Quantification of random & systematic XCO_2 and XCH_4 retrieval errors

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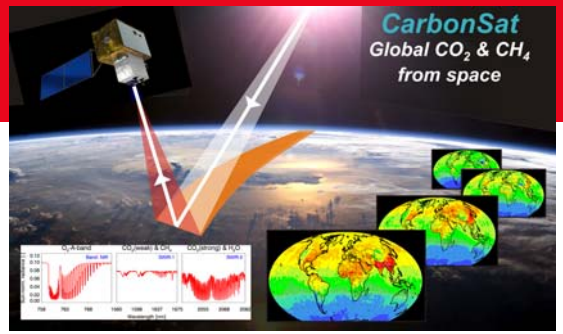

CarbonSat

CarbonSat [1,2] has been selected by ESA to be one of two candidate missions for Earth Explorer 8 (EE-8) to be launched around 2019.

The main Level 2 data products of CarbonSat are dry-air column averaged mole fractions of CO_2 and methane, denoted XCO_2 and XCH_4, useful to get quantitative information on regional / local surface fluxes (emission and uptake).

In addition, CarbonSat will potentially deliver a number of scientifically very interesting secondary data products such as Vegetation Chlorophyll Fluorescence (VCF) [3].

The envisaged ground pixel size is 2x2 km², which is required in order to disentangle natural and anthropogenic CO_2 sources and sinks and to capture important emission targets such as coal fired power plants. The goal is to obtain global coverage within 6 days (500 km swath width).

Study goal & approach

CarbonSat is currently being optimized. For example, it has been identified that especially the required high spectral resolution in the NIR (around 0.76 µm) and SWIR-2 (around 2 µm) bands are major drivers for the instrument design and related costs.

In this ongoing study it is being investigated if the spectral resolution can be relaxed by more than a factor 2 without degrading the quality of the XCO_2 and XCH_4 data products.

To investigate this we have performed simulated retrievals focussing on systematic XCO_2 retrieval errors caused by aerosols, cirrus clouds and Vegetation Chlorophyll Fluorescence (VCF).

Preliminary conclusions

Our simulations indicate that the spectral resolution can be relaxed by roughly a factor of two in the NIR and SWIR-2 bands.

For compensation this requires an extension of the spectral ranges covered by the NIR and SWIR-2 bands and somewhat higher signal-to-noise ratios (SNR). Using these optimized parameters it appears that the quality of the XCO_2, XCH_4 and VCF data products can even be improved.

Acknowledgements

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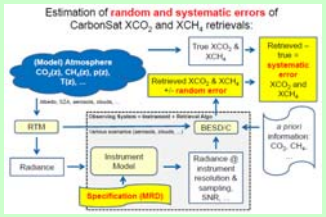
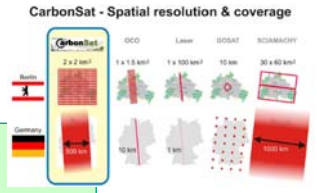
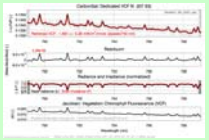
Analysis method

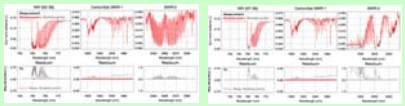




VCF pre-processing (Inst. 7, Scenario 3)



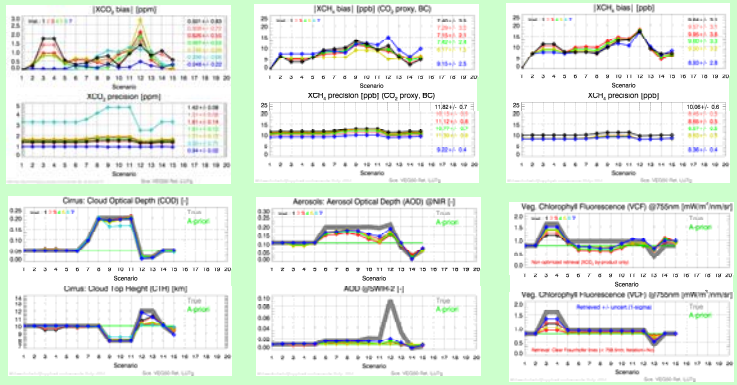
I02 – S08 3-band fits I07 – S08



Analysis results

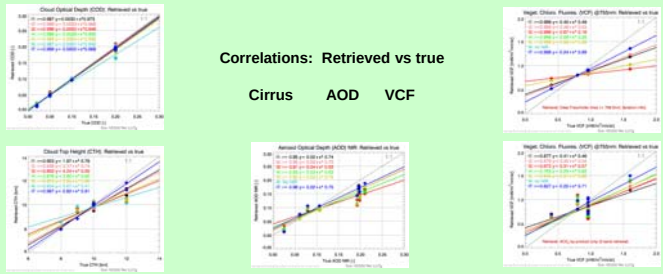
Main results:

XCO_2 and XCH_4 bias & precision



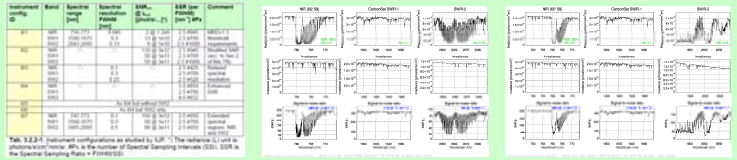
Correlations: Retrieved vs true

Cirrus AOD VCF

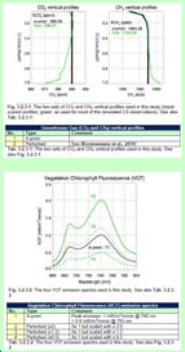


Instrument configurations

Configurations 01-07 Spectra Instrument 02 Spectra Instrument 07

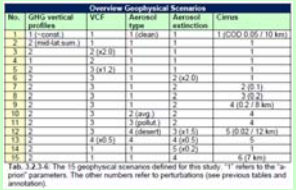


Geophysical scenarios



Scenarios:
GHG profiles, VCF, aerosols, cirrus

Overview:
Scenarios 01 - 15



Selected references

[1] Bovensmann, H. Buchwitz, M., Burrows, J. P., Reuter, M., et al., A remote sensing technique for global monitoring of power plant CO_2 emissions from spece and related applications, Atmos. Meas. Tech., 3, 781-811, 2010.

[2] Velazco, V. A., M. Buchwitz, H. Bovensmann, M. Reuter, et al., Towards space based verification of CO_2 emissions from strong localized sources: fossil fuel power plant emissions as seen by a CarbonSat constellation, Atmos. Meas. Tech., 4, 2809-2822, 2011.

[3] Frankenberg, O'Dell, C, Guanter, L., and McDuffie, J., Chlorophyll fluorescence remote sensing from space in scattering atmospheres: Implications for its retrieval and interferences with atmospheric CO_2 retrievals, Atmos. Meas. Tech. Discuss., 5, 2487–2527, 2012.

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