

Quality assessment of QA4ECV NO₂ and HCHO OMI climate data records and validation with NDACC ground-based DOAS data

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The FP7 QA4ECV (Quality Assurance for Essential Climate Variables) project has (i) established a prototype quality assurance system for the C3S (Copernicus Climate Change Service) and (ii) produced quality assured Essential Climate Variable (ECV) data records from several satellites. Here we report on a comprehensive quality assessment of two ECV precursor data records: QA4ECV NO₂ from OMI (tropospheric and stratospheric column) and QA4ECV HCHO from OMI (tropospheric column).

The quality assurance system builds on internationally endorsed standards, such as International Vocabulary of Metrology (VIM), Guide to the Expression of Uncertainty in Measurement (GUM), and the GEO-CEOS Quality Assurance framework for Earth Observation (QA4EO).

The quality assessment of satellite climate data records applies a generic validation protocol virtually applicable to all atmospheric ECVs, which builds on the heritage of several EC, ESA and EUMETSAT projects. Beyond classical data comparisons, this validation protocol also yields a wide range of quality indicators informing potential users on the actual horizontal and vertical resolution, vertical sensitivity, bias, long-term stability etc. of the data records. The validation protocol has been implemented in a prototype atmospheric validation server also developed within QA4ECV (QA4ECV-AVS), accessible online, which also constitutes the backbone for the Validation Data Analysis Facility (VDAF) of the Sentinel-5p Mission Performance Centre (MPC) in charge of the operational validation of the TROPOMI atmospheric data products.

The validation protocol and the QA4ECV-AVS have been applied for the quality assessment of the QA4ECV climate data records using, as reference measurements, the ground-based DOAS data acquired at several sites of the Network for the Detection of Atmospheric Composition Change (NDACC): MAX-DOAS data for tropospheric columns, and zenith-sky DOAS data for stratospheric columns. Interpretation of the data comparisons is not straightforward due to the interference of satellite data errors, reference measurement errors, and comparison errors caused by differences in temporal/spatial/vertical sampling and smoothing of natural variability. Therefore, a comprehensive uncertainty budget is established, coupling the detailed ex-ante uncertainty components provided with the QA4ECV satellite and ground-based data products.