OSPAR COMMISSION

# Reduction of Atmospheric Nitrogen Deposition to OSPAR Convention Waters Achievable by Implementing Gothenburg Protocol/EU-NEC Directive

UPDATED 2019

2018

Monitoring and Assessment Series

**OSPAR Convention**

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

**Convention OSPAR**

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

**Acknowledgements**

This report was prepared by Jerzy Bartnicki, Jan Eiof Jonson, Michael Gauss, Agnes Nyiri and Heiko Klein of The Meteorological Synthesizing Centre-West (MSC-W) of EMEP, Norwegian Meteorological Institute. The authors are indebted to the scientific team at MSC-W for their help in providing the results included in this report. The authors are also grateful to OSPAR for financing the work presented in this report. Please note, Table 5.1 was updated in 2019, it was previously showing the same data as Table 5.2.

## Contents

## 1. Introduction

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

Data provided by EMEP to ICG-Eut 2017 showed that atmospheric deposition still constitutes an important source of nutrient inputs to the OSPAR area. Especially, the Greater North Sea is a problem area with respect to eutrophication. Therefore it is of interest to OSPAR to investigate how large reductions of atmospheric nitrogen inputs can be expected from the implementation of the Gothenburg Protocol and the implementation of the EU NEC Directive 2016/2284. According to OSPAR, quantifying these reductions will help in determining the amount of nutrient inputs that needs to be reduced via rivers and will hence contribute to determining the “distance to target”.

Under the Gothenburg Protocol the signatories have agreed to national reduction targets for $NO_x$ and $NH_3$ to be achieved from 2020 onwards, taking 2005 as the reference year. The “EU Directive 2016/2284 of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants” lays down national emission reduction commitments for EU-countries, which, from 2020 to 2029 are identical to those set in the revised Gothenburg Protocol. From 2029 onwards the Directive is setting higher reduction requirements for nitrogen emissions than the Gothenburg Protocol that will result in further reductions of atmospheric nitrogen depositions to the Greater North Sea. Hence it is important to also consider these additional reduction requirements.

To adequately capture the effects of the Gothenburg Protocol as well as the EU-NEC Directive a two-step approach was proposed.

As a first step an estimation of the reductions in $NO_x$ and $NH_3$ that can be expected for OSPAR Region II from the full implementation of the Gothenburg Protocol from 2020 up to 2029. The reference year is 2005. The reductions should be calculated for the whole of Region II as well as for the national EEZs of OSPAR Contracting Parties in Region II (Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden and the United Kingdom).

As a second step an estimation of the reductions in $NO_x$ and $NH_3$ that can be expected for the OSPAR Region II from the full implementation of the EU-NEC Directive after 2030. The reference year is 2005. The reductions should be calculated for the whole of Region II as well as for the national EEZs of OSPAR Contracting Parties in Region II (Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden and the United Kingdom). Furthermore, in this scenario the reductions expected from the implementation of the NECA in the North Sea (and Baltic Sea) should also be considered.

According to the contract with OSPAR, the following tasks for MSC-W of EMEP were specified:

- Task 1: use geographical definitions of EEZs from www.marineregions.org to (i) implement EEZs borders in the EMEP grid; and (ii) calculate the percentages of EEZs in each EMEP grid square (was performed under another contract with OSPAR related to routine annual calculations of nitrogen deposition to OSPAR Regions and EEZs).

- Task 2: prepare final emission data for the years 2005, 2020 and 2030 (the kind of emissions to be used other than nitrogen components, to be discussed with OSPAR experts).
- Task 3: perform 20 model runs for the emissions in the years 2005, 2020 and 2030 with 20 available meteorological years and calculate nitrogen depositions in the EMEP model domain. This will include preparation of meteorological data and new scripts for each run.
- Task 4: calculate nitrogen depositions in the EEZs and the entire OSPAR Region II.
- Task 5: compare calculated depositions, and analyse the effects of reductions, creating tables and maps.
- Task 6: write a short summary report for OSPAR.

Task 1 was performed under another contract with OSPAR related to routine annual calculations of nitrogen deposition to OSPAR Regions and EEZs.

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

The model is regularly evaluated against measurements from the EMEP network under the LRTAP convention (e.g. Gauss et al., 2017a/b; Tsyro et al., 2017), but also in a large number of international research projects and operational services (e.g. Copernicus Atmosphere Monitoring Service, http://macc-raq-op.meteo.fr/). 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. The model code (software) is also available as Open Source (https://github.com/metno/emep-ctm) and has been widely used both as a research tool and for underpinning of air quality legislation.

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

In this project the model version with 50 km × 50 km resolution was used for all model runs. The details of this domain and model grid system are presented in Figure 1.2. There are two reasons why the lower resolution version of the model was used for the computations. First, there is only one year (2015) with available meteorological data for the high resolution version. Secondly, the high resolution version cannot be used for source-receptor calculations at present because of very long time of the computations and related significant costs. However, this version will be used by MSC-W of EMEP for calculating all depositions in the future as more computing power and storage become available.

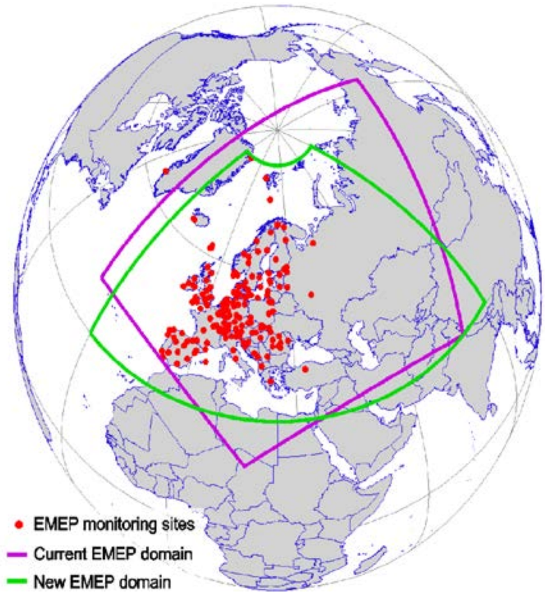



**Figure 1.1** The old (purple) and new (green) official EMEP domains. The new domain has been used for the first time this year, and has the resolution to 0.1deg×0.1deg in a regular longitude-latitude grid. The old domain has the resolution 50km×50km in a polar-stereographic grid.

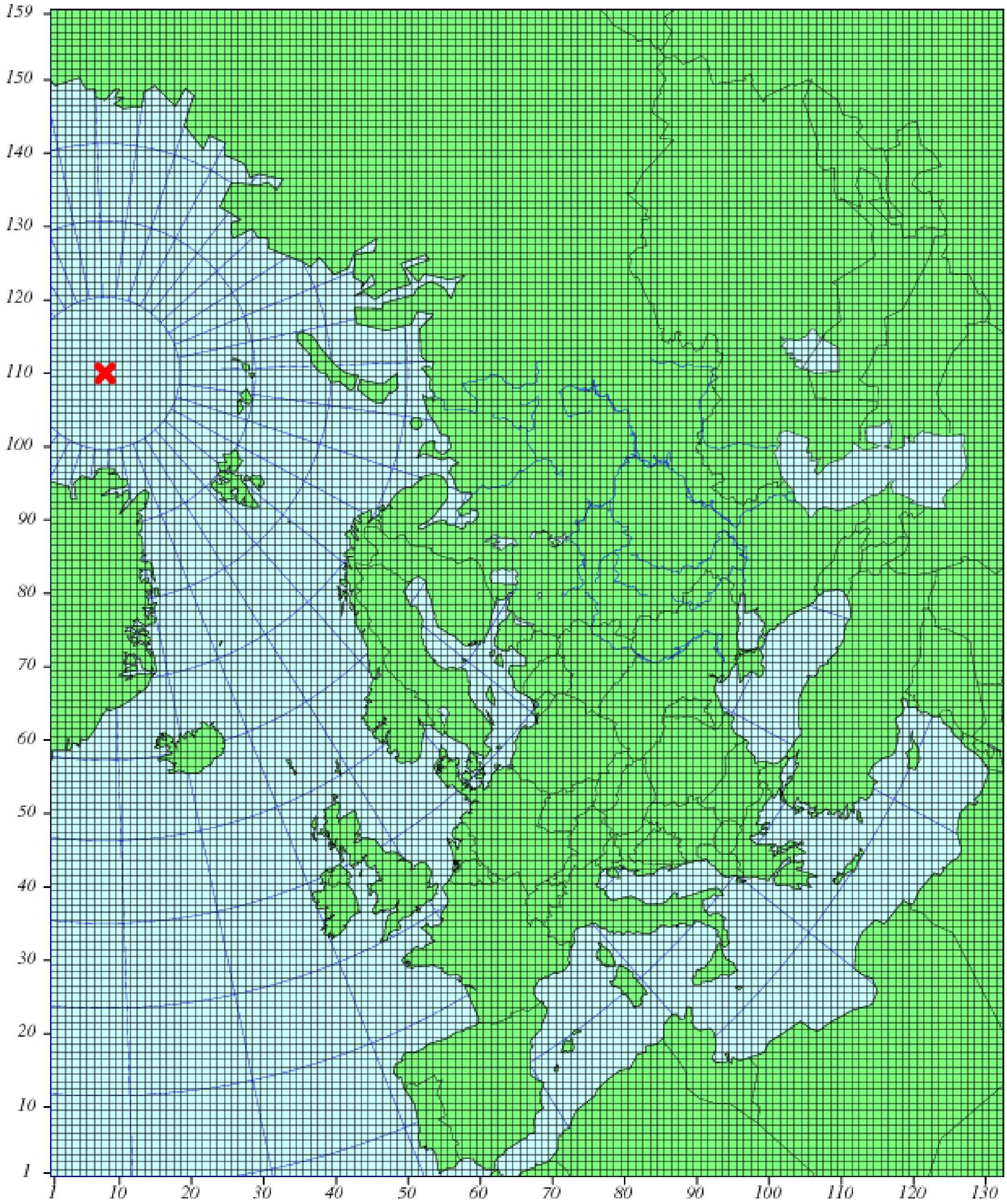



**Figure 1.2** The official EMEP domain with 50 km × 50 km resolution, used for all EMEP model calculations presented in the present report.

In the report, and especially in Chapter 3 dealing with emissions, acronyms for the countries and other emission sources are used. The list and explanations of these acronyms are presented in Table 1.1.

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

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

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

## 2. Main OSPAR Region II and EEZs in the EMEP grid

A new definition of the OSPAR Region II was used in the present calculations, as specified at: www.marineregions.org; and requested by OSPAR. In addition, Exclusive Economic Zone (EEZ) for each OSPAR Contracting Party was implemented into the EMEP grid system. This work has been done under the Contract for preparatory work by EMEP to routinely produce atmospheric load products, and here we only present new OSPAR Region II and EEZs used in these projects. In some cases (e.g. Sweden) only the parts of EEZs belonging to OSPAR Convention Waters were implemented into the EMEP grid.

### 2.1 Main OSPAR Region II

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

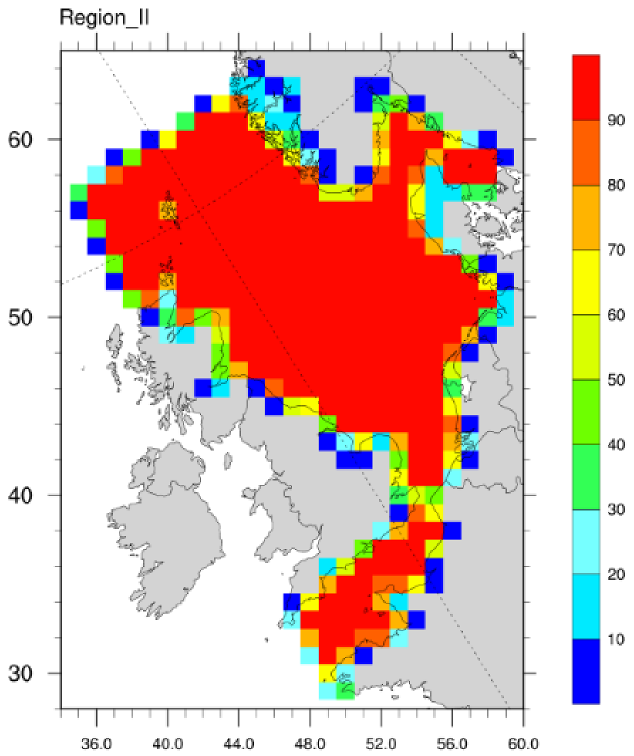



**Figure 2.1** Percentage of the EMEP grids in the MAIN OSPAR Region II.

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

## 2.2 Exclusive Economic Zones

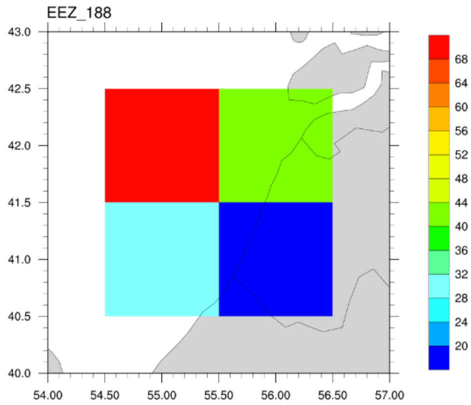
National EEZs of OSPAR Contracting Parties in Region II (Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden and the United Kingdom) were implemented into the EMEP grid system. The list of EEZs for these countries is shown in Table 2.1.

**Table 2.1** National EEZs of OSPAR Contracting Parties in Region II (Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden and the United Kingdom). The area includes total zones, also outside the OSPAR Convention, e.g. a part of the Baltic Sea for some countries.

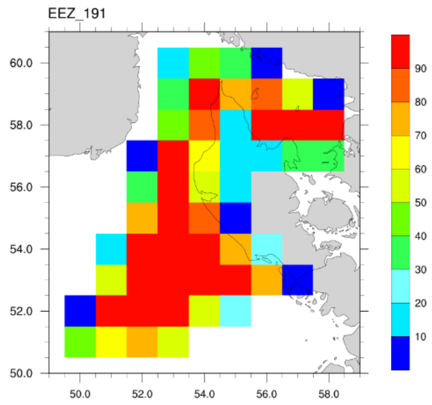
| EEZ-ID | Country | EMEP-ID | Area ($km^2$) | Name |
|---|---|---|---|---|
| EEZ_188 | Belgium | 3 | 3492 | Belgian Exclusive Economic Zone |
| EEZ_191 | Denmark | 6 | 104885 | Danish Exclusive Economic Zone |
| EEZ_209 | France | 8 | 344795 | French Exclusive Economic Zone |
| EEZ_190 | Germany | 60 | 56598 | German Exclusive Economic Zone |
| EEZ_189 | Netherlands | 17 | 64444 | Dutch Exclusive Economic Zone |
| EEZ_216 | Norway | 18 | 933668 | Norwegian Exclusive Economic Zone |
| EEZ_185 | Sweden | 23 | 155952 | Swedish Exclusive Economic Zone |
| EEZ_213 | UK | 27 | 732923 | United Kingdom Exclusive Economic Zone |

The same calculations as for OSPAR Region II were performed for each EEZ of the Contracting Parties listed above and included in Table 2.1. The percentage of EMEP grids covered by each of selected EEZ are shown in Figure 2.2.

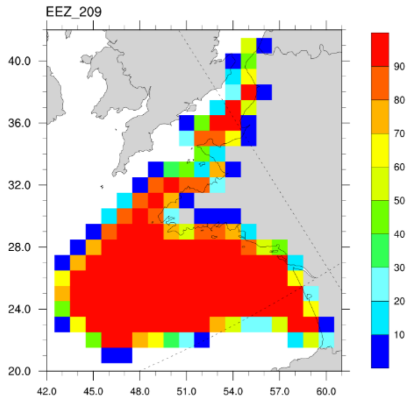
Belgian Exclusive Economic Zone




Danish Exclusive Economic Zone




French Exclusive Economic Zone




German Exclusive Economic Zone

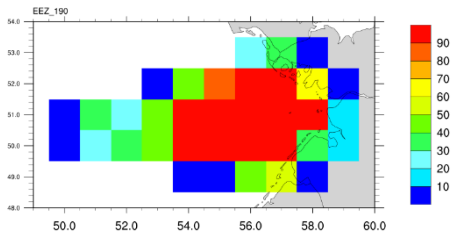
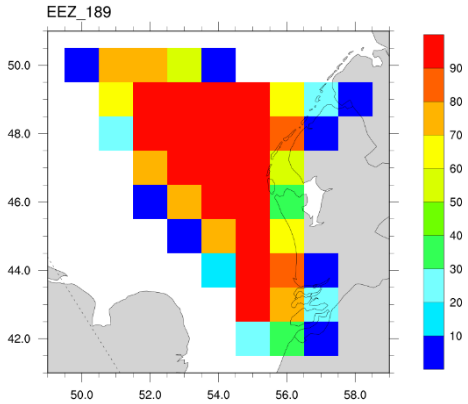
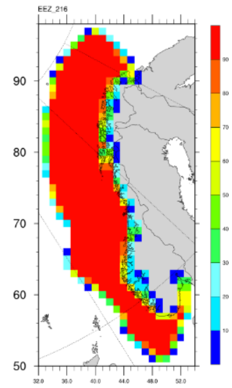



**Figure 2.2** Percentage of the EMEP grids in each of the selected EEZs.

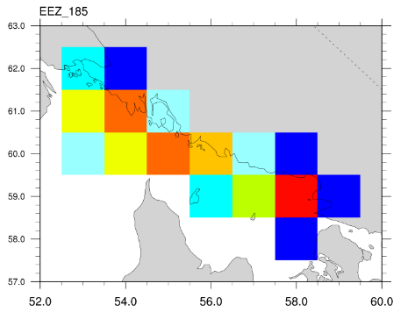
Dutch Exclusive Economic Zone




Norwegian Exclusive Economic Zone



Swedish Exclusive Economic Zone




United Kingdom Exclusive Economic Zone

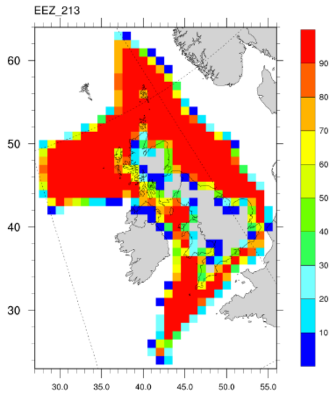



**Figure 2.2 (cont.)** Percentage of the EMEP grids in each of the selected EEZs.

## 3. Estimation of emissions for the years 2005, 2020 and 2030

Emissions for the years 2005, 2020 and 2030 to be used as input for the EMEP MSC-W model calculations in the current project had to be specified. This task involved two parts: 1. calculations of emissions for which reductions are specified in Gothenburg Protocol and NEC Directive, and 2. Specification of remaining EMEP emissions, outside Gothenburg Protocol and NEC Directive.

### 3.1 Emissions specified by Gothenburg Protocol and NEC Directive

For emissions, the year 2005 was chosen as the reference year both in the Gothenburg Protocol and in the EU NEC Directive. The reductions of nitrogen oxides and ammonia emissions for the year 2020 and 2030, compared to 2005, were specified by OSPAR according to Gothenburg Protocol and NEC Directive as shown in Table 3.1. However, these reductions were specified as a percent of annual 2005 emissions. The question was how correct and up to date the emission numbers reported for 2005 emissions were. Therefore, as a first step the OSPAR Contracting Parties and then the HELCOM Contracting Parties were asked to check and correct their emissions for the reference year 2005.

Since the EMEP MSC-W model is using not only nitrogen oxides and ammonia emissions as input, but also $SO_2$, VOC and $PM_{2.5}$ emissions, the Contracting Parties were asked to check 2005 emission for these components as well, including the percentage reductions. These corrections for the year 2005 are shown in Table 3.2. There were no corrections for the percentage reductions for the years 2020 and 2030.

### 3.2 Emissions used by the EMEP MSC-W model

Not all EMEP sources, necessary to run the EMEP MSAC-W model are listed in Tables 3.1 and 3.2. Therefore, it was necessary to specify the remaining emission sources for the years 2005, 2020 and 2030, which serve as input for the MEP MSC-W model.

In our approach, the land-based anthropogenic emissions for remaining EMEP source are based on the ECLIPSE V5a baseline scenario (CLE), as this is one of the best consistent gridded emission dataset available for all years included in this study (2005, 2020 and 2030). The ECLIPSE V5a global emission data has a resolution of 0.5 deg × 0.5 deg (Amman, et al., 2013). The ECLIPSE V5a global emissions are available on the web:

http://www.iiasa.ac.at/web/home/research/researchPrograms/air/ECLIPSEv5a.html

**Table 3.1:** Reduction requirements according to EU NEC Directive for NOx and $NH_3$ (Annex II tables A and B of EU NEC Directive), according to Annex 10.

| Member State | NOx-reduction compared to 2005 | | NH3-reduction compared to 2005 | |
|---|---|---|---|---|
| | For any year from 2020 to 2029 | For any year from 2030 | For any year from 2020 to 2029 | For any year from 2030 |
| Belgium | 41 | 59 | 2 | 13 |
| Bulgaria | 41 | 58 | 3 | 12 |
| Czech Republic | 35 | 64 | 7 | 22 |
| Denmark | 56 | 68 | 24 | 24 |
| Germany | 39 | 65 | 5 | 29 |
| Estonia | 18 | 30 | 1 | 1 |
| Greece | 31 | 55 | 7 | 10 |
| Spain | 41 | 62 | 3 | 16 |
| France | 50 | 69 | 4 | 13 |
| Croatia | 31 | 57 | 1 | 25 |
| Ireland | 49 | 69 | 1 | 5 |
| Italy | 40 | 65 | 5 | 16 |
| Cyprus | 44 | 55 | 10 | 20 |
| Latvia | 32 | 34 | 1 | 1 |
| Lithuania | 48 | 51 | 10 | 10 |
| Luxembourg | 43 | 83 | 1 | 22 |
| Hungary | 34 | 66 | 10 | 32 |
| Malta | 42 | 79 | 4 | 24 |
| Netherlands | 45 | 61 | 13 | 21 |
| Austria | 37 | 69 | 1 | 12 |
| Poland | 30 | 39 | 1 | 17 |
| Portugal | 36 | 63 | 7 | 15 |
| Rumania | 45 | 60 | 13 | 25 |
| Slovenia | 39 | 65 | 1 | 15 |
| Slovakia | 36 | 50 | 15 | 30 |

| Member State | NOx-reduction compared to 2005 | | NH3-reduction compared to 2005 | |
|---|---|---|---|---|
| | For any year from 2020 to 2029 | For any year from 2030 | For any year from 2020 to 2029 | For any year from 2030 |
| Finland | 35 | 47 | 20 | 20 |
| Sweden | 36 | 66 | 15 | 17 |
| UK | 55 | 73 | 8 | 16 |
| EU-28 | 42 | 63 | 6 | 19 |

**Table 3.2** Reduction requirements according to Gothenburg Protocol and reference emissions for 2005 corrected by OSPAR and HELCOM Contracted Parties. Values that have been corrected by Contracting Parties recently are included in red (see text). Unit: ktonnes, (emissions of $SO_x$ and $NO_x$ are given as ktonnes $SO_2$ and ktonnes $NO_2$, respectively.)

| Country | $SO_2$ | | $NO_x$ | | $NH_3$ | | VOC | | $PM_{2.5}$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | % | 2005 | % | 2005 | % | 2005 | % | 2005 | % |
| Belarus | 79 | 20 | 171 | 21 | 136 | 7 | 349 | 15 | 46 | 10 |
| Croatia | 63 | 55 | 81 | 31 | 40 | 1 | 101 | 34 | 13 | 18 |
| Norway | 24 | 10 | **205** | 23 | **27** | 8 | **230** | 40 | **39** | 30 |
| Switzerland | 17 | 21 | 94 | 41 | 64 | 8 | 103 | 30 | 11 | 26 |
| Austria | 27 | 26 | 231 | 37 | 63 | 1 | 162 | 21 | 22 | 20 |
| Belgium | **142** | 43 | **319** | 41 | **68** | 2 | **178** | 21 | **36** | 20 |
| Bulgaria | 777 | 78 | 154 | 41 | 60 | 3 | 158 | 21 | 44 | 20 |
| Cyprus | 38 | 83 | 21 | 44 | 5,8 | 10 | 14 | 45 | 2,9 | 46 |
| Czech_Rep. | 219 | 45 | 286 | 35 | 82 | 7 | 182 | 18 | 22 | 17 |
| Denmark | **26.13** | 35 | **202.78** | 56 | **87.56** | 24 | **148.7** | 35 | **25.96** | 33 |
| Estonia | 76 | 32 | 36 | 18 | 9,8 | 1 | 41 | 10 | 20 | 15 |
| Finland | 69 | 30 | 177 | 35 | 39 | 20 | 131 | 35 | 36 | 30 |
| France | 467 | 55 | 1430 | 50 | 661 | 4 | 1232 | 43 | 304 | 27 |
| Germany | 517 | 21 | **1574.6** | 39 | **678.1** | 5 | 1143 | 13 | 121 | 26 |
| Greece | 542 | 74 | 419 | 31 | 68 | 7 | 222 | 54 | 56 | 35 |
| Hungary | 129 | 46 | 203 | 34 | 80 | 10 | 177 | 30 | 31 | 13 |
| Ireland | 71 | 65 | 127 | 49 | 109 | 1 | 57 | 25 | 11 | 18 |
| Italy | 403 | 35 | 1212 | 40 | 416 | 5 | 1286 | 35 | 166 | 10 |
| Latvia | 6,7 | 8 | 37 | 32 | 16 | 1 | 73 | 27 | 27 | 16 |
| Lithuania | **31** | 55 | **60** | 48 | **32** | 10 | **75** | 32 | **20** | 20 |
| Luxemburg | 2,5 | 34 | 19 | 43 | 5 | 1 | 9,8 | 29 | 3,1 | 15 |
| Malta | 11 | 77 | 9,3 | 42 | 1,6 | 4 | 3,3 | 23 | 1,3 | 25 |
| Netherlands | 65 | 28 | 370 | 45 | 141 | 13 | 182 | 8 | 21 | 37 |
| Poland | 1224 | 59 | 866 | 30 | 270 | 1 | 593 | 25 | 133 | 16 |
| Portugal | **178** | 63 | **259** | 36 | **49** | 7 | **210** | 18 | **57** | 15 |
| Romania | 643 | 77 | 309 | 45 | 199 | 13 | 425 | 25 | 106 | 28 |

| Country | $SO_2$ | | $NO_x$ | | $NH_3$ | | VOC | | $PM_{2.5}$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | % | 2005 | % | 2005 | % | 2005 | % | 2005 | % |
| Slovakia | 89 | 57 | 102 | 36 | 29 | 15 | 73 | 18 | 37 | 36 |
| Slovenia | 40 | 63 | 47 | 39 | 18 | 1 | 37 | 23 | 14 | 25 |
| Spain | 1282 | 67 | 1292 | 41 | 365 | 3 | 809 | 22 | 93 | 15 |
| Sweden | 36 | 22 | **185** | 36 | **63** | 15 | **215** | 25 | **27** | 19 |
| UK | 706 | 59 | 1580 | 55 | 307 | 8 | 1088 | 32 | 81 | 30 |

For the sources included in the Gothenburg Protocol and NEC Directive the ECLIPSE V5a gridded emissions were scaled for 2005 in order to match national totals as specified in Table 3.2 exactly. In order to match the national emission reduction commitments set out in the Gothenburg Protocol and NEC Directive the ECLIPSE V5a gridded emissions were scaled also for the years 2020 and 2030, for the countries which were involved in those two agreements. For the remaining countries (outside the Gothenburg Protocol and NEC Directive) and remaining areas within the EMEP modelling domain the ECLIPSE V5a emissions of the respective years have been used directly.

As the estimates of shipping emissions for the future are rather uncertain, we used ECLIPSE shipping emission data for 2005 in all model runs. Alternatively we could have used a more recent (2014) data set, which has been made available to us by the Finnish Meteorological Institute (FMI). However, we considered the consistency between shipping and land-based emissions as important and decided therefore not to mix shipping emissions and land-based emissions for different years. For later studies it is likely that we will have additional data sets from FMI (valid for 2015, 2020, and 2030), produced in the framework of the EnviSuM project (funded by the *Interreg* Baltic Sea Region Programme). We will then be able to combine the FMI data for shipping with Eclipse V5a land-based data for the same years, to achieve better consistency.

For the emissions from forest fires and additional biomass burning we have used an 11 years' average (2005-2015) of daily emission estimates of the Fire Inventory from NCAR (FINN), which can be found in Wiedinmyer et al., (2011) .

The national emission totals used in the EMEP MSC-W model simulations performed in this project can be found in Table 3.3 - for the year 2005, Table 3.4 - for the year 2020 and in Table 3.5 – for the year 2030.

**Table 3.3** The national emission totals for the year 2005 used in the EMEP MSC-W model simulations. . Unit: ktonnes, (emissions of $SO_x$ and $NO_x$ are given as ktonnes $SO_2$ and ktonnes $NO_2$, respectively).

| Source | $SO_x$ | $NO_x$ | CO | VOC | $NH_3$ | $PM_{2.5}$ | $PM_{co}$ |
|---|---|---|---|---|---|---|---|
| AL | 18.9 | 19.4 | 80.8 | 33.9 | 17.3 | 9.3 | 2.0 |
| AT | 27.0 | 231.0 | 552.2 | 162.0 | 63.0 | 22.0 | 12.1 |
| BE | 142.0 | 319.0 | 573.0 | 178.0 | 68.0 | 36.0 | 19.4 |
| BG | 777.0 | 154.0 | 420.6 | 158.0 | 60.0 | 44.0 | 11.1 |
| DK | 26.1 | 202.8 | 567.0 | 148.7 | 87.6 | 26.0 | 11.5 |
| FI | 69.0 | 177.0 | 537.8 | 131.0 | 39.0 | 36.0 | 13.4 |
| FR | 467.0 | 1430.0 | 3215.3 | 1232.0 | 661.0 | 304.0 | 177.6 |
| GR | 542.0 | 419.0 | 836.4 | 222.0 | 68.0 | 56.0 | 23.3 |
| HU | 129.0 | 203.0 | 630.5 | 177.0 | 80.0 | 31.0 | 12.5 |
| IS | 0.7 | 6.2 | 153.0 | 6.4 | 2.7 | 0.7 | 0.3 |
| IE | 71.0 | 127.0 | 211.9 | 57.0 | 109.0 | 11.0 | 6.4 |
| IT | 403.0 | 1212.0 | 3150.7 | 1286.0 | 416.0 | 166.0 | 51.4 |
| LU | 2.5 | 19.0 | 53.7 | 9.8 | 5.0 | 3.1 | 1.0 |
| NL | 65.0 | 370.0 | 818.2 | 182.0 | 141.0 | 21.0 | 12.9 |
| NO | 24.0 | 205.0 | 778.6 | 230.0 | 27.0 | 39.0 | 8.0 |
| PL | 1224.1 | 866.0 | 2711.8 | 593.0 | 270.0 | 133.0 | 70.5 |
| PT | 174.2 | 243.5 | 557.7 | 197.7 | 48.1 | 54.5 | 23.7 |
| RO | 643.0 | 309.0 | 1325.6 | 425.0 | 199.0 | 106.0 | 34.3 |
| ES | 1252.5 | 1261.1 | 1760.8 | 777.6 | 360.4 | 90.1 | 65.2 |
| SE | 36.0 | 185.0 | 683.7 | 215.0 | 63.0 | 27.0 | 14.9 |
| CH | 17.0 | 94.0 | 494.5 | 103.0 | 64.0 | 11.0 | 5.5 |
| TR | 1456.7 | 847.0 | 2594.9 | 692.6 | 416.5 | 349.8 | 108.1 |
| GB | 706.0 | 1580.1 | 2712.9 | 1088.0 | 307.0 | 81.0 | 57.5 |

| Source | $SO_x$ | $NO_x$ | CO | VOC | $NH_3$ | $PM_{2.5}$ | $PM_{co}$ |
|---|---|---|---|---|---|---|---|
| BY | 79.0 | 171.0 | 469.9 | 349.0 | 136.0 | 46.0 | 18.1 |
| UA | 1073.4 | 874.9 | 3446.8 | 594.4 | 253.1 | 391.6 | 194.5 |
| MD | 7.4 | 27.5 | 89.9 | 30.9 | 16.5 | 10.5 | 4.6 |
| EE | 76.0 | 36.0 | 115.9 | 41.0 | 9.8 | 20.0 | 8.0 |
| LV | 6.7 | 37.0 | 183.1 | 73.0 | 16.0 | 27.0 | 4.4 |
| LT | 31.0 | 60.0 | 212.4 | 75.0 | 32.0 | 20.0 | 6.2 |
| CZ | 219.0 | 286.0 | 638.4 | 182.0 | 82.0 | 22.0 | 14.4 |
| SK | 89.0 | 102.0 | 322.4 | 73.0 | 29.0 | 37.0 | 26.4 |
| SI | 40.0 | 47.0 | 236.5 | 37.0 | 18.0 | 14.0 | 3.1 |
| HR | 63.0 | 81.0 | 162.0 | 101.0 | 40.0 | 13.0 | 4.8 |
| BA | 224.9 | 33.3 | 110.8 | 44.8 | 18.4 | 20.4 | 16.9 |
| CS | 454.5 | 163.3 | 630.5 | 168.3 | 64.1 | 70.9 | 47.8 |
| MK | 104.1 | 35.4 | 61.6 | 23.2 | 8.5 | 12.2 | 9.8 |
| KZ | 1827.5 | 477.7 | 1235.8 | 498.6 | 123.4 | 119.1 | 61.8 |
| GE | 4.9 | 25.1 | 205.4 | 58.9 | 42.1 | 19.1 | 3.0 |
| CY | 38.0 | 21.0 | 26.4 | 14.0 | 5.8 | 2.9 | 1.9 |
| AM | 1.5 | 14.3 | 84.4 | 24.0 | 11.2 | 3.9 | 1.3 |
| MT | 11.0 | 9.3 | 5.9 | 3.3 | 1.6 | 1.3 | 0.4 |
| DE | 517.0 | 1574.6 | 3790.5 | 1143.0 | 678.1 | 121.0 | 82.3 |
| RU | 5370.9 | 4419.2 | 12065.7 | 4472.1 | 786.4 | 1331.4 | 691.8 |
| EGYP | 367.5 | 464.2 | 1091.4 | 395.3 | 450.7 | 249.1 | 85.7 |
| KG | 24.9 | 26.4 | 128.3 | 28.0 | 27.8 | 8.3 | 3.4 |
| AZ | 111.5 | 99.8 | 331.9 | 167.0 | 47.0 | 16.8 | 4.0 |
| AFGH | 67.6 | 42.7 | 771.1 | 171.7 | 69.6 | 86.3 | 8.1 |
| CHIN | 239.1 | 140.0 | 1963.2 | 331.8 | 254.1 | 174.3 | 41.7 |

| Source | $SO_x$ | $NO_x$ | CO | VOC | $NH_3$ | $PM_{2.5}$ | $PM_{co}$ |
|---|---|---|---|---|---|---|---|
| FSUA | 553.1 | 482.0 | 1463.9 | 359.2 | 264.4 | 89.8 | 27.7 |
| INDI | 26.6 | 38.3 | 352.0 | 75.1 | 77.9 | 48.8 | 13.1 |
| ISRA | 418.4 | 211.7 | 510.7 | 155.4 | 29.6 | 38.8 | 35.0 |
| MIDE | 830.8 | 1487.8 | 4827.7 | 1290.0 | 282.5 | 552.2 | 166.3 |
| MONG | 1.9 | 4.1 | 7.5 | 1.9 | 4.8 | 0.6 | 0.5 |
| NAFR | 459.0 | 734.6 | 1979.9 | 1045.9 | 327.6 | 290.0 | 100.7 |
| OAFR | 0.1 | 0.2 | 3.6 | 0.6 | 0.1 | 0.3 | 0.0 |
| PAKI | 58.9 | 67.5 | 1381.6 | 194.2 | 193.3 | 176.2 | 53.8 |

**Table 3.4** The national emission totals for the year 2020 used in the EMEP MSC-W model simulations. Unit: ktonnes, (emissions of $SO_x$ and $NO_x$ are given as ktonnes $SO_2$ and ktonnes $NO_2$, respectively.)

| Source | $SO_x$ | $NO_x$ | CO | VOC | $NH_3$ | $PM_{2.5}$ | $PM_{co}$ |
|---|---|---|---|---|---|---|---|
| AL | 12.6 | 23.6 | 66.3 | 27.6 | 19.9 | 9.1 | 2.6 |
| AT | 20.0 | 145.5 | 393.5 | 128.0 | 62.4 | 17.6 | 13.6 |
| BE | 80.9 | 188.2 | 941.5 | 140.6 | 66.6 | 28.8 | 15.4 |
| BG | 170.9 | 90.9 | 215.5 | 124.8 | 58.2 | 35.2 | 10.3 |
| DK | 17.0 | 89.2 | 244.0 | 96.7 | 66.5 | 17.4 | 10.8 |
| FI | 48.3 | 115.1 | 382.5 | 85.2 | 31.2 | 25.2 | 11.5 |
| FR | 210.2 | 715.0 | 1779.0 | 702.3 | 634.5 | 221.9 | 186.9 |
| GR | 140.9 | 289.1 | 549.4 | 102.1 | 63.2 | 36.4 | 11.9 |
| HU | 69.7 | 134.0 | 239.3 | 123.9 | 72.0 | 27.0 | 11.8 |
| IS | 0.5 | 2.8 | 161.9 | 4.1 | 3.2 | 0.6 | 0.3 |
| IE | 24.9 | 64.8 | 530.8 | 42.8 | 107.9 | 9.0 | 6.5 |
| IT | 262.0 | 727.2 | 1866.9 | 835.9 | 395.2 | 149.4 | 51.4 |
| LU | 1.7 | 10.8 | 16.0 | 7.0 | 5.0 | 2.6 | 1.0 |
| NL | 46.8 | 203.5 | 568.7 | 167.4 | 122.7 | 13.2 | 14.0 |
| NO | 21.6 | 157.9 | 403.3 | 138.0 | 24.8 | 27.3 | 8.0 |
| PL | 501.9 | 606.2 | 2449.2 | 444.7 | 267.3 | 111.7 | 70.2 |
| PT | 64.2 | 155.2 | 317.9 | 161.9 | 44.4 | 46.5 | 19.5 |
| RO | 147.9 | 170.0 | 1057.4 | 318.8 | 173.1 | 76.3 | 30.4 |
| ES | 414.9 | 742.7 | 1517.9 | 606.7 | 348.8 | 77.2 | 66.2 |
| SE | 28.1 | 118.4 | 419.3 | 161.3 | 53.6 | 21.9 | 16.6 |
| CH | 13.4 | 55.5 | 257.8 | 72.1 | 58.9 | 8.1 | 5.1 |
| TR | 2081.5 | 1108.0 | 2570.6 | 583.4 | 499.7 | 454.7 | 206.9 |
| GB | 289.5 | 711.0 | 1350.6 | 739.8 | 282.4 | 56.7 | 48.7 |

| Source | $SO_x$ | $NO_x$ | CO | VOC | $NH_3$ | $PM_{2.5}$ | $PM_{co}$ |
|---|---|---|---|---|---|---|---|
| BY | 63.2 | 135.1 | 460.4 | 296.7 | 126.5 | 41.4 | 19.8 |
| UA | 533.6 | 663.8 | 3111.2 | 375.8 | 280.9 | 314.8 | 150.9 |
| MD | 3.1 | 17.2 | 73.1 | 25.3 | 16.9 | 11.5 | 4.4 |
| EE | 51.7 | 29.5 | 90.4 | 36.9 | 9.7 | 17.0 | 2.9 |
| LV | 6.2 | 25.2 | 105.3 | 53.3 | 15.8 | 22.7 | 4.2 |
| LT | 14.0 | 31.2 | 139.3 | 51.0 | 28.8 | 16.0 | 5.4 |
| CZ | 120.5 | 185.9 | 532.7 | 149.2 | 76.3 | 18.3 | 13.6 |
| SK | 38.3 | 65.3 | 257.0 | 59.9 | 24.7 | 23.7 | 8.4 |
| SI | 14.8 | 28.7 | 175.6 | 28.5 | 17.8 | 10.5 | 2.1 |
| HR | 28.4 | 55.9 | 113.8 | 66.7 | 39.6 | 10.7 | 4.8 |
| BA | 36.2 | 24.1 | 108.3 | 29.7 | 24.5 | 11.7 | 6.0 |
| CS | 85.8 | 98.5 | 516.5 | 121.1 | 49.3 | 54.5 | 23.2 |
| MK | 19.0 | 25.0 | 43.7 | 14.8 | 8.4 | 7.3 | 3.3 |
| KZ | 1775.1 | 496.5 | 2147.8 | 771.4 | 140.7 | 137.5 | 58.6 |
| GE | 10.7 | 72.4 | 506.2 | 110.2 | 51.8 | 20.1 | 4.0 |
| CY | 6.5 | 11.8 | 11.2 | 7.7 | 5.2 | 1.6 | 0.7 |
| AM | 1.1 | 8.2 | 48.6 | 18.8 | 15.7 | 4.0 | 1.7 |
| MT | 2.5 | 5.4 | 2.3 | 2.5 | 1.5 | 1.0 | 0.2 |
| DE | 408.4 | 960.5[1] | 3004.4 | 994.5[1] | 644.2 | 89.5 | 83.9 |
| RU | 3140.2 | 4408.9 | 13668.9 | 3795.0 | 697.1 | 1599.6 | 704.0 |
| EGYP | 182.5 | 611.5 | 1876.7 | 530.8 | 361.0 | 343.1 | 113.7 |

[1] *These values were obtained by applying the reduction requirement to the German emissions of 2005 as shown in Table 3.2 without considering that emissions of nitrogen oxides and non-methane volatile organic compounds (NMVOC) from activities falling under the 2014 Nomenclature for Reporting (NFR), as provided by the LRTAP Convention categories 3B (manure management) and 3D (agricultural soils), are not accounted for the purpose of complying to the NEC Directive (EU 2016/2284) [see art.4 (3.d)] and that therefore the 2020 emissions for NOx and NMVOC from Germany could be slightly higher and could amount, for example, to 1005.2 ktonne or 999.0 ktonne assuming NOx and NMVOC emissions from 3B and 3D remain constant from 2015 to 2020.*

| Source | $SO_x$ | $NO_x$ | CO | VOC | $NH_3$ | $PM_{2.5}$ | $PM_{co}$ |
|---|---|---|---|---|---|---|---|
| KG | 21.4 | 34.9 | 249.8 | 49.0 | 34.8 | 10.6 | 3.7 |
| AZ | 67.0 | 221.3 | 799.0 | 420.2 | 59.8 | 33.1 | 6.2 |
| AFGH | 16.6 | 40.9 | 729.7 | 139.9 | 63.6 | 60.9 | 9.2 |
| CHIN | 323.8 | 281.6 | 2257.0 | 412.2 | 455.8 | 194.2 | 55.9 |
| FSUA | 711.8 | 856.6 | 4568.2 | 924.9 | 324.5 | 119.2 | 30.3 |
| INDI | 60.5 | 66.5 | 413.2 | 104.6 | 110.5 | 60.3 | 16.8 |
| ISRA | 405.2 | 185.7 | 545.9 | 151.8 | 34.3 | 249.2 | 635.4 |
| MIDE | 635.8 | 2068.8 | 6442.5 | 1253.5 | 568.4 | 711.8 | 285.4 |
| MONG | 1.6 | 4.0 | 3.7 | 1.1 | 6.3 | 0.5 | 0.3 |
| NAFR | 334.4 | 951.2 | 2587.5 | 1119.0 | 263.7 | 382.5 | 121.3 |
| OAFR | 0.1 | 0.5 | 8.0 | 1.3 | 0.1 | 0.6 | 0.0 |
| PAKI | 94.9 | 107.6 | 1613.2 | 199.0 | 262.9 | 262.9 | 122.6 |

**Table 3.5** The national emission totals for the year 2030 used in the EMEP MSC-W model simulations. Unit: ktonnes, (emissions of $SO_x$ and $NO_x$ are given as ktonnes $SO_2$ and ktonnes $NO_2$, respectively.)

| Source | $SO_x$ | $NO_x$ | CO | VOC | $NH_3$ | $PM_{2.5}$ | $PM_{co}$ |
|---|---|---|---|---|---|---|---|
| AL | 17.6 | 23.5 | 67.1 | 24.6 | 22.1 | 8.9 | 2.9 |
| AT | 15.9 | 71.6 | 327.6 | 103.7 | 55.4 | 11.9 | 12.5 |
| BE | 48.3 | 130.8 | 654.7 | 115.7 | 59.2 | 22.0 | 18.7 |
| BG | 93.3 | 64.7 | 157.4 | 91.6 | 52.8 | 26.0 | 9.2 |
| DK | 9.4 | 57.9 | 255.7 | 69.3 | 63.1 | 11.3 | 10.5 |
| FI | 45.5 | 93.8 | 272.5 | 68.1 | 31.2 | 23.8 | 11.4 |
| FR | 107.4 | 443.3 | 1179.4 | 591.4 | 575.1 | 130.7 | 189.9 |
| GR | 65.0 | 188.5 | 264.9 | 84.4 | 61.2 | 28.0 | 11.8 |
| HU | 34.8 | 69.0 | 238.0 | 74.3 | 54.4 | 14.0 | 11.7 |
| IS | 0.6 | 2.1 | 38.5 | 3.5 | 3.4 | 0.6 | 0.4 |
| IE | 10.7 | 39.4 | 105.0 | 38.8 | 103.6 | 6.5 | 6.5 |
| IT | 116.9 | 424.2 | 1594.2 | 694.5 | 349.4 | 99.6 | 46.8 |
| LU | 1.3 | 3.2 | 14.6 | 5.7 | 3.9 | 1.9 | 1.1 |
| NL | 30.6 | 144.3 | 434.4 | 154.7 | 111.4 | 11.6 | 12.9 |
| NO | 25.9 | 111.2 | 283.8 | 101.4 | 35.5 | 34.0 | 8.8 |
| PL | 367.2 | 528.3 | 1640.9 | 438.8 | 224.1 | 55.9 | 66.3 |
| PT | 29.5 | 88.7 | 294.7 | 119.6 | 40.8 | 25.7 | 20.6 |
| RO | 77.2 | 123.6 | 661.9 | 233.8 | 149.3 | 44.5 | 30.0 |
| ES | 151.6 | 475.4 | 1140.0 | 472.4 | 302.3 | 45.3 | 66.6 |
| SE | 28.1 | 62.9 | 291.2 | 137.6 | 52.3 | 21.9 | 16.5 |
| CH | 7.4 | 36.2 | 189.6 | 70.1 | 54.1 | 6.4 | 7.0 |
| TR | 2315.9 | 1291.6 | 2598.3 | 545.2 | 583.6 | 507.0 | 249.1 |
| GB | 84.7 | 426.6 | 1049.8 | 663.7 | 257.9 | 43.7 | 47.8 |

| Source | $SO_x$ | $NO_x$ | CO | VOC | $NH_3$ | $PM_{2.5}$ | $PM_{co}$ |
|---|---|---|---|---|---|---|---|
| BY | 87.1 | 186.3 | 449.0 | 144.5 | 170.1 | 71.7 | 21.9 |
| UA | 543.7 | 704.5 | 4069.0 | 339.9 | 292.0 | 396.5 | 187.7 |
| MD | 3.9 | 16.4 | 66.0 | 22.3 | 17.4 | 13.7 | 4.8 |
| EE | 24.3 | 25.2 | 81.5 | 29.5 | 9.7 | 11.8 | 2.8 |
| LV | 3.6 | 24.4 | 86.2 | 45.3 | 15.8 | 15.4 | 3.6 |
| LT | 12.4 | 29.4 | 104.4 | 39.7 | 28.8 | 12.8 | 4.9 |
| CZ | 74.5 | 103.0 | 290.7 | 91.0 | 64.0 | 8.8 | 12.8 |
| SK | 16.0 | 51.0 | 195.4 | 49.6 | 20.3 | 18.9 | 7.6 |
| SI | 3.2 | 16.5 | 113.7 | 17.4 | 15.3 | 5.6 | 2.2 |
| HR | 10.7 | 34.8 | 86.2 | 52.5 | 30.0 | 5.9 | 4.4 |
| BA | 58.5 | 26.5 | 72.3 | 25.4 | 24.8 | 12.8 | 7.3 |
| CS | 102.3 | 87.8 | 421.6 | 101.2 | 46.5 | 56.3 | 30.1 |
| MK | 17.3 | 20.4 | 31.4 | 11.4 | 7.0 | 6.6 | 3.1 |
| KZ | 1886.9 | 406.6 | 1134.0 | 643.1 | 150.3 | 134.1 | 61.6 |
| GE | 12.7 | 89.1 | 553.5 | 110.6 | 56.4 | 15.3 | 4.2 |
| CY | 2.7 | 9.4 | 9.2 | 7.0 | 4.6 | 0.9 | 0.7 |
| AM | 1.2 | 8.3 | 45.3 | 18.0 | 17.9 | 4.2 | 1.9 |
| MT | 0.6 | 2.0 | 1.6 | 2.4 | 1.2 | 0.6 | 0.2 |
| DE | 217.2 | 551.1[2] | 2482.1 | 823.0[2] | 481.4 | 69.0 | 76.5 |
| RU | 3800.4 | 3872.8 | 10540.5 | 3111.2 | 748.4 | 1710.2 | 683.2 |
| EGYP | 204.1 | 701.8 | 1699.1 | 453.7 | 398.2 | 334.2 | 94.1 |

[2] *These values were obtained by applying the reduction requirement to the German emissions of 2005 as shown in Table 3.2 without considering that emissions of nitrogen oxides and non-methane volatile organic compounds (NMVOC) from activities falling under the 2014 Nomenclature for Reporting (NFR), as provided by the LRTAP Convention categories 3B (manure management) and 3D (agricultural soils), are not accounted for the purpose of complying to the NEC Directive (EU 2016/2284) [see art.4 (3.d)] and that therefore the 2030 emissions for NOx and NMVOC from Germany could be slightly higher and could amount, for example, to 625.5 ktonne or 832.8 ktonne assuming NOx and NMVOC emissions from 3B and 3D remain constant from 2015 to 2030.*

| Source | $SO_x$ | $NO_x$ | CO | VOC | $NH_3$ | $PM_{2.5}$ | $PM_{co}$ |
|---|---|---|---|---|---|---|---|
| KG | 21.1 | 36.5 | 245.2 | 51.5 | 38.2 | 11.3 | 4.0 |
| AZ | 85.0 | 267.4 | 950.4 | 542.0 | 66.8 | 49.6 | 7.9 |
| AFGH | 21.6 | 39.4 | 627.0 | 119.9 | 73.8 | 69.8 | 11.8 |
| CHIN | 181.4 | 214.7 | 1407.3 | 337.1 | 537.6 | 132.4 | 53.3 |
| FSUA | 835.4 | 911.2 | 4491.2 | 988.5 | 350.2 | 149.4 | 33.5 |
| INDI | 60.9 | 97.1 | 382.2 | 115.9 | 128.4 | 45.4 | 11.0 |
| ISRA | 281.4 | 147.6 | 349.6 | 118.0 | 32.4 | 39.7 | 34.2 |
| MIDE | 858.5 | 2438.7 | 5689.7 | 1353.3 | 647.4 | 414.3 | 184.3 |
| MONG | 1.6 | 3.6 | 2.2 | 0.9 | 7.0 | 0.5 | 0.3 |
| NAFR | 331.3 | 984.1 | 2312.4 | 954.1 | 293.8 | 355.7 | 98.1 |
| OAFR | 0.7 | 1.2 | 14.9 | 2.7 | 0.2 | 1.2 | 0.1 |
| PAKI | 130.0 | 150.0 | 1241.4 | 181.8 | 307.4 | 244.4 | 99.9 |

## 4. Calculation of nitrogen depositions

All nitrogen depositions presented here were computed in the domain presented in Fig. 1.1 (50 km resolution) with the latest version of the EMEP MSC-W model and latest available emissions. Annual depositions of oxidised and reduced nitrogen were computed for the years 2005, 2020, 2030, for OSPAR Region II and for all EEZs.

Since we do not know the meteorological conditions for the years 2020 and 2030, we have calculated weather normalised depositions for these years. In this approach, the EMEP MSC-W model was run for the 20 meteorological years from 1995 to 2014, repeatedly with emissions from the years 2005, 2020 and 2030. Then, the median value was calculated over 20 depositions from each meteorological year. To be consistent, the same approach was applied for the reference year 2005. In this way the effect of meteorological variability was significantly reduced for the reference year 2005 and for two projection years.

### 4.1 Annual nitrogen depositions in reference year 2005

Annual nitrogen depositions to the Main OSPAR Region II, calculated for each meteorological year with emissions for reference year 2005, are shown in Figure 4.1 for depositions of oxidised, reduced and total nitrogen. The normalised depositions of oxidised, reduced and total nitrogen in the reference year 2005 are: 444 ktonnes N, 214 ktonnes N and 663 ktonnes N, respectively.

Cumulative distributions of annual nitrogen depositions to the Main OSPAR Region II calculated with emissions from the reference year 2005 are presented in Figure 4.2. These distributions are quite regular with most of the value uniformly distributed around the median value. However, the minimum and maximum values are located relatively far away from the median depositions.

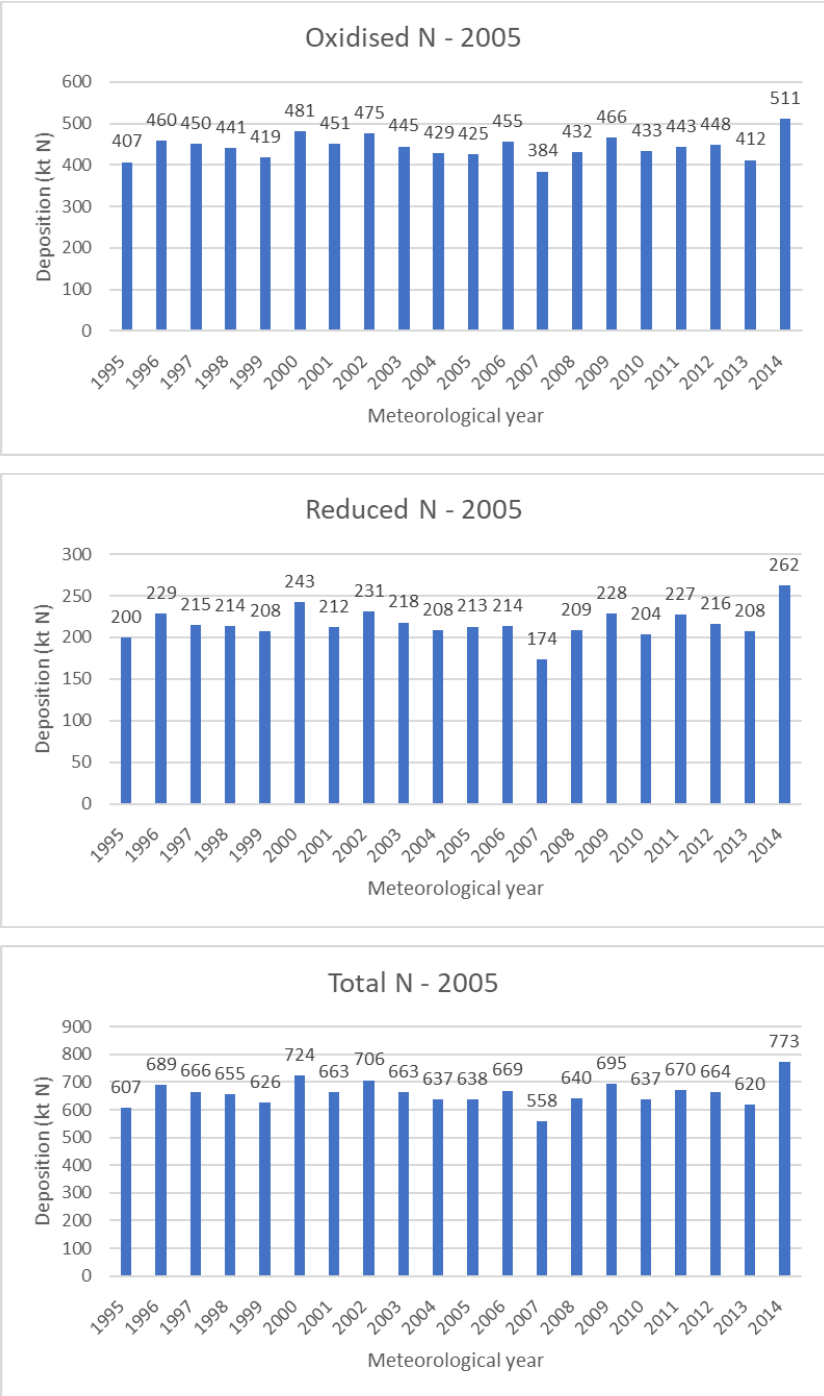



**Figure 4.1** Annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region II calculated for each meteorological year in the period 1995-2014, with emissions from the year 2005.

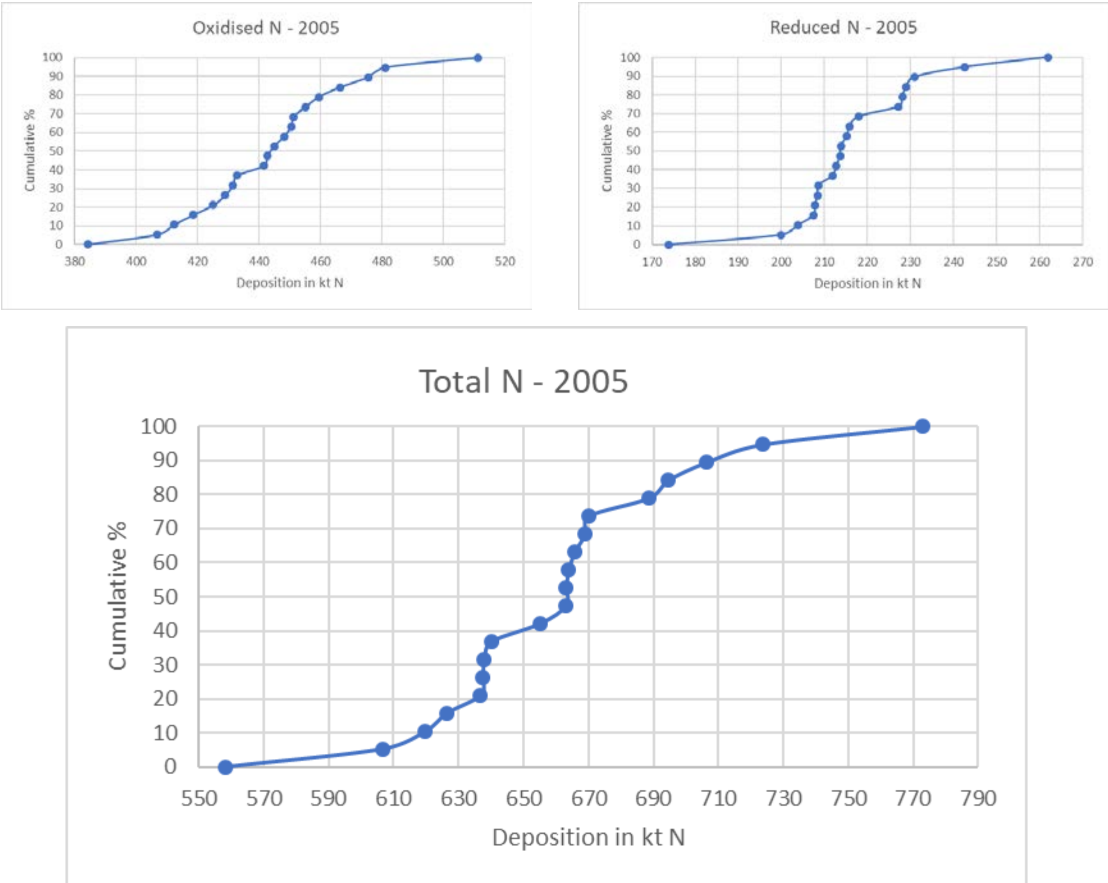



**Figure 4.2** Cumulative distribution of annual nitrogen depositions to the Main OSPAR Region II calculated for emissions from the reference year 2005 with each meteorological year.

Annual nitrogen depositions to selected EEZs, calculated for each meteorological year with emissions from reference year 2005, are shown in Tables 4.1, 4.2 and 4.3 for depositions of oxidised, reduced and total nitrogen, respectively. Maximum of nitrogen deposition can be noticed for the UK EEZ, followed by Norwegian and French EEZs. The minimum deposition in the reference year 2005 was calculated for the Belgian EEZ.

**Table 4.1** Annual depositions of oxidised nitrogen to selected EEZs, calculated for each meteorological year with emissions from reference year 2005.

| EEZ | Country | Minimum | Median | Maximum |
|---|---|---:|---:|---:|
| EEZ_188 | Belgium | 2.5 | 2.9 | 3.3 |
| EEZ_191 | Denmark | 46.2 | 53.2 | 64.9 |
| EEZ_209 | France | 80.0 | 93.5 | 105.7 |
| EEZ_190 | Germany | 35.3 | 38.2 | 46.1 |
| EEZ_189 | Netherlands | 44.5 | 47.0 | 55.2 |
| EEZ_216 | Norway | 192.0 | 215.8 | 238.1 |
| EEZ_185 | Sweden | 8.3 | 10.0 | 13.9 |
| EEZ_213 | UK | 214.0 | 249.3 | 303.1 |

**Table 4.2** Annual depositions of reduced nitrogen to selected EEZs, calculated for each meteorological year with emissions from reference year 2005.

| EEZ | Country | Minimum | Median | Maximum |
|---|---|---:|---:|---:|
| EEZ_188 | Belgium | 1.7 | 1.9 | 2.1 |
| EEZ_191 | Denmark | 2.6 | 26.6 | 35.4 |
| EEZ_209 | France | 50.7 | 56.8 | 63.9 |
| EEZ_190 | Germany | 17.7 | 20.4 | 26.1 |
| EEZ_189 | Netherlands | 22.0 | 25.5 | 31.2 |
| EEZ_216 | Norway | 48.9 | 62.4 | 77.3 |
| EEZ_185 | Sweden | 4.8 | 5.7 | 8.1 |

**Table 4.3** Annual depositions of total nitrogen to selected EEZs, calculated for each meteorological year with emissions from reference year 2005.

| EEZ | Country | Minimum | Median | Maximum |
|---|---|---|---|---|
| EEZ_188 | Belgium | 4.2 | 4.8 | 5.4 |
| EEZ_191 | Denmark | 68.0 | 80.1 | 100.3 |
| EEZ_209 | France | 130.7 | 151.5 | 169.5 |
| EEZ_190 | Germany | 53.7 | 58.2 | 71.8 |
| EEZ_189 | Netherlands | 66.5 | 72.5 | 86.2 |
| EEZ_216 | Norway | 242.9 | 278.6 | 312.6 |
| EEZ_185 | Sweden | 13.4 | 15.6 | 22.0 |
| EEZ_213 | UK | 314.1 | 372.1 | 455.9 |

### 4.2 Annual nitrogen depositions in the year 2020

Annual nitrogen depositions to the Main OSPAR Region II, calculated for each meteorological year with emissions for reference year 2020, are shown in Figure 4.5 for depositions of oxidised, reduced and total nitrogen. The normalised depositions of oxidised, reduced and total nitrogen in the year 2020 are: 316 ktonnes N, 197 ktonnes N and 516 ktonnes N, respectively. Compared to 2005, these values are 29%, 8% and 22% lower, respectively.

Cumulative distributions of annual nitrogen depositions to the Main OSPAR Region II calculated with emissions from the reference year 2020 are presented in Figure 4.6. As for 2005, probability distributions of the depositions are quite regular again with minima and maxima being relatively far away from the median values, especially for reduced nitrogen deposition.

Annual nitrogen depositions to selected EEZs, calculated for each meteorological year with emissions from reference year 2020, are shown in Tables 4.4, 4.5 and 4.6 for depositions of oxidised, reduced and total nitrogen, respectively. Compared to 2005, reduction in oxidised nitrogen deposition in 2020 is in the range 17% (Norwegian EEZ) – 36% (Belgian EEZ). For reduced nitrogen the reductions are lower, in the range 1% (French EEZ) – 14% (Swedish EEZ). For total nitrogen deposition the range is 16% (Norwegian EEZ) – 23% (Belgian EEZ).

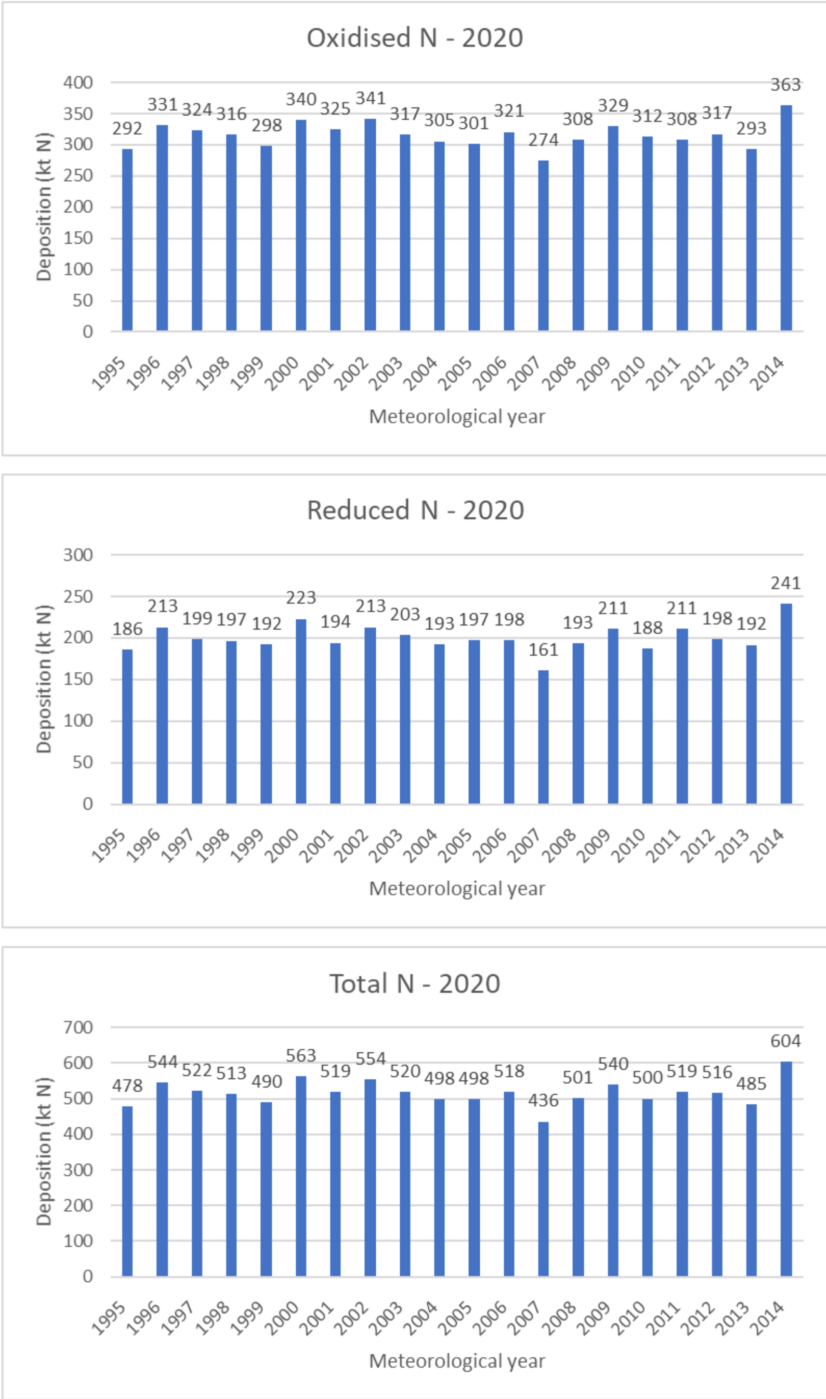



**Figure 4.5** Annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region II calculated for each meteorological year in the period 1995-2014, with emissions from the year 2020.

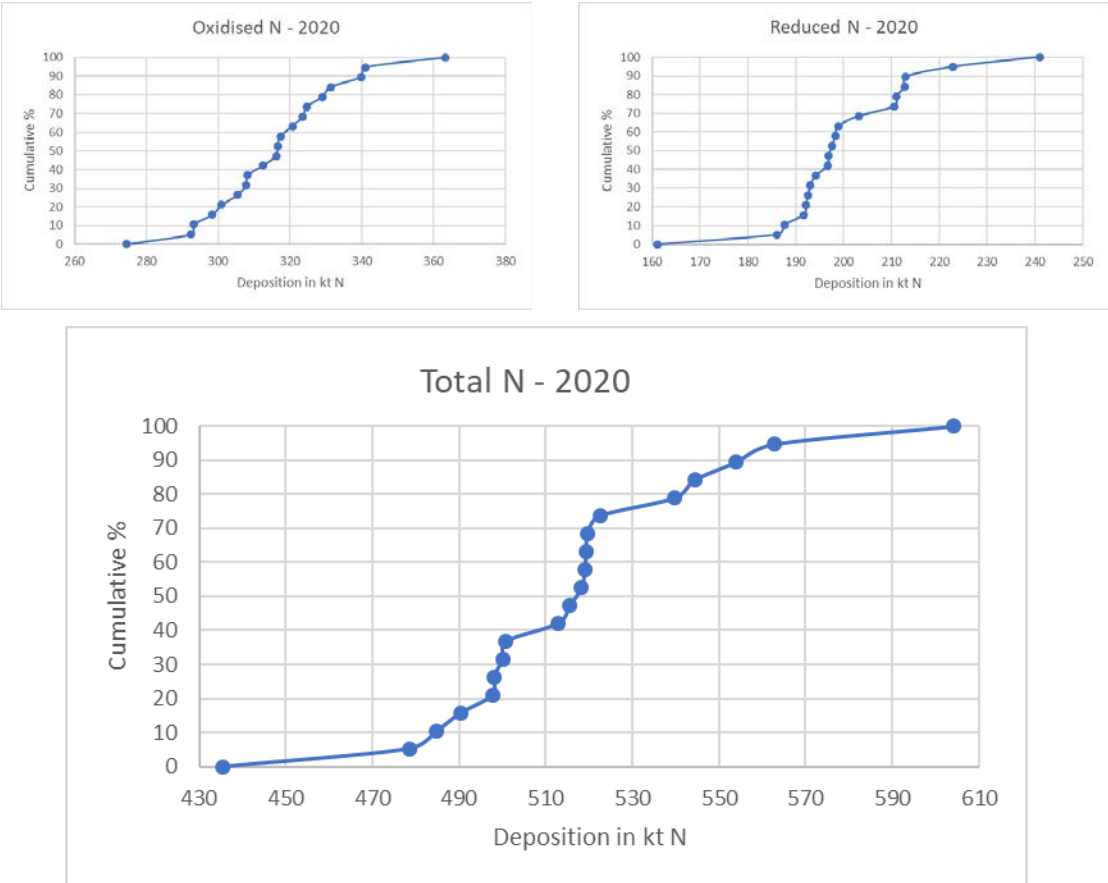



**Figure 4.6** Cumulative distribution of annual nitrogen depositions calculated to the Main OSPAR Region II for emissions from the year 2020 with each meteorological year.

**Table 4.4** Annual depositions of oxidised nitrogen to selected EEZs, calculated for each meteorological year with emissions from the year 2020.

| EEZ | Country | Minimum | Median | Maximum |
|---|---|---:|---:|---:|
| EEZ_188 | Belgium | 1.7 | 1.9 | 2.2 |
| EEZ_191 | Denmark | 34.1 | 39.3 | 47.3 |
| EEZ_209 | France | 59.5 | 69.3 | 75.7 |
| EEZ_190 | Germany | 25.9 | 28.1 | 34.5 |
| EEZ_189 | Netherlands | 28.8 | 31.7 | 37.3 |
| EEZ_216 | Norway | 159.0 | 178.5 | 194.3 |
| EEZ_185 | Sweden | 6.1 | 7.4 | 10.2 |

**Table 4.5** Annual depositions of reduced nitrogen to selected EEZs, calculated for each meteorological year with emissions from the year 2020.

| EEZ | Country | Minimum | Median | Maximum |
|---|---|---|---|---|
| EEZ_188 | Belgium | 1.7 | 1.8 | 2.0 |
| EEZ_191 | Denmark | 18.6 | 23.1 | 31.0 |
| EEZ_209 | France | 50.8 | 55.9 | 62.9 |
| EEZ_190 | Germany | 16.3 | 19.2 | 24.4 |
| EEZ_189 | Netherlands | 20.6 | 24.2 | 29.6 |
| EEZ_216 | Norway | 43.5 | 55.5 | 69.4 |
| EEZ_185 | Sweden | 4.2 | 4.9 | 7.0 |
| EEZ_213 | UK | 96.4 | 117.6 | 144.7 |

**Table 4.6** Annual depositions of total nitrogen to selected EEZs, calculated for each meteorological year with emissions from the year 2020.

| EEZ | Country | Minimum | Median | Maximum |
|---|---|---|---|---|
| EEZ_188 | Belgium | 3.3 | 3.7 | 4.2 |
| EEZ_191 | Denmark | 52.7 | 62.5 | 78.3 |
| EEZ_209 | France | 110.4 | 125.5 | 138.6 |
| EEZ_190 | Germany | 42.9 | 46.9 | 57.7 |
| EEZ_189 | Netherlands | 50.1 | 56.0 | 66.4 |
| EEZ_216 | Norway | 204.6 | 234.5 | 261.6 |
| EEZ_185 | Sweden | 10.6 | 12.2 | 17.1 |
| EEZ_213 | UK | 248.1 | 291.9 | 357.9 |

### 4.3 Annual nitrogen depositions in the year 2030

Annual nitrogen depositions to the Main OSPAR Region II, calculated for each meteorological year with emissions for reference year 2030, are shown in Figure 4.9 for depositions of oxidised, reduced and total nitrogen. The normalised depositions of oxidised, reduced and total nitrogen in the year 2030 are: 263 ktonnes N, 177 ktonnes N and 442 ktonnes N, respectively. Compared to 2005, these values are 41%, 17% and 33% lower, respectively.

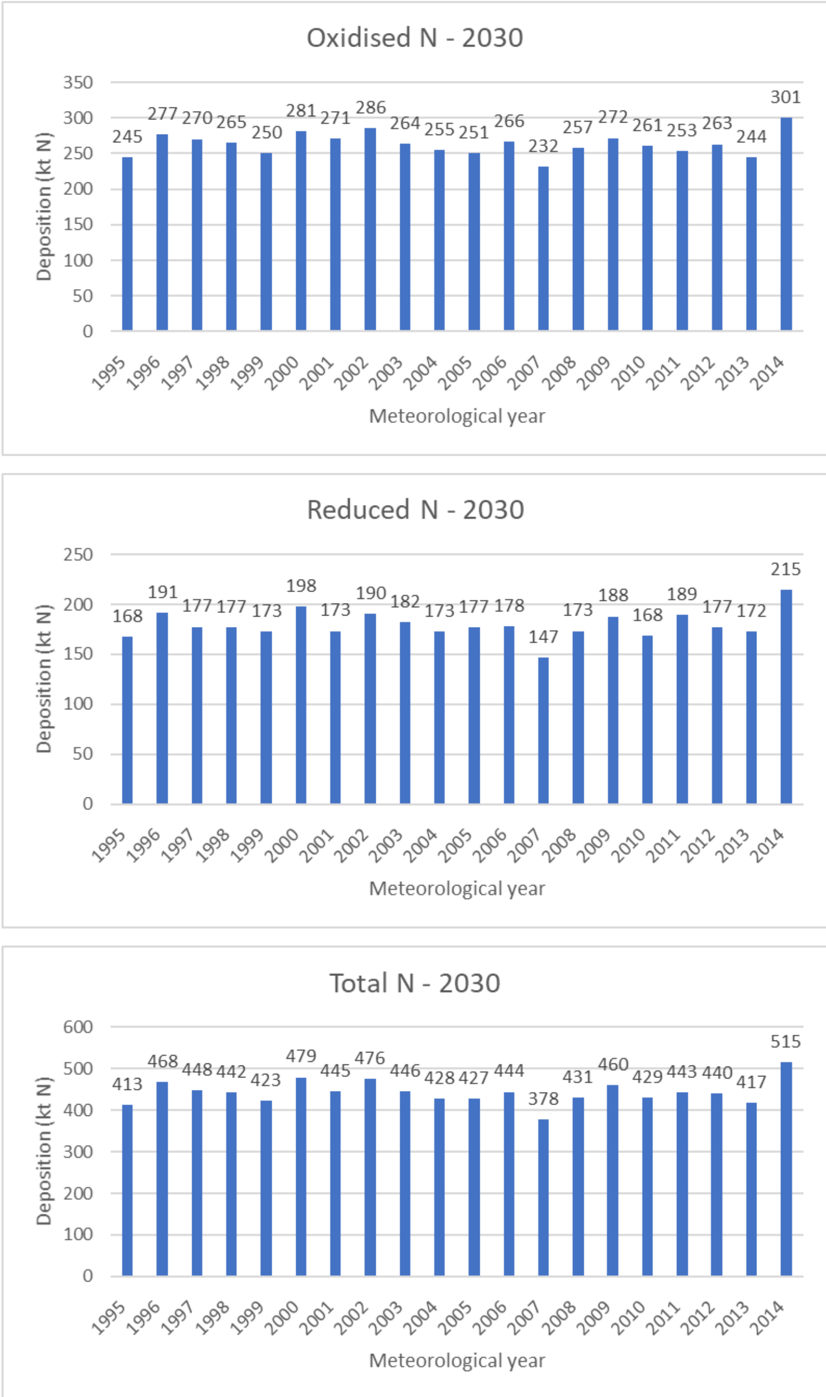



**Figure 4.9** Annual depositions of oxidised, reduced and total nitrogen to the Main OSPAR Region II calculated for each meteorological year in the period 1995-2014, with emissions from the year 2030.

Cumulative distributions of annual nitrogen depositions to the Main OSPAR Region II calculated with emissions from the reference year 2030 are presented in Figure 4.10. Also for 2030, probability distributions of the depositions are quite regular again with minima and maxima being relatively far away from the median.

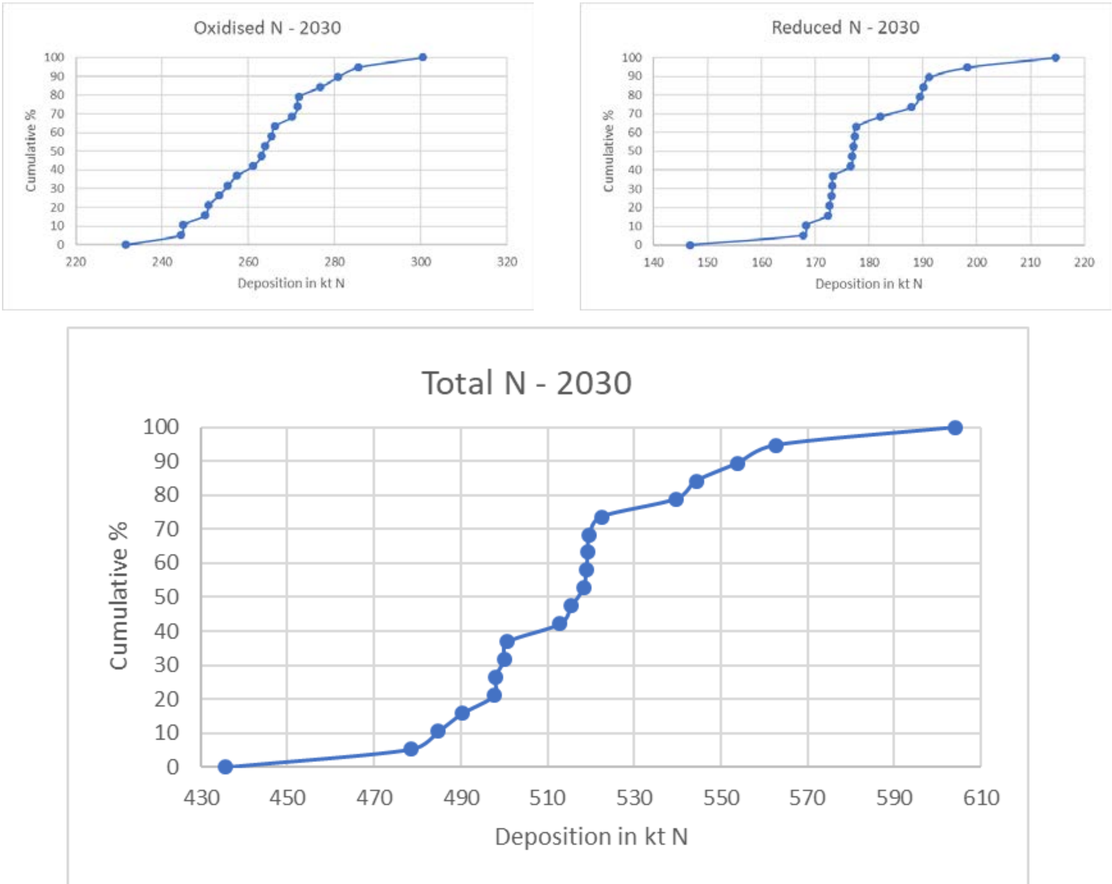



**Figure 4.10** Cumulative distribution of annual nitrogen depositions calculated to the Main OSPAR Region II for emissions from the year 2030 with each meteorological year.

Annual nitrogen depositions to selected EEZs, calculated for each meteorological year with emissions from the year 2030, are shown in Tables 4.7, 4.8 and 4.9 for depositions of oxidised, reduced and total nitrogen, respectively. Compared to 2005, reduction in oxidised nitrogen deposition in 2030 is in the range 25% (Norwegian EEZ) – 51% (Belgian EEZ). For reduced nitrogen the reductions are lower, in the range 8% (French EEZ) – 25% (Danish EEZ). For total nitrogen deposition the range is 23% (Norwegian EEZ) – 35% (Belgian EEZ).

**Table 4.7** Annual depositions of oxidised nitrogen to selected EEZs, calculated for each meteorological year with emissions from the year 2030.

| EEZ | Country | Minimum | Median | Maximum |
|---|---|---:|---:|---:|
| EEZ_188 | Belgium | 1.3 | 1.4 | 1.7 |
| EEZ_191 | Denmark | 29.0 | 33.3 | 39.4 |
| EEZ_209 | France | 50.7 | 58.8 | 62.5 |
| EEZ_190 | Germany | 22.1 | 24.1 | 29.5 |
| EEZ_189 | Netherlands | 22.2 | 25.1 | 29.4 |
| EEZ_216 | Norway | 145.0 | 161.0 | 175.4 |
| EEZ_185 | Sweden | 5.1 | 6.2 | 8.4 |
| EEZ_213 | UK | 129.1 | 146.9 | 177.1 |

**Table 4.8** Annual depositions of reduced nitrogen to selected EEZs, calculated for each meteorological year with emissions from the year 2030.

| EEZ | Country | Minimum | Median | Maximum |
|---|---|---:|---:|---:|
| EEZ_188 | Belgium | 1.5 | 1.7 | 1.9 |
| EEZ_191 | Denmark | 16.6 | 20.1 | 26.9 |
| EEZ_209 | France | 47.7 | 52.2 | 58.4 |
| EEZ_190 | Germany | 13.6 | 16.2 | 20.4 |
| EEZ_189 | Netherlands | 18.6 | 21.9 | 26.5 |
| EEZ_216 | Norway | 41.1 | 51.3 | 64.1 |
| EEZ_185 | Sweden | 3.7 | 4.3 | 5.9 |
| EEZ_213 | UK | 90.2 | 108.4 | 132.1 |

**Table 4.9** Annual depositions of total nitrogen to selected EEZs, calculated for each meteorological year with emissions from the year 2030.

| EEZ | Country | Minimum | Median | Maximum |
|---|---|---:|---:|---:|
| EEZ_188 | Belgium | 2.8 | 3.1 | 3.5 |
| EEZ_191 | Denmark | 45.6 | 53.5 | 66.3 |
| EEZ_209 | France | 98.4 | 111.2 | 120.9 |
| EEZ_190 | Germany | 36.5 | 39.9 | 48.3 |
| EEZ_189 | Netherlands | 42.2 | 46.7 | 55.2 |
| EEZ_216 | Norway | 187.7 | 213.9 | 237.2 |
| EEZ_185 | Sweden | 9.1 | 10.4 | 14.3 |
| EEZ_213 | UK | 219.3 | 254.6 | 309.3 |

# 5. Comparison of depositions in the years 2005, 2020 and 2030

One of the tasks of the present project was comparison of calculated depositions to the Main OSPAR Region II and EEZs for the years 2005, 2020, 2030 and evaluation of deposition reductions in the year 2020 and 2030.

**5.1 Depositions to Main OSPAR region II**

A comparison of the calculated nitrogen depositions to the Main OSPAR Region II for all meteorological years and the three emission years 2005, 2020 and 2030 is shown in Figure 5.1. For all meteorological years, all types of calculated nitrogen deposition are lower in 2020 than in the reference year 2005. They are also lower in 2030 compared booth to 2005 and 2020.

A comparison of cumulative distributions of annual nitrogen depositions to the Main OSPAR Region II calculated with emissions from the years 2005, 2020 and 2030 is presented in Figure 5.2. For all considered years the cumulative distributions are similar with regular shape and minima and maxima values located relatively far away from the median values.

Comparison of calculated normalised nitrogen depositions to the Main OSPAR Region II for the years 2005, 2020 and 2030 is shown in Figure 5.3. Percentage reductions in 2020 and 2030 depositions of oxidised, reduced and total nitrogen deposition to the Main OSPAR Region II in comparison to the reference year 2005 is shown in Figure 5.4.

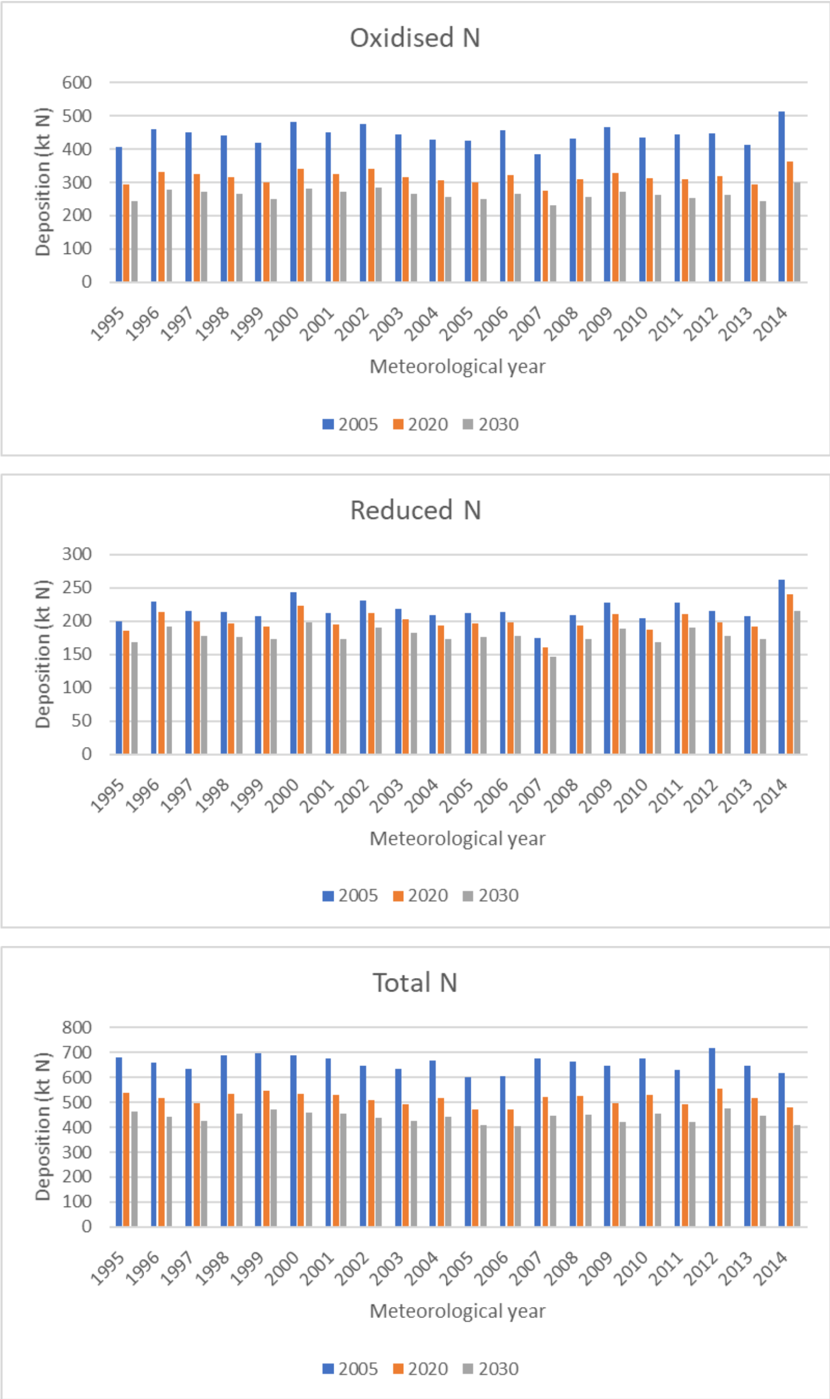



**Figure 5.1** Comparison of calculated nitrogen depositions to the Main OSPAR Region II for all meteorological years and three emission years 2005, 2020 and 2030.

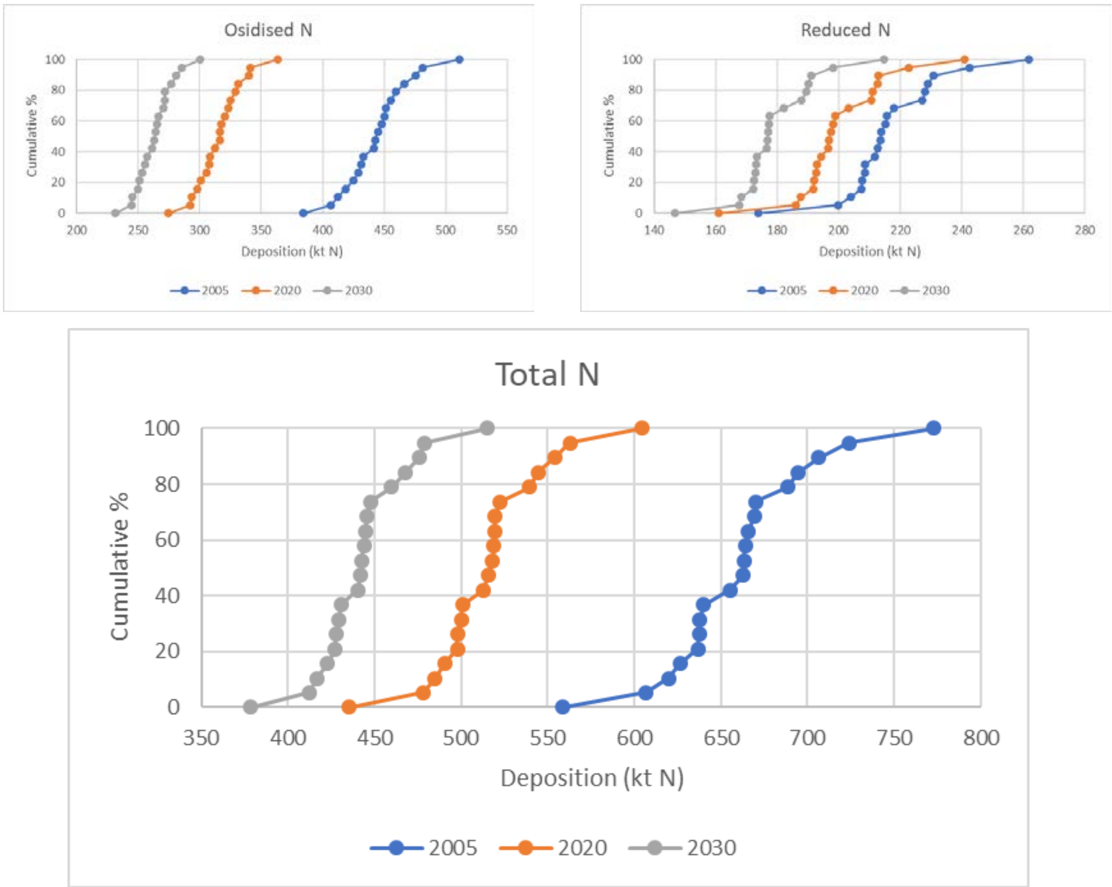



**Figure 5.2** Comparison of cumulative distributions of annual nitrogen depositions to the Main OSPAR Region II calculated with emissions from the years 2005, 2020 and 2030.

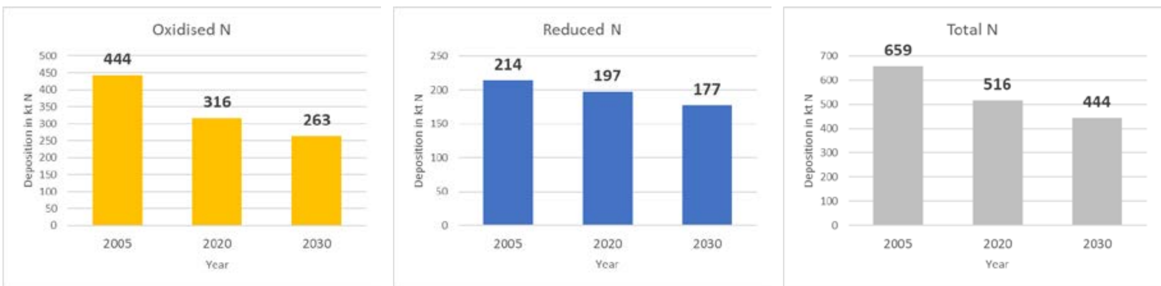



**Figure 5.3** Comparison of calculated normalised nitrogen depositions to the Main OSPAR Region II for the years 2005, 2020 and 2030.

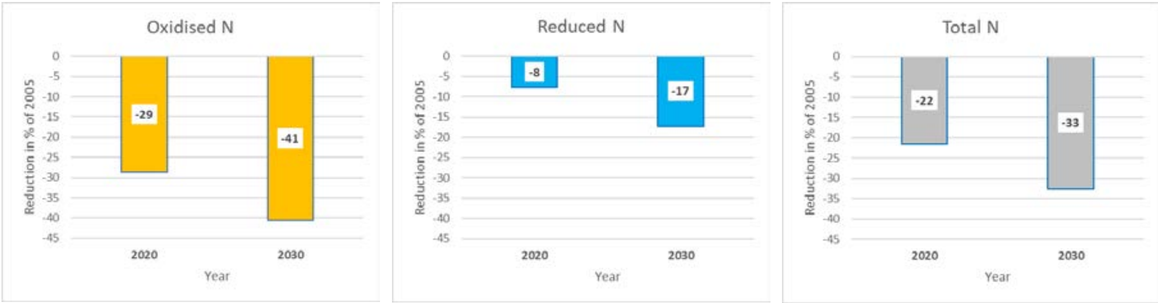



**Figure 5.4** Percentage reductions in 2020 and 2030 depositions to the Main OSPAR Region II compared to the reference year 2005. Results for oxidised, reduced and total nitrogen deposition.

Compared to the reference year 2005, annual 2020 deposition of oxidised nitrogen to the Main OSPAR Region II declined from 444 ktonnes N to 316 ktonnes N, which corresponds to 29% reduction as effect of the Gothenburg Protocol. Deposition of oxidised nitrogen in 2030 declined even farther to 263 ktonnes N as the effect of NEC Directive, which corresponds to 41% reduction. The effects of the Gothenburg Protocol and NEC Directive are less significant in case of reduced nitrogen deposition. Compared to the reference year 2005, annual 2020 deposition of reduced nitrogen to the Main OSPAR Region II declined from 214 ktonnes N to 197 ktonnes N, which corresponds to 8% reduction as effect of the Gothenburg Protocol. Deposition of reduced nitrogen in 2030 declined to 177 ktonnes N as the effect of NEC Directive, which corresponds to 17% reduction. Finally, compared to the reference year 2005, annual 2020 deposition of total nitrogen to the Main OSPAR Region II declined from 663 ktonnes N to 516 ktonnes N, which corresponds to 22% reduction as effect of the Gothenburg Protocol. Deposition of oxidised nitrogen in 2030 declined farther to 442 ktonnes N as the effect of NEC Directive, which corresponds to 33% reduction.

### 5.2 Depositions to EEZs

Comparison of annual nitrogen depositions to EEZs in the years 2005, 2020 and 2030 and reductions of nitrogen deposition to EEZs in the years 2020 and 2030, compared to depositions in reference year 2005 are given in Tables 5.1, 5.2 and 5.3 for oxidised, reduced and total nitrogen, respectively. In case of oxidised nitrogen deposition, the largest reductions can be noticed for Belgian EEZ, 36% in 2020 and 51% in 2030 and the lowest reductions for Norwegian EEZ, 17% in 2020 and 25% in 2030. In case of reduced nitrogen deposition, the largest reductions can be noticed in 2020 for Swedish EEZ - 17% and in 2030 for Danish EEZ - 25%. The lowest reductions occur for French EEZ, 1% in 2020 and 8% in 2030. Finally, in case of total nitrogen deposition, the largest reductions can be noticed for Belgian EEZ, 23% in 2020 and 35% in 2030 and the lowest reductions for Norwegian EEZ, 16% in 2020 and 23% in 2030.

**Table 5.1** Annual depositions of oxidised nitrogen to EEZS in the years 2005, 2020, 2030 and reductions of reduced nitrogen depositions in the years 2020 and 2030 to EEZs in percent of 2005 depositions.

| EEZ | Country | Deposition (ktonnes N) | | | Reductions (%) | |
|---|---|---|---|---|---|---|
| | | 2005 | 2020 | 2030 | 2020 | 2030 |
| EEZ_188 | Belgium | 2.9 | 1.9 | 1.4 | -36 | -51 |
| EEZ_191 | Denmark | 53.2 | 39.3 | 33.3 | -26 | -37 |
| EEZ_209 | France | 93.5 | 69.3 | 58.8 | -26 | -37 |
| EEZ_190 | Germany | 38.2 | 28.1 | 24.1 | -26 | -37 |
| EEZ_189 | Netherlands | 47.0 | 31.7 | 25.1 | -32 | -47 |
| EEZ_216 | Norway | 215.8 | 178.5 | 161.0 | -17 | -25 |
| EEZ_185 | Sweden | 10.0 | 7.4 | 6.2 | -26 | -38 |
| EEZ_213 | UK | 249.3 | 175.0 | 146.9 | -30 | -41 |

**Table 5.2** Annual depositions of reduced nitrogen to EEZS in the years 2005, 2020, 2030 and reductions of reduced nitrogen depositions in the years 2020 and 2030 to EEZs in percent of 2005 depositions.

| EEZ | Country | Deposition (ktonnes N) | | | Reductions (%) | |
|---|---|---|---|---|---|---|
| | | 2005 | 2020 | 2030 | 2020 | 2030 |
| EEZ_188 | Belgium | 1.9 | 1.8 | 1.7 | -2 | -10 |
| EEZ_191 | Denmark | 26.6 | 23.1 | 20.1 | -13 | -25 |
| EEZ_209 | France | 56.8 | 55.9 | 52.2 | -1 | -8 |
| EEZ_190 | Germany | 20.4 | 19.2 | 16.2 | -6 | -21 |
| EEZ_189 | Netherlands | 25.5 | 24.2 | 21.9 | -5 | -14 |
| EEZ_216 | Norway | 62.4 | 55.5 | 51.3 | -11 | -18 |
| EEZ_185 | Sweden | 5.7 | 4.9 | 4.3 | -14 | -24 |
| EEZ_213 | UK | 123.9 | 117.6 | 108.4 | -5 | -12 |

**Table 5.3** Annual depositions of total nitrogen to EEZS in the years 2005, 2020, 2030 and reductions of reduced nitrogen depositions in the years 2020 and 2030 to EEZs in percent of 2005 depositions.

| EEZ | Country | Deposition (ktonnes N) | | | Reductions (%) | |
|---|---|---|---|---|---|---|
| | | 2005 | 2020 | 2030 | 2020 | 2030 |
| EEZ_188 | Belgium | 4.8 | 3.7 | 3.1 | -23 | -35 |
| EEZ_191 | Denmark | 80.1 | 62.5 | 53.5 | -22 | -33 |
| EEZ_209 | France | 151.5 | 125.5 | 111.2 | -17 | -27 |
| EEZ_190 | Germany | 58.2 | 46.9 | 39.9 | -19 | -31 |
| EEZ_189 | Netherlands | 72.5 | 56.0 | 46.7 | -23 | -36 |
| EEZ_216 | Norway | 278.6 | 234.5 | 213.9 | -16 | -23 |
| EEZ_185 | Sweden | 15.6 | 12.2 | 10.4 | -22 | -33 |
| EEZ_213 | UK | 372.1 | 291.9 | 254.6 | -22 | -32 |

## 6. Conclusions

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

- The reductions in calculated depositions to the Main OSPAR Region II and selected EEZs, to a large extent reflect the reductions of the nitrogen emissions under the Gothenburg Protocol and the NEC Directive;
- For the Main OSPAR Region II, reductions in depositions of oxidised nitrogen depositions in the years 2020 and 2030 compared to 2005 are clearly higher than reductions in depositions of *reduced* nitrogen depositions;
- Also in all selected EEZs, reductions of the depositions of oxidised nitrogen depositions in the years 2020 and 2030 compared to 2005 are significantly higher than reductions of reduced nitrogen depositions;
- The major effects of the implementation of the Gothenburg Protocol and NEC Directive can be noticed in the Belgian Exclusive Economic Zone in case of oxidised nitrogen and in the Danish and Swedish EEZs in case of reduced nitrogen. In case of total nitrogen deposition, the major effects can be seen in the Belgian and Dutch EEZs.

## 7. References

Bartnicki J. and H. Fagerli (2003) Atmospheric supply of nitrogen to OSPAR Convention Waters. Summary Report for UBA. EMEP Technical Report MSC-W 4/2003. Norwegian Meteorological Institute. Oslo. Norway.

Bartnicki J. and H. Fagerli (2004) Atmospheric nitrogen in the OSPAR Convention Area. Summary Report for UBA. EMEP Technical Report MSC-W 4/2004. Norwegian Meteorological Institute. Oslo. Norway.

Bartnicki J. and H. Fagerli (2006) Atmospheric nitrogen in the OSPAR Convention Area in the period 1990-2004. Summary Report for the OSPAR Convention. EMEP Technical Report MSC-W 4/2006. Norwegian Meteorological Institute. Oslo. Norway.

Bartnicki J. and A. Benedictow (2017) Atmospheric Deposition of Nitrogen to OSPAR Convention waters in the period 1995-2014. Technical Report MSC-W 1/2017. Norwegian Meteorological Institute. Oslo. Norway.

EMEP Status Report 1/2017. "Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components" Joint MSC-W & CCC & CEIP Report.

Gauss, M., Hjellbrekke, A.-G., Aas, W., and Solberg, S. (2017a) Ozone, Supplementary material to EMEP Status Report 1/2017, available online at www.emep.int, The Norwegian Meteorological Institute, Oslo, Norway.

Gauss, M., Tsyro, S., Fagerli, H., Hjellbrekke, A.-G., and Aas, W. (2017b) Acidifying and eutrophying components, Supplementary material to EMEP Status Report 1/2017, available online at www.emep.int, The Norwegian Meteorological Institute, Oslo, Norway.

Simpson, D., Benedictow, A., Berge, H., Bergström, R., Emberson, L. D., Fagerli, H., Flechard, C. R., Hayman, G. D., Gauss, M., Jonson, J. E., Jenkin, M. E., Nyíri, A., Richter, C., Semeena, V. S., Tsyro, S., Tuovinen, J.-P., Valdebenito, Á., and Wind, P. (2012) The EMEP MSC-W chemical transport model – technical description, Atmos. Chem. Phys., 12, 7825-7865, doi:10.5194/acp-12-7825-2012.

Simpson, D., S. Tsyro, and P. Wind. Updates to the emep/msc-w model. In Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components. EMEP Status Report 1/2015. The Norwegian Meteorological Institute, Oslo, Norway, 2015.

Simpson, D., A. Nyíri, S. Tsyro, Á. Valdebenito, and P. Wind. Updates to the emep/msc-w model. In Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components. EMEP Status Report 1/2016. The Norwegian Meteorological Institute, Oslo, Norway, 2016.

Simpson, D., R. Bergström, H. Imhof, and P. Wind. Updates to the emep/msc-w model, 2016-2017. In Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components. EMEP Status Report 1/2017. The Norwegian Meteorological Institute, Oslo, Norway, 2017.

Simpson, D., S. Tsyro, and P. Wind. Updates to the emep/msc-w model. In Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components. EMEP Status Report 1/2015. The Norwegian Meteorological Institute, Oslo, Norway, 2015.

Simpson, D., A. Nyíri, S. Tsyro, Á. Valdebenito, and P. Wind. Updates to the emep/msc-w model. In Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components. EMEP Status Report 1/2016. The Norwegian Meteorological Institute, Oslo, Norway, 2016.

Simpson, D., R. Bergström, H. Imhof, and P. Wind. Updates to the emep/msc-w model, 2016-2017. In Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components. EMEP Status Report 1/2017. The Norwegian Meteorological Institute, Oslo, Norway, 2017.

Tsyro, S., M. Karl, D. Simpson, Á. Valdebenito, and P. Wind. Updates to the emep/msc-w model. In Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components (2014) EMEP Status Report 1/2014. The Norwegian Meteorological Institute, Oslo, Norway.

Tsyro, S., Gauss, M., Hjellbrekke, A.-G., and Aas, W.: PM10, PM2.5 and individual aerosol components (2017) Supplementary material to EMEP Status Report 1/2017, available online at www.emep.int, The Norwegian Meteorological Institute, Oslo, Norway, 2017.

Victoria House
37-63 Southampton Row
London WC1B 4DA
United Kingdom

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

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ISBN: 978-1-911458-55-5
Publication Number: 715/2018