ESA Climate Change Initiative (CCI)

Data Access Requirements Document (DARD)

for the Essential Climate Variable (ECV)

Greenhouse Gases (GHG)

Written by:

GHG-CCI project team

Lead author: O.Hasekamp, SRON-Netherlands Institute for Space Research

ESA Climate Change Initiative (CCI)

**Data Access Requirements
Document
Version 3 (DARDv3)**

for the Essential Climate Variable (ECV)
Greenhouse Gases (GHG)

Page 2

Version 3
26 Feb. 2013

Change log:

Version Nr.	Date	Status	Reason for change
Version 1, draft 1	14 Okt 2010	Template version for input by project partners, parts for SCIA and GOSAT included Author: O.Hasekamp	
Version 1, draft 2	7 Dec 2010	Sections on SCIA, GOSAT, CAI, MIPAS, CarbonTracker, ECMWF, GTOPO drafted Author: O.Hasekamp Contributions: A. Butz, H. Boesch, R. Parker, M. Buchwitz, M. Reuter, G. Lichtenberg, A. Laeng, G. Stiller, T. von Clarmann	Input project partners
Version 1, draft 3	26 Jan 2011	Draft of all sections, modified section on ECMWF data Author: O.Hasekamp Contributions: J. Notholt, B. Dils, T. Blumenstock, C. Crevoisier, C. Popp	All input received from project partners. Correspondence with David Tan (ECMWF)
Version 1, draft 4	7 Feb 2011	SCIAMACHY AAI and MERIS data are added, ECMWF section modified, removed section on KIT-TCCON sites Author: O.Hasekamp Contributions: M. Reuter	Input from IUP, correspondence with David Tan (ECMWF). KIT TCCON sites are already covered in Sec. 6.1
Version 1	24 Feb 2011	Minor editorial changes Author: O.Hasekamp	

ESA Climate Change Initiative (CCI)

**Data Access Requirements
Document
Version 3 (DARDv3)**

for the Essential Climate Variable (ECV)
Greenhouse Gases (GHG)

Page 3

Version 3
26 Feb. 2013

Version 2	15 May 2012	Small changes compared to V1. Most important: GOSAT L1 data	
Version 2	6 June 2012	Corrected description NDACC accuracy	Input Notholt / Sussmann
Version 2	29 August 2012	Corrected TCCON accuracy/precision description to be consistent with PVASR	Input Buchwitz
Version 3, draft 1	18 Feb 2013	Editorial corrections, added ASTER GDEM	Hasekamp

ESA Climate Change Initiative (CCI)

Data Access Requirements Document Version 3 (DARDv3)

for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)

Page 4

Version 3
26 Feb. 2013

Table of Contents

	ESA Climate Change Initiative (CCI)	Page 6
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)**	Version 3
		26 Feb. 2013
	for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	

1 Summary

This document is the 3rd version of the Data Access Requirements Document (DARDv3), which is a deliverable of the ESA project GHG-CCI. The GHG-CCI project started on 1st September 2010. The GHG-CCI project is one of several projects of ESA's Climate Change Initiative (CCI). The GHG-CCI project will deliver the Essential Climate Variable (ECV) Greenhouse Gases (GHG). State-of-the-art retrieval algorithms for remote sensing of the ECV "Greenhouse Gases" (GHGs) are being developed further in the frame of this project. Multi-year Carbon Dioxide (CO_2) and Methane (CH_4) data sets will be generated and validated.

Two existing satellite sensors are being used as the main data sources: SCIAMACHY on ENVISAT and TANSO on GOSAT. Both instruments measure NIR/SWIR spectra of reflected solar radiation and are sensitive to CO_2 and CH_4 concentration changes close to the Earth's surface. Consequently they carry information on regional surface fluxes. The accuracy requirements for such an application are demanding, especially for CO_2 but also for CH_4. A two-year, round-robin exercise has been conducted for eight different CO_2 and CH_4 retrieval algorithms, as developed for SCIAMACHY and GOSAT. The four products XCO2 and XCH4 from SCIAMACHY and GOSAT are the "core ECV products".

GHG data products (columns and profiles) derived from AIRS, IASI, MIPAS and ACE-FTS measurements will also be used because they constrain GHG concentrations in upper layers, i.e., layers above the boundary layer, and for comparisons. Data products from these sensors are "potential ECV products". For these sensors algorithms are being further improved and their accuracy will be assessed. In addition, data products produced elsewhere has been used for comparisons (e.g., the operational GOSAT data products from NIES).

This document identifies all the data that are needed as input to perform the GHG-CCI project, including

- all required Level 1, and if necessary Level 0, products from ESA and Third Party Missions
- all ancillary data
- all in-situ observation data sources as well as higher-level products needed for product inter-comparison
- historical data archives, currently operational sources and sources due to become operational in next 3 years

For each data source the DARD includes (if applicable):

- information about the originating system
- identification of the data class (in-situ, EO, model)
- specification of the sensor type and key technical characteristics

- information about data availability & coverage (times-scale, geographic, temporal),

- source data product name & reference to product technical specification documents

- estimates of the data quantity

- indication of data quality and reliability

- description of the ordering and delivery mechanism

- identification of access conditions & pricing

All the data needed for the GHG-CCI project, listed in this document, are readily available to the project team. Within the first few months of this project, the data access problems of GOSAT L1-FTS data though ESA have been resolved by ESA project.

2 Satellite data for ECV production

2.1 SCIAMACHY level 1b

The SCIAMACHY level-1b data are needed in the project to produce the total column CO_2 and CH_4 core EVC products. They serve as input for the retrieval algorithms to be used in this project.

Originating system:

SCIAMACHY is onboard the ESA satellite ENVISAT which was launched in March 2002. The SCIAMACHY level-1b data product is generated from the level 0 product by ESA and DLR

Data class:

Earth Observation

Sensor type and key technical characteristics:

SCIAMACHY is a grating spectrometer that measures the radiance reflected by the Earth atmosphere and surface, and the solar irradiance, in the spectral range 240 nm to 1700 nm, and in selected regions between 2000 nm and 2400 nm. The measurements have a spectral resolution that ranges from 0.2-1.5 nm (depending on the spectral range). Measurements are made in both limb and nadir mode. In this project only nadir measurements will be used. Channel 4 and 6 are to be used. The ground pixel size for these channels is 30X60 km2.

Table 1: Sciamachy channels

channel	wavelength range	resolution [nm]
1	240 – 314	0.24
2	309 – 405	0.26
3	394 - 620	0.44
4	604 - 805	0.48
5	785 - 1050	0.54
6	1000 - 1750	1.48
7	1940 - 2040	0.22
8	2265 - 2380	0.26

Data availability & coverage:

SCIAMACHY data are available since 2002 and the instrument is still operational. Global coverage is obtained in ~6 days.

Source data product name & reference to product technical specification documents

SCIAMACHY level 1b data

ENVISAT-1 Products Specifications, Volume **15**: SCIAMACHY Products Specifications, ESA, PO-RS-MDA-GS-2009, Date: 27-06-2007

	ESA Climate Change Initiative (CCI)	Page 9
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)**	Version 3
		26 Feb. 2013
	for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	

Data quantity

1.95 Tb / year

Data quality and reliability

The CO_2 retrievals in this project make use of the channels 4 and 6. The CH_4 retrievals make use of channel 6. The data quality of channel 6 is sufficient till 2005 to perform CH_4 retrievals. In 2005 but especially after 2005, the quality of the retrieved methane is degrading due to a degradation of the SCIAMACHY detector in the spectral region used for methane and CO_2 retrieval.

SCIAMACHY channel 7&8 theoretically contain important information to aid the CH_4 and CO_2 retrievals. However, due to ice contamination the data from these channels are not of sufficient quality for use in CH_4 and CO_2 retrieval algorithms.

Ordering and delivery mechanism

The team has default access to the SCIAMACHY Level-1 data.

Access conditions & pricing

The team has default access to the SCIAMACHY Level-1 data. IUP and SRON as PI and co-PI institutes. University of Leicester through a category-1 proposal: The SCIAMACHY products are free of charge.

Issues:

Significant effort is needed to solve channel 6 degradation issues. This will partly be done within level 1-2 processing algorithms.

2.2   GOSAT TANSO-FTS level 1b

Level 1b data of the TANSO-FTS (Thermal And Near-infrared Sensor for carbon Observation -Fourier Transform Spectrometer) onboard GOSAT (Greenhouse gas Observing SATtellite) are needed in the project to produce the total column CO2 and CH4 core EVC products. They serve as input for the retrieval algorithms to be used in this project.

Originating system:

The GOSAT satellite has been launched in January 2009. The GOSAT observational data are routinely processed at the GOSAT Data Handling Facility. The development of the GOSAT Data Handling Facility (GOSAT DHF) was completed in late 2008, and NIES has been maintaining it for the routine processing of the GOSAT data

Data class:

Earth Observation

Sensor type and key technical characteristics:

TANSO-FTS is an instrument that utilizes optical interference. Within the instrument the incoming light is split into two beams which propagate in separate optical paths to create an optical path difference between the two. These beams are then recombined to cause interference. FTS measures the intensity of the interference by continuously changing the optical path difference. A spectrum, which is distribution of light intensity over a span of wavelength, is obtained via performing mathematical operation called the Fourier transform on that measured data.

FTS observes sunlight reflected from the earth's surface and light emitted from the atmosphere and the surface. The former is observed in the spectral bands 1 through 3 of FTS in the daytime, and the latter is captured in band 4 during both the day and the night. Within this project only level 1 data from the SWIR channels 1-3 will be used. Prior to reaching the detectors of the instrument, the light in the bands 1 through 3 is split into two orthogonally-polarized components (P and S components) and measured independently. The light in the band 4, however, is not split. The instrument thereby observes the incoming light in seven different channels.

The TANSO-FTS Level 1b data are radiance spectra that are obtained by performing the Fourier transformation on the signals detected by FTS. A single data file of the FTS Level 1B data contains the radiance spectra obtained during 1/60 of an orbital revolution (defined as "one scene").

Table 2: GOSAT-FTS bands

channel	wavelength range [nm]	resolution [cm^{-1}]
1	758-775	0.2
2	1460-1720	0.2
3	1920-2080	0.2
4	5560-14300	0.2

Data availability & coverage:

TANSO-FTS level-1b data are available since April 2009. Over a three-day period, GOSAT-FTS takes fifty-six thousand measurements, covering the entire globe.

Source data product name & reference to product technical specification documents

GOSAT Level 1 Product Description Document, Japan Aerospace Exploration Agency, March 2010, NEB-080035D, available through https://data.gosat.nies.go.jp/productpubinfo/productpubinfo/ProductPubInfoPage/open.do

Data quantity

5.5 Gbyte / day of global daytime data

Data quality and reliability

The quality of the retrieved CO_2 and CH_4 columns obviously depends on the quality of the GOSAT level-1 data. Therefore, the validation of the CO_2 and CH_4 columns in this project will also provide insight in the quality of the level 1 data.

First indication is that data quality is reasonably good, but there is a signal offset in the NIR band.

Ordering and delivery mechanism

Registered users can download TANSO-FTS data from https://data.gosat.nies.go.jp/

GOSAT level 1b data are also available through ESA. Here, data for one month can be downloaded from a rolling ftp archive and older data can be ordered through EOLI-SA.

Access conditions & pricing

Usage of the GOSAT data products is allowed only for purposes of academic research and educational activities, etc. For other purposes such as commercial use, it must be consulted with the NIES GOSAT Project Office beforehand. The data are free of charge

Issues:

- The issues with respect to data availability at the ESA archive have been resolved.

- For the period 19 April 2011 - 16 April 2012 level 1 data v140 were processed. This version includes a correction for non-linearity in the O2 A-band. Unfortunately, these data are of insufficient quality for Full Physics retrievals (which need the O2 A-band). Since 16 April 2012 v150 is out of which the quality is unconfirmed. The plan is to reprocess the full mission with version v150.

	ESA Climate Change Initiative (CCI)	Page 12
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)**	Version 3
		26 Feb. 2013
	for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	

2.3   GOSAT CAI (Cloud and Aerosol Imager) level 1b & level 2

Data from the Cloud and Aerosol Imager (CAI) onboard GOSAT are required in order to select cloud-free scenes for GOSAT CO_2 and CH_4 retrievals.

Originating system:

The GOSAT satellite has been launched in January 2009. The GOSAT observational data are routinely processed at the GOSAT Data Handling Facility. The development of the GOSAT Data Handling Facility (GOSAT DHF) was completed in late 2008, and NIES has been maintaining it for the routine processing of the GOSAT data

Data class:

Earth observation

Sensor type and key technical characteristics:

Table 3: CAI spectral bands

	wavelength	spatial resolution	swath
Band 1	380 nm	0.5 km	1000 km
Band 2	674 nm	0.5 km	1000 km
Band 3	870 nm	0.5 km	1000 km
Band 4	1600 nm	1.5 km	750 km

CAI has a ground pixel size of 0.5km X 0.5 km and a swath of 1000 km.

Level 1b data are calibrated radiances. Level 2 data is a cloud flag in 16 confidence levels.

Data availability & coverage:

Data are available since April 2009. Global coverage is obtained in about 3 days.

	ESA Climate Change Initiative (CCI)	Page 13
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)**	Version 3
		26 Feb. 2013
	for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	

Source data product name & reference to product technical specification documents

CAI level 1b and level2:
https://data.gosat.nies.go.jp/GosatWebDds/productorder/distribution/auth/product_format_doc_NIES_eng_ver1.30.pdf

Data quantity

level 1b data: 1.5 Tb per month

level 2 data: 600 Gb per month

Data quality and reliability

It will be investigated within this project what the added value of is CAI data on CO_2 and CH_4 retrievals.

Ordering and delivery mechanism

Same as GOSAT-FTS level 1b data, see above.

Access conditions & pricing

Same as GOSAT-FTS level 1b data, see above.

Issues:

The issues with respect to data access / download have been resolved.

2.4 IASI

The IASI (Infrared Atmospheric Sounder Interferometer) Level 1c data are needed in this project to produce mid-tropospheric column of CO_2 and CH_4. They serve as input for the retrieval algorithms used in this project, in conjunction with data from the AMSU instrument.

Originating system:

The MetOp-A satellite has been launched in October 2006, and IASI declared operational in July 2007. The IASI level-1c data are generated from the level 0 and level-1b data by CNES, and distributed by EUMETSAT.

Data class:

Earth Observation.

Sensor type and key technical characteristics:

IASI consists of a Fourier Transform Spectrometer based on a Michelson Interferometer, coupled to an integrated imaging system which allows characterization of cloudiness inside the spectrometer field of view. The instrument provides spectra of high radiometric quality at 0.5 cm^{-1} resolution (apodized), with a spectral sampling of 0.5 cm^{-1} from 645 to 2760 cm^{-1}. Data samples are taken at intervals of 25 km along and across track (nadir), each sample having a maximum diameter of about 12 km. The scan duration of eight seconds and the horizontal spacing of the full Earth views are identical to those of the AMSU-A instrument. This facilitates synergistic use of the two instruments. The imager of the IASI samples the sounder pixels with a kilometric spatial resolution. This enables registration with the AVHRR/3 instrument.

Data availability & coverage:

IASI data are available since July 2007 and the instrument is still operational. Global coverage is obtained in ~6 days.

Source data product name & reference to product technical specification documents

IASI Level-1c spectra. IASI Level 1 Product Format Specification, Techn. Report EUM.EPS.SYS.SPE.990003, EUMETSAT, October 2010. (www.eumetsat.int)

Data quantity

~14Gb per day, global coverage.

Data quality and reliability

Since launch, the performance of the instrument is shown to be exceptional in terms of calibration and stability. The stability of the instrument is monitored continuously by the CNES Technical Expertise Centre, using on-board measurements, and by EUMETSAT, where stable, clear fields of view are compared with forward modeled radiances from numerical weather prediction model output.

Ordering and delivery mechanism

IASI level-1c are distributed in near real time via the EumetCast system of EUMETSAT. IASI data are also available from the EUMETSAT Data Centre (formerly known as the UMARF or Archive Services) upon request, which can be accessed through http://www.eumetsat.int/Home/Main/Access_to_Data/Data_Centre/index.htm?l=en. Access

is through a Web interface, the Online Ordering Application, through which the users are able to browse and order products.

Access conditions & pricing

Data are free of charge.

Issues

EUMETSAT is considering restricting the dissemination of IASI data through EumetCast to the only compressed spectra generated by Principal Component Analysis. This would prevent us from performing GHG retrievals since PC scores are likely not retaining the 'small' GHG signatures in the radiances.

2.5 AIRS

The AIRS (Atmospheric Infrared Sounder) Level 1b data are needed in this project to produce mid-tropospheric column of CO_2. They serve as input for the retrieval algorithms used in this project, in conjunction with data from the AMSU instrument.

Originating system:

The AIRS instrument is onboard NASA's Aqua satellite. Aqua was launched on May 4, 2002, and has six Earth-observing instruments on board, collecting a variety of global data sets. Aqua was the first member launched of a group of satellites termed the Afternoon Constellation, or sometimes the A-Train.

Data class:

Earth Observation.

Sensor type and key technical characteristics:

AIRS is a high-spectral resolution, grating multispectral infrared sounder operated in a cross-track-scanning mode with AMSU-A and HSB for all weather capability. It measure's the Earth's outgoing radiation at 0.4 to 1.0 μm and 3.7 to 15.4 μm with an array grating spectrometer (3.74 to 15.4 μm), with a spectral resolution of 1200 ($λ / Δλ$), yielding a spectral resolution of 0.5-2cm^{-1}.

Data availability & coverage:

AIRS data are available since summer 2002 and the instrument is still operational, albeit the loss of some channels throughout its lifetime. Global coverage is obtained in ~6 days.

Source data product name & reference to product technical specification documents

AIRS Level-1b spectra. Documentation at http://disc.sci.gsfc.nasa.gov/AIRS/documentation

Data quantity

~800Mb per day, 324 channels, global.

Data quality and reliability

The solar flare of 28th October 2003 lead to a spectral degradation, which was only fixed in Spring 2004. Some channels have been degraded over the AIRS lifetime. Overwise, the AIRS channel is working within specifications.

Ordering and delivery mechanism

AIRS level-1b are distributed in near real time by NOAA. They are also available at the NASA DISC (Data and Information Service Center) at http://disc.sci.gsfc.nasa.gov/AIRS/data-holdings/by-data-product/data_products.shtml.

Access conditions & pricing

Data are free of charge.

Issues

None.

	ESA Climate Change Initiative (CCI)	Page 17
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)**	Version 3
		26 Feb. 2013
	for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	

2.6 AMSU

The AMSU (Atmospheric Microwave Sounding Unit) level-1b data are needed in the project to produce the mid-tropospheric column of CO_2 and CH_4. They serve as input to the retrieval algorithms to be used in this project.

Originating system:

AMSU is flying onboard both Aqua and MetOp-A. It is derived from the Microwave Sounding Unit (MSU) which began service in 1978 on TIROS-N and continued on the NOAA 6 through 14 satellites. AMSU flies on the NOAA KLM and N satellites as well as NASA's Aqua and European MetOp-A platform.

Data class:

Earth Observation.

Sensor type and key technical characteristics:

AMSU is a cross-track scanning total-power radiometer that measures scene radiance in the microwave spectrum with 20 channels and a 48 or 16 km resolution. It is divided into two separate modules: AMSU Module A-1 with channels 3 to 15, and AMSU Module A-2 with channels 1 and 2. The AMSU-A instrument has an IFOV of 3.3° at the half-power points providing a nominal spatial resolution at nadir of 48 km (29.8 mi). The antenna provides a cross-track scan, scanning ± 48.3° from nadir with a total of 30 Earth fields-of-view per scan line. The instrument completes one scan every 8 seconds. The footprint (resolution at nadir) is 50 km. The swath width is approximately 2000 km.

Data availability & coverage:

AMSU data are available since May 2002 for Aqua and July 2007 for MetOp-A and both instruments are still operational. Global coverage is obtained in ~6 days.

Source data product name & reference to product technical specification documents

AMSU Level-1b spectra. Documentation at http://disc.sci.gsfc.nasa.gov/AIRS/documentation

Data quantity

~2Mb per day, 8461 channels, global.

Data quality and reliability

On Aqua, AMSU 7 channel has never been working. On MetOp-A, AMSU 7 has started to exceed specifications in January 2009 and has been declared lost in December 2009.

Ordering and delivery mechanism

AMSU level-1b are distributed via the CLASS website at http://www.class.ncdc.noaa.gov/

Access conditions & pricing

Data are free of charge.

Issues

None.

	ESA Climate Change Initiative (CCI)	Page 18
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)**	Version 3
		26 Feb. 2013
	for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	

2.7 ACE-FTS

The ACE-FTS (Atmospheric Chemistry Experiment - Fourrier Transform Interferometer) level1b data are needed in the project to produce the vertical profiles of CO_2. They serve as input for the retrieval algorithms to be used in this project.

Originating system:

The Atmospheric Chemistry Experiment (ACE) is a Canadian satellite mission for remote sensing of the Earth's atmosphere that was launched into a high-inclination (74°), circular low-earth (650 km from the surface) orbit on August 13, 2003.

Data class:

Earth Observation.

Sensor type and key technical characteristics:

The ACE-FTS is the main instrument on SCISAT-1. It is a high spectral resolution (0.02 cm^{-1}) Fourier Transform Spectrometer (FTS) operating from 2.2 to 13.3 µm (750-4400 cm^{-1}) with a Michelson interferometer that was custom designed and built by ABB-Bomem in Quebec City. The FTS has a circular field of view (FOV) of 1.25 mrad, a mass of about 41 kg, and an average power consumption of 37 W. Double-sided interferograms are Fourier transformed on the ground to obtain the desired atmospheric spectra. The detectors are cooled to 80-100 K by a passive radiator pointing toward deep space.

Data availability & coverage:

ACE-FTS data are available since July 2004 and the instrument is still operational.

Source data product name & reference to product technical specification documents

ACE-FTS level2 data version 2.2 (version 3 now available)

Data quantity

~30Gb per year

Data quality and reliability

ACE Validation Special Issue of Atmospheric Chemistry and Physics (2008-2009). ACE Special Issue of Geophysical Research Letters (2005)

(http://www.ace.uwaterloo.ca/publications.html#ValidationPapers)

Ordering and delivery mechanism

Need authorization from ACE-science Team (PI : Peter Bernath bernath@uwaterloo.ca; Data process administrator : Sean McLeod : sdmcleod@brutus.waterloo.ca). Data are delivered by ftp.

Access conditions & pricing

Version 2.2 and version 3 are available only for ACE-Science team members and authorized users (Free of charge).

Issues

None

3   Level 2 data for Round Robin Comparison

3.1   GOSAT CH4 and CO2 vertical columns from NIES

The GOSAT level-2 CH4 and CO2 total column data (derived from GOSAT-FTS SWIR measurements) from the operational GOSAT processor at NIES are needed as input for the Round-Robin validation in this project. They will be traded against the results of other algorithms to produce CH4 and CO2 columns from GOSAT.

Originating system:

The GOSAT satellite has been launched in January 2009. The GOSAT observational data are routinely processed at the GOSAT Data Handling Facility. The development of the GOSAT Data Handling Facility (GOSAT DHF) was completed in late 2008, and NIES has been maintaining it for the routine processing of the GOSAT data

Data class:

Earth Observation

Sensor type and key technical characteristics:

See section 2.2 for a technical description of the GOSAT-FTS instrument and level 1b data. The CO2 and CH4 total column level-2 data are generated from the GOSAT-FTS level 1b data in the NIR band and the 1.6 micron SWIR band.

Data availability & coverage:

GOSAT-FTS level-2 data are available since April 2009. Over a three-day period, GOSAT-FTS takes fifty-six thousand measurements, covering the entire globe. Level-2 data are only available for cloud free scenes. Multiple quality checks are applied which significantly reduces the coverage.

Source data product name & reference to product technical specification documents

Algorithm Theoretical Basis Document (ATBD) for CO2 and CH4 column amounts retrieval from GOSAT TANSO-FTS SWIR, Document No: NIES-GOSAT-PO-014, available from https://data.gosat.nies.go.jp/productpubinfo/productpubinfo/ProductPubInfoPage/open.do

Data quantity

~25Mb / month (CO2 and CH4)

Data quality and reliability

The data quality and reliability will be investigated during this project.

Ordering and delivery mechanism

Registered users can download GOSAT-FTS data from https://data.gosat.nies.go.jp/

ESA has announced to also provide a GOSAT-FTS level-1b data download service.

Access conditions & pricing

Usage of the GOSAT data products is allowed only for purposes of academic research and educational activities, etc. For other purposes such as commercial use, it must be consulted with the NIES GOSAT Project Office beforehand.

	ESA Climate Change Initiative (CCI)	Page 20
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)**	Version 3
		26 Feb. 2013
	for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	

The data are free of charge

Issues:

See issues for GOSAT-FTS level 1b data.

	ESA Climate Change Initiative (CCI)	Page 21
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)**	Version 3
		26 Feb. 2013
	for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	

3.2 GOSAT CO2 vertical columns from ACOS

In addition to the operational level 2 products from NIES, we will also use the GOSAT level-2 CO2 total column data from the NASA ACOS processor at JPL as input for the Round-Robin validation and trade it against the results of other algorithms.

Originating system:

JPL ACOS processing facility

Data class:

Earth Observation

Sensor type and key technical characteristics:

See section 2.2 for a technical description of the GOSAT-FTS instrument and level 1b data. The CO2 total column level-2 data are generated from the GOSAT-FTS level 1b data in the NIR and SWIR spectral bands. The level 1b $\rightarrow$ 2 processing algorithm uses the OCO full physics retrieval algorithm

Data availability & coverage:

As above.

Source data product name & reference to product technical specification documents

Algorithm Theoretical Basis Document (ATBD) for CO2 column retrieval not yet released.

Data quantity

~196 Mb / month

Data quality and reliability

The data quality and reliability will be investigated during this project.

Ordering and delivery mechanism

ACOS GOSAT level 2 data can be obtained free of charge from http://mirador.gsfc.nasa.gov/

Access conditions & pricing

As above

Issues:

See issues for GOSAT-FTS level 1b data. Note that the ACOS team generates separate ACOS L1B data.

	ESA Climate Change Initiative (CCI)	Page 22
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)**	Version 3
		26 Feb. 2013
	for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	

4 Additional Level-2 Data

4.1 MIPAS CH4

General Description

MIPAS is a high resolution limb emission Fourier transform spectrometer designed to measure trace gas distributions from the upper troposphere to the mesosphere at global coverage during day and night (Fischer et al, 2008). IMK operates a scientific data processor (von Clarmann et al., 2003) which relies on ESA level 1B data. The IMK methane data product covers mixing ratio profiles of the period 2002-2004 when MIPAS operated in its original high spectral resolution mode (Glatthor et al. 2005), as well as data from 2005-2010 when MIPAS measured at reduced spectral resolution (Chauhan et al., 2009; von Clarmann et al. 2009). MIPAS high resolution data nominal measurement mode data are sampled along the orbit each 510 km, and a vertical profile contains information from up to 17 tangent altitudes, depending on cloud coverage. MIPAS reduced resolution nominal mode data are sampled along the orbit each 410 km, and a vertical profile contains information from up to 27 tangent altitudes, while reduced resolution UTLS-1 mode data are sampled along the orbit each 290 km, and a vertical profile contains information from up to 19 tangent altitudes. MIPAS profiles from IMK are sampled on a constant vertical grid with a grid-width of 1-km in the lower stratosphere and coarser above. Available diagnostics include measurement error covariance data, averaging kernels, altitude resolution and horizontal resolution. While the final quality assessment of these data is part of this study, preliminary analysis proved high precision but a positive bias in the upper troposphere and lower stratosphere. IMK MIPAS data are available via a data server.

References

H. Fischer et al., , Atmos. Chem. Phys., 8, 2151-2188, 2008

T. von Clarmann et al., J. Geophys. Res., 108, 4736, 15 pp., 2003

N. Glatthor et al., J. Atmos. Sci., 62, 787–800, 2005.

S. Chauhan et al., Atmos. Meas. Tech., 2, 337-353, 2009.

T. von Clarmann et al., Atmos. Meas. Tech., 2, 159-175, 2009.

5   Auxilary Data

5.1   ECMWF model data

The retrieval algorithms to produce vertical columns of CO_2 and CH_4 need as input for each scene the temperature vertical profile, pressure vertical profile, specific humidity vertical profile, and wind speed. Here, temperature and pressure are needed to calculate absorption cross sections, the specific humidity vertical profile is needed to account for water vapor absorption, and the wind speed is needed to calculate the Fresnel reflection contribution on a rough ocean surface. The meteorological data mentioned above will be taken from the ECMWF model.

Originating system:

ECMWF has developed one of the most comprehensive earth-system models available anywhere. The ECMWF model is uses the '4D-Var' data assimilation approach, which provides a physically consistent best fit to observations. For this project the ERA-interim archive as well as the operational archive is of importance. Here, the ERA interim data will be used to produce the ECV time series as this dataset uses one model version for the entire period. For sensitivity studies it is planned to use one year of data from the operational archive.

Data class:

Model

Required ECMWF data:

Class: **ERA interim**

Stream: Atmospheric model

Type: Analysis

Dates: 01/01/2002 to 31/12/2012

Time: 00:00:00, 06:00:00, 12:00:00, 18:00:00

Spatial grid: N128 Quasi-regular Gaussian grid (~0.7^o)

Parameters at **model** levels:

• temperature, specific humidity (all levels)

• logarithm of surface pressure, geopotential (lowest level)

Parameters at surface:

•   10 metre U wind component

•   10 metre V wind component

Class: **ERA interim**

Stream: Atmospheric model

Type: Forecast

Dates: 01/01/2002 to 31/12/2012

Requested forecast times: 3-, 6-, 9-, 12- HH for both 00 and 1200 UTC analyses

Spatial grid: N128 Quasi-regular Gaussian grid (~0.7^{o})

Parameters at **model** levels:

- temperature, specific humidity (all levels)
- logarithm of surface pressure, geopotential (lowest level)

Parameters at surface:

- 10 metre U wind component
- 10 metre V wind component

Class: **Operational archive**

Stream: Atmospheric model

Type: Analysis

Dates: 01/01/2010 to 31/12/2010

Time: 00:00:00, 06:00:00, 12:00:00, 18:00:00

Spatial grid: N256 Quasi-regular Gaussian grid (~0.3^{o})

Parameters at **model** levels:

- temperature, specific humidity (all levels)
- logarithm of surface pressure, geopotential (lowest level)

Parameters at surface:

- 10 metre U wind component
- 10 metre V wind component

Class: **Operational archive**

Stream: Atmospheric model

Type: Forecast

Dates: 01/01/2010 to 31/12/2010

Requested forecast times:3-, 6-, 9-, 12- HH for both 00 and 1200 UTC analyses

Spatial grid: N256 Quasi-regular Gaussian grid (~0.3^{o})

Parameters at **model** levels:

- temperature, specific humidity (all levels)

- logarithm of surface pressure, geopotential (lowest level)

Parameters at surface:

- 10 metre U wind component

- 10 metre V wind component

Data availability & coverage:

All data are required on a global scale, with a delay of one month (maximum)

Source data product name & reference to product technical specification documents

ECMWF ERA-Interim - Berrisford, P., D. Dee, K. Fielding, M. Fuentes, P. Kallberg, S. Kobayashi and S. Uppala: The ERA-Interim archive, ERA report series, 1, ECMWF, August 2009 (http://www.ecmwf.int/publications/library/do/references/show?id=89203)

ECMWF operational archive - http://www.ecmwf.int/products/data/archive/descriptions/od/oper/index.html

Data quantity

ERA-interim analysis: ~40 Gb per year

ERA-interim forecast: ~80 Gb per year

operational archive analysis: ~160 Gb per year

operational archive forecast: ~320 Gb per year

Data quality and reliability

The ECMWF model data sets are considered to be among the best available data sets for meteorological parameters.

Ordering and delivery mechanism

To be proposed by ECMWF

Access conditions & pricing

Access is restricted, will be arranged through this ECV project

Issues:

None.

5.2   Carbon Tracker Data

The retrieval algorithms for CH4 columns from SCIAMACHY and GOSAT that are based on the "proxy approach" retrieve the ration of the CH4 and CO2 columns, where the CO2 column serves as a proxy for the light path. In order to obtain the CH4 column, the retrieved ratio needs to be multiplied by the best estimate of the CO2 column. It is assumed that data from the Carbon Tracker model can provide the best estimate of the true CO2 column.

Originating system:

Carbon Tracker is a data assimilation system developed at the National Oceanic and Atmospheric Administration's (NOAA's) Earth System Research Laboratory (ESRL). It is based on a state-of-the-art atmospheric transport model coupled to an ensemble Kalman filter. CarbonTracker assimilates atmospheric CO_2 mole fractions, using a variety of in situ measurements worldwide.

Data class:

Model

Sensor type and key technical characteristics:

n/a

Data availability & coverage:

CarbonTracker provides global daily data at a spatial resolution of 3 by 2 degree. Data are available with a delay of about 1 year.

Source data product name & reference to product technical specification documents

CarbonTracker 3D Mole Fractions

Peters, W. *et al.* (2007), An atmospheric perspective on North American carbon dioxide exchange: CarbonTracker, *PNAS*, November 27, 2007 , vol. 104, no. 48, 18925-18930

Data quantity

~ 30 Gbyte / year of data.

Data quality and reliability

CarbonTracker has been validated with many independent measurements and is considered to provide be the most accurate global CO_2 data set.

Ordering and delivery mechanism

Data can be downloaded from ftp://ftp.cmdl.noaa.gov/ccg/co2/carbontracker/molefractions/

Access conditions & pricing

Unrestricted access, free of charge

Issues:

None.

5.3   GTOPO30 DEM

The retrieval algorithms for CO_2 and CH_4 columns from SCIAMACHY and GOSAT use information about the surface elevation from digital elevation maps.

Originating system: GTOPO30 is a global digital elevation model (DEM) resulting from a collaborative effort led by the staff at the U.S. Geological Survey's EROS Data Center. Elevations in GTOPO30 are

regularly spaced at 30-arc seconds (approximately 1 kilometer).

Data class: Model

Sensor type and key technical characteristics:

n/a

Data availability & coverage: GTOPO30 is a global data set with horizontal grid spacing of 30-arc seconds (0.008333333333333 degrees). The horizontal coordinate system is decimal degrees of latitude and longitude referenced to WGS84. The vertical units represent elevation in meters above mean sea level. The elevation values range from -407 to 8,752 meters.

Source data product name & reference to product technical specification documents

GTOPO30 Digital Elevation Model

Data quantity: ~2GB total

Data quality and reliability

TBD.

Ordering and delivery mechanism: GTOPO30 is available electronically through via FTP from the EROS Data Center (at no cost).

Access conditions & pricing

Unrestricted access, free of charge

Issues:

No issues

5.4 ASTER DEM

The RemoTeC retrieval algorithm for CO2 and CH4 columns from GOSAT use information about the surface elevation from the ASTER digital elevation map.

Originating system: The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model Version 2 (GDEM V2) is provided by a joint effort of The Ministry of Economy, Trade, and Industry (METI) of Japan and the United States National Aeronautics and Space Administration (NASA).

Data class: Model

Sensor type and key technical characteristics:

n/a

Data availability & coverage: ASTER GDEM V2 provide elevation data ranging from 85 degrees south to 85 degrees north at a 30 meter resolution.

Source data product name & reference to product technical specification documents

ASTER GDEM V2. http://www.jspacesystems.or.jp/ersdac/GDEM/E/index.html

Data quantity: ~100GB total

Data quality and reliability

TBD.

Ordering and delivery mechanism: ASTER GDEM V23 is available for download at http://asterweb.jpl.nasa.gov/gdem.asp

Access conditions & pricing

Unrestricted access, free of charge

Issues:

No issues

5.5 MERIS RR

The IUP full physics retrieval algorithm for CO_2 columns from SCIAMACHY uses MERIS reduced resolution level 1b data to calculate a cloud mask with ESA's BEAM software. This is used to flag potentially cloud contaminated scenes.

Originating system: MERIS is a programmable, medium-spectral resolution, imaging spectrometer operating in the solar reflective spectral range with fifteen spectral bands. Its field of view around nadir covers a swath width of 1150 km. With a pixel resolution of about 1x1km (in reduced resolution) it gives valuable sub pixel information about fractional cloud coverage within the SCIAMACHY pixels.

Data class: Satellite

Sensor type and key technical characteristics: n/a

Data availability & coverage: As MERIS is mounted on ENVISAT, it covers the same time period as SCIAMACHY. The entire reduced resolution L1b dataset is available at IUP.

Data quantity: ~23TB total

Data quality and reliability

TBD.

Ordering and delivery mechanism: Dataset already available at IUP.

Access conditions & pricing

Unrestricted access, free of charge

Issues:

No issues

	ESA Climate Change Initiative (CCI)	Page 30
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)** for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	Version 3 26 Feb. 2013

5.6   SCIAMACHY AAI

The IUP retrieval algorithms for CO_2 columns from SCIAMACHY use the SCIAMACHY absorbing aerosol index (AAI) processed at the KNMI by TEMIS (Tropospheric Emission Monitoring

Internet Service). AAI is used to flag aerosol contaminated scenes.

Originating system: SCIAMACHY.

Data class: Satellite

Sensor type and key technical characteristics: see above (SCIAMACHY)

Data availability & coverage: see above (SCIAMACHY)

Data quantity: ~50GB total

Data quality and reliability: n/a

Ordering and delivery mechanism: Dataset available via TEMIS website

Access conditions & pricing

Unrestricted access, free of charge

Issues:

2010 is processed with near real time orbits. Waiting for reprocessing with consolidated SCIAMACHY data.

6 Validation Data

6.1 TCCON FTS CO2 and CH4 data

TCCON data for CO_2 and CH_4 will be available in two ways. Data from the European sites (Bialystok/Poland, Bremen/Germany, Garmisch/Germany, Orleans/France) will be available directly from the PIs of the sites, because all European TCCON sites are part of the GHG-cci proposal. Data from the non-European sites (Park Falls/USA, Lamont/USA, Darwin/Australia, Wollongong/Australia, Lauder/New Zeeland) will be made available at the end of March 2011.

Originating system:

Ground based

Data class:

Ground based

Sensor type and key technical characteristics:

The measurements are performed using the solar absorption spectroscopy in the near infrared using a Fourier Transform Spectrometer (FTS).

Data availability & coverage:

The table below gives those TCCON sites that are part of the GHG_cci, the date when observations started, and the timetable for the submission of the TCCON ground-based results.

Table 4: TCCON sites used for validation

Location	Lat (°)	Lon (°)	Altitude (km)	Start	Data delivery
Bialystok/Poland	53°N	23°E	0.15	03.2009	every 3 month
Bremen/Germany	53°N	9°E	0.04	07.2004	every 3 months
Darwin/Australia	12°S	131°E	0.03	08.2005	beginning of 2011
Garmisch/Germany	47°N	11°E	0.74	07.2007	every 3 months
Izana/Tenerife	28°N	17°W	2.37	05.2007	every 3 months
Lauder/New-Zealand	45°S	170°E	0.37	06.2004	beginning of 2011
Ny-Ålesund/ Spitsbergen	79°N	12°E	0.02	04.2002	every 3 months
Orleans/France	48°N	2°E	0.13	06.2009	every 3 months
Park Falls,U.S.A.	46°N	90°W	0.44	05.2004	beginning of 2011
Wollongong/Australia	34°S	151°E	0.01	05.2008	beginning of 2011

	ESA Climate Change Initiative (CCI)	Page 32
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)**	Version 3
		26 Feb. 2013
	for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	

Source data product name & reference to product technical specification documents

D. Wunch, G.C. Toon, J.-F. L. Blavier, R. Washenfelder, J. Notholt, B.J. Connor, D.W.T. Griffith, V. Sherlock, P.O. Wennberg, The Total Carbon Column Observing Network (TCCON) *Phil. Trans. R. Soc. A.*, in press, 2010.

Data quantity

Individual measurements can be taken in intervals of about 20 min. The observations can only be taken with the direct sunlight. This limits the amount of data, which is different from site to site.

Data quality and reliability

For XCO2 the precision is 0.25% (1ppm) and the systematic error (bias) is 0.2% (0.8 ppm). For XCH4 the precision is 0.40% (7ppb) and the systematic error (bias) is also 0.40% (7 ppb).

Ordering and delivery mechanism

The data will be delivered as tables.

Access conditions & pricing

The data from the European sites will be made available every 3 months. Since the PIs of these sites are partners of the GHG_cci the data are for free. The data from the non-European sites will be available at the end of March 2011. Due to the contract arrangement the data are for free, except for the payment of travel support to participate at corresponding conferences.

Issues:

None.

6.2 NDACC FTS CO2 and CH4 data

NDACC CH4 data

Originating system:

Ground based

Data class:

Ground based

Sensor type and key technical characteristics:

The measurements are performed using the solar absorption spectroscopy in the mid infrared using a Fourier Transform Spectrometer (FTS).

Data availability & coverage:

All data of the listed NDACC stations (http://www.acd.ucar.edu/irwg/irwg_groups.html) is available for use but the following stations have committed themselves to update their respective datasets by May 2011: Eureka 80N, NyAlesund 78.9N, Kiruna 67.8N, Harestua 60.2N, Bremen 53.1N, Jungfraujoch 46.6N, Toronto 43.7N, Tsukuba 36N, Paramaribo 6N, Izana 28.3N, Reunion 20.8S and Wollongong 34.5S

Source data product name & reference to product technical specification documents

A paper regarding the NDACC retrieval specifications and results is in preparation (to be published in 2011)

Data quantity

Individual measurements can be taken in intervals of about 20 min, but since most NDACC sites measure a wide range of species and corresponding spectral bands, intervals are typically longer. The observations can only be taken with the direct sunlight under cloud free conditions. This limits the amount of data, which is different from site to site.

Data quality and reliability

The optimal precision of the MIR observations is in the order of 0.3%. The station to station bias is in the order of up to 1.5%, the overall mean bias versus TCCON is smaller.

Ordering and delivery mechanism

The data will be delivered as hdf files, compliant with the NDACC database archiving guidelines.

Access conditions & pricing

All data is available from the NDACC anonymous ftp site ftp.cpc.ncep.noaa.gov/ndacc or will be made available directly as hdf files.

Issues: None.

6.3 In situ data

Ground-based measurements of CO_2 and CH_4 mixing ratios are required to provide the link between long-term in situ records and FTS and SCIAMACHY and GOSAT derived total columns.

Originating system:

Global programs: Global Atmosphere Watch (GAW) and Advanced Global Atmosphere Gas Experiments (AGAGE). The GAW program was established by WMO to provide scientific data for monitoring the atmosphere's chemical composition. GAW is the atmospheric chemistry component of GCOS. AGAGE is a global network providing continuous measurements of biogenic and anthropogenic gases. Both networks provide mainly observations at background sites.

Regional programs: Data from regional networks with continuous CO_2 and/or CH_4 measurements (e.g. CarboEurope, NOAA ESRL GMD Tall Tower Network) including observations from tall towers of suitable quality will be collected.

Data class:

Ground based, in-situ

Sensor type and key technical characteristics:

CH_4 and CO_2 are measured in-situ with a range of techniques. CH_4 is measured either by Gas Chromatography - Flame Ionization Detectors (GC-FID, at GAW and AGAGE sites) or more recently by spectroscopic techniques. CO_2 is measured using non- dispersive infrared sensors (NDIR) and cavity enhanced laser-spectrometers at GAW sites. All measurements are traceable to the WMO CO_2 mole fraction scale and NOAA04 CH_4 mol fraction scale, respectively.

Data availability & coverage:

GAW and AGAGE provide continuous CO_2 hourly data from over 50 sites and CH_4 from more than 30 sites worldwide which are publicly available through the World Data Center for Greenhouse Gases (WDCGG). Atmospheric CO_2 mixing ratios from the NOAA GMD Tower Network are publicly available from nine sites in the USA. CarboEurope provides atmospheric CO_2 and CH_4 mixing ratios at around 20 sites in Europe. Note that not all sites from the abovementioned networks provide measurements for the entire SCIAMACHY lifespan (2002-today).

Source data product name & reference to product technical specification documents

Data submitted to the GAW World Data Center (WDCGG)

14th WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques. Helsinki, Finland, 10-13 September 2007, GAW report No. 186

	ESA Climate Change Initiative (CCI)	Page 35
ghg cci	**Data Access Requirements Document Version 3 (DARDv3)**	Version 3
		26 Feb. 2013
	for the Essential Climate Variable (ECV) Greenhouse Gases (GHG)	

Data quantity

Data quantity depends on measurement period and type and is therefore different from site to site. One year of hourly data from one station does usually not exceed 800 kB. Therefore, we estimate that the data quantity will be in the order of 1-3 Gbyte.

Data quality and reliability

Accuracy of 2ppb for CH_4 and 0.1ppm for CO_2 (c.f. 14th WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques. Helsinki, Finland, 10-13 September 2007, GAW report No. 186)

Ordering and delivery mechanism

Publicly available data can be downloaded from:

http://gaw.kishou.go.jp/wdcgg/ (GAW and AGAGE)

ftp://ftp.cmdl.noaa.gov/ccg/co2/towers/ (NOAA GMD Tower Network)

Registered users can access CarboEurope data from:

http://ce-atmosphere.lsce.ipsl.fr/database/index_database.html

Access conditions & pricing

Unrestricted access, free of charge (GAW, AGAGE, and NOAA GMD Tower Network data)

Restricted access, free of charge for CarboEurope data

Issues:

No issues.