Retrieving H_2O/HDO columns over cloudy and clear-sky scenes from the Tropospheric Monitoring Instrument (TROPOMI)

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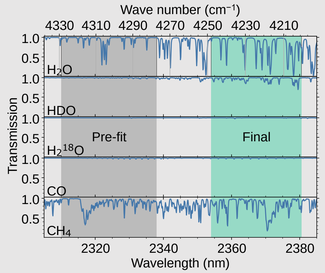
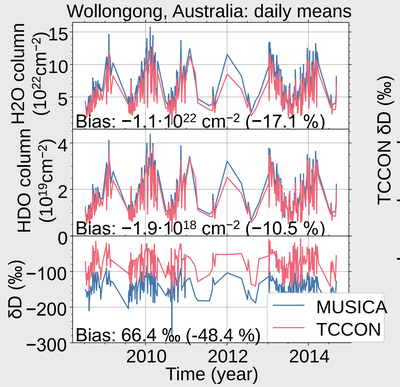
Retrieval

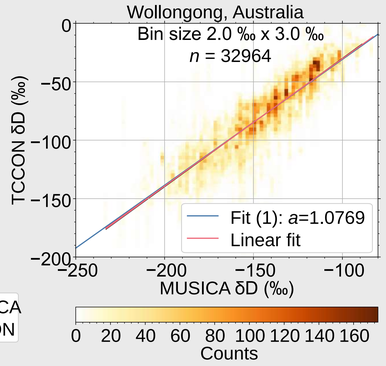
- profile-scaling approach
- account for scattering using Practical Improved Flux Method (PIFM)
- spectral window 2354–2380.5 nm
- fit of H2O, HDO, CH4, CO and Lambertian surface albedo
- fit effective cloud parameters in pre-fit in window 2310–2338 nm
- Scattering cross-sections from HITRAN 2016



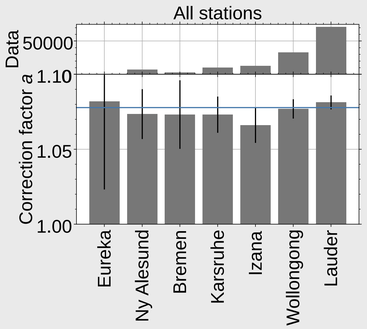
Validation data sets: ground-based FTIR observations

- NDACC-MUSICA: optimised for water isotopologues, data after 2014 only for 3 stations
- TCCON: recent data, but HDO data product not calibrated or validated
- Seven stations in both networks



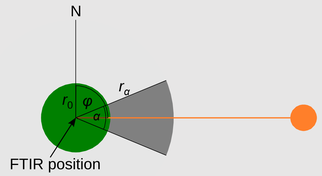


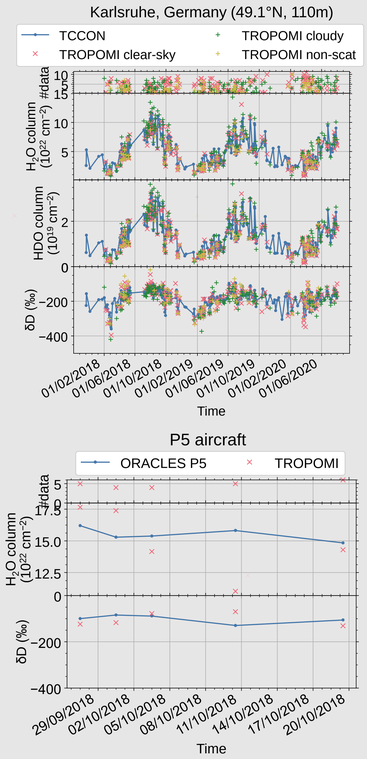
- TCCON H_2O total columns validated
- MUSICA δD profiles validated
- Bias in TCCON HDO
- Difference mainly scaling of column
- Correction: Scale TCCON HDO column by factor *a* to match MUSICA δD
- Equivalent to δD ↦ *a* δD+*a*−1 (1)
- Correction factor shows small variation between stations
- Use average correction factor 1.0778 for all TCCON stations

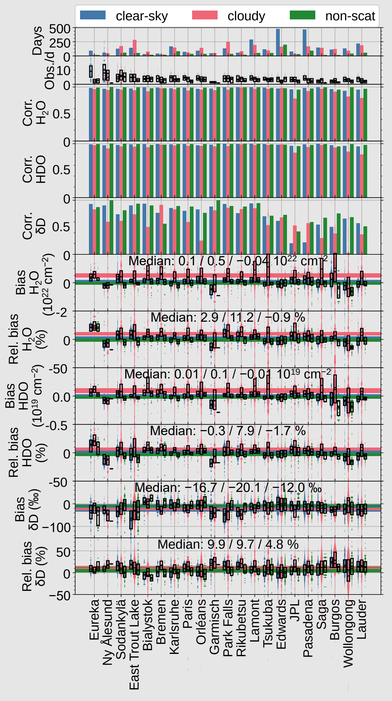


Validation

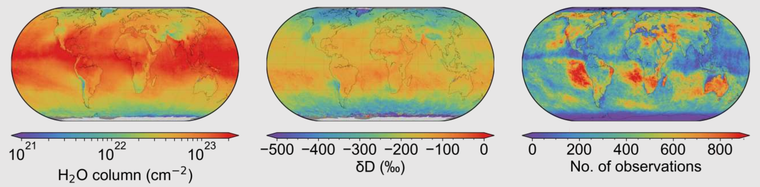
- 2h co-location time
- 30 km radius around station
- cone in FTIR viewing direction with opening angle α depending on solar zenith angle φ
- equal co-location area for all cases





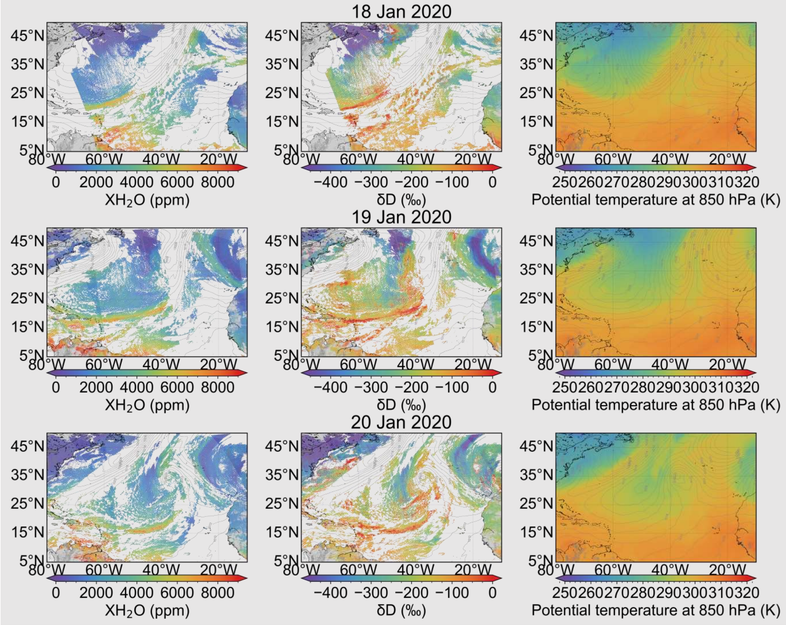


Global picture for September 2018



Application: case study of cold air outbreak using single overpass data

- depleted cold continental air transported from high to low latitudes
- evolution nicely visible on day-by-day basis

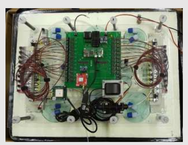


Conclusions

- new TROPOMI H_2O/HDO dataset including cloudy and clear-sky scenes
- huge enhancement in coverage, particularly enabling data over oceans
- retrieval performance under clear-sky conditions similar to old clear-sky-only dataset
- single overpass results enable new case studies

Outlook: calibration of TCCON HDO

- TCCON HDO misses aircraft correction factor which accounts for errors due uncertainties in spectroscopy that tend to be highly reproducible
- currently no in situ HDO measurements at TCCON stations available
- development of novel balloon-borne flask sampling system to measure tropospheric profiles of HDO
- sampler design based on proven drone-borne instrument (Rozmiarek et al., AMT 2021)
- analysis of samples after recovery using Picarro analyzer
- field campaign at Sodankylä planned for March 2022
- determination of aircraft correction factor from balloon measurements



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