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Towards global and regional methane budgets estimated by high spatial resolution atmospheric inverse model with GOSAT retrievals

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Background and aim

Atmospheric CH₄ started to increase again since 2007, after a period of near-zero growth from 1999 to 2006. Various



reasons have been discussed, but larger uncertainty still remains, especially on regional scales. In this study, we estimate global and regional CH_4 fluxes for 2011 by a high resolution variational inverse model, based on **NIES-TM-FLEXPART** transport model. The atmospheric CH_4 observations from both ground-based measurements and satellite-based (**GOSAT**) retrievals are assimilated. We show that the observations from GOSAT give additional view about the emissions in regions where ground-based observation network is sparse.

Materials and methods

Prior emission data

- Anthropogenic sources: EDGAR v4.3.2^[3]
- Biospheric sources (wetlands, soil sink): VISIT^[2]
- Biomass burning: GFAS v1.2^[4]
- Others: ocean, geological, termite

(top) Total posterior CH₄ fluxes from S2, i.e. both ground based and GOSAT observations are assimilated.

(right) Differences in S1 and
S2 posterior CH₄ flux
estimates. Positive values
indicate higher emission
estimates with GOSAT



Atmospheric concentration observations

 Ground-based: NOAA, EC, InGOS and many others
 Satellite: GOSAT SWIR Level 2 (L2) X_{CH4} data versions 02.21-02.60^[5]

Inversion method

- 4DVAR (m1qn3) follows approach by Meirink *et al.*, ACP 2008
- Optimize anthropogenic and natural fluxes biweekly on 0.1°×0.1° resolution
- Correlation length: 500 km, 15 days

Atmospheric transport

- NIES-TM (Eulerian, 2.5°×2.5°)
- + FLEXPART (Lagrangian, 0.1°×0.1°) ^[1]
- Lagrangian response = 3 days

I Inversion setup:

- S1: only ground-based observations assimilated
- S2: in situ and GOSAT observations assimilated



observations assimilated.



(top) Regional monthly anthropogenic and biospheric CH₄ fluxes (GCP regions). The seasonal cycles from the two inversions differ only little. The largest differences are found in anthropogenic emissions during winter.

(top) Atmospheric CH_4 at Hateruma (HAT).

(top) Global mean X_{CH4} and comparison with assimilated data. The statistics are in the unit of ppb.

– GOSAT "bias" subtracted from L2 data*1

 *1 The average X_{CH4} differences between the GOSAT and optimized forward simulation (only ground based observations assimilated) by month and 5°

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