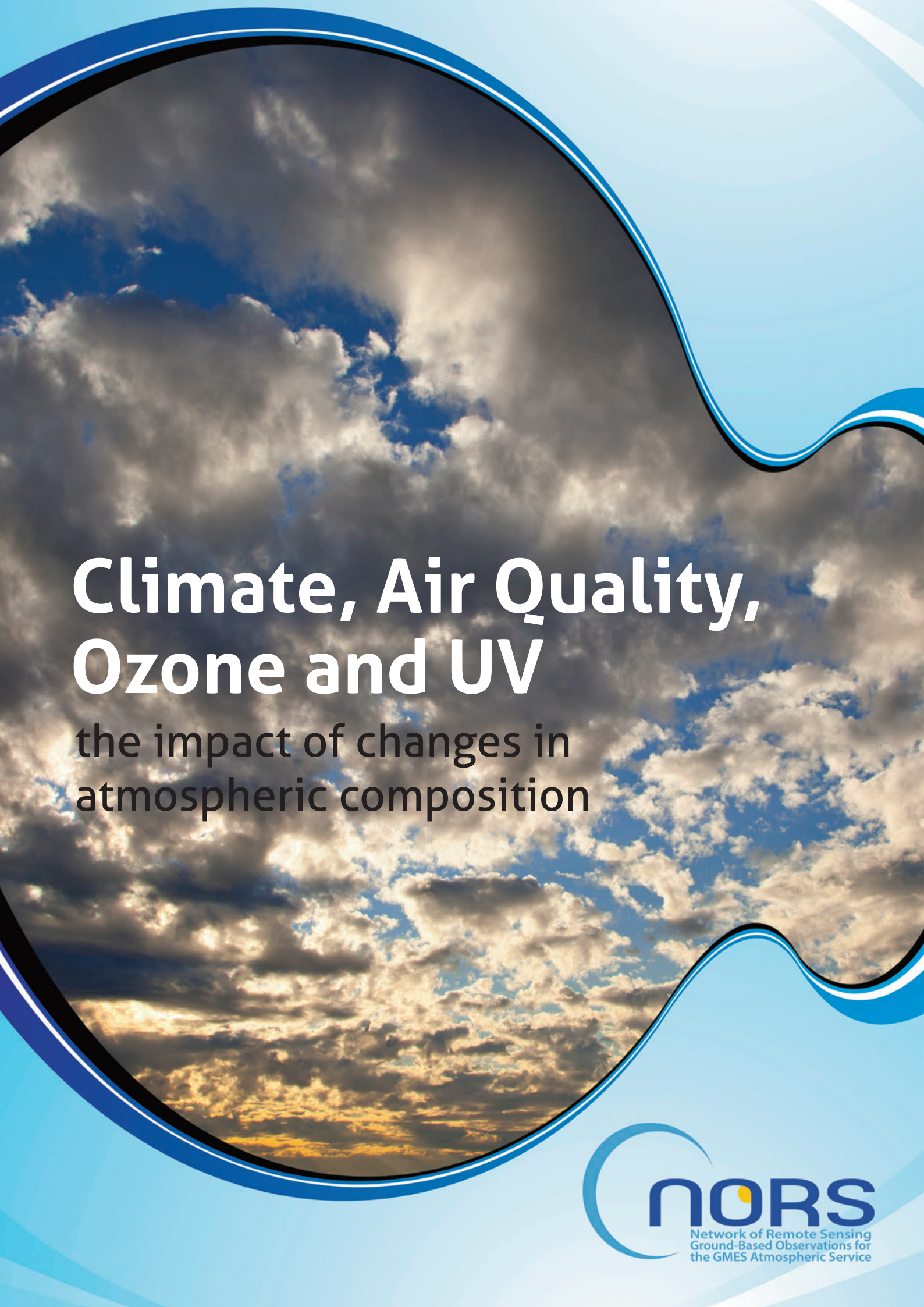


Climate, Air Quality, Ozone and UV

the impact of changes in atmospheric composition

nORS
Network of Remote Sensing Ground-Based Observations for the GMES Atmospheric Service

Copernicus – observing the Earth

Adjacent Digital Politics Ltd examines the European Union's efforts to study, monitor, and research the Earth's atmosphere…

A long-term objective of the European Union is to achieve levels of air quality that does not result in unacceptable impacts on, and risks to, human health and the environment.

In Europe, emissions of many air pollutants have decreased substantially over the past decades, resulting in improved air quality across the region. However, concentrations are still too high, and air quality problems persist.

The EU acts at many levels to reduce exposure to air pollution: through legislation; cooperation with sectors responsible for air pollution, as well as international, national and regional authorities and non-governmental organisations; and research. EU policies aim to reduce exposure by reducing emissions and setting limits and target values for air quality.

The European Environment Agency (EEA) is actively involved in the monitoring and research of air pollution and acts as the European Union's air pollution data centre. The centre provides access to data and information related to the amount of air pollutants emitted into the atmosphere from different anthropogenic sources as well as measured ambient air pollution at monitoring stations across Europe. Priority is given to providing policy-relevant data and information for European and national institutions, professionals, researchers and the public. It supports the implementation of EU legislation linked to air emissions and air quality.

EEA's work focuses on:

- Making a range of air pollution data publicly available;
- Documenting and assessing air pollution trends and related policies and measures in Europe, and;
- Investigating the trade-offs and synergies between air pollution and policies in different areas, including climate change, energy, transport and industry.

In 2013 Europe's air was a central theme of work at the EEA, with several assessments looking at issues related to gases, liquid droplets and solid particles polluting the atmosphere in many parts of Europe. Assessments from the EEA fed into a review of European Union air policy, which resulted in a 'Clean air policy package' introducing several new legislative proposals.

Scientific understanding of air pollution is improving. More sensitive measurements are demonstrating that air pollution is more serious than previously thought, while at the same time, medical science is showing the extent it affects people.

Atmospheric research is delivering the essential data required to analyse the air we breathe with funding from the European Union. Under the FP7, research and development activities were supported up to 2014, but now we are entering the Horizon 2020 phase with €80bn of funding for research as an investment in our future.

A key project within the atmospheric monitoring sector is Copernicus – formerly titled Global Monitoring for Environment and Security (GMES). It is a joint initiative of the European Commission and European Space Agency (ESA), aiming to provide an autonomous and operational Earth observation capacity.

The objective of the Copernicus programme is to rationalise the use of various sources of data in order to provide quality up-to-date information, services and knowledge and provide an overall picture of the Earth's atmospheric conditions. By providing in-depth information, Copernicus should allow policy-makers within the European Union to prepare legislation on environmental concerns, and enable effective monitoring.

The geo-spatial information services offered by Copernicus can be grouped into 6 main interacting themes: land, ocean, emergency response, atmosphere, security and climate change. The first 3 Copernicus services under the land, ocean and emergency response themes and 2 additional services addressing the atmosphere and security themes were unveiled at the Copernicus Forum held in Lille in September 2008. The services support a wide range of applications including environment protection, management of urban areas, regional and local planning, agriculture, forestry, fisheries, health, transport, climate change, sustainable development, civil protection and tourism.

The ESA is providing a well-engineered Space Component for the provision of Earth-observation data to feed into a range of services for monitoring the environment and supporting civil security activities.

The Copernicus Space Component comprises 2 types of satellite missions, ESA's five families of dedicated Sentinels and missions from other space agencies, called Contributing Missions. A unified ground segment, through which the data is streamed and made freely available for Copernicus services, completes the Space Component.

In November 2013, free and open access to Sentinel satellite data was granted for the Copernicus operational phase.

The European Delegated Act on Copernicus data and information policy entered into force, providing free, full and open access to users of environmental data from the Copernicus programme, including data from the Sentinel satellites.

Studies show that Copernicus could generate a financial benefit of some €30bn and a minimum of about 50,000 new jobs by 2030.

"The free and open Sentinel data policy will be a breakthrough in the use of satellite data for specialised users, but also for the general public," said Josef Aschbacher, Head of the ESA Copernicus Space Office.

He added that: "It will create innovative solutions, such as providing satellite-based information on air or water quality for everyone."

References:

European Environment Agency

European Space Agency

www.copernicus.eu

NORS

Demonstration **N**etwork **O**f ground-based **R**emote **S**ensing Observations in support of the Copernicus Atmospheric Service

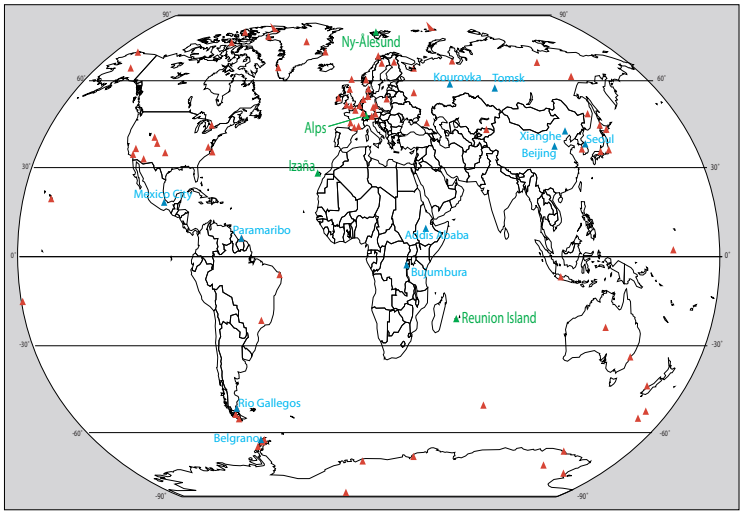
What is NORS about?

NORS is an FP7 R&D project (grant agreement 284421) that is funded in support of the pre-operational Copernicus Atmosphere Service (CAS), with the aim of improving the Service.

NORS focuses on assessing and improving the quality of the CAS products, currently delivered by the MACC-II project (www.copernicus-atmosphere.eu), by improving and enhancing the use of ground-based remote sensing data of atmospheric composition for independent validation of the CAS products, in the following three ways:

- by improving the quality and consistency of the ground-based remote sensing data and their suitability for validation purposes,
- by improving the timely delivery of the ground-based remote sensing data,
- by developing a Web-based validation server that performs comparisons between CAS products and NORS reference data in an automatic way, according to the atmospheric community's best practices [1 and references therein].

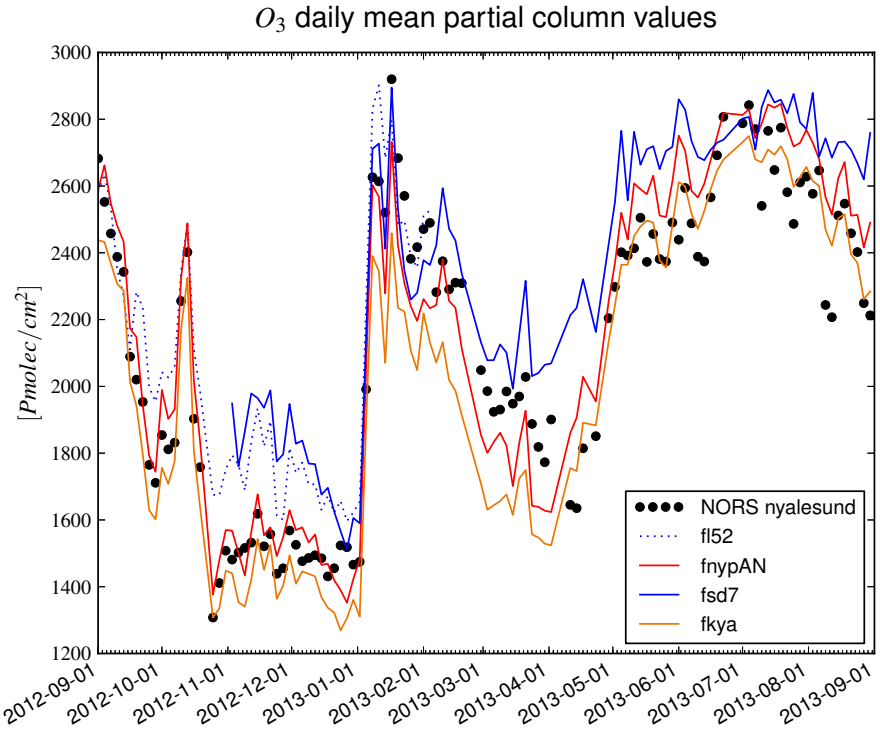
NDACC Sites



▲ Operational NDACC stations
▲ NDACC stations selected as pilot stations in NORS
▲ Stations to be developed in NORS to potentially become NDACC stations

The ground-based remote sensing network underlying NORS is the Network for Detection of Atmospheric Composition Change (NDACC), which is a research network, operated in a coordinated manner since 1991, with more than 70 observatories worldwide (www.ndacc.org). NORS demonstrates its goals starting from 4 pilot NDACC stations and a selection of target products, but it is preparing the extension to more/all NDACC sites and products.

In more detail



Typical example of validation results: figure showing the comparison between ozone column data in the altitude range 25-60km above Ny-Alesund, Norway, from NORS microwave data (black dots) versus different MACC-II models (blue and red solid and dotted lines)

1) For improving the quality and consistency of the ground-based remote sensing data, they have been optimized and harmonized across the network, they have been better documented and their uncertainties have been evaluated, and new products are under development.

2) For improving the timely delivery of the ground-based remote sensing data, the NORS partners have committed themselves to delivery within 1 month from data acquisition at latest (some are already doing it faster). They have established more automatic data processing and submission procedures, and the standard GEOMS HDF format (http://avdc.gsfc.nasa.gov/GEOMS). Under the impulse of NORS, additional NDACC partners are adopting similar approaches and are achieving rapid data delivery.

3) A Web-based validation server has been built. It collects the data from the CAS and from NORS/NDACC on a daily basis and generates automatically comparison reports (plots and statistics). All algorithms used in the comparison tool chain will be open source; they are documented in a paper to be published in the peer-reviewed literature. They are compliant with the atmospheric community's best practices [1]. Reports generated by the NORS validation server have already been used in the MACC-II Validation Reports [2].

As such, the scientists and users involved with CAS and with NDACC get automatic feedback concerning their data: they can easily detect deficiencies from which guidance towards the required improvements can be derived.

The NORS server is publicly accessible at:
http://nors-server.aeronomie.be.
It can also be accessed via the MACC-II Webpages, under:
http://www.gmes-atmosphere.eu/services/aqac/global_verification/

In summary

NORS is designed to demonstrate an operational validation of CAS products using tailored data from NDACC, based on four pilot stations and a few target species (gases and aerosols). The longer-term goal is to get the whole Network and new candidate stations involved, and to expand the set of target species to all species monitored in NDACC and of interest to the Copernicus Atmospheric Service.

How does this project benefit European citizens?
By enhancing the quality of the CAS products, NORS will help improving our knowledge of our atmosphere and its evolution. As such, Europe will be able to face environmental challenges – which have a significant socio-economic impact – with better confidence.

Why should NORS be sustained on the long-term ?
The Copernicus Atmospheric Service products are of no value if their quality is not assessed and characterized [3]. The quality assessment and characterisation must continue throughout the lifetime of the CAS, knowing that the CAS products evolve continuously. The evolution of the CAS products is a must as new satellite data become available, new model developments need to be integrated, and as new and/or updated user requirements appear [3].

Such continuous quality assessment requires the continuous, long-term availability and delivery, on an operational and fast basis, of independent, high-quality, appropriate and well-documented, reference data.

The timely provision of such reference ground-based remote sensing network data from the international Network for the Detection of Atmospheric Changes (NDACC) for quality assessment of the CAS products, and the implementation of facilities for performing this quality assessment in an operational mode is exactly what has been set up in the EU NORS FP7 project and needs to be continued.

Additional benefits of sustaining NORS
An important additional achievement of NORS is the enhanced value (timeliness, consistency, characterization etc.) of the NDACC data, not only for validation purposes but also for environmental monitoring purposes. Moreover, at some points in time, when a satellite stops functioning, NDACC data may be the only ones that provide essential information about certain atmospheric constituents – e.g. for comparison with model data – and are the ones that guarantee continuity between the lost satellite and the follow-up one. This is a supplementary argument for sustaining NDACC as an essential component in the Copernicus Atmosphere Core Service.

It should be noticed that the Validation Server has been built in such a way that non-standard comparisons can also be accommodated. With 'non-standard' we refer to different reference data (not coming from NDACC) and/or different models (not coming from the present CAS prototype).

It should also be noticed that the Web-based validation server can easily be expanded to also accommodate comparisons between the ground-based remote sensing data of NORS/NDACC and upstream satellite data, in particular the ones that are used in the MACC-II assimilation models. All comparison algorithms remain valid to a large extent. Tools for collocation between satellite data and NORS/NDACC data do exist from a former ESA GECA project (http://earth.eo.esa.int/cgi-bin/confatmos09.pl?abstract=380).

It is stated in [3] that "Monitoring the observations quality and availability is part of the (Copernicus Atmosphere) Core Service", and, "Space agencies should be responsible for calibration/validation activities with regard to (single-instrument) space observations." A NORS-type activity can provide this important asset without much additional development effort, and as such, contribute to the so-called 'observation acquisition and pre-processing' element of the Copernicus Atmosphere Core Service [3].

References

[1] EC FP7 MACC Validation Protocol, 2010, and references therein, in particular GUM: Joint Committee for Guides in Metrology (JCGM/WG 1) 100:2008, Evaluation of measurement data – Guide to the expression of uncertainty in a measurement (GUM), http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf
QA4EO – A Quality Assurance framework for Earth Observation, established by the CEOS – see http://qa4eo.org/documentation.html

[2] September issue of the MACC-II Deliverable D_82.9 'Validation report of the MACC near-real time global atmospheric composition service. System evolution and performance statistics – Status up to May 2013' which is available on the MACC-II Webpages at http://www.gmes-atmosphere.eu/services/aqac/global_verification/validation_ reports/.

[3] Global Monitoring for Environment and Security Atmosphere Core Service (GACS) Implementation Group – Final Report, April 2009.

NORS facts
EU FP7 grant agreement 284421

Duration: November 1, 2011-July 31, 2014.
An extension is under discussion

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