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ENVIRONMENTAL RADIOACTIVITY ANNUAL REPORT

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NATIONAL RADIATION LABORATORY
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SUMMARY

During 1990 artificial radioactivity in the environment in New Zealand and Rarotonga continued to be at a trace level only, typical of recent years. There has been no significant change in artificial radioactivity levels since 1989.

Average levels were: total beta activity in air, 0.09 mBq/m^3; ^{90}Sr deposition, 0.1 MBq/km^2; ^{137}Cs in milk, 0.14 Bq/gK; ^{90}Sr in milk, 0.036 Bq/gCa. Total beta activity depositions at Hokitika and Rarotonga were 201 MBq/km^2 and 80 MBq/km^2 respectively. Atmospheric and deposited beta activity were due primarily to ^{210}Pb.

No artificial radionuclides were detected on high-volume air filters.

The report provides atmospheric monitoring data for natural ^{7}Be and ^{210}Pb, including plots of variations in concentration during the year. Average concentrations of ^{7}Be and ^{210}Pb were 2.6 mBq/m^3 and 0.06 mBq/m^3 respectively.

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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. The emphasis now is more on 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 is involved in international networks which have been set up by the International Atomic Energy Agency (IAEA) and the World Health Organisation (WHO) to improve cooperation and information dissemination, particularly during nuclear emergencies. It also takes part in quality assurance programmes run by the WHO, IAEA, and the US Environmental Protection Agency (USEPA), and has recently begun analytical intercomparisons with the Environmental Surveillance & Study Laboratory, Tahiti.

Although the primary purpose of the monitoring programme is to monitor levels of artificial radioactivity, atmospheric measurements are extended to include naturally occurring radioactive materials, for comparative and scientific purposes. The atmospheric monitoring includes measurements of concentrations of lead-210 (^{210}Pb), polonium-210 (^{210}Po), and beryllium-7 (^{7}Be) in the atmosphere. Beryllium-7 is produced mainly in the upper atmosphere through the interaction of cosmic radiation with oxygen and nitrogen atoms while ^{210}Pb and ^{210}Po, being decay products of gaseous radon-222 (^{222}Rn) which diffuses out of soils, are of lower-atmospheric origin. Levels of potassium-40 (^{40}K) and uranium (^{238}U) and thorium (^{232}Th) decay products are also monitored as indicators of the resuspended dust content of air filters.

The environmental radioactivity monitoring programme therefore comprises the following measurements:

Atmospheric radioactivity - total beta activity (TBA), fission product, ^{7}Be, ^{210}Pb, ^{210}Po, ^{238}U and ^{232}Th decay products, and ^{40}K 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 (^{90}Sr) deposition is monitored with monthly collections at Kaitaia, Hokitika and Rarotonga;

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

This report summarises results of all the measurements, with the exception of natural atmospheric ^{210}Po, ^{238}U, ^{232}Th and ^{40}K levels which are to be published later elsewhere.

Earlier reports in this series give information on terms of reference, reference levels and potential health hazard[1,2], technical information[3,4], the design of the programme[3,5], and trends in levels[4]. The radioactivity units used throughout this report are the becquerel (Bq), millibecquerel (mBq), or Megabecquerel (Mbq).

1990 MONITORING RESULTS

Monitoring results for 1990 are summarised in Tables 1 and 2, while fluctuations in atmospheric radioactivity during 1990 are illustrated in Figs 1 - 3, and variations in ^{7}Be levels during the 4 year period 1987 - 1990 are depicted in Fig 4. The precision of measurements is indicated by the 95% confidence limits tabulated with the results.

Atmospheric radioactivity

Atmospheric radioactivity monitoring results are summarised in Table 1. The monitoring was conducted at Kaitaia, Hokitika and Rarotonga where centrifugal fan pumps drew air through filters (Microdon FA2311) at a flow rate of approximately 3 m^3/min. The filters were changed once per week, with a weekly volume sampled of approximately 30 000 m^3, and analysed by high-resolution gamma spectroscopy for artificial gamma-emitting radionuclides and natural radionuclides, by gas-flow proportional counting for TBA, and radiochemically for ^{210}Pb and ^{210}Po.

Unfortunately, the Rarotonga air pump suffered a major midyear breakdown and the site was without a pump for a period of 4 weeks. (The gap in data is accentuated in Fig.3 where 5-week moving-average values are plotted, showing an 8 week gap.)

Artificial radionuclides

No artificial radionuclides were detected on air filters from any monitoring site during 1990 (the limit of detection for individual radionuclides is of the order of 1 microbecquerel per m^3, for weekly average levels).

Total beta activity

The TBA, due mainly to the natural radionuclide ^{210}Pb (and its decay product bismuth-210, ^{210}Bi), ranged from <0.04 to 0.22 mBq/m^3, with an overall average of 0.09 mBq/m^3, as in 1989[6].

Natural radionuclides

Beryllium-7 levels ranged from 0.8 to 5.2 mBq/m^3, with an overall average of 2.6 mBq/m^3, as in 1989[6].

Lead-210 levels ranged from 0.01 to 0.18 mBq/m^3, with an overall average of 0.06 mBq/m^3, as in 1989[6]. The variation of TBA, ^{7}Be and ^{210}Pb levels with time is illustrated in Figures 1 - 3, which show 5-week moving-average values for each site during 1990.

In 1989 it was observed[6] that TBA and ^{7}Be levels followed similar trends during that year. This was also the case in 1990, although the similarity was less apparent at Hokitika.

Fluctuations in ^{210}Pb levels generally reflected TBA levels, as would be expected when the TBA is largely due to ^{210}Pb (and ^{210}Bi). The "excess" TBA (above the ^{210}Pb level), apparent throughout the year at Kaitaia and Rarotonga, and during the summer and autumn periods at Hokitika, is interesting and research into its origin is continuing. Significant contributions are likely to be made by natural uranium, thorium and potassium in resuspended dust and sea spray. However, similarities with variations in ^{7}Be levels, as observed in 1989[6], suggest possible stratospheric origin.

Trends in atmospheric ^{7}Be levels during the period 1987 - 1990 are illustrated in Fig 4. During 1990 the usual trend continued, of winter troughs and summer peaks at Kaitaia and Hokitika, and a spring peak at Rarotonga.

The periodicity of ^{7}Be levels, and relationships between TBA and natural radionuclide levels, are being studied further.

Radioactive deposition

Total beta activity

The 1990 TBA deposition at Hokitika was 201 ± 12 MBq/km^2, with 3039 mm of rainfall. At Rarotonga the deposition was 80 ± 12 MBq/km^2, with 1681 mm of rain.

These depositions were essentially the same as those recorded in 1989[6].

Deposited beta activity has, in recent years, been assumed to be due to natural ^{210}Pb. This assumption was tested in a 12 month study which concluded during 1990. Weekly rainwater samples from Hokitika were analysed for ^{210}Pb as well as TBA, and trends in levels monitored. It was found that their levels followed identical weekly variations during the period, and total depositions were: TBA 212 ± 6 MBq/km^2; ^{210}Pb 194 ± 4 MBq/km^2. The ^{210}Pb thus accounted for 92% of the TBA. (Although ^{7}Be is also deposited in rainwater, it is not a beta emitter and so makes no contribution to TBA.)

Strontium-90

Strontium-90 deposition has been at such low levels in recent years that is has been necessary, since 1986, for strontium recovered from the monthly rainwater collections to be aggregated into two 6 monthly measurements per year, in order that any ^{90}Sr present may be detected.

During 1990, ^{90}Sr deposition continued to be at the limits of detection, typical of recent years: Kaitaia 0.1 MBq/km^2, Hokitika 0.1 MBq/km^2, Rarotonga 0.2 MBq/km^2. These ^{90}Sr depositions may be contrasted with the TBA deposition recorded above.

Radioactivity in milk

Caesium-137

Caesium-137 levels in cows' milk were assessed by gamma spectroscopic analysis of 3-month aggregates of monthly samples. Results are shown in Table 2, with units of Bq per gram potassium (Bq/gK) and Bq per kilogram of milk powder (Bq/kg).

The 1990 average ^{137}Cs levels were: Auckland <0.04 Bq/gK; Taranaki 0.34 Bq/gK; Westland <0.04 Bq/gK. The three-region mean was 0.14 Bq/gK or 2 Bq/kg powder, similar to the 1989 mean of 0.19 Bq/gK[6].

Strontium-90

Strontium-90 levels in cows' milk were measured by radiochemical analysis of 3-month aggregated samples. Results are shown in Table 2, with units of Bq per gram calcium (Bq/gCa) and Bq/kg powder.

The 1990 average ^{90}Sr levels were: Auckland 0.028 Bq/gCa; Taranaki 0.042 Bq/gCa; Westland 0.037 Bq/gCa. The three-region mean was 0.036 Bq/gCa or 0.5 Bq/kg powder, similar to the 1989 mean of 0.041 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 at trace levels only during 1990, consistent with an environment containing only residual global weapons-test fallout.

The 1990 results were essentially the same as those reported for 1989[6] as indicated in the comparison of New Zealand site averages below:

	1990	**1989**	
TBA (air)	0.09	0.09	mBq/m^3
TBA (rain)	201	264	MBq/km^2
^{90}Sr (rain)	0.1	0.1	MBq/km^2
^{90}Sr (milk)	0.5	0.5	Bq/kg
^{137}Cs (milk)	2.0	2.6	Bq/kg

There was no detectable influx of fresh fission products into the region during 1990.

Environmental radioactivity is mainly of natural origin with the major component of atmospheric radioactivity being ^{7}Be. Concentrations of ^{7}Be peaked in summer at Kaitaia and Hokitika, and in spring at Rarotonga. Lead-210 and TBA levels showed relatively litte variation. Deposited beta radioactivity was almost entirely due to ^{210}Pb.

OTHER ENVIRONMENTAL WORK

A "Workshop on Environmental Radioactivity and Radionuclide Measurement" was attended in Adelaide during 1990 and 3 papers presented[7] summarising some aspects of work conducted at the Laboratory. Two other papers[8,9] also appeared in the literature.

There was a continuing demand for export certificates and radioactivity tests during 1990. During the year 655 export certificates were issued, 236 commercial tests performed, and 3 imports checked.

The Laboratory's involvement in international analytical intercomparisons continued, with the analysis of air filters for total beta activity, total alpha activity, ^{137}Cs and ^{90}Sr (USEPA); natural water for uranium isotopes (USEPA); water for ^{131}I (USEPA); milk for ^{137}Cs, ^{131}I, ^{90}Sr and K (USEPA); and vegetation and plankton samples for ^{90}Sr and ^{137}Cs (Tahiti). Performance in all intercomparisons was excellent.

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 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-J Okey, Ms R M Larkin and Ms Y F Osborne. Rachael Larkin left the Laboratory on 21 February 1990 to persue further studies, and Yvonne Osborne joined the staff on 6 August 1990.

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Table 1: Summary of measured 1990 atmospheric and deposited radioactivity levels.

Atmospheric radioactivity*

		Kaitaia	Hokitika	Rarotonga
TBA:	range	0.05-0.22	<0.04-0.19	0.04-0.16
	mean	0.11	0.08	0.08
^{7}Be:	range	0.8-4.8	0.8-4.5	1.4-5.2
	mean	2.9	2.2	2.8
^{210}Pb:	range	0.02-0.18	0.01-0.18	0.02-0.11
	mean	0.07	0.05	0.06
Fission products		nil	nil	nil

Deposited radioactivity*

	Kaitaia	Hokitika	Rarotonga
TBA		201 ± 12	80 ± 12
^{90}Sr	0.1 ± 0.2	0.1 ± 0.2	0.2 ± 0.2
Rain	1072	3039	1681

*** Units: atmospheric levels : mBq/m^3**
deposition : total year's deposition, MBq/km^2
rainfall : total year's rainfall, mm

TABLE 2: Caesium-137 and strontium-90 levels in dairy milk during 1990. Results are expressed as Bq ^{137}Cs per gram potassium, Bq ^{90}Sr per gram calcium, and as per 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	<0.04	<0.6	0.69 ± 0.03	10.5 ± 0.4	0.15 ± 0.01	2.3 ± 0.2
2	<0.04	<0.5	0.38 ± 0.03	4.3 ± 0.3	<0.04	<0.5
3	0.10 ± 0.01	1.5 ± 0.1	0.20 ± 0.02	2.9 ± 0.3	<0.04	<0.6
4	<0.04	<0.6	0.09 ± 0.01	1.0 ± 0.1	<0.04	<0.6
Mean	<0.04	<0.6	0.34	4.7	<0.04	<0.6

Strontium-90

Qtr	Auckland		Taranaki		Westland	
	Bq/g Ca	Bq/kg	Bq/g Ca	Bq/kg	Bq/g Ca	Bq/kg
1	0.025 ± 0.005	0.32 ± 0.06	0.044 ± 0.006	0.60 ±0.08	0.042 ± 0.005	0.55 ± 0.07
2	0.025 ± 0.006	0.33 ± 0.08	0.043 ± 0.006	0.60 ± 0.08	0.020 ± 0.005	0.27 ± 0.07
3	0.036 ± 0.008	0.46 ± 0.10	0.024 ± 0.007	0.29 ± 0.08	0.030 ± 0.008	0.39 ± 0.10
4	0.027 ± 0.004	0.36 ± 0.06	0.055 ± 0.007	0.75 ± 0.09	0.056 ± 0.008	0.71 ± 0.10
Mean	0.028	0.37	0.042	0.56	0.037	0.48

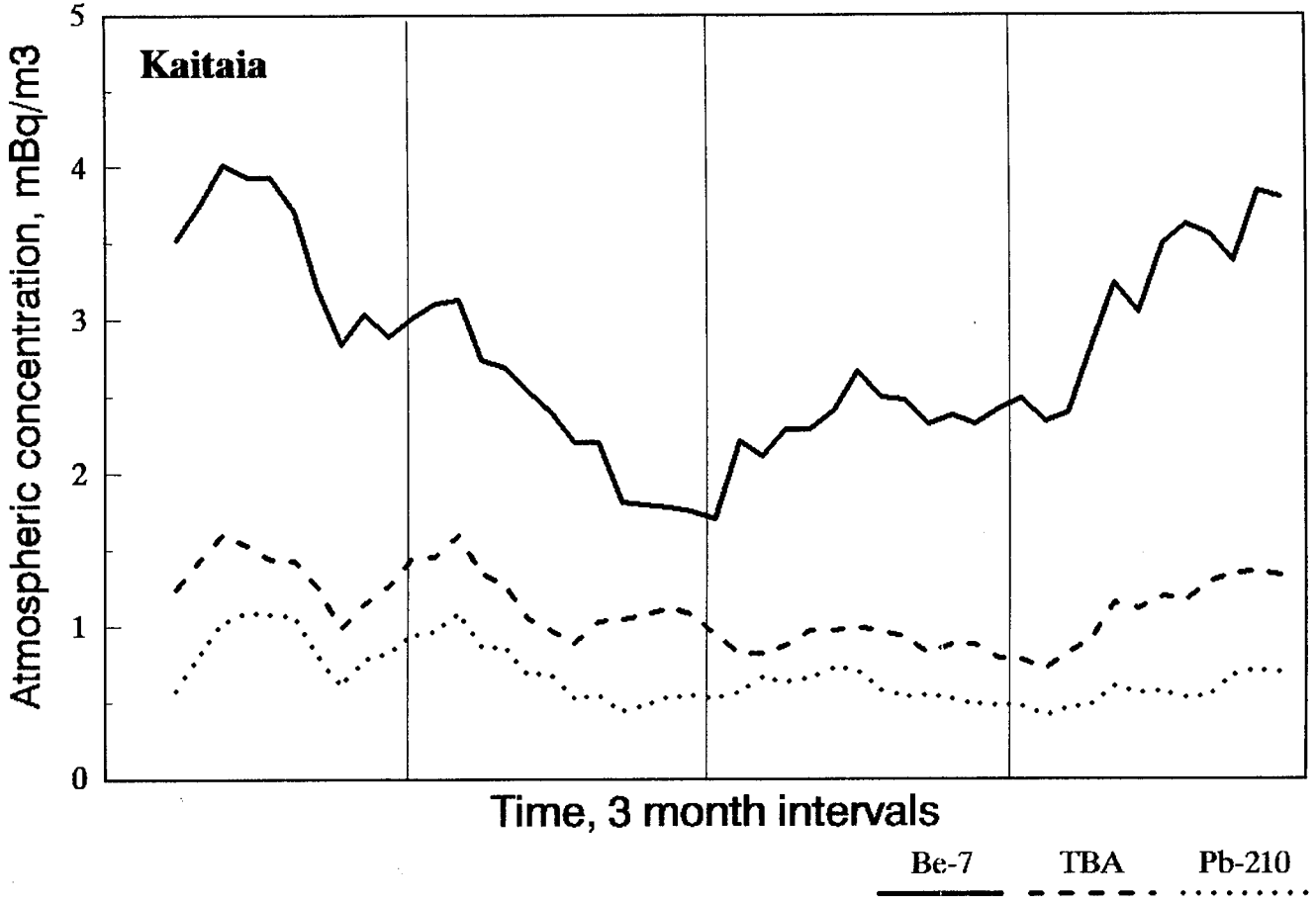

Fig 1. Five-week moving-average atmospheric concentrations of total beta activity (TBA), ^{7}Be and ^{210}Pb at **Kaitaia** during 1990. *For scaling purposes TBA and ^{210}Pb results were multiplied by 10.*

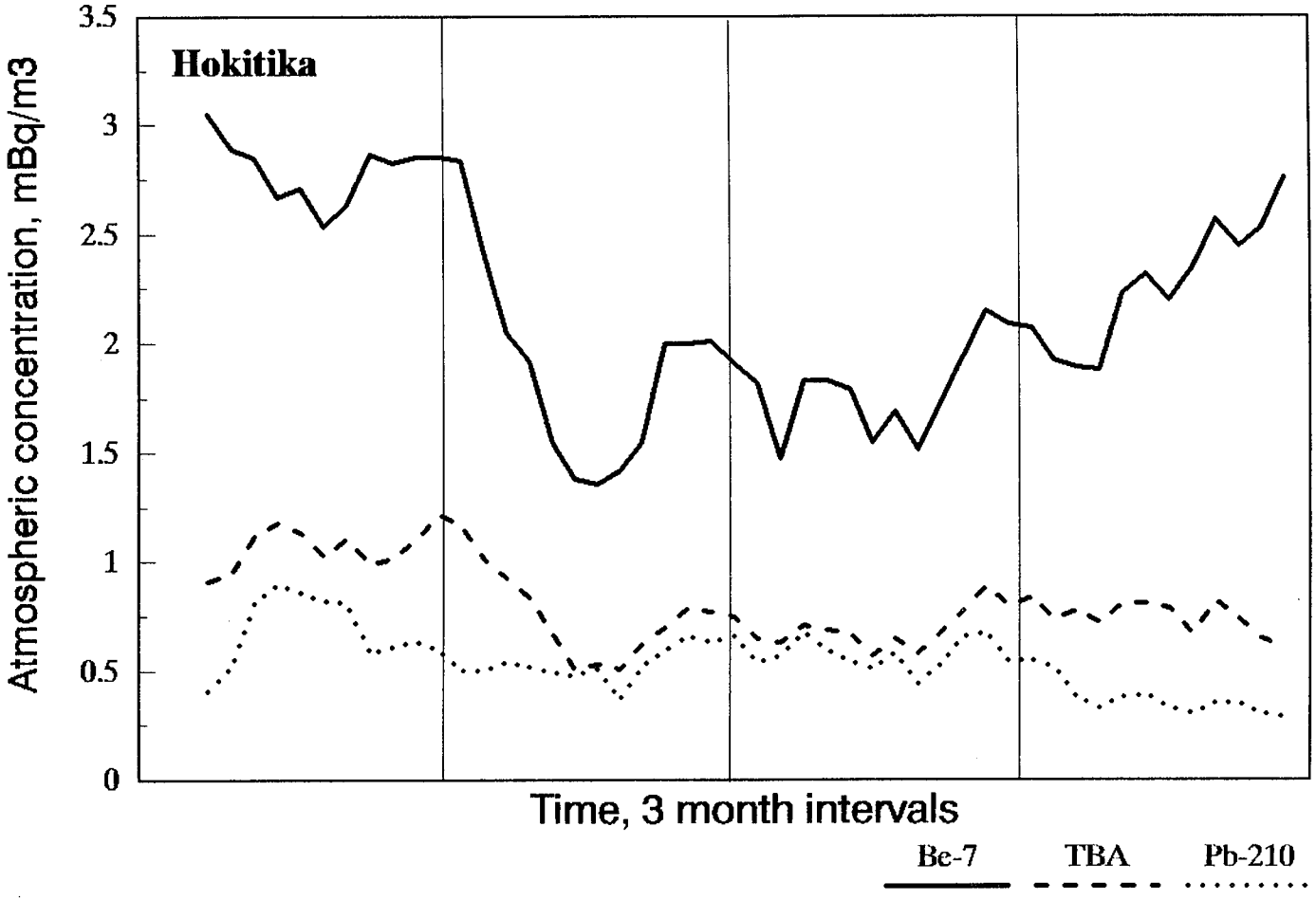

Fig 2. Five-week moving-average atmospheric concentrations of total beta activity (TBA), ^{7}Be and ^{210}Pb at **Hokitika** during 1990. *For scaling purposes TBA and ^{210}Pb results were multiplied by 10.*

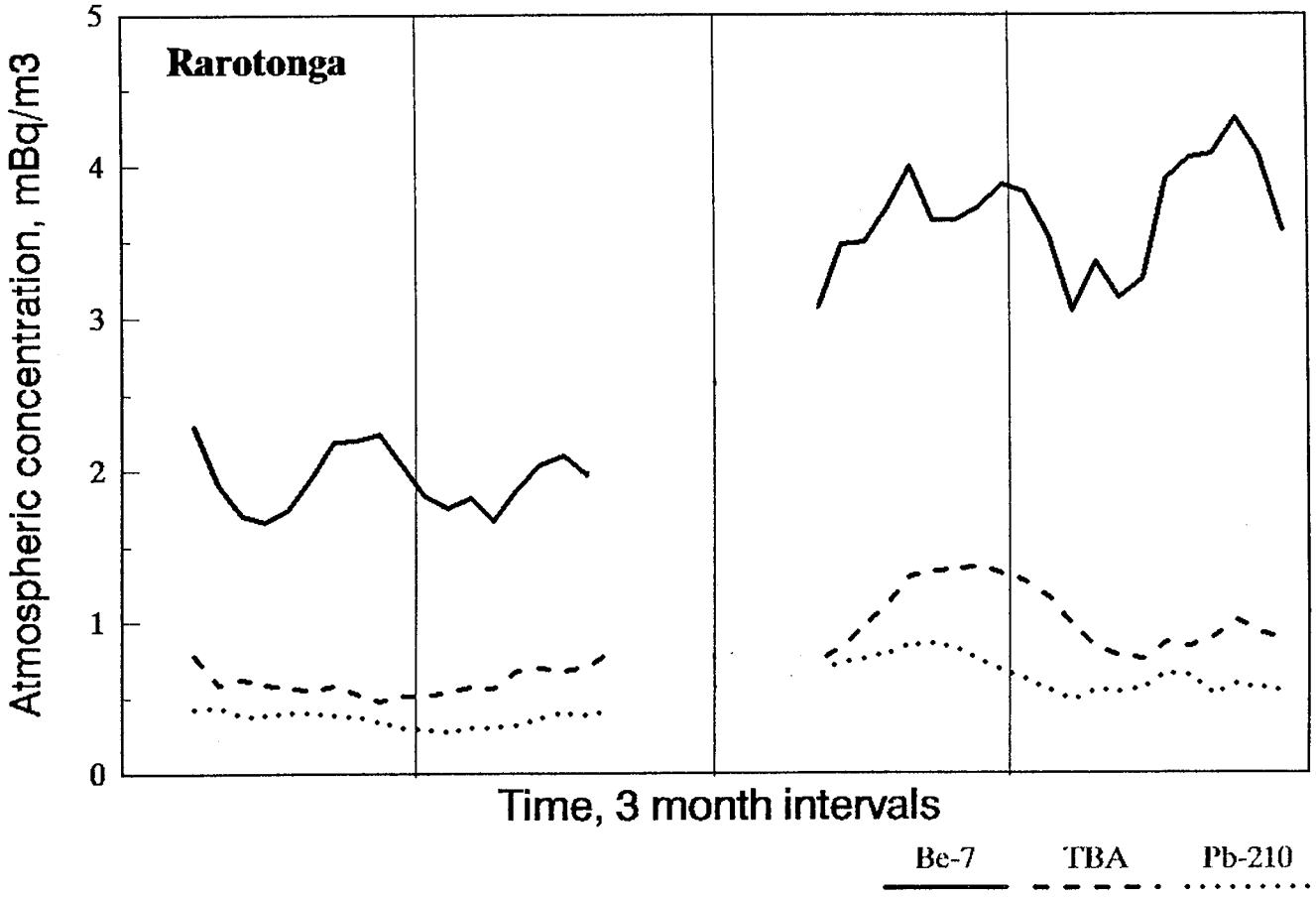

Fig 3. Five-week moving-average atmospheric concentrations of total beta activity (TBA), ^{7}Be and ^{210}Pb at **Rarotonga** during 1990. *For scaling purposes TBA and ^{210}Pb results were multiplied by 10.*

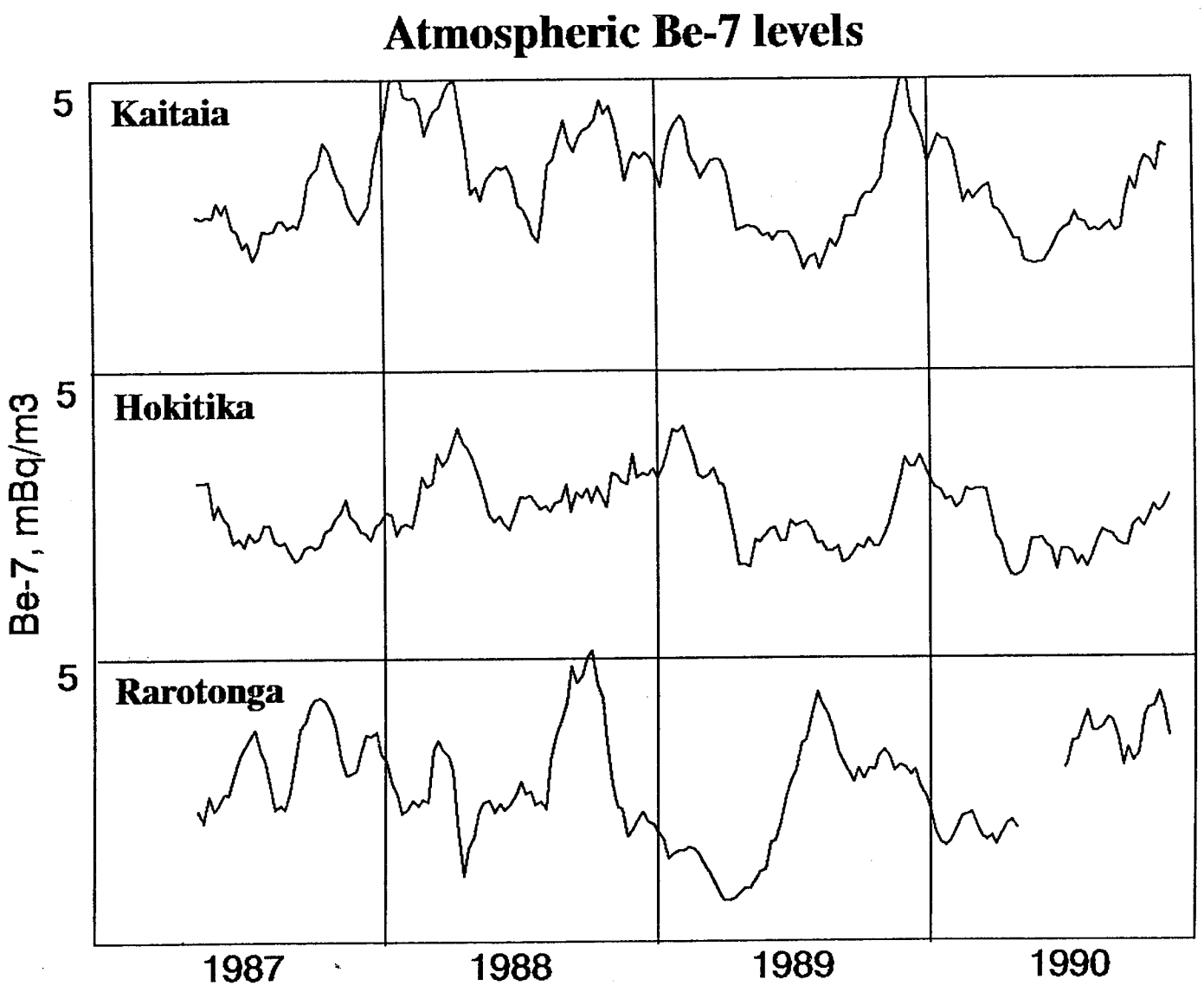

Fig 4. Variations in atmospheric ^{7}Be levels at Kaitaia, Hokitika and Rarotonga during the period 1987 - 1990.