ESA Earth Explorer 8 Candiate Mission CarbonSat: Error Budget for Atmospheric Carbon Dioxide and Methane Retrievals

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Introduction

CarbonSat [1,2] has been selected by ESA as one of two candidate missions for Earth Explorer 8 (EE-8). End of 2015 one mission will be selected for a launch around 2023.

The main Level 2 data products of CarbonSat are column-averaged dry air mole fractions of CO₂ and CH₄, i.e., XCO₂ and XCH₄, needed to get quantitative information on regional and local surface fluxes (emissions and uptake).

In addition, CarbonSat will deliver a number of scientifically interesting secondary data products such as vegetation chlorophyll Solar-Induced Fluorescence (SIF) [2, 4].

The CO₂ and CH₄ source / sink applications require to meet demanding precision and accuracy requirements. Here we present error analysis results using the latest version of the CarbonSat retrieval algorithm (BESD/C) and the latest instrument and mission specification focussing on the minimum (threshold) performance. Some results are updates of results shown in [2,3].

CarbonSat mission goals

The main goal of CarbonSat is to advance our knowledge on the natural and man-made sources and sinks of the two most important anthropogenic greenhouse gases carbon dioxide (CO₂) and methane (CH₄) from the global via the sub-continental to the local scale.

CarbonSat will be the first satellite mission to image small scale emission hot spots of CO₂ (e.g., cities, volcanoes, industrial areas) and CH₄ (e.g., fossil fuel production, landfills, seeps) and to quantify their emissions and discriminate them from surrounding biospheric fluxes.

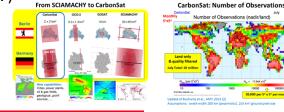
Selected references

[1] Bovensmann, H., Buchwitz, M., Burrows, J. P., Reuter, M., et al., A remote sensing technique for global monitoring of power plant CO₂ emissions from space and related applications, Atmos. Meas. Tech., 3, 781-811, 2010.

[2] Buchwitz, M., Reuter, M., Bovensmann, H., et al., Carbon Monitoring Satellite (CarbonSat): assessment of atmospheric CO_2 and CH_4 retrieval errors by error parameterization, Atmos. Meas. Tech., 6, 3477-3500, 2013.

[3] Buchwitz, M., Reuter, M., Bovensmann, H., et al., Carbon Monitoring Satellite (CarbonSat): assessment of scattering related atmospheric CO₂ and CH₄ retrieval errors and first results on implications for inferring city CO₂ emissions, Atmos. Meas. Tech. Discuss., 6, 4769-4850, 2013.

[4] 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.



Error analysis results

CarbonSat: Error Budget Nadir/Land CarbonSat XCO₂ and XCH, Error Budget Nadir/Land (v5)

> XCO₂ XCH₄ [ppm] [ppb]

1.20 9.00 1.20 9.00

0.20 1.97 0.45 4.47 0.20 1.97 0.20 1.97

0.32

2.62 0.30 2.50 0.10

ument (Threshold)

Reg All values 1-sigma

Bias XCO

Bias XCH₄: 0.7 +/- 1.2 ppl Quality filter (t symbols): Retri COD+AOD<0

Ngood: 24 (53%) Nall: 45

3×10° 2×10° 1×10° **Radiometric errors: Polarization**

ISRF)

Random error per sounding Systematic (monthly region scale, non-con part only)

0.17 1.80 0.40 4.00 0.17 1.80 0.17 1.80

0.20 1.97 0.17 1.80 0.48 3.00 0.48 3.00

 0.14
 1.13
 0.10
 0.80
 0.10
 0.80

 Total (root-sum-square (RSS)):
 1.50
 11.69
 0.47
 4.33

 guired (MRDv1.2, threshold (T)):
 3.00
 12.00
 0.50
 6.00

Buchwitz et al., ESA Living Planet Symposium, Edinburgh, 2013

Simulated retrievals: Clouds & aerosols

Answer Opsied Dupin, (JoCo + INFO, HIT To The COD via pro-processing from 1939 nm saturated water nation3-band-retrieval, ... Scenario: SZA: 50°, surface: vegetation

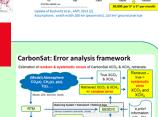
Precision" "Relative accuracy XCH4 XCO2 XCH4 [ppb] [ppm] fpph3

0.80 0.10 0 0.80 0.10 0 0.80 0.10 0

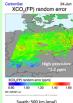
> 0.10 0.80 0.20 2.00 0.10 0.80

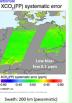
0.10 0.80 0.00

0.80

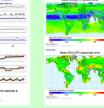


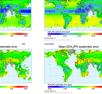
CarbonSat: Single ground pixel XCO₂



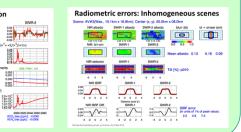


CarbonSat: XCO₂ and XCH₄ Monthly 5°x5°

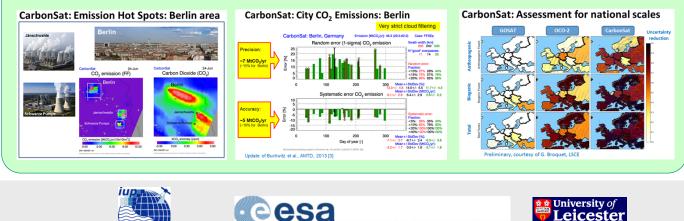








Selected applications: City and country-scale CO₂ fluxes





www.iup.uni-bremen.de/carbonsat

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