

Water vapour Isotopologues from TROPOMI (WIFT)

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ATMOSPHERE

Introduction

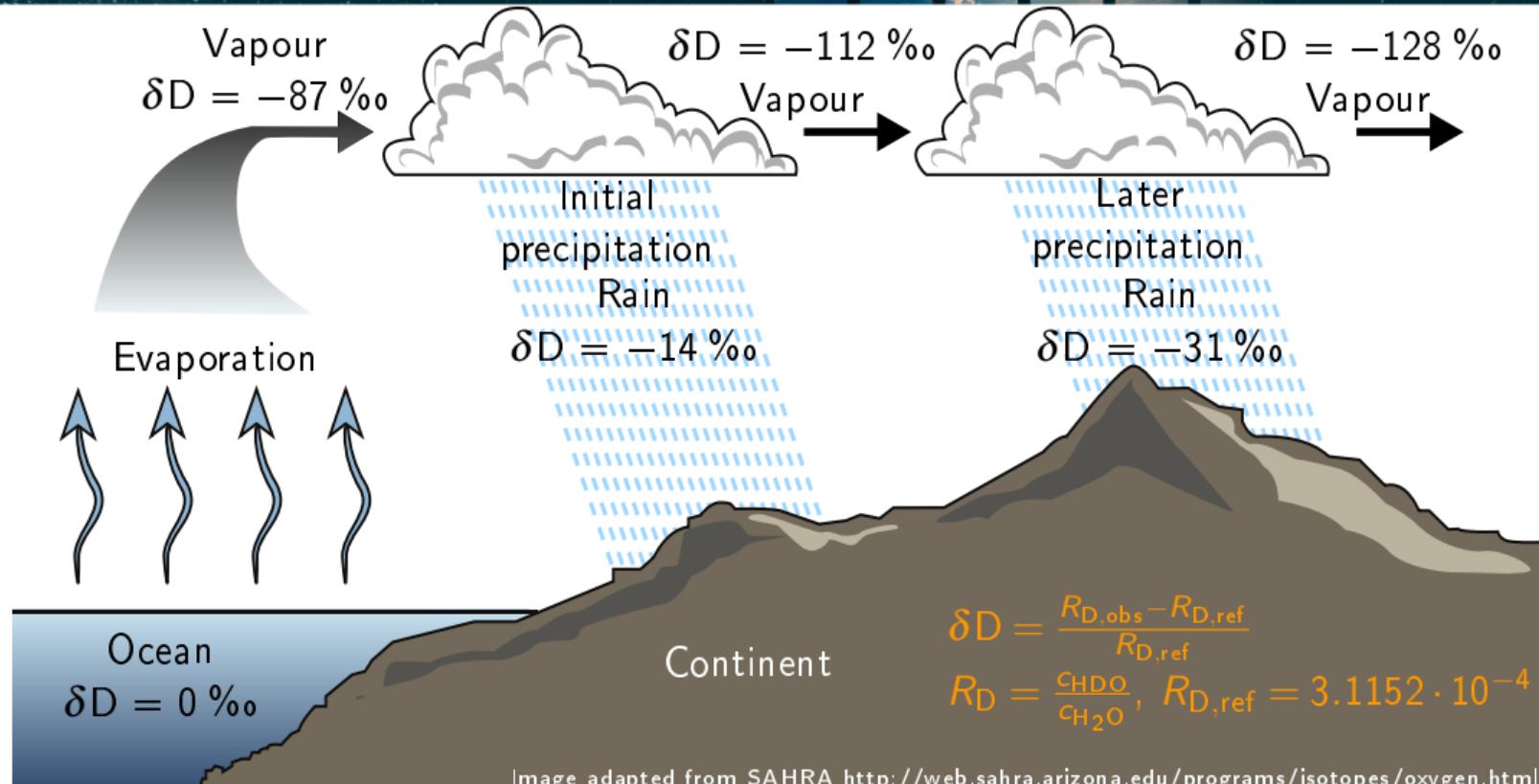


Image adapted from SAHRA <http://web.sahra.arizona.edu/programs/isotopes/oxygen.html>

Project objectives



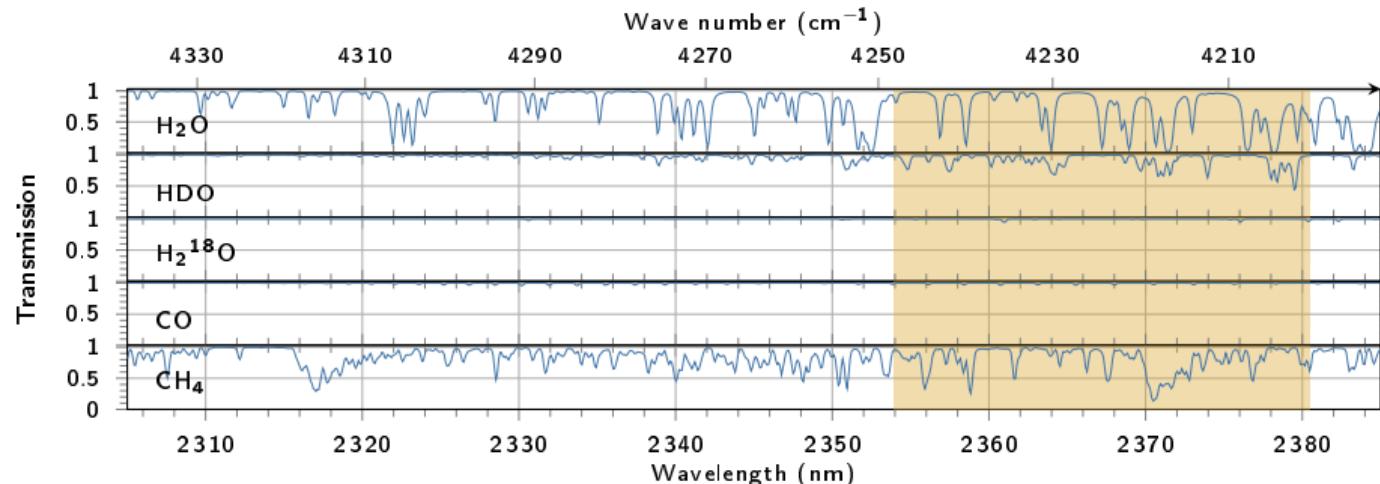
- Develop a validated water vapour isotopologue data product for TROPOMI
 - Non-scattering retrieval: clear sky scenes over land
 - Scattering retrieval: scenes with clear sky or low clouds
- Science study on hydrological cycle using the new data set



- Clear-sky data set produced
- Problem with reference data set for validation: bias in TCCON HDO data product!
- Made correction of TCCON HDO product, validated clear-sky data set
- First scientific case study using single overpass data of new set
- Published results in Atmospheric Measurement Techniques (AMT)
- Began ongoing work on retrievals over low clouds, still problems with cloud detection

Retrieval setup

- Profile-scaling approach with SICOR algorithm



- Fit of H_2O , HDO, CH_4 , CO, and Lambertian surface albedo
- Scattering cross-sections from HITRAN 2016
- Ignoring scattering in forward model, cloud filtering with VIIRS

Validation data sets: ground based FTIR measurements



- Fourier transform infrared (FTIR) observations of direct solar beam
- Two networks of stations: Total Carbon Column Observing Network (TCCON) and Network for the Detection of Atmospheric Composition Change (NDACC)
- Seven stations in both networks



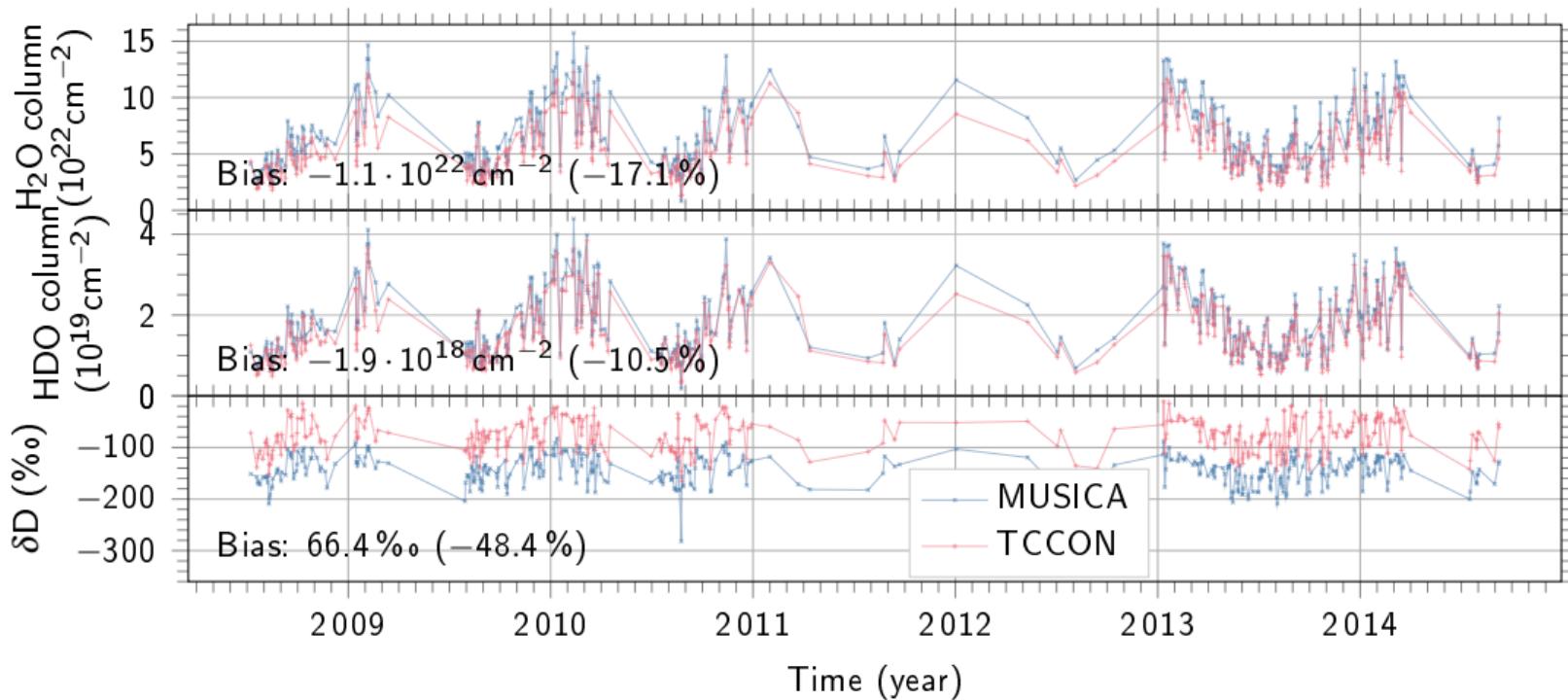
Image: KIT

- TCCON data product
 - H₂O and HDO included
 - H₂O column validated with and adapted to in situ measurements
 - Data available 3 months to 1 year after measurement
- NDACC-MUSICA data product
 - Multi-platform remote Sensing of Isotopologues for investigating the Cycle of Atmospheric water
 - Dedicated water vapour isotopologue product from reprocessed NDACC observations
 - Includes H₂O, HDO and H₂¹⁸O
 - δD validated with aircraft measurements
 - Available until 2014 ⇒ no temporal overlap with TROPOMI



Differences between TCCON and NDACC-MUSICA

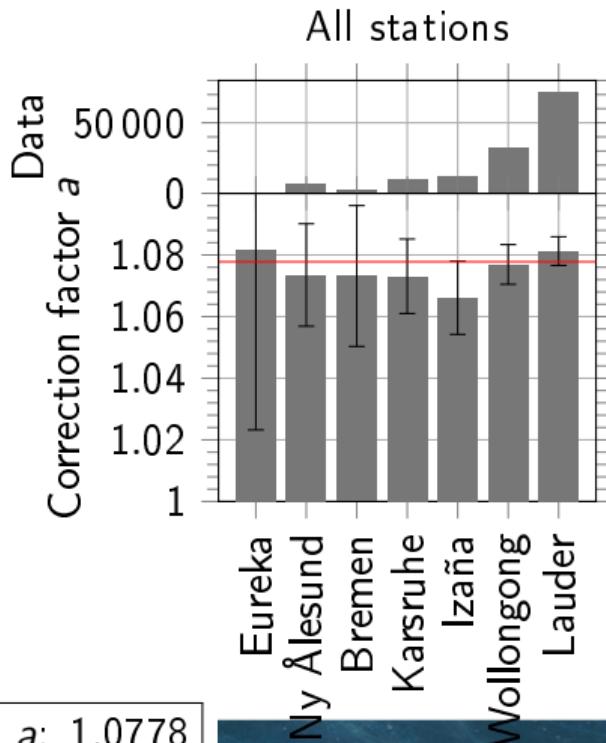
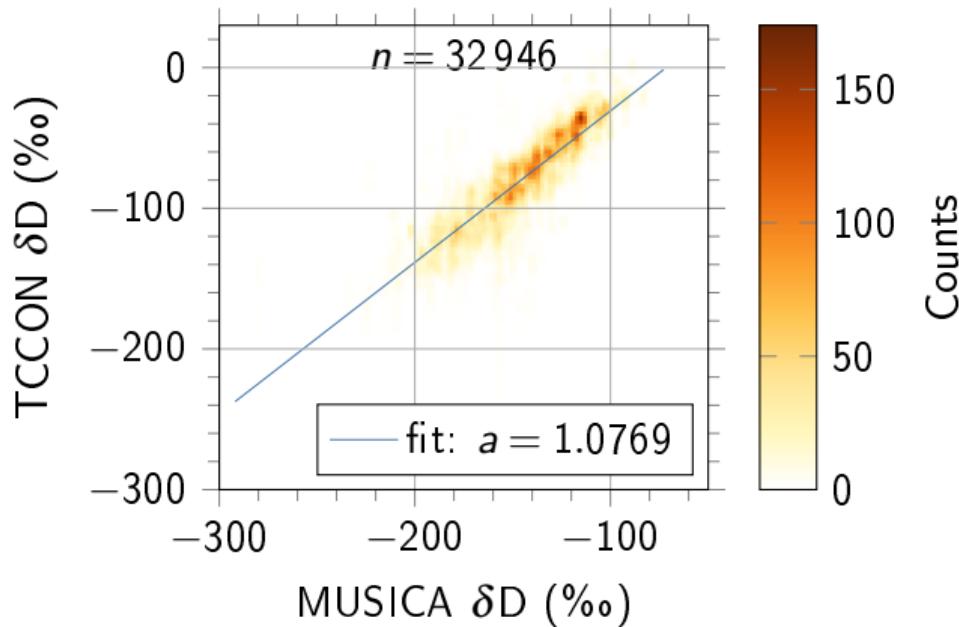
Wollongong, Australia: daily means



Correcting inconsistency in validation data sets

- Scaling of HDO with factor a equivalent to $\delta D \mapsto a\delta D + a - 1$

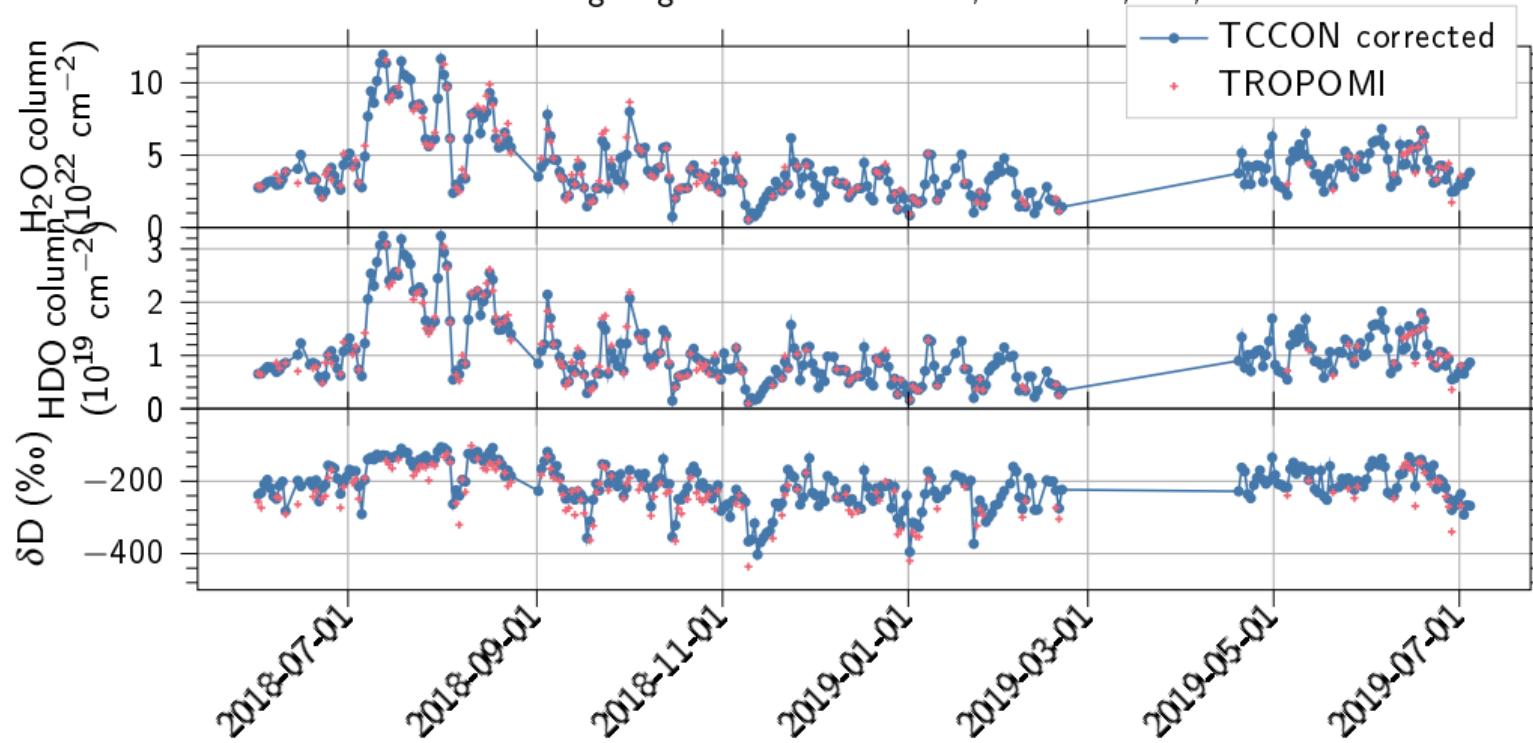
Wollongong, Australia



Validation of TROPOMI: time series Edwards



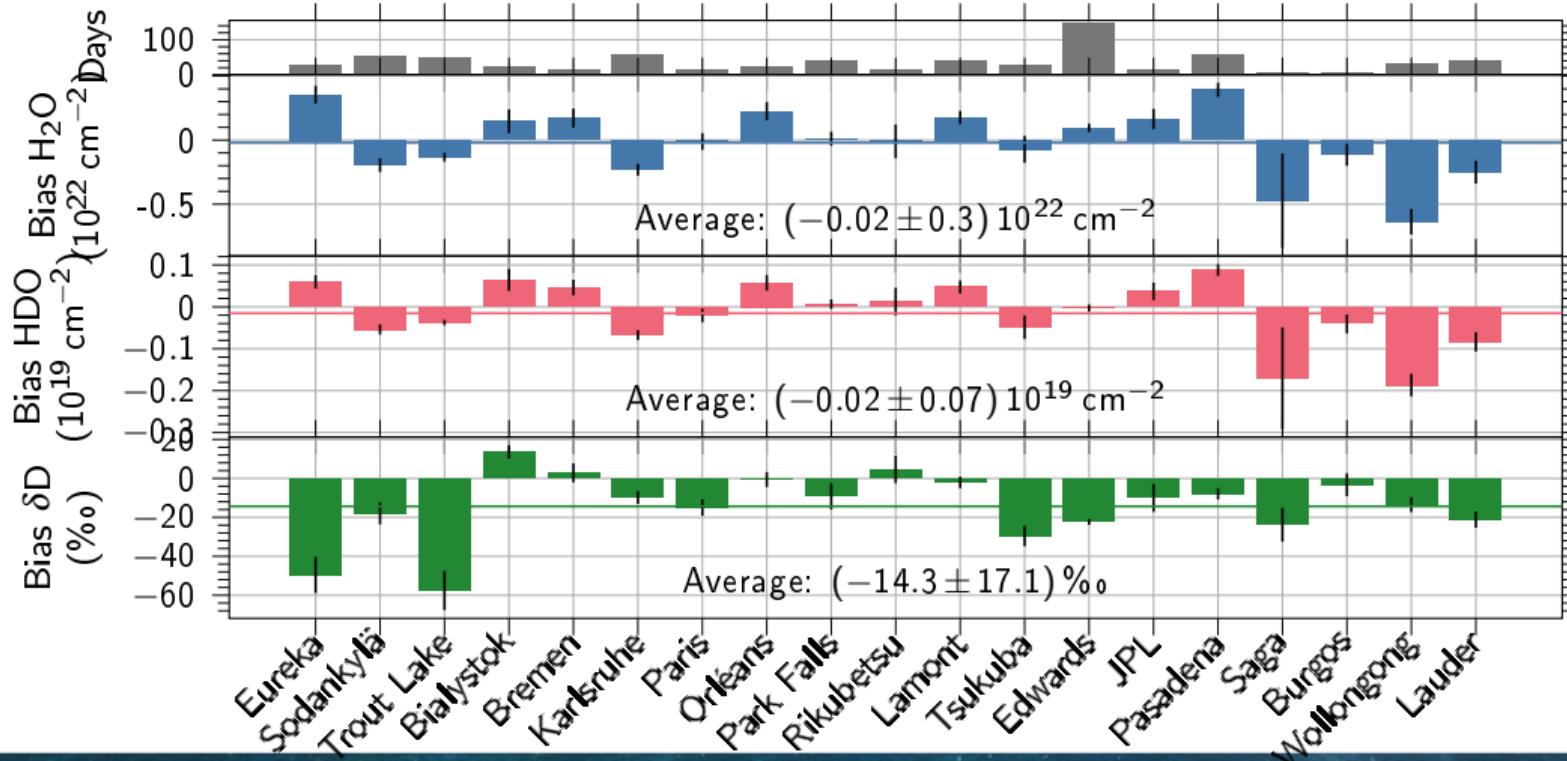
Armstrong Flight Research Center, Edwards, CA, USA



Validation of TROPOMI: all stations



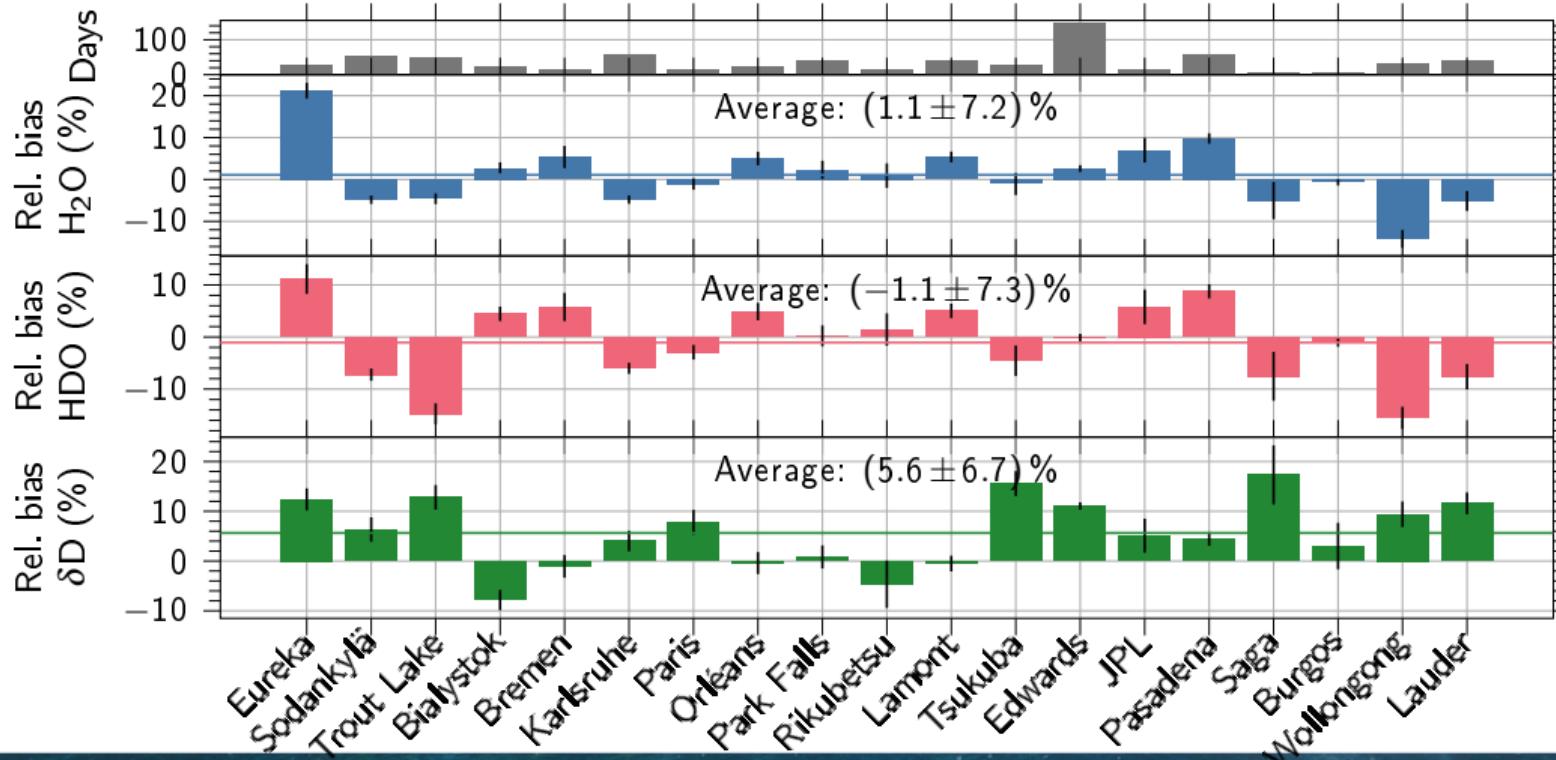
Collocation radius 30 km, FOV 45°, time difference 2 h



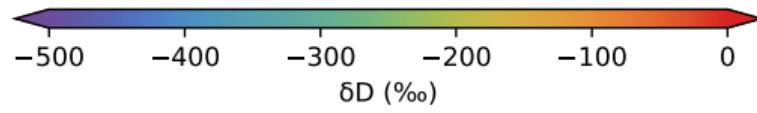
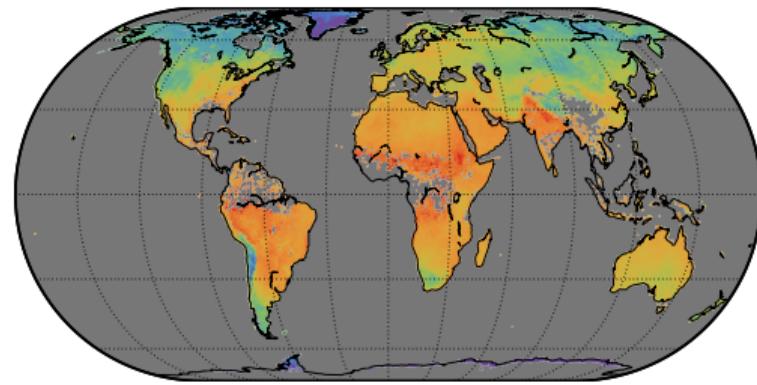
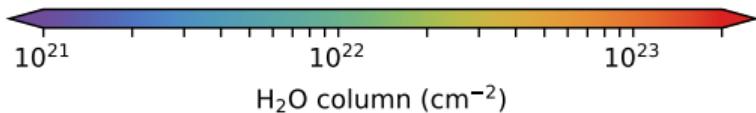
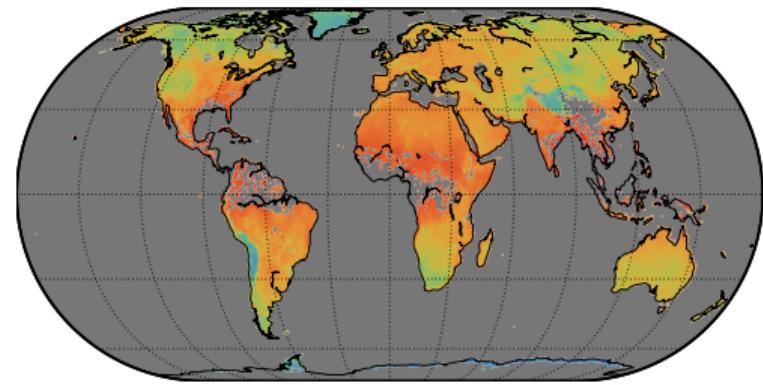
Validation of TROPOMI: all stations



Collocation radius 30 km, FOV 45°, time difference 2 h

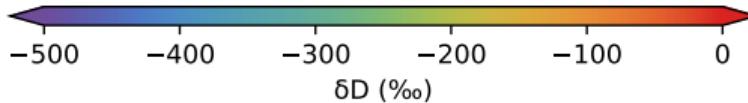
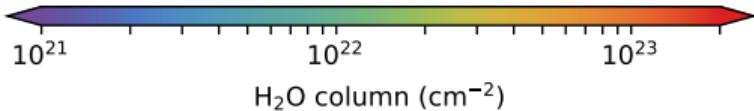
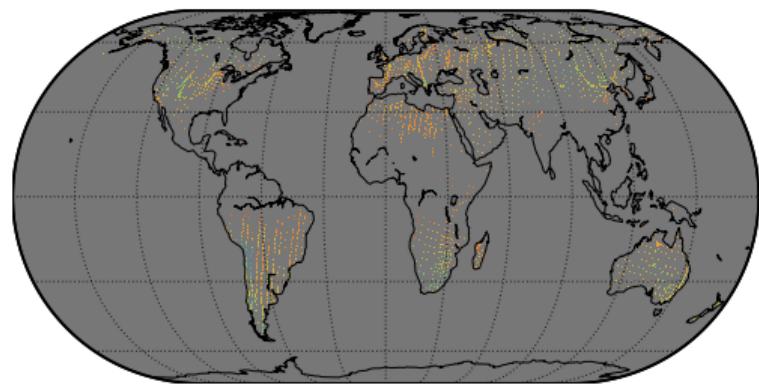


Results: global plot September 2018



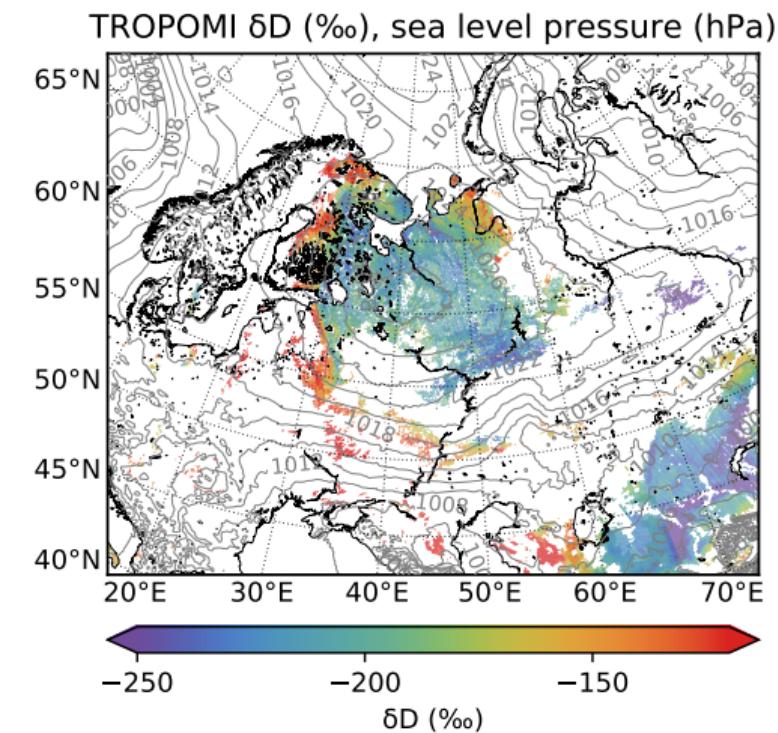
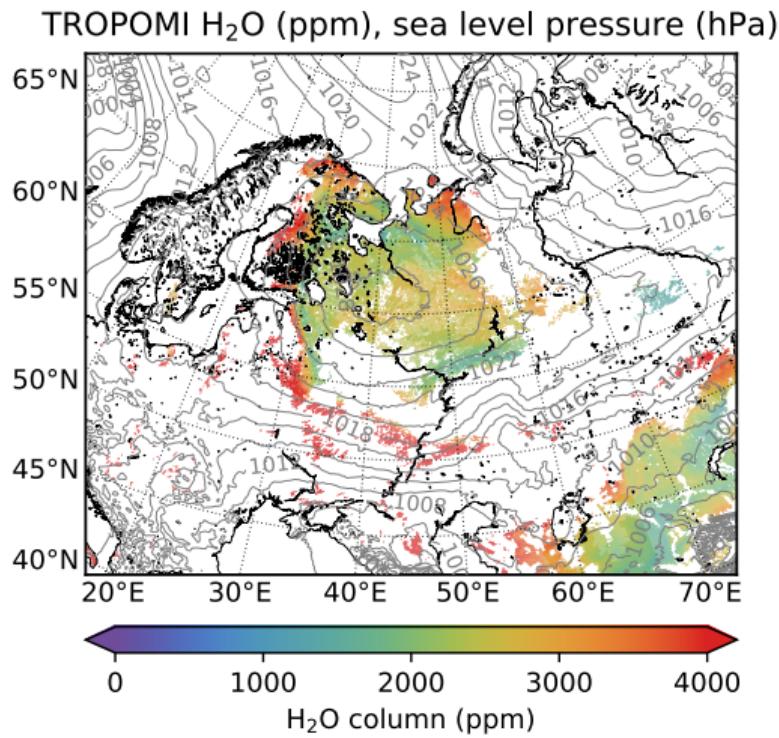
Unprecedented coverage with sensitivity for the whole column!

Comparison: GOSAT September 2018

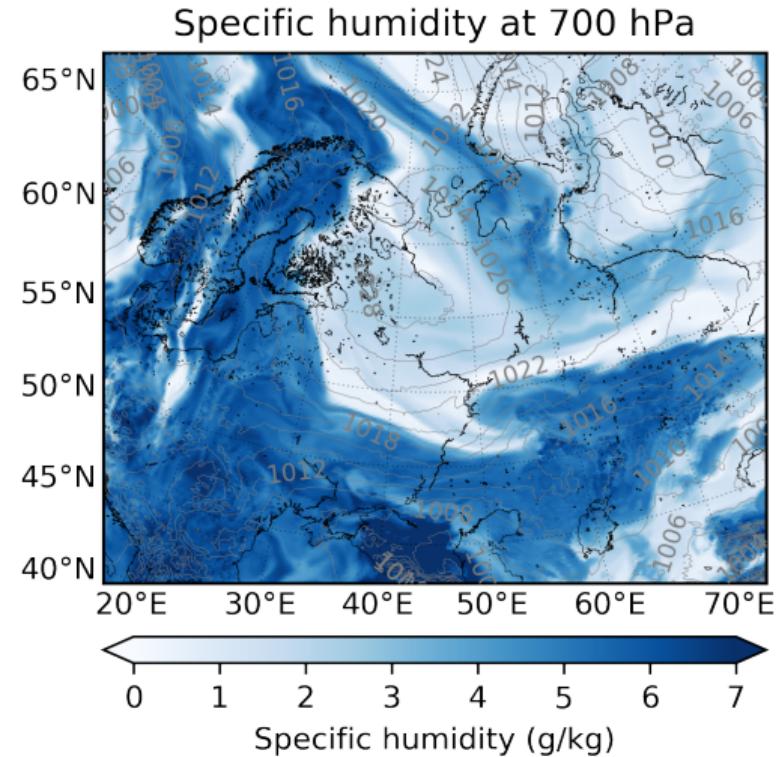
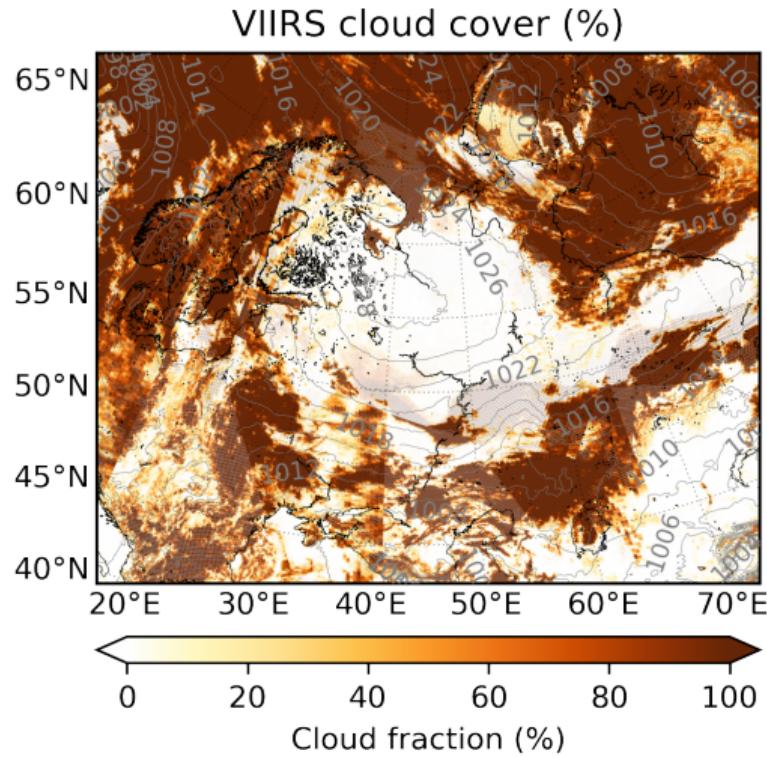


State of the art

Single overpass results for 30 Jul 2018



Stationary blocking on 30 Jul 2018



Summary and advancement vs. state of art



- State of art: $\text{H}_2\text{O}/\text{HDO}$ from satellite either from thermal infrared (no sensitivity in boundary layer) or with bad spatial coverage
- Achievement: first $\text{H}_2\text{O}/\text{HDO}$ satellite data set with good data quality, daily global coverage with high spatial resolution and sensitivity in the boundary layer
- Problem with reference data sets: bias in TCCON corrected by scaling HDO to match MUSICA δD for collocated measurements
- Good agreement of TROPOMI with corrected TCCON
- Single overpass results allow new interesting case studies
- High demand from isotopologue community

TROPOMI results contain modified Copernicus Sentinel data.

Next steps



- Data product over low clouds with scattering retrieval
 - Solve problems with cloud detection
 - Process new data set and validate it
 - Publish and release second data set
- Compare with model simulations
- Science study in cooperation with isotopologue community (future users)

Outlook: tackling the bias in TCCON

- New project to create an in situ reference to calibrate TCCON: Water vapour Isotopologue Flask sampling for the Validation Of Satellite data (WIFVOS)
- Flask sampling system on a small (< 15 kg payload) balloon
- Transfer existing drone sampler to balloon platform
- Development and flights at TCCON station Sodankylä
- To be submitted to ESA EO science for society permanently open call

