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Drone-based AirCore measurements at Sodankylä

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Motivation

- Drone based profiles near surface to provide an overlap with balloon borne and tower data. Use in situ profiles to validate FTS retrievals.
- Perform high-resolution measurements of GHGs (CH_4 and CO_2) on a local scale. Focus on wetland emissions. The most important biogenic source for methane are the wetlands (Ciais et al., 2013). The net methane emission from wetlands is a balance between methane produced in anaerobic conditions by archaea and methane consumed by methane oxidizing microorganisms in the aerobic peat layers.



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Sodankylä FTS

Bruker IFS 125HR with A547N
solar tracker.

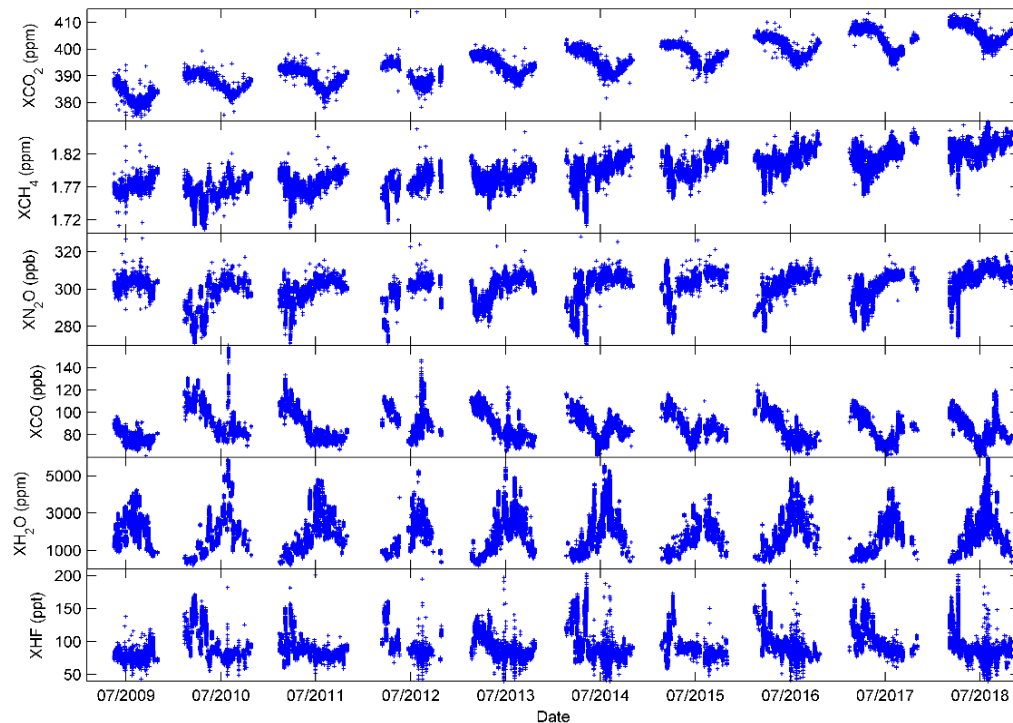
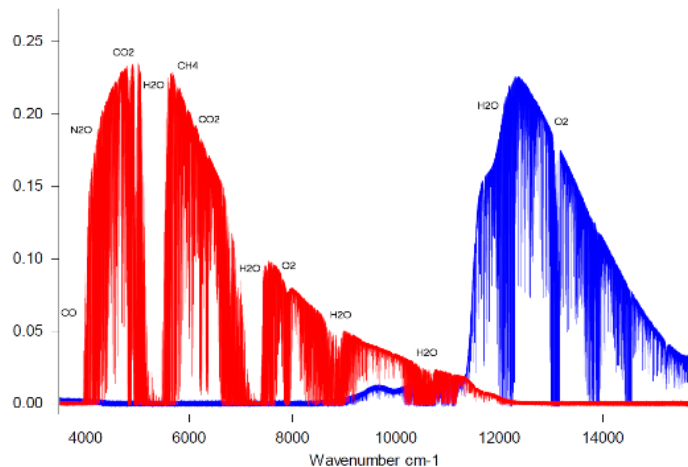
Detectors:

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

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

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

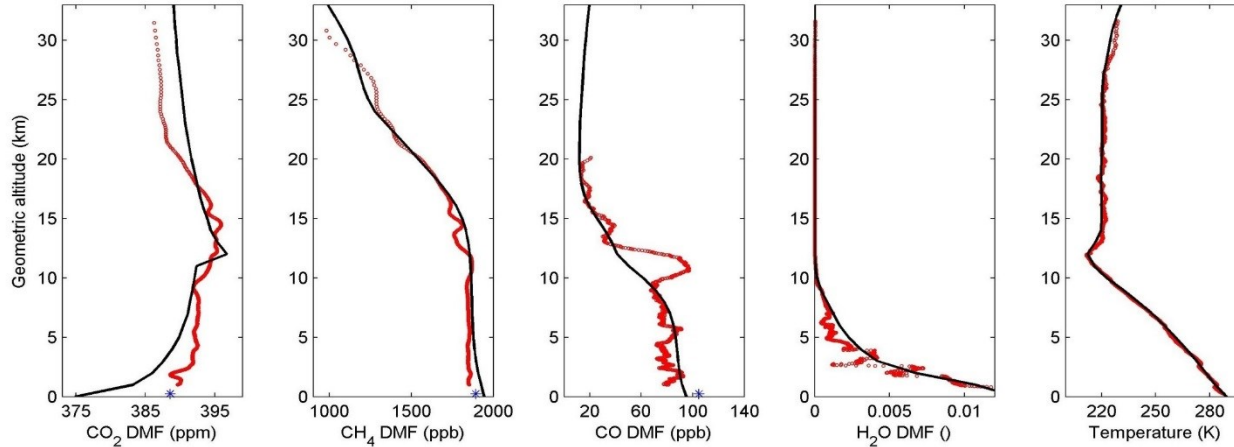
In operation since FEB-2009



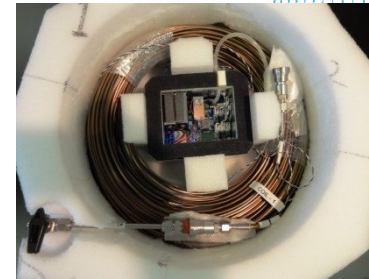
Updated from Kivi, R. and Heikkinen, P.: Fourier transform spectrometer measurements of column CO₂ at Sodankylä, Finland, Geosci. Instrum. Method. Data Syst., 5, 271-279, doi:10.5194/gi-5-271-2016, 2016.



Method: AirCore



- At Sodankylä we have performed AirCore observations during various seasons. An example of AirCore profiles of CO_2 , CH_4 and CO taken in September 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. After the landing we have analysed the sample using the Picarro G2401 gas analyser.
- Karion et al., JAOT 2010; Hooghiem et al., AMT 2018.



AirCore instrument with an open cover



Drone based measurements

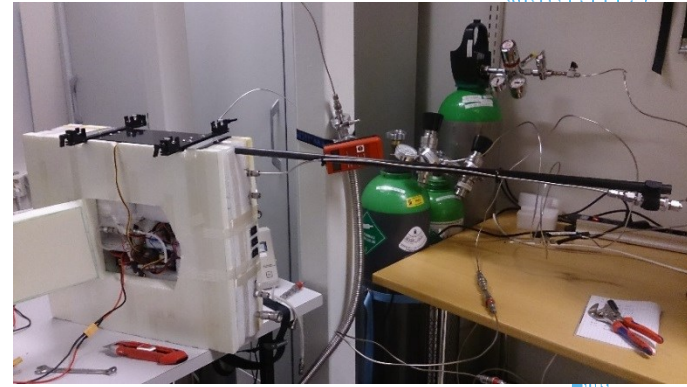
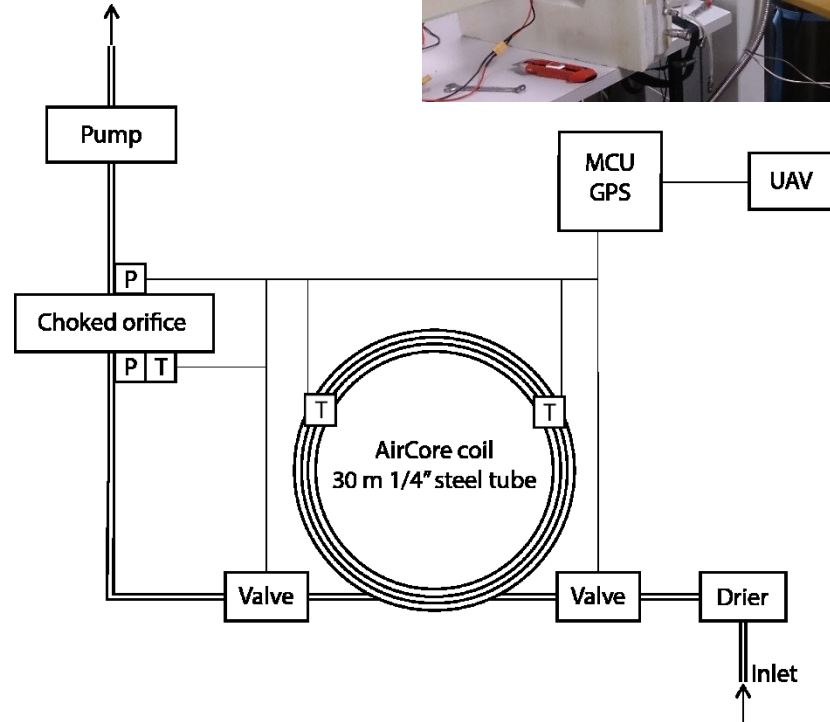
- Drone based AirCore measurements in July-August 2018
- DJI Matrice 600 for load-bearing
- DJI Mavic Pro for aerial photography and mapping
- Load:
 - Max ~6 kg
 - 30 m 1/4" AirCore (<4 kg)
 - Rikola hyperspectral camera





Drone-based AirCore

- AirCore coil
- Electric valves
- Dryer
- Pump + choked orifice
- MCU
- Datalogger
- Pressure sensors
- Thermometers

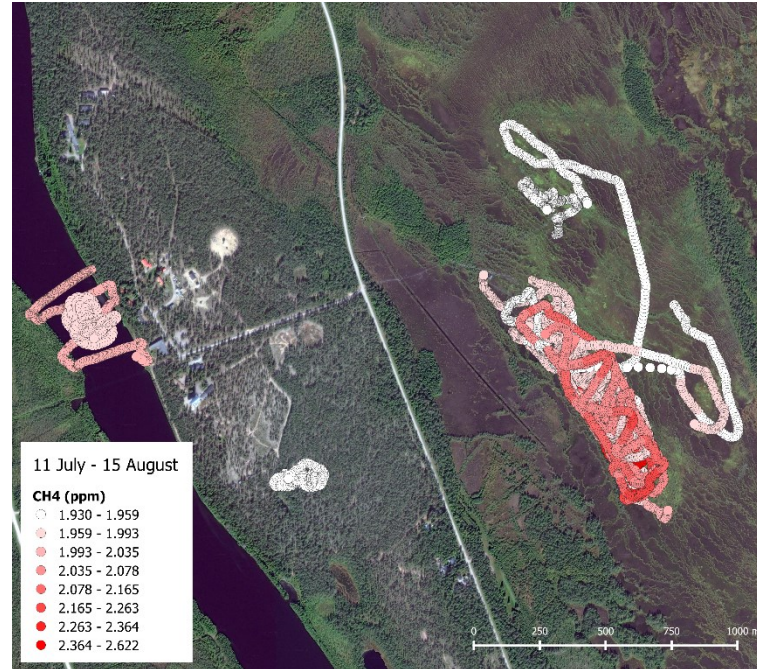




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Flights

- ~20 flights over wetland, river and forest
- Focus especially on methane emissions from wetland
- Various approaches:
 - Up and downwind
 - Hotspots
 - Profiling



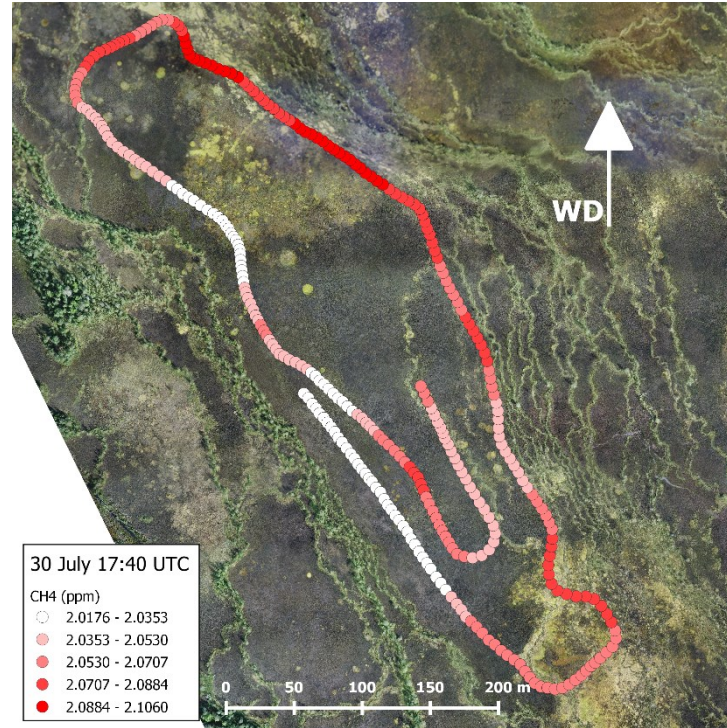
11/7 - 6/8

Background map by Google Maps



Results

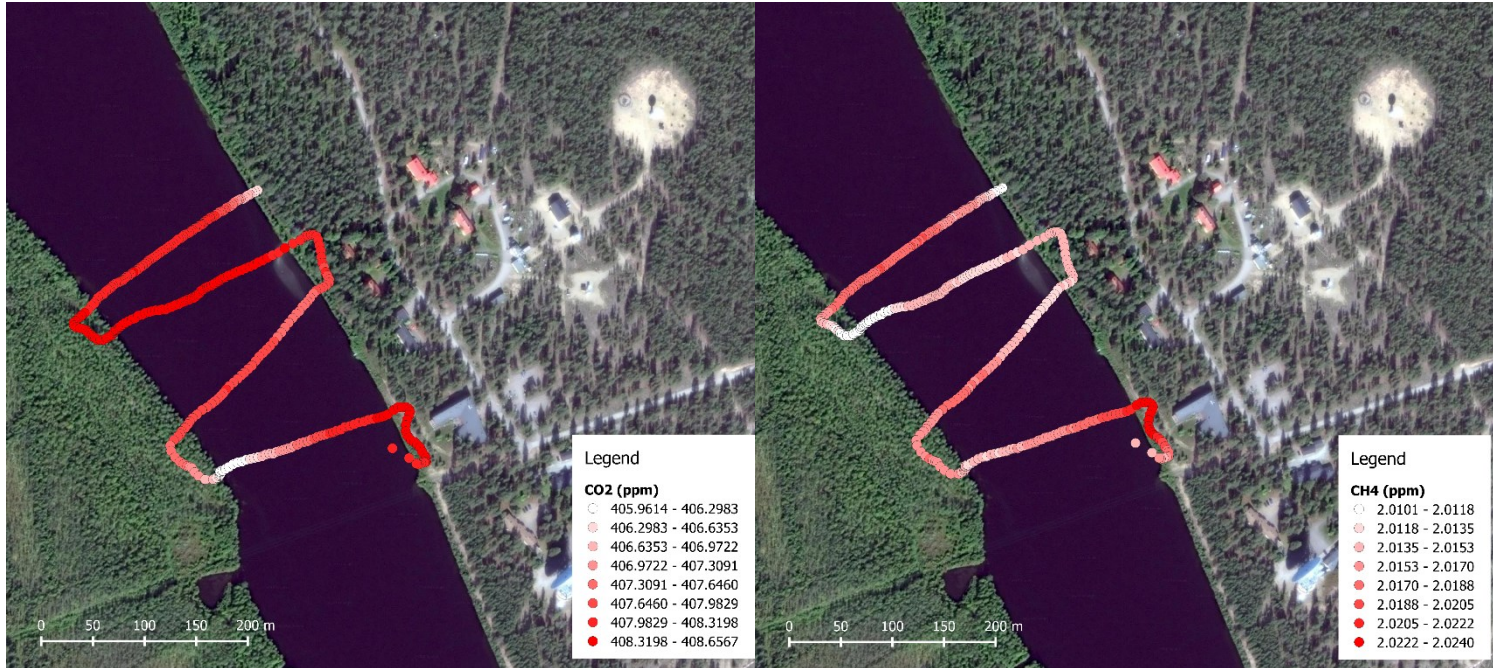
- CH₄ emissions from Arctic wetlands
- Functioning methodology for GHG measurements at high spatial resolutions



30/7 17:40-17:51 UTC



Results



2/8 7:21-7:23 UTC

Background map by Google Maps



Summary

- Drone-based measurements of CO₂ and CH₄ over wetland, river and forest sites were performed.
- Drone-based AirCore provides
 - High spatial resolution
 - Fast sampling and analysis



Future plans

- Add other sampling systems: bag and flask sampling.
- Measurements of SIF (solar induced fluorescence). First flight took place in May 9, 2019.
- AirCore campaign in Traînou, France in June 2019.
- Balloon slow descent measurements.



Publications

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