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ENVIRONMENTAL RADIOACTIVITY ANNUAL REPORT

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SUMMARY

During 1991 artificial radioactivity in the environment in New Zealand and Rarotonga continued to be at trace levels only, typical of recent years. There has been no significant change in artificial radioactivity levels since 1990.

Averages levels measured were: total beta activity in air, 0.11 mBq/m^3; ^{90}Sr deposition, 0.2 Bq/m^2; ^{137}Cs in milk, 0.2 Bq/g K; ^{90}Sr in milk, 0.03 Bq/g Ca. Total beta activity deposition at Hokitika and Rarotonga were 240 Bq/m^2 and 73 Bq/m^2 respectively. Atmospheric and deposited radioactivity were due primarily to natural ^{210}Pb.

No artificial radionuclides were detected on high-volume air filters during 1991.

The report includes data on trends in natural atmospheric radioactivity levels during the year. Average concentrations of ^{7}Be and ^{210}Pb were 2.7 mBq/m^3 and 0.05 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 the Environmental Surveillance & Study Laboratory (LESE), 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 a product of the spallation of cosmic radiation in the upper atmosphere, while ^{210}Pb and ^{210}Po are decay products of gaseous radon-222 (^{222}Rn, which diffuses out of soil) and 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 the above measurement programmes. 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].

1991 MONITORING RESULTS

Monitoring results for 1991 are summarised in Tables 1 and 2, while fluctuations in atmospheric radioactivity during 1991 are illustrated in Figs 1 - 3, and variations in ^{7}Be levels during the 5 year period 1987 - 1991 are depicted in Fig 4.

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.

Artificial radionuclides

No artificial radionuclides were detected by gamma spectroscopic analysis of air filters from any monitoring site during 1991 (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 0.5 mBq/m^3, with an overall average of 0.11 mBq/m^3, similar to the 1990[6] average, 0.09 mBq/m^3. When corrected for the contribution made by beta emissions due to natural ^{232}Th and ^{238}U decay products (excluding ^{210}Pb/^{210}Bi) and ^{40}K on the filters, the average TBA level was 0.07 mBq/m^3 (Table 1), similar to the average ^{210}Pb level described below.

Natural radionuclides

Beryllium-7 levels ranged from 0.4 to 7.8 mBq/m^3, with an overall average of 2.7 mBq/m^3. TBA and ^{7}Be levels followed similar trends during that year as shown in Figs 1 - 3.

Lead-210 levels ranged from 0.01 to 0.18 mBq/m^3, with an overall average 0.05 mBq/m^3. 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 1991.

Trends in atmospheric ^{7}Be levels during the period 1987 - 1991 are illustrated in Fig 4. During 1991 the usual trend continued, of winter troughs and summer peaks at Kaitaia and Hokitika, and a spring peak at Rarotonga. An unusual feature was a sharp peak in ^{7}Be and TBA levels at Rarotonga in May (giving the highest ^{7}Be level recorded for any site during 1991, of 7.8 mBq/m^3, during week 19), followed by less noticeable peaks at the New Zealand sites shortly after (Figs 1 - 3).

Radioactive deposition

Total beta activity

The 1991 TBA deposition at Hokitika was 240 ± 12 Bq/m^2, with 2746 mm of rainfall. At Rarotonga the deposition was 73 ± 12 Bq/m^2, with 1658 mm of rain. These depositions were essentially the same as those recorded in 1990[6].

Strontium-90

Strontium-90 deposition has been at such low levels in recent years that it 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. This has unavoidably increased the uncertainty of the results.

During 1991, ^{90}Sr deposition continued to be at the limits of detection, typical of recent years: Kaitaia 0.3 Bq/m^2, Hokitika 0.1 Bq/m^2, and Rarotonga 0.2 Bq/m^2. These ^{90}Sr depositions may be contrasted with the TBA deposition, mainly of natural origin, recorded above. It should be noted that these ^{90}Sr levels are near the limit of detection and the confidence intervals (Table 1) are correspondingly wide. The Kaitaia measurement should not, therefore be interpreted as a significant increase over the 1990[6] level (0.1 ± 0.2 Bq/m^2).

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/g K) and Bq per kilogram of milk powder (Bq/kg).

The 1991 average ^{137}Cs levels were: Auckland 0.1 Bq/g K; Taranaki 0.4 Bq/g K; Westland 0.1 Bq/g K. The three-region mean was 0.2 Bq/g K or 2.6 Bq/kg powder.

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/g Ca) and Bq/kg powder.

The 1991 average ^{90}Sr levels were: Auckland 0.03 Bq/g Ca; Taranaki 0.03 Bq/g Ca; Westland 0.03 Bq/g Ca. The three-region mean was 0.03 Bq/g Ca or 0.5 Bq/kg powder.

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 1991, consistent with an environment containing only residual global weapons-test fallout.

The 1991 results were essentially the same as those reported for 1990[6] as indicated in the comparison of New Zealand site averages below:

	1991	1990	
TBA (air)	0.11	0.09	mBq/m^3
TBA (rain)	240	201	Bq/m^2
^{90}Sr (rain)	0.2	0.1	Bq/m^2
^{90}Sr (milk)	0.4	0.5	Bq/kg
^{137}Cs (milk)	2.6	2.0	Bq/kg

There was no detectable influx of fresh fission products into the region during 1991.

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 during an unusual sharp peak in May at Rarotonga. Lead-210 levels, comprising most of the measured beta activity, showed relatively little variation.

OTHER ENVIRONMENTAL WORK

A Workshop on Environmental Radioactivity was attended in Tahiti during September and 2 papers presented[7] summarising some aspects of work conducted at the Laboratory. This workshop was the inaugural meeting of the South Pacific Environmental Radioactivity Association (SPERA). A report on the meeting was published in *Radiation Protection News and Notes*[8].

There was a continuing demand for export certificates and radioactivity tests during 1991. During the year 562 export certificates were issued and 256 commercial analyses performed. No imported foodstuffs were tested.

The Laboratory's involvement in international analytical intercomparisons run by the US EPA continued, with the analysis of air filters for total beta activity, total alpha activity, ^{137}Cs and ^{90}Sr; milk for ^{131}I, ^{137}Cs, ^{90}Sr and K; water for U isotopes; and water for ^{131}I. Two intercomparison sets of plankton samples from LESE (Tahiti) were also analysed for ^{137}Cs.

During 1991 Dr Matthews visited the LESE in Tahiti and the Radiation Measurements Facility at University of Arizona. Mr C Poletiko of the LESE, Tahiti, visited NRL.

ACKNOWLEDGEMENT

The assistance given by the staff of this and other Government Departments, especially the New Zealand Meteorological Service, the Rarotonga 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.

REFERENCES

1. Environmental Radioactivity Annual Reports, Nos: NRL-F/48 (1971) - NRL-F/70 (1990). National Radiation Laboratory, Christchurch.

2. Environmental Radioactivity: Fallout from nuclear weapons tests conducted by France in the South Pacific...and comparisons with previous test series. Reports NRL-F/47 (1971) summarizing all monitoring since 1966, NRL-F/49 (1972), NRL-F/51 (1973), NRL-F/53 (1974). National Radiation Laboratory, Christchurch.

3. Environmental Radioactivity Annual Report, NRL-F/65 (1985). National Radiation Laboratory, Christchurch.

4. Environmental Radioactivity Annual Report, NRL-F/64 (1984). National Radiation Laboratory, Christchurch.

5. Environmental Radioactivity Annual Report, NRL-F/66 (1986). National Radiation Laboratory, Christchurch.

6. Environmental Radioactivity Annual Report, NRL-F/70 (1990). National Radiation Laboratory, Christchurch.

7. Matthews K M: Environmental radioactivity monitoring in New Zealand and the South Pacific; Detection of small peaks in gamma spectra. Both to be published in Proceedings of Workshop on Environmental Radioactivity, Tahiti, September 1991.

8. Matthews K M: Conference report; Radiation Protection News and Notes, No 16, 1991; National Radiation Laboratory, Christchurch.

Table 1: A summary of atmospheric and deposited radioactivity levels measured during 1991.

Atmospheric radioactivity (mBq/m^3)

		Kaitaia	Hokitika	Rarotonga
TBA:	range	<0.04-0.25	0.04-0.21	<0.04-0.50
	mean	0.12	0.10	0.11
Corrected TBA*				
	range	0-0.22	0-0.19	0-0.49
	mean	0.09	0.07	0.07
^{7}Be:	range	1.6-6.3	1.0-4.1	0.4-7.8
	mean	2.9	2.1	3.0
^{210}Pb:	range	0.02-0.18	0.01-0.18	0.02-0.14
	mean	0.06	0.05	0.05
Fission products		nil	nil	nil

Deposited radioactivity (Bq/m^2)

	Kaitaia	Hokitika	Rarotonga
TBA		240 ± 12	73 ± 12
^{90}Sr	0.3 ± 0.4	0.1 ± 0.2	0.2 ± 0.4
Rain, cm	122	275	166

* Corrected TBA is the total beta activity remaining after subtraction of contributions by natural radionuclides of the ^{232}Th and ^{238}U decay series (in resuspended dust, excluding $^{210}Pb/^{210}Bi$) and ^{40}K.

Table 2. Caesium-137 and strontium-90 levels in cows' milk during 1991.

Results are expressed as Bq ^{137}Cs per gram potassium, Bq ^{90}Sr per gram calcium, and as Bq per kilogram of milk powder, for each quarter year period in the 3 regions. The 95% confidence intervals are of the order of 10% and 20% of the stated results for ^{137}Cs and ^{90}Sr respectively; nd = not detected (detection limit 0.04 Bq ^{137}Cs/g K).

Caesium-137

Qtr	Auckland		Taranaki		Westland	
	Bq/g K	Bq/kg	Bq/gK	Bq/kg	Bq/g K	Bq/kg
1	nd	nd	0.60	8.2	nd	nd
2	nd	nd	0.30	4.0	0.1	1.0
3	0.1	0.9	0.2	3.4	0.1	1.0
4	0.1	1.5	0.5	6.7	0.2	2.4
Mean	0.1	0.9	0.4	5.6	0.1	1.3

Strontium-90

Qtr	Auckland		Taranaki		Westland	
	Bq/g Ca	Bq/kg	Bq/g Ca	Bq/kg	Bq/g Ca	Bq/kg
1	0.03	0.36	0.04	0.50	0.03	0.40
2	0.03	0.33	0.04	0.52	0.03	0.46
3	0.03	0.38	0.03	0.37	0.04	0.49
4	0.03	0.36	0.03	0.40	0.03	0.42
Mean	0.03	0.36	0.03	0.45	0.03	0.44

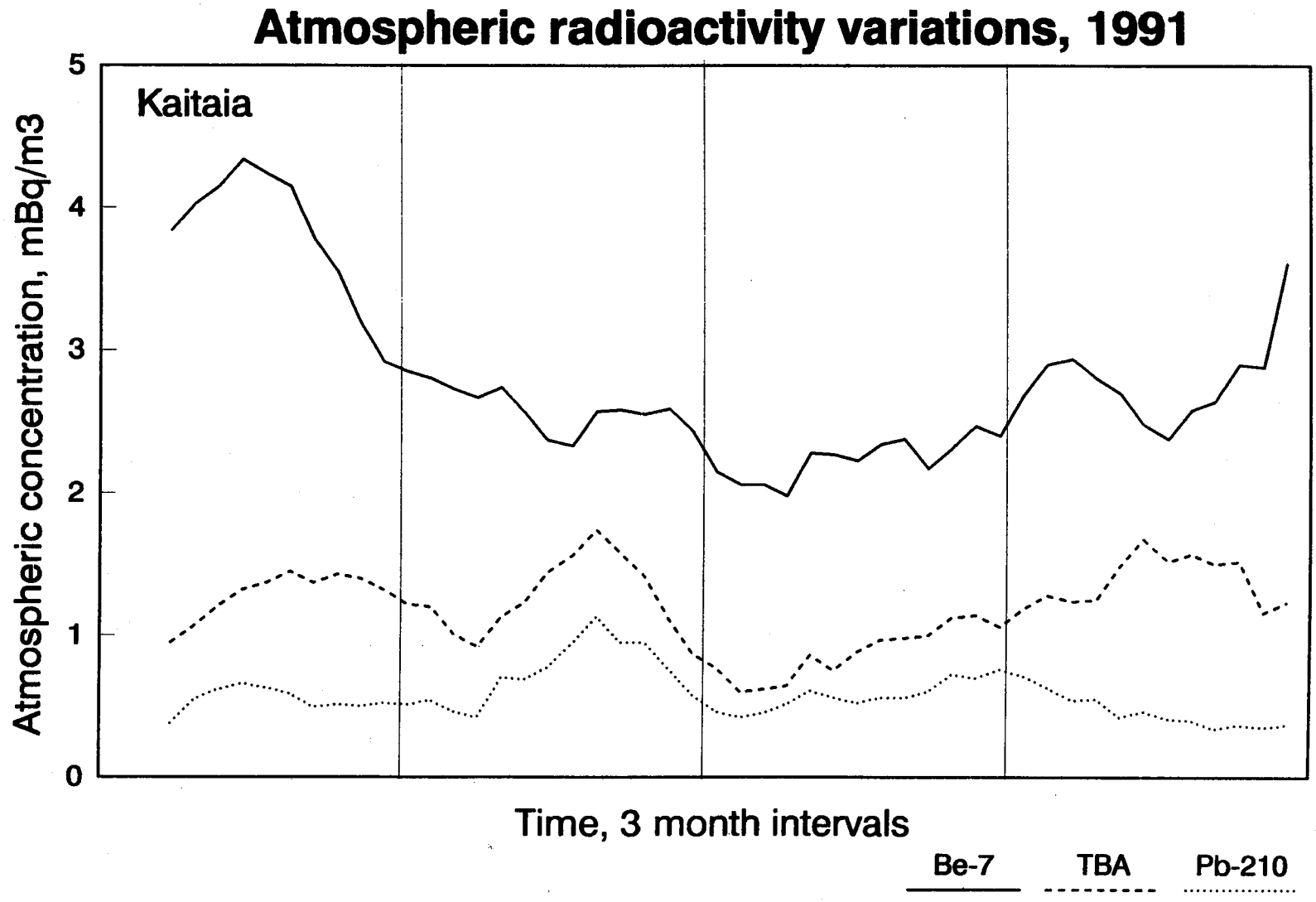

Fig 1. Five-week moving-average atmospheric concentrations of total beta activity (TBA), ^{7}Be and ^{210}Pb at Kaitaia during the 1991 calendar year. *For scaling purposes TBA and ^{210}Pb results were multiplied by 10.*

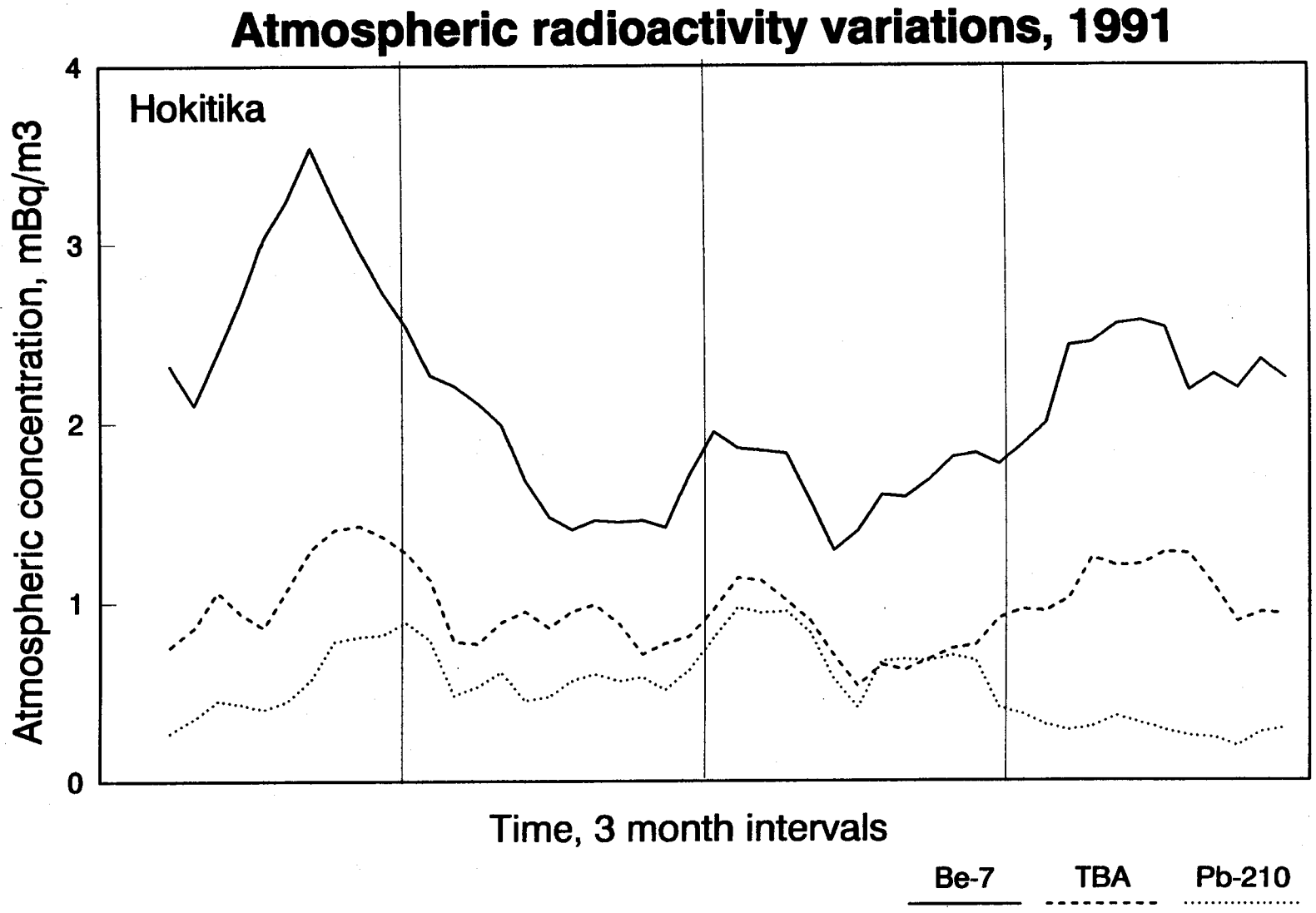

Fig 2. Five-week moving-average atmospheric concentrations of total beta activity (TBA), ^{7}Be and ^{210}Pb at Hokitika during the 1991 calendar year. *For scaling purposes TBA and ^{210}Pb results were multiplied by 10.*

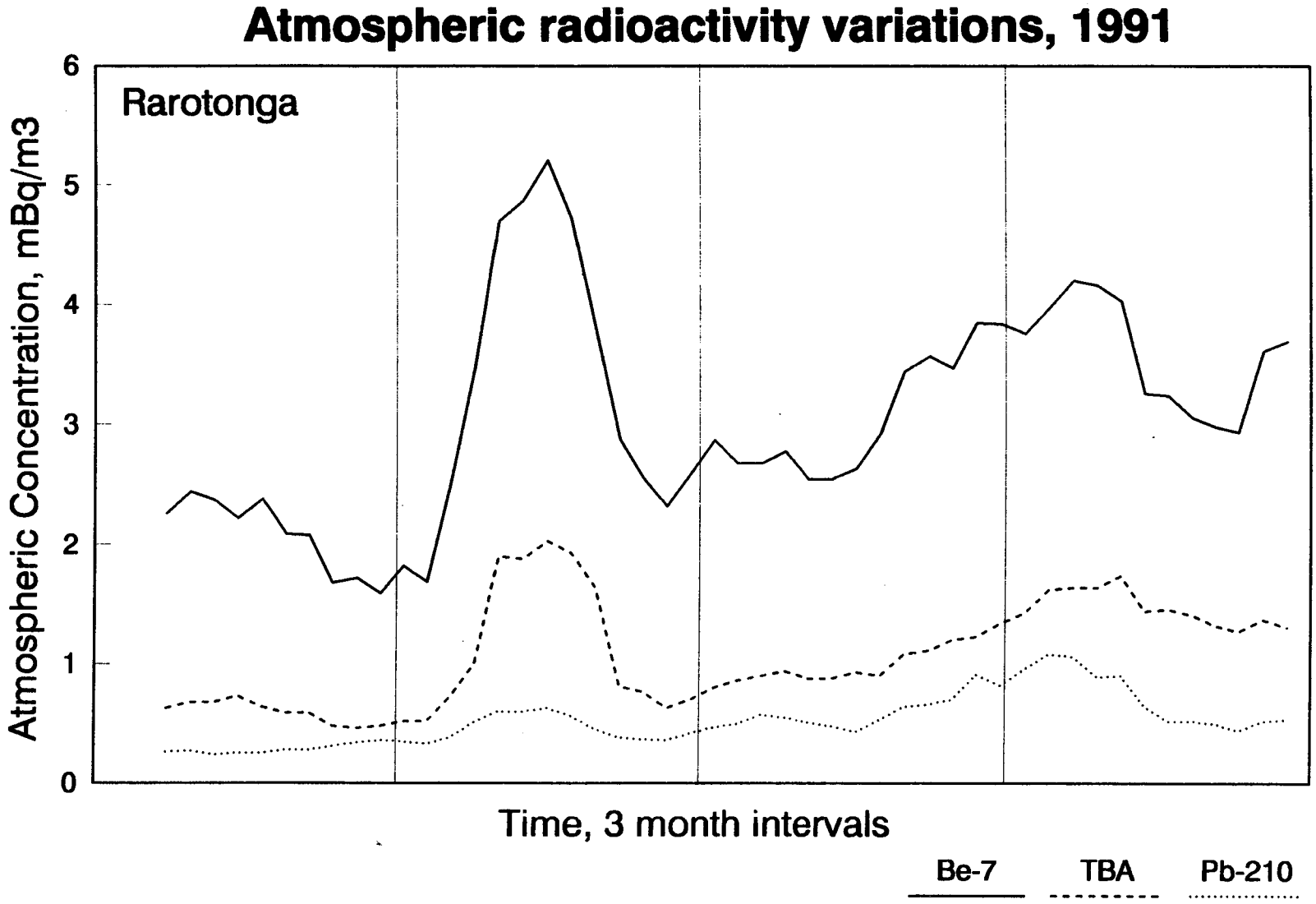

Fig 3. Five-week moving-average atmospheric concentrations of total beta activity (TBA), ^{7}Be and ^{210}Pb at Rarotonga during the 1991 calendar year. *For scaling purposes TBA and ^{210}Pb results were multiplied by 10.*

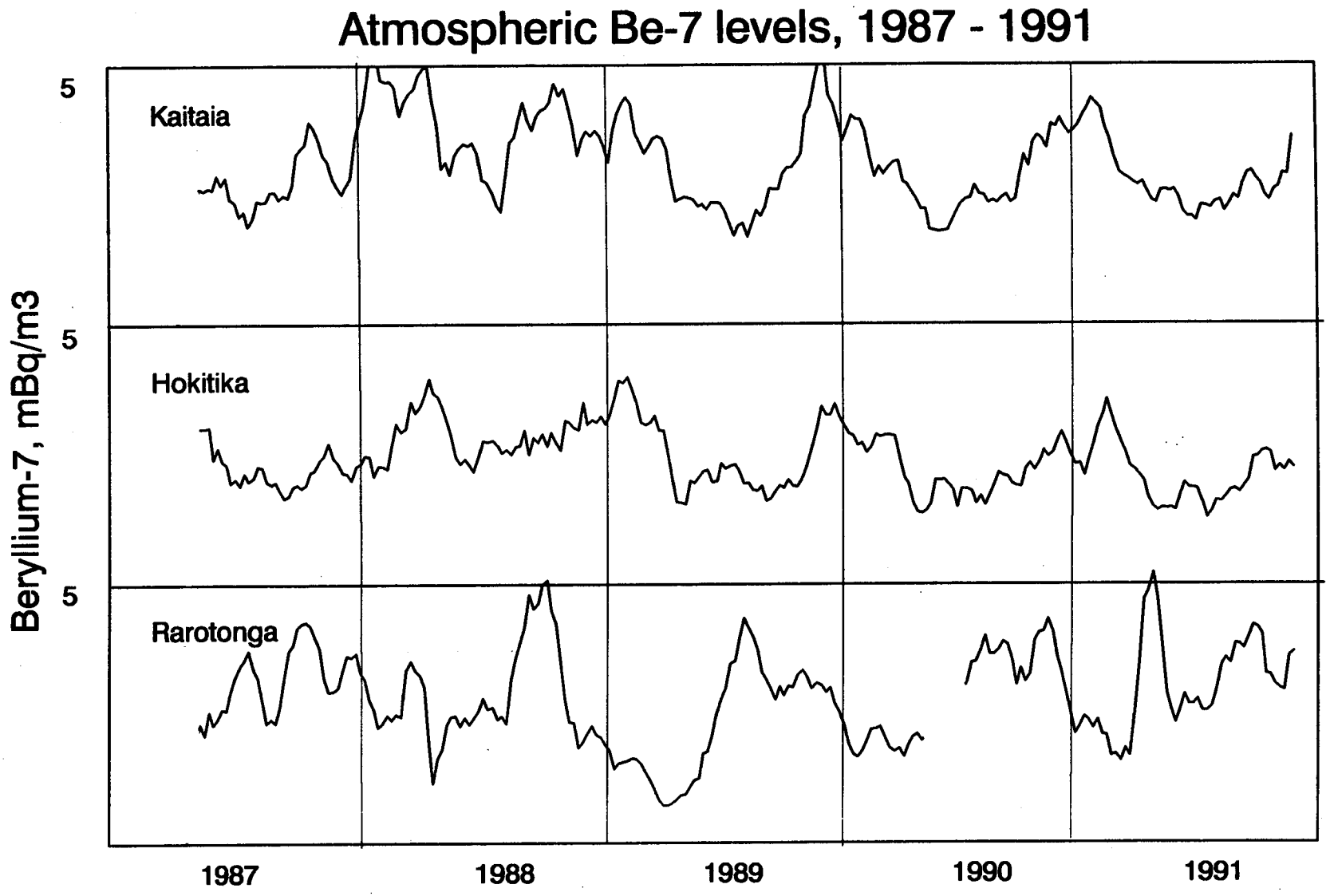

Fig 4. Variations in atmospheric ^{7}Be levels at Kaitaia, Hokitika and Rarotonga during the period 1987 - 1991.