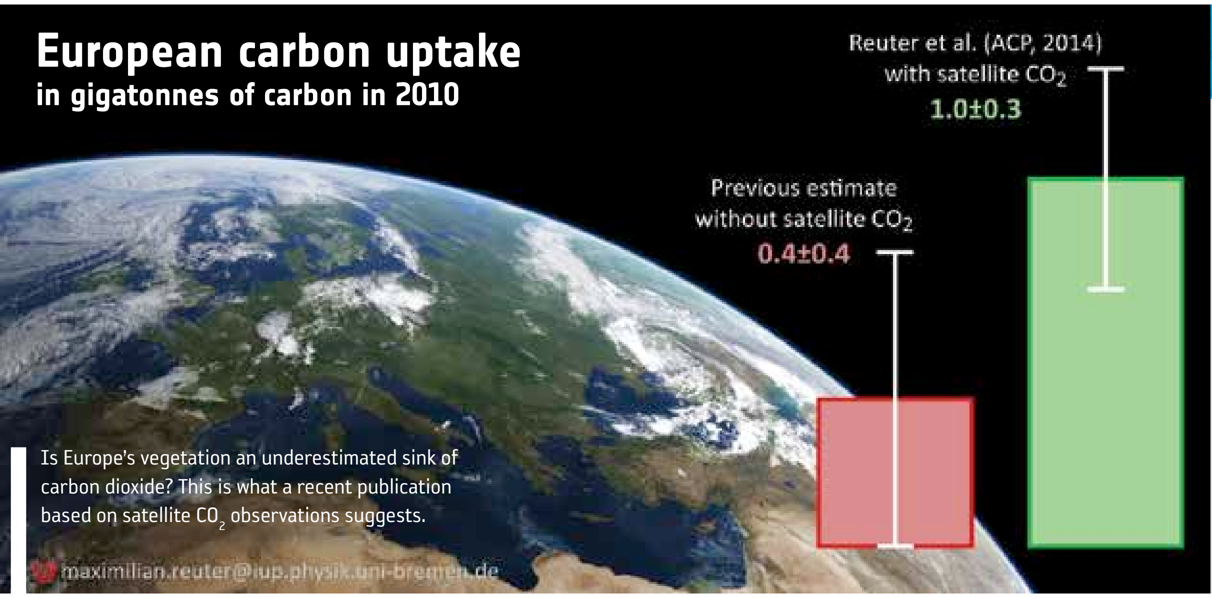
climate change initiative

→ GHG NEWSLETTER

Special Issue: COP-21 | September 2015



Is Europe's vegetation an underestimated sink of carbon dioxide? This is what a recent publication based on satellite CO_2 observations suggests.

In this issue:

Greenhouse Gases CCI Overview

The focus of GHG-CCI is to generate global data sets of carbon dioxide (CO_2) and methane (CH_4), which are the two most important anthropogenic ("man made") greenhouse gases (GHGs). Satellite observations combined with modelling can provide important missing global information on regional CO_2 and CH_4 sources and sinks as required, for example, for better climate prediction and verification of reported GHG emissions. The focus of the GHG-CCI project is to further improve state-of-the-art retrieval algorithms needed to convert the satellite radiance measurements into atmospheric GHG information and to use the resulting data sets to improve our knowledge of the various natural and anthropogenic GHG sources and sinks.

GHG-CCI has recently successfully completed the first year of Phase 2 of this project. Phase 2 started in February 2014 and is a continuation of the initial Phase 1, which ended in 2013.

During Phase 2 the focus is on "data production and data usage" by consistent re-processing and extending the existing satellite-derived greenhouse gas time series, to further improve the data quality and to use the new data sets to improve our knowledge on greenhouse gas surface fluxes ("sources and sinks").

A new extended and improved data set has been generated, the GHG-CCI "Climate Research Data Package No. 2" (CRDP#2), which is available free of charge for all interested users. The GHG-CCI core data products are column-averaged dry-air mole fractions of CO_2 and CH_4, denoted XCO_2 and XCH_4.

Here we present a short overview about the GHG-CCI Phase 2 activities and achievements, including the latest data products, and present some scientific highlights from using the GHG-CCI data products to address important carbon and climate related scientific issues.

→

ghg cci

Recent Achievements

A major milestone of the ongoing Phase 2 (March 2014-February 2017) of the GHG-CCI project has been reached in early April 2015 as documented by the successful GHG-CCI Phase 2 first Annual Review Meeting, which took place at ESA's ESRIN facility in Frascati near Rome.

The focus of the first year of Phase 2 of GHG-CCI was on:

- The refinement of the user requirements (see User Requirements Document, URDv2), publicly available as all other documents from http://www.esa-ghg-cci.org/ -> Documents).
- The improvement of the retrieval algorithms used for the processing of the satellite data to generate the GHG-CCI satellite-derived atmospheric CO2 and CH4 data products.
- The generation of improved data sets which are part of the recently released "Climate Research Data Package No. 2" (CRDP#2) (see below and http://www.esa-ghg-cci.org/ -> CRDP (Data)),
- The improvement of the data product format (see Product Specification Document, PSDv3),
- The validation of CRDP#2 (see Product Validation and Intercomparison Report, PVIRv3.2),
- An initial user assessment of CRDP#2 (see GHG-CCI Climate Assessment Report, CARv2), and
- Several publications of the scientific findings in peer-reviewed scientific journals (see page 4 and http://www.esa-ghg-cci.org/ -> Publications).

Outlook: GHG-CCI will deliver extended data sets with improved quality via re-processing and processing of new satellite data once per year. The next data set – CRDP#3 - will be available in April 2016 including documentation, initial validation and initial user assessment.

New CO_2 and CH_4 data sets: GHG-CCI "Climate Research Data Package No. 2" (CRDP#2)

CRDP#2 is the second version of the GHG-CCI "Essential Climate Variable" (ECV) Greenhouse Gases (GHG) data base. CRDP#2 contains the satellite-derived carbon dioxide and methane GHG-CCI data products. This data set and its documentation is available free of charge for all interested users.

GHG-CCI Climate Research Data Package (CRDP#2)															
Product ID	Product (Level 2, mole fractions)	Years processed													
		2002	03	04	05	06	07	08	09	10	11	12	13	14	15
GHG-CCI Core Products: ECV Core Algorithm (ECA) Products															
XCO2_SCIA	XCO_2														
XCH4_SCIA	XCH_4														
XCO2_GOSAT	XCO_2														
XCH4_GOSAT	XCH_4														
XCO2_EMMA	XCO_2														
Additional Constraints Algorithm (ACA) Products															
CO2_IASI	CO_2 (1)														
CH4_IASI	CH_4 (1)														
CH4_SCIAOCC	CH_4 (2)														
CO2_SCIAOCC	CO_2 (2)														
CO2_ACEFTS	CO_2 (2)														
CH4_MIPAS	CH_4 (2)														
CO2_AIRS	CO_2 (1)														

Comments:

ACA products:
(1) Mid / upper tropospheric column
(2) Upper tropospheric / stratospheric profile

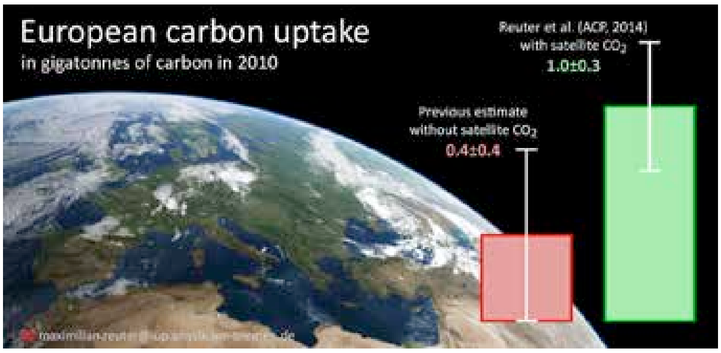
CRDP#2
Also available

ECA Algorithms for column-averaged dry air mole fractions:
XCO2_SCIA: BESD, WFMD
XCH4_SCIA: WFMD, IMAP
XCO2_GOSAT: SRFP (RemoTeC), OCFP (UoL-FP)
XCH4_GOSAT: SRFP & SRPR (RemoTeC), OCPR (UoL-PR)
XCO2_EMMA: Various (SCIA & GOSAT merged)

ghg cci

Is Europe an underestimated sink for CO_2?

Currently the global terrestrial biosphere on average takes up about 25% of our CO_2 emissions, i.e., vegetation is a strong carbon sink. For climate prediction it is important to know if this will also be the case in the future. Unfortunately, our knowledge on the natural carbon sinks and sources has large gaps. For many regions it is essentially unknown if they are currently sinks or sources. Even for regions located in northern mid-latitudes the uncertainty is large: It is well known that a strong sink is located in northern extra-tropics but it is unclear where exactly this sink is.



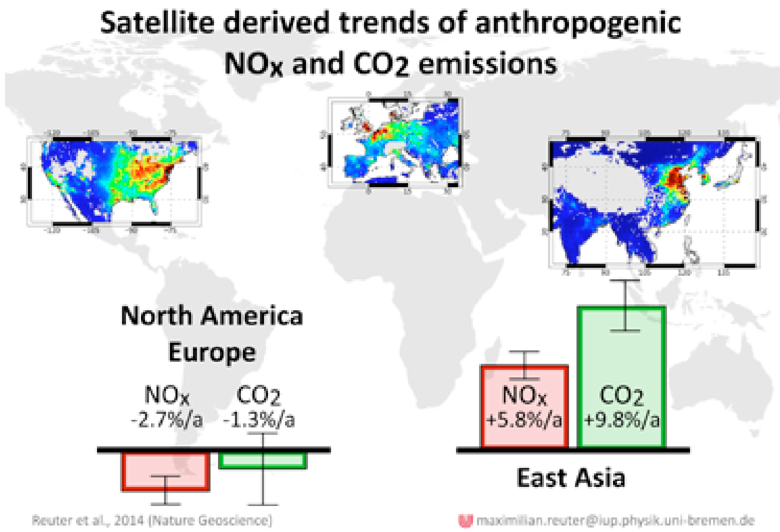
To address this issue GHG-CCI team members have used GHG-CCI and other satellite CO_2 observations to assess the magnitude of the European carbon sink. The results indicate that Europe is a stronger carbon sink than expected (see figure). For details please see Reuter et al., Satellite-inferred European carbon sink larger than expected, Atmospheric Chemistry and Physics, 2014.

Several research groups are currently further investigating this somewhat unexpected and not yet well-understood finding (e.g., Feng et al., ACPD, 2015, Houweling et al., JGR, 2015).

Anthropogenic CO_2 and NO_x emissions

Using SCIAMACHY satellite data it has been found by GHG-CCI team members that anthropogenic, i.e., man-made, emissions of CO_2 and nitrogen oxides (NOX) are slightly decreasing in North America and Europe but are increasing by several percent per year in East Asia.

However, the good news for East Asia is that less NO_x is emitted per amount of emitted CO_2 or amount of fossil fuel burned. This indicates a trend towards the use of cleaner technology in East Asia. For details please see Reuter et al., Decreasing emissions of NOX relative to CO_2 in East Asia inferred from satellite observations, Nature Geoscience, 2014.



Methane emissions from fracking

SCIAMACHY satellite data have also been used to quantify methane emissions and leakage rates for major oil and gas producing "fracking" areas in the USA. Quite high methane emissions have been found and leakage rates which are much higher than expected.

For details please see Schneising et al., Remote sensing of fugitive methane emissions from oil and gas production in North American tight geologic formations, Earth's Future, 2014.

ghg cci

Overview of scientific publications

Selected peer-reviewed publications based on or related to GHG-CCI data products and activities:

Alexe, M., P. Bergamaschi, A. Segers, et al., Inverse modeling of CH_4 emissions for 2010–2011 using different satellite retrieval products from GOSAT and SCIAMACHY, Atmos. Chem. Phys., 15, 113–133, doi:10.5194/acp-15-113-2015, 2015.

Basu, S., S. Guerlet, A. Butz, et al., Global CO_2 fluxes estimated from GOSAT retrievals of total column CO_2, Atmos. Chem. Phys., 13, 8695-8717, 2013.

Basu, S., Krol, M., Butz, A., et al., The seasonal variation of the CO_2 flux over Tropical Asia estimated from GOSAT, CONTRAIL and IASI, Geophys. Res. Lett., doi: 10.1002/2013GL059105, 2014.

Buchwitz, M., M. Reuter, O. Schneising, et al., 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, Remote Sensing of Environment, doi:10.1016/j.rse. 2013.04.024, pp. 19, 2013.

Chevallier, F., and C. W. O'Dell, Error statistics of Bayesian CO_2 flux inversion schemes as seen from GOSAT, Geophys. Res. Lett., doi: 10.1002/grl.50228, 2013.

Chevallier, F., Palmer, P.I., Feng, L., et al., Towards robust and consistent regional CO_2 flux estimates from in situ and space-borne measurements of atmospheric CO_2, Geophys. Res. Lett., 41, 1065-1070, DOI: 10.1002/2013GL058772, 2014.

Cressot, C., F. Chevallier, P. Bousquet, et al., On the consistency between global and regional methane emissions inferred from SCIAMACHY, TANSO-FTS, IASI and surface measurements, Atmos. Chem. Phys., 14, 577-592, 2014.

Crevoisier, C., D. Nobileau, R. Armante, et al., The 2007–2011 evolution of tropical methane in the mid-troposphere as seen from space by MetOp-A/IASI, Atmos. Chem. Phys., 13, 4279-4289, 2013.

Dils, B., M. Buchwitz, M. Reuter, et al., The Greenhouse Gas Climate Change Initiative (GHG-CCI): comparative validation of GHG-CCI SCIAMACHY/ENVISAT and TANSO-FTS/GOSAT CO_2 and CH_4 retrieval algorithm products with measurements from the TCCON, Atmos. Meas. Tech., 7, 1723-1744, 2014.

Fraser, A., Palmer, P. I., Feng, L., et al., Estimating regional methane surface fluxes: the relative importance of surface and GOSAT mole fraction measurements, Atmos. Chem. Phys., 13, 5697-5713, doi:10.5194/acp-13-5697-2013, 2013.

Fraser, A., P. I. Palmer, L. Feng, et al., Estimating regional fluxes of CO_2 and CH_4 using space-borne observations of XCH_4:XCO_2, Atmos. Chem. Phys., 14, 12883-12895, doi:10.5194/acp-14-12883-2014, 2014.

Guerlet, S., S. Basu, A. Butz, et al., Reduced carbon uptake during the 2010 Northern Hemisphere summer from GOSAT, Geophys. Res. Lett., doi: 10.1002/grl.50402, 2013.

Guerlet, S., A. Butz, D. Schepers, et al., Impact of aerosol and thin cirrus on retrieving and validating XCO_2 from GOSAT shortwave infrared measurements, J. Geophys. Res. Lett., doi: 10.1002/jgrd.50332, 2013.

Hayman, G. D., O'Connor, F. M., Dalvi, M., et al., Comparison of the HadGEM2 climate-chemistry model against in-situ and SCIAMACHY atmospheric methane data, Atmos. Chem. Phys., 14, 13257-13280, doi:10.5194/acp-14-13257-2014, 2014.

Hollmann, C.J. Merchant, R. Saunders, et al., The ESA Climate Change Initiative: satellite data records for essential climate variables, Bulletin of the American Meteorological Society (BAMS), 0.1175/BAMS-D-11-00254.1, 2013.

Houweling, S., D. Baker, S. Basu, et al., An intercomparison of inverse models for estimating sources and sinks of CO_2 using GOSAT measurements, J. Geophys. Res. Atmos., 120, 5253–5266, doi:10.1002/2014JD022962, 2015.

Monteil, G., Houweling, S., Butz, A., et al., Comparison of CH_4 inversions based on 15 months of GOSAT and SCIAMACHY observations, J. Geophy. Res., doi: 10.1002/2013JD019760, Vol 118, Issue 20, 11807-11823, 2013.

Oshchepkov, S., A. Bril, T. Yokota, et al., Effects of atmospheric light scattering on spectroscopic observations of greenhouse gases from space. Part 2: Algorithm intercomparison in the GOSAT data processing for CO_2 retrievals over TCCON sites, J. Geophys. Res., 118, 1493–1512, doi:10.1002/jgrd.50146, 2013.

Parazoo, N. C., Bowman, K., Frankenberg, C., et al., Interpreting seasonal changes in the carbon balance of southern Amazonia using measurements of XCO_2 and chlorophyll fluorescence from GOSAT, Geophys. Res. Lett., 40, 2829–2833, doi:10.1002/grl.50452, 2013.

Reuter, M., H. Boesch, H. Bovensmann, et al., A joint effort to deliver satellite retrieved atmospheric CO_2 concentrations for surface flux inversions: the ensemble median algorithm EMMA, Atmos. Chem. Phys., 13, 1771-1780, 2013.

Reuter, M., M. Buchwitz, A. Hilboll, et al., Decreasing emissions of NO_x relative to CO_2 in East Asia inferred from satellite observations, Nature Geoscience, 28 Sept. 2014, doi:10.1038/ngeo2257, pp.4, 2014.

Reuter, M., M. Buchwitz, M. Hilker, et al., Satellite-inferred European carbon sink larger than expected, Atmos. Chem. Phys., 14, 13739-13753, doi:10.5194/acp-14-13739-2014, 2014.

Ross, A. N., Wooster, M. J., Boesch, H., Parker, R., First satellite measurements of carbon dioxide and methane emission ratios in wildfire plumes, Geophys. Res. Lett., 40, 1-5, doi:10.1002/grl.50733, 2013.

Shindell, D. T., O. Pechony, A. Voulgarakis, et al., Interactive ozone and methane chemistry in GISS-E2 historical and future climate simulations, Atmos. Chem. Phys., 13, 2653–2689, doi:10.5194/acp-13-2653-2013, 2013.

Schneising, O., J. Heymann, M. Buchwitz, et al., Anthropogenic carbon dioxide source areas observed from space: assessment of regional enhancements and trends, Atmos. Chem. Phys., 13, 2445-2454, 2013.

Schneising, O., M. Reuter, M. Buchwitz, et al., Terrestrial carbon sink observed from space: variation of growth rates and seasonal cycle amplitudes in response to interannual surface temperature variability, Atmos. Chem. Phys., 14, 133-141, 2014.

Schneising, O., J. P. Burrows, R. R. Dickerson, et al., Remote sensing of fugitive methane emissions from oil and gas production in North American tight geologic formations, Earth's Future, 2, DOI: 10.1002/2014EF000265, pp. 11, 2014.

Wecht, K.J, D.J. Jacob, M.P. Sulprizio, et al., Spatially resolving methane emissions in California: constraints from the CalNex aircraft campaign and from present (GOSAT, TES) and future (TROPOMI, geostationary) satellite observations, Atmos. Chem. Phys., 14, 8173-8184, doi:10.5194/acp-14-8173-2014, 2014.

www.esa-ghg-cci.org

Michael Buchwitz, University of Bremen | Michael.Buchwitz@iup.physik.uni-bremen.de