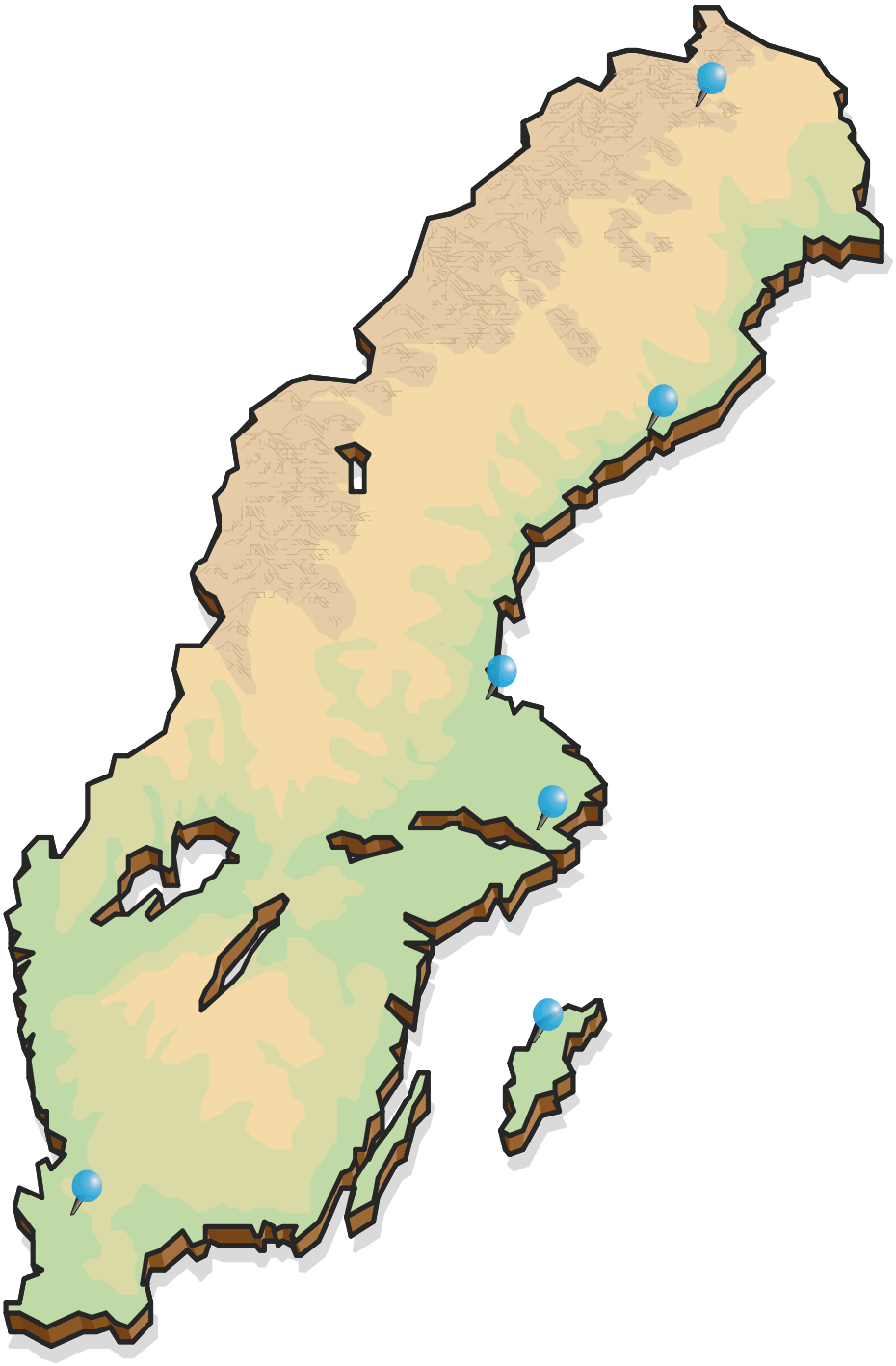
Radionuclide particles in ground level air in Sweden during 2023

SÖDERSTRÖM C, EDVARDSSON E, ELMGREN K,
LILJEGREN S AND OLSSON H



FOI-R--5622--SE
ISSN 1650-1942 June 2024

Söderström C, Edvardsson E, Elmgren K,
Liljegren S and Olsson H

Radionuclide particles in ground level air in Sweden during 2023

Titel	Radionuklider i markluft i Sverige, årsrapport 2023
Title	Radionuclide particles in ground level air in Sweden during 2023
Rapportnr/Report no	FOI-R--5622--SE
Månad/Month	Juni/June
Utgivningsår/Year	2024
Antal sidor/Pages	20
ISSN	1650-1942
Uppdragsgivare/Client	Statens Strålsäkerhetsmyndighet
Forskningsområde	CBRN-frågor
FoT-område	Inget FoT-område
Projektnr/Project no	E41511
Godkänd av/Approved by	Niklas Brännström
Ansvarig avdelning	CBRN-skydd och säkerhet

Bild/Cover: FOI

Sammanfattning

Stationer för filtrering av markluft finns på sex ställen i Sverige: Kiruna, Umeå, Gävle, Kista, Visby och Ljungbyhed. Filtren pressas och analyseras veckovis med hjälp av gammaspektroskopi med germaniumdetektor.
Nederbörd samlas in på fyra av stationerna: Kiruna, Gävle, Kista och Ljungbyhed. Nederbördsproverna askas in och mäts därefter med hjälp av gammaspektroskopi.
I denna rapport presenteras vecko- respektive månadsvisa aktivitetskoncentrationer av ^{7}Be och ^{137}Cs under 2023 för luft och nederbörd för de olika stationerna. I de fall andra antropogena radionuklider detekterats presenteras även dessa.

Nyckelord: Luftburen radioaktivitet, deposition, ^{7}Be, ^{60}Co, ^{131}I, ^{134}Cs, ^{137}Cs

Summary

Filtering of ground level air is performed continuously at six different locations in Sweden: Kiruna, Umeå, Gävle, Kista, Visby and Ljungbyhed. The filters are pressed into weekly samples and the contents of different radionuclides are measured by gamma spectroscopy.
Precipitation is collected at four of the stations: Kiruna, Gävle, Kista and Ljungbyhed. The samples are ashed and the contents of radionuclides are measured.
In this report weekly respectively monthly activity concentrations of ^{7}Be and ^{137}Cs during 2023 in air and precipitation are presented for the different stations. Other anthropogenic radionuclides detected are also presented.

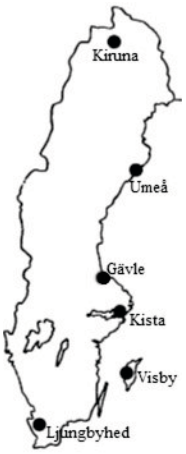
Keywords: Airborne radionuclides, deposition, ^{7}Be, ^{60}Co, ^{131}I, ^{134}Cs, ^{137}Cs

Contents

1 Sampling and analysis procedures

Sampling of ground level air is performed at six different locations in Sweden, as follows:

Location	Latitude (°N)	Longitude (°E)	Altitude (m)
Kiruna	67.84	20.42	415
Umeå	63.85	20.34	46
Gävle	60.67	17.19	7
Kista	59.40	17.95	30
Visby	57.61	18.32	59
Ljungbyhed	56.08	13.22	45



At all stations, except Kista, 1000 m^3/h of air is filtered through glass fibre filters (HB5773). At each station the filters are changed twice a week (Monday and Thursday or Friday) and sent by mail to FOI's laboratory in Kista for activity measurement and analysis. At the station in Kista 1600 m^3/h of air is filtered and the filters are changed every 28th hour.

Weekly samples are made from each station by taking 3/4 of each filter (1/4 of the filter is archived) and compressing them together into a disc (60 mm diameter and 13 mm thick). These samples are measured 3-4 days after collection, on shielded High Purity Germanium (HPGe) detectors. From the station in Kista, the filters are assembled in a Marinelli-like geometry by pressing them into one circular disc (94 mm diameter, 16 mm thickness), placed on top of the detector, and into six rectangular bricks (77x48x13 mm) placed around the detector.

At five of the stations (Kiruna, Umeå, Gävle, Kista and Ljungbyhed) a small part of the air flow (12 m^3/h) downstream the filter is passed through an active charcoal cartridge in order to collect gaseous iodine. The cartridges are changed weekly but only analysed if particulate iodine has been detected in the filter.

The stations at Kiruna, Gävle, Kista and Ljungbyhed are each equipped with a stainless steel funnel (1 m radius) to collect precipitation. The precipitation is passed through a column consisting of a filter part, an an-ion exchanger part and a cat-ion exchanger part. The columns are changed weekly and sent by mail to FOI's laboratory in Kista. Four samples are combined to a monthly sample by ashing. The samples are measured on HPGe detectors. From these measurements the total deposition is calculated.

The particulate radionuclides detected in the filters are normally due to the naturally occurring isotopes i.e. radon daughters and ^{7}Be. In addition ^{137}Cs is commonly detected at most stations due to resuspension of the Chernobyl fallout. In Sections 2 and 3, the activity concentrations of ^{7}Be and ^{137}Cs are presented, respectively. The precipitation measurement results are presented in Section 4. Other anthropogenic radionuclides detected are presented in Section 5.

Uncertainties are given as relative combined standard uncertainty according to GUM. For a more detailed description of uncertainty estimations see FOI Report 'Implementation of uncertainty of measurement according to GUM' (FOI-D--0643--SE, internal report, in Swedish).

2 Concentrations of ^{7}Be in air

Table 2. ^{7}Be concentrations in Sweden, 2023.

Week starting	Kiruna	Umeå	Gävle	Kista	Visby	Ljungbyhed
2 Jan	2020 (2.7)	2350 (4.9)	1540 (2.8)	2050 (2.8)	1780 (2.8)	1540 (2.7)
9 Jan	1290 (2.7)	980 (4.9)	940 (2.8)	1300 (2.9)	1880 (2.8)	1840 (2.7)
16 Jan	1010 (2.7)	1100 (4.9)	1030 (2.8)	1380 (2.9)	1620 (2.8)	1350 (2.7)
23 Jan	2230 (2.7)	940 (2.8)	1030 (2.8)	1240 (2.8)	1600 (2.8)	1840 (2.7)
30 Jan	1360 (2.7)	500[3] (2.8)	960 (2.8)	1010 (2.8)	1050 (2.8)	970 (2.8)
6 Feb	1740 (2.8)	2220[4] (2.8)	2000 (4.9)	2750 (2.8)	2510 (2.7)	2300 (2.8)
13 Feb	1790 (2.8)	1970 (2.8)	1980 (4.9)	2080 (2.8)	2030 (2.7)	3110 (2.8)
20 Feb	1140 (2.7)	1040 (4.9)	930 (2.8)	1100 (2.8)	1430 (2.7)	1020 (2.8)
27 Feb	1510 (2.7)	1860 (4.9)	1400 (2.8)	1910 (2.8)	2290 (2.8)	1270 (2.7)
6 Mar	1500 (2.7)	1780 (2.8)	1520 (4.9)	2100 (2.8)	2500 (2.8)	2460 (2.7)
13 Mar	2100 (2.7)	1610 (4.9)	1640 (2.8)	2250 (2.8)	2830 (2.8)	2620 (2.7)
20 Mar	1850 (2.7)	1700 (4.9)	1720[7] (2.8)	1850 (2.8)	2490 (2.8)	2230 (2.8)
27 Mar	1920 (2.7)	2000 (4.9)	1930[8] (2.8)	2440 (2.8)	1830 (2.8)	2630 (2.7)
3 Apr	1830[1] (2.8)	1980 (4.9)	2090[1] (2.8)	2520 (2.8)	1870 (2.8)	3050 (2.7)
10 Apr	5380[2] (2.7)	4760 (4.9)	5100[2] (2.8)	5680 (2.8)	4680 (2.8)	3470 (2.7)
17 Apr	1430 (2.8)	2790 (2.8)	2700[9] (4.9)	4660 (2.8)	4310 (2.7)	5730 (2.7)
24 Apr	1780 (6.8)	1370[5] (2.8)	1020 (4.9)	1330 (2.8)	1670 (2.7)	2750 (2.7)
1 May	3050 (2.7)	2530[6] (4.9)	2740[6] (2.8)	2810 (2.8)	2750 (2.7)	3420 (2.7)
8 May	4150 (2.7)	6040 (4.9)	6370 (2.7)	7900 (2.8)	6140 (2.8)	7030 (2.7)
15 May	3160 (5.0)	4020 (2.8)	3700 (2.8)	4580 (2.8)	3040 (2.8)	4010 (2.7)
22 May	1700 (2.7)	2100 (4.9)	2780 (2.7)	3780 (2.8)	3010 (2.8)	3480 (2.7)
29 May	1470 (4.9)	1700 (2.8)	2270[10] (2.7)	2630 (2.8)	4000[12] (2.8)	2880 (2.8)
5 Jun	2930 (2.7)	1950 (4.9)	2390[11] (2.8)	2610 (2.8)	2740 (2.8)	3650 (2.7)
12 Jun	3490 (2.7)	4140 (2.7)	4700 (4.9)	5790 (2.8)	4930 (2.8)	5280 (4.9)
19 Jun	3990 (2.8)	2540 (2.8)	3210 (4.9)	4390 (2.8)	3550 (2.7)	3850 (4.9)
26 Jun	3470 (4.9)	3630 (2.7)	2620 (2.8)	2980 (2.8)	2510 (2.8)	2500 (2.8)

Values are reported in μBq/m^{3}.
Relative combined standard uncertainty (1σ%) within brackets.

[1] Sampling 8 days: 3/4-11/4
[2] Sampling 6 days: 11/4-17/4
[3] Sampling 4 days: 30/1-3/2
[4] Sampling 10 days: 3/2-13/2
[5] Sampling 8 days: 24/4-2/5
[6] Sampling 6 days: 2/5-8/5
[7] Sampling 8 days: 20/3-28/3
[8] Sampling 6 days: 28/3-3/4
[9] Sampling 8 days: 17/4-25/4
[10] Sampling 9 days: 29/5-7/6
[11] Sampling 5 days: 7/6-12/6
[12] Sampling 4 days: 1/6-5/6

Table 2, continued. ^{7}Be concentrations in Sweden, 2023.

Week starting	Kiruna	Umeå	Gävle	Kista	Visby	Ljungbyhed
3 Jul	2540 (4.9)	1950 (4.9)	1630 (2.8)	2100[3] (2.8)	2260 (2.8)	2300 (2.7)
10 Jul	5450 (2.7)	3590 (7.6)	2790 (4.9)	3590 (2.8)	2760 (2.8)	2590 (2.8)
17 Jul	920 (2.8)	720 (8.7)	1410 (2.8)	1590 (2.8)	1460 (2.8)	1890 (2.7)
24 Jul	2090 (2.7)	1660 (11.1)	1860 (2.8)	2030 (2.8)	1850 (2.8)	1830 (2.8)
31 Jul	2460 (2.7)	1940 (8.7)	1440 (2.8)	2100 (2.8)	2130 (2.8)	2030 (2.8)
7 Aug	2750 (2.8)	1920 (7.6)	1690 (2.8)	1940 (2.8)	1560 (2.8)	2370 (4.9)
14 Aug	1620 (4.9)	1710 (8.6)	1310 (2.8)	2100 (2.8)	2170 (2.8)	2820 (2.7)
21 Aug	3140 (2.8)	2470 (7.6)	1960 (2.8)	2340 (2.8)	2240 (4.9)	2130 (4.9)
28 Aug	1540 (2.7)	1510 (8.6)	1530 (2.8)	2340[4] (2.8)	2410 (2.8)	2220 (2.7)
4 Sep	1920 (2.8)	2550 (7.6)	2570 (2.7)	2740 (2.8)	2550 (2.8)	3360 (4.9)
11 Sep	990 (2.7)	1440 (8.6)	1620 (2.8)	1980 (2.8)	2180 (2.8)	2810[6] (2.7)
18 Sep	940 (2.8)	1600 (8.6)	2020 (2.8)	2620 (2.8)	2560 (2.8)	2330[7] (2.7)
25 Sep	1370 (2.7)	1300 (8.6)	1240 (2.8)	1560 (2.8)	1940 (2.8)	1580 (2.7)
2 Oct	470 (2.7)	730 (8.7)	990 (2.8)	1540 (2.8)	1330 (2.8)	1390 (2.7)
9 Oct	1140 (2.8)	890 (8.6)	1430 (2.8)	1940 (2.8)	1970 (2.8)	2590 (2.7)
16 Oct	3140 (2.7)	1510 (8.6)	1230 (2.8)	960 (2.8)	740 (2.8)	960 (2.7)
23 Oct	1820 (2.7)	2390 (8.6)	3090 (2.7)	3280 (2.8)	1700 (2.8)	970 (2.7)
30 Oct	1210 (2.7)	800 (6.1)	840 (4.9)	1570[5] (2.9)	1480 (2.8)	1680 (2.7)
6 Nov	790 (2.7)	650 (2.8)	500 (2.7)	1110 (3.3)	1180 (2.7)	1470 (4.9)
13 Nov	1590 (2.7)	1010 (4.9)	1710 (2.8)	2650 (2.8)	1770 (2.7)	1490 (2.7)
20 Nov	1230 (2.7)	1130 (4.9)	1250 (2.8)	1680 (2.8)	1230 (2.7)	1300 (2.7)
27 Nov	1230 (2.7)	1160 (2.8)	890 (2.9)	1160 (2.8)	1140 (2.8)	970 (2.7)
4 Dec	960 (2.7)	1030 (2.7)	1000 (2.8)	1090 (2.8)	960 (2.8)	850 (2.7)
11 Dec	960 (2.7)	1310 (4.9)	970 (2.8)	1020 (2.8)	860 (2.8)	1020 (2.7)
18 Dec	750 (2.7)	770 (4.9)	680[1] (2.8)	830 (2.8)	640 (2.8)	1320 (2.7)
25 Dec	350 (2.8)	990 (4.9)	1490[2] (2.8)	1100 (2.8)	1140 (2.8)	1230[8] (2.7)

Values are reported in μBq/m^3.
Relative combined standard uncertainty (1σ%) within brackets.

[1] Sampling 9 days: 18/12-27/12
[2] Sampling 6 days: 27/12-2/1
[3] Sampling 4 days: 6/7-10/7
[4] Sampling 5 days: 28/8-1/9
[5] Sampling 5 days: 30/10-3/11
[6] Sampling 9 days: 11/9-20/9
[7] Sampling 5 days: 20/9-25/9
[8] Sampling 8 days: 25/12-2/1

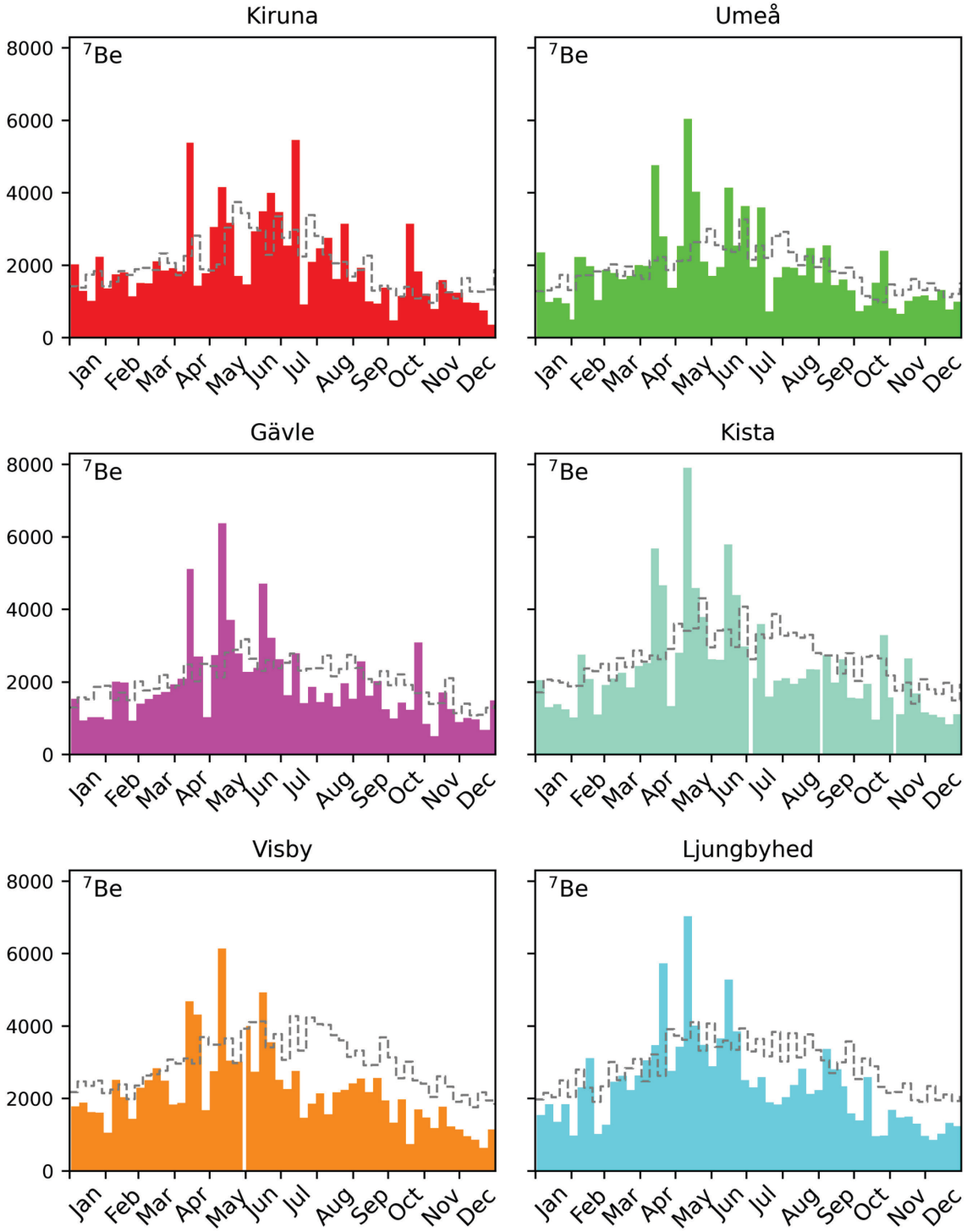


Figure 1. Activity concentrations (µBq/m^3) in ground level air of ^{7}Be in the Swedish network during 2023. The dotted line shows average concentration for the preceding ten years.

3 Concentrations of ^{137}Cs in air

Table 3. ^{137}Cs concentrations in Sweden, 2023.

Week starting	Kiruna	Umeå	Gävle	Kista	Visby	Ljungbyhed
2 Jan	< 0.2	0.6 (13)	1.0 (12)	0.3 (8)	0.1 (34)	0.2 (13)
9 Jan	0.2 (43)	0.7 (11)	0.4 (35)	0.3 (14)	0.2 (14)	0.2 (13)
16 Jan	< 0.2	0.9 (10)	0.8 (4)	0.2 (14)	0.2 (17)	0.3 (12)
23 Jan	< 0.3	0.7 (10)	0.5 (25)	0.2 (10)	0.2 (30)	0.2 (14)
30 Jan	< 0.2	0.8[3] (13)	1.9 (5)	0.6 (5)	0.3 (35)	0.2 (13)
6 Feb	< 0.2	0.7[4] (16)	0.5 (16)	0.4 (7)	0.2 (24)	0.6 (11)
13 Feb	< 0.2	0.5 (20)	0.6 (7)	0.2 (14)	0.1 (30)	0.3 (21)
20 Feb	0.1 (25)	0.5 (13)	0.5 (12)	0.3 (8)	0.3 (10)	< 0.8
27 Feb	< 0.2	0.4 (9)	0.4 (16)	0.3 (9)	0.1 (25)	0.2 (31)
6 Mar	< 0.2	0.9 (11)	1.3 (8)	0.6 (5)	0.2 (13)	0.5 (8)
13 Mar	< 0.2	1.0 (8)	0.7 (18)	0.3 (8)	0.3 (12)	0.2 (16)
20 Mar	< 0.2	0.5 (14)	0.7[7] (10)	0.2 (18)	0.2 (16)	0.3 (38)
27 Mar	0.0 (69)	0.5 (12)	1.5[8] (5)	0.2 (8)	0.2 (13)	0.4 (14)
3 Apr	< 0.2[1]	1.5 (6)	3.0[1] (4)	0.3 (7)	0.2 (10)	0.3 (10)
10 Apr	< 0.3[2]	1.0 (10)	1.1[2] (12)	0.3 (7)	0.5 (10)	< 0.5
17 Apr	< 0.2	0.7 (14)	1.7[9] (6)	0.3 (7)	0.4 (12)	0.3 (17)
24 Apr	< 0.2	0.5[5] (18)	0.7 (12)	0.2 (11)	0.4 (14)	< 0.5
1 May	< 0.2	0.5[6] (15)	0.7[6] (14)	0.2 (11)	0.2 (19)	0.2 (30)
8 May	< 0.3	1.6 (5)	4.1 (4)	1.1 (4)	1.2 (4)	0.8 (5)
15 May	< 0.4	1.9 (7)	3.0 (3)	0.4 (7)	0.2 (24)	0.2 (28)
22 May	0.1 (61)	3.7 (4)	4.5 (3)	1.6 (3)	0.8 (9)	< 0.5
29 May	< 0.3	4.6 (3)	3.8[10] (3)	1.3 (4)	0.4[12] (26)	0.4 (33)
5 Jun	< 0.3	2.6 (5)	1.9[11] (7)	0.5 (7)	0.2 (24)	0.4 (13)
12 Jun	0.3 (29)	6.2 (3)	3.2 (4)	0.5 (6)	0.2 (25)	0.3 (30)
19 Jun	0.4 (9)	2.0 (7)	1.3 (8)	0.2 (11)	0.3 (14)	0.2 (45)
26 Jun	0.2 (42)	1.4 (5)	1.2 (12)	0.2 (12)	< 0.4	0.1 (48)

Values are reported in µBq/m^3.
Relative combined standard uncertainty (1σ%) within brackets.

[1] Sampling 8 days: 3/4-11/4
[2] Sampling 6 days: 11/4-17/4
[3] Sampling 4 days: 30/1-3/2
[4] Sampling 10 days: 3/2-13/2
[5] Sampling 8 days: 24/4-2/5
[6] Sampling 6 days: 2/5-8/5
[7] Sampling 8 days: 20/3-28/3
[8] Sampling 6 days: 28/3-3/4
[9] Sampling 8 days: 17/4-25/4
[10] Sampling 9 days: 29/5-7/6
[11] Sampling 5 days: 7/6-12/6
[12] Sampling 4 days: 1/6-5/6

Table 3, continued. ^{137}Cs concentrations in Sweden, 2023.

Week starting	Kiruna	Umeå	Gävle	Kista	Visby	Ljungbyhed
3 Jul	< 0.4	1.1 (8)	1.7 (6)	0.6[3] (10)	0.2 (25)	0.1 (31)
10 Jul	0.2 (26)	0.8 (13)	1.0 (9)	0.2 (13)	0.2 (28)	< 0.4
17 Jul	< 0.2	1.1 (10)	1.1 (12)	< 0.2	< 0.4	0.1 (59)
24 Jul	0.1 (22)	1.6 (12)	1.0 (11)	0.1 (19)	< 0.5	< 0.2
31 Jul	0.1 (44)	2.1 (9)	1.0 (12)	0.1 (30)	0.1 (19)	< 0.5
7 Aug	0.2 (30)	2.0 (8)	1.4 (7)	< 0.2	0.2 (40)	< 0.3
14 Aug	0.3 (32)	2.1 (9)	1.1 (14)	0.3 (10)	0.1 (39)	< 0.5
21 Aug	0.4 (18)	2.9 (9)	1.1 (15)	0.2 (16)	< 0.3	< 0.3
28 Aug	0.4 (18)	4.6 (8)	1.8 (9)	0.3[4] (11)	0.1 (42)	< 0.5
4 Sep	0.4 (10)	4.1 (8)	1.6 (5)	0.2 (12)	0.1 (41)	0.1 (42)
11 Sep	< 0.2	3.3 (8)	1.9 (7)	0.3 (8)	0.3 (18)	0.1[6] (36)
18 Sep	< 0.2	3.2 (8)	1.5 (9)	0.2 (11)	0.2 (11)	< 0.3[7]
25 Sep	< 0.2	2.8 (8)	1.1 (13)	0.2 (12)	0.2 (13)	0.2 (17)
2 Oct	< 0.2	1.4 (10)	1.0 (13)	0.3 (8)	0.1 (33)	0.1 (48)
9 Oct	< 0.6	1.4 (9)	1.1 (7)	0.2 (9)	0.1 (16)	0.2 (13)
16 Oct	< 0.2	0.7 (14)	0.8 (8)	0.2 (11)	0.1 (63)	0.2 (15)
23 Oct	< 0.2	0.4 (18)	0.9 (9)	0.4 (6)	< 0.1	< 0.2
30 Oct	< 0.2	0.5 (12)	0.7 (14)	0.2[5] (13)	0.1 (51)	0.2 (32)
6 Nov	< 0.2	0.4 (31)	0.3 (11)	0.2 (11)	0.1 (34)	0.2 (47)
13 Nov	< 0.2	1.0 (7)	0.7 (16)	0.4 (6)	< 0.3	0.1 (42)
20 Nov	< 0.2	0.3 (18)	0.3 (29)	0.3 (7)	0.1 (31)	0.3 (16)
27 Nov	< 0.2	0.2 (42)	0.3 (15)	0.7 (5)	0.1 (40)	0.4 (15)
4 Dec	0.1 (28)	1.2 (5)	2.1 (7)	0.8 (5)	0.4 (14)	0.3 (22)
11 Dec	< 0.2	0.5 (13)	0.5 (18)	0.3 (6)	0.1 (34)	0.1 (36)
18 Dec	< 0.2	0.6 (10)	0.7[1] (13)	0.2 (9)	0.1 (24)	0.1 (18)
25 Dec	< 0.2	0.6 (11)	0.6[2] (13)	0.8 (4)	0.1 (21)	0.2[8] (24)

Values are reported in µBq/m^3.
Relative combined standard uncertainty (1σ%) within brackets.

[1] Sampling 9 days: 18/12-27/12
[2] Sampling 6 days: 27/12-2/1
[3] Sampling 4 days: 6/7-10/7
[4] Sampling 5 days: 28/8-1/9
[5] Sampling 5 days: 30/10-3/11
[6] Sampling 9 days: 11/9-20/9
[7] Sampling 5 days: 20/9-25/9
[8] Sampling 8 days: 25/12-2/1

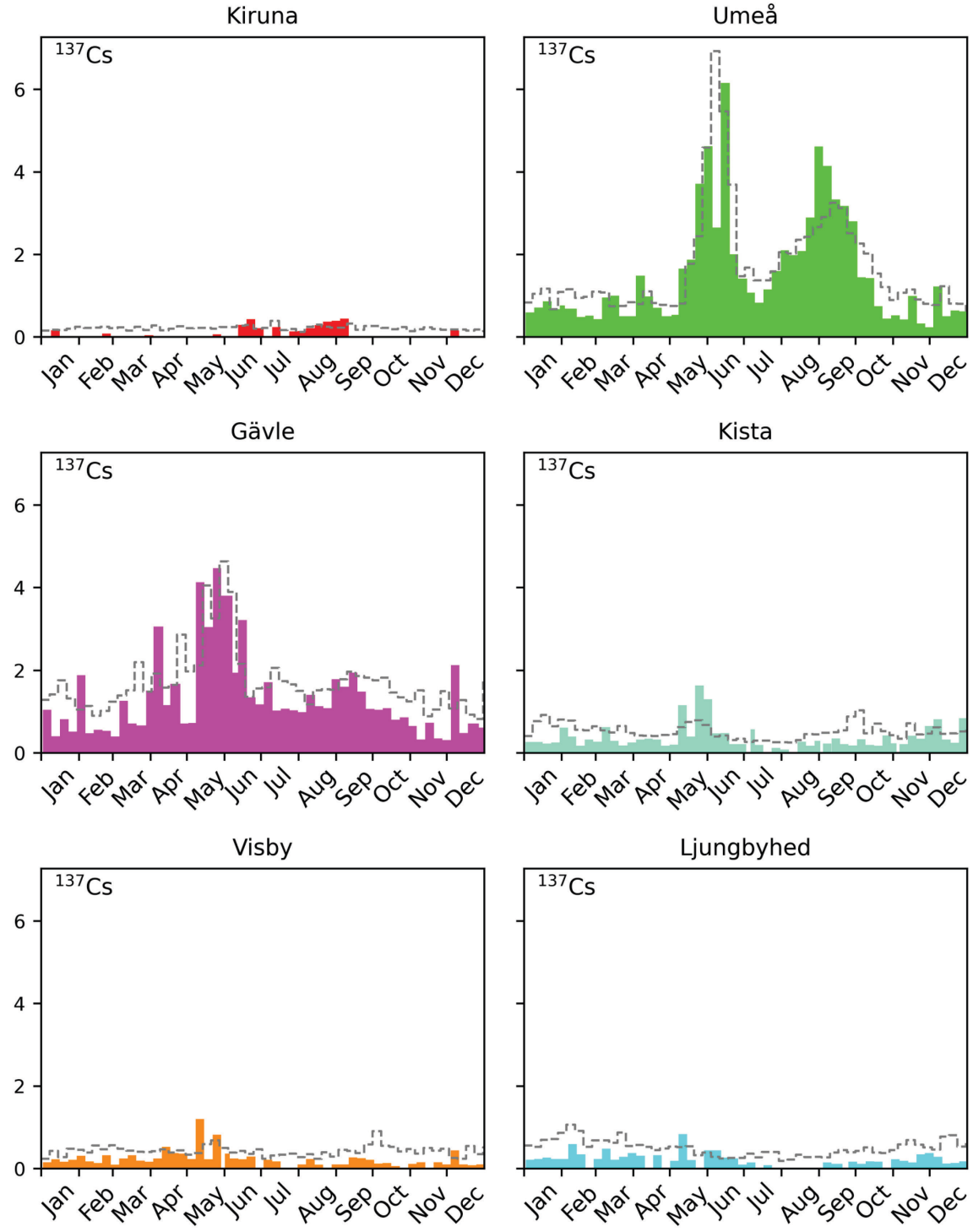


Figure 2. Activity concentrations (μBq/m^3) in ground level air of ^{137}Cs in the Swedish network during 2023. The dotted line shows average concentration for the preceding ten years.

4 Deposition measurements

Table 4.1. Kiruna

Period	^{7}Be		^{137}Cs		Precipitation (mm)
26 Dec - 23 Jan	10100	(5)	< 7		20
23 Jan - 20 Feb	5000	(5)	< 8		10
20 Feb - 20 Mar	4000	(5)	8	(29)	13
20 Mar - 17 Apr	2600	(5)	< 8		4
17 Apr - 15 May	25300	(5)	6	(16)	30
15 May - 12 Jun	31300	(5)	7	(60)	52
12 Jun - 10 Jul	49700	(5)	12	(11)	23
10 Jul - 7 Aug	71900	(5)	4	(38)	67
7 Aug - 4 Sep	66800	(5)	8	(12)	93
4 Sep - 2 Oct	52000	(5)	14	(17)	119
2 Oct - 30 Oct	11200	(5)	7	(29)	28
30 Oct - 27 Nov	5100	(5)	< 8		8
27 Nov - 25 Dec	5000	(5)	< 5		4

Values are reported in mBq/m^2.
When a nuclide is not detected, minimal detectable concentration (<MDC) is given.
Relative combined standard uncertainty (1σ%) within brackets.

Table 4.2. Gävle

Period	^{7}Be		^{137}Cs		Precipitation (mm)
27 Dec - 23 Jan	9200	(5)	26	(11)	76
23 Jan - 20 Feb	2400	(5)	11	(34)	40
20 Feb - 20 Mar	6000	(5)	15	(19)	49
20 Mar - 17 Apr	19400	(5)	19	(11)	30
17 Apr - 15 May	13500	(5)	12	(11)	22
15 May - 7 Jun	8800	(5)	36	(8)	8
7 Jun - 3 Jul	16000	(5)	27	(11)	22
3 Jul - 31 Jul	38600	(5)	53	(7)	86
31 Jul - 28 Aug	100500	(5)	77	(6)	221
28 Aug - 25 Sep	21600	(5)	15	(13)	68
25 Sep - 23 Oct	18700	(5)	12	(15)	49
23 Oct - 20 Nov	27400	(5)	14	(13)	110
20 Nov - 18 Dec	24900	(5)	15	(27)	73

Values are reported in mBq/m^2.
Relative combined standard uncertainty (1σ%) within brackets.

Table 4.3. Kista

Period	^{7}Be		^{137}Cs		Precipitation (mm)
12 Dec - 9 Jan	75900	(5)	6	(28)	47
9 Jan - 6 Feb	26800	(5)	< 8		37
6 Feb - 6 Mar	14000	(5)	< 3		25
6 Mar - 3 Apr	34500	(5)	5	(39)	50
3 Apr - 2 May	24300	(5)	< 5		26
2 May - 29 May	5600	(5)	< 7		6
29 May - 26 Jun	12200	(5)	5	(37)	9
26 Jun - 24 Jul	65000	(5)	10	(23)	70
24 Jul - 21 Aug	174100	(5)	13	(15)	122
21 Aug - 18 Sep	20700	(5)	3	(77)	29
18 Sep - 16 Oct	21900	(5)	< 10		50
16 Oct - 13 Nov	73200	(5)	< 8		75
13 Nov - 11 Dec	20600	(5)	< 8		20

Values are reported in mBq/m^2.
When a nuclide is not detected, minimal detectable concentration (<MDC) is given.
Relative combined standard uncertainty (1σ%) within brackets.

Table 4.4. Ljungbyhed

Period	^{7}Be		^{137}Cs		Precipitation (mm)
2 Jan - 30 Jan	82300	(5)	6	(33)	101
30 Jan - 27 Feb	58400	(5)	8	(46)	57
27 Feb - 27 Mar	47800	(5)	< 9		61
27 Mar - 24 Apr	29500	(5)	< 7		28
24 Apr - 24 May	18000	(5)	6	(40)	9
24 May - 19 Jun	28800	(5)	4	(49)	18
19 Jun - 18 Jul	58800	(5)	11	(17)	76
18 Jul - 14 Aug	181100	(5)	4	(36)	126
14 Aug - 11 Sep	54800	(5)	< 8		57
11 Sep - 9 Oct	55800	(5)	2	(53)	54
9 Oct - 6 Nov	120300	(5)	4	(38)	133
6 Nov - 4 Dec	52300	(5)	< 9		64
4 Dec - 2 Jan	115900	(5)	7	(31)	123

Values are reported in mBq/m^2.
When a nuclide is not detected, minimal detectable concentration (<MDC) is given.
Relative combined standard uncertainty (1σ%) within brackets.

5 Other detections

5.1 Detections during week 21, 2023

During the week 21, 22-29 May 2023, low concentrations of a few anthropogenic radioisotopes were detected in the samples from Gävle, Kista (Stockholm) and Visby. In Gävle and Visby ^{134}Cs and ^{137}Cs were detected and in Kista the detections also included ^{60}Co, see Table 5.1.

Table 5.1. Detections of anthropogenic radionuclides during week 21, 2023.

Station	Sampling period	^{60}Co	^{134}Cs	^{137}Cs
Kiruna	22 May - 29 May	< 0.2	< 0.2	0.1 (61)
Umeå	22 May - 29 May	< 0.3	< 0.3	3.7 (4)
Gävle	22 May - 29 May	< 0.2	0.8 (5)	4.5 (3)
Kista	21 May - 28 May	0.1 (25)	0.3 (6)	1.6 (3)
Visby	22 May - 29 May	< 0.3	0.3 (13)	0.8 (9)
Ljungbyhed	22 May - 29 May	< 0.6	< 0.6	< 0.5

Values are reported in µBq/m^3
When a nuclide is not detected, minimal detectable concentration (<MDC) is given.
Relative combined standard uncertainty (1σ%) within brackets.

From the station in Kista some of the individual 28 hour samples from the week were measured separately to give a better estimation of the time period of the detections, the results from these measurements are shown in Table 5.2.

Table 5.2. Measurements of individual 28 hours filters from the station in Kista.

Station	Sampling period	^{60}Co	^{134}Cs	^{137}Cs
Kista	21 May - 23 May	< 0.8	< 0.8	< 0.7
Kista	23 May - 24 May	0.9 (23)	1.2 (9)	1.3 (16)
Kista	24 May - 25 May	< 1.2	1.0 (12)	1.9 (15)
Kista	25 May - 26 May	< 0.9	< 0.8	4.5 (6)

Values are reported in µBq/m^3
When a nuclide is not detected, minimal detectable concentration (<MDC) is given.
Relative combined standard uncertainty (1σ%) within brackets.

Detections of anthropogenic radionuclides, mainly fission and activation products, were reported by STUK from the Finnish stations in Kotka, Imatra and Vantaa, southeast Finland (Figure 3) for the same time period[1]. Detections of a similar mix of anthropogenic radionuclides were also reported from Narva, northeast Estonia for the period[2].

Wind directions in the eastern parts of Sweden were mainly easterly for the relevant period assuming that these detections could have a common source. Atmospheric transport model (ATM) calculations backward in time were performed to find possible source sites. Three samples with short acquisition times (two from Kista, and one from Vantaa, Finland) and

[1] Measured activity concentrations in Finland can be found at: *https://stuk.fi/ulkoilman-radioaktiiviset-aineet*

[2] Data from the Estonian radiation monitoring network can be found at: *https://www.keskkonnaamet.ee/keskkonnakasutus-keskkonnatasu/kiirgus/kiirgusseire-ja-kriisireguleerimine#kiirgusseire-aruande*

one sample with longer acquisition time but where the collection period was favourable (Kotka, Finland) were used for these simulations. The results can be seen in Figure 3, where the field shown is where ATM models overlap for these four detections, i.e. likely source areas. As seen several nuclear power plants fall into these areas, consistent with a release time between 18-21/5. The colour of the field in the figures is log of the estimated source term in Becquerel.

The calculations gives a good correlation for a presumed release to the east or northeast of the Gulf of Finland a few days before the detections in Sweden.

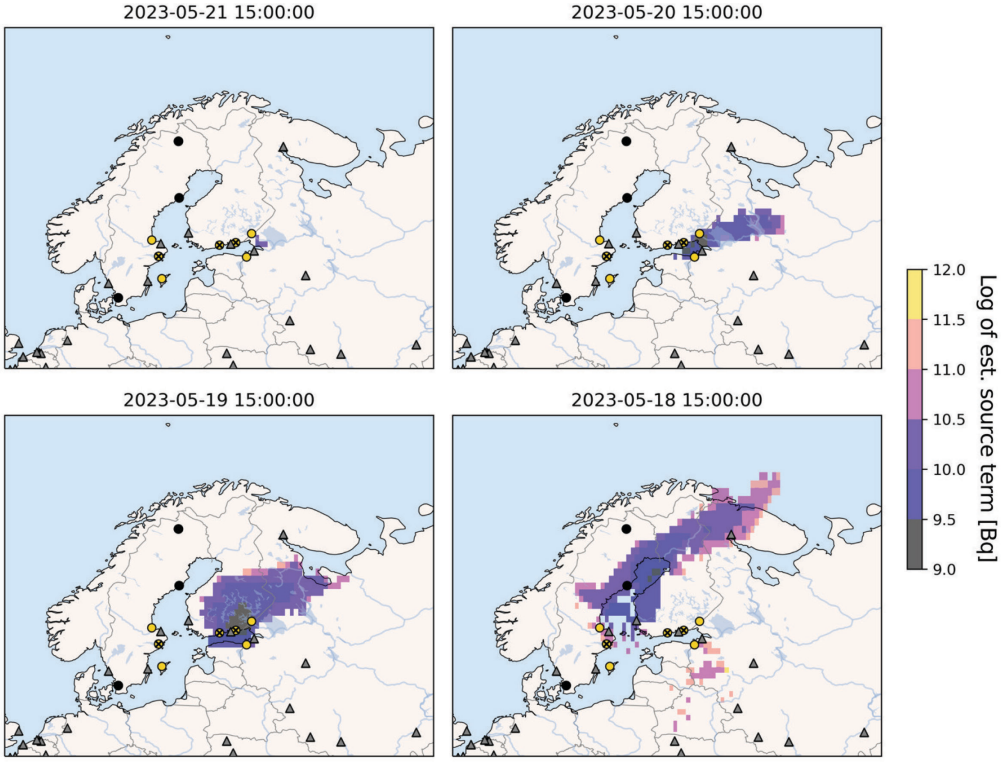


Figure 3. ATM calculations for the detections of anthropogenic radionuclides during week 21, 2023. Detections were made at all stations marked with yellow dots. Detections at the cross marked yellow dots were used for the ATM calculations. The black dots show the rest of the Swedish stations and the triangles mark the position of nuclear power plants in the region.

5.2 Detections of ^{131}I during 2023

At a few occasions during the year ^{131}I was detected in the network. Detections of low concentrations of ^{131}I are common. The sources for the detections have not been established.

Table 5.3. Detections of ^{131}I during 2023.

Station	Sampling period	^{131}I	
Gävle	7 Jun - 12 Jun	1.2	(30)
Gävle	12 Jun - 19 Jun	0.9	(29)
Kiruna	23 Oct - 30 Oct	0.3	(39)

Values are reported in µBq/m^3
Relative combined standard uncertainty (1σ%) within brackets.

FOI
Defence Research Agency
SE-164 90 Stockholm

Phone: +46 8 555 030 00
Fax: +46 8 555 031 00

www.foi.se