IWGGMS-14, U. Toronto, Canada, 8-10 May 2018

First Copernicus Climate Change Service (C3S) satellite-derived greenhouse gas (CO_2, CH_4) data sets

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Research conducted under the framework of the GOSAT RA (Project CONSCIGO)

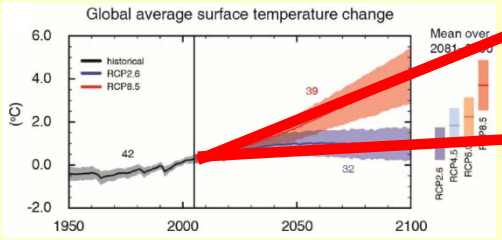
Funding:

European Commission | Copernicus Europe's eyes on Earth | Climate Change Service | ECMWF on behalf of the European Commission | esa Climate Change Initiative (CCI)

Essential Climate Variable (ECV) „Greenhouse Gases“

CO_2 and CH_4 are the two most important greenhouse gases emitted by humans & increasing atmospheric concentrations result in global warming.

Observed and predicted temperature change (AR5)



Future?

Ecomomie?

Population?

Technology?

GHG sources and sinks?

Reliable climate prediction requires a good understanding of the natural and anthropogenic (surface) **sources and sinks of CO_2 and CH_4**.

Important questions are, for example

- Where are they ?
- How strong are they ?
- How do they respond to a changing climate ?

A better understanding requires appropriate global observations and (inverse) modelling.

ECV GHG (GCOS-154*)):

“Retrievals of greenhouse gases, such as CO_2 and CH_4, of sufficient quality to estimate regional sources and sinks.”

*) „SYSTEMATIC OBSERVATION REQUIREMENTS FOR SATELLITE-BASED DATA PRODUCTS FOR CLIMATE“

Overview key European programmes / projects

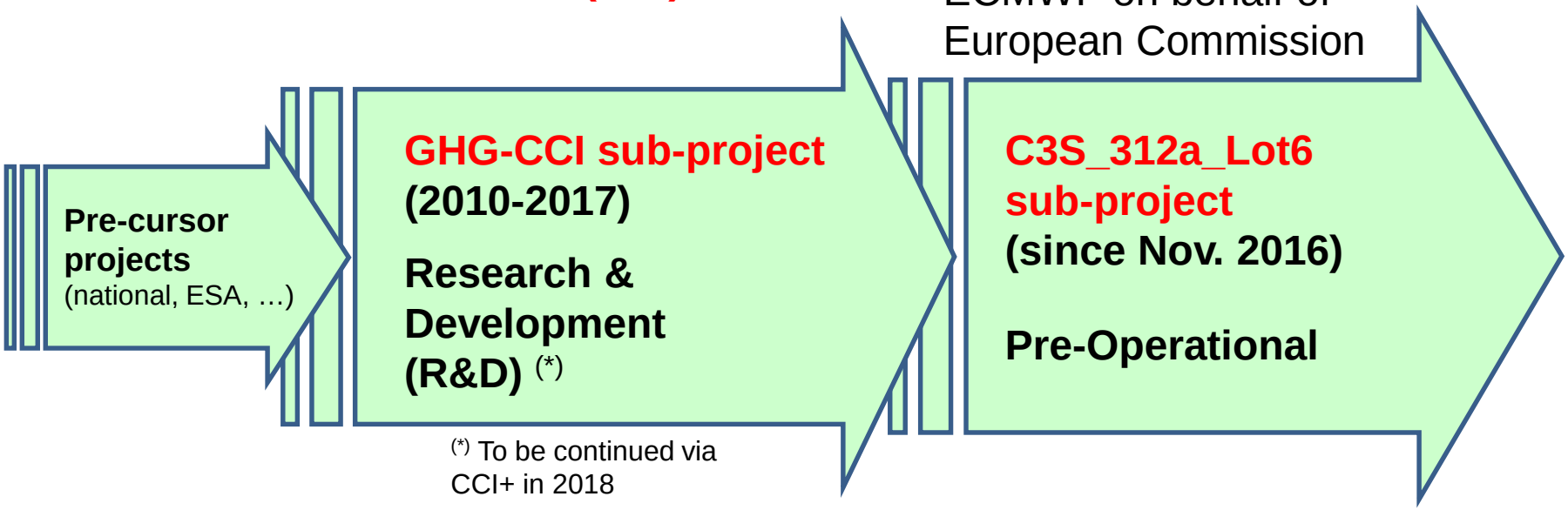
Long-term accurate satellite derived CO_2 and CH_4 for climate applications:

http://www.esa-ghg-cci.org/

https://climate.copernicus.eu/

Climate Change Initiative (CCI): ESA

Copernicus Climate Change Service (C3S): ECMWF on behalf of European Commission



Fast (Near-Real-Time) satellite derived CO_2 and CH_4 for, e.g., forecasting:

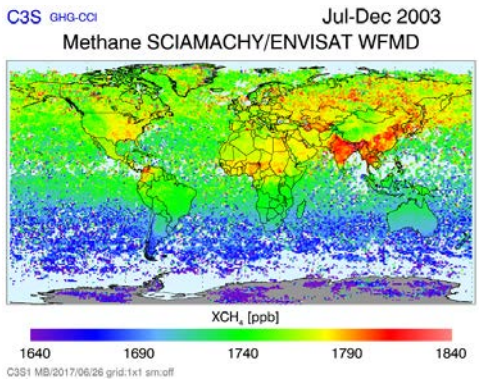
http://atmosphere.copernicus.eu/

Copernicus Atmosphere Monitoring Service (CAMS): ECMWF on behalf of EC

C3S GHG satellite data products

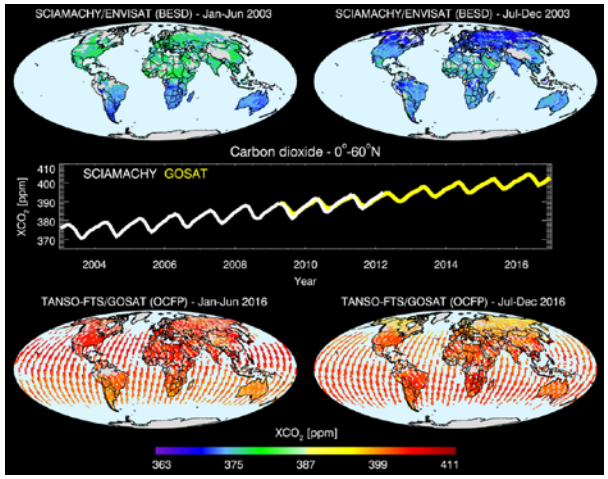
Individual sensor Level 2 (L2) products:

- **SCIAMACHY XCO_2** (CO2_SCI_BESD, CO2_SCI_WFMD)
- **SCIAMACHY XCH_4** (CH4_SCI_WFMD, CH4_SCI_IMAP)
- **GOSAT XCO_2** (CO2_GOS_OCFP, CO2_GOS_SRFP)
- **GOSAT XCH_4** (CH4_GOS_OCFP, CH4_GOS_SRFP, CH4_GOS_OCPR, CH4_GOS_SRPR)
- **IASI mid-trop CO_2** (CO2_IASA_NLIS, CO2_IASB_NLIS)
- **IASI mid-trop CH_4** (CO2_IASA_NLIS, CO2_IASB_NLIS)
- **AIRS mid-trop CO_2** (CO2_AIR_NLIS)



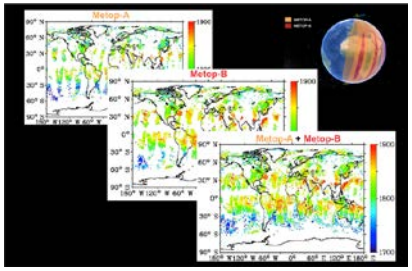
Merged L2 products:

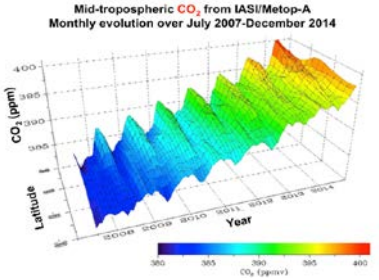
- **XCO2_EMMA** (based on listed indiv. sensor L2 products + GOSAT/NIES + GOSAT/NASA/ACOS)
- **XCH4_EMMA** (based on listed indiv. sensor L2 products + GOSAT/NIES)

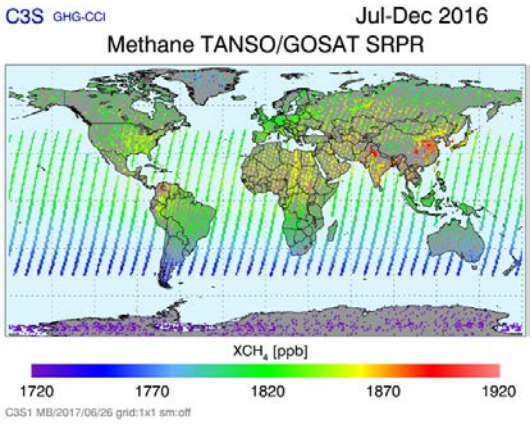


Merged L3 products:

- **XCO2_OBS4MIPS** (based on merged L2 product)
- **XCH4_OBS4MIPS** (based on merged L2 product)







GHG-CCI: http://www.esa-ghg-cci.org/

Datei Bearbeiten Ansicht Chronik Lesezeichen Extras Hilfe

ESA GHG CCI website | CO2 wil

www.esa-ghg-cci.org 90% Suchen

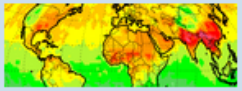
esa climate change initiative European Space Agency

ESA | CCI | aerosol | cloud | cmug | fire | ghg | glaciers | land cover | ocean col. | ozone | sea ice | sea level | soil moi. | sst | ice sheets

ghg

Navigation

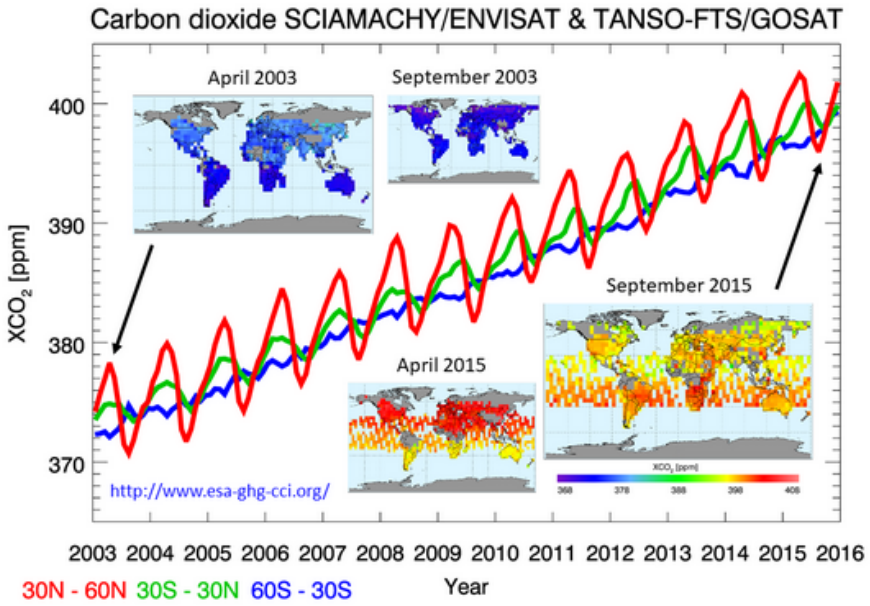
- Overview
- Project Team
- Product Description
- Round Robin
- CRDP (Data)
- Validation
- Publications
- Contact
- Documents
- Image Gallery
  - Carbon Dioxide
  - Methane



Hosted by IUP
Universität Bremen

GHG-CCI

Carbon dioxide (CO_2) and methane (CH_4) are the two most important anthropogenic greenhouse gases (GHGs). Satellite observations combined with modelling helps to improve our knowledge on CO_2 and CH_4 sources and sinks as required for better climate prediction. GHG-CCI aims at delivering the high quality satellite retrievals needed for this application.



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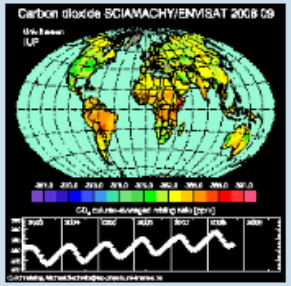
Search

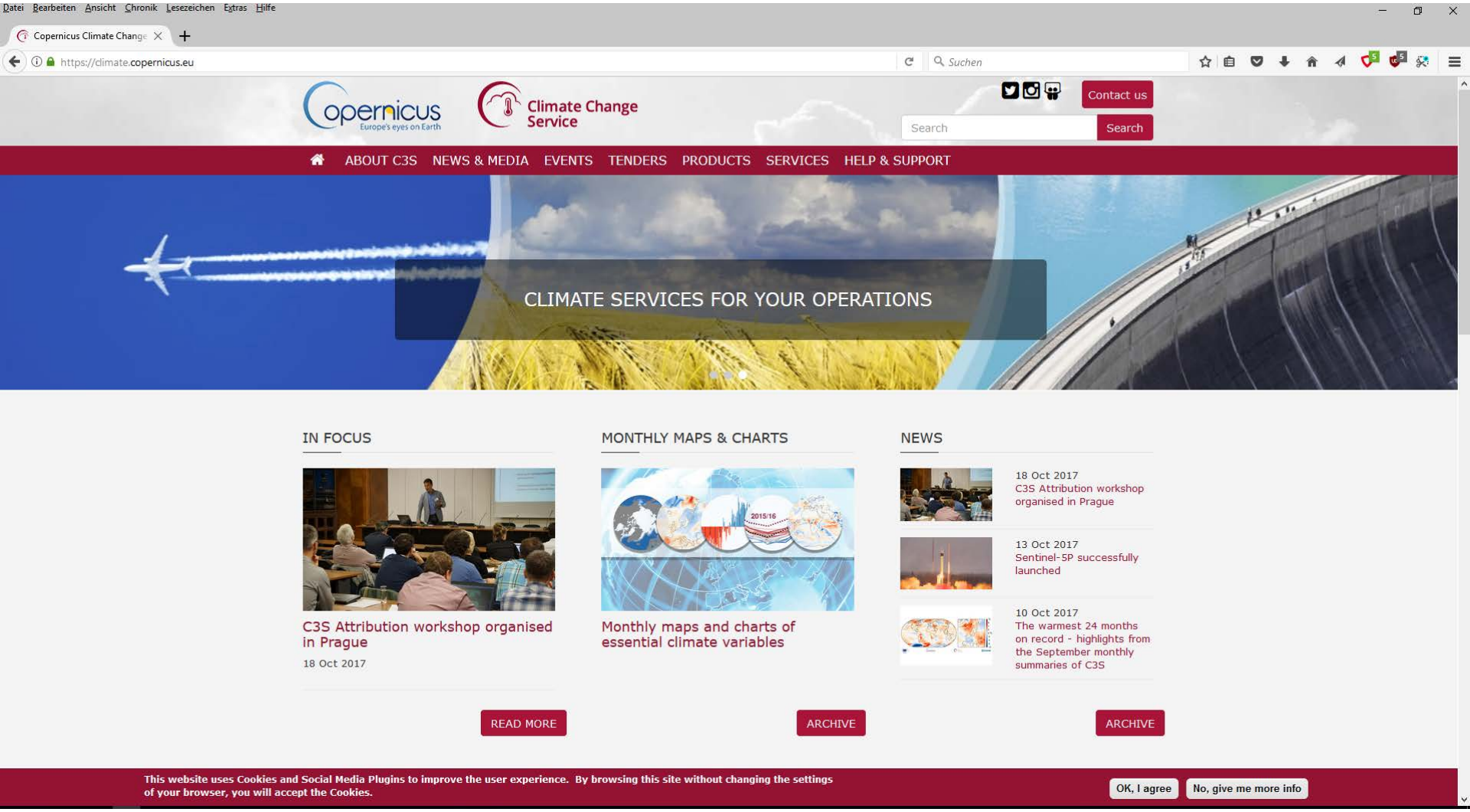


Calendar

« April 2018 »

Mon	Tue	Wed	Thu	Fri	Sat	Sun
						1
2	3	4	5	6	7	8

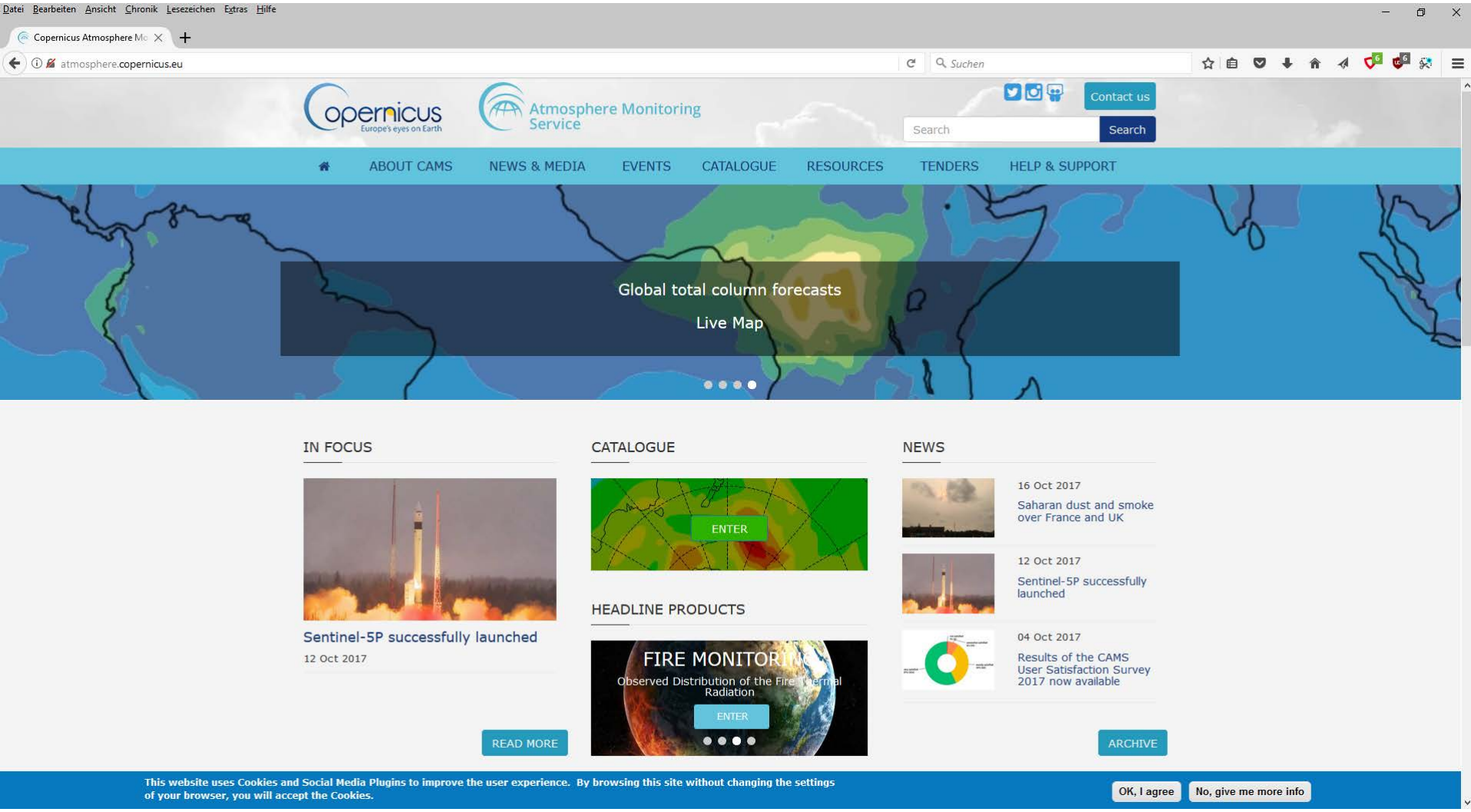
C3S: https://climate.copernicus.eu/



Our contributions:

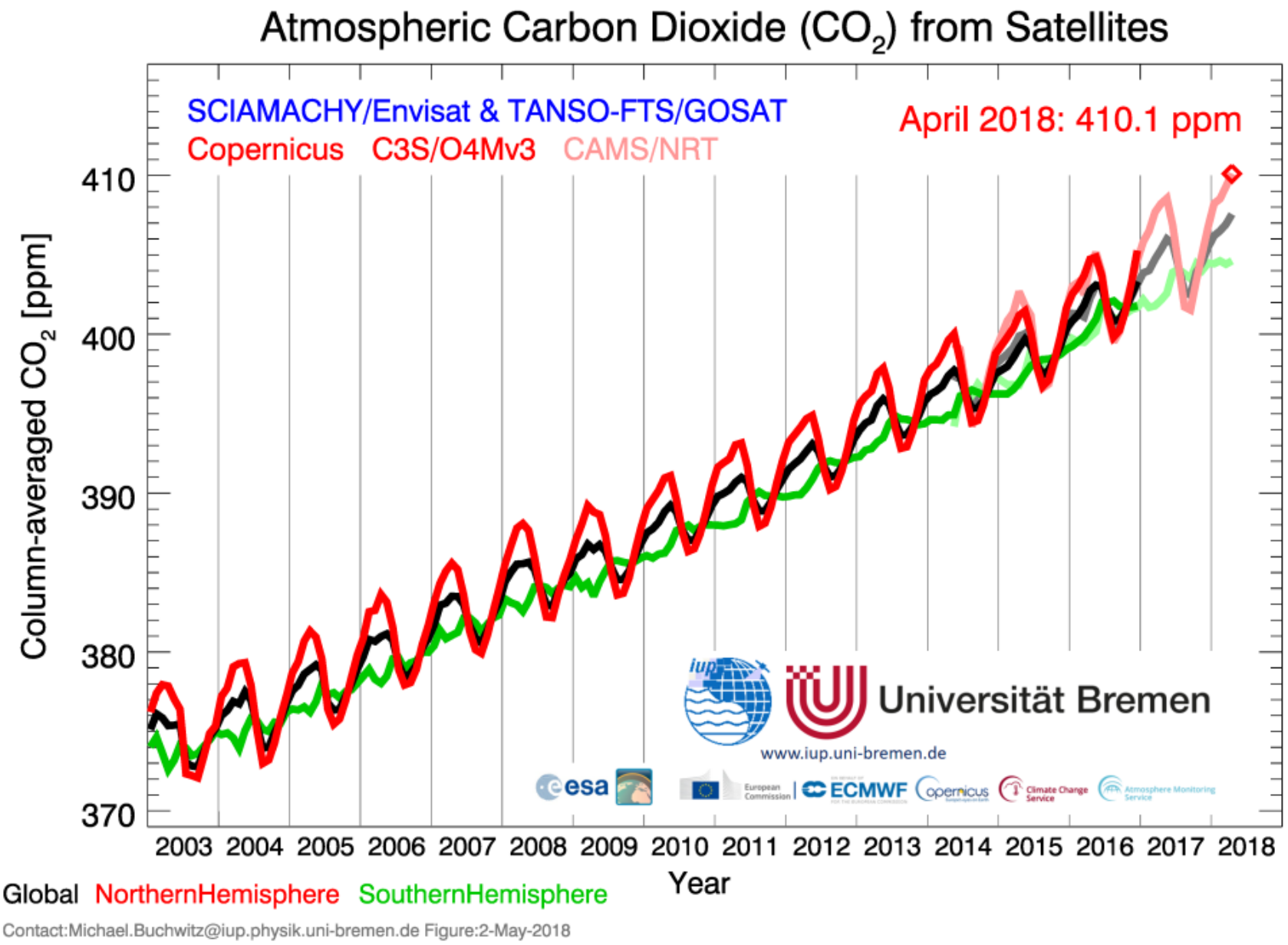
- Long-term accurate satellite-derived CO_2 and CH_4
- Extended each year by one year (data set No. 1: 2003-2016)

CAMS: http://atmosphere.copernicus.eu/

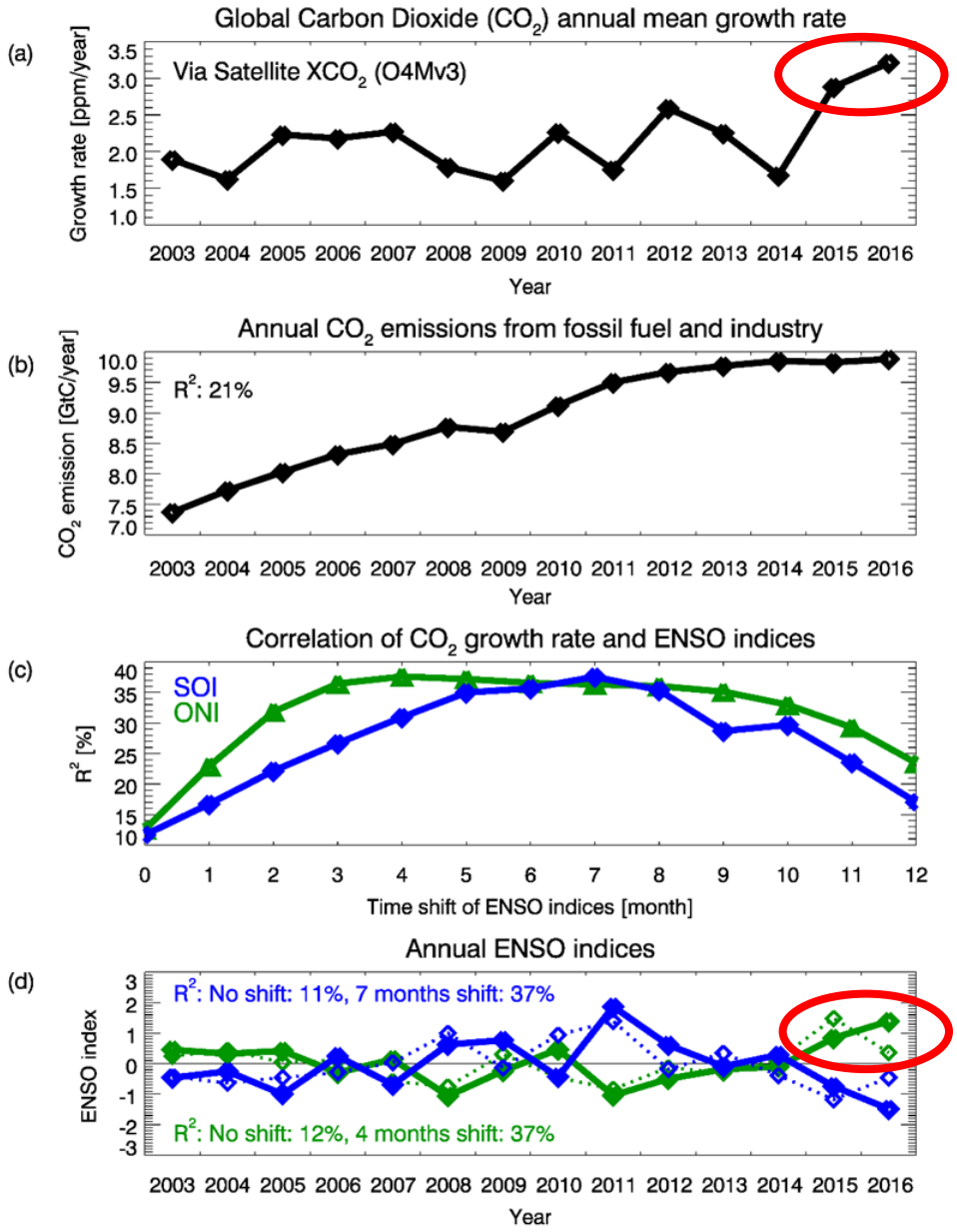


Our contributions: Satellite-derived products in quasi-NRT:
GOSAT XCO_2 (U. Bremen), GOSAT XCH_4 (SRON),
IASI mid-trop CH_4 (LMD/CNRS), GOSAT SIF (U. Leicester)

C3S and CAMS XCO_2 time series



XCO2_OBS4MIPS: Annual mean XCO_2 growth rates



Large increase of atmospheric CO_2 during 2015 & 2016 (~ 3 ppm/year)

… despite nearly constant CO_2 emissions

Reason: 2015 / 2016 El Nino

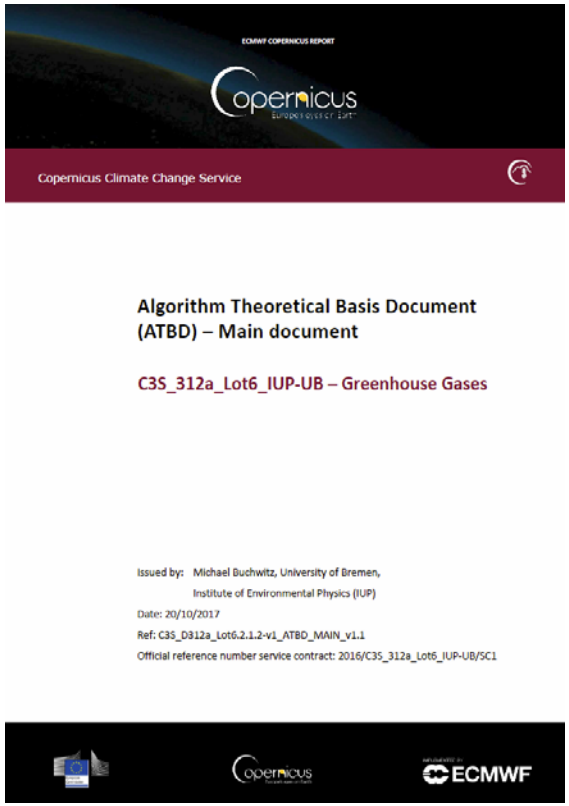
Buchwitz et al.,
ACPD (in review), 2018

C3S GHG: Documentation

Requirements

User Guide

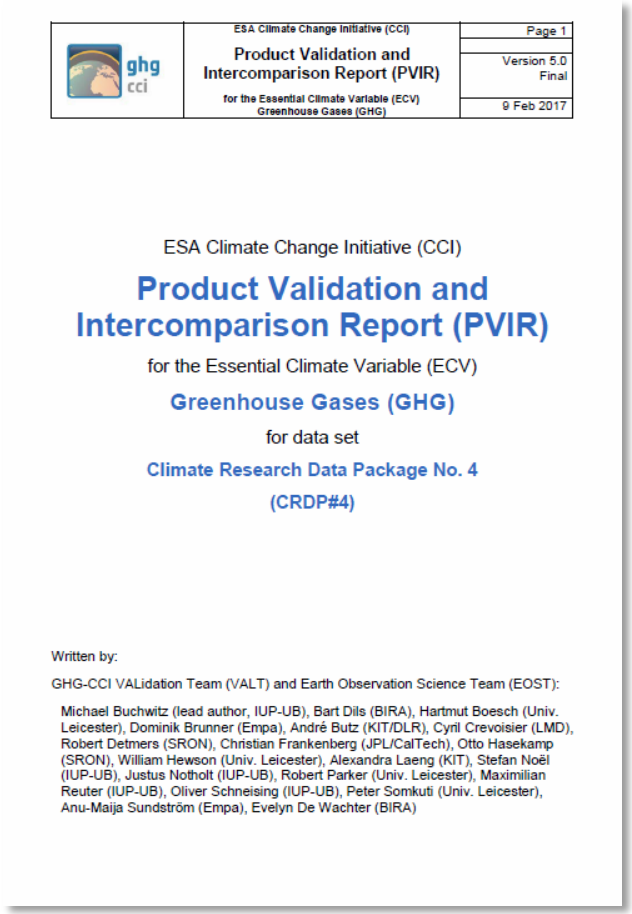
ATBD



Product Quality

Main document + several ANNEXes per product / groups of products

GHG-CCI: Data quality: XCO_2



ESA Climate Change Initiative (CCI) | Page 1

ghg cci

Product Validation and Intercomparison Report (PVIR)

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

Version 5.0 Final

9 Feb 2017

ESA Climate Change Initiative (CCI)

Product Validation and Intercomparison Report (PVIR)

for the Essential Climate Variable (ECV)

Greenhouse Gases (GHG)

for data set

Climate Research Data Package No. 4

(CRDP#4)

Written by:

GHG-CCI VALidation Team (VALT) and Earth Observation Science Team (EOST):

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http://www.esa-ghg-cci.org/?q=webfm_send/352

(253 pages)

Based on comparisons with

TCCON

total carbon column observing network

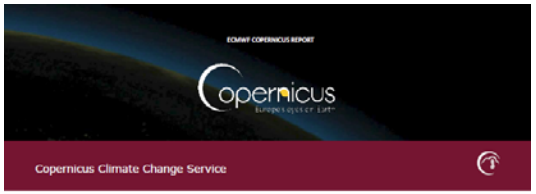
GHG-CCI: Estimates of achieved data quality (#): CRDP#4 XCO_2

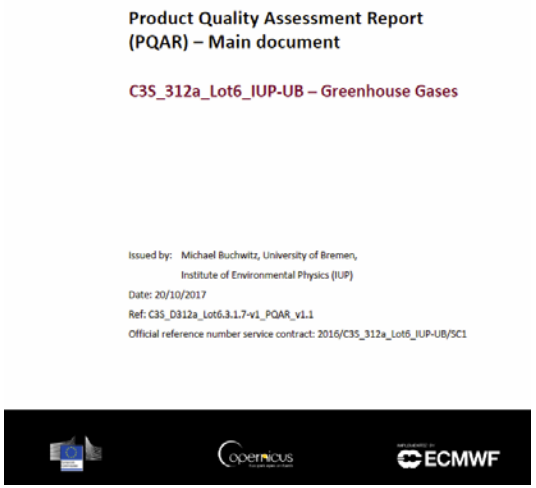
Sensor	Algorithm	Random error [ppm]	Systematic error [ppm]	Stability [ppm/year]		Details (section)
				Long-term drift	Year-to-year	
SCIAMACHY on ENVISAT	BESD v02.01.02	1.9 1.9 2.0 1.9	0.37 - 0.56 0.38 – 0.40 0.39 – 0.43 0.4 – 0.8	-0.03 +/- 0.06 (*) -0.13 +/- 0.28 (?) -0.02 +/- 0.33 (?) -0.01 +/- 0.08 (*)	0.32 +/- 0.08 0.34 (?) 0.23 (?) 1.68 +/- 2.03 (*)	VAL (Sect. 3) DP (6.1.1) EMMA (6.1.5) QA/QC (7.1)
SCIAMACHY on ENVISAT	WFMD V4.0	2.7 2.6 2.9 3.0 2.7	0.57 – 0.71 0.48 – 0.52 0.60 – 0.75 0.60 – 0.63 0.5 – 1.0	-0.03 +/- 0.10 (*) [0.00, 0.04] (?) 0.14 +/- 0.21 (?) 0.23 +/- 0.42 (?) -0.04 +/- 0.09 (*)	0.31 +/- 0.11 0.21 (?) 0.46 (?) 0.33 (?) 1.86 +/- 2.41 (*)	VAL (3) DP (6.1.2) DP (6.1.1) EMMA (6.1.5) QA/QC (7.1)
TANSO on GOSAT	OCFP v7.0 (UoL-FP)	1.8 1.9 1.8 1.7	0.36 - 0.58 0.47 0.36 – 0.42 0.3 – 0.5	-0.07 +/- 0.07 (*) 0.11 (?) -0.15 +/- 0.11 (?) -0.09 +/- 0.08	0.29 +/- 0.06 0.9 (?) 0.23 (?) 1.48 +/- 2.06 (*)	VAL (3) DP (6.1.3) EMMA (6.1.5) QA/QC (7.1)
TANSO on GOSAT	SRFP v2.3.8 (RemoTeC)	2.0 1.9 2.1 1.9	0.36 - 0.51 0.43 0.28 – 0.48 0.4 – 0.5	0.02 +/- 0.04 (*) -0.05 +/- 0.12 (*) 0.00 +/- 0.16 (?) -0.06 +/- 0.11 (*)	0.27 +/- 0.12 0.34 +/- 0.12 0.24 (?) 1.30 +/- 2.11 (*)	VAL (3) DP (6.1.4) EMMA (6.1.5) QA/QC (7.1)
SCIAMACHY & GOSAT	EMMA v2.2a	2.0 2.4	0.37 - 0.45 0.47 – 0.54	0.08 +/- 0.22 (*) -0.30 +/- 0.64 (?)	0.18 +/- 0.12 0.25 (?)	VAL (3) EMMA (6.1.5)
SCIAMACHY & GOSAT	EMMA v2.2b	1.7 1.8	0.29 - 0.38 0.32 – 0.40	-0.08 +/- 0.20 (*) -0.13 +/- 0.42 (?)	0.16 +/- 0.11 0.20 (?)	VAL (3) EMMA (6.1.5)
TANSO on GOSAT	EMMA v2.2c	1.7 1.8	0.30 - 0.39 0.24 – 0.44	-0.14 +/- 0.20 (*) -0.04 +/- 0.16 (?)	0.16 +/- 0.12 0.26 (?)	VAL (3) EMMA (6.1.5)
Required	G / B / T	< 1 / 3 / 8	< 0.2 / 0.3 / 0.5	< 0.2 / 0.3 / 0.5		/URD GHG-CCI v2.1/
Required	Target	< 0.5 ppm (uncertainty; 1-sigma)		< 0.15 ppm/year		/GCOS-200/

(#) As estimated (mostly) by comparison with ground-based TCCON observations neglecting TCCON accuracy (1-sigma) of 0.4 ppm
(*) NOT significant; (?) Significance unclear
Green numbers: at least URDv2.1 threshold requirement met; single values random and systematic errors are 1-sigma

Product Quality Assessment Report (PQAR): Overview XCO_2

Product Quality





Threshold requirement:

Accuracy: < 0.5 ppm

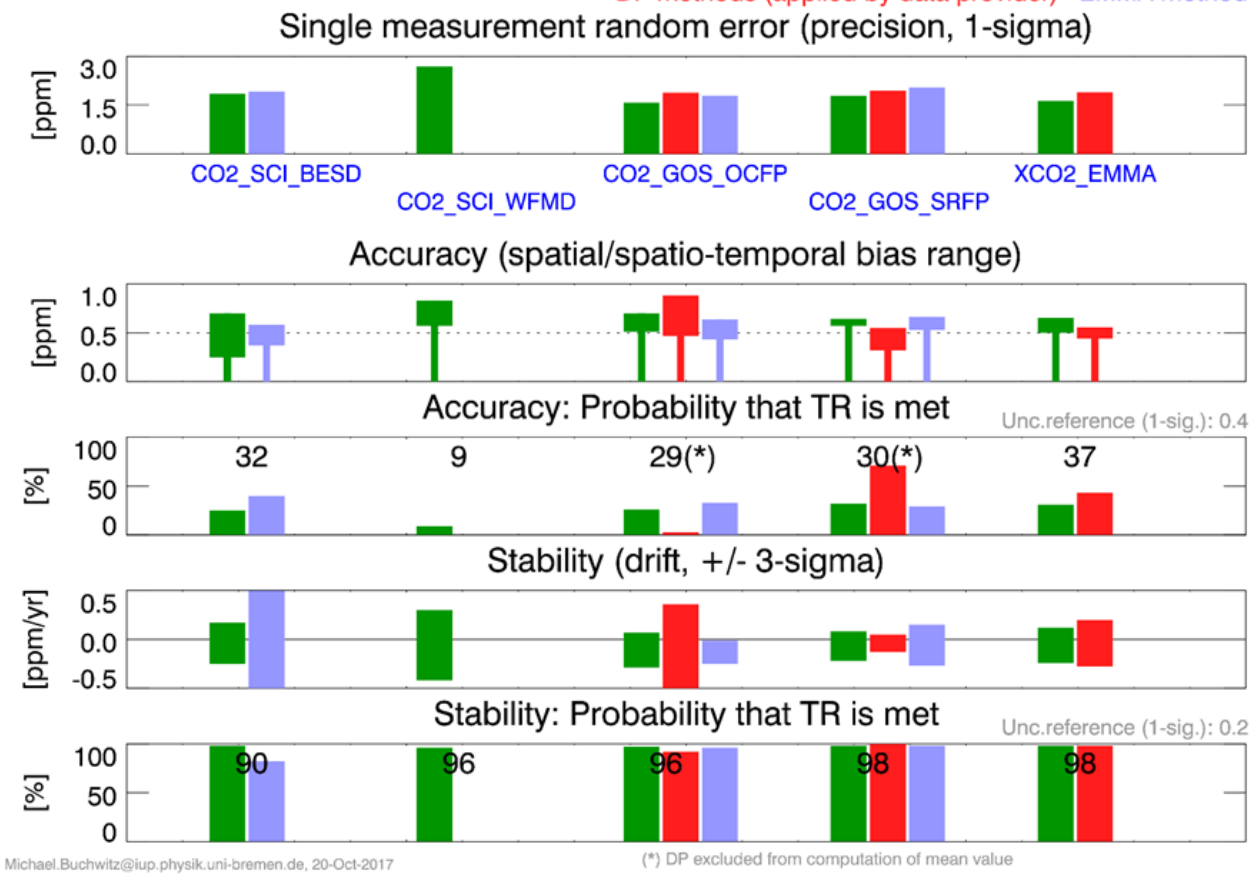
Stability: < 0.5 ppm/year

Based on comparisons with

TCCON
total carbon column observing network

C3S Level 2 products: XCO_2

QA/QC method (applied to all products)
DP methods (applied by data provider) EMMA method

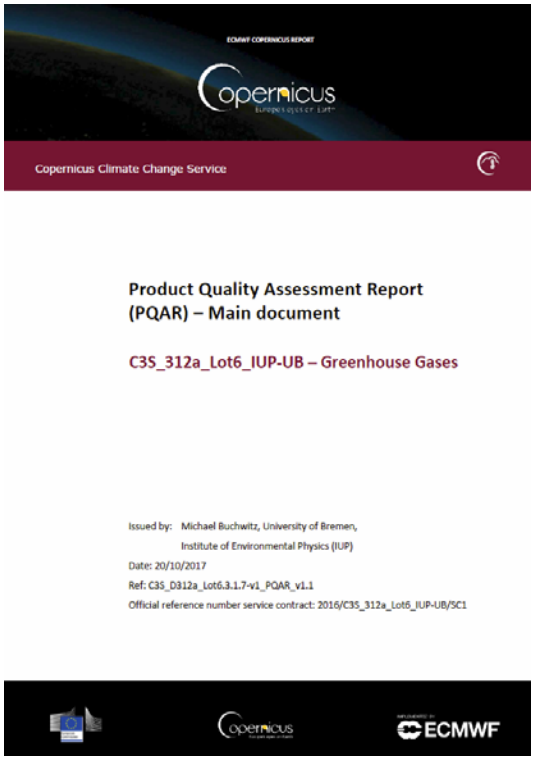


Michael.Buchwitz@iup.physik.uni-bremen.de, 20-Oct-2017

(*) DP excluded from computation of mean value

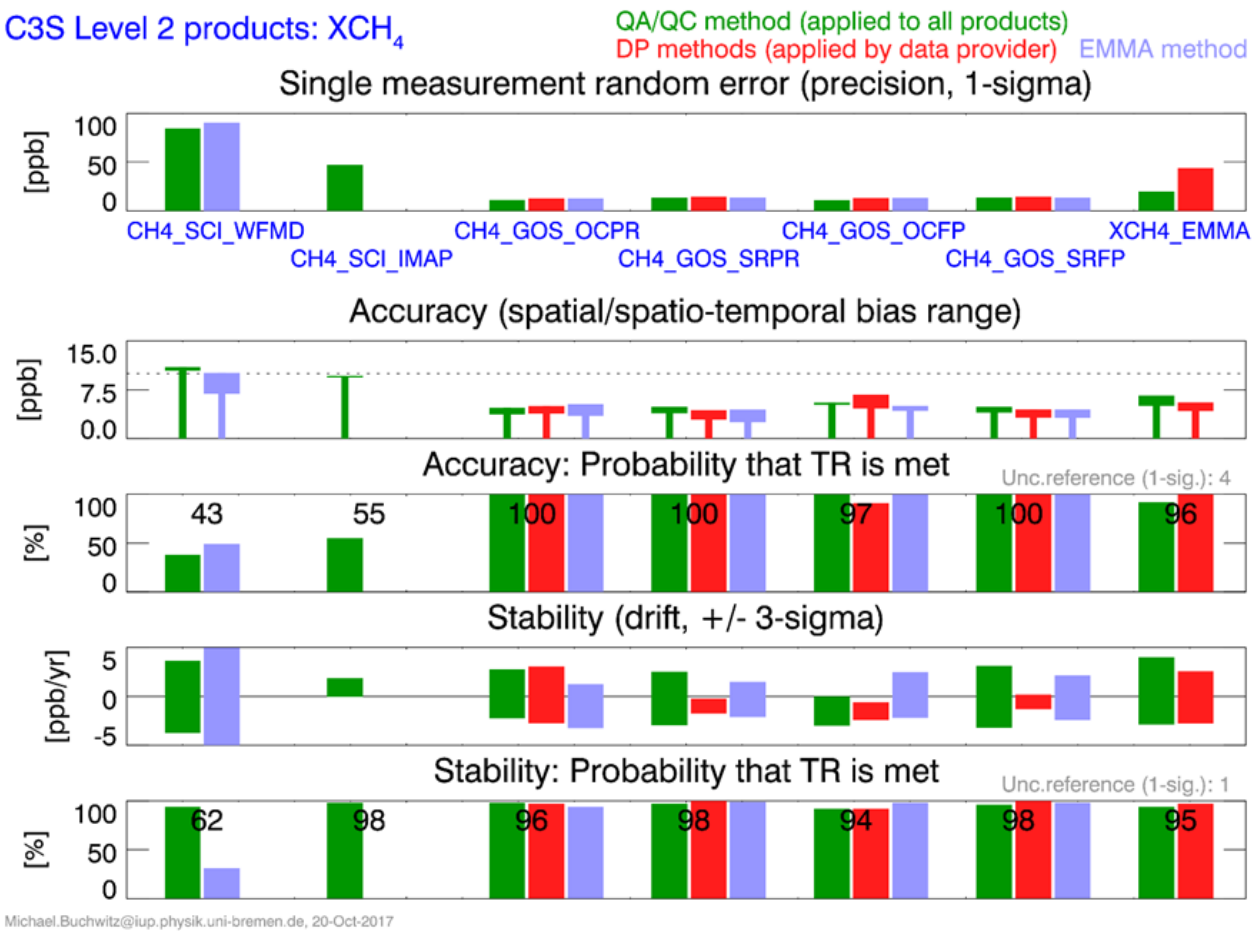
Product Quality Assessment Report (PQAR): Overview XCH_4

Product Quality



Based on comparisons with

TCCON
total carbon column observing network

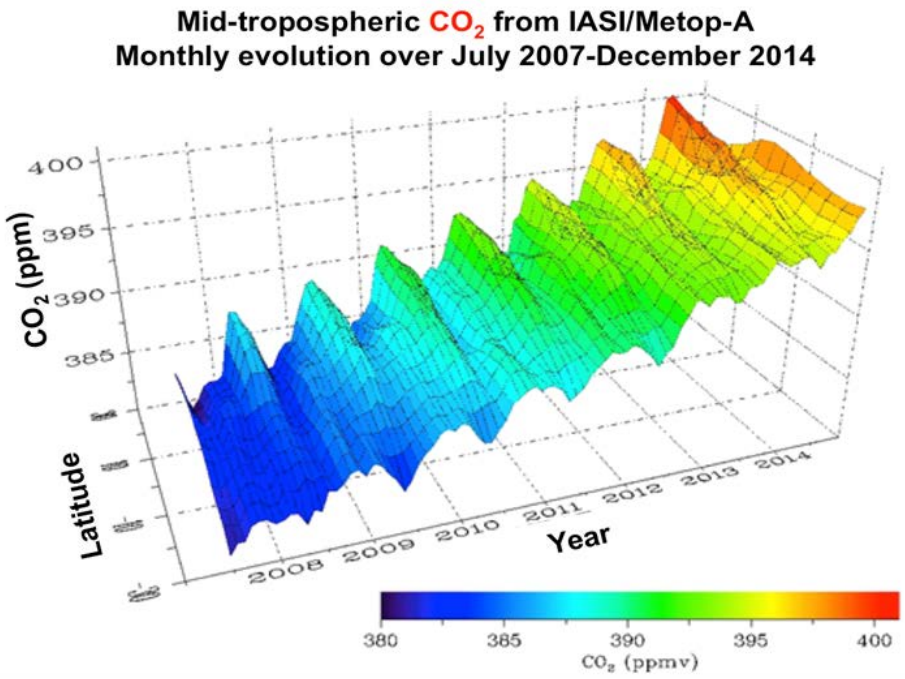


Threshold requirement:

Accuracy: < 10 ppb

Stability: < 3 ppb/year

Mid-tropospheric CO_2 and CH_4 IASI Metop-A & Metop-B

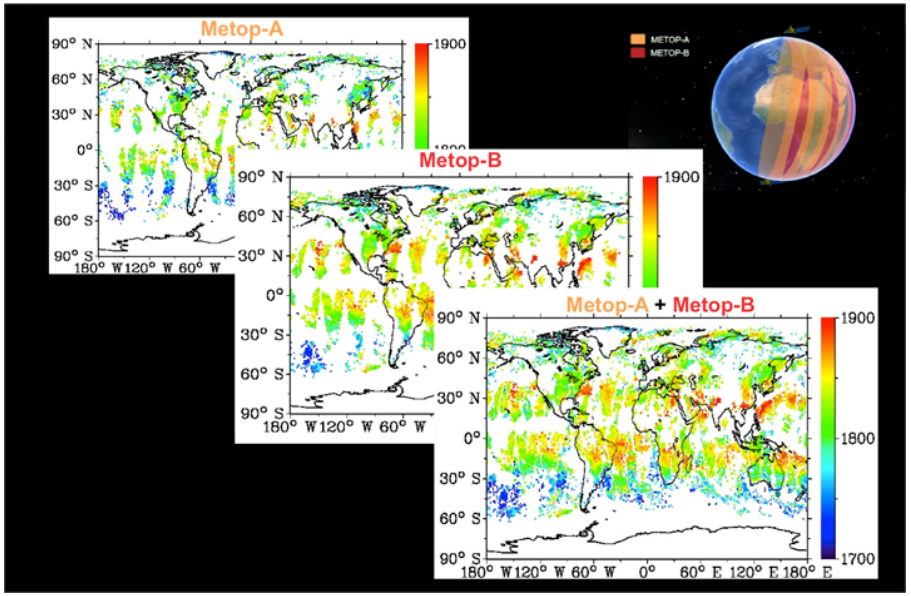


First data set:

- Daily NetCDF as for all other L2 products

CO2_IASA_NLIS: 2007-2015
CO2_IASB_NLIS: 2013-2016

CH4_IASA_NLIS: 2007-2015
CH4_IASB_NLIS: 2013-2016



Summary & conclusions

- The GHGs CO_2 and CH_4 are „Essential Climate Variables“ (**ECVs**)

- Key European projects & related GHG satellite contributions:
  - **GHG-CCI** (R&D) and **C3S** ((pre-)operational processing) for carbon & climate applications
  - **CAMS** NRT, e.g., for ECMWF forecasting

- First C3S satellite-derived GHG data set (2003-2016) soon available via **Copernicus Climate Data Store** (CDS; https://climate.copernicus.eu/)

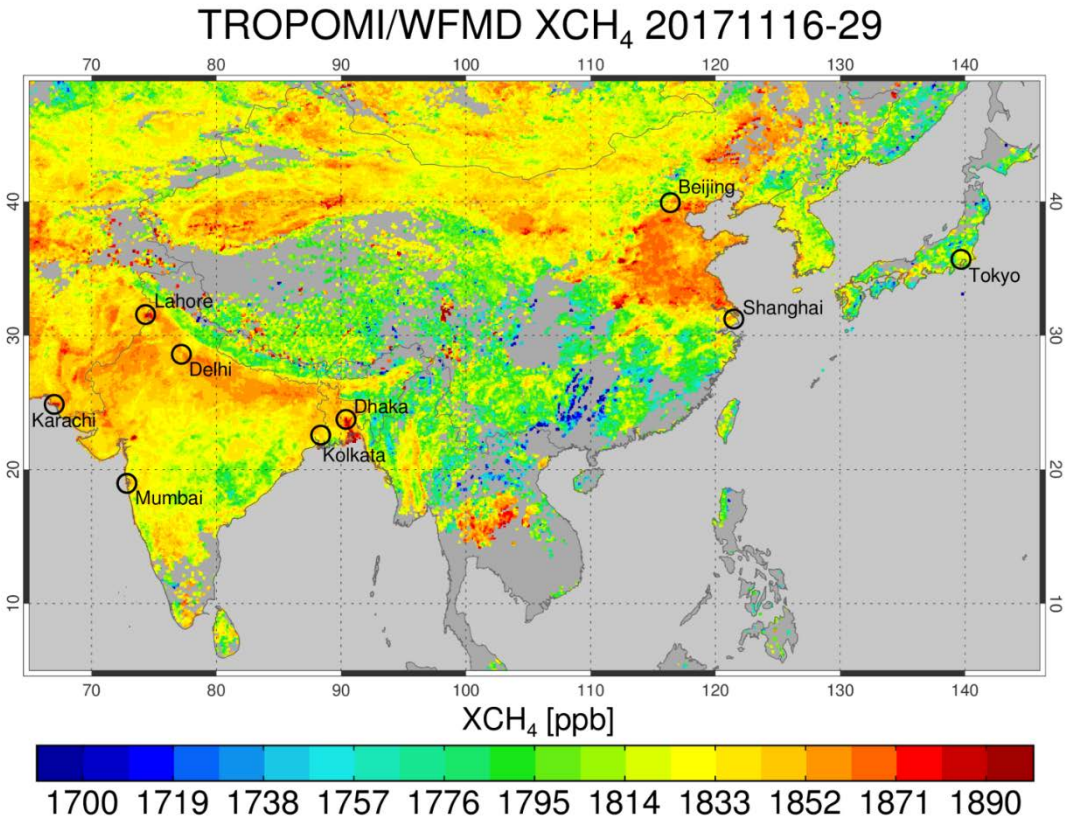
- Second C3S data set (2003-2017) available end of 2018

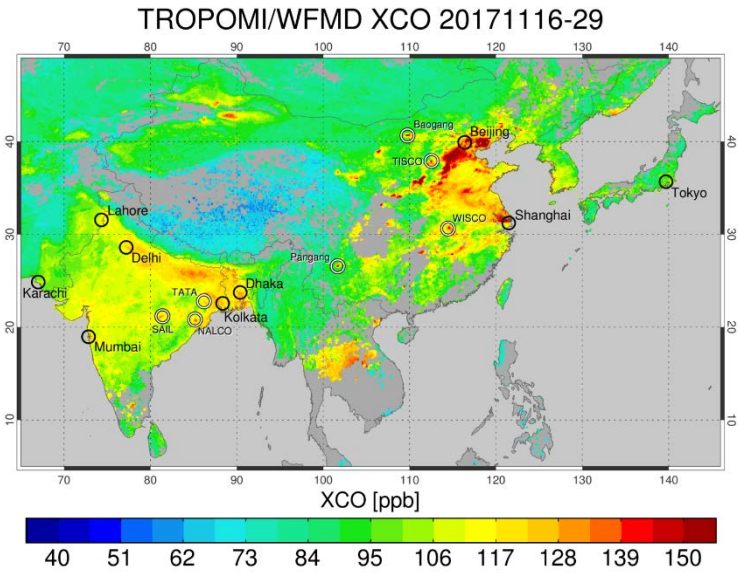
- Future versions will also include other sensors: OCO-2, Sentinel-5-Precursor, GOSAT-2, …

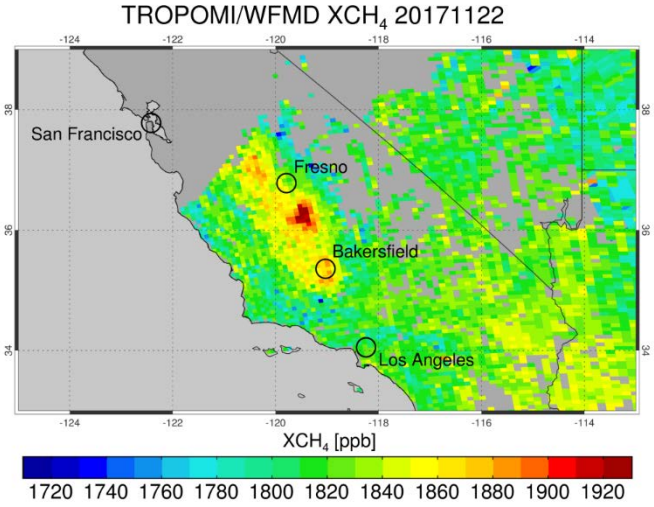
Funding:

European Commission | Copernicus Europe's eyes on Earth | Climate Change Service | ON BEHALF OF ECMWF FOR THE EUROPEAN COMMISSION | esa Climate Change Initiative (CCI)

First **preliminary** results from S5P via scientific algorithm WFM-DOAS







Disclaimer: *The presented work has been performed within the framework of the Sentinel-5 Precursor Validation Team or Level 1/Level 2 Product Working Group activities. Results are based on preliminary (not fully calibrated/validated) Sentinel-5 Precursor data that are still subject to change.*

Acknowledgement: *Sentinel-5 Precursor is a European Space Agency (ESA) mission implemented on behalf of the European Commission (EC). The TROPOMI payload is a joint development by ESA and the Netherlands Space Office (NSO). The Sentinel-5 Precursor ground-segment development has been funded by ESA and with national contributions from The Netherlands, Germany, and Belgium.*