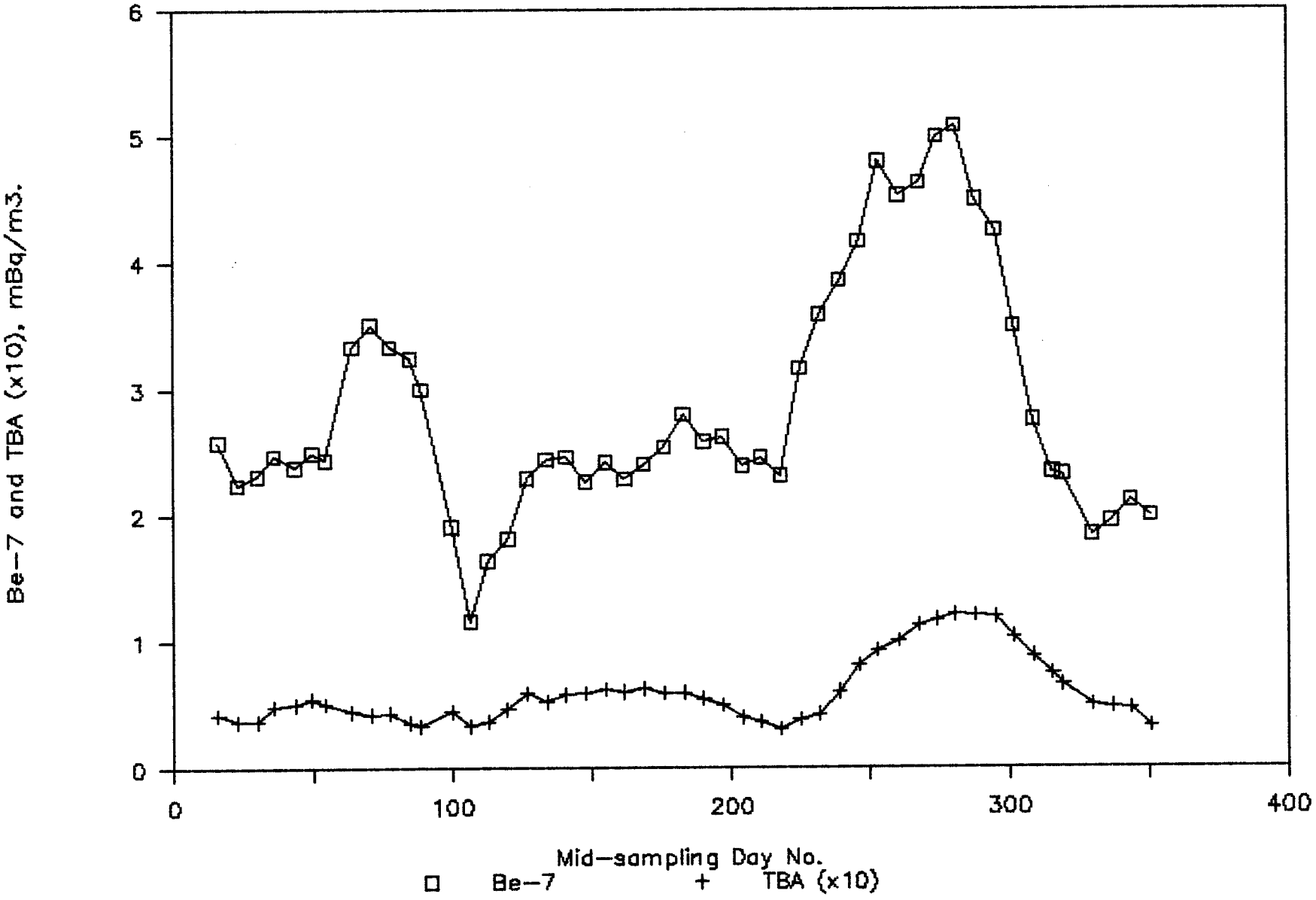
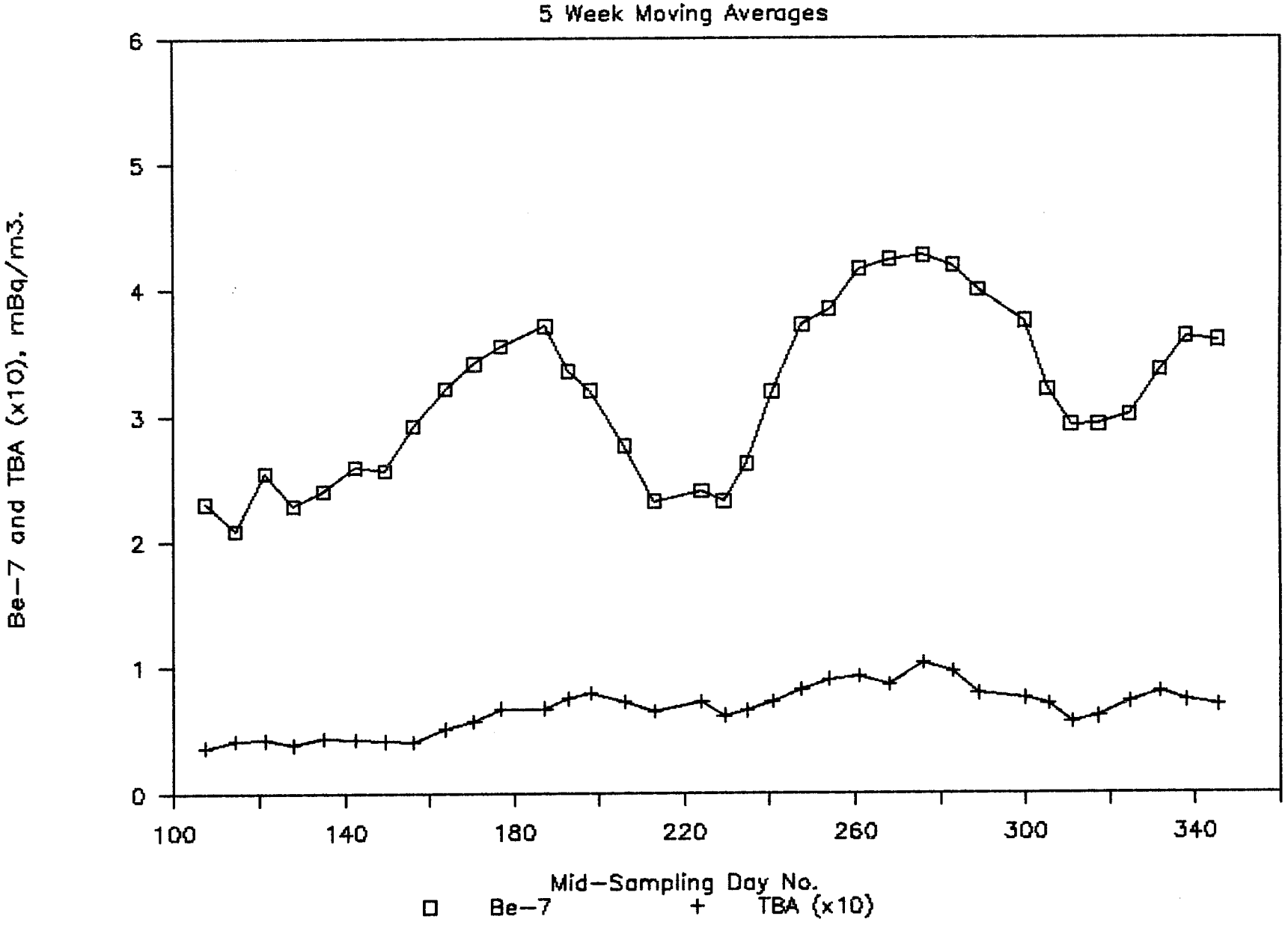


RAROTONGA ATMOSPHERIC MONITORING 1988

5 Week Moving Averages.



RAROTONGA ATMOSPHERIC MONITORING 1987



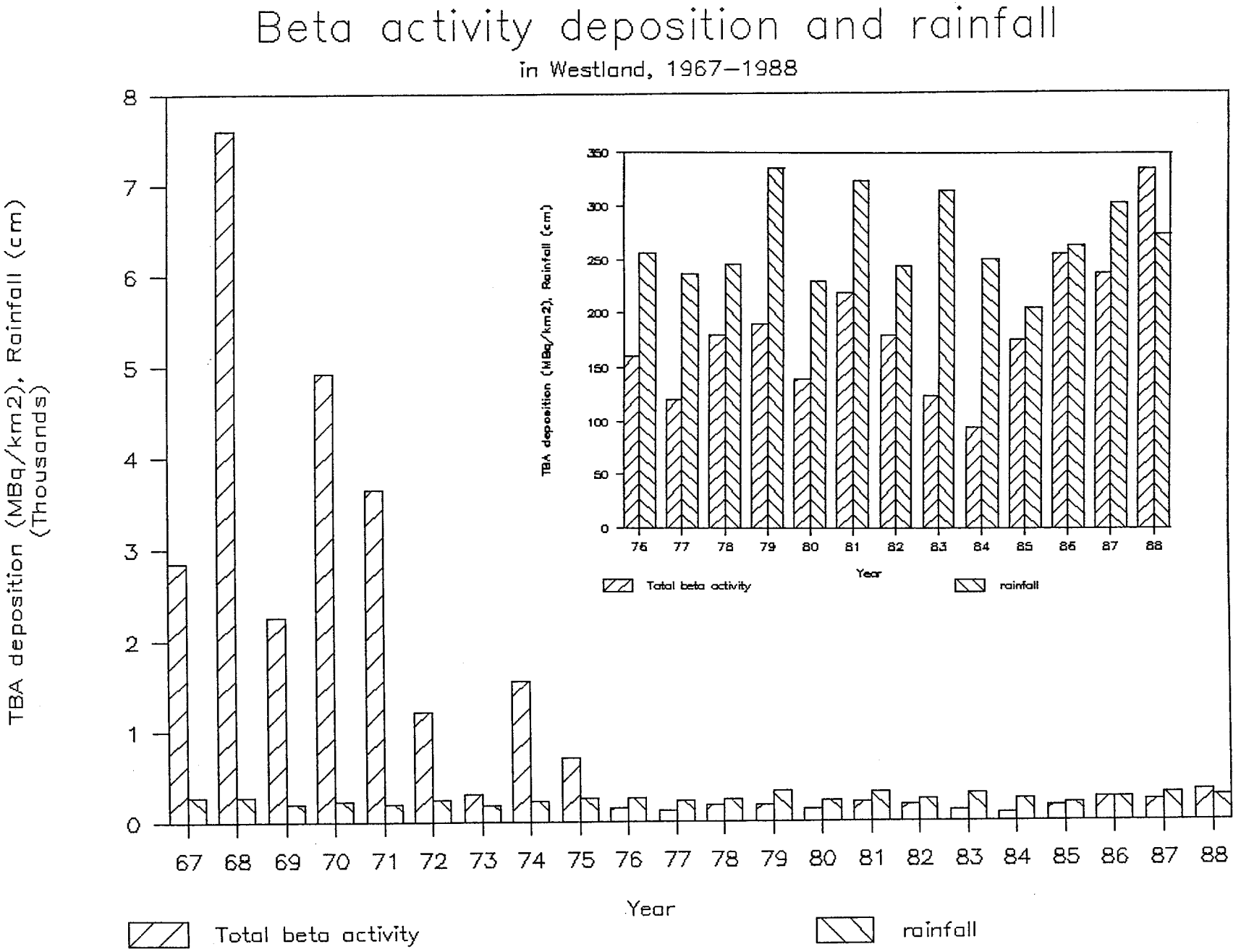


Fig. 7. Annual total beta activity deposition and rainfall in Westland during the period 1967 - 1988. The inset shows, on an enlarged scale, the trend over recent years.

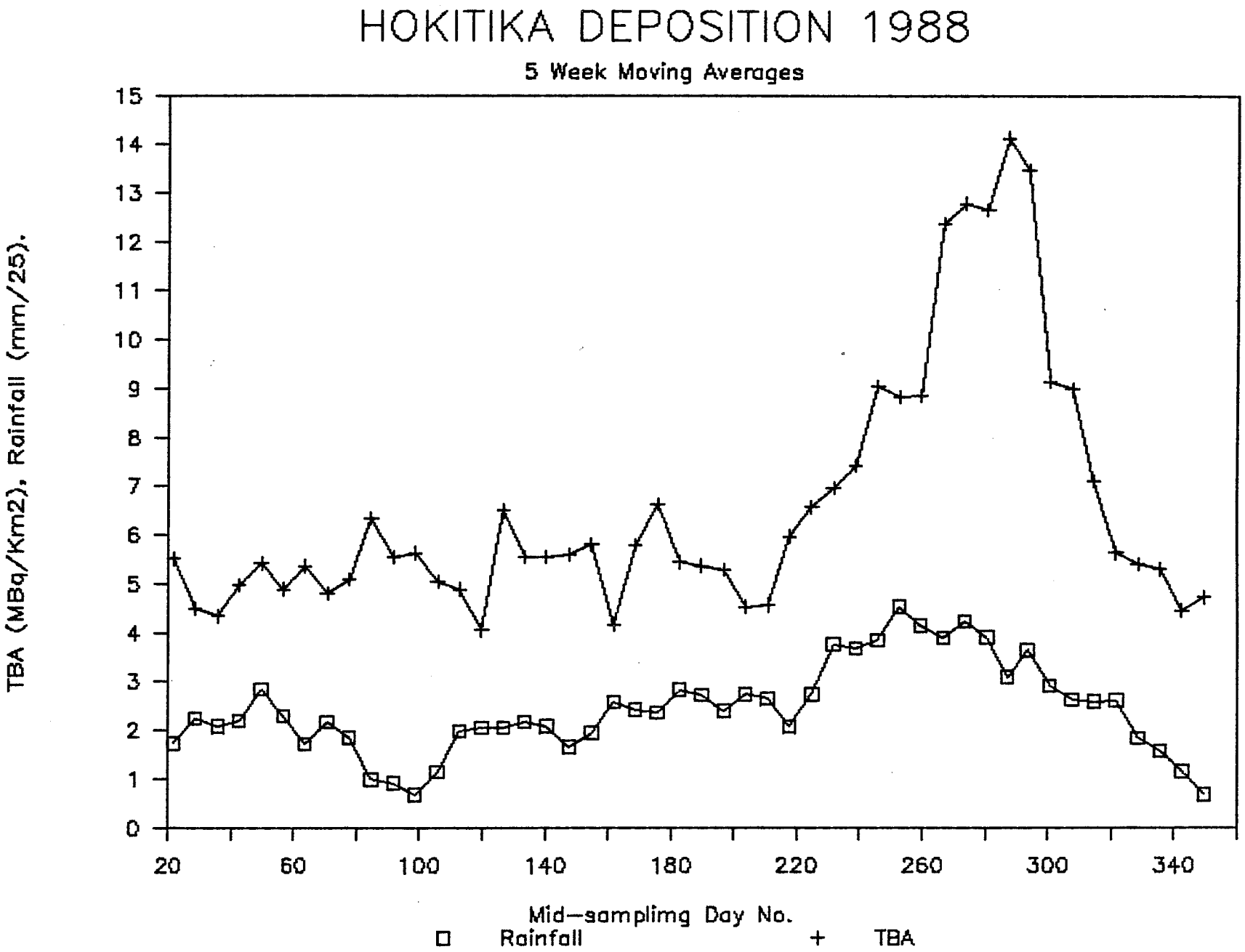


Fig.8. The variation of weekly total beta activity deposition and rainfall at Hokitika during 1988. For scaling purposes the rainfall (mm) was divided by 25.

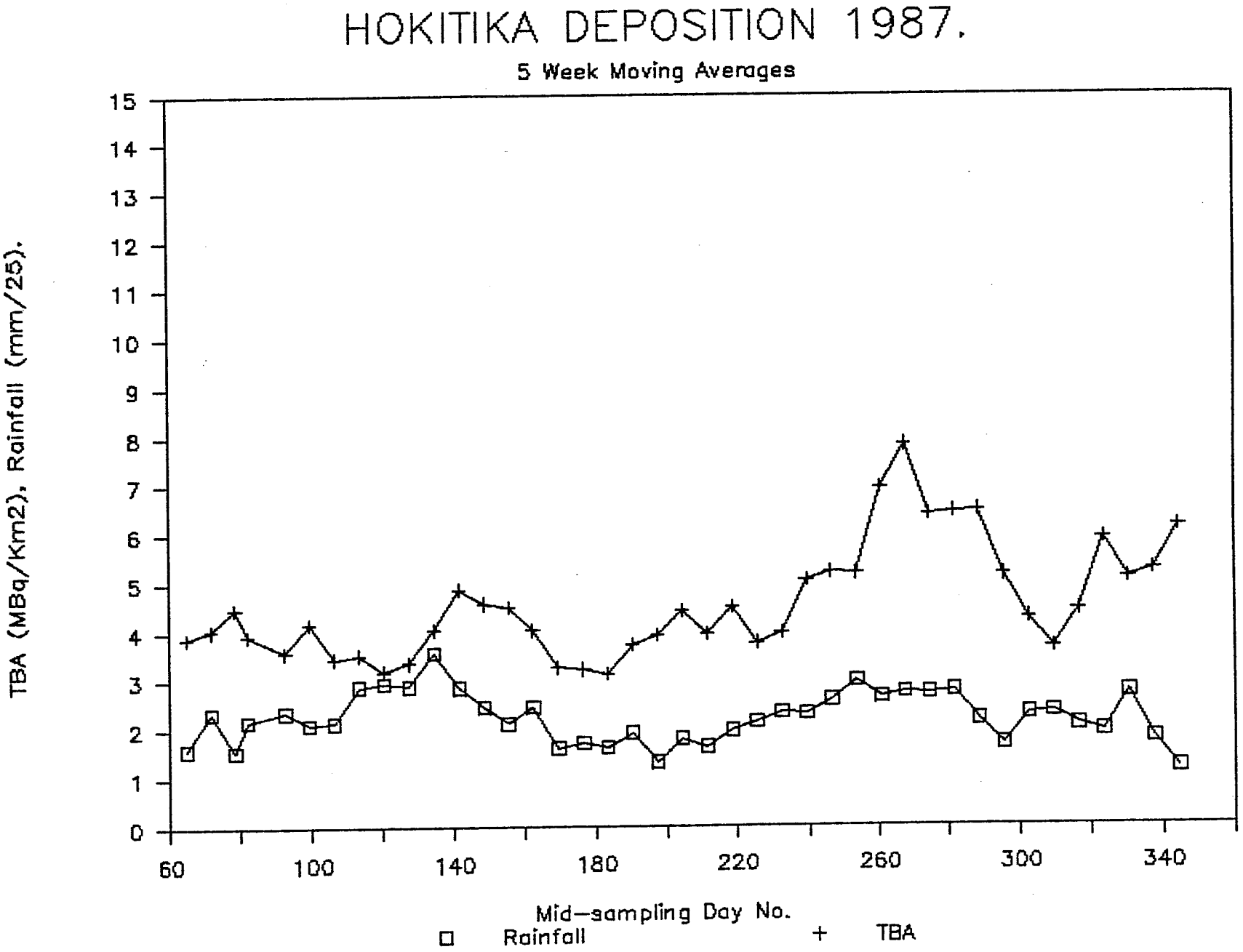


Fig.9. The variation of weekly total beta activity deposition and rainfall at Hokitika during 1987. For scaling purposes the rainfall (mm) was divided by 25.