

QA4ECV

Prototyping a Quality Assurance system for Essential Climate Variables

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A response to FP7 2013 Space Call

- Developing traceable quality assurance methods for ECVs
 - “methodologies [...] should be based on the concept of traceability as it is used in metrology.”
 - “wherever possible traced to reference standards of SI derived units”
 - “providing information on the quality and “fit for purpose” nature of the respective climate dataset as potential important metadata for policy relevant information in the context of the DG CLIMA clearinghouse.”
- Generating multi-decadal satellite-derived global ECV records
 - “proposed quality assurance methodologies should be applied to the ECV records [...] to assess their compliance with GCOS criteria”



**QA4EO Principle**

Data and derived products shall have associated with them a fully traceable indicator of their quality

Quality Indicator

A Quality Indicator (QI) shall provide sufficient information to allow all users to readily evaluate the “fitness for purpose” of the data or derived product

Traceability

A QI shall be based on a documented and quantifiable assessment of evidence demonstrating the level of traceability to internationally agreed (where possible SI) reference standards

- EO data quality strategy initiated in 2008 by “space-community” on behalf of GEO to facilitate interoperability for the GEOSS
- Applicable to all EO activities including *in-situ* (suborbital) and modelling
- Quality does not have to be “best”, but “simply” quantified and documented

<http://QA4EO.org>



Identifier	Description
QA4EO-QAEO-GEN-DQK-001	A guide to establish a Quality Indicator on a satellite sensor derived data product
QA4EO-QAEO-GEN-DQK-002	A guide to content of a documentary procedure to meet the Quality Assurance requirements of CEOS
QA4EO-QAEO-GEN-DQK-003	A guide to "reference standards" in support of Quality Assurance requirements of QA4EO
QA4EO-QAEO-GEN-DQK-004	A guide to comparisons - organisation, operation and analysis to establish measurement equivalence to underpin the Quality Assurance requirements of QA4EO
QA4EO-QAEO-GEN-DQK-005	A guide to establishing validated models, algorithms and software to underpin the Quality Assurance requirements of QA4EO
QA4EO-QAEO-GEN-DQK-006	A guide to expression of uncertainty of measurements
QA4EO-QAEO-GEN-DQK-007	A guide to establishing quantitative evidence of traceability to underpin the Quality Assurance requirements of QA4EO

Community-specific guidelines [Click to close](#)

Identifier	Description
QA4EO-WGCV-IVO-CLP-001	Use of the Moon for in-flight calibration stability monitoring
QA4EO-WGCV-IVO-CLP-002	Protocol for the CEOS WGCV Comparison of techniques/instruments used for surface IR radiance/brightness temperature measurements
QA4EO-WGCV-IVO-CLP-003	A procedure for establishing a "land-based" reference standard test-site

QA4ECV in brief

- EC FP7 project (02.2014 - 01.2018)
- Coordination:
 - F. Boersma (KNMI) => ATMOSPHERE (NO₂, HCHO, CO)
 - J.-P. Muller (UCL) => LAND (albedo, LAI, FAPAR)
- 17 research institutes, SMEs and international organizations, including QA4EO board members
- Involvement of NDACC/UVVIS, NDACC/IR and TCCON partners



Project objectives

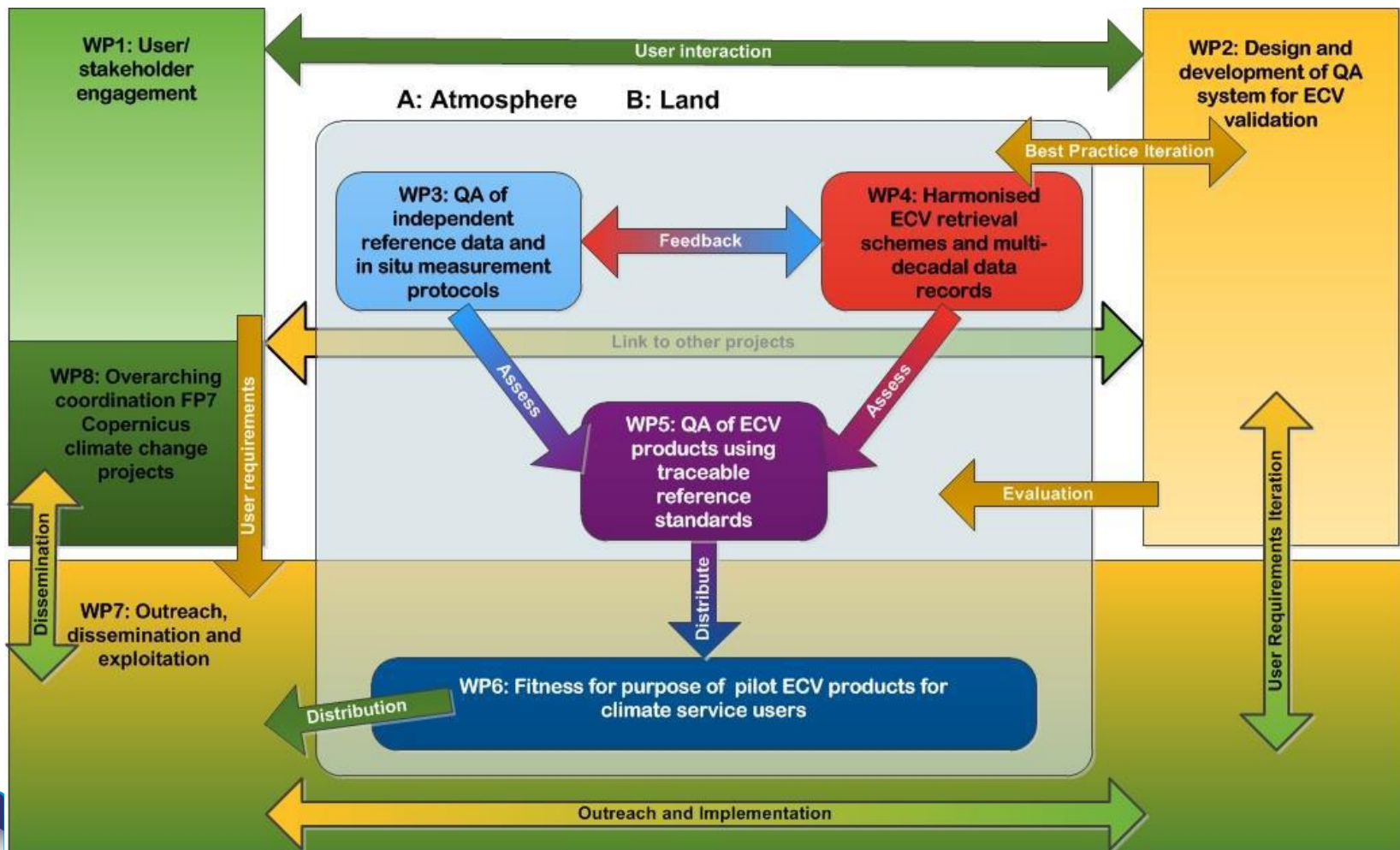
1 Develop traceable quality assurance methods for ECVs including:

- 1.1 A robust, generic and trustable system for quality assurance (QA) of satellite retrievals, data products, and in situ retrievals that can be applied to many ECVs as a prototype of a sustainable service.
- 1.2 Multi-use QA tools (software, procedures, analysis) and SI/community traceable standards to support the climate science community to implement consistent QA processes on their own satellite-derived products.
- 1.3 An independent verification framework, capable of assessing the quality characteristics of input data, processing algorithms and resultant products for both external suppliers and customers of ECV product development teams.

2 Generate multi-decadal satellite-derived global ECV records including:

- 2.1 Multi-decadal Climate Data Records (CDR) for terrestrial ECVs and atmospheric ECVs that are based on satellite calibrated data, state of the art retrievals and are fully traceable with uncertainty metrics ready for ingestion into models.
- 2.2 Testable evidence of their uncertainty metrics using both quality assured algorithms and product validation at a per pixel level. Meta data on the ECV and in situ retrievals will be provided.





Task Leader	Deputy leader	Responsibility	Main Tasks
ATMOSPHERE AND LAND			
Ronald van der A, KNMI	Emma Woolliams NPL	User engagement (WP1)	Communication with ECV users and producers, coordination of dissemination activities, ensure interaction with WP2
Nigel Fox, NPL	Anne De Rudder, IASB-BIRA	Development QA system for ECV (WP2)	Coordination of QA system development activities. Ensure interactions with WP1 (user/other project interaction) and WP3-5 (ECVs).
Michel Van Roozendaal, IASB-BIRA	Jean-Luc Widlowski, JRC	QA of independent reference data and retrieval algorithms (WP3)	Coordination of quality assurance for independent reference data sets and ECV retrieval algorithms Ensure availability of reference data
Jan-Peter Muller, UCL	Folkert Boersma, KNMI	Harmonised ECV retrieval schemes and multi-decadal data records (WP4)	Coordination of the modelling activities Ensure availability of model results for dissemination and validation
Jean-Christopher Lambert, IASB-BIRA	Nadine Gobron, JRC	Validation of multi-decadal ECV data using the QA system (WP5)	Coordination of the application of QA system to Land and Atmosphere ECV retrievals and CDRs
Alexander Loew, MPG	Andreas Richter, IUP-UB	Fitness for purpose of ECV products (WP6)	Coordination of the fitness for purpose evaluation activities, GCOS compliance and user services.
Ronald van der A, KNMI	Carsten Brockmann, BC	Outreach, dissemination and exploitation (WP7)	Create a communication forum and web-portal for all stakeholders, QA training. Develop user services, implement advice Advisory Committee
Albert Klein Tank, KNMI	Folkert Boersma, KNMI	Overarching coordination FP7 Copernicus climate change projects (WP8)	Information exchange between 5 FP7-projects and outside world, joint stakeholder liaison activities, coordinated approach of relevant Commission DGs
Folkert Boersma, KNMI	Jan-Peter Muller, UCL	Project Scientific and Technical coordination (WP9)	Co-ordinate Land & Atmosphere teams and their interfacing, coordination Land with Atmosphere QA aspects.

<http://www.qa4eo.org/survey/>

Survey

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

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!

Enter Survey

Project Partners: IASB - BIRA, IUP - UB, MPG, ULB, AUTH, CSIC, TU/e, S&T, UCL, JRC, EUMETSAT, BC, FASTOPT, Govaerts Consulting, NPL and CGI



QA4ECV User Workshop held in Vienna at EGU 2014



QA system: Generic

- Design of generic QA framework for ECVs

*Traceability: property of a measurement result whereby the result can be related to a **reference** through a **documented unbroken chain of calibrations**, each contributing to the measurement **uncertainty** (ISO)*

- Traceability chains of ECV production
- Traceability chains of QA/validation process
- Prototype generic QA system/service elements: Standards, methods, tools

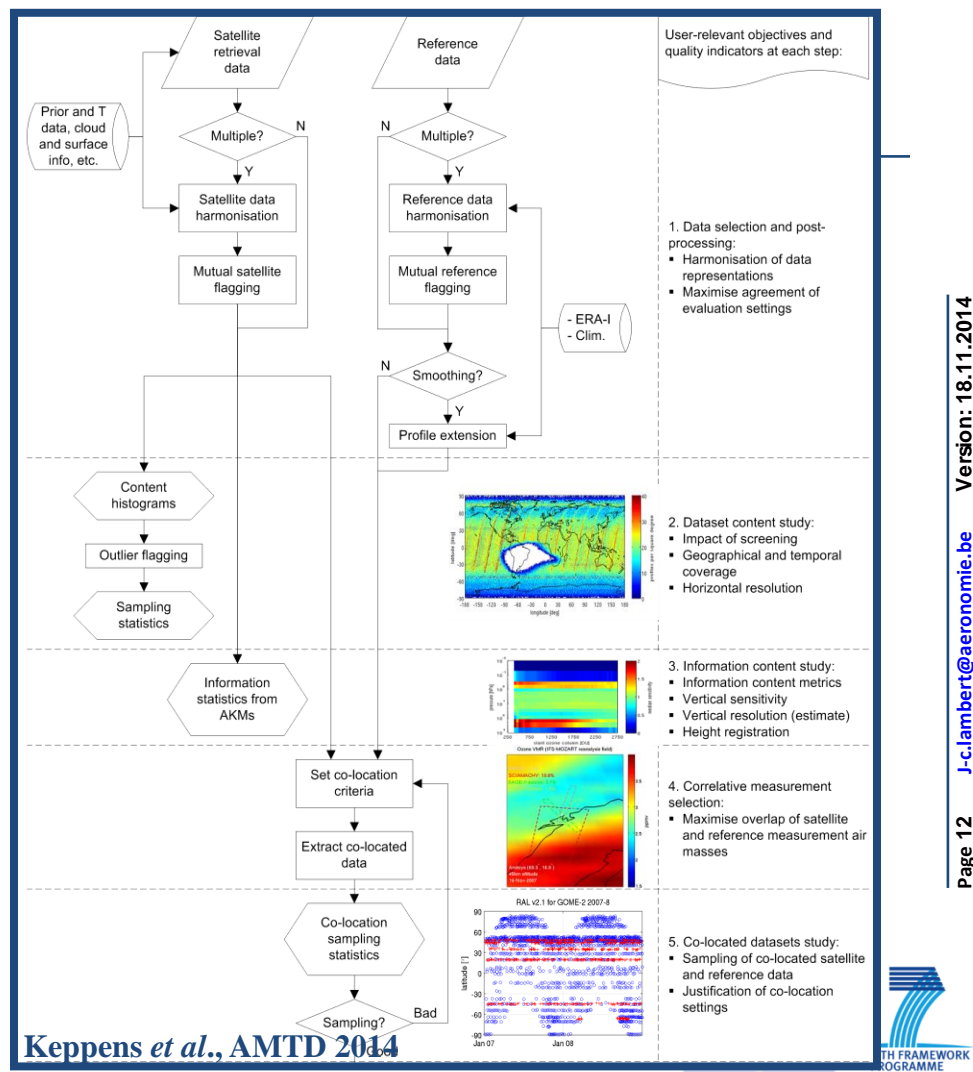




Traceability of the QA/validation process

Example: validation of
nadir ozone profile
retrievals

(Talk by A. Keppens yesterday)



Traceability chain of validation

Keppens *et al.*, AMTD 2014

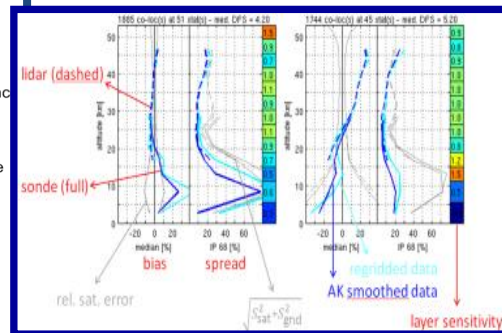


* u_S , u_C , and u_R for satellite, comparison, and reference units, respectively.

** Regridding only, or regridding including function smoothing (Gaussian, triangular, others). Regridding possibly by summation for sub-columns.

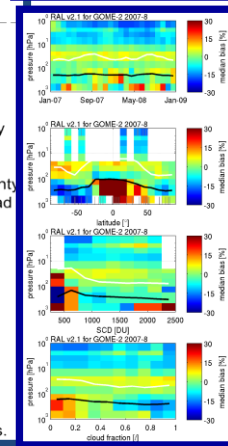
6. Vertical resampling of reference profiles:

- Common vertical grid
- Apply satellite measurement smoothing to reference profile



7. Comparisons:

- Difference average (bias) as measure for satellite accuracy
- Total satellite uncertainty estimation by combining bias and random satellite uncertainty or bias and comparison spread
- Comparison bias and spread dependences on physical conditions and/or retrieval metadata
- Difference timeseries for stability analysis



CDR Maturity Matrix

Climate Data Record (CDR) Maturity Matrix						CDRP-MTX-0008 V3.0
Maturity	Software Readiness	Metadata	Documentation	Product Validation	Public Access	Utility
1	Conceptual development	Little or none	Draft Climate Algorithm Theoretical Basis Document (C-ATBD); paper on algorithm submitted	Little or None	Restricted to a select few	Little or none
2	Significant code changes expected	Research grade	C-ATBD Version 1+ ; paper on algorithm reviewed	Minimal	Limited data availability to develop familiarity	Limited or ongoing
3	Moderate code changes expected	Research grade; Meets intl standards: ISO or FGDC for collection; netCDF for file	Public C-ATBD; Peer-reviewed publication on algorithm	Uncertainty estimated for select locations/times	Data and source code archived and available; caveats required for use.	Assessments have demonstrated positive value.
4	Some code changes expected	Exists at file and collection level. Stable. Allows provenance tracking and reproducibility of dataset. Meets international standards for dataset	Public C-ATBD; Draft Operational Algorithm Description (OAD); Peer-reviewed publication on algorithm; paper on product submitted	Uncertainty estimated over widely distributed times/location by multiple investigators; Differences understood.	Data and source code archived and publicly available; uncertainty estimates provided; Known issues public	May be used in applications; assessments demonstrating positive value.
5	Minimal code changes expected; Stable, portable and reproducible	Complete at file and collection level. Stable. Allows provenance tracking and reproducibility of dataset. Meets international standards for dataset	Public C-ATBD, Review version of OAD, Peer-reviewed publications on algorithm and product	Consistent uncertainties estimated over most environmental conditions by multiple investigators	Record is archived and publicly available with associated uncertainty estimate; Known issues public. Periodically updated	May be used in applications by other investigators; assessments demonstrating positive value
6	No code changes expected; Stable and reproducible; portable and operationally efficient	Updated and complete at file and collection level. Stable. Allows provenance tracking and reproducibility of dataset. Meets current international standards for dataset	Public C-ATBD and OAD; Multiple peer-reviewed publications on algorithm and product	Observation strategy designed to reveal systematic errors through independent cross-checks, open inspection, and continuous interrogation; quantified errors	Record is publicly available from Long-Term archive; Regularly updated	Used in published applications; may be used by industry; assessments demonstrating positive value
1 & 2	Research					
3 & 4	IOC					
5 & 6	FOC					

With update and evolution from CORE -CLIMAX

QA system: Specific

ATMOSPHERE ECVs

- Pilots: NO₂, HCHO, CO
- QA/Validation system independent from ECV production chain
- Tools and prototype by S&T

LAND ECVs

- Pilots: albedo, LAI, FAPAR
- QA/Validation system integrated in ECV production chain
- Tools and prototype by CGI



Harmonisation
and synergies



Atmospheric reference data

Objective: Provide traceable quality assurance for the independent reference data used in the validation of satellite atmospheric ECV

T3.5 - Establish independent Atmosphere reference data

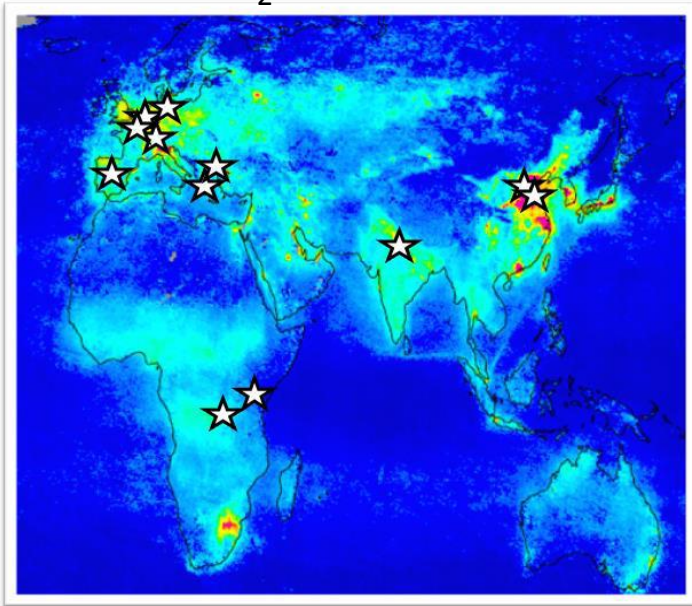
T3.6 - Quality assurance of Atmosphere reference data

T3.7 - Validation of Atmosphere reference data

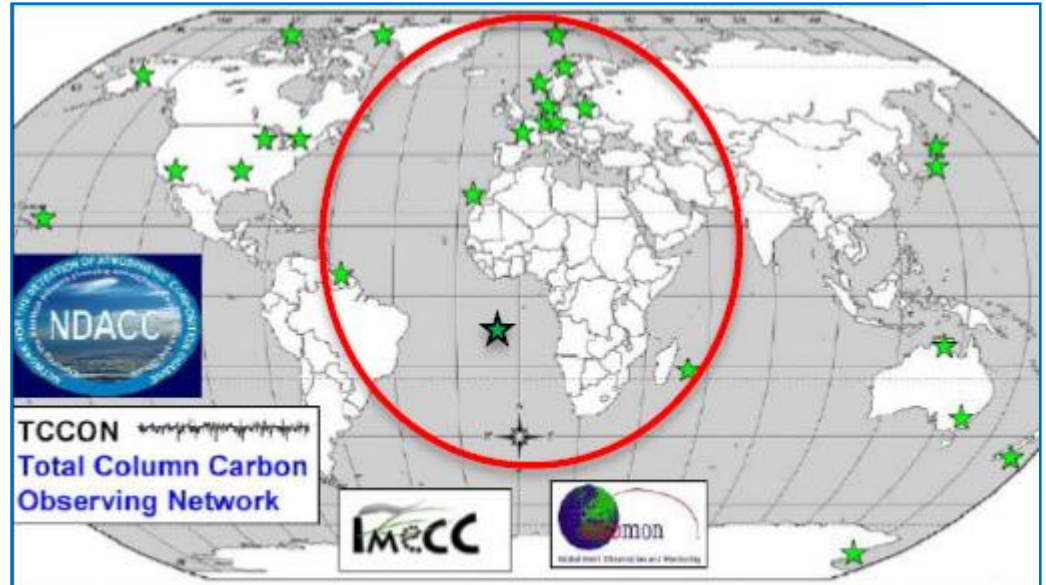


Atmospheric reference data

MAX-DOAS Network
NO₂ and HCHO



NDACC and TCCON FTIR Networks
CO



Legacy and interactions

- Legacy of NDACC and TCCON; PROMOTE, MACC, PASODOBLE; GEOmon, SECPEA/A3C, Multi-TASTE, GECA, NORS; ESA CCI
- Achieved in iteration with Copernicus climate projects, European and global community incl. ESA CCI, EUMETSAT SAFs, EEA, CEOS, INSPIRE, CHARMe, CORE-CLIMAX, MACC-III/CAMS, GAIA-CLIM, GIO Global Land...

THANK YOU !