



**The TANGO mission: A satellite tandem
to measure major sources of
anthropogenic greenhouse gas
emissions**

Jochen Landgraf and the Tango Team



Paris Agreement



Objective:

limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels.

Action:

Derive measures to achieve the goals e.g. reduce fossil fuel emissions

Monitor:

Check the progress

Satellite observations are an important tool to verify progress of the required emission reductions.



The Need for

**a European mission for targeted
CO₂ and CH₄ observations with...**

High Spatial Resolution

High Precision

Flexible Mission Operation

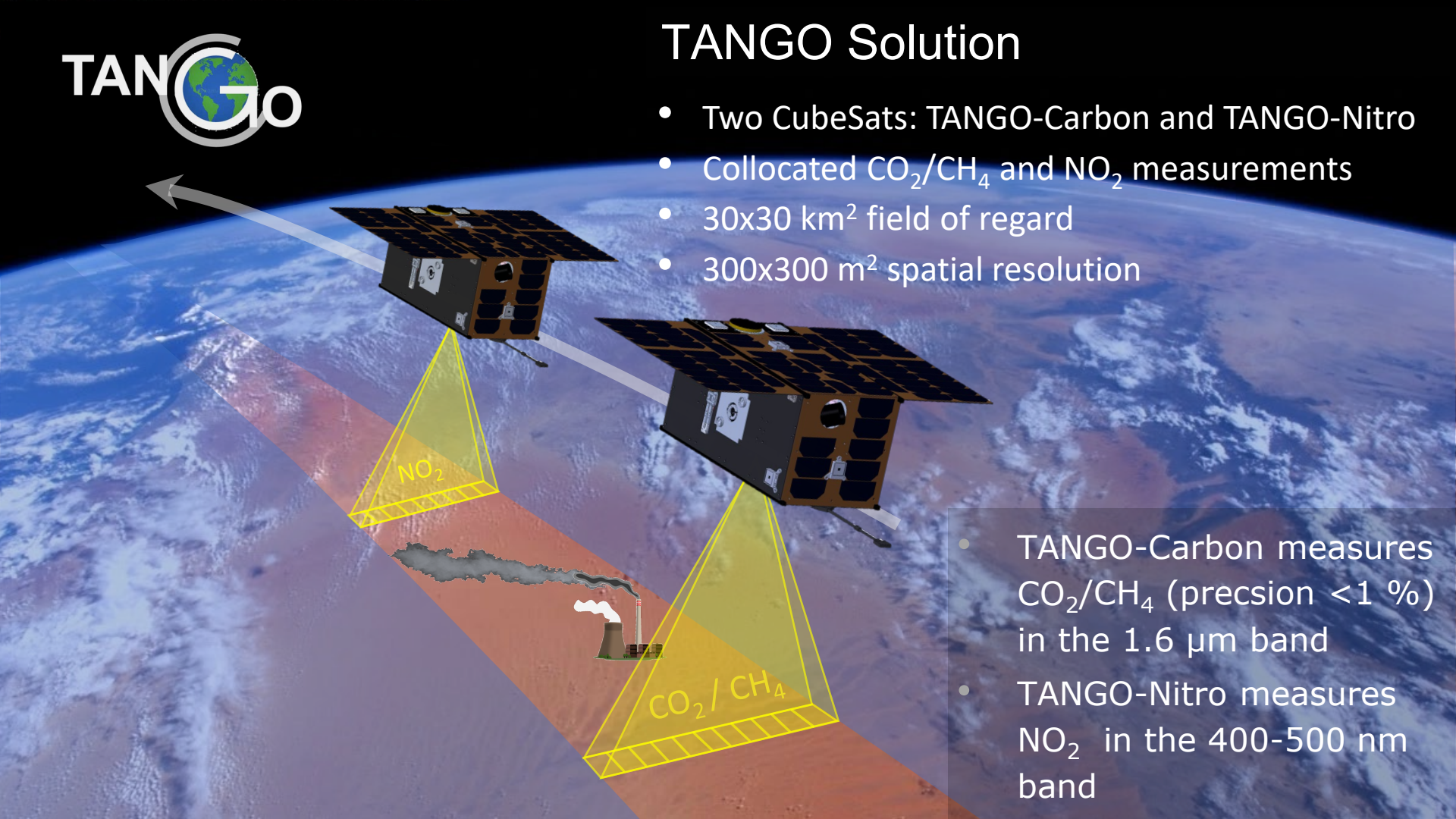
Open Data Policy And Free Data Access



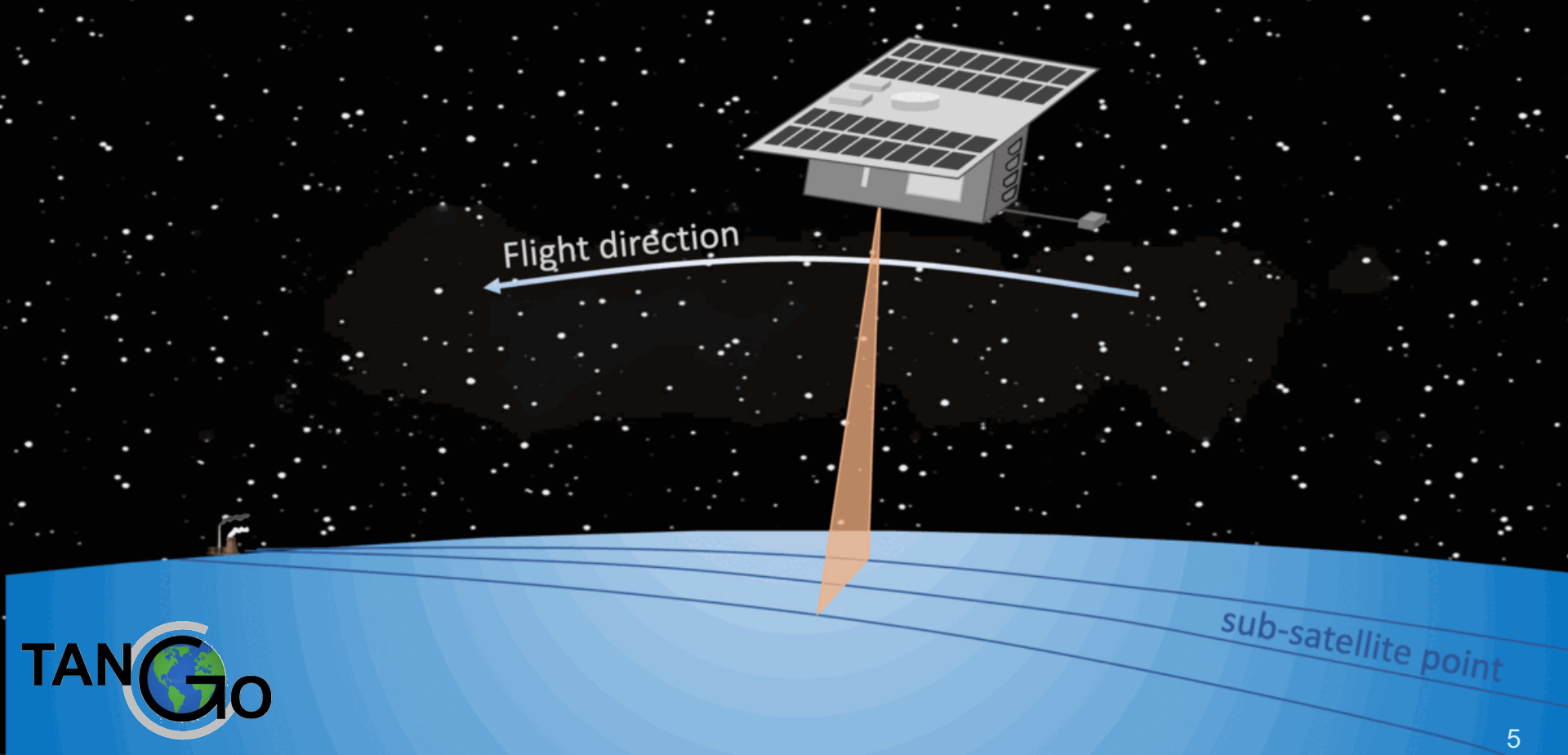
TANGO Solution

- Two CubeSats: TANGO-Carbon and TANGO-Nitro
- Collocated CO_2/CH_4 and NO_2 measurements
- $30 \times 30 \text{ km}^2$ field of regard
- $300 \times 300 \text{ m}^2$ spatial resolution

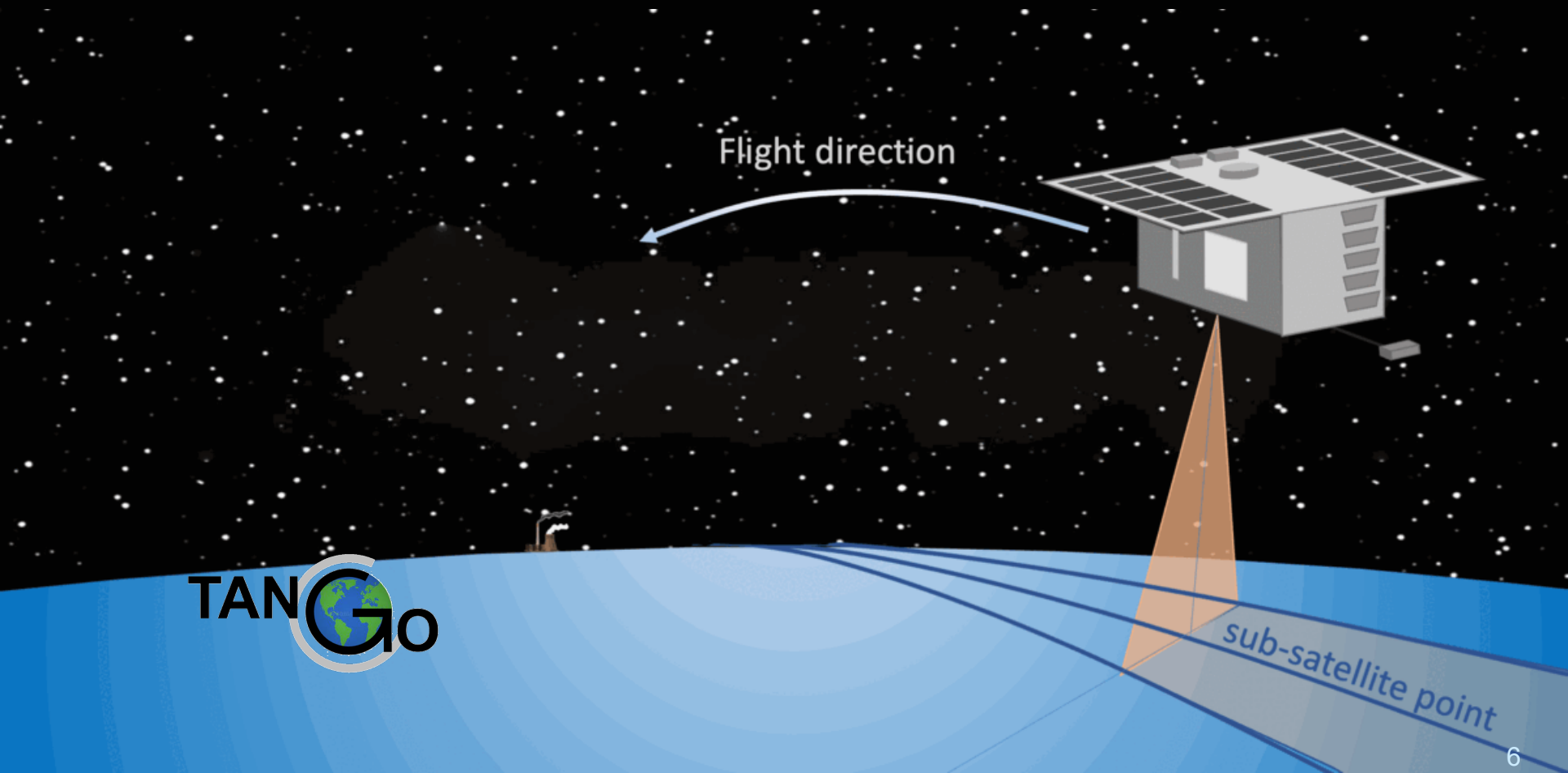
- TANGO-Carbon measures CO_2/CH_4 (precision $< 1\%$) in the $1.6 \mu\text{m}$ band
- TANGO-Nitro measures NO_2 in the 400-500 nm band



Agile Platform and Forward Motion Compensation

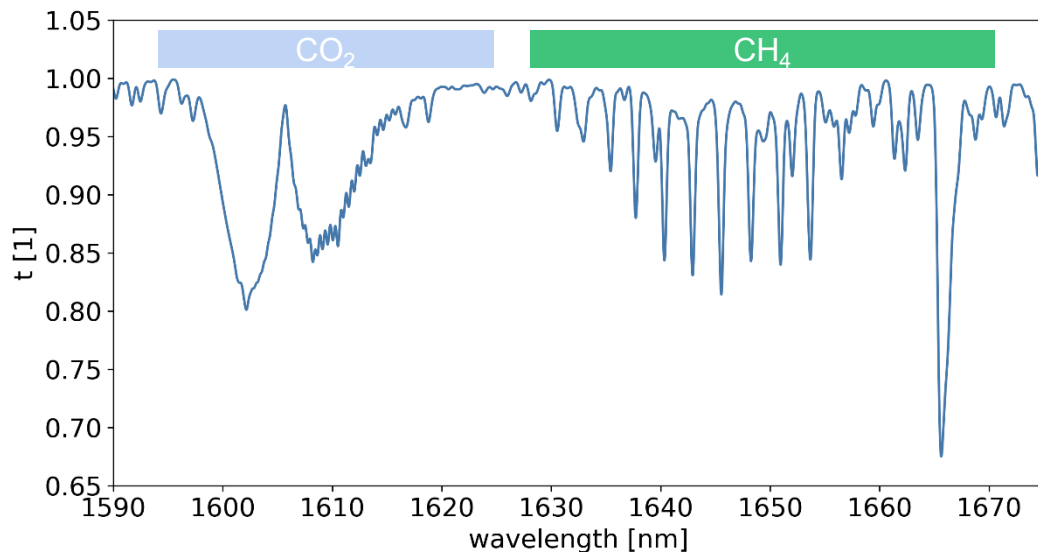


Agile Platform and Across Track Pointing



The CO₂ and CH₄ Data Analysis

Radiance measurements in the 1.6 μm band



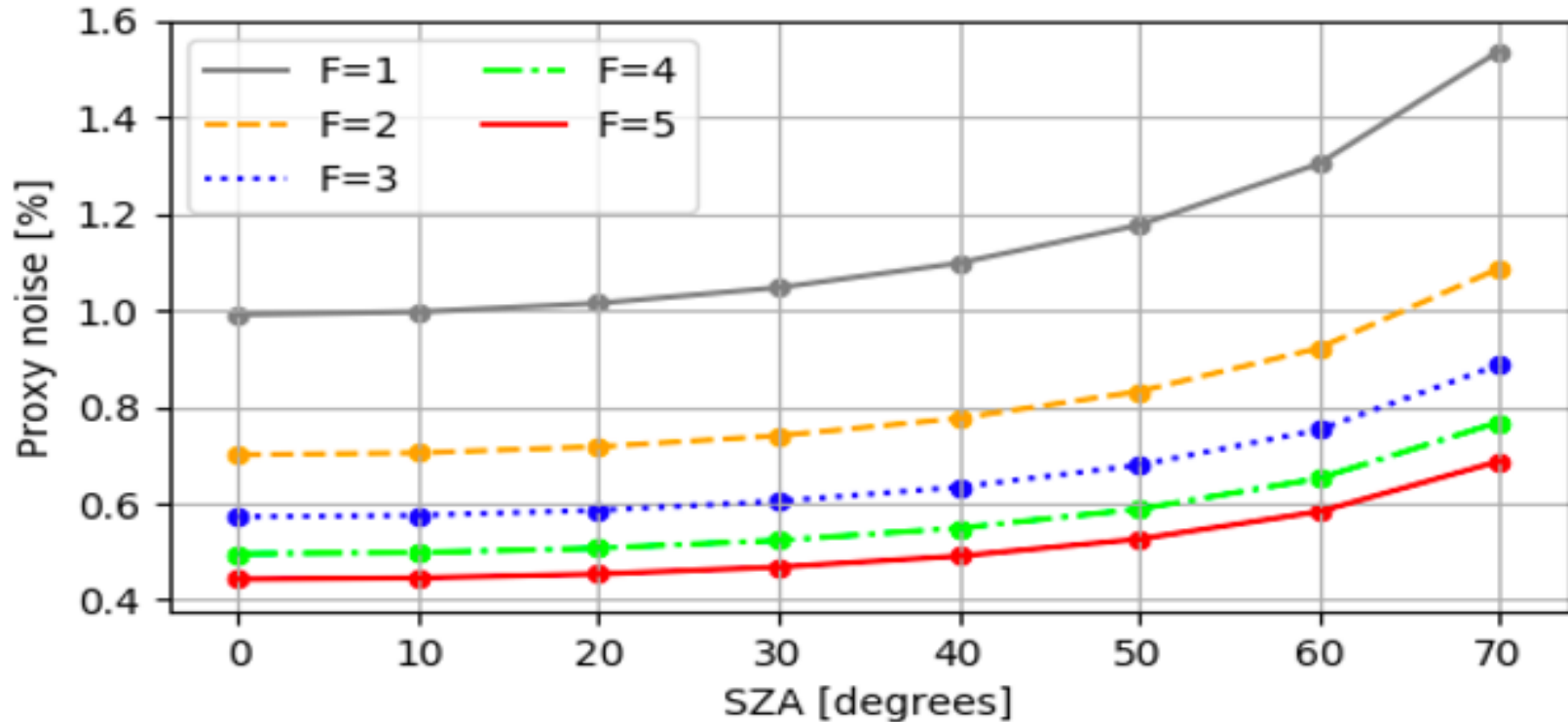
Proxy retrieval approach:

$$XCH_4^{pro} = \frac{[CH_4]}{[CO_2]} XCO_2^{mod}$$

$$XCO_2^{pro} = \frac{[CO_2]}{[CH_4]} XCH_4^{mod}$$

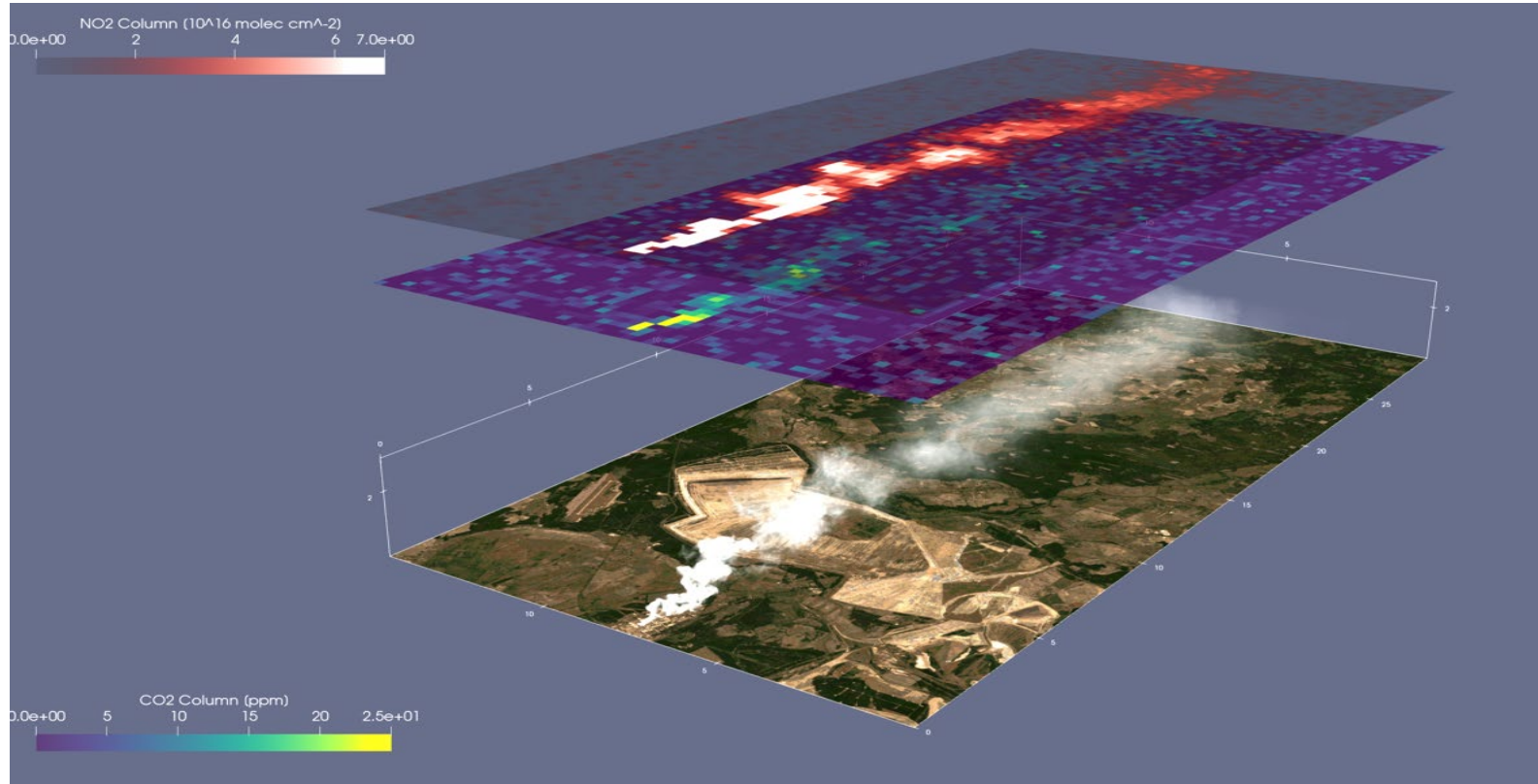
- + Only minor aerosol induced error
- + Both CH₄ and CO₂ product
- Difficulties to interpret mixed sources
- Precision is a factor ~1.5 lower than that of [CH₄] and [CO₂]

CO₂ and CH₄ precision estimate



Corresponding CO₂ and CH₄ proxy noise for HgCdTe (MCT) detector and different forward motion compensation (F).

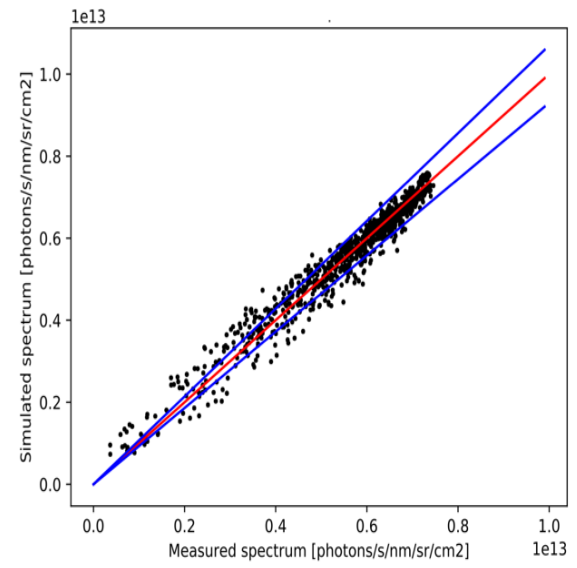
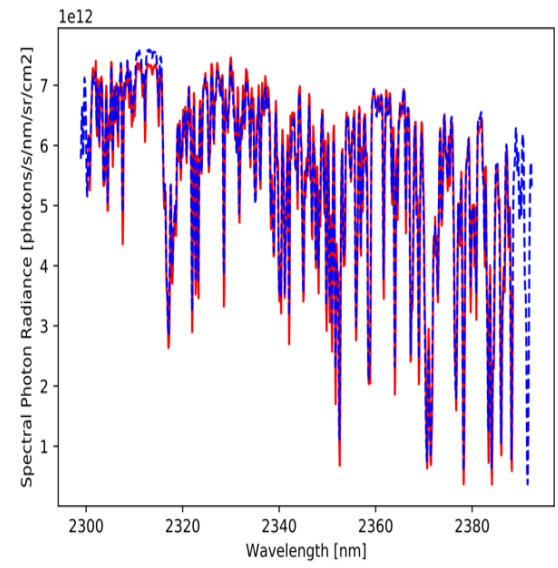
CO₂ and its Committed NO₂ plume



Vicarious Calibration



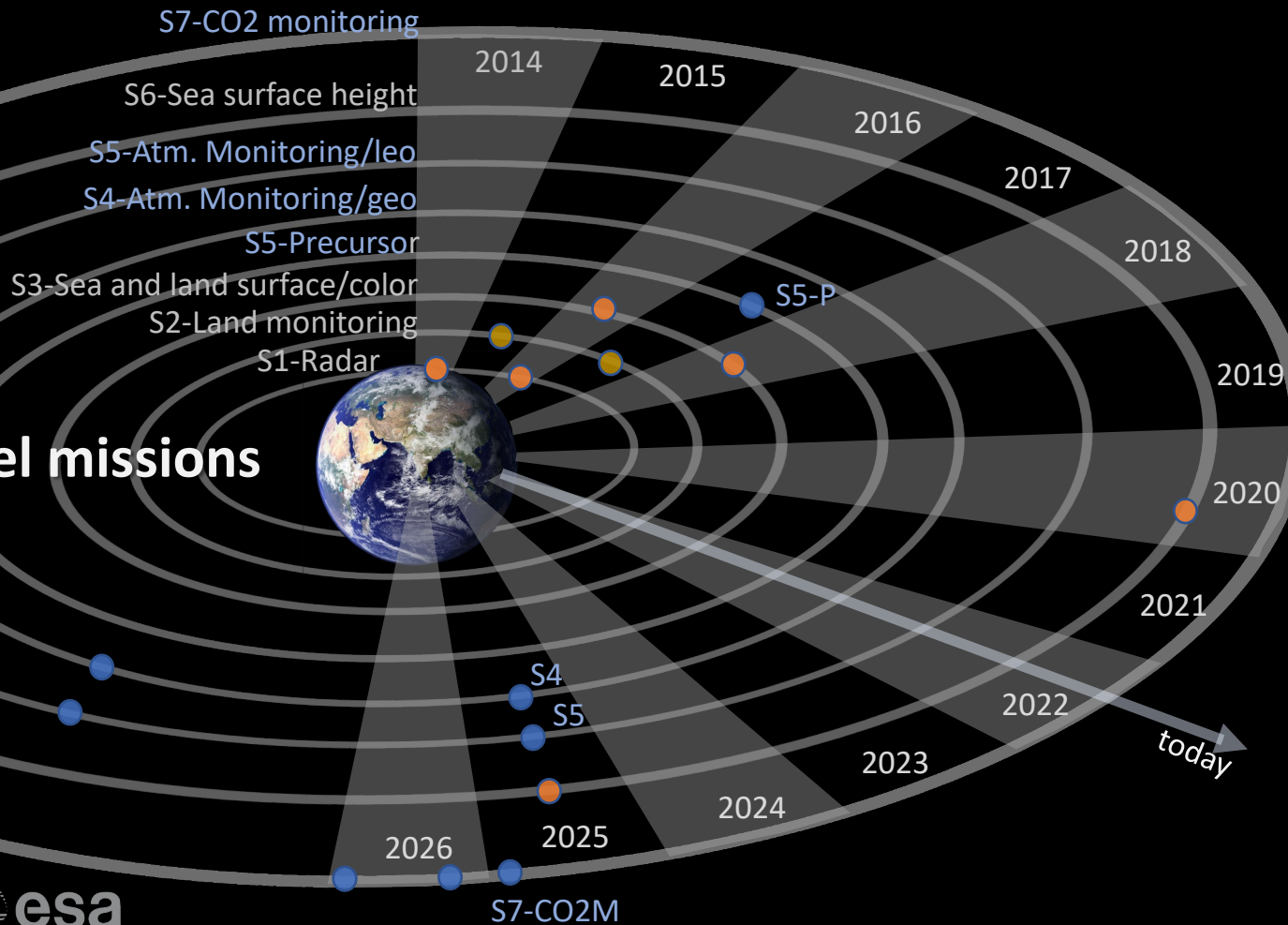
TROPOMI 2.3 μm radiance observation and RT simulation



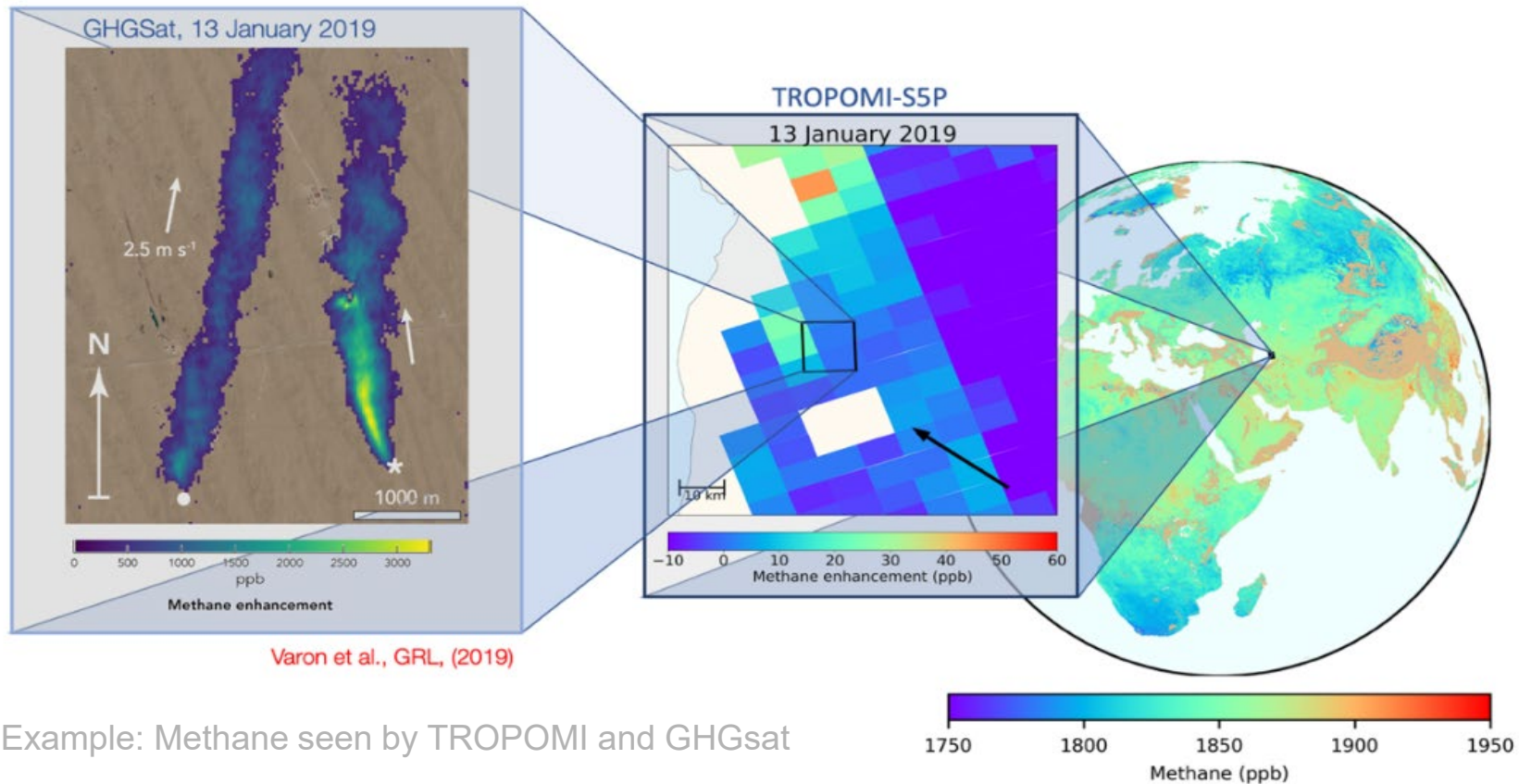
CEOS LANDNET sites can be used to calibrate the ARA of TANGO.

Tim van Kempen

Copernicus Sentinel missions



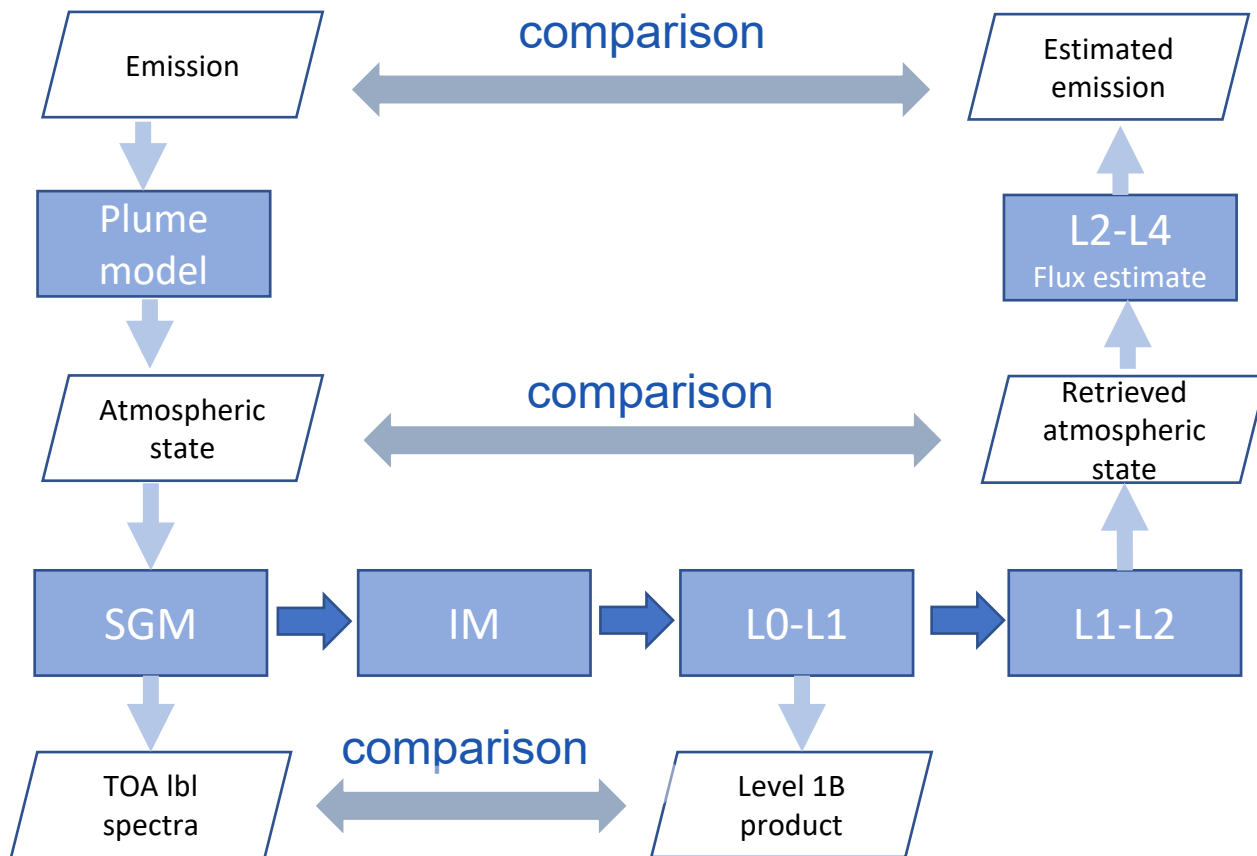
TANGO and Copernicus CO2M



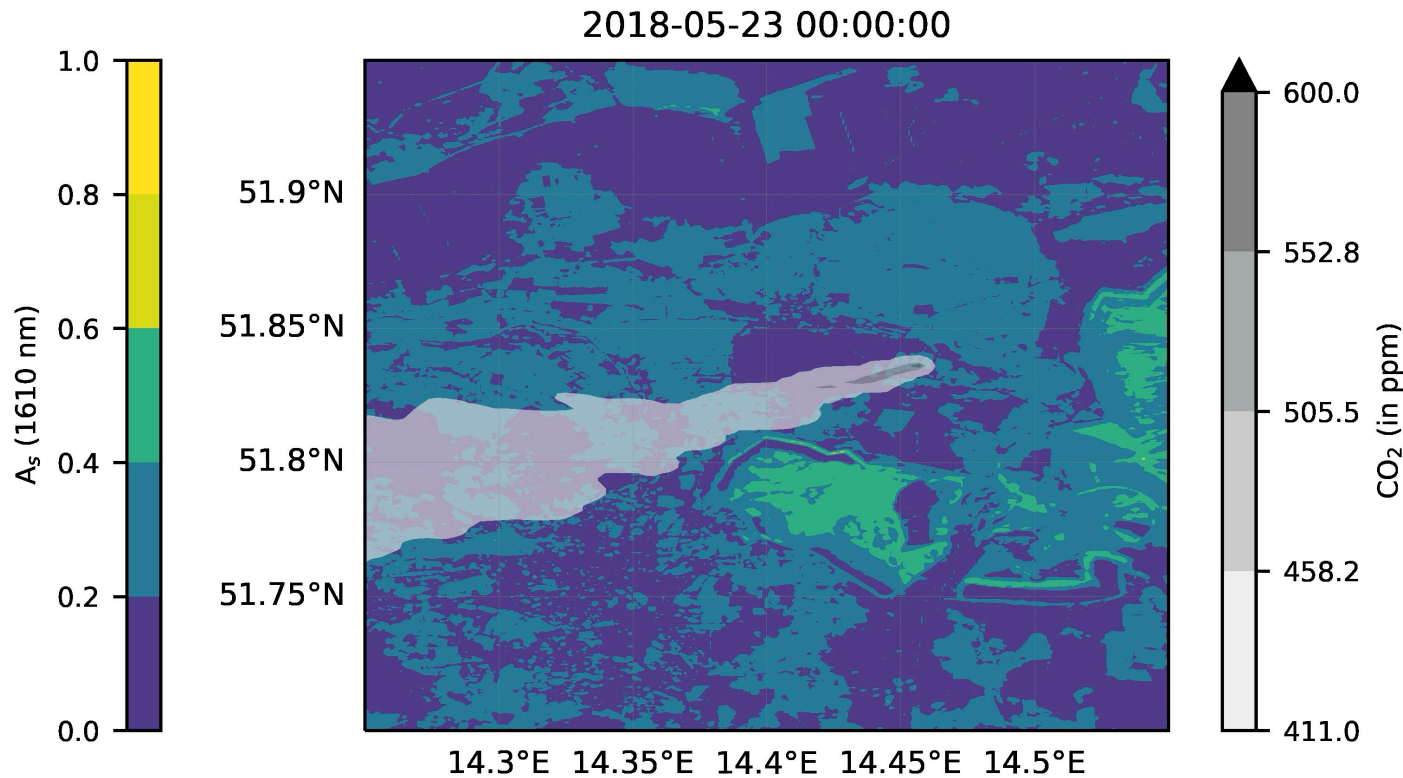
Varon et al., GRL, (2019)

Example: Methane seen by TROPOMI and GHGSat

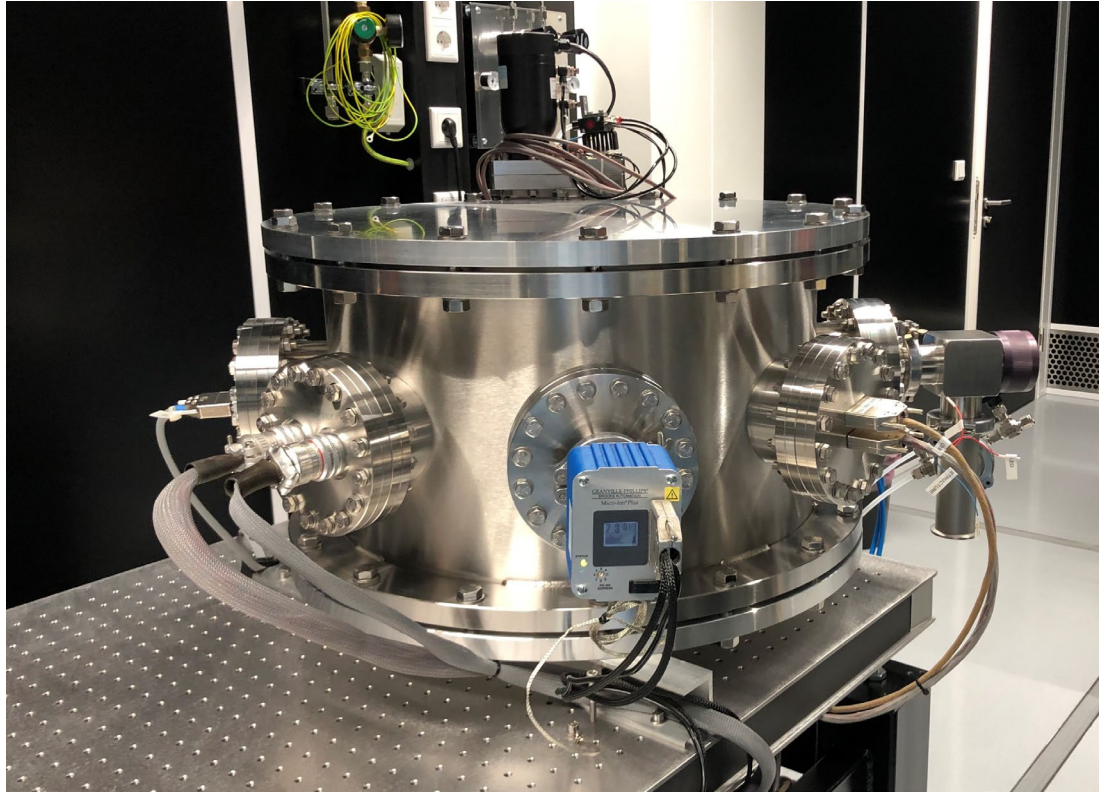
Tango End-2-End Simulator



Tango: The End-to-End Simulator



Instrument Specification: SWIR Detector Specification



1. Characterization of three different detector candidates, Ryan Cooney and team (SRON)
2. Spectrometer stray light analysis: TNO Tango team



Twin ANthropogenic Greenhouse gas Observers

- Targeted mission (30 x 30km² field of regard)
- Resolution 300 x 300 m²

- Complementary to CO2M/S5
- Envisaged launch (2026)

