

Harmonizing the ACOS GOSAT v9 and OCO-2 v10 XCO₂ products

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The most up-to-date versions of ACOS XCO₂ products for GOSAT and OCO-2 are b9 and b10, respectively.

There will not be any updates for some time, although b11 is being actively developed.

The bias in the Ocean-Glint data between these two products is unacceptably large (subjective) for co-assimilation into flux inversion models.

Is it possible to mitigate this bias via some sort of bias correction, allowing the products to be “harmonized”?

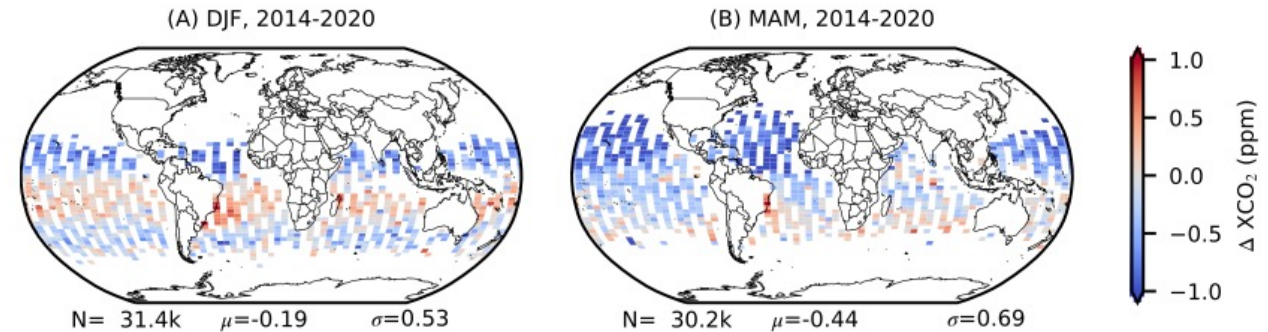
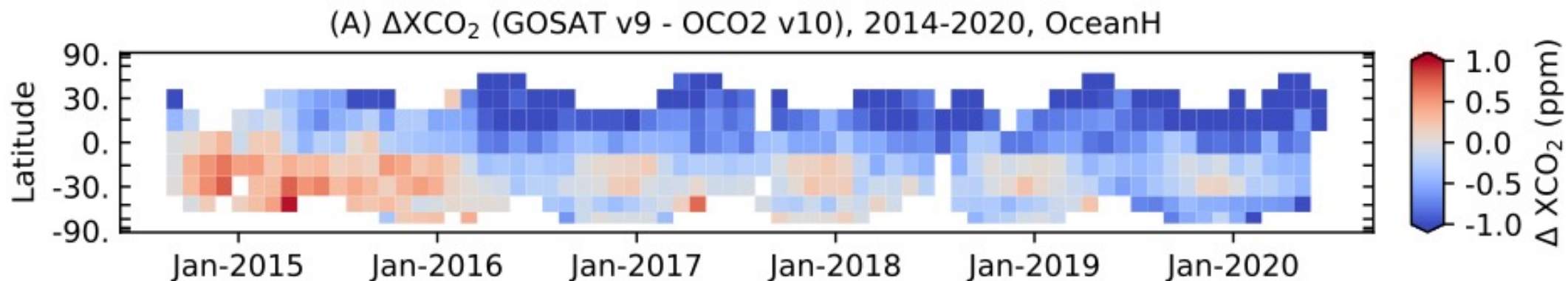


Figure 1: Difference in XCO₂ between ACOS GOSAT v9 and OCO-2 v10 at 2.5 latitude by 5 longitude for the overlapping period August 2014 through 2020.

Figure 2: Same data as shown in Fig. 1, but the longitude information has been collapsed and replaced with time.

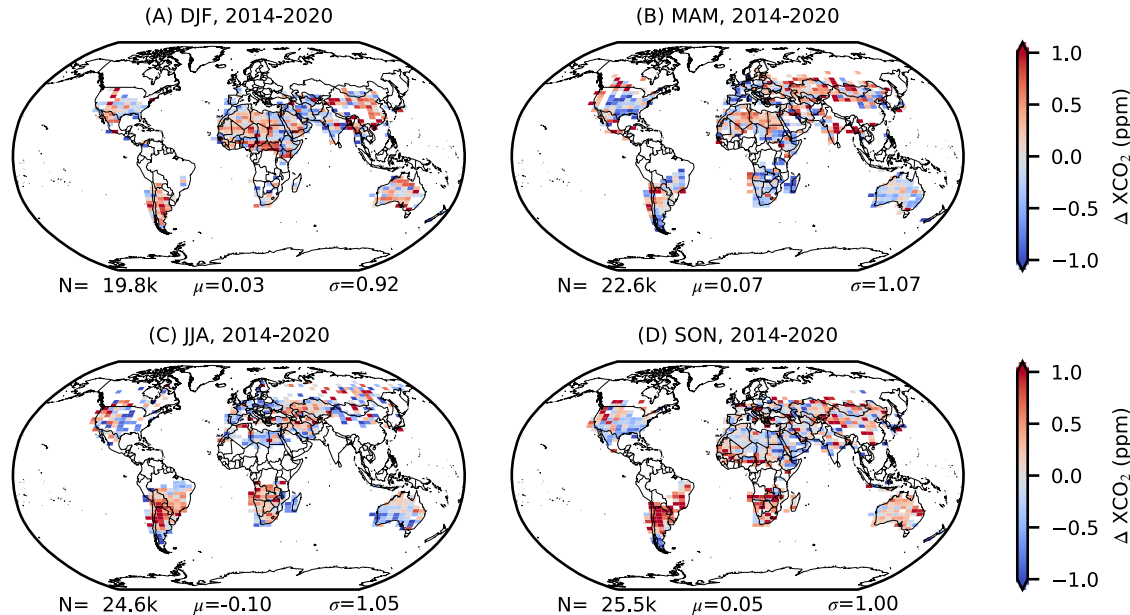


Motivation

- The current newest versions of ACOS products for GOSAT and OCO-2 are v9 and v10, respectively.
- To minimize sources of bias incurred from the L2FP, it would be ideal to run the same version of the algorithm to intercompare XCO₂ from the two sensors. However, from a logistical standpoint this is not always practical as it requires tremendous resources to generate each new product.
- Changes occurred from b9 to b10 that probably induce changes in XCO₂. In order to confidently assimilate GOSAT v9 and OCO-2 v10, algorithm biases must be mitigated.
- In addition to algorithm biases, there will be sensor biases due to calibration errors, and differences in viewing geometry and time of observation. These must also be accounted for in a systematic way to put the XCO₂ products on the same footing.

Seasonal maps of ΔXCO_2 (GOSAT v9 – OCO2 v10)

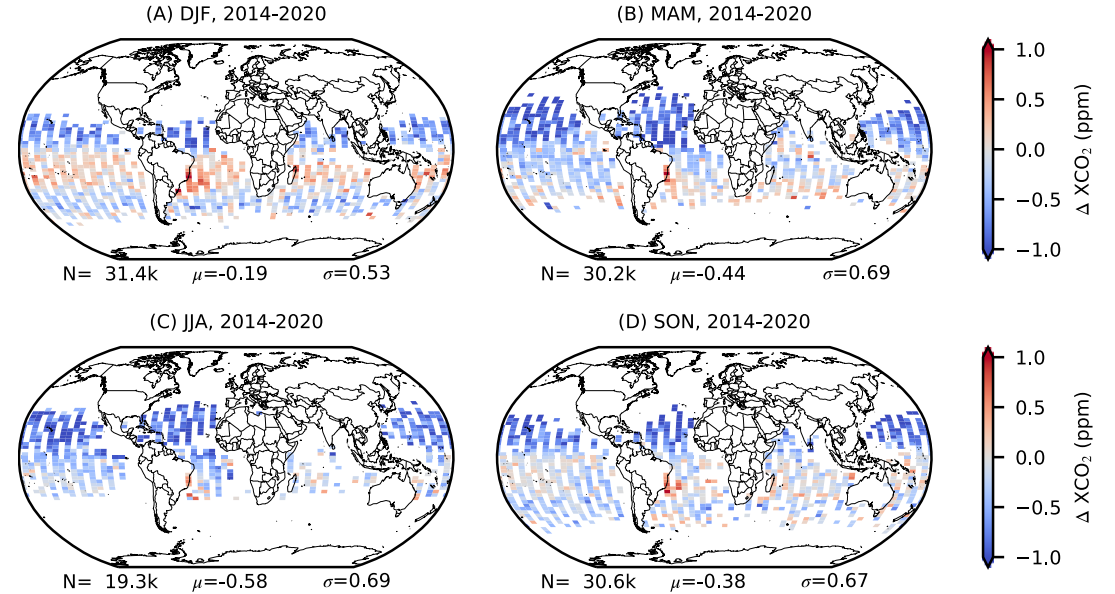
Land



The mean global bias for land is ≤ 0.1 ppm, with stddev ~ 1 ppm.

This seems pretty reasonable considering the only correction here is for the difference in the L2FP CO_2 prior.

Ocean

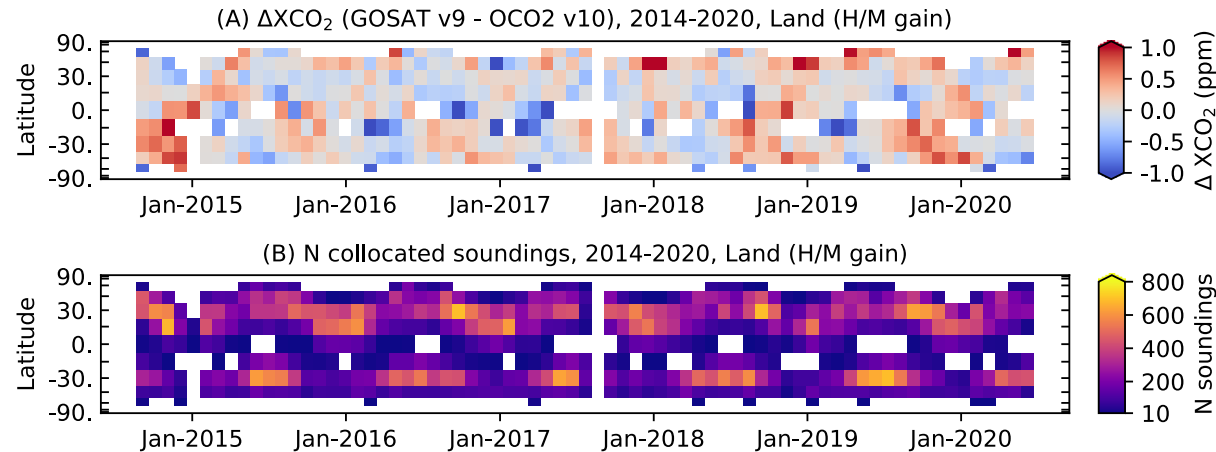


However, for ocean, the mean global bias is 0.2 to 0.6 ppm, with stddev ~ 0.5 ppm. Generally, GOSAT is lower than OCO-2.

Considering that real XCO_2 variation over the oceans is smaller than land, and the L2FP should be more consistent given no topo or surface features, this ΔXCO_2 seems unacceptably large.

Hovmoller of ΔXCO_2 (GOSAT v9 – OCO2 v10)

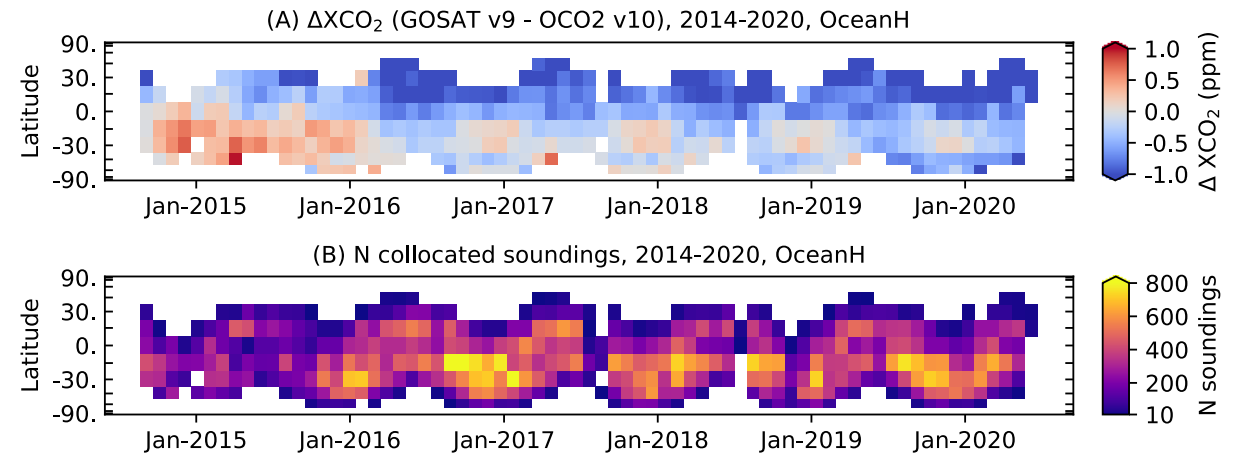
Land (H&M gain)



ΔXCO_2 for land is somewhat random, although there could be a seasonal variation (?), with +ve values in the SH springs and NH winters.

The +ve signal is largest in the SH spring (~SON) in 2014, 2018, and 2019. The signal was muted in 2015-2017.

OceanH



The signal for ocean is much stronger and coherent.

In 2014-2015 the signal was +ve in the SH and slightly –ve in the NH. Since 2016 the NH has a strong –ve signal and a close to neutral signal in the SH.

This seems like it could be an issue with the L2FP CO2 priors, although a correction has been made to this data. (order 0.2 ppm)

Path Forward

- The general sense from the flux inversion community is that the bias in the Ocean-glnt data between GOSAT b9 and OCO-2 b10 is too large to safely co-assimilate these data into their models.
- How can these data be harmonized, i.e., bias corrected, to allow for safe co-assimilation?
- Recently selected ROSES proposal will fund an effort to investigate and implement such a correction.
 - [Crowell, Assessing Drivers of Tropical Carbon Flux Variability across Spatial and Temporal Scales with Space-based Observations]
- Note that it will probably be a while before matching versions of ACOS GOSAT and OCO-2 exist. There is currently no funding to reprocess ACOS GOSAT with b10 nor with b11 which is in development.