NILU
TEKNISK NOTAT NR 7/78
REFERANSE: 00878
DATO: FEBRUAR 1978

KILDERL

BY
BRIAN LAMB

NORWEGIAN INSTITUTE FOR AIR RESEARCH
P.O. BOX 130. 2001 LILLESTRØM
NORWAY

KILDERL

KILDERL is a modified version of the NILU computer program called KILDER by Schjoldager (1974). These programs use the gaussian plume model to calculate the pollutant concentration at each point in a grid containing one or more emission sources. Both volume and point sources can be simulated. The basic formulations and procedures employed in KILDER remain unchanged in KILDERL. Thus, the KILDER program manuel should be consulted for descriptions and details concerning the application of KILDER and KILDERL. The primary purpose for modifying KILDERL was to evaluate the contribution of a source or group of sources to the total concentration. During the development of this capability the following provisions were included in KILDERL:

1) The concentration grid caused by one or more volume sources can be calculated and printed. The concentration grid caused by each point source can calculated and printed. The concentration grids resulting from two groups of sources can be calculated and printed. Finally, the concentration array produced by all sources will be calculated and printed (Figures 1, 2 and 3). These options are only applicable for a single meteorological situation (on Card 10, IOBS=1).

2) The concentration profile along any one X-axis and/or along any one Y-axis can be plotted (Figures 4 and 5).

3) The concentration array resulting from all sources can be plotted in 3 dimensions as a function of X and Y (Figure 6).

4) The topography data can be printed and/or plotted in 3 dimensions as a function of X and Y (Figure 7).

5) The distance between grid points along either the X or Y axis equals MÅLEST/100 where MÅLEST is the map scale. In KILDER, the distance is calculated as MÅLEST/50.

6) For a specified concentration standard, C_S, and calculated concentrations, C(X,Y), the area (m^2) where $C(X,Y) > C_S$ can be calculated.

7) The value of an impact function, $I \equiv \int_Y \int_X C(X,Y)\, dxdy$ for $C(X,Y) > C_S$, can be estimated. For calculation purposes, the integrals are simplified to,

$$I = \sum_{J=1}^{Ymax} \sum_{J=1}^{Xmax} C_{ij} \cdot A$$

where A is the area per grid square. The calculated value of I roughly corresponds to the volume under the surface given by plotting C(X,Y) as a function of X and Y.

8) Concentrations can be calculated in $\mu g/m^3$ or for SF_6 emissions, in parts per trillion (1 part $SF_6/10^{12}$ parts air).

9) Deposited pollutant concentrations in grass $C_G(X,Y)$ can be calculated for a specified deposition velocity, VD, and total deposition time, T_D with the following formula,

$$C_G(X,Y) = C(X,Y) \cdot V_D \cdot T_D \cdot K$$

where K is a constant for conversion of units; the value of K used in the program is based on the assumption that there is an average vegetation cover equal to 400 grams/m^2. Values of C_G are calculated in ppm (dry weight).

In order to use KILDERL, the control cards and input data should be punched as follows:

CONTROL CARDS:

```
NAME, CM200000, PC, MT1
CHARGE, X0032H - XXXX.
ATTACH (KILDERL, ID = NILU)
LABEL, TAPE 7, W, L=PLOT, X= SV, Y, F = S, RING
KILDERL
```

If the plotting provisions are not used, the card "Label, tape 7 ...." should be removed from the control card sequence.

DATA INPUT FORMAT

Card 1

Variable: ITITLE (8)

Format 8A10

Cards 2-5

Variables: SIGA1(4), SIGE1(4), P1(4), R1(4)

Format : 8F10.2

These are the dispersion coefficients for calculating σ_y and σ_z for releases from heights less than 50 m.

$$\sigma_y = SIGA1\ X^{P1}$$

$$\sigma_z = SIGE1\ X^{R1}$$ where X is the downwind distance in meters.

Cards 6-9

Variables: SIGA2 (4), SIGE2(4), P2(4), R2(4)

Format : 8F10.2

These are the dispersion coefficients for calculating σ_y and σ_z for releases from heights greater than 50 m.

$$\sigma_y = SIGA2\ X^{P2}$$

$$\sigma_z = SIGE2\ X^{R2}$$

Card 10

Variables: IOBS, IUTSL, IFTID, IOPT, IRES, IXMAX, IYMAX

Format : 7 I10

- IOBS : Number of meteorological observations
- IUTSL : Number of emission sources
- IFTID : See KILDER manual
- IOPT : See KILDER manual
- IRES : IRES=1, calculate the concentration at a single point
- IXMAX : Number of grid points along the X-axis
- IYMAX : Number of grid points along the Y-axis

Card 11

Variables: HEIGHT, MÅLEST, NSEK, IKART, IHOYD, IXO, NSOURC

Format : 7I10

Height : Height above ground at which concentrations will be calculated (meters).

MÅLEST : Map scale

NSEK : See KILDER manual

IKART : IKART=0, map will be printed only for the whole period

: IKART=1, map will be printed for each time interval

IKART=2, maps will be printed for the contribution of the first "NSOURC" sources, for each point source, and for all sources.

IKART=3, maps will be printed for the contribution of the first NSOURC sources, for the contribution of the last (IUTSL-NSOURC) sources and for all sources.

IHOYD : IHOYD=1, the topography data will be printed

IXO : IXO=0, concentrations will be given in parts per trillion (1 part in 10^{12})

IXO=1, concentrations will be given in $\mu g/m^3$

NSOURC : Number of sources whose contributions will be summed and printed according to the value of IKART.

Card 12

Variables: IPLOT, IPROFL, IFX, IFY, ICON3D, ITOP3D

Format : 6I5

IPLOT : IPLOT=1, plots will be drawn (control cards must include "Label" card)

IPROFL : IPROFL=1, the concentration profile across the IFY row and/or along the IFX column will be plotted.

IFX : Column number to be plotted; IFX=0 no plot will be drawn.

IFY : Row number to be plotted; IFY=0 no plot will be drawn.

ICON3D : ICON3D=1, final concentration array will be plotted in 3 dimensions.

ITOP3D : ITOP3D=1, topography data will be plotted in 3 dimensions.
(ICON3D and ITOP3D cannot both equal 1; only one 3-dimensional perspective will be drawn during each run of the program.)

Card 13

Variables: ALPHA, BETA

Format : 2F10,1

ALPHA : Reflection factor from the ground

BETA : Reflection factor from an inversion lid.

Card 14

Variables: TMID, DELTAH, HFAK, XRES, YRES, VD, DTIME, STANDRD

Format : 8F10,1

TMID : Average air temperature during period.

DELTAH : See KILDER manual.

HFAK : Reduction factor for plume centerline height HFAK=0, topography data will not be read.

XRES,YRES: Coordinate of reception point for IRES=1

VD : Deposition velocity (cm/sec)

DTIME : Total deposition time (days)

STANDRD : Concentration standard ($\mu g/m^3$ or ppt). Area where concentration equals or exceeds standard will be calculated. The integral:

$$I = \int_X \int_Y C(X,Y)\, dxdy \quad \text{for } C > \text{STANDRD will also}$$

be calculated.

Cards 15 - (15+IYMAX, for IXMAX <12)
or (15+2•IYMAX, for IXMAX >12)

Variable: IY = 1, IYMAX
(HOYDE (IX,IY), IX = IXMAX).
Format : 12F5.0

HOYDE : Height of the ground above sea level (in meters)

The remaining cards are identical to those described in the KILDERL manual.

REFERENCE

Schjoldager, J. Program KILDER, NILU Tecnical Note 2/75. (1974).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
40	7	9	12	15	19	22	26	29	32	34	35	36	35	34	32	29	26	22	19	15	12	9	7	5
39	7	9	12	15	19	23	26	30	33	35	37	37	37	35	33	30	26	23	19	15	12	9	7	5
38	7	9	12	15	19	23	27	31	34	37	38	39	38	37	34	31	27	23	19	15	12	9	7	5
37	6	9	12	15	19	23	28	32	35	38	40	40	40	38	35	32	28	23	19	15	12	9	6	4
36	6	9	12	15	19	24	28	33	36	39	41	42	41	39	36	33	28	24	19	15	12	9	6	4
35	6	8	12	15	20	24	29	34	38	41	43	44	43	41	38	34	29	24	20	15	12	8	6	4
34	6	8	11	15	20	25	30	35	39	43	45	46	45	43	39	35	30	25	20	15	11	8	6	4
33	5	8	11	15	20	25	30	36	41	45	47	48	47	45	41	36	30	25	20	15	11	8	5	3
32	5	7	11	15	20	25	31	37	42	46	49	50	49	46	42	37	31	25	20	15	11	7	5	3
31	5	7	10	15	20	26	32	38	44	49	52	53	52	49	44	38	32	26	20	15	10	7	5	3
30	4	7	10	14	20	26	33	39	46	51	54	55	54	51	46	39	33	26	20	14	10	7	4	3
29	4	6	10	14	20	26	33	41	48	53	57	58	57	53	48	41	33	26	20	14	10	6	4	2
28	4	6	9	14	20	26	34	42	50	56	60	61	60	56	50	42	34	26	20	14	9	6	4	2
27	3	5	9	13	19	27	35	43	52	59	63	65	63	59	52	43	35	27	19	13	9	5	3	2
26	3	5	8	13	19	27	36	45	54	62	67	69	67	62	54	45	36	27	19	13	8	5	3	1
25	2	5	8	12	19	27	36	46	56	65	71	73	71	65	56	46	36	27	19	12	8	5	2	1
24	2	4	7	12	18	27	37	48	59	69	75	77	75	69	59	48	37	27	18	12	7	4	2	1
23	2	4	7	11	18	26	37	49	62	73	80	83	80	73	62	49	37	26	18	11	7	4	2	1
22	1	3	6	11	17	26	38	51	65	77	85	88	85	77	65	51	38	26	17	11	6	3	1	0
21	1	3	5	10	16	26	38	53	68	82	91	95	91	82	68	53	38	26	16	10	5	3	1	0
20	1	2	5	9	16	25	38	54	71	87	98	103	98	87	71	54	38	25	16	9	5	2	1	0
19	1	2	4	8	15	25	38	55	75	93	106	111	106	93	75	55	38	25	15	8	4	2	1	0
18	0	1	4	7	14	24	38	57	78	99	115	121	115	99	78	57	38	24	14	7	4	1	0	0
17	0	1	3	7	13	23	38	58	82	107	126	133	126	107	82	58	38	23	13	7	3	1	0	0
16	0	1	2	6	12	22	38	59	86	115	138	147	138	115	86	59	38	22	12	6	2	1	0	0
15	0	0	2	5	11	21	37	60	90	124	153	164	153	124	90	60	37	21	11	5	2	0	0	0
14	0	0	1	4	10	21	37	60	94	135	171	186	171	135	94	60	37	21	10	4	1	0	0	0
13	0	0	1	3	9	20	36	61	97	146	194	214	194	146	97	61	36	20	9	3	1	0	0	0
12	0	0	0	3	8	19	36	62	100	159	223	252	223	159	100	62	36	19	8	3	0	0	0	0
11	0	0	0	2	7	18	37	63	103	173	262	308	262	173	103	63	37	18	7	2	0	0	0	0
10	0	0	0	1	5	17	38	66	104	186	320	396	320	186	104	66	38	17	5	1	0	0	0	0
9	0	0	0	0	4	15	39	71	107	197	342	405	342	197	107	71	39	15	4	0	0	0	0	0
8	0	0	0	0	2	13	41	80	108	141	359	417	359	141	109	80	41	13	2	0	0	0	0	0
7	0	0	0	0	1	9	43	94	127	136	374	432	374	136	127	94	43	9	1	0	0	0	0	0
6	0	0	0	0	0	5	43	115	153	158	158	454	158	158	153	115	43	5	0	0	0	0	0	0
5	0	0	0	0	0	1	39	152	191	192	192	192	192	192	191	152	39	1	0	0	0	0	0	0
4	0	0	0	0	0	0	21	236	258	258	258	258	258	258	258	236	21	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	327	327	327	327	327	327	327	327	327	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 1: Concentration grid caused by 10 area sources.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
40	6	7	9	10	11	12	13	13	13	12	11	10	9	7	6	5	4	3	2	1	1	0	0	0
39	6	7	9	10	11	12	13	13	13	12	11	10	9	7	6	5	4	3	2	1	1	0	0	0
38	6	8	9	11	12	13	14	14	14	13	12	11	9	8	6	5	3	2	2	1	0	0	0	0
37	6	8	9	11	12	13	14	14	14	13	12	11	9	8	6	5	3	2	1	1	0	0	0	0
36	6	8	10	11	13	14	15	15	15	14	13	11	10	8	6	5	3	2	1	1	0	0	0	0
35	6	8	10	12	13	15	15	16	15	15	13	12	10	8	6	4	3	2	1	1	0	0	0	0
34	6	8	10	12	14	15	16	16	16	15	14	12	10	8	6	4	3	2	1	1	0	0	0	0
33	6	8	10	12	14	16	17	17	17	16	14	12	10	8	6	4	3	2	1	0	0	0	0	0
32	6	8	10	13	15	17	18	18	18	17	15	13	10	8	6	4	3	2	1	0	0	0	0	0
31	6	8	10	13	15	17	19	19	19	17	15	13	10	8	6	4	3	1	1	0	0	0	0	0
30	6	8	11	13	16	18	20	20	20	18	16	13	11	8	6	4	2	1	1	0	0	0	0	0
29	6	8	11	14	17	19	21	21	21	19	17	14	11	8	6	4	2	1	0	0	0	0	0	0
28	5	8	11	14	17	20	22	22	22	20	17	14	11	8	5	3	2	1	0	0	0	0	0	0
27	5	8	11	15	18	21	23	24	23	21	18	15	11	8	5	3	2	1	0	0	0	0	0	0
26	5	8	11	15	19	22	24	25	24	22	19	15	11	8	5	3	1	1	0	0	0	0	0	0
25	5	7	11	15	20	23	26	27	26	23	20	15	11	7	5	3	1	0	0	0	0	0	0	0
24	4	7	11	16	20	25	28	29	28	25	20	16	11	7	4	2	1	0	0	0	0	0	0	0
23	4	7	11	16	21	26	29	31	29	26	21	16	11	7	4	2	1	0	0	0	0	0	0	0
22	3	6	11	16	22	28	32	33	32	28	22	16	11	6	3	2	0	0	0	0	0	0	0	0
21	3	6	10	16	23	29	34	36	34	29	23	16	10	6	3	1	0	0	0	0	0	0	0	0
20	2	5	10	16	24	31	37	39	37	31	24	16	10	5	2	1	0	0	0	0	0	0	0	0
19	2	5	9	16	25	33	40	42	40	33	25	16	9	5	2	1	0	0	0	0	0	0	0	0
18	1	4	9	16	25	35	43	46	43	35	25	16	9	4	1	0	0	0	0	0	0	0	0	0
17	1	3	8	15	26	38	47	51	47	38	26	15	8	3	1	0	0	0	0	0	0	0	0	0
16	0	2	7	15	26	40	52	56	52	40	26	15	7	2	0	0	0	0	0	0	0	0	0	0
15	0	2	6	13	27	43	57	63	57	43	27	13	6	2	0	0	0	0	0	0	0	0	0	0
14	0	1	4	12	26	45	63	70	63	45	26	12	4	1	0	0	0	0	0	0	0	0	0	0
13	0	0	3	10	25	48	71	80	71	48	25	10	3	0	0	0	0	0	0	0	0	0	0	0
12	0	0	2	8	23	50	79	92	79	50	23	8	2	0	0	0	0	0	0	0	0	0	0	0
11	0	0	1	5	20	52	90	108	90	52	20	5	1	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	3	16	51	103	129	103	51	16	3	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	1	10	48	117	158	117	48	10	1	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	5	39	133	199	133	39	5	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	1	25	146	263	146	25	1	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	8	143	368	143	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	88	560	88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	2	892	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	△ 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 2: Concentration grid caused by a single point source.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
40	14	17	21	26	30	35	39	42	45	46	47	46	45	42	38	34	30	25	21	17	13	10	8	5
39	13	17	22	26	31	36	40	44	46	48	49	48	46	43	39	35	30	26	21	17	13	10	7	5
38	13	17	22	26	32	36	41	45	48	50	51	50	48	45	41	36	31	26	21	17	13	10	7	5
37	13	17	22	27	32	37	42	47	50	52	53	52	49	46	42	37	32	26	21	17	13	9	7	5
36	13	17	22	27	33	38	44	48	52	54	55	54	51	48	43	38	32	27	21	17	13	9	6	4
35	12	17	22	27	33	39	45	50	54	56	57	56	53	49	44	39	33	27	21	16	12	9	6	4
34	12	17	22	28	34	40	46	52	56	58	59	58	55	51	46	40	33	27	21	16	12	8	6	4
33	12	16	22	28	35	41	48	54	58	61	62	61	58	53	47	41	34	27	21	16	12	8	5	3
32	11	16	22	28	35	42	49	56	60	63	64	63	60	55	49	42	34	27	21	16	11	8	5	3
31	11	16	21	28	36	43	51	58	63	66	67	66	62	57	50	43	35	28	21	15	11	7	5	3
30	10	15	21	28	36	45	53	60	66	69	71	69	65	59	52	44	35	28	21	15	10	7	4	3
29	10	15	21	28	37	46	55	62	69	73	74	72	68	62	54	45	36	28	21	15	10	6	4	2
28	9	14	21	28	37	47	56	65	72	76	78	76	71	64	55	46	37	28	20	14	9	6	4	2
27	9	14	20	28	38	48	58	68	75	80	82	80	75	67	57	47	37	28	20	14	9	6	3	2
26	8	13	20	28	38	49	60	71	79	84	86	84	78	70	59	48	37	28	20	13	8	5	3	1
25	7	12	19	28	39	51	63	74	83	89	91	88	82	73	61	49	38	28	19	13	8	5	2	1
24	7	12	19	28	39	52	65	77	87	94	96	93	87	76	64	51	38	27	19	12	7	4	2	1
23	6	11	18	28	39	53	67	81	92	99	102	99	91	80	66	52	38	27	18	11	7	4	2	1
22	5	10	17	27	40	54	70	85	97	105	108	105	97	84	69	53	39	27	17	11	6	3	1	0
21	5	9	16	27	40	56	72	89	102	112	115	112	102	88	71	54	39	26	17	10	5	3	1	0
20	4	8	15	26	40	57	75	93	108	119	123	119	109	93	74	55	39	26	16	9	5	2	1	0
19	3	7	14	25	40	58	78	98	115	127	131	128	116	98	77	56	39	25	15	8	4	2	1	0
18	2	6	13	24	40	60	82	103	122	135	141	138	124	104	80	58	39	24	14	7	4	1	0	0
17	2	5	11	23	40	61	86	109	130	145	152	149	134	111	84	59	38	23	13	7	3	1	0	0
16	1	4	10	21	39	63	90	116	138	156	165	162	145	118	87	59	38	22	12	6	2	1	0	0
15	0	2	8	19	38	65	95	123	148	168	180	178	159	126	91	60	37	21	11	5	2	0	0	0
14	0	1	6	17	37	67	100	131	158	181	198	198	176	136	94	61	37	21	10	4	1	0	0	0
13	0	1	4	14	35	68	107	142	169	195	219	225	197	147	98	61	36	20	9	3	1	0	0	0
12	0	0	2	11	32	70	116	155	180	210	247	260	225	159	101	62	36	19	8	3	0	0	0	0
11	0	0	1	7	27	70	127	172	193	225	283	313	263	173	103	63	37	18	7	2	0	0	0	0
10	0	0	0	4	22	69	141	195	207	238	[illegible]	399	320	186	104	66	38	17	5	1	0	0	0	0
9	0	0	0	2	15	63	157	229	224	245	358	407	347	[illegible]	107	71	39	15	4	0	0	0	0	0
8	0	0	0	0	7	53	175	280	242	[illegible]	364	417	359	141	109	80	41	13	2	0	0	0	0	0
7	0	0	0	0	2	35	189	357	274	[illegible]	376	452	374	136	127	94	43	9	1	0	0	0	0	0
6	0	0	0	0	0	14	187	483	297	167	[illegible]	454	[illegible]	158	153	115	43	5	0	0	0	0	0	0
5	0	0	0	0	0	1	128	712	279	192	192	192	192	192	191	152	39	1	0	0	0	0	0	0
4	0	0	0	0	0	0	241	1128	260	258	258	258	258	258	258	236	21	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	327	327	327	327	327	327	327	327	327	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 3: Concentration grid caused by a point source and 10 area sources.

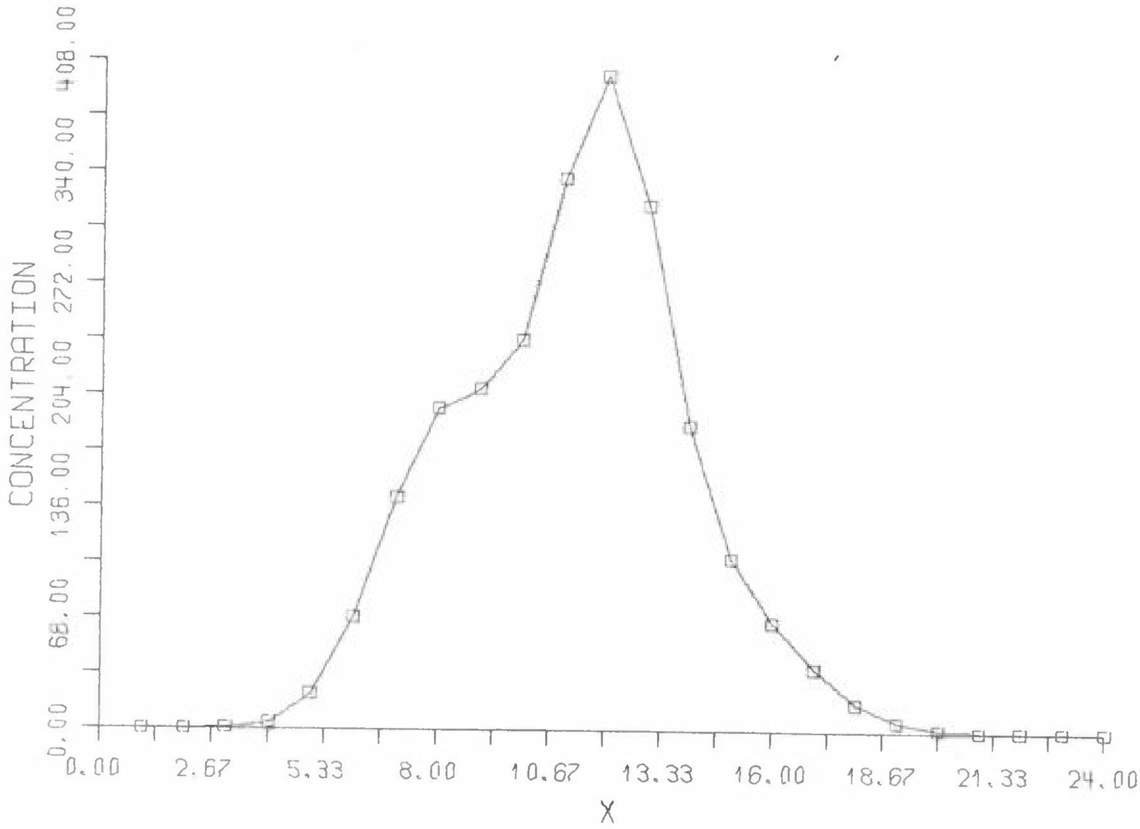

Figure 4: Crosswind plume profile calculated for IFY=10

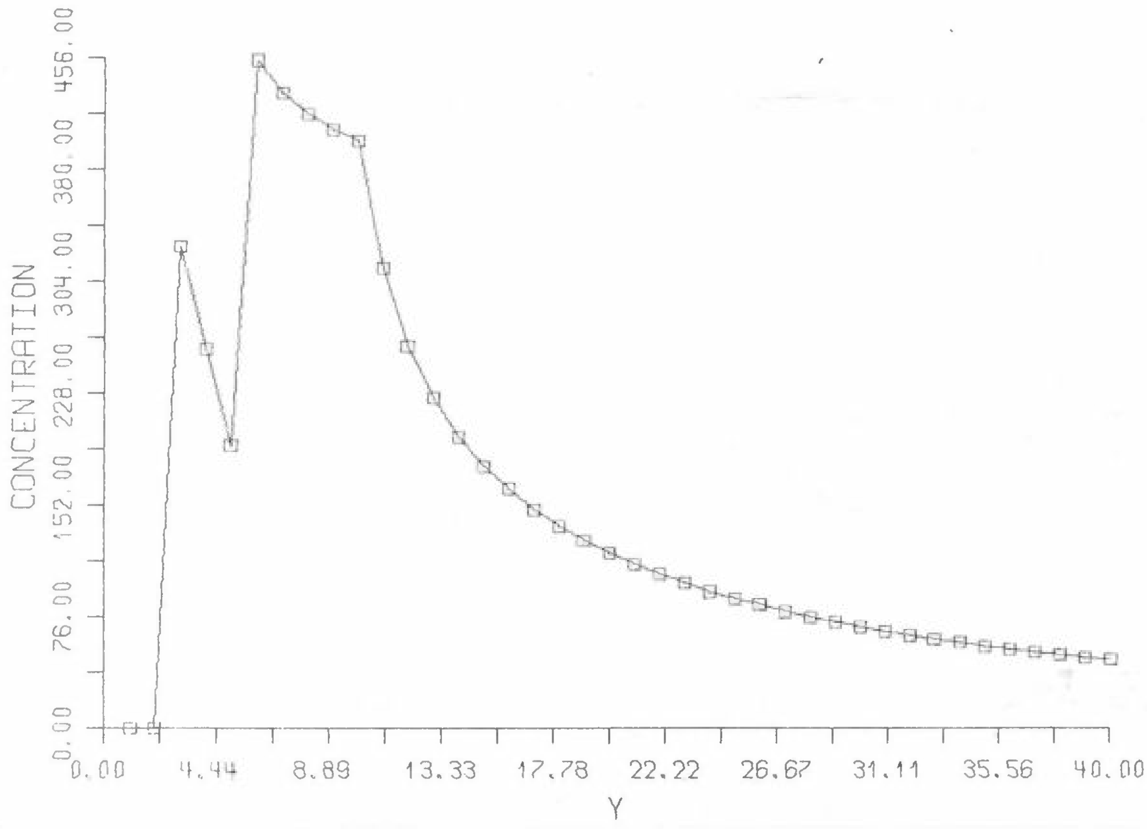

Figure 5: Concentration profile parallel to the wind calculated at IFX = 12

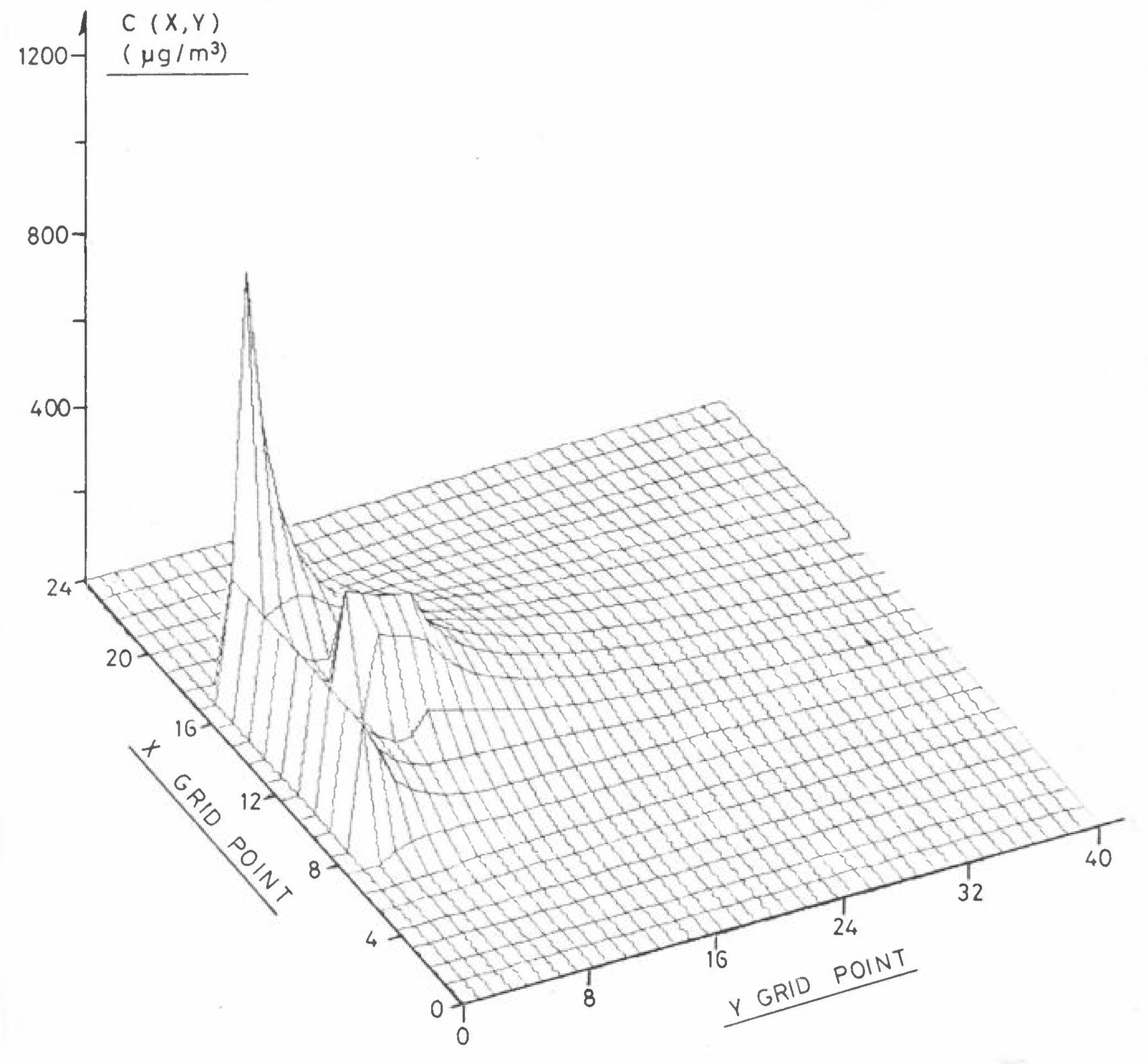

Figure 6: Three-dimensional concentration array: C(x,y).

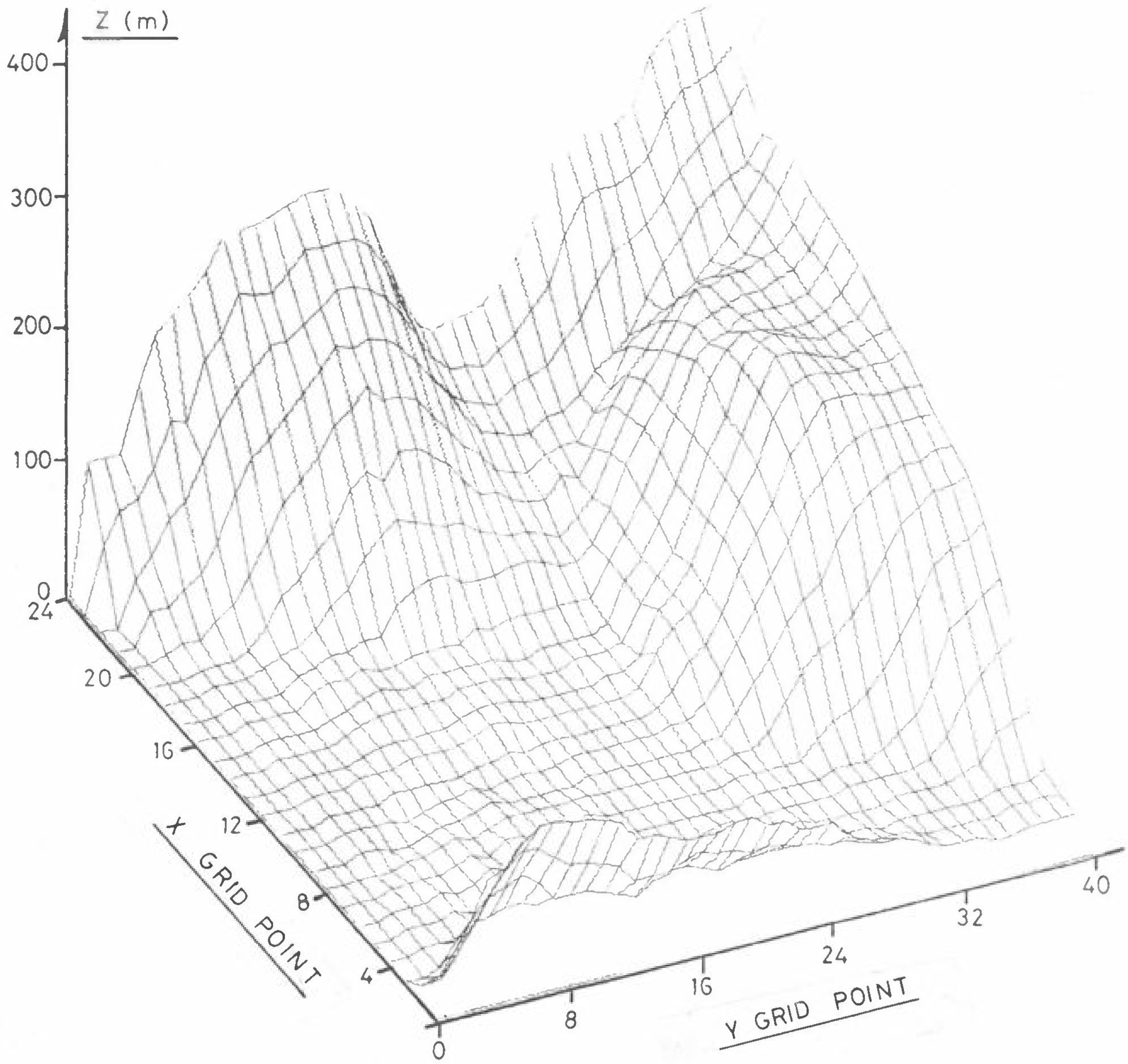

Figure 7: Three dimensional topographical perspective.