



Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019



OSPAR
QUALITY STATUS REPORT 2023

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.

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.



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EMEP MSC-W Report for OSPAR

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

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Executive Summary

Airborne nitrogen deposition to the OSPAR Maritime Area for the 30-year period 1990-2019 has been calculated with the EMEP MSC-W Chemistry Transport Model on a horizontal resolution of $0.1^\circ\text{lon} \times 0.1^\circ\text{lat}$. Emission data for the 2000-2019 period were updated by the EMEP Centre on Emission Inventories and Projections in 2021. Model results for the 1990s are based on official emission data reports of 2019.

Emissions from OSPAR Contracting Parties show statistically significant downward trends in the case of NOx ('oxidized nitrogen'), while downward trends in ammonia ('reduced nitrogen') emissions are less significant or even non-existent. Emissions of oxidized nitrogen come mainly from transport and power generation, while reduced nitrogen emissions are completely dominated by agriculture.

According to our model results, actual (non-normalized) depositions of oxidised nitrogen were clearly lower in 2019 than in 1995 in all OSPAR Regions, with the largest decline in Region V (57%). Annual deposition of reduced nitrogen decreased in all OSPAR Regions, but the reductions are much smaller than in the case of oxidised nitrogen, with the largest reduction in OSPAR Region I (19%). Concerning annual deposition of total (oxidised+reduced) nitrogen, there is a decline between 1995 and 2019 in all OSPAR Regions (in the range 28% - 46%), the largest decline being in Region V and the smallest in Region II.

In all considered Exclusive Economic Zones (EEZs) within the OSPAR Maritime Area, there is a clear decline in the actual depositions of oxidised nitrogen between 1995 and 2019 (in the range of 19% - 61%), while the annual deposition of reduced nitrogen was higher in 2019 than in 1995 in 7 EEZs. In the other 17 EEZs, deposition of reduced nitrogen has decreased, by up to 26%. In all 24 EEZs, the annual deposition of total nitrogen decreased from 1995 to 2019 (in the range of 9% - 50%).

It has to be noted, however, that percentage changes reported here with respect to the reference year 1995 can vary significantly from year to year due to meteorological conditions. This is especially true for the smallest EEZs. Therefore, we calculate changes in 5-year means as well, allowing for more robust results. In this year's report this has been done for the 2015-2019 period with respect to the 1995-1999 period.

Normalized depositions of oxidized and reduced nitrogen were lower in 2019 than in 1995 in all OSPAR Regions and in all EEZs. Among the OSPAR Regions, the largest decreases in oxidized nitrogen deposition (about 50%) occurred in OSPAR Region II and in EEZ189-NL. Largest decreases in reduced nitrogen are modelled for EEZ188-BE (29%). Among OSPAR Regions, the largest decrease in reduced nitrogen is in Region II (18%).

The country to which the EEZ (or partial EEZ) belongs usually makes the largest contribution to nitrogen deposition in this EEZ (or partial EEZ). While actual (i.e. non-normalized) contributions show strong interannual variability due to changes in meteorology, normalized contributions better reflect changes in emissions (i.e. the effect of policy measures during the last 25 years). Thus, significant downward trends in normalized depositions of oxidized nitrogen are modelled in all considered receptor areas.

For the first time this year, EMEP MSC-W calculated nitrogen deposition also for the 67 COMP4 Assessment Units. Actual (non-normalized) and normalized depositions have been assessed. As many of the COMP4 Assessment Units are rather small and/or have a very thin and elongated shape, normalization was made with meteorological data only from the years since 2016, for which the EMEP MSC-W transfer coefficients (necessary for normalization) are available on $0.3^\circ\text{lon} \times 0.2^\circ\text{lat}$ horizontal resolution, i.e. much finer than the earlier $50 \times 50 \text{ km}^2$ grid. The normalized results for the smallest/thinnest COMP4 Assessment Units should nevertheless be considered as uncertain, as they are only poorly resolved by the model grid. Results for actual (non-normalized) deposition are more certain because they can be derived directly from EMEP's $0.1^\circ\text{lon} \times 0.1^\circ\text{lat}$ model calculations.

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In regard to actual depositions of oxidized nitrogen, there has been a decrease from 1995 to 2019 in all 67 COMP4 Assessment Units. The largest decrease (58%) is modelled in NAAC1B ("Noratlantic Area NOR-NorC1(D5)B"), while the smallest decrease (15%) is found in SK ("Skagerak"). For reduced nitrogen, there are decreases in most COMP4 Assessment Units, but not in all. The largest decrease (56%) is modelled in NAAC1D ("Noratlantic Area NOR-NorC1(D5)D") and the largest increase (32%) is in OWCO ("Ocean Waters CO (D5)"). It should be noted that NAAC1D is extremely small (only about 23 km²), representing only a fraction of an EMEP model grid cell, so that the uncertainty in the exact magnitude of nitrogen deposition is large for NAAC1D (and Assessment Units of similar size).

Nevertheless, it is safe to say that actual oxidized nitrogen depositions have decreased over the 1995-2019 period in all COMP4 Assessment Units (and statistically significantly so), while for reduced nitrogen the trends are less significant, with depositions having decreased or increased slightly, depending on the Assessment Area in question.

Concerning normalized depositions, similar statements can be made. For oxidized nitrogen, the largest decrease (55%) is in ECPM2 ("East Coast (permanently mixed) 2"), while the smallest decrease (20%) has been modelled for SAAOC ("Sudatlantic Area SUD-OCEAN(D5)"). In the case of reduced nitrogen, the largest decrease (33%) is modelled for SCHPM1 ("Scheldt plume 1") while the largest increase (4%) is in SHPM ("Shannon plume"). Strictly speaking, SHPM is too small to be properly represented by the model grid used for the normalization procedure, so the 4% number should be taken as an indication only. It is very likely that there is no significant trend in normalized reduced nitrogen deposition in this Area.

Source-receptor relationships ('Source apportionment') have been calculated to assess Contracting Parties' contributions to nitrogen deposition in the OSPAR Maritime Area over the 1995-2019 period.

For the first time this year, source apportionment was also calculated for "partial EEZs", i.e. parts of those EEZs that fall within more than one OSPAR Region. This applies to 9 out of the 24 EEZs considered by EMEP MSC-W. EEZs can fall within up to five OSPAR Regions. In total, 25 partial EEZs are considered.

Récapitulatif

Les dépôts atmosphériques d'azote dans la zone maritime OSPAR pour la période 1990-2019 ont été calculés avec le modèle de transport de la chimie du EMEP MSC-W à une résolution de 0,1°lon x 0,1°lat.

Les émissions des Parties contractantes d'OSPAR montrent des tendances à la baisse statistiquement significatives dans le cas de l'azote oxydé, tandis que les tendances à la baisse des émissions d'azote réduit sont moins significatives ou inexistantes.

Selon les résultats du modèle, les dépôts réels (non normalisés) d'azote oxydé étaient clairement inférieurs en 2019 à ceux de 1995 dans toutes les régions d'OSPAR, la baisse la plus importante étant enregistrée dans la Région V (57%). Les retombées annuelles d'azote réduit ont diminué dans toutes les régions d'OSPAR, mais les réductions sont beaucoup plus faibles que dans le cas de l'azote oxydé, la réduction la plus importante se situant dans la Région I d'OSPAR (19%). En ce qui concerne les retombées annuelles d'azote total, on constate une baisse entre 1995 et 2019 dans toutes les régions d'OSPAR, la baisse la plus importante étant dans la Région V et la plus faible dans la Région II.

Dans toutes les zones économiques exclusives (ZEE) considérées de la zone maritime d'OSPAR, on observe une baisse des dépôts réels d'azote oxydé entre 1995 et 2019 (de l'ordre de 19% - 61%), tandis que le dépôt annuel d'azote réduit était plus élevé en 2019 qu'en 1995 dans 7 ZEE. Dans les autres ZEE, les dépôts d'azote réduit ont diminué (jusqu'à 26 %).

Les dépôts normalisés (en fonction des conditions météorologiques) d'azote oxydé et réduit étaient plus faibles en 2019 qu'en 1995 dans toutes les régions d'OSPAR et dans toutes les ZEE. Parmi les régions d'OSPAR, les plus fortes baisses des dépôts d'azote oxydé (environ 50%) ont eu lieu dans la Région II d'OSPAR et dans la ZEE 189-NL. Les plus fortes diminutions de l'azote réduit sont modélisées pour la ZEE188-BE (29%). Parmi les régions d'OSPAR, la plus grande diminution de l'azote réduit se situe dans la Région II (18%).

Le pays auquel appartient la ZEE apporte généralement la plus grande contribution aux dépôts d'azote dans cette ZEE. Alors que les contributions réelles (c'est-à-dire non normalisées) présentent une forte variabilité interannuelle due aux changements météorologiques, les contributions normalisées reflètent mieux les changements dans les émissions (c'est-à-dire l'effet des mesures politiques au cours des 25 dernières années).

EMEP MSC-W a également calculé les dépôts d'azote pour les 67 unités d'évaluation du COMP4. Étant donné que de nombreuses unités d'évaluation du COMP4 sont plutôt petites et/ou ont une forme très mince et allongée, la normalisation a été effectuée avec des données météorologiques pour 2016-2019, pour lesquelles les coefficients de transfert de l'EMEP MSC-W (nécessaires pour la normalisation) sont disponibles avec une résolution suffisamment fine. Les résultats normalisés pour les plus petites unités d'évaluation du COMP4 doivent néanmoins être considérés comme incertains. Les résultats concernant les dépôts réels sont plus sûrs car ils peuvent être dérivés directement des calculs du modèle $0,1^\circ\text{lon} \times 0,1^\circ\text{lat}$ de l'EMEP.

En ce qui concerne les dépôts effectifs d'azote oxydé, on observe une diminution entre 1995 et 2019 dans les 67 unités d'évaluation du COMP4. Pour l'azote réduit, on observe des diminutions dans la plupart des unités d'évaluation du COMP4, mais pas dans toutes. En ce qui concerne les dépôts normalisés, des déclarations similaires peuvent être faites.

Les relations source-récepteur ("répartition par source") ont été calculées pour évaluer les contributions des Parties contractantes aux dépôts d'azote dans la zone maritime OSPAR au cours de la période 1995-2019.

1 Introduction

Nitrogen deposition to OSPAR Convention Waters has been a subject of cooperation between EMEP MSC-W (Meteorological Synthesizing Centre – West) 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.

This report covers results for all the three contracts that EMEP MSC-W had with OSPAR in 2021. The following Deliverables were listed in these contracts (all deliverables relate to nitrogen):

1. Emissions data by Contracting Parties (from national reports to EMEP) and by sector
2. Actual atmospheric deposition to each OSPAR Region
3. Actual atmospheric deposition to national EEZs in each OSPAR region
4. Actual atmospheric deposition divided up as EEZ within each OSPAR Region
5. Actual atmospheric deposition to each COMP4 Assessment Unit
6. Normalised nitrogen deposition to each OSPAR Region
7. Normalised nitrogen deposition to each COMP4 Assessment Unit
8. Source apportionment – by Contracting Party (CP) to OSPAR Region
9. Source apportionment – by Contracting Parties to national EEZ within each OSPAR Region
10. Quality Control of OSPAR's CAMP data

All products should be delivered with trends back to 1995 or, if feasible, 1990.

The Quality Control of OSPAR's CAMP data (item 10) was part of NILU's work (Norwegian Institute for air research) and is not subject of this report. Emission data (item 1) is provided annually by EMEP CEIP (Centre for Emission Inventories and Projections). EMEP MSC-W's work consisted of extracting data relevant for OSPAR and to present tables and analyses of trends and sector contributions.

For the first time this year, nitrogen depositions had to be calculated for "partial EEZs" (items 4 and 9), i.e. parts of those EEZs that fall within more than one OSPAR Region. This is the case for 9 of the 24 EEZs considered by EMEP MSC-W. EEZs can fall within up to five OSPAR Regions. In total, 25 partial EEZs are considered.

Also for the first time this year, nitrogen depositions had to be calculated for the COMP4 Assessment Units. Actual and normalized depositions have been calculated for 67 COMP4 Assessment Units (as defined in a table provided by OSPAR in May 2021), with trends back to 1990 in the case of actual (non-normalized) depositions, and back to 1995 in the case of normalized depositions. Since many of the COMP4 Assessment Units are rather small, we decided to base the normalization only on those 4 meteorological years for which EMEP MSC-W has calculated transfer coefficients on $0.3^{\circ}(\text{lon}) \times 0.2^{\circ}(\text{lat})$ resolution, i.e. 2016, 2017, 2018 and 2019. For consistency normalization is done with these years also in the results for all other receptor areas considered in this report.

After the description of the model setup in Chapter 2, we present the emission data (Chapter 3) and the definitions of receptor areas considered for OSPAR (Chapter 4), followed by the model results in Chapters 5 (depositions) and 6 (source apportionment). In Chapter 7, conclusions are listed, while Chapter 8 describes the data files that have been submitted to OSPAR along with this report.

2 Modeling

2.1 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 was documented in detail in Simpson et al. (2012) and in the annual chapters on model updates in subsequent EMEP status reports (see Simpson et al., 2021, and references therein).

The model is regularly evaluated against measurements from the EMEP network under the LRTAP convention (e.g. Gauss et al., 2019; 2020), 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. A detailed evaluation of this year's EMEP MSC-W model simulation (for 2019) can be viewed at the new AeroVal evaluation interface at https://aeroval.met.no/evaluation.php?project=emeep&exp_name=2021-reporting

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 MSC-W model results and activities is further ensured by the availability of the model code as Open Source at <https://github.com/metno/emeep-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.

2.2 Experimental setup

Meteorological data have been generated by the ECMWF IFS model cy40r1 for the period 1990 to 2018 and cy46r1 for 2019 (see ECMWF model documentation). The version change for 2019 was inevitable because cy40r1 is not supported anymore, but changes in the meteorological driver have a relatively small effect on model results (changes in the chemistry transport model as well as the emission data are more important).

Emission data for the 1990-1999 period were obtained in June 2019 from the EMEP Centre CEIP and listed in the EMEP Status Report 1/2019 (EMEP, 2019). Some countries had not updated their emission data for PM (particulate matter) for the 1990s, which is why EMEP MSC-W had not calculated trends back to 1990 in recent reports. In the case of nitrogen deposition the importance of PM emissions is rather minor, so this year we decided to calculate nitrogen deposition all the way back to 1990 and to include these data in the tables provided to OSPAR. Nevertheless, this report focuses only on the period 1995 to 2019.

New emission data for 2000-2019 were obtained in June 2021 from the EMEP Centre CEIP and listed in the EMEP Status Report 1/2021 (EMEP, 2021) and were used in the model runs covering the 2000-2019 period. More details about the emission data used in our model calculations are given in Chapter 3 of this report.

EMEP MSC-W model version rv4.42 (documented and evaluated in EMEP Status report 1/2021) was run for the entire trend period 1990-2019, using the meteorological and emission data described above, on 0.1°lon x 0.1°lat resolution and within the longitude-latitude domain outlined in green in Figure 1.

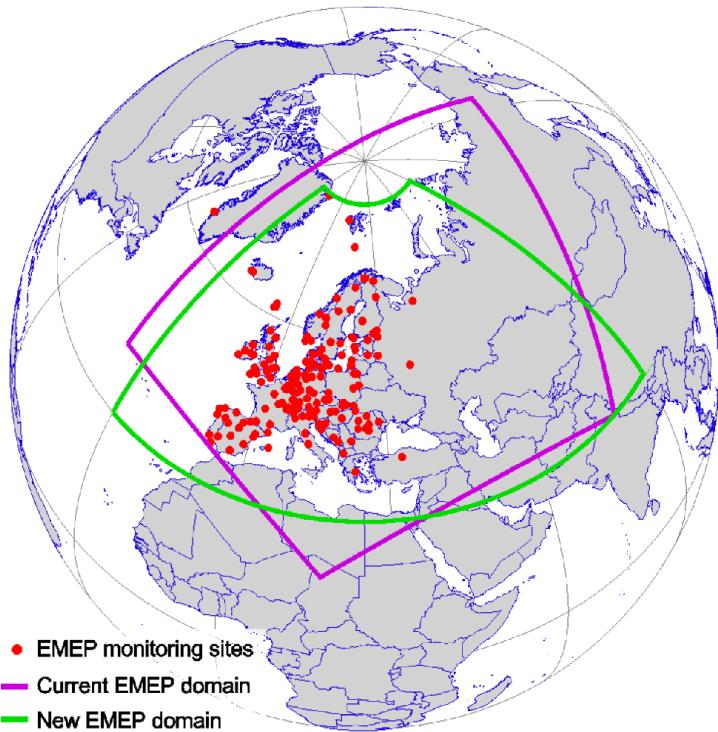


Figure 1: The old (purple) and new (green) official EMEP domains. The new domain was used for the first time for the EMEP status runs in 2017 (EMEP, 2017), and has $0.1^\circ\text{lon} \times 0.1^\circ\text{lat}$ resolution in a regular longitude-latitude grid. All calculations for this report were done on the new official EMEP domain.

3 Emission data by Contracting Parties and by sector

In this chapter we present the emission data used for modelling at EMEP MSC-W. They are provided on an annual basis by the EMEP Centre on Emission Inventories and Projects (CEIP) and are publicly available (*WebDab Emission database* at <https://ceip.at>, see “Emissions as used in EMEP models”).

Annual emissions of oxidized nitrogen (NOx) and reduced nitrogen (ammonia/NH₃) are listed in Tables 1 and 2, respectively, for the 1995-2019 period and the OSPAR Contracting Parties¹. Figure 2 visualizes the evolution for the same period. Data for the European Union (EU) are not tabulated because the number of members has changed several times during the considered period. For NOx, emissions from international shipping are listed as well. For completeness, emissions of total nitrogen are listed in Table 3.

The Mann-Kendall test has been used to test the hypothesis of there being negative trends in the 2000-2019 time series for NOx and NH₃ emissions. All NOx emission trends from 2000 are negative and significant at the 5% level. All NH₃ emission trends from 2000 are negative and significant at the 5% level, except for Germany, Iceland, Ireland and Norway.

¹ Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Iceland (IS), Ireland (IE), Luxembourg (LU), The Netherlands (NL), Norway (NO), Portugal (PT), Spain (ES), Sweden (SE), Switzerland (CH) and the United Kingdom (GB).

Table 1. Annual emissions of nitrogen oxides from OSPAR Contracting Parties, international shipping (NOS: North Sea, and ATL: Part of the Atlantic Ocean included in the EMEP MSC-W model domain, but not part of NOS) in the period 1995 – 2019, as used in the EMEP MSC-W model calculations of nitrogen deposition. Unit: ktonnes(N)/year. The period 2000–2019 is based on data submissions in 2021, while data for 1995–1999 are based on data submissions of 2019. The table continues on the next page. The last column shows the total of all emissions.

| Year | BE | DK | FI | FR | DE | IS | IE | LU | NL |
|-------------|-----|----|----|-----|-----|-----|----|-----|-----|
| 1995 | 116 | 89 | 83 | 545 | 664 | 11 | 52 | 11 | 169 |
| 1996 | 113 | 99 | 84 | 537 | 642 | 11 | 52 | 11 | 165 |
| 1997 | 109 | 85 | 83 | 517 | 623 | 11 | 51 | 11 | 157 |
| 1998 | 110 | 79 | 78 | 525 | 615 | 10 | 53 | 10 | 150 |
| 1999 | 103 | 73 | 77 | 509 | 608 | 10 | 53 | 11 | 148 |
| 2000 | 110 | 69 | 73 | 520 | 580 | 10 | 56 | 13 | 144 |
| 2001 | 106 | 68 | 74 | 509 | 562 | 8.9 | 55 | 13 | 140 |
| 2002 | 102 | 67 | 74 | 496 | 544 | 10 | 53 | 13 | 135 |
| 2003 | 101 | 70 | 76 | 483 | 530 | 9.4 | 53 | 14 | 133 |
| 2004 | 104 | 65 | 72 | 470 | 515 | 10 | 53 | 17 | 129 |
| 2005 | 99 | 62 | 63 | 455 | 500 | 8.6 | 54 | 17 | 127 |
| 2006 | 95 | 62 | 68 | 429 | 503 | 8.5 | 53 | 16 | 124 |
| 2007 | 91 | 58 | 64 | 409 | 489 | 9.3 | 51 | 14 | 120 |
| 2008 | 83 | 53 | 59 | 379 | 470 | 8.6 | 47 | 13 | 118 |
| 2009 | 74 | 47 | 54 | 355 | 443 | 8.5 | 39 | 12 | 108 |
| 2010 | 74 | 46 | 57 | 348 | 448 | 8.0 | 37 | 12 | 106 |
| 2011 | 69 | 43 | 52 | 331 | 440 | 7.3 | 33 | 12 | 101 |
| 2012 | 66 | 39 | 49 | 323 | 437 | 7.2 | 34 | 11 | 96 |
| 2013 | 63 | 38 | 48 | 316 | 437 | 7.0 | 34 | 10 | 92 |
| 2014 | 60 | 35 | 46 | 295 | 424 | 6.9 | 34 | 10 | 86 |
| 2015 | 60 | 35 | 42 | 289 | 415 | 7.1 | 35 | 8.7 | 86 |
| 2016 | 57 | 35 | 41 | 275 | 408 | 6.5 | 35 | 7.8 | 82 |
| 2017 | 54 | 34 | 40 | 265 | 393 | 6.6 | 34 | 6.9 | 79 |
| 2018 | 52 | 32 | 39 | 247 | 368 | 6.8 | 34 | 6.3 | 77 |
| 2019 | 49 | 30 | 36 | 236 | 346 | 6.3 | 31 | 5.9 | 73 |

Table 1. Continued from previous page.

| Year | NO | PT | ES | SE | CH | GB² | NOS | ATL | Total |
|-------------|-----------|-----------|------------|-----------|-----------|-----------------------|------------|------------|--------------|
| 1995 | 67 | 87 | 418 | 76 | 35 | 808 | 239 | 302 | 3771 |
| 1996 | 70 | 81 | 402 | 74 | 34 | 780 | 244 | 308 | 3709 |
| 1997 | 73 | 82 | 403 | 72 | 33 | 718 | 250 | 315 | 3590 |
| 1998 | 74 | 86 | 399 | 69 | 33 | 690 | 257 | 324 | 3564 |
| 1999 | 72 | 89 | 407 | 67 | 33 | 650 | 269 | 340 | 3519 |
| 2000 | 68 | 89 | 411 | 66 | 31 | 624 | 283 | 355 | 3499 |
| 2001 | 67 | 88 | 402 | 63 | 30 | 609 | 279 | 350 | 3425 |
| 2002 | 65 | 90 | 412 | 61 | 29 | 579 | 273 | 343 | 3346 |
| 2003 | 66 | 83 | 409 | 60 | 28 | 566 | 268 | 337 | 3284 |
| 2004 | 65 | 83 | 416 | 59 | 28 | 547 | 264 | 334 | 3231 |
| 2005 | 66 | 84 | 410 | 58 | 28 | 541 | 260 | 327 | 3161 |
| 2006 | 66 | 78 | 395 | 57 | 28 | 520 | 256 | 322 | 3081 |
| 2007 | 67 | 75 | 393 | 56 | 28 | 498 | 251 | 317 | 2991 |
| 2008 | 65 | 69 | 331 | 54 | 28 | 447 | 234 | 290 | 2749 |
| 2009 | 62 | 65 | 296 | 50 | 26 | 387 | 224 | 275 | 2524 |
| 2010 | 64 | 60 | 277 | 51 | 26 | 379 | 235 | 296 | 2524 |
| 2011 | 64 | 55 | 275 | 49 | 25 | 355 | 229 | 290 | 2429 |
| 2012 | 63 | 51 | 262 | 47 | 25 | 363 | 227 | 285 | 2384 |
| 2013 | 61 | 50 | 232 | 47 | 25 | 344 | 221 | 276 | 2300 |
| 2014 | 58 | 49 | 234 | 46 | 23 | 322 | 202 | 244 | 2174 |
| 2015 | 55 | 50 | 235 | 45 | 22 | 312 | 204 | 259 | 2159 |
| 2016 | 52 | 48 | 221 | 44 | 22 | 285 | 204 | 255 | 2077 |
| 2017 | 49 | 49 | 220 | 43 | 21 | 275 | 198 | 255 | 2021 |
| 2018 | 49 | 47 | 210 | 42 | 20 | 267 | 199 | 258 | 1952 |
| 2019 | 46 | 45 | 197 | 39 | 19 | 256 | 231 | 283 | 1928 |

² Here and elsewhere in this report, the abbreviation 'GB' is used for the United Kingdom of Great Britain and Northern Ireland. This is because EMEP MSC-W under the UN LRTAP Convention is required to use ISO 3166-1 alpha-2 codes.

Table 2. Annual emissions of ammonia from OSPAR Contracting Parties in the period 1995 – 2019, as used in the EMEP MSC-W model calculations of nitrogen deposition. Unit: ktonnes(N)/year.

| Year | BE | DK | FI | FR | DE | IS | IE | LU | NL | NO | PT | ES | SE | CH | GB | Total |
|-------------|-----------|-----------|-----------|------------|------------|------------|------------|------------|------------|-----------|-----------|------------|-----------|-----------|------------|-------------|
| 1995 | 105 | 89 | 27 | 522 | 535 | 4.1 | 93 | 5.4 | 185 | 26 | 60 | 384 | 50 | 52 | 249 | 2387 |
| 1996 | 107 | 86 | 28 | 526 | 543 | 4.2 | 96 | 5.5 | 187 | 27 | 61 | 411 | 50 | 52 | 256 | 2440 |
| 1997 | 106 | 86 | 29 | 521 | 538 | 4.2 | 98 | 5.5 | 179 | 26 | 60 | 416 | 51 | 50 | 261 | 2432 |
| 1998 | 106 | 86 | 29 | 523 | 545 | 4.3 | 102 | 5.5 | 166 | 27 | 59 | 432 | 51 | 50 | 262 | 2446 |
| 1999 | 106 | 81 | 31 | 522 | 545 | 4.4 | 100 | 5.6 | 165 | 27 | 61 | 441 | 50 | 49 | 258 | 2445 |
| 2000 | 77 | 80 | 29 | 546 | 516 | 3.8 | 99 | 5.0 | 143 | 24 | 63 | 431 | 49 | 50 | 250 | 2365 |
| 2001 | 75 | 78 | 29 | 541 | 520 | 3.8 | 99 | 4.9 | 138 | 24 | 60 | 428 | 49 | 50 | 243 | 2343 |
| 2002 | 73 | 77 | 30 | 529 | 510 | 3.7 | 99 | 4.8 | 132 | 24 | 59 | 420 | 49 | 49 | 241 | 2298 |
| 2003 | 70 | 76 | 30 | 522 | 507 | 3.7 | 99 | 4.6 | 129 | 25 | 54 | 428 | 49 | 48 | 235 | 2280 |
| 2004 | 66 | 77 | 31 | 515 | 495 | 3.6 | 97 | 4.7 | 128 | 25 | 54 | 424 | 49 | 48 | 235 | 2251 |
| 2005 | 64 | 74 | 31 | 511 | 500 | 3.7 | 99 | 4.6 | 126 | 25 | 53 | 398 | 48 | 49 | 230 | 2216 |
| 2006 | 64 | 71 | 30 | 503 | 496 | 3.8 | 100 | 4.5 | 128 | 25 | 52 | 394 | 47 | 49 | 226 | 2194 |
| 2007 | 62 | 70 | 30 | 509 | 503 | 3.9 | 94 | 4.6 | 125 | 25 | 53 | 400 | 47 | 50 | 223 | 2199 |
| 2008 | 60 | 69 | 29 | 513 | 506 | 3.9 | 96 | 4.6 | 115 | 25 | 51 | 365 | 47 | 50 | 210 | 2145 |
| 2009 | 60 | 66 | 30 | 505 | 508 | 3.9 | 96 | 4.5 | 113 | 25 | 49 | 363 | 45 | 49 | 212 | 2129 |
| 2010 | 60 | 66 | 30 | 509 | 510 | 3.8 | 95 | 4.6 | 110 | 25 | 49 | 359 | 45 | 49 | 215 | 2130 |
| 2011 | 59 | 64 | 29 | 500 | 515 | 3.8 | 91 | 4.5 | 109 | 25 | 49 | 349 | 45 | 48 | 213 | 2103 |
| 2012 | 59 | 63 | 29 | 501 | 519 | 3.7 | 96 | 4.4 | 104 | 25 | 47 | 345 | 44 | 47 | 213 | 2099 |
| 2013 | 59 | 61 | 28 | 498 | 525 | 3.6 | 97 | 4.3 | 103 | 25 | 46 | 347 | 45 | 46 | 210 | 2099 |
| 2014 | 57 | 60 | 29 | 502 | 531 | 3.9 | 94 | 4.5 | 106 | 25 | 48 | 365 | 45 | 47 | 220 | 2137 |
| 2015 | 58 | 62 | 28 | 508 | 528 | 3.9 | 98 | 4.5 | 108 | 25 | 49 | 373 | 45 | 46 | 223 | 2157 |
| 2016 | 58 | 62 | 27 | 508 | 526 | 4.0 | 103 | 4.5 | 107 | 25 | 49 | 377 | 44 | 46 | 226 | 2165 |
| 2017 | 56 | 64 | 27 | 504 | 514 | 3.9 | 106 | 4.7 | 109 | 24 | 49 | 392 | 44 | 46 | 227 | 2171 |
| 2018 | 56 | 63 | 26 | 499 | 495 | 3.8 | 111 | 4.6 | 106 | 25 | 49 | 391 | 44 | 45 | 226 | 2146 |
| 2019 | 55 | 62 | 26 | 488 | 483 | 3.7 | 103 | 4.6 | 101 | 24 | 49 | 388 | 44 | 44 | 224 | 2099 |

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

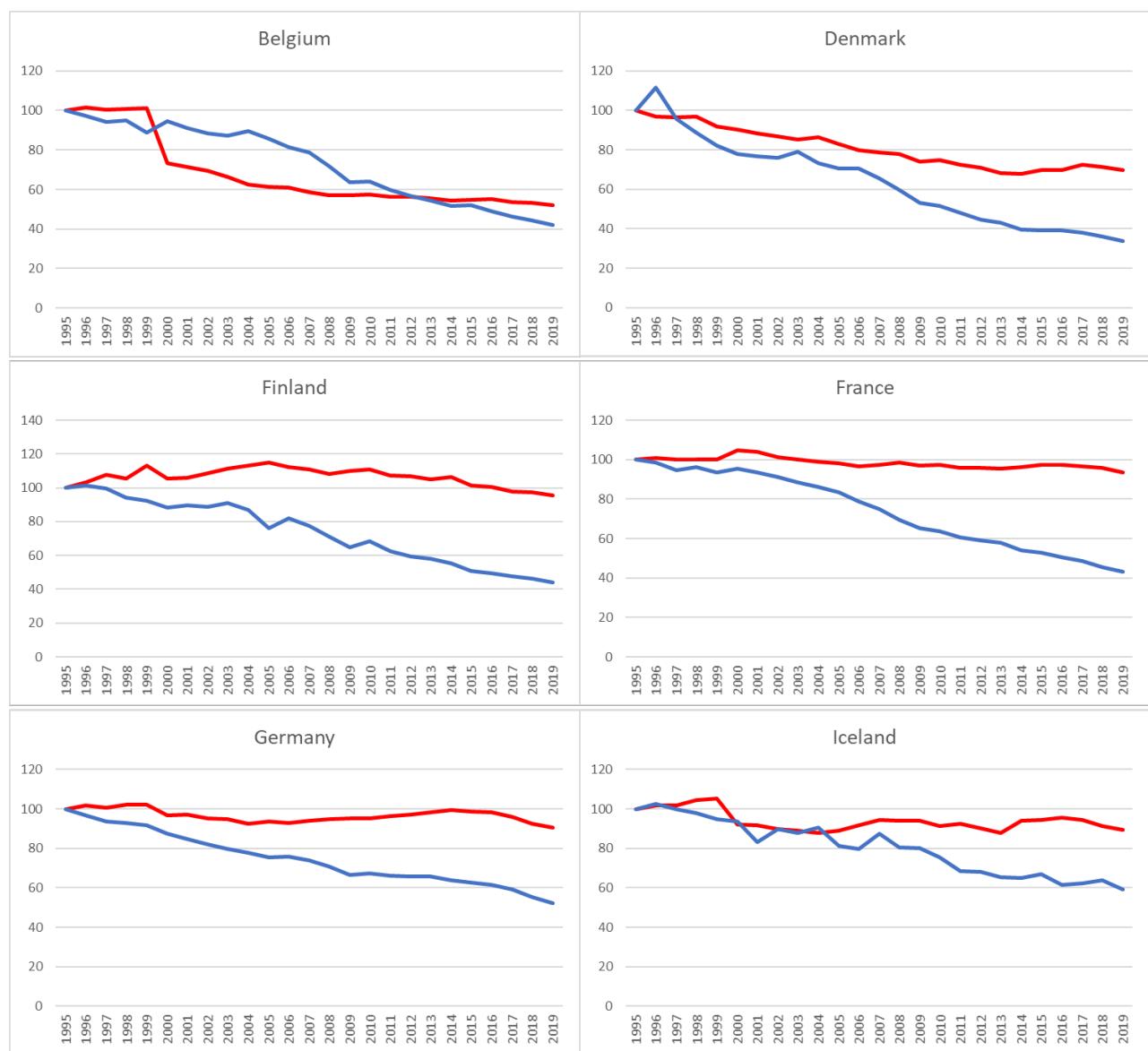
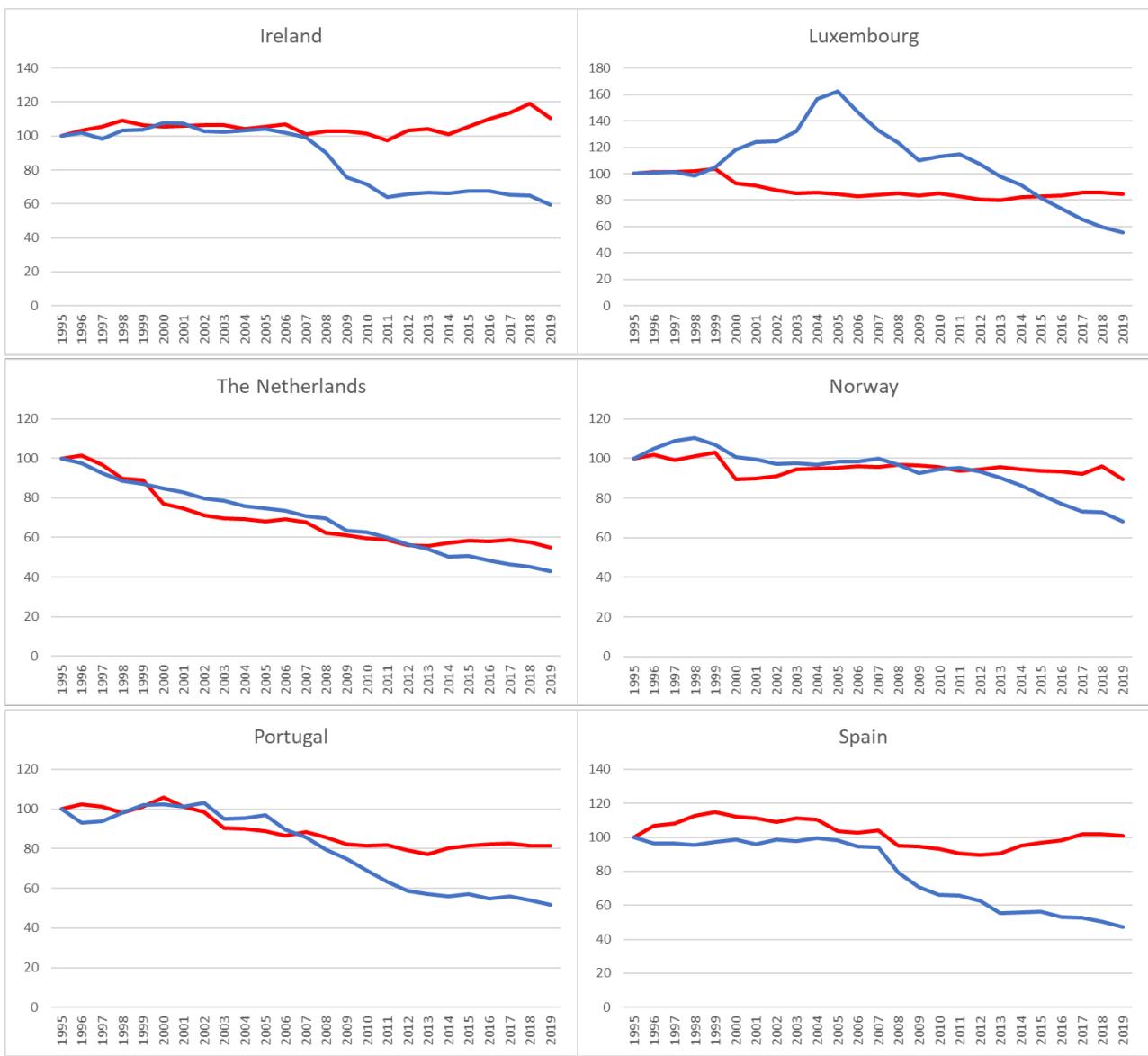


Figure 2: Change in emissions provided by the EMEP Centre CEIP for modelling, based on official data submissions by Contracting Parties. Blue: Oxidized nitrogen (NO_x); red: reduced nitrogen (NH₃); 1995=100%. It has to be noted that the 1990s are based on submissions in 2019, while all years from 2000 are based on submissions from 2021. Unit: %. (Figure continues on next page.)

**Figure 2: Continued.**

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

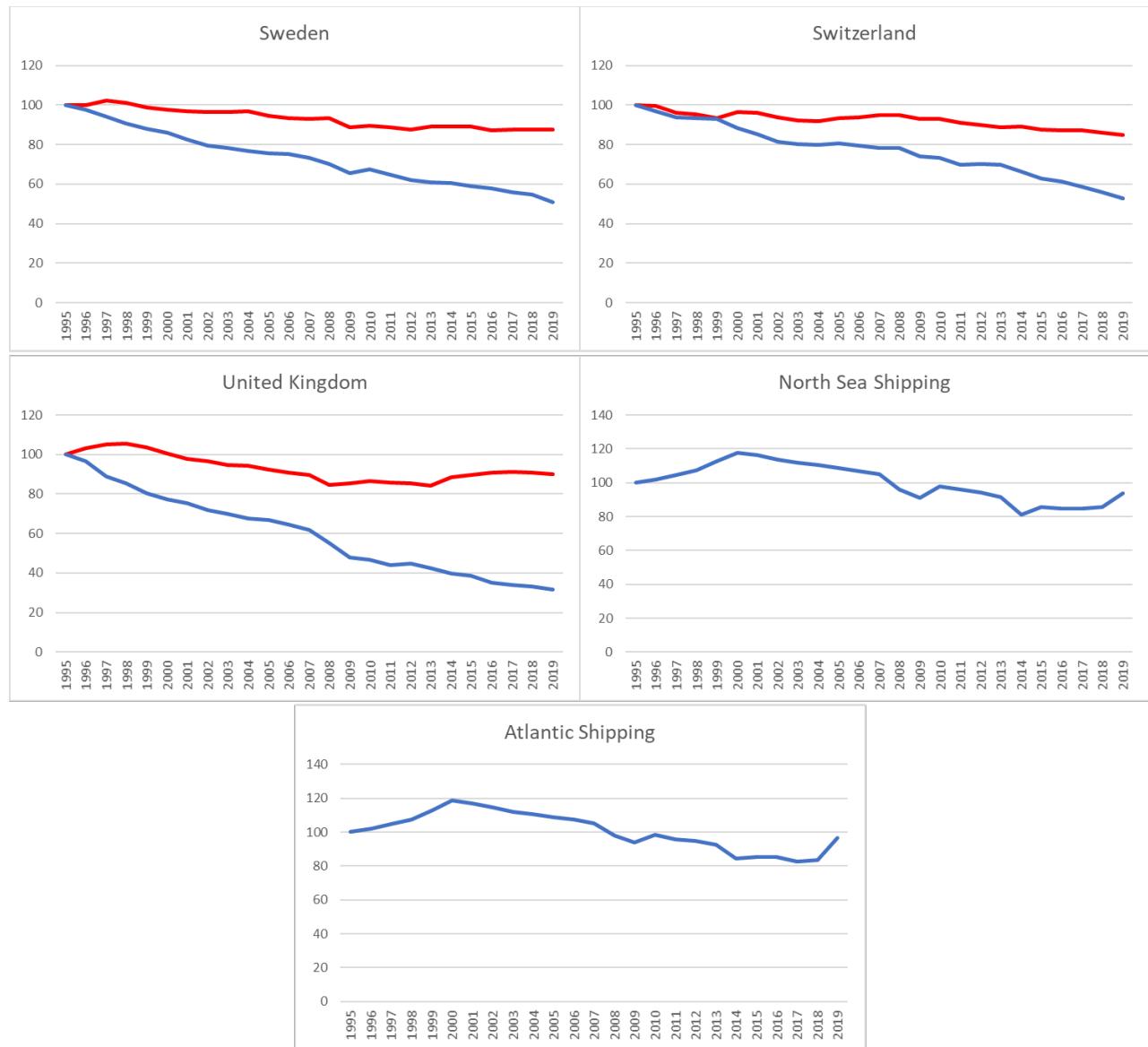


Figure 2: Continued.

Table 3. National annual emissions of total nitrogen from OSPAR Contracting Parties, international shipping (NOS: North Sea, and BAS: Baltic Sea), and from other sources within the EMEP MSC-W model domain in the period 1995 – 2019, as used in the EMEP MSC-W model calculations of nitrogen deposition. Units: ktonnes(N)/year. The table continues on the next page. The last column shows the total of all emissions.

| | BE | DK | FI | FR | DE | IS | IE | LU | NL |
|-------------|------------|------------|------------|-------------|-------------|-----------|------------|-----------|------------|
| 1995 | 221 | 177 | 110 | 1067 | 1199 | 15 | 145 | 16 | 354 |
| 1996 | 219 | 185 | 112 | 1063 | 1186 | 15 | 149 | 16 | 353 |
| 1997 | 215 | 170 | 112 | 1038 | 1161 | 15 | 149 | 16 | 336 |
| 1998 | 216 | 164 | 107 | 1048 | 1161 | 15 | 155 | 16 | 316 |
| 1999 | 209 | 154 | 108 | 1030 | 1153 | 14 | 153 | 17 | 313 |
| 2000 | 187 | 149 | 102 | 1066 | 1096 | 14 | 154 | 18 | 286 |
| 2001 | 181 | 146 | 103 | 1050 | 1082 | 13 | 154 | 18 | 278 |
| 2002 | 175 | 144 | 103 | 1025 | 1053 | 13 | 152 | 18 | 267 |
| 2003 | 171 | 146 | 106 | 1004 | 1037 | 13 | 152 | 19 | 262 |
| 2004 | 170 | 142 | 103 | 985 | 1010 | 13 | 150 | 21 | 256 |
| 2005 | 164 | 136 | 95 | 967 | 1000 | 12 | 152 | 22 | 252 |
| 2006 | 158 | 133 | 99 | 932 | 999 | 12 | 152 | 20 | 252 |
| 2007 | 153 | 128 | 94 | 918 | 992 | 13 | 146 | 19 | 245 |
| 2008 | 143 | 122 | 88 | 892 | 976 | 12 | 143 | 18 | 233 |
| 2009 | 134 | 113 | 84 | 860 | 951 | 12 | 135 | 16 | 220 |
| 2010 | 135 | 112 | 87 | 857 | 957 | 12 | 132 | 17 | 217 |
| 2011 | 128 | 107 | 81 | 831 | 954 | 11 | 124 | 17 | 210 |
| 2012 | 125 | 102 | 78 | 823 | 956 | 11 | 130 | 16 | 199 |
| 2013 | 122 | 99 | 77 | 815 | 962 | 11 | 132 | 15 | 195 |
| 2014 | 117 | 95 | 75 | 797 | 954 | 11 | 128 | 14 | 191 |
| 2015 | 118 | 97 | 70 | 796 | 943 | 11 | 133 | 13 | 194 |
| 2016 | 115 | 97 | 68 | 782 | 934 | 10 | 138 | 12 | 189 |
| 2017 | 110 | 98 | 66 | 770 | 907 | 11 | 140 | 12 | 188 |
| 2018 | 108 | 95 | 65 | 747 | 864 | 11 | 145 | 11 | 183 |
| 2019 | 104 | 92 | 62 | 724 | 829 | 10 | 134 | 11 | 174 |

Table 3. Continued from previous page.

| Year | NO | PT | ES | SE | CH | GB | NOS | ATL | Total |
|-------------|-----------|-----------|-----------|-----------|-----------|-----------|------------|------------|--------------|
| 1995 | 94 | 147 | 802 | 127 | 88 | 1057 | 239 | 302 | 6157 |
| 1996 | 97 | 142 | 813 | 125 | 86 | 1036 | 244 | 308 | 6149 |
| 1997 | 99 | 142 | 819 | 123 | 83 | 979 | 250 | 315 | 6022 |
| 1998 | 101 | 144 | 831 | 120 | 83 | 952 | 257 | 324 | 6010 |
| 1999 | 99 | 149 | 849 | 117 | 82 | 908 | 269 | 340 | 5964 |
| 2000 | 91 | 152 | 842 | 115 | 81 | 873 | 283 | 355 | 5865 |
| 2001 | 91 | 149 | 829 | 112 | 80 | 853 | 279 | 350 | 5768 |
| 2002 | 89 | 149 | 831 | 109 | 78 | 820 | 273 | 343 | 5643 |
| 2003 | 90 | 136 | 837 | 108 | 77 | 801 | 268 | 337 | 5564 |
| 2004 | 90 | 137 | 841 | 107 | 76 | 782 | 264 | 334 | 5482 |
| 2005 | 91 | 137 | 807 | 105 | 77 | 771 | 260 | 327 | 5377 |
| 2006 | 91 | 130 | 790 | 104 | 77 | 746 | 256 | 322 | 5276 |
| 2007 | 92 | 127 | 793 | 103 | 77 | 721 | 251 | 317 | 5190 |
| 2008 | 91 | 120 | 696 | 101 | 77 | 657 | 234 | 290 | 4894 |
| 2009 | 88 | 114 | 658 | 94 | 75 | 600 | 224 | 275 | 4653 |
| 2010 | 89 | 109 | 636 | 96 | 74 | 594 | 235 | 296 | 4654 |
| 2011 | 89 | 104 | 623 | 94 | 72 | 568 | 229 | 290 | 4532 |
| 2012 | 88 | 98 | 607 | 91 | 72 | 575 | 227 | 285 | 4484 |
| 2013 | 86 | 96 | 579 | 91 | 71 | 554 | 221 | 276 | 4399 |
| 2014 | 83 | 97 | 599 | 91 | 70 | 541 | 202 | 244 | 4311 |
| 2015 | 80 | 99 | 608 | 90 | 68 | 535 | 204 | 259 | 4316 |
| 2016 | 76 | 97 | 598 | 88 | 67 | 511 | 204 | 255 | 4242 |
| 2017 | 73 | 98 | 612 | 87 | 66 | 502 | 198 | 255 | 4192 |
| 2018 | 74 | 96 | 601 | 86 | 65 | 492 | 199 | 258 | 4098 |
| 2019 | 69 | 94 | 585 | 83 | 63 | 481 | 231 | 283 | 4027 |

The contract with OSPAR also asked for emissions *by sector*. All data are summarized separately for oxidized and reduced nitrogen in two Excel sheets, submitted along with this report (see Chapter 8).

EMEP emissions reporting is based on the GNFR system (**G**ridded **N**omenclature **F**or **R**eporting), which has been in use in EMEP since 2017 and has many advantages over the older SNAP system, in particular a larger level of detail. Documentation on how GNFR (and the underlying NFR sector emissions) are grouped is given in the Reporting Guidelines of CEIP (CEIP, 2019), and in particular their Annex 1.

The Excel files submitted with this report to OSPAR contain data for all GNFR sectors, while Figures 3 and 4 visualize percentage shares only for the following 5 aggregated sectors:

- Transport (aviation landing/take-off, road traffic and offroad traffic, inland shipping)
- Power (including mainly combustion, but also other processes)
- OtherComb (stationary combustion other than power generation)
- Agriculture
- All other sources (this also includes some combustion from industry)

Table 4 shows how GNFR sectors were aggregated into these 5 sectors for the sake of visualization in Figures 3 and 4. There are clear differences between countries, but Transport is the single-most important sector in all countries for oxidized nitrogen emissions, while Agriculture is the dominant sector in all countries for reduced nitrogen emissions.

Table 4. Aggregation of GNFR sectors to ‘HELCOM sectors’, also used for the figures produced for OSPAR below.

| GNFR sectors | Simplified sectors used in this chapter |
|--------------------------------------|---|
| GNFR_A : Public Power | → Power |
| GNFR_C : Other Stationary Combustion | → OtherComb |
| GNFR_F : Road Transport | |
| GNFR_G : Shipping | |
| GNFR_H : Aviation | |
| GNFR_I : Offroad | |
| GNFR_K : Agriculture Livestock | → Agriculture |
| GNFR_L : Agriculture Other | |
| GNFR_B : Industry | |
| GNFR_D : Fugitive | |
| GNFR_E : Solvents | |
| GNFR_J : Waste | |
| GNFR_M : Other | → Other |

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

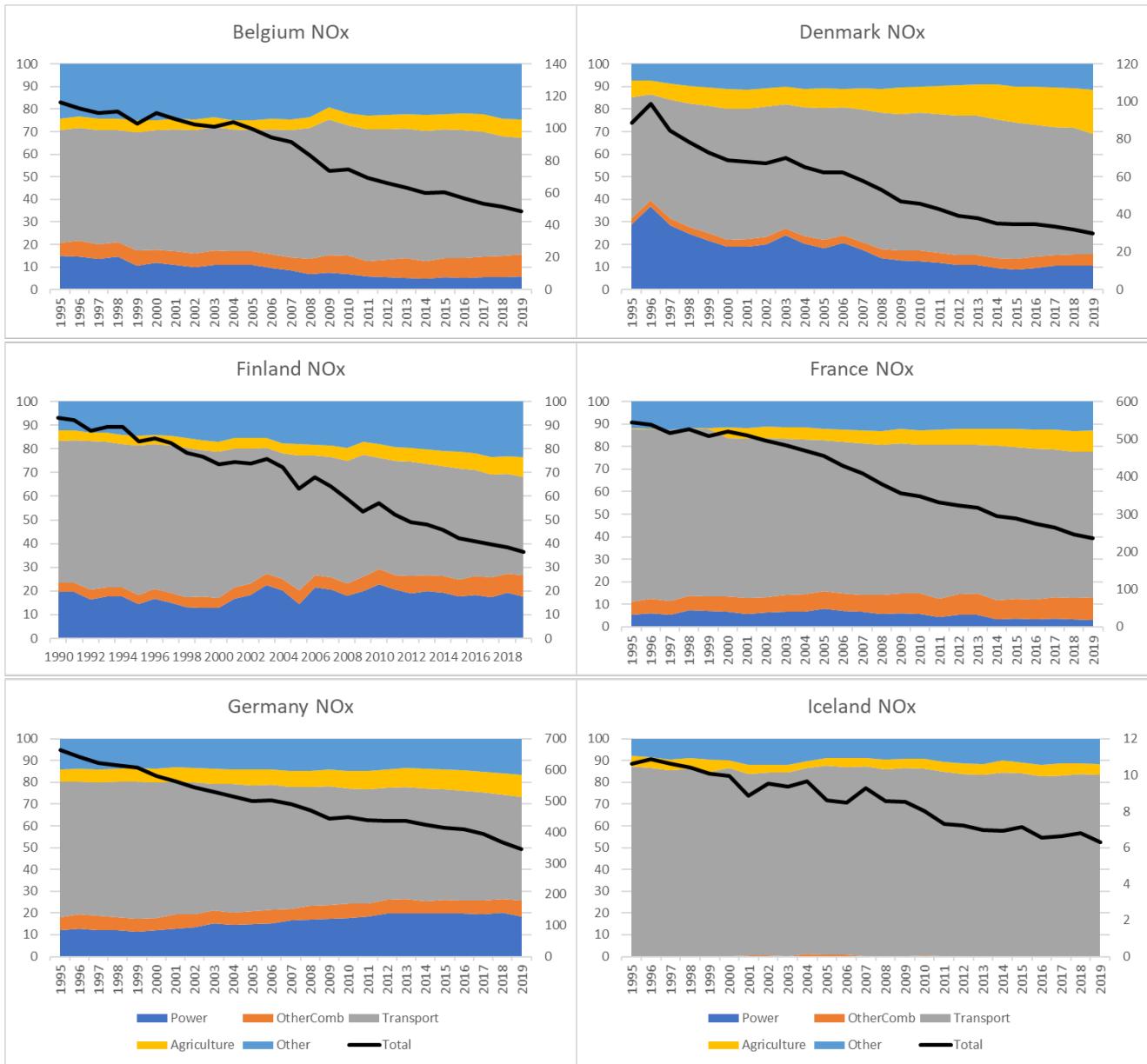
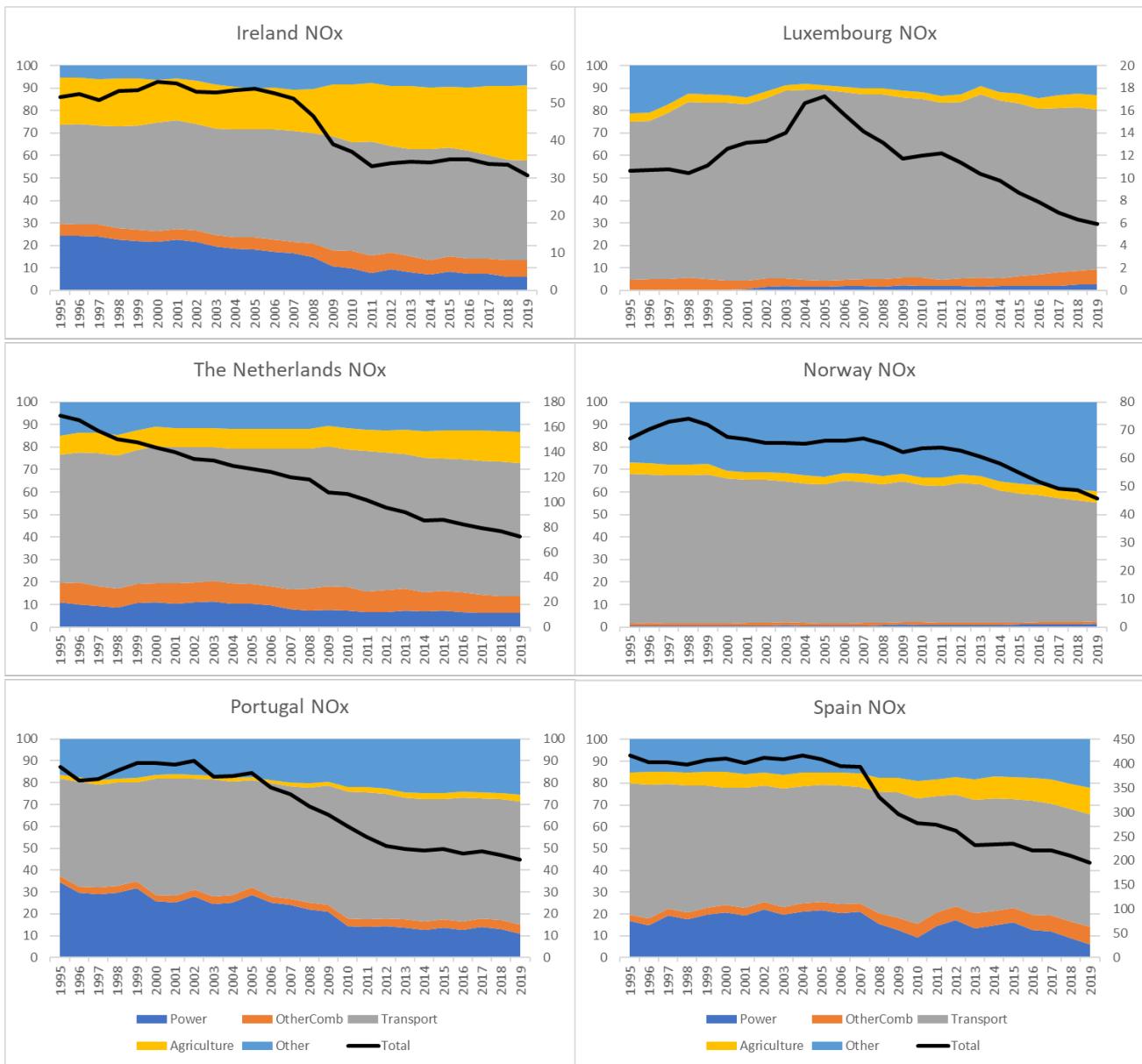


Figure 3: Percentage contributions from different sectors to annual emissions of oxidized nitrogen (NOx) in the OSPAR Contracting Parties from 1995 to 2019 (left axis, unit: %). Power (dark blue), Other stationary combustion (orange), Transport (grey), Agriculture (yellow), and 'Other' (light blue) are sums of several GNFR sectors, as described in Table 4. Transport makes the largest contribution to emissions of oxidized nitrogen in all OSPAR Contracting Parties. NOS (North Sea shipping) and ATL (shipping in parts of the Atlantic Ocean included in the EMEP MSC-W model domain, but not in NOS) are pure transport sources so that those two panels are grey (they are included here only for completeness). The black line in each plot shows total annual emissions of NOx (right axis, unit: ktonnes(N)/year). The figure continues on the next two pages.

**Figure 3: Continued.**

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

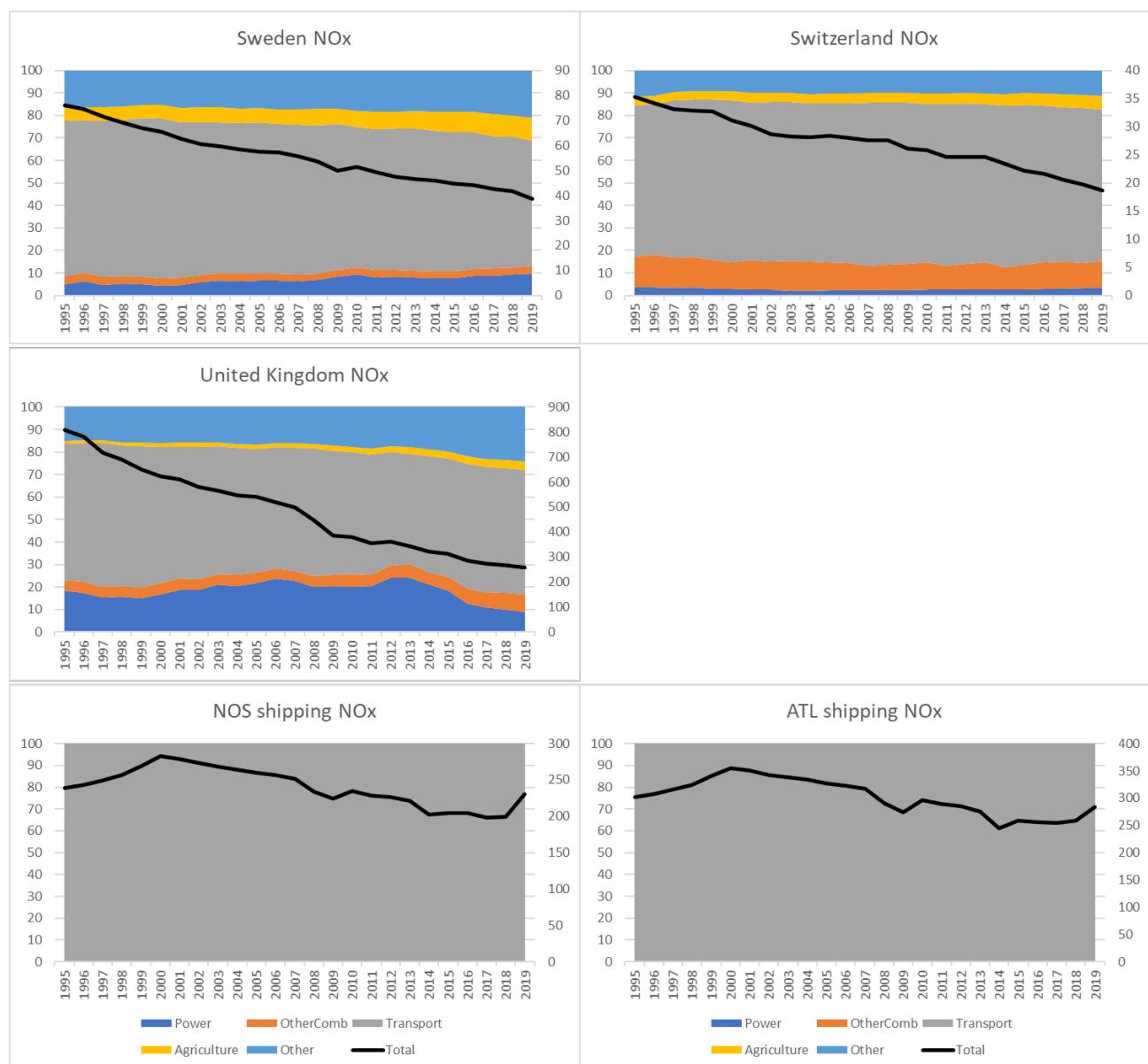


Figure 3: Continued.



Figure 4: Percentage contributions from different sectors to annual emissions of reduced nitrogen (NH₃) in the OSPAR Contracting Parties from 1995 to 2019 (left axis, unit: %). Power (dark blue), Other stationary combustion (orange), Transport (grey), Agriculture (yellow), and 'Other' (light blue) are sums of several GNFR sectors, as described in Table 4. As obvious from the figure, agriculture largely dominates the emissions of reduced nitrogen in all OSPAR Contracting Parties. The black line in each plot shows total annual emissions of NH₃ (right axis, unit: ktonnes(N)/year). The figure continues on the next two pages.

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

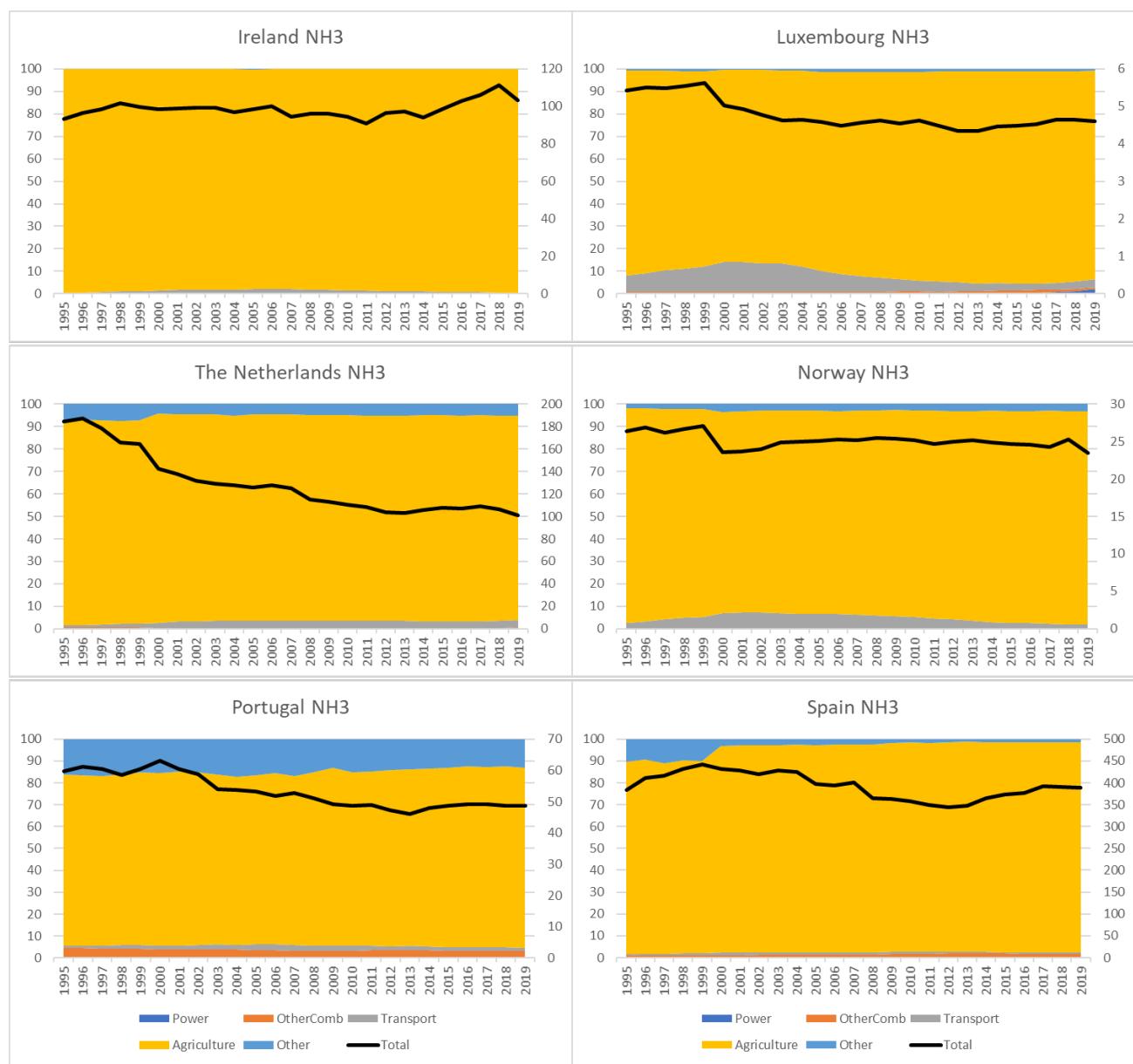
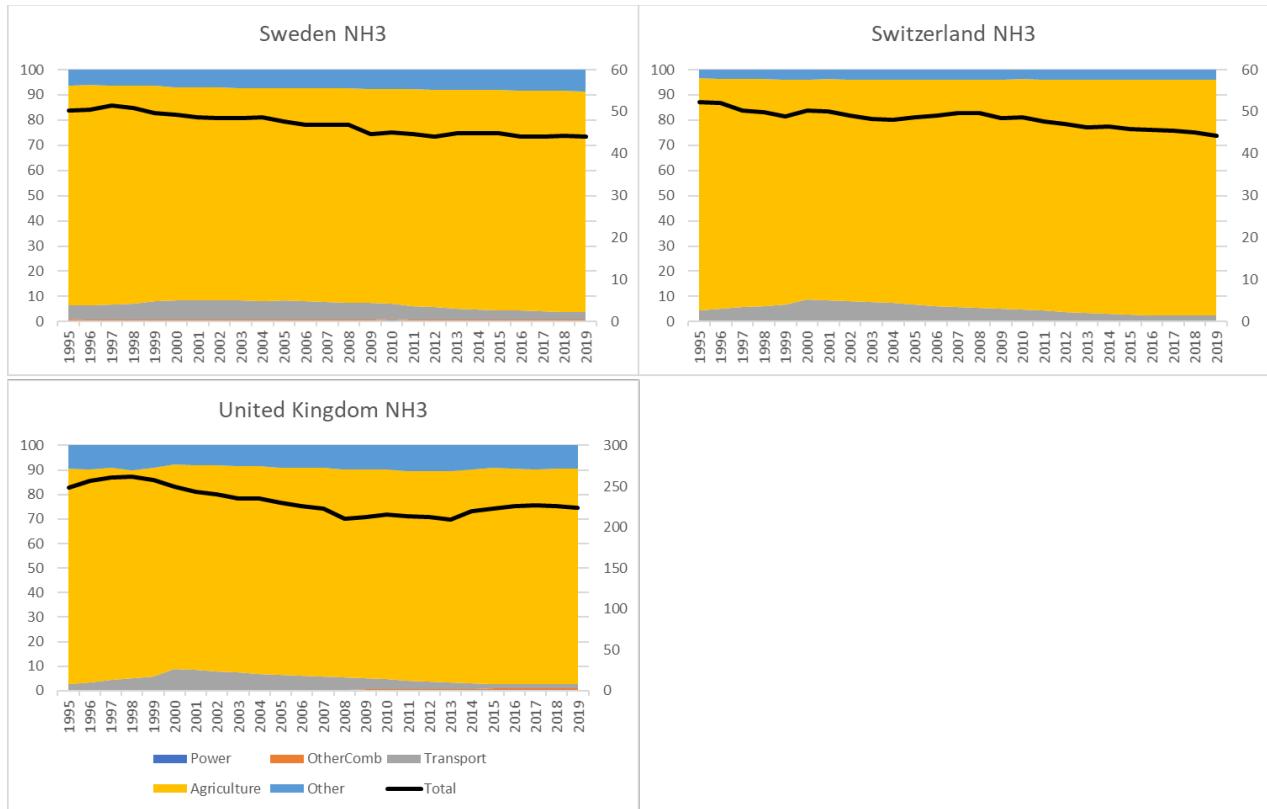


Figure 4: Continued.

**Figure 4: Continued.**

4 OSPAR receptor areas

In this chapter we describe the receptor areas considered in the model calculations done by EMEP MSC-W for OSPAR. The term ‘receptor areas’ in this context means the regions for which nitrogen depositions are diagnosed, and contributions to which are calculated by the EMEP MSC-W model. Until last year, only the five OSPAR Regions and the 24 Exclusive Economic Zones (EEZs) in the OSPAR Maritime Area were considered. This year, for the first time, we calculate nitrogen depositions also for ‘partial EEZs’ (pieces of EEZs belonging to different OSPAR Regions) and for the COMP4 Assessment Units.

4.1 OSPAR Regions

All OSPAR Regions cover a certain number of grid cells in the EMEP grid system, either in full or in part. We have calculated this percentage for each EMEP grid square covered by each OSPAR Region. The results are illustrated in Figure 5 for the $0.1^\circ\text{lon} \times 0.1^\circ\text{lat}$ grid.

Table 5 lists the OSPAR Regions and their areas within the EMEP model domain, calculated on the $0.1^\circ\text{lon} \times 0.1^\circ\text{lat}$ grid.

Table 5. The five OSPAR Regions as implemented in the EMEP MSC-W analysis in the $0.1^\circ\text{lon} \times 0.1^\circ\text{lat}$ grid. OSPAR Regions I and V are not fully covered by the EMEP model grid (actual areas as the shape files from OSPAR are shown in parentheses).

| Region | Area covered by the EMEP model domain |
|------------------|--|
| OSPAR Region I | 4 338 950 km ² (of 5.53 million km ²) |
| OSPAR Region II | 761 897 km ² (fully covered) |
| OSPAR Region III | 391 622 km ² (fully covered) |
| OSPAR Region IV | 541 863 km ² (fully covered) |
| OSPAR Region V | 4 084 360 km ² (of 6.35 million km ²) |

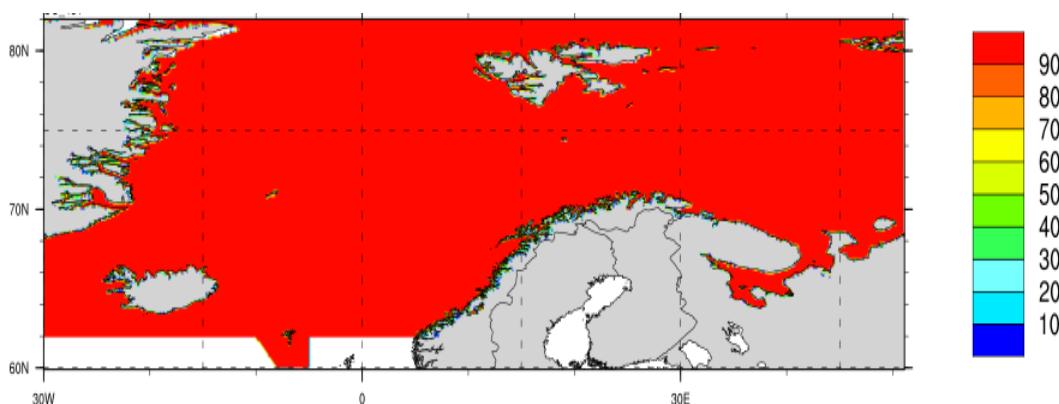


Figure 5a: Visualization of OSPAR Region I in the EMEP grid. The plot shows how large a percentage of each EMEP model grid cell lies within OSPAR Region I. EMEP model grid cells cover only $0.1^\circ\text{lon} \times 0.1^\circ\text{lat}$ pixels, and thus appear very small in this plot. Red colour means that the model grid cell is fully within OSPAR Region I. Other colours mean that the grid cell is only partly within OSPAR Region I. OSPAR Region I is not fully covered by the EMEP model domain - it is cut at 30°W , which is the western boundary of the EMEP model domain (and this plot) and at 82°N , which is the northern boundary of the EMEP model domain (and this plot).

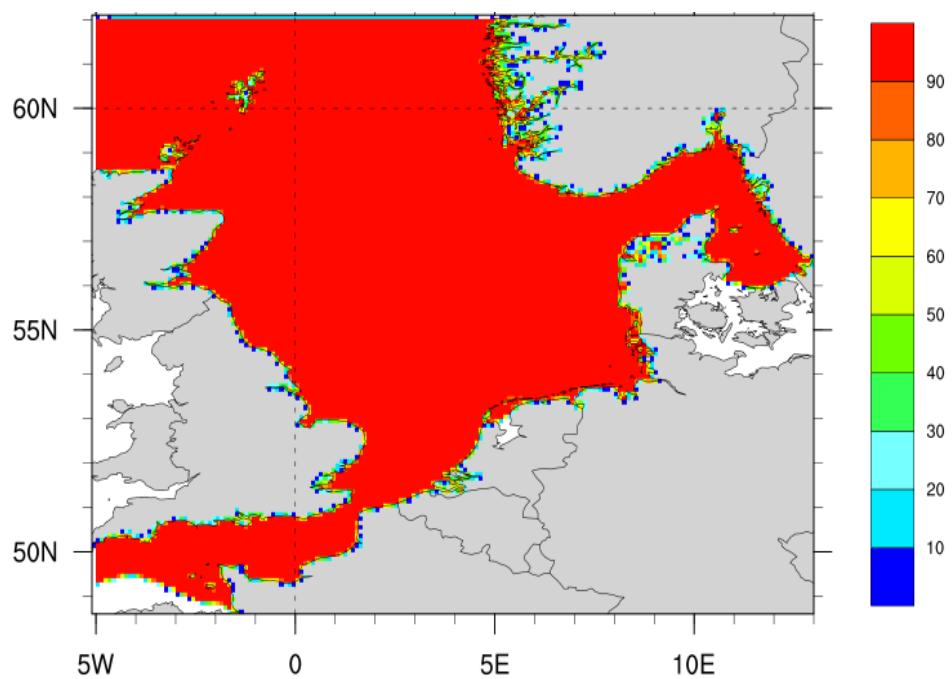


Figure 5b: As Figure 5a, but for OSPAR Region II.

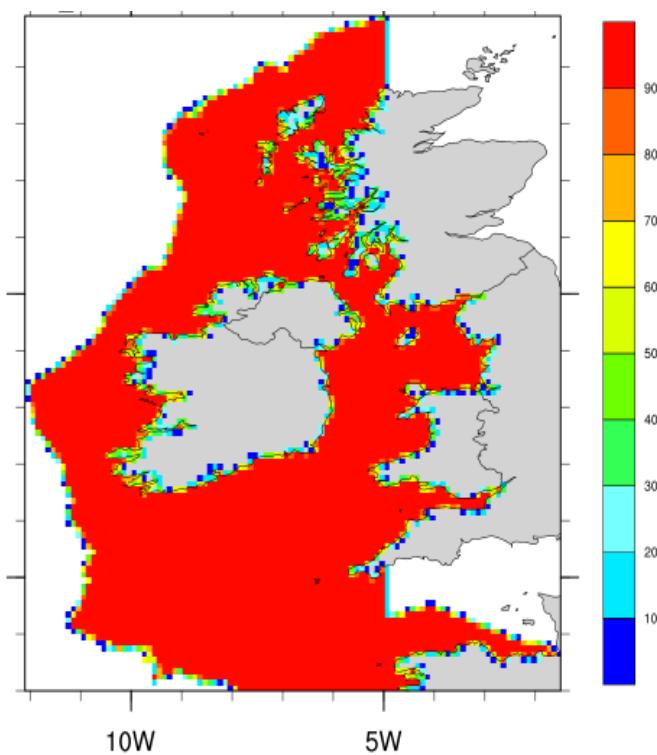


Figure 5c: As Figure 5b, but for OSPAR Region III.

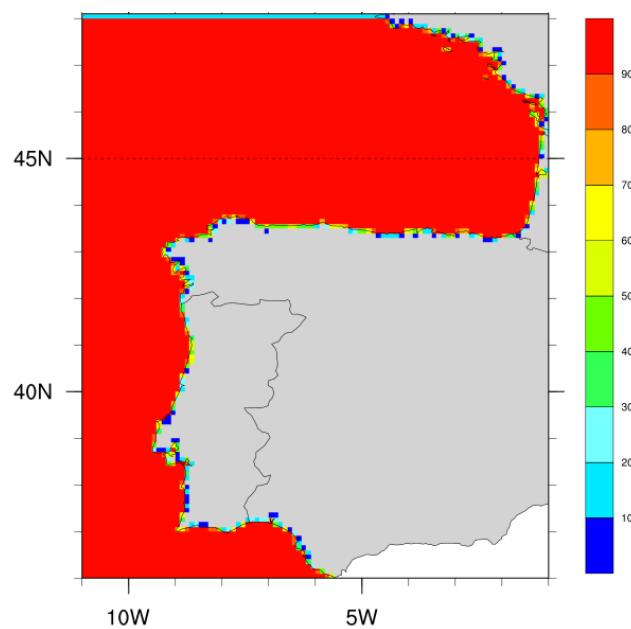


Figure 5d: As Figure 5a, but for OSPAR Region IV.

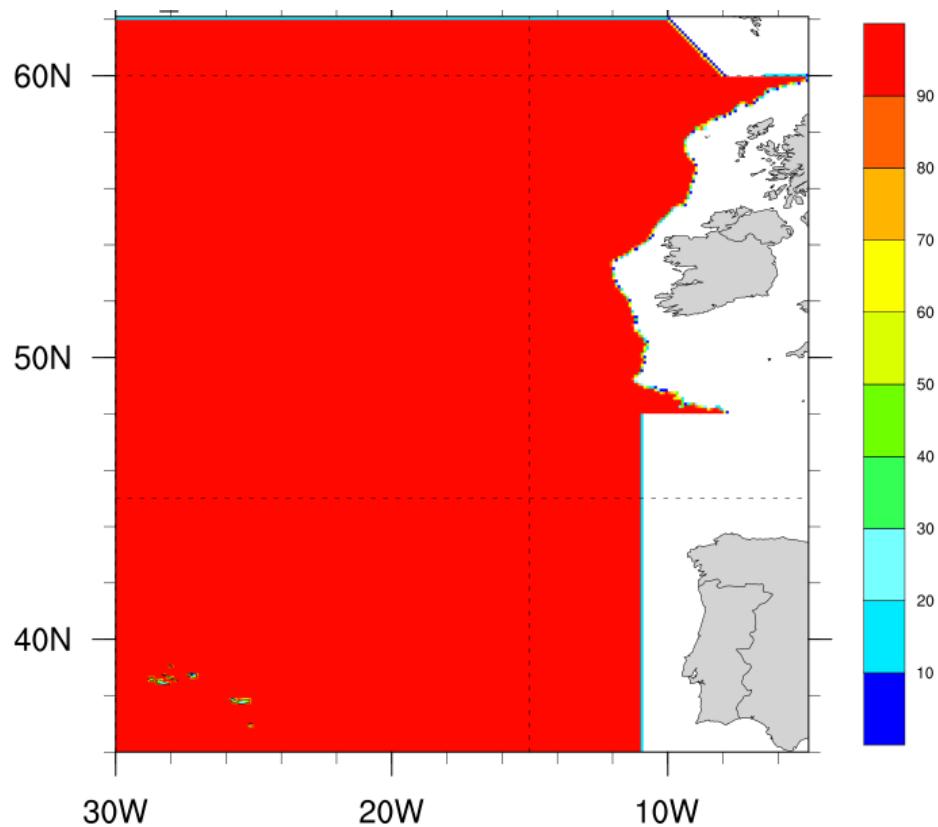


Figure 5e: As Figure 5a, but for OSPAR Region V.

4.2 Exclusive Economic Zones

National EEZs of OSPAR Contracting Parties were implemented in the EMEP $0.1^\circ \times 0.1^\circ$ grid system in 2019 according to the specification suggested by OSPAR (www.marineregions.org). In some cases (e.g. Sweden) only those parts of EEZs that belong to the OSPAR Maritime Area were implemented in the EMEP grid. Table 6 lists the regions and their areas within the EMEP model domain, calculated on the $0.1^\circ \text{lon} \times 0.1^\circ \text{lat}$ grid. The percentages of EMEP grids covered by each EEZ are shown in Figure 6.

Table 6. The twenty-four Exclusive Economic Zones implemented in the EMEP MSC-W analysis in the $0.1^\circ \text{lon} \times 0.1^\circ \text{lat}$ grid. Areas listed here include only the parts that are located within the OSPAR Convention area (i.e. within OSPAR regions). For example, those parts of the French and Spanish EEZs, which are located in the Mediterranean Sea are not included in this analysis. However, hyperlinks to marineregions.org are given in the table (last accessed 13 Dec 2021), showing the entire EEZs' definitions.

| Number EEZ | Name | Area in the EMEP MSC-W model domain (km ²) |
|---------------|---|--|
| EEZ 48 | Portuguese Exclusive Economic Zone (Azores) | 489 112 |
| EEZ 65 | Faeroe Exclusive Economic Zone | 264 129 |
| EEZ 71 | Icelandic Exclusive Economic Zone | 754 957 |
| EEZ 91 | Portuguese Exclusive Economic Zone | 270 655 |
| EEZ 99 | Joint regime area Spain / France | 3 018 |
| EEZ 100 | Joint regime area UK / Denmark (Faeroe Islands) | 8 330 |
| EEZ 108 | Irish Exclusive Economic Zone | 429 347 |
| EEZ 109 | Guernsey Exclusive Economic Zone | 6 755 |
| EEZ 110 | Jersey Exclusive Economic Zone | 2 403 |
| EEZ 119 | Joint regime area Iceland / Denmark (Faeroe) | 1 419 |
| EEZ 123 | Joint regime area Iceland / Norway (Jan Mayen) | 45 270 |
| EEZ 185 | Swedish Exclusive Economic Zone | 14 610 |
| EEZ 187 | Joint regime area Sweden / Norway | 172 |
| EEZ 188 | Belgian Exclusive Economic Zone | 3 628 |
| EEZ 189 | Dutch Exclusive Economic Zone | 63 267 |
| EEZ 190 | German Exclusive Economic Zone | 41 757 |
| EEZ 191 | Danish Exclusive Economic Zone | 76 440 |
| EEZ 209 | French Exclusive Economic Zone | 259 201 |
| EEZ 212 | Greenlandic Exclusive Economic Zone | 642 488 |
| EEZ 213 | United Kingdom Exclusive Economic Zone | 739 926 |
| EEZ 215 | Svalbard Exclusive Economic Zone | 704 339 |
| EEZ 216 | Norwegian Exclusive Economic Zone | 945 160 |
| EEZ 224 | Jan Mayen Exclusive Economic Zone | 290 509 |
| EEZ 273 | Spanish Exclusive Economic Zone | 301 088 |

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

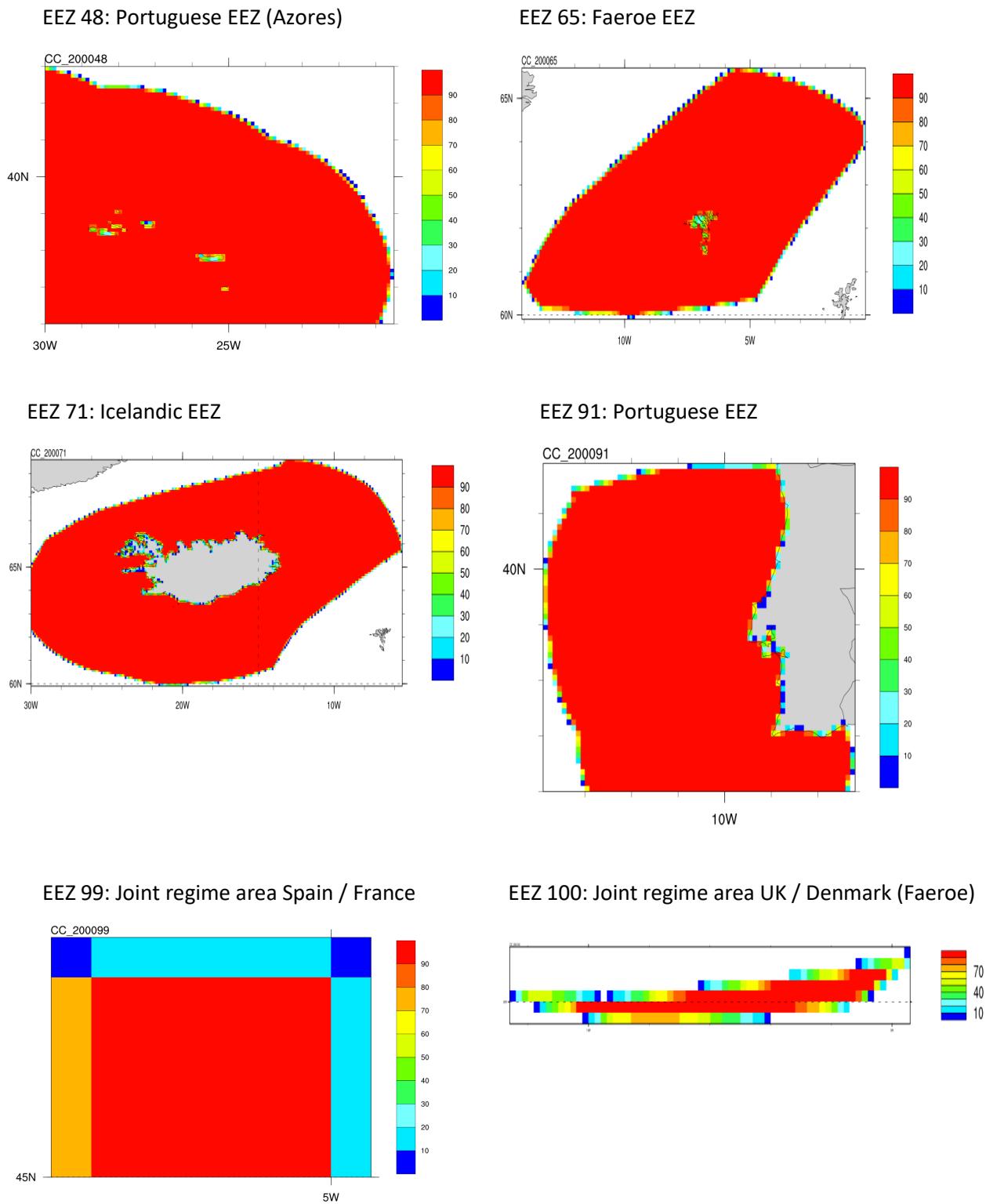
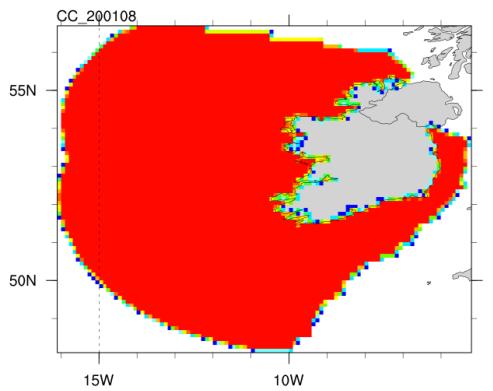
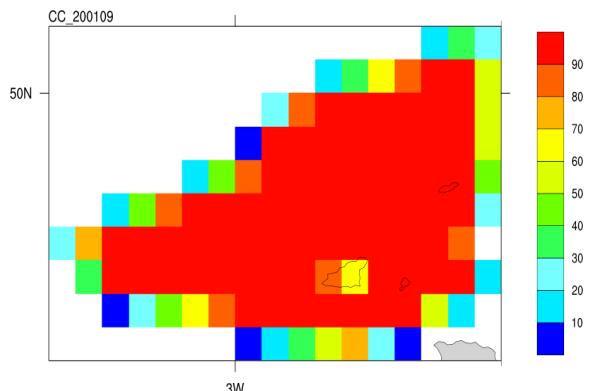


Figure 6: Visualization of EEZs in the EMEP grid. The plots show how large a percentage of each EMEP model grid cell lies within the respective EEZ. EMEP model grid cells cover $0.1^\circ\text{lon} \times 0.1^\circ\text{lat}$ pixels and thus appear very small in some of the plots. Red colour means that the model grid cell is fully within the EEZ. Other colours mean that the grid cell is only partly within the EEZ. Some EEZs are not fully covered by the EMEP model domain, e.g. EEZ 48 (PT/Azores) is cut at 30°W , which is the western boundary of the EMEP model domain. Parts of EEZs outside the OSPAR regions are not included in the plots (and the analysis). The figure continues on the next 3 pages.

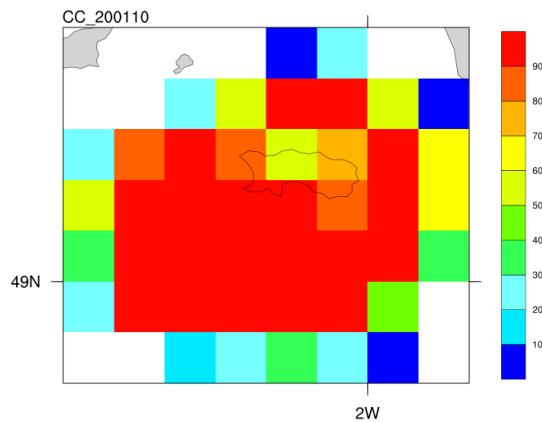
EEZ 108: Irish EEZ



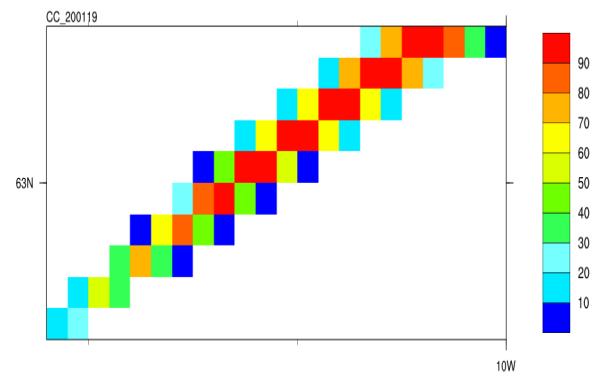
EEZ 109: Guernsey EEZ



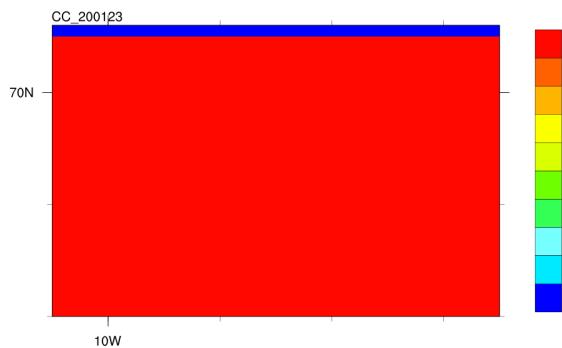
EEZ 110: Jersey EEZ



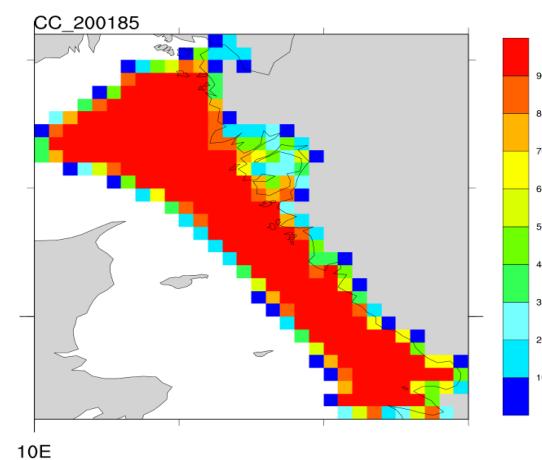
EEZ 119: Joint regime area Iceland / Denmark (Faeroe Islands)



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



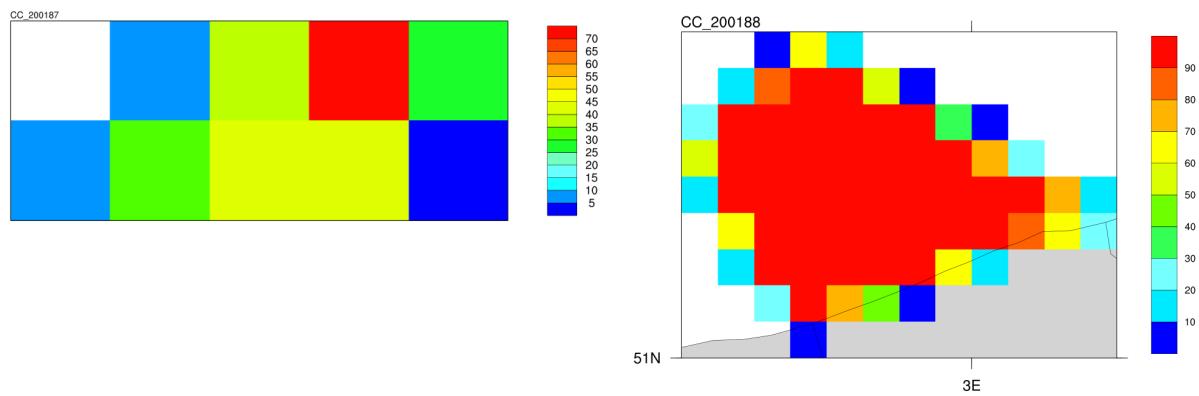
EEZ 185: Swedish EEZ

**Figure 6:** Continued.

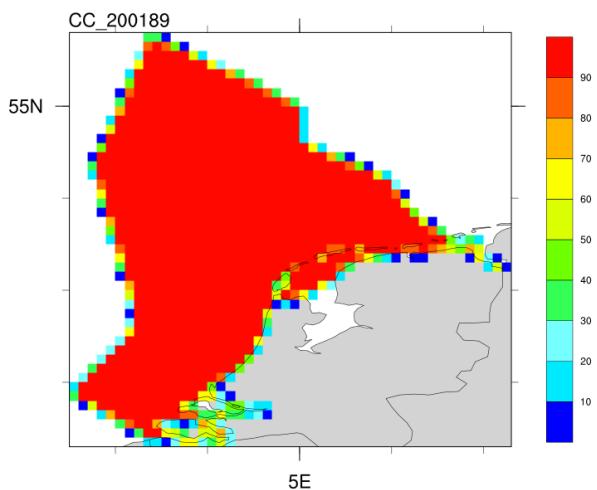
EEZ 187: Joint regime area Sweden / Norway

EEZ 188: Belgian EEZ

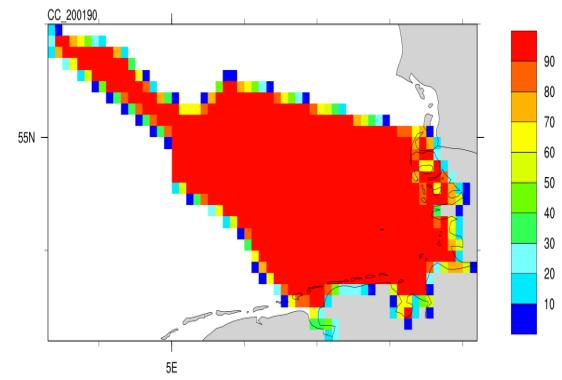
Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019



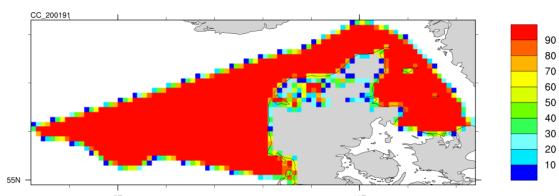
EEZ 189: Dutch EEZ



EEZ 190: German EEZ



EEZ 191: Danish EEZ



EEZ 209: French EEZ

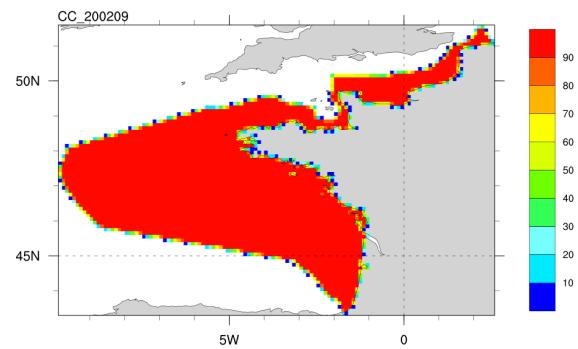
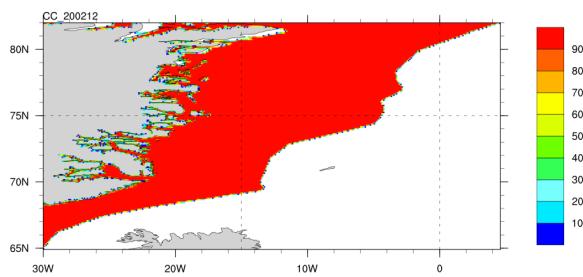
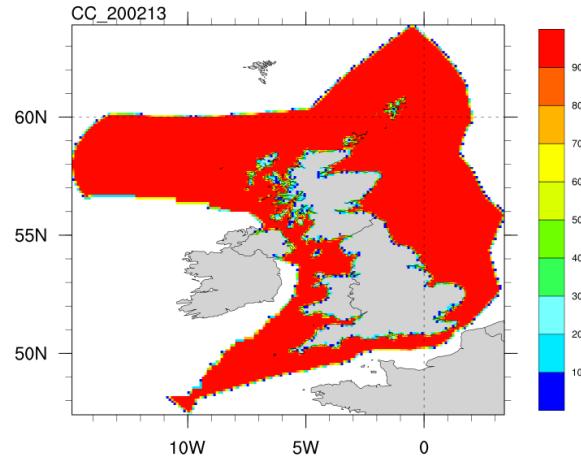


Figure 6: Continued.

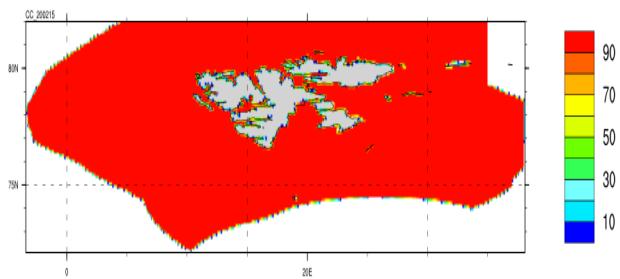
EEZ 212: Greenlandic EEZ



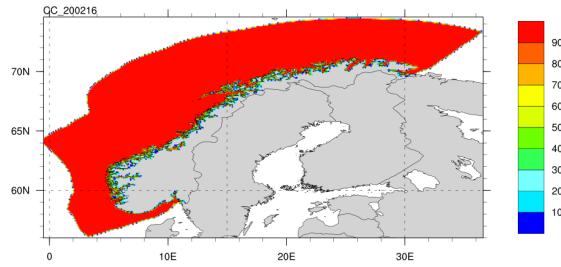
EEZ 213: United Kingdom EEZ



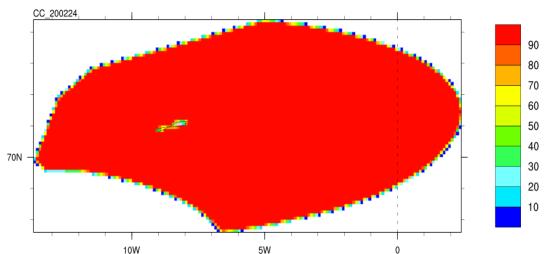
EEZ 215: Svalbard EEZ



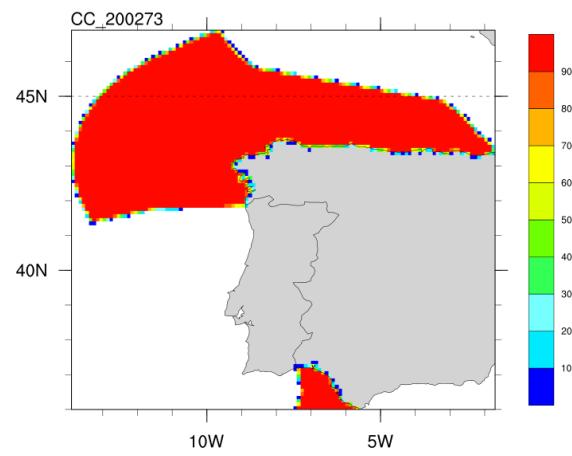
EEZ 216: Norwegian EEZ



EEZ 224: Jan Mayen EEZ



EEZ 273: Spanish EEZ

**Figure 6:** Continued.

4.3 Partial EEZs

Nine of the EEZs described in the previous section fall within more than one OSPAR region. This year, OSPAR requested that calculations of nitrogen deposition be made separately for these “partial EEZs”. For example, the French EEZ covers parts of OSPAR regions II, III, IV and V, while the UK EEZ covers parts of all five OSPAR regions. The division into partial EEZs is visualized at the example of EEZ 65 (Faeroe Exclusive Economic Zone) in Figure 7. In total, 25 partial EEZs are considered (see Table 7).

Fifteen of the EEZs considered by EMEP MSC-W are entirely located in one OSPAR Region (e.g. the German EEZ in Region II), so that no additional receptor areas had to be defined in these cases. Thus, the total number of receptor areas for which nitrogen deposition is calculated has increased from 29 to 54.

Table 7. The twenty-five partial EEZs implemented in the EMEP MSC-W analysis in the 0.1°lon x 0.1°lat grid. Areas listed here include only the parts that are located within the OSPAR Convention area (i.e. within OSPAR regions).

| Number of EEZ | Name | Located in: | Area in the EMEP MSC-W model domain (km ²) |
|---------------|---|------------------|--|
| EEZ_I_065 | Faeroe Exclusive Economic Zone | OSPAR Region I | 201 099 |
| EEZ_II_065 | Faeroe Exclusive Economic Zone | OSPAR Region II | 10 530 |
| EEZ_V_065 | Faeroe Exclusive Economic Zone | OSPAR Region IV | 52 500 |
| EEZ_I_071 | Icelandic Exclusive Economic Zone | OSPAR Region I | 604 247 |
| EEZ_V_071 | Icelandic Exclusive Economic Zone | OSPAR Region V | 150 710 |
| EEZ_IV_091 | Portuguese Exclusive Economic Zone | OSPAR Region IV | 133 522 |
| EEZ_V_091 | Portuguese Exclusive Economic Zone | OSPAR Region V | 137 133 |
| EEZ_I_100 | Joint regime area United Kingdom / Denmark (Faeroe Islands) | OSPAR Region I | 3 789 |
| EEZ_II_100 | Joint regime area United Kingdom / Denmark (Faeroe Islands) | OSPAR Region II | 94 |
| EEZ_V_100 | Joint regime area United Kingdom / Denmark (Faeroe Islands) | OSPAR Region V | 4 447 |
| EEZ_III_108 | Irish Exclusive Economic Zone | OSPAR Region III | 149 441 |
| EEZ_V_108 | Irish Exclusive Economic Zone | OSPAR Region V | 279 906 |
| EEZ_II_209 | French Exclusive Economic Zone | OSPAR Region II | 26 554 |
| EEZ_III_209 | French Exclusive Economic Zone | OSPAR Region III | 41 792 |
| EEZ_IV_209 | French Exclusive Economic Zone | OSPAR Region IV | 188 091 |
| EEZ_V_209 | French Exclusive Economic Zone | OSPAR Region V | 2 765 |
| EEZ_I_213 | United Kingdom Exclusive Economic Zone | OSPAR Region I | 29 298 |
| EEZ_II_213 | United Kingdom Exclusive Economic Zone | OSPAR Region II | 356 027 |
| EEZ_III_213 | United Kingdom Exclusive Economic Zone | OSPAR Region III | 199 788 |
| EEZ_IV_213 | United Kingdom Exclusive Economic Zone | OSPAR Region IV | 2 585 |
| EEZ_V_213 | United Kingdom Exclusive Economic Zone | OSPAR Region V | 152 229 |
| EEZ_I_216 | Norwegian Exclusive Economic Zone | OSPAR Region I | 784 147 |
| EEZ_II_216 | Norwegian Exclusive Economic Zone | OSPAR Region II | 161 013 |
| EEZ_IV_273 | Spanish Exclusive Economic Zone | OSPAR Region IV | 205 509 |
| EEZ_V_273 | Spanish Exclusive Economic Zone | OSPAR Region V | 95 579 |

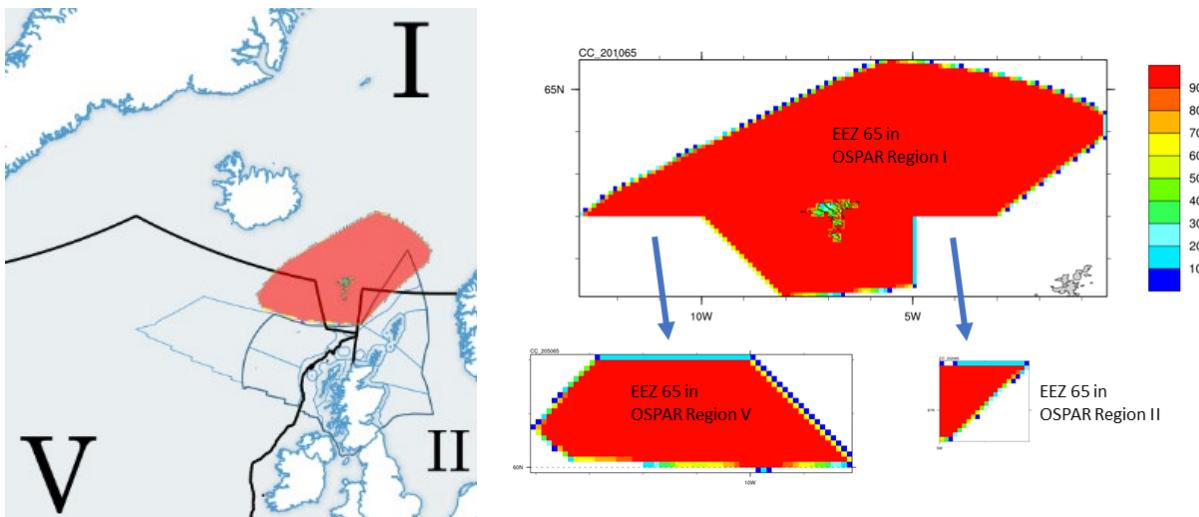


Figure 7: Left panel: OSPAR regions I, II and V, and EEZ 65 (Faeroe Exclusive Economic Zone) indicated in light red colour. Right panels: Division of EEZ 65 into three separate parts, belonging to OSPAR Regions I, II, and V, respectively. These three partial EEZs are listed in the first 3 rows of Table 7.

4.4 COMP4 Assessment Units

For the first time this year, EMEP MSC-W calculated nitrogen deposition also for the 67 COMP4 Assessment Units. The definitions of these Assessment Units were provided to EMEP MSC-W in May 2021 and implemented in the EMEP $0.1^\circ \times 0.1^\circ$ grid and in the tools to analyse nitrogen deposition and source-receptor relationships. The Assessment Units are listed in Table 8. Figure 8 shows the percentages of EMEP grids covered by each COMP4 Assessment Unit (only for those areas that are larger $10\,000\text{ km}^2$).

At the INPUT meeting in January 2022, EMEP MSC-W was informed that there are new definitions of COMP4 Assessment Units (now the number is sixty-four). The new definitions were provided to EMEP MSC-W in February 2022, but it was not possible to redo the calculations at this time. This can of course be done in future contracts.

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Table 8. The sixty-seven COMP4 Assessment Units implemented in the EMEP MSC-W analysis in the 0.1°lon x 0.1°lat grid in 2021. Abbreviations and names are printed here as contained in the shape files provided to EMEP MSC-W in May 2021. The table continues on the next page.

Remarks: 1) Assessment Units marked by * are no longer included in the new table of definitions (provided to EMEP MSC-W in February 2022); 2) 'OC' was called 'CO' in the table of definitions provided to EMEP MSC-W in May 2021 – in some data files or figures created by EMEP MSC-W before February 2022 the old abbreviation may still be present; 3) NT: question marks in regard to 'Contracting Parties involved' are retained from new table of definitions.

| Abbreviation | Long name | Area in the EMEP MSC-W model domain (km ²) | Contracting Parties involved ³ |
|--------------|--|--|---|
| CFR | Coastal FR channel | 7512 | FR, UK |
| CCTI | Channel coastal shelf tidal influenced | 5281 | FR, UK |
| ATL | Atlantic | 929017 | ES, FR, IE, UK, NO |
| SHPM | Shannon plume | 450 | IE |
| CNOR1 | Coastal NOR 1 | 9054 | NO |
| CNOR2 | Coastal NOR 2 | 2803 | NO |
| CNOR3 | Coastal NOR 3 | 2050 | NO |
| DB | Dogger Bank | 15078 | NL, DE, DK, UK |
| KD | Kattegat Deep | 5214 | DK, SE |
| NT | Norwegian Trench | 59758 | NO, SE?, DK? |
| SNS | Southern North Sea | 62503 | FR, BE, NL, UK |
| GBC | German Bight (deep) | 4737 | DE |
| ADPM | Adour plume | 328 | FR |
| GBSW | Gulf of Biscay shelf waters | 21646 | FR |
| SPM | Seine plume | 1205 | FR |
| GDPM | Gironde plume | 2968 | FR |
| CUKC | Coastal UK channel | 6694 | UK |
| CWMTI | Channel well mixed tidal influenced | 21077 | FR, UK |
| SCHPM1 | Scheldt plume 1 | 688 | BE, NL |
| ELPM | Elbe plume | 8097 | DE |
| SCHPM2 | Scheldt plume 2 | 122 | NL |
| MPM | Meuse plume | 239 | NL |
| RHPM | Rhine plume | 2625 | NL |
| EMPM | Ems plume | 1593 | DE |
| THPM | Thames plume | 5770 | UK |
| HPM | Humber plume | 1493 | UK |
| ECPM1 | East Coast (permanently mixed) 1 | 3757 | UK |
| ECPM2 | East Coast (permanently mixed) 2 | 1681 | UK |
| IS2 | Intermittently Stratified 2 | 27225 | IE, UK |
| OC (CO) | Outer Coastal Germany/Denmark | 19006 | DE, DK |
| ENS | Eastern North Sea | 61017 | NL, DE, DK |
| CWCC | Coastal Waters CC (D5) | 862 | PT |

³ In this column, 'UK' is used as abbreviation for the United Kingdom of Great Britain and Northern Ireland, as it is based on a table provided by the OSPAR Secretariat and not on EMEP data.

Table 8. Continued.

| Abbreviation | Long name | Area in the EMEP MSC-W model domain (km²) | Approximate location |
|---------------------|---------------------------------|---|---------------------------------|
| OWCO | Ocean Waters CO (D5) | 19104 | PT |
| OWAO | Ocean Waters AO (D5) | 98378 | PT |
| IWCI* | Intermediate Waters CI (D5) | 1423 | PT |
| OWBO | Ocean Waters BO (D5) | 182631 | PT |
| ASS | Atlantic Seasonally Stratified | 218564 | FR, IE, UK |
| CIRL | Coastal IRL 3 | 9829 | IE |
| CUK1 | Coastal UK 1 | 11144 | UK |
| IS1 | Intermittently Stratified 1 | 74617 | UK |
| IRS | Irish Sea | 33399 | IE, UK |
| KC | Kattegat Coastal | 10108 | DK, SE |
| NNS | Northern North Sea | 265130 | UK, DK, SE, NO |
| CWM | Channel well mixed | 42618 | FR, UK |
| LBPM | Liverpool Bay plume | 1493 | UK |
| SK | Skagerak | 5968 | DK, SE |
| SS | Scottish Sea | 54934 | UK |
| CWBC | Coastal Waters BC (D5) | 3798 | PT |
| IWB1* | Intermediate Waters BI (D5) | 2057 | PT |
| CWAC | Coastal Waters AC (D5) | 2601 | PT |
| IWAI* | Intermediate Waters AI (D5) | 5881 | PT |
| LPM | Loire plume | 1615 | FR |
| GBCW | Gulf of Biscay coastal waters | 11514 | FR |
| NAAP2 | Noratlantic Area NOR-NorP2(D5) | 9773 | ES |
| NAAO1 | Noratlantic Area NOR-NorO1(D5) | 263322 | ES |
| NAAPF | Noratlantic Area NOR-Plataforma | 39104 | ES |
| NAAC3 | Noratlantic Area NOR-NorC3(D5) | 3771 | ES |
| NAAC2 | Noratlantic Area NOR-NorC2(D5) | 2961 | ES |
| NAAC1A | Noratlantic Area NOR-NorC1(D5)A | 884 | ES |
| NAAC1B | Noratlantic Area NOR-NorC1(D5)B | 150 | ES |
| NAAC1C | Noratlantic Area NOR-NorC1(D5)C | 59 | ES |
| NAAC1D | Noratlantic Area NOR-NorC1(D5)D | 23 | ES |
| SAAP2 | Sudatlantic Area SUD-P2(D5) | 1207 | ES |
| SAAOC | Sudatlantic Area SUD-OCEAN(D5) | 10443 | ES |
| SAAP1 | Sudatlantic Area SUD-P1(D5) | 2789 | ES |
| SAAC1 | Sudatlantic Area SUD-C1(D5) | 619 | ES |
| SAAC2 | Sudatlantic Area SUD-C2(D5) | 415 | ES |

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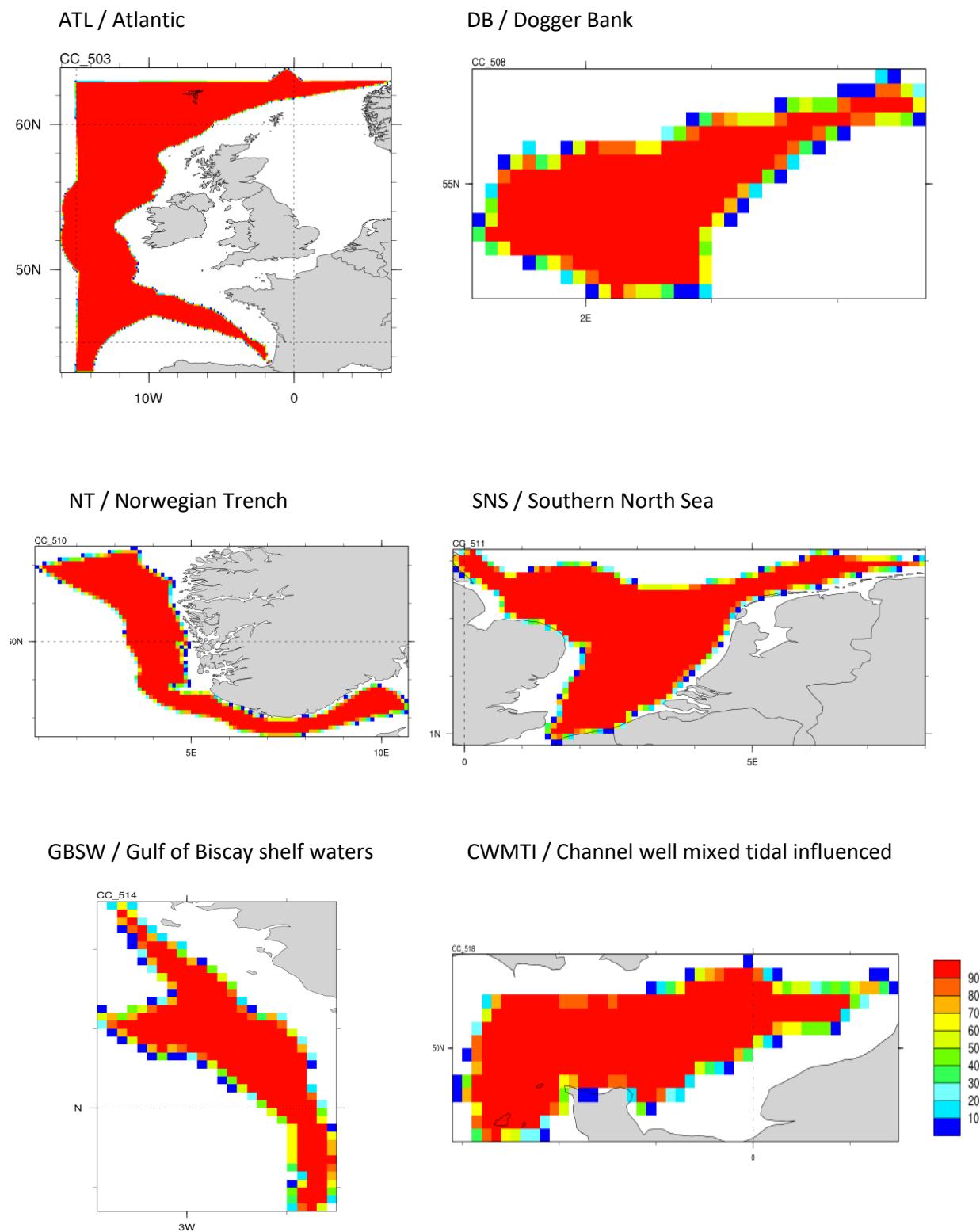
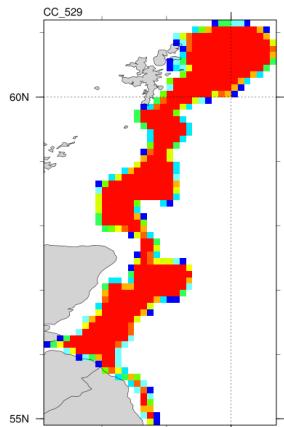
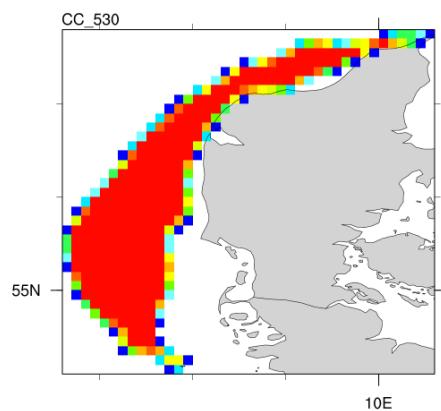


Figure 8: Visualization of COMP4 Assessment Units in the EMEP grid. The plots show how large a percentage of each EMEP model grid cell lies within the respective COMP4 Assessment Unit. EMEP model grid cells cover $0.1^\circ\text{lon} \times 0.1^\circ\text{lat}$ pixels and thus appear very small in some of the plots. Red colour means that the model grid cell is fully within the COMP4 Assessment Unit. Other colours mean that the grid cell is only partly within the COMP4 Assessment Unit. Only those COMP4 Assessment Units covering more than $10\,000\text{ km}^2$ are shown. The figure continues on the next 3 pages.

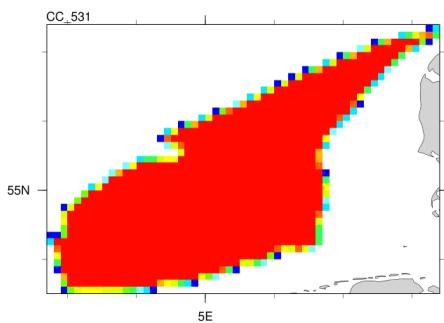
IS2 / Intermittently Stratified 2



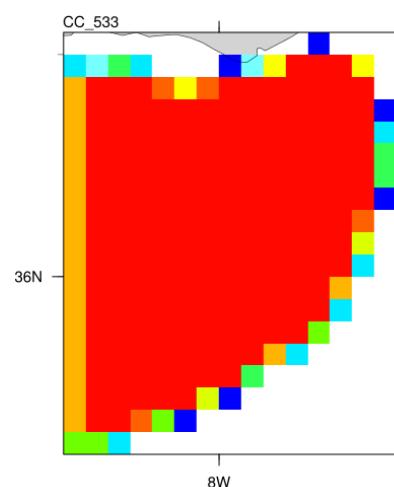
CO / Coastal Offshore



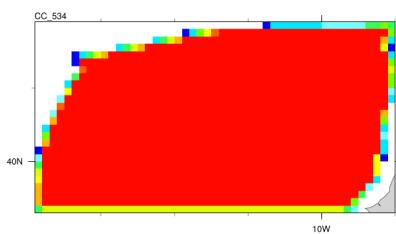
ENS / Eastern North Sea



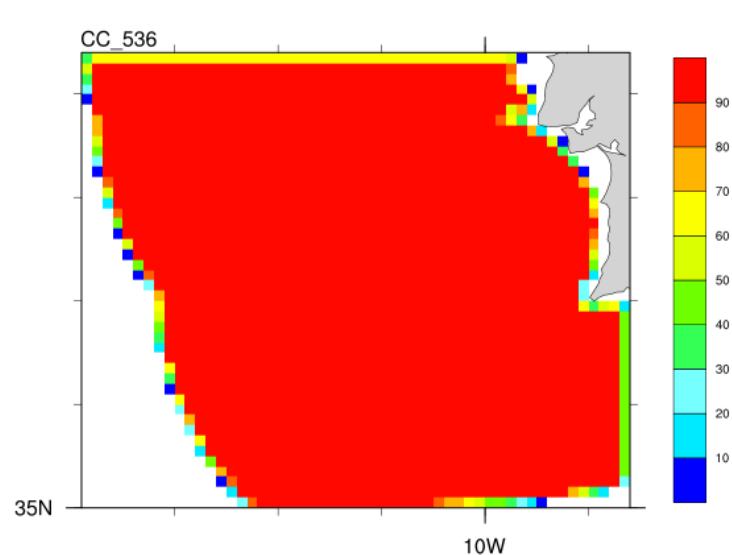
OWCO / Ocean Waters CO (D5)



OWAO / Ocean Waters AO (D5)



OWBO / Ocean Waters BO (D5)

**Figure 8:** Continued.

ASS / Atlantic Seasonally Stratified

CUK1 / Coastal UK 1

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

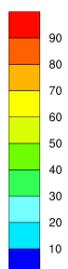
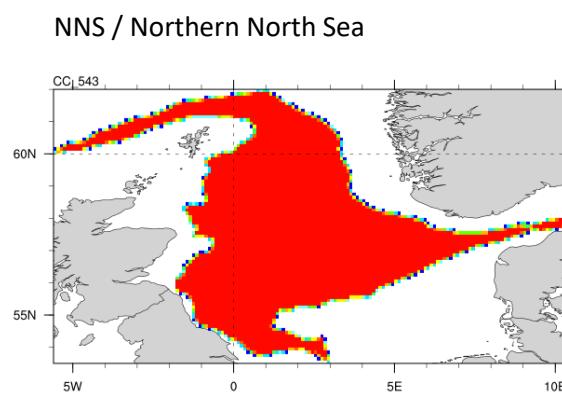
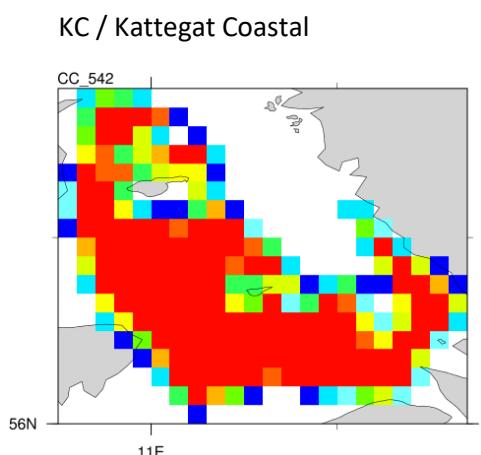
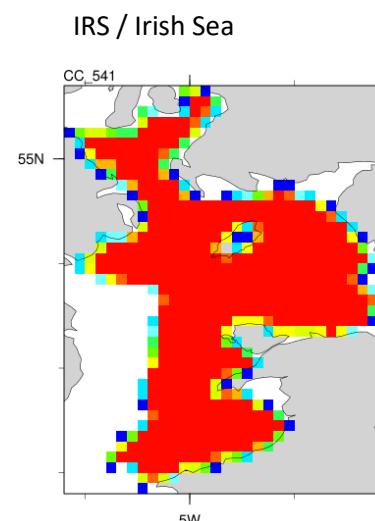
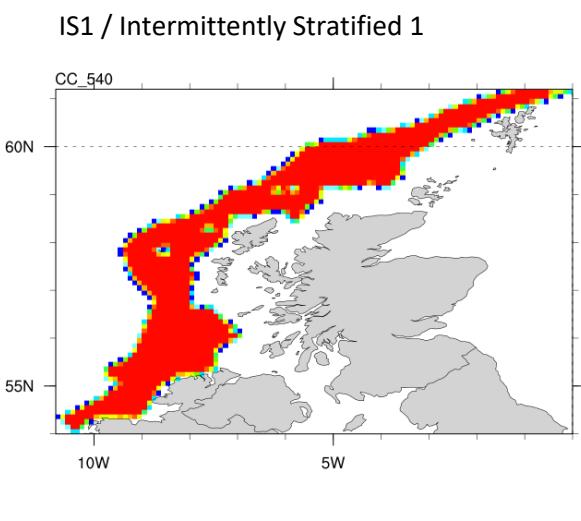
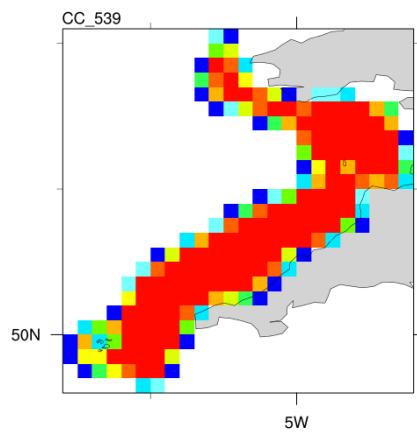
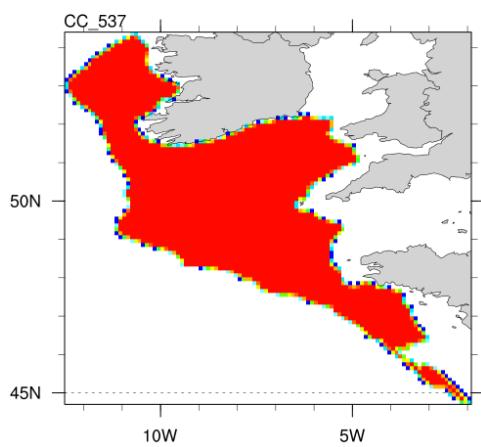
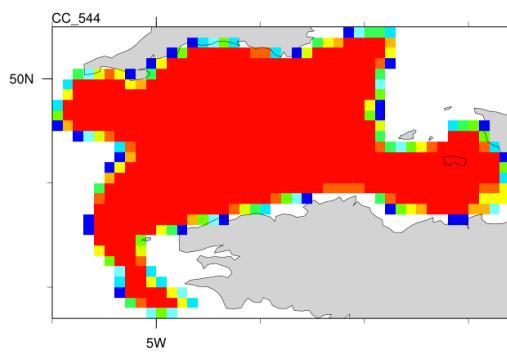
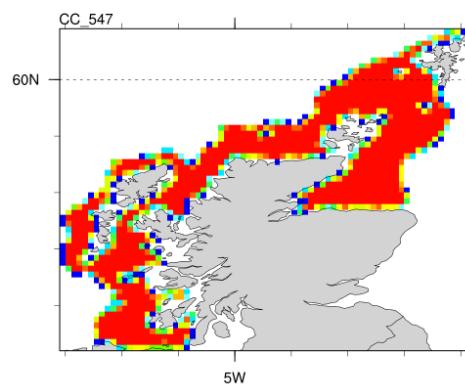


Figure 8: Continued.

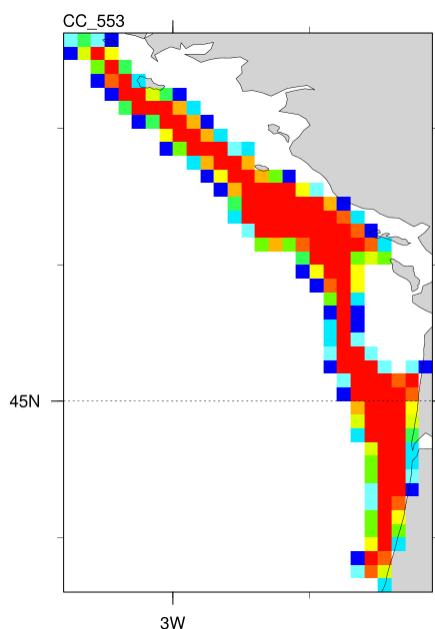
CWM / Channel well mixed



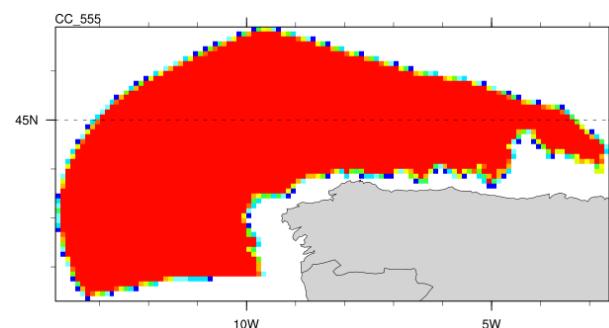
SS / Scottish Sea



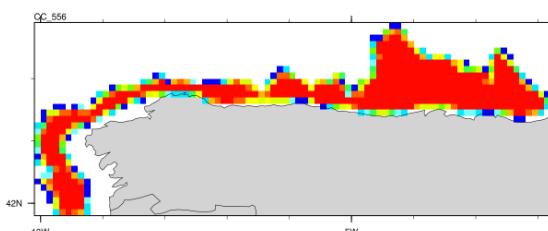
GBCW / Gulf of Biscay coastal waters



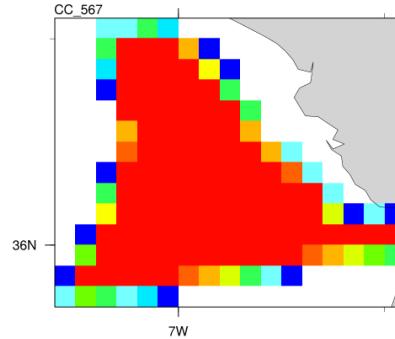
NAAO1 / Noratlantic Area NOR-NorO1(D5)



NAAPF / Noratlantic Area NOR-Plataforma



SAAOC / Sudatlantic Area SUD-OCEAN(D5)

**Figure 8:** Continued.

5 Actual and normalized depositions of nitrogen

Actual and normalized depositions of nitrogen have been computed for the five OSPAR Regions, the twenty-four EEZs, the twenty-five partial EEZs, and the COMP4 Assessment Units, for each year of the period 1990-2019.

Normalized ('weather-averaged') depositions follow the changes in emissions better than actual depositions and thus illustrate the effect of policy measures on nitrogen emissions. In the normalization, only the years 2016-2019 have been used this year for OSPAR. In earlier reports, more meteorological years had been used, but now, as more (and smaller) receptors are considered, it appeared safest to rely only on those years for which transfer coefficients are calculated on a higher resolution than in earlier years (i.e. on the 0.3°lon x 0.2°lat grid rather than the old 50km x 50km polar-stereographic grid). Another reason, specifically for OSPAR, is that some of the receptors considered (e.g. EEZ048) are not fully covered by the EMEP model domain (see Sections 4.1 and 4.2 and in particular Figures 5 and 6). When the EMEP model domain was changed in 2017 (for reporting the status of 2015), the parts included in the domain changed for these receptors, both in shape and in area. This would lead to artificial changes in the transfer coefficients from early years before the grid change to the later years in the period.

All results have been submitted to OSPAR in separate data files (see Chapter 8). In this report we show plots and tables with results back to 1995.

5.1 Depositions to OSPAR Regions

Figure 9 shows actual (non-normalized) oxidized and reduced nitrogen depositions from 1995 to 2019 for all OSPAR Regions. Depositions of oxidised nitrogen have clearly decreased since the 1990s, while for reduced nitrogen the decreases are much smaller. Nevertheless, the trends in *total* (oxidized+reduced) nitrogen deposition are decreasing in all OSPAR Regions and are statistically significant at the 5% confidence level.

Table 9 lists the percentage differences between 1995 and 2019, and between the two 5-year periods of 1995-1999 and 2015-2019 for actual depositions. Due to the large inter-annual variability in meteorological conditions, differences between depositions in one year with respect to those in one reference year (1995 in this case) can change considerably from year to year. Therefore, 5-year averages are calculated to provide a more robust result for the changes since the 1990s.

Table 10 lists actual *and* normalized depositions in the 5 OSPAR regions for the year 2019, i.e. the most recent year for which model calculations have been made.

Figure 10 shows normalized results. The normalization is based on meteorological data from 4 years (2016, 2017, 2018 and 2019). Normalized depositions of oxidized and reduced nitrogen were lower in 2019 than in 1995 in all OSPAR Regions. The largest decreases occurred in OSPAR Region II, both for *oxidized* nitrogen deposition (49%) and for *reduced* nitrogen deposition (18%). An interesting feature is that normalized oxidized deposition to OSPAR Region V in the 1990s is much smaller than the actual values (see accompanying Excel sheet). It seems that recent meteorology (2016-2019) has been less favourable for oxidized nitrogen deposition than the meteorology of the 1990s. We aim to investigate this possible climate change signal further.

Tables 11 and 12 contain the normalized values for the five OSPAR Regions, i.e. the data Figure 10 is based upon.

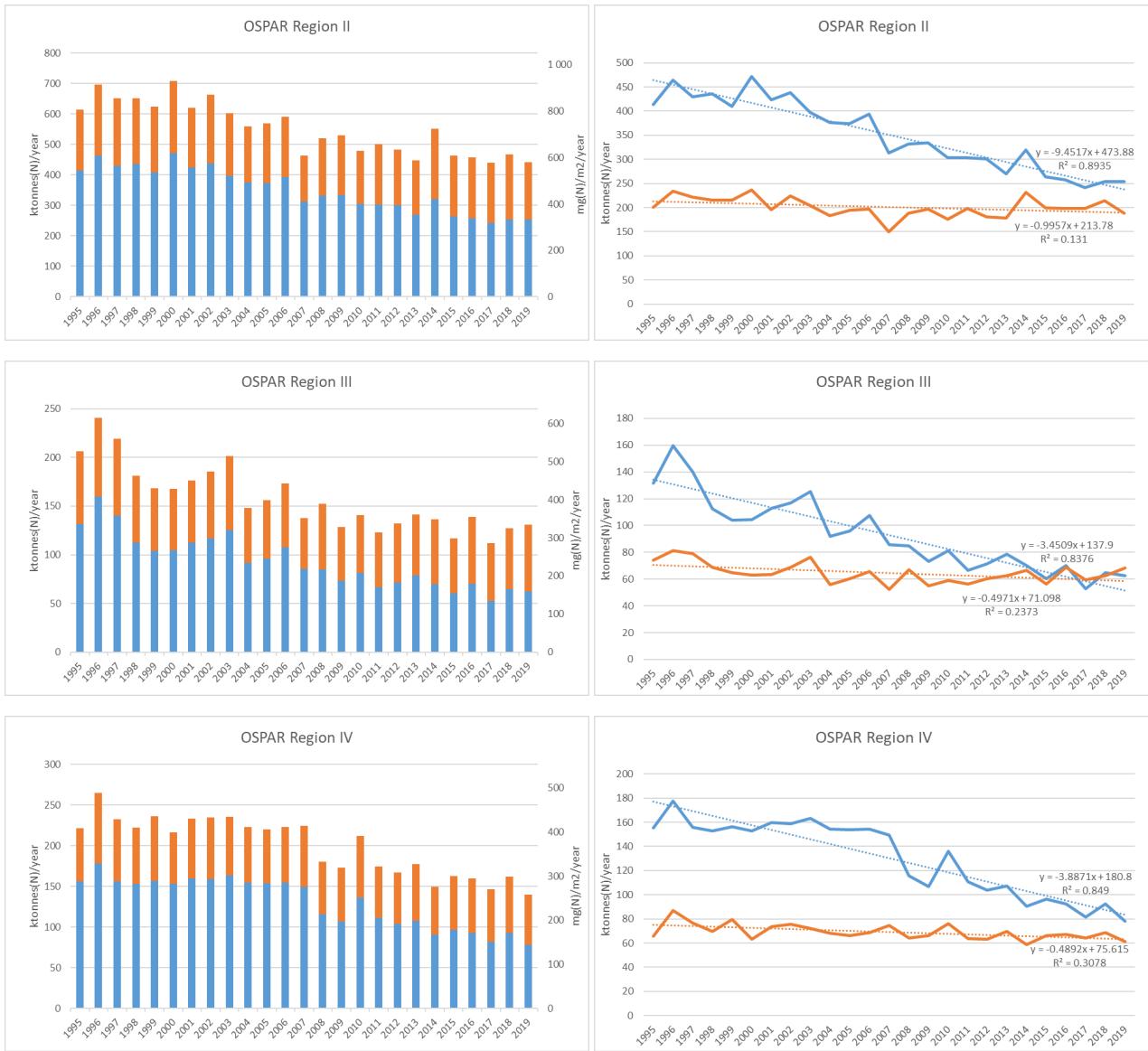


Figure 9a: Left panels: Time series of annual depositions of oxidised (blue), reduced (red) and total nitrogen (sum of blue and red) to OSPAR Regions II, III and IV, as calculated by the EMEP MSC-W model for the period 1995-2019. Unit: ktonnes(N)/year (left axis) or mg(N)/m²/year (right axis). Right panels: Linear regression for oxidised (blue) and reduced (red) nitrogen deposition, with coefficients of determination (R^2) indicated in the figure.

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

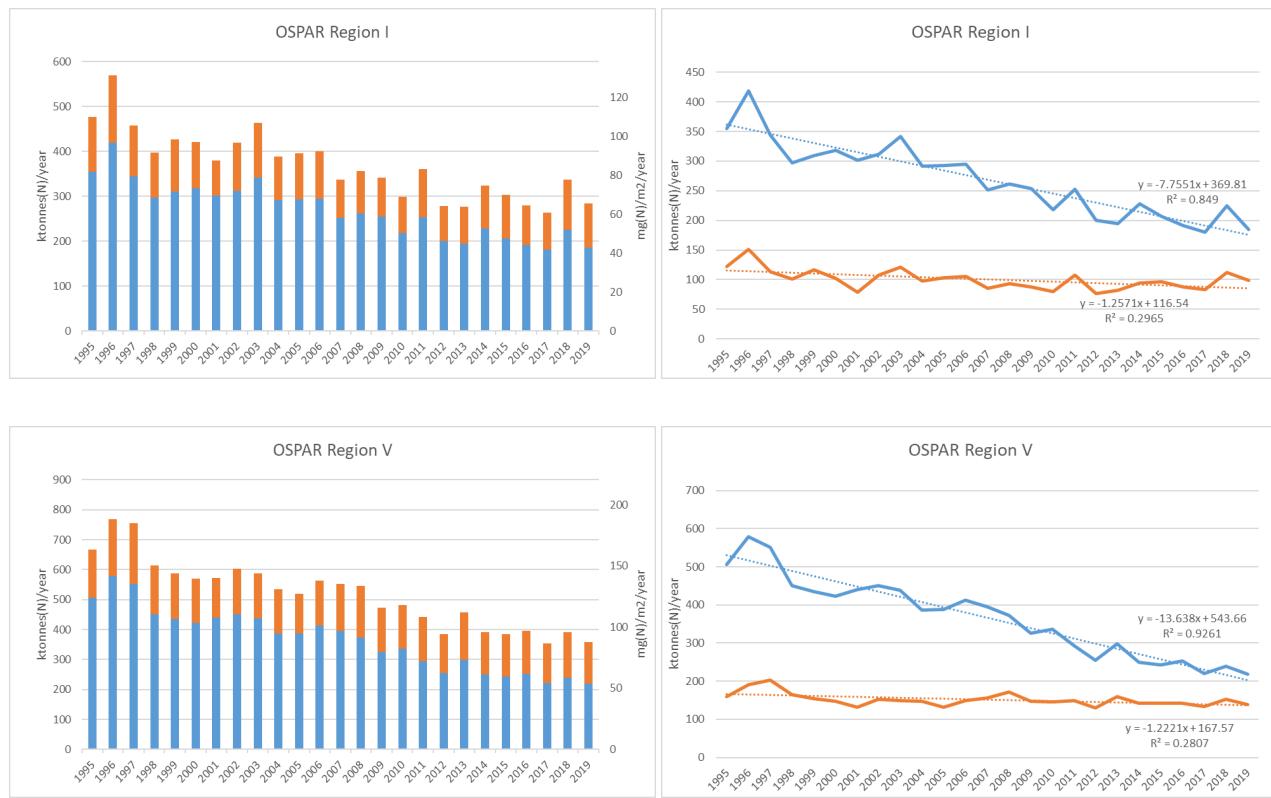


Figure 9b: As Figure 9a, but for OSPAR Regions I and IV.

Table 9. Percentage differences in actual (non-normalized) depositions between 2019 and 1995 for oxidised, reduced and total nitrogen, in the five OSPAR Regions. Also shown are the percentage differences between the 5-year periods of 2015-2019 and 1995-1999.

| OSPAR Region | Oxidised N | | Reduced N | | Total N | |
|--------------|------------|--------------------------|-----------|--------------------------|-----------|--------------------------|
| | 1995→2019 | (1995-1999) →(2015-2019) | 1995→2019 | (1995-1999) →(2015-2019) | 1995→2019 | (1995-1999) →(2015-2019) |
| I | -48 % | -43 % | -19 % | -21 % | -40 % | -37 % |
| II | -39 % | -41 % | -6 % | -8 % | -28 % | -30 % |
| III | -53 % | -52 % | -8 % | -14 % | -37 % | -38 % |
| IV | -50 % | -45 % | -6 % | -13 % | -37 % | -35 % |
| V | -57 % | -53 % | -13 % | -19 % | -46 % | -44 % |

Table 10. Deposition of oxidised, reduced and total nitrogen, in the five OSPAR Regions in 2019. Both actual numbers (based on 2019 meteorology) and weather-normalized values (based on meteorological data of 2016, 2017, 2018 and 2019) are given. Results for other years are provided separately in Excel format (see Chapter 8). Unit: tonnes(N)/year.

| OSPAR Region | Oxidised N | | Reduced N | | Total N | |
|--------------|------------|------------|-----------|------------|---------|------------|
| | Actual | Normalized | Actual | Normalized | Actual | Normalized |
| I | 185 116 | 193 742 | 99 028 | 94 459 | 284 144 | 288 201 |
| II | 253 671 | 248 115 | 188 215 | 195 168 | 441 887 | 443 284 |
| III | 62 465 | 61 830 | 68 314 | 63 535 | 130 779 | 125 365 |
| IV | 78 076 | 86 200 | 61 374 | 64 740 | 139 450 | 150 940 |
| V | 219 158 | 233 393 | 139 201 | 139 339 | 358 359 | 372 732 |



Figure 10a: Left panels: Time series of normalized depositions of oxidised (blue), reduced (red) and total nitrogen (sum of blue and red) to OSPAR Regions I and V, as calculated by the EMEP MSC-W model for the period 1995-2019. Unit: ktonnes(N)/year (left axis) or mg(N)/m²/year (right axis). Right panels: Linear regression for oxidised (blue) and reduced (red) nitrogen deposition, with coefficients of determination (R^2) indicated in the figure.

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

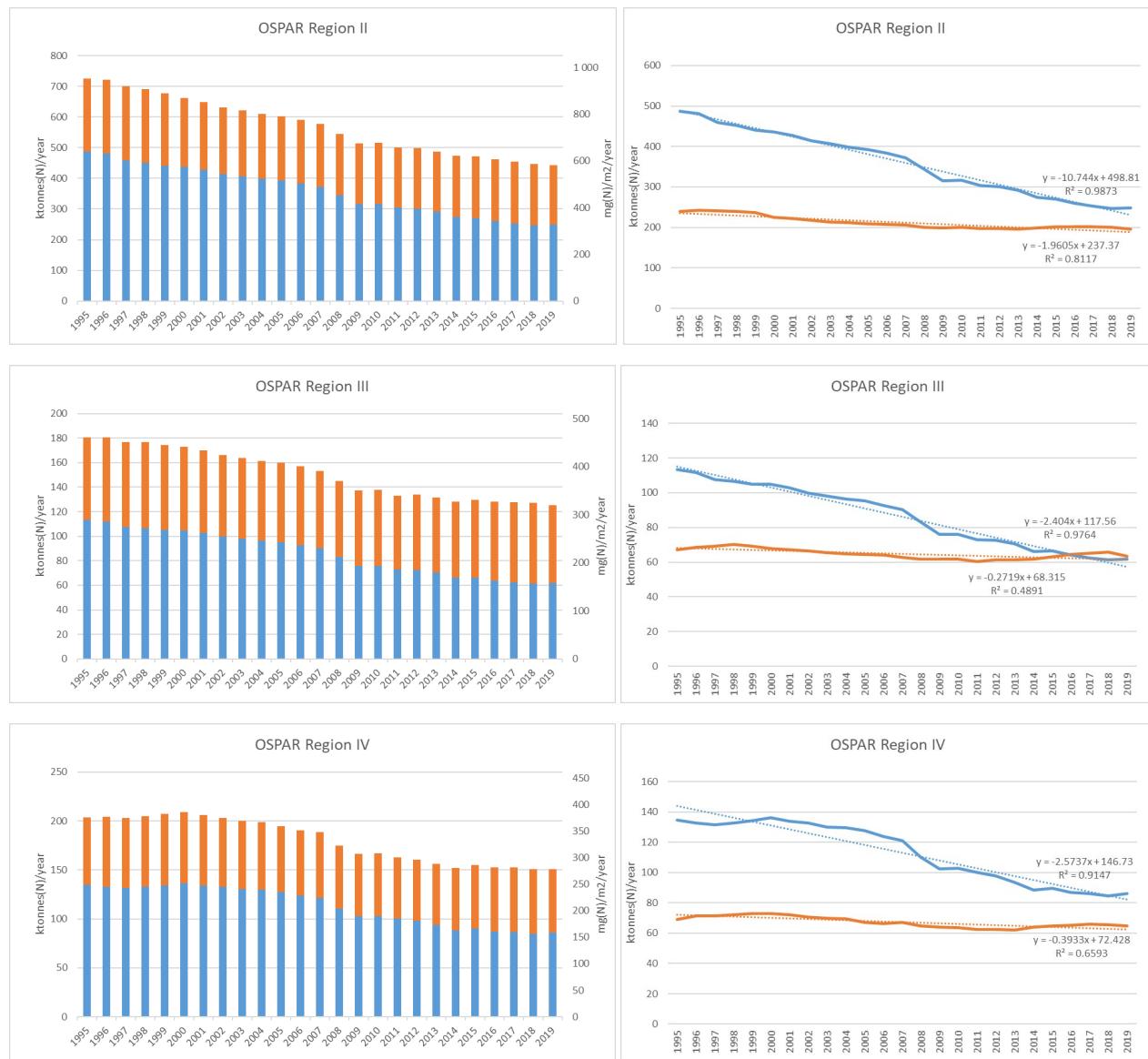


Figure 10b: As Figure 10a, but for OSPAR Regions II, III and IV.

Table 11. Normalized deposition of oxidized nitrogen to the 5 OSPAR Regions in the period 1995 to 2019. Unit: ktonnes(N)/year.

| | Region I | Region II | Region III | Region IV | Region V |
|-------------|-----------------|------------------|-------------------|------------------|-----------------|
| 1995 | 298 | 487 | 113 | 135 | 307 |
| 1996 | 296 | 481 | 112 | 133 | 305 |
| 1997 | 289 | 459 | 107 | 132 | 300 |
| 1998 | 286 | 452 | 107 | 133 | 300 |
| 1999 | 282 | 441 | 105 | 134 | 300 |
| 2000 | 281 | 437 | 105 | 136 | 302 |
| 2001 | 277 | 428 | 103 | 134 | 298 |
| 2002 | 271 | 414 | 100 | 133 | 294 |
| 2003 | 268 | 407 | 98.1 | 130 | 291 |
| 2004 | 265 | 399 | 96.5 | 129 | 289 |
| 2005 | 261 | 393 | 95.3 | 128 | 287 |
| 2006 | 257 | 383 | 92.8 | 124 | 282 |
| 2007 | 252 | 372 | 90.2 | 121 | 278 |
| 2008 | 239 | 345 | 83.1 | 110 | 266 |
| 2009 | 226 | 316 | 75.9 | 103 | 254 |
| 2010 | 227 | 317 | 76.1 | 103 | 256 |
| 2011 | 221 | 304 | 72.8 | 100 | 251 |
| 2012 | 219 | 301 | 72.6 | 97.8 | 250 |
| 2013 | 215 | 291 | 70.4 | 93.7 | 245 |
| 2014 | 206 | 274 | 66.3 | 88.4 | 237 |
| 2015 | 204 | 271 | 66.3 | 89.8 | 238 |
| 2016 | 199 | 260 | 64.0 | 87.1 | 235 |
| 2017 | 196 | 253 | 62.5 | 86.3 | 233 |
| 2018 | 194 | 247 | 61.5 | 84.8 | 231 |
| 2019 | 194 | 248 | 61.8 | 86.2 | 233 |

Table 12. As Table 11, but for *reduced* nitrogen.

| | Region I | Region II | Region III | Region IV | Region V |
|-------------|-----------------|------------------|-------------------|------------------|-----------------|
| 1995 | 107 | 239 | 67.0 | 69.0 | 154 |
| 1996 | 106 | 242 | 68.7 | 71.3 | 157 |
| 1997 | 106 | 240 | 69.3 | 71.4 | 158 |
| 1998 | 105 | 239 | 70.1 | 72.3 | 159 |
| 1999 | 104 | 236 | 69.2 | 73.0 | 158 |
| 2000 | 102 | 225 | 67.9 | 72.9 | 155 |
| 2001 | 101 | 221 | 67.1 | 72.0 | 153 |
| 2002 | 100 | 217 | 66.4 | 70.5 | 150 |
| 2003 | 99.0 | 214 | 65.6 | 70.0 | 148 |
| 2004 | 98.2 | 211 | 64.8 | 69.3 | 147 |
| 2005 | 97.9 | 209 | 64.4 | 67.3 | 145 |
| 2006 | 97.0 | 207 | 64.1 | 66.5 | 143 |
| 2007 | 96.5 | 206 | 62.8 | 67.1 | 143 |
| 2008 | 94.4 | 201 | 61.7 | 64.7 | 139 |
| 2009 | 93.5 | 199 | 61.7 | 63.9 | 138 |
| 2010 | 93.1 | 200 | 61.6 | 63.7 | 138 |
| 2011 | 92.7 | 198 | 60.4 | 62.6 | 136 |
| 2012 | 93.0 | 197 | 61.4 | 62.3 | 136 |
| 2013 | 92.9 | 196 | 61.3 | 62.2 | 136 |
| 2014 | 94.1 | 199 | 61.8 | 63.9 | 138 |
| 2015 | 95.4 | 201 | 63.2 | 64.9 | 141 |
| 2016 | 95.8 | 202 | 64.4 | 65.2 | 142 |
| 2017 | 96.3 | 202 | 65.1 | 66.1 | 143 |
| 2018 | 95.8 | 200 | 65.9 | 65.7 | 143 |
| 2019 | 94.5 | 195 | 63.5 | 64.7 | 139 |

5.2 Depositions to Exclusive Economic Zones

Actual (non-normalized) atmospheric nitrogen depositions to each of the twenty-four Exclusive Economic Zones during the period 1995-2019 are shown in Figure 11. There is a clear decline in the deposition of oxidised nitrogen between 1995 and 2019 in all EEZs. The deposition of reduced nitrogen was larger in 2019 than in 1995 in seven of the EEZs. Again, one has to keep in mind that the inter-annual variability in these depositions is large due to meteorological conditions (e.g. in last year's report - for 2018 - many more EEZs showed an increase with respect to 1995). Nevertheless, it is clear that, overall, the downward trend in reduced nitrogen deposition is much smaller than that of oxidised nitrogen deposition.

Table 13 lists the percentage differences between 1995 and 2019, and between the two 5-year periods of 1995-1999 and 2015-2019 for actual depositions, while Table 14 lists actual *and* normalized depositions in the 24 EEZs for the year 2019, i.e. the most recent year for which model calculations have been made.

Tables 15 and 16 contain normalized depositions of oxidized and reduction nitrogen to the twenty-four EEZs.

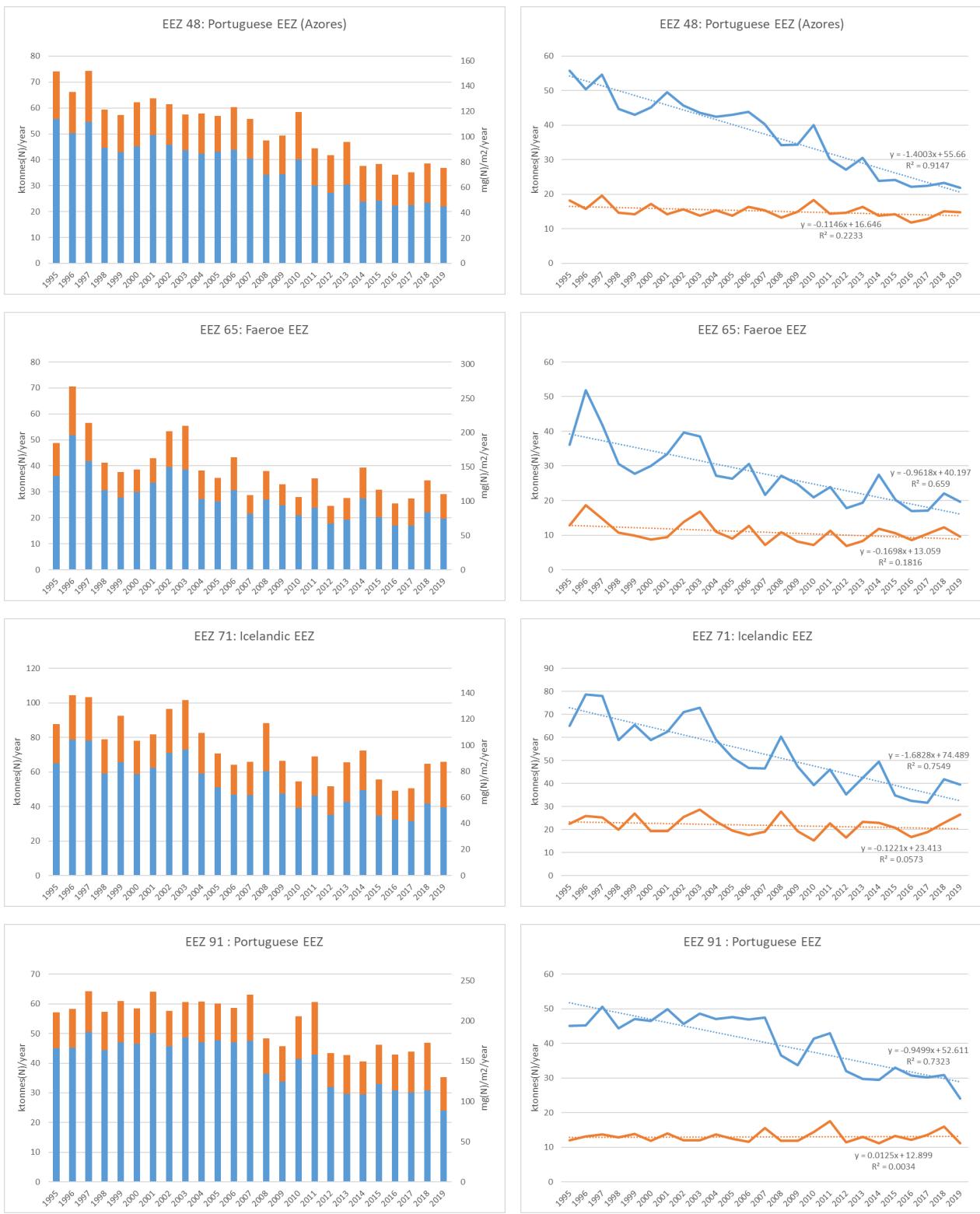


Figure 11: Left panels: Time series of actual (non-normalized) depositions of oxidised (blue), reduced (red) and total nitrogen (sum of blue and red) to selected EEZs, as calculated by the EMEP MSC-W model for the period 1995-2019. Unit: ktonnes(N)/year (left axis) or mg(N)/m²/year (right axis). Right panel: Linear regression for oxidised (blue) and reduced (red) nitrogen deposition, with coefficients of determination (R^2) indicated in the figure. The figure continues on the next pages.

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

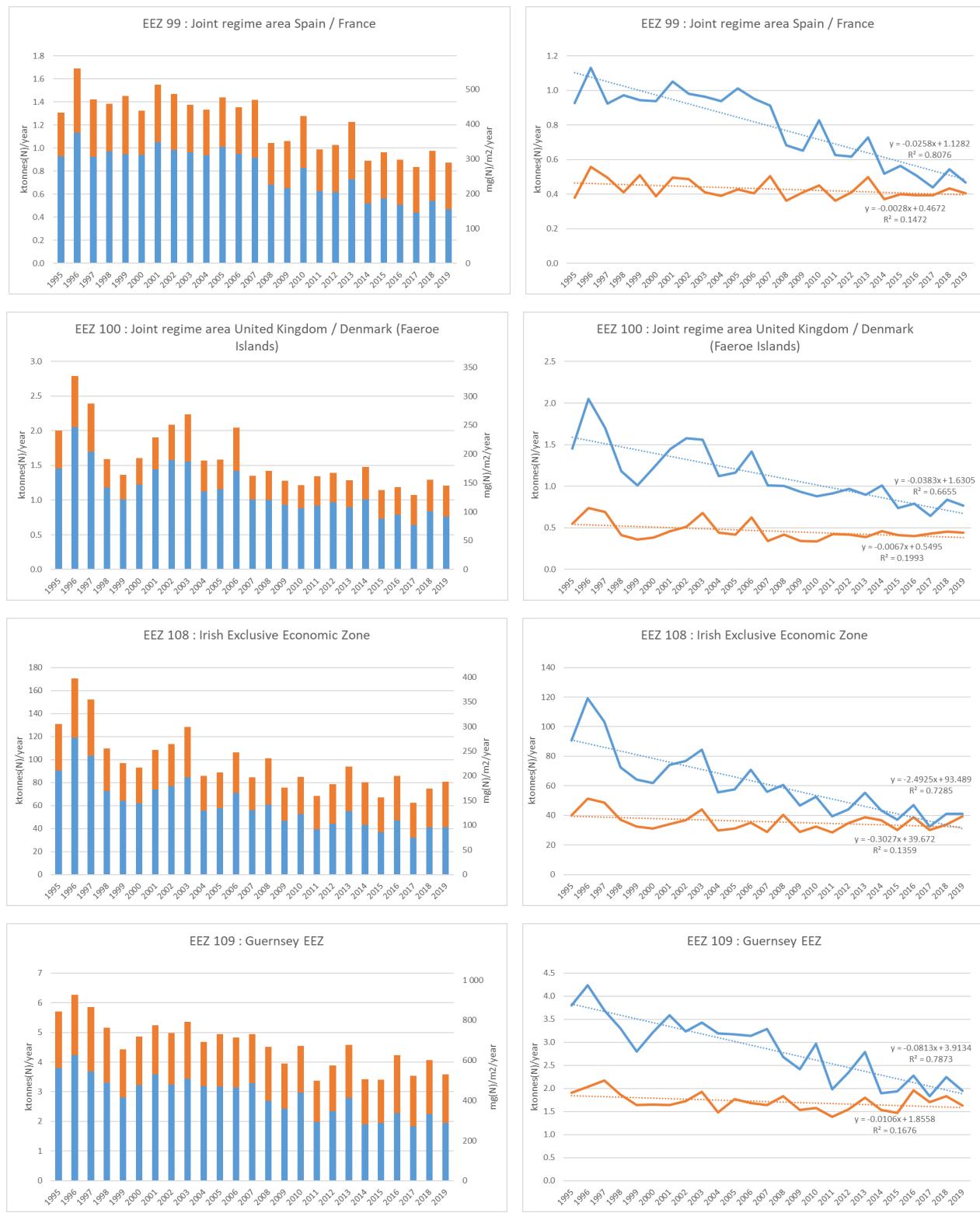
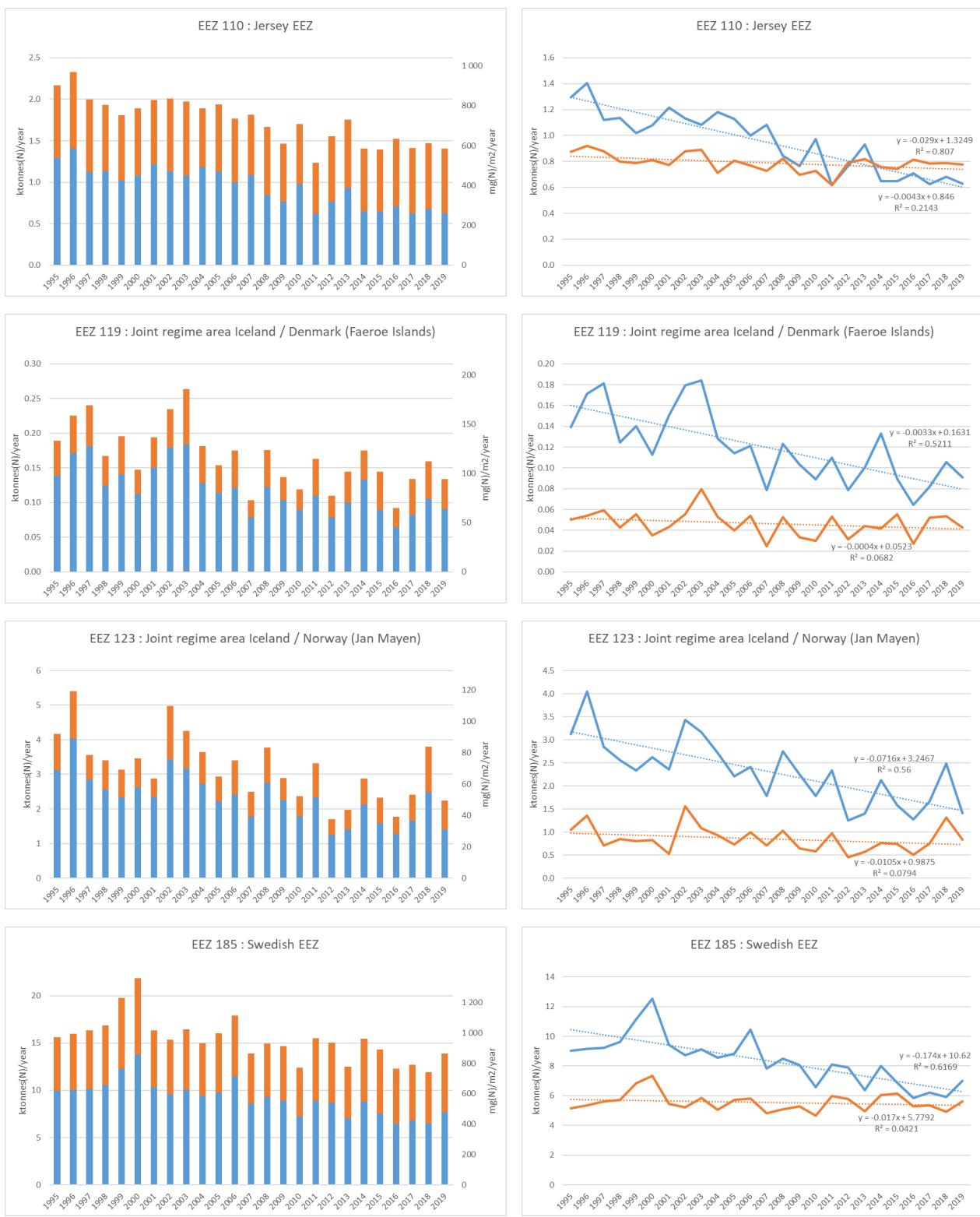


Figure 11: (continued)

**Figure 11: (continued)**

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

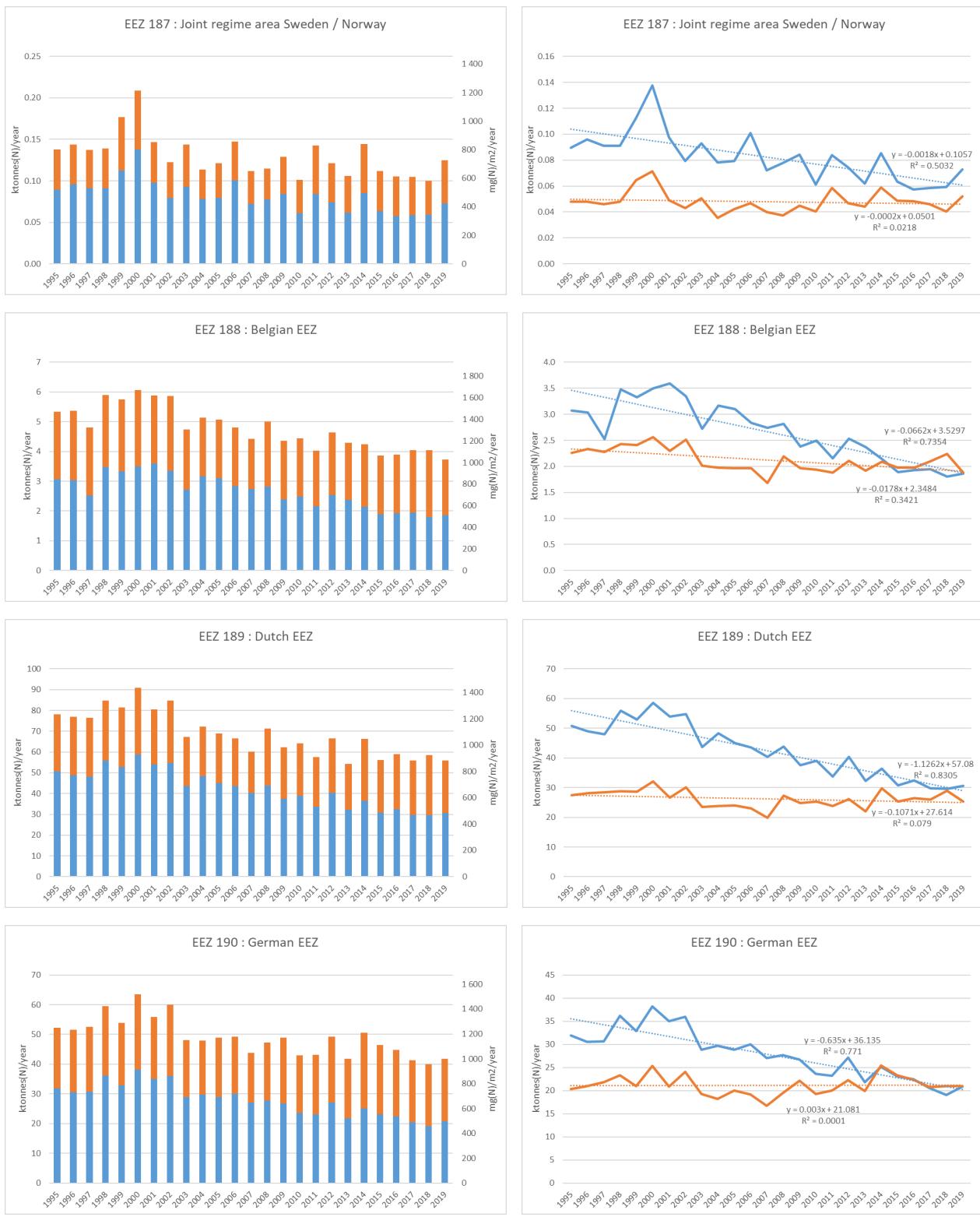
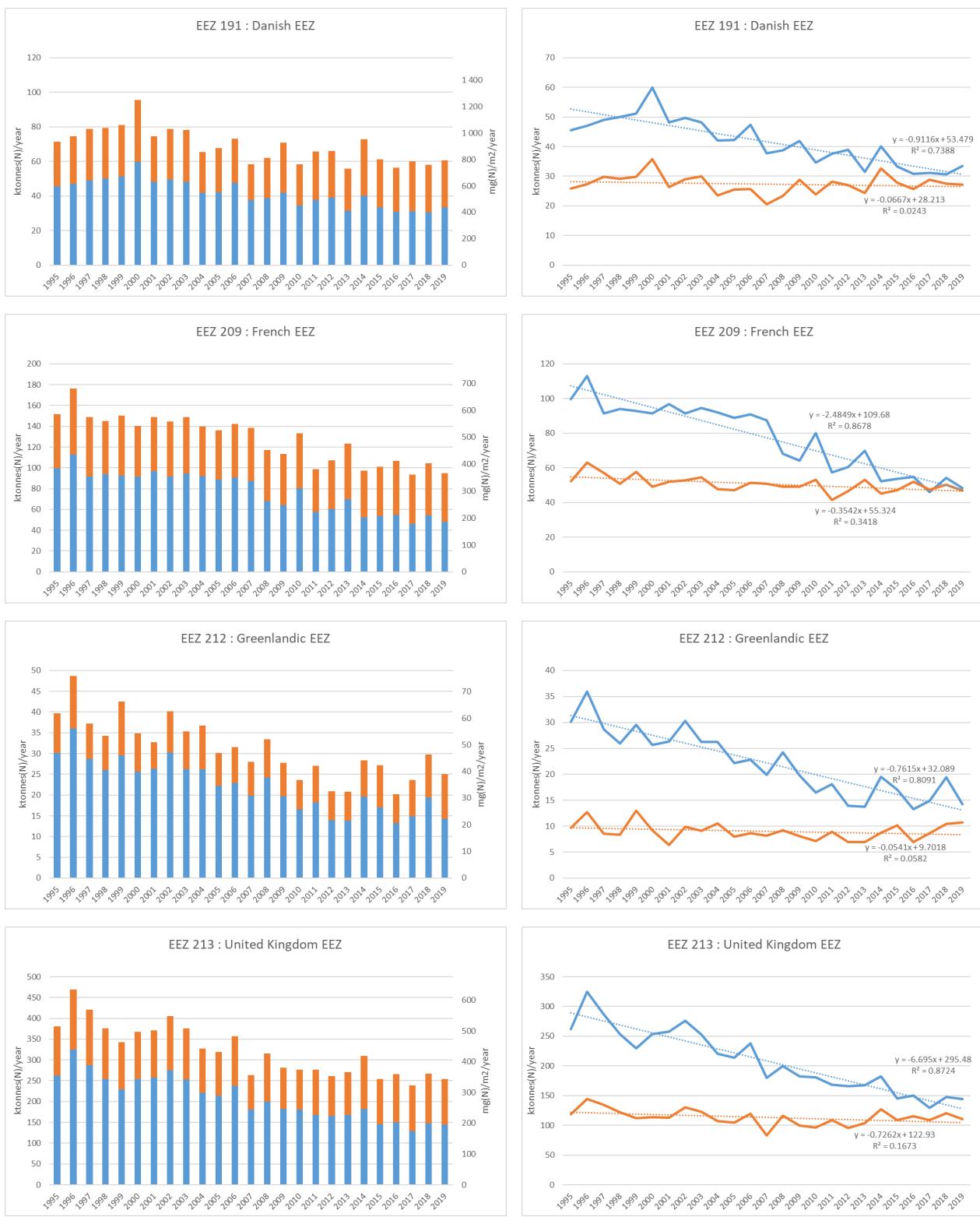


Figure 11: (continued)

**Figure 11: (continued)**

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019



Figure 11: (continued)

Table 13. Percentage differences in 2019 compared to 1995 for oxidised, reduced and total nitrogen, in the twenty-four Exclusive Economic Zones listed in Table 6. Also shown are the percentage differences in the 5-year period 2015–2019 with respect to the 5-year period of 1995–1999.

| EEZ | Oxidised N | | Reduced N | | Total N | |
|---------|------------|-----------------------------|-----------|-----------------------------|-----------|-----------------------------|
| | 1995→2019 | (1995-1999) →(2015-2019) | 1995→2019 | (1995-1999) →(2015-2019) | 1995→2019 | (1995-1999) →(2015-2019) |
| EEZ 48 | -61 % | -54 % | -19 % | -17 % | -50 % | -45 % |
| EEZ 65 | -46 % | -49 % | -25 % | -23 % | -40 % | -42 % |
| EEZ 71 | -39 % | -48 % | 18 % | -12 % | -25 % | -39 % |
| EEZ 91 | -47 % | -36 % | -7 % | 1 % | -38 % | -28 % |
| EEZ 99 | -50 % | -49 % | 7 % | -14 % | -33 % | -37 % |
| EEZ 100 | -47 % | -49 % | -20 % | -22 % | -40 % | -42 % |
| EEZ 108 | -55 % | -56 % | -2 % | -18 % | -38 % | -44 % |
| EEZ 109 | -49 % | -43 % | -14 % | -11 % | -37 % | -31 % |
| EEZ 110 | -52 % | -45 % | -11 % | -8 % | -35 % | -30 % |
| EEZ 119 | -35 % | -43 % | -15 % | -12 % | -29 % | -35 % |
| EEZ 123 | -55 % | -44 % | -20 % | -13 % | -46 % | -36 % |
| EEZ 185 | -23 % | -34 % | 10 % | -5 % | -11 % | -23 % |
| EEZ 187 | -19 % | -35 % | 8 % | -8 % | -9 % | -26 % |
| EEZ 188 | -40 % | -39 % | -17 % | -13 % | -30 % | -28 % |
| EEZ 189 | -40 % | -40 % | -8 % | -7 % | -29 % | -28 % |
| EEZ 190 | -35 % | -35 % | 3 % | 1 % | -20 % | -20 % |
| EEZ 191 | -26 % | -34 % | 5 % | -4 % | -15 % | -23 % |
| EEZ 209 | -52 % | -48 % | -10 % | -13 % | -37 % | -35 % |
| EEZ 212 | -53 % | -48 % | 11 % | -10 % | -37 % | -38 % |
| EEZ 213 | -45 % | -47 % | -7 % | -11 % | -33 % | -36 % |
| EEZ 215 | -52 % | -43 % | -26 % | -25 % | -45 % | -38 % |
| EEZ 216 | -42 % | -41 % | -15 % | -21 % | -35 % | -36 % |
| EEZ 224 | -58 % | -44 % | -17 % | -17 % | -49 % | -38 % |
| EEZ 273 | -52 % | -46 % | -8 % | -16 % | -39 % | -36 % |

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

Table 14. Deposition of oxidized, reduced and total nitrogen, to the twenty-four EEZs in 2019. Both actual numbers (based on 2019 meteorology) and weather-normalized values (based on meteorological data of 2016, 2017, 2018 and 2019) are given. Results for other years are provided separately in Excel format (see Chapter 8). Unit: tonnes(N)/year.

| EEZ | Oxidised N | | Reduced N | | Total N | |
|--------|------------|------------|-----------|------------|---------|------------|
| | Actual | Normalized | Actual | Normalized | Actual | Normalized |
| EEZ048 | 21 956 | 22 752 | 14 813 | 13 519 | 36 769 | 36 270 |
| EEZ065 | 19 599 | 18 724 | 9 594 | 10 031 | 29 193 | 28 755 |
| EEZ071 | 39 487 | 36 011 | 26 422 | 20 837 | 65 909 | 56 848 |
| EEZ091 | 24 088 | 29 511 | 11 176 | 13 184 | 35 263 | 42 695 |
| EEZ099 | 468 | 485 | 405 | 401 | 873 | 886 |
| EEZ100 | 766 | 749 | 440 | 423 | 1 206 | 1 172 |
| EEZ108 | 41 066 | 39 858 | 39 470 | 34 787 | 80 536 | 74 645 |
| EEZ109 | 1 949 | 2 081 | 1 634 | 1 745 | 3 583 | 3 827 |
| EEZ110 | 628 | 660 | 775 | 775 | 1 402 | 1 434 |
| EEZ119 | 91 | 85 | 43 | 43 | 134 | 128 |
| EEZ123 | 1 405 | 1 692 | 835 | 836 | 2 240 | 2 528 |
| EEZ185 | 6 991 | 6 156 | 5 629 | 5 192 | 12 621 | 11 348 |
| EEZ187 | 73 | 61 | 52 | 46 | 125 | 107 |
| EEZ188 | 1 857 | 1 865 | 1 880 | 1 996 | 3 737 | 3 861 |
| EEZ189 | 30 557 | 30 143 | 25 260 | 25 953 | 55 817 | 56 096 |
| EEZ190 | 20 843 | 20 356 | 21 012 | 20 599 | 41 855 | 40 955 |
| EEZ191 | 33 439 | 30 966 | 27 088 | 26 678 | 60 527 | 57 644 |
| EEZ209 | 48 173 | 50 636 | 46 858 | 48 236 | 95 031 | 98 872 |
| EEZ212 | 14 268 | 15 355 | 10 728 | 9 058 | 24 996 | 24 413 |
| EEZ213 | 144 206 | 140 631 | 110 133 | 111 748 | 254 338 | 252 379 |
| EEZ215 | 17 632 | 18 961 | 10 566 | 10 056 | 28 197 | 29 016 |
| EEZ216 | 108 946 | 108 575 | 56 516 | 56 010 | 165 462 | 164 585 |
| EEZ224 | 8 280 | 10 103 | 5 028 | 4 834 | 13 309 | 14 937 |
| EEZ273 | 36 252 | 41 520 | 27 761 | 30 485 | 64 013 | 72 005 |

Table 15. Normalized deposition of oxidized nitrogen to the 24 EEZs in the OSPAR Maritime Area in the period 1995 to 2019. In the headers, only the numbers of the EEZs are given. For example, '065' means EEZ065 (Faeroe Exclusive Economic Zone). Unit: ktonnes(N)/year. The table continues on the next page.

| | 048 | 065 | 071 | 091 | 099 | 100 | 108 | 109 | 110 | 119 | 123 | 185 |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 1995 | 25 | 34 | 57 | 40 | 0.8 | 1.4 | 68 | 3.7 | 1.2 | 0.2 | 2.8 | 11 |
| 1996 | 25 | 33 | 56 | 40 | 0.8 | 1.4 | 67 | 3.6 | 1.2 | 0.1 | 2.8 | 11 |
| 1997 | 25 | 32 | 54 | 40 | 0.8 | 1.3 | 65 | 3.5 | 1.1 | 0.1 | 2.7 | 11 |
| 1998 | 25 | 32 | 54 | 41 | 0.8 | 1.3 | 64 | 3.5 | 1.1 | 0.1 | 2.7 | 10 |
| 1999 | 25 | 31 | 53 | 42 | 0.8 | 1.3 | 63 | 3.5 | 1.1 | 0.1 | 2.6 | 10 |
| 2000 | 26 | 31 | 53 | 43 | 0.8 | 1.3 | 63 | 3.5 | 1.1 | 0.1 | 2.6 | 10 |
| 2001 | 25 | 30 | 52 | 42 | 0.8 | 1.2 | 62 | 3.4 | 1.1 | 0.1 | 2.5 | 10 |
| 2002 | 25 | 29 | 51 | 42 | 0.8 | 1.2 | 61 | 3.3 | 1.1 | 0.1 | 2.5 | 10 |
| 2003 | 25 | 29 | 50 | 41 | 0.8 | 1.2 | 60 | 3.3 | 1.0 | 0.1 | 2.5 | 10 |
| 2004 | 25 | 28 | 50 | 41 | 0.8 | 1.2 | 59 | 3.2 | 1.0 | 0.1 | 2.4 | 9.3 |
| 2005 | 25 | 28 | 49 | 40 | 0.7 | 1.1 | 58 | 3.1 | 1.0 | 0.1 | 2.4 | 9.2 |
| 2006 | 25 | 27 | 48 | 39 | 0.7 | 1.1 | 57 | 3.1 | 1.0 | 0.1 | 2.3 | 9.0 |
| 2007 | 24 | 27 | 47 | 39 | 0.7 | 1.1 | 55 | 3.0 | 1.0 | 0.1 | 2.3 | 8.8 |
| 2008 | 24 | 25 | 45 | 35 | 0.6 | 1.0 | 52 | 2.7 | 0.9 | 0.1 | 2.2 | 8.2 |
| 2009 | 23 | 23 | 42 | 33 | 0.6 | 0.9 | 48 | 2.5 | 0.8 | 0.1 | 2.0 | 7.6 |
| 2010 | 24 | 23 | 42 | 34 | 0.6 | 0.9 | 48 | 2.6 | 0.8 | 0.1 | 2.0 | 7.7 |
| 2011 | 23 | 22 | 41 | 33 | 0.6 | 0.9 | 46 | 2.5 | 0.8 | 0.1 | 2.0 | 7.4 |
| 2012 | 23 | 22 | 41 | 32 | 0.6 | 0.9 | 46 | 2.4 | 0.8 | 0.1 | 2.0 | 7.3 |
| 2013 | 23 | 21 | 40 | 31 | 0.5 | 0.9 | 45 | 2.4 | 0.8 | 0.1 | 1.9 | 7.1 |
| 2014 | 22 | 20 | 38 | 29 | 0.5 | 0.8 | 42 | 2.2 | 0.7 | 0.1 | 1.8 | 6.7 |
| 2015 | 23 | 20 | 38 | 30 | 0.5 | 0.8 | 42 | 2.2 | 0.7 | 0.1 | 1.8 | 6.6 |
| 2016 | 23 | 19 | 37 | 29 | 0.5 | 0.8 | 41 | 2.1 | 0.7 | 0.1 | 1.8 | 6.4 |
| 2017 | 22 | 19 | 37 | 29 | 0.5 | 0.8 | 40 | 2.1 | 0.7 | 0.1 | 1.7 | 6.3 |
| 2018 | 22 | 19 | 36 | 29 | 0.5 | 0.7 | 40 | 2.0 | 0.6 | 0.1 | 1.7 | 6.1 |
| 2019 | 23 | 19 | 36 | 30 | 0.5 | 0.7 | 40 | 2.1 | 0.7 | 0.1 | 1.7 | 6.2 |

Table 15. Continued.

| | 187 | 188 | 189 | 190 | 191 | 209 | 212 | 213 | 215 | 216 | 224 | 273 |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 1995 | 0.1 | 3.6 | 61 | 40 | 59 | 87 | 22 | 279 | 25 | 190 | 16 | 65 |
| 1996 | 0.1 | 3.6 | 60 | 39 | 58 | 85 | 22 | 274 | 25 | 189 | 16 | 64 |
| 1997 | 0.1 | 3.4 | 57 | 37 | 56 | 83 | 22 | 262 | 25 | 183 | 16 | 63 |
| 1998 | 0.1 | 3.4 | 56 | 37 | 55 | 83 | 21 | 258 | 25 | 181 | 15 | 64 |
| 1999 | 0.1 | 3.3 | 55 | 36 | 53 | 83 | 21 | 251 | 24 | 177 | 15 | 64 |
| 2000 | 0.1 | 3.3 | 54 | 36 | 53 | 84 | 21 | 249 | 24 | 175 | 15 | 66 |
| 2001 | 0.1 | 3.3 | 53 | 35 | 52 | 82 | 21 | 244 | 24 | 172 | 15 | 64 |
| 2002 | 0.1 | 3.2 | 51 | 34 | 50 | 81 | 20 | 236 | 24 | 167 | 14 | 64 |
| 2003 | 0.1 | 3.1 | 50 | 33 | 50 | 79 | 20 | 232 | 24 | 165 | 14 | 63 |
| 2004 | 0.1 | 3.0 | 49 | 33 | 49 | 78 | 20 | 227 | 23 | 162 | 14 | 63 |
| 2005 | 0.1 | 3.0 | 49 | 32 | 48 | 77 | 20 | 224 | 23 | 160 | 14 | 62 |
| 2006 | 0.1 | 2.9 | 47 | 31 | 47 | 75 | 19 | 218 | 23 | 157 | 14 | 60 |
| 2007 | 0.1 | 2.8 | 46 | 30 | 45 | 73 | 19 | 212 | 23 | 154 | 13 | 59 |
| 2008 | 0.1 | 2.6 | 42 | 28 | 42 | 67 | 18 | 196 | 22 | 144 | 13 | 53 |
| 2009 | 0.1 | 2.4 | 39 | 26 | 39 | 62 | 17 | 178 | 21 | 134 | 12 | 50 |
| 2010 | 0.1 | 2.4 | 39 | 26 | 39 | 62 | 18 | 178 | 21 | 135 | 12 | 50 |
| 2011 | 0.1 | 2.3 | 37 | 25 | 38 | 60 | 17 | 171 | 21 | 131 | 12 | 48 |
| 2012 | 0.1 | 2.3 | 37 | 25 | 37 | 59 | 17 | 170 | 21 | 129 | 12 | 47 |
| 2013 | 0.1 | 2.2 | 36 | 24 | 36 | 57 | 17 | 164 | 20 | 125 | 11 | 45 |
| 2014 | 0.1 | 2.0 | 33 | 22 | 34 | 53 | 16 | 155 | 20 | 119 | 11 | 43 |
| 2015 | 0.1 | 2.0 | 33 | 22 | 34 | 54 | 16 | 153 | 20 | 117 | 11 | 43 |
| 2016 | 0.1 | 1.9 | 32 | 21 | 33 | 52 | 16 | 147 | 19 | 113 | 10 | 42 |
| 2017 | 0.1 | 1.9 | 31 | 21 | 32 | 51 | 16 | 143 | 19 | 110 | 10 | 42 |
| 2018 | 0.1 | 1.8 | 30 | 20 | 31 | 50 | 15 | 140 | 19 | 108 | 10 | 41 |
| 2019 | 0.1 | 1.9 | 30 | 20 | 31 | 51 | 15 | 141 | 19 | 109 | 10 | 42 |

Table 16. As Table 15, but for reduced nitrogen. The table continues on the next page.

| | 048 | 065 | 071 | 091 | 099 | 100 | 108 | 109 | 110 | 119 | 123 | 185 |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 1995 | 16 | 12 | 24 | 14 | 0.4 | 0.5 | 36 | 2.0 | 0.8 | 0.0 | 1.0 | 6.5 |
| 1996 | 16 | 12 | 24 | 15 | 0.4 | 0.5 | 37 | 2.0 | 0.9 | 0.0 | 1.0 | 6.4 |
| 1997 | 16 | 12 | 24 | 15 | 0.4 | 0.5 | 37 | 2.0 | 0.9 | 0.1 | 1.0 | 6.4 |
| 1998 | 16 | 12 | 24 | 15 | 0.4 | 0.5 | 38 | 2.0 | 0.9 | 0.1 | 1.0 | 6.4 |
| 1999 | 16 | 12 | 24 | 15 | 0.4 | 0.5 | 37 | 2.0 | 0.9 | 0.0 | 1.0 | 6.2 |
| 2000 | 16 | 11 | 23 | 15 | 0.4 | 0.5 | 37 | 2.0 | 0.9 | 0.0 | 0.9 | 6.0 |
| 2001 | 16 | 11 | 23 | 15 | 0.4 | 0.5 | 36 | 1.9 | 0.9 | 0.0 | 0.9 | 6.0 |
| 2002 | 15 | 11 | 22 | 15 | 0.4 | 0.5 | 36 | 1.9 | 0.8 | 0.0 | 0.9 | 5.9 |
| 2003 | 15 | 11 | 22 | 14 | 0.4 | 0.4 | 36 | 1.9 | 0.8 | 0.0 | 0.9 | 5.8 |
| 2004 | 15 | 11 | 22 | 14 | 0.4 | 0.4 | 35 | 1.8 | 0.8 | 0.0 | 0.9 | 5.7 |
| 2005 | 14 | 10 | 22 | 14 | 0.4 | 0.4 | 35 | 1.8 | 0.8 | 0.0 | 0.9 | 5.7 |
| 2006 | 14 | 10 | 22 | 14 | 0.4 | 0.4 | 35 | 1.8 | 0.8 | 0.0 | 0.9 | 5.6 |
| 2007 | 14 | 10 | 22 | 14 | 0.4 | 0.4 | 34 | 1.8 | 0.8 | 0.0 | 0.9 | 5.6 |
| 2008 | 14 | 10 | 21 | 13 | 0.4 | 0.4 | 34 | 1.8 | 0.8 | 0.0 | 0.8 | 5.5 |
| 2009 | 13 | 10 | 21 | 13 | 0.4 | 0.4 | 34 | 1.8 | 0.8 | 0.0 | 0.8 | 5.4 |
| 2010 | 13 | 10 | 21 | 13 | 0.4 | 0.4 | 34 | 1.8 | 0.8 | 0.0 | 0.8 | 5.4 |
| 2011 | 13 | 10 | 21 | 13 | 0.4 | 0.4 | 33 | 1.7 | 0.8 | 0.0 | 0.8 | 5.3 |
| 2012 | 13 | 10 | 21 | 12 | 0.4 | 0.4 | 34 | 1.7 | 0.8 | 0.0 | 0.8 | 5.3 |
| 2013 | 13 | 10 | 21 | 12 | 0.4 | 0.4 | 34 | 1.7 | 0.8 | 0.0 | 0.8 | 5.3 |
| 2014 | 13 | 10 | 21 | 13 | 0.4 | 0.4 | 34 | 1.8 | 0.8 | 0.0 | 0.8 | 5.3 |
| 2015 | 14 | 10 | 21 | 13 | 0.4 | 0.4 | 35 | 1.8 | 0.8 | 0.0 | 0.9 | 5.4 |
| 2016 | 14 | 10 | 21 | 13 | 0.4 | 0.4 | 35 | 1.8 | 0.8 | 0.0 | 0.9 | 5.3 |
| 2017 | 14 | 10 | 22 | 13 | 0.4 | 0.4 | 36 | 1.8 | 0.8 | 0.0 | 0.9 | 5.4 |
| 2018 | 14 | 10 | 21 | 13 | 0.4 | 0.4 | 36 | 1.8 | 0.8 | 0.0 | 0.9 | 5.3 |
| 2019 | 14 | 10 | 21 | 13 | 0.4 | 0.4 | 35 | 1.7 | 0.8 | 0.0 | 0.8 | 5.2 |

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

Table 16. Continued.

| | 187 | 188 | 189 | 190 | 191 | 209 | 212 | 213 | 215 | 216 | 224 | 273 |
|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 1995 | 0.1 | 2.8 | 35 | 26 | 34 | 53 | 11 | 127 | 11 | 66 | 5.6 | 32 |
| 1996 | 0.1 | 2.9 | 35 | 26 | 34 | 54 | 11 | 129 | 11 | 67 | 5.7 | 33 |
| 1997 | 0.1 | 2.8 | 35 | 26 | 34 | 54 | 11 | 130 | 11 | 67 | 5.6 | 33 |
| 1998 | 0.1 | 2.8 | 34 | 26 | 33 | 54 | 11 | 130 | 11 | 66 | 5.6 | 34 |
| 1999 | 0.1 | 2.8 | 34 | 25 | 33 | 54 | 10 | 129 | 11 | 66 | 5.6 | 34 |
| 2000 | 0.1 | 2.4 | 31 | 24 | 31 | 54 | 10 | 124 | 11 | 63 | 5.4 | 34 |
| 2001 | 0.1 | 2.4 | 31 | 24 | 31 | 54 | 10 | 122 | 11 | 62 | 5.3 | 34 |
| 2002 | 0.1 | 2.3 | 30 | 23 | 30 | 52 | 10 | 120 | 10 | 61 | 5.2 | 33 |
| 2003 | 0.1 | 2.3 | 29 | 23 | 30 | 52 | 10 | 119 | 10 | 60 | 5.2 | 33 |
| 2004 | 0.0 | 2.2 | 29 | 22 | 30 | 51 | 10 | 117 | 10 | 60 | 5.1 | 33 |
| 2005 | 0.0 | 2.2 | 28 | 22 | 29 | 50 | 10 | 116 | 10 | 60 | 5.1 | 32 |
| 2006 | 0.0 | 2.2 | 28 | 22 | 29 | 50 | 9.4 | 115 | 10 | 59 | 5.0 | 31 |
| 2007 | 0.0 | 2.1 | 28 | 22 | 29 | 50 | 9.4 | 114 | 10 | 59 | 5.0 | 32 |
| 2008 | 0.0 | 2.1 | 27 | 22 | 28 | 49 | 9.2 | 110 | 10 | 58 | 4.9 | 30 |
| 2009 | 0.0 | 2.1 | 27 | 22 | 28 | 49 | 9.1 | 110 | 10 | 57 | 4.9 | 30 |
| 2010 | 0.0 | 2.1 | 27 | 22 | 28 | 49 | 9.1 | 111 | 10 | 57 | 4.9 | 30 |
| 2011 | 0.0 | 2.1 | 27 | 21 | 27 | 48 | 9.1 | 109 | 10 | 57 | 4.8 | 29 |
| 2012 | 0.0 | 2.0 | 26 | 21 | 27 | 48 | 9.1 | 110 | 10 | 57 | 4.8 | 29 |
| 2013 | 0.0 | 2.0 | 26 | 21 | 27 | 48 | 9.1 | 109 | 10 | 57 | 4.8 | 29 |
| 2014 | 0.0 | 2.1 | 27 | 22 | 27 | 49 | 9.2 | 111 | 10 | 57 | 4.9 | 30 |
| 2015 | 0.0 | 2.1 | 27 | 22 | 28 | 49 | 9.3 | 113 | 10 | 58 | 4.9 | 30 |
| 2016 | 0.0 | 2.1 | 27 | 22 | 27 | 49 | 9.3 | 114 | 10 | 58 | 5.0 | 31 |
| 2017 | 0.0 | 2.1 | 27 | 22 | 28 | 50 | 9.3 | 115 | 10 | 58 | 5.0 | 31 |
| 2018 | 0.0 | 2.0 | 27 | 21 | 27 | 49 | 9.2 | 114 | 10 | 58 | 4.9 | 31 |
| 2019 | 0.0 | 2.0 | 26 | 21 | 27 | 48 | 9.1 | 112 | 10 | 56 | 4.8 | 30 |

5.3 Depositions to partial EEZs

Actual (non-normalized) atmospheric nitrogen depositions have been computed for each of the twenty-five partial Exclusive Economic Zones listed in Table 7, for each year of the period 1990-2019. Results are shown for total nitrogen depositions during the 1995-2019 period in Figure 12.

Table 17 lists the percentage differences between 1995 and 2019, and between the two 5-year periods of 1995-1999 and 2015-2019 for actual depositions.

Normalized results are listed for oxidized and reduced nitrogen in Tables 18 and 19, respectively, and for the whole period from 1995 to 2019.

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

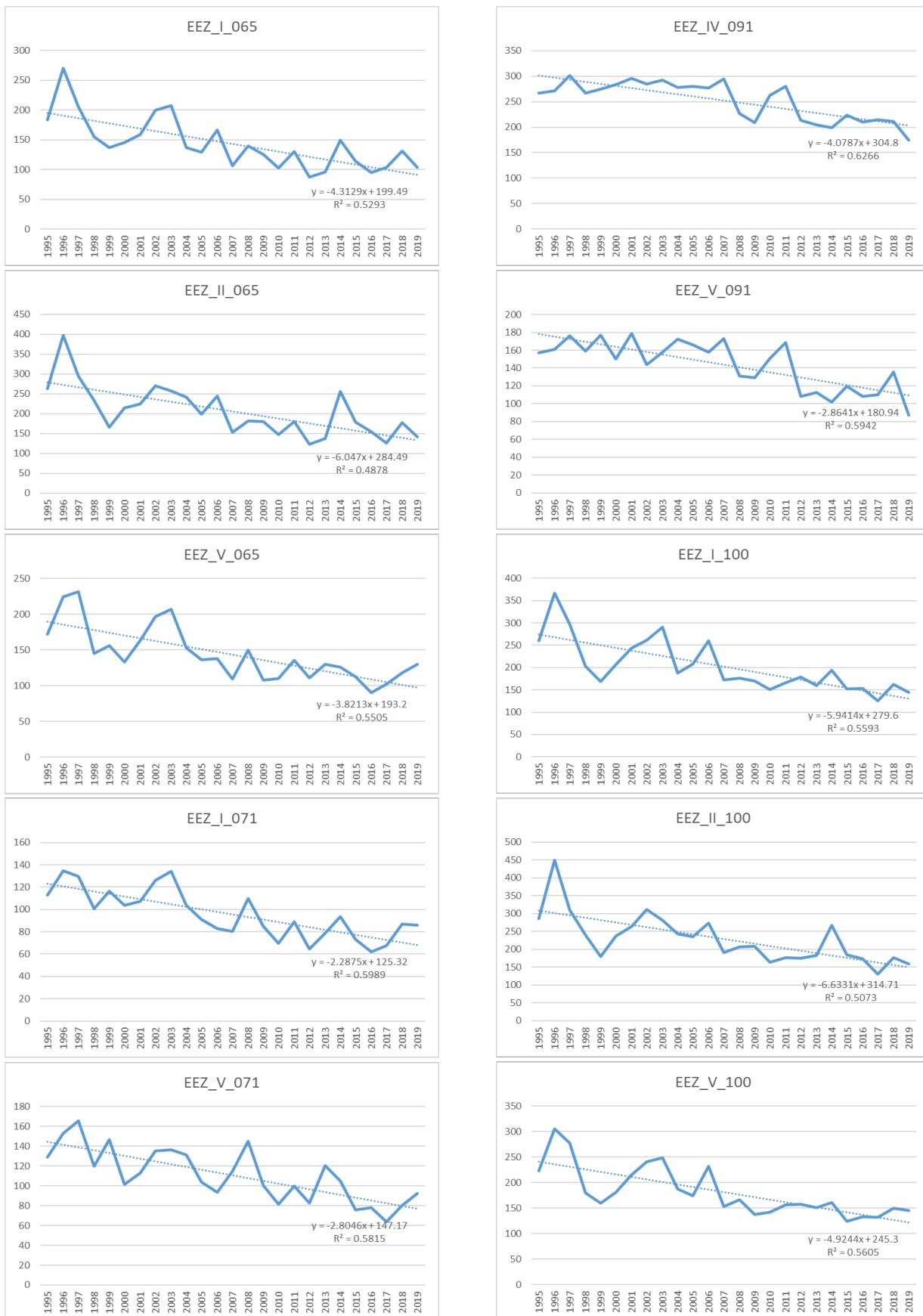
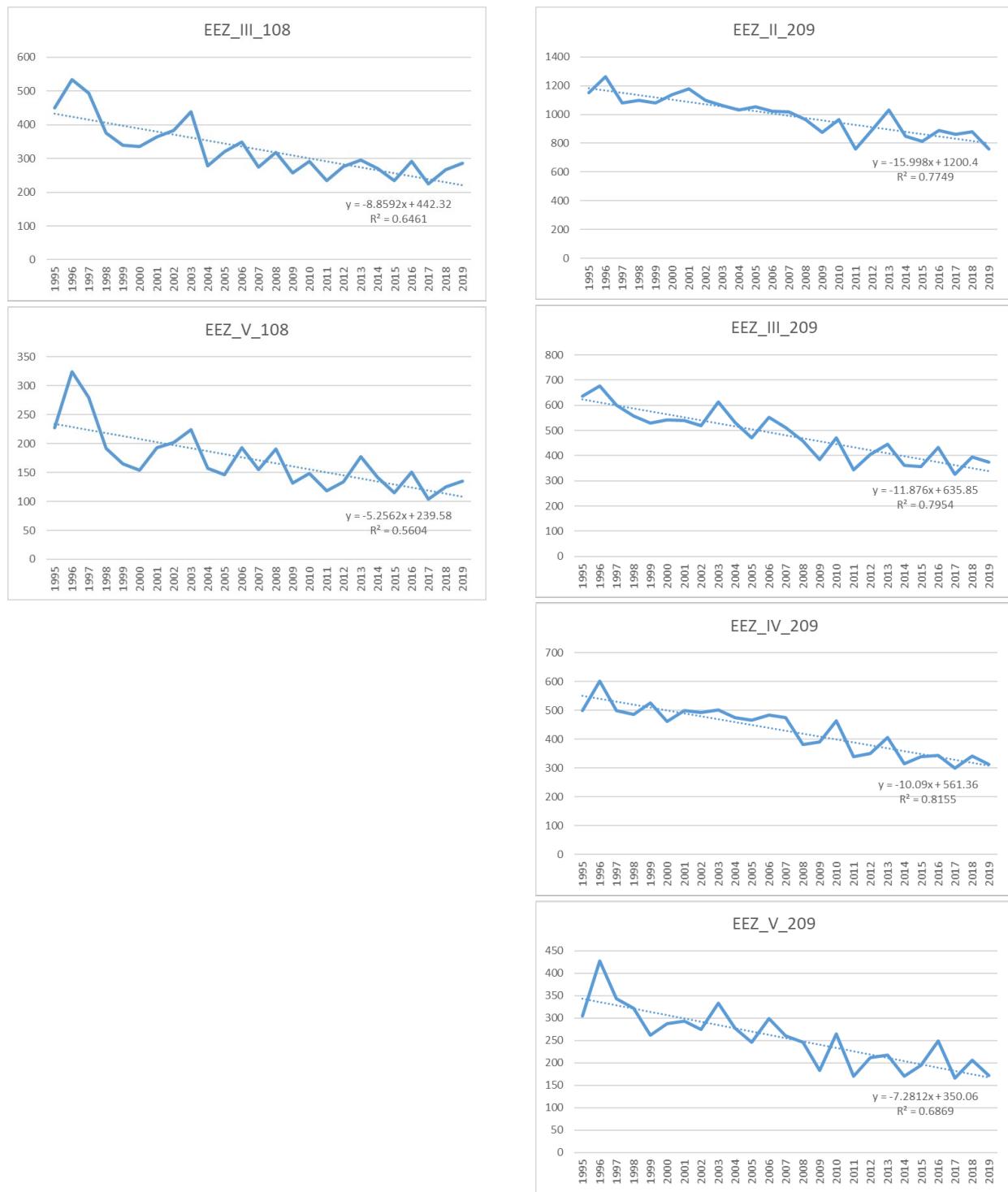


Figure 12: Time series of actual depositions of total nitrogen to the partial EEZs listed in Table 7, as calculated by the EMEP MSC-W model for the period 1995-2019. Linear regression lines, with coefficients of determination (R^2), are indicated in the figure. Unit: mg(N)/m²/year. (Figure continues on the next 2 pages.)

**Figure 12:** Continued.

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

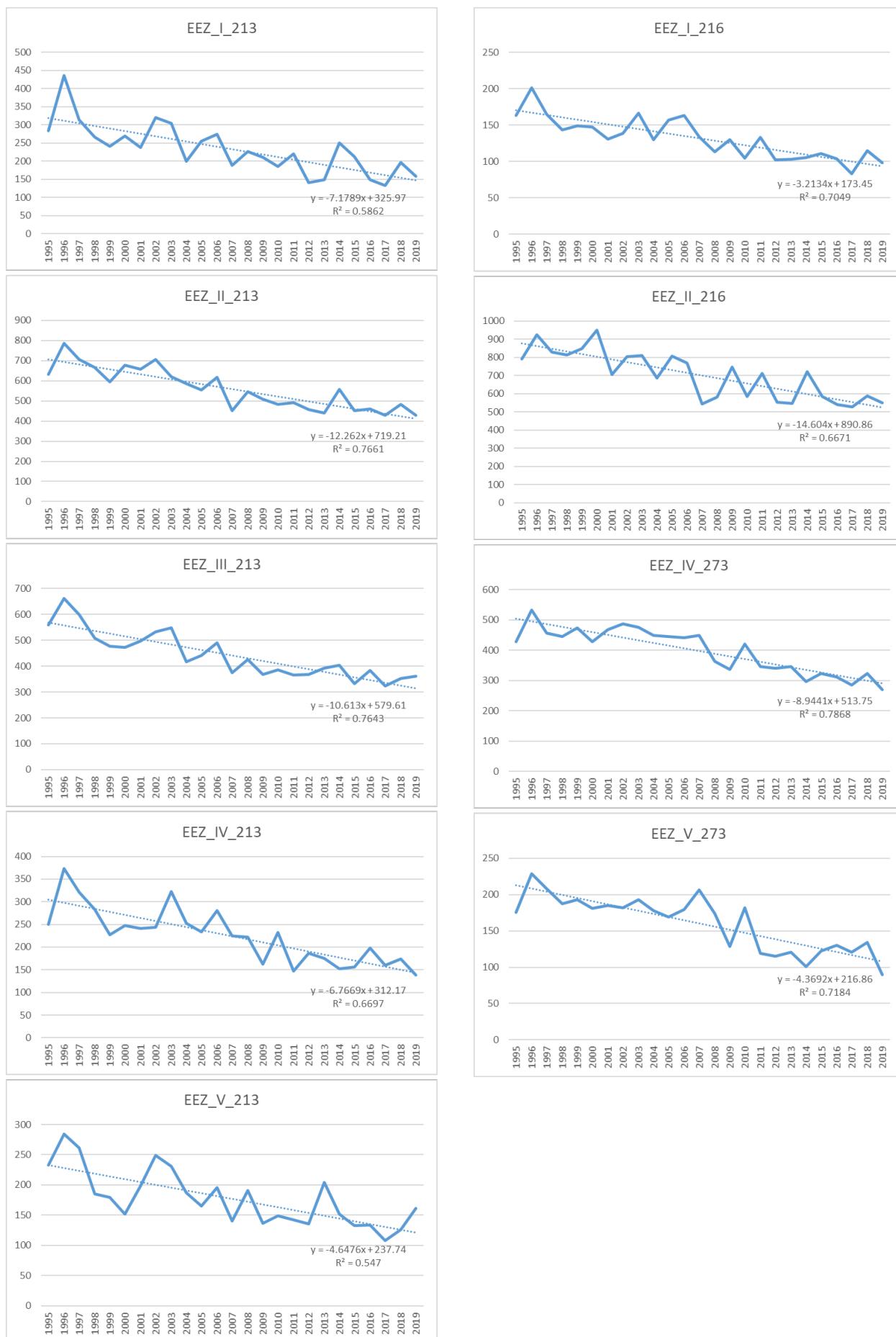


Figure 12: Continued.

Table 17. Percentage differences in 2019 compared to 1995 for oxidised, reduced and total nitrogen, in the twenty-five partial Exclusive Economic Zones listed in Table 7. Also shown are the percentage differences in the 5-year period 2015–2019 with respect to the 5-year period of 1995–1999.

| EEZ | Oxidised N | | Reduced N | | Total N | |
|-------------|------------|-----------------------------|-----------|-----------------------------|-----------|-----------------------------|
| | 1995→2019 | (1995-1999) →(2015-2019) | 1995→2019 | (1995-1999) →(2015-2019) | 1995→2019 | (1995-1999) →(2015-2019) |
| EEZ_I_065 | -48 % | -49 % | -32 % | -24 % | -44 % | -42 % |
| EEZ_II_065 | -49 % | -50 % | -38 % | -23 % | -46 % | -43 % |
| EEZ_V_065 | -36 % | -49 % | 5 % | -17 % | -25 % | -41 % |
| EEZ_I_071 | -39 % | -46 % | 20 % | -9 % | -24 % | -37 % |
| EEZ_V_071 | -42 % | -54 % | 9 % | -22 % | -28 % | -45 % |
| EEZ_IV_091 | -43 % | -33 % | -2 % | 4 % | -34 % | -25 % |
| EEZ_V_091 | -52 % | -40 % | -15 % | -5 % | -44 % | -32 % |
| EEZ_I_100 | -51 % | -49 % | -28 % | -26 % | -45 % | -43 % |
| EEZ_II_100 | -50 % | -50 % | -29 % | -25 % | -44 % | -44 % |
| EEZ_V_100 | -44 % | -48 % | -11 % | -19 % | -35 % | -40 % |
| EEZ_III_108 | -56 % | -56 % | -2 % | -14 % | -36 % | -41 % |
| EEZ_V_108 | -54 % | -56 % | -2 % | -23 % | -41 % | -47 % |
| EEZ_II_209 | -49 % | -41 % | -11 % | -4 % | -34 % | -26 % |
| EEZ_III_209 | -53 % | -48 % | -19 % | -17 % | -41 % | -37 % |
| EEZ_IV_209 | -52 % | -49 % | -7 % | -16 % | -37 % | -37 % |
| EEZ_V_209 | -55 % | -51 % | -11 % | -11 % | -44 % | -40 % |
| EEZ_I_213 | -47 % | -49 % | -36 % | -34 % | -44 % | -45 % |
| EEZ_II_213 | -42 % | -45 % | -7 % | -7 % | -32 % | -34 % |
| EEZ_III_213 | -51 % | -51 % | -9 % | -14 % | -36 % | -38 % |
| EEZ_IV_213 | -56 % | -52 % | -9 % | -18 % | -45 % | -43 % |
| EEZ_V_213 | -44 % | -51 % | 3 % | -19 % | -31 % | -42 % |
| EEZ_I_216 | -46 % | -43 % | -18 % | -23 % | -40 % | -38 % |
| EEZ_II_216 | -38 % | -40 % | -13 % | -19 % | -31 % | -34 % |
| EEZ_IV_273 | -50 % | -45 % | -6 % | -15 % | -37 % | -35 % |
| EEZ_V_273 | -58 % | -48 % | -16 % | -17 % | -49 % | -40 % |

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

Table 18. Normalized deposition of oxidized nitrogen to *partial EEZs*. In the headers, only the numbers of the EEZs are given. For example, 'II_065' means the part of EEZ065 (Faeroe Exclusive Economic Zone) that falls within OSPAR Region II. Unit: ktonnes(N)/year. The table continues on the next page.

| | I_065 | II_065 | V_065 | I_071 | V_071 | IV_091 | V_091 | I_100 | II_100 | V_100 | III_108 | V_108 |
|-------------|-----------|------------|------------|-----------|------------|-----------|-----------|------------|------------|------------|-----------|-----------|
| 1995 | 26 | 1.9 | 6.5 | 46 | 11 | 26 | 14 | 0.7 | 0.0 | 0.7 | 33 | 35 |
| 1996 | 25 | 1.9 | 6.4 | 46 | 11 | 26 | 14 | 0.7 | 0.0 | 0.7 | 32 | 35 |
| 1997 | 24 | 1.8 | 6.2 | 44 | 10 | 26 | 14 | 0.6 | 0.0 | 0.7 | 31 | 34 |
| 1998 | 24 | 1.8 | 6.1 | 44 | 10 | 26 | 14 | 0.6 | 0.0 | 0.7 | 31 | 34 |
| 1999 | 23 | 1.7 | 5.9 | 43 | 10 | 27 | 15 | 0.6 | 0.0 | 0.7 | 31 | 33 |
| 2000 | 23 | 1.7 | 5.9 | 43 | 10 | 28 | 15 | 0.6 | 0.0 | 0.7 | 31 | 33 |
| 2001 | 23 | 1.7 | 5.8 | 42 | 10 | 27 | 15 | 0.6 | 0.0 | 0.7 | 30 | 33 |
| 2002 | 22 | 1.6 | 5.6 | 41 | 10 | 27 | 15 | 0.6 | 0.0 | 0.6 | 29 | 32 |
| 2003 | 22 | 1.6 | 5.5 | 40 | 10 | 27 | 15 | 0.6 | 0.0 | 0.6 | 29 | 31 |
| 2004 | 21 | 1.6 | 5.4 | 40 | 10 | 26 | 14 | 0.6 | 0.0 | 0.6 | 28 | 31 |
| 2005 | 21 | 1.5 | 5.4 | 39 | 10 | 26 | 14 | 0.6 | 0.0 | 0.6 | 28 | 30 |
| 2006 | 21 | 1.5 | 5.3 | 39 | 9.4 | 25 | 14 | 0.5 | 0.0 | 0.6 | 27 | 30 |
| 2007 | 20 | 1.5 | 5.1 | 38 | 9.2 | 25 | 14 | 0.5 | 0.0 | 0.6 | 27 | 29 |
| 2008 | 19 | 1.4 | 4.8 | 36 | 8.8 | 23 | 13 | 0.5 | 0.0 | 0.5 | 25 | 27 |
| 2009 | 17 | 1.3 | 4.4 | 34 | 8.4 | 21 | 12 | 0.4 | 0.0 | 0.5 | 22 | 25 |
| 2010 | 17 | 1.3 | 4.4 | 34 | 8.4 | 22 | 12 | 0.4 | 0.0 | 0.5 | 22 | 25 |
| 2011 | 17 | 1.2 | 4.2 | 33 | 8.1 | 21 | 12 | 0.4 | 0.0 | 0.5 | 22 | 25 |
| 2012 | 17 | 1.2 | 4.2 | 33 | 8.1 | 20 | 11 | 0.4 | 0.0 | 0.5 | 21 | 24 |
| 2013 | 16 | 1.2 | 4.1 | 32 | 7.9 | 20 | 11 | 0.4 | 0.0 | 0.5 | 21 | 24 |
| 2014 | 15 | 1.1 | 3.9 | 31 | 7.7 | 18 | 10 | 0.4 | 0.0 | 0.4 | 20 | 23 |
| 2015 | 15 | 1.1 | 3.9 | 31 | 7.7 | 19 | 11 | 0.4 | 0.0 | 0.4 | 20 | 23 |
| 2016 | 15 | 1.0 | 3.8 | 30 | 7.5 | 19 | 10 | 0.4 | 0.0 | 0.4 | 19 | 22 |
| 2017 | 14 | 1.0 | 3.7 | 29 | 7.4 | 19 | 10 | 0.4 | 0.0 | 0.4 | 19 | 22 |
| 2018 | 14 | 1.0 | 3.6 | 29 | 7.3 | 18 | 10 | 0.4 | 0.0 | 0.4 | 18 | 21 |
| 2019 | 14 | 1.0 | 3.6 | 29 | 7.3 | 19 | 11 | 0.4 | 0.0 | 0.4 | 18 | 21 |

Table 18. Continued.

| | II_209 | III_209 | IV_209 | V_209 | I_213 | II_213 | III_213 | IV_213 | V_213 | I_216 | II_216 | IV_273 | V_273 |
|-------------|---------------|----------------|---------------|--------------|--------------|---------------|----------------|---------------|--------------|--------------|---------------|---------------|--------------|
| 1995 | 19 | 14 | 53 | 0.5 | 5.7 | 185 | 66 | 0.4 | 21 | 87 | 103 | 54 | 11 |
| 1996 | 19 | 14 | 52 | 0.5 | 5.6 | 182 | 65 | 0.4 | 21 | 87 | 102 | 54 | 10 |
| 1997 | 18 | 14 | 51 | 0.5 | 5.4 | 174 | 63 | 0.4 | 20 | 85 | 98 | 53 | 10 |
| 1998 | 18 | 14 | 51 | 0.5 | 5.3 | 170 | 62 | 0.4 | 20 | 84 | 96 | 53 | 10 |
| 1999 | 18 | 14 | 51 | 0.5 | 5.2 | 166 | 61 | 0.4 | 20 | 83 | 94 | 54 | 10 |
| 2000 | 18 | 14 | 52 | 0.5 | 5.2 | 164 | 60 | 0.4 | 20 | 82 | 93 | 55 | 11 |
| 2001 | 18 | 14 | 51 | 0.5 | 5.1 | 161 | 59 | 0.4 | 19 | 81 | 91 | 54 | 10 |
| 2002 | 17 | 13 | 50 | 0.5 | 4.9 | 155 | 57 | 0.4 | 19 | 79 | 88 | 54 | 10 |
| 2003 | 17 | 13 | 49 | 0.5 | 4.8 | 152 | 56 | 0.4 | 18 | 78 | 87 | 53 | 10 |
| 2004 | 17 | 13 | 49 | 0.5 | 4.7 | 149 | 55 | 0.4 | 18 | 77 | 85 | 53 | 10 |
| 2005 | 16 | 13 | 48 | 0.5 | 4.7 | 147 | 55 | 0.4 | 18 | 76 | 84 | 52 | 10 |
| 2006 | 16 | 12 | 46 | 0.5 | 4.6 | 143 | 53 | 0.4 | 17 | 75 | 82 | 50 | 10 |
| 2007 | 15 | 12 | 45 | 0.5 | 4.5 | 139 | 52 | 0.4 | 17 | 73 | 80 | 49 | 10 |
| 2008 | 14 | 11 | 41 | 0.4 | 4.2 | 128 | 48 | 0.3 | 16 | 69 | 75 | 45 | 8.8 |
| 2009 | 13 | 10 | 38 | 0.4 | 3.8 | 116 | 43 | 0.3 | 15 | 65 | 69 | 41 | 8.2 |
| 2010 | 13 | 10 | 38 | 0.4 | 3.9 | 117 | 43 | 0.3 | 15 | 66 | 69 | 41 | 8.3 |
| 2011 | 13 | 10 | 37 | 0.4 | 3.7 | 111 | 41 | 0.3 | 14 | 64 | 66 | 40 | 8.1 |
| 2012 | 12 | 10 | 37 | 0.4 | 3.7 | 111 | 41 | 0.3 | 14 | 63 | 66 | 39 | 8.0 |
| 2013 | 12 | 10 | 35 | 0.4 | 3.6 | 107 | 40 | 0.3 | 14 | 62 | 64 | 38 | 7.7 |
| 2014 | 11 | 8.9 | 33 | 0.3 | 3.4 | 101 | 38 | 0.3 | 13 | 59 | 60 | 36 | 7.3 |
| 2015 | 11 | 8.9 | 33 | 0.3 | 3.4 | 99 | 38 | 0.3 | 13 | 58 | 59 | 36 | 7.4 |
| 2016 | 11 | 8.7 | 32 | 0.3 | 3.2 | 95 | 36 | 0.3 | 12 | 56 | 57 | 35 | 7.2 |
| 2017 | 10 | 8.5 | 32 | 0.3 | 3.1 | 92 | 35 | 0.3 | 12 | 55 | 55 | 35 | 7.1 |
| 2018 | 10 | 8.3 | 31 | 0.3 | 3.1 | 90 | 35 | 0.3 | 12 | 54 | 54 | 34 | 7.0 |
| 2019 | 10 | 8.6 | 31 | 0.3 | 3.1 | 91 | 35 | 0.3 | 12 | 54 | 54 | 34 | 7.2 |

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Table 19. As Table 18, but for reduced nitrogen. The table continues on the next page.

| | I_065 | II_065 | V_065 | I_071 | V_071 | IV_091 | V_091 | I_100 | II_100 | V_100 | III_108 | V_108 |
|-------------|-------|--------|-------|-------|-------|--------|-------|-------|--------|-------|---------|-------|
| 1995 | 8.6 | 0.6 | 2.3 | 19 | 5.0 | 9 | 5.0 | 0.2 | 0.0 | 0.3 | 21 | 15 |
| 1996 | 8.7 | 0.6 | 2.4 | 19 | 5.1 | 10 | 5.3 | 0.2 | 0.0 | 0.3 | 22 | 16 |
| 1997 | 8.7 | 0.6 | 2.4 | 19 | 5.1 | 10 | 5.3 | 0.2 | 0.0 | 0.3 | 22 | 16 |
| 1998 | 8.7 | 0.6 | 2.4 | 19 | 5.1 | 10 | 5.3 | 0.2 | 0.0 | 0.3 | 22 | 16 |
| 1999 | 8.6 | 0.6 | 2.4 | 19 | 5.0 | 10 | 5.4 | 0.2 | 0.0 | 0.3 | 22 | 16 |
| 2000 | 8.3 | 0.6 | 2.3 | 18 | 4.9 | 10 | 5.3 | 0.2 | 0.0 | 0.3 | 22 | 15 |
| 2001 | 8.2 | 0.6 | 2.3 | 18 | 4.8 | 10 | 5.3 | 0.2 | 0.0 | 0.3 | 21 | 15 |
| 2002 | 8.0 | 0.6 | 2.2 | 18 | 4.7 | 9.5 | 5.2 | 0.2 | 0.0 | 0.2 | 21 | 15 |
| 2003 | 7.9 | 0.6 | 2.2 | 17 | 4.7 | 9.2 | 5.1 | 0.2 | 0.0 | 0.2 | 21 | 15 |
| 2004 | 7.8 | 0.6 | 2.2 | 17 | 4.6 | 9.2 | 5.1 | 0.2 | 0.0 | 0.2 | 21 | 14 |
| 2005 | 7.8 | 0.6 | 2.2 | 17 | 4.6 | 8.9 | 4.9 | 0.2 | 0.0 | 0.2 | 21 | 14 |
| 2006 | 7.7 | 0.6 | 2.1 | 17 | 4.6 | 8.7 | 4.9 | 0.2 | 0.0 | 0.2 | 21 | 14 |
| 2007 | 7.7 | 0.6 | 2.1 | 17 | 4.5 | 8.9 | 4.9 | 0.2 | 0.0 | 0.2 | 20 | 14 |
| 2008 | 7.5 | 0.6 | 2.1 | 17 | 4.4 | 8.4 | 4.7 | 0.2 | 0.0 | 0.2 | 20 | 14 |
| 2009 | 7.4 | 0.5 | 2.1 | 17 | 4.4 | 8.2 | 4.6 | 0.2 | 0.0 | 0.2 | 20 | 14 |
| 2010 | 7.4 | 0.6 | 2.1 | 17 | 4.4 | 8.2 | 4.6 | 0.2 | 0.0 | 0.2 | 20 | 14 |
| 2011 | 7.3 | 0.5 | 2.0 | 16 | 4.4 | 8.1 | 4.5 | 0.2 | 0.0 | 0.2 | 19 | 14 |
| 2012 | 7.4 | 0.5 | 2.0 | 16 | 4.4 | 7.9 | 4.5 | 0.2 | 0.0 | 0.2 | 20 | 14 |
| 2013 | 7.3 | 0.5 | 2.0 | 16 | 4.4 | 7.9 | 4.5 | 0.2 | 0.0 | 0.2 | 20 | 14 |
| 2014 | 7.5 | 0.6 | 2.1 | 17 | 4.4 | 8.2 | 4.6 | 0.2 | 0.0 | 0.2 | 20 | 14 |
| 2015 | 7.6 | 0.6 | 2.1 | 17 | 4.5 | 8.3 | 4.7 | 0.2 | 0.0 | 0.2 | 21 | 14 |
| 2016 | 7.6 | 0.6 | 2.1 | 17 | 4.5 | 8.4 | 4.7 | 0.2 | 0.0 | 0.2 | 21 | 14 |
| 2017 | 7.6 | 0.6 | 2.1 | 17 | 4.5 | 8.6 | 4.8 | 0.2 | 0.0 | 0.2 | 21 | 14 |
| 2018 | 7.6 | 0.6 | 2.1 | 17 | 4.5 | 8.5 | 4.8 | 0.2 | 0.0 | 0.2 | 22 | 14 |
| 2019 | 7.4 | 0.5 | 2.1 | 16 | 4.4 | 8.5 | 4.7 | 0.2 | 0.0 | 0.2 | 21 | 14 |

Table 19. Continued.

| | II_209 | III_209 | IV_209 | V_209 | I_213 | II_213 | III_213 | IV_213 | V_213 | I_216 | II_216 | IV_273 | V_273 |
|-------------|---------------|----------------|---------------|--------------|--------------|---------------|----------------|---------------|--------------|--------------|---------------|---------------|--------------|
| 1995 | 13 | 8.0 | 31 | 0.2 | 1.7 | 79 | 38 | 0.2 | 8.6 | 27 | 40 | 28 | 4.5 |
| 1996 | 14 | 8.1 | 32 | 0.2 | 1.8 | 80 | 39 | 0.2 | 8.8 | 27 | 40 | 29 | 4.6 |
| 1997 | 14 | 8.1 | 32 | 0.2 | 1.8 | 80 | 39 | 0.2 | 8.9 | 27 | 40 | 29 | 4.6 |
| 1998 | 14 | 8.1 | 32 | 0.2 | 1.8 | 80 | 39 | 0.2 | 8.9 | 27 | 40 | 29 | 4.6 |
| 1999 | 14 | 8.1 | 32 | 0.2 | 1.7 | 79 | 39 | 0.2 | 8.8 | 26 | 39 | 30 | 4.7 |
| 2000 | 13 | 8.2 | 32 | 0.2 | 1.7 | 76 | 38 | 0.2 | 8.5 | 25 | 37 | 29 | 4.6 |
| 2001 | 13 | 8.1 | 32 | 0.2 | 1.6 | 75 | 37 | 0.2 | 8.4 | 25 | 37 | 29 | 4.6 |
| 2002 | 13 | 7.9 | 31 | 0.2 | 1.6 | 73 | 37 | 0.2 | 8.3 | 25 | 36 | 29 | 4.5 |
| 2003 | 13 | 7.8 | 31 | 0.2 | 1.6 | 72 | 37 | 0.2 | 8.2 | 25 | 36 | 29 | 4.4 |
| 2004 | 13 | 7.7 | 31 | 0.2 | 1.6 | 71 | 36 | 0.2 | 8.1 | 24 | 36 | 28 | 4.4 |
| 2005 | 12 | 7.6 | 30 | 0.2 | 1.6 | 71 | 36 | 0.2 | 8.1 | 24 | 35 | 27 | 4.3 |
| 2006 | 12 | 7.5 | 30 | 0.2 | 1.6 | 70 | 36 | 0.2 | 8.0 | 24 | 35 | 27 | 4.2 |
| 2007 | 12 | 7.6 | 30 | 0.2 | 1.5 | 69 | 35 | 0.2 | 7.9 | 24 | 35 | 27 | 4.3 |
| 2008 | 12 | 7.5 | 29 | 0.2 | 1.5 | 67 | 34 | 0.2 | 7.7 | 24 | 34 | 26 | 4.1 |
| 2009 | 12 | 7.4 | 29 | 0.2 | 1.5 | 67 | 34 | 0.2 | 7.7 | 23 | 34 | 26 | 4.1 |
| 2010 | 12 | 7.4 | 29 | 0.2 | 1.5 | 67 | 34 | 0.2 | 7.7 | 23 | 34 | 26 | 4.1 |
| 2011 | 12 | 7.3 | 29 | 0.2 | 1.5 | 66 | 34 | 0.2 | 7.6 | 23 | 33 | 25 | 4.0 |
| 2012 | 12 | 7.3 | 29 | 0.2 | 1.5 | 66 | 34 | 0.2 | 7.7 | 23 | 33 | 25 | 4.0 |
| 2013 | 12 | 7.3 | 29 | 0.2 | 1.5 | 66 | 34 | 0.2 | 7.6 | 23 | 33 | 25 | 4.0 |
| 2014 | 12 | 7.4 | 29 | 0.2 | 1.5 | 68 | 34 | 0.2 | 7.7 | 23 | 34 | 26 | 4.1 |
| 2015 | 12 | 7.5 | 29 | 0.2 | 1.5 | 68 | 35 | 0.2 | 7.9 | 24 | 34 | 26 | 4.2 |
| 2016 | 12 | 7.5 | 30 | 0.2 | 1.5 | 69 | 36 | 0.2 | 8.0 | 24 | 34 | 26 | 4.2 |
| 2017 | 12 | 7.5 | 30 | 0.2 | 1.5 | 69 | 36 | 0.2 | 8.0 | 24 | 34 | 27 | 4.2 |
| 2018 | 12 | 7.5 | 30 | 0.2 | 1.5 | 68 | 36 | 0.2 | 8.1 | 24 | 34 | 27 | 4.2 |
| 2019 | 12 | 7.3 | 29 | 0.2 | 1.5 | 67 | 35 | 0.2 | 7.8 | 23 | 33 | 26 | 4.1 |

5.4 Depositions to COMP4 Assessment Units

For the first time this year, airborne nitrogen depositions were calculated for the COMP4 Assessment Units. Some of these areas are very small and/or have a rather thin and elongated shape, so that they are poorly resolved by the EMEP model grid.

A detailed uncertainty analysis was beyond the scope of this contract, but as a rule of thumb, areas should extend over at least 3 model grid cells (both in east-west and in south-east direction) to give numerically stable results in source-receptor calculations. Since source-receptor calculations are used to calculate transfer coefficients, and transfer coefficients are needed for our normalization procedure, the resolution of our source-receptor calculations (i.e. $0.3^\circ\text{lon} \times 0.2^\circ\text{lat}$) is a limiting factor. A 3×3 array of grid cells (fulfilling the above-mentioned criterion for numerical stability) in this resolution has sizes between about 1000 and 6000 km^2 , depending on the latitude within the OSPAR Maritime Area. However, since many of the COMP4 Assessment Units also have a very thin and elongated shape, we recommend that only the results for those Units larger than about 10 000 km^2 be considered as reasonably certain (this applies to the 24 Units shown in Figure 8).

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In the case of actual (non-normalized) results the requirement is much less strict because they are based on our $0.1^\circ \times 0.1^\circ$ trend simulations and do not make use of any transfer coefficients. Actual depositions for COMP4 Assessment Units as small as 1000 km^2 , and even smaller (if they are not too thin and elongated), can be considered as reasonably certain. Statements about long-term trends and the relative differences between depositions to COMP Assessment Units are in any case more certain than the absolute numbers.

Independently of these uncertainty considerations, normalized and actual atmospheric nitrogen depositions have been computed in this contract for all the sixty-seven COMP4 Assessment Units (as defined in a table provided by OSPAR in May 2021), and for each year of the period 1990-2019. All results have been provided to OSPAR in a separate file in Excel format, together with this report (see Chapter 8).

Figure 13 shows *actual* total nitrogen deposition from 1995 to 2019 for COMP4 Assessment Units that are larger than $10\,000 \text{ km}^2$, while Table 20 lists the percentage differences between 1995 and 2019, and between the two 5-year periods of 1995-1999 and 2015-2019 for actual depositions in all COMP4 Assessment Units. Due to the large inter-annual variability in meteorological conditions, differences between depositions in one year with respect to those in one reference year (1995 in this case) can change considerably from year to year. Therefore, 5-year averages are calculated to provide a more robust result for the changes since the 1990s.

In regard to actual depositions of *oxidized* nitrogen, there has been a decrease from 1995 to 2019 in all 67 COMP4 Assessment Units. The largest decrease (58%) is modelled in NAAC1B ("Noratlantic Area NOR-NorC1(D5)B"), while the smallest decrease (15%) is found in SK ("Skagerak"). For *reduced* nitrogen, there are decreases in most COMP4 Assessment Units, but not in all. The largest *decrease* (56%) is modelled in NAAC1D ("Noratlantic Area NOR-NorC1(D5)D") and the largest *increase* (32%) in OWCO ("Ocean Waters CO (D5)"). However, it should be noted that NAAC1D is extremely small (only about 23 km^2), representing only a fraction of an EMEP MSC-W model grid cell. The numbers for this assessment area (and areas of similar size) should thus be considered as an indication only. Nevertheless, it is safe to say that (actual) oxidized nitrogen depositions have decreased in all COMP4 Assessment Units (and statistically significantly so), while for reduced nitrogen the trends are less significant, with depositions having both decreased and increased slightly, depending on the Area.

Figure 14 shows *normalized* total nitrogen deposition from 1995 to 2019 for COMP4 Assessment Units that are larger than $10\,000 \text{ km}^2$. The normalization is based on meteorological data of 4 years (2016-2019).

Trends in total nitrogen deposition are decreasing in all COMP4 Assessment Units shown in Figure 8 and they are statistically significant at the 5% confidence level. Further analysis shows that oxidized nitrogen deposition has decreased significantly since the 1990s, while for reduced nitrogen the decreases are much smaller. For oxidized nitrogen, the largest decrease (55%) is in ECPM2 ("East Coast (permanently mixed) 2"), while the smallest decrease (20%) is modelled for SAAOC ("Sudatlantic Area SUD-OCEAN(D5)"). In the case of reduced nitrogen, the largest *decrease* (33%) is modelled for SCHPM1 ("Scheldt plume 1") while the largest *increase* (4%) is in SHPM ("Shannon plume"). Strictly speaking, SHPM is too small to be properly represented by the model grid used for the normalization procedure, so that the 4% number should only be taken as an indication. It is very likely that there is no significant trend in this Area.

Table 21 lists actual and normalized depositions in all 67 COMP4 Assessment Units for the year 2019, i.e. the most recent year for which model calculations have been made.

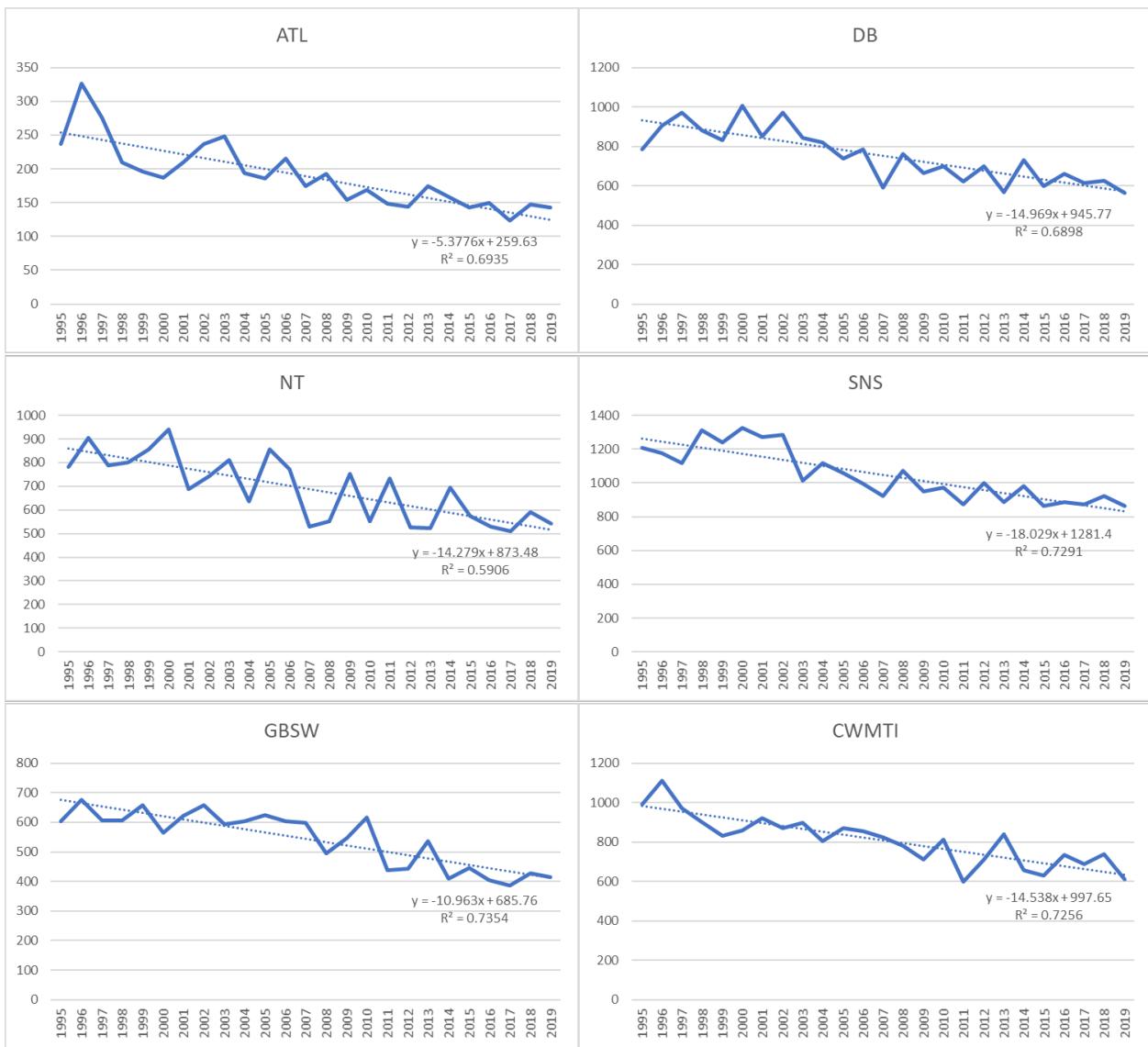


Figure 13: Time series of actual (non-normalized) depositions of total nitrogen to COMP4 Assessment Units larger than 10 000 km², as calculated by the EMEP MSC-W model for the period 1995–2019. Unit: mg(N)/m²/year. Linear regression lines, with coefficients of determination (R^2), are indicated in the figure. (Figure continues on the next 3 pages.)

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

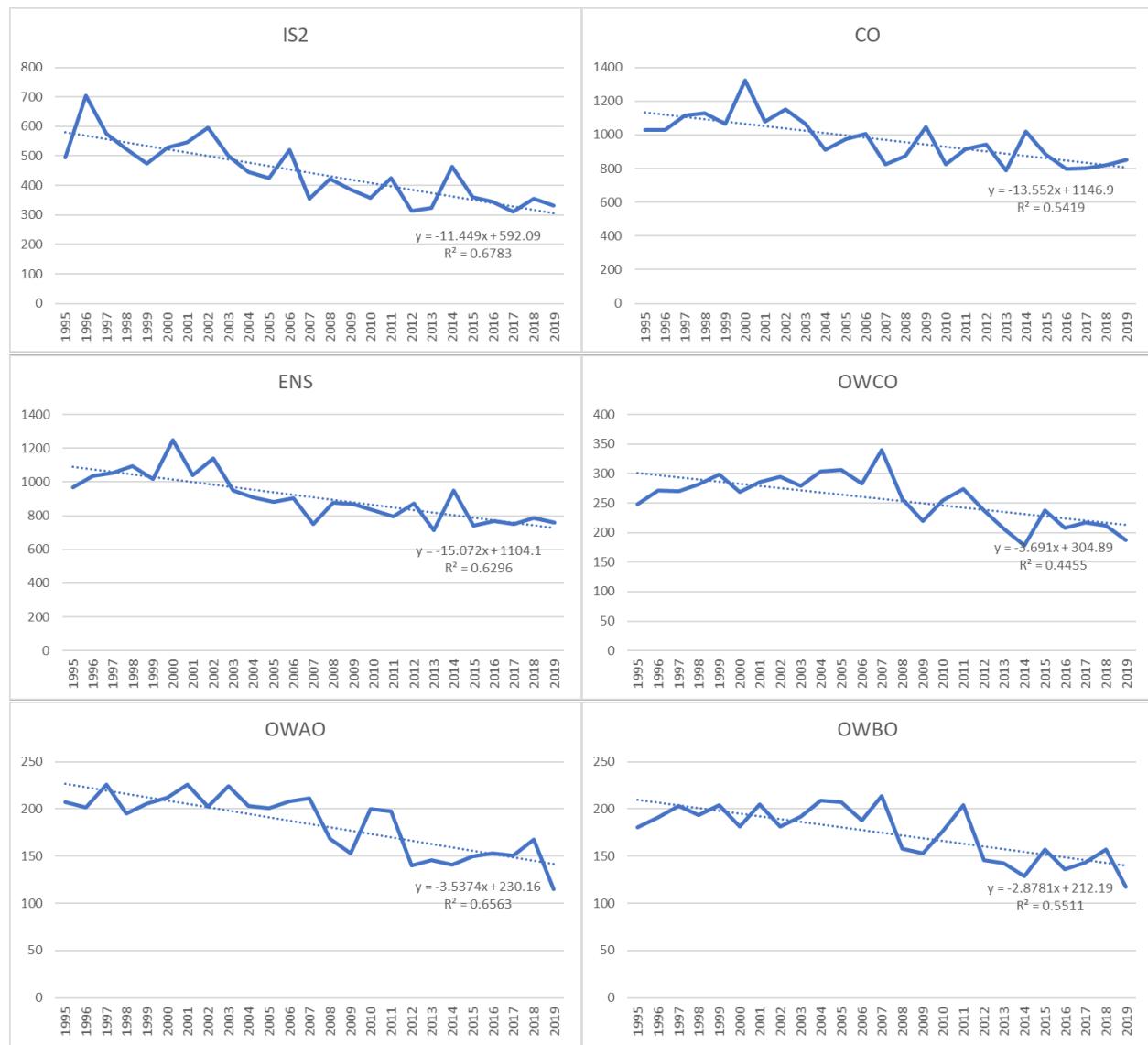
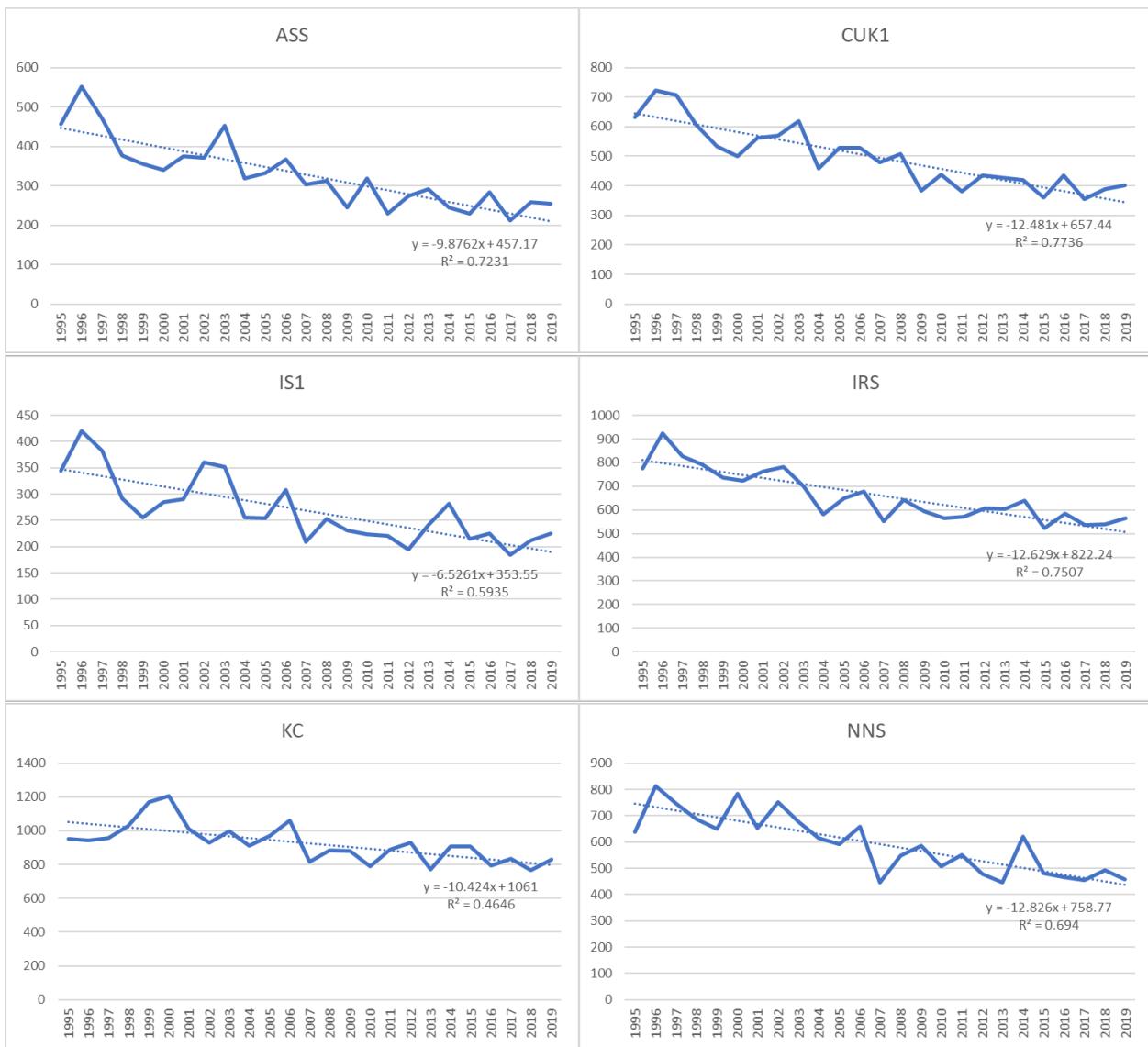


Figure 13: Continued.

**Figure 13:** Continued.

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

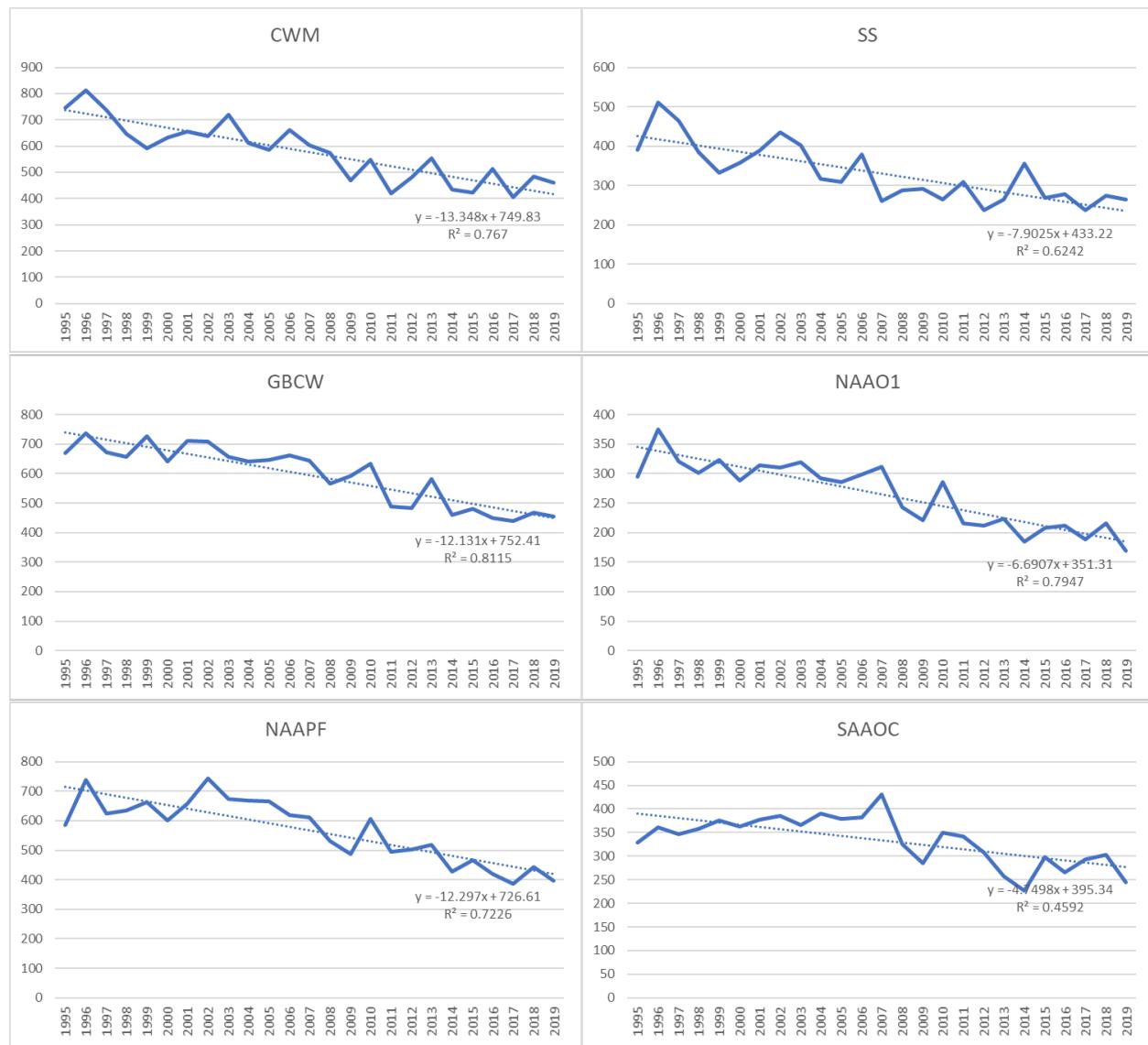


Figure 13: Continued.

Table 20. Percentage differences in 2019 compared to 1995 for oxidised, reduced and total nitrogen, in the sixty-seven COMP4 Assessment Units listed in Table 8. Also shown are the percentage differences in the 5-year period 2015-2019 with respect to the 5-year period of 1995-1999. (Table continues on the next page.)

| COMP4 Assessment Unit | Oxidised N | | Reduced N | | Total N | |
|-----------------------------|------------|-----------------------------|-----------|-----------------------------|-----------|-----------------------------|
| | 1995→2019 | (1995-1999) →(2015-2019) | 1995→2019 | (1995-1999) →(2015-2019) | 1995→2019 | (1995-1999) →(2015-2019) |
| CFR | -50 % | -41 % | -7 % | 0 % | -33 % | -23 % |
| CCTI | -41 % | -40 % | -2 % | 1 % | -27 % | -25 % |
| ATL | -50 % | -52 % | -10 % | -21 % | -40 % | -43 % |
| SHPM | -52 % | -55 % | 22 % | -3 % | -21 % | -33 % |
| CNOR1 | -43 % | -39 % | -29 % | -19 % | -40 % | -34 % |
| CNOR2 | -46 % | -41 % | -31 % | -29 % | -41 % | -37 % |
| CNOR3 | -23 % | -36 % | 1 % | -13 % | -15 % | -27 % |
| DB | -40 % | -42 % | 4 % | 0 % | -28 % | -30 % |
| KD | -22 % | -32 % | 16 % | 3 % | -8 % | -19 % |
| NT | -38 % | -40 % | -13 % | -20 % | -30 % | -33 % |
| SNS | -40 % | -41 % | -6 % | 0 % | -28 % | -27 % |
| GBC | -34 % | -33 % | 2 % | 2 % | -20 % | -20 % |
| ADPM | -51 % | -46 % | -18 % | -16 % | -36 % | -32 % |
| GBSW | -50 % | -49 % | -1 % | -10 % | -31 % | -34 % |
| SPM | -52 % | -41 % | -11 % | -1 % | -34 % | -23 % |
| GDPM | -53 % | -51 % | 0 % | -7 % | -31 % | -33 % |
| CUKC | -50 % | -45 % | -20 % | -8 % | -39 % | -32 % |
| CWMTI | -50 % | -42 % | -18 % | -6 % | -39 % | -29 % |
| SCHPM1 | -42 % | -39 % | -21 % | -22 % | -32 % | -31 % |
| ELPM | -33 % | -34 % | 1 % | 0 % | -20 % | -20 % |
| SCHPM2 | -41 % | -38 % | -15 % | -14 % | -31 % | -28 % |
| MPM | -43 % | -39 % | -15 % | -14 % | -32 % | -29 % |
| RHPM | -41 % | -40 % | -11 % | -11 % | -29 % | -28 % |
| EMPM | -40 % | -35 % | 0 % | 1 % | -22 % | -19 % |
| THPM | -42 % | -43 % | -2 % | 9 % | -28 % | -25 % |
| HPM | -46 % | -47 % | 16 % | 24 % | -25 % | -23 % |
| ECPM1 | -45 % | -50 % | -16 % | -17 % | -36 % | -39 % |
| ECPM2 | -39 % | -48 % | 12 % | -2 % | -21 % | -31 % |
| IS2 | -41 % | -47 % | -12 % | -17 % | -33 % | -39 % |
| CO | -29 % | -34 % | 2 % | -3 % | -17 % | -22 % |
| ENS | -33 % | -38 % | 5 % | -2 % | -21 % | -26 % |
| CWCC | -52 % | -37 % | 3 % | 8 % | -42 % | -27 % |

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

Table 20. Continued.

| COMP4 Assessment Unit | Oxidised N | | Reduced N | | Total N | |
|-----------------------------|------------|-----------------------------|-----------|-----------------------------|-----------|-----------------------------|
| | 1995→2019 | (1995-1999) →(2015-2019) | 1995→2019 | (1995-1999) →(2015-2019) | 1995→2019 | (1995-1999) →(2015-2019) |
| OWCO | -33 % | -29 % | 32 % | 15 % | -24 % | -22 % |
| OWAO | -52 % | -38 % | -18 % | 2 % | -44 % | -29 % |
| IWCI | -53 % | -38 % | 9 % | 10 % | -41 % | -27 % |
| OWBO | -43 % | -34 % | 0 % | 2 % | -35 % | -27 % |
| ASS | -57 % | -54 % | -17 % | -22 % | -44 % | -44 % |
| CIRL | -48 % | -52 % | 5 % | -3 % | -26 % | -32 % |
| CUK1 | -51 % | -51 % | -11 % | -18 % | -36 % | -39 % |
| IS1 | -48 % | -49 % | -5 % | -11 % | -35 % | -37 % |
| IRS | -48 % | -50 % | 5 % | -6 % | -27 % | -32 % |
| KC | -25 % | -32 % | 6 % | 2 % | -13 % | -18 % |
| NNS | -38 % | -43 % | -3 % | -12 % | -28 % | -34 % |
| CWM | -51 % | -46 % | -15 % | -15 % | -38 % | -35 % |
| LBPM | -42 % | -47 % | 6 % | -11 % | -22 % | -32 % |
| SK | -15 % | -34 % | 23 % | -4 % | -2 % | -24 % |
| SS | -43 % | -48 % | -9 % | -13 % | -33 % | -37 % |
| CWBC | -40 % | -34 % | 9 % | 1 % | -27 % | -24 % |
| IWBI | -43 % | -34 % | -6 % | 2 % | -35 % | -26 % |
| CWAC | -41 % | -34 % | -23 % | -15 % | -34 % | -26 % |
| IWAI | -46 % | -37 % | -17 % | -8 % | -37 % | -27 % |
| LPM | -55 % | -53 % | -14 % | -16 % | -38 % | -37 % |
| GBCW | -51 % | -50 % | -4 % | -11 % | -32 % | -34 % |
| NAAP2 | -49 % | -44 % | -7 % | -13 % | -32 % | -31 % |
| NAAO1 | -54 % | -47 % | -9 % | -17 % | -43 % | -39 % |
| NAAPF | -47 % | -45 % | -6 % | -17 % | -32 % | -35 % |
| NAAC3 | -48 % | -43 % | -2 % | -7 % | -28 % | -26 % |
| NAAC2 | -47 % | -42 % | -6 % | -10 % | -28 % | -26 % |
| NAAC1A | -50 % | -40 % | 0 % | 6 % | -28 % | -19 % |
| NAAC1B | -58 % | -50 % | -27 % | -29 % | -43 % | -39 % |
| NAAC1C | -49 % | -39 % | -52 % | -56 % | -51 % | -49 % |
| NAAC1D | -43 % | -43 % | -56 % | -59 % | -51 % | -53 % |
| SAAP2 | -44 % | -38 % | 20 % | 7 % | -31 % | -27 % |
| SAAOC | -33 % | -27 % | 17 % | 10 % | -26 % | -21 % |
| SAAP1 | -41 % | -34 % | 18 % | 7 % | -31 % | -26 % |
| SAAC1 | -49 % | -42 % | 24 % | 12 % | -32 % | -28 % |
| SAAC2 | -46 % | -38 % | 17 % | 6 % | -31 % | -25 % |

Table 21. Deposition of oxidised, reduced and total nitrogen, to the sixty-seven COMP4 Assessment Units in 2019. Both actual numbers (based on 2019 meteorology) and weather-normalized values (based on meteorological data of 2016, 2017, 2018 and 2019) are given. Results for other years are provided separately in Excel format (see Chapter 8). Unit: tonnes(N)/year. (Table continues on the next page.)

| COMP4 Assessment Unit | Oxidised N | | Reduced N | | Total N | |
|-----------------------------|------------|------------|-----------|------------|---------|------------|
| | Actual | Normalized | Actual | Normalized | Actual | Normalized |
| CFR | 2 767 | 3 106 | 3 441 | 3 904 | 6 208 | 7 010 |
| CCTI | 2 311 | 2 358 | 2 064 | 2 343 | 4 374 | 4 701 |
| ATL | 80 685 | 79 431 | 52 256 | 49 881 | 132 941 | 129 312 |
| SHPM | 48 | 44 | 88 | 72 | 137 | 117 |
| CNOR1 | 2 170 | 2 251 | 933 | 1 076 | 3 103 | 3 326 |
| CNOR2 | 1 138 | 1 127 | 693 | 682 | 1 831 | 1 809 |
| CNOR3 | 1 001 | 885 | 740 | 686 | 1 740 | 1 571 |
| DB | 5 183 | 5 411 | 3 340 | 3 694 | 8 524 | 9 105 |
| KD | 2 348 | 2 099 | 1 979 | 1 876 | 4 327 | 3 975 |
| NT | 20 443 | 19 790 | 12 068 | 12 131 | 32 512 | 31 921 |
| SNS | 29 142 | 28 407 | 24 970 | 25 993 | 54 112 | 54 400 |
| GBC | 2 485 | 2 411 | 2 359 | 2 297 | 4 844 | 4 707 |
| ADPM | 93 | 99 | 122 | 137 | 215 | 236 |
| GBSW | 4 093 | 3 960 | 4 888 | 4 712 | 8 981 | 8 672 |
| SPM | 423 | 487 | 602 | 694 | 1 025 | 1 181 |
| GDPM | 577 | 565 | 843 | 803 | 1 420 | 1 368 |
| CUKC | 2 179 | 2 351 | 1 948 | 2 287 | 4 127 | 4 637 |
| CWMTI | 6 877 | 7 508 | 5 948 | 6 923 | 12 825 | 14 431 |
| SCHPM1 | 388 | 399 | 473 | 490 | 861 | 889 |
| ELPM | 4 068 | 3 898 | 4 143 | 4 034 | 8 212 | 7 932 |
| SCHPM2 | 72 | 73 | 69 | 72 | 141 | 145 |
| MPM | 144 | 146 | 141 | 144 | 284 | 290 |
| RHPM | 1 522 | 1 528 | 1 581 | 1 590 | 3 102 | 3 118 |
| EMPM | 813 | 845 | 1 113 | 1 088 | 1 925 | 1 933 |
| THPM | 2 665 | 2 579 | 2 376 | 2 592 | 5 041 | 5 170 |
| HPM | 558 | 554 | 611 | 665 | 1 168 | 1 220 |
| ECPM1 | 902 | 861 | 645 | 713 | 1 547 | 1 574 |
| ECPM2 | 580 | 547 | 604 | 610 | 1 184 | 1 158 |
| IS2 | 5 699 | 5 396 | 3 308 | 3 597 | 9 007 | 8 993 |
| CO | 8 818 | 8 169 | 7 351 | 7 089 | 16 169 | 15 258 |
| ENS | 27 237 | 26 289 | 19 232 | 19 583 | 46 469 | 45 873 |
| CWCC | 112 | 143 | 60 | 71 | 172 | 213 |

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

Table 21. Continued

| COMP4 Assessment Unit | Oxidised N | | Reduced N | | Total N | |
|-----------------------------|------------|------------|-----------|------------|---------|------------|
| | Actual | Normalized | Actual | Normalized | Actual | Normalized |
| OWCO | 2 720 | 3 097 | 866 | 936 | 3 586 | 4 034 |
| OWAO | 7 609 | 9 759 | 3 706 | 4 781 | 11 314 | 14 540 |
| IWCI | 173 | 219 | 97 | 115 | 270 | 334 |
| OWBO | 15 523 | 18 920 | 5 912 | 6 798 | 21 436 | 25 718 |
| ASS | 29 227 | 30 155 | 26 465 | 24 457 | 55 692 | 54 612 |
| CIRL | 2 293 | 2 153 | 3 248 | 3 187 | 5 540 | 5 340 |
| CUK1 | 2 232 | 2 220 | 2 242 | 2 151 | 4 474 | 4 370 |
| IS1 | 9 346 | 8 712 | 7 494 | 6 819 | 16 840 | 15 531 |
| IRS | 8 094 | 7 850 | 10 731 | 10 368 | 18 825 | 18 218 |
| KC | 4 352 | 4 024 | 4 033 | 3 964 | 8 385 | 7 988 |
| NNS | 75 900 | 74 007 | 45 183 | 47 521 | 121 083 | 121 528 |
| CWM | 10 271 | 10 632 | 9 305 | 9 120 | 19 576 | 19 752 |
| LBPM | 500 | 487 | 654 | 627 | 1 153 | 1 114 |
| SK | 2 636 | 2 199 | 1 971 | 1 695 | 4 606 | 3 894 |
| SS | 8 330 | 7 967 | 6 160 | 6 256 | 14 490 | 14 222 |
| CWBC | 687 | 762 | 459 | 445 | 1 146 | 1 207 |
| IWBI | 292 | 342 | 138 | 156 | 430 | 498 |
| CWAC | 509 | 560 | 414 | 479 | 923 | 1 038 |
| IWAI | 978 | 1 101 | 763 | 885 | 1 740 | 1 986 |
| LPM | 279 | 278 | 381 | 385 | 660 | 664 |
| GBCW | 2 233 | 2 188 | 3 007 | 2 925 | 5 240 | 5 113 |
| NAAP2 | 2 172 | 2 421 | 2 602 | 2 791 | 4 774 | 5 213 |
| NAAO1 | 26 597 | 31 100 | 17 781 | 20 248 | 44 378 | 51 349 |
| NAAPF | 7 891 | 8 299 | 7 584 | 7 592 | 15 475 | 15 891 |
| NAAC3 | 936 | 1 029 | 1 319 | 1 420 | 2 255 | 2 449 |
| NAAC2 | 893 | 969 | 1 426 | 1 520 | 2 319 | 2 489 |
| NAAC1A | 256 | 278 | 397 | 432 | 653 | 709 |
| NAAC1B | 46 | 50 | 74 | 76 | 120 | 127 |
| NAAC1C | 25 | 28 | 27 | 29 | 52 | 57 |
| NAAC1D | 12 | 12 | 13 | 13 | 25 | 25 |
| SAAP2 | 244 | 280 | 137 | 152 | 381 | 432 |
| SAAOC | 1 965 | 2 282 | 586 | 678 | 2 551 | 2 960 |
| SAAP1 | 550 | 650 | 244 | 279 | 794 | 928 |
| SAAC1 | 118 | 136 | 83 | 93 | 201 | 229 |
| SAAC2 | 80 | 93 | 58 | 65 | 138 | 157 |

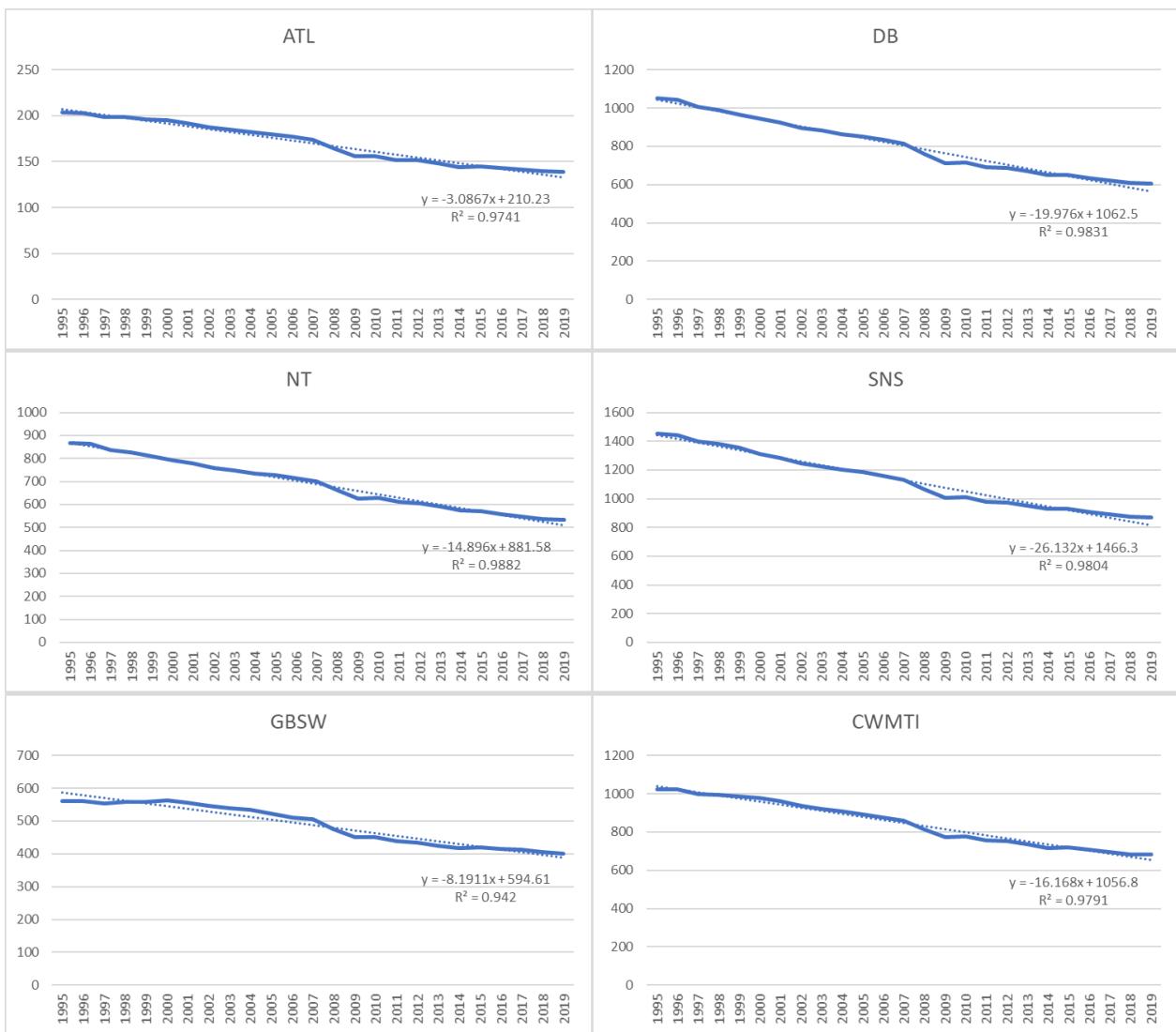


Figure 14: Time series of normalized depositions of total nitrogen to COMP4 Assessment Units larger than 10 000 km², as calculated by the EMEP MSC-W model for the period 1995-2019. Unit: mg(N)/m²/year. Linear regression lines, with coefficients of determination (R^2), are indicated in the figure. (Figure continues on the next 3 pages.)

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

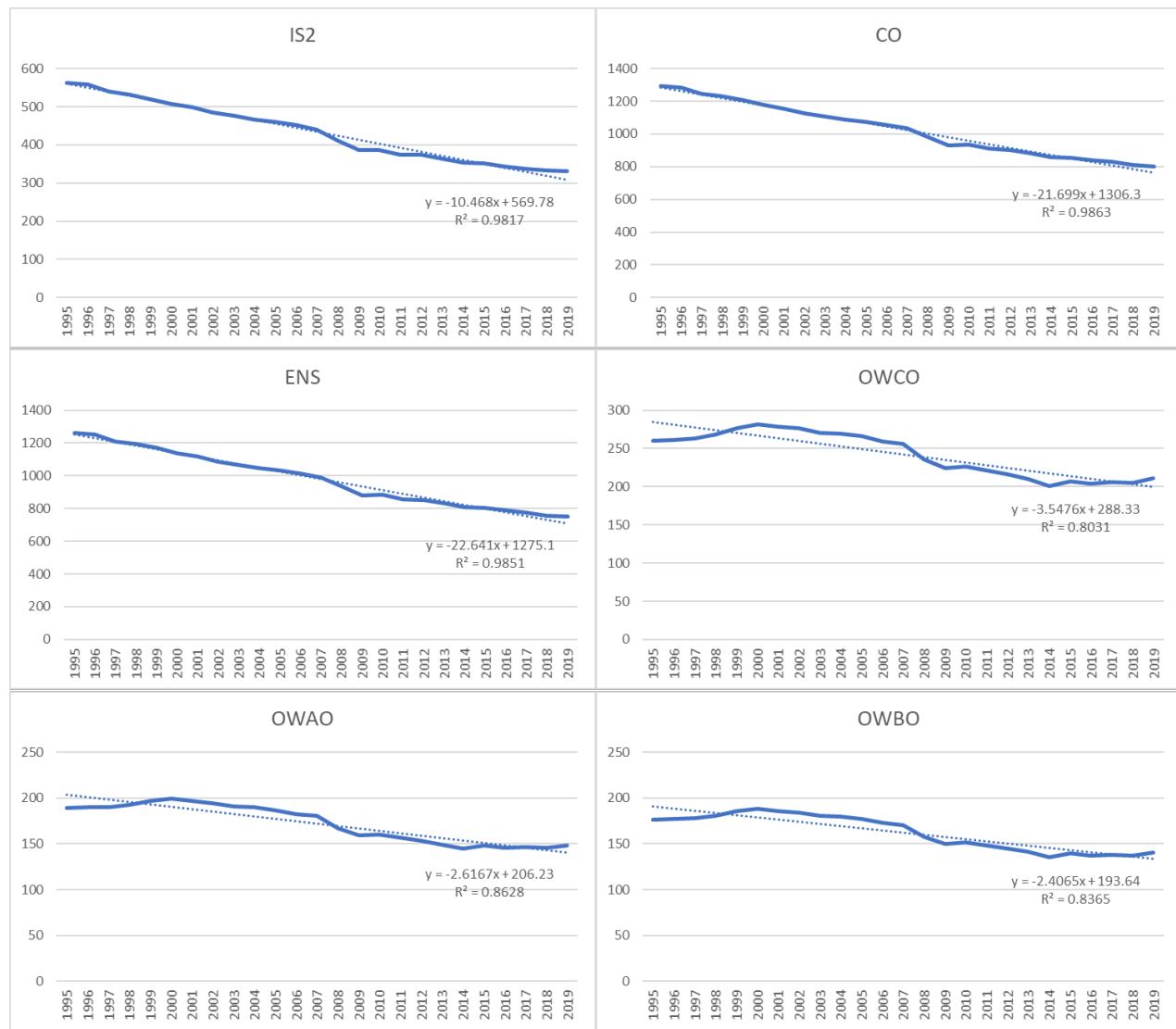
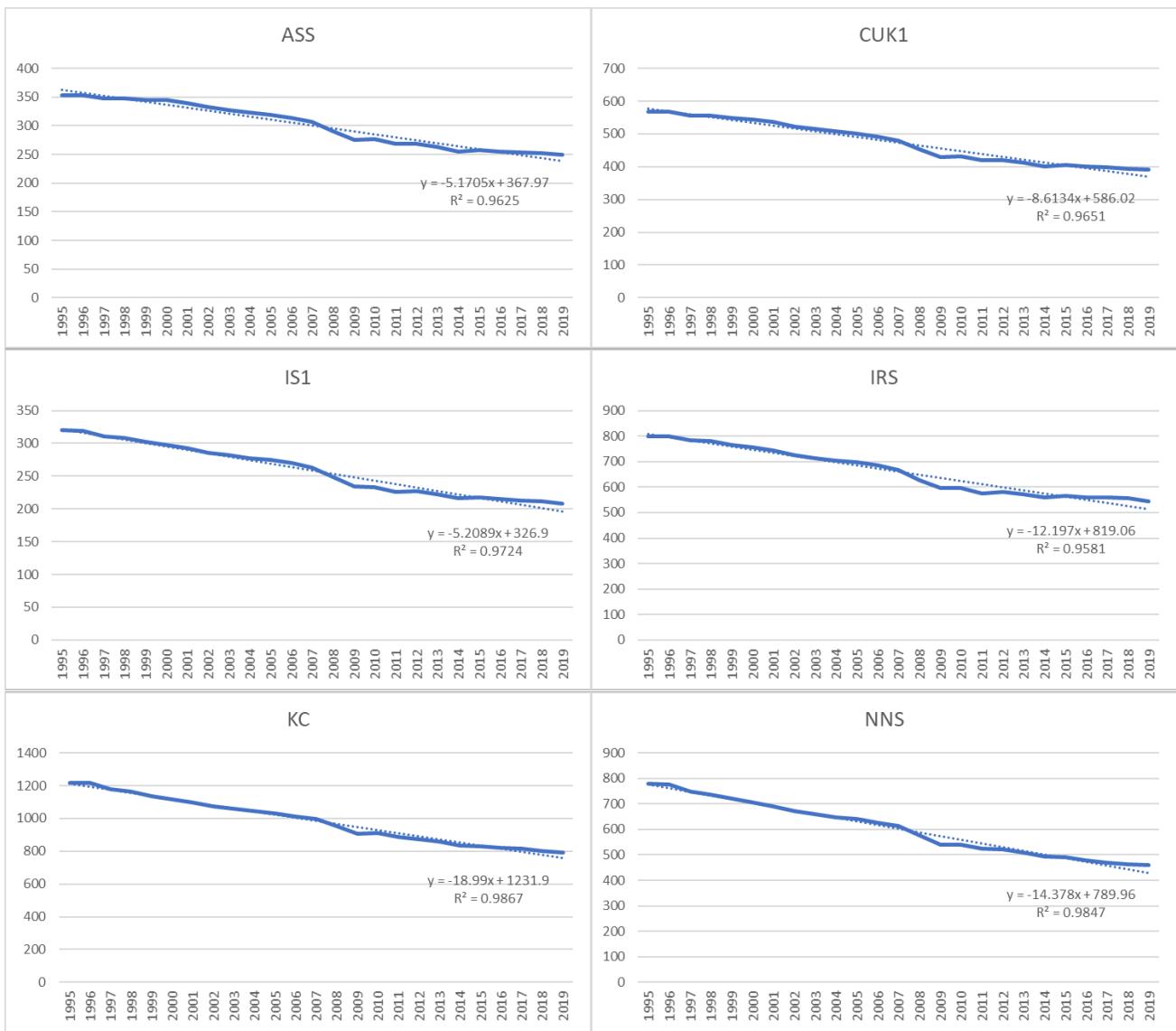


Figure 14: Continued.

**Figure 14:** Continued.

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

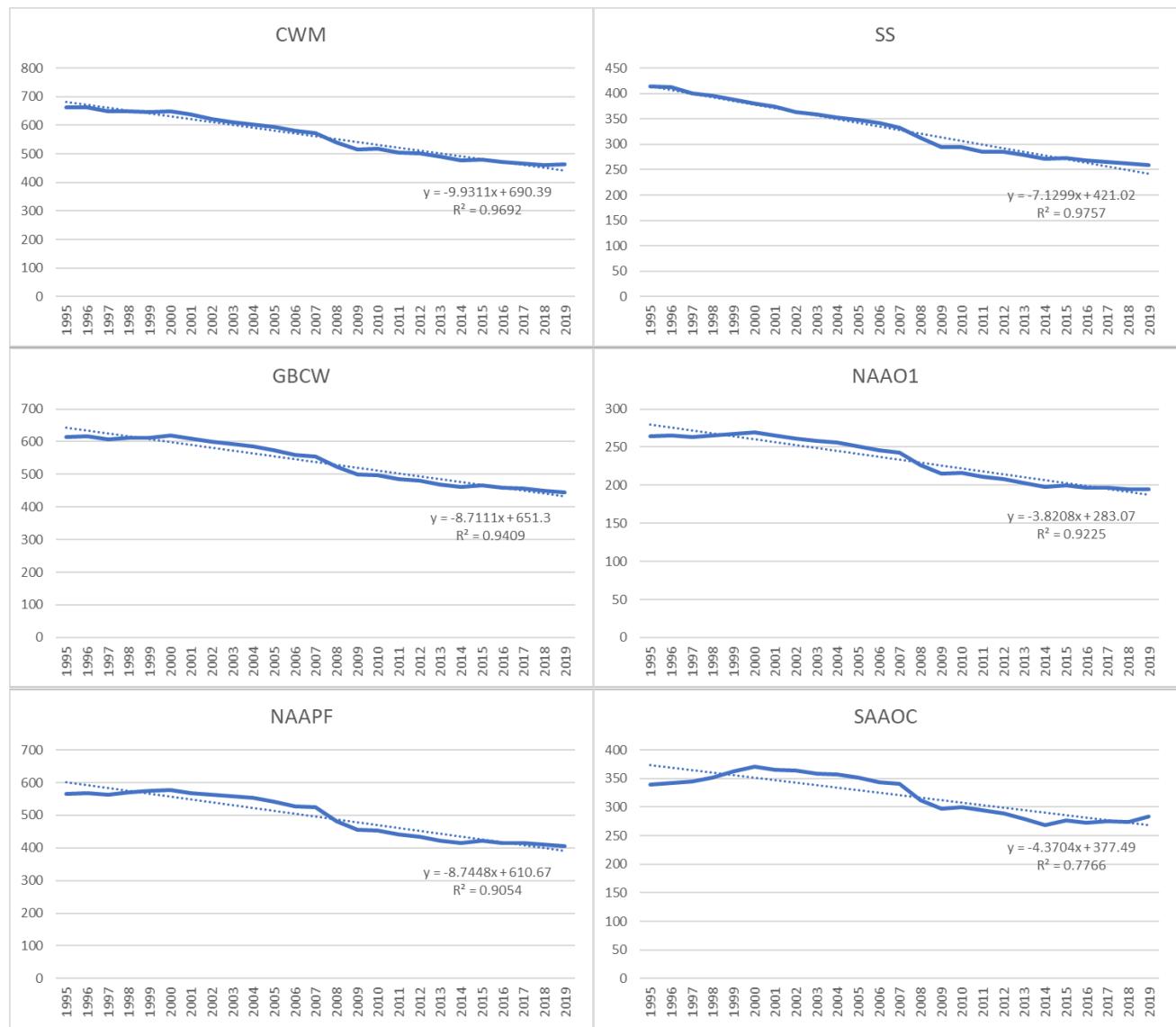


Figure 14: Continued.

6 Source apportionment by Contracting Parties

Source apportionment has been calculated for OSPAR Regions, EEZs and partial EEZs. For source apportionment, normalized results are considered more relevant than actual (non-normalized) depositions because they are less influenced by meteorological year-to-year variability and thus are a better measure for the influence of the various emitters (emitting countries or areas). The next two sections are thus based on *normalized* results for 2019. The accompanying data tables provide results also for earlier years (see Chapter 8).

6.1 Source apportionment to OSPAR Regions

Contributions from OSPAR Contracting Parties (and all other sources) to oxidized and reduced nitrogen deposition in OSPAR Regions have been provided to OSPAR in a separate file in ASCII format (see Chapter 8). Figure 15 summarizes the results by showing the Top-10 contributors to total normalized nitrogen deposition in each of the 5 OSPAR Regions. The normalization has been done with meteorological data for the years 2016 to 2019.

The two largest OSPAR Regions (I and V) receive the largest contributions from the boundary (abbreviated ‘BIC’ in EMEP MSC-W terminology, originally meaning ‘Boundary and Initial Conditions’), while OSPAR Regions II, III and IV receive their largest contributions from the United Kingdom (II and III) and Spain (IV). Other important contributions are made by international shipping and other large countries such as Russia, Germany and France. The Top-10 contributions typically make up around 90% of the total, except for Region I.

Table 22 lists the numbers Figure 15 is based upon, but also gives hints as to how much of the contributions is due to oxidized nitrogen and how much is reduced nitrogen. As far as international shipping contributions are concerned, they are entirely oxidized as ships do not emit reduced nitrogen in any significant amounts. The sum of total nitrogen deposition is usually dominated by (the longer-lived) oxidized nitrogen species, but individual contributions *can* be dominated by (the shorter-lived) reduced nitrogen, especially if the emitting country has large emissions of agriculture and/or is close to the receptor region.

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

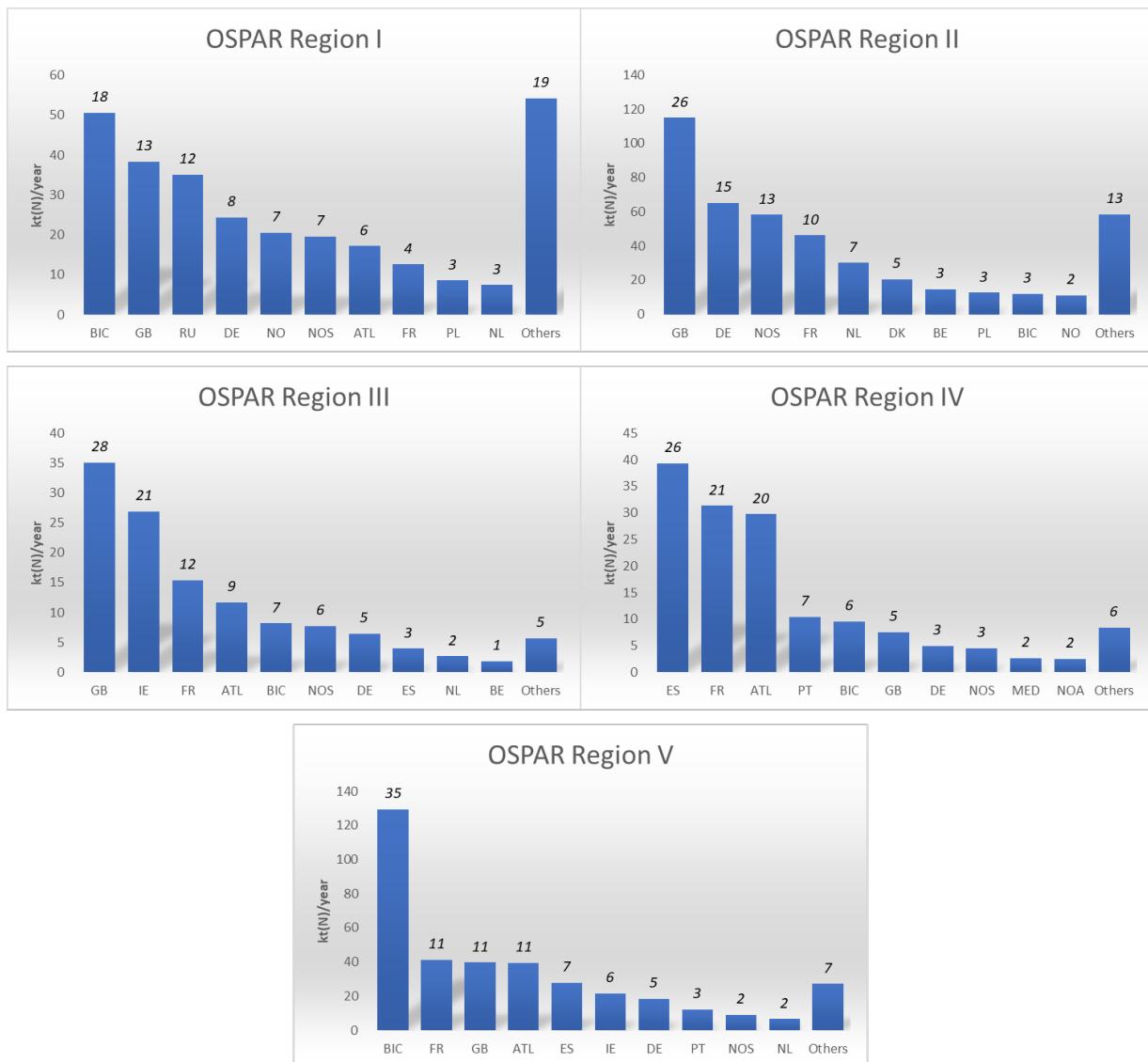


Figure 15. Top-10 contributors to normalized total nitrogen depositions in the 5 OSPAR Regions. Unit: ktonnes(N)/year. The numbers on top of each bar indicate the percentage of the total deposition to the respective Region. All numbers are based on 2019 emissions and 2016-2019 average meteorology. For example, France contributes 41.4 ktonnes(N)/year to OSPAR Region V, corresponding to about 11% of the total nitrogen deposition to that Region. All numbers are listed in Table 22. ('BIC': Influence from sources outside the EMEP model domain, 'NOS': North Sea shipping, 'ATL': North Atlantic shipping except North Sea, 'Others': All contributions that are not among the Top-10.)

Table 22. Top-10 contributors to normalized total nitrogen depositions in the 5 OSPAR Regions. Unit: ktonnes(N)/year. The numbers on top of each bar indicate the percentage of the total deposition to the respective Region. All numbers are based on 2019 emissions and 2016-2019 average meteorology. ('BIC': Influence from sources outside the EMEP model domain, 'NOS': North Sea shipping, 'ATL': North Atlantic shipping except North Sea, 'Others': All contributions that are not among the Top-10.) (ox-N)% gives the percentage of oxidized nitrogen within the country's contribution, while (re-N)% gives the percentage of reduced nitrogen. For example, Norway is number 5 among the Top-10 contributors to total nitrogen deposition in OSPAR Region I, with a contribution of 20.6 ktonnes(N)/year, corresponding to about 7% of the total nitrogen deposition in that Region. 68% of Norway's contribution to OSPAR Region I is oxidized nitrogen, the rest (32%) is reduced nitrogen.

| Region I | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
|------------|-------|------|------|------|------|------|------|------|------|------|--------|-------|
| Source | BIC | GB | RU | DE | NO | NOS | ATL | FR | PL | NL | Others | Sum |
| kt(N)/yr | 50.6 | 38.4 | 35.0 | 24.4 | 20.6 | 19.5 | 17.1 | 12.6 | 8.5 | 7.4 | 54.2 | 288.2 |
| % | 18 | 13 | 12 | 8 | 7 | 7 | 6 | 4 | 3 | 3 | 19 | 100 |
| (ox-N)% | 100 | 57 | 52 | 47 | 68 | 100 | 100 | 35 | 48 | 52 | 53 | 67 |
| (re-N)% | 0 | 43 | 48 | 53 | 32 | 0 | 0 | 65 | 52 | 48 | 47 | 33 |
| Region II | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | GB | DE | NOS | FR | NL | DK | BE | PL | BIC | NO | Others | Sum |
| kt(N)/yr | 115.0 | 65.0 | 58.3 | 46.2 | 30.1 | 20.3 | 14.5 | 12.6 | 11.8 | 11.1 | 58.3 | 443.3 |
| % | 26 | 15 | 13 | 10 | 7 | 5 | 3 | 3 | 3 | 2 | 13 | 100 |
| (ox-N)% | 55 | 40 | 100 | 32 | 39 | 27 | 45 | 55 | 100 | 63 | 62 | 56 |
| (re-N)% | 45 | 60 | 0 | 68 | 61 | 73 | 55 | 45 | 0 | 37 | 38 | 44 |
| Region III | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | GB | IE | FR | ATL | BIC | NOS | DE | ES | NL | BE | Others | Sum |
| kt(N)/yr | 35.0 | 26.9 | 15.4 | 11.7 | 8.2 | 7.7 | 6.4 | 4.0 | 2.7 | 1.8 | 5.7 | 125.4 |
| % | 28 | 21 | 12 | 9 | 7 | 6 | 5 | 3 | 2 | 1 | 5 | 100 |
| (ox-N)% | 43 | 19 | 25 | 100 | 100 | 100 | 47 | 38 | 52 | 54 | 59 | 49 |
| (re-N)% | 57 | 81 | 75 | 0 | 0 | 0 | 53 | 62 | 48 | 46 | 41 | 51 |
| Region IV | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | ES | FR | ATL | PT | BIC | GB | DE | NOS | MED | NOA | Others | Sum |
| kt(N)/yr | 39.3 | 31.3 | 29.7 | 10.4 | 9.6 | 7.5 | 5.0 | 4.6 | 2.7 | 2.5 | 8.4 | 150.9 |
| % | 26 | 21 | 20 | 7 | 6 | 5 | 3 | 3 | 2 | 2 | 6 | 100 |
| (ox-N)% | 36 | 24 | 100 | 48 | 100 | 62 | 52 | 100 | 100 | 62 | 48 | 57 |
| (re-N)% | 64 | 76 | 0 | 52 | 0 | 38 | 48 | 0 | 0 | 38 | 52 | 43 |
| Region V | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | BIC | FR | GB | ATL | ES | IE | DE | PT | NOS | NL | Others | Sum |
| kt(N)/yr | 129.4 | 41.4 | 39.7 | 39.3 | 27.7 | 21.7 | 18.6 | 12.3 | 8.9 | 6.6 | 27.2 | 372.7 |
| % | 35 | 11 | 11 | 11 | 7 | 6 | 5 | 3 | 2 | 2 | 7 | 100 |
| (ox-N)% | 100 | 18 | 38 | 100 | 25 | 18 | 32 | 27 | 100 | 35 | 40 | 63 |
| (re-N)% | 0 | 82 | 62 | 0 | 75 | 82 | 68 | 73 | 0 | 65 | 60 | 37 |

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

6.2 Source apportionment to EEZs and partial EEZs

Contributions from OSPAR Contracting Parties (and all other sources) to oxidized and reduced nitrogen deposition in EEZs and partial EEZs have been provided to OSPAR in a separate file in ASCII format (see Chapter 8). Figure 16 summarizes the results for a selection of large EEZs by showing the Top-10 contributors to total normalized nitrogen deposition. The normalization has been done with meteorological data for the years 2016 to 2019. Table 23 lists the numbers Figure 16 is based upon, but also includes all other EEZs. As far as international shipping contributions are concerned, they are entirely oxidized as ships do not emit reduced nitrogen in any significant amounts. The sum of total nitrogen deposition is usually dominated by (the longer-lived) oxidized nitrogen species, but individual contributions can be dominated by (the shorter-lived) reduced nitrogen, especially if the emitting country has large emissions of agriculture and/or is close to the receptor region.

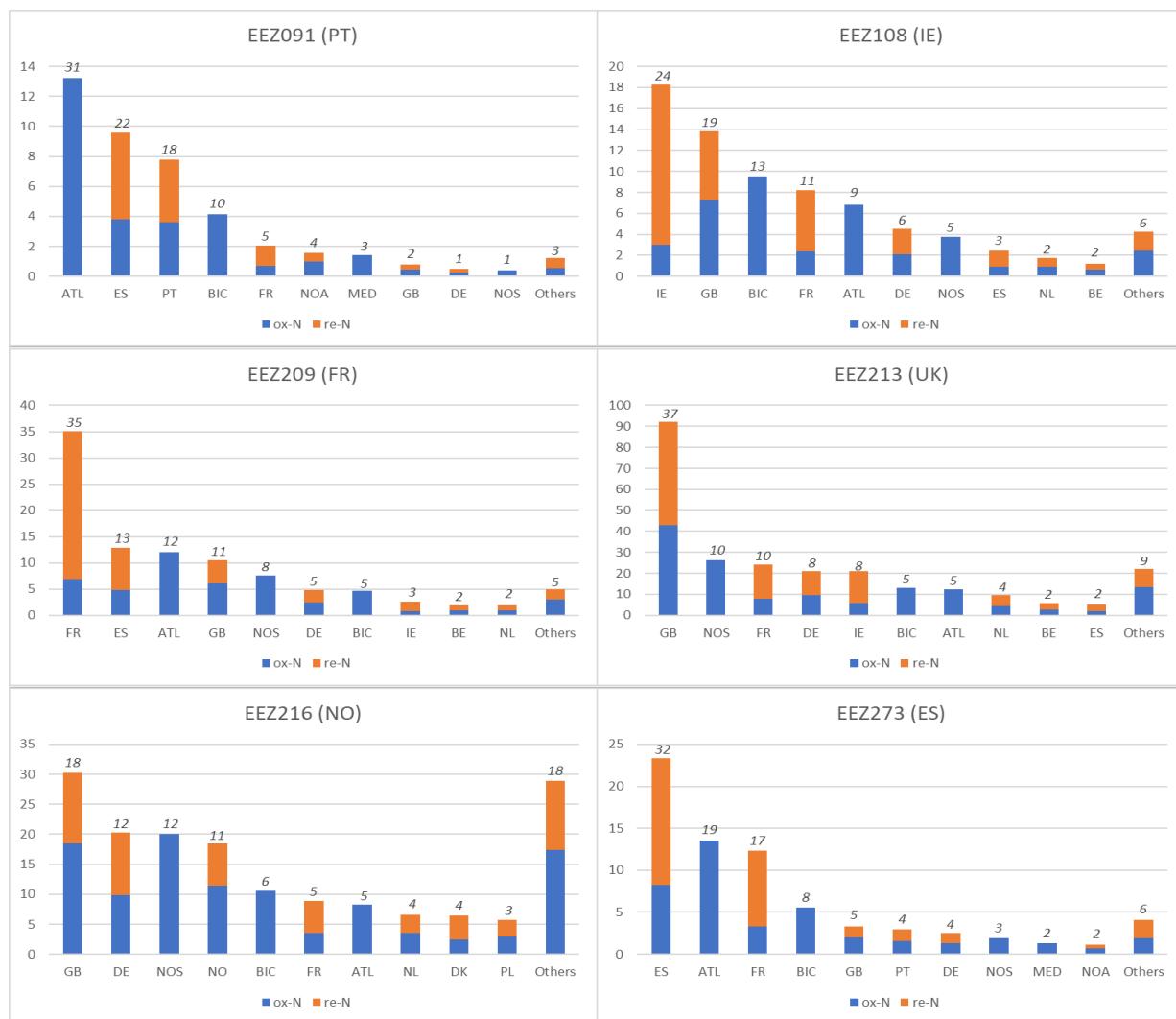


Figure 16. Top-10 contributors to normalized total nitrogen depositions in 6 of the 24 EEZs. Unit: ktonnes(N)/year. The numbers on top of each bar indicate the percentage of the total deposition to the respective Region. For example, Germany contributes 20.3 ktonnes(N)/year to EEZ216, corresponding to about 12% of the total nitrogen deposition to that EEZ. About half of this contribution is reduced nitrogen, and the other half oxidized. All numbers are based on 2019 emissions and 2016-2019 average meteorology. ‘BIC’: Influence from sources outside the EMEP model domain, ‘NOS’: North Sea shipping, ‘ATL’: North Atlantic shipping except North Sea, ‘MED’: Mediterranean shipping, ‘Others’: All contributions that are not among the Top-10. As reduced nitrogen emissions from shipping are considered negligible, their contributions are oxidized only (bars entirely blue). Numbers for all 24 EEZs are listed in Table 23.

Table 23. As Table 22, but for the 24 Exclusive Economic Zones.

| EEZ048 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
|---------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|--------|------|
| Source | BIC | PT | ATL | ES | FR | GB | DE | IE | NOA | NL | Others | Sum |
| kt(N)/yr | 16.8 | 7.4 | 4.0 | 2.7 | 2.4 | 0.8 | 0.5 | 0.3 | 0.3 | 0.2 | 0.8 | 36.3 |
| % | 46 | 20 | 11 | 7 | 7 | 2 | 1 | 1 | 1 | 1 | 2 | 100 |
| (ox-N)% | 100 | 7 | 100 | 14 | 11 | 21 | 21 | 11 | 23 | 20 | 47 | 63 |
| (re-N)% | 0 | 93 | 0 | 86 | 89 | 79 | 79 | 89 | 77 | 80 | 53 | 37 |
| EEZ065 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | GB | BIC | NOS | DE | IE | FR | ATL | NO | NL | PL | Others | Sum |
| kt(N)/yr | 7.8 | 3.5 | 2.9 | 2.7 | 1.8 | 1.8 | 1.6 | 1.0 | 1.0 | 0.7 | 3.9 | 28.8 |
| % | 27 | 12 | 10 | 9 | 6 | 6 | 6 | 4 | 3 | 2 | 14 | 100 |
| (ox-N)% | 57 | 100 | 100 | 47 | 33 | 35 | 100 | 77 | 52 | 48 | 53 | 65 |
| (re-N)% | 43 | 0 | 0 | 53 | 67 | 65 | 0 | 23 | 48 | 52 | 47 | 35 |
| EEZ071 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| source | BIC | GB | DE | IS | FR | NOS | ATL | IE | NL | PL | Others | Sum |
| kt(N)/yr | 13.7 | 10.1 | 5.1 | 4.5 | 4.1 | 3.2 | 3.0 | 2.8 | 1.7 | 1.2 | 7.3 | 56.8 |
| % | 24 | 18 | 9 | 8 | 7 | 6 | 5 | 5 | 3 | 2 | 13 | 100 |
| (ox-N)% | 100 | 49 | 40 | 48 | 29 | 100 | 100 | 29 | 46 | 40 | 49 | 63 |
| (re-N)% | 0 | 51 | 60 | 52 | 71 | 0 | 0 | 71 | 54 | 60 | 51 | 37 |
| EEZ091 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| source | ATL | ES | PT | BIC | FR | NOA | MED | GB | DE | NOS | Others | Sum |
| kt(N)/yr | 13.2 | 9.6 | 7.8 | 4.2 | 2.1 | 1.6 | 1.4 | 0.8 | 0.5 | 0.4 | 1.2 | 42.7 |
| % | 31 | 22 | 18 | 10 | 5 | 4 | 3 | 2 | 1 | 1 | 3 | 100 |
| (ox-N)% | 100 | 40 | 47 | 100 | 32 | 62 | 100 | 57 | 48 | 100 | 46 | 69 |
| (re-N)% | 0 | 60 | 53 | 0 | 68 | 38 | 0 | 43 | 52 | 0 | 54 | 31 |
| EEZ099 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| source | ES | FR | ATL | GB | BIC | DE | NOS | PT | IE | BE | Others | Sum |
| kt(N)/yr | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 |
| % | 26 | 26 | 16 | 6 | 6 | 4 | 4 | 3 | 2 | 1 | 5 | 100 |
| (ox-N)% | 39 | 25 | 100 | 64 | 100 | 51 | 100 | 57 | 33 | 58 | 60 | 55 |
| (re-N)% | 61 | 75 | 0 | 36 | 0 | 49 | 0 | 43 | 67 | 42 | 40 | 45 |
| EEZ100 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| source | GB | BIC | IE | NOS | DE | FR | ATL | NL | NO | PL | Others | Sum |
| kt(N)/yr | 0.4 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 1.2 |
| % | 32 | 12 | 9 | 9 | 8 | 6 | 6 | 3 | 2 | 2 | 11 | 100 |
| (ox-N)% | 57 | 100 | 33 | 100 | 46 | 36 | 100 | 51 | 78 | 52 | 52 | 64 |
| (re-N)% | 43 | 0 | 67 | 0 | 54 | 64 | 0 | 49 | 22 | 48 | 48 | 36 |
| EEZ108 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| source | IE | GB | BIC | FR | ATL | DE | NOS | ES | NL | BE | Others | Sum |
| kt(N)/yr | 18.3 | 13.8 | 9.5 | 8.2 | 6.8 | 4.5 | 3.8 | 2.4 | 1.8 | 1.2 | 4.3 | 74.6 |
| % | 24 | 19 | 13 | 11 | 9 | 6 | 5 | 3 | 2 | 2 | 6 | 100 |
| (ox-N)% | 16 | 53 | 100 | 29 | 100 | 47 | 100 | 37 | 53 | 54 | 57 | 53 |
| (re-N)% | 84 | 47 | 0 | 71 | 0 | 53 | 0 | 63 | 47 | 46 | 43 | 47 |
| EEZ109 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| source | FR | GB | NOS | DE | ATL | ES | BIC | IE | NL | BE | Others | Sum |
| kt(N)/yr | 1.1 | 0.7 | 0.6 | 0.3 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 3.8 |
| % | 30 | 19 | 16 | 7 | 7 | 5 | 4 | 3 | 3 | 2 | 5 | 100 |
| (ox-N)% | 20 | 52 | 100 | 52 | 100 | 37 | 100 | 30 | 50 | 49 | 62 | 54 |
| (re-N)% | 80 | 48 | 0 | 48 | 0 | 63 | 0 | 70 | 50 | 51 | 38 | 46 |

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1995-2019

Table 23. Continued.

| EEZ110 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
|----------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|------|
| Source | FR | GB | NOS | ATL | DE | ES | IE | BIC | NL | BE | Others | Sum |
| kt(N)/yr | 0.6 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 1.4 |
| % | 44 | 14 | 12 | 6 | 5 | 5 | 3 | 3 | 2 | 2 | 4 | 100 |
| (ox-N)% | 15 | 58 | 100 | 100 | 54 | 39 | 30 | 100 | 52 | 48 | 63 | 46 |
| (re-N)% | 85 | 42 | 0 | 0 | 46 | 61 | 70 | 0 | 48 | 52 | 37 | 54 |
| EEZ119 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | GB | BIC | NOS | DE | IE | FR | ATL | NL | NO | IS | Others | Sum |
| kt(N)/yr | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| % | 26 | 15 | 9 | 9 | 7 | 7 | 6 | 3 | 3 | 2 | 13 | 100 |
| (ox-N)% | 58 | 100 | 100 | 45 | 33 | 33 | 100 | 50 | 75 | 67 | 53 | 66 |
| (re-N)% | 42 | 0 | 0 | 55 | 67 | 67 | 0 | 50 | 25 | 33 | 47 | 34 |
| EEZ123 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | GB | BIC | DE | NOS | FR | NO | ATL | NL | IE | PL | Others | Sum |
| kt(N)/yr | 0.5 | 0.5 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.5 | 2.5 |
| % | 19 | 18 | 10 | 8 | 6 | 5 | 5 | 4 | 4 | 3 | 18 | 100 |
| (ox-N)% | 55 | 100 | 48 | 100 | 36 | 74 | 100 | 52 | 32 | 49 | 54 | 67 |
| (re-N)% | 45 | 0 | 52 | 0 | 64 | 26 | 0 | 48 | 68 | 51 | 46 | 33 |
| EEZ185 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | DE | DK | NOS | GB | SE | BAS | PL | NL | FR | NO | Others | Sum |
| kt(N)/yr | 2.1 | 1.6 | 1.1 | 1.1 | 1.0 | 0.8 | 0.8 | 0.5 | 0.5 | 0.2 | 1.6 | 11.3 |
| % | 19 | 14 | 10 | 9 | 9 | 7 | 7 | 5 | 5 | 2 | 14 | 100 |
| (ox-N)% | 43 | 25 | 100 | 64 | 27 | 100 | 51 | 54 | 43 | 63 | 59 | 54 |
| (re-N)% | 57 | 75 | 0 | 36 | 73 | 0 | 49 | 46 | 57 | 37 | 41 | 46 |
| EEZ187 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | DE | NOS | DK | GB | PL | SE | BAS | FR | NO | NL | Others | Sum |
| kt(N)/yr | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| % | 19 | 11 | 10 | 8 | 7 | 7 | 6 | 5 | 5 | 5 | 16 | 100 |
| (ox-N)% | 45 | 100 | 30 | 67 | 50 | 38 | 100 | 40 | 60 | 60 | 59 | 57 |
| (re-N)% | 55 | 0 | 70 | 33 | 50 | 63 | 0 | 60 | 40 | 40 | 41 | 43 |
| EEZ188 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | GB | FR | BE | NOS | DE | NL | BIC | ATL | IE | ES | Others | Sum |
| kt(N)/yr | 0.8 | 0.8 | 0.7 | 0.6 | 0.3 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 3.9 |
| % | 22 | 20 | 17 | 15 | 8 | 7 | 2 | 2 | 1 | 1 | 4 | 100 |
| (ox-N)% | 54 | 31 | 11 | 100 | 45 | 29 | 100 | 100 | 40 | 43 | 68 | 48 |
| (re-N)% | 46 | 69 | 89 | 0 | 55 | 71 | 0 | 0 | 60 | 57 | 32 | 52 |
| EEZ189 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | GB | NL | NOS | DE | FR | BE | BIC | IE | PL | ATL | Others | Sum |
| kt(N)/yr | 14.2 | 8.2 | 8.1 | 8.0 | 6.3 | 3.4 | 1.2 | 1.0 | 0.9 | 0.9 | 3.8 | 56.1 |
| % | 25 | 15 | 14 | 14 | 11 | 6 | 2 | 2 | 2 | 2 | 7 | 100 |
| (ox-N)% | 58 | 24 | 100 | 36 | 37 | 34 | 100 | 39 | 61 | 100 | 61 | 54 |
| (re-N)% | 42 | 76 | 0 | 64 | 63 | 66 | 0 | 61 | 39 | 0 | 39 | 46 |
| EEZ190 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | DE | GB | NOS | NL | FR | BE | DK | PL | BIC | IE | Others | Sum |
| kt(N)/yr | 12.8 | 6.8 | 5.2 | 4.9 | 2.9 | 1.5 | 1.1 | 1.1 | 0.7 | 0.6 | 3.3 | 41.0 |
| % | 31 | 17 | 13 | 12 | 7 | 4 | 3 | 3 | 2 | 1 | 8 | 100 |
| (ox-N)% | 23 | 63 | 100 | 32 | 42 | 54 | 33 | 60 | 100 | 41 | 70 | 50 |
| (re-N)% | 77 | 37 | 0 | 68 | 58 | 46 | 67 | 40 | 0 | 59 | 30 | 50 |

Table 23. Continued.

| EEZ191 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
|---------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|--------|-------|
| Source | DE | DK | GB | NOS | NL | FR | PL | BAS | BE | SE | Others | Sum |
| kt(N)/yr | 11.5 | 9.1 | 8.5 | 6.6 | 3.6 | 3.4 | 2.9 | 2.2 | 1.5 | 1.2 | 7.2 | 57.6 |
| % | 20 | 16 | 15 | 11 | 6 | 6 | 5 | 4 | 3 | 2 | 12 | 100 |
| (ox-N)% | 41 | 16 | 63 | 100 | 49 | 42 | 53 | 100 | 58 | 42 | 63 | 54 |
| (re-N)% | 59 | 84 | 37 | 0 | 51 | 58 | 47 | 0 | 42 | 58 | 37 | 46 |
| EEZ209 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | FR | ES | ATL | GB | NOS | DE | BIC | IE | BE | NL | Others | Sum |
| kt(N)/yr | 35.0 | 12.8 | 12.1 | 10.5 | 7.6 | 4.8 | 4.7 | 2.7 | 1.9 | 1.9 | 4.9 | 98.9 |
| % | 35 | 13 | 12 | 11 | 8 | 5 | 5 | 3 | 2 | 2 | 5 | 100 |
| (ox-N)% | 20 | 38 | 100 | 59 | 100 | 52 | 100 | 32 | 46 | 51 | 62 | 51 |
| (re-N)% | 80 | 62 | 0 | 41 | 0 | 48 | 0 | 68 | 54 | 49 | 38 | 49 |
| EEZ212 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | BIC | GB | DE | NOS | FR | RU | PL | NO | NL | ATL | Others | Sum |
| kt(N)/yr | 7.4 | 3.1 | 2.8 | 1.2 | 1.1 | 1.1 | 0.9 | 0.9 | 0.8 | 0.8 | 4.5 | 24.4 |
| % | 30 | 13 | 11 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 18 | 100 |
| (ox-N)% | 100 | 47 | 34 | 100 | 27 | 32 | 33 | 61 | 39 | 100 | 41 | 63 |
| (re-N)% | 0 | 53 | 66 | 0 | 73 | 68 | 67 | 39 | 61 | 0 | 59 | 37 |
| EEZ213 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | GB | NOS | FR | DE | IE | BIC | ATL | NL | BE | ES | Others | Sum |
| kt(N)/yr | 92.2 | 26.1 | 24.3 | 21.1 | 20.9 | 13.0 | 12.4 | 9.5 | 5.7 | 4.9 | 22.2 | 252.4 |
| % | 37 | 10 | 10 | 8 | 8 | 5 | 5 | 4 | 2 | 2 | 9 | 100 |
| (ox-N)% | 47 | 100 | 32 | 46 | 28 | 100 | 100 | 48 | 49 | 39 | 61 | 56 |
| (re-N)% | 53 | 0 | 68 | 54 | 72 | 0 | 0 | 52 | 51 | 61 | 39 | 44 |
| EEZ215 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | BIC | RU | GB | DE | NO | ATL | NOS | PL | FR | NL | Others | Sum |
| kt(N)/yr | 8.8 | 5.1 | 2.3 | 2.2 | 1.4 | 1.4 | 1.0 | 1.0 | 0.9 | 0.6 | 4.5 | 29.0 |
| % | 30 | 18 | 8 | 8 | 5 | 5 | 3 | 3 | 3 | 2 | 15 | 100 |
| (ox-N)% | 100 | 38 | 47 | 37 | 76 | 100 | 100 | 37 | 28 | 42 | 47 | 65 |
| (re-N)% | 0 | 62 | 53 | 63 | 24 | 0 | 0 | 63 | 72 | 58 | 53 | 35 |
| EEZ216 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | GB | DE | NOS | NO | BIC | FR | ATL | NL | DK | PL | Others | Sum |
| kt(N)/yr | 30.3 | 20.3 | 20.0 | 18.4 | 10.6 | 8.9 | 8.3 | 6.6 | 6.5 | 5.7 | 29.0 | 164.6 |
| % | 18 | 12 | 12 | 11 | 6 | 5 | 5 | 4 | 4 | 3 | 18 | 100 |
| (ox-N)% | 61 | 48 | 100 | 62 | 100 | 40 | 100 | 54 | 37 | 52 | 60 | 66 |
| (re-N)% | 39 | 52 | 0 | 38 | 0 | 60 | 0 | 46 | 63 | 48 | 40 | 34 |
| EEZ224 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | BIC | GB | DE | NOS | FR | NO | ATL | NL | IE | RU | Others | Sum |
| kt(N)/yr | 3.0 | 2.5 | 1.5 | 1.2 | 0.9 | 0.8 | 0.7 | 0.5 | 0.5 | 0.4 | 2.9 | 14.9 |
| % | 20 | 17 | 10 | 8 | 6 | 6 | 5 | 3 | 3 | 3 | 19 | 100 |
| (ox-N)% | 100 | 55 | 47 | 100 | 35 | 74 | 100 | 52 | 32 | 52 | 53 | 68 |
| (re-N)% | 0 | 45 | 53 | 0 | 65 | 26 | 0 | 48 | 68 | 48 | 47 | 32 |
| EEZ273 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| Source | ES | ATL | FR | BIC | GB | PT | DE | NOS | MED | NOA | Others | Sum |
| kt(N)/yr | 23.3 | 13.6 | 12.3 | 5.5 | 3.3 | 2.9 | 2.6 | 1.9 | 1.3 | 1.2 | 4.1 | 72.0 |
| % | 32 | 19 | 17 | 8 | 5 | 4 | 4 | 3 | 2 | 2 | 6 | 100 |
| (ox-N)% | 35 | 100 | 27 | 100 | 61 | 55 | 51 | 100 | 100 | 61 | 48 | 58 |
| (re-N)% | 65 | 0 | 73 | 0 | 39 | 45 | 49 | 0 | 0 | 39 | 52 | 42 |

7 Conclusions

The main outcome from this work can be summarised as follows:

- Emission data have been provided by the EMEP Centre for Emission Inventories and Projections (CEIP) for the 1990s (based on 2019 data submissions from Contracting Parties) and for the 2000 to 2019 period (based on 2021 data submissions from Contracting Parties);
- emissions of oxidized nitrogen show statistically significant reductions in all OSPAR Contracting parties, while emissions of reduced nitrogen have been decreasing significantly only in some countries;
- emissions of oxidized nitrogen come mainly from transport and from power generation, while reduced nitrogen emissions are mainly due to agriculture;
- based on emission data from CEIP and meteorological data from ECWMF (European Centre for Medium-Range weather forecasts), EMEP MSC-W has calculated nitrogen depositions to OSPAR regions and Exclusive Economic Zones (EEZs) for the 1990 to 2019 period;
- in all OSPAR Regions, actual (non-normalized) deposition of *oxidised* nitrogen was clearly lower in 2019 than in 1995, with the maximum decline in Region V (57%);
- the difference between 1995 and 2019 shows a decrease in the actual deposition of *reduced* nitrogen, too, in all OSPAR Regions, in the range of 6-19%, although this decrease is much lower than in the case of *oxidised* nitrogen;
- concerning actual deposition of *total* nitrogen, there is a decline between 1995 and 2019 in all OSPAR Regions, in the range of 28-46%, with the largest decline in Region V and the smallest in Region II;
- in all considered EEZs, there is a clear decrease in the actual deposition of *oxidised* nitrogen between 1995 and 2019, in the range of 19-61%;
- in 17 EEZs, actual deposition of *reduced* nitrogen was smaller in 2019 than in 1995 (by up to 26%), while in the other considered EEZs it has increased (by up to 18%) with respect to 1995;
- in all considered EEZs, the actual deposition of *total* nitrogen has decreased from 1995 to 2019, in the range of 9-50%;
- it has to be noted that inter-annual variability in nitrogen depositions is large, mainly due to meteorological conditions. Therefore, changes have been calculated for this report also for the 5-year period 2015-2019 with respect to the 5-year period 1995-1999. That calculation shows decreases in all OSPAR Regions and EEZs (except EEZs 91 and 190 in the case of *reduced* nitrogen deposition);
- normalized depositions of oxidized and reduced nitrogen were lower in 2019 than in 1995 in all OSPAR Regions and in all EEZs. Among the OSPAR Regions, the largest decreases in oxidized nitrogen deposition (about 50%) occurred in OSPAR Region II and in EEZ189. The largest decrease in reduced nitrogen is modelled for EEZ188 (29%). Among OSPAR Regions, the largest decrease in reduced nitrogen is in Region II (18%);
- source-receptor relationships (source apportionment) have been calculated, and the Top-10 contributors have been identified for all OSPAR Regions and EEZs;
- in general, receptor areas are most influenced by the countries adjacent to them, but large emitters can make important contributions even if they are far away, mainly as oxidized nitrogen deposition;

- contributions tend to be larger for sources located upwind of the receptor area, 'upwind' usually meaning 'west of' in the annual average;
- the largest contribution to nitrogen deposition in OSPAR Regions II and III is made by the United Kingdom, while OSPAR Region IV receives the single-largest contribution from Spain; the more remote Regions I and V are strongly influenced by the boundary condition (i.e. sources outside the EMEP model domain);
- for the first time this year, also 'partial' EEZs' (parts of EEZs within different OSPAR Regions) and COMP4 Assessment Units (as defined in a file provided by OSPAR in May 2021) have been considered;
- in all COMP4 Assessment Units, normalized deposition of *oxidized* nitrogen was clearly lower in 2019 than in 1995, with the largest decrease in ECPM2 (55%);
- among COMP4 Assessment Units, normalized deposition for *reduced* nitrogen shows both decreases and increases since 1995: the largest *decrease* (56%) is modelled in NAAC1D ("Noratlantic Area NOR-NorC1(D5)D") while the largest *increase* (32%) is in OWCO ("Ocean Waters CO (D5)");
- the 5-year average *oxidized* nitrogen deposition decreases in all COMP4 Assessment Units, and *reduced* nitrogen deposition in most of them. Some increases are seen, the largest one (24%) in HPM ("Humber Plume");
- a detailed uncertainty analysis for the results concerning COMP4 Assessment Units was beyond the scope of this study but we consider uncertainties for the smallest COMP4 Assessment Units as rather large (as was already mentioned in the contract); this is particularly true for those Areas that have a very thin and elongated shapes.

This year the trend calculation was extended back to 1990. However, in this report we focus only on the 25-period from 1995-2019 in order to be consistent with previous report and also because the emission data for the 1990s were not updated for modelling this year. Nevertheless, model results for all years back to 1990s are included in the Excel data sheets provided to OSPAR as an attachment to this report (Chapter 8).

8 Accompanying data sheets

As the numbers of sources and receptors relevant to OSPAR have become quite large, not all results could be shown in this report. Several data files have thus been submitted along with this report:

a) N_depositions OSPAR_2021 (Excel format) : Actual and normalized depositions of oxidized, reduced and total nitrogen to all OSPAR receptors of interest in the period 1995-2019. The data for actual depositions extend back to 1990. The Excel file also contains a 'README' sheet for information about versions, units, contact details, etc., as well as a sheet with definitions of all receptor areas considered in this work (i.e. OSPAR Regions, EEZs, partial EEZs and COMP4 Assessment Units, as included in the EMEP MSC-W model domain).

b) SR OSPAR_normalized_2021 (ASCII format) : All contributions to OSPAR Regions, EEZs and partial EEZs. Tables for each source-receptor pair are preceded by a header specifying:

- the species, i.e. oxidized nitrogen ("ox-N") or reduced nitrogen ("re-N")
- the unit (Mg(N)/year = tonnes(N)/year)
- the receptor ("Basin"), and the source country ("Source") abbreviated by its Alpha-2 code.

OSPAR regions I to V are abbreviated as 'OR1', 'OR2', ... 'OR5' in the file. An example screenshot is shown in Figure 17. Minimum and maximum values are given in addition to the Normalized value. The column 'Annual' is for internal checks only and should not be used.

c) NOx_emis_for OSPAR_2021 (Excel format) : Emissions for oxidized nitrogen (NOx) from OSPAR Contracting parties, as provided by CEIP for modelling purposes. The Excel file also contains a 'README' sheet for information about versions, units, contact details, etc.

d) NH3_emis_for OSPAR_2021 (Excel format) : Emissions for reduced nitrogen (ammonia) from OSPAR Contracting parties, as provided by CEIP for modelling purposes. The Excel file also contains a 'README' sheet for information about versions, units, contact details, etc.

| Ox-N deposition in Mg(N)/year: Basin=OR4; Source=SI | | | | |
|---|---------|------------|--------|---------|
| Year | Minimum | Normalised | Annual | Maximum |
| 1995 | 26.61 | 30.37 | 0.00 | 31.94 |
| 1996 | 27.61 | 31.51 | 0.00 | 33.14 |
| 1997 | 27.14 | 30.97 | 0.00 | 32.57 |
| 1998 | 24.54 | 28.01 | 0.00 | 29.46 |
| 1999 | 22.05 | 25.17 | 0.00 | 26.47 |
| 2000 | 21.89 | 24.98 | 0.00 | 26.27 |
| 2001 | 22.02 | 25.13 | 0.00 | 26.43 |
| 2002 | 21.86 | 24.95 | 0.00 | 26.24 |
| 2003 | 20.57 | 23.48 | 0.00 | 24.69 |
| 2004 | 20.06 | 22.89 | 0.00 | 24.07 |
| 2005 | 20.28 | 23.14 | 0.00 | 24.34 |
| 2006 | 20.48 | 23.37 | 0.00 | 24.58 |
| 2007 | 19.95 | 22.77 | 0.00 | 23.95 |
| 2008 | 21.32 | 24.32 | 0.00 | 25.58 |
| 2009 | 18.10 | 20.65 | 0.00 | 21.72 |
| 2010 | 17.89 | 20.42 | 0.00 | 21.47 |
| 2011 | 17.58 | 20.06 | 0.00 | 21.10 |
| 2012 | 17.00 | 19.40 | 0.00 | 20.41 |
| 2013 | 15.99 | 18.25 | 0.00 | 19.19 |
| 2014 | 14.43 | 16.47 | 0.00 | 17.32 |
| 2015 | 13.02 | 14.86 | 0.00 | 15.63 |
| 2016 | 12.80 | 14.61 | 15.36 | 15.36 |
| 2017 | 12.59 | 14.37 | 14.86 | 15.11 |
| 2018 | 11.99 | 13.68 | 14.19 | 14.39 |
| 2019 | 10.88 | 12.42 | 10.88 | 13.06 |

| Ox-N deposition in Mg(N)/year: Basin=OR4; Source=SK | | | | |
|---|---------|------------|--------|---------|
| Year | Minimum | Normalised | Annual | Maximum |
| 1995 | 11.63 | 21.57 | 0.00 | 32.75 |
| 1996 | 11.52 | 21.39 | 0.00 | 32.45 |

Figure 17: Screenshot of the source-receptor data table provided along with this report, containing contributions from all OSPAR Contracting Parties and other sources in the EMEP model domain to the OSPAR Regions, EEZs and partial EEZs. The example shows SI (Slovenia) and SK (Slovakia) contributions to OSPAR Region IV (OR4). The column 'Annual' is for internal checks only and should not be used.

9 References

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