Quality Assurance for Essential Climate Variables (QA4ECV): Overview and Year 1 highlights

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www.qa4ecv.eu

CORE-CLIMAX meeting,
Brussels, 15 January 2015,

QA4ECV project

- 4-year EU FP7 Space project (2014 – 2017)
- Led by KNMI with 17 contributing institutions

What is the project designed to achieve?

The objective of QA4ECV is two-fold: to design and develop a generic quality assurance system that can be applied by users to evaluate whether a satellite data set is mature enough for a particular purpose. The second goal is to generate long-term (30-year) data records of atmosphere and land parameters relevant to air pollution and climate change.

QA4ECV is a partnership of:

- European scientists
- data providers
- developers of future climate services
- national standards institute
- international organisations

Royal Netherlands Meteorological Institute · aeronomie.be · Universität Bremen · Max-Planck-Institut für Meteorologie · ULB Université Libre de Bruxelles · Aristotle University of Thessaloniki · CSIC · Wageningen UR · s[&]t · UCL · JRC European Commission · EUMETSAT · Brockmann Consult · FastOpt · rayference · CGI · NPL National Physical Laboratory

User perspective

I need good new data … and quickly. A new data product could be very good, but if it is not being conveniently served and described, it is not good for me…
So I am going to use whatever I have and know already.

User

10/21/2011 Leptoukh QA4EO'11

This is where QA4ECV comes in

What is QA4ECV providing?

Users need clear info on validity of EO/climate data sets

Unique records available, but need info on strength/weakness

Need objective system

Need guidance

web portal

Quality Assurance System

- Provides traceable quality info on EO/climate data
- Tied to international standards
- QA tools to support user community in tracing quality
- Multi-decadal records for atmosphere/terrestrial ECVs

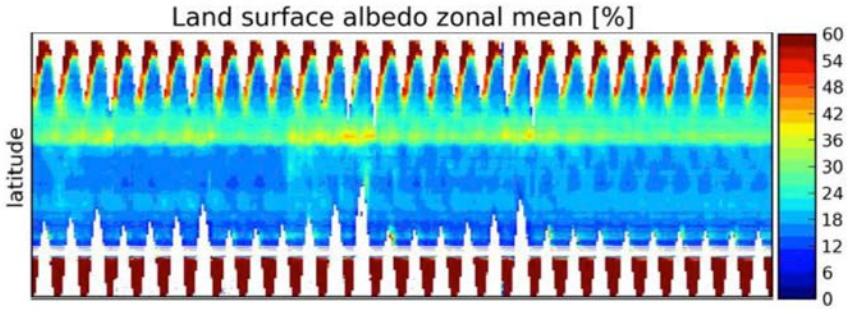
Maturity	Uncertainty Characterisation	Metadata
1	Not organised	Some
2	Nomenclature defined, limited information	Research grade
3	Nomenclature applied, comprehensive information	Sufficient to understand data

There is a need for quality-assured long-term climate data records

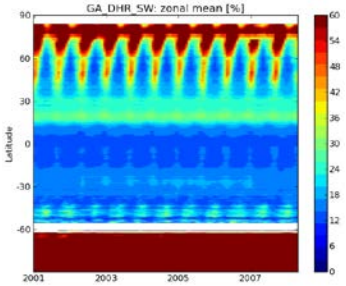
… but more than a ‘validation service’

Generation of 3 **Land ECV records** (albedo, LAI, FAPAR)

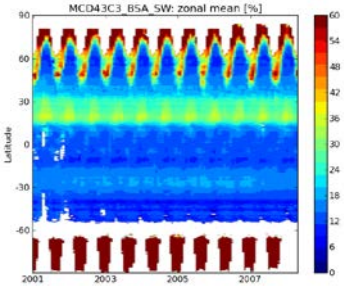
UCL



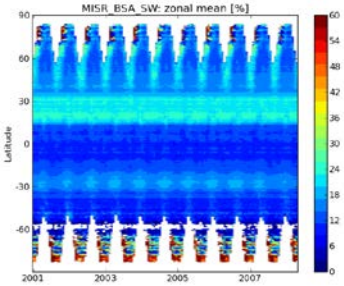
Alex Löw



GlobAlbedo



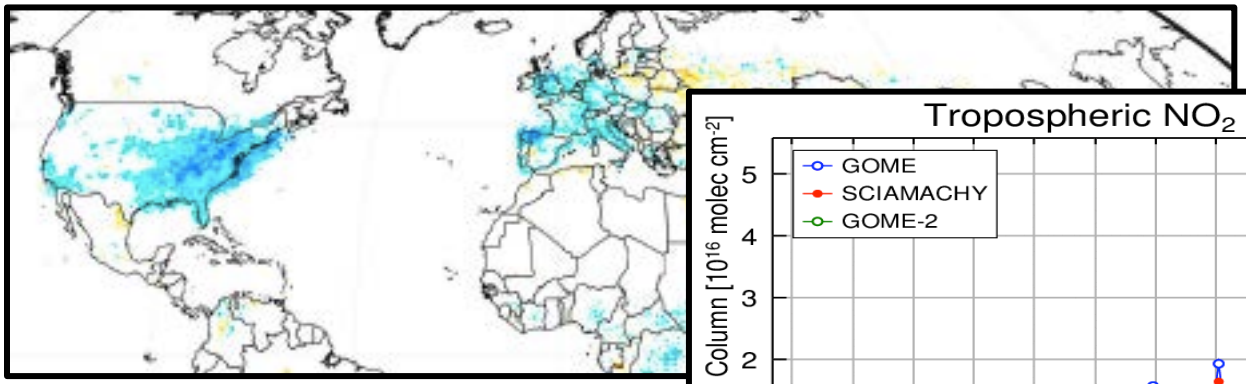
MODIS



MISR

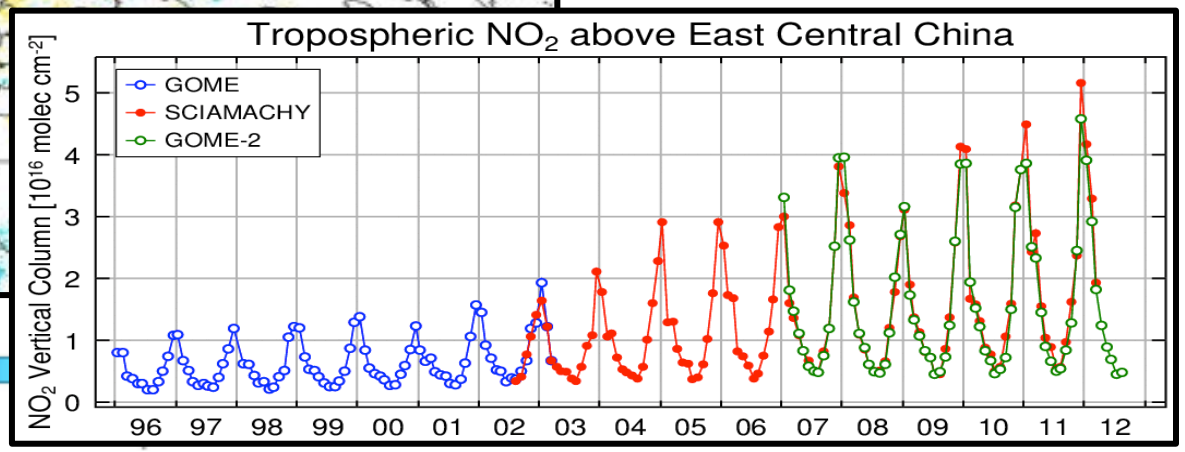
Generation of 3 **Atmosphere ECV records** (NO_2, HCHO, CO)

KNMI, Bremen



NO_2 trends (% yr^{-1})
1996 - 2012

-20 -15 -10



Overview of what have we done so far

2014 QA4ECV

- Establish user and provider needs
- Link with related projects and outreach to community
- Designed the specifications for a Quality Assurance system
- Provide Traceability Chains for all 6 ECVs
- WP4 highlight (example): maturing NO_2 ECV algorithm

C3S

- QA4ECV and Copernicus Climate Services
- Applications of NO_2 ECV relevant to C3S

(WP1) User requirements

- User requirements of quality assurance for atmosphere and land satellite data products
- Link sent to >10,000 people: 2% response rate

  www.qa4ecv.eu/survey
- User survey meeting held at EGU in May 2014 (>50 participants)

QA4ECV User Requirements Survey for Quality Information in Satellite-derived Climate Data Records

Take Land/Ocean Products Survey | Take Atmosphere Products Survey

QA4ECV ('Quality Assurance for multi-decadal ECVs') is a 4-year European Union Framework 7 project. The project is led by KNMI with 16 other contributing institutions from across Europe (see below).
The aim of QA4ECV is to develop a prototype of an internationally accepted Quality Assurance framework that provides free and open access to quality information along with traceable processing steps for deriving uncertainties associated with data records used for climate services.

The goal of this survey is to obtain a user perspective on the need for and most effective ways of presenting quality assessment (QA) information within current and future satellite-derived ECV data records. In particular, we are interested in the type of QA information that is required and the utility it will serve in your application area(s).

Complete the survey for your chance to win a complete set of NPL SI mugs!

(WP1) User survey

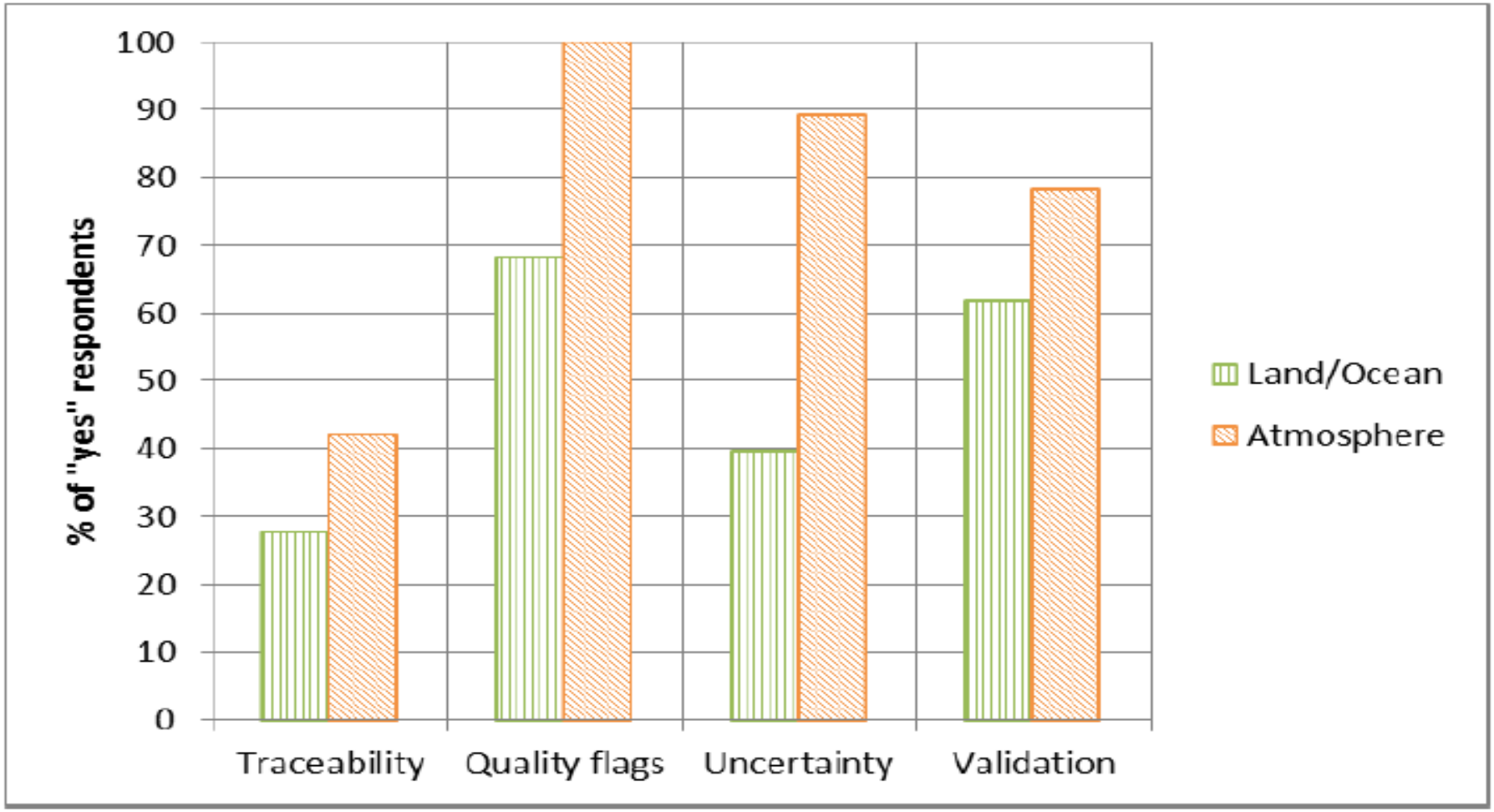
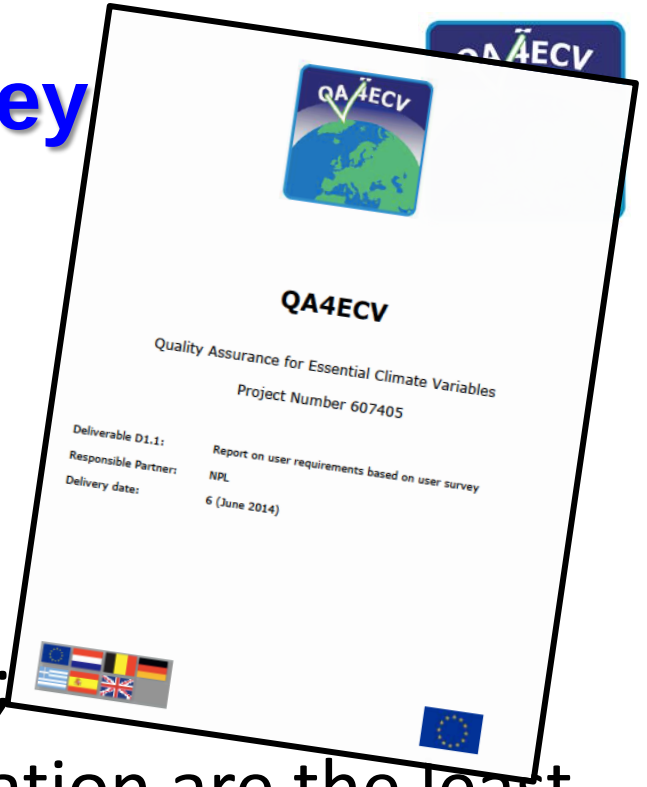


Figure 8- Percentage of respondents who answered "yes" when asked if a particular quality assurance component was easily accessible.

(WP1) Conclusions user survey

User survey report delivered (D1.1) and available from website



Conclusions:

- If quality assurance information is readily available it would be useful;
- Uncertainty and traceability information are the least readily accessible quality assurance components;
- Although quality flags are contained in many products these are often insufficient for the application;
- Quality assurance in atmospheric products appears further developed compared to land products.

(WP1) Linkage with existing services

Made links with ESA CCI and EUMETSAT SAF data providers

- Surveyed 6 data suppliers for Survey Report (D1.1)
- CGI linked with ESA CCI Systems Engineering Working Group

Table of contents

What aspects of a proposed uncertainty simulation / propagation tool would be most useful to each CCI team?

- Wide range of answers
- High-level view of error propagation preferred (over per pixel)
- Some appetite for ‘best practices’ on error propagation

(WP2) Design of the QA system

Lessons from WP1:

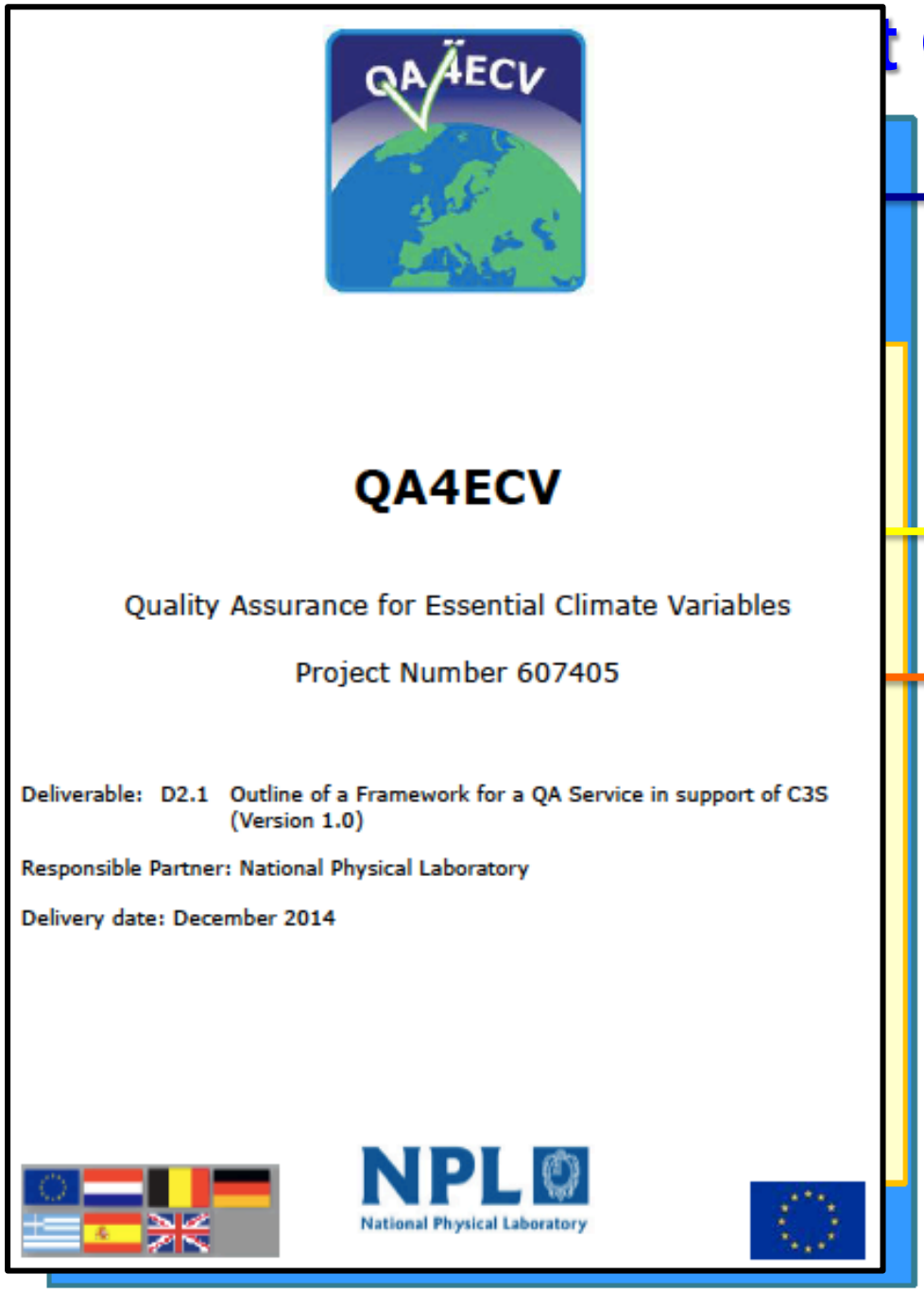
- Both data providers and data users need QA information
- QA information is often missing, but considered necessary/useful
- Uncertainty and traceability information is missing
- Very different requirements on the 'level' of QA

Define the aim of the QA system

- Towards maturity-based QA endorsement on ECV/CDRs leading to user confidence
- For those who (1) produce, (2) validate, and (3) use ECVs
- Provision of a mechanism for evaluation of QA procedures
- In the long run, ISO-standard compliant, but too early for that now

Work by NPL, BIRA, CGI, S&T

t QA system



QA4ECV Office :

- Prepares evaluation criteria
- Ensures tools, data, and training
- Guidance + support for the system
- Conduct evaluation + endorse QA compliance
- Integrates QA services developed elsewhere

QA4ECV System :

- Series of QA compliance procedures
- User-friendly tools, methods
- Standards guidelins
- Training modules
- TUPT is key element
- Allow levels of QA compliance

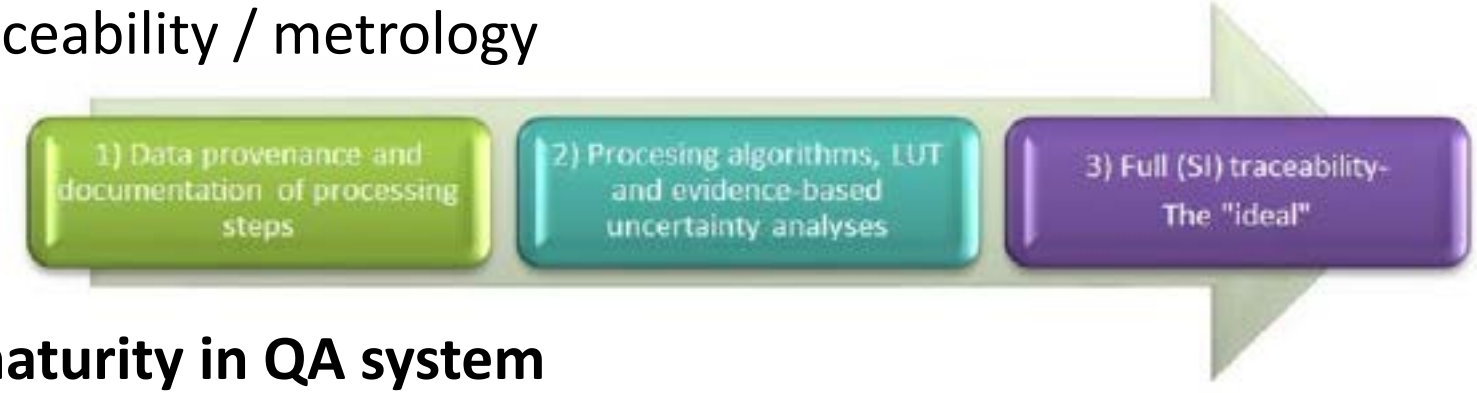
QA4ECV web portal

- Central location for all QA info
- Entry point for TUPT
- House all tools

QA system: lessons from other projects

Traceability in QA system

- Cataloguing and versioning process of **CHARMe** will be adopted
- Data processing steps take into account
- Full traceability / metrology



System maturity in QA system

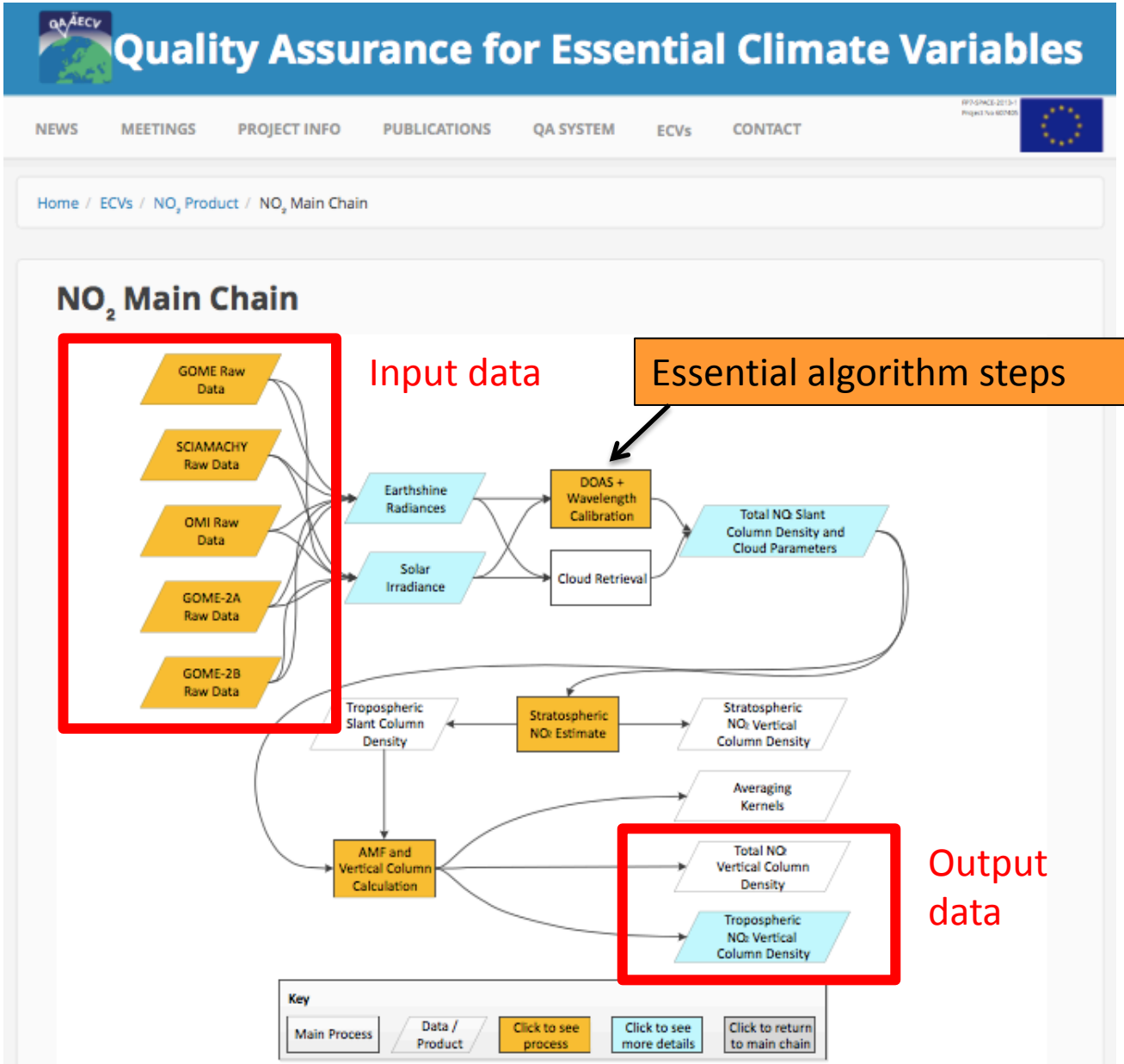
Use the maturity model for completeness of CDRs from **CORE-CLIMAX**

Fitness-for-purpose

Will be assessed against:

- Land and Atmosphere validation chains
- **WMO** quality management framework and requirements
- **GCOS** requirements
- **CORE-CLIMAX** Application Performance Metric

(WP2) Traceability Diagrams



NO_2 Product

Produced by: Royal Netherlands Meteorological Institute (KNMI)

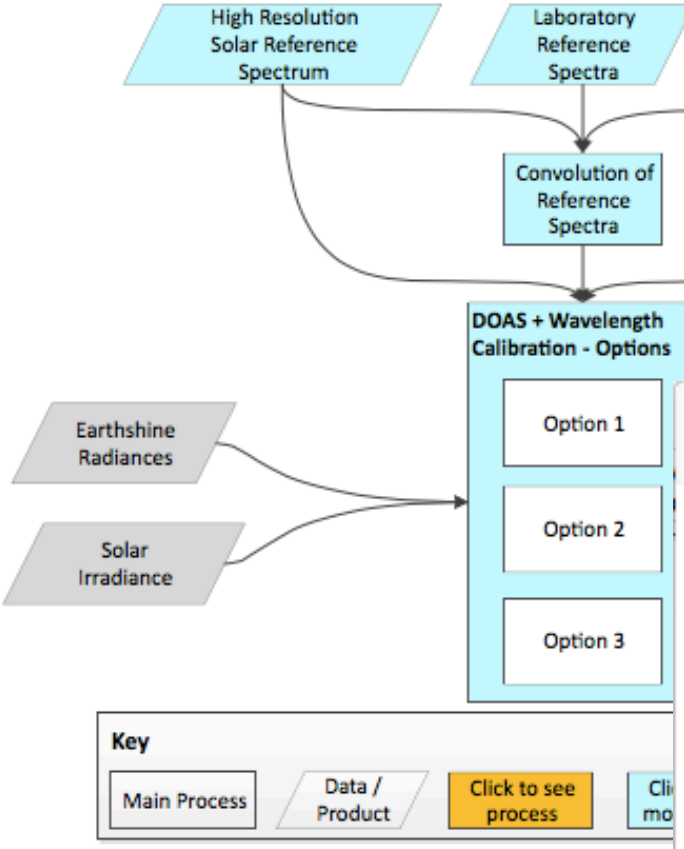
Click on orange boxes process to see more detail on sub-chain

Click on blue boxes to see more detail for further details on the particular process or data / product

(WP2) More detail

Home / ECVs / NO_2 Product / NO_2 Main Chain / DOAS + Wavelength Calibration Chain

DOAS + Wavelength Calibration Chain



Process Configuration

The slant column processing is controlled by a process configuration file. The configuration file contains (as an example):

- Which reference spectra to include in the fit.
- The wavelength window of the fit.
- The degree of the DOAS polynomial.
- Choice of shifting radiance to irradiance (or vice versa) wavelength grid when computing the radiance or irradiance (interpolation method).
- Choice of fitting function
- Wavelength calibration of radiances procedure (see DOAS options)

DOAS + Wavelengt Options

This DOAS process Van Geffen et al. (2 three options whic implemented for th

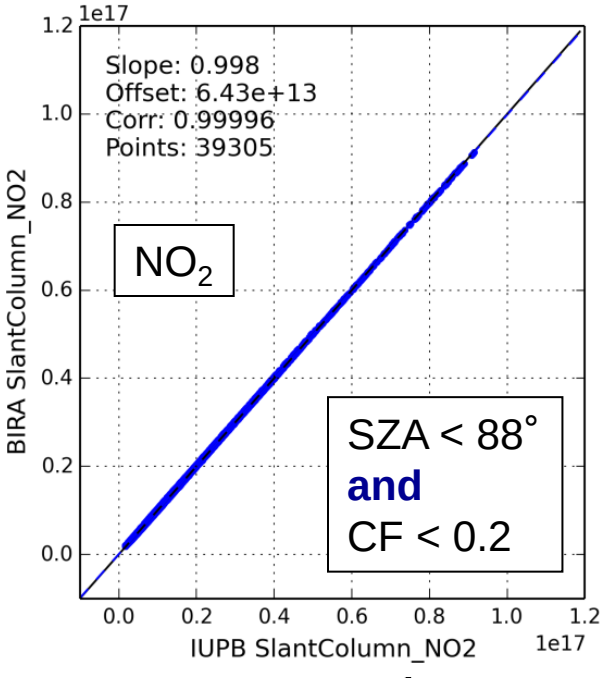
- **Option 1** un wavelength c radiances an the DOAS fit the wavelen radiance to t irradiance.

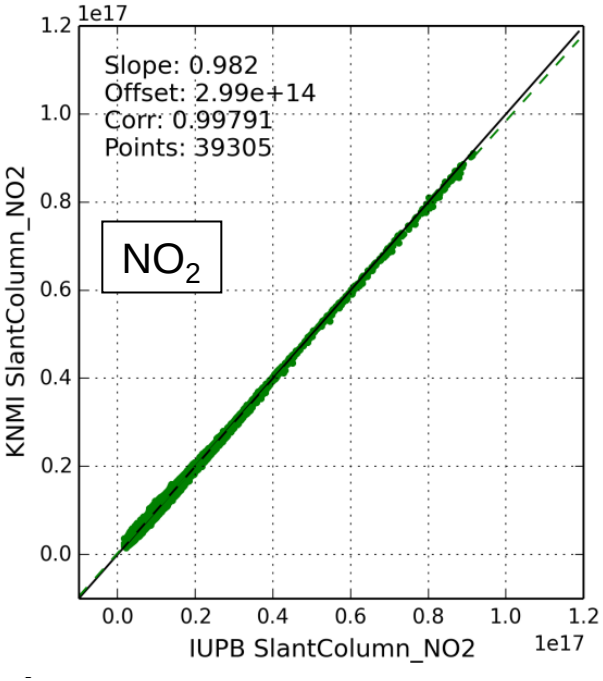
(WP4) QA4ECV highlight

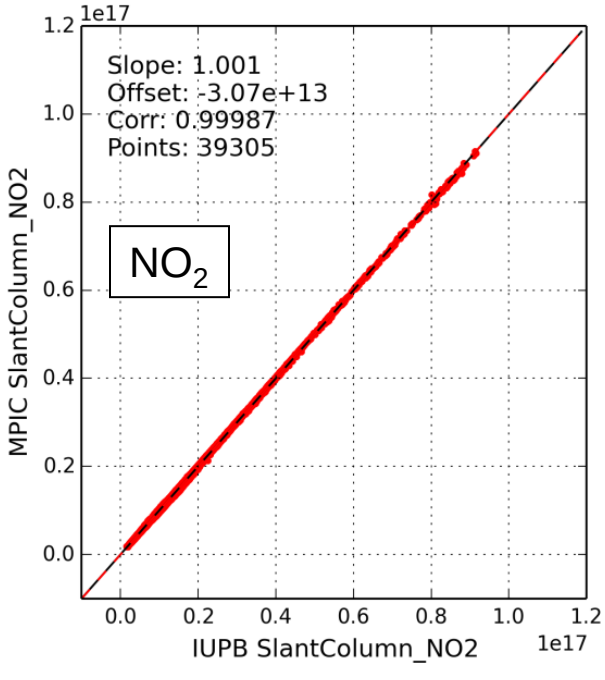
Towards Atmosphere ECVs – example DOAS OMI NO_2 evaluation

From 4 institutes:

- BIRA: v1, uploaded Oct 2014 (**v2 uploaded Dec 2014**)
- IUPB: v2, uploaded Nov 2014 (fit algorithm impoved)
- KNMI: **Re-processed, two versions**: Non-linear and linear mode
- MPIC: v1, uploaded Nov 2014





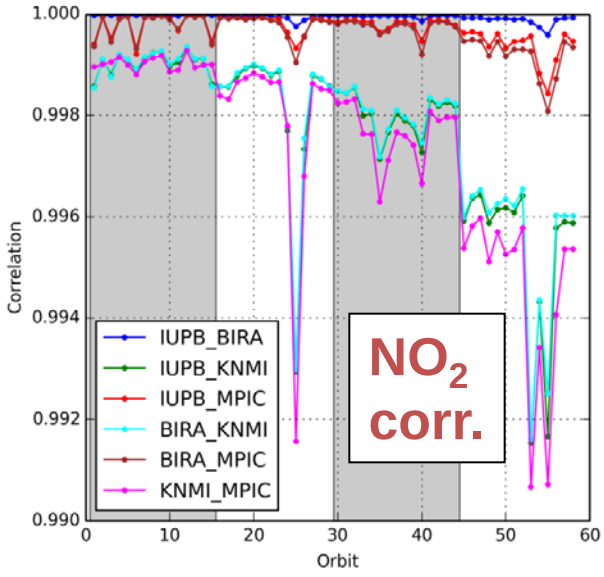


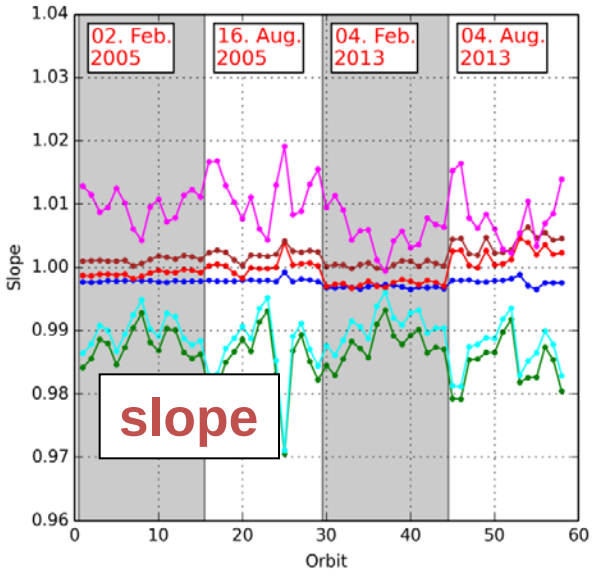
Enno Peters, IUPB

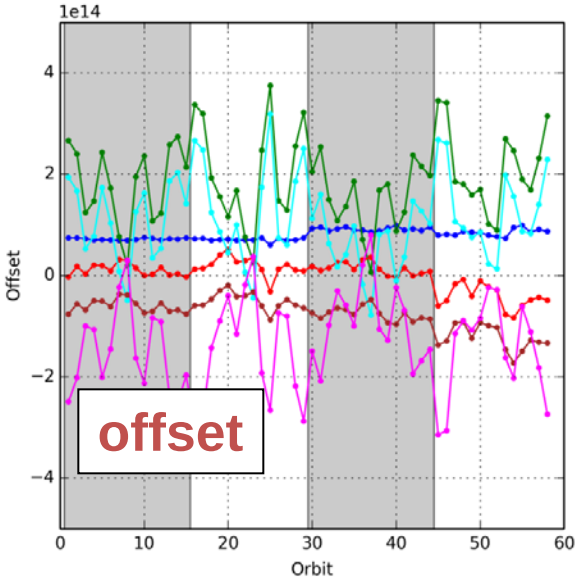
(WP4) QA4ECV highlight

Towards Atmosphere ECVs – OMI orbits in 2005 and 2013

- Correlation always > 99%
- Correlation decreases with time
- Slope typically 0.98 to 1.02, offset up to 3-4E14
- No clear trends in offset and slope



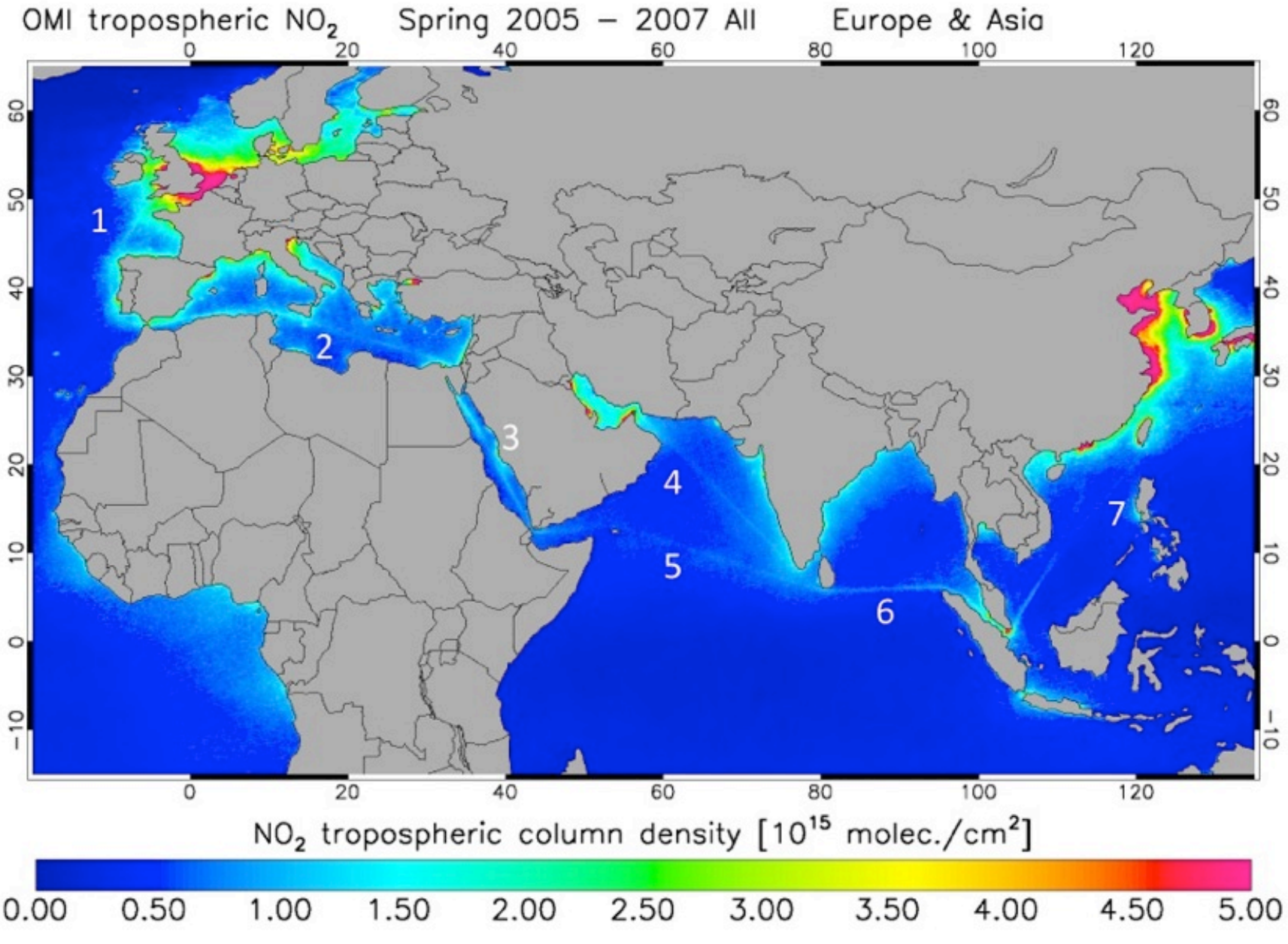




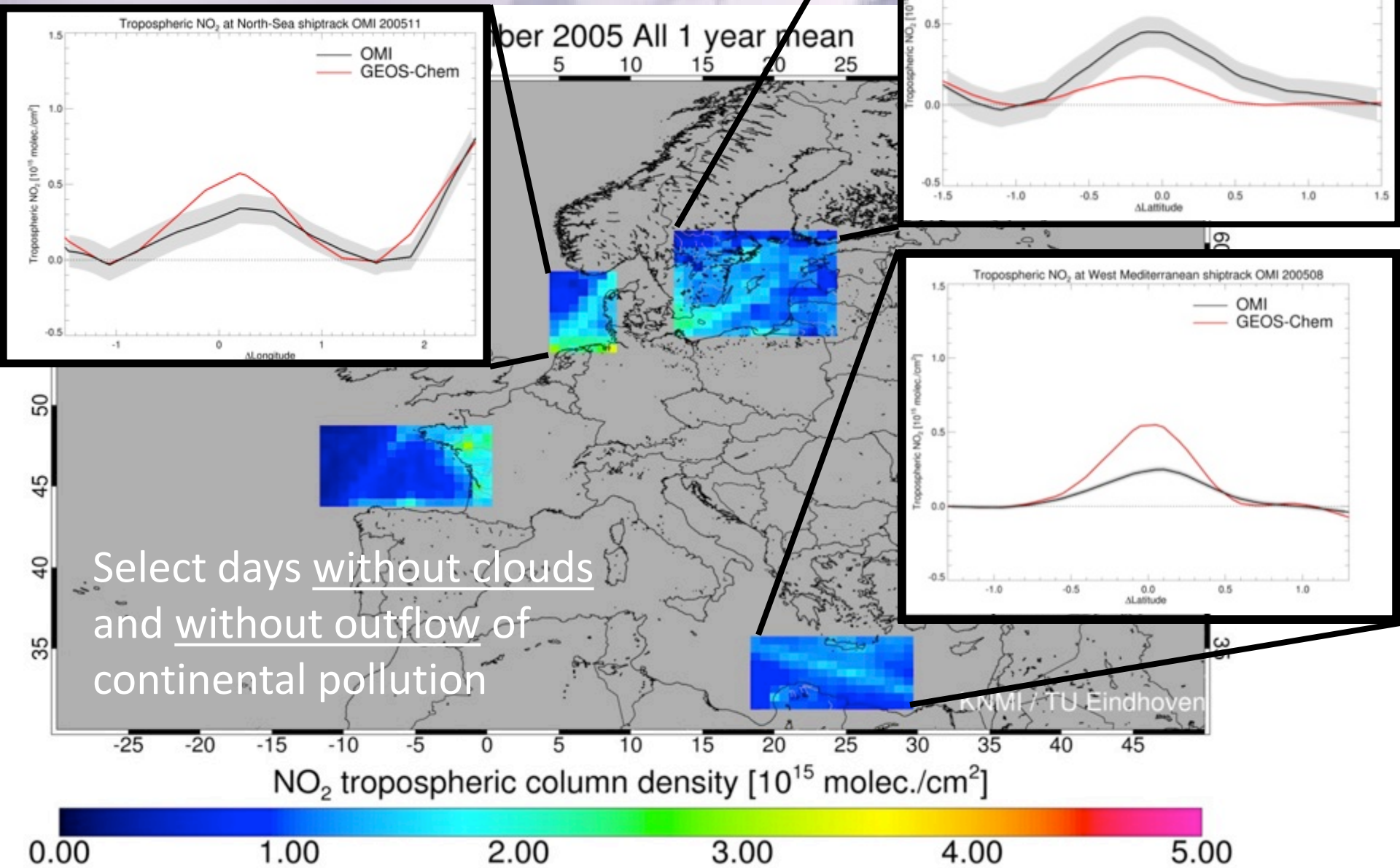
Enno Peters, IUPB

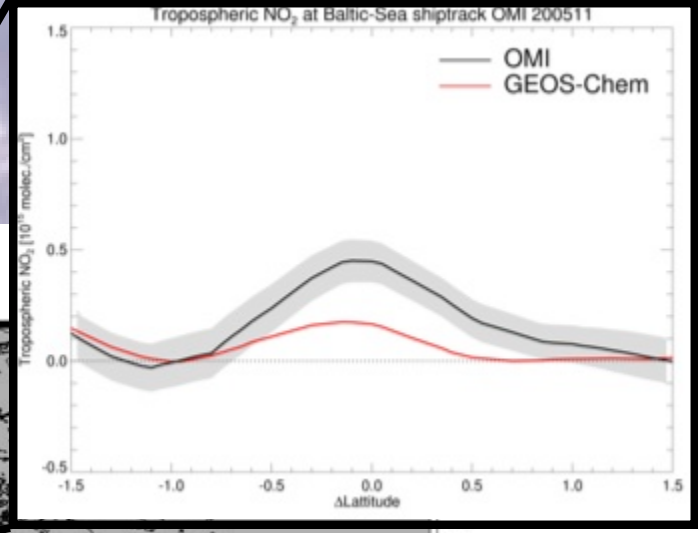
Excellent level of agreement

NO_2 data good enough for …



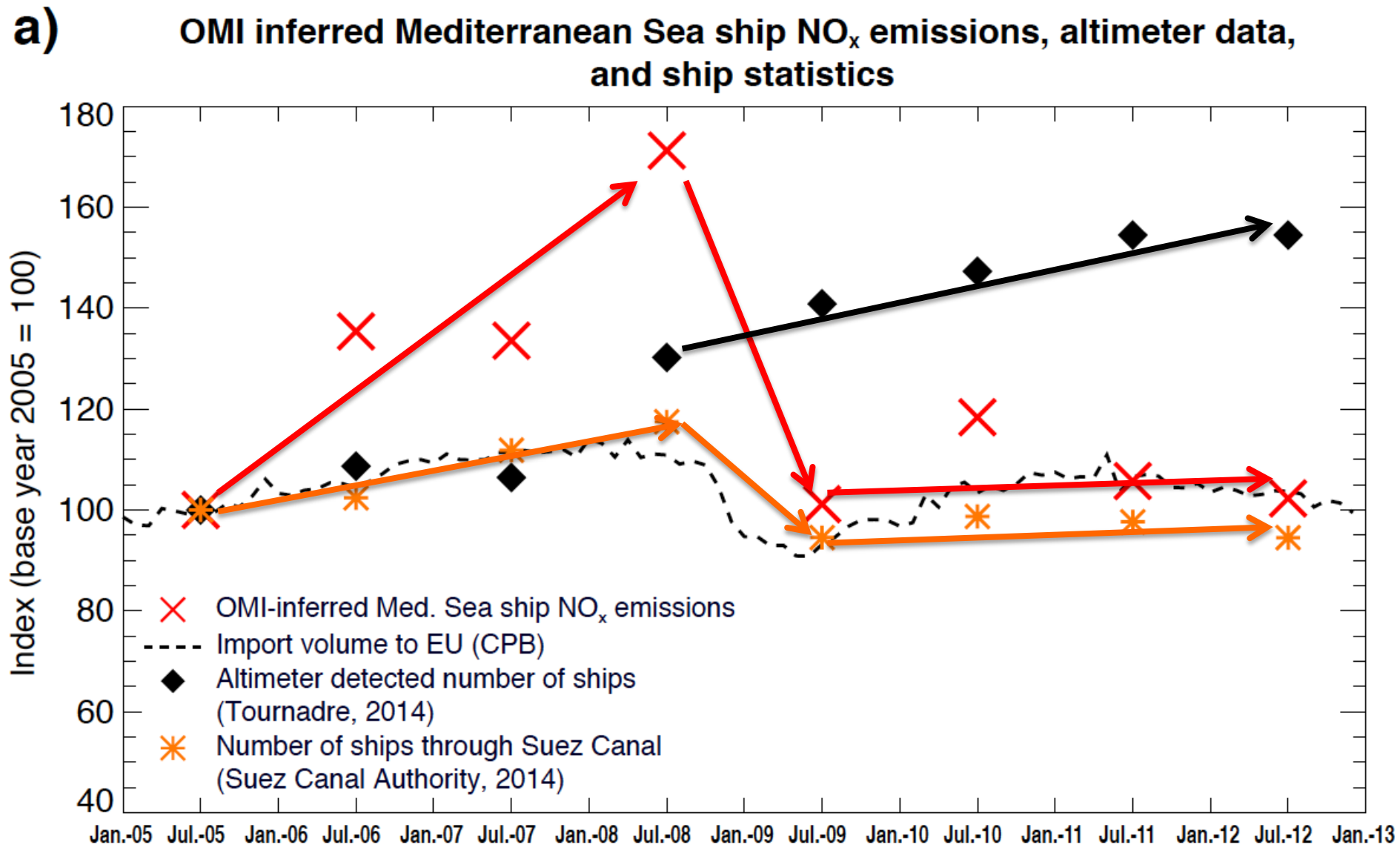
1. NO_x emission estimates



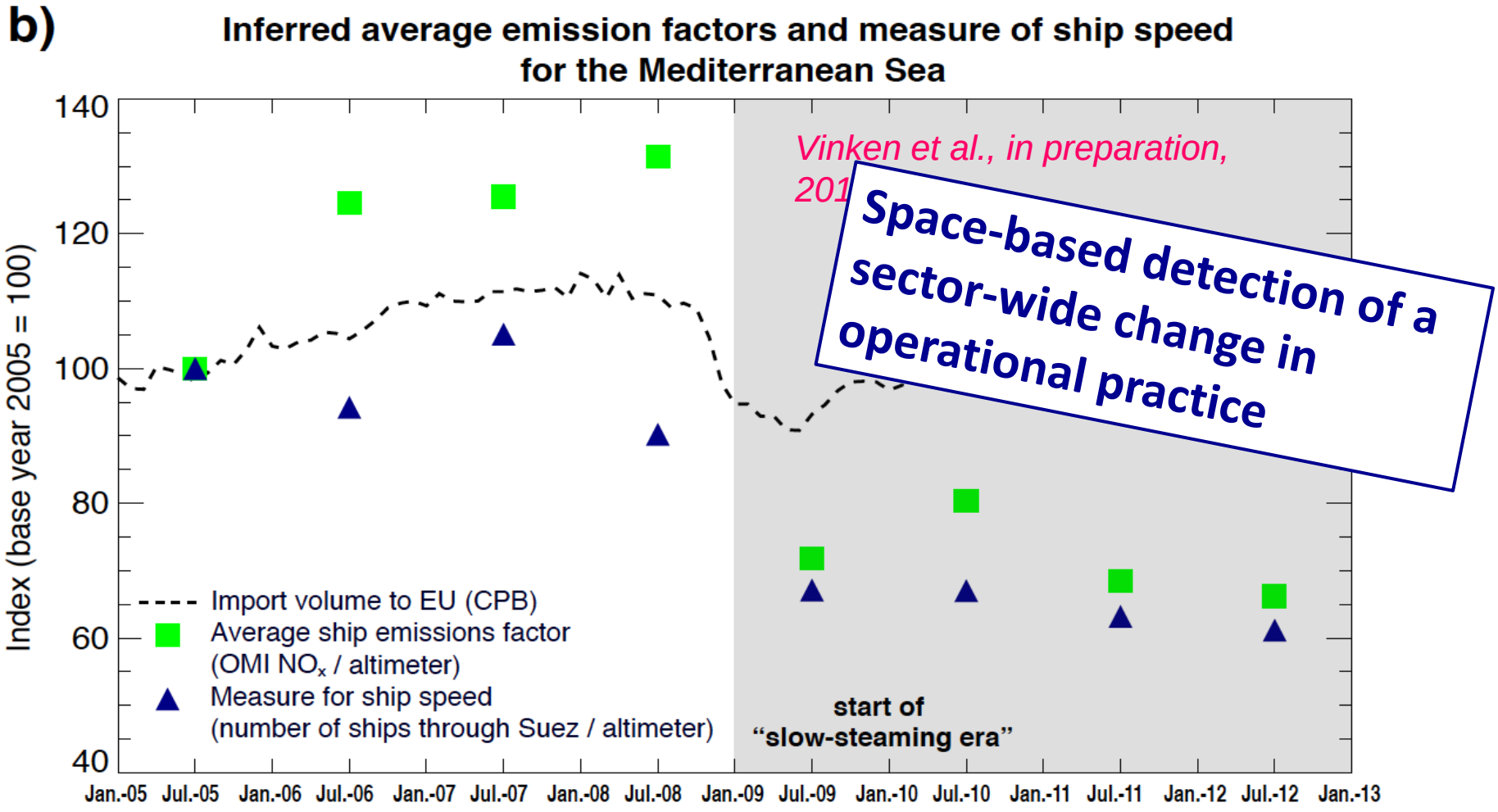


Select days without clouds and without outflow of continental pollution

1. NO_x emission trends 2005 - 2012



1. NO_x emission estimates from ships in Europe



Normal (20-25 knots; 37 – 46 km/hr) **Slow steaming** (14-20 knots; 25 – 37 km/hr)

QA4ECV and C3S

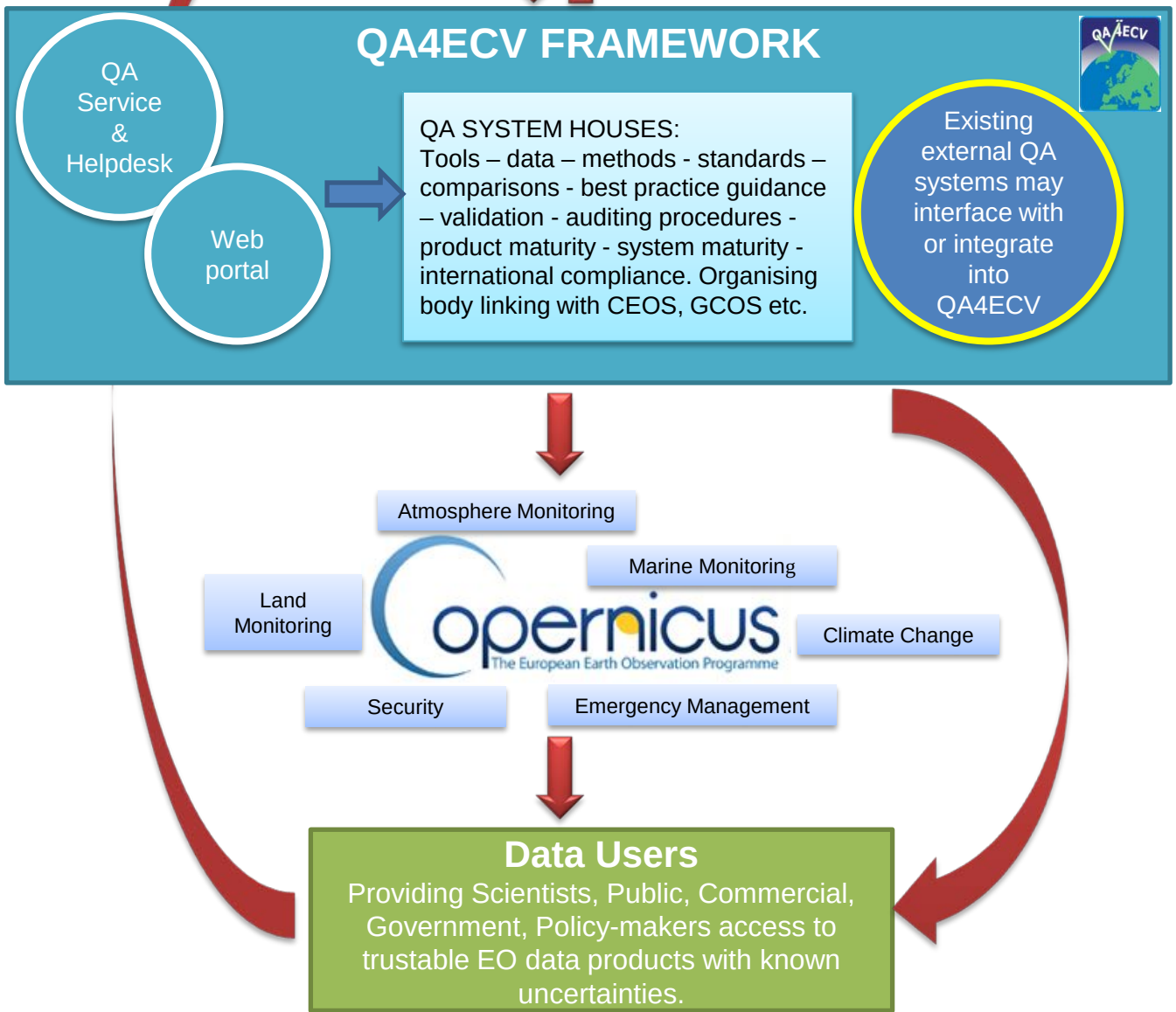
Demo best practices in QA4ECV will be useful to C3S

The top-level tools developed:

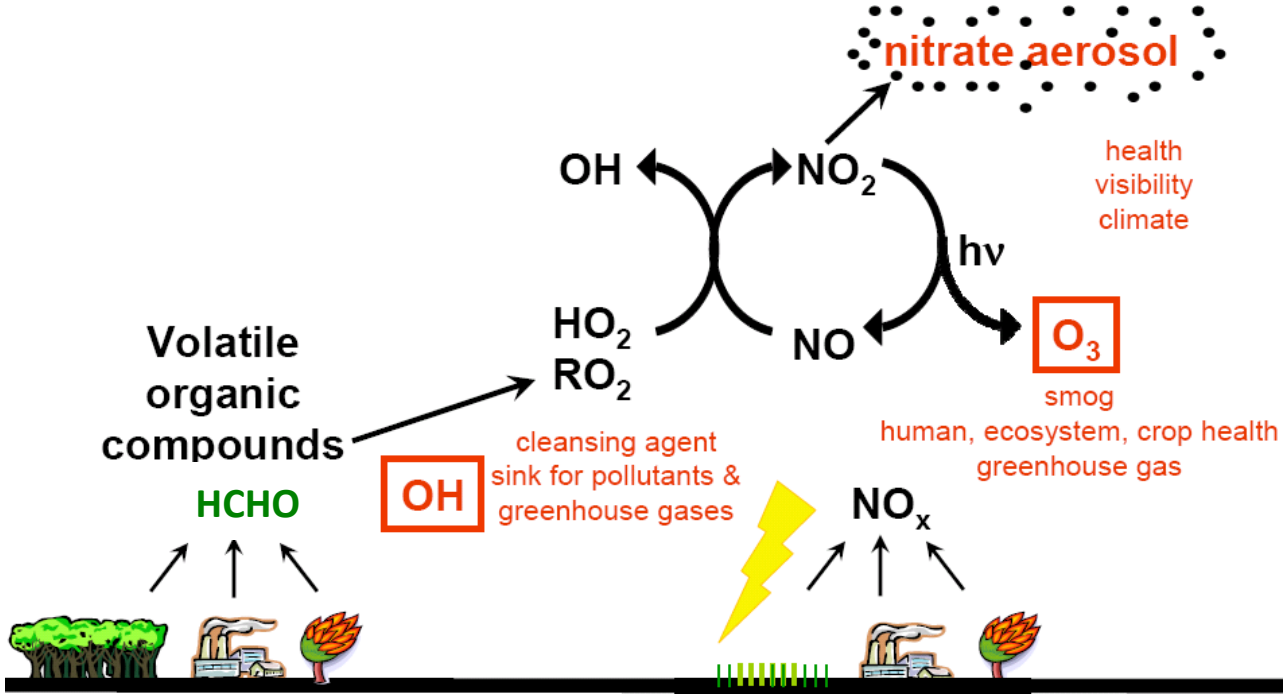
- Traceability assessment & visualisation (uncertainty propagation);
- Templates for evaluating and presenting uncertainty for ECVs
- Best practise on QA of validation data (comparisons how to run/analyse etc);
- How to document ECV to demonstrate QA in consistent manner will all be useable by any ECV.

Copernicus Services should develop direct link with the projects to make best use of the outcomes.

Potential interaction mechanism



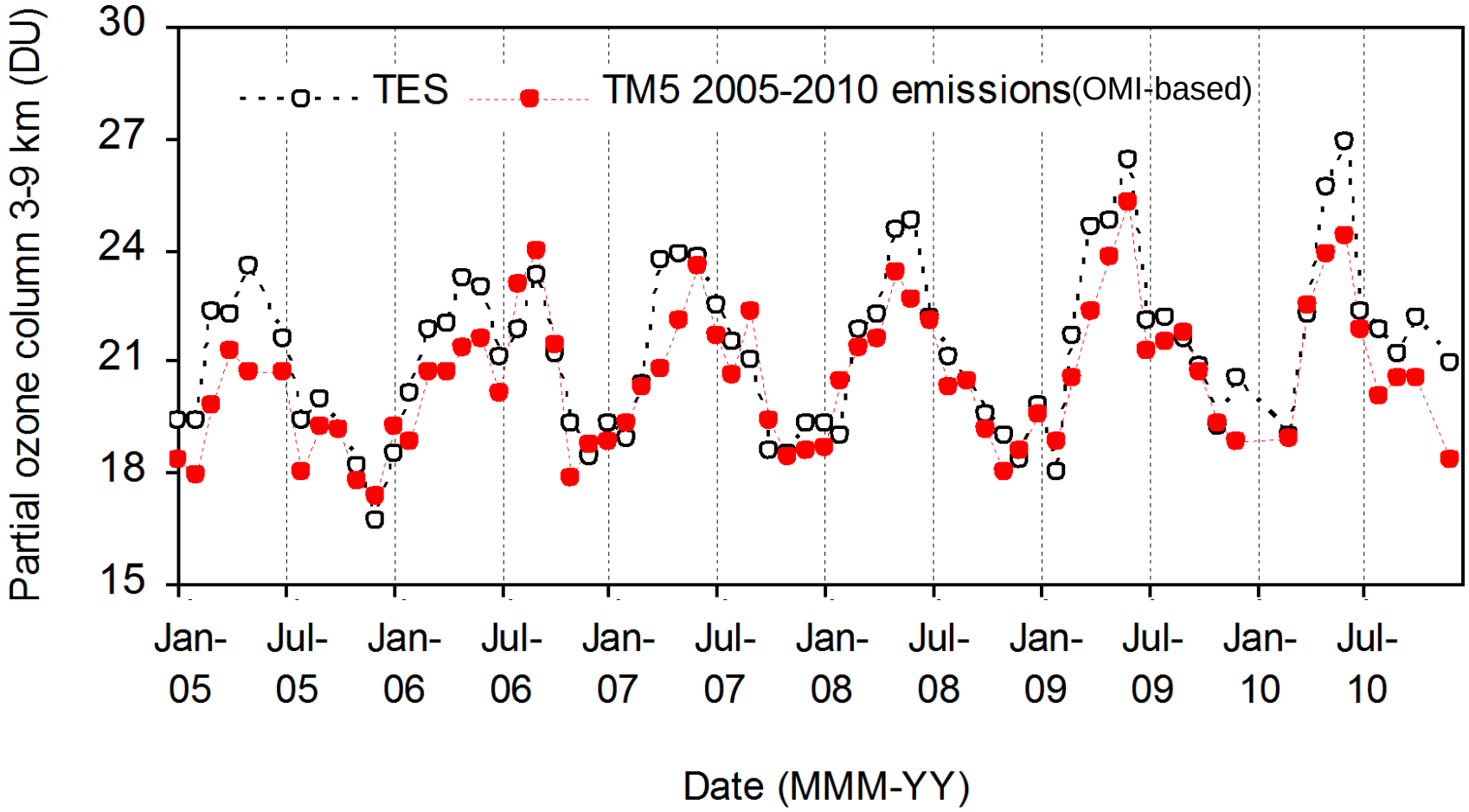
… illustrate need for O3A precursors



To understand what drives O_3 and aerosol concentrations, any atmosphere monitoring service needs precursor gases

- For composition and AQ monitoring
- For global anthropogenic and biogenic emission evaluation
- For model evaluation
- Highly relevant for mitigation strategies

Without NO_2 we do not understand strong changes in tropospheric O_3



TM5 reproduces TES O_3 trend only if OMI-based NO_x emissions are taken into account

QA4ECV project

- 4-year EU FP7 Space project (2014 – 2017)
- Led by KNMI with 17 contributing institutions

How does the project exceed the current state of knowledge?

Currently, there is no coherent and consistent framework for quality assurance of satellite data in place. QA4ECV will develop such a system for ECVs, tied to SI-standards. The project will also provide consolidated, multi-decadal ECVs for which no consistent long-term time series exists yet. These atmosphere and land ECVs will include the uncertainty information needed to make full use of them.

Why is this project important for Europe and how does it benefit European citizens?

QA4ECV will help scientists and policy makers in judging the usefulness of satellite data. This is especially important for policy makers who are increasingly relying on Earth Observation (EO) data to make decisions on mitigating and adapting to climate change. These decisions need to be 'evidence-based' and this requires complete confidence in EO-derived products.

Involved partners

UCL
NPL National Physical Laboratory
Centre for Carbon Measurement
Brockmann Consult GmbH
Joint Research Centre — The European Commission's in-house science service
FastOpt
rayference
CGI
s[&]t
ULB Université Libre de Bruxelles
CSIC Consejo Superior de Investigaciones Científicas
Wageningen University Wageningen UR
Royal Netherlands Meteorological Institute — Ministry of Infrastructure and the Environment
Universität Bremen
aeronomie.be
Max-Planck-Institut für Meteorologie

Land experts

Atmosphere experts

QA4ECV is a partnership of:

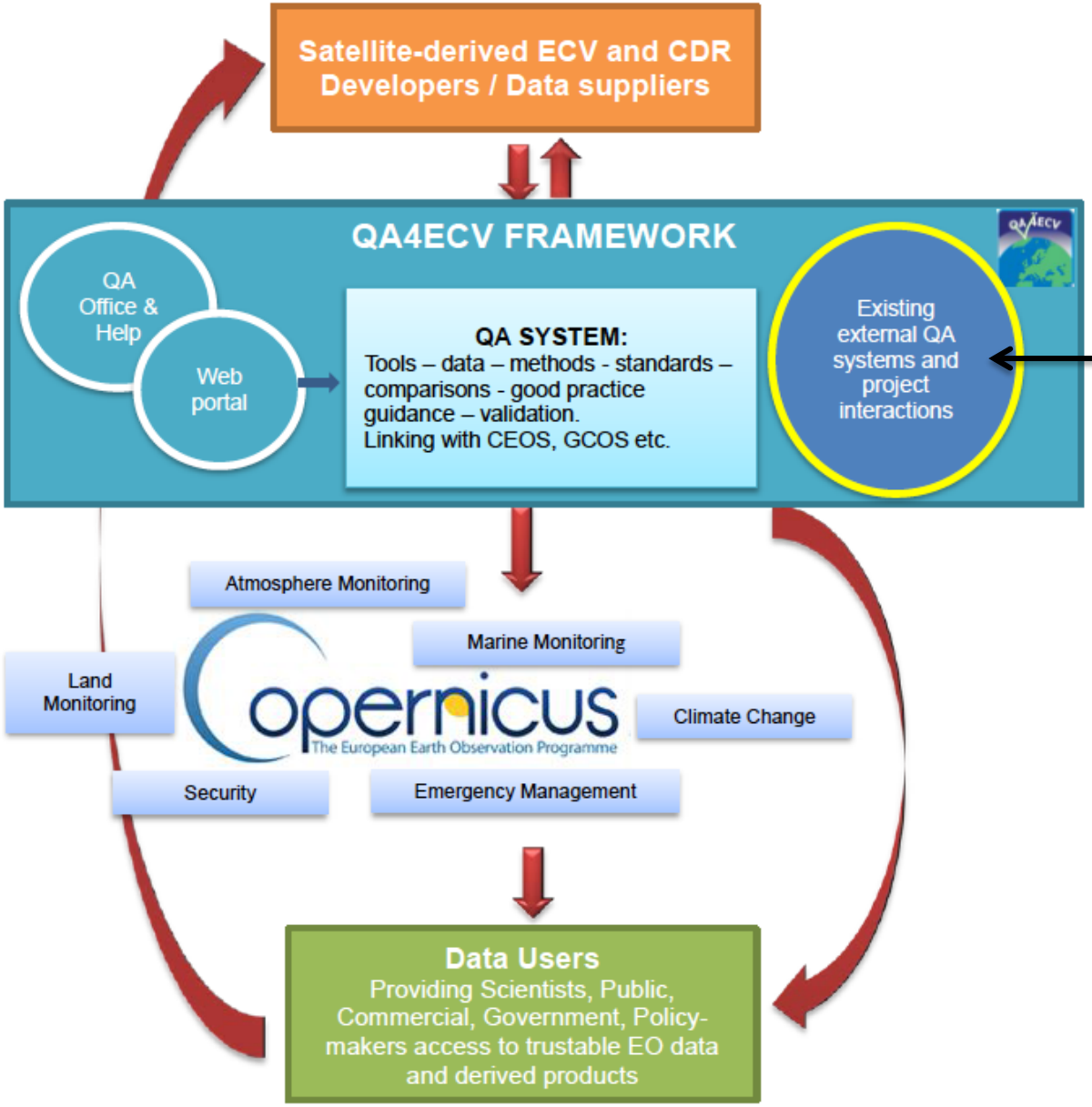
- European scientists
- data providers
- developers of future climate services
- national standards institute
- international organisations

18 partners

6 European countries

UK:	3
Netherlands:	3
Belgium:	3
Germany:	5
Spain:	1
Greece:	1
International:	2

QA4ECV interaction mechanism

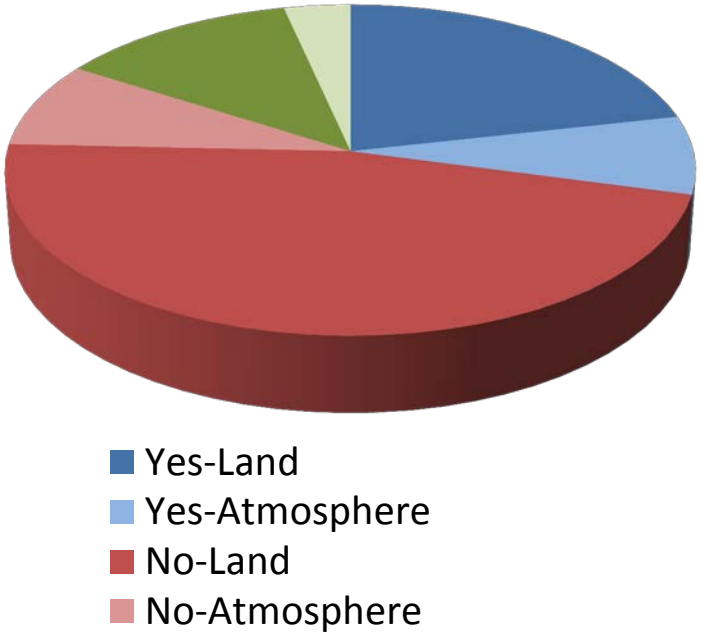


Integrate lessons from ESA CCI, CHARMe, GECA/NORS, CLIP-C, CORE-CLIMAX, GAIA-CLIM, FIDUCEO

Traceability

- 90% of users say that it is important/very important to known the processing chain

- Is the processing chain information easily accessible?

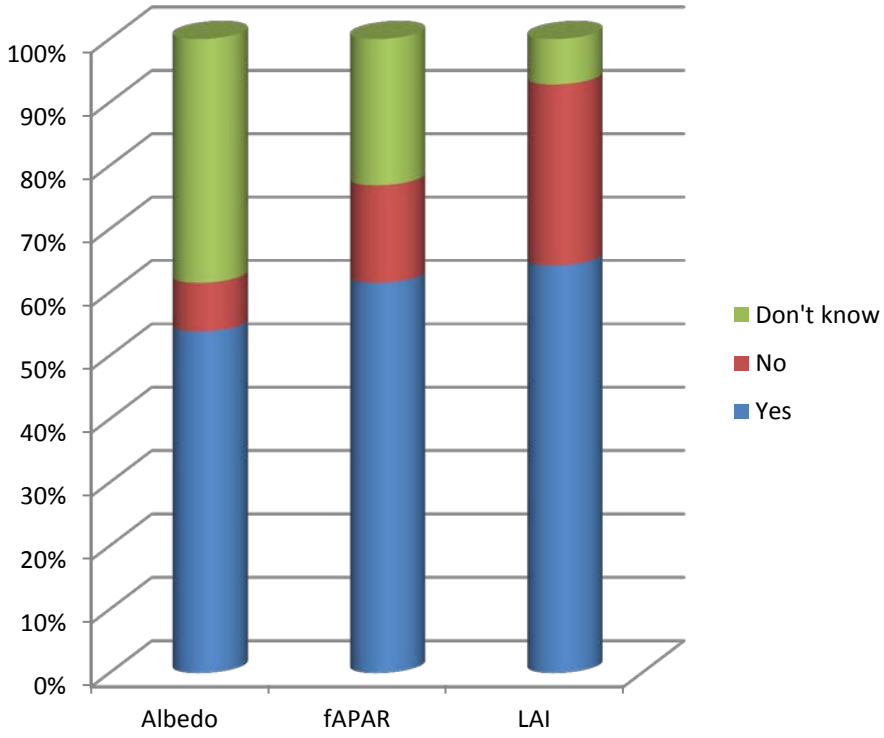


- 95% of users would use the data if it were accessible

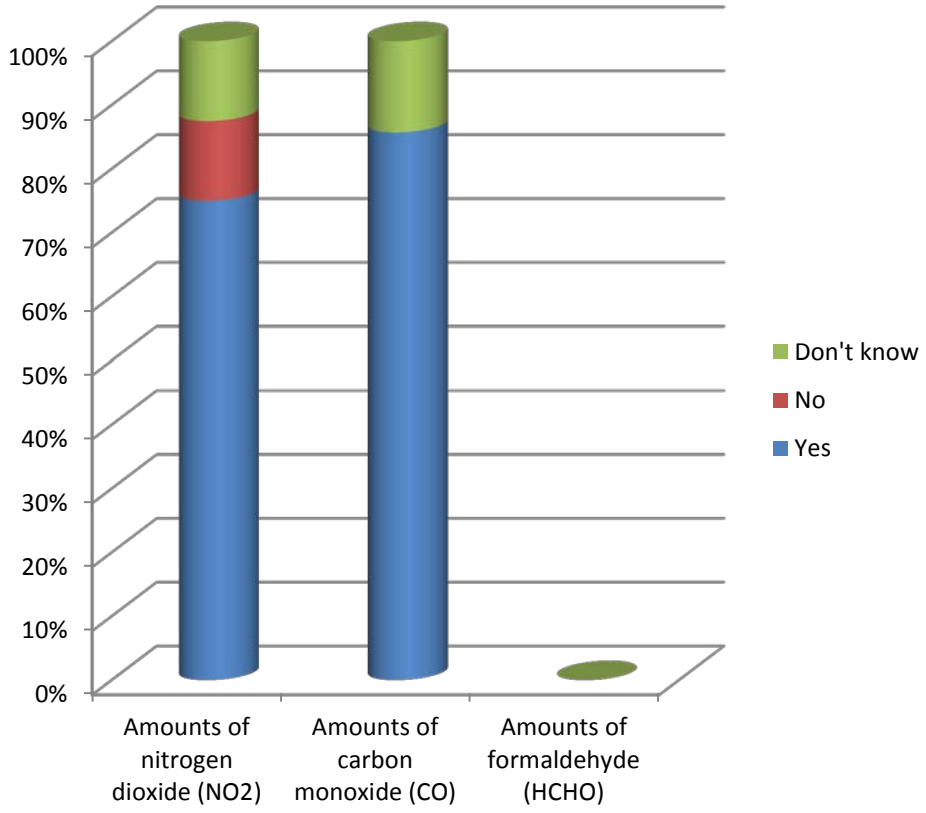
http://www.qa4ecv.eu/survey

Validation

- Are the products you use validated?



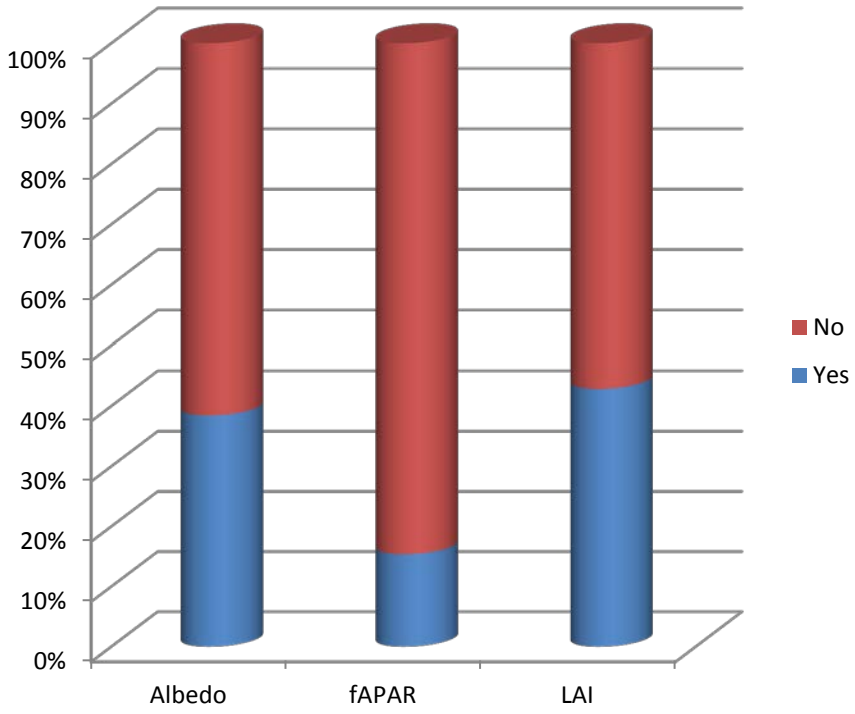
Land products



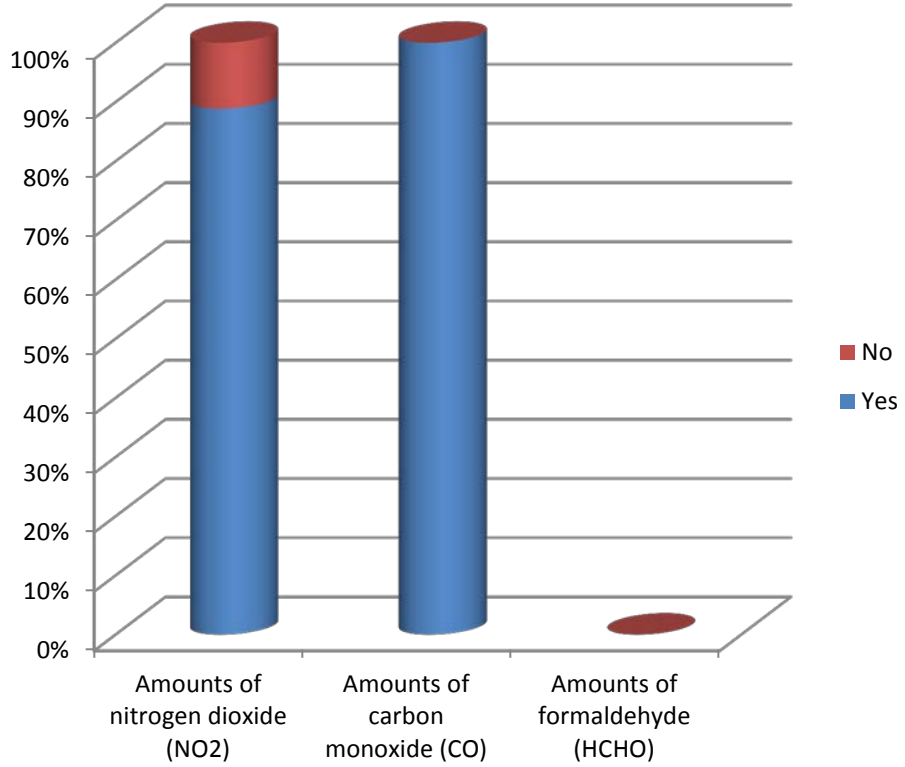
Atmosphere products

Uncertainty

- Do the products you use include uncertainty values/statement of confidence?



Land products



Atmosphere products

D. Data product quality (Q14)

Would your product benefit from adherence to ISO Information Quality Standards, which details the principles for quality evaluation and QA methodologies?

"Would be too stringent"
"We are really not there yet"
"ISO information quality standards are too abstract"
"ISO standards bear too little relation to the retrieved products "
"Link product quality to a known standard (not ISO) is a better idea"
"in the future"
"reservation due to the additional workload necessary for accreditation"
"our products are already inter-compared in the scientific community. They plan not adhere to an ISO but are defining their own quality certificates"
"Don't know"

Not a single, unambiguously positive answer

4. How can CHARMe elements support QA4ECV?

CHARMe could be helpful to:

- Help to collect/publish uncertainty and traceability info by:
  - Creating annotations for the 6 QA4ECV ECVs in controlled environment;
  - Help document the quality assurance for the 6 ECVs now,
  - and maybe for many ECVs in the future.
- CHARMe can develop into first qualitative step to judge fitness-for-purpose;
- QA4ECV provides the quantitative basis for fitness-for-purpose.