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USER'S GUIDE FOR THE "KILDER" DISPERSION MODELLING SYSTEM

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SUMMARY

This report contains a multiple source description of the Gaussian type dispersion models POINT-KILDER and AREA-KILDER, which are operational at the NORD ND-560 computer at the Norwegian Institute for Air Research (NILU). It also contains a description of three supporting programs, READ-FIELD, PRINT-FIELD and SUM-FIELD. The programs are part of a program system at NILU, going from calculating emissions and concentrations from different source types and components to presentations and exposure calculations.

In this report we have presented program examples based upon data from model calculations performed by NILU for the lower Nervion area (Bilbao) in Spain. The data are only test examples and should not be used in other connections.

The program POINT-KILDER calculates sector averaged long term concentrations at ground level in a grid of receptor points, with emissions from several point sources, taking into account data on dispersion, topography, buildings and penetration through an upper stable layer.

The program AREA-KILDER calculates sector averaged long term concentrations at ground level in a grid of receptor points, from sources in an emission field given in the same grid system. The program divides each grid area source into 100 point sources and takes into account the impact from the area source within its own square.

In connection to the dispersion models POINT-KILDER and AREA-KILDER, NILU has developed a set of service programs to evaluate the input and results of the calculations. To prepare a data field for input to the dispersion calculations the program READ-FIELD may be used, whereas PRINT-FIELD presents a print-out of data or results. The program SUM-FIELD gives the sum of several data or result fields, for instance the sum of concentration fields from KILDER-runs for different source groups.

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USER´S GUIDE FOR THE "KILDER" DISPERSION MODELLING SYSTEM

1 INTRODUCTION

The KILDER dispersion model system has been in use at the Norwegian Institute for Air Research (NILU) for about 15 years. The models have been continuously revised and updated to include the latest theories for dispersion calculations. The programs POINT-KILDER and AREA-KILDER are versions of the NILU programs PUNKT-KILDER and AREAL-KILDER, where all input-output statements are translated to English, and some options are not included. In addition, we have today in use at NILU about 40 different supporting programs written in Norwegian (Gram, 1987), of which READ-FIELD, PRINT-FIELD and SUM-FIELD are translated into English and are described in this report.

The program system includes programs for such as calculating emissions from traffic, house heating and industrial sources, handling and presentation of data fields and exposure calculations. The last chapter of this report contains a list of all the programs in the NILU system including a short description.

The theoretical background for the Gaussian models and its applications in the NILU dispersion models is described in a separate report, T. Bøhler: "User´s guide for the Gaussian type dispersion models CONCX and CONDEP", NILU TR 8/87. The routines used in the KILDER system for calculating plume rise, buildings, penetration and topography are the same as in CONCX, and will not be described in this report.

2 THE KILDER SYSTEM AND FILE CONFIGURATION

The programs can operate in different modes: interactive or as a batch mode job. When running interactive, the program asks questions to the terminal, otherwise the program reads the input data from a run-file. It is possible to read some of the data from a separate file, such as fixed informations about the model area and the stack and emission data. All meteorological data, such as wind speed, inversion height and the meteorological frequency matrix are read from a separate file. The input records are read in free format, unless a format is specified.

The output of the programs is given in data fields with concentration values together with the print-out. It is possible to run the programs separately for different source categories, or even to use different meteorological data for the sources in separate sub-regions of the area. With SUM-FIELD we get the total concentration fields. The values are calculated for points located in the centre of each grid. Due to the need of a model which can work for several different areas, the models are using variable dimensioning in the source code, limited to a grid of KX*KY=1200 points, but this can easily be changed in the program code if necessary.

2.1 FILE TYPES

When carrying out model calculations for an area, the number of files are normally increasing rapidly. It has therefore proved to be important to give the files describing names.

The program system uses some standard file types:

Run-file	:RUN	For these files the file type must be given together with the file name
Input data file	:SYMB	
Output-file	:PRNT	These are special files where the file type is given by the program and shall not be specified
Result-file	:FELT	
METFIL-file	:MET	

At the NILU computer ND-560 16 characters may be used for a file name, in addition to 4 characters for the file type. If the file names and file-families are declared systematically it will be easier to recall the content of all the files.

2.2 DATA FIELDS

The main data communication between the different programs is made through files with data fields.

In the data fields the following data are written UNFORMATTED and stored as binary data:

```
KCOMP,UNIT,KX,KY,X(KX,KY)
```

KCOMP = Name of the compound which is calculated, (10 characters). This will normally be 'SO2', 'NOX' or 'CO', but may also be variables such as 'INHABITANT', 'HEIGHT' or 'TRAFFIC'

UNIT = Unit of the values which is in the field, (10 characters). This will for concentrations be 'UG/M3', for emission fields 'KG/H', but may also be 'PERSONS', 'M' or 'DIESEL-KM'

KX,KY = Dimensions for the data-field X, integers

X(KX,KY) Data-field with values of the real-variable array X in a KX*KY-matrix

At the ND-560 computer the files with data fields are declared with a file type :FELT, to distinguish them from other files. These files are not readable by the text editor. The formatted output from a program is put on a file with the same file name as the data field, but with file type :PRNT. Some of the -KILDER and -FIELD programs create several different fields which are written to the :FELT file. A :FELT file may thus contain several fields, and the programs have to ask for which field to be read.

2.3 THE METEOROLOGY INPUT FILE

The KILDER programs read all the meteorological data for a period or for a region from a file called METFIL, which has to be specified as :MET. All KILDER programs reads from the same file, but they do not always use all the data on the file. The program METFREC gives an output file with a joint frequency matrix and some other data, but this has to be adjusted to obtain the correct METFIL-format.

When making calculations for different seasons or for different parts of an area, we only need to change to another :MET-file.

The following data should be included in the METFIL file:

PERIOD	Which data period is used (max. 20 char.)
TMID	Average temperature for the period (^{0}C)
VIND<4>	Average wind speed for each wind speed class (m/s) (from METFREC)
ZO	Height of wind measurements

The wind speed Uz at the height Z is calculated in the plume rise calculations in POINT-KILDER:

$$U_z = U_O \left(\frac{Z}{Z_O}\right)^{RN}$$

where RN is a stability dependent wind profile exponent.

YRN — The program asks if we want standard values RN=0.20,0.28,0.36,0.42: Y/N

If the answer is N, then the program reads:

RN<4> — New values for the wind profile exponents for the four stability classes

YIN — The program asks for default value HINV=1000 meter for the mixing height: Y/N

If the answer is N, then the program reads:

HINV<4> Stability dependent mixing height. The vertical dispersion parameter sigma z is not allowed to increase more than to HINV. The program POINT-KILDER calculates the partial penetration through a stable layer at height HINV.
The ground level concentration is reduced according to the calculated penetration factor P.

FREK<4,4,12> Format:(4X,16F4.1)
Joint frequency matrix from METFREC, 4 classes of stability, 4 wind speed classes and 12 wind direction sectors. One line for each sector. Each line may start with a direction, but this is not read.

STIL<4> Format:(4X,4F4.1)
Frequency of "calm" from METFREC, in 4 classes of stability. KILDER adjusts the matrix for "calm" by distributing the frequency of "calm" according to the wind rose for the actual stability class.

A METFIL file may look as SUMMER-RIB:MET:

```
SUMMER BULK RICH   , 19.,       ,Period, average temperature.
1.1, 3.1, 4.8, 7.0,             ,Wind speed
10.0,                           ,Height for wind measurements
Y,                              ,Standard wind profile exp. Y/N?
N,                              ,Standard inv.height 1000m. Y/N?
1500,1200,500,300,              ,New inversion heights
 30 1.9  .2  .5  .4 1.5  .9  .1  .0  .2  .1  .0  .0  .0  .0  .0  .0
 60 1.4  .0  .1  .1  .7  .4  .1  .0  .1  .0  .0  .0  .0  .0  .0  .0
 90  .8  .1  .3  .2  .2  .2  .0  .0  .0  .1  .0  .0  .0  .0  .0  .0
120  .8  .3  .4  .2  .6  .4  .1  .0  .0  .1  .0  .0  .0  .0  .0  .0
150  .8  .3 1.3 1.0  .4 2.9 5.5  .6  .0 1.8  .7  .0  .0  .4  .1  .0
180  .5  .0 1.2  .8  .1 1.4 3.3  .1  .0  .4  .6  .0  .0  .1  .1  .0
210  .8  .3 1.2 1.5  .1  .4  .8  .0  .0  .1  .1  .0  .0  .2  .0  .0
240  .0  .0  .2  .6  .0  .0  .0  .0  .0  .1  .0  .0  .0  .2  .0  .0
270  .2  .0  .4  .7  .1  .1  .0  .0  .0  .1  .0  .0  .0  .0  .0  .0
300 2.3  .6 1.4  .9 1.8 3.4  .6  .1 1.3  .8  .0  .0  .1  .2  .0  .0
330 1.7  .3  .4  .6 6.4 3.1  .2  .0 9.1 6.9  .0  .0 1.4 4.6  .0  .0
360 1.2  .2  .2  .4 2.3  .8  .1  .1  .4  .4  .0  .0  .3  .1  .0  .0
     .3  .0  .0 1.1          ,Calm
```

The first part of the data are read in free format. The text to the left may be useful, but is not read by the program. The last part is read formatted, as described above.

2.4 DATA INPUT FORMAT

The programs will often read values into an array, noted in the program description by < >. VIND<4> means that the program shall read 4 values, according to the FORTRAN notation (VIND(I),I=1,4).

Data are normally read in free format (separated by commas), unless a format is specified. When all data from a data line is read, we may put additional comments, as described in the example above.

In a formatted read each column on a line has its special significance. The variable type and the number of columns this variable occupies must be specified.

Character variables such as name, text etc. are read in A-format.
A10 means: read 10 characters.

Integers are read in I-format, f.eks. I5 which means: read an integer number within a field of 5 places, right-hand adjusted.

Other variables (real) are read in F-format or E-format. The format F6.2 means: read the number within a field of 6 places. If there is a decimal point (.) within the field, this is used. Otherwise, the program puts a decimal point two places from the right-hand side. Extreme high or small numbers may be read in E-format, but this needs more space. As an example: The number -1.234E-6 is read in the format E9.3, which means a mantissa with six locations and an exponent with three locations.

The notation T26 in a format statement means that the reading shall continue from column 26.

3 THE GAUSSIAN PLUME EQUATION

The Gaussian plume equation calculates the downwind concentration of an inert gas being continuously emitted from a single source. When applying sector averaging it is assumed that the cross wind concentration distribution is constant within an angular sector corresponding to the resolution in the wind direction data.

Normally a joint frequency distribution of 4 stability classes, 4 wind speed classes and 12 wind directions (30^0 sectors) is used. The Gaussian dispersion formula for the ground level concentration with sector averaging in n sectors and with emissions from p point sources can then be expressed as follows:

$$C(x,y,0) = n/2\pi \sum_{i=1}^{p} \sum_{k=1}^{12} \sum_{l=1}^{4} \sum_{m=1}^{4} f(k,l,m) * Q_i * D(x_i,u) * S(p,k) * (1.0-P)$$

where the dispersion function $D(x_i,u)$ is defined as

$$D(x_i,u) = \sqrt{2/\pi} * (1+\alpha)/2 * \exp(-1/2 * (H/\sigma_z)^2) / (us * x_i * \sigma_z),$$

the sector function S(p,k) as

$$S(p,k) = \begin{cases} 1 \text{ if receptor point is within sector k downwind of source p} \\ 0 \text{ otherwise} \end{cases}$$

P = fraction of the plume that penetrates an elevated stable layer

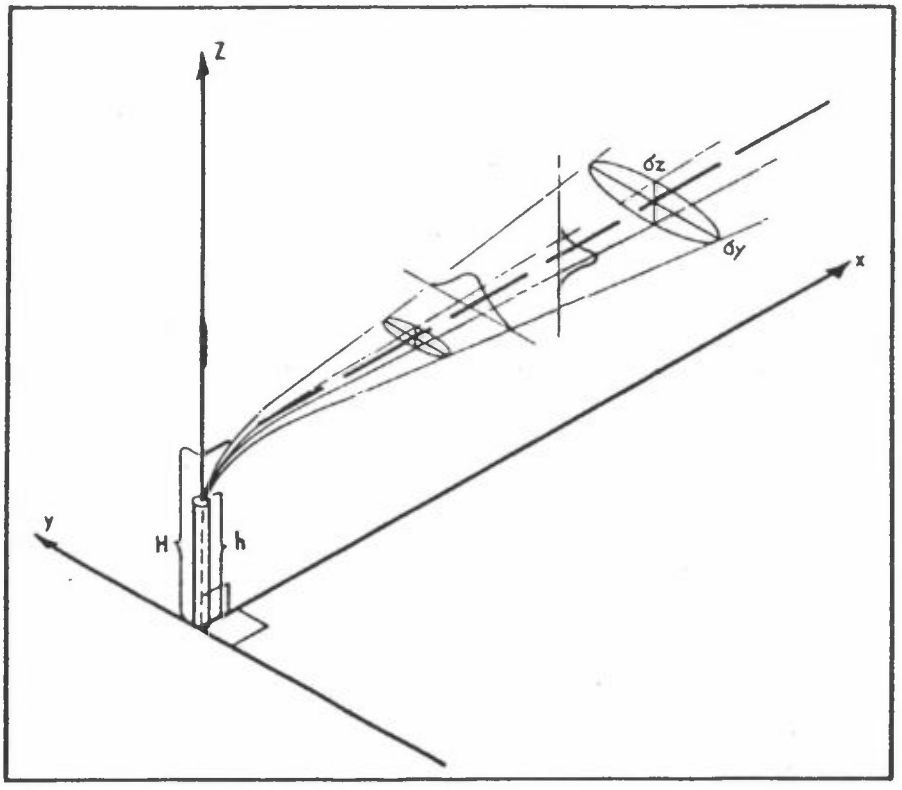
and

f(k,l,m) = the frequency of occurrence for wind sector k, wind speed class l and stability class m

(x,y,0) = location of the receptor point given in Cartesian coordinates with the origin at ground level at the source location and x-axis parallel to wind direction

x_i = distance from the source to the receptor (m)
Q_i = continuous source emission rate (kg/h or g/s)
H = effective plume height (m)
α = ground level reflection coefficient
n = number of sectors = 12
σ_z = standard deviation of the vertical concentration distribution
us = mean transport wind speed

For further discussion of the use of the Gaussian plume model see Bøhler (1987).



4 DISPERSION CALCULATIONS FOR AREA SOURCES

An area source represents the emission from several small sources within a grid square, mostly from domestic heating, small industries and road traffic. The emission field is often calculated from fields with oil consumption or traffic work.

In the program AREA-KILDER the pollution contribution from an area source is taken into account by considering 100 point sources evenly distributed over the square-km (Fortak, 1970). The contribution from an area source is tabulated as a function of distance, wind speed and dispersion conditions. Actual concentration values are calculated by linear interpolation between tabulated values.

Each area source is assigned to a box class, which defines the height of the initial vertical turbulence elements, which again is a function of the average building height.

The vertical standard deviation σ_z is calculated from:

$$\sigma_z^2 = \sigma_{z_o}^2 + H_b^2 \cdot F_a$$

where

$\sigma_{z_o} = a * x^p$

H_b = box height

F_a = wind speed correction factor = $0.5 * (1.0 + 0.7/u)^2$

u = mean wind speed for the wind speed class.

5 POINT-KILDER

The program POINT-KILDER calculates sector averaged long term concentrations at ground level in a grid og receptor points, with emission from several point sources, taking into account data on dispersion, topography, buildings and penetration through an upper stable layer.

5.1 INPUT DATA FOR POINT-KILDER

The program POINT-KILDER may be run interactive, as a mode job or as a batch job. The first time the program should be run interactive, to get familiar with the dialogue. Later a RUN-file is prepared, and for later runs this may be changed in the editor.

This description shows how to run the program at the ND-560 computer at NILU. At other installations there may be local changes. For interactive computations the program will give questions to the screen, but these are not described here.

Some data will always be read from the terminal/batch file, and these are noted in the description with an asterisk at the beginning of the line.

* @ENTER,user,password,project password,time limit

* @ND POINT-KILDER

* KX,KY — Dimension of the area, number of grid points easterly and northerly

* IN — 1: input from terminal/batch file
2: input from a separate file

If IN=2, the program reads:

* INFI — Name of the input file
All data which should remain constant are read from this file, whereas data which is varied from one run to another should be taken from the RUN-file.

From terminal/batch the program askes for:

* OUTFI — Name of the output file. The name of the file is abbreviated to max. 11 characters, and 4 characters from the component name KCOMP is added. The data field is put on the file OUTFI-KCOMP:FELT, whereas the output is put on the file OUTFI-KCOMP:PRNT.

From the input file INFI (or the terminal/batch if IN=1) the program reads:

Standard components are: 1=SO2, 2=NOX, 3=CO, 4=PARTICLES, 5=HC, 6=OTHER OK? Y/N:

YN — If standard components is used, the answer is Y, otherwise N

If YN=N, the program reads (LCOMP(I), I=1,6)
6 new names of the components

From terminal/batch the program asks for:

* ICOMP — The calculations are carried out for compound no. ICOMP, which is called KCOMP=LCOMP(ICOMP). The first 4 characters of the compound name will be combined with OUTFI to give the output file name

Reading from INFI (or the terminal/batch if IN=1) continues:

TEXT	One line with text as a heading for the calculations
IGRID	Grid size (in meters)
UTMX,UTMY	UTM-coordinates for the lower left corner of the grid. Normally the source positions should be given in UTM-coordinates (see below), but they may also be given in local coordinates with UTMX=UTMY=0.0
ANORD	It is possible to rotate the model area. ANORD tells the direction of the y-axis of the model area (in degrees), normally 0.0
BACKG	Background concentration which may be added. For a composite calculation with different source groups the background should be added when we are making the sum of the data fields in SUM-FIELD
TOP	Do you want to correct for topography? Y/N

If TOP=Y, the program asks for

TOPFIL	Name of the topography field (which should be a :FELT file)
DGR	Standard ground level reflection factor ALPHA = 1.0 OK? Y/N

If DGR=N, the program asks for

ALPHA	Ground level reflection factor, which is the relative amount of inert gas reflected from the surface by impaction. Can be used to estimate the effect of deposition on concentrations.

DHL — It is possible to use different dispersion parameters for high and low sources (Brookhaven/McElroy-Pooler) if we read IDISP=3 in the routine SIGMA (see below) Standard limit between high and low sources = 50m OK? Y/N

If DHL=N, the program asks for

HL — New limit for distinguishing between high and low sources. Sources with effective stack height >HL will use dispersion parameters for high sources, others for low sources.

The subroutine SIGMA reads:

IDISP — Selection of dispersion parameters:
1: McElroy-Pooler
2: Brookhaven
3: McElroy-Pooler for low sources, Brookhaven for high sources with effective stack height > HL
4: New values

If IDISP=4, the program asks for

SIGL
(CZL(I),I=1,4)
(PZL(I),I=1

Name and dispersion parameters for low sources

$$\sigma_z \text{ (low)} = CZL \cdot X^{PZL}$$

SIGH
(CZH(I),I=1,4)
(PZH(I),I=1

Name and dispersion paramenters for high sources

$$\sigma_z \text{ (high)} = CZH \cdot X^{PZH}$$

Stack data are read in the subroutine EMPIPE

From terminal/batch the program asks for:

* NSGR,(FAGR(I),I=1,NSGR)

NSGR = number of source group codes

FAGR = factors for these

It is possible to separate the sources into groups (see below). By this we may include or exclude groups of sources. This is useful especially when the sources are influenced by different dispersion conditions in different areas.

Reading from INFI (or the terminal/batch if IN=1) continues:

JUT

1: Emissions in g/s

2: Emissions in kg/h

PIFORM

Input format for stack data, enclosed in parentheses ( ).

The program reads one dummy line with heading for the stack data, and then reads the stack data according to PIFORM, until a line starting with END is given:

PIPE,(SKOR(I),I=1,8),KOD,(UT(I),I=1,ICOMP)

PIPE	Source name
SKOR(1)	UTMX
SKOR(2)	UTMY
SKOR(3)	Stack height
SKOR(4)	Stack diameter
SKOR(5)	Gas temperature
SKOR(6)	Gas velocity
SKOR(7)	Building height (default 10 m)
SKOR(8)	Building width (default 30 m)
KOD	Source group code (default=1)
UT	Emission data for max. 6 compounds

Only sources with emission rates different from zero are included in the further calculations. The numbering of a source is thus to some extent depending on what is done to the other sources higher up on the list. Instead of using the idea of group codes some of the users of this program have preferred to enter the source list in the editor, rearrange it and move the END line below the last source which is to be included.

All data SKOR(3)-SKOR(6) must be present, otherwise the program skips the source and gives a warning message.

If the stack data is read from file (IN=2) it is possible to adjust the emission rates without changing the data on the file:

* NUSC Number of emission figures which should be re-scaled

If NUSC > 0 the program asks for:

* IZ,SCALE Scale factor for source no. IZ

* YAP Is this source no. correct? Y/N
  If N, try again with a correct IZ

The name of the MET-file is read from terminal/batch:

* METFIL Name of the file with meteorological data. The file should be of the type :MET. See the separate description of of this file in chapter 2.3.

* YCO Finally the program asks if we want a survey of the contribution from each point source in selected grid points (max.8): Y/N

If YCO=Y, the program reads:

NPO,(IPO(1,I),IPO(2,I),I=1,NPO)

NPO Number of grid points (max.8)

IPO(1,I),IPO(2,I) I- and J-indices for each grid point

5.2 TEST EXAMPLE FOR POINT-KILDER

This test example shows a case with two different source groups with separate meteorology files. The output from the program is shown in Appendix A.

The program POINT-KILDER uses four different files: TEST-POINT:MODE, TEST-POINT:DATA and the two met-files SUMMER-RIB:MET and SUMMER-HIST:MET. The met-file SUMMER-RIB:MET is described above and SUMMER-HIST:MET is similar.

The program POINT-KILDER has to be run twice and the MODE-file TEST-POINT:MODE will be:

```
@ND POINT-KILDER
12,16,                    Grid size
2,                        Input data from file
TEST-POINT:DATA,          Input file name
TE-PO-SUM-1,              Output file name for source group 1
2,                        Component no. 2, 'SO2 SUM'
2,1,0,                    2 source groups, only gr.1 is included
0,                        No scaling of individual sources
SUMMER-RIB,               Met-file for source group 1 (without :MET)
Y,                        Contribution in selected grid points
5,8,3,6,6,7,9,4,13,8,14,  5 grid points
@ND POINT-KILDER
12,16,                    Grid size
2,                        Input data from file
TEST-POINT:DATA,          Input file name
TE-PO-SUM-2,              Output file name for source group 2
2,                        Component no.
2,0,1,                    2 source groups, only gr.2 is included
0,                        No scaling of individual sources
SUMMER-HIST,              Met-file for source group 2 (without :MET)
Y,                        Contribution in selected grid points
5,8,3,6,6,7,9,4,13,8,14,  5 grid points
```

The file TEST-POINT:DATA will be:

```
N,                      Not standard components
SO2AV,SO2SUM,,,,,,      New component names
TEST POINT-KILDER
1000,                   Grid size
506.00,4784.00,         UTM x and y
310.72,                 Direction of north in the model area
0.0,                    Background
N,                      No correction for topography
Y,                      Alpha=1.0
Y,                      Limit high/low=50m
2,                      Brookhaven
2,                      Emissions in kg/h
```

```
(A10,2F8.2,T27,4F6.0,2F5.0,T61,I2,2F7.2)
SOURCE       UTMX    UTMY     H    D     T    VG  HE   AE K  SO2AV SO2SUMM
BA/003-15C 50095  479283 59.0 2.40  200  2.3              2  32.10  33.17
BA/003-15D 50095  479277 78.5 4.00  200  2.9              2   7.70   3.49
BE/008-2   50061  479458 50.0 1.50   63 11.6              1  91.06 110.77
BE/010-1   50213  479267 15.0 0.60  300  8.5              2  13.60   9.88
BI/023-1   50248  479194 42.0 0.65   45 11.7  20  100 2  13.30  16.85
BI/023-3   50247  479198 47.0 1.32   90 14.8  20  100 2  60.90  71.17
BI/033-1   50240  479188 60.0 1.00  200 18.5              2   5.90
ER/005-5   50368  479427 24.0 1.15   70  8.7              1   7.10   5.20
ER/005-8   50372  479422 24.0 0.79  120  4.6              1          8.71
ER/007-3   50407  479433 44.0 1.00  300 16.3              1  22.00  15.99
ER/020-1   50159  479584 80.0 2.00   15  7.0              1 150.00 150.00
ER/042-1   50120  479608 80.0 1.20   60 11.1              1 267.00 267.00
LE/003-1   49978  479675 39.5 1.00  200  1.0              1 122.47  81.59
LE/004-2   49980  479657 30.0 0.90  100  4.8              1          21.58
MO/003-1   49825  479573 26.0 1.50  200  4.8  15   40 1  56.80  64.84
PE/001-11  50009  479577 26.5 3.90  190  5.4  10  100 1  59.60  59.60
RA/010-3   50214  479270 21.0 0.60  300  4.3              2  86.80  64.94
RA/024-B1  50197  479167 15.0 0.80  175 14.8              2  14.30  10.39
SE/001-5   50012  479598 80.0 2.30  150  2.3              1  90.30  90.30
SE/001-6   50013  479561 64.0 4.30  180  1.7              1  14.90  14.90
SE/001-8   50034  479562 61.5 3.90  170  3.3              1  28.90  28.90
TR/001-B7  49929  479408 35.0 1.60  800  5.0  15  100 1   7.65   8.72
TR/002-1   49809  479514 40.0 2.30  600  4.9              1 106.85  77.64
END
```

6 AREA-KILDER

The program AREA-KILDER calculates sector averaged long term concentrations at ground level in a grid of receptor points from sources in an emission field given in the same grid system. The program divides each grid area source into 100 point sources, and takes into account the impact from the area source within its own grid square.

6.1 INPUT DATA TO AREA-KILDER

The program AREA-KILDER may also be run interactive or as a batch job. The first time the program should be run interactive, to get familiar with the dialogue. Later a RUN-file is prepared, and after that the RUN-file may be corrected.

This description shows how to run the program at the ND 560 computer at NILU. At other installations there may be local changes. When running interactive the program will give questions to the screen, but these are not described here.

Some data are always read from the terminal/batch file, and these are noted in the description with an asterisk at the beginning of the line.

The program AREA-KILDER reads a separate emission field from an emission file, so the same coupling between compounds and file names is not obtained as in the program POINT-KILDER.

* @ENTER,user,password,project password,timelimit

* @ND AREA-KILDER

* KX,KY Dimension of the area, number of grid points easterly and northerly

* IN 1: input from terminal/batch file
2: input from a separate file

If IN=2, the program asks for:

* INFI — Name of the input file.
All data which should remain constant are read from this file, whereas data which is varied from one run to another should be taken from the RUN-file.

From terminal/batch the program asks for:

* OUTFI — Name of the output file.
The data field is put on the file OUTFI:FELT, whereas the output is put on the file OUTFI:PRNT

From INFI (or the terminal/batch if IN=1) the program asks for:

TEXT — One line with text as a heading for the calculations

IGRID — Grid size in meter

ANORD — It is possible to rotate the grid area. ANORD tells the direction of the y-axis of the grid (in degrees), normally 0.0

BACKG — Background concentration which may be added. For a composite calculation with different source groups the background should be added when making the sum of the data fields in SUM-FIELD

In the routine SIGMA the program reads:

IDISP — Selection of dispersion parameters:
1: McElroy-Pooler
2: Brookhaven
3: New values

If IDISP=3, the program reads:

SIGM (CZA(I),I=1,4) (PZA(I),I=1,4)	New name and dispersion parameters

In the routine EMAREA data about the emission are read:

From INFI (or the terminal/batch if IN=1) the program reads:

INBOX,JFEL Box codes are field no. JFEL on the file INBOX:FELT

From terminal/batch the program asks for:

* INFELT,IFEL Emission field with emissions in kg/h is field no. IFEL on the file INFELT:FELT

* IKO 1: Sources from the whole area
2: Sources from a part of the area

If IKO=2, the program asks for:

* INCODE,KFEL Area code field is field no. KFEL on the file INCODE:FELT

* NCOD,(IFAK(I),I=J,NCOD)
There are NCOD emission codes, and each code has the factor IFAK=0 or 1. If we want to use one meteorology file for the northern part of the area and another for the southern, we prepare a data field with 1 and 2 in the different areas. The computations are made first for area 1 using METFIL1 and IFAK= 1 and 0, then for area 2 with METFIL2 and IFAK= 0 and 1.

From INFI (or the terminal/batch if IN=1) the program continues reading:

SCAL,QL — Emissions have to be multiplied by SCAL to have the unit kg/h.
The program is dimensioned for up to 500 area sources. In order to reduce the computer time somewhat area sources with emissions less than QL kg/h may be excluded. If the emissions from these area sources represents more than 5% of the total area emissions, QL is divided by two, until the 5% limit is satisfied.

In the routine CQCALC the program gets information about the boxes from the file INFI (or the terminal/batch if IN=1):

NBOX — Number of box classes, max. 9

(HBOX(I),I=1,NBOX)
Height of each box class. This should be a measure for the height of the initial turbulence elements in each area source box.

(HEM(I),I=1,NBOX)
Height of emission for each box class. For traffic emissions this will be 1-2 m., for domestic heating the box height.

Finally the program asks for the name of the MET-file:

* METFIL — Name of the file with meteorological data. The file should be of the type :MET. See the separate description of of this file in chapter 2.3.

The OUTFI:FELT-file now contains two data fields. The first field gives the total long term concentration, whereas the second gives the concentration from one grid element to itself. This gives us an opportunity to use other models to calculate the local contribution.

6.2 TEST EXAMPLE FOR AREA-KILDER

This test example shows a case where the sources in one part of the area uses one meteorology file whereas the sources in the other part of the area uses another meterology file. The output from the program is shown in Appendix B.

The program AREA-KILDER uses four different files: TEST-AREA:MODE, RUN-AREA:DATA and the met-files SUMMER-RIB:MET and SUMMER-HIST:MET. The met-files are the same as described under the test example for the program POINT-KILDER.

The program AREA-KILDER has to be run two times and the MODE-file TEST-AREA:MODE will be:

```
@ND AREA-KILDER
12,16,
2,                  Input data from file
RUN-AREA:DATA,      Input data file
TE-AR-SUM-1-SO2S,   Output file for region 1
TEST-AREA,1,        Emission file, field no.1
2,                  Select a part of the area
TEST-MET,1,         Codes for the emission/met. regions, field no.1
2,1,0,              Number of regions, and factors
SUMMER-RIB,         Met-file for region 1 (without :MET)

@ND AREA-KILDER
12,16,
2,                  Input data from file
RUN-AREA:D,         Input data file
TE-AR-SUM-2-SO2S,   Output file for region 2
TEST-AREA,1,        Emission file, field no.1
2,                  Select a part of the area
TEST-MET,1,         Codes for the emission/met. regions, field no.1
2,0,1,              Number of regions, and factors
SUMMER-HIST,        Met-file for region 2 (without :MET)
```

The file RUN-AREA:DATA will be:

```
TEST AREA SOURCES FROM GROUP X, THE X  AREA
1000,              Grid size
310.72,            Direction to north of the model area
0,                 Background concentration
2,                 Brookhaven
TEST-BOX,1,        Box codes, field no.1
1.0,0.05,          Scale factor, emission limit
4,                 Number of box classes
10,20,40,50,       Box heights
5,10,20,25,        Emission heights
```

7 READ-FIELD

7.1 INPUT DATA TO READ-FIELD

The program READ-FIELD is normally run interactive, and it reads a data matrix into a data field. Some data are always read from the terminal/batch file, and these are noted in the description with an asterisk at the beginning of the line.

* @ENTER,user,password,project password,timelimit

* @ND READ-FIELD

* KX,KY	Dimension of the area, number of grid points easterly and northerly
* INFI,OUTFI	Name of the input and output files. The data field is put on the file OUTFI:FELT, whereas the output is put on the file OUTFI:PRNT
* IGRID	Grid size (in meters)
* ISC	Scaling of output: 1: No scaling 2: Automatic scaling

From INFI the program reads:

KCOMP,UNIT,FAKT	Format (2A10,F10.2) KCOMP component name, 10 characters UNIT unit, 10 characters FAKT scaling factor to convert the data on INFI to the correct unit
INFORM	Input format for reading of the data, enclosed in parentheses ( ).
((X(I,K),I=1,KX),K=KY,1)	Data field, read according to the format INFORM, KX values at each line. The northmost line is read first, then southwards.

7.2 EXAMPLE AND OUTPUT FROM READ-FIELD

As an example the program shall read an emission field from our test area. The input batch file may be:

```
@ENTER,user,password,project password,timelimit
@ND READ-FIELD
16,12
TEST-AREA:DATA,TEST-AREA-SO2
1000
2
```

The file TEST-AREA:DATA may be:

```
SO2 AREA  KG/H       1.0
(5X,12F5.2)
  16 0.00 1.90 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
  15 2.86 0.00 0.00 0.18 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
  14 0.00 0.06 0.00 0.00 0.00 0.00 0.00 0.00 0.00 1.67 0.00 0.00
  13 0.00 3.00 0.00 0.31 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
  12 0.00 0.00 0.25 8.86 0.00 6.88 0.00 0.02 5.68 0.00 4.03 0.00
  11 0.00 0.00 8.44 0.00 0.00 0.00 0.00 0.00 7.28 0.00 0.00 0.00
  10 0.00 0.00 0.00 9.54 0.57 0.00 0.00 5.00 0.00 1.85 0.00 0.00
   9 0.00 1.04 1.50 1.65 3.30 0.09 0.00 5.00 0.00 0.00 0.00 0.00
   8 0.00 0.00 0.00 0.00 1.44 9.51 0.00 0.32 0.96 0.00 2.80 0.00
   7 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
   6 0.00 0.00 0.07 0.00 0.00 0.00 0.00 3.39 0.00 0.45 0.00 0.00
   5 0.00 0.00 0.02 0.00 0.00 9.41 0.83 0.00 3.40 3.93 0.00 0.00
   4 0.00 0.00 8.74 0.00 0.32 0.00 0.00 0.01 0.88 0.00 0.00 0.00
   3 0.00 0.00 0.00 0.00 1.73 0.00 0.00 0.01 0.00 4.10 0.00 0.00
   2 0.00 0.00 0.00 0.00 0.13 4.28 0.10 0.00 0.00 1.27 7.15 3.38
   1 0.00 0.00 0.00 9.03 1.97 0.07 0.00 0.00 0.00 0.00 8.51 0.18
       1    2    3    4    5    6    7    8    9   10   11   12
```

The output for this field will be on the file TEST-AREA-SO2:PRNT, but here we will prefer to make the listing from PRINT-FIELD.

8 PRINT-FIELD

8.1 INPUT DATA FOR PRINT-FIELD

The program PRINT-FIELD is normally run interactive, and it makes a print-out of a data field. Some data are always read from the terminal/batch file, and these are noted in the description with an asterisk at the beginning of the line.

* @ENTER,user,password,project password,time limit

* @ND PRINT-FIELD

* KX,KY Dimension of the area, number of grid points easterly and northerly

* INFI,OUTFI Name of the input and output files. The output of the file INFI is put on the file OUTFI:PRNT

* IGRID Grid size in meter

* ISC Scaling of output:
1: No scaling
2: Automatic scaling
3: Read scale factor

If ISC=3, the program asks for:

* CII Scale factor

8.2 EXAMPLE AND OUTPUT FROM PRINT-FIELD

To make a listing of the file read in READ-FIELD, an interactive job can be executed:

```
@ND  PRINT-FIELD
16,12,                          Grid dimensions
TEST-AREA-SO2,LINE-WRITER,      Input file, output at the line-writer
1000,                           Grid size
2,                              Automatic scaling
```

On the line-writer the following output is given:

```
MAP OF SO2 AREA    UNIT: KG/H

HIGHEST VALUE IS  9.5400E+00, IN ( 4 ,10)
SUM= 1.69349E+02       SCALE: 1.0E-02

EACH SQUARE IS  1000 METER
         1    2    3    4    5    6    7    8    9   10   11   12
J=16     0. 190.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
J=15   286.   0.   0.  18.   0.   0.   0.   0.   0.   0.   0.   0.
J=14     0.   6.   0.   0.   0.   0.   0.   0.   0. 167.   0.   0.
J=13     0. 300.   0.  31.   0.   0.   0.   0.   0.   0.   0.   0.
J=12     0.   0.  25. 886.   0. 688.   0.   2. 568.   0. 403.   0.
J=11     0.   0. 844.   0.   0.   0.   0.   0. 728.   0.   0.   0.
J=10     0.   0.   0. 954.  57.   0.   0. 500.   0. 185.   0.   0.
J= 9     0. 104. 150. 165. 330.   9.   0. 500.   0.   0.   0.   0.
J= 8     0.   0.   0.   0. 144. 951.   0.  32.  96.   0. 280.   0.
J= 7     0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
J= 6     0.   0.   7.   0.   0.   0.   0. 339.   0.  45.   0.   0.
J= 5     0.   0.   2.   0.   0. 941.  83.   0. 340. 393.   0.   0.
J= 4     0.   0. 874.   0.  32.   0.   0.   1.  88.   0.   0.   0.
J= 3     0.   0.   0.   0. 173.   0.   0.   1.   0. 410.   0.   0.
J= 2     0.   0.   0.   0.  13. 428.  10.   0.   0. 127. 715. 338.
J= 1     0.   0.   0. 903. 197.   7.   0.   0.   0.   0. 851.  18.
         1    2    3    4    5    6    7    8    9   10   11   12
```

9 SUM-FIELD

9.1 INPUT DATA FOR SUM-FIELD

The program SUM-FIELD may be run interactive or as a batch job. The first time the program should be run interactive to be familiar with the dialogue. Later a RUN-file is prepared, and after that corrections are made in the old RUN-file. In this description there is described how the program should be run at the ND 560 computer located at NILU. At other installations there may be some minor changes. When run interactive the program will give questions to the screen, but these are not given here.

```
@ENTER,user,password,project password,timelimit

@ND SUM-FIELD
```

KX,KY	Dimension of the area, number of grid points easterly and northerly
NFELT,IGRID	Reads NFELT fields (max. 16) IGRID Grid size in meter
IPR,ISF	IPR=0: No printout of single fields 1: Writes the fields before scaling 2: Writes the fields after scaling ISF=1: Puts the sum-field on a new file

For NFELT fields the program reads:

KFIL,KREC,FAK	KFIL	File name. If it is the same as previous, put '' as file name.
	KREC	Record no. at the file
	FAK	Scaling factor

Then it continues:

BACKGR	Background value	
SUM,UNITS	SUM	Notation for the sum field
	UNITS	Unit for the sum field. If one of these is the same as for the last field, put ´´.
OUTFI	The print-out is put on the file OUTFI: PRNT, whereas the data field is put on the file OUTFI:FELT if ISF=1	

9.2 EXAMPLE AND OUTPUT FROM SUM-FIELD

To get the sum of the concentration fields calculated in POINT-KILDER and AREA-KILDER, the following interactive job is executed:

```
@ND SUM-FIELD
12,16,                    Grid dimensions
4,1000,                   4 fields, grid size 1000m
0,0,                      No output of the fields, no new sum-file
TE-PO-SUM-1-SO2S,1,1.,    First field from point sources
TE-PO-SUM-2-SO2S,1,1.,    Second field from point sources
TE-AR-SUM-1-SO2S,1,1.,    First field from area sources
TE-AR-SUM-2-SO2S,1,1.,    Second field from area sources
5.0,                      Background
SO2 TEST,´´               Compound,unit same as before
OUTPUT,                   Output to the file OUTPUT:PRNT
```

The sum to the right means the sum of the numeric values for the whole field. When emission fields are added we get the total emission for the area, whereas for concentrations the sum will have a more difficult interpretation. Nevertheless the sum of concentration values will give valuable information about the total contribution from different sources or source categories.

The file OUTPUT:PRNT will be:

```
FIELD 1 ON FILE TE-PO-SUM-1-SO2S, SO2SUM   WITH UNIT UG/M3 SUM= 1.8534E+03
FIELD 1 ON FILE TE-PO-SUM-2-SO2S, SO2SUM   WITH UNIT UG/M3 SUM= 6.9985E+02
FIELD 1 ON FILE TE-AR-SUM-1-SO2S, SO2 AREA WITH UNIT UG/M3 SUM= 5.0332E+02
FIELD 1 ON FILE TE-AR-SUM-2-SO2S, SO2 AREA WITH UNIT UG/M3 SUM= 1.6270E+02
                                                           ---------------
                                                           SUM= 4.1792E+03

A BACKGROUND VALUE OF    5.000 UG/M3 IS ADDED


MAP OF SO2 TEST    UNIT: UG/M3

HIGHEST VALUE ER  9.5390E+01, IN (  6 , 13)
        SUM= 4.17923E+03     SCALE:  1.0E-01

EACH SQUARE IS   1000 METER
         1    2    3    4    5    6    7    8    9   10   11   12
J=16   108. 144. 145. 167. 211. 210. 308. 249. 213. 164. 152. 137.
J=15   111. 159. 162. 193. 215. 256. 372. 271. 195. 176. 155. 141.
J=14   111. 146. 209. 281. 226. 346. 349. 251. 199. 192. 154. 138.
J=13   119. 158. 246. 486. 288. 954. 298. 190. 188. 165. 147. 132.
J=12   126. 158. 318. 424. 383. 529. 203. 187. 214. 167. 167. 133.
J=11   130. 182. 311. 453. 614. 677. 346. 146. 183. 130. 125. 103.
J=10   124. 182. 252. 474. 472. 545. 373. 165. 161. 129. 112. 101.
J= 9   143. 184. 246. 531. 520. 445. 304. 184. 136. 125. 110. 100.
J= 8   144. 179. 338. 882. 500. 364. 306. 228. 124. 114. 119. 100.
J= 7   137. 228. 281. 485. 350. 325. 249. 198. 127. 112. 115.  97.
J= 6   136. 196. 325. 335. 292. 283. 215. 194. 169. 122. 111. 101.
J= 5   145. 214. 281. 247. 246. 234. 195. 189. 174. 141. 112. 104.
J= 4   134. 193. 253. 222. 217. 217. 178. 166. 165. 154. 110. 110.
J= 3   157. 174. 210. 204. 196. 184. 160. 153. 155. 161. 132. 124.
J= 2   143. 157. 171. 200. 172. 164. 154. 142. 144. 156. 177. 133.
J= 1   133. 144. 153. 191. 161. 154. 142. 136. 135. 143. 170. 112.
         1    2    3    4    5    6    7    8    9   10   11   12
```

10 OTHER PROGRAMS IN THE KILDER AND FELT PROGRAM SYSTEM

In addition to the programs POINT-KILDER, AREA-KILDER, READ-FIELD, PRINT-FIELD and SUM-FIELD which are described above, the KILDER and FELT program system at NILU consists of the following programs, all written in Norwegian (Gram, 1987):

APP-FELT.....Appends data fields to an existing file

EPISODE.....Three-dimensional model for calculation of hourly concentrations over an area

FORH-FELT.....Calculates the ratio between the values of two data fields

INNHOLD-FELT.....Gives the content of a multi-field file

INP-FELT.....Reads single values to a field

ISO-FELT.....Plots map with iso-contour lines

IVER-FELT.....Plots fields from EPISODE

KILDE-PLOT.....Plots map with point sources

KODE-FELT.....Substitutes code values in a field with other values

LINJE-KILDER.....Give long term concentrations from line sources (streets)

LIST-FELT.....Gives a listing of values of several fields in every grid point

MIDL-FELT.....Makes 24-hr. averages from EPISODE

OLJE-FORB-FELT.....Gives fields for oil consumption

OLJE-PUNKT-UTSL.....Gives emissions from point sources with oil consumption

OLJE-UTSL-FELT.....Gives emission fields from oil consumption

OVER-FELT.....Calculates number of people over certain values

PLUKK-FELT.....Takes out some fields from a multi-field file to another file

PRES-FELT.....Presents a field file on the screen

PROD-FELT.....Gives the product of two fields (one of these may be a mask)

PROS-FELT.....Calculates the percentage contributions to the sum of several fields

RODE-FELT.....Distributes population or other variables over an area

RUTE-EKSP.....Calculates number of individuals exposed for concentrations above certain values

SE-FELT.....Presents a field on the screen for corrections and changes

SKAL-FELT.....Scales a field

SMAV-UTSL.....Calculates traffic emissions from small roads and streets

SNITT-FELT.....Makes a cut-out from an area

SUBST-FELT.....Reads new values for a part of an area

TID-FELT.....Gives a listing of values in a few points from EPISODE

TRAFIKK.....Determines traffic parameters from gasoline consumption etc.

TRAF-UTSL.....Calculates traffic work, emissions and street concentrations, and the area of max. conc. within each square

UTSL-FELT.....Gives an emission field from many point sources

VEI-PLOT.....Makes a plotted map of the main streets within an area and concentrations with different color codes

VIND-FELT.....Makes a plot of a wind field

VOLUM-KILDER.....Gives long term concentrations from volume sources (long factory buildings or buildings with diffuse emissions)

11 REFERENCES

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Fortak, H.G. (1970) Numerical simulation of temporal and spatial distributions of urban air pollution concentration. In: Proceedings of symposium on multiple-source urban diffusion models. Carolina 1969. Ed. by Arthur C. Stern. Research Triangle Park, North Carolina. (U.S. Environmental Protection Agency. Office of Air Programs Publication. AP 86.)

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OSV.

APPENDIX A

Test output from POINT-KILDER

*** NORWEGIAN INSTITUTE FOR AIR RESEARCH ***

PROGRAM POINT-KILDER
Version 1987-12-10

TEST POINT-KILDER
*** Run-time 1987-12-15 KL. 08.52 ***

Data is read from file..... TEST-POINT:DATA
Calculations are made for..... SO2SUM
The following source groups are included: 1,
Default building dimensions:..... height=10 m
width =30 m
Number of sources..... 16
Ground level reflection factor ALPHA..... 1.000
Concentrations are ground level values and 30 degrees sector averages.
The lower left corner of the area has the UTM-coordinates
(500.00,4789.00).
The centre of lower left square has the local coordinates (.50, .50)
The area has its y-axis at..... 310.72 degrees
Dispersion parameters from Brookhaven for low sources
Brookhaven for high sources
(over 50. meter)

Joint frequency matrix for SUMMER BULK RICH read from file SUMMER-RIB

	1.1m/s				3.1m/s				4.8m/s				7.0m/s			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
30	1.9	.2	.5	.5	1.5	.9	.1	.0	.2	.1	.0	.0	.0	.0	.0	.0
60	1.4	.0	.1	.1	.7	.4	.1	.0	.1	.0	.0	.0	.0	.0	.0	.0
90	.8	.1	.3	.2	.2	.2	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0
120	.8	.3	.4	.2	.6	.4	.1	.0	.0	.1	.0	.0	.0	.0	.0	.0
150	.8	.3	1.3	1.1	.4	2.9	5.5	.6	.0	1.8	.7	.0	.0	.4	.1	.0
180	.5	.0	1.2	.9	.1	1.4	3.3	.1	.0	.4	.6	.0	.0	.1	.1	.0
210	.8	.3	1.2	1.7	.1	.4	.8	.0	.0	.1	.1	.0	.0	.2	.0	.0
240	.0	.0	.2	.7	.0	.0	.0	.0	.0	.1	.0	.0	.0	.2	.0	.0
270	.2	.0	.4	.8	.1	.1	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0
300	2.4	.6	1.4	1.0	1.8	3.4	.6	.1	1.3	.8	.0	.0	.1	.2	.0	.0
330	1.7	.3	.4	.7	6.4	3.1	.2	.0	9.1	6.9	.0	.0	1.4	4.6	.0	.0
360	1.2	.2	.2	.5	2.3	.8	.1	.1	.4	.4	.0	.0	.3	.1	.0	.0
360	1.2	.2	.2	.5	2.3	.8	.1	.1	.4	.4	.0	.0	.3	.1	.0	.0

Mean temperature for the period is 19.0 degrees C

Stability	1	2	3	4
Exp of wind profile	.20	.28	.36	.42
Mixing height	800.	800.	400.	400.

Source data:

Source no.	Source Name	Relative coordinates X	Y	Stack height m	Stack diameter m	Stack temp. degr.C	Gas velocity m/s	Building height m	width m	Emission kg/h
1	BE/008-2	4.63	3.18	50.0	1.50	63.	11.6	10.	30.	110.77
2	BE/010-1	4.17	.78	15.0	.60	300.	8.5	10.	30.	9.88
3	ER/005-5	6.39	.65	24.0	1.15	70.	8.7	10.	30.	5.20
4	ER/005-8	6.38	.59	24.0	.79	120.	4.6	10.	30.	8.71
5	ER/007-3	6.69	.39	44.0	1.00	300.	16.3	10.	30.	15.99

Gas temp. 15.0 less than air temp., is set to 19.0 degrees

6	ER/020-1	6.22	3.26	80.0	2.00	19.	7.0	10.	30.	150.00
7	ER/042-1	6.15	3.71	80.0	1.20	60.	11.1	10.	30.	267.00
8	LE/003-1	5.73	5.22	39.5	1.00	200.	1.0	10.	30.	81.59
9	LE/004-2	5.61	5.09	30.0	.90	100.	4.8	10.	30.	21.58
10	MO/003-1	3.96	5.72	26.0	1.50	200.	4.8	15.	40.	64.84
11	PE/001-11	5.19	4.35	26.5	3.90	190.	5.4	10.	100.	59.60
12	SE/001-5	5.37	4.46	80.0	2.30	150.	2.3	10.	30.	90.30
13	SE/001-6	5.09	4.21	64.0	4.30	180.	1.7	10.	30.	14.90
14	SE/001-8	5.24	4.06	61.5	3.90	170.	3.3	10.	30.	28.90
15	TR/001-B7	3.39	3.85	35.0	1.60	800.	5.0	15.	100.	8.72
16	TR/002-1	3.41	5.45	40.0	2.30	600.	4.9	10.	30.	77.64
									SUM	1015.62

MAP OF SO2SUM UNIT: UG/M3

HIGHEST VALUE IS 6.8395E+01, IN (6 , 5)
SUM= 1.71270E+03 SCALE: 1.0E-01

EACH SQUARE IS 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12
J=16	11.	12.	12.	12.	16.	23.	45.	62.	61.	59.	56.	51.
J=15	10.	13.	13.	13.	18.	31.	51.	70.	68.	66.	59.	56.
J=14	11.	13.	15.	15.	21.	36.	58.	79.	76.	68.	65.	55.
J=13	11.	13.	17.	17.	33.	41.	66.	90.	84.	76.	72.	56.
J=12	12.	14.	18.	20.	40.	49.	78.	104.	93.	86.	66.	54.
J=11	13.	15.	19.	24.	49.	59.	94.	115.	107.	86.	74.	55.
J=10	15.	17.	21.	29.	63.	75.	111.	138.	126.	93.	68.	61.
J= 9	16.	19.	25.	32.	84.	92.	131.	168.	121.	94.	72.	64.
J= 8	20.	23.	29.	40.	113.	116.	208.	175.	137.	93.	77.	66.
J= 7	24.	33.	40.	61.	104.	158.	297.	192.	116.	97.	77.	66.
J= 6	38.	52.	70.	125.	91.	236.	232.	173.	119.	96.	72.	57.
J= 5	43.	59.	88.	261.	223.	684.	193.	101.	85.	60.	51.	43.
J= 4	51.	69.	169.	199.	216.	443.	116.	62.	47.	55.	45.	38.
J= 3	51.	84.	144.	172.	618.	504.	354.	38.	21.	18.	13.	12.
J= 2	45.	82.	105.	262.	339.	380.	254.	54.	26.	17.	14.	12.
J= 1	54.	68.	86.	192.	281.	284.	162.	124.	25.	21.	17.	13.
	1	2	3	4	5	6	7	8	9	10	11	12

Concentration field is put on file TE-PO-SUM-SO2S:FELT

PLUME RISE STATISTICS

Plume rise, and plume index:

1: No building turbulence

2: Building turbulence (He>0.5 Hb)

3: Trapped by buildings (He=0.5 Hb)

should this source be among the area sources?

	1.10 M/S				3.10 M/S				4.80 M/S				7.00 M/S			
STACK	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
BE/008-2	120. 1	111. 1	98. 1	89. 1	75. 1	72. 1	84. 1	77. 1	66. 1	64. 1	79. 1	0.-1	60. 1	58. 1	74. 1	0.-1
BE/010-1	63. 1	61. 1	57. 1	50. 1	31. 2	30. 2	43. 2	38. 2	22. 2	21. 2	36. 2	0.-1	5. 3	5. 3	5. 3	0.-1
ER/005-5	72. 1	69. 1	66. 1	58. 1	41. 1	40. 1	54. 1	48. 1	35. 1	33. 2	48. 2	0.-1	28. 2	28. 2	43. 2	0.-1
ER/005-8	49. 1	48. 1	56. 1	50. 1	31. 2	30. 2	44. 2	40. 2	27. 2	26. 2	40. 2	0.-1	24. 2	24. 2	37. 2	0.-1
ER/007-3	179. 1	164. 1	109. 1	96. 1	92. 1	87. 1	90. 1	81. 1	75. 1	71. 1	84. 1	0.-1	65. 1	63. 1	79. 1	0.-1
ER/020-1	105. 1	101. 1	94. 1	92. 1	80. 1	79. 1	78. 1	78. 1	78. 1	77. 1	77. 1	0.-1	77. 1	76. 1	76. 1	0.-1
ER/042-1	122. 1	115. 1	118. 1	110. 1	95. 1	93. 1	107. 1	101. 1	90. 1	88. 1	102. 1	0.-1	85. 1	84. 1	99. 1	0.-1
LE/003-1	52. 1	50. 1	61. 1	57. 1	42. 1	41. 1	54. 1	51. 1	40. 1	40. 1	51. 1	0.-1	39. 1	39. 1	50. 1	0.-1
LE/004-2	57. 1	55. 1	62. 1	56. 1	39. 1	38. 1	52. 1	48. 1	35. 1	34. 1	48. 1	0.-1	33. 1	32. 1	45. 1	0.-1
MO/003-1	117. 1	111. 1	81. 1	71. 1	46. 2	43. 2	51. 2	44. 2	31. 2	29. 2	44. 2	0.-1	23. 2	22. 2	38. 2	0.-1
PE/001-11	411. 1	382. 1	134. 1	114. 1	162. 1	151. 1	100. 2	85. 2	107. 2	99. 2	83. 2	0.-1	75. 2	70. 2	71. 2	0.-1
SE/001-5	148. 1	136. 1	125. 1	115. 1	100. 1	95. 1	108. 1	101. 1	90. 1	88. 1	103. 1	0.-1	85. 1	83. 1	99. 1	0.-1
SE/001-6	221. 1	198. 1	127. 1	113. 1	111. 1	103. 1	103. 1	93. 1	90. 1	85. 1	95. 1	0.-1	78. 1	74. 1	90. 1	0.-1
SE/001-8	285. 1	255. 1	142. 1	125. 1	135. 1	123. 1	111. 1	99. 1	105. 1	97. 1	102. 1	0.-1	87. 1	82. 1	95. 1	0.-1
TR/001-B7	193. 1	178. 1	105. 1	92. 1	87. 2	81. 2	79. 2	69. 2	64. 2	60. 2	70. 2	0.-1	51. 2	49. 2	64. 2	0.-1
TR/002-1	285. 1	259. 1	125. 1	108. 1	125. 1	116. 1	98. 1	86. 1	93. 1	87. 1	88. 1	0.-1	74. 1	70. 1	81. 1	0.-1

PENETRATION																
BE/008-2	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00-1	.00 1	.00 1	.00 1	.00-1
BE/010-1	.00 1	.00 1	.00 1	.00 1	.00 2	.00 2	.00 2	.00 2	.00 2	.00 2	.00 2	.00-1	.00 3	.00 3	.00 3	.00-1
ER/005-5	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 2	.00 2	.00-1	.00 2	.00 2	.00 2	.00-1
ER/005-8	.00 1	.00 1	.00 1	.00 1	.00 2	.00 2	.00 2	.00 2	.00 2	.00 2	.00 2	.00-1	.00 2	.00 2	.00 2	.00-1
ER/007-3	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00-1	.00 1	.00 1	.00 1	.00-1
ER/020-1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00-1	.00 1	.00 1	.00 1	.00-1
ER/042-1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00-1	.00 1	.00 1	.00 1	.00-1
LE/003-1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00-1	.00 1	.00 1	.00 1	.00-1
LE/004-2	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00-1	.00 1	.00 1	.00 1	.00-1
MO/003-1	.00 1	.00 1	.00 1	.00 1	.00 2	.00 2	.00 2	.00 2	.00 2	.00 2	.00 2	.00-1	.00 2	.00 2	.00 2	.00-1
PE/001-11	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 2	.00 2	.00 2	.00 2	.00 2	.00-1	.00 2	.00 2	.00 2	.00-1
SE/001-5	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00-1	.00 1	.00 1	.00 1	.00-1
SE/001-6	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00-1	.00 1	.00 1	.00 1	.00-1
SE/001-8	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00-1	.00 1	.00 1	.00 1	.00-1
TR/001-B7	.00 1	.00 1	.00 1	.00 1	.00 2	.00 2	.00 2	.00 2	.00 2	.00 2	.00 2	.00-1	.00 2	.00 2	.00 2	.00-1
TR/002-1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00 1	.00-1	.00 1	.00 1	.00 1	.00-1

APPENDIX B

Test output from AREA-KILDER

MAP OF BOX CODE UNIT: CONSTANTS

HIGHEST VALUE IS 3.0000E+00, IN (5 , 1)
SUM= 3.58000E+02 SCALE: 1.0E+00

EACH SQUARE IS 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12
J=16	1.	1.	1.	2.	2.	1.	1.	1.	2.	2.	1.	1.
J=15	1.	1.	2.	2.	2.	1.	1.	2.	2.	2.	1.	1.
J=14	1.	2.	2.	3.	2.	1.	1.	2.	2.	2.	1.	1.
J=13	2.	2.	2.	3.	2.	2.	2.	2.	2.	1.	1.	1.
J=12	1.	3.	3.	3.	3.	2.	2.	2.	1.	1.	1.	1.
J=11	1.	3.	3.	3.	3.	3.	2.	2.	1.	1.	1.	1.
J=10	1.	3.	3.	3.	3.	3.	2.	2.	1.	1.	1.	1.
J= 9	1.	3.	3.	3.	3.	3.	2.	2.	1.	1.	1.	1.
J= 8	1.	3.	3.	3.	3.	3.	2.	2.	1.	1.	1.	1.
J= 7	1.	3.	3.	3.	3.	3.	2.	2.	1.	1.	1.	1.
J= 6	1.	3.	3.	3.	3.	3.	2.	2.	1.	1.	1.	1.
J= 5	1.	2.	2.	3.	3.	3.	2.	2.	1.	1.	1.	1.
J= 4	1.	3.	2.	3.	3.	3.	2.	2.	1.	1.	1.	1.
J= 3	1.	1.	2.	3.	3.	3.	3.	3.	2.	1.	1.	1.
J= 2	1.	1.	1.	2.	3.	3.	3.	3.	2.	1.	1.	1.
J= 1	1.	1.	1.	2.	3.	3.	3.	3.	2.	2.	2.	1.
	1	2	3	4	5	6	7	8	9	10	11	12

MAP OF SO2 AREA UNIT: KG/H

HIGHEST VALUE IS 9.5400E+00, IN (4 , 10)
SUM= 1.69369E+02 SCALE: 1.0E-02

EACH SQUARE IS 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12
J=16	0.	190.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
J=15	286.	0.	0.	18.	0.	0.	0.	0.	0.	0.	0.	0.
J=14	0.	6.	0.	0.	0.	0.	0.	0.	0.	167.	0.	0.
J=13	0.	300.	0.	31.	0.	0.	0.	0.	0.	0.	0.	0.
J=12	0.	0.	25.	886.	0.	688.	0.	2.	568.	0.	403.	0.
J=11	0.	0.	844.	0.	0.	0.	0.	0.	728.	0.	0.	0.
J=10	0.	0.	0.	954.	57.	0.	0.	500.	0.	185.	0.	0.
J= 9	0.	104.	150.	165.	330.	9.	0.	500.	0.	0.	0.	0.
J= 8	0.	0.	0.	0.	144.	951.	0.	32.	96.	0.	280.	0.
J= 7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
J= 6	0.	0.	7.	0.	0.	0.	0.	339.	0.	45.	0.	0.
J= 5	0.	0.	2.	0.	0.	941.	83.	0.	340.	393.	0.	0.
J= 4	0.	0.	874.	0.	32.	0.	0.	1.	88.	0.	0.	0.
J= 3	0.	0.	0.	0.	173.	0.	0.	1.	0.	410.	0.	0.
J= 2	0.	0.	0.	0.	13.	428.	10.	0.	0.	127.	715.	338.
J= 1	0.	0.	0.	903.	197.	7.	0.	0.	0.	0.	851.	18.
	1	2	3	4	5	6	7	8	9	10	11	12

Emissions are read from the file TEST-AREA

MAP OF MET AREA UNIT: CONSTANTS

HIGHEST VALUE IS 2.0000E+00, IN (1 , 1)
SUM= 2.34000E+02 SCALE: 1.0E+00

EACH SQUARE IS 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12
J=16	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J=15	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J=14	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J=13	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J=12	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J=11	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J=10	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J= 9	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J= 8	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J= 7	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J= 6	2.	2.	2.	2.	2.	2.	2.	1.	1.	1.	1.	1.
J= 5	2.	2.	2.	2.	2.	2.	2.	1.	1.	1.	1.	1.
J= 4	2.	2.	2.	2.	2.	2.	2.	1.	1.	1.	1.	1.
J= 3	2.	2.	2.	2.	2.	2.	2.	1.	1.	1.	1.	1.
J= 2	2.	2.	2.	2.	2.	2.	2.	1.	1.	1.	1.	1.
J= 1	2.	2.	2.	2.	2.	2.	2.	1.	1.	1.	1.	1.
	1	2	3	4	5	6	7	8	9	10	11	12

Only a part of the emission field is used,
Area codes are read from the file TEST-MET
The following code groups are included:1,

Emissions less than .050 kg/h are not included

Sum emission 132.6140 kg/h from 40 area sources

Sum emission .0510 kg/h from 8 area sources that are not included

The following box classes are used:

Box	Height	Emis.height
1	10.	5.
2	20.	10.
3	40.	20.
4	50.	25.

*** NORWEGIAN INSTITUTE FOR AIR RESEARCH***

PROGRAM AREA-KILDER
Version 1987-12-10

TEST AREA SOURCES FROM GROUP X, THE X AREA

*** Run-time 15/12-1987 KL. 8.50 ***

Calculations are made for SO2 AREA
Number of area sources generated from the emission field: 40
Concentrations are ground level values and 30 degrees sector averages
The area has its y-axis at 310.72 degrees
Dispersion parameters from Brookhaven

Joint frequency matrix for SUMMER BULK RICH read from file SUMMER-RIB

	1.1m/s				3.1m/s				4.8m/s				7.0m/s			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
30	1.9	.2	.5	.5	1.5	.9	.1	.0	.2	.1	.0	.0	.0	.0	.0	.0
60	1.4	.0	.1	.1	.7	.4	.1	.0	.1	.0	.0	.0	.0	.0	.0	.0
90	.8	.1	.3	.2	.2	.2	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0
120	.8	.3	.4	.2	.6	.4	.1	.0	.0	.1	.0	.0	.0	.0	.0	.0
150	.8	.3	1.3	1.1	.4	2.9	5.5	.6	.0	1.8	.7	.0	.0	.4	.1	.0
180	.5	.0	1.2	.9	.1	1.4	3.3	.1	.0	.4	.6	.0	.0	.1	.1	.0
210	.8	.3	1.2	1.7	.1	.4	.8	.0	.0	.1	.1	.0	.0	.2	.0	.0
240	.0	.0	.2	.7	.0	.0	.0	.0	.0	.1	.0	.0	.0	.2	.0	.0
270	.2	.0	.4	.8	.1	.1	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0
300	2.4	.6	1.4	1.0	1.8	3.4	.6	.1	1.3	.8	.0	.0	.1	.2	.0	.0
330	1.7	.3	.4	.7	6.4	3.1	.2	.0	9.1	6.9	.0	.0	1.4	4.6	.0	.0
360	1.2	.2	.2	.5	2.3	.8	.1	.1	.4	.4	.0	.0	.3	.1	.0	.0

Stability			1	2	3	4	
Exp of wind profile			.20	.28	.36	.42	
Mixing height			800.	800.	400.	400.	
Source	Code		Coordinates			Box code	Emission kg/h
1	GRID	11	1	10.50	.50	2.	8.510
2	GRID	12	1	11.50	.50	1.	.180
3	GRID	10	2	9.50	1.50	1.	1.270
4	GRID	11	2	10.50	1.50	1.	7.150
5	GRID	12	2	11.50	1.50	1.	3.380
6	GRID	10	3	9.50	2.50	1.	4.100
7	GRID	9	4	8.50	3.50	1.	.880
8	GRID	9	5	8.50	4.50	1.	3.400
9	GRID	10	5	9.50	4.50	1.	3.930
10	GRID	8	6	7.50	5.50	2.	3.390
11	GRID	10	6	9.50	5.50	1.	.450
12	GRID	5	8	4.50	7.50	3.	1.443
13	GRID	6	8	5.50	7.50	3.	9.510
14	GRID	8	8	7.50	7.50	2.	.320
15	GRID	9	8	8.50	7.50	1.	.960
16	GRID	11	8	10.50	7.50	1.	2.800
17	GRID	2	9	1.50	8.50	3.	1.040
18	GRID	3	9	2.50	8.50	3.	1.500
19	GRID	4	9	3.50	8.50	3.	1.651
20	GRID	5	9	4.50	8.50	3.	3.300
21	GRID	6	9	5.50	8.50	3.	.090
22	GRID	8	9	7.50	8.50	2.	5.000
23	GRID	4	10	3.50	9.50	3.	9.540
24	GRID	5	10	4.50	9.50	3.	.570
25	GRID	8	10	7.50	9.50	2.	5.000
26	GRID	10	10	9.50	9.50	1.	1.850
27	GRID	3	11	2.50	10.50	3.	8.440
28	GRID	9	11	8.50	10.50	1.	7.280
29	GRID	3	12	2.50	11.50	3.	.250
30	GRID	4	12	3.50	11.50	3.	8.860
31	GRID	6	12	5.50	11.50	2.	6.880
32	GRID	9	12	8.50	11.50	1.	5.680
33	GRID	11	12	10.50	11.50	1.	4.030
34	GRID	2	13	1.50	12.50	2.	3.000
35	GRID	4	13	3.50	12.50	3.	.310
36	GRID	2	14	1.50	13.50	2.	.060
37	GRID	10	14	9.50	13.50	2.	1.670
38	GRID	1	15	.50	14.50	1.	2.860
39	GRID	4	15	3.50	14.50	2.	.180
40	GRID	2	16	1.50	15.50	1.	1.900

MAP OF SO2 AREA UNIT: UG/M3

HIGHEST VALUE IS 9.5744E+00, IN (9 , 11)
SUM= 5.03755E+02 SCALE: 1.0E-02

EACH SQUARE IS 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12
J=16	135.	215.	131.	129.	138.	134.	142.	129.	137.	175.	181.	164.
J=15	233.	192.	141.	135.	165.	155.	173.	150.	171.	244.	217.	194.
J=14	168.	155.	132.	173.	211.	196.	231.	181.	247.	364.	263.	254.
J=13	115.	196.	154.	281.	227.	313.	263.	229.	446.	454.	383.	298.
J=12	101.	196.	236.	363.	286.	454.	290.	329.	850.	522.	601.	341.
J=11	119.	176.	311.	426.	275.	404.	267.	422.	957.	486.	486.	264.
J=10	100.	168.	389.	375.	288.	324.	312.	568.	655.	471.	349.	279.
J= 9	98.	192.	275.	398.	269.	295.	306.	580.	416.	386.	321.	265.
J= 8	100.	160.	241.	301.	294.	318.	266.	429.	357.	321.	412.	261.
J= 7	96.	135.	178.	209.	248.	333.	208.	312.	304.	305.	367.	222.
J= 6	85.	114.	136.	158.	220.	242.	205.	313.	337.	419.	337.	269.
J= 5	81.	98.	115.	140.	174.	188.	205.	289.	447.	539.	365.	307.
J= 4	73.	85.	99.	125.	145.	160.	187.	221.	379.	464.	333.	355.
J= 3	67.	76.	93.	111.	124.	141.	154.	202.	302.	525.	518.	500.
J= 2	63.	73.	89.	102.	113.	129.	148.	184.	253.	483.	826.	603.
J= 1	60.	72.	83.	93.	105.	118.	139.	167.	237.	363.	745.	373.
	1	2	3	4	5	6	7	8	9	10	11	12

MAP OF SO2 AREA UNIT: UG/M3

HIGHEST VALUE IS 4.6677E+00, IN (9 , 11)
SUM= 5.42491E+01 SCALE: 1.0E-02

EACH SQUARE IS 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12
J=16	0.	122.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
J=15	183.	0.	0.	7.	0.	0.	0.	0.	0.	0.	0.	0.
J=14	0.	2.	0.	0.	0.	0.	0.	0.	0.	62.	0.	0.
J=13	0.	112.	0.	5.	0.	0.	0.	0.	0.	0.	0.	0.
J=12	0.	0.	4.	156.	0.	256.	0.	0.	364.	0.	258.	0.
J=11	0.	0.	149.	0.	0.	0.	0.	0.	467.	0.	0.	0.
J=10	0.	0.	0.	168.	10.	0.	0.	186.	0.	119.	0.	0.
J= 9	0.	18.	26.	29.	58.	2.	0.	186.	0.	0.	0.	0.
J= 8	0.	0.	0.	0.	25.	168.	0.	12.	62.	0.	180.	0.
J= 7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
J= 6	0.	0.	0.	0.	0.	0.	0.	126.	0.	29.	0.	0.
J= 5	0.	0.	0.	0.	0.	0.	0.	0.	218.	252.	0.	0.
J= 4	0.	0.	0.	0.	0.	0.	0.	0.	56.	0.	0.	0.
J= 3	0.	0.	0.	0.	0.	0.	0.	0.	0.	263.	0.	0.
J= 2	0.	0.	0.	0.	0.	0.	0.	0.	0.	81.	458.	217.
J= 1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	317.	12.
	1	2	3	4	5	6	7	8	9	10	11	12

Output is put on file TE-AR-SUM-SO2S:PRNT
Concentration field is put on file TE-AR-SUM-SO2S:FELT
Contribution from the squares is field 2

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DATO JUNE 1988	ANSV. SIGN. J. Schjoldager	ANT. SIDER 53	PRIS NOK 90,-
TITTEL User's Guide for the "KILDER" dispersion modelling system.		PROSJEKTLEDER Frederick Gram	
		NILU PROSJEKT NR. E-8726	
FORFATTER(E) Frederick Gram		TILGJENGELIGHET* A	
		OPPDRAGSGIVERS REF.	

OPPDRAGSGIVER (NAVN OG ADRESSE)
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3 STIKKORD (à maks. 20 anslag)
Programbeskrivelse | Spredningsmodell | Multippel kilde

REFERAT (maks. 300 anslag, 7 linjer)
Rapporten inneholder en beskrivelse av de gaussiske spredningsmodellene POINT-KILDER og AREA-KILDER som beregner langtidskonsentrasjoner med utslipp fra punkt- og areal-kilder. Det er også beskrevet tre støtte-programmer, READ-FIELD, PRINT-FIELD og SUM-FIELD.

TITLE
User's Guide for the "KILDER" dispersion modelling system.

ABSTRACT (max. 300 characters, 7 lines)
The report contains a description of the Gaussian type dispersion models POINT-KILDER and AREA-KILDER which calculates long-term concentrations from point and area sources. It also contains a description of three supporting programs, READ-FIELD, PRINT-FIELD and SUM-FIELD.

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