

Deliverables O-INT 1.1 / O-INT 1.2 / O-INT 1.3

MACC Downstream Services and End User Requirements Document reviewed by users

Version 1.1

27.08.2010



Executive Summary

This document explores the key user requirements of both GMES downstream services (G-STEP and PASODOBLE; more to come with 2nd and 3rd FP7 space call) and of the intermediate and end users of MACC core services. It merges the MACC deliverables O-INT 1.1 (downstream services requirements) and O-INT 1.2 (end user requirements) into one document. User requirements have been evaluated from presentations in the user session / user Advisory Board of the first MACC assembly, from return of a questionnaire distributed on the MACC website, during the meeting and via an extensive mailing list from PROMOTE and GEMS projects and further applicable documents (PASODOBLE, PROMOTE). The continuity of PROMOTE services also impact on MACC user requirements. Stable and fast dynamic ftp access to the data as well as a routinely and timely delivery of regular (daily) products are key requirements of all users. Moreover the documentation of methods, models and validation status is a major concern of most users of MACC services. The request to cover Iceland and Turkey fully (both are EEA member states) by the MACC models has been raised by EEA.

Version 1.0 of the requirements document was distributed to MACC users and services for a first iteration and extension. This version 1.1 (which constitutes deliverable O-INT 1.3 reviewed by users) includes the evaluation of 11 additional questionnaires received after iterating version 1.0 of the document. Moreover feedback of users (e.g. the local urban user group) through circulation by the user advisory board has been implemented into the user requirements.

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1. Introduction

1.1 User requirements evaluation

The Description of Work of the FP7 GMES downstream atmosphere project PASODOBLE (project start in May 2010) has been negotiated with the MACC consortium in order to guarantee best possible coherence in services. The requirements of the downstream service are part of a negotiation note between PASODOBLE and MACC. The key elements of this negotiation note with respect to requirements of PASODOBLE for MACC have been incorporated into this document. An open user session has been held at the first MACC assembly hosted by ECMWF in Reading (UK) in January 2010. The needs and requirements presented there have been analysed and included into the formulation of the end user requirements of MACC services. Moreover, a questionnaire has been sent to possible and confirmed MACC users (based on user lists of predecessor projects GEMS and PROMOTE). This questionnaire is included below. It is also available on the MACC web portal. The response of the users (seven user responses in the first version of this document, 18 in version 1.1) also adds to the user requirements presented in this document together with the feedback of users who already contributed to version 1.0. The review of version 1.0 by user groups mainly resulted in extensions of user requirements which had not been part of version 1.0 before. The local urban user group has been included in the review process of this document and their requirements have been included in the general end user requirements. The main interest of this group is the provision of local air quality forecasts which require regional forecasts as input. A great benefit of regional forecast provision through MACC (and follow-on, as continuity is named a key requirement) is seen here.

Some MACC services continue the work begun in the PROMOTE project. Users of PROMOTE services thus now become MACC users and the requirements formulated for PROMOTE services still apply to the continued services in MACC. Thus also the PROMOTE core user needs and requirements have been analysed and have been added to the formulation of MACC user requirements, where appropriate. The PROMOTE heritage of user requirements is indicated as “PROMOTE origin” in this document, when these are additional to the requirements by MACC users through downstream service requirements, questionnaire responses, or the open user session presentations.

1.2 The questionnaire

This section contains the questionnaire sent out to over 100 possible and confirmed users of MACC services and continuing to be available in the MACC web portal (O-INT sub project web site). It has also been distributed within the local urban user group.

Questionnaire to Users and User Advisory Board

Kindly return this questionnaire to Christian.Nagl@umweltbundesamt.at.

0) Kindly provide some information on your organization and major tasks, where MACC products could be of help.

1) Which PROMOTE or GEMS service(s) have you used (if any)?

PROMOTE

- Ozone
- UV
- Air quality
- Climate
- Aviation
- Ozone
- global Europe regional local
- record near-real time forecast

GEMS

- Global Aerosol
- Global Reactive Gases
- Global Greenhouse Gases
- Regional Air Quality

2) Which **MACC** service(s) do you use or consider using ([see http://www.gmes-atmosphere.eu](http://www.gmes-atmosphere.eu))?

- Global Aerosol
- Global Reactive Gases
- Global Greenhouse Gases
- European Air Quality
- Solar radiation and UV
- Other
- record near-real time forecast

3) Have you any specific lessons learnt from PROMOTE or GEMS (improvements due to user involvement)?

4) What are your key technical requirements

Format:

Timeliness:

Medium of data transfer:

Mode of data transfer:

quick-looks data files

Other:

5) What are your requirements with regard to access mode?

push pull

routine delivery

manual access to archives

Comments:

6) What is your expected frequency of use?

daily

monthly

intermittent

Comments:

7) What are your general expectations for the service(s); what will be the benefits?

8) How will the service(s) be used in your every day work?

9) What are your requirements for documentation?

10) What are your requirements for validation?

11) What are your requirements for training?

12) Do you have any suggestions for service extensions or new services?

13) Are you an intermediate service provider? If so, who is your end user (i.e. citizen, public authorities, ...)?

14) Do you have any suggestions for improving user involvement?

2. MACC Product/Service Users

2.1 Downstream services (with contributions to user requirements definitions)

PASODOBLE

PASODOBLE is an FP7 GMES atmosphere downstream project closely related to MACC. Its goal is to develop and demonstrate user-driven downstream information services for the regional and local air quality sector by combining space-based data, in-situ data and models in four service lines:

- health community support for people at risk, hospitals, pharmacies and doctors
- public forecasting and assessment support for agencies, tourist industries and sport event organizers
- compliance monitoring support on particulate matter for regional environmental agencies
- local forecast model evaluation support for local authorities and city bodies

The PASODOBLE consortium consists of 21 partners from 13 countries.

MACC services to be used:

Europe: air quality (forecasts and reanalyses), aerosol (SAT), UV, emissions.

G-STEP

G-STEP is a University of Leicester based knowledge-exchange hub. The aim of G-STEP is to support the exploitation of Earth Observation data and information in order to assist business, research and public sector organisations. G-Step will use European Union and European Space Agency (GMES) data and programmes, supplied from satellite, aerial and ground based observations. One primary goal of G-STEP is to exploit these GMES technologies and the wider R&D base to advance business innovation and competitiveness.

MACC services to be used:

Global: reactive gases (NO_x), aerosol

Europe: reactive gases (NO_x), aerosol

Further downstream services

Further downstream service projects are emerging: EVOSS (European Volcano Observatory Space Service), Carbones, EURO4M (FP7 2nd space call) and later ones may be added from the FP 7 3rd space call. Their requirements will be assessed once they become available.

2.2 End users (with contributions to user requirements definitions)

PROMOTE users

MACC continues some of the PROMOTE services, thus MACC users have partly also been PROMOTE users. For the services which originate from PROMOTE, the user requirements of PROMOTE Stage II (2006 – 2009) apply also to the respective MACC services and are referenced here as PROMOTE origin.

MACC services in continuation of PROMOTE:

Global: reactive gases, ozone, greenhouse gases, aerosol (satellite focus)

Europe: solar radiation, UV, air quality

Landesamt für Umwelt- und Verbraucherschutz (LANUV-NRW):

LANUV is a state authority, directly downstream of the Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz (Ministry for Environment and Environmental Protection, Agriculture and Consumer Protection) of the German federal state North Rhine Westphalia. Among many other tasks LANUV is responsible for the assessment of the air quality throughout the territory of NRW and at hot spots of air pollution to meet the national immission protection law (BImSchG) and international obligations (directives of the European Union).

MACC services to be used:

Europe: air quality (analysis and NRT)

European Environment Agency (EEA):

The European Environment Agency (EEA) is an agency of the European Union. Our task is to provide sound, independent information on the environment. We are a major information source for those involved in developing, adopting, implementing and evaluating environmental policy, and also the general public. Currently, the EEA has 32 member countries.

EEA's mandate is

- to help the Community and [member countries](#) make informed decisions about improving the environment, integrating environmental considerations into economic policies and moving towards sustainability

- to coordinate the European environment information and observation network

EEA already used PROMOTE NRT air quality data.

MACC Services to be used:

Europe: aerosol (analysis and NRT), reactive gases (analysis and NRT), solar radiation (analysis and NRT), UV (analysis and NRT)

German Federal Environment Agency (UBA-D):

The German Federal Environment Agency (Umweltbundesamt, UBA) was founded in 1974. Its key statutory mandates are to provide scientific support to the Federal Government, to implement environmental laws, and to inform the public about environmental protection.

“For people and the environment” is the mission statement of the Federal Environment Agency (UBA). Founded in 1974, the UBA is Germany’s central federal authority on environmental matters. Its key statutory mandates are:

- To provide scientific support to the Federal Government (e.g.. the Federal Ministries for Environment, Health, Research, Transport, Building and Urban Affairs);
- Implementation of environmental laws (e.g. emissions trading, authorisation of chemicals, pharmaceuticals, and plant protection agents)
- Information of the public about environmental protection.

UBA acts as partner and Germany’s contact point for many international organisations, including the WHO.

The mandate of UBA’s department Air Quality – as far as it might be related to MACC products – includes: Operation of the observational network for monitoring long-range and transboundary air pollution in Germany and for observations in international frameworks (UN-ECE, HelCom, OsPar, GAW). The department evaluates air quality observations of its own observational network and the networks of the Federal Länder as well as the situation and development of air quality in Germany, reports on air quality both to the public and to international bodies, and acts as EEA’s NRC Air Quality. UBA Air Quality coordinates air quality research as well as standardization, harmonization and quality control of air quality modelling as a base for the development of national air quality strategies and for the evaluation of air quality strategies of the Federal Länder and the municipalities. UBA Air Quality participates in air quality related bodies and working groups of UN-ECE CLRTAP and the EU.

MACC services to be used:

Europe: air quality (analysis)

all MACC services on record and in NRT

VITO:

As independent and customer-oriented research organisation, VITO provides innovative technological solutions as well as scientifically based advice and support in order to stimulate sustainable development and reinforce the economic and social fabric of Flanders.

MACC services to be used:

Europe: meteorological conditions (analysis, NRT and forecast), aerosol (analysis, NRT and forecast), greenhouse gases (analysis, NRT and forecast)

German Weather Service (DWD):

The Deutscher Wetterdienst (DWD), which was founded in 1952, is as National Meteorological Service of the Federal Republic of Germany responsible for providing services for the protection of life and property in the form of weather and climate information. This is the core task of the DWD and includes the meteorological safeguarding of aviation and marine shipping and the warning of meteorological events that could endanger public safety and order. The DWD coordinates the meteorological interests of Germany on a national level in close agreement with the Federal Government and represents the Government in intergovernmental and international organisations as, for example the World Meteorological Organization (WMO).
Used PROMOTE hourly global forecasts of total column O₃.

MACC services to be used:

Global: aerosol and O₃ column (forecast)

Europe: O₃ column (forecast)

GeoModel:

Company providing support for the planning, operation and management of solar energy systems. GeoModel runs solar radiation model and provides additional data, spatial analyses and simulation tools aimed to specific user groups. Data and simulation tools can be accessed throughout online interactive system <http://solargis.info>. More information about company can be found at <http://geomodel.eu>
Used GEMS Global aerosol service.

MACC services considered to be used are:

Global: aerosol (record, NRT, forecast), solar radiation (record, NRT, forecast), UV (record, NRT, forecast)

Agency for Environment and Energy Management (ADEME):

Within the frame of public policies defined by the French government, ADEME's mission is to stimulate, animate, coordinate, facilitate and perform operations aiming at the environment protection and energy management.

Regarding air quality, ADEME has in charge the:

- coordination and funding of French Air Quality Monitoring Networks (Directives and EMEP)
- National Air Quality databases for NRT and validated French AQ observations, and reports to the EEA (EIONET)
- guidance, organisation and funding of research programmes regarding atmospheric pollution and its impacts on health and environment

ADEME is also partner (with INERIS, Météo France and CNRS) of the national PREVAIR system providing NRT observations, forecasts and analyses of AQ.

Used PROMOTE and GEMS Services are PROMOTE Air Quality, GEMS Global Reactive Gases and GEMS Regional Air Quality.

MACC services considered to be used are

Global: aerosol (record, NRT, forecast), reactive gases (record, NRT, forecast)

European: Air Quality (record, NRT, forecast)

NIES:

NIES works with GOSAT - project information is available at www.gosat.nies.go.jp
NIES plans to try using MACC aerosol product for research on bias correction in the remote sensing CO2 and CH4 products. It is not yet used.
NIES already used GEMS global aerosol product.

MACC services considered to be used are:

Global: aerosol

University of Leicester:

As part of the Earth Observation Group at the University of Leicester, UK, my main area of current research is retrieving carbon dioxide and methane total column dry air mole fractions from the Greenhouse gases observing satellite (GOSAT) which is the first dedicated greenhouse gas satellite launched in Jan 2009. The key difficulties in retrieving these trace gases to the precision required for inverse modeling for regional surface fluxes to be determined are spectroscopy, aerosols and cirrus clouds. Using the MACC aerosol and cirrus optical depth and mixing ratio information for forecasted, near real time, dates allows for simultaneous retrievals of trace gases and aerosols/cirrus and has the potential for constraining our retrieval precision and quantification of aerosols/cirrus globally.

Used GEMS NRT and forecast Global Aerosol and Global Greenhouse Gases services.

MACC services to be used:

Global: aerosol (NRT and forecast).

UK Metoffice:

Use of MACC products in risk forecasts for patients suffering from Chronic Obstructive Pulmonary Disease (COPD) and for aerosol forcing monitoring (done by Hadley Centre).

MACC services to be used:

Global: aerosol (NRT, forecast)

Europe: air quality (forecast)

Isfahan Un iversity:

Use of MACC products for scientific analysis surveying on energy consumption that deteriorate environment.

MACC services to be used:

Global: greenhouse gases (forecast)

Laboratoire de Physique et Chimie de l'Environnement, Centre national de la recherche scientifique (CNRS-Orleans):

Use of MACC products for mesoscale modeling of atmospheric chemistry in the troposphere and lower stratosphere and for comparison with the model outputs.

MACC services to be used:

Global: aerosol, reactive gases (record)

Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences:

performing atmospheric correction and BRDF inversion

MACC services to be used:

Global: aerosol (NRT)

Belgian Interregional Environment Agency (IRCEL-CELINE):

The Belgian Interregionale Environment Agency (IRCEL-CELINE) is responsible for the forecasting of episodes with enhanced air pollution on behalf of the three Belgian Regions. In our forecasting procedures we use neural-network as well as deterministic air quality models (CHIMERE, AURORA). Besides this own used models we also use information provided by foreign models (e.g. for instance the results on the gems.ecmwf.int website). We were also a PROMOTE end user and are now participation in the PASADOBLE project.

MACC services to be used:

Europe: air quality (record, NRT, forecast)

ICARE:

ICARE processes and provides online archive of satellite data to study the atmosphere (aerosols, clouds, radiation and water cycle). Any MACC products (observations or model forecast) relevant to these fields are of potential interest.

MACC services to be used:

Global: aerosol (record, NRT)

CENSE:

CENSE – Center for environmental and sustainability research. Faculty of Sciences and Technology. Universidade Nova de Lisboa. MACC products could be helpful on the air quality forecast at local/mesoscale level.

MACC services to be used:

Global: aerosol, reactive gases (record, NRT, forecast)

Europe: air quality (record, NRT, forecast)

EMPA:

Empa operates the Swiss national air quality network and is strongly involved in worldwide measurements of reactive as well as persistent atmospheric trace gases and particulates for

example in the framework of GAW. Additionally, it employs several modeling systems for the assessment of source-receptor relationships and impact studies. Those modeling efforts can greatly benefit from the use of MACC emissions and boundary condition data.

MACC services to be used:

Global: aerosol, reactive gases (record, NRT)

Europe: air quality (record, NRT)

CNRS Research Laboratory:

Research laboratory, mesoscale modeling of atmospheric chemistry in the troposphere and lower stratosphere, Use of MACC products to compare with the model output.

MACC services to be used:

Global: aerosol, reactive gases (record)

European Topic Centre on Air and Climate Change (ETC/ACC):

The European Topic Centre on Air and Climate Change (ETC/ACC) assists the EEA in its support to EU policy in the field of air pollution and climate change. The ETC/ACC reports on the progress of EU environmental policy on air quality, air emission and climate change issues. It participates in assessments and supports the European Environmental Outlook reports of the EEA, it collects data concerning the current state of the environment on air and climate change, and it is involved in further harmonising European monitoring networks and reporting obligations.

MACC products could serve as reference material next to currently used data collection, but also as integrated part of our data collection, our state and outlook assessment activities. As such, we are seeking for synergies, connectivities, compatibilities and integrations / merges of our activities and products with (future) MACC activities and products.

Please note that the answers in this questionnaire do not reflect the opinion of the ETC as a whole, but of PBL as a partner within the ETC; focusing on a specific part of the ETC/ACC work for EEA.

MACC services to be used:

Global: aerosol, reactive gases, greenhouse gases (record, NRT)

Europe: air quality, solar radiation and UV (record, NRT)

3. User Requirements

3.1 Downstream requirements

3.1.1 PASODOBLE

MACC air quality forecasts and analyses will serve as boundary conditions for further nesting activities of local and urban scale models. Furthermore, an emission inventory for use in PASODOBLE will be provided by MACC as well as additional parameters that were derived within PROMOTE at European scale, like forecasts of UV or satellite based aerosol products. As learned from PROMOTE experience, it is important to keep a maximum of information in emission inventory species concentrations (e.g. components of PM_{2.5} rather than the bulk concentration). Moreover ECMWF fields (analysis and forecast) should be provided by MACC. The PASODOBLE Airsheds have been re-defined at the IC_AIRSHEDS Splinter Meeting held along the PASODOBLE Kick-Off Meeting (21.-23.06.2010). It is important that these areas are covered by MACC European services.

Requirements for MACC data used as boundary conditions in PASODOBLE:

- harmonised access to Core Products (recommended by GAS implementation group)
- harmonised nesting approaches towards finer scales and higher resolutions
- common reading routines

The following MACC data products are required by PASODOBLE during the development and delivery of the PASODOBLE services. A timely, adequate and routinely delivery for the defined products is required, preferably two times daily (00:00 and 12:00).

- Regional (=Europe) AQ forecasts ENS at highest resolution and accuracy available
- Regional (=Europe) AQ analyses EVA at highest resolution and accuracy available
- Global / European aerosol concentrations (SYNAER) SAT at given accuracy
- UV maps RAD for Europe, surface level UV at highest resolution and accuracy available
- Regional (=Europe) emissions EMIS at spatial resolution of 6 km

At least by one PASODOBLE partner (VITO), a ftp-push system would be preferred for data access.

3.1.2 G-STEP

G-STEP will use EU/ESA GMES data and programmes, supplied from satellite, aerial and ground based observations along with data from the wider R&D base to advance business innovation and competitiveness.

The following MACC data products are required by G-STEP for demonstrating applications of space data and for encouraging the supply of local forecast information to relevant groups (e.g. health organizations), and for supplying information to environmental consultants. Therefore G-STEP relies on timely routine delivery of MACC core services with easy access to data for supporting operational delivery of public information.

- Global, regional (=European) and local reactive gases analyses and forecasts GRG at highest resolution and accuracy available
- Global, regional (=European) and local aerosol (PM + speciation) analyses and forecasts AER at highest resolution and accuracy available
- Access to demonstration products for raising business awareness

3.2 *End User requirements (questionnaire & user session) by service*

3.2.1 *Global Aerosol*

3.2.1.1 Lessons learned from PROMOTE or GEMS

- Boundary condition requirements have helped to improve global modeling subprojects, especially AER.

3.2.1.2 Key technical requirements

- online data files access in near-real time with the possibility of a dynamic enquiry
- Data format should preferably be netCDF(4) , but options shall be available (e.g. DWD requests grib or ASCII).
- Also csv, xml, grib (3x) and ASCII are mentioned, netCDF is not suitable for all end users.
- Daily data delivery should be before 6am, at best at 01UTC, as 6am is much too late for some users.
- Quick looks are appreciated.
- Products should remain accessible (archive) 1 week to 1 month behind real time.
- access to meteorological parameters (ECMWF forecasts and reanalyses)
- hourly to three-hourly time resolution
- spatial resolution of a few tens of kilometres
- Good and complete description of the dataset and of what observations were assimilated in order to be able to identify independent observations for model validation.
- Coverage of Iceland and Turkey (total) for EEA tasks.

3.2.1.3 Access mode requirements

- FTP (pull) access for both, routinely delivery and manual archive access
- data exchange agreements to fall within existing decision making frameworks rather than as separate project specific stand-alone bilaterals
- The current access mode to the data is OK but FTP pull or standing order are preferred.

3.2.1.4 Excepted frequency of use

- daily for NRT and forecast products
- monthly for research
- occasional access to archived reanalysis products

3.2.1.5 General expectations for the services / benefits

- Use of daily data from MACC project could improve the quality of solar energy products and increase the awareness of potential customers of these data.
- Aerosol data are also used as boundary conditions for finer resolved (local) modeling.
- Research based on MACC data is mentioned to lead to a number of research publications.
- Continuity of PROMOTE / MACC services is a key requirement.
- improved quality of UVI forecast based on actual aerosol data instead of climatological data
- Prerequisites for MACC services to become beneficial to non-research organizations such as environmental agencies (e.g. UBA-D) are operational availability and continuity.
- Policy scenarios for future years: use of chemical boundary conditions, meteorology including radiation, and emission inventories to nest own national scenario runs. For services of this kind to be helpful, they must be consistent with existent European policy structure (e.g. EU Clean Air For Europe (CAFE), Convention on Long-range Transboundary Air Pollution). By definition of O-POL, this seems to be granted
- MACC services can be used for evaluation of mesoscale and statistical air quality models as well as for boundary conditions in these models.
- One consistent dataset for the domain of Europe which serves as a basis for reliable and high-quality air pollution studies, decreasing the workload for data transformation, the exploration of new data sources and the maintenance of a number of different datasets and thus giving more time for research.
- Analysis of the wider exchange and use of NRT data on atmospheric composition in Europe.
- Access to NRT AQ data has been a major issue in the GMES process during the last years. Through the research GEMS and PROMOTE projects, significant efforts have been laid down in making data from national environmental agencies and research networks available in a suitable format and timely delivered. The ambition has been to assimilate such surface observations into operational modeling systems in order to improve analysis and forecast of AQ, and to use NRT data for NRT evaluation of model performances. Up to now, the NRT AQ data are mainly used for verification of model output in the GEMS and PROMOTE projects.
- The GEMS project has also set up a web page showing an overview of data (ozone, NO₂, SO₂, CO and PM₁₀) at the European scale. This page is showing partly the same information as the EEA ozone web, but there is data from different countries/regions in the two systems. Neither of the systems have access to all data. Best would be the systems would merge into one common environment holding all data.
- In MACC, NRT data is to be used not only for validation but for data assimilation, that is, to produce better air quality forecast and analysis over Europe and the globe.

3.2.1.6 use of services in every day work

- MACC aerosols products may be used in the near real time and forecasts of a broadband solar radiation.
- Operational AQ forecasting, alerts and information and occasional assessments and episode analysis
- Use of reanalyses to improve state of the environment assessment
- MACC aerosol products may be used in UV-Index forecasts (of DWD)
- input in the aerosol forcing processing tool (developed by Met Office Hadley Centre and Max Planck Institute Hamburg)
- ICARE offers a comparison tool of MACC data to satellite data through a web interface. Browse images made available to the public and data only to registered users.
- Emission data as well as initial / boundary conditions will be used as input data for quasi-operational air quality simulations on European scale. Additionally, the data will serve as input for research projects.

3.2.1.7 Documentation requirements

- description of the methods used to derive products
- description of each product delivered
- data format and model description
- documentation of model inputs, process, outputs and validation
- summary of quality analyses
- short “data access” manual including conditions of use
- link (email) to the responsible person or “principal investigator” for each product
- Should follow TCCCA rules: Transparent, Consistent, Complete, Compatible and Accurate. Products (and results) need to be proven by peer reviewed articles. Documentation on data and correction history is needed. Documentation on all levels of uncertainties (images, analysis, calculations, etc.) is needed per product.

3.2.1.8 Validation requirements

- validation report for each product
- quick looks of validation scores
- quality flag and uncertainty information should be delivered within the data
- continuous quality control
- High resolution of the model data to distinguish between rural, urban, or suburban environments traditionally covered by air quality observation networks.

3.2.1.9 Training requirements

- online access to the “user cases”
- online documentation
- e-training
- hotline for questions
- hands on training sessions
- workshops with the explanation on the MACC model results and other products

3.2.1.10 Suggestions for service extensions / new services

- increase of the spatial resolution of the global datasets
- information about form of services, availability, conditions of the use of datasets in the future
- regional aerosols: speciation rather than total PM2.5
- include all aerosol species in the optical depth product rather than only total AOD
- include single scattering albedo (e.g. from climatology with regular updates) and number concentrations to global and local aerosol products
- quick looks of meteorological parameters and emissions
- access to the TNO emission inventory (Europe)
- More important than extensions or new services is that services become operational, are sustained in the long term and are well coordinated with the existent European policy structure.
- GEMS web interface is very useful and we (Met Office HC) hope it continues with MACC products, with access to the largest set of variables possible.
- user involvement in product and accuracy improve by access to the software code

3.2.1.11 End users of intermediate service providers

industrial and individual users in the PV sector, citizen, public authorities, local AQ monitoring networks, researchers (climate and others)

3.2.2 Global Reactive Gases

3.2.2.1 Lessons learned from PROMOTE or GEMS?

- Improvement of TNO/GEMS NO_x inventory necessary with respect to overshooting NO_x emissions in large cities.
- EURAD model simulations in PROMOTE largely underestimated NO_x levels in southern Switzerland at the northern border of the Po Valley, while good agreement was found north of the Alps. This points to an underestimation of NO_x sources in the Po Valley.

3.2.2.2 Key technical requirements

- online data files access in near-real time with the possibility of a dynamic enquiry
- data format should preferably be netCDF(4), but options shall be available
- also csv, xml, grib (3x) and ASCII are mentioned, netCDF is not suitable for all end users.
- daily data delivery should be before 6am, at best at 01UTC, as 6am is much too late for some users.
- Quick looks are appreciated.
- access to meteorological parameters (ECMWF forecasts and reanalyses)
- hourly to three-hourly time resolution
- spatial resolution of a few tens of kilometres
- spatial resolution of ozone record better than one-by-one degree
- acceptable error: lower than 5%
- Good and complete description of the dataset and of what observations were assimilated in order to be able to identify independent observations for model validation.
- Coverage of Iceland and Turkey (total) for EEA tasks.

3.2.2.3 Access mode requirements

- FTP (pull) access for both, routinely delivery and manual archive access
- data exchange agreements to fall within existing decision making frameworks rather than as separate project specific stand-alone bilaterals

3.2.2.4 Excepted frequency of use

- daily for NRT and forecast products
- occasional access to archived reanalysis products

3.2.2.5 General expectations for the services / benefits

- boundary conditions for finer resolved (local) modeling
- Continuity of PROMOTE / MACC services is a key requirement.
- MACC services can be used for evaluation of mesoscale and statistical air quality models as well as for boundary conditions in these models.
- One consistent dataset for the domain of Europe which serves as a basis for reliable and high-quality air pollution studies, decreasing the workload for data transformation, the exploration of new data sources and the maintenance of a number of different datasets and thus giving more time for research.
- Analysis of the wider exchange and use of NRT data on atmospheric composition in Europe.
- Access to NRT AQ data has been a major issue in the GMES process during the last years. Through the research GEMS and PROMOTE projects, significant efforts have been laid down in making data from national environmental agencies and research networks available in a suitable format and timely delivered. The ambition has been to assimilate such surface observations into operational modeling systems in order to improve analysis and forecast of AQ, and to use NRT data for NRT evaluation of model performances. Up to now, the NRT AQ data are mainly used for verification of model output in the GEMS and PROMOTE projects.
- The GEMS project has also set up a web page showing an overview of data (ozone, NO₂, SO₂, CO and PM₁₀) at the European scale. This page is showing partly the same information as the EEA ozone web, but there is data from different countries/regions in the two systems. Neither of the systems have access to all data. Best would be the systems would merge into one common environment holding all data.
- In MACC, NRT data is to be used not only for validation but for data assimilation, that is, to produce better air quality forecast and analysis over Europe and the globe.

3.2.2.6 use of services in every day work

- operational AQ forecasting, alerts and information and occasional assessments and episode analysis
- Emission data as well as initial / boundary conditions will be used as input data for quasi-operational air quality simulations on European scale. Additionally, the data will serve as input for research projects.

3.2.2.7 Documentation requirements

- description of each product delivered
- data format and model description
- Should follow TCCCA rules: Transparent, Consistent, Complete, Compatible and Accurate. Products (and results) need to be proven by peer reviewed articles. Documentation on data and correction history is needed. Documentation on all levels of uncertainties (images, analysis, calculations, etc.) is needed per product.

3.2.2.8 Validation requirements

- quick looks of validation scores
- quality flag and uncertainty information should be delivered within the data
- High resolution of the model data to distinguish between rural, urban, or suburban environments traditionally covered by air quality observation networks.

3.2.2.9 Training requirements

- e-training
- hotline for questions
- hands on training sessions
- workshops with the explanation on the MACC model results and other products

3.2.2.10 Suggestions for service extensions / new services

- quick looks of meteorological parameters and emissions
- access to the TNO emission inventory (Europe)
- More important than extensions or new services is that services become operational, are sustained in the long term and are well coordinated with the existent European policy structure.

3.2.2.11 End users of intermediate service providers

- citizen, public authorities, local AQ monitoring networks, researchers

3.2.3 Global Greenhouse Gases

3.2.3.1 Lessons learned from PROMOTE or GEMS?

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3.2.3.2 Key technical requirements

- Time series of more than 20 years would be appreciated.
- MS Powerpoint and MS Excel have been mentioned as preferred data format.
- Coverage of Iceland and Turkey (total) for EEA tasks.

3.2.3.3 Access mode requirements

- data exchange agreements to fall within existing decision making frameworks rather than as separate project specific stand-alone bilaterals

3.2.3.4 Excepted frequency of use

-

3.2.3.5 General expectations for the services / benefits

- regional assessment of climate forcing by greenhouse gases
- Analysis of the wider exchange and use of NRT data on atmospheric composition in Europe.
- Access to NRT AQ data has been a major issue in the GMES process during the last years. Through the research GEMS and PROMOTE projects, significant efforts have been laid down in making data from national environmental agencies and research networks available in a suitable format and timely delivered. The ambition has been to assimilate such surface observations into operational modeling systems in order to improve analysis and forecast of AQ, and to use NRT data for NRT evaluation of model performances. Up to now, the NRT AQ data are mainly used for verification of model output in the GEMS and PROMOTE projects.
- The GEMS project has also set up a web page showing an overview of data (ozone, NO₂, SO₂, CO and PM₁₀) at the European scale. This page is showing partly the same information as the EEA ozone web, but there is data from different countries/regions in the two systems. Neither of the systems have access to all data. Best would be the systems would merge into one common environment holding all data.
- In MACC, NRT data is to be used not only for validation but for data assimilation, that is, to produce better air quality forecast and analysis over Europe and the globe.

3.2.3.6 use of services in every day work

-

3.2.3.7 Documentation requirements

- Should follow TCCCA rules: Transparant, Consistent, Complete, Compatible and Accurate. Products (and results) need to be proven by peer reviewed articles. Documentation on data and correction history is needed. Documentation on all levels of uncertainties (images, analysis, calculations, etc.) is needed per product.

3.2.3.8 Validation requirements

- validation report for each product
- quality flag and uncertainty information should be delivered within the data
- continuous quality control

3.2.3.9 Training requirements

-

3.2.3.10 Suggestions for service extensions / new services

- More important than extensions or new services is that services become operational, are sustained in the long term and are well coordinated with the existent European policy structure.

3.2.3.11 End users of intermediate service providers

-

3.2.4 *European Air Quality*

3.2.4.1 Lessons learned from PROMOTE or GEMS?

- It is important that users can have access to the data that is used for PROMOTE or GEMS services. This data can then be used by the user for user specific tasks (e.g. for nesting procedures). As already mentioned during the evaluation of the PROMOTE services it should be interesting to produce daily validation graphs for the air quality forecasts for day-1 and the measurements from day-1 to the representative measuring locations.

3.2.4.2 Key technical requirements

- online data files access in near-real time with the possibility of a dynamic enquiry
- data format should preferably be netCDF(4)
- Also HDF, csv, xml, grib and ASCII are mentioned.
- Daily data delivery should be before 6am.
- access to meteorological parameters (ECMWF forecasts and reanalyses)
- hourly to three-hourly time resolution
- spatial resolution of a few tens of kilometres (50 x 50 km² or better)
- Good and complete description of the dataset and of what observations were assimilated in order to be able to identify independent observations for model validation.
- Coverage of Iceland and Turkey (total) for EEA tasks.

3.2.4.3 Access mode requirements

- FTP (pull) access for both, routinely delivery and manual archive access
- data exchange agreements to fall within existing decision making frameworks rather than as separate project specific stand-alone bilaterals

3.2.4.4 Excepted frequency of use

- daily for NRT and forecast products
- occasional access to archived reanalysis products

3.2.4.5 General expectations for the services / benefits

- boundary conditions for finer resolved (local) modeling
- Continuity of PROMOTE / MACC services is a key requirement.
- MACC services can provide even better and more accurate AQ forecasts.
- MACC services can be used for evaluation of mesoscale and statistical air quality models as well as for boundary conditions in these models.
- One consistent dataset for the domain of Europe which serves as a basis for reliable and high-quality air pollution studies, decreasing the workload for data transformation, the exploration of new data sources and the maintenance of a number of different datasets and thus giving more time for research.
- Analysis of the wider exchange and use of NRT data on atmospheric composition in Europe.
- Access to NRT AQ data has been a major issue in the GMES process during the last years. Through the research GEMS and PROMOTE projects, significant efforts have been laid down in making data from national environmental agencies and research networks available in a suitable format and timely delivered. The ambition has been to assimilate such surface observations into operational modeling systems in order to improve analysis and forecast of AQ, and to use NRT data for NRT evaluation of model performances. Up to now, the NRT AQ data are mainly used for verification of model output in the GEMS and PROMOTE projects.
- The GEMS project has also set up a web page showing an overview of data (ozone, NO₂, SO₂, CO and PM₁₀) at the European scale. This page is showing partly the same information as the EEA ozone web, but there is data from different countries/regions in the two systems. Neither of the systems have access to all data. Best would be the systems would merge into one common environment holding all data.
- In MACC, NRT data is to be used not only for validation but for data assimilation, that is, to produce better air quality forecast and analysis over Europe and the globe.

3.2.4.6 use of services in every day work

- operational AQ forecasting, alerts and information and occasional assessments and episode analysis
- monitoring of respiratory risks: effective intervention for targeted population
- The results of the services are used (together with our own AQ forecasts) at IRCEL-CELINE in the daily smog warnings procedures.
- Emission data as well as initial / boundary conditions will be used as input data for quasi-operational air quality simulations on European scale. Additionally, the data will serve as input for research projects.

3.2.4.7 Documentation requirements

- description of each product delivered
- data format and model description
- documentation of the model grid setup
- validation procedure should be documented and published regularly (e.g. annual)
- Should follow TCCCA rules: Transparent, Consistent, Complete, Compatible and Accurate. Products (and results) need to be proven by peer reviewed articles. Documentation on data and correction history is needed. Documentation on all levels of uncertainties (images, analysis, calculations, etc.) is needed per product.

3.2.4.8 Validation requirements

- quick looks of validation scores
- quality flag and uncertainty information should be delivered within the data
- forecast must be reasonable estimate of outdoor pollutant exposure
- daily validation graphs for the air quality forecasts for day-1 and the measurements from day-1 for the representative measuring locations
- High resolution of the model data to distinguish between rural, urban, or suburban environments traditionally covered by air quality observation networks.

3.2.4.9 Training requirements

- e-training
- hotline for questions
- workshops with the explanation on the MACC model results and other products

3.2.4.10 Suggestions for service extensions / new services

- quick looks of meteorological parameters and emissions
- access to the TNO emission inventory (Europe)
- patient questionnaires
- More important than extensions or new services is that services become operational, are sustained in the long term and are well coordinated with the existent European policy structure.

3.2.4.11 End users of intermediate service providers

- citizens, public authorities, local AQ monitoring networks, researchers, general public, health services and environmental consultants

3.2.5 Solar radiation and UV

3.2.5.1 Lessons learned from PROMOTE or GEMS?

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3.2.5.2 Key technical requirements

- online netCDF(4) and ASCII data files access in near-real time
- maps of UV and solar radiations
- naming convention for daily files

3.2.5.3 Access mode requirements

- FTP (pull) access for both, routinely delivery and manual archive access
- daily product delivery at 01:00UTC

3.2.5.4 Excepted frequency of use

- daily for NRT and forecast products
- occasional access to archived reanalysis products

3.2.5.5 General expectations for the services / benefits

- Provision of high quality data for operational use in further applications (UVI forecasts)

3.2.5.6 use of services in every day work

-

3.2.5.7 Documentation requirements

- description of the methods used to derive products
- data format and model description
- documentation of model inputs, process, outputs and validation
- summary of quality analyses
- short “data access” manual including conditions of use
- link (email) to the responsible person or “principal investigator” for each product
- Should follow TCCCA rules: Transparent, Consistent, Complete, Compatible and Accurate. Products (and results) need to be proven by peer reviewed articles. Documentation on data and correction history is needed. Documentation on all levels of uncertainties (images, analysis, calculations, etc.) is needed per product.

3.2.5.8 Validation requirements

- validation report for each product
- quality flag and uncertainty information should be delivered within the data
- continuous quality control

3.2.5.9 Training requirements

- online access to the “user cases”
- online documentation

3.2.5.10 Suggestions for service extensions / new services

- increase of the spatial resolution of the global datasets
- information about form of services, availability, conditions of the use of datasets in the future

3.2.5.11 End users of intermediate service providers

- industrial and individual users in the PV sector

3.3 Detailed list of specific requirements

The following lists of requirements broken down into sections (technical, data policy, data access) serves as baseline to derive formalized service specifications and trace requirements back to the originating user (group).

3.3.1 Technical

| Number | Requirement | Service | Originator |
|---------------|--|-------------------------|-------------------|
| T1 | All data products shall be available in netCDF(4) format (data files). | all | multiple |
| T2 | Aerosol and O ₃ forecast data shall be provided in ASCII format. | aerosol, reactive gases | several |
| T3 | Meteorological (ECMWF) data should be provided to service users. | all | several |
| T4 | Quick looks of the produced data are appreciated. | All | multiple |
| T5 | Quick looks of emissions and meteorological data shall be generated. | All | several |
| T6 | Aerosol products shall include all aerosol species separately together with total optical depth and PM2.5. | aerosol, European AQ | several |
| T7 | Aerosol products (Europe) shall contain PM2.5 by aerosol species. | aerosol, European AQ | ADEME |
| T8 | Aerosol products shall include single scattering albedo. | aerosol | DWD |
| T9 | For aerosol products (global) the resolution shall be better than 1.25° (GEMS products). | aerosol | GeoModel |
| T10 | For aerosol products (Europe) the resolution shall be few tens of km. | aerosol | VITO |

| | | | |
|------------|---|------------------------|-----------------|
| T11 | Aerosol products shall be available on an hourly to 3-hourly resolution. | aerosol | VITO |
| T12 | Daily data delivery should be before 6am for aerosol products | aerosol | multiple |
| T13 | Daily data delivery should be before 6am for reactive gases products. | reactive gases | multiple |
| T14 | Daily data delivery should be before 6am for European AQ data. | European AQ | multiple |
| T15 | Daily data delivery shall be at 01:00 UTC for European O ₃ data. | reactive gases | DWD |
| T16 | Daily data delivery shall be at 01:00 UTC for global aerosol data. | aerosol | DWD |
| T17 | Aerosol products shall be available in NRT and by archive access. | aerosol | multiple |
| T18 | Radiation products shall be available in NRT and by archive access. | solar radiation and UV | GeoModel |
| T19 | The spatial resolution of global products shall be increased. | all | GeoModel |
| T20 | For every product delivered a short product description shall be available. | all | multiple |
| T21 | For every dataset a data format description shall be available. | all | multiple |
| T22 | For every model used in the data production a (short) model description shall be available. | all | several |
| T23 | For every model inputs, process, outputs and validation shall be described for a better understanding of the results. | all | Univ. Leicester |

| | | | |
|------------|--|-----|----------|
| T24 | For every product a validation report shall be available. | all | multiple |
| T25 | Quality / validation flags shall be included into the data. | all | several |
| T26 | An uncertainty measure (error) shall be shipped with the data. | all | GeoModel |
| T27 | Quick looks of validation scores shall be available on the web. | all | ADEME |
| T28 | A mailing list for the announcement of releases of new reports / deliverables shall be created instead of only a “news” section on the MACC webpage. | all | ADEME |
| T29 | Coverage of Iceland and Turkey (total) for EEA tasks. | all | EEA |

Tab. 1: Specific technical requirements

3.3.2 Data Policy

| Number | Requirement | Service | Originator |
|---------------|--|----------------|-------------------|
| DP1 | A short “data access manual” including the conditions of use shall be available on the MACC webpage. | all | GeoModel |
| DP2 | A link (email) to the responsible person or “principal investigator” for each product shall be available. | all | GeoModel |
| DP3 | Services, availability and conditions of the use of datasets in the future shall be described concisely, so that the users can plan development of value added services. | all | GeoModel |

Tab.2: Specific data policy requirements**3.3.3 Data Access**

| Number | Requirement | Service | Originator |
|---------------|--|------------------|-------------------|
| DA1 | Aerosol products shall be accessible by ftp pull. | aerosol | multiple |
| DA2 | Reactive gases products shall be accessible by ftp pull. | reactive gases | multiple |
| DA3 | European AQ products shall be accessible by ftp pull. | European AQ | multiple |
| DA4 | Radiation products shall be accessible by ftp pull. | radiation and UV | several |
| DA5 | Good availability and connectivity (e.g. in the case of several users) must be maintained. | All | several |

| | | | |
|------------|---|--------------------------------------|----------|
| DA6 | Aerosol, reactive gases and European AQ data shall be accessible by routine delivery and manual access to the data archive (ftp dynamic enquiry). | aerosol, reactive gases, European AQ | multiple |
| DA7 | A hotline for questions on data access issues would be appreciated. | all | ADEME |

Tab.3: Specific data access requirements

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