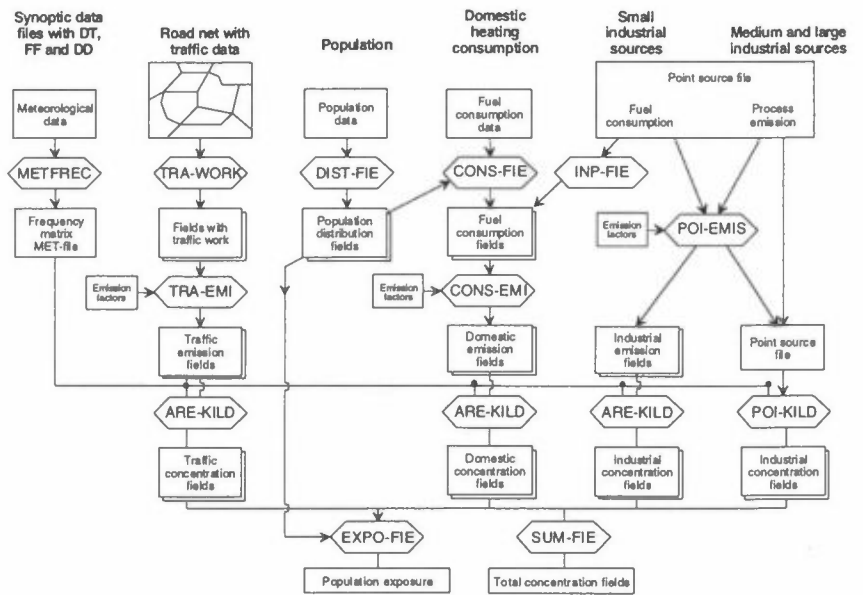


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The "KILDER" air pollution modelling system, version 2.0

Frederick Gram



KILDER

Read this first!

The KILDER modelling system is not a complicated model. But as a watch is built up by cogwheels of different size this is a set of different small programs interacting as a unit. It is a tool for calculating different aspects of air pollution in an area, depending on available data and the problem at hand.

If you want to calculate concentrations over an area from hour to hour, you need detailed information of both spatially and hourly variations in emissions, wind fields, stability and other dispersion variables, and you need another model. For long-term calculations, some of these variations are included in the statistics, and the demand of details in the input data is less. The dispersion models POI-KILD and ARE-KILD are using many standard or default values, but if you have more detailed informations, this may be used. The models are very flexible with respect of the area of calculation. In Pécs we want to use a grid of 48 x 28 with 500 m squares, in Bombay we have used 20 x 42 km, and in Bilbao we even used a grid of 20 x 54, turned 45° to northwest. For all we use the same program system, the changes between the areas lies in the input to the system.

The manual contains a lot of information, experience and tips, specially in the first chapters, which is not repeated later.

To install the program package, you copy the .EXE files from the diskette to directory \KILDER. Another diskette contains many of the files referred to in the manual, as test examples.

The programs are started by C:\KILDER\xxxx, where xxxx is the actual program name. The program will ask for a license code which is given to each user.

Summary

The KILDER Air Pollution Modelling System is a system of small PC-programs for calculation of long-term emission, dispersion, concentration and exposure from different source categories. It has been developed from active use at NILU for more than 20 years to an integrated set of about 25 different programs.

The KILDER system may be divided into three parts:

- *The dispersion models POI-KILD and ARE-KILD,*
- *Meteorological programs WINDFREC, STABFREC and METFREC,*
- *Supporting programs for calculating emissions and exposure and for operating with binary data fields.*

This report is made as a loose leaf system with a detailed introduction to the KILDER data files, and a separate description for each program with examples. The data in some examples are collected from actual studies, other are only test examples and should not be used in other connections. In addition some chapters with more theoretical background, or practical information are included.

The programs **POI-KILD** and **ARE-KILD** are multiple source Gaussian type dispersion models calculating sector-averaged, long-term averaged ground level concentrations in a regular grid of receptor points. They are using average emission data and a frequency matrix of wind direction, wind speed and stability classes.

POI-KILD is using emissions from several point sources, taking into account data on dispersion, topography, buildings and penetration through an upper stable layer.

ARE-KILD is using a field with area source emissions. Each area source is divided into 100 point sources, and the impact from the area source within its own square is calculated separately.

The meteorological programs **WINDFREC**, **STABFREC** and **METFREC** are analysing wind, stability and a joint frequency distribution of wind direction, wind speed and stability.

The **supporting programs** may be divided into several groups:

- programs for input/output etc. of fields, presentation and for field handling;
- programs for preparing area code fields and distribution of data;
- programs for calculating emissions from traffic, industry and combustion;
- programs for plotting;
- programs for exposure calculations.

As the PC operating system DOS only accepts 8-character file names, the program names has to be abbreviated in order to remind about what they are doing. The programs are normally creating a file with binary fields, called xxx.FLD, and a corresponding file with print-out, called xxx.PRN.

The programs are, the program packages will not always include all of them:

READ-FIE	reads a field with values,
INP-FIE	reads input values to specified squares of a field ,
PRIN-FIE	makes a print-out map of a field ,
LIST-FIE	makes a list of values for several fields ,
READ-PRN	reads a .PRN -file,
LOOK-FIE	looks at a binary file and displays values around a specified point,
CONT-FIE	gives the content of a .FLD file (sum, min., max. for each field),
PRES-FIE	presents a field map to the screen,
SUM-FIE	makes the sum of several fields ,
PROD-FIE	makes a product of two fields ,
GRP-FIE	generates group -codes from for instance population distribution,
CODE-FIE	adjusts fields according to area code fields ,
RATI-FIE	calculates the ratio between two fields
POP-DIST	calculates population distribution within regions
POP-FIE	distributes data to fields , f.ex. population.
CONS-FIE	calculates fields with consumption of fuels as oil, coal or wood,
CONS-EMI	calculates emission fields from consumption fields and emission factors,
POI-EMIS	calculates point source emissions from consumption data and emission factors,
TRA-WORK	calculates fields with traffic work from road net data,
TRA-EMIS	calculates emission fields from fields with traffic work and emission factors,
ISO-PLO	makes plot with iso -lines,
ROAD-PLO	makes a plot of a road network,
EXPO-FIE	calculates exposure from concentration fields, population fields and road data.
CONV-FIE	converts old .FLD files to a new structure.

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Introduction

The KILDER dispersion modelling system has been in use at the Norwegian Institute for Air Research (NILU) for more almost 20 years. It has been gradually developed by active use at NILU, and the most commonly used programmes are included in this report. Some of the programs were been transferred into English versions for planning use in Bilbao, Spain in 1988. These and some more programs were transferred to PC-versions for Central Pollution Control Board (CPCB) in Dehli, India in May 1992.

The basic units are two Gaussian dispersion models, POI-KILD and ARE-KILD for calculating long-term ground-level concentrations over an area from point and area sources, respectively (NILU TR 6/92) . The system also includes 3 programs for statistical evaluation of meteorological and air quality data: WINDFREC, STABFREC and METFREC (NILU TR 4/92). The KILDER modelling system is, however, more than two dispersion models. Today about 30 different supporting programs are available (some of them only in Norwegian). 8 of these were transferred into English PC-versions for CPCB in May 1992 (NILU TR 6/92). Since then there has been made a minor change in the file structure, but a program, CONV-FIE converts old files to the new structure. The KILDER system has also been used in air pollution modelling for URBAIR in the mega-cities Bombay, Jakarta, Manila and Kathmandu and will be used in Pecs, Hungary and Ostrava, the Czech Republic.

In this report, the former three reports are collected to one loose-leaf system which is much easier to support. At the same time some other programs are included to the "package", and all are up-graded to a version 2.0.

One major feature in the KILDER system is that the file structure is based upon binary files with data fields. The data fields are matrixes with different types of values and they may be read into the computer or calculated in different programs. As the files are binary we can not use an editor to look at them, and it is very difficult to change values, which means that this is a safe file structure. The programs are originally written to serve different purposes, so one might in some cases get questions that may seem to be irrelevant for the actual case. For model calculations you need hourly emission fields, whereas an emission survey report needs annual emission fields.

Another advantage is that the system consists of a series of programs which are making small steps. In an emission survey the input data may be very deficient, and we have to use other data instead. We may for instance have an estimate of the total consumption of fuels for the area, but will distribute this according to the population distribution. It will then be possible take into account different fuel use in different regions by using various consumption per capita for the regions.

The examples to the programs are not real; some are taken from different studies, adjusted to fit the format of this report better, some are just examples. It would be nice if we could follow the calculations for one region through all the programs, but the cities and the data sources are all so different that this has not been possible. This is at the same time the strength of the KILDER system, it is so flexible that the programs may utilize the data that are available for the preparation of the fields.

The programs can operate in different modes: interactive or as a batch 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-FIE 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 $KX*KY=2500$ points, but this can easily be changed in the program code if necessary.

Figure 1 shows some elements of the "KILDER" air pollution modelling system.

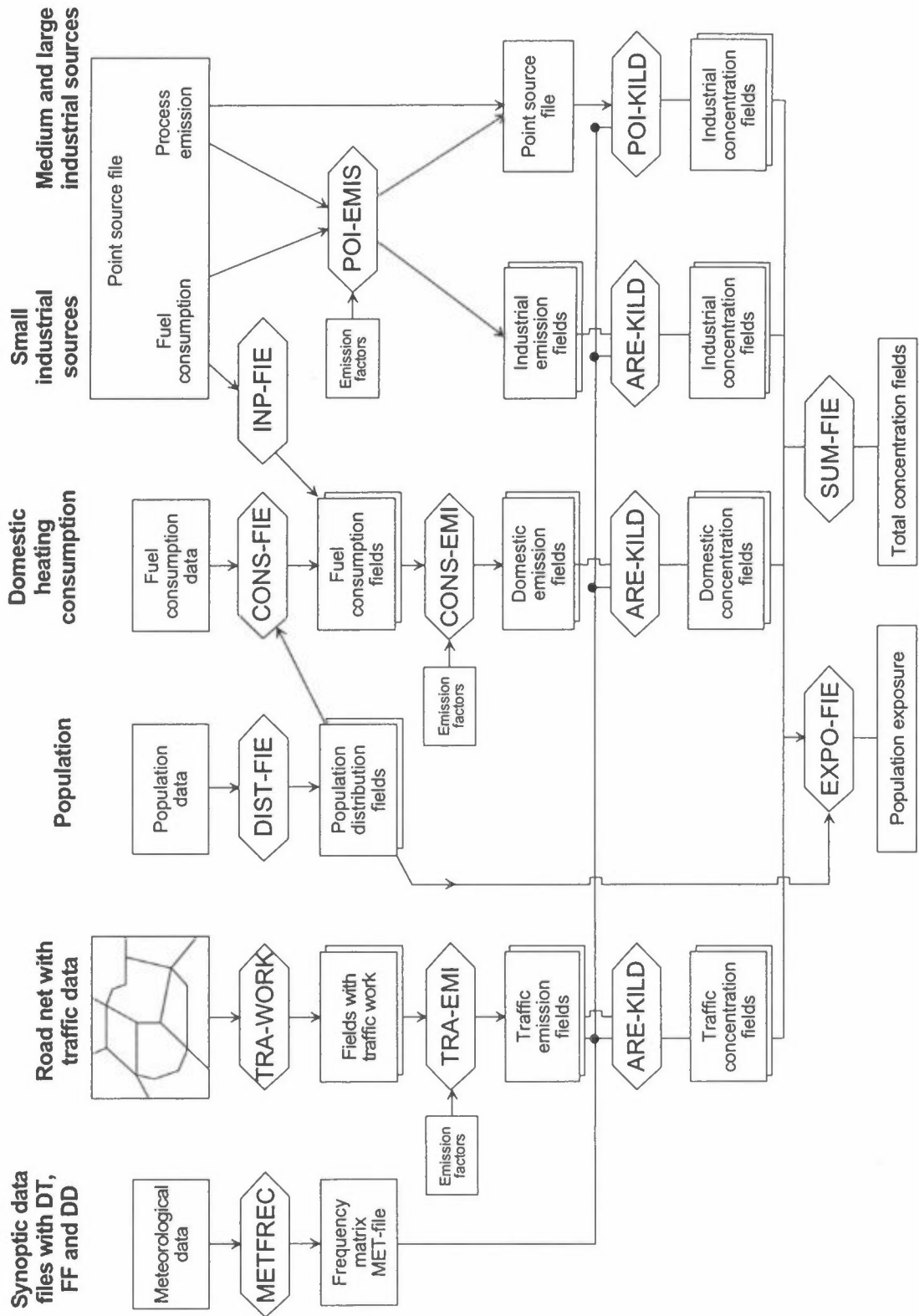


Figure 1: The "KILDER" air pollution modelling system

About data fields and the program structure

The main data communication between the different programs is made through files with data fields. A data field consists of values in a gridded network together with some "around-information". In the data fields the following data are written **unformatted** and stored as **binary** data:

COMPOUND, UNIT, PERIOD, PLACE, SOURCE, DATE, KX, KY, ISIZE,
X(KX,KY)

The first 6 character variables has been introduced in order to keep the "around-information" together with the data. This is safer than to write on the data listing the background for the data.

COMPOUND	Name of the compound (16 characters). This will normally be 'SO2', 'NOx' or 'CO', but may also be variables such as 'INHABITANTS', 'HEIGHT' or 'TRAFFIC',
UNIT	Unit of the field (16 characters). This will for concentrations be 'ug/m3*', for emission fields 'kg/h', but may also be 'PERSONS', 'M' or 'DIESEL-KM',
PERIOD	Period for the data (16 characters). This may be 'WINTER 92/93', '1993', 'Morning traffic',
PLACE	Place for the data (16 characters). Normally one might study only one area at the time, and the data may be stored at directories with the name of the place, but it is useful to have the place in connection with the rest of the data,
SOURCE	Source type (16 characters). 'WOOD CONS.', 'TRAFFIC', 'OIL', 'SMALL INDUSTRY',
DATE	Date when the file was written (16 characters), '1996/08/24 14.15',
ISIZE	Grid size in meter,
KX, KY	Number of points in the east direction and the north direction, respectively,
X[KX,KY]	Data field with values of the real-variable array X in a KX • KY-matrix. All values of a field are stored as real numbers, even if they are integers.

* As the greek letter μ is a special computer character, it is very common to use **ug** as microgram.

File types

In the MS/DOS file system 8 characters may be used in the file name, in addition to 3 characters for the file type. In the KILDER system we use reserve the extension to the file names to identify related **file families**. If the file families are declared systematically it will be easier to recall the content of all the files. You have to keep order of the file names and the file types yourself, the program does not check that you use a correct file (except that some of them are adding the extension code to the file name).

- .FLD binary data fields. These are not readable by a normal editor, but PRIN-FIE makes a listing of the file, and by LOOK-FIE you get displayed values around a specific point.
- .PRN output file. The routine MAP makes a map of the field which is written to a .PRN-file. Normally a program creates both a .FLD file and a .PRN file.
- .DAT input data file.
These files may be combined to a file family, with input data at FILE.DAT as input and FILE.FLD and FILE.PRN as result files.
- .RUN input data to a program may be saved and used as input for a later run.
Ex.: 'TRAF-NOX.RUN', 'HIMALTSP.RUN'.
A program is started by C:\KILDER\READ-FIE<TRAF-NOX.RUN.
- .SYN file with hourly meteorological synoptic data, one file for each month.
- .MET file with statistics of meteorological data for use in POI-KILD and ARE-KILD.

When we are performing calculations for an area we will have both emission and concentration fields for many source groups. It is essential to follow a uniform system in the file names:

For **fuel consumption** fields, use: FUEL-SOURCE.DAT
.PRN
.FLD,

ex: 'COAL-IND' with industrial coal consumption, 'OIL-DOM' with domestic oil consumption.

For **emission** files, use: COMPOUND-SOURCE.DAT
.PRN
.FLD,

ex: 'COAL-DOM', which may contain three fields with emissions from domestic coal consumption: SO₂, NO_x and SPM; 'TSPBRICK' with TSP-emissions from brick factories or 'EMI-TRAF' with fields with emissions from traffic.

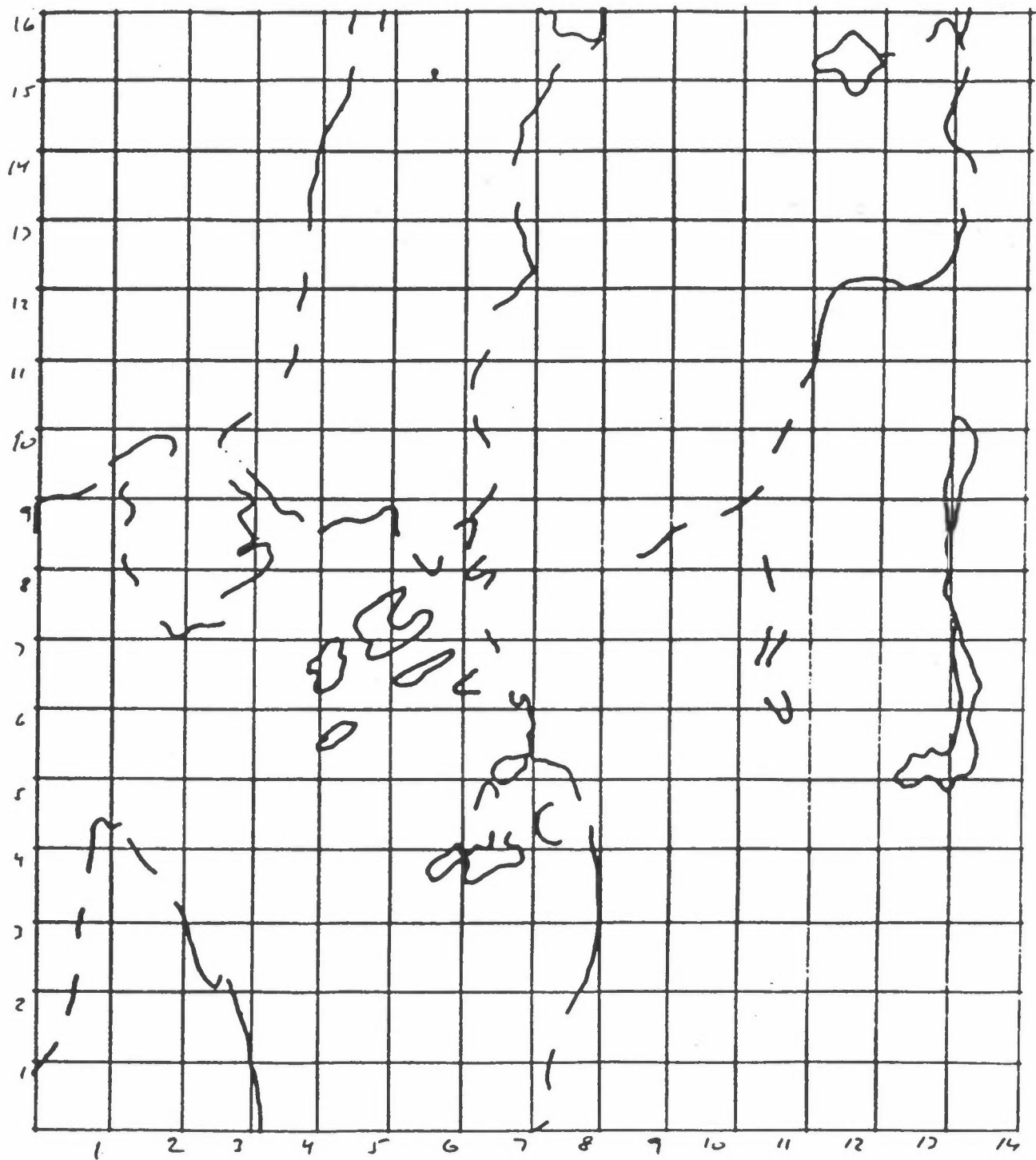


Figure 1: Overlay for print-out.

MAXMIN	gives the highest and lowest value in a field.
INFE	for reading and OUTFE for writing of binary unformatted files, GETFE to fetch a data field.
WHEN	gives the date for the creation of a field: '1996/08/15 11.08'.
LICENSE	all the programs are started by reading a license code for the program.

Data input format

The programs are normally run **interactive** with input from the **terminal**, and are started by writing the program name:

```
C:\KILDER\INP-FIE,
```

and the program will ask for the license code.

The programs may also be run as a **batch job** where all the answers from the interactive job is put on a **separate file**:

```
C:\KILDER\INP-FIE<PECS-OIL.RUN
```

Input from the terminal are separated by a comma, a space or a return.

When the program asks for a **character** variable, f.ex. a file name, it should normally be within apostrophes. An exception is short answers, Y/N.

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

Data are normally read in **free format** (separated by commas or one or more blanks or a return), unless a **format** is specified. When all data from a data line is read, additional comments may be written, as shown in the examples.

Many of the programs needs more data than just answering some simple questions, and data are read from files, mostly with the extension .DAT. The data files are ASCII-files prepared with an editor without any hidden control characters, such as Microsoft's EDIT, PWBED etc. **Do not use the tabulator to move on the editor line, use spaces!** If the data are prepared from a worksheet like Excel, they have to be right justified with an equal number of decimals and exported as Formatted text (space delimited). Sometimes it will be necessary to edit the file to get it correct.

The data are read from **formatted** or **unformatted** records, normally one **record** takes one line of the file. Data from a .RUN-file is normally read unformatted, while some of the data on a .DAT-file may be read formatted. Normally the

FORMAT will be given in the program description, sometimes it is read into the program.

The KILDER program system is intended to be as flexible as possible, due to its use at different places and with different input data. Therefore it is sometimes necessary to tell the program how it shall read an input record, and we read a FORMAT specifier in a character string called FORMIN. A FORMAT specifier is a string of characters between two parentheses which tells how and from where in the record the variables should be read. The variables may be of the type **real**, **integer** or **character**. Normally the name of an **integer** variable will begin with one of the characters I to N, a **character** variable will be declared specific, and the rest will be **real** variables. The following list is a selection of the formatting rules:

Fw.d: Real variable, the field is *w* characters wide, with a fractional part *d* digits wide from the right. If a decimal point is present, it is used, otherwise the rightmost *d* digits are interpreted as following the decimal point. The field may also contain an exponent.

Example:

with the format F8.3 the following values will be read as:

Input:	5	2468	-2468	5.6	56	-28E2
Read:	.005	2.468	-24.680	5.600	0.056	-2.800

The last value is read as $-0.028 * 10^2 = -2.8$

Iw: Integer variable, the field is *w* characters wide, it must **not** contain any decimal point.

Aw: Character variable, *w* characters, including blanks. In a formatted read, a character variable should **not** be embedded with apostrophes.

nX: *n* characters are skipped in the input record.

Tc: Tabulator, continue reading from character *c*.

/: Continue reading from next record (line).

The A, I and F descriptors may be preceded by a repetition factor, and all may be grouped together within parentheses for repetition. Multiple reading is often expressed as a DO-loop as (POS(I), I=1,4).

Examples:

In TRA-WORK the following data are read:

ROAD, NODES, (POS(I), I=1,4), (ITRAF(I), I=1,NT), and the data may be read with the specification FORMIN=(A20,A10,4F8.3,4I8).

In POP-FIE the following data are read:

DIS, NSQ, (XR(I), YR(I), VAL(I), I=1,NSQ), with the specification FORMIN=(A4,2X,I4,7(2I3,F4.1)).

In POI-KILD stack data are read as:

FACT, (STACK(I), I=1,9), CODE, (EM(I), I=1,ICOMP), with the format
FORMIN =(A10, 9F6.0,I2,6F6.1)

In the example to READ-FIE a data field is read with 14 values on each line with the format (2X,14F3.0), and the first 2 characters of the line is not read by the program.

Meteorology

Atmospheric stability

In its simplest terms, the term **stability** of the atmosphere is its tendency to resist or enhance vertical motion, or alternatively to suppress existing turbulence. Stability is related to both wind shear and temperature structure in the vertical, but it is generally the latter which is used as an indicator of the condition.

The actual distribution of temperature in the vertical is known as "atmospheric lapse rate". This seldom approximates the adiabatic lapse rate in the lowest 100 m over any extended time period. Examples of typical atmospheric lapse rates are shown in Figure 1. The different atmospheric conditions (temperature profiles) also act different on vertical plume dispersion.

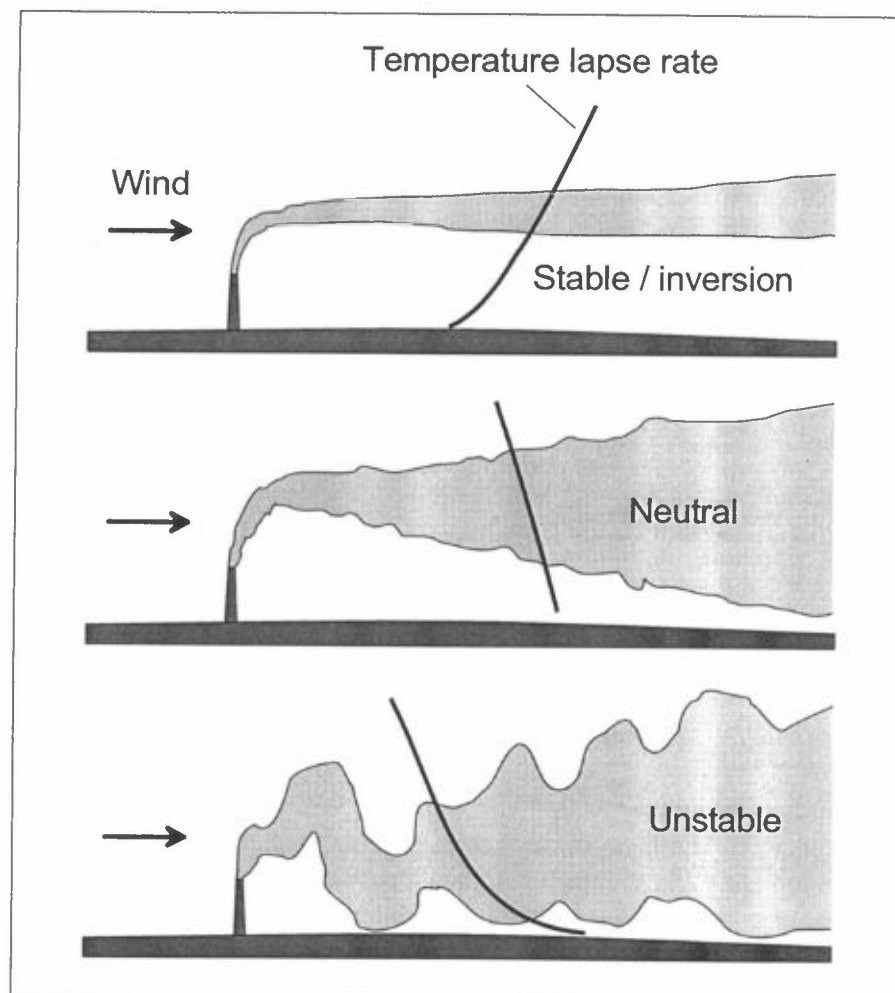


Figure 1: Typical atmospheric lapse rates and corresponding plumes.

On days with strong solar heating or when cold air is being transported over a much warmer surface (sea), the rate of decrease of temperature with height usually exceeds $-1\text{ }^{\circ}\text{C}/100\text{ m}$, implying that any small volume displaced upwards would become less dense than its surroundings and tend to continue its upward motion. A superadiabatic condition favours strong convection, **instability**, and turbulence.

A neutral condition in which the lapse rate in the atmosphere is nearly identical to the dry adiabatic lapse rate, implies no tendency for a displaced parcel to gain or lose buoyancy. **Near neutral** conditions are associated with overcast skies and moderate to strong wind speeds.

An atmosphere in which the temperature decreases less than $-1\text{ }^{\circ}\text{C}/100\text{ m}$ is actually **slight stable**, since a small parcel displaced upwards will become more dense than its surroundings and tend to descend to its original position, whereas a parcel downwards will become warmer and rise to the original level.

A **stable** atmospheric layer in which temperature increases with height strongly resists vertical motion and tends to suppress turbulence. It is therefore of particular interest in air pollution, since it allows very limited dispersion. There has also been much confusion over different types of temperature inversions, and clarification is therefore particularly in order (Figure 2).

Stability parameters

Several parameters for describing the stability conditions or turbulence in the atmosphere have been evaluated:

- the vertical temperature difference ($\delta T/\delta z$),
- the Bulk Richardson number (Ri_B),
- horizontal fluctuations in wind direction (σ_θ),
- Pasquill-Gifford classification.

Pasquill and Gifford studied cloud growth and standard deviations of wind direction for a plume from a 100 m. stack (Brookhaven) and defined six turbulence classes discriminated by wind speed, cloud cover and solar radiation as shown in Table 1.

In the KILDER system four stability classes are used: Unstable, Neutral, Light stable and Stable. The unstable classes A-C from Pasquill-Gifford are combined to one unstable class.

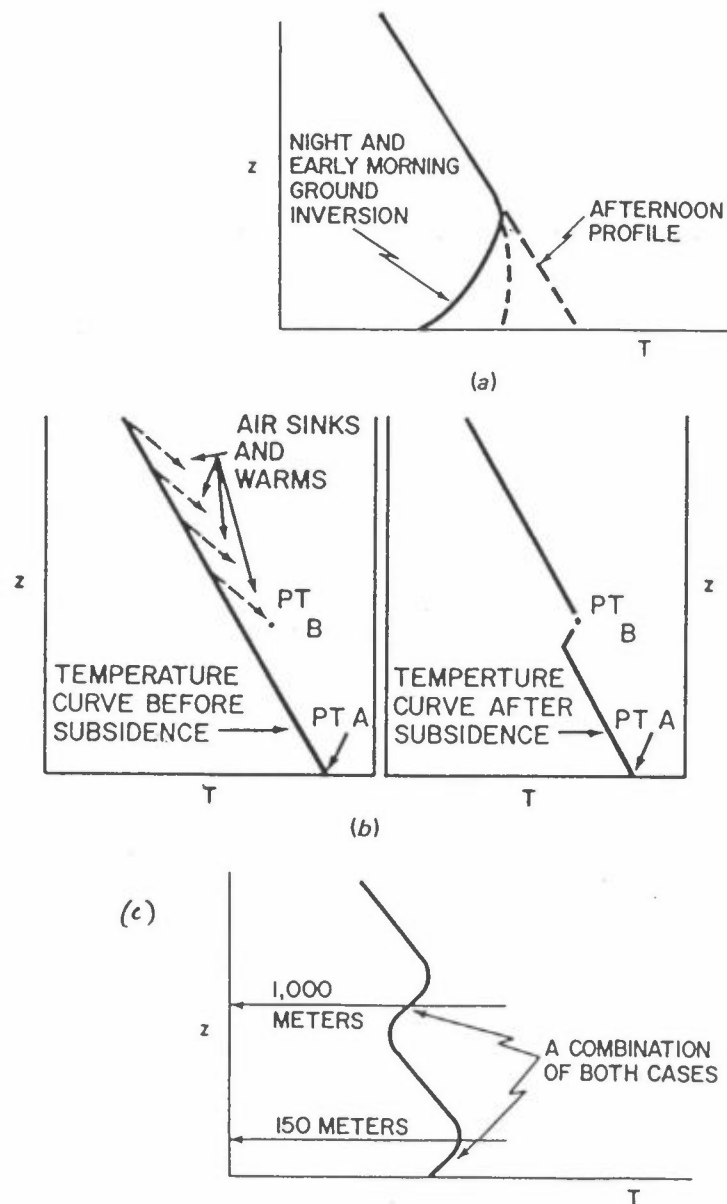


Figure 2: Temperature inversions. (a) During the day. (b) The sinking of air leads to warming aloft the formation of inversions. (c) A combination of cases.

Table 1: Relation of turbulence types to weather conditions

Surface wind speed, m/sec	Daytime insolation			Nighttime conditions	
	Strong	Moderate	Slight	Thin overcast or $\geq 1/8$ cloudiness	
				$\leq 3/8$ cloudiness	
<2	A	A	B		
2	A-B	B	C	E	F
4	B	B-C	C	D	E
6	C	C-D	D	D	D
<u>>6</u>	<u>C</u>	<u>D</u>	<u>D</u>	<u>D</u>	<u>D</u>

The Bulk Richardson number (Ri_B) includes both thermal induced turbulence (temperature stratification) and mechanical induced turbulence (wind profile) to describe the dispersion conditions in the area.

$$Ri_B = g (\Delta\theta/\Delta z) z^2 / (T u^2),$$

where $\Delta\theta$ is the potential difference measured between the height difference Δz . z is the height above the surface of the measured wind speed (u) and g/T is the buoyancy parameter. The criteria for the four classes of turbulence were:

I	:	Unstable		$< Ri_B$	< -0.003
II	:	Neutral	-0.003	$< Ri_B$	< 0.0075
III	:	Light stable	0.0075	$< Ri_B$	< 0.05
IV	:	Stable	0.05	$< Ri_B$	

Figure 3 shows typical seasonal and diurnal variations of stability in Bilbao, Spain, based upon temperature difference and the Bulk Richardson number. Unstable conditions and well developed vertical dispersion of air pollutants most often occurred in the early afternoon in the spring and summer seasons. The Bulk Richardson parameter resulted in a higher frequency of near neutral conditions at daytime, especially in the early afternoon. This was caused by the relatively high wind speeds occurring in the sea breeze at these hours.

At night time hours, stable conditions occurred during all seasons. In the winter season light stable and stable conditions occurred both night and day.

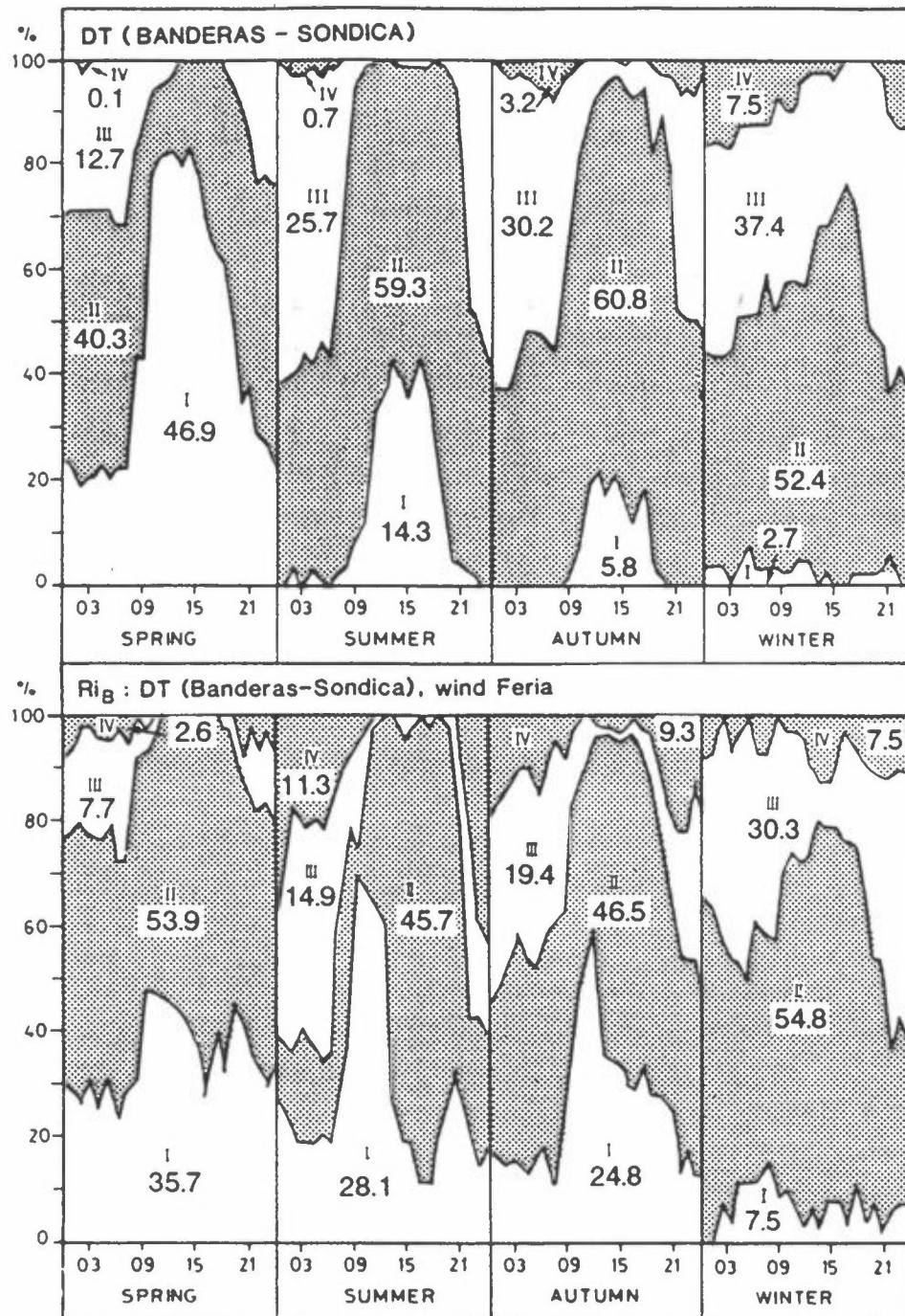


Figure 3: Seasonal and diurnal variation of four classes of stability based upon temperature difference and the Bulk Richardson number.

Synoptic monthly data files

The three programs WINDFREC, STABFREC and METFREC analyzes meteorological and air quality data. The data are read from a common **synoptic** data file with one line for each observation set, one month with data in each file. The observations are normally hourly, but the programs can also read half-hourly data, with two lines for each hour. The file includes a time group, stability data, wind data and concentration data.

- The first 4 columns contains a **time group** YY, MM, DD, HH: year, month, day and hour. If we have 30 minutes values, we have 2 observations for each hour, but shall **not** have minutes;
- The next 2 columns contains data for one or two **stability** variables. This may be either a stability class 1-6, ΔT or σ_θ in the first column, or a upper temperature in the first column and a lower temperature in the second column;
- Column 7 and 8 contains variable 3 or 4, **wind** direction (degrees, the wind is blowing from direction DD) and wind speed (m/s);
- We may include up to 8 concentration variables in the columns 9 to 16.

Data for the time group and the first 4 variables (stability and wind) must be all present at the file. If they are not used, insert dummy data or put the value -99.0. In METFREC we may have additional data for up to 8 concentration variables, and we may select from the program which concentration variable we want to study. The data are read unformatted, but it is recommended to have the data in separate columns. Missing or erroneous data are given a code value, -99.0, or other.

The synoptic data file is prepared in an editor or from Microsoft Excel or equivalent. If the data are prepared in or imported to Excel the file should be arranged so that all columns are left justified, with the same number of decimals within each column. The file should be saved as Formatted Text (Space delimited).

A synoptic file shall be of the type .SYN. When identifying a .SYN-file, only 8 characters are available for the file name. It is recommended to use a combination of the place and the month name: 'MAV95APR.SYN', 'JAN-MUK.SYN', 'HUNSEP91.SYN'.

The file may start with an information label which contains information about the data, the stations, the variables etc. The information label ends with a line which begins with 'START' or 'Start'. The program reads then:

IFO = F Data are read **formatted**
= * Data are read **unformatted**

If IFO = F, read:

FORMIN Format of the data file, within parentheses. Ex: (4I4, 7F6.1, 5F7.2)

ISA 1 all the data are from the same station (place)

2 data from different stations (places)

If ISA=1, read:

STATION Name of the station (with apostrophes)

If ISA=2, read:

STDELTA, STUPPER, STLOWER, STWIND, STCONC

Names of the different stations (with apostrophes)

Then the program reads 2 dummy lines, which may contain additional information about the data.

Now follows the data: year, month, day and hour (but not minutes), 4 meteorological variables and up to 8 other variables:

YY, MM, DD, HH, (Y(I), I=1,12)

One line for each observation, NDAY*24 lines for hourly values, NDAY*48 lines for half-hour values. If there are too many or too few lines, the programs will give error messages and stop. The data are read unformatted, with data in separate columns.

The programs WINDFREC, STABFREC and METFREC do not use the time group to anything except to find the start and end date for the data. They assume that the first (or two) lines are belonging to hour no. 1 and so on.

Figure 1 shows the beginning of a synoptic data file.

Time				Stab.		Wind		Variables							
				1	2	3	4	5	6	7	8	9	10	11	12
START															
1															
'MAV'															
YY	MM	DD	HH	BIT	DEG	deg	m/s	m/s	% R	BIT	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3
				DT 33-	Temp	WD	WS	WG	Hum	TD33-	O3	NO	NO2	SO2	POR
1995	04	01	00	508.1	2.0	323.3	4.2	7.7	73.5	507.5	61.69	4.96	14.25	2.65	17.50
1995	04	01	00	509.3	2.2	326.9	4.4	7.5	71.0	508.1	59.70	4.96	14.25	1.33	23.00
1995	04	01	01	508.0	2.2	281.8	5.1	8.4	69.9	507.8	58.71	4.96	14.25	1.33	29.50
1995	04	01	01	508.1	2.2	332.0	4.8	8.1	70.4	507.8	57.71	8.06	14.25	1.33	17.50
1995	04	01	02	507.8	2.2	329.8	4.5	7.1	70.0	507.1	56.72	3.72	13.30	1.33	16.50
1995	04	01	02	508.3	2.2	334.9	4.3	7.1	69.7	507.3	55.72	4.34	13.30	1.33	29.00
1995	04	01	03	508.1	2.1	285.0	3.7	6.0	70.0	507.8	54.73	3.72	13.30	2.65	13.00
1995	04	01	03	508.8	2.1	331.7	3.1	4.8	70.2	507.6	53.73	3.72	14.25	1.33	20.50
1995	04	01	04	509.5	2.2	327.2	2.8	4.8	69.1	508.0	52.74	3.72	14.25	1.33	35.00
1995	04	01	04	509.8	2.2	262.4	2.6	4.7	68.6	508.8	50.75	9.30	19.00	2.65	23.50
1995	04	01	05	509.8	2.3	304.1	3.2	4.1	66.9	508.3	45.77	9.92	22.80	2.65	36.50
1995	04	01	05	507.1	2.3	301.5	2.7	3.6	67.4	507.3	45.77	9.92	21.85	2.65	28.00
1995	04	01	06	504.6	2.5	281.6	3.2	4.5	65.4	506.1	41.79	9.30	22.80	2.65	34.00
1995	04	01	06	503.0	3.1	284.0	3.0	4.3	60.3	505.8	38.81	11.78	26.60	1.33	30.00
1995	04	01	07	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	30.85	22.94	38.00	5.30	28.50
1995	04	01	07	500.1	2.5	250.8	4.0	5.0	62.9	505.3	29.85	35.96	41.80	11.93	45.50
1995	04	01	08	502.5	2.5	260.3	4.4	5.8	64.6	505.6	36.82	29.14	38.00	10.60	32.00
1995	04	01	08	503.1	2.3	292.5	2.7	3.9	68.3	506.5	41.79	24.18	31.35	7.95	38.00
1995	04	01	09	500.5	2.1	266.1	2.5	3.9	71.9	506.0	29.85	37.82	44.65	5.30	49.50
1995	04	01	09	501.0	2.2	266.5	4.6	6.6	74.9	505.5	30.85	42.78	43.70	6.63	44.50
1995	04	01	10	500.0	2.6	259.1	4.7	6.6	70.8	504.5	29.85	60.14	51.30	3.98	57.00
1995	04	01	10	495.6	3.2	245.4	3.8	5.3	68.5	502.1	34.83	37.20	46.55	5.30	45.00
1995	04	01	11	494.6	4.4	263.2	5.1	7.7	61.5	503.8	37.81	32.86	39.90	2.65	58.00
1995	04	01	11	494.6	5.0	266.6	6.4	9.4	57.4	503.5	44.78	27.28	36.10	3.98	29.00
1995	04	01	12	498.0	5.4	262.1	6.3	9.0	55.0	504.3	45.77	29.76	33.25	7.95	43.50
1995	04	01	12	499.0	5.4	270.9	5.7	8.5	56.5	504.0	55.72	26.04	29.45	7.95	33.50
1995	04	01	13	499.5	5.5	272.9	5.8	8.2	58.4	504.5	63.68	18.60	34.20	5.30	29.50
1995	04	01	13	499.0	5.3	273.0	5.6	8.1	60.3	505.0	63.68	21.70	29.45	6.63	30.00
1995	04	01	14	503.5	5.2	274.7	5.5	7.8	65.4	506.1	60.70	21.08	31.35	7.95	31.50
1995	04	01	14	503.0	5.7	262.8	5.4	8.1	63.6	505.0	62.69	20.46	32.30	7.95	31.00
1995	04	01	15	503.3	5.7	275.5	5.9	8.4	64.1	505.6	59.70	17.98	29.45	5.30	27.50
1995	04	01	15	504.3	5.3	277.9	5.9	8.3	70.3	506.1	57.71	21.70	28.50	3.98	28.00
1995	04	01	16	505.3	5.2	261.4	5.0	7.6	71.8	507.3	58.71	22.94	31.35	5.30	17.00
1995	04	01	16	505.5	5.4	267.0	4.2	6.8	69.8	507.5	56.72	24.18	38.00	5.30	37.00
1995	04	01	17	505.8	4.8	267.4	5.4	8.0	75.7	507.5	55.72	22.94	37.05	2.65	46.00
1995	04	01	17	503.3	4.2	260.5	4.7	6.9	83.1	506.5	46.77	26.66	47.50	2.65	8.00
1995	04	01	18	506.6	4.0	246.0	3.8	5.2	86.3	507.1	44.78	31.00	44.65	5.30	45.50
1995	04	01	18	505.3	4.1	232.7	3.3	4.5	86.7	506.8	45.77	24.18	39.90	1.33	43.00
1995	04	01	19	507.1	4.2	230.6	3.0	4.4	86.4	507.5	43.78	27.28	38.00	0.00	32.00
1995	04	01	19	507.1	4.3	230.1	3.5	4.7	84.5	507.8	33.83	33.48	47.50	1.33	23.50
1995	04	01	20	506.5	4.3	227.6	4.0	5.7	85.6	508.1	38.81	14.88	31.35	0.00	24.00
1995	04	01	20	505.8	4.2	221.7	3.1	4.8	86.4	507.0	37.81	18.60	35.15	0.00	30.50
1995	04	01	21	506.6	4.2	234.4	2.9	4.4	86.8	507.8	43.78	12.40	24.70	0.00	27.00
1995	04	01	21	507.5	4.3	220.2	3.6	5.3	85.5	508.1	37.81	17.36	27.55	1.33	17.50
1995	04	01	22	508.0	4.6	216.5	4.1	5.5	82.4	508.0	36.82	15.50	29.45	0.00	34.50
1995	04	01	22	510.1	4.9	196.3	3.1	4.4	79.8	509.6	36.82	13.64	28.50	0.00	22.50
1995	04	01	23	518.5	5.5	225.1	3.0	4.4	75.5	515.5	39.80	8.68	20.90	0.00	24.00
1995	04	01	23	512.3	5.2	233.6	3.5	4.9	76.4	510.3	-99.00	-99.00	-99.00	-99.00	-99.00
1995	04	02	00	509.5	5.0	221.4	3.2	4.6	77.8	509.0	48.76	6.20	15.20	1.33	20.50
1995	04	02	00	507.8	5.0	222.0	3.0	4.0	78.4	508.6	41.79	11.78	27.55	1.33	33.00
1995	04	02	01	508.1	5.1	239.4	3.0	4.3	77.9	508.5	46.77	7.44	18.05	1.33	34.00
1995	04	02	01	509.8	5.1	243.4	3.4	4.6	77.1	509.6	44.78	6.82	16.15	1.33	23.50
1995	04	02	02	509.0	5.1	241.3	3.6	5.0	76.2	507.8	41.79	8.06	17.10	1.33	21.50
1995	04	02	02	508.1	4.8	248.7	3.7	4.5	78.9	509.0	44.78	6.20	16.15	1.33	32.00
1995	04	02	03	510.1	4.8	253.8	3.7	4.8	79.7	508.8	43.78	6.82	15.20	0.00	43.00
1995	04	02	03	508.5	4.8	246.4	3.7	4.5	79.2	508.5	41.79	9.92	19.00	1.33	20.50

and so on

Figure 1: Synoptic data-file for the KILDER system, data are read unformatted.

Program WINDFREC

General description of the program.

This program reads synoptic data from a .SYN-file and presents standard statistics for wind direction and wind speed for four wind speed classes and up to 36 wind sectors (wind rose). The following data are input for the program:

- Wind direction (variable 3), degrees
- Wind speed (variable 4), m/s.

The program WINDFREC gives the following results:

- Diurnal variation of wind directions
- Distribution of wind speed with wind directions
- Average and maximum wind speed for each wind sector
- Average wind speed for selected wind speed classes.

The program dialogue and results.

The program WINDFREC is an interactive program with a dialogue to the users terminal, but the input may also be read from a batch file. The questions are written in Courier, the answers written in **bold**. The results are written to a user specified result-file. The example below is a typical input sequence for the program. The program uses all the wind data available, but in the example the print-out is restricted to every 3. hour.

C:\KILDER\WINDFREC

The program will always begin to ask where it will find the input data (with apostrophes):

```
Enter the name of input file or 'TERM'.....: TERM'
```

If the answer is 'TERM' or 'term', the rest of the data is read from the terminal (interactive), otherwise the data are read from the input file, which must be a .RUN-file.

```
Enter the name of the result-file (with apostrophes
and .PRN) .....: 'WIND4-6.PRN'
Enter number of months.....: 3
Wind distribution for each I. hour, enter I.....: 3
Enter hour for the first distribution.....: 1
```

If the number of months are more than 1, the following question is given:

```
Do you want a separate output for each month? Y/N) ..: N
```

Further:

```

Enter lower wind speed for not-calm.....: 0.3
Enter number of limits for windspeed classes (Max 6): 5
Enter 5 limits for windspeed classes.....: 1,2,4,6,8
Enter number of wind sectors (12, 16, 32).....: 12

```

A wind direction = 0 may be interpreted in three ways:

1. Wind direction = 360 (north)
2. Calm
3. Data not available

```

Enter 1, 2 or 3.....: 1
Enter number of observations per hour (1 or 2).....: 2
Enter code for missing data (-99.0 or other).....: -99.0

```

For each month is read:

```

Enter number of days in the month.....: 30
Enter name of input file.(with apostrophes
and .SYN) .....: 'METK0495.SYN'

```

Figure 1 shows a batch-file 'WIND4-6.RUN', and Figure 2 shows the corresponding output from 'WIND4-6.PRN'.

'WIND4-6.PRN'	, Output
3	, Months
3	, Wind rose every 3. hour
1	, First rose at 01
N	, Total output
0.3	, Calm limit
5	, 5 wind groups
1,2,4,6,8	, Limits
12	, Sectors
1	, 0 is north
2	, 2 data per hour (30 min.)
-99.0	, Missing code
30	, Days in April
'METK0495.SYN'	, Data file
31	, Days in May
'METK0595.SYN'	, Data file
30	, Days in June
'METK0695.SYN'	, Data file

Figure 1: Batch-file WIND4-6.RUN.

With regard to Figure 2, there also exists wind roses for the hours 02, 03, 05, 06 etc., but we have only asked for print-out for 01, 04, 07 etc.

```

Station : MAV
Period  : 95. 4. 1 - 95. 6.30
Wind direction 0 = 360 deg
Calm:   .3 m/s or less

          DIURNAL VARIATION OF WIND DIRECTIONS (%)

*) Wind-
direction 01 04 07 10 13 16 19 22 Wind-
          30 2.3 1.7 3.9 .0 2.3 2.8 5.7 5.6 3.2
          60 10.3 7.3 4.5 6.4 4.6 4.0 7.4 7.3 5.7
          90 25.7 19.1 15.1 3.5 7.5 7.9 9.7 14.7 13.6
          120 8.6 11.8 15.6 12.8 9.8 6.8 6.3 11.9 10.1
          150 4.0 2.2 3.4 11.6 15.5 12.4 6.9 4.5 7.1
          180 4.6 5.6 5.6 7.0 8.0 15.3 6.3 2.8 6.3
          210 4.0 1.7 4.5 9.9 8.0 9.6 2.3 2.8 5.5
          240 7.4 14.6 14.0 16.9 12.6 10.2 14.9 10.2 13.3
          270 14.3 16.3 18.4 23.8 23.0 20.9 21.1 16.4 19.1
          300 4.6 6.7 4.5 5.8 3.4 4.5 10.3 4.0 5.9
          330 5.1 2.8 2.2 2.3 5.2 5.1 5.1 2.3 3.9
          360 .6 .0 .0 .0 .0 .0 1.1 .6 .2
          Calm 8.6 10.1 8.4 .0 .0 .6 2.9 16.9 6.2

Nobs      ( 175) ( 178) ( 179) ( 172) ( 174) ( 177) ( 175) ( 177) (4209)
Average
wind m/s  1.9  2.2  2.6  3.5  3.8  3.4  2.4  1.9  2.7

          DISTRIBUTION OF WINDSPEED WITH WIND DIRECTIONS (%)

          Class I : Wind speed   .3 - 1.0 m/s
          Class II : Wind speed  1.1 - 2.0 m/s
          Class III : Wind speed  2.1 - 4.0 m/s
          Class IV : Wind speed  4.1 - 6.0 m/s
          Class V  : Wind speed  6.1 - 8.0 m/s
          Class VI : Wind speed  > 8.0 m/s

*) Wind-
direction  I  II  III  IV  V  VI Total Nobs Average
          30  .2  .3  1.3  1.0  .2  .1  3.2 ( 135) 4.0 27.0
          60  .6  1.1  2.5  1.0  .3  .1  5.7 ( 238) 3.1 10.2
          90  2.9  4.1  5.2  1.1  .2  .1 13.6 ( 572) 2.3 17.4
          120 2.3  3.7  2.9  .9  .2  .2 10.1 ( 424) 2.2 18.7
          150 1.2  2.6  3.0  .3  .0  .0  7.1 ( 299) 2.2  7.2
          180  .8  1.9  2.5  .7  .3  .1  6.3 ( 265) 2.8 18.6
          210 1.1  1.4  2.2  .5  .3  .0  5.5 ( 233) 2.6  8.4
          240 1.5  3.3  5.5  2.0  .8  .1 13.3 ( 561) 3.0 15.4
          270 1.3  2.9  8.4  4.4  1.8  .3 19.1 ( 802) 3.6 34.0
          300  .4  1.4  3.1  .8  .1  .2  5.9 ( 249) 3.1 20.9
          330  .1  .4  1.9  1.2  .3  .1  3.9 ( 164) 3.9  9.4
          360  .0  .0  .0  .0  .0  .1  .2 (  7) 6.0  9.5
          Calm 6.2 ( 260)
Total     12.4 23.0 38.5 14.0 4.4 1.4 100.0 (4209)
Average
wind m/s  .7  1.6  3.0  4.9  6.8 10.9 2.7

*) This number indicates central direction of sector
    
```

Figure 2: Output-file WIND4-6.PRN.

In the print-out are the values rounded to the nearest 0.1 %. For the hourly wind rose in the first part of Figure 2 one single observation will represent $100/175 = 0.57\%$. In the total wind rose and in the second part of the figure one observation will represent $100/4209 = 0.024\%$. In the example a value of 0.1 % corresponds to between 3 and 6 observations. This also gives that the sum of the percentages in a group will not always add up to the Total value. For the sector 150 the maximum wind speed is reported as 7.2 m/s, while the percentage for wind speed class 6.1-8.0 m/s is .0.

The last part of Figure 2 may be taken into Excel to give a graphic presentation of the wind rose as shown in Figure 3.

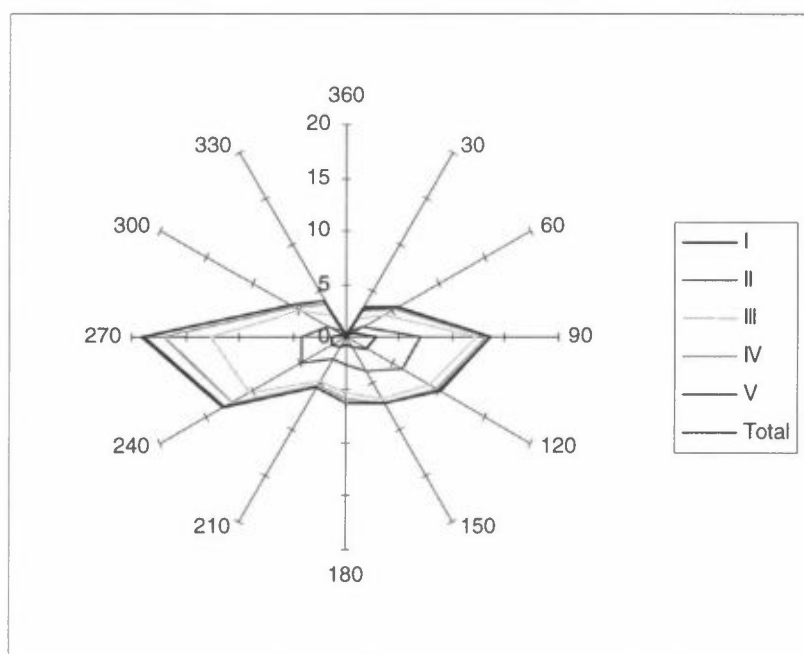


Figure 3: Wind rose from MAV, presented in Excel.

Program STABFREC

General description of the program.

This program presents diurnal distribution in four classes of stability for a stability parameter: Unstable, Neutral, Light stable and Stable. The following data are input for the program:

- Temperature difference ΔT in degrees or bits (variable 1) or
- Temperature difference ΔT as $T_{\text{upper}} - T_{\text{lower}}$ (variable 1-variable 2) or
- σ_{θ} , fluctuations in wind data or
- stability class 1-6.

When temperature difference is used as a stability measure, Unstable will be represented by a negative ΔT , while Stable has positive ΔT . If we instead use fluctuations in wind, σ_{θ} or similar, Unstable will have large values, while Stable will have small values. Gifford (1976) has studied σ_{θ} for different Pasquill classes and found the following values:

Stability	Pasquill	σ_{θ} (at 10 m)
Slight unstable	C	15 deg
Neutral	D	10 deg
Slightly stable	E	5 deg
Moderately stable	F	2.5 deg

According to this, a default set of limiting values to the different classes is set to 12.5, 7.5 and 3.5 degrees, but other values may be used.

The stability may also be given from an external stability classification. If the stability is grouped as Pasquill classes A, B...F, these should be changed into 1-6. In the KILDER programs, the unstable classes A-C (1-3) are treated one unstable class. Such a stability class should be read as variable 1.

The program dialogue and results.

The program STABFREC is an interactive program with a dialogue to the users terminal, but the input may also be read from a batch file. The questions are written in Courier, the answers written in **bold**. The results are written to a user specified result-file. The example below is a typical input sequence for the program. The number of variables will vary with the data. Instead of using the temperature difference as a stability parameter you may use another variable, with other limits for the stability classes.

PROGRAM STABFREC

The program will always begin to ask where it will find the input data:

Enter the name of input file or 'TERM'.....: **'TERM'**

If the answer is 'TERM', the rest of the data is read from the terminal (interactive), otherwise the data are read from the input file, which ought to be a .RUN-file.

```
Enter the name of the result-file (with apostrophes
and .PRN) : 'STAB4-6.PRN'
Enter number of months.....: 3
```

If the number of months are more than 1, the following question is given:

```
Do you want a separate output for each month? (Y/N): Y
```

Stability can be represented in several ways:

1. Temperature difference directly from the file
2. Temperature difference: ($T_{upper} - T_{lower}$)
3. Bits
4. σ in wind data
5. Stability class 1-6.

```
Select option.....: 3
```

For option 2 the program will ask:

```
Enter height difference (m) between the upper and
lower level for the temperature measurements.....: 65.
```

Further:

```
Enter 3 limits for the stability classes.....: 491,512,533
For option 4 the values should be decreasing
Enter number of observations per hour (1 or 2).....: 2
Enter code for missing data (-99.0 or other).....: -99.0
```

For each month is read:

```
Enter number of days in the month.....: 30
Enter name of input file.(with apostrophes
and .SYN).....: 'METK0495.SYN'
```

Figure 1 shows a batch-file 'STAB4-6.RUN', and Figure 2 shows the corresponding output from 'STAB4-6.PRN'.

'STAB4-6.PRN'	, Output-file
3	, Months
N	, Output for the whole period
3	, Stability from bits
491,512,533	, Stability limits
2	, Obs. Per hour
-99.0	, Code for missing data
30	, Days in April
'METK0495.SYN'	, Data-file
31	, Days in May
'METK0595.SYN'	, Data-file
30	, Days in June
'METK0695.SYN'	, Data-file

Figure 1: Batch-file STAB4-6.RUN.

```

*****
*
*   Norwegian Institute for Air Research (NILU)
*
*   P R O G R A M   S T A B F R E C
*
* Program STABFREC needs following INPUT-data:
* - Temperature in two heights, Delta T or DT-bits
*
* The program calculates the diurnal variation of
* stability (%)
*
*   ** RUN 1996/01/17 15.52 **
*****

```

```

Stability   : MAV
Parameter   : Temperature difference (DT)
Unit        : Bits
Period      : 95.04.01 - 95.06.30

```

DIURNAL VARIATION OF STABILITY (%)

```

Class I: Unstable          DT <491.0 Bits
Class II: Neutral         491.0 < DT <512.0 Bits
Class III: Light stable   512.0 < DT <533.0 Bits
Class IV: Stable          533.0 < DT          Bits

```

Hour	Classes			
	I	II	III	IV
1	.0	46.3	40.6	13.1
2	.0	43.4	42.9	13.7
3	.0	46.2	38.2	15.6
4	.0	39.3	41.0	19.7
5	.0	51.7	34.1	14.2
6	.0	73.4	18.1	8.5
7	1.7	90.5	6.1	1.7
8	7.9	91.6	.6	.0
9	23.9	76.1	.0	.0
10	42.4	57.6	.0	.0
11	52.8	47.2	.0	.0
12	44.1	55.9	.0	.0
13	44.8	55.2	.0	.0
14	33.1	66.9	.0	.0
15	29.1	70.9	.0	.0
16	20.9	79.1	.0	.0
17	11.5	88.5	.0	.0
18	5.2	93.6	1.2	.0
19	.6	89.1	9.1	1.1
20	.6	61.5	32.2	5.7
21	.0	49.1	39.4	11.4
22	.0	44.1	39.0	16.9
23	.0	46.6	44.3	9.1
24	.0	45.9	41.3	12.8
Total	13.3	62.9	17.8	6.0

```

Number of obs.: 4209
Missing obs.   : 159

```

Figure 2: Output-file STAB4-6.PRN.

The output may also be taken into Excel to give a graphic presentation of the diurnal variation of the stability as shown in Figure 3.

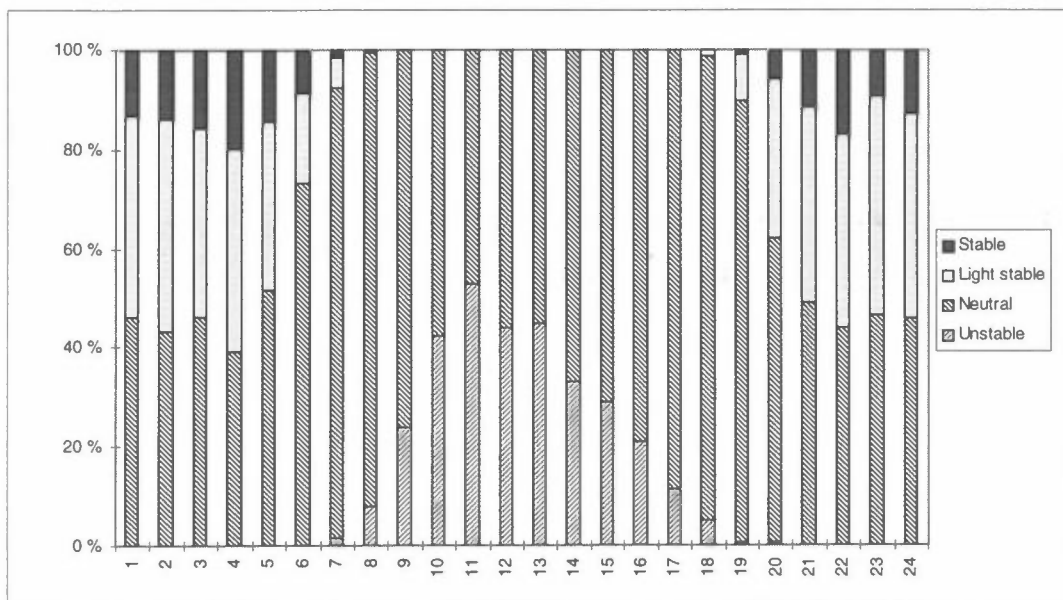


Figure 3: Diurnal variation of stability.

Program METFREC

General description of the program.

This program presents joint frequency distribution of wind speed, wind direction, stability and air quality for four wind classes, 12 or 16 wind sectors and four stability classes for a given period. The output from METFREC is used as input to the dispersion models POI-KILD and ARE-KILD. The program also calculates average values for a concentration variable in the same groups. The following data are input for the program:

- Stability parameter (variable 1 (and 2))
- Wind direction (variable 3)
- Wind speed (variable 4)
- Concentration parameter (optionally variable 5, see later).

The stability parameter and its limits should be the same as in STABFREC.

The results from METFREC are given in two parts:

The first part presents a joint frequency distribution matrix with the occurrence in percent within four classes of wind speed and stability and 12, 16 or 36 wind direction sectors. The values of the line "Total" gives the occurrence in percent of each stability class in each wind class for all wind directions. The values in the column "Rose" gives the occurrence in percent of winds blowing from this sector for all classes of wind speed and stability. If the program is run with 12 or 16 sectors, the frequency distribution matrix may be written to a special file which may be prepared as a meteorological input file to the dispersion models POI-KILD and ARE-KILD.

The second part of the program presents in the same way average and maximum values of concentrations or other variables, sorted into boxes of different meteorological conditions related to the wind/stability classification given in the first part. The fifth variable may be a SO₂-concentration, but can also be other variables as turbulence or mixing height.

The program dialogue and results.

The program METFREC is an interactive program with a dialogue with the terminal, but the input may also be read from a batch file. The questions are written in Courier, the answers written in **bold**. The results are written to a user specified result-file. The example below is a typical input sequence for the program. The number of variables will vary with the data. Instead of using the temperature difference as a stability parameter you may use another variable, with other limits for the stability classes.

C:\KILDER\PROGRAM METFREC

The program will always begin to ask where it will find the input data:

Enter the name of input file or 'TERM'.....: **'TERM'**

If the answer is 'TERM', the rest of the data is read from the terminal (interactive), otherwise the data are read from the input file, which ought be a .RUN-file.

Enter the name of the result-file (with apostrophes
and .PRN) : **'MET-4-6.PRN'**
Do you want a separate output-file for frequency
distribution? (Y/N).....: **Y**

If the answer is Y, then:

Enter the name of the output-file for frequency
distribution (with apostrophes and .MET).....: **'MET-4-6.MET'**

If this is a different file family than the result-file, you get a warning.

Further:

Enter number of months.....: **3**

If the number of months are more than 1, the following question is given:

Do you want a separate output for each month? (Y/N): **Y**

Stability can be represented in five ways:

- 1: Temperature difference directly from the file
- 2: Temperature difference: ($T_{upper} - T_{lower}$)
- 3: Bits
- 4: σ in wind data
- 5: Stability class 1-6

Select option.....: **3**

Enter 3 limits for the stability classes.....: **491,512,533**

Enter number of wind sectors (12, 16, 32).....: **12**

A wind direction = 0 may be interpreted in three ways:

1. Wind direction = 360 (north)
2. Calm
3. Data not available

Enter 1, 2 or 3.....: **1**

Enter 3 limits for windspeed classes.....: **2,4,6**

Enter lower wind-speed for not-calm.....: **0.3**

Enter number of hours per day.....: **24**

If we want separate daytime and nighttime matrices, the number will be different from 24, and the following question is given:

Enter hours to be included:.....:
7,8,9,10,11,12,13,14,15,16,16,17

Further:

Reading of concentration data (variable 5)? (Y/N)...: **Y**

If the answer is Y, then:

Enter compound and unit (with apostrophes), number of decimals (0, 1 or 2), and the column on the data file.....: **'SO2', 'ug/m3', 1, 11**

Further:

Enter number of observations per hour (1 or 2).....: **2**
 Enter code for missing data (-99.0 or other).....: **-99.0**

For each month is read:

Enter number of days in the month.....: **30**
 Enter name of input file.(with apostrophes and .SYN).....: **'METK0495.SYN'**

Figure 1 shows a batch-file 'MET-4-6.RUN', and Figures 2 and 3 shows the corresponding output from 'MET-4-6.PRN' and 'MET-4-6.MET'.

'MET-4-6.PRN'	, Output-file
Y	, Met-file
'MET-4-6.MET'	, Met-file
3	, Months
N	, Not monthly output
3	, Stability from bits
491,512,533	, Bit limits
1	, 0 is north
12	, Sectors
2,4,6	, Wind groups
.3	, Calm limit
24	, Hours per day
2	, Obs. per hour
-99.0	, Missing code
Y	, Concentration variable
'SO2', 'ug/m3', 1, 11	, Compound, unit, decimals, place
30	, Days in April
'METK0495.SYN'	, Data file
31	, Days in May
'METK0595.SYN'	, Data file
30	, Days in June
'METK0695.SYN'	, Data file

Figure 1: Batch-file MET-4-6.RUN.

```

*****
*
*           P R O G R A M   M E T F R E C
*
* The program calculates a frequency distribution in percent
* as a function of wind direction, 4 stability classes and 4
* wind speed classes.
*
*
*           ** RUN 1996/01/29 14.47 **
*
*****
    
```

```

Stability : MAV      - BITS
Wind       : MAV
Period    : 95.04.01. - 95.06.30.
Unit      : Percent
    
```

JOINT FREQUENCY DISTRIBUTION OF STABILITY, WIND SPEED AND WIND DIRECTION

		Class I: Unstable				Class II: Neutral				Class III: Light stable				Class IV: Stable				
		DT <491.0 Bits				491.0 < DT <512.0 Bits				512.0 < DT <533.0 Bits				533.0 < DT				Bits
		Calm: U less or equal .3 m/s																
Wind-direction		.0- 2.0 m/s				2.0- 4.0 m/s				4.0- 6.0 m/s				over 6.0 m/s				Rose
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	
30	.00	.39	.02	.10	.27	.90	.02	.00	.15	.83	.07	.00	.02	.32	.02	.00	3.12	
60	.05	.68	.34	.68	.29	1.64	.15	.34	.07	.83	.07	.00	.02	.27	.02	.00	5.47	
90	.05	2.49	3.71	.81	.39	3.27	.71	.85	.22	.81	.02	.00	.02	.20	.05	.00	13.60	
120	.24	3.54	1.68	.17	.81	2.05	.12	.02	.29	.56	.02	.00	.00	.24	.10	.00	9.86	
150	.66	2.59	.51	.02	1.32	1.51	.15	.00	.22	.10	.00	.00	.00	.02	.02	.00	7.13	
180	.22	2.07	.37	.10	1.03	1.46	.07	.00	.20	.46	.02	.00	.00	.39	.00	.00	6.39	
210	.10	1.68	.61	.05	.68	1.49	.07	.00	.24	.32	.00	.00	.22	.10	.00	.00	5.57	
240	.32	2.95	1.12	.37	1.12	3.47	.66	.27	.44	1.39	.12	.05	.20	.71	.00	.02	13.20	
270	.12	2.83	.85	.34	1.10	5.96	1.15	.29	1.24	2.81	.32	.12	.12	1.90	.12	.00	19.28	
300	.05	1.15	.46	.12	.07	2.93	.12	.02	.10	.66	.05	.00	.02	.27	.00	.00	6.03	
330	.00	.34	.12	.02	.17	1.64	.05	.00	.12	1.07	.00	.00	.02	.39	.00	.00	3.95	
360	.00	.02	.00	.00	.00	.05	.00	.00	.00	.00	.00	.00	.00	.07	.02	.00	.17	
Calm	.02	1.34	3.71	1.15													6.22	
Total		1.8322	.0913	.52	3.93	7.2526	.36	3.27	1.81	3.30	9.84	.71	.17	.66	4.88	.37	.02	100.00
Occurrence		41.4 %				38.7 %				14.0 %				5.9 %				100.0 %
Wind speed		1.28 m/s*				3.0 m/s				4.9 m/s				7.8 m/s				2.93 m/s*
*: Calm not included																		

Frequency of occurrence of the stability classes

	Class I	Class II	Class III	Class IV	
Occurrence	13.0 %	63.2 %	17.9 %	5.9 %	100.0 %

Figure 2: Output-file. MET-4-6.PRN.

MEAN CONCENTRATION OF SO2 FOR STABILITY, WIND SPEED, WIND DIRECTION

Variable : SO2
Unit : ug/m3
Period : 95.04.01. - 95.06.30.

Wind-direction	.0- 2.0 m/s				2.0- 4.0 m/s				4.0- 6.0 m/s				over 6.0 m/s				Rose
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	
30	-	12.8	21.2	34.5	21.1	13.9	6.6	-	33.6	14.1	10.6	-	19.9	14.1	13.3	-	16.0
60	31.1	27.8	17.5	36.3	21.8	16.8	7.1	10.8	22.5	16.6	18.1	-	11.9	15.5	15.9	-	20.4
90	33.1	24.4	18.6	27.5	18.6	27.1	22.1	15.4	17.7	14.1	4.0	-	15.9	12.3	18.6	-	21.9
120	44.7	28.8	23.1	9.8	83.8	48.8	23.1	33.1	30.8	40.6	5.3	-	-	13.6	20.5	-	36.7
150	66.2	32.2	26.9	27.8	63.8	27.3	15.2	-	188.2	18.2	-	-	-	.0	15.9	-	43.9
180	37.8	32.0	19.3	29.8	23.6	22.7	27.4	-	21.2	23.2	21.2	-	-	11.3	-	-	25.6
210	33.1	27.1	22.5	13.9	21.3	19.4	6.2	-	19.9	19.3	-	-	-	13.8	25.5	-	22.2
240	42.3	22.1	18.4	8.2	25.6	15.9	11.5	14.1	15.4	17.1	21.2	37.1	2.2	6.4	-	4.0	18.0
270	24.1	22.4	17.3	14.0	30.2	19.8	9.6	16.3	22.7	12.2	8.3	8.8	21.2	6.8	4.2	-	17.4
300	24.5	18.6	17.4	13.3	35.8	18.1	15.6	5.3	25.2	17.4	19.9	-	19.9	9.6	-	-	17.9
330	-	19.4	15.1	25.2	25.2	19.3	10.6	-	23.9	7.7	-	-	1.3	4.6	-	-	14.8
360	-	5.3	-	-	-	11.9	-	-	-	-	-	-	-	19.4	15.9	-	14.8
Calm	21.2	15.6	20.3	12.4													17.8
Average	47.7	25.3	19.9	20.5	38.4	22.4	13.9	14.6	33.5	15.9	12.8	16.9	11.7	9.1	13.4	4.0	22.7
Concentr.		24.1				24.3				19.9				9.6			
Average concentration in selected stability classes																	
	Class I				Class II				Class III					Class IV			
Concentr.	37.1				21.4				18.4					18.5			

Figure 2: cont.

MAX. CONCENTRATION OF SO2 FOR STABILITY, WIND SPEED, WIND DIRECTION

Variable : SO2
 Unit : ug/m3
 Period : 95.04.01. - 95.06.30.

Wind-direction	.0- 2.0 m/s				2.0- 4.0 m/s				4.0- 6.0 m/s				over 6.0 m/s				Rose
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	
30	-	29.	21.	99.	32.	54.	7.	-	111.	30.	20.	-	20.	24.	13.	-	
60	32.	225.	36.	156.	50.	233.	28.	70.	34.	30.	25.	-	12.	29.	16.	-	
90	33.	122.	62.	178.	56.	243.	56.	129.	24.	32.	4.	-	16.	24.	20.	-	
120	237.	196.	74.	20.	618.	310.	38.	33.	64.	217.	5.	-	-	32.	30.	-	
150	319.	341.	97.	28.	727.	174.	24.	-	311.	29.	-	-	-	0.	16.	-	
180	93.	343.	25.	69.	72.	119.	37.	-	27.	194.	21.	-	-	29.	-	-	
210	46.	213.	76.	20.	29.	42.	8.	-	37.	41.	-	-	23.	69.	-	-	
240	111.	115.	50.	27.	80.	212.	28.	49.	38.	93.	33.	40.	4.	28.	-	4.	
270	28.	106.	29.	29.	118.	272.	28.	25.	38.	41.	24.	17.	32.	61.	20.	-	
300	29.	64.	27.	21.	53.	93.	23.	5.	38.	32.	20.	-	20.	37.	-	-	
330	-	30.	29.	25.	29.	311.	20.	-	29.	29.	-	-	1.	23.	-	-	
360	-	5.	-	-	-	24.	-	-	-	-	-	-	-	20.	16.	-	
Calm	21.	42.	101.	60.													

Number of obs.: 4097
 Missing obs. : 271

Figure 2: cont.

```

Period      : 95.04.01. - 95.06.30.
12,
1.3, 3.0, 4.9, 7.8,

30 .00 .39 .02 .10 .27 .90 .02 .00 .15 .83 .07 .00 .02 .32 .02 .00
60 .05 .68 .34 .68 .29 1.64 .15 .34 .07 .83 .07 .00 .02 .27 .02 .00
90 .05 2.49 3.71 .81 .39 3.27 .71 .85 .22 .81 .02 .00 .02 .20 .05 .00
120 .24 3.54 1.68 .17 .81 2.05 .12 .02 .29 .56 .02 .00 .00 .24 .10 .00
150 .66 2.59 .51 .02 1.32 1.51 .15 .00 .22 .10 .00 .00 .00 .02 .02 .00
180 .22 2.07 .37 .10 1.03 1.46 .07 .00 .20 .46 .02 .00 .00 .39 .00 .00
210 .10 1.68 .61 .05 .68 1.49 .07 .00 .24 .32 .00 .00 .22 .10 .00 .00
240 .32 2.95 1.12 .37 1.12 3.47 .66 .27 .44 1.39 .12 .05 .20 .71 .00 .02
270 .12 2.83 .85 .34 1.10 5.96 1.15 .29 1.24 2.81 .32 .12 .12 1.90 .12 .00
300 .05 1.15 .46 .12 .07 2.93 .12 .02 .10 .66 .05 .00 .02 .27 .00 .00
330 .00 .34 .12 .02 .17 1.64 .05 .00 .12 1.07 .00 .00 .02 .39 .00 .00
360 .00 .02 .00 .00 .00 .05 .00 .00 .00 .00 .00 .00 .00 .07 .02 .00
      .02 1.34 3.71 1.15                      Calm

```

Figure 3: Output-file MET-4-6.MET.

In the examples above the input and output files were given the same "family name" XXX-4-6.RUN and XXX-4-6.PRN, where XXX was WIND, STAB and MET, respectively, and -4-6 was to tell that the period was April-June. When we shall use the file MET-4-6.MET as input to the dispersion models POI-KILD and ARE-KILD, it is renamed to MAV-4-6.MET, to tell that the data was from the station MAV. Some other data should also be added to the file, as shown in Figure 4.

The frequency matrix of the .MET-file is read unformatted, with one or more spaces delimiting the numbers. If one of the frequencies is greater than 10.0, a space has to be inserted.

```

APR-JUN-95      , Period
MAV PECS        , Place
20.             , Tmid
12              , Sectors
1.3, 3.0, 4.9, 7.8 , Wind speed
10.             , Height of wind measurements
0.3            , Starting velocity for wind sensor
Y              , Standard wind profiles
Y              , Standard mixing height
30 .00 .39 .02 .10 .27 .90 .02 .00 .15 .83 .07 .00 .02 .32 .02 .00
60 .05 .68 .34 .68 .29 1.64 .15 .34 .07 .83 .07 .00 .02 .27 .02 .00
90 .05 2.49 3.71 .81 .39 3.27 .71 .85 .22 .81 .02 .00 .02 .20 .05 .00
120 .24 3.54 1.68 .17 .81 2.05 .12 .02 .29 .56 .02 .00 .00 .24 .10 .00
150 .66 2.59 .51 .02 1.32 1.51 .15 .00 .22 .10 .00 .00 .00 .02 .02 .00
180 .22 2.07 .37 .10 1.03 1.46 .07 .00 .20 .46 .02 .00 .00 .39 .00 .00
210 .10 1.68 .61 .05 .68 1.49 .07 .00 .24 .32 .00 .00 .22 .10 .00 .00
240 .32 2.95 1.12 .37 1.12 3.47 .66 .27 .44 1.39 .12 .05 .20 .71 .00 .02
270 .12 2.83 .85 .34 1.10 5.96 1.15 .29 1.24 2.81 .32 .12 .12 1.90 .12 .00
300 .05 1.15 .46 .12 .07 2.93 .12 .02 .10 .66 .05 .00 .02 .27 .00 .00
330 .00 .34 .12 .02 .17 1.64 .05 .00 .12 1.07 .00 .00 .02 .39 .00 .00
360 .00 .02 .00 .00 .00 .05 .00 .00 .00 .00 .00 .00 .00 .07 .02 .00
      .02 1.34 3.71 1.15                      , Calm

```

Figure 4: Input-file MAV-4-6.MET.

The meteorology input file METFILE

The programs POI-KILD and ARE-KILD read all the meteorological data for a period or for a region from a file called METFILE, which has to be specified as .MET. Both KILDER programs reads met.data 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 of wind and stability and some additional data, which has to be adjusted to obtain the correct METFIL-format. When performing calculations for different seasons or for different parts of an area, only a new .MET-file has to be obtained.

If hourly mixing height data are available, it is recommended to run METFREC with the mixing heights as variable no. 5. It could be useful to make two separate METFREC runs for daytime and night-time in order to take into account different dispersion conditions and emission rates for day and night.

The following data should be included in the METFILE file:

When reading character variables from this file, they shall not be embedded in apostrophes.

PERIOD	Which data period is used (16 characters)
PLACE	Name of the area/met. station (16 characters)
TMID	Average temperature for the period (°C)
NSEC	Number of sectors (12 or 16)
WIND<4>	Average wind speed for each wind speed class (m/s) (from METFREC)
ZO	Height of wind measurements (m)
STVEL	Starting velocity for wind sensor (m/s)

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

$$u_z = u_0 \left(\frac{z}{z_0} \right)^{RN} \quad (1)$$

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, the program reads:

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

YIN The program asks for standard values for the mixing height.
ZMIX=700.,500.,300.,200.m: Y/N

If the answer is N, the program reads:

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

If NSEC=12, then:

IDIR, FREK<4,4,NSEC> Format: (I4,16F5.2)
 Joint frequency matrix from METFREC, 4 classes of stability, 4 wind speed classes and NSEC wind direction sectors. The direction IDIR is not used by the programmes. One line for each sector.

If NSEC=16, then:

FREK<4,4,NSEC> Format: (4X,16F5.2)
 Frequency matrix, but the direction NNE,.. is not read.

CALM<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. The mean wind speed in the lowest wind speed class is adjusted by a mean wind speed for "calm" = 0.7*STVEL.

A METFIL file may look as SUM-RIB.MET:

The lines with an * is output from METFREC, the rest must be included by the editor.

```
*DAY WINTER           , Period
  DELHI               , Place
    11.0,             , Tmid
* 12,                 , Sectors
* .6, 1.7, 2.7, 5.1, , Wind speed
  10.0,               , Height for wind measurements
  0.2,                , Start velocity for wind sensor
  Y,                  , Standard wind profile exp
  N,                  , Standard mix. height
  1200.,1000.,400.,150., , New mixing heights
* 30 2.43 .00 .27 .00 .81 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
* 60 .27 .00 .00 .00 .27 .00 .00 .00 .27 .00 .00 .00 .00 .00 .00
* 90 .81 .00 .27 .00 .27 .00 .27 .00 .27 .00 .00 .00 .27 1.62 .00 .00
* 120 .54 .00 .81 .00 1.08 .00 .54 .00 .54 .00 .27 .00 .27 1.35 .00 .00
* 150 2.97 .00 .27 .00 2.16 .00 .27 .00 2.70 .00 .27 .00 .27 1.62 .00 .00
* 180 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
* 210 .00 .00 .00 .00 .27 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
* 240 1.62 .00 .00 .27 .54 .00 .00 .00 .27 .00 .00 .00 .00 .00 .00 .00
* 270 2.16 .00 .54 .27 .81 .00 .00 .00 .54 .00 .00 .00 .00 .54 .00 .00
* 300 2.97 .00 2.70 .54 2.97 .00 .54 .00 2.16 .81 .54 .00 .54 10.49 .00 .00
* 330 2.16 .00 .54 .27 4.04 .00 .81 .00 3.24 1.62 .81 .00 .27 14.80 .00 .00
* 360 .81 .00 .54 .00 .27 .00 .00 .00 .27 .27 .00 .00 .00 1.89 .00 .00
* 7.53 .00 1.89 2.43 , Calm
```

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

Emission

Emission factors

In all studies of air pollution there is a need for accurate data on the quantity and the characteristics of emissions from the numerous sources that contribute to the problem. The large number of these individual sources and the diversity of source types makes conducting field measurements of emissions on a source-by-source basis at the point of release impractical. The only feasible method of determining pollutant emissions for a given community is to make generalized estimates of typical emissions from each of the source types.

An **emission factor** is a statistical average of the rate at which a pollutant is released to the atmosphere as a result of some activity, such as combustion or industrial production. The emission factor relates the quantity of pollutants emitted to some indicator such as production capacity, quantity of fuel burned, or vehicle kilometers travelled by cars. The fundamental equation to perform emission estimates is the following:

$$\text{activity rate} * \text{emission factor} * \text{time factor} = \text{emission rate},$$

where

- **activity rate** relates the amount of fuel used in a special burner, the material produced by a special process or the length driven by a special vehicle type to the period of time covered and is given as m³ of fuel, tons of aluminum or vehicle-km for trucks over 16 tons,
- **emission factor** indicates the amount of pollutant released per unit of activity rate and is given in kg/ton coal, kg/ton aluminum or g/km driven,
- **conversion factor** is necessary to convert the activity units to the emission factor units. It should be 1.0, but may be 0.92 ton/m³ of oil, 30 MJ/kg coal,
- **time factor** gives the connection between the activity period and the emission period. For annual emissions the factor will be 1.0, for hourly emissions 1.0/(365 * 24).
- **emission rate** specifies the amount of pollutant generated per unit time and is given as tons pollutant per year, kg per hour or g/second.

The emission factors are determined as average values from detailed measurements of the emission from different processes, engineering estimates, etc. and are compiled for use by individuals and groups responsible for conducting air pollution emission inventories. For calculation of emissions from traffic there is established detailed tables for different types of vehicles in different driving modes. These may be used for calculating emissions in one road when all traffic parameters are given. For long-term calculations for a city as in the KILDER system we calculate fields with traffic work for different vehicle types, and the emission factors should be averages

In using emission factors from the literature the user should thoroughly check whether the conditions under which such factors have been established are well

understood. Central works are "Compilation of Air Pollutant Emission Factors" from U.S. Environmental Protection Agency (AP-42) and CORINAIR 90 prepared to European Environment Agency for NO_x and VOC (Corinair, 1994).

In the KILDER system a selection of actual emission factors are collected to an emission factor file, called INFAK (with apostrophes and .DAT). This file is used in the following programs:

- POI-EMIS, point source emissions from fuel consumption/production;
- CONS-EMI, area source emissions from fuel consumption fields;
- TRA-EMIS, area source emissions from fields with traffic work.

The KILDER system is not a tool to perform a total emission survey, but more a tool to perform a preliminary survey only a limited set of emission factors will be used. At the beginning of the file we may put all informations about how this file was created, all the assumptions the factors are based upon and actual references.

The programs starts reading of data when it finds a line beginning with START or Start. Then:

NCOMP, (MCOMP(K),K=1,NCOMP)

	FORMAT (I4, 37X,6A8)
NCOMP	Number of compounds (max. 6)
MCOMP	Name of the compounds (SO ₂ , NO _x etc.), without apostrophes. These should be the same as the compounds at the point source file in POI-KILD

Then follows a list with emission factors for different vehicles, fuels or process types.

IFU, FUELTYPE, UNIT, DENS, (FACT(K,J), K=1,NCOMP)

	FORMAT (I4,1X,A20,A8,7F8.3)
IFU	Fuel type code, integer, col. 1-4 IFU= 1-9 different vehicle types, 10- 99 different fuel types, 100-999 different industrial processes.
FUELTYPE	Vehicle type, fuel type or process type, col. 6-25
UNIT	Not used by the programs, but is useful as an information
DENS	Density (see below), col. 34-41
FACT	Emission factor for NCOMP compounds for vehicle/ fuel/process type IFU

DENS is the conversion factor mentioned above. It will not always be a density, but more a factor for adjustment between the consumption unit and the emission factor unit. For vehicles, the emission calculations will be based upon traffic work, and the factors are average values for average driving conditions. If we have more detailed separated information about the traffic we may use different traffic emission factors.

For liquid fuels, the consumption unit will normally be m³. If the emission factor is given as kg/m³, DENS should be 1.0, but if it is as kg/ton, DENS should be the actual density of the oil. For solid fuels the consumption will normally be given in tons, the emission factor as kg/ton, and DENS = 1.0. The emissions from gaseous fuels are often given as g/m³, and the density will be 0.001. UNIT reminds us about the unit for the emission factors. The programs are flexible with respect to the input data, but you must keep order of the different units.

For industrial processes, UNIT will often be the amount produced, for example tons of aluminium, and the emission factor is given as kg/tons. It might just as well be number of barrels or even cars and kg/barrel or car.

Example:

For calculating emissions in Pécs the file 'EMISSZIO.DAT' could be*:

```
Emission factors Pécs, kg/unit
IFU Fuel type          UNIT          DENS      SO2      NOx      CO      Part
IIIIxAAAAAAAAAAAAAAAAxxxxxxxxFFFF.FFFfff.fffFFFF.FFFfff.fffFFFF.FFF
START
  4 Fuel type          UNIT          DENS      SO2      NOx      CO      Part
  1 Gasoline cars <3.5t g/km          1.0      0.05    2.12    9.1     0.24
  2 Diesel 3.5-16t    g/km          1.0      0.11    7.4     7.3     0.82
  3 Heavy diesel truck g/km          1.0      1.47    14.8    7.3     1.4
  4 Bus                g/km          1.0      1.35    18.2    6.2     1.2
  5 Motor cycle       g/km          1.0      0.08    0.08    22.0    0.17

 11 Sawdust           ton           1.0      0.04    3.0     15.0    10.0
 12 Wood              ton           1.0      0.05    3.0     15.0    2.1

 21 Dom. fuel, 0.3%S  ton           1.0      5.50    2.5     1.3     0.2
 23 Med. fuel, 1.2%S  ton           1.0      23.0    4.5     1.2     5.0
 24 Med. fuel, 3.0%S  ton           1.0      57.0    4.5     1.2     5.0
 29 Gas oil, .05%S    ton           1.0      0.90    2.5     1.3     0.2

 41 Earth gas         m3            0.001    0.13    1.8     1.4     0.001
 42 Biogas            m3            0.001    0.01    0.06    1.8     0.002
 43 PB (propane-butane) m3            0.001    1.0     3.4     1.0     0.001

 50 Coal              ton           1.0      48.5    2.3     1.88    46.3
 51 Pecs coal         ton           1.0      34.2    2.4     1.87    50.0
 57 Coal nuts         ton           1.0      41.8    3.0     2.38    48.6
 59 Coke              ton           1.0      38.0    6.0     2.73    20.6

 91 Kender (hemp)     ton           1.0      0.001   0.05    12.19   18.29
```

*The traffic emission factors are collected from Corinair emission factors and other sources, just as an example of an emission factor file.

The emission factor for gas are normally given as g/m³, and we must multiply this with 0.001 to get kg/unit, kg/m³.

If the oil consumption is given as m³, UNIT will be 0.86, 0.92 or 0.95

Other emission factor files:

Emission factors for Oslo 1985.

Based upon A. Rosland: "Emission Coefficients", SFT 1985 and other sources

START

4 Fuel type	UNIT	DENS	SO2	NOx	CO	PART
11 Wood	ton	1.00	0.20	0.7	100.0	10.0
12 Dest. oil	m3	0.83	3.65	2.5	6.5	0.3
13 Heavy oil	m3	0.95	18.4	4.2	0.4	1.3
14 Dom. coal	ton	1.00	19.0	1.5	45.0	10.0

The table below shows emission factors for vehicles used for calculations in Delhi:

Emission factors for Delhi (CPCB 1982, CUPS/10/1982-83).

Start

4 Car type	UNIT	DENS	SO2	NOX	CO	PART
1 MC/TC	g/km	1.00	0.02	0.07		0.20
2 Petrol	g/km	1.00	0.08	3.20		0.33
3 Diesel	g/km	1.00	0.39	0.99		0.45
4 Heavy	g/km	1.00	1.50	21.00		0.75

Program POI-EMIS

In the program POI-KILD we calculate concentrations from point sources. All informations about the point sources (name, position, stack parameters and emissions) are collected in a **stack-file** INSTA, see the description for POI-KILD.

In some cases we start with informations about activity data as **fuel consumption** or **production** instead of emission data. The program POI-EMIS is prepared as a tool for calculating average hourly emissions from such consumption data, especially when we have a series of different consumption data sets. For this you have to prepare a stack-file as described for POI-KILD, see also the example to this.

In POI-EMIS the stack-file INSTA is read and copied to a new stack-file OUTFL.DAT until two dummy lines preceding the source data. For each source the emissions are calculated, using consumption data, period length and emission factors. The program uses the same emission factor file as in CONS-EMI, see the separate description. If the emissions of all the compounds are less than certain limits, the emissions are collected in an **area source** file OUTFL.FLD and OUTFL.PRN. Otherwise they are written together with the other source data to OUTFL.DAT, according to the POI-KILD format.

The fuel consumption data may be for a year or a shorter period, and the program calculates the average emission rate kg/h.

Input data to POI-EMIS

KX, KY, NCOMP	Grid dimensions, number of points eastward and northward and number of compounds (max 6)
INSTA	Input file with stack and consumption data (with apostrophes and .DAT)
OUTFI	Name of the output files (with apostrophes) Stack data and point source emissions are written to OUTFI.DAT The area emission fields (if any) will be written binary to the file OUTFI.FLD, the output is written to the file OUTFI.PRN
PERIOD, PLACE	Both with apostrophes
ICON	We may have different sets with consumption data at the file (max. 5), we want to use no. ICON
NDAY	Number of days in the data period
INFAK	Emission factors are read from INFAK (with apostrophes and .DAT).
(QLIM(I), I=1,NCOMP)	Limits for point source emissions (kg/h)

Consumption data

The preliminary stack-file INSTA contains both data about the stack and the consumption or other activity. Instead of the line with STACK, (SKOR(I), I=1,8), ICOD, (EM(I), I=1 NCOMP), the program reads STACK, SKOR(I), I=1, 2), SKORTE, ICOD, IFU, (CON(I), I=1, ICON).

STACK	Stack (factory) name A10 (without apostroph)
SKOR (1), (SKOR(2)	UTMX (km), co-ordinates of the stack UTMY (km)
SKORTE	Text, corresponding to STACK (3) -- STACK (9), within apostrophes.
ICODE	Source group code 1-9
IFU	Fuel type code, according to the emission factor file.
CON	Consumption data sets, with units corresponding to the emission factor file.

Emission factors are read from the file INFAK (with apostrophes and .DAT), see the separate description of the emission factor file.

Example:

From Pécs we have a file with point source data and 5 sets with consumption data: for every 3 months and for a year. The point source data will be copied to a new file together with calculated emission data.

In addition to these emissions there will be emissions from industrial processes that has to be included in the point source dispersion calculations.

42,28,4	Grid size, 4 components
'FELMERNI.DAT'	Point source file with source data and consumption data
'EM-P-WIN'	Point source emission file, emissions from "point sources", winter
'WINTER','PECS'	Period, place
1	ICONS=1, consumption for January-February-March
90	90 days
'EMISSZIO.DAT'	Emission-factor file
1.0,0.8,3.5,1.0	Limits for the emissions of SO ₂ , NO _x , CO and PART

Stack data and point source emissions are written to the file OUTFI.DAT, the area emission fields (if any) will be written binary to the file OUTFI.FLD, the output is written to the file OUTFI.PRN.

Program CONS-FIE

This program reads data about the **consumption** of fuels as oil, coal, wood or other, mainly for domestic use, and makes consumption fields. In the program CONS-EMI these data are multiplied by emission factors to make **emission** fields.

Originally CONS-FIE was written to give maps for an emission survey. Consumption data for a list of point sources was read, and the consumption for a large number of consumers was combined to area sources. In addition to this, there was a rest-consumption which had to be distributed in different ways, mainly according to the population distribution. In most cases detailed consumption figures are not available, and this part is taken out of this version of the programme CONS-FIE. If consumption data for point or area sources are available, these may be read to fields by INP-FIE.

The consumption may be given as a total for the whole area, as separate data for different regions, or as *pro capita* consumption figures. In a region the different zones may have a varying social standard with unlike specific consumption. As domestic heating may be the dominant source of air pollution in many regions, it is important to have a realistic model for the consumption. The more local knowledge that is the basis for the estimates, the better will the result be.

The program is normally run interactive. It may be necessary to run it twice or more, because it asks for data that may be not are available in advance, but are calculated by the programme.

Input data to CONS-FIE

KX, KY Grid dimensions, number of points eastward and northward

OUTFI Name of the output files (with apostrophes). The data fields will be written binary to the file OUTFI.FLD, the output is written to the file OUTFI.PRN

PERIOD, PLACE, SOURCE All with apostrophes

NFUEL Number of fuel types (max. 8)

For each fuel type is read (with apostrophes):

TYPE, UNIT TYPE = fuel type (COAL, WOOD, KEROSENE, FUEL OIL etc.)
UNIT = unit (tons/year, m³/year etc.)

NZO Number of zones for distribution of the consumption (max. 9)

POPFILE, ZONEFILE Names of the files with population and zone codes (with apostrophes and .FLD, or 'NONE')
 If POPFILE = 'NONE', all squares are given weight = 1
 If ZONEFILE = 'NONE', then NZO **must** be 1
 Only one file name can be 'NONE'

The programme counts the number of squares in each zone group if POPFILE = 'NONE', otherwise the number of inhabitants in each zone group, IPOPU. Here we may proceed in two ways:

IDIS IDIS=1 Total consumption is distributed according to a weighted population distribution
 IDIS=2 Total consumption is calculated from consumption pro capita in different zones

If IDIS = 1, for each fuel type K is read:

(ALL(K,L), L=1,IZO) Total amount of fuel type K consumed in each zone. The consumption in square (I,J), which belongs to zone L is calculated as
 $CONS(I,J,K)=ALL(K,L)*POP(I,J)/IPOPUL$

If IDIS = 2, for each fuel type K is read:

(CAP(K,L), L=1,IZO) Pro capita consumption of fuel type K in each zone The consumption in square (I,J), which belongs to zone L is calculated as
 $CONS(I,J,K)=CAP(K,L)*POP(I,J)$

Example:

In example 2 to READ-FIE we have read a field with zone codes called TESTAREA.FLD. We want to distribute consumption figures according to the population, which is at the file POPU85.FLD. (The figures are not real.) This gives the following input to CONS-FIE:

14,16	Grid dimensions
TESTCONS	Fields at TESTCONS.FLD, output at TESTCONS.PRN
'1985','OSLO','DOM. HEATING'	Period, place and source 3 fuel types
'WOOD'; 'tons/y'	Fuel types, unit
'DIST.OIL','m ³ /y'	
'HEAVY OIL','m ³ /y'	
8	8 zones. Population data for zone 9 was not included at POPU85.FLD, and no fuel is allocated to this area.
'POPU85.FLD','TESTAREA.FLD'	Population and zone file
1	IDIS=1, fuel consumption for each zone is read

3218,2456,385,	zone 1	Consumption of 3 fuel types, 8 zones
416,1509, 82,	zone 2	
1796,6958,436,	zone 3	
2619,5077,562,	zone 4	
3055,7603,812,	zone 5	
812,1285,409,	zone 6	
2628,3329,756,	zone 7	
897,1018,318,	zone 8	

This gives the following output to the file TESTCONS.PRN:

Population in each zone group:

1	30650
2	88590
3	31770
4	10220
5	18850
6	77690
7	56690
8	54840

Data is put on file TESTCONS.FLD

MAP OF WOOD UNIT: tons/y PERIOD: 1994 PLACE: TESTPLACE

MAXIMUM VALUE IS 1.2019E+03, IN (2,10)
 SUM= 1.54410E+04 SCALE FACTOR: 10

GRID SIZE: 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
J=16	2.	2.	.	.	.	.	.	.	.	.	.	.	.	.
J=15	2.	2.	.	.	15.	.	7.	2.	1.	.	.	.	2.	3.
J=14	3.	6.	6.	5.	22.	50.	31.	2.	2.	.	.	1.	4.	4.
J=13	11.	19.	11.	5.	48.	50.	1.	4.	3.	2.	2.	3.	2.	3.
J=12	17.	18.	12.	12.	36.	2.	3.	11.	4.	3.	3.	3.	1.	21.
J=11	12.	9.	9.	45.	2.	3.	4.	3.	2.	3.	1.	.	20.	11.
J=10	16.	120.	44.	3.	7.	103.	102.	2.	2.	2.	1.	13.	13.	.
J= 9	.	16.	52.	4.	2.	50.	68.	4.	2.	3.	16.	9.	.	.
J= 8	.	4.	25.	.	.	.	2.	9.	3.	12.	21.	12.	.	.
J= 7	.	.	.	.	.	.	.	3.	4.	13.	23.	21.	.	.
J= 6	.	.	.	.	.	.	1.	2.	3.	15.	8.	15.	.	.
J= 5	.	.	.	.	.	.	.	2.	4.	6.	8.	11.	.	.
J= 4	.	.	.	.	.	.	.	1.	5.	7.	7.	.	.	.
J= 3	.	.	.	.	.	.	.	.	7.	5.	5.	.	.	.
J= 2	.	.	.	.	.	.	.	.	6.	.	1.	.	.	.
J= 1	.	.	.	.	.	.	.	1.	3.	1.	1.	.	.	.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

and similar fields for DIST. OIL and HEAVY OIL.

Example 2:

From the example above we have data for the consumption and the population within the 8 zones. This enables us to calculate a specific wood consumption factor CAP in tons wood pr. year per person:

Zone	1	2	3	4	5	6	7	8
Cons.	0.1050	0.0047	0.0565	0.2563	0.1621	0.0105	0.0464	0.0164

In the same way we may calculate consumption per person for other fuels. It will perhaps be easier to estimate a consumption in kg or liter per day, but it has to be transformed to consumption per year/person.

Program CONS-EMI

From the **consumption** fields that was created by CONS-FIE, **emission** fields are created by CONS-EMI. The program is run interactive.

There are some questions by the program which may seem senseless, but they have their use and their history. Consumption fields will very often tell about the annual consumption of fuels. It is useful to calculate annual emissions, by the use of emission factors. But as an input for model calculations hourly emissions are needed, in kg/h. In Norway most of the fuel is used during winter, and the major pollution problems are due to winter situations with bad dispersion conditions. Therefore we need winter emissions. In hourly model calculations the emissions from heating is adjusted by the hourly temperature and degree-days.

Other places there may also be great seasonal variations in the consumption, and it is necessary to take this into account when preparing hourly emissions.

Input data to CONS-EMI

KX, KY, NCOMP Grid dimensions, number of points eastward and northward and number of compounds (max 6)

INFILE File with consumption figures (with apostrophes and .FLD)

INFAK File with emission factors (with apostrophes and .DAT)

OUTFI Name of the output files (with apostrophes).
The data fields will be written binary to the file OUTFI.FLD, the output is written to the file OUTFI.PRN

(IFE(I), I=1, NFU) Field numbers for the consumption fields at INFILE.

NFU, (IFU(I), I=1, NFU)
 NFU Number of fuel types/consumption fields (max. 8)
 IFU Fuel type code from emission factor file

IUV IUV=0 Yearly emissions
 IUV=1 Average hourly emissions shall be calculated

(PALL(J), J=1, NFU)
 % of the total consumption allocated. This should be 100 % from CONS-FIE, but we have the opportunity to adjust this by multiplying the data with 100./PALL(J).

If IUV = 1, then:

(PPER(J), J=1, NFU) % of the total consumption that is used during the period

NDAY Number of days in the period (365, 182 or other)
 PERIOD New period (with apostrophes)
 The period for the emission data may be different
 from the consumption data

PLACE and SOURCE will be taken from INFILE, PERIOD from INFILE if IUV = 0, and DATE is the current date.

Emission factors are read from the file INFAK.DAT (with apostrophes and .DAT). See the separate description of the emission factor file.

Example:

Calculation of emissions from fuel consumption in Oslo in 1985, both annual emissions and hourly winter mean emissions.

14,16,4 Grid size, 4 components
 'TESTCONS.FLD' Consumption file
 'FUEL-FAK.DAT' Emission factor file
 'EM-D-WIN' Emission file, emissions from "domestic", winter

 3, 11, 12, 13 3 fuel types from the emission factor file FUEL-FAK.DAT, code 11, 12 and 13.

 1,2,4 Field number 1,2 and 4 at TESTCONS.FLD.

 1 IUV = 1, hourly emissions to be calculated
 70.,95.,100. 70 % of the wood consumption is allocated, 95 % of dist. oil, and 100 % of heavy oil

 82.0, 75.0, 55.0 82 % of the wood is used during the winter season, 75% of the dist. oil, and 55 % of the heavy oil

 182 Winter season (october-march)

 'WINTER 85' Data for "Winter 85" will actually be used for calculations for the winter 1984/85

The emission factor file FUEL-FAK.DAT will be:

Emission factors for Oslo 1985.
 Based upon A. Rosland: "Emission Coefficients", SFT 1985 and other sources

START	4 Fuel type	UNIT	DENS	SO2	NOx	CO	PART
11	Wood	ton	1.00	0.20	0.7	100.0	10.0
12	Dist. oil	m3	0.83	3.65	2.5	6.5	0.3
13	Heavy oil	m3	0.95	18.4	4.2	0.4	1.3
14	Dom. coal	m3	1.00	19.0	1.5	45.0	10.0

The emission factors will vary from place to place, depending on access to "clean" fuels the burner type and many other factors. The SO₂-factor will be $20 * \%S * \rho$, where %S is the sulphur content and ρ is the density of the fuel.

To calculate annual emission fields to file EMIS-DOM, IUUV is set to 0, but PPER, NDAY and PERIOD is not read.

Program TRA-WORK

The calculation of area emissions from traffic, has to be done in two steps, by TRA-WORK and TRA-EMIS. Fields with **traffic work** is calculated in TRA-WORK, and these are multiplied by emission factors in TRA-EMIS.

First of all it is necessary to define a **main road network**, and perform traffic countings. The more informations that can be collected, the better the results will be. If detailed data exists (driving conditions, traffic composition etc.), more detailed models for calculating the emissions may be used. It is possible to some extent to use the results of traffic modelling, but these does not always include all traffic groups, and one should be careful to use the results uncritically, and be aware of all assumptions.

The work starts with a good official map for the area (1:20 000 or better), with a km-grid (UTM-system or similar). A tourist road map is not sufficient, as these are very often handdrawn and not to scale. All main roads should be registered, all main road crossings (= nodes) numbered, and the coordinates of the nodes should be measured out. If there is a bend of the road, it may be necessary to have an extra node. If the coordinates exists in a GIS-system, this would be excellent. In this way a road network is built up, and a file with node positions is made. It will also be useful to have the road names in the file, but the program does not need it. It is possible to transform the coordinates to another system, but the best will be to have the node positions in the correct system. This file should be plotted out by the program ROAD-PLO or other, to assure that the network is according to the maps. (This program is a part of the KILDER Model System, but it is dependent of the plotter facilities, and needs separate plotter driver routines. Therefore it is not included in the standard package.) Figure 1 below shows a plot of the main road network in the southern part of Bombay.

The next step is to fill the network file with traffic data. Normally this will be **Annual Average Daily Traffic (AADT)**, but it might also be workday traffic **WDT**. Very often countings are performed with a morning period (06-09), a mid-day period (11-13) and an afternoon period (15-18). To extend this to AADT it is necessary to establish relationships between short-term countings and AADT. The countings may give total traffic, but should preferably be splitted into different vehicle groups. These may be private (mostly gasoline) cars, light utility vehicles (diesel), heavy trucks, buses and motorcycles/tricycles, depending on the local traffic composition. It will also be useful to carry out some hourly countings for a 24-hour period to get an impression of the diurnal variation, both of the total traffic and for the different vehicle groups.

In the beginning we may have data only from a few counting points, but with local knowledge about traffic streams the data may be extended to attached roads. Figure 2 below shows the beginning of a traffic data file from the URBAIR study in Bombay.

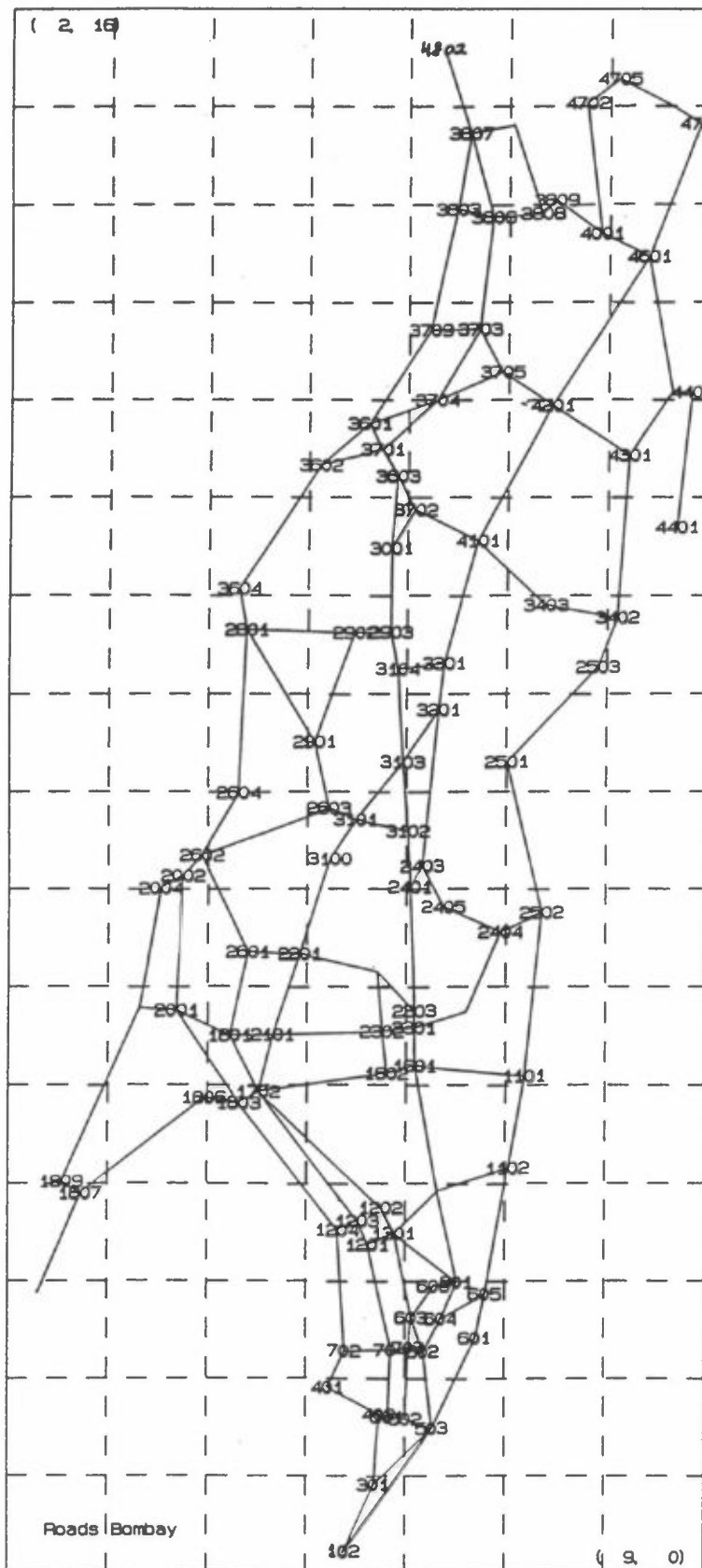


Figure 1: Main road network for Southern Bombay.

Traffic data for Bombay										
Start		x1	y1	x2	y2	light	heavy	bus	aadtot	
(A20,A10,4F6.3,3I6,I7)										
N. Parekh Marg	102	301	5.383	0.231	5.684	0.917	5866	133	0	5999
Sharid Bhagat Singh	102	503	5.383	0.231	6.271	1.492	11700	2233	83	14016
Gen. J. Bhonsle Marg	301	402	5.684	0.917	5.734	1.634	16233	200	33	16466
N. Parekh Marg	301	503	5.684	0.917	6.271	1.492	8066	1133	50	9249
Madame Cama Road	401	402	5.220	1.910	5.734	1.634	7333	616	0	7949
Netaji Subash Road	401	702	5.220	1.910	5.388	2.278	26133	516	0	26649
Madame Cama Road	402	501	5.734	1.634	5.825	1.605	19183	2183	83	21449
Madame Cama Road	501	502	5.825	1.605	6.001	1.589	11383	1016	83	12482
Maharsi Karve Marg	501	704	5.825	1.605	5.854	2.289	14866	2000	166	17032
Mayo Road	502	503	6.001	1.589	6.271	1.492	17233	2783	833	20849
K.B. Patil Marg	502	703	6.001	1.589	6.032	2.312	5866	2050	733	8649
Sharid Bhagat Singh	503	601	6.271	1.492	6.708	2.416	10666	766	500	11932
Mahatma Gandhi Road	503	602	6.271	1.492	6.181	2.274	8583	2333	816	11732
Sharid Bhagat Singh	601	605	6.708	2.416	6.803	2.867	15966	1600	550	18116
Mahatma Gandhi Road	602	603	6.181	2.274	6.062	2.624	7066	583	33	7682
Dadabhai Naoroji Rd	602	604	6.181	2.274	6.459	2.809	13633	3983	1016	18632
Veer Nariman Road	602	703	6.181	2.274	6.032	2.312	16366	2433	50	18849
H. Somani Marg	603	606	6.062	2.624	6.288	2.952	7600	716	566	8882
H. Somani Marg	603	703	6.062	2.624	6.032	2.312	13499	1166	766	15431
Mahatma Gandhi Road	603	1301	6.062	2.624	5.887	3.483	12983	900	233	14116
Mehta Road	604	605	6.459	2.809	6.803	2.867	16	1000	0	1016
Dadabhai Naoroji Rd	604	801	6.459	2.809	6.521	2.988	45833	5083	1383	52299
D' Mello Road	605	1102	6.803	2.867	7.025	4.152	14666	500	616	15782
H. Somani Marg	606	801	6.288	2.952	6.521	2.988	7600	716	566	8882
Veer Nariman Road	702	704	5.388	2.278	5.854	2.289	3466	650	0	4116
Netaji Subash Road	702	1204	5.388	2.278	5.315	3.517	22650	533	0	23183
Veer Nariman Road	703	704	6.032	2.312	5.854	2.289	18000	3250	33	21283
Maharsi Karve Marg	704	1201	5.854	2.289	5.619	3.369	17700	2033	83	19816
Mahapalika Marg	801	1301	6.521	2.988	5.887	3.483	26083	2133	316	28532

Figure 2: Traffic data file from Bombay, 'BOMBROAD.DAT'

In the program TRA-WORK traffic data for the main road network is read, and data fields with **road length** and with **traffic work** for the different vehicle groups are written to file. In the program TRA-EMIS these fields are read and multiplied by emission factors to give emission fields. Normally, traffic data will be as AADT, Annual Average Daily Traffic, but may also be morning traffic, afternoon traffic etc.

In this approach to calculate traffic emission fields we have no information about parameters as speed, gradient, cold start and catalyst. These have to be included in the emission factors used in TRA-EMIS. Another program, ROAD-EMI, calculates emission fields from detailed traffic data, but is not included here.

In the PC-model ROADAIR emissions, concentrations and exposure of the population along a defined road network is calculated. The model is developed to give maximum hourly concentrations of CO, NO₂ and PM₁₀, but the input data file may be used as input to TRA-WORK with the addition of a reading FORMAT. It is important that the ROADAIR-file also includes the roads outside built-up areas (between villages etc.).

The program TRA-WORK is normally run interactive, but the traffic data are read from file.

Input data to TRA-WORK

KX, KY	Grid dimensions, number of points eastward and northward
NT	Number of vehicle types/traffic fields (max. 4)
INFILE	Name of the input file (with apostrophes and .DAT)
OUTFI	Name of the output files (with apostrophes) The data fields will be written binary to the file OUTFILE, the output is written to the file OUTFI.PRN It is useful to use the same family name for INFILE and OUTFILE.
PERIOD, PLACE	With apostrophes
ITRA	Traffic data may exist in three ways: ITRA=1: traffic data for NT vehicle types (max. 4), ITRA=2: total traffic distributed to NT vehicle types, according to the road type, ITRA=3: traffic data from a ROADAIR input file, with % heavy traffic, AADT and daily number of buses. In this case, NT must be 3.

Normally, we have information about the traffic composition for only a few roads. But by systematic countings in representative road types it is possible to classify the roads into a few groups, for example: Toll roads, Main arterial roads, Local arterial roads, Roads in industrial areas and Local roads. Some roads may be prohibited for certain vehicles. This grouping has to be done by local people, based upon local knowledge of the traffic.

If $NT > 1$ and $ITRA = 1$ or 2 , then

(CART(I), I=1,NT) Name of NT vehicle types (with apostrophes)

If $ITRA=3$, the car types will be Light, Heavy and Buses.

If $ITRA=2$, then

NRT Number of road types (max 5)

(FAD(JR,IT), IT=1,NT) Proportion of the traffic on road type JR by
vehicle type IT
One line for each road type JR.

UTMX, UTM Y Coordinates of the lower left corner

ISIZE Grid size in meter (normally 1000 or 500)

ITR Necessary transformation of coordinates:

ITR=0 No transformation

ITR=1 Coordinate system should be rotated and translated
(see below)

ITR=2 The direction of the x-axis should be turned

ITR=3 The direction of the y-axis should be turned
 ITR=4 x- and y-coordinates should be interchanged
 (this may also be arranged by the input format
 FORMIN)

Sometimes we may get the node coordinates from elsewhere in a other coordinate system than for our calculations, so it is necessary to transform the coordinates by rotation and translation. If ITR=1, coordinates for two reference points in the two coordinate systems are read:

U1F,V1F	Coordinates for ref. point 1 in the FROM-system
X1T,Y1T	Coordinates for ref. point 1 in the TO-system
U2F,V2F	Coordinates for ref. point 2 in the FROM-system
X2T,Y2T	Coordinates for ref. point 2 in the TO-system

The program will ask for a control

YD	Distances between the reference points in the two coordinate systems. OK? Y/N (without apostrophes) If N, read new reference coordinates
----	---

As a control, it is useful to print out all road segments within a specified square:

YP	Y/N (without apostrophes)
----	---------------------------

If YP=Y, enter:

IRUX, IRUY	Indices for the square
------------	------------------------

Input data for the road network is read from INFILE. The file is read until a line with 'START' or 'Start' in column 1-5. The program halts, and you enter a Return to continue.

Then the program reads a line with input data format FORMIN (with parentheses). From INFILE the data are read, according to FORMIN, until 'END' in column 1-3 or the end of the file. The input format is depending of the input data:

IF ITRA=1, read:

ROAD, NODES, (POS(I), I=1,4), (ITRAF(I), I=1,NT)	FORMAT according to FORMIN
ROAD	Road name, 20 characters
NODES	Node numbers 10 characters (used only for road segment identification),
POS	4 node positions,
ITRAF	NT traffic sets, integer (max. 4)

Example: FORMIN= (A20,A10,4F8.3,4I6), reads gives ROAD in column 1-20, NODES in col. 21-30, POS in 31-38, 39-46, 47-54 and 55-62, and ITRAF in 63-70, 71-78, 79-86 and 87-94.

If ITRA=2, read:

ROAD, NODES, (POS(I), I=1,4), TRAFS, JRT	
ROAD	Road name, 20 characters
NODES	Node numbers 10 characters (used only for road segment identification),
TRAFS	Sum traffic,
JRT	Road type

Example: FORMIN= (A20,A10,4F8.3,I6,I2), which gives ROAD in column 1-20, NODES in col. 21-30, POS in 31-38, 39-46, 47-54 and 55-62, TRAFS in 63-70 and JRT in col. 71-72.

The traffic will be distributed to the different NT vehicle types according to the factor FAD(JR,IT) for each road type JR.

If ITRA=3, the traffic data are read from a ROADAIR-file. This file type has its own structure, and the program TRA-WORK reads the data according to this.

The traffic will be distributed into LIGHT, HEAVY and BUSES according to:

LIGHT =	ITRAF*(1.0 - (PHEA/100.)),
HEAVY =	ITRA * (PHEA/100.),
BUSES =	IBUS

Example 1:

For the calculation of the traffic work from the main road traffic in Bombay, the following input was used:

20,42	, Grid
4	, 3 vehicle types, plus sum
'BOMBROAD.DAT'	, Traffic data file
'BOMBTRAF'	, Traffic work file
'1990','Bombay'	, Period, place
1	, using the 4 traffic data sets
'LIGHT','HEAVY','BUS','TOTAL'	Vehicle types
2.0,0.0	, Coordinates of the lower left corner
1000	, Grid size
1.0	, Scale
0	, No coordinate transformation
N	, No print-out of roads

The file BOMBROAD.DAT is shown in Figure 2.

The output will be maps of:

Main Road Length
Traffic work Light
Traffic work Heavy

Traffic work Bus
Traffic work Sum.

The program will also give informations about road length and traffic work for roads outside the grid area.

Example 2:

To make fields with traffic from a ROADAIR-file from Pécz we must make some changes to the file as shown in Figure 3: Start and the input format. The data that are read from the file are marked by A, F or I at the top of the file, columns marked by X are not read.

This gives the following input:

42,28	, Grid
3	, 3 vehicle types: light, heavy and buses
'ROADAIR.DAT'	, Input file
'ROADAIR'	, Output file
'1994','PECZ'	, Period, place
3	, Reading from a ROADAIR-file
576.0,74.0	, Coordinates of the lower left corner
500	, Grid size
1.0	, Scale
4	, x and y must be changed
Y	, Printout of roads
23,15	, in grid 23,15

The output will be maps of:

Main Road Length
Traffic work Light
Traffic work Heavy
Traffic work Bus

Figure 4 shows a part of the output from the program. The beginning is messages from the reading of the ROADAIR-file: roads that have to be divided for calculation reasons and road segments outside the calculation area. It is mixed with data for the roads in grid (23,15): coordinates, road length and traffic work from light, heavy and buses.


```

Traffic data are read from the file ROADAIR.DAT
The coordinates of the lower left corner is (576.0, 74.0)
Road KOMLOI UT      ( 27.000 21.000)-( 26.200 26.000) divided in 3 at
                    26.733 22.667
                    26.467 24.333
Road MOHACSI UT PECS TABL ( 29.800 10.400)-( 27.600 14.200) divided in 3 at
                    29.067 11.667
                    28.333 12.933
Road ZSOLNAY UT MOHACSI U ( 22.800 14.800)-( 26.000 16.400) divided in 3 at
                    23.867 15.333
ZSOLNAY UT MOHA 23 15 22.800 14.800 23.000 14.900 .112 1283.0 96.2 148.1
                    24.933 15.867
LANC UTCA FELSO 23 15 22.800 14.800 22.727 15.000 .106 1552.8 45.4 19.3
RAKOCZI U. 35. 23 15 22.000 14.711 22.400 14.800 .205 2668.5 .6 263.3
ALSOMALOM UTCA 23 15 22.000 14.200 22.400 14.800 .361 11115.8 210.6 498.7
Road SIKLOSI UT      ( 21.800 8.400)-( 21.600 12.000) divided in 3 at
                    21.733 9.600
                    21.667 10.800
Road VERSENY UTCA    ( 18.900 12.200)-( 23.800 13.200) divided in 3 at
                    20.533 12.533
                    22.167 12.867
FELSOMALOM UTCA 23 15 22.400 14.800 22.400 15.000 .100 352.8 6.8 .4
RAKOCZI UT ALSO 23 15 22.400 14.800 22.800 14.800 .200 5323.7 351.4 374.4
BAJCSI ZS. U. 9 23 15 22.818 14.000 22.000 14.800 .444 2353.9 14.2 190.1
Road HUNYADI UT 17. ( 22.800 14.800)-( 20.800 17.400) divided in 2 at
                    21.800 16.100
HUNYADI UT 17. 23 15 22.800 14.800 22.646 15.000 .126 437.0 7.4 35.7
Road SZIGETI UT      ( 15.000 13.600)-( 18.200 14.500) divided in 3 at
                    16.067 13.900
                    17.133 14.200
Road 6-OS MOL KUT    ( 9.800 12.600)-( 15.200 12.800) divided in 4 at
                    11.150 12.650
                    12.500 12.700
                    13.850 12.750

```

```

Sum road length in square (23,15) is      1.654 km.
Sum traffic-work in square (23,15) is 25087.490 car-km.LIGHT
                                         732.738 car-km.HEAVY
                                         1529.956 car-km.BUSES
Field for MAIN ROADS      is put on file ROADAIR.FLD

```

```

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```

```

MAP OF : MAIN ROADS      UNIT: KM          SOURCE: Traffic
PERIOD : 1994           PLACE: PECS        GRID SIZE: 500 METER
CREATED: 1996/10/29 19.05

```

```

MAXIMUM VALUE IS 1.6540E+00, IN (23,15)
SUM= 1.28626E+02  SCALE FACTOR: 1.0E-03

```


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
J=26
J=25
J=24
J=23
J=22
J=21	204.	.	.	.	.	.	.
J=20	326.	183.	.	.	.	.	.
J=19	.	349.	.	.	.	.	.	.	.	.	.	.	.	.	509.	.	.	.	.	.
J=18	.	140.	610.	122.	.	.	.	.	.	.	.	.	.	.	509.	.	.	.	555.	503.
J=17	356.	304.	.	.	.	.	.	.	.	509.	.	.	.	521.	.
J=16	.	.	.	407.	152.	506.	.	.	.	.	.	.	.	.	508.	.	.	.	573.	521.
J=15	506.	.	.	.	.	.	.	.	.	504.	300.	519.	879.	1020.	.
J=14	506.	.	.	.	.	.	.	.	.	202.	967.	864.	1094.	187.	142.
J=13	.	.	301.	502.	502.	907.	502.	502.	802.	500.	500.	500.	500.	500.	500.	895.	615.	501.	1280.	902.
J=12	500.	.	.	.	.	.	.	.	.	.	1009.	.
J=11	500.	.	.	.	.	563.	309.	.	.	.	202.	350.
J=10	500.	.	.	.	.	253.	563.	274.	.	.	58.	391.
J= 9	500.	.	.	.	.	.	.	.	288.	563.	239.	1172.
J= 8	508.	.	.	.	.	.	.	.	.	.	606.	890.
J= 7	102.	408.	.	.	.	.	.	.	.	283.	424.	232.
J= 6	510.	.	.	.	.	.	.	.	283.	424.	220.	360.
J= 5	406.	506.	506.	506.	506.	506.	485.	424.	.	580.	.	.
J= 4	515.	.	394.	186.	.	.
J= 3	206.	309.	.	.	.	.	.
J= 2	515.	.	.	.	.	.	.
J= 1	515.	.	.	.	.	.	.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Figure 4: Part of the output for the traffic in Pécz.

We will have similar maps for the second part of the road field, and fields for traffic work Light, Heavy and Bus. We see that as this was a ROADAIR-file, the road network is not always continuous.

Traffic on small roads

In addition to the emissions from the traffic on the main roads there will always be a lot of traffic on the smaller roads. The traffic work on these will normally be of the order of 15-25 % of the total traffic work, and with emissions of 20-30% of the total. As the amount of information varies from city to city it is very difficult

to give a standard procedure for estimating these emissions. One approach is to start with the sale of gasoline, assuming that all gasoline is used within the city region.

By using statistical consumption figures for different vehicle types, and their part of the traffic work on the main roads, it is possible to estimate an upper value for the total traffic work. The difference from the main road traffic work may be distributed according to the population, or according to the population, but with different weight in different regions. This may be done in the program CODE-FIE.

In the URBAIR study of Jakarta it was calculated a traffic work on the main roads of about $14 \cdot 10^9$ car-km, whereas the gasoline consumption figures indicates a traffic work of about $17 \cdot 10^9$ car-km. The difference $3 \cdot 10^9$ car-km/y will be due to traffic on local roads (or error in data). The local traffic work may be distributed by multiplying the population field by $3 \cdot 10^9 / 7.1 \cdot 10^6 = 422.5$ car-km/person.year.

The total traffic work may be calculated by SUM-FIE, as the sum of 'TRAFTOT.FLD' * 1.0, and 'JPOP90.FLD' * 422.5.

This estimate was based upon an average factor for the whole DKI Jakarta. In the densest populated areas the car density is probably lower than in other areas. Based upon local knowledge about the social standard in the different regions of the city it should be possible to define zones with different traffic work *pro capita*.

The average value of 422.5 car-km/person corresponds to about 1.15 km/person*day at local roads. In some zones this should be 0.25 km/day or lower, in other 2.5 km/day and even more.

Program TRA-EMIS

The program is normally run interactive, and it reads one or more fields with traffic work from TRA-WORK and calculates emission fields.

Input data to TRA-EMIS

KX, KY,NTR	Grid dimension, number of points eastward and northward and the number of traffic fields (max. 4)
INFILE	Traffic work file (with apostrophes and .FLD).
ITR	Field number for the first traffic work field. (Normally 2 for files from TRA-WORK, as the first field is the road length.)
OUTFI	Name of the output files (with apostrophes) The data fields will be written binary to the file OUTFI.FLD, the output is written to the file OUTFI.PRN
INFAK	Emission factor file (with apostrophes and .DAT)
(IVE(I), I=1,NTR)	Vehicle type codes on the emission factor file

Emission factors for NCOMP compounds are read from the file INFAK (with apostrophes and .DAT), see the separate description of the emission factor file. The program will prepare NCOMP fields with emissions as a sum of the contributions of each vehicle type.

Example:

For calculation of emissions from the traffic fields for Bombay, the input will be:

20,42,3	, Grid, 3 traffic fields
'BOMBTRAF.FLD'	, Traffic work file
2	, First field on the file is the road length
'BO-TR-EM'	, Output file, traffic emissions in Bombay
'EMISFACT.DAT'	, Emission factor file for Bombay
2,4,4	, Using emission factor code 2 for private cars and 4 , both for trucks and buses

Program POP-DIST

To prepare an emission survey many of the activities has to be distributed according to the population distribution. We have several programs that uses population distribution to estimate consumption of fuels and other activities in different ways. For calculation of a population distribution field we have two programs: POP-DIST and POP-FIE. We need data for the population within districts and sub-districts, and we need a detailed map with the borders of the sub-districts.

From a national census it will normally be possible to get data for the population within each sub-district. These are read in the program POP-DIST, which calculates how many % of of the population in the district that lives within each sub-district. From this we are preparing a population distribution key to transfer the population figures to the grid, and in POP-FIE we are making the population fields. When the distribution key is established, it is later easy to distribute new population figures.

Input data to POP-DIST

INFILE Population file (with apostrophes and .DAT)
 OUTFILE Result-file (with apostrophes and .PRN)

Population data are read from INFILE:

The file is read until Start in col. 1-5. Then:

INFO Input format (with parentheses, but without apostrophes)
 NREG Number of regions

For each region:

NDIST Number of districts.

For each district:

ZONE, RODE, RODENAME, INH
 ZONE and RODE as A3, RODENAME as A20, inhabitants
 INH as integers. NDIST lines, one line for each rode until
 RODE=SUM.

At the end of each region the sum is read, and checked against the sum of the districts, and finally the total population is read and checked against the sum of the regions.

The program gives a message if the population at SUM differs from the SUM for the rodes.

Example:

The population of Jakarta is divided into 5 regions (central, north, west, south and east Jakarta). Each of these are divided into 7-10 kecamatans, and these again into 5-10 kelurahans, to a total of 260 kelurahans. The table below shows the beginning of a file with area and population within the kelurahans for central Jakarta. The ZONE code is the same for all the kelurahans within a kecamatan, and in this case the RODE name is a figure read as characters. We have put a space between the names, and the first line tells where to put the data.

```
XAAAxaaaXaaaaaaaaaAAAAAAAAAAffff.ffIIIIIIIII
Start
(2(1X,A3),1X,A20,7X,I8)
5,          number of regions
8,          number of districts (kecamatan)
P 1  1 Gelora          2.59   3764
P 1  2 Bendungan Hilir 1.58   28739
P 1  3 Karet Tengsin   1.53   31007
P 1  4 Petamburan     0.90   33486
P 1  5 Kebon Melati    1.26   49809
P 1  6 Kebon Kacang    0.71   27597
P 1  7 Kampung Bali    0.73   17750
P 1  SUM Tanah Abang  9.30  192152

P 2  1 Menteng        2.44   30806
P 2  2 Pegangsaan     0.98   23857
P 2  3 Cikini         0.82   13451
P 2  4 Gondangdia     1.46    6769
P 2  5 Kebon Sirih    0.83   15891
P 2  SUM Menteng     6.53   90774

P 3  1 Kenari         0.91   10936
P 3  2 Paseban        0.71   26283
P 3  3 Kramat         0.71   28147
P 3  4 Kwitang        0.45   17005
P 3  5 Senen          0.82    9196
P 3  6 Bungur         0.63   21022
P 3  SUM Senen       4.23  112589

P 4  1 Rawa Sari      1.25   25604
P 4  2 Cempaka Putih Timur 2.22   28785
P 4  3 Cempaka Putih Barat 1.22   38108
P 4  SUM Cempaka Putih 4.69   92497

P 5  1 Johar Baru     1.19   39197
P 5  2 Kampung Rawa   0.30   22846
P 5  3 Galur          0.27   19750
P 5  4 Tanah Tinggi   0.62   41073
P 5  SUM Johar Baru   2.38  122866
```

P 6	1	Harapan Mulya	0.53	25631
P 6	2	Cempaka Baru	0.99	36862
P 6	3	Sumur Batu	1.15	24096
P 6	4	Serdang	0.82	32045
P 6	5	Utan Panjang	0.54	29167
P 6	6	Kebon Kosong	1.16	30893
P 6	7	Kemayoran	0.53	22995
P 6	8	Gunung Sahari Selat	1.53	24839
P 6	SUM	Kemayoran	7.25	226528

P 7	1	Pasar Baru	1.69	16770
P 7	2	Gunung Sahari Utara	1.86	21850
P 7	3	Kartini	0.55	25650
P 7	4	Karang Anyar	0.51	29559
P 7	5	Manggu Dua Selatan	1.29	30653
P 7	SUM	Sawah Besar	5.92	124482

P 8	1	Cideng	1.26	20670
P 8	2	Petojo Selatan	1.14	20619
P 8	3	Gambir	2.58	4509
P 8	4	Kebon Kelapa	0.78	12530
P 8	5	Petojo Utara	1.12	19696
P 8	6	Duri Pulo	0.72	34840
P 8	SUM	Gambir	7.60	112864

P99	SUM	Jakarta Pusat	47.90	1074752
-----	-----	---------------	-------	---------

B 8	1	Krukut	0.55	22952
B 8	2	Maphar	0.59	18527
B 8	3	Taman Sari	0.68	18863
B 8	4	Keagungan	0.32	20784
B 8	5	Glodok	0.38	9558
B 8	6	Mangga Besar	0.51	10931
B 8	7	Tangki	0.37	14917
B 8	8	Pinangsia	0.96	13794
B 8	SUM	Taman Sari	4.36	130326

B99	SUM	Jakarta Barat	126.15	1815316
-----	-----	---------------	--------	---------

		DKI JAKARTA	666.26	8222515
--	--	-------------	--------	---------

The output gives the corresponding percentage of each kecamatan:

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Zone	Rode	District	Pop	%
P 1	1	Gelora	3764	1.96
P 1	2	Bendungan Hilir	28739	14.96
P 1	3	Karet Tengsin	31007	16.14
P 1	4	Petamburan	33486	17.43
P 1	5	Kebon Melati	49809	25.92
P 1	6	Kebon Kacang	27597	14.36
P 1	7	Kampung Bali	17750	9.24

P 1		Tanah Abang	192152	100.00

P 2	1	Menteng	30806	33.94
P 2	2	Pengangsaan	23857	26.28
P 2	3	Cikini	13451	14.82
P 2	4	Gondangdia	6769	7.46
P 2	5	Kebon Sirih	15891	17.51

P 2		Menteng	90774	100.00

P 3	1	Kenari	10936	9.71
P 3	2	Paseban	26283	23.34
P 3	3	Kramat	28147	25.00
P 3	4	Kwitang	17005	15.10
P 3	5	Senen	9196	8.17
P 3	6	Bungur	21022	18.67

P 3		Senen	112589	100.00

P 4	1	Rawa Sari	25604	27.68
P 4	2	Cempaka Putih Timur	28785	31.12
P 4	3	Cempaka Putih Barat	38108	41.20

P 4		Cempaka Putih	92497	100.00

P 5	1	Johar Baru	39197	31.90
P 5	2	Kampung Rawa	22846	18.59
P 5	3	Galur	19750	16.07
P 5	4	Tanah Tinggi	41073	33.43

P 5		Johar Baru	122866	100.00

P 6	1	Harapan Mulya	25631	11.31
P 6	2	Cempaka Baru	36862	16.27
P 6	3	Sumur Batu	24096	10.64
P 6	4	Serdang	32045	14.15
P 6	5	Utan Panjang	29167	12.88
P 6	6	Kebon Kosong	30893	13.64
P 6	7	Kemayoran	22995	10.15
P 6	8	Gunung Sahari Selat	24839	10.97

P 6	Kemayoran	226528	100.00
P 7	1 Pasar Baru	16770	13.47
P 7	2 Gunung Sahari Utara	21850	17.55
P 7	3 Kartini	25650	20.61
P 7	4 Karang Anyar	29559	23.75
P 7	5 Manggu Dua Selatan	30653	24.62
P 7	Sawah Besar	124482	100.00
P 8	1 Cideng	20670	18.31
P 8	2 Petojo Selatan	20619	18.27
P 8	3 Gambir	4509	4.00
P 8	4 Kebon Kelapa	12530	11.10
P 8	5 Petojo Utara	19696	17.45
P 8	6 Duri Pulo	34840	30.87
P 8	Gambir	112864	100.00
	region Jakarta Pusat	1074752	

This percentages should be used in preparing of the DISTFILE.DAT in POP-FIE.

We might also use the **area** of each kelurahan to distribute the areas of each region to the grid. Some activity will be proportional to the area, combined with some regional codes.

Program POP-FIE

This program is written as a tool for distributing characteristics when total figures for several districts are given. This will mainly be population, but it has also been used to distribute working places and wood consumption.

From official statistics the population within districts/zones is given, and the problem is to distribute this to the grid. The more detailed the information is, the better will the result be. The work starts with a map with the grid, and with the borders of each zone. For each zone it is estimated how many % of the zone that is covered by each square. When it is a homogeneous zone the area distribution may be used, otherwise dense populated parts must be given more weight than the rest of the zone. In some cases we have data for sub-districts and we may calculate by the use of POP-DIST how many % of the population within a district that lives within each sub-district. In this way we prepare a distribution file DISTFILE.DAT, as shown in the example below. We may have several different sets for the population data on POPFILE.DAT (ex. POP1990, POP2000 and POP2010), and we select which we want. We may also have different distribution files according to different area use plans, but such plans will normally only affect the distribution in special districts.

Example:

Figure 1 shows a part of the map for Central Jakarta, with a km-grid. The districts (kecamatan) P 1, Tanah Abang and P 2, Menteng are indicated with their borders, together with the sub-districts (kelurahans). From POP-DIST we have calculated the percentage of the population within the kecamatan that are living within each kelurahan. These percentages are distributed to the corresponding grids. Kelurahan Bendungan Hilir has 14.96% of the population of area P 1, and this is distributed with 5.0% in (700,312), 4.0% in (699,313), 4.0% in (700,313), 0.5% in (699,314) and 1.5 % in (700,314). Kelurahan Kebon Melati has 25.92 % of the population, distributed to 12. % in (700,314), 10.0% in (701,314) and 3.9% in (700,315).

For each square we are making the sum of the individual contributions. This procedure has to be done by hand, with a good map and good local knowledge.



Figure 1: Map of central Jakarta districts and sub-districts.

Following the procedure, we find that the population within the kecamatan P 1, Tanah Abang should be distributed according to the following 18 squares:

(698,311) 0.2%, (699,311) 1.0%, (698,312) 0.2%, (699,312) 0.1%, (700,312) 6.0%, (701,312) 1.0%, (698,313) 0.3%, (699,313) 4.2%, (700,313) 10.0%, (701,313) 5.0%, (699,314) 10.5%, (700,314) 18.0%, (701,314) 11.0%, (699,315) 3.0%, (700,315) 15.2%, (701,315) 9.6%, (700,316) 2.2% and (701,316) 2.5%,

and P 2, Menteng to the 14 squares:

(702,313) 0.9%, (703,313) 3.0%, (704,313) 11.0%, (705,313) 2.3%, (701,314) 7.0%, (702,314) 13.8% (703,314) 15.9%, (704,314) 11.0%, (701,315) 3.1%, (702,315) 9.5% (703,315) 13.5%, (701,316) 2.0%, (702,316) 5.0% and (703,316) 2.0%.

In this way the file DISTFILE is prepared:

```
AAAAiiiiiiiiiiFF.Fiiiiiiiiff.fiiiiiiiiFF.Fiiiiiiiiff.fiiiiiiiiFF.Fiiiiiiiiff.f
P 1 18 698 311 0.2 699 311 1.0 698 312 0.2 699 312 0.1 700 312 6.0 701 312 1.0
      698 313 0.3 699 313 4.2 700 31310.0 701 313 5.0 699 31410.5 700 31418.0
      701 31411.0 699 315 3.0 700 31515.2 701 315 9.6 700 316 2.2 701 316 2.5
P 2 14 702 313 0.9 703 313 3.0 704 31311.0 705 313 2.3 701 314 7.0 702 31413.8
      703 31415.9 704 31411.0 701 315 3.1 702 315 9.5 703 31513.5 701 316 2.0
      702 316 5.0 703 316 2.0
```

and so on.

POPFILE will normally consist of different sets with population data (for different years, different area strategies etc.), but it may also be other types of data which are given for each district. If it is working places, the distribution codes will be different.

This procedure is based upon a steady population distribution or an even population growth. If there are plans for development within one sub-district the population distribution key for that area must be revised, but for the rest of the area the keys may be unchanged.

As an example of a POPFILE different data sets for the population of Jakarta may be used:

	1987	1990	1994
P 1	229896	192152	186727
P 2	116581	90774	115479
P 3	134547	112589	126465
P 4	84400	92497	88901
P 5	112850	122866	108863
P 6	206107	226528	232221
P 7	152040	124482	141627
P 8	129493	112864	119610
T 1	80366	119517	119328
T 2	55939	100860	92721
T 3	94709	157674	142296
T 4	159711	211757	190714

and so on. These data are collected from different sources, and the variations in the population from year to year, particularly for the kecamatans are so large that it will be necessary to examine the background for the data in detail. Are the borders changed?

Now we can go to the input:

Input data to POP-FIE

KX, KY	Grid dimensions, number of points eastward and northward
DISTFILE, POPFILE	Distribution code file, population file (both with apostrophes and .DAT)
OUTFILE	Name of the output files (with apostrophes)
ISIZE	Grid size in meters
COMPOUND, UNIT, PERIOD, PLACE, SOURCE	all with apostrophes
UTMX, UTMX	Co-ordinates for lower left corner if the grid coordinates are given in the UTM grid. With a local coordinate system, UTMX = UTMX = 0
NT, JT	NT data sets at INFILE, we want no. JT. (Max. 4 data sets.)

From DISTFILE distribution data are read until end, for a maximum of 150 districts. Each district may be covered by max. 21 squares. If this is not sufficient, you have to divide the area or the districts in smaller parts.

If NSQ is 6 or less:

DIS, NSQ, (XR(I),YR(I),VAL(I), I=1,NSQ)
(A4, I3,6(2I4,F4.1))

DIS Name of the district, an abbreviated name or a number (A4). Must be the same as in POPFILE.
The district covers NSQ squares, each with coordinates (XR,YR) and with VAL % of the value for the district, VALUE.

If NSQ is 7 or more:

DIS, NSQ, (XR(I),YR(I),VAL(I), I=1,7)
(A4, I3,6(2I4,F4.1))
Distribution for the first 6 squares
(XR(I),YR(I),VAL(I), I=7,NSQ)
(7X,6(2I4,F4.1))
Distribution for the rest, 6 squares per line.

From POPFILE population data are read:

DIS,(VALUE(I), I=1,JT) (A4,4I8)
DIS is the name of the district, which should be the same as in DISTFILE
Data set no. JT is used, with the value VALUE(JT)

When all data are read the program asks if we want to re-scale the data, Y / N.

If the answer is Y or y, then:

SCALE Scale factor

Finally the program asks whether we want a listing of the data for each square, Y/N.

Example:

For calculating the distribution for Jakarta in 1990 the input will be:

20.20 , GRId dimensions
'DISTFILE.DAT', 'POPFILe.DAT' , Input files
'JAK-POP' , Output file
1500 , Grid size
'INHABITANT', 'PERSON', '1990', 'JAKARTA', 'POPULATION'
686.0, 295.0, , Lower left corner
3.2 , 3 data sets at POPFILE, we want no. 2.

Then distribution codes are read from DISTFILE.DAT, and population from POPFILE.DAT.

The output of the program will be a population distribution map as shown in Figure 2. This covers 7,108,354 persons, with a maximum of 120,388 persons living in grid (11,15).

In this example the distribution was evaluated for a 1500 m grid, but the procedure will be the same. Lower left corner has the co-ordinates (686.0, 295.0).

MAP OF : INHABITANT UNIT: PERSON SOURCE: POPULATION
 PERIOD : 1990 PLACE: JAKARTA GRID SIZE: 1500 METER
 CREATED: 1995/07/28 17.41

MAXIMUM VALUE IS 1.2039E+05, IN (11,15)
 SUM= 7.10835E+06 SCALE FACTOR: 100

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
J=20	.	.	1.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3.	6.
J=19	39.	47.	23.	5.	2.	4.	.	.	.	.	.	.	.	76.	162.	63.	173.	63.	41.	9.
J=18	64.	107.	104.	32.	7.	39.	157.	255.	255.	.	.	195.	139.	426.	822.	673.	398.	217.	28.	10.
J=17	51.	72.	117.	130.	94.	22.	123.	558.	528.	540.	390.	100.	392.	493.	772.	278.	351.	306.	42.	24.
J=16	78.	97.	87.	106.	145.	202.	469.	459.	790.	898.	1045.	397.	147.	147.	131.	137.	39.	39.	39.	29.
J=15	72.	110.	116.	92.	92.	356.	635.	722.	565.	395.	1204.	855.	635.	316.	122.	132.	65.	43.	37.	26.
J=14	43.	105.	84.	69.	111.	193.	370.	828.	651.	228.	813.	895.	638.	356.	199.	151.	96.	45.	35.	90.
J=13	.	.	35.	49.	49.	189.	370.	778.	730.	1098.	489.	486.	499.	636.	392.	231.	252.	127.	104.	97.
J=12	.	.	40.	190.	112.	225.	227.	974.	758.	763.	585.	945.	865.	708.	520.	194.	155.	81.	81.	37.
J=11	.	.	59.	97.	116.	250.	260.	348.	565.	729.	682.	768.	933.	682.	384.	341.	341.	325.	169.	.
J=10	.	.	.	.	129.	263.	291.	313.	407.	399.	888.	863.	840.	711.	357.	268.	211.	209.	.	.
J= 9	.	.	.	.	79.	240.	298.	445.	402.	139.	557.	452.	527.	513.	66.	175.	153.	112.	.	.
J= 8	.	.	.	.	29.	303.	159.	380.	396.	118.	672.	319.	425.	369.	66.	31.	.	.	.	.
J= 7	.	.	.	.	47.	199.	129.	204.	257.	253.	313.	208.	228.	268.	62.	52.	.	.	.	.
J= 6	.	.	.	.	.	82.	123.	258.	213.	200.	228.	304.	255.	272.	177.	63.	16.	.	.	.
J= 5	.	.	.	.	.	.	73.	105.	112.	144.	188.	207.	287.	181.	164.	76.	32.	.	.	.
J= 4	.	.	.	.	.	.	.	23.	25.	67.	155.	237.	252.	49.	82.	60.	32.	.	.	.
J= 3	.	.	.	.	.	.	.	.	44.	91.	78.	137.	132.	94.	55.	32.	12.	.	.	.
J= 2	.	.	.	.	.	.	.	10.	55.	64.	56.	.	88.	89.	58.	33.	11.	.	.	.
J= 1	.	.	.	.	.	.	.	6.	41.	25.	.	.	.	30.	66.	20.	7.	.	.	.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Figure 2: Map for population distribution in Jakarta.

Program EXPO-FIE

This program reads concentration fields from a number of source groups together with a population distribution field. In its first phase the sum of the concentration values is calculated, together with a background value. If the concentration in a square is above certain limits, the corresponding population is counted. In the next phase the concentration from each source group is successively increased and reduced by +/- 10% and 25%, and new exposure figures are calculated.

The program is normally run interactive.

Input data to EXPO-FIE

KX, KY, NF	Grid dimension, number of points eastward and northward number of concentration fields (max. 8)
POPFIELD	Population file name (with apostrophes and .FLD)
OUTFILE	Output file name (with apostrophes). The output will be written to OUTFILE.PRN
IPER	IPER=1: Output as persons, 2: Percentage of the total population
BACKGR	Background concentration ($\mu\text{g}/\text{m}^3$)

For NF fields is read:

KFILE, KREC, FACT	File name (with apostrophes and .FLD), record number and scale factor. If the file is the same as previous, enter 'SAME'
ILI, NLIM	ILI= 1: read start value and increments, 2: read values NLIM: number of limits (max. 20)

If ILI=1, then:

LIM, DLIM Start value LIM and increment DLIM (may be negative)

If ILI=2, then:

(CLIM(I), I=1,NLIM) Limit values

Example:

In Kathmandu TSP concentrations were calculated from 7 source groups. To calculate PM_{10} -exposure the values had to be multiplied by different scale factors. The program changes the source type to 'ALL SOURCES', but does not change the compound name from TSP to PM_{10} . This may be done by an editor.

This gives the following input:

```

****                               , License code
27, 21, 7                          , Grid dimensions, 7 fields
'POPULATION.FLD'                    , Population file
'EXPOPM10.PRN'                      , Output file
1                                    , Persons
10.0                                 , Background
'TRAF-TSP.FLD', 1, 1.0              , Proportion of PM10 in TSP
'RESU-TSP.FLD', 1, 0.25              ,
'DOM-TSP.FLD', 1, 0.50              ,
'BRICKTSP.FLD', 1, 0.25              ,
'HOFF-TSP.FLD', 1, 0.25              ,
'HIMALPOI.FLD', 1, 0.42              ,
'HIMAL2.FLD', 1, 0.25                ,
1,20                                 , 20 boxes
20, 20                               , start at 20, interval 20

```

This gives the following output:

```

Date 1995/03/10 11.56
Background          10.000000
TRAF-TSP.FLD       1          1.000000
RESU-TSP.FLD       1          2.500000E-01
DOM-TSP.FLD        1          5.000000E-01
BRICKTSP.FLD       1          2.500000E-01
HOFF-TSP.FLD       1          2.500000E-01
HIMALPOI.FLD       1          4.200000E-01
HIMAL2.FLD         1          2.500000E-01

MAP OF : PM10          UNIT: UG/M3          SOURCE: ALL SOURCES
PERIOD : Winter average PLACE: KATHMANDU    GRID SIZE: 1000 METER
CREATED: 1995/03/10 10.28

MAXIMUM VALUE IS 1.5028E+02, IN ( 8, 8)
SUM= 1.98872E+04    SCALE FACTOR: 0.1

```

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
J=20	202.	219.	235.	252.	265.	284.	308.	333.	353.	371.	379.	368.	366.	361.
J=19	210.	230.	250.	268.	287.	305.	330.	364.	395.	421.	431.	418.	409.	399.
J=18	219.	241.	265.	286.	309.	329.	357.	397.	450.	498.	501.	491.	475.	443.
J=17	229.	252.	279.	304.	331.	356.	390.	431.	501.	567.	595.	588.	549.	493.
J=16	238.	268.	296.	322.	352.	387.	427.	469.	544.	629.	687.	676.	633.	551.
J=15	226.	286.	322.	352.	381.	433.	486.	529.	605.	694.	764.	739.	688.	595.
J=14	228.	277.	348.	390.	427.	465.	528.	578.	677.	794.	816.	789.	715.	618.
J=13	249.	301.	357.	452.	501.	521.	534.	583.	682.	805.	855.	782.	699.	615.
J=12	230.	318.	337.	429.	573.	621.	620.	613.	652.	722.	797.	789.	713.	638.
J=11	209.	234.	281.	318.	423.	653.	667.	651.	648.	692.	744.	755.	727.	629.
J=10	197.	217.	248.	282.	338.	462.	703.	733.	699.	669.	729.	780.	750.	668.
J= 9	190.	209.	237.	272.	321.	397.	906.	1275.	985.	658.	696.	857.	852.	794.
J= 8	185.	203.	227.	263.	315.	402.	619.	1503.	1054.	633.	704.	836.	918.	872.
J= 7	180.	196.	213.	231.	238.	263.	365.	377.	500.	422.	535.	759.	870.	922.
J= 6	156.	161.	170.	185.	204.	227.	257.	275.	322.	323.	360.	440.	606.	696.
J= 5	145.	152.	160.	171.	185.	199.	213.	224.	249.	260.	280.	328.	436.	432.
J= 4	139.	143.	149.	157.	167.	177.	185.	191.	203.	219.	234.	263.	296.	346.
J= 3	132.	136.	140.	146.	153.	160.	166.	172.	178.	192.	202.	217.	224.	224.
J= 2	127.	130.	134.	139.	144.	150.	153.	158.	161.	172.	177.	185.	188.	189.
J= 1	124.	127.	129.	132.	137.	140.	144.	147.	150.	157.	161.	162.	164.	166.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

	14	15	16	17	18	19	20	21	22	23	24	25	26	27
J=20	361.	342.	323.	302.	281.	265.	255.	244.	232.	222.	212.	201.	187.	165.
J=19	399.	375.	355.	335.	309.	290.	271.	260.	248.	236.	228.	218.	202.	175.
J=18	443.	410.	397.	372.	334.	312.	292.	276.	264.	251.	241.	232.	216.	186.
J=17	493.	439.	417.	383.	346.	326.	310.	296.	280.	261.	248.	234.	219.	194.
J=16	551.	482.	424.	391.	368.	348.	332.	320.	300.	279.	258.	236.	214.	197.
J=15	595.	510.	444.	413.	393.	381.	366.	349.	329.	310.	286.	254.	226.	203.
J=14	618.	524.	460.	414.	408.	417.	422.	396.	367.	356.	333.	286.	244.	213.
J=13	615.	541.	462.	440.	437.	457.	514.	514.	448.	436.	441.	363.	273.	226.
J=12	638.	533.	463.	480.	509.	488.	535.	610.	552.	507.	539.	430.	296.	236.
J=11	629.	536.	476.	461.	519.	474.	447.	473.	516.	504.	475.	357.	271.	231.
J=10	668.	565.	497.	469.	418.	382.	355.	353.	406.	473.	390.	302.	247.	218.
J= 9	794.	675.	539.	474.	411.	348.	316.	306.	332.	399.	381.	287.	232.	205.
J= 8	872.	827.	596.	442.	364.	315.	284.	267.	262.	260.	286.	245.	206.	186.
J= 7	922.	786.	568.	391.	327.	289.	262.	242.	230.	223.	212.	204.	187.	172.
J= 6	696.	521.	390.	321.	283.	260.	239.	221.	209.	201.	192.	184.	174.	163.
J= 5	432.	363.	285.	251.	232.	217.	210.	199.	191.	183.	176.	170.	163.	155.
J= 4	346.	290.	242.	221.	204.	189.	177.	169.	165.	162.	162.	158.	153.	147.
J= 3	224.	226.	207.	194.	182.	173.	165.	158.	153.	148.	144.	141.	139.	139.
J= 2	189.	191.	185.	175.	167.	160.	155.	150.	145.	141.	138.	134.	131.	128.
J= 1	166.	167.	166.	162.	157.	152.	147.	143.	139.	136.	132.	130.	127.	125.
	14	15	16	17	18	19	20	21	22	23	24	25	26	27

Exposure when source TRAFFIC is adjusted					
Limit	SUM	+25%	+10%	-10%	-25%
20.	1009178	1009424	1009178	1009178	1008174
40.	773083	787345	785233	773083	771521
60.	475645	496939	489285	474670	448781
80.	67809	180878	124406	28903	28903
100.	2209	2209	2209	2209	2209
120.	1476	1476	1476	1476	1476
140.	492	492	492	492	492
160.	0	0	0	0	0
180.	0	0	0	0	0
200.	0	0	0	0	0

Exposure when source RESUSPENSION is adjusted					
Limit	SUM	+25%	+10%	-10%	-25%
20.	1009178	1009178	1009178	1009178	1008965
40.	773083	787345	776232	773083	773083
60.	475645	494181	489285	474670	466427
80.	67809	133708	117925	55616	28903
100.	2209	2209	2209	2209	2209
120.	1476	1476	1476	1476	1476
140.	492	492	492	492	492
160.	0	0	0	0	0
180.	0	0	0	0	0
200.	0	0	0	0	0

Exposure when source DOMESTIC is adjusted					
Limit	SUM	+25%	+10%	-10%	-25%
20.	1009178	1011186	1010395	1005202	1000559
40.	773083	809971	791128	760417	735991
60.	475645	506274	495748	452444	411336
80.	67809	192143	135417	28903	28903
100.	2209	3149	2209	2209	2209
120.	1476	1476	1476	1476	1476
140.	492	492	492	492	492
160.	0	0	0	0	0
180.	0	0	0	0	0
200.	0	0	0	0	0

Exposure when source BRICK FACTORIES is adjusted					
Limit	SUM	+25%	+10%	-10%	-25%
20.	1009178	1012568	1010395	1002425	1000277
40.	773083	808207	792865	766162	724528
60.	475645	521268	490852	465874	420796
80.	67809	182830	138994	54492	8983
100.	2209	14295	3149	2209	2209
120.	1476	1476	1476	1476	1476
140.	492	492	492	492	492
160.	0	0	0	0	0
180.	0	0	0	0	0
200.	0	0	0	0	0

Exposure when source HOFFMAN KILNS is adjusted

Limit	SUM	+25%	+10%	-10%	-25%
20.	1009178	1009178	1009178	1009178	1008965
40.	773083	773937	773937	773083	773083
60.	475645	477212	477212	475645	472956
80.	67809	67809	67809	67809	67809
100.	2209	2209	2209	2209	2209
120.	1476	1476	1476	1476	1476
140.	492	492	492	492	492
160.	0	0	0	0	0
180.	0	0	0	0	0
200.	0	0	0	0	0

Exposure when source HIMAL STACK is adjusted

Limit	SUM	+25%	+10%	-10%	-25%
20.	1009178	1009424	1009178	1008965	1008293
40.	773083	778247	773083	772568	772568
60.	475645	475645	475645	475645	474670
80.	67809	104635	67809	67809	55616
100.	2209	3149	2209	2209	2209
120.	1476	1476	1476	1476	1476
140.	492	492	492	492	492
160.	0	0	0	0	0
180.	0	0	0	0	0
200.	0	0	0	0	0

Exposure when source HIMAL DIFFUSE is adjusted

Limit	SUM	+25%	+10%	-10%	-25%
20.	1009178	1009424	1009424	1007924	1007555
40.	773083	788751	777040	772568	769705
60.	475645	493610	475645	474301	462850
80.	67809	114839	72994	55616	55370
100.	2209	3395	3149	1476	1476
120.	1476	2209	1476	492	0
140.	492	1476	492	0	0
160.	0	492	492	0	0
180.	0	492	0	0	0
200.	0	0	0	0	0

Dispersion

Gaussian Dispersion

The steady-state Gaussian plume equation calculates the downwind concentration of an inert gas being continuously emitted from a single source with constant meteorology. 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.

In KILDER a joint frequency distribution of 4 stability classes, 4 wind speed classes and $n = 12$ or 16 wind directions (30° or 22.5° sectors) is used. The Gaussian dispersion formula for the **ground level** concentration C with sector averaging in n sectors and with emissions from p point sources can then be expressed as follows:

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

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

$$D(x_i, u) = \sqrt{2 / \pi} * (1 + \alpha) / 2 * \exp\left[- \left(H / \sigma_z \right)^2 / \left(u_s * x_i * \sigma_z \right) \right], \quad (2)$$

the sector function $S(p, k)$ as

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

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

$F(k, l, m)$ = the frequency of occurrence for wind sector k , wind speed class l and stability class m , from METFREC

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

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) = $H_s + \Delta H$

H_s = physical stack height

α = ground level reflection coefficient

σ_z = standard deviation of the vertical concentration distribution

u_s = mean transport wind speed

Figure 1 shows the geometry of a single point source.

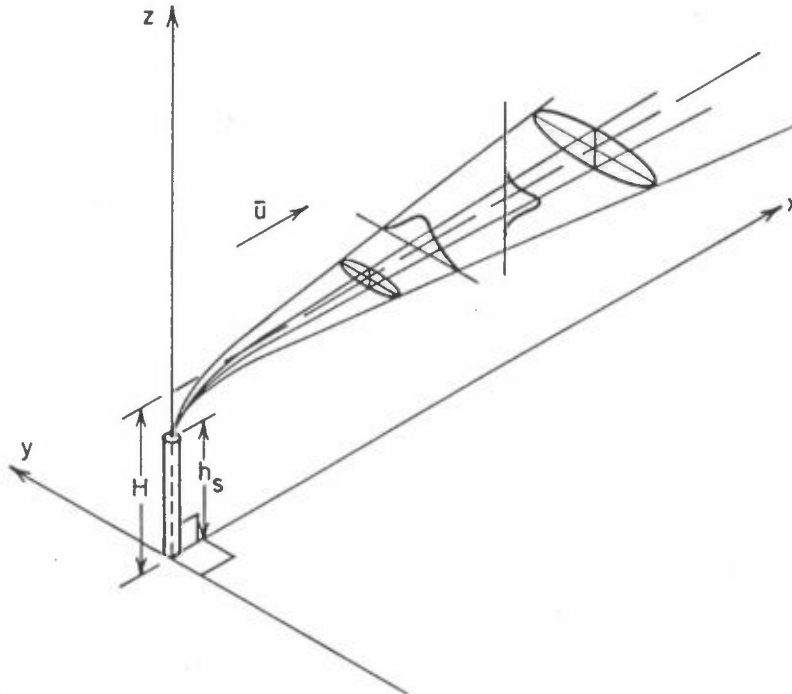


Figure 1: Gaussian point source geometry.

Wind speed

The mean transport wind speed should be representative of the conditions throughout the vertical interval in which the plume is dispersing. The wind speed in the lower atmosphere varies with height above ground. Since wind measurements are generally performed near ground level (10 m above ground), an adjustment for the expected height range of dispersion has to be made. The variation of wind speed with height depends also upon the atmospheric stability.

The height dependency of the wind speed is described by a power law:

$$\bar{u}(z) = \bar{u}(z_o) \left(\frac{z}{z_o} \right)^m \quad (3)$$

with

- z = height above ground,
- z_o = reference height above ground,
- \bar{u} = time averaged wind speed,
- m = wind profile exponent (corresponds to RN in the .MET-file).

The mean transport speed representative of an appropriate height range, e.g. from the effective source height (H) to ground level (for dispersion calculations), may then be calculated by integration:

$$\bar{u} = \frac{1}{\Delta z} \int \bar{u}(z) dz = \frac{1}{(z_2 - z_1)} \int_{z_1}^{z_2} \bar{u}(z_0) \cdot \left(\frac{z}{z_0}\right)^m dz, \quad (4)$$

Several empirical values of wind profile exponents (m) for different turbulence conditions have been published. The wind profile exponents are user input parameters, and in the NILU models the following values have been applied as standard values:

Stability class	m
Unstable	0.20
Neutral	0.28
Slightly stable	0.36
Stable	0.42

Atmospheric stability (see also chapter STABILITY)

The diffusion of air pollutants in the lower atmosphere is strongly influenced by the local atmospheric stability. The diffusion of effluents is more rapid in the unstable than in the stable atmosphere.

The stability of the atmosphere can be derived from vertical and horizontal turbulence measurements, or from measurements of the vertical temperature profile and wind speed. Estimates of the net radiation or cloud cover, mixing height, and solar elevation have also been used. For practical reasons the turbulence situations of the atmosphere are usually described by a discrete set of stability classes.

Several different turbulent classification schemes have been developed and used. Pasquill defined 6 turbulence classes:

- A = extremely unstable
- B = moderately unstable
- C = slightly unstable
- D = neutral
- E = slightly stable
- F = moderately stable

The meteorological data used to determine the turbulence type are usually the surface wind speed, daytime insolation, and night-time cloudiness.

In the NILU data input for dispersion models, the three unstable classes have been combined into one. The stability classes may be defined by vertical temperature gradients or by direct measurements of the standard deviation of the horizontal wind direction fluctuations, where such data are available. The stability classes are defined as follows:

Stability class	Temperature gradient dT (deg/100 m)	Corresponds to:	
		Pasquill	Brookhaven
Unstable	$dT < -1$	A+B+C	B_1+B_2
Neutral	$-1 \leq dT < 0$	D	C
Slightly stable	$0 \leq dT < 1$	E	-
Stable	$dT \leq 1$	F	D

Diffusion parameters

A main assumption for solving the diffusion equation is the existence of a Gaussian normal distribution of the plume concentrations perpendicular to the transport direction. The diffusion parameter σ_y and σ_z are defined as the standard deviations of the concentration distributions in the lateral and vertical, respectively. They are functions of the downwind distance from the emission source and of the stability of the atmosphere. The standard deviations have mainly been determined from tracer experiments carried out during different wind and turbulence conditions.

The most appropriate set of diffusion parameters should be selected for each particular application. The choice will be dependent upon source height, surface roughness and, in some cases, averaging time or transport distance. A set of different parameters has been evaluated at NILU and represents the basis for our selection of stability classes.

When direct turbulence measurements are not available, the following form of diffusion parameters is used:

$$\sigma_y(x) = ax^p, \sigma_z(x) = bx^q.$$

where x is the distance downwind from the source.

The dispersion models POI-KILD and ARE-KILD are statistical models using lateral sector averaging. In this case the horizontal variations are included in the Gaussian formula in Equation 1.

The most commonly used coefficients for b and q are listed in the Table 1 below, and apply to averaging times of up to one hour. Several other formulas have been 100 m and 10 km suggested, among them Briggs' for open-country between:

$$\sigma_z(x) = a \cdot x \cdot (1 + bx)^c$$

Table 1: Commonly used dispersion coefficients applicable for different source types and surface roughness.

Source and surface specifications	Coefficients	Unstable	Neutral	Slightly stable	Stable
Surface and low sources.	b	0.08	0.91	1.93	-
Rough surface, urban area	q	1.2	0.70	0.47	-
Ref.: Mc Elroy, J.L. and Pooler, F., 1968					
High stacks, smooth to medium rough surface.	b	0.33	0.22	0.16	0.06
	q	0.86	0.78	0.74	0.71
Ref.: Smith, M., 1968 (Brookhaven)					
Sea surface.	b	0.253	0.531	0.167	-
Ref.: Raynor et al., 1977	q	0.637	0.418	0.578	-
Open-country	a	0.08	0.06	0.03	0.016
$10^2 < x < 10^4$ m	b	0.0002	0.0015	0.0003	0.0003
Ref.: Briggs, 1974	c	-0.5	-0.5	-1	-1

Stack downwash

An effluent emitted vertically from a stack rise due to its momentum or can be brought downward by the low pressure in the wake of the stack, which occurrence depends on the ratio of the exit gas velocity, W_s , to the crosswind velocity, U .

The physical stack height is modified according to Briggs (1974):

$$H_s = \begin{cases} H_s + 2(W_s / U - 1.5)D_s & \text{for } W_s < 1.5 U \\ H_s & \text{for } W_s \geq 1.5 U \end{cases} \quad (5)$$

where H_s is the physical stack height, W_s is the exit gas velocity and D_s is the inside stack-top diameter. The modified stack height H_s is further used to calculate the effective plume height.

Plume rise equations

The plume rise due to momentum or buoyancy is estimated using Briggs' algorithm (Briggs 1969, 1971 and 1975). The calculated values of ΔH_b in this chapter are used to evaluate the effects of buildings, penetration and topography in following chapters to end up with the final plume height, H .

Neutral-Unstable Momentum Rise

Regardless of the atmospheric stability, neutral-unstable momentum rise is calculated. The plume rise is calculated as follows:

$$\Delta H_m = 3D_s W_s / U. \quad (6)$$

This equation is most applicable when W_s/U is greater than 4. Since momentum rise occurs quite close to the point of release, the distance to final rise is set equal to zero.

Neutral-Unstable Buoyancy Rise

The value of the buoyancy flux parameter, F (m^4/s^3) is needed for computing the distance to final rise and the plume rise.

$$F = (gW_s D_s^2 \Delta T) / (4T_s) \quad (7)$$

where $\Delta T = T_s - T_a$, T_s is the stack temperature (K), and T_a is the ambient air temperature (K).

The distance to final rise x_f (in kilometers) is the distance at which atmospheric turbulence begins to dominate entrainment.

For F less than 55,

$$x_f = 0.049F^{5/8} . \quad (8)$$

For F equal to or greater than 55,

$$x_f = 0.119F^{2/5} . \quad (9)$$

The plume rise, ΔH (in meters), is determined from the equations:

For F less than 55,

$$\Delta H_b = 21.425F^{3/4} / U . \quad (10)$$

For F equal to or greater than 55,

$$\Delta H_b = 38.71F^{3/5} / U . \quad (11)$$

If the neutral-unstable momentum rise (previously calculated from Eq. 6) is higher than the neutral-unstable buoyancy rise calculated here, momentum rise applies and the distance to final rise is set equal to zero.

Stability Parameter

For stable equations, the stability parameter s is calculated from the equation:

$$s = g(\delta\theta / \delta z)T_a . \quad (12)$$

As an approximation $\delta\theta / \delta z$ is taken as 0.02 K/m for the light stable class, and 0.035 K/m for the stable class.

Stable Momentum Rise (Cold gases)

When the stack gas temperature is less than the ambient air temperature, it is assumed that the plume rise is dominated by momentum. The plume rise is then calculated by using the equation:

$$\Delta H_m = 1.5[(W_s^2 D_s^2 T_a) / (4T_s U)]^{1/3} s^{-1/6}. \quad (13)$$

This value of ΔH_m is compared with the value for neutral-unstable momentum rise (Eq. 6) and the lower of the two values is used as the resulting plume height.

Stable Buoyancy Rise

For situations where $T_s \geq T_a$, buoyancy is assumed to dominate. The distance to final rise (in kilometres) is determined by the equation:

$$x_f = 0.0020715 U s^{-1/2}. \quad (14)$$

The plume rise is determined by:

$$\Delta H_b = 2.6[F / U \cdot s]^{1/3}. \quad (15)$$

The stable buoyancy rise for calm conditions is also evaluated:

$$\Delta H_b = 4F^{1/4} \cdot s^{-3/8}. \quad (16)$$

The lower of the two values obtained from Eqs. 15 and 16 is taken as the plume rise.

If the stable momentum rise is higher than the stable buoyancy rise calculated here, momentum rise applies and the distance to final rise is set equal to zero.

Building effects

Briggs (1974) has outlined a useful procedure for estimating the effective height of emission incorporated building-induced disturbances to the flow. The procedure is as follows:

1. Calculate the following height H' :

$$H' = H_s + \Delta H_m$$

where ΔH_m is the momentum plume rise, eqs. (6) or (13).

If stack downwash occurs, $H' = H_s$ from Equation (5).

Let L_b be the smallest of the frontal building dimensions building height H_b or building width W_b .

a) If H' is greater than $H_b + 1.5 L_b$, the plume is above the region of building influence. Continue to the next chapter to check for penetration by using $H_e = H' + \Delta H$ as the effective plume height. ΔH is the plume rise from the plume rise calculations.

b) If H' is less than H_b , set

$$H'' = H' - 1.5 L_b \quad (17)$$

c) If H' is between H_b and $H_b + 1.5 L_b$, set

$$H'' = 2H' - (H_b + 1.5 L_b) \quad (18)$$

For the cases b) and c) the plume may remain aloft or may be entrained into the wake cavity and become essentially a ground level source.

If H'' is greater than $0.5 L_b$, the plume remains elevated and concentrations can be calculated by using standard formulae with modified stack height equal H'' , and effective plume height $H_e = H'' + \Delta H$. Continue to the next chapter to check for penetration by using H_e as the effective plume height.

If H'' is less than $0.5 L_b$, the plume is trapped in the cavity zone and should be treated as a ground source with initial dimensions equal the projected frontal area of the building, $A = H_b \cdot W_b$, or with the emission height $0.5 \cdot H_b'$.

For the cases b) and c), where the plume is influenced by the buildings, an additional dispersion factor is combined with the standard dilution factor as follows (Briggs, 1970).

$$\sigma_y = \left(\sigma_y^2 + cA / \pi \right)^{1/2} \quad (19)$$

$$\sigma_z^2 = \left(\sigma_z^2 + cA / \pi \right)^{1/2} \quad (20)$$

where $c = 1.0$ and $A = H_b W_b$.

In POI-KILD the building effects are taken into account, whereas in ARE-KILD these are included in the box heights as a measure of the initial turbulence. Thus,

in the stack file in POI-KILD the height and width of the nearest buildings (within $3 \cdot H_s$ m) should be given in STACK(8) and STACK(9).

Plume penetration

A buoyant plume rising into a well-mixed layer trapped by stable air may partially or completely penetrate the elevated stable layer. To compute ground level concentrations for this situation, the fraction of the plume that penetrates the stable layer is first estimated and the emission rate, Q_s , and effective plume height, h_e , for the material remaining within the mixed layer are modified.

The fraction P of the plume that penetrates the elevated stable layer is estimated as follows (Weil and Brower, 1984):

1. No penetration:

$$P = 0 \text{ if } \frac{Z_i}{\Delta H} \geq 1.5 \quad (21)$$

2. Total penetration:

$$P = 1 \text{ if } \frac{Z_i}{\Delta H} \leq 0.5 \quad (22)$$

3. Partial penetration:

$$P = 1.5 - \frac{Z_i}{\Delta H} \text{ if } 0.5 < \frac{Z_i}{\Delta H} < 1.5 \quad (23)$$

where ΔH is the predicted plume rise and $Z_i = Z_i - H_s$, where Z_i is the height of the stable layer aloft, and H_s is the stack height.

The plume material remaining within the mixed layer is assumed to contribute to ground level concentrations. The modified source strength, Q is then:

$$Q = Q_s (1 - P) \quad (24)$$

where Q_s is the emission rate on top of the stack.

To modify the effective plume height for plumes trapped within the mixed layer, it is assumed that the plume rise due to penetration, ΔH_p , is linearly varying between $0.62 Z_i$ for total penetration.

Thus for partial penetration ($0 < P < 1$):

$$\Delta H_p = (0.62 + 0.38P)Z_i \quad (25)$$

The modified plume height to be used further, H_m , is the lowest value of the height in the unlimited atmosphere, H_e , from chapter 3.6, and the height due to penetration, such as:

$$H_m = \min(H_e, H_p), \quad H_p = H_s + \Delta H_p \quad (26)$$

Continue to the next chapter to check for terrain effects by using H_m for the effective plume height.

Topography

When the plume is moving towards the hill, the streamlines will follow the terrain. The plume will be lifted, but not as much as the hill. The effect of elevated terrain on the ground level concentrations is included in POI-KILD by reducing the effective plume height, H_m , assuming:

$$H = H_m - \Delta H_t, \quad \Delta H_t = k \cdot (H_t - H_{sb}) \quad (27)$$

where H_t is the height of terrain above stack base level H_{sb} and k is a terrain factor ($0 < k < 1$) dependent upon steepness, distance from source, stability, etc., shown in Table 2.

Table 2: Terrain factor, k , to evaluate the effect of a hill on a source with stack height H_s .

Distance (x)	k
0 < x ≤ 5 H _s	0.7
5 H _s < x ≤ 10 H _s	0.5
10 H _s < x ≤ 20 H _s	0.3
20 H _s < x ≤ 30 H _s	0.1
30 H _s < x	0.0

As we are calculating in a 1 km or a 500 m grid, the topography effects will normally be small. The height of the terrain in a square should be an average for the whole square, while the stack base may be taken as an accurate height. In the same square as the stack, we have no topography effects. For a stack with height 100 m, the effective plume height 1 km away from a hill ($x = 10 * H_s$) will be reduced by 30% of the hill height. In the next square, 2 km away, the plume height will be reduced by 10% of the hill height in that square.

POI-KILD, dispersion calculations for point sources

The program POI-KILD calculates sector averaged long term average concentrations at ground level in a grid of receptor points, with emission from several point sources, taking into account data on dispersion, topography, buildings and penetration through an upper stable layer. The program is dimensioned for 80 sources, but this can be easily increased. Another possibility is to split the sources into different source groups, make separate calculations for each source groups, and add the results by SUM-FIE.

Input data for POI-KILD

The program POI-KILD gets its input data from different sources; interactive from the terminal or from a RUN-file, from a file with **stack data**, and from a METFIL-file with meteorological data (described in separate chapter). To run the program for the first time it may be run interactive to perform a .RUN-file with all answers for the next calculations.

Stack-file INSTA

All stack data are read from the file INSTA (which should be of type .DAT). At this file all other data which should remain constant are collected, whereas data which varied from one run to another should be read interactive from a .RUN-file.

The program does not give a dialogue when reading from the file INSTA, as the file is already prepared and the questions answered. Nevertheless, questions will be useful in preparing the file. The file is read until a line that begins with START or Start in columns 1-5. This means that we may put useful comments at the beginning of the file. The data at the file is read in different subroutines.

After the line with START the program reads:

TEXT	One line with a heading for the computations (A80)
ISIZE	Grid size in meter (integer).
UTMX, UTM Y	Co-ordinates for south-west corner of the grid array (real).
ANORTH	Direction of the Y-axis (in degrees, counter-clockwise, normally =0 (real).
NCOMP, ICO	Number of compounds with emission data ICO=0: standard compounds. 1=SO ₂ , 2=NO _x , 3=CO, 4=Particles, 5=HC and 6=Other. ICO=1: new compounds

If INO=1, the program reads new compound names.

(LCOMP(I), I=1, NCOMP)

The compound names (in apostrophes) (max. 6). The calculations are carried out for component no. ICOMP, which is read interactive, see page 4.

BACKG A background concentration of component no. ICOMP may be added to the result. For a composite calculation with different source groups the background should be added when making the sum of the data fields

TOP Do you want to correct for topography? Y/N

If TOP=Y, the program asks for

TOPFIL Name of the topography field (with apostrophes and .FLD)

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 = 50 m 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 one set of dispersion parameters for high sources, other for low sources.

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	$\left\{ \begin{array}{l} \text{Name and dispersion parameters for low} \\ \text{sources} \\ \sigma_z (\text{low}) = CZL \cdot X^{PZL} \end{array} \right.$
(CZL(I), I=1,4)	
(PZL(I), I=1,4)	
SIGH	$\left\{ \begin{array}{l} \text{Name and dispersion parameters for high} \\ \text{sources} \\ \sigma_z (\text{high}) = CZH \cdot X^{PZH} \end{array} \right.$
(CZH(I), I=1,4)	
(PZH(I), I=1,4)	

JEM, ITT JEM=1: Emission in g/s
 =2: Emission in kg/h
 ITT =1: Temperature in degrees C
 =2: Temperature in degrees K

The program reads two dummy lines with heading for the stack data, and then reads the stack data, until the end of the file. In the example file these lines are used to show the variable names, and the format. A line beginning with an asterisk (*) is not read by the program.

STACK,(SKOR(I), I=1,8), ICOD,(EM(I), I=1,ICOMP)

Format: (A10,9F7.2,I2,6F7.2)

STACK Stack (factory name) A10 (without apostrophes)
 SKOR(1) UTMX (km)
 SKOR(2) UTMX (km)
 SKOR(3) Stack base (m.a.s.l)
 SKOR(4) Stack height (m)
 SKOR(5) Stack diameter (m)
 SKOR(6) Gas temperature ° C or K, according to index ITT
 SKOR(7) Gas velocity (m/s)
 SKOR(8) Building height (default 10 m)
 SKOR(9) Building width (default 30 m)
 ICOD Source group code 1-9 (default=1),
 EM Emission data for max. 6 compounds, unit: see JEM. The calculations are performed with emission EM(ICOMP).

All data SKOR(1)-STACK(7) must be present, otherwise the program skips the source and gives a warning message.

For the building dimensions the program uses default height=10 m and width=30 m. For McElroy-Pooler dispersion parameters no building turbulence is calculated.

RUN-file or interactive input

C:\KILDER\POI-KILD

Starts the program when running it interactive.

C:\KILDER\POI-KILD <run-file.RUN

Starts the program from the run-file.RUN. It may be useful to use the same name for the RUN-file and OUTFI.

The run-file, or the answers to the interactive questions will be:

**** License code

KX, KY Dimensions of the area, number of grid points easterly and northerly.

INSTA Name of the INSTA file with stack data etc. (with apostrophes and .DAT). The main part of the input data is read from INSTA, but still some from the terminal.

OUTFI Name of the output files (with apostrophes). The concentration data field is written binary (unformatted) to the file OUTFI.FLD, whereas the output from the program is written to the file OUTFI.PRN.

ICOMP The calculations are carried out for component no. ICOMP, which is called COMPOUND=LCOMP(ICOMP).

Do you want to use all sources (1) or select groups (2). If 2, read:

NCOD, (IFACT(I), I=1,NCOD)

NCOD = number of source groups codes (max. 9).
IFACT = factors 0/1 for these.

It is possible to classify the sources at the file INSTA into source groups by the parameter ICOD at the stack file. By this we may include or exclude groups of sources in the calculations without changes in the file INSTA. This is useful especially when the sources are influenced by different dispersion conditions in different parts of the area. It is also possible to include different monthly emission figures at the stack file and select the correct set of emission data by the use of ICODE.

[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 sources which is not to be included to the top of the file, before START.]

It is possible to adjust the emission rates for some stacks without changing the data on the file:

NEMCH Number for emission figures which should be changed

If NEMCH > 0 the program asks for:

IZ, SCALE Scale factor for source no. IZ

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

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.

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

METFIL Name of the file with meteorological data (with apostrophes and .MET). See the separate description of this file.

YCON 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 YCON=Y, program reads:

NPOINT, (IPO(I), JPO(I), I=1,NPOINT)

NPOINT Number of grid points (max. 8)

IPO(I), JPO(I)

I- and J-indices for each grid point.

Test example for POI-KILD

As a test example is used calculations for point sources in Grenland, Norway.
The data for the sources are arranged a little.

The stack file GREPOINT.DAT will be:

```

START
POINT SOURCES IN GRENLAND
1000      , Grid size
28,45    , Lower left corner
0,       , North is north
N,       , Not standard compounds
3, 'SO2', 'NOx', 'Part', New compounds
0.0,     , Background
N,       , No correction for topography
Y,       , Ground level reflection 1.0
3,       , McElroy-Pooler for low sources, Brookhaven for high sources
Y,       , Standard limit 50 m
2,1,     , Emission in kg/h and temp. in deg. C
AAAAAAAAAfffff.fffffF.Ffffff.FFffff.FFffff.FFffff.FFffff.FFffff.FFffff.FFffff.FFffff.FFffff.FF
* Source X(km) Y(km) Z(m) H(m) D(m) T(c) V(m/s) HB(m) WB(m)Grp SO2 NOX Part
SENTRALSJK 34.00 61.90 20.00 25.00 0.60 220.00 1.00 12.00 50.00 1 1.00 1.70 0.10
POLLY      34.30 62.30 10.00 15.00 0.64 205.00 2.90 12.00 50.00 1
*
* Source X(km) Y(km) Z(m) H(m) D(m) T(c) V(m/s) HB(m) WB(m)Grp SO2 NOX Part
BORGESTAD 36.82 58.48 5.00 16.00 0.67 165.00 10.20 12.00 50.00 2 0.50
BORGESTAD 36.80 58.52 5.00 12.00 0.67 165.00 7.80 12.00 50.00 2 0.20
BORGESTAD 36.79 58.50 5.00 15.00 0.60 10.00 1.00 12.00 50.00 2 0.10 0.10
FJELDHAMME 38.70 54.50 75.00 20.00 1.00 60.00 15.60 15.00 30.00 2
*
* Source X(km) Y(km) Z(m) H(m) D(m) T(c) V(m/s) HB(m) WB(m)Grp SO2 NOX Part
HY-RA-CRAC 34.17 51.05 5.00 50.00 1.80 215.00 13.00 31.00 3 41.30
HY-RA-ETYL 33.73 51.06 5.00 90.00 2.70 300.00 0.40 3 1.10
HY-RA-KJEL 34.20 51.03 5.00 50.00 2.80 170.00 10.00 3 17.60
HY-RA-VCMF 33.73 51.56 5.00 50.00 1.20 300.00 8.00 3 7.60
HY-RA-EDC 33.73 51.30 5.00 35.00 0.50 15.00 10.00 3 3.80
*
* Source X(km) Y(km) Z(m) H(m) D(m) T(c) V(m/s) HB(m) WB(m)Grp SO2 NOX Part
SU-CELUF 34.98 62.98 5.00 40.00 2.00 70.00 7.10 30.00 50.00 5 6.00 7.90 4.40
DIFFUS 34.96 62.95 5.00 30.00 30.00 50.00 5 13.00
FYRHUS 35.13 62.61 5.00 50.00 1.90 95.00 5.00 5 4.30 3.10
*
* Source X(km) Y(km) Z(m) H(m) D(m) T(c) V(m/s) HB(m) WB(m) Grp SO2 NOX Part
LAND-DA1 36.07 53.47 5.0 38.0 30.0 10.0 4 0.20 5.94
LAND-F1 35.74 53.67 5.0 58.0 1.8 24.0 5.5 4 4.30 3.50
LAND-F17 35.48 54.06 5.0 50.0 1.6 45.0 13.0 4 5.30
LAND-F19 35.48 54.02 5.0 83.0 1.3 15.0 15.0 4 9.90 12.40
LAND-F20 35.50 54.00 5.0 83.0 0.6 20.0 13.0 4 0.66
LAND-F27 35.47 54.03 5.0 83.0 10.2 30.0 21.0 4 5.40
LAND-F29 35.47 54.02 5.0 83.0 0.8 40.0 22.0 4 3.60
LAND-F33 35.48 54.05 5.0 53.0 1.8 40.0 8.0 4 2.10
LAND-F61 35.52 54.01 5.0 115.0 11.4 30.0 20.0 4 5.80
LAND-KS-4 35.89 53.55 5.0 63.0 2.2 30.0 13.0 4 5.20
LAND-NH3F 35.96 54.32 5.0 20.0 50.0 20.0 4 0.20 22.11
LAND-NO3F 36.02 53.60 5.0 100.0 3.0 20.0 18.0 4 60.06
MAGN-Mg13 36.01 53.92 5.0 45.0 1.6 55.0 9.0 4 1.00 3.40 0.50
MAGN-Mg4 36.00 53.83 5.0 42.0 2.0 190.0 11.0 4 7.00 6.90 2.20
MAGN-Mg4D 36.42 53.54 5.0 72.0 1.6 300.0 18.5 4 5.00 7.00 14.90
MAGN-S3 35.86 54.00 5.0 100.0 3.5 20.0 9.0 4 13.10 4.50
    
```

The meteorology file GREN-WIN.MET will be:

WINTER-AVERAGE,	Period
GRENLAND,	Place
-1.5,	Average temp.
12,	Number of sectors
1.0,3.2,4.9,7.1,	Wind speeds
10.0,	Wind in 10 m
0.3,	Starting velocity
Y,	Standard wind profile exp.
N,	Not standard inv.heights
700.0,500.0,300.0,300.0,	Inv. heights
30 0.3 1.9 0.3 0.1 0.7 3.1 0.1 0.0 0.4 1.9 0.0 0.0 0.1 0.1 0.0 0.0	
60 0.7 6.5 4.7 5.5 3.1 8.4 1.6 0.9 0.8 1.0 0.3 0.1 0.0 0.1 0.0 0.0	
90 0.3 3.6 4.0 4.7 0.5 0.6 0.0 0.0 1.4 0.0 0.0 0.0 0.2 0.0 0.0 0.0	
120 0.2 0.9 0.8 0.9 0.0 0.5 0.0 0.0 1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
150 0.1 2.1 0.6 0.6 0.3 0.6 0.2 0.0 0.1 0.1 0.1 0.0 0.0 0.0 0.0 0.0	
180 0.5 2.7 0.5 0.3 0.5 2.0 0.1 0.0 0.8 2.4 0.1 0.0 0.7 1.5 0.0 0.1	
210 0.4 2.4 0.7 0.4 0.3 1.8 0.2 0.0 0.2 0.4 0.2 0.1 0.0 0.1 0.0 0.0	
240 0.2 1.5 1.2 0.1 0.1 0.3 0.0 0.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
270 0.1 0.5 0.8 0.4 0.1 0.2 0.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
300 0.1 0.3 0.3 0.2 0.0 0.2 0.0 0.0 0.0 0.1 0.0 0.0 0.0 0.0 0.0 0.0	
330 0.0 0.4 0.1 0.0 0.3 0.8 0.1 0.0 0.2 0.4 0.0 0.0 0.2 0.1 0.0 0.0	
360 0.0 0.1 0.0 0.0 0.1 0.7 0.1 0.0 0.3 1.0 0.0 0.0 0.1 0.1 0.0 0.0	
0.0 0.8 0.9 1.1,	Calm

The result will be found at the file POI-GREN.PRN:

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 - - - - 0 0 0 - - - -

Welcome to the program POI-KILD, for calculating
 long-term mean values from a number of point sources.

The source POLLY has no emission and is not included.
 The source FJELDHAMME has no emission and is not included.
 The source DIFFUS has no emission and is not included.
 Stack data for LAND-DA1 are not complete: 36.07 53.47 5.00 38.00 30.00 10.00 .00
 and the source is not included.
 The source LAND-F17 has no emission and is not included.
 The source LAND-F27 has no emission and is not included.
 The source LAND-F29 has no emission and is not included.
 The source LAND-F33 has no emission and is not included.
 The source LAND-F61 has no emission and is not included.
 The source LAND-KS-4 has no emission and is not included.
 Stack data for LAND-NH3F are not complete: 35.96 54.32 5.00 20.00 50.00 20.00 .00
 and the source is not included.
 The source MAGN-S3 has no emission and is not included.
 Sum emission from 2 sources without complete data: 28.05 kg/h
 Remember to include these as area sources!!
 10 sources with no emissions

POINT SOURCES IN GRENLAND
 Stack data are read from file..... GREPOINT.DAT
 Computations are made for..... NOx
 Ground level reflection factor ALPHA..... 1.000
 The concentration are ground level values with 30o sector averages
 The SW corner of the area has coordinates (28.00, 45.00)
 The centre of grid (1,1) has the local coordinates (.50, .50)
 Dispersion parameters from McElroy-Pooler for low sources,
 Brookhaven for elevated sources (above 50. meters)

Frequency matrix for WINTER-AVERAGE, in GRENLAND, is read from file GREN-WIN.MET

	1.0m/s				3.2m/s				4.9m/s				7.1m/s			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
30	.3	2.0	.3	.1	.7	3.1	.1	.0	.4	1.9	.0	.0	.1	.1	.0	.0
60	.7	6.7	5.0	6.0	3.1	8.4	1.6	.9	.8	1.0	.3	.1	.0	.1	.0	.0
90	.3	3.7	4.3	5.1	.5	.6	.0	.0	1.4	.0	.0	.0	.2	.0	.0	.0
120	.2	.9	.9	1.0	.0	.5	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0
150	.1	2.2	.6	.7	.3	.6	.2	.0	.1	.1	.1	.0	.0	.0	.0	.0
180	.5	2.8	.5	.3	.5	2.0	.1	.0	.8	2.4	.1	.0	.7	1.5	.0	.1
210	.4	2.5	.7	.4	.3	1.8	.2	.0	.2	.4	.2	.1	.0	.1	.0	.0
240	.2	1.6	1.3	.1	.1	.3	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
270	.1	.5	.9	.4	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
300	.1	.3	.3	.2	.0	.2	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0
330	.0	.4	.1	.0	.3	.8	.1	.0	.2	.4	.0	.0	.2	.1	.0	.0
360	.0	.1	.0	.0	.1	.7	.1	.0	.3	1.0	.0	.0	.1	.1	.0	.0

Stability 1 2 3 4
 Windprof.exponent .20 .28 .36 .42
 Mixing height 700. 500. 300. 300.

The wind speed in the lowest wind speed group is adjusted for calm from 1.00 m/s to .96 m/s
 All point sources are included

Number of sources..... 18
 Default building dimensions:.....HEIGHT=10m
 WIDTH=30m

Source data:

Name	Relative coordinates		Stack base m	Stack height m	Stack diameter m	Gas temp. oC	Exit velocity m/s	Building		NOx emission kg/h	
	X	Y						height m	width m		
1	SENTRALSYK	6.00	16.90	20.00	25.0	.60	220.	1.0	10.	30.	1.70
2	BORGESTAD	8.80	13.50	5.00	16.0	.67	165.	10.2	12.	50.	.50
3	BORGESTAD	8.80	13.50	5.00	12.0	.67	165.	7.8	12.	50.	.20
4	BORGESTAD	8.80	13.50	5.00	15.0	.60	10.	1.0	12.	50.	.10
5	HY-RA-CRAC	6.17	6.05	5.00	50.0	1.80	215.	13.0	10.	31.	41.30
6	HY-RA-ETYL	5.73	6.06	5.00	90.0	2.70	300.	.4	10.	30.	1.10
7	HY-RA-KJEL	6.20	6.03	5.00	50.0	2.80	170.	10.0	10.	30.	17.60
8	HY-RA-VCMF	5.73	6.56	5.00	50.0	1.20	300.	8.0	10.	30.	7.60
9	HY-RA-EDC	5.73	6.30	5.00	35.0	.50	15.	10.0	10.	30.	3.80
10	SU-CELU	6.98	17.98	5.00	40.0	2.00	70.	7.1	30.	50.	7.90
11	FYRHUS	7.13	17.61	5.00	50.0	1.90	95.	5.0	10.	30.	3.10
12	LAND-F1	7.74	8.67	5.00	58.0	1.80	24.	5.5	10.	30.	4.30
13	LAND-F19	7.48	9.02	5.00	83.0	1.30	15.	15.0	10.	30.	9.90
14	LAND-F20	7.50	9.00	5.00	83.0	.60	20.	13.0	10.	30.	.66
15	LAND-NO3F	8.02	8.60	5.00	100.0	3.00	20.	18.0	10.	30.	60.06
16	MAGN-Mg13	8.01	8.92	5.00	45.0	1.60	55.	9.0	10.	30.	3.40
17	MAGN-Mg4	8.00	8.83	5.00	42.0	2.00	190.	11.0	10.	30.	6.90
18	MAGN-Mg4D	8.42	8.54	5.00	72.0	1.60	300.	18.5	10.	30.	7.00
										SUM	177.12

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MAP OF : NOx UNIT: UG/M3 SOURCE: POINT SOURCES
 PERIOD : WINTER-AVERAGE PLACE: GRENLAND GRID SIZE: 1000 METER
 CREATED: 1996/09/10 09.46
 MAXIMUM VALUE IS 5.6226E+00, IN (5, 8)
 SUM= 3.10635E+02 SCALE FACTOR: 1.0E-03

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
J=20	431.	350.	388.	468.	501.	710.	718.	863.	608.	632.	574.	494.	461.	410.	379.	355.
J=19	495.	547.	616.	752.	744.	749.	943.	729.	708.	659.	578.	497.	463.	434.	404.	379.
J=18	598.	680.	794.	1038.	895.	1841.	4533.	792.	715.	684.	582.	542.	506.	469.	436.	406.
J=17	620.	851.	1010.	1430.	1899.	3725.	1217.	920.	809.	730.	616.	578.	534.	509.	471.	426.
J=16	757.	960.	1137.	1407.	1361.	926.	977.	942.	939.	823.	677.	629.	581.	535.	480.	373.
J=15	791.	900.	1118.	1021.	861.	832.	997.	1061.	1040.	979.	757.	693.	633.	558.	420.	365.
J=14	781.	875.	769.	691.	907.	948.	1008.	1403.	1829.	928.	838.	760.	667.	489.	419.	383.
J=13	771.	678.	560.	616.	979.	1075.	1082.	1726.	1387.	1002.	921.	800.	565.	487.	444.	403.
J=12	580.	545.	605.	668.	783.	1114.	1174.	1771.	1525.	1118.	958.	649.	557.	509.	462.	419.
J=11	1069.	764.	631.	698.	751.	1088.	1194.	1373.	1686.	1121.	713.	618.	579.	499.	436.	317.
J=10	1091.	1211.	1342.	1500.	1566.	1551.	1260.	1099.	1163.	675.	560.	448.	418.	386.	352.	319.
J= 9	1100.	1223.	1354.	1479.	1513.	1713.	2937.	2041.	555.	465.	470.	453.	425.	377.	341.	257.
J= 8	1763.	1345.	1553.	2002.	3072.	4012.	4081.	1320.	653.	385.	369.	346.	300.	309.	281.	256.
J= 7	2467.	2828.	3149.	3546.	4092.	3942.	1468.	530.	486.	447.	294.	275.	250.	225.	202.	182.
J= 6	2433.	2694.	3239.	3962.	5623.	2623.	1234.	354.	345.	380.	371.	267.	244.	220.	198.	179.
J= 5	3100.	3517.	3991.	4234.	2241.	1332.	909.	402.	258.	270.	247.	224.	223.	212.	192.	174.
J= 4	2920.	3274.	3445.	1923.	1194.	835.	680.	314.	284.	234.	218.	200.	180.	135.	123.	114.
J= 3	2719.	2842.	1663.	884.	977.	609.	268.	248.	232.	221.	192.	178.	163.	148.	116.	107.
J= 2	2371.	1400.	702.	754.	721.	451.	209.	201.	191.	183.	188.	159.	147.	135.	124.	101.
J= 1	1179.	565.	603.	648.	609.	377.	152.	158.	160.	151.	163.	152.	133.	123.	114.	105.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Results are printed to file POI-GREN.PRN																
Concentrations are put on file POI-GREN. FLD																

PLUME RISE STATISTICS

Plume rise, and index:

- 1: No building turbulence (He>0.5 Hb)
 - 2: Building turbulence (He=0.5 Hb)
 - 3: Trapped by buildings (He=0.5 Hb)
- should this source be included in the area sources?
- 1: No occurrence of the stability/wind speed class

SOURCE	.96 M/S				3.20 M/S				4.90 M/S				7.10 M/S			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
SENTRALSYSK	34.1	33.1	43.1	40.1	25.2	25.2	35.2	32.2	24.2	23.2	33.2	31.2	23.2	23.2	33.2	31.2
BORGESTAD	76.1	74.1	61.1	53.1	26.2	25.2	38.2	32.2	18.2	17.2	32.2	27.2	6.3	6.3	32.2	27.2
BORGESTAD	64.1	63.1	55.1	47.1	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
BORGESTAD	16.1	16.1	24.1	22.1	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
HY-RA-CRAC	335.1	300.1	137.1	120.1	135.1	125.1	108.1	97.1	106.1	99.1	100.1	90.1	88.1	83.1	100.1	90.1
HY-RA-ETYL	122.1	116.1	118.1	111.1	94.1	92.1	106.1	101.1	90.1	89.1	102.1	98.1	87.1	86.1	102.1	98.1
HY-RA-KJEL	438.1	360.1	152.1	132.1	166.1	152.1	118.1	105.1	126.1	116.1	107.1	95.1	100.1	93.1	107.1	95.1
HY-RA-VCMF	172.1	158.1	110.1	98.1	87.1	82.1	90.1	81.1	73.1	70.1	83.1	76.1	65.1	63.1	83.1	76.1
HY-RA-EDC	47.1	46.1	53.1	49.1	39.1	38.1	47.1	45.1	37.1	36.1	45.1	43.1	36.1	35.1	45.1	43.1
SU-CELUF	166.1	153.1	101.1	89.1	53.2	48.2	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3
FYRHUS	152.1	139.1	105.1	94.1	79.1	75.1	84.1	77.1	67.1	64.1	78.1	72.1	60.1	58.1	78.1	72.1
LAND-F1	100.1	95.1	95.1	88.1	70.1	67.1	81.1	75.1	64.1	62.1	76.1	72.1	60.1	59.1	76.1	72.1
LAND-F19	123.1	117.1	118.1	111.1	95.1	93.1	106.1	102.1	91.1	90.1	103.1	98.1	88.1	86.1	103.1	98.1
LAND-F20	99.1	96.1	105.1	100.1	88.1	87.1	97.1	94.1	86.1	85.1	95.1	92.1	84.1	84.1	95.1	92.1
LAND-NO3F	277.1	247.1	174.1	164.1	153.1	144.1	146.1	136.1	135.1	129.1	140.1	131.1	124.1	119.1	140.1	131.1
MAGN-Mg13	136.1	126.1	97.1	87.1	72.1	69.1	80.1	73.1	62.1	60.1	74.1	68.1	56.1	54.1	74.1	68.1
MAGN-Mg4	331.1	300.1	130.1	113.1	129.1	119.1	101.1	89.1	99.1	93.1	92.1	82.1	80.1	75.1	92.1	82.1
MAGN-Mg4D	392.1	337.1	163.1	145.1	168.1	154.1	133.1	121.1	135.1	126.1	125.1	114.1	115.1	109.1	125.1	114.1

Sentralsyk, Borgestad and SU-Celuf are all influenced by buildings. First, you must control the building and stack data.

SOURCE CONTRIBUTIONS:

EMISSION	5, 6	12, 4	10, 13	7, 18	
SENTRALSJK	1.700	8.7264E-04	1.1724E-03	4.0036E-03	4.4211E-01
BORGESTAD	.500	2.6837E-03	5.3472E-04	1.0625E-02	7.8157E-03
BORGESTAD	.200	1.0865E-03	2.2257E-04	5.0195E-03	3.8581E-03
BORGESTAD	.100	5.4312E-04	1.1592E-04	3.1540E-03	2.0516E-03
HY-RA-CRAC	41.300	1.0497E+00	3.7026E-02	1.5739E-01	1.1991E-01
HY-RA-ETYL	1.100	1.0243E-01	1.6180E-03	7.0971E-03	4.4771E-03
HY-RA-KJEL	17.600	2.7220E-01	1.1566E-02	4.9658E-02	4.1315E-02
HY-RA-VCMF	7.600	5.4088E-01	1.0568E-02	4.9968E-02	3.2355E-02
HY-RA-EDC	3.800	1.6946E+00	1.0756E-02	3.1700E-02	1.8166E-02
SU-CELUF	7.900	3.4130E-03	4.1394E-03	1.4501E-02	3.3757E+00
FYRHUS	3.100	1.4113E-03	1.6301E-03	7.2120E-03	8.3573E-02
LAND-F1	4.300	2.5522E-01	9.3507E-03	7.3742E-02	2.9249E-02
LAND-F19	9.900	1.2031E-01	1.6752E-02	1.4395E-01	6.2539E-02
LAND-F20	.660	8.8935E-03	1.2132E-03	1.1146E-02	4.4826E-03
LAND-NO3F	60.060	1.1306E+00	7.0954E-02	3.1311E-01	2.3196E-01
MAGN-Mg13	3.400	1.6702E-01	6.8420E-03	5.5864E-02	2.2469E-02
MAGN-Mg4	6.900	1.6520E-01	8.6064E-03	3.9312E-02	2.8208E-02
MAGN-Mg4D	7.000	1.0552E-01	7.2713E-03	2.4591E-02	2.2419E-02
SUM		5.6226E+00	2.0034E-01	1.0021E+00	4.5327E+00

ARE-KILD, 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, wood or coal consumption or traffic work.

The program ARE-KILD 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.

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

The vertical standard deviation σ_z is calculated from:

$$\sigma_z^2 = \sigma_{z_0}^2 + H_b^2 \cdot F_a$$

where

$$\sigma_{z_0} = a * x^p$$

$$H_b = \text{box height}$$

$$F_a = \text{wind speed correction factor} = 0.5 * (1.0 + 0.7 / \bar{u})^2$$

$$\bar{u} = \text{mean wind speed for the wind speed class.}$$

The result from the program will be two separate data fields, one with the total concentration, and one with the concentration contribution from emissions within a square to the square itself.

Input data for ARE-KILD

The program ARE-KILD gets its data from different sources; interactive from the terminal or from a .RUN-file, from a file with constant data, and from a METFIL-file with meteorological data (as described in separate chapter). To run the program for the first time it may be run interactive to perform a .RUN-file with all the answers for the next calculations.

Input file INFI

This file includes all information that shall be constant during a set of computations. The program gives no dialogue when reading from this file, as the file is already prepared and the questions answered. Nevertheless, we will use questions in the preparing of the file. The file will be read with a line that begins with START in columns 1-5. This means that we may put useful comments at the beginning of the file. The data at the file is read in different subroutines.

The program asks for:

- TEXT One line with text as a heading for the calculations
- ISIZE Grid size in meter
- ANORTH It is possible to rotate the grid area. ANORTH 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.
- IDISP Selection of dispersion parameters:
 1: McElroy-Pooler
 2: Brookhaven
 3: New values

If IDISP=3, the program reads:

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

INBOX, JFIE

Box codes are field no. JFIE on the file INBOX (with apostrophes and .FLD).

INEMIS, IFILE

The emission field is field no. IFILE at the file INEMIS (with apostrophes and .FLD).

- IKO It is possible to run for selected parts of the emission field.
 IKO=1 uses the whole emission field.
 IKO=2 uses "splitted" emission field.

If IKO=2, then:

INCODE, IFIE

A field with area codes is read as field no. IFIE at the file INCODE (with apostrophes and .FLD).

NCOD, (IFAK(I), I=1, NCOD)

Factors 0/1 for which area codes that shall be included in the calculations. 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 (by INP-FIE) with 1 and 2 in the different areas. The computations are first made for area 1 using a METFIL1 AND IFAK=1 and 0, next for area 2 with a METFIL2 and IFAK=0 and 1.

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 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:

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, normally 1.2 * average building height in the square.

(HEMI(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.

The OUTFI.FLD-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.

RUN-file or interactive data

C:\KILDER\ARE-KILD Starts the program.

C:\KILDER\ARE-KILD <runfile.RUN

Starts the program when using a .RUN-file.

It may be useful to use the same name for the RUN-file and OUTFI.

The run-file, or the answers to the interactive questions will be:

**** License code

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

INFI Name of the input file (with apostrophes and .DAT).

OUTFI Name of the output files (with apostrophes). The concentration data fields are written binary (unformatted) to the file OUTFI.FLD, whereas the output from the program is written to the file OUTFI.PRN.

- IPR Normally IPR=0, but it may sometimes be useful to look at some of the tables generated in the program (IPR=1).
- METFIL Name of the file with meteorological data (with apostrophes and .MET). See the separate description of this file in chapter 2.3).

Test example for ARE-KILD

As a test example is used calculations of NOx from traffic in Grenland, Norway.

The INFI file NOXTRAF.DAT will be:

```
START
NOX FROM MAIN ROADS IN GRENLAND
1000,           Grid size
0,             North is north
0,             No background
1,             McElroy-Pooler
'BOXGREN.FLD',1, Box code file
'NOXTRAF.FLD',1, Emission file
1,             Uses the whole area
1.0,0.01,      Scale, lower emission limit
3,             3 boxes
10.,15.,25.,   Box heights
2.,2.,2.,      Emission heights
```

The file box code file BOXGREN.FLD is read from the file BOXGREN.DAT, read in READ-FIE:

```
(2X,16F3.0)
'BOX CODE', 'INTEGER', '1995', 'GRENLAND', 'BUILDINGS'
16,20,1000,1.0
20 1 1 1 1 1 1 2 1 1 1 1 1 1 1 1
19 1 1 1 1 1 2 2 2 1 1 1 1 1 1 1
18 1 1 1 1 1 1 2 2 1 1 1 1 1 1 1
17 1 1 1 1 1 1 2 2 1 1 1 1 1 1 1
16 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1
15 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1
14 1 1 1 1 1 1 1 1 2 2 1 1 1 1 1
13 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1
12 1 1 1 1 1 1 1 1 2 2 1 1 1 1 1
11 1 1 1 1 1 1 1 1 2 2 1 1 1 1 1
10 1 1 1 1 1 1 1 3 1 1 1 1 1 1 1
9 1 1 1 1 1 1 1 3 3 1 1 1 1 1 1
8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
2 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1
1 1 1 1 1 1 1 1 1 1 1 2 2 1 1 1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
```

The meteorology file GREN-WIN.MET will be:

WINTER-AVERAGE,	Period
GRENLAND,	Place
-1.5,	Average temp.
12,	Number of sectors
1.0,3.2,4.9,7.1,	Wind speeds
10.0,	Wind in 10 m
0.3,	Starting velocity
Y,	Standard wind profile exp.
N,	Not standard inv.heights
700.0,500.0,300.0,300.0,	Inv. heights
30 0.3 1.9 0.3 0.1 0.7 3.1 0.1 0.0 0.4 1.9 0.0 0.0 0.1 0.1 0.0 0.0	
60 0.7 6.5 4.7 5.5 3.1 8.4 1.6 0.9 0.8 1.0 0.3 0.1 0.0 0.1 0.0 0.0	
90 0.3 3.6 4.0 4.7 0.5 0.6 0.0 0.0 1.4 0.0 0.0 0.0 0.2 0.0 0.0 0.0	
120 0.2 0.9 0.8 0.9 0.0 0.5 0.0 0.0 1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
150 0.1 2.1 0.6 0.6 0.3 0.6 0.2 0.0 0.1 0.1 0.1 0.1 0.0 0.0 0.0 0.0	
180 0.5 2.7 0.5 0.3 0.5 2.0 0.1 0.0 0.8 2.4 0.1 0.0 0.7 1.5 0.0 0.1	
210 0.4 2.4 0.7 0.4 0.3 1.8 0.2 0.0 0.2 0.4 0.2 0.1 0.0 0.1 0.0 0.0	
240 0.2 1.5 1.2 0.1 0.1 0.3 0.0 0.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
270 0.1 0.5 0.8 0.4 0.1 0.2 0.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
300 0.1 0.3 0.3 0.2 0.0 0.2 0.0 0.0 0.0 0.1 0.0 0.0 0.0 0.0 0.0 0.0	
330 0.0 0.4 0.1 0.0 0.3 0.8 0.1 0.0 0.2 0.4 0.0 0.0 0.2 0.1 0.0 0.0	
360 0.0 0.1 0.0 0.0 0.1 0.7 0.1 0.0 0.3 1.0 0.0 0.0 0.1 0.1 0.0 0.0	
0.0 0.8 0.9 1.1,	Calm

The result will be found at the file POI-GREN.PRN:

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 NILU
 VERSION 2.0, 1-10-1996
 - - - - 0 0 0 - - - -

MAP OF : NOX TRAF UNIT: KG/H SOURCE: TRAFFIC GRENLAND
 PERIOD : 1993 PLACE: Grenland GRID SIZE: 1000 METER
 CREATED: 1996/10/04 12.45

MAXIMUM VALUE IS 4.1094E+00, IN (7,19)
 SUM= 1.13737E+02 SCALE FACTOR: 1.0E-03

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
J=20	.	.	221.	27.	477.	238.	2329.	379.	50.	.	.	.	.	.	.	.
J=19	.	.	29.	447.	1514.	1790.	4109.	1374.	.	.	.	.	.	.	.	.
J=18	.	.	91.	331.	165.	2773.	2881.	1720.	430.	.	.	.	.	.	.	.
J=17	590.	120.	470.	720.	1072.	1855.	2287.	2321.	700.	.	.	.	.	.	.	.
J=16	.	478.	68.	.	1066.	927.	786.	2255.	1455.	364.	.	.	.	.	.	.
J=15	.	15.	.	.	369.	64.	312.	762.	2796.	1015.	.	.	.	.	.	.
J=14	.	9.	6.	245.	35.	.	322.	2.	1620.	1767.	.	.	.	.	.	.
J=13	.	.	116.	179.	.	.	161.	389.	1773.	1388.	.	.	.	.	.	.
J=12	.	.	285.	.	.	.	.	188.	2528.	2009.	.	.	.	.	.	.
J=11	.	.	314.	.	.	.	.	367.	2841.	3303.	2536.	174.	.	.	.	.
J=10	182.	679.	218.	254.	254.	269.	335.	228.	1537.	1278.	.	2184.	1075.	.	.	.
J= 9	.	70.	365.	38.	.	.	.	.	116.	2297.	913.	611.	2004.	2067.	.	.
J= 8	.	.	.	325.	132.	.	.	.	.	1070.	1104.	601.	1363.	511.	1661.	1694.
J= 7	207.	139.	.	.	.	.	.	833.	2900.	143.	.	.
J= 6	243.	94.	.	.	.	.	.	2224.	.	.	.
J= 5	288.	49.	.	.	.	.	2339.	.	.	.
J= 4	412.	.	.	.	.	2162.	.	.	.
J= 3	135.	287.	.	.	.	2240.	44.	.	.
J= 2	372.	50.	.	.	1939.	259.	.	.
J= 1	552.	465.	2749.	376.	.	.	.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Emissions are read from the file NOXTRAF.FLD field no. 1
 Emissions less than .010 kg/h are not included
 Sum emission 119.494 kg/h from 132 area sources
 Sum emission .016 kg/h from 3 area sources that are not included

The following box classes are used:

Box	Height	Emis.height
1	10.	2.
2	15.	2.
3	25.	2.

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 - - - - 0 0 0 - - - -

Welcome to the program ARE-KILD,
 for calculating long-term mean values from a field
 with area emissions.

NOX FROM MAIN ROADS IN GRENLAND
 Calculations are made for NOX TRAF
 Number of area sources generated from the emission field: 132
 Concentrations are ground level values and 30 degrees sector averages
 Dispersion parameters from McElroy-Pooler

Frequency matrix for WINTER-AVERAGE, GRENLAND,
 read from GREN-WIN.MET

	1.0m/s				3.2m/s				4.9m/s				7.1m/s			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
30	.3	2.0	.3	.1	.7	3.1	.1	.0	.4	1.9	.0	.0	.1	.1	.0	.0
60	.7	6.7	5.0	6.0	3.1	8.4	1.6	.9	.8	1.0	.3	.1	.0	.1	.0	.0
90	.3	3.7	4.3	5.1	.5	.6	.0	.0	1.4	.0	.0	.0	.2	.0	.0	.0
120	.2	.9	.9	1.0	.0	.5	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0
150	.1	2.2	.6	.7	.3	.6	.2	.0	.1	.1	.1	.0	.0	.0	.0	.0
180	.5	2.8	.5	.3	.5	2.0	.1	.0	.8	2.4	.1	.0	.7	1.5	.0	.1
210	.4	2.5	.7	.4	.3	1.8	.2	.0	.2	.4	.2	.1	.0	.1	.0	.0
240	.2	1.6	1.3	.1	.1	.3	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
270	.1	.5	.9	.4	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
300	.1	.3	.3	.2	.0	.2	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0
330	.0	.4	.1	.0	.3	.8	.1	.0	.2	.4	.0	.0	.2	.1	.0	.0
360	.0	.1	.0	.0	.1	.7	.1	.0	.3	1.0	.0	.0	.1	.1	.0	.0

Stability	1	2	3	4
Windprof.exponent	.20	.28	.36	.42
Mixing height	700.	500.	300.	300.

The wind speed in the lowest wind speed group is adjusted for calm from
 1.00 m/s to .96 m/s

The map of concentrations will be as:

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 VERSION 2.0, 1-10-1996
 - - - - 0 0 0 - - - -

MAP OF : NOX TRAF UNIT: UG/M3 SOURCE: TRAFFIC GRENLAND
 PERIOD : WINTER-AVERAGE, PLACE: GRENLAND, GRID SIZE: 1000 METER
 CREATED: 1996/10/04 12.45
 MAXIMUM VALUE IS 7.1132E+00, IN (6,20)
 SUM= 6.02192E+02 SCALE FACTOR: 1.0E-03

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
J=20	888.	1136.	1375.	1853.	2450.	3644.	3471.	2019.	1111.	764.	606.	507.	436.	381.	337.	301.
J=19	1261.	1625.	2257.	3562.	4789.	6461.	5358.	2755.	1324.	876.	673.	554.	471.	408.	359.	319.
J=18	1675.	2173.	3025.	3970.	5664.	7113.	5206.	3159.	1722.	996.	736.	599.	504.	435.	381.	337.
J=17	2430.	2904.	3694.	4584.	5873.	5864.	5087.	3634.	2026.	1159.	817.	640.	532.	457.	400.	353.
J=16	2440.	2962.	3198.	3984.	4527.	4201.	4301.	3953.	2714.	1608.	944.	686.	561.	477.	415.	365.
J=15	2163.	2269.	2503.	2909.	2805.	2761.	3313.	4046.	3824.	2090.	1073.	730.	593.	502.	434.	380.
J=14	1842.	1939.	2092.	2140.	1962.	2243.	2599.	3568.	3676.	2450.	1159.	777.	633.	534.	459.	398.
J=13	1710.	1800.	1913.	1796.	1775.	2053.	2451.	3705.	4014.	2423.	1275.	871.	699.	584.	495.	419.
J=12	1608.	1798.	1851.	1738.	1855.	2121.	2615.	4222.	4768.	3129.	1719.	1138.	832.	668.	546.	451.
J=11	1619.	1898.	1884.	1833.	1996.	2344.	3118.	5113.	6029.	5062.	3217.	1603.	1164.	851.	639.	501.
J=10	2024.	2200.	2019.	2164.	2375.	2774.	3330.	4483.	4800.	3578.	3048.	3282.	2113.	1251.	831.	572.
J= 9	1721.	1844.	1983.	1972.	2131.	2338.	2561.	2968.	3753.	4065.	3767.	3596.	3731.	2448.	1120.	817.
J= 8	1449.	1592.	1744.	1928.	1898.	1925.	2024.	2288.	3287.	3486.	3517.	3897.	3248.	2400.	2676.	1610.
J= 7	1302.	1397.	1547.	1635.	1735.	1707.	1744.	1960.	2327.	2791.	4230.	3907.	1830.	1496.	1026.	377.
J= 6	1211.	1278.	1334.	1411.	1511.	1589.	1613.	1661.	1848.	2353.	3597.	2651.	1214.	628.	380.	284.
J= 5	1134.	1167.	1189.	1221.	1313.	1471.	1567.	1541.	1671.	1848.	3159.	2408.	931.	448.	326.	248.
J= 4	1056.	1071.	1075.	1099.	1176.	1295.	1477.	1599.	1491.	1654.	2972.	2149.	829.	413.	293.	225.
J= 3	976.	980.	992.	1030.	1077.	1165.	1371.	1443.	1508.	1593.	2864.	2138.	839.	398.	266.	205.
J= 2	884.	897.	929.	967.	1025.	1117.	1195.	1411.	1504.	1598.	2790.	2160.	939.	390.	243.	182.
J= 1	796.	829.	860.	899.	962.	999.	1080.	1249.	1566.	2148.	3360.	2436.	870.	373.	223.	160.

and the corresponding map for the contribution from the grid itself:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
J=20	.	.	142.	17.	306.	152.	1404.	243.	32.	.	.	.	.	.	.	.
J=19	.	.	19.	287.	971.	1079.	2478.	828.	.	.	.	.	.	.	.	.
J=18	.	.	59.	212.	106.	1778.	1737.	1037.	275.	.	.	.	.	.	.	.
J=17	378.	77.	301.	462.	688.	1190.	1379.	1399.	449.	.	.	.	.	.	.	.
J=16	.	307.	43.	.	683.	595.	504.	1446.	877.	233.	.	.	.	.	.	.
J=15	.	9.	.	.	236.	41.	200.	489.	1793.	612.	.	.	.	.	.	.
J=14	.	.	.	157.	23.	.	207.	.	976.	1066.	.	.	.	.	.	.
J=13	.	.	75.	115.	.	.	103.	249.	1137.	837.	.	.	.	.	.	.
J=12	.	.	183.	.	.	.	.	120.	1524.	1211.	.	.	.	.	.	.
J=11	.	.	201.	.	.	.	.	235.	1713.	1992.	1626.	112.	.	.	.	.
J=10	117.	435.	140.	163.	163.	172.	215.	119.	986.	820.	.	1401.	690.	.	.	.
J= 9	.	45.	234.	24.	.	.	.	.	60.	1473.	585.	392.	1285.	1326.	.	.
J= 8	.	.	.	208.	84.	.	.	.	.	686.	708.	386.	874.	328.	1065.	1086.
J= 7	133.	89.	.	.	.	.	534.	1859.	91.	.	.	.
J= 6	156.	60.	.	.	.	.	1426.	.	.	.	.
J= 5	184.	31.	.	.	.	1500.	.	.	.	.
J= 4	264.	.	.	.	1386.	.	.	.	.
J= 3	86.	184.	.	.	1436.	28.	.	.	.
J= 2	239.	32.	.	1244.	156.	.	.	.
J= 1	354.	298.	1657.	226.	.	.	.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Print-out is put on file TRAFNOX.PRN
Concentrations are put on file TRAFNOX.FLD
Contribution from the squares is field 2.

Support

Program READ-FIE

The program reads one or more data matrixes from an ASCII-file and stores them binary at a .FLD-file with print-out at a .PRN-file. It is normally run interactive.

Input data to READ-FIE

KX, KY	Grid dimensions, number of points eastward and northward
INFILE	Name of the input file (with apostrophes and .DAT)
OUTFI	Name of the output files (with apostrophes) The data fields will be written binary to the file OUTFI.FLD, the output is written to the file OUTFI.PRN
NFIELD	Number of fields to be read
INT	Output of input data: 0= small integers, 1=reals

The following data are read from INFILE:

INFORM	Input format for the data (with parentheses) Integers are read into the program as reals with format Fx.0.
--------	--

Before each data field is two lines with heading, which is read **unformatted**:

COMPOUND, UNIT, PERIOD, PLACE, SOURCE all with apostrophes

LX, LY, ISIZE, FACTOR

LX, LY	Grid dimensions (same as KX, KY)
ISIZE	Grid size in meter
FACTOR	Scale factor to convert the data at the file to the correct unit.

((X(I,K), I=1,KX), K=KY,1,-1) Data field, read according to the format
INFORM;
KX values at each line. The northmost line is read first, then southwards.
All data are read as reals, but with output according to INT.

The MAP routine scales normally (INT=1) the output map to 4 ciphers for the maximum value. For small integers we have no scaling (INT=0), otherwise we get values as 200.*0.01.

Finally a line (which may contain the grid numbering) is read.

Example and output from READ-FIE

As an example the program shall read an emission field from a test area. The input data will be:

C:\KILDER\READ-FIE	
14,16	Grid dimensions
'TES-READ.DAT'	Input file
'TES-READ'	Result file
1,	Reading one field
1,	Data are reals

The input file 'TES-READ.DAT' will be:

```
(2X,14F3.0)
'SO2', 'KG/H', 'WINTER 85', 'OSLO', 'OIL HEATING'
14,16,1000,0.1
16 3 0 0 0 3 1 3 3 3 2 0 0 2 4
15 3 4 5 3 4 9 11 8 3 2 0 1 7 11
14 3 7 10 7 40 22 19 19 7 5 17 14 17 11
13 10 8 10 18 26 37 27 25 24 21 15 12 23 13
12 13 10 11 20 50 31 35 19 29 15 23 12 10 3
11 5 37 18 32 53 33 45 23 34 16 10 5 8 0
10 5 3 19 32 125 107 35 16 18 14 10 9 1 0
9 0 2 6 6 25 77 11 40 19 8 10 11 1 0
8 0 3 3 0 0 0 3 5 8 10 7 19 0 0
7 0 0 0 0 0 0 5 3 8 5 4 10 0 0
6 0 0 0 0 0 0 1 3 6 11 9 13 0 0
5 0 0 0 0 0 0 0 3 7 17 14 4 0 0
4 0 3 0 0 0 0 0 0 6 8 4 3 0 0
3 2 4 0 0 0 0 0 1 8 6 3 2 0 0
2 2 0 2 0 0 0 0 1 2 2 1 1 0 0
1 1 0 1 0 0 0 0 0 0 3 1 1 0 0
1 2 3 4 5 6 7 8 9 10 11 12 13 14
```

The figures in the file should be multiplied by 0.1 to give the unit KG/H. The column to the left and the last line will not be read by the programme, but they may be useful.

The data field will be written binary to TES-READ.FLD, whereas the output is written to TES-READ.PRN. The output is very similar to the input file.

Another example:

In CONS-FIE we shall distribute some oil consumption according to the population distribution in different regions, given as integers.

The input will be:

C:\KILDER\READ-FIE

14,16

'TESTAREA.DAT'

'TESTAREA'

1,

0,

Grid dimensions

Input file

Fields at TESTAREA.FLD, output at
TESTAREA.PRN.

Reading one field

Data are small integers

The regions are read from the file TESTAREA.DAT:

(4X,14F3.0)

'AREA CODE', 'CODE NUMBER', '1994', 'TESTPLACE', 'AREA'

14,16,1000,1.0

16	3	3	3	3	5	5	5	5	6	6	6	6	6	6
15	3	3	3	3	5	5	5	6	6	6	6	6	6	6
14	3	3	3	3	5	5	5	6	6	6	6	6	6	6
13	3	3	3	3	5	5	2	6	6	6	6	6	6	6
12	3	3	3	3	5	2	2	6	6	6	6	6	6	7
11	3	3	3	5	2	2	2	2	6	6	6	7	7	7
10	3	4	4	2	2	1	1	2	6	6	6	7	7	0
9	0	4	4	2	2	1	1	2	6	6	7	7	0	0
8	0	4	4	0	0	0	8	8	8	7	7	7	0	0
7	0	0	0	0	0	0	8	8	8	7	7	7	0	0
6	0	0	0	0	0	0	8	8	8	7	7	7	0	0
5	9	9	0	0	0	0	8	8	8	8	7	7	0	0
4	9	9	0	0	0	8	8	8	8	8	8	0	0	0
3	9	9	9	0	0	0	0	8	8	8	8	0	0	0
2	9	9	9	0	0	0	0	8	8	8	8	8	0	0
1	9	9	9	0	0	0	0	8	8	8	8	8	0	0
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

The last line is not read by the program.

Program INP-FIE

In this program values for one or more squares may be read to data fields. It is possible to read values for 12 fields at the same time. In the program values may be given for specified squares or areas of squares. The program is normally run as a batch job.

Input data to INP-FIE

KX, KY, NF Grid dimensions, number of points eastward and northward, and the number of fields (max. 12).

OUTFI Name of the output files (with apostrophes). The data fields will be written binary to the file OUTFI.FLD, the output is written to the file OUTFI.PRN.

IADD Shall you add the values in a square (Y/N, without apostrophes)?

IFD, IFO, IFI IFD=0 reads only background values
 1 reads IX, IY and values
 2 reads local/UTM-coord. and values
 3 reads rectangles with values
 4 reads grid number* and values
 * numbering horizontal like
 73, 74, 75, , 84

 25, 26, 27, , 36
 13, 14, 15, , 24
 1, 2, 3, , 12
 for a 12*7 net
 . IFO=1 reads data unformatted
 2 reads data formatted
 IFI = 1 reads data from terminal (always unformatted)
 2 reads data from file INFILE
 3 reads several fields (each with one variable) from
 file INFILE (NF=1, IFD=1)

If IFI=2 or 3, read:

INFILE Name of the input file (with apostrophes and .DAT)

The file is read until 'START' or 'Start'.

Input continues from file or terminal:

PERIOD, PLACE, SOURCE All with apostrophes

ISIZE, LX, LY Grid size in meters, grid dimensions

When all data are read, the program asks:

Do you need to re-scale the data? Y/N.

If the answer is Y, NF scale factors are requested, and the values read are multiplied by these.

Finally the program asks for scaling of the output:

ISC=1 No scaling (the values are printed as they are)

ISC=2 Automatic scaling

ISC=3 New scale factor

If ISC=3, a new scale factor is read.

Example for input to INP-FIE

In TESTPLACE we want to adjust emission fields at the file TESTHEAT.FLD for 2 planned central heating networks as indicated in the figure below:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
J=16	3.	3.	.	.	.	.	.	.	.	.	.	.	.	.
J=15	4.	3.	.	.	10.	.	4.	18.	14.	.	.	.	20.	33.
J=14	6.	11.	11.	9.	14.	31.	19.	17.	17.	.	.	13.	37.	41.
J=13	20.	33.	19.	9.	30.	31.	29.	37.	25.	20.	16.	32.	23.	27.
J=12	30.	32.	21.	21.	22.	42.	67.	104.	39.	32.	28.	24.	12.	45.
J=11	22.	17.	17.	28.	51.	60.	92.	55.	20.	28.	8.	1.	43.	23.
J=10	28.	47.	17.	74.	157.	98.	97.	49.	16.	14.	7.	28.	28.	14.
J= 9	19.	6.	20.	83.	48.	48.	64.	80.	22.	33.	34.	20.	25.	.
J= 8	.	1.	10.	2.	7.	1.	15.	54.	20.	26.	45.	25.	5.	.
J= 7	4.	6.	10.	.	.	.	1.	20.	23.	28.	49.	45.	.	.
J= 6	.	.	.	.	.	.	4.	11.	18.	33.	18.	33.	.	.
J= 5	.	.	.	.	.	.	2.	15.	22.	39.	18.	25.	9.	.
J= 4	.	.	.	.	.	.	2.	6.	30.	45.	42.	25.	.	.
J= 3	.	.	.	.	.	.	2.	.	41.	30.	29.	10.	.	.
J= 2	.	.	.	.	.	.	.	2.	34.	1.	4.	3.	.	.
J= 1	.	.	.	.	.	.	.	9.	18.	3.	4.	1.	.	.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

We want to prepare a mask to adjust the emissions within the areas indicated above:

C:\KILDER\INP-FIE

```
****          license code
14,16,1       grid dimensions, 1 field
'CENTMASK'    output file name
N            no addition of values
1,2          reads IX, IY from a separate file
'CENTHEAT.DAT' input file name
N            no re-scaling of data
2            automatic scaling of output
```

From the file 'CENTHEAT.DAT' is read:

```
'2000','TESTPLACE','CENTRAL HEATING'
1000,14,16      grid size and dimensions
1,'PLANT','INTEGER', background, compound, unit
2,10,2
2,11,2
3,10,2
3,11,2
3,12,2
9,8,3
10,6,3
10,7,3
10,8,3
10,9,3
11,6,3
11,7,3
11,8,3
11,9,3
12,7,3
-1,,,,,
```

The program CODE-FIE may be used to reduce the emissions from the file TESTHEAT.FLD according to the area codes in the file CENTHEAT.FLD.

The file TESTHEAT might also be read interactive (IFI=1) as a combination of rectangles:

```
2,10,3,11,2
Y
3,12,3,12,2
Y
10,6,11,9,3
Y
9,8,9,8,3
```

Y
12,7,12,7,3
N

Another way to reduce the emissions is to prepare a mask which later shall be used in PROD-FIE:

C:\KILDER\INP-FIE
14,16,1 grid dimensions, 1 field
'CENTMASK' output file name
N no addition of values
1,1 reads IX, IY and values from the terminal
'2000','TESTPLACE','CENTRAL HEATING'
1000 grid size
1.0,'MASK','FACTOR',background, compound and unit
2,10,-0.15
2,11,-0.83
3,10,-0.75
3,11,-0.66
3,12,-0.22
9,8,-0.75
10,6,-0.50
10,7,-0.75
10,8,-0.80
10,9,-0.60
11,6,-0.40
11,7,-0.90
11,8,-0.85
11,9,-0.50
12,7,-0.50
-1,,,,,
N no re-scaling of data
2 automatic scaling of output

There is a background of 1.0, and in the squares covered by the central heating network the emissions will be reduced according to the values. This mask will be multiplied by the emission field in the program PROD-FIE.

Program PRIN-FIE

Normally the results from a programme will be as corresponding .FLD and .PRN files. Sometimes the .PRN file may have been deleted, or you want it presented in another way. PRIN-FIE makes a print-out of a .FLD-file.

Input data to PRIN-FIE

KX, KY	Grid dimensions, number of points eastwards and northward
INFILE	Name of the file that shall be printed (with apostrophes and .FLD)
OUTFILE	Name of the output file (with apostrophes and .PRN)
	Normally, INFILE and OUTFILE will be the same family.
NFIE,	Number of fields to be printed. If you do not know how many fields you have, say 0 and you get all.
If NFIE > 0, read:	IFIE (I), I=1,NFIE Number of the fields to be printed
ISC	Scaling: ISC=1 No scaling (small integers) ISC=2 Automatic scaling ISC=3 New unit for some fields ISC=4 Separate scale factor for each field ISC=5 Common scale factor for all fields
	If ISC=3 or higher, enter for each field:
CSC	New scale factor
	If CSC is different from 1.0, then:
UNIT	New unit (with apostrophes). If you want the same unit, put ''

Example and output from PRIN-FIE

```
C:\KILDER\PRIN-FIE
14,16            Grid dimensions
'TESTZONE.FLD' Field to be printed
'TESTZONE.PRN' Print-file
1                1 field
1                Field no. 1
1                ISC=1 (small integers)
```

Field for ZONE CODE is put on file testzone.FLD

MAP OF: ZONE CODE UNIT: CODE NUMBER PERIOD: 1994 PLACE: TESTPLACE

MAXIMUM VALUE IS 4.0000E+00, IN (8, 6)
 SUM= 3.17000E+02 SCALE FACTOR: 1.0

GRID SIZE: 1000 METER

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

Another example:

C:\KILDER\PRIN-FIE	
22,18	Grid dimensions
'POP-OSLO.FLD'	Field to be printed
'POP-OSLO.PRN'	Print-file
1	1 field
1	Field no. 1
2	ISC=2 (automatic scaling)

In many cases it would be useful to take the .PRN-file into an editor and substitute 'blank-zero-period' by 'blank-blank-period'. In this way the zeros from all the grids with no activity or emissions are suppressed and the map is easier to read.

Program LIST-FIE

This program makes a "synoptic" listing of one or more (max. 6) fields, with the index I, J, and the values.

Input data to LIST-FIE

KX, KY,NF	Grid dimensions, number of points eastwards and northward and the number of fields (max. 6).
INFILE	Name of the file that shall be printed (with apostrophes and .FLD)
OUTFILE	Name of the output file (with apostrophes and .PRN)
IPR	Printing of empty squares Y/N?
EF	E: Output in E-format F: Output in F-format
(IDES(I), I=1,NFIE)	Number of decimals in the output.

Example and output from LIST-FIE

```
C:\KILDER\LIST-FIE
****          License code
42,28,4       Grid dimensions
'GAZ-QART.FLD' Field to be listed
'GAZ-LIST.PRN' Print-file
N             No printing of empty squares
F            F-format
1,1,1,1      1 decimal
```

The file GAZ-LIST.PRN will be:

```
Print-out of the file      : GAZ-QART.FLD
      GAZ 1.Q   GAZ 2.Q   GAZ 3.Q   GAZ 4.Q
I  J   M3/QUART M3/QUART M3/QUART M3/QUART
19 13  473783.0 172701.0 10122.0 135615.0
19 14  297404.0 106896.0 11119.0  73600.0
19 15  247901.0 138320.0 72445.0 139621.0
19 16  113006.0  73019.0 54682.0  85346.0
20 13   60477.0  24195.0  6929.0  30638.0
20 14  728267.0 286918.0 83299.0 423802.0
20 15  637185.0 261040.0 81069.0 348947.0
20 16  463597.0 206114.0 71999.0 255951.0
21 14  270986.0 200730.0 35685.0 152168.0
21 15  418363.0 175562.0 51614.0 209193.0
21 16  678828.0 290417.0 60650.0 368670.0
22 13  184940.0 132806.0 31920.0  68830.0
22 14   94405.0  42705.0 15259.0  55487.0
22 15  604212.0 248688.0 72758.0 330779.0
22 16 1219351.0 487316.0 115288.0 634913.0
23 13     .0     .0     .0     2160.0
23 14   70647.0  20667.0  1897.0  27452.0
23 15  281750.0  93329.0 22759.0 137246.0
23 16 1034607.0 390692.0 82141.0 515870.0
24 15   39927.0  16654.0  8435.0  22149.0
24 16  367827.0 124566.0 31042.0 184049.0
```

Only the squares with values are printed.

Program READ-PRN

This program is the opposite to PRIN-FIE. It is similar to READ-FIE, but it gets its input from an old .PRN-file. It is useful when a .FLD file has been deleted, but you still have the .PRN file. The program is normally run interactive.

Input data to READ-PRN

KX, KY	Grid dimensions, number of points eastward and northward
INFILE	Name of the input file (with apostrophes and .PRN)
OUTFI	Name of the output files (with apostrophes) The data fields will be written binary to the file OUTFI.FLD, the output is written to the file OUTFI.PRN If INFILE is equal to OUTFI, you will get an error message. In such cases it is better to rename INFILE.PRN to a temporary name.
PERIOD, PLACE, SOURCE	all with apostrophes
NFIELD	Number of fields to be read. If 0, you should get all the fields.
INT	Output of input data: 0= small integers, 1=reals

Example and output from READ-PRN

As an example the program shall read the .PRN-file from the example 1 in READ-FIE. The input data will be:

14,16	Grid size
'TEST-REA.PRN'	Input file, TES-READ.PRN is re named
'TES-READ'	Result file
'WINTER 85','OSLO','OIL HEATING'	Period, place and source
1,	Reading one field
1,	Data are reals

The output should be the same as for example 1 in READ-FIE.

Program SUM-FIE

In the program SUM-FIE we may calculate a sum of different fields. It is normally run interactive.

Input data to SUM-FIE

KX, KY	Grid dimensions, number of points eastward and northward
NFIELD, NCOMP	Number of NFIELD fields (max. 12), each with NCOMP components
IPR, ISF	IPR=0 No print-out of single fields IPR=1 Print-out of single fields before scaling IPR=2 Print-out of single fields after scaling ISF=1 makes a new .FLD file

For NFIELDs we read for component no. 1:

KFILE, KREC, FAK	File KFILE (with apostrophes and .FLD). If this is the same as previous, put 'SAME' as the file name. Record number KREC at the file. The data should be multiplied by FAK.
BACKGR	Background value for component no. 1
COMPS, UNIS	COMPS = compound for the sum field (with apostrophes) UNIS = unit of the sum (with apostrophes) If you enter 'SAME' you will get the same as for the last field
SUMSO	SUMSO = source for the sum (with apostrophes), Ex.: SUM NOX TRAF', 'SUM SO2 OIL'
OUTFILE	Name of the output files (with apostrophes) Output is written to the file OUTFI.PRN If ISF=1 data fields will be written binary to the file OUTFI.FLD

For the following components (J= 2 to NCOMP) we read:

(KREC(N), N=1, NFIELD)	Record numbers for component J at the different files
(FAK(N), N=1, NFIELD)	New scale factors
BACKGR	Background value for component no. J

COMPS, UNIS COMPS = compound for the sum field (with apostrophes)
 UNIS = unit of the sum (with apostrophes)
 If you enter 'SAME' you will get the same as for the **last** field

A new notation for PERIOD and PLACE will be taken from the last field.

Example 1:

We want to calculate the sum of NO_x- and TSP-emissions from different sources in Testplace.

NO_x- and TSP-emissions from gasoline and diesel traffic are field 8-9 and 13-14 respectively at the file TRAFFIC.FLD, emissions from oil heating field 2 and 4 at OIL-85.FLD, and emissions from solid fuels (wood and coal) as field 3 and 4 at SOLID.FLD. The consumption of solid fuels is increased by 20 %. This gives the following input:

```
PROGRAM\SUM-FIE
14,16           ,Area dimension
4,2            ,4 fields, two components
0,1           ,No print-out of single fields, creates a
              ,.FLD-file (ISF=1)
'TRAFFIC.FLD',8,1.0 ,traffic, field 8, gasoline cars
'SAME',9,1.0    ,same file, field 9, diesel cars
'OIL-85.FLD',2,1.0 ,oil, field 2
'SOLID.FLD',3,1.2 ,field 3, increased by 20 %
0.0           ,No background value
'SUM NOX','KG/H' ,Sum, unit
'ALL SOURCES'  ,Source
'SUM-EMIS'    ,Output file. Results at SUM-EMIS.PRN, and
              ,SUM.FLD
13,14,4,4     ,Field numbers for TSP
1.,1.,1.,1.2  ,New factors
'SUM TSP','KG/H' ,Sum, unit
```

Example 2:

We have calculated TSP-concentrations in Kathmandu, but want an estimate of PM10-levels. The different source groups have a different proportion PM10/TSP.

```

PROGRAM\SUM-FIE
27,21          Area dimension
7,1           7 fields, one component
0,0           No print-out of single fields, no .FLD-
file
'traf-tsp.fld',1,1.00  Traffic          all as PM10
'resu-tsp.fld',1,0.25  Resuspension,    25% as PM10
'dom-tsp.fld' ,1,0.50  Domestic,        50% as PM10
'bricktsp.fld',1,0.25  Brick factories, 25% as PM10
'hoff-tsp.fld',1,0.25  Hoffman kilns,   25% as PM10
'himalpoi.fld',1,0.42  Himal cement,    42% as PM10
'himal2.fld' ,1,0.25  Himal diffuse,   25% as PM10
10.0          Background 10 ug/m3
'SUM PM10','ug/m3'    Sum, unit
'ALL SOURCES'        Source
'SUM-EMIS'           Results at SUM-EMIS.PRN, but no .FLD-file

```


Output from Example 2:

```

Field no. 1 at file traf-tsp.fld, TSP TRAF , unit UG/M3      Sum= 1.3973E+03
Field no. 1 at file resu-tsp.fld, TSP RESUSP, unit UG/M3
is multiplied by 2.500E-01 to give unit ug/m3              Sum= 9.2766E+02
Field no. 1 at file dom-tsp.fld , ASS. FUELS, unit UG/M3
is multiplied by 5.000E-01 to give unit ug/m3              Sum= 3.7140E+03
Field no. 1 at file bricktsp.fld, TSP-BRICK , unit UG/M3
is multiplied by 2.500E-01 to give unit ug/m3              Sum= 5.2707E+03
Field no. 1 at file hoff-tsp.fld, TSP-HOFF , unit UG/M3
is multiplied by 2.500E-01 to give unit ug/m3              Sum= 2.4260E+02
Field no. 1 at file himalpoi.fld, TSP , unit METER
is multiplied by 4.200E-01 to give unit ug/m3              Sum= 7.1557E+02
Field no. 1 at file himal2.fld , TSP , unit UG/M3
is multiplied by 2.500E-01 to give unit ug/m3              Sum= 1.9493E+03
-----
SUM= 1.9887E+04

A background value of 10.000 ug/m3 is added

```

```

MAP OF : SUM PM10          UNIT: ug/m3          SOURCE: ALL SOURCES
PERIOD : Winter average   PLACE: KATHMANDU     GRID SIZE: 1000 METER
CREATED: 1995/03/14 09.19

```

```

MAXIMUM VALUE IS 1.5028E+02, IN ( 8, 8)
SUM= 1.98872E+04 SCALE FACTOR: 0.1

```

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
J=21	194.	207.	222.	236.	248.	266.	287.	309.	327.	337.	343.	332.	329.	325.
J=20	202.	219.	235.	252.	265.	284.	308.	333.	353.	371.	379.	368.	366.	361.
J=19	210.	230.	250.	268.	287.	305.	330.	364.	395.	421.	431.	418.	409.	399.
J=18	219.	241.	265.	286.	309.	329.	357.	397.	450.	498.	501.	491.	475.	443.
J=17	229.	252.	279.	304.	331.	356.	390.	431.	501.	567.	595.	588.	549.	493.
J=16	238.	268.	296.	322.	352.	387.	427.	469.	544.	629.	687.	676.	633.	551.
J=15	226.	286.	322.	352.	381.	433.	486.	529.	605.	694.	764.	739.	688.	595.
J=14	228.	277.	348.	390.	427.	465.	528.	578.	677.	794.	816.	789.	715.	618.

And so on.

The program asks: Change more values? until a N. Then the program asks for another point to be displayed, and new values for (IX,IY) is read until IX= -1.

If the answer to YN above was Y or y, then we may change the heading:

YH Y/N

If the answer is Y or y, then:

NCOMP, NUNIT New compound and unit (with apostrophes) PERIOD and
PLACE will be the same as before,

and

DATE will be the current date.

If the answer to YN above was Y or y, then the field shall be written to file. But you have a last opportunity to change your mind:

YF Y/N

After this the program will go to the next field or end.

Example and output from LOOK-FIE

```
FIELD 1  GWH/PERS          GWH/PERS          1985
OSLO          POPULATION      1995/04/26 11.06
```

Enter indices (IX,IY) for the point (IX=-1, end of this session):

```
      10          9
    9,10      10,10      11,10
1.06843E-03  8.04243E-03  2.49520E-02
```

```
      9, 9      10, 9      11, 9
0.00000E+00  0.00000E+00  0.00000E+00
```

```
      9, 8      10, 8      11, 8
-1.00000E+00 -1.00000E+00 -1.00000E+00
```

Do you want to change some values? Y/N: Y

Enter IX,IY and new value for the point (IX,IY):

```
      11          9      1.000000E-03
The value in (11, 9) is changed from .000E+00 to .100E-02
```

Change more values? Y/N: Y

Enter IX,IY and new value for the point (IX,IY):

```
      10          9      7.000000E-04
The value in (10, 9) is changed from .000E+00 to .700E-03
```

Change more values? Y/N: N

Enter indices (IX,IY) for the point (IX=-1, end of this session):

```
      7          9
    6,10      7,10      8,10
0.00000E+00  5.78474E-03  4.65967E-03
```

```
      6, 9      7, 9      8, 9
-1.00000E+00  3.21623E-02  4.59461E-03
```

```
      6, 8      7, 8      8, 8
0.00000E+00  0.00000E+00  0.00000E+00
```

Do you want to change some values? Y/N: Y

Enter IX,IY and new value for the point (IX,IY):

```
      6          10      1.000000E-03
The value in ( 6,10) is changed from .000E+00 to .100E-02
```

Change more values? Y/N: Y

Enter IX,IY and new value for the point (IX,IY):

```
      6          8      5.000000E-04
The value in ( 6, 8) is changed from .000E+00 to .500E-03
```

Change more values? Y/N: N

Enter indices (IX,IY) for the point (IX=-1, end of this session):

```
      -1          0
PRINT-OUT WRITTEN TO GWH-LOOK.PRN
```


PROGRAM PRES-FIE

Sometimes it is useful to have a look at the fields at the screen, without a full listing, therefore PRES-FIE. If you want a listing of a field, use PRIN-FIE.

Input data to PRES-FIE

KX, KY Grid dimensions, number of points eastward and northward

INFILE Name of the file (with apostrophes and .FLD)

ISC Scaling:
 ISC=1 No scaling (small integers)
 ISC=2 Automatic scaling

The program prints the heading and the first 20 lines of the first field to the screen. To continue, type CR. Then the program asks: NEXT? YES / JUMP / END:

If the answer is YES, the next field is displayed.

If the answer is JUMP, the program will have:

 JUMP The program reads JUMP fields, and displays the last.

Example of output from PRES-FIE.

```
MAP OF : TR.WORK LIGHT            UNIT:  CARKM/HOUR            SOURCE: CAR TRAFFIC
PERIOD : 1994                    PLACE:  GRENLAND            GRID SIZE: 1000 METER
CREATED: 1996/04/12 12.47
          SUM: 3.95922E+04            SCALE: 1.0E+00
          1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
J=23  0  0  0  0  2  8 31  0  5  0  0  0  0  0  0
J=22  0  0  8  1 19  9 92 15  1  0  0  0  0  0  0
J=21  0  0  1 17 60 70159 55  0  0  0  0  0  0  0  0
J=20  0  0  2 10  6 98 98 66 16  0  0  0  0  0  0
J=19 17  3 15 23 32 57 68 73 27  0  0  0  0  0  0
J=18  0 14  2  0 30 27 26 68 53 14  0  0  0  0  0
J=17  0  0  0  0 10  2 11 21 84 39  0  0  0  0  0
J=16  0  0  0  7  1  0 12  0 46 66  0  0  0  0  0
J=15  0  0  3  5  0  0  5 15 53 49  0  0  0  0  0
J=14  0  0  8  0  0  0  0  7 77 75  0  0  0  0  0
J=13  0  0  9  0  0  0  0  9 101124 76  5  0  0  0
J=12  5 21  6  7  7  8  9  5 53 51  0 63 29  0  0
J=11  0  2 11  1  0  0  0  0  3 85 35 22 57 53  0
J=10  0  0  0 10  4  0  0  0  0 37 41 18 39 13 42 43
J= 9  0  0  0  0  6  4  0  0  0  0 25 88  4  0  0
J= 8  0  0  0  0  0  7  3  0  0  0  0 76  0  0  0
J= 7  0  0  0  0  0  0  9  1  0  0  0 73  0  0  0
J= 6  0  0  0  0  0  0  0 13  0  0  0 64  0  0  0
J= 5  0  0  0  0  0  0  0  4  9  0  0 67  1  0  0
J= 4  0  0  0  0  0  0  0  0 12  1  0 60 10  0  0
```

Next page:

J= 3	0	0	0	0	0	0	0	0	0	0	18	15	82	13	0	0	0
J= 2	0	0	0	0	0	0	0	0	0	0	0	39	0	25	3	0	0
J= 1	0	0	0	0	0	0	0	0	0	0	0	32	2	13	20	0	0
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	

NEXT? YES/JUMP/END: yes

MAP OF : TR.WORK HEAVY UNIT: CARKM/HOUR SOURCE: CAR
 TRAFFIC
 PERIOD : 1994 PLACE: GREENLAND GRID SIZE: 1000
 METER

CREATED: 1996/04/12 12.47

SUM: 3.25745E+03 SCALE: 1.0E-02

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
J=23	0	0	0	0	14	46164	0	26	0	0	0	0	0	0	0	0	0
J=22	0	0	45	5101	49506	79	9	0	0	0	0	0	0	0	0	0	0
J=21	0	0	6	91319410978289	0	0	0	0	0	0	0	0	0	0	0	0	0
J=20	0	0	21	79	35602772354	89	0	0	0	0	0	0	0	0	0	0	0
J=19175	35148213317502744633148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
J=18	0141	20	0313241256699298	74	0	0	0	0	0	0	0	0	0	0	0	0	0
J=17	0	3	0	0115	13	75289845234	0	0	0	0	0	0	0	0	0	0	0
J=16	0	2	1	78	11	0	76	0517351	0	0	0	0	0	0	0	0	0
J=15	0	0	36	57	0	0	38	85546262	0	0	0	0	0	0	0	0	0
J=14	0	0	90	0	0	0	0	42853409	0	0	0	0	0	0	0	0	0
J=13	0	0	97	0	0	0	0	0149781786698	49	0	0	0	0	0	0	0	0
J=12	49185	59	69	69	76106	97407300	0638361	0	0	0	0	0	0	0	0	0	0
J=11	0	19	99	10	0	0	0	0	33551187117636755	0	0	0	0	0	0	0	0
J=10	0	0	0	88	37	0	0	0	0281243180434190631643	0	0	0	0	0	0	0	0
J= 9	0	0	0	0	51	34	0	0	0	0194808	43	0	0	0	0	0	0
J= 8	0	0	0	0	0	59	23	0	0	0	0486	0	0	0	0	0	0
J= 7	0	0	0	0	0	0	70	12	0	0	0626	0	0	0	0	0	0
J= 6	0	0	0	0	0	0	0	0101	0	0	0641	0	0	0	0	0	0
J= 5	0	0	0	0	0	0	0	0	33	70	0	0669	13	0	0	0	0
J= 4	0	0	0	0	0	0	0	0	0	91	12	0574	57	0	0	0	0

Next page:

J= 3	0	0	0	0	0	0	0	0	0	0141130896103	0	0	0	0	0	0	0
J= 2	0	0	0	0	0	0	0	0	0	0	0473	0200	27	0	0	0	0
J= 1	0	0	0	0	0	0	0	0	0	0	0403	15102162	4	0	0	0	0
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	

NEXT? YES/JUMP/END: END

Program CONT-FIE

The program CONT-FIE gives a list of the **content** of the fields on a file. It is normally run interactive.

Input data to CONT-FIE

KX, KY	Grid dimension, number of points eastward and northward
INFILE,	Name of the file (with apostrophes and .FLD)
OUTFILE	Name of the output file (with apostrophes and .PRN), or 'TERM'

The program writes the heading, max., min. and the sum for each field.

Example and output from CONT-FIE

From the program ROAD-EMI we have calculated traffic work and emissions from a road network to the file TRAFBRU.FLD. We want a condensed content of this file:

PROGRAM\CONT-FIE

16,23	Grid size
TRAFBRU.FLD	File name
BRUTRAF.PRN	Output file

This gives the following print-out:

Print-out for the file: TRAFBRU.FLD

```
Field no. 1, TR.AR.LIGHT Unit: CARKM/HOUR Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 1.5979E+03, IN ( 7,21)
SUM= 3.95922E+04
```

```
Field no. 2, TR.AR.HEAVY Unit: CARKM/HOUR Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 9.7810E+01, IN ( 7,21)
SUM= 3.25745E+03
```

```
Field no. 3, GASOLINE Unit: L/HOUR Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 1.2809E+02, IN ( 7,21)
SUM= 2.70614E+03
```

```
Field no. 4, DIESEL Unit: L/HOUR Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 3.9773E+01, IN ( 7,21)
SUM= 1.19067E+03
```

Field no. 5, ROAD LENGTH Unit: KM VEI Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 6.8818E+00, IN (7,21)
SUM= 1.98256E+02

Field no. 6, CO LIGHT Unit: KG/H Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 2.7732E+01, IN (7,21)
SUM= 5.73392E+02

Field no. 7, CO HEAVY Unit: KG/H Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 6.4376E-01, IN (7,21)
SUM= 1.67966E+01

Field no. 8, NOx LIGHT Unit: KG/H Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 2.7655E+00, IN (7,21)
SUM= 7.74638E+01

Field no. 9, NOx HEAVY Unit: KG/H Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 1.1216E+00, IN (7,21)
SUM= 3.55133E+01

Field no. 10, NO2 LIGHT Unit: KG/H Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 1.0409E-01, IN (7,21)
SUM= 2.86942E+00

Field no. 11, NO2 HEAVY Unit: KG/H Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 1.6824E-01, IN (7,21)
SUM= 5.32699E+00

Field no. 12, Ep LIGHT Unit: KG/H Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 8.3124E-02, IN (7,21)
SUM= 2.02593E+00

Field no. 13, Ep HEAVY Unit: KG/H Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 9.7235E-02, IN (7,21)
SUM= 3.24216E+00

Field no. 14, SO2 LIGHT Unit: KG/H Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 7.6109E-02, IN (7,21)
SUM= 1.62861E+00

Field no. 15, SO2 HEAVY Unit: KG/H Period: 1994 Place: GREENLAND
Source: CAR TRAFFIC Date:1995/04/12 12.47
MAXIMUM VALUE IS 9.3770E-02, IN (7,21)
SUM= 2.94921E+00

Program PROD-FIE

In the program PROD-FIE we can multiply two data-fields. This might be a concentration field multiplied with a population field to obtain a exposure measure, but normally a mask is used to cut out a section from a field, or to adjust the values of a field, as shown in the example to INP-FIE. The mask may be prepared in READ-FIE or INP-FIE. It is normally run interactive.

Input data to PROD-FIE

KX, KY	Grid dimensions, number of points eastward and northward
NFIELD, INFIELD, INMASK	Number of fields, name of the file and the mask file (with apostrophes and .FLD)
OUTFILE	Name of the output files (with apostrophes). The data fields will be written binary to the file OUTFI.FLD, the output is written to the file OUTFI.PRN.

The program asks further: Do you want a print-out of single fields? Y/N.

For each of the NFIELD fields at INFIELD the program asks:

FAK, NUNIT	FAK is a scale factor to adjust the values if necessary, NUNIT (with apostrophes). is a new unit. If you want the same unit as before, you say 'SAME'.
------------	--

Example for PROD-FIE

In the last example for INP-FIE we prepared a mask for the reduction of emissions due to a planned central heating network.

```
C:\KILDER\PROD-FIE
14,16           , grid dimensions
1,'TESTHEAT.FLD','CENTMASK.FLD'
'CENTHRAT'     , emission reduction field
N              , no print-out
1.0,'SAME'     , no extra scaling of the emissions.
```


Program CONV-FIE

In the program package which was prepared for CPCB in India (NILU TR 6/92) it was used a file heading with Compound, Unit, Period and Place. Since then the elements Source and Date has been introduced, and all .FLD files has to be converted to the new structure by CONV-FIE. It is normally run interactive.

Input data to CONV-FIE

KX, KY Grid dimension, number of points eastward and northward
OLDFILE, NEWFILE Name of the old and new file (with apostrophes, but
 without .FLD)
SOURCE Source type (with apostrophes)

New fields are written to NEWFILE.FLD, with print-out at NEWFILE.PRN.
DATE is taken as the current date.

Program CODE-FIE

The program reads a .FLD-file with different code-indices (max. 20) for an area. These indices will be applied to adjust the values in another field with different factors, so that

$$Z(I,J) = Y(I,J) * FACT(IX(I,J)).$$

Input data to CODE-FIE

KX, KY	Grid dimension, number of points eastward and northward
INFILE, NF	Name of the input file with Y-field (with apostrophes and .FLD) NF = number of fields. If NF < 0, we want only one field, number NF, else we want all the NF fields.
INCODE, NFI	Name of the file with the code indices (with apostrophes and .FLD), field no. NFI
OUTFILE	Name of the output files (with apostrophes and .FLD), fields are written to OUTFILE.FLD, with print-out at OUTFILE.PRN

The program asks if we want to have a print-out of the input fields Y/N. It checks the code file for the highest and lowest index, IMAX and IMIN. If IMIN=0, something is wrong with the field. If IMAX >20, something is also wrong.

The program asks for

(FACT(I),I=1,IMAX) Factors. In all the squares of INCODE where the index is 1, the values of INFILE shall be multiplied by FACT(1), and so on.

Example for input to CODE-FIE

In the example to INP-FIE we prepared a field with 1's as a background and two areas with 2's and 3's, CENTMASK.FLD. The emission in area 1 (code=2) shall be reduced by 16 %, and in area 2 (code=3) by 27 %. This gives:

```
C:\KILDER\CODE-FIE
****          license code
14,16         grid dimensions
'TESTHEAT.FLD',1  input file
'CENTMASK.FLD',1 code file
'CENTHEAT'      output file
N              no printing of input fields
1.0,0.84,0.73  factors
```


The result will be as:

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 NILU
 VERSION 2.0, 1-10-1996
 - - - - 0 0 0 - - - -

MAP OF : ENERGY UNIT: GWH SOURCE: HEATING
 PERIOD : WINTER-AVERAGE PLACE: OSLO GRID SIZE: 1000 METER
 CREATED: 1996/09/10 09.46
 MAXIMUM VALUE IS 1.5722E+02, IN (5,10)
 SUM= 5.91063E+03 SCALE FACTOR: 1.0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
J=16	3.	3.	.	.	.	.	.	.	.	.	.	.	.	.
J=15	4.	3.	.	.	10.	.	4.	18.	14.	.	.	.	20.	33.
J=14	6.	11.	11.	9.	14.	31.	19.	17.	17.	.	.	13.	37.	41.
J=13	20.	33.	19.	9.	30.	31.	29.	37.	25.	20.	16.	32.	23.	27.
J=12	30.	32.	18.	21.	22.	42.	67.	104.	39.	32.	28.	24.	12.	45.
J=11	22.	14.	14.	28.	51.	60.	92.	55.	20.	28.	8.	1.	43.	23.
J=10	28.	39.	14.	74.	157.	98.	97.	49.	16.	14.	7.	28.	28.	14.
J= 9	19.	6.	20.	83.	48.	48.	64.	80.	22.	24.	25.	20.	25.	.
J= 8	.	1.	10.	2.	7.	1.	15.	54.	15.	19.	33.	25.	5.	.
J= 7	4.	6.	10.	.	.	.	1.	20.	23.	28.	36.	33.	.	.
J= 6	.	.	.	.	.	.	4.	11.	18.	24.	13.	33.	.	.
J= 5	.	.	.	.	.	.	2.	15.	22.	39.	18.	25.	9.	.
J= 4	.	.	.	.	.	.	2.	6.	30.	45.	42.	25.	.	.
J= 3	.	.	.	.	.	.	2.	.	41.	30.	29.	10.	.	.
J= 2	.	.	.	.	.	.	.	2.	34.	1.	4.	3.	.	.
J= 1	.	.	.	.	.	.	.	9.	18.	3.	4.	1.	.	.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14

PROGRAM RATI-FIE

The program reads two .FLD-files and calculates the ratio between the values in each square.

Input data to RATI-FIE

KX, KY	Grid dimension, number of points eastward and northward
NUMER, DENOM, OUTFILE	Field no. KNUM at file NUMER.FLD is divided by
KNUM, KDEN	field no. KDEN at file DENOM.FLD, and stored at file OUTFILE
LOMPOUND, LUNIT	Designation of the ratio (ex. SO ₂ /NO _x ') and unit (ex. Ratio'), with apostrophes
PERIOD, PLACE	Period and place, with apostrophes
TEST	If the denominator = 0.0, the ratio Value is TEST

Then the program asks if we want maps of the initial fields (Y/N).

Example for input to RATI-FIE

In calculations of NO_x-emissions in Bergen two different methods have been used, and we want to check the results.

```
C:\KILDER\RATI-FIE
****          license code
11,23         grid dimensions
'LINJER.FLD','TRA-NOXK.FLD','RATIO' LINJER/TRA-NOXK =
RATIO
1,1          field no. at the files
'AIRQ/KILDER','RATIO'  designation, unit
'1992','BERGEN'      period, place
-1.0          RATIO=-1 if TRA-NOXK=0
N             no printing of input fields
```

The result will be as:

Field no. 1 at file LINJER is divided by field no. 1 at file
TRA-NOXK

If denominator is 0, the value is -1.00

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- - - - O O O - - - -

MAP OF : AIRQ/KILDER UNIT: RATIO SOURCE: TRAFIKK
PERIOD : 1992 PLACE: BERGEN GRID SIZE: 1000 METER
CREATED: 1997/02/03 14.01

MAXIMUM VALUE IS 1.0527E+00, IN (7, 4)
MINIMUM VALUE IS -1.0000E+00, IN (2, 1)
SUM= 6.55326E-01 SCALE FACTOR: 0.01

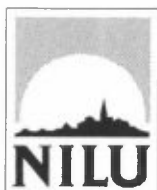
	1	2	3	4	5	6	7	8	9	10	11
J=23	.	.	.	.	79.	68.	69.	72.	101.	87.	.
J=22	.	.	.	.	.	68.	77.	90.	100.	78.	65.
J=21	.	.	.	.	.	86.	75.	95.	103.	78.	70.
J=20	.	.	.	.	.	.	.	94.	.	.	.
J=19	.	.	.	.	.	95.	87.	90.	.	.	.
J=18	.	.	.	.	.	93.	100.	82.	.	.	.
J=17	.	.	.	.	.	.	83.	.	.	.	.
J=16	.	.	.	.	.	.	81.	93.	.	.	.
J=15	.	.	.	.	.	.	.	86.	.	.	.
J=14	.	102.	.	.	.	.	83.	86.	81.	.	.
J=13	.	101.	89.	.	86.	90.	92.	80.	78.	48.	.
J=12	101.	93.	89.	85.	88.	.	77.	93.	90.	89.	.
J=11	83.	96.	79.	85.	.	95.	90.	84.	90.	72.	75.
J=10	99.	94.	81.	78.	.	77.	68.	.	90.	75.	.
J= 9	76.	105.	80.	.	83.	101.	73.	101.	99.	77.	.
J= 8	76.	90.	73.	99.	84.	71.	79.	102.	79.	54.	.
J= 7	.	.	.	99.	91.	60.	102.	102.	80.	.	81.
J= 6	.	.	.	.	91.	95.	102.	102.	101.	72.	84.
J= 5	.	.	.	96.	94.	90.	.	102.	94.	85.	97.
J= 4	.	.	.	75.	93.	90.	105.	90.	76.	78.	95.
J= 3	.	102.	102.	90.	92.	91.	93.	93.	.	69.	83.
J= 2	.	.	100.	92.	92.	82.	83.	89.	.	.	70.
J= 1	.	.	89.	.	.	91.	.	89.	.	.	73.
	1	2	3	4	5	6	7	8	9	10	11

In the output, the -1.0-code was written as -100. due to the scaling of the output. These were removed by substituting -100. by blank-blank-blank-period.

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AUTHOR(S) Frederick Gram		CLASSIFICATION * A	
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<p>ABSTRACT</p> <p>The KILDER Air Pollution Modelling System is a system of small PC-programs for calculation of long-term emission, dispersion, concentration and exposure from different source categories.</p> <p>The KILDER system may be divided into three parts:</p> <ul style="list-style-type: none"> • The dispersion models POI-KILD and ARE-KILD for point- and area-sources, respectively • Meteorological programs WINDFREC, STABFREC and METFREC • Supporting programs for calculating emissions and exposure and for operating with binary data fields. 			
NORWEGIAN TITLE. Modellsystemet "KILDER", versjon 2.0.			
KEYWORDS Modeller	Utslipp	Spredning	
<p>ABSTRACT (in Norwegian)</p> <p>Programsystemet "KILDER" består av en rekke små PC-programmer til beregning av langtidsverdier for utslipp, spredning, konsentrasjoner og eksponering for en rekke kildegrupper.</p> <p>KILDER-systemet kan deles i tre deler:</p> <ul style="list-style-type: none"> • Spredningsmodellene POI-KILD og ARE-KILD for henholdsvis punkt- og areal-kilder, • Meteorologiprogrammene WINDFREC, STABFREC and METFREC for å analysere meteorologiske data • Hjelpesprogrammer til å beregne utslipp og eksponering og for å behandle binære resultat-felter. 			

* Classification

A	Unclassified (can be ordered from NILU)
B	Restricted distribution
C	Classified (not to be distributed)