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# Atmospheric Carbon Dioxide and Methane measurements at Sodankylä, Finland

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# Sodankylä FTS



Bruker *IFS 125HR* with *A547N*  
solar tracker.

Detectors:

*RT-InGaAs*: 12800 - 4000  $cm^{-1}$

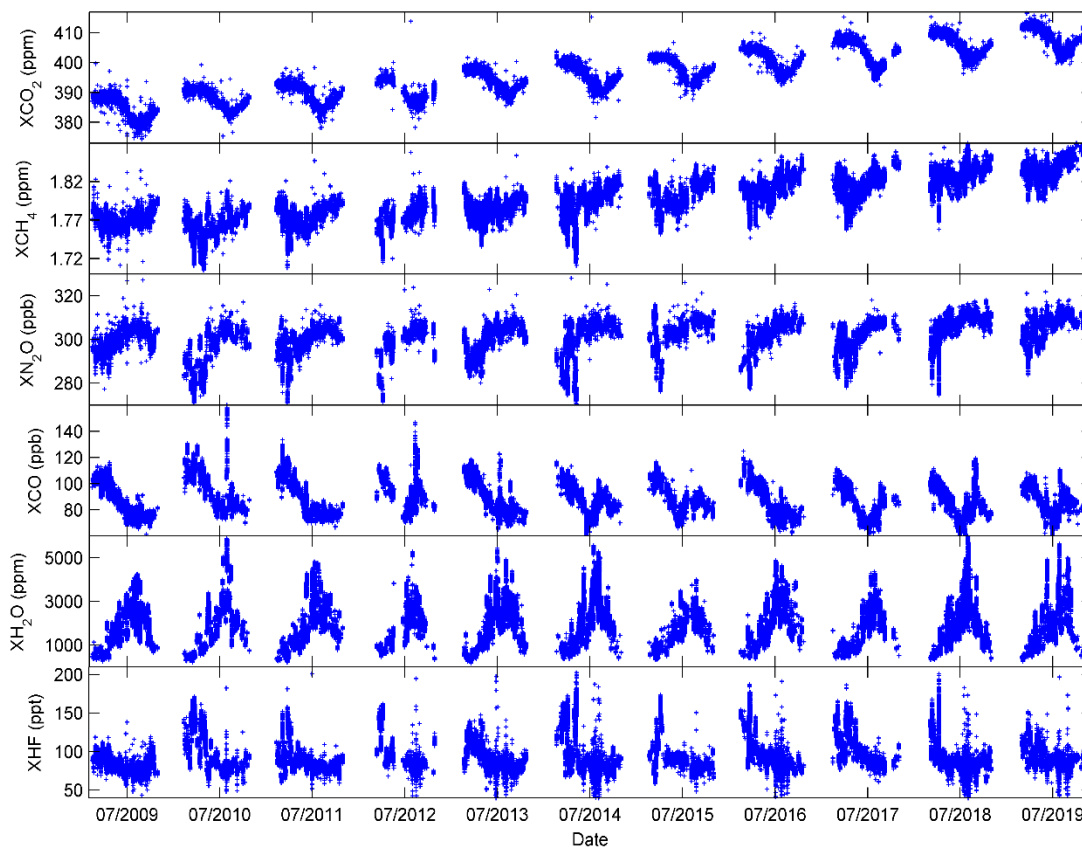
*RT-Si*: 25000 - 9000  $cm^{-1}$

*LN-InSb*: 10000 - 1850  $cm^{-1}$

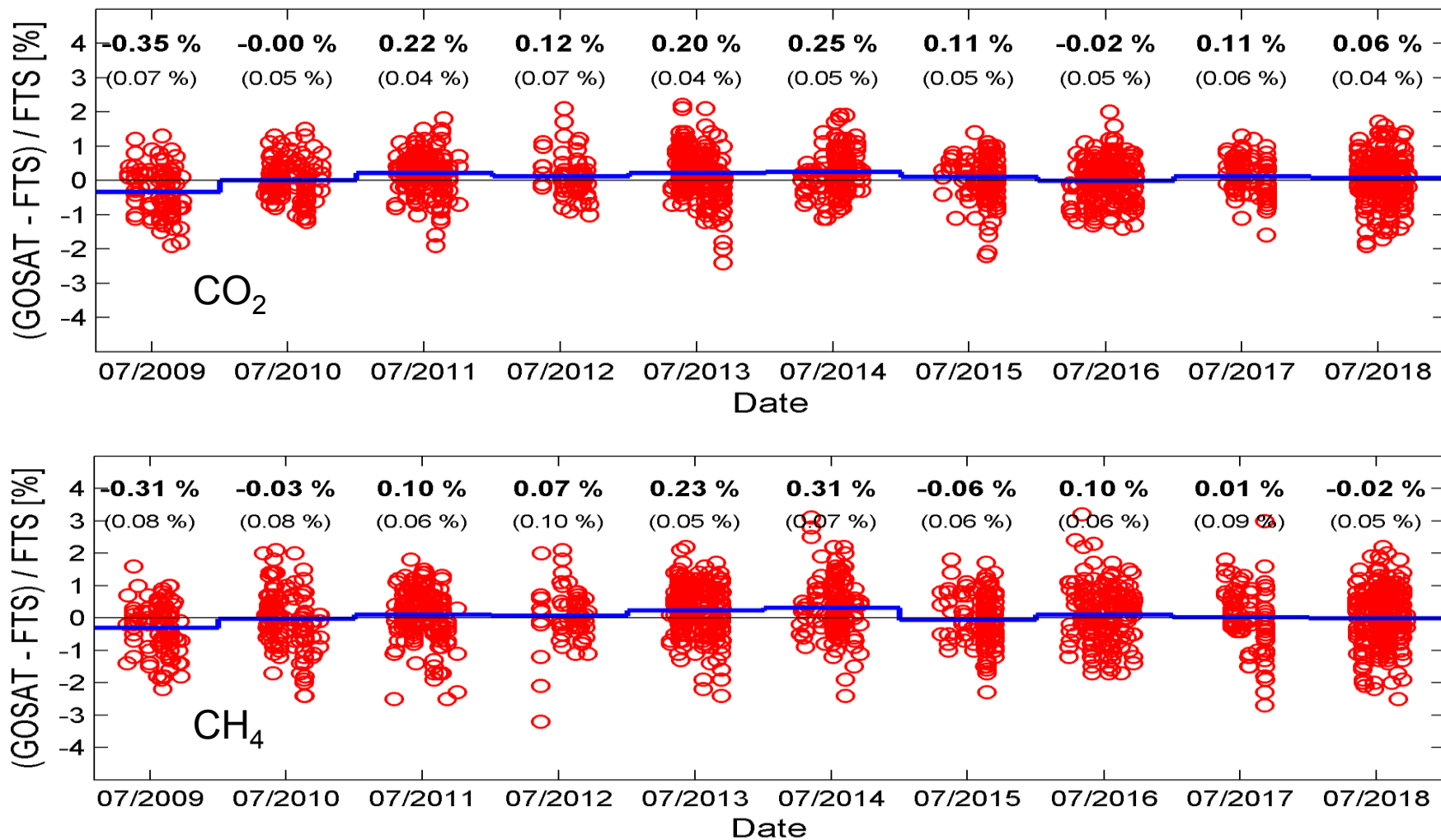
In operation since FEB-2009,  
participates in the TCCON network



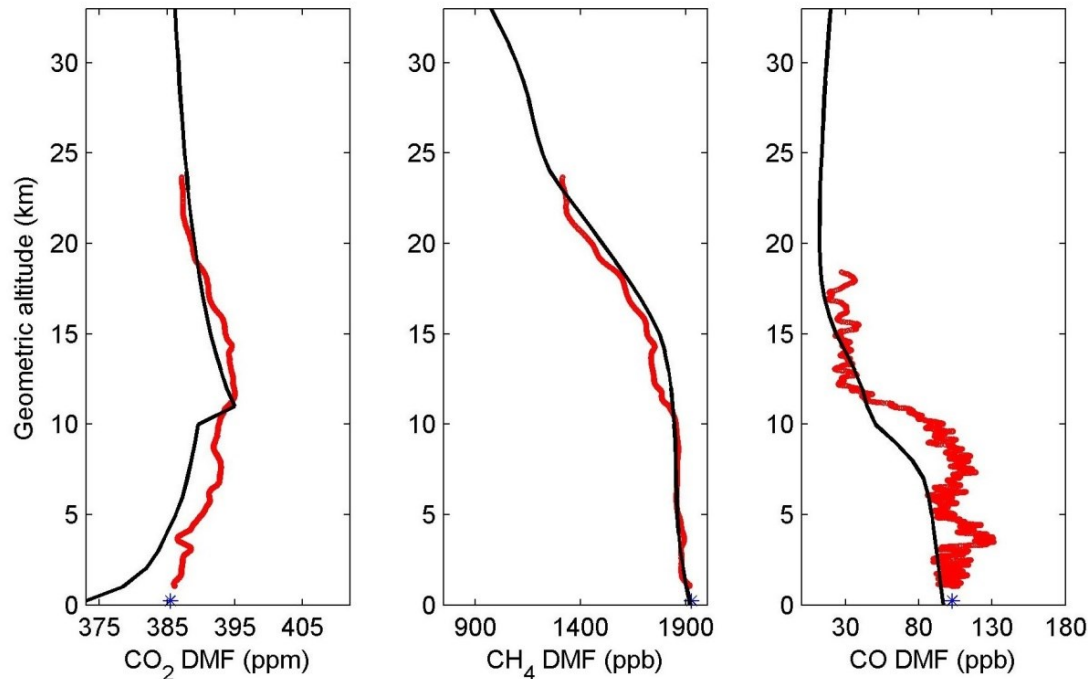
Map of the TCCON sites



Column-averaged dry air mole fractions at Sodankylä since 2009. Carbon dioxide has increased by  $2.3 \pm 0.2$  ppm per year and methane by  $7.0 \pm 0.5$  ppb per year.



Sodankylä FTS comparisons with GOSAT observations for CO<sub>2</sub> (upper panel) and CH<sub>4</sub> (lower panel). Relative difference for CO<sub>2</sub> is 0.09 %, for CH<sub>4</sub> relative difference is 0.06 %.



- At Sodankylä we have performed AirCore observations during all seasons. An example of AirCore profiles of  $\text{CO}_2$ ,  $\text{CH}_4$  and CO is shown above. AirCore profiles are in red and the TCCON a priori profiles in black. Blue star corresponds to tower measurements at Sodankylä.
- The AirCore system at Sodankylä is built as a stainless steel tubing of about 100 m long, consisting of ~40 m of 1/4" and ~60 m of 1/8" tube. This configuration makes it possible to measure profiles with vertical resolution of 5 mb in the stratosphere and 15 mb in the troposphere.
- The system also involves a data acquisition unit to store pressure and temperature during an AirCore flight, a RS92 radiosonde and a positioning device.
- AirCore is lifted to the stratosphere using a meteorological balloon. Shortly after landing we have analysed the sample using a Picarro G2401 gas analyser. Recently we have been developing a drone borne AirCore instrument.



Balloon and drone borne AirCore instruments.



## Conclusions:

FTS measurements have been performed over 11 years. We find statistically significant increase of column amounts of carbon dioxide by  $2.3 \pm 0.2$  ppm per year and methane increase by  $7.0 \pm 0.5$  ppb per year.

There is a good agreement between GOSAT and ground based TCCON observations. In case of  $\text{CO}_2$  the relative difference between the two instruments has been  $0.09 \pm 0.02$  % and in case of  $\text{CH}_4$  the relative difference has been  $0.06 \pm 0.02$  %

AirCore observations can be performed at Sodankylä on regular basis. The AirCore in situ observations are used to study accuracy of the remote sensing retrievals. A new drone based AirCore instrument is under development.

## Reference:

Kivi, R. and Heikkinen, P.: Fourier transform spectrometer measurements of column  $\text{CO}_2$  at Sodankylä, Finland, Geosci. Instrum. Method. Data Syst., 5, 271–279, <https://doi.org/10.5194/gi-5-271-2016>, 2016.