Supplementary material for

Assessment of anthropogenic methane emissions over large regions based on GOSAT observations and high resolution transport modeling.

1. Correction for biases in GOSAT XCH_4 related to terrain height.

Biases in XCH_4 due to terrain height (variability in depth of atmospheric column) becomes significant in regional analysis, especially over mountainous regions of East Asia and North America in our analysis. The correction of bias is defined as

$$XCH_{4\,bc} = XCH_4 - f(h_{terr})$$

where $f(h_{terr})$ is a quadratic polynomial regression fit between terrain height (h_{terr}) and XCH_4 specific to each analysis region. The distribution of XCH_4 versus terrain height for each analysis region and the corresponding regression fit is given in figure S1.

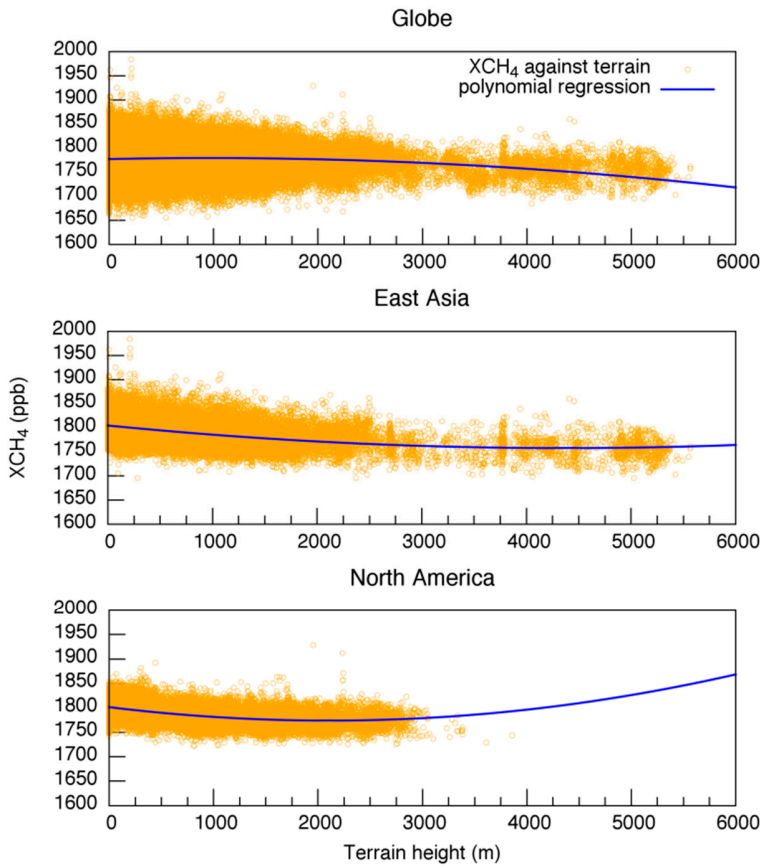

Figure S1. Dependence of XCH_4 on terrain height over various analysis domains.

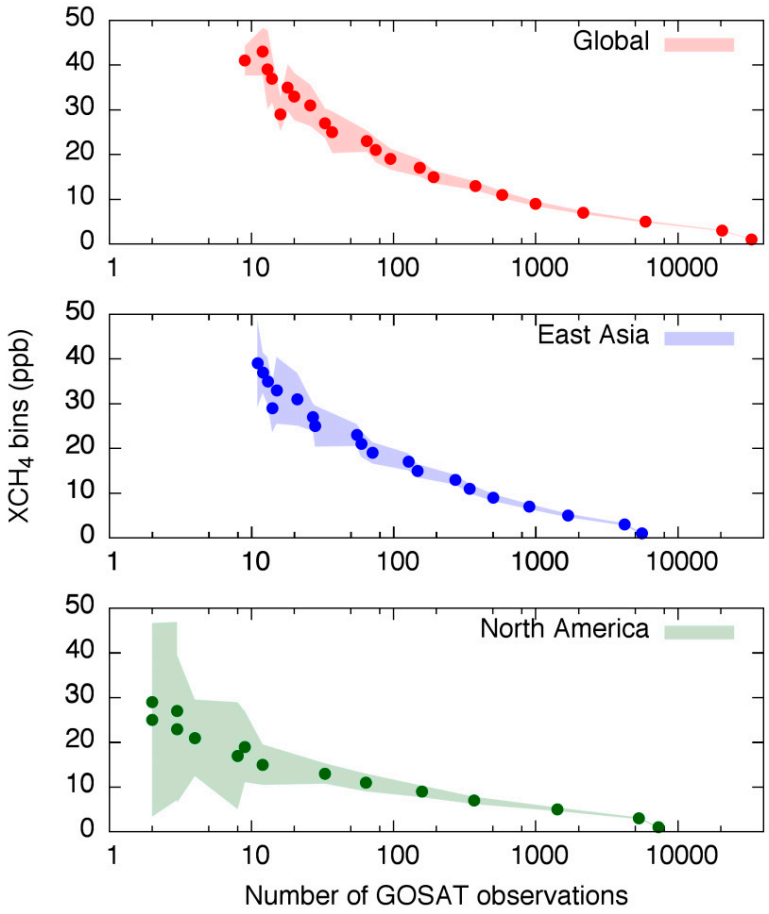

Figure S2. Number of GOSAT XCH_4 observations used in each 2 ppb bin and the associated standard errors (shading) for each regions analysed for the Globe (upper panel), East Asia (middle panel) and North America (lower panel).

2. Error associated with averaging GOSAT observations

The error associated with the average observed XCH_4 enhancements (shading in Figure 2) are estimated as the standard deviation divided by square root of observations number in each enhancement bins. The standard error serves as good model for error in binned averages. It is assumed that the influence of the systematic errors is largely cancelled by our analysis procedure. We calculate the observed XCH_4 abundance ($\Delta XCH_{4,obs}$) as the difference between observed background value and individual observations. As this

procedure is carried out for every month within same region (10°x10°), most of systematic errors (region specific or time specific), such as identified by *Kulawik et. al.* [1] are expected to be removed. Thus from the error estimate in *Kulawik et. al.* [1] $\varepsilon^2 = a^2 + b^2/n$, where a is the systematic (correlated) error and b random (uncorrelated) error and n, the number of observations in averaging, the first term (a) on the right-hand side is reduced significantly due to the differencing and averaging. As the results of our analysis show good correlation between model and observations, it suggests cancellation of the sizeable systematic regional and seasonal biases of the GOSAT retrievals by differencing within the same region and month.

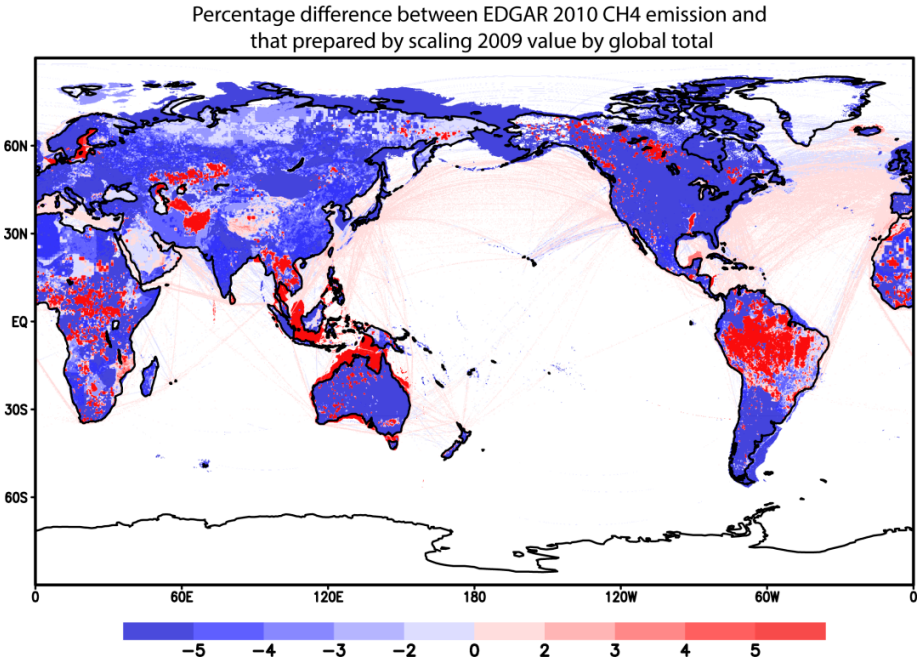

Figure S3. Percentage difference of EDGAR CH_4 emission for 2010 and that prepared for the same year by scaling 2009 emission by global total reported by EDGAR.

References

1. Kulawik, S.; Wunch, D.; O'Dell, C.; Frankenberg, C.; Reuter, M.; Oda, T.; Chevallier, F.; Sherlock, V.; Buchwitz, M.; Osterman, G.; et al. Consistent evaluation of ACOS-GOSAT, BESD-SCIAMACHY, CarbonTracker, and MACC through comparisons to TCCON. *Atmospheric Measurement Techniques* **2016**, *9*, 683–709, doi:10.5194/amt-9-683-2016.