# Kiruna site report

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ATMOSPHERIC TRACE GASES AND REMOTE SENSING (ASF)

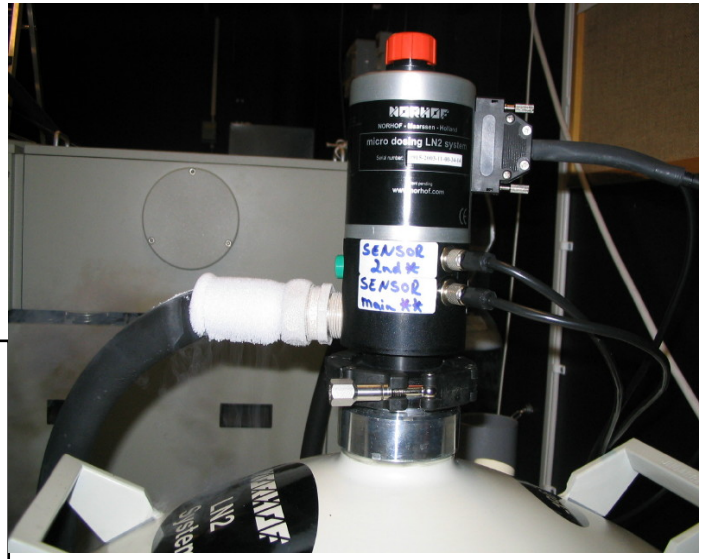


# Kiruna site report

- Start in 03/1996, > **20 years of obs**.!
- **Regular cell** measurements
- **Remote control** since 2004
- **Upgrade to 125 HR** in July 2007
- **Camtracker software** in 9/2010
- **In 2018: 102** days of observation
  thks to good weather cond. & to **Uwe**!
- Solar tracking system failed in
  July & August 2017
- Breakdown of Norhof LN2 filling line
- **Laser broken** in 2010, 2011, 2014 &
  **end of 2018!**
- SIOS laser lifetime incr. fr. 2 to **4a**!

# Kiruna & Izana: Issue with Norhof $LN_2$ filling system

**Just a reminder of last year's slide: Don't forget to replace e-caps in your Norhof and Newport systems after 10 years the latest!**




Recommendation by Jochen Groß:

1. Replace e-caps after 10 years the latest!
2. Use better e-caps (as compared to the original ones)!
3. For further questions please contact him.

Same applies to Newport's controler of solar tracker motor stages!

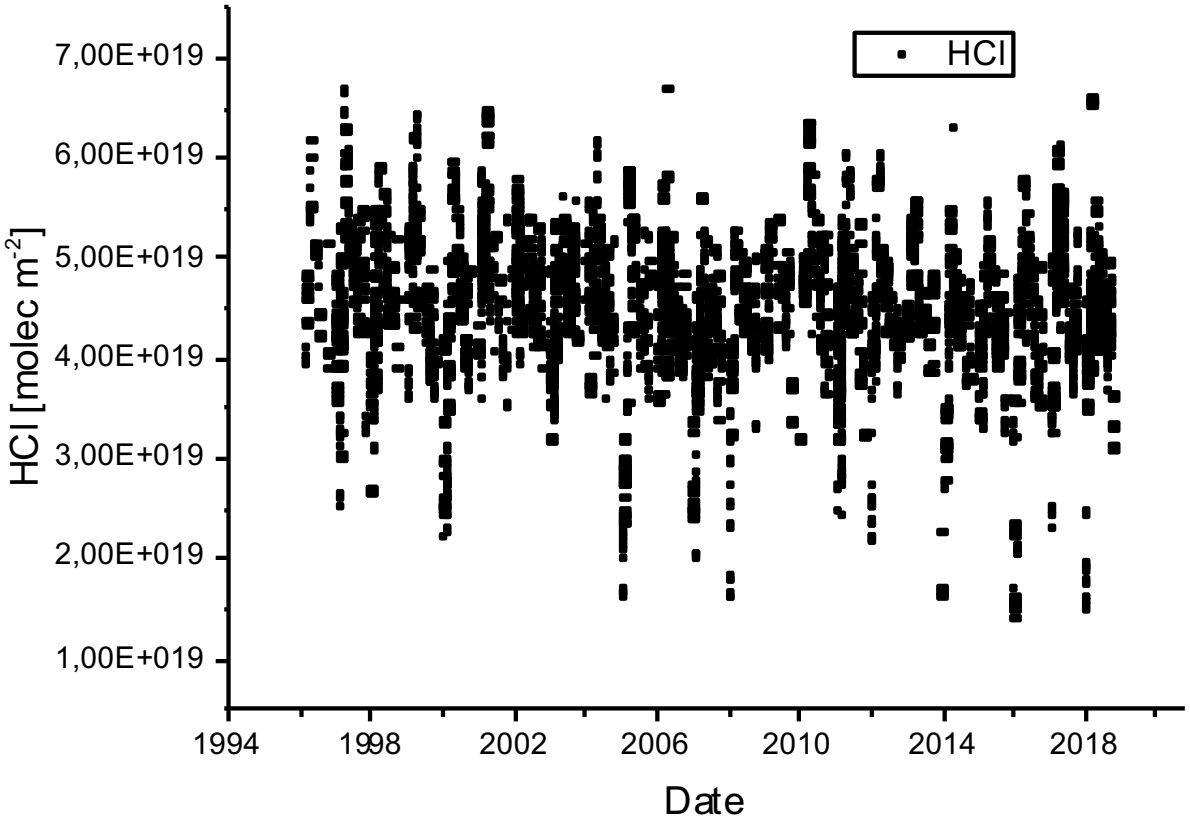
# Kiruna: Data analysis

**Data analysis:**
PROFFIT 9.6

**Data base:**
NASA data: 1996 - end of 2007
HDF data: 1996 - April **2019**

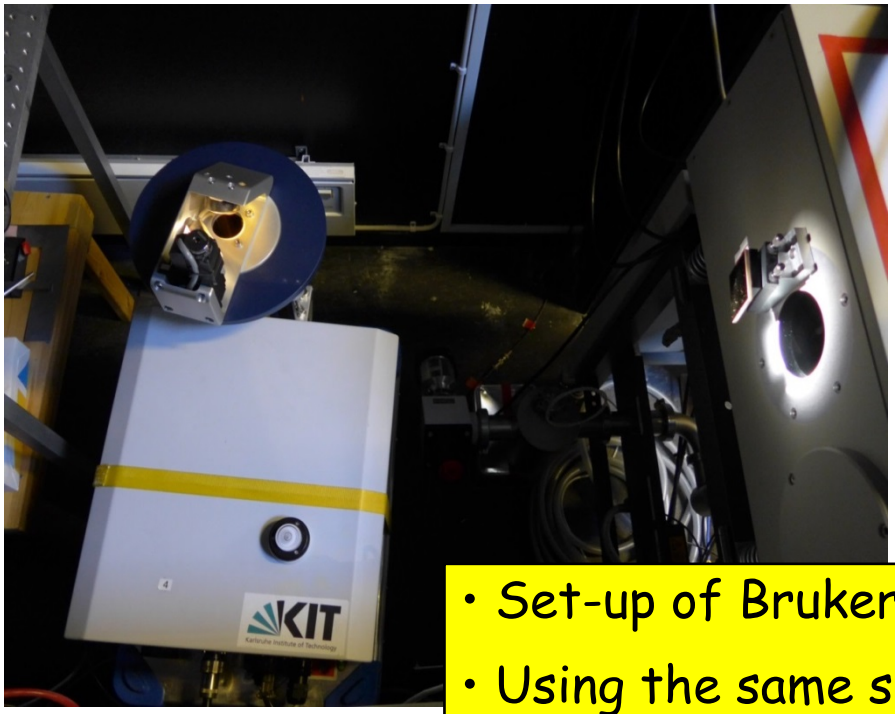
**Species:**
$O_3$, HCl, HF, ($HNO_3$), $N_2O$, $CH_4$, ($ClONO_2$), $C_2H_6$, CO, HCN, $NO_2$, NO
Last archiving date: May **2019**

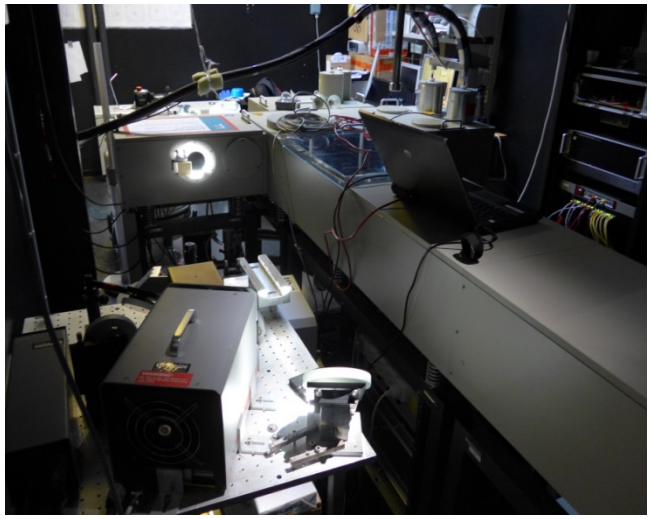
# Kiruna: Time series of HCl




1. Chlorine activation in several winters
2. Negative trend from 1996 to 2009 [Kohlhepp et al., ACP 2011 & 2012]
3. Increase from 2007 to 2011 [Mahieu et al., Nature, 2014]
4. Decrease again since 2012 ?

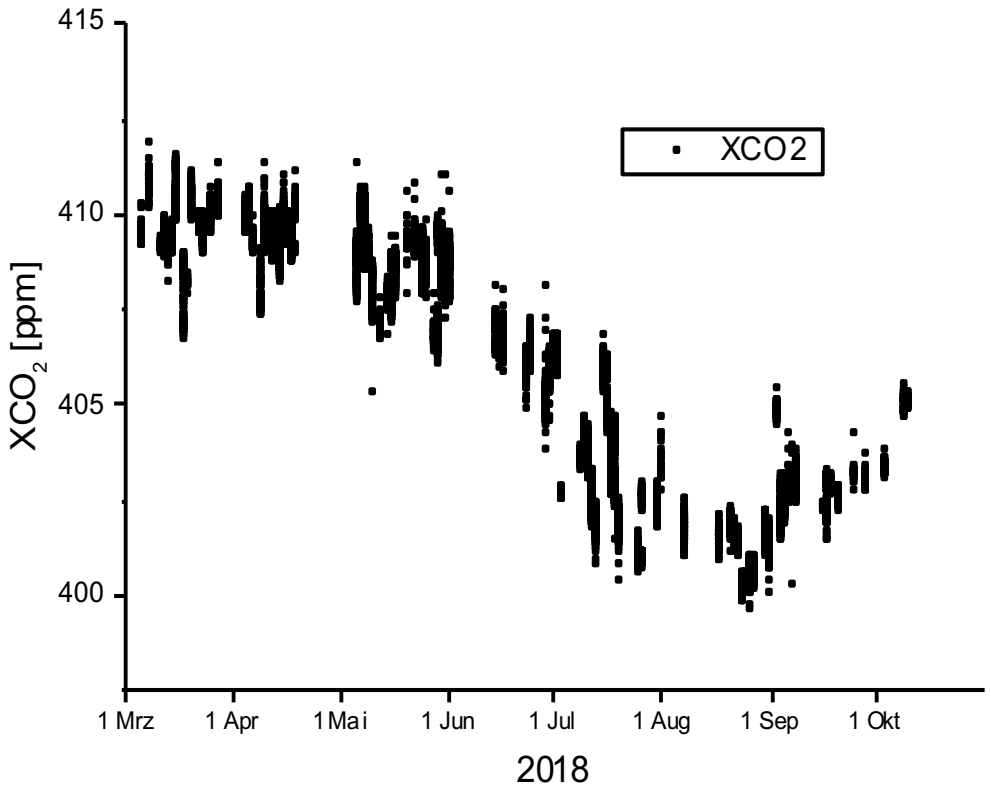
# Kiruna: HR plus Bruker EM-27



- Set-up of Bruker EM-27 at IRF
- Using the same solar beam as the HR
- Complementary to NDACC instrument
- Measuring GHG ($CO_2$ & $CH_4$) with high precision
- Data analysed by Qiansi Tu

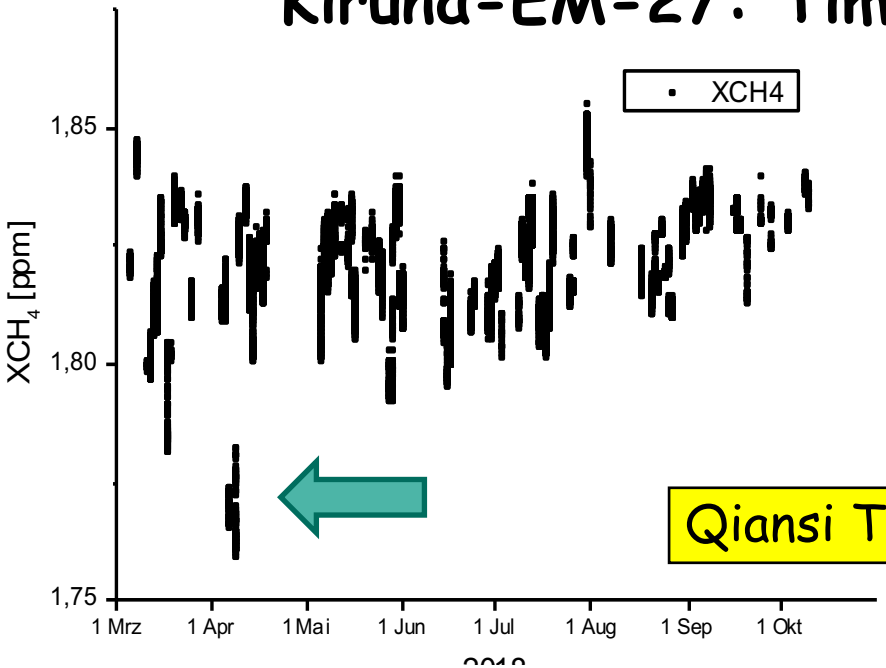
# Kiruna-EM-27: Time series of $XCO_2$




- High precision GHG measurements: $XCO_2$
- Seasonal cycle
- Complementary to Bruker HR
- Not a big effort!

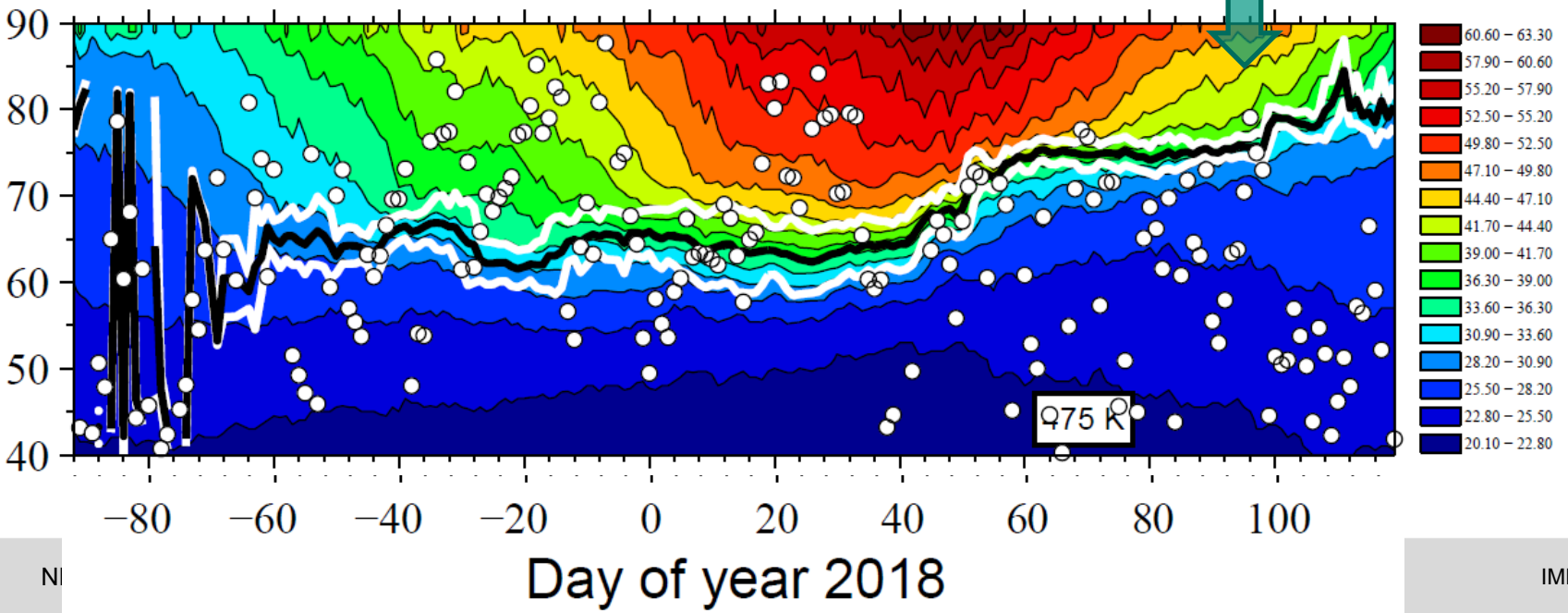
Qiansi Tu

# Kiruna-EM-27: Time series of $XCH_4$




Qiansi Tu

- High precision GHG measurements: $XCH_4$
- $XCH_4$ complementary to IRWG profiles
- Seasonal cycle
- Kiruna inside polar vortex on April 7 & 9



# Projects

- ESA project FRM4GHG
- ESA project COCCON processor
- DLR project on TROPOMI validation
- EU project Verify
  (F. Hase: EM-27 field campaign)
- DFG project MOTIF & TEDDY
  (M. Schneider: IASI retrievals
  & model comparisons)
- ACTRIS-D: NDACC as infrastructure project for the German/European roadmap still under evaluation!

Two PhD students hired in 2018:

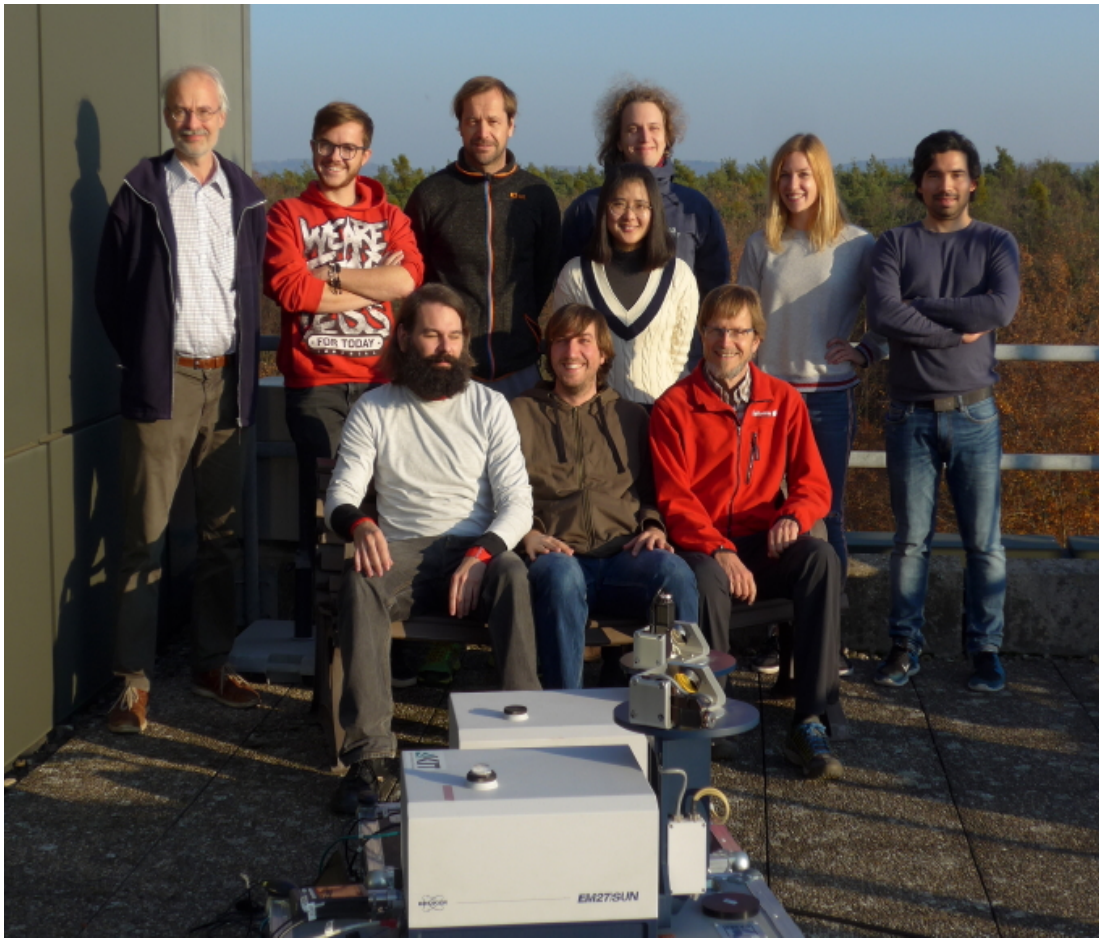
- ✓ Amelie Röhling for DLR project on S5P validation
- ✓ Carlos Alberti for EU project Verify

# Summary Kiruna site report

- ✓ NDACC measurements continued
- ✓ Bruker EM-27 added for GHG
- ✓ Data analysis and archiving up to date
- ✓ Time series of more than 20 years
- ✓ Publications: 12 papers in 2018 and 8 in 2019 in total (not only NDACC)
- ✓ Thanks to DFG, DLR, ESA & EU projects!



# Best regards from Karlsruhe FTIR group




PhD students since 2018: Amelie Röhling, Carlos Alberti

Thank you!

Congratulations to Qiansi Tu: PhD defense on May 14, 2019!

# Izaña Site Report

Omaira García, Eliezer Sepúlveda, AEMET
Matthias Schneider, Thomas Blumenstock, Frank Hase, KIT

AEMet
Agencia Estatal de Meteorología

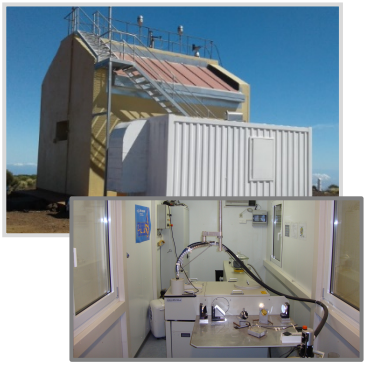
KIT
Karlsruher Institut für Technologie

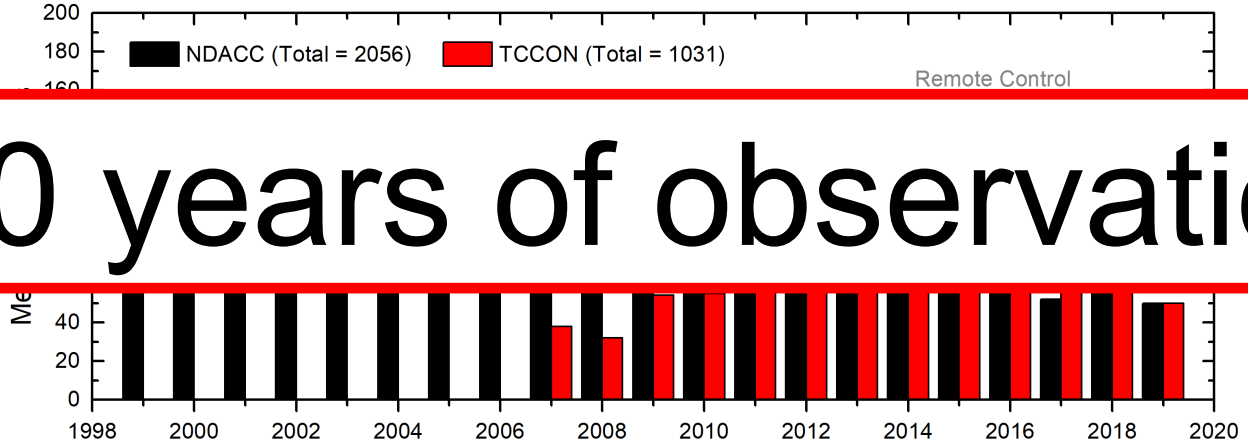
# Izaña Observatory and FTS Programme


## Strategic Geographic Location

Excellent conditions for atmospheric observations, representative of Subtropical North Atlantic Free Troposphere

**FTS programme started in 1999**



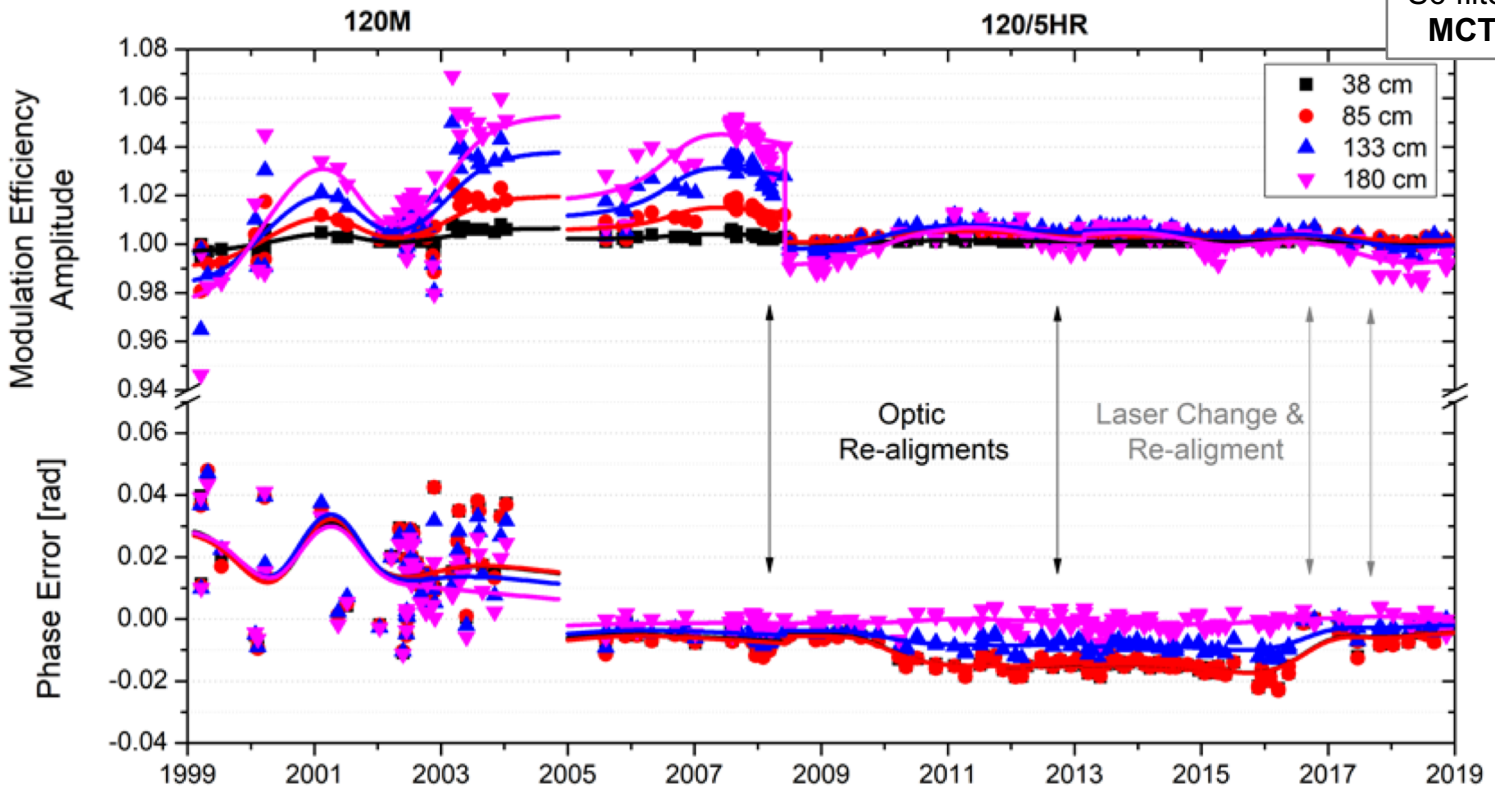



**20 years of observations!!**

# IZO FTS Programme

Since 1999 two Bruker IFS instruments have been installed at IZO: 120M in 1999-2005 and 120/5HR in 2005-onwards. Both instruments have been well-charectized (**continuous ILS N2O-cell measurements**) during the 20 years of observations.

S6 filter settings, **MCT detector**



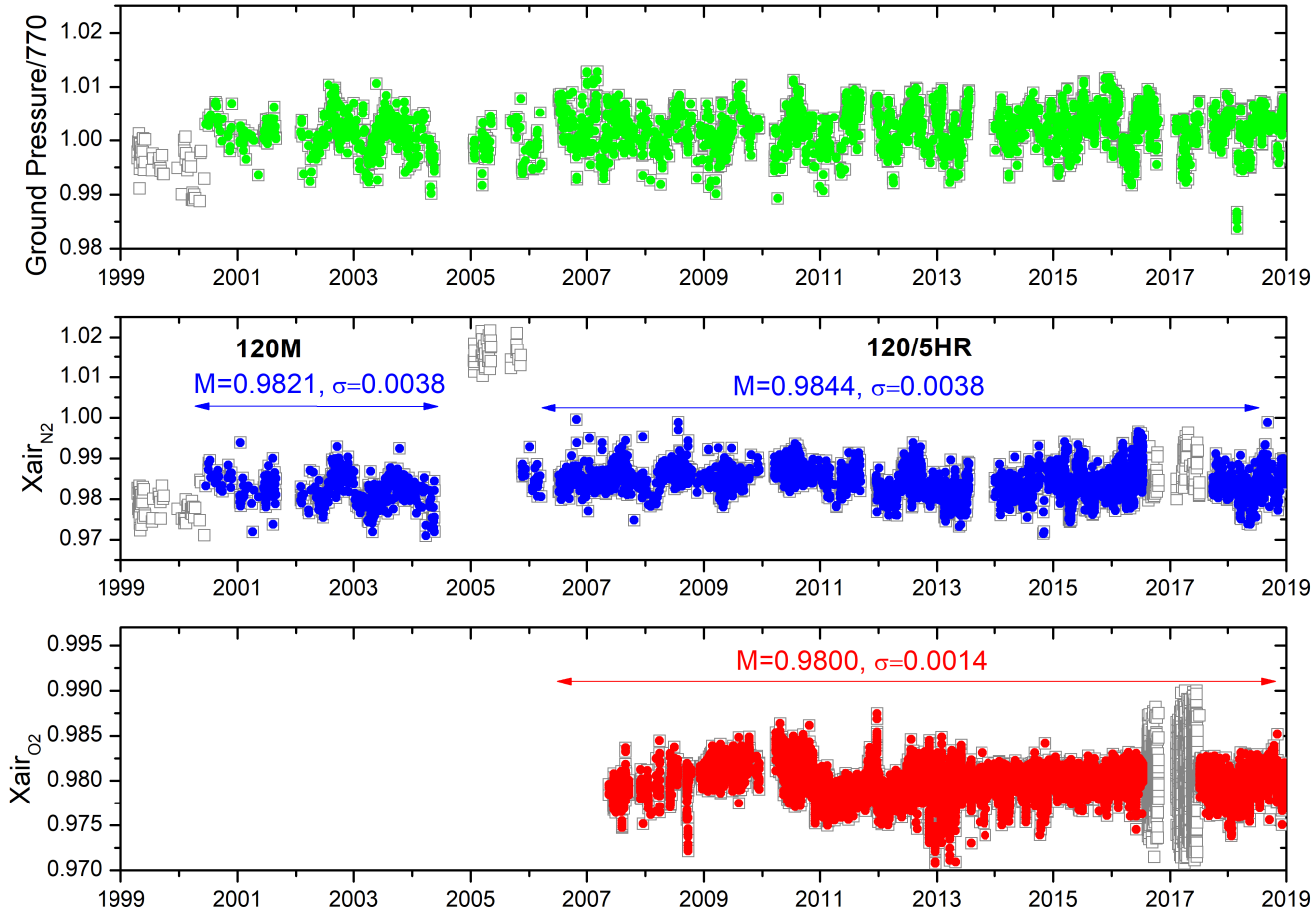

There are some gaps in the NDACC and TCCON archives during last years due to instrumental issues (laser, sun tracker's control, MIR detectors,…).
Change of MIR detectors (MCT and InSb) in December 2018.

# IZO FTS Programme

Karlsruher Institut für Technologie

Agencia Estatal de Meteorología

Temporal Stability: $X_{air}$ time series, calculated using the $N_2$ and $O_2$ column amounts for the NDACC and TCCON ranges, respectively. **Very stable instruments**!




The periods in grey correspond to instrumental issues on ground pressure records and/or FTS instruments and were ruled out for calculating the mean (M) and standard deviation (σ) statistics displayed on the figure.

NDACC

TCCON

Precision of **0.38% for NDACC** and **0.14% for TCCON**

# IZO Atmospheric Observations

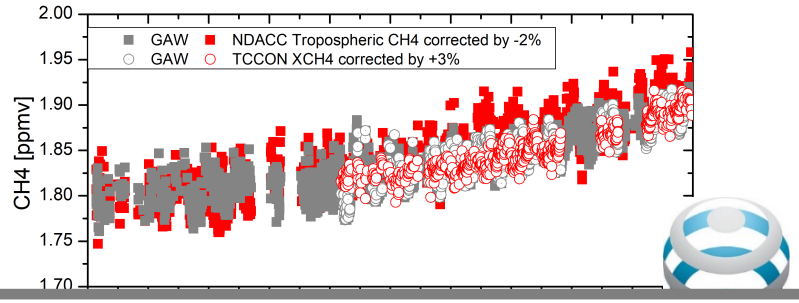
Comprehensive Programme for Atmospheric Composition Monitoring

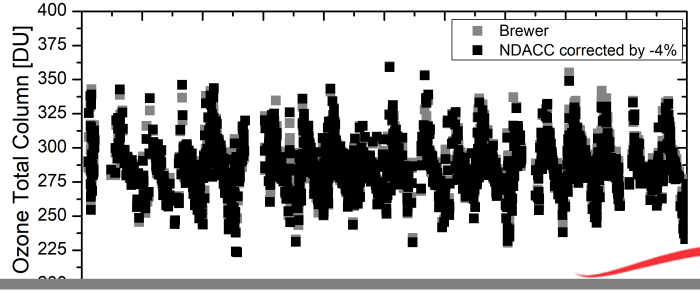
⇨

Documentation of the **quality and long-term consistency** of the FTS products

# IZO Atmospheric Observations and FTS

Coincident Daily Time Series

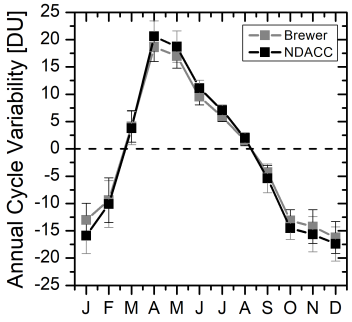


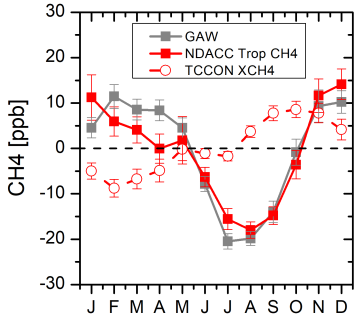



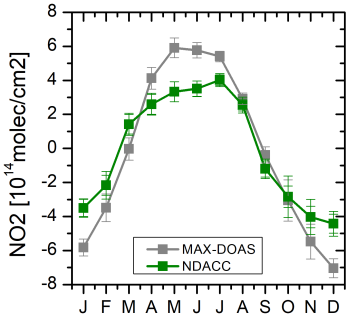

**By comparing to other independent IZO records, the IZO FTS observations have documented high quality and long-term consistency during the 20 years of measurements.**

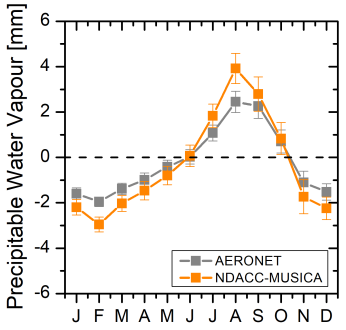
For more details, please refer to the poster:
"20 years of Fourier Transform Spectrometry at Izaña Atmospheric Observtory"

Annual Cycle



# On-going Projects

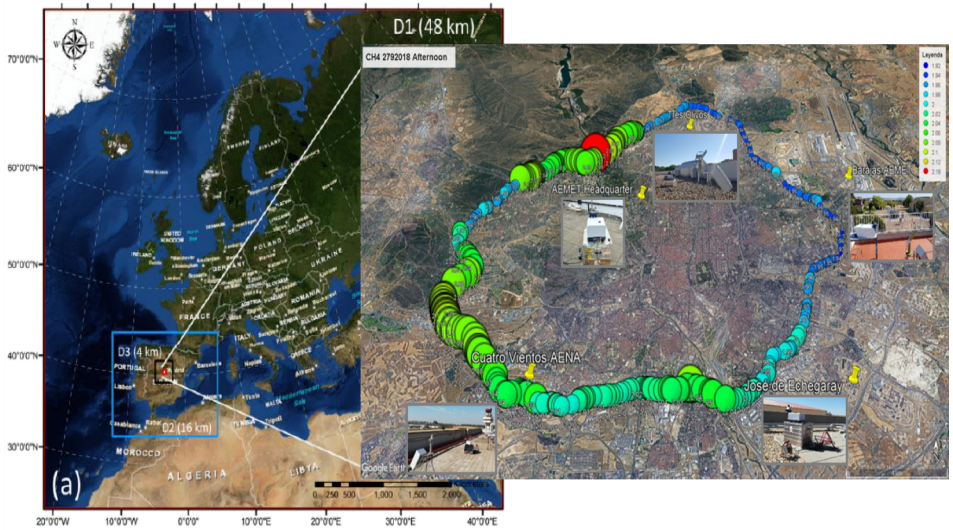
1. Ozone Isotopologue Monitoring from Ground-Based FTIR Spectrometry in collaboration with St. Peterburg FTS group.
2. Ground-level Water Vapour Isotopologues measurements within MOTIV project.
3. Retrieval of Aerosol Optical Depth from FTS spectra, AEMET.
4. Project INMENSE (IASI for surveyiNg MethanE and NitrouS oxidE in the troposphere), MINECO, 2017-2019: Analysing the potential of EUMETSAT/IASI for observing global tropospheric CH4 and N2O distributions using the MUSICA/IASI strategy.

## 5. Project MEGEI-MAD (AEMET): COCCON EM27/SUNs

Instalation of EM27/SUN at IZO

Intercomparison of EM27/SUN at Madrid during MEGEI-MAD campaign

# MEGEI-MAD within COCCON




**WHAT?:** Monitoring of urban CO2 and CH4 emissions of Madrid, the highest population density city in Spain.

**HOW?:** Combining total column observations (COCCON EM27 FTIR spectromers) and ground-level records (Picarro Inc analyzer, G-2301-m). Emission and transport simulations from HERMES v3.0 will be incorporated to the posterior analysis.

**WHERE and WHEN?:** Field campaing carried out between 17th September-9th October 2018 in the Madrid Metropolitan area.

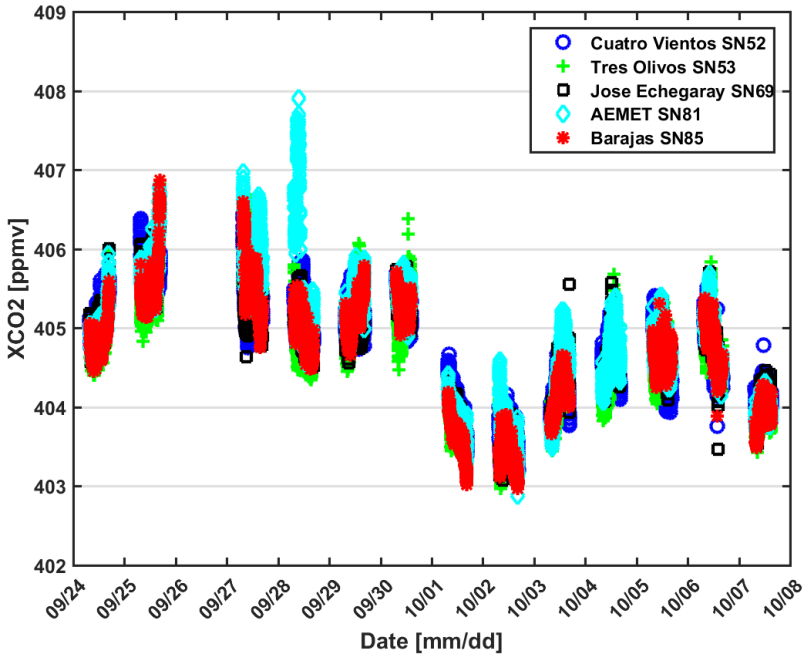
- Five EM27 FTIRs were located on the outer perimeter of Madrid along the prevailing wind axis (upwind and downwind of the city source, figure on the left).

- Two mobile surveys took place each day (08:30 GMT and 13:45 GMT), completing a 62 km closed loop along the external side of the peripheric M40 Highway, at a constant speed of 60 km/hour (figure on the left).

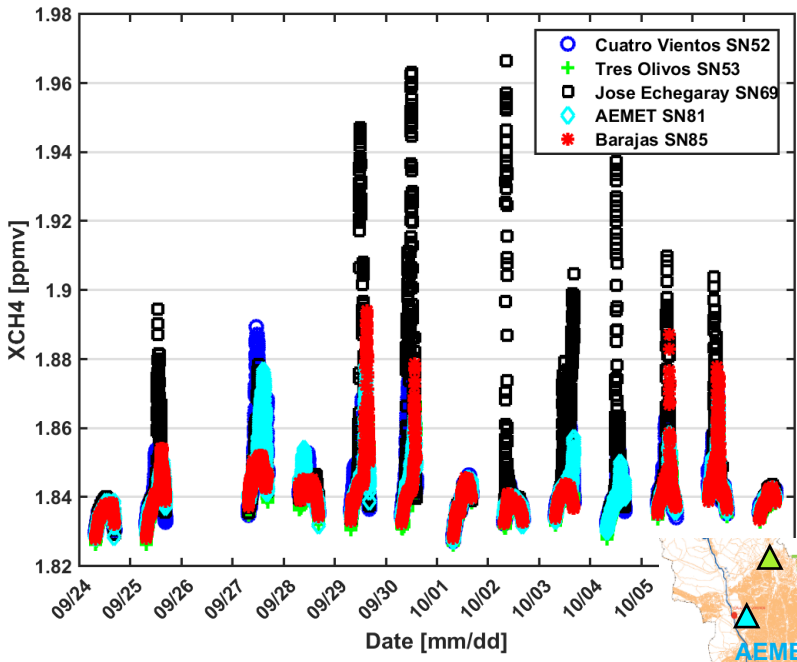
## PARTNERS

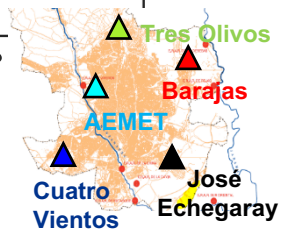
# MEGEI-MAD within COCCON

## $CO_2$




## $CH_4$




Excellent Weather Conditions ≥ 6000 spectra
Strong $CH_4$ plumes (+10%)

For more details, please refer to the poster: “Monitoring of Urban Greenhouse Gases Emissions combining COCCON EM27 spectrometers and in-situ records (MEGEI-MAD)”

# Publications related with IZO FTS

Karlsruher Institut für Technologie

Agencia Estatal de Meteorología

**2018**

1.Borger, C., et al.: Evaluation of **MUSICA IASI tropospheric water vapour profiles** using theoretical error assessments and comparisons to GRUAN Vaisala RS92 measurements, AMT, 11, 4981-5006.

2.Borsdorff, T., et al.: Mapping **carbon monoxide** pollution from space down to city scales with daily global coverage, AMT, 11, 5507-5518.

3.García, O. E., et al.: The **MUSICA IASI CH4 and N2O products** and their comparison to HIPPO, GAW and NDACC FTIR references, Atmos. Meas. Tech., 11, 4171-4215.

4.Gaudel, A, et al.: The **Tropospheric Ozone** Assessment Report: Present-day distribution and trends of tropospheric ozone relevant to climate and global atmospheric chemistry model evaluation, Elem Sci Anth.

5.O'Dell, C. W., et al.: Improved retrievals of **carbon dioxide** from Orbiting Carbon Observatory-2 with the version 8 ACOS algorithm , AMT, 11, 6539-6576.

6.Vigouroux, C., et al.,: NDACC harmonized **formaldehyde** time-series from 21 FTIR stations covering a wide range of column abundances, AMT, 11, 5049-5073.

7.Wu, L., et al.: **Carbon dioxide** retrieval from OCO-2 satellite observations using the RemoTeC algorithm and validation with TCCON measurements, AMT, 11, 3111-3130.

**2019**

8.Frey, M., et al: Building the COllaborative Carbon Column Observing Network (**COCCON**): long-term stability and ensemble performance of the EM27/SUN Fourier transform spectrometer, AMT, 12, 1513-1530.

9.Kivimäki, E., et al.: Evaluation and Analysis of the Seasonal Cycle and Variability of the Trend from GOSAT **Methane** Retrievals, Remote Sens. 2019, 11, 882.

10.Wei, Z., et al. : A global database of **water vapor isotopes** measured with high temporal resolution infrared laser spectroscopy, Scientific Data, 6, 180302.

11.Zhou, M., et al.: An intercomparison of total column-averaged **nitrous oxide** between ground-based FTIR TCCON and NDACC measurements at seven sites and comparisons with the GEOS-Chem model, AMT, 12, 1393-1408.

# After 20 years of operation the IZO FTS programme has demonstrated a great value for climate research

- ≥ 200 Conferences
- ~ 100 Peer-Reviewed Papers
  (1st: Schneider et al., 2005)
- ~ 15-20 Funded Projects
- ~ 10 PhDs

# THANKS!!!

Karlsruhe Institute of Technology

Agencia Estatal de Meteorología

*Izaña Atmospheric Observatory*
*http://izana.aemet.es*