



GSE – PROMOTE 2

C6 Validation Report

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TITLE:

GMES SERVICE ELEMENT PROMOTE 2

C6 Validation Report

**INTEGRATED AIR QUALITY SERVICE
Version 1**



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C6 Validation Report
Integrated AQ

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LIST OF ACRONYMS

3DVAR	three-dimensional variational data assimilation
CHIMERE	IPSL/LISA/INERIS CTM
CTM	Chemistry Transport Model
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
HDF	hierarchical data format
INERIS	Institut National de l'Environnement industriel et des RISques
IPSL	Institut Pierre Simon Laplace
KNMI	Royal Netherlands Meteorological Institute
LISA	Laboratoire Interuniversitaire des Systèmes Atmosphériques
LOTOS-EUROS	LOng Term Ozone Simulation – EUROpean Operational Smog model
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
TNO	Netherlands Organisation for Applied Scientific Research

N/A	Not Available
n.a.	not applicable
n.s.	not specified

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1 INTEGRATED EUROPEAN AIR QUALITY ANALYSIS AND FORECAST

1.1 Service Summary

This service provides forecasts and analyzed maps of air pollutants concentration throughout Europe. Ground level concentrations of ozone, nitrogen dioxide and particulate matter simulated by numerical models with a near 50km*50km resolution are available. The results are issued from several chemistry-transport models widely validated. The final products result from an ensemble approach allowing the best modelling result from a combination of different models. Up to two days forecasts are provided. The so-called analyzed maps are issued from simulations, corrected assimilating in-situ observations. They are daily available using near-real time measurement data. Daily updates will be envisaged.

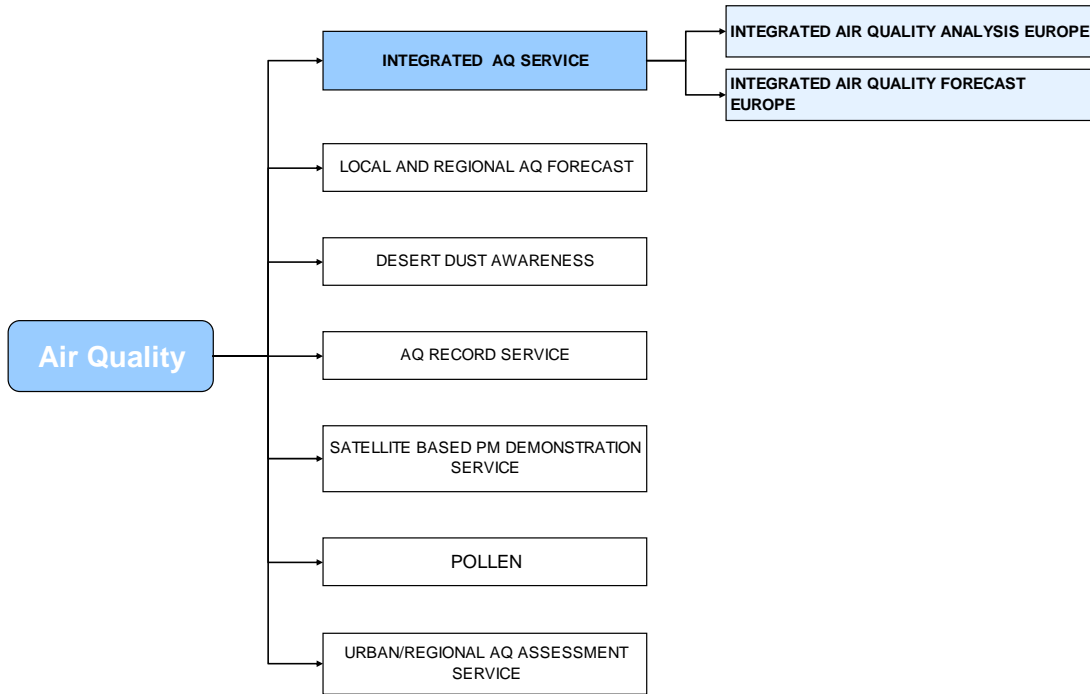


Figure 1.1-1 Structure and position of the Integrated European AQ Analysis and Forecast Service within PROMOTE 2 Air Quality.

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1.2 Product characterization

O3	
Parameter	concentration
Typical range	20-360
Determination of the typical range (Method, criteria)	Regulatory monitoring with in-situ measurement stations
Units	$\mu\text{g}/\text{m}^3$
<i>Standards</i>	<i>European Directive on ambient ozone- 12/02/2002- 2002/03/CE</i>
NO2	
Parameter	Concentration
Typical range	10-500
Determination of the typical range (Method, criteria)	Regulatory monitoring with in-situ measurement stations
Units	$\mu\text{g}/\text{m}^3$
<i>Standards</i>	<i>European Directive on atmospheric limit values for SO2, NOx, NO2, PM10 and Pb- 22/04/1999 – 1999/30/CE</i>
PM	
Parameter	Concentration
Typical range	10-300
Determination of the typical range (Method, criteria)	Regulatory monitoring with in-situ measurement stations
Units	$\mu\text{g}/\text{m}^3$
<i>Standards</i>	<i>European Directive on atmospheric limit values for SO2, NOx, NO2, PM10 and Pb- 22/04/1999 – 1999/30/CE</i>

Table 1.2-1 Characterization of the Integrated AQ Analysis products

1.2.1 Validation plan and validation data

The results issued from the Integrated Air Quality platform are model outputs (forecasts) or model outputs assimilating observation data (analyses). The results of the individual models involved will be evaluated as well as the ensemble results that should integrate in

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a relevant way each model contribution. It is expected that the ensemble will be more reliable than its individual components.

All the results will be evaluated against observation data fields issued from in situ and satellite measurements. A basic description of the validation datasets is given in Table 1.2-2.

VALIDATION DATA	
Ground based observations	
AIRBASE	<p><i>Data availability and access:</i> free ; validated database managed by the European Environment Agency which gather measurements from regulatory networks (http://air-climate.eionet.europa.eu/databases/airbase/)</p> <p><i>Spatial coverage and resolution:</i> EU 25; resolution depends on the pollutants and the country</p> <p><i>Temporal coverage and resolution:</i> hourly or daily values depending on the pollutant updated on an annual basis</p> <p><i>Location(s) (coordinates):</i> N/A</p> <p><i>Accuracy:</i> in line with the accuracy asked by the Directives</p>
EMEP	<p><i>Data availability and access:</i> free ; validated database managed by the Chemical Co-ordinating Centre of EMEP (http://www.nilu.no/projects/ccc/index.html)</p> <p><i>Spatial coverage and resolution:</i> Europe; resolution depends on the pollutants and the country</p> <p><i>Temporal coverage and resolution:</i> hourly or daily values depending on the pollutant updated on an annual basis</p> <p><i>Location(s) (coordinates):</i> N/A</p> <p><i>Accuracy:</i> in line with the accuracy set by the EMEP monitoring strategy</p>
EUSAAR	<p><i>Data availability and access:</i> data to be asked to the EUSAAR coordination</p> <p><i>Spatial coverage and resolution:</i> EU 25; 1 to 2 super sites by country</p> <p><i>Temporal coverage and resolution:</i> hourly or daily values depending on the pollutant characteristics monitored</p> <p><i>Location(s) (coordinates):</i> http://www.eusaar.net/download/eusaar_leaflet.pdf</p> <p><i>Accuracy:</i> N/A</p>
OzoneWeb	<p><i>Data availability and access:</i> non validated near real time ozone data gathered and managed by the European Environment Agency</p> <p><i>Spatial coverage and resolution:</i> EU 25</p> <p><i>Temporal coverage and resolution:</i> hourly or daily values</p> <p><i>Location(s) (coordinates):</i> N/A</p> <p><i>Accuracy:</i> N/A</p>
NRT networks in the EU countries	<p><i>Data availability and access:</i> to be discussed with the national bodies in charge of the air quality networks management. Near real time data are not validated or partially validated data. Formal contacts for Germany, Finland, France, and</p>

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	Italy. Spatial coverage and resolution: EU25 Temporal coverage and resolution: hourly or daily Location(s) (coordinates): N/A Accuracy: N/A
<i>In-situ observations</i>	
GALION	<i>GAW Aerosol Lidar Observation Network</i> <i>Contacts still need to be established</i>
EARLINET	<i>Data availability and access:</i> aerosol LIDAR network established within the FP5 program (http://www.earlinetasos.org/). Data availability still needs to be checked <i>Spatial coverage and resolution:</i> almost 25 sites <i>Temporal coverage and resolution:</i> to be checked <i>Location(s) (coordinates):</i> N/A <i>Accuracy:</i> N/A
EO Data	
MERIS	Data availability and access: MERIS Aerosol are available 7/7 days on the ACRI ftp server (restricted access to PROMOTES users UBA and UIBK) Spatial coverage and resolution: 1km Temporal coverage and resolution: <ul style="list-style-type: none"> o NRT: track, daily and 3 days composite o Archive: monthly, yearly Location(s) (coordinates)/computational domain: Austria: 8E-20E , 44-50N Accuracy: N/A
SYNAER	Data availability and access: NRT (12hrs.) through PROMOTE-2 web portal Spatial coverage and resolution: MSG FOV, 60x30 km ² pixels Temporal coverage and resolution: since 672005 + parts of 2003 and 2004 Location(s) (coordinates)/computational domain: http://wdc.dlr.de and http://gse-promote.org Accuracy: AOD ~ 0.1, speciation TBD
PARASOL	<i>Description available in a future version</i>

Table 1.2-2 Data used /that will be used for the validation of the Integrated AQ Service products

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Statistical indicators such the bias, the root mean square error, the correlation factor or the ratio of the modelled and observed variances will be computed. Two kinds of validation will be performed:

- A near real time evaluation using the near real time observation data that are daily available
- A posteriori evaluation, every six months, using official validated datasets. Generally those datasets are available with a determined frequency which could be quite low, so six months to proceed to the validation against validated data should be a relevant periodicity. It will be adjusted depending on data availability.

1.2.2 Validation of individual components

Air quality forecasts and analyses provided by the IAQ platform will be validated in two steps:

- A near real time procedure will evaluate model results (individual models and ensemble) against a set of in-situ data (Ozone-Web, NRT national data, Lidar networks). Considering the near real time constraints these data are not validated and the validation procedure could show disappointing results because of non-reliable measurement data. However not validated data are generally quickly corrected by the organisations in charge of the air quality monitoring networks so that the model performances should also be quickly corrected. Near real time model evaluation “on line” will also be one of the communication tool linked to the platform.
- Model validation against validated data field will be performed every 6 months. All the data available (ground level, 3D, columns) will be used to deal with this objective. Evaluation reports compiling the validation scores will be provided by the service.

Model validation process is based on the calculation of statistical scores against observations. The modelling teams to compute the model results at the measurement sites location will implement a spatial interpolation procedure. The typical indicators that will be calculated are:

- The bias ($\mu\text{g}/\text{m}^3$): average of the absolute differences between model results and observation. It helps to characterise the good fit between the mean values.
- The Root mean square error (RMSE): helps to characterise the good fit between observed and modelled mean values without bias effect.
- The correlation coefficient: The higher the correlation - a number between -1 and 1, with no dimension - the better the model reproduces the temporal variations of the observations.
- The ratio of the modelled and observed variances.

For the forecast products related to pollutants with regulatory threshold values it will be interested to compute “contingency tables” which estimate the percentage of good predictions, of false alerts and of missing events



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VALIDATION OF INDIVIDUAL COMPONENTS

Data quality

In-situ data (identification of outliers, uncertainty...)

In situ ground level data (AIRBASE, EMEP) characterised by quality objectives fixed by the European Directives :

- For SO₂, NO₂, NO_x, CO : uncertainty 15%
- For benzene :uncertainty 25%
- For PM₁₀, PM_{2.5} and lead : uncertainty 25%
- For ozone and related NO and NO₂ : uncertainty 15%

EO Data (identification of outliers, bad retrievals, uncertainty...)

Still need to be defined for the purpose of the IAQ

MODELS/ASSIMILATION

NRT Assimilation of in-situ data

In situ NRT ground level data characterised by quality objectives fixed by the European Directives (although not validated) :

- For SO₂, NO₂, NO_x, CO : uncertainty 15%
- For benzene :uncertainty 25%
- For PM₁₀, PM_{2.5} and lead : uncertainty 25%
- For ozone and related NO and NO₂ : uncertainty 15%



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EURAD Inverse
Modelling Version 4.2
Individual daily evaluation

Based on previous evaluation procedures:

$$\text{BIAS} = \sum_i C_{\text{mod},i} - C_{\text{obs},i}, \text{RMSE} = \sqrt{\frac{\sum_{i=1}^N (C_{\text{mod},i} - C_{\text{obs},i})^2}{N}}$$

Against ground-based in-situ data (in [$\mu\text{g}/\text{m}^3$]):

SO₂: -2 to 0.5 (BIAS), < 5 (RMSE)

NO₂: -5 to 3 (BIAS), < 10 (RMSE)

NO: -15 to 5 (BIAS), < 20 (RMSE)

O₃: -2 to 2 (BIAS), < 5 (RMSE)

CO: -80 to 40 (BIAS), < 150 (RMSE)

PM10: -10 to 2 (BIAS), < 20 (RMSE)

Against SCIAMACHY/GOME NO₂ column retrievals (by KNMI in [10^{15} molec/cm²]):

GOME: -0.5 to 0.2 (BIAS), < 2 (RMSE)

SCIAMACHY: -1.0 to 0.4 (BIAS), < 3 (RMSE)

References: (see Section *References*)

CHIMERE V200501H
Individual daily evaluation

A priori constraints defined by previous evaluation procedures :

-Bias : -2.5 to 5 $\mu\text{g}/\text{m}^3$ (daily ozone peak), 7 to 18 $\mu\text{g}/\text{m}^3$ (hourly ozone average), -6 $\mu\text{g}/\text{m}^3$ (daily NO₂ average), -6 to -2 $\mu\text{g}/\text{m}^3$ (daily PM10 average),

-RMSE : 17 to 20 $\mu\text{g}/\text{m}^3$ (daily ozone peak), 25 to 30 $\mu\text{g}/\text{m}^3$ (daily ozone average), 8 to 20 $\mu\text{g}/\text{m}^3$ (daily NO₂ average), 8 to 14 $\mu\text{g}/\text{m}^3$ (daily PM10 average),

- Correlation coefficient : 0.8-0.9 (daily ozone peak), 0.7-0.75 (daily ozone average), 0.4-0.5 (daily NO₂ average), 0.3 to 0.6 (daily PM10 average),

- Variability: 0.8-0.9 (daily ozone peak), 0.7-0.8 (daily ozone average), 0.8 to 1.2 (daily NO₂ average), and 0.8 to 1.0 (daily PM10 average).



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	$\text{Bias} = \sum_i C_{\text{mod},i} - C_{\text{obs},i}$ $\text{RMSE} = \sqrt{\frac{\sum_{i=1}^N (C_{\text{mod}} - C_{\text{obs}})^2}{N}}$ $\text{Corr} = \frac{\sum_{i=1}^N (C_{\text{mod}} - \overline{C_{\text{mod}}})(C_{\text{obs}} - \overline{C_{\text{obs}}})}{\sqrt{\sum_{i=1}^N (C_{\text{mod}} - \overline{C_{\text{mod}}})^2} \sqrt{\sum_{i=1}^N (C_{\text{obs}} - \overline{C_{\text{obs}}})^2}}$ $\text{VAR} = \frac{\sigma_{\text{mod}}}{\sigma_{\text{obs}}}$
<p>MOCAGE_03082006 Individual daily evaluation</p>	<p>A priori constraints defined by previous evaluation procedures:</p> <p>Bias : 3-5 mg.m-3 (daily ozone peak), 7-10 mg.m-3 (hourly ozone), -5 mg.m-3 (daily NO2 peak, rural), -3 mg.m-3 (hourly NO2, rural).</p> <p>RMSE : 23-28 mg.m-3 (daily ozone peak), 26-30 mg.m-3 (hourly ozone), 10-12 mg.m-3 (daily NO2 peak, rural), 6-8 mg.m-3 (hourly NO2, rural).</p> <p>Correlation : 0.65-0.75 mg.m-3 (daily ozone peak), 0.65-0.75 mg.m-3 (hourly ozone), 0.3-0.4 mg.m-3 (daily NO2 peak, rural), 0.3-0.4 mg.m-3 (hourly NO2, rural).</p> <p>Variability : 0.8-0.9 (daily ozone peak), 0.6-0.7 (hourly ozone), 0.8-0.9 (daily NO2 peak, rural), 0.5-0.6 (hourly NO2, rural).</p>
	$\text{Bias} = \sum_i C_{\text{mod},i} - C_{\text{obs},i}$ $\text{RMSE} = \sqrt{\frac{\sum_{i=1}^N (C_{\text{mod}} - C_{\text{obs}})^2}{N}}$ $\text{Corr} = \frac{\sum_{i=1}^N (C_{\text{mod}} - \overline{C_{\text{mod}}})(C_{\text{obs}} - \overline{C_{\text{obs}}})}{\sqrt{\sum_{i=1}^N (C_{\text{mod}} - \overline{C_{\text{mod}}})^2} \sqrt{\sum_{i=1}^N (C_{\text{obs}} - \overline{C_{\text{obs}}})^2}}$ $\text{VAR} = \frac{\sigma_{\text{mod}}}{\sigma_{\text{obs}}}$

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<p>LOTOS-EUROS version 1.1.</p> <p>Individual daily evaluation</p>	<p>Boundary conditions from Logan climatology (ozone), measurements or TM3 model</p> <p>Initial conditions are an interpolation of boundary conditions or can be retrieved from a restart file</p> <p>Daily averaged NO2: correlation 0.4-0.5, RMSE 11 µg/m³, relative bias -27%, bias -3 µg/m³, and variability 0.77.</p> <p>Daily O3 peak: correlation 0.8, RMSE 20 µg/m³, bias -3 µg/m³, variability 0.95</p> <p>Daily averaged O3: correlation 0.7, RMSE 25 µg/m³, bias -4 µg/m³, variability 0.99</p> <p>PM10: correlation 0.6-0.7, Relative bias -30-40%,</p> <hr/> $\text{Bias} = \frac{\sum_{i=1}^N C_{\text{mod},i}}{N} - \frac{\sum_{i=1}^N C_{\text{obs},i}}{N}$ $\text{RMSE} = \sqrt{\frac{\sum_{i=1}^N (C_{\text{mod},i} - C_{\text{obs},i})^2}{N}}$ $\text{variability} = \frac{\sigma_{\text{mod}}}{\sigma_{\text{obs}}}$
<p>SILAM v.4.0.1 Individual daily evaluation</p>	<p>Evaluation of the new v.4.0.1 is on-going for a full list of chemicals. A priori preliminary scores defined by previous evaluation of SILAM v.3.8.1 for sulphur oxides. For specific values, see maps below.</p>
<p>Evaluation of models ensemble results</p>	<p>Evaluation of the ensemble model results will be started as far as the ensemble will be available (summer 2007). The statistical indicators used will be those described above for the individual models.</p>

Table 1.2-3 Validation of the individual components of the Integrated AQ Analysis Service

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1.3 Integrated AQ analysis for Europe

Description: Provision of operational chemistry transport models runs to build ensemble model re-analyses of ozone and PM (tentatively) in a near real time process.

Service is/will be operational since/after: operational in 2008

Research partners: -

Service validation contact: - Cecile Honoré (INERIS)

1.3.1 Validation against specifications and against user requirements

* Requirements written in *Italics* are only recommended and not compulsory for Phase 1.

VALIDATION AGAINST SERVICE SPECIFICATIONS			
No limitations/delays for compliance between theoretical and actual service specifications reported			
VALIDATION AGAINST USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	Ground level concentrations of O ₃ and PM (tentatively) with an ensemble approach		
Accuracy	n.s.	<i>30%</i>	minimum 50% target 30%
Spatial coverage	Europe	Austria (44N, 50N-8E, 20E) Europe	Austria (Lat 44°N-50°N; Lon 8°E - 20°E) Europe
Horizontal resolution	30x50 Km ²	<i>50x50 Km²</i>	50x50 Km ²
Vertical resolution	n.a.	n.a.	n.a.
Grid/Projection	Lat-long (UTM)	<i>UTM; Georeferenced</i>	Lat-long (UTM)
Temporal coverage	Since 2003	n.s.	No ensemble available
Temporal resolution	24 h	<i>24-1 h</i>	Hourly for O ₃ , daily for PM
Specific time resolutions	n.s.	Daily AOD data derived from MERIS Daily Alpha data derived from	Operational: (delivered by ftp 7/7)

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		MERIS Monthly and yearly mean AOD derived from MERIS Monthly and yearly mean Alpha derived from MERIS Daily high-resolution RGB images derived from MERIS	days)
User Interfaces			
PROMOTE Web	Complete, operational, up to date	Complete, operational, up to date	Operational by the end of June 2007
ftp	ACRI Server	n.s.	IAQ server operational in 2008
e-mail	n.s.	In case of interruptions or modifications	Operational on the IAQ server in 2008
Data formats and data delivery			
Data availability	Phase 1: 600 Mb Phase 2 and 3: 1 Tb	Phase 1: 600 Mb Phase 2 and 3: 1 Tb	Phase 1: 100Mb/day
Data access	n.s.	ftp (via ACRI Server)	ftp on each partner site
Delivery Mode	Analysis NRT	NRT	NRT on each partner' site
Delivery frequency	Daily	Daily	Daily on each partner' site
Data Format	Gif, jpg and binary	NetCDF; jpeg (RGB quicklooks)	Gif, jpg and binary (netCDF) on each partner site
Historical archive	Model applications since 2003; Database analysis since Summer 2007 on	n.s.	Model applications since 2003
Visualization	Maps	Daily colour Maps	Maps on each partner' site

* Requirements written in *Italics* are only recommended and not compulsory for Phase 1.

Table 1.3-1 validation against specifications and against user requirements for the AQ Analysis Service

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1.3.2 Quality Assessment and control procedures for the Integrated AQ Analysis

Service quality			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Quality checks	Daily evaluation of individual and ensemble results	n.s.	Daily evaluation of individual models results
Product confidence data	n.s.	95%	95% for each individual model
Error bar definition and representation	n.s.	<i>2 standard deviation; EURAD</i>	2 standard deviation for each individual model
Representation of missing data	n.s.	<i>Value <<0 (e.g. – 99.99); Interpolation; EURAD; colour white in maps.</i>	n.a. (no missing modelled data)
Documentation of process failure	n.s.	<i>E-mail indicating interruptions or modifications</i>	E-mail indicating interruptions or modifications on the PREV' Air system
Version control mechanisms and representation	n.s.	<i>Version number and last date of modification in background; EURAD.</i>	Version number and last date of modification in background for each individual model;

* Requirements written in *Italics* are only recommended and not compulsory for Phase 1.

Table 1.3-2 Quality assessment and control procedures for final products of the Integrated AQ Analysis sub-service

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1.4 Integrated Air Quality Forecast for Europe

Description: Provision of operational chemistry transport models runs to build an ensemble model, simulating up to three days forecasts of ozone, nitrogen dioxide and PM concentrations

Service is/will be operational since/after: 2008

Research partners: -

Validation contact: Cécile Honoré (INERIS)

1.4.1 Validation against specifications and against user requirements

* Requirements written in *Italics* are only recommended and not compulsory for Phase 1.

VALIDATION AGAINST SERVICE SPECIFICATIONS			
No limitations/delays for compliance between theoretical and actual service specifications reported			
VALIDATION AGAINST USER REQUIREMENTS			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Product	Ground level concentrations of O3, NO2 and PM		
Accuracy	N/A	n.s.	30% for ozone 50% for PM and NO2
Spatial coverage	Europe	Europe	Europe
Horizontal resolution	30x50 Km ²	<i>50x50 Km²</i>	50km x 50km
Vertical resolution	n.a.	n.a.	n.a.
Grid/Projection	Lat-long (UTM)	<i>UTM; georeferenced lat-long</i>	Lat-Long
Temporal coverage	Daily forecast 72 h	Daily forecast 48-72 h	Daily (for each individual model)
Temporal resolution	n.s.	<i>24-1 h</i>	Hourly to daily depending on the pollutant
User Interfaces			

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PROMOTE Web	n.s.	Operational, complete and up to date	Operational by the end of June 2007
Other Web Sites	n.s.	n.s.	www.prevail.org www.eurad.uni-koeln.de/ www.silam.fmi.fi
ftp	n.s.	n.s.	IAQ server operational in 2008
On demand	n.s.	n.s.	Operational on the IAQ server in 2008
Data formats and data delivery			
Data availability	Pollutant concentrations; ensemble forecast; uncertainty analysis	Pollutant concentrations; ensemble forecast; uncertainty analysis from 3 models	Pollutant concentrations from each individual model; statistical scores against measurements from 3 models
Data access	ftp and online (maps)	Freely available online	ftp on each partner site
Delivery Mode	NRT	NRT	NRT on each partner' site
Delivery frequency	Daily	Daily, <i>at 7 a.m.</i> (U.T)	Daily on each partner' site
Data Format	Maps (gif,jpg), binary	Maps and numerical	Gif, jpg and binary (netCDF) on each partner site
Historical archive	Summer 2007 on	n.s.	Model applications since 2003
Visualization	Maps GIF; plots for ensemble results evaluation	Daily colour Maps	Maps on each partner' site

* Requirements written in *Italics* are only recommended and not compulsory for Phase 1.

Table 1.4-1 Validation against specifications and against user requirements of the Integrated AQ Forecast sub-service

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1.4.2 Quality Assessment and control procedures for the Integrated AQ Forecast

* Requirements written in *Italics* are only recommended and not compulsory for Phase 1.

Service Quality			
SPECIFICATION	S5	REQUIRED*	ACTUAL
Quality checks	Daily evaluation of both individual and ensemble model results	<i>n.s.</i>	Daily evaluation of individual model results
Product confidence data	n.s.	<i>95%</i>	95%
Error bar definition and representation	n.s.	<i>2 standard deviation; EURAD</i>	2 standard deviation for each individual model
Representation of missing data	n.s.	<i>Value <<0 (e.g. – 99.99); Interpolation; EURAD; colour white in maps.</i>	N. A. (no missing modelled data)
Documentation of process failure	n.s.	<i>e-mail indicating interruptions or modifications</i>	E-mail indicating interruptions or modifications on the PREV' Air system
Version control mechanisms and representation	n.s.	<i>Version number and last date of modification in background; EURAD.</i>	Version number and last date of modification in background for each model

Table 1.4-2 Quality assessment and control procedures for final products of the Integrated AQ Forecast sub-service

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1.5 References

1.5.1 Electronic references and online data access paths

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1.5.2 Bibliographic references

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