OSPAR COMMISSION

Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1990-2020

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Atmospheric Deposition of Nitrogen to the OSPAR Maritime Area in the period 1990-2020

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Contents

Executive Summary

Airborne nitrogen depositions to the OSPAR Maritime Area for the 31-year period 1990-2020 have been calculated with the EMEP MSC-W Chemistry Transport Model on a horizontal resolution of 0.1°longitude x 0.1°latitude, based on emission data updated in 2022 by the EMEP Centre on Emission Inventories and Projections. The 1990-2020 period is the longest period for which EMEP MSC-W has done this type of calculation for OSPAR until now.

Results for actual and weather-normalized nitrogen depositions are presented in this report and accompanying data sheets for the 5 OSPAR Regions, the 24 Exclusive Economic Zones (EEZs) within the OSPAR Maritime Area, the 25 so-called 'partial EEZs' (EEZs divided up into different OSPAR regions), and the 64 COMP4 (Fourth Common Procedure) Assessment Units. The new definitions of the COMP4 Assessment Units (as of August 2022) were implemented in the EMEP MSC-W analysis routines as part of this contract. Normalization ("weather-averaging") was done using meteorological data for the years 2016 to 2020.

According to our model results, actual (non-normalized) depositions of oxidised nitrogen were clearly lower in 2020 than in 1990 in all OSPAR Regions, EEZs and COMP4 Assessment Units. In the case of reduced nitrogen depositions, there are both increases and decreases, depending on the receptor area under consideration. This is mainly due to the much less significant (or even absent) downward trends seen in the emissions of reduced nitrogen in many countries. However, total (oxidized+reduced) nitrogen depositions were lower in 2020 than in 1990 in all OSPAR Regions, all EEZs and nearly all COMP4 Assessment Units.

This year, we have included a trend analysis for depositions over the 31-year period from 1990 to 2020, but also separately for the 1990s and for the most recent decade (2010-2020), using the Mann-Kendall test. Statistically significant downward trends are found in all receptor areas for oxidized nitrogen, while for reduced nitrogen there are far less areas with significant downward trends; indeed some of them show increases. In general, trends in weather-normalized depositions are more significant than those in actual depositions because the interannual variability in meteorology is filtered out.

Récapitulatif

Les dépôts atmosphériques d'azote dans la zone maritime OSPAR pour une période de 31 ans (1990-2020) ont été calculés avec le modèle de transport de la chimie du EMEP MSC-W à une résolution horizontale de 0,1°longitude x 0,1°latitude, sur la base des données d'émission mises à jour en 2022 par le Centre des inventaires et des projections des émissions de l'EMEP. La période de 1990 à 2020 est la plus longue pour laquelle le MSC-W a effectué ce type de calcul pour OSPAR jusqu'à présent.

Les résultats des dépôts d'azote réels et normalisés en fonction des conditions météorologiques sont présentés dans ce rapport et dans les fiches de données qui l'accompagnent pour les 5 Régions OSPAR, les 24 zones économiques exclusives (ZEE) de la zone maritime OSPAR, les 25 "ZEE partielles" (ZEE divisées en différentes régions OSPAR) et les 64 unités d'évaluation COMP4 (Quatrième procédure commune). Les nouvelles définitions des unités d'évaluation COMP4 (à partir d'août 2022) ont été appliquées dans les routines d'analyse du MSC-W dans le cadre de ce contrat. La normalisation ("weather-averaging") a été effectuée à l'aide de données météorologiques pour les années 2016 à 2020.

Selon les résultats du modèle, les dépôts réels (non normalisés) d'azote oxydé étaient clairement inférieurs en 2020 à ceux de 1990 dans toutes les Régions d'OSPAR, toutes les ZEE, et toutes les unités

d’évaluation COMP4. Dans le cas des dépôts d'azote réduit, on observe à la fois des augmentations et des diminutions, en fonction de la zone réceptrice considérée. Cela est principalement dû aux tendances à la baisse beaucoup moins significatives (voire absentes) observées dans les émissions d'azote réduit dans de nombreux pays. Toutefois, les dépôts d'azote total (oxydé+réduit) étaient plus faibles en 2020 qu'en 1990 dans toutes les Régions OSPAR, toutes les ZEE et presque toutes les unités d'évaluation COMP4.

Cette année, nous avons inclus une analyse des tendances des dépôts sur la période de 31 ans allant de 1990 à 2020, mais aussi séparément pour les années 1990 et pour la décennie la plus récente (2010-2020), en utilisant le test de Mann-Kendall. Des tendances à la baisse statistiquement significatives sont observées dans toutes les zones réceptrices pour l'azote oxydé, tandis que pour l'azote réduit, les zones présentant des tendances à la baisse significatives sont beaucoup moins nombreuses ; certaines d'entre elles affichent même des augmentations. En général, les tendances des dépôts normalisés en fonction des conditions météorologiques sont plus significatives que celles des dépôts réels, car la variabilité interannuelle de la météorologie est filtrée.

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 the 2022 contract between OSPAR and EMEP MSC-W, entitled "CONTRACT FOR EMEP-W products on atmospheric deposition in support of NEAES Strategic Objectives 1 and 2 to achieve clean seas in the OSPAR marine area". The following Deliverables were listed in the contract:

a. Update of receptor areas implementing the new COMP areas so that data can be extracted for the following areas: Five OSPAR Regions; Twenty-four EEZ; Twenty-five 'partial EEZs' (EEZ divided up into different OSPAR regions); Sixty-four COMP4 Assessment Units (Fourth Common Procedure).
b. Actual and normalized Nitrogen deposition to each OSPAR Region and to each EEZ, to each partial EEZ and the 40 largest COMP4 units including reports, figures, and tables.

The term "Partial EEZs" in this context refers to the different parts of EEZs falling 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.

The term "COMP4 units" refers to the sixty-four COMP4 Assessment Units as defined in a shape file provided by OSPAR to EMEP MSC-W in August 2022. All of these units have been implemented in the EMEP MSC-W analysis routines for nitrogen deposition, although only 40 of them were required by the contract (as the smallest and thinnest Units are only poorly resolved by the EMEP model grid).

Calculations have been done for the entire 1990-2020 period. As usual, and as required by the contract, results are provided in this report and the accompanying Excel file both for *actual* deposition (best representation of real depositions in each year) and for *normalized* deposition (based on emissions in each year but on average meteorology).

For the normalization procedure we have used meteorological data for the years 2016, 2017, 2018, 2019 and 2020.

After the description of the model setup in Chapter 2, we present the emission data used in the model calculations (Chapter 3) and the definitions of receptor areas considered for OSPAR (Chapter 4). The model results and the main conclusions are presented in Chapters 5 and 6 respectively, while Chapter 7 briefly introduces the Excel 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 (Simpson et al., 2020; 2021; 2022; and references therein).

The model is regularly evaluated against measurements from the EMEP network under the LRTAP Convention (e.g. Gauss et al., 2020) and online at the AeroVal evaluation web pages (https://aeroval.met.no/evaluation.php?project=emep), but also in a large number of international research projects and operational services (e.g. Copernicus Atmosphere Modelling Service https://regional.atmosphere.copernicus.eu/).

A detailed evaluation of this year's EMEP MSC-W model simulation (for 2020) can be viewed at https://aeroval.met.no/evaluation.php?project=emep&exp_name=2022-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 to 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/emep-ctm. In this way, the scientific community as well as advanced policy users can check and apply the model themselves, both as a research tool and for underpinning of air quality legislation.

2.2 Experimental setup

Meteorological data, needed as input to the EMEP MSC-W model, have been generated by the ECMWF IFS numerical weather prediction model, version cy40r1, for the period 1990 to 2018 and version cy46r1 for 2019 and 2020 (see ECMWF model documentation). The version change between 2018 and 2019 was inevitable because cy40r1 is not supported anymore. However, changes in the weather prediction model have a relatively small effect on the chemistry transport model results (changes in the chemistry transport model itself and in the emission data are more important).

Emission data for 1990-2020 were obtained in June 2022 from the EMEP Centre CEIP (EMEP, 2022, their Chapter 3) and were used in the model runs covering the same 31-year period. More details about the emission data used in our model calculations are given in the next Chapter.

EMEP MSC-W model version rv4.45 (documented and evaluated in EMEP Status report 1/2022) was run for the entire 1990-2020 period, using the meteorological and emission data described above, on 0.1°lon x 0.1°lat resolution and within the longitude-latitude domain outlined shown in Figure 1.

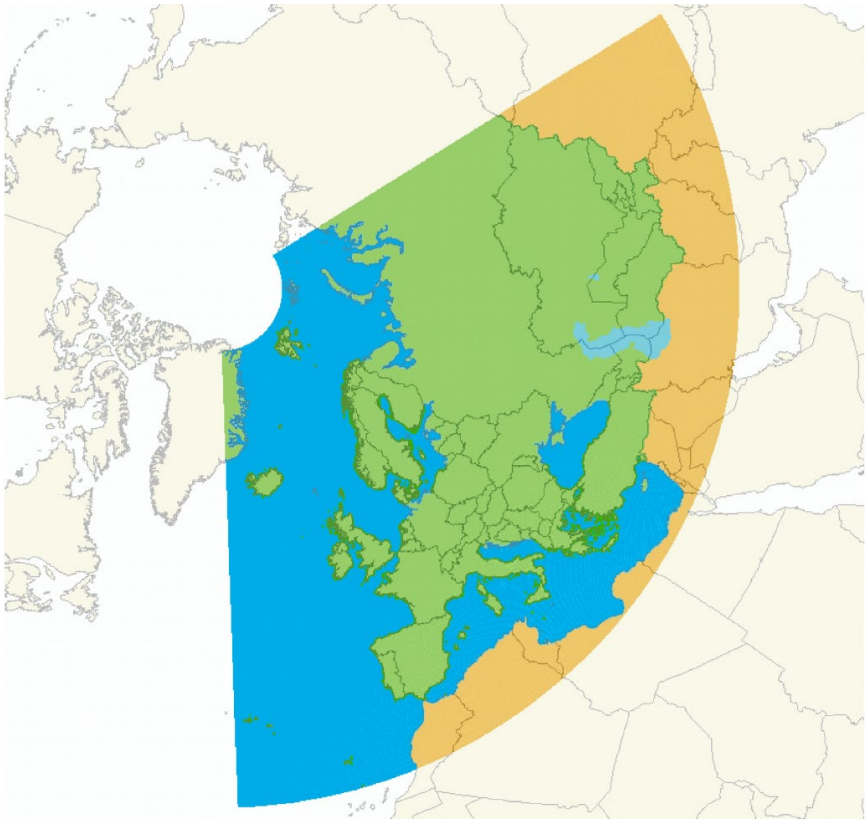


Figure 1: Domain used in the EMEP model calculations

3 Emission data by Contracting Parties

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/NH_3) are listed in Tables 1 and 2, respectively, for the 1990-2020 period and the OSPAR Contracting Parties[1]. Emissions from international shipping in the North Sea and North-East Atlantic areas (see Figure 2), and all other sources combined, are listed as well. Figure 3 visualizes the evolution of emissions 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. The emissions of other sources (labelled 'Other' in the Figure and the Tables) may appear large, but it has to be noted that these sources are far away from the OSPAR maritime area and thus are not very important for nitrogen deposition in the OSPAR receptor areas that are considered in this report. However, for accurate modelling they must always be included in the EMEP MSC-W model simulations.

As discussed in earlier reports, emissions of oxidized nitrogen have been considerably reduced over the years, while ammonia emissions do not show very clear reductions during the later years. This is reflected also in the results for deposition of nitrogen, to be presented in Chapter 5.

[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).

For completeness, emissions of *total* nitrogen (oxidized+reduced) are listed in Table 3.

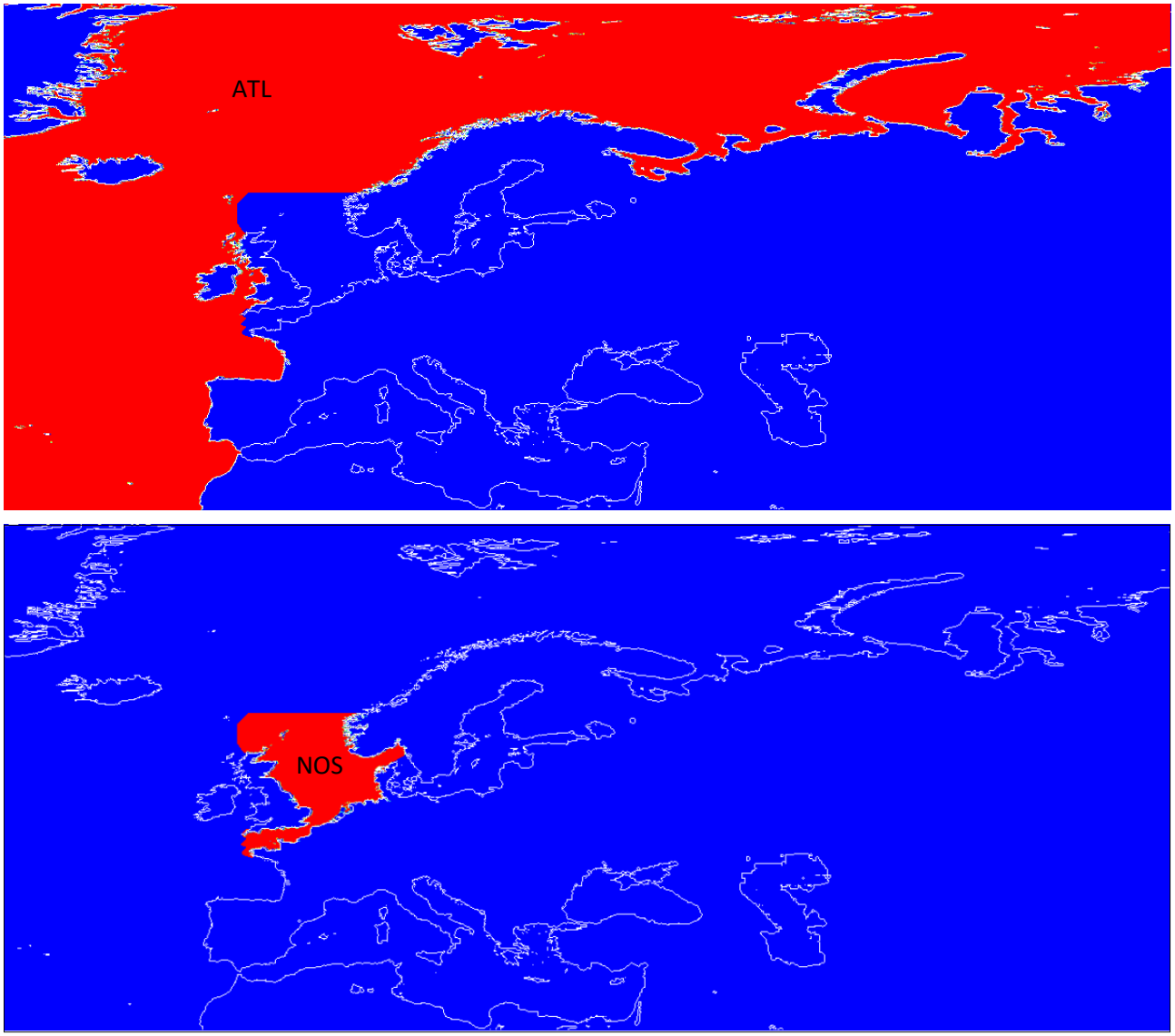


Figure 2: Visualization of the ATL and NOS shipping emission regions in the EMEP model domain. NOS: North Sea shipping, ATL: North-East Atlantic shipping except North Sea

Table 1. Annual emissions of oxidized nitrogen from OSPAR Contracting Parties in the period 1990 – 2020, as used in the EMEP MSC-W model calculations of nitrogen deposition. Unit: ktonnes(N)/year. Country abbreviations according to ISO 3166-1 alpha-2. NOS: North Sea shipping (see Figure 2); ATL: North East Atlantic shipping (see Figure 2); OSPAR: sum of the 15 OSPAR contracting parties included in this table; Other: all other areas within the EMEP model domain (this also includes international shipping, e.g. from the Baltic and Mediterranean Seas). The table continues on the next page.

	BE	DK	FI	FR	DE	IS	IE	LU	NL
1990	129	91	93	635	863	9	51	12	204
1991	129	106	92	652	796	9	52	14	200
1992	129	92	88	642	751	9	55	14	196
1993	128	92	89	612	721	10	53	14	191
1994	127	93	89	592	682	10	53	12	178
1995	125	87	83	578	665	10	52	11	174
1996	121	97	84	566	640	10	53	11	170
1997	117	83	83	545	617	10	52	11	161
1998	117	77	78	556	609	10	54	11	155
1999	109	71	77	545	599	10	55	11	153
2000	109	67	73	527	575	10	55	13	147
2001	105	66	74	514	558	9	55	13	144
2002	102	66	74	502	540	9	53	13	139
2003	101	69	76	485	526	9	53	14	138
2004	104	64	72	472	512	10	53	17	133
2005	99	61	63	456	497	9	54	17	131
2006	94	61	68	429	500	8	52	16	129
2007	91	57	64	409	484	9	51	14	124
2008	83	52	59	384	465	8	46	13	121
2009	74	46	54	360	436	8	39	12	110
2010	74	45	57	350	440	8	37	12	108
2011	69	42	52	333	432	7	33	12	104
2012	66	39	49	326	430	7	34	11	98
2013	63	37	48	319	430	7	34	10	95
2014	60	35	46	297	416	7	34	10	87
2015	60	34	42	291	409	7	35	9	86
2016	56	34	41	276	401	6	35	8	81
2017	53	33	40	266	386	7	34	7	78
2018	51	32	39	248	360	7	34	6	76
2019	47	29	36	237	337	6	31	6	71
2020	41	27	32	201	298	6	29	5	64

Table 1. Continued.

	NO	PT	ES	CH	SE	GB[2]	OSPAR	NOS	ATL	Other
1990	60	79	404	44	88	943	3706	194	236	6828
1991	58	84	416	43	89	919	3659	202	246	6476
1992	59	90	422	41	85	905	3579	218	265	6277
1993	61	87	403	37	81	862	3440	212	259	5965
1994	62	87	405	37	82	845	3354	218	265	5719
1995	66	90	407	35	79	805	3266	225	274	5565
1996	69	85	403	34	77	779	3198	230	280	5527
1997	71	86	408	32	73	726	3076	235	287	5453
1998	72	90	407	32	71	701	3040	242	295	5370
1999	69	93	409	32	69	665	2966	254	309	5264
2000	65	91	411	31	68	639	2882	267	323	5286
2001	65	91	401	30	65	621	2813	263	319	5312
2002	63	92	408	29	62	591	2744	258	312	5330
2003	64	85	411	28	61	579	2698	253	307	5396
2004	63	86	416	28	60	560	2649	249	303	5452
2005	64	86	409	28	59	553	2586	245	298	5524
2006	64	80	400	28	58	532	2520	242	293	5487
2007	65	76	400	28	57	508	2438	237	288	5478
2008	63	71	341	28	54	455	2245	221	264	5355
2009	60	67	306	26	51	397	2045	212	249	5264
2010	61	62	289	26	52	388	2009	222	269	5304
2011	60	57	289	25	50	360	1925	216	263	5331
2012	59	53	274	25	48	366	1884	214	259	5348
2013	58	52	253	25	46	346	1823	208	251	5330
2014	58	51	251	23	46	322	1742	191	222	5315
2015	55	52	258	22	45	311	1716	196	229	5366
2016	53	50	246	22	44	284	1635	192	221	5475
2017	51	51	247	21	42	273	1588	193	226	5653
2018	50	49	243	20	41	261	1516	195	227	5768
2019	48	47	226	19	38	244	1424	195	235	5837
2020	45	41	193	16	36	212	1246	185	203	5647

[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 (reduced nitrogen) from OSPAR Contracting Parties in the period 1990 – 2020, as used in the EMEP MSC-W model calculations of nitrogen deposition. Unit: ktonnes(N)/year. Country abbreviations according to ISO 3166-1 alpha-2. OSPAR: sum of the 15 OSPAR contracting parties included in this table; Other: all other areas within the EMEP model domain. (No significant emissions of ammonia from international shipping, thus NOS and ATL are not included in this table.) The table continues on the next page.

	BE	DK	FI	FR	DE	IS	IE	LU	NL
1990	87	116	29	547	591	4	90	5	284
1991	87	112	28	547	528	4	92	5	295
1992	87	109	27	537	527	4	94	5	243
1993	87	106	27	534	521	4	94	5	242
1994	87	103	28	529	505	4	95	5	209
1995	87	97	28	533	505	4	95	5	179
1996	86	93	29	538	513	4	99	5	182
1997	84	92	30	533	507	4	101	5	174
1998	82	92	30	535	514	4	105	5	162
1999	80	88	32	535	512	4	103	5	160
2000	78	85	29	544	514	4	99	5	142
2001	77	83	30	540	517	4	99	5	137
2002	74	81	30	528	507	4	99	5	131
2003	71	80	31	521	505	4	99	5	129
2004	67	79	31	515	491	4	97	5	128
2005	66	76	32	511	497	4	99	5	126
2006	65	73	31	503	492	4	100	5	129
2007	63	73	31	508	499	4	94	5	125
2008	61	72	30	513	501	4	96	5	115
2009	61	69	31	506	504	4	96	5	113
2010	62	69	31	509	506	4	95	5	110
2011	61	66	30	501	509	4	91	5	109
2012	61	65	30	502	514	4	96	5	103
2013	60	63	29	500	520	4	97	5	101
2014	59	63	30	503	527	4	94	5	104
2015	59	64	28	509	526	4	98	5	106
2016	59	65	28	509	523	4	103	5	106
2017	58	66	27	506	510	4	106	5	109
2018	57	66	27	501	489	4	111	5	107
2019	56	62	27	491	474	4	103	5	102
2020	56	63	25	472	442	4	102	5	102

Table 2. Continued.

	NO	PT	ES	CH	SE	GB	OSPAR	Other
1990	25	63	378	57	50	260	2585	6938
1991	24	63	368	56	48	259	2516	6687
1992	25	63	364	55	49	249	2436	6578
1993	23	61	345	55	50	244	2399	6227
1994	23	61	358	54	51	249	2359	6029
1995	23	60	351	54	50	242	2314	5879
1996	24	61	384	53	50	250	2370	5808
1997	23	60	385	51	51	255	2357	5715
1998	24	59	406	51	51	256	2375	5659
1999	24	61	407	51	50	251	2362	5591
2000	24	63	426	51	49	246	2360	5476
2001	24	60	422	51	49	241	2338	5464
2002	24	59	413	50	49	239	2293	5511
2003	25	56	421	49	49	234	2278	5576
2004	25	57	418	49	49	238	2252	5642
2005	25	53	393	49	48	232	2215	5707
2006	25	52	389	50	47	228	2193	5729
2007	25	53	395	50	47	222	2194	5728
2008	25	51	360	50	47	212	2143	5681
2009	25	49	358	48	45	212	2126	5667
2010	25	49	355	48	45	214	2126	5665
2011	25	49	346	47	45	213	2100	5714
2012	25	47	344	47	44	210	2097	5797
2013	25	46	347	46	45	208	2096	5834
2014	25	48	364	46	45	215	2132	5848
2015	25	49	370	46	45	217	2151	5889
2016	25	49	373	45	44	220	2159	6114
2017	24	50	389	45	44	223	2167	6348
2018	25	50	388	45	44	222	2142	6511
2019	24	51	385	44	44	219	2090	6716
2020	24	52	395	44	44	213	2043	6852

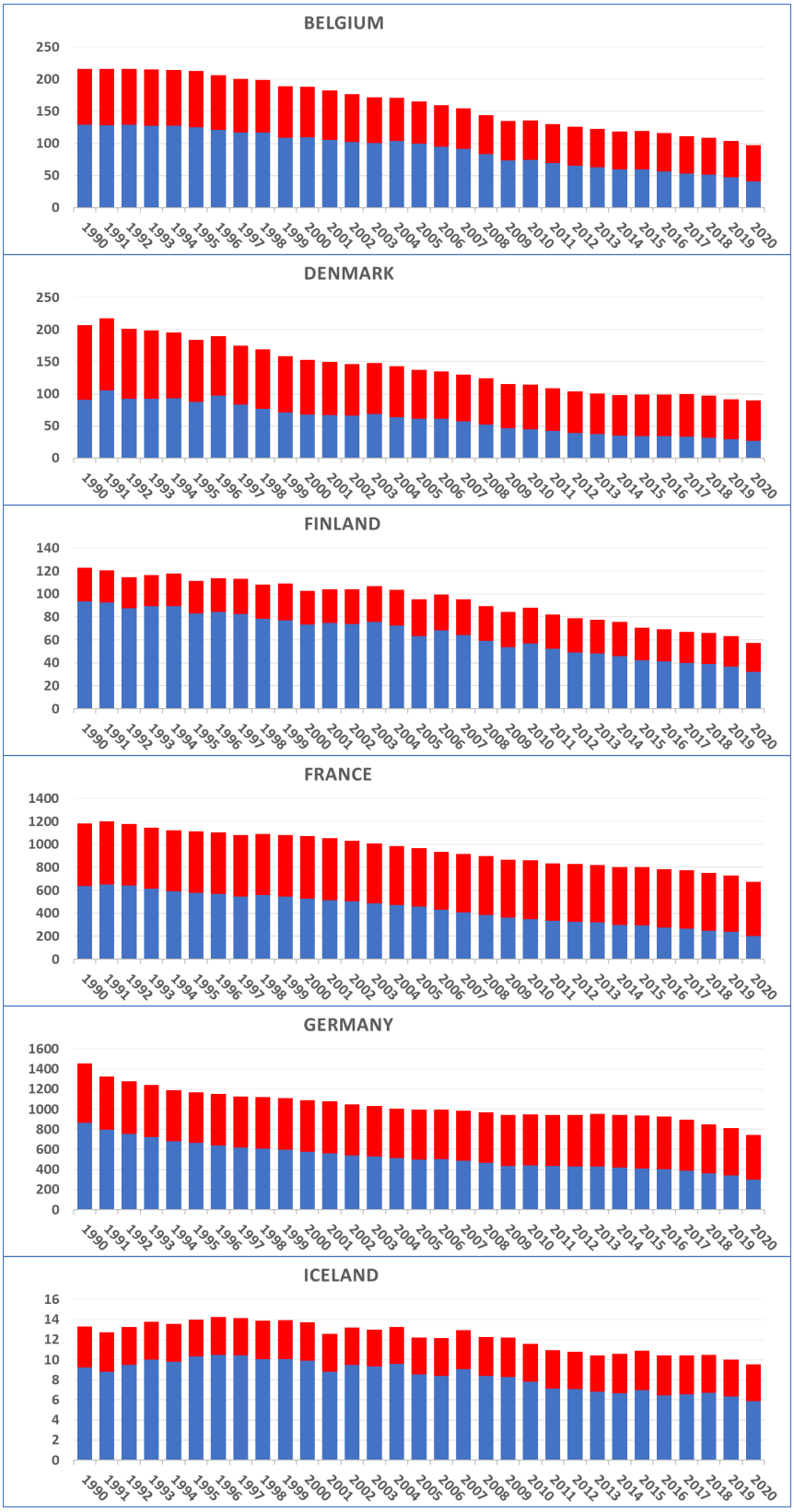


Figure 3: Change in emissions during the 1990-2020 period, as provided by the EMEP Centre CEIP for modelling, based on official data submissions by Contracting Parties. Blue: Oxidized nitrogen (NOx); red: reduced nitrogen (NH_3). Unit: ktonnes(N)/year. (Figure continues on the next two pages.)

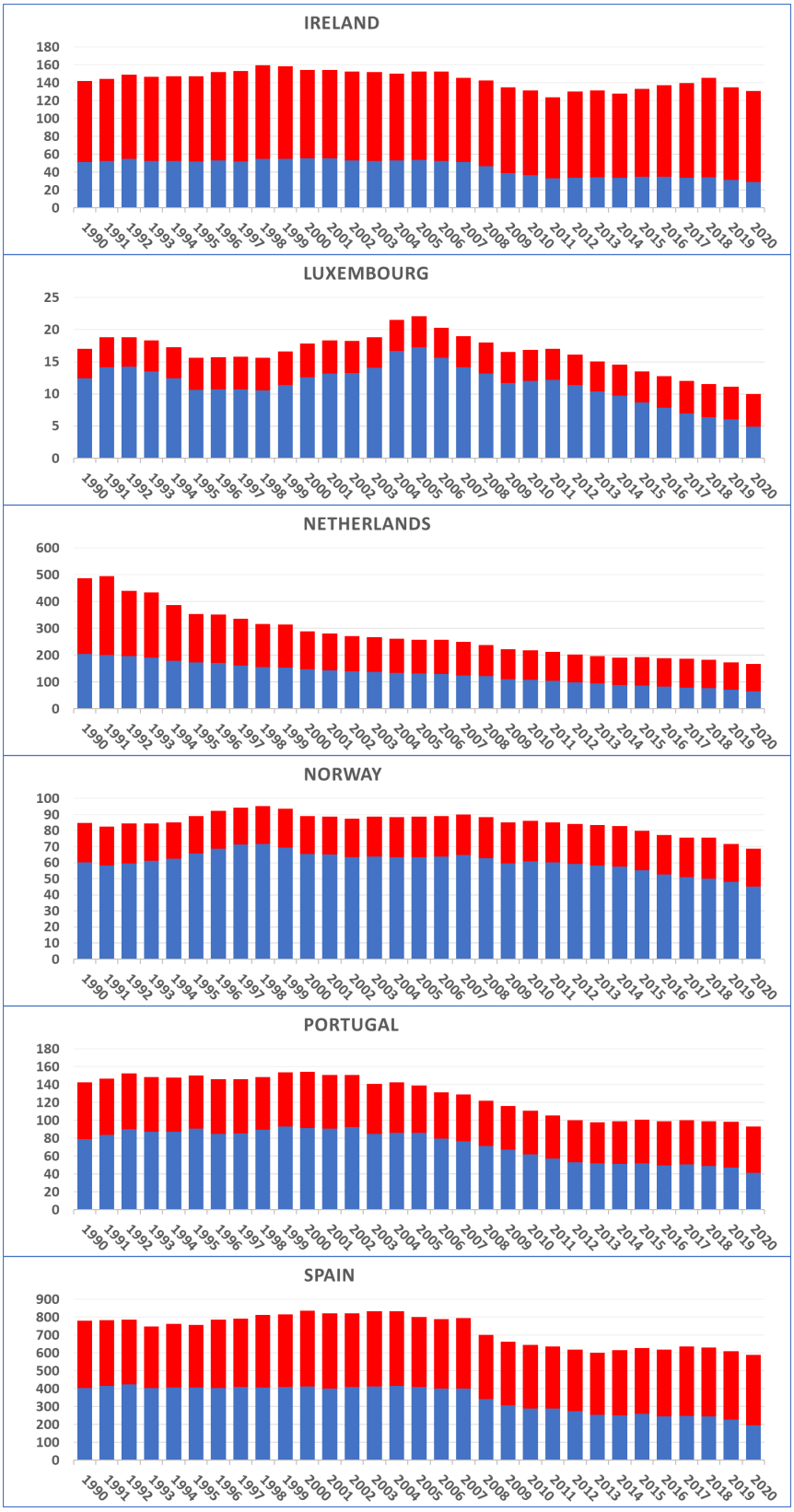


Figure 3: Continued.

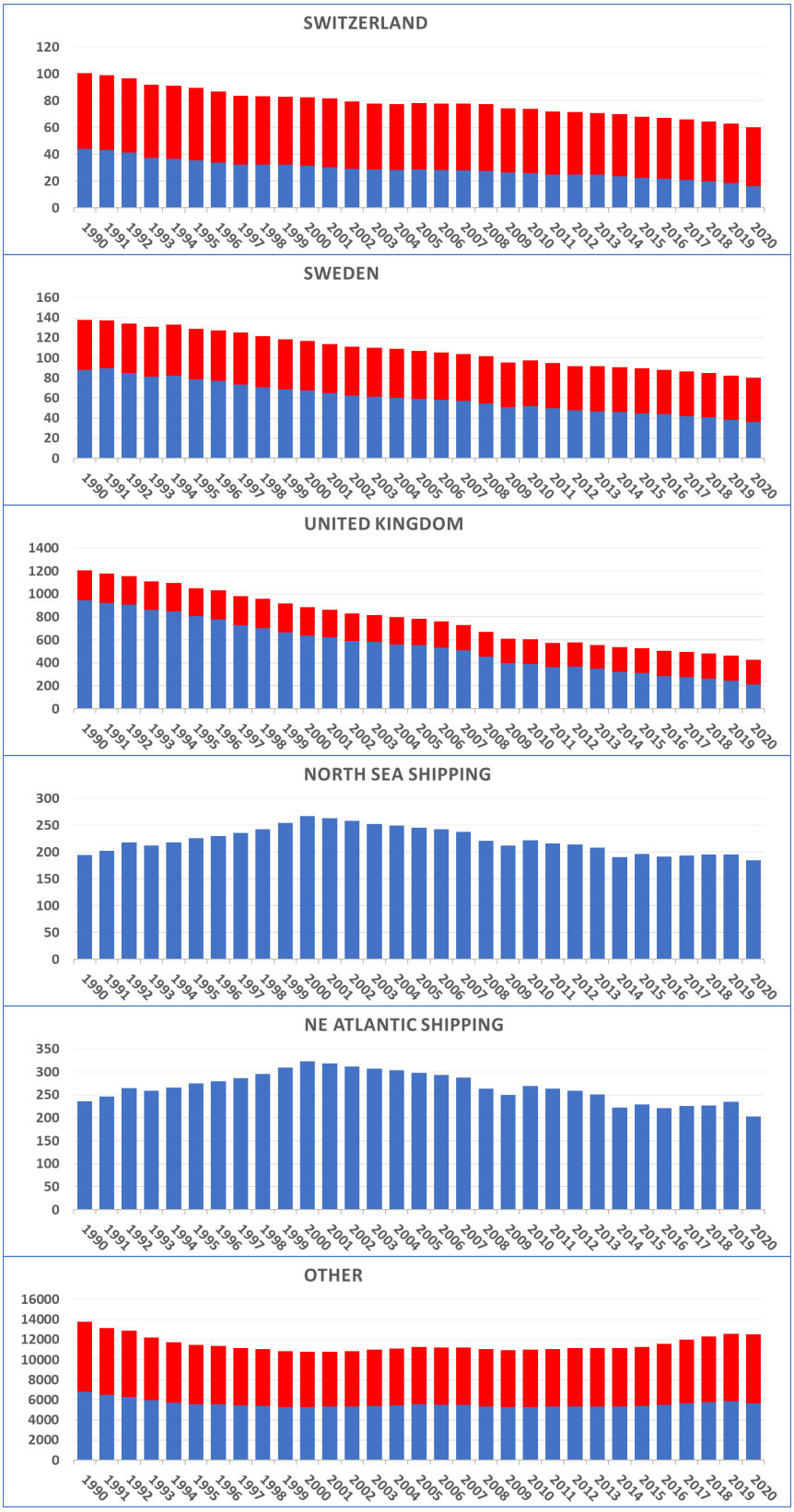


Figure 3: Continued.

Table 3. National annual emissions of total nitrogen (oxidized+reduced) from OSPAR Contracting Parties in the period 1990 – 2020, as used in the EMEP MSC-W model calculations of nitrogen deposition. Unit: ktonnes(N)/year. Country abbreviations according to ISO 3166-1 alpha-2. NOS: North Sea shipping (see Figure 2); ATL: North East Atlantic shipping (see Figure 2); OSPAR: sum of the 15 OSPAR contracting parties included in this table; Other: all other areas within the EMEP model domain. The table continues on the next page.

Year	BE	DK	FI	FR	DE	IS	IE	LU	NL
1990	216	207	123	1182	1454	13	142	17	487
1991	216	218	120	1199	1324	13	144	19	495
1992	216	201	115	1178	1278	13	149	19	439
1993	215	198	117	1146	1242	14	146	18	433
1994	214	195	118	1120	1187	14	147	17	387
1995	213	184	111	1111	1170	14	147	16	353
1996	206	190	113	1103	1152	14	152	16	352
1997	200	175	113	1079	1124	14	153	16	336
1998	199	169	108	1092	1122	14	160	16	317
1999	189	159	109	1080	1110	14	158	17	313
2000	188	153	103	1071	1090	14	154	18	289
2001	182	149	104	1055	1076	13	154	18	281
2002	176	146	104	1030	1047	13	152	18	270
2003	172	148	107	1006	1031	13	152	19	267
2004	171	143	104	987	1002	13	150	22	261
2005	165	138	95	967	993	12	152	22	257
2006	160	135	99	932	992	12	152	20	258
2007	154	130	95	918	983	13	145	19	250
2008	144	124	89	897	966	12	143	18	237
2009	135	115	84	866	940	12	135	17	222
2010	136	114	88	859	946	12	131	17	218
2011	130	109	82	834	941	11	124	17	213
2012	126	104	79	828	944	11	130	16	201
2013	123	101	78	819	950	10	131	15	196
2014	118	98	76	800	943	11	128	15	191
2015	119	99	71	800	935	11	133	13	192
2016	116	99	69	785	924	10	137	13	188
2017	111	100	67	772	896	10	140	12	187
2018	108	97	66	750	849	10	145	12	183
2019	104	91	63	728	811	10	135	11	173
2020	97	90	57	673	740	10	131	10	167

Table 3. Continued.

Year	NO	PT	ES	CH	SE	GB	OSPAR	NOS	ATL	Other
1990	85	142	781	101	138	1204	6292	194	236	13766
1991	82	147	784	99	137	1178	6175	202	246	13163
1992	84	153	786	96	134	1153	6015	218	265	12855
1993	84	148	749	92	131	1106	5839	212	259	12192
1994	85	148	764	91	133	1094	5713	218	265	11749
1995	89	150	758	89	129	1047	5580	225	274	11444
1996	92	146	786	87	127	1029	5567	230	280	11335
1997	94	146	793	84	125	980	5432	235	287	11168
1998	95	148	814	83	122	957	5415	242	295	11028
1999	93	154	816	83	118	916	5328	254	309	10855
2000	89	155	836	83	117	884	5242	267	323	10761
2001	89	151	823	82	113	862	5151	263	319	10776
2002	87	151	821	79	111	830	5037	258	312	10841
2003	89	141	833	78	110	814	4977	253	307	10972
2004	88	142	834	77	109	798	4901	249	303	11094
2005	89	139	801	78	107	785	4801	245	298	11231
2006	89	131	789	78	105	760	4712	242	293	11216
2007	90	129	795	78	104	730	4633	237	288	11206
2008	88	122	701	77	102	667	4388	221	264	11036
2009	85	116	663	74	95	609	4170	212	249	10931
2010	86	111	645	74	97	602	4135	222	269	10969
2011	85	106	635	72	95	573	4025	216	263	11045
2012	84	100	618	71	92	577	3982	214	259	11145
2013	83	98	600	71	91	554	3919	208	251	11163
2014	83	99	615	70	91	538	3874	191	222	11163
2015	80	101	628	68	90	528	3867	196	229	11255
2016	77	99	619	67	88	504	3794	192	221	11589
2017	75	100	635	66	86	496	3754	193	226	12001
2018	75	99	631	64	85	483	3658	195	227	12279
2019	72	98	611	63	82	463	3514	195	235	12553
2020	69	93	588	60	80	425	3289	185	203	12498

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. We now consider 118 receptor areas for OSPAR: 1) the five OSPAR Regions, 2) the twenty-four Exclusive Economic Zones (EEZs) in the OSPAR Maritime Area, 3) the twenty-five 'partial EEZs' (pieces of EEZs belonging to different OSPAR Regions), and 4) the sixty-four COMP4 Assessment Units.

4.1 OSPAR Regions

All five 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 4 for the 0.1°longitude x 0.1°latitude grid.

Table 4 lists the OSPAR Regions and their areas within the EMEP model domain, calculated on the 0.1°longitude x 0.1°latitude grid.

Table 4. The five OSPAR Regions as implemented in the EMEP MSC-W analysis in the 0.1°lon x 0.1°lat grid. OSPAR Regions I and V are not fully covered by the EMEP model domain/grid (actual areas as in the shape files from OSPAR are shown in parentheses).

Region	**Area included in the EMEP model domain**
OSPAR Region I	4 311 747 km^2 (of 5.53 million km^2)
OSPAR Region II	748 583 km^2 (fully covered)
OSPAR Region III	381 860 km^2 (fully covered)
OSPAR Region IV	538 119 km^2 (fully covered)
OSPAR Region V	4 080 366 km^2 (of 6.35 million km^2)

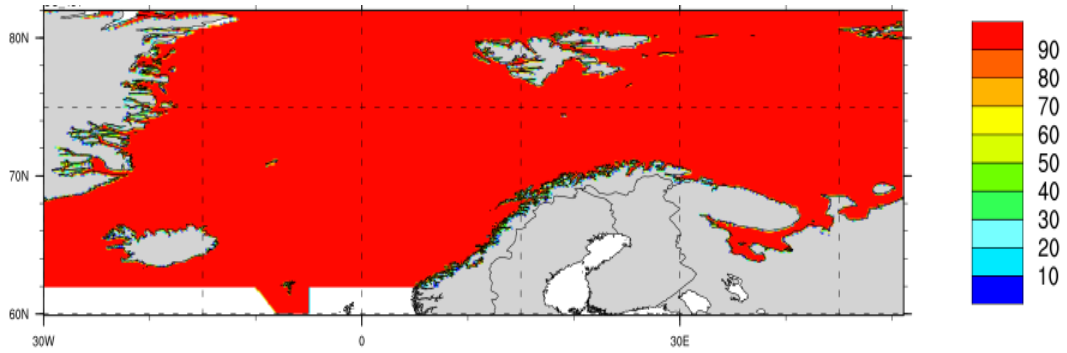


Figure 4a: Visualization of OSPAR Region I in the EMEP grid. The plot shows how large a percentage of each EMEP model grid cell lies within OSPAR Region I. EMEP model grid cells cover only 0.1°lon x 0.1°lat pixels, and thus appear very small in this plot. Red colour means that the model grid cell is 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).

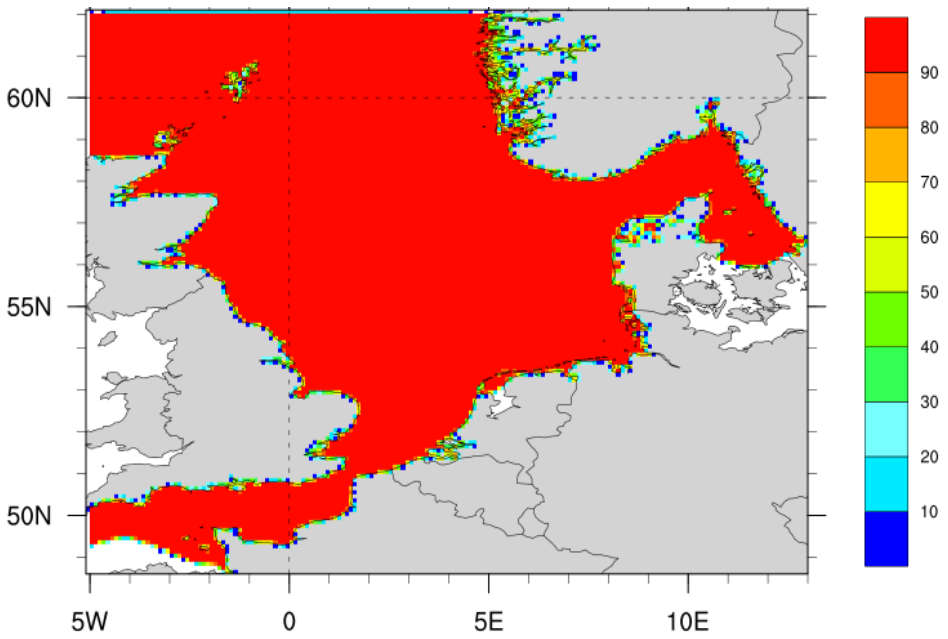


Figure 4b: As Figure 4a, but for OSPAR Region II.

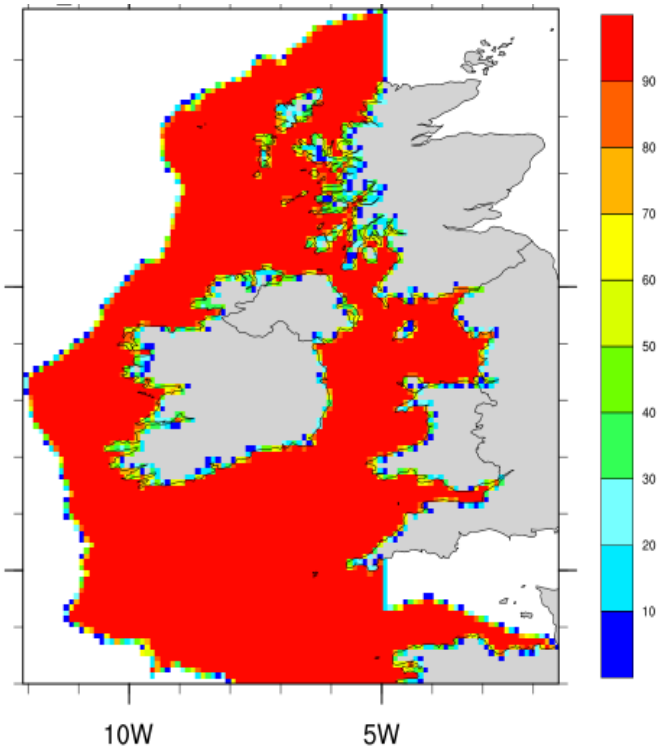


Figure 4c: As Figure 4b, but for OSPAR Region III.

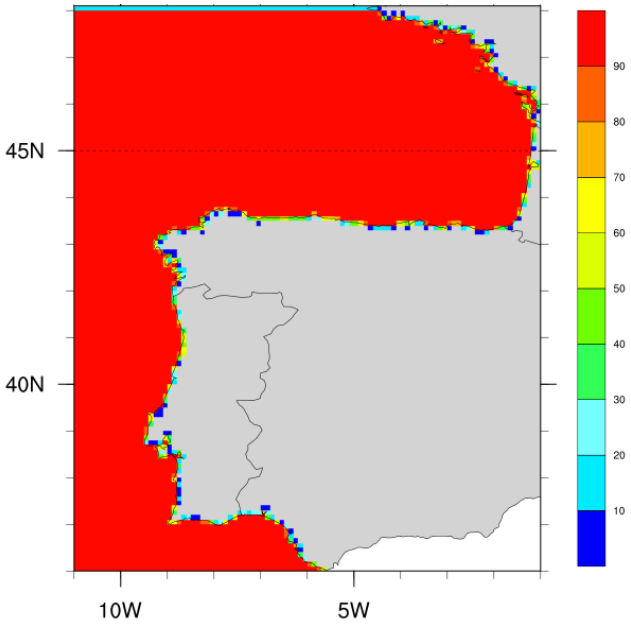


Figure 4d: As Figure 4a, but for OSPAR Region IV.

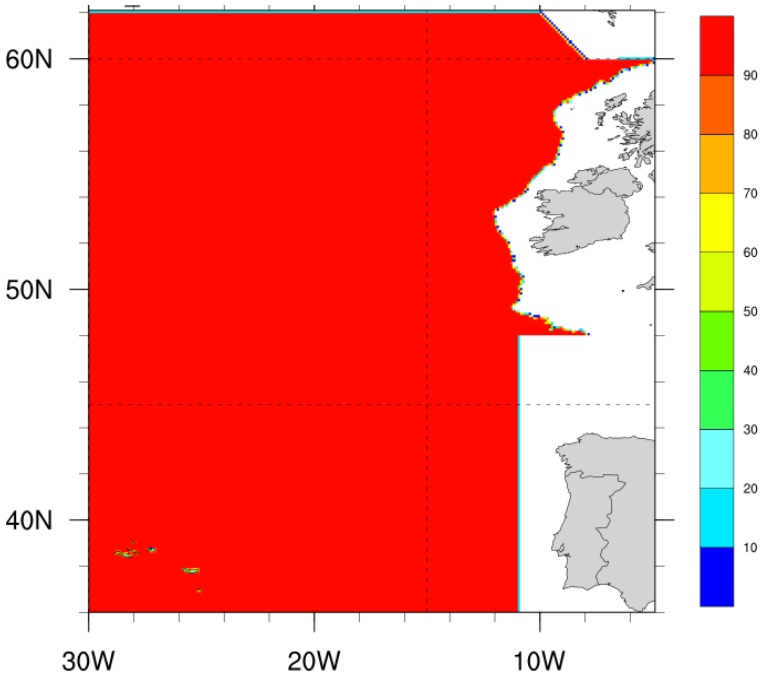


Figure 4e: As Figure 4a, but for OSPAR Region V.

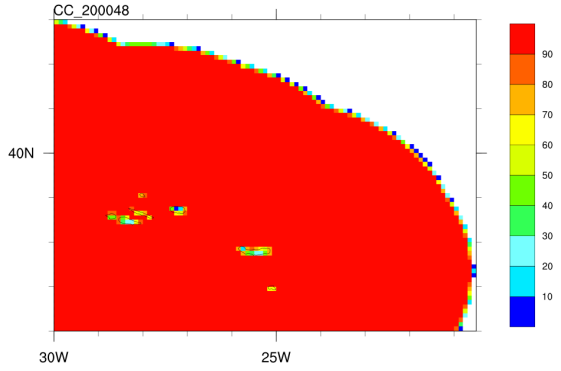
4.2 Exclusive Economic Zones

National EEZs of OSPAR Contracting Parties were implemented in the EMEP 0.1°×0.1° 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 5 lists the regions and their areas within the EMEP model domain, calculated on the 0.1°lon x 0.1°lat grid. The percentages of EMEP grid cells covered by each EEZ are shown in Figure 5.

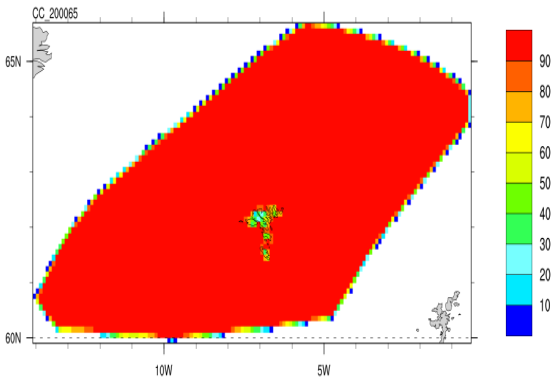
Table 5. The twenty-four Exclusive Economic Zones implemented in the EMEP MSC-W analysis in the 0.1°lon x 0.1°lat grid. Areas listed here include only the parts that are located within the OSPAR Convention area (i.e. within OSPAR regions). For example, those parts of the French and Spanish EEZs, which are located in the Mediterranean Sea are not included in this analysis. However, hyperlinks to marineregions.org are given in the table (last accessed 16 Dec 2022), 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)	487 910
EEZ 65	Faeroe Exclusive Economic Zone	262 572
EEZ 71	Icelandic Exclusive Economic Zone	750 705
EEZ 91	Portuguese Exclusive Economic Zone	269 184
EEZ 99	Joint regime area Spain / France	2 857
EEZ 100	Joint regime area UK / Denmark (Faeroe Islands)	7 895
EEZ 108	Irish Exclusive Economic Zone	425 135
EEZ 109	Guernsey Exclusive Economic Zone	6 504
EEZ 110	Jersey Exclusive Economic Zone	2 284
EEZ 119	Joint regime area Iceland / Denmark (Faeroe)	1 264
EEZ 123	Joint regime area Iceland / Norway (Jan Mayen)	45 105
EEZ 185	Swedish Exclusive Economic Zone	13 424
EEZ 187	Joint regime area Sweden / Norway	141
EEZ 188	Belgian Exclusive Economic Zone	3 470
EEZ 189	Dutch Exclusive Economic Zone	62 043
EEZ 190	German Exclusive Economic Zone	40 658
EEZ 191	Danish Exclusive Economic Zone	74 638
EEZ 209	French Exclusive Economic Zone	255 780
EEZ 212	Greenlandic Exclusive Economic Zone	634 585
EEZ 213	United Kingdom Exclusive Economic Zone	728 809
EEZ 215	Svalbard Exclusive Economic Zone	700 964
EEZ 216	Norwegian Exclusive Economic Zone	926 079
EEZ 224	Jan Mayen Exclusive Economic Zone	289 545
EEZ 273	Spanish Exclusive Economic Zone	298 494

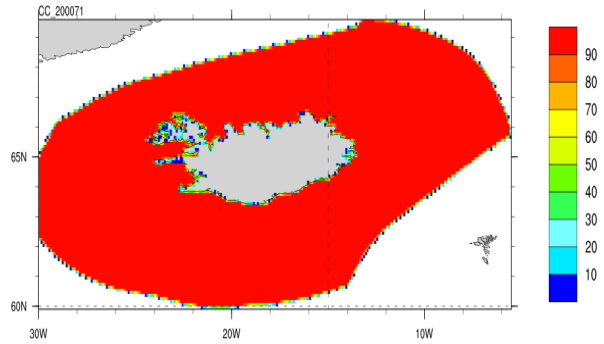
EEZ 48: Portuguese EEZ (Azores)



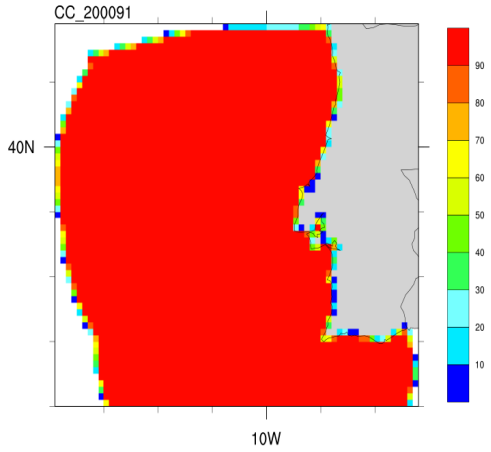
EEZ 65: Faeroe EEZ



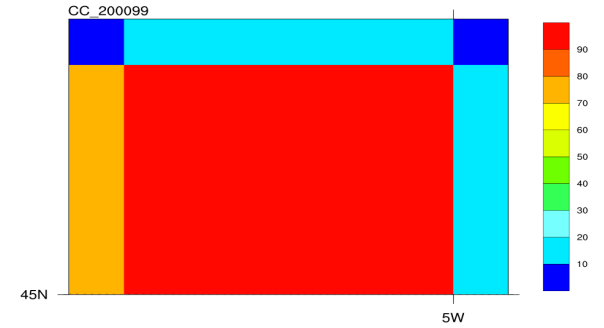
EEZ 71: Icelandic EEZ



EEZ 91: Portuguese EEZ



EEZ 99: Joint regime area Spain / France



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

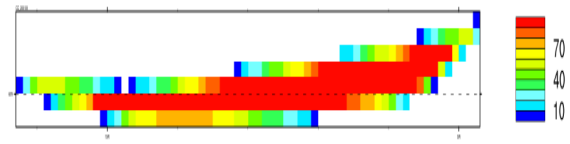
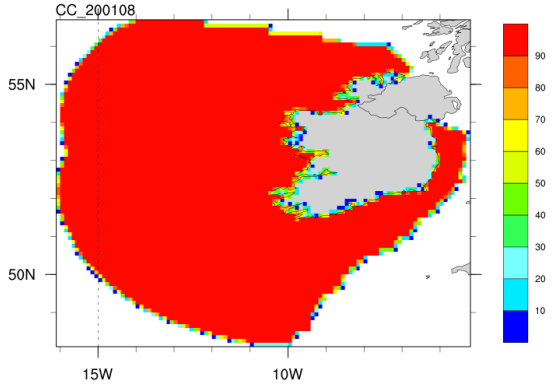


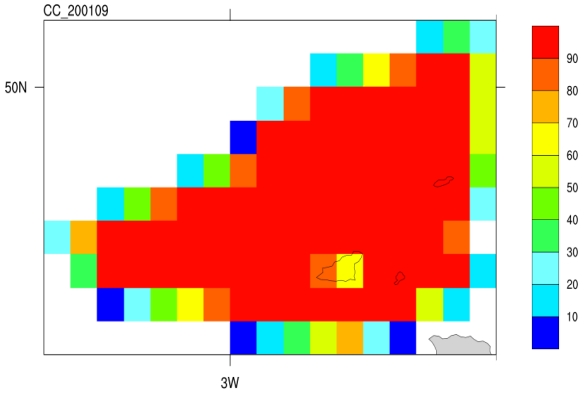
Figure 5: Visualization of EEZs in the EMEP grid. The plots show how large a percentage of each EMEP model grid cell lies within the respective EEZ. EMEP model grid cells cover 0.1°lon x 0.1°lat pixels and thus appear very small in some of the plots. Red colour means that the model grid cell is fully 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 30W°, 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.

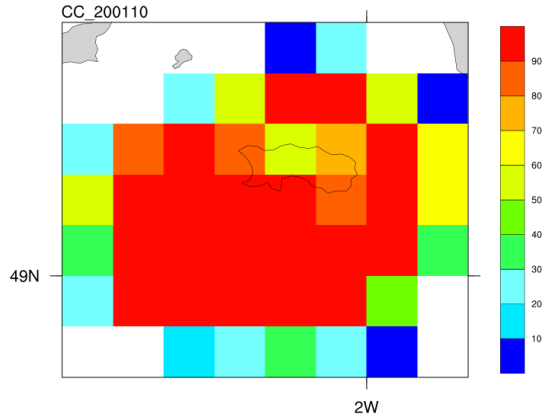
EEZ 108: Irish EEZ



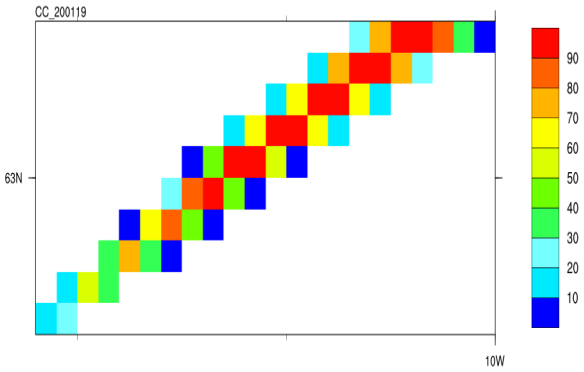
EEZ 109: Guernsey EEZ



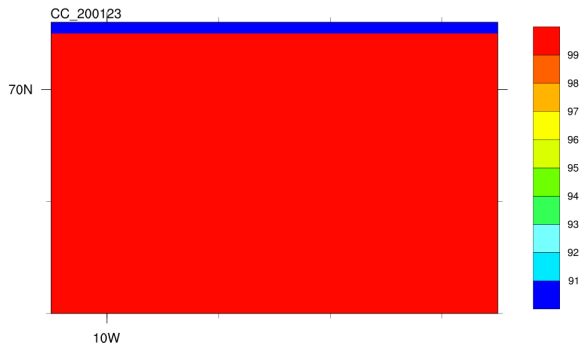
EEZ 110: Jersey EEZ



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



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



EEZ 185: Swedish EEZ

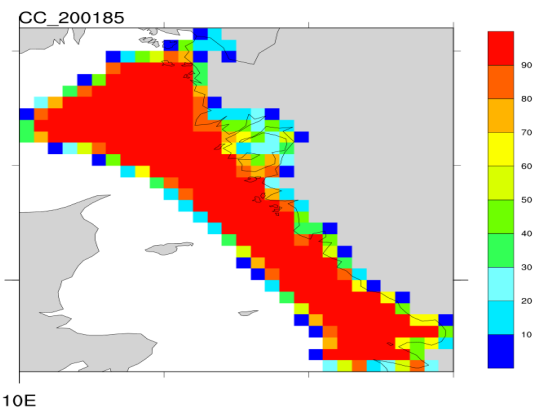
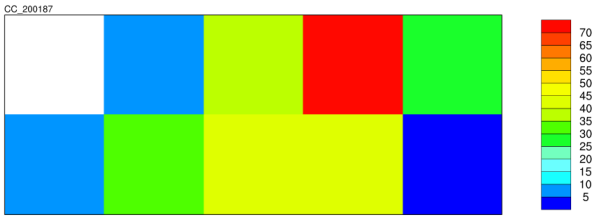
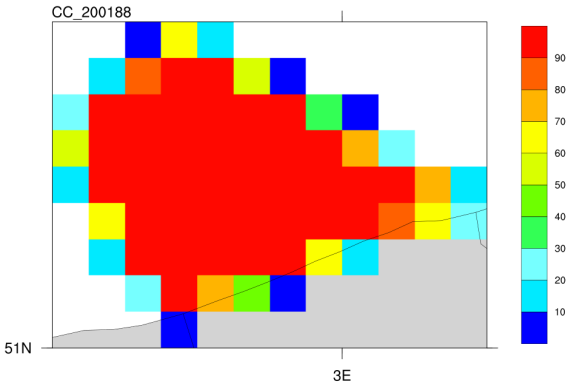


Figure 5: Continued.

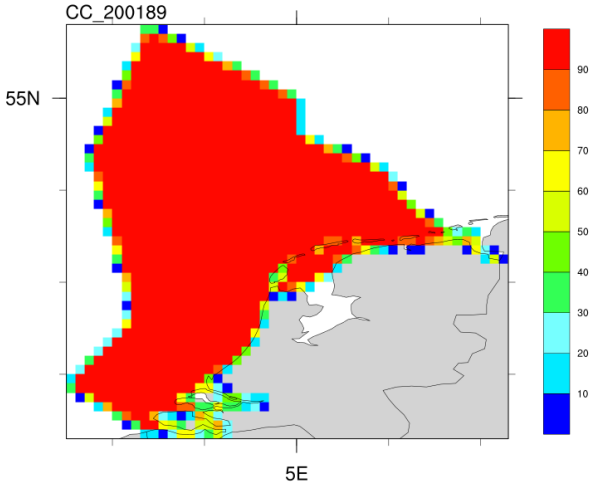
EEZ 187: Joint regime area Sweden / Norway



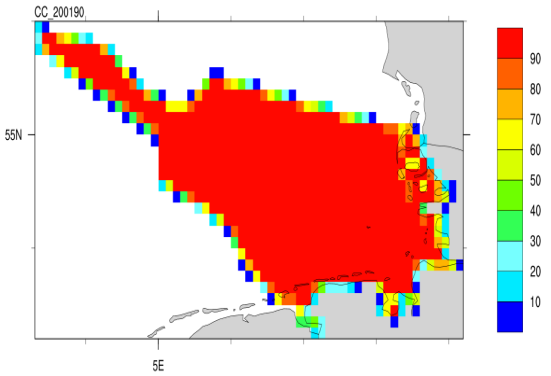
EEZ 188: Belgian EEZ



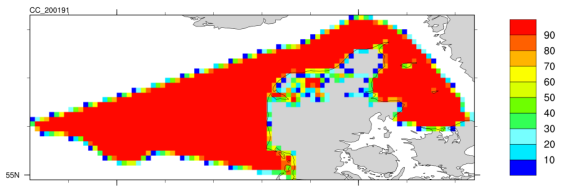
EEZ 189: Dutch EEZ



EEZ 190: German EEZ



EEZ 191: Danish EEZ



EEZ 209: French EEZ

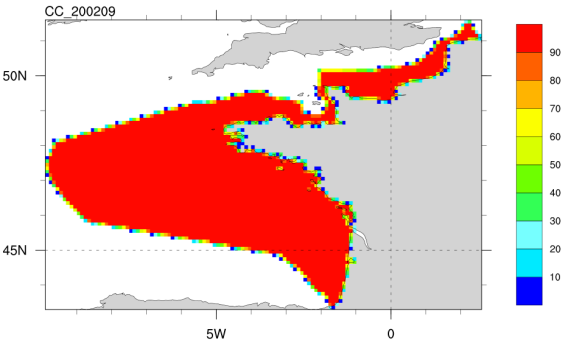
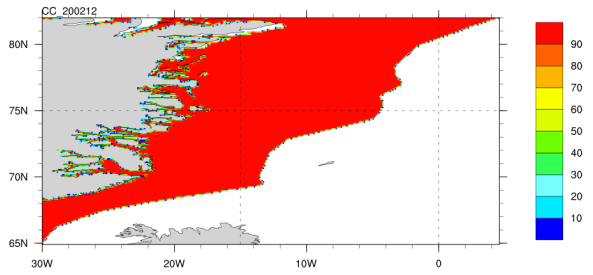
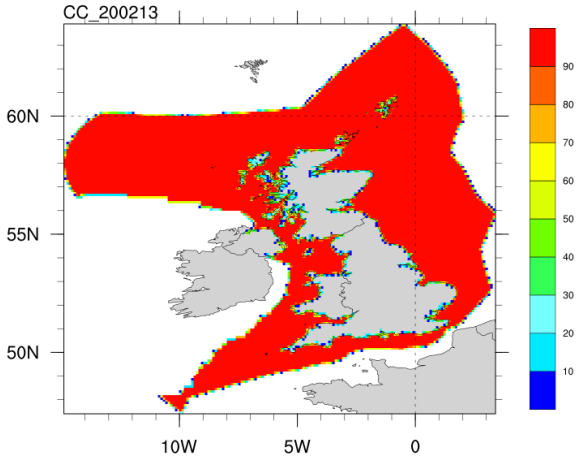


Figure 5: Continued.

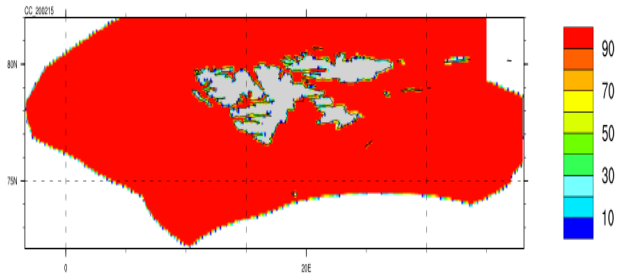
EEZ 212: Greenlandic EEZ



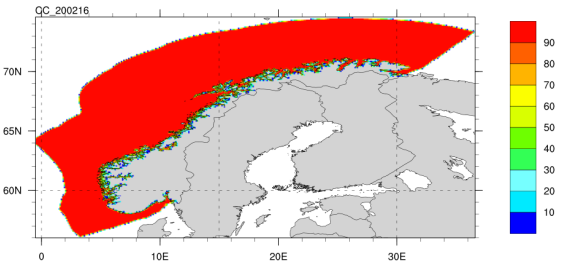
EEZ 213: United Kingdom EEZ



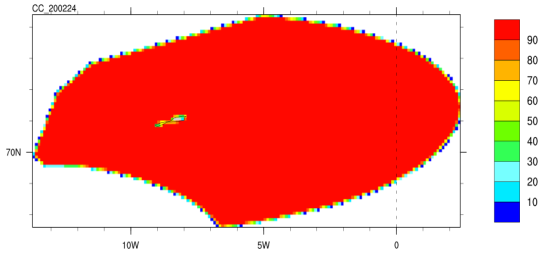
EEZ 215: Svalbard EEZ



EEZ 216: Norwegian EEZ



EEZ 224: Jan Mayen EEZ



EEZ 273: Spanish EEZ

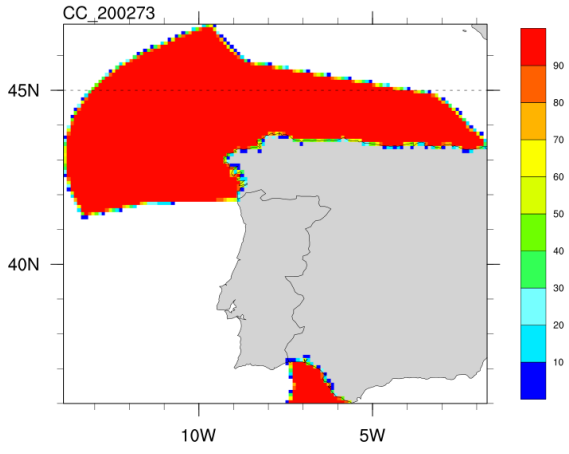


Figure 5: Continued.

4.3 Partial EEZs

Nine of the EEZs described in the previous section fall within more than one OSPAR region. We refer to the parts in different OSPAR regions as "partial EEZs". For example, the French EEZ covers parts of OSPAR regions II, III, IV and V (i.e. is divided into four partial EEZs), while the UK EEZ covers parts of all five OSPAR regions (i.e. is divided into five partial EEZs). The division into partial EEZs is visualized at the example of EEZ 65 (Faeroe Exclusive Economic Zone) in Figure 6. In total, 25 partial EEZs are considered (see Table 6).
Fifteen of the EEZs considered by EMEP MSC-W are entirely located within one OSPAR Region (e.g. the German EEZ lies fully in Region II), so that no partial EEZs had to be defined in these cases.

Table 6. The twenty-five partial EEZs implemented in the EMEP MSC-W analysis routines. Areas listed here include only the parts that are located within the OSPAR Convention area (i.e. within the five 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	200 166
EEZ_II_065	Faeroe Exclusive Economic Zone	OSPAR Region II	10 350
EEZ_V_065	Faeroe Exclusive Economic Zone	OSPAR Region V	52 057
EEZ_I_071	Icelandic Exclusive Economic Zone	OSPAR Region I	601 407
EEZ_V_071	Icelandic Exclusive Economic Zone	OSPAR Region V	149 298
EEZ_IV_091	Portuguese Exclusive Economic Zone	OSPAR Region IV	132 790
EEZ_V_091	Portuguese Exclusive Economic Zone	OSPAR Region V	136 394
EEZ_I_100	Joint regime area United Kingdom / Denmark (Faeroe Islands)	OSPAR Region I	3 628
EEZ_II_100	Joint regime area United Kingdom / Denmark (Faeroe Islands)	OSPAR Region II	74
EEZ_V_100	Joint regime area United Kingdom / Denmark (Faeroe Islands)	OSPAR Region V	4 192
EEZ_III_108	Irish Exclusive Economic Zone	OSPAR Region III	145 815
EEZ_V_108	Irish Exclusive Economic Zone	OSPAR Region V	279 321
EEZ_II_209	French Exclusive Economic Zone	OSPAR Region II	25 520
EEZ_III_209	French Exclusive Economic Zone	OSPAR Region III	40 882
EEZ_IV_209	French Exclusive Economic Zone	OSPAR Region IV	186 716
EEZ_V_209	French Exclusive Economic Zone	OSPAR Region V	2 662
EEZ_I_213	United Kingdom Exclusive Economic Zone	OSPAR Region I	28 902
EEZ_II_213	United Kingdom Exclusive Economic Zone	OSPAR Region II	352 278
EEZ_III_213	United Kingdom Exclusive Economic Zone	OSPAR Region III	193 924
EEZ_IV_213	United Kingdom Exclusive Economic Zone	OSPAR Region IV	2 418
EEZ_V_213	United Kingdom Exclusive Economic Zone	OSPAR Region V	151 287
EEZ_I_216	Norwegian Exclusive Economic Zone	OSPAR Region I	771 086
EEZ_II_216	Norwegian Exclusive Economic Zone	OSPAR Region II	154 993
EEZ_IV_273	Spanish Exclusive Economic Zone	OSPAR Region IV	203 697
EEZ_V_273	Spanish Exclusive Economic Zone	OSPAR Region V	94 797

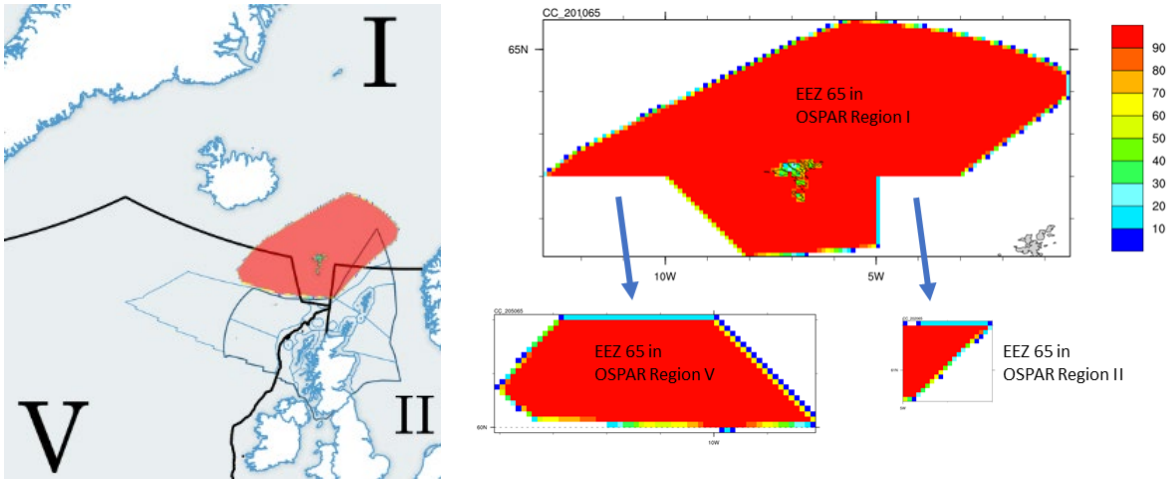


Figure 6: Left panel: OSPAR regions I, II and V, and EEZ 65 (Faeroe Exclusive Economic Zone) indicated in light red colour. Right panels: Division of EEZ 65 into three separate parts, belonging to OSPAR Regions I, II, and V, respectively. These three partial EEZs are listed in the first 3 rows of Table 6.

4.4 COMP4 Assessment Units

Updated definitions of the 64 COMP4 Assessment Units were provided as shape files to EMEP MSC-W in 2022 and implemented in the EMEP 0.1°×0.1° grid and the tools to analyse nitrogen deposition. With respect to last year, we have 3 COMP4 Assessment Units less (64 rather than 67) because some of the earlier units were combined. Furthermore, the assessment unit previously called 'CO Coastal Offshore' is now called 'OC Outer Coastal DEDK'. We have used the shape file which was sent to us by OSPAR as an e-mail attachment on 30 August 2022.

The COMP4 Assessment Units are listed in Table 7, while Figure 7 shows the percentages of EMEP grid cells covered by each COMP4 Assessment Unit (only for those areas that are larger than 10 000 km^2).

According to the contract, EMEP MSC-W had to calculate nitrogen deposition for the 40 largest COMP4 Assessment Units. These are listed in black font in Table 7 (remaining units are grey). The rationale behind this choice was that the smallest and thinnest units cannot be resolved well enough by the EMEP model grid to allow for accurate source-receptor calculations. These, however, are needed in the normalization routine only.

The results for *actual* depositions can be considered as reasonably accurate for all COMP4 units, while normalized deposition should only be used for the 40 largest COMP4 units. The smallest of those units has an area of about 2 600 km^2. Last year we recommended to use only results for receptor areas larger than 10 000 km^2, which was a more conservative limit because for last year's contract contributions from individual countries had to be reported, rather than only the *total* normalized deposition (i.e. the sum of contributions from all countries), which is a more robust result.

Table 7. The sixty-four COMP4 Assessment Units implemented in the EMEP MSC-W analysis in the 0.1°lon x 0.1°lat grid in 2022. Abbreviations and names are printed here as contained in the shape files provided to EMEP MSC-W in August 2022. Units not belonging to the 40 largest units are written in grey font. The table continues on the next page.

Abbreviation	Long name	Area in the EMEP MSC-W model domain (km^2)	Contracting Parties involved[3]
CFR	Coastal FR channel	7 146	FR, UK
CCTI	Channel coastal shelf tidal influenced	5 064	FR, UK
ATL	Atlantic	924 824	ES, FR, IE, UK, NO
SHPM	Shannon plume	379	IE
CNOR1	Coastal NOR 1	8 635	NO
CNOR2	Coastal NOR 2	2 606	NO
CNOR3	Coastal NOR 3	1 723	NO
DB	Dogger Bank	14 660	NL, DE, DK, UK
KD	Kattegat Deep	4 922	DK, SE
NT	Norwegian Trench	58 801	NO, SE, DK
SNS	Southern North Sea	61 520	FR, BE, NL, UK
GBC	German Bight (deep)	4 525	DE
ADPM	Adour plume	285	FR
GBSW	Gulf of Biscay shelf waters	20 936	FR
SPM	Seine plume	1 108	FR
GDPM	Gironde plume	2 816	FR
CUKC	Coastal UK channel	6 272	UK
CWMTI	Channel well mixed tidal influenced	20 570	FR, UK
SCHPM1	Scheldt plume 1	579	BE, NL
ELPM	Elbe plume	7 808	DE
SCHPM2	Scheldt plume 2	93	NL
MPM	Meuse plume	205	NL
RHPM	Rhine plume	2 271	NL
EMPM	Ems plume	1 451	DE
THPM	Thames plume	5 495	UK
HPM	Humber plume	1 366	UK
ECPM1	East Coast (permanently mixed) 1	3 509	UK
ECPM2	East Coast (permanently mixed) 2	1 443	UK
IS2	Intermittently Stratified 2	26 373	IE, UK
OC	Outer Coastal DEDK	18 460	DE, DK
ENS	Eastern North Sea	60 319	NL, DE, DK
CWCC	Coastal Waters CC (D5)	2 018	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 7. Continued.

Abbreviation	Long name	Area in the EMEP MSC-W model domain (km^2)	Approximate location
OWCO	Ocean Waters CO (D5)	18 859	PT
OWAO	Ocean Waters AO (D5)	97 884	PT
OWBO	Ocean Waters BO (D5)	182 696	PT
ASS	Atlantic Seasonally Stratified	216 452	FR, IE, UK
CIRL	Coastal IRL 3	9 546	IE
CUK1	Coastal UK 1	10 644	UK
IS1	Intermittently Stratified 1	73 074	UK
IRS	Irish Sea	32 543	IE, UK
KC	Kattegat Coastal	9 597	DK, SE
NNS	Northern North Sea	262 706	UK, DK, SE, NO
CWM	Channel well mixed	41 855	FR, UK
LBPM	Liverpool Bay plume	1 350	UK
SK	Skagerak	5 739	DK, SE
SS	Scottish Sea	52 961	UK
CWBC	Coastal Waters BC (D5)	4 222	PT
CWAC	Coastal Waters AC (D5)	7 349	PT
LPM	Loire plume	1 490	FR
GBCW	Gulf of Biscay coastal waters	10 803	FR
NAAP2	Noratlantic Area NOR-NorP2(D5)	8 293	ES
NAAO1	Noratlantic Area NOR-NorO1(D5)	261 130	ES
NAAPF	Noratlantic Area NOR-Plataforma	36 992	ES
NAAC3	Noratlantic Area NOR-NorC3(D5)	2 635	ES
NAAC2	Noratlantic Area NOR-NorC2(D5)	1 640	ES
NAAC1A	Noratlantic Area NOR-NorC1(D5)A	546	ES
NAAC1B	Noratlantic Area NOR-NorC1(D5)B	84	ES
NAAC1C	Noratlantic Area NOR-NorC1(D5)C	26	ES
NAAC1D	Noratlantic Area NOR-NorC1(D5)D	13	ES
SAAP2	Sudatlantic Area SUD-P2(D5)	925	ES
SAAOC	Sudatlantic Area SUD-OCEAN(D5)	10 077	ES
SAAP1	Sudatlantic Area SUD-P1(D5)	2 458	ES
SAAC1	Sudatlantic Area SUD-C1(D5)	399	ES
SAAC2	Sudatlantic Area SUD-C2(D5)	271	ES

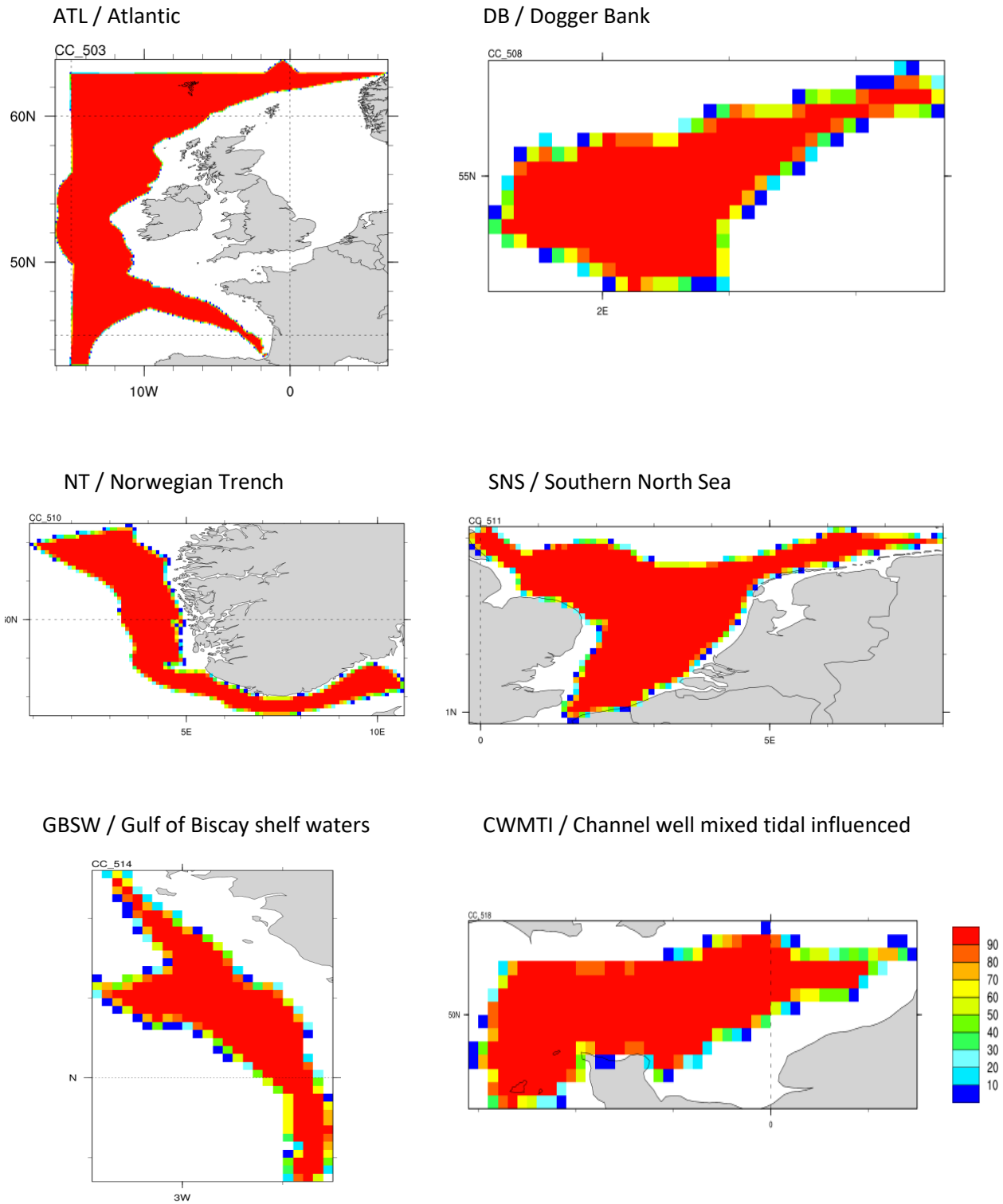
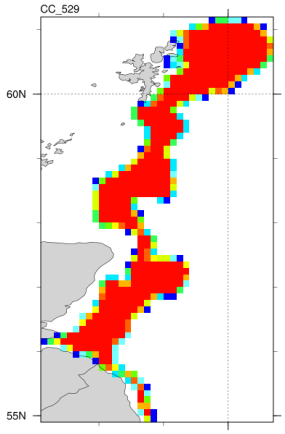
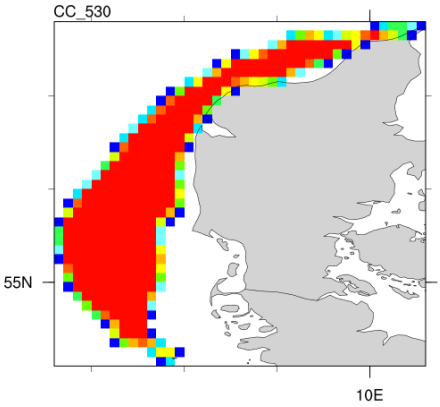


Figure 7: Visualization of COMP4 Assessment Units in the EMEP grid. The plots show how large a percentage of each EMEP model grid cell lies within the respective COMP4 Assessment Unit. EMEP model grid cells cover 0.1°lon x 0.1°lat pixels and thus appear very small in some of the plots. Red colour means 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 km^2 are shown. The figure continues on the next 3 pages.

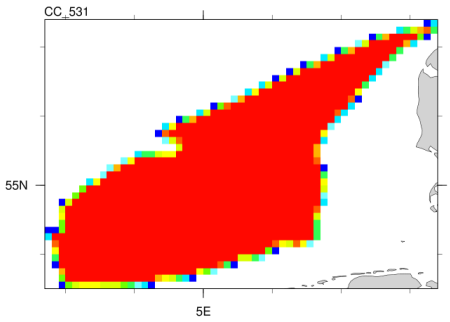
IS2 / Intermittently Stratified 2



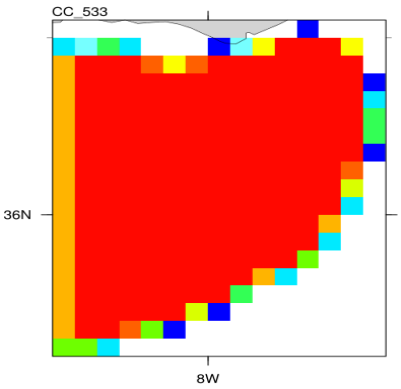
CO / Coastal Offshore



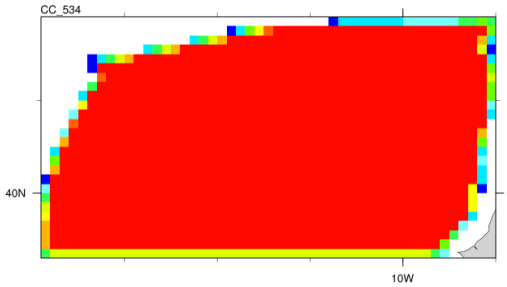
ENS / Eastern North Sea



OWCO / Ocean Waters CO (D5)



OWAO / Ocean Waters AO (D5)



OWBO / Ocean Waters BO (D5)

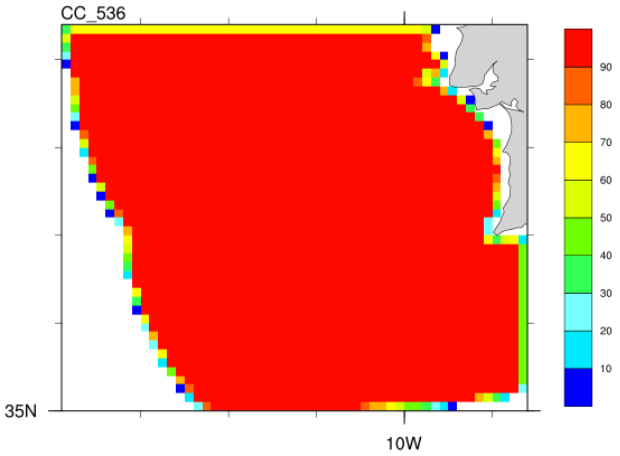
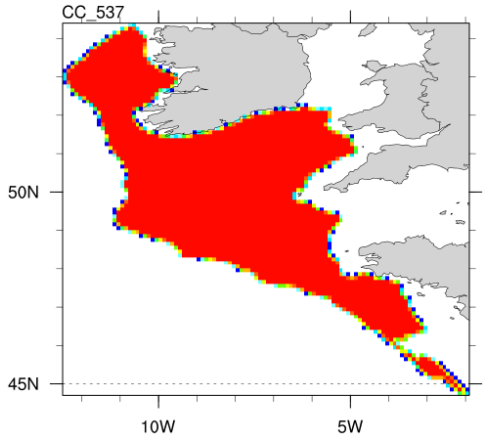
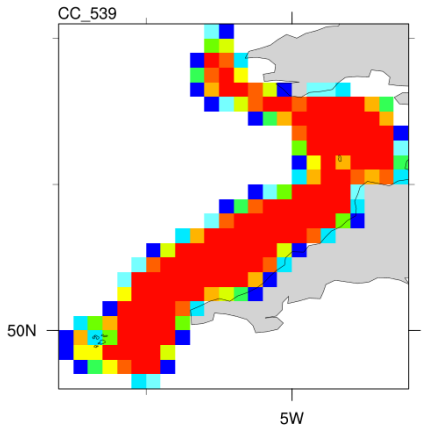


Figure 7: Continued.

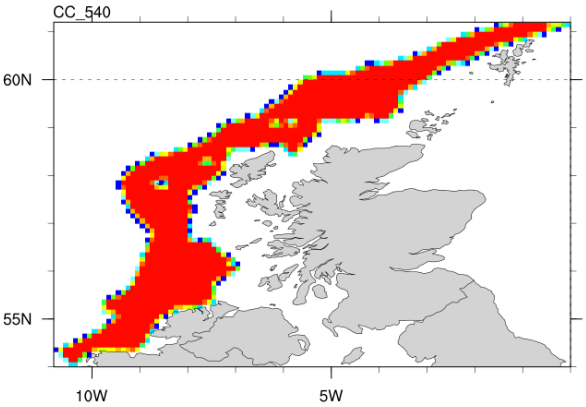
ASS / Atlantic Seasonally Stratified



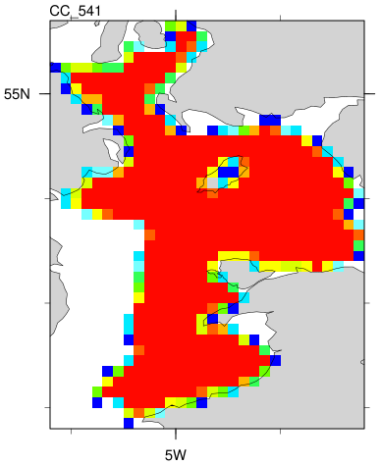
CUK1 / Coastal UK 1



IS1 / Intermittently Stratified 1



IRS / Irish Sea



NNS / Northern North Sea

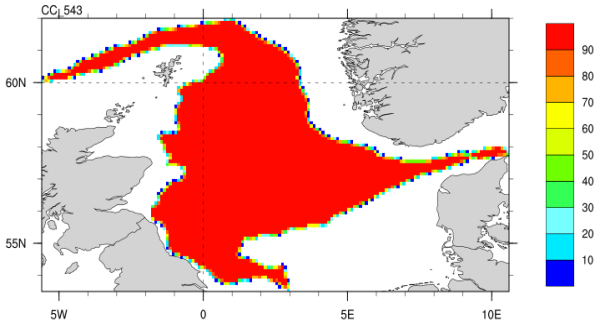
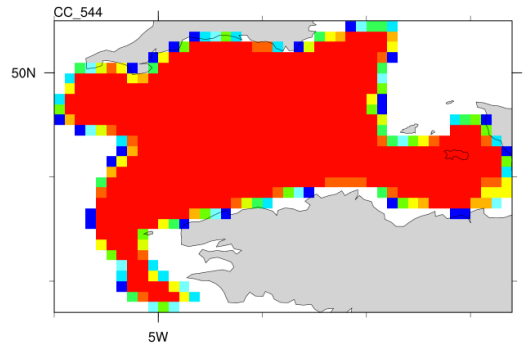
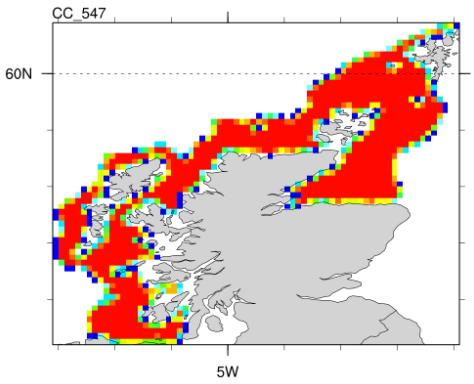


Figure 7: Continued.

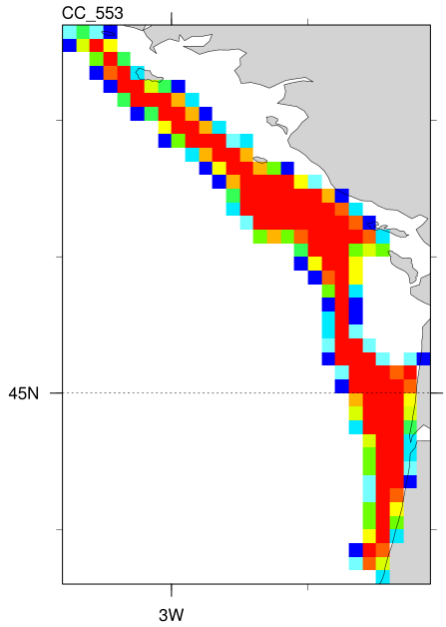
CWM / Channel well mixed



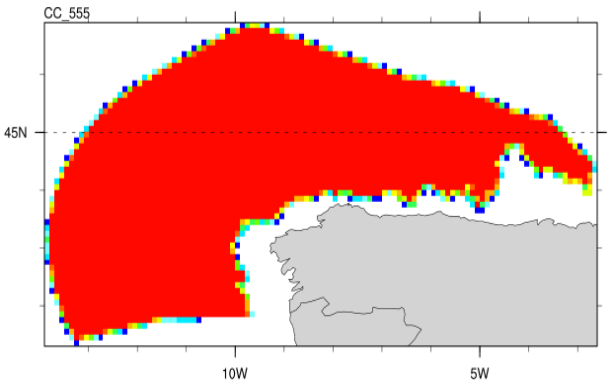
SS / Scottish Sea



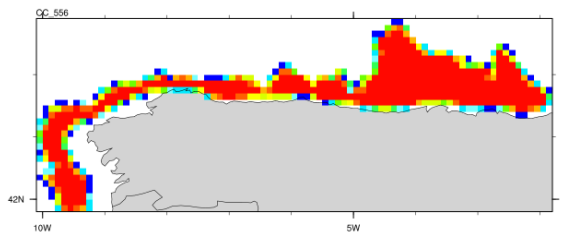
GBCW / Gulf of Biscay coastal waters



NAAO1 / Noratlantic Area NOR-NorO1(D5)



NAAPF / Noratlantic Area NOR-Plataforma



SAAOC / Sudatlantic Area SUD-OCEAN(D5)

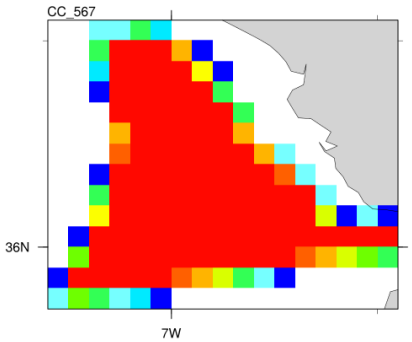


Figure 7: Continued.

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 sixty-four COMP4 Assessment Units, for each year of the period 1990-2020.

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, the years 2016-2020 have been used this year for OSPAR. In reports before 2021, more meteorological years had been used, but now, as more (and smaller) receptors are considered, it appears 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 here (e.g. EEZ048) are not fully covered by the EMEP model domain (see Sections 4.1 and 4.2 and in particular Figures 4 and 5). 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 earlier years before the grid change to the later years in the period.

5.1 OSPAR Regions

Figure 8 shows actual (non-normalized) oxidized and reduced nitrogen depositions from 1990 to 2020 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 95% confidence level.

Figure 9 shows normalized results. The normalization is based on meteorological data from 5 years (2016, 2017, 2018, 2019 and 2020). Normalized depositions of oxidized and reduced nitrogen were lower in 2020 than in 1990 in all OSPAR Regions.

Table 8 lists actual *and* normalized depositions in the 5 OSPAR regions for the year 2020, i.e. the most recent year for which model calculations have been made.

Tables 9 and 10 give all statistically significant trends (at the 95% confidence level) for actual and normalized nitrogen deposition, respectively. Considering the entire 31-year period, downward trends for (actual) oxidized and total nitrogen deposition are significant in all five OSPAR regions, while for reduced nitrogen deposition there is a significant downward trend only in OSPAR Regions I, II and V. Considering the last decade (2010 to 2020) total nitrogen deposition has declined significantly only in OSPAR Regions I and III. When looking at normalized trends (filtering out interannual variability in meteorology), downward trends are significant in all OSPAR Regions for oxidized, reduced and total nitrogen over the 31-year period. However, in the latest decade (2010-2020) there is no statistically significant downward trend for reduced nitrogen deposition. In Region III there is even an upward trend, albeit small.

Table 11 contains the entire 1990-2020 timeseries of normalized total nitrogen depositions for the five OSPAR Regions. Results for oxidized and reduced nitrogen separately can be found in the accompanying data sheet (Chapter 7).

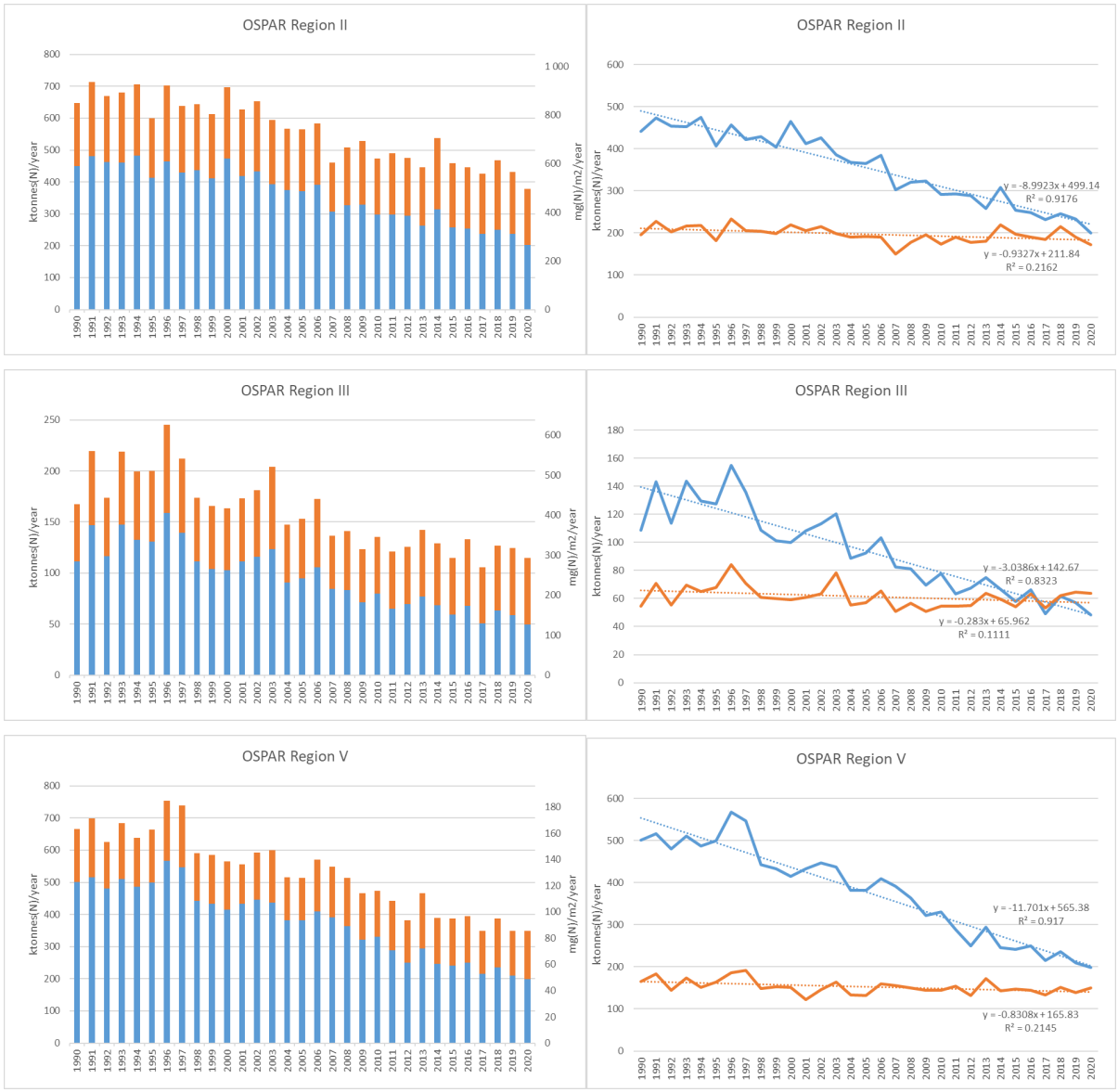


Figure 8a: Left panels: Time series of actual depositions of oxidised (blue), reduced (red) and total nitrogen (sum of blue and red) to OSPAR Regions II, III and IV, as calculated by the EMEP MSC-W model for the period 1990-2020. Unit: ktonnes(N)/year (left axis) or mg(N)/m^2/year (right axis). Right panels: Linear regression for oxidised (blue) and reduced (red) nitrogen deposition, with coefficients of determination (R^2) indicated in the figure.

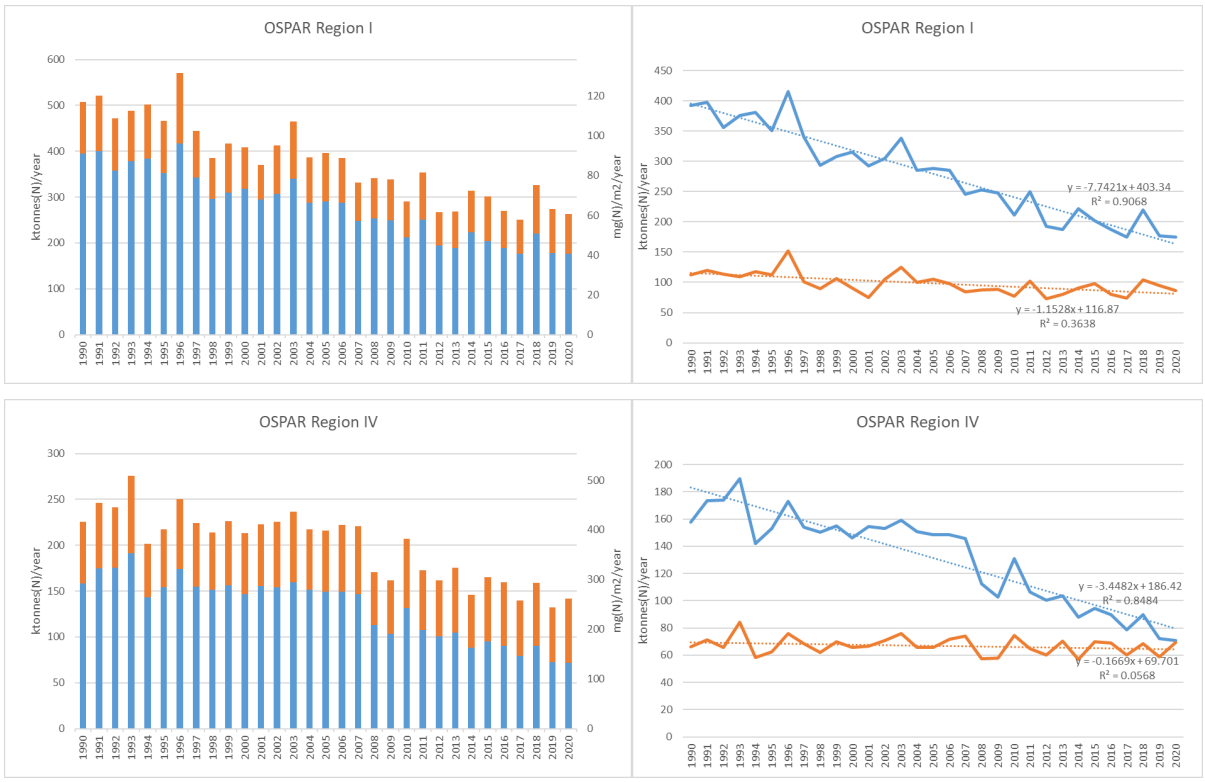


Figure 8b: As Figure 8a, but for OSPAR Regions I and IV.

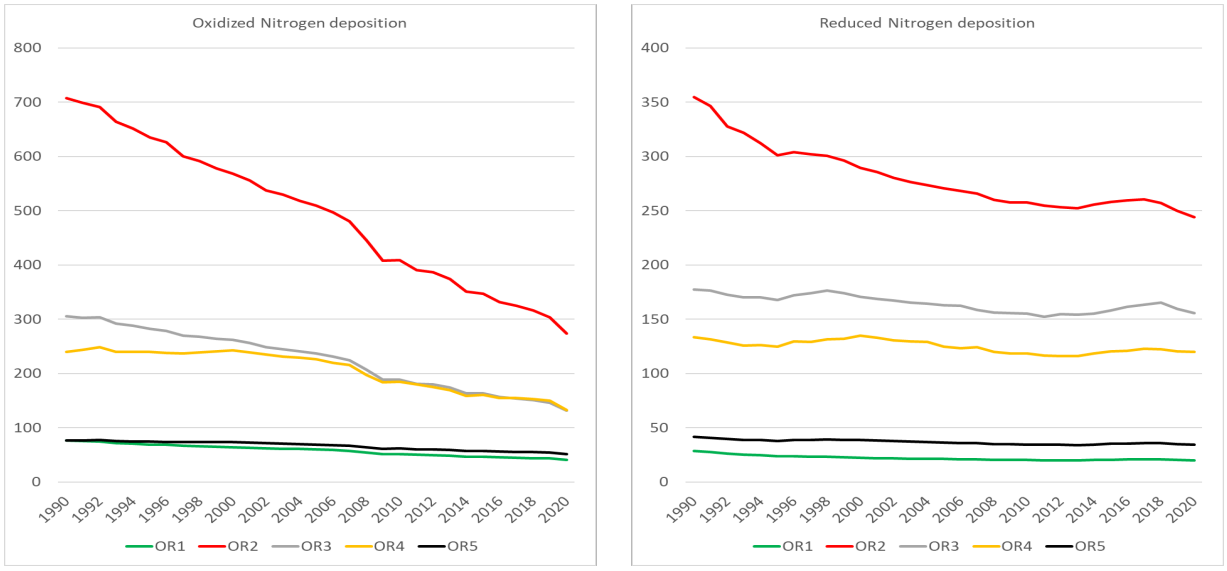


Figure 9: Normalized deposition of oxidized (left panel) and reduced (right panel) nitrogen to the five OSPAR Regions ('OR1'= OSPAR Region I, etc.). Unit: mg(N)/m^2/year.

Table 8. Deposition of oxidised, reduced and total nitrogen, in the five OSPAR Regions in 2020. Both actual numbers (based on 2020 meteorology) and weather-normalized values (based on meteorological data of 2016-2020) are given. Results for other years are provided separately in Excel format (see Chapter 7). Unit: ktonnes(N)/year.

OSPAR Region	Oxidised N		Reduced N		Total N	
	Actual	Normalized	Actual	Normalized	Actual	Normalized
I	175	173	87	86	262	259
II	199	205	172	183	372	387
III	48	50	64	59	112	110
IV	71	71	70	64	141	136
V	198	210	150	140	348	350

Table 9a. Trends in **actual** (non-normalized) depositions of oxidized, reduced, and total nitrogen to the five OSPAR Regions. The values correspond to the slopes of the linear regression line, given in units of tonnes(N)/year, calculated for the whole 31-year period (1990 – 2020), for the 1990s and for the most recent decade. Missing values, indicated by hyphens, mean that there is no trend that is significant at the 95% confidence level (i.e. the Mann-Kendall test yields a p-value larger than 0.05).

OSPAR Region	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
I	-7 655	-8 879	-	-1 058	-	-	-8 707	-11 302	-
II	-9 174	-	-8 403	-1 077	-	-	-10 184	-	-7 378
III	-3 019	-	-2 335	-	-	-	-3 313	-	-
IV	-3 436	-	-4 640	-	-	-	-3 599	-	-4 812
V	-11 453	-	-11 535	-680	-	-	-12 004	-	-10 828

Table 9b. Same as Table 9a, but the trends are given in %/decade.

OSPAR Region	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
I	-18	-20	-	-8	-	-	-16	-20	-
II	-18	-	-32	-4	-	-	-14	-	-20
III	-19	-	-38	-	-	-	-11	-	-
IV	-18	-	-46	-	-	-	-12	-	-32
V	-20	-	-40	-3	-	-	-16	-	-27

Table 10a. Trends in **normalized** depositions of oxidized, reduced, and total nitrogen to the five OSPAR Regions. The values correspond to the slopes of the linear regression line, given in units of tonnes(N)/year, calculated for the whole 31-year period (1990 – 2020), for the 1990s and for the most recent decade. Missing values, indicated by hyphens, mean that there is no trend that is significant at the 95% confidence level (i.e. the Mann-Kendall test yields a p-value larger than 0.05).

OSPAR Region	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
I	-5 030	-5 241	-4 141	-870	-2 517	-	-5 921	-7 892	-3 949
II	-10 804	-10 884	-8 897	-2 222	-4 166	-	-13 058	-15 588	-9 143
III	-2 244	-1 830	-1 858	-292	-	338	-2 498	-1 923	-1 504
IV	-2 056	-	-2 268	-264	-	-	-2 284	-	-1 919
V	-3 484	-1 696	-3 513	-888	-	-	-4 389	-2 417	-2 775

Table 10b. Same as Table 10a, but the trends are given in %/decade.

OSPAR Region	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
I	-16	-16	-22	-10	-23	-	-14	-18	-16
II	-20	-20	-33	-10	-18	-	-17	-19	-22
III	-19	-14	-30	-4	-	0	-13	-10	-17
IV	-15	-	-28	-3	-	-	-11	-	-17
V	-11	-4	-16	-6	-	-	-9	-5	-11

Table 11. Normalized deposition of total nitrogen to the 5 OSPAR Regions in the period 1990 to 2020. Unit: ktonnes(N)/year.

	Region I	Region II	Region III	Region IV	Region V
1990	453	795	184	201	480
1991	443	782	183	202	478
1992	432	762	182	203	475
1993	418	738	177	197	465
1994	409	721	175	197	462
1995	399	700	172	196	457
1996	398	696	172	198	460
1997	389	675	169	197	456
1998	385	667	170	199	457
1999	379	654	167	200	456
2000	372	642	165	203	456
2001	367	629	162	200	450
2002	360	612	159	197	444
2003	357	603	157	194	439
2004	352	592	155	193	435
2005	348	584	153	189	430
2006	343	572	150	184	424
2007	337	559	146	183	419
2008	322	528	138	170	403
2009	308	498	131	162	391
2010	309	498	131	163	392
2011	302	483	127	159	385
2012	300	479	128	157	383
2013	296	468	125	153	379
2014	289	454	122	149	372
2015	288	453	123	151	375
2016	283	442	121	148	372
2017	282	438	121	149	372
2018	279	429	121	148	370
2019	273	414	117	146	365
2020	259	387	110	136	350

5.2 Exclusive Economic Zones

Actual (non-normalized) atmospheric nitrogen depositions to each of the twenty-four Exclusive Economic Zones during the period 1990-2020 are shown in Figure 10. There is a clear decline in the deposition of oxidised nitrogen between 1990 and 2020 in all EEZs. The deposition of reduced nitrogen was larger in 2020 than in 1990 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. Nevertheless, it is clear that, overall, the downward trend in reduced nitrogen deposition is much smaller than that of oxidised nitrogen deposition.

Table 12 lists actual *and* normalized depositions to the 24 EEZs for the year 2020, i.e. the most recent year for which model calculations have been made.

Table 13 and 14 give all statistically significant trends (at the 95% confidence level) for actual and normalized nitrogen deposition, respectively.

Table 15 contains the entire 1990-2020 time series of normalized total nitrogen depositions to the 24 EEZs.

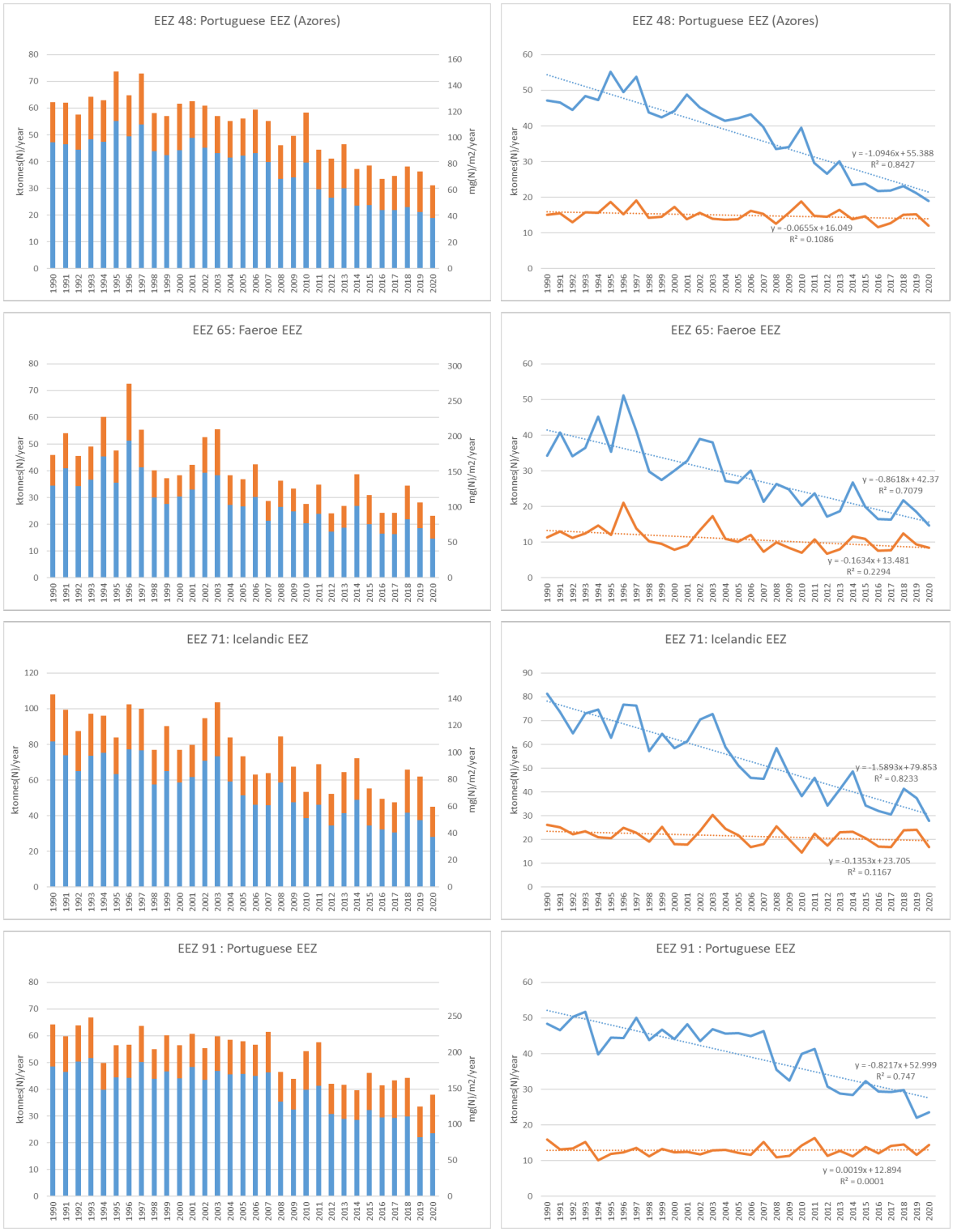


Figure 10: Left panels: Time series of actual (non-normalized) depositions of oxidised (blue), reduced (red) and total nitrogen (sum of blue and red) to selected EEZs, as calculated by the EMEP MSC-W model for the period 1990-2020. Unit: ktonnes(N)/year (left axis) or mg(N)/m^2/year (right axis). Right 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.

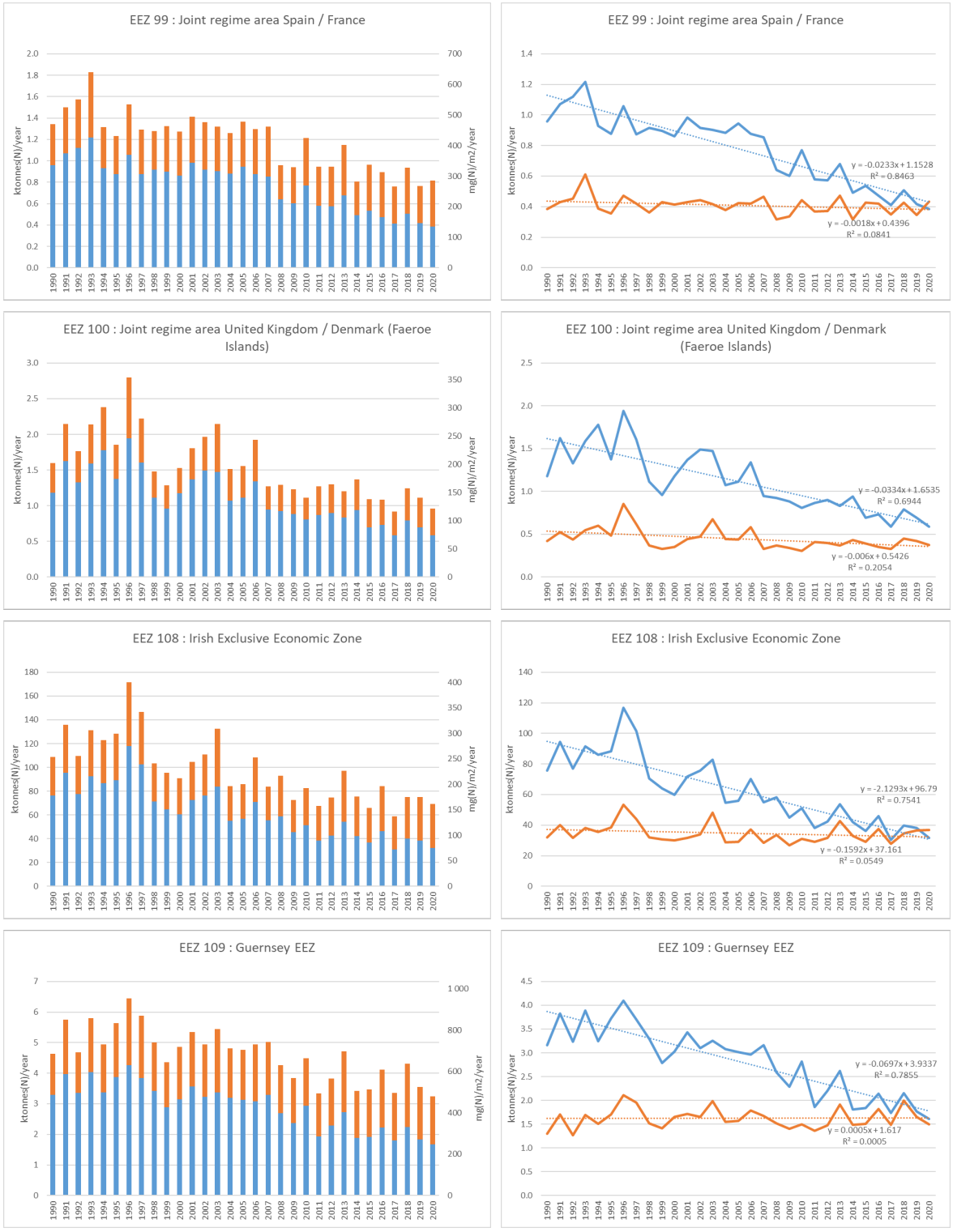


Figure 10: Continued.

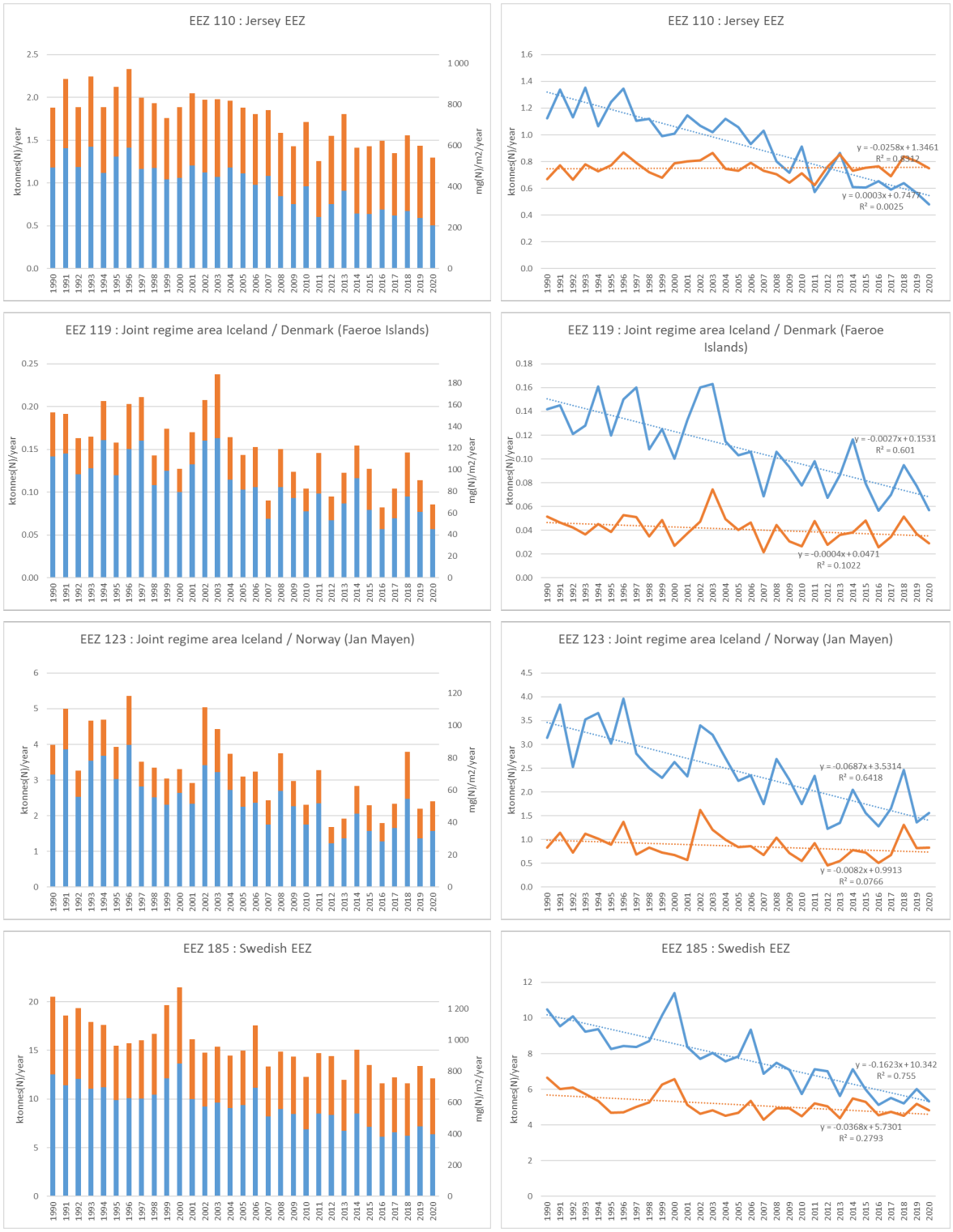


Figure 10: Continued.

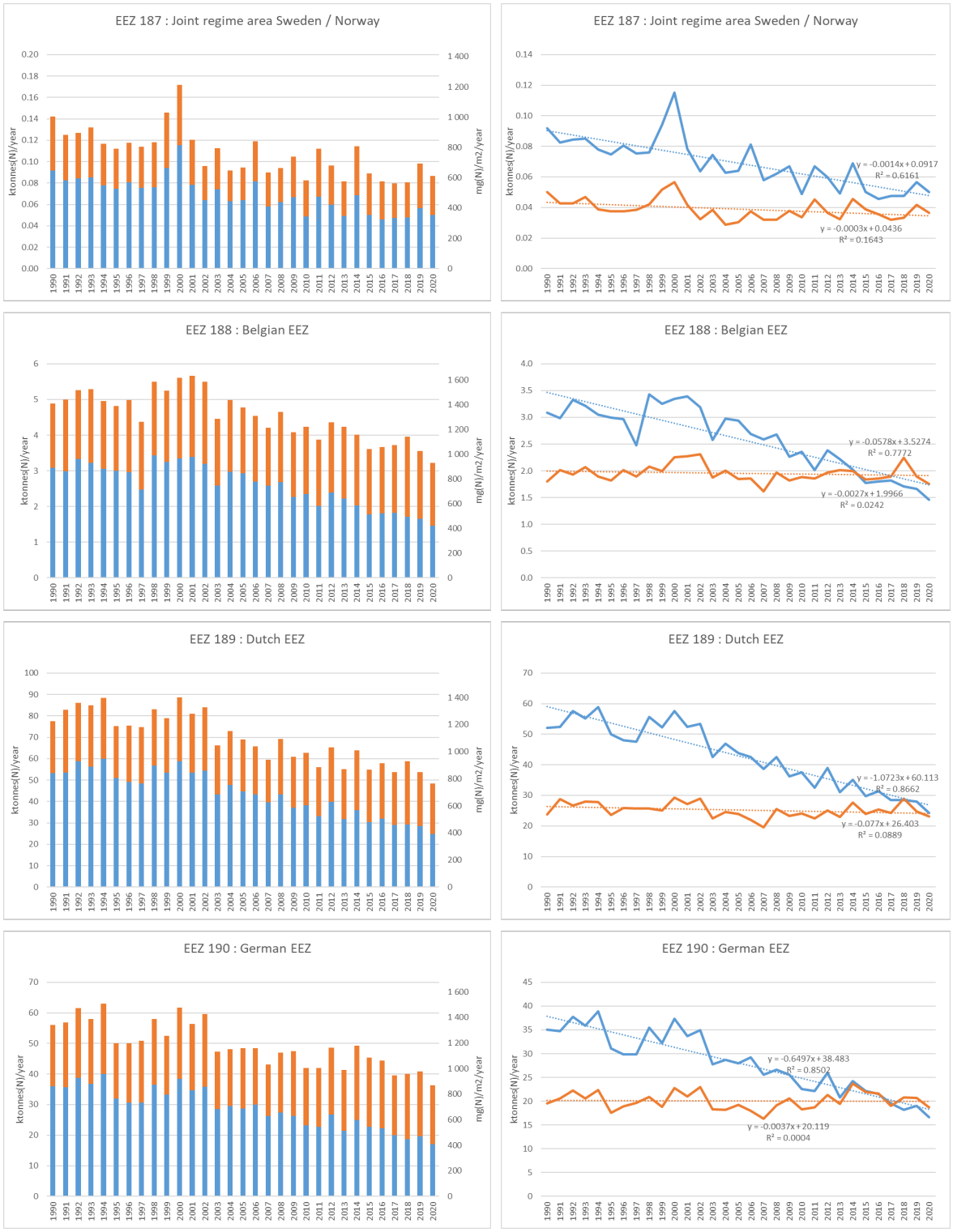


Figure 10: Continued.

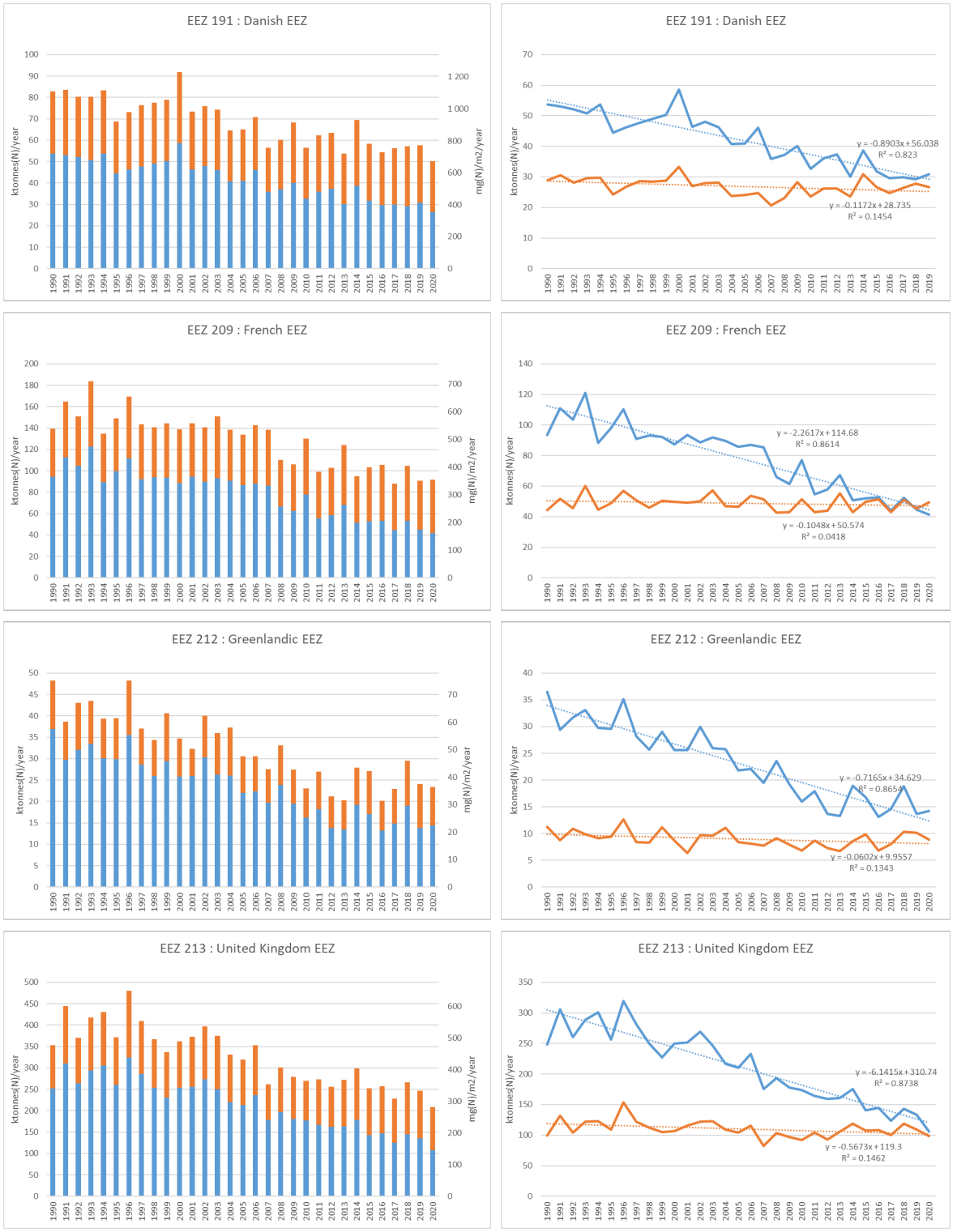


Figure 10: Continued.

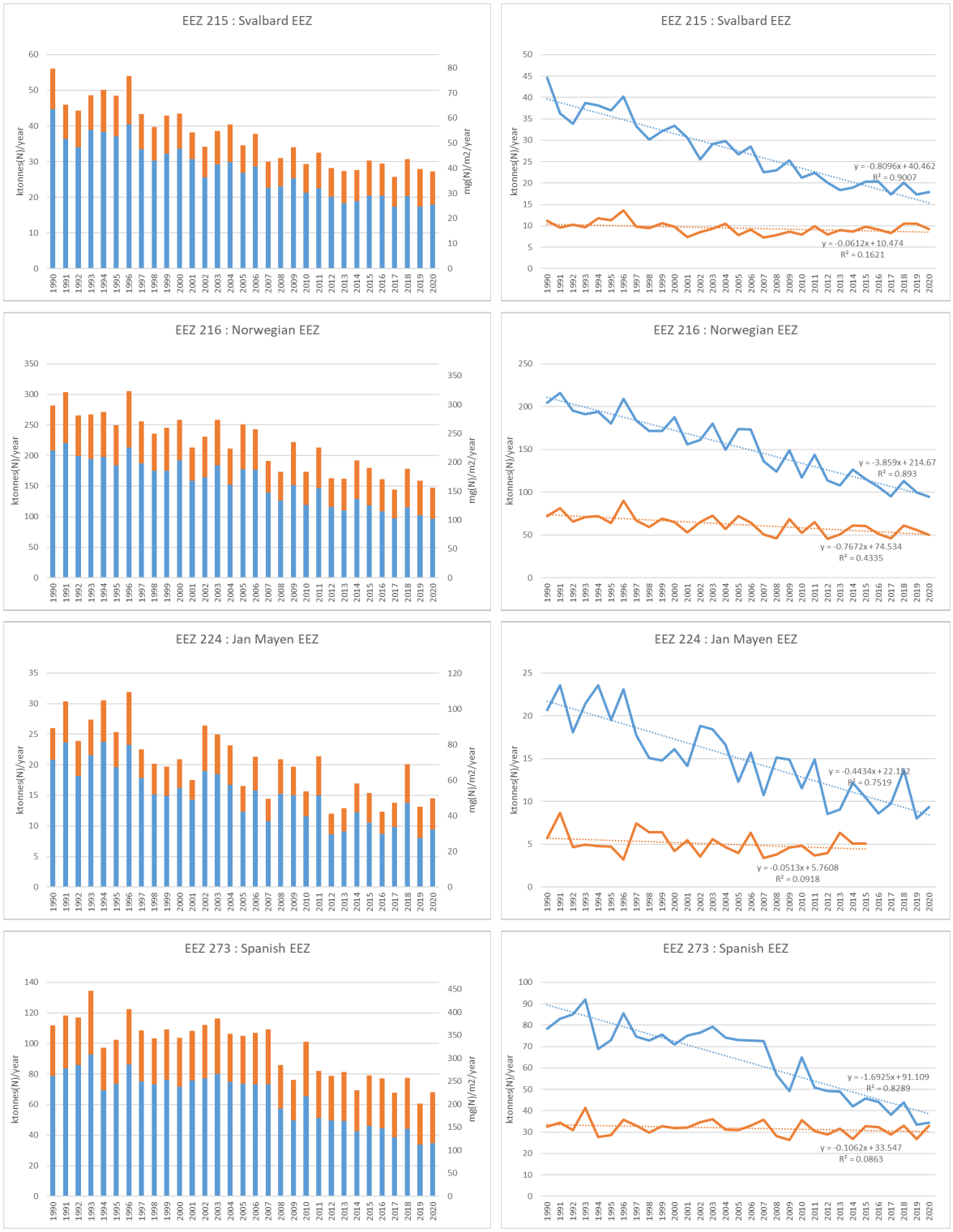


Figure 10: Continued.

Table 12. Deposition of oxidized, reduced and total nitrogen, to the twenty-four EEZs in 2020. Both actual numbers (based on 2020 meteorology) and weather-normalized values (based on meteorological data of 2016 to 2020) 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	18 946	20 803	12 098	13 473	31 044	34 277
EEZ065	14 616	15 834	8 416	8 823	23 032	24 657
EEZ071	27 878	31 461	16 917	19 045	44 795	50 505
EEZ091	23 576	24 222	14 395	13 508	37 971	37 730
EEZ099	384	387	434	388	817	776
EEZ100	586	608	375	372	961	980
EEZ108	31 743	33 571	36 731	33 455	68 475	67 026
EEZ109	1 614	1 674	1 498	1 625	3 112	3 299
EEZ110	482	518	751	739	1 233	1 257
EEZ119	57	65	29	34	86	99
EEZ123	1 559	1 527	831	801	2 390	2 328
EEZ185	5 329	4 864	4 824	4 599	10 153	9 463
EEZ187	50	45	37	35	87	79
EEZ188	1 462	1 489	1 759	1 862	3 221	3 351
EEZ189	24 308	24 700	23 122	24 276	47 430	48 977
EEZ190	16 597	16 718	18 707	19 005	35 304	35 724
EEZ191	26 357	25 886	23 832	24 878	50 190	50 764
EEZ209	41 314	41 651	49 445	46 396	90 759	88 047
EEZ212	14 220	14 077	8 897	8 590	23 117	22 667
EEZ213	105 996	115 000	98 786	103 446	204 783	218 446
EEZ215	17 903	17 676	9 195	9 435	27 097	27 112
EEZ216	94 558	91 755	50 119	51 081	144 677	142 836
EEZ224	9 356	9 117	5 092	4 685	14 447	13 802
EEZ273	34 334	34 540	33 090	30 558	67 423	65 098

Table 13a. Trends in **actual** (non-normalized) depositions of oxidized, reduced, and total nitrogen to the twenty-four EEZs within the OSPAR Maritime Area. The values correspond to the slopes of the linear regression line, given in units of tonnes(N)/year, calculated for the whole 31-year period (1990 – 2020), for the 1990s and for the most recent decade. Missing values, indicated by hyphens, mean that there is no trend that is significant at the 95% confidence level (i.e. the Mann-Kendall test yields a p-value larger than 0.05).

EEZ	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
EEZ 48	-1 115	-	-1 194	-	-	-	-1 210	-	-1 680
EEZ 65	-798	-	-	-145	-	-	-945	-	-
EEZ 71	-1 604	-	-	-135	-	-	-1 729	-	-
EEZ 91	-803	-	-1 453	-	-	-	-792	-	-
EEZ 99	-23	-18	-29	-	-	-	-24	-	-29
EEZ 100	-33	-	-23	-4	-	-	-36	-	-
EEZ 108	-1 992	-	-	-	-	-	-2 075	-	-
EEZ 109	-70	-	-62	-	-	-	-70	-	-
EEZ 110	-26	-	-25	-	-	-	-26	-	-
EEZ 119	-3	-	-	-	-	-	-3	-	-
EEZ 123	-69	-	-	-	-	-	-79	-	-
EEZ 185	-155	-	-	-30	-	-	-191	-	-
EEZ 187	-1	-	-	0	-	-	-2	-	-
EEZ 188	-61	-	-82	-	-	-	-61	-	-80
EEZ 189	-1 083	-	-1 083	-	-	-	-1 112	-	-941
EEZ 190	-639	-	-612	-	-	-	-623	-	-
EEZ 191	-892	-	-805	-123	-	-	-1 009	-	-
EEZ 209	-2 284	-	-2 144	-	-	-	-2 347	-	-
EEZ 212	-706	-708	-	-67	-	-	-783	-	-
EEZ 213	-6 432	-	-5 795	-	-	-	-6 727	-	-4 136
EEZ 215	-791	-	-328	-	-	-	-827	-	-
EEZ 216	-3 886	-3 335	-2 989	-726	-	-	-4 769	-	-3 308
EEZ 224	-443	-699	-	-53	-	-	-519	-	-
EEZ 273	-1 664	-	-2 114	-	-	-	-1 746	-	-2 230

Table 13b. Same as Table 13a, but the trends are given in %/decade.

EEZ	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
EEZ 48	-20	-	-52	-	-	-	-17	-	-47
EEZ 65	-19	-	-	-9	-	-	-16	-	-
EEZ 71	-22	-	-	-12	-	-	-19	-	-
EEZ 91	-17	-	-41	-	-	-	-14	-	-
EEZ 99	-20	-10	-50	-	-	-	-13	-	-33
EEZ 100	-17	-	-27	-3	-	-	-13	-	-
EEZ 108	-19	-	-	-	-	-	-12	-	-
EEZ 109	-16	-	-43	-	-	-	-10	-	-
EEZ 110	-19	-	-47	-	-	-	-10	-	-
EEZ 119	-20	-	-	-	-	-	-19	-	-
EEZ 123	-17	-	-	-	-	-	-13	-	-
EEZ 185	-16	-	-	-9	-	-	-14	-	-
EEZ 187	-15	-	-	-9	-	-	-13	-	-
EEZ 188	-18	-	-38	-	-	-	-11	-	-24
EEZ 189	-18	-	-35	-	-	-	-13	-	-23
EEZ 190	-18	-	-26	-	-	-	-12	-	-
EEZ 191	-17	-	-19	-6	-	-	-13	-	-
EEZ 209	-19	-	-46	-	-	-	-11	-	-
EEZ 212	-20	-30	-	-7	-	-	-17	-	-
EEZ 213	-19	-	-39	-	-	-	-14	-	-23
EEZ 215	-20	-	-16	-	-	-	-17	-	-
EEZ 216	-18	-8	-19	-10	-	-	-16	-	-15
EEZ 224	-18	-22	-	-1	-	-	-15	-	-
EEZ 273	-19	-	-47	-	-	-	-13	-	-33

Table 14a. Trends in **normalized** depositions of oxidized, reduced, and total nitrogen to the twenty-four EEZs within the OSPAR Maritime Area. The values correspond to the slopes of the linear regression line, given in units of tonnes(N)/year, calculated for the whole 31-year period (1990 – 2020), for the 1990s and for the most recent decade. Missing values, indicated by hyphens, mean that there is no trend that is significant at the 95% confidence level (i.e. the Mann-Kendall test yields a p-value larger than 0.05)..

EEZ	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
EEZ 48	-128	83	-179	-109	-	69	-221	-	-
EEZ 65	-674	-633	-559	-83	-137	-	-755	-770	-551
EEZ 71	-864	-732	-765	-155	-277	-	-1 023	-1 036	-712
EEZ 91	-483	400	-649	-65	-	106	-537	395	-510
EEZ 99	-13	-4	-13	-2	-	-	-15	-	-12
EEZ 100	-29	-28	-23	-3	-4	-	-31	-32	-22
EEZ 108	-1 246	-962	-1 047	-142	-	222	-1 368	-1 019	-827
EEZ 109	-70	-50	-64	-11	-8	-	-81	-61	-62
EEZ 110	-23	-15	-20	-4	-	-	-27	-19	-20
EEZ 119	-3	-2	-2	0	-1	-	-3	-3	-2
EEZ 123	-53	-50	-45	-8	-16	-	-61	-67	-45
EEZ 185	-215	-231	-183	-64	-135	-	-279	-364	-196
EEZ 187	-2	-2	-2	0	-1	-	-2	-3	-2
EEZ 188	-78	-70	-66	-30	-39	-	-107	-112	-71
EEZ 189	-1 371	-1 380	-1 128	-406	-932	-	-1 801	-2 426	-1 157
EEZ 190	-874	-931	-726	-238	-651	-	-1 115	-1 611	-783
EEZ 191	-1 289	-1 407	-1 061	-379	-793	-	-1 670	-2 216	-1 145
EEZ 209	-1 577	-826	-1 532	-239	-	-	-1 828	-971	-1 411
EEZ 212	-300	-305	-256	-89	-234	-	-392	-554	-240
EEZ 213	-6 080	-5 918	-4 901	-904	-1 206	-	-6 882	-7 059	-4 648
EEZ 215	-321	-378	-261	-105	-391	43	-432	-751	-214
EEZ 216	-3 703	-3 420	-3 314	-496	-1 068	-	-4 227	-4 659	-3 374
EEZ 224	-283	-268	-246	-45	-94	-	-328	-369	-241
EEZ 273	-964	-	-1 081	-105	-	180	-1 061	-	-884

Table 14b. Same as Table 14a, but the trends are given in %/decade.

EEZ	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
EEZ 48	-4	4	-9	-5	-	4	-5	-	-
EEZ 65	-19	-17	-29	-8	-14	-	-16	-16	-21
EEZ 71	-15	-12	-22	-8	-14	-	-13	-13	-16
EEZ 91	-11	14	-25	-3	-	6	-8	11	-16
EEZ 99	-16	-3	-30	-4	-	-	-12	-	-17
EEZ 100	-19	-18	-30	-7	-11	-	-16	-16	-21
EEZ 108	-17	-13	-27	-4	-	1	-13	-9	-15
EEZ 109	-18	-12	-31	-6	-6	-	-14	-10	-20
EEZ 110	-19	-12	-31	-5	-	-	-13	-8	-18
EEZ 119	-18	-16	-28	-8	-13	-	-16	-15	-21
EEZ 123	-17	-16	-25	-9	-17	-	-15	-16	-19
EEZ 185	-19	-19	-31	-12	-22	-	-16	-20	-21
EEZ 187	-19	-19	-30	-11	-22	-	-16	-20	-21
EEZ 188	-20	-17	-33	-11	-15	-	-16	-16	-21
EEZ 189	-21	-20	-34	-13	-26	-	-18	-22	-23
EEZ 190	-20	-20	-33	-12	-24	-	-17	-22	-22
EEZ 191	-20	-20	-32	-12	-23	-	-17	-21	-22
EEZ 209	-18	-8	-30	-5	-	-	-13	-6	-18
EEZ 212	-13	-13	-17	-10	-22	-	-12	-16	-12
EEZ 213	-20	-19	-33	-7	-10	-	-16	-16	-21
EEZ 215	-12	-14	-15	-12	-29	2	-12	-19	-10
EEZ 216	-18	-17	-29	-9	-18	-	-16	-17	-22
EEZ 224	-16	-15	-24	-9	-17	-	-14	-15	-18
EEZ 273	-15	-	-28	-3	-	2	-11	-	-16

Table 15. Normalized deposition of total nitrogen to the twenty-four EEZs in the OSPAR Maritime Area in the period 1990 to 2020. 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
1990	39.9	47.7	82.4	50.5	1.20	1.93	108	5.73	2.06	0.19	4.21	18.5
1991	40.0	47.0	81.1	51.4	1.20	1.90	107	5.71	2.05	0.18	4.15	18.2
1992	40.0	46.3	80.0	52.8	1.20	1.88	107	5.66	2.03	0.18	4.07	17.6
1993	39.4	44.8	78.2	51.2	1.17	1.82	104	5.49	1.98	0.18	3.96	17.0
1994	39.4	44.1	77.0	51.6	1.16	1.79	103	5.42	1.96	0.17	3.89	16.6
1995	39.2	43.1	75.7	52.0	1.15	1.75	101	5.34	1.94	0.17	3.81	16.1
1996	39.7	42.9	75.7	52.4	1.16	1.74	101	5.33	1.93	0.17	3.79	16.1
1997	39.6	41.8	74.2	52.7	1.15	1.69	99.8	5.23	1.90	0.16	3.70	15.6
1998	39.7	41.4	73.7	53.6	1.16	1.68	100	5.23	1.90	0.16	3.67	15.4
1999	40.1	40.6	72.8	54.8	1.16	1.64	99.0	5.19	1.89	0.16	3.61	15.1
2000	40.7	40.0	71.8	55.9	1.17	1.61	97.7	5.17	1.89	0.16	3.55	14.8
2001	40.1	39.3	70.5	55.1	1.16	1.58	96.3	5.08	1.86	0.15	3.49	14.5
2002	39.6	38.3	69.3	54.5	1.14	1.54	94.3	4.96	1.81	0.15	3.41	14.2
2003	39.0	37.7	68.5	53.4	1.12	1.52	93.2	4.88	1.79	0.15	3.37	14.0
2004	39.0	37.2	67.8	53.3	1.11	1.50	91.9	4.81	1.76	0.15	3.32	13.8
2005	38.2	36.7	66.9	52.1	1.09	1.48	91.0	4.73	1.73	0.14	3.28	13.6
2006	37.7	36.0	66.0	50.9	1.07	1.45	89.6	4.63	1.70	0.14	3.23	13.4
2007	37.7	35.2	65.2	50.4	1.05	1.41	87.3	4.54	1.67	0.14	3.17	13.1
2008	36.5	33.2	62.4	46.7	0.99	1.33	83.3	4.30	1.60	0.13	3.02	12.5
2009	35.7	31.3	60.0	44.5	0.94	1.25	79.3	4.09	1.53	0.12	2.87	11.9
2010	35.8	31.3	59.9	44.9	0.94	1.25	79.2	4.11	1.53	0.12	2.87	11.9
2011	35.6	30.3	58.4	43.9	0.92	1.20	76.7	3.99	1.49	0.12	2.80	11.6
2012	35.2	30.2	58.1	42.9	0.91	1.20	77.1	3.97	1.49	0.12	2.78	11.4
2013	34.8	29.5	57.2	41.9	0.89	1.18	75.9	3.89	1.46	0.12	2.73	11.2
2014	34.6	28.6	56.1	40.5	0.86	1.14	73.6	3.76	1.42	0.11	2.65	10.9
2015	34.9	28.5	56.2	41.3	0.87	1.13	74.3	3.78	1.43	0.11	2.65	10.8
2016	34.8	27.8	55.3	40.4	0.86	1.11	73.6	3.70	1.40	0.11	2.59	10.7
2017	35.0	27.6	55.0	41.0	0.86	1.10	73.7	3.68	1.40	0.11	2.57	10.6
2018	34.9	27.2	54.4	40.8	0.85	1.08	73.5	3.62	1.38	0.11	2.53	10.4
2019	35.0	26.3	53.0	40.8	0.83	1.05	71.0	3.53	1.34	0.11	2.47	10.0
2020	34.3	24.7	50.5	37.7	0.78	0.98	67.0	3.30	1.26	0.10	2.33	9.46

Table 15. Continued.

	187	188	189	190	191	209	212	213	215	216	224	273
1990	0.15	6.54	106	73.5	105	142	35.7	428	42.4	276	24.1	95.5
1991	0.15	6.51	105	71.8	102	142	34.9	423	41.2	271	23.8	95.9
1992	0.15	6.36	101	69.2	99.2	142	34.1	416	40.1	266	23.3	96.4
1993	0.14	6.19	97.9	67.3	96.1	138	33.2	403	38.8	257	22.6	93.3
1994	0.14	6.06	94.6	64.9	93.4	136	32.6	397	37.8	252	22.3	93.3
1995	0.13	5.91	91.1	62.7	90.5	135	31.9	387	36.8	247	21.8	92.9
1996	0.13	5.86	90.5	62.4	89.8	135	31.8	385	36.6	246	21.8	93.9
1997	0.13	5.71	87.6	60.5	87.0	133	31.2	375	36.0	240	21.3	93.6
1998	0.13	5.65	86.2	59.7	85.9	134	30.9	372	35.5	238	21.1	94.8
1999	0.13	5.56	84.7	58.8	84.0	134	30.4	365	35.0	233	20.8	95.3
2000	0.12	5.47	82.6	57.5	82.4	134	29.9	358	34.4	229	20.4	96.5
2001	0.12	5.35	80.9	56.5	80.7	132	29.5	352	34.0	225	20.1	95.1
2002	0.12	5.20	78.4	54.9	78.6	129	29.1	342	33.5	220	19.7	93.7
2003	0.12	5.09	77.1	54.1	77.6	127	28.8	337	33.3	217	19.5	92.9
2004	0.12	4.98	75.7	53.1	76.2	126	28.5	332	33.0	214	19.2	92.2
2005	0.11	4.90	74.5	52.4	75.0	123	28.2	327	32.7	211	19.0	90.0
2006	0.11	4.80	73.2	51.6	73.6	121	27.9	320	32.4	208	18.7	88.2
2007	0.11	4.68	71.3	50.5	72.0	119	27.6	312	31.9	203	18.4	87.4
2008	0.11	4.43	67.0	48.1	68.5	113	26.7	293	30.9	193	17.5	81.2
2009	0.10	4.21	63.3	45.7	64.7	107	25.8	276	29.9	182	16.7	77.4
2010	0.10	4.22	63.2	45.7	64.9	108	25.8	276	30.0	183	16.8	77.6
2011	0.10	4.10	61.3	44.6	63.0	105	25.4	267	29.6	178	16.4	75.9
2012	0.10	4.07	60.6	44.2	62.2	104	25.2	266	29.5	176	16.3	74.7
2013	0.09	3.98	59.3	43.4	60.9	102	25.0	260	29.3	173	16.0	73.1
2014	0.09	3.86	57.4	42.3	59.0	99.2	24.6	252	28.8	167	15.6	71.3
2015	0.09	3.87	57.4	42.2	59.0	100	24.6	252	28.8	166	15.5	72.3
2016	0.09	3.78	56.0	41.3	57.8	98.1	24.3	247	28.6	162	15.3	70.9
2017	0.09	3.74	55.4	40.8	57.4	97.9	24.2	245	28.6	160	15.2	71.5
2018	0.09	3.67	54.2	39.7	56.1	96.5	24.0	242	28.4	158	14.9	70.8
2019	0.08	3.56	52.3	38.3	54.0	94.4	23.5	234	28.0	153	14.6	69.7
2020	0.08	3.35	49.0	35.7	50.8	88.0	22.7	218	27.1	143	13.8	65.1

5.3 Partial EEZs

Actual (non-normalized) atmospheric nitrogen depositions have been computed for each of the twenty-five partial Exclusive Economic Zones (listed in Table 6), for each year of the period 1990-2020.

Normalized results are listed for total nitrogen in Table 16. Both actual and normalized results for oxidized and reduced nitrogen are listed in the accompanying Excel file (see Chapter 7). The results are qualitatively consistent with those for the EEZs (previous section), with clear downward trends in many areas for oxidized nitrogen, but much less so for reduced nitrogen. Depositions of oxidized and total nitrogen were lower in 2020 than in 1990 in all the twenty-five partial Exclusive Economic Zones, while for reduced nitrogen deposition, small *increases* are seen in almost half of them.

Table 16. Normalized deposition of total 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
1990	36.2	2.72	8.81	66.6	15.7	31.9	18.6	0.95	0.02	0.96	54.4	53.6
1991	35.6	2.67	8.69	65.5	15.5	32.6	18.8	0.94	0.02	0.95	54.2	53.3
1992	35.1	2.63	8.58	64.6	15.3	33.6	19.2	0.92	0.02	0.94	54.0	52.8
1993	34.0	2.55	8.32	63.2	15.0	32.6	18.6	0.89	0.02	0.91	52.5	51.4
1994	33.4	2.50	8.21	62.2	14.8	32.9	18.7	0.88	0.02	0.89	52.1	50.8
1995	32.7	2.44	8.03	61.1	14.6	33.2	18.8	0.86	0.02	0.87	51.3	50.0
1996	32.5	2.43	8.00	61.1	14.6	33.4	18.9	0.85	0.02	0.87	51.5	50.0
1997	31.6	2.35	7.80	59.9	14.3	33.7	19.0	0.83	0.02	0.84	50.8	49.1
1998	31.3	2.33	7.75	59.4	14.3	34.3	19.3	0.82	0.02	0.84	51.1	49.1
1999	30.8	2.28	7.61	58.7	14.1	35.2	19.6	0.80	0.02	0.82	50.5	48.6
2000	30.2	2.24	7.49	57.9	14.0	36.0	19.9	0.79	0.02	0.81	49.7	48.1
2001	29.7	2.20	7.36	56.7	13.7	35.4	19.6	0.77	0.02	0.79	49.0	47.4
2002	28.9	2.14	7.18	55.8	13.5	35.1	19.4	0.75	0.02	0.77	48.0	46.3
2003	28.6	2.11	7.09	55.1	13.4	34.3	19.1	0.74	0.02	0.76	47.5	45.7
2004	28.1	2.07	6.99	54.6	13.3	34.3	19.0	0.73	0.02	0.75	46.8	45.2
2005	27.7	2.05	6.90	53.7	13.1	33.5	18.7	0.72	0.02	0.74	46.4	44.6
2006	27.2	2.01	6.78	53.0	13.0	32.6	18.3	0.71	0.02	0.73	45.8	43.9
2007	26.6	1.96	6.62	52.4	12.8	32.3	18.1	0.69	0.02	0.71	44.4	42.9
2008	25.1	1.84	6.26	50.1	12.3	29.9	16.8	0.65	0.01	0.67	42.4	40.9
2009	23.6	1.73	5.91	48.0	11.9	28.5	16.1	0.61	0.01	0.63	40.4	38.9
2010	23.7	1.73	5.91	48.0	11.9	28.7	16.2	0.61	0.01	0.63	40.3	38.9
2011	22.9	1.67	5.72	46.8	11.6	28.0	15.9	0.59	0.01	0.60	38.9	37.8
2012	22.8	1.66	5.71	46.5	11.6	27.4	15.6	0.58	0.01	0.60	39.3	37.8
2013	22.3	1.62	5.60	45.7	11.5	26.7	15.2	0.57	0.01	0.59	38.8	37.2
2014	21.6	1.57	5.43	44.8	11.3	25.7	14.7	0.55	0.01	0.57	37.5	36.1
2015	21.5	1.56	5.43	44.9	11.3	26.3	15.0	0.55	0.01	0.57	38.0	36.3
2016	21.0	1.52	5.32	44.1	11.2	25.7	14.7	0.54	0.01	0.56	37.8	35.8
2017	20.8	1.51	5.29	43.8	11.2	26.2	14.9	0.53	0.01	0.55	37.9	35.7
2018	20.5	1.48	5.22	43.3	11.1	26.0	14.8	0.52	0.01	0.55	38.1	35.4
2019	19.8	1.43	5.07	42.2	10.8	26.1	14.7	0.51	0.01	0.53	36.6	34.5
2020	18.6	1.34	4.77	40.1	10.4	24.1	13.6	0.47	0.01	0.50	34.6	32.5

Table 16. 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
1990	33.1	22.4	85.9	0.79	8.16	283	106	0.63	30.3	119	156	79.3	16.2
1991	33.0	22.4	86.1	0.79	8.03	279	106	0.62	30.0	117	153	79.7	16.2
1992	32.6	22.3	85.9	0.78	7.90	273	104	0.62	29.6	115	149	80.2	16.2
1993	31.7	21.7	83.3	0.76	7.65	264	101	0.60	28.8	112	144	77.6	15.8
1994	31.2	21.5	82.7	0.75	7.53	260	100	0.60	28.4	110	141	77.6	15.7
1995	30.7	21.3	82.1	0.75	7.35	253	98.4	0.59	27.8	109	138	77.4	15.6
1996	30.6	21.3	82.5	0.75	7.32	251	98.4	0.59	27.7	109	137	78.3	15.7
1997	30.0	21.0	81.6	0.73	7.11	244	96.5	0.58	27.1	107	133	78.0	15.5
1998	29.9	21.0	82.2	0.74	7.04	241	96.5	0.58	27.0	106	131	79.2	15.7
1999	29.6	21.0	82.2	0.73	6.90	236	94.9	0.58	26.5	104	129	79.6	15.7
2000	29.5	21.0	82.6	0.73	6.77	231	93.4	0.58	26.1	102	126	80.7	15.8
2001	29.0	20.7	81.4	0.72	6.65	227	91.9	0.57	25.7	101	124	79.5	15.6
2002	28.3	20.2	79.8	0.70	6.47	220	89.7	0.56	25.1	98.7	120	78.3	15.3
2003	27.8	19.9	78.8	0.69	6.38	217	88.4	0.55	24.8	97.9	119	77.7	15.1
2004	27.3	19.6	77.9	0.68	6.28	213	87.3	0.54	24.4	96.5	117	77.1	15.0
2005	26.9	19.3	76.4	0.67	6.20	210	86.3	0.53	24.1	95.3	115	75.3	14.7
2006	26.3	18.9	74.8	0.66	6.08	206	84.6	0.52	23.7	94.1	113	73.8	14.4
2007	25.8	18.6	73.9	0.65	5.94	200	82.2	0.51	23.1	92.4	111	73.2	14.3
2008	24.7	17.7	69.6	0.61	5.59	188	77.7	0.49	21.9	87.9	105	67.8	13.4
2009	23.5	16.8	66.4	0.58	5.25	176	73.5	0.46	20.7	83.4	98.4	64.5	12.8
2010	23.6	17.0	66.6	0.59	5.26	176	73.5	0.46	20.7	84.2	98.6	64.7	12.9
2011	22.9	16.5	65.0	0.57	5.09	171	71.0	0.45	20.0	82.1	95.6	63.2	12.6
2012	22.8	16.4	64.3	0.57	5.06	170	71.2	0.45	20.0	81.3	94.7	62.2	12.5
2013	22.4	16.1	63.0	0.55	4.94	166	69.9	0.44	19.7	79.9	92.6	60.9	12.2
2014	21.8	15.5	61.4	0.53	4.77	160	67.9	0.43	19.1	77.2	89.5	59.4	11.9
2015	21.9	15.6	62.0	0.54	4.74	160	68.3	0.43	19.1	76.7	89.1	60.3	12.0
2016	21.4	15.3	60.8	0.53	4.62	156	67.4	0.42	18.8	74.9	86.9	59.2	11.8
2017	21.2	15.3	60.8	0.53	4.57	154	67.3	0.42	18.7	74.3	85.9	59.7	11.8
2018	20.9	15.1	60.0	0.52	4.49	151	66.9	0.41	18.5	73.3	84.2	59.1	11.7
2019	20.3	14.8	58.8	0.51	4.34	146	64.7	0.41	18.0	71.4	81.2	58.2	11.5
2020	19.0	13.8	54.8	0.47	4.05	136	60.7	0.38	16.9	67.0	75.9	54.4	10.7

5.4 COMP4 Assessment Units

Airborne nitrogen depositions have been calculated for the sixty-four 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°lon x 0.2°lat) is a limiting factor. A 3x3 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.

Independently of these uncertainty considerations, normalized and actual atmospheric nitrogen depositions have been computed in this contract for all the sixty-four COMP4 Assessment Units (as defined in a table provided by OSPAR in August 2022), and for each year of the period 1990-2020. All results have been provided to OSPAR in a separate file in Excel format, together with this report (see Chapter 7).

Figure 11 shows time series of actual (non-normalized) depositions of total nitrogen to four selected COMP4 Assessment Units.

Table 17 and 18 give all statistically significant trends (at the 95% confidence level) for actual and normalized nitrogen deposition, respectively.

Normalized results are listed for total nitrogen in Table 19. Actual and normalized results for oxidized and reduced nitrogen are listed in the accompanying Excel file (see Chapter 7). The results are qualitatively consistent with those for the EEZs, with clear downward trends in many areas for oxidized nitrogen, but much less so for reduced nitrogen. Depositions of oxidized and total nitrogen were lower in 2020 than in 1990 in all twenty-four COMP4 Assessment Units, while for reduced nitrogen deposition, small increases are seen in almost half of them.

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. Trends *in total* nitrogen deposition are decreasing in all COMP4 Assessment Units and are statistically significant at the 95% confidence level. For reduced nitrogen the decreases are much smaller.

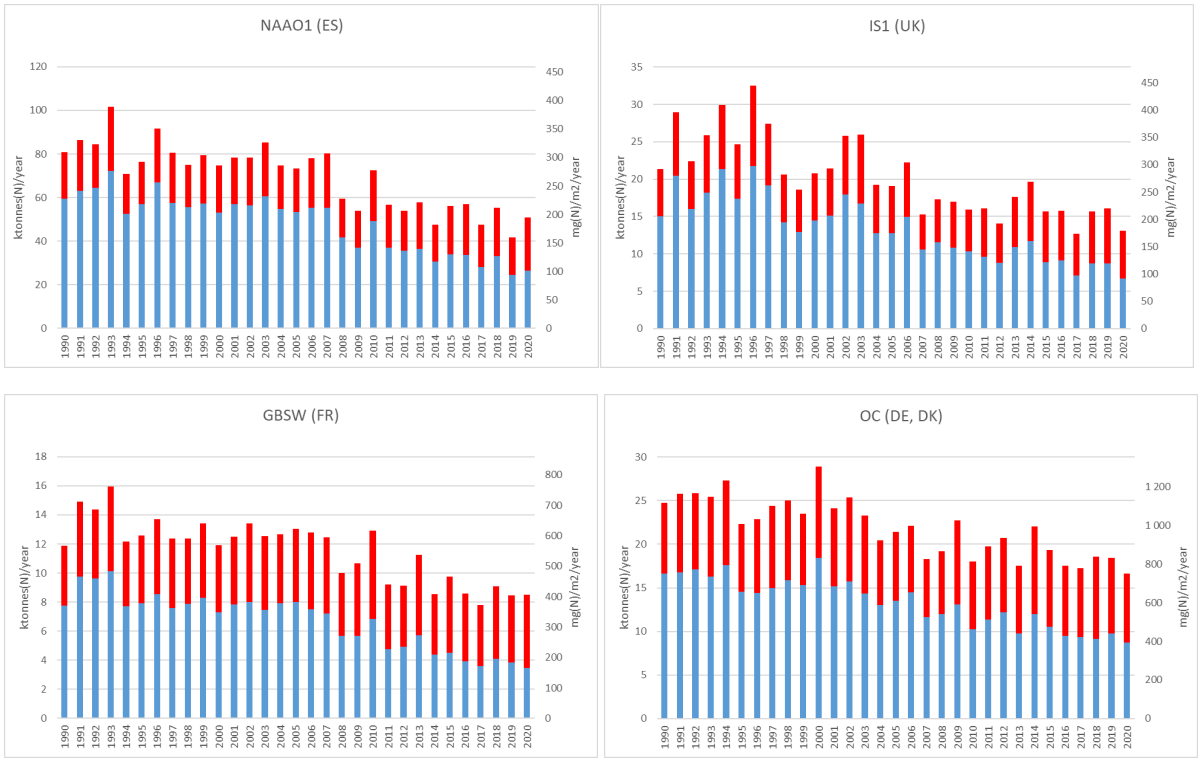


Figure 11: Time series of actual (non-normalized) depositions of total nitrogen to four selected COMP4 Assessment Units, as calculated by the EMEP MSC-W model for the period 1990-2020. Unit: ktonnes(N)/year (left axes) and mg(N)/m^2/year (right axes).

Table 17a. Trends in **actual** (non-normalized) depositions of oxidized, reduced, and total nitrogen to the sixty-four COMP4 Assessment Units. The values correspond to the slopes of the linear regression line, given in units of tonnes(N)/year, calculated for the whole 31-year period (1990 – 2020), for the 1990s and for the most recent decade. Missing values, indicated by hyphens, mean that there is no trend that is significant at the 95% confidence level (i.e. the Mann-Kendall test yields a p-value larger than 0.05). Units not belonging to the 40 largest units are given in grey font. See Section 4.4 for further explanation. (Table continues on the next page.)

COMP4 Unit	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
CFR	-105	-	-132	-	-	-	-100	-	-
CCTI	-78	-	-90	-	-	-	-67	-	-
ATL	-3647	-	-3353	-	-	-	-3900	-	-2932
SHPM	-2	-	-	-	-	-	-2	-	-
CNOR1	-76	-79	-	-18	-40	-	-95	-121	-
CNOR2	-37	-	-32	-6	-	-	-44	-	-
CNOR3	-19	-	-	-5	-	-	-24	-	-
DB	-222	-	-235	-	-	-	-238	-	-
KD	-56	-	-	-	-	-	-65	-	-
NT	-656	-	-368	-161	-	-	-830	-	-
SNS	-1069	-	-1237	-	-	305	-1058	-	-841
GBC	-73	-	-74	-	-	-	-65	-	-
ADPM	-4	-	-5	-1	-	-	-4	-	-9
GBSW	-198	-	-230	-	-	-	-204	-	-232
SPM	-18	-	-	-	-	-	-17	-	-
GDPM	-30	-	-30	-	-	-	-29	-	-26
CUKC	-90	-	-94	-	-	-	-95	-	-
CWMTI	-261	-	-314	-	-	-	-268	-	-
SCHPM1	-12	-	-15	-2	-	-	-13	-	-16
ELPM	-125	-	-122	-	-	-	-122	-	-
SCHPM2	-2	-	-2	-	-	-	-2	-	-2
MPM	-4	-	-4	-	-	-	-4	-	-5
RHPM	-49	-	-47	-6	-	-	-53	-	-35
EMPM	-28	-	-27	-	-	-	-29	-	-
THPM	-92	-	-119	11	-	56	-81	-	-
HPM	-24	-	-27	-	-	28	-20	-	-
ECPM1	-40	-	-42	-5	-	-	-44	-	-40
ECPM2	-23	-	-26	-	-	-	-23	-	-12
IS2	-247	-	-192	-37	-	-	-283	-	-
OC	-234	-	-166	-	-	-	-251	-	-

Table 17a. Continued.

COMP4 Unit	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
ENS	-849	-	-692	-	-	-	-920	-	-
CWCC	-9	-	-19	-	-	-	-9	-	-20
OWCO	-61	-	-134	7	-	-	-55	-	-120
OWAO	-302	-	-424	-	-	-	-305	-	-
OWBO	-496	-	-861	-	-	-	-504	-	-
ASS	-1592	-	-1158	-	-	-	-1672	-	-
CIRL	-107	-	-69	-	-	60	-114	-	-
CUK1	-101	-	-76	-	-	-	-103	-	-
IS1	-403	-	-264	-	-	-	-438	-	-
IRS	-381	-	-340	-	-	91	-402	-	-
KC	-104	-	-95	-18	-	-	-129	-	-
NNS	-2993	-	-2658	-413	-	-	-3424	-	-
CWM	-431	-	-363	-	-	-	-467	-	-
LBPM	-20	-	-16	-	-	-	-22	-	-
SK	-56	-	-	-11	-	-	-67	-	-
SS	-336	-	-233	-43	-	-	-380	-	-
CWBC	-20	-	-34	-	-	-	-21	-	-37
CWAC	-40	-	-56	-	-	-	-42	-	-
LPM	-15	-	-11	-	-	-	-16	-	-
GBCW	-111	-	-116	-	-	-	-115	-	-103
NAAP2	-87	-	-128	-15	-	-44	-101	-	-173
NAAO1	-1334	-	-1474	-	-	-	-1357	-	-
NAAPF	-366	-	-581	-35	-	-	-396	-	-723
NAAC3	-25	-	-33	-2	-	-9	-27	-	-43
NAAC2	-19	-	-25	-4	-	-	-24	-	-30
NAAC1A	-5	-	-	1	-	3	-4	-	-
NAAC1B	-1	-1	-1	-1	-	-	-2	-	-
NAAC1C	0	-	-1	-	-	-	-1	-	-1
NAAC1D	0	0	0	-	-	-	0	-1	-1
SAAP2	-5	-	-	-	-	-	-4	-	-
SAAOC	-34	-	-76	3	-	-	-31	-	-
SAAP1	-11	-	-23	-	-	-	-10	-	-
SAAC1	-2	-	-4	-	-	-	-2	-	-
SAAC2	-2	-	-	-	-	-	-2	-	-

Table 17b. Same as Table 17a, but the trends are given in %/decade.

COMP4 Unit	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
CFR	-18	-	-49	-	-	-	-9	-	-
CCTI	-16	-	-38	-	-	-	-9	-	-
ATL	-20	-	-40	-	-	-	-15	-	-24
SHPM	-16	-	-	-	-	-	0	-	-
CNOR1	-18	-18	-	-11	-28	-	-16	-20	-
CNOR2	-19	-	-20	-10	-	-	-16	-	-
CNOR3	-15	-	-	-10	-	-	-13	-	-
DB	-20	-	-43	-	-	-	-16	-	-
KD	-17	-	-	-	-	-	-14	-	-
NT	-18	-	-16	-11	-	-	-16	-	-
SNS	-18	-	-38	-	-	1	-12	-	-23
GBC	-17	-	-26	-	-	-	-10	-	-
ADPM	-21	-	-57	-7	-	-	-15	-	-41
GBSW	-18	-	-49	-	-	-	-9	-	-34
SPM	-19	-	-	-	-	-	-10	-	-
GDPM	-18	-	-50	-	-	-	-8	-	-34
CUKC	-16	-	-39	-	-	-	-10	-	-
CWMTI	-16	-	-45	-	-	-	-10	-	-
SCHPM1	-18	-	-36	-3	-	-	-12	-	-20
ELPM	-17	-	-18	-	-	-	-11	-	-
SCHPM2	-17	-	-34	-	-	-	-12	-	-20
MPM	-17	-	-33	-	-	-	-11	-	-18
RHPM	-17	-	-29	-2	-	-	-11	-	-13
EMPM	-19	-	-27	-	-	-	-12	-	-
THPM	-18	-	-43	8	-	1	-11	-	-
HPM	-20	-	-44	-	-	29	-11	-	-
ECPM1	-18	-	-43	0	-	-	-13	-	-27
ECPM2	-21	-	-50	-	-	-	-14	-	-27
IS2	-18	-	-36	-4	-	-	-15	-	-
OC	-16	-	-15	-	-	-	-11	-	-

Table 17b. Continued.

COMP4 Unit	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
ENS	-18	-	-31	-	-	-	-13	-	-
CWCC	-17	-	-40	-	-	-	-14	-	-29
OWCO	-13	-	-30	11	-	-	-9	-	-19
OWAO	-17	-	-41	-	-	-	-14	-	-
OWBO	-17	-	-40	-	-	-	-14	-	-
ASS	-18	-	-40	-	-	-	-11	-	-
CIRL	-18	-	-45	-	-	2	-8	-	-
CUK1	-16	-	-32	-	-	-	-7	-	-
IS1	-18	-	-35	-	-	-	-13	-	-
IRS	-18	-	-40	-	-	17	-9	-	-
KC	-17	-	-21	-9	-	-	-14	-	-
NNS	-20	-	-36	-7	-	-	-16	-	-
CWM	-17	-	-40	-	-	-	-11	-	-
LBPM	-18	-	-32	-	-	-	-10	-	-
SK	-16	-	-	-8	-	-	-13	-	-
SS	-18	-	-27	0	-	-	-12	-	-
CWBC	-16	-	-40	-	-	-	-12	-	-24
CWAC	-14	-	-35	-	-	-	-11	-	-
LPM	-19	-	-43	-	-	-	-10	-	-
GBCW	-19	-	-48	-	-	-	-10	-	-32
NAAP2	-20	-	-50	-6	-	-19	-14	-	-36
NAAO1	-18	-	-46	-	-	-	-12	-	-
NAAPF	-21	-	-56	-6	-	-	-16	-	-44
NAAC3	-17	-	-41	-2	-	-11	-11	-	-26
NAAC2	-18	-	-40	-4	-	-	-11	-	-23
NAAC1A	-13	-	-	7	-	13	-4	-	-
NAAC1B	-20	-13	-37	-5	-	-	-13	-	-
NAAC1C	-20	-	-45	-	-	-	-14	-	-30
NAAC1D	-20	-19	-47	-	-	-	-14	-19	-31
SAAP2	-12	-	-	-	-	-	-8	-	-
SAAOC	-10	-	-29	5	-	-	-8	-	-
SAAP1	-12	-	-34	-	-	-	-9	-	-
SAAC1	-13	-	-34	-	-	-	-9	-	-
SAAC2	-13	-	-	-	-	-	-10	-	-

Table 18a. Trends in **normalized** depositions of oxidized, reduced, and total nitrogen to the sixty-four COMP4 Assessment Units. The values correspond to the slopes of the linear regression line, given in units of tonnes(N)/year, calculated for the whole 31-year period (1990 – 2020), for the 1990s and for the most recent decade. Missing values, indicated by hyphens, mean that there is no trend that is significant at the 95% confidence level (i.e. the Mann-Kendall test yields a p-value larger than 0.05). Units not belonging to the 40 largest units are given in grey font. See Section 4.4 for further explanation. (Table continues on the next page.)

COMP4 Unit	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
CFR	-119	-98	-103	-23	-17	-	-142	-122	-106
CCTI	-88	-72	-78	-19	-18	-	-107	-98	-79
ATL	-2452	-1846	-2191	-317	-351	-	-2766	-2226	-1974
SHPM	-1	-1	-1	-	0	1	-1	0	-
CNOR1	-79	-65	-73	-8	-16	-	-87	-82	-73
CNOR2	-46	-45	-38	-6	-13	-	-52	-59	-40
CNOR3	-28	-31	-24	-6	-16	-	-34	-47	-25
DB	-264	-282	-209	-39	-61	-	-302	-350	-205
KD	-75	-82	-64	-26	-55	-	-100	-139	-69
NT	-806	-798	-685	-128	-266	-	-935	-1085	-707
SNS	-1308	-1308	-1074	-349	-629	-	-1670	-2006	-1091
GBC	-101	-107	-85	-29	-82	-	-131	-190	-91
ADPM	-3	-1	-3	0	-	-	-3	-	-2
GBSW	-132	-66	-124	-18	-	-	-151	-64	-111
SPM	-18	-14	-16	-3	-	-	-21	-17	-16
GDPM	-19	-10	-18	-3	-	-	-22	-10	-17
CUKC	-85	-69	-74	-17	-18	-	-101	-88	-69
CWMTI	-273	-215	-242	-48	-41	-	-322	-269	-236
SCHPM1	-14	-13	-12	-8	-12	-2	-23	-25	-14
ELPM	-162	-175	-136	-49	-116	-	-211	-301	-151
SCHPM2	-2	-2	-2	-1	-2	-	-4	-5	-2
MPM	-5	-5	-5	-2	-6	-	-8	-11	-5
RHPM	-60	-58	-50	-28	-82	-	-92	-143	-54
EMPM	-33	-34	-28	-13	-42	-	-47	-77	-32
THPM	-114	-115	-94	-25	-33	-	-137	-148	-91
HPM	-27	-30	-21	-5	-6	-	-32	-35	-19
ECPM1	-41	-44	-32	-6	-7	-	-46	-51	-30
ECPM2	-25	-28	-19	-4	-5	-	-30	-33	-17
IS2	-255	-268	-202	-32	-44	-	-283	-314	-197
OC	-345	-372	-287	-98	-213	-	-444	-593	-311

Table 18a. Continued.

COMP4 Unit	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
ENS	-1211	-1267	-983	-245	-505	-	-1454	-1847	-1023
CWCC	-6	6	-7	-1	-	2	-6	6	-5
OWCO	-42	58	-63	-3	-	11	-45	59	-54
OWAO	-171	101	-223	-21	-	34	-186	120	-174
OWBO	-285	285	-426	-28	-	62	-308	289	-347
ASS	-957	-614	-888	-120	-	-	-1079	-678	-756
CIRL	-86	-73	-69	-8	-	28	-92	-66	-44
CUK1	-79	-59	-69	-13	-	-	-91	-67	-57
IS1	-344	-323	-271	-37	-	36	-373	-352	-240
IRS	-343	-317	-265	-49	-	68	-383	-322	-196
KC	-146	-164	-123	-58	-123	-	-204	-290	-138
NNS	-3457	-3625	-2771	-512	-892	-	-3945	-4562	-2771
CWM	-343	-216	-328	-54	-32	-	-398	-262	-308
LBPM	-22	-23	-17	-3	-	3	-25	-24	-14
SK	-80	-85	-69	-22	-48	-	-101	-135	-72
SS	-344	-341	-271	-42	-38	-	-383	-386	-248
CWBC	-15	15	-19	-4	-	5	-18	13	-14
CWAC	-29	23	-34	-8	-	12	-36	20	-22
LPM	-9	-5	-8	-2	-	-	-10	-5	-8
GBCW	-71	-36	-66	-10	-	-	-82	-35	-63
NAAP2	-51	-	-53	-	-	24	-54	-	-34
NAAO1	-740	-122	-837	-93	-	-	-828	-	-710
NAAPF	-213	-39	-224	-19	-	47	-234	-	-175
NAAC3	-15	-	-17	-	-	9	-16	12	-9
NAAC2	-13	-	-14	-	9	8	-13	9	-6
NAAC1A	-4	2	-4	-	4	3	-4	6	-
NAAC1B	-1	-	-1	-	1	1	-1	1	-
NAAC1C	0	-	0	-	0	0	0	-	0
NAAC1D	0	0	0	-	-	0	0	-	0
SAAP2	-3	3	-4	-	1	1	-3	5	-3
SAAOC	-27	40	-42	-	-	7	-27	44	-35
SAAP1	-8	10	-11	-	3	3	-7	13	-8
SAAC1	-1	1	-2	-	1	1	-1	2	-1
SAAC2	-1	1	-1	-	1	1	-1	2	-1

Table 18b. Same as Table 18a, but the trends are given in %/decade.

COMP4 Unit	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
CFR	-20	-15	-33	-6	-5	-	-14	-11	-19
CCTI	-19	-14	-32	-8	-10	-	-15	-13	-20
ATL	-17	-12	-27	-6	-7	-	-14	-11	-18
SHPM	-17	-11	-26	-	3	4	-9	-4	-
CNOR1	-19	-15	-30	-8	-14	-	-16	-15	-23
CNOR2	-20	-19	-33	-8	-15	-	-17	-18	-23
CNOR3	-19	-20	-30	-11	-23	-	-16	-21	-21
DB	-22	-22	-35	-9	-16	-	-18	-20	-24
KD	-19	-19	-31	-12	-23	-	-16	-21	-20
NT	-20	-19	-32	-10	-19	-	-17	-19	-23
SNS	-21	-20	-34	-11	-20	-	-17	-20	-22
GBC	-20	-20	-33	-13	-25	-	-17	-22	-22
ADPM	-18	-6	-32	-3	-	-	-11	-	-15
GBSW	-18	-8	-32	-4	-	-	-12	-4	-17
SPM	-20	-14	-33	-5	-	-	-13	-9	-18
GDPM	-18	-9	-32	-4	-	-	-12	-5	-17
CUKC	-19	-15	-32	-7	-9	-	-15	-12	-19
CWMTI	-19	-14	-31	-7	-8	-	-15	-11	-20
SCHPM1	-20	-17	-33	-12	-19	-7	-16	-18	-20
ELPM	-20	-20	-33	-12	-23	-	-17	-21	-22
SCHPM2	-20	-17	-33	-14	-26	-	-17	-21	-21
MPM	-20	-17	-33	-14	-27	-	-17	-21	-21
RHPM	-20	-19	-34	-16	-33	-	-18	-25	-21
EMPM	-20	-19	-33	-14	-28	-	-17	-24	-20
THPM	-21	-20	-34	-9	-13	-	-16	-17	-21
HPM	-22	-23	-36	-7	-10	-	-17	-18	-20
ECPM1	-22	-22	-35	-8	-11	-	-17	-19	-22
ECPM2	-22	-24	-36	-7	-10	-	-17	-19	-20
IS2	-21	-21	-34	-8	-13	-	-18	-19	-23
OC	-20	-20	-33	-12	-23	-	-17	-21	-22

Table 18b. Continued.

COMP4 Unit	Oxidized Nitrogen			Reduced Nitrogen			Total Nitrogen		
	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020	1990-2020	1990-2000	2010-2020
ENS	-21	-21	-34	-11	-21	-	-18	-21	-23
CWCC	-11	17	-25	-2	-	8	-8	13	-15
OWCO	-9	20	-24	-1	-	8	-7	17	-17
OWAO	-11	11	-25	-3	-	5	-9	8	-16
OWBO	-10	16	-24	-2	-	6	-8	13	-16
ASS	-18	-10	-29	-4	-	-	-13	-8	-18
CIRL	-20	-16	-32	-2	-	3	-12	-9	-13
CUK1	-19	-13	-31	-5	-	-	-14	-10	-17
IS1	-20	-17	-30	-5	-	0	-15	-14	-19
IRS	-21	-18	-33	-4	-	1	-14	-12	-16
KC	-19	-20	-31	-13	-23	-	-16	-22	-20
NNS	-21	-21	-34	-10	-17	-	-18	-20	-24
CWM	-18	-10	-30	-6	-5	-	-13	-8	-19
LBPM	-21	-21	-35	-5	-	0	-15	-15	-17
SK	-19	-19	-30	-12	-23	-	-16	-20	-21
SS	-20	-19	-32	-6	-9	-	-16	-16	-20
CWBC	-11	18	-26	-4	-	7	-9	12	-15
CWAC	-12	15	-27	-4	-	8	-8	10	-13
LPM	-18	-8	-31	-5	-	-	-12	-5	-17
GBCW	-18	-8	-32	-4	-	-	-12	-4	-17
NAAP2	-15	-	-29	-	-	7	-9	-	-12
NAAO1	-15	-1	-27	-4	-	-	-11	-	-17
NAAPF	-16	-2	-30	-2	-	3	-11	-	-16
NAAC3	-14	-	-28	-	-	8	-8	6	-10
NAAC2	-15	-	-29	-	9	9	-8	6	-10
NAAC1A	-13	10	-27	-	11	10	-6	10	-
NAAC1B	-15	-	-30	-	11	10	-7	7	-
NAAC1C	-17	-	-31	-	9	8	-11	-	-15
NAAC1D	-17	-1	-32	-	-	7	-10	-	-14
SAAP2	-10	17	-24	-	10	10	-7	15	-14
SAAOC	-8	20	-23	-	-	9	-6	18	-16
SAAP1	-9	18	-24	-	9	10	-7	16	-15
SAAC1	-11	14	-25	-	10	10	-7	13	-13
SAAC2	-11	14	-26	-	10	10	-7	13	-13

Table 19. Deposition of oxidised, reduced and total nitrogen, to the sixty-four COMP4 Assessment Units in 2020. Both actual numbers (based on 2020 meteorology) and weather-normalized values (based on meteorological data of 2016-2020) are given. Results for other years are provided separately in Excel format (see Chapter 7). Units not belonging to the 40 largest units are given in grey font. See Section 4.4 for further explanation. 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	2 098	2 407	3 306	3 520	5 404	5 928
CCTI	1 795	1 884	1 855	2 102	3 651	3 987
ATL	63 987	67 506	52 008	48 391	115 995	115 897
SHPM	39	34	83	64	122	97
CNOR1	2 025	1 884	1 072	1 006	3 097	2 890
CNOR2	966	894	697	722	1 662	1 616
CNOR3	739	647	554	521	1 293	1 168
DB	3 867	4 324	3 112	3 441	6 979	7 766
KD	1 758	1 702	1 726	1 717	3 483	3 420
NT	17 712	16 905	11 289	11 443	29 001	28 347
SNS	22 592	23 381	22 915	24 553	45 507	47 934
GBC	1 953	1 951	2 141	2 119	4 094	4 070
ADPM	64	72	106	115	170	187
GBSW	3 455	3 314	5 045	4 583	8 500	7 897
SPM	310	362	596	611	906	973
GDPM	475	463	802	746	1 277	1 209
CUKC	1 649	1 815	1 698	1 994	3 347	3 808
CWMTI	5 660	6 091	5 558	6 395	11 218	12 485
SCHPM1	276	278	412	411	689	689
ELPM	3 246	3 200	3 692	3 740	6 938	6 940
SCHPM2	48	47	56	55	104	102
MPM	111	106	129	124	239	230
RHPM	1 148	1 119	1 364	1 356	2 512	2 475
EMPM	639	646	968	957	1 607	1 603
THPM	1 857	2 017	1 984	2 288	3 841	4 305
HPM	378	416	513	575	891	991
ECPM1	601	664	560	619	1 161	1 283
ECPM2	317	380	454	501	771	881
IS2	4 165	4 391	3 064	3 239	7 229	7 629
OC	7 267	6 867	6 575	6 688	13 842	13 555
ENS	21 452	21 961	16 896	18 340	38 348	40 301
CWCC	282	273	171	171	453	444

Table 19. Continued.

COMP4 Assessment Unit	Oxidised N		Reduced N		Total N	
	Actual	Normalized	Actual	Normalized	Actual	Normalized
OWCO	2 665	2 557	1 147	994	3 812	3 550
OWAO	8 108	8 166	5 446	4 911	13 554	13 077
OWBO	14 710	15 534	7 652	7 201	22 362	22 735
ASS	25 389	25 217	27 828	24 092	53 217	49 309
CIRL	1 481	1 719	2 747	2 994	4 228	4 713
CUK1	1 824	1 789	2 167	2 038	3 991	3 827
IS1	6 710	7 236	6 353	6 334	13 063	13 570
IRS	5 674	6 322	9 987	9 826	15 661	16 148
KC	3 211	3 249	3 640	3 650	6 850	6 899
NNS	57 192	61 438	40 318	44 830	97 510	106 267
CWM	8 595	8 708	8 893	8 720	17 487	17 428
LBPM	346	365	543	541	889	906
SK	2 036	1 851	1 623	1 564	3 659	3 415
SS	6 356	6 522	5 995	5 705	12 351	12 227
CWBC	653	669	508	469	1 160	1 138
CWAC	1 233	1 216	1 222	1 222	2 455	2 437
LPM	219	218	369	349	588	567
GBCW	1 778	1 761	2 826	2 697	4 604	4 458
NAAP2	1 558	1 670	2 218	2 265	3 777	3 934
NAAO1	26 511	26 096	24 341	20 941	50 852	47 036
NAAPF	5 868	6 524	6 873	7 175	12 741	13 699
NAAC3	546	551	815	823	1 361	1 374
NAAC2	423	429	713	724	1 136	1 154
NAAC1A	158	147	270	270	428	417
NAAC1B	24	25	44	43	68	67
NAAC1C	9	11	11	12	21	23
NAAC1D	5	6	7	7	12	13
SAAP2	196	178	115	117	311	295
SAAOC	1 975	1 848	702	667	2 677	2 515
SAAP1	520	479	242	246	762	726
SAAC1	83	76	58	60	142	136
SAAC2	58	53	42	43	99	96

6 Conclusions

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

- Emission data have been updated by the EMEP Centre for Emission Inventories and Projections (EMEP CEIP) for the entire 31-year period from 1990 to 2020 period (based on data submissions received from Contracting Parties by June 2022);
- 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 the five OSPAR Regions, the twenty-four Exclusive Economic Zones (EEZs) in the OSPAR Maritime Area, the twenty-five 'partial EEZs' and the sixty-four COMP4 Assessment Units for the 1990-2020 period;
- in all OSPAR Regions, actual (non-normalized) deposition of *oxidised* nitrogen was clearly lower in 2020 than in 1990, with the maximum decline in Region V (60%);
- actual deposition of *reduced* nitrogen was lower in 2020 than in 1990 in OSPAR Regions I, II and V (in the range of 9-23%), but larger by 16% and 95% in OSPAR regions III and IV, respectively;
- actual deposition of *total* nitrogen was lower in 2020 than in 1990 in all OSPAR Regions (in the range of 32-48%), with the largest reduction in Regions I and V and the smallest reduction in Region III;
- the decrease in actual nitrogen deposition over the whole 1990-2020 period is statistically significant in all OSPAR Regions, except for reduced nitrogen deposition in OSPAR Regions III and IV;
- normalized nitrogen deposition shows significant downward trends over the 31-year period in all OSPAR regions for both reduced, oxidized and total nitrogen; however, when limiting the trend analysis to the last decade (2010-2020) no statistically significant downward trend in reduced nitrogen deposition is found in any of the OSPAR regions;
- qualitatively, the findings for the EEZs, partial EEZs and COMP4 Assessment Units are similar to the results for the OSPAR Regions, with clear decreases for oxidized nitrogen deposition over the 31-year period, but much smaller (or absent) decreases for reduced nitrogen deposition;
- over the 1990-2020 period, (actual) oxidized and total nitrogen deposition has decreased significantly in all EEZs, but for reduced nitrogen deposition the decrease is statistically significant in less than half of the EEZs; for *normalized* depositions, all downward trends are significant even for reduced nitrogen (albeit smaller than those for oxidized and total nitrogen);
- in all COMP4 Assessment Units, normalized deposition of *oxidized* nitrogen was clearly lower in 2020 than in 1990 (with decreases in the range of 31 to 64%); for total nitrogen it was lower in all but one assessment unit; for reduced nitrogen there are both increases and decreases;

7 Accompanying data sheets

As the number of receptor areas relevant to OSPAR has become quite large, not all results can be shown in this report. Two data files have thus been submitted along with this report:

a) 'N_depositions_OSPAR_2022' (Excel format): Actual and normalized depositions of oxidized, reduced and total nitrogen to all OSPAR receptors of interest in the period 1990-2020. 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).

b) 'N_emissions_OSPAR_2022' (Excel format): Emissions for oxidized nitrogen (NOx) and reduced nitrogen (ammonia) from OSPAR Contracting parties, as provided by CEIP for modelling purposes.

The data files are sent to the OSPAR secretariat with file names as given above and a version identifier ('v1', 'v2', etc.).

Numerous figures are included in the Excel files.

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