



Royal Netherlands  
Meteorological Institute  
*Ministry of Infrastructure  
and Water Management*

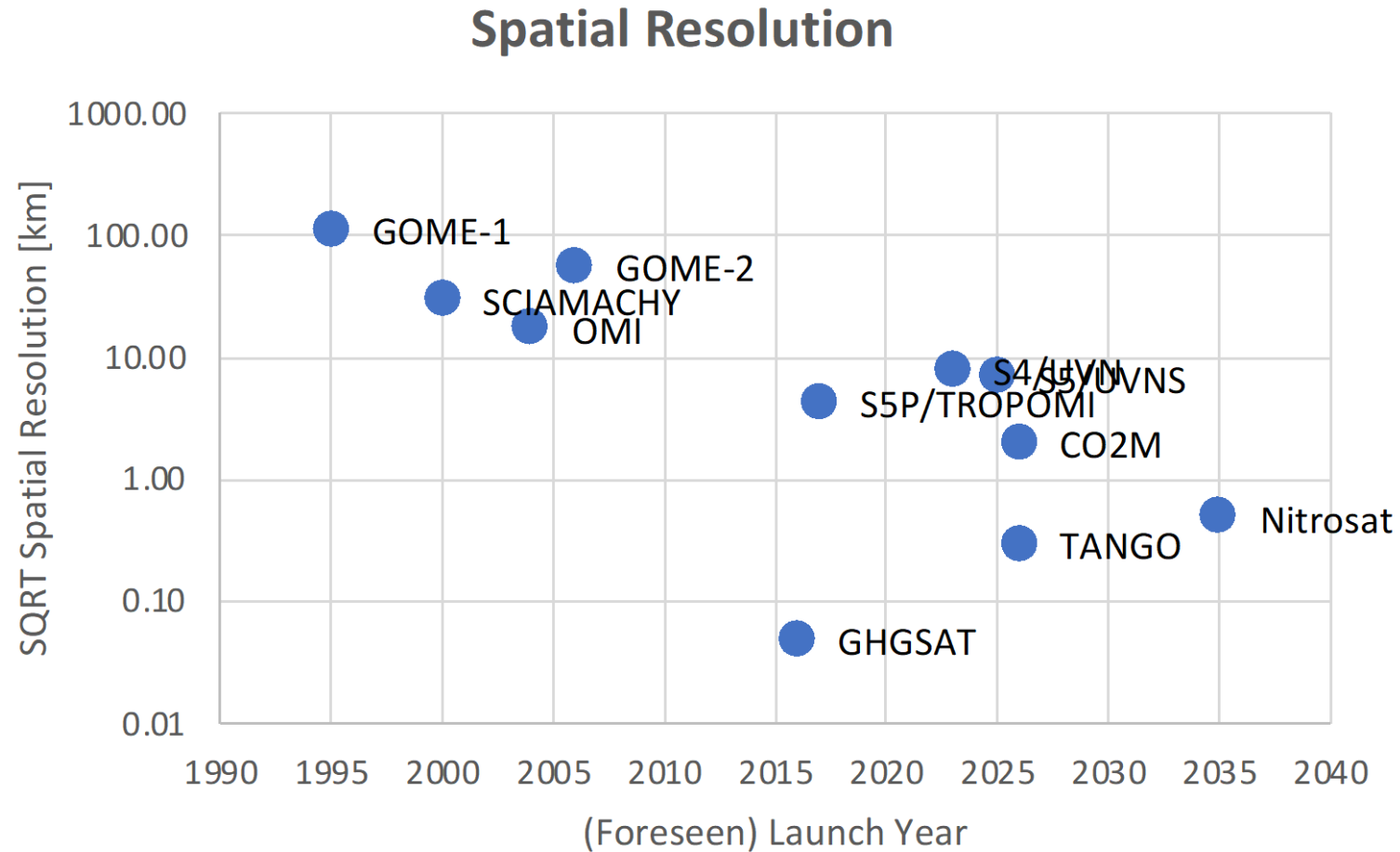
# High-Resolution Atmospheric Composition Observations from Space

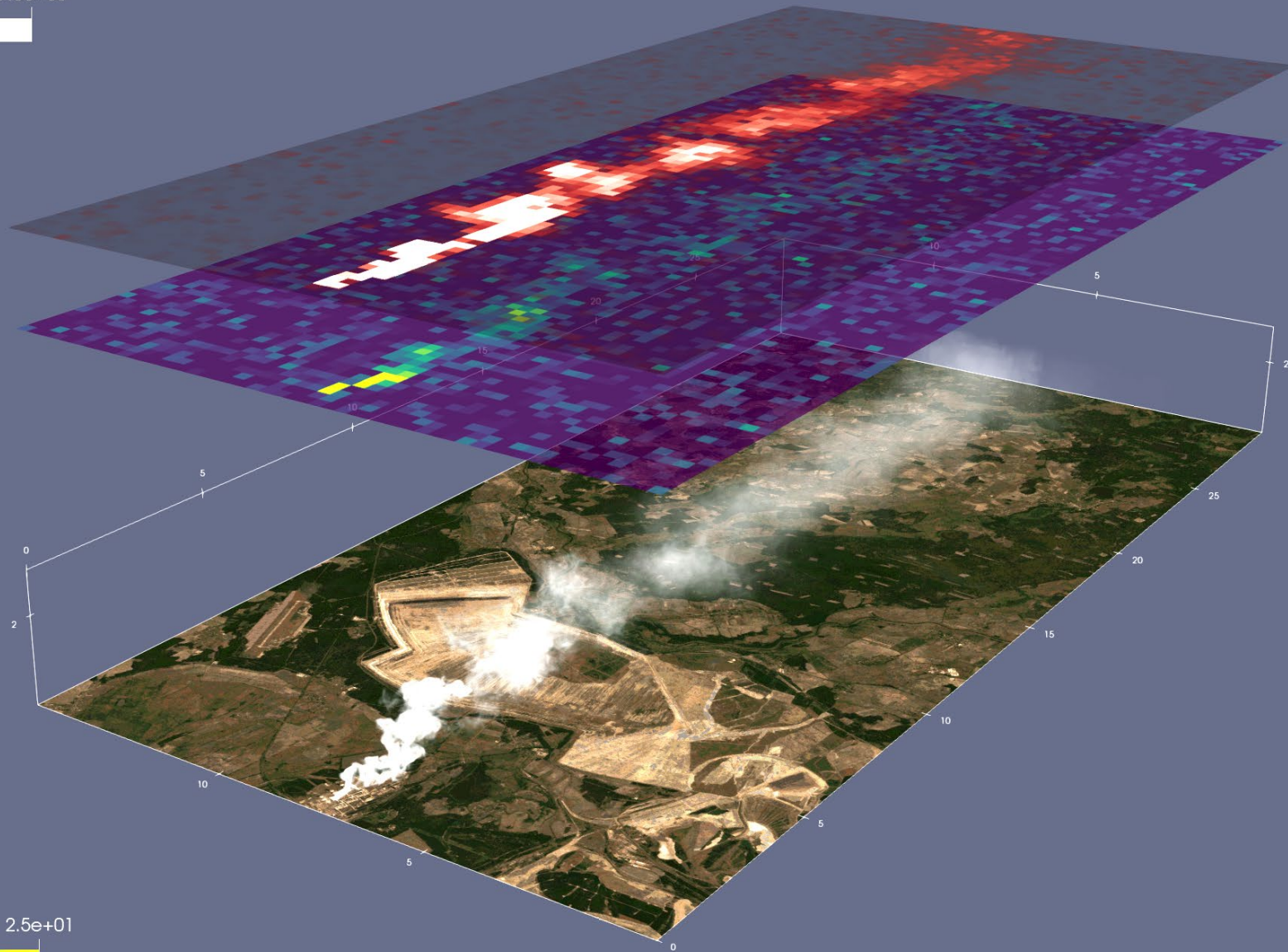
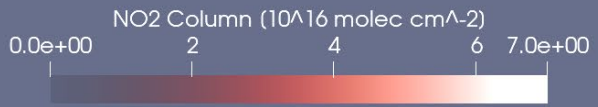
LPS 22, A1.03

Pepijn Veefkind KNMI/TU-Delft



# Atmospheric Composition Instruments

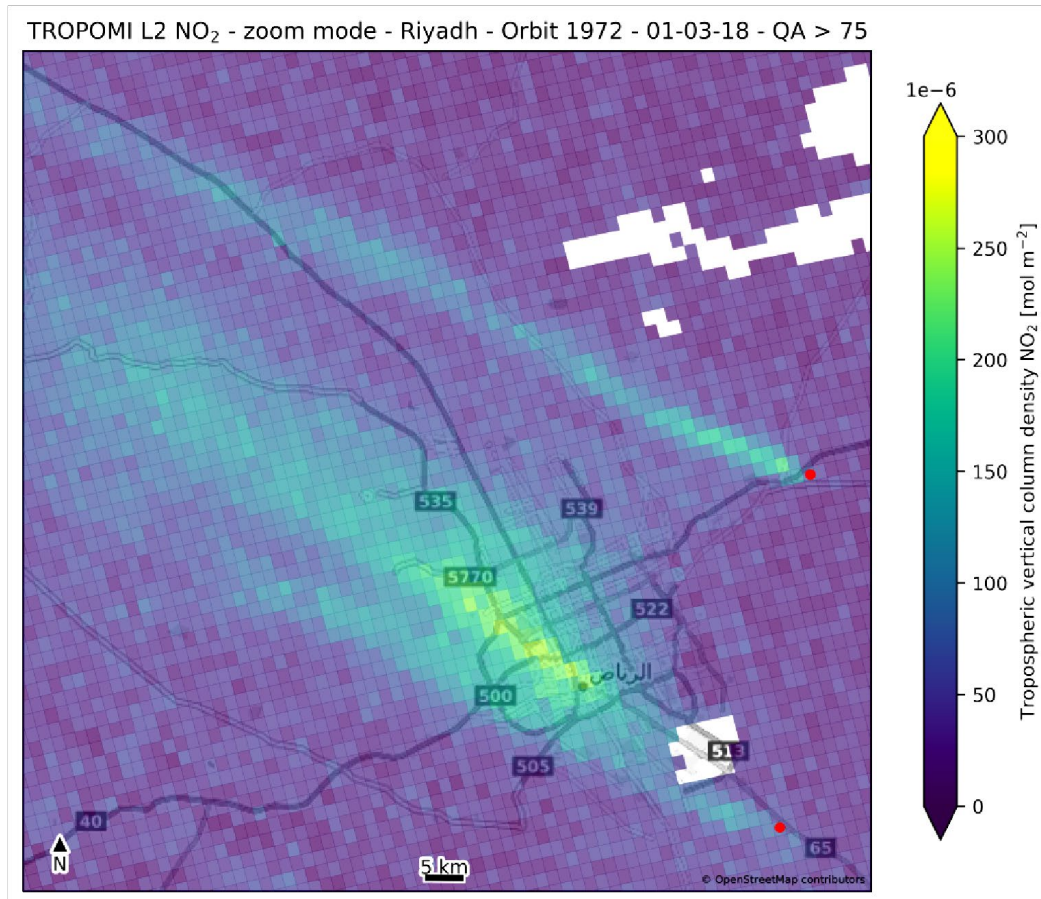








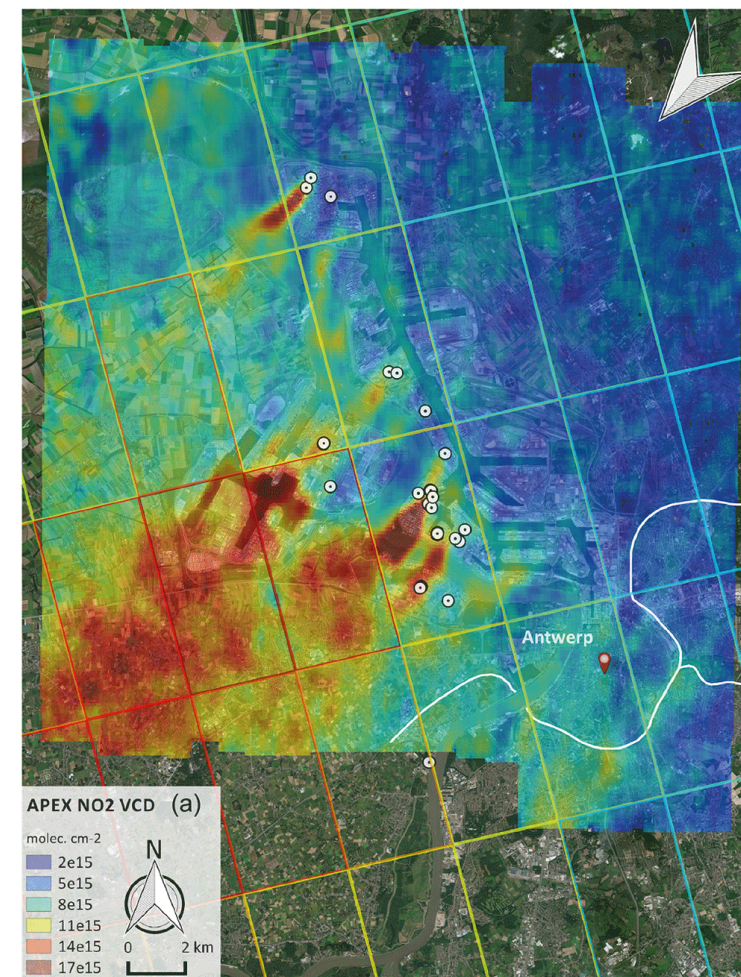
## Riyadh, Saudi Arabia



Leune, TU-Delft/KNMI

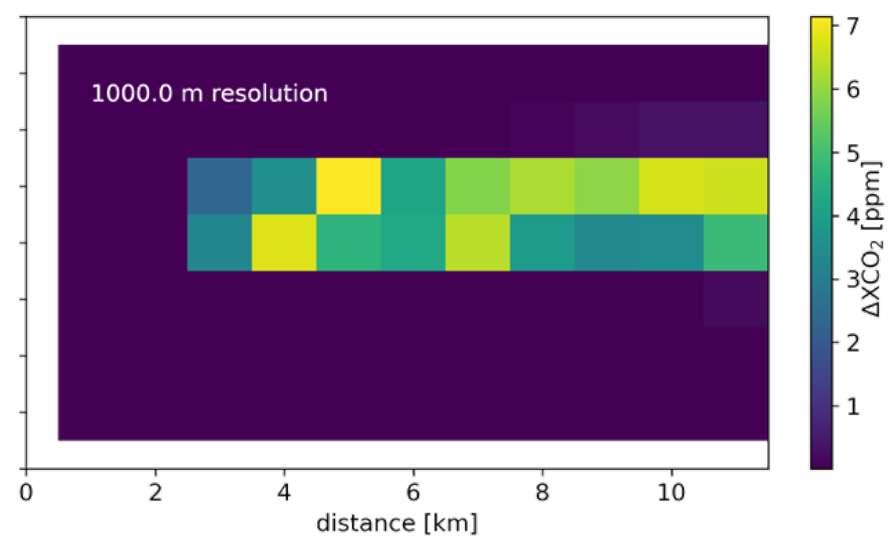
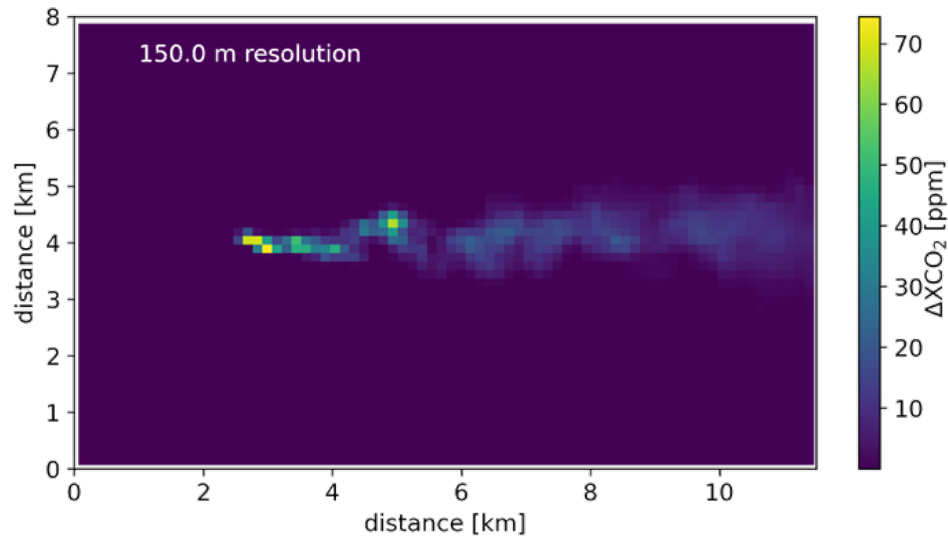
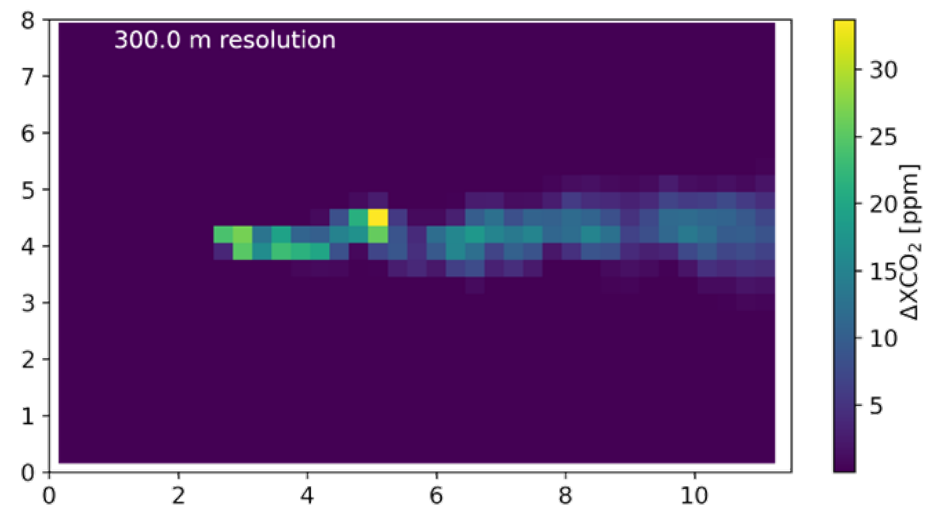
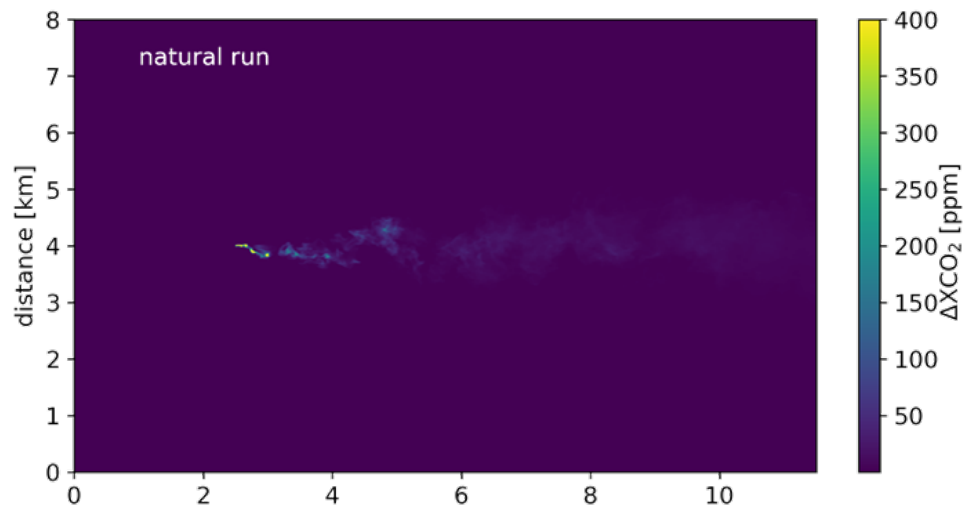
Royal Netherlands Meteorological Institute  
August 30, 2022

## Antwerp, Belgium



Tack et al, Atmos. Meas. Tech., 14, 615–646, 2021  
<https://doi.org/10.5194/amt-14-615-2021>

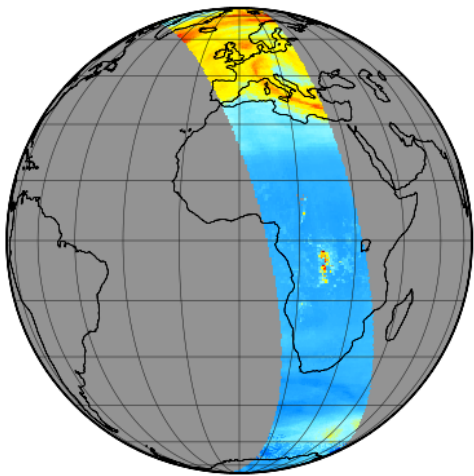
# CO<sub>2</sub> emission plume seen with different spatial resolutions





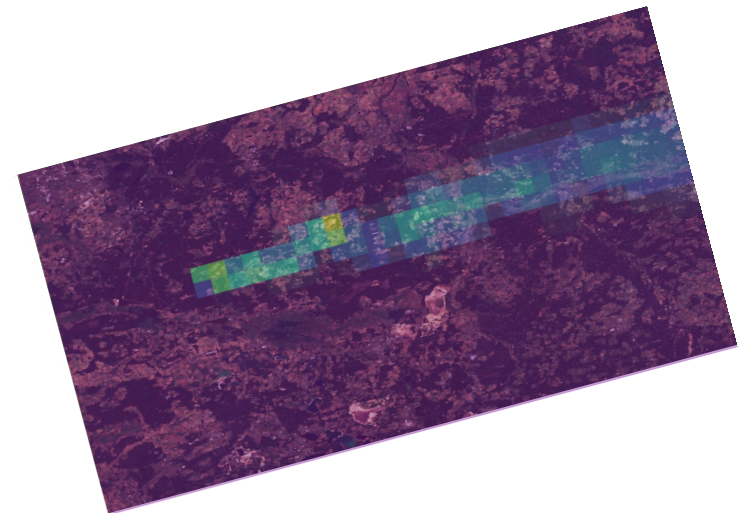
## LOW/MEDIUM RESOLUTION

- > Wide swath
- > Concentration mapping
- > Backbone missions

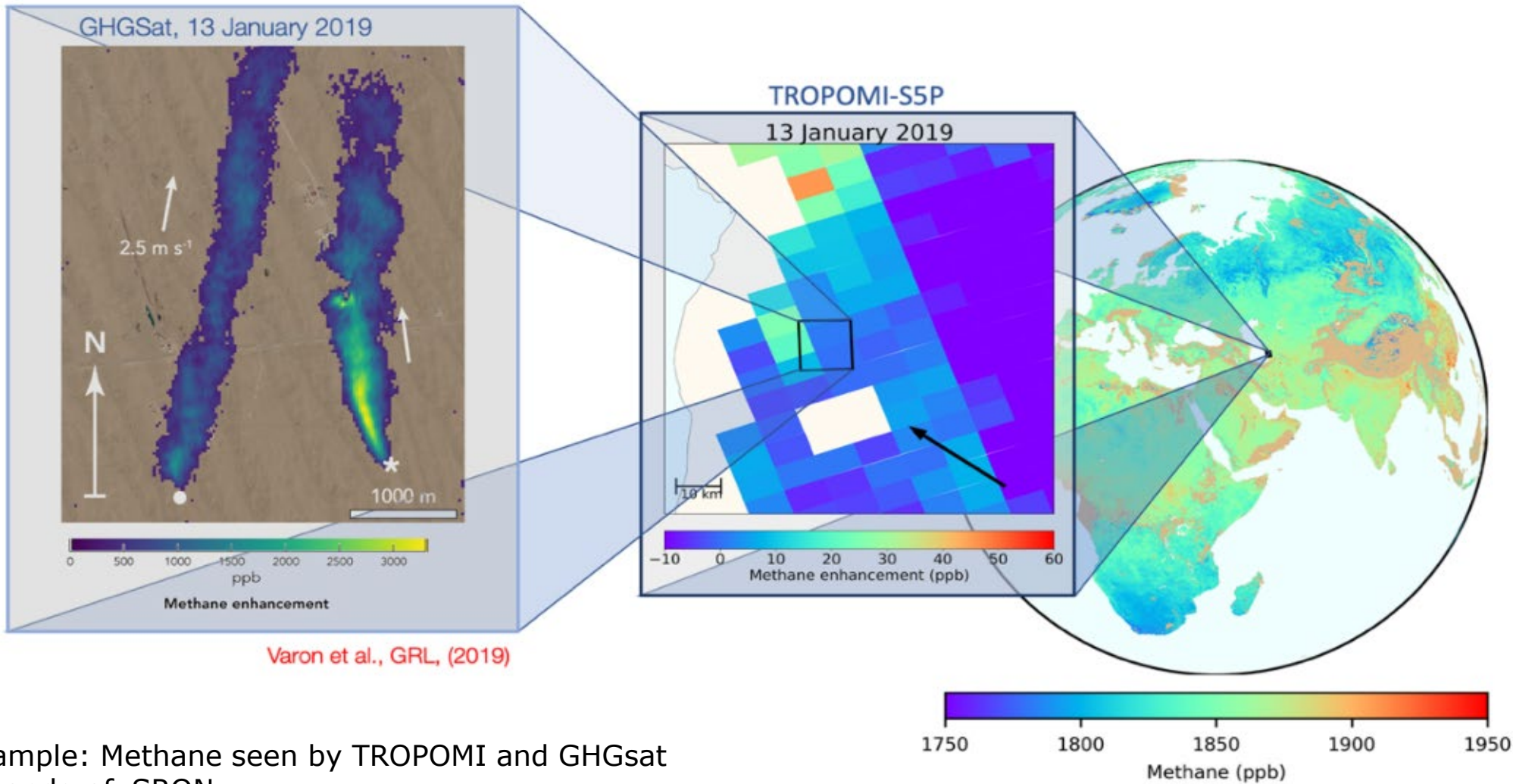


## HIGH RESOLUTION

- > Limited swath
- > Target modes
- > Agile platforms
- > Add zoom-in capabilities
- > Satellite constellations







Varon et al., GRL, (2019)

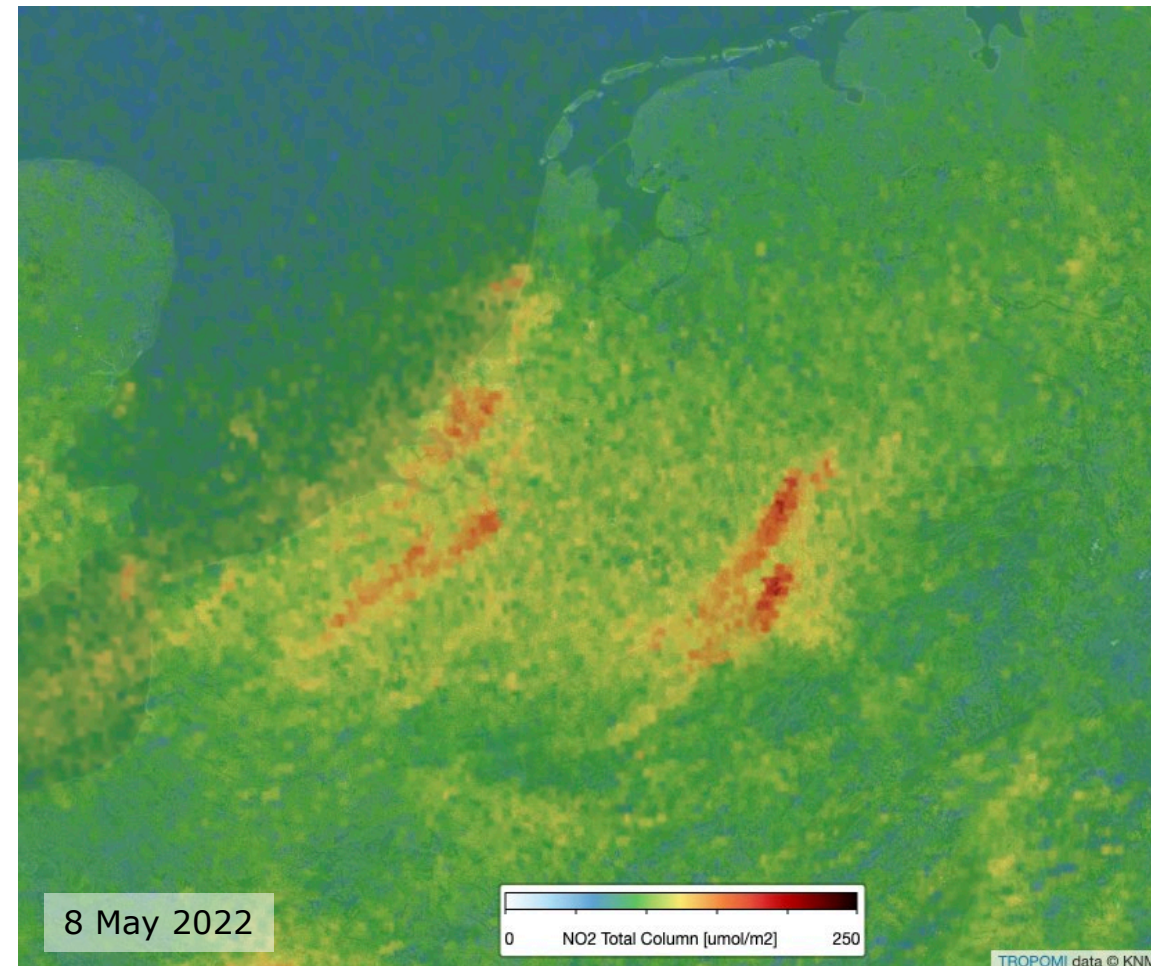
Example: Methane seen by TROPOMI and GHGSat  
J. Landgraf, SRON



# Retrieval Algorithms: NO<sub>2</sub>

## Auxiliary Information

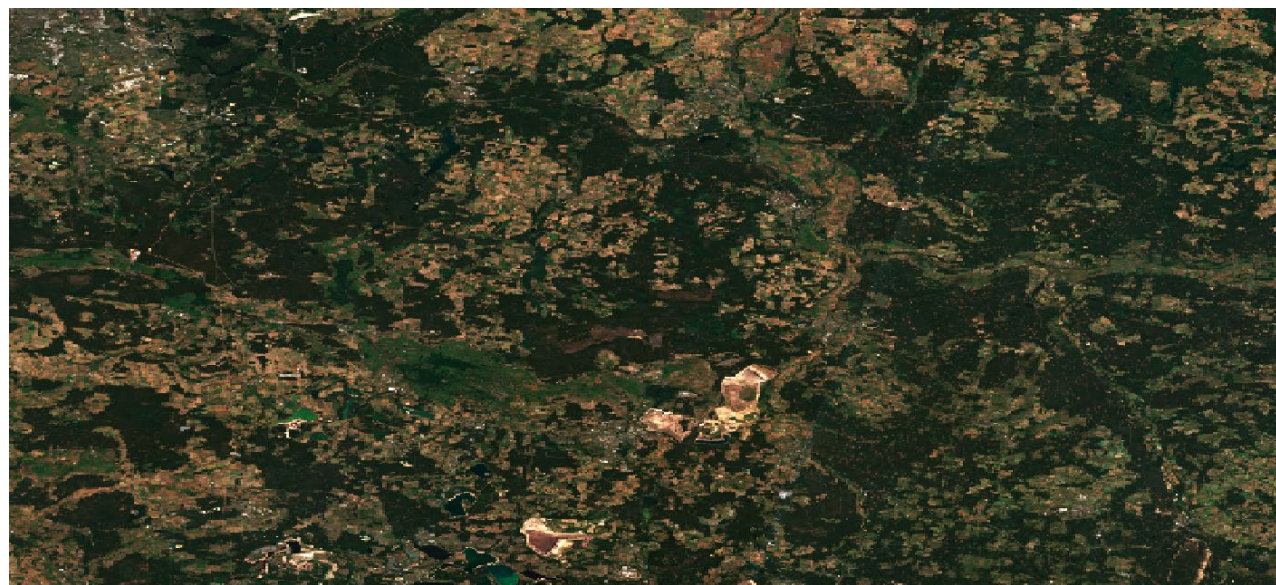
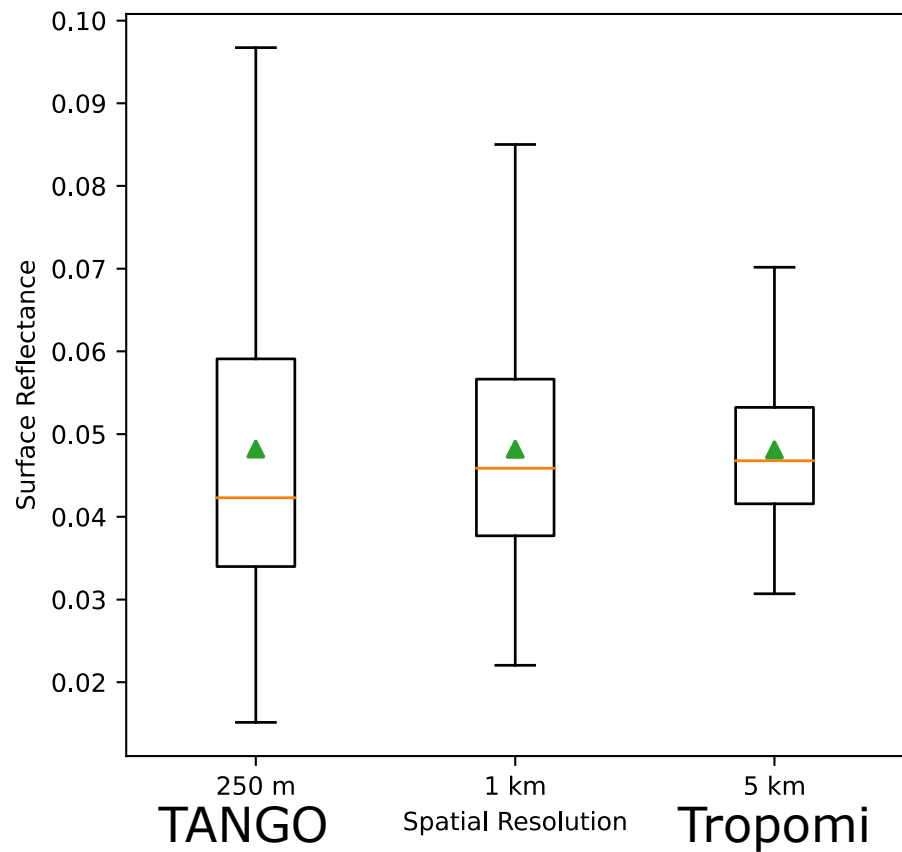
- > Surface reflectivity
- > Cloud & aerosol information
- > Atmospheric profiles (PT, NO<sub>2</sub>)







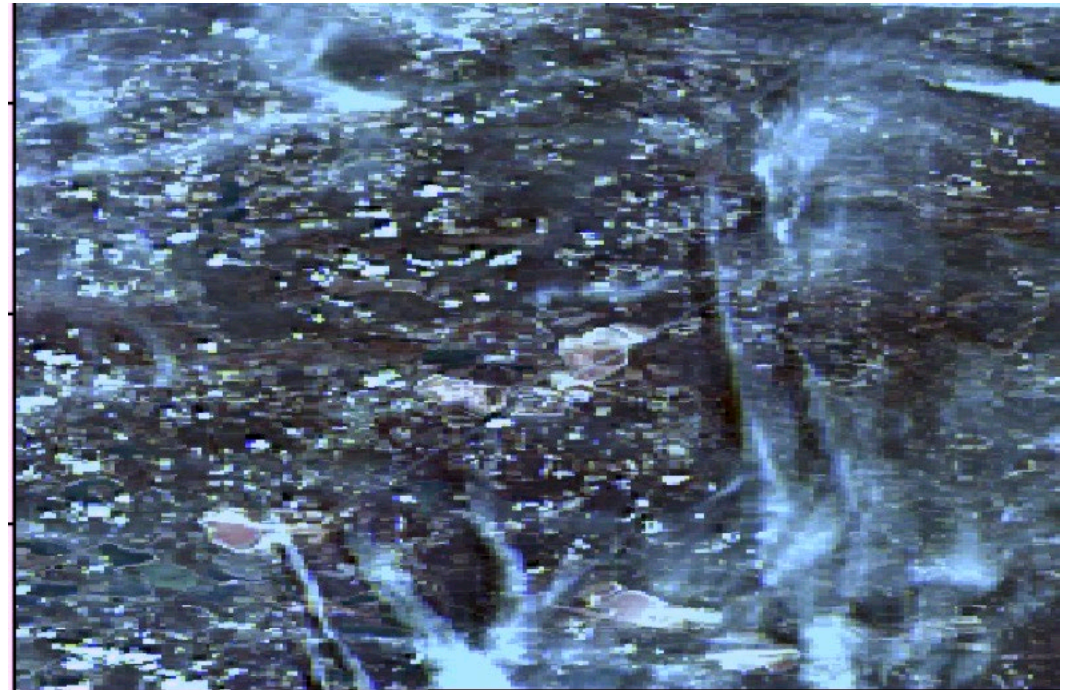
# Surface Reflectance Variability





# Clouds and Aerosol

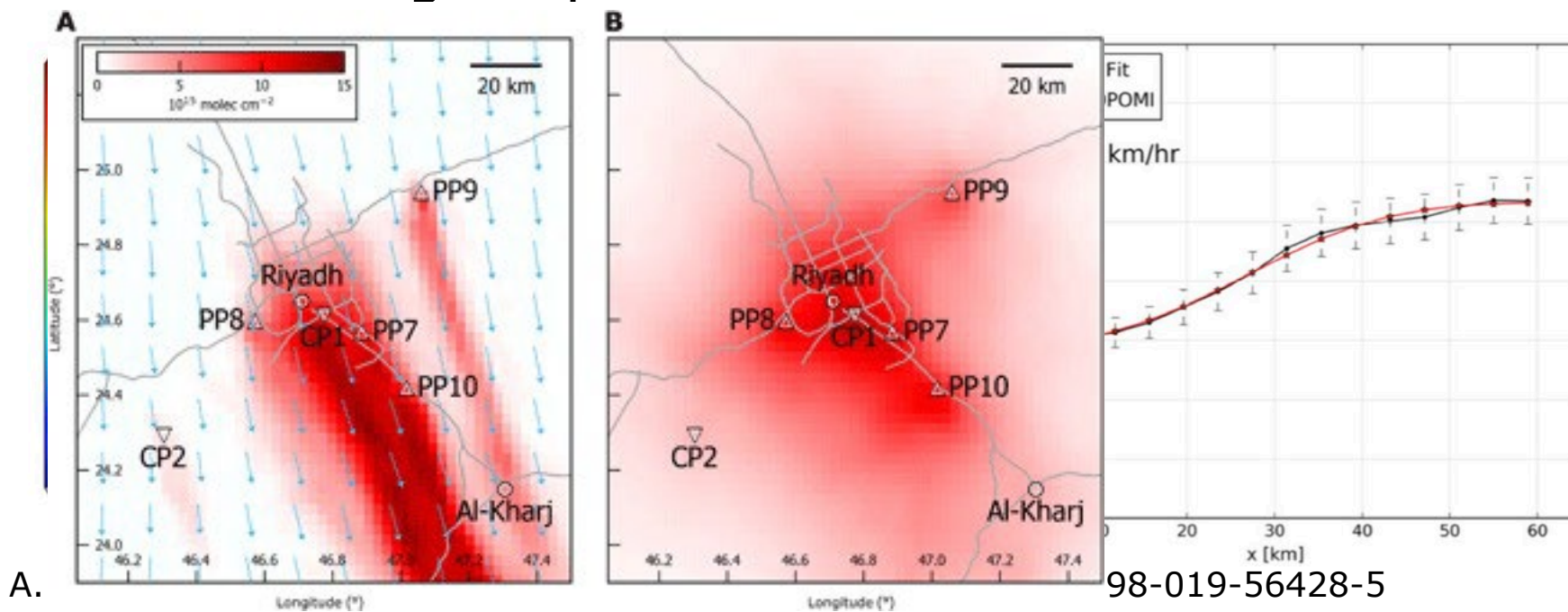
- › Develop accurate algorithms to identify clear pixels.
- › Develop methods to identify/correct 3D cloud effects.
- › Develop methods to correct for the atmospheric light path.





# Interpretation of Data

- > Modelling of turbulent plumes
  - meteo data at high spatial-temporal resolution
- > Accounting for parallax effects.



98-019-56428-5

Beirle et al., Sci. Adv., <https://doi.org/10.1126/sciadv.aax9800>





# Conclusions and Recommendations

- › High-spatial resolution atmospheric composition observations are coming!
- › Apply imaging requirements in instrument designs.
- › Develop global climatologies and/or APIs of surface reflectance information with high resolution ( $\sim 250\text{m}$ ).
- › Develop methods to estimate / correct for 3-D cloud effects, including cloud shadows.
- › Develop Level 2 product & tooling such that a-priori information can be replaced if better data is available
- › For emission monitoring missions: include the plume emissions as a data product in the core ground segment.
- › Develop solutions that can serve multiple missions.