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Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2017

Hazardous Substances and Eutrophication Series

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Preparation of the routine products

for OSPAR

by MSC-W of EMEP

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2017

Michael Gauss, Agnes Nyiri, and Heiko Klein

Meteorological Synthesising Centre-West (MSC-W) of EMEP
Norwegian Meteorological Institute

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Executive Summary

The EMEP MSC-W Chemistry Transport Model (version rv4.33) has been applied to calculate nitrogen deposition to the OSPAR Maritime Area in the period 1995-2017. The model calculations were made in 2019, using emission data provided by the EMEP Centre on Emission Inventories and Projections based on officially reported data as of May 2019.

For the first time, a horizontal resolution of 0.1 x 0.1 degrees was used for the entire 23-year period, allowing a more accurate representation of the five OSPAR regions and the 24 Extended Economic Zones (EEZs), for which nitrogen deposition was computed. As usual, the deposition of nitrogen was calculated separately for oxidized nitrogen (NO, NO_2, etc.) and reduced nitrogen (ammonia, ammonium nitrate, etc.) as these two groups have different emission sources and thus require different policy measures for mitigation.

According to our model results, annual deposition of oxidised nitrogen was clearly lower in 2017 than in 1995 in all OSPAR regions, with the largest decline in Region III (61.7%). Annual deposition of reduced nitrogen decreased in four out of five OSPAR Regions, in the range 2-27%, which is a much lower decrease than for oxidised nitrogen. A small increase (1%) was calculated for Region II. Concerning annual deposition of total (oxidised+reduced) nitrogen, there is a decline between 1995 and 2015 in all Regions (in the range 30-48%), with the largest decline in Region III.

In all considered EEZs, there is a clear decline in the annual deposition of oxidised nitrogen between 1995 and 2017 (in the range 34-66%), while the annual deposition of reduced nitrogen was higher in 2017 than in 1995 in six EEZs. In 18 EEZs, however, deposition of reduced nitrogen has decreased as well, by up to 36%. In all considered EEZs, the annual deposition of total nitrogen has decreased from 1995 to 2017 (in the range 18-55%).

Récapitulatif

Le modèle de chimie-transport du Centre de synthèse météorologique - Ouest (CSM-O) de l'EMEP (version rv4.33) a été appliqué pour calculer les dépôts d'azote dans la zone maritime OSPAR au cours de la période 1995-2017. Les calculs du modèle ont été effectués en 2019, en utilisant les données d'émission fournies par le Centre des inventaires et des projections des émissions de l'EMEP, sur la base des données notifiées en mai 2019.

Pour la première fois, une résolution horizontale de 0,1 x 0,1 degrés a été utilisée pour toute la période de 23 ans, permettant une représentation plus précise des cinq régions OSPAR et des 24 zones économiques étendues (ZEE), pour lesquelles les dépôts d'azote ont été calculés. Comme d'habitude, le dépôt d'azote a été calculé séparément pour l'azote oxydé (NO, NO2, etc.) et l'azote réduit (ammoniac, nitrate d'ammonium, etc.) car ces deux groupes ont des sources d'émission différentes et nécessitent donc des mesures d'atténuation différentes.

Selon les résultats de notre modèle, le dépôt annuel d'azote oxydé était nettement plus faible en 2017 qu'en 1995 dans toutes les régions OSPAR, la baisse la plus importante étant enregistrée dans la Région III (61,7 %). Le dépôt annuel d'azote réduit a diminué dans quatre des cinq Régions OSPAR, dans une fourchette de 2 à 27 %, ce qui est une diminution beaucoup plus faible que pour l'azote oxydé. Une légère augmentation (1 %) a été calculée pour la Région II. En ce qui concerne les dépôts annuels d'azote total (oxydé + réduit), on observe une diminution entre 1995 et 2015 dans toutes les régions (de l'ordre de 30 à 48 %), la plus forte baisse étant enregistrée dans la Région III.

Dans toutes les ZEE considérées, on constate une nette diminution des dépôts annuels d'azote oxydé entre 1995 et 2017 (de l'ordre de 34 à 66 %), tandis que les dépôts annuels d'azote réduit étaient plus élevés en 2017 qu'en 1995 dans six ZEE. Dans 18 ZEE, cependant, les dépôts d'azote réduit ont également diminué, jusqu'à 36 %. Dans toutes les ZEE considérées, les dépôts annuels d'azote total ont diminué de 1995 à 2017 (de 18 à 55 %).

1. Introduction

Nitrogen deposition to OSPAR Convention Waters has been a subject of a cooperation between MSC-W (Meteorological Synthesizing Centre – West) of EMEP and OSPAR since 2003, starting with the first EMEP report for OSPAR delivered by Bartnicki and Fagerli (2003). This cooperation has been continued and documented in numerous reports until the present day.

2. Tasks in 2019

In 2019 OSPAR requested calculations of atmospheric nitrogen deposition (oxidised, reduced and total) to the five main OSPAR regions, as well as to the twenty-four Exclusive Economic Zones (EEZ), for the period 1995 to 2017. If feasible, this period should be extended backward to 1990.

Additional products, such as normalised depositions and source-receptor matrices, have not been requested this year. These were last provided by Bartnicki et al. (2018) for the period 1995 to 2015.

3. Modelling

3.1 The EMEP MSC-W model

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; 2018; 2019).

The model is regularly evaluated against measurements from the EMEP network under the LRTAP convention (e.g. Gauss et al., 2018; 2019), but also in a large number of international research projects and operational services, for example in the Copernicus Atmosphere Monitoring Service (CAMS, see http://www.regional.atmosphere.copernicus.eu/), where evaluation graphs are updated every day and quarterly evaluation reports are issued online on a quarterly basis.

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 as Open Source at 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.

3.2 Experimental setup

The EMEP MSC-W model version rv4.33 has been used for the deposition calculations presented here, i.e. the same version as was used for the EMEP Status report 2019 (EMEP, 2019). Simulations were done for the 23-year period from 1995 to 2017.

For the first time this year, and following changes in the official EMEP model grid, the calculations for OSPAR have been run on 0.1°×0.1° resolution on a regular longitude-latitude grid rather than on the old 50 km × 50 km polar-stereographic grid that was used in previous years (see Figure 1). This has become possible as meteorological as well as emission data could be obtained in 2019 on this resolution for the entire trend period.

The meteorological data have been generated by running the ECMWF IFS model cycle 40r1 (see ECMWF model documentation). Emission data were obtained in June 2019 from the EMEP Centre CEIP and listed in the EMEP Status Report 1/2019 (EMEP, 2019). For the first time this year, emission data were delivered on 0.1°×0.1° resolution for the entire time period of 1990-2017. However, or some countries PM emissions were not submitted for the 1990s. Therefore, for the EMEP MSC-W simulations of 1995-1999, PM emissions of 2000 were used for these countries, while all other emissions were used as reported for 1995-1999. As the importance of PM emissions for nitrogen depositions in the OSPAR regional are negligible, this methodology was considered as justifiable in this case, as the calculation for OSPAR are exclusively concerned with nitrogen depositions. The period 1990 to 1994 was not simulated due to the high computational cost and (given the absence of PM emissions for some countries) the absence of synergies with other projects.

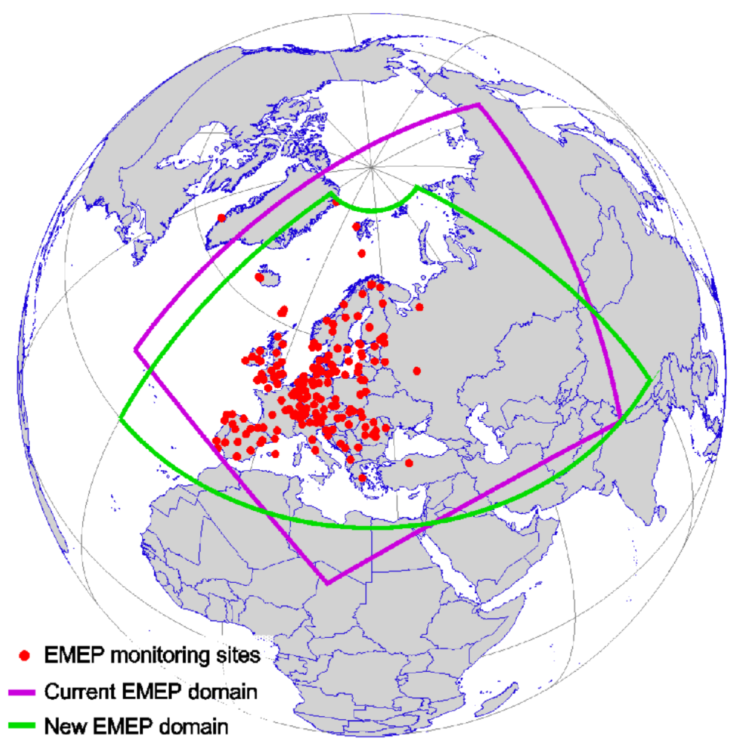


Figure 1: The old (purple) and new (green) official EMEP domains. The new domain was used for the first time for the EMEP status runs in 2017 (EMEP, 2017), and has 0.1°×0.1° resolution in a regular longitude-latitude grid. The old domain has the resolution 50km × 50km in a polar-stereographic grid.

4. OSPAR Regions and EEZs in the new EMEP grid

New definitions of the OSPAR Regions, as specified at www.marineregions.org, and requested by OSPAR, were implemented in the new EMEP grid system. In addition, Exclusive Economic Zones (EEZ) for each OSPAR Contracting Party were implemented. These implementations resulted in slightly different (more precise) mapping of the OSPAR Main Regions and EEZs to the EMEP grid. At the same time some areas are not fully included in the model domain (e.g. OSPAR Regions I and V). This was the case in the old model domain, too, but the (small) cuts in the North-Western model boundaries were slightly different. Also for EEZs 48, 91, 110, 212 the areas included in the new domain are slightly different from those that were included in the old model domain. This factor can contribute to the differences from the previous calculations (Bartnicki and Benedictow, 2017; Bartnicki et al., 2018). In this chapter, all OSPAR Regions and EEZs considered in this report are plotted in the way they are included in the EMEP model domain.

4.1 Main OSPAR Regions

All OSPAR Regions cover a certain number of grid squares in the EMEP grid system, either in full or only partly. We have calculated this percentage for each EMEP grid square covered by each OSPAR Region. The result is illustrated in Figure 2a for the Main OSPAR Region II, both for the old polar-stereographic grid and for the new 0.1°×0.1° longitude-latitude grid, in order to illustrate the difference between the grids. The OSPAR Region II is extended compared to earlier definitions used by EMEP (Bartnicki and Benedictow, 2017) and includes the Kattegat. Figures 2b, 2c, 2d, and 2e show the other four Main OSPAR regions in the new grid.

Table 1 lists the regions and their areas within the new EMEP model domain and calculated on the 0.1°×0.1° longitude-latitude grid.

Table 1: The five Main OSPAR Regions as implemented in the EMEP MSC-W analysis in the 0.1°×0.1° longitude-latitude grid.

Region	EMEP ID	Area included in the EMEP model domain (km2)
OSPAR Region I	CC_451	4.34E+06
OSPAR Region II	CC_452	7.78E+05
OSPAR Region III	CC_453	3.75E+05
OSPAR Region IV	CC_454	5.42E+05
OSPAR Region V	CC_455	4.08E+06

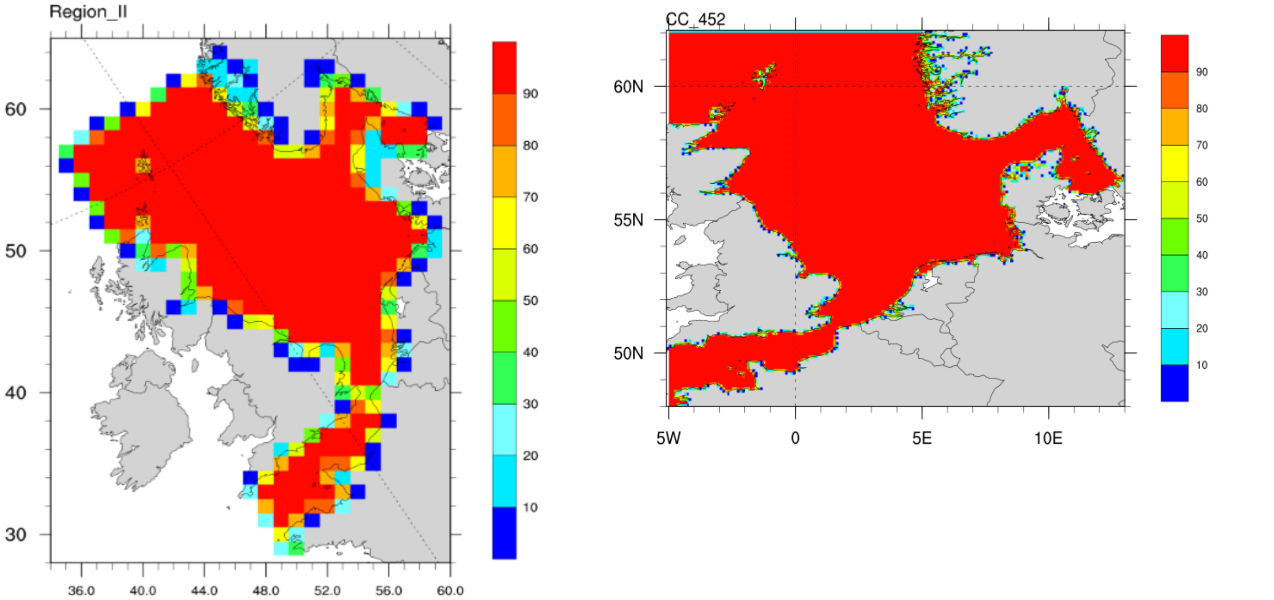


Figure 2a: Percentage of the EMEP grids in the Main OSPAR Region II. Left: old polar-stereographic grid, right: new 0.1°×0.1° longitude-latitude grid.

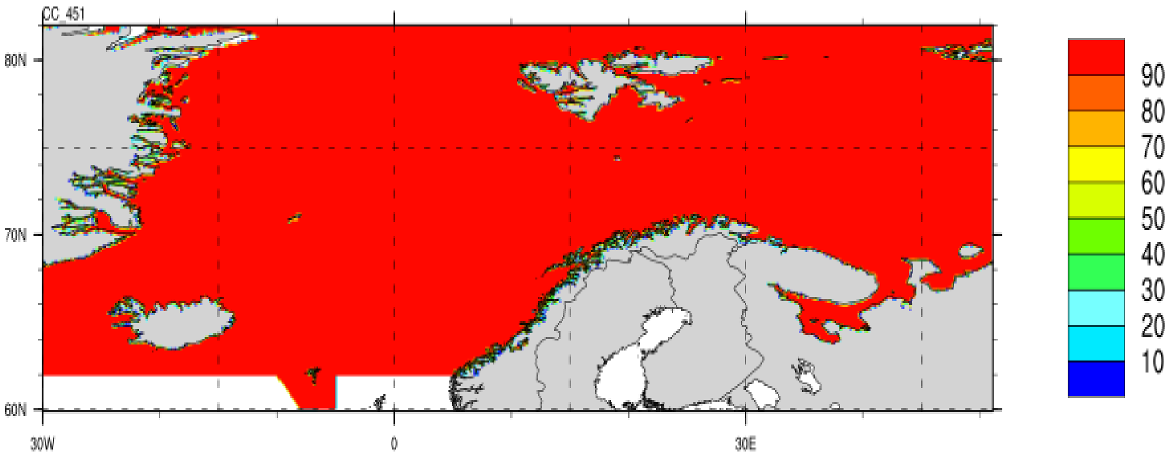


Figure 2b: Percentage of the EMEP grids in the Main OSPAR Region I in the new 0.1°×0.1° longitude-latitude grid.

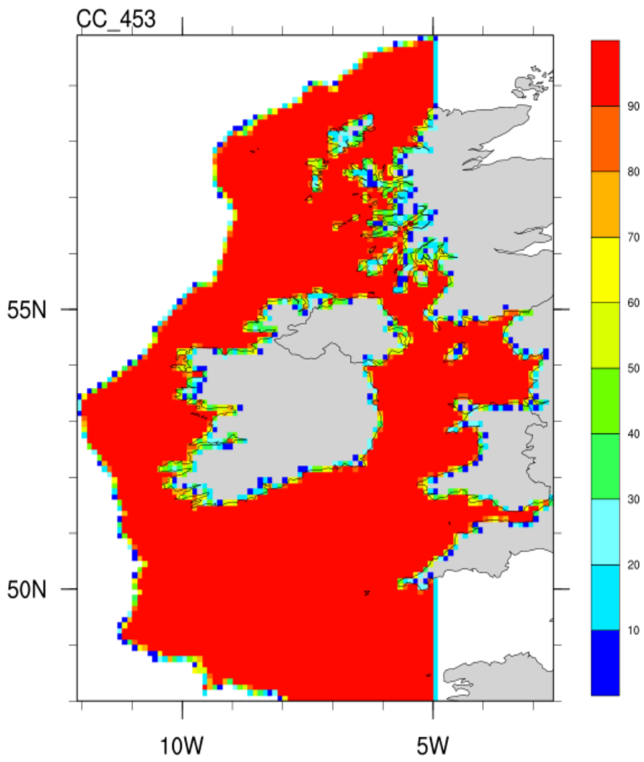


Figure 2c: Percentage of the EMEP grids in the Main OSPAR Region III in the new 0.1°×0.1° longitude-latitude grid.

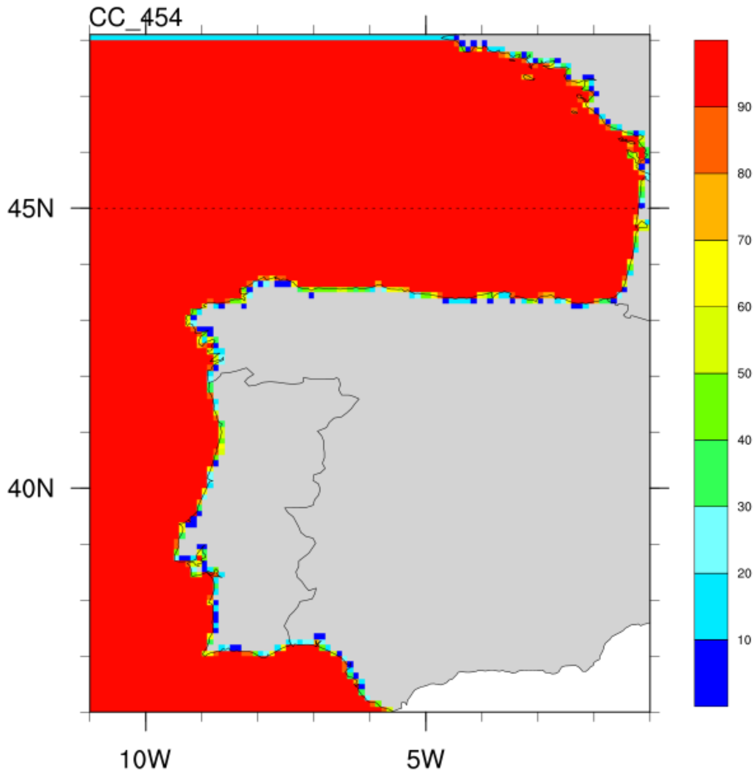


Figure 2d: Percentage of the EMEP grids in the Main OSPAR Region IV in the new 0.1°×0.1° longitude-latitude grid.

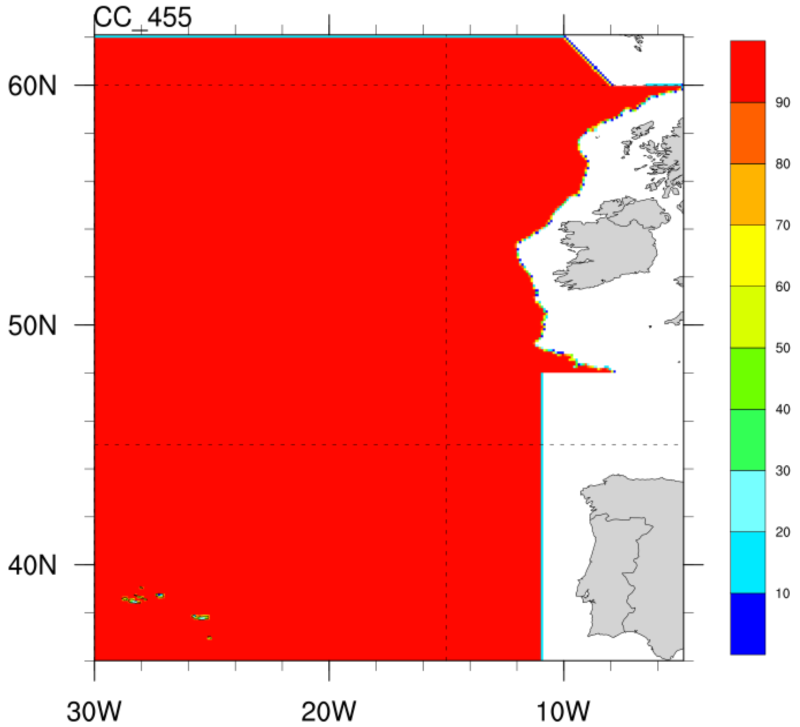


Figure 2e: Percentage of the EMEP grids in the Main OSPAR Region V in the new 0.1°×0.1° longitude-latitude grid.

4.2 Exclusive Economic Zones

National EEZs of OSPAR Contracting Parties were implemented into the EMEP grid system according to the specification suggested by OSPAR www.marineregions.org. In some cases (e.g. Sweden) only the parts of EEZs belonging to the OSPAR area were implemented into the EMEP grid. Table 2 lists the regions and their areas within the new EMEP model domain and calculated on the 0.1°×0.1° longitude-latitude grid. The percentages of EMEP grids covered by each of selected EEZ are shown in Figure 3.

Table 2: The twenty-four Extended Economic Zones as implemented in the EMEP MSC-W analysis in the 0.1°×0.1° longitude-latitude grid. The area includes total zones, also outside the OSPAR Convention, e.g. a part of the Baltic Sea for some countries.

Number EEZ	Name	EMEP ID	Area in the EMEP MSC-W model domain (km^2)
EEZ 48	Portuguese Exclusive Economic Zone (Azores)	CC_200048	4.89E+05
EEZ 65	Faeroe Exclusive Economic Zone	CC_200065	2.64E+05
EEZ 71	Icelandic Exclusive Economic Zone	CC_200071	7.55E+05
EEZ 91	Portuguese Exclusive Economic Zone	CC_200091	2.71E+05
EEZ 99	Joint regime area Spain / France	CC_200099	3.02E+03
EEZ 100	Joint regime area United Kingdom / Denmark (Faeroe Islands)	CC_200100	8.33E+03
EEZ 108	Irish Exclusive Economic Zone	CC_200108	4.29E+05
EEZ 109	Guernsey Exclusive Economic Zone	CC_200109	6.76E+03
EEZ 110	Jersey Exclusive Economic Zone	CC_200110	2.40E+03
EEZ 119	Joint regime area Iceland / Denmark (Faeroe Islands)	CC_200119	1.42E+03
EEZ 123	Joint regime area Iceland / Norway (Jan Mayen)	CC_200123	4.53E+04
EEZ 185	Swedish Exclusive Economic Zone	CC_200185	1.46E+04
EEZ 187	Joint regime area Sweden / Norway	CC_200187	1.72E+02
EEZ 188	Belgian Exclusive Economic Zone	CC_200188	3.63E+03
EEZ 189	Dutch Exclusive Economic Zone	CC_200189	6.33E+04
EEZ 190	German Exclusive Economic Zone	CC_200190	4.18E+04
EEZ 191	Danish Exclusive Economic Zone	CC_200191	7.64E+04
EEZ 209	French Exclusive Economic Zone	CC_200209	2.59E+05
EEZ 212	Greenlandic Exclusive Economic Zone	CC_200212	6.42E+05
EEZ 213	United Kingdom Exclusive Economic Zone	CC_200213	7.40E+05
EEZ 215	Svalbard Exclusive Economic Zone	CC_200215	7.04E+05
EEZ 216	Norwegian Exclusive Economic Zone	CC_200216	9.45E+05
EEZ 224	Jan Mayen Exclusive Economic Zone	CC_200224	2.91E+05
EEZ 273	Spanish Exclusive Economic Zone	CC_200273	3.01E+05

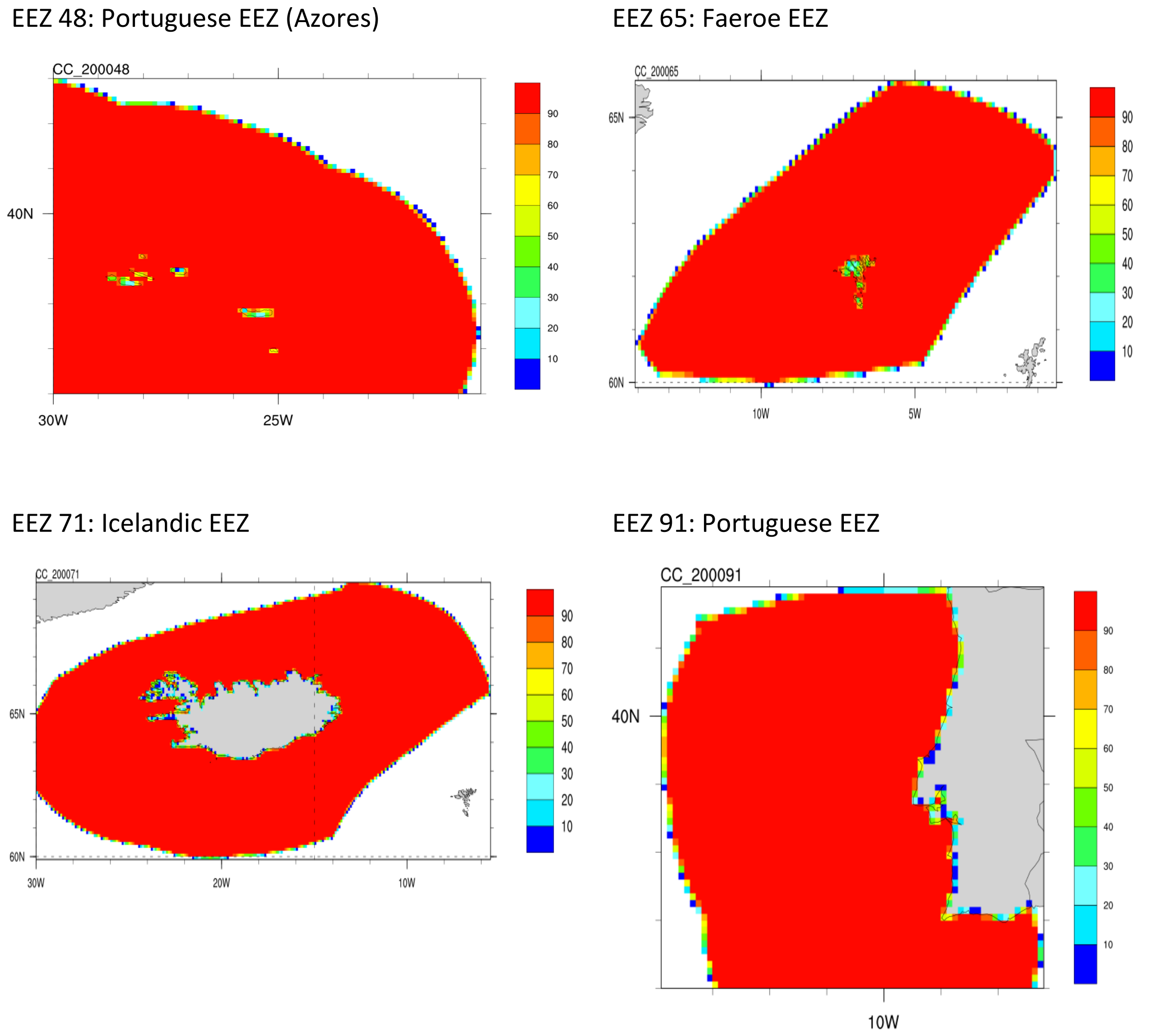
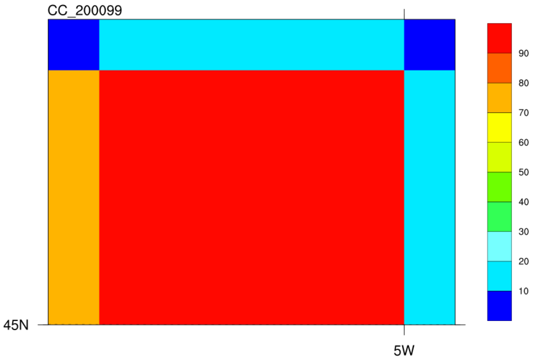
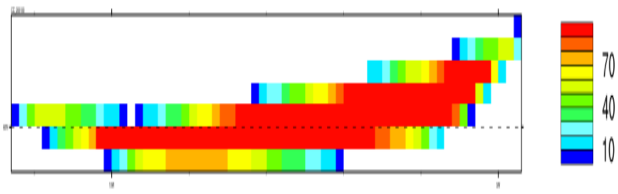


Figure 3: Percentage of the EMEP grids in each of the selected EEZs in the new 0.1°×0.1° longitude-latitude grid.

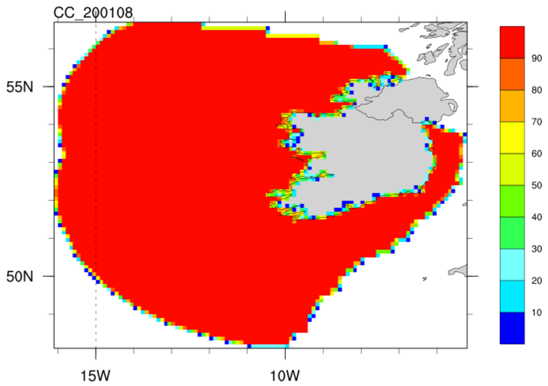
EEZ 99: Joint regime area Spain / France



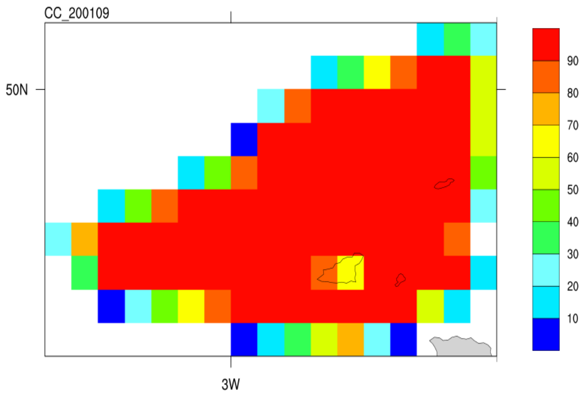
EEZ 100: Joint regime area UK / Denmark (Faeroe Islands)



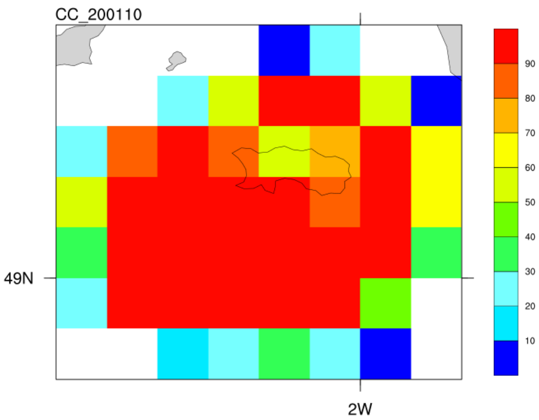
EEZ 108: Irish EEZ



EEZ 109: Guernsey EEZ



EEZ 110: Jersey EEZ



EEZ 119: Joint regime area Iceland / Denmark (Faeroe Islands)

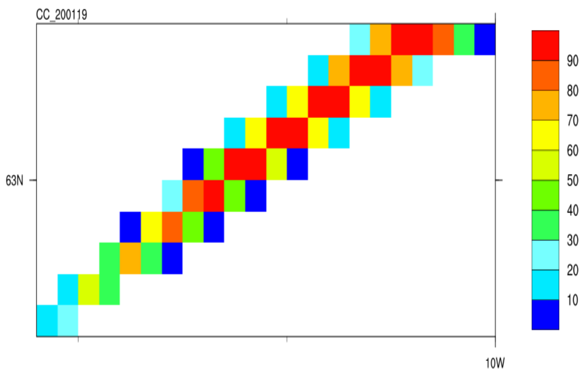
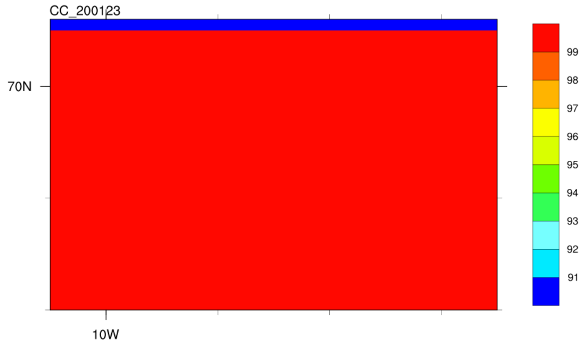
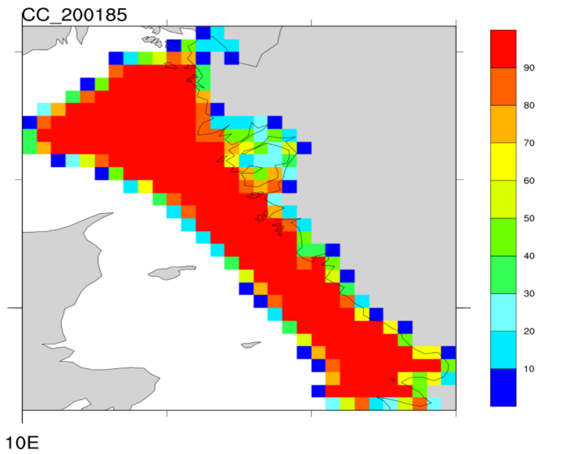


Figure 3 (continued): Percentage of the EMEP grids in each of the selected EEZs.

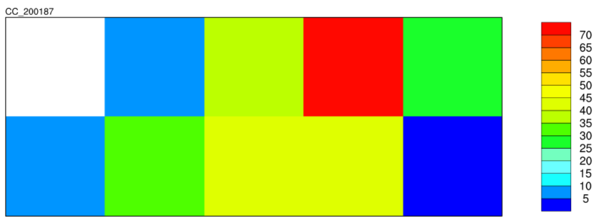
EEZ 123: Joint regime area Iceland / Norway (Jan Mayen)



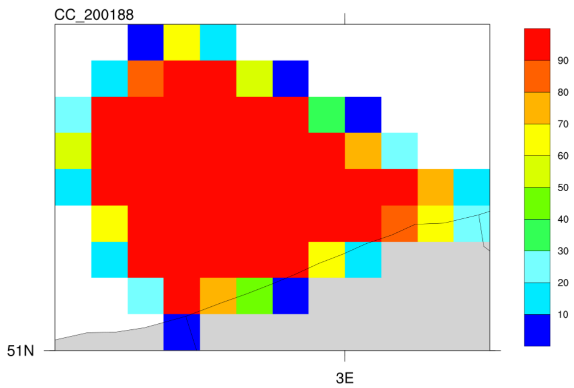
EEZ 185: Swedish EEZ



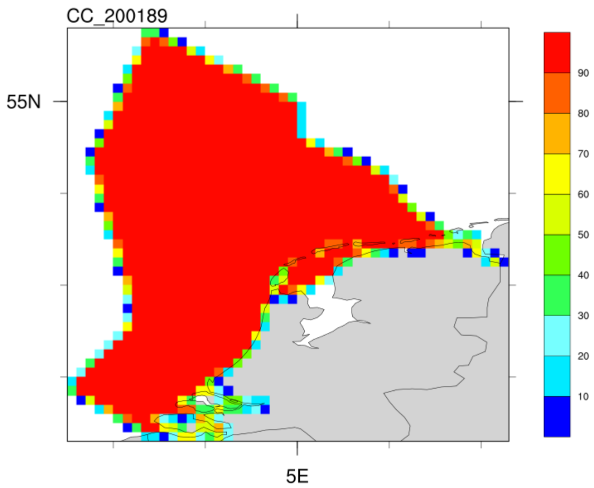
EEZ 187: Joint regime area Sweden / Norway



EEZ 188: Belgian EEZ



EEZ 189: Dutch EEZ



EEZ 190: German EEZ

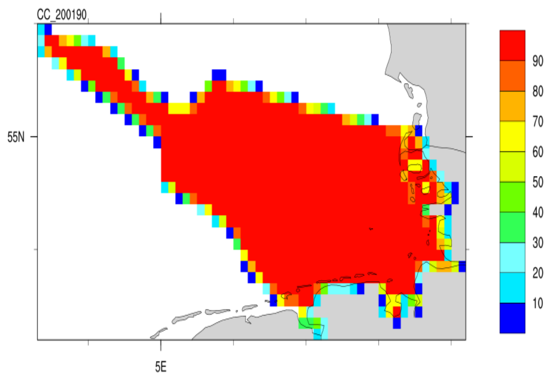
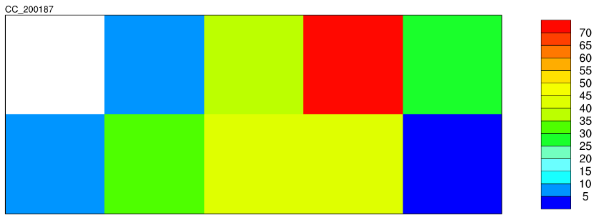
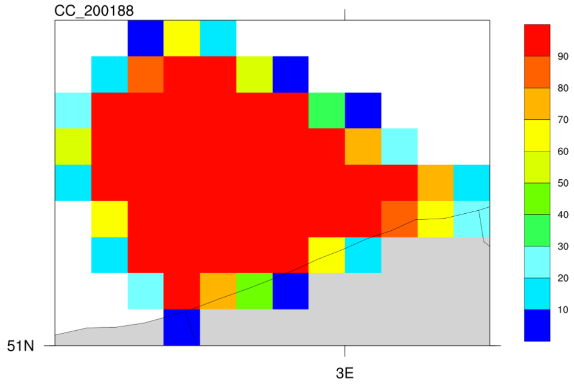


Figure 3 (continued): Percentage of the EMEP grids in each of the selected EEZs.

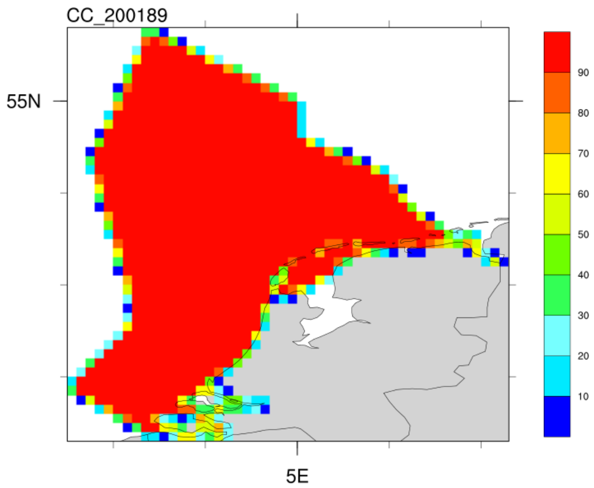
EEZ 187: Joint regime area Sweden / Norway



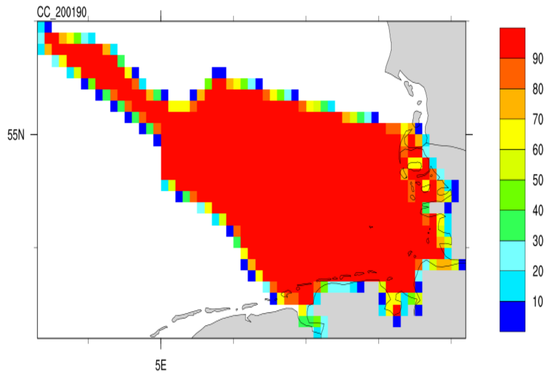
EEZ 188: Belgian EEZ



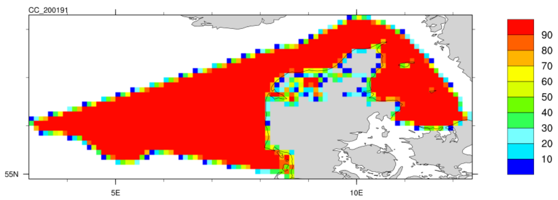
EEZ 189: Dutch EEZ



EEZ 190: German EEZ



EEZ 191: Danish EEZ



EEZ 209: French EEZ

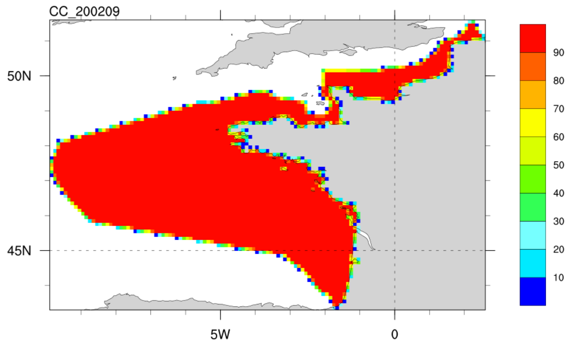
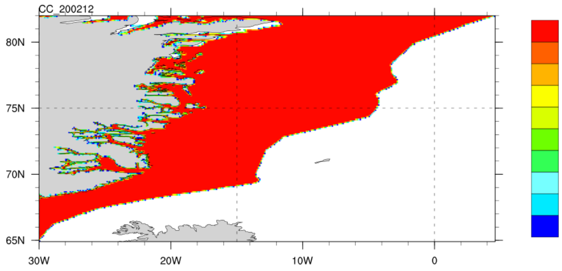
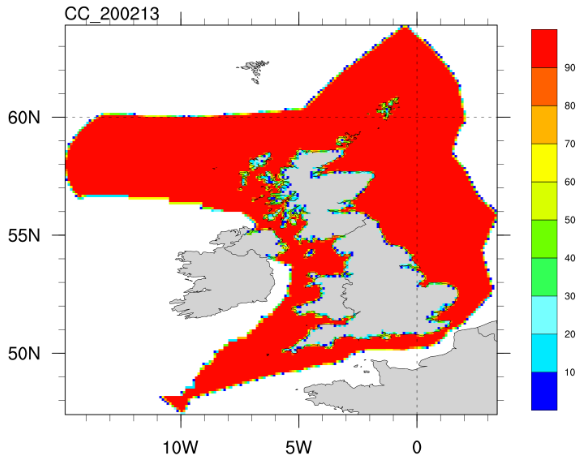


Figure 3 (continued): Percentage of the EMEP grids in each of the selected EEZs.

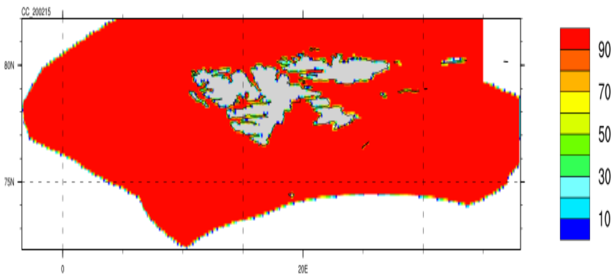
EEZ 212: Greenlandic EEZ



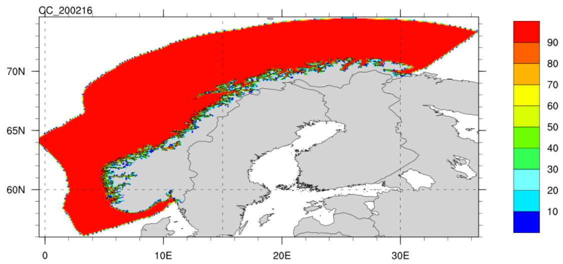
EEZ 213: United Kingdom EEZ



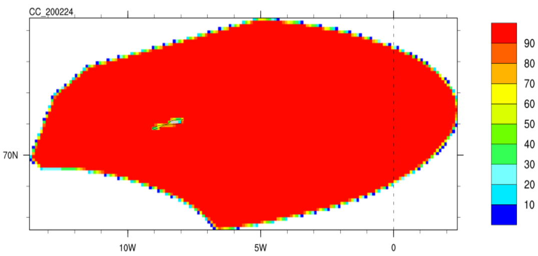
EEZ 215: Svalbard EEZ



EEZ 216: Norwegian EEZ



EEZ 224: Jan Mayen EEZ



EEZ 273: Spanish EEZ

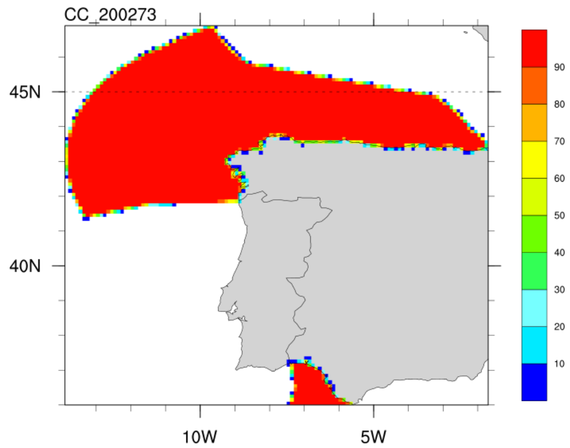


Figure 3 (continued): Percentage of the EMEP grids in each of the selected EEZs.

5. Annual atmospheric depositions to OSPAR Regions

All results are provided in a separate file on Excel format. Table 3 only provides the percentage differences between 1995 and 2017, and also between the 5-year period 1995-1999 and the 5-year period 2013-2017.

Annual depositions of oxidised nitrogen and reduced nitrogen have clearly decreased since the 1990s. One small exception is reduced nitrogen in OSPAR region II, which was 1.2% higher in 2017 than in 1995. However, the 2013-2017 average is clearly lower than the 1995-1999 average also in this case.

Figure 4 shows the entire 23-year time series for all OSPAR regions.

Table 3: Percentage differences in 2017 compared to 1995 for oxidised, reduced and total nitrogen, in the five Main OSPAR Regions. Also shown are the percentage differences in the 5-year period 2013-2017 with respect to the 5-year period 1995-1999. All differences are given in %.

OSPAR Region	**Oxidised N**		**Reduced N**		**Total N**	
	1995→2017	**(1995-1999) →(2013-2017)**	**1995→2017**	**(1995-1999) →(2013-2017)**	**1995→2017**	**(1995-1999) →(2013-2017)**
I	-51.1	-43.2	-27.3	-19.3	-44.9	-36.9
II	-44.6	-39.0	1.2	-5.6	-30.2	-27.9
III	-61.7	-49.9	-21.2	-15.4	-47.7	-37.8
IV	-49.4	-42.5	-2.4	-3.9	-35.5	-30.6
V	-57.1	-49.8	-18.7	-12.6	-47.6	-40.4

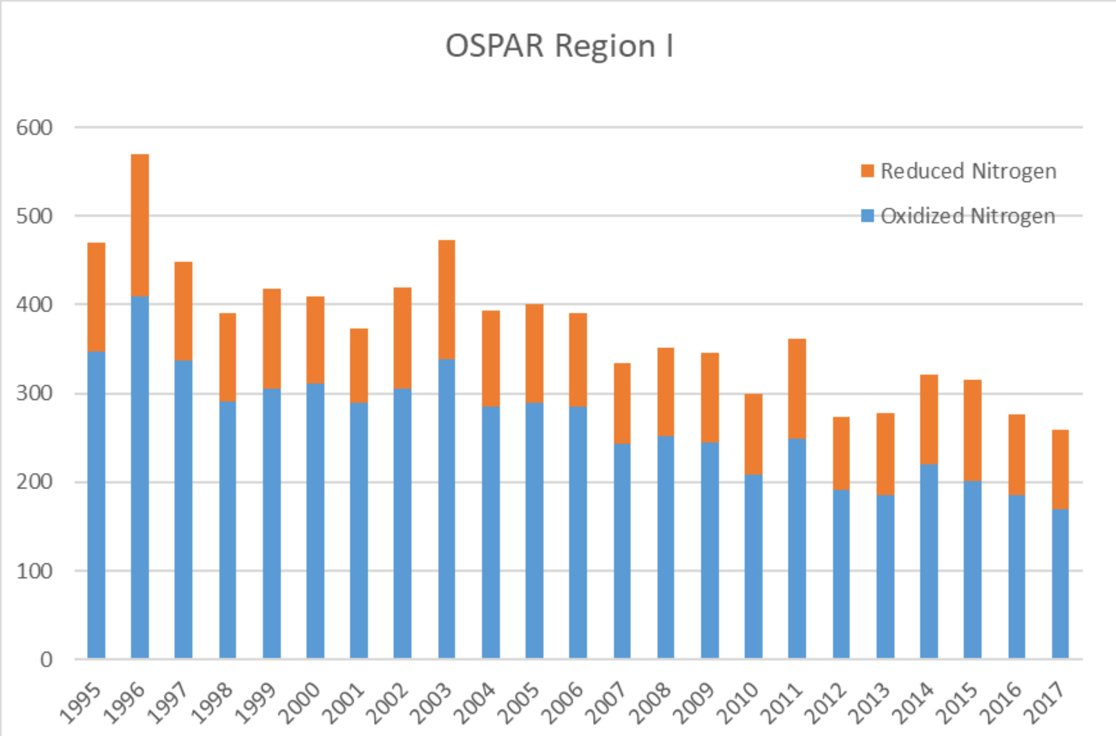


Figure 4a: Time series of annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region I, for the period 1995-2017. Unit: ktonnes(N)/year.

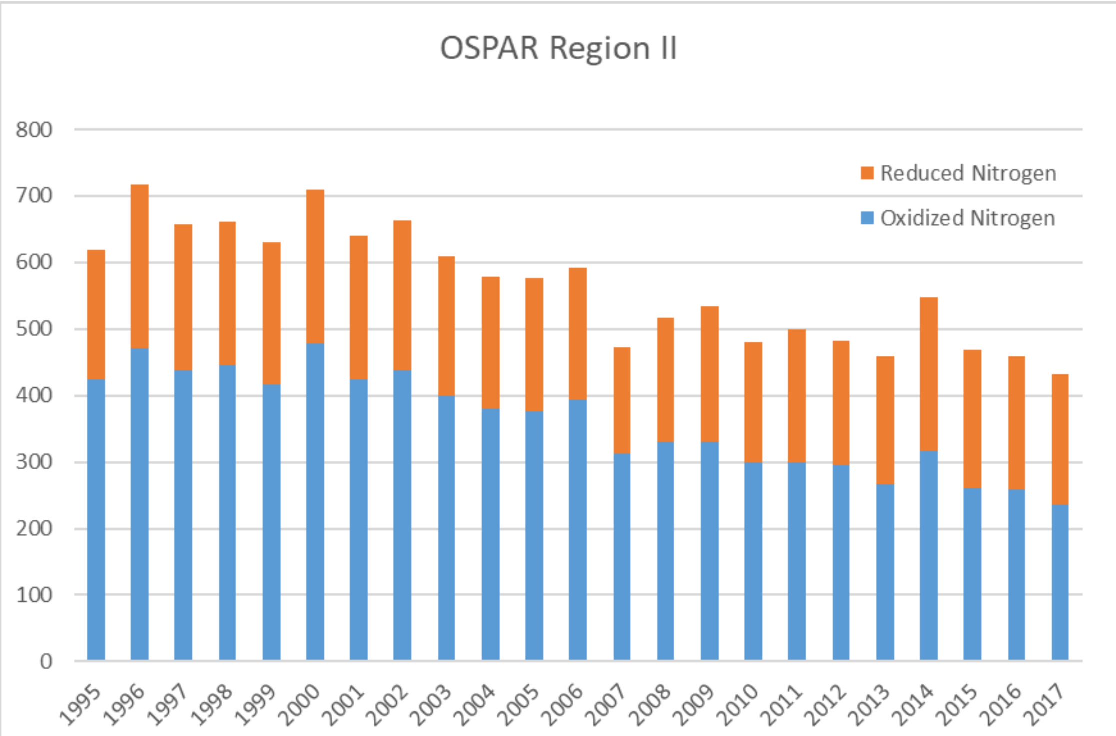


Figure 4b: Time series of annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region II, for the period 1995-2017. Unit: ktonnes(N)/year.

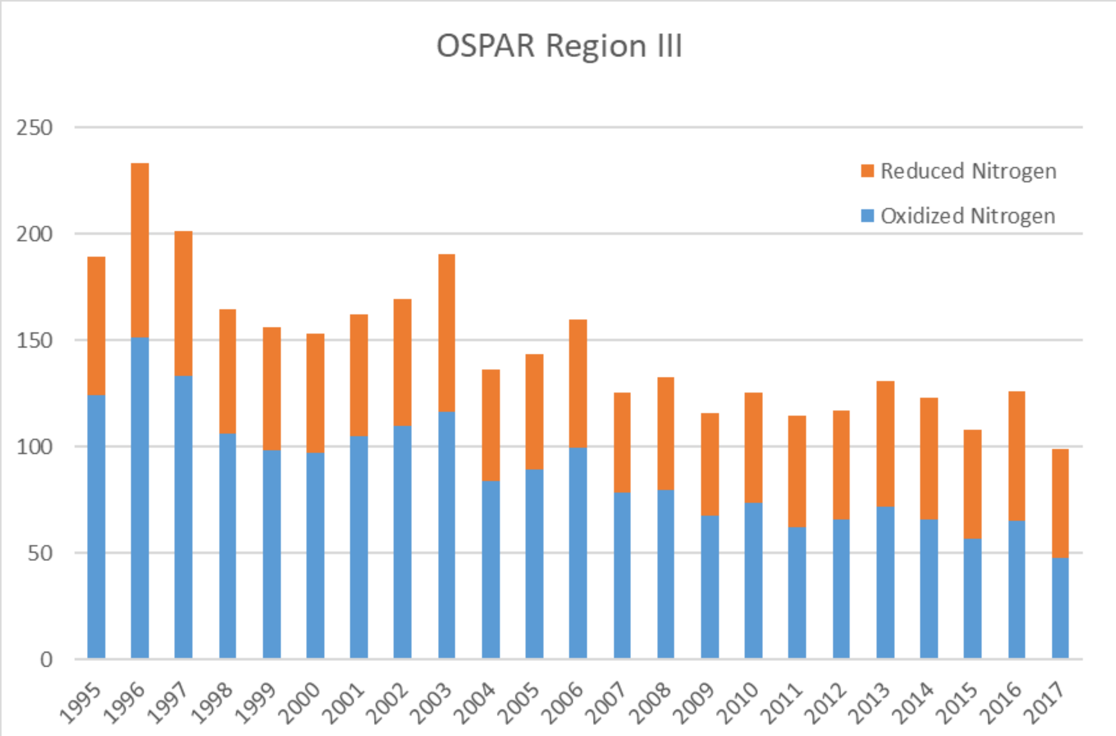


Figure 4c: Time series of annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region III, for the period 1995-2017. Unit: ktonnes(N)/year.

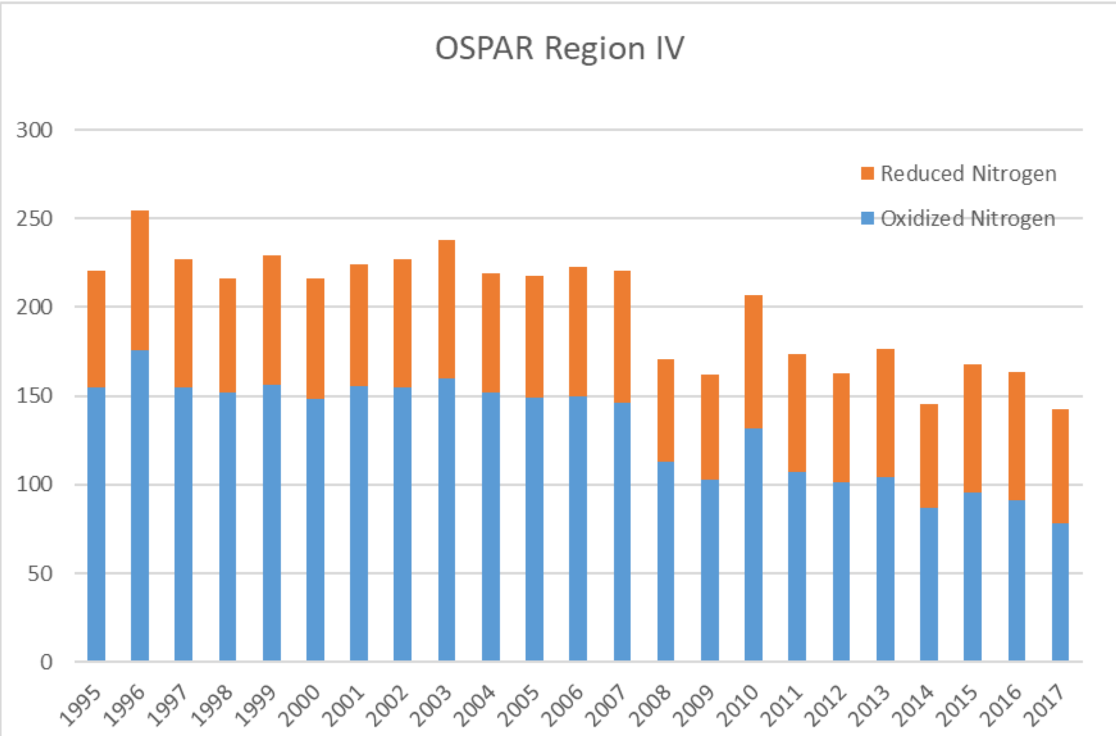


Figure 4d: Time series of annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region IV, for the period 1995-2017. Unit: ktonnes(N)/year.

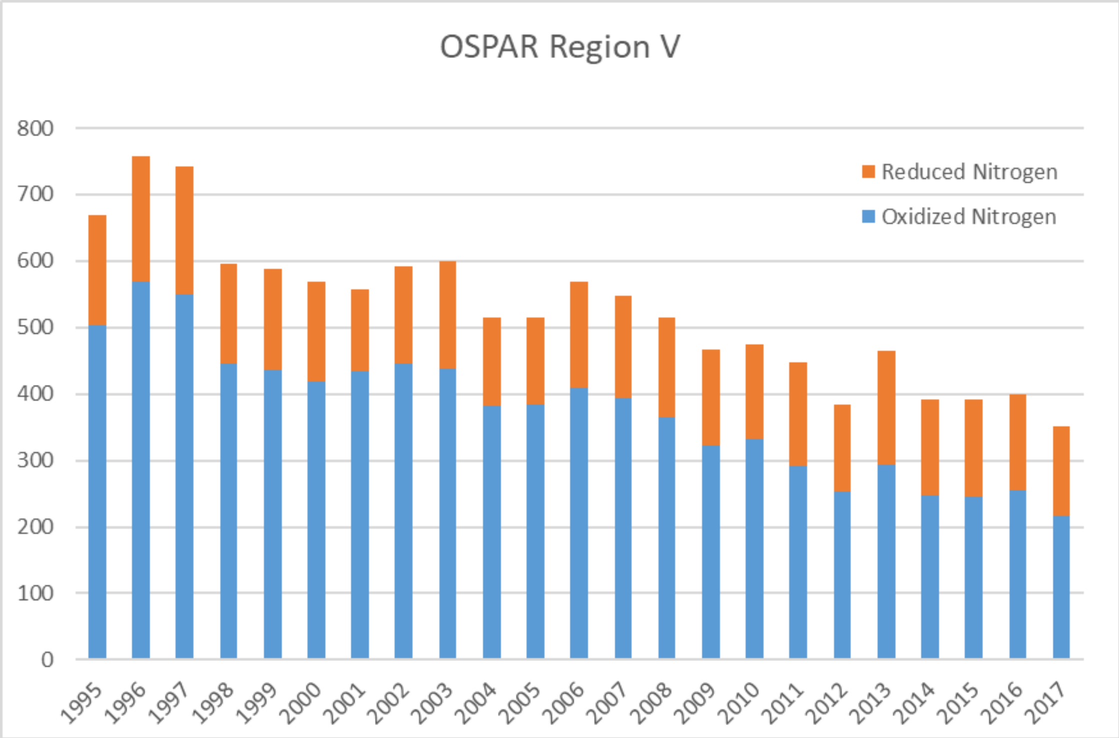


Figure 4e: Time series of annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region V, for the period 1995-2017. Unit: ktonnes(N)/year.

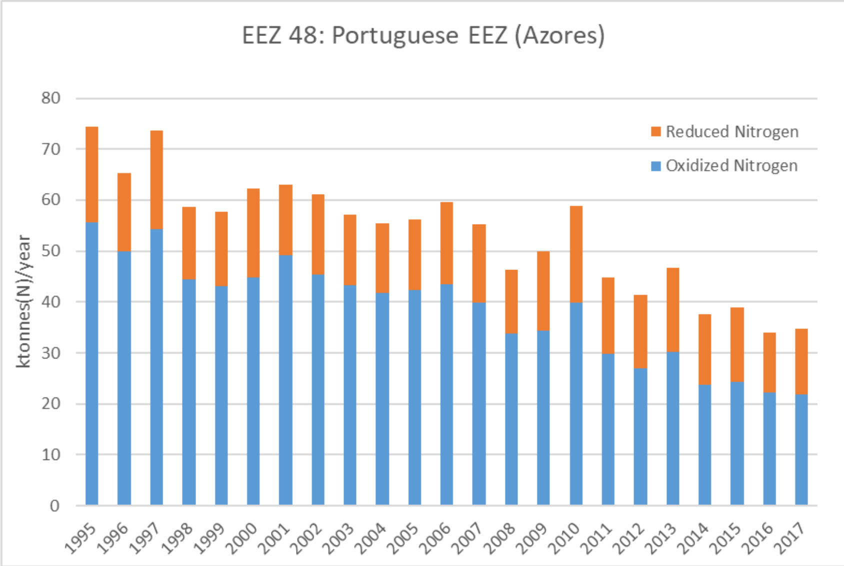
6. Annual atmospheric depositions to EEZs

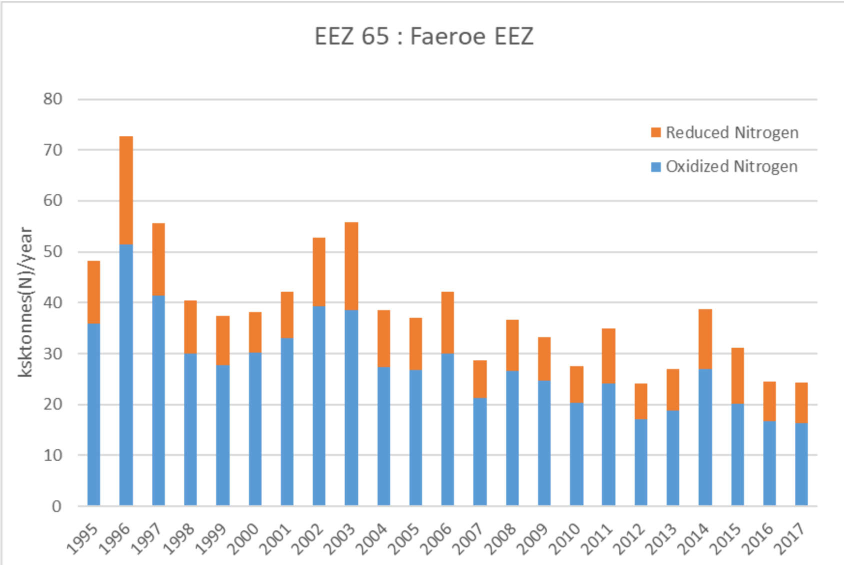
Annual atmospheric nitrogen depositions were also computed for each of the twenty-four Extended Economic Zones, for each year of the period 1995-2015. All results are provided in a separate file on Excel format. Table 4 only provides the percentage differences between 1995 and 2017, and also between the 5-year period 1995-1999 and the 5-year period 2013-2017.

There is clear decline in the deposition of oxidised nitrogen between 1995 and 2017 in all considered EEZs. For deposition of reduced nitrogen, the trend is decreasing in most EEZs, although there are a few exceptions, most notably in EEZ 91, where reduced nitrogen deposition was about 20% higher in 2017 than in 1995. The increase in the 5-year average is less pronounced, however.

Table 4: Percentage differences in 2017 compared to 1995 for oxidised, reduced and total nitrogen, in the twenty-four Extended Economic Zones. Also shown are the percentage differences in the 5-year period 2013-2017 with respect to the 5-year period 1995-1999. All differences are given in %.

EEZ	Oxidised N		Reduced N		Total N	
	1995→2017	(1995-1999) →(2013-2017)	1995→2017	(1995-1999) →(2013-2017)	1995→2017	(1995-1999) →(2013-2017)
EEZ 48	-60.7	-50.5	-32.0	-15.6	-53.4	-41.8
EEZ 65	-54.4	-47.0	-35.5	-31.0	-49.5	-42.7
EEZ 71	-51.8	-45.0	-17.7	-10.9	-43.4	-36.4
EEZ 91	-36.3	-35.8	20.9	3.4	-23.8	-27.2
EEZ 99	-53.8	-44.5	-0.1	-1.7	-37.8	-31.2
EEZ 100	-57.6	-45.8	-32.0	-28.8	-50.9	-41.1
EEZ 108	-65.7	-52.5	-29.1	-15.5	-54.6	-41.0
EEZ 109	-55.4	-43.2	-11.7	-5.3	-41.4	-30.5
EEZ 110	-54.5	-43.4	-8.3	-0.1	-36.8	-26.1
EEZ 119	-42.1	-38.8	-10.5	-19.2	-34.3	-33.8
EEZ 123	-47.2	-46.9	-23.7	-27.3	-41.8	-42.3
EEZ 185	-35.1	-33.5	1.9	-4.7	-21.8	-22.9
EEZ 187	-37.8	-34.8	-14.2	-10.1	-29.9	-26.3
EEZ 188	-41.4	-37.0	-1.3	-8.6	-25.9	-25.4
EEZ 189	-44.6	-39.1	1.2	-4.1	-29.4	-27.1
EEZ 190	-38.6	-32.2	8.4	7.2	-21.2	-16.9
EEZ 191	-33.9	-33.0	11.1	-2.3	-18.1	-21.8
EEZ 209	-55.9	-45.3	-11.1	-4.2	-40.8	-31.0
EEZ 212	-51.6	-48.5	-15.8	-18.7	-42.8	-40.9
EEZ 213	-52.8	-44.3	-7.5	-10.2	-39.3	-33.6
EEZ 215	-54.6	-45.7	-16.6	-11.9	-43.9	-36.0
EEZ 216	-48.7	-40.1	-26.9	-22.1	-42.9	-35.0
EEZ 224	-51.6	-45.4	-29.5	-26.9	-46.5	-40.9
EEZ 273	-48.0	-42.7	2.0	-5.9	-33.6	-31.6





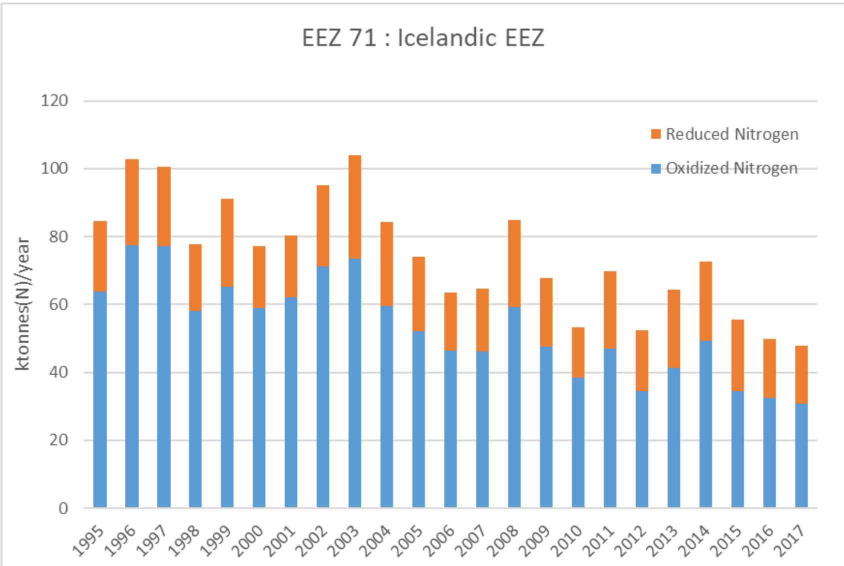


Figure 5: Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2017.

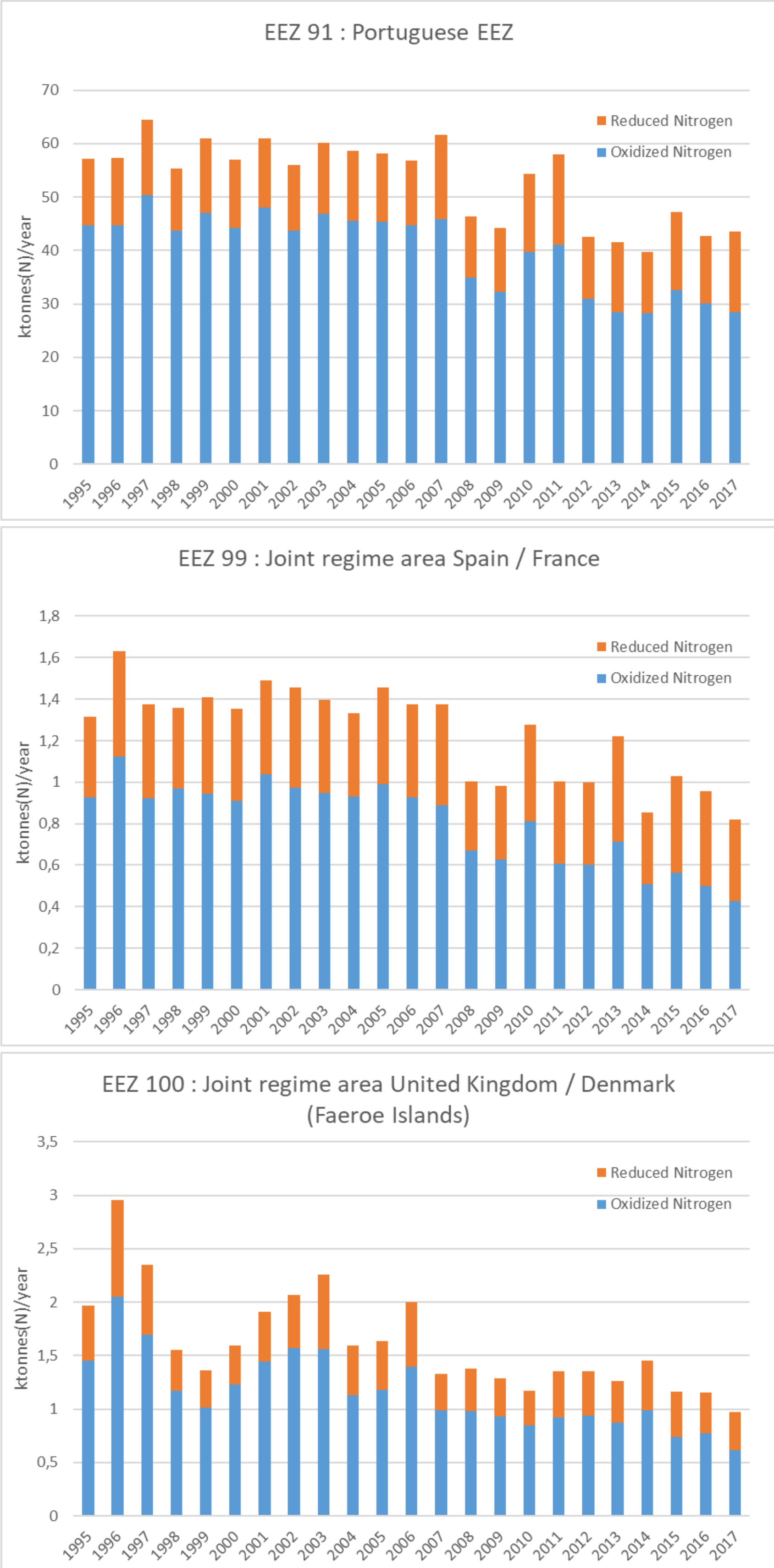
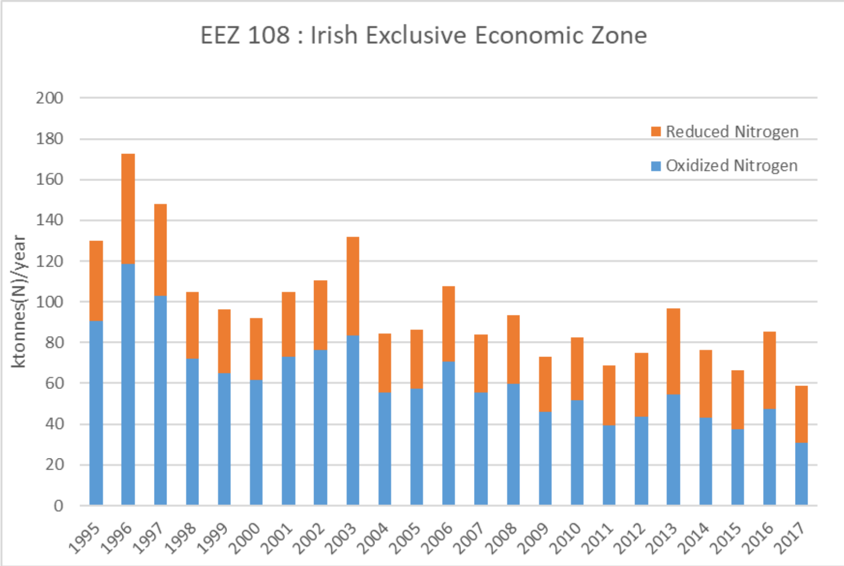
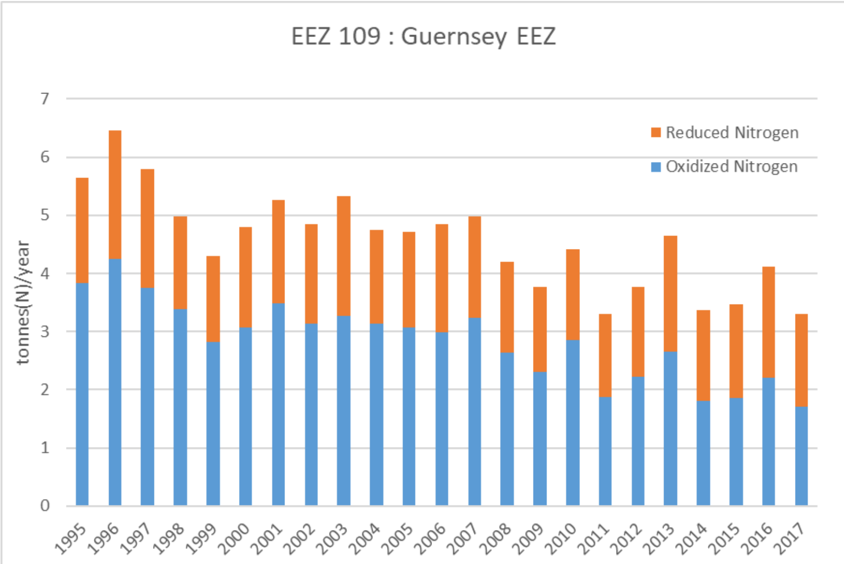


Figure 5 (continued): Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2017.





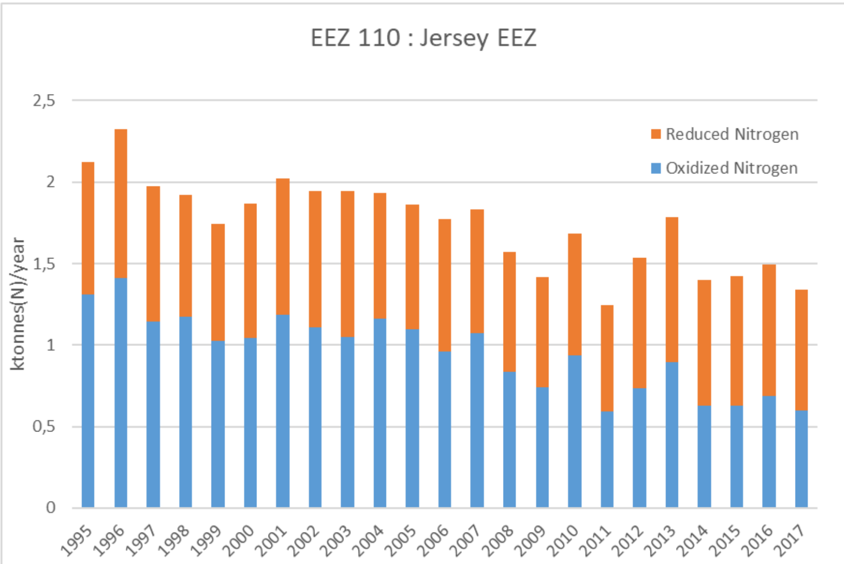


Figure 5 (continued): Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2017.

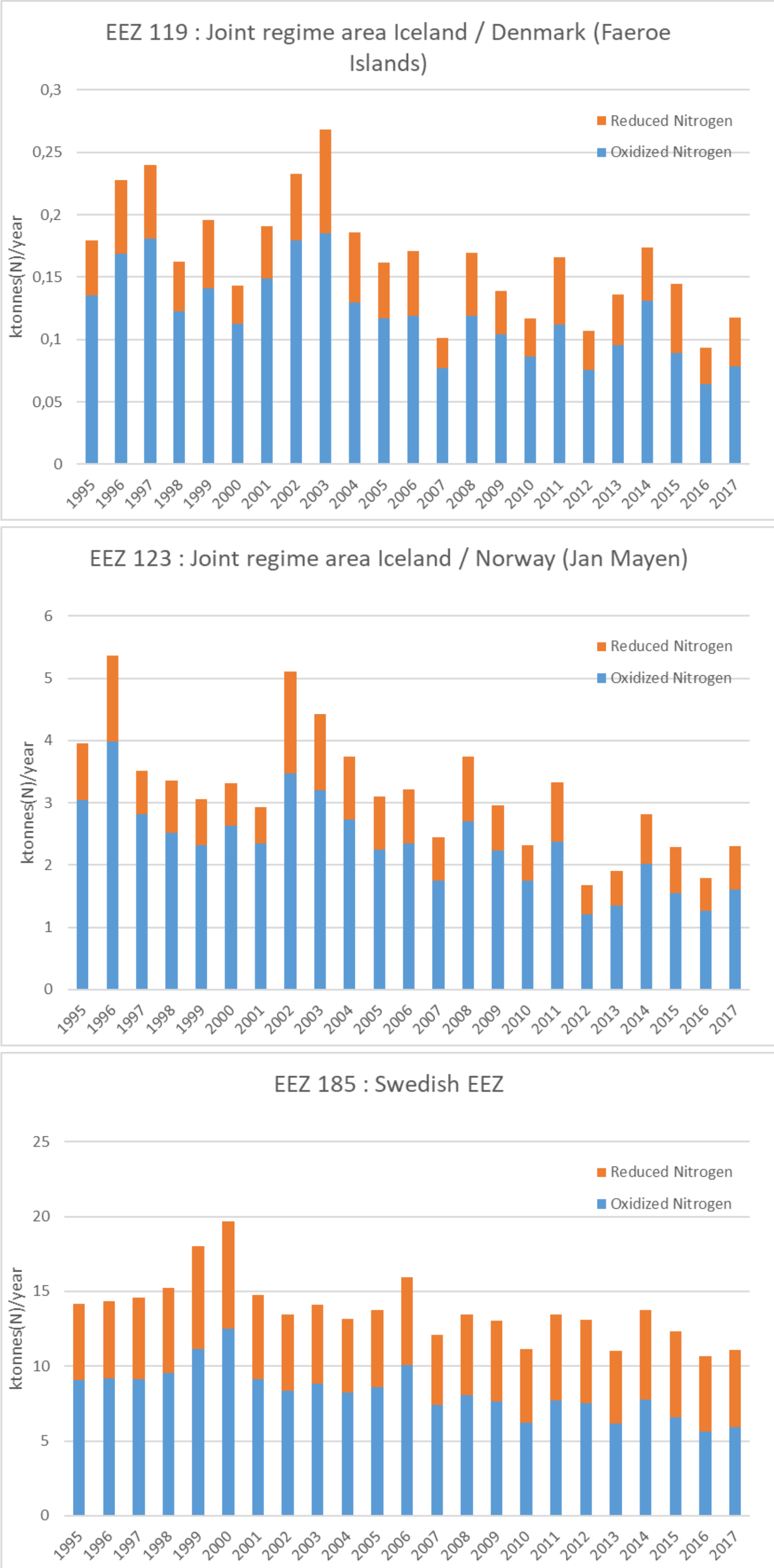


Figure 5 (continued): Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2015.

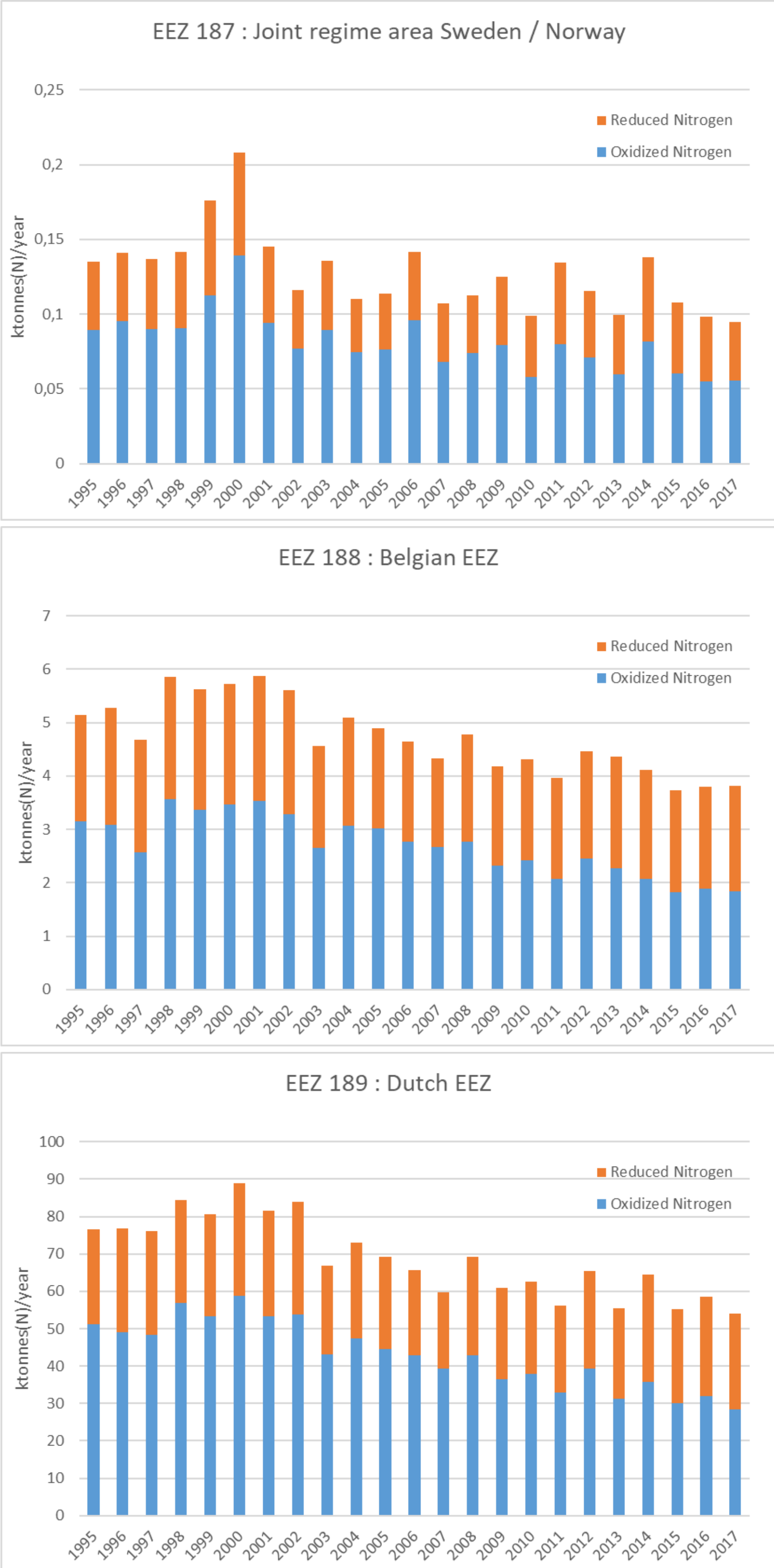


Figure 5 (continued): Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2017.

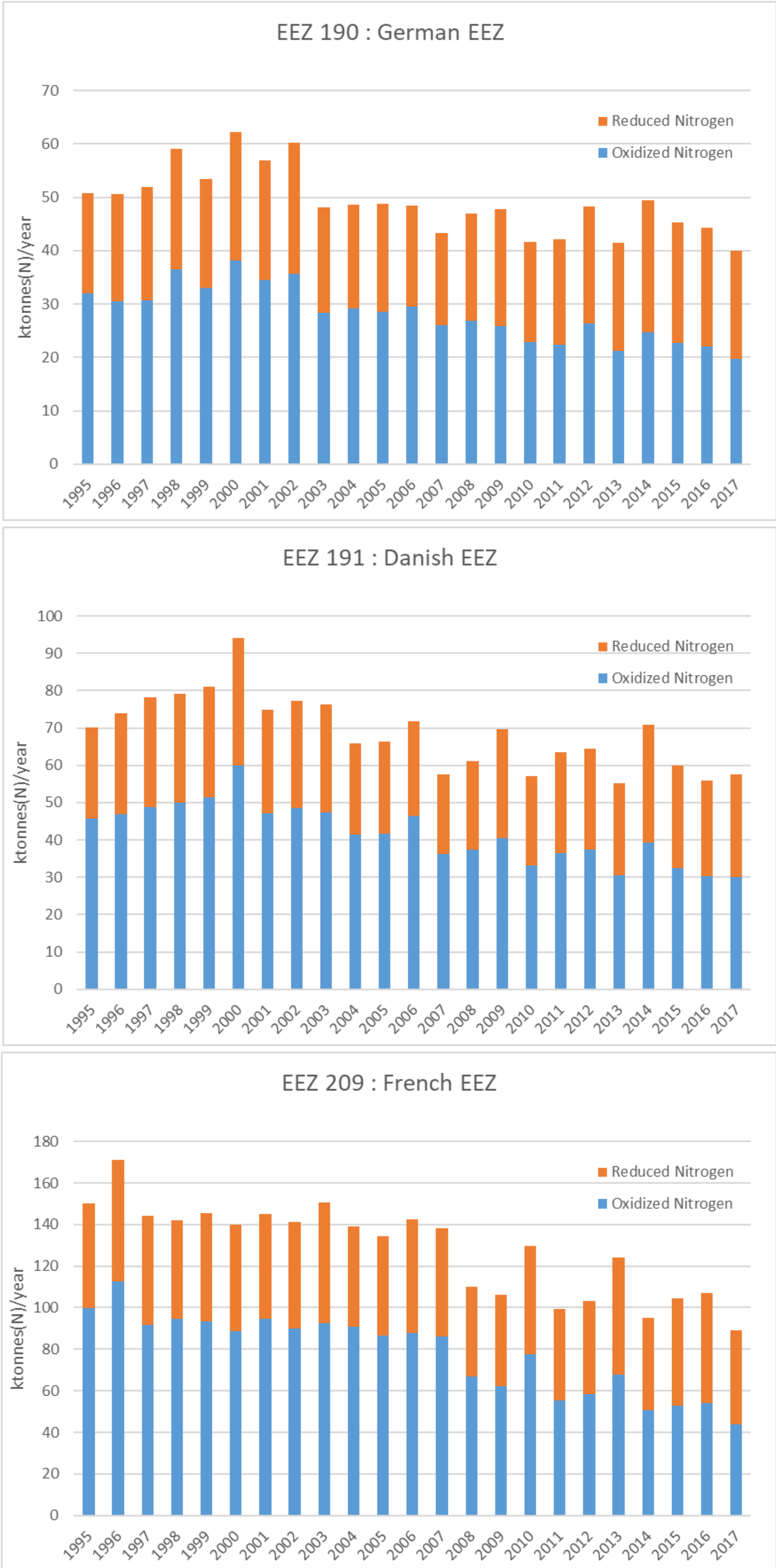


Figure 5 (continued): Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2015.

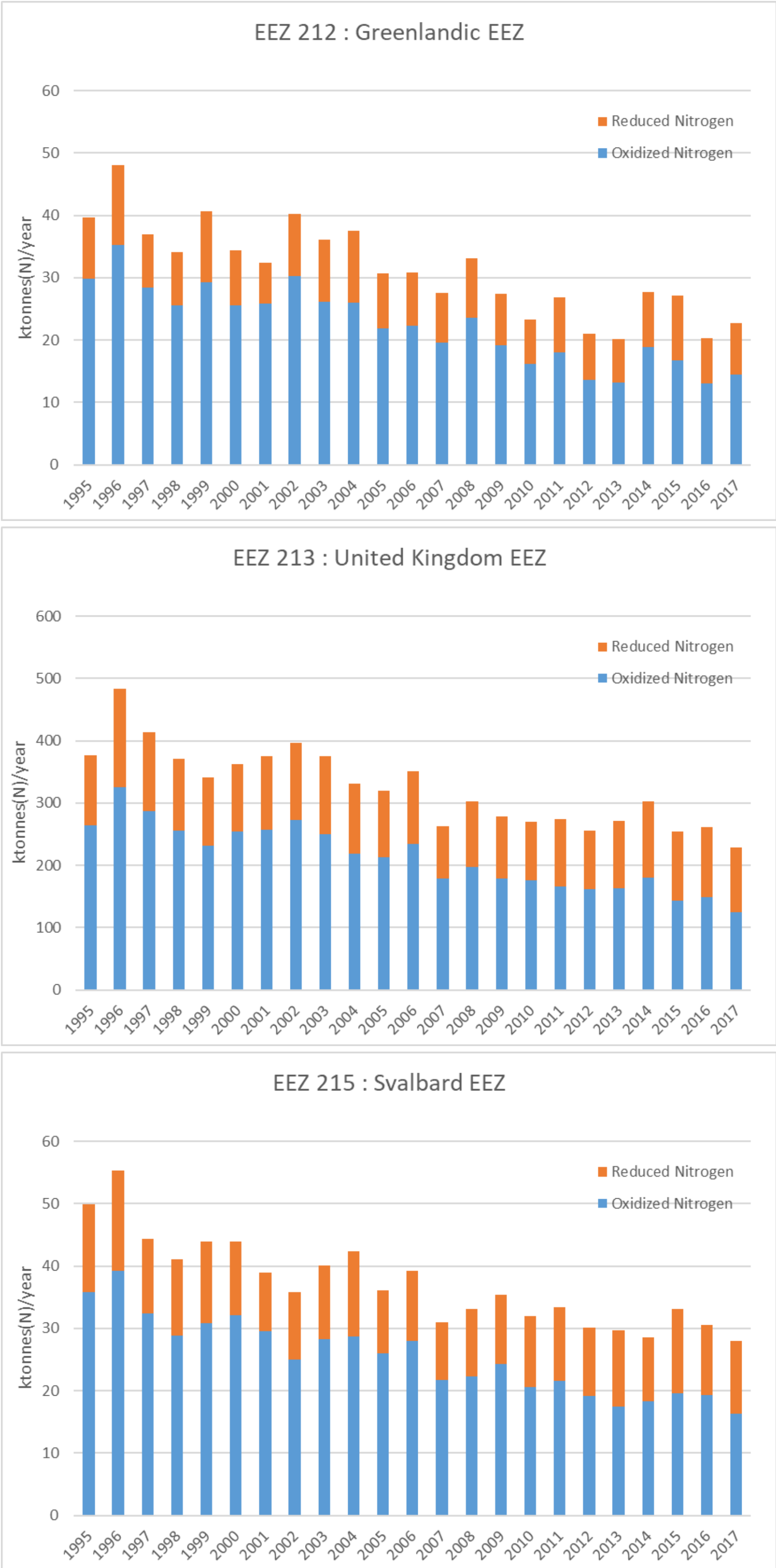
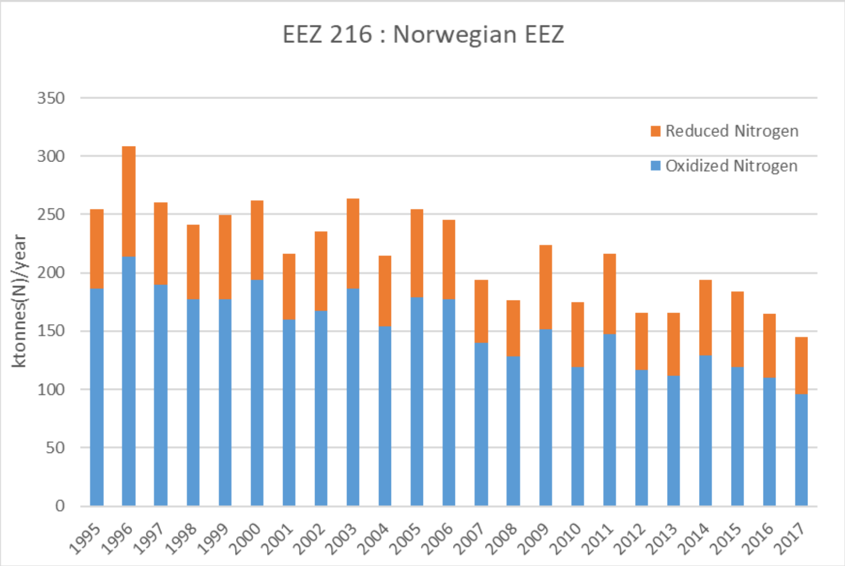
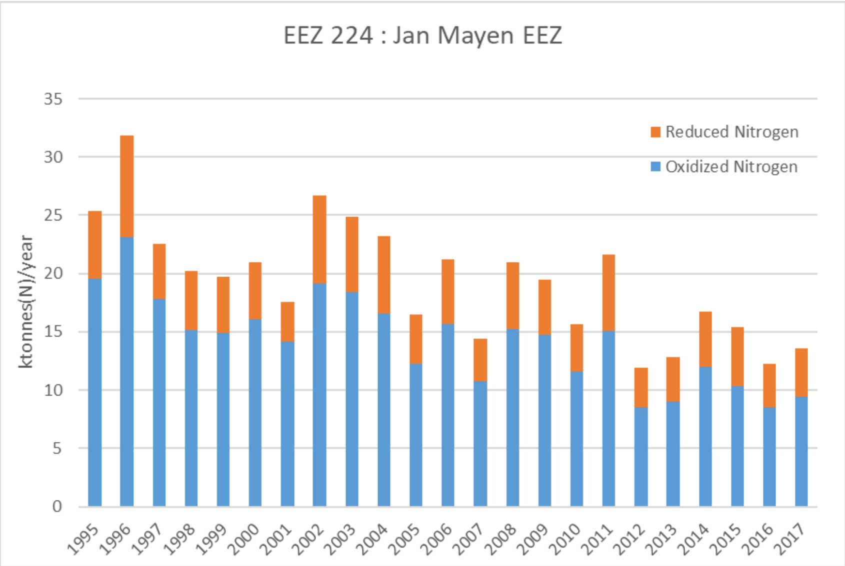


Figure 5 (continued): Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2017.





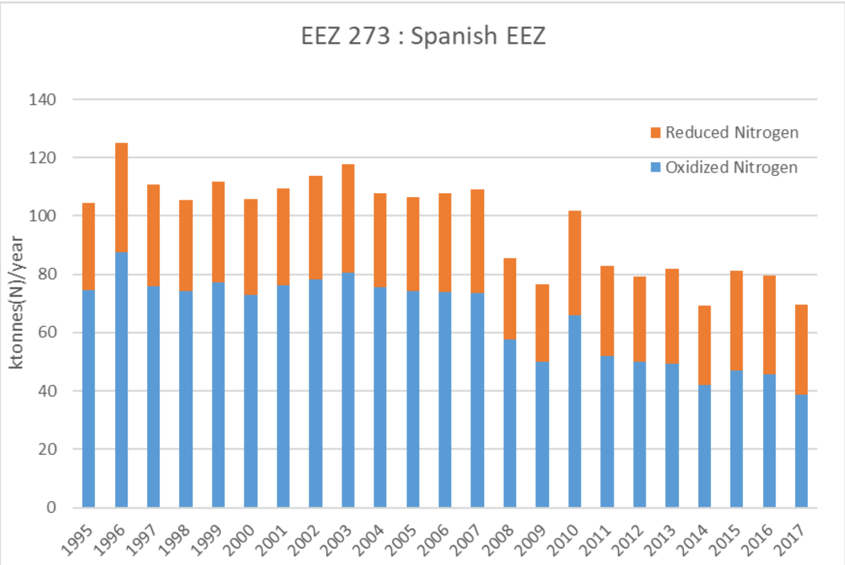


Figure 5 (continued): Time series of annual depositions of oxidised, reduced and total nitrogen to selected EEZs, for the period 1995-2017.

7. Conclusions

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

- the five Main OSPAR Regions and the twenty-four Exclusive Economic Zones have been implemented in the new 0.1°×0.1° longitude-latitude EMEP grid system and can be used in the future routine computations for OSPAR;
- for the first time this year, depositions have been calculated on a 0.1°×0.1° longitude-latitude grid for the period 1995-2017 using latest emission data (2019 submissions to CEIP) and EMEP model version rv4.33, driven by meteorology from the ECMWF IFS model version cy40r;
- in all OSPAR regions, annual deposition of *oxidised* nitrogen is clearly lower in 2017 than in 1995 in the range 45-62%, with the maximum decline in Region III;
- there is a decrease in the annual deposition of *reduced* nitrogen, too, in four out of five OSPAR Regions, in the range 2-27%, i.e. a lower decrease than in case of *oxidised* nitrogen. A small increase (1%) is calculated for Region II;
- concerning annual deposition of total nitrogen, there is decline between 1995 and 2015 in all Regions in the range 30-48% with the most significant decline in Region III;
- in all considered EEZs, there is a clear decrease in the annual deposition of *oxidised* nitrogen between 1995 and 2017, in the range 34-66%;
- in six EEZs, annual deposition of *reduced* nitrogen was higher in 2017 than in 1995, while in all other considered EEZs it has decreased, by up to 36%;
- in all considered EEZs, the annual deposition of *total* nitrogen has decreased from 1995 to 2017, in the range 18-55%.

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OSPAR COMMISSION

The Aspect
12 Finsbury Square
London EC2A 1AS
United Kingdom

t: +44 (0)20 7430 5200
f: +44 (0)20 7242 3737
e: secretariat@ospar.org
www.ospar.org

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