
# Inventory of Requirement Documents

**6.5.2011**



| | |
|---|---|
| PROJECT: | MACC Monitoring Atmospheric Composition and Climate |
| SUB-PROJECT / CLUSTER: | MAN Management and System Engineering |
| WORK PACKAGE / TASK: | MAN_3 System engineering for the GMES Atmospheric Service |
| DELIVERABLE: | D_MAN_3.5 (a) |

| | |
|---|---|
| PROJECT: | MACC Monitoring Atmospheric Composition and Climate |
| SUB-PROJECT / CLUSTER: | MAN Management and System Engineering |
| WORK PACKAGE / TASK: | MAN_3 System engineering for the GMES Atmospheric Service |
| DELIVERABLE: | D_MAN_3.5 (a) |

| | |
|---|---|
| title / *titre* | Inventory of Requirement Documents |
| author / *auteur* | Anne De Rudder (IASB-BIRA) |
| reference / *référence* | FP7-MACC-MAN-3-5-a |
| issue / *édition* | 1 |
| revision / *révision* | 0 |
| status / *état* | final draft |
| date of issue / *date d'édition* | 6.5.2011 |
| document type / *type de document* | Framework/Management Document |

| | FUNCTION | NAME | DATE |
|---|---|---|---|
| AUTHOR | GAS System Engineering | A. De Rudder (IASB-BIRA) | 13.4.2011 |
| REVIEWED BY MANAGEMENT AND OUTREACH | MACC Project Coordinator<br>GAS System Engineering<br><br>Outreach Cluster<br>*O-INTERFACE to end users*<br>*O-POL Support of policy* | A. Simmons (ECMWF)<br>J.-C. Lambert (IASB-BIRA)<br><br><br>T. Holzer-Popp (DLR)<br>Ø. Hov (MET.NO)<br>M. Gauss (MET.NO) | 15.4.2011<br>xx.xx.xxxx<br><br><br>14.4.2011<br>19.4.2011<br>19.4.2011 |
| ISSUED BY | GAS System Engineering | A. De Rudder (IASB-BIRA) | 6.5.2011 |

# DOCUMENT CHANGE RECORD

| Issue | Revision | Date | Modified Items / Reason for Change |
|---|---|---|---|
| 0 | 0 | 8.11.2010 | Document created and bibliography compiled |
| | | 6.4.2011 | Sections 1, 3, 4, 5 & 6 completed |
| | | 13.4.2011 | Section 2 completed.<br>Executive summary and Section 1.2 (last 2 paragraphs) updated.<br>Items added to Sections 4, 5 and 6. |
| | 1 | 20.4.2011 | Suggested changes from reviewer integrated (more explicit information on AQFD and NEC Directive in Section 3.2.1).<br>Paragraphs on the Gothenburg Protocol (in Section 3.1.1) updated, paragraphs on its result assessment and follow-up added.<br>Items added to Sections 4 & 5. |
| | | 21.4.2011-5.5.2011 | Paragraph on follow-up to the Kyoto Protocol added (Section 3.1.3).<br>Sections 3.2.2 and 3.2.3 inserted (EU legislation on stratospheric $O_3$ and climate).<br>Items inserted into Sections 4 & 5.<br>Section 7 added.<br>Section 1.3 updated.<br>Table of contents updated. |
| 1 | 0 | 6.5.2011 | Final editorial changes. |

# EXECUTIVE SUMMARY

Monitoring Atmospheric Composition and Climate (MACC) is the EU FP7 project establishing the core global and regional atmospheric environmental service of the Global Monitoring for the Environment and Security (GMES) European programme. This technical note draws up an inventory of existing requirement documents and databases of relevance to MACC. The requirements in question belong to a wide spectrum, from quantitative data specifications, through data processing validation and documentation, delivery frequency, service reliability, to monitoring obligations in the context of regulations about the reduction in emissions of man-made compounds.

A first category of documents and databases includes those published by groups of current or potential users of MACC services, obviously directly applicable to MACC. A second group is made of international regulations which provide general guidelines that MACC product providers must be aware of, and sometimes quantitative requirements applying to datasets produced and services developed in the framework of these regulations, but which also constrain some of the users' activities, particularly policy makers or national agencies, and are consequently applicable to MACC as well, even though in a more indirect way. Finally, a call for participation to the shaping of the latest European regulation that will apply to the GMES Atmospheric Service (GAS) is addressed to all MACC partners.

# TABLE OF CONTENTS

# 1. INTRODUCTION

## 1.1 MACC and the GMES Atmospheric Service

Monitoring Atmospheric Composition and Climate (MACC) is establishing the core global and regional atmospheric environmental service of the European GMES programme. It is funded under the Seventh Framework Programme of the European Union and began on 1 June 2009. MACC is undertaken by a consortium largely drawn from the partners in the earlier GEMS and PROMOTE projects, the core systems and service lines of which provided the starting point for the project.

MACC combines state-of-the-art atmospheric modelling with Earth observation data – from satellite and in situ measurement systems – to provide information services covering European Air Quality, Global Atmospheric Composition, Climate, and UV and Solar Energy. It monitors the distributions and long-range transport of greenhouse gases (GHG) such as carbon dioxide and methane, aerosols, and reactive gases such as tropospheric ozone and nitrogen dioxide. It provides global forecasts of reactive gases and aerosols, as well as detailed forecasts and assessments of air quality in Europe. It also provides records and forecasts of stratospheric ozone, UV radiation and solar energy.

## 1.2 Purpose of this note

In order to fulfil its commitment to provide adequate (or "fit-for-purpose") products and services, MACC has to take into account requirements from potential and current users, which depend on the nature of the targeted applications. The suitability of the GMES Atmospheric Service to its applications, or its flexibility to adapt, up to a reasonable extent, to new applications, is a key element contributing to the measure of its quality.

The extent and diversity of the range of activities and services addressed by MACC is expected to give rise to a matching diversity of requirements. However, important common features emerge from user requirements, namely the need of validated products and quality-controlled services. The MACC Validation Protocol [**RD-23**] defines the top-level approach for validating all components of the MACC Product Portfolio [**RD-44**], thus providing the rules to be followed by the MACC service providers in order to meet this general quality requirement.

In addition, general and specific requirement documents which are of direct relevance to MACC have been issued in the context of various programmes and projects, including MACC itself. Furthermore, users of MACC services will themselves be constrained by some requirements defined by international or regional environmental protocols and regulations. These will thus indirectly affect MACC and must be kept in mind while developing the services. Finally, we shall see that MACC may actively contribute to shape the regulations to which it will be subject, by informing the designers of rules that are still being drafted.

The purpose of this technical note is to list those requirement documents that must be considered while developing and operating the GMES Atmospheric Service and to provide MACC WP leaders the necessary information to assess their relevance to the particular services for which they are responsible. The contents of the overviewed documents may grossly be divided in three categories: irrelevant elements (e.g. non-atmospheric disciplines or variables), elements relevant to the project as a whole (e.g. high level data quality requirements) and elements relevant to particular services (e.g. species dependent requirements, need in specific additional observation, etc.).

## 1.3 Document overview

The structure of this document matches the classification underlined above:

1. Section 1 is this introduction.
2. Section 2 deals with requirements from past and current users of services to form the GMES Atmospheric Service (GAS) and from international communities of experts in Earth observation, climate monitoring and atmospheric chemistry.
3. Section 3 addresses contextual requirements and regulations constraining both service providers and users of the GAS. The last of these regulations, INSPIRE, is still being shaped and contribution from MACC partners to this process will hopefully help setting up a proper framework to the GAS activities in the future.
4. Section 4 lists the requirement documents to which the previous two sections refer (4.1 and 4.2), as well as other reference documents quoted in the text (4.3). In each subsection, documents are ordered chronologically, apart from undated webpages, which are ordered alphabetically.
5. Section 5 expands abbreviations and acronyms ordered alphabetically (including abbreviations of generic chemical names), provides some basic information on the quoted institutions, centres, programmes and projects, and points to related home pages.
6. Section 6 provides a list of element symbols and chemical formulae of compounds quoted in the text.
7. Section 7 lists the main international regulatory texts quoted in this note, with reference to the corresponding page numbers.

# 2. USER REQUIREMENTS

## 2.1 Within GMES

MACC and predecessor projects (PROMOTE, GEMS) that have contributed to build up the GMES Atmospheric Service (GAS) have conducted user requirement surveys as well as service evaluations by their users, which include suggestions for improvement. As users of upstream sources, participants to these projects have also issued requirement documents addressed to core services.

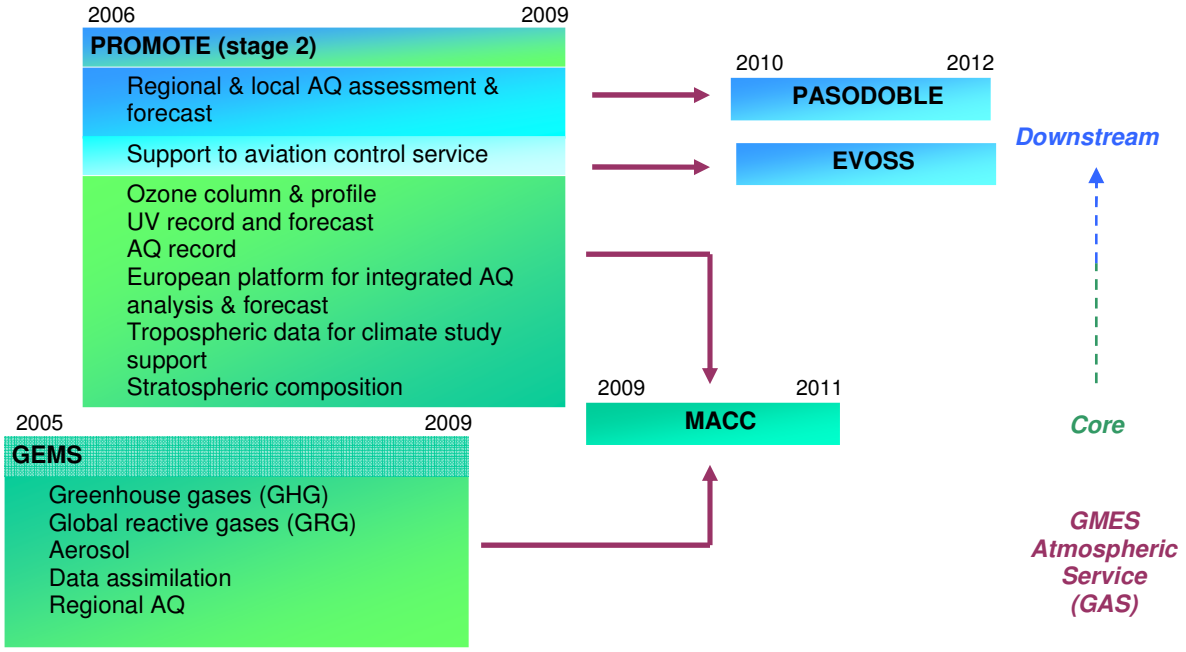


**Figure 1.** MACC continues, expands and operates core atmospheric services developed during the EC-funded project GEMS and the ESA-funded project PROMOTE.

### 2.1.1 PROMOTE

Protocol Monitoring for the GMES Service Element Atmosphere (PROMOTE) and its follow-up project PROMOTE-2 were funded by ESA from 2003 to 2009 to lay down foundations of the GMES atmospheric service (see [**RD-22**]). Its components included monitoring and forecast of stratospheric ozone and UV, stratospheric composition, greenhouse gases and climate (all three activities continued under MACC), regional and urban air quality (continued under MACC and PASODOBLE), volcanic aerosol (continued under EVOSS), as illustrated in **Figure 1**.

The PROMOTE project devoted a large room to the users' involvement in the process of developing the services. Service providers and users were bound through SLA where basic product specifications were laid down, which somehow reflected the user's expectations, taking into account the state of knowledge and development already achieved. But, more importantly, users provided detailed requirement documents as well as service evaluations. Since PROMOTE was based on a one-year re-evaluation cycle, these documents were reviewed and updated several times. Their latest issues are listed below.

User requirements:

The following documents include desirable data and service specifications, which are of course application-dependent, such as acceptable uncertainty limits, spatiotemporal coverage and resolution, record length (in time) and consistency, delivery timing and frequency, delivery reliability, delivery channel, data extraction and plotting facilities, existence of a help desk, existence of a warning or alert service, and so on.

2006: PROMOTE U1 Global User Needs Directory [**UR-3**]

2006: PROMOTE U5 Core User Needs Dossier [**UR-4**]

2009: PROMOTE-2 U1 Core User Needs and User Standards Dossier [**UR-11**]

User surveys:

2006: PROMOTE U8 Core User Group Executive Report [**UR-1**; **UR-2**]

2009: The PROMOTE final Service Utility Report [**UR-8**; **UR-10**] includes an overview of each PROMOTE service by its principal users.

### 2.1.2 GEMS

Global and Regional Earth-System (Atmosphere) Monitoring Using Satellite and In-Situ Data (GEMS) was a FP6 project (2005-2009) developing comprehensive monitoring and forecasting systems for trace atmospheric constituents important for climate and air quality, to contribute to the GAS. Components of GEMS, which are further developed and operated under MACC, included greenhouse gases (GHG), global reactive gases (GRG), aerosol, data assimilation and regional air quality. Data requirements have been formulated by service developers within GEMS regarding the input needed to set up the global biomass burning (BB) emission monitoring service of GMES.

**Biomass burning data requirements.**

In a communication to the 2006 EUMETSAT Meteorological Satellite Conference, Kaiser et al. [**UR-5**] provided a documented wish-list regarding inputs needed by the GEMS and GEOLAND projects to set up the global BB emission monitoring service of the GMES. The desirable inputs include satellite observations of the amounts of burnt biomass and emitted trace gases and aerosols, with the injection height profile, the type of vegetation burnt and the burnt area. Requirements about quantitative and qualitative data specifications associated to these inputs are also expressed; they relate to coverage (wished to be global), spatiotemporal resolution, delivery timing (NRT), consistency and length (10 years) of historical record, and improved accuracy with regard to currently available data.

As regards the last point, it was proposed to develop a Global Fire Assimilation System (GFAS) able to integrate land cover and meteorology in order to derive more accurate products from existing observations, activity which is now addressed by MACC (Kaiser et al., 2009 [**RD-18**]).

### 2.1.3 MACC

***Data and service quality requirements***

As mentioned in the introduction, the MACC Validation Protocol [**RD-23**] defines the top-level quality requirements to be met by data and services delivered by MACC. The document provides general principles applying to the validation of atmospheric services and specific guidelines for the validation of the MACC thematic lines, as well as quality control rules and standards of reference.

Since the MACC Validation Protocol explicitly refers to international standards of practice such as the Quality Assurance Framework for Earth Observation (QA4EO) [**RD-20**] formalised by the CEOS, such quality requirements will not be overviewed in this note.

***User requirements***

The MACC User Requirement Document [**UR-13**] is, *par excellence,* the first source of information regarding the needs and expectations of the MACC service users. Its first version, issued in August 2010, gathers together requirements from downstream services, i.e. services using MACC products as input (PASODOBLE, G-STEP), and from end users. A second version will be issued towards MACC Month 24 (May 2011), possibly integrating feedback from additional users, especially newly emerging downstream services (EVOSS, Carbones, EURO4M, …).

The document summarises, for each MACC thematic line, the first results of an ongoing enquiry addressed to over a hundred possible and confirmed users of MACC services, who were invited to fill in a questionnaire. Although questions were not explicitly related to data specifications, accuracy, spatiotemporal resolution, historical record length, etc. do appear as key technical requirements mentioned to matter. Other requirements relate to data validation, service delivery (access mode, frequency, NRT availability, format, documentation, sustainability, consistency with European policy), access to additional datasets, training opportunities.

## 2.2 External to GMES

This section overviews existing sets of quantitative and/or qualitative requirements that have been formulated by international communities of experts gathered together around some common theme of interest (climate monitoring, Earth observation, atmospheric chemistry). The information presented in what follows includes publications as well as online databases.

### 2.2.1 Global Climate Observing System (GCOS)

The Global Climate Observing System (GCOS) was established in 1992. Its focus is on satellite and *in situ* observations for climate in the atmospheric, oceanic, and terrestrial domains. The atmospheric elements of GCOS have been planned jointly with the responsible WMO commissions and are implemented within the World Weather Watch (WWW) programme. The GCOS publications quoted below are available from the Global Observing Systems Information Center (GOSIC); so are the links to the various versions of the WMO/CEOS database of observational requirements.

***GCOS Requirements***

Documents containing GCOS requirements are listed below. The purpose of the last two documents in the list is to *"help producers of climate-relevant datasets in the way they document, assess the quality of, and publicize their work related to the generation, processing and analysis of climate datasets and derived products […], based on observations from surface-based, airborne and satellite-based instruments"* [**UR-12**].

- Systematic Observation Requirements for Satellite-Based Products for Climate, 2006 [**UR-6**].
- GCOS Reference Upper-Air Network (GRUAN): Justification, requirements, siting and instrumentation options, 2007 [**UR-7**].

- Guideline for the Generation of Satellite-Based Datasets and Products Meeting GCOS Requirements, 2009 [**UR-9**].
- Guideline for the Generation of Datasets and Products Meeting GCOS Requirements, 2010 [**UR-12**] (update to the previous).

***The CEOS/WMO Database of Observational Requirements***

A database of observational requirements [**UR-14**], regularly reviewed by groups of experts, is available from the WMO Database webpage [**RD-52**] as an Excel workbook. It has been established jointly by the GCOS, GOOS, WCRP and WMO under the umbrella of the Space-Based Global Observing System (GOS). It is a component of the WMO Rolling Requirements Review (RRR) process.

In its last version (March 1, 2011), this database provides user requirements for some 181 basic variables in different layers or at different heights of the ocean/atmosphere system, as a function of the targeted application in a list of 23 application types. Requirements relate to accuracy (as reflected by the numerical value of the absolute or relative uncertainty), horizontal and vertical resolution, observing cycle (time interval between observations of the variable at the same point) and delay of availability.

Users have the possibility to input information into the database, either about measurement requirements, or about *in situ* and space-based observing capabilities. Guidance on how to access and use the database and how to input information into it are provided in the CEOS/WMO Database Manual [**RD-17**].

Regarding satellite observation, the Atmosphere Observation Panel for Climate (AOPC) has specified the requirements to meet GCOS needs. The full version of these requirements is part of the WMO/CEOS affiliates' searchable database [**RD-27**], not operational at the time of writing. However, an excerpt of this database can be found on the GOSIC website, in the form of a table including the main requirements for a list of thirty parameters [**RD-43**]. Requirements shown in this table include units, accuracy, minimal and optimal spatial resolution, observing cycle. The full version of the database includes additional specifications such as the desirable delivery delay. It also includes requirements formulated by OOPC and TOPC. The 2004 version of the database can be found as Appendix 2 to the Technical Document GCOS-107 [**UR-6**] quoted above.

### 2.2.2 CEOS Measurement Requirements

Established in 1984, the Committee on Earth Observation Satellites (CEOS) coordinates civil space-borne observations of the Earth in view to enhance international coordination and data exchange and to optimise societal benefit. Its fifty members and associate members include space agencies as well as other national and international organisations. The CEOS Systems Engineering Office (SEO) was created in April 2007 to facilitate the development of CEOS space constellation plans.

The SEO Systems Database [**RD-28**] is designed to support CEOS strategic planning and gap assessments. One of its components provides measurement requirements for the 111 GOS atmospheric parameters [**UR-15**].

### 2.2.3 IGACO

The Integrated Global Observing Strategy (IGOS) was launched in June 1998 at the first meeting of its partners, IGOS-P 1 [**RD-5**]. IGOS was a strategic planning process that sought to provide a comprehensive framework to harmonise the common interests of the major space-based and *in situ* systems for global observation of the Earth, by linking research, long-term monitoring, operational programmes, data producers and data users. The IGOS partnership officially ended in mid-2008 at the 14th meeting of its partners, IGOS-P 14.

IGOS had defined a number of themes in which observations were made for selected fields of common interest. One of these themes was the Integrated Global Atmospheric Chemistry Observations (IGACO) theme. When IGOS was disbanded in 2008, the IGOS thematic communities were transitioned into the GEO/GEOSS framework and became known as Communities of Practice. "*A Community of Practice (CoP) is a user-led community of stakeholders, from providers to the final beneficiaries of Earth observation data and information, with a common interest in specific aspects of societal benefits to be realized by GEOSS implementation"* [**RD-42**]. IGACO became the GEO "Atmospheric Chemistry" CoP, distinct from the "Air Quality" CoP. The first objective common to all GEO CoP is to "*identify, gather, and seek agreement on their particular user community requirements"* [**RD-42**], task that had already been endorsed and initiated by the IGOS themes.

As regards atmospheric chemistry, the IGACO theme team published in 2004 a comprehensive report that identified major issues, established observational requirements, reviewed existing observational systems and proposed a 10-year implementation plan to adapt the systems to meet the formulated requirements [**RD-10**].

Chapter 4 of this report, "Atmospheric Chemical Observations for Targeted Parameters", reviews all available observation methods and platforms (including ground based, airborne, satellite measurements) and identifies detailed requirements (spatiotemporal resolution, precision, trueness, delay of availability – depending on the application) regarding a number of chemical species and critical ancillary parameters selected for their crucial role in at least one of four environmental issues – air quality, oxidation efficiency, climate and stratospheric ozone depletion – and for the feasibility of their long-term global observation. The parameters addressed by the report are listed in **Table 1**. In general, each requirement is assigned two numerical values: the target (optimal case) and the threshold (minimum to be useful). For gaseous species, requirements are assessed as a function of the atmospheric region (LT, UT, LS, USM) or layer (for tropospheric and total columns).

**Table 1.** Key atmospheric parameters reviewed in Chapter 4 of the 2004 IGACO report **[RD-10]**, for which requirements are formulated.

| **Chemical species** | | **Critical ancillary parameters** |
|---|---|---|
| $O_3$ | $HNO_3$ (nitrogen reservoir) | Temperature |
| CO | $N_2O$ | Pressure |
| $J(NO_2)$ | $SO_2$ | Wind speed (u, v, w) |
| $J(O^1D)$ | BrO, ClO, OClO (active halogens) | Cloud top height |
| $H_2O$ (water vapour) | HCl, $ClONO_2$ (Cl reservoirs) | Cloud coverage |
| HCHO | $CH_3Br$, CFC-12, HCFC-22, halons (halogen sources) | Albedo |
| VOC | $CO_2$ | Lightning flash frequency |
| $NO_X$ (active nitrogen) | $CH_4$ | Fires |
| **Aerosol optical properties** (including solar radiation scattering & absorption) | | Solar radiation |

# 3. INTERNATIONAL REGULATIONS

Nations have agreed with a number of conventions aiming at coordinating the effort to improve and guarantee air quality at regional and global scales, to prevent man-induced climate change and to temper its inevitable adverse effects. The European Commission and/or many of the European Union member states are parties to the conventions and protocols listed in Section 3.1 below. Section 3.2 deals with EU legislative texts which were issued in this global context and have a focus on services developed with the purpose to support control regulations.

On one hand, environmental international regulations lay down general and specific principles applying to the coordination of research and monitoring and to the dissemination of results and information. In this respect, they stipulate user requirements (the users being the parties to the protocols or their supreme bodies) applying to atmospheric services (that carry out research and monitoring, and deliver data and information). Services developed and operated by MACC to be part of the GMES Atmospheric Service must thus take into account the principles, and in some cases the service output specifications, laid down in these official texts. They also benefit from the input of international infrastructures supporting implementation of the regulations.

On the other hand, the parties to these conventions have agreed to reach defined targets in terms of reduced emissions of pollutants. In this respect, the regulations constrain the potential users of MACC atmospheric services (governmental agencies, policy makers at a national scale). In this view, the role of the atmospheric services is to assist their users in achieving the targets, by carrying out monitoring and supplying efficiency assessments and forecasts.

Finally, just as environmental agreements, protocols and laws are triggered and fed by scientific studies, legislation aiming at harmonising practices related to services also relies on feedback from experts. In this respect, MACC project partners have their say in the shaping of regulations being designed currently (e.g. INSPIRE implementing rules).

## 3.1 Worldwide conventions and protocols

Each of the three environmental themes tackled below has been the object of some important set of worldwide regulations. In each case, a convention has set up the general principles forming the framework within which one or several protocols could be elaborated, which defined in more concrete terms measures to be taken, with provisions allowing regular updates. Because they are more binding, protocols have generally been less widely ratified than their mother conventions.

### 3.1.1 Transboundary air pollution

***The Convention on Long-Range Transboundary Air Pollution (CLRTAP)***

The Convention on Long-Range Transboundary Air Pollution (CLRTAP) [**IR-1**] was adopted in Geneva in 1979. As far as the EC is concerned, it entered into force on the 15$^{th}$ of July 1982. It sets up a general framework for cooperation on improving air quality and combating the discharge of air pollutants. Its geographic scope embeds Western Europe, Eastern Europe, Caucasus and Central Asia (EECCA), the United States and Canada. Parties to the convention agree to carry out research and monitoring, and to exchange results and information. Moreover, quantitative emission thresholds are set in the protocols following up the CLRTAP.

Chemicals targeted by the CLRTAP were initially restrained to sulphur compounds, responsible for the formation of acid rain. The scope of the convention, in terms of pollutants, was later widened through its follow-up protocols, to include nitrogen oxides, VOC, POP and heavy metals, with, among other objectives, to reduce near ground level ozone concentrations and harmful effects of particulate matter.

In Europe, the European Monitoring and Evaluation Programme (EMEP) forms the backbone for review and assessment of air pollution in the light of agreements on emission reduction. EMEP has three main components: collection of emission data for $SO_2$, $NO_X$, VOC and other air pollutants; measurement of air and precipitation quality; and modelling of atmospheric dispersion. International centres have been created under the auspices of EMEP to support the effort towards the achievement of the CLRTAP goals:

- The Chemical Coordinating Centre (CCC) hosted by NILU (Norway).
- The Meteorological Synthesizing Centre-East (MSC-E) located in Moscow (Russia).
- The Meteorological Synthesizing Centre-West (MSC-W) hosted by MET.NO (Norway).
- The Centre for Integrated Assessment Modelling (CIAM) hosted by IIASA (Austria).
- The Centre on Emission Inventories and Projections (CEIP) hosted by UBA (Austria).

### *The CLRTAP protocols, a suite converging toward the Gothenburg Protocol*

The CLRTAP was completed by eight protocols. Of particular immediate relevance to MACC is the last one, the Gothenburg Protocol – see (8) below –, which superseded a number of its predecessors – namely, Protocols (2), (3) and (4) below – and is currently being revised in view to be updated and prolonged. All eight protocols are listed below, since they illustrate the progress made both in taking the measure of the issues and in achieving temporary targets.

(1) 1984 : Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) [**IR-2**], entered into force on January 28, 1988.

The protocol defines cost-sharing modalities of the EMEP monitoring programme.

(2) 1985 : Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent [**IR-4**], entered into force on September 2, 1987.

Target: sulphur.

Target year: 1993.

Reference year: 1980.

According to UNECE, substantial cuts in sulphur emissions have been recorded in Europe following the 1985 protocol. Based on the latest available data, by 1993, the 21 parties to the protocol had, as a whole, reduced 1980 sulphur emissions by more than 50%, while all had reached the reduction target, eleven of them having even achieved reductions of at least 60% (see [**RD-45**]).

(3) 1988 : Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes [**IR-6**], entered into force on February 14, 1991.

Target: $NO_X$.

This protocol drew a two-step action:

1°) Freezing of the emissions of nitrogen oxides or their transboundary fluxes at their values of 1987 (1978 for the US).

According to UNECE, nineteen of the twenty-five parties to the protocol seem to have stabilized emissions at that level or reduced them below that level (see [**RD-46**]).

2°) Applying the *"multi-pollutant, multi-effect critical load approach"*, a new protocol would, by addressing all significant emission sources, provide for further reduction of emissions of nitrogen compounds, including ammonia, and volatile organic compounds, in view of their contribution to photochemical pollution, acidification and eutrophication, and their effects on human health, the environment and materials.
This new protocol was the Gothenburg Protocol – see (8) below.

(4) 1991 : Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes [**IR-7**], entered into force on September 29, 1997.

Targets: VOC.

Target year: 1999.

This protocol specified three options for emission reduction targets that had to be chosen by each party upon signature or ratification: (i) 30% reduction in VOC emissions by 1999 using a year between 1984 and 1990 as a basis; (ii) the same reduction as for (i) within a Tropospheric Ozone Management Area (TOMA) specified in Annex I to the protocol and ensuring that by 1999 total national emissions did not exceed 1988 levels; (iii) where 1988 emissions did not exceed a specified level, parties might opt for a stabilization at that level.

(5) 1994 : Protocol on Further Reduction of Sulphur Emissions [**IR-9**], entered into force on August 5, 1998.

Target: sulphur.

An effects-based approach, the critical load concept, best available technology (BAT), energy savings, the application of economic instruments and other considerations were applied in the preparation of this protocol. This led to a differentiation of emission reduction obligations of parties to the protocol. The effects-based approach, which aimed at gradually attaining critical loads, set long-term targets for reductions in sulphur emissions, although it had been recognized that critical loads would not be reached in one single step. An important new feature was introduced in connection with the adoption of this new sulphur protocol, namely the creation of an Implementation Committee whose structure, functions and procedures were defined. The role of the Committee, consisting of eight parties, was to analyse and evaluate on a periodic basis information related to compliance with parties' obligations with a view to securing constructive solutions in case of non-compliance.

(6) 1998 : Aarhus Protocol on Heavy Metals [**IR-13**], entered into force on December 29, 2003.

Targets: cadmium, lead, mercury.

One basic obligation of the parties is to reduce their emissions for these three metals below their levels of 1990 (or an alternative year between 1985 and 1995). The protocol aims to cut emissions from industrial sources (iron, steel and non-ferrous metal industry), combustion processes (power generation, road transport) and waste incineration.

(7) 1998 : Aarhus Protocol on POP [**IR-14**], entered into force on October 23, 2003.

Targets: sixteen substances singled out according to agreed risk criteria, comprising eleven pesticides, two industrial chemicals and three by-products/contaminants. Seven new substances were added to the list in an amendment of the protocol in 2009.

The ultimate objective of the protocol is to eliminate any discharges, emissions and losses of POP.

(8) 1999 : Gothenburg Protocol [**IR-16**], entered into force on May 17, 2005.

Targets: sulphur, $NO_X$, VOC, ammonia.

Target year: 2010 (in the current version).

2010 emission ceilings were set for the above compounds. The protocol also set tight limit values for specific emission sources (e.g. combustion plant, electricity production, dry cleaning, cars and lorries) and required best available techniques (BAT) to be used to keep emissions down. VOC emissions from such products as paints or aerosols, as well as ammonia emissions from agriculture practice had also to be cut.

### *Assessment of results of the Gothenburg Protocol in Europe*

It had been estimated by UNECE [**RD-47**] that once the protocol would be implemented, Europe's sulphur emissions should be cut by at least 63%, its $NO_X$ emissions by 41%, its VOC emissions by 40% and its ammonia emissions by 17% compared to 1990. The area in Europe with excessive levels of acidification should have shrunk from 93 million hectares in 1990 to 15 million hectares. That with excessive levels of eutrophication should have fallen from 165 million hectares in 1990 to 108 million hectares. The number of days with excessive ozone levels should have been halved. Consequently, it was estimated that life-years lost as a result of the chronic effects of ozone exposure would be about 2,300,000 lower in 2010 than in 1990, and that there would be approximately 47,500 fewer premature deaths resulting from ozone and particulate matter in the air. The exposure of vegetation to excessive ozone levels should have been cut down by 44% compared to 1990.

The UNECE Working Group on Effects (WGE) of the CLRTAP has monitored the impact of the Gothenburg Protocol in Europe [**RD-48**]. Some of the expected results of the Protocol, like the halting of forest and lake acidification allowed by the reduction in sulphur emissions, have been achieved over most of Europe. However, if no additional measure is taken, further decrease in biodiversity is expected almost everywhere in Europe due to the expected increase in nitrogen deposition allowed by the relatively weak Protocol requirement regarding ammonia emissions. Human exposure to ozone levels higher than recommended by the WHO is likely to persist, and so is exposure to PM, which is not currently addressed by the protocol [**RD-26**].

### *Follow-up to the Gothenburg Protocol*

The Gothenburg Protocol is presently under revision, with the hope to agree on more stringent ceilings for emissions after 2020. Negotiations are ongoing with the aim to agree on an amended or new protocol by the end of 2011. The revision also considers the inclusion of new components such as emissions of PM and black carbon, and intercontinental transport of air pollution [**RD-37**].

## 3.1.2 Ozone layer

### *The Vienna Convention for the Protection of the Ozone Layer*

The Vienna Convention for the Protection of the Ozone Layer [**IR-3**; **IR-20**] was agreed in 1985 in Vienna, Austria, by governments determined to protect human health and the environment against adverse effects resulting from the depletion of the Earth's protective ozone layer and the associated change in ultra-violet solar radiation (UV-B) reaching the Earth's surface and the biosphere. It came into force in 1988.

The text of the Vienna Convention was published by the UNEP Ozone Secretariat in 2001 [**IR-20**]. The eighth edition of its Vienna Convention Handbook [**IR-29**] celebrated the universal ratification of the treaty on the 16th of September 2009. It includes the full text of the Convention, the main decisions made by the conference of its parties at its regular meetings up to 2008, and its rules of procedure.

In addition to urging its parties to take appropriate measures in accordance with its provisions and the provisions of its protocols, the Convention states that it is expected from its parties to cooperate to better understand and assess the effects of human activities on the ozone layer and the effects of the modification of the ozone layer, through further research and systematic observations.

### *The Montreal Protocol on Substances that Deplete the Ozone Layer*

In 1987, the parties to the Vienna Convention adopted the Montreal Protocol on Substances that Deplete the Ozone Layer [**IR-5**; **IR-17**], with the objective of phasing out the production and consumption of ozone-depleting substances. Article 6 of the Protocol requires the control measures to be revised at least every four years (starting 1990), based on the review and assessment of latest available information on scientific, environmental, technical and economic aspects of the depletion of the ozone layer.

The Montreal Protocol entered into force on the 1st of January 1989. It was later amended at some of the meetings of its parties (London 1990, Copenhagen 1992, Montreal 1997, Beijing 1999). Furthermore, practical measures applicable to the production and consumption of the controlled substances were adjusted at the same meetings, as well as in Vienna (1995) and Montreal (2007).

A version of the Protocol integrating the aforesaid amendments and adjustments till 1999 was published by the UNEP Ozone Secretariat in 2000 [**IR-17**]. At the occasion of the universal ratification of the Vienna Convention in 2009, the Ozone Secretariat also published the eighth edition of its Handbook for the Montreal Protocol [**IR-30**], which includes, in addition to the updated text of the treaty, the decisions of its parties up to 2008, as well as a summary of the control measures under the Protocol.

Substances controlled by the Montreal Protocol are listed and grouped in its Annexes as follows, together with their estimated ozone depleting potentials (ODP), the values of which have been reviewed periodically and updated at the occasion of amendments to the protocol.

- Annex A. CFCs; halons(*).
- Annex B. More CFCs; carbon tetrachloride ($CCl_4$); methyl chloroform ($C_2H_3Cl_3$).
- Annex C. HCFCs; HBFCs; bromochloromethane ($CH_2BrCl$).
- Annex E. Methyl bromide ($CH_3Br$).

Annex D lists a number of products containing substances grouped in Annex A.

The ODP of some substance is defined here as the ratio of the ozone loss due to a given mass of that substance to the ozone loss attributable to the same mass of CFC-11 ($CFCl_3$) [**RD-50**]. This measure of the noxiousness of CFCs as regards their action on ozone was first proposed by Wuebbles (1983) [**RD-2**].

A list of all substances targeted by the Montreal Protocol is supplied, for example, by the US EPA, which also provides their ODP values as found in the Montreal Protocol, the US Clean Air Act

(*) Halons are molecules made of C, F, Br and, in some cases, Cl and / or H atoms. Halons listed in Annex A of the Montreal Protocol are $CF_2BrCl$, $CF_3Br$ and $C_2F_4Br_2$.

[**RD-1**] and the WMO 2006 Ozone Assessment Report [**RD-14**], as well as different estimates of their GWP values (see [**RD-51**]).

In each Annex to the Protocol, compounds are gathered together into two or three groups, to which different reduction rules apply [**IR-30**, Section 1.2: Summary of control measures under the Montreal Protocol]. Moreover, for each group, there are two sets of rules. One applies to developing countries whose annual consumption per capita lies below the limit set in Article 5 of the Protocol – called "Article 5(1) countries". The other one applies to the remaining countries.

The principle of the regulation is to decrease national production and consumption numbers, by stages, from a base level corresponding to the national consumption in a given year, to zero. By January 2040, all targeted substances should have ceased to be produced and consumed. The differences in the rules (applying to different groups of chemicals or to different types of countries) lie in the base level years, the number of stages, the percentage of the base level to be reached at each stage, etc.

For each group, the reduction imposed to Article 5(1) countries lags by five to nine years behind the reduction imposed to their non-Article 5(1) counterparts. Base level years sit between 1986 and 1991 for non-Article 5(1) countries and between 1995 and 2010 for Article 5(1) countries. Regarding CFCs, halons and carbon tetrachloride, the deadline for stopping production and consumption was January 2010 for Article 5(1) countries, and January 1994 or 1996 for other countries.

### 3.1.3 Climate change

#### *The United Nations Framework Convention on Climate Change (UNFCCC)*

The United Nations adopted the Framework Convention on Climate Change (UNFCCC) [**IR-8**] in New York in May 1992. It entered into force in 1994.

The Convention springs from the recognition of the potentially adverse effects, on natural ecosystems and humankind, of an atmospheric warming induced by greenhouse gases (GHG) emitted through human activity. Its objective is to achieve "stabilisation of greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system" [**IR-8**, Article 2], admitting that in some cases mitigation of adverse effects might be inevitably necessary. Each party to the Convention is responsible for pursuing this objective through national policies and the implementation of relevant measures over its domain of jurisdiction.

The parties to the Convention commit themselves to undertake a number of actions about greenhouse gases (GHG) that do not already fall in the realm of the Montreal Protocol, namely

(a) to maintain updated inventories of GHG emissions and removals at national or regional scale;
(b) to design and implement programmes to minimize man-induced climate change;
(c) to develop and exchange technologies supporting this endeavour;
(d) to protect or enhance ecosystems that act as GHG sinks or reservoirs;
(e) to cooperate in adapting to climate change and in healing damaged areas;
(f) to consider climate change issues when making economic decisions, while minimising possible social or environmental drawbacks of measures aiming at climate change mitigation;
(g) to collaborate in conducting systematic observation, collecting data and promoting research;
(h) to exchange any relevant information;
(i) to promote public awareness, education and training related to climate change;

(j) to inform the Conference of the Parties (COP) of the progress made with regard to the Convention implementation.

Country parties listed in Annex I to the Convention (including mainly developed countries) further committed themselves to thrive to return, by 2002, to 1990 levels of carbon dioxide and other GHG not already dealt with by the Montreal Protocol.

### *The Kyoto Protocol*

At its third COP meeting (COP 3), in December 1997, the UNFCCC was strengthened by the Kyoto Protocol [**IR-12**], which sets tighter targets for thirty-seven industrialised countries and the European community. More importantly, these thresholds are now binding – whereas the Convention only recognised that they were desirable. It is nevertheless agreed that these measures should be seen as preliminary steps to outline the path to future international action on climate change. Rules for implementation of the Kyoto Protocol were forged at the 7$^{th}$ meeting of the UNFCCC COP (COP 7) in Marrakesh, Morocco, in 2001, and are known as the Marrakesh Accords [**RD-7**]. The Kyoto Protocol entered into force on the 16$^{th}$ of February 2005. The annual Meeting of its Parties (CMP) is combined with the UNFCCC COP annual meeting.

Species targeted by the Kyoto Protocol are

- carbon dioxide ($CO_2$),
- methane ($CH_4$),
- nitrous oxide ($N_2O$),
- hydrofluorocarbons (HFCs),
- perfluorocarbons (PFCs), and
- sulphur hexafluoride ($SF_6$).

Over the five-year period 2008-2012, industrialised country parties are ascribed emission ceilings according to their "differentiated responsibilities". These "assigned amounts" are calculated as to achieve an average reduction of 5% with regard to 1990 emission levels. Over that time period, the European Community as a whole (as one of the parties to the protocol) and twenty-six of its member countries must have separately achieved a reduction of 8% of the 1990 values. Under the Protocol, countries' actual emissions have to be monitored and precise records have to be kept of the trades carried out (referring to a provision of the Protocol allowing these trades). The Kyoto Protocol Reference Manual [**RD-16**] provides guidance in accounting emissions and assigned amounts.

Approval of the Kyoto Protocol by the EC was endorsed in 2002 by a Decision of the European Council [**IR-22**].The quantified emission limitation and reduction commitments agreed by the EC and its member states for the period 2008-2012 are set out in Annex II to this Decision.

### *The Cancún Agreements and the road ahead*

Although it is widely agreed that more stringent measures should follow the Kyoto Protocol, the Cancún Agreements reached in Mexico in December 2010 did not bring any significant progress in this respect, but rather reaffirmed the importance of the issue and strengthened the framework for further action [**RD-49**]. At this occasion, industrial countries agreed to develop low-carbon development strategies and submitted emission reduction targets for 2020 (and in some cases beyond that date), which have been published by the UNFCCC secretariat [**RD-25**].

The next meeting of the Parties to the Kyoto Protocol, CMP 7, will take place, together with COP 17, at Durban, South Africa, in November 2011.

## 3.2 European legislation

This section attempts to brush an overview of the existing regulations about ambient air quality, protection of the ozone layer, climate change and exchange of information at the European scale.

### 3.2.1 Air quality

European air quality policy started in the 1980s. It is not the purpose to present in these lines an exhaustive account of the very large number of European regulations touching the subject. However, important milestones that punctuate this process are overviewed below.

#### *The Air Quality Framework Directive (AQFD) and its daughter directives*

In 1996, the Air Quality Framework Directive (AQFD) [**IR-10**] established a system under which the EC agreed on limit values for specific pollutant concentrations in a series of daughter directives (see for example [**RD-36**]; [**RD-40**]; Wettestad and Farmer, 2003 [**RD-8**]). Four daughter directives followed, staggered over the years 1999 to 2005, respectively targeting $SO_2$, $NO_X$, PM and lead [**IR-15**]; benzene and CO [**IR-18**]; ambient ozone [**IR-21**]; metals (As, Cd, Hg, Ni) and polycyclic aromatic hydrocarbons [**IR-23**].

The AQFD paved the way for the CAFÉ programme; as will be seen below, three of its daughter directives were later merged into the Pure Air for Europe Directive of 2008, sometimes called the "CAFÉ Directive".

#### *The Clean Air for Europe (CAFÉ) Programme*

The Clean Air for Europe (CAFÉ) programme was launched by the EC in March 2001 with the aim to *"develop long-term strategic integrated policy advice to protect against significant negative effects of air pollution on human health and the environment"* [**RD-6**].

The objectives of CAFÉ are to

(a) collect and validate scientific information and develop scientific knowledge on the effects of air pollution (including validation of emission inventories, air quality assessment, projections, cost-effectiveness studies and integrated assessment modeling);

(b) support the correct implementation, and review the effectiveness, of existing legislation and develop new proposals as and when necessary;

(c) ensure that the requisite measures are taken at the relevant level, and develop structural links with the relevant policy areas;

(d) develop, by 2004, an integrated strategy to include appropriate objectives and cost-effective measures; in a first phase, the focus is on particulate matter, tropospheric ozone, acidification, eutrophication and damage to cultural heritage;

(e) disseminate the information gathered during the programme among the general public.

An important feature of CAFÉ is the stress on the vital role of scientific input in orienting and guiding its implementation – as expressed by Objective (a) above –, and, accordingly, on the links with the EU research framework programmes.

In accordance with Objective (d) above, the CAFÉ programme underpinned the design, in 2005, of the Thematic Strategy on Air Pollution which was actually developed under the Sixth Environmental Action Programme (EAP) (2002-2012). The strategy is based on a pragmatic approach – that is, it takes into account practical considerations of feasibility. In order to attain its health and environmental objectives, which are to reduce PM and ozone detrimental effects on health, as well as damages caused to ecosystems by excessive acidification and eutrophication, the strategy sets as a target for Year 2020 to have decreased emissions of $SO_2$, $NO_X$, VOC, ammonia and primary $PM_{2.5}$[(*)] respectively by 82, 60, 51, 27 and 59 percent relatively to the corresponding emission values in 2000 [**RD-11**].

### *National Emission Ceilings (NEC)*

The Directive on National Emission Ceilings for Certain Atmospheric Pollutants (or NEC Directive) [**IR-19**] was adopted in 2001 soon after the CAFÉ programme was launched, and was amended later on. It was meant to support the achievement of the AQFD (and later CAFÉ) concentration and emission targets. National emission ceilings (NEC) were set for the emissions of $SO_2$, $NO_X$, VOC and $NH_3$, which were more stringent than those of the Gothenburg Protocol [**RD-37**; **RD-41**].

In addition to bringing down their emissions below the specified NEC by Year 2010 (which was also the year initially targeted by the Gothenburg Protocol), EC member states had the obligation to report their past and projected national emission inventories to the EC and EEA. The data reported annually are available from the EEA NEC Directive Inventory website [**RD-39**].

By October 2009, based on the reported 2007 national emissions and on the provisional 2008 inventories, it became clear that, if no additional restriction measure was taken, thirteen of the EC-27 member countries would fail to achieve at least one of their four 2010 emission targets – and three of these at the most [**RD-19**]. The $SO_2$ emission ceiling was the most widely expected to be met, the $NO_X$ emission ceiling the most widely expected to be trespassed.

The revision of the NEC Directive is on the agenda of the Thematic Strategy on Air Pollution evoked in the previous lines. The Directive amendment should set emission ceilings to be respected by 2020 for the four already regulated families of substances and for the primary emissions of $PM_{2.5}$. The revision will build upon the evaluations and reviews carried out under the umbrella of several programmes, including the CAFÉ programme described above [**RD-38**].

### *The Pure Air for Europe Directive*

The Directive on Ambient Air Quality and Cleaner Air for Europe (or "Pure Air for Europe" Directive) [**IR-27**] was developed under the umbrella of the CAFÉ Programme and, after adoption by the European Parliament and the Council, published in the Official Journal of the EU on the 11th of June 2008, day of its entry into force (see [**RD-36**]). Member States were compelled to provide themselves with laws and administrative instruments necessary to comply with the clauses of the Directive, and to have brought these into force by the 11th of June 2010.

---

(*) "Primary" PM is PM issued directly from fossil fuel combustion or biomass burning, or PM forming the bioaerosol (airborne microorganisms). "Secondary" PM is formed after emission of precursor pollutants ($SO_2$, $NO_X$, VOC, $NH_3$).

The Directive refers to previous environmental legislation on AQ, which it partly supersedes. More precisely, it quotes the NEC Directive [**IR-19**], replaces (and updates) the first three AQFD daughter directives [**IR-15**; **IR-18**; **IR-21**] and integrates a decision of the European Parliament on the exchange of observational data [**IR-11**]. It also complements (and leaves room for the future possibility of incorporating) the fourth AQFD daughter directive about metals and polycyclic aromatic hydrocarbons [**IR-23**].

Whereas international protocols overviewed in Section 3.1 – as well as the NEC Directive – set limit values to emission or production figures, the Pure Air for Europe Directive defines boundary values for measured concentrations, leaving up to the responsible authorities (and to the NEC Directive) the role of determining measures applying to emissions in order to achieve the targeted concentrations. A novelty worthy of notice is that it defines the minimum information (including forecasts) that routine and alert services must provide to the public [**IR-27**, Annex XVI].

Ambient atmospheric chemicals and particles targeted by the Pure Air for Europe Directive are

- Sulphur dioxide ;
- Nitrogen dioxide and oxides of nitrogen (understood as $NO_X$) as a family ;
- Lead ;
- Benzene ;
- Carbon monoxide ;
- Volatile organic compounds (VOC) ;
- Ozone ;
- Particulate matter $PM_{2.5}$ and $PM_{10}$.

The thirty-five articles of the Directive are grouped into six chapters. Chapters II, III and IV form the core of the actual provisions regarding the control of pollutants, while Chapter V includes a description of what information should be delivered by atmospheric services. The chapters are completed by seventeen annexes dealing with technical matters such as quantitative criteria and thresholds for AQ assessment (Annex II); standard *in situ* measurement methods (Annex VI); target, limit, threshold and critical values according to various types of impact on humans and ecosystems (Annexes VII, XI, XII, XIII and XIV), etc.

**Methodology.** Chapter I (Articles 1 to 4) outlines the aims of the Directive, the vocabulary used, the responsibilities and the methodology. The latter is based on the partitioning of the territory into zones and agglomerations by each Member State.

**AQ assessment and data quality.** Chapter II (Articles 5 to 11) deals with mandatory assessment of air quality. It provides rules for the identification and classification of zones and agglomerations in terms of degrees of pollution; defines which type of continuous monitoring needs to be implemented in each zone; and establishes mandatory criteria applying to assessment methods (location and number of sampling points, reference measurement methods). Data quality objectives [**IR-27**, Annex I] are an important feature with which AQ assessment must comply; they include minimal uncertainties, time coverage, etc., as well as the obligation to establish and follow quality assurance and quality control procedures. The chapter is divided into two sections: Section 1 treats the case of $SO_2$, $NO_2$, $NO_X$, PM, Pb, benzene and CO; Section 2 deals with ozone and its precursors ($NO_X$, VOC) in ambient air.

A requirement stated in Annex VI, Section D ("Introduction of new equipment") is that all apparatus used in fixed measurements (i.e., for the purpose of AQ monitoring in the framework of the Directive) must comply with the corresponding reference method ("or equivalent", as defined in Annex VI, Section B) by the 11$^{th}$ of June 2013.

**AQ management.** Chapter III (Articles 12 to 22) deals with mandatory management of air quality, i.e. preservation of unpolluted areas and reduction of pollutant concentrations over polluted zones. Thresholds are provided in the annexes for a number of parameters, *inter alia* the $PM_{2.5}$ average exposure indicator (AEI), defined as the last 3-year running mean concentration of $PM_{2.5}$ (expressed in $\mu g.m^{-3}$). Targets have to be reached by some deadline depending on the compound. Some of the deadlines were already in force at the time when the Directive was issued ($SO_2$, CO, $PM_{10}$); other deadlines vary from 2010 to 2020. Reduction of $PM_{2.5}$ is allowed to happen in three stages marked by defined milestones (target value to be reached by 1st of January 2010, landing limit values by the beginning of 2015 and 2020).

**AQ action planning, including information and alert.** Chapter IV (Articles 23 to 25) provides guidelines on the design and implementation of action plans in the event that levels of pollutants still exceed the specified targets or limits beyond the agreed deadline, whether exceeding concentrations happen to be episodic or of a more endemic nature, and whether they are of local or cross-boundary extent. Beside measures aiming at reducing the concentration of pollutants, the planning activity must include a communication facet which depends on the level of pollution with respect to "information" and "alert" thresholds. These are respectively defined as concentration values potentially harmful, from brief exposure, to particularly sensitive sections of the population or to the population as a whole [**IR-27**, Article 2 and Annex XII]. Annex XV provides a list of mandatory items to be included in AQ plans.

**Public information.** Article 26 (part of Chapter V) and Annex XVI stipulate which information must be conveyed to the public, at the least, as a regular activity, i.e. regardless of any emergency situation, as well as in the context of the afore-mentioned *ad hoc* plans.

The remaining articles (27 to 35) deal with reporting (how member states should report to the EC about progress regarding the national implementation of the Directive), implementation by the EC and other administrative matters.

### 3.2.2 Stratospheric ozone

As years passed by, the EC has adopted a number of regulations to phase out ozone depleting substances (ODS) in accordance with the Montreal Protocol and its amendments. The last comprehensive regulation on ODS [**IR-34**] replaces the previous ones. It was published in 2009 and amended a year later [**IR-36**]. In spite of the fact that European consumption of ODS regulated by the Montreal Protocol had been reduced to zero in 2010 [**RD-35**], the last regulations acknowledge the need of a continuous watch of the ozone layer, of handling the future release of ODS still trapped in buildings or appliances, and of measures to avoid the making of new ODS and to ensure that substances with a high GWP are not substituted for the old ones. The list of substances controlled under the last regulation has been published at the beginning of 2011 [**RD-24**].

### 3.2.3 Climate change

After an initial focus on $CO_2$ – cf. for example the 1991 Community strategy to limit carbon dioxide emissions [**RD-3**] –, the EU effort regarding limits imposed to greenhouse gas (GHG) emissions has consisted in

- implementing policies to help it meet its Kyoto Protocol target, i.e. 8% reduction of 1990 levels of GHG emissions over the period 2008-2012 for the EU countries collectively – as mentioned in Section 3.1.3, endorsement of the Kyoto Protocol measures was the object of a Decision by

the European Council [**IR-22**], which also specifies quantitative reduction commitments [**IR-22**, Annex II];

- working towards further reduction of GHG after 2012, at a European and a global scales.

Created in 2010, the EC Directorate General for Climate Action (in short, DG CLIMA) is in charge of dealing with the prevention of man-induced climate change, mitigation of its adverse effects and adaptation to its inevitable consequences.

Beside plans touching forest management, promotion of renewable energy and low-carbon economy – including carbon capture & storage and the emission trading system (ETS) applying to emissions from factories and power plants –, the following initiatives and policies regarding GHG monitoring and abatement must be mentioned.

### *Greenhouse gas monitoring*

Under the auspices of the European Climate Change Programme (ECCP) two rounds – ECCP I, from 2000 to 2004, followed in 2005 by ECCP II [**RD-29**] –, several decisions have been adopted by the European Parliament, the Council and the Commission between 2002 and 2004 regarding GHG monitoring and reporting [**RD-30**]. In accordance with these decisions, the watch was undertaken by the EC with the assistance of EEA, and annual greenhouse gas inventories are submitted to the UNFCCC Secretariat [**RD-30**].

### *Fluorinated species abatement: the F-Gas Regulation and the MAC Directive*

In 2006, the so-called F-Gas Regulation [**IR-24**] and MAC Directive [**IR-25**] laid down specific requirements targeting emissions of fluorinated greenhouse gases at all stages of their production and use. The F-Gas Regulation was further completed in 2007 and 2008 by ten legislative texts that implemented its measures. The impact of this set of regulatory acts is currently being evaluated by the EC, which should communicate its conclusions in a report to be published by the end of 2011 [**RD-31**].

### *The Effort Sharing Decision: looking to Year 2020…*

In March 2007, the EU member states agreed on an integrated climate and energy policy [**RD-15**, Chapter III]. In particular, they expressed their commitment to cut GHG emissions down, by Year 2020, by at least 20% of 1990 levels – and by 30% in the event that a global climate agreement would be reached, taking effect at the beginning of 2013, whereby other major emitting countries would make similar commitments [**RD-15**, § 31; **RD-32**; **RD-33**].

The 2009 Effort Sharing Decision [**IR-31**] reaffirms these commitments [**IR-31**, §§ (2) & (3)] and establishes annual binding targets for the period 2013–2020 applicable to amounts of GHG emitted by sectors not belonging to the ETS scope, i.e. by transport, buildings, agriculture and waste. Each EU member state is meant to contribute to this effort according to its relative wealth, leading to an overall reduction of emissions of approximately 10% in 2020 compared to 2005, which, together with the reduction expected to result from the ETS scheme, is hoped to achieve the announced 20% minimal decrease relatively to 1990 levels [**RD-34**].

### *… and beyond*

These measures are understood as transitory steps on the way to a sustainable situation. In its 2007 conclusions, the EU Council underlined the vital importance of keeping the global average temperature at not more than 2°C above its pre-industrial value [**RD-15**, § 27] and expressed its

conviction that, in this endeavour, industrial countries should aim at collectively reducing their GHG emissions by 60% to 80% by 2050 compared to 1990 [**RD-15**, § 30], thereby contributing to the 2050 global target of a 50% emission reduction required to keep the temperature increase above pre-industrial levels below the critical 2°C value [**IR-31**, § (2)].

### 3.2.4 Communication of data and information

#### *The INSPIRE Directive*

The European Directive establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) [**IR-26**] was published in the Official Journal of the EU on the 25th of April 2007 and entered into force twenty days later. By the 15th of May 2009, member states had to design and implement some administrative and legislative *corpus* to comply with its clauses.

Contrary to all previous regulatory texts quoted above, the INSPIRE Directive does not aim at protecting the environment by controlling the amount of determined substances emitted by man into the atmosphere. Its scope includes any dataset with a social usefulness, which possesses a geographic extent or is related to some geographic location (which is the way "spatial" must be understood in this context); its double objective is to harmonise such datasets over the European continent and to make them available to the community (citizens, administrations, agencies, universities, research institutions, hospitals, doctors, policy makers, etc.) all over Europe, through a network of information services.

The targeted "data themes" are listed and grouped in the three annexes to the Directive. They encompass subject matters as diverse in nature as, for example, postal addresses, transport networks, epidemiology, biotopes... Items 13 and 14 of Annex III are entitled "atmospheric conditions" and "meteorological geographical features".

The relationship between INSPIRE and GMES is stated explicitly among the preliminary considerations of the Directive. It is expected that the two initiatives will be mutually beneficial, and the INSPIRE Directive is seen as "adding value" to the 2004-2008 Action Plan to establish a GMES capacity in Europe [**RD-9**]. Furthermore, it is now required from EU FP7 projects that contribute to the elaboration of the GMES services to set up utilities and deliver products that comply with INSPIRE specifications.

The INSPIRE Directive itself does not include any practical consideration regarding these specifications but rather foresees the upcoming definition of implementing rules (IR) in a series of follow-up regulations and decisions tackling particular practical aspects of datasets and information services.

#### *High level metadata and service specifications*

Implementing rules regarding the following topics have already been published.

- 2008: INSPIRE Metadata Regulation [**IR-28**]. Discovery metadata.
- 2009: INSPIRE Monitoring and Reporting Decision [**IR-32**]. Monitoring of INSPIRE implementation and reporting by the member states.
- 2009: INSPIRE Network Services Regulation [**IR-33**]. Minimal requirements expected from services in terms of performance, capacity, availability, types of operations.
- 2010: INSPIRE Data and Service Sharing Regulation [**IR-35**].
- 2010: INSPIRE Download and Transformation Services Regulation [**IR-37**].

- 2010: INSPIRE Interoperability Regulation [**IR-38**].

A summary of the content of the first four documents above (the fourth still at the stage of a draft, at the time) can be found in the PROMOTE Technical Note on INSPIRE [**RD-21**, Section 2]. This note also draws a picture of the international effort to support INSPIRE implementation and of its relevance to the GAS.

### *Atmospheric metadata and data specifications*

The last set of INSPIRE implementing rules, to be adopted not later than the 15th of May 2012, will pertain to specifications for data themes listed in Annexes II and III, in particular scientific atmospheric datasets. These IR are currently being drafted and will become available for comments during a public consultation phase starting on the 21st of June 2011 and lasting until the 21st of October 2011. A "testing" exercise will run in parallel to that consultation phase, through which contributors will be invited to provide some sample dataset (or metadata set) in view of testing the adequacy of the proposed INSPIRE model to actual candidates, and of improving it accordingly. Contributors are any institution, group or project registered with INSPIRE as a LMO or a SDIC (see link to the INSPIRE website in Section 5).

In the context of its MAN_3 WP, MACC will collect inputs from project participants and will take part to the consultation phase as a SDIC.

Additionally, participation from MACC partners to either phase (consultation and/or testing) is warmly encouraged since it will help to fit INSPIRE with an adequate set of instruments to meet its goals as far as atmospheric services are at stake.

Formal aspects of participation as well as a summary of issues already raised in the past in the context of PROMOTE are provided in the PROMOTE Technical Note on INSPIRE [**RD-21**, Sections 7.1 and 7.2].

Among a number of features required by atmospheric data and services, key questions remain unanswered, namely the need to integrate the vertical and time dimensions fully in coordinate reference systems; to accept alternative vertical scales (pressure, for example); and, last but not least, to provide, with any dataset, some quality indicator as defined by QA4EO [**RD-20**]. The compliance of INSPIRE with standards already in use within the scientific community worldwide is of course crucial as regards its future capacity to encompass reliable scientific information.

# 4. REFERENCES

## 4.1 User requirements (UR)

UR-1 Paliouras, E. et al., PROMOTE U8 Core User Group Executive Report, Version 1, March 4, 2005.

UR-2 Paliouras, E. et al., PROMOTE U8 Core User Group Executive Report, Version 2, April 19, 2006.
☞ http://www.gse-promote.org/docs/Core_User_Group_Executive_Report.pdf

UR-3 van Oss, R. et al., PROMOTE U1 Global User Needs Directory, Version 2, May 23, 2006.

UR-4 Paliouras, E. et al., PROMOTE U5 Core User Needs Dossier, Version 12, May 23, 2006.
☞ http://www.gse-promote.org/docs/Core_User_Needs_Dossier.pdf

UR-5 Kaiser, J. W. et al., Observation Requirements for Global Biomass Burning Emission Monitoring, Proceedings of the EUMETSAT Meteorological Satellite Conference, Helsinki, Finland, 12-16 June 2006.
☞ http://gems.ecmwf.int/do/get/PublicDocuments/1529/591?showfile=true
☞ http://www.eumetsat.int/Home/Main/AboutEUMETSAT/Publications/ConferenceandWorkshopProceedings/2006/groups/cps/documents/document/pdf_conf_p48_s3_04_kaiser_v.pdf

UR-6 GCOS, Systematic Observation Requirements for Satellite-Based Products for Climate, GCOS-107, WMO, September 2006.
☞ http://www.wmo.int/pages/prog/gcos/Publications/gcos-107.pdf

UR-7 GCOS, GCOS Reference Upper-Air Network (GRUAN): Justification, requirements, siting and instrumentation options, GCOS-112, WMO, April 2007.
☞ http://www.wmo.int/pages/prog/gcos/Publications/gcos-112.pdf

UR-8 Nagl, C. et al., PROMOTE-2 U7 Service Utility Report, Version 2, November 25, 2008.
☞ http://www.gse-promote.org/docs/U7_Service_Utility_Reports_v2.0_final.pdf

UR-9 GCOS, Guideline for the Generation of Satellite-Based Datasets and Products Meeting GCOS Requirements, GCOS-128, March 2009.
☞ http://www.wmo.int/pages/prog/gcos/Publications/gcos-128.pdf

UR-10 Nagl, C. et al., PROMOTE-2 U7 Service Utility Report, Version 3.2, November 20, 2009.

UR-11 Stebel, K. et al., PROMOTE-2 U1 Core User Needs and User Standards Dossier, Summary Report, December 17, 2009.

UR-12 GCOS, Guideline for the Generation of Datasets and Products Meeting GCOS Requirements, GCOS-143, WMO, May 2010.
☞ http://www.wmo.int/pages/prog/gcos/Publications/gcos-143.pdf

UR-13 Holzer-Popp, T. et al., MACC Downstream Services and End User Requirements Document reviewed by users, Version 1.1 (MACC Deliverable D_O-INT_1.1/1.2/1.3), August 27, 2010.
☛ http://www.gmes-atmosphere.eu/documents/deliverables/o-int/MACC_O-INT_Requirements_Document_v1%201_27082010.pdf

UR-14 GCOS, GOOS, WCRP and WMO, Database of Observational Requirements, updated March 1, 2011.
☞ http://www.wmo.int/pages/prog/sat/Requirements/Observational-requirements_web.xls

UR-15 CEOS Requirements Database.
☞ http://ceos-sysdb.com/CEOS/requirements/requirements_high_level.php

## 4.2 International regulations (IR)

IR-1 UNECE, Convention on Long-Range Transboundary Air Pollution (CLRTAP), November 13, 1979.
☞ http://www.unece.org/env/lrtap/full%20text/1979.CLRTAP.e.pdf

IR-2 UNECE, Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Long-Term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe ("EMEP Protocol"), Geneva, Switzerland, September 28, 1984.
☞ http://www.unece.org/env/lrtap/full%20text/1984.EMEP.e.pdf

IR-3 UNEP, Vienna Convention for the Protection of the Ozone Layer ("Vienna Convention"), Vienna, Austria, March 22, 1985.
☞ http://sedac.ciesin.org/entri/texts/vienna.ozone.layer.protection.1985.html

IR-4 UNECE, Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent, Helsinki, Finland, July 8, 1985.
☞ http://www.unece.org/env/lrtap/full%20text/1985.Sulphur.e.pdf

IR-5 UNEP, Protocol on Substances that Deplete the Ozone Layer ("Montreal Protocol"), Montreal, Canada, September 16, 1987.
☞ http://sedac.ciesin.org/entri/texts/montreal.protocol.ozone.1987.html

IR-6 UNECE, Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution Concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes, Sofia, Bulgaria, October 31, 1988.
☞ http://www.unece.org/env/lrtap/full%20text/1988.NOX.e.pdf

IR-7 UNECE, Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution Concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes, Geneva, Switzerland, November 18, 1991.
☞ http://www.unece.org/env/lrtap/full%20text/1991.VOC.e.pdf

IR-8 UN, United Nations Framework Convention on Climate Change (UNFCCC), New York, USA, May 9, 1992.
☞ http://unfccc.int/resource/docs/convkp/conveng.pdf

IR-9 UNECE, Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Further Reduction of Sulphur Emissions, Oslo, Norway, June 14, 1994.
☞ http://www.unece.org/env/lrtap/full%20text/1994.Sulphur.e.pdf

IR-10 Council Directive 96/62/EC of 27 September 1996 on ambient air quality assessment and management ("Air Quality Framework Directive"), Official Journal of the European Communities, November 21, 1996.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31996L0062:EN:HTML

IR-11 Council Decision 97/101/EC of 27 January 1997 establishing a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States, Official Journal of the European Communities, February 5, 1997.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31997D0101:EN:HTML

IR-12 UN, Kyoto Protocol to the United Nations Framework Convention on Climate Change, December 11, 1997.
☞ http://unfccc.int/resource/docs/convkp/kpeng.pdf

IR-13 UNECE, Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Heavy Metals, Aarhus, Denmark, June 24, 1998.
☞ http://www.unece.org/env/lrtap/full%20text/1998.Heavy.Metals.e.pdf

IR-14 UNECE, Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants (POP), Aarhus, Denmark, June 24, 1998.
☞ http://www.unece.org/env/lrtap/full%20text/1998.POPs.e.pdf

IR-15 Council Directive 1999/30/EC of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air ("First AQFD Daughter Directive"), Official Journal of the European Communities, June 29, 1999.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1999:163:0041:0060:EN:PDF

IR-16 UNECE, Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground-Level Ozone ("Gothenburg Protocol"), Gothenburg, Sweden, November 30, 1999.
☞ http://www.unece.org/env/lrtap/full%20text/1999%20Multi.E.Amended.2005.pdf

IR-17 UNEP Ozone Secretariat, The Montreal Protocol on Substances that Deplete the Ozone Layer as either adjusted and/or amended in London 1990, Copenhagen 1992, Vienna 1995, Montreal 1997 and Beijing 1999 ("Montreal Protocol"), UNEP, Nairobi, Kenya, March 2000.
☞ http://www.unep.org/ozone/pdfs/montreal-protocol2000.pdf

IR-18 Directive 2000/69/EC of the European Parliament and of the Council of 16 November 2000 relating to limit values for benzene and carbon monoxide in ambient air ("Second AQFD Daughter Directive"), Official Journal of the European Communities, December 13, 2000.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:313:0012:0021:EN:PDF

IR-19 Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants ("NEC Directive"), Official Journal of the European Communities, November 27, 2001.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2001L0081:20070101:EN:PDF

IR-20 UNEP Ozone Secretariat, The Vienna Convention for the Protection of the Ozone Layer ("Vienna Convention"), UNEP, Nairobi, Kenya, November 2001.
☞ http://www.unep.org/ozone/pdfs/viennaconvention2002.pdf

IR-21 Directive 2002/3/EC of the European Parliament and of the Council of 12 February 2002 relating to ozone in ambient air ("Third AQFD Daughter Directive"), Official Journal of the European Communities, March 9, 2002.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:067:0014:0030:EN:PDF

IR-22 Decision 94/69/EC of the EU Council of 25 April 2002 concerning the approval, on behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments thereunder, Official Journal of the European Communities, May 5, 2002.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002D0358:EN:HTML

IR-23 Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air ("Fourth AQFD Daughter Directive"), Official Journal of the European Union, January 26, 2005.
☞ http://www.irceline.be/~celinair/documents/EU_guidelines/zwmet_pak_en.pdf

IR-24 Regulation (EC) N° 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases ("F-Gas Regulation"), Official Journal of the European Union, June 14, 2006.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:161:0001:0011:EN:PDF

IR-25 Directive 2006/40/EC of the European Parliament and of the Council of 17 May 2006 relating to emissions from air-conditioning systems in motor vehicles and amending Council Directive 70/156/EEC ("MAC Directive"), Official Journal of the European Union, June 14, 2006.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:161:0012:0018:EN:PDF

IR-26 Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) ("INSPIRE Directive"), Official Journal of the European Union, April 25, 2007.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:108:0001:0014:en:PDF

IR-27 Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe ("Pure Air for Europe" Directive), Official Journal of the European Union, June 11, 2008.
☞ http://www.epa.ie/downloads/legislation/air/quality/name,25020,en.html
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF

IR-28 Commission Regulation (EC) No 1205/2008 of 3 December 2008 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata ("INSPIRE Metadata Regulation"), Official Journal of the European Union, December 4, 2008.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:326:0012:0030:EN:PDF

IR-29 UNEP Ozone Secretariat, Handbook for the Vienna Convention for the Protection of the Ozone Layer, Eighth Edition, 2009.
☞ http://www.unep.ch/ozone/Publications/VC_Handbook/VC-Handbook-2009.pdf

IR-30 UNEP Ozone Secretariat, Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer, Eighth Edition, 2009.
☞ http://www.unep.ch/ozone/Publications/MP_Handbook/MP-Handbook-2009.pdf

IR-31 Decision N° 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 ("Effort Sharing Decision"), Official Journal of the European Union, June 5, 2009.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0136:0148:EN:PDF

IR-32 Commission Decision of 5 June 2009 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards monitoring and reporting ("INSPIRE Monitoring and Reporting Decision"), Document Number C(2009) 4199, Official Journal of the European Union, June 11, 2009.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:148:0018:0026:EN:PDF

IR-33 Commission Regulation (EC) No 976/2009 of 19 October 2009 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards the Network Services ("INSPIRE Network Services Regulation"), Official Journal of the European Union, October 20, 2009.

☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:274:0009:0018:EN:PDF

IR-34 Regulation (EC) N° 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer, Official Journal of the European Union, October 31, 2009.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:286:0001:0030:EN:PDF

IR-35 Commission Regulation (EU) No 268/2010 of 29 March 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards the access to spatial data sets and services of the Member States by Community institutions and bodies under harmonised conditions ("INSPIRE Data and Service Sharing Regulation"), Official Journal of the European Union, March 30, 2010.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:083:0008:0009:EN:PDF

IR-36 Commission Regulation (EU) N° 744/2010 of 18 August 2010 amending Regulation (EC) N° 1005/2009 of the European Parliament and of the Council on substances that deplete the ozone layer, with regard to the critical use of halons, Official Journal of the European Union, August 19, 2010.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:218:0002:0008:EN:PDF

IR-37 Commission Regulation (EU) N° 1088/2010 of 23 November 2010 amending Regulation (EC) N° 976/2009 as regards download services and transformation services ("INSPIRE Download and Transformation Services Regulation"), Official Journal of the European Union, December 8, 2010.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:323:0001:0010:EN:PDF

IR-38 Commission Regulation (EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services ("INSPIRE Interoperability Regulation"), Official Journal of the European Union, December 8, 2010.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:323:0011:0102:EN:PDF

## 4.3 Reference papers and documents (RD)

RD-1 US EPA, Clean Air Act, 1970.
☞ http://www.epa.gov/air/caa/

RD-2 D. J. Wuebbles, Chlorocarbon Emission Scenarios: Potential Impact on Stratospheric Ozone, J. Geophys. Res., 88(C2), 1433-1443, 1983.
☞ http://europa.agu.org/?uri=/journals/jc/JC088iC02p01433.xml&view=article

RD-3 A Community strategy to limit carbon dioxide emissions and improve energy efficiency, EU press release, May 13, 1992.
☞ http://europa.eu/rapid/

RD-4 GCOS, Report of the GCOS Space-Based Observation Task Group (Darmstadt, Germany, May 3-6, 1994), GCOS-7, WMO, November 1994.
☞ http://www.wmo.int/pages/prog/gcos/Publications/gcos-7.pdf

RD-5 IGOS, Report of the first IGOS partners meeting, ICSU Secretariat, Paris, France, June 6, 1998.
☞ http://www.igospartners.org/docs/IGOS-P-meetings/IGOS-P-1-report.doc

RD-6 CEC, The Clean Air for Europe (CAFÉ) Programme: Towards a Thematic Strategy for Air Quality, Communication from the Commission COM (2001) 245, 15 pp., Brussels, Belgium, 4 May 2001.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2001:0245:FIN:EN:PDF

RD-7 UNFCCC, The Marrakesh Accords and the Marrakesh Declaration, unedited version, November 2001.
☞ http://unfccc.int/cop7/documents/accords_draft.pdf

RD-8 Wettestad, Jørgen and Andrew Farmer, The EU Air Quality Framework Directive: Shaped and Saved by Interaction?. Paper for the 2003 International Studies Association Annual Convention, Portland, Oregon, 26 February – 1 March, 2003, 28 pp., January 20, 2003.
☞ http://ecologic.eu/download/projekte/850-899/890/isa/isa_eu_air_quality_framework_directive.pdf

RD-9 Communication from the Commission to the European Parliament and the Council Global Monitoring for Environment and Security (GMES): Establishing a GMES capacity by 2008 – (Action Plan (2004-2008)), COM (2004) 65, 23 pp., Brussels, Belgium, February 3, 2004.
☞ http://www.gmes.info/pages-principales/library/reference-documents/

RD-10 IGACO, The Changing Atmosphere, An Integrated Global Atmospheric Chemistry Observation Theme for the IGOS Partnership, Report of the IGACO Theme Team, ESA SP-1282, GAW Report N° 159, WMO Technical Document 1235, 54 pp., September 2004.
☞ http://www.igospartners.org/docs/theme_reports/IGACO-ThemeReport-Sep2004.pdf

RD-11 CEC, Thematic Strategy on Air Pollution, COM (2005) 446, 18 pp., Brussels, Belgium, 21 September 2005.
☞ http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0446:FIN:EN:PDF
☞ http://ec.europa.eu/environment/archives/cafe/pdf/strat_com_en.pdf

RD-12 CEC, Impact Assessment, Annex to the Communication on Thematic Strategy on Air Pollution and to the Directive on "Ambient Air Quality and Cleaner Air for Europe", SEC (2005) 1133, 170 pp., Brussels, Belgium, 21 September 2005.
☞ http://ec.europa.eu/environment/archives/cafe/pdf/ia_report_en050921_final.pdf

RD-13 Jennings, S. G. et al., PROMOTE U3 Science Review for Ozone, UV, Air Quality, Greenhouse Gases and Aerosol, January 22, 2006.
☞ http://www.gse-promote.org/docs/Science_Review.pdf

RD-14 WMO, Scientific Assessment of Ozone Depletion: 2006, Global Ozone Research and Monitoring Project – Report No. 50, 572 pp., Geneva, Switzerland, 2007.
☞ http://www.wmo.int/pages/prog/arep/gaw/ozone_2006/ozone_asst_report.html

RD-15 EU Council Presidency, Presidency Conclusions of the Brussels European Council of 8/9 March 2007, Ref. n° 7224/1/07 REV 1, May 2, 2007.
☞ http://register.consilium.europa.eu/pdf/en/07/st07/st07224-re01.en07.pdf

RD-16 UNFCCC, Kyoto Protocol Reference Manual on Accounting of Emissions and Assigned Amount, Climate Change Secretariat, Bonn, Germany, November 2008.
☞ http://unfccc.int/resource/docs/publications/08_unfccc_kp_ref_manual.pdf

RD-17 CEOS/WMO, Manual of the CEOS/WMO Database on User Requirements and *In Situ* and Space Capabilities, Issue 1.6, February 2009.
☞ http://www.wmo.int/pages/prog/sat/documents/DbManualIssue1_6.pdf

RD-18 Kaiser, J.W., J. Flemming, M.G. Schultz, M. Suttie and M.J. Wooster, The MACC Global Fire Assimilation System: First Emission Products (GFASv0), ECMWF Technical Memorandum 596, 20pp., ECMWF, Reading, UK, August 20, 2009.

☞ http://gems.ecmwf.int/do/get/PublicDocuments/1529/1406?showfile=true

RD-19 EEA, EU set to miss 2010 air pollutant limits, article published on October 1, 2009
☞ http://www.eea.europa.eu/highlights/europe-set-to-miss-2010-air-pollutant-limits

RD-20 QA4EO, A Quality Assurance Framework for Earth Observation: Principles, January 14, 2010.
☞ http://qa4eo.org/docs/QA4EO_Principles_v4.0.pdf

RD-21 De Rudder, A., and J.-C. Lambert, PROMOTE 2 D4 Service Network INSPIRE Technical Note, 20 pp., January 21, 2010.
☞ http://www.gse-promote.org/docs/INSPIRE_Tech_Note_final.pdf

RD-22 PROMOTE Final Report, German Aerospace Center, 2010.
☞ http://www.gse-promote.org/docs/FinalReport_WebVersion.pdf

RD-23 Lambert, JC, MACC Validation Protocol, Version 1, 47 pp., October 11, 2010.
☞ http://www.gmes-atmosphere.eu/documents/deliverables/man/

RD-24 EC DG CLIMA, Indicative list of substances controlled under Regulation (EC) N° 1005/2009, February 4, 2011.
☞ http://147.67.243.36/Public/irc/env/review_2037/library?l=/supporting_documents/110204_substancespdf/_EN_1.0_&a=d

RD-25 UNFCCC, Compilation of economy-wide emission reduction targets to be implemented by Parties included in Annex I to the Convention, 9 pp., March 10, 2011.
☞ http://unfccc.int/resource/docs/2011/sb/eng/inf01.pdf

## Web pages

RD-26 Abstract of the Review of the Gothenburg Protocol, Report of the Task Force on Integrated Assessment Modelling and the Centre for Integrated Assessment Modelling, CIAM Report 1/2007.
☞ http://www.pbl.nl/en/publications/2007/ReviewoftheGothenburgProtocol

RD-27 CEOS Affiliates' Database.
☞ http://www.wmo.int/cgi-bin/search.pl?DATABASE=ceosafdr.txt

RD-28 CEOS Systems Database.
☞ http://ceos-sysdb.com/CEOS/

RD-29 EC Climate Action, European Climate Change Programme.
☞ http://ec.europa.eu/clima/policies/eccp/

RD-30 EC Climate Action, Greenhouse gas monitoring and reporting, Documentation.
☞ http://ec.europa.eu/clima/documentation/g-gas/

RD-31 EC Climate Action, Fluorinated Greenhouse Gases.
☞ http://ec.europa.eu/clima/policies/f-gas/

RD-32 EC Climate Action, What is the EU doing on climate change?
☞ http://ec.europa.eu/clima/policies/brief/

RD-33 EC Climate Action, The EU climate and energy package.
☞ http://ec.europa.eu/clima/policies/package/

RD-34 EC Climate Action, Effort Sharing Decision.
☞ http://ec.europa.eu/clima/policies/effort/

RD-35 EC Climate Action, Protection of the ozone layer.
☞ http://ec.europa.eu/clima/policies/ozone/

RD-36 EC Environment, Air Quality Legislation.
☞ http://ec.europa.eu/environment/air/quality/legislation/existing_leg.htm

RD-37 EC Environment, National Emission Ceilings.
☞ http://ec.europa.eu/environment/air/pollutants/ceilings.htm

RD-38 EC Environment, Revision of the NEC Directive.
☞ http://ec.europa.eu/environment/air/pollutants/rev_nec_dir.htm

RD-39 EEA NEC Directive Inventory.
☞ http://www.eea.europa.eu/data-and-maps/data/national-emission-ceilings-nec-directive-inventory

RD-40 Eionet ROD, AQFD page.
☞ http://rod.eionet.europa.eu/instruments/274

RD-41 Eionet ROD, NEC Directive page.
☞ http://rod.eionet.europa.eu/instruments/522

RD-42 GEO Communities of Practice.
☞ http://www.earthobservations.org/cop.shtml

RD-43 GOSIC, Space Based Climate Observations for GCOS - Requirements for Satellite Observations for GCOS.
☞ http://gosic.org/space/gcossreq.htm

RD-44 MACC Product Portfolio.
☞ http://www.gmes-atmosphere.eu/about/product_portfolio/

RD-45 UNECE, Protocol on the Reduction of Sulphur Emissions.
☞ http://www.unece.org/env/lrtap/sulf_h1.htm

RD-46 UNECE, Protocol concerning the Control of Emissions of Nitrogen Oxides.
☞ http://www.unece.org/env/lrtap/nitr_h1.htm

RD-47 UNECE, Protocol to Abate Acidification, Eutrophication and Ground-level Ozone.
☞ http://www.unece.org/env/lrtap/multi_h1.htm

RD-48 UNECE WGE homepage.
☞ http://www.unece.org/env/lrtap/WorkingGroups/wge/welcome.html

RD-49 UNFCCC, The Cancun Agreements, Overview.
☞ http://cancun.unfccc.int/

RD-50 US EPA, Ozone Layer Protection Glossary.
☞ http://www.epa.gov/ozone/defns.html

RD-51 US EPA, Ozone-Depleting Substances.
☞ http://www.epa.gov/ozone/science/ods/index.html

RD-52 WMO, On-line databases and questionnaires.
☞ http://www.wmo.int/pages/prog/sat/Databases.html

# 5. ABBREVIATIONS, ACRONYMS, NAMES & LINKS

| | |
|---|---|
| AEI | Average Exposure Indicator |
| AOPC | *Atmosphere Observation Panel for Climate*<br>☞ http://www.wmo.int/pages/prog/gcos/index.php?name=AOPC |
| AQ | Air Quality |
| AQFD | *Air Quality Framework Directive* [**IR-10**] |
| BAT | Best Available Technology / Technologies |
| BB | Biomass Burning |
| CAFÉ | *Clean Air For Europe*, European programme to establish a long-term integrated strategy to tackle air pollution and to protect against its effects on human health and the environment<br>☞ http://europa.eu/legislation_summaries/environment/air_pollution/l28026_en.htm |
| Carbones | FP7 project to provide a 30-year long re-analysis of carbon fluxes and pools (2010 – 2014)<br>☞ http://www.carbones.eu/ |
| CCC | *Chemical Coordinating Centre* of EMEP at NILU, Norway<br>☞ http://tarantula.nilu.no/projects/ccc/ |
| CEC | *Commission of the European Communities* |
| CEIP | *Centre on Emission Inventories and Projections* of EMEP at UBA, Austria<br>☞ http://www.ceip.at/ |
| CEOS | *Committee on Earth Observation Satellites*<br>☞ http://www.ceos.org/ |
| CFC | Chlorofluorocarbon |
| CIAM | *Centre for Integrated Assessment Modelling* of EMEP at IIASA, Austria<br>☞ http://www.iiasa.ac.at/~rains/ciam.html |
| CLRTAP | *Convention on Long-Range Transboundary Air Pollution*<br>☞ http://www.unece.org/env/lrtap/full%20text/1979.CLRTAP.e.pdf |
| CMP | Meeting of the Parties to the Kyoto Protocol |
| CoP | *Community of Practice* of the GEO, "user-led community of stakeholders, from providers to the final beneficiaries of EO data and information, with a common interest in specific aspects of societal benefits to be realized by GEOSS implementation" |
| COP | *Conference of the Parties* to the UNFCCC |
| DG | *Directorate(s) General,* department(s) of the EC |
| DG CLIMA | *Directorate General for Climate Action* of the EC<br>☞ http://ec.europa.eu/dgs/clima/ |
| EAP | *Environment Action Programme* of the EC<br>The Sixth EAP was launched in 2002. It ends in 2012.<br>☞ http://ec.europa.eu/environment/newprg/ |
| EC | *European Commission*<br>☞ http://ec.europa.eu/ |

| | |
|---|---|
| ECCP | *European Climate Change Programme*<br>☞ http://ec.europa.eu/clima/policies/eccp/ |
| ECMWF | *European Centre for Medium-Range Weather Forecasts*, Reading, UK<br>☞ http://www.ecmwf.int/ |
| EEA | *European Environment Agency*<br>☞ http://www.eea.europa.eu/ |
| EECCA | *Eastern Europe, Caucasus and Central Asia*, a geographic block including the twelve countries Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, the Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan (reference: OECD) |
| Eionet | *European Environment Information and Observation Network*<br>☞ http://www.eionet.europa.eu/ |
| EMDA | *East Midlands Development Agency*, UK<br>☞ http://www.emda.org.uk/ |
| EMEP | *European Monitoring and Evaluation Programme*, scientifically based and policy driven programme under the CLRTAP for international co-operation to solve transboundary air pollution problems<br>☞ http://www.emep.int/ |
| EO | Earth Observation |
| EPA | *Environmental Protection Agency*, United States<br>☞ http://www.epa.gov/ |
| ERDF | *European Regional Development Fund* |
| ESA | *European Space Agency*<br>☞ http://www.esa.int/ |
| ETS | *Emission Trading System*, a European trading scheme applying to GHG emissions by factories and power plants<br>☞ http://ec.europa.eu/clima/policies/ets/ |
| EU | Europe, European, European Union |
| EUMETSAT | *European Organisation for the Exploitation of Meteorological Satellites*<br>☞ http://www.eumetsat.int/ |
| EURO4M | *European Reanalysis and Observations for Monitoring*, FP7 project (April 2010 – March 2014)<br>☞ http://www.euro4m.eu/ |
| EVOSS | *European Volcano Observatory Space Services*, FP7 project (March 2010 – February 2013)<br>☞ http://www.congrex.nl/10a04/sessions/CXNL_10a04_920755.htm |
| FP6 | *Sixth Framework Programme* of the EC<br>☞ http://ec.europa.eu/research/fp6/ |
| FP7 | *Seventh Framework Programme* of the EC<br>☞ http://ec.europa.eu/research/fp7/ |
| GAS | *GMES Atmospheric Service*<br>☞ http://www.gmes.info/pages-principales/services/atmosphere-monitoring/ |
| GAW | *Global Atmosphere Watch*, programme of the WMO<br>☞ http://www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html |

| | |
|---|---|
| GCOS | *Global Climate Observing System*<br>☞ http://www.wmo.int/pages/prog/gcos/<br>☞ http://gosic.org/ios/GCOS-main-page.htm |
| GEMS | *Global and regional Earth-system (Atmosphere) Monitoring using Satellite and in-situ data*, FP6 project (2005-2009).<br>☞ http://gems.ecmwf.int/ |
| GEO | *Group on Earth Observations*<br>☞ http://www.earthobservations.org/ |
| GEOLAND | *Integrated GMES Project on Land Cover and Vegetation*, FP6 project (2005-2007)<br>☞ http://www.fp6.gmes-geoland.info/ |
| GEOLAND2 | *Integrated GMES Project on Land Cover and Vegetation*, FP7 project (2008-2012)<br>☞ http://www.gmes-geoland.info/ |
| GEOSS | *Global Earth Observation System of Systems*<br>☞ http://www.earthobservations.org/geoss.shtml |
| GFAS | *Global Fire Assimilation System* |
| GHG | Greenhouse Gas(es) |
| GMES | *Global Monitoring for Environment and Security*, joint initiative of the EC and ESA for the establishment of a European capacity for EO<br>☞ http://www.gmes.info/ |
| GOOS | *Global Ocean Observing System*<br>☞ http://www.ioc-goos.org/ |
| GOS | *Global Observing System*<br>☞ http://www.wmo.int/pages/prog/www/OSY/GOS.html |
| GOSIC | *Global Observing Systems Information Center* of the GCOS<br>☞ http://gosic.org/ |
| GRG | Global Reactive Gas(es) |
| GRUAN | *GCOS Reference Upper-Air Network*<br>☞ http://www.dwd.de/gruan/<br>☞ http://www.wmo.int/pages/prog/gcos/index.php?name=GRUAN |
| G-STEP | *GMES Space Technology Exchange Partnership*, an initiative to support EO data provision to business, co-funded by ERDF through EMDA, Prospect Leicestershire and the University of Leicester; launched in June 2009<br>☞ http://www2.le.ac.uk/projects/g-step/ |
| GWP | Global Warming Potential |
| HBFC | Hydrobromofluorocarbon |
| HCFC | Hydrochlorofluorocarbon |
| HFC | Hydrofluorocarbon |
| ICSU | *International Council for Science*<br>☞ http://www.icsu.org/ |
| IGACO | *Integrated Global Atmospheric Chemistry Observations Theme*, former IGOS Atmospheric Chemistry theme, now replaced by the Atmospheric Chemistry GEO CoP |
| IGOS | *Integrated Global Observing Strategy*<br>☞ http://www.igospartners.org/ |

| | |
|---|---|
| IIASA | *International Institute for Applied Systems Analysis*, Laxenburg, Austria<br>☞ http://www.iiasa.ac.at/ |
| INSPIRE | *Infrastructure for Spatial Information in the European Community*<br>☞ http://inspire.jrc.ec.europa.eu/ |
| IR | Implementing Rule(s) – in the context of the INSPIRE Directive |
| LMO | Legally Mandated Organisation – in the context of the INSPIRE Directive implementation |
| LS | Lower Stratosphere |
| LT | Lower Troposphere |
| MAC | Motor Vehicle Air-Conditioning – in the context of the MAC Directive |
| MACC | *Monitoring Atmospheric Composition and Climate*, FP7 project (June 2009 – October 2011)<br>☞ http://www.gmes-atmosphere.eu/ |
| MET.NO | *Norwegian Meteorological Institute*, Oslo, Norway<br>☞ http://met.no/ |
| MSC-E | *Meteorological Synthesizing Centre-East* of EMEP, Moscow, Russia<br>☞ http://www.msceast.org/ |
| MSC-W | *Meteorological Synthesizing Centre-West* of EMEP at MET.NO, Norway<br>☞ http://www.emep.int/mscw/ |
| NEC | *National Emission Ceiling(s)* – in the context of the NEC Directive [**IR-19**] |
| NILU | *Norsk institutt for luftforskning* – Norwegian Institute for Air Research, Kjeller, Norway.<br>☞ http://www.nilu.no/ |
| NRT | Near-Real Time |
| ODP | Ozone Depleting Potential |
| ODS | Ozone Depleting Substance(s) |
| OECD | *Organisation for Economic Co-operation and Development*<br>☞ http://www.oecd.org/ |
| OOPC | *Ocean Observations Panel for Climate*<br>☞ http://ioc-goos-oopc.org/ |
| PASODOBLE | *PROMOTE Air quality Services integrating Observations - Development of Basic Localised Information for Europe*, FP7 project (May 2010 – April 2013)<br>☞ http://www.myair-eu.org/ |
| PFC | Perfluorocarbon |
| PM | Particulate Matter |
| $PM_{10}$ | PM of largest dimension 10 µm or less |
| $PM_{2.5}$ | PM of largest dimension 2.5 µm or less (“fine” particles) |
| POP | Persistent Organic Pollutant(s) |
| PROMOTE | *Protocol Monitoring for the GMES Service Element Atmosphere*, project supported by the ESA (July 2006 – December 2009)<br>☞ http://www.gse-promote.org/ |
| QA4EO | *Quality Assurance Framework for Earth Observation* |

| | |
|---|---|
| | ☞ http://qa4eo.org/ |
| ROD | *Reporting Obligations Database* of Eionet<br>☞ http://rod.eionet.europa.eu/ |
| RRR | *Rolling Requirements Review*, WMO process to compare user requirements for observations with observing system capabilities<br>☞ http://www.wmo.int/pages/prog/sat/RRR-and-SOG.html |
| SDIC | Spatial Data Interest Community – in the context of the INSPIRE Directive implementation |
| SEO | *Systems Engineering Office* of CEOS<br>☞ http://ceos.org/index.php?option=com_content&view=category&layout=blog&id=51&Itemid=92 |
| SLA | Service Level Agreement(s) |
| TOMA | Tropospheric Ozone Management Area |
| TOPC | *Terrestrial Observation Panel for Climate*<br>☞ http://www.fao.org/gtos/TOPC.html<br>☞ http://www.wmo.int/pages/prog/gcos/index.php?name=TOPC |
| UBA | *Umweltbundesamt* (Austrian Environment Agency)<br>☞ http://www.umweltbundesamt.at/ |
| UK | *United Kingdom* |
| UN | *United Nations*<br>☞ http://www.un.org/ |
| UNECE | *United Nations Economic Commission for Europe*<br>☞ http://www.unece.org/ |
| UNEP | *United Nations Environment Programme*<br>☞ http://www.unep.org/ |
| UNFCCC | *United Nations Framework Convention on Climate Change*<br>☞ http://unfccc.int/ |
| USM | Upper Stratosphere and Mesosphere |
| UT | Upper Troposphere |
| UV | Ultra-Violet |
| VOC | Volatile Organic Compound(s) |
| WCRP | *World Climate Research Programme*<br>☞ http://www.wcrp-climate.org/ |
| WGE | *Working Group on Effects* of the CLRTAP, set up by UNECE<br>☞ http://www.unece.org/env/lrtap/WorkingGroups/wge/welcome.html |
| WHO | *World Health Organization*<br>☞ http://www.who.int/ |
| WMO | *World Meteorological Organization*<br>☞ http://www.wmo.int/ |
| WP | Work Package |
| WWW | *World Weather Watch* Programme of the WMO<br>☞ http://www.wmo.int/pages/prog/www/ |

# 6. CHEMICALS

| | |
|---|---|
| As | arsenic |
| Br | bromine |
| BrO | bromine monoxide |
| C | carbon |
| $CCl_4$ | carbon tetrachloride |
| $CFCl_3$ | trichlorofluoromethane (CFC-11) |
| $CF_2BrCl$ | chlorobromodifluoromethane (halon-1211) |
| $CF_2Cl_2$ | dichlorodifluoromethane (CFC-12) |
| $CF_3Br$ | trifluorobromomethane (halon-1301) |
| $CHF_2Cl$ | chlorodifluoromethane (HCFC-22) |
| $CH_2BrCl$ | bromochloromethane |
| $CH_2O$ | formaldehyde (also written HCHO) |
| $CH_3Br$ | methyl bromide |
| $CH_4$ | methane |
| CO | carbon monoxide |
| $CO_2$ | carbon dioxide |
| $C_2F_4Br_2$ | halon-2402 |
| $C_2H_3Cl_3$ | 1,1,1-trichloroethane, or methyl chloroform |
| $C_6H_6$ | benzene |
| Cd | cadmium |
| Cl | chlorine |
| ClO | chlorine monoxide |
| $ClONO_2$ | chlorine nitrate |
| F | fluorine |
| H | hydrogen |
| HCl | hydrochloric acid |
| $HNO_3$ | nitric acid |
| $H_2O$ | water (vapour) |
| Hg | mercury |
| $NH_3$ | ammonia |
| NO | nitric oxide |
| $NO_2$ | nitrogen dioxide |
| $NO_X$ | NO and $NO_2$ ($NO_X$ concentration is the sum of the concentrations of NO and $NO_2$) |
| $N_2O$ | nitrous oxide |
| Ni | nickel |

| | |
|---|---|
| OClO | chlorine dioxide |
| $O_3$ | ozone |
| Pb | lead |
| S | sulphur |
| $SF_6$ | sulphur hexafluoride |
| $SO_2$ | sulphur dioxide |

# 7. INDEX OF MAIN INTERNATIONAL REGULATION TEXTS

## 7.1 Worldwide regulations



## 7.2 European legislation

| | |
|---|---|
| PROJECT: | MACC Monitoring Atmospheric Composition and Climate |
| SUB-PROJECT / CLUSTER: | MAN Management and System Engineering |
| WORK PACKAGE / TASK: | MAN_3 System engineering for the GMES Atmospheric Service |
| DELIVERABLE: | D_MAN_3.5 (a) |