The Greenhouse Gas Climate Change Initiative (GHG-CCI): comparison and quality assessment of near-surface-sensitive satellite-derived CO_2 and CH_4 global data sets

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The GHG-CCI project is one of several projects of the European Space Agency's (ESA) Climate Change Initiative (CCI). The goal of the CCI is to generate and deliver data sets of various satellite-derived Essential Climate Variables (ECVs) in line with GCOS (Global Climate Observing System) requirements. The "ECV Greenhouse Gases" (ECV GHG) is the global distribution of important climate relevant gases – atmospheric CO_2 and CH4 - with a quality sufficient to obtain information on regional CO_2 and CH4 sources and sinks. Two satellite instruments deliver the main input data for GHG-CCI: SCIAMACHY/ENVISAT and TANSO-FTS/GOSAT. The first order priority goal of GHG-CCI is the further development of retrieval algorithms for near-surface-sensitive column-averaged dry air mole fractions of CO_2 and CH4, denoted XCO_2 and XCH4, to meet the demanding user requirements. GHG-CCI focusses on four core data products: XCO_2 from SCIAMACHY and TANSO and XCH4 from the same two sensors. For each of the four core data products at least two candidate retrieval algorithms have been independently further developed and the corresponding data products have been quality assessed and inter-compared. This activity is referred to as "Round Robin" (RR) activity within the CCI. The main goal of the RR was to identify for each of the four core products which algorithm to be used to generate the Climate Research Data Package (CRDP), which will essentially be the first version of the ECV GHG. This manuscript gives an overview about the GHG-CCI RR and related activities. This comprises the establishment of the user requirements, the improvement of the candidate retrieval algorithms and comparisons with ground-based observations and models. The manuscript summarizes the final RR algorithm selection decision and its justification. Comparison with ground-based Total Carbon Column Observing Network (TCCON) data indicates that the "breakthrough" single measurement precision requirement has been met for SCIAMACHY and TANSO XCO_2 (< 3 ppm) and TANSO XCH4 (< 17 ppb). The achieved relative accuracy for XCH4 is 3-15 ppb for SCIAMACHY and 2-8 ppb for TANSO depending on algorithm and time period. Meeting the 0.5 ppm systematic error requirement for XCO_2 remains a challenge: approximately 1 ppm has been achieved at the validation sites but also larger differences have been found in regions remote from TCCON. More research is needed to identify the causes for the observed differences. In this context GHG-CCI suggests to take advantage of the ensemble of existing data products, for example, via the EnseMble Median Algorithm (EMMA).