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The Kincaid case

Comparing results of the OPS model with measurements around a high source

10.2.e

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1. Site description

Aim of this study is the validation of the OPS model with observational data collected during a measuring campaign in 1980-1981, also known as the Kincaid case. The study site is a coal-fired electric generating plant with a capacity of 1100 MW, located near Kincaid, IL. The main source of emissions is a stack (h_s) of 187 meter height. During the years 1980 and 1981, a measurement campaign was held to gather information on the dispersion of air pollution. SO_2 emission and concentration were measured during 252 days in April-August 1980 and March-June 1981. Additionally SF_6 was released and measured periodically on 50 days in total. Concentrations SO_2 are measured within a circle of 20 km around the stack. The geometric coordinates of the stack are 39°35'26"N, 89°29'48"W. The plant is located in a rural area, a flat landscape with little vegetation, in Illinois. The roughness length (z_0) of the surroundings is approximately 0.10 meter. A meteorological observation point, situated at 645 meter east of the stack, was in use for the purposes of the study.

Figure 1. Impression of the Kincaid site.

Figure 2. Location of the site in US (red marker)

2. Sources of input data

Two versions of the OPS model are used, the short term version OPS-ST and the long-term version OPS-LT. Data to be used in this exercise are available at four sources of information on the Kincaid case, such as model input data and measuring results for comparison with the model output. Two external sources are the NERI Model Validation Kit (MVK) and the site of the scientist and expert John Irwin. These two sources of information concern the same measurement campaign, but show differences in selection, formats and post processing. Two internal sources of information are the data of RIVM researchers 10.2.e and 10.2.e (Annex 1). The RIVM data are derived from the two external sources, but preprocessed for use as OPS input data. Annex 1 provides a summary of available data in these four sources.

3. Selection of data

3.1 Emissions SF_6 and SO_2

SF_6 emissions are reported in the NERI-MVK file *Emissions.dat*. During the campaign (between 80-04-20 – 80-07-26 and 81-05-09 – 81-06-01), SF_6 emissions and measurements took place on 51 days and in total during 478 hours. This MVK-file does report data for 29 days (235 hours). For each hour on the mentioned days, the stack temperature, the exit velocity and the SF_6-emission when applicable are given. The average SF_6-emission is 14.27 g/s, the average stack temperature 420.9 K and the exit velocity 20.82 m/s. The NERI-MVK does not report SO_2-emissions.

The Irwin data-set gives stack information on meteorology and emissions by the file *KincaidNearSurfaceMetData11022011.txt*. Described are all hours between 80-04-03 – 80-08-31 and 81-03-09 – 81-06-15. Besides meteorological parameters, for each hour SF_6 (if released) and SO_2 emission rates, stack temperature and exit velocity are reported in the file, as well as the conversion factors µg/m³ to ppb. The file describes SF_6 emission during 478 hours (at 51 days) with an average of 15.18 g/s, and SO_2 emission during 5063 hours (at 219 days) days with an average of 4937 g/s. On average (during all SO_2 hours), the stack temperature is 416.6 K, the exit velocity 19.78 m/s, the SF_6 conversion $6.00 \cdot 10^{-3}$ µg/m³/ppb and the SO_2 conversion 2.63 µg/m³/ppt. The average T_{10m} = 291.0 K and WS_{10m} = 3.97 m/s.

The Irwin data set encloses also a file with 5min values, *KincaidList5minData.txt*, with values for SO_2 emissions, but they are not consistent with the preceding file. Calculated on base of 5-min values, the average SO_2 rate should be 2050 g/s. Compared with the emission rate of 4937 g/s above, based on 1-hour vales in *KincaidNearSurfaceMetData11022011.txt*, a difference of a factor 2.4 occurs. The suspicion arises that the concentration in the flue gas is reported instead of the emission. It appears that hourly emissions derived from 5-minute values do not correlate well with the hourly emissions in the file with hourly values; while using the 5-minute values multiplied with the exit velocity results in a correlation with $R^2 = 1$. Still, there is an inconsistency between the two files. If the 5-minute values would be the concentrations in the flue gas, the emission should be the concentration multiplied by the exit velocity and the surface area of the stack opening ($e = c \cdot v \cdot O$). The stack diameter is 9 m with an area of 64 m². That assumption leads to emissions that are too high by a factor 550 in comparison to the reported hourly emissions. The ppb-conversion factor (on average 2.6) does not solve the problem. The short documentation does not bring clarity. Both files are compiled by Irwin. In the end, we choose to use the file with hourly emissions.

Conclusion: Information on emissions in both references, NERI-VMK and Irwin, are consistent with each other, but the described period is longer in the Irwin data set (because of SO_2). For SF_6 emissions, there is no preference for a data-set (same period, same values, but a different format). The SO_2 emissions are only available in the Irwin data set.

The emissions in the Irwin data-set are supposed to be the most complete, with average emission rates 15.18 g/s SF_6, respectively 4937 g/s SO_2 (1-hour values).

3.2 SF_6 measurements and receptor points

Data-files *SF6_ALL.DAT* (MVK) and *Kincaid-KB-50(SF6-Developmental).txt* (Irwin) are different names for the same files with exactly the same content, hourly concentrations for points on arcs. File *KB50andKB51_SF6Data_Format.txt* gives the description of the format.

The series 50 and 51 of measuring results are combined by Irwin. The sample height is not defined in the documentation. During the campaign, measuring points are chosen on different locations every day, probably depending on wind direction. No locations are available with repeating measurements during the campaign. For this, it is difficult to derive period average concentrations. It is not clear how to compare OPS results (averages) with the SF_6-results.

3.3 SO_2 measurements and receptor points

SO_2 concentrations are measured at 30 sample points for distances up to 20 km. Coordinates are given by Irwin in the file *KincadHOURLYSO211022011.txt,* but the hourly concentrations per locations are more manageable in file *KincaidCombinedSO2-52and_53.txt*. Table 1 shows the calculated average concentrations per location during the measuring period. Measurements (> 0) are available for in total 6044 hours on 252 days. The measurements are continuous with an average cover ratio of 80% of the hours, so it is possible to calculate average concentrations per sample point.

The average conversion factor is 2.63 µg/m³/ppt.

Table 1. Co-ordinates per locations and period average SO_2 concentrations

	UTM East (km)	North (km)	Heigth (m)	SO_2 Em. (g/s)	Total hours
Stack	285.597	4385.088	187	4937	6048
location	x (km)	y (km)	Distance s (km)	Av.conc. (µg/m³)	%
A	283.70	4392.39	7.54	5.0	75
B	278.89	4396.51	13.25	3.2	79
C	282.57	4402.05	17.23	3.8	80
D	284.48	4391.05	6.07	2.6	81
E	286.57	4393.03	8.00	1.7	77
F	285.69	4400.34	15.25	3.1	76
G	283.24	4399.72	14.82	3.8	70
H	289.40	4404.32	19.60	2.4	78
I	288.90	4390.95	6.73	2.9	82
J	289.93	4392.27	8.39	2.6	82
K	294.39	4399.23	16.65	1.7	79
L	290.00	4396.65	12.37	3.5	74
M	289.39	4399.29	14.70	3.7	83
N	290.84	4401.35	17.09	2.5	80
O	291.10	4389.42	7.00	1.6	72

P	291.97	4391.42	8.98	2.3	83
Q	297.78	4394.32	15.29	2.9	82
R	294.67	4395.32	13.68	3.3	78
S	289.80	4388.55	5.45	5.6	65
T	285.82	4386.95	1.88	5.0	63
1	282.18	4396.05	11.48	4.9	82
2	286.15	4395.68	10.61	4.3	96
3	292.98	4391.85	10.01	3.1	87
4	285.70	4388.25	3.16	17.9	91
5	277.40	4385.40	8.20	2.5	75
6	285.18	4382.90	2.23	2.7	96
7	287.85	4382.95	3.11	1.8	84
8	294.73	4382.25	9.56	9.4	87
9	287.75	4376.02	9.32	2.0	74
10	280.60	4377.88	8.77	5.1	96

3.4 Meteorology

In the NERI-MVK files, meteorological data are given for two periods: a short period with only values for 171 hours with SF_6-measurements (80-04-14 – 80-07-25, 81-05-16 – 81-06-01, in files *MET_K<n>.DAT* with *n* = 1, 2, 3), as well as for an extended period with 24 hours per day (80-04-14 – 80-08-03, 81-05-04 – 81-06-01, in files *MET_K<n>-L.DAT* with *<n>* = 1, 2, 3). The meteorological data in the Irwin data set does describe a few weeks longer period (80-04-03 – 80-08-31, 81-03-09 – 80-06-17) in file *KincaidNearSurfaceMetData11022011.txt*. The reported indicators differ in both files but the overlap of content is consistent.

The Irwin data set encloses two kinds of data-files: with 5-minutes and 1-hour values. The 1-hour values are derived from the 5-minutes values. Because in the OPS model 1-hour data are needed, the 1-hour values will be used if available.

Both sources record the meteorological parameters necessary for OPS, but the Irwin file encloses the longest period. Global radiation (RAD-SOLAR/ RAD-TOTAL/ RAD-NET, welke?), temperature (TT10M, as approximation for h_o = 1.5 m), wind direction (WD10M) and wind velocity (WS10M) can be obtained directly from the file *KincaidNearSurfaceMetData11022011.txt*. The relative humidity RH and precipitation are given in the Irwin data set in the file with 5-minutes values *KincaidList5minData.txt*. The values for 1 hour can be derived from the 12 periods of 5-minutes, the average for RH, the total for precipitation and the number of periods with precipitation for the duration. During the months in 1980, one observation per hour is admitted for precipitation, and in 1981 one value per 5-minutes. This has no consequence for determining the OPS-parameter 'precipitation intensity' (in mm/h), but the 'length of rain events' (in 0.01 h) is incalculable in 1980. Approximately a relation between the duration (in h) and precipitation (in cm) can be derived for the observations in 1981, resulting in: duration = 0.2 · precipitation with a maximum of 1 h (see Figure 3). This relation gives an estimation of the length of rain events in the 1980 period.

The wind velocity in upper layers is given in the file KincaidTowerMetData09222011.txt, at height of 100 meter. No data on snow cover is available in both data sets.

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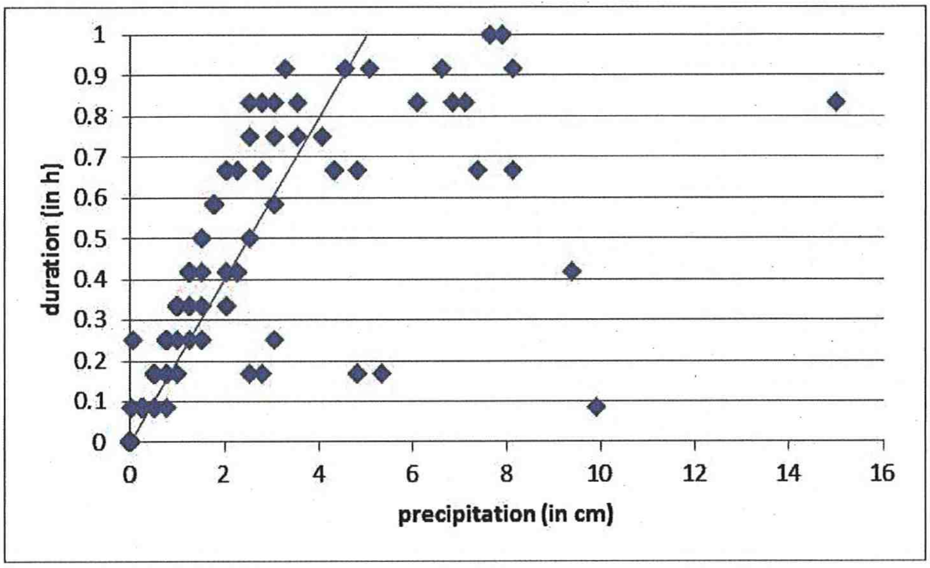


*Figure 3. Plot of duration and amount of precipitation during showers observed in 1981, used to derive a relationschip (*duration = 0.2 · precipitation*) for estimating the duration of showers in 1980.*

Table 2. Needed parameters for OPS (ops_manual_2_meteo.pdf) and availability in dataset NERI-MVK and Irwin

	Parameter	Scale(3)	Observation height	Units	For-mat	No data value	required	NERI-MVK SF_6	Irwin data-set SF_6/SO_2
once a day:									
a	date (local time)(2)			yymmdd	3i2.2		y		
b	snow cover indicator	NL		0=no 1=yes	i2	8	n	×	×
c	length of rain events	NL		0.01 h	i4	-88	n	×	✓ (local)
d	precipitation intensity	NL		0.1 mm/h	i4	-88	n	×	✓ (local)
e	precipitation intensity	local		0.1 mm/h	i4	-88	n	×	✓
every hour:									
f	global radiation	NL	1.5 m	$J/cm^2/h$	i4	-88	y	✓ (local)	✓ (local)
g	temperature	NL	1.5 m	0.1 0C	i5	-880	y	✓ (local)	✓ (local)
h	precipitation duration	NL	1.5 m	0.01 h	i4	-88	y	×	×
i	precipitation duration	local	1.5 m	0.01 h	i4	-88	y	×	✓
j	wind direction	NL	200 m(1)	degrees	i4	-88	n	×	✓ (100 m)
k	wind velocity(4)	NL	200 m(1)	0.1 m/s	i4	-88	n	×	✓ (100 m)
l	wind direction	NL	10 m	degrees	i4	-88	y(5)	✓ (local)	✓ (local)
m	wind velocity(4)	NL	10 m	0.1 m/s	i4	-88	y(5)	✓ (local)	✓ (local)
n	wind direction	local	10 m	degrees	i4	-88	n(5)	✓	✓
o	wind velocity(4)	local	10 m	0.1 m/s	i4	-88	n(5)	✓	✓
p	relative humidity	NL	1.5 m	%	i4	-88	n	×	✓ (local)

(1) 200 m or at a level to be specified

(2) Solar noon is expected to be at 13:00 h
(3) local: average of an OPS meteo district; NL: average of the Netherlands
(4) wind velocity converted to a standard roughness length of 0.03 m
(5) either local (district) or NL data must be available

4. Modelling results

Two kinds of air pollution are measured and modelled, SF_6 and SO_2, and two versions of the OPS model are used, short term OPS-ST (versions 3.0.2 and 10.3.2) and long term OPS-LT (OPS-Pro 2013). The results are discussed in next paragraphs.

4.1 SF_6 results

Receptor points for SF_6 were located on concentric circles around the emission source. The measuring points are scattered on a circle, while each day the wind direction was decisive for the locations on the circles. For each hour, the measuring results are represented by the maximum concentration and the direction thereby. The modelled receptor points on every circle are chosen on 72 fixed directions on the wind rose (every 5°). The hourly maximum concentration and direction are determined for each circle and compared with the measured concentrations. Results of the short term version OPS-ST (10.3.2) only are discussed here, because measured concentrations are not available as period average concentrations, but only for a selection of hours.

The direction of the observed and modelled maxima do correspond quite well with a correlation of $R^2 = 0.77$, see Figure 4. For each hour, maxima of model results and observations are compared per circle and for the total field. Maxima per circle in three ways: the interpolated value at the direction of the observed maximum, the value at the nearest receptor point and the maximum value at the circle. For the total field: the maximum modelled value of all circles and the maximum observation. Taking distance and direction in account, the correlation between modelled and measured concentration per hour is poor, see Table 3. Only comparison of the field maximum per hour, regardless of the distance and direction, results in an acceptable model performance according to the indicators suggested by Chang and Hanna (2005). Figure 5 shows the plot of field maxima per hour. The observed distance to the maximum is located between 3 and 50 km (on average 15 km), the modelled distance to the maximum is between 3 and 15 km (on average 5 km). However, the averages of all daily maxima concentrations match better: measured is 0.66 µg/m³ and modelled is 0.78 µg/m³, an overestimation of 18%.

Table 3. Performance indicators, modelling SF_6 with OPS-ST (version 10.3.2)

Run	Performance indicators Hanna (2004)					Regression model			
	FB	MG	NMSE	VG	FAC2	Slope	Inter-cept	R^2	RMSE
Short Term (OPS-ST)									
Interpolation at sample point	1.04	3.22	4.85	n.a.	0.29	0.10	0.37	0.05	0.48
Nearest receptor point	0.91	2.38	4.07	n.a.	0.33	0.08	0.38	0.05	0.48
Maximum per circle	-0.03	0.95	1.23	7.98	0.43	0.10	0.34	0.08	0.43
Field maximum	0.16	1.06	0.72	2.52	0.57	0.58	0.01	-0.07	0.61

Green background: acceptable model performance. The ranges indicating acceptable model performance, suggested by Chang and Hanna (2005), are
fractional bias (FB): |FB| < 0.3, geometric mean bias (MG): 0.7 < MG < 1.3, normalized mean square error

(NMSE): NMSE < 1.5, geometric variance (VG): VG < 4 and prediction within a factor two (FAC2): FAC2 > 50%.

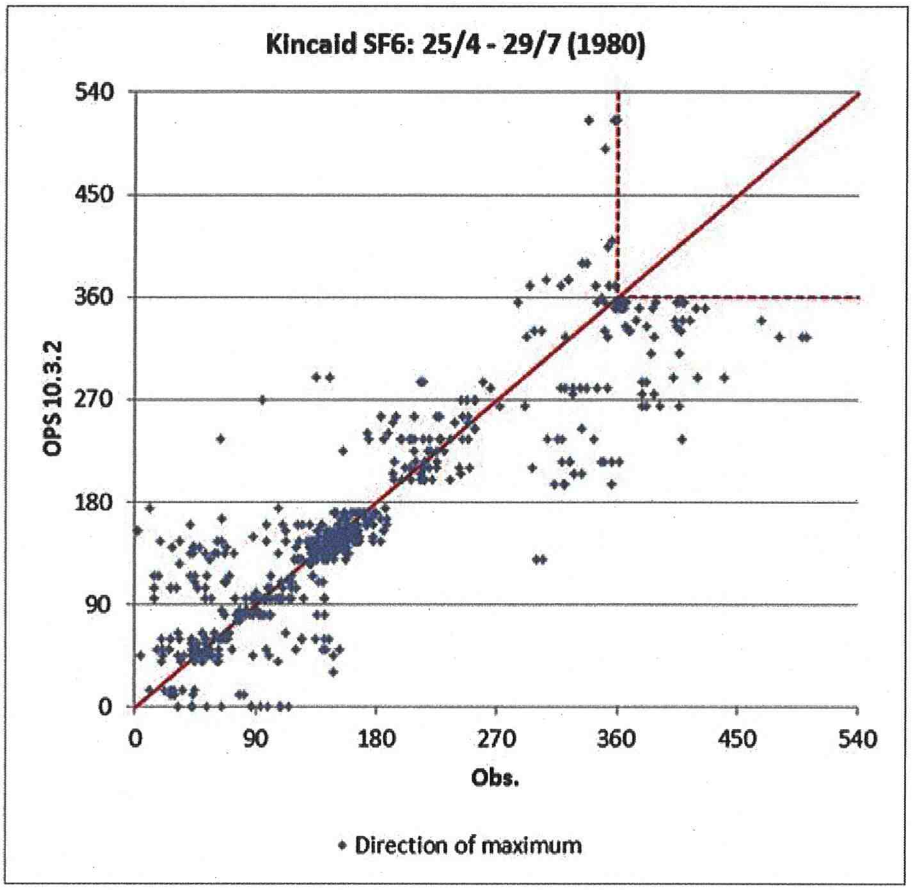


Figure 4. Plot of direction of maximum concentration as observed and modelled. For an hour with a difference of more than 180°, a shift of 360° is introduced in order to improve the representation in the figure.

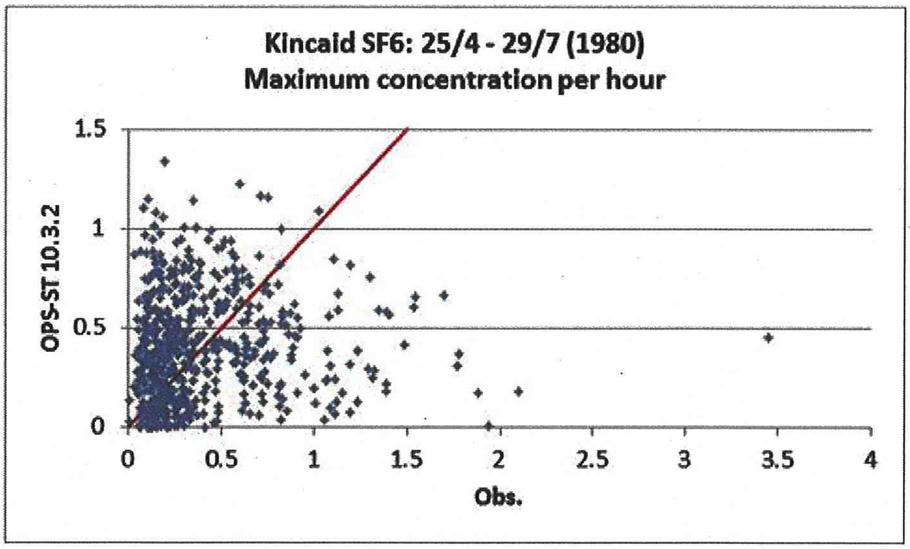


Figure 5. Plot of field maximum concentration as observed and modelled.

4.2 Comparison of SO_2 concentrations modelled with OPS-ST (3.0.2 and 10.3.2) and OPS-LT (OPS-Pro 2013) with measurement results

Measurement results are available for the following periods in 1980 and 1981:

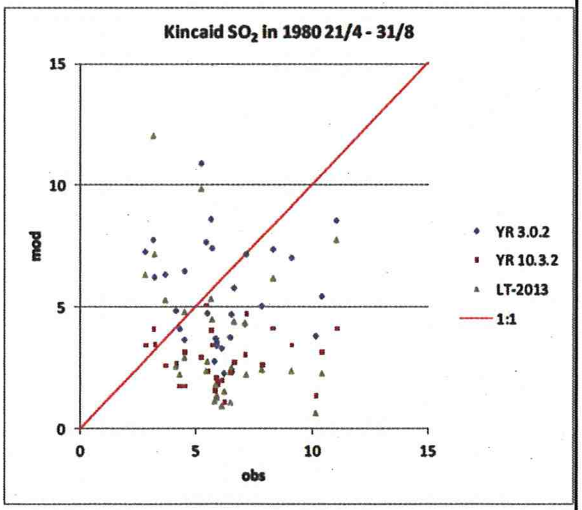
1) 1980, the measurement period 80-04-21 to 80-08-31;
2) 1980, the period 26 April to 22 May, selected for validation by [redacted];
3) 1980, the period 23 May to 22 June, selected for validation by [redacted];
4) 1981, the measurement period 81-03-09 to 81-06-15.

The hourly measurements are determined according to the method described by [redacted] in mail dated September 29, 1994 (Annex 3).

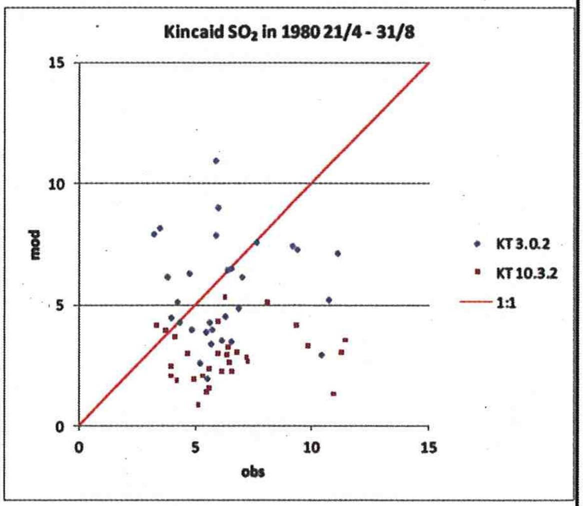
Period average concentrations SO_2 are compared in all cases. OPS-LT (version OPS-Pro 2013) supplies the period averages for 1980 and 1981. OPS-ST (two versions 3.0.2 and 10.3.2), has the option to calculate hourly values or period average concentrations. In case of the option hourly concentrations, period average concentrations are calculated for hours with both measuring and modelling results. Figure 6 shows plots of measured and modelled concentrations of SO_2 for each of the four periods, left with modelled period averages and right averages of modelled hourly values.

Figure 6 presents plots with results for the four periods with period averages (left) and hourly values (right). Table 4 summarizes the model performance for the various combinations, using the indicators suggested by Chang and Hanna (2005). The table shows differences between model versions and between periods. Period 1 seems to be a difficult period to model, nearly no performance indicator is within an acceptable range. An acceptable performance for version 3.0.2 is proved for 1980 and period 2, and for all versions for 1981.

Figure 7 shows the results on the cross section North-South, during period 1 and period 2, used by Van Jaarsveld for validation.



OPS option: period averages modelled



OPS option: hourly values modelled

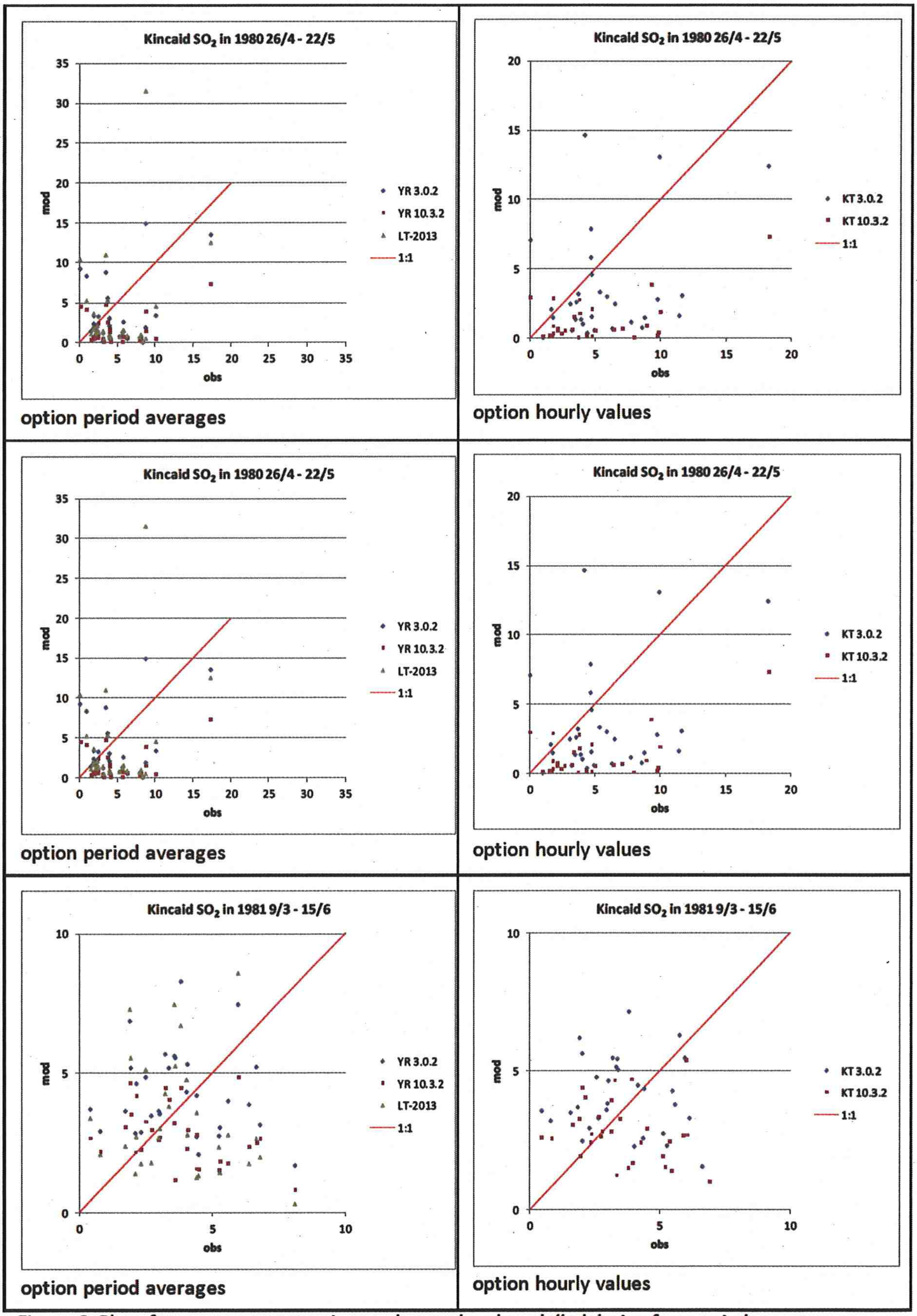


Figure 6. Plot of average concentration as observed and modelled during four periods.

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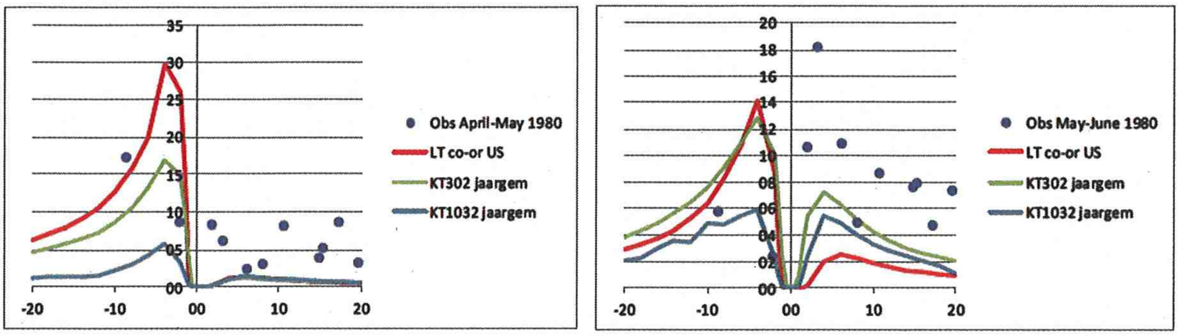
Table 4. Performance indicators for 4 periods in 1980 and 1981 and 3 versions of OPS modelling SO_2

Run	Performance indicators Hanna (2004)					Regression model			
	FB	MG	NMSE	VG	FAC2	Slope	Inter-cept	ρ	RMSE
1980									
Period average ST 3.0.2	0.10	1.12	0.26	1.34	0.80	-0.02	6.27	-0.02	2.98
Period average ST 10.3.2	0.73	2.17	0.90	2.36	0.37	0.09	5.92	0.04	3.99
Period average LT 2013	0.49	2.00	0.90	3.70	0.43	-0.22	6.98	-0.28	4.55
Average of hours ST 3.0.2	0.12	1.15	0.25	1.32	0.80	0.05	5.99	0.05	2.95
Average of hours ST 10.3.2	0.75	2.25	0.95	2.46	0.37	0.27	5.60	0.13	4.20
Period 1									
Period average ST 3.0.2	0.37	2.24	1.40	142	0.47	0.27	3.81	0.29	4.61
Period average ST 10.3.2	1.07	4.69	3.33	354	0.10	0.62	3.80	0.31	4.72
Period average LT 2013	0.27	2.05	2.30	44.8	0.33	0.17	4.08	0.29	6.19
Average of hours ST 3.0.2	0.49	2.33	1.25	n.a.	n.a.	0.31	4.65	0.31	4.96
Average of hours ST 10.3.2	1.21	6.87	4.22	n.a.	n.a.	1.32	3.24	0.52	4.92
Period 2									
Period average ST 3.0.2	0.19	1.15	0.36	1.40	0.77	0.40	4.74	0.27	3.86
Period average ST 10.3.2	0.63	1.81	0.80	1.85	0.63	1.17	2.77	0.48	4.59
Period average LT 2013	0.46	1.88	1.13	5.39	0.53	-0.33	8.59	-0.30	5.98
Average of hours ST 3.0.2	0.20	1.20	0.48	1.65	0.80	0.18	5.06	0.13	3.71
Average of hours ST 10.3.2	0.65	1.91	0.85	2.01	0.67	1.02	3.60	0.48	4.94
1981									
Period average ST 3.0.2	-0.12	0.81	0.40	1.79	0.67	-0.12	4.31	-0.10	2.55
Period average ST 10.3.2	0.31	1.27	0.64	2.14	0.57	-0.58	5.40	-0.33	2.60
Period average LT 2013	0.11	1.17	0.71	2.90	0.50	-0.16	4.35	-0.18	3.01
Average of hours ST 3.0.2	-0.14	0.80	0.35	1.74	0.77	-0.09	3.93	-0.07	2.25
Average of hours ST 10.3.2	0.23	1.18	0.50	1.90	0.57	-0.31	4.41	-0.20	2.24

Green background: acceptable model performance. The ranges indicating acceptable model performance, suggested by Chang and Hanna (2005), are
fractional bias (FB): |FB| < 0.3, geometric mean bias (MG): 0.7 < MG < 1.3, normalized mean square error (NMSE): NMSE < 1.5, geometric variance (VG): VG < 4 and prediction within a factor two (FAC2): FAC2 > 50%.

In the next figures, we present results for a north-south cross-section.



(a) Period 1 (b) Period 2

Figure 7. Cross section North-South of average SO_2 concentrations in April-May 1980 (a) and May-June 1980 (b).

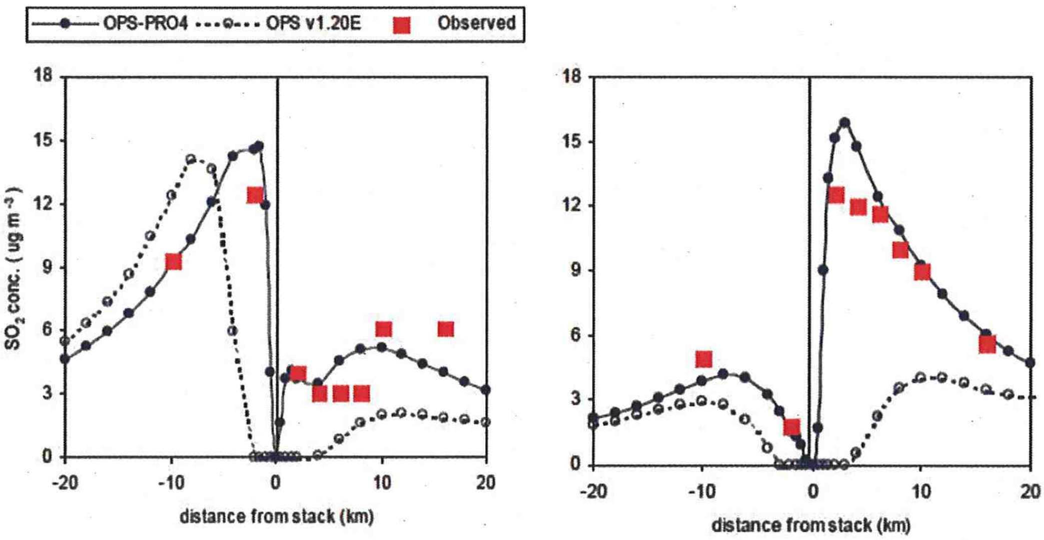


Figure 8. Cross section North-South of average SO_2 concentrations in April-May 1980 (a) and May-June 1980 (b). Original figure from van Jaarsveld, 2004.

4.3 Findings

- In general, the correlation between OPS results, modelled for this "high source", and observations is low in all test periods. However, the model performance, displayed on the indicators suggested by Chang and Hanna (2005), is reasonable. The performance drops when results detailed in time and space are desired, or when a short period (< 4 weeks) is modelled.
- There are fairly large differences between different versions of OPS for the Kincaid case.
- The modelled direction of the point at the ground with the highest concentration agrees well with the observed direction. The distance to this point is underestimated. The value of SF6-concentration at the highest point is overestimated with 15% to 20% on average, and the scatter is large. A comparison between the different versions, comes up to the advantage of OPS-ST version 3.0.2.
- The short term versions of OPS have an option to calculate an period average concentrations or all hourly values in that period. The average of all hours (skipping hours with missing observations) agrees well with the calculated period average.

10.2.e performed a validation test on OPS with Kincaid data (van Jaarsveld, 2004). Comparison between his results and results of the current versions lead to the following conclusions:

- The **observed** concentrations in the two periods reported by Van Jaarsveld (2004) are not exactly reproducible (despite the description in Annex 3), but our interpretation of observations are fairly close to his. The difference is in the deduction of the background concentration.
- The **modelled** concentrations (version OPS-Pro4 and v1.20E) for the two periods as reported are not reproducible with the versions currently used. During the first period, the observations on the south side are lower than on the north side. During the second period, this is just the other way. The model results of Van Jaarsveld show a similar effect. In the calculations with current versions of OPS, concentrations are the highest on the south side in both periods.
- Version 10.3.2 has an option called EPRI case, however, this option leads to slightly higher values but does not improve the profile.

References

Chang JC, Hanna SR (2005) Technical descriptions and user's guide for the BOOT statistical model evaluation software package, Version 2.0.

Jaarsveld J.A. van (2004) Description and validation of OPS-Pro 4.1, RIVM report 500045001/2004.

Annex 1.

Stack height h_s = 187 meter
Stack geometric coordinates (39.5906°N, 89.4967°E) = UTM (285.66 E, 4385.10 N);
Meteo at 645 meter east of stack (183 meter a.m.s.l.)
Roughness length approximately z_0 = 0.10 meter

A. NERI - Model Validation Kit (MVK)

Reference:	http://www.jsirwin.com/KincaidHourlyDiscussion.html
Compound:	**SF_6**
Measuring period:	80-04-20 – 80-07-25 & 81-05-16 – 81-06-01
Total measuring hours:	171 hours on 24 days
Emission:	data file with 1h values over 235 hours on 29 days, average SF_6-emission is 14.27 g/s, average stack temperature 420.9 K, average exit velocity 20.8 m/s
Meteorology:	period: 80-04-14 – 80-08-03 & 81-05-04 – 81-06-01, hourly OPS-parameters: wv(10m), ws(10m), solar rad., T daily OPS-parameters: –
Number of files:	12 data files, 4 info files
Documentation:	Users 'Guide to the NERI-MVK

B. Site John Irwin

Reference:	http://www.harmo.org/kit/download.asp
Compound:	**SF_6**
Measuring period:	80-04-20 – 80-07-29 & 81-05-09 – 81-06-01
Total measuring hours:	372 hours on 50 days
Emission:	data file with 1h values over 478 hours on 51 days, average SF_6-emission is 15.18 g/s
Compound:	**SO_2 (1h and/or 5 min)**
Measuring period:	80-04-03 – 80-08-31 & 81-03-09 – 81-06-17
Total measuring hours:	6044 hours on 252 days
Emission:	a) data file with 1h values (*KincaidNearSurfaceMetData11022011.txt)* over 5063 hours on 219 days, as well as stack temp and exit velocity, average emission is 4936.7 g/s (1980: 5290.8 g/s, 1981: 4278.0 g/s), average stack temperature 416.6 K, average exit velocity 19.8 m/s [average conversion factor SO_2 = 2.629]; b) data file with 5-min values (*KincaidList5minData.txt)* with 60456 periods of 5-min and average emission 2050 g/s (sic!), with use of conversion factor ug/m^3/PPB (av. 2.652) resulting in an

average emission 5406.3 g/s (1980: 5351.7 g/s, 1981: 5504.1 g/s)
[average stack temperature 411.9 K (420.9 - 401.2)]

Meteorology: period: 80-04-03 – 80-08-31 & 81-03-09 – 81-06-17,
hourly parameters: prec.duration, solar.rad. [beginning 80-04-21], T, wv(10m), ws(10m), wv(100m), ws(100m)
daily parameters: length of rain events, prec. intensity

Number of files: SF_6: 5 data files, 2 info files
SO_2: 5 data files, 4 info files

Documentation: 7 pdf + site

C. OPS input-files [redacted]

Reference: LT: S:\OPS\[redacted]\test\Kincaid\[redacted]
ST: D:\usr\[redacted]\KTMOD\kincaid[so2]

Compound: **SO_2**

Emission: 1980: q = .610E+04 g/s, hc = 142.2 MW, d=0, s=0, tb=4
1981: q = .352E+04 g/s, hc = 93.1 MW, d=0, s=0, tb=4 with:

tb	2	4	6	8	10	12	14	16	18	20	22	24
04	90	83	82	91	100	110	110	108	107	106	107	106

Meteorology: LT: a0ep02 (1980), a0ep03 (1981), details unknown
ST: mbas2nw (800428-800525), mbas3nw (800526-800622)

Stack co-ordinates: RD-xy = (285665, 4385169) [circa UTM]

Documentation: _README.txt

D. OPS input-files [redacted]

Reference: S:\OPS\[redacted]\test\Kincaid

Compound: **SO_2**

Emission: ..\Bronbestand: q = 2.050E+03 g/s, hc = 117.6 MW

Meteorology: by use of *KincaidList5minData.txt*, in combination with zenith angle for assessment of the global radiation:
MPARKNMI_80.out: (80-03-03/) 80-04-03 – 80-11-30
MPARKNMI_81.out: 81-02-09 – 81-06-15 (/81-06-21)
LT: a080lt, a080Hv (z_0 = 0.10 resp. z_0 = 0.15)

Stack co-ordinates: RD-xy = (128385, 445700)

Documentation: S:\OPS\[redacted]\test\Kincaid\diversen[redacted]\doc\kincaid_setup_20120924.doc

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Annex 2. SO_2 measurement network in Kincaid

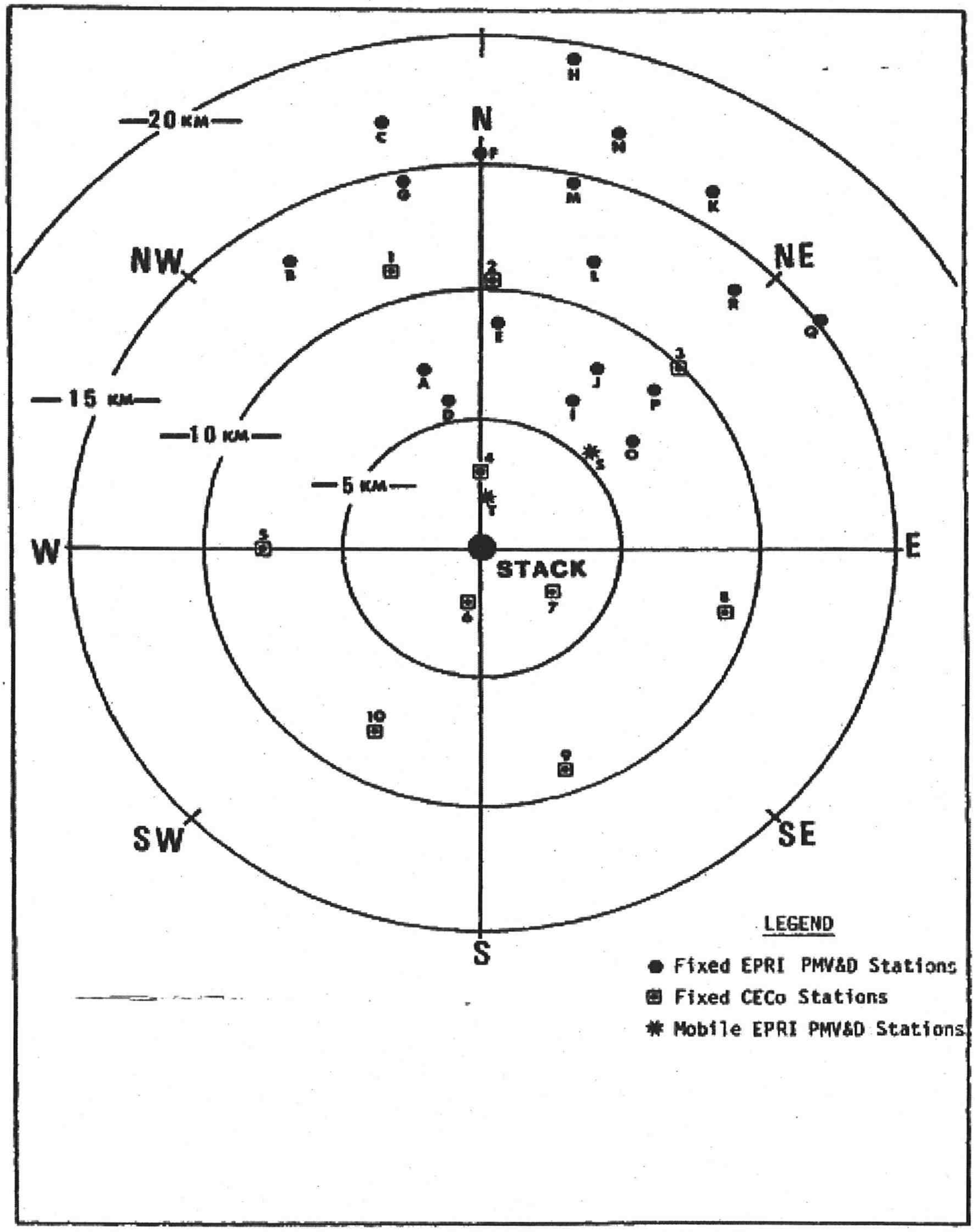

Figure 4-2. EPRI PMV&D and CECo air quality monitoring network - Plains Site field experiment.

Annex 3. Mail of [redacted] with description of preprocessing hourly measurements, September 29, 1994

RIJKSINSTITUUT VOOR VOLKSGEZONDHEID EN MILIEUHYGIENE

TELEFAX

Bestemd voor : [redacted]
Afkomstig van : [redacted]
Afdeling : Laboratorium voor Luchtonderzoek
Datum : 29 sept. 1994
Onderwerp : EPRI/KINCAID data

Telefoon : 030 - [redacted]
Telefax : 030 - [redacted]
e-mail : ....@rivm.nl

Eerste pagina van 4 pagina's

Antonie van Leeuwenhoeklaan 9, Postbus 1, 3720 BA BILTHOVEN, Telex: 47215 rivm nl
Bereikbaar zowel vanaf C.S. Utrecht als Station Bilthoven met Lus 57

Aan : [redacted]
Van : 10.2.e [redacted]
Datum : 29 september 1994

Onderwerp : SO_2 achtergrondsconcentraties in EPRI/Kincaid dataset

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Beste [redacted]

De SO_2 metingen opgenomen in de Kincaid dataset vertonen nogal wat onregelmatigheden. Zo hebben een aantal stations een ondergrens van 3 ug/m3. Bij andere stations lijkt er een tijdelijke bias aanwezig te zijn. Ook zijn vele uren 'afgekeurd'. De toenmalige kwaliteit van dit soort metingen moeten we denk ik niet te hoog inschatten. De door mij gevolgde procedure om de concentraties van bias en achtergrondsbijdragen te ontdoen is de volgende:

<u>bias</u>

- per station en per dag de laagste concentratie >= 0 gedefinieerd als de bias en deze concentratie afgetrokken van alle uurconcentraties

<u>achtergrondsconcentratie</u>

- ik heb eerst een sector gedefinieerd (in graden) waarin de pluim zou kunnen liggen:

  $sector = 180^0 / wv_{10} + 10^0$ $\qquad$ ($|sector| < 180$)

  waarin wv_{10} de windsnelheid op 10 m hoogte (in m/s). Vervolgens heb ik het verschil bepaald tussen de bron-receptor richting wd en de windrichting gemeten op 100m hoogte wd_{100}:

  $wdif = wd - wd_{100}$

  Een station reken ik tot de achtergrond indien:

  $|wdif| > sector$

  met als additionele voorwaarden dat ook het vorige uur $|wdif| > sector$ en de concentratie van het betreffende station kleiner is dan 100 ug/m3. De concentraties van de aldus verkregen achtergrondstations heb ik voor het betreffende uur gemiddeld en afgetrokken van de concentraties gemeten op de overige stations. Eventuele ontstane

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negatieve concentraties zijn door mij op nul gezet.

De verkregen periodegemiddelde concentraties kunnen aanzienlijk verschillen van de sec gemeten concentraties (ruwweg een faktor 2). De resultaten die ik krijg over de periode 800428 t/m 800525 heb ik bijgesloten (ik hoop dat het leesbaar is).
Ik besef dat er vele andere methoden voor achtergrondscorrectie kunnen worden toegepast. Het ging mij in eerste instantie om de termijngemiddelde ruimtelijke verdeling van concentraties rondom een hoge puntbron. Deze is m.i. niet erg gevoelig voor de keuze van de achtergrondscorrectie.
Ik hoop dat e.e.a. voor jullie bruikbaar is.

met vriendelijke groeten

10.2.e

gemiddelde S[redacted] concentraties in [redacted]g/m
Periode : 800428 - 800525

so2-2

mean conc. per station:

5623	7134	6052	5318	0424	5146	5745	1160	1118	1422	2744	1335	1244	1650	1713
3.0	4.4	6.2	3.4	3.3	7.2	2.6	4.9	3.6	2.5	2.1	4.7	3.6	2.4	2.4
487	436	405	461	396	409	443	352	461	441	455	338	470	477	306

2019	3829	2832	1412	0106	6033	0232	2321	0009	7500	0077	0877	3079	0799	6591
3.3	4.0	4.9	10.1	5.5	3.1	6.5	5.2	3.9	4.9	13.5	9.7	2.3	10.2	13.5
440	328	364	477	511	519	518	351	519	515	516	516	519	518	516

mean conc. per pasquill class:

A	B	C	D	E	F	G
30.6	13.9	5.9	2.6	1.8	1.4	1.6
425	1912	2576	3694	2177	1952	728

mean conc. per OPS class:

ABC	D1	Dm	Dh	E	F
8.7	1.6	1.5	13.0	1.5	1.4
1758	3733	2892	3404	741	936

mean conc. per hour:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1.1	.8	.8	.8	1.2	.9	1.2	2.7	3.9	5.3	12.6	15.6	14.5	15.6	16.8	10.5	8.6	5.7	3.4	2.4	1.4	1.8	1.4	2.0
581	576	572	574	572	570	582	568	568	570	572	539	544	547	549	536	540	549	541	542	576	555	563	578

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