A Study of Extraction and Analysis of Emission and Absorption Events of Greenhouse Gases with GOSAT

Koki KASAI[1], Kei SHIOMI[2,1], Atsushi KONNO[1], Takeo TADONO[2,1], Masahiro HORI[2,1]

[1]Hokkaido University, Japan [2]Japan Aerospace Exploration Agency (JAXA)

1. Introduction

- On January 23, 2009, Greenhouse Gases Observing Satellite (GOSAT) was launched, and XCO_2 and XCH_4 are observed globally with high spatial resolution.
- Lindqvist et al. (2015) found that GOSAT/ACOS captured the seasonal cycle amplitude with about 1.0 ppm accuracy compared to TCCON.
- In this study, to detect emission and absorption events by using GOSAT observation data, the function which expresses typical inter-annual and seasonal variation is fitted to time series data.

2. Data processing

- Two satellite observation datasets (ACOS and NIES) and two atmospheric model datasets (CT2015 and CT-CH4) are used (Table 1).

Table 1: Datasets used in this study

Dataset	ACOS	NIES	CT2015	CT-CH_4
Long name	ACOS GOSAT/TANSO-FTS Level 2 Full Product B3.5	NIES TANSO-FTS L2 column amount (SWIR) V02.xx	CarbonTracker CT2015	CarbonTracker-CH_4
Institute	NASA/JPL	NIES	NOAA/ESRL	NOAA/ESRL
Period	2009.04.22 - 2014.06.07	2009.04.23 – 2015.08.02	2000.01.01 – 2015.01.01	2000.01.01 – 2011.01.01
Spatial resolution	10.5 km (Instantaneous Field of View)		3 degree (lon.) 2 degree (lat.)	6 degree (lon.) 4 degree (lat.)
Temporal resolution	3 days (recurrence period)		3 hours	
References	Wunch et al., 2011 O'Dell et al., 2012 Crisp et al., 2012	Yoshida et al., 2013	Peters et al., 2007	Peters et al., 2007

2.1 XCO_2 and XCH_4 calculation

- For CT2015 and CT-CH4, daytime mean is calculated from 3-hourly data to compare properly with satellite observation data (Table 2).
- XCO_2 and XCH_4 are computed from weighted average of 3-D mole fractions in CT2015 and CT-CH_4 (Fig. 1).

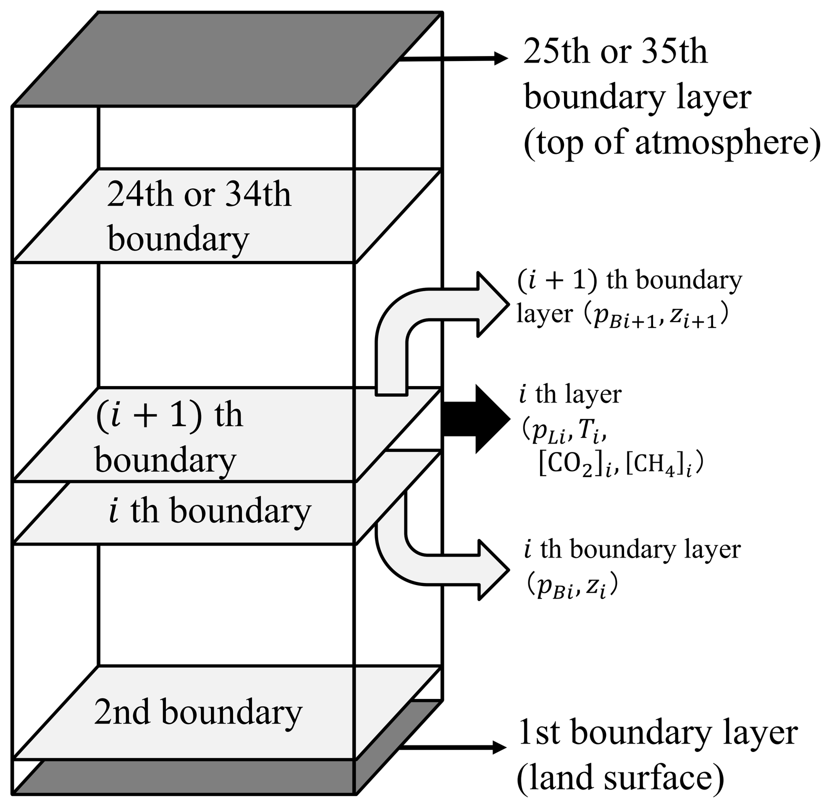


Fig. 1: Definition of atmospheric model data for calculating XCO_2 or XCH_4

Table 2: Calculating daytime mean from 3-hourly data

	Area	Averaged time for daytime mean (UTC)
1	180W – 135W	19:30, 22:30, 01:30(+1 day)
2	135W – 90W	16:30, 19:30, 22:30
3	90W – 45W	13:30, 16:30, 19:30
4	45W – 0	10:30, 13:30, 16:30
5	0 – 45E	07:30, 10:30, 13:30
6	45E – 90E	04:30, 07:30, 10:30
7	90E – 135E	01:30, 04:30, 07:30
8	135E – 180E	22:30(-1 day), 01:30, 04:30

2.2 Function fitting

Fitted function in this study is as follows:

$$y(t) = a_0 + a_1 t + b_1 \sin\left(\frac{2\pi}{365}t\right) + c_1 \cos\left(\frac{2\pi}{365}t\right),$$

where t: elapsed days

$y(t)$: estimated XCO_2 or XCH_4

a_0, a_1, b_1, c_1: fitted parameters to be determined

Seasonal amplitude A [mol mol-1] and annual growth rate GR [mol mol-1 yr-1]are expressed by fitted parameters as follows:

$$A = \sqrt{b_1^2 + c_1^2},\ GR = a_1 \times 365.$$

2.3 ACOS XCH_4

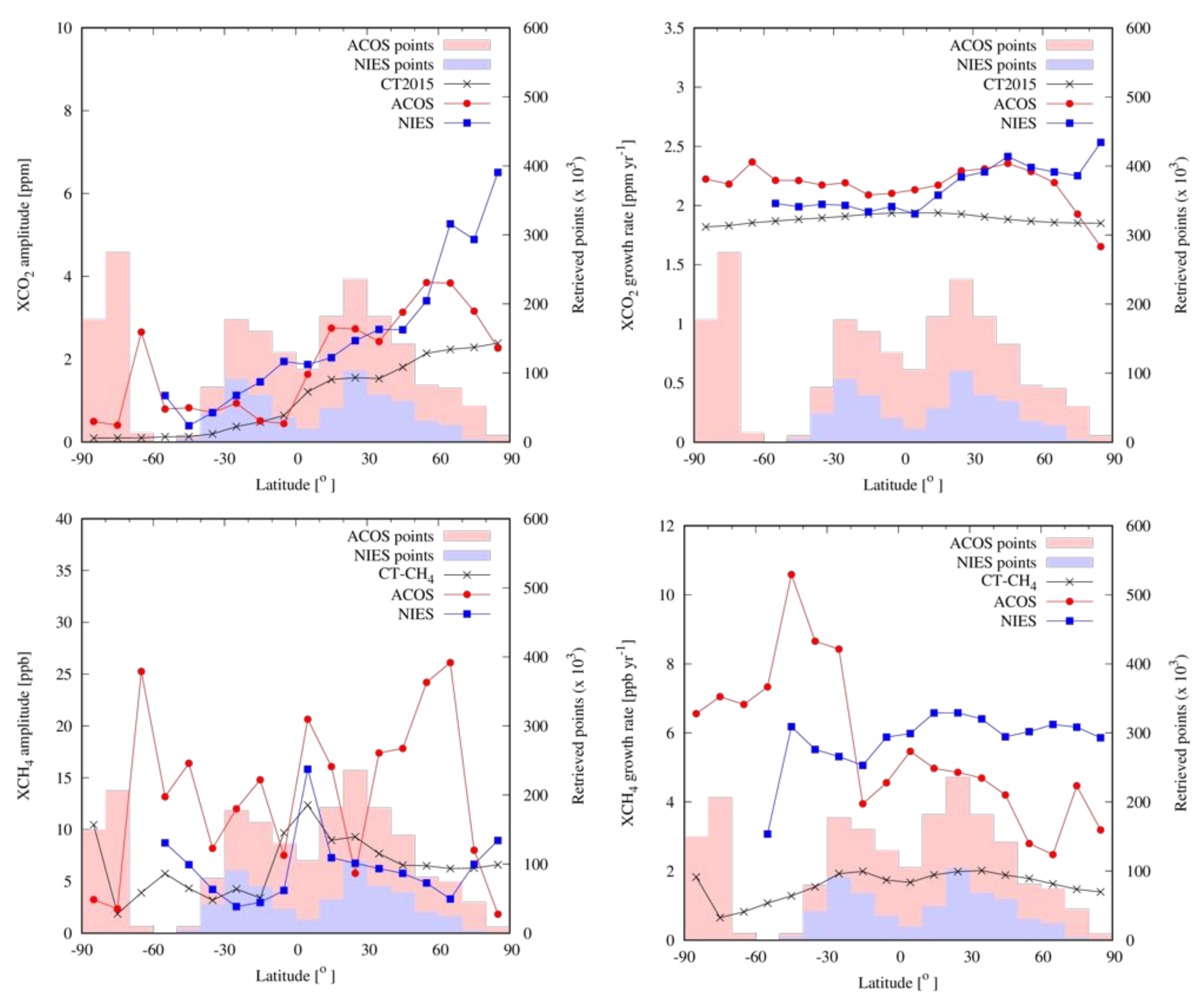
XCH_4 is not retrieved in ACOS, but it could be calculated as follows:

$$\mathrm{XCH4} = \frac{\mathrm{ch4\_column\_idp}}{\sum \mathrm{retrieved\_dry\_air\_column\_layer\_thickness}} \times 10^9\ \text{[ppb]}.$$

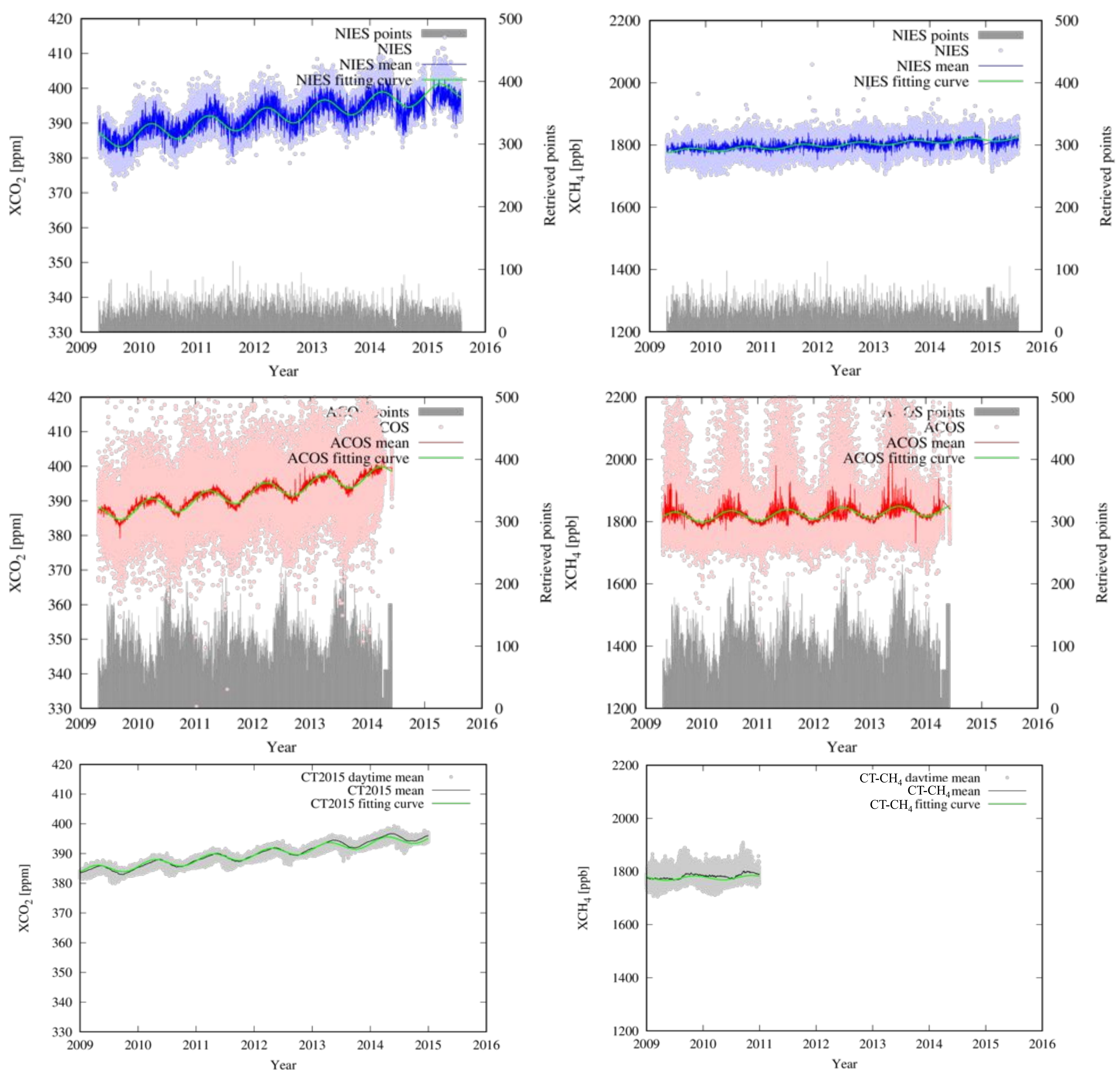
Therefore, results show not only XCO_2 of ACOS but also XCH_4.

3. Results

3.1 Latitudinal average of seasonal amplitude and growth rate



3.2 XCO_2 and XCH_4 time series variation (30 deg N)



4. Conclusion

- XCO_2 in northern hemisphere shows clear seasonal change from satellite observation data.
- XCH_4 is not so clear seasonal amplitude, and especially ACOS XCH_4 should be screened with some criteria.

Acknowledgements

GOSAT project is a joint effort of the Japan Aerospace Exploration Agency (JAXA), the National Institute for Environmental Studies (NIES), and the Ministry of the Environment (MOE), Japan.
ACOS data were produced by the ACOS/OCO-2 project at the Jet Propulsion Laboratory, California Institute of Technology, and obtained from the JPL website, co2.jp.nasa.gov.
This study is processed by JSPS KAKENHI Grant Number JP 16J02111.

References

Wunch et al., 2011, *Atmos. Chem. Phys. Discuss.*, **11**, 20899-20946, 2011b.
O'Dell et al., 2012, *Atmos. Chem. Phys. Discuss.*, **4**, 6097-6158.
Crisp et al., 2012, *Atmos. Meas. Tech.*, **5**, 687-707.
Yoshida et al., 2013, *Atmos. Meas. Tech.*, **6**, 17-30.
Peters et al., 2007, *PNAS*, **104**, 48, 18925-18930.
Lindqvist et al., 2015, *Atmos. Chem. Phys.*, **15**, 13023-13040.