



GSE - PROMOTE-2
IAQ – Product Specification

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GMES SERVICE ELEMENT
PROMOTE2

Product Specification

Integrated Air Quality Service

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List of abreviations

3DVAR	three-dimensional variational data assimilation
CHIMERE	IPSL/LISA CTM
CTM	Chemistry Transport Model
DLR	German Aersospace Center
EMEP	cooperative programme for monitoring and evaluation of long-range transmission of air pollutants in Europe
EPA	Environmental Protection Agency
EURAD	EUROpean Air pollution Dispersion model
FMI	Finish Meteorological Institute
HDF	hierarchical data format
IAQ	intgrated air quality (platform)
INERIS	Institut National de l'Environnement industriel et des RISques
IPSL	Institut Pierre Simon Laplace
LISA	Laboratoire Interuniversitaire des Systèmes Atmosphériques
LOTOS	long term ozone simulation
MERIS	medium resolution imaging spectrometer
Météo-France	French Meteorological Office
MOCAGE	Meteo-France CTM
NRT	Near Real Time
OI	optimal interpolation
OL	offline
OMF	Observation Minus Forecast
PM	Particulate Matter
RIU	Rhenish Institute for Environmental Research at the Univ. of Cologne

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1. INTRODUCTION

European integrated air quality analyses and forecasts

The Integrated air quality Service aims at providing numerical air pollutant forecasts and near real time maps throughout Europe, for regulatory atmospheric pollutants. Ozone, nitrogen dioxide and Particulate Matter will be mainly concerned. This service is based on the results of simulations issued from chemistry-transport models (CTM) run at the European scale. Observation fields from in-situ measurement networks and from satellite retrievals (when available) are used to improve the numerical fields following an a posteriori procedure (analyzed maps) or in forecast mode.

This service will bring technical elements to answer authorities and public expectations related to air quality. Indeed, the citizens feel more and more concerned by the state of the environment and the atmospheric pollution is one of the most sensitive topics. The graphic products issued from the service will help to enhance comprehension and anticipation of pollution events. This is also of high interest for the authorities in charge of air quality management. Supporting the implementation of the thematic Strategy for Air Pollution (CAFE), the European Environment Agency (EEA) builds air quality databases for Europe gathering observations. The integrated air quality service will propose relevant and consistent information to fill these databases with spatialised fields of air pollution issued from numerical treatments. Need for near real time data raises also at the national and local levels to anticipate strong pollution episodes and the effect of potential control measures. This can allow a better management of these events. The integrated Air quality platform gives a relevant approximation of the pollutants concentration fields which could be used either in state to diagnose the air pollution situation or as input data of local scale models for higher resolution simulations.

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2 SERVICE OVERVIEW

2.1 Introduction

Building an integrated platform to provide in an operational daily way, information related to air quality, implies that several components have to be developed.

1. Compilation of observation data. In-situ measurements issued from official monitoring networks are widespread throughout the whole of Europe, but still need to be gathered and consistently compiled to feed the service. Availability of 3-dimensional data (radiosondes, LIDARs networks, aircraft measurements..) is increasing and this new type of information needs also to be considered.
2. Compilation of satellite retrievals and implementation of their appropriate treatment to allow their use to deal with the service purposes.
3. Provision of operational chemistry transport models runs, on a daily basis, simulating up to three days forecasts of ozone, nitrogen dioxide and PM concentrations, and maps of the D-day and the day before corrected with the observations (compiled at the sublevels 1 and 2).
4. Integration of the model runs in a common platform; uncertainty analysis and feasibility study for providing "ensemble" outputs (only one result issued from a combination of different models results). In a first stage three models will be included in the service (those which have demonstrated to be operational in PROMOTE stage 1) and at the end of the project, five models should be concerned.

2.2 Service structure

- 1- **Compilation of in situ- data.** Air quality monitoring networks are differently managed different depending on the country. In some cases, their implementation is totally centralised and put under the supervision of national organizations: environment agencies, national weather services, research institutes... In other cases, local organisations are responsible for the network in geographically limited areas. In these cases the national level can interfere or not to insure the consistency of the data throughout the country. These data are crucial to evaluate numerical models, to improve forecasts and to provide a posteriori analysed maps, but they are difficult to compile because of their variety. The partners involved in the service have their own contacts to get, generally partly and at least in their own country, some in-situ data. A compilation work will be done to build a relevant database for the service. Partnership with the European Environment Agency needs to be established to access to the air quality databases they process.

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- 2- Compilation of satellite data.** Satellite retrievals are provided by some partners of the service for nitrogen dioxide and PM. These data however need to be processed to be correctly interpreted by the models, and if possible used in an operational way. Exchanges between the satellite community and the modellers are still needed to specify the nature of the expected satellite products. This is the first stage of this step, followed by the implementation of routines in the air quality models devoted to the assimilation of satellite data (if possible). Assimilation to inverse emission and improve data provided by the emission inventories should be a relevant application. Available earth observation data will be used to evaluate the model results. The relevance of assimilating satellite retrievals for air quality forecasting and analysis will be assessed by the modelling teams, but no product is defined with this topic.
- 3- Provision of air quality model results.** At the end of the project, five models will run in an operational way to provide ozone, nitrogen dioxide and PM concentration fields throughout Europe with a 50km*50km resolution. Comparison of the model results to observations will ensure the relevance of the simulations and will help to build users' confidence. Intercomparison of the model results is also necessary to assess the range of variability of the outputs, which can be seen as a part of the modelling uncertainty. This task, involving all the modelling teams, is necessary to define consistent fields of input data, to choose the relevant outputs and to interpret the differences that will be found.
- 4- Integration of the results in a common platform.** The added value of the service is to give the opportunity to the users to get reliable information about air quality, issued from several models and from available observation datasets. However a significant effort is needed to develop such a consistent approach, which should also comply with the users requirements. Specific study to assess the relevance of different "ensemble" approaches is planned. The graphic outputs (the maps) as well as the numerical fields will be available on the platform for downloading. The integrated platform providing air quality forecasts and analyses, as an ensemble result is the final product of the service.

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3 PRODUCT SPECIFICATION

3.1 Introduction

This chapter provides the specification of all products in the integrated air quality service. One product generally contains one parameter; only when several parameters are simultaneously generated on equal grids by one generation system, more parameters are collected in one product.

The following tables summarize the integrated air quality service products. Each product has been assigned a unique identifier to assure clear referencing; the identifier is also given in the table.

Necessary input data such as satellite reflectances and spectra (level 1) and synoptic geophysical parameters in satellite projection (level 2) or ground-based in situ data and meteorological fields are treated as input which will not be specified in this document. These input data will be listed in the product specifications and described in more detail in document C10 "Data Sources Inventory".

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Integrated air quality Service	
Service description name	
<p>Long-term strategy: Elaborate a European network of slyill and experience to provide operational air quality forecasts and analysesof groud level pollutant concentrations in Europe Availability: 2008 for the first results Stage 2 goal: forecasts and analysed maps of ozone, nitrogen dioxide and PM throughout Europe with a 50km*50km resolution Users: AIRPARIF, EEA, Helsinki Concil</p>	
Product acronym	Product name
IAQ-forecasts-GSE-PRO2	Integrated Air quality forecasts in Europe
IAQ-analyses-GSE-PRO2	Integrated Air quality analyses in Europe

Table 3.1-1: List of products in the IAQ service

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3.2 Specification of the Products of the IAQ Service

3.2.1 Product 1 : IAQ-forecasts-GSE-PRO2

Up to two-days air quality forecasts throughout Europe, computed with chemistry-transport models with a 50km*50km resolution are available on a daily basis. They results from three model runs (in a first stage) which have been evaluated in a forecast mode for several years. In a second stage (year 2 and 3) two additional models will be incorporated. These results are combined in such a way that only one “ensemble output” is provided by the service. Ozone, nitrogen dioxide and PM are the pollutants concerned with this product.

The IAQ service will be based on the following ingredients:

1) Input data

- Air emission data issued from the EMP emission inventoy (www.emep.int)
- Meteorological forecasts provided by meteorological models (closely linked to each chemistry-transport model)
- Land use description
- In-situ observation data

2) Models involved

- EURAD (RIU) – 1st stage
- CHIMERE (CNRS/INERIS) – 1st stage
- MOCAGE (Météo France) – 1st stage
- LOTOS-EUROS (TNO) -2nd stage
- SILAM (FMI) – 2nd stage



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Product description	
Summary	Near surface air pollutant concentration forecasts throughout Europe (O3, NO2, PM)
Product properties	
Parameter(s)	Ground level concentrations of ozone, nitrogen dioxide and particulate matter
Accuracy	To be defined
Geometric resolution	30km to 50km
Grid / projection	Latitude/longitude
Spatial coverage	Europe
Temporal coverage	Daily forecasts for the D-day, D+1 and D+2
Data format	Maps (gif, jpg) and numerical data (binary)
availability	Daily operational
Production Process	
Method/algorithm	Ensemble forecasts based on 3 to 5 chemistry-transport models results
Model / assimilation	Assimilation of in-situ-data (pollutant concentrations) for intialistion of the forecasting process
reference	
Quality standards	
Production	Applied for each model independently and common procedure for the whole ensemble
Product	Difference between the ensemble forecasts and the measurements
Validation	Statistical analysis of the difference between the forecasts and the measurements
Input data	
EO data	- SYNAER PM data (for evaluation) - MODIS fire product (for SILAM)
Other data	-Emission data : EMEP emission inventory

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	<ul style="list-style-type: none"> - land use data - meteorological forecasts issued from different models dependinf on the CTM configuration : ECMWF, HIRLAM, ARPEGE, AVN, MM5 - in-situ O3, NO2 and PM data (for validation)
Optional or other specific properties (if applicable)	
Historical archive	Archived model applications since 2003 Database of forecasts since Summer 2007
Offline/NRT	Offline for the archives and NRT for the forecasts
Visualization standards	To be defined
Underlying primary user requirement(s)	
Key requirement	<ul style="list-style-type: none"> - ensemble: daily maps of concentrations over Europe, - boundary conditions for downstream services, - time series for the monitoring stations
Originator(s)	Public, EEA, National Environment Agencies

Table 3.2-1: Characteristics of the IAQ-forecasts-GSE-PRO2 product

3.2.2 Product 2 : IAQ-analyses-GSE-PRO2

Ozone and PM concentration analyzed maps are provided throughout Europe on a daily basis. These maps are computed with chemistry-transport models run with a 50km*50km resolution. They results from three model runs (in a first stage) which have been evaluated for several years. In a second stage (year 2 and 3) two more models will be incorporated. So-called analysed-maps mean that the simulations are corrected assimilating observation data to improve the representation of the pollution patterns. These results are combined in such a way that only one “ensemble output” is provided by the service. The product is focused on ozone, because of the availability of a dense measurement network, but a feasibility study is also proposed for PM .

The IAQ service will be based on the following ingredients:

1) Input data

- Air emission data issued from the EMP emission inventoy (www.emep.int)
- Meteorological forecasts provided by meteorological models (closely linked to each chemistry-transport model)



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- Land use description
- In-situ observation data
- EO data if available with a relevant space and time resolution

2) Models involved

- EURAD (RIU) – 1st stage
- CHIMERE (CNRS/INERIS) – 1st stage
- MOCAGE (Météo France) – 1st stage
- LOTOS-EUROS (TNO) -2nd stage
- SILAM (FMI) – 2nd stage

Product description	
Summary	Near surface air pollutant concentration analyses throughout Europe (O3, PM tentatively)
Product properties	
Parameter(s)	Ground level concentrations of ozone and particulate matter
Accuracy	To be defined
Geometric resolution	30km to 50km
Grid / projection	Latitude/longitude
Spatial coverage	Europe
Temporal coverage	Daily
Data format	Maps (gif, jpg) and numerical data (binary)
availability	Daily operational
Production Process	
Method/algorithm	Ensemble based on 3 to 5 chemistry-transport models results
Model / assimilation	NRT assimilation of in-situ-data (pollutant concentrations) for correcting the simulation (ground level air quality monitoring network) Assimilation of EO if available and relevant

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reference	
Quality standards	
Production	Applied for each model independently and common procedure for the whole ensemble
Product	Difference between the ensemble forecasts and the measurements with a selection of data non use in the assimilation, cross-validation
Validation	Statistical analysis of the difference between the forecasts and the measurements, cross-validation
Input data	
EO data	<ul style="list-style-type: none"> - SYNAER PM data (for evaluation) - MODIS for fire products (for SILAM)
Other data	<ul style="list-style-type: none"> - Emission data : EMEP emission inventory - land use data - meteorological forecasts issued from different models depending on the CTM configuration : ECMWF, HIRLAM, ARPEGE, AVN, MM5 - in-situ O3, and PM data (for assimilation and validation)
Optional or other specific properties (if applicable)	
Historical archive	Archived model applications since 2003 Database of analyses since Summer 2007
Offline/NRT	Offline for the archives and NRT for the analyses
Visualization standards	To be defined
Underlying primary user requirement(s)	
Key requirement	<ul style="list-style-type: none"> - ensemble: daily maps of concentrations over Europe including observations, - boundary conditions for downstream services, - time series for the monitoring stations
Originator(s)	Public, EEA, National Environment Agencies

Table 3.2-2: Characteristics of the IAQ-analyses-GSE-PRO2product

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