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COMPUTING SOURCE-RECEPTOR MATRICES WITH THE EMEP EULERIAN ACID DEPOSITION MODEL

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Preface and acknowledgements

This document was prepared for the Twenty Third Session of the Steering Body of EMEP (Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe). It presents the current method used for routine computations of the source-receptor matrices for oxidized sulphur, oxidized nitrogen and reduced nitrogen with the EMEP Eulerian Acid Deposition model. Computed source-receptor matrices, as well as, import-export budgets for 1997 are also presented in the note. The complete description of the latest version of the EMEP Eulerian Acid Deposition model is given in Olendrzynski (1999).

The author is grateful to Anton Eliassen, Leonor Tarrason, Krzysztof Olendrzynski, Erik Berge and Svetlana Tsyro for valuable discussions and suggestions on the presented method. Huge computational task, which required 22 days model run on CRAY T3E, would not be possible without support from the Norwegian University of Science and Technology (NTNU) in Trondheim, and especially without help of Årve Dispen and Jørn Amundsen.

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1. INTRODUCTION

In general there exist two major problems when computing source-receptor matrices with the Eulerian model. The first one is caused by the nonlinearities in the model chemistry. The second is created by the nonlinearities imposed by the numerical method used for the advection equation. In addition, these two nonlinearities can interact amplifying the unwanted effects. In practical applications these problems arise during the computations of depositions resulting from emissions in European countries, when the sum of individual contributions is not necessary equal to the total deposition from all the European sources.

In order to investigate these problems and to find out the optimal solution, four different methods of computing source-receptor matrices were tested. The best method was then applied for computations of partial (6 sources and 10 receptors) source-receptor matrices for 1996 and full (43 sources and 43 receptors) source-receptor matrices for 1997. The results of the Eulerian model for 1996 were compared with the results of the Lagrangian model for the same year. Also the results of the Eulerian model for 1996 were compared with the computations for 1997.

2. DEFINITION OF SOURCE-RECEPTOR MATRICES

The source-receptor matrices provide the important connection between emissions and depositions of pollutant over different time and spatial scales. Here, we are concerned with the annual country-to-grid source-receptor matrices which are defined in the following way:

$$
\begin{aligned}
A_{ijk} &= [S_{ox}]_{ijk} / [SO_2]_k \\
B_{ijk} &= [N_{ox}]_{ijk} / [NO_2]_k \\
C_{ijk} &= [N_{rd}]_{ijk} / [NH_3]_k
\end{aligned}
\qquad (1)
$$

where: A_{ijk}, B_{ijk}, C_{ijk} are the source-receptor matrices from country k to the grid (i,j) for sulphur, oxidized nitrogen and reduced nitrogen, respectively;$[S_{ox}]_{ijk}$, $[N_{ox}]_{ijk}$, $[N_{rd}]_{ijk}$ are annual depositions of sulphur, oxidized nitrogen and reduced nitrogen, respectively to the grid (i,j); $[SO_2]_k$, $[NO_2]_k$, $[NH_3]_k$ are annual total emissions of SO_2, NO_2 and NH_3 from country k.

The country-to-grid source-receptor matrices are calculated by computing, in the first step, annual depositions (dry + wet) in the model domain resulting from the emissions in each individual country or another emission source (e.g. ship traffic, volcanoes etc.). In the second step, the deposition fields are divided by the total annual emissions from a given source. For practical applications only the first step of this process is performed at MSC-W. In addition, so called country-to-country source-receptor matrices are computed each year by the MSC-W of EMEP based on the country-to-grid matrices. The country-to-country matrices are also called source-receptor matrices and this type of matrices, which and are routinely reported to the Steering Body of EMEP, will be mainly discussed in this report.

An important assumption in calculating source receptor matrices is the linearity of the model equations. This assumption is not entirely fulfilled in the EMEP Eulerian Acid Deposition model because of the non-linear chemical reactions. Although departure from the linear relationship is relatively small in the model, it creates a problem for computing source-receptor matrices.

3. FOUR METHODS FOR COMPUTING SOURCE-RECEPTOR MATRICES WITH THE EULERIAN MODEL

Source-receptor matrices have been already computed with the Eulerian model for 1992 Jakobsen *et al.*, 1997). In this approach (method-1, which can also be referred to as the direct method), deposition from the selected European country was computed by running the model with only this country emissions. The major disadvantage of this direct and convenient, from the practical point of view, approach is a problem with the underestimation of aerosol production due to non-linear chemistry. To overcome this problem three other methods have been tested with more indirect calculation technique. All four methods are summarized in Table 1.

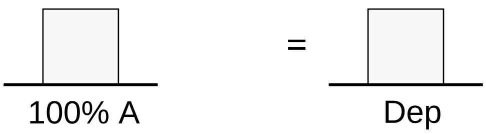
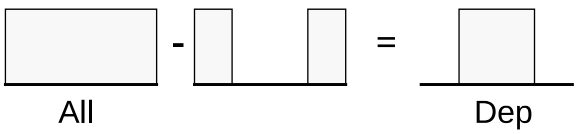
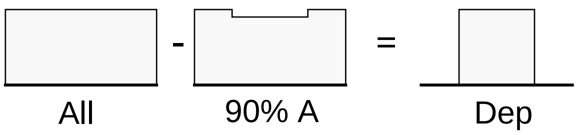
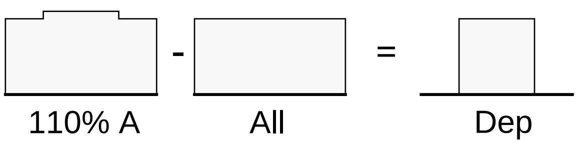
It should be stressed that all methods, presented here, assume no major changes in the model structure for computing source-receptor matrices. From the theoretical perspective, it is possible to develop a solution which takes both total emissions and emissions from the individual sources into account at the same time during the model run. However, such a solution requires a lot of programming and changes in the numerical structure of the model. It is also unclear if the computer resources allow a run of a modified model version presently, and finally if the results are significantly better compared to the relatively simple methods. Taking these factors into account and having in mind a short time available for the final computations of source-receptor matrices, only four methods presented in Table 1 have been tested for selecting the best option for the 1997 computations. In the future more complex solution will be also investigated.

The second method (which can also be referred to as the reverse method) keeps much higher (compared to method-1) levels of aerosol production outside the emitter area. This means that compared to method one, simulated concentrations and depositions are closer to reality in method two. The disadvantage, in this case, takes the form of several, small negative values of the computed deposition in the vicinity of large gradients in the emission fields. This is the result of mostly numerical non-linearity and partly chemical nonlinearity in the emitter area and is also common for methods three and four. The negative values in the calculated deposition fields are eliminated by the mass conserving filtering procedure (Bartnicki, 1989).

One way to improve the situation, concerning nonlinear effects in the emitter area, is to reduce emissions from the selected country by 10% only, instead of eliminating them completely. This is the main idea behind method-3. This method is even closer to reality than method-2.

This idea is expanded further in method-4. In this method, a small hole in the emissions is replaced by slightly elevated emissions and reverse order of substruction. Since the advection algorithm (Both 1989a, 1989b) tolerates “mountains” better than “valleys”, the numerical nonlinearity should theoretically have a smaller effect in method-4 than in method-3.

Table1: Schematic illustration of four methods for calculating s-r matrices.

No.	Method - scheme	Method - description
1.		Deposition due to emission in country **A** computed in the model run with emissions from country **A** only.
2.		Deposition due to emission in country **A** computed as a difference between the model run with all emissions and the model run with all emissions except emissions from country **A**.
3.		Deposition due to emission in country **A** computed as a difference (multiplied by 10) between the model run with all emissions and the model run with all emissions except 10% emissions from country **A**.
4.		Deposition due to emission in country **A** computed as a difference (multiplied by 10) between the model run with all emissions (+10% emissions from country A) and the model run with all emissions included.

The four methods for calculating source-receptor matrices have been compared in two numerical tests. In these tests, separate runs were performed for emissions from selected countries and all other sources in the model domain except emissions from these countries. In addition, the model was also run for all European emissions. Then, the sum of the depositions from separate runs (sources) was compared with the depositions calculated with all European emissions. A comparison has been performed in the traditional EMEP domain common for the Lagrangian and the Eulerian model (Figure 1).

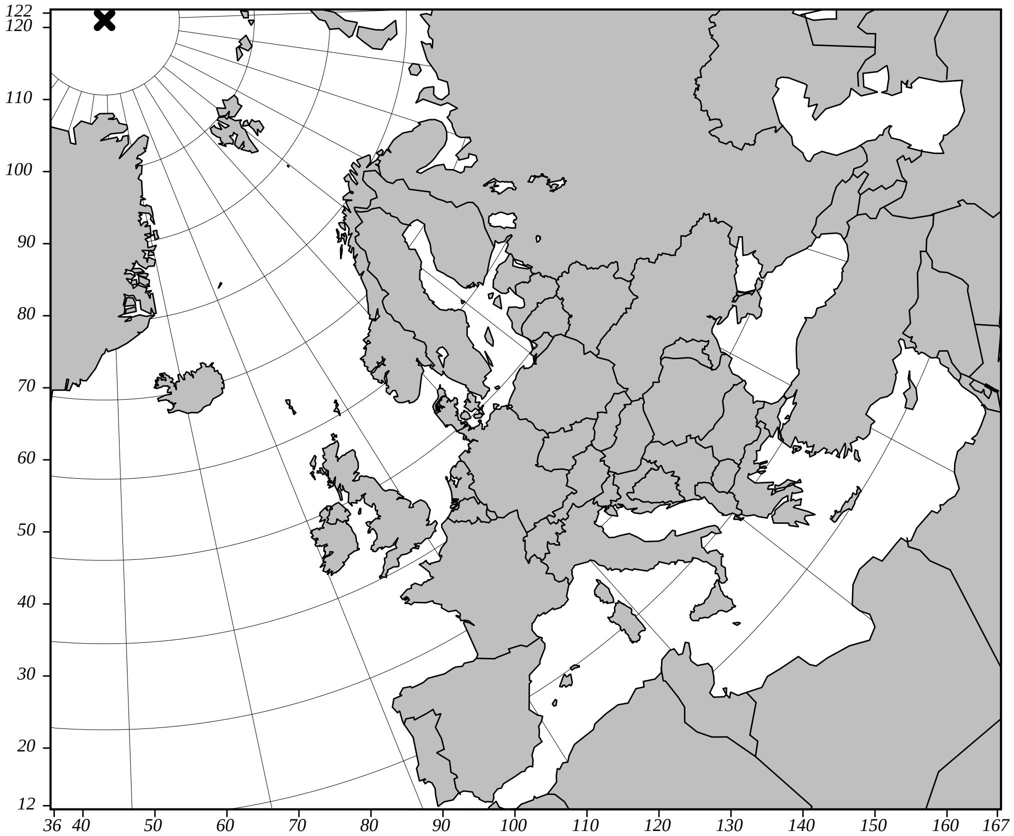


Figure 1: The EMEP domain in which all depositions were calculated and all methods tested.

The following variables have been calculated for the comparison of the runs:

$$MEN(TOT) = \sum_{i=36}^{I} \sum_{j=12}^{J} D_{ij} \quad (2)$$

where D_{ij} is the deposition matrix (for one of three compounds) computed from all European emissions, I=155 - for the Lagrangian model and Eulerian model applied to 1996 calculations, I=167 - for the Eulerian model applied to 1997 calculations;

$$MEN(SUM) = \sum_{i=36}^{I} \sum_{j=12}^{J} d_{ij} \quad (3)$$

where d_{ij} is the deposition matrix computed as a sum of the separate runs;

$$MASS(TOT) = \sum_{i=36}^{I} \sum_{j=12}^{J} \frac{D_{ij} \cdot \Delta x \cdot \Delta x}{m^2(i, j)} \tag{4}$$

where $\Delta x = 50$ km is the grid size and $m(i,j)$ is the map factor;

$$MASS(SUM) = \sum_{i=36}^{I} \sum_{j=12}^{J} \frac{d_{ij} \cdot \Delta x \cdot \Delta x}{m^2(i, j)} \tag{5}$$

$$RMSE = \sum_{i=36}^{I} \sum_{j=12}^{J} \sqrt{\frac{(d_{ij} - D_{ij})^2}{(I-35) \times (J-11)}} \tag{6}$$

The last variable - MAX(SUM-TOT) is the maximum of grid difference between depositions calculated with all sources included and as a sum of the contribution from separate sources.

4. COMPARISON OF FOUR METHODS FOR A ONE DAY RUN

Computation of the source-receptor matrices with the Eulerian model requires significant computer resources. A one year run for one source/emitter requires approximately 11 hours of CPU time on CRAY T3E. Therefore, it was necessary to limit the tests, especially in the first phase and save the main resources for computations of full source-receptor matrices for 1997.

As a consequence of limited computer resources, in the first test, transport of pollutants was computed for one day only. Four runs were performed with individual emissions from France, Germany, Poland and all EMEP sources except those three countries. In addition, the model was run (reference run) with all sources in the EMEP domain (including individual sources mentioned before).

The results for oxidized sulphur, oxidized nitrogen and reduced nitrogen are presented in Tables 2, 3 and 4, respectively, for all four methods. In the case of perfect linearity, deposition calculated as a sum of depositions from individual sources should be identical to the deposition computed with all sources. The differences indicate departure from linearity for each method tested. In Tables 2, 3 and 4, the best results for each variable are shaded.

The results show that the departures from linearity are not large for all the methods tested. However, method-1 and method-2 are definitely better than method-3 and method-4. In addition, method-2 performs slightly better than method-1. Therefore, for the next test, with full one year run, only method-2 and method-1 were selected.

Table 2: Comparison of four methods for sulphur.

Variable	Units	Method 1	Method 2	Method 3	Method 4
MEAN(TOT)	mg m^{-2}	0.5041	0.5041	0.5041	0.5041
MEAN(SUM)	mg m^{-2}	0.5055	0.5028	0.4824	0.4811
(SUM-TOT)/TOT	%	0.2677	-0.2621	-4.3192	-4.559
MASS(TOT)	tonnes	145.1358	145.1358	145.1358	145.1358
MASS(SUM)	tonnes	145.5180	144.7497	138.8474	138.4863
(SUM-TOT)/TOT	%	0.2633	-0.2658	-4.3325	-4.5814
RMSE	mg m^{-2}	0.0350	0.0287	0.1181	0.1237
RMSE/MEAN(TOT)	%	6.9431	5.7022	23.4221	24.5464
MAX(SUM-TOT)	mg m^{-2}	1.6500	1.2007	2.2703	2.3003

Table 3: Comparison of four methods for oxidized nitrogen.

Variable	Units	Method 1	Method 2	Method 3	Method 4
MEAN(TOT)	mg m^{-2}	0.0934	0.0934	0.0934	0.0934
MEAN(SUM)	mg m^{-2}	0.0932	0.0936	0.0957	0.0961
(SUM-TOT)/TOT	%	-0.2346	0.2111	2.4913	2.8926
MASS(TOT)	tonnes	26.9134	26.9134	26.9134	26.9134
MASS(SUM)	tonnes	26.8537	26.9751	27.6211	27.7407
(SUM-TOT)/TOT	%	-0.2215	0.2292	2.6297	3.0741
RMSE	mg m^{-2}	0.0081	0.0070	0.0376	0.0403
RMSE/MEAN(TOT)	%	8.6699	7.5461	40.2295	43.1442
MAX(SUM-TOT)	mg m^{-2}	0.2400	0.1992	0.3290	0.3391

Table 4: Comparison of four methods for reduced nitrogen.

Variable	Units	Method 1	Method 2	Method 3	Method 4
MEAN(TOT)	mg m^{-2}	0.1940	0.1940	0.1940	0.1940
MEAN(SUM)	mg m^{-2}	0.1945	0.1935	0.1878	0.1925
(SUM-TOT)/TOT	%	0.2379	-0.2325	-3.1938	-0.7505
MASS(TOT)	tonnes	55.0224	55.0224	55.0224	55.0224
MASS(SUM)	tonnes	55.1566	54.8894	53.2563	54.6082
(SUM-TOT)/TOT	%	0.2439	-0.2411	-3.2099	-0.7527
RMSE	mg m^{-2}	0.0116	0.0079	0.0450	0.0378
RMSE/MEAN(TOT)	%	5.9784	4.0868	23.2029	19.4954
MAX(SUM-TOT)	mg m^{-2}	0.3300	0.1623	0.6382	0.3708

5. COMPARISON OF TWO METHODS FOR A ONE YEAR RUN

The direct method (method-1) and the reverse method (method-2) were further compared for a full one year simulation (1996) with six countries as individual emissions sources: Germany Poland, Italy, United Kingdom, Czech Republic and Croatia. Two additional runs were performed with the Eulerian model for 1996. First including all the sources except the six countries mentioned and secondly, with all the sources including the six mentioned above countries (reference run).

Differences between the total run with all the sources included and a sum of the runs with individual sources expressed as percentage of the total deposition in the EMEP domain (Table 5) was selected as the most important indication of nonlinearity. The differences in Table 5 are small for both methods, but for all types of deposition method-2 performs better than method-1. Method-1 slightly overestimates the deposition of oxidized sulphur and reduced nitrogen and underestimates oxidized nitrogen. Method-2 behaves in an exactly opposite way underestimating depositions of oxidized sulphur and reduced nitrogen, and overestimating oxidized nitrogen.

Table 5: Differences between total run with all sources included and a sum of the runs with individual sources for 1996. Units: % of the total deposition in the EMEP domain.

Method	Oxidized sulphur	Oxidized nitrogen	Reduced nitrogen
Method-1	2.35	-1.63	0.067
Method-2	-0.31	1.44	-0.005

As an additional important measure, maximum differences between the total run with all the sources included and a sum of the runs with individual sources expressed as percentage of the total deposition in the EMEP domain was also calculated (Table 6). Also in this case method-2 performs better than method-1.

Table 6: Maximum differences between total run with all sources included and a sum of the runs with individual sources for 1996. Units: % of the total deposition in the grid.

Method	Oxidized sulphur		Oxidized nitrogen		Reduced nitrogen	
	Difference	Location	Difference	Location	Difference	Location
Method-1	10.1	(103,61)	4.2	(94,62)	2.7	(93,62)
Method-2	-5.9	(111,67)	-1.9	(94,62)	-2.5	(93,62)

Differences between method-2 and method-1 (deposition computed with method-2 minus deposition computed with method-1 for emissions from the Czech Republic) are shown in Figures 2, 3 and 4, for oxidized sulphur, oxidized nitrogen and reduced nitrogen, respectively.

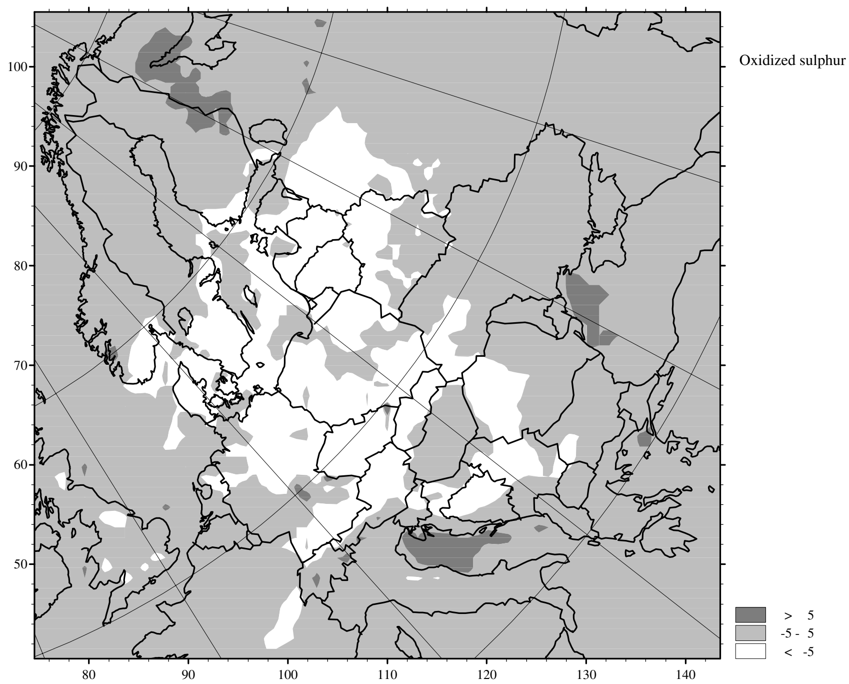


Figure 2: The difference between1996 annual deposition of oxidized sulphur computed with method-2 and deposition computed with method-1. Units: mg (S) m^{-2} yr^{-2}. Emissions from the Czech Republic.

In all maps, the area where the deposition computed with method-2 is at least 5 mg m^{-2} higher than the deposition computed with method-1 is marked in black. White area denotes the deposition computed with method-2, at least 5 mg m^{-2} lower the deposition computed with method-1, and grey denotes the depositions computed with both methods equal within 5 mg m^{-2}

Concerning oxidized sulphur (Figure 2), the deposition computed with method-2 is lower, compared to the deposition computed with method-1 in the emitter country, and around it in the area of approximately 1000 kilometres from the source, especially to the North. However, there is one point in the source country (close to the Polish border) where the deposition computed with method-2 is higher. There are three spots, relatively far away from the source, where the deposition computed with method-2 is higher. The closest spot to the emitter is a part of the Adriatic Sea, next a part of the Black Sea and far away is the area in Russia in the Kola Peninsula. Generally, deposition of oxidized sulphur computed with method-2 is lower than the deposition computed with method-1 in the source region and in the area around it, and it is higher farther away from the source.

For oxidized nitrogen (Figure 3), the deposition computed with method-2 is lower, compared to the deposition computed with method-1 only in the emitter country. In the neighbouring countries to the emitter, and slightly further away, several scatter spots can be noticed with the deposition computed with method-2 higher than the deposition computed with method-1. For the rest of the model domain both depositions are equal within 5 mg m^{-2}

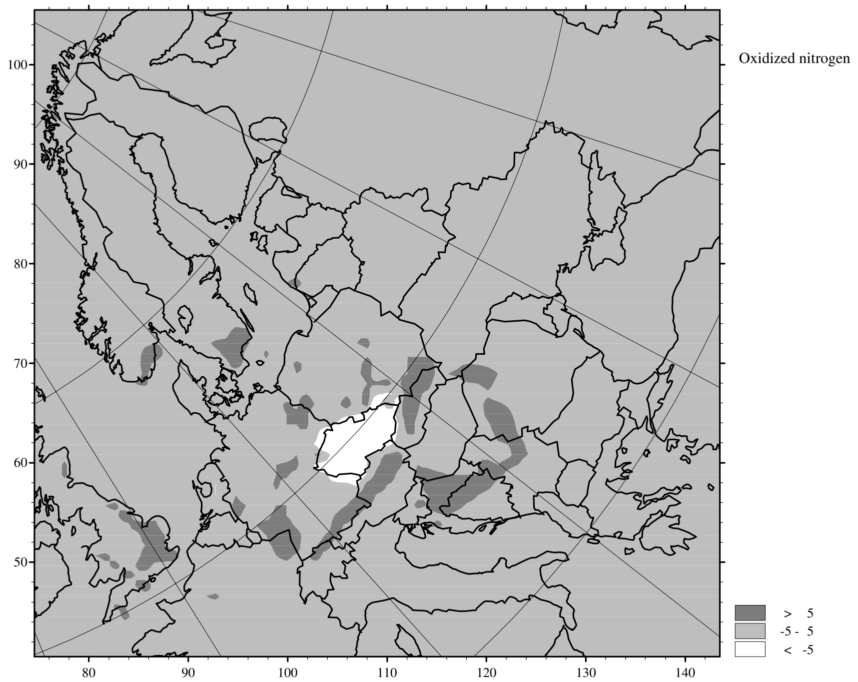


Figure 3: The difference between1996 annual deposition of oxidized nitrogen computed with method-2 and deposition computed with method-1. Units: mg (N) m^{-2} yr^{-2}. Emissions from the Czech Republic.

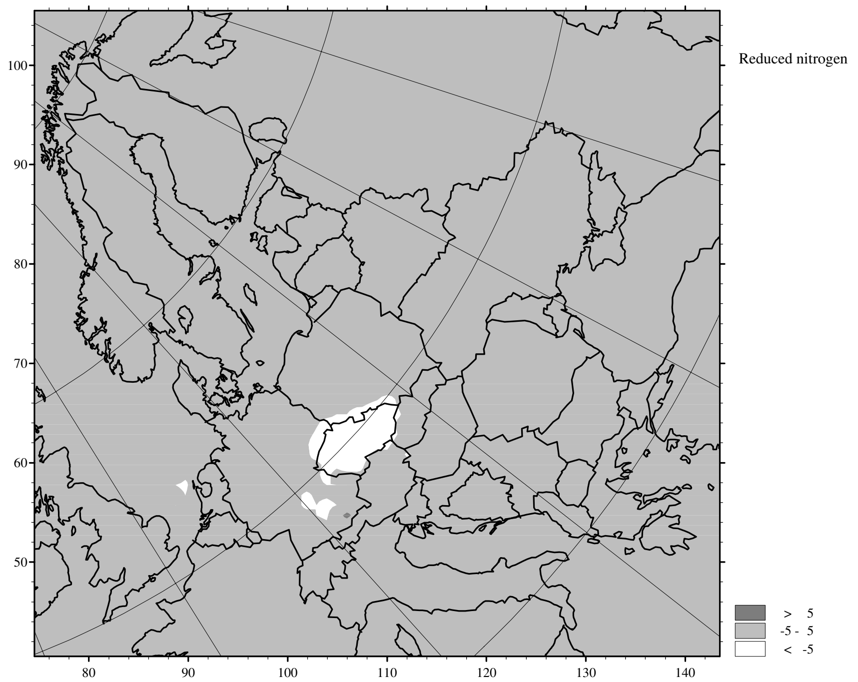


Figure 4: The difference between1996 annual deposition of reduced nitrogen computed with method-2 and deposition computed with method-1. Units: mg (N) m^{-2} yr^{-2}. Emissions from the Czech Republic.

Concerning reduced nitrogen (Figure 4), the deposition computed with method-2 is lower, compared to the deposition computed with method-1 in the emitter country and in two small single spots outside: in Germany and over the North Sea. In the rest of the model domain both depositions are equal within 5 mg m^{-2}. However, far away from the source the deposition of reduced nitrogen computed with method-2 is slightly higher, compared to the deposition computed with method-1.

There is a clear common pattern for sulphur and nitrogen maps presented in Figures 2, 3 and 4. Deposition computed with method-2 is lower then the deposition computed with method-1 close to the source and higher in the distant locations from the source. This pattern indicates more long range transport of pollutants when method -2 is applied in the computations.

The results presented in this Chapter show that the reverse method gives slightly better results than the direct method when computing annual depositions in the model domain for individual emitters. In addition, the assumptions of the reverse method are closer to reality than the assumptions of the direct method. Therefore, the reverse method has been chosen for the computations of the complete source-receptor matrices for 1997. However, before these computations were carried out, the Eulerian results for 1996 were compared with the source-receptor matrices computed with the Lagrangian model.

6. COMPARISON OF SOURCE-RECEPTOR MATRICES PRODUCED BY THE LAGRANGIAN AND THE EULERIAN MODEL FOR 1996

In the presentation and analysis of the source-receptor matrices, two or three letters codes are used for the emitters and/or receptors. These codes are presented in Table 7.

Table 7: Codes for all sources and receptors used in the computations.

Country/Region	Code	Country/Region	Code
Armenia	AM	Malta	MT
Austria	AT	Netherlands	NL
Belarus	BY	Norway	NO
Belgium	BE	Poland	PL
Bosnia and Hercegovina	BA	Portugal	PT
Bulgaria	BG	Republic of Moldova	MD
Croatia	HR	Romania	RO
Cyprus	CY	Russian Federation	RO
Czech Republic	CZ	Slovakia	SK
Denmark	DE	Slovenia	SI
Finland	FI	Spain	ES
France	FR	Sweden	SE
Georgia	GE	Switzerland	CH
Germany	DE	Ukraine	UA
Greece	GR	Yugoslavia	YU
Hungary	HU	Remaining Land Areas	REM
Iceland	IS	The Baltic Sea	BAS
Ireland	IE	The Mediterranean Sea	MED
Italy	IT	The North Sea	NOS
Latvia	LV	Remaining N.E. Atlantic	ATL
Lithuania	LT	Natural Oceanic	NAT
Luxembourg	LU	European Union	EU

In Table 7, Russian Federation indicates the part the Russian Federation inside the EMEP domain of calculations. The same applies to the Remaining N.E. Atlantic region and Natural Oceanic emission area. Remaining Land Areas include North Africa, Albania, Estonia, Kazakhstan, Azerbaijan, Georgia, Syria, Lebanon, Israel, parts of Uzbekistan, Turkmenistan, Iran, Iraq and Jordan. The European Union includes 15 countries already listed in Table 7: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden and United Kingdom.

Three different versions of the source-receptor matrices were computed with the Lagrangian model for 1996. The first version, which used meteorological input data from the HIRLAM model output (Tsyro, 1998) produced to high total depositions in some cases exceeding emissions. The main reason for high depositions in this model version was a parameterization of the vertical exchange of pollutants between the mixing layer and a free troposphere which was originally developed for the meteorological input data from the LAM50E model but not for HIRLAM. The second version used meteorological input data from the LAM50E model output (ADDENDUM, 1998) and produced slightly lower depositions, all below the emission values. The last, most recent version (Tsyro, 1999) used also meteorological input data from the LAM50E model output but with updated emission data for 1996 (Mylona *et al.,* 1999), the same emissions as used by the Eulerian Acid Deposition model.

The latest version of the Eulerian Acid Deposition model, used for the computations of source-receptor matrices for 1996 and 1997 was described by Olendrzynski (1999). From the computational point of view, calculation of the source-receptor matrices with the Eulerian model is a time consuming process. Computations were performed on the parallel version of CRAY (T3E) located in Trondheim, Norway. Typically 16 processors were used for this task and to compute source receptor matrices for one year approximately 22 days of the CPU time was required.

Because of the problem with computer time, in the analysis of the differences between the Lagrangian and Eulerian model, only six countries (Germany, Italy, Poland United Kingdom Czech Republic and Croatia) were selected as emitters and only ten countries were selected as receptors. These examples still show a general pattern visible for the complete set of receptors. Six of the selected receptors were the same as the emitters and four additional represented long-range transport sulphur and nitrogen to the North (Norway), East (Russian Federation), South-East (Turkey) and South, Spain.

Concerning the results for 1996, partial (6 emitters and 10 receptors) source-receptor matrices for oxidized sulphur are shown in Tables 8, 9 and 10 for the Eulerian model, Lagrangian model and differences between Eulerian and Lagrangian, respectively.

In terms of absolute values (Table 10), major differences between the Eulerian and the Lagrangian model can be noticed for indigenous (i.e. country to itself) depositions and transport from selected emitters to the Russian Federation. The largest absolute difference, in the depositions computed with the Eulerian and Lagrangian model, occurs for Italy (6.4 ktonnes or 56% of the Lagrangian deposition). For other emitters, indigenous deposition computed with the Eulerian model is 9% - 32% larger than the one computed with the Lagrangian model. Concerning transport to Russian Federation, the largest difference (41.1 ktonnes or 71% of the Lagrangian deposition) occurs for Poland as emitter.

Table 8: Partial 1996 source-receptor matrix for oxidized sulphur - Eulerian model. Units: 100 tonnes of S.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	2147	56	517	240	646	3
	IT	64	1791	58	8	61	20
	PL	661	48	3210	62	465	7
	GB	132	10	86	2107	60	0
	CZ	327	18	396	15	711	3
	HR	29	83	52	2	40	41
	NO	120	10	100	255	49	1
	RU	544	133	990	160	375	11
	ES	19	37	7	25	8	0
	TR	16	23	34	2	14	1

Table 9: Partial 1996 source-receptor matrix for oxidized sulphur - Lagrangian model. Units: 100 tonnes of S.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	1867	90	447	222	752	3
	IT	62	1151	45	10	48	19
	PL	630	36	2957	47	480	8
	GB	97	5	54	1680	44	0
	CZ	332	27	316	17	545	3
	HR	24	72	40	2	31	31
	NO	51	1	58	112	22	0
	RU	154	21	579	49	116	3
	ES	12	15	3	22	4	0
	TR	5	13	16	0	6	0

Table 10: Partial 1996 source-receptor matrices for oxidized sulphur - Differences between Eulerian and Lagrangian model. Units: 100 tonnes of S.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	280	-34	70	18	-106	0
	IT	2	640	13	-2	13	1
	PL	31	12	253	15	-15	-1
	GB	35	5	32	427	16	0
	CZ	-5	-9	80	-2	166	0
	HR	5	11	12	0	9	10
	NO	69	9	42	143	27	1
	RU	390	112	411	111	259	8
	ES	7	22	4	3	4	0
	TR	11	10	18	2	8	1

Table 11: Partial 1996 source-receptor matrix for oxidized nitrogen - Eulerian model. Units: 100 tonnes of N.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	1407	44	122	173	147	2
	IT	51	1662	19	12	16	16
	PL	263	36	889	45	137	4
	GB	117	14	37	1248	20	0
	CZ	124	15	100	8	138	2
	HR	14	100	17	2	12	14
	NO	66	7	24	156	10	0
	RU	177	88	213	86	59	5
	ES	19	55	3	23	2	1
	TR	8	25	10	3	3	1

Table 12: Partial 1996 source-receptor matrix for oxidized nitrogen - Lagrangian model. Units: 100 tonnes of N.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	1021	81	108	211	138	2
	IT	71	763	17	13	17	10
	PL	263	38	580	51	121	6
	GB	93	5	19	626	12	0
	CZ	144	27	70	18	97	2
	HR	18	75	14	2	10	11
	NO	56	2	32	118	10	0
	RU	149	24	257	65	49	3
	ES	22	13	2	25	2	0
	TR	4	15	7	0	3	0

Table 13: Partial 1996 source-receptor matrices for oxidized nitrogen - Differences between Eulerian and Lagrangian model. Units: 100 tonnes of N.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	386	-37	14	-38	9	0
	IT	-20	899	2	-1	-1	6
	PL	0	-2	309	-6	16	-2
	GB	24	9	18	622	8	0
	CZ	-20	-12	30	-10	41	0
	HR	-4	25	3	0	2	3
	NO	10	5	-8	38	0	0
	RU	28	64	-44	21	10	2
	ES	-3	42	1	-2	0	1
	TR	4	10	3	3	0	1

Table 14: Partial 1996 source-receptor matrix for reduced nitrogen - Eulerian model. Units: 100 tonnes of N.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	2447	12	99	43	57	2
	IT	23	1483	6	1	7	13
	PL	193	10	1495	10	65	4
	GB	72	4	23	989	8	0
	CZ	165	3	57	2	216	2
	HR	7	35	8	0	6	60
	NO	41	2	18	40	4	0
	RU	119	30	185	22	39	5
	ES	6	10	1	4	1	0
	TR	3	3	6	0	1	0

Table 15: Partial 1996 source-receptor matrix for reduced nitrogen - Lagrangian model. Units: 100 tonnes of N.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	3043	37	62	46	44	1
	IT	50	1799	5	2	5	6
	PL	171	13	1679	8	51	3
	GB	48	2	8	1314	3	0
	CZ	131	10	53	3	335	1
	HR	9	33	5	0	4	100
	NO	33	1	19	27	3	0
	RU	62	8	132	9	12	1
	ES	10	5	0	6	0	0
	TR	1	3	2	0	1	0

Table 16: Partial 1996 source-receptor matrices for reduced nitrogen - Differences between Eulerian and Lagrangian model. Units: 100 tonnes of N.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	-596	-25	37	-3	13	1
	IT	-27	-316	1	-1	2	7
	PL	22	-3	-184	2	14	1
	GB	24	2	15	-325	5	0
	CZ	34	-7	4	-1	-119	1
	HR	-2	2	3	0	2	-40
	NO	8	1	-1	13	1	0
	RU	57	22	53	13	27	4
	ES	-4	5	1	-2	1	0
	TR	2	0	4	0	0	0

For relative differences (absolute expressed in percent of the Lagrangian deposition), the largest difference (900%) can be noticed for the transport of sulphur from Italy to Norway. The relative differences are most pronounced for the Russian Federation and Norway as receptors. In comparison to the Lagrangian model, there is definitely more indigenous deposition in the Eulerian model (9%-56%), as well as more transport to distant receptors. For example, there is 72%-900% more transport to Norway, 71%-533% more transport to the Russian federation, 14%-147% more transport to Spain and 77%-220% more transport to Turkey. There is slightly less transport to the receptors in the middle range (e.g. Italy to czech Republic -33%).

When the sums of all depositions in the partial source-receptor matrices are compared for oxidized sulphur, there is 27% more deposition from the Eulerian model than from the Lagrangian model. This number corresponds well to the 25% percent of all depositions from inatributable sources calculated with the Lagrangian model for the full 1996 source-receptor matrices. In the Eulerian model, all depositions can be assigned to one of the receptors, and therefore, contributions from all emitters are on average expected to be slightly higher than in the Lagrangian model.

The results for oxidized nitrogen for 1996 are shown, as partial source-receptor matrices, in Tables 11, 12 and 13 for the Eulerian model, Lagrangian model and differences between Eulerian and Lagrangian, respectively.

As in the case of oxidized sulphur, major differences in the results of the Eulerian and the Lagrangian model can be noticed for indigenous depositions and transport of oxidized nitrogen from selected emitters to the Russian Federation. However, compared to oxidized sulphur, differences in the indigenous depositions are higher and differences in the transport to the Russian Federation lower for oxidized nitrogen. The largest absolute difference in the indigenous depositions computed with the Eulerian and Lagrangian model occurs for Italy (89.9 ktonnes or 118% of the Lagrangian deposition). For other emitters, indigenous deposition computed with the Eulerian model is 27% - 99% larger than the one computed with the Lagrangian model. Concerning transport to Russian Federation, largest difference (6.4 ktonnes or 267% of the Lagrangian deposition) occurs for Italy as emitter.

For relative differences, the largest difference (323%) can be noticed for the transport of oxidized nitrogen from Italy to Norway. The relative differences are mostly visible for Italy as emitter ranging, depending on receptor, from -46% (transport to Germany) to +323% (transport to Norway). In comparison to the Lagrangian model, there is more indigenous deposition in the Eulerian model (27%-118%), and slightly more, but less than in the case of oxidized sulphur, transport to distant receptors.

When the sums of all depositions in the partial source-receptor matrices are compared for oxidized nitrogen, there is 43% more deposition from the Eulerian model than from the Lagrangian model. This is approximately twice as much as contribution of all depositions from inatributable sources calculated with the Lagrangian model for 1996, and twice as much as the number computed for oxidized sulphur, mostly due to the large differences in indigenous depositions computed with the Eulerian and the Lagrangian model.

Partial 1996 source-receptor matrices for reduced nitrogen are shown in Tables 14, 15 and 16 for the Eulerian model, Lagrangian model and differences between Eulerian and Lagrangian, respectively.

Again, in terms of absolute values, major differences between the Eulerian and the Lagrangian model can be noticed for indigenous depositions and transport of reduced nitrogen from selected emitters to the Russian Federation. However, contrary to oxidized sulphur and oxidized nitrogen, indigenous depositions computed with the Eulerian model are lower than those computed with the Lagrangian model in the case of reduced nitrogen. The largest absolute difference in the depositions computed with the Eulerian and Lagrangian model occurs for Germany (-59.6 ktonnes or -20% of the Lagrangian deposition). For other emitters, indigenous deposition computed with the Eulerian model is 40% - 11% smaller than the one computed with the Lagrangian model. Concerning transport to the Russian Federation, largest difference (5.3 ktonnes or 40% of the Lagrangian deposition) occurs for Poland as an emitter.

For relative differences, the largest difference (400%) can be noticed for the transport of reduced nitrogen from Croatia to the Russian Federation. The relative differences are largest for the Russian Federation and Turkey as receptors. In comparison to the Lagrangian model, there is definitely less indigenous deposition in the Eulerian model (11%-40%), and more transport to distant receptors. For example, there is 40%-400% more transport to the Russian Federation.

When the sums of all depositions in the partial source-receptor matrices are compared for reduced nitrogen, there is 13% less deposition from the Eulerian model than from the Lagrangian model. This number corresponds well to 14% percent of all depositions from inatributable sources calculated with the Lagrangian model for the full 1996 source-receptor matrices.

The source-receptor matrices computed from the Eulerian and the Lagrangian model were compared earlier (Jakobsen *et al.*, 1997) for 1992. However, compared to 1996, a different Eulerian model version was used in this study. The results for oxidized and reduced nitrogen were similar for 1992 and 1996, but slightly different for oxidized sulphur, mainly due to that 1992 indigenous deposition from the Eulerian model was larger than from the Lagrangian model whereas, for 1996, this relation was just opposite.

The differences between the Eulerian and Lagrangian model results for 1996 can also be noticed in the ratios of dry to total deposition of different compounds. These ratios are shown in Table 17.

Table 17: Ratio of wet to total deposition in 1996 for the Eulerian and Lagrangian model. Unit: % of total annual deposition.

Model	Oxidized sulphur	Oxidized nitrogen	Reduced nitrogen
Eulerian	53	42	57
Lagrangian	53	36	38

The contribution of dry deposition to total deposition in the Eulerian model is the same as in the Lagrangian model for oxidized sulphur, slightly higher for oxidized nitrogen, and much higher for reduced nitrogen. The higher dry deposition contribution to the total in the Eulerian model is not a surprise due to the multilayer structure and good resolution close to the surface of the Eulerian model as compared to the mixing layer concept of the Lagrangian model. Closer to reality representation of the vertical concentration profile in the Eulerian model means higher, than in the Lagrangian model, concentrations near the surface and also higher dry depositions.

7. RESULTS FOR 1997

7.1 Non-linear effects in 1997 runs

The non-linear effects in the computations for 1997 are visible as differences in the depositions computed in the run with all emission sources included (TOT), and the sum of the runs with contributions from all individual emitters (SUM). Differences between TOT and SUM in the entire EMEP are -0.5%, +2.1% and 0.1% for oxidized sulphur, oxidized nitrogen and reduced nitrogen, respectively. Maximum absolute differences in single grids are 8.5%, 7.5% and 2.1%, for oxidized sulphur, oxidized nitrogen and reduced nitrogen, respectively.

Also, because of nonlinearities, depositions computed for individual receptors in the run with all emissions and as a sum of runs with individual emitters are not the same. Depositions from the total and separate runs, including differences in percent of the total run are given in Table 18. The differences between the total and separate runs indicate the range of uncertainties in the computed source-receptor matrices due to nonlinear effects. The ranges of differences, in Table 18, are (-5%,+4%), (-8%+8%) and (-3%,+5%) for oxidized sulphur, oxidized nitrogen and reduced nitrogen, respectively.

7.2 Comparison of the Eulerian model results for 1996 and 1997

Partial source-receptor matrices for 1996, computed with the Eulerian model, were compared with the Eulerian model results for 1997. To avoid the influence of emission changes in this comparison, the computed deposition for 1996 were scaled according to the ratios of 1997 emissions to 1996 emissions presented for selected countries in Table 19. The largest differences between 1996 and 1997 emissions can be noticed in Table 19 for oxidized sulphur. For oxidized nitrogen differences are smaller and minor for reduced nitrogen.

Differences between 1997 and 1996 partial source-receptor matrices for oxidized sulphur, expressed as a percentage of the emissions are shown in Table 20. Corresponding differences for oxidized sulphur and reduced nitrogen are given in Table 21 and Table 22, respectively.

Empty cells in Tables 20-22 mean zero depositions in 1996, and non-zero but small depositions computed for 1997. Compared to 1996 results, the most significant changes and increase of depositions for all three compounds in 1997 can be noticed for Turkey as a receptor. In the extreme case, the deposition of ammonia emitted in Italy in 1997 is almost ten times higher than the deposition of ammonia emitted in Italy in 1996. The increased deposition in Turkey can be, to large extend, explained by the larger area of this country in the extended EMEP grid applied for 1997 computations.

Table 18: Comparison of depositions from total and separate runs.

Receptor	Oxidized sulphur			Oxidized nitrogen			Reduced nitrogen		
	SUM	TOTAL	DIFF	SUM	TOTAL	DIFF	SUM	TOTAL	DIFF
AT	758	784	-3	496	482	3	726	723	0
BE	437	442	-1	403	431	-7	387	401	-3
BG	2149	2180	-1	466	455	2	597	600	-1
DK	354	360	-2	296	315	-6	349	353	-1
FI	1003	989	1	533	502	6	310	303	2
FR	3540	3571	-1	3567	3584	0	3906	3958	-1
DE	3886	3980	-2	3195	3248	-2	3835	3881	-1
GR	1529	1554	-2	506	498	2	529	532	-1
HU	1459	1485	-2	565	552	2	586	589	-1
IS	90	87	4	67	63	5	26	25	3
IE	408	412	-1	282	306	-8	580	594	-2
IT	3894	3960	-2	2280	2261	1	2310	2318	0
LU	30	31	-1	31	32	-3	35	36	-1
NL	427	429	-1	426	465	-8	621	637	-2
NO	764	744	3	525	499	5	312	301	4
PL	7262	7333	-1	2482	2454	1	2510	2525	-1
PT	554	554	0	503	495	2	370	374	-1
RO	3525	3595	-2	911	882	3	1622	1625	0
ES	3431	3447	0	2150	2132	1	1828	1826	0
SE	1232	1226	1	996	957	4	607	591	3
CH	309	312	-1	238	240	-1	452	453	0
TR	3118	3150	-1	1573	1548	2	2204	2196	0
GB	3331	3344	0	2206	2205	0	1358	1357	0
BY	1530	1573	-3	599	585	2	1515	1520	0
UA	5222	5309	-2	1598	1578	1	4789	4793	0
MD	291	294	-1	88	87	2	296	294	1
RU	15472	15425	0	5968	5732	4	7361	7281	1
LV	390	410	-5	230	214	7	226	220	3
LT	466	489	-5	259	247	5	332	327	1
CZ	2159	2181	-1	740	734	1	664	673	-1
SK	879	909	-3	333	329	1	377	378	0
SI	260	269	-3	151	151	0	144	145	-1
HR	708	729	-3	342	331	3	288	288	0
BA	966	1000	-3	305	291	5	264	259	2
YU*	1803	1849	-3	437	420	4	636	635	0
MK	300	309	-3	82	81	2	126	125	1
CY	36	36	0	26	25	2	12	12	5
REM	7986	7986	0	3092	3074	1	4594	4595	0
BAS	2689	2706	-1	1067	987	8	1014	1009	1
NOS	6392	6418	0	2489	2327	7	1981	1982	0
ATL	14200	14089	1	5117	4881	5	2729	2678	2
MED	12562	12453	1	2068	2034	2	1975	1995	-1
BLS	2827	2812	1	605	571	6	1072	1073	0

SUM is the deposition at the receptor (in tonnes of S or N) computed as a sum of the contributions from individual sources.
TOTAL is the deposition at the receptor (in tonnes of S or N) computed in one run with all emission sources included.
DIFF is the difference between SUM and TOTAL expressed in percent of TOTAL.

Table 1: The ratio of 1997 to 1996 emissions for selected emitters.

Emitter country	SO_2	NO_2	NH_3
Germany	0.95	0.96	1.00
Italy	1.00	1.00	1.00
Poland	0.92	1.00	0.97
United Kingdom	0.82	0.91	1.01
Czech Republic	0.74	0.98	1.00
Croatia	1.11	1.09	1.04

Table 2: Differences between 1997 and 1996 partial source-receptor matrices for oxidized sulphur. Units: % of the emissions from each emitter.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	-16	4	-34	0	-8	-33
	IT	7	-8	-17	100	-24	9
	PL	16	2	66	27	27	-13
	GB	-44	20	-80	52	-70	
	CZ	13	17	13	33	101	0
	HR	25	-14	-27	50	-17	122
	NO	-15	-40	-49	-52	-53	-100
	RU	9	27	9	-19	-26	17
	ES	-28	32	0	-38	-17	
	TR	227	413	161	350	170	300

Table 3: Differences between 1997 and 1996 partial source-receptor matrices for oxidized nitrogen. Units: % of the emissions from each emitter.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	16	36	-26	47	-10	-50
	IT	65	-4	21	64	25	41
	PL	47	6	39	73	40	0
	GB	-26	-14	-76	32	-65	
	CZ	37	47	-9	129	110	0
	HR	92	13	-12	50	17	180
	NO	-21	-43	-46	-24	-60	
	RU	15	10	36	4	-7	20
	ES	33	71	100	24	100	100
	TR	300	300	260	267	233	200

Table 4: Differences between 1997 and 1996 partial source-receptor matrices for reduced nitrogen. Units: % of the emissions from each emitter.

		Emitters					
		DE	IT	PL	GB	CZ	HR
Receptors	DE	12	133	-29	56	-21	-50
	IT	52	36	17	100	-29	-29
	PL	51	90	7	100	42	-25
	GB	-40	25	-82	1	-63	
	CZ	22	267	-2	150	10	0
	HR	86	66	-38	0	0	5
	NO	-12	0	-24	-20	-50	
	RU	-5	43	21	0	-28	-20
	ES	-17	100	0	0	0	
	TR	267	967	167		300	

Compared to 1996 results, some differences in 1997 computations can be noticed for the relative contribution of dry and wet deposition to the total deposition. In Table 23, ratio of dry to total deposition is presented for the Eulerian model results in 1996 and 1997, and in addition, for the Lagrangian model results in 1996. The contribution of dry to total deposition in the Eulerian model results is higher for 1997 than for 1996. The main reason for this is the approximately 20% lower annual precipitation in the EMEP domain in 1997 compared to 1996.

Table 5: Ratio of dry to total deposition for different models and years.

Model & year	Oxidized sulphur	Oxidized nitrogen	Reduced nitrogen
Lagrangian - 1996	53	36	38
Eulerian - 1996	53	42	57
Eulerian - 1997	65	62	66

7.3 Source-receptor matrices and import-export budgets for 1997

The main, and for the first time, routine application of the EMEP Eulerian Acid Deposition model this year was the computation of source-receptor matrices and import-export budgets for 1997.

Source-receptor matrices for oxidized sulphur, oxidized nitrogen and reduced nitrogen are shown in Tables 24, 25 and 26, respectively. In these tables, the last column denoted as SUM gives the sum of all depositions to the considered receptor, which is equal to the sum of all columns in the source-receptor matrix. The last row in the source-receptor matrices, also denoted as SUM, gives the sum of all depositions from the considered emitter, which is equal to the sum of all rows in the source-receptor matrix.

In Tables 27, 28 and 29, the so called percent source-receptor matrices are shown for oxidized sulphur, oxidized nitrogen and reduced nitrogen, respectively. These matrices are defined as:

$$s_p(i, j) = 100\% \cdot s(i, j) / \left(\sum_{k=1}^{N_r} s(k, j) \right) \tag{7}$$

where $s_p(i,j)$ is the percent source-receptor matrix, $s(i,j)$ is the source-receptor matrix, and N_r is the number of receptors.The percent source-receptor matrices give contribution of each emitter to the total deposition in each receptor.

The parts of the source-receptor matrices involving a group of 15 countries belonging to European Union are presented in Table 30. The only reason for a separate treatment of the EU part of the source-receptor matrices was the clarity of the presentation. With the EU part included, definitions of "SUM" columns and rows in the full matrices would be not correct.

Export-import budgets for 1997 are presented in Table 31. In the export-import budgets, export of pollutant mass - $E_m(i)$ from the country *i* is defined as

$$E_m(i) = Q(i) - s(i, i) \tag{8}$$

where $Q(i)$ is the emission from country i and $s(i,i)$ is the element in the source-receptor matrix representing indigenous deposition to the country *i*. Exported fraction of emission $E_{\%}(i)$ from the country *i* is given by

$$E_{\%}(i) = 100\% \cdot \frac{Q(i) - s(i, i)}{Q(i)} \tag{9}$$

Import of pollutants mass to the country *i* is defined as deposition resulting from all emissions except emission from the country *i*:

$$I_m(i) = \sum_{k=1}^{N_e} s(k, j) - s(i, i) \tag{10}$$

where N_e is the number of emitters in the source receptor matrix. Imported deposition is also given, in Table 30, as a fraction, $I_{\%}$, of the total deposition to the country *i*:

$$I_{\%} = 100\% \cdot \left(\sum_{k=1}^{N_e} s(k, j) - s(i, i) \right) / \left(\sum_{k=1}^{N_e} s(k, j) \right) \tag{11}$$

Source-receptor matrices, import-export budgets and other results of the computations for 1997 will by available on internet in the middle of September under address: *http://www.emep.int*.

Table 24:
Source-receptor (country-to-country) matrix for oxidized sulphur in 1997
(Units: 100 tonnes of S, Emitters → Receptors ↓)

	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	SUM	
AT	61	13	10	2	0	48	145	3	33	0	1	89	1	5	0	50	1	8	30	0	5	0	18	1	2	0	2	0	0	78	19	65	6	8	7	0	0	3	2	7	1	0	0	1	32	758	AT
BE	0	165	0	1	0	76	40	0	1	0	1	3	1	45	0	4	1	0	24	0	0	0	32	0	0	0	0	0	0	6	0	0	0	1	0	0	0	1	0	24	2	0	0	2	3	437	BE
BG	2	2	1179	0	0	8	32	63	62	0	0	49	0	1	0	55	1	228	18	0	0	4	4	2	45	2	7	0	1	21	15	5	4	52	147	7	1	17	1	1	1	0	0	2	110	2149	BG
DK	1	9	1	73	0	21	49	0	4	1	2	3	0	5	1	28	1	1	12	4	0	0	44	0	1	0	6	0	1	7	2	1	0	1	1	0	0	1	34	26	2	0	0	7	2	354	DK
FI	1	7	2	9	201	19	70	0	16	0	1	7	0	3	3	74	0	8	19	19	0	0	24	15	11	0	288	11	9	20	6	2	1	6	6	0	0	54	55	8	3	0	0	7	13	1003	FI
FR	4	111	11	4	0	1560	184	6	18	0	10	156	6	31	0	34	30	5	786	1	15	0	174	0	2	0	1	0	0	37	5	9	4	11	8	0	0	22	3	105	53	1	0	25	107	3540	FR
DE	20	151	8	23	1	353	1711	3	41	0	9	58	8	74	1	315	6	8	149	3	22	0	197	3	4	0	12	2	3	442	15	9	2	10	8	0	0	7	42	94	11	0	0	12	49	3886	DE
GR	1	1	482	0	0	9	16	437	31	0	0	65	0	0	0	26	1	56	31	0	0	5	2	1	15	0	2	0	0	11	7	3	2	32	58	9	1	39	0	1	1	0	0	4	175	1529	GR
HU	13	3	28	1	0	13	72	9	596	0	0	51	0	1	0	137	1	99	21	0	1	1	5	2	12	0	4	0	1	60	92	18	22	49	79	0	0	6	2	2	1	0	0	1	53	1459	HU
IS	0	2	0	0	0	5	3	0	0	22	3	1	0	1	0	2	0	0	9	0	0	0	17	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	3	0	0	14	1	90	IS
IE	0	5	1	1	0	19	8	0	1	0	202	2	0	2	0	2	2	0	35	0	0	0	88	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	7	15	0	0	10	5	408	IE
IT	12	9	49	1	0	103	65	29	47	0	1	1641	1	3	0	44	9	25	160	0	9	1	14	1	6	0	1	0	0	34	11	53	24	72	42	1	0	37	1	5	5	0	0	10	1367	3894	IT
LU	0	5	0	0	0	8	5	0	0	0	0	1	2	1	0	1	0	0	4	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	30	LU
NL	0	68	0	1	0	47	64	0	2	0	2	2	0	108	0	8	1	0	19	0	0	0	40	0	0	0	1	0	0	7	1	0	0	1	0	0	0	1	1	43	2	0	0	3	3	427	NL
NO	1	14	4	18	5	40	97	2	10	1	7	6	0	6	49	47	1	4	34	14	1	0	100	3	3	0	151	3	3	17	4	2	0	4	4	0	0	6	18	37	15	0	0	28	8	764	NO
PL	12	27	53	24	4	68	731	12	181	0	3	49	1	13	2	4909	3	67	55	8	2	1	65	31	69	1	53	9	23	437	91	18	7	36	41	1	0	15	52	24	3	0	0	7	58	7263	PL
PT	0	0	0	0	0	5	1	0	0	0	0	4	0	0	0	0	337	0	145	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	40	1	0	7	6	554	PT
RO	8	7	341	2	0	25	106	52	222	0	1	104	0	3	0	235	2	1452	32	1	1	8	12	10	149	6	21	2	3	65	59	16	10	114	240	3	1	23	3	4	1	0	0	3	175	3525	RO
ES	1	4	7	0	0	80	13	4	5	0	2	49	0	2	0	6	156	3	2836	0	1	0	13	0	1	0	0	0	0	5	1	3	2	7	5	0	0	29	0	4	92	12	0	19	72	3431	ES
SE	3	22	6	57	31	56	181	2	28	0	5	14	1	9	18	113	1	9	43	119	1	0	93	10	9	0	101	10	10	35	9	4	2	10	9	0	0	23	114	35	8	0	0	16	14	1232	SE
CH	2	8	2	0	0	64	23	1	2	0	0	64	1	3	0	4	2	1	42	0	39	0	12	0	0	0	0	0	0	5	0	3	1	2	1	0	0	2	0	4	1	0	0	1	20	309	CH
TR	4	3	532	1	0	20	49	142	56	0	0	118	0	1	0	81	1	162	56	0	1	778	9	7	177	3	57	1	2	27	16	9	4	53	74	3	32	318	2	2	1	0	0	16	299	3118	TR
GB	1	30	4	4	0	107	70	1	5	0	61	12	1	14	1	16	5	3	101	1	1	0	2625	0	1	0	1	0	0	13	2	1	1	4	3	0	0	3	3	147	43	0	0	31	16	3331	GB
BY	3	7	45	7	5	20	121	7	55	0	1	21	0	3	1	388	0	59	19	3	1	2	21	290	110	1	87	20	42	43	21	5	3	19	25	0	0	20	14	5	1	0	0	2	31	1530	BY
UA	9	11	325	7	3	35	232	62	252	0	1	107	0	5	1	738	1	449	42	3	1	25	26	104	1806	21	211	9	20	110	87	19	10	85	111	3	1	59	13	7	2	0	0	7	200	5222	UA
MD	0	1	30	0	0	2	10	5	11	0	0	7	0	0	0	28	0	85	2	0	0	1	1	3	47	8	4	0	1	5	3	1	1	6	8	0	0	3	0	0	0	0	0	0	17	291	MD
RU	17	41	542	30	104	126	566	109	290	0	7	169	2	15	7	995	0	454	134	26	3	122	106	385	1612	13	7515	89	93	206	98	37	14	127	150	4	7	861	80	28	12	0	0	32	241	15471	RU
LV	1	4	8	4	5	11	47	2	12	0	1	6	0	2	1	66	0	7	8	3	0	0	11	15	12	0	22	43	26	13	4	1	1	4	4	0	0	15	16	4	1	0	0	2	8	390	LV
LT	1	4	10	6	2	11	52	2	14	0	1	6	0	2	0	121	0	10	11	3	0	0	15	16	14	0	21	13	68	15	5	1	1	4	4	0	0	6	13	4	1	0	0	2	8	466	LT
CZ	15	12	7	3	0	34	352	2	72	0	1	21	1	5	0	413	1	11	19	1	1	0	16	2	5	0	4	1	1	1058	37	10	3	9	10	0	0	3	5	7	1	0	0	1	17	2159	CZ
SK	6	3	19	1	0	9	68	5	172	0	0	23	0	1	0	219	1	27	11	0	0	0	4	2	11	0	4	1	1	68	133	9	4	20	22	0	0	3	2	2	0	0	0	1	25	879	SK
SI	6	1	5	0	0	6	15	2	12	0	0	45	0	0	0	10	1	4	11	0	0	0	1	0	1	0	0	0	0	10	3	79	16	6	5	0	0	2	0	0	0	0	0	0	17	260	SI
HR	7	2	17	0	0	15	35	7	72	0	0	71	0	1	0	35	1	19	29	0	1	0	3	0	3	0	1	0	0	25	13	27	102	114	47	0	0	6	1	1	1	0	0	1	50	708	HR
BA	4	2	21	1	0	16	35	9	55	0	0	69	0	1	0	33	1	16	26	0	1	1	5	1	4	0	1	0	0	24	11	8	16	461	60	1	0	9	1	2	1	0	0	1	68	966	BA
YU*	5	4	84	1	0	19	54	26	135	0	0	86	0	1	0	82	1	107	24	0	1	1	7	1	15	0	3	0	1	38	27	9	13	255	655	6	0	21	2	2	1	0	0	1	114	1803	YU*
MK	1	0	53	0	0	3	6	32	11	0	0	21	0	0	0	9	0	14	9	0	0	1	1	0	2	0	0	0	0	4	3	1	1	14	35	13	0	19	0	0	0	0	0	0	45	300	MK
CY	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	2	0	0	0	0	0	1	2	36	CY
AM	0	0	4	0	0	0	1	2	1	0	0	1	0	0	0	1	0	1	0	0	0	18	0	0	2	0	2	0	0	0	0	0	0	1	1	0	1	62	0	0	0	0	0	0	3	104	AM
MT	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	8	MT
REM	6	9	321	4	11	79	97	207	83	0	2	365	0	3	1	121	23	120	266	4	2	257	22	24	299	2	469	16	10	39	22	17	8	94	101	6	35	4131	22	6	21	3	0	45	881	8253	REM
BAS	4	37	13	134	90	83	380	3	53	0	6	22	1	17	6	476	1	21	53	93	1	0	104	22	23	0	100	41	33	74	20	7	3	17	16	0	0	81	540	52	6	0	0	28	28	2689	BAS
NOS	5	212	11	77	1	561	562	3	32	1	60	40	3	165	26	184	10	9	210	13	3	1	2382	2	4	0	9	1	2	102	12	6	2	14	11	0	0	7	43	1285	74	0	0	200	45	6391	NOS
ATL	7	127	9	33	22	691	423	7	39	93	415	87	4	46	33	155	844	19	2314	16	5	1	1768	14	25	1	1020	7	8	96	14	10	3	8	15	0	0	51	34	237	2560	5	0	2798	136	14200	ATL
MED	23	17	1214	3	0	411	181	810	259	0	2	2142	1	7	0	209	42	254	970	1	6	149	40	5	76	3	11	1	2	114	60	80	89	388	289	12	69	586	4	13	57	24	0	296	3643	12562	MED
BLS	4	4	484	2	1	15	74	76	101	0	0	70	0	1	0	167	0	424	26	1	0	85	9	19	636	14	113	2	5	37	28	7	4	53	92	2	3	73	4	2	1	0	0	34	152	2827	BLS
SUM	271	1166	5949	535	489	4902	7049	2145	3093	119	809	5928	39	608	150	10640	1489	4250	8850	340	126	1471	8131	991	5217	79	10311	285	372	3412	956	556	384	2174	2399	74	174	6651	1130	2241	3043	48	0	3676	8330	121056	SUM
	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	SUM	

Table 25:

Source-receptor (country-to-country) matrix for oxidized nitrogen in 1997

(Units: 100 tonnes of N, Emitters → Receptors ↓)

	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	SUM	
AT	76	10	1	3	0	33	129	1	6	0	0	92	1	11	1	15	1	2	7	1	13	1	12	0	1	0	1	0	0	37	5	19	4	1	1	0	0	0	2	6	2	0	0	0	0	496	AT
BE	0	128	0	1	0	66	56	0	0	0	1	3	2	51	1	1	1	0	8	0	1	0	42	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	29	6	0	0	0	0	403	BE
BG	5	1	172	1	1	6	16	31	13	0	0	33	0	2	1	19	1	62	5	1	1	9	3	2	18	2	10	0	0	8	6	2	3	6	15	1	0	4	2	2	2	0	0	0	0	466	BG
DK	1	8	0	37	1	19	37	0	1	1	2	3	0	16	7	10	1	0	4	8	1	0	58	1	0	0	4	0	0	3	1	0	0	0	0	0	0	1	24	37	8	0	0	0	0	296	DK
FI	1	5	0	16	190	12	37	0	1	0	1	4	0	10	11	23	0	1	3	43	1	0	22	6	2	0	41	4	4	5	1	0	0	0	0	0	0	13	57	12	5	0	0	0	0	533	FI
FR	10	117	2	8	1	1861	254	4	4	1	12	243	12	73	5	15	35	2	306	4	44	1	218	1	2	0	5	0	0	17	2	6	3	3	1	0	0	3	6	143	142	1	0	0	0	3567	FR
DE	36	156	1	34	3	298	1568	1	6	1	8	60	14	202	10	90	5	1	38	14	59	0	231	3	2	0	10	1	1	129	5	3	1	1	0	0	0	2	45	130	28	0	0	0	0	3195	DE
GR	3	1	52	1	1	14	13	205	5	0	0	82	0	2	1	11	2	16	18	1	2	13	5	1	7	1	6	0	0	5	2	2	2	6	7	1	1	10	2	2	4	0	0	0	0	506	GR
HU	29	3	4	2	1	12	49	3	157	0	0	55	0	4	1	61	1	21	6	2	3	1	5	1	5	0	4	0	0	40	46	9	17	8	8	0	0	1	3	3	2	0	0	0	0	565	HU
IS	0	2	0	1	1	5	5	0	0	8	3	1	0	2	2	2	1	0	2	1	0	0	19	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	4	7	0	0	0	0	67	IS
IE	0	7	0	1	0	25	15	0	0	0	32	2	0	8	2	1	4	0	14	1	1	0	96	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	21	47	0	0	0	0	282	IE
IT	31	9	9	3	1	151	81	24	13	0	1	1588	1	11	2	23	9	8	95	3	33	5	18	1	4	0	5	0	0	20	6	32	24	24	8	1	0	8	4	9	16	1	0	0	0	2280	IT
LU	0	5	0	0	0	7	7	0	0	0	0	0	4	2	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	31	LU
NL	0	41	0	2	0	32	72	0	0	0	2	2	1	157	1	2	1	0	5	1	1	0	52	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	44	6	0	0	0	0	426	NL
NO	1	11	0	25	7	30	50	0	1	1	5	4	0	22	95	13	1	0	8	28	1	0	108	1	0	0	10	1	1	4	1	0	0	0	0	0	0	1	20	50	20	0	0	0	0	525	NO
PL	21	25	3	42	8	61	371	3	29	0	2	38	2	44	9	1235	2	13	14	28	7	1	71	25	20	1	36	4	10	188	32	6	4	3	3	0	0	4	68	37	10	0	0	0	0	2483	PL
PT	0	1	0	0	0	12	3	0	0	0	1	5	0	1	0	1	282	0	93	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2	93	1	0	0	0	503	PT
RO	16	4	50	3	2	17	59	17	54	0	0	85	0	7	1	87	1	257	8	3	4	11	9	7	50	7	20	0	1	32	30	7	8	14	22	1	0	5	5	4	3	0	0	0	0	911	RO
ES	4	5	1	1	1	138	24	3	2	0	3	94	0	6	2	6	159	2	1468	1	4	1	26	0	1	0	3	0	0	4	1	3	2	2	1	0	0	4	1	10	157	7	0	0	0	2150	ES
SE	3	19	0	72	45	48	111	0	3	1	4	10	1	33	40	48	1	1	9	190	3	0	99	5	2	0	26	4	5	12	2	1	1	1	0	0	0	7	117	58	15	0	0	0	0	996	SE
CH	2	6	0	0	0	51	25	0	0	0	0	60	1	5	0	1	1	0	8	0	61	0	7	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	3	2	0	0	0	0	238	CH
TR	7	3	64	4	3	25	32	93	10	0	0	100	0	5	3	36	2	51	28	4	3	780	11	6	66	5	92	1	1	10	6	3	3	7	8	1	12	66	5	5	8	0	0	0	0	1573	TR
GB	2	30	0	8	1	111	83	0	1	1	35	12	1	53	11	9	8	1	36	5	3	1	1494	0	1	0	3	0	0	7	1	1	0	1	0	0	0	1	6	180	99	0	0	0	0	2206	GB
BY	5	4	3	12	7	14	59	2	8	0	1	13	0	8	3	141	1	10	4	10	2	3	16	88	34	1	63	6	17	18	8	2	1	1	1	0	0	4	16	8	3	0	0	0	0	599	BY
UA	15	6	38	12	8	23	95	23	42	0	1	64	0	11	5	270	1	106	10	12	4	39	21	59	344	21	197	3	8	44	35	6	5	8	9	1	0	17	18	10	6	0	0	0	0	1598	UA
MD	1	0	4	1	0	1	4	2	2	0	0	4	0	1	0	11	0	19	0	1	0	2	1	2	16	7	4	0	0	2	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0	88	MD
RU	21	19	44	49	137	61	195	30	30	2	3	97	1	34	32	289	3	85	20	72	9	111	81	168	351	12	3423	28	40	54	25	9	6	9	9	1	1	242	96	39	27	0	0	0	0	5969	RU
LV	2	4	1	11	8	9	33	0	2	0	1	4	0	7	2	29	0	1	2	12	1	0	13	7	3	0	16	7	9	6	1	0	0	0	0	0	0	4	24	7	2	0	0	0	0	230	LV
LT	2	4	1	14	4	10	36	1	2	0	1	4	0	7	2	49	0	2	3	10	1	1	18	10	4	0	16	4	12	7	2	0	0	0	0	0	0	2	20	8	2	0	0	0	0	259	LT
CZ	26	12	1	5	1	29	163	1	13	0	1	22	1	14	1	91	1	2	5	3	5	0	16	1	1	0	3	0	0	284	12	4	2	1	1	0	0	0	6	9	2	0	0	0	0	740	CZ
SK	12	3	2	2	0	8	37	2	33	0	0	23	0	4	0	82	0	6	3	1	2	1	4	1	3	0	2	0	0	40	40	4	3	3	3	0	0	1	2	2	1	0	0	0	0	333	SK
SI	12	1	1	0	0	6	11	1	3	0	0	64	0	1	0	4	0	1	4	0	1	0	1	0	0	0	0	0	0	5	1	18	9	2	1	0	0	0	0	1	1	0	0	0	0	151	SI
HR	17	2	3	1	0	16	25	4	17	0	0	112	0	2	0	15	1	4	12	1	3	1	3	0	1	0	2	0	0	14	6	11	42	15	5	0	0	1	1	2	2	0	0	0	0	342	HR
BA	11	2	3	1	0	15	25	5	16	0	0	99	0	3	1	15	1	4	10	1	3	2	4	0	1	0	2	0	0	14	6	5	14	27	6	0	0	2	1	2	2	0	0	0	0	305	BA
YU*	12	3	13	2	1	15	32	11	38	0	0	94	0	4	1	32	1	26	9	2	3	2	6	1	5	1	4	0	0	21	14	4	12	23	34	2	0	4	2	3	3	0	0	0	0	437	YU*
MK	1	0	7	0	0	3	3	16	2	0	0	20	0	0	0	3	0	3	3	0	0	1	1	0	1	0	1	0	0	1	1	1	1	2	4	1	0	3	0	0	1	0	0	0	0	82	MK
CY	0	0	1	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	26	CY
AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	10	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	38	AM
MT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MT
REM	18	11	45	15	24	143	93	160	17	1	2	491	1	17	10	70	28	39	159	21	12	309	48	17	72	4	373	6	6	24	10	10	11	20	14	2	15	778	34	21	59	5	0	0	0	3231	REM
BAS	6	23	1	79	49	51	166	1	5	0	3	16	1	37	12	99	1	3	10	88	4	0	83	9	5	0	31	6	8	21	5	2	1	1	1	0	0	11	172	46	12	0	0	0	0	1067	BAS
NOS	6	105	1	47	3	273	266	1	3	1	28	34	4	203	55	35	9	2	53	18	8	1	786	2	1	0	9	1	1	21	2	1	1	1	1	0	0	1	26	389	91	0	0	0	0	2489	NOS
ATL	10	103	1	57	33	518	313	3	5	33	146	67	5	134	129	58	255	4	397	42	13	2	1058	8	6	0	103	2	3	29	4	3	1	2	1	0	0	8	44	296	1216	3	0	0	0	5117	ATL
MED	21	8	43	6	4	193	74	203	16	1	1	733	1	13	5	41	21	27	239	6	14	94	30	3	17	2	20	0	1	20	8	16	20	24	12	2	12	40	8	14	48	6	0	0	0	2068	MED
BLS	5	1	40	3	2	10	20	30	7	0	0	42	0	3	2	32	1	53	7	3	2	76	6	7	85	7	100	1	1	7	5	2	2	4	6	1	1	20	4	3	3	0	0	0	0	605	BLS
SUM	455	910	609	585	548	4431	4747	884	565	53	299	4582	60	1230	467	3073	842	839	3134	643	333	1489	4808	445	1134	75	4655	81	136	1160	334	193	206	221	187	15	52	1295	848	1656	2162	26	0	0	0	50494	SUM
	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	SUM	

Table 26:

Source-receptor (country-to-country) matrix for reduced nitrogen in 1997

(Units: 100 tonnes of N, Emitters → Receptors ↓)

	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	SUM	
AT	239	7	1	2	0	23	234	0	12	0	0	80	1	8	0	8	1	2	6	1	25	0	5	1	2	0	1	0	0	32	10	18	3	1	1	0	0	1	0	0	0	0	0	0	0	726	AT
BE	0	207	0	1	0	77	32	0	0	0	1	1	6	43	0	1	1	0	5	0	1	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	387	BE
BG	3	0	257	0	0	2	7	41	9	0	0	14	0	1	0	9	0	111	3	0	1	5	1	2	36	6	4	0	0	3	4	1	2	4	52	11	0	10	0	0	0	0	0	0	0	597	BG
DK	1	4	0	218	0	11	62	0	1	0	2	1	0	11	1	8	0	0	2	7	1	0	13	1	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	349	DK
FI	1	3	0	10	145	7	22	0	1	0	1	1	0	5	5	17	0	1	2	20	0	0	7	10	5	0	13	4	4	2	1	0	0	0	1	0	0	19	0	0	0	0	0	0	0	310	FI
FR	5	93	1	3	0	3181	118	1	1	0	10	96	10	31	0	4	14	1	195	1	62	0	57	0	1	0	1	0	0	3	0	1	1	1	1	0	0	12	0	0	0	0	0	0	0	3906	FR
DE	57	103	1	39	0	229	2745	1	3	0	7	28	17	267	2	68	3	1	25	7	96	0	67	4	3	0	4	1	2	45	3	1	1	1	1	0	0	3	0	0	0	0	0	0	0	3835	DE
GR	1	0	25	0	0	4	3	349	3	0	0	21	0	0	0	4	0	11	6	0	1	11	0	1	8	1	1	0	0	1	1	0	1	3	14	23	0	34	0	0	0	0	0	0	0	529	GR
HU	35	1	3	1	0	5	29	2	235	0	0	30	0	2	0	22	0	44	4	1	2	0	1	2	20	1	2	0	0	20	55	12	19	5	27	1	0	3	0	0	0	0	0	0	0	586	HU
IS	0	1	0	1	0	3	2	0	0	8	3	0	0	1	0	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	IS
IE	0	3	0	1	0	18	6	0	0	0	484	1	0	3	0	0	1	0	6	0	0	0	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	580	IE
IT	21	2	5	0	0	45	35	8	5	0	0	2022	0	2	0	7	3	4	37	0	31	1	2	1	3	0	1	0	0	5	2	13	10	9	9	1	0	22	0	0	0	0	0	0	0	2310	IT
LU	0	6	0	0	0	10	7	0	0	0	0	0	9	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	LU
NL	0	73	0	2	0	27	115	0	0	0	2	1	1	382	0	1	0	0	3	0	1	0	13	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	621	NL
NO	1	7	1	26	3	20	36	0	1	0	5	2	0	12	101	13	1	1	5	23	1	0	32	3	2	0	5	1	1	2	1	0	0	1	1	0	0	2	0	0	0	0	0	0	0	312	NO
PL	21	13	4	30	2	34	292	3	19	0	2	19	1	27	2	1557	1	19	10	18	7	1	20	84	110	3	27	4	17	92	49	4	3	2	6	1	0	7	0	0	0	0	0	0	0	2510	PL
PT	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	297	0	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	370	PT
RO	14	2	52	1	0	8	36	15	70	0	0	44	0	4	0	41	1	918	6	1	3	6	3	11	191	49	12	0	1	16	23	4	6	11	58	4	0	12	0	0	0	0	0	0	0	1622	RO
ES	1	2	1	0	0	99	5	1	1	0	2	20	0	1	0	1	114	0	1547	0	2	0	4	0	0	0	0	0	0	1	0	1	1	1	1	0	0	22	0	0	0	0	0	0	0	1828	ES
SE	2	10	0	68	20	29	77	0	2	0	3	4	1	19	24	38	1	1	6	220	2	0	27	9	5	0	11	3	5	6	2	1	0	1	1	0	0	8	0	0	0	0	0	0	0	607	SE
CH	2	5	0	0	0	67	38	0	0	0	0	47	1	4	0	1	1	0	8	0	271	0	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	452	CH
TR	3	1	37	1	0	9	11	42	7	0	0	32	0	1	0	16	1	50	11	0	1	1568	1	6	112	10	42	0	1	4	3	2	1	5	14	4	5	205	0	0	0	0	0	0	0	2204	TR
GB	1	18	1	5	0	100	43	0	1	0	114	5	1	23	1	4	3	0	18	2	3	0	1006	0	1	0	0	0	0	3	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1358	GB
BY	5	2	3	6	2	8	36	1	6	0	1	6	0	4	1	128	0	15	3	4	2	1	6	944	192	4	52	12	40	8	6	1	1	2	4	0	0	8	0	0	0	0	0	0	0	1515	BY
UA	12	3	27	6	1	11	55	15	35	0	1	31	0	6	1	212	1	184	7	4	3	19	6	219	3515	131	167	2	9	21	30	4	4	7	19	3	0	20	0	0	0	0	0	0	0	4789	UA
MD	0	0	3	0	0	0	2	1	1	0	0	2	0	0	0	5	0	53	0	0	0	1	0	4	107	107	2	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	296	MD
RU	15	10	35	23	47	30	113	18	27	0	2	43	1	15	7	217	1	102	13	27	6	93	22	343	851	23	4789	31	43	28	19	5	4	9	20	3	1	324	0	0	0	0	0	0	0	7361	RU
LV	1	2	1	6	2	5	22	0	1	0	1	2	0	4	1	27	0	2	1	7	1	0	5	24	7	0	9	40	32	3	1	0	0	0	1	0	0	17	0	0	0	0	0	0	0	226	LV
LT	1	2	1	8	1	6	27	1	1	0	1	2	0	5	1	54	0	2	2	6	1	0	7	53	12	1	13	11	102	3	2	0	0	0	1	0	0	4	0	0	0	0	0	0	0	332	LT
CZ	52	6	1	4	0	18	202	0	9	0	0	11	1	9	0	54	0	2	3	2	6	0	5	2	4	0	2	0	1	238	25	3	2	1	1	0	0	1	0	0	0	0	0	0	0	664	CZ
SK	16	2	2	1	0	5	28	1	41	0	0	13	0	3	0	59	0	9	2	1	2	0	1	3	20	1	2	0	1	29	118	3	3	2	5	0	0	2	0	0	0	0	0	0	0	377	SK
SI	17	0	1	0	0	2	7	0	4	0	0	39	0	0	0	1	0	1	2	0	1	0	0	0	1	0	0	0	0	2	1	52	8	1	1	0	0	1	0	0	0	0	0	0	0	144	SI
HR	17	1	2	0	0	6	13	2	24	0	0	58	0	1	0	5	1	4	6	0	2	0	0	0	3	0	0	0	0	6	6	19	65	30	13	0	0	3	0	0	0	0	0	0	0	288	HR
BA	11	1	2	1	0	6	15	2	15	0	0	47	0	1	0	7	0	4	6	0	2	0	1	0	3	0	0	0	0	8	6	4	18	70	26	1	0	5	0	0	0	0	0	0	0	264	BA
YU*	10	1	9	1	0	6	19	7	41	0	0	43	0	2	0	15	0	44	5	0	2	1	2	1	12	1	1	0	0	11	13	3	11	26	317	13	0	19	0	0	0	0	0	0	0	636	YU*
MK	1	0	5	0	0	1	2	18	1	0	0	8	0	0	0	1	0	3	1	0	0	1	0	0	1	0	0	0	0	1	1	0	1	1	21	38	0	19	0	0	0	0	0	0	0	126	MK
CY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	12	CY
AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	121	0	0	0	0	0	0	0	169	AM
MT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MT
REM	6	3	18	4	4	38	25	41	7	0	1	122	0	3	1	23	9	23	45	5	4	272	5	15	95	3	274	9	5	5	4	3	3	7	27	9	3	3616	0	0	0	0	0	0	0	4736	REM
BAS	5	14	1	191	36	32	244	0	4	0	3	6	1	28	7	122	1	3	7	130	3	0	27	18	13	0	18	16	16	12	4	1	1	1	2	0	0	48	0	0	0	0	0	0	0	1014	BAS
NOS	6	118	1	138	1	430	318	1	2	0	45	13	2	186	20	30	4	1	32	18	9	0	575	2	2	0	3	0	1	12	2	1	1	1	2	0	0	3	0	0	0	0	0	0	0	1981	NOS
ATL	5	58	1	37	10	641	170	1	3	15	382	24	3	67	39	33	193	2	292	15	11	0	625	7	8	0	44	2	3	13	2	1	1	1	1	0	0	18	0	0	0	0	0	0	0	2729	ATL
MED	18	3	19	1	0	123	25	189	8	0	1	671	0	3	0	11	11	29	183	1	10	265	3	2	29	3	6	0	0	6	6	13	20	22	39	11	12	232	0	0	0	0	0	0	0	1975	MED
BLS	3	1	41	1	0	3	11	21	6	0	0	20	0	1	0	18	0	113	4	1	1	90	1	15	521	36	96	0	1	4	3	1	1	4	13	3	0	38	0	0	0	0	0	0	0	1072	BLS
SUM	610	787	562	836	276	5382	5290	784	608	24	1074	3632	57	1186	215	2843	663	1765	2589	524	575	2391	2626	1788	5896	381	5609	138	286	653	405	174	191	233	703	130	27	4900	0	0	0	0	0	0	0	56814	SUM
	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	SUM	

Table 27:
Contribution (in percent) of each emitter to the total deposition of oxidized sulphur in each country (region) in 1997

	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	
AT	8	2	1	0	0	6	19	0	4	0	0	12	0	1	0	7	0	1	4	0	1	0	2	0	0	0	0	0	0	10	2	9	1	1	1	0	0	0	0	1	0	0	0	0	4	AT
BE	0	38	0	0	0	17	9	0	0	0	0	1	0	10	0	1	0	0	5	0	0	0	7	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	0	0	0	0	1	BE
BG	0	0	55	0	0	0	1	3	3	0	0	2	0	0	0	3	0	11	1	0	0	0	0	0	2	0	0	0	0	1	1	0	0	2	7	0	0	1	0	0	0	0	0	0	5	BG
DK	0	3	0	21	0	6	14	0	1	0	1	1	0	1	0	8	0	0	4	1	0	0	12	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	10	7	1	0	0	2	1	DK
FI	0	1	0	1	20	2	7	0	2	0	0	1	0	0	0	7	0	1	2	2	0	0	2	2	1	0	29	1	1	2	1	0	0	1	1	0	0	5	5	1	0	0	0	1	1	FI
FR	0	3	0	0	0	44	5	0	0	0	0	4	0	1	0	1	1	0	22	0	0	0	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	3	1	0	0	1	3	FR
DE	1	4	0	1	0	9	44	0	1	0	0	1	0	2	0	8	0	0	4	0	1	0	5	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	1	2	0	0	0	0	1	DE
GR	0	0	32	0	0	1	1	29	2	0	0	4	0	0	0	2	0	4	2	0	0	0	0	0	1	0	0	0	0	1	0	0	0	2	4	1	0	3	0	0	0	0	0	0	11	GR
HU	1	0	2	0	0	1	5	1	41	0	0	3	0	0	0	9	0	7	1	0	0	0	0	0	1	0	0	0	0	4	6	1	2	3	5	0	0	0	0	0	0	0	0	0	4	HU
IS	0	2	0	0	0	6	4	0	0	25	3	1	0	1	0	2	0	0	10	0	0	0	19	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	2	3	0	0	15	1	IS
IE	0	1	0	0	0	5	2	0	0	0	49	1	0	0	0	0	1	0	9	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	3	1	IE
IT	0	0	1	0	0	3	2	1	1	0	0	42	0	0	0	1	0	1	4	0	0	0	0	0	0	0	0	0	0	1	0	1	1	2	1	0	0	1	0	0	0	0	0	0	35	IT
LU	0	15	0	0	0	25	16	0	0	0	0	2	7	3	0	2	0	0	12	0	0	0	6	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	1	0	0	0	2	LU
NL	0	16	0	0	0	11	15	0	0	0	0	1	0	25	0	2	0	0	4	0	0	0	9	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	10	0	0	0	1	1	NL
NO	0	2	0	2	1	5	13	0	1	0	1	1	0	1	6	6	0	1	4	2	0	0	13	0	0	0	20	0	0	2	0	0	0	0	1	0	0	1	2	5	2	0	0	4	1	NO
PL	0	0	1	0	0	1	10	0	2	0	0	1	0	0	0	68	0	1	1	0	0	0	1	0	1	0	1	0	0	6	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	PL
PT	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	61	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	0	0	1	1	PT
RO	0	0	10	0	0	1	3	1	6	0	0	3	0	0	0	7	0	41	1	0	0	0	0	0	4	0	1	0	0	2	2	0	0	3	7	0	0	1	0	0	0	0	0	0	5	RO
ES	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	5	0	83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	1	2	ES
SE	0	2	1	5	2	5	15	0	2	0	0	1	0	1	1	9	0	1	3	10	0	0	8	1	1	0	8	1	1	3	1	0	0	1	1	0	0	2	9	3	1	0	0	1	1	SE
CH	1	3	1	0	0	21	7	0	1	0	0	21	0	1	0	1	0	0	14	0	13	0	4	0	0	0	0	0	0	2	0	1	0	1	0	0	0	1	0	1	0	0	0	0	6	CH
TR	0	0	17	0	0	1	2	5	2	0	0	4	0	0	0	3	0	5	2	0	0	25	0	0	6	0	2	0	0	1	0	0	0	2	2	0	1	10	0	0	0	0	0	1	10	TR
GB	0	1	0	0	0	3	2	0	0	0	2	0	0	0	0	0	0	0	3	0	0	0	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	1	0	GB
BY	0	0	3	0	0	1	8	0	4	0	0	1	0	0	0	25	0	4	1	0	0	0	1	19	7	0	6	1	3	3	1	0	0	1	2	0	0	1	1	0	0	0	0	0	2	BY
UA	0	0	6	0	0	1	4	1	5	0	0	2	0	0	0	14	0	9	1	0	0	0	0	2	35	0	4	0	0	2	2	0	0	2	2	0	0	1	0	0	0	0	0	0	4	UA
MD	0	0	10	0	0	1	3	2	4	0	0	3	0	0	0	10	0	29	1	0	0	0	0	1	16	3	1	0	0	2	1	0	0	2	3	0	0	1	0	0	0	0	0	0	6	MD
RU	0	0	4	0	1	1	4	1	2	0	0	1	0	0	0	6	0	3	1	0	0	1	1	2	10	0	49	1	1	1	1	0	0	1	1	0	0	6	1	0	0	0	0	0	2	RU
LV	0	1	2	1	1	3	12	0	3	0	0	1	0	0	0	17	0	2	2	1	0	0	3	4	3	0	6	11	7	3	1	0	0	1	1	0	0	4	4	1	0	0	0	1	2	LV
LT	0	1	2	1	0	2	11	0	3	0	0	1	0	0	0	26	0	2	2	1	0	0	3	3	3	0	4	3	15	3	1	0	0	1	1	0	0	1	3	1	0	0	0	0	2	LT
CZ	1	1	0	0	0	2	16	0	3	0	0	1	0	0	0	19	0	0	1	0	0	0	1	0	0	0	0	0	0	49	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	CZ
SK	1	0	2	0	0	1	8	1	20	0	0	3	0	0	0	25	0	3	1	0	0	0	1	0	1	0	0	0	0	8	15	1	0	2	3	0	0	0	0	0	0	0	0	0	3	SK
SI	2	0	2	0	0	2	6	1	5	0	0	17	0	0	0	4	0	1	4	0	0	0	0	0	0	0	0	0	0	4	1	31	6	2	2	0	0	1	0	0	0	0	0	0	7	SI
HR	1	0	2	0	0	2	5	1	10	0	0	10	0	0	0	5	0	3	4	0	0	0	0	0	0	0	0	0	0	4	2	4	14	16	7	0	0	1	0	0	0	0	0	0	7	HR
BA	0	0	2	0	0	2	4	1	6	0	0	7	0	0	0	3	0	2	3	0	0	0	0	0	0	0	0	0	0	2	1	1	2	48	6	0	0	1	0	0	0	0	0	0	7	BA
YU*	0	0	5	0	0	1	3	1	7	0	0	5	0	0	0	5	0	6	1	0	0	0	0	0	1	0	0	0	0	2	2	0	1	14	36	0	0	1	0	0	0	0	0	0	6	YU*
MK	0	0	18	0	0	1	2	11	4	0	0	7	0	0	0	3	0	5	3	0	0	0	0	0	1	0	0	0	0	1	1	0	0	5	12	4	0	6	0	0	0	0	0	0	15	MK
CY	0	0	4	0	0	0	1	3	1	0	0	2	0	0	0	1	0	1	1	0	0	10	0	0	1	0	0	0	0	0	0	0	0	1	1	0	60	5	0	0	0	0	0	2	5	CY
AM	0	0	4	0	0	0	1	2	1	0	0	1	0	0	0	1	0	1	0	0	0	18	0	0	2	0	2	0	0	0	0	0	0	1	1	0	1	60	0	0	0	0	0	0	3	AM
MT	0	0	1	0	0	1	1	1	1	0	0	26	0	0	0	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	2	59	MT
REM	0	0	4	0	0	1	1	3	1	0	0	4	0	0	0	1	0	1	3	0	0	3	0	0	4	0	6	0	0	0	0	0	0	1	1	0	0	50	0	0	0	0	0	1	11	REM
BAS	0	1	0	5	3	3	14	0	2	0	0	1	0	1	0	18	0	1	2	3	0	0	4	1	1	0	4	2	1	3	1	0	0	1	1	0	0	3	20	2	0	0	0	1	1	BAS
NOS	0	3	0	1	0	9	9	0	1	0	1	1	0	3	0	3	0	0	3	0	0	0	37	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	20	1	0	0	3	1	NOS
ATL	0	1	0	0	0	5	3	0	0	1	3	1	0	0	0	1	6	0	16	0	0	0	12	0	0	0	7	0	0	1	0	0	0	0	0	0	0	0	0	2	18	0	0	20	1	ATL
MED	0	0	10	0	0	3	1	6	2	0	0	17	0	0	0	2	0	2	8	0	0	1	0	0	1	0	0	0	0	1	0	1	1	3	2	0	1	5	0	0	0	0	0	2	29	MED
BLS	0	0	17	0	0	1	3	3	4	0	0	2	0	0	0	6	0	15	1	0	0	3	0	1	22	1	4	0	0	1	1	0	0	2	3	0	0	3	0	0	0	0	0	1	5	BLS
	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	

Table 28:

Contribution (in percent) of each emitter to the total deposition of oxidized nitrogen in each country (region) in 1997.

	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	
AT	15	2	0	1	0	7	26	0	1	0	0	18	0	2	0	3	0	0	1	0	3	0	2	0	0	0	0	0	0	7	1	4	1	0	0	0	0	0	0	1	0	0	0	0	0	AT
BE	0	32	0	0	0	16	14	0	0	0	0	1	1	13	0	0	0	0	2	0	0	0	10	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	7	1	0	0	0	0	BE
BG	1	0	37	0	0	1	3	7	3	0	0	7	0	0	0	4	0	13	1	0	0	2	1	0	4	0	2	0	0	2	1	0	1	1	3	0	0	1	0	0	0	0	0	0	0	BG
DK	0	3	0	13	0	6	12	0	0	0	1	1	0	6	2	3	0	0	1	3	0	0	20	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	8	13	3	0	0	0	0	DK
FI	0	1	0	3	36	2	7	0	0	0	0	1	0	2	2	4	0	0	1	8	0	0	4	1	0	0	8	1	1	1	0	0	0	0	0	0	0	3	11	2	1	0	0	0	0	FI
FR	0	3	0	0	0	52	7	0	0	0	0	7	0	2	0	0	1	0	9	0	1	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	FR
DE	1	5	0	1	0	9	49	0	0	0	0	2	0	6	0	3	0	0	1	0	2	0	7	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	1	4	1	0	0	0	0	DE
GR	1	0	10	0	0	3	3	41	1	0	0	16	0	0	0	2	0	3	4	0	0	3	1	0	1	0	1	0	0	1	0	0	0	1	1	0	0	2	0	0	1	0	0	0	0	GR
HU	5	1	1	0	0	2	9	1	28	0	0	10	0	1	0	11	0	4	1	0	0	0	1	0	1	0	1	0	0	7	8	2	3	1	1	0	0	0	0	0	0	0	0	0	0	HU
IS	0	2	0	2	1	7	7	0	0	12	4	1	0	3	2	2	1	0	3	1	0	0	28	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	6	11	0	0	0	0	IS
IE	0	2	0	0	0	9	5	0	0	0	11	1	0	3	1	0	2	0	5	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	17	0	0	0	0	IE
IT	1	0	0	0	0	7	4	1	1	0	0	70	0	0	0	1	0	0	4	0	1	0	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	IT
LU	0	16	0	0	0	24	21	0	0	0	0	2	12	5	0	0	0	0	3	0	1	0	7	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	LU
NL	0	10	0	0	0	7	17	0	0	0	0	0	0	37	0	0	0	0	1	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	1	0	0	0	0	NL
NO	0	2	0	5	1	6	10	0	0	0	1	1	0	4	18	2	0	0	1	5	0	0	20	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	4	10	4	0	0	0	0	NO
PL	1	1	0	2	0	2	15	0	1	0	0	2	0	2	0	50	0	1	1	1	0	0	3	1	1	0	1	0	0	8	1	0	0	0	0	0	0	0	3	2	0	0	0	0	0	PL
PT	0	0	0	0	0	2	1	0	0	0	0	1	0	0	0	0	56	0	18	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	PT
RO	2	0	5	0	0	2	6	2	6	0	0	9	0	1	0	10	0	28	1	0	0	1	1	1	5	1	2	0	0	3	3	1	1	1	2	0	0	1	1	0	0	0	0	0	0	RO
ES	0	0	0	0	0	6	1	0	0	0	0	4	0	0	0	0	7	0	68	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	ES
SE	0	2	0	7	4	5	11	0	0	0	0	1	0	3	4	5	0	0	1	19	0	0	10	1	0	0	3	0	0	1	0	0	0	0	0	0	0	1	12	6	2	0	0	0	0	SE
CH	1	3	0	0	0	21	11	0	0	0	0	25	0	2	0	0	0	0	3	0	26	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	CH
TR	0	0	4	0	0	2	2	6	1	0	0	6	0	0	0	2	0	3	2	0	0	50	1	0	4	0	6	0	0	1	0	0	0	0	1	0	1	4	0	0	0	0	0	0	0	TR
GB	0	1	0	0	0	5	4	0	0	0	2	1	0	2	1	0	0	0	2	0	0	0	68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	4	0	0	0	0	GB
BY	1	1	0	2	1	2	10	0	1	0	0	2	0	1	1	24	0	2	1	2	0	0	3	15	6	0	11	1	3	3	1	0	0	0	0	0	0	1	3	1	0	0	0	0	0	BY
UA	1	0	2	1	0	1	6	1	3	0	0	4	0	1	0	17	0	7	1	1	0	2	1	4	21	1	12	0	1	3	2	0	0	0	1	0	0	1	1	1	0	0	0	0	0	UA
MD	1	0	4	1	0	1	4	2	2	0	0	4	0	1	0	12	0	21	1	1	0	2	1	2	18	8	5	0	0	2	2	0	0	0	1	0	0	1	1	0	0	0	0	0	0	MD
RU	0	0	1	1	2	1	3	0	1	0	0	2	0	1	1	5	0	1	0	1	0	2	1	3	6	0	57	0	1	1	0	0	0	0	0	0	0	4	2	1	0	0	0	0	0	RU
LV	1	2	0	5	3	4	14	0	1	0	0	2	0	3	1	13	0	1	1	5	0	0	6	3	1	0	7	3	4	3	1	0	0	0	0	0	0	2	10	3	1	0	0	0	0	LV
LT	1	2	0	5	1	4	14	0	1	0	0	2	0	3	1	19	0	1	1	4	0	0	7	4	2	0	6	2	5	3	1	0	0	0	0	0	0	1	8	3	1	0	0	0	0	LT
CZ	3	2	0	1	0	4	22	0	2	0	0	3	0	2	0	12	0	0	1	0	1	0	2	0	0	0	0	0	0	38	2	1	0	0	0	0	0	0	1	1	0	0	0	0	0	CZ
SK	4	1	1	0	0	2	11	1	10	0	0	7	0	1	0	25	0	2	1	0	1	0	1	0	1	0	1	0	0	12	12	1	1	1	1	0	0	0	1	1	0	0	0	0	0	SK
SI	8	0	0	0	0	4	7	1	2	0	0	42	0	1	0	3	0	1	3	0	1	0	1	0	0	0	0	0	0	3	1	12	6	1	1	0	0	0	0	0	0	0	0	0	0	SI
HR	5	1	1	0	0	5	7	1	5	0	0	33	0	1	0	4	0	1	3	0	1	0	1	0	0	0	0	0	0	4	2	3	12	5	1	0	0	0	0	0	1	0	0	0	0	HR
BA	4	1	1	0	0	5	8	2	5	0	0	33	0	1	0	5	0	1	3	0	1	1	1	0	0	0	1	0	0	5	2	2	4	9	2	0	0	1	0	1	1	0	0	0	0	BA
YU*	3	1	3	0	0	3	7	2	9	0	0	22	0	1	0	7	0	6	2	0	1	1	1	0	1	0	1	0	0	5	3	1	3	5	8	0	0	1	1	1	1	0	0	0	0	YU*
MK	1	0	9	0	0	4	4	19	2	0	0	25	0	1	0	3	0	4	4	0	1	1	1	0	1	0	1	0	0	2	1	1	1	2	5	1	0	4	0	1	1	0	0	0	0	MK
CY	0	0	2	0	0	1	1	14	0	0	0	5	0	0	0	1	0	1	1	0	0	32	0	0	1	0	2	0	0	0	0	0	0	0	0	0	31	2	0	0	0	0	0	0	0	CY
AM	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	26	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	AM
MT	1	0	1	0	0	8	4	3	1	0	0	51	0	1	0	3	1	1	9	0	1	2	2	0	1	0	1	0	0	1	1	1	1	1	1	0	0	2	1	1	2	0	0	0	0	MT
REM	1	0	1	0	1	4	3	5	1	0	0	15	0	1	0	2	1	1	5	1	0	10	1	1	2	0	12	0	0	1	0	0	0	1	0	0	0	24	1	1	2	0	0	0	0	REM
BAS	1	2	0	7	5	5	16	0	0	0	0	2	0	4	1	9	0	0	1	8	0	0	8	1	0	0	3	1	1	2	0	0	0	0	0	0	0	1	16	4	1	0	0	0	0	BAS
NOS	0	4	0	2	0	11	11	0	0	0	1	1	0	8	2	1	0	0	2	1	0	0	32	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	16	4	0	0	0	0	NOS
ATL	0	2	0	1	1	10	6	0	0	1	3	1	0	3	3	1	5	0	8	1	0	0	21	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	6	24	0	0	0	0	ATL
MED	1	0	2	0	0	9	4	10	1	0	0	35	0	1	0	2	1	1	12	0	1	5	1	0	1	0	1	0	0	1	0	1	1	1	1	0	1	2	0	1	2	0	0	0	0	MED
BLS	1	0	7	0	0	2	3	5	1	0	0	7	0	0	0	5	0	9	1	1	0	13	1	1	14	1	17	0	0	1	1	0	0	1	1	0	0	3	1	0	1	0	0	0	0	BLS
	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	

Table 29:

Contribution (in percent) of each emitter to the total deposition of reduced nitrogen in each country (region) in 1997

	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	
AT	33	1	0	0	0	3	32	0	2	0	0	11	0	1	0	1	0	0	1	0	3	0	1	0	0	0	0	0	0	4	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	AT
BE	0	54	0	0	0	20	8	0	0	0	0	0	2	11	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	BE
BG	0	0	43	0	0	0	1	7	1	0	0	2	0	0	0	2	0	19	0	0	0	1	0	0	6	1	1	0	0	1	1	0	0	1	9	2	0	2	0	0	0	0	0	0	0	BG
DK	0	1	0	62	0	3	18	0	0	0	1	0	0	3	0	2	0	0	1	2	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	DK
FI	0	1	0	3	47	2	7	0	0	0	0	0	0	2	2	6	0	0	1	6	0	0	2	3	2	0	4	1	1	1	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	FI
FR	0	2	0	0	0	81	3	0	0	0	0	2	0	1	0	0	0	0	5	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	FR
DE	1	3	0	1	0	6	72	0	0	0	0	1	0	7	0	2	0	0	1	0	3	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	DE
GR	0	0	5	0	0	1	1	66	1	0	0	4	0	0	0	1	0	2	1	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	3	4	0	6	0	0	0	0	0	0	0	GR
HU	6	0	0	0	0	1	5	0	40	0	0	5	0	0	0	4	0	8	1	0	0	0	0	0	3	0	0	0	0	3	9	2	3	1	5	0	0	1	0	0	0	0	0	0	0	HU
IS	0	2	0	2	0	10	7	0	0	33	11	1	0	3	1	2	0	0	4	0	0	0	21	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	IS
IE	0	1	0	0	0	3	1	0	0	0	84	0	0	1	0	0	0	0	1	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	IE
IT	1	0	0	0	0	2	2	0	0	0	0	88	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	IT
LU	0	17	0	0	0	28	21	0	0	0	0	0	24	3	0	0	0	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	LU
NL	0	12	0	0	0	4	19	0	0	0	0	0	0	61	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NL
NO	0	2	0	8	1	6	12	0	0	0	2	1	0	4	32	4	0	0	2	7	0	0	10	1	1	0	2	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	NO
PL	1	1	0	1	0	1	12	0	1	0	0	1	0	1	0	62	0	1	0	1	0	0	1	3	4	0	1	0	1	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	PL
PT	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	80	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	PT
RO	1	0	3	0	0	0	2	1	4	0	0	3	0	0	0	3	0	57	0	0	0	0	0	1	12	3	1	0	0	1	1	0	0	1	4	0	0	1	0	0	0	0	0	0	0	RO
ES	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	6	0	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	ES
SE	0	2	0	11	3	5	13	0	0	0	0	1	0	3	4	6	0	0	1	36	0	0	5	2	1	0	2	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	SE
CH	0	1	0	0	0	15	8	0	0	0	0	10	0	1	0	0	0	0	2	0	60	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	CH
TR	0	0	2	0	0	0	1	2	0	0	0	1	0	0	0	1	0	2	0	0	0	71	0	0	5	0	2	0	0	0	0	0	0	0	1	0	0	9	0	0	0	0	0	0	0	TR
GB	0	1	0	0	0	7	3	0	0	0	8	0	0	2	0	0	0	0	1	0	0	0	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	GB
BY	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	8	0	1	0	0	0	0	0	62	13	0	3	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	BY
UA	0	0	1	0	0	0	1	0	1	0	0	1	0	0	0	4	0	4	0	0	0	0	0	5	73	3	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	UA
MD	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	2	0	18	0	0	0	0	0	1	36	36	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	MD
RU	0	0	0	0	1	0	2	0	0	0	0	1	0	0	0	3	0	1	0	0	0	1	0	5	12	0	65	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	RU
LV	1	1	0	3	1	2	10	0	1	0	0	1	0	2	0	12	0	1	1	3	0	0	2	10	3	0	4	18	14	1	1	0	0	0	0	0	0	7	0	0	0	0	0	0	0	LV
LT	0	1	0	3	0	2	8	0	0	0	0	1	0	1	0	16	0	1	1	2	0	0	2	16	4	0	4	3	31	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	LT
CZ	8	1	0	1	0	3	30	0	1	0	0	2	0	1	0	8	0	0	0	0	1	0	1	0	1	0	0	0	0	36	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	CZ
SK	4	0	1	0	0	1	8	0	11	0	0	3	0	1	0	16	0	2	1	0	1	0	0	1	5	0	1	0	0	8	31	1	1	1	1	0	0	0	0	0	0	0	0	0	0	SK
SI	12	0	0	0	0	2	5	0	3	0	0	27	0	0	0	1	0	1	2	0	1	0	0	0	0	0	0	0	0	1	1	36	6	1	1	0	0	1	0	0	0	0	0	0	0	SI
HR	6	0	1	0	0	2	4	1	8	0	0	20	0	0	0	2	0	2	2	0	1	0	0	0	1	0	0	0	0	2	2	7	22	11	4	0	0	1	0	0	0	0	0	0	0	HR
BA	4	0	1	0	0	2	6	1	6	0	0	18	0	0	0	3	0	1	2	0	1	0	0	0	1	0	0	0	0	3	2	1	7	27	10	0	0	2	0	0	0	0	0	0	0	BA
YU*	2	0	1	0	0	1	3	1	6	0	0	7	0	0	0	2	0	7	1	0	0	0	0	0	2	0	0	0	0	2	2	0	2	4	50	2	0	3	0	0	0	0	0	0	0	YU*
MK	1	0	4	0	0	1	1	14	1	0	0	6	0	0	0	1	0	2	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	17	30	0	15	0	0	0	0	0	0	0	MK
CY	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	48	0	0	1	0	0	0	0	0	0	0	0	0	0	0	37	7	0	0	0	0	0	0	0	CY
AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	72	0	0	0	0	0	0	0	AM
MT	1	0	1	0	0	5	1	3	0	0	0	60	0	0	0	1	1	1	4	0	1	2	0	0	1	0	0	0	0	0	0	1	1	1	2	1	0	12	0	0	0	0	0	0	0	MT
REM	0	0	0	0	0	1	1	1	0	0	0	3	0	0	0	0	0	0	1	0	0	6	0	0	2	0	6	0	0	0	0	0	0	0	1	0	0	76	0	0	0	0	0	0	0	REM
BAS	0	1	0	19	4	3	24	0	0	0	0	1	0	3	1	12	0	0	1	13	0	0	3	2	1	0	2	2	2	1	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	BAS
NOS	0	6	0	7	0	22	16	0	0	0	2	1	0	9	1	2	0	0	2	1	0	0	29	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NOS
ATL	0	2	0	1	0	23	6	0	0	1	14	1	0	2	1	1	7	0	11	1	0	0	23	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	ATL
MED	1	0	1	0	0	6	1	10	0	0	0	34	0	0	0	1	1	1	9	0	1	13	0	0	1	0	0	0	0	0	0	1	1	1	2	1	1	12	0	0	0	0	0	0	0	MED
BLS	0	0	4	0	0	0	1	2	1	0	0	2	0	0	0	2	0	11	0	0	0	8	0	1	49	3	9	0	0	0	0	0	0	0	1	0	0	4	0	0	0	0	0	0	0	BLS
	AT	BE	BG	DK	FI	FR	DE	GR	HU	IS	IE	IT	LU	NL	NO	PL	PT	RO	ES	SE	CH	TR	GB	BY	UA	MD	RU	LV	LT	CZ	SK	SI	HR	BA	YU*	MK	CY	REM	BAS	NOS	ATL	MED	BLS	NAT	VUL	

Table 30: Parts of the source-receptor matrices which involve EU countries. Units 100 tonnes of S or N.

Emitters: 15 EU countries			
Receptors	Oxidized sulphur	Oxidized nitrogen	Reduced nitrogen
AT	417	378	609
BE	391	361	384
BG	181	108	72
DK	224	196	334
FI	383	344	224
FR	3064	3159	3815
DE	2766	2668	3596
GR	565	348	385
HU	191	172	112
IS	42	40	16
IE	364	206	577
IT	2047	2024	2179
LU	26	28	35
NL	353	367	618
NO	344	302	173
PL	1073	733	493
PT	494	402	368
RO	356	233	134
ES	3158	1933	1796
SE	637	644	488
CH	220	167	178
TR	405	317	111
GB	3032	1879	1340
BY	240	155	85
UA	544	303	157
MD	29	15	7
RU	1454	823	379
LV	105	106	60
LT	115	113	69
CZ	481	298	313
SK	133	99	74
SI	88	102	69
HR	172	196	105
BA	170	178	91
YU*	229	190	96
MK	74	49	31
CY	3	6	1
AM	5	2	1
MT	3	0	0
REM	1096	1233	310
BAS	1029	613	724
NOS	4305	1834	1887
ATL	6805	3142	2523
MED	4651	1552	1230
BLS	284	134	66
EU	17922	14939	16748

Receptors: 15 EU countries			
Emitters	Oxidized sulphur	Oxidized nitrogen	Reduced nitrogen
AT	106	170	330
BE	600	543	532
BG	584	66	35
DK	175	189	349
FI	234	246	166
FR	2512	2825	3865
DE	2624	2487	3505
GR	486	239	361
HU	232	42	29
IS	2	5	0
IE	297	100	627
IT	2105	2200	2283
LU	22	38	45
NL	303	637	799
NO	25	93	34
PL	718	254	160
PT	551	508	437
RO	126	34	23
ES	4395	2105	1924
SE	148	273	259
CH	55	166	224
TR	8	22	14
GB	3366	2378	1267
BY	31	19	27
UA	53	21	29
MD	1	2	2
RU	416	106	33
LV	25	10	8
LT	25	12	12
CZ	699	244	102
SK	78	26	21
SI	152	66	36
HR	43	38	17
BA	164	39	17
YU*	149	20	30
MK	11	2	25
CY	1	1	0
REM	223	50	124
BAS	258	267	0
NOS	507	686	0
ATL	278	629	0
MED	14	11	0
BLS	0	0	0
NAT	153	0	0
VUL	1866	0	0
EU	17922	14939	16748

Table 31:
Import-Export Budgets for 1997

Receptors	Oxidized sulphur						Oxidized Nitrogen						Reduced Nitrogen					
	Export		Import		Sea	EMEP	Export		Import		Sea	EMEP	Export		Import		Sea	EMEP
	Mass	%	Mass	%	%	%	Mass	%	Mass	%	%	%	Mass	%	Mass	%	%	%
AT	226	79	698	92	15	95	447	85	420	85	9	87	380	61	487	67	6	99
BE	1037	86	272	62	33	97	889	87	275	68	24	90	589	74	180	46	24	99
BG	5646	83	970	45	25	87	513	75	294	63	13	89	377	59	340	57	10	89
DK	472	87	280	79	46	98	718	95	258	87	25	78	622	74	131	38	44	100
FI	299	60	802	80	23	98	601	76	343	64	11	69	135	48	165	53	17	99
FR	3595	70	1981	56	34	95	3134	63	1707	48	21	89	2320	42	725	19	22	98
DE	5629	77	2174	56	22	96	3919	71	1627	51	15	87	2591	49	1089	28	14	99
GR	2278	84	1092	71	33	79	933	82	301	59	21	78	532	60	180	34	24	89
HU	2689	82	863	59	15	94	445	74	408	72	6	94	391	63	351	60	4	97
IS	100	82	68	75	76	97	79	91	59	88	40	61	16	66	17	67	60	98
IE	623	76	207	51	59	98	345	92	250	89	47	79	603	55	95	16	40	99
IT	4967	75	2253	58	36	90	3792	70	693	30	17	85	1772	47	288	12	19	96
LU	38	95	28	93	25	97	63	94	27	88	17	89	49	85	27	76	12	99
NL	512	83	320	75	38	98	1273	89	269	63	27	86	814	68	240	39	24	99
NO	103	68	715	94	42	99	581	86	430	82	30	69	117	54	211	68	31	99
PL	5993	55	2353	32	11	98	2291	65	1248	50	8	87	1324	46	953	38	7	99
PT	1529	82	217	39	48	80	958	77	221	44	23	68	499	63	74	20	26	83
RO	3108	68	2072	59	16	93	714	74	654	72	9	86	902	50	704	43	8	97
ES	7469	72	595	17	35	86	2254	61	682	32	19	84	1286	45	280	15	18	91
SE	226	65	1113	90	36	99	662	78	806	81	18	75	307	58	387	64	31	99
CH	92	71	270	87	12	96	320	84	177	74	11	87	311	53	181	40	6	99
TR	992	56	2340	75	13	83	1327	63	793	50	8	71	1076	41	637	29	13	90
GB	5655	68	706	21	52	98	4130	73	712	32	35	85	1654	62	352	26	46	99
BY	751	72	1240	81	6	95	486	85	511	85	5	78	860	48	571	38	3	99
UA	3856	68	3416	65	13	92	1042	75	1255	79	8	82	2488	41	1273	27	10	98
MD	77	91	283	97	21	93	84	92	81	92	11	82	280	72	189	64	10	99
RU	4730	39	7957	51	10	84	3817	53	2545	43	4	64	1223	20	2572	35	3	93
LV	252	85	347	89	18	97	100	94	223	97	9	76	100	72	187	82	13	99
LT	317	82	398	85	13	96	161	93	247	95	8	78	186	64	229	69	7	99
CZ	2447	70	1101	51	12	97	1003	78	455	62	8	90	429	64	427	64	7	98
SK	877	87	747	85	13	95	335	89	293	88	6	89	293	71	259	69	4	98
SI	523	87	181	69	18	92	197	92	133	88	11	90	126	71	92	64	10	98
HR	300	75	606	86	25	95	184	81	300	88	11	91	132	67	224	78	12	97
BA	1939	81	505	52	20	91	216	89	278	91	13	91	185	72	194	73	12	91
YU*	1955	75	1148	64	16	92	166	83	402	92	10	93	425	57	319	50	8	95
MK	72	85	287	96	18	87	17	96	81	99	13	80	102	73	88	70	10	93
CY	213	91	15	40	31	74	62	88	18	69	19	74	29	87	8	63	39	81
REM	4746	53	4123	50	9	75	1172	60	2453	76	4	66	2256	38	1120	24	6	83
BAS	603	53	2150	80	55	99	901	84	895	84	24	79	0	0	1014	100	0	100
NOS	983	43	5106	80	70	99	1582	80	2100	84	38	84	0	0	1981	100	0	100
ATL	1945	43	11641	82	60	68	2637	68	3901	76	36	56	0	0	2729	100	0	100
MED	36	60	12538	100	49	79	33	84	2061	100	24	66	0	0	1975	100	0	100
BLS	0	0	2827	100	0	100	0	0	605	100	0	100	0	0	1072	100	0	100
EU	28710	62	6894	28	37	92	18460	55	2931	16	22	84	10456	38	1003	6	23	97

Export in 100 tonnes (mass of S or N) and as a percentage of the country (region) emission.
Import in 100 tonnes (mass of S or N) and as a percentage of the total deposition to the country (region).
Sea is the percent of the country (region) emission deposited to the sea surface.
EMEP is the percent of the country (region) emission deposited to the EMEP domain.

8. CONCLUSIONS

The most important conclusions from the study presented here can be summarized in the following points:

- Nonlinear chemistry and nonlinear effects induced by the numerical solution of the transport equation are the major problems in computing source-receptor matrices with the EMEP Eulerian Acid Deposition model.

- Four different methods for calculating source-receptor matrices were compared for one day model run. Based on the results only two methods were selected for further tests: so called ‘direct method’ and the ‘reverse method’.

- The direct and reverse methods were further compared for a one full year run (1996) with six countries as emitters and ten countries as receptors. In this test the reverse method performed better than the direct method, and therefore it was selected for the final computations for 1997.

- The results of the computations with the reverse method for 1996, in the form of partial (6 emitters and 10 receptors) source-receptor matrices, were compared with the source-receptor matrices computed with the Lagrangian model for the same year. Similar differences between the Eulerian and Lagrangian model can be observed in the computed partial source-receptor matrices for oxidized sulphur and oxidized nitrogen. In the Eulerian model, there is more deposition close to the source and more deposition far away from the source. Generally, the numbers in partial source-receptor matrices are higher in the case of the Eulerian model (27% for oxidized sulphur and 43% for oxidized nitrogen). These differences can be, to a large extend, explained by the fact that all depositions, in the Eulerian model, can be related to the contributing sources. This is not the case for the source-receptor matrices computed with the Lagrangian model, which include the column: ‘Total inatributable sources’ (IND). Total deposition from inatributable sources accounts for 25% and 22% for oxidized sulphur and oxidized nitrogen, respectively, in the 1996 source-receptor matrices for the Lagrangian model.

- For reduced nitrogen, differences in computed partial source-receptor matrices between the Eulerian and Lagrangian model indicate more efficient transport of ammonia outside the emission source in the Eulerian model. Close to the source, depositions of ammonia calculated with the Lagrangian model are slightly higher than those by the Eulerian model. In distant receptors (e.g. The Russian Federation) an opposite effect can be observed (depositions from the Eulerian model higher than depositions from the Lagrangian model). Average difference between the Eulerian and Lagrangian model, for all receptors in the partial source-receptor matrix for ammonia deposition calculated from the Eulerian model is 13% higher than the Lagrangian deposition and it is of the same order as the contribution of the inatributable sources of ammonia, 14%, in the full 1996 source-receptor matrix computed with the Lagrangian model.

- The contribution of dry deposition to total deposition, computed by the Eulerian model is the same as computed with the Lagrangian model in the case of oxidized sulphur, slightly higher in the case of oxidized nitrogen, and much higher for reduced nitrogen. The contribution of dry deposition to the total deposition in 1996 computed with the Lagrangian model is 53%, 36% and 38% for oxidized sulphur, oxidized nitrogen and reduced nitrogen, respectively. The corresponding contributions for the Eulerian model are: 53%, 42% and 57%.

- Contribution of dry deposition to the total deposition is even larger in the results of the Eulerian model for 1997: 65%, 62% and 66% for oxidized sulphur, oxidized nitrogen and reduced nitrogen, respectively. Larger contribution of dry deposition to total in 1997 can be, to some extend, explained by the differences in precipitation, which was approximately 20% lower in 1997 than in 1996 in the input files for the Eulerian model.

- Comparison of partial source-receptor matrices computed for 1996 and 1997 showed larger deposition values for 1997. On average, deposition in partial source-receptor matrices computed for 1997 was 7%, 16% and 14% higher than in 1996. Because, of higher dry to wet deposition ratio in 1997, higher 'country-to-itself' depositions can be noticed but on average, differences are within the range expected from different meteorological conditions.

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