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of the North-East Atlantic

COMPREHENSIVE ATMOSPHERIC MONITORING PROGRAMME

Observations from
N.E. Atlantic Coastal Stations in 2000

Working Group on Inputs to the Marine Environment (INPUT)

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Observations from N.E. Atlantic Coastal Stations in 2000

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Cover photograph:
Sunrise over the Irish Sea from Cloghy Beach, Co. Down, Northern Ireland, Autumn 1993.

Summary

This report was submitted as a draft to INPUT 2002, January 2002, for their consideration and comment. This final version incorporates all such comments received by mid-March 2002 and is now submitted to OSPAR ASMO.

This report contains the results of monitoring undertaken for CAMP during 2000. The programme calls for Mandatory Monitoring of a range of nutrients, heavy metals and organic compounds in precipitation and air, and encourages participation in a Voluntary Monitoring of additional compounds. Monitoring should be conducted at monitoring stations located in proximity to the coast. Most stations do meet the ten kilometre objective. The furthest station from the coast is located some 26 kilometres inland.

A larger number of stations have reported than in previous years. All countries submitted data. Participation in the Mandatory programme for components in precipitation is reasonable. However, some toxins, e.g. γ-HCH and mercury, are not widely monitored. Consideration may be given to increased monitoring of these components. Monitoring of airborne compounds is at a similar level of compliance. Rather less attention is given to the Voluntary programme, notably the precipitation element in which organic substances feature.

Metal and organic concentrations frequently are below the detection limits of analytical devices and in some cases detection limits are unusually high. Differences in techniques and laboratories may be worth some evaluation. Side-by-side samples analysed at different laboratories yield large differences in estimates. Similarly, there are clear differences in the estimates provided by different countries which may not only reflect differences in environmental occurrence. These various factors might invite review of practices by individual Parties.

The geographical, temporal and component coverage of the air quality programme has improved in recent years, and together with good effort by Parties in reviewing historical data submissions means that the air database is now in a suitable state to allow temporal and spatial assessments of pollutant supply to be made. This can be done in future as needed both for coastal waters and for basins.

Beyond normal reporting, INPUT's attention is drawn to the Kiev Report, 2003, for which OSPAR will be invited to submit pollutant loading data for coastal water. As this will comprise both year 2000 data, and trend data, example trend information has been presented which INPUT is invited to consider with a view to its development for Kiev.

Observations from N.E. Atlantic Coastal Stations in 2000

1 Introduction

This report describes the observations reported by coastal monitoring stations across the OSPAR region (see Figure 1.1) under the Comprehensive Atmospheric Monitoring Programme (CAMP) for the year 2000. This was presented to the Working Group on Inputs to the Marine Environment, OSPAR, Evora, Portugal 15 - 17 January 2002.

The monitoring regime proposed by CAMP is summarised in chapter two listing the components for which monitoring is suggested, the methods of sampling, and the recommended location of monitoring sites. In support of this summary, the Principles for the CAMP as described in the Summary Record for the Environmental Assessment and Monitoring Committee (ASMO) of OSPAR annual meeting at Spa, 1998, is given in Appendix B.

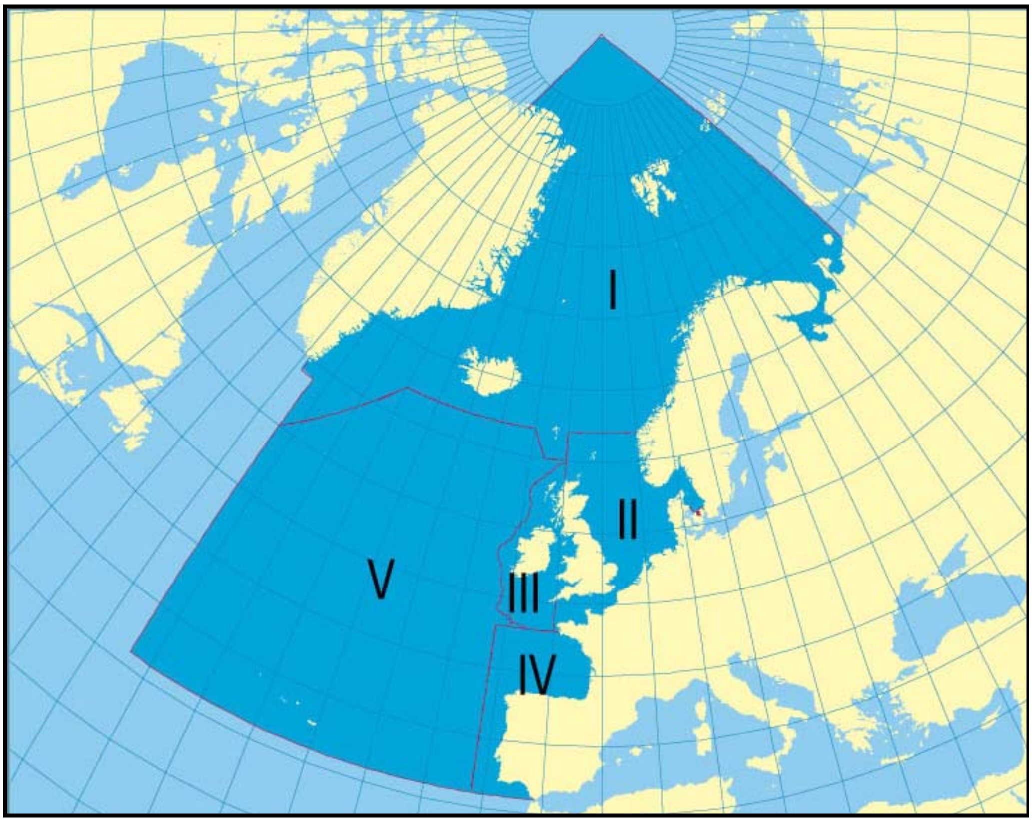


Figure 1.1: OSPAR maritime area and regions: 1: Arctic waters 2: Greater North Sea 3: Celtic Seas 4: Bay of Biscay and Iberian Coast 5: Wider Atlantic. Source: www.ospar.org.

Chapter three summarises the monitoring activities which served CAMP in 2000, listing the stations reporting, their individual monitoring regimes, and the components they have reported. This provides an overview of the implementation of CAMP recommendations. Actual observations are summarised (annual mean values) in chapter four. The monthly mean wet depositions and air concentrations values themselves from each station for 2000 are provided in Appendix A. These are values aggregated from reported concentrations in air and precipitation. Reported time periods are often shorter. The monthly values have been previously forwarded to country data originators for review in accordance with the revised CAMP time schedule (June 2001 - See Appendix B). Finally, Appendix C supplies a list of the current contact names and addresses for the data originators in each country, and for the CAMP Data Manager.

2 The Comprehensive Atmospheric Monitoring Programme

The Comprehensive Atmospheric Monitoring Programme forms one element within the wider Joint Assessment and Monitoring Programme of OSPAR. Amongst the intentions of CAMP are assessment of the atmospheric input of selected contaminants to the OSPAR maritime area and regions (see Figure 1.1). This is to be achieved via a monitoring regime with indicated substances, time resolution, methodologies, and sampling locations. Thus defined, the programme may assist in assessment of the quality status of the marine environment.

The components of interest to CAMP are divided into two groups, for measurement on a mandatory basis and for measurement on a voluntary basis. These are listed in table 2.1.

2.1 Components

Table 2.1: Components to be measured within CAMP.

	Mandatory	Voluntary
Precipitation	As, Cd, Cr, Cu, Pb, Hg, Ni, Zn, γ-HCH, NH_4^+, NO_3^-	PCB 28,52,101,118,138,153,180 Phenanthrene, anthracene, flouranthene, pyrene, benzo(*a*)anthracene, chrysene, benzo(*a*)pyrene, benzo(*ghi*)perylene, indeno(*1,2,3-cd*)pyrene
Airborne	NO_2, HNO_3, NH_3, NH_4^{+a}, NO_3^{-a}	As, Cd, Cr, Cu, Pb, Hg, Ni, Zn, γ-HCH, PCB 28,52,101,118,138,153,180, Phenanthrene, anthracene, flouranthene, pyrene, benzo(*a*)anthracene, chrysene, benzo(*a*)pyrene, benzo(*ghi*)perylene, indeno(*1,2,3-cd*)pyrene, NO

[a]) total ammonium (NH_3 + NH_4^+) and total nitrate (HNO_3 +NO_3^-) is an alternative.

For quality assurance purposes the reporting of pH, electrical conductivity, and concentrations in precipitation of all major ions (Na^+, K^+, Mg^{2+}, Ca^{2+}, SO_4^{2-}, Cl^-, NH_4^+, NO_3^-, HCO_3^-) is also encouraged.

2.2 Sampling

Precipitation sampling using wet-only samplers is recommended. Regular inter-comparisons between wet-only and bulk samplers should be undertaken where bulk samplers are used instead. Account should be taken of any need to undertake summer cooling of samples.

For measuring precipitation amount practice has shown variable results in the efficiency of chemical samplers. According to design, problems such as poor capture, evaporation or snow blow-out can influence results. The use of a standard rain-gauge parallel to the chemical sampling can assist in the calculation of deposition fluxes from concentrations and precipitation amounts.

Currently acceptable precipitation sampling frequencies are between one week and one month. The recommendation, however, is for one week sampling, possibly with combination of samples to longer periods (e.g. one month) prior to analysis. It is recommended to have two sampling periods for weeks which cross month boundaries, even if one of these is only a one-day sample. Achieving equal months in reported values greatly aids comparability between samples taken in different countries. Where weekly samples are simply assigned to the month in which most days fall noticeable temporal errors in data may, of course, be introduced. This is even more true where two-week samples are taken. The recommendation to change samples on the first day of the month in addition to the periodic routine is most strongly endorsed by NILU as CAMP Data Manager for all sample periods, and most especially when longer/two week sampling periods are used. As an aid to achieving consistency, it is recommended that samples are always changed at a fixed time, e.g. at 08.00 UTC on each Tuesday and on the first day of each month.

Amongst airborne components, a sampling period of 24 hr is recommended for heavy metals and for POP's, not less than 24 hr for nitrate and ammonia, with continuous monitoring of NO and NO_2 aggregated to hourly values.

2.3 Station siting

The Principles for CAMP call for each Contracting Party bordering the maritime area (excluding EU) to operate at least one monitoring station as part of CAMP. Where Parties border more than one region (see Figure 1.1) at least one station should be operating in each. These stations should be so-called *background stations*, i.e. not directly influenced by emission sources local to them. The intention of the programme is assessment of inputs to the marine environment. In accordance with this, the Principles explicitly call for stations to be located not more than 10 km from the coastline.

2.4 Data reporting

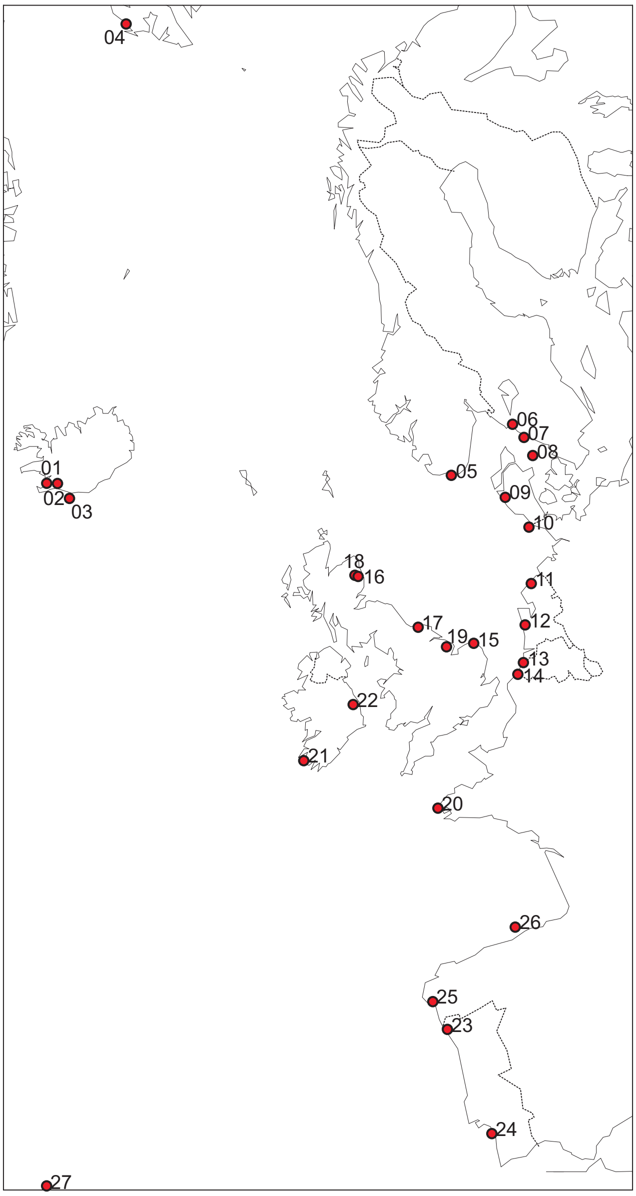
The monitoring data assembled through CAMP is stored on a relational database. This must account for considerable diversity in procedures across countries. In some cases several separate instruments operate side-by-side to serve different programmes. In others data is aggregated from the same instrument in different ways before submission to different programmes. On occasions different components are reported to different programmes from the same instrument. More than one person in some countries may have responsibilities in reporting data to programmes. Correct association of observed concentrations with observed precipitation amounts is vital. The potential for data duplication or mis-attribution is significant.

In consequence, all data reported to CAMP should be very carefully identified. As well as station and component identification, all data originators in participating countries are asked to assign unique names to the field instruments, to the methodologies, and to ensure programme labelling. Reporting is also requested in a standardised format which seeks to ensure comparability and allow quality assurance. The NASA/Ames format of reporting is used for data files, being thus-named after development by NASA.

Flagging of data is an important aid to quality management in use of the data. Data originators may be aware of unusual uncertainties associated with individual data elements. It is also important to be able to indicate such factors as concentrations being found to be below the analytical detection limit. Details of file formats and flags can be found at www.nilu.no/projects/ccc.

The time schedule for data reporting calls for submission of data by countries to the CAMP Data Manager by 30 September in the year subsequent to monitoring. Following initial reporting-back by the Data Manager in draft form, participants are requested to submit revised or corrected data by mid November.

3 N.E. Atlantic coastal atmospheric monitoring, 2000



Region	map no	code	Station name	Region	map no	code	Station name	Region	map no	code	Station name
I	1	IS0002	Irafoss	**II**	9	DK0031	Ulborg	**II**	17	GB0014	High Muffles
	2	IS0090	Reykjavik		10	DE0001	Westerland		18	GB0091	Banchory
	3	IS0091	Storhofdi			DE0041	Wstlnd Tinnum		19	GB0095	Driby
	4	NO0042	Zeppelin		11	NL0009	Kollumerwaard	**II/III**	20	FR0090	Porspoder [also IV]
		NO0057	Ny-Ålesund		12	NL0091	De Zilk	**III**	21	IE0001	Valentia
II	5	NO0099	Lista		13	BE0003	Brugge		22	IE0002	Turlough Hill
		NO0001	Birkenes			BE0004	Knokke	**IV**	23	PT0003	V. d. Castelo
	6	SE0002	Rorvik		14	BE0011	Moerkerke		24	PT0004	Monte Velho
	7	SE0097	Gardsjoen			BE0013	Houtem		25	ES0005	Noia
		SE0098	Svartedalen		15	GB0090	East Ruston		26	ES0008	Niembro
	8	DK0008	Anholt		16	GB0016	Glen Dye	**V**	27	PT0010	A. d. Heroismo

Figure 3.1: Stations reporting to CAMP, 2000

Table 3.1: List of coastal stations reporting to CAMP for 2000.

Country	Station code	Station name	Latitude (deg.min)	Longitude (deg.min)	Altitude (m)	Distance from sea (km)
Belgium	BE0003R	Brugge	51.15N	3.12E	10	8
	BE0004R	Knokke	51.21N	3.20E	0	1
	BE0011R	Moerkerke	51.01N	2.35E	0	9
	BE0013R	Houtem	51.15N	3.21E	10	12
Denmark	DK0008R	Anholt	56.43N	11.31E	40	
	DK0031R	Ulborg	56.17N	8.26E	40	20
France	FR0090R	Porspoder	48.3N	4.46W	50	0.5
Germany	DE0001R	Westerland	55.36N	8.33E	5	0.55
	DE0041R	Westerland-Tinnum				3
Iceland	IS0002R	Irafoss	64.06N	21.01W	66	26
	IS0090R	Reykjavik	64.08N	21.54W	52	1
	IS0091R	Storhofdi	63.24N	20.17W	118	0.5
Ireland	IE0001R	Valentia Observatory	51.56N	10.15W	9	0
	IE0002R	Turlough Hill	53.02N	6.24W	420	19
Netherlands	NL0009R	Kollumerwaard	53.2N	6.16E	1	7.5
	NL0091R	De Zilk	52.18N	4.31E	4	2.5
Norway	NO0042R	Zeppelin	78.54N	11.53E	474	2
	NO0057R	Ny Ålesund	78.54N	11.55E	8	0.3
	NO0099R	Lista	58.06N	6.34E	13	0.1
	NO0001R	Birkenes	58.23N	8.15E	190	20
Portugal	PT0003R	Viana do Castelo	41.42N	8.48W	16	3
	PT0004R	Monte Velho	38.05N	8.48W	43	1.5
	PT0010R	Angra do Heroismo	38.4N	27.13W	74	1
Spain	ES0005R	Noia	42.44N	8.55W	685	
	ES0008R	Niembro	43.26N	4.05W	134	
Sweden	SE0002R	Rørvik	57.25N	11.56E	10	0.65
	SE0097R	Gårdsjøn	58.03N	12.01E	113	12
	SE0098R	Svartedalen	57.59N	12.06E	120	16
United Kingdom	GB0014R	High Muffles	54.20N	0.48W	265	22
	GB0016R	Glen Dye	56.58N	2.25W	85	24
	GB0090R	East Ruston	52.48N	1.28E	5	8
	GB0091R	Banchory	57.05N	02.32W	120	26.5
	GB0095R	Driby	53.14N	0.04E	47	16

The CAMP principles call for monitoring stations to be located where possible within ten kilometres of the coast. By-and-large this objective is met, although observations from a few more distant sites have been reported for 2000. An increased number of stations reported in 2000 than for previous years.

Table 3.2: National submissions of precipitation data for 2000 – Mandatory List.

	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	γ-HCH	NH_4	NO_3
Belgium	•	•	•	•	•	•	•	•	•	•	•
Denmark	•	•	•	•	•		•	•		•	•
France	•	•	•	•	•		•	•		•	•
Germany	•	•	•	•	•	•	•	•	•	•	•
Iceland	•	•	•	•	•		•	•	•	•	•
Ireland	•	•	•	•	•	•	•	•	•	•	•
Netherlands	•	•	•	•	•	•	•	•	•	•	•
Norway	•	•	•	•	•	•	•	•	•	•	•
Portugal		•		•	•		•	•		•	•
Spain										•	•
Sweden	•	•	•	•	•	•	•	•		•	•
United Kingdom	•	•	•	•	•		•	•		•	•

Grey areas in table were not reported.

Furthermore, year 2000 data was reported by all countries virtually within the deadlines. Subsequent validation of aggregated monthly values, however, was only partially achieved within the deadlines. There remain some uncertainties over questions of reporting format, flagging of data and so forth but in general the reporting requirements were met.

Table 3.3: Submissions of air concentration data for 2000 – Mandatory List.

	NO_2	NO_3	NH_x
Belgium	•		
Denmark		•	•
France			
Germany	•	•	•
Iceland		•	
Ireland			
Netherlands	•	•	•
Norway	•	•	•
Portugal			
Spain	•	•	•
Sweden	•	•	•
United Kingdom			

Grey areas in table were not reported.

Table 3.4: Submissions of precipitation data for 2000 – Voluntary List.

	PCB's	Phenanthrene	Anthracene	Flouranthene	Pyrene	Benzo(α)anthracene	Chrysene	Benzo(α)pyrene	Benzo(x)perylene	Indeno(1,2,3-cd) pyrene	others
Belgium											pesticides
Denmark											
France											
Germany		•	•	•	•	•	•	•	•	•	
Iceland	•[10]										pesticides
Ireland	•[6]										pesticides
Netherlands											
Norway											
Portugal											
Spain											
Sweden											
United Kingdom											

Grey area in table were not reported.

PCB Number in superscript indicates number of individual congeners reported. Voluntary list defines 7.

Whilst otherwise largely adhered to, γ-HCH and mercury in precipitation from the mandatory list are not widely monitored by participating countries.
Furthermore, the recommended CAMP voluntary monitoring programme for components in precipitation has in general not been closely adhered to.

Table 3.5: Submissions of air concentration data for 2000 – Voluntary List.

	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	γ-HCH	Other organics	NO
Belgium				•	•		•	•			•
Denmark	•	•	•	•	•		•	•			
France											
Germany	•	•		•	•		•				
Iceland	•	•	•	•	•	•	•	•	•	•	
Ireland											
Netherlands	•	•			•			•			•
Norway	•	•	•	•	•	•	•	•	•	•	
Portugal											
Spain											
Sweden											
United Kingdom	•	•	•	•	•		•	•			

Grey areas in table were not reported.

Table 3.6: Sampling regime for components in precipitation.

Station code	Station name	Nutrients	Heavy Metals	Organics
BE0003R	Brugge	W1W		
BE0004R	Knokke		WM *plus* BM As,Cd,Pb,Zn	WM
DK0008R	Anholt		BM	
DK0031R	Ulborg		BM	
FR0090R	Porspoder	B2W	B2W	
DE0001Rb	Westerland-Tinnum	W1W(M)	W1W(M)	
ES0005R	Noia	BD		
ES0008R	Niembra	BD		
IS0002R	Irafoss	BW	B1W	
IS0090R	Reykjavik	BW	B1W	
IS0091R	Storhofdi			B2W
IE0001R	Valentia Observatory		BM	
IE0002R	Turlough Hill	WD	BM	BM
NL0009R	Kollumerwaard	W4W	W4W	
NL0091R	De Zilk	W4W	W4W except WW Hg	B4W
NO0057R	Ny Alesund	BHW		
NO0099R	Lista	BD	BHW	
PT0003R	Viana do Castelo	BD	BD	
PT0004R	Monte Velho	BD	BD	
PT0010R	Angra do Heroismo	W1W	W1W	
SE0002R	Rørvik	WD	BM	
SE0097R	Gårdsjøn		BM	
SE0098R	Svartedalen	BM		
GB0014R	High Muffles	WD	BM	
GB0090R	East Ruston		BM	
GB0091R	Banchory		BM	

Code:
First letter: B = Bulk sampler; W = wet-only sampler
Subsequent letters: D = daily; 1W = 1 week samples; 2W = 2 week samples
4w = 4 week samples; M = Monthly samples
Letters in parenthesis: Reporting frequency

The sampling regimes across the stations do not always permit ready estimates of equivalent monthly observations. Notable is the procedure in the Netherlands with four-week sampling irrespective of calendar months, and the single two month sample at one UK site on one occasion. This produces 13 sampling periods per year with a somewhat uncertain attribution within calendar months. Several countries do not recommence their chosen monitoring period at the start of each month as recommended. A similar issue of comparability arises with the temporal resolution of reported data. Whilst some countries collect samples during a month and combine these prior to analysis, others analyse samples at a finer resolution. These may then be reported directly in 'raw' state, or may be aggregated by the host country to monthly values for reporting. There is potential for inconsistent treatment of data in consequence, notably with respect to flagged data.

Table 3.7: Sampling regime for airborne components.

Station code	Station name	Nitrogen components	Heavy Metals	Organics
BE0004R	Knokke		FD	
BE0011R	Moerkerke	MnH		
BE0013R	Houtem	MnH		
DK0008R	Anholt	FD	FD	
DK0031R	Ulborg	FD	FD	
DE0001R	Westerland	AD		
	Westerland-Tinnum	HVD	HVM	
IS0091R	Storhofdi	HV2W	HV2W	F2W
ES0005R	Noia	AD		
ES0008R	Niembra	AD		
NL0009R	Kollumerwaard	FD NO3,NH4: MnH NO,NO2	FD	
NL0091R	De Zilk	FD NO3,NH4: DH NH3: MnH NO,NO2		
NO0001R	Birkenes	FD		
NO0042R	Zeppelin	FD	FHW	
NO0099R	Lista	FD	FHW	
SE0002R	Rørvik	FD HNO3+NO3,NHx: AD NO2		

Code:
First letters: Mn = Monitor; F = Filter; A = Absorbing solution; HV = High Volume sampler; D = Denuder
Subsequent letters: H = hourly; D = daily; HW = half weekly, 2W = 2 weekly samples; M = monthly.

4 Observed Atmospheric Quality

In this chapter the annual average values of the mandatory and the voluntary list substances are provided as an overview of atmospheric conditions around the North East Atlantic in 2000. Observations of nitrogen and of arsenic, cadmium, copper and lead are plotted to provide a view of spatial distributions. The reported data in monthly format is provided in Appendix A.
In making the annual estimates all samples flagged 659, 658, 654, 653, 599, 499, 460, 459, 458, 260, 259, or 256 were excluded (see Appendix C for list of data flags). **NOTE**: The CAMP principles have been followed with respect to detection limits. Where flag 780 was given, this data value was employed. Where 781 was flagged, a value of half the detection limit was used.

4.1 Nitrogen

In Figures 4.1 and 4.2 the estimated depositions of nitrogen in precipitation across the CAMP region are shown. Values represent the sum of precipitation-weighted monthly mean concentrations multiplied by precipitation amount for those CAMP stations reporting nitrogen in precipitation. The summed annual values can be found in Table 4.1. Some of the tabulated data was not employed where this was apparently elevated in comparison to neighbouring stations or previous years. This new data is included here. Associated air concentration data is presented in Table 4.2 (mean annual values).

Table 4.1: Reduced and oxidised nitrogen supply per station, year 2000: Mean precipitation weighted concentrations (mg N l^{-1}), and estimated annual wet depositions (mg N m^{-2}).

Area	Station code	Location	concentrations NH_4 mg N /l	NO_3 mg N /l	precip mm	depositions NH_4 mg N /m^2	NO_3 mg N /m^2
I	IS0002	Irafoss	0.08	0.04	1769	140	72
I	IS0090	Reykjavik	0.25	0.07	675	169	49
I	NO0057	Ny Alesund	0.10	0.08	421 (11)	42	32
II	NO0001	Birkenes	0.32	0.43	2327	739	994
II	NO0099	Lista	0.46	0.62	1494	694	926
II	SE0002	Roervik	0.23	0.33	886	203	295
II	SE0098	Svartedalen	0.59	0.56	1135 (10)	675	634
II	DK0008	Anholt	0.45	0.60	703	314	422
II	DE0001	Westerland	0.58	0.62	630	385	411
II	NL0009	Kollumerwaard	0.90	0.51	625	565	321
II	NL0091	De Zilk	0.52	0.44	1000 (11)	515	443
II	BE0003	Brugge	0.80	0.48	812	651	389
II	GB0014	High Muffles	0.50	0.50	1153	581	511
II	GB0016	Glen Dye	0.33	0.36	1237	409	445
II	GB0095	Driby	0.54	0.48	619	333	299
II/III	FR0090	Porspoder	0.24	0.31	1322	318	408
III	IE0002	Turlough Hill	0.21	0.12	1907 (10)	409	228
IV	ES0008	Niembro	0.27	0.42	655	178	273
IV	PT0003	V.d.Castelo	0.12	0.11	1891	223	205
IV	PT0004	Monte Velho	0.11	0.13	574	65	72
V	PT0010	A.d.Heroismo	0.06	0.19	919	59	182

text under table: numbers in (brackets) indicate number of months where less than 12.

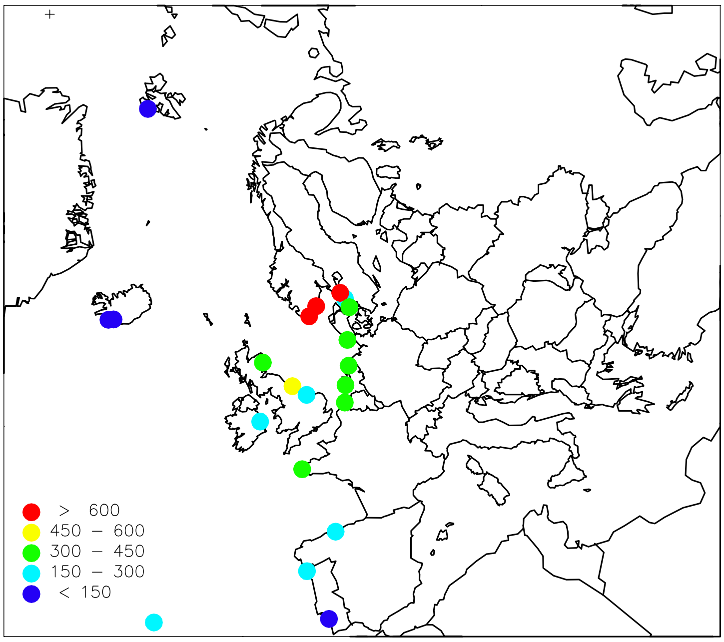


Figure 4.1: Estimated deposition of oxidised nitrogen in precipitation, 2000. Units: mg N m^{-2} yr^{-1}.

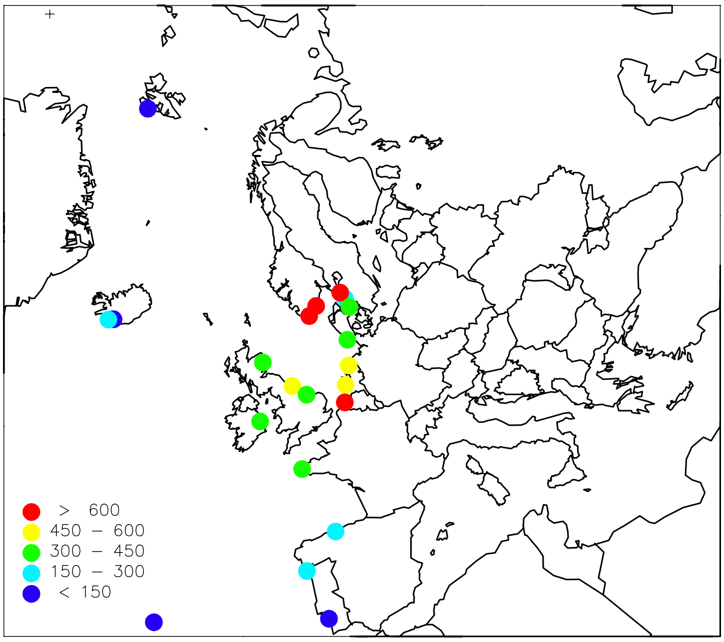


Figure 4.2: Estimated deposition of reduced nitrogen in precipitation, 2000. Units: mg N m^{-2} yr^{-1}.

Table 4.2: Observed annual mean air concentrations of reduced and oxidised nitrogen, 2000. Units: $\mu g\ N\ m^{-3}$.

		NH_3 $\mu g\ N/m^3$	NH_4 $\mu g\ N/m^3$	NH_x $\mu g\ N/m^3$	NO_3 $\mu g\ N/m^3$	HNO_3+NO_3 $\mu g\ N/m^3$	NO $\mu g\ N/m^3$	NO_2 $\mu g\ N/m^3$
IS0091	Storhofdi				0.04			
NO0042	Zeppelin			0.10		0.03		
NO0001	Birkenes			0.43		0.20		0.57
SE0002	Roervik			0.87		0.63		1.48
DK0031	Ulborg			1.40		0.66		
DE0001	Westerland		0.51		0.74			2.16
NL0009	Kollumerwaard		0.87		0.54		0.73	3.71
NL0091	De Zilk	0.69	1.30		0.75		2.23	6.20
BE0011	Moerkerke						1.98	5.99
BE0013	Houtem						1.13	1.98
ES0005(6)	Noia		0,31	0.09		0,42		2.69: abs.sol.
								1.47: monitor
ES0008	Niembro		0.48	2.53		0.52		2.64: abs.sol.
								2.14: monitor

text under table: numbers in (brackets) indicate number of months where less than 12.

4.2 Metals

Tables 4.3 and 4.4 lists the annual summary data for metal deposition in precipitation around N.E. Atlantic coasts. The spatial patterns are illustrated for arsenic, cadmium, copper and lead in Figures 4.3-4.6. Table 4.5 provides annual average concentrations in air.

The CAMP principles propose side-by-side comparisons bulk and wet-only samplers where bulk samplers are used. A bulk sampler will collect dry as well as wet deposition, and the sample will be concentrated due to water evaporation during the warm season. The only case of this being followed systematically is at BE0007. However, comparison in this case is complicated through different laboratories and different methodologies being used for analysis of samples from each sampler. Samples from the bulk collector are analysed at a laboratory in Antwerp using AAS, whilst samples from the wet-only collector are analysed using Graphite furnace AAS at a laboratory in Ghent which commonly undertakes water quality analysis. The difference in estimates can be large. Monthly deposition estimate for each of these can be found in Appendix A. Following review at INPUT 2001, Belgium decided to undertake CAMP analysis at the Antwerp laboratory in future. This data will be available from year 2001.

Metal data frequently are below the detection limits of analytical devices. When all or nearly all results are below the detection limit, the averages and depositions in Table 4.3 and 4.4 have followed CAMP principles, i.e. represents estimates where provided or otherwise 50% of the detection limit. This calculation may not be completely consistent in this report, and there is a need to work out better calculation procedures, preferably in co-operation with HELCOM and EMEP.

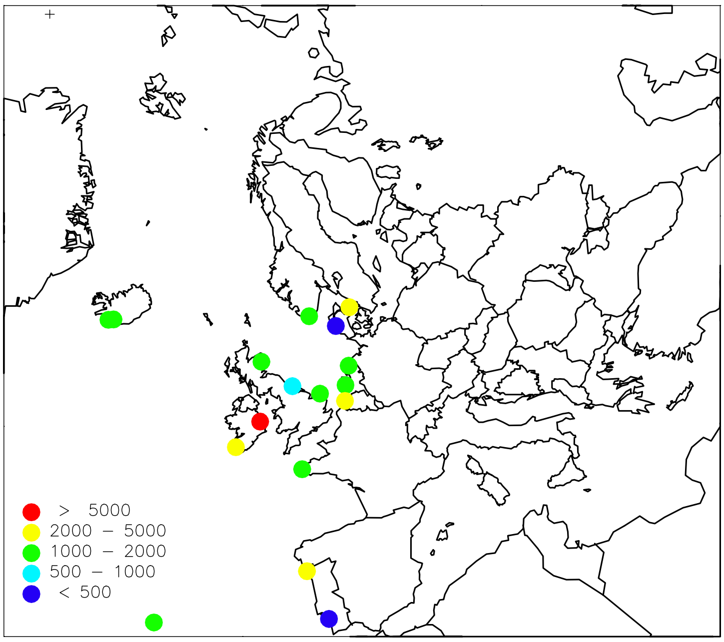


Figure 4.3: Estimated deposition of copper in precipitation, 2000. Units: µg Cu $m^{-2}yr^{-1}$.

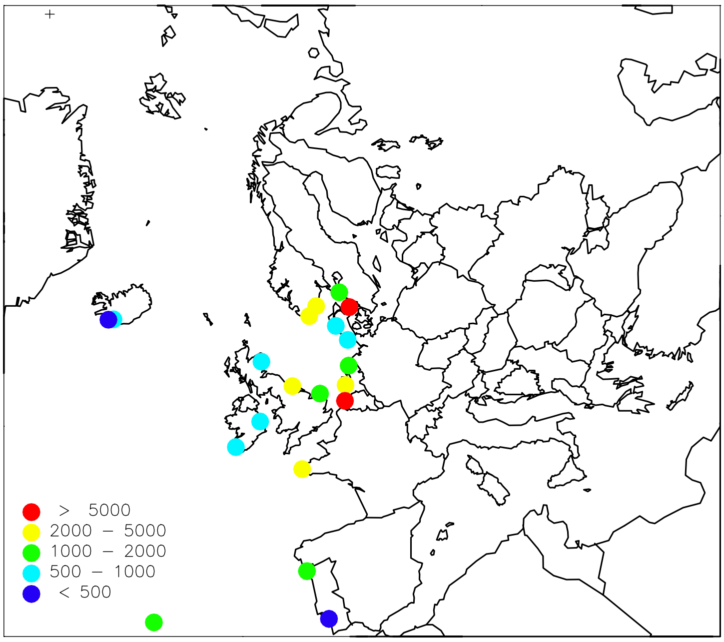


Figure 4.4: Estimated deposition of lead in precipitation, 2000. Units: µg Pb $m^{-2}yr^{-1}$.

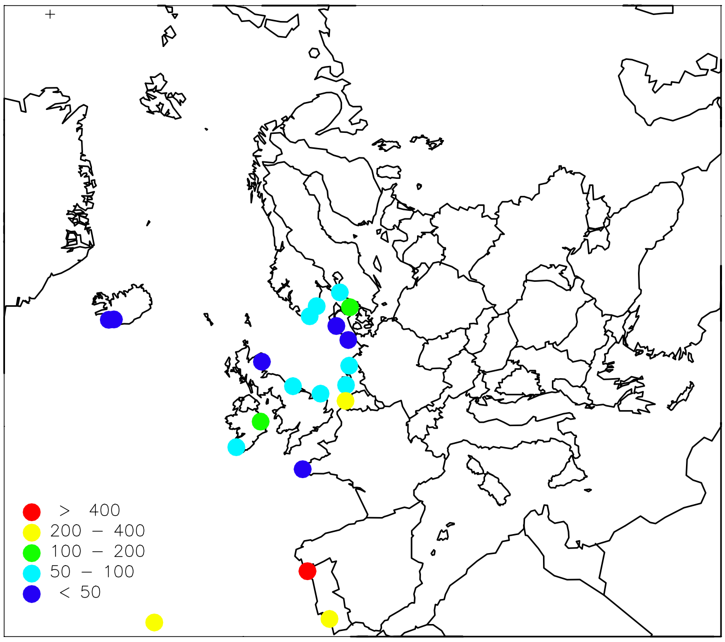


Figure 4.5: Estimated deposition of cadmium in precipitation, 2000.
Units: µg Cd $m^{-2}yr^{-1}$.

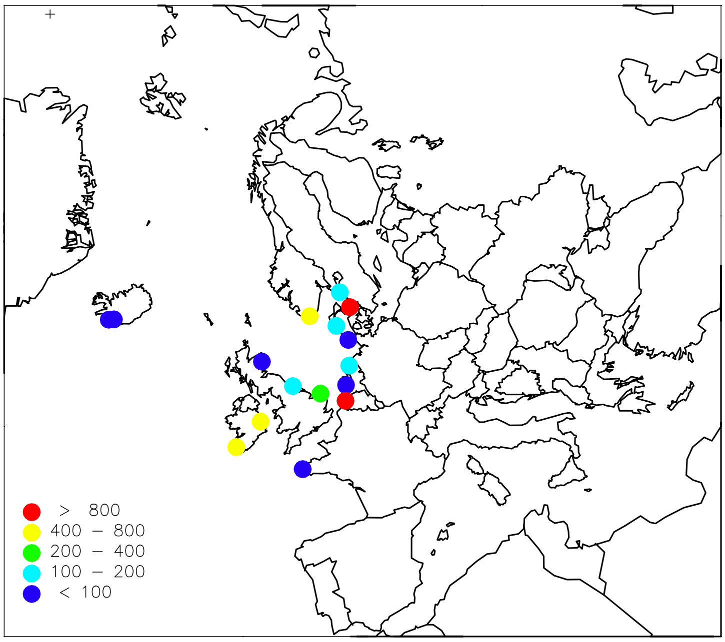


Figure 4.6: Estimated deposition of arsenic in precipitation, 2000.
Units: µg As $m^{-2}yr^{-1}$.

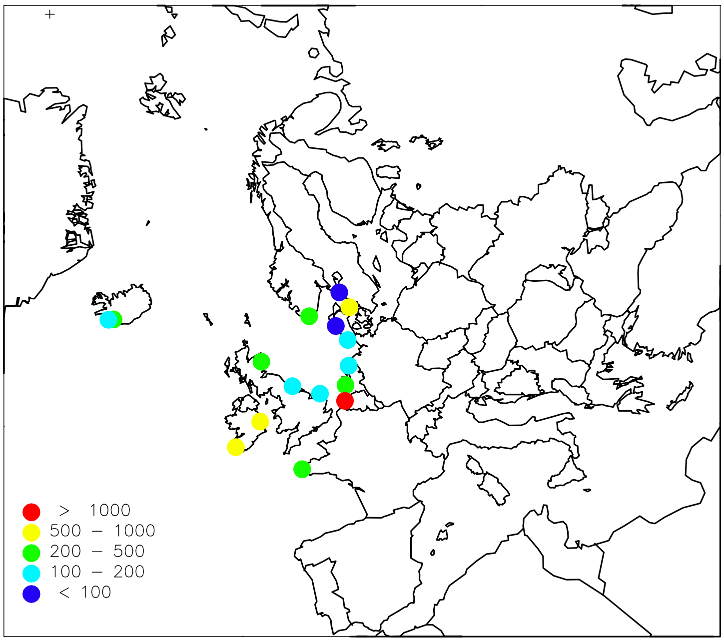


Figure 4.7: Estimated deposition of Chromium in precipitation, 2000. Units: µg Cr m^{-2} yr^{-1}

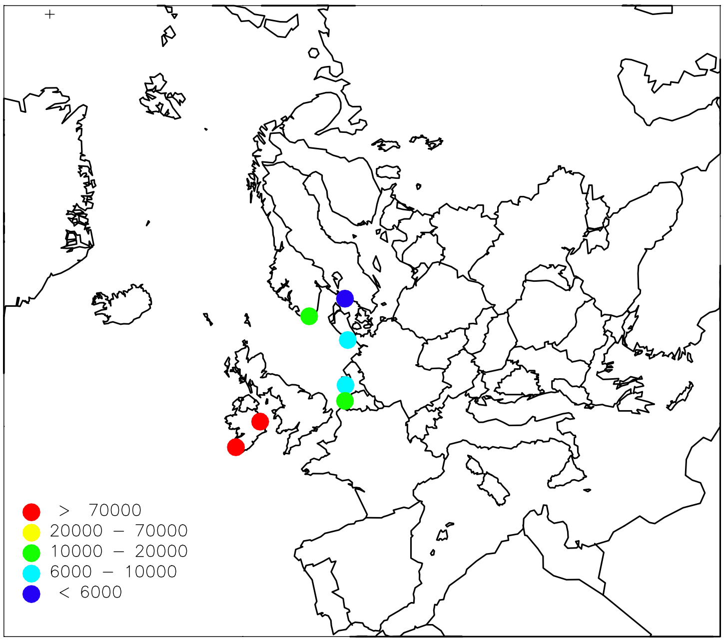


Figure 4.8: Estimated deposition of mercury in precipitation, 2000. Units: ng Hg m^{-1} yr^{-1}.

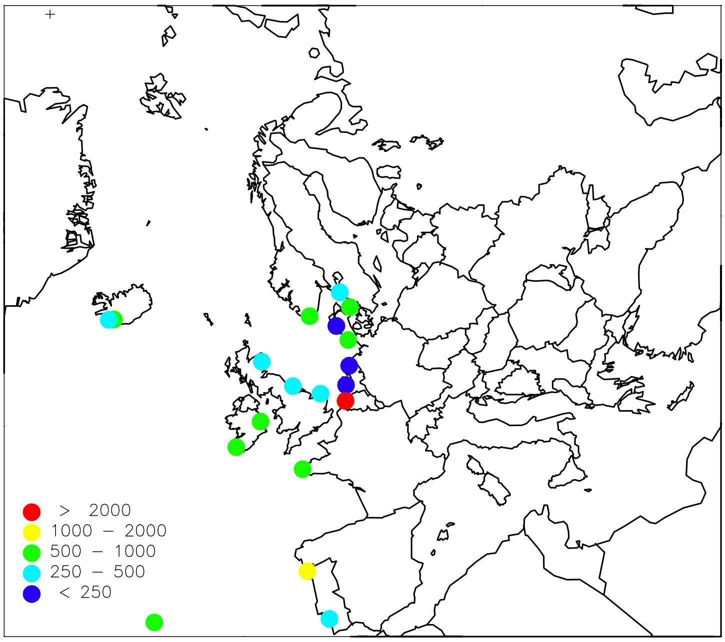


Figure 4.9: Estimated deposition of nickel in precipitation, 2000. units: µg Ni m^{-1} yr^{-1}.

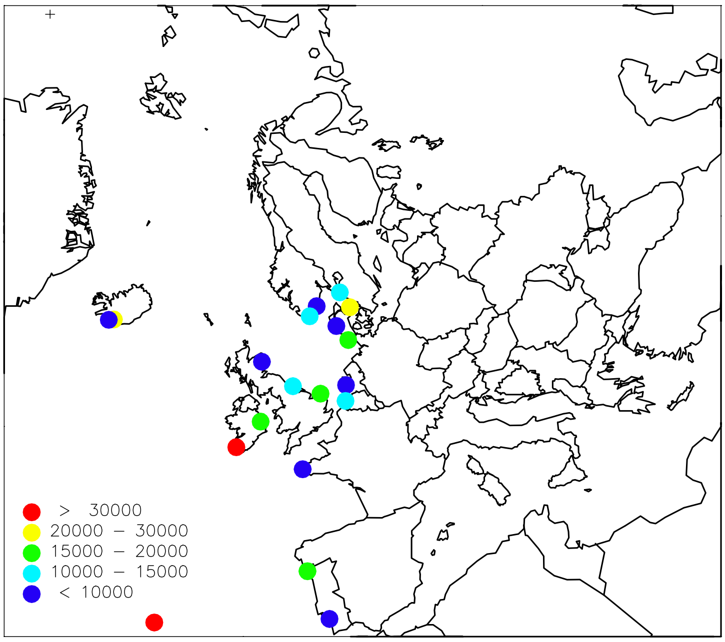


Figure 4.10: Estimated deposition of zinc in precipitation, 2000. Units: µg Zn m^{-1} yr^{-1}.

Table 4.3: Mean concentrations of metals in precipitation (prec. weighted), 2000.

		As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Precip
		$\mu g/l$	$\mu g/l$	$\mu g/l$	$\mu g/l$	$\mu g/l$	ng/l	$\mu g/l$	$\mu g/l$	mm
IS02	Irafoss	0.03	0.02	0.26	1.04	0.56		0.38	17.03	1545
IS90	Reykjavik	0.04	0.01	0.18	1.58	0.61		0.67	4.27	745
NO01	Birkenes		0.03			1.39			3.22	2253
NO99	Lista	0.29	0.04	0.16	1.11	1.63	7.02^{11}	0.34	6.60	1472^{11} 1570^{12}
SE02	Roervik						7.32			772
SE97	Gaardsjoen	0.10	0.05	0.08		1.59		0.25	13.01	1042
DK08	Anholt	1.38	0.24	0.95	5.63	9.90		1.11	41.86	670
DK31	Ulborg	0.13^{10}	0.03^{10}	0.10^{10}	0.53^{10}	0.76^{10}		0.20^{10}	7.90^{10}	837^{10}
DE41	West. Tinnum	0.15	0.07	0.18		1.09	9.54	0.79	24.53	630 662^{Hg}
NL09	Kollumerw.	0.25^{10}	0.08^{10}	0.27^{10}	1.92^{10}	2.15^{10}		0.31^{10}		674^{10}
NL91	De Zilk	0.12^{11}	0.07^{11}	0.33^{11}	2.21^{11}	3.99^{11}	10.54	0.33^{11}	7.48^{11}	693^{11} 731^{12}
BE04	Knokke wet only	1.29^{11}	0.68^{11}	5.79^{11}	3.55^{11}	25.60^{11}	21.54^{11}	3.70^{11}	18.07^{11}	724^{11} 822^{12}
	bulk		0.30^{11}		4.50^{11}	6.14^{11}			14.14^{10}	1147^{11} 969^{Zn}
GB14	High Muffles	0.14^{8}	0.05^{8}	0.14^{7}	0.79^{7}	2.04^{7}		0.22^{7}	9.61^{8}	1153^{8} 1113^{7}
GB90	East Ruston	0.31^{11}	0.09^{11}	0.22	1.77^{11}	1.64		0.36^{11}	26.88	731^{12} 708^{11}
GB91	Banchory	0.07^{11}	0.04^{11}	0.25^{11}	1.03^{10}	0.90^{11}		0.26^{10}	9.26^{11}	1049^{11} 1015^{Cu} 982^{Ni}
FR90	Porspoder	0.04	0.02	0.18	0.86	1.81		0.71	2.26	1322
IE01	Valentia Is.	0.41	0.04	0.41	2.32	0.50	50.00	0.41	32.59	1769
IE02	Turlough Hill	0.33^{11}	0.07^{11}	0.40^{11}	5.95^{11}	0.52^{11}	41.38^{11}	0.39^{11}	8.33^{11}	1579^{11} 1907^{12}
PT03	V.d.Castelo		0.39		1.24	0.75		0.71	10.43	1891
PT04	Monte Velho		0.38^{9}		0.46^{9}	0.59^{9}		0.69^{9}	7.66^{9}	574^{9}
PT10	A.d.Heroismo		0.42		1.31	1.63		0.76	35.77	919

Numbers or superscript indicate no. months if other than 12.

Table 4.4: Estimated annual wet depositions of priority metals, 2000.

		As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
		$\mu g/m^2$	$\mu g/m^2$	$\mu g/m^2$	$\mu g/m^2$	$\mu g/m^2$	ng/m^2	$\mu g/m^2$	$\mu g/m^2$
IS02	Irafoss	42	25	399	1608	858		583	26305
IS90	Reykjavik	28	8	137	1181	456		497	3185
NO01	Birkenes		69			3132			7265
NO99	Lista	456	61	252	1750	2559	11027^{11}	536	10362
SE02	Roervik						5646		
SE97	Gaardsjoen	105	55	81		1654		258	13553
DK08	Anholt	923	163	634	3774	6632		746	28038
DK31	Ulborg	108^{10}	29^{10}	85^{10}	440^{10}	633^{10}		165^{10}	6613^{10}
DE41	West. Tinnum	100	43	120		715	6321	517	16152
NL09	Kollumerw.	166^{10}	57^{10}	182^{10}	1293^{10}	1451^{10}		209^{10}	
NL91	De Zilk	85^{11}	52^{11}	244^{11}	1618^{11}	2916^{11}	7703	239^{11}	5469^{11}
BE04	Knokke wet only	1057^{11}	559^{11}	4758^{11}	2920^{11}	21046^{11}	17707^{11}	3043^{11}	14854^{11}
	bulk		340^{11}		5168^{11}	7041^{11}			16220^{10}
GB14	High Muffles	165^{8}	57^{8}	164^{7}	914^{7}	2349^{7}		258^{7}	11083^{8}
GB90	East Ruston	225^{11}	64^{11}	158	1295^{11}	1198		262^{11}	19646
GB91	Banchory	78^{11}	45^{11}	264^{11}	1081^{10}	946^{11}		270^{10}	9710^{11}
FR90	Porspoder	53	31	241	1131	2399		938	2990
IE01	Valentia Is.	722	74	722	4109	889	88445	722	57649
IE02	Turlough Hill	638^{11}	124^{11}	764^{11}	11344^{11}	989^{11}	78920^{11}	744^{11}	15877^{11}
PT03	V.d.Castelo		740		2336	1422		1345	19726
PT04	Monte Velho		217^{9}		265^{9}	341^{9}		395^{9}	4402^{9}
PT10	A.d.Heroismo		389		1215	1524		708	33351

Numbers or superscript indicate no. months if other than 12.

Table 4.5: Observed mean annual air concentrations of metals, 2000.

		As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Months
		ng/m³	*ng/m³*	*ng/m³*	*ng/m³*	*ng/m³*	*ng/m³*	*ng/m³*	*ng/m³*	
BE04	Knokke				20.08	41.18		22.58	74.5	Pb 11
DE01	Westerland	1.02	0.17			6.47				
DK08	Anholt	0.35	0.08	0.37	1.18	4.94		1.44	10.30	
DK31	Ulborg	0.28	0.08	0.36	0.98	4.25		0.92	10.13	
GB14	High Muffles	0.50	0.24	1.26	3.12	6.57		2.45	67.46	
GB90	East Ruston	0.89	0.22	1.23	2.24	10.23		0.97	30.50	
GB91	Banchory	0.28	0.05	0.67	0.91	2.13		0.58	20.80	11;Ni 10
IE01	Valentia Island	0.35	0.08	0.37	1.18	4.94		1.44	10.30	
IS91	Storhofdi	0.10	0.09	9.74	1.35	0.54		6.24	9.01	
NL09	Kollumerwaard	0.24	0.09			4.40			11.95	
NO99	Lista	0.29	0.07	0.84	0.66	2.47	1.60	0.82	6.15	Hg 10
NO42	Zeppelinfjellet	0.30	0.02	0.04	0.41	0.41	1.81	0.08	1.57	Hg 4

4.3 Organic compounds

In Tables 4.7–4.12 the annual average values for organic compounds reported to CAMP are listed. With restricted data it is more difficult to identify factors of relevance in interpreting data and developing monitoring efforts. Nevertheless quite strong differences in reported concentrations of some organic compounds between sites suggests either marked gradients, or differences in techniques which may be beneficial to evaluate. Concentrations of organic compounds like of metals frequently are below the detection limits. Comments given with respect to the treatment of metal data are also valid for the organics.

Table 4.6: Annual mean precipitation weighted concentrations of PCB's in precipitation, 2000.

			PCB's									
			28	**31**	**52**	**101**	**105**	**118**	**138**	**153**	**156**	**180**
		months	*ng/l*	*ng/l*	*ng/l*	*ng/l*	*ng/l*	*ng/l*	*ng/l*	*ng/l*	*ng/l*	*ng/l*
IE02	Turlough	10			1.43	2.14		2.17	1.98	1.98		1.65
IS91	Storhofdi	12	0.07	0.07	0.03	0.01	0.01	0.01	0.02	0.02	0.004	0.01

Table 4.7: Estimated annual wet depositions of PCB's, 2000.

		PCB's									
		28	**31**	**52**	**101**	**105**	**118**	**138**	**153**	**156**	**180**
	months	*ng/m2*	*ng/m2*	*ng/m2*	*ng/m2*	*ng/m2*	*ng/m2*	*ng/m2*	*ng/m2*	*ng/m2*	*ng/m2*
IE02	10			2728.15	4084.35		4136.45	3772.10	3772.10		3142.95
IS91	12	45.62	41.67	17.72	6.43	5.74	5.64	8.97	10.23	2.40	7.42

Table 4.8: Observed mean annual air concentrations of PCB's, 2000.

	mnths	PCB's									
		28	**31**	**52**	**101**	**105**	**118**	**138**	**153**	**156**	**180**
		pg/m3	pg/m3	pg/m3	pg/m3	pg/m3	pg/m3	pg/m3	pg/m3	pg/m3	pg/m3
IS91 Storhofdi	12	1.71	1.39	0.71	0.30	0.10	0.16	0.24	0.27	0.10	0.18

Table 4.9: Observed annual wet depositions and mean annual concentrations of non-PCB voluntary list organic substances (prec. weighted), 2000.

	anthracene	**pyrene**	**benzo(a) pyrene**	**benzo(ghi) perylene**	**chrysene**	**indeno(123cd) pyrene**
Depositions						
	ng/m2	*ng/m2*	*ng/m2*	*ng/m2*	*ng/m2*	*ng/m2*
DE41 Tinnum	4548	10264	2063	3558	6597	2726
Precipitation concentrations						
	ng/l	*ng/l*	*ng/l*	*ng/l*	*ng/l*	*ng/l*
DE41 Tinnum	6.91	15.59	3.13	5.40	10.02	4.14

4.4 Time Trends

For the pan-European state of the environment Kiev Report, 2003, OSPAR will be invited to submit both year 2000 and time trend deposition data for the coastal water. The information required will be aggregated rather than station specific raw data. As a suggestion for further development, the following sample of information held on the database is presented whilst only simple indication of the data now assembled by CAMP, figure 4.11 displays time trends for selected components since 1995. These are combinations of several stations (listed) with each station given equal weighing and normalized against its 1994-s two-year mean deposition. These are the stations for which long records are available. Many other stations have not reported so continuously. The figure are intended to contribute do debate. Time trends are of depositions in precipitation, expressed as percentage of 1994-5 means.

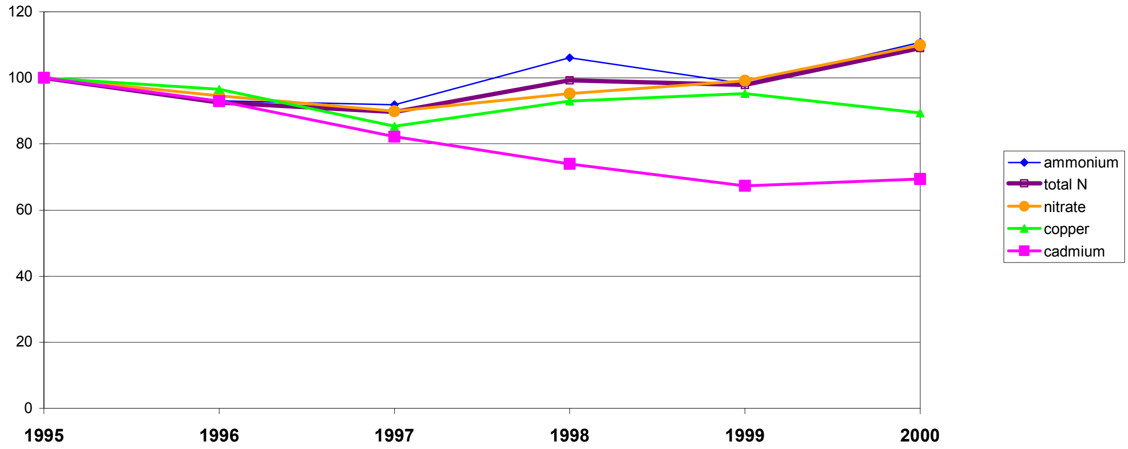


Figure 4.11: Selected time trends of observed annual deposition precipitation: Percentage of 1994-5 depositions.

Table 4.10: Stations used to construct displayed time trends. Stations have complete or near complete data from 1994 to 2000. Stations weighted equally.

Nitrogen	Cadmium	Copper
be03	dk31	be04
de01	gb14	dk31
gb06	gb91	gb14
gb14	ie02	gb90
ie02	nl09	ie01
nl09	nl91	is02
no01	no01	is90
pt04	no99	nl09
se02	se97	nl91
		no99

5 Summary

5.1 Observed values

This report contains the results of monitoring undertaken for CAMP during 2000. The programme calls for Mandatory Monitoring of a range of nutrients, heavy metals and organic compounds in precipitation and air, and encourages participation in a Voluntary Monitoring of additional compounds. Summary results for rates of deposition in precipitation to the coastal waters of the five North Sea zones are given in table 5.1.

Table 5.1: Estimated annual average rates of deposition in precipitation of nutrients and metals to the coastal waters of the five OSPAR maritime areas

Zone	NO_3 *mg N/l*	NH_4 *mg N/l*	As *µg/l*	Cd *µg/l*	Cr *µg/l*	Cu *µg/l*	Pb *µg/l*	Hg *ng/l*	Ni *µg/l*	Zn *µg/l*	prec *mm*
I	0.12	0.05	0.03	0.01	0.23	1.22	0.57		0.47	12.88	970-1150
II	0.47	0.47	0.23	0.08	0.23	1.32	2.44	8.41	0.42	11.33	930-1160
III	0.21	0.12	0.31	0.05	0.38	3.79	0.90	49.99	0.51	15.97	1750-1840
IV	0.15	0.17		0.39		1.06	0.72		0.71	9.79	1100-1230
V	0.06	0.19		0.42		1.32	1.66		0.77	36.29	920

Maritime regions shown in figure 1.1. Distribution of monitoring stations between regions given in tables 3.1, 4.1. and 4.3. Values are precipitation weighted. Precipitation values represent the range across components for that region. Part-year values scaled to 12-months proportional with precipitation if known, otherwise linearly with time.

Stations coverage is variable between regions. Region 2 is represented by upto 13 stations according to component, whilst region 5 is represented by only one station. Patterns are to a good degree understandable. Values in Zone 2 (Greater North Sea) tend to the upper end of observations. Those in Zone 1 (Arctic waters) and to a lesser extent Zone 4 (Bay of Biscay/Iberian Coast) are at the lower end. It is inevitably more difficult to extend the results from a single station, as in Wider Atlantic (Zone 5) waters, to the whole Zone; careful QA/QC work for the station is thus advisable. Other results indicate benefit might be gained from a thorough quality review. For example, the Zone 3 (Celtic Seas) value for mercury reflects high reported concentrations by two Irish stations, these being notably above the observations from the five stations supplying the estimate for Zone 2.

5.2 Monitoring and reporting procedures, year 2000.

Monitoring should be conducted at monitoring stations located in proximity to the coast. Most stations in 2000 did meet the ten kilometre objective, the furthest station from the coast being some 26 kilometres inland. All countries submitted data.

Geographical coverage is greatest for the Greater North Sea (zone 2). For this region the derivation of reliable estimates of total-basin supply may be considered feasible. Perhaps inevitably given the restricted coastline therein, coverage is most limited for wider Atlantic waters (zone 5). Improved coverage might also be desirable for the Celtic seas (zone 3) and especially for Arctic waters (zone 1): at present observations are reported only from the western and northern extremities, despite very long coastlines. Several countries do have additional stations within their national networks, and review by Parties of whether additional existing national stations which might be able to supply data of value to OSPAR might be undertaken.

Monitoring of Mandatory precipitation components is reasonable, although some were monitored to a notably lesser degree than others, e.g. γ-HCH and mercury. Less attention is given to the Voluntary programme, especially to the precipitation element in which organic substances feature.

Countries monitor equivalent time periods, with some exceptions. A number of countries do recommence their monitoring periods at the start of each month thus allowing true monthly values to be derived. However, some do not, and some have very long monitoring period, making comparability less straightforward. Reporting practices also vary. Whilst some aggregate all samples in each month prior to analysis, others aggregate results of several shorter samples, and others report raw short-period data. Reporting of observations to the CAMP manager followed the revised time scale reasonably well (see Appendix B). Delay occurred at the stage of review by countries of calculated monthly values.

Differences in techniques, laboratories and procedures may be worth some evaluation by countries. For example, metal and organic concentrations frequently are below the detection limits of analytical devices and in some cases detection limits are unusually high. Side-by-side samples analysed at different laboratories yield large differences in estimates. Similarly, some quite clear differences in the estimates provided by different countries may not only reflect differences in environmental occurrence. Where there is a very limited geographical coverage of stations the importance of good practice is highlighted. In light of these various factors, Parties are invited to carefully review their practices.

Appendix A

Observed monthly mean depositions in precipitation and concentrations in air at CAMP coastal monitoring stations, 2000

Appendix is divided by country, and thereafter by station. Each station heading contains observations of both precipitation and airborne concentrations during 2000. The following countries and stations which reported data for 2000 are listed.

Belgium	BE0003, BE0004, BE0011, BE0013
Denmark	DK0008, DK0031
France	FR0090
Germany	DE0001
Iceland	IS0002, IS0090, IS0091
Ireland	IE0001, IE0002
Netherlands	NL0009, NL0091
Norway	NO0042, NO0099, NO0001
Portugal	PT0003, PT0004, PT0010
Spain	ES0005, ES0008
Sweden	SE0002, SE0097, SE0098
United Kingdom	GB0014, GB0016, GB0090, GB0091, GB0095

Grey areas on tables indicate measurements below detection limits, or derived from shorter time resolution measurements which were largely below detection limits. OSPAR principles were applied to calculate mean values (Appendix B).

Belgium

BE0003 Brugge
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	18.78	45.04	61.78	31.56	145.17	27.08	36.92	131.58	35.65	41.86	38.34	37.11	651	12
nitrate	mg N/m2	10.73	20.98	26.99	32.85	80.60	29.48	33.39	63.75	22.65	27.49	23.99	16.40	389	12
precipitation	mm	23.4	53.3	35.4	31.5	109.9	34.9	87.4	108.5	50.2	106.5	106.3	65.0	812	12

BE0004 Knokke
Mean Air Concentrations
Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	no. months
copper	ng/m3	20.00	20.00	21.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.08	12
lead	ng/m3	54.00	45.00	39.00	33.00	40.00	35.00	30.00	34.00	44.00	47.00	51.00	52.00	42.00	12
nickel	ng/m3	22.00	22.00	24.00	23.00	25.00	23.00	24.00	24.00	22.00	21.00	20.00	21.00	22.58	12
zinc	ng/m3	89.00	77.00	71.00	70.00	67.00	64.00	54.00	53.00	82.00	84.00	92.00	91.00	74.50	12

BE0004 Knokke

Depositions in Precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
Wet-only sampler															
aldrin	ng/m2	105.34	130.88	57.22	112.44		64.00	133.63	87.17	127.55	193.02	160.60	109.70	1282	11
p-DDD	ng/m2	52.67	65.44	28.61	56.22		32.00	66.82	43.58	63.78	96.51	80.32	54.85	641	11
p-DDE	ng/m2	52.67	65.44	28.61	56.22		32.00	66.82	43.58	63.78	96.51	80.32	54.85	641	11
p-DDT	ng/m2	52.67	65.44	28.61	56.22		32.00	66.82	43.58	63.78	96.51	80.32	54.85	641	11
dieldrin	ng/m2	52.67	65.44	28.61	56.22		32.00	66.82	43.58	63.78	96.51	80.32	54.85	641	11
endrin	ng/m2	105.34	130.88	57.22	112.44		64.00	133.63	87.17	127.55	193.02	80.32	109.70	1201	11
a-HCH	ng/m2	52.67	65.44	28.61	56.22		32.00	66.82	43.58	63.78	96.51	80.32	54.85	641	11
g-HCH	ng/m2	158.01	392.64	1401.79	3598.08		544.00	400.90	392.26	382.66	579.07	642.60	164.55	8657	11
heptachlor	ng/m2	52.67	65.44	28.61	56.22		32.00	66.82	43.58	63.78	96.51	80.32	54.85	641	11
arsenic	µg/m2	68.47	85.07	37.19	73.09		41.60	86.86	56.66	82.91	241.28	104.42	179.47	1057	11
cadmium	µg/m2	36.87	45.81	40.05	39.35		22.40	46.77	30.51	76.53	67.56	56.22	96.64	559	11
chromium	µg/m2	42.14	117.79	105.85	2754.78		172.80	734.98	104.60	153.06	173.72	249.00	148.84	4758	11
copper	µg/m2	352.89	137.42	163.07	134.93		278.40	106.91	65.38	318.88	453.61	401.60	506.60	2920	11
lead	µg/m2	1000.73	444.99	1830.91	2248.80		896.00	1804.03	4053.31	2423.49	3570.94	1445.75	1327.50	21046	11
mercury	ng/m2	526.70	1963.20	858.24	1686.60		1280.00	668.16	1307.52	1913.28	2895.36	2409.60	2198.16	17707	11
nickel	µg/m2	284.42	91.62	85.82	1855.26		44.80	46.77	56.66	114.80	135.12	120.48	206.89	3043	11
zinc	µg/m2	790.05	785.28	2574.72	2080.14		896.00	340.76	523.01	1084.19	1737.22	1285.12	2757.30	14854	11
precipitation	mm	52.7	65.4	28.6	56.2	98.1	32.0	66.8	43.6	63.8	96.5	107.7	110.7	822	12

BE0004 Knokke
Depositions in Precipitation (continued)

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
Bulk sampler															
cadmium	µg/m2	6.45	10.86	24.55	38.65	32.95	52.58		7.37	5.62	8.89	6.83	145.32	340	11
copper	µg/m2	395.16	521.66	278.07	657.51	493.57	237.28		278.05	469.83	739.65	567.84	529.83	5168	11
lead	µg/m2	341.64	335.71	437.09	2504.52	1536.48	445.32		186.26	294.49	122.68	328.97	507.97	7041	11
zinc	µg/m2	425.15	1536.29	1267.97	1160.27	3114.14	1168.03		1422.41	1811.89		3744.20	569.70	16220	10
precipitation	mm	94.9	124.8	66.7	77.3	105.6	55.7		67	112.4	177.8	136.5	128.6	1147	11

BE0011 Moerkerke
Mean Air Concentrations

		January	February	March	April	May	June	July	August	September	October	November	December	mean	months
NO2	µg N/m^3	8.52	6.39	6.70	6.09	6.09	4.87	4.26	5.48	5.17	5.48	5.78	7.00	5.99	12
NO	µg N/m^3	3.73	1.87	2.33	0.93	0.93	0.93	0.93	1.40	1.40	1.40	0.93	7.00	1.98	12

BE0013 Houtem
Mean Air Concentrations Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	mean	months
NO2	µg N/m^3	6.09	4.57	5.78	4.87	4.87	4.26	3.65	4.57	4.26	4.26	4.26	4.26	4.64	12
NO	µg N/m^3	1.87	0.93	1.87	0.93	0.93	0.00	0.00	0.93	0.93	0.93	0.00	4.20	1.25	12

Denmark

DK0008 – Anholt
Depositions in precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	total	months
ammonium	mg N/m^2	11.98	14.23	14.87	60.90	43.83	7.74	7.21	11.73	24.45	51.27	49.17	16.13	314	12
nitrate	mg N/m^2	14.86	21.99	21.20	55.05	50.04	21.44	14.93	39.50	32.30	58.04	70.16	22.95	422	12
arsenic	µg/m2	5.50	9.85	58.94	90.41	55.31	27.00	9.54	8.79	108.22	260.12	188.24	100.91	923	12
cadmium	µg/m2	1.10	1.07	4.98	15.63	10.85	5.54	1.52	3.40	23.56	43.60	36.58	15.68	163	12
chromium	µg/m2	5.58	8.73	45.63	198.95	44.02	25.33	10.13	24.37	60.32	106.85	78.06	26.49	634	12
copper	µg/m2	12.90	12.68	105.32	655.65	438.31	81.17	48.65	146.62	757.91	620.82	686.98	206.78	3774	12
lead	µg/m2	26.84	20.83	179.10	1091.88	623.38	151.24	72.79	250.82	818.23	1555.85	1340.84	499.84	6632	12
nickel	µg/m2	10.55	5.73	30.41	136.13	56.94	12.10	15.62	50.87	140.73	113.16	159.27	14.37	746	12
zinc	µg/m2	243.40	200.18	1822.05	2841.03	2614.08	1045.44	270.12	1665.70	3857.31	6124.96	5521.54	1832.32	28038	12
precipitation-N	mm	26.2	24.6	63.5	83.7	63.3	54.1	39.7	36.7	75.2	95.0	99.0	41.4	703	12
precipitation-metals	mm	22.7	23.5	57.6	71.9	61.5	52.7	31.8	31.2	80.4	85.8	87.4	63.4	670	12

Mean Air Concentrations Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	no. months
arsenic	ng/m3	0.23	0.28	0.21	0.60	0.29	0.30	0.13	0.14	0.40	0.61	0.57	0.42	0.35	12
cadmium	ng/m3	0.10	0.07	0.01	0.12	0.03	0.05	0.03	0.05	0.08	0.20	0.10	0.10	0.08	12
chromium	ng/m3	0.60	0.41	0.16	0.36	0.54	0.61	0.06	0.17	0.33	0.42	0.50	0.29	0.37	12
copper	ng/m3	0.92	1.17	0.53	1.47	1.19	1.31	0.22	0.68	1.28	1.87	2.12	1.46	1.18	12
lead	ng/m3	4.39	3.74	1.87	6.99	3.12	3.27	1.31	2.18	6.20	10.84	9.27	6.07	4.94	12
nickel	ng/m3	0.81	1.11	1.10	2.82	1.88	2.06	1.40	1.07	1.21	1.49	1.35	1.03	1.44	12
zinc	ng/m3	9.27	9.67	4.82	15.82	8.29	8.09	4.66	5.09	10.95	16.74	18.62	11.60	10.30	12

DK0031 – Ulborg
Depositions in precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	no. months
arsenic	µg/m^2	199.29	40.96	65.12		102.66	19.80	13.57	64.77	182.16	375.07		17.85	108	10
cadmium	µg/m^2	64.31	34.88	11.79		14.77	7.27	10.93	11.92	41.73	86.20		9.05	29	10
chromium	µg/m^2	137.00	83.56	63.02		84.25	12.05	9.09	29.81	73.89	227.31		19.50	74	10
copper	µg/m^2	607.33	233.50	161.55		315.70	104.54	127.49	157.83	707.69	1196.79		79.76	369	10
lead	µg/m^2	1360.44	540.81	293.93		738.43	175.10	111.71	215.38	907.35	1870.08		116.55	633	10
nickel	µg/m^2	319.88	108.84	198.11		58.19	17.32	25.58	99.99	223.44	188.11		33.64	127	10
zinc	µg/m^2	16021.09	5345.42	1486.25		6991.25	1217.57	1169.89	2083.49	6759.41	16204.74		1999.48	5928	10
precipitation	mm	126.24	98.60	70.57		79.74	45.16	50.68	65.41	100.04	142.22		58.65	837	10

Mean Air Concentrations Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	no. months
NO3+HNO3	µg N/m^3	0.46	0.79	0.44	1.60	0.82	0.61	0.30	0.38	0.68	0.33	0.87	0.65	0.66	12
NH3+NH4	µg N/m^3	0.80	1.29	1.11	3.69	2.41	1.20	0.98	0.83	1.47	0.66	1.18	1.22	1.40	12
arsenic	ng/m3	0.17	0.24	0.19	0.56	0.37	0.21	0.10	0.14	0.32	0.41	0.24	0.47	0.28	12
cadmium	ng/m3	0.07	0.06	0.03	0.09	0.06	0.06	0.05	0.00		0.13	0.12	0.19	0.08	12
chromium	ng/m3	0.27	0.22	0.08	0.49	0.84	0.58	0.09	0.23	0.36	0.44	0.47	0.28	0.36	12
copper	ng/m3	0.68	0.69	0.27	1.53	1.37	1.07	0.43	0.32	1.15	1.54	1.32	1.44	0.98	12
lead	ng/m3	3.45	4.05	1.93	6.82	3.67	3.47	1.60	1.52	5.17	7.75	5.88	5.65	4.25	12
nickel	ng/m3	0.71	0.88	0.78	1.59	1.16	1.22	0.83	0.75	0.85	0.75	0.81	0.68	0.92	12
zinc	ng/m3	7.49	8.71	6.28	14.41	11.72	7.89	4.30	4.35	11.45	16.73	13.39	14.79	10.13	12

France

FR0090R – Porspoder
Depositions in precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	11.86	5.06	41.92	37.37	72.81	30.96	47.71	9.41	35.76	18.21	3.54	3.15	318	12
nitrate	mg N/m^2	37.49	10.66	55.99	98.42	12.28	75.55	42.39	15.03	19.59	8.90	13.37	18.74	408	12
arsenic	µg/m^2	5.08	5.70	5.93	12.01	3.80	3.39	3.37	1.94	1.05	2.46	4.55	4.05	53	12
cadmium	µg/m^2	1.69	0.81	2.16	6.86	2.53	3.39	1.87	1.21	1.05	1.23	4.55	4.05	31	12
chromium	µg/m^2	20.33	3.26	2.16	3.43	26.57	32.19	12.34	5.08	17.77	13.55	86.53	18.22	241	12
copper	µg/m^2	99.10	113.96	44.20	187.04	61.99	108.42	118.56	64.13	37.62	65.30	127.51	103.22	1131	12
lead	µg/m^2	255.79	175.82	64.68	247.10	173.31	151.61	181.39	56.87	110.77	155.23	500.94	325.86	2399	12
nickel	µg/m^2	28.80	62.68	30.18	211.07	68.31	54.21	170.92	65.34	27.17	59.14	91.08	68.82	938	12
zinc	µg/m^2	286.29	103.38	213.98	657.23	266.92	327.79	289.85	54.45	147.35	204.51	195.82	242.88	2990	12
precipitation	mm	84.7	81.4	53.9	171.6	126.5	84.7	37.4	24.2	104.5	123.2	227.7	202.4	1322	12

Germany

DE0041 Westerland - Tinnum
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	25.82	27.62	29.34	43.65	55.27	30.20	20.49	32.23	38.21	25.58	37.91	18.20	385	12
nitrate	mg N/m^2	21.13	36.01	33.74	29.98	39.16	23.79	16.36	31.01	40.85	34.43	74.29	30.47	411	12
all organics are ng/m2															
HCB		22.36	11.28	14.29	70.33	10.10	13.23	25.03	6.68	15.61	25.40	41.60	21.11	277	12
alpha_HCH		10.92	24.56	24.19	18.52	35.18	27.69	39.71	19.47	31.87	67.97	74.79	44.01	419	12
anthracene		29.00	261.00	165.00	1509.00	251.00	222.00	347.00	220.00	275.00	224.00	517.00	528.00	4548	12
benz_a_anthracene		68.00	237.00	172.00	904.00	240.00	176.00	311.00	309.00	250.00	241.00	672.00	663.00	4243	12
benzo_a_pyrene		36.00	99.00	55.00	101.00	161.00	157.00	156.00	267.00	141.00	183.00	354.00	353.00	2063	12
benzo_b_fluoranthene		123.00	339.00	208.00	204.00	253.00	178.00	199.00	350.00	236.00	379.00	1350.00	1148.00	4967	12
benzo_ghi_perylene		98.00	236.00	175.00	139.00	205.00	133.00	181.00	310.00	188.00	267.00	845.00	781.00	3558	12
benzo_k_fluoranthene		53.00	135.00	82.00	93.00	114.00	81.00	92.00	164.00	98.00	150.00	479.00	428.00	1969	12
chrysene		129.00	428.00	265.00	548.00	311.00	241.00	293.00	445.00	304.00	487.00	1855.00	1291.00	6597	12
dieldrin		11.76	14.26	11.73	6.09	7.10	4.50	7.94	4.53	8.70	29.84	58.12	27.97	193	12
fluoranthene		276.04	866.33	3402.36	436.88	828.04	830.56	2246.88	477.12	627.30	3462.12	3701.88		17156	11
gamma_HCH		49.01	183.70	225.43	737.48	847.98	379.82	236.71	123.22	216.83	412.21	384.81	206.66	4004	12

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
inden_123cd_pyrene		40.00	162.00	143.00	87.00	137.00	86.00	40.00	221.00	135.00	203.00	646.00	826.00	2726	12
phenanthrene		277.00	1106.00	672.00	1847.00	872.00	758.00	887.00	1014.00	873.00	1500.00	3862.00	2736.00	16404	12
pyrene		179.00	550.00	379.00	1045.00	506.00	443.00	585.00	806.00	633.00	914.00	2333.00	1890.72	10264	12
arsenic	µg/m^2	3.75	8.89	7.95	5.99	6.95	4.13	2.95	4.94	7.62	14.21	19.66	12.70	100	12
cadmium	µg/m^2	2.26	2.07	3.39	2.97	2.80	3.21	1.66	2.34	3.24	4.99	9.12	5.00	43	12
chromium	µg/m^2	3.24	3.20	4.65	6.86	10.21	9.49	7.88	2.45	11.37	20.47	25.16	14.58	120	12
lead	µg/m^2	47.33	69.52	39.20	26.42	54.50	34.41	32.27	35.36	58.90	61.76	180.02	75.44	715	12
mercury	µg/m^2	240.10	350.47	191.45	429.63	398.41	472.00	264.46	447.78	480.60	439.71	1065.87	1540.07	6321	12
nickel	µg/m^2	27.06	36.04	31.94	40.74	37.32	67.43	23.97	25.19	28.86	65.14	77.32	55.94	517	12
zinc	µg/m^2	964.92	1139.32	1389.08	2036.85	1315.88	1269.45	811.36	996.71	1113.21	1497.42	2388.78	1229.02	16152	12
precipitation	all mm	29.4	36.4	48.4	36.7	49.1	46.5	46.1	22.1	58.9	84.6	115.4	84.8	658	12
precipitation -N		30.0	38.0	43.2	35.3	48.6	50.4	45.4	20.2	59.2	84.0	101.8	73.9	630	12
precipitation - Hg		34.5	39.2	44.1	36.9	47.8	49.2	45.7	22.0	59.3	92.7	109.2	81.6	662	12

DE0001 Westerland
Mean Air Concentrations

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	no. months
NO2	µg N/m^3	2.50	2.60	1.70	2.10	1.70	1.30	1.00	1.20	2.10	2.90	4.00	2.80	2.16	12
nitrate	µg N/m^3	0.56	0.96	0.53	1.20	0.52	0.56	0.18	0.60	0.88	0.88	1.03	1.00	0.74	12
ammonium	µg N/m^3	0.15	0.17	0.27	0.92	0.20	0.41	0.10	0.32	0.85	0.98	0.78	0.96	0.51	12
arsenic	ng/m3	0.64	1.09	0.56	1.16	1.62	0.60	0.79	0.80	1.30	1.30	0.63	1.74	1.02	12
cadmium	ng/m3	0.16	0.16	0.08	0.21	0.19	0.09	0.04	0.11	0.22	0.26	0.21	0.27	0.17	12
lead	ng/m3	7.31	6.57	3.01	7.90	6.56	4.17	2.19	3.54	8.30	10.73	7.99	9.31	6.47	12

Iceland

IS0002 – Irafoss

Depositions in precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N /m^2	6.443	7.0805	21.909	0.43	16.7165	45.792	0.952	2.366	19.676	14.836	3.717	0.238	140	12
nitrate	mg N /m^2	4.184	2.252	10.843	4.11	17.449	7.616	10.0245	2.09	8.801	1.733	2.38	0.846	72	12
arsenic	µg/m2	1.94	3.48	7.04	2.31	7.95	1.93	4.61	3.16		2.61	1.21	1.04	42	12
cadmium	µg/m2	6.86	2.90	3.50	0.83	2.01	0.75	2.04	1.25	1.16	1.04	0.78	1.74	25	12
chromium	µg/m2	4.60	21.95	14.08	25.39	18.92	25.56	9.22	197.43	20.70	5.22	30.50	24.98	399	12
copper	µg/m2	150.29	192.09	332.02	91.65	98.60	116.30	78.36	139.50	126.30	47.05	108.51	127.22	1608	12
lead	µg/m2	64.81	110.06	173.81	77.06	75.04	42.71	51.92	39.41	60.04	31.56	30.79	101.10	858	12
nickel	µg/m2	12.29	30.55	43.31	40.71	62.83	35.40	9.22	201.49	37.38	32.07	43.34	33.90	583	12
zinc	µg/m2	2913.65	3793.72	10398.85	618.90	803.08	436.49	1057.70	554.33	1395.48	1317.40	1132.82	1882.98	26305	12
	µg/m2														
precipitation-N	mm	69.6	124.3	242.6	86.3	204.9	77.0	190.8	117.8	183.7	102.3	48.5	40.0	1488	12
precipitation-metals	mm	77.6	139.3	281.7	93.4	188.3	76.2	184.7	120.2	188.4	104.5	48.6	41.7	1545	12

IS0090 Reykjavik

Depositions in Precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N /m^2	26.47	24.35	39.65	6.13	5.35	9.81	0.18	8.09	30.74	10.86	3.89	3.50	169	12
nitrate	mg N /m^2	4.16	3.44	9.09	2.87	5.64	5.60	4.09	2.64	7.66	1.88	0.764	1.2	49	12
arsenic	µg/m2	5.34	2.30	3.06	1.44	3.01	2.79	1.1176	1.94	3.92	1.29	0.30	1.11	28	12
cadmium	µg/m2	2.33	0.55	0.97	0.54	0.96	0.53	0.45	0.33	0.92	0.34	0.061	0.20497	8	12
chromium	µg/m2	17.39	3.26	6.71	26.77	10.85	26.48	13.176	5.12	15.86	2.58	2.34	6.15	137	12
copper	µg/m2	132.22	50.90	120.39	118.83	116.04	162.85	68.72	81.05	107.72	99.45	42.21	80.44	1181	12
lead	µg/m2	36.32	23.19	51.40	51.24	42.27	52.64	24.93	24.50	51.61	69.59	11.24	17.50	456	12
nickel	µg/m2	118.90	10.99	28.49	103.55	43.12	39.04	17.57	46.77	26.79	35.07	10.30	15.9518	497	12
zinc	µg/m2	326.83	101.93	174.64	456.23	405.70	350.66	161.43	161.16	430.75	338.99	136.56	140.183	3185	12
precipitation - N	mm	42.9	63.7	112.5	27.7	43.8	57.6	36.6	65.3	130.5	48.9	10.8	35.1	675	12
precipitation - rest	mm	82.9	65.1	119.5	31.7	47.2	58.8	37.1	63.1	137.0	51.7	12.4	38.7	745	12

IS0091 Storhofdi

Depositions in Precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
HCB	ng/m2	0.80	1.10	1.19	4.10	1.41	0.49	0.49	0.38	1.43	0.79	0.71	0.93	14	12
PCB28	ng/m2	4.8	4.80	4.80	4.80	4.81	4.80	1.8	1.78	4.31	1.80	1.80	5.29	46	12
PCB31	ng/m2	3.70	5.65	3.69	3.69	3.69	3.69	2.9	1.60	4.51	1.59	1.60	5.30	42	12
PCB52	ng/m2	1.8	1.80	1.80	1.80	1.79	1.80	1.30	0.80	1.58	0.81	0.79	1.60	18	12
PCB101	ng/m2	0.6	0.59	0.60	1.39	0.59	0.60	0.20	0.20	0.36	0.19	0.87	0.20	6	12
PCB105	ng/m2	0.3	0.90	0.55	0.94	0.30	0.40	0.24	0.10	0.56	0.25	0.63	0.51	6	12
PCB118	ng/m2	0.40	0.39	0.39	1.39	0.39	0.40	0.20	0.20	0.33	0.19	0.98	0.32	6	12
PCB138	ng/m2	0.70	0.69	0.70	2.45	0.70	0.70	0.3	0.30	0.69	0.30	0.87	0.52	9	12
PCB153	ng/m2	0.70	0.69	0.70	3.05	0.70	0.70	0.65	0.30	0.76	0.30	1.14	0.49	10	12
PCB156	ng/m2	0.19	0.19	0.20	0.20	0.19	0.19	0.20	0.20	0.19	0.19	0.20	0.20	2	12
PCB180	ng/m2	0.49	0.51	0.49	3.25	0.50	0.50	0.40	0.20	0.36	0.19	0.30	0.20	7	12
a-HCH	ng/m2	10.39	12.60	11.01	6.50	11.50	5.79	7.90	13.89	21.01	21.67	7.40	10.50	140	12
b-HCH	ng/m2	0.19	0.59	0.48	0.20	0.19	0.19	0.24	0.25	0.52	0.38	1.17	0.35	5	12
g-HCH	ng/m2	2.60	5.30	5.90	2.89	15.20	4.59	4.67	2.77	7.20	6.48	2.69	3.19	64	12
cis-CD	ng/m2	0.6	1.10	0.79	0.44	0.46	0.29	0.19	0.10	0.36	0.41	0.19	0.38	5	12
dieldrin	ng/m2	2.50	3.77	4.82	2.20	2.70	1.00	0.95	0.60	2.46	3.12	2.05	1.93	28	12
op-DDT	ng/m2	0.40	0.39	0.39	0.39		0.70	0.09	0.10	0.11	0.11	0.09	0.1	3	12
pp-DDD	ng/m2	0.19	0.19	0.20	0.20	0.19	0.39	0.20	0.20	0.19	0.19	0.20	0.20	3	12

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
pp-DDE	ng/m2	0.6	1.02	0.61	0.20	0.19	0.19	0.75	0.22	0.11	0.11	0.09	0.29	4	12
pp-DDT	ng/m2	0.3	1.04	0.30	0.44	1.56	0.297	0.20		0.19	1.30	0.20	0.20	6	12
trans-CD	ng/m2	0.3	0.44	0.46	0.29	0.30	0.29		0.10	0.37	0.11	0.09		3	12
trans-NO	ng/m2	0.3	0.44	0.46	0.29	0.30	0.29	0.09	0.10	0.11	0.11	0.09	0.1	3	12
precipitation	mm	35	57	75	23.5	68	18.5	53	48	99	76	22	42	617	12

Mean Air Concentrations Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
arsenic	ng/m3	0.07	0.14	0.11	0.17	0.11	0.08	0.08	0.06	0.12	0.07	0.10	0.11	0.10	12
cadmium	ng/m3	0.08	0.16	0.19	0.06	0.16	0.02	0.08	0.05	0.02	0.03	0.03	0.14	0.08	12
chromium	ng/m3	19.86	12.06	14.89	4.65	4.61	14.75	15.94	7.55	16.85	9.64	3.75	5.57	10.84	12
copper	ng/m3	1.86	1.61	0.98	3.08	1.11	0.83	0.65	0.44	1.95	0.76	1.86	2.17	1.44	12
lead	ng/m3	0.73	0.82	0.63	0.77	0.53	0.38	0.64	0.22	0.49	0.20	0.50	0.57	0.54	12
nickel	ng/m3	17.23	9.84	9.33	2.82	3.28	8.06	9.16	5.45	9.82	6.59	2.97	3.93	7.37	12
zinc	ng/m3	15.82	25.68	11.86	7.79	17.85	2.37	4.10	3.17	4.57	2.79	6.77	7.69	9.20	12
nitrate	µg N/m^3	0.03	0.02	0.03	0.04	0.05	0.07	0.11	0.02	0.04	0.02	0.06	0.02	0.04	12
HCB	pg/m3	5.19	6.68	5.23	6.67	6.30	5.18	3.61	4.30	6.85	6.03	5.56	8.74	5.87	12
PCB28	pg/m3	2.20	2.52	2.09	2.49	2.20	2.30	0.79	0.88	0.83	0.88	0.91	2.31	1.71	12
PCB31	pg/m3	1.69	1.95	1.61	1.92	1.70	1.77	0.71	0.79	0.74	0.78	0.81	2.16	1.39	12
PCB52	pg/m3	0.82	0.94	0.78	0.93	0.82		0.35	0.39	0.37	0.39	0.40	1.34	0.71	12
PCB101	pg/m3	0.27	0.31	0.26	0.31	0.27	0.28	0.33	0.19	0.38	0.09	0.29	0.56	0.30	12
PCB105	pg/m3	0.14	0.15	0.13	0.15	0.13	0.14	0.04	0.04	0.08	0.04	0.05	0.04	0.10	12
PCB118	pg/m3	0.185	0.20	0.17	0.20	0.18	0.19	0.08	0.09	0.13	0.09	0.10	0.18	0.16	12
PCB138	pg/m3	0.32		0.30	0.36	0.32	0.33	0.13	0.14	0.13	0.14	0.15	0.14	0.24	12

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
PCB153	pg/m3	0.32	0.37	0.31	0.36	0.32	0.34	0.36	0.15	0.23	0.15	0.15	0.23	0.27	12
PCB156	pg/m3	0.09	0.10	0.09	0.10	0.09	0.10	0.09	0.10	0.09	0.10	0.10	0.10	0.10	12
PCB180	pg/m3	0.23	0.26	0.22	0.26	0.23	0.24	0.09	0.10	0.09	0.28	0.10	0.10	0.18	12
a-HCH	pg/m3	6.30	7.74	5.65	8.02	7.91	7.84	6.91	8.41	11.46	8.31	6.80	8.30	7.80	12
b-HCH	pg/m3	0.09	0.10	0.09	0.10	0.19	0.34	0.05	0.05	0.05	0.05	0.05	0.05	0.10	12
g-HCH	pg/m3	1.89	1.95	3.04	4.59	6.53	4.61	3.25	2.87	5.26	3.58	4.97	3.41	3.83	12
cis-CD	pg/m3	0.82	0.79	0.88	1.04	1.08	1.06	1.43	1.29	1.21	1.13	0.93	0.83	1.04	12
dieldrin	pg/m3	0.96	1.16	1.27	1.20	1.38	1.44	1.18	0.85	0.97	0.97	1.07	0.89	1.11	12
op-DDT	pg/m3	0.19	0.21	0.17		0.18	0.19	0.05	0.05	0.05	0.05	0.05	0.05	0.12	12
pp-DDD	pg/m3	0.09	0.10	0.09	0.10		0.10	0.09	0.10	0.09	0.10	0.10	0.10	0.10	12
pp-DDE	pg/m3	0.23	0.21	0.31	0.10	0.18	0.10	0.30	0.21	0.17	0.19	0.40	0.31	0.23	12
pp-DDT	pg/m3	0.14	0.16		0.15	0.14	0.27	0.09	0.01	0.09	0.10	0.10	0.10	0.13	12
trans-CD	pg/m3	0.55	0.48	0.61	0.62	0.60	0.72	0.58	0.48	0.44	0.41	0.39	0.38	0.52	12
trans-NO	pg/m3	0.55	0.48	0.61	0.73	0.60	0.77	0.70	0.53	0.50	0.51	0.50	0.45	0.58	12

Ireland

IE0001 Valentia

Depositions in Precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
arsenic	µg/m2	26.03	49.30	10.63	19.25	30.38	27.03	41.00	45.35	76.10		135.00	107.35	722	12
cadmium	µg/m2	2.60	4.93	2.98	1.93	3.04	2.70	4.10	4.54	7.61	15.45	13.50	10.74	74	12
chromium	µg/m2	26.03	49.30	10.63	19.25	30.38	27.03	41.00	45.35	76.10	154.45	135.00	107.35	722	12
copper	µg/m2	62.46	49.30	51.00	19.25	72.90	27.03	41.00	181.40	76.10	154.45	3267.00	107.35	4109	12
lead	µg/m2	26.03	49.30	42.50	19.25	30.38	27.03	41.00	45.35	76.10	154.45	270.00	107.35	889	12
mercury	µg/m2	5205.00	9860.00	2125.00	3850.00	6075.00	5405.00	4100.00	4535.00	7610.00	15445.00	13500.00	10735.00	88445	12
nickel	µg/m2	26.03	49.30	10.63	19.25	30.38	27.03	41.00	45.35	76.10	154.45	135.00	107.35	722	12
zinc	µg/m2	4819.83	7513.32	2023.00	1547.70	1944.00	3005.18	4436.20	3165.43	2587.40	11985.32	9963.00	4658.99	57649	12
precipitation	mm	104.1	197.2	42.5	77	121.5	108.1	82	90.7	152.2	308.9	270	214.7	1769	12

Mean Air Concentrations Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	months
arsenic	ng/m3	0.23	0.28	0.21	0.60	0.29	0.30	0.13	0.14	0.40	0.61	0.57	0.42	0.35	12
cadmium	ng/m3	0.10	0.07	0.01	0.12	0.03	0.05	0.03	0.05	0.08	0.20	0.10	0.10	0.08	12
chromium	ng/m3	0.60	0.41	0.16	0.36	0.54	0.61	0.06	0.17	0.33	0.42	0.50	0.29	0.37	12
copper	ng/m3	0.92	1.17	0.53	1.47	1.19	1.31	0.22	0.68	1.28	1.87	2.12	1.46	1.18	12
lead	ng/m3	4.39	3.74	1.87	6.99	3.12	3.27	1.31	2.18	6.20	10.84	9.27	6.07	4.94	12
nickel	ng/m3	0.81	1.11	1.10	2.82	1.88	2.06	1.40	1.07	1.21	1.49	1.35	1.03	1.44	12
zinc	ng/m3	9.27	9.67	4.82	15.82	8.29	8.09	4.66	5.09	10.95	16.74	18.62	11.60	10.30	12

IE0002 Turlough Hill

Depositions in Precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N /m^2	33.03	9.69	16.07	73.44	61.82	79.85	27.68	48.85	32.66	25.44			409	10
nitrate	mg N /m^2	13.21	12.46	13.96	52.02	23.78	31.54	17.61	26.75	20.63	16.19			228	10
arsenic	µg/m2	27.53	34.60	10.58	38.25	23.78	16.78	31.45	58.15	85.95	115.65	195.00		638	11
cadmium	µg/m2	2.75	9.69	4.65	15.30	6.66	1.68	3.15	5.82	8.60	23.13	42.90		124	11
chromium	µg/m2	27.53	34.60	84.60	38.25	76.08	16.78	31.45	58.15	85.95	115.65	195.00		764	11
copper	µg/m2	165.15	138.40	224.19	137.70	104.61	16.78	106.93	58.15	85.95	439.47	9867.00		11344	11
lead	µg/m2	77.07	138.40	118.44	38.25	114.12	16.78	31.45	58.15	85.95	115.65	195.00		989	11
mercury	ng/m2	5505.00	6920.00	2115.00	7650.00	4755.00	3355.00	3145.00	5815.00	8595.00	11565.00	19500.00		78920	11
nickel	µg/m2	27.53	34.60	63.45	91.80	23.78	16.78	31.45	58.15	85.95	115.65	195.00		744	11
zinc	µg/m2	396.36	567.44	380.70	306.00	418.44	16.78	553.52	500.09	653.22	1827.27	10257.00		15877	11
alpha_HCH	ng/m2	770.70	415.20	359.55			603.90	62.90	116.30	85.95	115.65	195.00	328.60	3054	10
gamma_HCH	ng/m2	770.70	415.20	359.55			67.10	125.80	290.75	85.95	115.65	390.00	1150.10	3771	10
aldrin	ng/m2	770.70	415.20	359.55			134.20	62.90	116.30	85.95	115.65	195.00	328.60	2584	10
dieldrin	ng/m2	770.70	415.20	359.55			134.20	62.90	116.30	85.95	115.65	195.00	328.60	2584	10
endrin	ng/m2	770.70	415.20	359.55			167.75	62.90	116.30	85.95	115.65	195.00	328.60	2618	10

IE0002 Turlough Hill (continued)

Depositions in Precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
heptachlor	ng/m2	770.70	415.20	359.55			134.20	62.90	116.30	85.95	115.65	195.00	328.60	2584	10
heptachlor epoxide	ng/m2	770.70	415.20	359.55			67.10	62.90	116.30	85.95	115.65	195.00	328.60	2517	10
PCB52	ng/m2	770.70	415.20	359.55			134.20	62.90	174.45	171.90	115.65	195.00	328.60	2728	10
PCB101	ng/m2	1596.45	830.00	359.55			134.20	62.90	174.45	171.90	231.30		328.60	4084	10
PCB118	ng/m2	1596.45	830.00				301.95	62.90	174.45	171.90		195.00	328.60	4136	10
PCB138	ng/m2	770.70	830.00				134.20	62.90	465.20	171.90	115.65	195.00	328.60	3772	10
PCB153	ng/m2	770.70	830.00	697.95			134.20	62.90	465.20	171.90	115.65	195.00	328.60	3772	10
PCB180	ng/m2	770.70	830.00	359.55			134.20	62.90	174.45	171.90	115.65	195.00	328.60	3143	10
op_DDD	ng/m2	770.70	415.20	359.55			67.10	62.90	116.30	85.95	115.65	195.00	328.60	2517	10
op_DDT	ng/m2	770.70	415.20	359.55			67.10	62.90	116.30	85.95	115.65	195.00	328.60	2517	10
pp_DDD	ng/m2	1386.00	318.60	618.80			55.60	36.80	107.80	131.50	77.65	82.00	269.80	3085	10
pp_DDE	ng/m2	1386.00	318.60	618.80			55.60	36.80	107.80	131.50	77.65		269.80	3085	10
pp_DDT	ng/m2	1386.00	318.60	618.80			55.60	36.80	107.80	131.50	77.65		269.80	3085	10
precipitation	mm	110.1	138.4	42.3	153	95.1	67.1	62.9	116.3	171.9	231.3	390	328.6	1907	12

Netherlands

NL0009 Kollumerwaard
Depositions in Precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N /m^2			100.03			58.80	71.39	47.73	86.33	77.49	74.90	47.91	565	8
nitrate	mg N /m^2			59.23			25.24	38.42	32.12	54.84	31.22	48.74	30.92	321	8
arsenic	µg/m2	5.12	5.48	27.89	36.49	13.33	8.92	15.84	3.20	28.56	21.65			166	10
cadmium	µg/m2	4.16	5.48	7.03	6.18	7.75	2.95	3.96	2.94	9.14	7.02			57	10
chromium	µg/m2	17.73	19.01		10.43	21.66	10.09	18.72	11.08	24.75	17.06			182	10
copper	µg/m2	90.02	64.33	242.75	153.58	142.44	144.72	123.84	69.44	142.80	118.74			1293	10
lead	µg/m2	72.97	121.35	236.81	192.08	173.26	86.91	104.40	70.29	236.10	156.78			1451	10
nickel	µg/m2	13.98	14.99	47.15	22.46	17.08	26.38	14.76	19.60	19.52	13.45			209	10
precipitation-N	mm			104.0			39.2	73.6	43.0	98.1	73.8	102.6	90.4	625	8
precipitation-rest	mm	68.2	73.1	95.2	40.1	83.3	38.8	72.0	42.6	95.2	65.6			674	10

NL0009 Kollumerwaard
Mean Air Concentrations

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	months
ammonium	µg N/m^3	0.86	0.73	1.06	1.05	0.71	0.73	0.68	0.82	1.19	0.85	0.82	0.90	0.87	12
nitrate	µg N/m^3	0.55	0.50	0.65	0.75	0.47	0.43	0.31	0.45	0.76	0.49	0.59	0.52	0.54	12
nitrogen monoxide	µg N/m^3	1.28	0.39	0.18	0.82	0.41	0.25	0.32	0.30	0.57	0.63	0.92	2.66	0.73	12
nitrogen dioxide	µg N/m^3	5.69	4.68	2.51	4.14	2.56	1.83	1.24	1.88	3.53	3.96	6.86	5.61	3.71	12
arsenic	ng/m3	0.31	0.16	0.17	0.35	0.27	0.19	0.04	0.23	0.50	0.25	0.19	0.28	0.24	12
cadmium	ng/m3	0.15	0.07	0.08	0.14	0.06	0.06	0.02	0.04	0.11	0.10	0.09	0.11	0.09	12
lead	ng/m3	11.80	2.97	3.48	5.75	3.21	2.71	1.14	2.42	5.73	4.50	4.19	4.88	4.40	12
zinc	ng/m3	31.26	8.35	10.51	13.01	7.22	8.72	7.15	4.10	12.28	12.18	14.97	13.72	11.95	12

NL0091 De Zilk
Mean Air Concentrations

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	no. months
ammonia	µg N /m^3	0.22	0.41	0.13	1.01	0.62	0.10	0.28	1.31	1.72	0.95	0.59	0.99	0.69	12
ammonium	µg N /m^3	1.09	1.11	1.56	1.49	1.67	1.26	1.37	1.35	1.50	1.19	0.82	1.16	1.30	12
nitrate	µg N /m^3	0.62	0.71	1.06	1.02	0.97	0.66	0.63	0.71	0.84	0.68	0.50	0.62	0.75	12
nitrogen monoxide	µg N /m^3	4.36	2.21	1.50	1.23	0.52	0.77	0.61	0.81	2.54	2.36	3.04	6.78	2.23	12
nitrogen dioxide	µg N /m^3	7.31	6.45	5.53	7.58	4.38	3.52	2.76	3.66	7.58	7.13	9.89	8.64	6.20	12

NL0091 De Zilk

Depositions in Precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N /m^2	21.34	33.17	64.14	56.72	64.75		16.86	26.68	80.29	50.81	65.89	34.78	515	11
nitrate	mg N /m^2	19.89	27.49	53.07	38.34	40.52		22.77	21.30	53.60	42.22	90.18	33.96	443	11
arsenic	µg/m2		5.14	10.52	8.15	7.05	6.07	3.73	4.18	8.18	8.57	15.86	7.75	85	11
cadmium	µg/m2		3.56	8.04	5.41	4.61	2.80	0.84	1.76	4.69	4.57	10.15	5.58	52	11
chromium	µg/m2		17.81		11.15	24.44	4.78	12.92	6.03	28.34	29.69	54.96	26.86	244	11
copper	µg/m2		66.45	194.33	123.98	177.66	146.46	91.45	135.26	105.73	130.19	325.56	120.86	1618	11
lead	µg/m2		193.86	284.01	310.17	219.96	143.89	132.70	95.12	223.45	280.93	655.34	377.05	2916	11
mercury	ng/m2	368.00	621.10	469.20	879.20	666.10	418.10	471.10	584.40	1281.40	735.60	742.80	466.40	7703	12
nickel	µg/m2		14.04	32.94	18.02	19.27	18.77	10.19	15.08	22.35	23.41	43.34	21.18	239	11
zinc	µg/m2		280.85	411.29	622.05	564.00	329.36	213.71	164.72	523.20	628.10	1183.84	547.49	5469	11
g-HCH	ng/m2	398.50	343.00	1732.50	2198.00		93.50				570.00		521.00	6380	8
precipitation-N	mm	76.2	67.7	102.3	41.4	92.5	18.0	49.6	23.0	108.5	112.9	205.9	102.3	1000	12
precipitation-HCH	mm	79.7	68.6	106.7	31.4		18.7			104.7	114.0		104.2	628	8
precipitation-rest	mm	38.1	42.5	23.5	52.5	82.5	26.3	61.5	54.6	95.8	96.8	95.4	61.5	731	12

Norway

NO0001 Birkenes
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N /m^2	12.33	36.24	4.27	119.30	59.07	23.69	23.29	45.84	120.70	98.76	153.59	41.71	739	12
nitrate	mg N /m^2	28.67	67.70	10.55	101.19	38.30	36.17	26.69	38.48	109.46	140.77	305.79	90.37	994	12
cadmium	µg/m2	2.37	4.71	0.89	7.10	5.22	2.22	2.37	1.02	5.84	15.50	16.40	5.00	69	12
lead	µg/m2	92.32	142.42	46.43	260.44	145.33	79.01	77.18	81.11	335.25	721.99	897.80	252.24	3132	12
zinc	µg/m2	401.41	352.64	152.51	546.12	356.07	241.99	253.01	223.93	683.05	1334.09	1912.95	807.12	7265	12
precipitation-N	mm	122.3	152.8	56.8	109.0	114.1	78.3	155.2	79.8	218.7	330.7	705.6	204.3	2327	12
precipitation-metals	mm	139.7	152.0	63.6	109.3	118.7	74.0	124.9	78.8	216.4	344.5	630.9	200.0	2253	12

Mean Air Concentrations

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	no. months
NO2	µg N /m^3	0.52	0.61	0.52	0.54	0.51	0.37	0.36	0.35	0.52	0.68	0.70	1.16	0.57	12
HNO3+NO3	µg N /m^3	0.08	0.16	0.10	0.32	0.21	0.23	0.10	0.13	0.29	0.38	0.26	0.19	0.20	12
NH3+NH4	µg N /m^3	0.04	0.18	0.20	0.77	0.65	0.45	0.54	0.41	0.58	0.68	0.43	0.26	0.43	12

NO0099 Lista
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	41.79	46.06	22.08	64.91	42.76	35.77	0.22	57.42	93.10	139.57	104.23	45.59	694	12
nitrate	mg N/m^2	37.64	67.50	20.61	60.51	53.60	37.50	10.92	63.05	115.85	208.90	177.93	71.68	926	12
arsenic	µg/m2	41.72	27.62	7.67	26.87	24.28	6.45	12.66	15.62	22.45	172.58	57.48	40.62	456	12
cadmium	µg/m2	2.21	1.80	0.79	5.87	3.92	1.47	1.10	2.85	7.79	21.57	6.70	4.92	61	12
chromium	µg/m2	15.28	20.55	5.26	22.88	15.12	5.67	4.41	17.69	15.71	73.26	33.67	22.38	252	12
copper	µg/m2	433.21	168.80	44.72	110.30	89.28	37.43	62.14	121.25	90.05	356.39	138.96	97.80	1750	12
lead	µg/m2	149.18	114.97	30.95	268.83	138.16	76.53	35.24	169.70	238.99	834.12	322.95	179.18	2559	12
mercury	ng/m2	653.19	423.92	478.21	1478.48	971.17	987.17	317.52		422.53	3056.06	725.52	1513.63	11027	11
nickel	µg/m2	61.84	34.81	10.98	37.08	48.32	15.30	58.04	50.41	34.46	111.91	47.25	26.00	536	12
zinc	µg/m2	2068.40	723.36	218.87	712.02	537.90	248.36	323.74	505.94	794.62	2687.53	902.62	638.70	10362	12
HCB	ng/m2	28.08	37.27	12.27	19.82	23.98	13.17	11.60	34.68	50.41	239.81	227.17	132.71	831	12
alpha_HCH	ng/m2	58.02	45.40	26.47	88.14	35.50	21.97	31.56	40.39	79.80	267.17	136.47	65.25	896	12
gamma_HCH	ng/m2	50.85	99.18	50.56	1925.69	630.61	92.25	67.00	181.52	285.02	958.82	552.15	186.64	5080	12
precipitation-N	mm	109.1	144.9	63.8	61.2	66.9	59.5	44.6	88.1	152.6	304.1	275.0	124.2	1494	12
precipitation-organic	mm	84.33	128.97	55.26	132.15	68.13	59.06	46.21	100.23	133	402.36	284.32	157.24	1651	12
precipitation-metal	mm	105.353	128.46	52.55	117.34	78.32	48.87	44.1	98.26	132.04	449.42	186.03	129.37	1570	12

Mean Air Concentrations

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	months
arsenic	ng/m^3	0.11	0.15	0.56	0.40	0.35	0.23	0.20	0.18	0.35	0.33	0.34	0.32	0.29	12
cadmium	ng/m^3	0.04	0.04	0.08	0.11	0.06	0.06	0.03	0.05	0.12	0.07	0.06	0.08	0.07	12
chromium	ng/m^3	1.00	1.07	0.90	1.02	1.17	0.97	0.56	0.46	0.71	0.71	0.86	0.67	0.84	12
copper	ng/m^3	0.46	0.43	0.48	0.89	0.50	0.62	0.41	1.17	0.88	0.62	0.78	0.70	0.66	12
lead	ng/m^3	0.95	1.13	3.11	3.80	2.08	2.47	1.13	1.35	4.30	3.37	3.04	2.88	2.47	12
mercury	pg/m^3	2.00	1.70	1.25		1.78	1.88	1.47		1.64	2.19	0.56	1.52	1.60	10
nickel	ng/m^3	0.17	0.31	0.40	3.43	1.77	1.01	0.39	0.48	0.61	0.48	0.44	0.35	0.82	12
zinc	ng/m^3	3.39	2.70	15.31	7.11	6.13	4.97	4.41	3.25	8.47	5.93	6.61	5.59	6.15	12
HCB	pg/m^3	47.08	45.30	47.48	60.72	57.63	52.36	59.70	57.87	64.23	58.65	57.00	46.67	54.56	12
gamma_HCH	pg/m^3	6.81	8.08	7.40	47.58	40.49	45.64	18.43	23.39	32.78	32.07	21.85	10.52	24.58	12
alpha_HCH	pg/m^3	11.15	10.15	10.86	19.01	21.08	18.34	26.95	27.10	30.73	23.57	15.94	12.17	18.92	12

NO0042 Zeppelin Fjell
Mean Air Concentrations Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	months
HNO3+NO3	µg N /m3	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.03	0.03	12
NH3+NH4	µg N /m3	0.08	0.05	0.14	0.12	0.07	0.11	0.13	0.13	0.15	0.09	0.09	0.07	0.10	12
arsenic	ng/m3	0.24	0.33	0.29	0.18	0.50	0.23	0.18	0.25	0.22	0.27	0.49	0.44	0.30	12
cadmium	ng/m3	0.04	0.05	0.05	0.02	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.02	0.02	12
chromium	ng/m3	0.03	0.13	0.08	0.04	0.00	0.00	0.06	0.07	0.00	0.03	0.04	0.02	0.04	12
copper	ng/m3	0.47	0.83	0.71	0.33	0.69	0.21	0.38	0.46	0.21	0.16	0.19	0.27	0.41	12
lead	ng/m3	1.28	1.73	1.65	0.82	0.43	0.07	0.06	0.05	0.02	0.26	0.30	0.55	0.41	12
mercury	pg/m3									1.62	1.55	1.62	1.67	1.81	4
nickel	ng/m3	0.07	0.19	0.14	0.09	0.07	0.02	0.06	0.30	0.00	0.02	0.01	0.00	0.08	12
zinc	ng/m3	2.01	4.10	2.48	1.70	1.63	0.55	1.08	1.73	0.74	0.71	0.58	1.56	1.57	12
															0
gamma_HCH	pg/m3	4.25	4.70	4.90	7.62	9.28	5.80	5.14	4.20	4.72	8.41	7.23	4.71	5.91	12
HCB	pg/m3	42.88	52.38	48.20	54.78	53.56	66.55	60.78	62.48	58.98	58.83	58.78	51.46	55.80	12
alpha_HCH	pg/m3	12.60	15.10	16.96	22.93	21.54	22.43	23.68	28.22	24.55	24.00	20.80	15.88	20.72	12

NO0057 Ny Alesund
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	mean	months
ammonium	mg N/m^2	0.54		1.17	1.46	0.33	2.13	0.12	1.82	10.81	15.99	7.09	0.12	42	11
nitrate	mg N/m^2	0.44		0.48	2.55	0.99	1.16	3.33	0.35	6.33	7.86	7.53	0.56	32	11
precipitation	mm	3.6	1.1	11.6	28.0	8.1	10.6	24.0	14.1	115.0	133.3	47.9	23.4	421	12

Portugal

PT0003 Viana do Castelo
Depositions in Precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	9.06	11.98	7.99	17.38	29.47	4.70	58.44	46.32	26.69	11.06	23.67	13.62	243	12
nitrate	mg N/m^2	13.89	12.10	3.89	36.00	21.07	10.89	7.73	5.90	12.02	8.21	53.89	45.82	224	12
Cadmium	µg/m2	21.97	29.62	13.77	147.56	45.43	17.21	25.33	14.20	30.94	56.99	180.97	223.13	807	12
Copper	µg/m2	89.07	212.16	174.21	515.26	215.82	103.95	321.78	124.39	296.17	120.58	208.95	326.75	2549	12
Lead	µg/m2	33.35	44.96	43.96	390.83	68.95	26.12	38.44	21.54	46.96	86.49	410.81	338.63	1522	12
nickel	µg/m2	40.07	54.02	25.11	269.08	82.85	31.39	46.19	25.89	56.42	105.58	326.22	406.88	1470	12
zinc	µg/m2	1271.63	1733.41	783.02	2335.17	1629.24	766.82	2857.11	811.61	2105.52	2156.82	2524.53	3913.91	21530	12
precipitation	mm	51.7	69.7	32.4	347.2	106.9	40.5	59.6	33.4	72.8	134.1	417.3	525.0	1891	12

PT0004 Monte Velho

Depositions in Precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	0.08	2.51	17.29	6.53	4.83				4.34	30.08	5.38	4.01	73	9
nitrate	mg N/m^2	0.10	1.85	15.47	11.86	7.63				5.44	13.73	11.77	16.36	81	9
cadmium	µg/m2	2.13	4.63	2.98	49.47	17.00					16.83	44.33	102.85	244	9
copper	µg/m2	1.63	3.54	36.47	65.05	13.00				26.27	25.29	49.86	83.61	298	9
lead	µg/m2	3.23		11.76	82.84	25.80					25.54	67.27	156.09	384	9
nickel	µg/m2	3.88		5.43	90.21	31.00					30.69	80.83	187.55	445	9
zinc	µg/m2	60.00	98.10	525.00	1094.88	175.50				238.00	372.09	1141.49	1333.34	4958	9
precipitation	mm	5.0	10.9	7.0	116.4	40.0		0.7		8.5	39.6	104.3	242.0	574	10

PT0010 Angra do Heroismo
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	1.54	1.62	3.43	21.17	4.98	8.06	2.80	2.81	4.15	0.71	1.30	7.59	60	12
nitrate	mg N/m^2	18.17	7.20	15.13	31.88	9.02	18.08	13.92	10.36	15.04	10.27	5.59	30.50	182	12
cadmium	µg/m2	23.89	11.14	24.86	79.82	13.22	27.63	30.64	13.09	36.76	12.16	5.65	111.90	389	12
copper	µg/m2	111.67	66.65	153.22	231.84	43.85	174.13	115.97	59.48	106.23	50.20	22.61	102.96	1216	12
lead	µg/m2	76.91	101.42	37.73	226.79	61.27	125.88	98.91	29.54	126.92	124.44	170.46	383.18	1524	12
nickel	µg/m2	43.56	20.31	45.34	145.55	24.10	50.38	55.88	23.87	67.04	22.17	10.31	204.06	709	12
zinc	µg/m2	1731.43	726.39	11416.25	2868.70	1866.00	1661.37	1442.30	1013.08	2932.00	1696.26	667.83	5570.10	33351	12
precipitation	mm	56.2	26.2	66.5	187.8	31.1	65.0	72.1	30.8	86.5	28.6	13.3	263.3	919	12

Spain

ES0005 Noya

Mean Air Concentrations Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	months
ammonium	µg N /m^3	0.23	0.17	0.60	0.15	0.27	0.44							0.31	6
ammonia/um	µg N /m^3	0.07	0.08	0.15	0.07	0.08	0.11							0.09	6
hno3+no3	µg N /m^3	0.54	0.29	0.79	0.27	0.33	0.32							0.42	6
no2 - abs sol.	µg N /m^3	1.71	4.43	0.49	0.94	1.31	7.27							2.69	6
no2 - monitor	µg N /m^3	2.40	1.23	2.23	0.94	1.10	0.95							1.47	6

ES0008 Niembro

Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	8.05	7.50	15.57	38.10	35.78	17.45	14.54	12.50	7.16	11.63	6.10	3.68	178	12
nitrate	mg N/m^2	9.27	9.72	28.20	51.69	32.75	18.51	17.16	14.54	33.32	23.78	21.59	12.33	273	12
precipitation	µg/m2	18.8	23.6	76.2	86.0	43.0	30.8	36.8	16.4	46.4	87.6	133.2	56.2	655	12

Mean Air Concentrations

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	no. months
NH4	µg N /m^3	0.24	0.33	0.74	0.30	0.95	0.77	0.45	0.60	1.06	0.23	0.07	0.07	0.48	12
NH3+NH4	µg N /m^3	2.52	3.03	5.19	1.82	4.58	4.21	3.00	2.61	1.65	0.81	0.36	0.53	2.53	12
NO3+HNO3	µg N /m^3	0.51	0.59	1.21	0.29	0.66	0.62	0.51	0.58	0.56	0.37	0.20	0.17	0.52	12
NO2	µg N /m^3	2.26	1.75	0.94	0.88	2.70	6.62	5.09	5.04	2.29	1.64	0.68	1.82	2.64	12
NO2	µg N /m^3	2.50	4.00	2.94	1.87	1.63	1.47	1.73	1.70	2.09	2.18	2.03	1.52	2.14	12

Sweden

SE0002 Roervik
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	9.07	18.57	11.25	20.33	4.25	2.83	5.64	35.16	9.50	48.79	14.29	23.57	203	12
nitrate	mg N/m^2	23.37	25.24	22.00	22.38	4.06	3.85	19.02	38.54	22.15	67.98	17.93	28.83	295	12
mercury	ng/m2	398.40	445.20	237.60	561.60	464.40	759.00	411.80	1159.20	791.80	201.50	95.00	120.00	5646	12
precipitation-N (wo)	mm	29.5	40.4	44.9	72.6	73.7	72.7	57.5	51.4	47.2	121.3	151.1	123.6	886	12
precipitation-Hg (bulk)		27.7	27.0	26.9	57.6	88.4	52.0	83.6	66.9	33.8	106.0	104.6	97.1	772	12

Mean Air Concentrations

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	no. months
NO2	µg N /m^3	2.10	1.78	1.33	1.52	1.14	1.05	0.87	0.88	0.78	1.77	2.13	2.41	1.48	12
HNO3+NO3	µg N /m^3	0.56	0.62	0.34	1.05	0.68	0.64	0.32	0.48	0.39	0.93	0.92	0.64	0.63	12
NH3+NH4	µg N /m^3	0.56	0.53	0.50	1.63	0.91	1.07	0.44	0.71	0.80	1.44	1.06	0.80	0.87	12

SE0097 Gardsjoen

Depositions in Precipitation Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
arsenic	µg/m2	15.47	2.80	4.45	13.00	4.45	3.90	4.15	2.15	4.50	21.78	23.16	5.45	105	12
cadmium	µg/m2	2.73	1.68	8.90	5.20	1.78	1.56	6.64	2.15	1.00	8.47	9.65	5.45	55	12
chromium	µg/m2	4.55	6.72	16.02	3.25	4.45	3.90	4.15		14.50	6.05	9.65	5.45	81	12
lead	µg/m2	137.41	71.12	161.09	202.15	106.80	90.48	63.08	63.64	45.50	296.45	310.73	105.73	1654	12
nickel	µg/m2	22.75	20.72	40.05	15.60	11.57	14.82	19.09	20.21	15.00	14.52	36.67	27.25	258	12
zinc	µg/m2	335.79	512.96	922.04	625.30	923.82	2130.18	2763.90	2426.92	525.00	1301.96	764.28	320.46	13553	12
precipitation	mm	91.0	56.0	89.0	65.0	89.0	78.0	83.0	43.0	25.0	121.0	193.0	109.0	1042	12

SE0098 Svartedalen

Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	51.94	145.70	12.87	70.47	54.08	66.03	8.74	60.30		130.90	73.99		675	10
nitrate	mg N/m^2	69.96	171.55	20.67	40.89	48.88	36.27	14.26	47.70		81.60	102.68		634	10
precipitation	mm	106.0	235.0	39.0	87.0	104.0	93.0	46.0	90.0	14.0	170.0	151.0		1135	11

United Kingdom

GB0014 High Muffles
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	21.02	25.55	53.22	107.54	71.72	15.41	19.85	49.63	46.68	51.35	63.28	55.80	581	12
nitrate	mg N/m^2	18.85	17.66	41.96	104.82	43.53	17.70	16.42	37.82	47.85	42.22	71.48	50.49	511	12
arsenic	µg/m2	8.70	10.83	39.02		14.94		7.39	26.45		17.93	39.46		165	8
cadmium	µg/m2	2.68	6.82	16.00		4.27		2.02	5.88		4.89	14.43		57	8
chromium	µg/m2	15.39		43.18		37.35		9.41	24.49		16.30	17.96		164	7
copper	µg/m2	46.83		279.48		174.77		65.18	121.07		107.58	118.96		914	7
lead	µg/m2	104.36		749.01		250.10		75.60	292.48		220.05	657.84		2349	7
nickel	µg/m2	16.06		86.15		37.88		18.14	43.10		22.82	33.57		258	7
zinc	µg/m2	321.12	529.32	1833.17		647.03		595.26	3181.61		1844.83	2130.17		11083	8
precipitation-N	mm	65.7	40.0	59.6	159.6	94.6	12.3	67.3	79.3	116.7	163.0	204.8	90.2	1153	12
precipitation-rest	mm	66.9	40.1	219.2		106.7		67.2	195.9		163.0	294.5		1153	8

Mean Air Concentrations

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	months
arsenic	ng/m3	1.24	0.40	0.37		0.58		0.10	0.35		0.35	0.61		0.50	8
cadmium	ng/m3	0.70	0.25	0.19		0.13		0.11	0.26		0.12	0.19		0.24	8
chromium	ng/m3	1.20	1.34	1.77		1.83		1.09	0.77		1.05	1.04		1.26	8
copper	ng/m3	3.17	3.08	4.12		6.63		3.06	1.34		1.76	1.76		3.12	8
lead	ng/m3	6.60	5.00	4.61		4.74		4.60	7.70		9.70	9.60		6.57	8
nickel	ng/m3	3.14	0.78	3.99		1.52			2.20		2.99	2.49		2.45	7
zinc	ng/m3	237.70	38.30	52.38		32.36		70.70	34.42		37.20	36.63		67.46	8

GB0016 Glen Dye
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	3.06	1.92	35.34	69.43	7.46	14.55	19.39	53.37	107.00	25.41	24.94	47.38	409	12
nitrate	mg N/m^2	3.66	1.81	36.10	71.17	10.02	13.35	13.91	32.00	79.25	42.43	56.60	84.92	445	12
precipitation	mm	42.7	8.8	63.0	163.1	40.9	29.6	49.7	109.5	154.1	192.8	172.5	210.7	1237	12

GB0090 East Ruston
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
arsenic	µg/m2	75.82	52.28		29.93	15.68	4.21	7.38	5.46	13.41	7.74	6.68	6.15	224.73	11
cadmium	µg/m2	13.34	5.95		21.53	6.60	1.32	2.46	1.64	3.83	1.94	2.86	2.46	64	11
chromium	µg/m2	15.62	20.83		11.03	11.55	1.84	5.54	18.02	48.86	9.68	5.72	9.23	158	11
copper	µg/m2	158.50	320.45		201.08	167.48	50.23	82.41	39.31	63.23	55.18	47.70	109.47	1295	11
lead	µg/m2	76.20	127.50	94.00	178.50	198.00	15.78	86.10	76.44	143.70	58.08	76.32	67.65	1198	12
nickel	µg/m2	27.81	41.23		32.03	28.88	9.21	23.37	27.85	21.08	8.71	14.31	27.06	262	11
zinc	µg/m2	1325.88	1326.00	1776.60	2142.00	1188.00	2430.12	910.20	2953.86	680.18	3571.92	677.34	664.20	19646	12
precipitation	mm	38.1	42.5	23.5	52.5	82.5	26.3	61.5	54.6	95.8	96.8	95.4	61.5	731	12

Mean Air Concentrations

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	no. months
arsenic	ng/m3	1.86	1.36	0.84	1.55	0.10	1.05	0.32	0.36	0.49	0.60	1.35	0.75	0.89	12
cadmium	ng/m3	0.25	0.18	0.45	0.19	0.08	0.18	0.10	0.19	0.16	0.19	0.36	0.27	0.22	12
chromium	ng/m3	1.86	2.96	2.22	1.46	1.07	2.28	0.43	0.40	0.56	0.42	0.45	0.64	1.23	12
copper	ng/m3	2.82	2.19	2.67	1.98	1.74	2.05	1.14	1.76	1.95	2.31	3.81	2.48	2.24	12
lead	ng/m3	13.10	8.60	8.90	6.20	3.20	6.20	8.60	9.10	8.70	9.20	25.10	15.90	10.23	12
nickel	ng/m3	1.64	1.10	1.06	1.02	0.51	0.72	0.55	0.51	0.89	0.83	1.24	1.56	0.97	12
zinc	ng/m3	21.00	27.30	27.30	17.70	13.10	24.30	20.80	43.10	44.60	51.00	33.40	42.30	30.49	12

GB0091 Banchory
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
arsenic	µg/m2	1.60	1.52		22.78	3.85	2.84	3.86	6.86	10.34	7.87	11.85	4.39	78	11
cadmium	µg/m2	4.08	4.37		5.19	1.15	2.64	1.60	7.55	6.73	2.67	6.56	2.88	45	11
chromium	µg/m2	3.94	3.84		121.49	21.67	12.74	17.73	40.56	10.34	9.35	15.21	7.55	264	11
copper	µg/m2		134.55		375.03	159.50	66.83	54.13	72.46	49.96	46.30	91.58	30.60	1081	10
lead	µg/m2	29.38	16.84		244.46	69.66	47.52	31.96	167.79	96.69	80.14	102.62	58.72	946	11
nickel	µg/m2	20.67	14.24		122.97		14.12	6.92	27.93	16.45	9.35	21.13	15.92	270	10
zinc	µg/m2	489.60	218.50		2889.12	290.25	392.70	258.44	1153.04	1009.26	1202.04	1216.76	589.96	9710	11
precipitation	mm	34	23		185.2	67.5	33	36.4	99.4	124.6	148.4	160.1	137.2	1049	11

Mean Air Concentrations Grey shaded areas indicate measurements below, or derived largely from measurements below the detection limit

		January	February	March	April	May	June	July	August	September	October	November	December	annual mean	no. months
arsenic	ng/m3	0.10	0.36		0.10	0.34	0.32	0.20	0.09	0.36	0.34	0.47	0.39	0.28	11
cadmium	ng/m3	0.07	0.03		0.03	0.09	0.05	0.02	0.03	0.06	0.05	0.04	0.04	0.05	11
chromium	ng/m3	0.93	0.88		1.15	1.14	1.39	0.18	0.20	0.63	0.18	0.41	0.27	0.67	11
copper	ng/m3	0.70	0.41		1.32	1.08	0.78	1.05	0.61	1.10	0.65	1.23	1.06	0.91	11
lead	ng/m3	1.21	1.15		1.71	2.08	1.28	2.13	2.02	3.59	2.77	2.98	2.48	2.13	11
nickel	ng/m3	0.24	0.23		0.80	0.59	0.56		0.92	0.77	0.74	0.40	0.55	0.58	10
zinc	ng/m3	5.79	7.40		10.42	7.91	13.49	27.18	21.89	21.12	49.01	24.21	40.42	20.80	11

GB0095 Driby
Depositions in Precipitation

		January	February	March	April	May	June	July	August	September	October	November	December	annual total	no. months
ammonium	mg N/m^2	12.24	22.16	34.83	84.85	13.85	1.57	29.79	28.87	16.96	35.84	29.60	22.93	333	12
nitrate	mg N/m^2	9.39	14.67	17.04	78.13	8.02	2.11	35.72	23.88	15.22	41.13	29.50	24.32	299	12
precipitation	mm	18.5	43.5	22.8	118.6	25.2	3.3	33.9	32.0	42.6	135.2	105.1	38.1	619	12

Appendix B

Principles for the Comprehensive Atmospheric Monitoring Programme (CAMP)

1. Objectives

The main objectives of the CAMP are to monitor the concentrations of selected contaminants in precipitation and air and their depositions in order:

- to assess, as accurately as appropriate, the atmospheric input of the selected contaminants to the maritime area and regions thereof on an annual basis;
- to determine long-term trends in atmospheric inputs;
- for their use in relation to modelling activities, specifically to validate atmospheric transport models used for assessments of atmospheric inputs to maritime area.

2. The network[1]

Each Contracting Party bordering the maritime area (EU excluded) should have at least one monitoring station on the coast and/or offshore to be included in the joint monitoring programme. Contracting Parties which border more than one OSPAR Region should have at least one monitoring station at the coast and/or offshore within each. The station should be a so-called *background station*, that is, a station which is not directly influenced by local sources. The station should be located not more than 10 km from the coastline. At the station simultaneous measurements of the chemical composition of air and precipitation are to be performed.

3. Chemical composition of precipitation

3.1. Components to be measured[2]

The following contaminants are to be measured on a mandatory basis in precipitation:

- heavy metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc
- persistent organic contaminants: γ-HCH[3] (lindane)
- nutrients: ammonium (NH_4^+), nitrate (NO_3^-)

[1] Contracting Parties should take into account developments within the framework of other international organisations (particularly AMAP, EMEP, HELCOM and WMO).

[2] Not all contaminants included in the Joint Assessment and Monitoring Programme (JAMP) are mentioned here as mandatory or voluntary components. Reasons are either because the atmospheric pathways are negligible (e.g. oil, TBT) or because routine monitoring methods are extremely expensive or not yet fully developed (e.g. furans, dioxins). However, when information is available, for example during a measuring campaign, Contracting Parties are strongly encouraged to submit these data to the data base manager.

[3] In view of the low concentrations, the monitoring of α-HCH is no longer mandatory. When γ-HCH is not measured as a separate component, it should be clearly stated in the data reports that total HCH has been measured.

The following contaminants should be measured on a voluntary basis in precipitation:

- persistent organic contaminants: the PCB-congeners 28, 52, 101, 118, 138, 153 and 180[4]
  the following PAHs: phenanthrene, anthracene, fluoranthene, pyrene, benzo[*a*]anthracene, chrysene, benzo[*a*]pyrene, benzo[*ghi*]perylene, indeno[*1,2,3-cd*]pyrene

For quality assurance purposes Contracting Parties are encouraged to report pH, electrical conductivity and the concentrations in precipitation of the major ions (Na^+, K^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-, NH_4^+, NO_3^-, HCO_3^-).

3.2. Sampling and analysing methods[5]

For CAMP the use of wet-only samplers is recommended. The use of bulk collectors is acceptable when on a regular basis, an intercomparison of results of wet-only and bulk samplers actually in use in the network takes place. Samplers should be designed for sampling during all seasons and climatic conditions. Formation of ice in funnel or bottle must be avoided; at stations where high temperatures are expected in the summer, cooling of the samples might be needed. The size of funnel and bottles should be adapted to the length of the sampling period and expected precipitation amount.

Each individual sampler must be identified with a short, unique name[6], for bulk precipitation samplers, the bucket stand is named and the bucket itself is a nameless consumable. All measurements must be related to a field sampler or instrument identified in this manner. Official precipitation amounts should be reported where available (see paragraph 3.4). In addition, the precipitation amount measured in each individual sampler must be reported.

There are several methods for analysing of heavy metals (excluding mercury) in precipitation and in aerosol filters. Direct methods without extraction of the filters are instrumental neutron activation analysis (INAA), particle induced X-ray emission (PIXE) and X-ray fluorescence. Methods for analysing heavy metals in precipitation and dissolved particles from filters are atomic absorption spectroscopy (AAS) with flame- or electrothermal atomisation, inductively coupled plasma optical emission spectroscopy (ICP-OES) and inductively coupled plasma mass spectroscopy (ICP-MS). The latter method (ICP-MS) has been recommended at an EMEP workshop (Moscow, September 1996) as the analytical reference method for the heavy metals As, Cd, Cr, Cu, Ni, Pb, and Zn.

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4 Although atmospheric input is estimated to be the most important input route to the maritime system it is judged not appropriate to recommend the mandatory monitoring of PCBs taking into account that PCBs were due to be phased out in all Contracting Parties. In this regard it is proposed that it is more appropriate to recommend targeted monitoring activities in areas expected to have relatively high PCB loads.

5 See for an overview of sampling and analysing methods currently in use within Europe the report and proceedings of the workshop on the assessment of EMEP activities concerning Heavy Metals and Persistent Organic Pollutants and their further development, Moscow, Russian Federation, 24-26 September 1996; Report 117, Volumes I and II, World Meteorological Organisation, Global Atmospheric Watch, Geneva, Switzerland.

6 For more details, see chapter 6.1.

In designing a sampling methodology the JAMP guidelines for the Sampling and Analysis of Mercury in Air and Precipitation and the JAMP Guidance Note on Sampling and Analysis of PCBs in Air and Precipitation should be taken into account[7].

In general terms the detection limits of the measured contaminants should be well below the ambient levels by a factor of 10.

3.3. Sampling frequency

Sampling periods from one week to one month are acceptable. It is recommended however, that samples should be taken on a weekly basis in order to reduce the risk of (bio)chemical change in samples and/or the accidental contamination of samples (e.g. via bird droppings). When the samples are stored in a safe way (e.g. frozen) two or more samples can be combined before analysis to longer, regular intervals (e.g. monthly or 4-weekly averaged samples).

If weekly sampling is used and if a week includes two adjacent months, the measured data should be allocated to the month which comprises the largest number of days in the week in question. It is recommended , however, to have two sampling periods for a week that crosses a month boundary, even if one of these is only a one-day sample. It is recommended that samples are always changed at a fixed time (e.g. at 8.00 am (UT)) on every Tuesday and on the first of every month.

3.4. Precipitation amount

For the evaluation of the chemical composition of precipitation and for the estimation of wet deposition fluxes correct data on precipitation amounts is needed. Common practice has shown that the efficiency of chemical samplers for sampling of precipitation may differ considerably even for identical samplers; this results in different "observed" precipitation amounts (and therefore wet deposition fluxes). Parallel to the chemical measurements a standard rain gauge should be used according to WMO recommendations for measuring the precipitation amount. Alternatively, the results of a nearby located meteorological station which is shown to be representative for the CAMP-location may be used.

4. Chemical composition of ambient air and aerosol

4.1. Components to be measured

The following contaminants are to be measured on a mandatory basis in air:

- nutrients: in gaseous phase: NO_2, HNO_3, and NH_3
  in aerosol phase[8]: ammonium (NH_4^+) and nitrate (NO_3^-)

The following contaminants should be carried out on a voluntary basis in air:

- heavy metals: arsenic
  cadmium
  chromium
  copper
  lead
  mercury

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7 Secretariat Note: these JAMP Guidelines are available from the OSPAR Secretariat on request.

8 As an alternative total nitrate (sum of gaseous HNO_3 and particulate NO_3) and total ammonium (sum of gaseous NH_3 and particulate NH_4) can be measured.

	nickel zinc
• nutrients:	NO
• persistent organic contaminants:	γ-HCH (lindane) the PCB-congeners 28, 52, 101, 118, 138, 153 and 180 the following PAHs: phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[a]pyrene, benzo[ghi]perylene, indeno[1,2,3-cd]pyrene

4.2. Sampling and analysing methods[9]

High volume samplers or medium volume samplers equipped with cellulose fibre filters or membrane filters are currently in use for collection of aerosol. The recommended analytical method for As, Cd, Cr, Cu, Ni, Pb, and Zn is ICP-MS; other analytical methods are mentioned in section 3.2.

In designing a sampling methodology the JAMP Guidelines for Sampling and Analysis of Mercury in Air and Precipitation[10] and the JAMP Guidance Note on Sampling and Analysis of PCBs in Air and Precipitation[11] should be taken into account.

In general terms the detection limits of the measured contaminants should be well below the ambient levels by a factor of 10.

Knowledge of the particle size distribution is desirable for estimating dry deposition fluxes; size distribution forms an essential input parameter in transport/deposition models. Size distributions of heavy metal particles have been extensively studied with the help of cascade impactors. For routine monitoring cascade impactors are too expensive; a separation into two classes (cut-off at 2.5 μm) is possible using commercially available samplers.

4.3. Sampling frequency

For heavy metals and POP in gas and aerosol phase a sampling period of 24h is recommended. When only a limited number of samples can be taken within a given time period (e.g. due to budgetary constraints) it is suggested to take one 24h sample every five or six days[12]. In this strategy the number of samples to be analysed is limited to 70 or 60 annually; in this way, seasonal changes might be detectable and a reliable yearly averaged concentration will be obtained. In monitoring pesticides a higher frequency during the application period might be necessary.

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9 See for an overview of sampling and analysing methods currently in use within Europe the report and proceedings of the workshop on the assessment of EMEP activities concerning Heavy Metals and Persistent Organic Pollutants and their further development, Moscow, Russian Federation, 24-26 September 1996; Report 117, Volumes I and II, World Meteorological Organisation, Global Atmospheric Watch, Geneva, Switzerland.

10 Adopted by ASMO 1997; final version (23 February 1998) circulated to Contracting Parties on 24 February 1998.

11 Adopted by ASMO 1997; final version (23 February 1998) circulated to Contracting Parties on 24 February 1998.

12 A sampling frequency of once per week should be avoided as this might introduce a systematic error. There is, for example, a clear difference in NO_x concentrations during the weekend and during working days. For heavy metals and POP such systematic differences can not be excluded a priori.

With respect to the nitrogen species, the gaseous compounds NO and NO_2 should be measured on a continuous base (aggregated to hourly averages before reporting); for the other N-compounds sampling period/frequency should not be less than 24h-average samples on a daily base.

5. Quality assurance

The low ambient concentrations of trace elements will easily cause wrong measurements if strict precautions are not taken to prevent contamination and other sources of errors. Quality assurance (QA) is therefore recognised as an essential component in air quality monitoring. Until now a quality assurance and quality control programme for the CAMP network has not been developed. It is strongly recommended to develop such a programme in close co-operation with other international monitoring networks (in particular, HELCOM, AMAP and EMEP)[13]. It is unlikely that full QA procedures will be established in the short term in all laboratories participating in CAMP. Nevertheless a minimum requirement, to ensure that comparable quality data is produced, must be established. This minimum program should include the following points:

- requirements on documentation of procedures for sampling and analysis;
- a training programme for the persons involved in the various tasks of the monitoring procedure;
- regular of analytical intercalibrations of prepared samples;
- field intercalibrations of sampling and analyses;
- implementation of an audit program where stations are visited by experts.

It is essential that all participating organisations agree a programme to introduce QA procedures (at least the minimum set given above) and make a commitment to their strict adherence.

6. Reporting Procedures

In accordance with the OSPAR/NILU Data Management Contract, Annex 1, as presented to INPUT(1) 1998 (cf. INPUT(1) 98/3/Info.1)[14], Contracting Parties should submit, on a yearly base, CAMP data to the database manager (NILU, Kjeller, Norway) using a reporting format and according to the time schedule attached at Appendix 1. To allow data exchange and QA co-operation with EMEP, EMEP naming conventions should be used for organisation codes, station codes, field instrument references and sampling method references. In cases where the monitoring of components on the voluntary list is not performed, it would be useful if the Contracting Parties concerned could provide a short justification for not including these measurements in their national monitoring programmes.

Contracting Parties have to provide the database manager with one contact point (institutes and contact person) which is responsible for the monitoring activities on CAMP stations and which can serve as contact point for the exchange of information concerning

[13] See e.g. the conclusions and draft recommendations of the EMEP-WMO workshop on data analysis, validation and reporting, Usti nad Labem (Czech Republic), 27-30 April 1997, UN-ECE.EB.AIR/GE.1/1997/7.
One recommendation of the workshop may need special attention: results from various field intercomparisons of heavy metal deposition showed large differences between deposition even from identical samplers close to each other. A strong reduction in uncertainties can be realised by parallel measurements with at least two identical samplers at one site. When two or more samplers are installed, procedures for detecting outliers and for reporting the measurements (e.g. is the averaged or median value reported) have to be defined.

[14] Secretariat Note: details available from the OSPAR Secretariat on request.

monitoring data, atmospheric inputs of contaminants to the maritime area, methods of analysis of atmospheric contaminants and possible intercalibration activities.

6.1. Additional requirements on information of monitoring stations[15]

For a proper evaluation of the monitoring results the following (meta) information on the station should be supplied to the database manager:

- station name and station code;
- organisation responsible for operation of the station and name of contact person;
- co-ordinates; clearly indicate whether co-ordinates are given in degrees-minutes-seconds or in degrees and decimal units;
- altitude: height of the station above sea level (m);
- start date: date on which the station became operational;
- description of station environment: describe the siting of the station (e.g. located in a nature area, an agricultural area mainly with intensive cattle breeding);
- description of main emission sources: describe the nearest pollution sources (e.g. nearest city is Leyden (150,000 inhabitants, 15 km in southern direction);
- meteorological parameters measured at the station in addition to air contaminants;
- prevailing meteorological conditions (e.g. wind rose).

For each component the following information on the measurement configuration is needed:

- component;
- for automatic devices: name/type/version of monitor and measurement technique;
- for manual or semi-automatic devices: name/type of equipment to obtain sample, analytical principle used;
- calibration method, frequency of calibration;
- integration time of results;
- height of sampling point above surface;
- length of sampling line;
- whether the sampling line is heated;
- start/end date of configuration.

An organisation is defined as the operator of a station and the owner of a field instrument. The organisation code has the form NL01L (the last L declares that this organisation is a laboratory, and it is laboratory 1 in the Netherlands). Station number 3 in the Netherlands will have the code NL0003R (4 digit number, + the code R for regional background station). The organisation may have bulk samplers operated at several stations. We need to relate the sampler to the organisation with a reference like NL01L_bu1. A reference in this context is always constructed by the organisation code, an underscore character, and a name (the name only needs to be unique within the organisation that creates it, the

15 A preliminary list of requested items is presented here. Contents, units and formats will be specified in detail by the data base manager in the call for meta-information and monitoring data.

reference will then be unique world-wide). Also method references are created in the same manner.

7. Calculation of long-term averaged concentrations

7.1 Precipitation

The yearly averaged concentration in precipitation, $\overline{C}$, should be estimated by precipitation amount weighted averaging of the concentrations for each of the sampling periods:

$$\overline{C} = \frac{\sum_{i=1}^{N} P_i C_i}{\sum_{i=1}^{N} P_i} \qquad [1]$$

where N is the number of sampling periods in one year, P_i is the precipitation amount and C_i is the reported concentration in period i.

When the concentration in a period (or part of a period) is below the measurement limit of detection (DL), the value may be reported:

1. as the observed value or computed average with the flag 0.000, if an insignificant number of input elements are non-numeric (less than 25% missing or below the detection limit). For non-continuous instruments or samplers the value must be positive and above the detection limit, for continuous monitors the value may be below the noise level or may be negative (close to zero).
2. as an estimate with the flag 0.780 if a significant number of input elements (between 25% and 50%) are missing or below the detection limit. The estimate may be negative for continuous monitors, it may be below the detection limit (but positive) for non-continuous instruments.
3. as BDL (below detection limit), where the flag is 0.781 and the value contains the detection limit (no valid numerical value is available in this case). This can also be used for aggregates where 50% or more of the input elements are missing or BDL.
4. as missing with the flag 0.999 if 50% or more of the input elements are missing or BDL (the data originator, knowing his instrument, method and the typical variations in the signal, must decide whether missing or BDL is the most correct result).

It is recommended to report the actual measured value (method 1) with a clear indication of the DL (e.g. in parentheses). When the measurement technique does not permits this, the measurements should be flagged as *below detection limit*. In the framework of EMEP and HELCOM a reporting format including instructions for exception flagging (e.g. missing data, data below detection limit) has been adopted by these organisations[16]. It is recommended to follow similar procedures in reporting CAMP data.

When data coverage is less then 75% no reliable yearly average concentration can be calculated. During evaluation of data coverage concentrations below detection limit should be seen as *missing data.* In the evaluating of averages, the actual observed values

[16] See Krognes T, Gunstrøm T.Ø. and Schaug J. (1995) Air Quality databases at NILU. EBAS version 1.01. Report TR3/95, NILU, Kjeller, Norway.

are used for data below detection limit; when only a flag *below detection limit* is reported, a value of 50% of the reported detection limit[17] is used in the averaging procedure, eq [1].

7.2 Ambient air and aerosol

The monthly averaged concentration in air or aerosol, $\overline{C}_m$, is estimated by numerical averaging of the concentrations for each of the sampling periods:

$$\overline{C}_m = \frac{1}{N}\sum_{i=1}^{N} C_i \qquad [2]$$

where N is the number of sampling periods in one month, and C_i is the concentration in period i.

When the concentration in a period is below the measurement limit of detection (DL), the actual measured value should be reported with a clear indication of the DL (e.g. in parentheses), see the discussion above on precipitation data. When the measurement technique does not permits this, the measurements should be flagged as *below detection limit*.

When data coverage is less then 50% no reliable monthly average concentration can be calculated. During evaluation of data coverage concentrations below detection limit should be seen as *missing data.* In the evaluating of averages, the actual observed values are used for data below detection limit; when only a flag *below detection limit* is reported, a value of 50% of the reported detection limit is used in the averaging procedure, eq [2]. A yearly averaged concentration is obtained by averaging the monthly concentrations; at least nine monthly values (75%) should be available.

8. Methodology for assessment of atmospheric inputs

The atmospheric input is a mass of a contaminant carried to the maritime area via the atmosphere. Total deposition consists of the sum of wet and net dry deposition; for (semi)-volatile compounds the net dry deposition term includes the mass which has re-volatilised from the sea surface[18].

Although the location of CAMP monitoring stations has been carefully selected and measurements are not directly influenced by inland sources, the atmospheric input to the marine area can not be calculated directly from the (land-based) measurements. For several reasons deposition estimates based on averaging the deposition flux over all monitoring stations will be in error:

- As sources of contaminants are mainly land-based one can expect that the concentrations in the more remote parts of the Convention waters will be lower than at coastal stations; the use of coastal data might lead to an overestimation of atmospheric inputs.
- For (semi)-volatile POP the dry deposition estimates based on ambient data will not include the effect of re-volatilisation.

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[17] In earlier discussions on this point in the former ATMOS working group, a factor of 2/3 has been introduced. In agreement with the procedures of EMEP and HELCOM here a factor of 1/2 is recommended.

[18] Note that the net dry deposition term might be negative. This might be the case when some material which entered the maritime system by other pathways (e.g. wet deposition, riverine input, direct dumping) re-volatises.

- It is generally assumed that precipitation amounts at open sea are lower than at nearby land areas; the use of coastal precipitation data might lead to an overestimation of atmospheric inputs. Precipitation rates at coastal stations are extremely variable; for example, coastal stations in the United Kingdom have generally less precipitation than the stations in Norway, most probably due to orographic effects. To take this into account, and to correct for the smaller precipitation amount at open sea, a method which allows variable amounts of precipitation to be used based on 70% of the median values for coastal stations has been proposed for estimation of inputs to the North Sea.
- The CAMP monitoring stations are not regularly spaced along the coast line of the maritime area. For example, for the North Sea an averaging of deposition fluxes measured at coastal stations may over-estimate the atmospheric input due to the relatively higher network density in the southern, more polluted part of the North Sea. Other interpolation methods e.g. by inverse distance weighting, may overcome this problem but any concentration gradients from land to sea due to removal processes or due to dilution (the first point discussed above) is still not accounted for.

Since in the CAMP-network measurements are available on a monthly or 4-weekly basis only, it is not possible to separate on-shore and off-shore winds and estimate direction dependent concentrations. However, it is possible to apply a bulk gradient correction factor for each station derived from calculation with an atmospheric transport model. These *dispersion factors f(i)* are defined as the ratio of the modelled deposition flux at station *i* to the modelled deposition flux at the Convention Waters as a whole or sub-regions of it. This model-based dispersion factor can now be applied to extrapolate the measured deposition at the coastal station to the whole North Sea area and/or its sub-regions; total deposition is calculated by:

$$d_{(wet+dry)} = A\frac{\sum_{i=1}^{i=n_w} C_w(i)\, pa_{land}\; f_w(i)}{n_w} + A\frac{\sum_{i=1}^{i=n_a} C_a(i)\, v_d\; t\; f_a(i)}{n_a} \qquad [3]$$

where A is the total area of the North Sea (525,000 km^2) and/or sub-regions, n_w the number of stations with wet deposition measurements, n_a the number of stations with air concentrations measurements, v_d is the dry deposition velocity, t is the length of the period considered (here one year = 365*24*3600 s), $C_w(i)$ the weighted mean concentration in precipitation, pa_{land} is the precipitation amount and $C_a(i)$ the mean concentration in air at station *i*. $f_w(i)$ and $f_a(i)$ represent the dispersion factors for wet and dry deposition, respectively as calculated by the RIVM/TREND model As discussed above it is suggested to take for pa_{land} the median precipitation value of all the stations rather than using station specific precipitation amounts.

This procedure described above is the so-called Method 3a, more details can be found in Oslo and Paris Commissions (1994) Calculation of Atmospheric inputs of contaminants to the North Sea, 1987-1992.

9. Changes in methodology

If in future surveys there are significant changes of methodology of sampling or analysis, these should be reported to the Secretariat by Contracting Parties, together with any re-assessment of previously reported data.

Time schedule and data reporting format

Time schedule

Data measured in one calendar year should be reported in the next year according to the following time schedule:

30 June	Data and Metadata Request from NILU
30 September	Data submission deadline to NILU
31 October	Return of data for validation within 2 weeks
30 November	Draft reporting by NILU to OSPAR

Data reporting format

Data reporting format of data deliverance is in accordance with the terms of the OSPAR/NILU CAMP Data Management Contract.

Appendix C

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ABSTRACT

Observations from coastal air and precipitation monitoring stations in the year 2000 around the North-East Atlantic region are presented. Rates of pollutant supply in precipitation are given. The observations form the results of the Comprehensive Atmospheric Monitoring programme, CAMP, of the OSPAR Commission for the Protection of the North-East Atlantic.

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