CO_2 and CH_4 RemoTeC retrievals from GOSAT (2009-2019) and GOSAT-2 (2019)

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Introduction

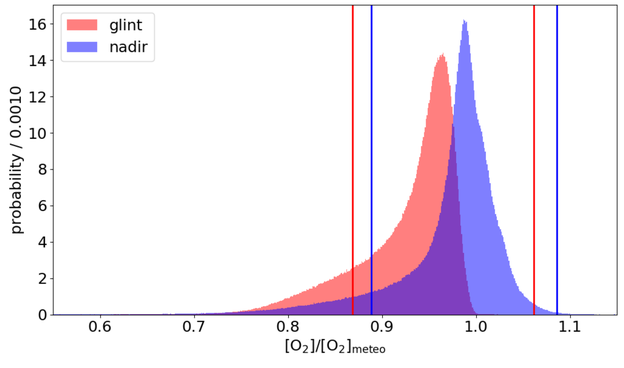
- The Japanese Greenhouse gases Observing SATellite (**GOSAT**), in orbit since January 2009, and its successor **GOSAT-2**, in orbit since October 2018, are dedicated to monitoring greenhouse gases (GHGs) on a global scale, enhancing our knowledge of the carbon cycle, and promoting space-borne GHG measurement techniques.
- The **RemoTeC** full-physics algorithm infers column-averaged dry air mole fractions (CDMs) from absorption spectra of sunlight backscattered at the earth's atmosphere and surface in the shortwave infrared (retrieval windows see figure in the upper right) measured by GOSAT and GOSAT-2.

Why?

- continue the GOSAT record with GOSAT-2
- check atmospheric model performances
- gain insights into the carbon cycle

Methods

- For **cloud filtering**, we use the retrieved O_2 column, the CO_2-, and the H_2O-ratio of retrieved CDMs in different retrieval windows.

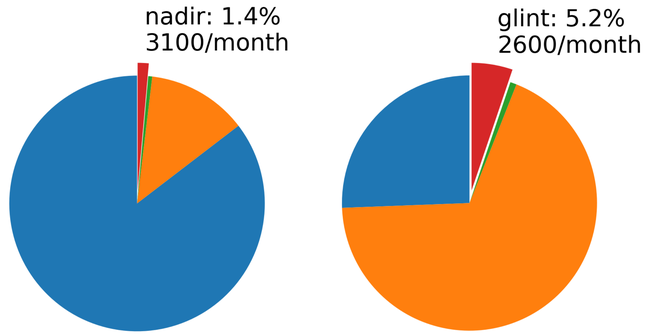


Exemplary histogram of the O_2-ratio with the criteria of the coarse cloud filter shown by vertical lines.

- For **validation**, we use co-located TCCON measurements (2) (time: 2 h, space: 5° or 1° for CO).

Creating a 10 years GOSAT XCO_2 and XCH_4 record: Filters and validation

- **Data filtering** to exclude erroneous measurements and soundings that are heavily influenced by scattering effects



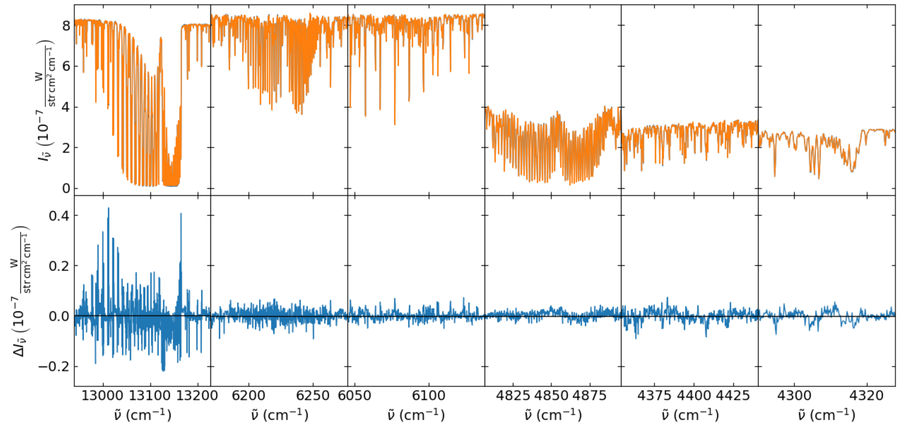
The pie charts show the amount of measurements between April 2009 and June 2019 excluded by different filters: a priori (blue), cloud (orange), a posteriori (green), and data passing all filters (red).

- For XCO_2 (XCH_4), a residual **bias** against TCCON of -1.12 % and -1.27 % (-0.66 % and -0.78 %) for nadir and glint geometry, respectively, is found. To **correct** for the bias, we **scale nadir measurements by a constant factor** and use a **multi-parameter correction for glint measurements**.

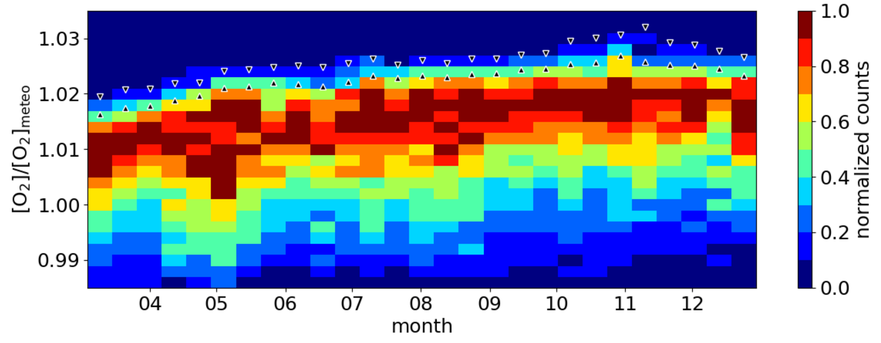
Validating GOSAT and GOSAT-2

- TCCON measurements as reference (2)
- **10 years GOSAT** XCO_2 and XCH_4:
  XCO_2 scatter: 0.58 % (land), 0.46% (ocean)
  XCH_4 scatter: 0.87 % (land), 0.65% (ocean)
- **GOSAT-2** March to December 2019:
  nadir scatter:
  0.81 % (XCO_2), 1.05 % (XCH_4),
  2.09 % (XN_2O), and 12.35 % (XCO)
  nadir bias:
  -3.67 % (XCO_2), -0.98 % (XCH_4),
  -3.99 % (XN_2O), and 8.73 % (XCO)

GOSAT-2: Spectral residuum and upper-edge study



Averaged spectrum of 100 measurements $I_{\tilde{\nu}}$ (orange) and spectral residuum $\Delta I_{\tilde{\nu}}$ (measured − modeled, blue) with, from left to right, O_2 A-band, weak CO_2 band, CH_4 band, strong CO_2 band, and new GOSAT-2 retrieval windows for N_2O (4354–4441 cm^{-1}) and CO (4290–4328 cm^{-1}). Different versions of the instrument line shape can not reduce the large spectral residuum.



Retrieved oxygen column in ocean-glint geometry over 10 months in ~10 days-bins. Each bin shows a normalized, color-coded histogram. **Temporal variability** is obvious both in the peak (dark red) and in the upper-edge ensemble of clean soundings (1) (black triangles).

References

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(2) D. Wunch, G. C. Toon, V. Sherlock, N. M. Deutscher, C. Liu, D. G. Feist, and P. O. Wennberg. The Total Carbon Column Observing Network's GGG2014 Data Version. 2015. doi: 10.14291/tccon.ggg2014.documentation.R0/1221662. URL https://data.caltech.edu/records/249. Publisher: CaltechDATA.