TM5(-4DVAR) activities at VU

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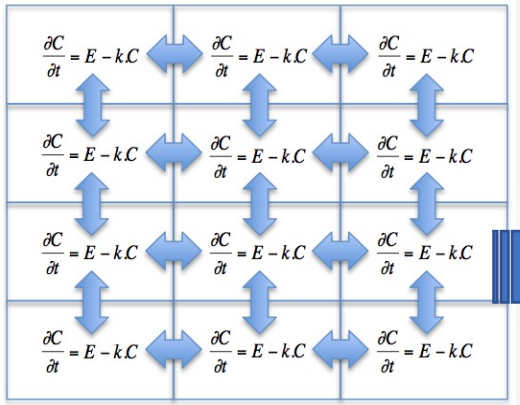
SRON Netherlands Institute for Space Research

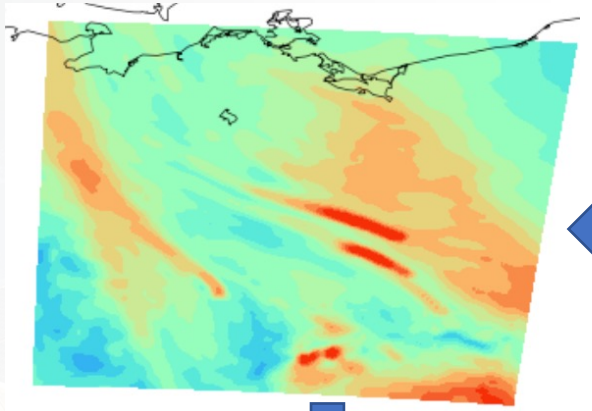
CAMS CH_4 reanalysis in coop. with TNO

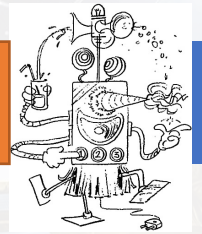
Atmospheric Data

a priori
emission estimate

Atmospheric transport
model







Optimizer

a posteriori
emission estimate

Observed & model
simulated data

Copernicus Atmosphere
Monitoring Service

Stream 1

1990

NOAA

2009

Stream 2

GOSAT

V17.r1 V18.r1 V19.r1

2017 2018 2019

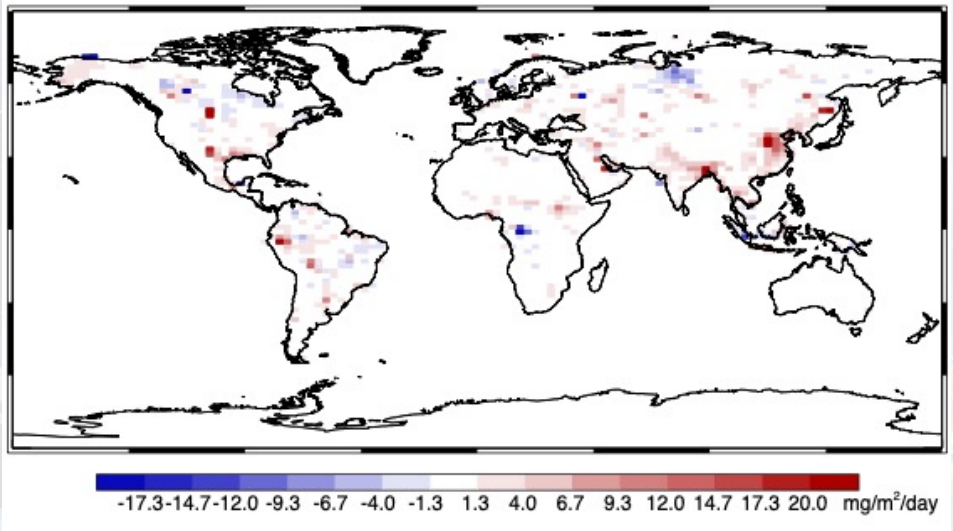
V17.r2 V18.r2 V19.r2

CAMS v19 Emission trend

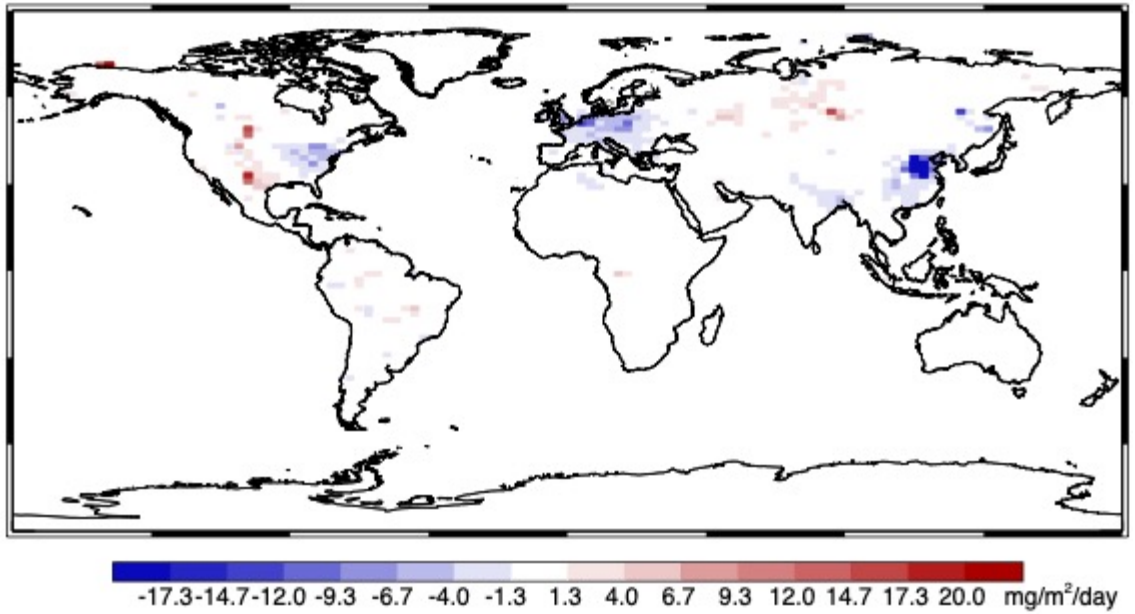
TWin 1: 2009 .. 2012
TWin 2: 2016 .. 2019

ΔE = TWin 2 – TWin 1

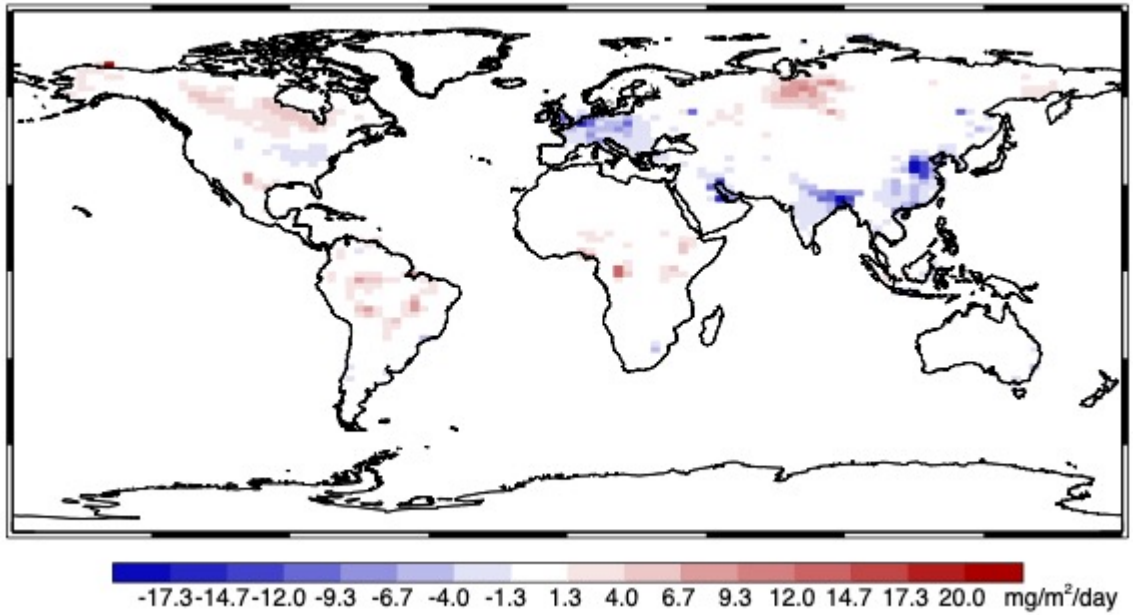
ΔE A Priori



ΔE Surface Inv. – ΔE A Priori



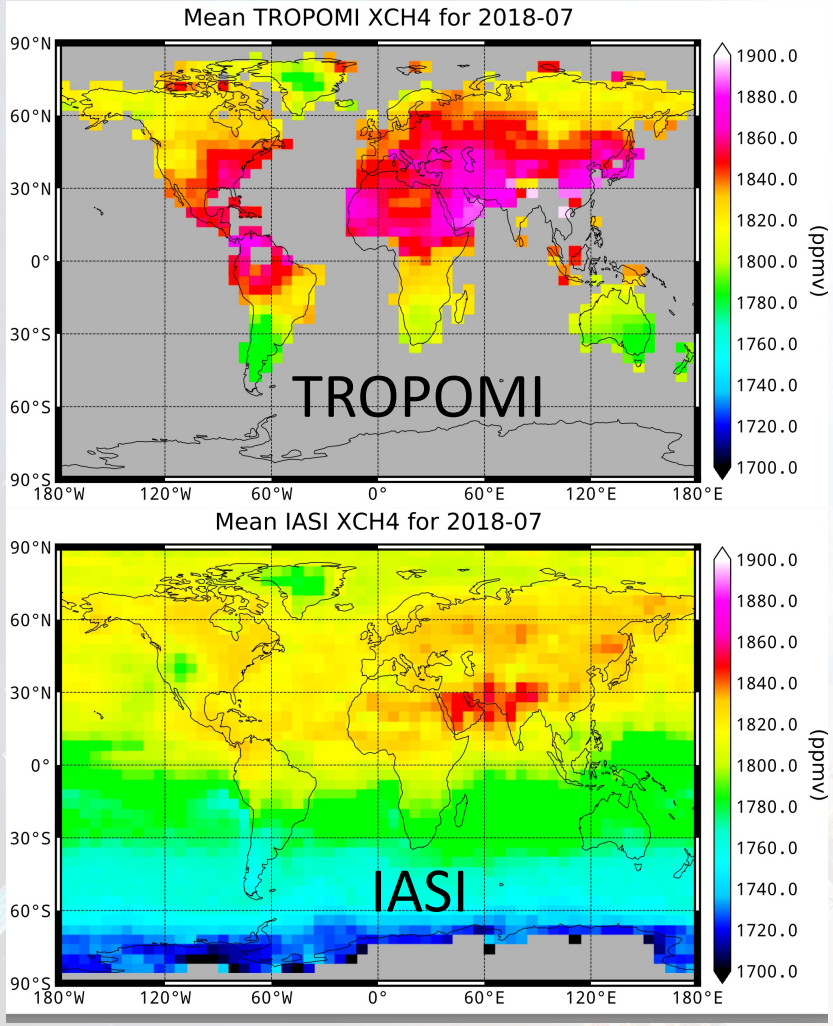
ΔE GOSAT Inv. – ΔE A Priori

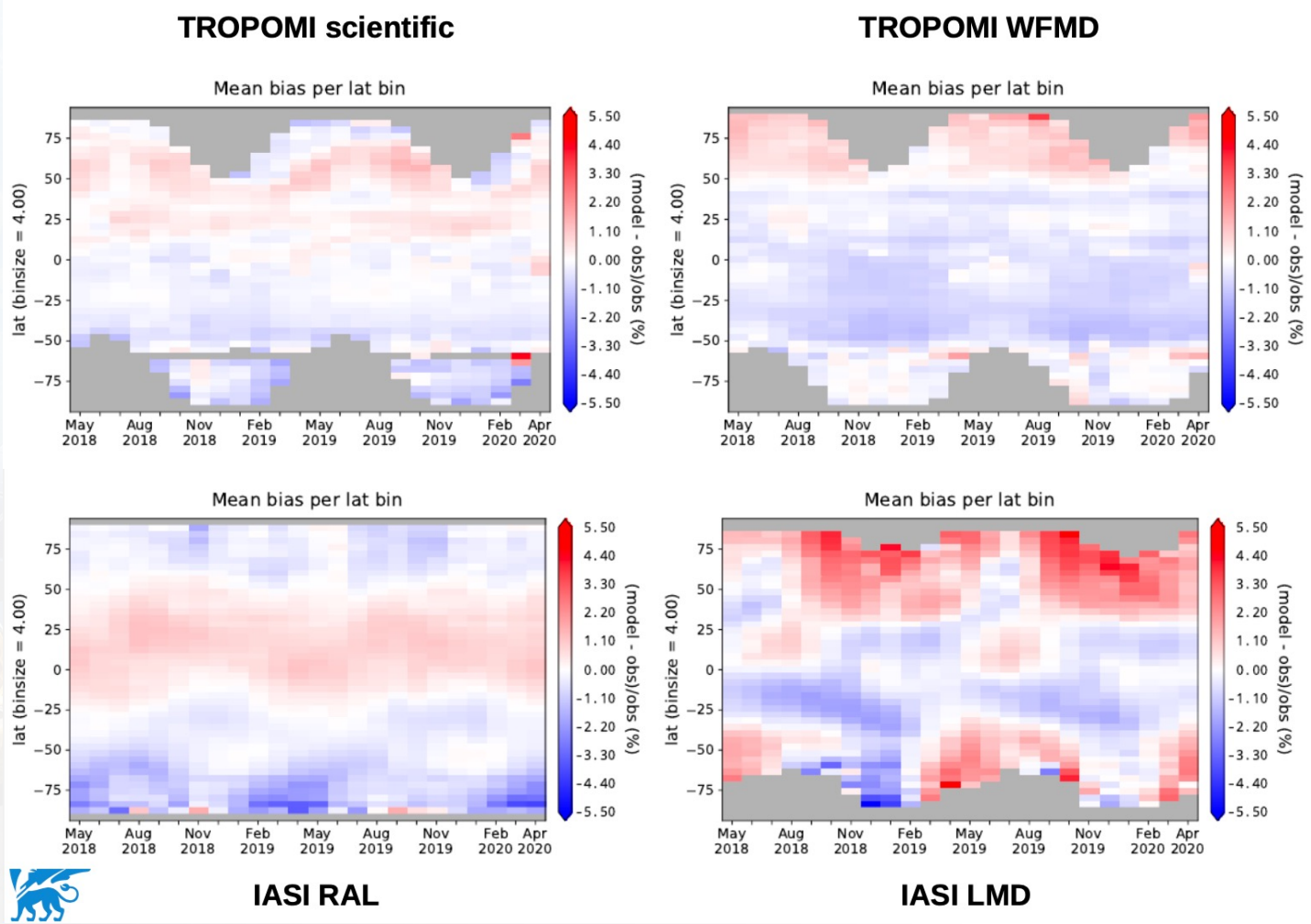


- Inversions shift the balance between anthropogenic & natural increase

Integration of new datasets

methaneplus.eu
METHANE+





- Issues with datasets that remain to be resolved …

TROPOMI: Emission increase from 2019 to 2020

Emission increase:

Surface data: 10 $TgCH_4/yr$

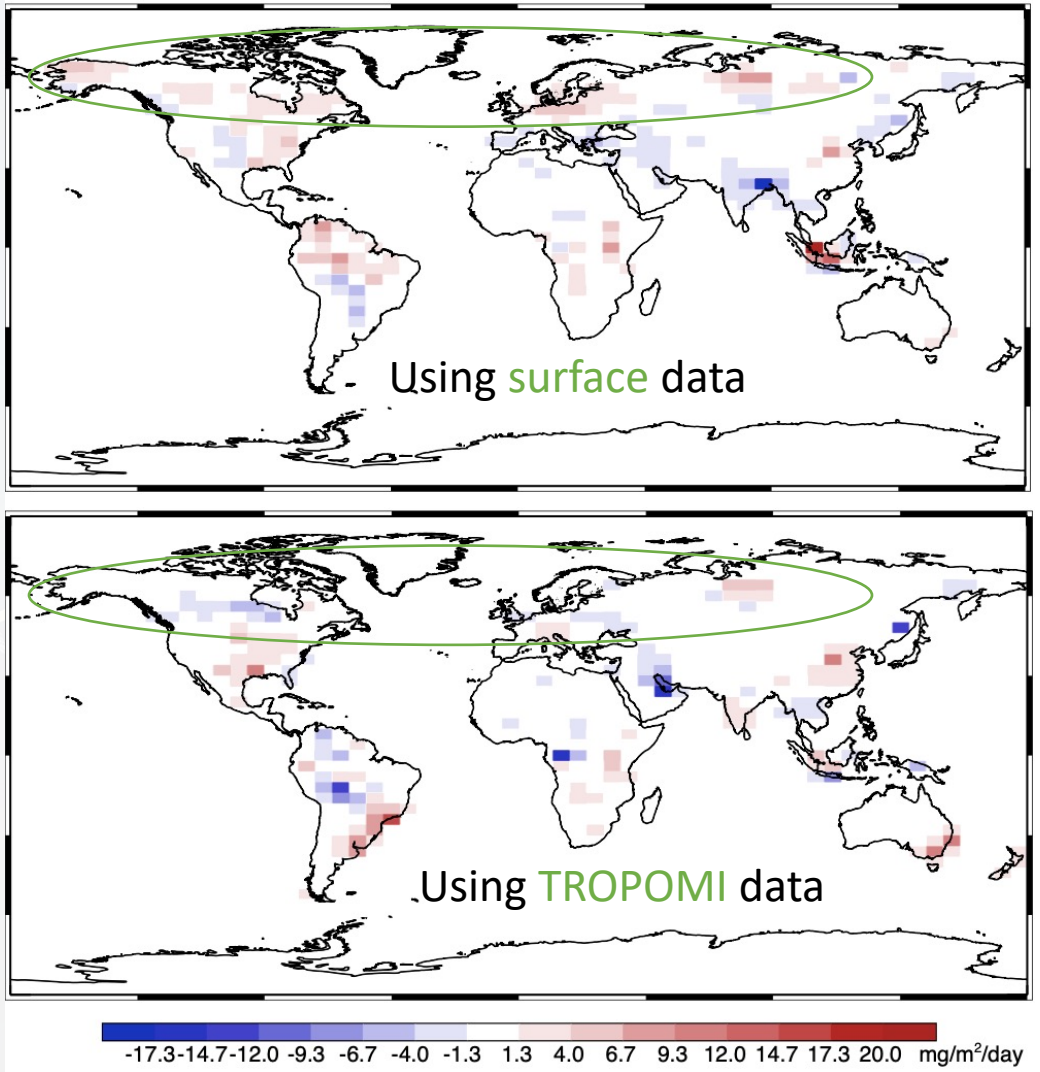
TROPOMI: 5.5 $TgCH_4/yr$

Surface inversion shows an increase in high northern latitudes, that is less clear using TROPOMI

⇒ Stevenson et al, ACP, 2021

CH_4 increase mostly due to OH decrease caused by NOx emission reductions

(May 2019 to Apr 2020) – (May 2019 to Apr 2018)



How accurate is TROPOMI at high latitudes?

BRIEF REPORT

Methane release from carbonate rock formations in the Siberian permafrost area during and after the 2020 heat wave

Nikolaus Froitzheim, Jaroslaw Majka, and Dmitry Zastrozhnov

+ See all authors and affiliations

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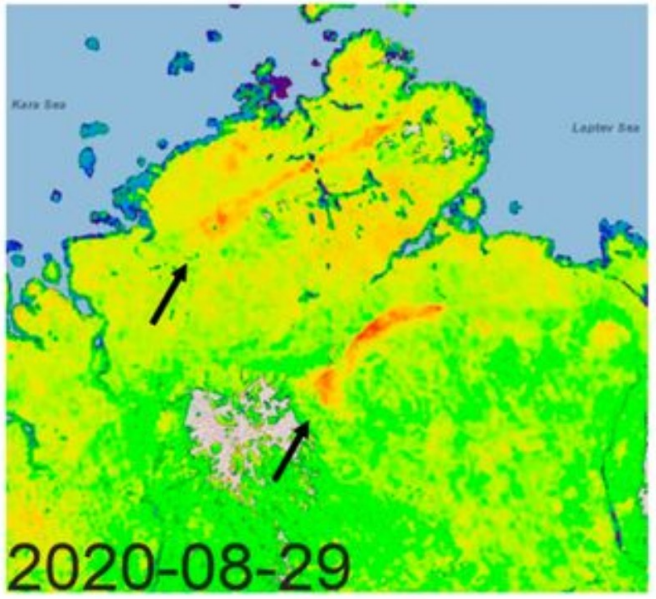

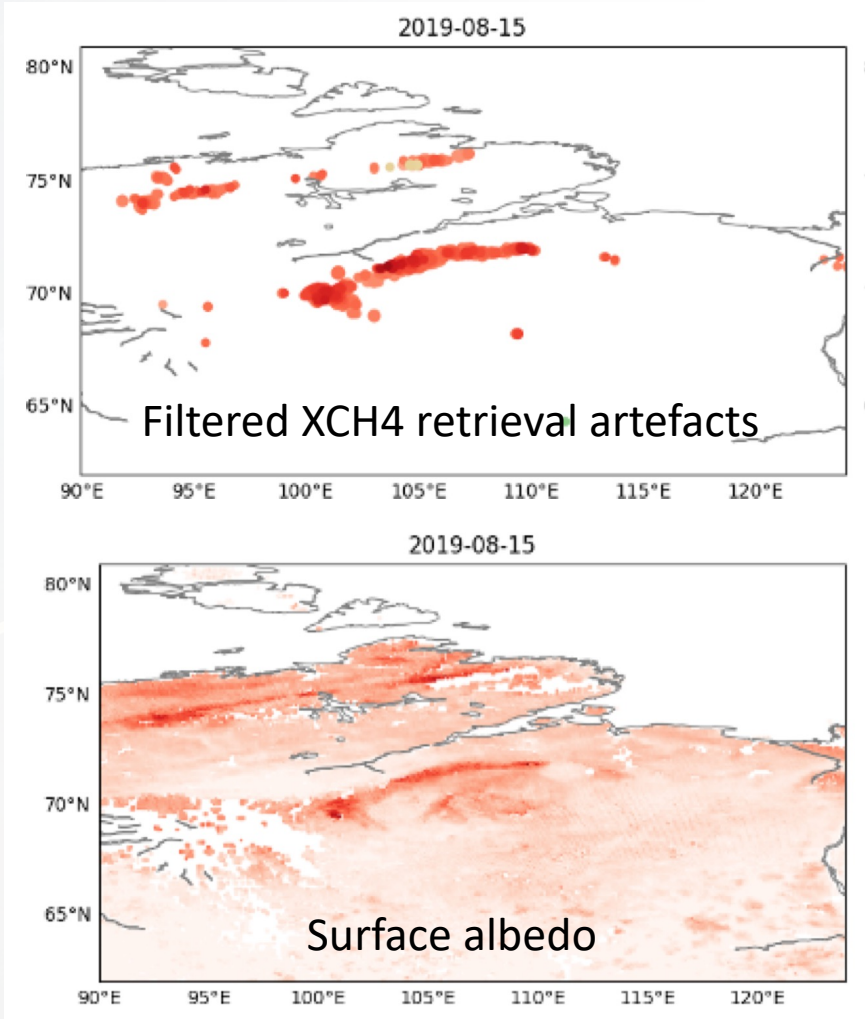

Barré et al, ACP, 2021

- Albedo/aerosol related errors still require improvement

Combining SWIR & TIR to constrain OH

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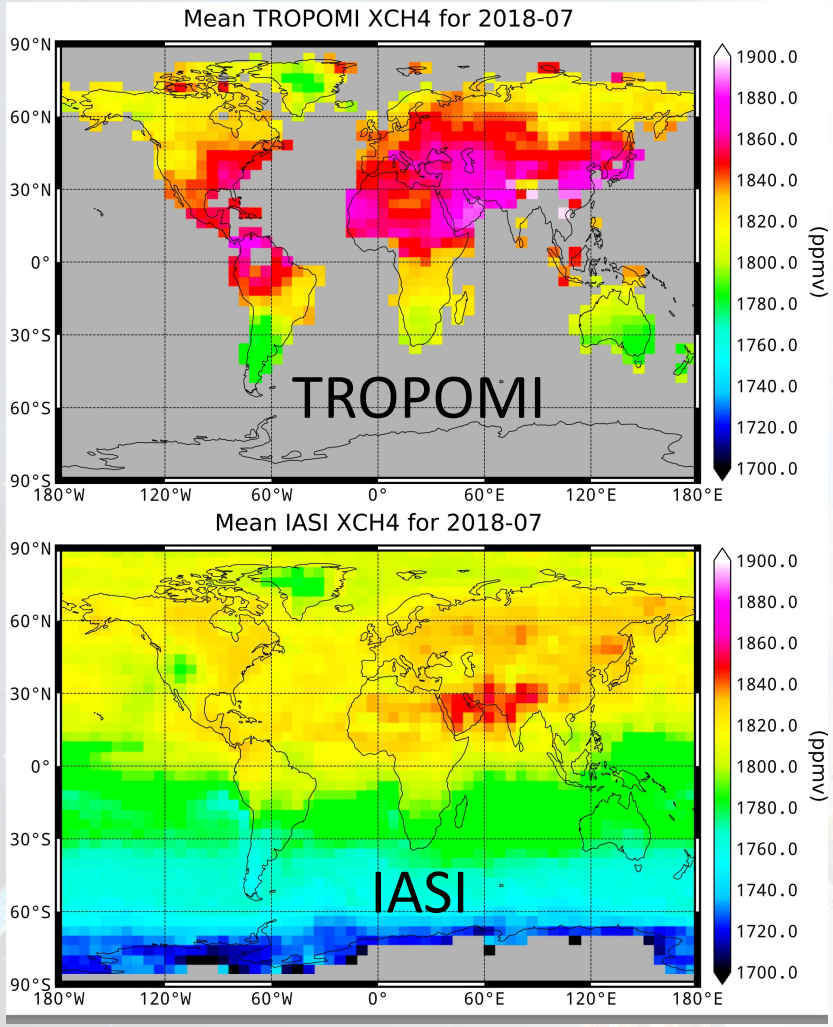
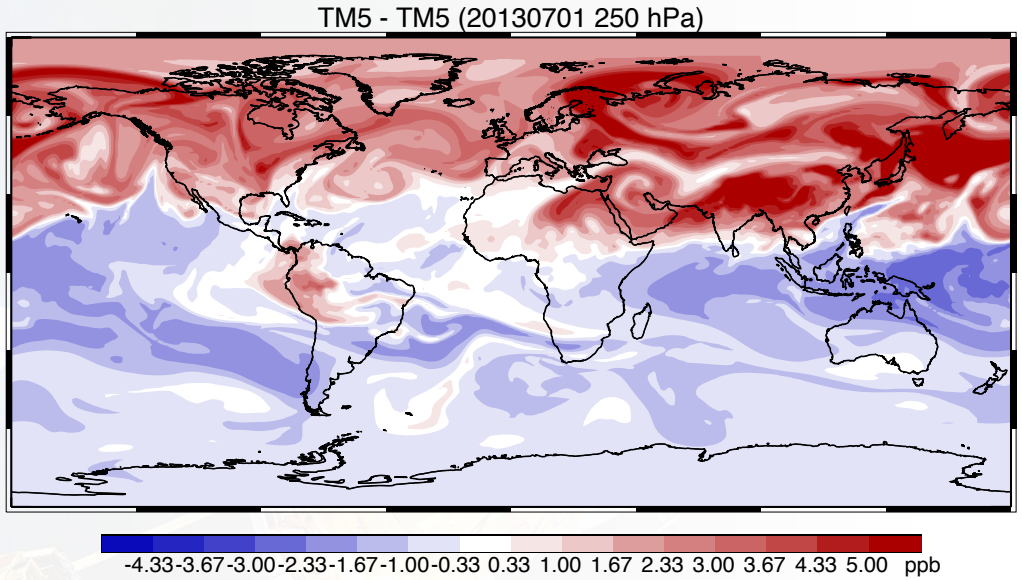
METHANE+



Δemis = 10% & ΔOH = 10%



Combined SWIR & TIR:

- Vertical profile information (DOFS > 1)
- Land-sea contrast

Combining TIR and SWIR datasets helps to independently constrain methane **sources and sinks**

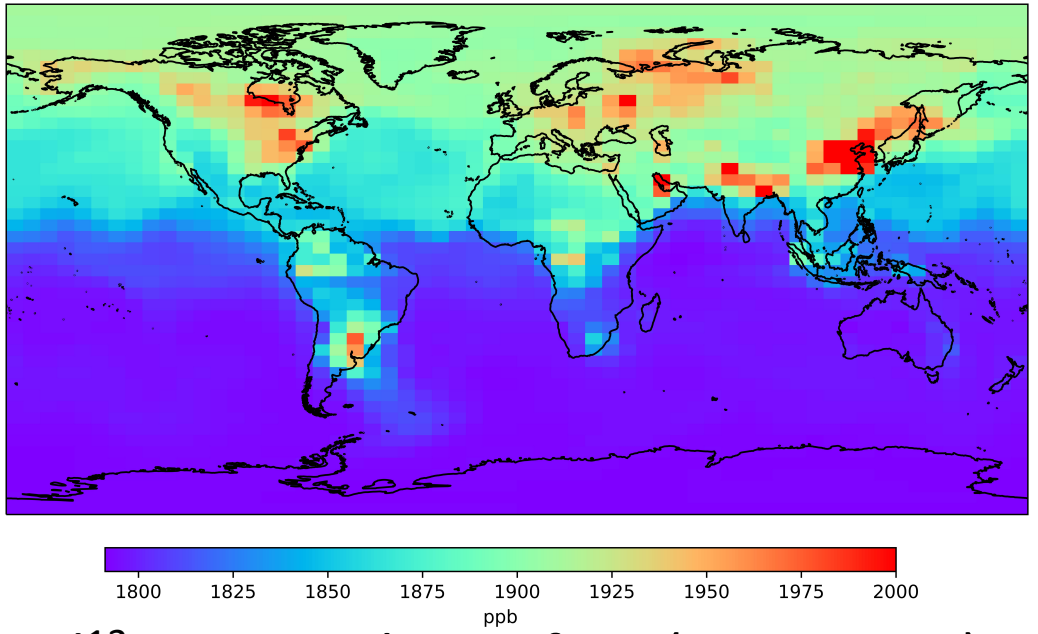
Joint optimization of CH_4 sources and sinks

- Box model environment to try out the required adjoint coding
- TM5-4DVAR implementation of MCF as example

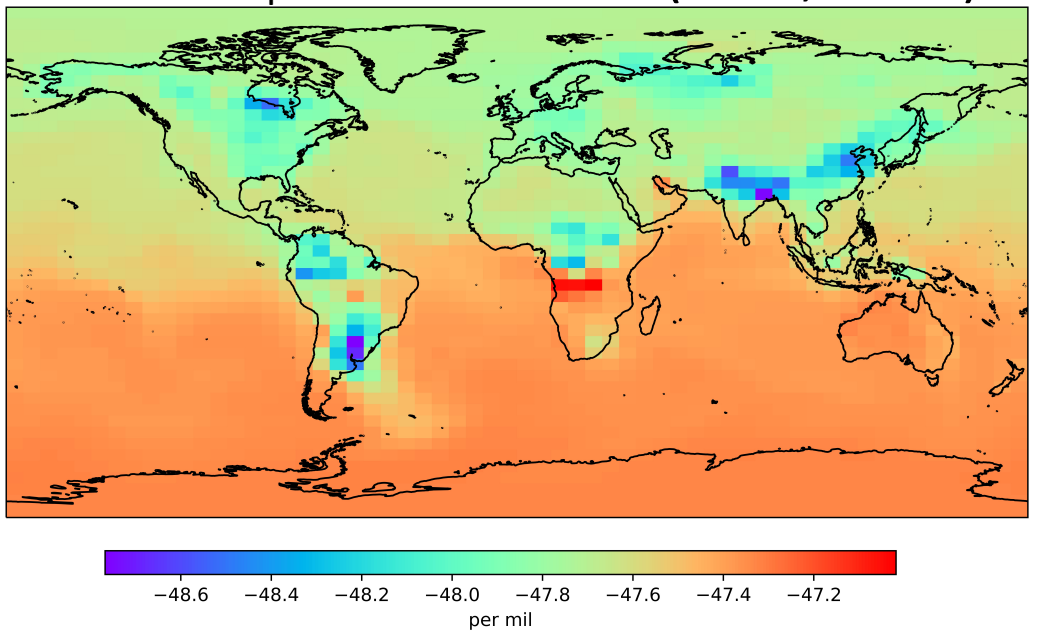
$d^{13}C$ and dD in TM5mp

- So far only forward modelling
- Extend the evaluation of the CAMS CH_4 reanalysis with isotopic data
- Preparation for pending proposal with IMAU on dD-CH_4

CH_4 at the surface (June, 2016)



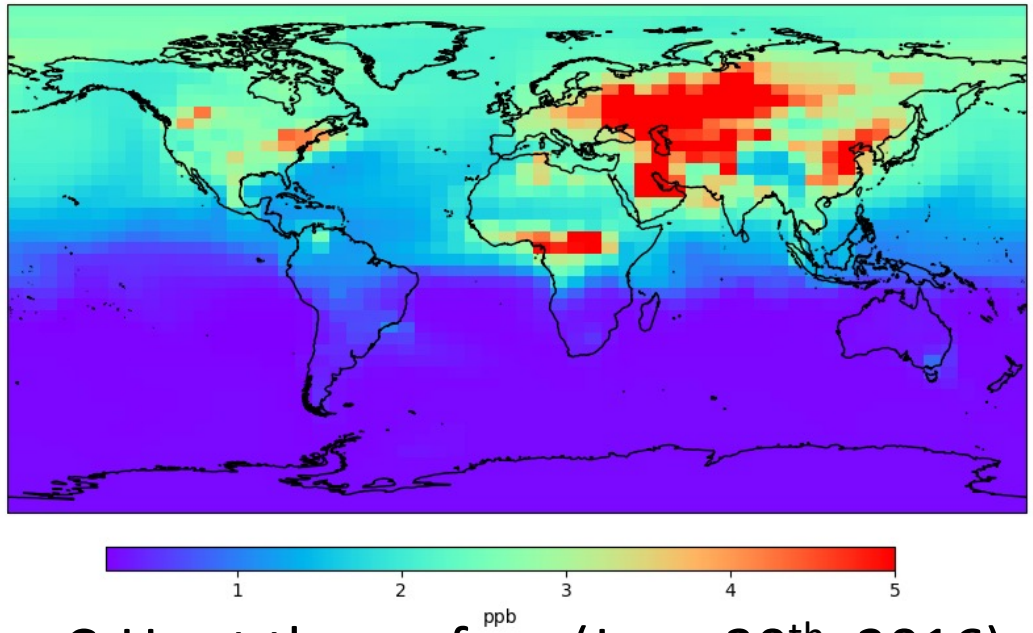
$d^{13}C$-CH_4 at the surface (June, 2016)



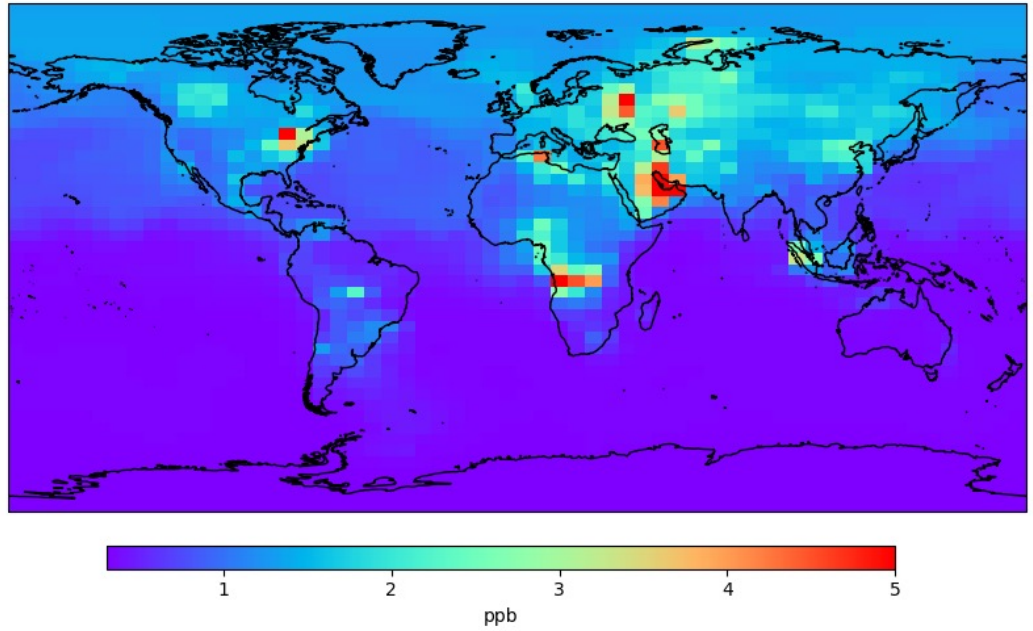
Ethane in TM5mp

- So far only forward modelling
- Extend the evaluation of the CAMS CH_4 reanalysis with ethane
- Used for testing the contribution of emissions from fossil fuel use

C_2H_6 at the surface (Jan 1th, 2016)



C_2H_6 at the surface (June 30th, 2016)



Plans for new phase of CAMS(55)

- CH_4 reanalysis towards 1^o x 1^o resolution
- Use of TM5mp-4DVAR
- Implementation of XIOS for parallel IO
- Make cpu intensive parts GPU-ready
- Integration of the PPVI technique (Pandey et al, 2021)
- Extension of the production chain with TROPOMI and IASI data