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Abstract

On April 27, 1983, March 29, 1984 and March 23 and 25, 1985 four mesoscale atmospheric dispersion experiments were performed near Kernforschungszentrum Karlsruhe. The experiments comprised:

- Tracking of tetroons by radar up to distances of 111 km.
- Release of the tracer SF_6 at a height of 100 m or 140 m, and downwind sampling at more than 50 locations during up to seven successive periods of 30 min duration each up to source distances of 66 km.
- Meteorological measurements at a 2oo m high tower.

The measured data are presented. They have been analysed to obtain dispersion parameters σ_y and σ_z as a function of downwind distance and sampling time. σ_y derived from tracer concentrations and from tetroon trajectories can be well compared, if the duration of the sampling time is taken into account. Vertical wind speeds, turbulence intensities and oscillation periods are determined from tetroon trajectories. The turbulence intensities of the vertical wind component derived from the tetroon's movement can be used to derive the stability category.

Mesoskalige atmosphärische Ausbreitungsexperimente mit Tracer und Tetroons am Kernforschungszentrum Karlsruhe

Zusammenfassung

Vier mesoskalige atmosphärische Ausbreitungsexperimente wurden am 27. April 1983, am 29. März 1984 und am 23. und 25. März 1985 in der weiteren Umgebung des Kernforschungszentrums Karlsruhe durchgeführt. Die Experimente umfaßten:

- Verfolgung von Tetroons mit einem Radar bis zu Entfernungen von 111 km.
- Freisetzung des Tracers SF_6 in 100 m oder 140 m Höhe mit Probenahme im Lee der Quelle
  - während bis zu sieben aufeinanderfolgenden Perioden von jeweils 30 min Dauer,
  - an mehr als 50 Stellen bis zu Quellenentfernungen von 66 km.
- Meteorologische Messungen an einem 200 m hohen Mast.

Die gemessenen Daten werden angegeben und Ausbreitungsparameter σ_y und σ_z in Abhängigkeit von Quellenentfernung und Sammelzeit abgeleitet. Die auf Tracer Konzentrationen und Tetroon Trajektorien beruhenden σ_y werden miteinander und mit Ergebnissen kurzreichweitiger Tracerexperimente verglichen, die früher am gleichen Standort durchgeführt worden waren. Aus den Tetroon Trajektorien werden vertikale Windgeschwindigkeiten, Turbulenzintensitäten und Schwingungsperioden berechnet. Die Turbulenzintensitäten, die sich auf die Vertikalbewegung beziehen, werden zu den herrschenden Ausbreitungskategorien in Beziehung gesetzt.

Table of contents page

1. INTRODUCTION

Airborne pollutants are considered to be responsible for health effects of human beings, and for damages at buildings, monuments and forest trees. When investigating the relations between emission of the pollutants and their effects the transport of the pollutants over several hundred kilometers and the turbulent diffusion and chemical reactions are very important. These phenomena are simulated by numerical models. Mesoscale field campaigns using tracers and tetroons furnish some of the measured data that are used as input for the models and to validate the models.

At the Joint Research Centre of Ispra and at the Kernforschungszentrum Karlsruhe (KfK), vertical and horizontal dispersion parameters have been determined as a function of the stability class and emission height by tracer experiments /1,2,3,4/. These experiments covered a downwind range up to about 10 km. Combined long range tracer experiments and tetroon flights can provide more information on atmospheric dispersion in the mesoscale range.

Estimates of plume trajectories have usually been based on wind data obtained at fixed points (Eulerian network). Atmospheric diffusion, however, depends on the movement of individual air parcels (Lagrangian consideration). Although Eulerian wind data are suitable for diffusion estimates over short times and distances, there are important difficulties inherent in this technique for longer durations and distances. Tetroon trajectories provide these Lagrangian-like data for mesoscale diffusion models.

Four mesoscale atmospheric experiments with the tracer sulphur hexafluoride (SF_6) and with tetroons were performed near KfK on

April 27, 1983
March 29, 1984, and
March 23 and 25, 1985.

The two last campaigns have been performed within the experiment TULLA /5/. With the aid of the experiment TULLA the leading pollutant sulphur dioxide is balanced, it is investigated how the orography influences the near ground airflow and channels the transport of the pollutants. Besides the transport, diffusion and chemical reactions of sulphur dioxide are simulated by numerical models.

2. EXPERIMENTAL TECHNIQUE

2.1 Meteorological measurements

From a 200 m high tower (Fig.1) erected on the KfK site, measurements were performed which provided the vertical profile of the temperature, the wind velocity, the wind direction and the standard deviation of the vertical and horizontal wind directions.

Because of the large number of meteorological instruments and the frequency of recording, the data were collected by on-line data reduction. In /6/ one can find a detailed description of the system and the data handling.

2.2 Tracer experiments

2.2.1 Performance

The tracer SF_6 was released through the

- 100 m high stack of the FR2 research reactor of KfK, which was no longer in operation, during the first and second experiment,
- 140 m high stack of the coal fired heating power station West at Karlsruhe during the third and fourth experiment.

The tracer was mixed with the air flow in the stacks. Air was sampled at more than 50 locations downwind of the source during up to 7 successive periods of 30 min each. The samplers were arranged close to 3 concentric arcs (zones) surrounding the source. The radii of the arcs were between 12 km and 60 km. The angle of the sampling sector was about 90° with its centre-line pointing to the north-east. Fig. 2 shows a map of the sampling sector. Tab. 1 shows the schedule in Central European Time for the release and sampling of the tracer.

2.2.2 Release of tracer

Because of the range of the experiment a tracer release rate of 22 - 29 g/s was estimated to be necessary for its detection above the background level over all the sampling sector. In order to keep the relatively high release rate of the tracer constant for the whole experiment, several cylinders of SF_6 were connected to a single flow-meter, through which the tracer was injected into the stack duct. A constant flow rate was ensured by observing the flow-meter and adjusting the pressure regulators of the cylinders. The tracer emission rate, calculated from the weight of the cylinders before and after the experiment and from the time of release, was kept constant during each experiment and is indicated in Tabs. 7 - 10.

2.2.3 Sampling equipment

Both manual (only during the first two experiments) and automatic sampling units were used to collect air samples (Fig.3). In principle, all samplers inflate a plastic bag by a small pump driven by a battery with a flow rate of about 0.2 l/min. Nevertheless, while each manual sampling unit requires one man for its operation, the automatic devices, once placed in the field, can collect up to 8 air samples, starting form a pre-fixed time and running in sequential progression for fixed pre-selectable time periods. Fig. 2 shows the experimental area with the indication of the tracer release points and the position of some sampling points on 3 different arcs.

After their collection, some of the samples were submitted to preliminary analysis to define approximately the angle of the sector covered by the tracer plume. Then all the air samples taken in this sector were transferred from the plastic bags into evacuated aluminium bottles. This was done to prevent any risk of contamination during the sample transport and storage before the SF_6 analysis at the Ispra laboratory which was performed by gas solid chromatography and electron capture detection /7/.

2.3 Tetroon flights

2.3.1 Tetroons

The balloons used have a tetrahedral shape (Fig.4); they are commonly referred to as tetroons (tetrahedral balloons). The tetroon is manufactured from polyester dyed red film with a skin thickness of 51 µm. Its mass and volume are 470 g and $1 m^3$, respectively (type T-PR51-1.000 from Raven Industries Inc., USA). It is inflated with helium to approximately 10 hPa overpressure and ballasted for the desired altitude. Once a tetroon has been launched it will rise until its buoyancy equilibrium is reached. Then its mean flight level will be on a surface of constant air density.

To facilitate the tracking of the tetroon by a radar it is equipped with an octahedral corner reflector manufactured from aluminium bars and aluminium coated plastic foil (type TD 75/12 from Cirra, France). The tetroons launched on March 25, 1985 bore two of these reflectors to enhance the backscattered signal.

To get rid of the ground clutter a transponder (transmitter - responder) was attached to each tetroon launched on March 29, 1984. The transponder characteristics are listed in Tab. 2. The transponder receives the radar pulses and responds at a slightly different frequency. To track the transponder the radar is run in its secondary mode: The receiving chain of the radar is tuned to the frequency of the transponder. Now the radar is able to discriminate the ground clutter which has the same frequency as the radar pulses emitted /8/. The finder of a transponder is asked to send it back to KfK. So more information about the complete tetroon trajectory is available. The places of discovery have been for

- MI8401: Bad Königshofen, travel distance 218 km
- MI8402: Lichtenfels, travel distance 245 km
- MI8403: not found,
- MI8405: Eppingen. travel distance 54 km

2.3.2 Radar tracking

The mobile radar WF 100-4 built by Enterprise Electronic Corp., Alabama, USA, was used to track the tetroons (Fig.5). The technical characteristics of the radar are compiled in Tab. 2. The owner of this radar is the German Weather Service at Essen. The operating base of the radar was the Galgenberg near Minfeld /8/ situated about 20 km west of KfK. It coordinates are 43° 5′ 3′′ n. Lat., 8° 8′ 30′′ e. Long., 161 m above msl. The tetroons bearing reflectors were launched directly beside the radar; those bearing transponders Southeast (136°) of the radar.

After the balanced tetroon reflector unit was released, it was tracked manually by the aid of a videocamera which was mounted on the radar antenna and a television monitor at the radar control panel. As soon as the echo of the reflector or transponder is seen on the R/A-scope in the control panel of the radar, the radar was switched to the automatic tracking mode.

2.3.3 Data acquisition and evaluation

During tracking of the tetroon by the radar the following data have been printed with a teletype and punched on paper tape every 10 s:

- time after release of the tetroon in min and s,

- distance d between radar and tetroon in m,

- elevation angle ϕ in degrees,

- azimuthal angle ϕ in degrees.

By means of a Fortran computer code averages of d, Φ and α have been calculated off-line using a window of 110 s (i.e. eleven 10-s-values). From these averages the position of the tetroons was calculated for each 10-s-step in x-,y- and z-coordinates. This rectangular system is oriented with the x- and y-axis in the East and North direction, respectively. The origin of the system is identical with the operating base of the radar.

$$x = d \cdot \cos \Phi \sin \alpha$$
$$y = d \cdot \cos \Phi \cos \alpha$$
$$z = d \cdot \sin \Phi$$

Taking into account the earth's curvature the height h of the tetroon relative to the radar is

$$h = z + d^2/2R$$

R = 6378 km is the radius of the earth.

The refraction of the radar beam is also taken into account, but in a crude manner: It is assumed that the radius of the earth can be replaced by an "equivalent radius" of $\frac{4}{3}R$.

Besides the average values $\bar{d}$, $\bar{\Phi}$, $\bar{\alpha}$, $\bar{x}$, $\bar{y}$ and $\bar{h}$ the velocities $\bar{u}$,$\bar{v}$ and $\bar{w}$, the wind direction in a x-, y-plane and the flight path are calculated for each 10-s-step based on these average values.

3. MEASURED DATA

3.1 Weather

3.1.1 April 27, 1983

Whereas the northern part of Germany was influenced by a small scale low pressure (p = 1001 hPa) over the Netherlands, our region lay in the transition regime of a weekly marked high-pressure (p = 1013 hPa) with its centre over Bavaria (Fig.6). Therefore, winds from south-west with a mean speed of about 5 m/s near ground prevailed. The direction of the winds near ground changed from 220° in the early morning to 244° during the course of the day. After 15:00 CET the wind turned back to a southerly direction and the speed fell off. (All indications of time in the paper are given in Central European Time (CET)). In the morning the sky was only partly clouded, but later a strong activity of thermal induced clouds developed. This fact can be seen in Tab. 3 with the strong change of the net solar radiation after 9:00 CET. Therefore the stability class changed from D to C and even to B.

3.1.2 March 29, 1984

Our region was influenced by a depression over the North Sea. A front (occlusion) has passed the experimental area at midnight (Fig.7). Therefore in the course of the day the wind was turning from south-west to nearly west. The sky was totally clouded in the morning and early afternoon. After 15:00 CET the cloudiness was only 3/8. So the stability class changed from D to the slightly unstable class C.

3.1.3 March 23, 1985

The whole area of Central-Europe was influenced by a depression with its center at the English North Sea coast. Cold air at high altitudes reached the experimental area during the day (Fig.8).

The scattered clouds vividly adapted convective character, and in the Rhine Valley/Black Forest region light showers appeared. The general wind direction was south-west. The stability class was D.

3.1.4 March 25, 1985

On this day, the change from the greater weather situation "low British Isles" to the "cyclonal - west" situation started (Fig.9). The transient situation brought a short time clear sky and anti-cyclonal weather situation for Baden-Württenberg. A rise of pressure already started in the evening hours of March 24, which built up a flat high over the ground. The new cumulus clouds which appeared in the morning, when the sun rose and clouds loosened, finally flattened off more and more. So the slightly unstable stability class C was present. The wind blew mainly from south - to south-west. In the early afternoon, the wind turned back to south-east, obviously under the influence of an approaching front over France.

3.2 Meteorological data

The most important meteorological data measured at the KfK tower are listed in Tabs. 3 - 6. The wind direction is measured with a wind vane[1] whereas a cup anemometer[2] measures the wind speed. The standard deviation of the horizontal and vertical wind directions are generated electronically with a sampling time of 180 s from measured data originating in vector vanes[3] at 40 m, 100 m and 160 m heights. On the next line the standard deviation of the horizontal fluctuation of the wind direction is indicated. Unlike the preceding ones, this standard deviation is measured with an ordinary wind vane[1] at 100 m height. The temperature gradient results from the difference in air temperature[4] measured at 30 m and 100 m heights. A double pyrradiometer[5] is used to measure the net radiation 1.5 m above ground.

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1 Wind vane, type 1466H, Lambrecht
2 Cup anemometer, type 114H, Rosenhagen
3 Vector vane, model 1053 III-2, Meteorology Research Inc.
4 Ventilated double PT 100 measuring sensor, Friedrichs
5 PD-type, Physikalisch-Meteorologisches Observatorium of Davos, Switzerland.

The stratification of the atmosphere is described by 6 stability classes based on the classification system by Pasquill /9/. The last four lines show the stability classes which where determined by four different methods /10/. The first method is based on the standard deviation of the fluctuatuon of the vertical wind direction measured by a vector vane at 100 m height. The second method is based on the standard deviation of the fluctuation of the horizontal wind direction measured by a wind vane[1] at 100 m height. The third method refers to the differences of temperature at 30 m and 100 m and the wind velocity at 40 m height. The fourth method is based on meteorological observations and closely follows the classification recommended by Manier /11/. The information concerning the degree of cloudiness, the type of clouds and the wind velocity was taken from the daily weather report of the Karlsruhe Weather Station. This station records the observations at intervals of 3 hours, but experimental periods often lie between the hours of observation. Consequently, the stability classes had to be defined by interpolation when the weather conditions changed with time. The stability classes listed in Tabs. 3-6 were averaged over a sampling period. Data have been marked by stars if instruments failed.

3.3 Tracer data

Tables 7-10 show the polar coordinates of the sampling locations and the tracer concentrations measured at these locations. From these concentrations the mean background concentration has already been subtracted. The mean background amounted to 11 ng/m³ during the first and to 12 ng/m³ during the other experiments. The concentration data and the polar coordinates R and ALPHA are expressed in ng/m³, m and degrees of arc, respectively. The angle ALPHA is measured relative to the northern direction and counted clockwise. The error of the angle ALPHA is less than one degree, the error of the downwind distance R is smaller than 50 m in zone I and smaller than 200 m in zones II and III. Bars in the column of concentration data refer to samples not evaluated. These samples

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1 Wind vane, type 1466H, Lambrecht

had either not been switched on or had been located too far from the centre of the plume or the samplers had failed. The limits of detection are indicated. The tables also show the emission rate and the time at which sampling was carried out.

Figs. 10 - 27 show the local distribution of the tracer concentrations for periods with simultaneous sampling in all zones. The isolines of constant concentration were interpolated from measured data and plotted by a computer. The isolines are labelled by the concentration values in $\mu g/m^3$. The sampling locations are plotted as open squares. The downwind distance of the sampling locations are shown on the ordinate. The step curve plotted on the periphery indicates the frequency distribution of transport direction. The transport direction refers to the mean wind direction measured during the sampling period at 100 m height above the ground. The azimuthal position of the sampling field is indicated at the step curve.

3.4 Trajectories of tetroons

The relevant flight data are shown in a condensed manner in Tabs. 1 and 11. The trajectories of all flights are plotted in three different types of graphs in Figs. 28 - 42.

Figs. 28 to 31 show the projection of the flight path into the x-, y-plane. The x-axis is pointing to the East, whereas the y-axis is pointing to the North. The trajectories have been plotted either in a handdrawn map with isolines of the topography and some landmarks or in an original ordinance survey map.

Figs. 32 to 35 show the height profile of the tetroon as a function of travel distance. The length scale is 10 times larger for the flights in the years 1983 and 1984 and 15 times for the flights in 1985 than the height scale. The profile of the terrain passed by the tetroon is indicated as a cross-hatched area.

Figs. 36 to 39 show the projection of the trajectories into the plane perpendicular to the mean transport direction looking downstream. Tetroon positions are marked at 5 min intervals by circles.

4. DATA EVALUATION

4.1 Dispersion parameters based on tracer concentrations

4.1.1 Horizontal dispersion parameter σ_y

The double Gaussian function describing the concentration C(x,y) close to the ground level at the field point P(x,y) downwind of the source reads:

$$C(x,y) = \frac{\chi(x,y)\dot{A}}{u} = \frac{\dot{A}}{\pi u \sigma_y(x)\sigma_z(x)} \exp\left[-\frac{y^2}{2\sigma_y^2(x)} - \frac{H^2}{2\sigma_z^2(x)}\right] \qquad (1)$$

This follows from the diffusion equation for steady-state conditions, constant emission rate and reflection of the tracer at ground level, where

$\dot{A}$	emission rate in g/s
u	mean wind velocity in m/s
$\chi(x,y)$	normalized diffusion factor in m^{-2}
x	downwind distance in m
y	crosswind distance in m
H	emission height in m
σ_y, σ_z	horizontal and vertical dispersion parameters, respectively, in m

The foot of the source coincides with the origin of the Cartesian coordinate system.

Equation (1) may be written as

$$C(x,y) = \hat{C} \exp\left[-\frac{y^2}{2\sigma_y^2}\right] \qquad (2)$$

$$y(\bar{R}_i) = \bar{R}_i \sin(\alpha_i - \alpha_o) \qquad (3)$$

where

$\hat{C}(\bar{R}_i)$ maximum concentration,

$\alpha_o(\bar{R}_i)$ azimuthal position of maximum concentration

at arc i surrounding the source with mean radius $\bar{R}_i$. From Eqs. (2) and (3) $\hat{C}$ and σ_y are calculated for the three arcs i and the different periods by a least squares fit.

The results of the individual periods are combined by forming the geometric mean values of the σ_y parameters. These mean values and their standard deviations are plotted in Figs. 40 and 41 versus the downwind distance on a double logarithmic scale.

In Figs. 40 and 41 the σ_y parameters of the mesoscale experiments are compared to those of the short-range tracer experiments performed in the environment of KfK at emission heights of 160 m and 195m /12/. The results of the short-range experiments, that correspond also to a sampling time of 0.5 h, are indicated in dashed lines. These dashed lines are extrapolated beyond a downwind distance of 10 km. During the mesoscale experiments the tracer SF_6 was released at a height of 100 m or 140 m only. Because of the great downwind distances of the sampling points the tracer plume rose considerably and was influenced only slightly by the roughness of the terrain. Therefore, the dispersion parameters derived are compared to those of the short-range experiments with emission heights of 160 m and 195 m.

4.1.2 Vertical dispersion parameter σ_z

Referring to Eq.(1)

$$\hat{C} = \frac{\dot{A}}{\pi u \sigma_y \sigma_z} \exp\left[-\frac{H^2}{2\sigma_z^2}\right] \simeq \frac{\dot{A}}{\pi u \sigma_y \sigma_z} \qquad (4)$$

This approximation is valid, if $H \ll \sigma_z$. This is true for great downwind distances as in our experiment. From Eq.(4) the vertical dispersion parameter σ_z can be assessed for the three arcs and the different periods. The wind speed u is taken from the tetroon trajectories

- MI8310 , u = 6.1 m/s ,
- MI8403 , u = 12.8 m/s ,
- TU8505 and TU8506, $\bar{u}$ = 9.65 m/s,
- TU8509 , u = 6.8 m/s,

respectively, as compiled in Tab.11. σ_y and $\hat{C}$ are the results of the least squares fit as described in Chapter 4.1.1 . Again the σ_z corresponding to the individual periods are combined by calculating the geometric mean values. These mean values and their standard deviations are plotted in Figs. 42 and 43 versus the downwind distance in a double logarithmic scale. Again the dashed lines in Figs. 42 and 43 refer to the short-range tracer experiments performed at KfK earlier /12/. The σ_z-parameters do not increase infinitely with the downwind distance but approaches a constant value. This is indicated in Figs. 42 and 43 for stability classes A to D by the horizontally dashed lines.

4.1.3 Dispersion parameters versus sampling time

The increase of σ_y with sampling time is investigated by summing up the tracer concentrations of successive sampling periods. The σ_y- values are calculated by a least squares fit as outlined in Ch. 4.1.1 for sampling times τ that are multiples of 0.5 h.

A power function

$$\sigma_y(\tau)/\sigma_y(\tau_1) = (\tau/\tau_1)^\alpha \qquad (5)$$

is chosen /13/ for the dependence of σ_y on sampling time τ, with τ_1 = 0.5 h. The exponent α is evaluated by a linear regression technique.

The relations $\sigma_y(\tau)/\sigma_y(\tau_1)$ are plotted versus the relation τ/τ_1 in a double logarithmic scale in Figs. 44 and 45 for the three downwind distances of the arcs of sampling. The exponents α and the corresponding correlation coefficients are compiled in Tab. 12.

As described in Ch. 4.1.2 σ_z values have been calculated as a function of sampling times τ too. In this procedure σ_y- and $\hat{C}$-values are used in Eq.(4) corresponding to sampling times that are multiples of 0.5 h. The results are plotted versus the sampling time in Figs. 46 and 47. For the greatest sampling time during one experiment (number of periods times 0.5 h) only one σ_z-value is available for each arc. In this case no error bars are plotted in Figs. 46 and 47.

4.1.4 Maximum concentration versus sampling time

The maximum concentration $\hat{C}$ (see Eq.2) is calculated as a function of sampling time τ as described in Chs. 4.1.1 and 4.1.3. A power function

$$\hat{C}(\tau)/\hat{C}(\tau_1) = (\tau/\tau_1)^{-\beta} \qquad (6)$$

is chosen /17/ for the dependence of $\hat{C}$ on τ, with $\tau_1 = 0.5$ h. The exponent β is evaluated by a linear regression technique. β is tabulated with the corresponding correlation coefficients in Tab. 13.

4.2 Horizontal dispersion parameter σ_y based on tetroon trajectories

As reported in /13/ lateral diffusion can be estimated from successive tetroon flights. This technique of estimating atmospheric diffusion is adequate as far as the diffusion of a continuous point source is considered. Panofsky and Brier /14/ showed that the best estimate of the variance of tetroon trajectories (σ_y^2) is given by:

$$\sigma_y^2 = (N-1)^{-1} \sum_{i=1}^{N} (y_i - \bar{y})^2 \qquad (7)$$

where N is the number of trajectories, y_i is the position of tetroon No.i on the y-axis, and $\bar{y}$ is the mean position of the N tetroons on the y-axis. The square root of this lateral variance is the horizontal dispersion parameter σ_y in the Gaussian dispersion formula.

According to this procedure, circles with equal radii are drawn and the distances between points of intersection of the trajectories with these circles are measured yielding σ_y-values at individual downwind distances x. The spacing of the downwind distance is 1 km starting at x = 2 km. All trajectories of one series are extrapolated up to the longest trajectory of this series.

If this procedure is applied no monotonous change but only oscillations of the wind direction should occur during the launch of the first and the end of tracking of the last tetroon of one series of trajectories. This time interval corresponds to the sampling time of the tracer experiment if σ_y-values of both experimental techniques are compared.

According to this procedure σ_y- parameters are calculated that are based on trajectories of tetroon listed in Tab. 1. The trajectories of TU8504 and TU8508 are omitted as their flight levels are very high as is indicated in Tab. 11. The results are plotted as solid lines in Figs. 40 and 41. If only two trajectories are available they may cross one another. The σ_y-values near the corresponding downwind distance are very low and even zero at the crossing point. This is the case for the experiment on March 25, 1985. This effect is eliminated by a smoothing procedure as in reality plumes are expanding with increasing source distance.

For the σ_y-parameters obtained in this way, the dependence on distance (x-axis) is described by

$$\sigma_y = \sigma_o x^p, \tag{8}$$

as used in /3,4/, in order to compare the results with those of the tracer experiments. By means of a least squares fit σ_o and p are evaluated and compiled in Tab. 14.

As described above for the downwind distance x the horizontal dispersion parameter σ_y is also evaluated as a function of time t. In this procedure x is replaced by t. t=0 is the launching time of each tetroon of one series. The spacing of the time steps depends on the flight time and is 60 s or 180 s starting at t = 4 min. The results are plotted in Figs. 48 and 49 versus the time being elapsed since the tetroon has been launched.

By analogy to Eq.(8) σ_y is described as a function of time t by

$$\sigma_y = \sigma_o t^p \tag{9}$$

The results are also listed in Tab. 14.

4.3 Evaluation of individual tetroon trajectories

4.3.1 Vertical air motion

Unless one is interested in precise estimates of vertical air speed at specific points in space, it is permissible to use the vertical tetroon speed as first-order estimate of vertical air speed, as is shown in /15/. However, because of the buoyancy force acting to return the tetroon to its equilibrium level, the tetroon's vertical speed is not usually that of the air in which it is embedded, i.e. the tetroon "slips" relative to the ambient air. To overcome this problem, a procedure has been published in /15/ to calculate the vertical air speed from the tetroon's vertical speed, the equilibrium level and the actual displacement of the tetroon from this level. Although in /15/ the computation has been done for the standard atmosphere less than 4 cm/s air speed deviation will result for either adiabatic or isothermal lapse rates with a tetroon displaced 600 m from its equilibrium level. Obviously, the lapse rate is of little consequence in deriving vertical air speeds from tetroons.

Figs. 50 and 51 show by example the vertical speed of tetroons MI8310 and TU8507 and the derived vertical air speed. Flights MI8310 and TU8507 are representative for unstable and stable stratification. Derived vertical air speeds are depicted to scale as vertical arrows along the height profile of the tetroon trajectory.

4.3.2 Turbulence intensity

The turbulence intensity i_u, i_v, i_w of the three components of wind speed u, v, w are a good measure of the behaviour of the atmosphere in dispersion processes. So the intensities have been calculated over a time of 1 h up to 4 h depending on the duration of the individual flights:

$$\left[\frac{\overline{u'^2}}{\bar{\mathrm{v}}^2}\right]^{1/2}, \left[\frac{\overline{v'^2}}{\bar{\mathrm{v}}^2}\right]^{1/2}, \left[\frac{\overline{w'^2}}{\bar{\mathrm{v}}^2}\right]^{1/2} \qquad (9)$$

Where v is the absolute value of the tetroon velocity. The results are compiled in Tab. 15.

4.3.3 Oscillation periods of the tetroons

To determine the periods of vertical and horizontal oscillations the trajectories were evaluated by a Fourier analysis. By way of example the power spectra has been plotted for three different flights(Fig.52). The periods of the oscillations in the three dimensions of all flights are listed in Tab. 15. The wave length in x-direction is the product of the oscillation period times the mean transport speed. In z-direction it is the product of the oscillation period times the mean of the amount of the vertical velocity. The power spectra show several maxima. Therefore, periods with the highest energy density are underlined.

5. DISCUSSION OF THE RESULTS

5.1 Vertical dispersion parameter σ_z

The stability classes that prevailed during the mesoscale experiments are compiled in the following table. The classes are derived from the standard deviations σ_ϕ and σ_θ of the vertical and horizontal wind directions measured by a vector vane 100 m above ground.

Date of experiment	σ_ϕ	σ_θ
April 27, 1983	B	C
March 29, 1984	D	D
March 23, 1985	C/D	D
March 25, 1985	B	B/C

As vertical dispersion is more influenced by σ_ϕ , the following conclusion can be drawn from Figs. 42 and 43:

- Extrapolation of σ_z from the short-range experiments to downwind distances greater than 10 km is validated by the mesoscale experiments. An exception is the 4th experiment: The σ_z-parameters from this mesoscale experiment are about 50% smaller than the extrapolated values of the short-range experiments.

5.2 Horizontal dispersion parameter σ_y

Horizontal dispersion is more influenced by σ_θ. From this matter and quite generally the following conclusions can be drawn referring to Figs. 40 and 41:

- Extrapolation of σ_y from the short-range experiments to distances greater than 10 km is validated by the mesoscale experiments.

- The slopes of the σ_y-parameters based on tetroon trajectories and short-range tracer experiments are approximately equal.

- With the exception of the 4th experiment the σ_y-parameters based on tetroon trajectories are greater than those based on the tracer experiments. This is due to the following facts:

  - The σ_y-parameters of the 4th experiment are based only on two trajectories. This result may be fortuitous.
  - As is shown by Tab. 1 tetroons and the tracer have not been tracked and sampled simultaneously.
  - The sampling time of the tracer was 0.5 h. The corresponding time of the tetroons, the time interval between the launching of the first one and the end of tracking the last one, was longer than 7 hours (see Tab. 1). This difference will be discussed in Ch. 5.3.

5.3 Dispersion parameters and maximum concentration versus sampling time

Vertical barriers to dispersion, under quasi steady-state meteorological conditions, act to make σ_z independent of sampling time for sufficiently large travel distances. This also is true for our experiments as can be seen from Figs. 46 and 47.

In general σ_y increases with sampling time /16,17/. This is shown quite generally by Figs. 44 and 45 and by Tab. 12. But the following more detailed conclusions can be drawn from Figs. 44 and 45 and Tab. 12 within one experiment and for one downwind distance:

- The correlation between σ_y and sampling time based on a power function is very high, but
- the increase of σ_y with sampling time - as qualified by the exponent α - varies considerably within the limits of 0.11 and 0.70, and
- there is no clear dependence of α on downwind distance.

The arithmetic mean value of α is 0.39; it is higher than the exponent of 0.25 published in /18/. The decrease of maximum concentration $\hat{C}$ with sampling time τ is described by the exponent β compiled in Tab. 13. As in the case of σ_y the correlation between $\hat{C}$ and τ is very high within one experiment and for one downwind distance. But there is no clear dependence of β on downwind distance, and β varies considerably within the limits of 0.10 and 0.71. The arithmetic mean value of β is 0.33 as compared to 0.50 published in /18/.

Applying Eq.(5) and using the exponent α from Tab. 12 the σ_y-parameters corresponding to a sampling time of 0.5 h are extrapolated to sampling times corresponding to the tetroons as compiled in Tab. 1. These extrapolated σ_y-parameters are plotted in Figs. 40

and 41 by crosses. They are quite identical to the results corresponding to the tetroons for the 3rd and 4th experiment. During these experiments three tetroons have been tracked more or less simultaneously with tracer sampling.

5.4 Vertical air motion

It is important to note from Figs. 50 and 51 that, while the difference between vertical speeds of tetroon and air is fairly large in isolated instances, in general the tetroon gives a reasonably good overall picture of the variation of vertical speed along the trajectory. Consequently, it is permissible to use the vertical tetroon speeds as first-order estimates of vertical air speeds, particularly in view of uncertainties in determining the real equilibrium flight level, unless one is interested in precise estimates of vertical air speed at specific points in space.

From these two examples and considerations in /15/ it can be stated that the tetroon does a better job in delineating the vertical motion when the amplitude of the vertical oscillation is large.

5.5 Turbulence intensity

In order to enable other experts to compare their results with our tetroon data, we have calculated turbulence intensities for the whole range of stability classes. Based on our earlier flights /8/, /19/, /20/ the Fig. 53 was created. No appropriate tetroon flight in very stable situation was available, so only five stability classes (A to E) are considered. In general more than five flights per stability class have been used. The mean values as well as the standard deviation of the turbulence intensity i_w are plotted versus the stability classes. With the exception of TU8510 the results in Tab. 15 are in a reasonable agreement with the findings of Fig. 53. A comparison with tetroon flights over quite different areas shows good results, too: In /21/ an average intensity i_w=0.35 is reported for daytime flights at Yucca Flat in a desert region in Nevada, U.S.A.

References

/1/ Schüttelkopf H., Thomas S., Vogt S., De Bortoli M., Gaglione P.; Experimental determination of the atmospheric dispersion parameters. Experiment performed July 2, 1980 at the Karlsruhe Nuclear Research Centre, EUR 7577EN (1981).

/2/ Bacci P., Carboni G., De Bortoli M., Gaglione P., Thomas P., Vogt S.; Atmospheric diffusion experiments performed in October 1980 at the Turbigo ENEL Power Plant, EUR 8334EN (1982).

/3/ Thomas P., Nester K.; Experimental determination of the atmospheric dispersion parameters at the Karlsruhe Nuclear Research Centre for emission heights of 60 and 100 m, Nucl. Techn. 68/3, pp. 293 (1985).

/4/ Thomas P., Nester K.; Experimental determination of the atmospheric dispersion parameters at the Karlsruhe Nuclear Research Centre for 160 m and 195 m emission heights. Part 2: Evaluation of measurements, KfK 3457 (1983).

/5/ Vogt S., Fiedler F.; Compilation of measuring activities of the TULLA-experiment, KfK 4176 (1986).

/6/ Von Holleuffer-Kypke R., Hübschmann W., Süss F., Thomas P.; Meteorologisches Informationssystem des Kernforschungszentrums Karlsruhe, Atomkernenergie Kerntechnik 44/4, pp. 300 (1984).

/7/ De Bortoli M., Gaglione P., Thomas P., Vogt S.; Experimental determination of atmospheric dispersion in the mesoscale by tracer and tetroons, EUR 9598EN (1984).

/8/ Vogt S., Thomas P.; Untersuchung mesoskaliger Luftströmungen in der Umgebung des Kernforschungszentrums Karlsruhe mit radar-verfolgten Tetroons, KfK 3565 (1984).

/9/ Pasquill F., Smith F. B.; Atmospheric diffusion, J. Wiley & Sons, London (1983).

/10/ Nester K.; Statistically equivalent systems for the determination of dispersion categories. Seminar on radioactive releases and their dispersion in the atmosphere following a hypothetical reactor accident, RISØ, April 22-25, 1980, Commission of the European Communities (1980).

/11/ Manier G.; Vergleich zwischen Ausbreitungsklassen und Temperaturgradient, Meteorol. Rdsch. 28, pp. 6-12 (1975).

/12/ Hübschmann W., Nester K., Thomas P.; Auswertung von Ausbreitungsversuchen, in Jahresbericht 1979 der Hauptabteilung Sicherheit, KfK 2939, pp. 183 (1980).

/13/ Slade D. H. (Editor); Meteorology and Atomic Energy, TID-24180, pp. 180 (1968).

/14/ Panofsky H. A., Brier G. W.; Some applications of statistics to meteorology, Pennsylvania State University, University Park, Penn. (1958).

/15/ Hoecker W. H.; Universal procedure for deploying constant-volume balloons and for deriving vertical air speeds from them, J. of Appl. Met. Vol. 14, pp. 1118 (1975).

/16/ Hanna L. R., Briggs G. R., Hosker R.P.; Handbook on atmospheric diffusion, DOE/TIC-11223 (1982).

/17/ Mueller L. R., Reisinger L. M.; Measured plume width versus sampling time: A look beyond 10 km, Atm. Env. 20/5, pp. 895-900 (1986).

/18/ Hino M.; Maximum ground-level concentrations and sampling time, Atm. Env.2, pp. 149-165 (1968).

/19/ Hübschmann W. G., Thomas P., Vogt S.; Tetroon flights as a tool in atmospheric meso-scale transport investigation. 13th Int. Techn. Meeting on Air pollution modelling and its application. Ile des Embiez, France, 14-17 Sept. (1982).

/20/ Vogt S., Thomas P.; Investigation of meso-scale atmospheric transport by means of radar tracked tetroons during PUKK. Contr. Phys. Atmosph. 55/4, pp. 409-416 (1982).

/21/ Angell J. K., Pack D. H.; Estimation of vertical air motions in desert terrain from tetroon flights. Monthly Weat. Review, pp. 273-283 (Aug. 1961).

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Date	Release of tracer	Sampling of tracer	Tetroons		
			No.	Start	End of tracking
27.04.83	10:00 - 13:30	1st arc: 10:30 - 13:30	MI8307	7:15	8:48
		2nd arc: 11:00 - 14:00	MI8308	9:10	10:50
		3rd arc: 12:00 - 15:00	MI8310	12:03	14:26
29.03.84	11:00 - 14:00	1st arc: 10:30 - 14:00	MI8401	8:00	9:50
		2nd arc: 11:00 - 14:30	MI8402	10:00	10:23
		3rd arc: 12:00 - 15:30	MI8403	11:00	12:04
			MI8505	13:30	15:04
23.03.85	11:00 - 15:55	all arcs: 13:00 - 16:00	TU8505	12:00	13:55
			TU8506	14:03	17:10
			TU8507	17:43	20:10
25.03.85	10:30 - 15:20	all arcs: 13:00 - 15:30	TU8509	11:49	16:42
			TU8510	17:05	20:45

Table 1: Time table in Central European Time (CET), Tetroons TU8504 and TU8508 are omitted and have not been used for σ_y- calculations.

	Radar	Transponder
Diameter of antenna	1.2 m	
Dimensions	5.85x2.08x3.05 m^3	15x8x8 cm^3
Weight	6.3 t	450 g
Gain of antenna	38 dB	5 dB
Polarization	linear, vertical	
Frequency	9375 MHz	9212 MHz
Peak power	60 kW	180 mW
Pulse repetition frequency	800 Hz	800 Hz
Pulse repetion length	0.25/1.0 µs	1.0 µs
Range	> 50 km	
Operating time	> 5 km	

Table 2: Technical details of Radar and transponder

		HEIGHT (M)	7.30	7.40	7.50	8.00	8.10	8.20	8.30	8.40	8.50	9.00	9.10	9.20	9.30	9.40	9.50	10.00
			Time in CET															
WIND DIRECTION (DEGREE)		40	231	222	223	223	232	227	223	225	229	230	226	239	240	233	224	222
		60	226	217	220	217	223	222	220	222	222	227	226	232	235	226	217	219
		100	222	216	218	215	221	217	218	221	218	224	225	233	226	223	213	219
		160	224	220	221	218	225	223	222	223	225	224	226	227	225	224	222	224
		200	229	225	226	224	229	227	227	228	231	229	229	229	227	228	229	229
WIND SPEED (M/S)		40	****	5.4	6.0	6.3	****	****	****	****	4.6	6.6	5.8	4.6	****	****	****	****
		60	6.1	6.5	6.7	6.8	7.0	6.7	7.4	7.0	4.9	7.4	6.0	5.1	5.6	5.2	5.9	6.3
		100	6.9	7.5	7.6	7.5	8.2	8.4	9.2	8.2	5.7	8.7	6.7	5.9	6.4	6.2	7.1	7.6
		160	7.9	8.2	8.6	8.7	9.2	9.6	10.2	9.1	6.7	9.5	8.2	6.5	6.8	6.4	7.7	8.8
		200	8.7	8.6	9.2	9.2	9.7	9.9	10.4	9.7	7.4	9.9	8.4	6.9	6.7	6.7	8.1	9.2
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	9.7	10.0	10.6	10.7	11.4	12.8	12.6	12.2	12.7	13.3	12.4	12.7	12.9	12.8	12.5	12.6
	HOR.	40	21.1	20.9	22.6	23.5	25.8	27.6	25.6	25.6	26.1	26.1	24.6	27.1	26.5	26.7	27.8	26.7
	VER.	100	6.3	6.6	6.4	7.1	7.2	7.1	6.5	6.5	7.9	8.4	8.6	9.0	9.5	9.4	9.4	9.0
	HOR.	100	9.3	9.3	9.6	10.4	11.3	11.0	10.2	10.1	10.7	11.5	11.6	13.0	13.4	14.2	15.1	13.8
	VER.	160	4.7	5.1	5.2	6.1	6.1	5.7	4.8	4.7	5.9	6.3	6.6	7.1	7.9	8.5	9.1	7.9
	HOR.	160	3.5	2.9	3.1	3.9	3.3	2.8	2.4	2.7	4.5	2.6	3.4	3.7	3.9	4.8	5.0	2.5
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	8.5	8.3	8.8	12.5	9.0	9.6	7.0	9.4	13.1	7.6	13.6	12.6	15.9	16.3	15.7	9.6
TEMPERATURE GRADIENT (K/100M)		30/100	-1.2	-1.2	-1.2	-1.4	-1.4	-1.3	-1.3	-1.4	-1.4	-1.7	-1.5	-1.6	-1.7	-1.3	-1.3	-1.4
NET RADIATION		(MW/CM**2)	3.0	7.6	6.1	13.9	12.6	10.5	11.6	16.9	20.0	26.7	25.5	23.0	22.9	13.5	12.1	18.6
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION			D			C			D			C			C		
	HOR. FLUCTUATION			D			D			D			D			C		
	TEMP. GRADIENT			C			C			C			C			****		
	SYNOP. OBSERV.			D			D			D			D			D		

Table 3/1: Meteorological data measured at KfK-site on April 27, 1983

Table 3 - continued

	HEIGHT (M)	10.10	10.20	10.30	10.40	10.50	11.00	11.10	11.20	11.30	11.40	11.50	12.00	12.10	12.20	12.30	12.40
		Time in CET															
WIND DIRECTION (DEGREE)	40	224	227	234	240	240	235	216	217	219	233	244	255	237	277	230	258
	60	219	224	231	237	233	231	211	217	217	230	242	253	233	269	227	254
	100	221	221	228	233	230	227	211	216	212	227	247	248	228	261	221	248
	160	224	226	233	233	230	227	221	217	223	228	246	244	231	256	228	247
	200	228	232	236	235	233	231	227	223	228	231	250	248	235	255	233	247
WIND SPEED (M/S)	40	****	****	****	****	****	****	****	****	5.0	4.8	5.0	****	****	****	****	****
	60	5.9	6.4	5.7	7.1	6.5	5.9	6.7	6.2	5.2	4.6	5.1	5.0	6.5	4.5	4.1	4.7
	100	6.6	7.5	6.8	8.3	7.7	6.4	7.9	7.2	6.2	5.5	5.3	5.3	7.1	5.1	4.8	5.2
	160	7.1	8.6	7.8	8.3	8.2	7.5	8.5	8.3	7.2	6.1	5.6	5.8	7.8	5.4	5.3	5.5
	200	7.5	9.1	8.5	8.6	8.5	7.8	8.8	8.5	7.6	6.3	6.0	6.0	8.0	5.7	5.6	5.6
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE) VER.	40	12.7	13.3	12.7	12.3	12.3	11.7	12.4	12.3	13.1	13.6	12.7	12.8	12.5	12.7	14.7	13.7
HOR.	40	27.1	28.1	26.7	27.3	25.0	23.7	24.9	29.3	31.8	32.5	28.6	27.1	25.8	27.7	29.3	34.5
VER.	100	8.6	8.5	8.7	8.3	7.7	8.1	9.4	10.1	11.1	11.9	12.1	12.1	11.2	10.9	12.5	11.3
HOR.	100	13.0	13.7	13.3	12.3	11.4	11.5	13.4	14.4	15.9	16.7	16.0	15.6	14.2	15.1	14.8	16.4
VER.	160	7.8	7.6	7.4	6.8	6.7	7.4	8.1	8.8	9.6	9.8	10.3	11.1	10.4	9.3	10.2	9.4
HOR.	160	4.2	3.2	3.8	2.8	3.2	4.2	3.9	4.2	5.1	3.8	4.8	5.0	2.7	3.5	4.8	3.4
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)	100	15.3	11.9	11.4	9.1	8.8	17.9	15.7	18.2	17.1	17.2	22.6	16.4	15.7	13.1	20.4	13.5
TEMPERATURE GRADIENT (K/100M)	30/100	-1.4	-1.5	-1.4	-1.5	-1.5	-1.7	-1.9	-1.7	-2.0	-1.6	-1.4	-1.9	-1.8	-1.7	-1.8	-1.6
NET RADIATION	(MW/CM**2)	18.8	20.0	18.7	24.6	25.3	35.3	39.6	43.1	44.3	30.9	40.9	46.9	46.6	30.9	45.2	40.3
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION	C			C			C			B			B			B
	HOR. FLUCTUATION	D			D			C			C			C			C
	TEMP. GRADIENT	****			****			****			B			****			****
	SYNOP. OBSERV.	C			C			C			B			B			B

Table 3/2: Meteorological data measured at KfK-site on April 27, 1983

		HEIGHT (M)	12.50	13.00	13.10	13.20	13.30	13.40	13.50	14.00	14.10	14.20	14.30	14.40	14.50	15.00	15.10	15.20
			Time in CET															
WIND DIRECTION (DEGREE)		40	261	244	219	222	224	245	235	228	217	244	228	246	243	236	242	236
		60	256	242	217	216	219	239	230	225	215	240	226	241	239	230	237	228
		100	246	241	216	213	220	234	233	221	221	239	226	236	233	227	231	226
		160	239	238	221	219	223	233	232	222	226	237	227	233	233	229	231	228
		200	235	237	221	223	228	234	236	231	232	239	231	234	237	233	233	231
WIND SPEED (M/S)		40	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	4.4
		60	4.7	3.9	4.1	6.1	4.6	5.5	4.0	4.5	4.9	5.4	5.1	4.6	4.7	4.2	4.4	4.8
		100	5.0	4.0	4.5	6.3	5.1	5.6	4.5	5.3	5.1	5.6	5.6	5.0	5.5	5.0	4.9	5.2
		160	5.2	4.3	5.1	6.6	5.7	5.6	4.9	5.8	5.5	6.0	6.1	5.2	5.7	5.5	5.8	5.7
		200	5.2	4.5	5.5	6.9	6.0	5.7	5.2	6.0	5.8	6.2	6.3	5.5	5.8	5.8	6.2	6.0
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	13.7	12.3	13.2	12.3	12.7	13.2	12.5	12.9	13.7	12.4	11.9	12.0	12.0	11.5	11.1	11.7
	HOR.	40	28.6	24.3	25.4	27.2	28.7	28.1	24.1	25.1	29.1	28.6	24.7	26.1	24.1	24.2	25.8	26.5
	VER.	100	11.9	10.9	12.7	12.0	11.8	12.6	11.9	12.3	12.4	13.0	11.8	11.0	9.8	8.9	8.3	9.4
	HOR.	100	14.5	13.9	15.7	16.5	16.7	15.4	14.5	14.4	14.9	14.4	12.7	13.0	11.9	11.3	11.8	12.7
	VER.	160	10.2	9.9	11.6	11.0	10.4	9.9	10.3	10.2	11.3	12.6	11.3	10.0	8.7	7.7	7.0	7.6
	HOR.	160	4.3	3.8	4.6	4.1	2.8	4.6	3.7	3.6	4.9	3.8	3.4	3.9	1.8	2.8	2.8	3.1
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	16.8	14.8	20.8	16.4	18.2	11.7	17.3	9.9	16.0	13.9	14.4	11.5	8.4	12.9	12.3	14.2
TEMPERATURE GRADIENT (K/100M)		30/100	-1.3	-1.4	-1.4	-1.4	-1.8	-1.6	-1.5	-1.6	-1.6	-1.8	-1.5	-1.4	-1.5	-1.5	-1.5	-1.5
NET RADIATION		(MW/CM**2)	32.8	25.1	29.5	34.5	38.7	35.9	26.9	36.3	30.6	41.3	24.1	18.8	19.8	17.4	20.5	19.5
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION				B			B			B			B			C	
	HOR. FLUCTUATION				C			C			C			D			C	
	TEMP. GRADIENT				****			****			****			****			C	
	SYNOP. OBSERV.				B			B			B			C			C	

Table 3/3: Meteorological data measured at KfK-site on April 27, 1983

		HEIGHT (M)	8.10	8.20	8.30	8.40	8.50	9.00	9.10	9.20	9.30	9.40	9.50	10.00	10.10	10.20	10.30	10.40
			Time in CET															
WIND DIRECTION (DEGREE)		40	223	226	227	223	224	221	220	222	222	230	240	239	236	238	248	236
		60	217	220	221	219	221	217	216	219	221	226	237	238	237	238	249	238
		100	215	217	219	220	220	218	215	217	216	225	234	236	234	234	243	236
		160	218	219	221	222	223	219	218	220	220	227	236	237	236	239	242	238
		200	223	224	226	226	229	225	225	225	226	233	239	240	240	242	245	241
WIND SPEED (M/S)		40	4.9	5.0	5.9	5.9	5.7	5.7	5.9	6.0	5.9	5.8	6.4	7.2	5.6	7.0	6.9	7.9
		60	6.1	6.1	6.5	7.2	7.1	6.8	7.3	7.5	7.5	7.4	7.6	8.1	6.7	8.5	8.1	9.3
		100	8.0	7.9	8.7	9.1	9.3	8.4	9.2	9.8	9.9	9.3	9.3	10.0	9.3	10.7	9.7	11.7
		160	9.6	10.0	10.9	11.0	11.1	10.0	11.1	11.4	11.8	11.0	11.4	11.8	11.0	11.9	10.7	13.5
		200	10.4	11.3	11.7	12.1	11.8	10.9	12.0	12.4	12.6	11.8	12.0	12.4	11.4	12.6	11.9	14.6
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	12.5	13.5	13.6	14.2	13.9	13.9	14.1	14.0	14.3	14.7	14.0	13.0	12.9	12.9	12.6	12.6
	HOR.	40	16.6	16.7	16.3	16.5	17.2	16.2	17.1	16.7	17.3	17.8	17.2	16.0	15.4	17.2	16.8	15.8
	VER.	100	5.7	5.9	6.4	6.3	6.5	6.8	7.2	7.0	6.7	6.6	6.7	6.6	6.4	6.6	6.6	6.8
	HOR.	100	8.3	8.7	9.4	8.8	8.8	8.7	9.2	9.0	8.5	9.0	9.8	9.5	8.8	10.1	9.9	9.5
	VER.	160	4.5	4.4	4.7	4.8	4.7	4.6	4.5	4.5	4.4	4.4	4.7	4.6	4.4	4.9	5.3	5.2
	HOR.	160	8.3	8.2	8.4	8.0	7.9	7.5	7.8	7.5	7.3	7.8	8.4	8.4	7.8	8.9	9.2	9.4
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	7.9	9.2	10.4	8.4	7.6	10.7	8.2	8.2	7.9	10.4	10.4	8.9	10.9	9.5	10.9	10.8
TEMPERATURE GRADIENT (K/100M)		30/100	-0.8	-0.9	-0.9	-1.0	-0.9	-0.9	-0.9	-0.9	-0.8	-0.8	-0.9	-0.9	-1.0	-0.9	-1.0	-1.0
NET RADIATION (MW/CM**2)			2.1	3.6	4.5	4.8	3.0	2.1	1.4	1.0	1.1	1.7	2.7	2.6	2.4	1.7	2.1	1.0
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION			D			D			D			D			D		
	HOR. FLUCTUATION			D			D			D			D			D		
	TEMP. GRADIENT			D			D			D			D			D		
	SYNOP. OBSERV.			D			D			D			D			D		

Table 4/1: Meteorological data measured at KfK-site on March 29, 1984

		HEIGHT (M)	10.50	11.00	11.10	11.20	11.30	11.40	11.50	12.00	12.10	12.20	12.30	12.40	12.50	13.00	13.10	13.20
			Time in CET															
WIND DIRECTION (DEGREE)		40	236	239	235	230	232	237	239	239	243	245	244	240	250	254	250	259
		60	238	238	234	227	231	232	238	238	244	246	243	241	249	252	251	256
		100	235	234	232	227	228	233	236	235	240	242	240	239	245	249	251	253
		160	238	236	235	229	232	235	238	241	243	244	242	241	246	252	254	257
		200	242	241	238	235	238	239	242	245	248	248	244	246	251	256	257	259
WIND SPEED (M/S)		40	9.4	6.8	8.7	8.3	8.9	7.7	7.5	6.3	5.5	5.9	5.2	5.0	5.0	5.3	5.1	5.0
		60	10.7	8.4	10.4	9.7	10.6	9.0	9.0	7.4	6.5	7.1	6.4	5.7	5.8	6.4	6.0	5.9
		100	13.7	10.4	12.9	12.4	13.0	11.7	11.6	8.9	8.3	8.5	7.8	7.3	7.3	8.1	7.4	7.3
		160	15.0	12.1	13.8	13.9	14.6	13.8	12.8	10.8	9.7	9.7	9.1	8.8	8.5	9.3	8.6	8.3
		200	15.3	12.5	14.1	14.2	14.7	14.6	13.2	11.6	10.3	10.5	9.7	9.7	9.4	10.0	9.2	9.3
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	12.8	13.4	13.1	13.1	12.8	12.7	13.0	12.9	12.7	12.6	12.7	13.6	13.2	13.0	12.6	12.2
	HOR.	40	15.9	16.2	16.6	15.7	15.7	15.7	15.9	15.5	14.6	14.6	14.3	15.8	15.1	14.6	14.6	15.4
	VER.	100	6.3	6.5	6.3	6.0	5.7	5.8	5.8	6.0	6.2	6.4	6.5	6.8	7.1	6.9	6.7	6.6
	HOR.	100	8.9	8.7	8.9	8.3	8.2	8.3	8.3	8.1	8.4	8.6	8.9	9.8	10.0	9.5	9.1	9.4
	VER.	160	4.5	4.8	4.8	4.6	4.1	4.0	3.9	4.0	4.2	4.4	4.8	5.2	5.3	5.4	5.2	5.3
	HOR.	160	8.6	8.0	8.4	7.9	7.7	7.4	7.3	7.8	7.9	7.8	8.4	9.2	9.3	9.7	9.4	9.9
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	7.0	11.8	7.1	8.0	8.0	9.5	7.0	9.3	9.0	9.1	11.3	11.4	9.3	10.4	7.8	11.4
TEMPERATURE GRADIENT (K/100M)		30/100	-1.0	-1.1	-1.2	-1.1	-1.1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-0.9	-0.9	-1.0
NET RADIATION (MW/CM**2)			3.4	4.5	3.2	2.6	2.2	3.7	2.2	1.5	1.9	2.2	1.5	1.0	1.3	1.2	1.0	3.7
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION		D			D			D			D			D			D
	HOR. FLUCTUATION		D			D			D			D			D			D
	TEMP. GRADIENT		D			D			D			D			D			D
	SYNOP. OBSERV.		D			D			D			D			D			D

Table 4/2: Meteorological data measured at KfK-site on March 29, 1984

		HEIGHT (M)	13.30	13.40	13.50	14.00	14.10	14.20	14.30	14.40	14.50	15.00	15.10	15.20	15.30
			Time in CET												
WIND DIRECTION (DEGREE)		40	255	256	253	256	259	247	253	261	265	264	267	264	270
		60	259	255	252	257	259	247	251	262	261	264	265	261	266
		100	255	256	252	251	260	246	251	259	261	263	262	259	262
		160	256	256	257	257	260	245	253	262	266	265	263	260	262
		200	257	259	259	259	260	248	255	262	266	266	263	259	262
WIND SPEED (M/S)		40	6.1	6.3	5.0	4.4	4.6	4.0	5.3	4.8	5.7	7.4	5.3	3.9	4.5
		60	6.9	7.0	6.2	4.6	5.5	4.7	6.4	5.8	6.4	8.1	6.3	4.7	5.0
		100	8.5	7.9	7.4	6.0	5.9	5.8	7.4	6.9	7.6	9.1	6.9	5.4	5.7
		160	9.6	9.1	8.5	7.0	6.5	6.8	8.1	8.0	8.9	10.1	7.4	6.4	6.3
		200	9.8	9.3	9.0	7.8	7.2	7.3	8.2	8.5	9.7	10.4	8.1	7.2	6.9
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	12.1	12.1	12.6	12.4	12.6	13.0	12.2	11.5	11.3	11.2	11.5	12.7	12.8
	HOR.	40	15.1	15.5	15.6	15.2	15.5	16.3	16.3	15.3	13.9	13.4	13.0	15.5	17.7
	VER.	100	6.8	7.2	7.3	7.6	7.9	7.5	6.7	6.1	6.3	6.9	6.7	7.3	7.4
	HOR.	100	9.6	9.6	10.1	9.4	10.8	10.7	10.3	9.0	8.2	8.8	7.8	8.9	10.4
	VER.	160	5.0	5.2	5.4	5.6	6.3	6.9	6.1	5.1	5.0	5.2	4.9	6.1	6.7
	HOR.	160	9.2	9.9	9.6	9.4	10.3	11.0	10.3	9.0	8.1	8.6	8.0	9.2	10.5
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	9.4	10.4	11.5	12.4	10.0	14.5	7.3	9.3	8.8	8.6	10.4	14.2	13.3
TEMPERATURE GRADIENT (K/100M)		30/100	-1.1	-1.1	-1.1	-1.3	-1.3	-1.1	-1.1	-1.2	-1.3	-1.3	-1.3	-1.4	-1.3
NET RADIATION		(MW/CM**2)	5.0	6.1	8.7	15.3	8.4	2.9	2.7	3.1	14.3	14.7	14.4	13.4	10.9
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION				C			C			D			C	
	HOR. FLUCTUATION				D			D			D			C	
	TEMP. GRADIENT				C			C			C			C	
	SYNOP. OBSERV.				D			C			D			C	

Table 4/3: Meteorological data measured at KfK-site on March 29, 1984

		HEIGHT (M)	9.40	9.50	10.00	10.10	10.20	10.30	10.40	10.50	11.00	11.10	11.20	11.30	11.40	11.50	12.00	12.10
			Time in CET															
WIND DIRECTION (DEGREE)		40	216	221	213	221	216	233	236	233	235	229	223	219	223	228	234	222
		60	217	218	212	221	215	231	238	235	236	229	224	222	223	229	234	220
		100	220	219	217	228	223	235	242	241	240	233	232	228	227	231	235	224
		160	218	219	216	225	223	235	240	238	239	231	230	230	228	231	232	223
		200	221	222	219	226	226	237	240	239	239	231	231	232	231	232	232	226
WIND SPEED (M/S)		40	6.8	5.6	5.8	6.0	6.3	7.5	6.7	7.1	6.9	8.6	3.9	3.4	3.5	5.1	7.0	7.1
		60	8.3	7.3	6.5	7.1	7.7	8.6	8.3	8.0	8.4	10.1	5.5	4.4	4.4	6.3	7.8	8.3
		100	9.6	8.7	8.0	8.7	9.3	10.7	9.8	10.2	11.0	13.2	7.4	6.1	6.5	7.7	8.9	9.4
		160	10.7	9.0	9.3	10.1	9.8	11.2	10.6	11.2	12.1	14.5	9.4	8.6	8.9	8.9	10.3	10.3
		200	11.2	9.5	9.8	10.7	9.9	11.2	10.7	11.7	12.3	14.7	10.6	10.0	10.4	10.1	11.3	10.6
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	14.3	14.6	15.5	15.4	15.8	15.3	14.3	14.5	14.2	14.0	13.9	15.6	14.6	14.8	14.2	13.5
	HOR.	40	17.5	17.8	18.1	17.8	18.3	17.7	15.6	16.1	16.7	15.9	15.7	17.3	16.4	16.3	16.1	15.4
	VER.	100	7.2	7.2	7.3	7.9	7.6	7.7	6.4	7.1	6.1	5.5	5.3	5.8	6.3	6.9	7.4	6.7
	HOR.	100	8.5	9.1	9.4	10.0	9.3	9.7	7.8	8.3	7.4	6.7	6.5	7.3	8.1	9.4	9.0	7.9
	VER.	160	5.5	6.2	6.3	6.6	6.4	6.0	5.1	5.5	4.6	3.9	3.4	3.3	3.7	4.4	5.2	5.0
	HOR.	160	7.4	8.8	9.0	9.3	8.5	8.9	7.6	7.7	6.9	6.1	6.0	5.8	6.4	7.5	7.8	7.4
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	8.3	9.9	9.7	11.9	8.0	8.1	8.6	9.3	5.6	6.9	7.0	8.4	8.9	10.0	9.0	6.1
TEMPERATURE GRADIENT (K/100M)		30/100	-1.4	-1.5	-1.6	-1.5	-1.6	-1.2	-1.3	-1.4	-0.8	-0.9	-0.6	-0.5	-0.5	-0.7	-0.8	-0.9
NET RADIATION (MW/CM**2)			23.3	25.9	29.4	24.2	17.6	7.2	15.6	9.3	7.9	2.6	13.4	21.0	20.8	27.6	37.2	21.7
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION			C			C			D			D			D		
	HOR. FLUCTUATION			D			D			D			D			D		
	TEMP. GRADIENT			C			C			D			D			D		
	SYNOP. OBSERV.			D			D			D			D			D		

Table 5/1: Meteorological data measured at KfK-site on March 23, 1985

	HEIGHT (M)	12.20	12.30	12.40	12.50	13.00	13.10	13.20	13.30	13.40	13.50	14.00	14.10	14.20	14.30	14.40	14.50
		Time in CET															
WIND DIRECTION (DEGREE)	40	221	219	219	211	218	203	208	203	217	241	250	226	220	216	221	217
	60	220	212	216	207	216	200	205	204	215	231	247	225	215	215	219	218
	100	222	220	221	214	221	206	208	210	219	228	242	227	220	220	222	221
	160	219	220	218	212	217	201	206	208	217	227	233	225	220	220	221	217
	200	222	222	220	215	218	202	209	211	217	227	229	222	221	221	222	221
WIND SPEED (M/S)	40	5.8	6.7	5.9	5.0	5.6	5.3	4.3	5.2	5.1	4.1	3.6	3.0	4.0	4.1	4.6	5.3
	60	7.1	7.8	7.1	5.7	6.4	6.4	5.2	6.0	5.9	4.5	4.3	3.6	4.8	4.9	5.1	6.0
	100	8.6	9.4	8.4	6.8	7.5	7.2	6.3	7.3	7.0	5.1	5.3	4.5	5.9	6.1	6.3	7.1
	160	9.7	10.7	8.9	8.1	8.5	7.4	7.0	7.5	7.6	6.4	5.5	5.4	6.6	6.5	7.0	7.7
	200	10.0	11.1	9.1	8.7	8.6	7.1	7.0	7.5	7.9	6.9	5.5	5.5	6.9	6.6	7.2	7.8
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE) VER.	40	13.5	14.1	13.9	14.2	14.0	11.7	****	****	****	13.9	12.1	9.8	10.5	11.9	12.7	13.1
HOR.	40	16.0	17.5	16.9	17.0	17.7	17.4	20.2	19.0	21.3	20.2	17.4	13.1	14.9	15.2	15.4	16.3
VER.	100	6.1	6.6	6.2	7.6	7.7	7.4	7.7	7.2	7.5	7.7	7.3	6.3	6.4	6.1	6.4	6.9
HOR.	100	7.3	8.0	8.1	9.0	9.5	8.8	11.1	9.2	9.2	9.5	9.7	8.4	9.6	8.4	8.5	9.1
VER.	160	4.5	4.6	4.5	5.9	6.0	5.6	6.1	5.5	5.8	5.6	5.9	5.8	5.2	4.4	4.4	4.9
HOR.	160	6.9	7.0	6.8	7.8	7.8	7.7	9.3	7.9	8.4	8.3	8.8	8.9	9.8	8.1	7.2	7.5
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)	100	8.6	7.9	7.5	12.6	11.3	12.7	18.7	7.1	10.5	11.1	6.9	16.2	8.0	6.6	9.6	8.7
TEMPERATURE GRADIENT (K/100M)	30/100	-1.0	-1.3	-1.3	-1.2	-1.2	-1.6	-1.8	-1.6	-1.4	-1.0	-0.1	0.2	-0.3	-0.9	-1.1	-1.5
NET RADIATION	(MW/CM**2)	15.7	34.8	17.5	8.8	10.8	34.0	34.9	18.5	9.4	3.8	2.0	7.4	12.6	9.8	20.6	25.1
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION	D			C			C			C			D			D
	HOR. FLUCTUATION	D			D			C			D			D			D
	TEMP. GRADIENT	D			C			B			D			D			C
	SYNOP. OBSERV.	D			C			C			C			C			C

Table 5/2: Meteorological data measured at KfK-site on March 23, 1985

		HEIGHT (M)	15.00	15.10	15.20	15.30	15.40	15.50	16.00	16.10	16.20	16.30	16.40	16.50	17.00	17.10	17.20	17.30
			Time in CET															
WIND DIRECTION (DEGREE)		40	215	200	204	197	184	191	191	193	193	212	198	209	207	216	218	216
		60	209	199	202	194	190	189	190	195	192	208	200	205	204	213	213	215
		100	214	207	209	200	193	193	196	200	198	209	206	208	209	217	220	221
		160	211	207	208	196	190	190	195	198	193	204	208	207	212	215	218	221
		200	213	210	209	198	192	191	198	200	195	202	210	208	216	218	221	225
WIND SPEED (M/S)		40	5.4	5.8	5.7	6.2	4.9	5.7	4.8	4.6	4.4	4.6	4.0	3.3	3.0	4.7	3.4	3.1
		60	6.2	7.0	6.6	7.5	5.4	6.3	5.5	5.4	5.6	5.5	5.1	3.9	3.9	5.8	4.4	3.7
		100	7.1	8.4	8.5	9.0	6.2	6.5	6.3	6.2	6.5	6.1	6.6	5.1	5.2	6.9	5.7	5.1
		160	7.3	9.1	9.3	9.3	6.7	8.0	7.1	6.7	7.1	6.6	7.0	6.3	6.1	7.6	6.7	5.8
		200	7.3	9.1	9.4	9.1	7.2	7.6	6.8	6.6	6.9	6.6	7.4	6.6	6.8	8.0	6.7	5.7
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	12.3	12.4	13.4	14.1	13.9	13.4	14.2	14.5	14.3	14.2	14.0	14.8	15.6	14.9	15.1	14.9
	HOR.	40	15.6	16.0	16.4	16.8	19.9	18.4	17.9	16.5	17.6	17.1	15.8	18.1	19.0	18.8	18.2	17.9
	VER.	100	6.7	6.5	6.2	5.8	7.1	7.4	7.2	7.2	6.2	6.1	5.9	6.0	7.2	7.1	6.7	6.6
	HOR.	100	8.5	8.7	8.0	7.2	9.9	10.1	9.6	9.6	8.7	9.3	8.4	8.4	11.0	10.8	9.5	8.8
	VER.	160	5.3	5.4	4.9	4.8	6.0	6.8	6.4	6.4	5.3	5.4	5.1	5.1	6.0	5.5	4.9	4.5
	HOR.	160	7.7	8.4	7.5	7.2	9.3	9.7	9.6	9.4	8.5	9.9	9.0	8.2	10.0	9.6	8.6	7.9
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	11.1	8.3	9.4	7.0	16.1	9.1	9.0	10.5	8.1	8.9	8.9	10.5	16.2	7.4	8.7	8.8
TEMPERATURE GRADIENT (K/100M)		30/100	-1.3	-1.2	-1.3	-1.3	-1.9	-1.6	-1.7	-1.7	-1.3	-1.1	-1.1	-1.0	-1.1	-1.2	-1.0	-0.9
NET RADIATION		(MW/CM**2)	9.8	14.9	11.2	12.5	29.9	19.8	16.9	15.9	4.4	3.4	3.3	3.6	8.9	3.9	-0.1	-0.2
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION				D			C			D			D			D	
	HOR. FLUCTUATION				D			D			D			D			D	
	TEMP. GRADIENT				C			B			C			C			C	
	SYNOP. OBSERV.				C			C			C			C			C	

Table 5/3: Meteorological data measured at KfK-site on March 23, 1985

		HEIGHT (M)	17.40	17.50	18.00	18.10	18.20	18.30	18.40	18.50	19.00	19.10	19.20	19.30	19.40	19.50	20.00	20.10
			Time in CET															
WIND DIRECTION (DEGREE)		40	243	209	197	201	209	208	203	196	208	210	187	182	205	247	228	224
		60	232	206	195	204	210	210	208	201	212	215	198	191	211	243	235	228
		100	220	214	206	213	219	220	216	214	223	229	216	211	224	246	245	234
		160	217	212	210	220	222	226	221	218	228	234	224	220	230	245	247	226
		200	220	215	216	225	225	231	228	225	234	235	228	226	233	246	246	227
WIND SPEED (M/S)		40	1.7	7.1	4.2	2.6	2.6	3.7	3.5	3.1	3.9	3.4	3.0	2.8	3.6	4.1	2.8	2.4
		60	2.4	8.9	5.7	3.8	4.1	5.3	5.1	4.8	5.5	5.0	4.2	4.2	5.0	5.4	3.8	3.0
		100	3.6	11.5	7.9	5.9	5.8	6.8	6.8	6.3	6.9	6.5	5.7	5.5	7.1	7.1	5.2	3.8
		160	5.1	12.4	8.9	7.1	7.1	7.8	8.0	7.5	7.9	7.6	6.9	6.5	9.4	8.3	6.0	4.5
		200	6.0	12.7	9.5	7.9	8.0	8.3	8.4	8.2	8.5	8.3	7.9	7.1	10.5	9.1	6.3	4.8
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	15.1	13.9	12.9	11.2	10.1	8.1	7.6	7.1	7.3	6.7	5.7	5.1	5.3	6.3	7.3	6.5
	HOR.	40	20.9	20.1	18.1	15.8	13.6	10.3	9.2	8.8	9.4	8.0	6.3	7.3	7.8	9.7	9.3	9.0
	VER.	100	7.6	6.7	5.3	4.3	3.4	2.5	2.0	1.7	1.7	1.7	1.9	1.9	2.0	3.2	3.7	3.4
	HOR.	100	11.4	10.3	8.1	7.4	6.1	4.5	3.2	2.9	3.2	2.6	2.3	3.7	4.1	5.7	5.6	4.7
	VER.	160	5.0	4.5	4.0	3.5	2.8	2.2	1.7	1.5	1.6	1.7	1.7	1.6	1.6	2.6	2.8	2.3
	HOR.	160	8.6	8.4	7.4	7.3	6.5	5.5	4.3	4.2	4.7	4.3	4.0	4.7	4.6	5.8	5.7	4.8
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	17.5	7.4	4.7	6.9	3.5	2.1	2.3	2.5	4.4	2.8	9.0	7.0	6.7	9.5	6.3	8.4
TEMPERATURE GRADIENT (K/100M)		30/100	-0.7	-0.4	0.2	0.7	1.1	1.2	1.4	1.5	1.5	1.5	1.3	1.1	1.0	0.6	0.4	0.2
NET RADIATION		(MW/CM**2)	-0.5	0.0	0.6	0.2	-1.9	-3.1	-3.6	-3.5	-1.6	-2.3	-2.1	-0.4	0.0	-0.5	-0.8	-1.5
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION			D			D			F			E			E		
	HOR. FLUCTUATION			D			F			F			E			D		
	TEMP. GRADIENT			D			E			F			F			E		
	SYNOP. OBSERV.			D			D			E			E			E		

Table 5/4: Meteorological data measured at KfK-site on March 23, 1985

		HEIGHT (M)	8.00	8.10	8.20	8.30	8.40	8.50	9.00	9.10	9.20	9.30	9.40	9.50	10.00	10.10	10.20	10.30
			Time in CET															
WIND DIRECTION (DEGREE)		40	193	198	199	203	197	213	227	218	218	215	221	217	209	228	221	222
		60	196	200	206	204	199	211	214	216	217	213	217	217	209	232	221	219
		100	210	214	216	206	201	211	217	218	220	213	220	214	212	227	225	223
		160	213	215	216	208	209	206	216	212	217	213	219	208	215	223	223	217
		200	215	217	219	211	210	208	214	214	216	216	218	206	217	223	223	218
WIND SPEED (M/S)		40	1.9	1.5	1.0	1.9	1.8	1.7	2.0	3.3	3.5	3.4	4.0	2.8	3.3	3.6	3.8	3.3
		60	2.8	2.5	1.8	2.5	2.3	2.3	2.7	4.0	3.9	4.3	4.5	3.2	3.5	3.9	4.4	3.7
		100	4.3	3.6	3.4	2.8	3.0	2.6	2.8	4.9	4.4	5.3	5.3	3.7	3.8	4.5	5.3	4.2
		160	5.9	5.2	4.6	3.7	4.1	3.0	3.8	5.1	5.1	6.0	5.9	4.1	4.1	5.0	5.6	4.5
		200	7.0	6.0	5.4	4.7	4.6	3.5	4.4	5.4	5.5	6.1	6.1	4.1	4.4	5.4	5.8	4.6
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	9.6	9.5	9.4	12.2	14.6	14.9	16.9	16.5	15.2	15.2	14.2	13.6	12.8	14.4	14.9	15.8
	HOR.	40	12.5	13.5	13.2	17.7	19.5	21.7	19.7	20.8	18.0	17.6	15.7	15.1	16.1	21.1	19.4	19.1
	VER.	100	5.6	5.4	5.4	6.4	7.8	8.6	9.4	8.7	8.2	9.1	8.9	8.3	9.2	10.8	10.8	11.5
	HOR.	100	7.9	7.6	7.7	8.4	11.9	15.7	16.5	16.0	13.1	12.7	11.6	9.9	12.4	13.2	12.4	12.8
	VER.	160	4.2	4.0	3.6	4.7	5.8	7.3	8.0	8.4	7.7	7.1	6.8	6.8	8.8	9.6	9.4	9.6
	HOR.	160	7.3	7.3	7.0	8.4	9.8	11.4	13.6	12.4	11.6	10.7	10.6	10.1	12.1	12.2	11.2	11.4
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	5.9	6.9	9.3	16.1	18.9	21.1	18.7	14.2	12.0	14.4	8.2	16.1	13.5	14.7	13.4	16.4
TEMPERATURE GRADIENT (K/100M)		30/100	-0.1	-0.1	-0.3	-0.6	-0.6	-0.9	-0.9	-1.1	-1.2	-1.1	-1.0	-0.9	-1.1	-1.3	-1.4	-1.2
NET RADIATION (MW/CM**2)			1.4	3.3	10.7	12.1	14.9	18.7	15.3	20.5	16.8	13.7	11.6	22.0	21.9	27.5	26.8	23.8
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION			D			C			C			C			C		
	HOR. FLUCTUATION			D			C			C			C			C		
	TEMP. GRADIENT			E			D			C			C			C		
	SYNOP. OBSERV.			C			C			C			C			C		

Table 6/1: Meteorological data measured at KfK-site on March 25, 1985

		HEIGHT (M)	10.40	10.50	11.00	11.10	11.20	11.30	11.40	11.50	12.00	12.10	12.20	12.30	12.40	12.50	13.00	13.10
			Time in CET															
WIND DIRECTION (DEGREE)		40	221	218	218	222	235	230	241	242	225	226	212	216	213	225	219	254
		60	224	215	214	218	233	229	240	238	219	219	210	212	217	223	214	251
		100	223	217	221	225	235	233	244	240	221	220	214	218	220	228	209	246
		160	218	213	218	221	229	231	240	236	216	215	214	225	215	224	206	237
		200	218	215	217	221	231	234	237	234	218	217	217	228	217	224	211	237
WIND SPEED (M/S)		40	3.5	3.6	5.0	3.4	4.8	4.5	3.9	3.6	3.8	3.8	4.8	3.0	5.1	4.1	3.6	3.5
		60	3.8	4.4	5.7	3.8	5.6	5.6	4.3	4.5	4.2	4.3	5.3	3.3	5.4	4.8	4.1	4.0
		100	4.3	5.6	6.5	4.7	6.8	6.7	4.9	5.2	4.6	4.6	5.6	3.8	6.0	5.5	4.5	4.2
		160	4.7	6.1	6.9	5.5	7.3	7.2	5.4	5.8	5.4	5.5	6.1	3.9	6.4	5.9	5.2	4.4
		200	4.9	6.2	7.1	5.9	7.6	7.3	5.7	5.9	5.5	5.8	6.5	4.1	6.6	6.2	5.4	4.2
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	16.7	16.5	16.8	17.3	16.7	16.7	15.4	15.8	16.7	18.0	18.3	18.1	17.0	15.7	17.4	18.5
	HOR.	40	20.4	20.8	19.8	19.2	20.0	19.1	18.6	20.6	20.3	20.6	20.7	19.6	18.9	18.2	19.2	23.8
	VER.	100	11.3	10.9	9.8	9.6	9.6	8.3	8.0	8.6	9.6	10.9	11.6	11.5	10.4	9.6	9.8	11.3
	HOR.	100	14.3	14.1	12.3	12.0	12.9	11.3	10.8	11.3	12.9	16.6	16.5	15.6	14.8	13.3	11.9	14.7
	VER.	160	9.7	9.9	8.6	8.4	8.1	7.1	6.9	7.2	8.1	9.3	9.7	10.1	9.1	9.2	9.7	11.4
	HOR.	160	12.0	12.0	10.6	10.3	10.8	9.2	9.2	9.6	10.7	12.5	12.4	13.0	12.1	11.9	10.9	14.1
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	16.7	13.9	7.7	19.8	13.5	8.4	16.4	16.4	17.3	18.4	17.9	20.0	13.8	12.1	13.2	23.5
TEMPERATURE GRADIENT (K/100M)		30/100	-1.2	-1.3	-1.4	-1.5	-1.4	-1.4	-1.2	-1.5	-1.3	-1.4	-1.5	-1.1	-1.7	-1.5	-1.4	-1.4
NET RADIATION	(MW/CM**2)		21.9	20.2	25.4	37.7	21.1	17.2	28.3	38.4	39.1	41.2	37.5	25.9	32.9	28.7	29.9	35.0
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION		B			C			C			B			C			B
	HOR. FLUCTUATION		C			C			C			C			C			C
	TEMP. GRADIENT		C			C			C			C			C			B
	SYNOP. OBSERV.		B			B			C			C			C			B

Table 6/2: Meteorological data measured at KfK-site on March 25, 1985

		HEIGHT (M)	13.20	13.30	13.40	13.50	14.00	14.10	14.20	14.30	14.40	14.50	15.00	15.10	15.20	15.30	15.40	15.50
			Time in CET															
WIND DIRECTION (DEGREE)		40	241	235	223	235	233	237	213	210	201	219	231	155	122	119	128	123
		60	235	230	224	234	230	239	217	206	203	203	221	158	121	118	125	118
		100	239	234	237	238	237	241	240	211	218	215	220	173	141	131	134	122
		160	235	230	236	232	236	240	241	208	214	213	214	178	139	128	134	117
		200	238	230	236	229	237	243	235	209	213	208	206	176	143	133	138	120
WIND SPEED (M/S)		40	3.6	4.1	3.5	3.8	2.9	2.4	1.8	3.4	3.3	1.8	2.1	2.1	3.4	4.1	3.1	2.4
		60	3.9	4.6	3.9	4.4	2.9	2.9	2.2	3.8	3.7	2.3	2.4	2.4	3.9	4.8	3.4	2.8
		100	4.1	5.0	4.1	4.8	3.3	2.8	2.7	4.1	3.8	2.4	2.7	2.4	4.2	4.8	3.8	2.8
		160	4.9	5.4	4.5	4.8	3.7	3.1	3.1	4.1	4.0	2.7	3.3	2.6	4.3	5.1	4.2	2.7
		200	5.1	5.4	4.7	4.8	4.0	3.0	3.0	4.2	4.1	2.8	3.3	2.6	4.0	5.1	4.3	3.1
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	17.2	17.4	17.7	16.4	14.8	14.7	18.1	17.9	17.9	17.5	17.9	15.1	15.6	13.7	12.7	12.5
	HOR.	40	20.3	19.3	20.0	17.4	16.7	17.6	21.4	20.9	19.7	17.2	21.0	16.8	18.9	16.6	16.1	14.6
	VER.	100	10.9	11.9	11.1	10.1	10.1	11.3	14.4	12.0	11.7	11.6	12.1	11.4	11.6	9.3	8.4	8.2
	HOR.	100	11.6	12.6	13.3	11.4	12.6	14.2	17.7	11.7	10.2	10.1	10.8	10.4	12.0	10.1	8.4	7.2
	VER.	160	10.9	11.1	10.2	9.4	9.9	11.2	14.0	11.6	12.1	12.7	11.4	11.8	11.2	8.9	8.5	8.4
	HOR.	160	13.3	12.6	12.8	10.7	12.5	13.8	17.2	15.3	14.6	15.9	16.7	15.1	17.0	13.9	11.5	10.4
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	14.6	14.0	19.8	10.1	18.4	28.9	27.4	9.4	16.5	19.0	25.1	28.1	17.6	12.3	11.0	14.3
TEMPERATURE GRADIENT (K/100M)		30/100	-1.3	-1.5	-1.6	-1.3	-1.2	-1.4	-1.0	-1.6	-1.6	-1.1	-1.3	-0.9	-1.5	-1.5	-1.2	-1.0
NET RADIATION		(MW/CM**2)	31.4	28.6	27.2	19.9	20.7	29.7	19.4	32.8	25.7	14.6	19.6	22.2	25.4	18.1	10.7	2.8
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION				B			B			B			B			C	
	HOR. FLUCTUATION				C			B			C			B			C	
	TEMP. GRADIENT				B			B			A			B			C	
	SYNOP. OBSERV.				B			B			B			B			B	

Table 6/3: Meteorological data measured at KfK-site on March 25, 1985

		HEIGHT (M)	16.00	16.10	16.20	16.30	16.40	16.50	17.00	17.10	17.20	17.30	17.40	17.50	18.00	18.10
			Time in CET													
WIND DIRECTION (DEGREE)		40	113	132	90	2	115	152	107	102	133	126	116	119	145	144
		60	111	128	90	67	111	152	122	98	121	130	114	118	146	150
		100	117	133	100	99	126	165	138	112	144	148	134	142	170	172
		160	115	130	99	172	138	162	142	119	148	164	161	169	181	180
		200	120	140	107	177	152	170	162	133	169	178	173	181	190	186
WIND SPEED (M/S)		40	2.1	1.7	1.4	0.8	1.6	1.5	0.9	1.5	0.7	1.1	1.3	1.5	1.7	2.0
		60	2.3	1.9	1.6	1.0	1.9	1.7	1.0	1.6	1.0	1.3	1.6	1.7	2.0	2.4
		100	2.2	2.0	1.6	1.1	2.0	2.0	1.2	1.5	1.0	1.3	1.6	1.7	2.2	2.8
		160	2.3	2.2	1.8	1.4	2.0	2.1	1.1	1.3	1.3	1.7	1.9	1.6	2.5	2.8
		200	2.5	2.3	1.8	1.2	2.1	2.3	0.9	1.3	1.1	2.0	1.9	1.7	2.8	3.2
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	12.3	12.1	14.9	16.9	16.7	13.5	11.8	11.7	9.0	7.3	5.2	4.1	3.9	3.5
	HOR.	40	14.3	14.5	15.3	****	****	****	****	****	****	****	****	****	7.5	6.1
	VER.	100	8.5	7.5	8.3	9.4	8.1	7.8	8.3	7.8	6.3	4.9	3.9	3.9	4.7	4.1
	HOR.	100	8.1	8.0	8.4	15.3	15.0	14.1	11.1	13.4	10.9	9.8	8.6	8.3	10.1	8.0
	VER.	160	7.9	6.7	****	****	****	****	****	****	****	****	****	****	3.4	3.3
	HOR.	160	11.4	11.1	****	****	****	****	****	****	****	****	****	****	12.4	10.7
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	16.0	14.4	25.9	****	12.2	14.5	45.1	8.9	22.9	13.2	14.4	13.0	10.0	6.4
TEMPERATURE GRADIENT (K/100M)		30/100	-1.0	-1.0	-1.1	-1.2	-1.0	-0.8	-1.0	-0.9	-0.8	-0.8	-0.6	-0.5	-0.2	0.0
NET RADIATION (MW/CM**2)			10.0	8.2	21.1	7.5	-1.1	3.7	6.2	-1.1	-0.3	-0.7	-1.1	-0.2	-1.0	-0.8
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION			C			C			C			D			D
	HOR. FLUCTUATION			C			C			B			C			D
	TEMP. GRADIENT			C			C			D			D			E
	SYNOP. OBSERV.			B			C			C			C			D

Table 6/4: Meteorological data measured at KfK-site on March 25, 1985

		HEIGHT (M)	18.20	18.30	18.40	18.50	19.00	19.10	19.20	19.30	19.40	19.50	20.00	20.10	20.20
			Time in CET												
WIND DIRECTION (DEGREE)		40	142	132	128	128	135	145	166	206	222	218	211	234	260
		60	145	133	125	126	131	141	167	206	219	214	209	237	260
		100	165	156	144	145	150	161	189	208	222	220	220	243	264
		160	176	167	157	156	165	174	201	208	224	221	222	245	262
		200	183	176	171	169	176	183	207	210	226	224	226	246	258
WIND SPEED (M/S)		40	2.3	2.1	2.6	2.8	2.5	2.8	3.4	4.5	4.3	5.6	3.4	7.6	6.9
		60	2.6	3.0	3.5	3.5	3.5	3.8	4.1	5.8	5.5	7.0	4.2	9.4	8.1
		100	2.9	3.0	3.4	3.5	3.5	3.9	4.8	7.8	7.0	8.8	5.9	12.2	9.6
		160	3.4	3.3	3.4	3.6	3.6	4.1	6.7	8.6	8.0	9.9	7.1	13.4	10.8
		200	3.6	3.3	3.3	3.4	3.5	4.2	7.5	8.8	8.4	10.1	7.7	13.7	11.5
STANDARD DEVIATION OF WIND DIR. VECTOR VANE (DEGREE)	VER.	40	3.4	4.0	3.9	3.5	3.6	4.5	6.3	9.5	10.7	11.4	11.4	11.6	11.3
	HOR.	40	5.7	5.9	5.5	4.5	4.9	6.1	7.9	15.0	15.4	15.2	15.0	15.8	14.1
	VER.	100	3.6	2.9	2.2	1.8	1.4	1.2	1.7	4.3	5.8	6.1	6.2	5.7	5.1
	HOR.	100	6.5	5.3	3.9	3.2	2.5	2.2	3.4	5.9	7.5	7.3	7.4	7.3	5.6
	VER.	160	2.8	2.3	1.8	1.6	1.4	1.2	1.7	4.2	5.3	5.8	6.0	5.1	4.3
	HOR.	160	9.3	7.8	6.7	6.2	6.0	5.6	7.2	9.4	11.1	10.9	10.6	9.9	7.9
STAND. DEVIATION OF HOR. WIND DIRECTION WIND VANE (DEGREE)		100	6.1	7.0	2.5	2.3	3.6	3.4	18.0	16.3	13.2	10.9	7.3	13.2	6.0
TEMPERATURE GRADIENT (K/100M)		30/100	-0.1	0.3	0.7	0.9	0.8	0.9	0.7	0.1	-0.3	-0.4	-0.2	-0.2	-0.4
NET RADIATION		(MW/CM**2)	-0.7	-0.9	-1.5	-0.9	-1.0	-0.8	-0.7	-0.7	-0.6	-0.8	-0.9	-0.9	-1.1
DIFFUSION CATEGORY BASED ON ...	VER. FLUCTUATION				E			F			D			D	
	HOR. FLUCTUATION				F			D			C			D	
	TEMP. GRADIENT				E			E			D			D	
	SYNOP. OBSERV.				E			E			E			D	

Table 6/5: Meteorological data measured at KfK-site on March 25, 1985

TABLE 7/1: RESULTS OF EXPERIMENT NO. 77 DATE : 83- 4-27

PERIODS 1 TO 5 FROM 10.30 TO 13.00

TRACER: SF6 EMISSION RATE: 22.60 NG/S EMISSION HEIGHT 100 M

		POSITION R (M)	ALPHA (DEGREE)	TRACER CONCENTRATION IN NG/M**3 SAMPLING PERIOD 1	SAMPLING PERIOD 2	SAMPLING PERIOD 3	SAMPLING PERIOD 4	SAMPLING PERIOD 5
I	A	10600	18	≤ 11	≤ 11	≤ 11	≤ 11	≤ 11
	B	12000	37	-	≤ 11	44	≤ 11	45
	C	12200	45	-	51	220	≤ 11	≤ 11
	D	11800	49	-	784	392	179	167
	E	11900	54	718	772	748	712	695
	F	12000	62	60	380	327	-	801
	G	11500	70	2	2	68	178	20
	H	12200	79	≤ 11	≤ 11	-	-	-
	I	12100	91	≤ 11	≤ 11	≤ 11	4	≤ 11
II	A	22600	14	-	≤ 11	≤ 11	≤ 11	≤ 11
	B	24700	50	-	54	-	-	15
	C	24800	52	-	309	-	108	26
	D	26000	64	-	32	114	280	327
	E	24800	67	-	7	422	179	238
	F	25400	72	-	-	380	9	29
	G	24200	91	-	-	-	≤ 11	12
III	A	43200	51	-	-	-	9	-
	B	43000	55	-	-	-	131	36
	C	42600	59	-	-	-	315	238
	D	46200	65	-	-	-	102	191
	E	48200	72	-	-	-	-	48

TABLE 7/2: RESULTS OF EXPERIMENT NO. 77 DATE : 83- 4-27

PERIODS 6 TO 9 FROM 13.00 TO 15.00

TRACER: SF6 EMISSION RATE: 22.60 NG/S EMISSION HEIGHT 100 M

		POSITION		TRACER CONCENTRATION IN NG/M**3			
		R (M)	ALPHA (DEGREE)	SAMPLING PERIOD 6	SAMPLING PERIOD 7	SAMPLING PERIOD 8	SAMPLING PERIOD 9
I	A	10600	18	≤ 11	-	-	-
	B	12000	37	2	-	-	-
	C	12200	45	20	-	-	-
	D	11800	49	191	-	-	-
	E	11900	54	902	-	-	-
	F	12000	62	1849	-	-	-
	G	11500	70	37	-	-	-
	H	12200	79	4	-	-	-
	I	12100	91	≤ 11	-	-	-
II	A	22600	14	≤ 11	≤ 11	-	-
	B	24700	50	30	7	-	-
	C	24800	52	≤ 11	26	-	-
	D	26000	64	399	315	-	-
	E	24800	67	197	197	-	-
	F	25400	72	18	4	-	-
	G	24200	91	≤ 11	≤ 11	-	-
III	A	43200	51	4	9	16	25
	B	43000	55	8	13	7	66
	C	42600	59	72	60	143	167
	D	46200	65	309	238	-	179
	E	48200	72	2	11	10	16

TABLE 8/1: RESULTS OF EXPERIMENT NO. 78 DATE : 84- 3-29

PERIODS 1 TO 5 FROM 10.30 TO 13.00

TRACER: SF6 EMISSION RATE: 22.30 NG/S EMISSION HEIGHT 100 M

		POSITION		TRACER CONCENTRATION IN NG/M**3				
		R (M)	ALPHA (DEGREE)	SAMPLING PERIOD 1	SAMPLING PERIOD 2	SAMPLING PERIOD 3	SAMPLING PERIOD 4	SAMPLING PERIOD 5
I	A	11500	28	≤ 12	≤ 12	≤ 12	≤ 12	≤ 12
	B	12000	37	≤ 12	≤ 12	≤ 12	-	≤ 12
	C	12200	45	≤ 12	≤ 12	77	≤ 12	≤ 12
	D	11800	49	≤ 12	456	2579	148	-
	E	11800	49	-	456	2556	302	6
	F	11900	54	≤ 12	71	1150	391	136
	G	11900	54	-	77	1245	421	130
	H	12000	62	≤ 12	16	385	4406	2573
	I	12000	62	-	-	243	4412	2407
	K	11500	70	-	17	71	-	-
	L	11500	77	≤ 12	≤ 12	-	-	-
	M	12200	80	≤ 12	≤ 12	≤ 12	≤ 12	≤ 12
	N	12500	87	≤ 12	≤ 12	-	≤ 12	-
II	A	24700	50	-	≤ 12	154	65	9
	B	24800	52	-	≤ 12	-	510	39
	C	24100	59	-	7	59	694	332
	D	24100	59	-	3	47	682	397
	E	26000	64	-	≤ 12	53	71	-
	F	24800	67	-	≤ 12	≤ 12	23	332
	G	25400	72	-	≤ 12	≤ 12	13	14
	H	25900	75	-	≤ 12	≤ 12	5	3
	I	23400	81	-	≤ 12	≤ 12	≤ 12	37
	K	23100	87	-	≤ 12	≤ 12	≤ 12	≤ 12
	L	24200	91	-	≤ 12	≤ 12	≤ 12	≤ 12
III	A	45200	46	-	-	-	≤ 12	≤ 12
	B	43200	51	-	-	-	18	8
	C	43000	55	-	-	-	368	124
	D	42600	59	-	-	-	154	557
	E	46200	65	-	-	-	-	-
	F	46900	68	-	-	-	≤ 12	71
	G	48200	72	-	-	-	-	-
	H	47500	74	-	-	-	≤ 12	43
	I	45300	78	-	-	-	-	≤ 12
	K	46000	83	-	-	-	20	5
	L	46900	88	-	-	-	-	≤ 12
	M	47300	93	-	-	-	-	≤ 12

TABLE 8/2: RESULTS OF EXPERIMENT NO. 78 DATE : 84- 3-29

PERIODS 6 TO 10 FROM 13.00 TO 15.30

TRACER: SF6 EMISSION RATE: 22.30 NG/S EMISSION HEIGHT 100 M

		POSITION		TRACER CONCENTRATION IN NG/M**3				
		R (M)	ALPHA (DEGREE)	SAMPLING PERIOD 6	SAMPLING PERIOD 7	SAMPLING PERIOD 8	SAMPLING PERIOD 9	SAMPLING PERIOD10
I	A	11500	28	≤ 12	≤ 12	-	-	-
	B	12000	37	≤ 12	≤ 12	-	-	-
	C	12200	45	≤ 12	≤ 12	-	-	-
	D	11800	49	19	5	-	-	-
	E	11800	49	-	-	-	-	-
	F	11900	54	≤ 12	≤ 12	-	-	-
	G	11900	54	-	-	-	-	-
	H	12000	62	59	≤ 12	-	-	-
	I	12000	62	-	-	-	-	-
	K	11500	70	-	1304	-	-	-
	L	11500	77	-	-	-	-	-
	M	12200	80	6	379	-	-	-
	N	12500	87	≤ 12	≤ 12	-	-	-
II	A	24700	50	≤ 12	≤ 12	≤ 12	-	-
	B	24800	52	≤ 12	≤ 12	≤ 12	-	-
	C	24100	59	18	21	≤ 12	-	-
	D	24100	59	20	≤ 12	≤ 12	-	-
	E	26000	64	753	83	≤ 12	-	-
	F	24800	67	711	190	7	-	-
	G	25400	72	231	1370	249	-	-
	H	25900	75	142	617	1138	-	-
	I	23400	81	16	113	237	-	-
	K	23100	87	≤ 12	37	24	-	-
	L	24200	91	≤ 12	≤ 12	≤ 12	-	-
III	A	45200	46	≤ 12	≤ 12	≤ 12	≤ 12	≤ 12
	B	43200	51	-	≤ 12	≤ 12	≤ 12	≤ 12
	C	43000	55	3	≤ 12	6	12	3
	D	42600	59	172	38	≤ 12	≤ 12	≤ 12
	E	46200	65	539	196	46	3	≤ 12
	F	46900	68	-	-	-	-	-
	G	48200	72	95	-	-	95	34
	H	47500	74	21	172	445	172	-
	I	45300	78	-	-	142	808	581
	K	46000	83	5	11	27	77	569
	L	46900	88	3	16	172	24	89
	M	47300	93	≤ 12	≤ 12	-	-	18

TABLE 9 : RESULTS OF EXPERIMENT NO. 79

PERIODS 1 TO 6 23- 3-85 FROM 13.00 TO 16.00

TRACER: SF6 EMISSION RATE: 28.12 G/S

POSITION		R (M)	ALPHA (DEGREE)	TRACER CONCENTRATION IN NG/M**3 SAMPLING PERIOD 1	SAMPLING PERIOD 2	SAMPLING PERIOD 3	SAMPLING PERIOD 4	SAMPLING PERIOD 5	SAMPLING PERIOD 6
I	A	11200	15	2052	3252	1776	1644	138	2580
	B	10600	18	2682	3666	1896	1914	1032	1890
	C	12800	22	494	2970	1938	2166	1494	210
	D	10600	24	888	2586	2712	2412	2118	31
	E	11900	26	414	2814	2274	2232	1860	13
	F	13000	28	492	1650	1860	1944	1920	84
	G	13300	34	-	660	1416	810	1374	138
	H	14000	40	78	390	1260	144	312	96
	I	14000	46	18	12	336	240	63	23
	K	14000	49	14	13	17	75	33	≤ 12
	L	14800	54	40	≤ 12	≤ 12	28	31	43
	M	14800	56	15	≤ 12	≤ 12	≤ 12	≤ 12	≤ 12
II	A	34800	16	15	-	-	-	-	-
	B	34300	20	≤ 12	≤ 12	186	432	54	12
	C	33500	21	≤ 12	≤ 12	264	228	234	-
	D	33500	25	≤ 12	42	270	270	534	222
	E	33900	28	≤ 12	41	228	121	546	276
	F	34000	31	12	90	300	87	450	336
	G	33800	33	44	282	276	90	390	360
	H	34000	36	44	600	174	84	240	378
	I	34500	39	264	492	150	24	85	150
	K	33800	40	420	132	90	36	150	210
	L	34200	43	528	84	43	20	108	126
	M	35500	45	708	72	78	≤ 12	90	102
	N	35600	47	828	48	22	≤ 12	78	108
	O	34800	51	24	20	13	30	63	42
	P	35600	53	39	≤ 12	≤ 12	≤ 12	46	-
	Q	36700	56	12	22	≤ 12	≤ 12	38	-
	R	34400	58	≤ 12	≤ 12	≤ 12	≤ 12	25	15
	S	34700	61	≤ 12	≤ 12	≤ 12	≤ 12	≤ 12	18
III	A	64600	9	≤ 12	12	≤ 12	≤ 12	≤ 12	≤ 12
	B	65600	11	20	≤ 12	32	≤ 12	15	12
	C	66600	15	28	≤ 12	33	≤ 12	≤ 12	35
	D	62000	17	≤ 12	≤ 12	≤ 12	≤ 12	≤ 12	150
	E	60400	20	≤ 12	≤ 12	16	20	≤ 12	34
	F	59000	22	-	15	-	-	-	-
	G	60200	27	≤ 12	≤ 12	12	≤ 12	78	108
	H	58200	31	12	23	≤ 12	-	96	60
	I	56400	32	-	12	12	114	144	66
	K	53000	33	13	34	54	120	140	81
	L	52800	37	≤ 12	≤ 12	150	-	84	96
	M	55800	39	≤ 12	≤ 12	210	174	66	66
	N	55600	44	15	186	144	96	24	43
	O	53600	47	312	174	15	30	31	132
	P	53600	50	378	20	≤ 12	33	22	54
	Q	53800	53	492	23	31	15	24	30
	R	55000	57	294	≤ 12	≤ 12	≤ 12	≤ 12	216
	S	56200	61	42	≤ 12	≤ 12	≤ 12	15	≤ 12

TABLE 10 : RESULTS OF EXPERIMENT NO. 80

PERIODS 1 TO 5 25- 3-85 FROM 13.00 TO 15.30

TRACER: SF6 EMISSION RATE: 28.51 G/S

POSITION		R (M)	ALPHA (DEGREE)	TRACER CONCENTRATION IN NG/M**3 SAMPLING PERIOD 1	SAMPLING PERIOD 2	SAMPLING PERIOD 3	SAMPLING PERIOD 4	SAMPLING PERIOD 5
I	A	11200	10	198	48	24	60	1824
	B	11200	15	22	≤ 12	14	630	2280
	C	10600	18	≤ 12	-	132	774	2118
	D	12800	22	-	≤ 12	≤ 12	636	1038
	E	11900	26	46	≤ 12	330	1122	1068
	F	13000	28	72	≤ 12	192	1404	1002
	G	13300	34	594	222	438	1752	318
	H	14000	40	1086	552	852	594	114
	I	14000	46	738	1398	762	516	300
	K	14000	49	564	1560	930	438	54
	L	14800	54	126	630	1008	438	20
	M	14800	56	≤ 12	45	39	978	606
	N	14000	58	192	12	26	12	21
	O	13900	65	29	29	150	12	72
II	A	33700	6	54	≤ 12	144	18	24
	B	34800	16	≤ 12	≤ 12	≤ 12	≤ 12	45
	C	34300	20	102	126	72	≤ 12	96
	D	33500	21	84	126	24	85	192
	E	33500	25	29	70	89	33	240
	F	33900	28	120	114	162	108	246
	G	34000	31	229	180	211	180	324
	H	33800	33	264	330	126	240	180
	I	34000	36	232	426	162	498	174
	K	34500	39	396	336	444	496	84
	L	33800	40	492	372	498	285	29
	M	34200	43	390	318	396	192	60
	N	35500	45	396	210	-	59	59
	O	35600	47	200	93	111	110	13
	P	34800	49	150	39	167	53	12
	Q	34800	51	144	17	19	48	18
	R	35600	53	192	12	26	12	21
	S	36700	56	54	29	150	12	72
III	A	64600	9	≤ 12	≤ 12	22	28	≤ 12
	B	65600	11	35	29	93	101	54
	C	66600	15	44	≤ 12	≤ 12	≤ 12	≤ 12
	D	62000	17	-	-	18	37	108
	E	60400	20	14	50	42	53	119
	F	59000	22	43	84	249	93	240
	G	60200	27	100	82	45	82	480
	H	58200	31	69	50	27	270	246
	I	56400	32	≤ 12	69	-	-	-
	K	53000	33	62	85	124	246	198
	L	52800	37	84	186	240	408	288
	M	55800	39	93	234	270	234	66
	N	55600	44	144	228	186	192	43
	O	53600	47	252	101	216	240	90
	P	53600	50	78	97	138	77	60
	Q	53800	53	62	≤ 12	114	12	72
	R	55000	57	138	-	144	12	162
	S	56200	61	≤ 12	26	12	29	72

Tetroon	Launch		Data averaged over tracked distance			Tracked up to	
	Date	Time	Height	Speed	Direction		
MI8307	27.4.83	7:15	200 m	9.3 m/s	41°	52 km	1 h 33 min
MI8308	27.4.83	9:10	400 m	9.4 m/s	42°	56 km	1 h 40 min
MI8310	27.4.83	12:03	300 m	6.1 m/s	63°	51 km	2 h 23 min
MI8401	29.3.84	8:00	300 m	12.1 m/s	48°	78 km	1 h 50 min
MI8402	29.3.84	10:10	600 m	14.6 m/s	61°	23 km	0 h 26 min
MI8403	29.3.84	11:00	400 m	12.8 m/s	66°	46 km	1 h 04 min
MI8405	29.3.84	13:30	350 m	8.3 m/s	80°	53 km	1 h 34 min
TU8504	23.3.85	9:26	1100 m	12.9 m/s	51°	51 km	1 h 07 min
TU8505	23.3.85	12:00	700 m	10.4 m/s	54°	71 km	1 h 55 min
TU8506	23.3.85	14:03	750 m	8.9 m/s	47°	98 km	3 h 07 min
TU8507	23.3.85	17:43	450 m	9.5 m/s	29°	84 km	2 h 27 min
TU8508	25.3.85	8:51	1600 m	11.0 m/s	59°	111 km	2 h 51 min
TU8509	25.3.85	11:49	600 m	6.9 m/s	12°	111 km	4 h 53 min
TU8510	25.3.85	17:05	550 m	6.8 m/s	29°	87 km	3 h 40 min

Table 11: General information about tetroon flights

Downwind distance	27.04.1983		29.03.1984		Downwind distance	23.03.1985		25.03.1985		
	α	R	α	R		α	R	α	R	$\bar{\alpha}$
12 km	uncorrelated		0.61	0.943	13 km	0.25	0.968	0.53	0.969	0.46
25 km	0.18	0.989	0.70	0.997	35 km	0.42	0.990	0.14	0.961	0.36
45 km	0.11	0.985	0.51	0.973	60 km	0.64	0.969	0.23	0.957	0.37
$\bar{\alpha}$	0.15		0.61			0.44		0.30		0.39

Table 12: Linear regression of the increase of σ_y with sampling time τ
$\sigma_y(\tau)/\sigma_y(\tau_1) = (\tau/\tau_1)^{\alpha}$, $\tau_1 = 0.5$ h

Downwind distance	27.04.1983		29.03.1984		Downwind distance	23.03.1985		25.03.1985		
	β	R	β	R		β	R	β	R	$\bar{\beta}$
12 km	0.18	0.962	0.38	0.999	13 km	0.14	0.944	0.41	0.978	0.28
25 km	0.34	0.970	0.71	0.999	35 km	0.39	0.985	0.10	0.942	0.38
45 km	0.42	0.968	0.32	0.956	60 km	0.48	0.980	0.13	0.956	0.34
$\bar{\beta}$	0.31		0.47			0.33		0.21		0.33

Table 13: Linear regression of the decrease of maximum concentration $\hat{C}$ with sampling time τ

$$\hat{C}(\tau)/\hat{C}(\tau_1) = (\tau/\tau_1)^{-\beta}, \quad \tau_1 = 0.5 \text{ h}$$

Date	Stability class	Sampling time	Dependence on distance[1]			Dependence on time[2]		
			Total distance	σ_o	p	Total time	σ_o	p
27.04.1983	C/D	5.0 h	55 km	0.501	0.924	2 h 3 min	3.903	0.896
29.03.1984	D	5.5 h	70 km	0.669	0.910	1 h 46 min	4.693	0.927
23.03.1985	D	5.7 h	91 km	0.145	1.040	3 h 6 min	1.238	1.058
25.03.1985	C	5.3 h	110 km	0.020	1.307	4 h 34 min	0.033	1.353

1) $\sigma_y = \sigma_o x^p$ (σ_y and x in m)

2) $\sigma_y = \sigma_o t^p$ (σ_y in m, t in s)

Table 14: Horizontal dispersion parameter σ_y based on tetroon trajectories

Flight number	Time considered (CET)	Stability class	Vertical speed (m/s) upwards Medium	Vertical speed (m/s) upwards Maximum	Vertical speed (m/s) downwards Medium	Vertical speed (m/s) downwards Maximum	Oscillation periods* (min) t_x	Oscillation periods* (min) t_y	Oscillation periods* (min) t_z	Wave length* l_x(km)	Wave length* l_z(w)	Turbulence intensities i_u	Turbulence intensities i_v	Turbulence intensities i_w
MI8307	7:36 - 8:36	C	0.68	2.78	- 0.44	- 1.56	30.0 7.5	30.0 10.0 3.3	20.0 9.2 3.2	16.7 4.2	672 309	0.152	0.097	0.079
MI8308	9:25 - 10:25	C	0.45	2.15	- 0.50	- 2.01	30.0 20.0 5.5	12.0 6.0	7.5 3.0	16.9 11.3 3.1	418 86	0.110	0.073	0.067
MI8310	12:14 - 14:14	B	0.72	2.31	- 0.69	- 2.64	24.0 15.0	60.0 17.1 7.5	20.0 13.3 3.2	8.8 5.4	559 134	0.169	0.171	0.165
MI8401	8:08 - 9:38	D	0.43	1.98	- 0.51	- 2.04	45.0 11.3	22.5 11.3	12.9	32.7 8.2	364	0.110	0.091	0.052
MI8403	11:05 - 12:05	D	0.53	1.84	- 0.69	- 2.13	30.0 15.0	30.0 7.5	8.5	23.0 11.5	311	0.073	0.101	0.062
MI8405	13:35 - 15:05	C/D	0.58	1.77	- 0.56	- 2.17	45.0 4.5	45.0 7.5 4.5	22.5 7.8 3.8	22.4 2.2	770 267 130	0.167	0.111	0.083
TU8505	12:12 - 13:42	C	0.58	2.33	- 0.50	- 2.03	22.5 10.0	45.0	15.0	6.2	486	0.104	0.095	0.067
TU8506	14:18 - 17:48	C/D	0.44	2.21	- 0.55	- 2.14	105.0 30.0	35.0 13.1	35.0 15.0	56.1 1.8	1040 446	0.144	0.082	0.074
TU8507	17:52 - 19:52	E	0.27	1.43	- 0.39	- 1.28	60.0	20.0	7.1	34.6	141	0.081	0.060	0.045
TU8509	11:58 - 15:58	B	0.53	2.56	- 0.76	- 2.30	40.0 15.0 7.7	120.0 7.7	21.8 12.0	16.6 6.2 3.2	850 468	0.386	0.394	0.136
TU8510	17:17 - 20:17	C→D→E	0.31	2.03	- 0.50	- 2.04	90.0 36.0 13.8	99.0 36.0 16.4	20.0	36.7 14.7 5.6	490	o.343	0.257	0.086

* the maximum is underlined

Table 15: Results of the evaluation of the individual tetroon trajectories

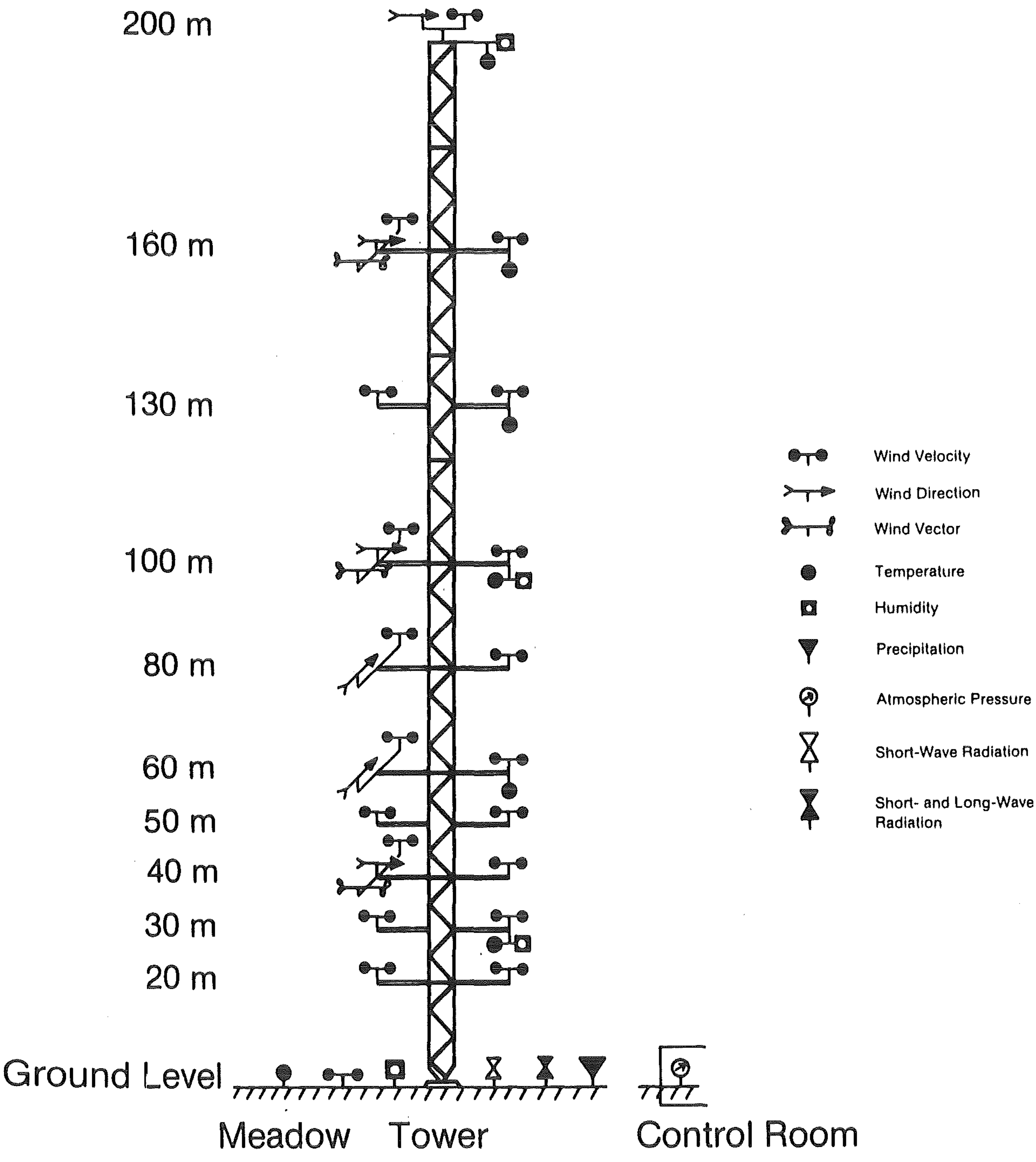


Fig. 1 - Meteorological tower at KfK - Karlsruhe.

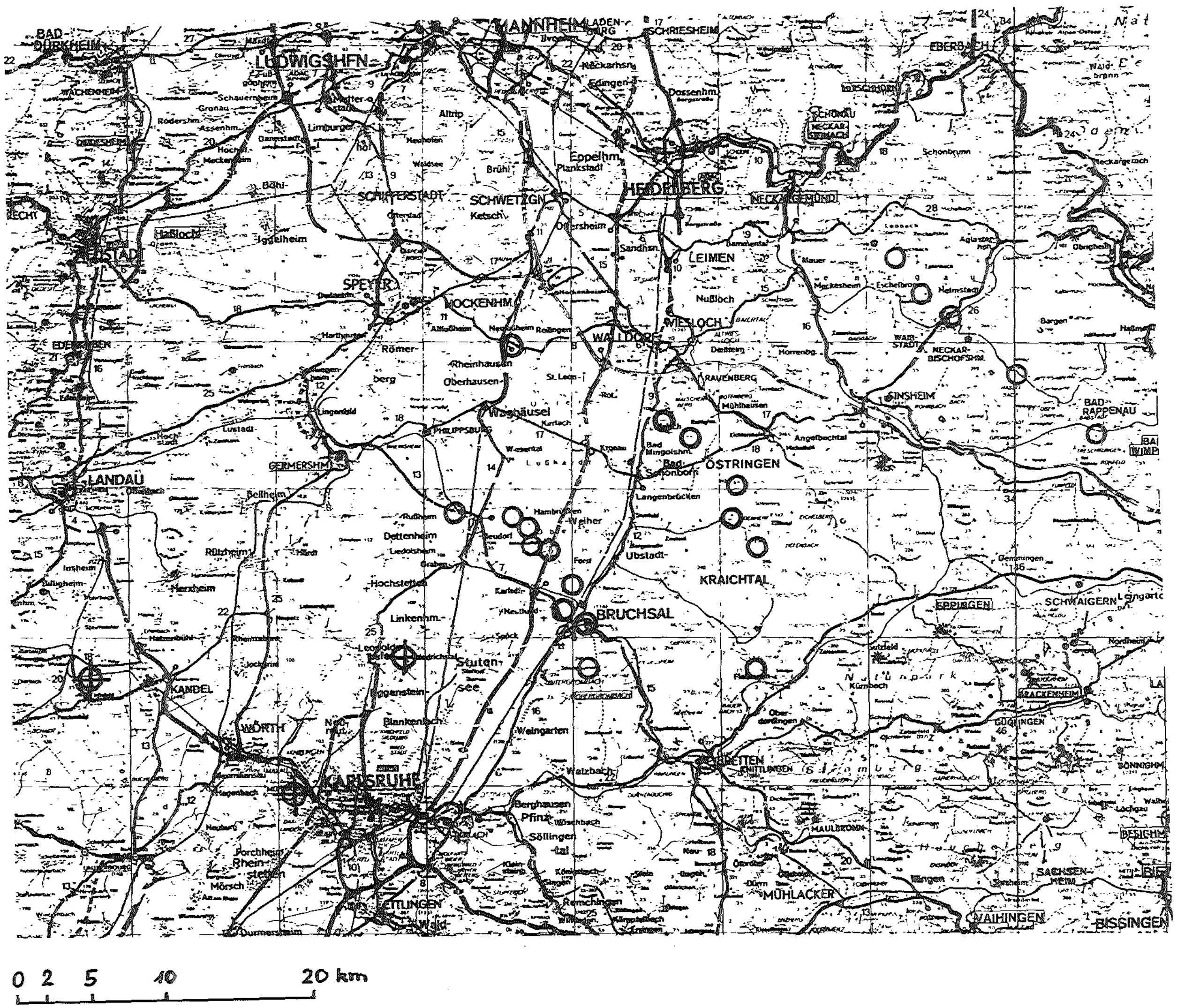


Fig. 2 - Map of the experimental area

-⌖- Radar and source of tracer

o Samplers for the tracer

Fig. 3: Automatic air sampler

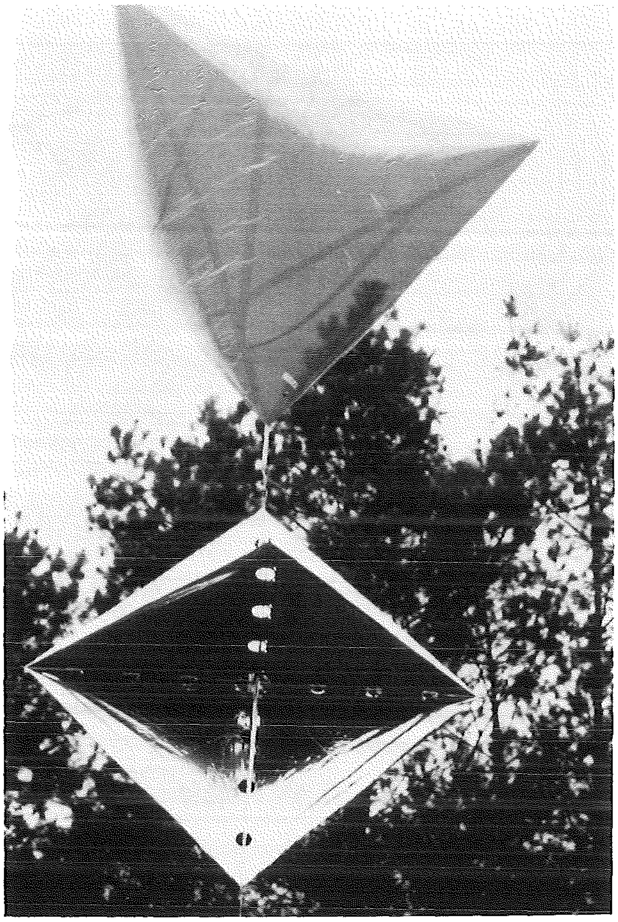


Fig. 4: Tetroon with a corner reflector

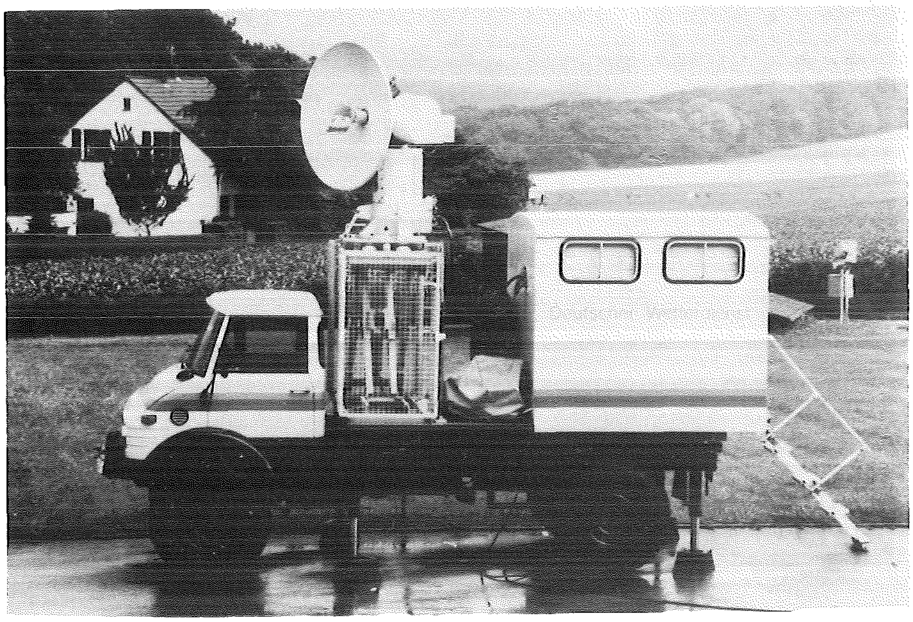


Fig. 5: Mobile radar WF 100-4

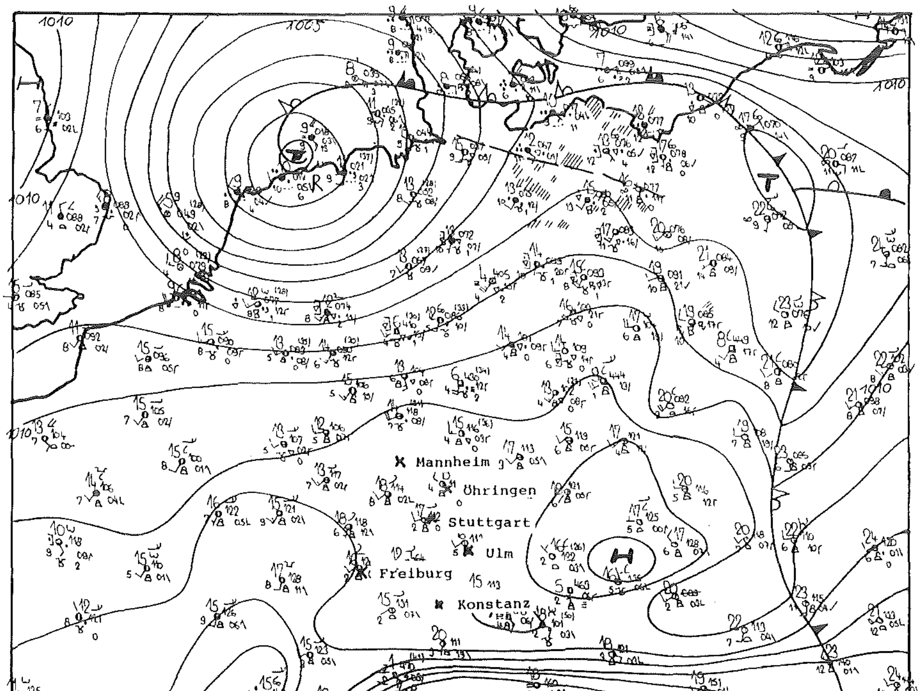


Fig. 6: Surface weather map on April 27, 1983, 13:00 CET

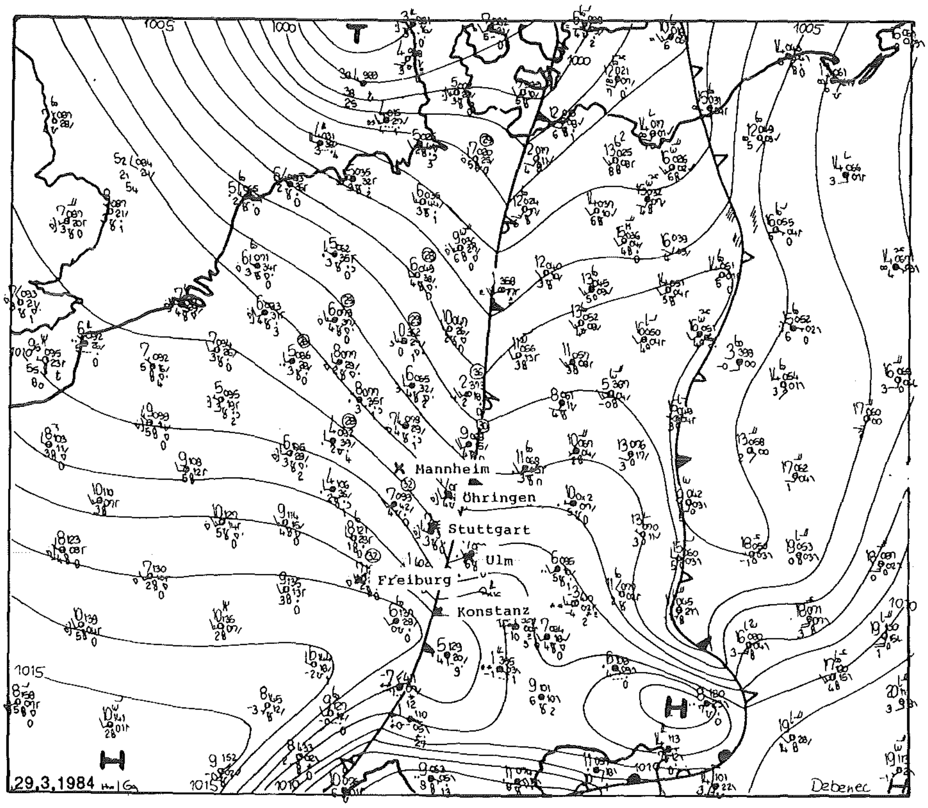


Fig. 7: Surface weather map on March 29, 1984, 13:00 CET

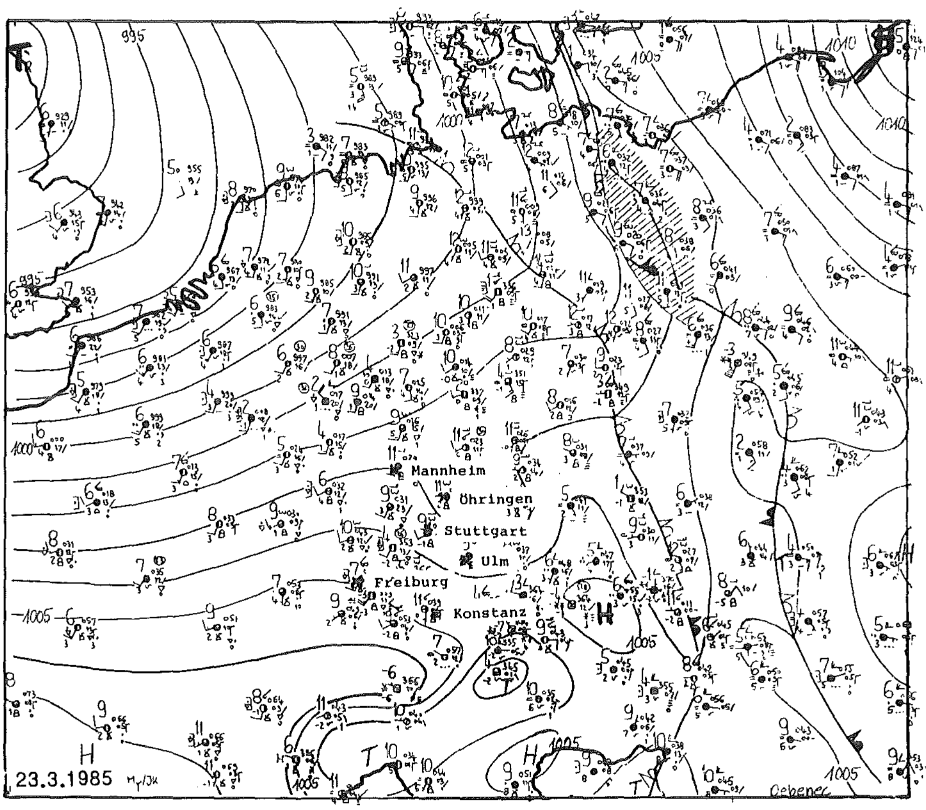


Fig. 8: Surface weather map on March 23, 1985, 13:00 CET

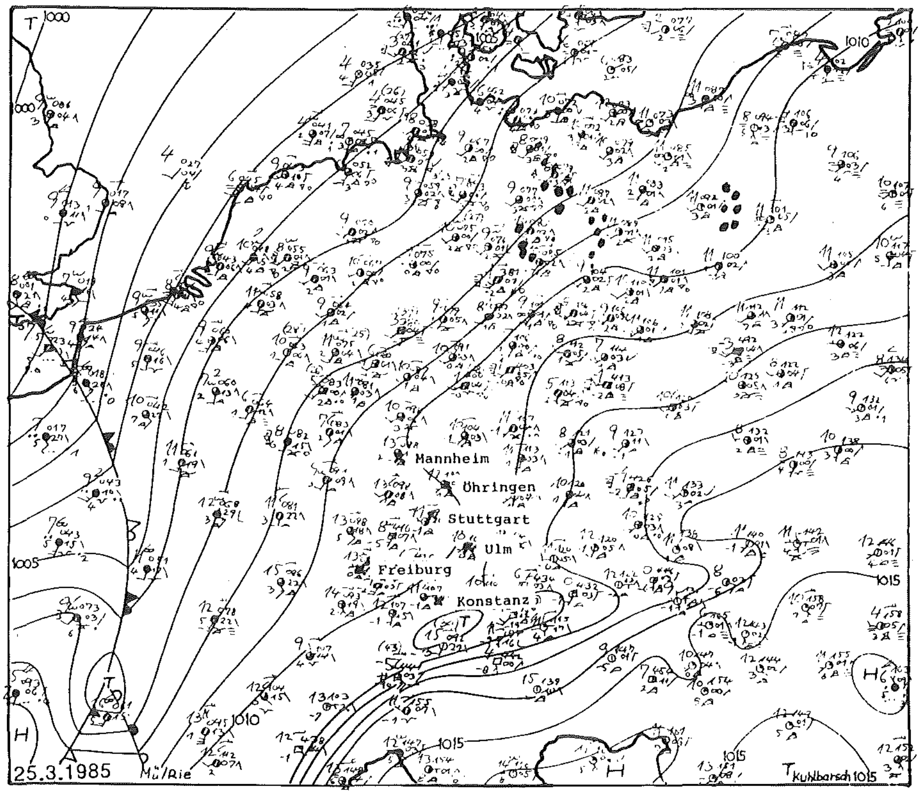


Fig. 9: Surface weather map on March 25, 1985, 13:00 CET

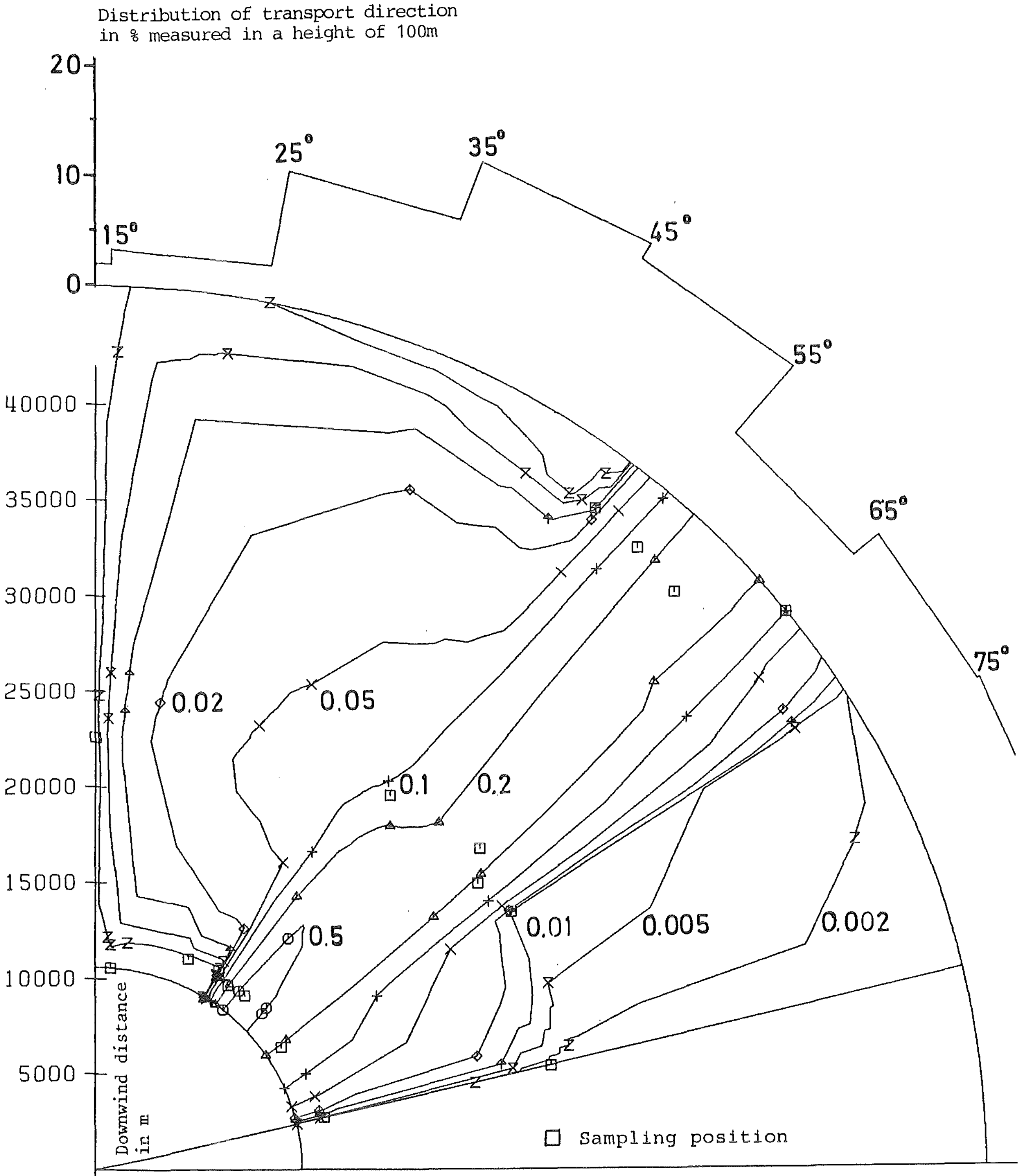


FIG. 10: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON APRIL 27, 1983, 4TH PERIOD

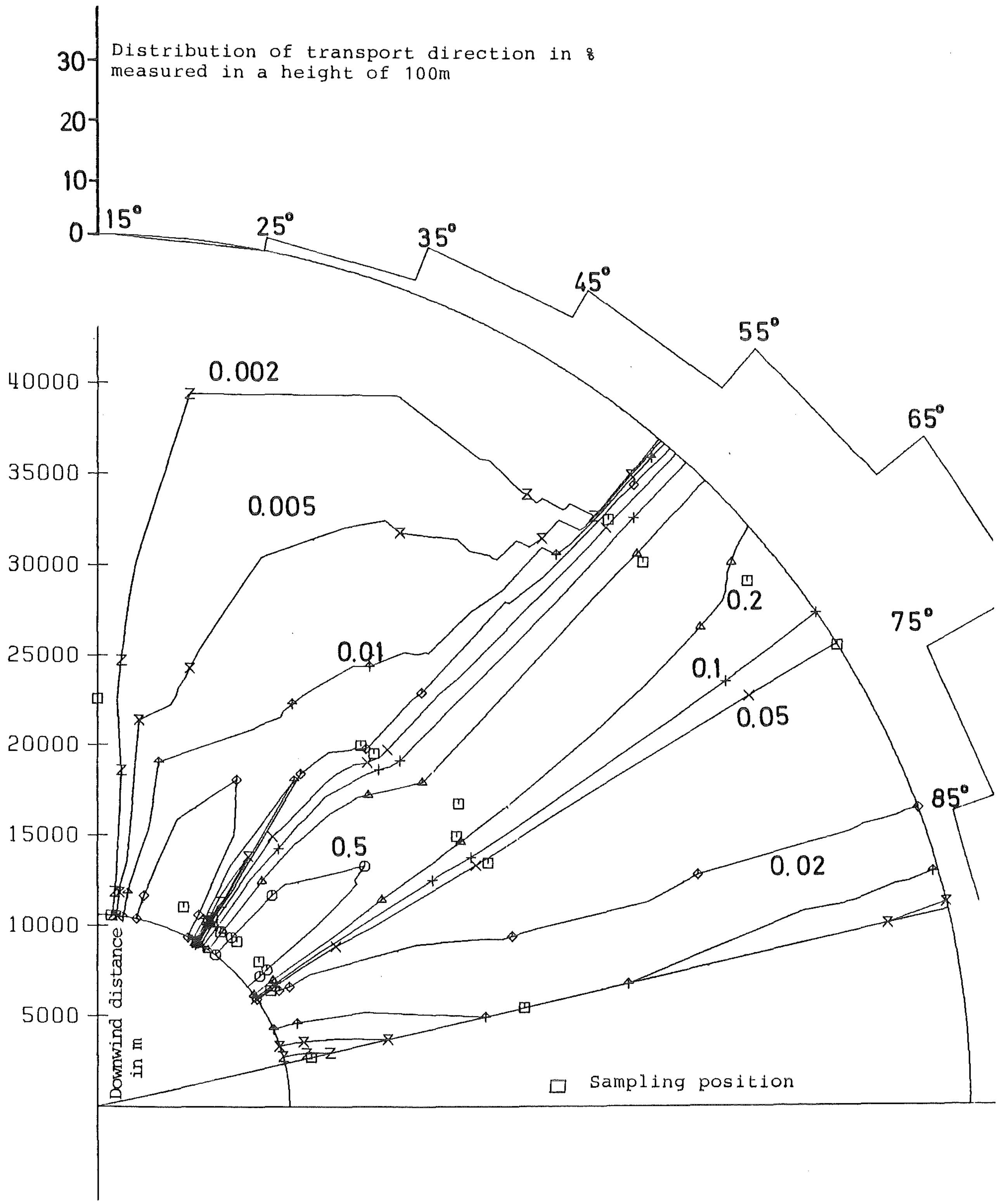


FIG. 11: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON APRIL 27, 1983, 5TH PERIOD

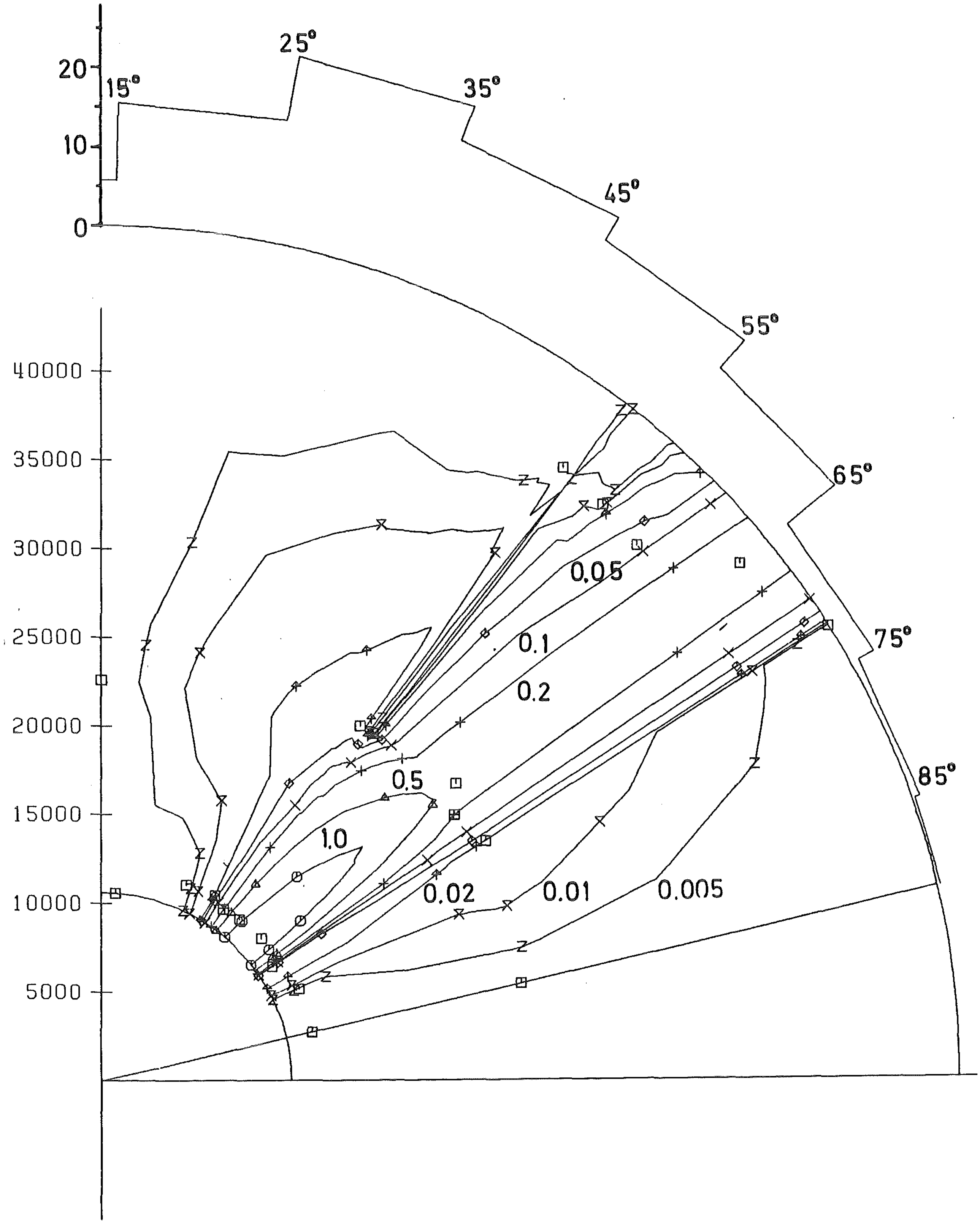


FIG. 12: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON APRIL 27, 1983, 6TH PERIOD
FOR DETAILED INFORMATION SEE FIG. 11

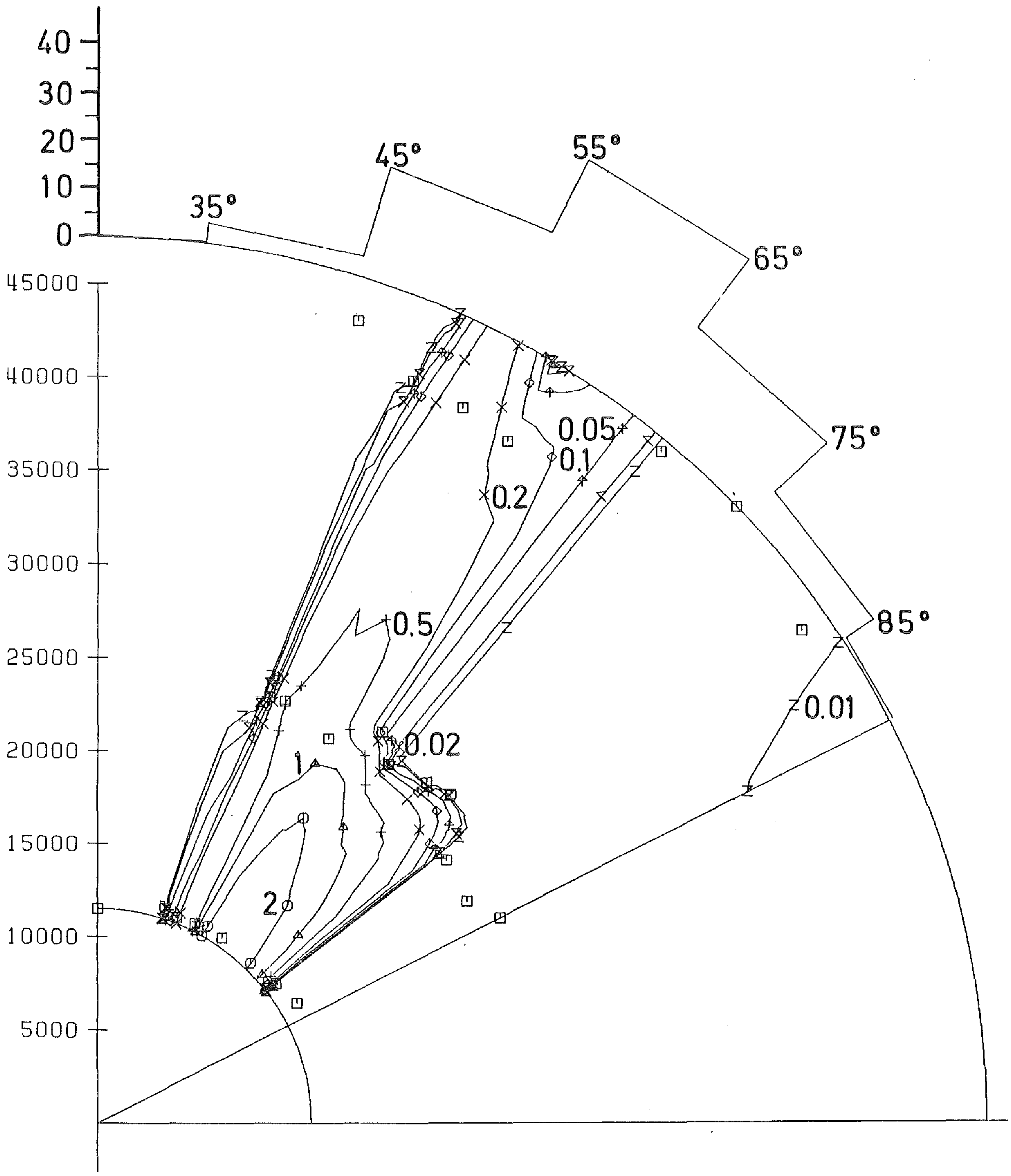


FIG. 13: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 29, 1984, 4TH PERIOD
FOR DETAILED INFORMATION SEE FIG. 11

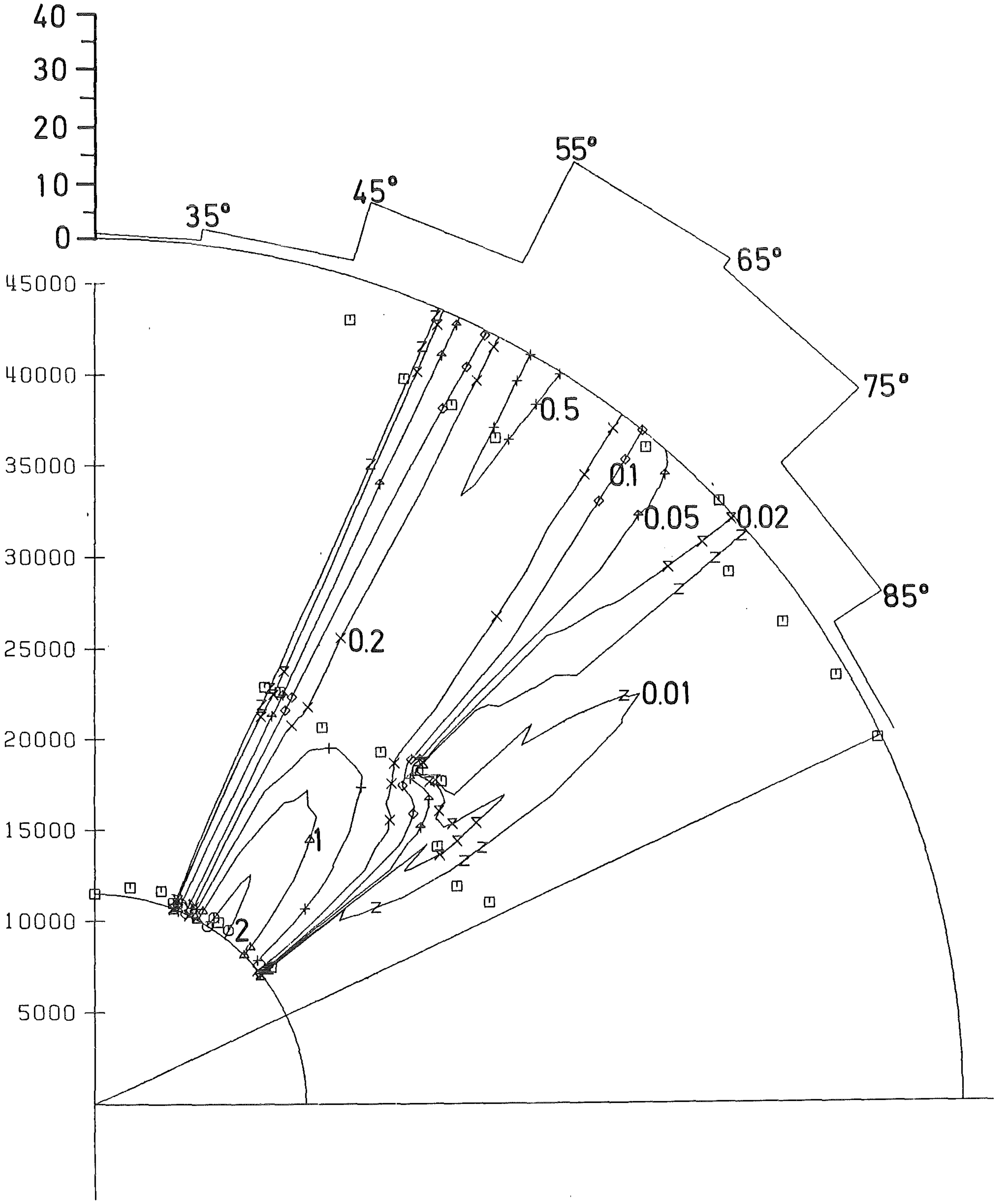


FIG. 14: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 29, 1984, 5TH PERIOD
FOR DETAILED INFORMATION SEE FIG.11

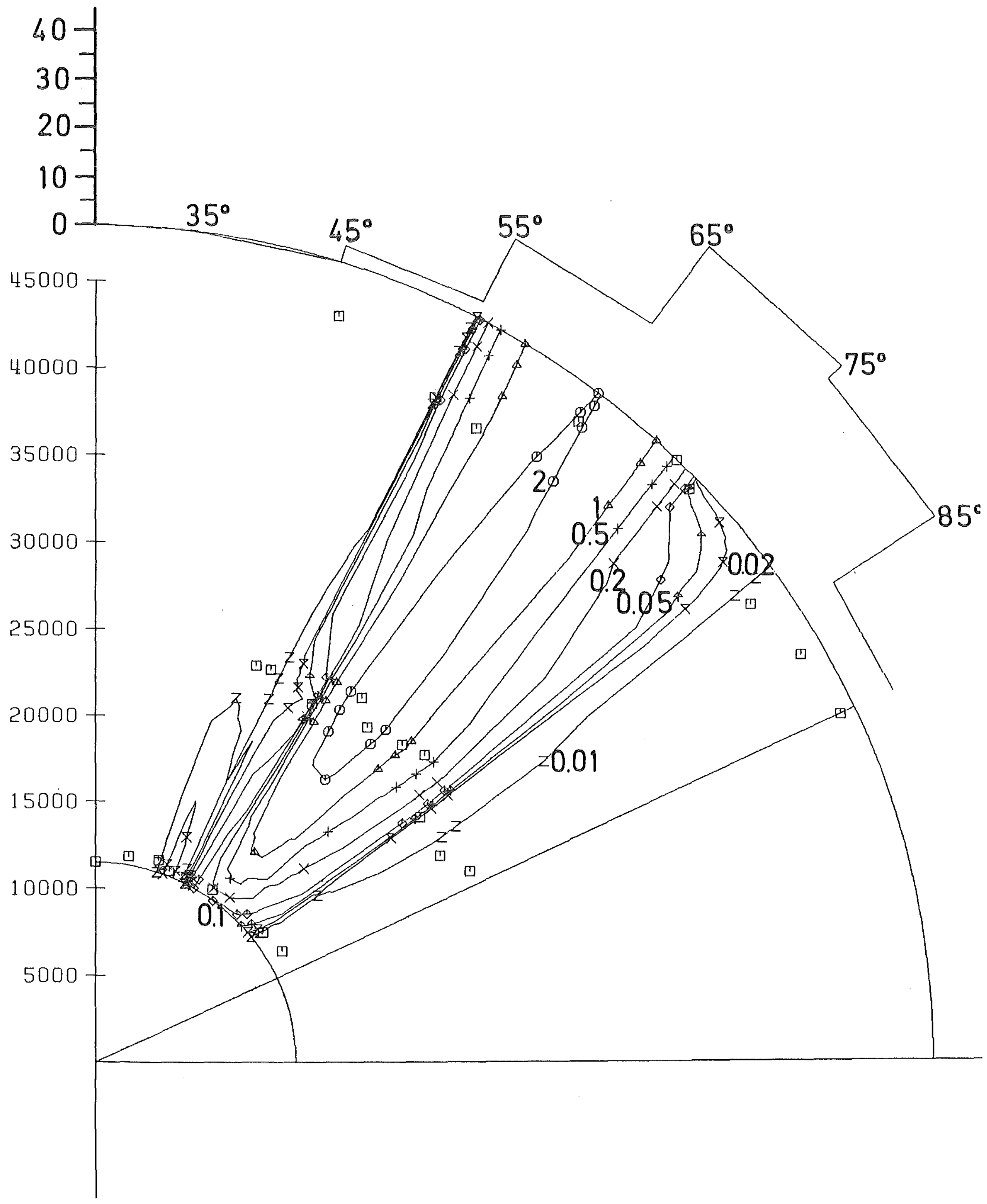


FIG. 15: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 29, 1984, 6TH PERIOD
FOR DETAILED INFORMATION SEE FIG. 11

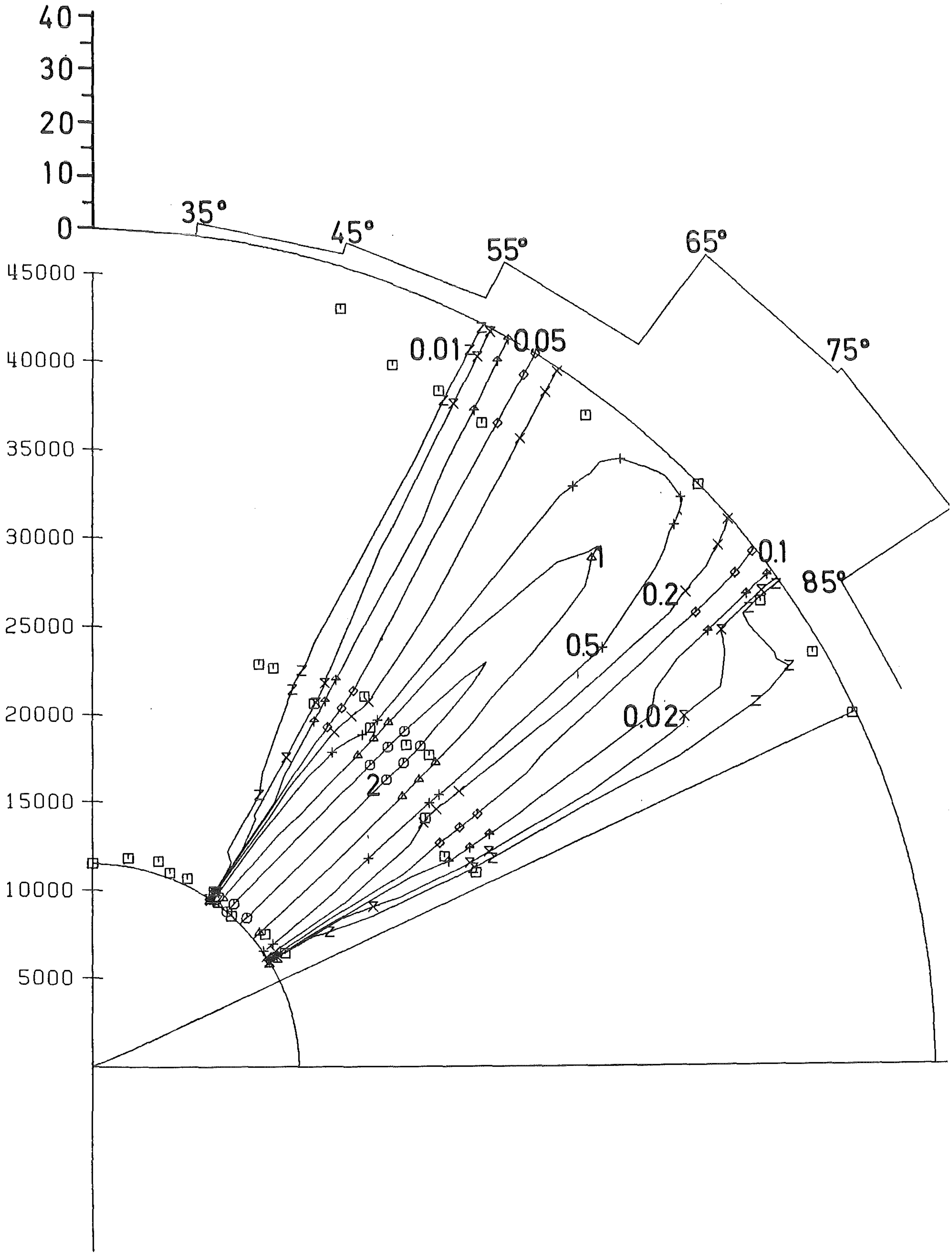


FIG. 16: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 29, 1984, 7TH PERIOD
FOR DETAILED INFORMATION SEE FIG. 11

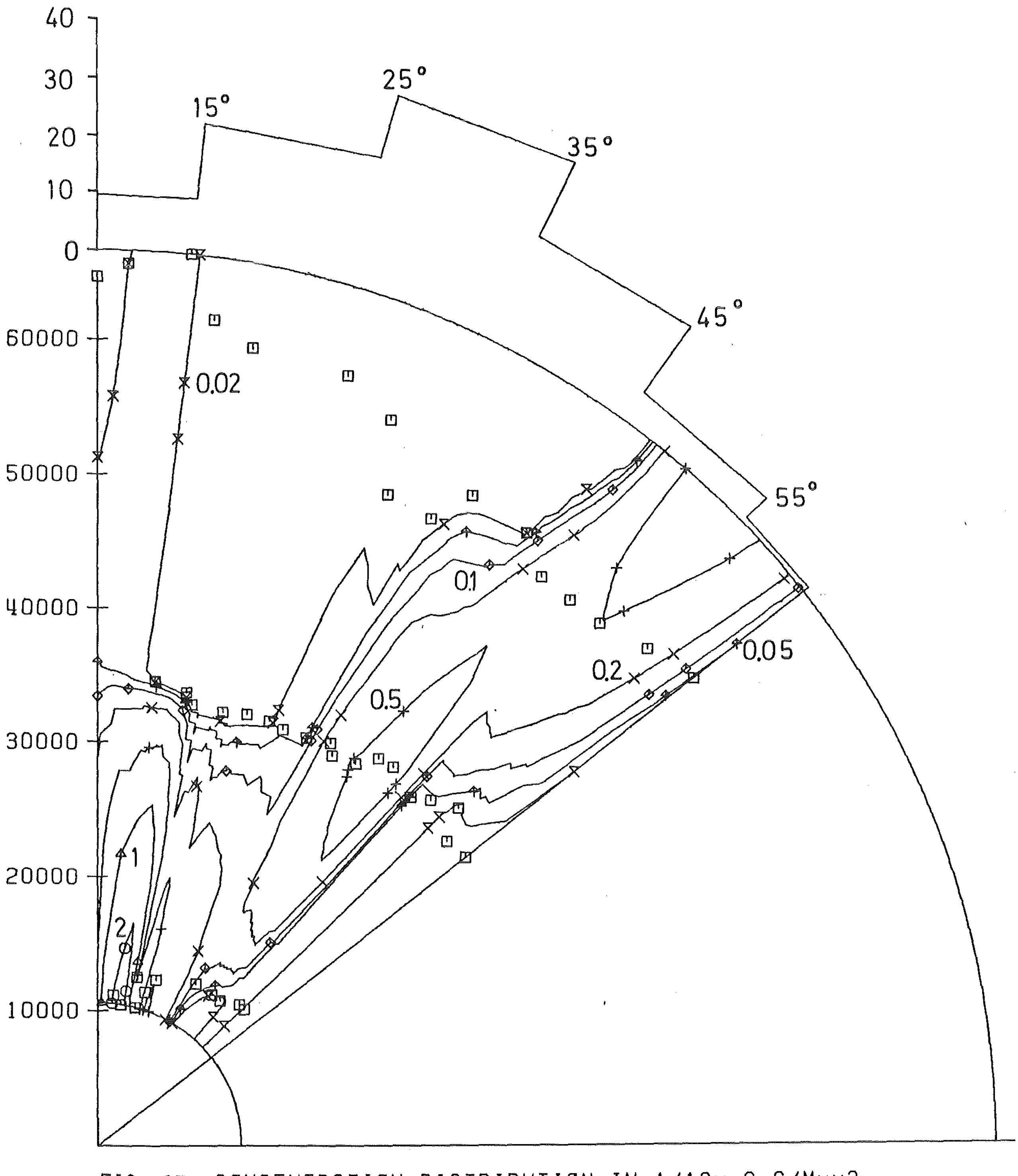


FIG. 17: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 23, 1985, 1ST PERIOD
FOR DETAILED INFORMATION SEE FIGURE 11

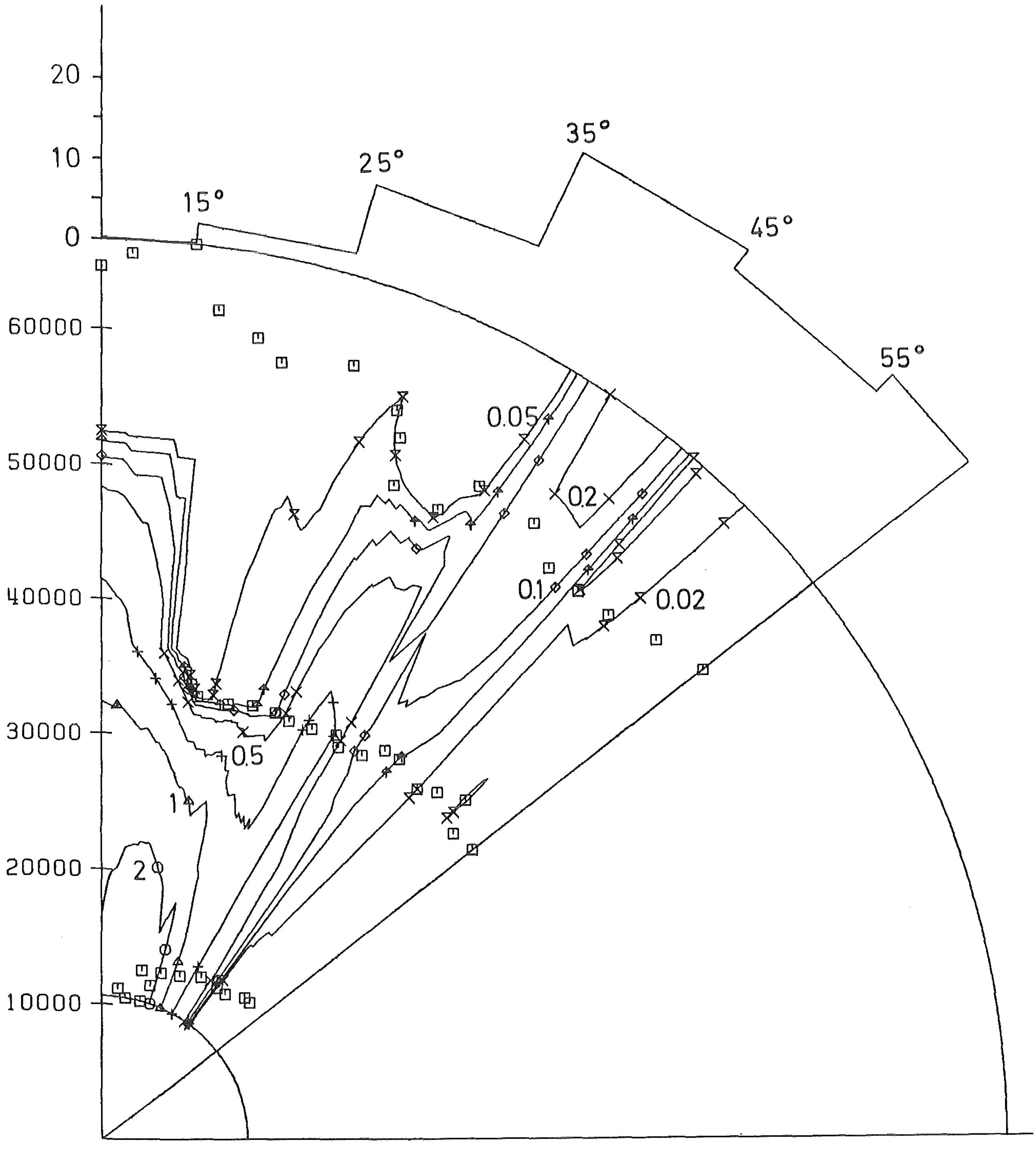


FIG. 18: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 23, 1985, 2ND PERIOD
FOR DETAILED INFORMATION SEE FIGURE 11

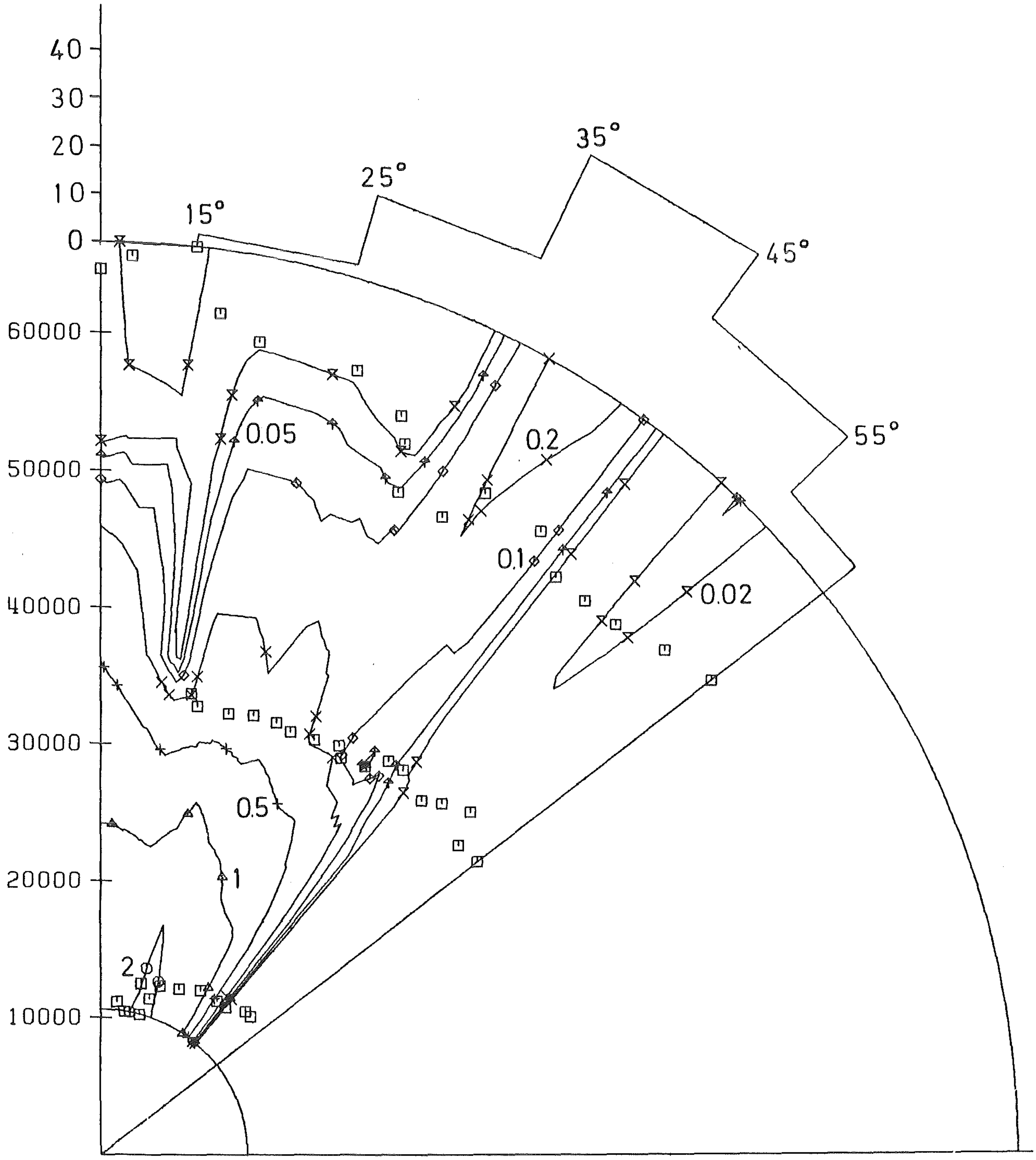


FIG. 19: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 23, 1985, 3RD PERIOD
FOR DETAILED INFORMATION SEE FIGURE 11

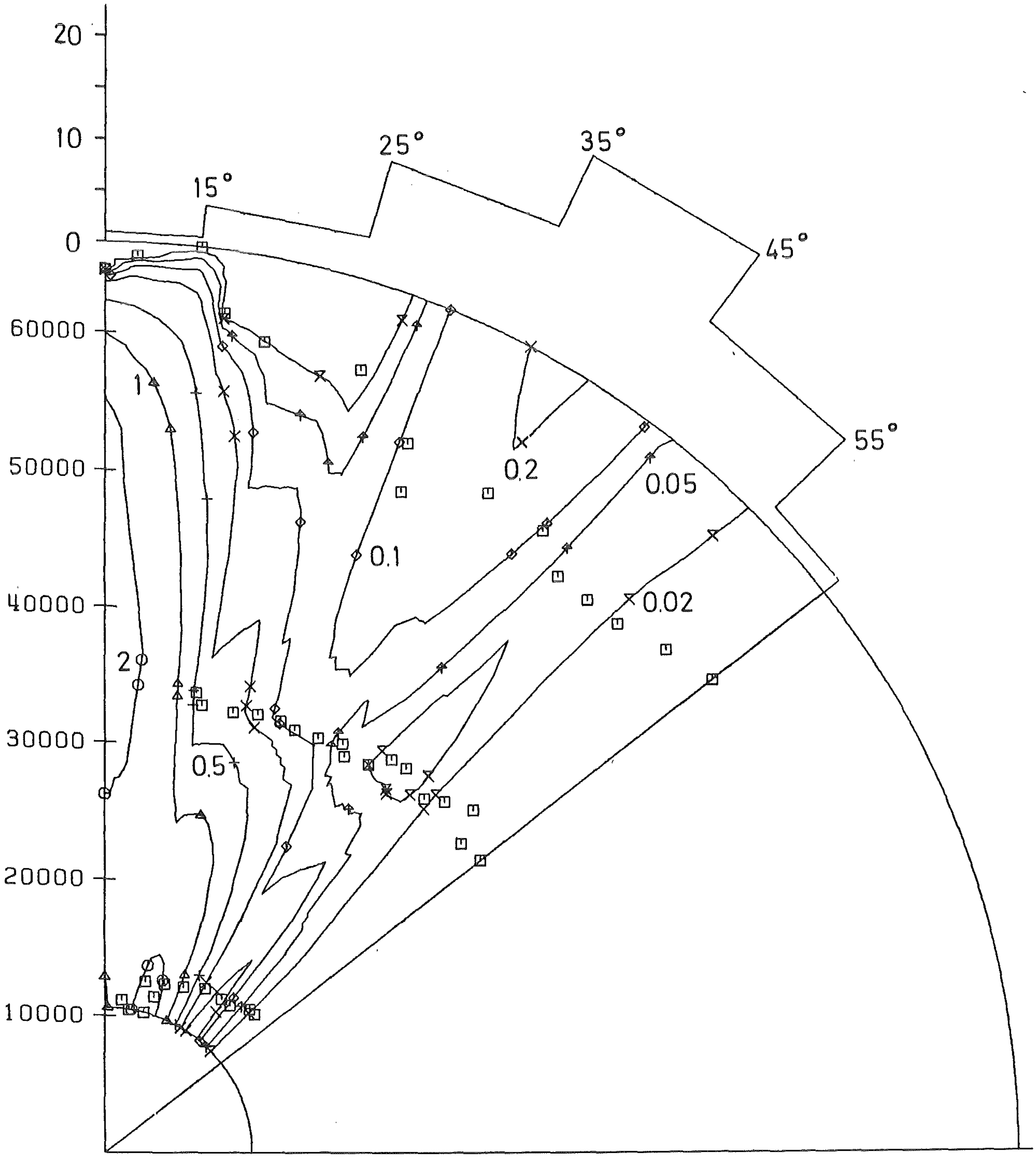


FIG. 20: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 23, 1985, 4TH PERIOD
FOR DETAILED INFORMATION SEE FIGURE 11

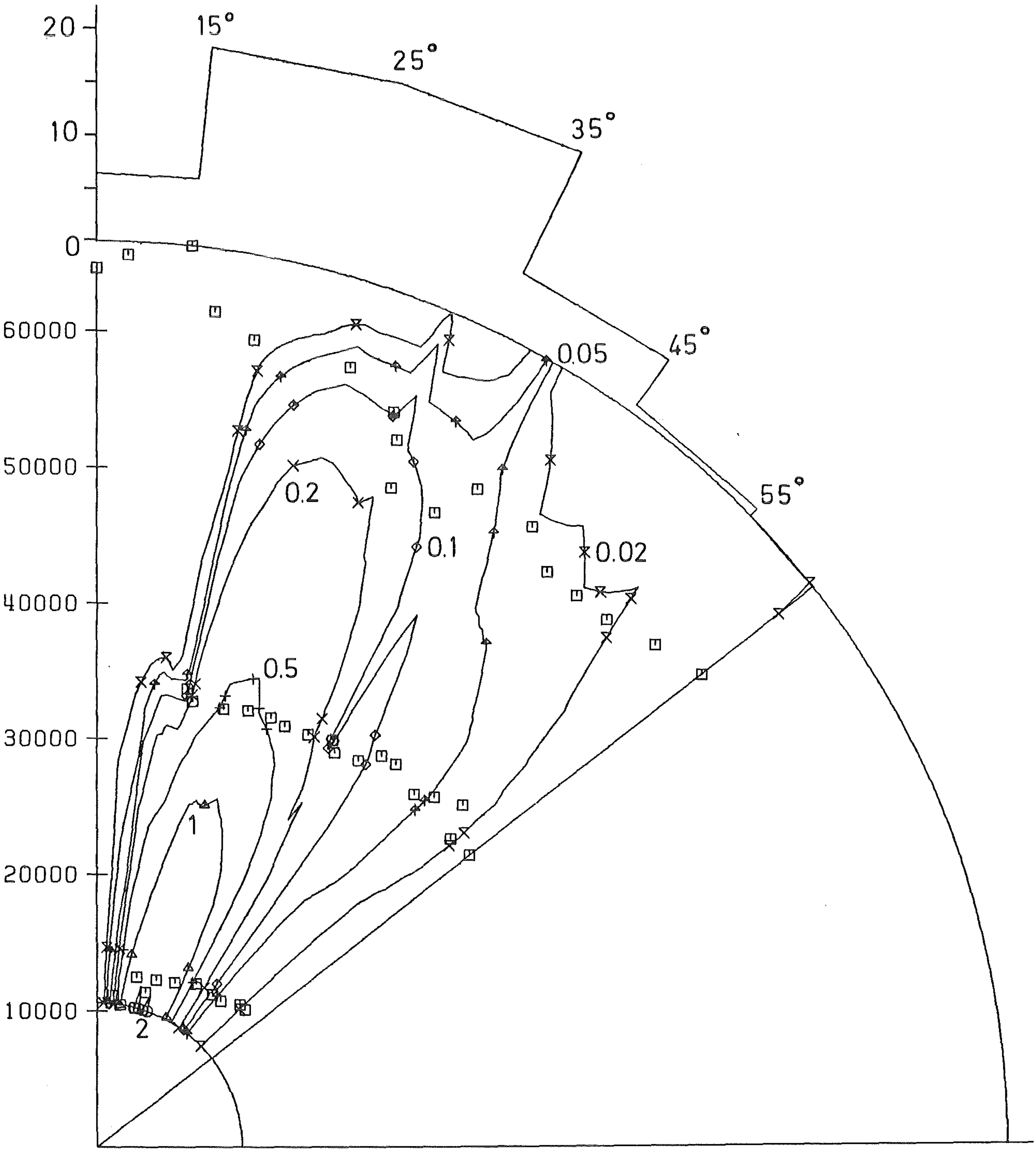


FIG. 21: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 23, 1985, 5TH PERIOD
FOR DETAILED INFORMATION SEE FIGURE 11

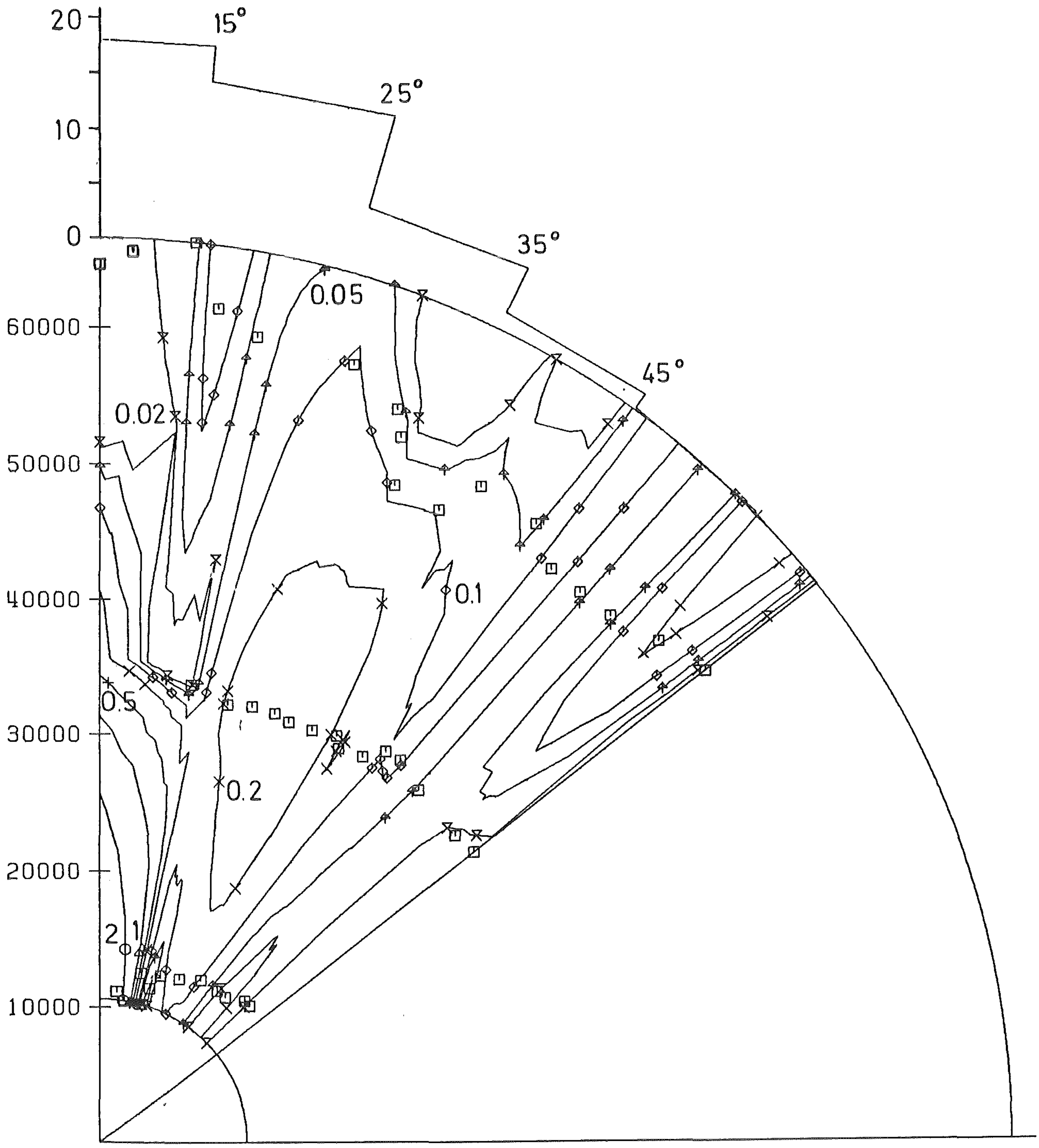


FIG. 22: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 23, 1985, 6TH PERIOD
FOR DETAILED INFORMATION SEE FIGURE 11

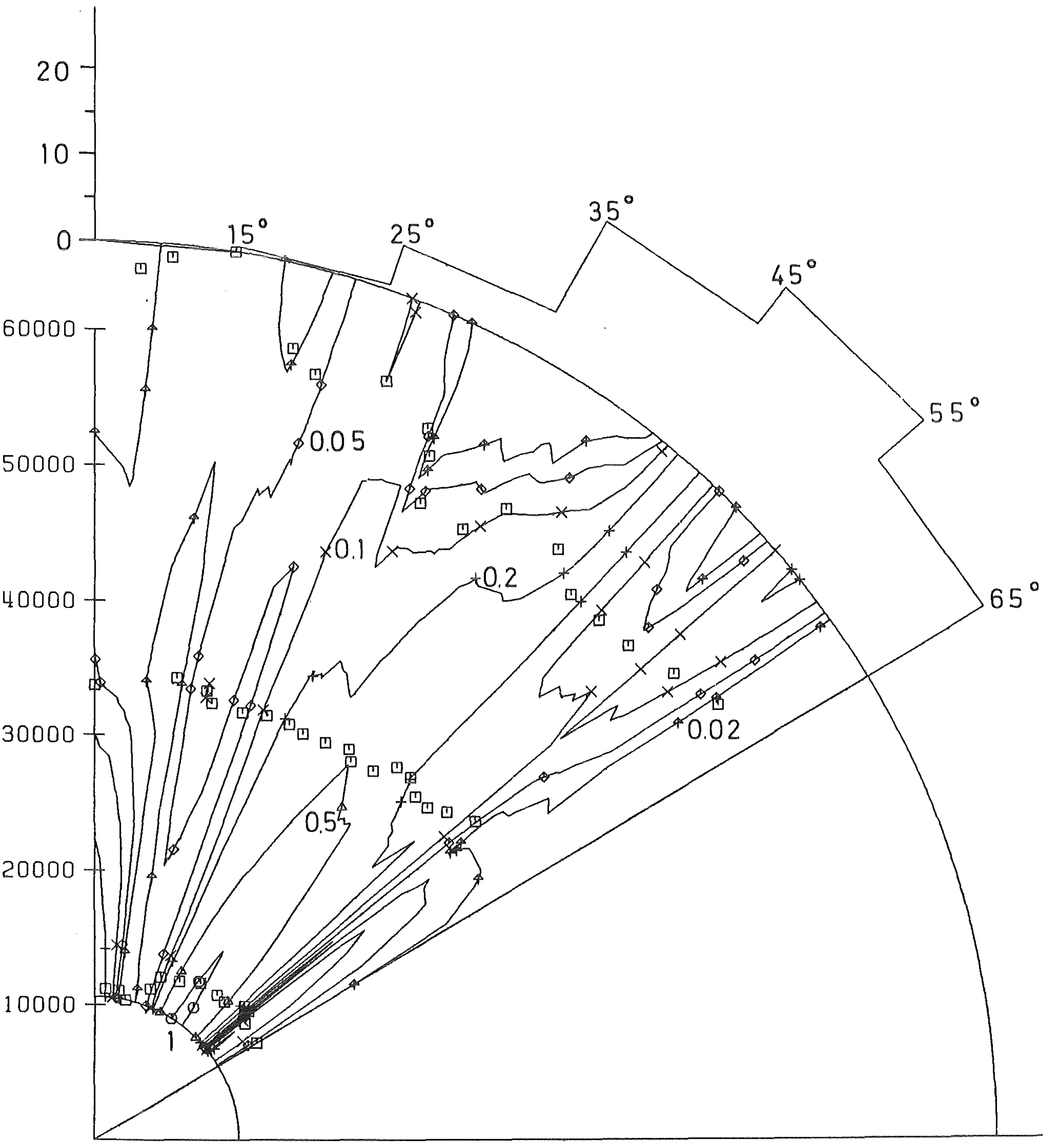


FIG. 23: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 25, 1985, 1ST PERIOD
FOR DETAILED INFORMATION SEE FIGURE 11

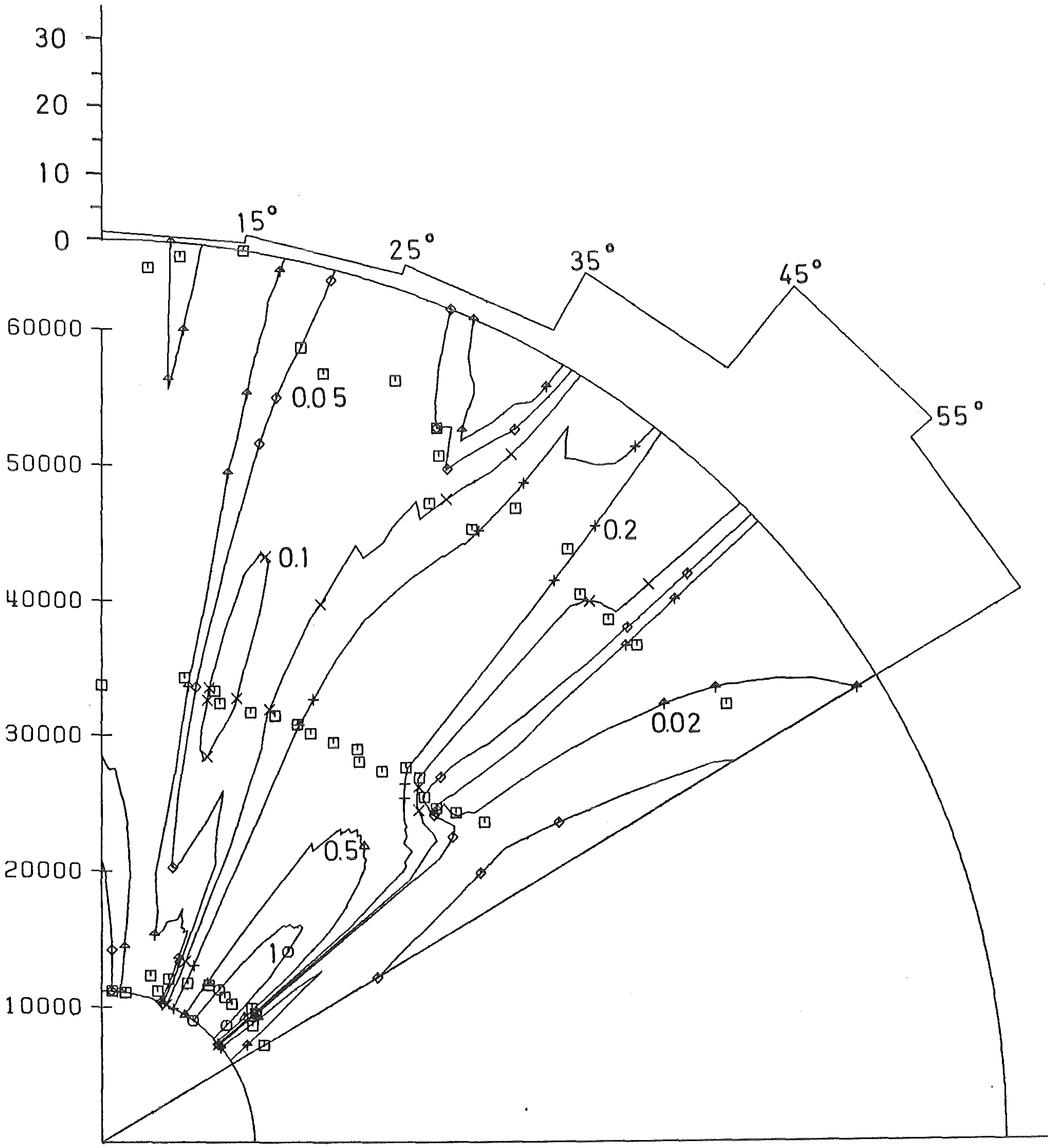


FIG. 24: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 25, 1985, 2ND PERIOD
FOR DETAILED INFORMATION SEE FIGURE 11

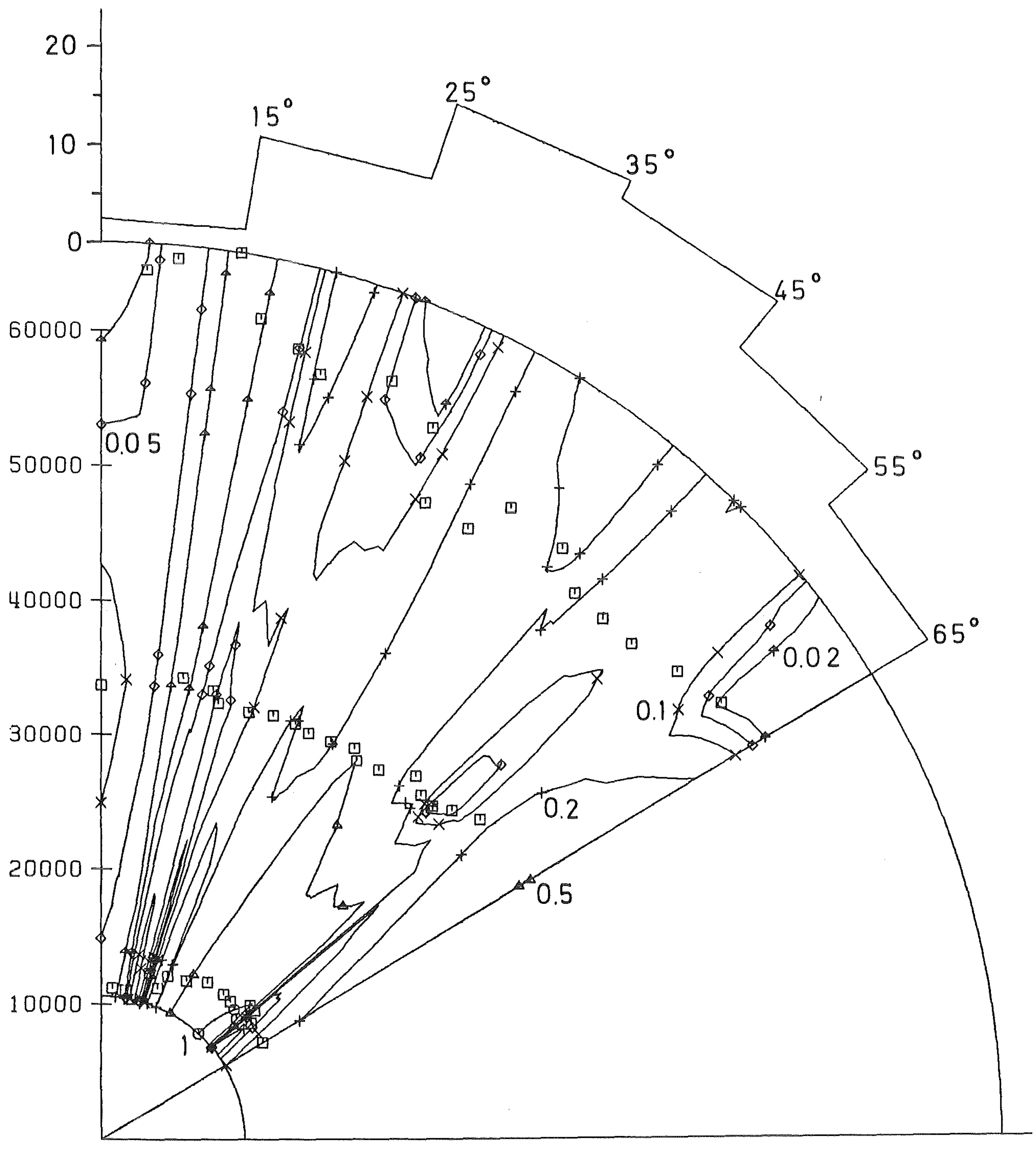


FIG. 25: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 25, 1985, 3RD PERIOD
FOR DETAILED INFORMATION SEE FIGURE 11

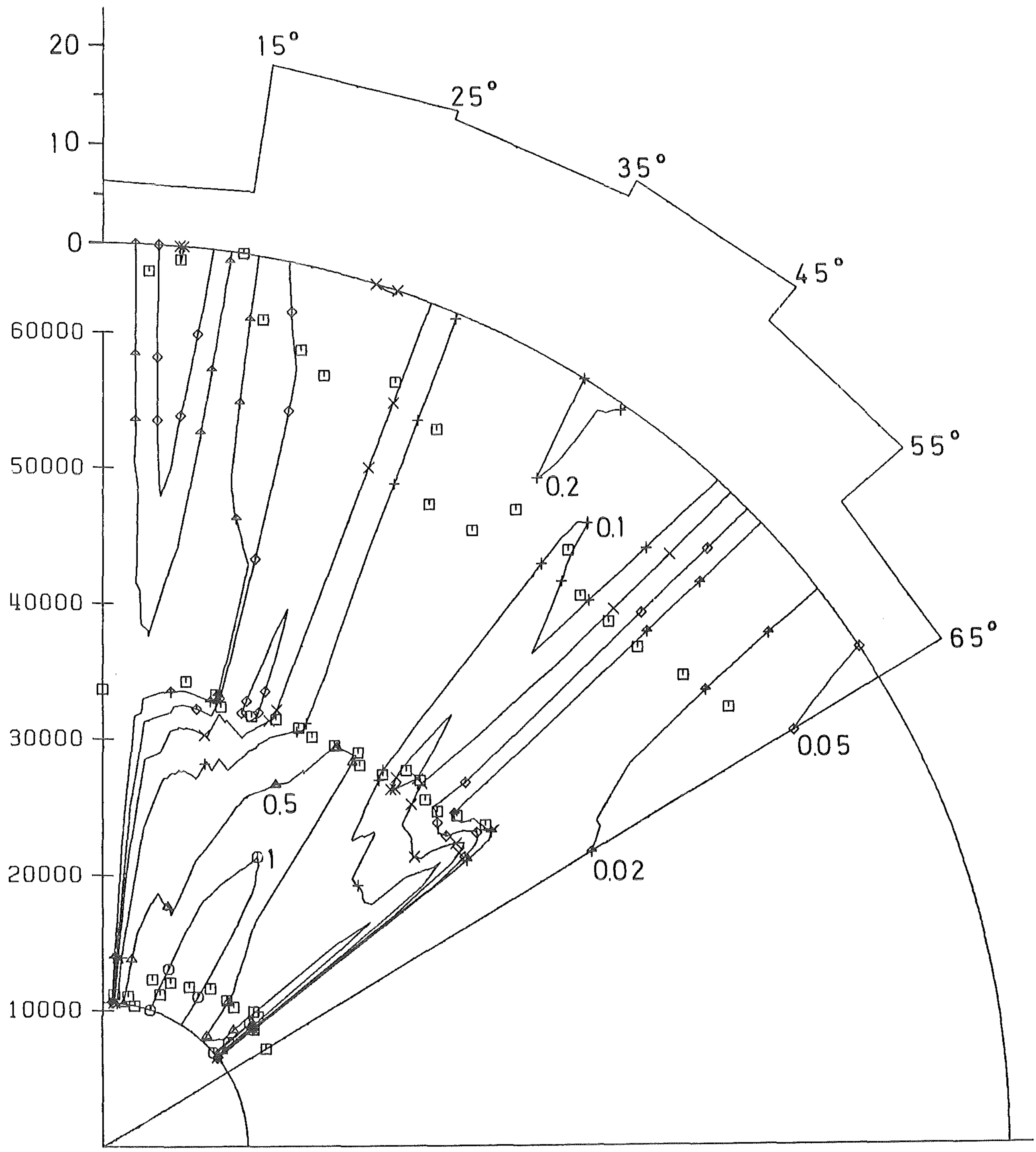


FIG. 26: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 25, 1985, 4TH PERIOD
FOR DETAILED INFORMATION SEE FIGURE 11

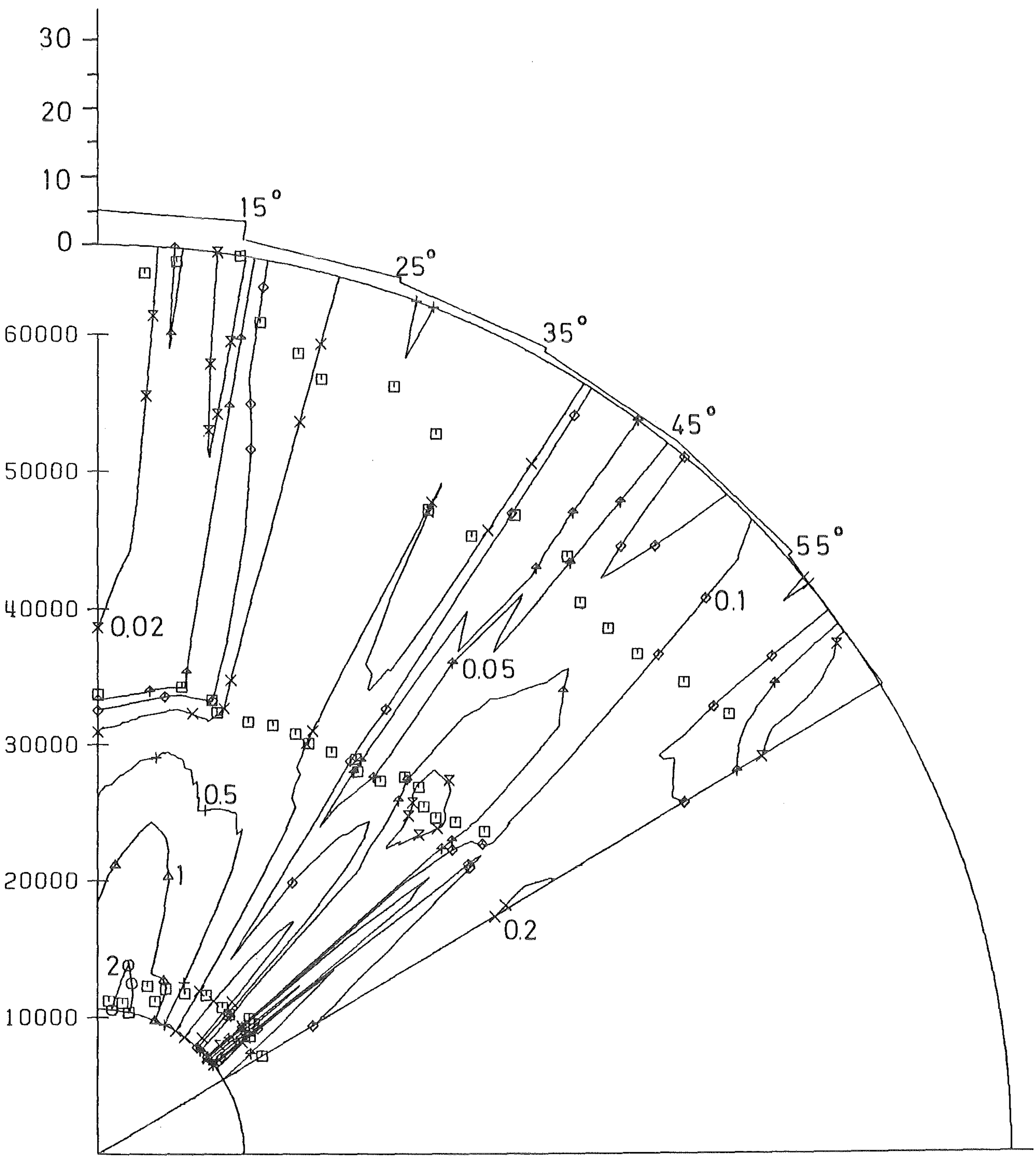


FIG. 27: CONCENTRATION DISTRIBUTION IN 1/10**6 G/M**3
EXPERIMENT ON MARCH 25, 1985, 5TH PERIOD
FOR DETAILED INFORMATION SEE FIGURE 11

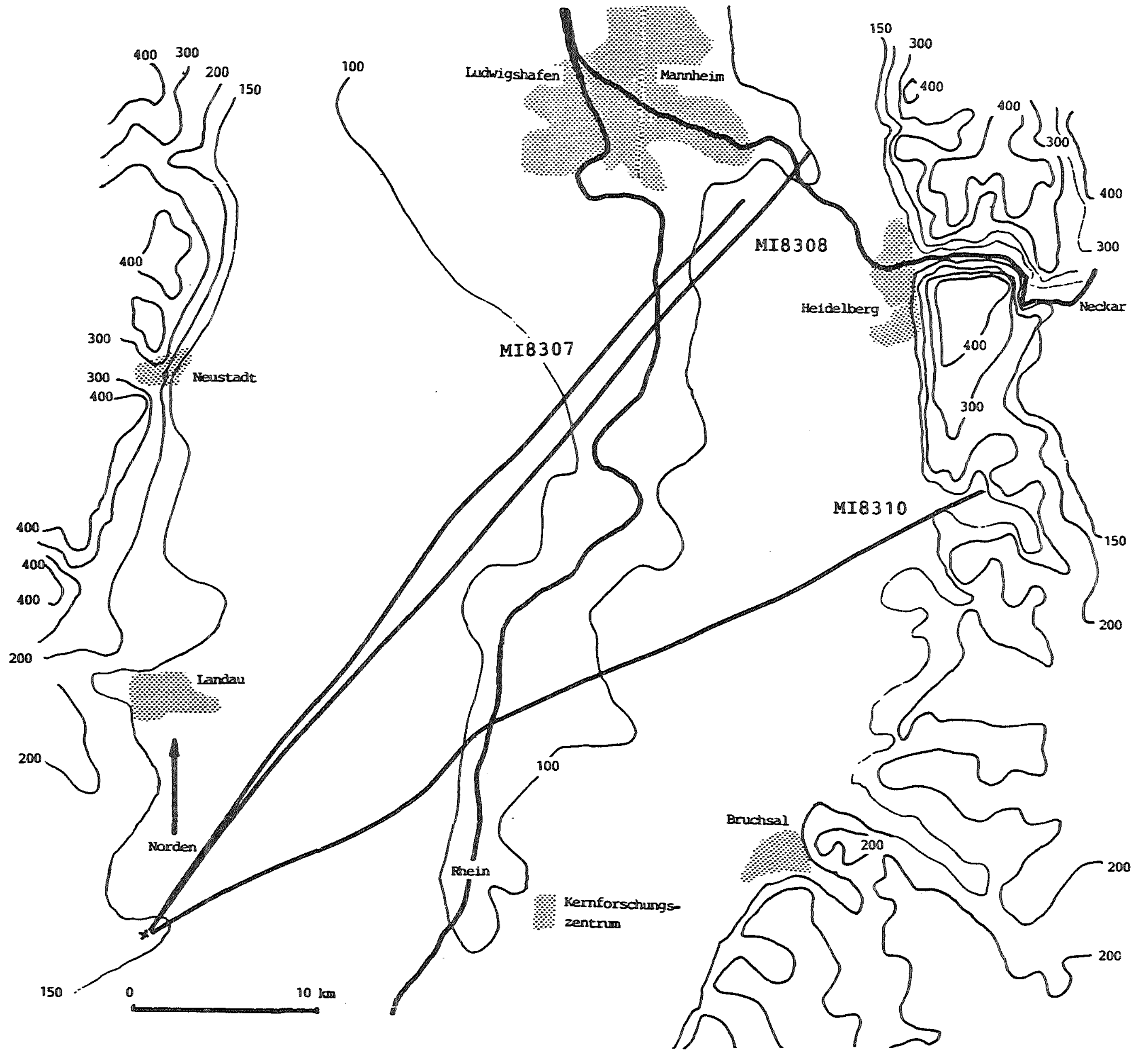


Fig. 28: Projection of tetroon trajectories, April 27, 1983

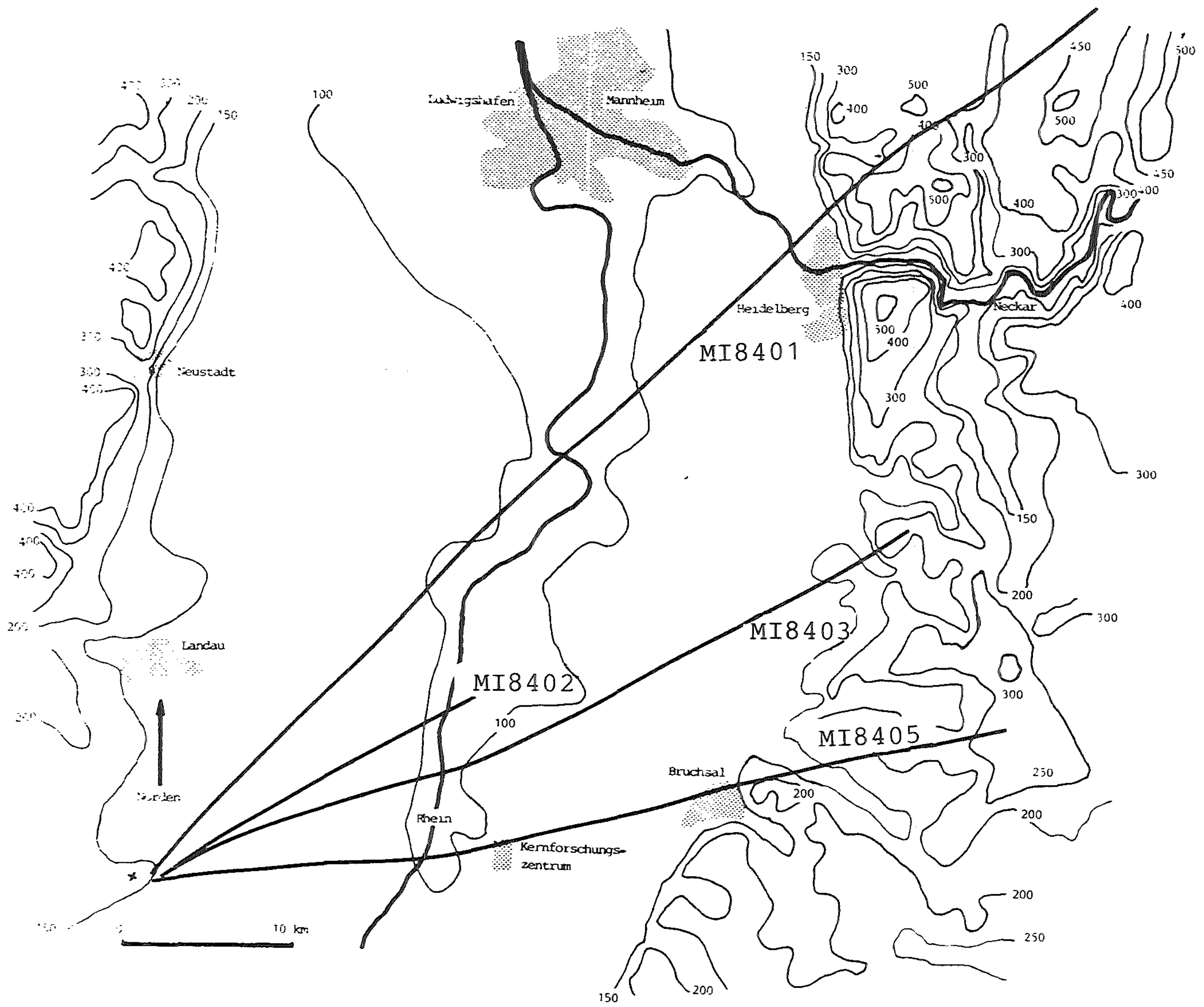


Fig. 29: Projection of tetroon trajectories, March 29, 1984.

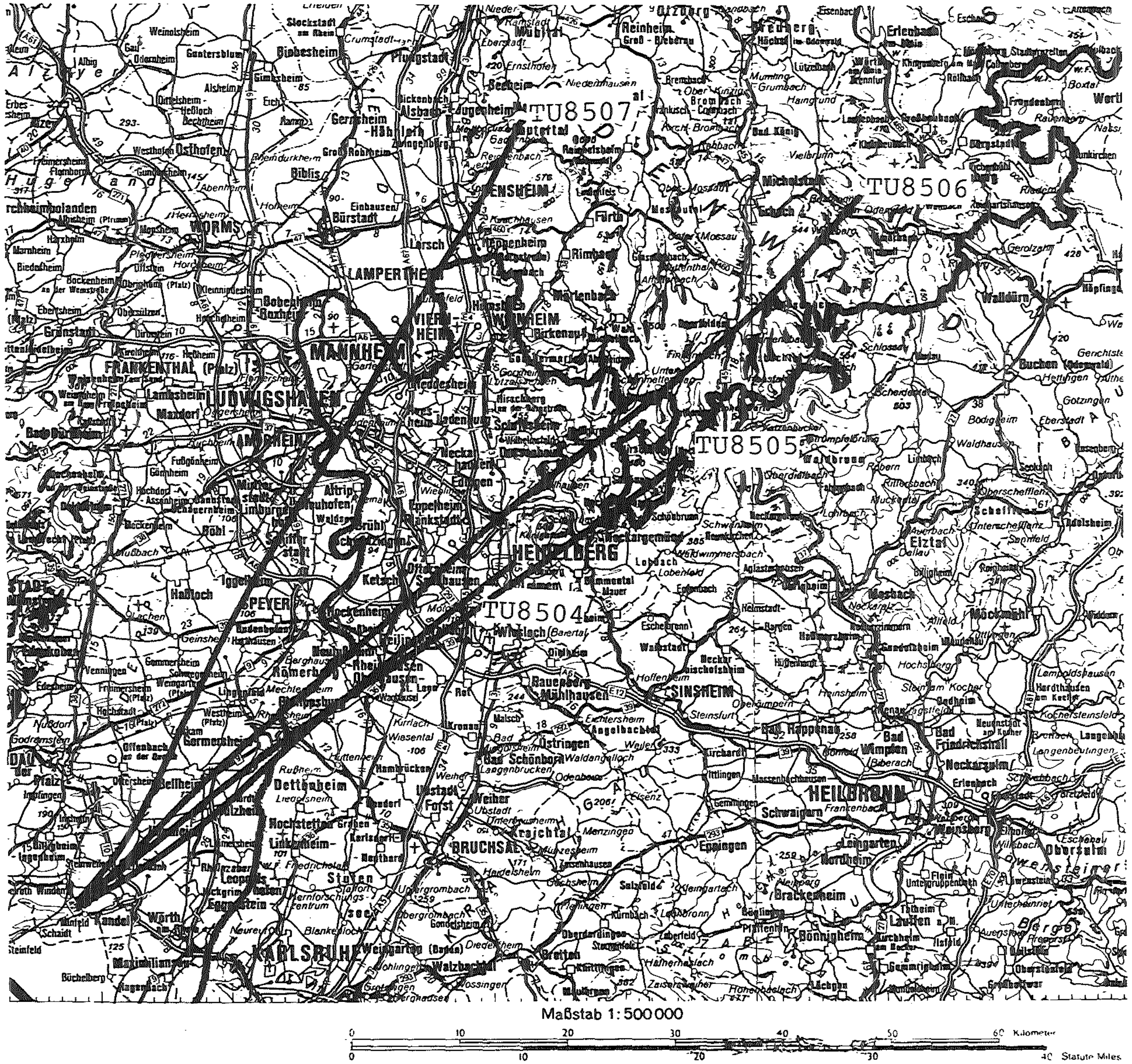


Fig. 30: Projection of tetroon trajectories, March 23, 1985.

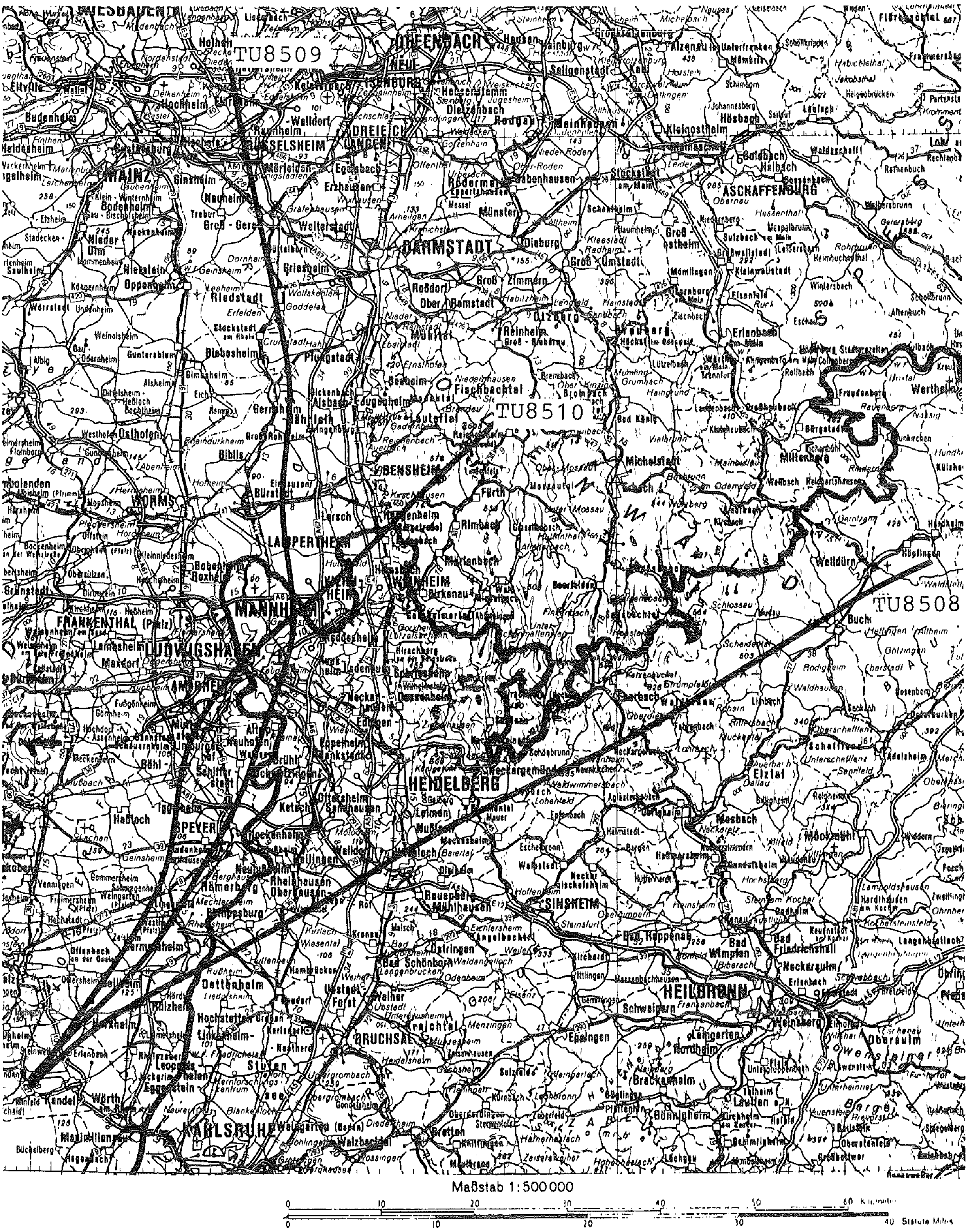


Fig. 31: Projection of tetroon trajectories, March 25, 1985.

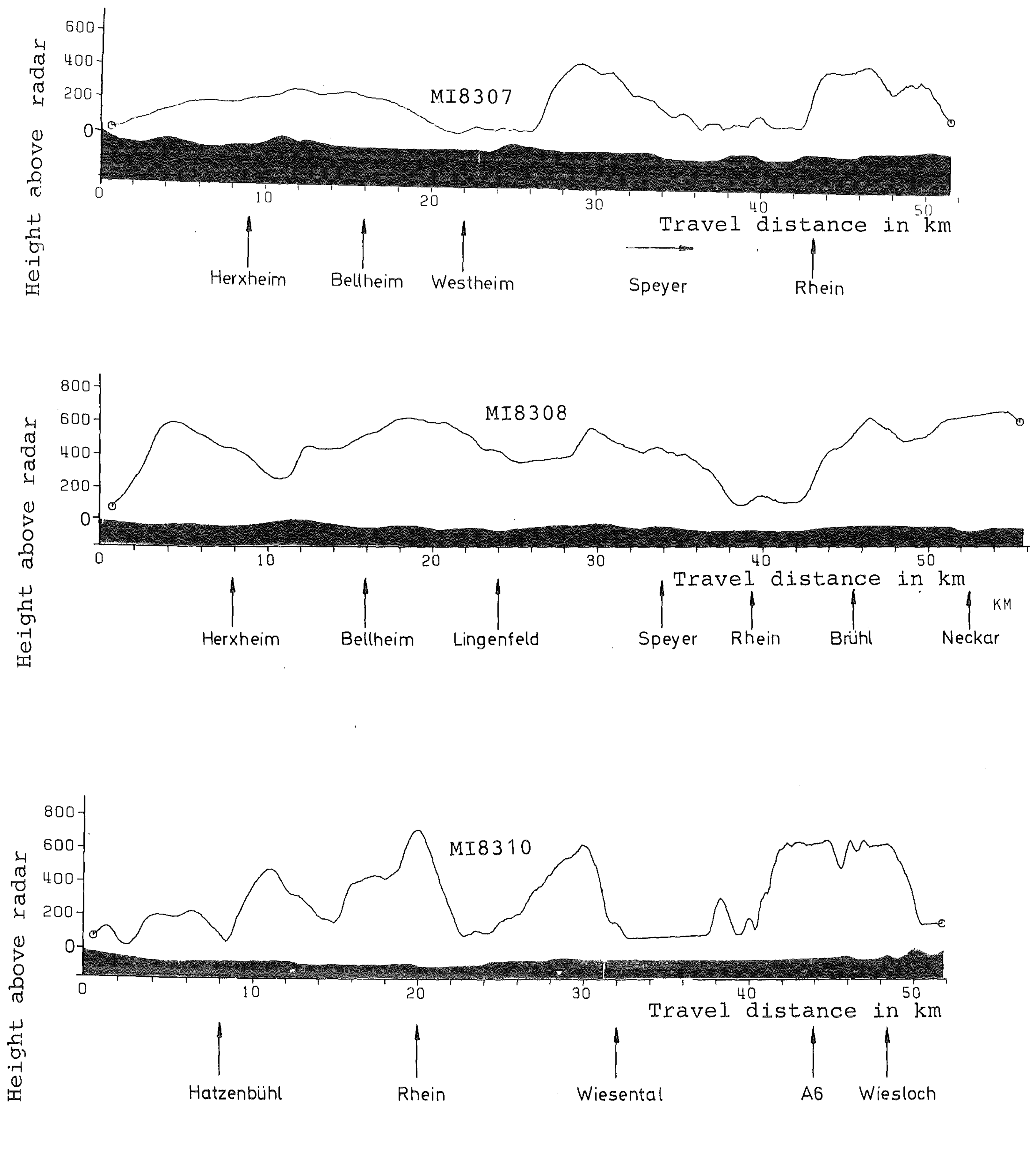


Fig. 32: Profiles of tetroon trajectories on April 27, 1983.

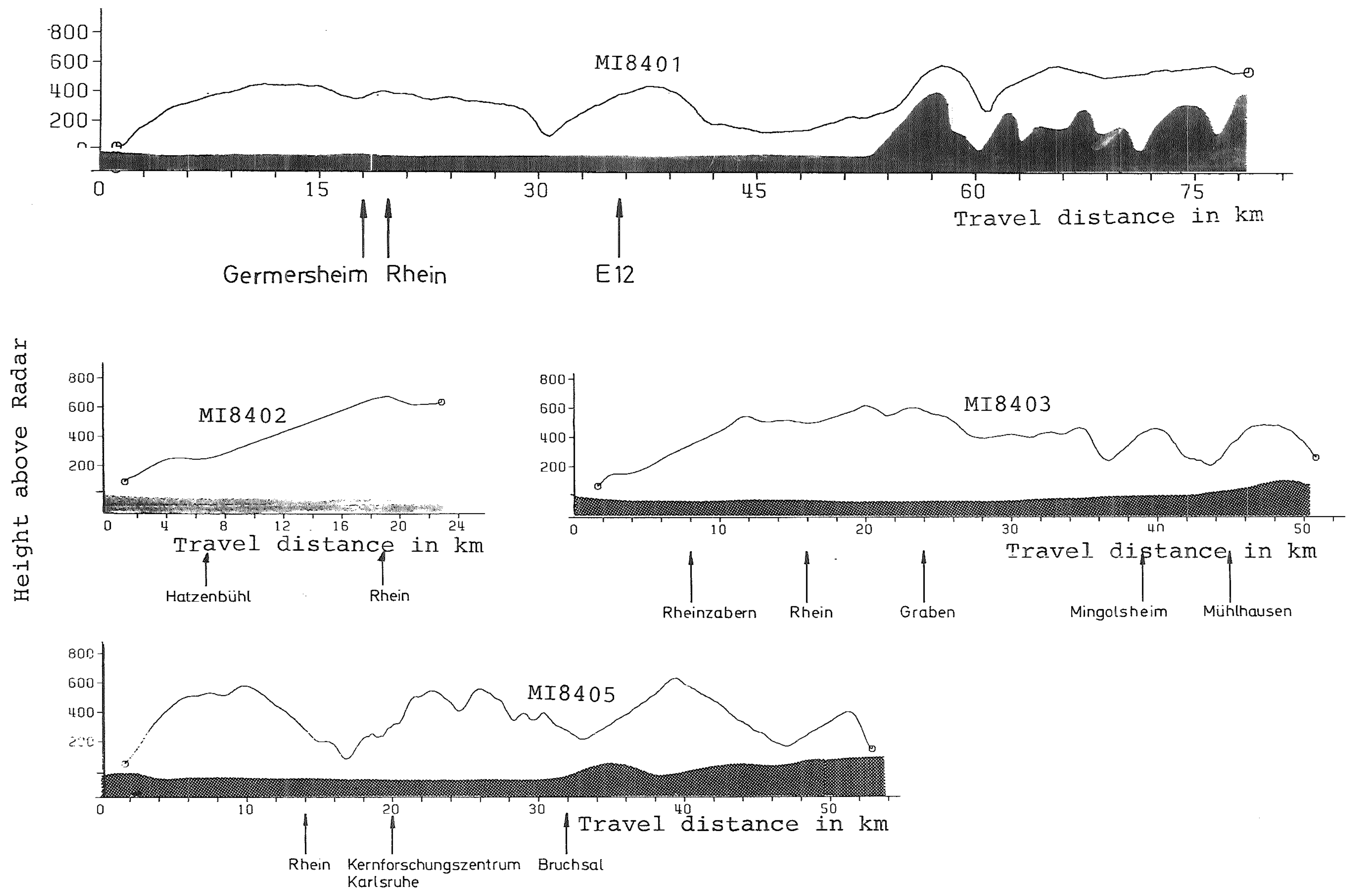


Fig. 33: Profiles of tetroon trajectories on March 29, 1984.

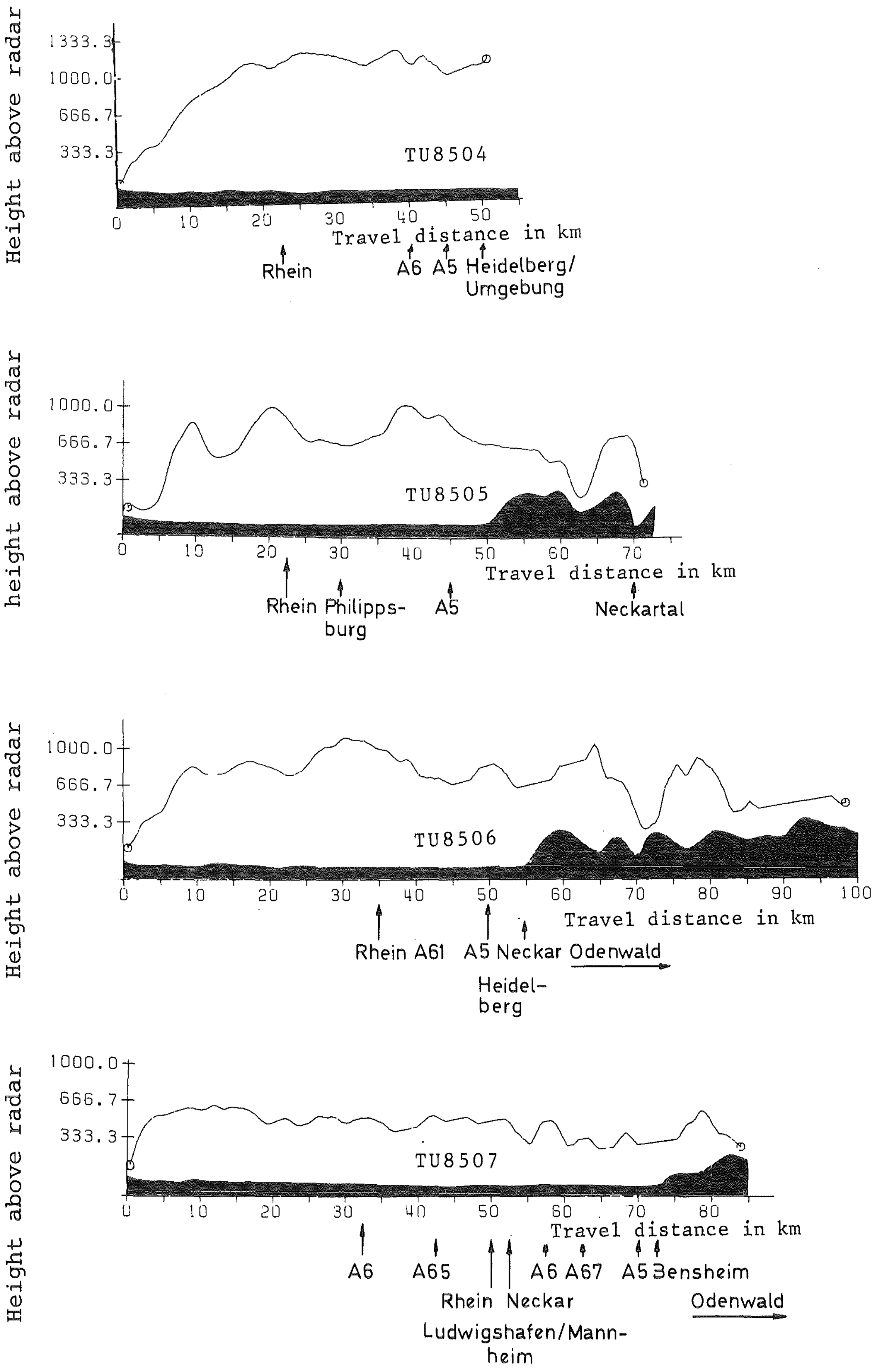


Fig. 34: Profiles of tetroon trajectories on March 23, 1985.

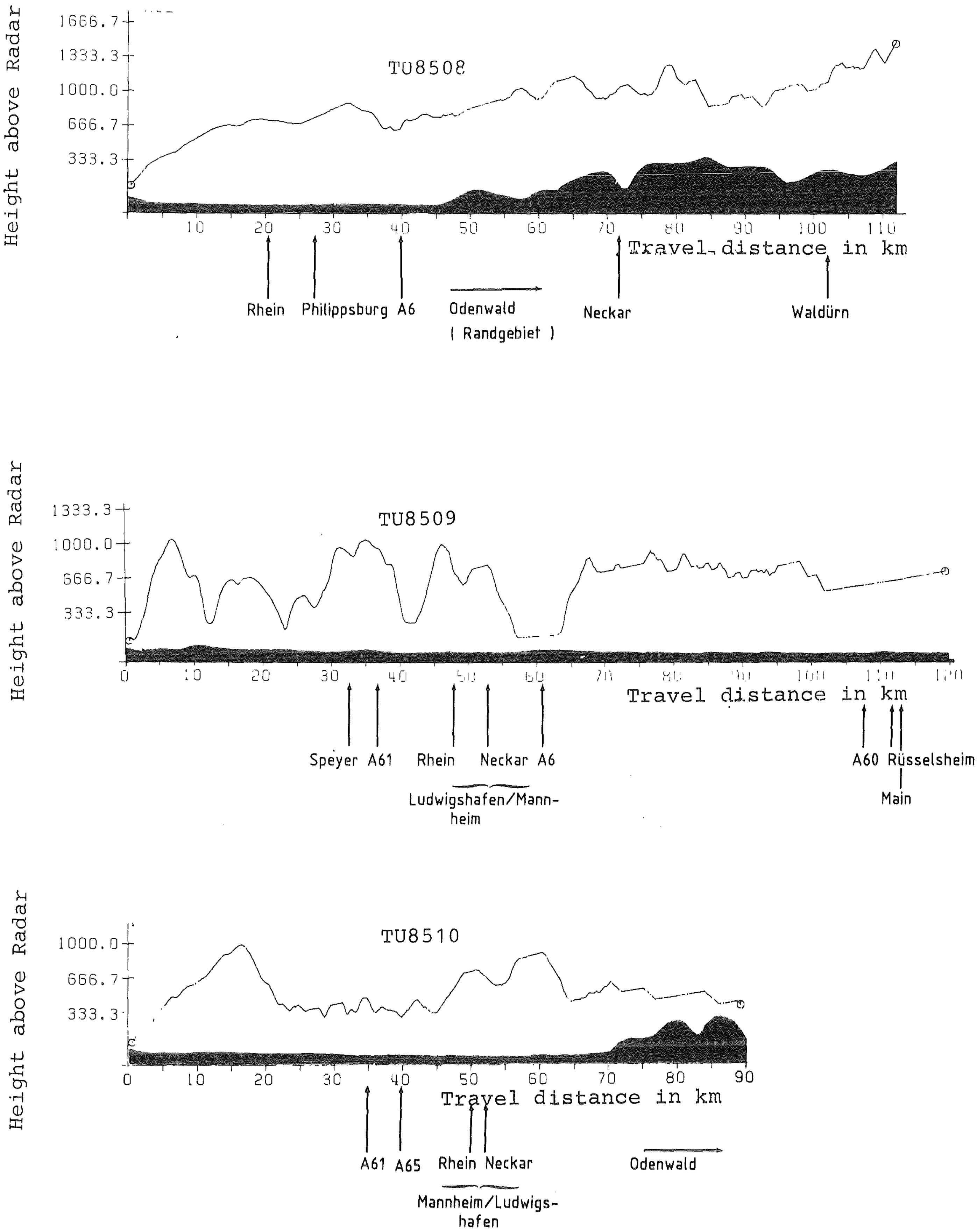


Fig. 35: Profiles of tetroon trajectories on March 25, 1985.

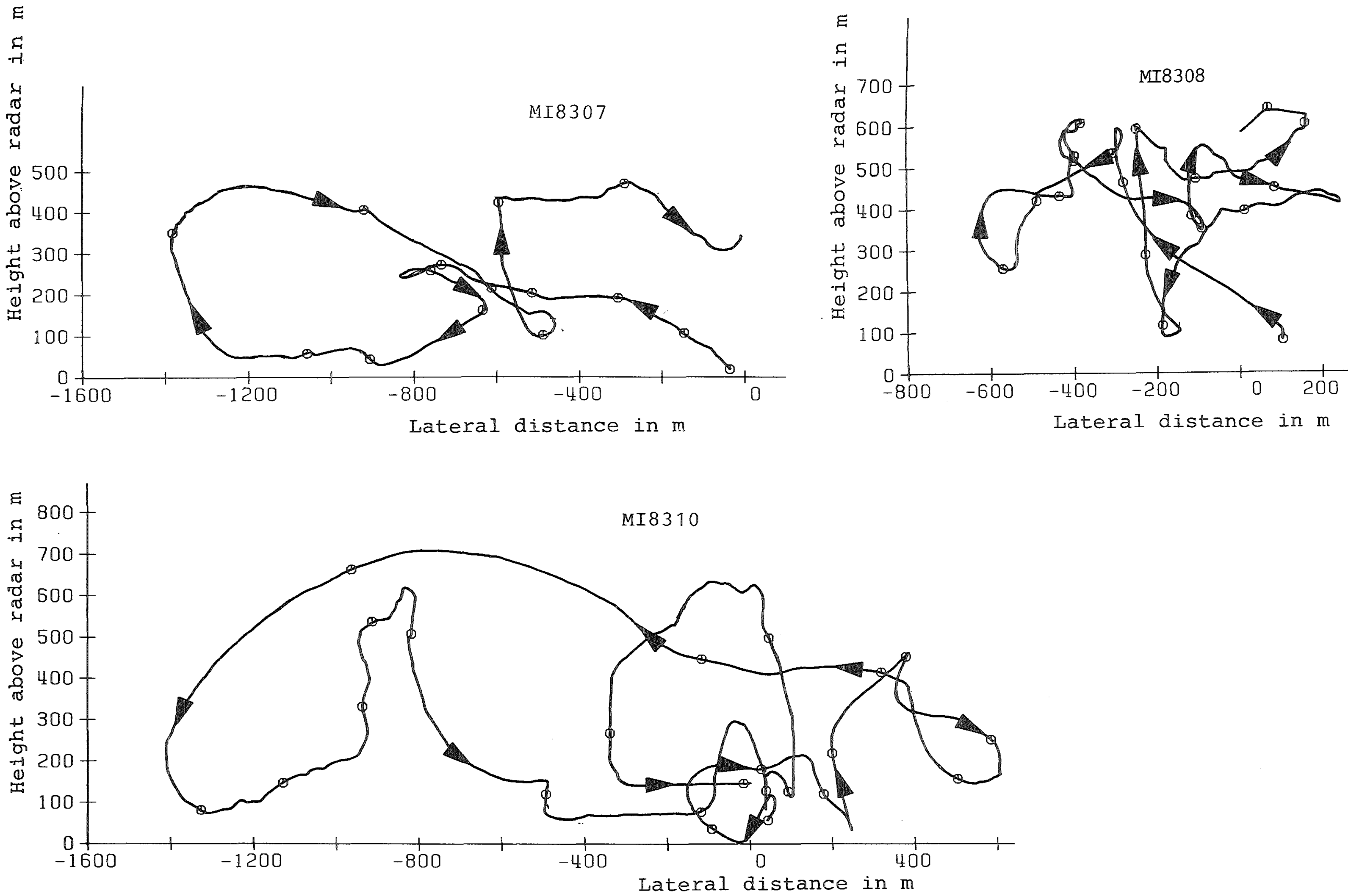


Fig. 36: Projection of trajectories into a plane perpendicular to the mean transport direction on April 27, 1983.

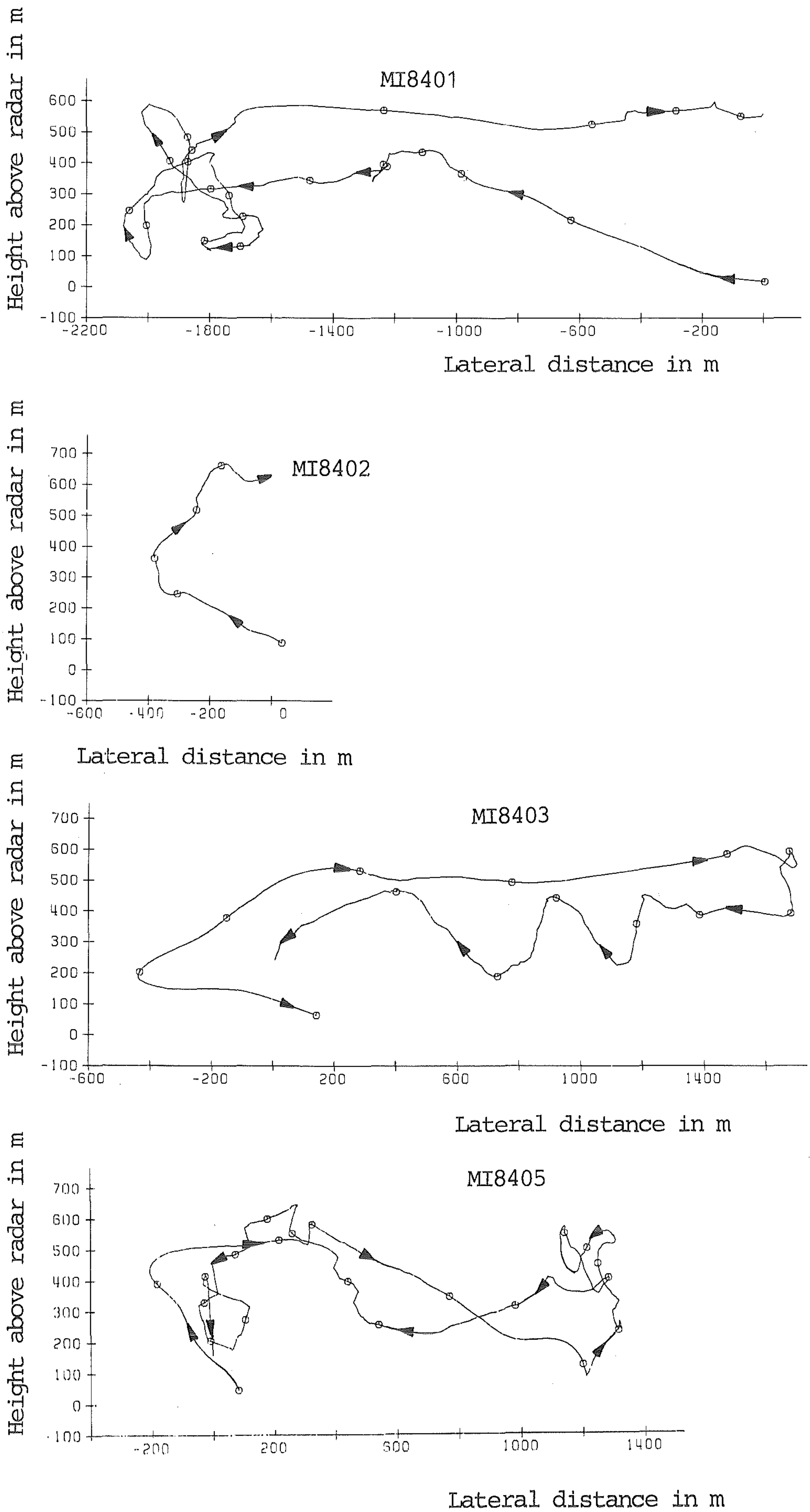


Fig. 37: Projection of trajectories into a plane perpendicular to the mean transport direction on March 29, 1984.

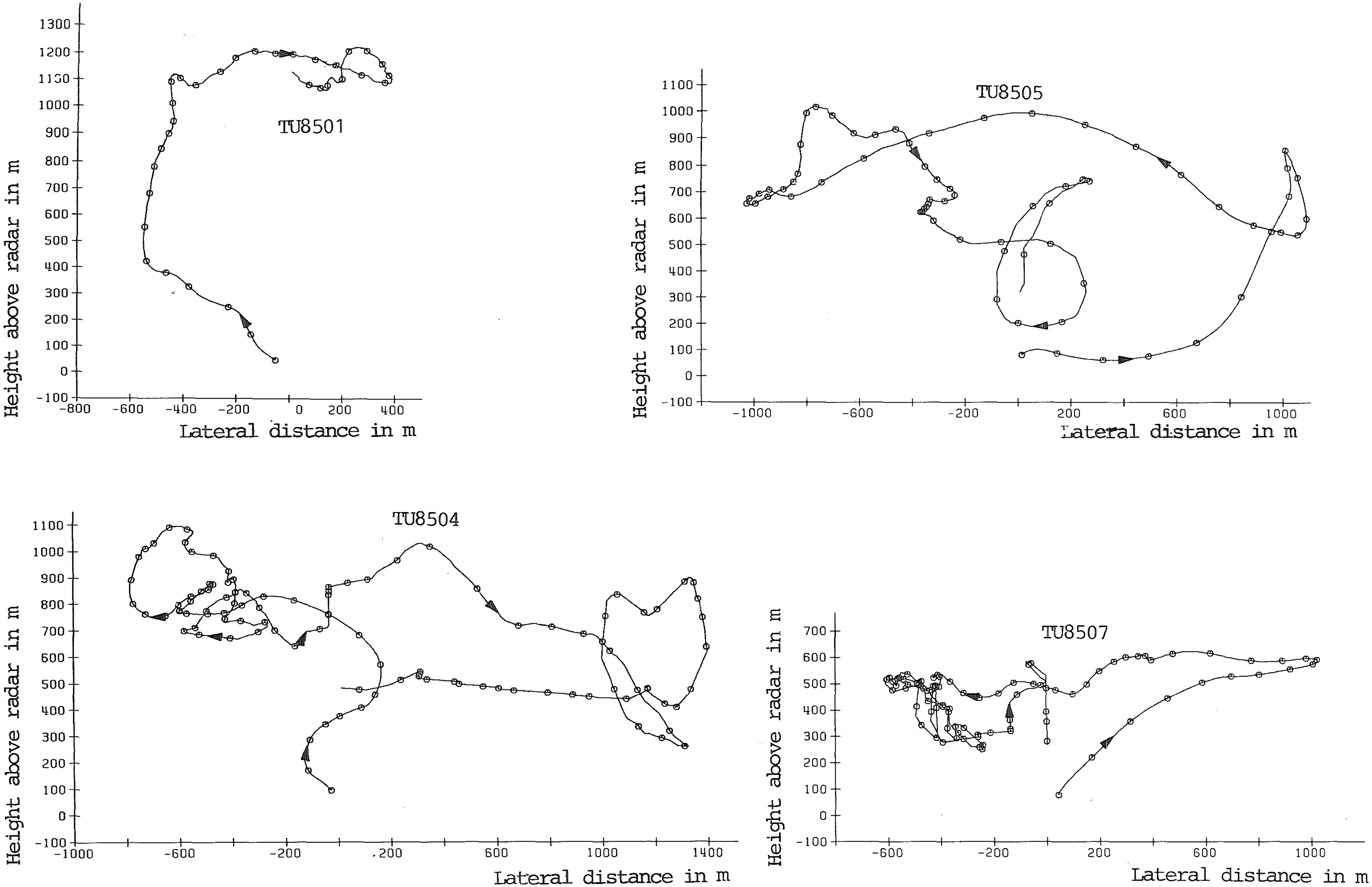


Fig. 38: Projection of trajectories into a plane perpendicular to the mean transport direction on March 23, 1985.

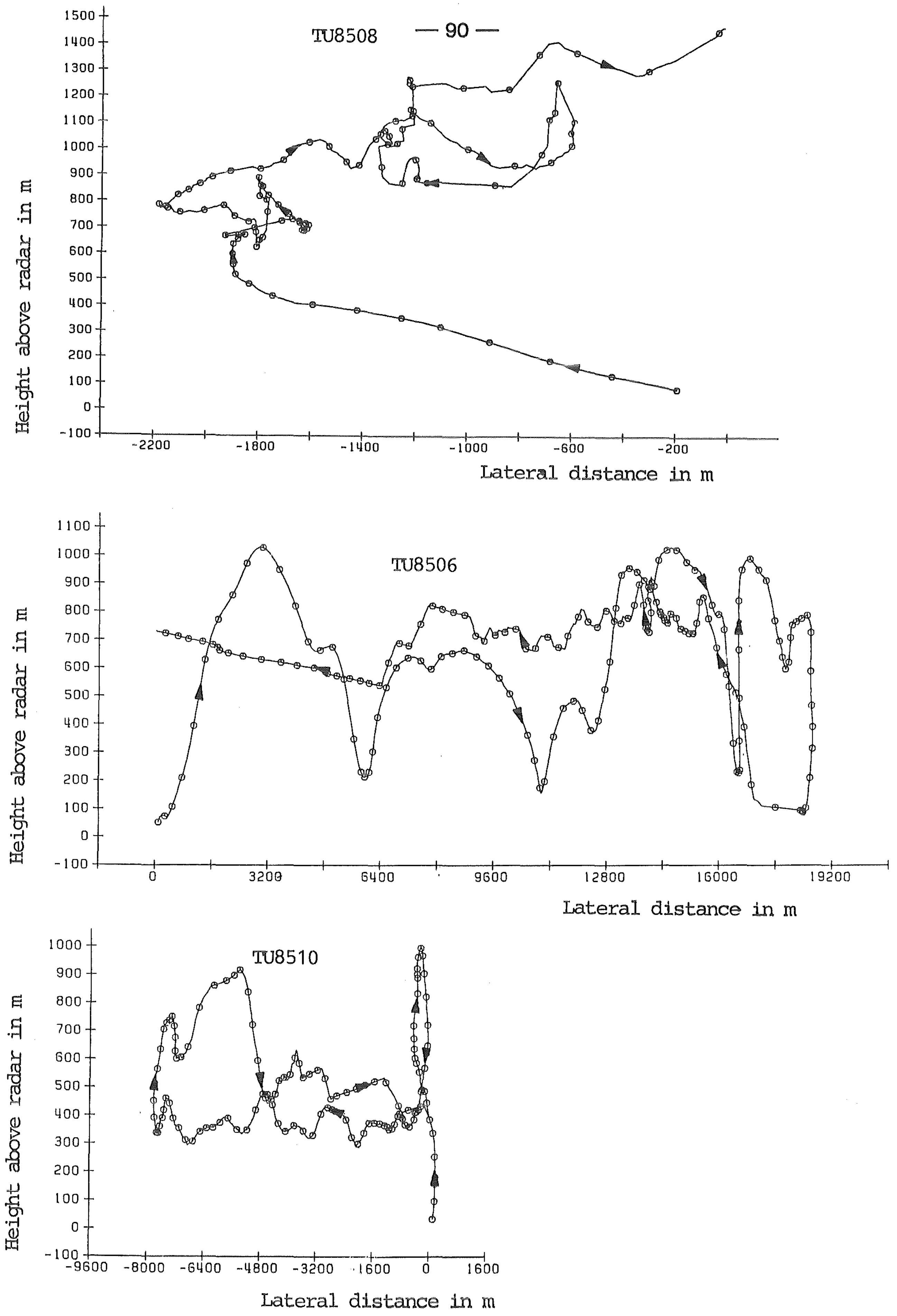


Fig. 39: Projection of trajectories into a plane perpendicular to the mean transport direction on March 25, 1985.

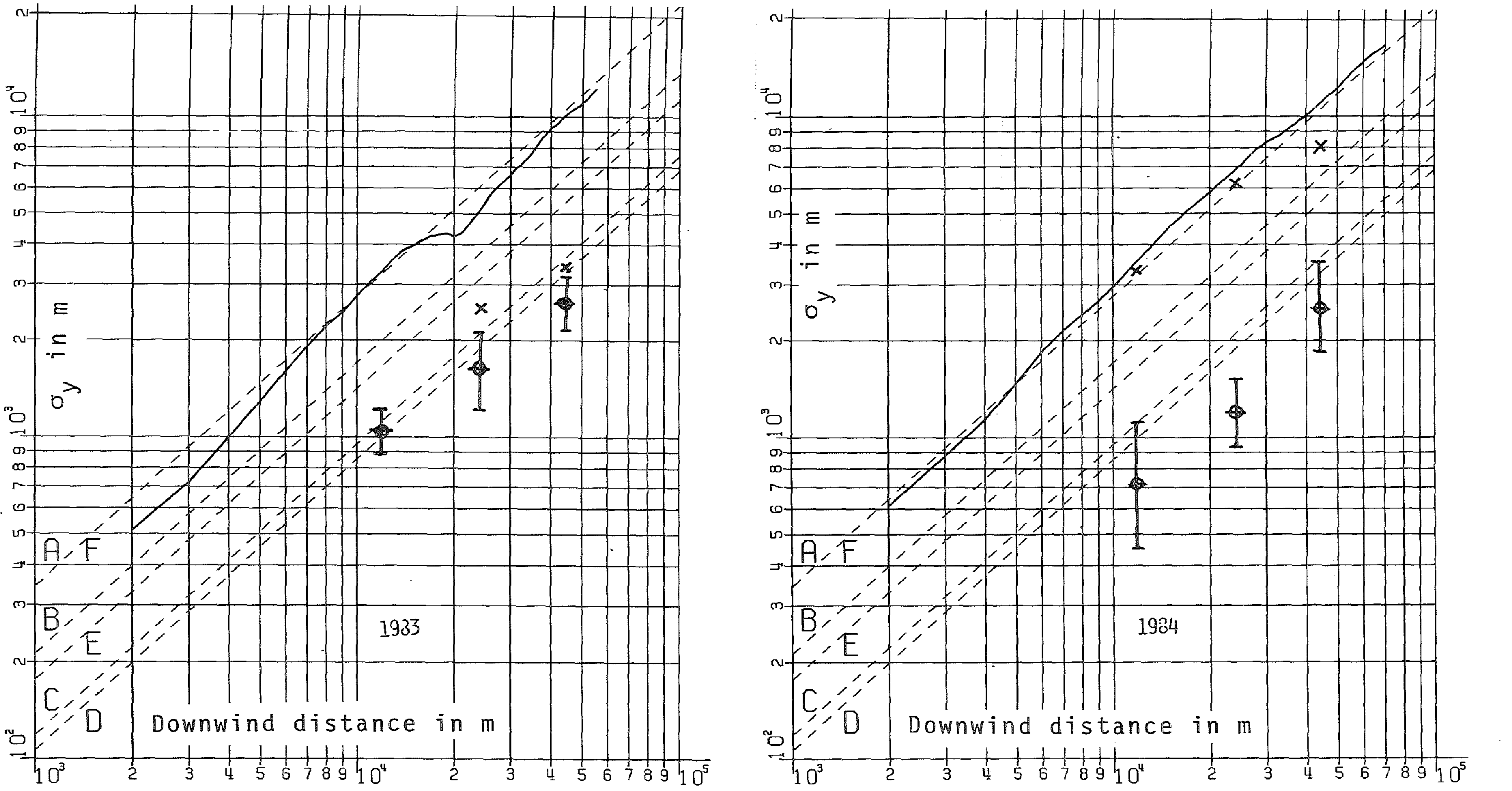


Fig. 40: Horizontal dispersion parameter σ_y

- - - - - short range tracer experiment at KfK /12/

——— tetroon trajectories

mesoscale tracer experiment, sampling time : 0.5h (⊕) and 5h (x)

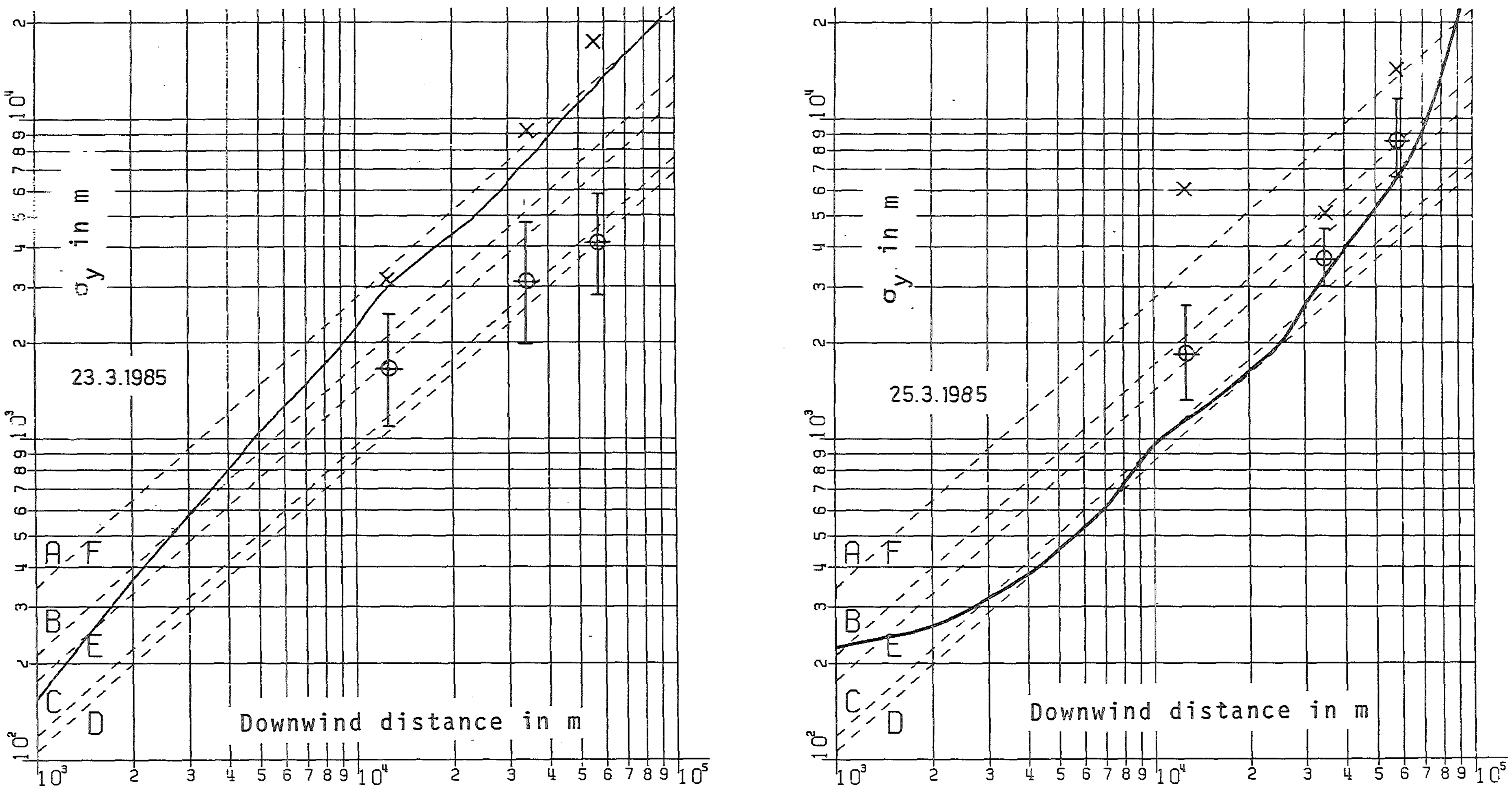
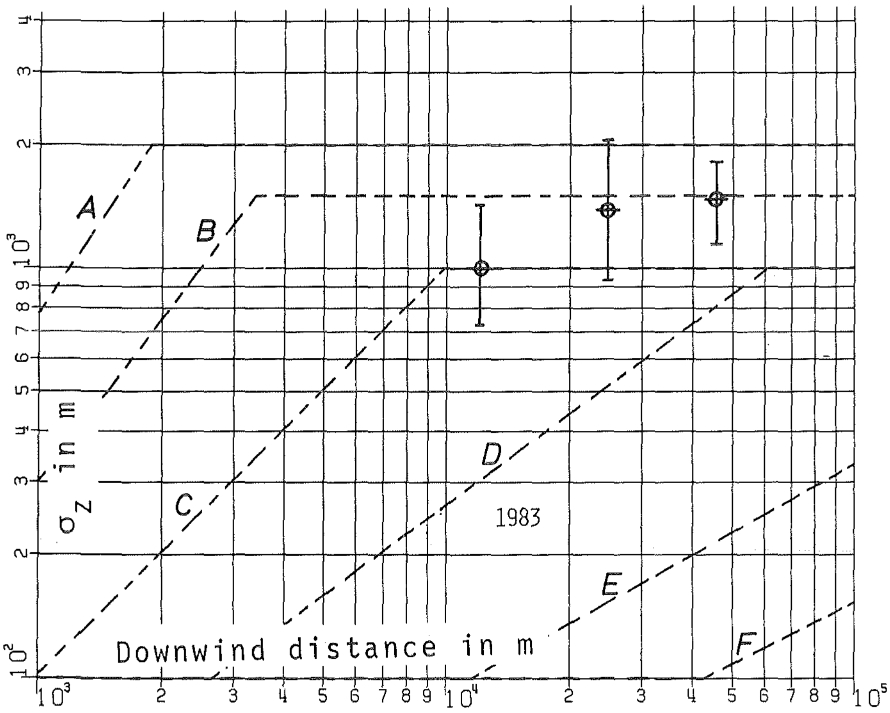


Fig. 41: Horizontal dispersion parameter σ_y

- - - - - short range tracer experiment at KfK /12/

———— tetroon trajectories

mesoscale tracer experiment, sampling time : 0.5h (⊕) and 5h (x)



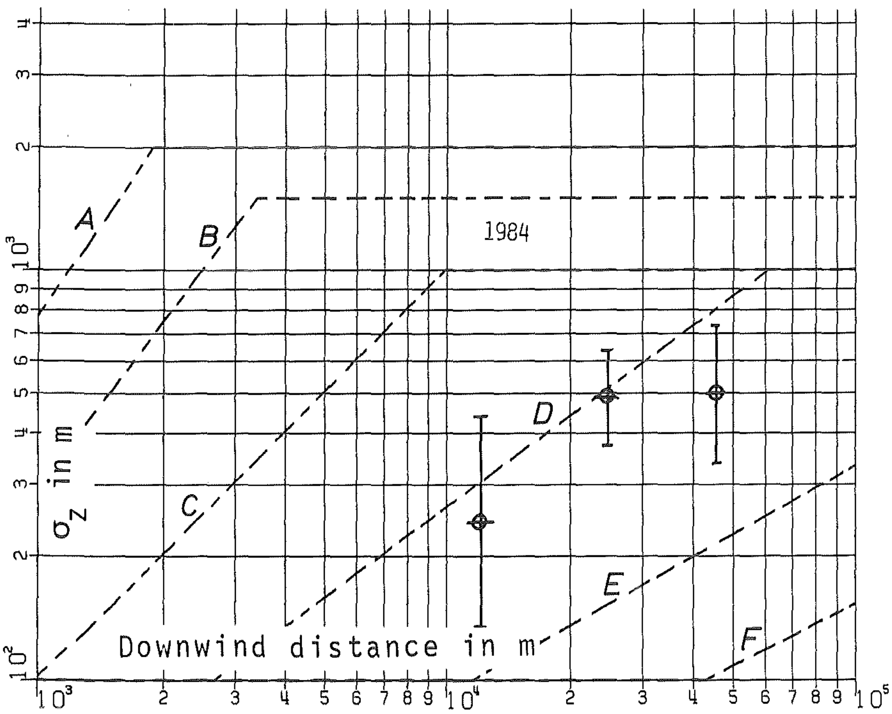
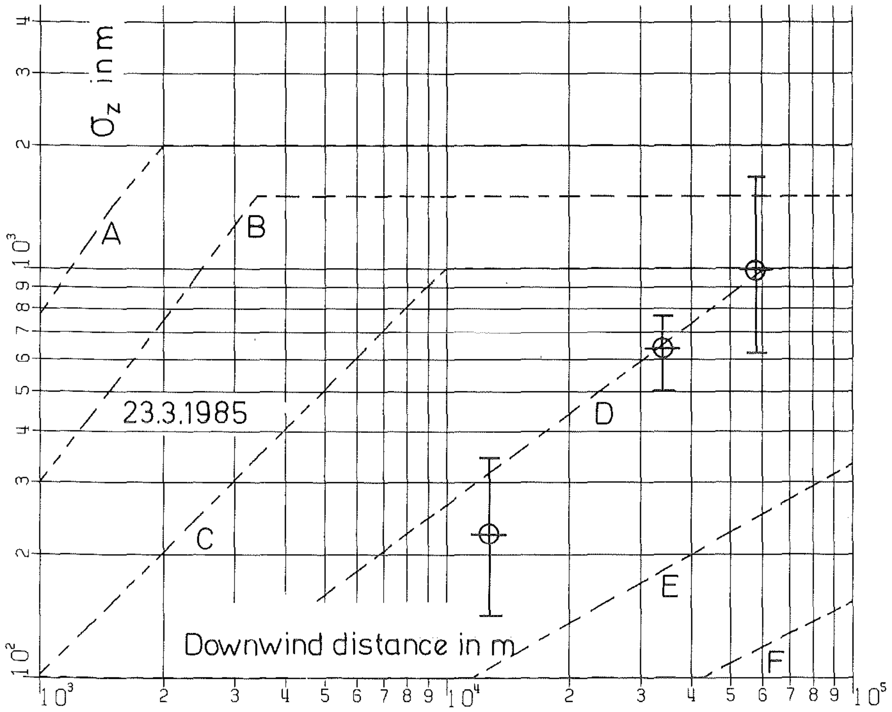


Fig. 42: Vertical dispersion parameter σ_z

- - - - short range tracer experiment at KfK /12/

⊕ mesoscale tracer experiment, sampling time: 0.5 h



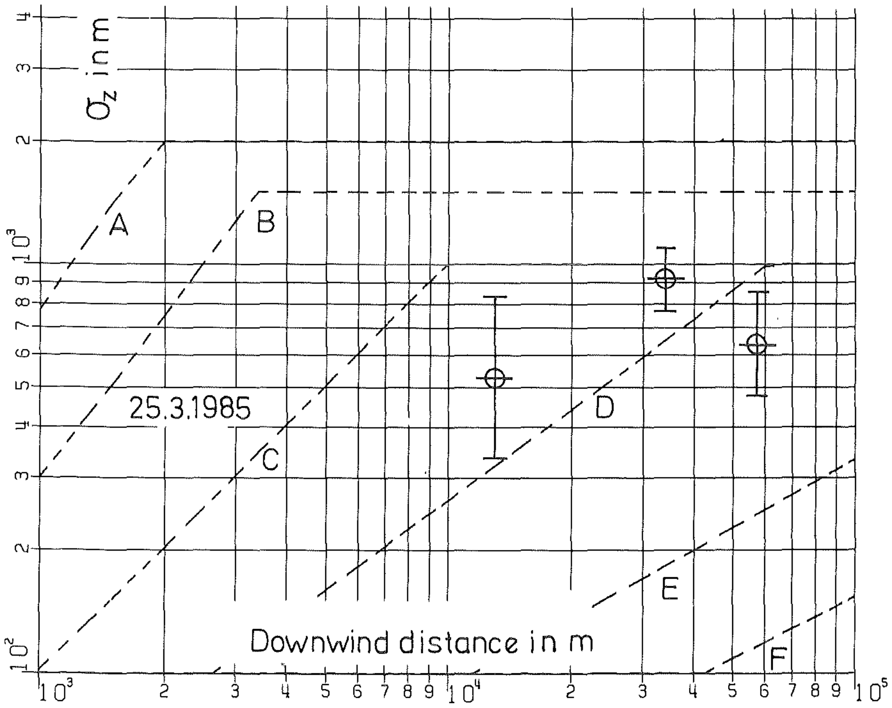


Fig. 43: Vertical dispersion parameter σ_z

- - - - short range tracer experiment at KfK /12/

⌖ mesoscale tracer experiment, sampling time: 0.5 h

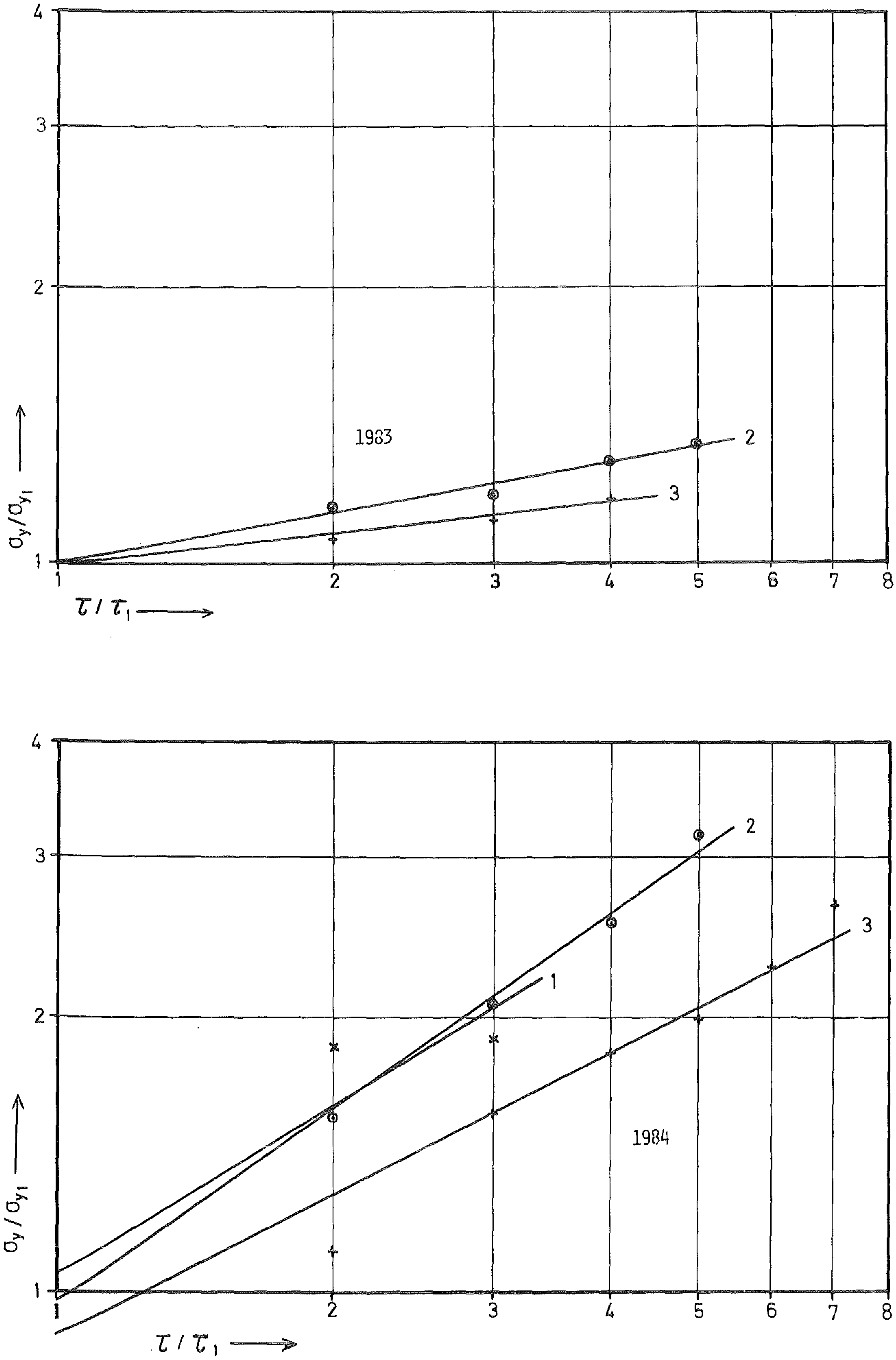
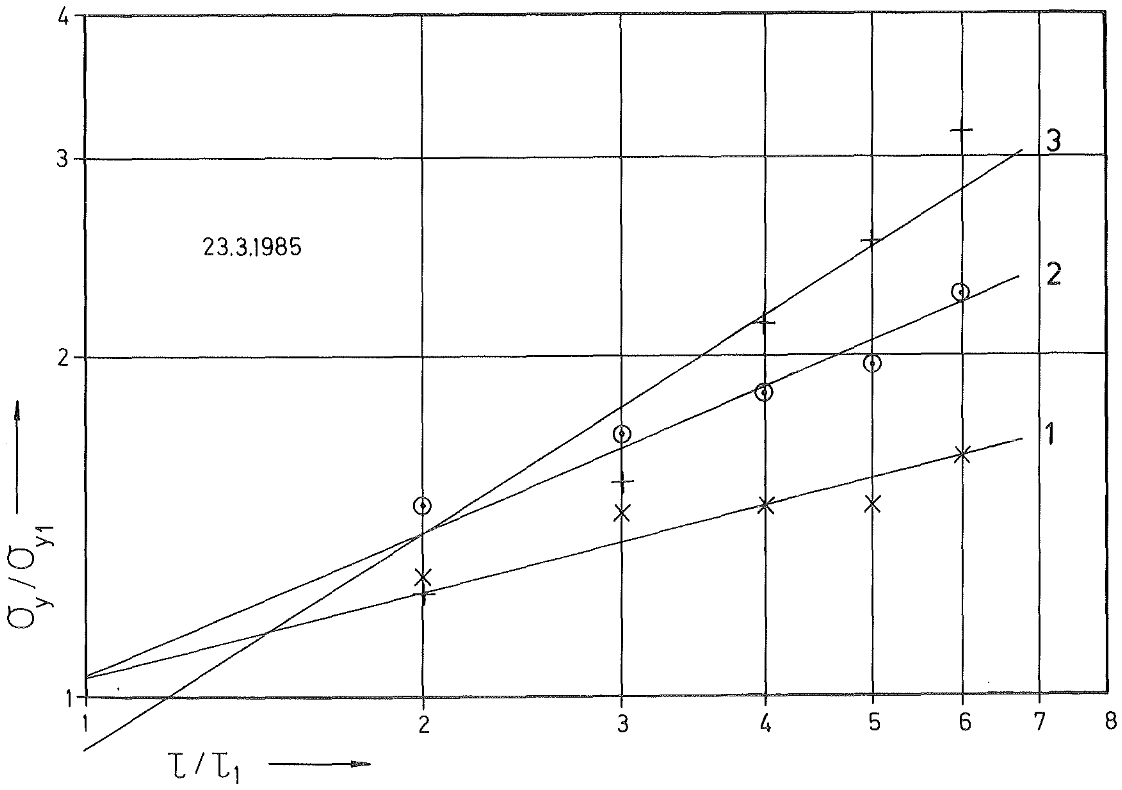


Fig. 44: σ_y as a function of sampling time τ

$\sigma_y(\tau) / \sigma_y(\tau_1) = (\tau/\tau_1)^\alpha$, $\tau_1 = 0.5$ h

x arc 1: 12.0 km, o arc 2: 24.6 km, + arc 3: 44.5 km



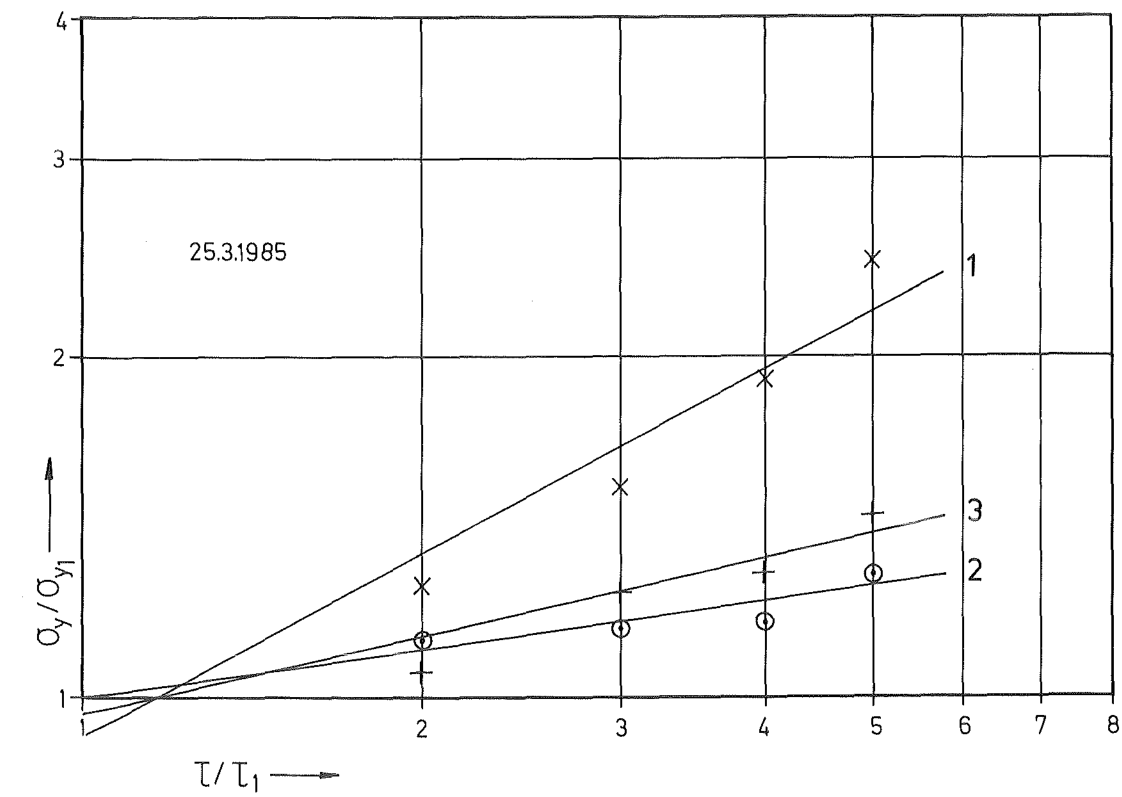
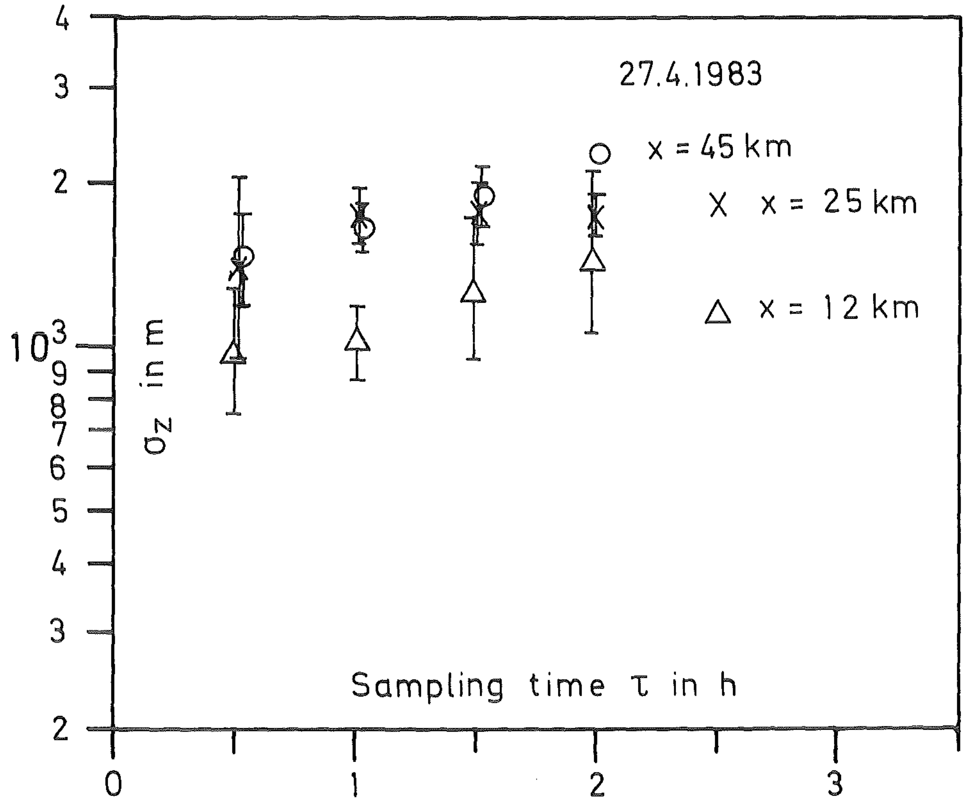


Fig. 45: σ_y as a function of sampling time τ

$\sigma_y(\tau) \,/\, \sigma_y(\tau_1) = (\tau/\tau_1)^{\alpha}$, τ_1 0.5 h

x arc 1: 13 km, o arc 2: 35 km, + arc 3: 60 km



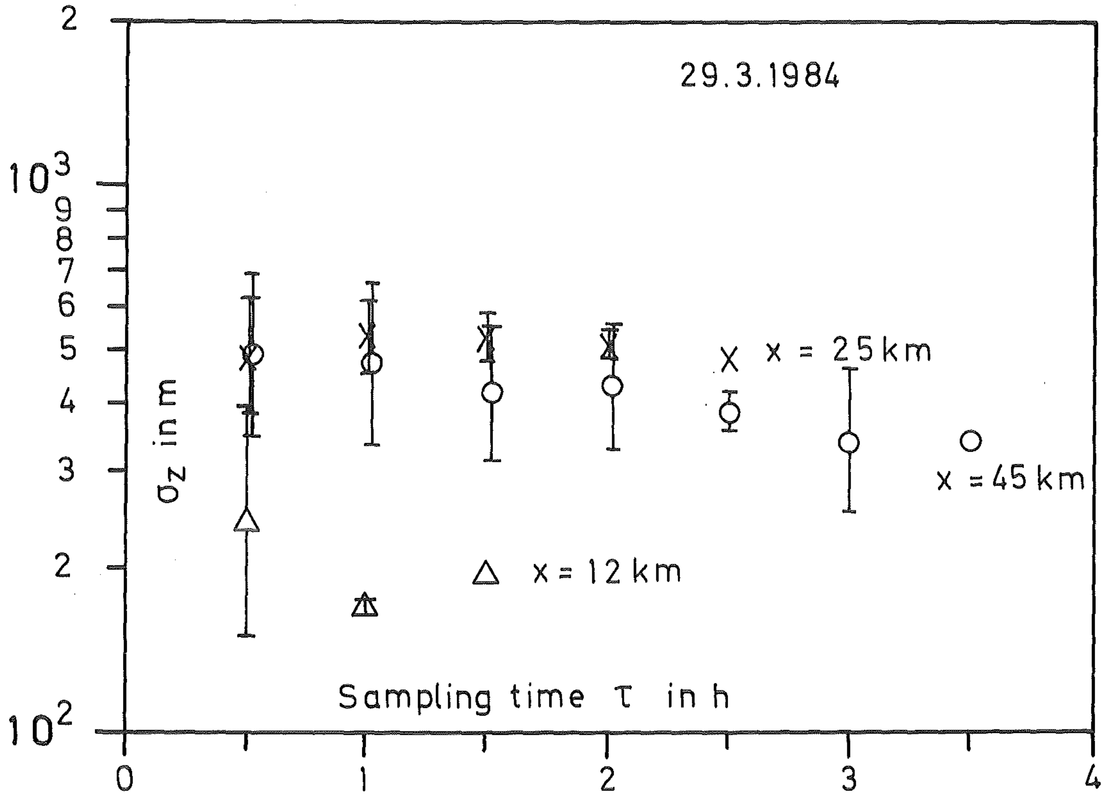
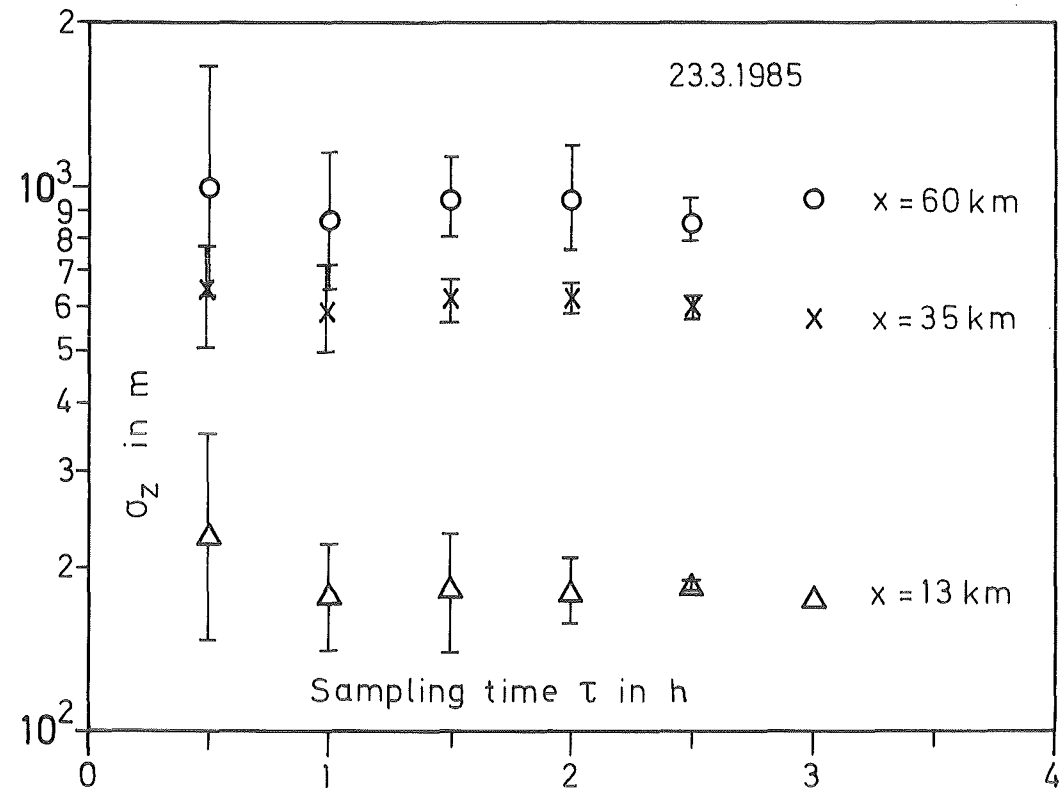


Fig. 46: Vertical dispersion parameter σ_z as a function of sampling time



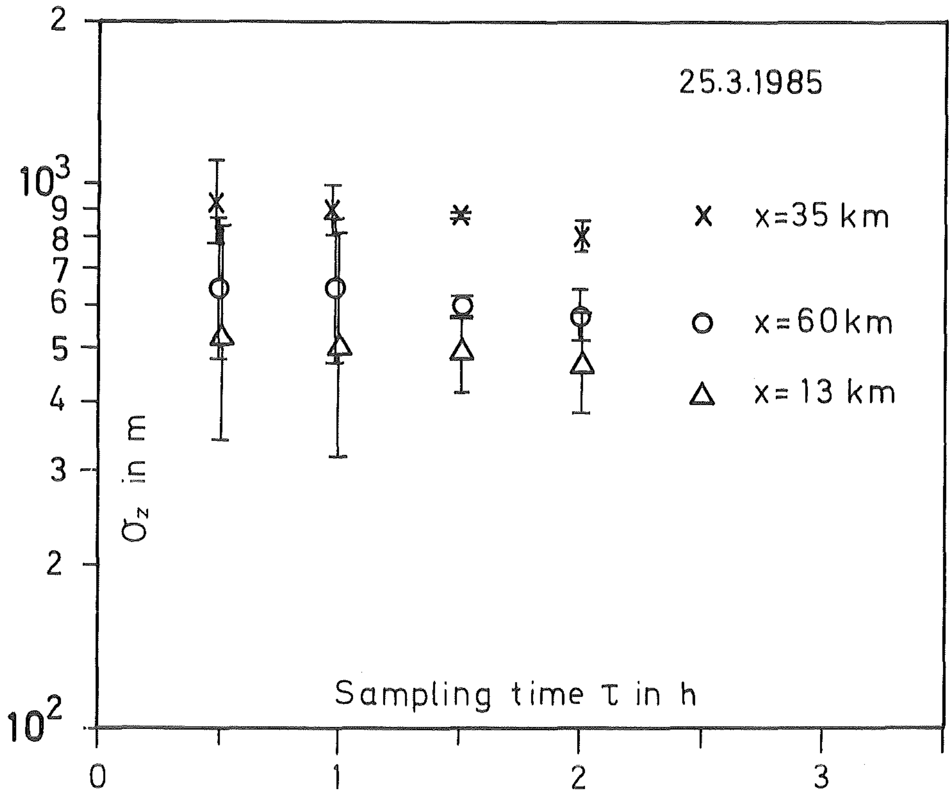


Fig. 47: Vertical dispersion parameter σ_z as a function of sampling time

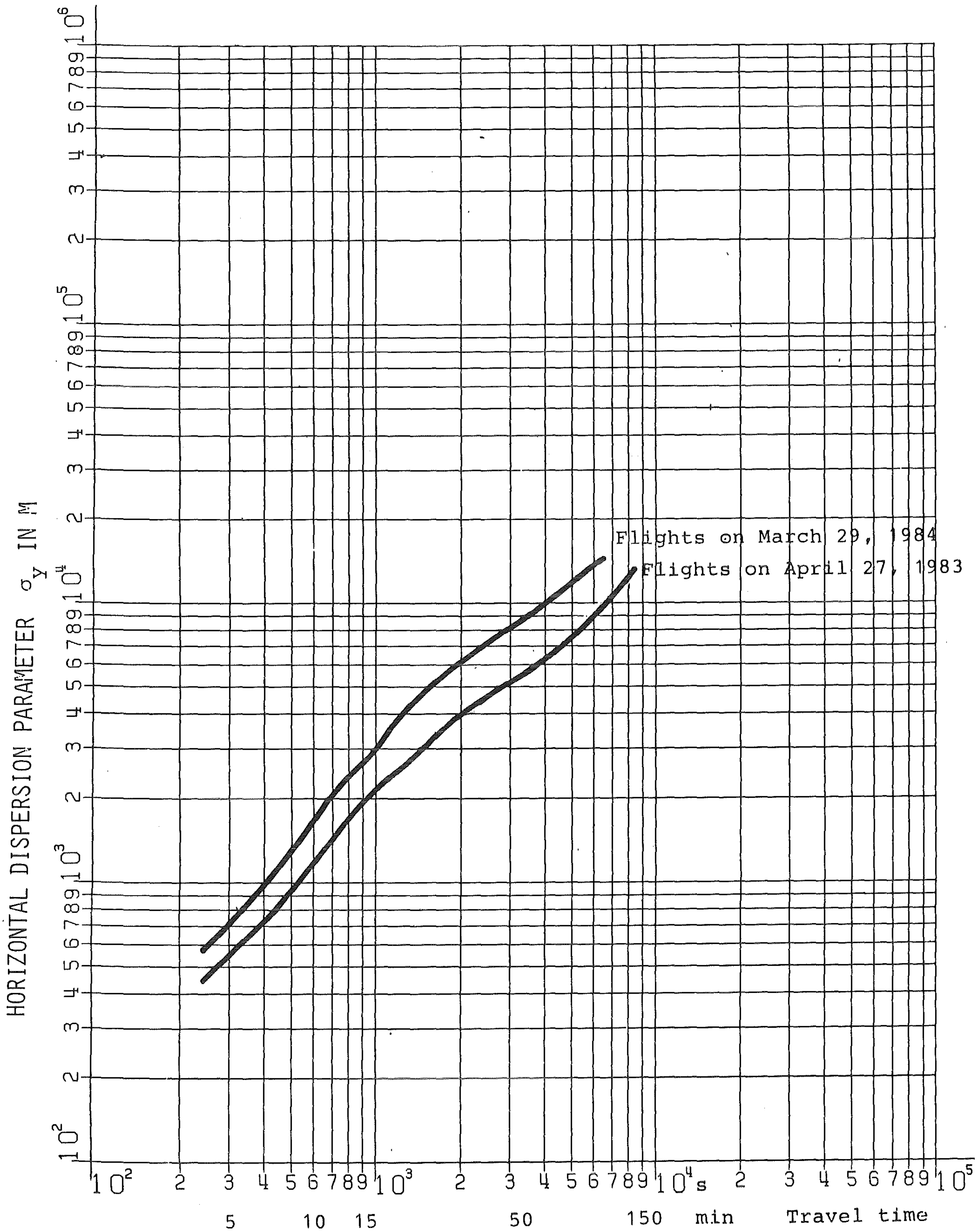


FIG. 48: HORIZONTAL DISPERSION PARAMETER σ_y BASED ON TETROON TRAJECTORIES AS A FUNCTION OF TIME (1983 AND 1984)

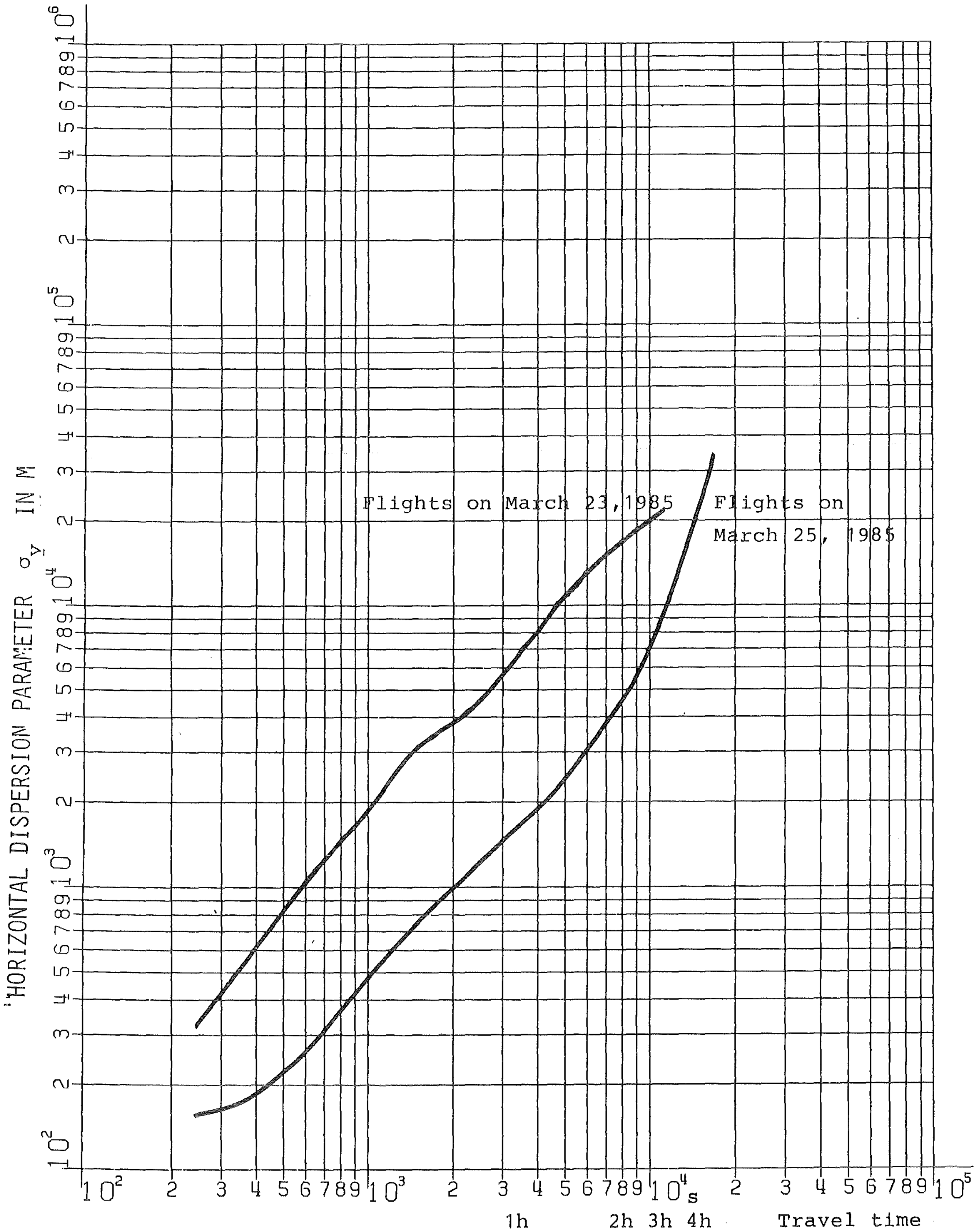


FIG. 49: HORIZONTAL DISPERSION PARAMETER σ_y BASED ON TETROON TRAJECTORIES AS A FUNCTION OF TIME (1985)

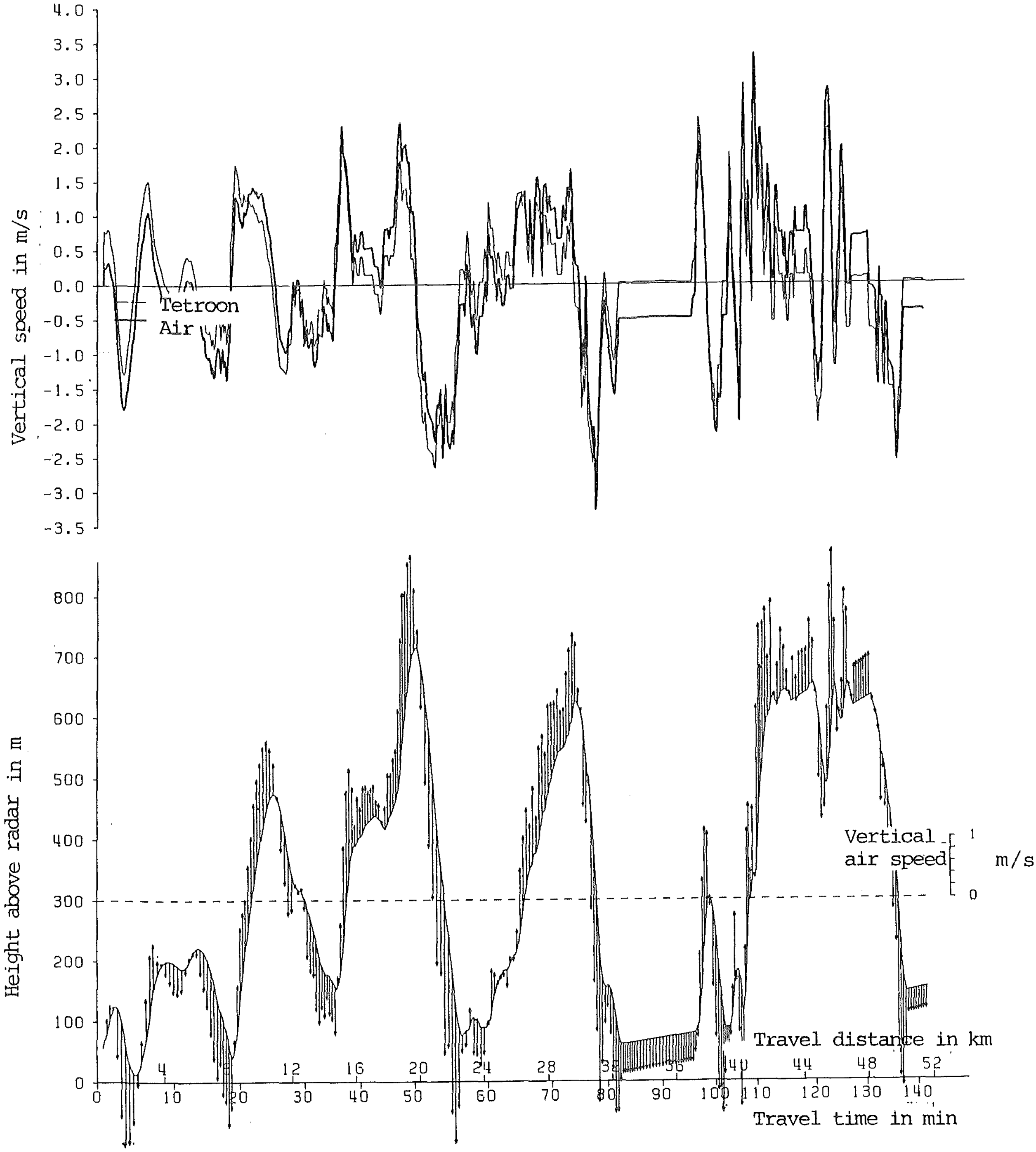


Fig. 50: Tetroon-derived vertical air speeds for flight MI8310. The traces at the top show the comparison between tetroon vertical speed and the vertical air speed.

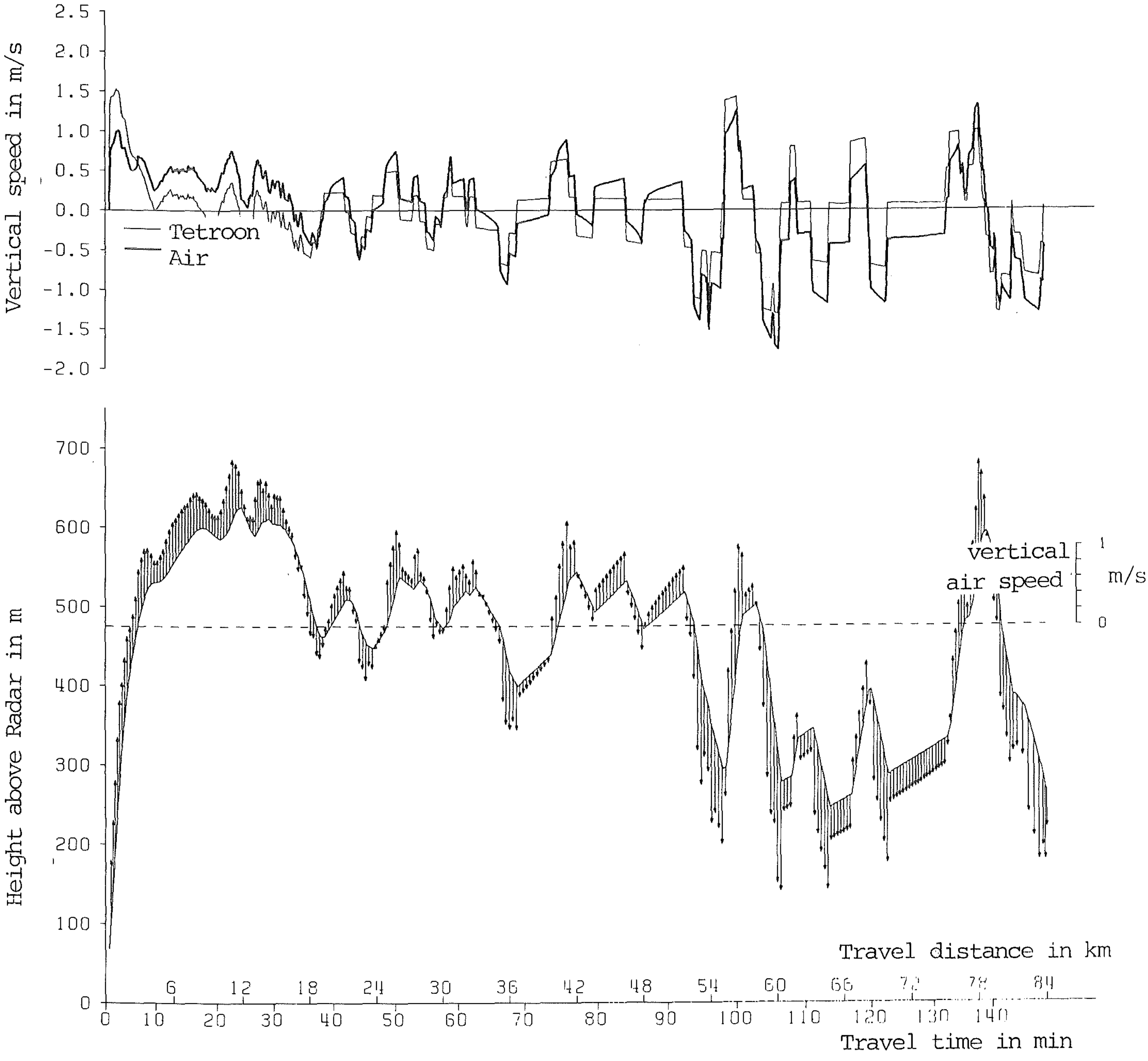


Fig. 51: Tetroon-derived vertical air speeds for flight TU8507.
The traces at the top show the comparison between tetroon vertical speed and the vertical air speed.

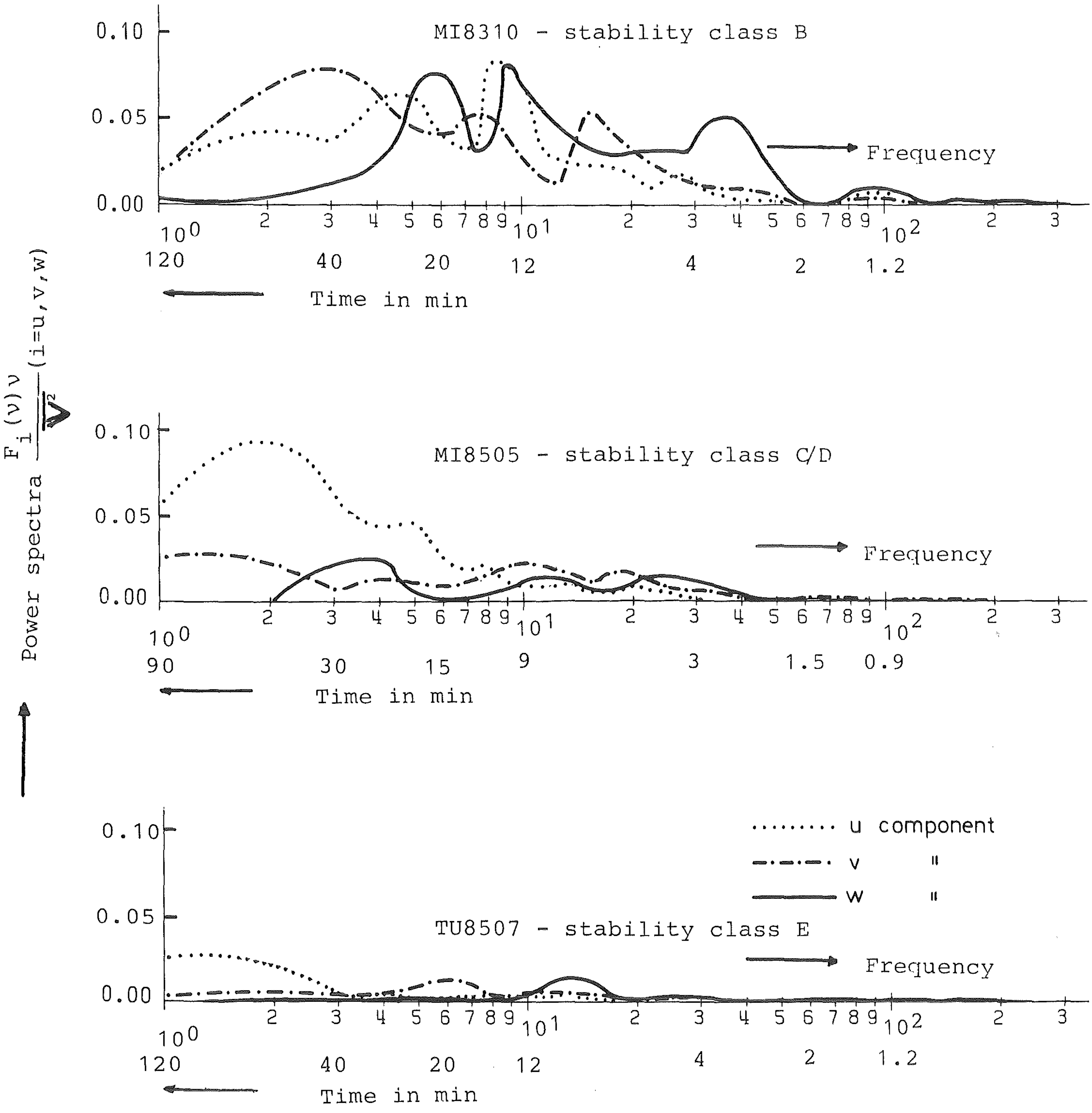


Fig. 52: Normalized power spectra of the three wind components.

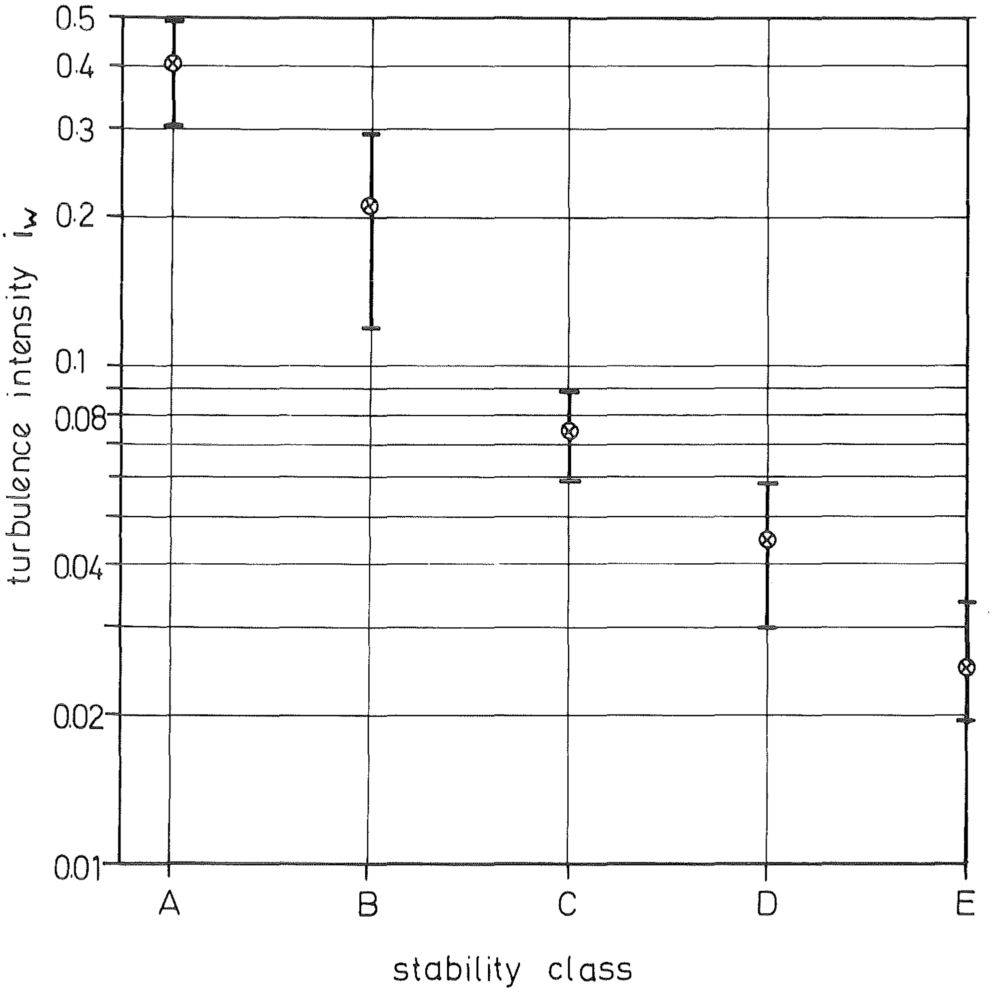


Fig. 53: Vertical turbulence intensity as a function of stability class.