Sentinel-5 Precursor Mission Status and Results on Methane measurements

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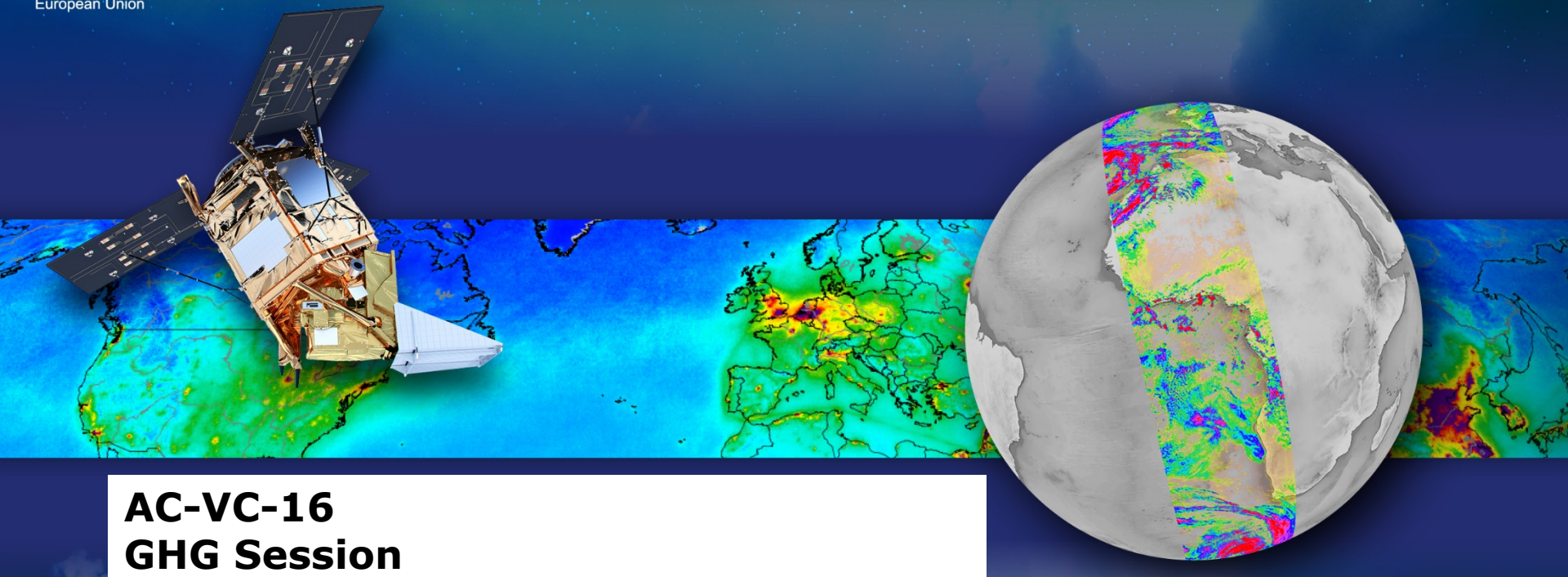

AC-VC-16
GHG Session
C. Zehner – ESA/S5p Mission Manager

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Sentinel-5 Precursor: first atmospheric Sentinel Mission

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- **Launched**: 13 October 2017, Plesetks
- **Launcher**: Rockot
- **Main Payload**: TROPOMI (co-funded by The Netherlands and ESA) - Hyper-spectral push-broom imaging spectrometer, 4 spectrometers with 2D detectors with 4000 spectral channels
- **Orbit**: Altitude of 820 km, 227 orbit repeat cycle
- **Daily Global Coverage:** 13:30 ascending node crossing time
- **Spatial Sampling:** in nadir 5.5 x 3.5 km, 24 million ground pixels per day
- **Mission Control**: ESOC
- **TROPOMI Mission Planning:** KNMI
- **Ground Stations**: Svalbard (NOR) and Inuvik (Canada)
- **Operational Data Processing**: DLR (on behalf of ESA)
- **Mission Design Life Time**: ~7 years
- **Mission Objective:** provide measurements for Ozone, Air Quality, and Climate Monitoring and Forecasting

Loose Formation flying of Sentinel-5P with Suomi-NPP

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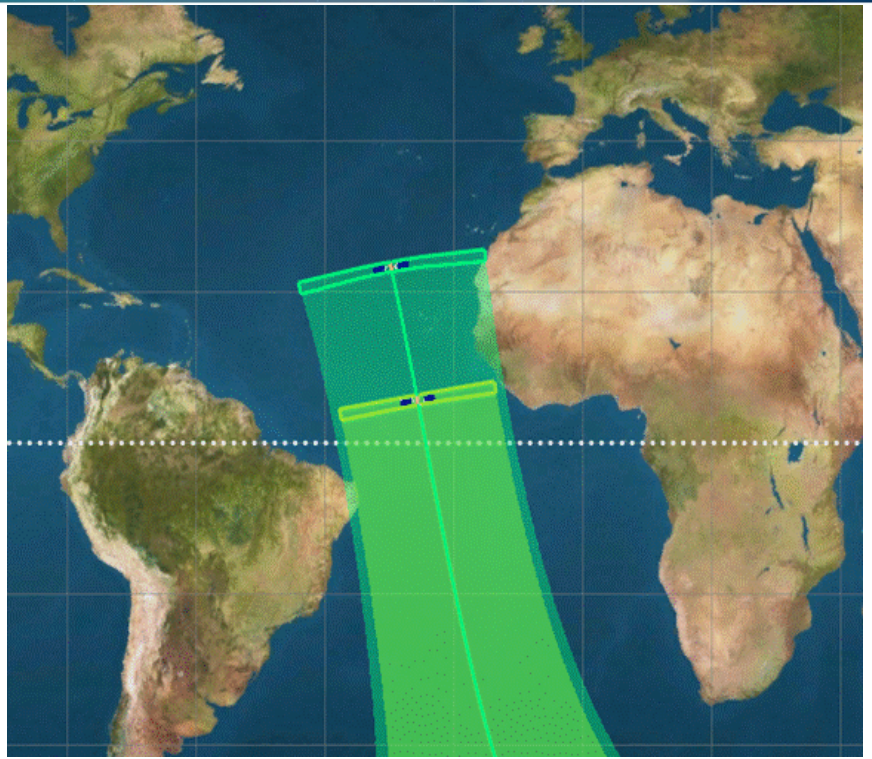
- improved Sentinel-5P/TROPOMI Methane retrieval
- intercomparison/validation of the products from both satellites
- future synergistic data exploitation



Open Data Access/CH4 Product Information

Access via the pre-operational Data Hub:

- **https://s5phub.copernicus.eu**
- **Login credentials are: s5pguest/s5pguest**

Product Uncertainty Requirements: Bias 1.5% - Random: 1%

Product Information:

https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-5p/products-algorithms

Validation Results: http://mpc-l2.tropomi.eu/#ch4

https://nikal.eventsair.com/QuickEventWebsitePortal/sentinel-5-precursor-workshop-2019/sentinel-5p

Validation: TROPOMI vs GOSAT proxy

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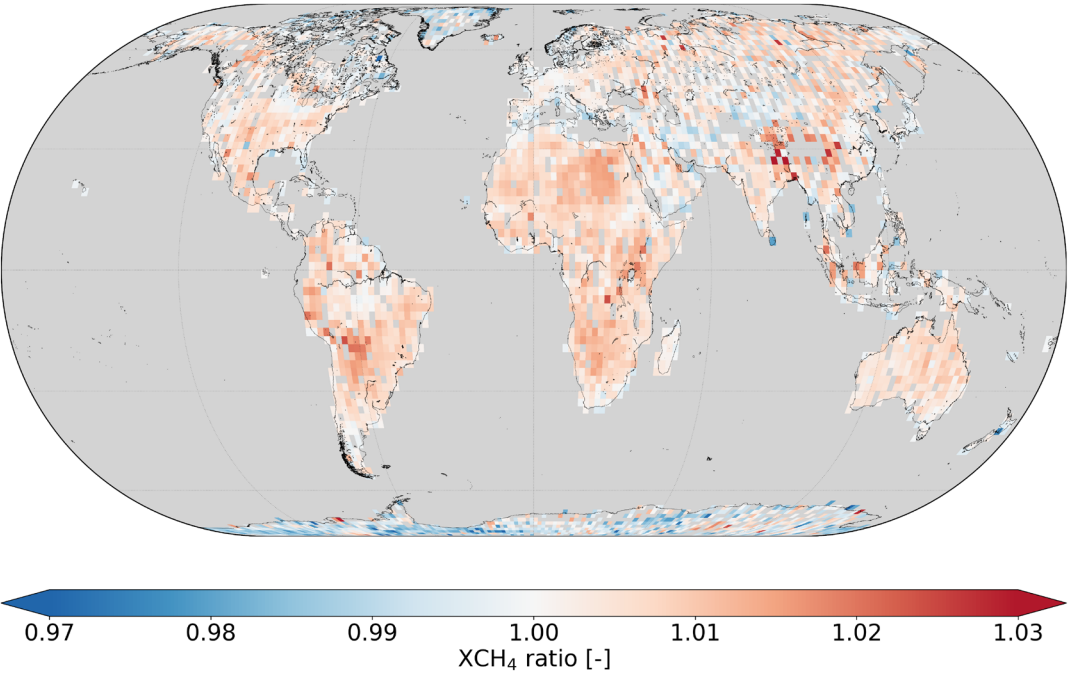
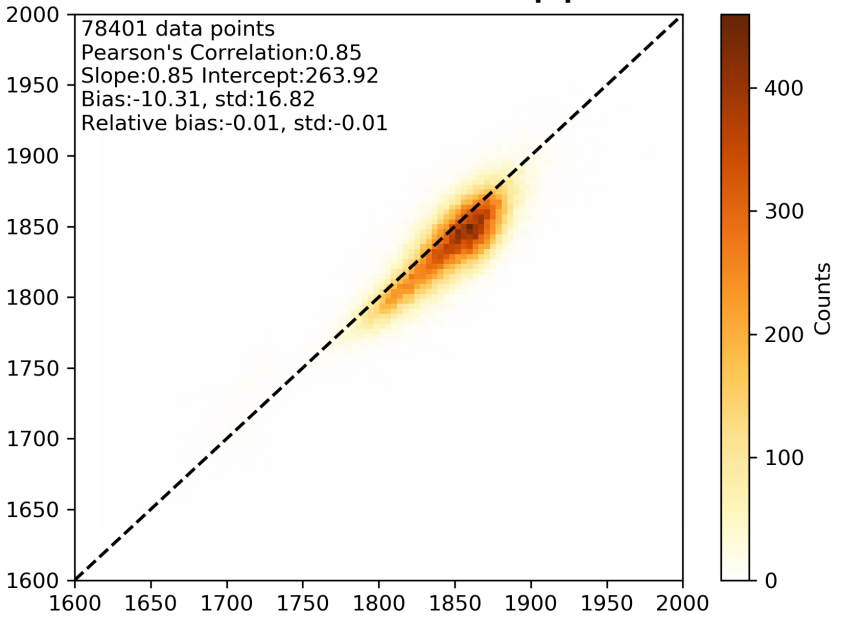
GOSAT / TROPOMI



Bias: -10 ± 16 ppb



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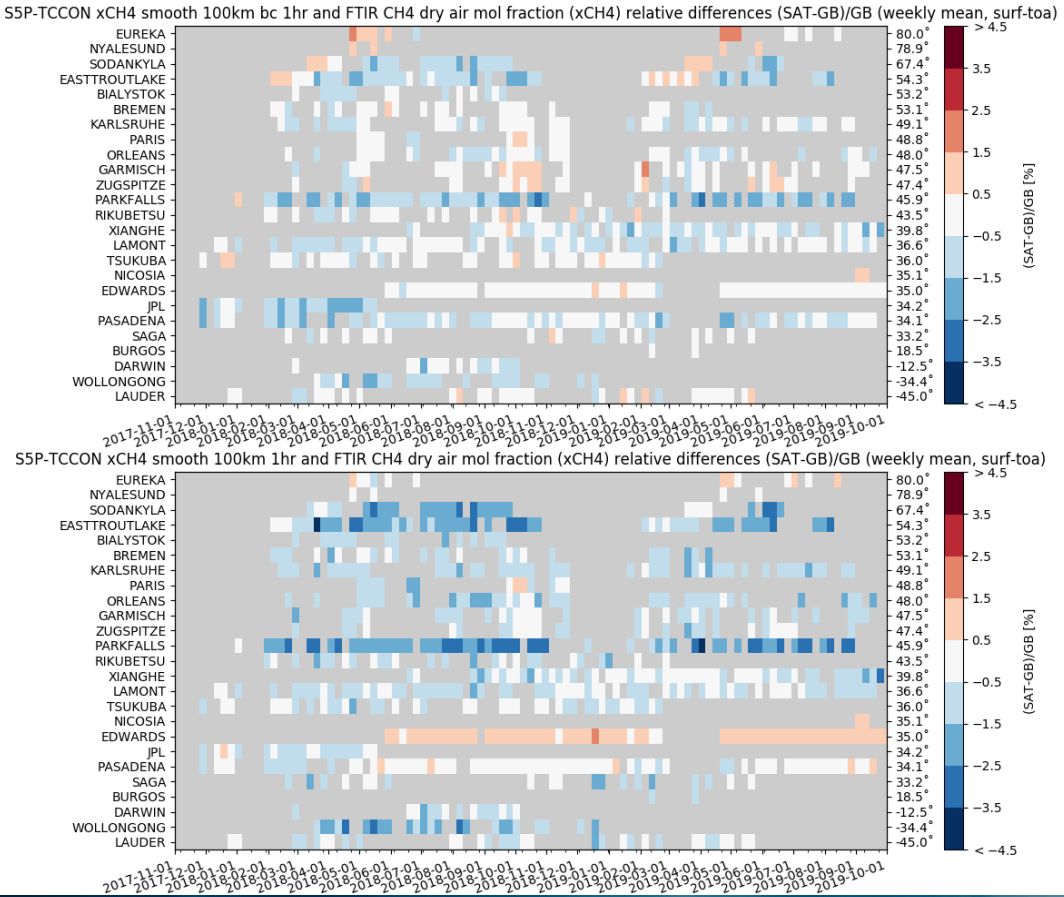
Validation Results (the product includes the bias corrected and bias uncorrected total column)



BIRA/IASB

Bias corrected S5P-XCH4

Bias corrected S5P XCH4 data show better match improved overall bias relative to TCCON

Standard S5P-XCH4

S5P standard CH4 product validation using TCCON – BIRA/IASB

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Site	#	Std	Correlation	Rel diff bias (%)	Rel diff std (%)	Lat
EUREKA	1384	0.8	0.79	0.22	0.67	80.0
NYALESUND	113	1.0	0.95	-0.23	0.17	78.9
SODANKYLA	3814	0.8	0.25	-1.57	1.01	67.4
EASTTROUTLAKE	8571	0.8	0.51	-1.76	0.96	54.3
BIALYSTOK	1821	0.8	0.37	-0.99	0.57	53.2
BREMEN	997	1.1	0.60	-0.67	0.51	53.1
KARLSRUHE	2742	0.7	0.68	-1.14	0.49	49.1
PARIS	1717	0.4	0.57	-0.61	0.76	48.8
ORLEANS	3689	0.6	0.62	-1.10	0.60	48.0
GARMISCH	1726	0.7	0.68	-0.62	0.47	47.5
ZUGSPITZE	344	1.2	0.48	-0.59	0.70	47.4
PARKFALLS	4643	0.6	0.56	-2.30	0.77	45.9
RIKUBETSU	1631	0.7	0.78	-0.73	0.60	43.5
XIANGHE	2686	1.3	0.81	-0.55	0.68	39.8
LAMONT	5816	1.0	0.77	-0.69	0.49	36.6
TSUKUBA	3523	1.0	0.85	-0.49	0.43	36.0
NICOSIA	155	1.2	0.28	1.31	0.45	35.1
EDWARDS	14894	0.9	0.83	0.94	0.43	35.0
JPL	3233	1.0	0.40	-0.54	0.65	34.2
PASADENA	13501	0.8	0.66	0.04	0.61	34.1
SAGA	1645	0.8	0.43	-0.64	0.58	33.2
BURGOS	165	0.4	0.16	-1.14	0.26	18.5
DARWIN	2766	0.4	0.13	-0.53	0.76	-12.5
WOLLONGONG	1642	0.8	0.62	-1.57	0.65	-34.4
LAUDER	3551	0.9	0.72	-0.51	0.47	-45.0
Mean		0.8	0.58	-0.66	0.59	

S5P bias corrected CH4 product validation using TCCON – BIRA/IASB

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Site	#	Std	Correlation	Rel diff bias (%)	Rel diff std (%)	Lat
EUREKA	1384	1.0	0.62	0.80	0.77	80.0
NYALESUND	113	1.0	0.97	0.63	0.13	78.9
SODANKYLA	3814	0.8	0.25	-0.55	1.01	67.4
EASTTROUTLAKE	8571	0.8	0.51	-0.83	0.95	54.3
BIALYSTOK	1821	0.7	0.46	-0.46	0.56	53.2
BREMEN	997	1.0	0.62	-0.18	0.50	53.1
KARLSRUHE	2742	0.8	0.64	-0.41	0.48	49.1
PARIS	1717	0.6	0.64	0.05	0.48	48.8
ORLEANS	3689	0.8	0.58	-0.43	0.50	48.0
GARMISCH	1726	0.7	0.66	0.21	0.48	47.5
ZUGSPITZE	344	1.2	0.42	0.25	0.75	47.4
PARKFALLS	4643	0.6	0.63	-1.40	0.74	45.9
RIKUBETSU	1631	0.7	0.79	-0.09	0.60	43.5
XIANGHE	2686	1.0	0.86	-0.51	0.63	39.8
LAMONT	5771	0.9	0.72	-0.44	0.56	36.6
TSUKUBA	3523	0.9	0.84	-0.04	0.45	36.0
NICOSIA	155	1.1	0.45	0.72	0.42	35.1
EDWARDS	14894	0.8	0.83	-0.00	0.43	35.0
JPL	3233	1.1	0.33	-1.34	0.63	34.2
PASADENA	13501	0.8	0.70	-0.72	0.57	34.1
SAGA	1645	0.8	0.45	-0.03	0.55	33.2
BURGOS	165	0.5	0.16	-0.16	0.22	18.5
DARWIN	2766	0.4	-0.01	-0.33	0.76	-12.5
WOLLONGONG	1626	0.9	0.65	-0.91	0.60	-34.4
LAUDER	3551	0.8	0.73	0.02	0.47	-45.0
Mean		0.8	0.58	-0.25	0.57	

Sentinel-5P Methane - Uncertainty

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- **Validation of S-5P bias corrected methane product with TCCON and NDACC:**
  - TCCON – Mean bias of -0.25% ± 0.57% r= 0.58(25 stations; < 100 km, Δt=1h)
  - NDACC – Mean bias of 0.52% ± 1.25% r=0.47 (10 stations; < 100 km, Δt=3h)

    ➔ S-5P bias corrected xCH4 accuracy and precision compliant with mission requirement;

- **Validation of S-5P standard methane product with TCCON and NDACC:**
  - TCCON – Mean bias of -0.66% ± 0.59% r=0.58 (25 stations; < 100 km, Δt=1h)
  - NDACC – Mean bias of -0.24% ± 1.23% r=0.47 (10 stations; < 100 km, Δt=3h)

    ➔ S-5P standard methane accuracy and precision compliant with mission requirement;

- Mission requirements for xCH4: target bias (1.5%) **OK** random (1%) **OK**

Methane Emission Source Detection by Sentinel-5P/GHGSat

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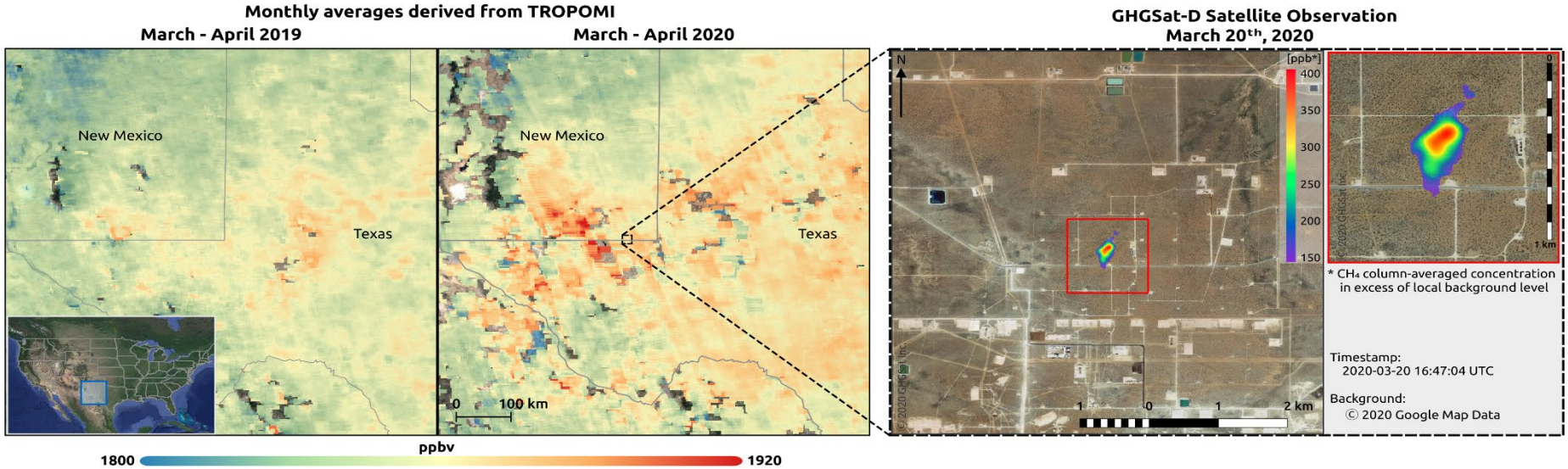

Methane Emission Source in the Permian Basin as measured by Sentinel-5P/TROPOMI and GHGSat

Open GHGSAT AO Call: earth.esa.int/aos – click on 'GHGSat'

http://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Detecting_methane_emissions_during_COVID-19

Sentinel-5 Precursor Methane Product Milestones

- 2019 Mar 01: **Release** of the Methane product to the public
- 2019 Mar 05: Successful Routine Operations Readiness Review (**RORR**) Meeting at ESRIN
- 2019 Aug 06: Successful change of TROPOMI operations to **smaller ground-pixel pixel size** (5.5. km a-long track instead of 7 km)
- 2019 Dec 11: **Improved time delivery** of the Methane Product as requested by CAMS (within about 2 days instead about 7 days) - implemented on Dec. 11
- 2020 Feb: Switch to **new VIIRS cloud data** input (impact analyses is still ongoing)
- 2020 autumn: planned release of the new Level 1 product and an **upgraded Methane product (improved bias correction using TROPOMI albedo information)**