

QUALITY and the GMES Atmospheric Service

Anne De Rudder

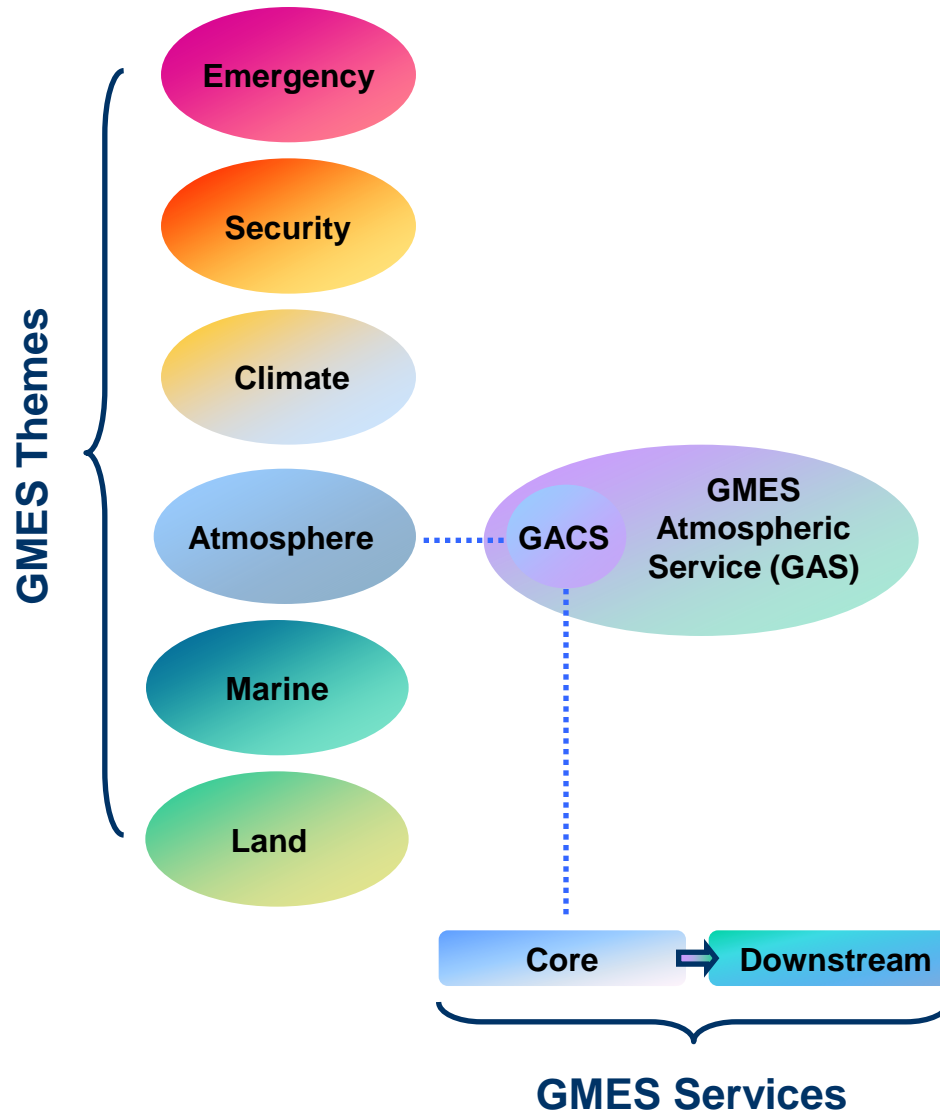
Belgian Institute for Space Aeronomy (IASB-BIRA), Brussels



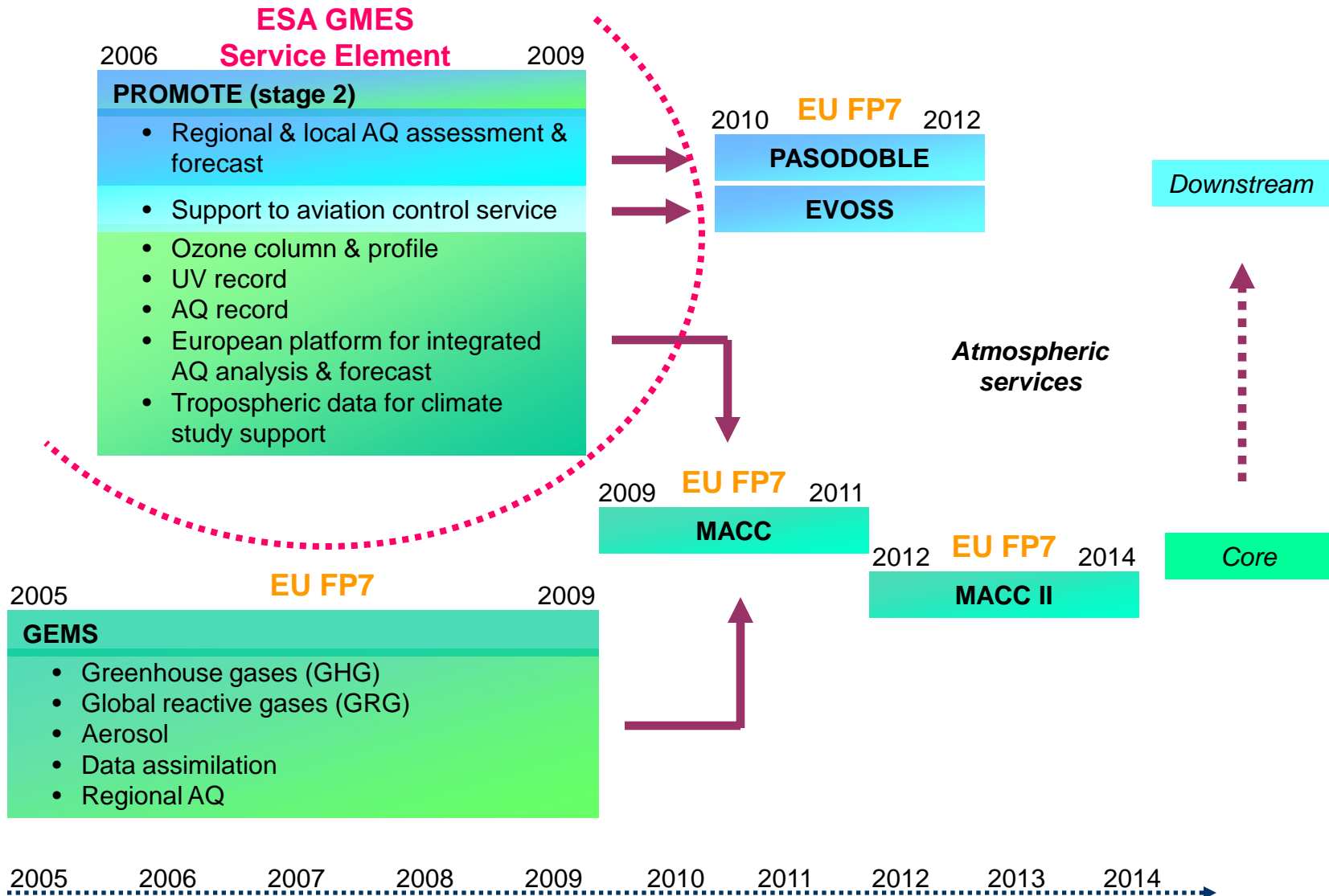
QA4EO Workshop
RAL, Harwell, UK
19 October 2011



Global Monitoring for Environment and Security (GMES)



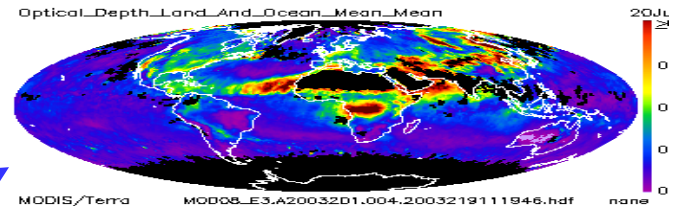
GMES Atmospheric Service (GAS) implementation



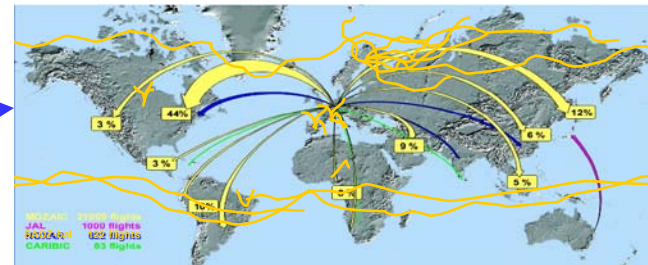
GAS input and output data: a wide range

- Emission inventories, vegetation maps, cartographic data, medical data.
- Measurements of atmospheric composition and dynamics from space, balloons, airplanes and the ground; remote sensing data and in situ measurements.
- Assimilated and simulated atmospheric fields; (re-)analyses, forecasts and predictions.
- Model output – from NWP, CTM, 3&4DVar, regional and local AQ, dispersion and (back-)trajectory.

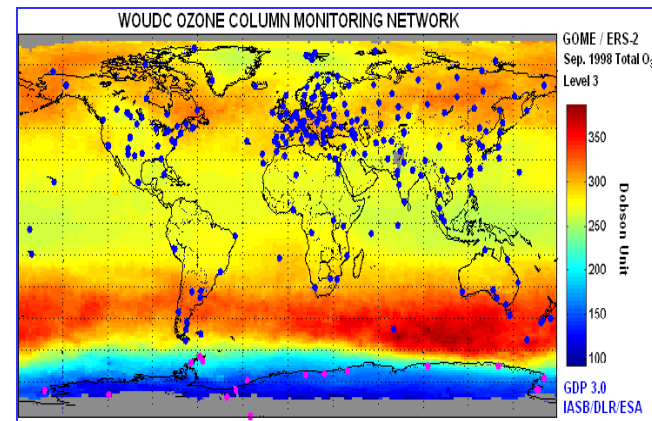
Satellites



Aircrafts and balloons

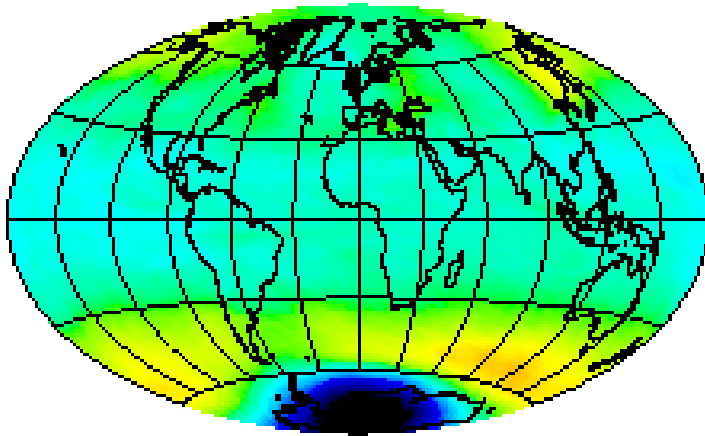


Ground networks

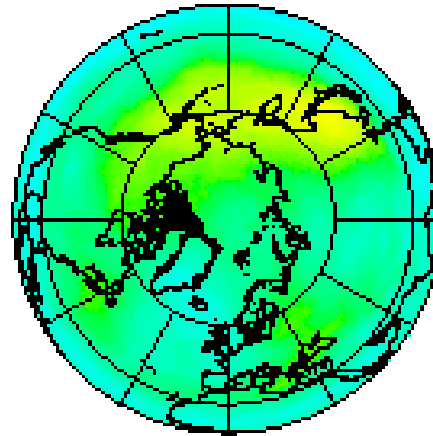


GAS core products - examples

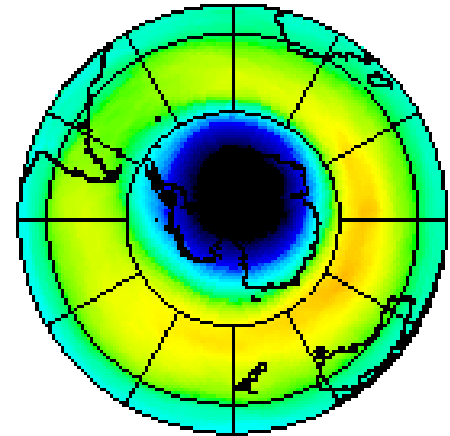
Reanalysis of global atmospheric composition



Global view



North Pole view



South Pole view

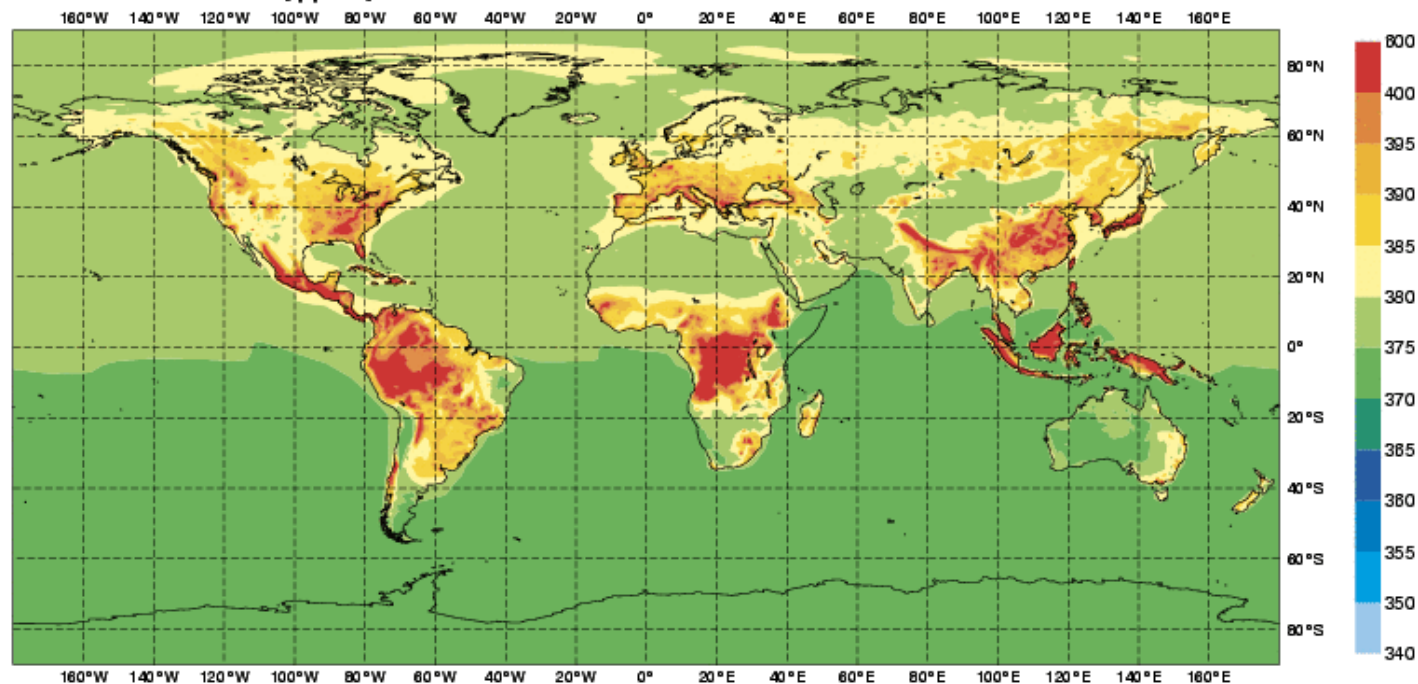
Monthly mean ozone for October 1997 obtained from multi-sensor reanalysis

GAS core products - examples

GHG monitoring in “delayed mode”

MACC Delayed mode Global Monthly Mean June 2009

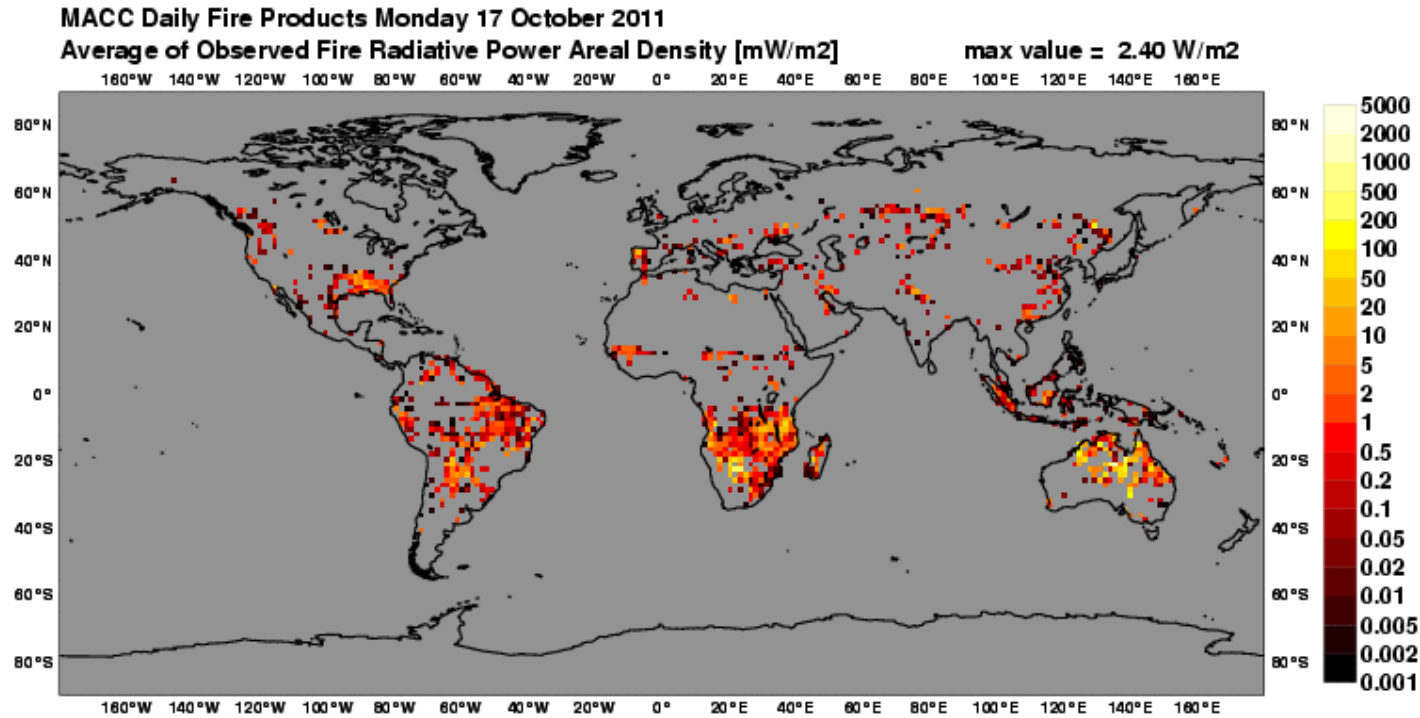
Surface Carbon Dioxide [ppmv] mean: 377.75 max: 519.80



Surface CO₂ mixing ratio monthly mean (June 2009)

GAS core products - examples

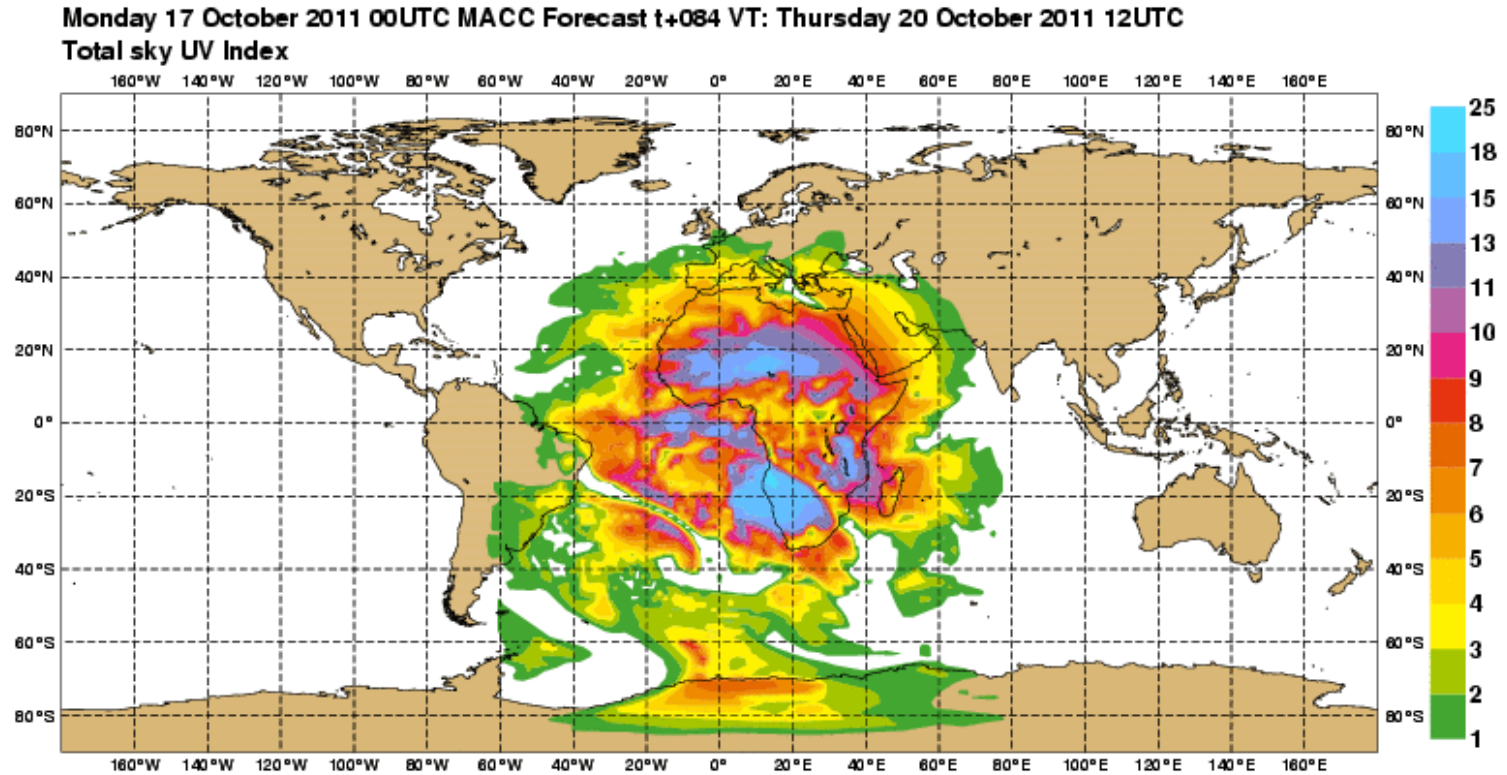
NRT observation



Averaged fire radiative power areal density observed by SEVIRI

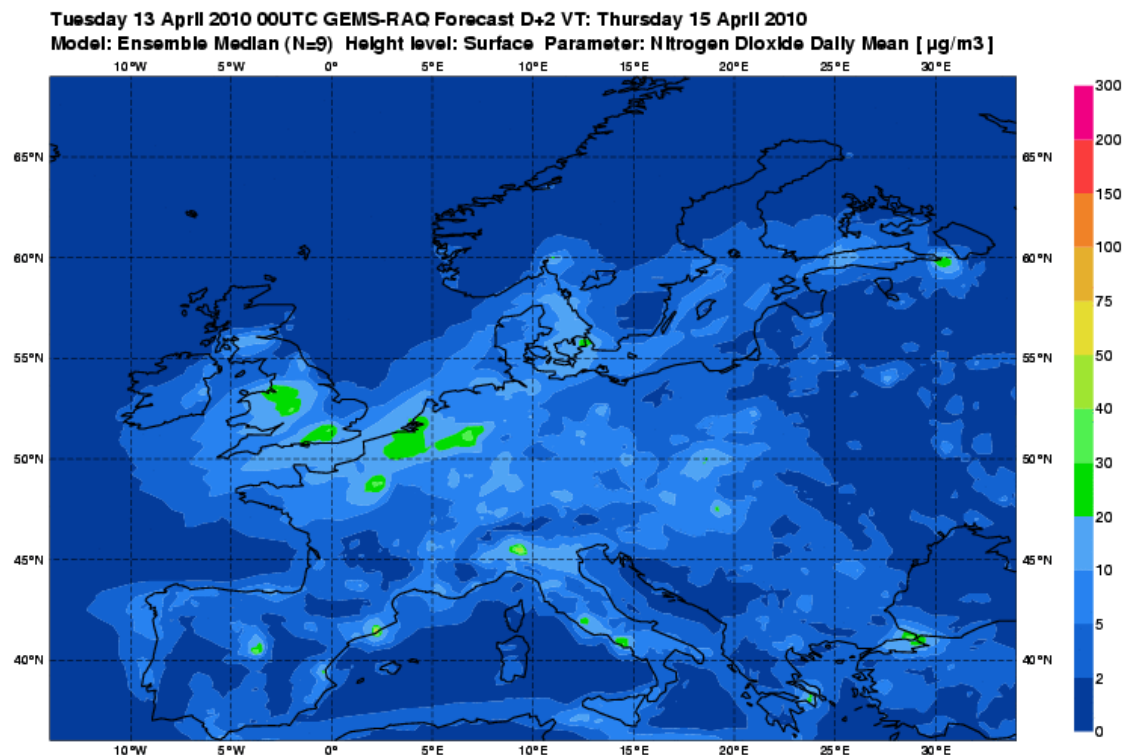
GAS core products - examples

Global forecasts



UV index 3-day forecast for October 20, 12UTC

Daily AQ forecasts for Europe from an ensemble of models



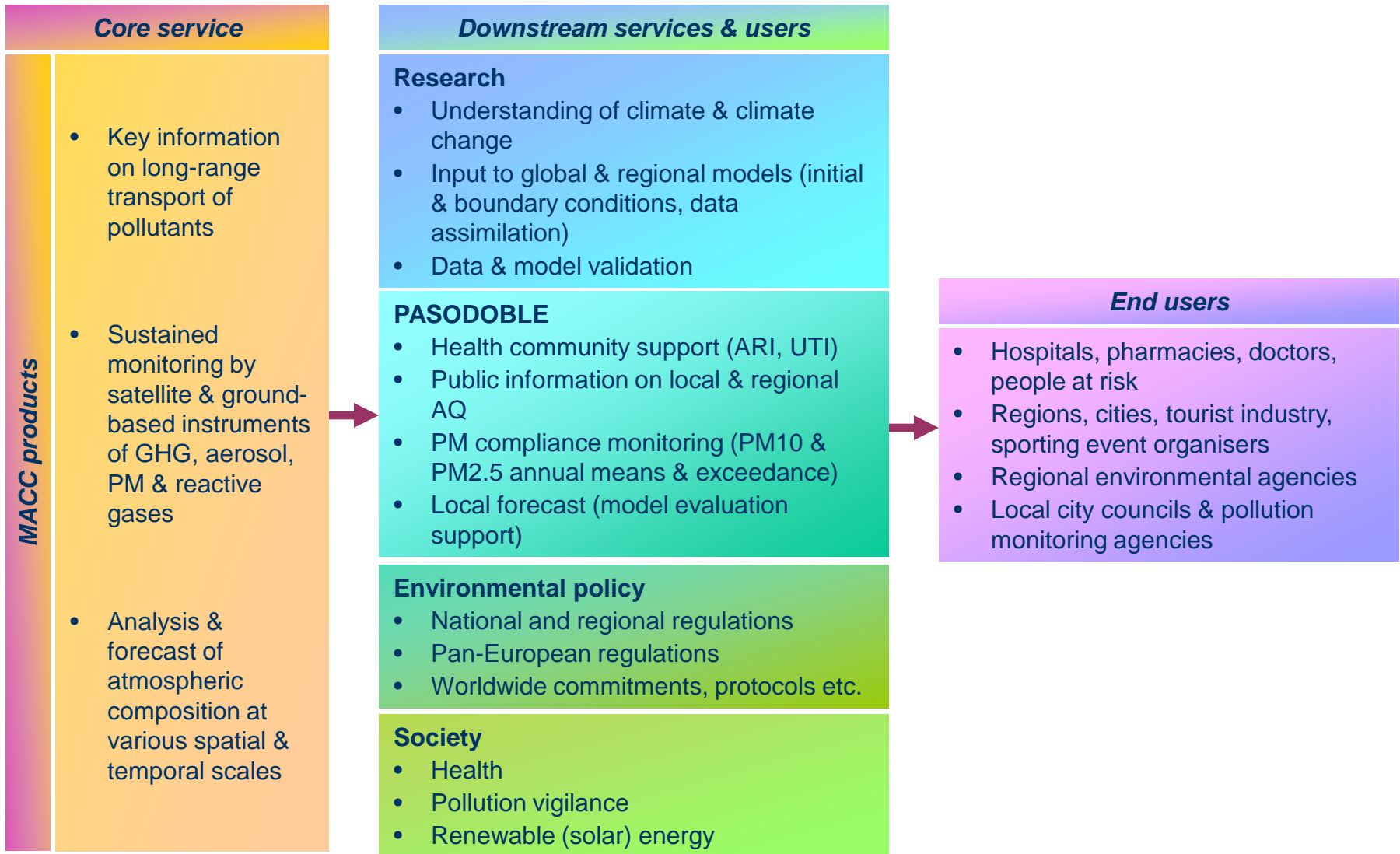
NO₂ daily mean surface concentration 2-day forecast for 15 April 2010

GAS downstream products - examples

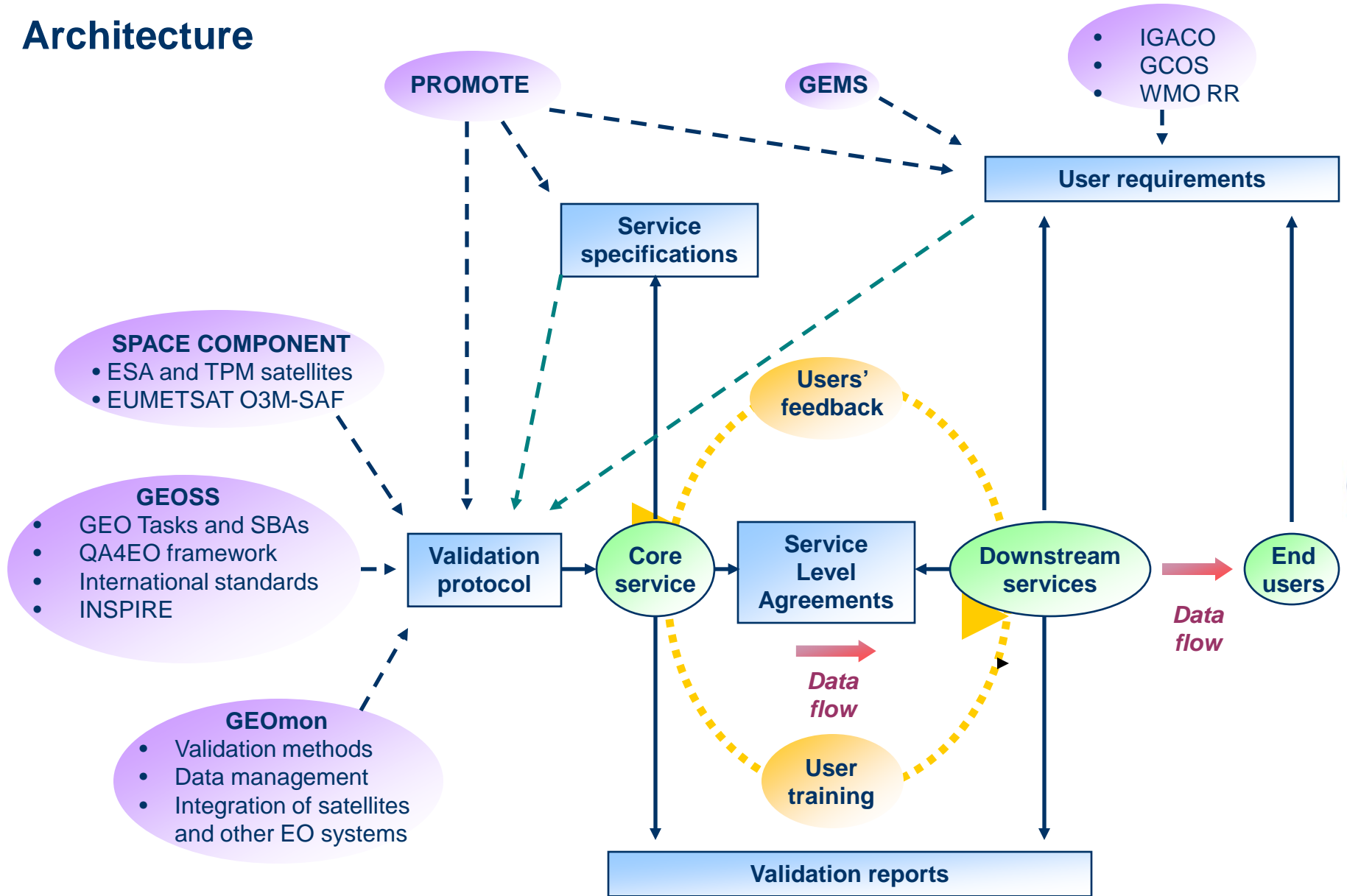
- Regional aggregate risk index for the health community
- Local AQ information for the tourism industry
- Annual mean PM10 ground level concentration in support to compliance monitoring by regional environmental agencies
- Local forecast model evaluation support for local authorities and city bodies



GAS Users: a broad spectrum



Architecture



GAS Validation Protocols

PASODOBLE June 2011

PROMOTE October 2009

C5_Service_Validation_Protocol_V3.pdf - Adobe Reader

File Edit View Document Tools Window Help

	GSE – PROMOTE 2 Atmospheric Services Validation Protocol	REF VERSION: ISSUE DATE PAGE
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DOSSIER: Common TASK: 2

PROMOTE

Atmospheric Monitoring Services
Stage 2 of the Earthwatch GMES Services Element

PROMOTE 2

**Atmospheric Services
Validation Protocol**

C5
Version 3
Issue 1

MACC October 2010

Copy of MACC VALIDATION PROTOCOL (13.10.2010)

File Edit View Insert Format Tools Table Window

Accept or Reject Changes...

Title + 14 pt Arial 14 B

Validation Protocol

[Issue 0
Revision 5
11.10.2010

PROJECT: MACC - Monitoring Atmospheric Composition and Climate
SUB-PROJECT / CLUSTER: MAN - Management and System Engineering
WORK PACKAGE / TASK: MAN_3 - System engineering for the GMES Atmospheric
DELIVERABLE: D_MAN_3_4

Page 1 Sec 1 1/47 At 6.6" Ln 20 Col 1 REC TRK EXT

PASODOBLE Validation Protocol (Iss1Rev0_01.06.2011).pdf - Adobe R...

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1 / 37 66.1% Find

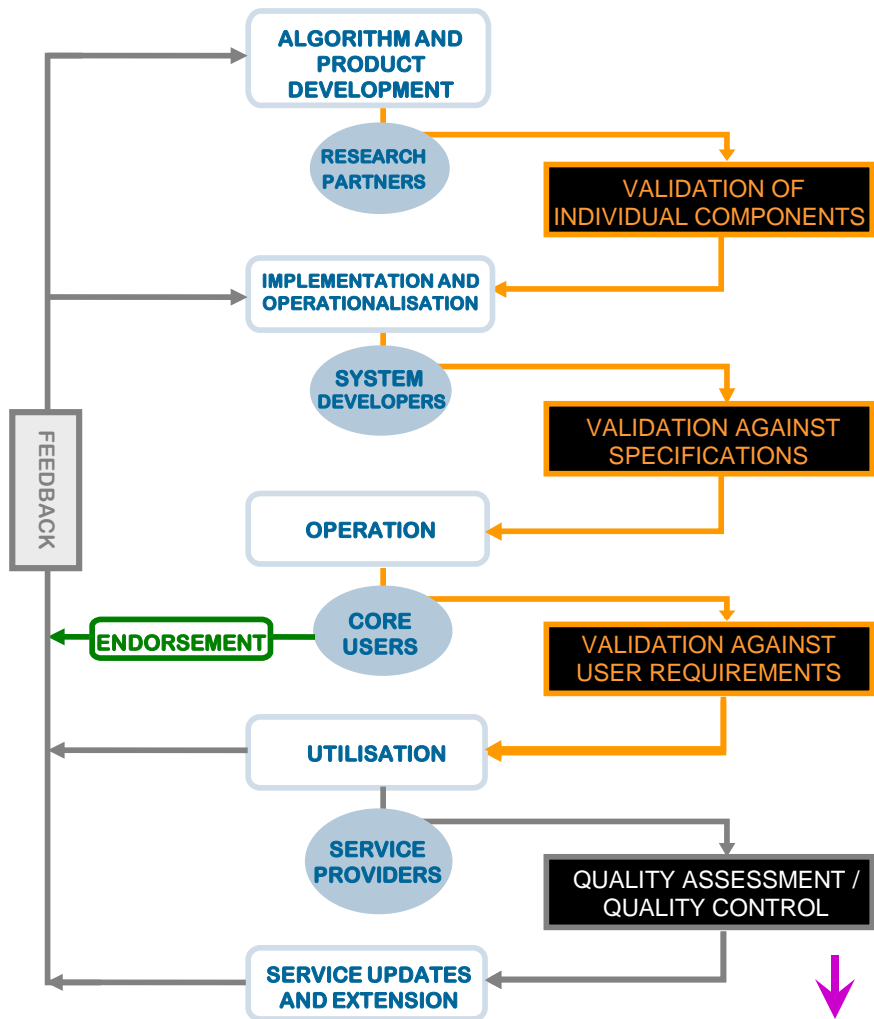
**Air Quality Services
Validation Protocol**

**Validation Protocol for the
GMES Atmospheric Service
on Air Quality**

PROVISIONAL RELEASE 01.06.2011

Page 1 Sec 1 1/47 At 6.6" Ln 20 Col 1 REC TRK EXT

GAS Validation Protocols



Validation of a service line

General principles

- Documented & traceable QI (QA4EO core requirement)
- Confrontation with independent reference data
- Error budget
- Analysis of information content

Specifics

- GHG & RG
- AQ forecasts & assessments
- O₃, solar UV radiation & indices
- Aerosol & PM
- Wild fire emissions & volcano outgassing
- Alerts & fast response

Quality control

Rules for long-term QA

User requirements

User requirements are collected and updated at different stages of each project.



**GMES SERVICE ELEMENT
PROMOTE2
U1 Core User Needs and
User Standards Dossier**

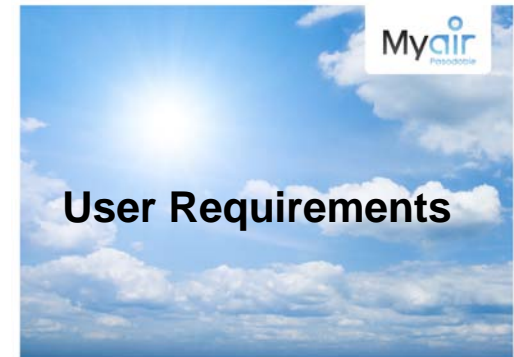
December 2009



**MACC Downstream Services and
End User Requirements Document**

Version 2.0

09.05.2011

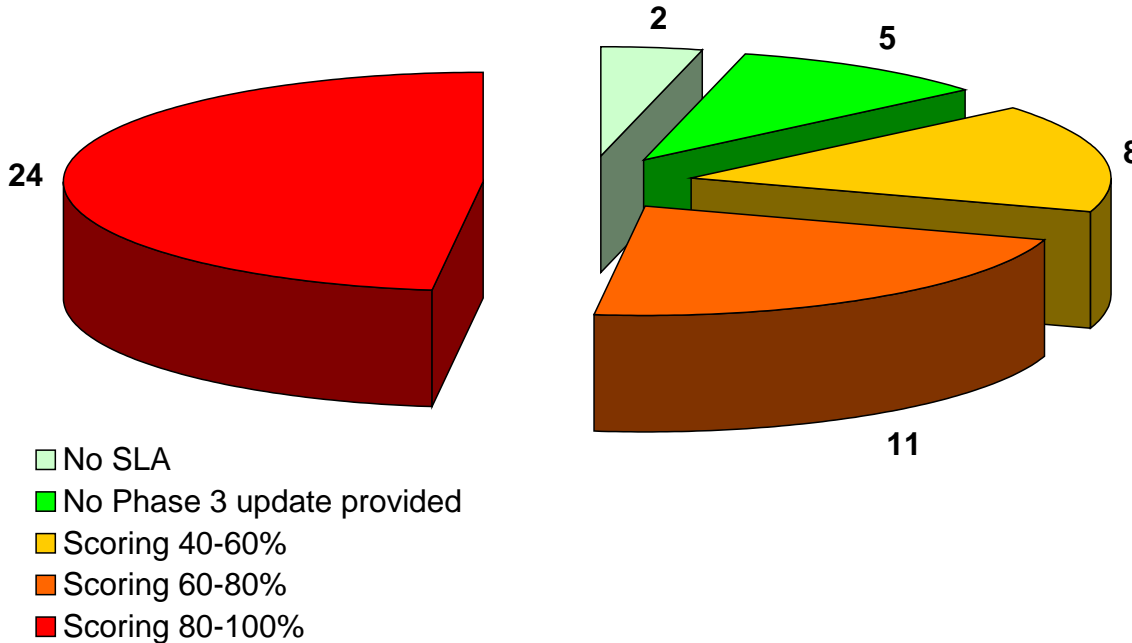


DS-HEALTH
Health Community Support Service
PASODOBLE
DS_HEALTH
D_DS-HEALTH_2.1
28 September 2010
ACRI-ST

Validation against user requirements

Analysis from PROMOTE Final Validation Report

(b) Phase 3



Agreement with user requirements (in number of products) for a total of 50 products. 23 specification items of 6 types (Accuracy, Coverage & resolution, Completeness & availability, Delivery, Documentation & communication, Format & support) were assessed.

User requirements


Inventory of requirements “out there”



IGACO 2004

IGACO

GCOS requirements 2006-2010

- GCOS-107 Systematic Observation Requirements for
-  World Meteorological Organization
Working together in weather, climate and water
- **WMO Observing Requirements Database**
Datasets and Products Meeting GCOS Requirements
- GCOS-143 Guideline for the Generation of Datasets and Products Meeting GCOS Requirements

September 2004
An international partnership for
cooperation in Earth observations

International legislation

The world

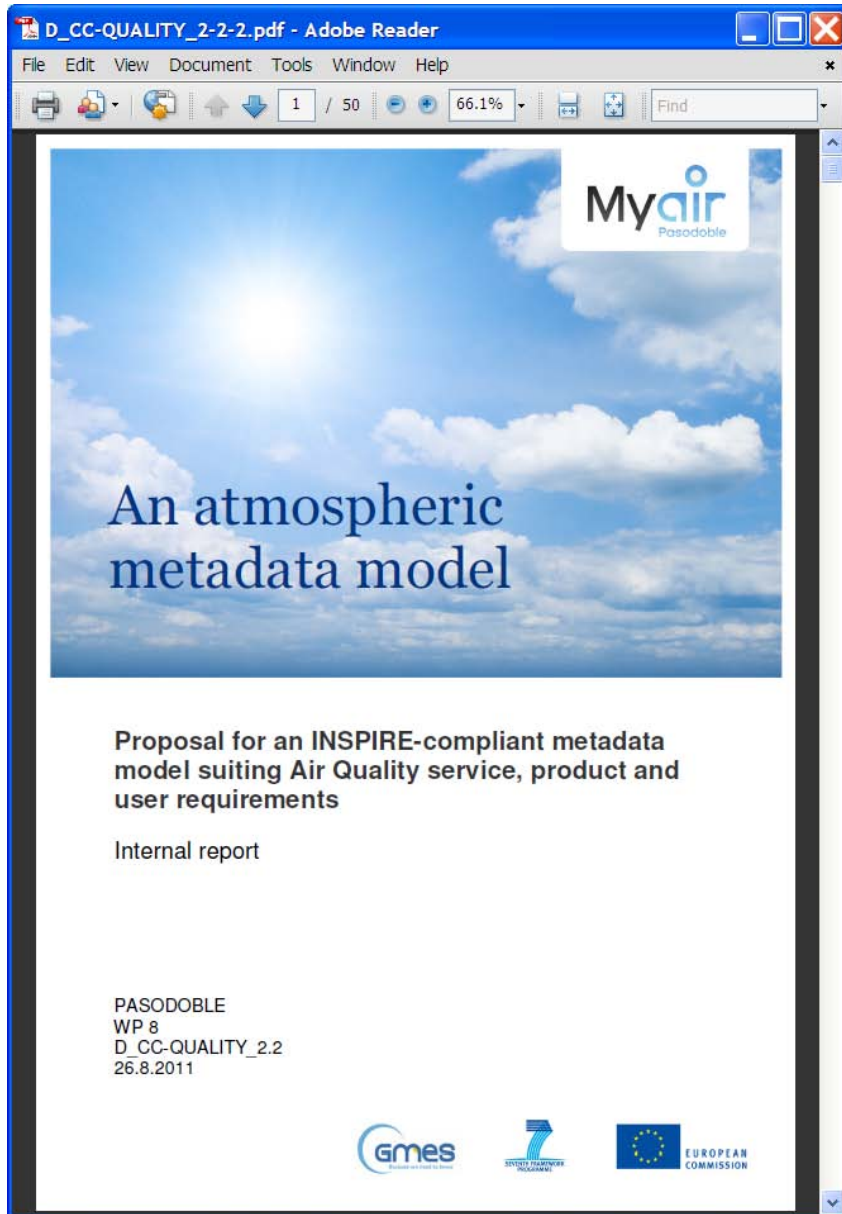
- 1979** *Convention on Long-Range Transboundary Air Pollution (CLRTAP)*
- 1999** *Gothenburg Protocol*
- 1985** *Vienna Convention for the Protection of the Ozone Layer*
- 1987** *Montreal Protocol on Substances that Deplete the Ozone Layer*
- 1992** *UN Framework Convention on Climate Change (UNFCCC)*
- 1997** *Kyoto Protocol*
- 2010** *Cancún Agreements*

Europe

- 1996** *Air Quality Framework Directive (AQFD) and daughters*
- 2001** *Clean Air for Europe (CAFÉ) Programme*
- 2001** *National Emission Ceilings (NEC) Directive*
- 2008** *Pure Air for Europe Directive*
- 1987-2009** *Regulations on ODS*
- 2006** *MAC Directive*
- 2006** *F-GAS Regulation*
- 2009** *Effort Sharing Decision*



Metadata



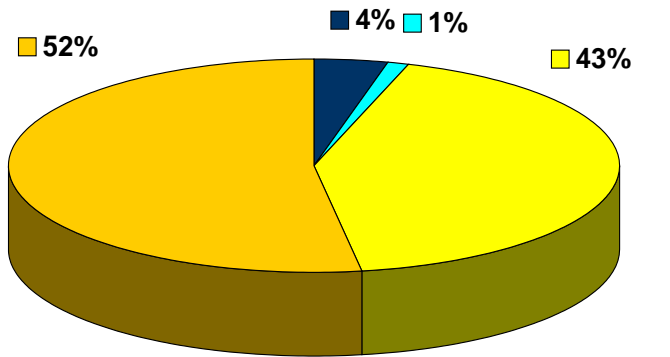
The provision of metadata only contributes to the service and product quality at the condition that the metadata themselves meet certain quality criteria.

Metadata should be

- specific
- accurate
- intelligible
- explicit
- complete
- consistent

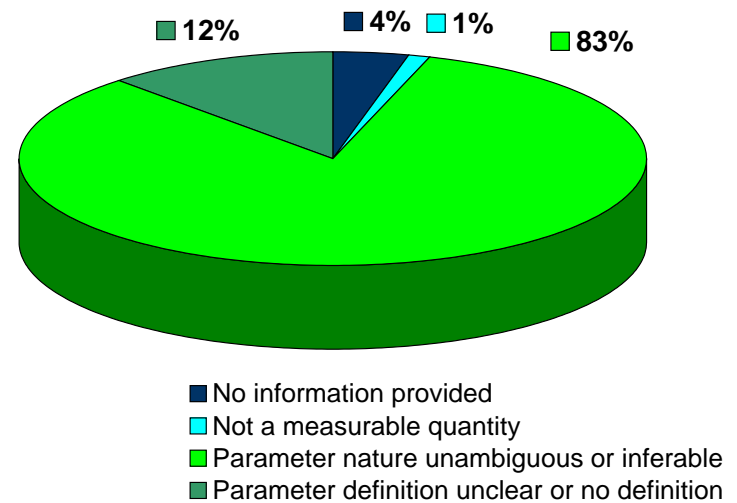
Metadata quality

(from PROMOTE Final Validation Report)



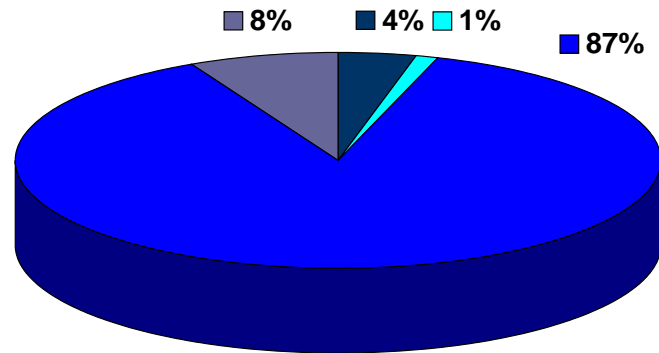
- No information provided
- Not a measurable quantity
- Parameter name accurate
- Parameter name inaccurate

Parameter name accuracy



- No information provided
- Not a measurable quantity
- Parameter nature unambiguous or inferable
- Parameter definition unclear or no definition

Parameter definition accuracy



- No information provided
- Not a measurable quantity
- Parameter name consistent with unit
- Parameter name inconsistent with unit

Parameter name and unit consistency

Metadata (cont.)

- A Product
 - A1 Identification and nature
 - A2 Domain of definition
 - A3 Domain of values
 - A4 **Quality**
 - A5 History
 - A6 Presentation, coding, format
 - A7 References
- B Product generation
 - B1 Developer
 - B2 Derivation chain and intermediate validation
 - B3 References
- C Product availability, distribution and usage
 - C1 Provider
 - C2 Applications
 - C3 Maintenance and update
 - C4 Delivery
 - C5 Terms and conditions
 - C6 Support
 - C7 References
- D Metadata

- Existence of quality assessment
- Validation method
- Validation datasets
- Validation results
- Content analysis
- Quality indicators

Metadata (cont.)

Beside the « conventional » uncertainty estimators, in the PASODOBLE Metadata Model, the following are also accepted as quality indicators

- numerical estimators of the accuracy or precision of the independent variables on which the measured quantity depends;
- for theoretical results, quality indicators, e.g. statistical estimates, comparison with observation, etc.;
- flags (indicating missing or suspicious data, or particular conditions of observation, or data that have been subject to some particular processing, etc.).
- QI of non-data products, that would, for example, measure the performance of a model or tool (by their rate of success or otherwise).

Metadata (cont.)

QIs and their methods of calculation (for example, when they are based on samples) need to be defined precisely.

Metadata elements requested for any QI:

- *Name*
- *Definition*
- *Unit*
- *Relevance:*

individual – vary from data point to data point, i.e. are a function of the same independent variables as the data itself ;

global – characterise the dataset as a whole.

Individual QI

- *Confidence interval and level*

Global QI

- *Value*

INSPIRE metadata compliance: the challenge

Issues follow from

- No notion of (independent or dependent) variable assuming numerical values → no attempt to characterise the variable (no mention of the variable unit, of uncertainties affecting its value, of its domain of definition).
- “Space” is essentially flat and timeless – 3rd and 4th dimensions are casual attributes of data.
- No requirement regarding QI – apart from accuracy of horizontal coordinates, but not detained in Metadata Regulation
- Mandatory provision of horizontal resolution as a (the main) criterion of quality based on the belief that the more detailed the representation, the truer the information conveyed
- Lineage: ragbag of interchangeable elements of utterly different natures (→ loss of content meaningfulness)
- Simplified preformatted metadata scheme jeopardizes the quality (completeness and explicit aspect) of metadata

Quality issues

- Popularisation of standard terminology (accuracy is used by different communities and individuals to mean different things)
- Popularisation of the importance of accuracy / precision indicators and of the fact that these are factors of quality only relative to the nature and needs of the targeted application.
- Fitness for purpose: what does it mean? – what purpose?
- Does anything “useful to know” (e.g. geographic resolution) provide an information on quality? Then any metadata would be about quality...
- What is a QI? Adapted QIs. Not always straightforward. E.g. qualitative information (conditions of measurement, a.s.o.) also provide some information on quality.
- VIM concepts such as the reproducibility of an experiment come from a pre-satellite era vision. What does reproducibility mean for a measurement which is made under changing conditions?

Quality issues (cont.)

- How complete the information about the QI must be? E.g. details of reference dataset used for comparison, etc.
- What to do for model validation? Large spectrum of models.
 - Validation of model results by comparison to reference observations is one way.
 - Can we assess errors on diagnostic variables in the same way as we assess errors on measurements? Are error budgets feasible?
 - Sensitivity studies to assess impact of parameterisations and approximations.
 - Statistical results from ensemble studies.
 - FAIRMODE approach for AQ modelling: Delta tool to evaluate local pollution models.
 - How do we evaluate an evaluation tool?
- Downstream services promised to financial autonomy (?) but marketing criteria (according to marketing experts) are in opposition to scientific criteria