OSPAR COMMISSION

Preparation of the routine products for OSPAR by MSC-W of EMEP - 2017

2018

Monitoring and Assessment Series

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic
(the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. The Contracting Parties are Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands,
Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom of Great Britain and Northern Ireland.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. Les parties contractantes sont : l'Allemagne, la Belgique, le Danemark, l'Espagne, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède, la Suisse et l'Union européenne.

Acknowledgements

This report was prepared by Jerzy Bartnicki, Heiko Klein, Michael Gauss and Jan Eiof Jonson of The Meteorological Synthesising Centre-West (MSC-W) of EMEP, Norwegian Meteorological Institute, OSLO. The authors are indebted to the scientific team at MSC-W for their help in providing the results included in this report. The authors are also grateful to OSPAR for financing the work presented in this report.

Contents

1. Introduction

Nitrogen deposition to OSPAR Convention Waters has been a subject of a cooperation between Meteorological Synthesizing Centre – West (MSC-W) of EMEP and OSPAR since 2003, starting with the first EMEP report for OSPAR (Bartnicki and Fagerli, 2003). This cooperation has been continued and documented in the next reports (Bartnicki and Fagerli, 2004; Bartnicki and Fagerli, 2006, Bartnicki and Benedictow 2017)

1.1 Objectives and tasks

The main goal of this project is a preparation by the MSC-W of EMEP the tools which can be routinely used every year for OSPAR. OSPAR requests calculations of atmospheric nitrogen deposition (both actual and normalised) to the five Main OSPAR regions, as well as nitrogen deposition to Exclusive Economic Zones (EEZ). Additional products for OSPAR are the source-receptor matrices for oxidized, reduced and total nitrogen, with sources being all EMEP Contracting Parties and international ship traffic, and receptors being all OSPAR regions and selected EEZs.

The main tasks of the project are the following:

- Task 1: Revision of the boundaries of the 'Greater North Sea' products to include the Kattegat and The Sound (for better agreement with MSFD regions) to produce deposition maps /data for the entire Greater North Sea.
- Task 2: Annual atmospheric deposition to each OSPAR Region.
- Task 3: Annual atmospheric deposition to national EEZs in each OSPAR Region. A one-off set of model runs from 1995 to the latest available year.
- Task 4: Source receptor matrices for each EEZ and region for the last available year.
- Task 5: Routine weather-normalised deposition estimates to each EEZ and OSPAR Region.

1.2 Model tool

The EMEP/MSC-W model, a multi-pollutant 3D Eulerian Chemical Transport Model, has been used for all nitrogen computations presented here. The model takes into account processes of emissions, advection, turbulent diffusion, chemical transformations, wet and dry depositions and inflow/outflow of pollutants into/out of the model domain. It has been documented in detail in Simpson et al., 2012 and in the annual chapters on model updates in subsequent EMEP status reports (Tsyro et al., 2014; Simpson et al., 2015; 2016; 2017).

The model is regularly evaluated against measurements from the EMEP network under the LRTAP convention (e.g. Gauss et al., 2016a/b, 2017a/b; Tsyro et al., 2016, 2017), but also in a large number of international research projects and operational services, for example in the Copernicus Atmosphere Monitoring Service (CAMS, see right menu at http://macc-raq-op.meteo.fr/), where evaluation graphs are updated every day and quarterly evaluation reports are issued online on a quarterly basis. Evaluation is made against rural and sub-urban measurement sites throughout Europe. Spatial and temporal correlation, i.e. the agreement between model and observations both in space and time, is checked systematically and also compared to the performances of other regional air quality models used in Europe. As in every model, deviations between model and observations do occur and are highly variable both in space and time, and these are subject of continuous investigation and model development. Nevertheless, the performance of the EMEP/MSC-W model can be considered as state-of-the-art over a large range of both gaseous species and particulate matter, and thereby is among the best air quality models available today. The transparency of the EMEP model results and activities is further ensured by the availability of the EMEP model code (software) as Open Source (https://github.com/metno/emep-ctm). In this way, the scientific community as well as advanced policy users can check and apply the model themselves, both as a research tool and for underpinning of air quality legislation.

The EMEP/MSC-W model version rv4.15 (EMEP Status Report 1/2017) has been used for the deposition calculations presented here. This version can be run on many different spatial resolutions, including 0.1×0.1 degree and 50×50 km, as presented in Figure 1.1.

In this project the model version with 50 km × 50 km resolution was used for all model runs. The details of this domain and model grid system are presented in Figure 1.2. There are two reasons why the lower resolution version of the model was used for the computations. First, there are only a few years with available meteorological data for the high-resolution version. Secondly, the high-resolution version cannot be used for source-receptor calculations at present because of very long time of the computations and related significant costs. However, this version will be used by MSC-W of EMEP for calculating all depositions in the future as more computing power and storage become available.

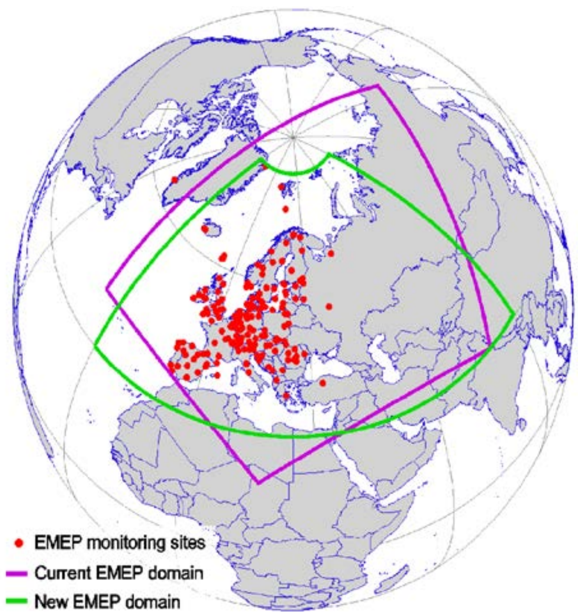


Figure 1.1 The old (purple) and new (green) official EMEP domains. The new domain has been used for the first time in the EMEP status report this year (EMEP, 2017), and has the resolution to 0.1deg×0.1deg in a regular longitude-latitude grid. The old domain has the resolution 50km×50km in a polar-stereographic grid.

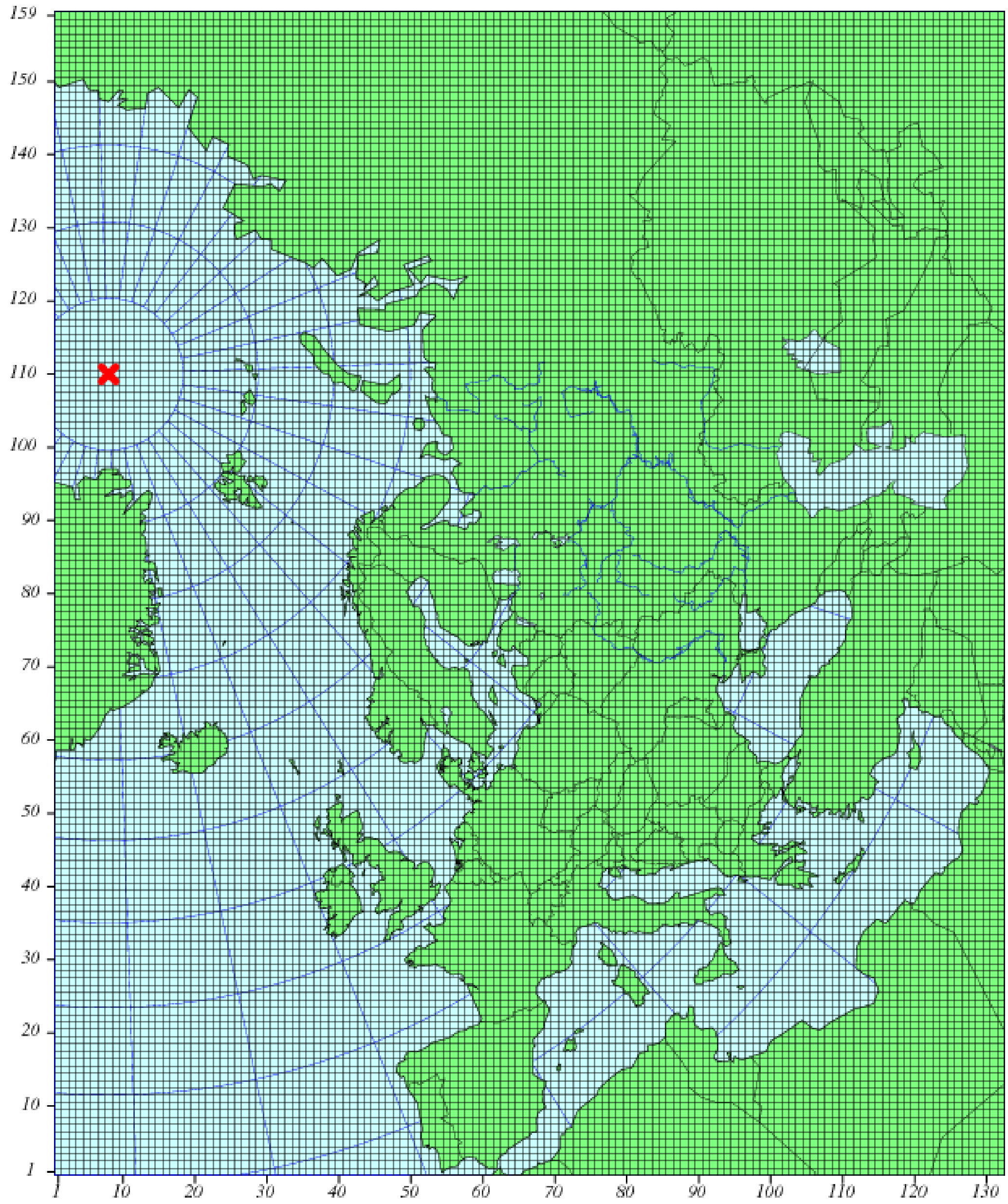


Figure 1.2 The official EMEP domain with 50 km × 50 km resolution, used for all EMEP model calculations presented in the present report.

In the report, acronyms for the countries and other emission sources are used. The list and explanations of these acronyms are presented in Table 1.1.

Table 1.1 EMEP identification number, acronyms for the countries (ISO) and emission sources and names used by the EMEP MSC-W model.

EMEP-ID	ISO	Name
1	AL	Albania
2	AT	Austria
3	BE	Belgium
4	BG	Bulgaria
6	DK	Denmark
7	FI	Finland
8	FR	France
11	GR	Greece
12	HU	Hungary
13	IS	Iceland
14	IE	Ireland
15	IT	Italy
16	LU	Luxembourg
17	NL	Netherlands
18	NO	Norway
19	PL	Poland
20	PT	Portugal
21	RO	Romania
22	ES	Spain
23	SE	Sweden
24	CH	Switzerland
25	TR	Turkey
27	GB	United Kingdom
39	BY	Belarus
40	UA	Ukraine
41	MD	Republic of Moldova
43	EE	Estonia
44	LV	Latvia
45	LT	Lithuania
46	CZ	Czech Republic

EMEP-ID	ISO	Name
47	SK	Slovakia
48	SI	Slovenia
49	HR	Croatia
50	BA	Bosnia and Herzegovina
51	CS	Serbia and Montenegro
52	MK	The former Yugoslav Republic of Macedonia
53	KZ	Kazakhstan
54	GE	Georgia
55	CY	Cyprus
56	AM	Armenia
57	MT	Malta
60	DE	Germany
61	RU	Russian Federation in the former official EMEP domain
63	EGYP	Egypt
68	KG	Kyrgyzstan
69	AZ	Azerbaijan
201	AFGH	Afghanistan
210	CHIN	China
211	FSUA	Former USSR (Asia) – Tajikistan, Turkmenistan, Uzbekistan
212	INDI	India
214	ISRA	Israel
219	MIDE	Middle East
220	MONG	Mongolia
224	NAFR	North Africa (Libya, Tunisia, Algeria, Sudan, Morocco)
226	OAFR	Other Africa
228	PAKI	Pakistan
350	INTSHIPS	International shipping

2. Main OSPAR Regions and EEZs in the EMEP grid

New definitions of the OSPAR Regions, as specified at: www.marineregions.org; and requested by OSPAR, were implemented in the EMEP grid system. In addition, Exclusive Economic Zones (EEZ) for each OSPAR Contracting Party were implemented into the EMEP grid system. These implementations resulted in slightly different (more precise) mapping of the OSPAR Main Regions to the EMEP grid. Therefore, the present results can be slightly different from the previous calculations (Bartnicki and Benedictow, 2017).

2.1 Main OSPAR Regions

The new OSPAR Region II is extended compared to previous definition used by EMEP (Bartnicki and Benedictow, 2017) and includes Kattegat. All OSPAR Regions cover a certain number of grid squares in the EMEP grid system, either in 100% or only partly. We have calculated this percentage for each EMEP grid square covered by each OSPAR Region. The result is illustrated in Figure 2.1 for the Main OSPAR Region II and in Figure 2.2 for the remaining Regions.

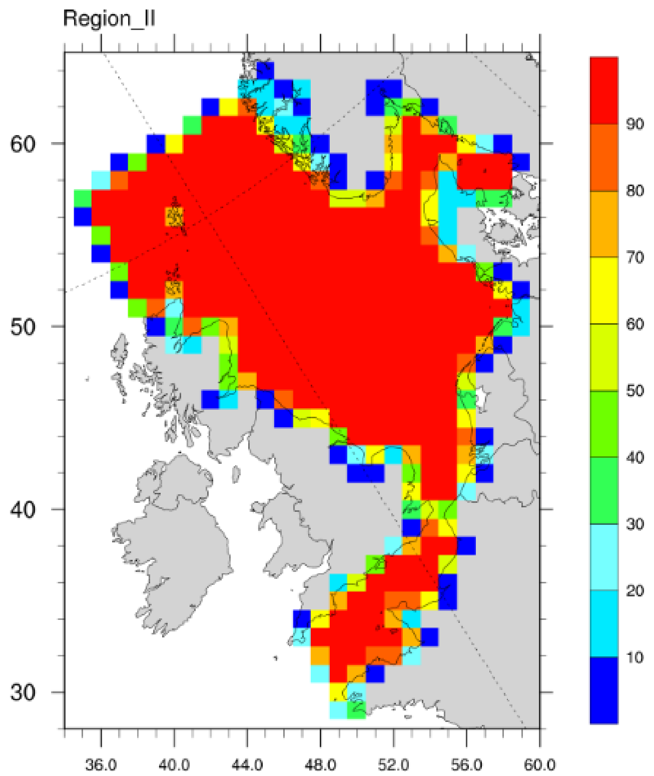
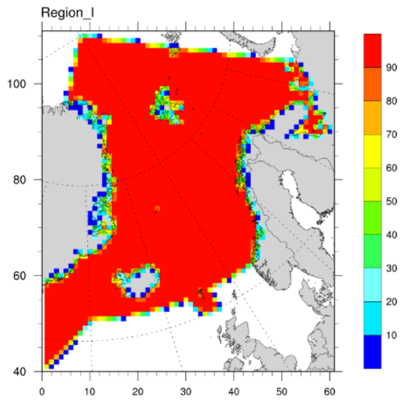


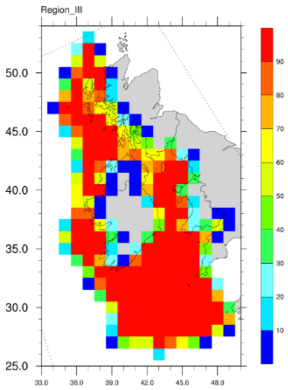
Figure 2.1 Percentage of the EMEP grids in the MAIN OSPAR Region II.

Altogether the MAIN OSPAR Region II covers 422 EMEP grid squares with the resolution 50 km, most of them in 100%.

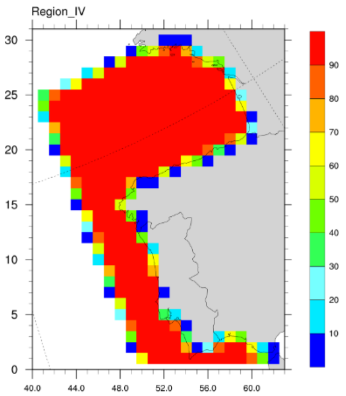
Main OSPAR Region I



Main OSPAR Region III



Main OSPAR Region IV



Main OSPAR Region V

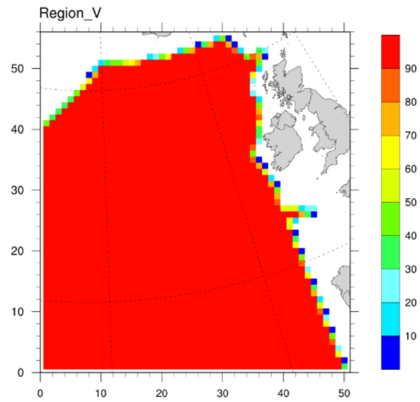


Figure 2.1 Percentage of the EMEP grids in the MAIN OSPAR Regions I, III, IV and V.

2.2 Exclusive Economic Zones

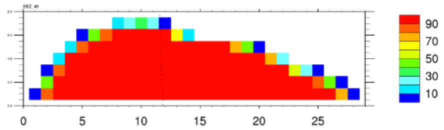
National EEZs of OSPAR Contracting Parties were implemented into the EMEP grid system according to specification suggested by OSPAR: www.marineregions.org. In some cases (e.g. Sweden) only the parts of EEZs belonging to OSPAR area were implemented into the EMEP grid. The list of EEZs included in this specification and implemented into the EMEP grid system is shown in Table 2.1.

Table 2.1 National EEZs of OSPAR Contracting Parties. The area includes total zones, also outside the OSPAR Convention, e.g. a part of the Baltic Sea for some countries.

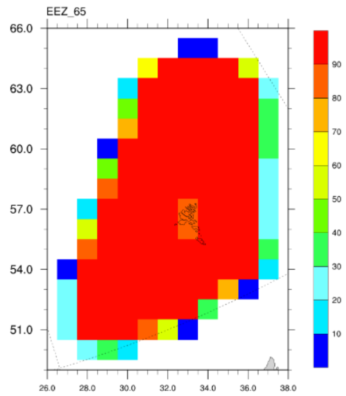
EEZ-ID	Country	EMEP-ID	Area (km^2)	Name
EEZ_48	Portugal	20	960421.0	Portuguese Exclusive Economic Zone (Azores)
EEZ_65	Denmark	6	264370.0	Faeroe Exclusive Economic Zone
EEZ_71	Iceland	13	763173.0	Icelandic Exclusive Economic Zone
EEZ_91	Portugal	20	315475.0	Portuguese Exclusive Economic Zone
EEZ_99	France, Spain	8,22	2859.5	Joint regime area Spain / France
EEZ_100	United Kingdom, Denmark	27,6	7935.6	Joint regime area United Kingdom / Denmark (Faeroe Islands)
EEZ_108	Ireland	14	426998.0	Irish Exclusive Economic Zone
EEZ_109	United Kingdom	27	6526.1	Guernsey Exclusive Economic Zone
EEZ_110	United Kingdom	27	2276.9	Jersey Exclusive Economic Zone
EEZ_119	Denmark, Iceland	6,13	1282.12	Joint regime area Iceland / Denmark (Faeroe Islands)
EEZ_123	Iceland, Norway	13,18	45504.5	Joint regime area Iceland / Norway (Jan Mayen)
EEZ_185	Sweden	23	155952.0	Swedish Exclusive Economic Zone
EEZ_187	Norway, Sweden	18,23	139.943	Joint regime area Sweden / Norway
EEZ_188	Belgium	3	3491.7	Belgian Exclusive Economic Zone
EEZ_189	Netherlands	17	64444.3	Dutch Exclusive Economic Zone
EEZ_190	Germany	60	56597.7	German Exclusive Economic Zone
EEZ_191	Denmark	6	104885.0	Danish Exclusive Economic Zone
EEZ_209	France	8	344795.0	French Exclusive Economic Zone
EEZ_212	Denmark	6	2270600.0	Greenlandic Exclusive Economic Zone
EEZ_213	United Kingdom	27	732923.0	United Kingdom Exclusive Economic Zone
EEZ_215	Norway	18	796621.0	Svalbard Exclusive Economic Zone
EEZ_216	Norway	18	933668.0	Norwegian Exclusive Economic Zone
EEZ_224	Norway	18	291638.0	Jan Mayen Exclusive Economic Zone
EEZ_273	Spain	22	561682.0	Spanish Exclusive Economic Zone

The same calculations as for OSPAR Regions were performed for each EEZ listed above and included in Table 2.1. The percentages of EMEP grids covered by each of selected EEZ are shown in Figure 2.2.

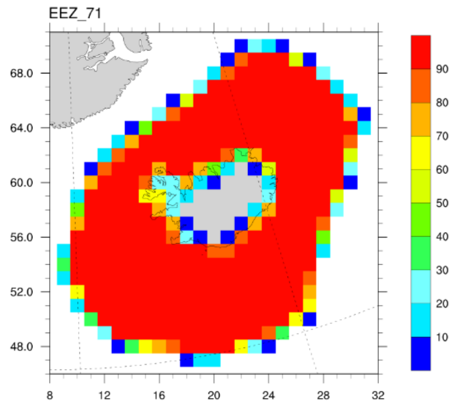
EEZ_48: Portuguese Exclusive Economic Zone (Azores)



EEZ_65: Faeroe Exclusive Economic Zone



EEZ_71: Icelandic Exclusive Economic Zone



EEZ_91: Portuguese Exclusive Economic Zone

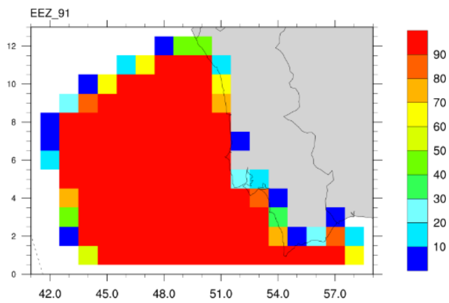
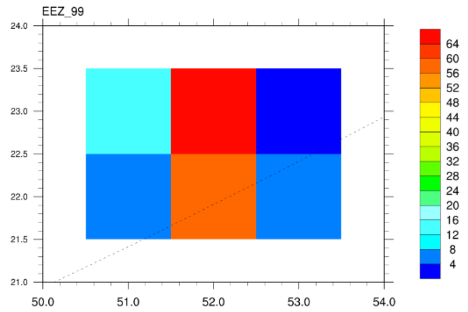
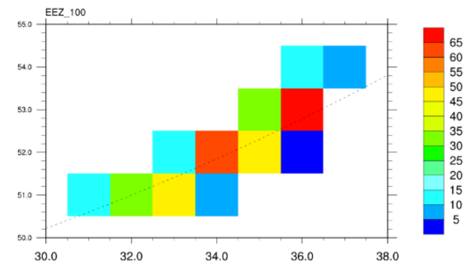


Figure 2.2 Percentage of the EMEP grids in each of the selected EEZs.

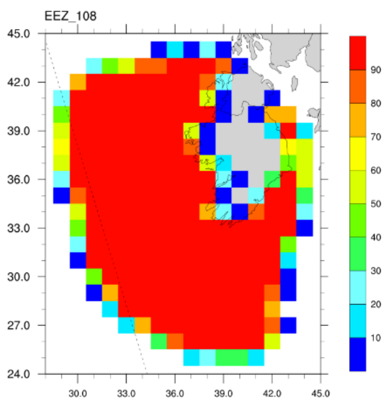
EEZ_99: Joint regime area Spain / France



EEZ_100: Joint regime area United Kingdom / Denmark (Faeroe Islands)



EEZ_108: Irish Exclusive Economic Zone



EEZ_109: Guernsey Exclusive Economic Zone

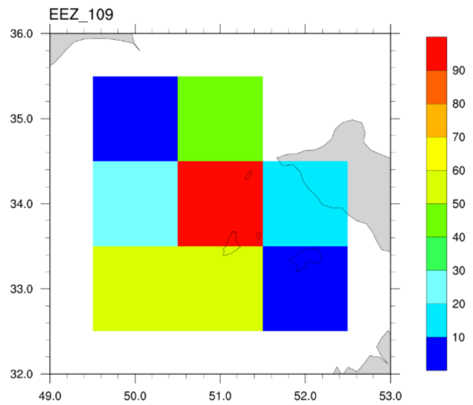
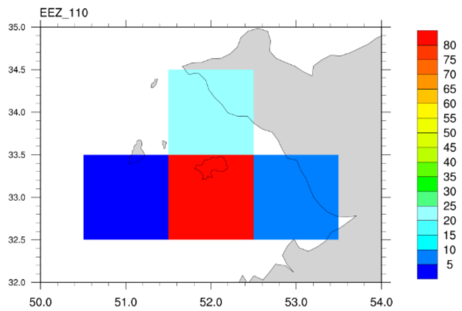
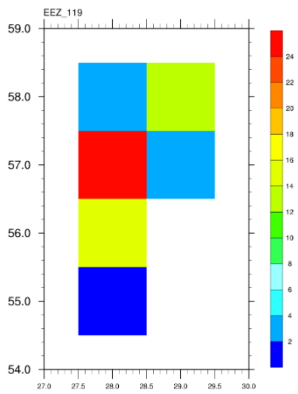


Figure 2.2 (cont.) Percentage of the EMEP grids in each of the selected EEZs.

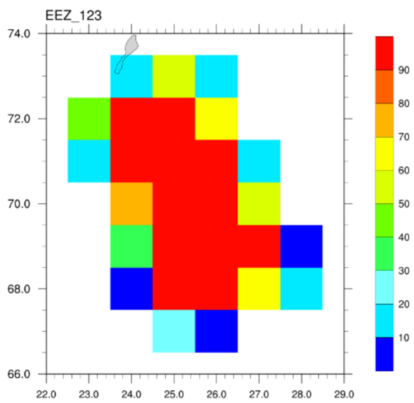
EEZ_110: Jersey Exclusive Economic Zone



EEZ_119: Joint regime area Iceland / Denmark (Faeroe Islands)



EEZ_123: Joint regime area Iceland / Norway (Jan Mayen)



EEZ_185:Swedish Exclusive Economic Zone

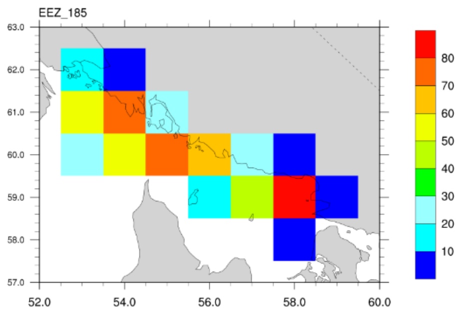
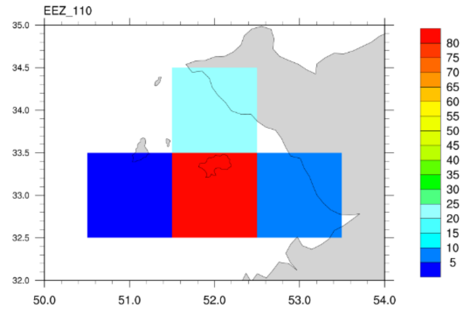
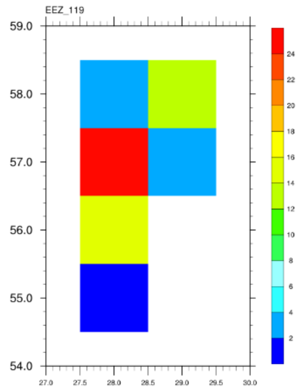


Figure 2.2 (cont.) Percentage of the EMEP grids in each of the selected EEZs.

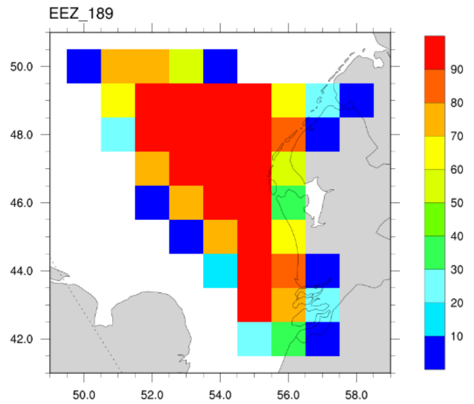
EEZ_187: Joint regime area Sweden / Norway



EEZ_188: Belgian Exclusive Economic Zone



EEZ_189: Dutch Exclusive Economic Zone



EEZ_190: German Exclusive Economic Zone

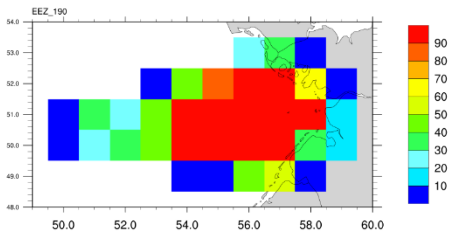
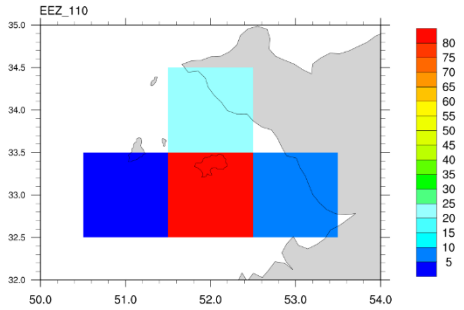
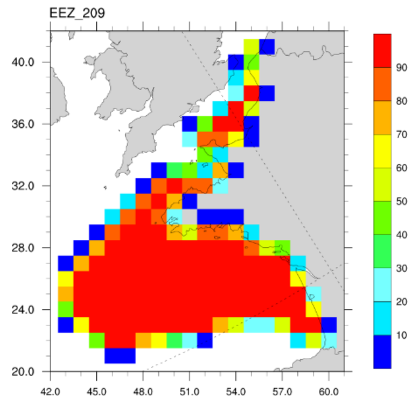


Figure 2.2 (cont.) Percentage of the EMEP grids in each of the selected EEZs.

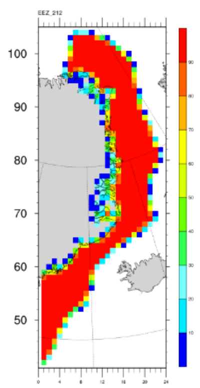
EEZ_191: Danish Exclusive Economic Zone



EEZ_209: French Exclusive Economic Zone



EEZ_212: Greenlandic Exclusive Economic Zone



EEZ_213: United Kingdom Exclusive Economic Zone

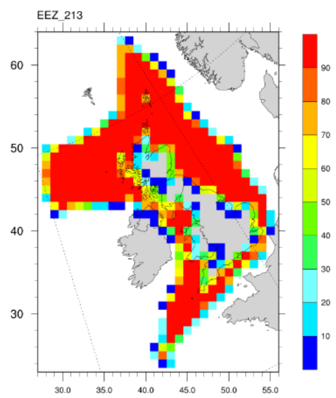
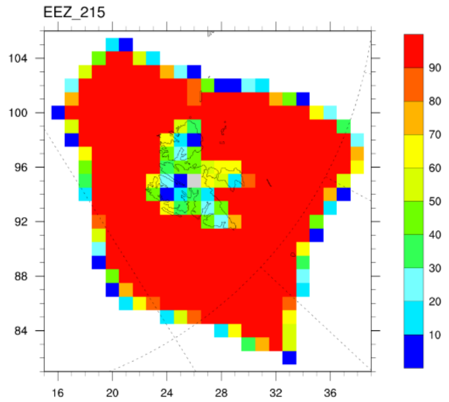
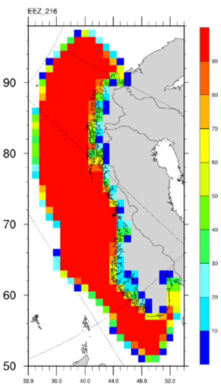


Figure 2.2 (cont.) Percentage of the EMEP grids in each of the selected EEZs.

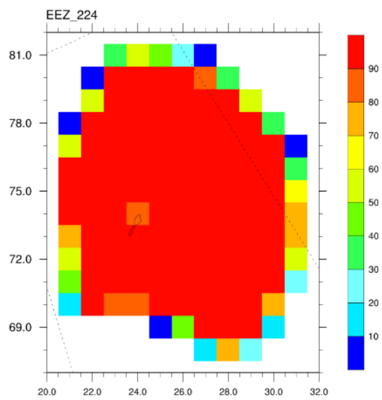
EEZ_215: Svalbard Exclusive Economic Zone



EEZ_216: Norwegian Exclusive Economic Zone



EEZ_224: Jan Mayen Exclusive Economic Zone



EEZ_273: Spanish Exclusive Economic Zone

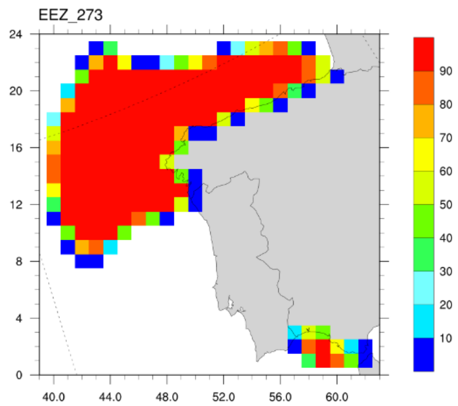


Figure 2.2 (cont.) Percentage of the EMEP grids in each of the selected EEZs.

3. Annual atmospheric depositions to the Main OSPAR Regions

All nitrogen depositions presented in the present here were computed in the domain presented in Fig. 1.1 with the latest version of the EMEP MSC-W model and latest available emissions. Annual depositions of oxidised and reduced nitrogen were computed for the period 1995-2015. The model version with 50 km resolution was used for computing annual depositions presented in this report.

In all regions, annual deposition of oxidised nitrogen is clearly lower in 2015 than in 1995 in the range 36-56%. Also, there is a decline in the deposition of reduced nitrogen in four out of five Regions, in the range 3-17%, definitely lower than in case of oxidised nitrogen. Concerning deposition of total nitrogen, there is decline between 1995 and 2015 in all Regions in the range 23-43%.

3.1 OSPAR Region I

Annual atmospheric nitrogen depositions to Main OSPAR Region I are shown in Figure 2.1, for oxidised, reduced and total nitrogen and for each year of the period 1995-2015.

There is a large (45%) decline in annual deposition of oxidised nitrogen between 1995 and 2015. Also, annual deposition of reduced nitrogen in 2014 is 6% lower than deposition in 1995. In case of total nitrogen, the reduction of annual deposition between the years 1995 and 2015 is 35%.

3.2 OSPAR Region II

Annual atmospheric nitrogen depositions to Main OSPAR Region II are shown in Figure 2.2, for oxidised, reduced and total nitrogen and for each year of the period 1995-2015.

Again, the decline in annual deposition of oxidised nitrogen between the years 1995 and 2015 is large – 36%., but annual deposition of reduced nitrogen in 2015 is only 3% lower than deposition in 1995. In case of total nitrogen, the reduction of annual deposition between the years 1995 and 2015 is 24%.

3.3 OSPAR Region III

Annual atmospheric nitrogen depositions to Main OSPAR Region III are shown in Figure 2.3, for oxidised, reduced and total nitrogen and for each year of the period 1995-2015.

In OSPAR Region III, there is a significant decline in annual deposition of oxidised nitrogen between the years 1995 and 2015 – 55%. Annual deposition of reduced nitrogen in 2015 is 17% lower than deposition in 1995 and in case of total nitrogen, the reduction of annual deposition between the years 1995 and 2015 is 40%.

3.4 OSPAR Region IV

Annual atmospheric nitrogen depositions to Main OSPAR Region IV are shown in Figure 2.4, for oxidised, reduced and total nitrogen and for each year of the period 1995-2015.

Also in OSPAR Region IV, there is a large (40%) decline in annual deposition of oxidised nitrogen between 1995 and 2015. This is the only OSPAR Region where deposition of reduced nitrogen in 2015 is higher (9%) than deposition in 1995. In case of total nitrogen, the reduction of annual deposition between the years 1995 and 2015 is 23%.

3.5 OSPAR Region V

Annual atmospheric nitrogen depositions to Main OSPAR Region V are shown in Figure 2.5, for oxidised, reduced and total nitrogen and for each year of the period 1995-2015.

In OSPAR Region V, there is the largest (56%), among all Regions, decline in annual deposition of oxidised nitrogen between 1995 and 2015. Annual deposition of reduced nitrogen in 2015 is 7% lower than deposition in 1995. In case of total nitrogen, the reduction of annual deposition between the years 1995 and 2015 is 43%, largest among all Regions.

Figure 2.1 Time series of annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region I, for the period 1995-2015.

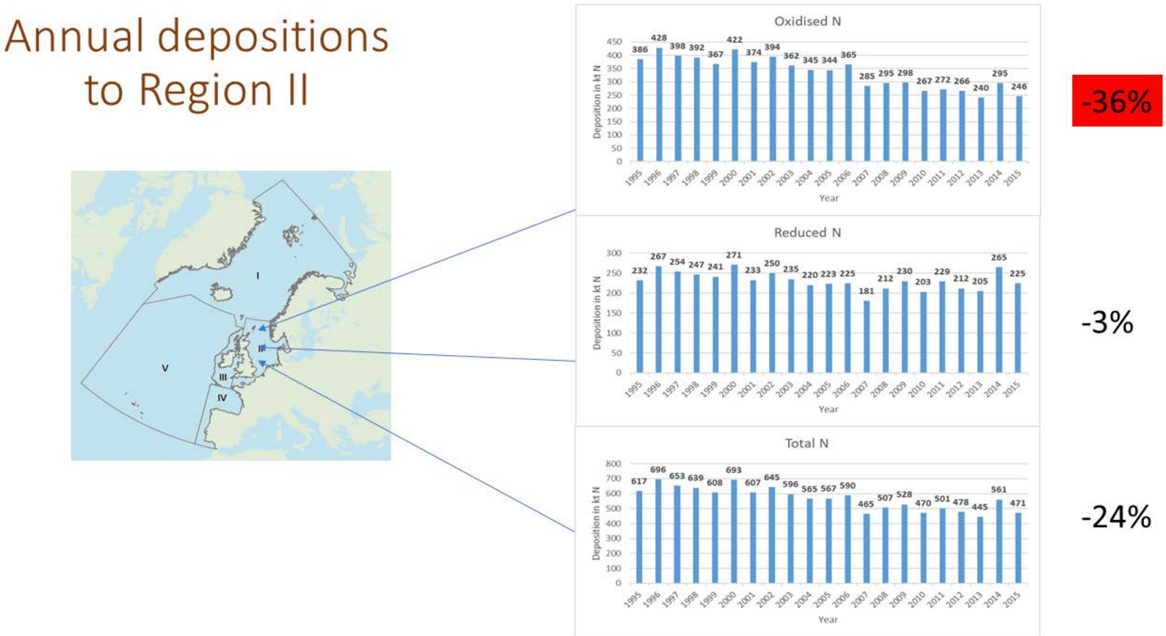


Figure 2.2 Time series of annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region II, for the period 1995-2015. OSPAR Region II is where the decrease in Oxidized N deposition is the lowest (only -36%, marked red) among all OSPAR Regions.

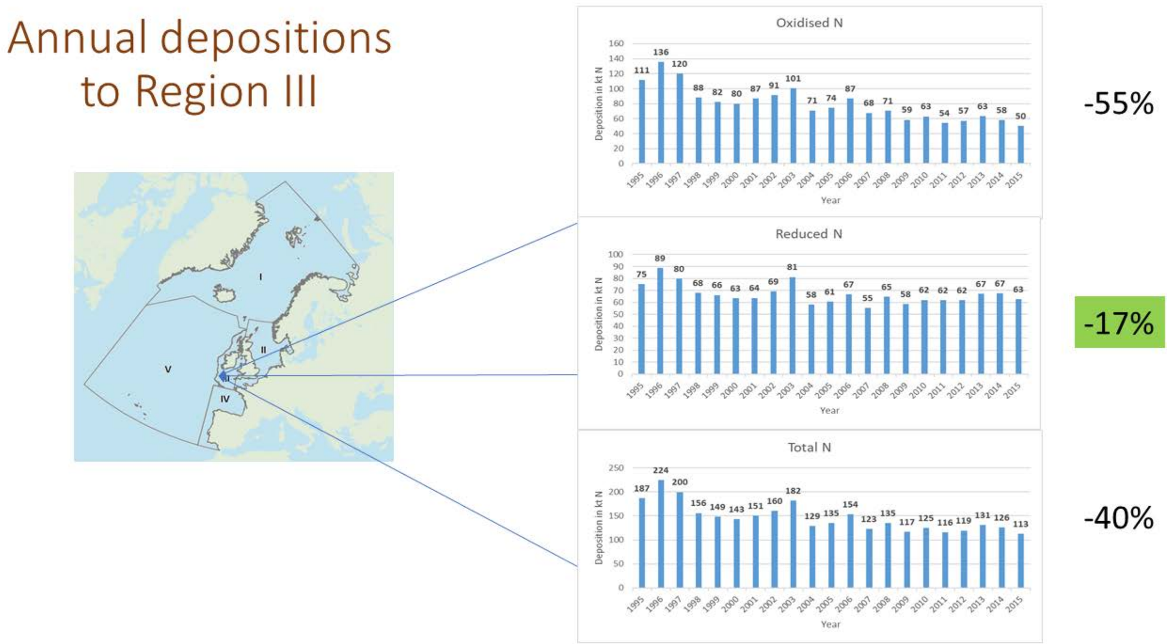


Figure 2.3 Time series of annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region III, for the period 1995-2015. OSPAR Region III is where the decrease in Reduced N deposition is the highest (-17%, marked green) among all OSPAR Regions.

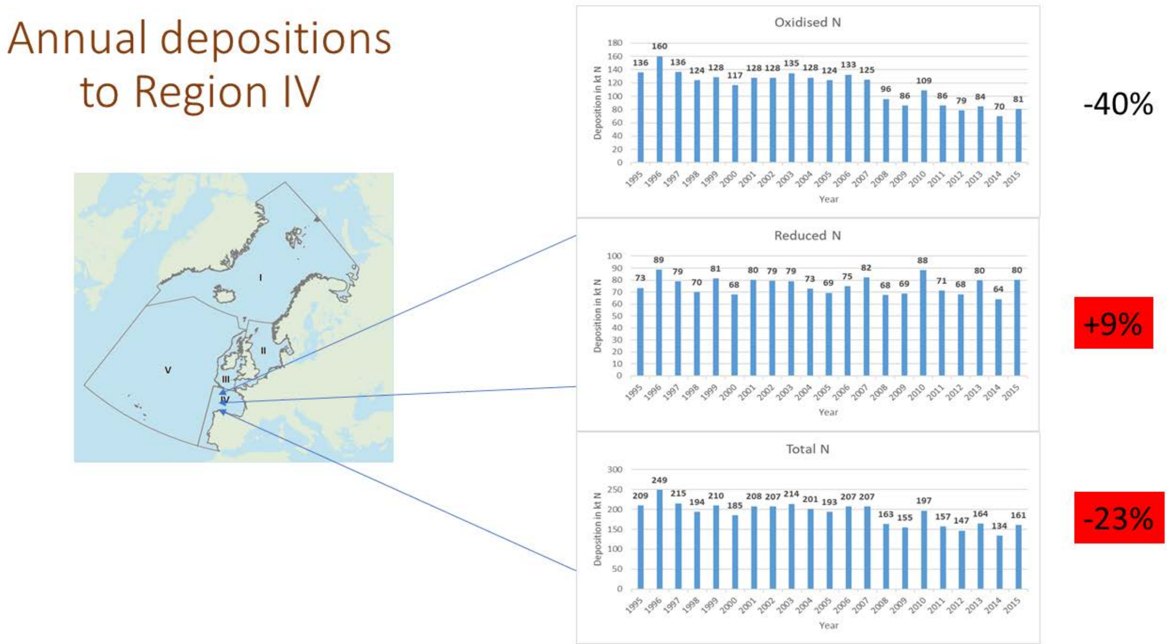


Figure 2.4 Time series of annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region IV, for the period 1995-2015. OSPAR Region VI is where the trend in Reduced N deposition is the least favourable (+9%, marked red) and the reduction in Total N deposition is the lowest (only -23%, marked red) among all OSPAR Regions.

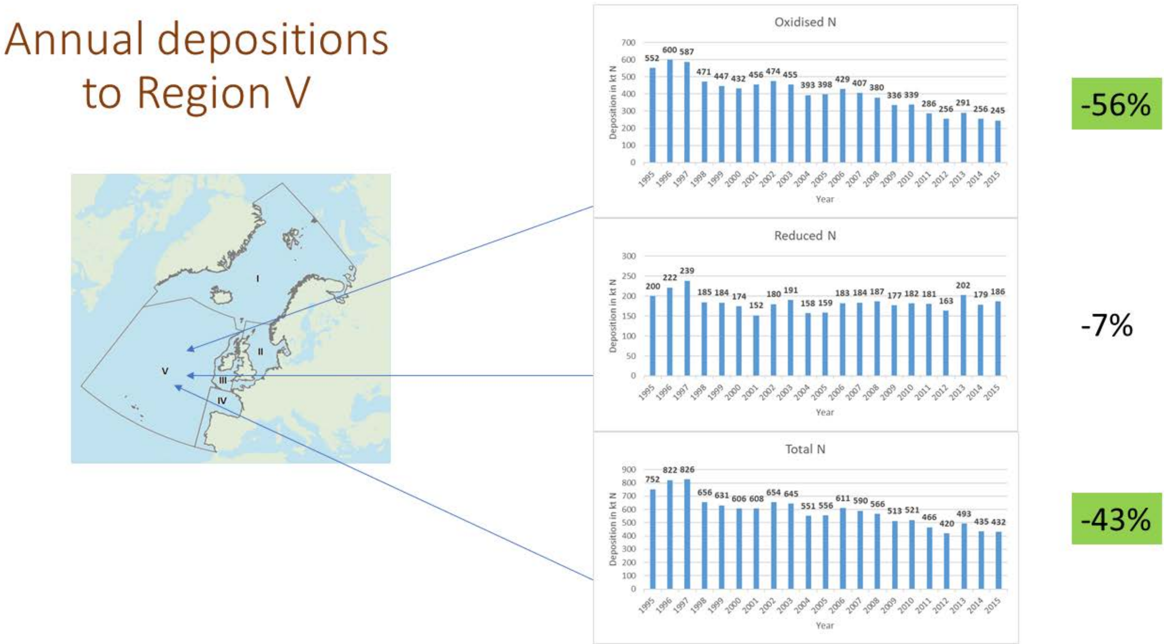


Figure 2.5 Time series of annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region V, for the period 1995-2015. OSPAR Region V is where the decreases in Oxidised N and Total N depositions are the highest (-56% and -43%, respectively, marked green) among all OSPAR Regions.

4. Annual atmospheric depositions to EEZs

Annual atmospheric nitrogen depositions were also computed for each of the 24 EEZs, for each year of the period 1995-2015. The results are shown in Figure 3.1.

There is clear decline in the deposition of oxidised nitrogen between 1995 and 2015, in all considered EEZs in the range 25-61%. This is not the case for the deposition of reduced nitrogen. In nine EEZs annual deposition of reduced nitrogen is higher in 2015 than in 1995 and in one EEZ it remains on the same level. The decline of the deposition of reduced nitrogen can be observed in 14 EEZs in the range 6-22%.

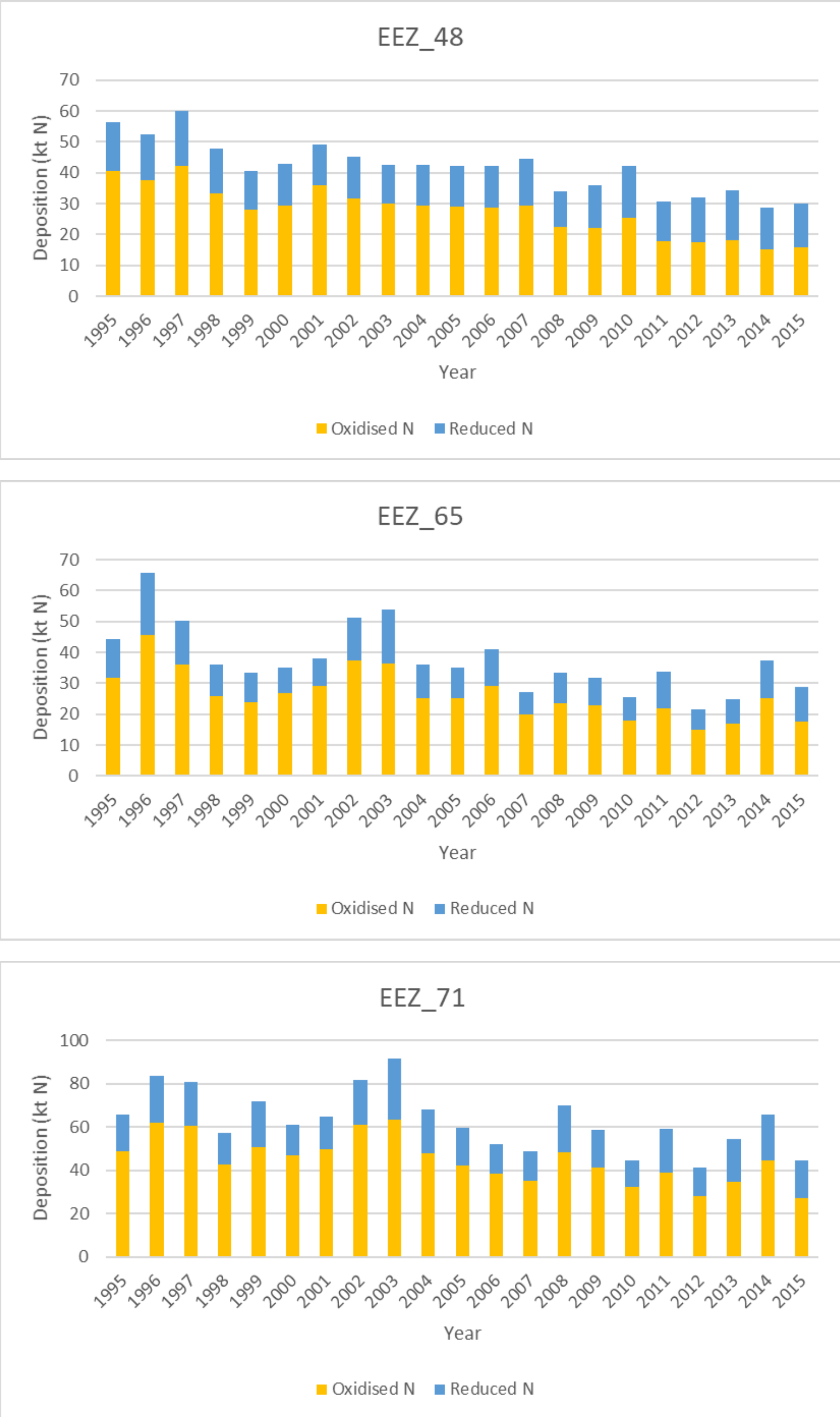
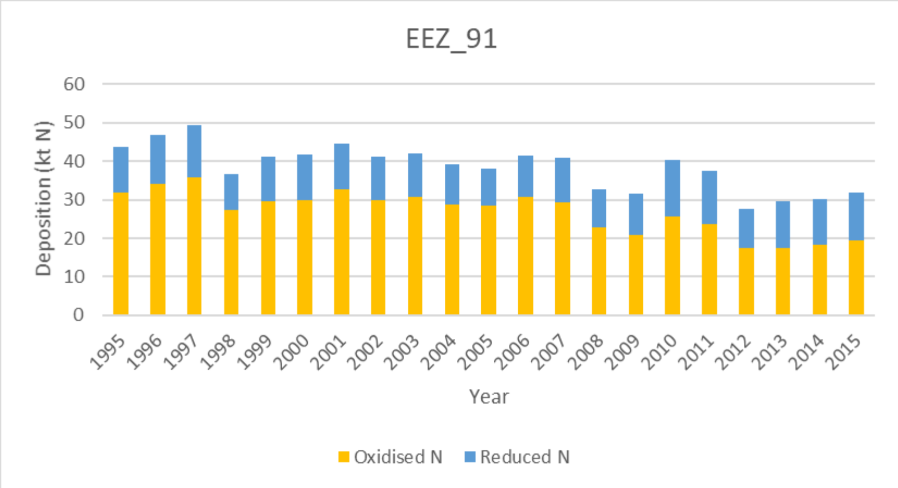
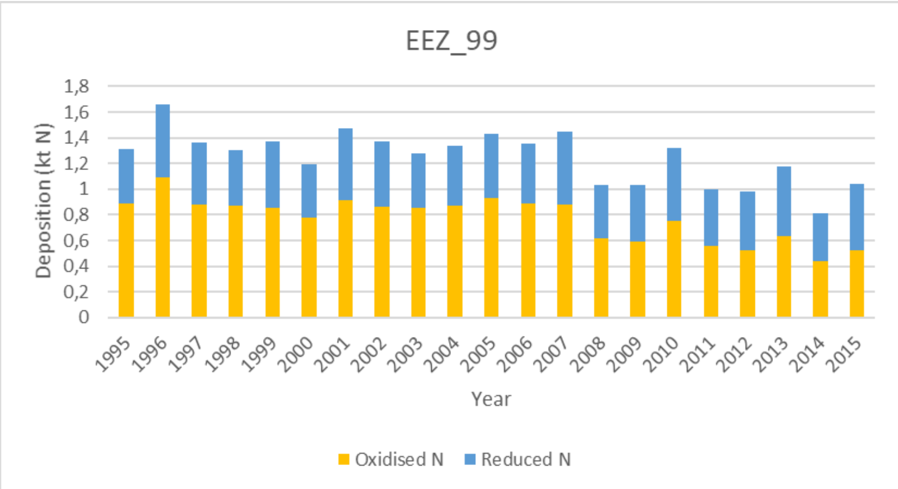


Figure 4.1 Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2015.





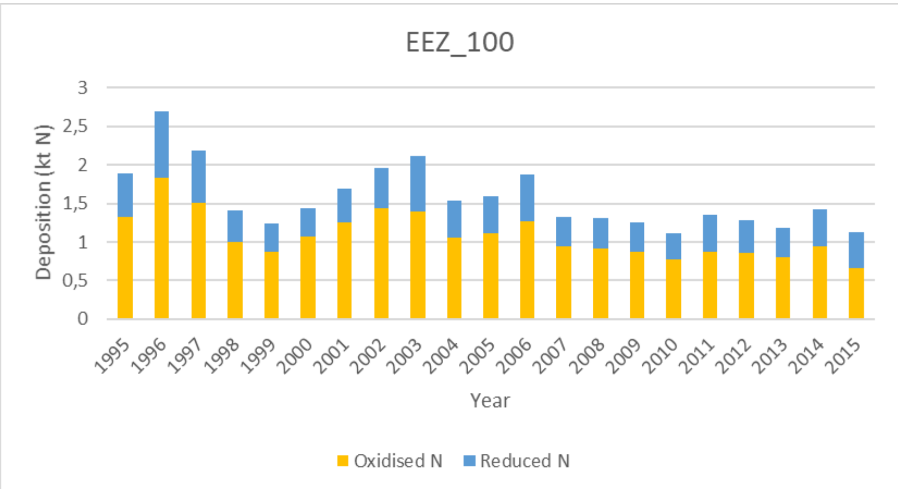


Figure 4.1 (cont.) Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2015.

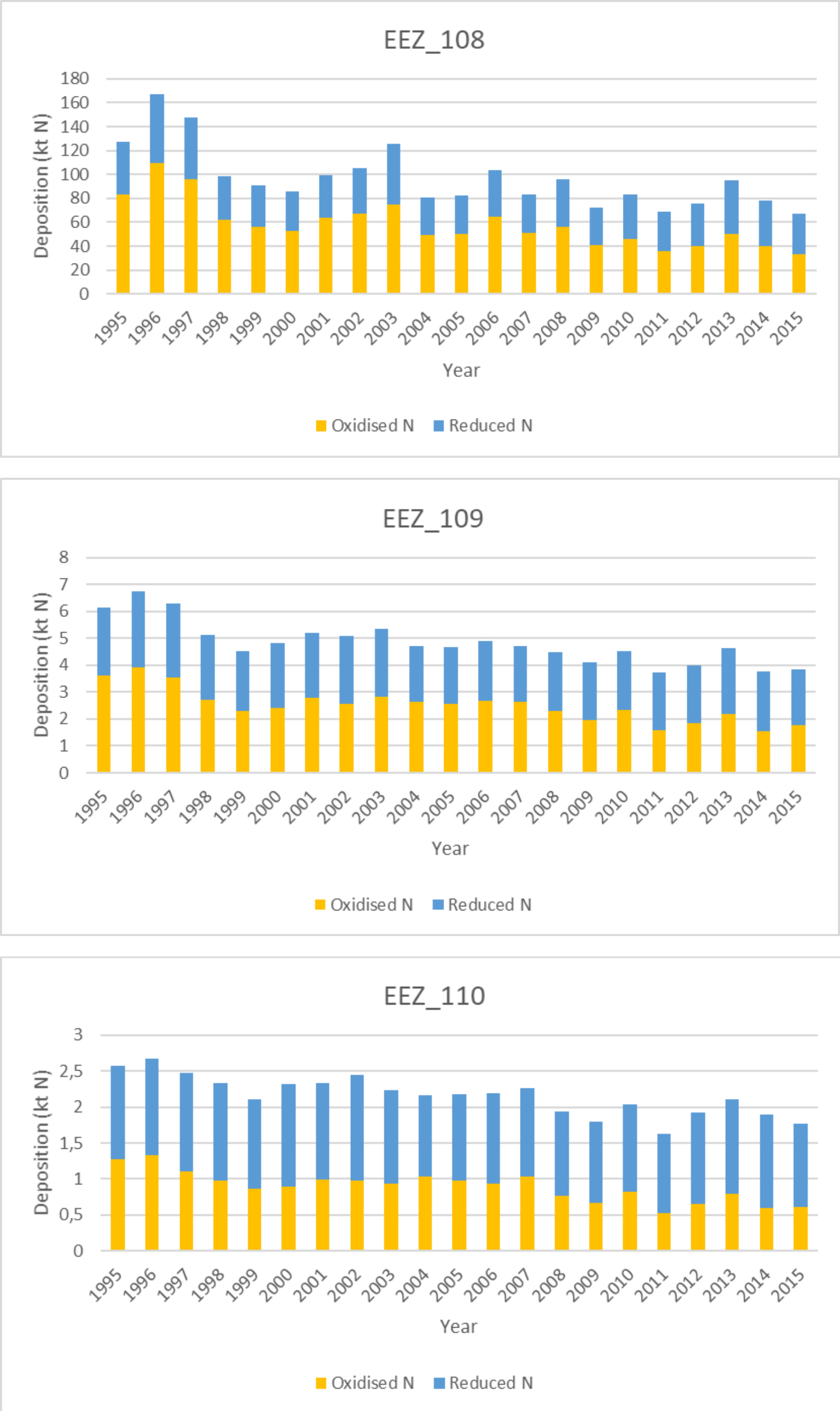
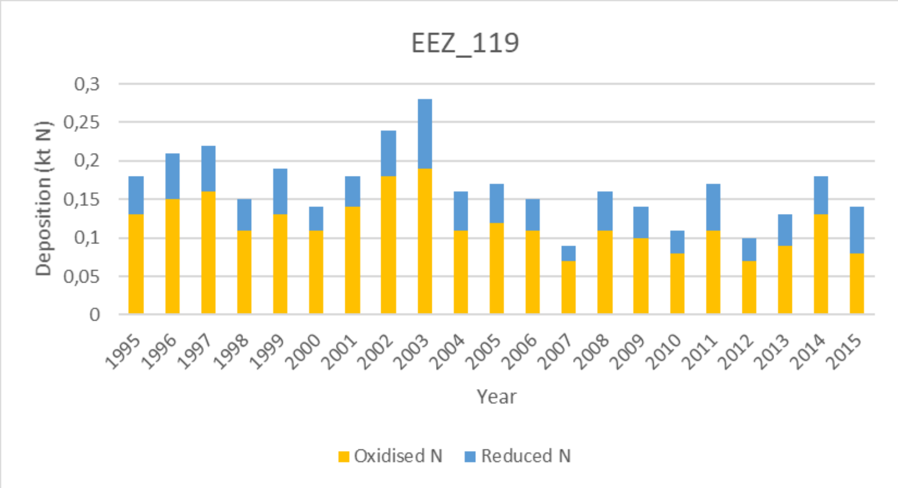
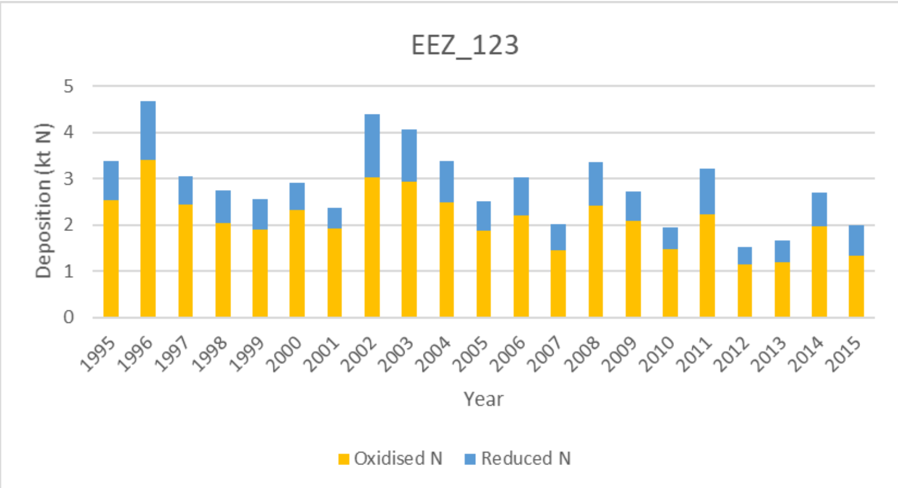


Figure 4.1 (cont.) Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2015.





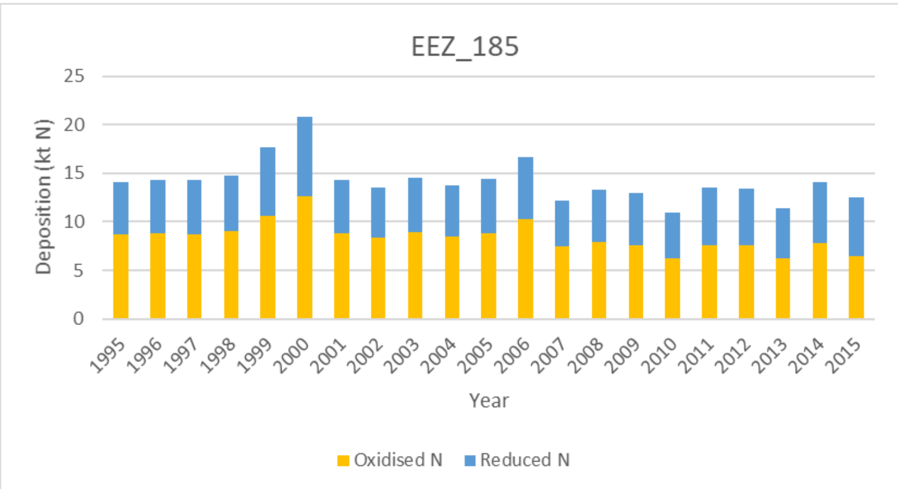
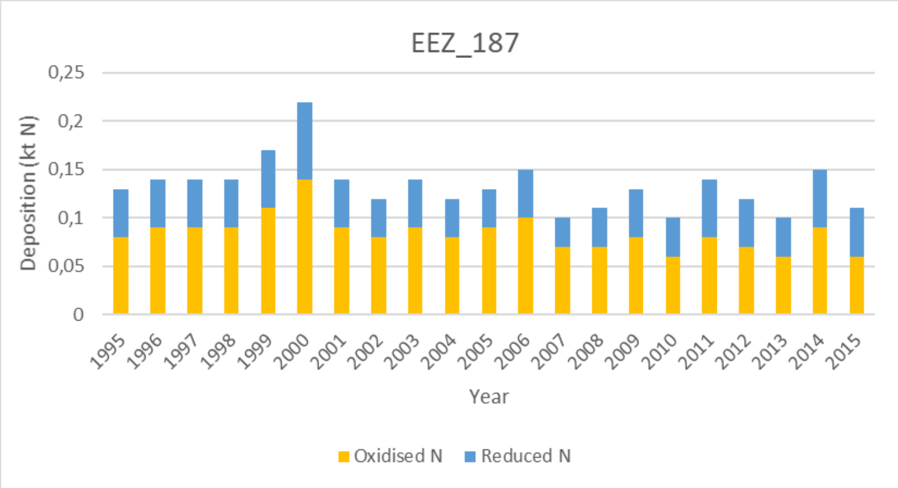
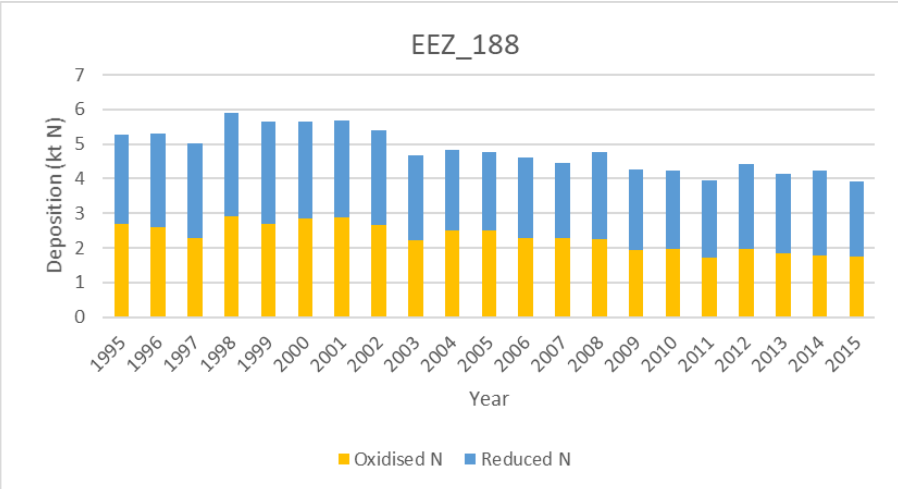


Figure 4.1 (cont.) Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2015.





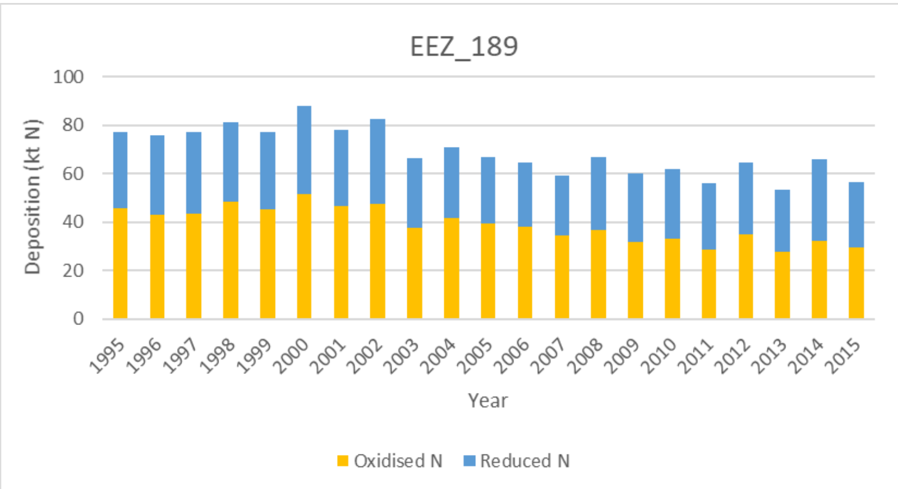
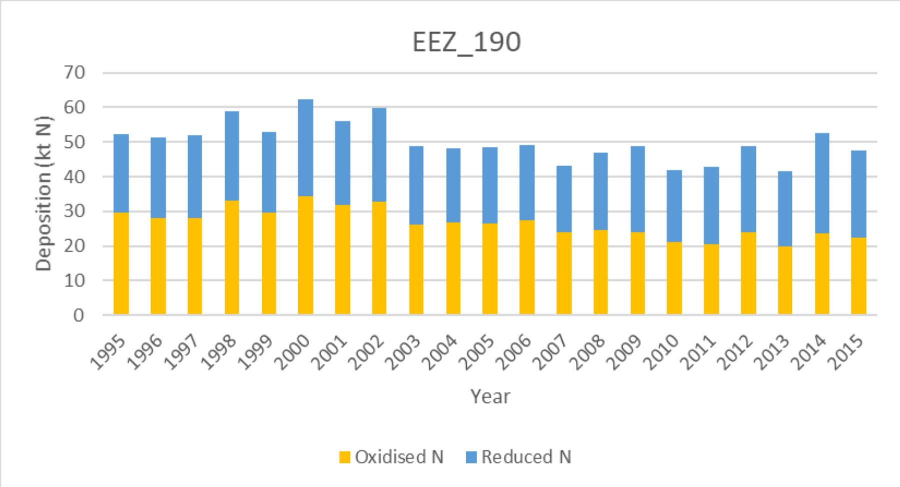
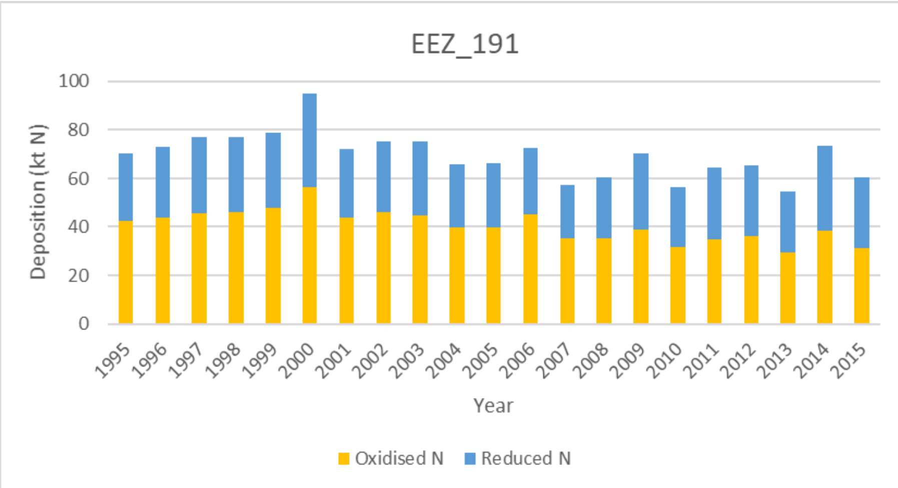


Figure 4.1 (cont.) Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2015.





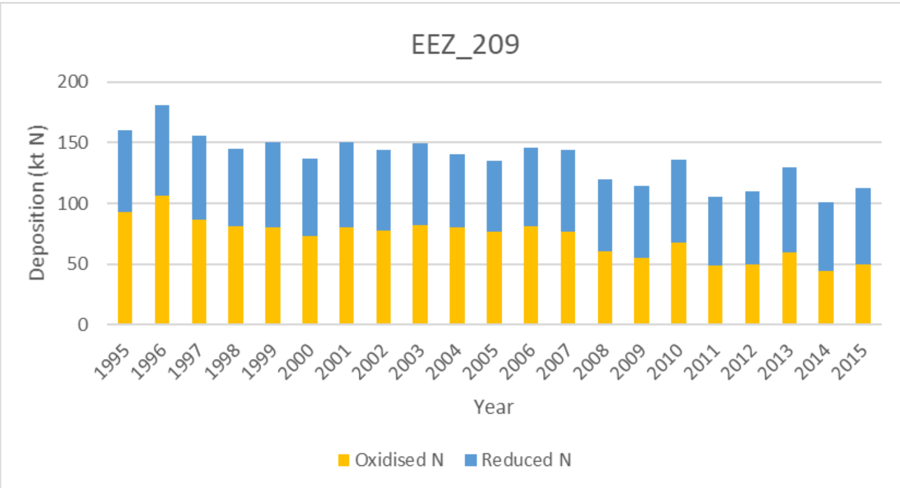
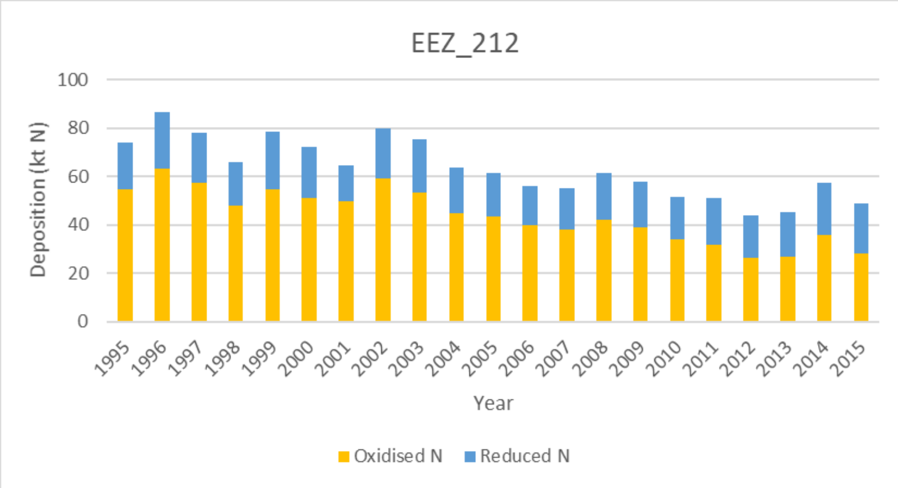
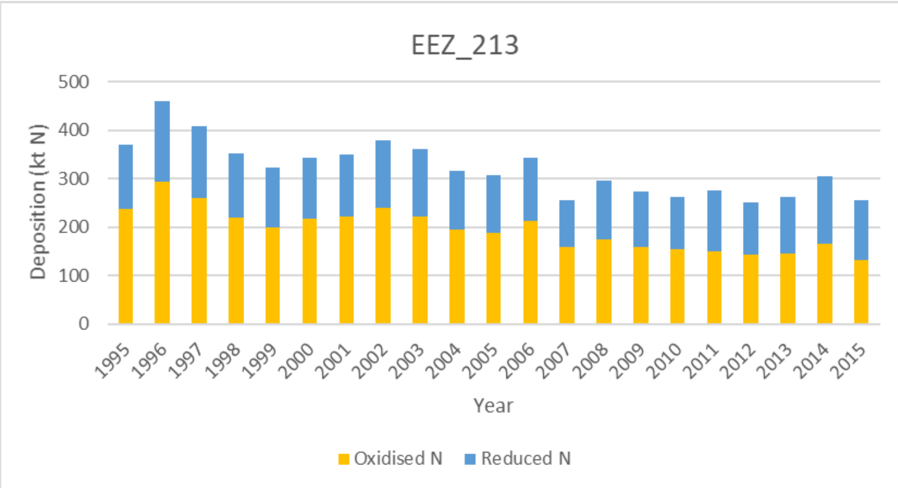


Figure 4.1 (cont.) Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2015.





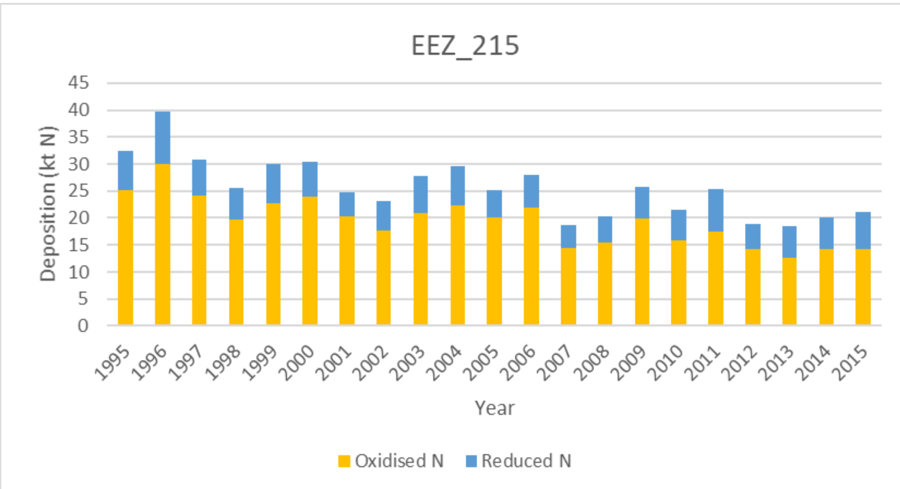


Figure 4.1 (cont.) Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2015.

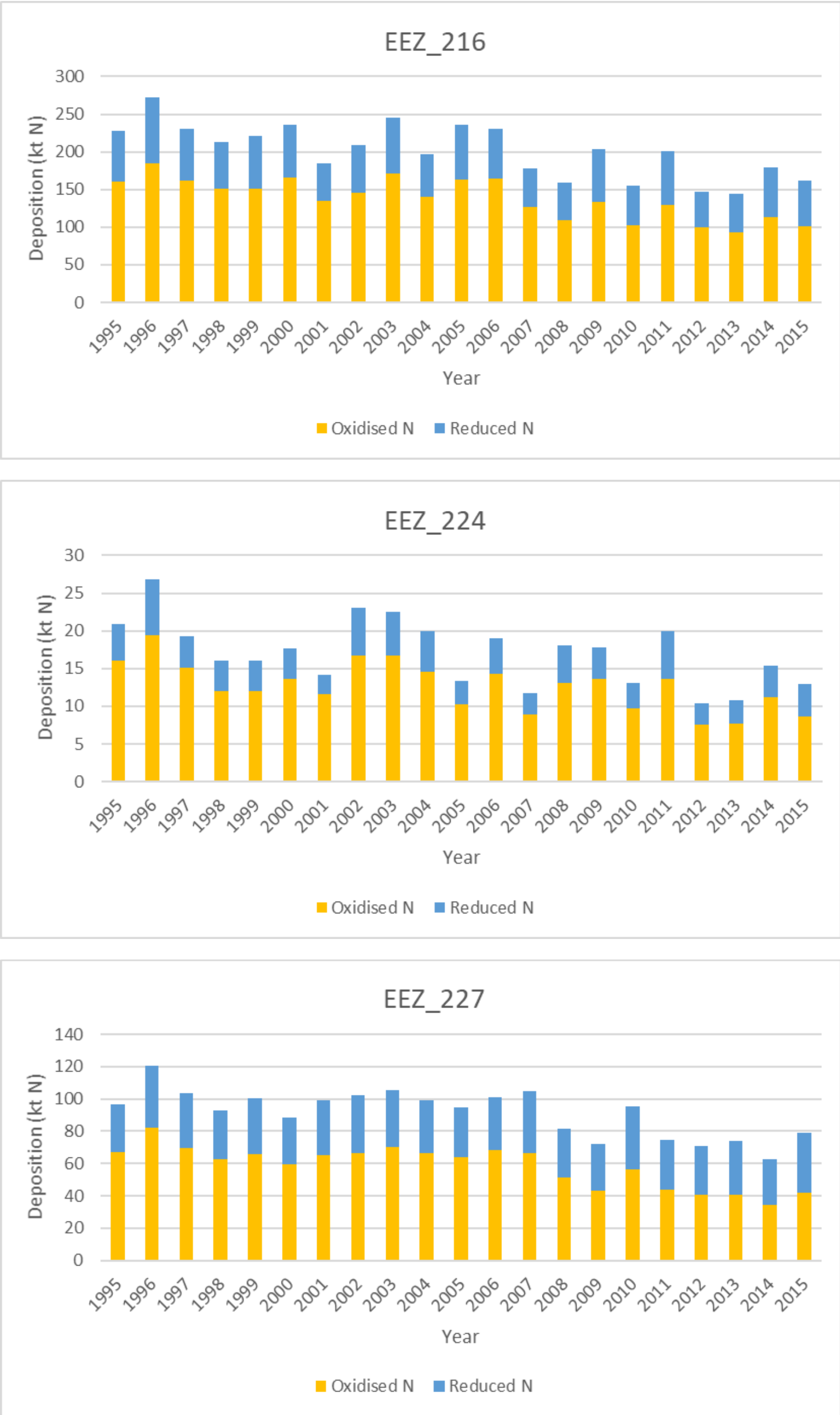


Figure 4.1 (cont.) Time series of annual depositions of oxidised, reduced and total nitrogen

5. Source-receptor matrices

Since the source-receptor matrices were not calculated for the year 2015, the latest EMEM model results were available. Therefore, we have calculated the source-receptor matrices for nitrogen depositions to the Main EMEP Regions and to EEZs for the same year 2014. These calculations used the updated definitions of the OSPAR MAIN Regions and new definitions of the EEZs, in the EMEP grid system

5.1 Main OSPAR Regions

For the Main OSPAR Regions, we have selected the ‘Top Ten’ contributors for oxidised, reduced and total nitrogen depositions to each region. The results are presented in Figures 5.1-5.5 for the Regions 1 to 5.

The number one sources for oxidised nitrogen deposition in 2014 are: Boundary and Initial Conditions, United Kingdom, United Kingdom, ship traffic on Atlantic Ocean and again Boundary and Initial Conditions for Regions 1, 2, 3, 4 and 5, respectively.

The number one sources for reduced nitrogen deposition in 2014 are: United Kingdom, Germany, United Kingdom, France and again France for Regions 1, 2, 3, 4 and 5, respectively.

In case of total nitrogen deposition, United Kingdom is the number one source for Regions 1, 2 and 3. France is the number one source for Region 4 and Boundary and initial conditions for Region 5.

Ship traffic is an important source in case of oxidised nitrogen deposition and can be found among Top Ten sources for all Regions.

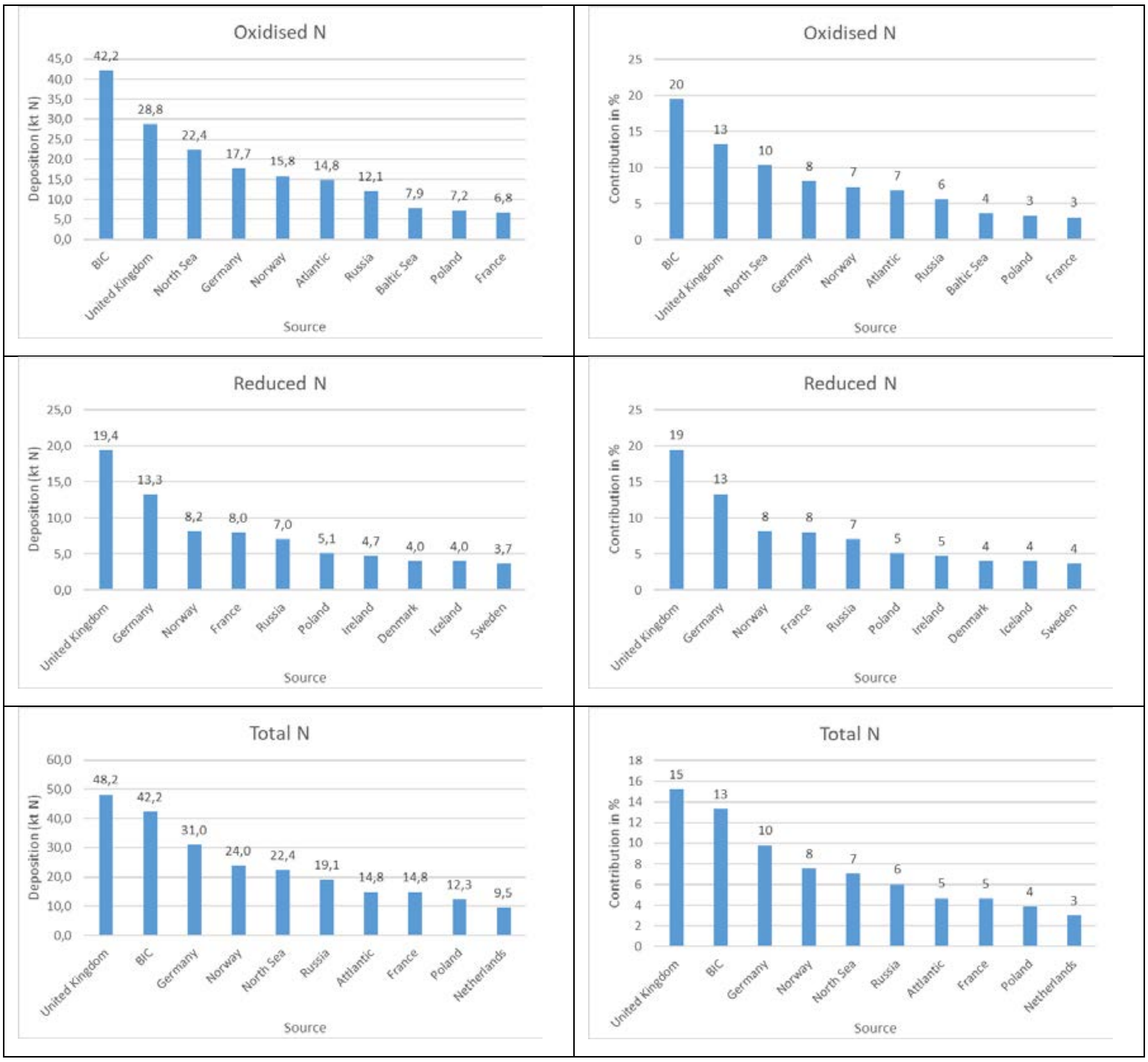


Figure 5.1 Top ten sources contributing to annual 2014 nitrogen deposition to the Main OSPAR Region I. Contribution in ktonnes N on the left and contribution in per cent of the total deposition on the right. BIC is a contribution from Boundary and Initial Conditions. Atlantic, North Sea and Baltic Sea are the contributions from the ship traffic on the Atlantic Ocean, North Sea and Baltic Sea, respectively.

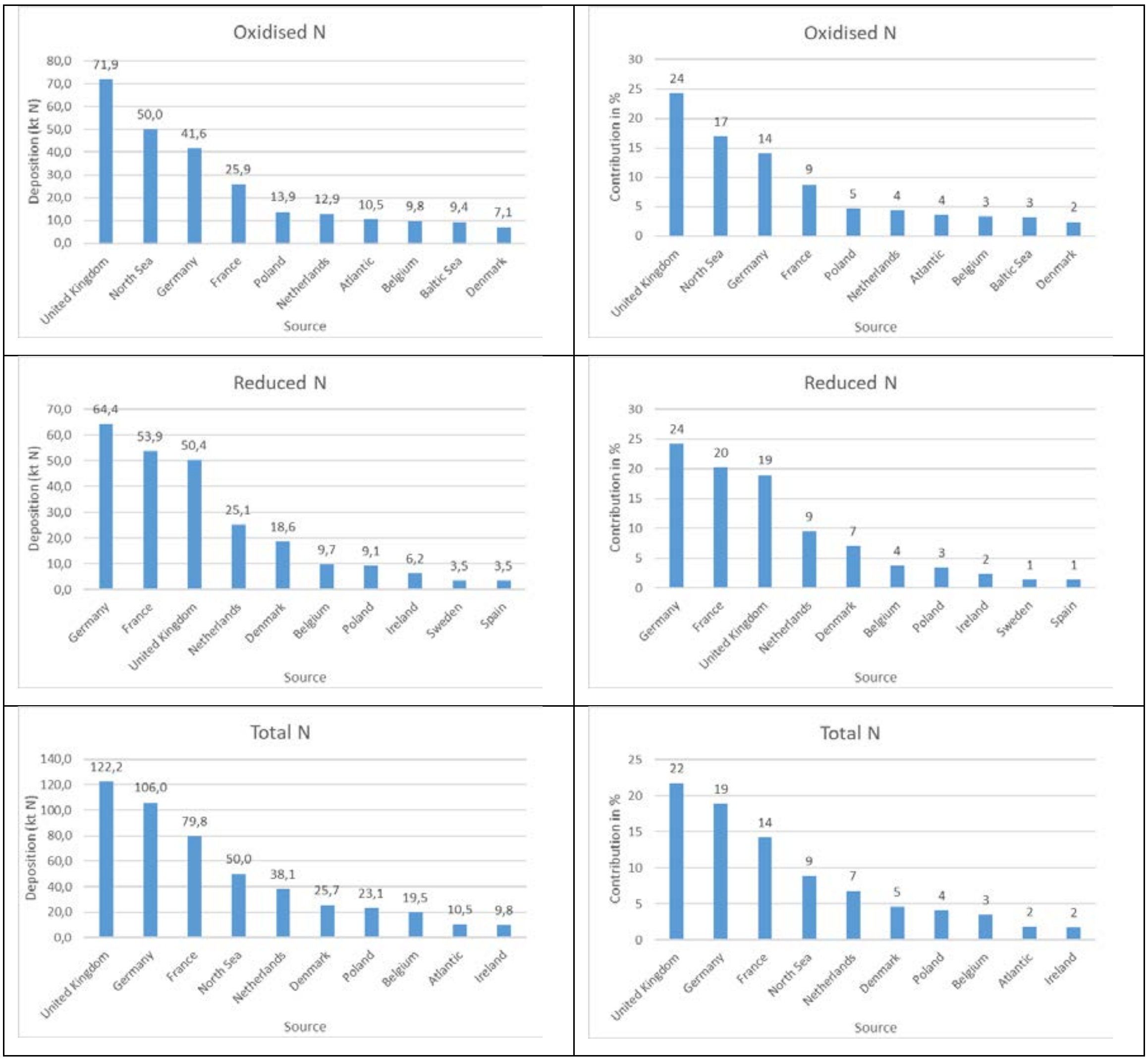


Figure 5.2 Top ten sources contributing to annual 2014 nitrogen deposition to the Main OSPAR Region II. Contribution in ktonnes N on the left and contribution in per cent of the total deposition on the right. Atlantic, North Sea and Baltic Sea are the contributions from the ship traffic on the Atlantic Ocean, North Sea and Baltic Sea, respectively.

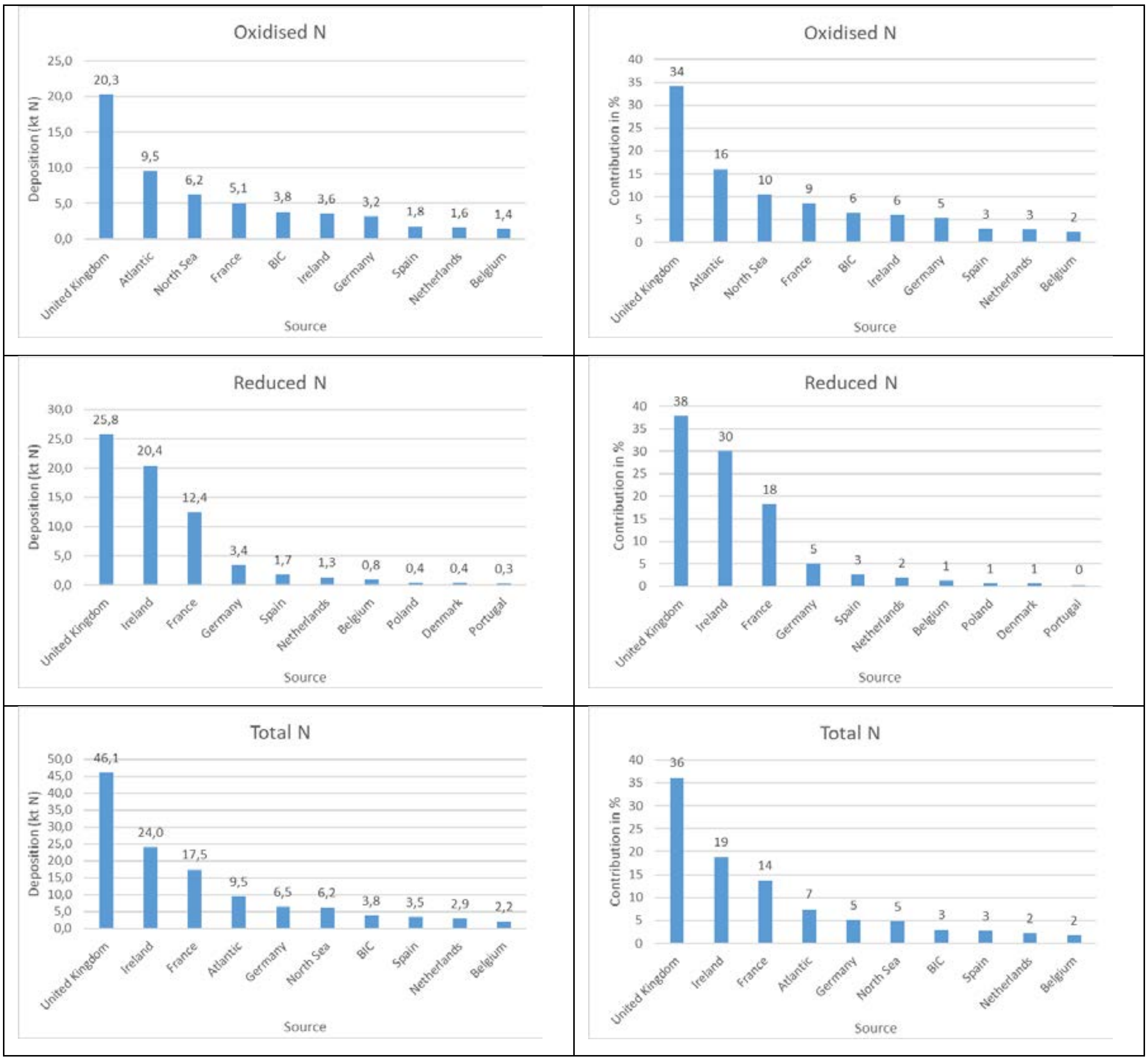


Figure 5.3 Top ten sources contributing to annual 2014 nitrogen deposition to the Main OSPAR Region III. Contribution in ktonnes N on the left and contribution in per cent of the total deposition on the right. BIC is a contribution from Boundary and Initial Conditions. Atlantic, North Sea and Baltic Sea are the contributions from the ship traffic on the Atlantic Ocean, North Sea and Baltic Sea, respectively.

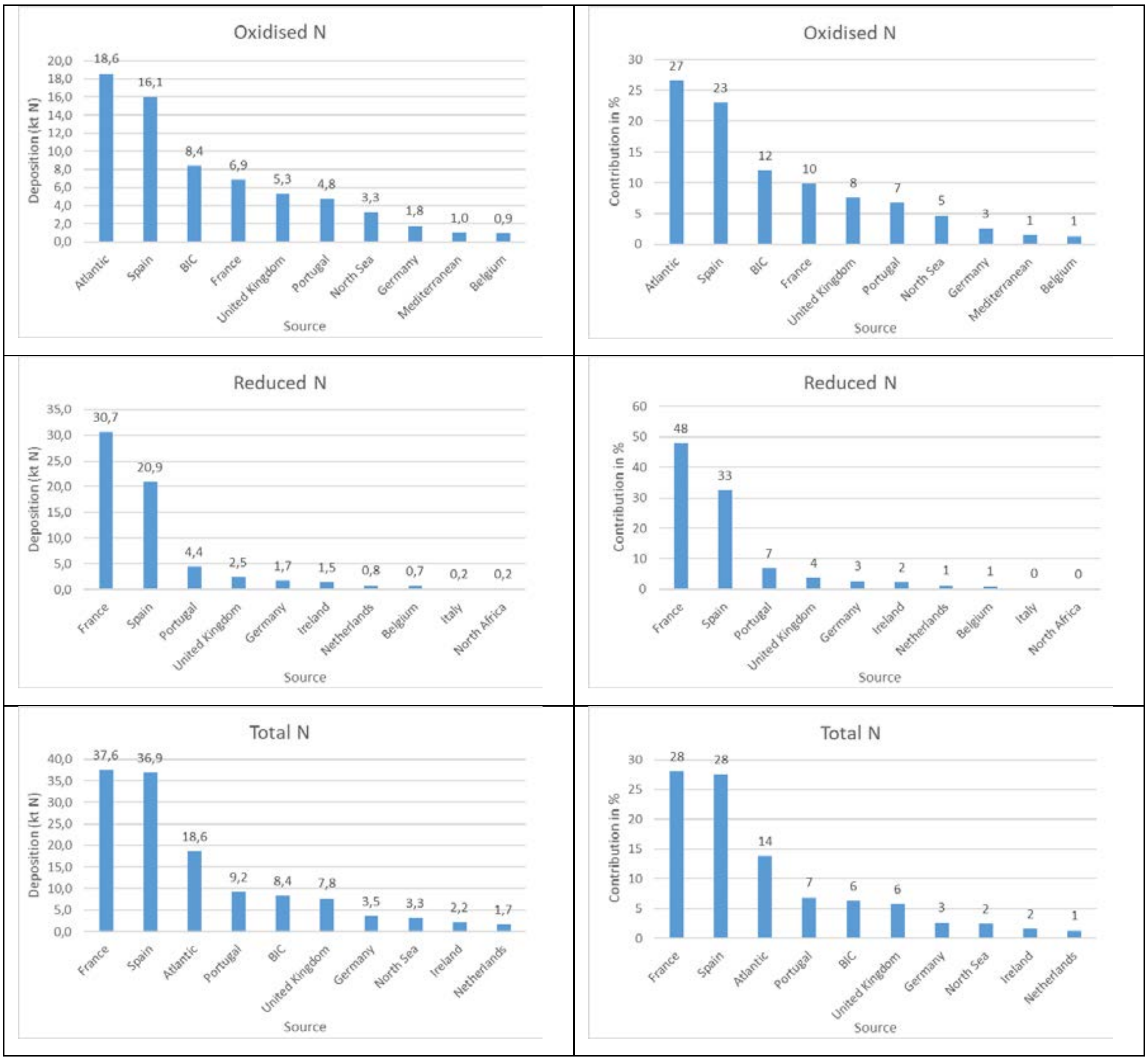


Figure 5.4 Top ten sources contributing to annual 2014 nitrogen deposition to the Main OSPAR Region IV. Contribution in ktonnes N on the left and contribution in per cent of the total deposition on the right. BIC is a contribution from Boundary and Initial Conditions. Atlantic, Mediterranean, North Sea and Baltic Sea are the contributions from the ship traffic on the Atlantic Ocean, Mediterranean Sea, North Sea and Baltic Sea, respectively.

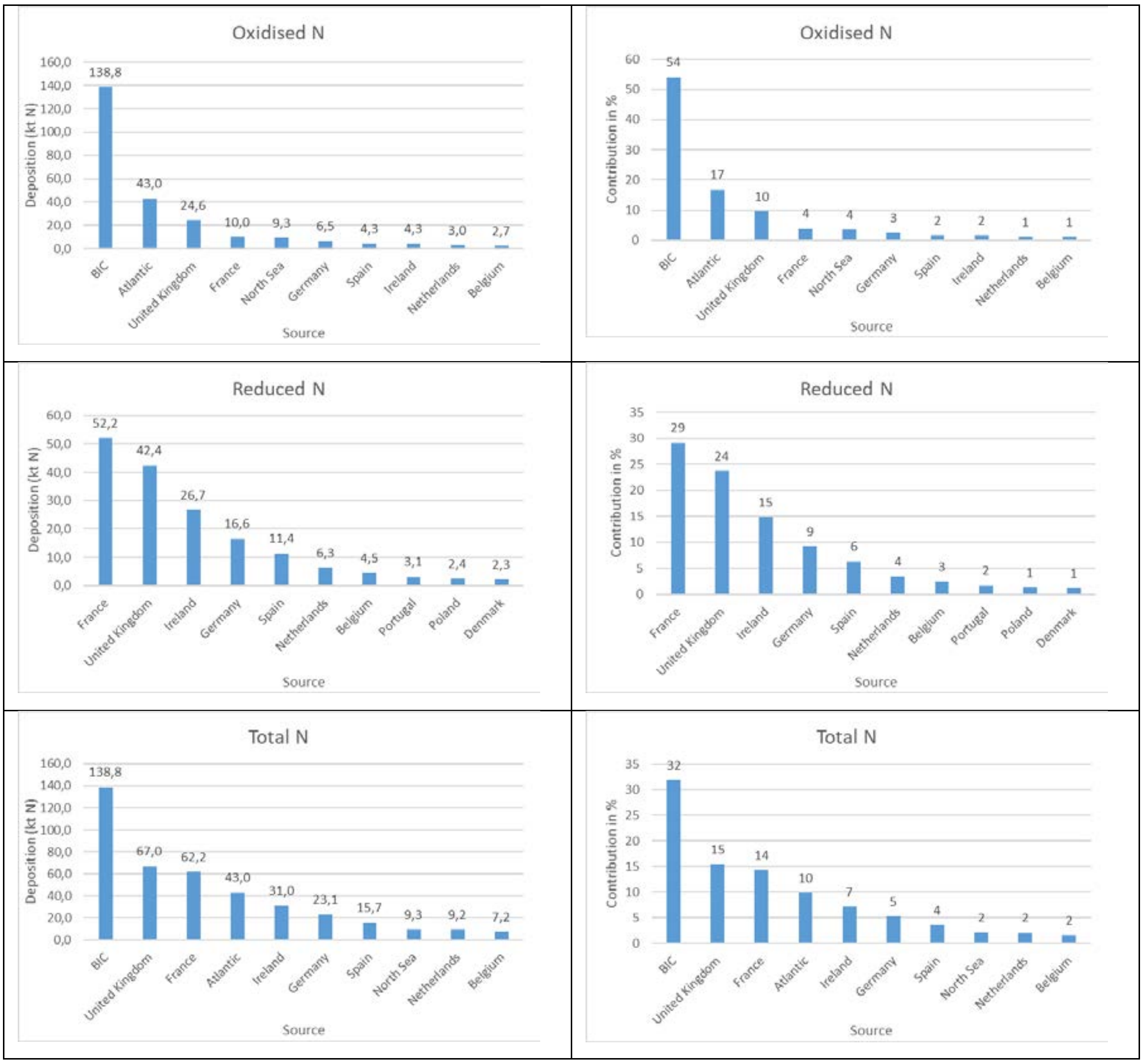


Figure 5.5 Top ten sources contributing to annual 2014 nitrogen deposition to the Main OSPAR Region V. Contribution in ktonnes N on the left and contribution in per cent of the total deposition on the right. BIC is a contribution from Boundary and Initial Conditions. Atlantic and North Sea are the contributions from the ship traffic on the Atlantic Ocean and North Sea, respectively.

5.2 Exclusive Economic Zones

There is a relatively large number (24) of EEZs for which source-receptor matrices were calculated, therefore, we present the results in the form of Tables: contributions to oxidised nitrogen depositions in Table 5.1 and contributions to reduced nitrogen depositions in Table 5.2.

Different sources play the most important role for individual EEZs, however again, the most important sources for oxidised and reduced nitrogen deposition are United Kingdom, France and Germany. In case, of oxidised nitrogen deposition, also ship traffic is as significant source.

Table 5.1 Contributions of EMEP sources to atmospheric annual 2014 depositions of oxidised nitrogen in the EEZs. Units: ktonnes N.

Source	EEZ 48	EEZ 65	EEZ 71	EEZ 91	EEZ 99	EEZ 100	EEZ 108	EEZ 109	EEZ 110	EEZ 119	EEZ 123	EEZ 185
AT	0 .00	0 .08	0 .13	0 .01	0 .00	0 .00	0 .04	0 .00	0 .00	0 .00	0 .00	0 .05
BA	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00
BE	0 .01	0 .59	1 .16	0 .07	0 .01	0 .02	0 .97	0 .04	0 .02	0 .00	0 .04	0 .24
BG	0 .00	0 .01	0 .01	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .01
BY	0 .00	0 .12	0 .16	0 .00	0 .00	0 .00	0 .02	0 .00	0 .00	0 .00	0 .01	0 .07
CH	0 .00	0 .04	0 .07	0 .01	0 .00	0 .00	0 .06	0 .00	0 .00	0 .00	0 .00	0 .02
CZ	0 .00	0 .17	0 .24	0 .01	0 .00	0 .00	0 .08	0 .00	0 .00	0 .00	0 .01	0 .11
DE	0 .02	3 .06	4 .54	0 .13	0 .01	0 .10	2 .17	0 .06	0 .02	0 .02	0 .19	1 .34
DK	0 .00	0 .67	0 .82	0 .01	0 .00	0 .02	0 .21	0 .00	0 .00	0 .00	0 .06	0 .44
EE	0 .00	0 .02	0 .03	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .01
ES	0 .01	0 .14	0 .18	2 .22	0 .12	0 .01	1 .03	0 .10	0 .04	0 .00	0 .00	0 .07
FI	0 .00	0 .09	0 .16	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .02	0 .03
FR	0 .04	1 .30	2 .09	0 .56	0 .05	0 .05	3 .66	0 .22	0 .10	0 .01	0 .07	0 .46
GB	0 .05	6 .13	8 .31	0 .45	0 .05	0 .32	11 .00	0 .36	0 .12	0 .03	0 .32	0 .81
GR	0 .00	0 .01	0 .02	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00
HR	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .01
HU	0 .00	0 .05	0 .07	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .03
IE	0 .01	0 .53	0 .74	0 .04	0 .01	0 .04	2 .41	0 .03	0 .01	0 .00	0 .01	0 .03
IS	0 .00	0 .11	2 .04	0 .00	0 .00	0 .00	0 .06	0 .00	0 .00	0 .00	0 .03	0 .00
IT	0 .00	0 .02	0 .02	0 .04	0 .00	0 .00	0 .06	0 .00	0 .00	0 .00	0 .00	0 .02
LT	0 .00	0 .05	0 .07	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .05
LU	0 .00	0 .07	0 .12	0 .01	0 .00	0 .00	0 .09	0 .00	0 .00	0 .00	0 .00	0 .02
LV	0 .00	0 .03	0 .04	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .03
MD	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00
NL	0 .01	0 .94	1 .60	0 .06	0 .01	0 .03	1 .09	0 .04	0 .02	0 .01	0 .06	0 .35
NO	0 .00	1 .16	1 .91	0 .01	0 .00	0 .02	0 .12	0 .00	0 .00	0 .01	0 .16	0 .11
PL	0 .00	0 .85	1 .10	0 .02	0 .00	0 .02	0 .22	0 .01	0 .00	0 .00	0 .07	0 .58
PT	0 .01	0 .03	0 .03	2 .27	0 .02	0 .00	0 .31	0 .02	0 .01	0 .00	0 .00	0 .01
RO	0 .00	0 .02	0 .01	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .03
RS	0 .00	0 .02	0 .02	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .01
RU	0 .00	0 .22	0 .32	0 .01	0 .00	0 .00	0 .03	0 .00	0 .00	0 .00	0 .04	0 .17
SE	0 .00	0 .36	0 .54	0 .00	0 .00	0 .01	0 .06	0 .00	0 .00	0 .00	0 .05	0 .28

Source	EEZ 48	EEZ 65	EEZ 71	EEZ 91	EEZ 99	EEZ 100	EEZ 108	EEZ 109	EEZ 110	EEZ 119	EEZ 123	EEZ 185
SI	0 .00	0 .01	0 .01	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .01
SK	0 .00	0 .04	0 .06	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .04
TR	0 .00	0 .02	0 .04	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .02
UA	0 .00	0 .19	0 .25	0 .01	0 .00	0 .00	0 .04	0 .00	0 .00	0 .00	0 .02	0 .09
ATL	0 .84	2 .00	4 .53	5 .59	0 .11	0 .09	7 .17	0 .22	0 .08	0 .01	0 .14	0 .10
BAS	0 .00	0 .78	1 .08	0 .01	0 .00	0 .02	0 .26	0 .01	0 .00	0 .00	0 .09	0 .72
BLS	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00
MED	0 .00	0 .03	0 .04	0 .23	0 .00	0 .00	0 .08	0 .01	0 .01	0 .00	0 .00	0 .02
NOA	0 .00	0 .00	0 .01	0 .01	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .00
NOS	0 .03	3 .56	5 .00	0 .23	0 .03	0 .12	3 .52	0 .34	0 .12	0 .02	0 .27	1 .28
BIC	14 .2	1 .75	7 .04	6 .18	0 .03	0 .07	5 .09	0 .06	0 .02	0 .01	0 .25	0 .09

Table 5.1 (cont.) Contributions of EMEP sources to atmospheric annual 2014 depositions of oxidised nitrogen in the EEZs. Units: ktonnes N.

Source	EEZ 187	EEZ 188	EEZ 189	EEZ 190	EEZ 191	EEZ 209	EEZ 212	EEZ 213	EEZ 215	EEZ 216	EEZ 224	EEZ 273
AT	0 .00	0 .01	0 .17	0 .19	0 .26	0 .04	0 .07	0 .61	0 .04	0 .41	0 .03	0 .03
BA	0 .00	0 .00	0 .00	0 .01	0 .01	0 .00	0 .02	0 .02	0 .01	0 .03	0 .01	0 .00
BE	0 .00	0 .06	1 .68	1 .08	1 .28	1 .00	0 .51	4 .44	0 .21	2 .67	0 .24	0 .43
BG	0 .00	0 .00	0 .01	0 .02	0 .04	0 .00	0 .01	0 .04	0 .01	0 .07	0 .00	0 .00
BY	0 .00	0 .00	0 .03	0 .05	0 .27	0 .01	0 .15	0 .41	0 .11	0 .88	0 .07	0 .00
CH	0 .00	0 .01	0 .10	0 .08	0 .11	0 .03	0 .03	0 .32	0 .01	0 .15	0 .01	0 .02
CZ	0 .00	0 .01	0 .34	0 .37	0 .61	0 .12	0 .17	1 .25	0 .08	1 .08	0 .06	0 .06
DE	0 .01	0 .13	4 .22	4 .58	7 .11	1 .86	2 .40	17 .13	0 .93	12 .87	1 .11	0 .81
DK	0 .00	0 .01	0 .28	0 .33	1 .21	0 .09	0 .53	2 .71	0 .23	3 .69	0 .30	0 .03
EE	0 .00	0 .00	0 .00	0 .00	0 .03	0 .00	0 .03	0 .04	0 .07	0 .20	0 .03	0 .00
ES	0 .00	0 .03	0 .46	0 .26	0 .40	7 .08	0 .04	2 .80	0 .02	0 .92	0 .03	8 .79
FI	0 .00	0 .00	0 .01	0 .01	0 .07	0 .00	0 .20	0 .13	0 .64	1 .28	0 .14	0 .00
FR	0 .01	0 .36	4 .25	2 .29	2 .81	6 .48	0 .94	13 .44	0 .28	5 .36	0 .41	3 .15
GB	0 .01	0 .50	8 .49	4 .68	6 .28	6 .83	2 .80	52 .62	1 .13	21 .91	1 .62	2 .25
GR	0 .00	0 .00	0 .01	0 .02	0 .04	0 .00	0 .01	0 .04	0 .01	0 .06	0 .01	0 .00
HR	0 .00	0 .00	0 .01	0 .02	0 .04	0 .01	0 .01	0 .05	0 .01	0 .05	0 .00	0 .00
HU	0 .00	0 .00	0 .08	0 .12	0 .22	0 .02	0 .04	0 .38	0 .03	0 .35	0 .02	0 .01

Source	EEZ 187	EEZ 188	EEZ 189	EEZ 190	EEZ 191	EEZ 209	EEZ 212	EEZ 213	EEZ 215	EEZ 216	EEZ 224	EEZ 273
IE	0 .00	0 .01	0 .33	0 .21	0 .33	0 .72	0 .19	4 .68	0 .07	1 .30	0 .08	0 .24
IS	0 .00	0 .00	0 .01	0 .00	0 .01	0 .01	0 .76	0 .15	0 .07	0 .15	0 .15	0 .01
IT	0 .00	0 .01	0 .17	0 .12	0 .16	0 .13	0 .02	0 .56	0 .01	0 .19	0 .00	0 .09
LT	0 .00	0 .00	0 .02	0 .02	0 .13	0 .01	0 .07	0 .16	0 .06	0 .42	0 .03	0 .00
LU	0 .00	0 .01	0 .13	0 .11	0 .14	0 .10	0 .05	0 .38	0 .02	0 .24	0 .02	0 .05
LV	0 .00	0 .00	0 .01	0 .01	0 .05	0 .00	0 .05	0 .07	0 .07	0 .29	0 .03	0 .00
MD	0 .00	0 .00	0 .01	0 .01	0 .02	0 .00	0 .01	0 .02	0 .00	0 .03	0 .00	0 .00
NL	0 .00	0 .06	1 .68	1 .40	1 .71	0 .93	0 .74	6 .26	0 .30	3 .90	0 .38	0 .41
NO	0 .00	0 .00	0 .12	0 .11	0 .34	0 .05	1 .42	1 .99	0 .97	8 .74	1 .04	0 .03
PL	0 .01	0 .02	0 .75	1 .21	3 .01	0 .32	0 .87	4 .57	0 .48	5 .92	0 .37	0 .12
PT	0 .00	0 .00	0 .05	0 .03	0 .05	1 .12	0 .01	0 .55	0 .01	0 .18	0 .01	2 .06
RO	0 .00	0 .00	0 .06	0 .09	0 .18	0 .03	0 .01	0 .21	0 .02	0 .26	0 .00	0 .01
RS	0 .00	0 .00	0 .03	0 .05	0 .09	0 .01	0 .01	0 .11	0 .01	0 .15	0 .01	0 .00
RU	0 .00	0 .01	0 .13	0 .16	0 .63	0 .04	0 .69	0 .74	1 .15	2 .40	0 .29	0 .01
SE	0 .00	0 .00	0 .07	0 .07	0 .56	0 .02	0 .47	0 .88	0 .50	3 .14	0 .33	0 .01
SI	0 .00	0 .00	0 .01	0 .02	0 .03	0 .01	0 .01	0 .05	0 .00	0 .05	0 .00	0 .01
SK	0 .00	0 .00	0 .07	0 .09	0 .19	0 .02	0 .04	0 .30	0 .03	0 .31	0 .02	0 .01
TR	0 .00	0 .00	0 .02	0 .03	0 .11	0 .01	0 .03	0 .11	0 .01	0 .22	0 .01	0 .00
UA	0 .00	0 .00	0 .12	0 .19	0 .57	0 .05	0 .23	0 .77	0 .11	1 .10	0 .09	0 .02
ATL	0 .00	0 .07	0 .96	0 .50	0 .69	9 .10	1 .79	11 .98	0 .77	5 .75	0 .78	9 .37
BAS	0 .01	0 .01	0 .45	0 .57	2 .12	0 .12	0 .85	3 .11	0 .61	4 .97	0 .50	0 .04
BLS	0 .00	0 .00	0 .00	0 .01	0 .01	0 .00	0 .00	0 .01	0 .00	0 .02	0 .00	0 .00
MED	0 .00	0 .01	0 .14	0 .09	0 .13	0 .55	0 .02	0 .54	0 .01	0 .23	0 .01	0 .48
NOA	0 .00	0 .00	0 .00	0 .00	0 .00	0 .02	0 .02	0 .02	0 .02	0 .01	0 .01	0 .01
NOS	0 .01	0 .36	5 .92	3 .82	5 .93	4 .98	2 .56	24 .40	1 .08	16 .95	1 .42	1 .40
BIC	0 .00	0 .06	0 .76	0 .46	0 .58	2 .60	17 .15	6 .06	4 .11	4 .98	1 .59	4 .45

Table 5.2 Contributions of EMEP sources to atmospheric annual 2014 depositions of reduced nitrogen in the EEZs. Units: ktonnes N.

Source	EEZ 48	EEZ 65	EEZ 71	EEZ 91	EEZ 99	EEZ 100	EEZ 108	EEZ 109	EEZ 110	EEZ 119	EEZ 123	EEZ 185
AT	0 .04	0 .04	0 .14	0 .02	0 .00	0 .00	0 .05	0 .00	0 .00	0 .00	0 .00	0 .03
BA	0 .00	0 .01	0 .02	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .00
BE	0 .54	0 .29	0 .51	0 .11	0 .01	0 .01	0 .64	0 .03	0 .01	0 .00	0 .01	0 .13
BY	0 .06	0 .25	0 .33	0 .00	0 .00	0 .01	0 .06	0 .00	0 .00	0 .00	0 .01	0 .11
CH	0 .02	0 .03	0 .13	0 .02	0 .00	0 .00	0 .08	0 .00	0 .00	0 .00	0 .00	0 .02
CZ	0 .04	0 .08	0 .17	0 .01	0 .00	0 .00	0 .08	0 .00	0 .00	0 .00	0 .01	0 .09
DE	1 .11	2 .32	3 .55	0 .20	0 .01	0 .08	2 .36	0 .06	0 .02	0 .01	0 .13	1 .63
DK	0 .05	0 .67	0 .69	0 .01	0 .00	0 .02	0 .23	0 .00	0 .00	0 .00	0 .05	1 .34
EE	0 .01	0 .02	0 .04	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .01
ES	0 .70	0 .13	0 .23	4 .10	0 .12	0 .00	1 .05	0 .10	0 .04	0 .00	0 .01	0 .06
FI	0 .00	0 .04	0 .07	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .01	0 .01
FR	6 .00	1 .32	2 .63	2 .09	0 .18	0 .04	7 .46	1 .62	1 .11	0 .01	0 .06	0 .44
GB	2 .24	3 .20	4 .72	0 .38	0 .02	0 .18	8 .61	0 .29	0 .07	0 .02	0 .20	0 .33
HR	0 .00	0 .01	0 .01	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .01
HU	0 .01	0 .04	0 .07	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .04
IE	1 .08	0 .92	1 .33	0 .10	0 .01	0 .06	15 .39	0 .07	0 .02	0 .00	0 .02	0 .05
IS	0 .04	0 .08	2 .22	0 .00	0 .00	0 .00	0 .02	0 .00	0 .00	0 .00	0 .04	0 .00
IT	0 .02	0 .03	0 .11	0 .10	0 .00	0 .00	0 .07	0 .00	0 .00	0 .00	0 .00	0 .02
LT	0 .02	0 .08	0 .12	0 .00	0 .00	0 .00	0 .02	0 .00	0 .00	0 .00	0 .00	0 .05
LU	0 .03	0 .03	0 .04	0 .01	0 .00	0 .00	0 .05	0 .00	0 .00	0 .00	0 .00	0 .01
LV	0 .01	0 .03	0 .04	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .02
MD	0 .00	0 .01	0 .01	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00
NL	0 .63	0 .66	0 .99	0 .10	0 .01	0 .02	0 .94	0 .04	0 .01	0 .00	0 .03	0 .35
NO	0 .05	0 .31	0 .45	0 .00	0 .00	0 .01	0 .02	0 .00	0 .00	0 .00	0 .04	0 .06
PL	0 .17	0 .52	0 .83	0 .01	0 .00	0 .01	0 .27	0 .00	0 .00	0 .00	0 .03	0 .39
PT	0 .24	0 .02	0 .02	4 .60	0 .01	0 .00	0 .19	0 .01	0 .00	0 .00	0 .00	0 .00
RS	0 .01	0 .03	0 .07	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .02
RU	0 .04	0 .18	0 .32	0 .01	0 .00	0 .01	0 .06	0 .00	0 .00	0 .00	0 .02	0 .07
SE	0 .04	0 .26	0 .32	0 .00	0 .00	0 .01	0 .06	0 .00	0 .00	0 .00	0 .03	0 .84
SI	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	0 .01
SK	0 .01	0 .02	0 .06	0 .00	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .03

Source	EEZ 48	EEZ 65	EEZ 71	EEZ 91	EEZ 99	EEZ 100	EEZ 108	EEZ 109	EEZ 110	EEZ 119	EEZ 123	EEZ 185
TR	0 .01	0 .08	0 .27	0 .00	0 .00	0 .00	0 .02	0 .00	0 .00	0 .00	0 .01	0 .03
UA	0 .03	0 .21	0 .42	0 .00	0 .00	0 .00	0 .11	0 .00	0 .00	0 .00	0 .01	0 .08
NOA	0 .02	0 .00	0 .02	0 .02	0 .00	0 .00	0 .01	0 .00	0 .00	0 .00	0 .00	0 .00

Table 5.2 (cont.) Contributions of EMEP sources to atmospheric annual 2014 depositions of reduced nitrogen in the EEZs. Units: ktonnes N.

Source	EEZ 187	EEZ 188	EEZ 189	EEZ 190	EEZ 191	EEZ 209	EEZ 212	EEZ 213	EEZ 215	EEZ 216	EEZ 224	EEZ 273
AT	0 .00	0 .01	0 .10	0 .10	0 .18	0 .03	0 .17	0 .43	0 .02	0 .25	0 .02	0 .03
BA	0 .00	0 .00	0 .00	0 .01	0 .02	0 .00	0 .03	0 .04	0 .01	0 .05	0 .01	0 .00
BE	0 .00	0 .82	2 .96	0 .82	0 .75	0 .89	0 .37	3 .35	0 .10	1 .46	0 .09	0 .36
BY	0 .00	0 .00	0 .09	0 .12	0 .49	0 .02	0 .74	0 .84	0 .21	1 .36	0 .06	0 .01
CH	0 .00	0 .01	0 .11	0 .10	0 .12	0 .05	0 .14	0 .35	0 .01	0 .14	0 .02	0 .02
CZ	0 .00	0 .01	0 .18	0 .21	0 .42	0 .05	0 .26	0 .83	0 .08	0 .73	0 .03	0 .04
DE	0 .01	0 .19	8 .42	15 .47	10 .60	1 .84	2 .91	19 .57	0 .71	13 .15	0 .72	0 .82
DK	0 .01	0 .01	0 .40	0 .80	8 .43	0 .08	0 .76	3 .29	0 .16	5 .67	0 .21	0 .04
EE	0 .00	0 .00	0 .00	0 .00	0 .02	0 .00	0 .10	0 .05	0 .05	0 .12	0 .02	0 .00
ES	0 .00	0 .02	0 .29	0 .17	0 .31	7 .02	0 .17	2 .61	0 .04	0 .94	0 .04	12 .72
FI	0 .00	0 .00	0 .00	0 .01	0 .03	0 .00	0 .19	0 .07	0 .34	0 .45	0 .06	0 .00
FR	0 .01	0 .81	5 .64	2 .46	2 .87	39 .54	2 .07	25 .82	0 .26	5 .99	0 .43	9 .96
GB	0 .00	0 .29	4 .68	2 .14	3 .00	3 .49	3 .54	54 .17	0 .94	12 .78	1 .01	1 .20
HR	0 .00	0 .00	0 .01	0 .02	0 .03	0 .00	0 .01	0 .04	0 .01	0 .05	0 .00	0 .00
HU	0 .00	0 .00	0 .06	0 .11	0 .22	0 .01	0 .10	0 .36	0 .05	0 .34	0 .01	0 .01
IE	0 .00	0 .03	0 .54	0 .30	0 .49	1 .66	0 .86	13 .85	0 .20	2 .25	0 .12	0 .52
IS	0 .00	0 .00	0 .00	0 .00	0 .00	0 .00	2 .11	0 .06	0 .10	0 .12	0 .16	0 .00
IT	0 .00	0 .00	0 .08	0 .08	0 .13	0 .10	0 .11	0 .39	0 .02	0 .17	0 .01	0 .13
LT	0 .00	0 .00	0 .03	0 .03	0 .19	0 .01	0 .31	0 .25	0 .10	0 .49	0 .03	0 .00
LU	0 .00	0 .00	0 .06	0 .04	0 .05	0 .04	0 .03	0 .16	0 .01	0 .10	0 .00	0 .03
LV	0 .00	0 .00	0 .01	0 .01	0 .05	0 .00	0 .12	0 .08	0 .06	0 .20	0 .02	0 .00
MD	0 .00	0 .00	0 .01	0 .01	0 .03	0 .00	0 .02	0 .03	0 .01	0 .05	0 .00	0 .00
NL	0 .00	0 .25	9 .19	4 .71	2 .17	0 .91	0 .71	6 .83	0 .20	3 .08	0 .18	0 .40
NO	0 .00	0 .00	0 .02	0 .02	0 .12	0 .00	0 .92	0 .46	0 .33	6 .08	0 .28	0 .00
PL	0 .00	0 .01	0 .39	0 .71	1 .93	0 .14	1 .38	3 .23	0 .37	3 .90	0 .15	0 .05
PT	0 .00	0 .00	0 .02	0 .01	0 .02	0 .53	0 .01	0 .30	0 .00	0 .11	0 .01	1 .36

Source	EEZ 187	EEZ 188	EEZ 189	EEZ 190	EEZ 191	EEZ 209	EEZ 212	EEZ 213	EEZ 215	EEZ 216	EEZ 224	EEZ 273
RS	0 .00	0 .00	0 .05	0 .09	0 .24	0 .02	0 .15	0 .30	0 .08	0 .42	0 .02	0 .01
RU	0 .00	0 .00	0 .02	0 .05	0 .13	0 .01	0 .10	0 .16	0 .05	0 .25	0 .02	0 .01
SE	0 .00	0 .00	0 .07	0 .08	0 .31	0 .02	1 .00	0 .61	0 .67	1 .14	0 .12	0 .01
SI	0 .01	0 .00	0 .05	0 .07	0 .82	0 .01	0 .66	0 .75	0 .31	2 .10	0 .17	0 .01
SK	0 .00	0 .00	0 .01	0 .01	0 .03	0 .00	0 .01	0 .04	0 .00	0 .04	0 .00	0 .01
TR	0 .00	0 .00	0 .04	0 .05	0 .12	0 .01	0 .09	0 .22	0 .03	0 .19	0 .01	0 .01
UA	0 .00	0 .00	0 .01	0 .04	0 .19	0 .01	0 .46	0 .23	0 .08	0 .53	0 .06	0 .00
NOA	0 .00	0 .00	0 .13	0 .17	0 .52	0 .05	0 .71	0 .93	0 .13	1 .27	0 .05	0 .02

6. Weather-normalised deposition estimates

Calculated annual depositions of nitrogen are dependent on both, nitrogen emissions and meteorological conditions for the considered year. An efficient method to eliminate or at least largely reduce the effects of variable meteorological conditions is the normalisation of the depositions. This method has been used for several years in the calculations for HELCOM concerning nitrogen deposition to the Baltic Sea (Bartnicki et. al, 2016).

6.1 Main OSPAR Regions

Here we present the normalised depositions of oxidised, reduced and total nitrogen for the Main OSPAR Regions. The normalised depositions of oxidised, reduced and total nitrogen to the Main OSPAR Regions are shown in Figures 6.1, 6.2 and 6.3, respectively. Minimum and maximum depositions for each emission year are also shown indicating the range of uncertainty caused by meteorological inter-annual variability.

Compared to 1995, normalised nitrogen depositions, in all cases except one, are lower in 2015. Concerning deposition of oxidised nitrogen, the largest decline (42%) can be noticed for Region 2 and the lowest (24%) for Region 5. In case of deposition of reduced nitrogen, the decline can be noticed in four Regions (1, 2, 3 and 5) in the range 6-13% with largest decline in Region 2. Annual deposition of reduced nitrogen increased 2% between 1995 and 2015 in Region 4. Normalised annual total deposition is lower in 2015, compared to 1995, in all Regions in the range 20-32%, with maximum decline (32%) in Region 2. Normalised depositions of reduced nitrogen show an increasing pattern in all Regions for the last 5-9 years. In two Regions (1 and 4), also an increase of the oxidised nitrogen deposition can be observed, but only for the last 1-2 years.

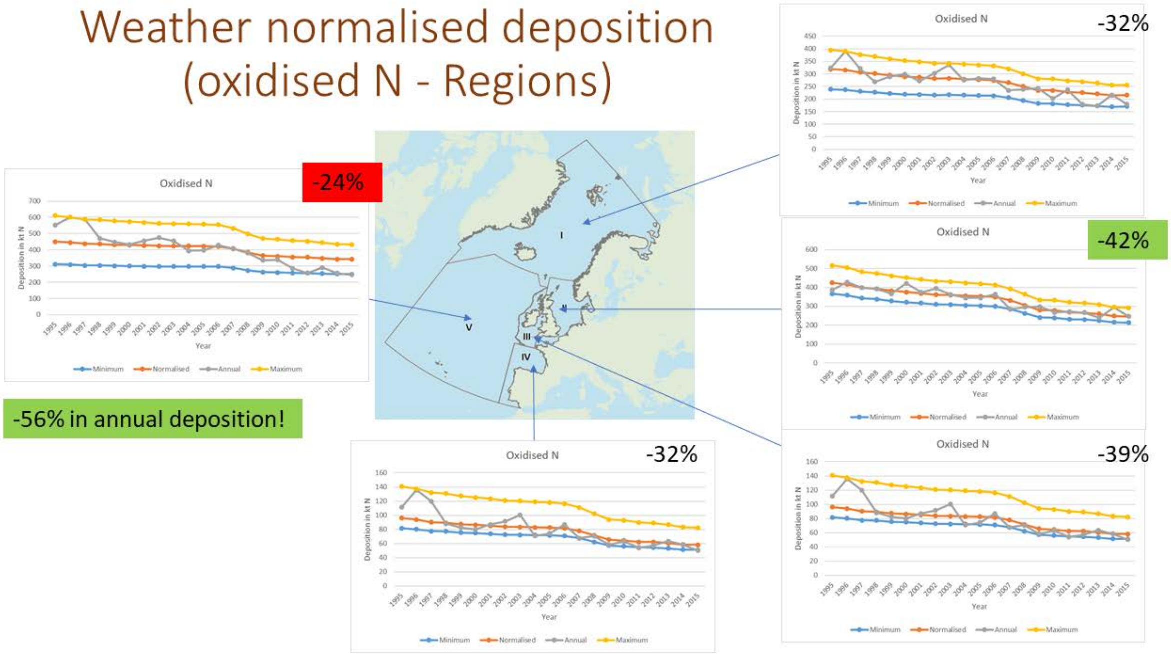


Figure 6.1 Normalised annual depositions of oxidised nitrogen for the Main OSPAR Regions. Minimum and maximum depositions for each emission year are also shown, as well as, annual depositions. Units: ktonnes N. OSPAR Region V is where the reduction in normalised Oxidised N deposition is the lowest (-24%, marked red) among all OSPAR Regions, while in Region II it is highest (-42%, marked green). However, it should be noted that the decrease in (not normalised) Oxidised N deposition in Region V is -56% (see Figure 2.5).

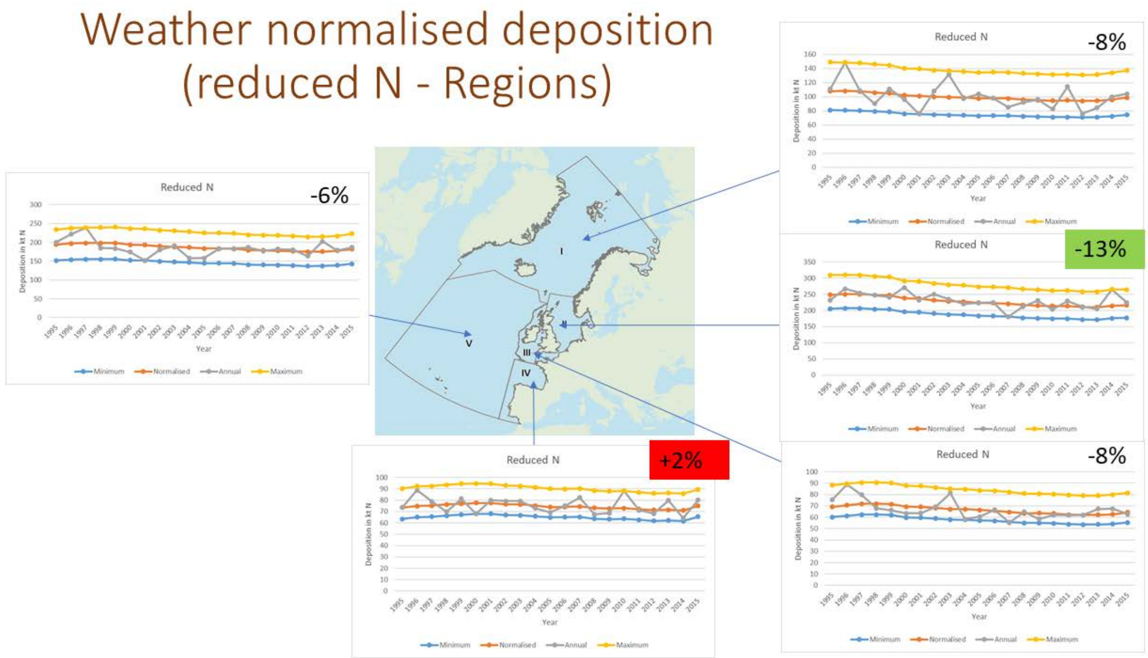


Figure 6.2 Normalised annual depositions of reduced nitrogen for the Main OSPAR Regions. Minimum and maximum depositions for each emission year are also shown, as well as, annual depositions. Units: ktonnes N. OSPAR Region IV is where the trend in normalised Reduced N deposition is the least favourable (+2%, marked red) among all OSPAR Regions, while in Region II has the highest reduction (-13%, marked green).

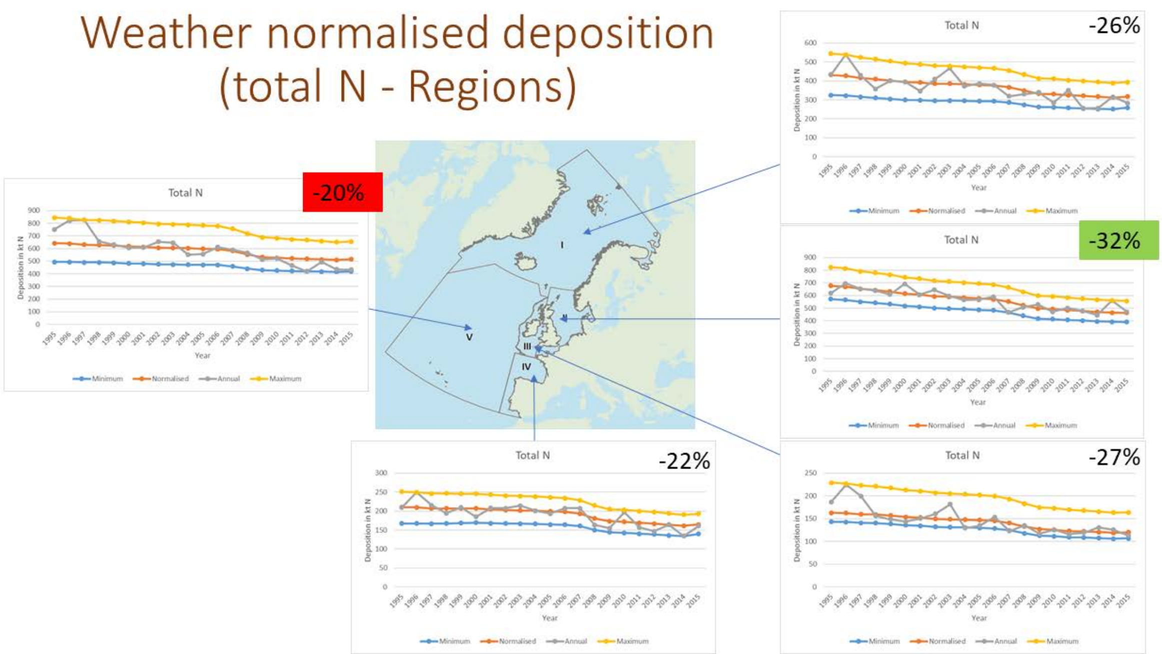
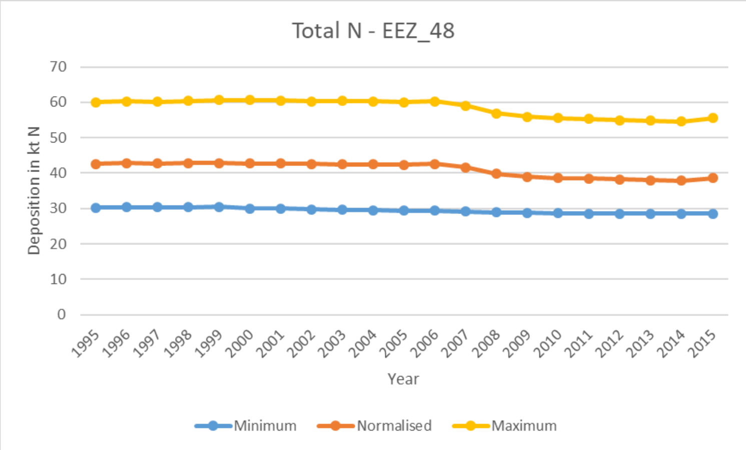
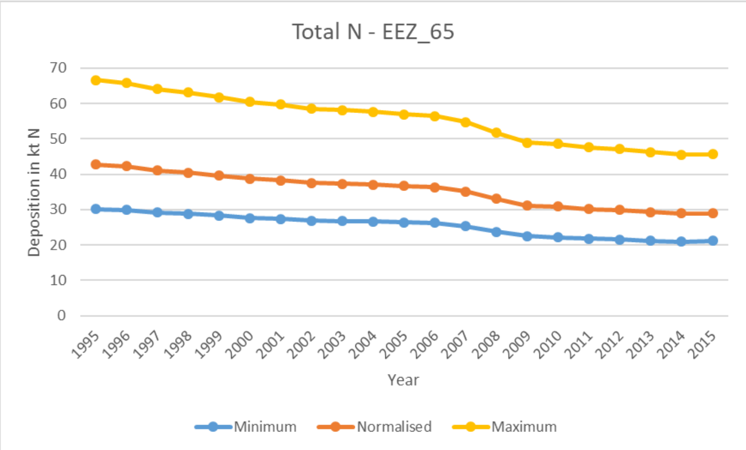


Figure 6.3 Normalised annual depositions of total nitrogen for the Main OSPAR Regions. Minimum and maximum depositions for each emission year are also shown, as well as, annual depositions. Units: ktonnes N. OSPAR Region V is where the reduction in normalised total N deposition is the lowest (-20%, marked red) among all OSPAR Regions, while in Region II it is the highest (-32%, marked green).

6.2 Exclusive Economic Zones





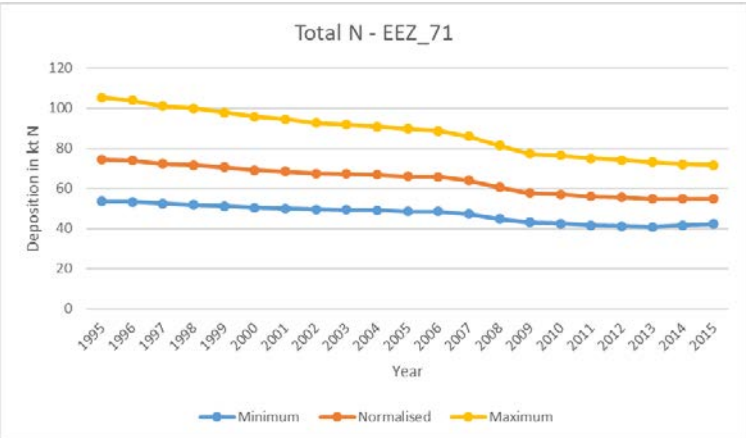
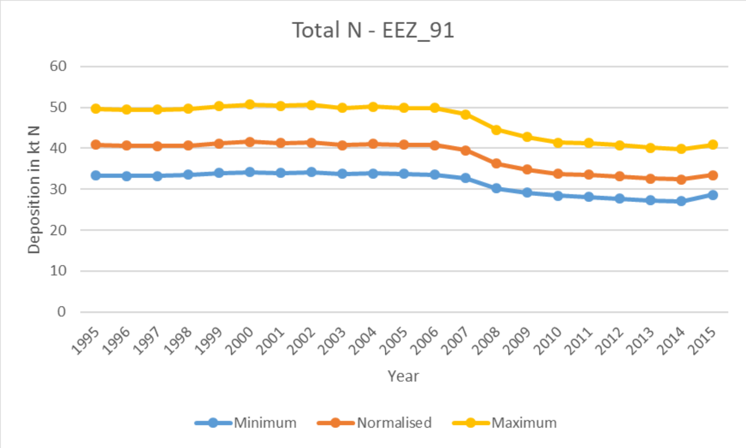
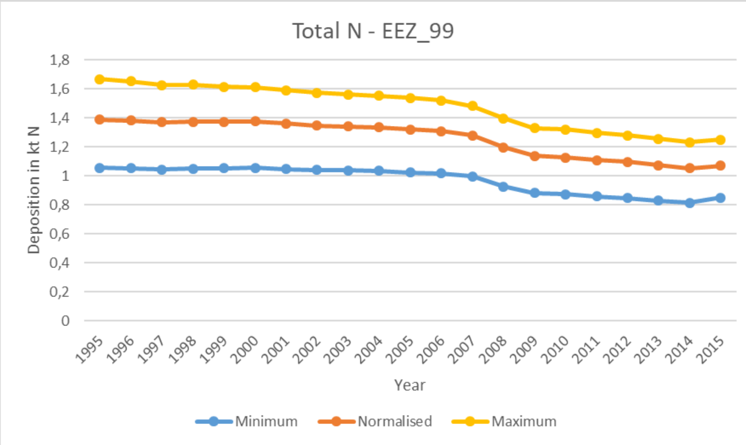


Figure 6.4 Normalised annual depositions of total nitrogen to EEZs. Minimum and maximum depositions for each emission year are also shown. Units: ktonnes N.





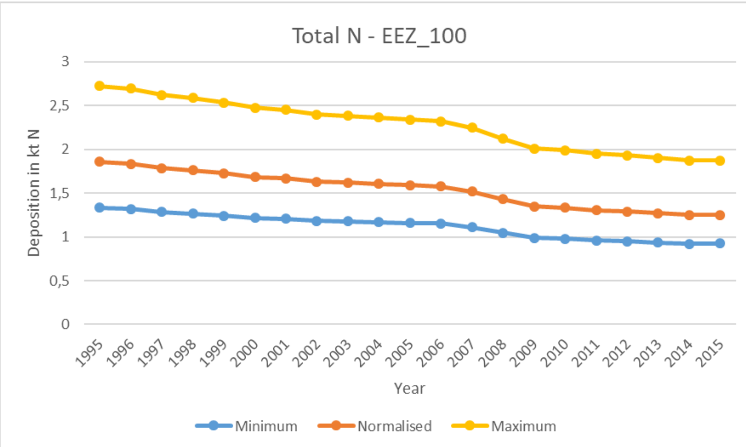
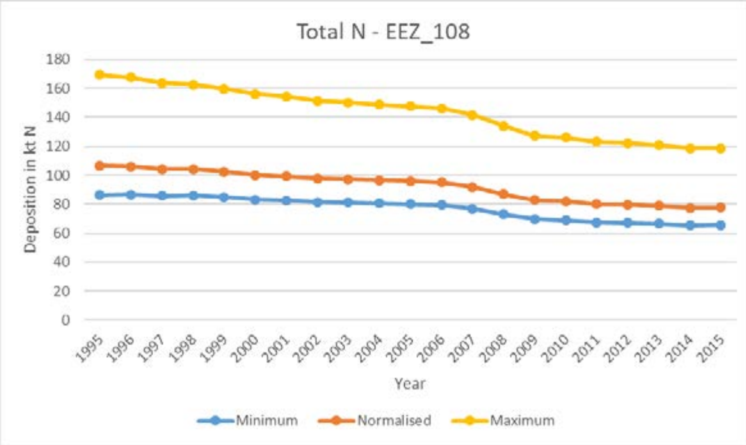
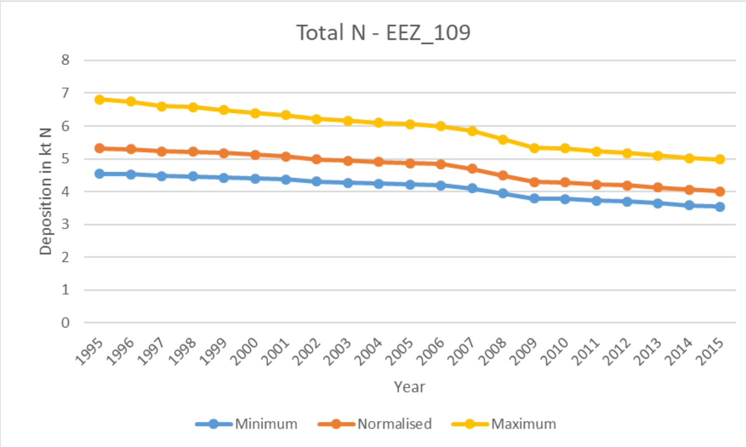


Figure 6.4 (cont.) Normalised annual depositions of total nitrogen to EEZs. Minimum and maximum depositions for each emission year are also shown. Units: ktonnes N.





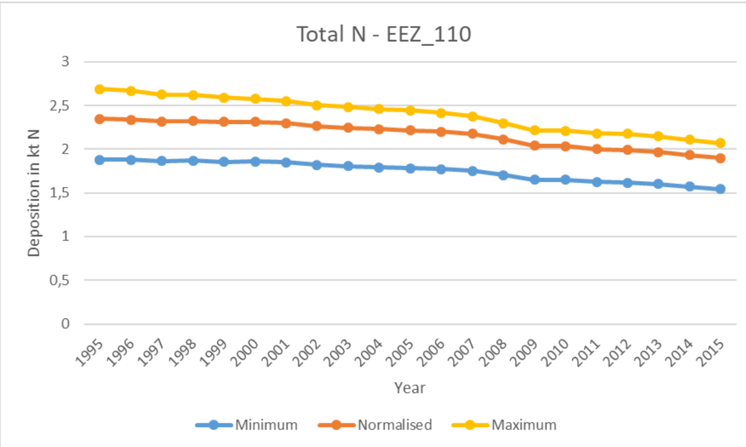
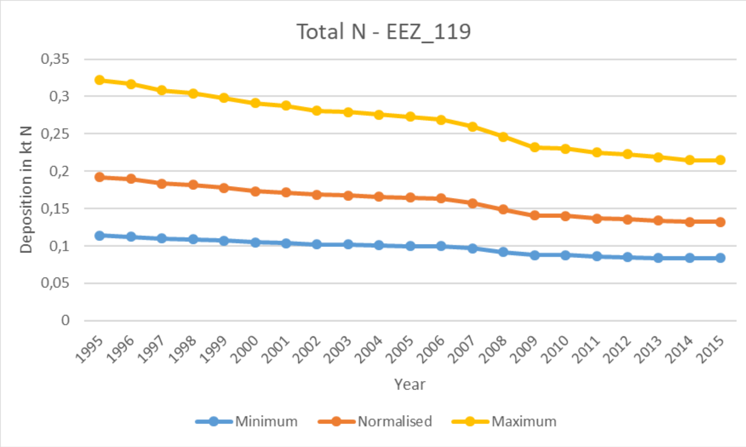
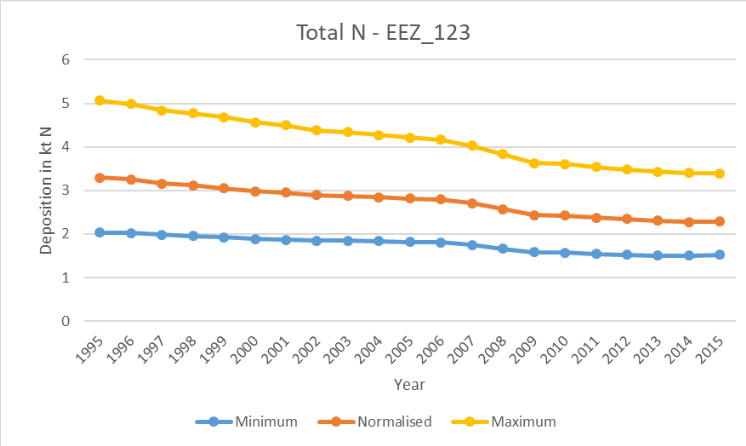


Figure 6.4 (cont.) Normalised annual depositions of total nitrogen to EEZs. Minimum and maximum depositions for each emission year are also shown. Units: ktonnes N.





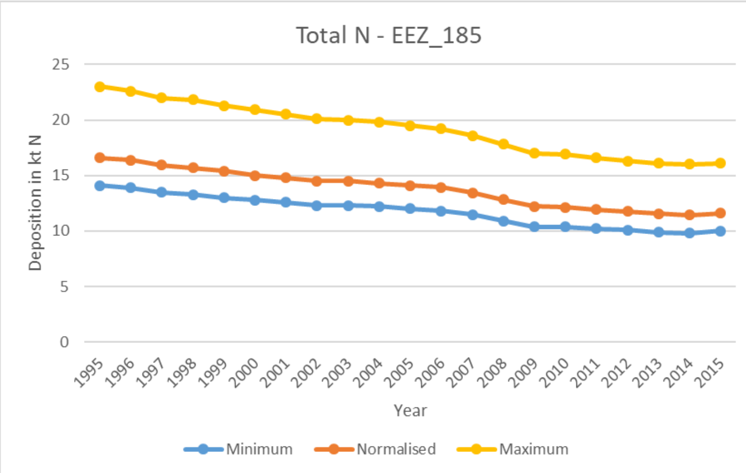
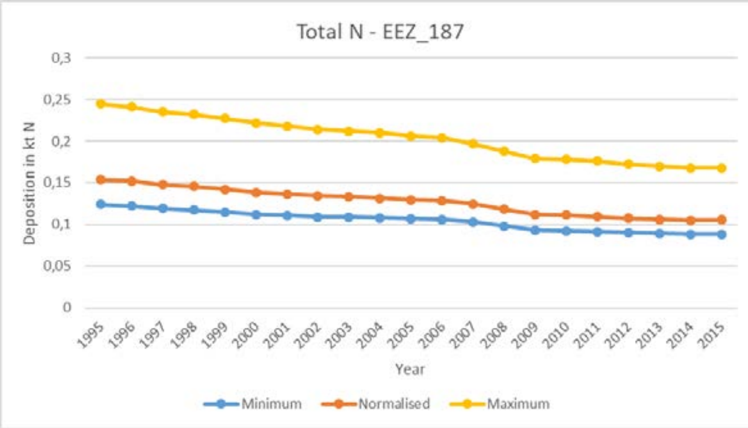
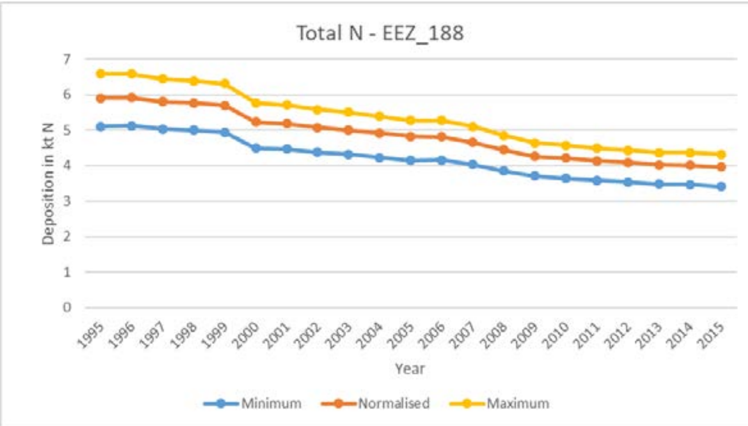


Figure 6.4 (cont.) Normalised annual depositions of total nitrogen to EEZs. Minimum and maximum depositions for each emission year are also shown. Units: ktonnes N.





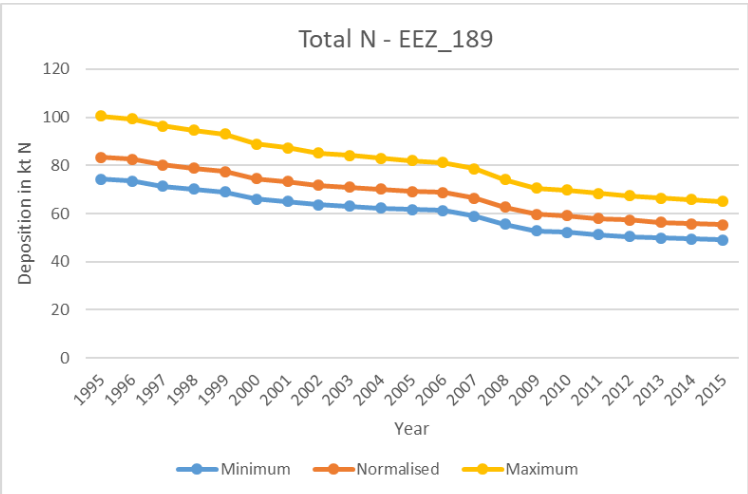


Figure 6.4 (cont.) Normalised annual depositions of total nitrogen to EEZs. Minimum and maximum depositions for each emission year are also shown. Units: ktonnes N.

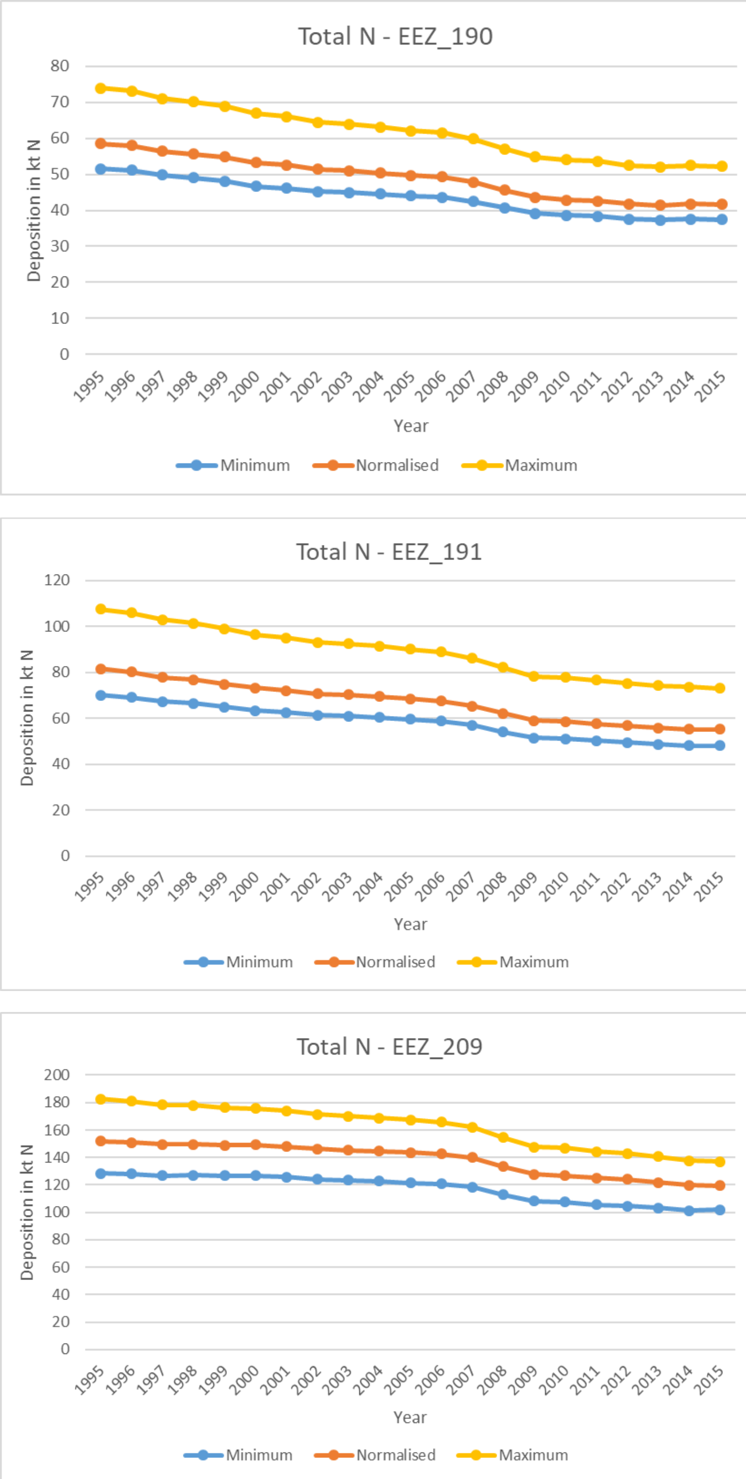
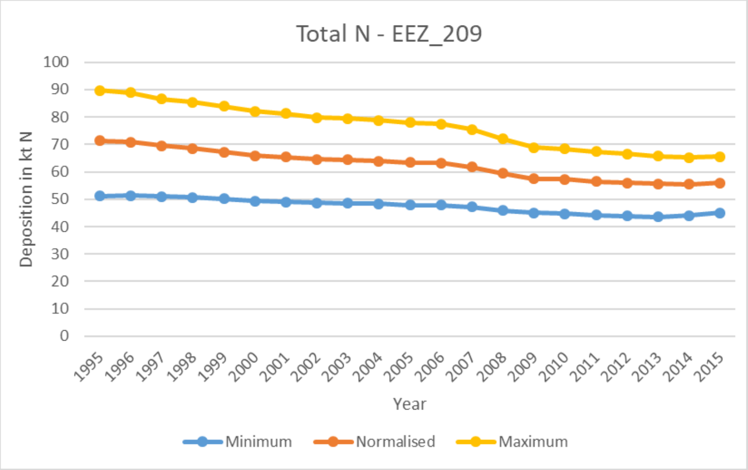
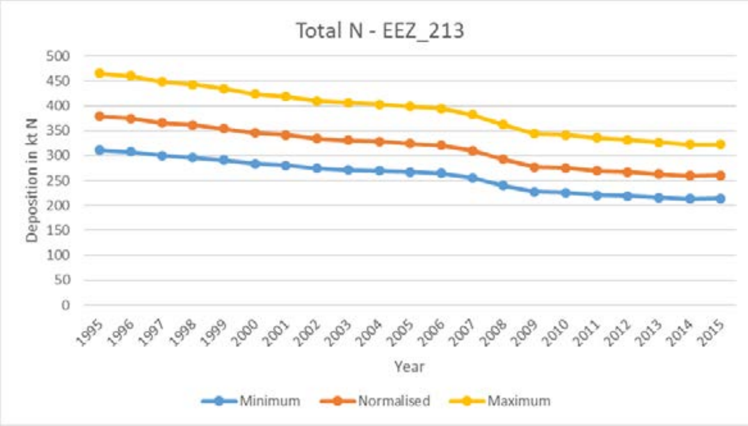


Figure 6.4 (cont.) Normalised annual depositions of total nitrogen to EEZs. Minimum and maximum depositions for each emission year are also shown. Units: ktonnes N.





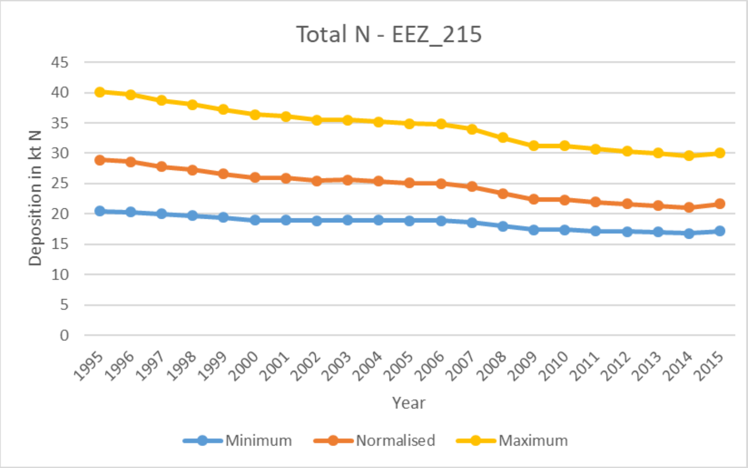


Figure 6.4 (cont.) Normalised annual depositions of total nitrogen to EEZs. Minimum and maximum depositions for each emission year are also shown. Units: ktonnes N.

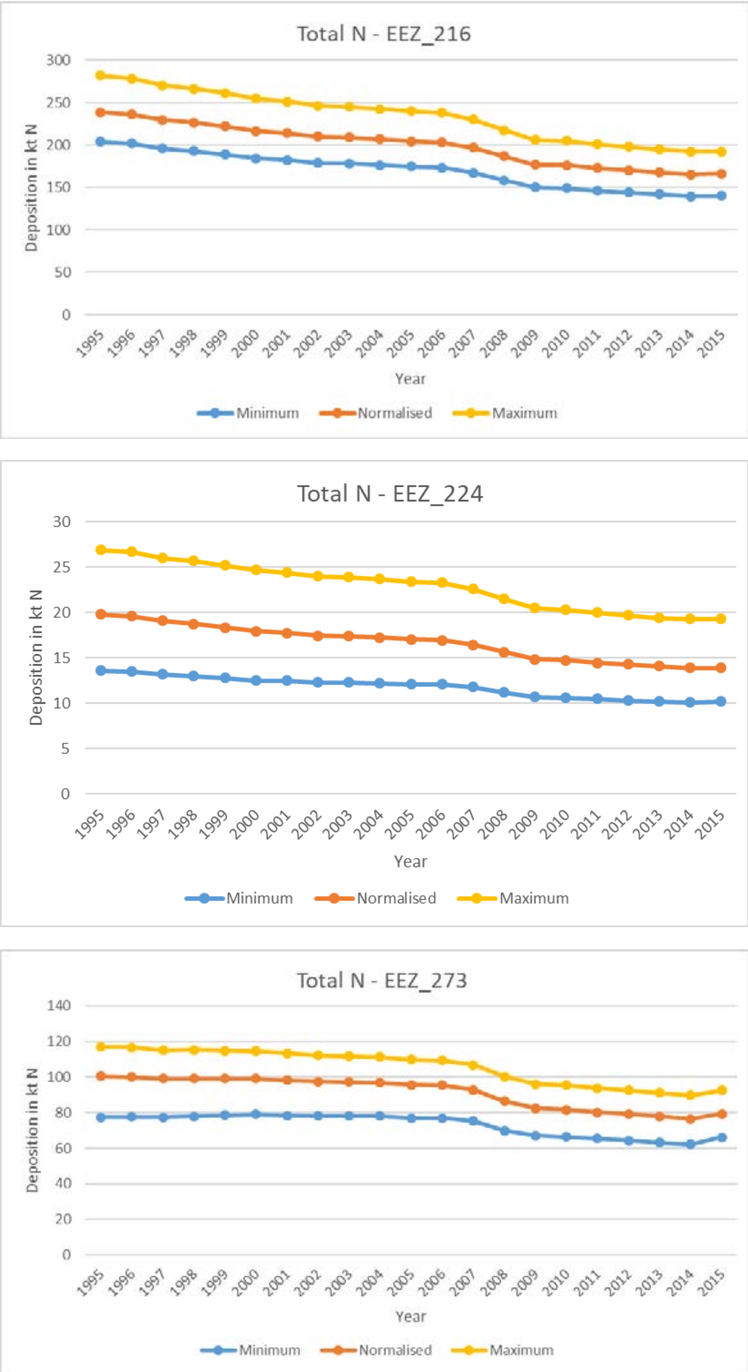


Figure 6.4 (cont.) Normalised annual depositions of total nitrogen to EEZs. Minimum and maximum depositions for each emission year are also shown. Units: ktonnes N.

7. Conclusions

The main conclusions from the project can be formulated as follows.

- New updated definitions of the Main OSPAR Regions have been implemented in the EMEP grid system and can be used in the future operational applications for OSPAR;
- Also, 24 Exclusive Economic Zones have been implemented into the EMEP grid system. They are ready to be used in the future routine computations for OSPAR;
- In all regions, annual deposition of oxidised nitrogen is clearly lower in 2015 than in 1995 in the range 36-56%, with the maximum decline in Region II;
- Also, there is a decline in the deposition of reduced nitrogen in four out of five Regions, in the range 3-17%, definitely lower than in case of oxidised nitrogen. The increase (9%) can be noticed in Region IV;
- Concerning annual deposition of total nitrogen, there is decline between 1995 and 2015 in all Regions in the range 23-43% with most significant decline in Region II;
- There is clear decline in the deposition of oxidised nitrogen between 1995 and 2015, in all considered EEZs in the range 25-61%;
- In nine EEZs annual deposition of reduced nitrogen is higher in 2015 than in 1995 and in one EEZ it remains on the same level. Decline of the deposition of reduced nitrogen can be observed in 14 EEZs in the range 6-22%;
- The number one sources for oxidised nitrogen deposition in 2014 are: Boundary and Initial Conditions, United, Kingdom, United Kingdom, ship traffic on Atlantic Ocean and again Boundary and Initial Conditions for Regions 1, 2, 3, 4 and 5, respectively;
- The number one sources for reduced nitrogen deposition in 2014 are: United Kingdom, Germany, United Kingdom, France and again France for Regions 1, 2, 3, 4 and 5, respectively;
- In case of total nitrogen deposition, United Kingdom is the number one source for Regions 1, 2 and 3. France is the number one source for Region 4 and Boundary and initial conditions for Region 5;
- Ship traffic is an important source in case of oxidised nitrogen deposition and can be found among Top Ten sources for all Regions.
- Different sources play the most important role for individual EEZs, however again, the most important sources for oxidised and reduced nitrogen deposition are United Kingdom, France and Germany. In case, of oxidised nitrogen deposition, also ship traffic is as significant source;
- Compared to 1995, normalised nitrogen depositions, in all cases except one, are lower in 2015. Concerning deposition of oxidised nitrogen, the largest decline (42%) can be noticed for Region 2 and the lowest (24%) for Region 5;
- In case of deposition of reduced nitrogen, the decline can be noticed in four Regions (1, 2, 3 and 5) in the range 6-13% with largest decline in Region 2. Annual deposition of reduced nitrogen increased 2% between 1995 and 2015 in Region 4;

- Normalised annual total deposition is lower in 2015, compared to 1995, in all Regions in the range 20-32%, with maximum decline (32%) in Region 2;
- Normalised depositions of reduced nitrogen show an increasing pattern in all Regions for the last 5-9 years. In two Regions (1 and 4), also an increase of the oxidised nitrogen deposition can be observed, but only for the last 1-2 years;
- In all 24 EEZs, annual normalised depositions of total nitrogen are lower in the year 2015, than in the year 1995.

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