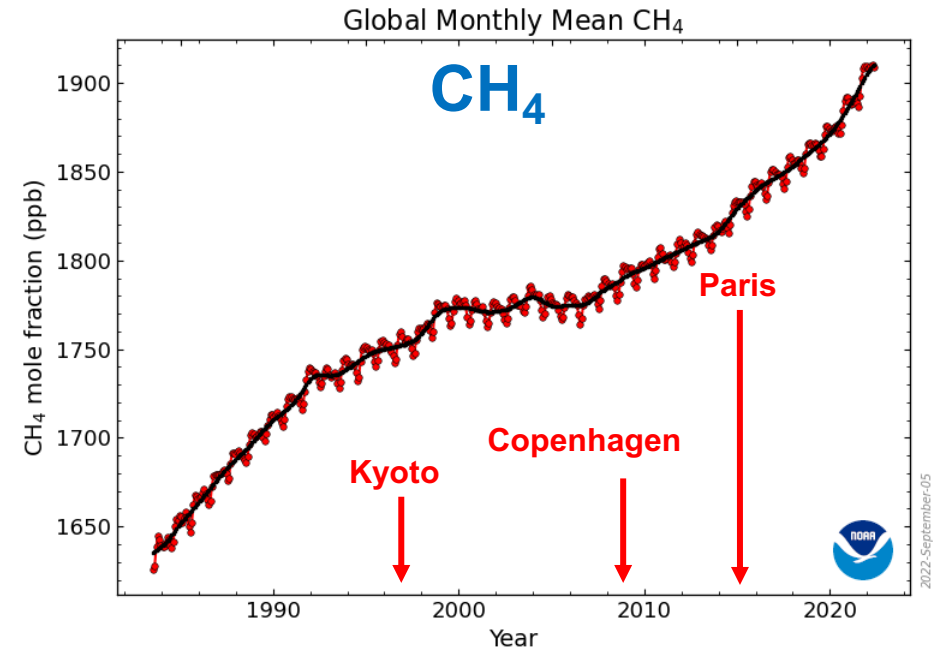
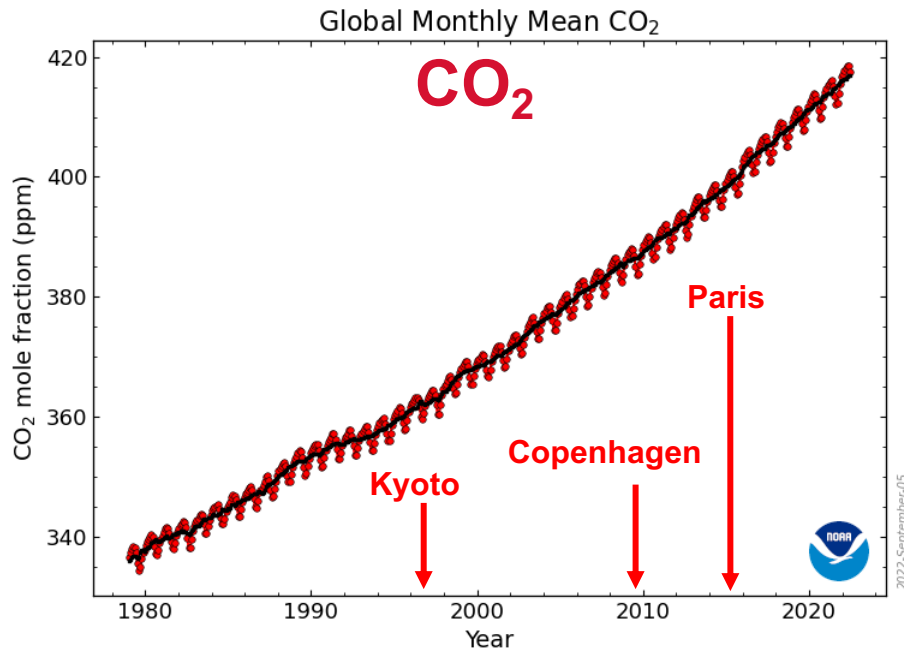




# Fernerkundungsmethoden zur Bestimmung anthropogener Treibhausgasemissionen

Prof. Hartmut Bösch

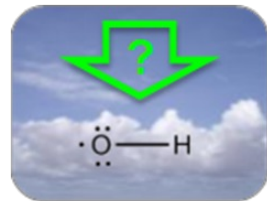
# Trotz Klimakonferenzen stetiger Anstieg von CO<sub>2</sub> und Methan



84 x  
Warming potential of  
CO<sub>2</sub>  
(over 20 years)

CO<sub>2</sub>: <https://gml.noaa.gov/ccgg/trends/>

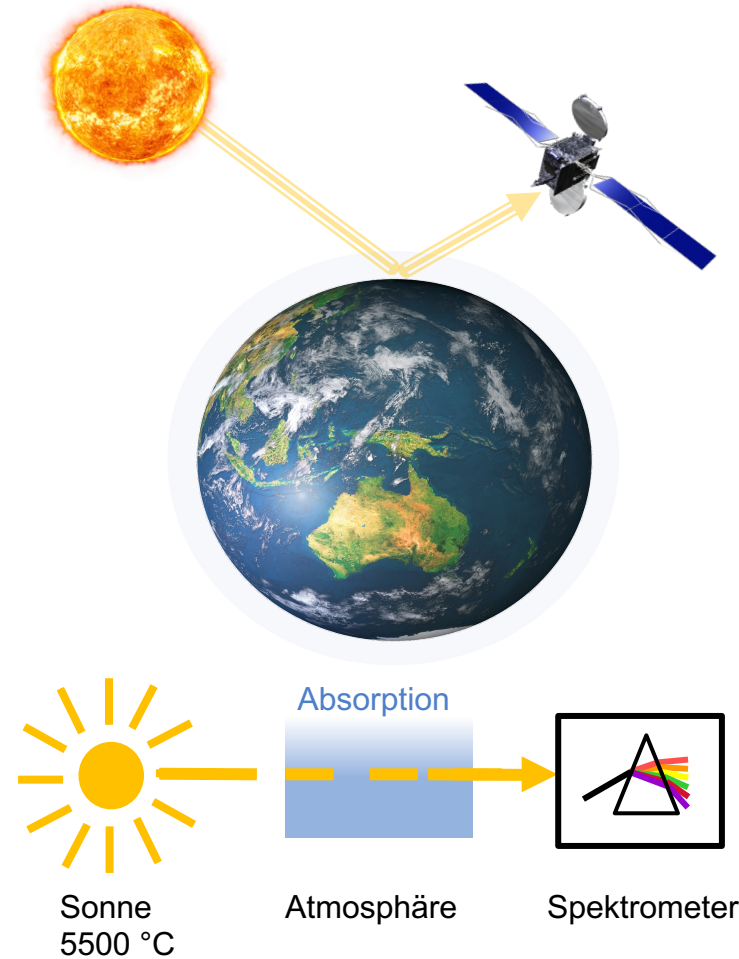
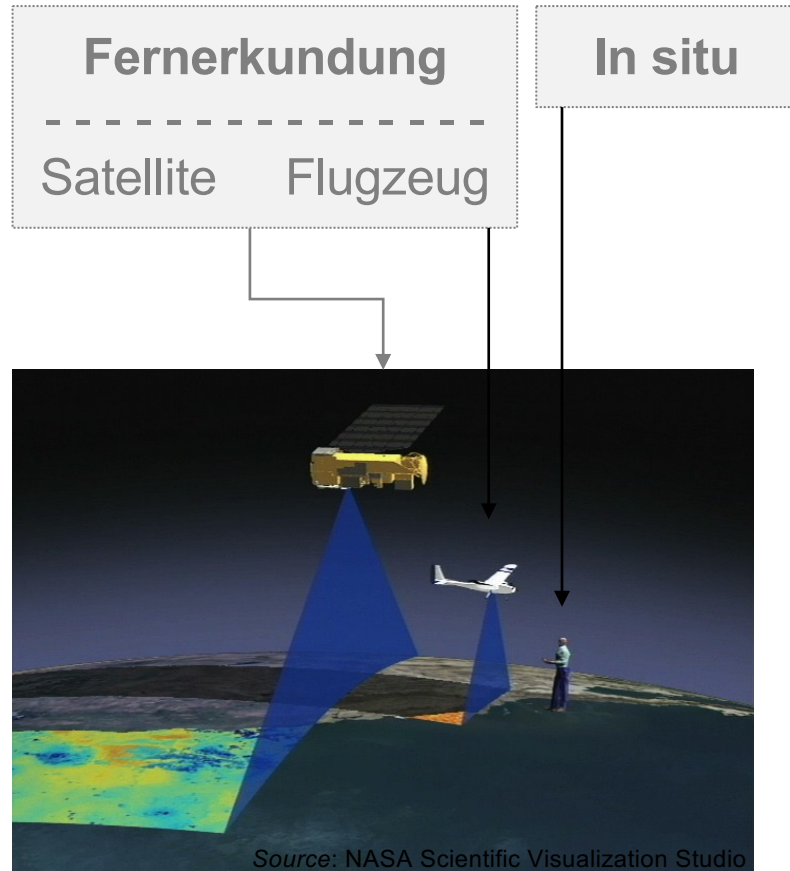
CH<sub>4</sub>: [https://gml.noaa.gov/ccgg/trends\\_ch4/](https://gml.noaa.gov/ccgg/trends_ch4/)



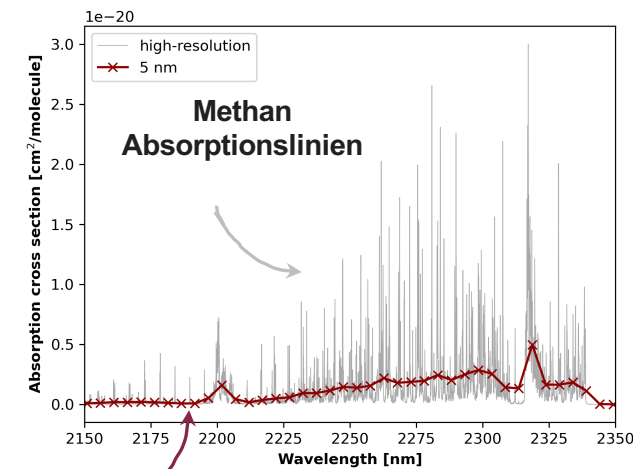
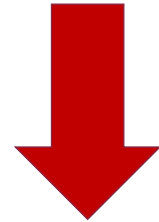
1 part per million CO<sub>2</sub> = 8 Giga Tonnen CO<sub>2</sub>  
 1 Tonne CO<sub>2</sub> = 500 m<sup>3</sup> Heissluftballon  
 = Aufnahme durch 50 Bäume pro Jahr

# Wie messen wir Methan?

„We can only manage, what we can measure“

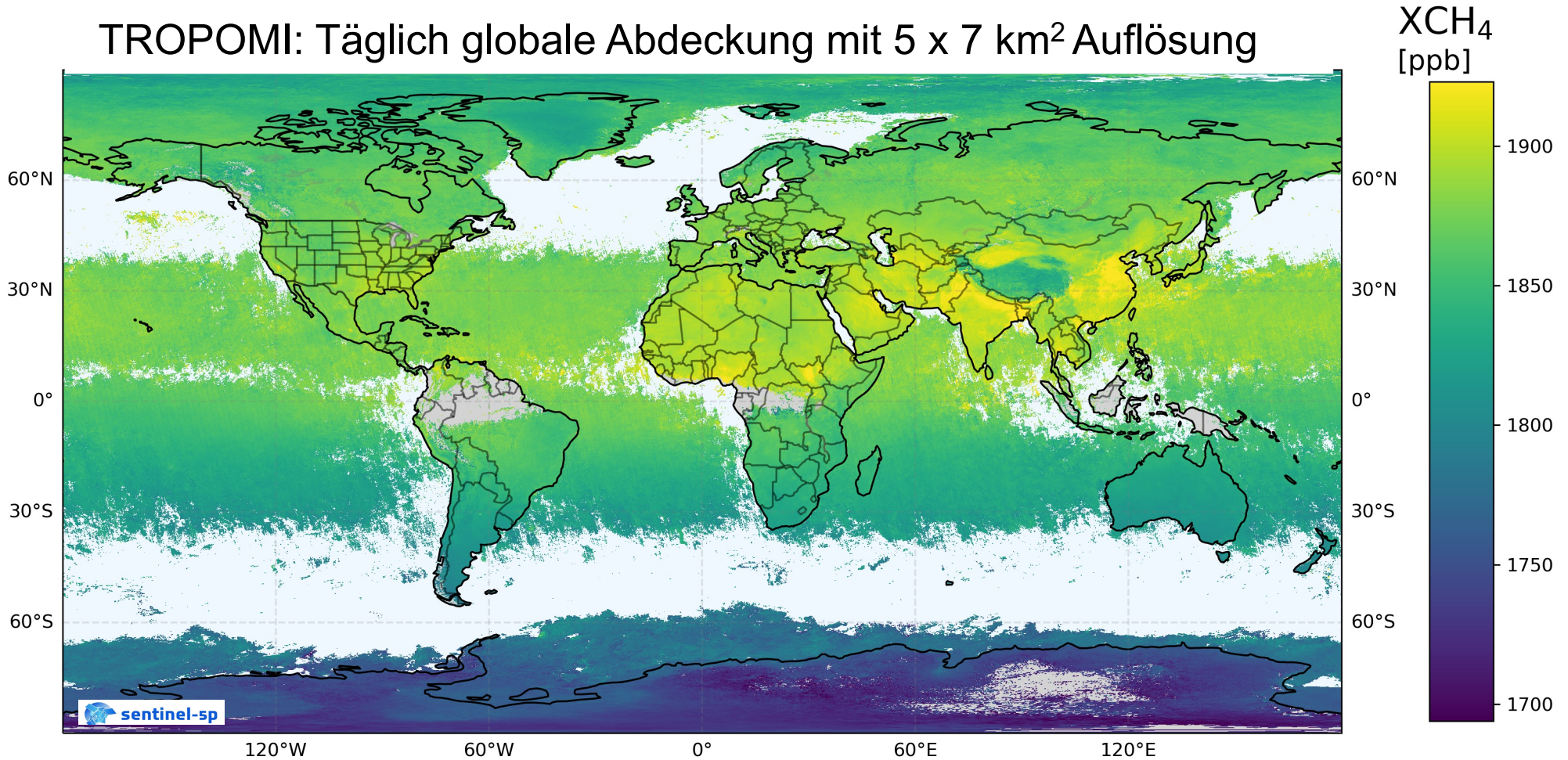


Jedes Gas hat  
typischen  
Fingerabdruck!

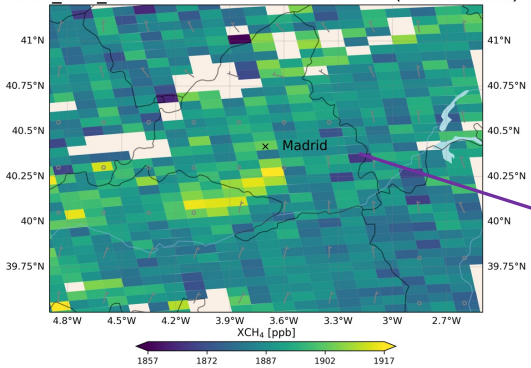


Wie ein Satellite  
es sieht

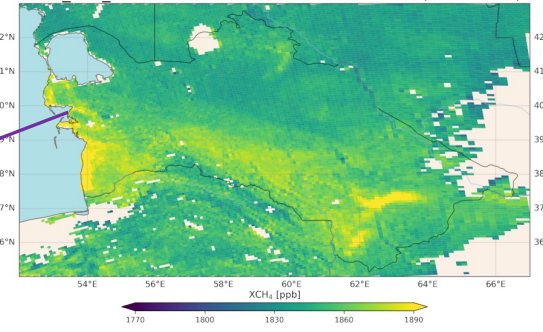
TROPOMI: Täglich globale Abdeckung mit 5 x 7 km<sup>2</sup> Auflösung



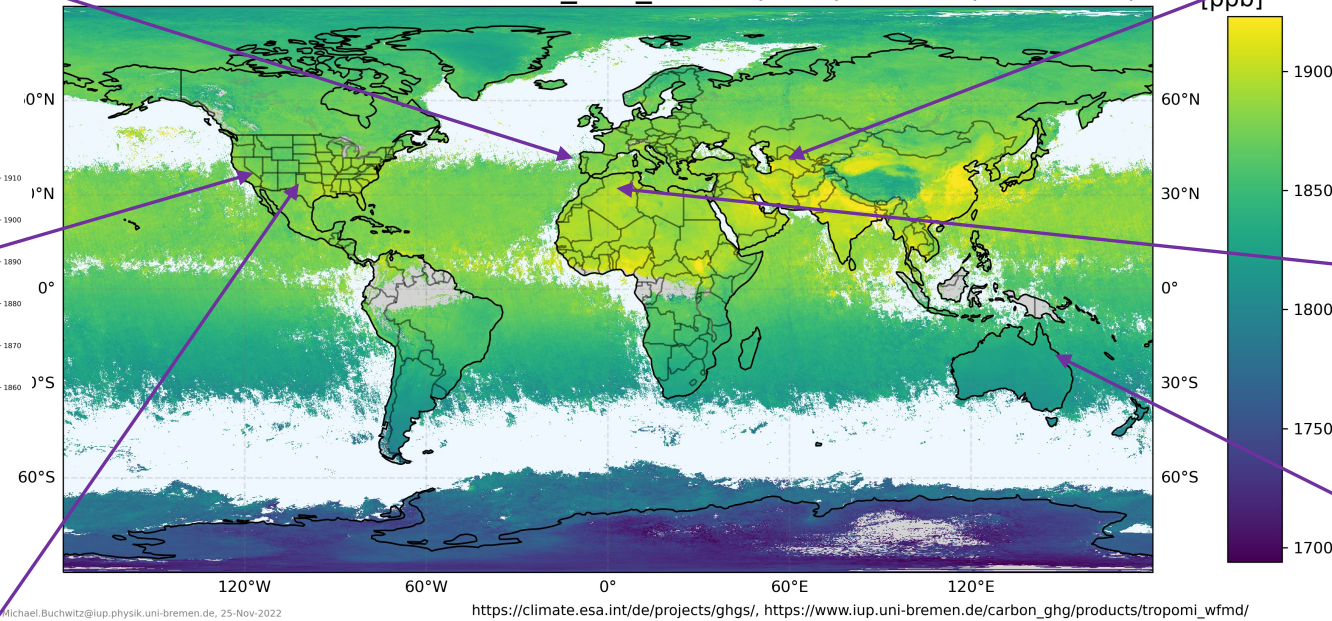
CH4 S5P\_WFMD v1.8 Madrid 20211008 (orbit:20659)



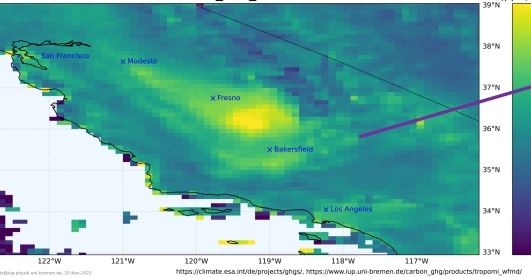
CH4 S5P\_WFMD v1.8 Turkmenistan 20180410 (orbit:2539)



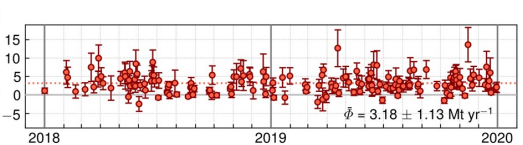
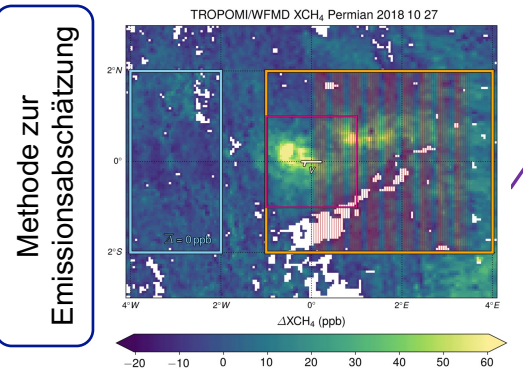
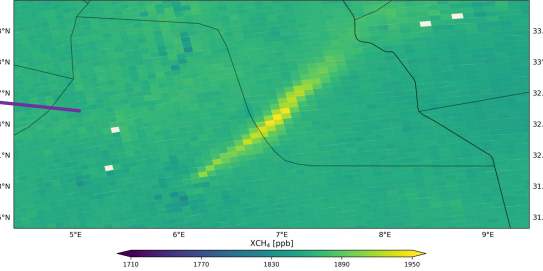
Methane - TROPOMI/S5P - CH4\_S5P\_WFMD(v1.8) - 2021 (0.1°x0.1°)



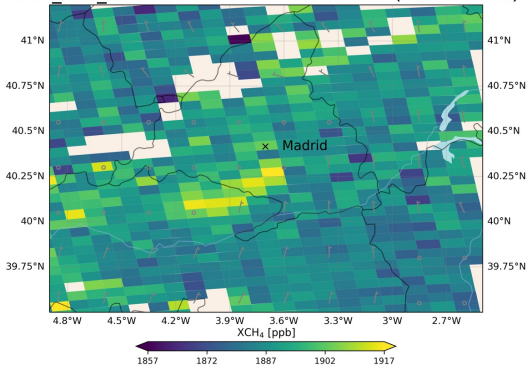
Methane - TROPOMI/S5P - CH4\_S5P\_WFMD(v1.8) - 2021 (0.1°x0.1°)



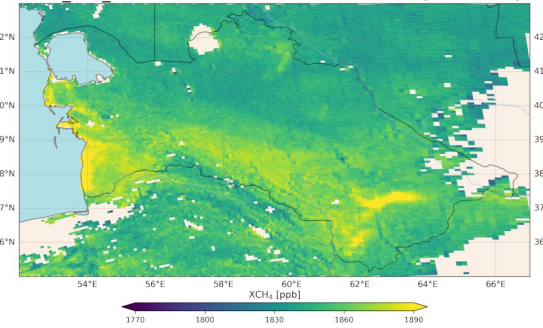
CH4 S5P\_WFMD v1.8 Algeria\_Hassi Messaoud 20200104 (orbit:11536)



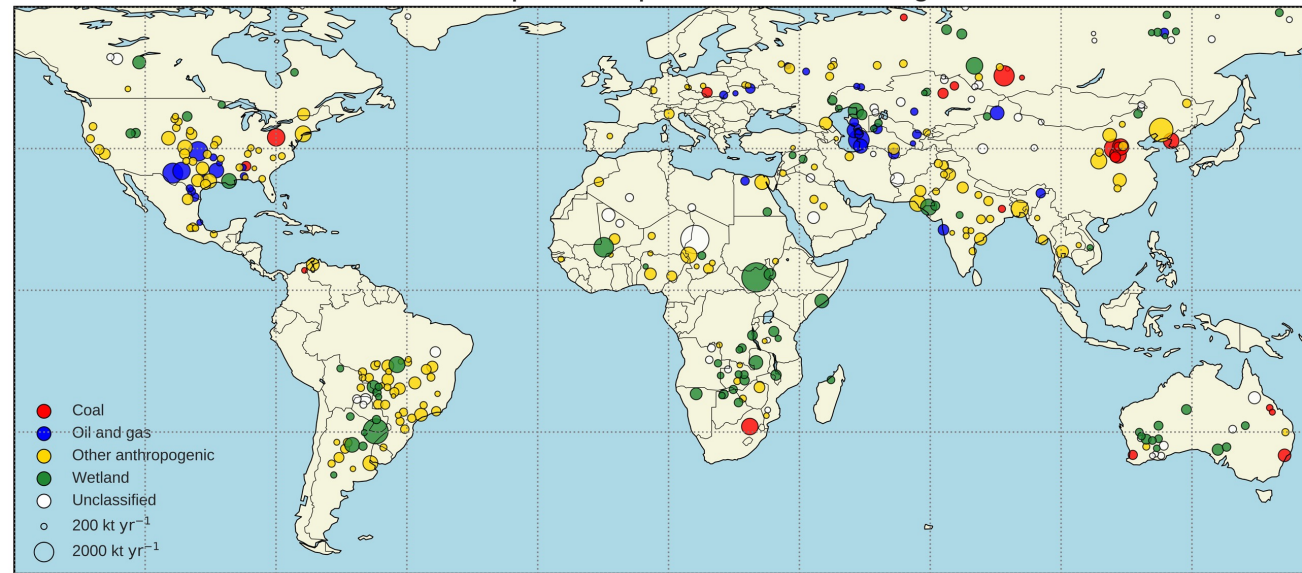
CH4 S5P\_WFMD v1.8 Madrid 20211008 (orbit:20659)



CH4 S5P\_WFMD v1.8 Turkmenistan 20180410 (orbit:2539)

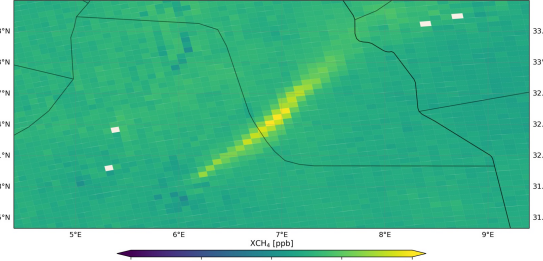


TROPOMI/WFMDv1.8 potential persistent source regions 2018-2021



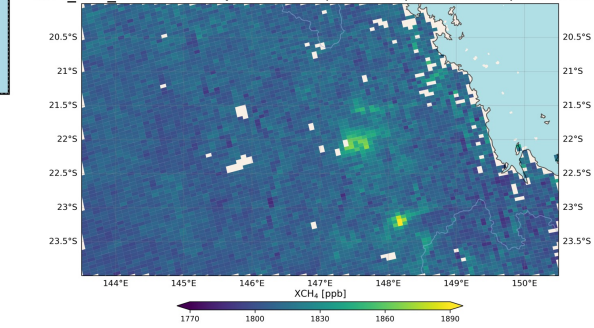
Michael Buchheit@iup.physik.uni-bremen.de, 2. Dec 2022

CH4 S5P\_WFMD v1.8 Algeria\_Hassi Messaoud 20200104 (orbit:11536)



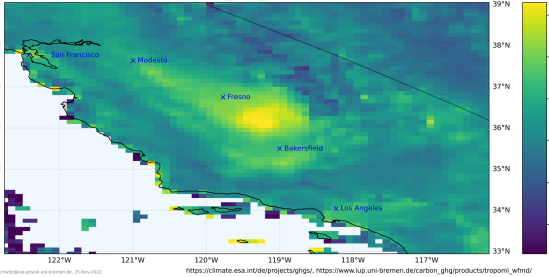
Michael Buchheit@iup.physik.uni-bremen.de, 26 Jan 2023

CH4 S5P\_WFMD v1.8 Queensland (Australia) 20190915 (orbit:9956)



Michael Buchheit@iup.physik.uni-bremen.de, 2. Mai 2023

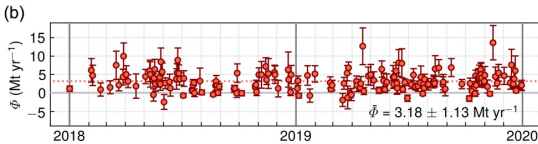
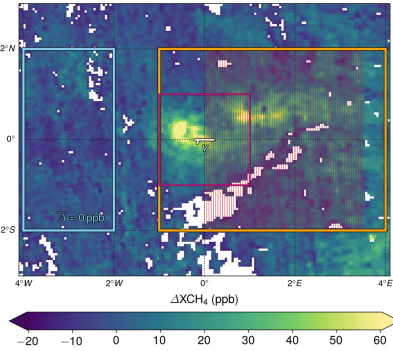
Methane - TROPOMI/S5P - CH4\_S5P\_WFMD(v1.8) - 2021 (0.1°x0.1°)



https://climate.esa.int/en/projects/ghgs/ https://www.iup.uni-bremen.de/carbon\_ghg/products/tropomi\_wfmd/

Methode zur  
Emissionsabschätzung

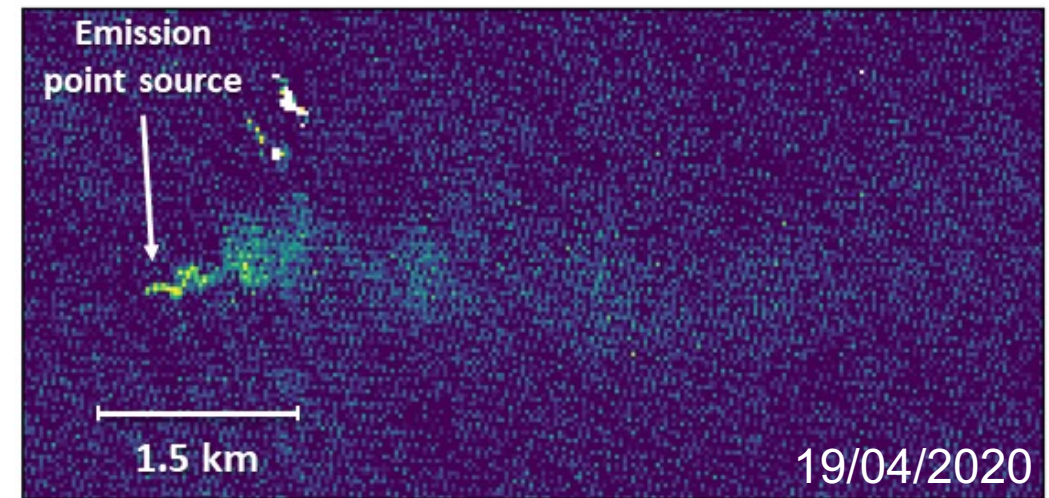
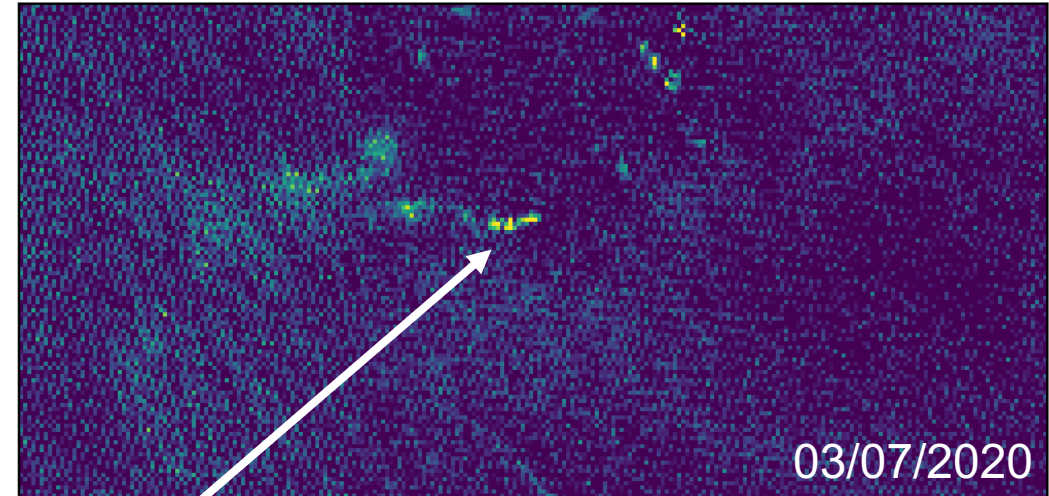
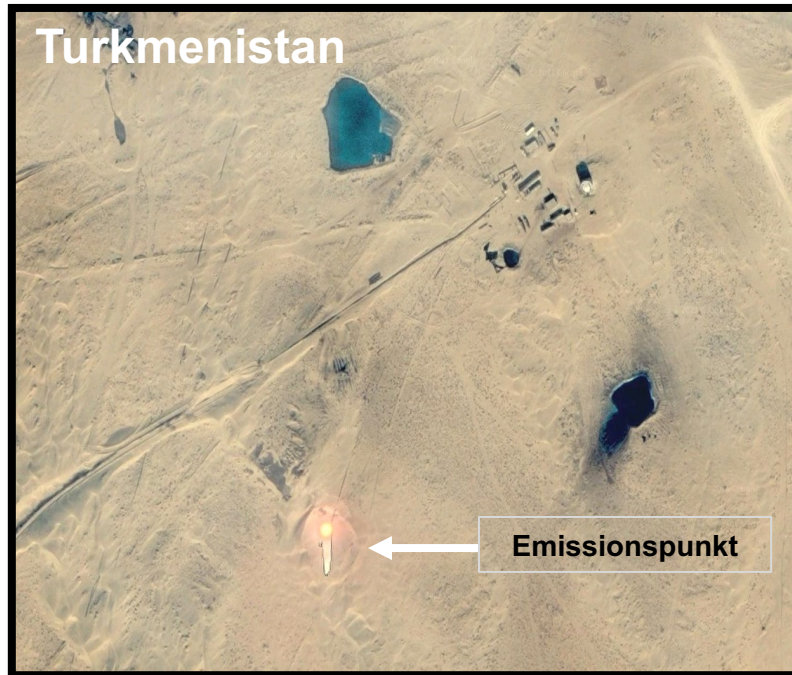
TROPOMI/WFMD XCH4 Permian 18 10 27



# Detail-Beobachtungen von Super-Emitter - Turkmenistan



Hyperspectral - **PRISMA**  
Bodenpixel: 30 x 30 m<sup>2</sup>  
Kontin. SWIR Bänder  
Spectral Aufl.: 12 nm



# Detail-Beobachtungen von Super-Emitter – Mittlerer Osten

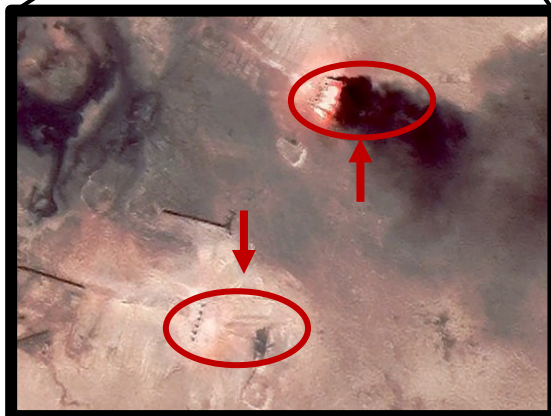
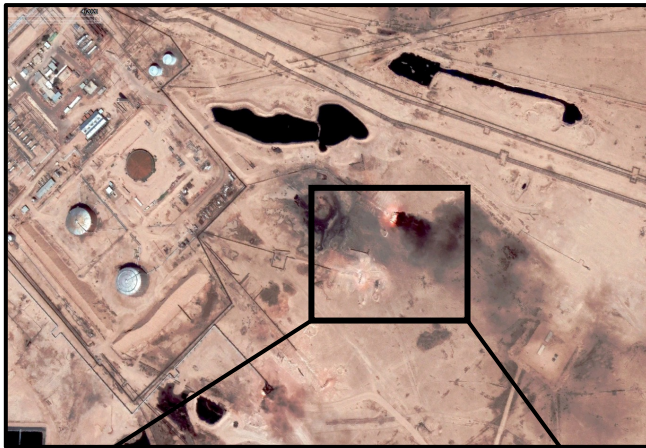


Multispectral – **Worldview-3**

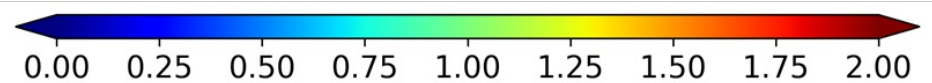
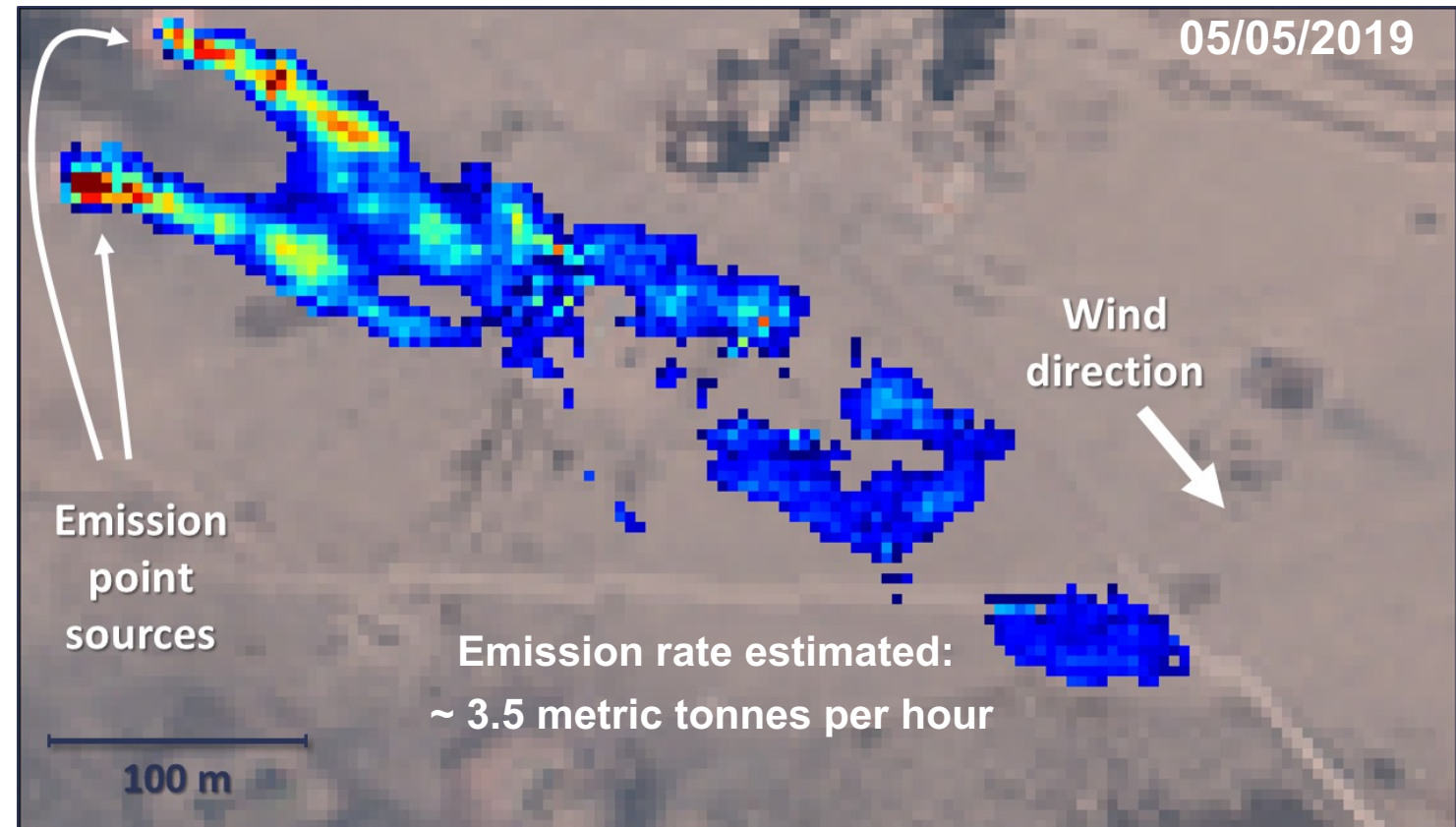
Bodenpixel: 4 x 4 m<sup>2</sup>

8 breite SWIR bänder

Spectral Aufl.: 30-70 nm



Google maps  
(04/2020)



Enhanced methane [parts per million]



- Methan ist ein sehr potentes Treibhausgas. Auf Grund seiner im Vergleich zu CO<sub>2</sub> hohen Klimawirkung und kurzen Lebensdauer ist es sehr zielführend, Methanemissionen in die Atmosphäre kurzfristig zu vermeiden (z.B. COP26 Methane Pledge).
- Satellitengestützte und Flugzeug Fernerkundung von Methan liefert wichtige Daten, um Methanemissionen besser zu verstehen und zu quantifizieren und schaffen die Grundlage für Überwachungssysteme
- Forschungsschwerpunkt am Institut für Umweltphysik der Universität Bremen:
  - Neuartiger Flugzeug CH<sub>4</sub> - Sensor: z.B. im Rahmen des Umweltprogramms der Vereinten Nationen (UNEP)
  - Satellit: Copernicus CO2M Mission (CO<sub>2</sub>, CH<sub>4</sub>), OHB und IUP Missionskonzept BreKliMon für eine Konstellation von Kleinsatelliten (gefördert von Bremer Aufbau-Bank)
  - Integriertes Treibhausgas Monitoring System für Deutschland (BMBF)