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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric CH_4 and CO_2 enhancements and biomass burning emission ratios derived from satellite observations of the 2015 Indonesian fire plumes" *by* Robert J. Parker et al.

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We would like to thank Referee 2 for taking the time to review our manuscript and appreciate the useful comments/corrections.

Major comments:

I understand number of good in-situ data is limited, but discussion on rough estimation of horizontal and vertical distribution of the plume is helpful to understand the usefulness of large footprint (10km), point-based and, column averaged observations of GOSAT.

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Discussion paper

During the extreme fire activity observed, plumes ranged in scale from small, low, isolated plumes to huge plumes covering much of the landmass. We have attempted to capture the extent of this large scale behaviour by including Figure 4, showing the GOSAT Cloud and Aerosol Imager data over the region.

It should be noted that whilst the GOSAT data is a column quantity, the shortwave infrared measurements are most sensitive to the surface and lower atmosphere (unlike for example the thermal infrared IASI measurements which are mainly sensitive to the mid-troposphere). Also as the referee notes, the sampling pattern of GOSAT is not necessarily suited to making such point-source measurements and future satellites with imaging capabilities such as Sentinel-5 Precursor would be more suited to this. However, as this work focuses on attempting to quantify the large-scale behaviour of the entire region, we believe that, while challenging, we were successful in identifying GOSAT soundings dominated by the fire emissions.

Further analysis or discussion on correlation between GOSAT-retrieved XCH4/XCO2 and CO will be useful.

Whilst we acknowledge that being able to use co-located CO measurements along with the CH4 and CO2 would be extremely valuable and aid in calculating emission factors, there were several issues that prevented us from being confident in doing so.

Firstly, CO is not available from GOSAT. The best option would likely be to use the IASI CO product however, there are certain issues in doing so. Firstly, the IASI L2 CO data available from Eumetsat had an undocumented bug in the data product, with any retrieved integrated column CO values above 4.0e-3 kg/m2 being flagged as "invalid". Due to the huge extent of these Indonesian values, this upper limit is regularly exceeded and means that no quantitative comparison can be done against this IASI data (although it can still be used qualitatively as we have done). We have passed this information on to Eumetsat and believe that they are currently fixing this bug in their product. Secondly, however, IASI has very different vertical sensitivity to GOSAT which

means even if we were able to confidently co-locate soundings (with different overpass times), the comparison would be complicated to interpret. Whilst these issues can be overcome (e.g. through the use of assimilation into a chemistry transport model), we felt that this was potentially better suited to a future study. It should also be noted that GOSAT-2 (scheduled for launch in 2018) will be capable of measuring co-located CH4, CO2 and CO simultaneously.

Minor Comments

All typographical changes/recommendations have been included.

For CO2 retrieval do the authors use both 1.6 and 2.0 micron bands or only 1.6 micron band, which is closer to the CH4 band?

We only use the 1.6um CO2 band. This is described in more detail in our previous publications (e.g. Parker et al., 2015) and already stated in the text.

"this proxy method utilises the fact that the majority of the influence of atmospheric scattering on the retrieved XCH4 can be negated through the co-retrieval of the spectrally close 1.6 μm CO2 band"

Description on CAI will help reader's understanding

We have added the following section to the text to provide more details.

"The second instrument is the Cloud and Aerosol Imager (TANSO-CAI), which provides multispectral imagery at 0.5 km resolution with bands at 0.38 μm, 0.67 μm, 0.87 μm and 1.6 μm. This allows additional cloud/aerosol information about the region of interest within which the TANSO-FTS measurement footprints fall."

Do the authors use glint data of TANSO-FTS?

Yes, we use the sun-glint observations over the ocean. We will make this more explicit in the text.

“Whilst primarily performed over land, retrievals are also possible over the ocean when GOSAT measures in a sunglint geometry”

Vertical profile information clarify the difference between in-situ CH4/CO2 and satellite measured column CH4/CO2. CH4/CO2 discussion using profile information from TANSO-FTS TIR band in the future might help.

Please see this section in the text:

“However, the majority of the ground-based emission ratios were derived from locations dominated by almost pure peat burning sampled close to source, whereas the space-based observations from GOSAT are derived from measurements of the smoke filling a 10.5 km diameter TANSO-FTS footprint and thus representative of much larger areas of combustion, very likely comprising a mix of peat and vegetation burning in the majority of cases.”

Regarding the TIR measurements from GOSAT, we don’t believe that the data quality of these products is yet at a level to be useful due to calibration issues with the spectra. In the future, or for example from GOSAT-2, being able to separate out vertical profile information through combination of the SWIR and TIR bands would prove useful for this type of work.

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