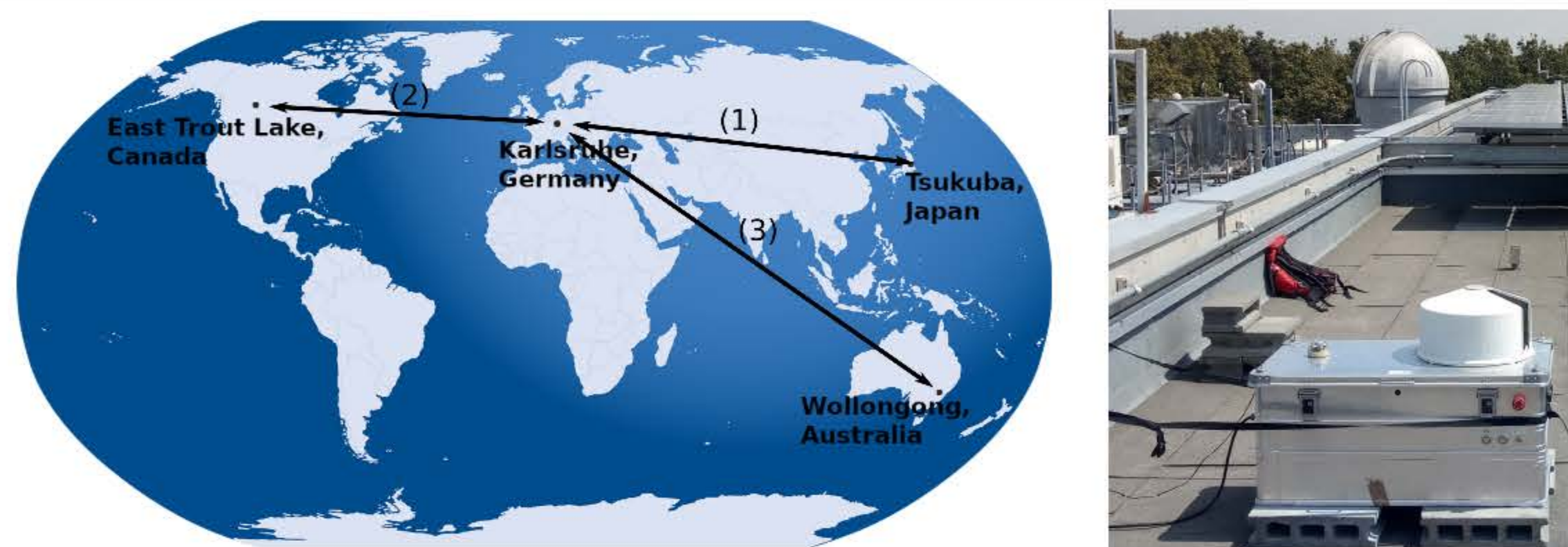


First results of the COCCON Travel Standard in Tsukuba, Japan

Will be presentend at the poster session at
Tuesday 12th of July 18:00 JST

Benedikt Herkommer¹, Frank Hase¹, Jochen Groß¹, Florian Dietrich², Jia Chen², Matthias Frey³, Isamu Morino³, Angelika Dehn⁴ and Paolo Castracane⁴

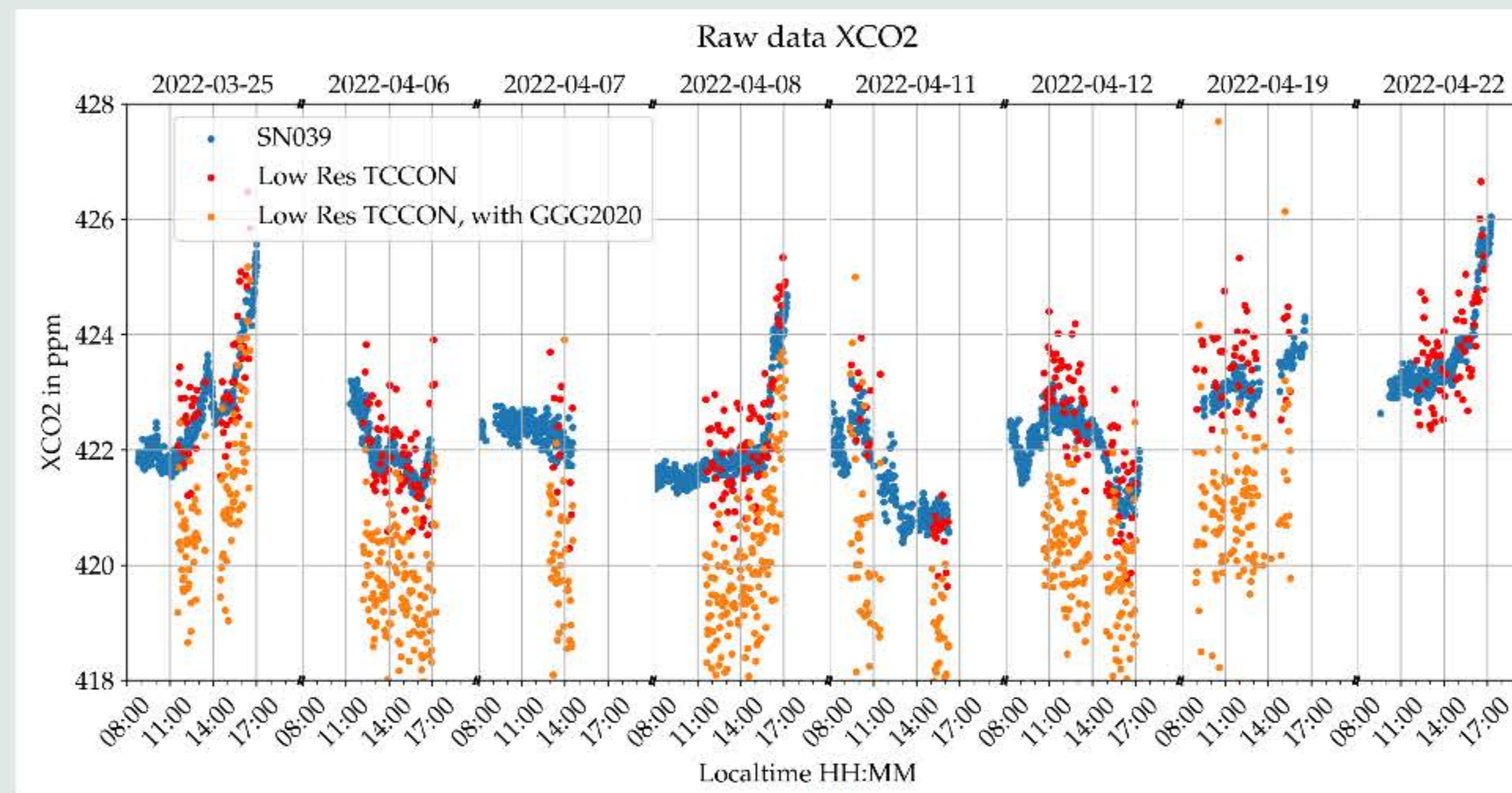
Introduction Travel Standard



- Use the EM27/SUN housed in an enclosure (created by TUM [1]) to visit several TCCON sites.
- By comparing them to a common reference, they can be calibrated against each other.
- Start in Japan (upper right picture), then to ETL, then to Wollongong. Make reference measurement in KA after each station.
- Low-resolution IFS125HR spectra are used for the comparison for matching sensitivities.
- Realizing a direct calibration bridge between TCCON Americas – Europe – Western Pacific

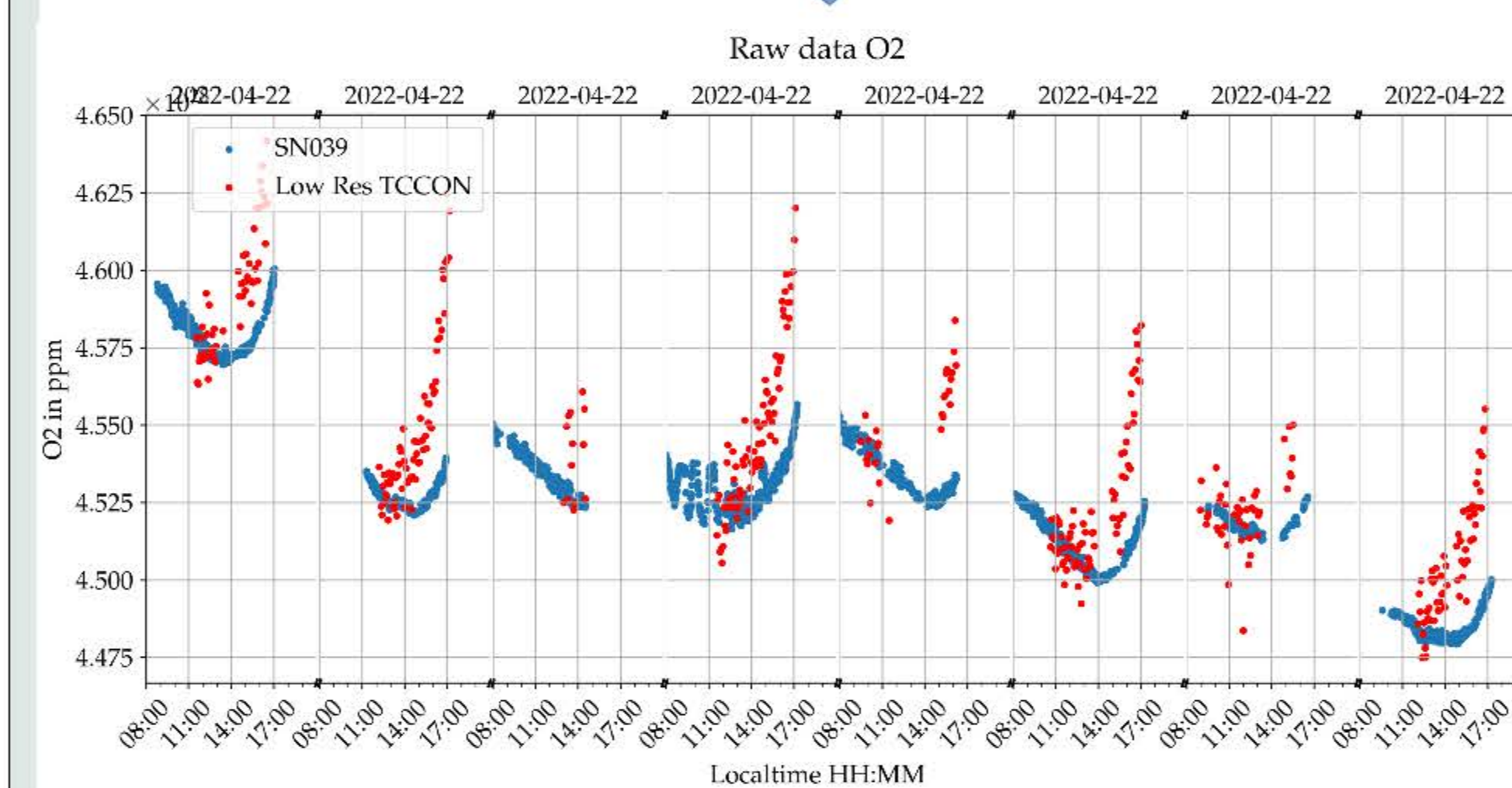


First Results from Tsukuba Site Visit



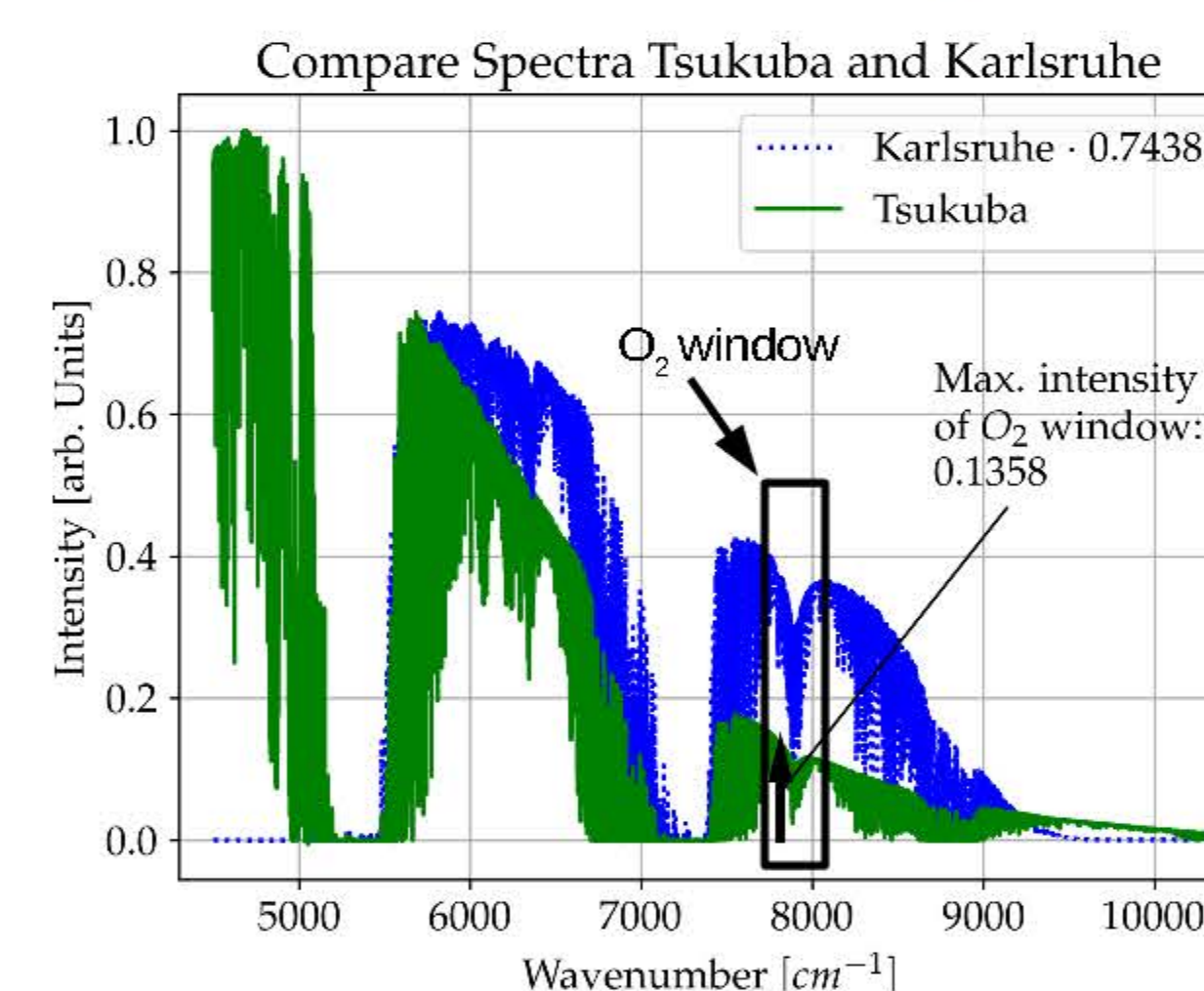
- Retrieved EM27 and low-res[4] TCCON data with PROFFAST.
- Good absolut agreement.
- But high noise level of TCCON XCO₂ product.
- Same noise level is found when performed with GGG2020, too.

What is the reason for the noise?



- Xgas is calculated by:
 $X_{Gas} = \frac{VC_{Gas}}{VC_{O_2}} \cdot 0.2095$
with
VC_{Gas}: the total number of molecules in a column.
- A noisy O₂ retrieval leads to XGas with a lot of noise.

What is the reason for the noise in VC_{O₂}?

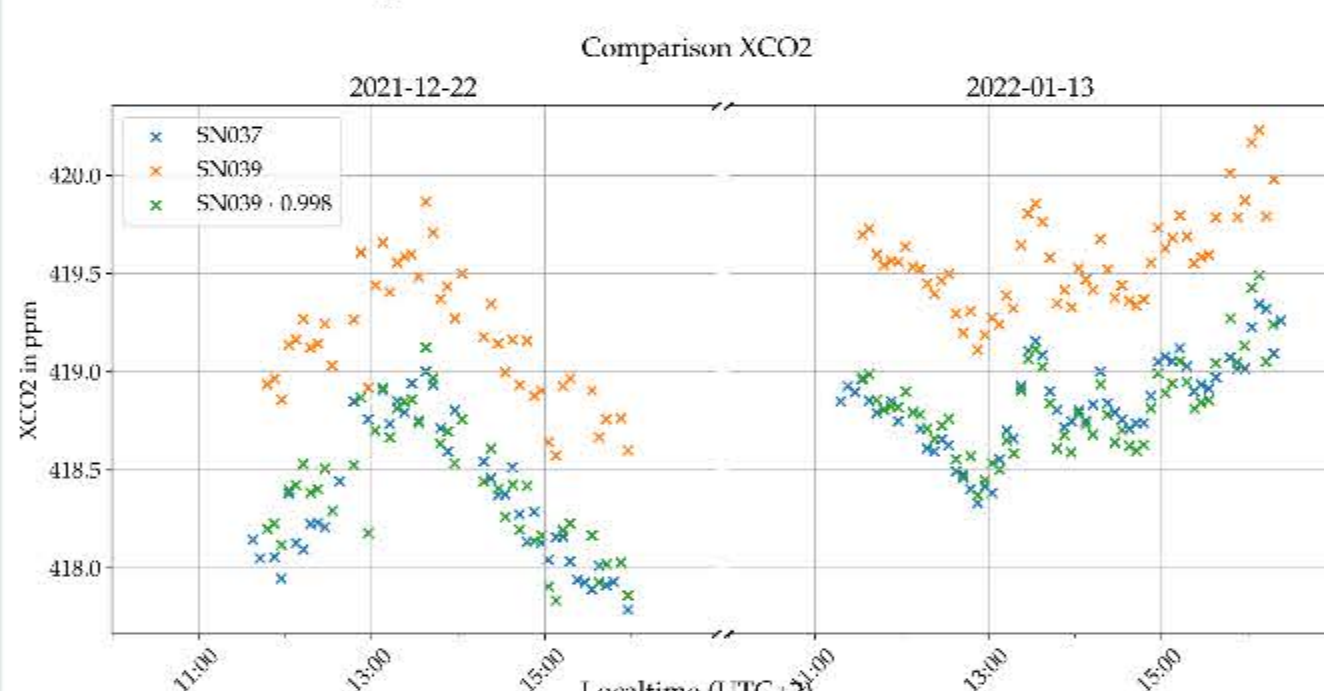


- Comparing the spectra of TCCON Karlsruhe and TCCON Tsukuba reveals a strong decrease at higher wavenumbers.
- This results in a low signal-to-noise ratio at the O₂ window compared to the other windows.
- A reason for the decrease an issue with the detector or the beamsplitter is assumed.
- This raises the question:
Is this an issue for other TCCON stations, too?

Side-by-side Calibration in Karlsruhe

Between target site visits, the travel standard stops over at KIT for performing open-path and side-by-side measurements with the COCCON reference and the TCCON spectrometer, and for implementing required modifications.

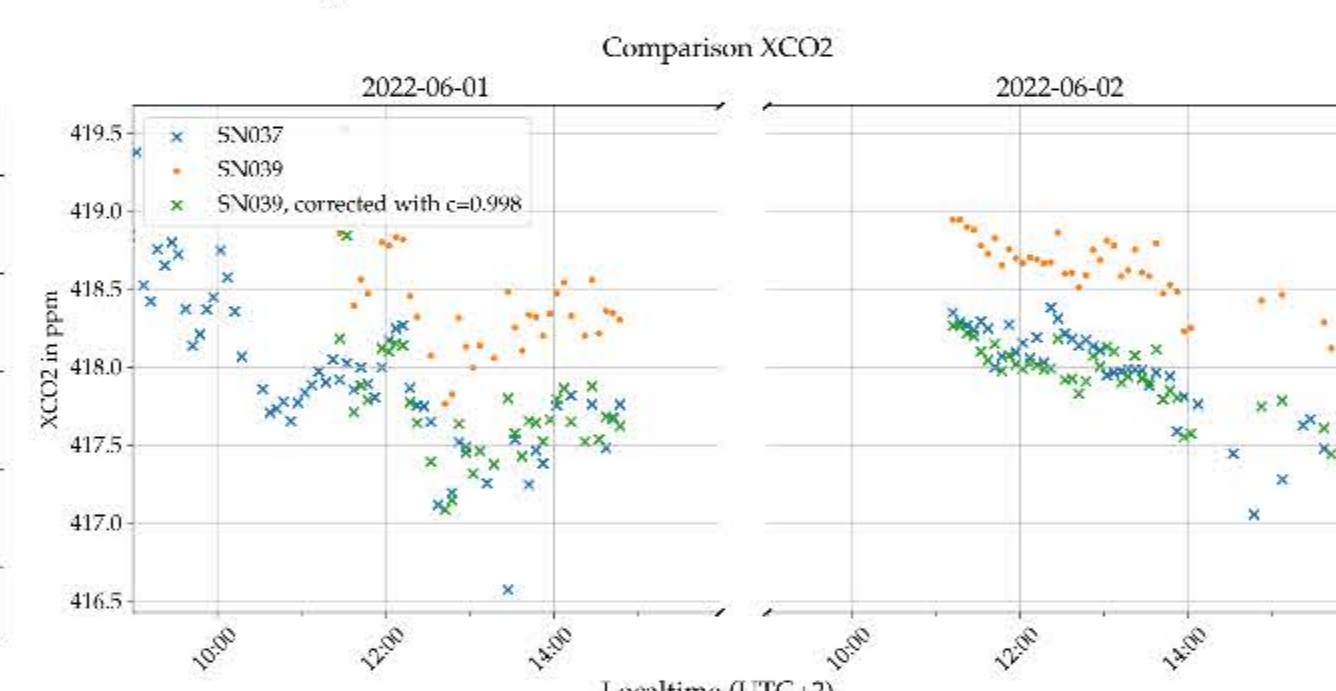
Before Japan:



Correction factors before Japan:

- XCO₂: 0.99824
- XAIR: 0.99647
- XCH₄: 1.00103

After Japan, before Canada:

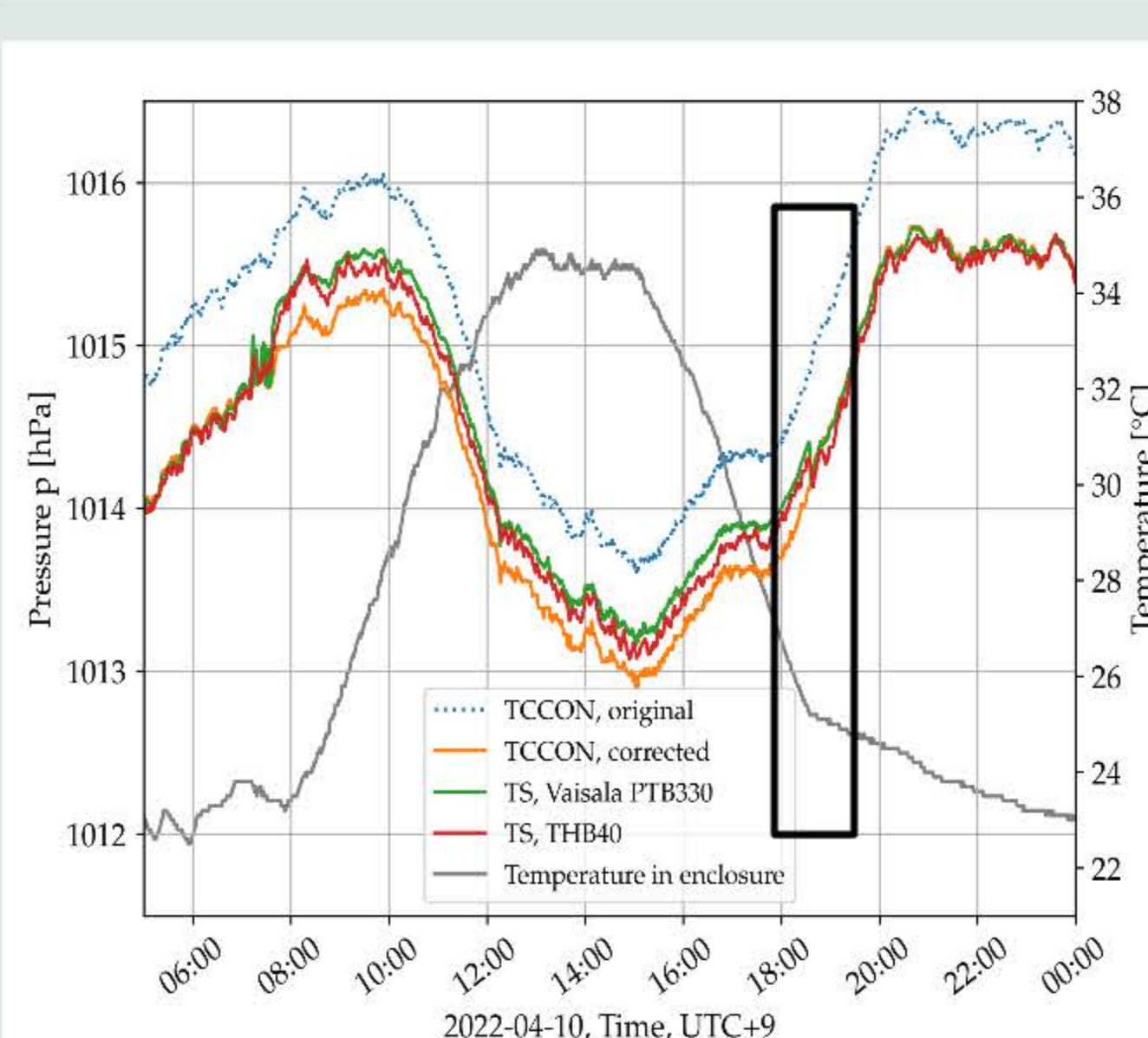


Corr. factors after Japan; Deviation in %:

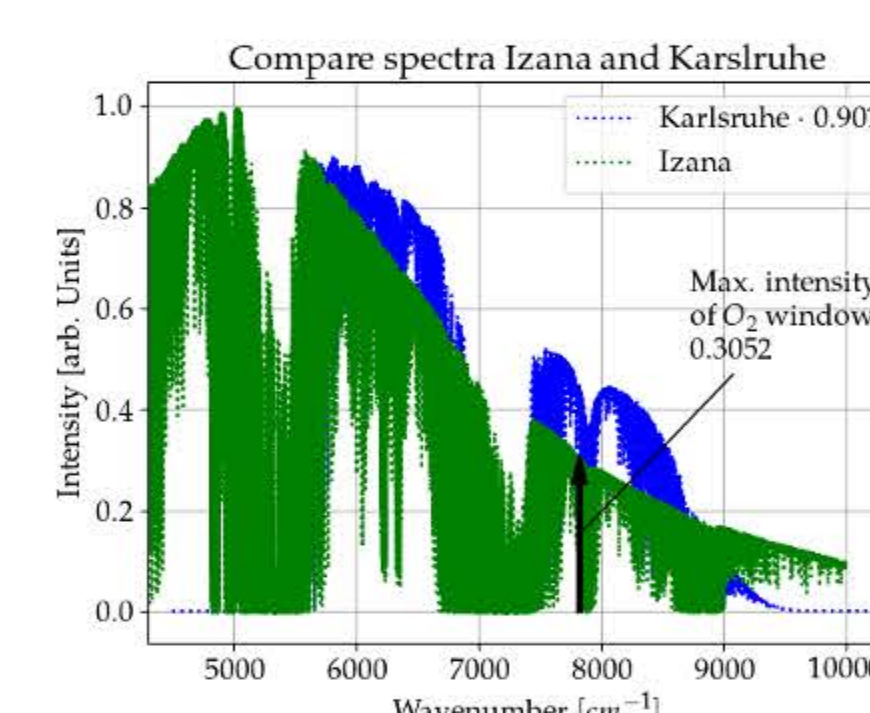
- XCO₂: 0.99837; 0.01375 %
- XAIR: 0.99731; 0.08448 %
- XCH₄: 1.00083; -0.01946 %

Good agreement of before and after visit of Tsukuba

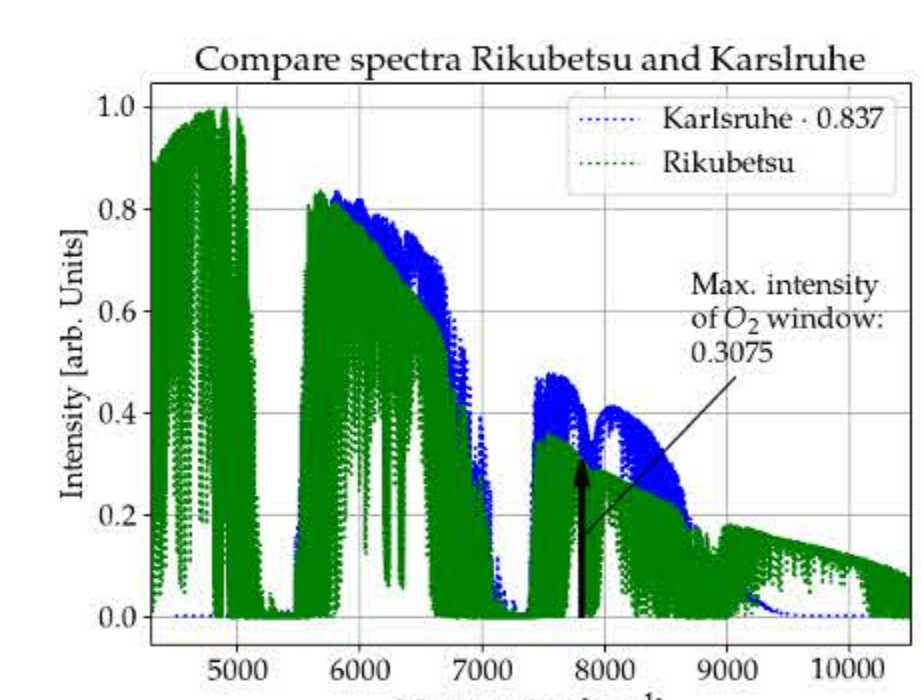
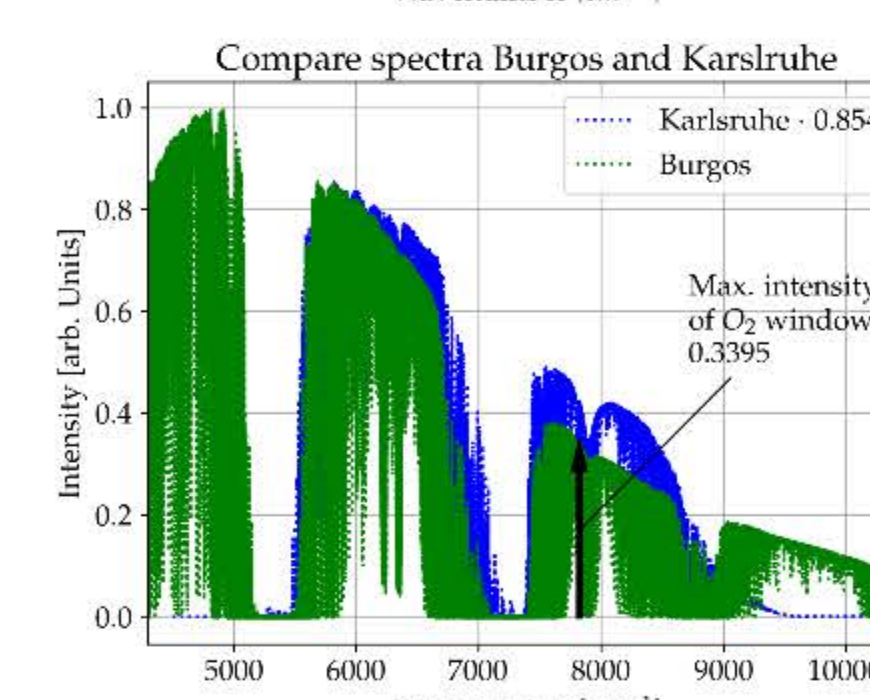
Lessons Learned: Pressure Records



- TCCON, original is corrected for height and instrument specific bias.
- Sudden pressure rise in enclosure (THB40 and Vaisala) found when venting fan starts to operate.
- See the black squared area: The temperature decreases slower (fan is off) and pressure are on the same level again.
- Solution: "Pressure measurement cup": A hole in the enclosure, covered by a cup and a pip leading to the outside.



- Check other stations: Norm the maximum value to unity and determine the maximum in the O₂ window.
- So far the spectra look better than the one of Tsukuba. However, still worse than the spectrum of Karlsruhe
- **Currently ongoing research with spectra of various other stations to find the reason and check if this is an widespread issue within the network.**



Literature, Affiliation and Contact

- [1] Dietrich, F. et al., MUCNet: Munich Urban Carbon Column network, Atmos. Meas. Tech., 14, 1111–1126, 2021
- [2] Heinle et al., Automated enclosure and protection system for compact solar-tracking spectrometers, Atmos. Meas. Tech., 11, 2173–2185, 2018
- [3] Frey et al., Building the Collaborative Carbon Column Observing Network(COCCON): long-term stability and ensemble performance of the EM27/SUN Fourier transform spectrometer, Atmos. Meas. Tech., 12, 1513–1530, 2019.
- [4] Petri, C. et al., Remote sensing of CO₂ and CH₄ using solar absorption spectrometry with a low resolution spectrometer, Atmos. Meas. Tech., 5, 1627–1635, 2012

- 1: Karlsruhe Institut of Technology (KIT)
- 2: Environmental Sensing and Modeling Technical University of Munich (TUM), Germany
- 3: National Institute of Environmental Studies (NIES), Japan
- 4: European Space Agency (ESA)

* contact:
Benedikt Herkommer
benedikt.herkommer@kit.edu