FRM4GHG

Fiducial Reference Measurements for Greenhouse Gases

Validation Plan

Deliverable: D5 of Phase 2

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Table of contents

1 Document change record

Issue	Date	Item	Comment
V0.0	2018-12-10	–	Initial version
V0.1	2018-12-13	–	Inserted comments from all partners
V1.0	2019-04-03	–	Inserted comments from ESA

2 Access list

This document is a deliverable "D5: Validation Plan" created for phase 2 of the project FRM4GHG to be submitted to ESA. The document will be a publicly accessible document and can be downloaded from the project webpage http://frm4ghg.aeronomie.be.

3 Document structure

Section 4 presents the purpose of the document.

Section 5 'Validation protocol' presents the description of the validation protocol to be used for the validation of the methane (CH_4) and carbon monoxide (CO) data products from the newly launched Sentinel-5 Precursor satellite.

Section 6 & 7 'Applicable and reference documents' presents a list of all applicable and reference documents.

Section 8 'Reference for software/tool mentioned' presents a list of all software/tool mentioned in this document.

4 Purpose

This document presents the definition and preparation of the validation protocol. It gives the measurements details from the campaign instruments used for the validation study. The document also gives details of the plan for the validation of the S-5P / TROPOMI methane and carbon monoxide data products. It describes the structure of the measured and auxiliary data to be submitted to ESA Atmospheric Validation Data Centre (EVDC) after the validation study.

5 Validation protocol

This section discusses the plan for the validation of the Sentienl-5 Precursor (S-5P) methane and carbon monoxide data using the participating instruments in the FRM4GHG campaign.

Sentinel-5 Precursor is the first of the ESA sentinels for monitoring the atmospheric composition. The mission was launched on 13 October 2017 as a contribution to the European Commission Copernicus Programme to improve our understanding of the earth's atmosphere and the environment. It has a polar sun synchronous orbit at an altitude of 824 km. The local overpass time is at 13:30. The mission duration is 7 years. Onboard the S-5P is a grating spectrometer called TROPOMI (TROPOspheric Monitoring Instrument) which covers 8 bands ranging from UV to the short-wave infrared (SWIR)

region. It uses a common telescope for the UNV[1] and SWIR channels. It has a push broom configuration and a wide swath of 108° which corresponds to 2600 km on the earth surface. The satellite has a spatial sampling of 7x7 km^2. The primary measured products are Ozone (O_3), Nitrogen Dioxide (NO_2), CO, CH_4, Formaldehyde (CH_2O), Sulfur Dioxide (SO_2), Aerosol, Clouds and UV-Index.

In this project the plan for the geophysical validation of S-5P methane and carbon monoxide products above the Sodankylä TCCON site will be addressed. The requirements for the CO product are: a systematic uncertainty (bias) of less than 15% and random uncertainty (std) of <10%. For the CH_4 product the requirements are less than 1.5% bias and less than 1% std.

The format of the data from the remote sensing instruments (Bruker IFS 125HR, Vertex70, IRcube, EM27/SUN, LHR and HR125LR) and AirCore that will be delivered for use in the validation effort is described in details in the deliverable D2.4 – 'Data Protocol' that was submitted during phase 1 of the FRM4GHG project. During phase 2 of the FRM4GHG project, a subset of the same instruments (Bruker IFS 125HR, Vertex70, IRcube, EM27/SUN and HR125LR) performed measurements of the total column concentrations of both methane and carbon monoxide at the campaign site (Sodankylä); the LHR instrument measured only the total column concentrations of methane. In addition to the remote sensing measurements, several AirCore launches were performed during the second phase of the project. These measurements provide profiles of methane and carbon monoxide concentrations from the ground up to about 30 km altitude. The AirCore profiles will be extended above the top measurement point with the a priori profile as used for the retrieval of S-5P data. The Xgas (e.g. XCO and XCH_4) value will be calculated from the extended AirCore profile. The Xgas from both the remote sensing and AirCore measurements will be used to validate the S-5P CH4 and CO products via a direct comparison. The coincidence criteria for the validation will be based on the different options for the time colocation such as ±1 hour, geolocation distance from the site such as 50 km or 100 km radius.

The S-5P offline (OFFL) and near-real time (NRTI) overpass files for the Sodankylä site are provided by the Payload Data Ground Segment (PDGS) at DLR and will be downloaded from the Copernicus data hub and Mission Performance Centre (MPC). The CO and CH4 validation will be performed for qa_value > 0.5 for the satellite pixels. The detail implication of the selection of these qa filtering can be found in the product readme files mentioned in the referenced document. Appropriate coincidence criteria for the validation of S-5P total column measurements will be tested using the reference data from the participating instruments of the campaign. The final report will be produced based on the validation results using optimized settings for the coincidence criteria. The validation results that will be reported will consist of comparative timeseries between S-5P and campaign measurement data and corresponding statistics (bias, std and correlation coefficients). The data used for the validation studies will be submitted to the EVDC server in the EVDC standard format.

6 Applicable documents

Statement of Work: Fiducial Reference Measurements for Ground-Based FTIR Greenhouse Gas Observations (FRM4GHG)
Prepared by: T. Fehr/B. Bojkov (EOP-GMQ), Reference: ESA-EOPG-MOM-SOW-0007

[1] The spectrometers for UV, UVVIS and NIR are jointly referred to as UVN

7 Reference documents

FRM4GHG deliverable D2.4: Data protocol, made available via the project website
http://frm4ghg.aeronomie.be/index.php/outreach/deliverables

S5P Mission Performance Centre Methane [L2__CH4___] Readme
https://sentinel.esa.int/documents/247904/3541451/Sentinel-5P-Methane-Product-Readme-File

S5P Mission Performance Centre Methane [L2__CO___] Readme
https://sentinel.esa.int/documents/247904/3541451/Sentinel-5P-Carbon-Monoxide-Level-2-Product-Readme-File

Requirements for the Geophysical Validation of Sentinel-5 Precursor Products
https://earth.esa.int/pi/esa?id=3182&sideExpandedNavigationBoxId=Aos&cmd=image&topSelectedNavigationNodeId=AOS&targetIFramePage=/web/guest/pi-community/apply-for-data/ao-s&ts=1548864588456&type=file&colorTheme=03&sideNavigationType=AO&table=aotarget

Sentinel-5 Precursor Calibration and Validation Plan for the Operational Phase
https://sentinel.esa.int/documents/247904/2474724/Sentinel-5P-Calibration-and-Validation-Plan.pdf

Sentinel-5 Precursor Scientific Validation Implementation Plan
https://sentinel.esa.int/documents/247904/2474724/Sentinel-5P-Science-Validation-Implementation-Plan

8 Software / tools:

The validation work was performed with the tools developed at BIRA-IASB and written in Python.