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## ABSTRACT

The activities of $^{103}Ru$, $^{131}I$, and $^{137}Cs$ in air and precipitation samples at some Norwegian stations after the Chernobyl reactor accident are reported. Two periods of increased radioactivity occured, in the first of these total airborne radioactivity increased up to three orders of magnitude over the normal background. The radionuclide concentrations measured in Scandinavia were among the highest measured after the accident. As expected, $^{131}I$ was the predominant radionuclide in the plume from Chernobyl. The results show that a few stations with continuous monitoring of radioactivity in air would have been sufficient to detect the transport into Norway of radioactive material from the accidental release at Chernobyl.

## CONTENTS

# AIR RADIOACTIVITY AT SELECTED STATIONS IN NORWAY AFTER THE CHERNOBYL REACTOR ACCIDENT

## 1 INTRODUCTION

The accidential release of radioactive materials from the Chernobyl nuclear power plant on 26 April 1986 is known to have caused a drastic increase of radioactivity in the environment reported in Europe, and Asia. Initial observations of radioactive fallout from the reactor accident have been reported in a series of publications, mainly in the journal Nature (e.g. Devell et al., 1986; Fry et al., 1986; Hill et al., 1986; Hohenemser et al., 1986; Thomas and Martin, 1986; Aoyama et al., 1986; Webb et al., 1986) and in various national reports. The Scandinavian countries are of particular interest in these reports since the radioactive plume was first discovered in Sweden and Finland and later in Norway. The weather in Europe during the accident, or at least at the beginning of the accident resulted in air transport from Chernobyl to Scandinavia. A high pressure centre was located over Ukraina with weak and varying wind at the surface and the south-east and south winds at 850 mb (ca. 1.5 km) blowing with a speed of 8 to 10 $m.s^{-1}$ (STUK, 1986).

In this report the activity of $^{131}I$, $^{137}Cs$ and $^{103}Ru$ in the air and precipitation at some Norwegian stations is presented and discussed with the use of air mass trajectories. A comparison of these data with the radionuclide concentrations in other countries is also shown.

## 2 EXPERIMENTAL

A location of stations is shown in Figure 1. Most of the data comes from the southern and central parts of Norway. A sampling time and a volume of filtered air is included in Table 1, while the respective data for the samples of precipitation are given in Table 2. Only few samples of precipitation were analysed because an accuracy of radioactivity measurements in

this study required at least 20 ml of precipitation sample and this volume was not always available.

## 2.1 SAMPLING PROCEDURE

The 24, 48, and 72 h samples were collected by the sampling equipment used ordinarily for the determination of sulphates in aerosols and gaseous sulphur dioxide. The sampling was done by drawing air through an air inlet, a Whatman 40 cellulose filter for particles and a Whatman 40 filter impregnated with potassium hydroxide for absorption of sulphur dioxide.

The filterholders were NILU-type double filterholders made of polycarbonate with 47 mm i.d. filters.

## 2.2 RADIOACTIVITY MEASUREMENTS

The radioactivity measurements were carried out at the Institute for Energy Technology (IFE) at Kjeller.

Air samples were analysed with the use of Ge(Li) detector for a period of 1 hour for each sample. The following standards were used: 5.5 nCi $^{137}$Cs and 10.4 nCi $^{131}$I. The $^{103}$Ru activity was calculated on the basis of the above standards.

Precipitation samples were also analysed with the Ge(Li) detector, however, measurement time was 2 hours per sample. The same standards were used as for air samples.

The activities of all radionuclides in all samples were corrected for radioactive decay during the time from sampling to analysis. This is particularly important for $^{131}$I which has a relatively short lifetime of 8.07 days (for 50% reduction of activity). All the activities are recalculated to give the activities during the sample collection period.

## 3 RESULTS

The results of the $^{103}Ru$, $^{131}I$ and $^{137}Cs$ activity measurements in the air are presented in time series diagrams for Birkenes, Skreådalen, Prestebakke, Nordmoen, Kårvatn, Hummelfjell, Tustervatn and Jergul in Figures 2 through 9 respectively.

The results of the $^{103}Ru$, $^{131}I$, and $^{137}Cs$ activity measurements in precipitation are shown in Table 3.

## 4 DISCUSSION

Accidential releases of radionuclides from the Chernobyl reactor have increased significantly the level of their activities in the air at all discussed stations except Jergul. The highest activities of all measured radionuclides were observed at three stations in central and northern parts of Norway, viz. Kårvatn, Nordmoen and Tustervatn during 28 to 30 April, 1986.

It is difficult to assess the precise time when the pollution load from Chernobyl has reached the area of measurements. The data for Kårvatn and Tustervatn are on the 24 h sampling basis and the Nordmoen activities are average for 2 days of sampling. More information in this aspect can be obtained when the chemical data are used together with the air mass trajectories. The 925 mb (ca. 760 m) forward trajectories for Chernobyl on 26 April, 1986 were computed at the Norwegian Meteorological Institute and are presented in Figure 10. They seem to indicate that the radioactive plume reached Kårvatn, Tustervatn and Nordmoen on 29 April in the morning.

The highest activities of $^{103}Ru$, $^{131}I$, and $^{137}Cs$ were measured in a filter sample collected at Kårvatn, 28-29 April. The values corresponded to 10.8 Bq. $m^{-3}$ of $^{131}I$, 5.7 Bq . $m^{-3}$ of $^{137}Cs$, and 0.86 Bq . $m^{-3}$ of $^{103}Ru$. These activities relate to radionuclides captured on the first Whatman 40 cellulose filter. Unfortunately, $^{131}I$ activities on the second, alkaline impregnated filter, were only measured for a batch of samples collected during the second pulse of elevated radioactivity, between 6 and 10 May. The

amount collected on the second filter was a rather constant fraction of 17-30% of $^{131}I$ activity on the first filter. This indicates that a significant fraction of the $^{131}I$ was, in fact, presented as a gaseous iodine compound. Chamberlain (1960) indicates that "metallic surfaces and also filter papers and similar materials acts as perfect sinks for trace quantities of elemental iodine vapour", so that gaseous $^{131}I_2$ may also have been adsorbed onto the first, aerosol filter. If so, the activity on the second filter could be due to $H^{131}I$.

Recently, Jenkins et al. (1985) have discussed the photochemistry of iodine. They conclude that, following rapid initial photodissociation of $I_2$, reaction with $O_3$ yields IO. A likely gaseous end product is $IONO_2$.

Gaseous $^{131}I$ was measured at Studsvik (Devell et al., 1986), who found that 75-80% of the activity due to $^{131}I$ passed through the aerosol filter and was absorbed in a charcoal cartridge behind the filter. The concentrations of radionuclide collected on filters were fairly stable during 28-29 April and typical value were 2-5 Bq . $m^{-3}$ of $^{137}Cs$ and 6-12 Bq . $m^{-3}$ of $^{131}I$. Thus, the radionuclide activities at Kårvatn are in the range observed in Sweden. Approximately 1 h-average activities in Konala, Helsinki during 28 to 29 April varied from 1 to 210 Bq . $m^{-3}$ for $^{131}I$, and 0.006 to 7.2 Bq . $m^{-3}$ for $^{137}Cs$ (STUK, 1986). The $^{131}I$ activities in Finland have been corrected, by assuming that as much as 85% of the radionuclide have penetrated the glass-fibre filter. Obviously, $^{131}I$ is released in a gas-phase, however, after transport for few thousand kilometres within the air masses a major part of gaseous $^{131}I$ is likely to be associated with aerosol articles. An assumption of 85% $^{131}I$ in the gas phase can be an overestimate, but there is no doubt that the amount of gaseous $^{131}I$ is significant.

No data exists for Hummelfjell during 28 to 29 April 1986. Lower activities of $^{103}Ru$, $^{131}I$ and $^{137}Cs$ were measured in southern Norway in 28 to 29 April, as shown in Figures 2 and 4 for Birkenes and Prestebakke, and the data for Jergul were at the detection limit (Figure 9).

A part of the radioactivity (as aerosols and gas phase) was washed out from the air by weak showers in Scandinavia during 27 to 29 April 1986. From April 26 a low pressure center over the Norwegian Sea was moving towards the east and relatively cold air behind this center decreased the temperatures and resulted in the shower activity. The rainfall over Scandinavia in 28-29

April is indicated in Figure 10. Very high activities of radionuclides were measured in precipitation sampled at Gulsvik (Table 3) on 28-29 April. The $^{131}I$ activity in this sample was 27 times higher than the $^{131}I$ limit for rain water used as drinking water in Finland (STUK, 1986). Samples from Tustervatn and Kårvatn also contained concentration of $^{131}I$ high. After 30 April no transport of air masses was observed from the accident area to Norway. As a result, the radioactivity in air and precipitation were drastically reduced.

The activities of $^{103}Ru$, $^{131}I$, and $^{137}Cs$ increased again in the beginning of May. The 850 mb backward trajectories are shown in Figure 11 for Birkenes and in Figure 12 for Kårvatn. The trajectories again indicate long range transport of air masses passing over the area of Chernobyl to Scandinavia. The radioactive load transported within the air masses caused an increase of the $^{103}Ru$, $^{131}I$, and $^{137}Cs$ activities at the Norwegian stations as shown in Figures 2-8. The activities were quite high, although not as high as in the first period which occurred during the first radioactivity releases from the reactor. This could suggest, that the action to put down the accidential releases was becoming efficient.

The accidental release of radionuclides from the Chernobyl reactor is also known to have increased the level of radioactivity in other European countries and even in Japan. The radioactive plume was first detected over Paris on 29 April (Thomas and Martin, 1986). They detected twenty radionuclides and the maximum activity was measured at 6.3 Bq . $m^{-3}$. The $^{137}Cs$ activity in the sample of rain water collected between 29 April and 3 May was 700 Bq . $l^{-1}$; thus almost 80 times lower than at Gulsvik during 28 to 29 April.

An increase of radioactivity in the air was first detected in the southern United Kingdom on 2 May and reached the maximum during the afternoon of this day (Fry et al., 1986). A typical value for the United Kingdom on 2 May seem to be as follows: 2.0 Bq . $m^{-3}$ of $^{131}I$, 1 Bq . $m^{-3}$ of $^{137}Cs$ and 1.5 Bq . $m^{-3}$ of $^{103}Ru$.

On 3 May, the radioactivity of the surface air and water increased abruptly in the middle of Honshu Island in Japan (Aoyama et al., 1986). The highest activities were found in the sample collected between 5 and 10 May. The $^{137}J$ activity was about a fiftieth of activities observed in Scandinavia. Ayoama

et al. (1986) indicate that 65-70% of the radioiodine was present in a gaseous form eight or nine days after emission.

It is important to assess the significance of measured values of the $^{103}Ru$, $^{137}Cs$, and $^{131}I$ activities during the Chernobyl accident. No data exists for the above Norwegian stations to compare these values with radioactivity measurements before the accident. However, Devell et al. (1986) report that atmospheric activities of radionuclides in Studsvik, Sweden at the time when the polluted plume reached the station have increased from the normal 5-10 counts per second to 20-150 counts per second. In Japan, the $^{137}Cs$ activities have changed from normal 15 $\mu Bq \cdot m^{-3}$ up to 24 $mBq \cdot m^{-3}$ during the accident.

It is also interesting to compare the activities measured in the air after the accident with the maximum permissible values. Russian maximum permissible activities of radionuclides in the air over the residential regions (no. 333-60) are 3.3 $mBq \cdot m^{-3}$ for $^{131}I$ and 3.7 $mBq \cdot m^{-3}$ for $^{137}Cs$ (e.g. Wokken, 1969). If these, rather old standards are not changed (no information about any changes was available to the authors), the activities of radionuclides reported here, and measured in Norway a few days after the Chernobyl accident were higher than the maximum permissible values in the Soviet Union by three orders of magnitude. Of course, these high activities were observed for a short time (few days) only.

The significance of the data collected after the Chernobyl accident, and particularly the significance of activity of long-lived nuclides such as $^{137}Cs$ can be estimated by comparison with the maximum atmospheric concentrations reached in 1963, after the cessation of major nuclear bomb tests in the atmosphere. $^{137}Cs$ is known as one of the major radionuclides released during the nuclear bomb tests. The monthly average $^{137}Cs$ activities in surface air in 1963 for some stations are shown in Table 4 (US AEC, 1973), together with the radionuclide activities at Kårvatn during 28 April - 9 May, 1986. Thus, the $^{137}Cs$ activity at Kårvatn at the time when the radioactive plume from Chernobyl reached the station was higher by three orders of magnitude than the $^{137}Cs$ activities in 1963. Thomas and Martin (1986) report that $^{137}Cs$ concentrations in France ($46^{0}07'N$) in 1963 were lower by two orders of magnitude that the maximum due to the Chernobyl accident at Paris.

The $^{131}I$ is not the predominant radionuclide emitted during the bomb tests. However, Aoyama et al. (1986) indicate that the level of $^{131}I$ observed in the surface air is of the same order of magnitude as that seen over Japan after the high-yield nuclear test by the Soviet Union in October 1961.

Bergh et al. (1959) measured radioactivity of precipitation, top water and milk in Norway during 1957 to 1958. The range of $^{137}Cs$ activities measured in samples collected for a few days (changing number of days from one sample to another) at Bergen, Møsvann, Kjeller and Ski in 1958 is presented in Table 5, together with the Gulsvik data for 28 to 29 April, 1986. The very high $^{137}Cs$ activity in the precipitation sample at Gulsvik was higher by three orders of magnitude than the values measured in Norway in 1958.

Because the relative proportions of gaseous $^{131}I$ and $^{131}I$ asorbed on particles is not known, estimates of the dry deposition of this radionuclide from the air filter data will be rather uncertain, and the figures in Table 6 should only be taken as an indication of the order of magnitude. It is assumed for the calculation that 30% of the $^{131}I$ penetrates the filter, and that all of the $^{131}I$ on the first filter is associated with aerosol filters. If the aerosol dry deposition is 0.1 cm . $s^{-1}$ and the dry dposition velocity for gaseous $^{131}I$ 1 cm . $s^{-1}$, this assumption leads to an effective dry deposition velocity of 0.4 cm . $s^{-1}$, when referred to the specific $^{131}I$ activities obtained from the air filter measurements. It should be stressed that this is a conservative estimate, because the proportion of gaseous $^{131}I$ may have been significantly higher during the first pulse of airborne radioactivity. An upper limit can be calculated on the basis of Devell et al.'s (1986) observation that 75-80% of the airborne $^{131}I$ passed through the aerosol filter. This gives a ratio of $^{131}I$ to $^{137}Cs$ which is close to the expected ratio for used reactor fuel, but too high in relation to expected loss during transport, because of higher dry deposition velocity for $^{131}I$ than for $^{137}Cs$.

The variable, and higher, ratio of $^{131}I$ to $^{137}Cs$ in the precipitation samples (Table 3), may be due to different scavenging mechanisms and efficiency for the gaseous and particle-associated radionuclides. The concentrations of $^{131}I$ are much more variable than $^{137}Cs$. The activities due to the latter are generally in the range 0.3-1.3 Bq . $ml^{-1}$, which fit quite well with the measured airborne concentration levels of $^{137}Cs$. Although the precipitation sampling station network is too sparse to indicate deposition

patterns, it appears that crude estimate of $^{137}Cs$ fallout could have obtained from a knowledge of the precipitation amounts 28-29 April, by assuming that 1 mm of precipitation resulted in a deposition of $^{137}Cs$ equivalent to ~1000 Bq . $m^{-3}$.

The actual 4.4 mm of precipitation at Gulsvik contributed 237 000 Bq . $m^{-2}$ of $^{131}I$ and 5800 Bq . $m^{-2}$ of $^{137}Cs$, which may be compared with the much lower estimated dry deposition amounts. Significant amounts of radionuclides in precipitation occurred also 4-6 May (Lista) and 8-9 May (Kårvatn).

## *5 CONCLUSION*

This information on radioactivity in air and precipitation in Norway following the Chernobyl incident, is mainly based on samples collected at a few monitoring sites for precipitation and long-range transport of air pollutants from fossil fuel.

As expected, $^{131}I$ was the most abundant radionuclide emitted from Chernobyl. This radionuclide is released mainly in the gas phase, and may be partly adsorbed on aerosol particles. Several authors have given figures for gas/-aerosol partition and filter penetration factors, but there is an apparent need for understanding of the chemical behaviour of $^{131}I$ in the atmosphere following accidental releases of this type. Unfortunately, the possibility of measuring $^{131}I$ on alkaline impregnated filters collected in the first episode of airborne radioactivity transport from Chernobyl to Norway, was not taken advantage of.

As shown by the air filter data, a limited number of air sampling stations is sufficient to detect and determine airborne radioactivity levels. A continuous monitoring system may be used in conjunction with routine collection of air filters, which are necessary to determine specific radioisotopes. Dry deposition in the growing season may be estimated from concentrations in air, using standard dry deposition velocities. Monitoring of wet deposition requires, in general, a denser network. However, knowledge of the precipitation pattern on a daily basis can be used together with airborne concentration levels, to make crude estimates of deposited amounts.

Further application of the data from this report would be in conjunction with atmospheric transport models for radioisotopes, e.g. the MESOS model developed for the Commission of the European Communities (CEC, 1983) and the model for long-range transport and deposition of air pollutants developed at the Norwegian Meteorological Institute (Eliassen and Saltbones, 1983), and calculations of population doses and risk assessments on a large scale.

The $^{137}$Cs activities and estimated deposition of this isotope can be used in connection with models of radionuclide movement in the ecological chain (e.g. Glowiak and Pacyna; 1974, 1977). Such models predict the contribution of atmospheric $^{137}$Cs to concentrations in soil, plants, and human diet.

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Table 1: Sampling period and volume of air for samples analysed in this report.

| Station | Sampling period | Air Volume $m^3$ | Station | Sampling period | Air Volume $m^3$ |
|---|---|---|---|---|---|
| Birkenes | 27-28/4-86 | 26.0 | Kårvatn | 27-28/4-86 | 17.0 |
| " | 28-29/4-86 | 25.8 | " | 28-29/4-86 | 18.2 |
| " | 29-30/4-86 | 24.8 | " | 29-30/4-86 | 18.8 |
| " | 30/4-1/5-86 | 25.9 | " | 30/4-1/5-86 | 18.4 |
| " | 1-2/5-86 | 26.0 | " | 1-2/5-86 | 16.5 |
| " | 2-3/5-86 | 25.5 | " | 2-3/5-86 | 16.8 |
| " | 3-4/5-86 | 24.6 | " | 3-4/5-86 | 21.4 |
| " | 4-5/5-86 | 25.4 | " | 4-5/5-86 | 16.3 |
| " | 5-6/5-86 | 24.8 | " | 7-8/5-86 9a | 15.4 |
| " | 6-7/5-86 | 25.8 | " | 7-8/5-86 9b | 15.4 |
| " | 7-8/5-86 1a | 24.5 | " | 8-9/5-86 10a | 18.7 |
| " | 7-8/5-86 1b | 24.5 | " | 8-9/5-86 10b | 18.7 |
| Prestebakke | 25-28/4-86 | 68.0 | Tustervatn | 27-28/4-86 | 19.3 |
| " | 28-30/4-86 | 43.0 | " | 27-28/4-86 | 16.9 |
| " | 30/4-2/5-86 | 44.6 | " | 29-30/4-86 | 19.0 |
| " | 2-5/5-86 | 63.9 | " | 30/4-1/5-86 | 17.1 |
| " | 7-9/5-86 4a | 41.3 | " | 1-2/5-86 | 19.2 |
| " | 7-9/5-86 4b | 41.3 | " | 2-3/5-86 | 16.5 |
| Nordmoen | 25-28/4-86 | 66.2 | " | 3-4/5-86 | 19.5 |
| " | 28-30/4-86 | 39.3 | " | 4-5/5-86 | 17.5 |
| " | 30/4-2/5-86 | 43.0 | " | 5-6/5-86 | 20.3 |
| " | 2-5/5-86 | 61.2 | " | 6-7/5-86 | 17.9 |
| " | 5-7/5-86 5a | 42.7 | " | 7-8/5-86 | 19.6 |
| " | 5-7/5-86 5b | 42.7 | " | 8-9/5-86 | 18.2 |
| " | 7-9/5-86 6a | 40.0 | " | 9-10/5-86 | 18.7 |
| " | 7-9/5-86 6b | 40.0 | " | 10-11/5-86 | 17.2 |
| Jergul | 27-28/4-86 | 22.3 | Hummelfjell | 30/4-1/5-86 | 15.9 |
| " | 28-29/4-86 | 22.6 | " | 1-2/5-86 | 15.6 |
| " | 29-30/4-86 | 21.9 | " | 1-3/5+4-5/5-86 | 26.3 |
| " | 30/4-1/5-86 | 23.1 | " | 3-4/5-86 | 16.5 |
| " | 1-2/5-86 | 21.6 | " | 7-8/5-86 7a | 15.9 |
| " | 2-3/5-86 | 22.1 | " | 7-8/5-86 7b | 15.9 |
| " | 3-4/5-86 | 21.3 | " | 8-9/5-86 8a | 14.6 |
| " | 4-5/5-86 | 22.2 | " | 8-9/5-86 8b | 14.6 |
| " | 5-6/5-86 | 22.1 | Skreådalen | 5-6/5-86 2a | 21.1 |
| " | 6-7/5-86 | 23.9 | " | 5-6/5-86 2b | 21.1 |
| " | 7-8/5-86 | 22.3 | " | 6-7/5-86 3a | 20.7 |
| " | 8-9/5-86 | 23.1 | " | 6-7/5-86 3b | 20.7 |
| " | 9-10/5-86 | 22.2 | | | |

Table 2: Sampling period and precipitation volume for samples analysed in this report.

| Station | Sampling period | Precipitation amount ml | mm |
|---|---|---|---|
| Tustervatn | 28-29/4-86 | 450 | 14.2 |
| " | 30/4-1/5-86 | 35 | 1.1 |
| Skreådalen | 29-30/4-86 | 284 | 9.0 |
| Kårvatn | 29-30/4-86 | 110 | 3.5 |
| " | 8-9/5-86 | 195 | 6.2 |
| Gulsvik | 28-29/4-86 | 140 | 4.4 |
| Vatnedalen | 29-30/4-86 | 152 | 4.8 |
| Lista | 29-30/4-86 | 220 | 7.0 |
| " | 4-5/5-86 | 70 | 2.2 |
| " | 5-6/5-86 | 199 | 6.3 |

Table 3: $^{103}Ru$, $^{131}I$, and $^{137}Cs$ activities in precipitation collected at some stations in Norway after the Chernobyl accident, in Bq . $ml^{-1}$.

| Station | Sampling period | Activity | | |
|---|---|---|---|---|
| | | $^{103}Ru$ | $^{131}I$ | $^{137}Cs$ |
| Skreådalen | 29-30/4-86 | < 0.06 | < 0.07 | < 0.06 |
| Kårvatn | 29-30/4-86 | < 0.06 | 2.22 | 0.34 |
| " | 8-9/5-86 | 0.33 | 0.32 | 0.13 |
| Gulsvik | 28-29/4-86 | 0.20 | 54.02 | 1.33 |
| Vatnedalen | 29-30/4-86 | < 0.06 | < 0.11 | < 0.06 |
| Lista | 29-30/4-86 | < 0.06 | < 0.11 | < 0.06 |
| " | 4-5/05-86 | 1.41 | 3.40 | 0.74 |
| " | 5-6/05-86 | 0.89 | 1.33 | 0.48 |
| Tustervatn | 28-29/4-86 | 0.09 | 9.18 | 0.74 |
| " | 30-1/5-86 | 0.27 | 4.29 | 0.37 |

Table 6: Estimated dry deposition of $^{131}I$ and $^{137}Cs$ 28-29 April

| Site | Isotope | Specific activity Bq . $m^{-3}$ 28-29.4 | 29-30.4 | Estimated dry deposition Bq . $m^{-2}$ |
|---|---|---|---|---|
| Prestebakke | $^{131}I$ | 0.95 | 0.95 | 700 - 7000 |
| | $^{137}Cs$ | 0.46 | 0.46 | 100 |
| Nordmoen | $^{131}I$ | 4.33 | 4.33 | 3000 - 30 000 |
| | $^{137}Cs$ | 1.98 | 1.98 | 300 |
| Birkenes | $^{131}I$ | 0.8 | 0.0 | 300 - 3000 |
| | $^{137}Cs$ | 0.4 | 0.06 | 40 |
| Kårvatn | $^{131}I$ | 10.8 | 4.5 | 5000 - 50 000 |
| | $^{137}Cs$ | 5.7 | 1.9 | 700 |
| Tustervatn | $^{131}I$ | 0.56 | 1.25 | 600 - 6000 |
| | $^{137}Cs$ | 0.04 | - | 10 |

Table 4: $^{137}Cs$ activities in surface air in 1963 (US AEC, 1973). Monthly average values in mBq . $m^{-3}$ .

| Site | Activity range |
|---|---|
| Thule, Greenland | 0.5 - 4.7 |
| New York | 2.6 - 5.5 |
| Miami, Florida | 0.7 - 5.5 |
| Mouna Loa, Hawaii | 0.9 - 4.8 |
| Lima, Peru | 0.01 - 0.3 |
| Santiago, Chile | 0.04 - 0.5 |
| Kårvatn (this work) 28/4-09/5-86 | 10.0 - 5710 |

Table 5: $^{137}Cs$ activities in precipitation in 1958. (Bergh et al. 1959). Values in mBq . $l^{-1}$ measured in samples collected for a few days.

| Site | Activity range |
|---|---|
| Bergen | 81 (July 30 - Aug. 2) - 877 (June 18 - July 8) |
| Møsvatn | 41 (Jan. 15 - Feb. 15) - 3045 (Mar. 15 - Apr. 15) |
| Kjeller | 70 (Sept. 11 - 22) - 1033 (May 28 - June 10) |
| Ski | 41 (Mar. 12 - Apr. 11) - 555 (May 23 - June 1) |
| Gulsvik (this work) | 1330 000 (Apr. 28 - 29, 1986) |

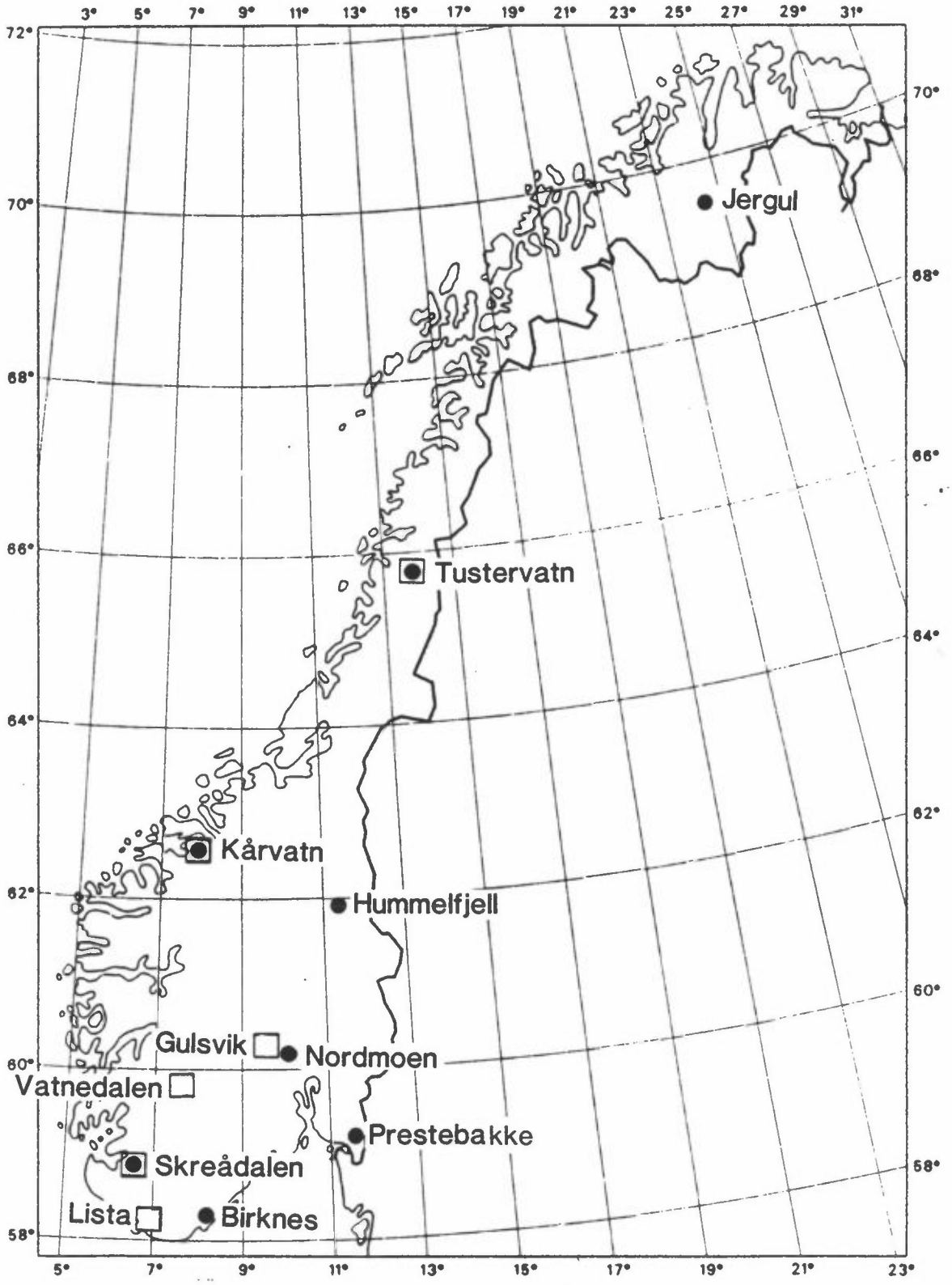


Figure 1: Location of sampling stations.
- ● Air sampling
- □ Precipitation sampling

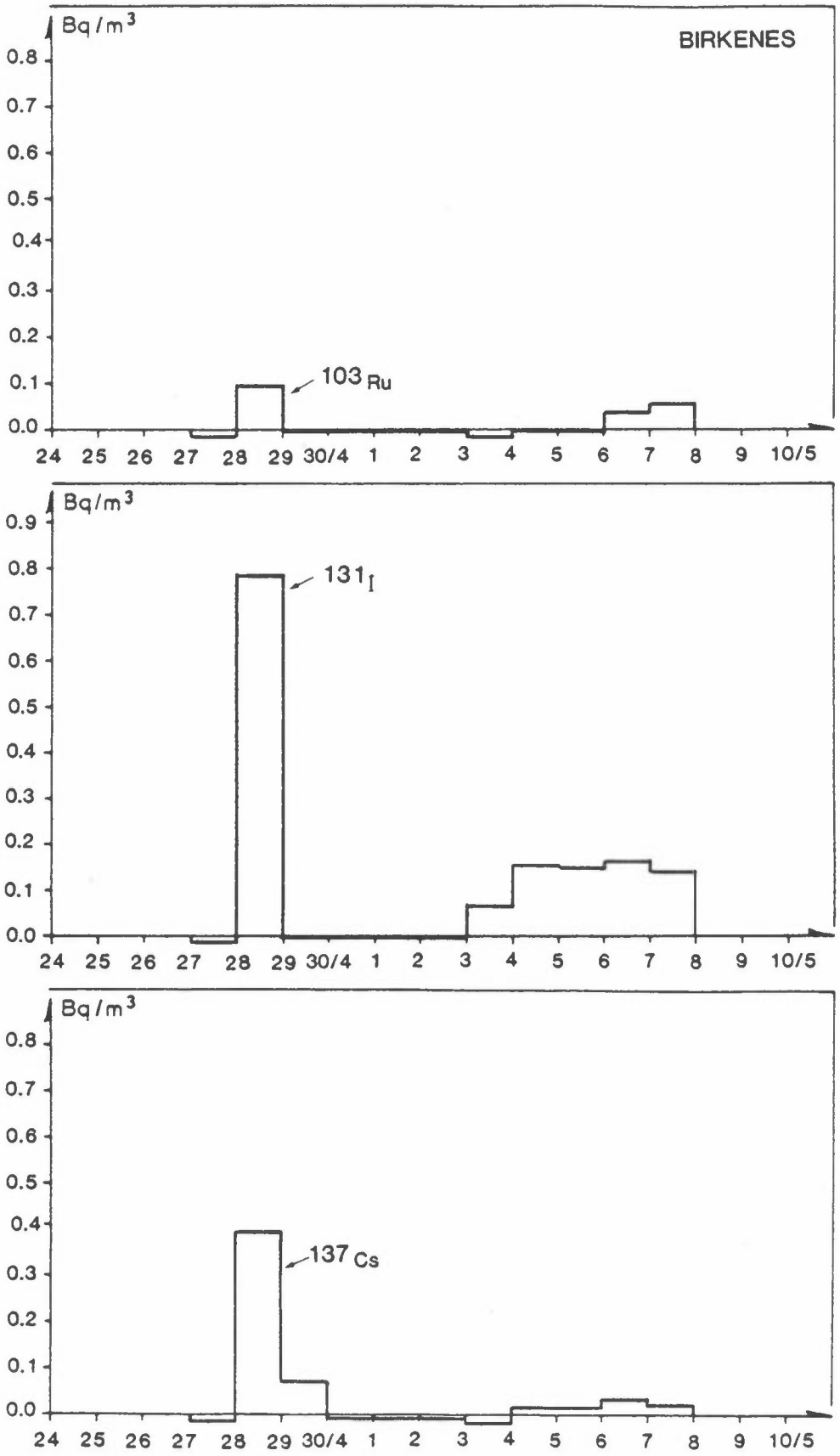


Figure 2: Air activity of $^{103}Ru$, $^{131}I$ and $^{137}Cs$ at Birkenes during 28 April to 8 May 1986. The values, below the scale represent activities at the detection limit.

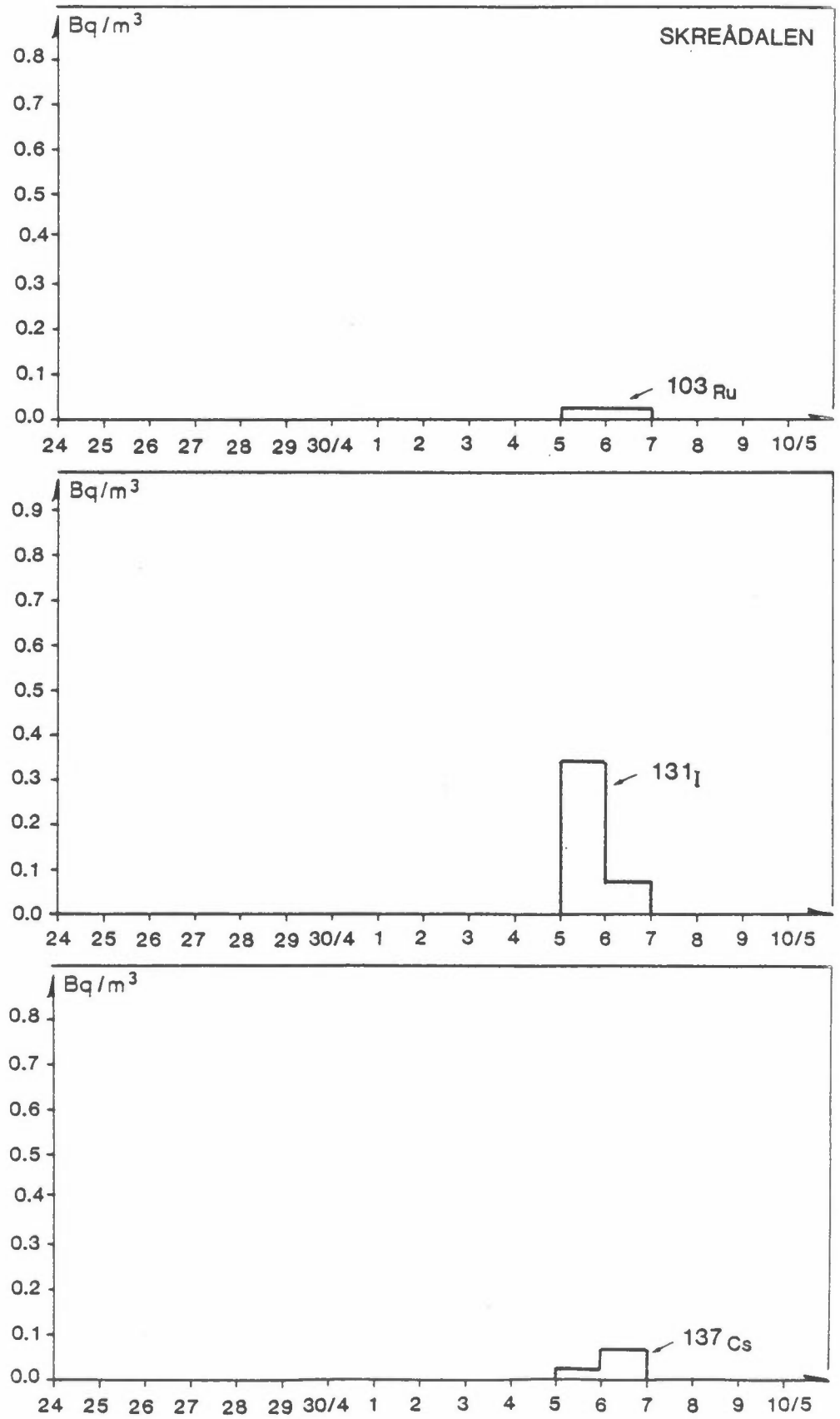


Figure 3: Air activity of $^{103}Ru$, $^{131}I$ and $^{137}Cs$ at Skreådalen during 5 to 7 May 1986.

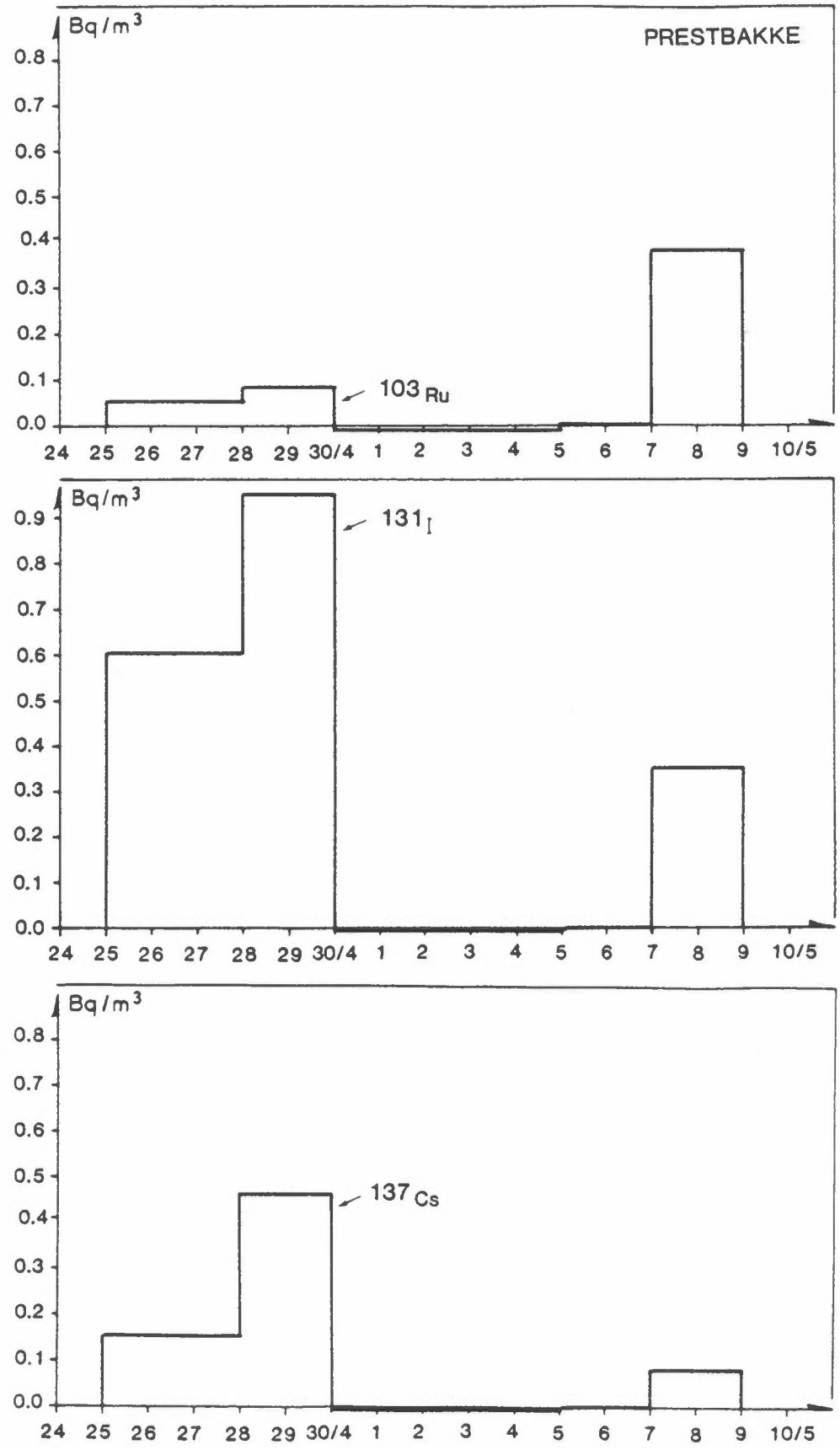


Figure 4: Air activity of $^{103}Ru$, $^{131}I$ and $^{137}Cs$ at Prestebakke during 25 April to 9 May 1986. The values, below the scale represent activities at the detection limit.

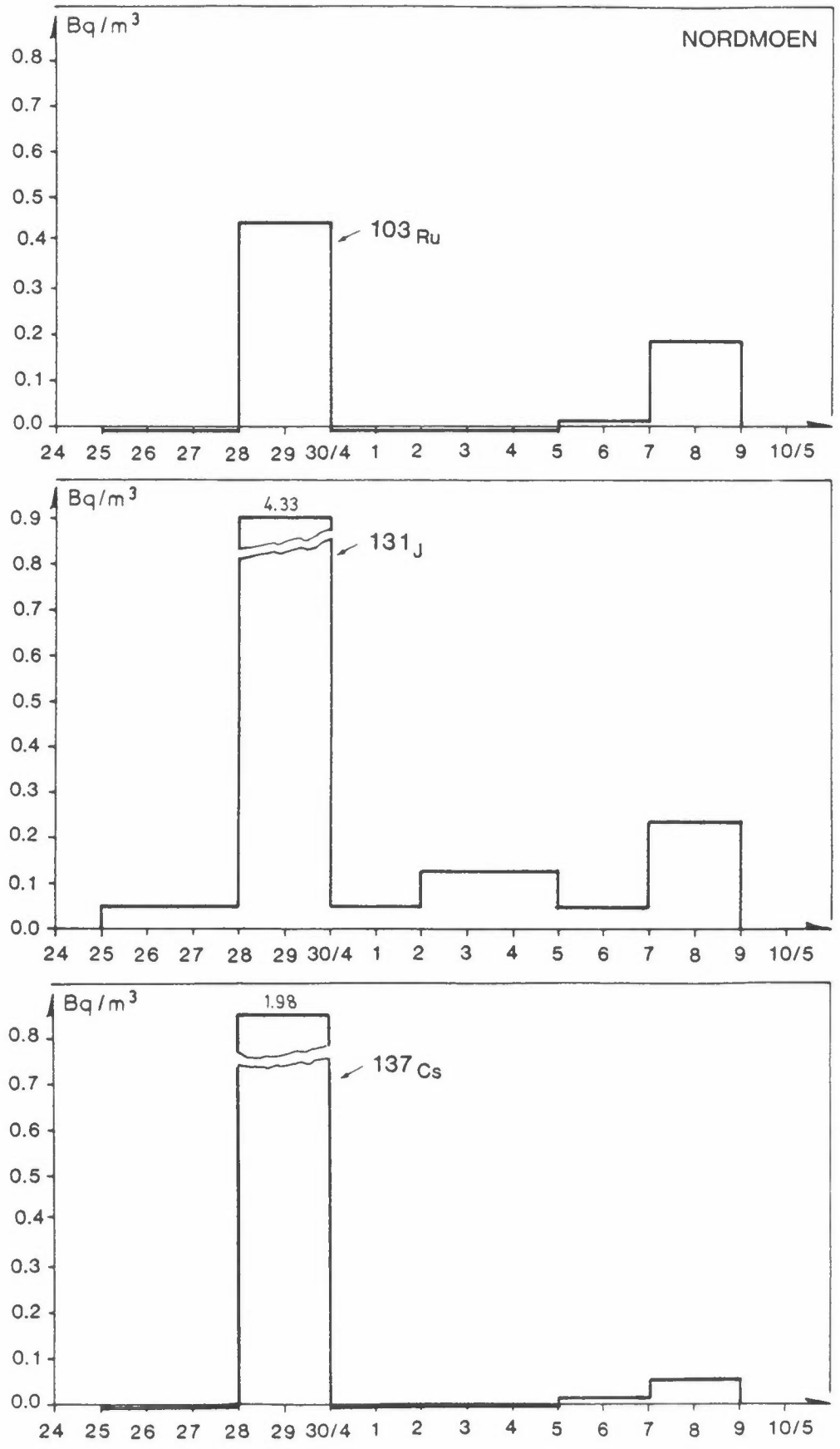


Figure 5: Air activity of $^{103}Ru$, $^{131}I$ and $^{137}Cs$ at Nordmoen during 25 April to 9 May 1986. The values, below the scale represent activities at the detection limit.

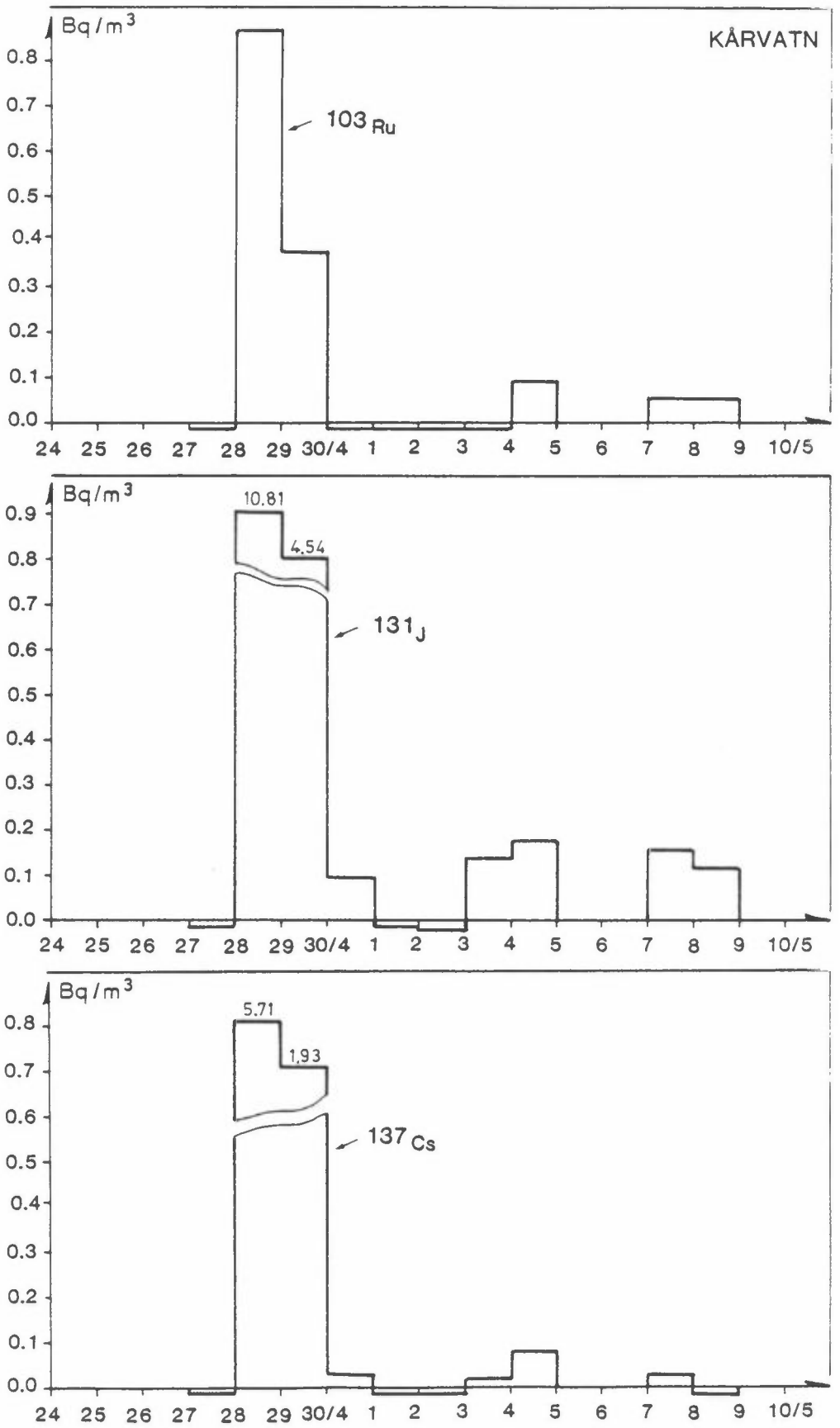


Figure 6: Air activity of $^{103}Ru$, $^{131}I$ and $^{137}Cs$ at Kårvatn during 27 April to 9 May 1986. The values, below the scale represent activities at the detection limit.

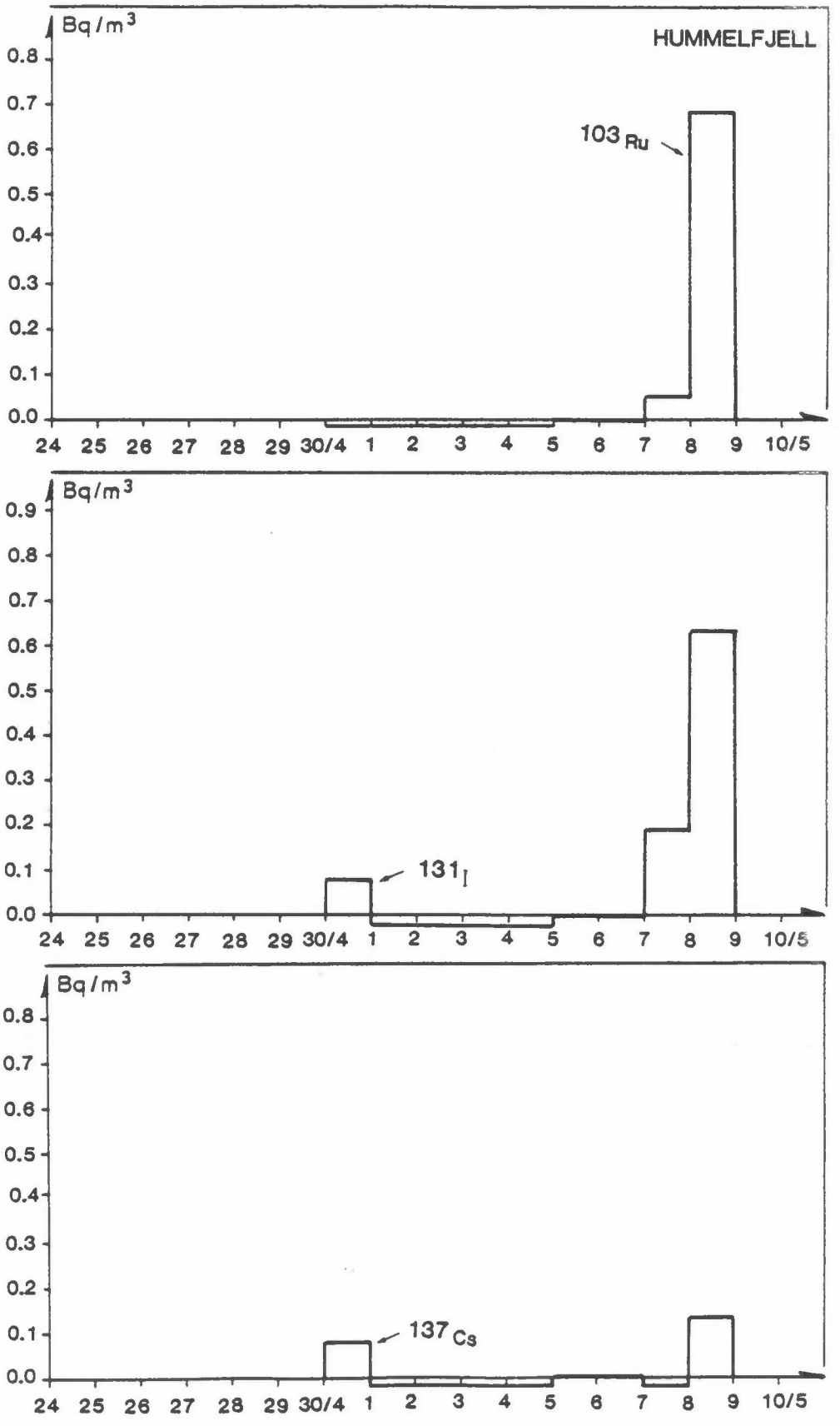


Figure 7: Air activity of $^{103}Ru$, $^{131}I$ and $^{137}Cs$ at Hummelfjell during 30 April to 9 May 1986. The values, below the scale represent activities at the detection limit.

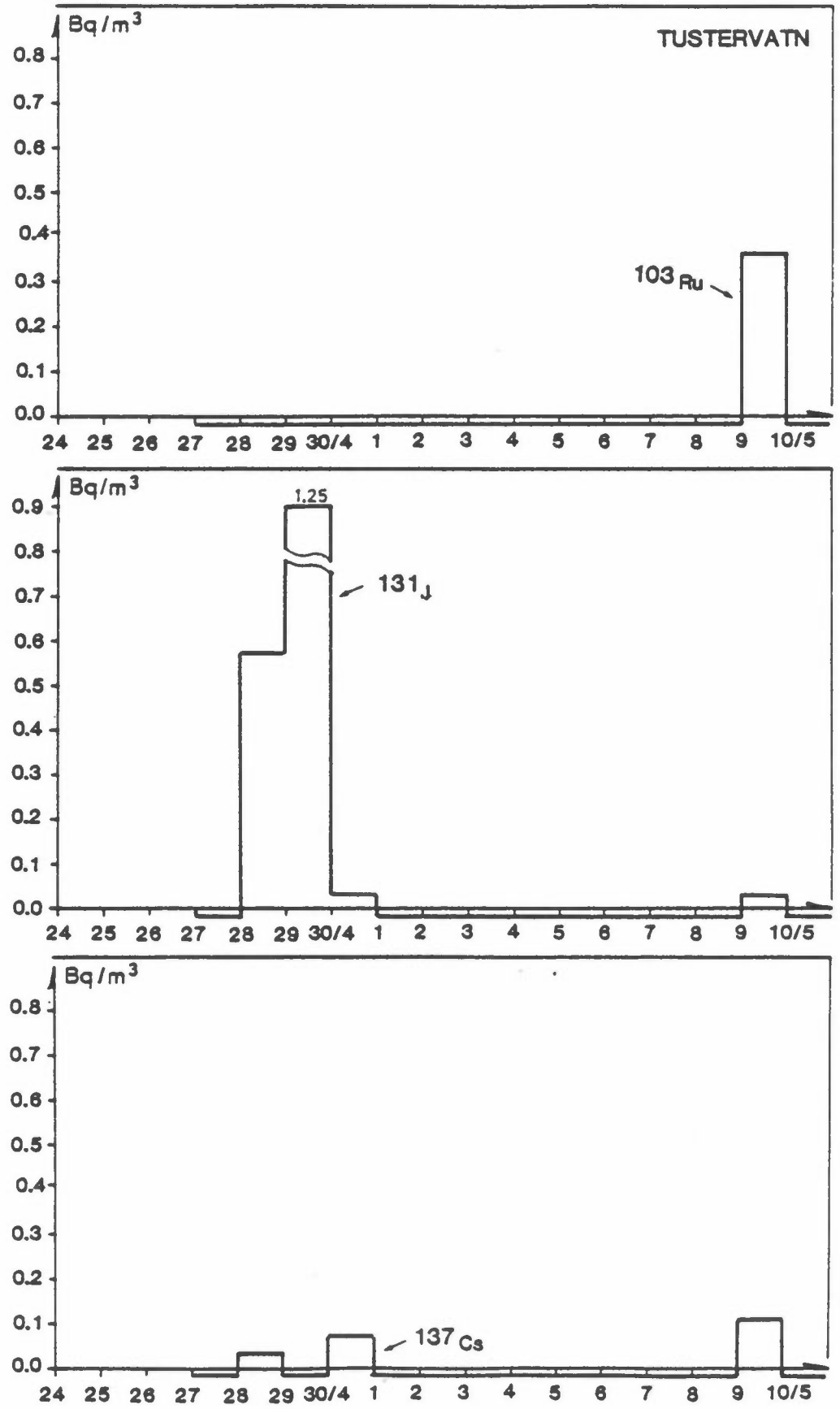


Figure 8: Air activity of $^{103}Ru$, $^{131}I$ and $^{137}Cs$ at Tustervatn during 27 April to 11 May 1986. The values, below the scale represent activities at the detection limit.

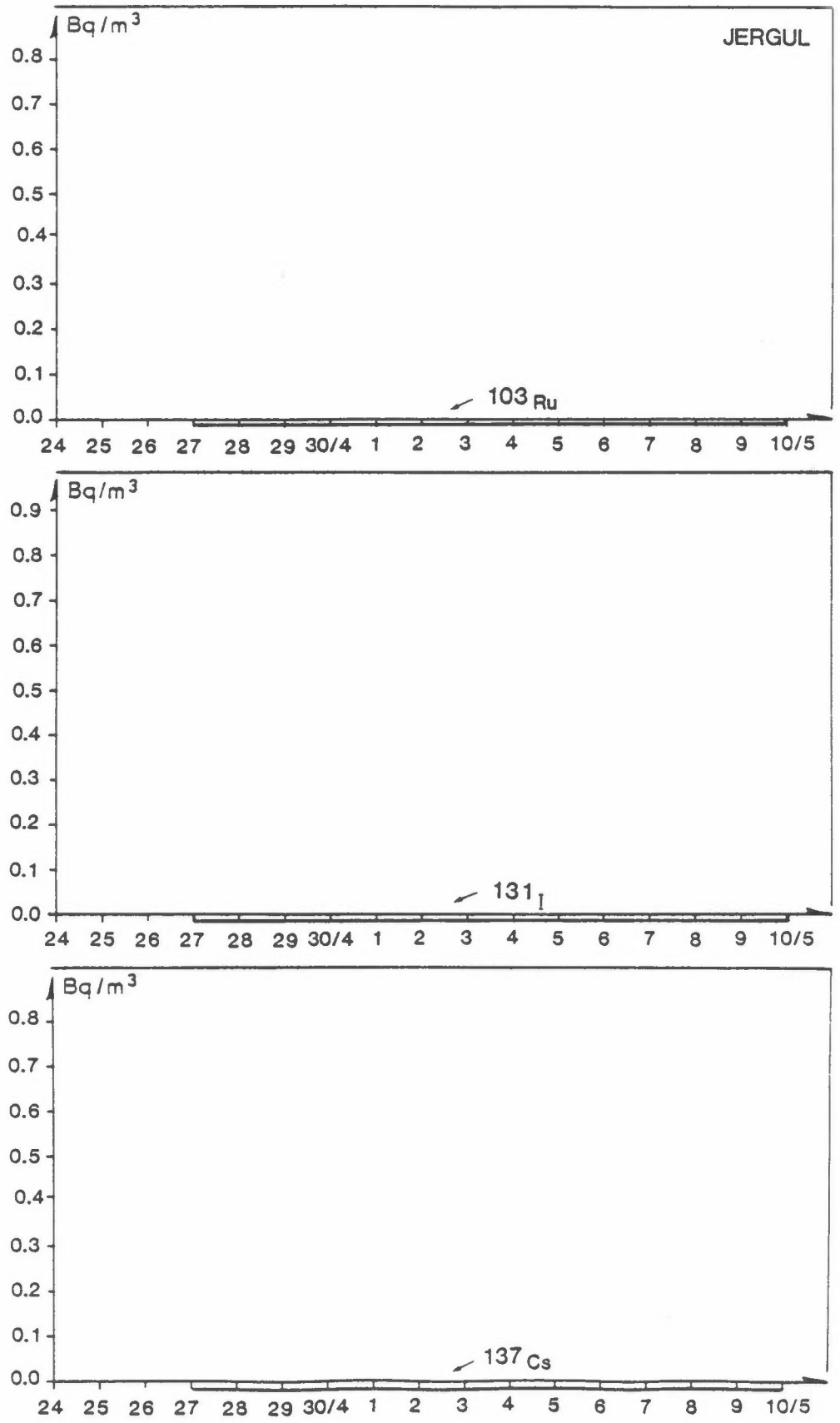


Figure 9: Air activity of $^{103}Ru$, $^{131}I$ and $^{137}Cs$ at Jergul during 27 April to 10 May 1986. The values, below the scale represent activities at the detection limit.

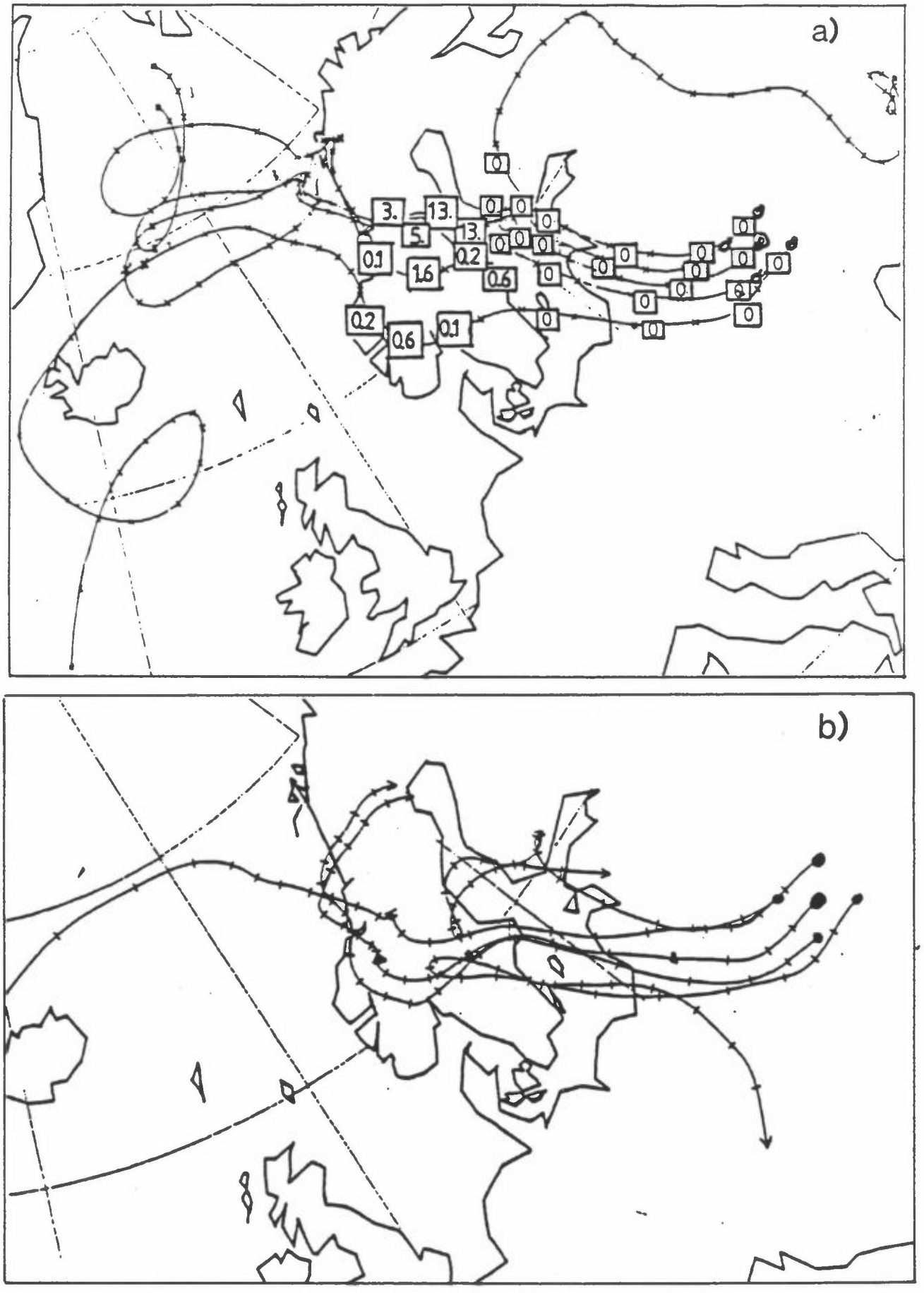


Figure 10: 925 mb forward trajectories for Chernobyl on 26 April 1986.
The 6 hr periods are indicated.
A: 00 GMT B: 06 GMT C: 12 GMT D: 18 GMT
(Numbers in squares indicate precipitation amounts in mm).

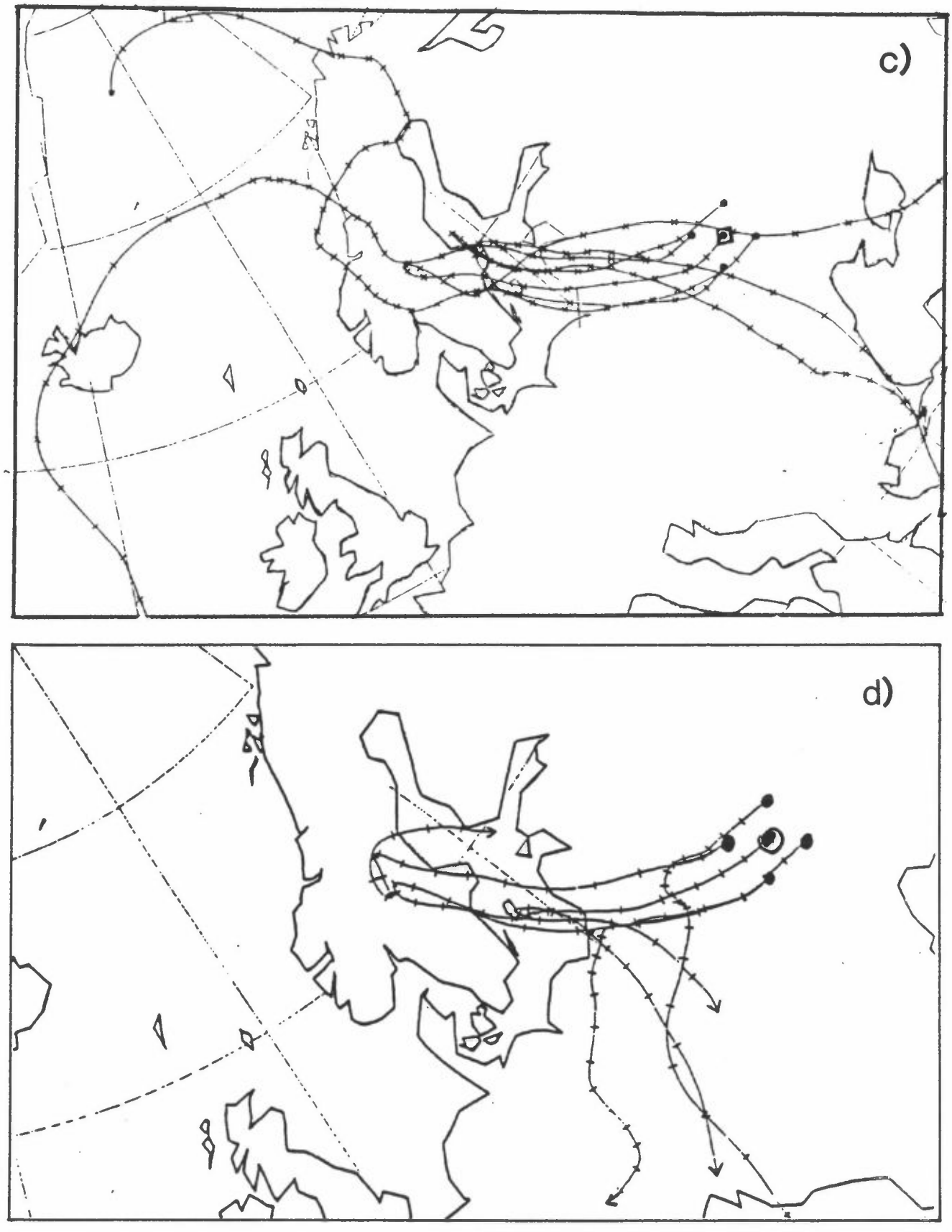


Fig.10 cont.

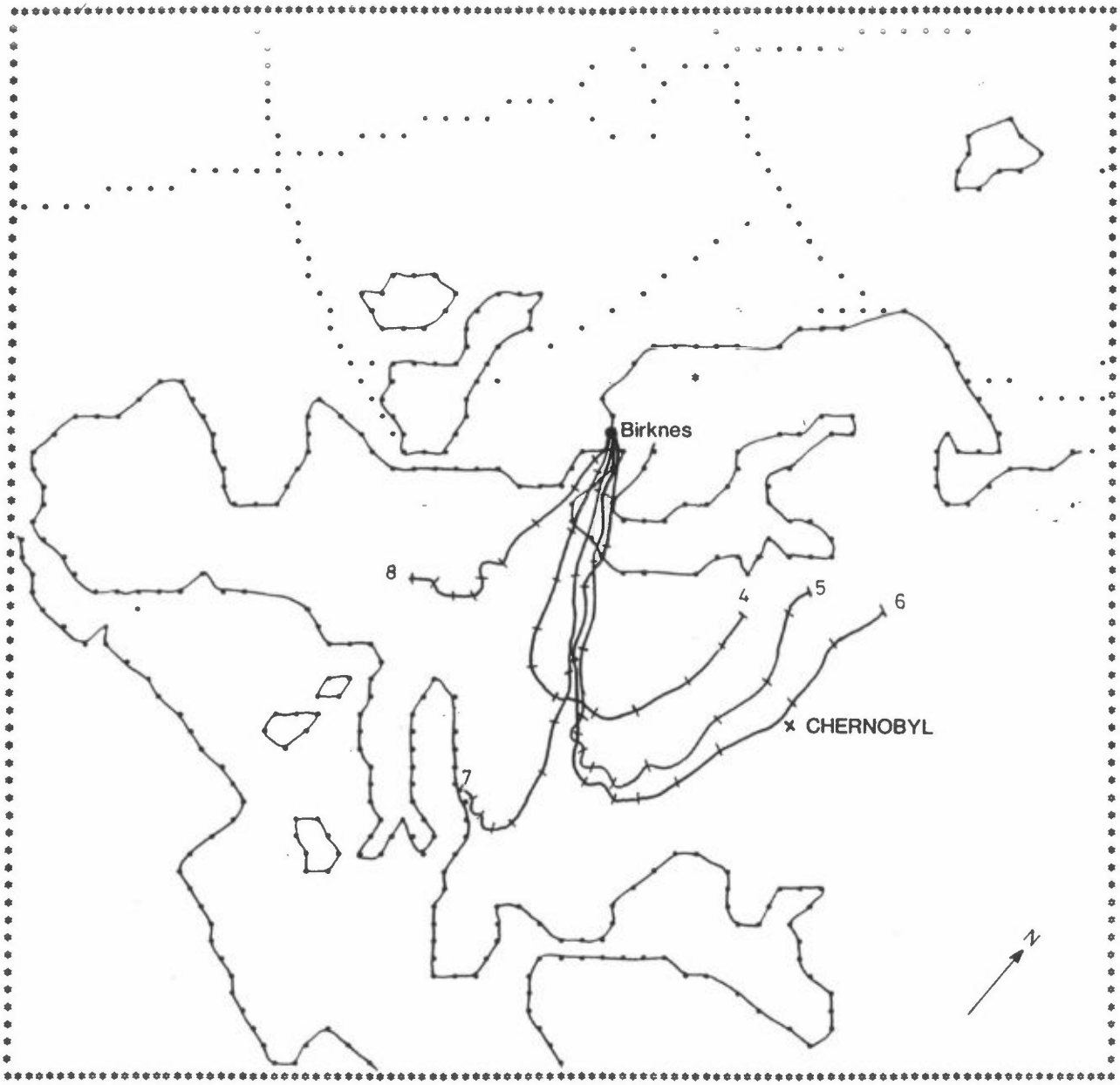


Figure 11: 850 mb backward trajectories for Birkenes during 4 to 8 May, 1986. The 8 hr periods are indicated.

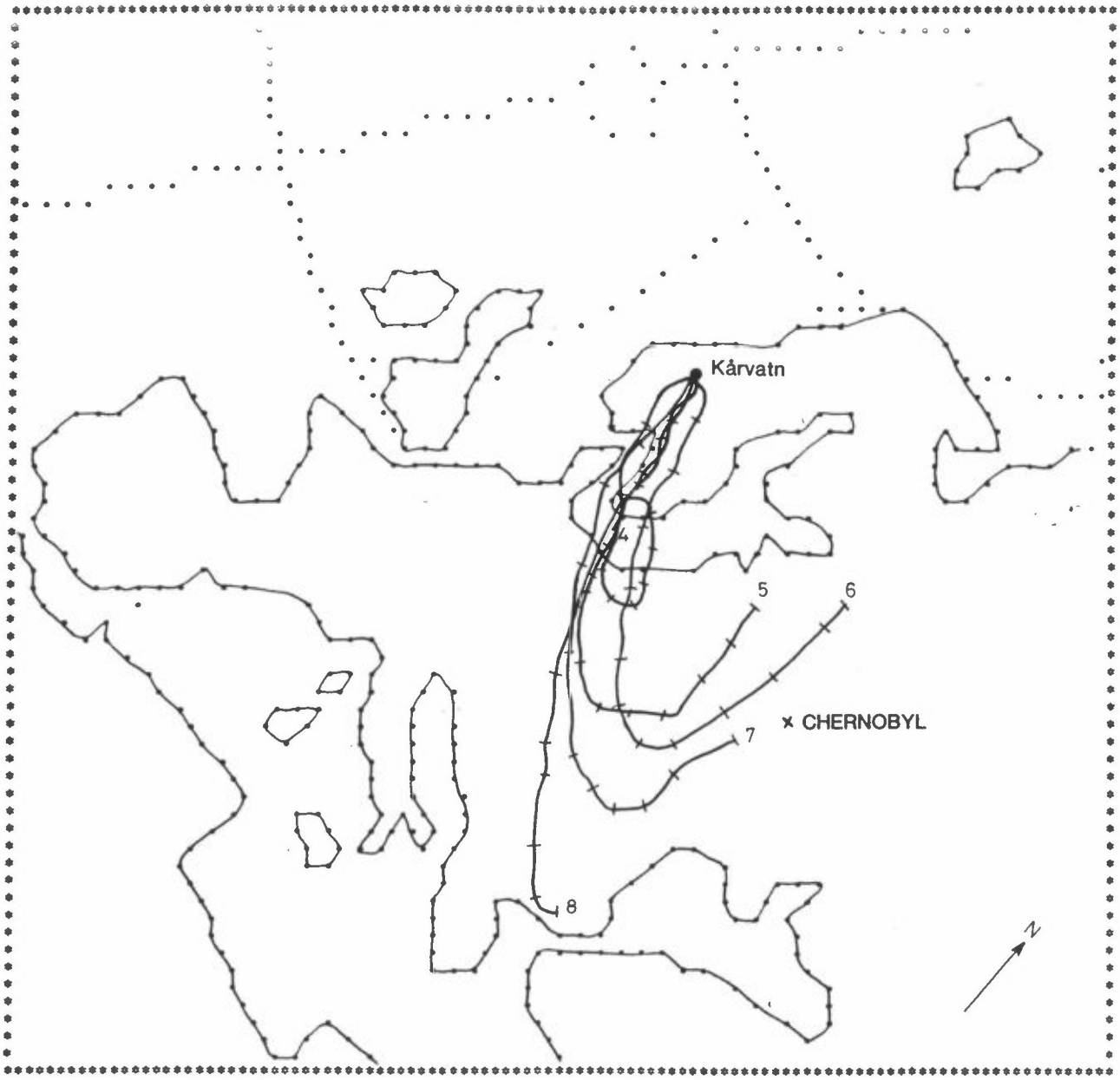


Figure 12: 850 mb backward trajectories for Kårvatn during 4 to 8 May, 1986. The 8 hr periods are indicated.

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| TITLE |
|---|
| ABSTRACT (max. 300 characters, 7 lines)<br><br>The activities of $^{103}$Ru, $^{131}$I, and $^{137}$Cs in air and precipitation sample at some Norwegian stations after the Chernobyl reactor accident are reported. Two periods of increased radioactivity occured, in the first of these total airborne radioactivity increased uo to three orders of magnitude over the normal background. The radionuclide concentrations measured in Scandinavia were among the highest measured after the accident. |

* Kategorier: Åpen - kan bestilles fra NILU A
Må bestilles gjennom oppdragsgiver B
Kan ikke utleveres C