

Shortwave infrared measurements of the TROPOMI instrument on the Sentinel 5 Precursor mission

Jochen Landgraf¹, Joost aan de Brugh¹, Haili Hu¹, Tobias Borsdorff¹, Remco
Scheepmaker¹, Andre Butz², Otto Hasekamp¹, and Ilse Aben¹

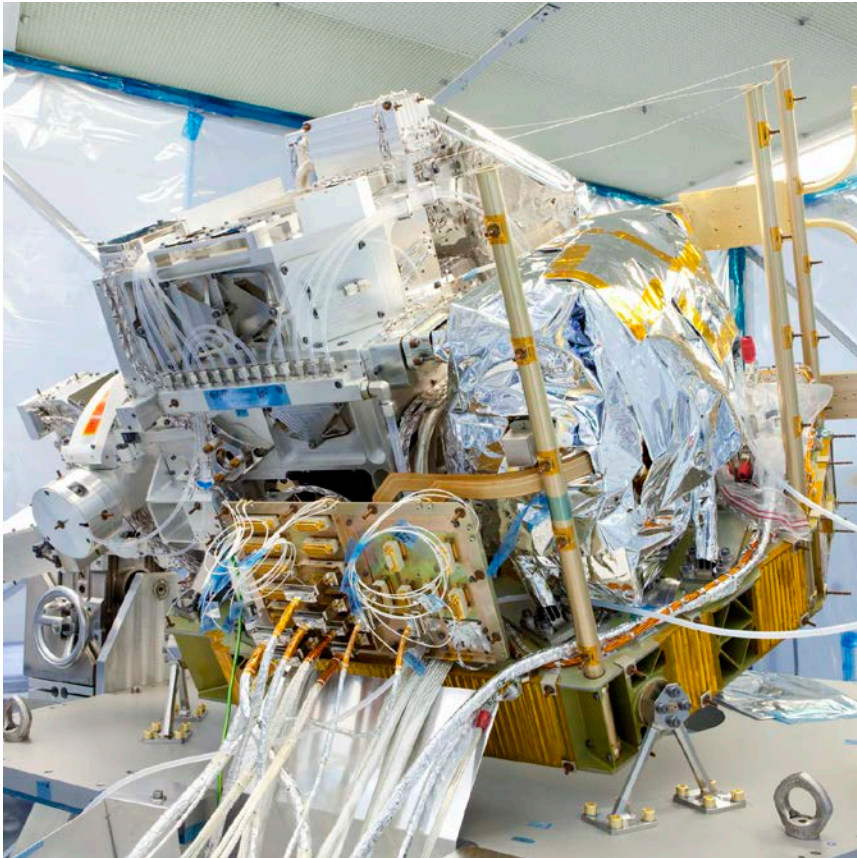


¹ SRON Netherlands Institute for Space Research, Utrecht, The Netherlands.

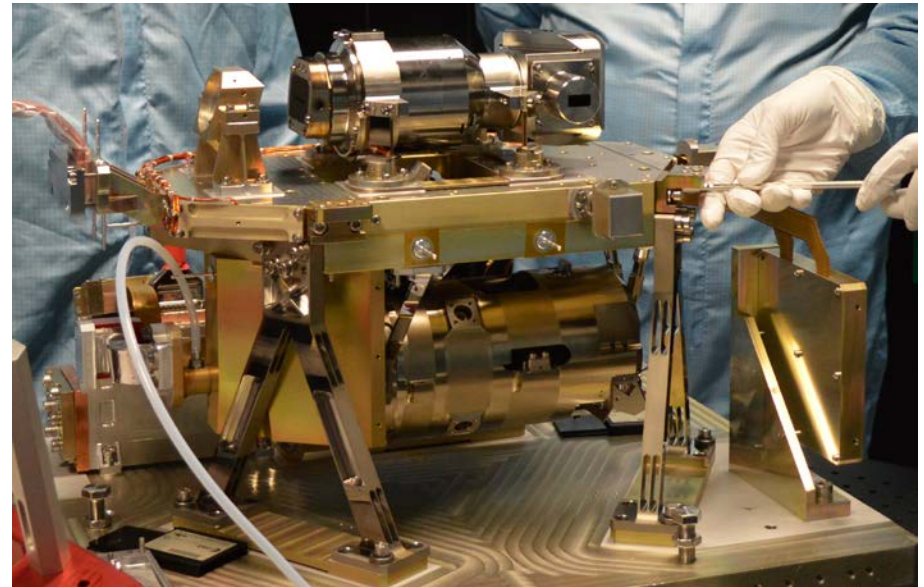
² Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

The TROPOMI instrument

Assembled TROPOMI instrument



The SWIR channel



Because of innovative immerse grating technology , the SWIR-3 channel has only a volume of 5 liters.

Technology will also be used for S5 and CarbonSat.

The 2.3 μm spectral range

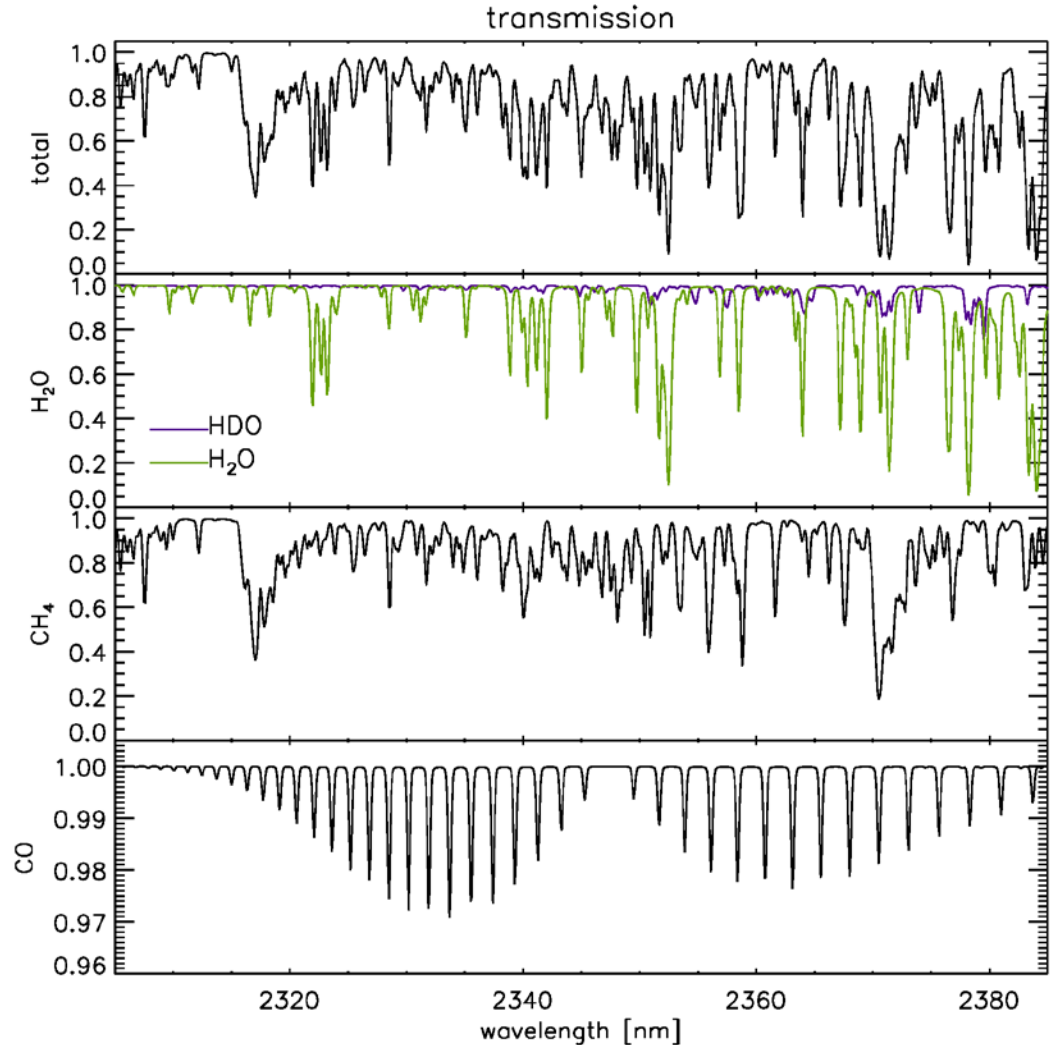
Spectral range contains information on:

- Water
- HDO
- Methane
- Carbon monoxide

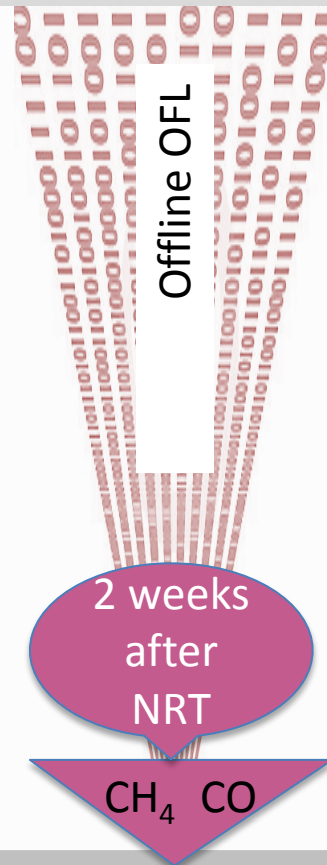
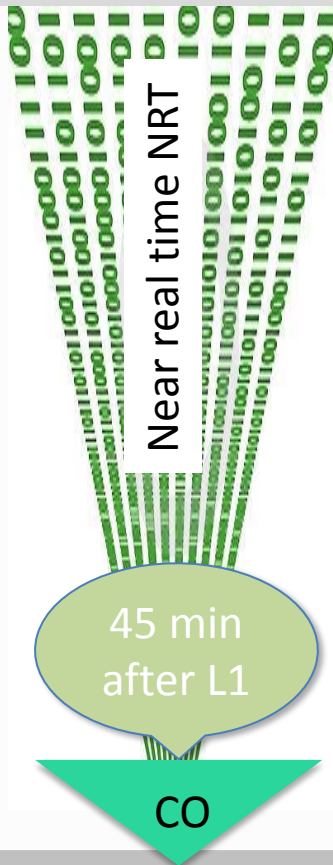
Quality requirement for operational data product:

CO: 10 % precision /
15 % accuracy

CH₄: 1 % precision /
1 % bias



Level 1 data product (2:15 hr after sensing)



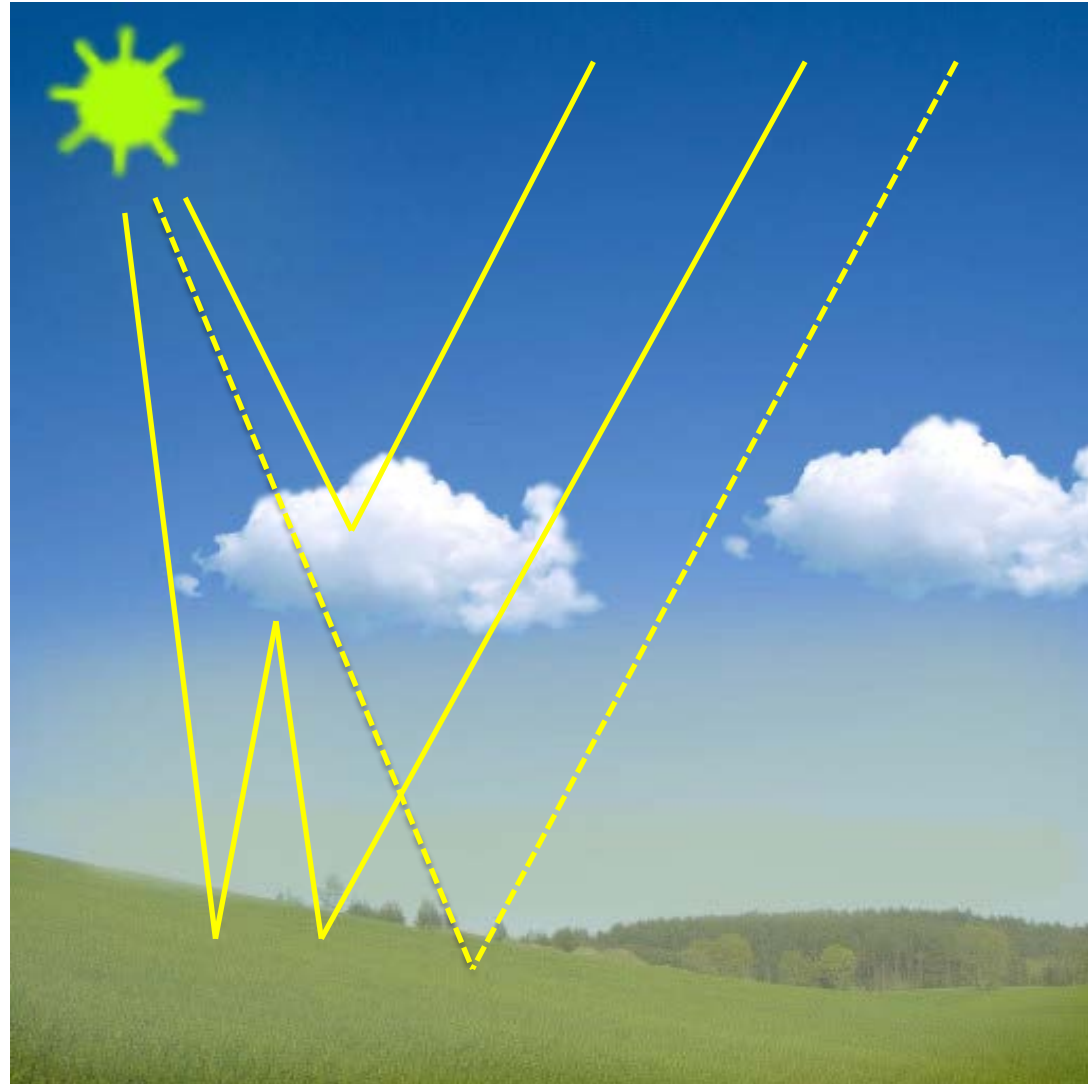
Level 2 data product

Physics based retrieval approach

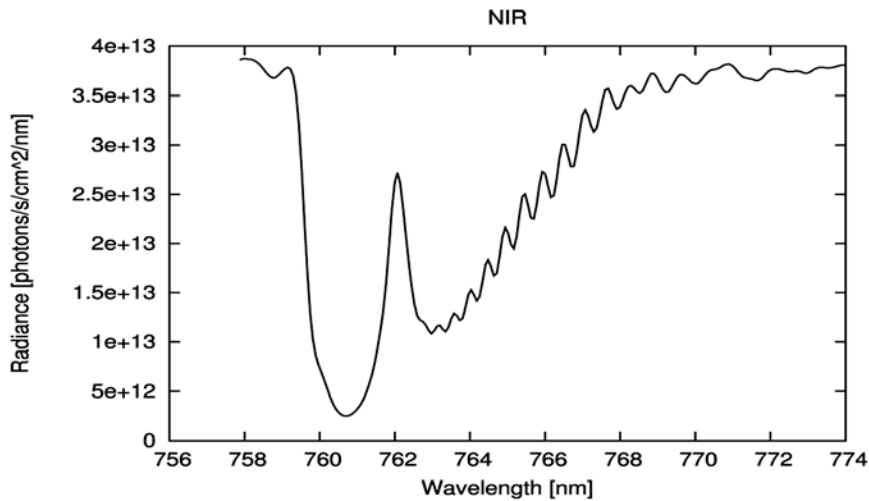
Light path can be shortened or enhanced due to atmospheric scattering.

A physics based retrieval aims to infer information on trace gases and atmospheric scattering simultaneously from the measurement.

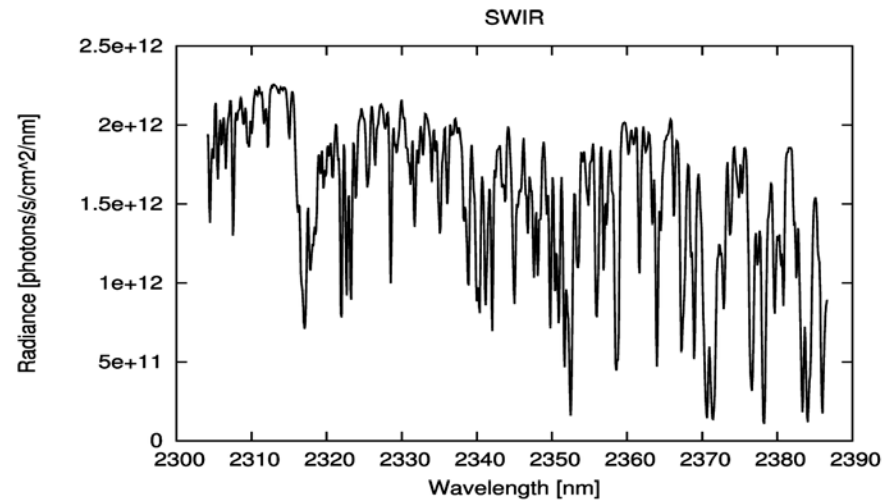
Both, the operational CH_4 and CO retrieval are based on this principle, which makes the algorithm numerically demanding.



Operational CH₄ algorithm: RemoTeC



NIR reflectance spectrum (758-774nm)



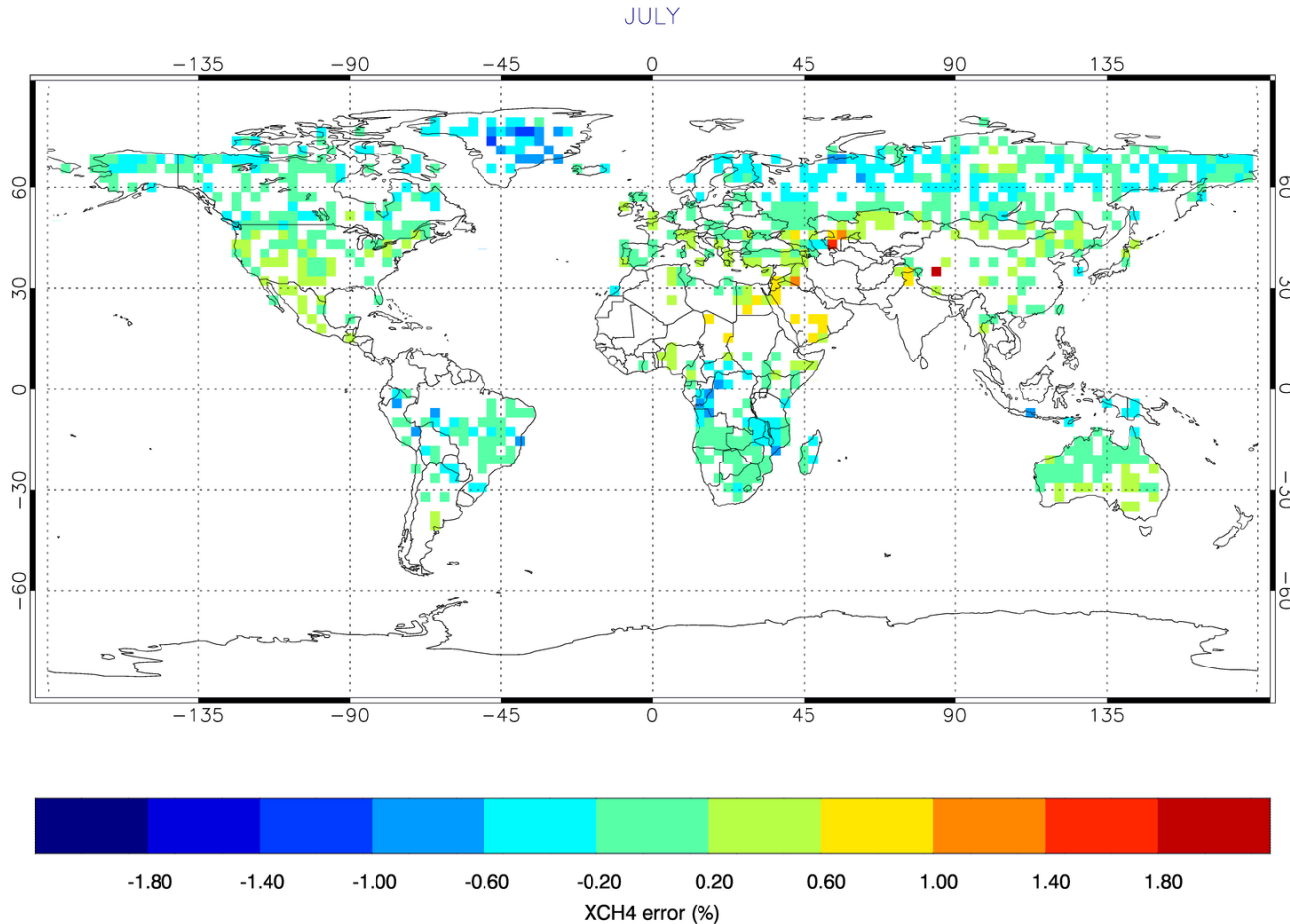
Full SWIR-3 spectrum (2305-2385nm)

- Cloud filtering using co-located VIIRS measurement
- Remaining scattering by aerosols and thin cirrus is accounted by the retrieval (O₂ A band in the NIR, and strong CH₄ bands in the SWIR)
- Height of a scattering layer, size and number of scattering particle
- H₂O, CH₄, CO
- 10 seconds per ground pixel

References:

Butz et al., 2009; 2010; 2011;
Schepers et al, 2012; Guerlet et al, 2013

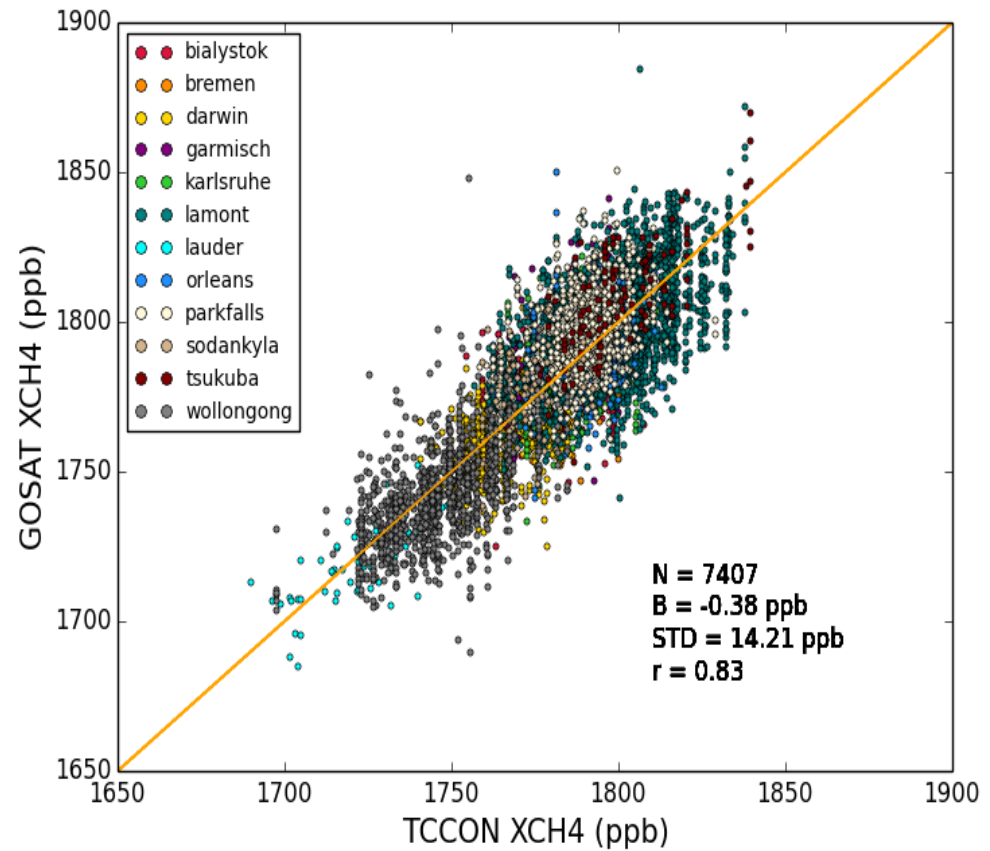
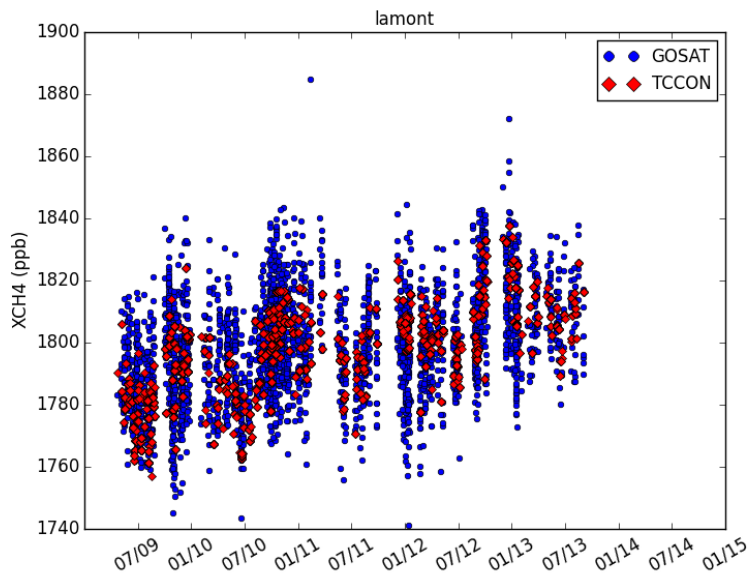
Ensemble of one day simulated measurements



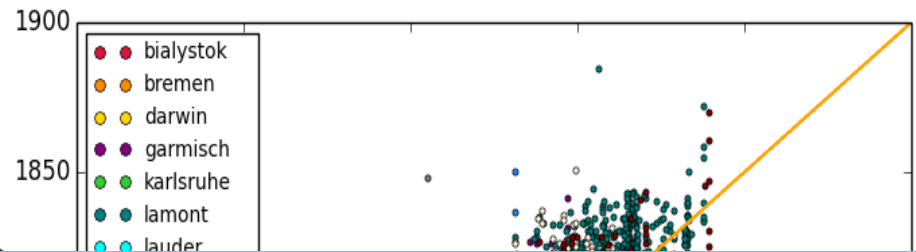
RMS error = 0.46 %

For 96 % of all retrievals error < 1 %

RemoTeC has GOSAT heritage including extensive validation with TCCON ground-based measurements

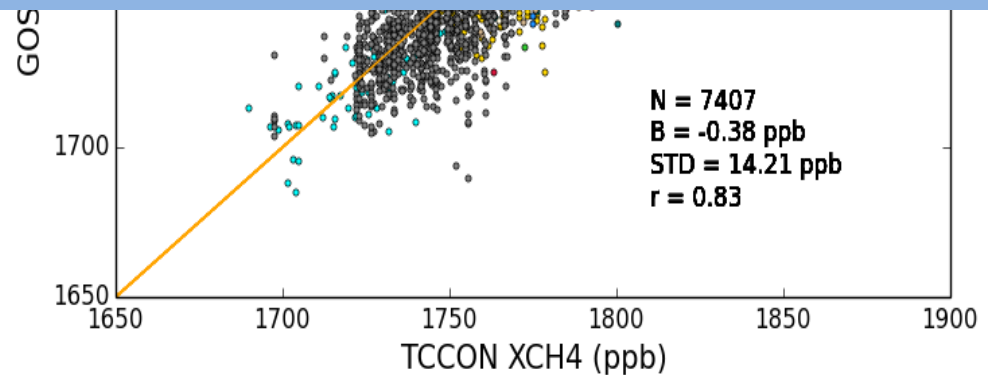
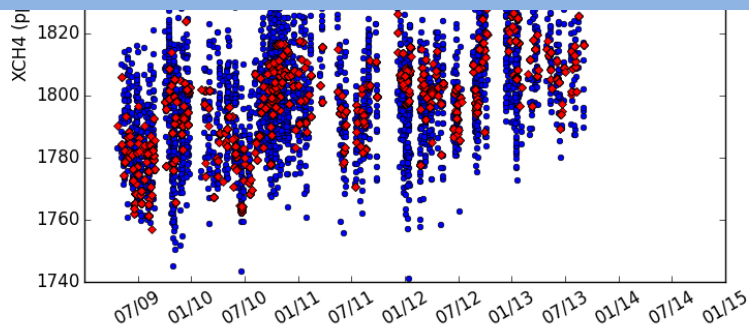


RemoTeC has GOSAT heritage including extensive validation with TCCON ground-based measurements



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More information: Poster 133 Schepers et al.



Operational CO algorithm: SICOR

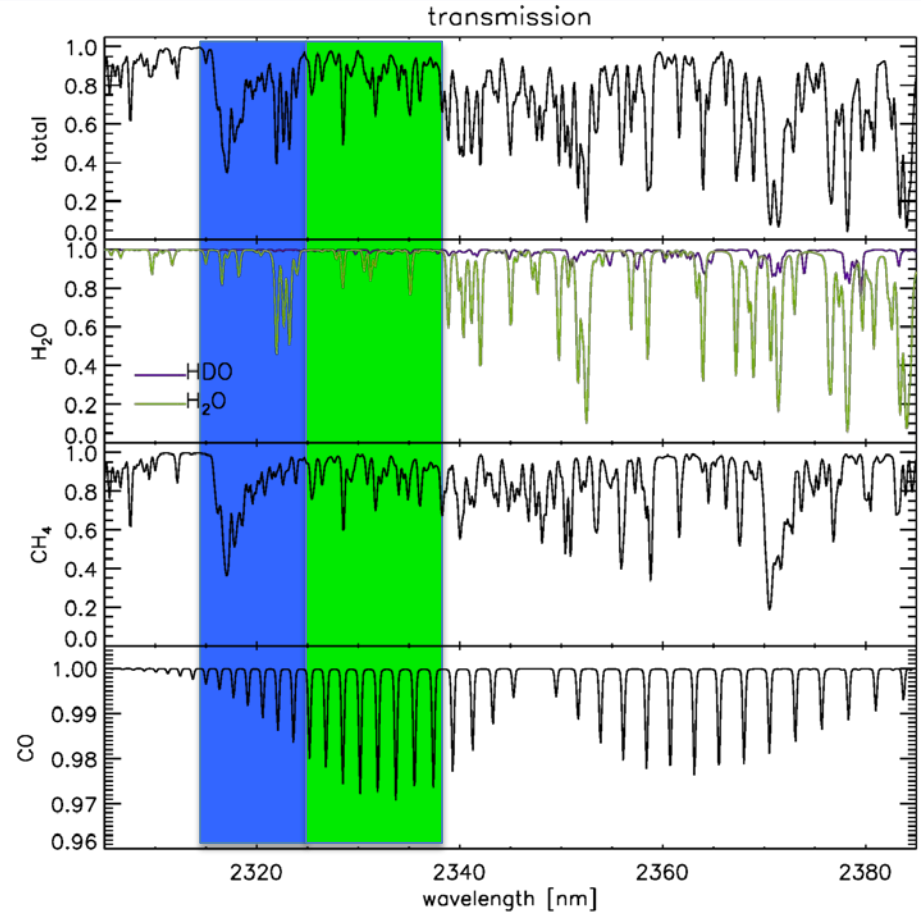
Band 1: 2315-2324 nm

non-scattering retrieval, difference between retrieved CH_4 and a priori knowledge used to filter on high and optically thick clouds

Band 2: 2324-2338 nm

remaining atmospheric scattering is described by a Gaussian height distribution. Fit parameters: CO, H_2O , scattering optical depth and scattering layer height, using a priori CH_4 .

Processing time: 0.15 seconds per ground pixel

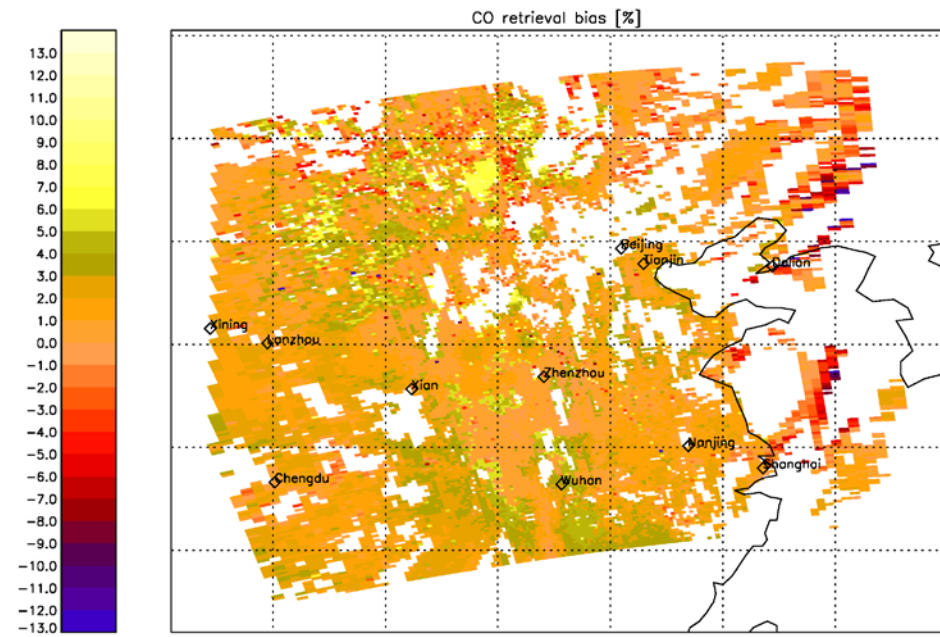
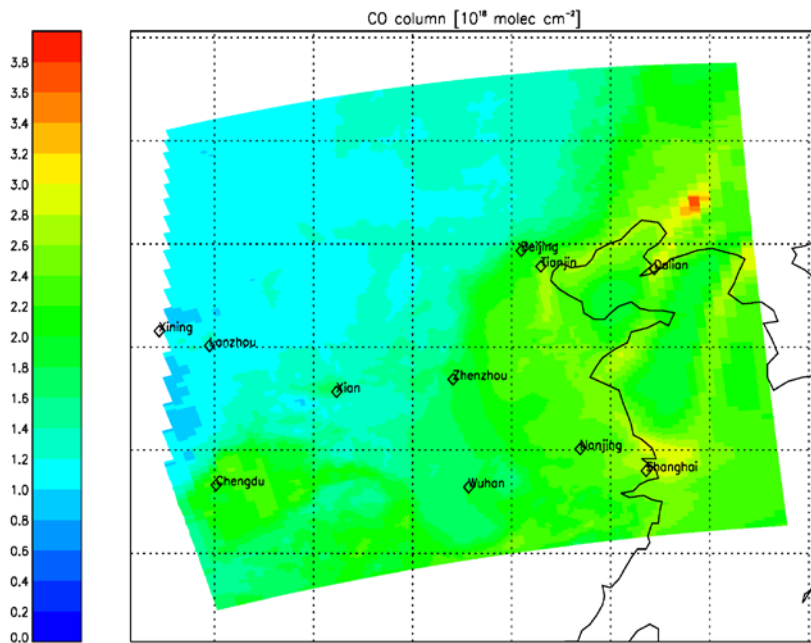


Reference:

Gloudemans et al., 2009

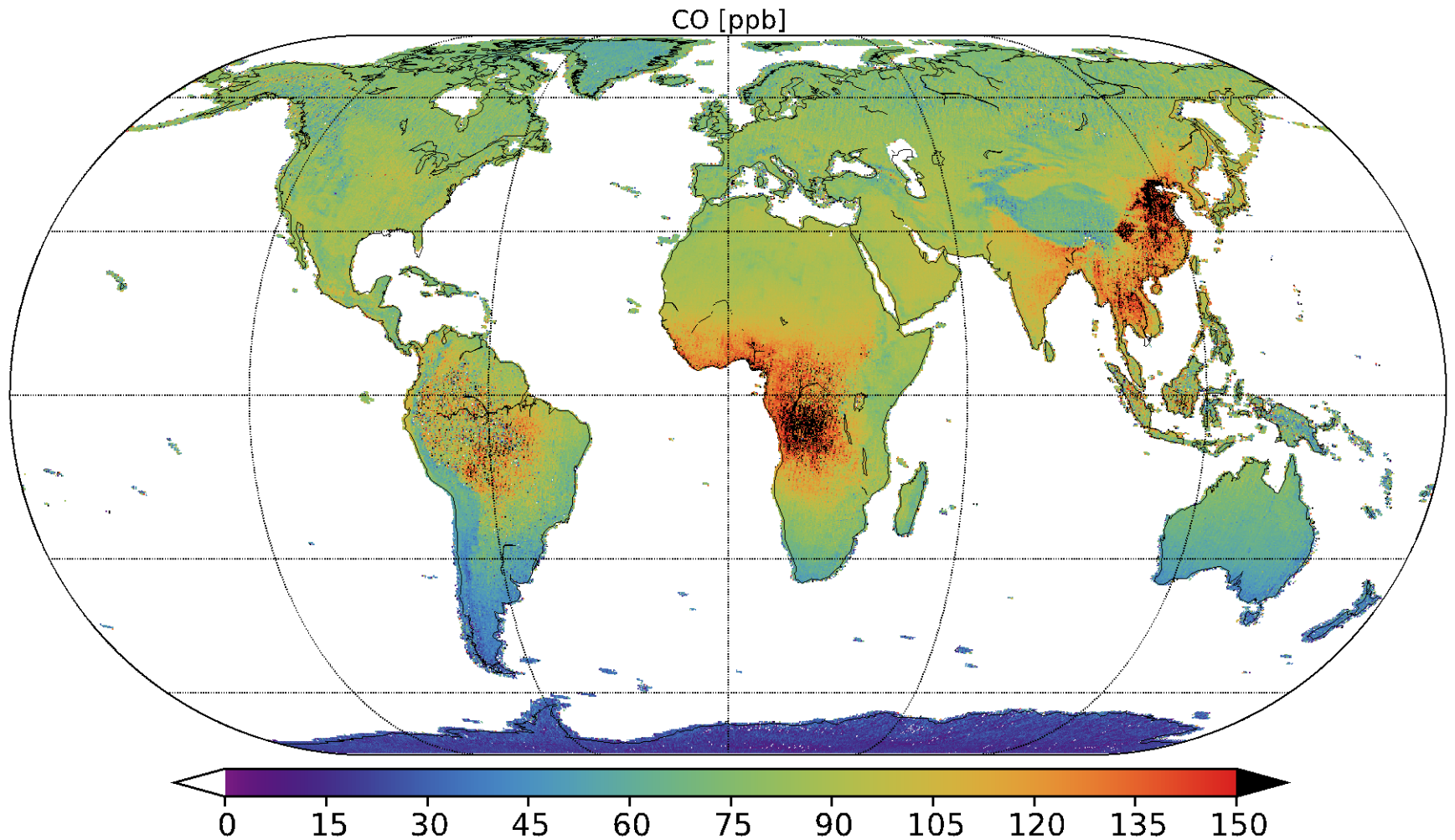
Vidot et al., 2012, Borsdorff et al., 2014

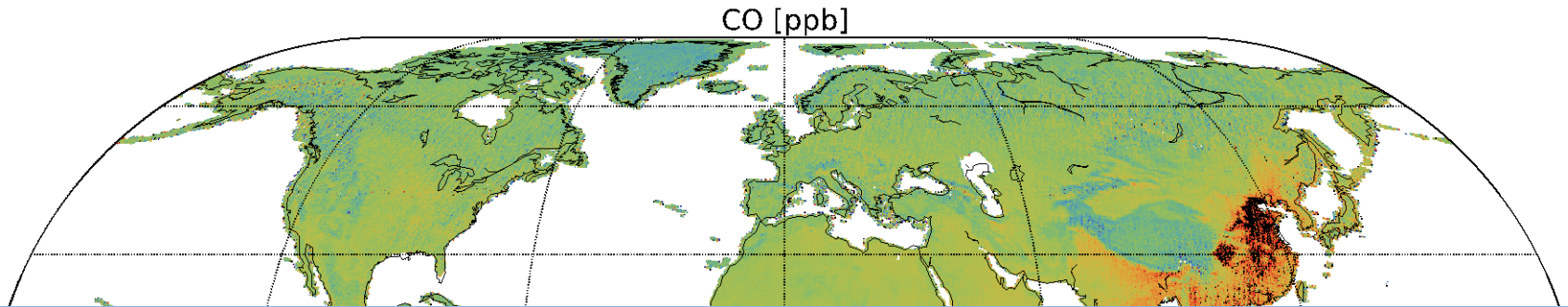
Estimate retrieval performance from simulated measurements



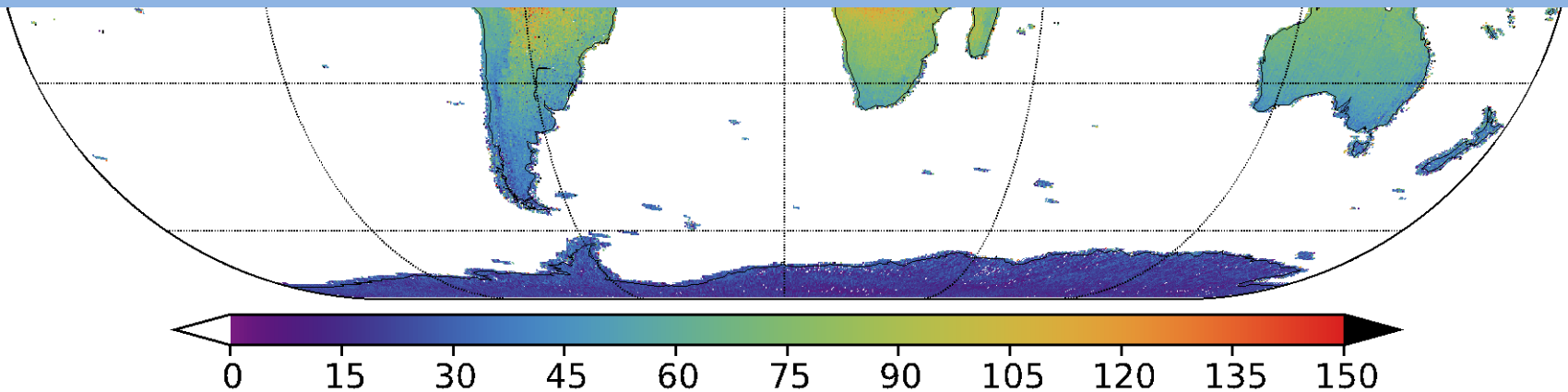
Simulated measurements for one MODIS granule combining MODIS cloud aerosol and surface albedo with ECMWF and Chimere trace gas fields.

CO mean bias: 1.6 %
Standard deviation: 2.3 %





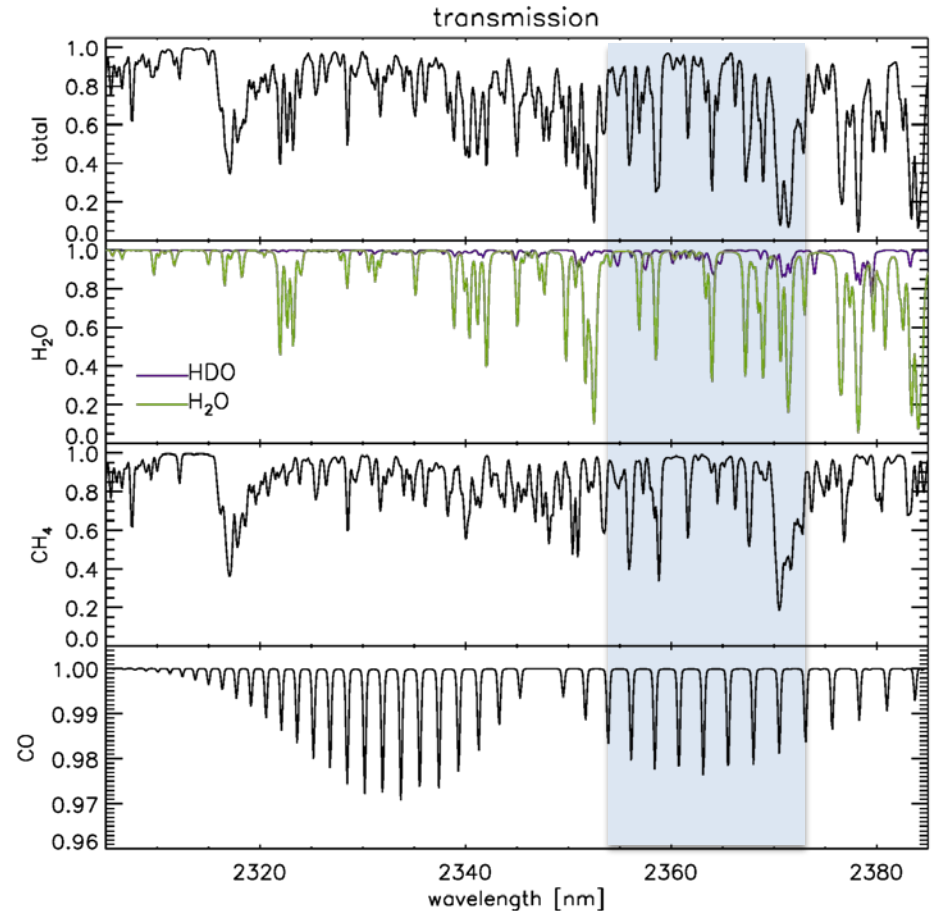
More information oral: Thursday, 11:00 hr Borsdorff



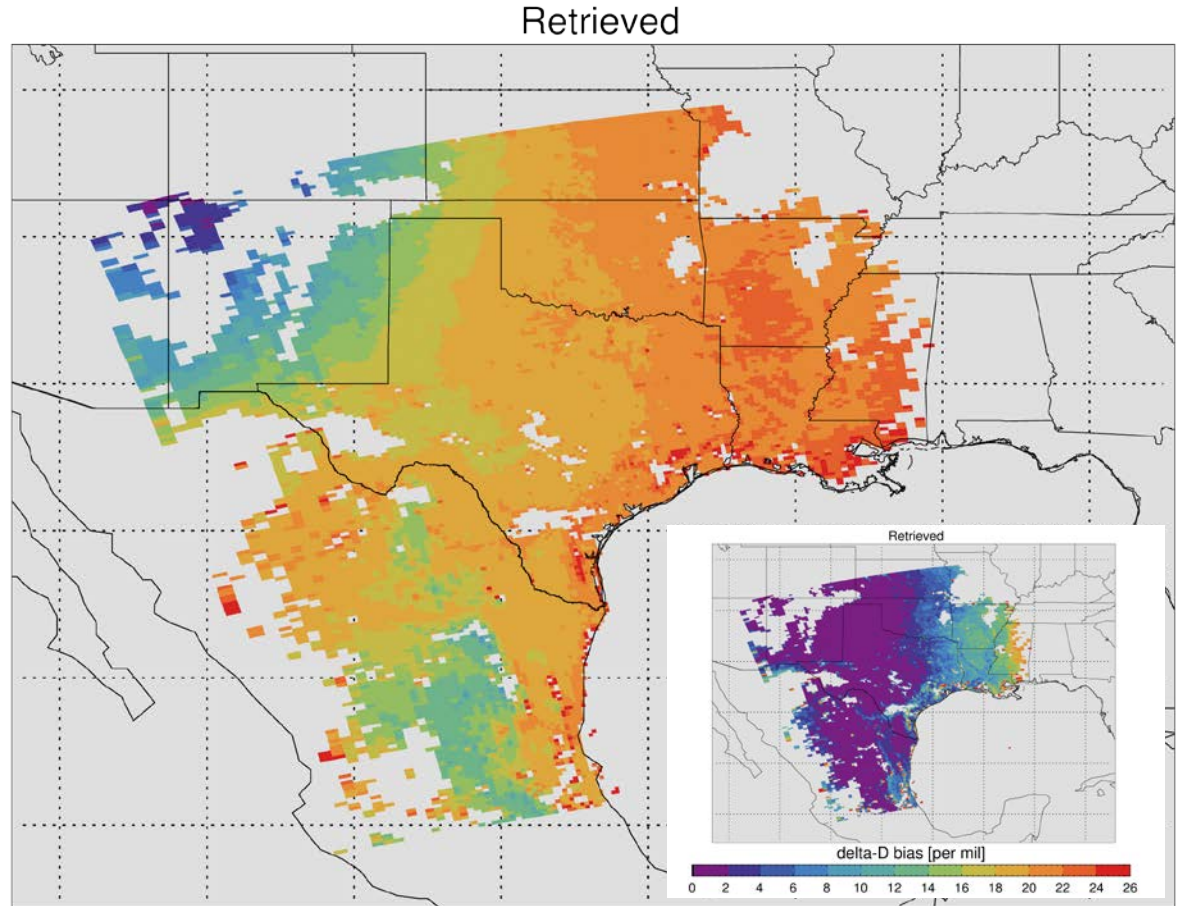
Scientific data product: HDO/H₂O

Band 1: 2354-2374 nm

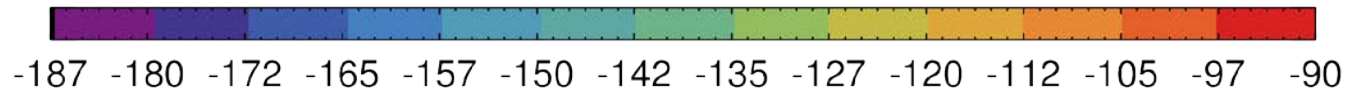
- Retrieval window: 2354–2374 nm, containing H₂O, HDO, H₂¹⁸O, CH₄ and CO lines
- Retrieval algorithm: simplified non-scattering version of the operational CO algorithm, requiring land-only, cloud-free conditions
- Cloud filtering is based on a two-band (weak vs strong) methane or water absorption approach
- Not part of the operational data stream



Estimate retrieval performance from simulated measurements

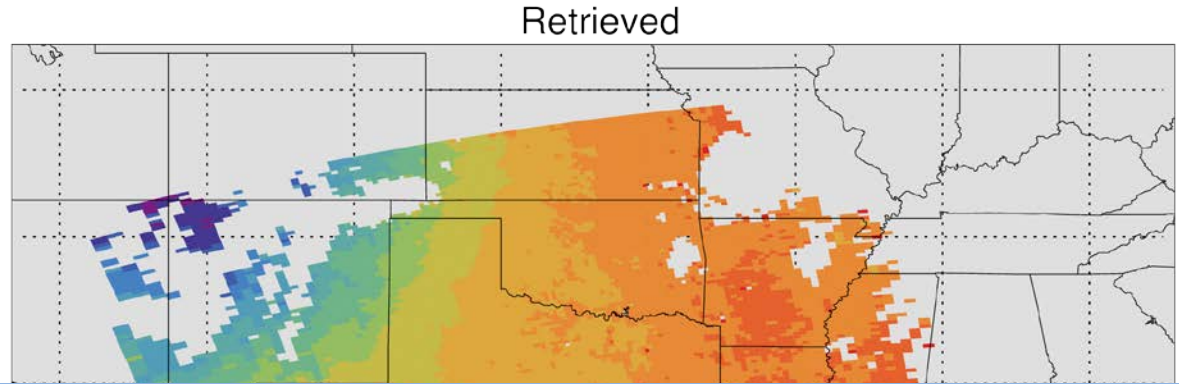


delta-D [per mil]



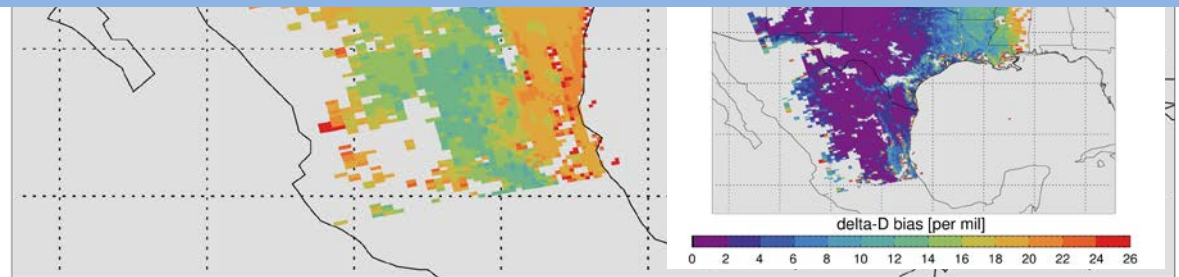
Reference:
Scheepmaker, R.A., *et al.*, 2015

Estimate retrieval performance from simulated measurements

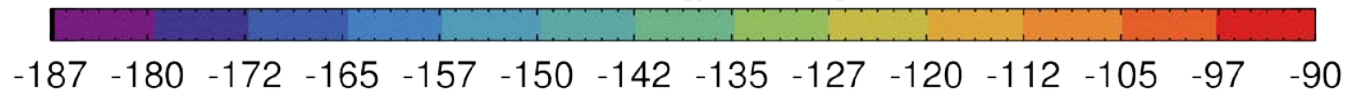


More information: Poster 11 Scheepmaker et al.

Reference:
Scheepmaker, R.A., *et al.*, 2015

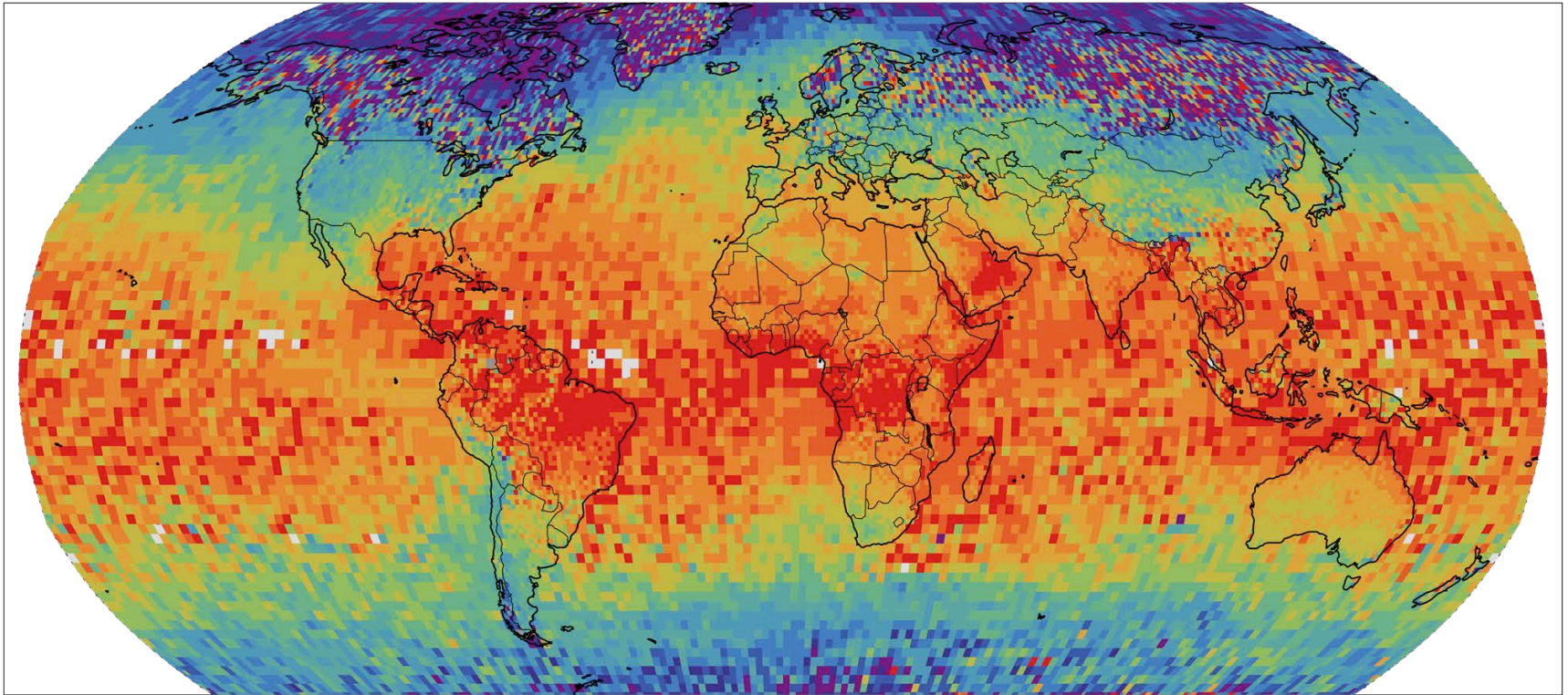


delta-D [per mil]

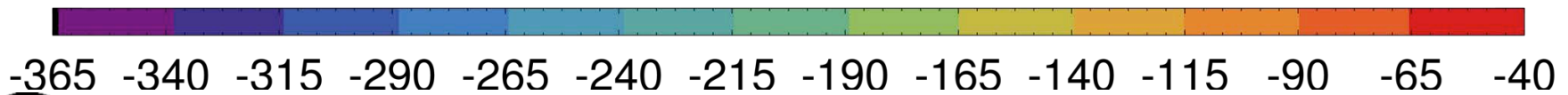


SCIAMACHY Heritage

IMAP v2.0 2003-2007 Offset Corrected



delta-D [per mil]



- CO and CH₄ operational algorithms are in place and compliant with user requirements
- Algorithms are verified with independent algorithms (poster 23, Krings, IUP Bremen)
- Algorithms have GOSAT and SCIAMACHY heritage
- Next to operational software, we need scientific algorithm development (Requires L1 data dissemination)