Quantification of methane emissions and the role of satellites moving from global to local scales

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Paris agreement & CH$_4$

- It is not only about CO$_2$!

- CH$_4$ has a pivotal role in the energy transition discussion

- Fossil CH$_4$ emission are highly uncertain

- Need for atmospheric monitoring => UK and CH UNFCCC reporting

Source: http://unfccc.int/focus/indc_portal/items/9240.php
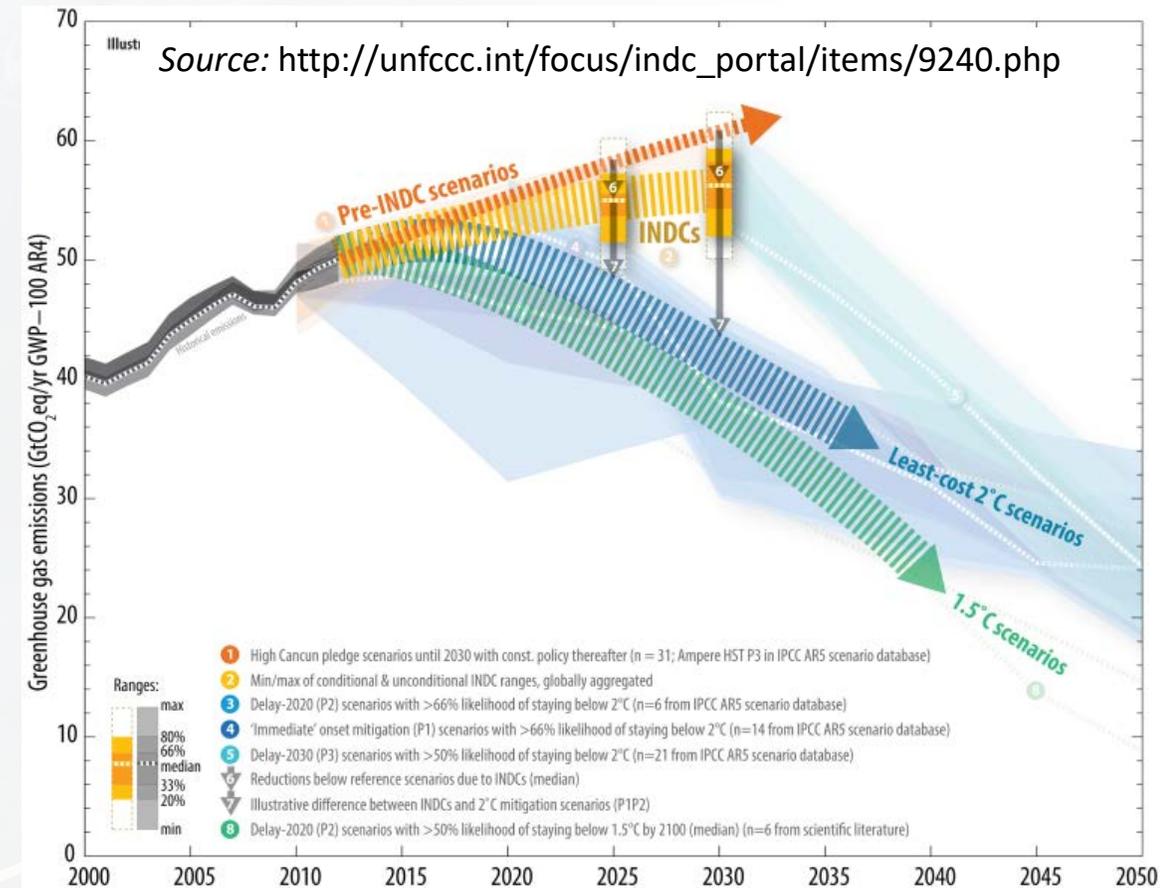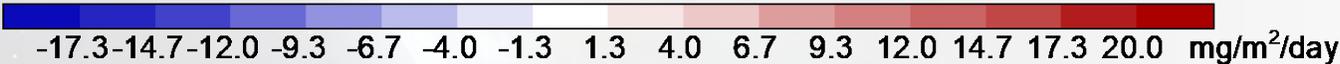
Global CH$_4$ emission monitoring

CAMS CH$_4$ inversion re-analysis (2000 – 2016) using surface network data

Long term emission trend: Atmosphere - Inventory
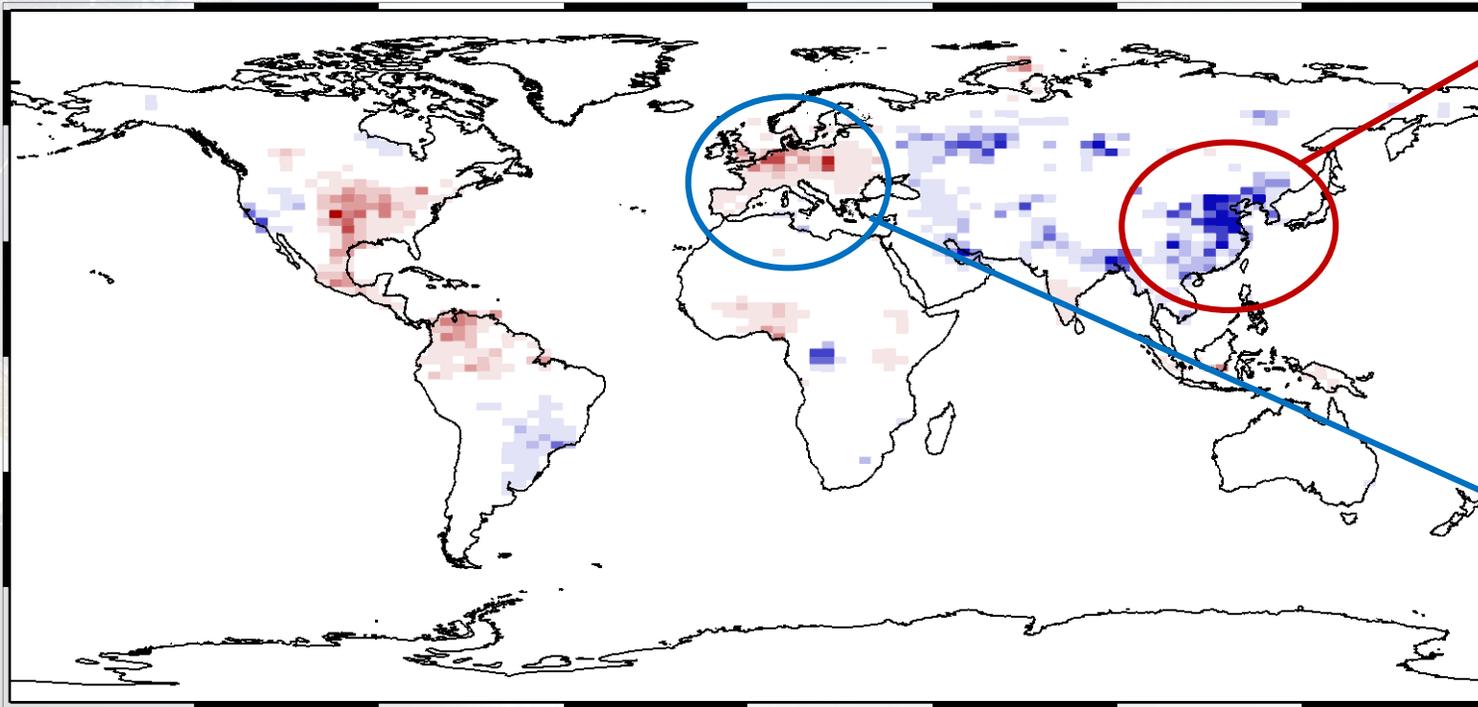
Downward correction of inventory trend

Upward correction of inventory trend (?)

-17.3 -14.7 -12.0 -9.3 -6.7 -4.0 -1.3 1.3 4.0 6.7 9.3 12.0 14.7 17.3 20.0 mg/m^2/day
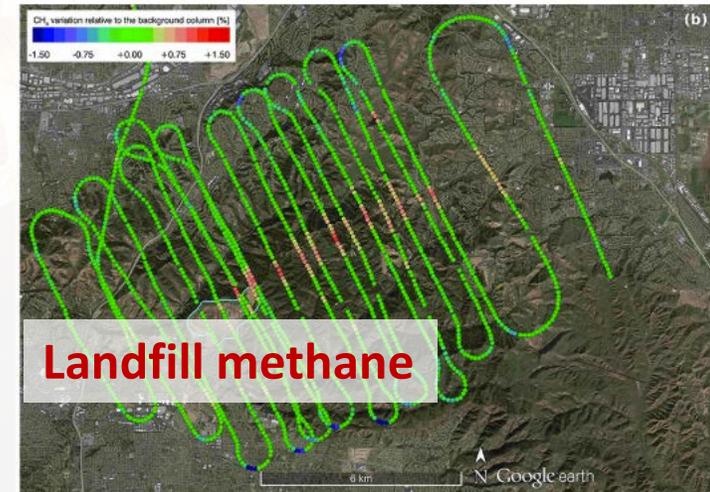
Local emission detection

- **SCIAMACHY:** Large sources,

  long-term averaging

- **Airborne:** Demonstration of the

  potential at higher resolution

  and measurement sensitivity

SCIAMACHY 2003-2009 xCH₄ enhancement (ppb)

4 Corners coalbed methane
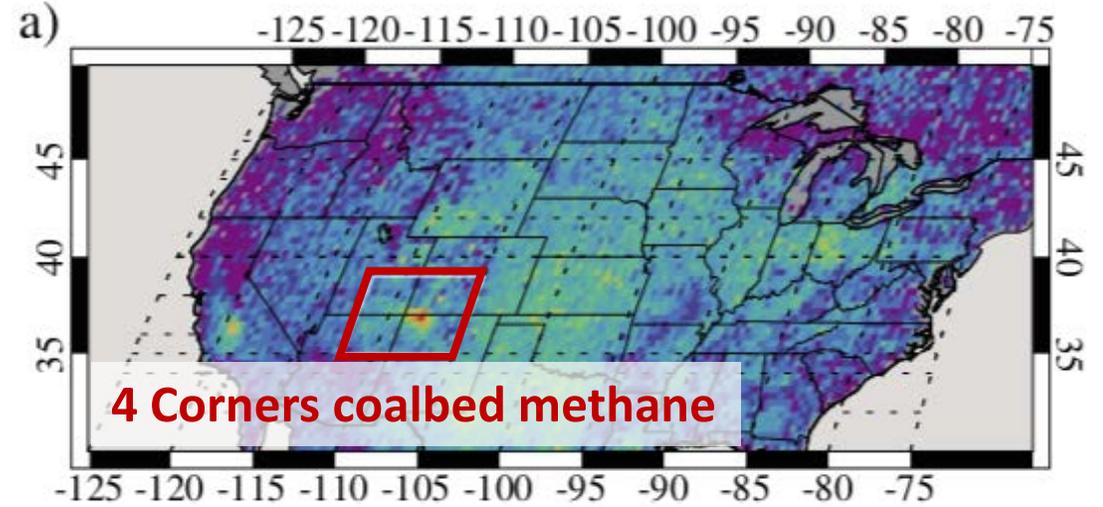
Kort et al, GRL, 2014
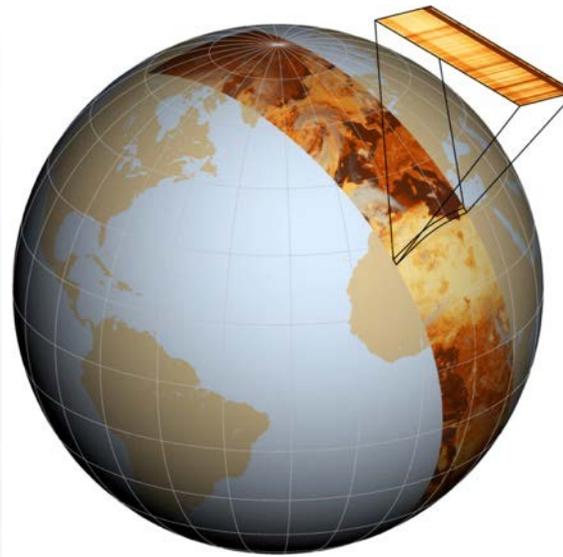
Airborne Methane Mapper (MAMAP)

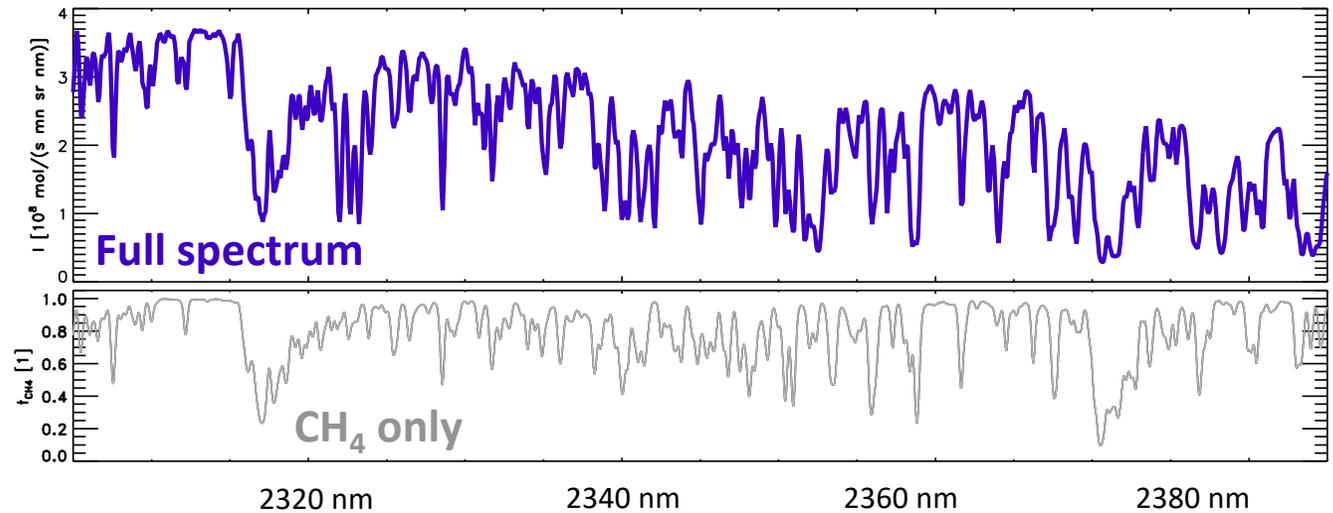Landfill methane

Krautwurst et al, AMT, 2017

S5p TROPOMI

- Grating spectrometer
- CH_4: 2.3 μm (instead of 1.6 μm)
- Swath: 2600km
- Ground pixel: 7x7km^2 (at nadir)

- Other gases: NO2, O3, SO2, ...
- Clouds (NASA Suomi NPP)
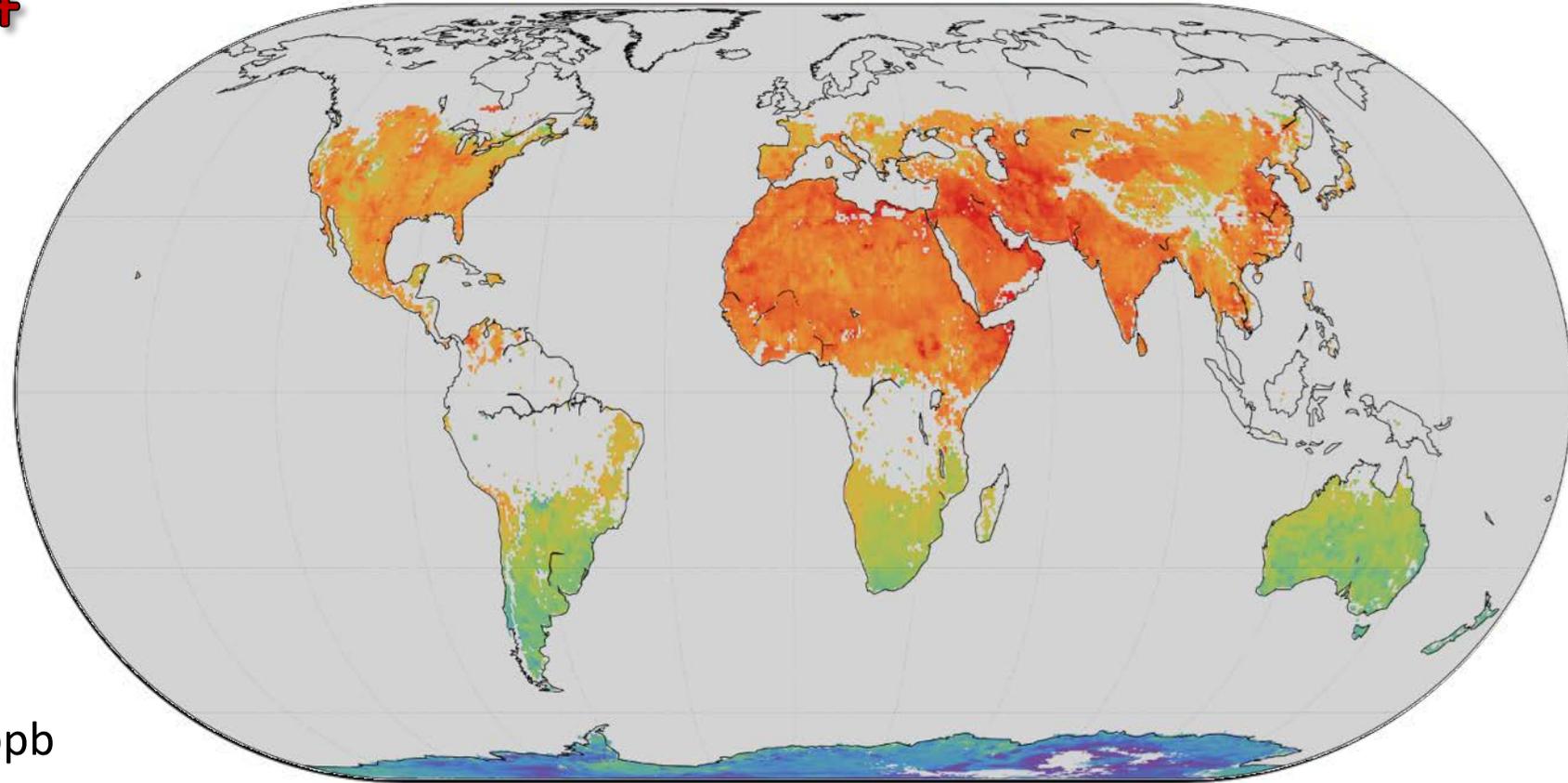

SWIR channel @ 2.3 μm
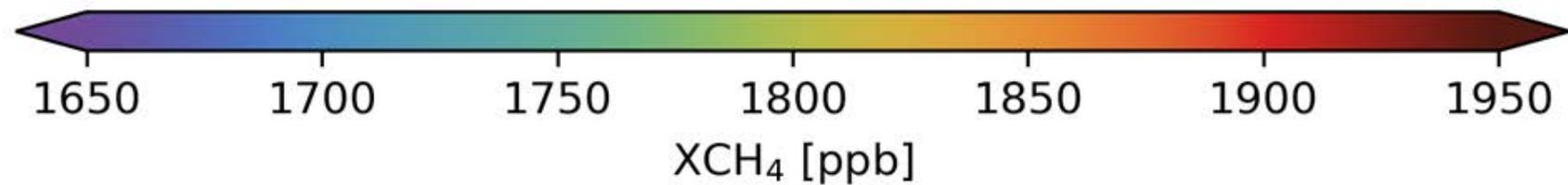

Full spectrum

CH_4 only

TROPOMI XCH4

XCH4 (2017/11 – 2017/12)

TCCON validation:

Bias: 1.5 ppb
Station to station variability: 6 ppb
Precision: 13 ppb

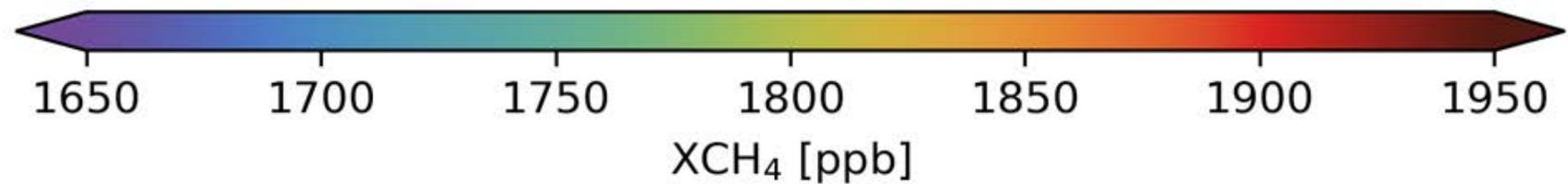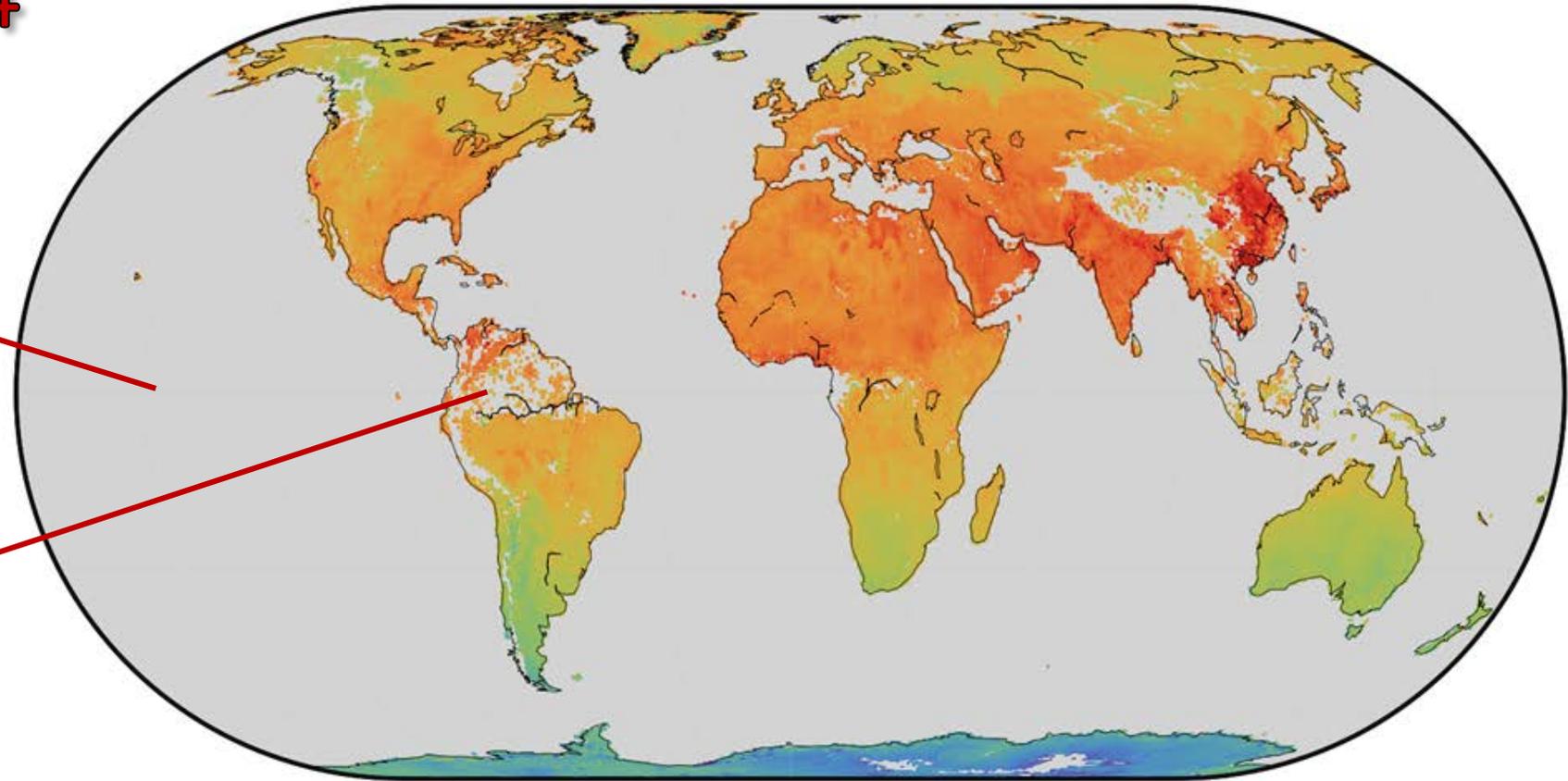Data publicly available at: https://scihub.copernicus.eu

TROPOMI XCH4

XCH4 (2018/6 – 2019/1)

No processing of sun glint data yet

Strict cloud filtering

XCH$_4$ [ppb]

1650   1700   1750   1800   1850   1900   1950

Data publicly available at: https://scihub.copernicus.eu
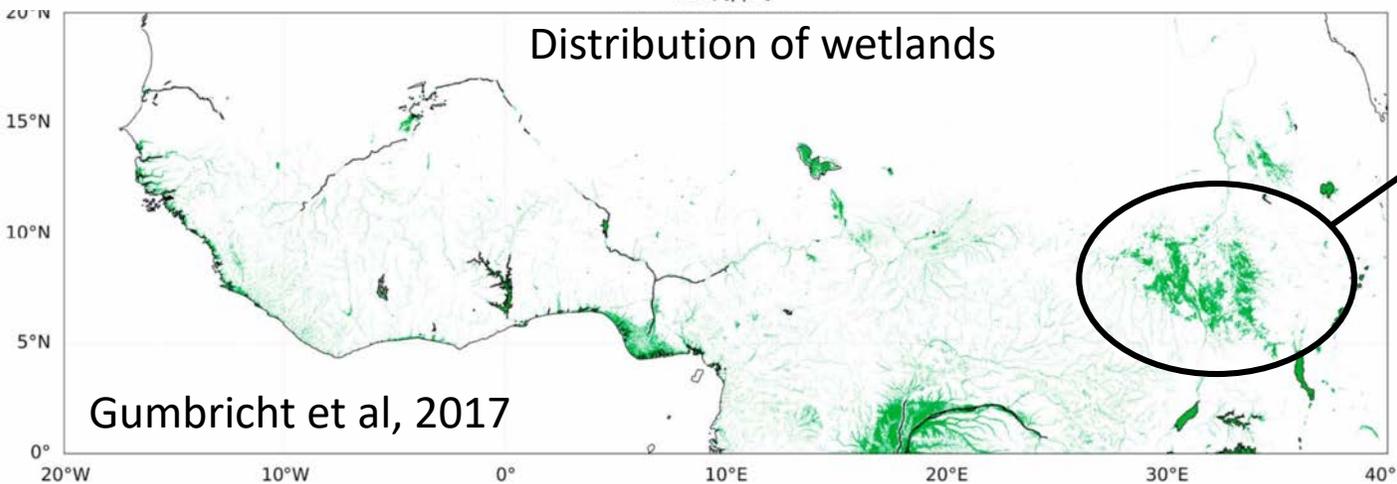
Local XCH4 enhancements: African wetlands

TROPOMI XCH4 (12 Nov – 30 Dec, 2017)
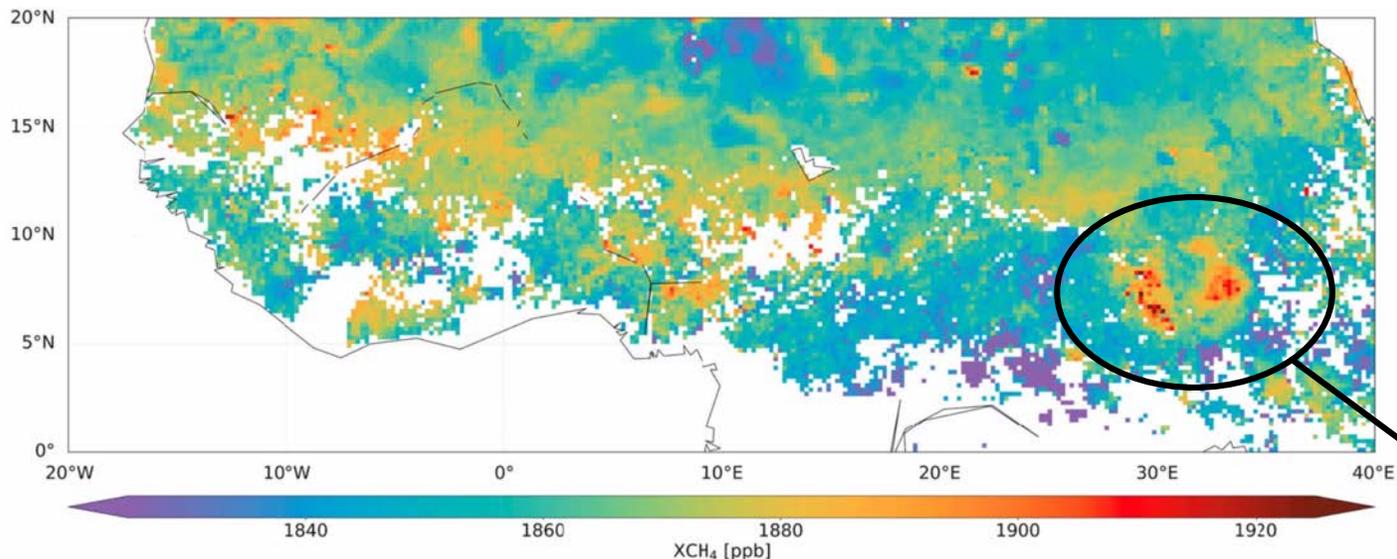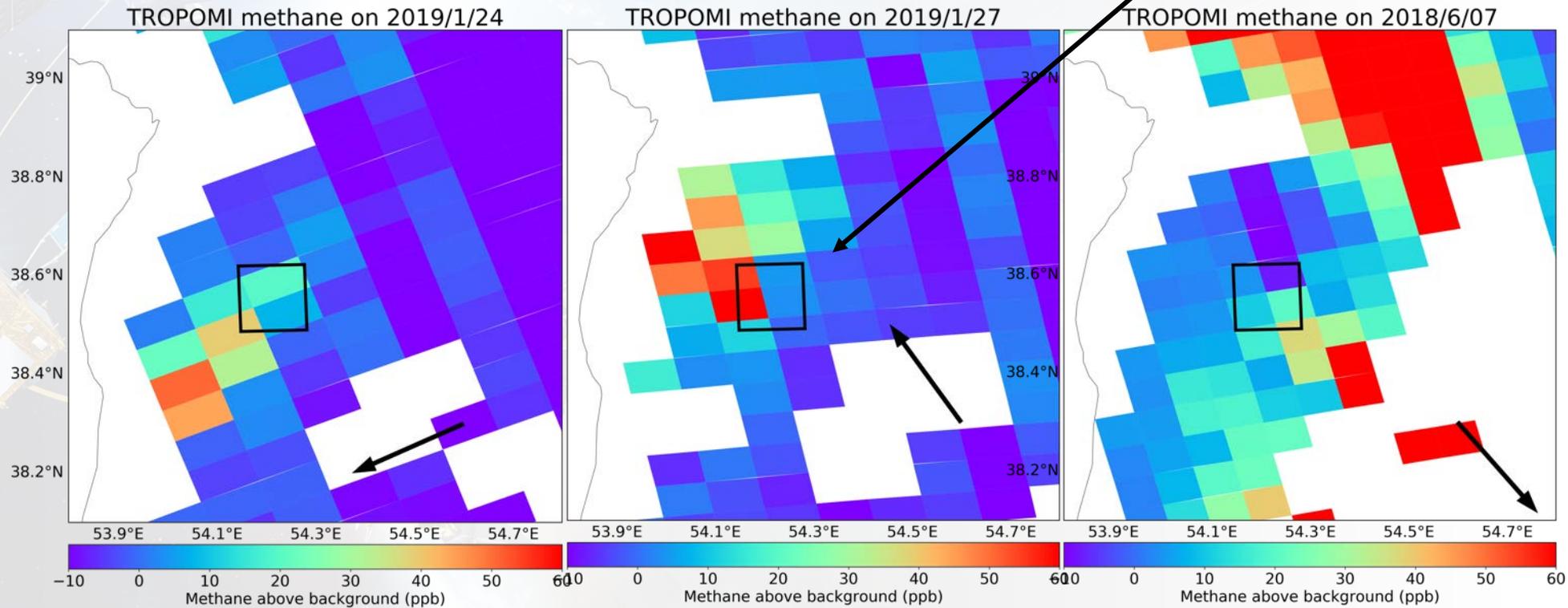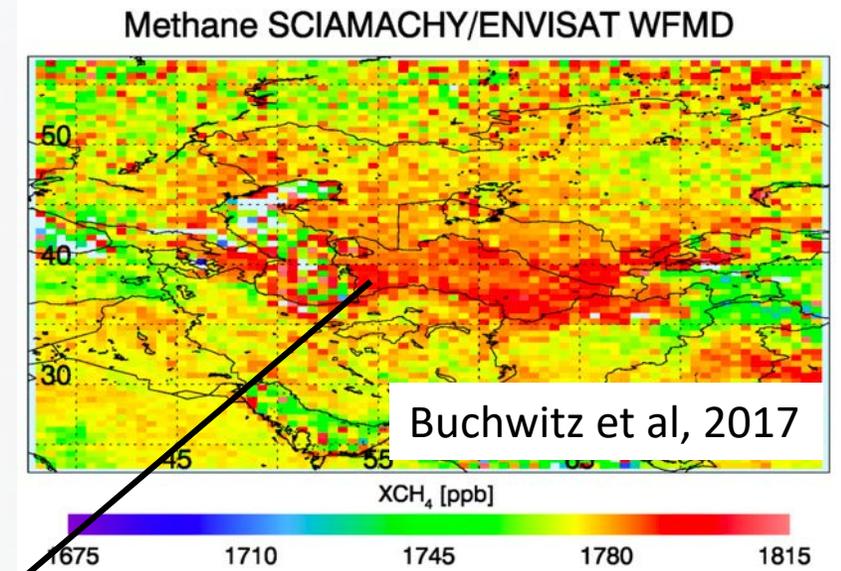
Distribution of wetlands

Gumbricht et al, 2017

Sudd Fresh water marshes
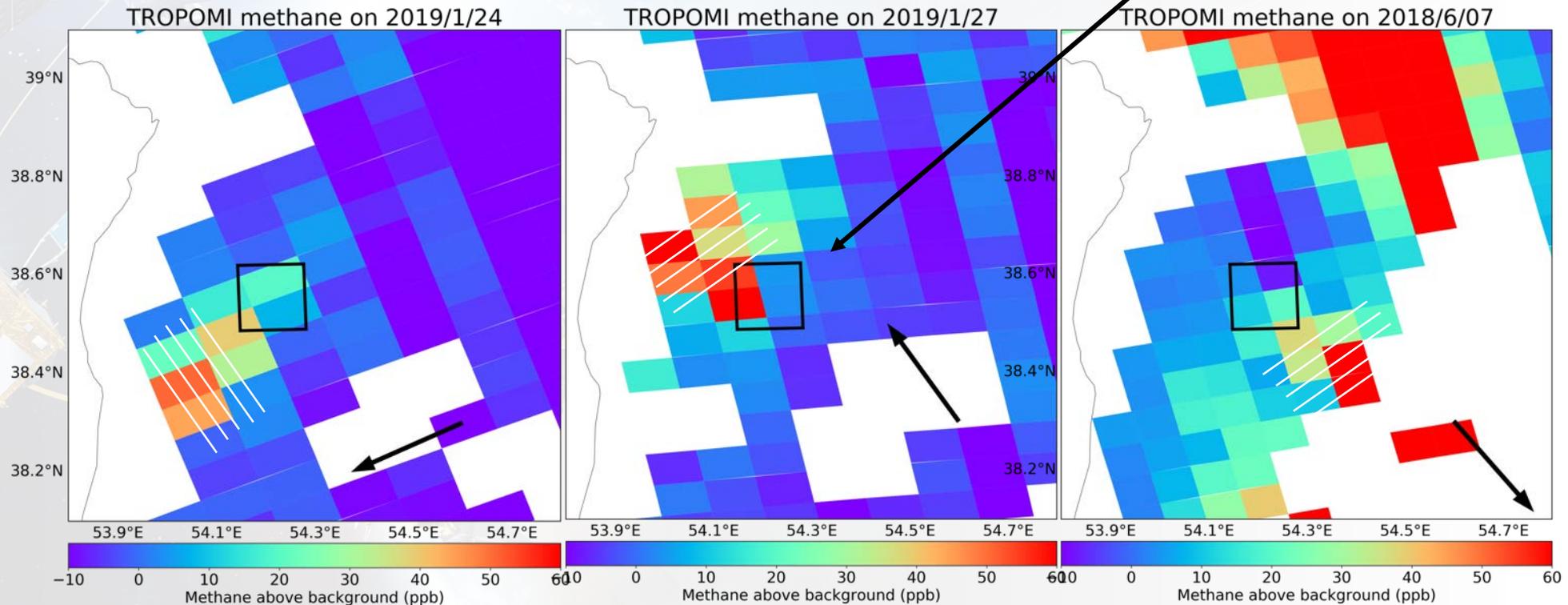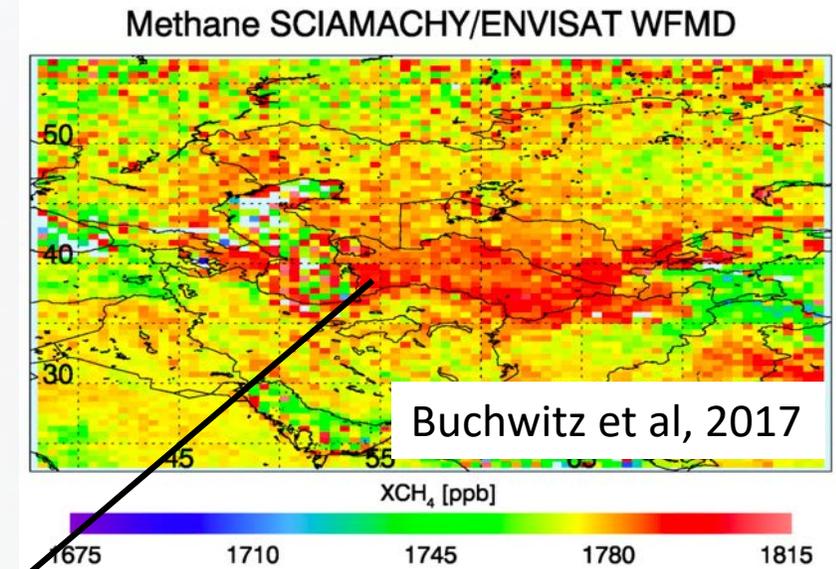South Sudan

Hu et al, 2018

Local XCH4: Turkmenistan Oil & Gas production

Methane SCIAMACHY/ENVISAT WFMD

Buchwitz et al, 2017

XCH₄ [ppb]

1675   1710   1745   1780   1815

TROPOMI methane on 2019/1/24   TROPOMI methane on 2019/1/27   TROPOMI methane on 2018/6/07

Varon et al (in review)

Methane above background (ppb)

Local XCH4: Turkmenistan Oil & Gas production

Cross sectional flux method: 10 – 42 t CH4 / hr

Methane SCIAMACHY/ENVISAT WFMD

Buchwitz et al, 2017

XCH₄ [ppb]

1675   1710   1745   1780   1815

TROPOMI methane on 2019/1/24

TROPOMI methane on 2019/1/27

TROPOMI methane on 2018/6/07

Varon et al (in review)

Methane above background (ppb)

Methane above background (ppb)

Methane above background (ppb)
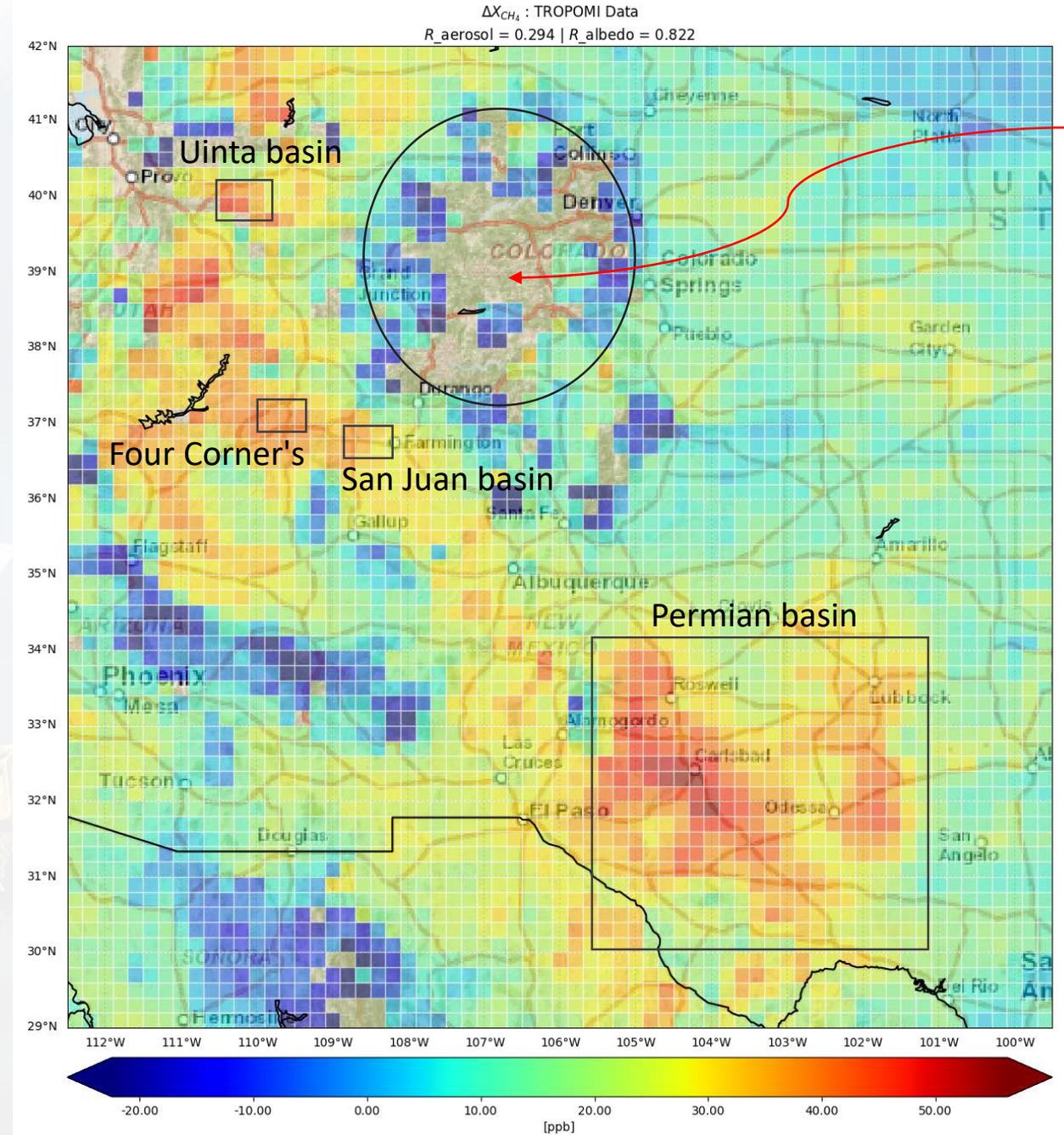
Oil & Gas production in the US

Permian basin Texas:
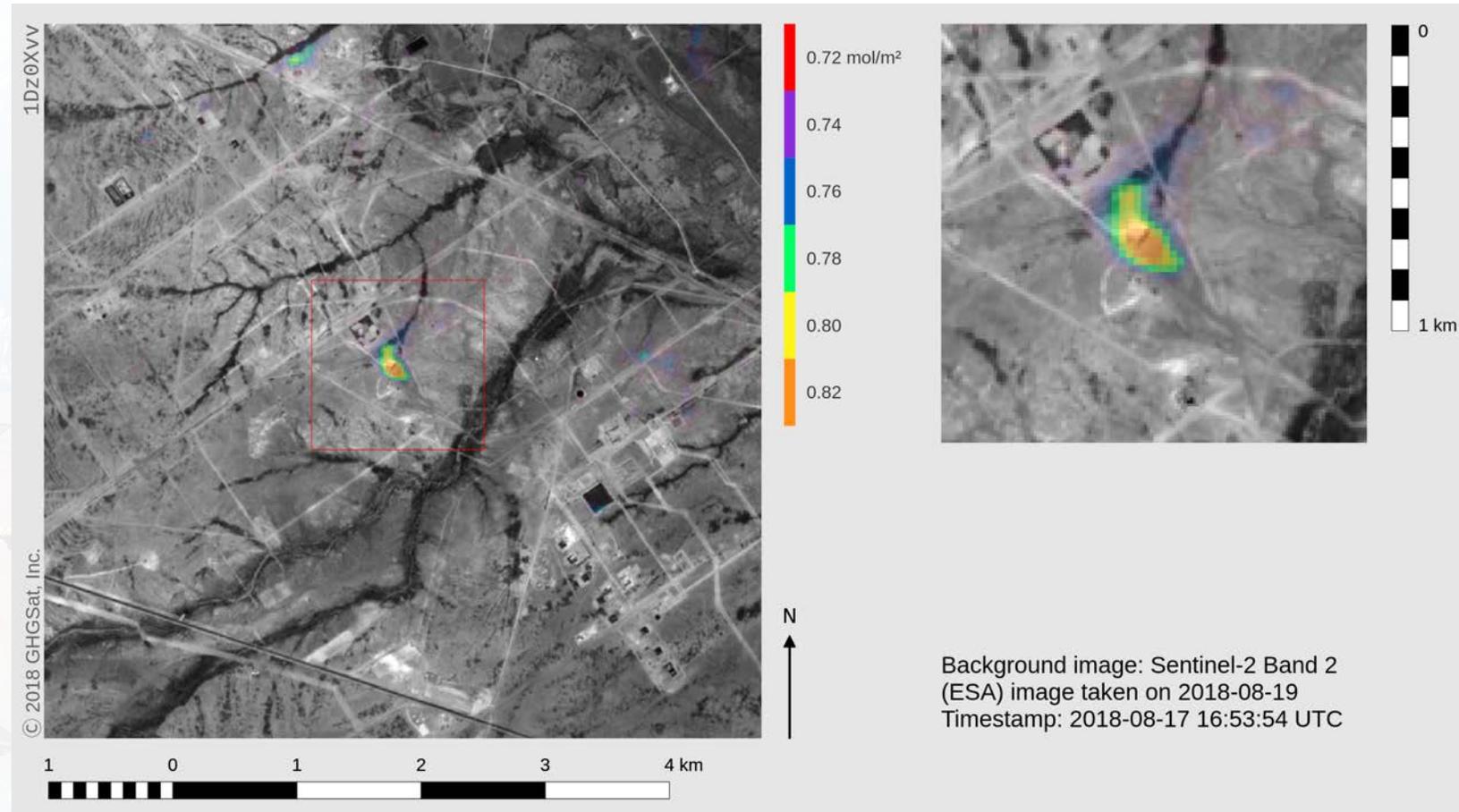
- Rapidly growing Oil & Gas production basin

- Interpretation complicated due to aerosol & surface albedo dependences

ΔX_{CH_4} : TROPOMI Data
$R\_aerosol = 0.294$ | $R\_albedo = 0.822$

Synergies TROPOMI - GHGSat

- Pixel size: < 50x50m^2
- Target scene: 12x12km^2

Permian basin CH$_4$ leak detection

0.72 mol/m^2
0.74
0.76
0.78
0.80
0.82

© 2018 GHGSat, Inc.

1DzØXvv

N

1 0 1 2 3 4 km

0

1 km

Background image: Sentinel-2 Band 2
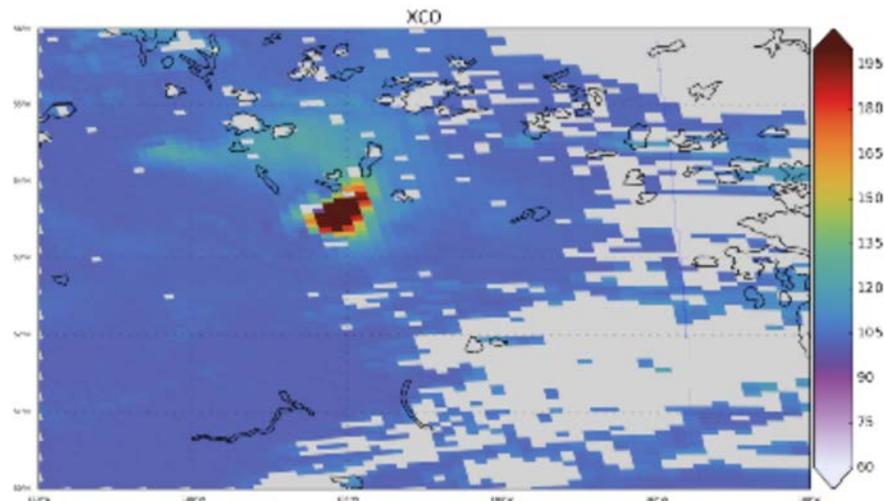(ESA) image taken on 2018-08-19
Timestamp: 2018-08-17 16:53:54 UTC

Emission quantification and the use of models

- Investigated using TROPOMI XCO:
- Biomass burning plumes and steel plants
- Plume shape (direction and intensity)
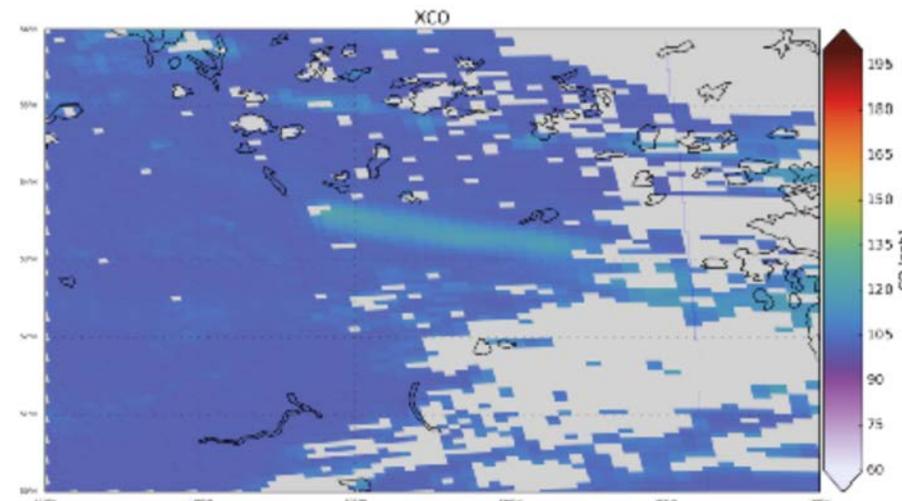 strongly dependent on effective emission height
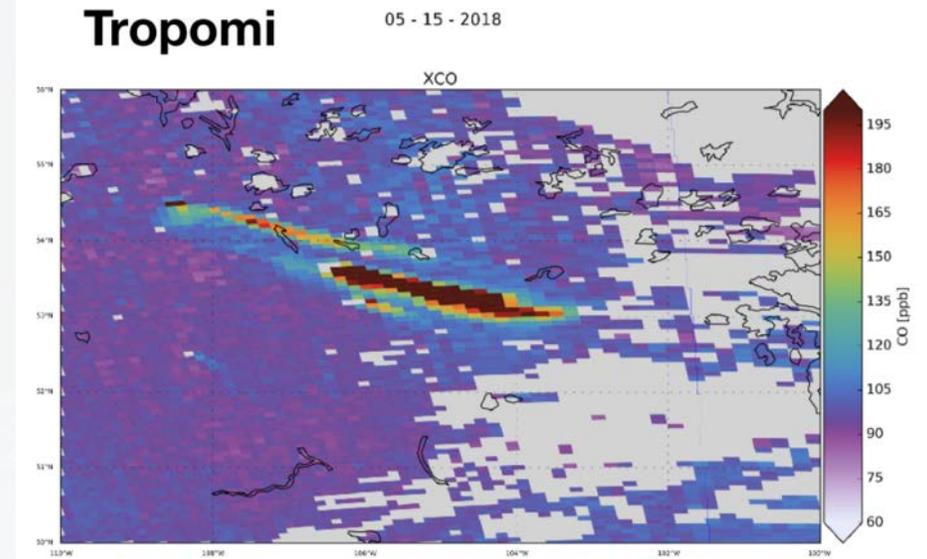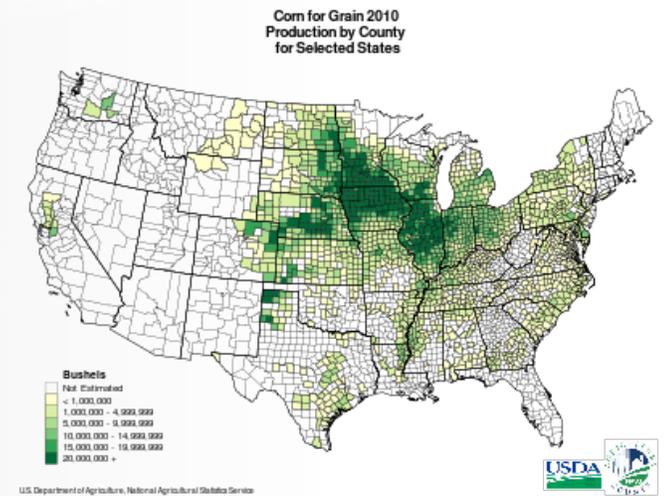

Ivar van der Velde (SRON)

Remaining issues / challenges

- Surface albedo dependence as f(AOD)
- Corrected in the operational data

Corn for Grain 2010
Production by County
for Selected States

TROPOMI XCH$_4$ (uncorrected)
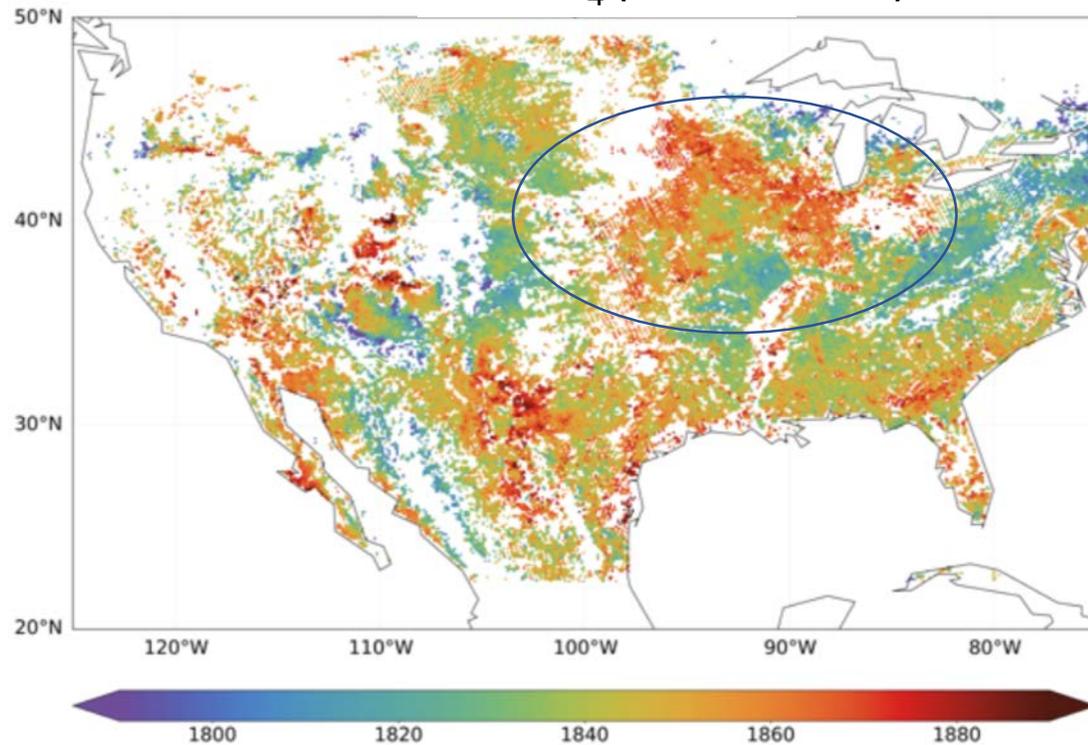
WRF simulated XCH$_4$
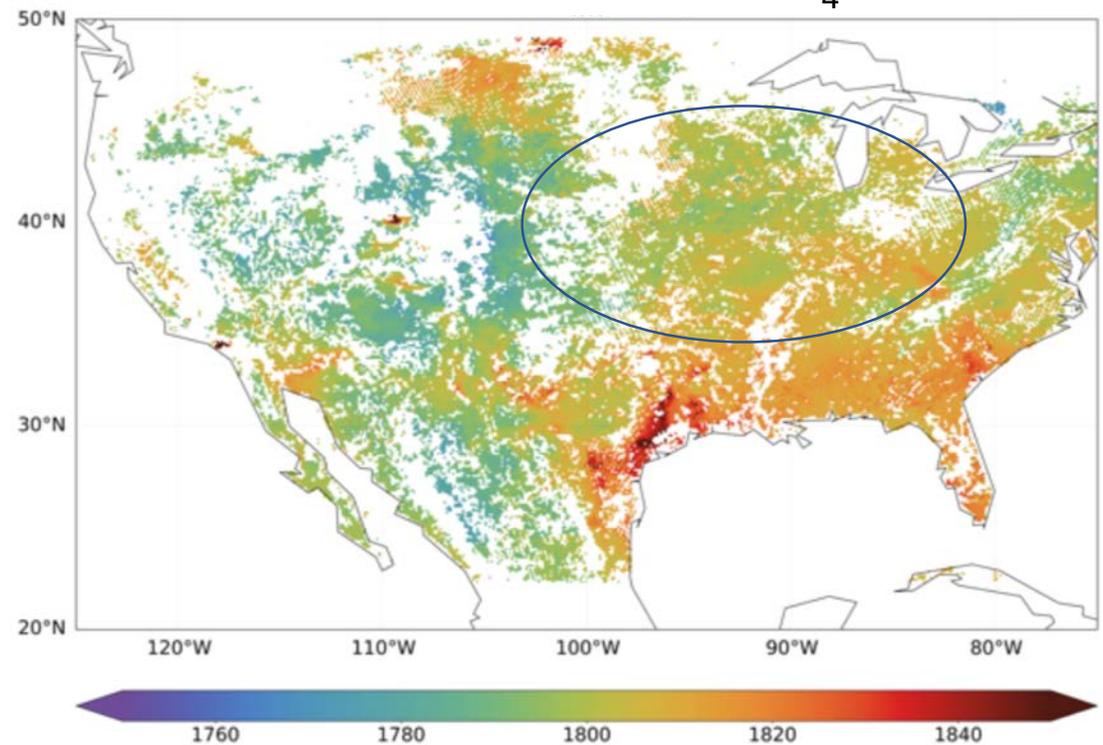
Summary
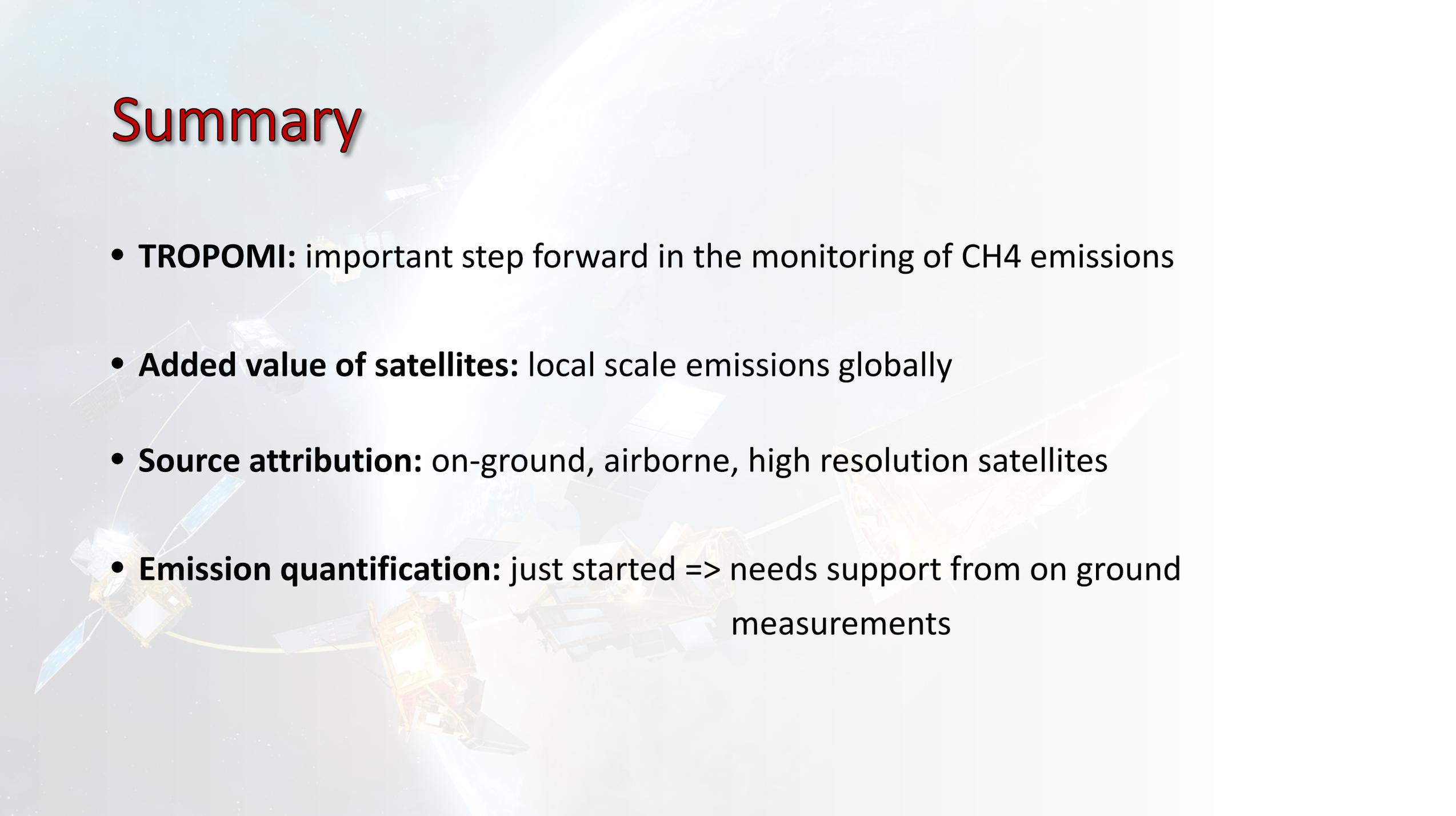
- **TROPOMI:** important step forward in the monitoring of CH4 emissions

- **Added value of satellites:** local scale emissions globally

- **Source attribution:** on-ground, airborne, high resolution satellites

- **Emission quantification:** just started => needs support from on ground
measurements