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EXECUTIVE BODY FOR THE CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)

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PROGRESS IN ACTIVITIES IN 2009 AND FUTURE WORK

MEASUREMENTS AND MODELLING (ACIDIFICATION, EUTROPHICATION, PHOTO-OXIDANTS, HEAVY METALS, PARTICULATE MATTER AND PERSISTENT ORGANIC POLLUTANTS)

DRAFT REVISED MONITORING STRATEGY

Prepared by the Chemical Coordinating Centre
in consultation with the Bureau of the Steering Body

1. This document presents the draft monitoring strategy for the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) for 2010–2019 as revised by the Chemical Coordinating Centre (CCC) in consultation with the Bureau of the EMEP Steering Body and as mandated by the Steering Body at its thirty-second session in 2008 (ECE/EB.AIR/GE.1/2008/2, para. 33 (f)).

I. INTRODUCTION

2. The Convention identifies a number of issues where close collaboration of its Parties is important to achieve its goals. These include requirements with respect to instrumentation and other techniques for monitoring ambient concentrations of air pollutants, the need to exchange meteorological and physico-chemical data relating to the processes during transmission, the need to use standardized or comparable procedures for monitoring and for the establishment of monitoring stations. Monitoring of atmospheric concentrations and deposition rates is one of the basic elements to achieve the objectives of EMEP.

3. The main objectives of EMEP are:

(a) To provide observational and modelling data on air pollutant concentrations, deposition rates, emissions and transboundary fluxes on the regional scale and identify the trends in time;

(b) To identify the sources of the pollution concentrations and depositions and to assess the effects of changes in emissions;

(c) To improve our understanding of chemical and physical processes relevant to assessing the effects of air pollutants on ecosystems and human health in order to support the development of cost-effective abatement strategies;

(d) To explore the environmental concentrations of new chemical substances that might require the attention of the Convention in the future.

4. EMEP is requested to provide Parties to the Convention with information on emissions, concentrations and deposition rates of air pollutants, with quantified source attribution in order to abate air pollution including long-range transport of air pollutants. This information is an important basis for developing further emission control strategies and implementing the Convention and its Protocols, as well as for establishing additional measures and new Protocols.

5. At its twenty-eight session, in 2004, the Steering Body amended and adopted a monitoring strategy for the period 2004–2009 (EB.AIR/GE.1/2004/5). The Executive Body further approved the monitoring strategy at its twenty-second session and made a decision concerning its implementation (ECE/EB.AIR/83/Add.1, decision 2004/1). The decision urges Parties to make resources available for the full implementation of the strategy at national level within the geographic scope of EMEP without undue delay. It requests CCC to provide technical support to the Parties and the Steering Body to follow the implementation of the strategy closely, to review it and to keep the Executive Body informed on the progress.

6. The EMEP observations and model calculations are important elements in establishing the air pollution situation in the United Nations Economic Commission for Europe (UNECE) region and provide links both to global and to urban scales. Air pollution is also addressed by other conventions, bodies and institutions. The EMEP Strategy for 2010–2019[1] discusses the links between EMEP observations and the information requirements of those other bodies.

II. OBJECTIVES AND GENERAL REQUIREMENTS

7. The new EMEP monitoring strategy for 2010–2019 covers the same period than the new Strategy for EMEP and addresses the information needs outlined in the overall strategy.

8. EMEP monitoring should be designed to support the achievement of the main objectives of EMEP (outlined in chapter I). In view of the considerations outlined in the EMEP Strategy, the monitoring programme should ensure:

(a) Sufficient ongoing long-term monitoring of concentrations and deposition fluxes to test the effectiveness of the Convention's protocols as well as other European policies;

(b) Adequate spatial coverage in new EMEP areas as well as in areas that have been insufficiently covered up to now;

(c) Sufficient temporal resolution that will allow investigation of atmospheric processes and model improvements as well as analysis of individual pollution events important in relation to human health and ecosystem impacts;

(d) Co-located and concurrent monitoring of all relevant components and adoption of standard methodologies and adequate quality assurance procedures;

(e) Conduct of monitoring in an affordable way for all Parties, particularly those with economic limitations, but at the same time in a way that takes advantages of the scientific development and emerging capabilities at the national level.

9. In line with the monitoring strategy for 2004–2009, which acknowledged the need for information related to linkages of geographical scales (e.g. local versus regional scales, intercontinental transport and global changes), the revised strategy proposes further measures to this end for the current strategic period. The 2004–2009 monitoring strategy also highlighted the need to address the interaction of global changes (including climate change) with air quality issues. The revised EMEP monitoring strategy defines the requirements to achieve these goals.

[1] The new EMEP Strategy has been submitted for approval to the Steering Body at its thirty-third session (ECE/EB.AIR/GE.1/2009/10).

10. EMEP monitoring constitutes the core infrastructure for monitoring atmospheric composition change throughout the EMEP domain by ensuring adequate geographical coverage of monitoring efforts by Parties as well as by ensuring that that these data can be combined with data generated outside the region. One of the key challenges is to understand the role of intercontinental transport of pollutants of short-lived species as well as long-lived species affecting the topics addressed by EMEP. EMEP observations contribute to the Global Earth Observation System of Systems (GEOSS). EMEP observations and monitoring sites are particularly well suited to serve as complementary sources of data to airborne and spaceborne remote sensing instrumentation, and it is expected that satellite data will towards the end of the coming strategic period provide essential information for addressing air pollution across the EMEP domain. The capabilities of satellites, however, will continue to rely on the reliable data for calibration and validation that EMEP observations contribute to.

11. EMEP monitoring should support, in an integrated way, information needs associated with the coupling between atmospheric composition and deposition rates with climate variability/change. These include radiative forcing agents with a significant regional gradient (e.g. aerosols and ozone) where transboundary fluxes of the agents and their source-receptor relationships need to be assessed. Secondly, the monitoring of long-lived greenhouse gases should be closely integrated with the traditional EMEP parameters, where relevant, with a view to further developing the monitoring programme defined for the strategic period of 2004–2009. Finally, the EMEP observation efforts should support the coupling between the carbon cycle and reactive nitrogen cycle.

12. EMEP monitoring constitutes the core capacity for observing atmospheric composition contributing to the evaluation of the regional contribution to local air pollution. This work is to be closely harmonized in the European Union member countries with the implementation of the Directive on Ambient Air Quality and Cleaner Air for Europe (Air Quality Directive). There is a need for additional sites that provide a comprehensive list of parameters in order to adequately describe the physical and chemical processes occurring during transport. The performance and spatial resolution of the EMEP models is expected to improve during the strategic period 2010–2019, and there is a potential for using urban background sites to support the EMEP work. It is recommended that EMEP develop the supporting monitoring capacity jointly with other forums and bodies that address local pollution issues.

III. COORDINATION AND COOPERATION NEEDS

13. Taking into account the complexity and costs of atmospheric composition monitoring, EMEP will, as far as possible, harmonize and make use of relevant data compiled under other networks.

14. The monitoring requirements provide important data for the assessment of environmental issues considered by other conventions including local air quality, climate change, water quality and biodiversity. There is also a significant overlap in the technical infrastructures at the national level, and most EMEP supersites (see below) are also core infrastructures for measurements of parameters needed to assess such topics. Due to the significant interactions between the suite of chemical constituents and the associated physical properties of air pollutants, as well as the synergies in abatement measures, national and international monitoring efforts should be closely coordinated. Such an approach will ensure a sound observational basis for EMEP by combining resources and avoiding duplication of efforts. Examples of other initiatives and frameworks include European Union legislation (e.g. the Air Quality Directive), the Working Group on Effects and its International Cooperative Programmes (e.g. ICP Forest, ICP Integrated Monitoring and ICP Vegetation) under the Convention, as well as various national and international programmes (e.g. the Arctic Monitoring and Assessment Programme (AMAP), the Commission of the Convention on the Protection of the Marine Environment of the Baltic Sea Area (HELCOM), the Commission for the Protection of the Marine Environment of the North-East Atlantic (OSPARCOM), the World Meteorological Organization Global Atmosphere Watch (WMO-GAW), the United Nations Framework Convention on Climate Change, the Stockholm Convention on Persistent Organic Pollutants under the United Nations Environment Programme (UNEP), and others.)

15. The monitoring strategy of EMEP is to use progress in scientific understanding represented by new methods for the conduct of monitoring, new technologies and techniques to integrate observations from measurement platforms (e.g. in situ, profiles, remote sensing) and methods for integrating observational data with modelling efforts through, for example, data assimilation. EMEP will, where relevant and appropriate, introduce monitoring of parameters at a timeliness allowing more rapid access to data on the air pollution situation across the EMEP domain. EMEP will in collaboration with the European Environment Agency contribute to the provision of near-real time data for Global Monitoring for the Environment and Security (GMES) in agreement with the Parties. Such efforts will be based on voluntary contributions from Parties and will follow the guidance of the EMEP Steering Body.

IV. ORGANIZATION OF THE NEW MONITORING PROGRAMME (2010–2019)

16. The monitoring programme will be organized to allow for monitoring stations to operate at three different levels of scope and complexity, each targeting EMEP objectives in different ways. In addition, EMEP will make use of data from supplementary sites which offer data of adequate quality and at a relevant spatial representativeness, but without necessarily fulfilling all the other measurement obligations defined by the strategy.

17. The main objective of monitoring at level 1 sites is to provide long-term basic chemical and physical measurements of the traditional EMEP parameters. Level 1 activities should be the first priority when extending the network to areas not adequately covered by measurements up to now in Eastern Europe, Caucasus and Central Asia (EECCA) and in South-Eastern Europe (SEE). By undertaking a more demanding monitoring programme, a subset of the level 1 stations should gradually be upgraded to level 2 sites.

18. Level 2 sites provide the additional physical/chemical speciation of relevant components that is necessary for assessing the air pollution including long-range transport of air pollutants, and thus represent an essential supplement to the level 1 sites. The aim is to operate 20–30 level 2 sites throughout the EMEP domain. Level 2 sites are defined according to a topic that Parties choose to focus on as the basis of their national priorities, and they do not have to cover all topics. A level 1 site extending its programme to include the level 2 activities for any of the specific topics will be identified as a "supersite" for this topic. Level 1 and level 2 sites will typically be operated by institutions nominated by the respective Parties for implementing their monitoring obligations. Level 2 sites activities will typically involve long-term continuous monitoring.

19. Level 3 activities are research-oriented. The main objective of level 3 sites is to improve the scientific understanding of the relevant physico-chemical processes in relation to regional air pollution and its control. Level 3 activities will typically be undertaken by research groups and may also include campaign data. Level 3 sites are a voluntary component of the monitoring network. Level 3 sites are also nominated as "EMEP supersites"; this is intended to be an important motivation factor and to provide appropriate recognition of the data providers.

20. The specification of the different levels of monitoring is as follows:

(a) Level 1:

(i) Measurements at level 1 include parameters required to describe basic aspects of tropospheric chemistry and deposition rates of substances involved in the atmospheric cycling of particulate matter, photochemical oxidants, acidifying and eutrophying compounds and heavy metals, as well as their trends over time. Although it is not a formal requirement at level 1 sites, the EU Member States that have commitments under Directive 2008/50/EC are recommended to undertake the required background measurements at their existing EMEP sites rather than establish new sites for this purpose. Requirements at level 1 sites also include meteorological parameters, but these may be taken from an adjacent meteorological site, if representative;

(ii) Supplemental level 1 sites are sites from which only a selected number of the full level 1 site parameters are measured;

(iii) The costs for establishing and operating level 1 sites are lower than for level 2 sites. Furthermore, low-cost methods can be applied for determining the partitioning between gas and particle phases of nitrogen compounds;

(iv) Measuring of persistent organic pollutants (POPs) is not required at level 1.

(b) Level 2: measurements at level 2 sites include all parameters required at level 1 sites plus a series of additional ones. Such additional parameters could include high time resolution (by continuous methods), reliable gas/particle distribution information for semi-volatile nitrogen compounds, speciation of precursors to photochemical oxidants (nitrogen oxide (NOx) compounds and volatile organic compounds (VOCs)), physical and optical characterization of aerosols (particulate matter 1 (PM_1) mass concentration, size number distribution, aerosol optical depth, light scattering and light absorption measurements), extended chemical speciation of particles (elemental and organic carbon, mineral dust), tracers to address air mass origin and the role of anthropogenic versus natural influence (carbon monoxide(CO), methane (CH_4) and halocarbons). For heavy metals, the level- 2 programme includes air concentrations of cadmium (Cd) and lead (Pb) (with copper (Cu), zinc (Zn), arsenic (As), chromium (Cr) and nickel (Ni) as a secondary priority) and mercury (Hg) in air and precipitation. POPs monitoring is mandatory in level 2 and should include measurements both in air and in precipitation. Not all parameters listed above are required, however, to comply with the level 2 “supersite” requirements. Many of these observations are available as a result of research efforts undertaken at EMEP sites, and are typically funded from other sources than from national EMEP monitoring budgets.

(c) Level 3: Level 3 measurements are research-driven and may partly be available at locations other than level 1 and level 2 sites. The research measurements at level 3 need to respond to the EMEP monitoring objectives and challenges. Interesting parameters for EMEP include: (i) dry deposition flux measurements (sulphur, nitrogen, ozone, VOCs, Hg, others); (ii) vertical profiles of ozone and aerosols (soundings or lidar); (iii) Hg speciation (total gaseous mercury (TGM), reactive gaseous mercury (RGM), total particulate mercury (TPM)); (iv) congener specific POPs (polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzodioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs)); (v) observations of POPs and Hg in other compartments than in the atmosphere, to be obtained through collaboration with other relevant bodies and institutions; (vi) chemical speciation of organic carbon (OC) in aerosols, including also carbon dioxide (CO_2) and nitrous oxide (N_2O) measurements made at EMEP sites in association with other monitoring frameworks; and (vii)

isotope information on OC and VOCs. Other parameters may be added to this list as they become relevant for EMEP.

21. Table 1 in annex to the present document summarizes the parameters to be monitored at the three respective levels, as well as the minimum time resolution for measurement and it provides a reference to relevant monitoring obligations defined by collaborating conventions and programmes. Information about reference methods and methodologies is available in the EMEP manual for sampling and chemical analysis, as well as in the quality assurance/quality control (QA/QC) section of the EMEP webpage (http://www.emep.int/).

22. Since the different compounds studied under EMEP are intrinsically linked, it is important that the mandatory EMEP monitoring network consists of co-located and concurrent measurements in both precipitation and air. It is recognized, however, that POPs measurements may not always be co-located with level 1 sites, since many of the POP sites are operated in support of other programmes, such as OSPARCOM, HELCOM and AMAP as well as in line with the European Union Air Quality Directive and other relevant legislation. It is recommended that Parties co-locate their POPs measurements with EMEP level 1/level 2 stations wherever possible.

23. The temporal resolution for the EMEP mandatory monitoring programme should be sufficient to support analysis of chemical and physical characteristics of synoptic scale transport. Thus, the temporal resolution should generally not exceed 24 hours. Finer temporal resolution is recommended where appropriate methods exist. However, Parties can opt for monitoring at a lower level and at a longer time resolution when the measurement activity requires significant financial resources making a continuous time integrated sampling at 24-hour resolution unrealistic, or if concentrations levels are so low that detection levels become a problem. In such cases it is recommended to continue current practice of limiting the sampling to a few short-time integrated samples per week (2 hours, 24 or 48 hours per week, e.g. VOCs, carbonyls, POPs, EC/OC) or alternatively to integrate over a full week (inorganic compounds in $PM_{2.5.}$ and Hg).

24. Sampling frequencies need to be continuously revised by the Task Force on Measurements and Modelling to address the requirements for the evolving needs of the Convention.

25. The site density is defined through target densities for each level, whilst providing for some flexibility. In general, the monitoring density should reflect on the residence time of the pollutants in the atmosphere and should be highest in areas with strong gradients in air concentrations and deposition. For the compounds of interest for EMEP, a target site density of

at least one to two sites per 100,000 km^2 is recommended. All Parties with an area larger than 10,000 km^2 are requested to operate at least one level 1 site.

26. Level 2 activities represent the core requirement of the EMEP monitoring network and all Parties with a land area larger than 50,000 km^2 are expected to operate at least one site, and countries with a land area larger than 100,000 km^2 are expected to operate Level 2 sites for more than one topic. Possibilities for regional collaboration on the operation of sites should be explored, and the collaboration with WMO through the operation of joint EMEP-GAW supersites is essential in the implementation.

27. Level 3 measurements are voluntary, but at the same time important for further progress. Most Parties already operate sites addressing these components, and efforts should be made to involve the relevant groups to the EMEP work as well as to make the data available. The level 3 sites can to some extent be expected to reflect the priority pollution issues for different subregions, and the availability of data may depend on the availability of research funds. In view of these considerations, EMEP could contribute to securing a long-term provision of essential parameters that are currently not covered through any monitoring obligations, such as aerosol and ozone lidar measurements, climate gases and others.

28. EMEP will maintain and further improve its quality assurance programme to make sure that observation data are of known quality and adequate for their intended use. Field inter-comparisons and laboratory ring tests are important, as well as the maintenance of good links between national data providers and the EMEP centres. These activities can be strengthened through collaboration with the central quality assurance facilities in the European Union and in the WMO-GAW system. Measurements should also satisfy the requirements in terms of quality assurance and quality control (www.nilu.no/projects/ccc/qa/index.htm). The EMEP Manual for Sampling and Chemical Analysis gives the criteria that need to be satisfied for instrumentation and analytical methods. Other methods such as automatic monitors can replace manual methods when the data quality can be proven to be equivalent or better.

V. COMPLIANCE, IMPLEMENTATION AND FURTHER EVOLUTION OF THE MONITORING STRATEGY

29. All Parties are requested to ensure the full implementation of the monitoring strategy.

30. It is essential to extend the implementation of the programme throughout the UNECE region, in particular in EECCA and SEE, starting with level 1.

31. Due to the large number of parameters to be measured, and the proposed site density, some Parties might for various reasons have different priorities or have difficulties in conducting all activities defined at mandatory level 1 and level 2. EMEP will thus, on a provisional basis, acknowledge information not fully satisfying the requirements given for level 1. Any major change in the monitoring programme of a Party should be made in consultation with CCC.

32. Parties with economies in transition that have not been able to operate an adequate EMEP monitoring site in the past are encouraged to enter the programme as soon as possible, but if necessary at a lower level of ambition, e.g. by implementing only parts of the programme in the beginning. CCC is committed to provide guidance to the Parties on which parameters to monitor pending their abilities, location, etc.

33. There is a need for regional cooperation to provide a sufficient number of level 2 sites. Parties are urged to coordinate their efforts in order to share and reduce costs. The Parties, in close consultation with the EMEP centres, should do the selection of level 2 sites. Full advantage should be taken of other monitoring frameworks in Europe, such as GAW, the national monitoring networks reporting to the European Commission under the European Union Air Quality Directives and the Exchange of Information Decision as well as national and local monitoring efforts.

34. The EMEP monitoring network must be dynamic and ready to adapt to new needs and requirements identified by EMEP and the Convention. At the same time, consistent long-term time series should be maintained to monitor emission changes. This requires the strategy and its implementation to be regularly reviewed and, as appropriate, revised. The Task Force on Measurements and Modelling will coordinate reviews and facilitate the involvement of the EMEP centres and experts from the Parties in this process. The results of reviews and recommendations for revisions will be presented to the EMEP Steering Body.

Annex

MONITORING REQUIREMENTS FOR THE VARIOUS LEVELS SPECIFIED BY THE MONITORING STRATEGY

Levels 1 and 2 are mandatory. The Notes column refers to requirements for variables to be measured as part of the EU and WMO monitoring obligations. Information on reference methods is provided in the EMEP Manual for Sampling and Chemical Analysis and in the QA/QC section available on the EMEP-CCC website.

Level 1 sites : Observations contribute to the assessment of atmospheric transport and deposition of key parameters relevant for acidification, eutrophication, photochemical oxidants, heavy metals and particulate matter (see also para. 20 (a))			
Programme	**Parameters**	**Minimum time resolution**	**Notes**
Inorganic compounds in precipitation	SO_4^{2-}, NO_3^-, NH_4^+, H^+ (pH), Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^- , (cond)	Daily	Recommended by WMO/GAW and its precipitation network (GAW Report No 158 and GAW report No 172 (Strategic plan 2008-2015)
Heavy metals in precipitation	Cd, Pb (1st priority), Cu, Zn, As, Cr, Ni (2nd priority)	Daily/weekly	Deposition of As, Cd, Ni is required in the Directive 2004/107/EC. CEN method established
Inorganic compounds in air	SO_2, SO_4^{2-}, NO_3^-, HNO_3, NH_4^+, NH_3, (sNO_3, sNH_4), HCl, Na^+, K^+, Ca^{2+}, Mg^{2+}	Daily	Recommended to be complemented with low cost denuders or passive samplers
NO_2 in air	NO_2	Hourly/Daily	EU Directive 2008/50/EC (note differences in reference methodology)
Ozone in air	O_3	Hourly	EU Directive 2008/50/EC
PM mass in air	$PM_{2.5}$, PM_{10}	Hourly/Daily	EU Directive 2008/50/EC. Included in WMO/GAW recommendation for the aerosol network, GAW report No. 153
Gas particle ratios of N-species	NH_3, NH_4^+,HCl, HNO_3, NO_3^- (in combination with filtre pack sampling)	Monthly	Low-cost methods
Meteorology	Precipitation amount (RR), temperature (T), wind direction (dd), wind speed (ff), relative humidity (rh), atmospheric pressure (pr)	Daily (RR), Hourly	Can be taken from a representative meteorological site

Level 2 sites: Level 2 sites should also measure a majority of parameters required at level 1. (See also para. 20 (b))

Programme	Parameters	Minimum time resolution	Notes
Acidification and eutrophication Observations contributes to the assessment of nitrogen chemistry, influence by local emissions and dry deposition fluxes (see also para. 18b)			
Gas particle ratio	NH_3/NH_4^+, HNO_3/NO_3^- (artifact-free methods)	Hourly/Daily	
Ammonia in emission areas (optional)	NH_3	Monthly	Optional low cost alternative to provide high spatial resolution information in emission areas, where desired.
Photochemical oxidants observations contributes to the assessment of oxidant precursors (see also paragraph 18b)			
NOx	NO, NO_2	Hourly	In the EU Directive 2008/50/EC, WMO GAW
Light hydrocarbons	C_2-C_7	Hourly	In the EU Directive 2002/3/EC and benzene in 2008/50/EC, WMO GAW
Carbonyls	Aldehydes and ketones	8hourly twice a week	In the EU Directive 2002/3/EC,
CH_4	Methane	hourly	WMO GAW
Heavy metals observations contributes to the assessment of mercury and heavy metals fluxes (see also paragraph 18b)			
Mercury in precipitation	Hg	Weekly	In the EU Directive 2004/107/EC
Mercury in air	Hg (TGM),	Hourly/Daily	In the EU Directive 2004/107/EC
Heavy metals in air	Cd, Pb (1st priority.), Cu, Zn, As, Cr, Ni (2nd priority)	Daily/Weekly	In the EU Directive 2004/107/EC for As, Cd, Ni and 2008/50/EC for Pb
Persistent organic pollutants observations contributes to the assessment of persistent organic pollutants (see also paragraph 18b)			
POPs in precipitation	PAHs, PCBs, HCB, chlordane, HCHs, DDT/DDE	Weekly	PAH in EU Directive 2004/107/EC. POP is included in UNEP Stockholm Convention
POPs in air	PAHs, PCBs, HCB, chlordane, HCHs, DDT/DDE	Daily/Weekly	PAH in EU Directive 2004/107/EC. POP is included in UNEP Stockholm Convention

Particulate matter observations contributes to the assessment of particulate matter and its source apportionment (see also paragraph 20 (c)).			
PM mass in air	PM_1	Hourly/Daily	
Mineral dust in PM10	Si, Al, Fe, Ca	Daily/Weekly	Chemical speciation included in WMO/GAW recommendation for the aerosol network, GAW report No 153 and No 172
EC and OC in PM10	Elemental and Organic Carbon	Daily/Weekly	Chemical speciation included in WMO/GAW recommendation for the aerosol network, , GAW report No 153 and No 172
Aerosol absorption	Light absorption coefficient	Hourly/Daily	Included in WMO/GAW recommendation for the aerosol network, GAW report No 153/172. Core parameter
Aerosol size/number distribution	dN/dlogDp	Hourly/Daily	Included in WMO/GAW recommendation for the aerosol network, GAW report No 153/172
Aerosol scattering	Light scattering coefficient	Hourly/Daily	Included in WMO/GAW recommendation for the aerosol network, GAW report No 153/172. Core parameter
Aerosol Optical Depth	AOD at 550 nm	Hourly	Included in WMO/GAW recommendation for the aerosol network, GAW report No 153/172. Core parameter
Tracers observations contributes to the assessment of individual long-range transport events and their source apportionment (see also paragraph 18b)			
Carbon Monoxide	CO	Hourly	In the EU Directive 2004/107/EC, WMO GAW report No 172
Halocarbons	CFCs, HCFCs, HFCs, PFCs, SF_6	Hourly	WMO GAW report No 172

Level 3 sites
Research based and voluntary -monitoring at these sites do not require all level 1 and level 2 parameters. Level 3 sites also include campaign type data. Observations contribute to the understanding of processes relevant for long-range transport of air pollutants and support model development and validation (see also para. 18c).

Programme	**Parameters**	**Minimum time resolution**	**Notes**
Dry deposition flux	SO_2, NH_3, HNO_3 (SO_4^{2-}, NH_4^+, NO_3^-)	Hourly	
Dry deposition flux of O3	O_3	Hourly	
Dry deposition flux of VOCs	OVOCs and terpenes	Hourly	
Hydrocarbons	C_6-C_{12}	Hourly/Daily	WMO GAW report No 172
NOy chemistry	PAN, organic nitrates	Hourly/Daily	WMO GAW report No 172
Vertical profiles	O_3 soundings, aerosol Lidar,	Hourly/Daily	Included in WMO/GAW recommendation for the aerosol network (GAW report No 153).
OC fractionation	Water soluble and water insoluble OC (WSOC/WINSOC)	Hourly/Daily	
Organic tracers	Levoglucosan, others	Daily, weekly	
Isotopic information	OC, VOCs	Hourly/Daily/ Weekly	
Greenhouse gases	CO_2, N_2O	Hourly	WMO GAW report No 172
Hydrogen	Hydrogen (H_2)	Hourly	WMO GAW report No 172
Major inorganics in both $PM_{2.5}$ and PM_{10}	SO_4^{2-}, NO_3^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^+ (Cl^-)	Hourly/Daily	Included in WMO/GAW recommendation for the aerosol network, GAW report No 153/172.
Mercury speciation	TGM, RGM and TPM	Daily/Weekly	
Congener-specific	POPs PCBs, PAHs, PCDDs and PCDFs	Daily/Weekly	

GAW Report No. 172: WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008–2015.
