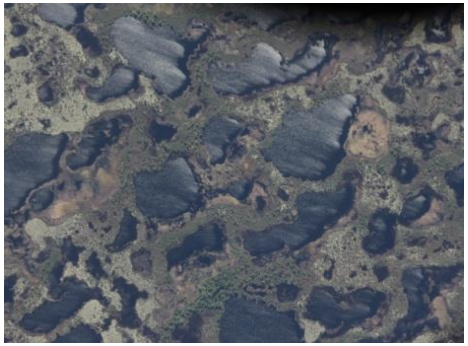
Studying the spatial and seasonal variability of greenhouse gases across West Siberia: large-scale mobile measurement campaigns of 2018-2019





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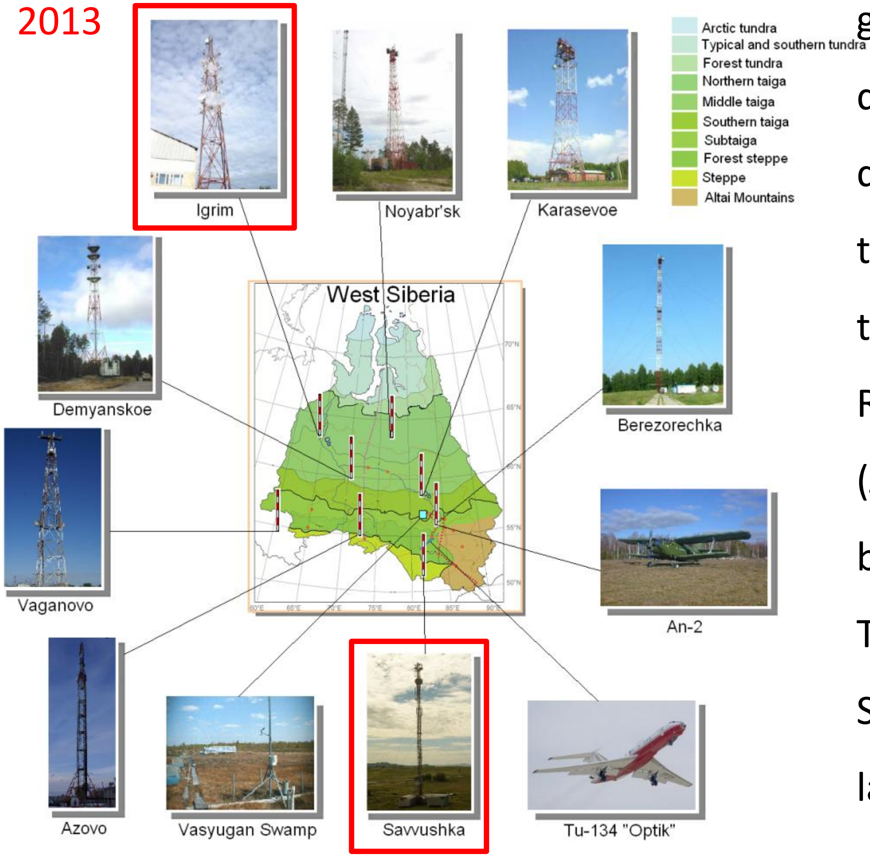
A.V. Kozlov, A.V. Fofonov, V. Arshinova

Motivation

JR-STATION

discontinued in 2013



discontinued in 2014

The continuous ground-based measurements of greenhouse gases carried out in Siberia in the past two decades allowed the long-term trends, as well as the diurnal and seasonal cycles of CO_2 and CH_4 to be derived for this poorly studied region (Belikov et al., 2019). To date, these in-situ observations are made at the joint Japan-Russia Siberian Tall Tower Inland Observation Network (JR-STATION) consisted of 6 automated stations that should be maintained several times per year.

The above network covers a significant part of the West Siberian Plain extending between 54.5° and 63.2° north latitude and between 62.3° and 85.0° east longitude. Its stations are spaced 300 to 900 km apart.

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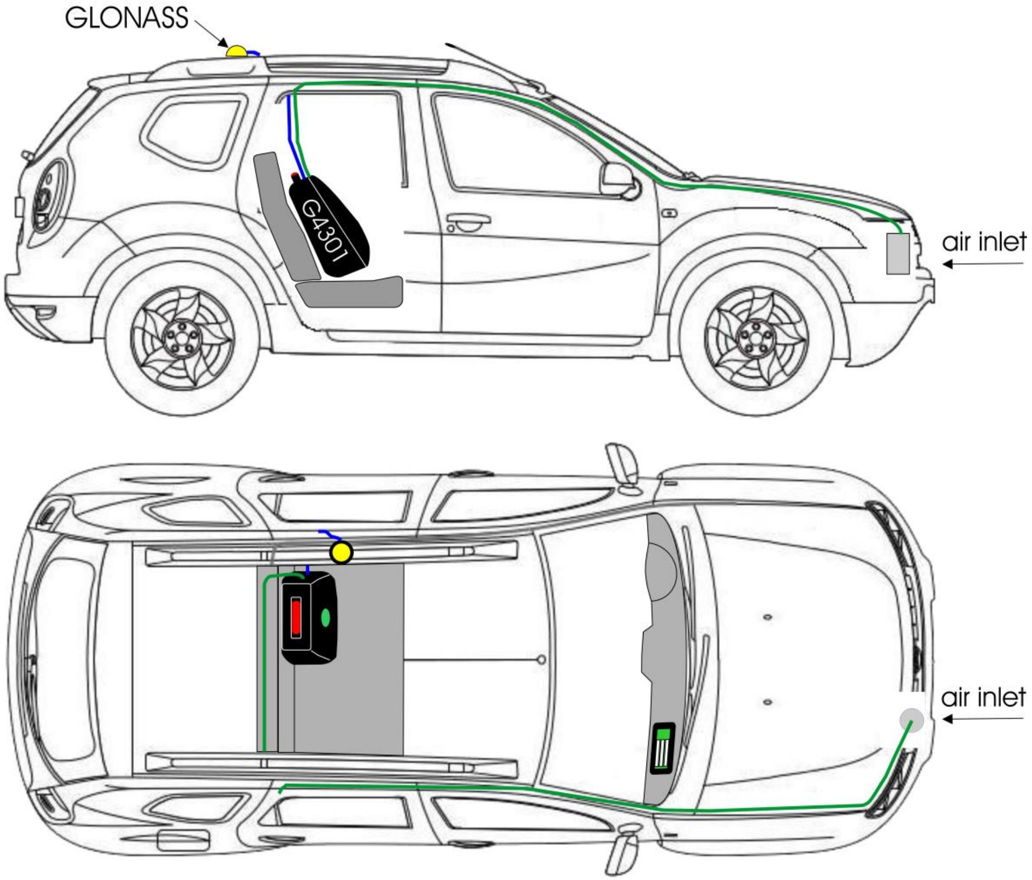
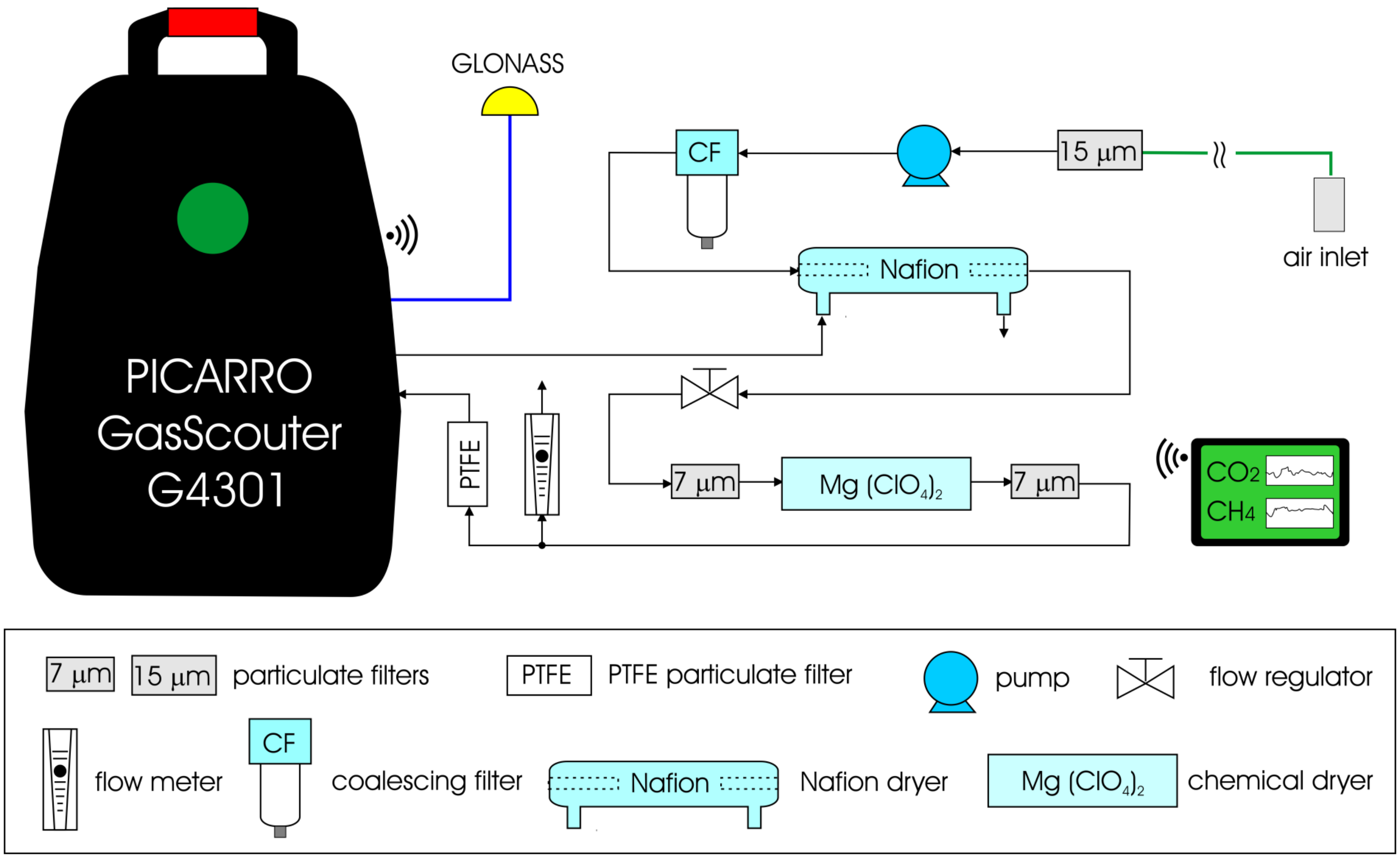
Belikov et al. D Analysis of the Diurnal, Weekly, and Seasonal Cycles and Annual Trends in Atmospheric CO_2 and CH_4 at Tower Network in Siberia from 2005 to 2016. Atmosphere **2019**, 10, 689.

Experimental: mobile measurement platform

CO_2 and CH_4
Picarro G4301



Experimental: ambient air delivering and drying



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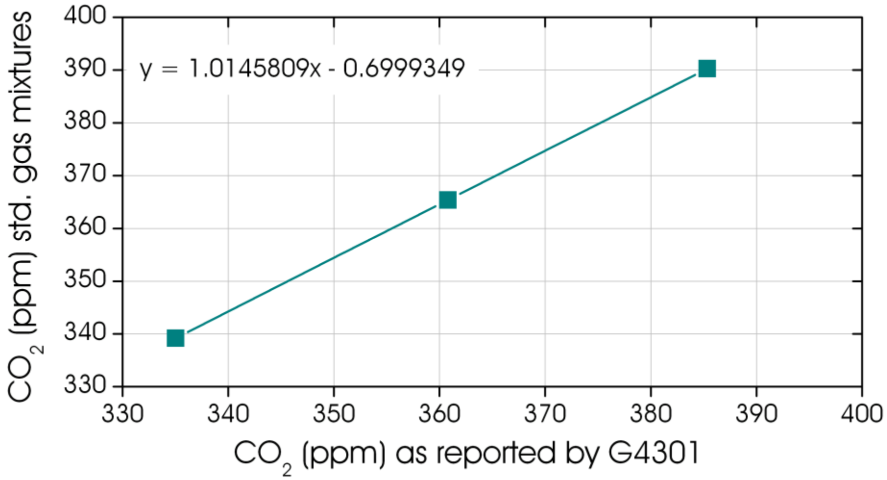
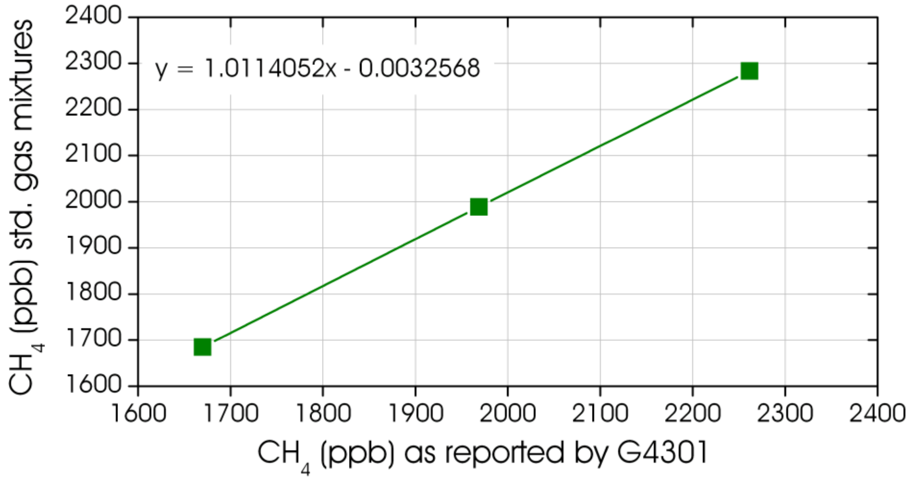
Experimental: calibration

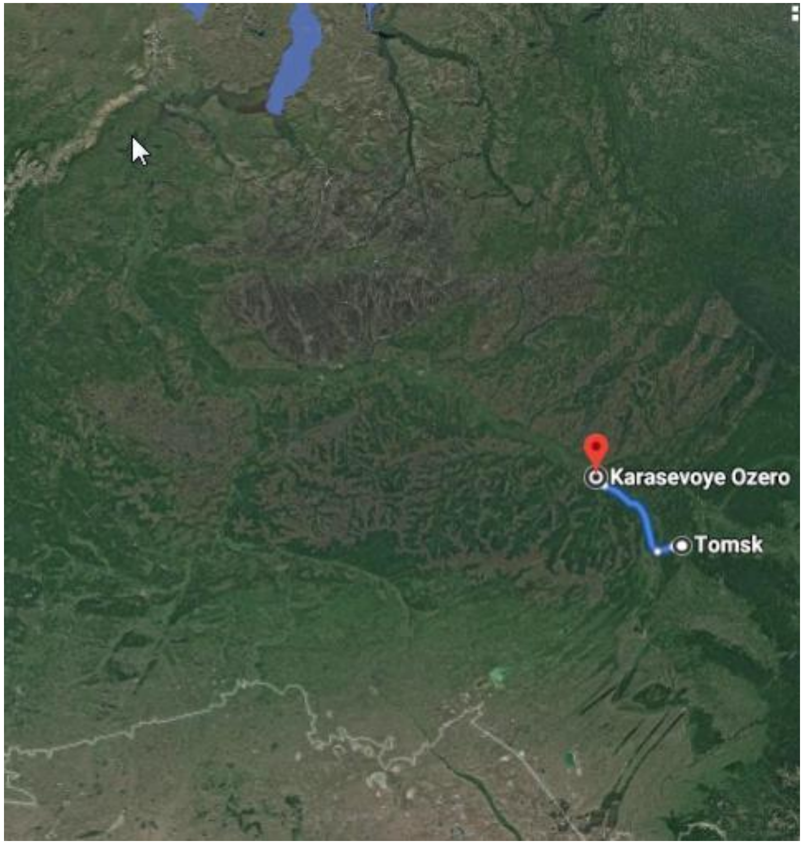
	CO_2	CH_4	CO_2 (G4301)	CH_4 (G4301)
Standard 1	339.17 ppm	1685.17 ppb	335.01±0.16 ppm	1669.78±0.81 ppb
Standard 2	365.40 ppm	1988.74 ppb	360.78±0.17 ppm	1968.74±0.85 ppb
Standard 3	390.24 ppm	2283.61 ppb	385.35±0.17 ppm	2261.48±0.86 ppb

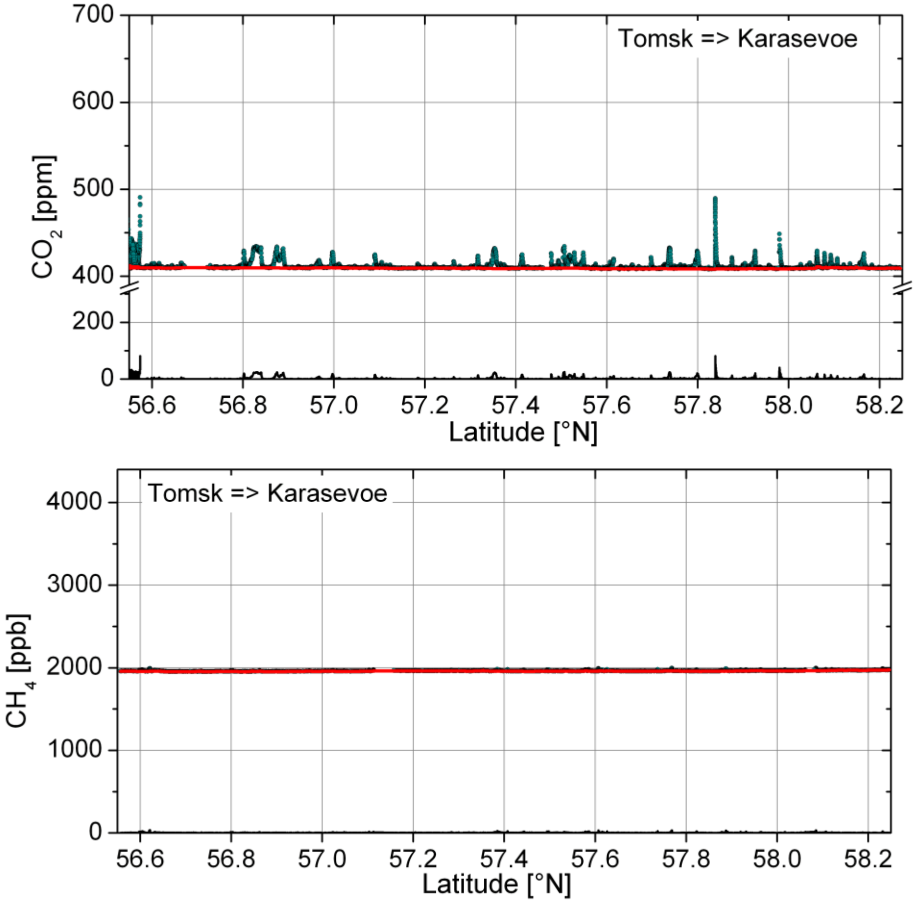




1st campaign: October-November 2018

Distance 310 km





Latitudinal distribution of CO_2 and CH_4: raw data (·), baseline (—), and excess values (—).

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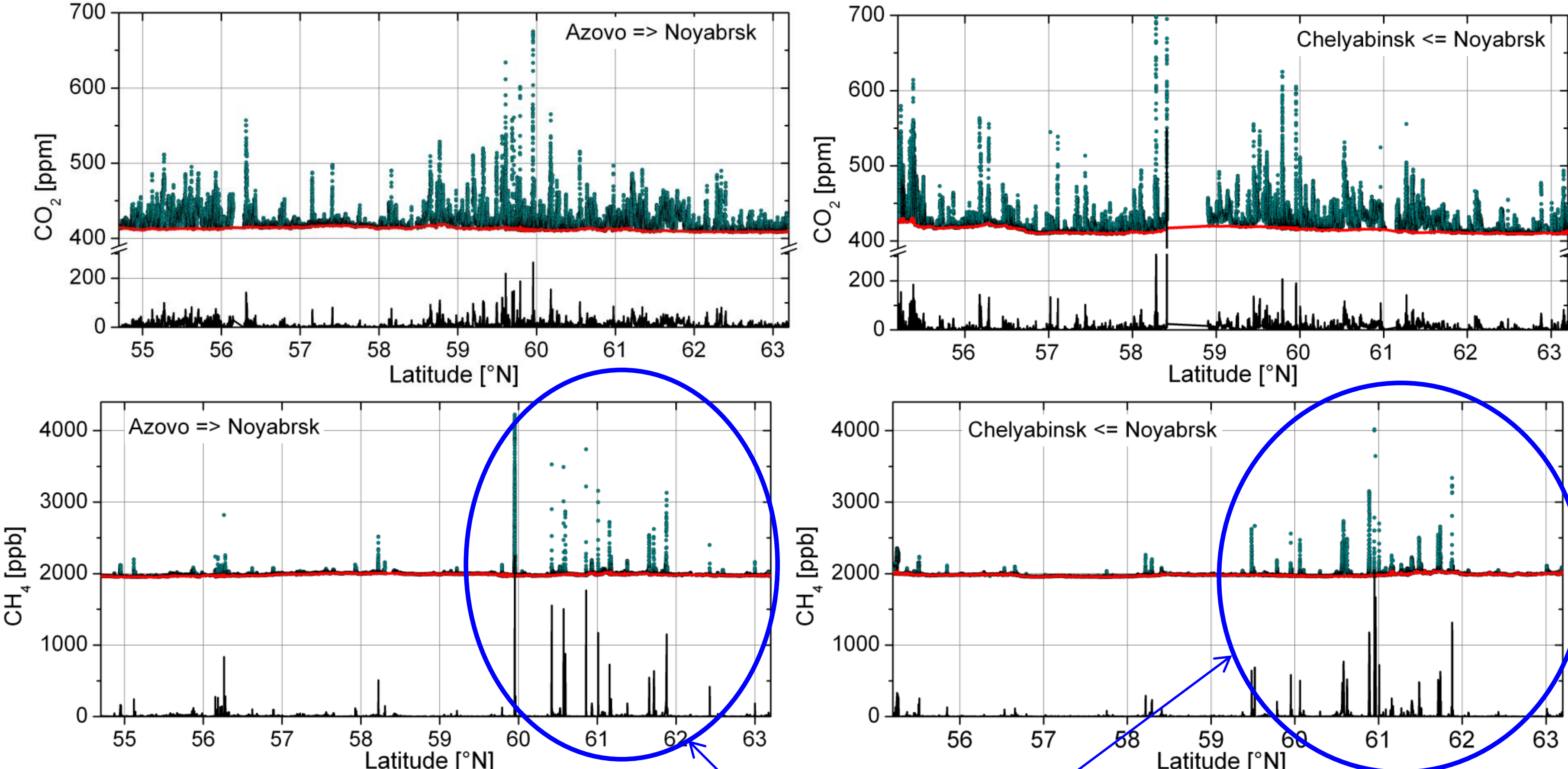
1st campaign: October-November 2018

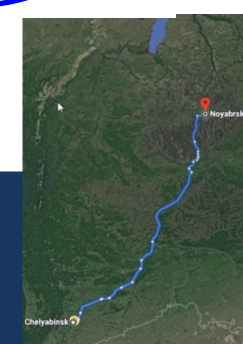
Distance 1590 km

Distance 1500 km



Latitudinal distribution of CO_2 and CH_4: raw data (·), baseline (—), and excess values (—).

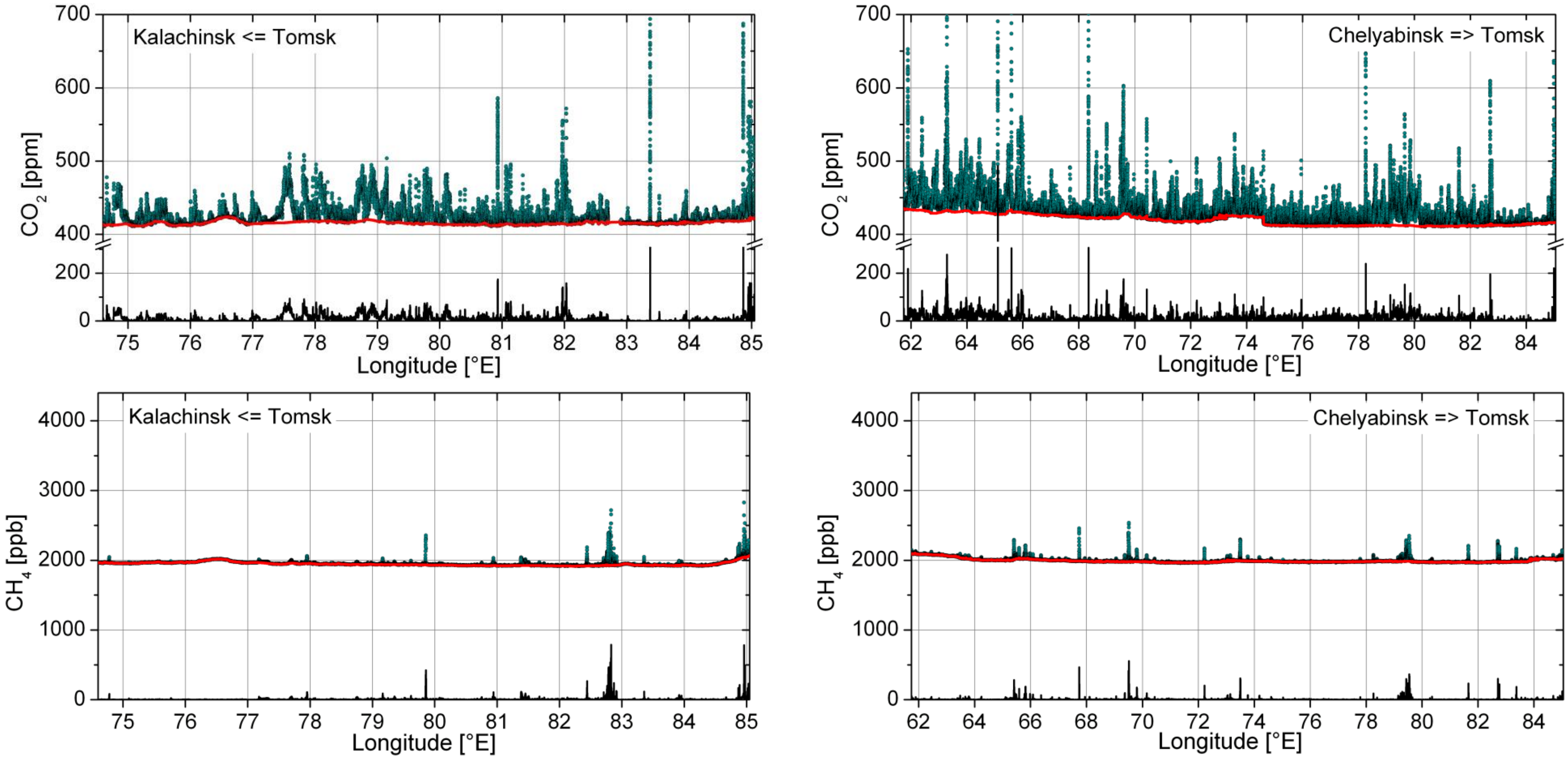
Area of oil and gas extraction



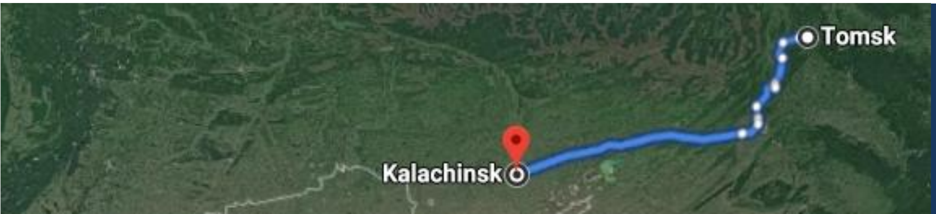
1st campaign: October-November 2018

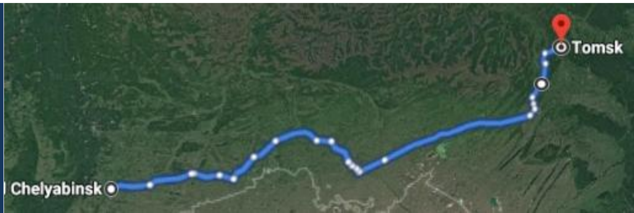
Distance 820 km

Distance 1850 km



Longitudinal distribution of CO_2 and CH_4: raw data (•), baseline (—), and excess values (—).



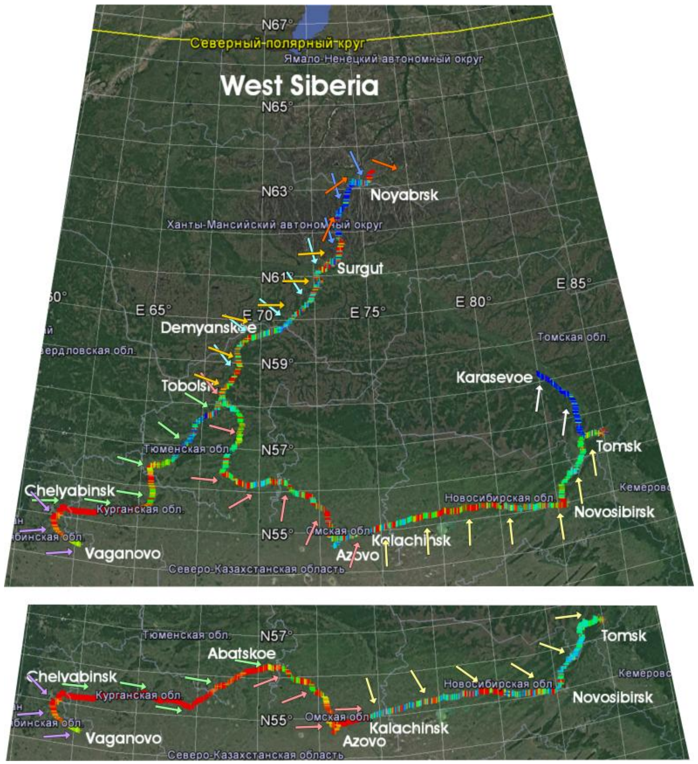


1st campaign: October-November 2018

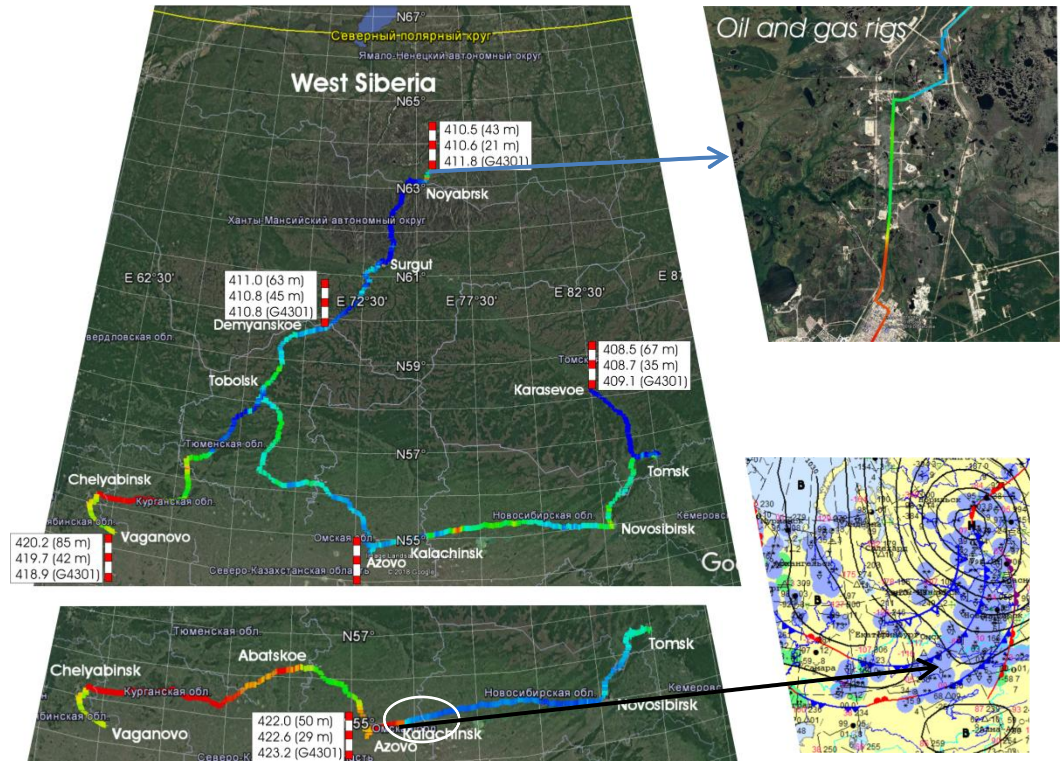
CO_2(ppm)

425
424
423
422
421
420
419
418
417
416
415
414
413
412
411
410

Raw data



Baseline values



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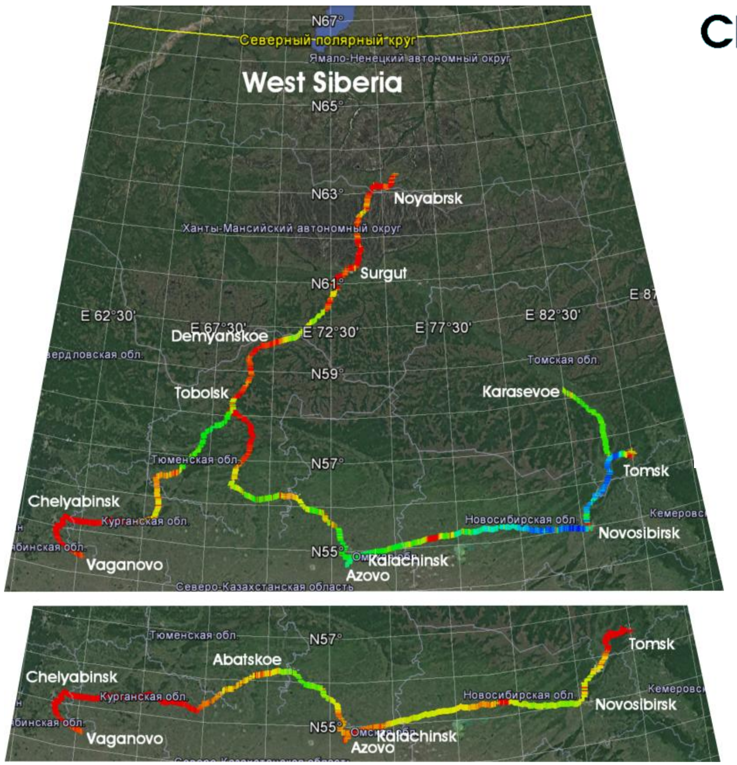
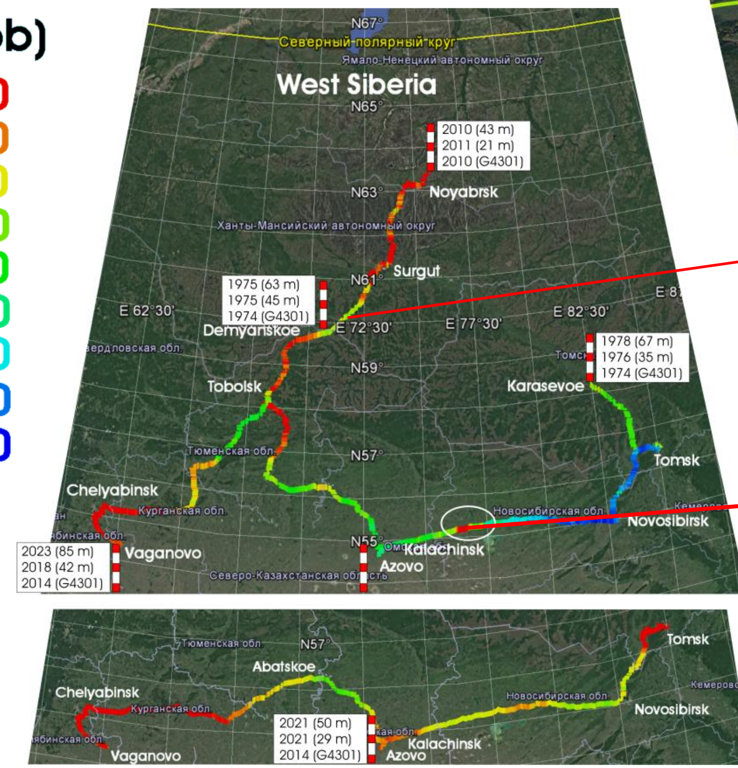
1st campaign: October-November 2018

Raw data

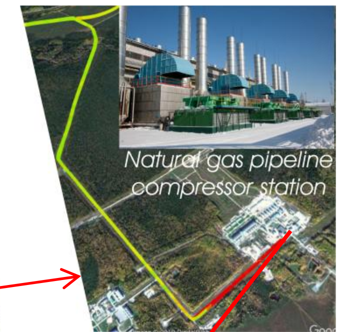


Baseline values



CH$_4$(ppb)

2000
1990
1980
1970
1960
1950
1940
1930
1920



4408 ppb

Chany lakes and wetlands

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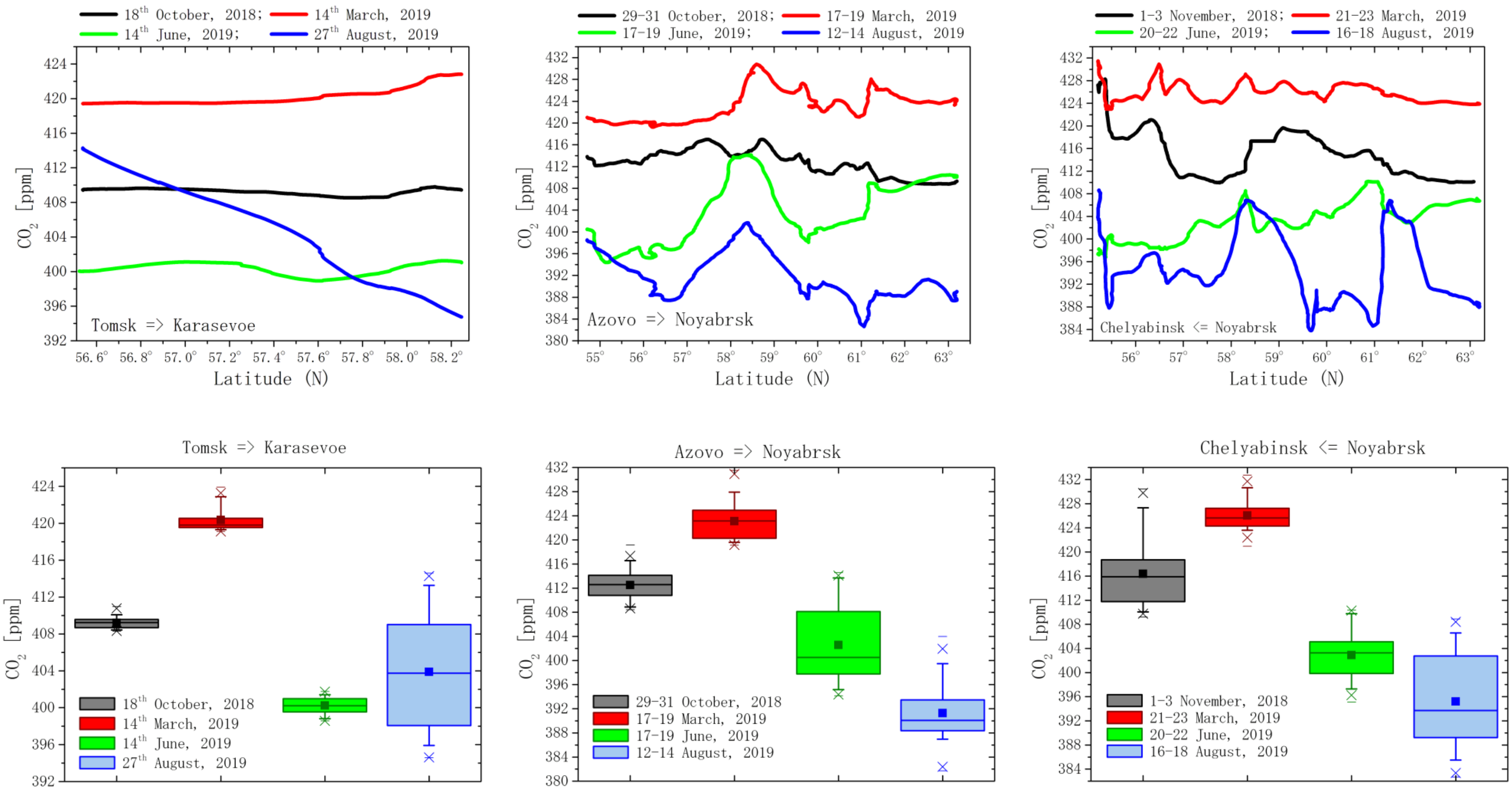
Latitudinal distribution of CO_2 baseline values: seasonal pattern



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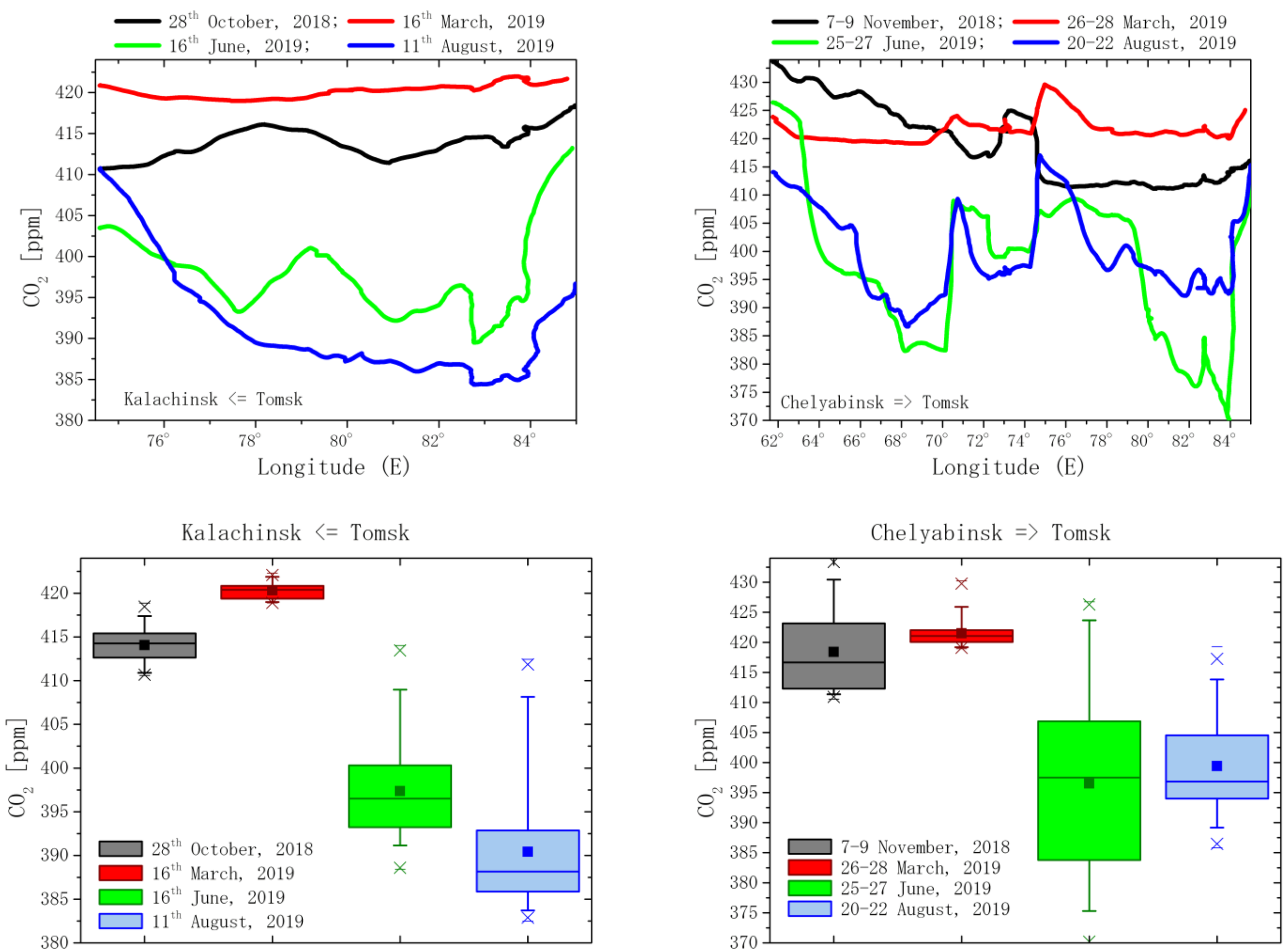
Longitudinal distribution of CO_2 baseline values: seasonal pattern



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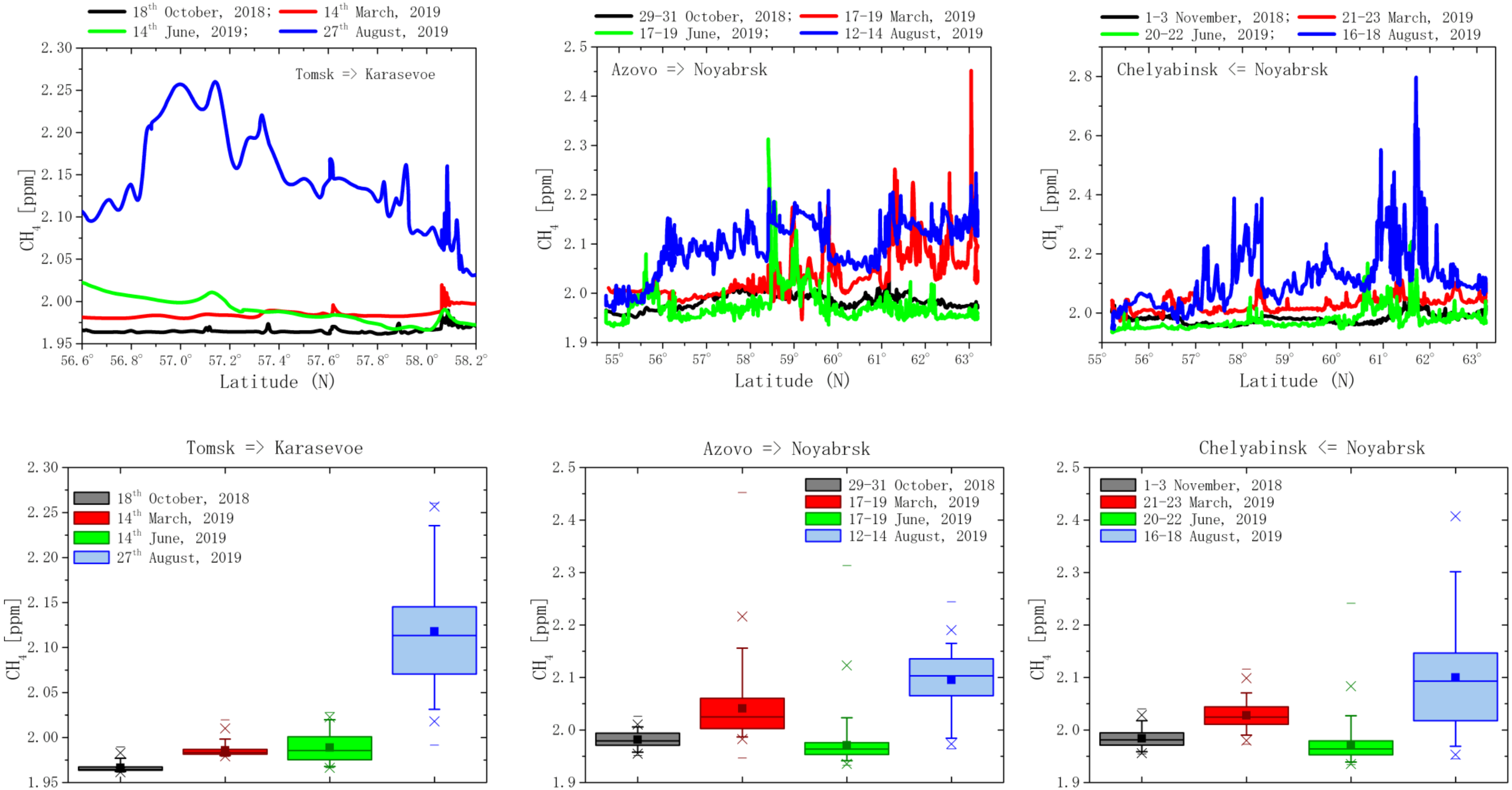
Latitudinal distribution of CH_4 baseline values: seasonal pattern



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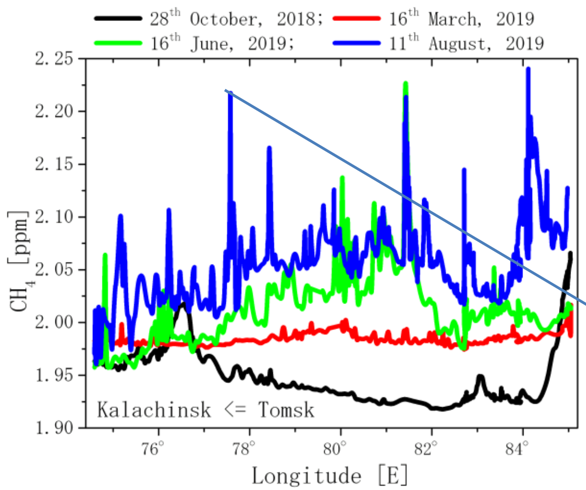
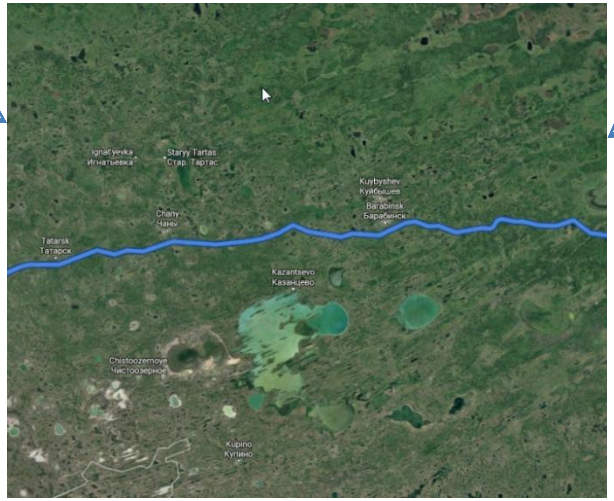
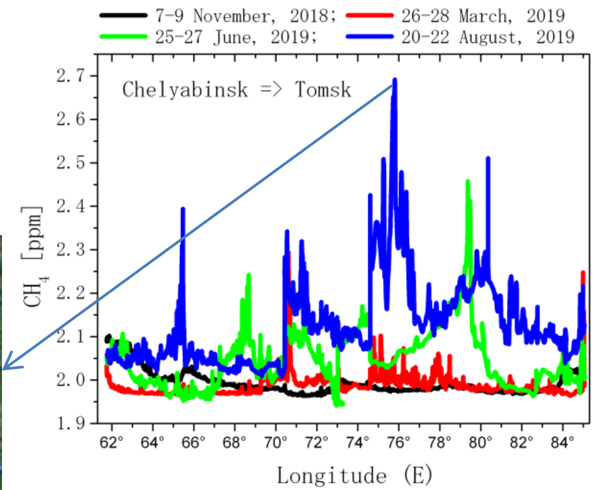
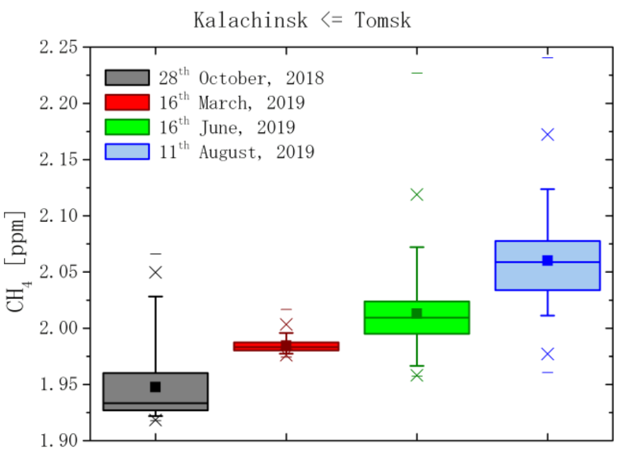
Longitudinal distribution of CH_4 baseline values: seasonal pattern

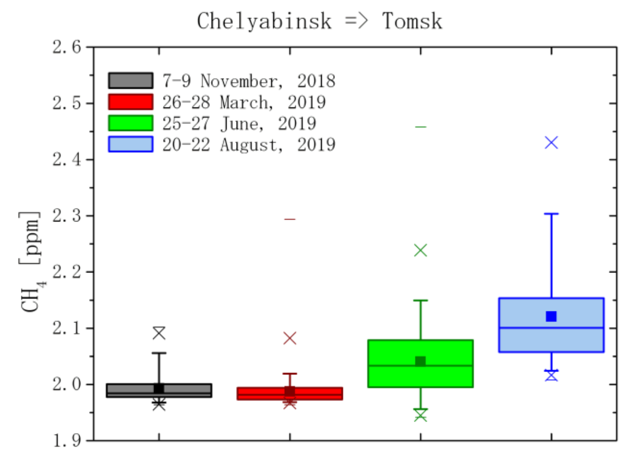


Chany lakes and wetlands









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Average baseline values

Transect (distance)	Date	CO_2, ppm			CH_4, ppb		
		Mean	IQR	Median	Mean	IQR	Median
Tomsk → Karasevoe (310 km)	18.10.2018	409.2±0.5	0.9	409.2	1966.5±4.7	3.7	1964.4
	14.03.2019	420.4±1.1	1.0	419.8	1985.7±6.7	5.3	1983.4
	14.06.2019	400.2±0.9	1.4	400.2	1988.8±15.8	25.7	1985.7
	27.08.2019	403.9±5.8	10.9	403.7	2118.0±59.6	74.7	2113.4
Azovo → Noyabrsk (1590 km)	29-31.10.2018	412.5±2.3	3.3	412.6	1981.8±15.1	23.3	1979.3
	17-19.03.2019	423.1±2.9	4.6	423.1	2040.9±54.2	57.5	2025.2
	17-19.06.2019	402.6±5.8	10.4	400.5	1971.0±34.5	22.7	1963.8
	12-14.08.2019	391.3±4.1	5.1	390.1	2095.5±51.9	70.2	2103.1
Noyabrsk → Chelyabinsk (1500 km)	1-3.11.2018	416.4±5.1	6.9	415.9	1984.1±17.5	23.4	1981.3
	21-23.03.2019	426.0±2.2	2.9	425.6	2028.0±24.7	33.3	2024.7
	20-22.06.2019	402.9±3.6	5.2	403.3	1971.1±29.4	26.8	1964.1
	16-18.08.2019	395.2±7.1	13.5	393.7	2100.2±104.3	128.8	2093.3
Tomsk → Kalachinsk (820 km)	28.10.2018	414.1±1.9	2.8	414.3	1947.7±31.4	33.1	1933.4
	16.03.2019	420.3±0.9	1.5	420.4	1984.5±5.8	7.1	1983.2
	16.06.2019	397.4±5.4	7.1	396.5	2012.9±32.0	28.9	2009.4
	11.08.2019	390.4±6.6	7.0	388.2	2060.1±36.0	43.7	2058.8
Chelyabinsk → Tomsk (1850 km)	7-9.11.2018	418.4±6.5	10.8	416.7	1993.0±25.8	23.1	1984.5
	26-28.03.2019	421.5±2.1	2.0	421.1	1987.4±24.0	21.0	1981.8
	25-27.06.2019	396.5±13.7	23.1	397.5	2040.5±63.8	83.3	2033.4
	20-22.08.2019	399.4±7.6	10.6	396.9	2120.8±90.6	95.8	2100.6
West Siberia	18.10-9.11.2018	415.6±5.4	5.9	414.1	1980.5±26.69	26.1	1979.4
	14-28.03.2019	422.9±3.0	4.6	422.0	2011.4±41.23	46.8	2000.5
	14-27.06.2019	400.0±9.1	9.5	400.5	1999.2±54.18	58.9	1982.7
	11-28.2019	395.1±7.6	10.6	393.4	2100.5±81.7	84.6	2090.2

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Summary

✓ Mobile measurement campaigns carried out across West Siberia in 2018-2019 allowed the spatial distribution of CO_2 and CH_4 to be obtained with a high resolution.

✓Analysis of the data obtained shows the presence of both a latitudinal gradient and mesoscale inhomogeneities in the spatial distribution of greenhouse gases, especially methane.

✓The average baseline values of CO_2 and CH_4 mixing ratios observed in West Siberia in late October - early November 2018, March, June and August 2019 were:

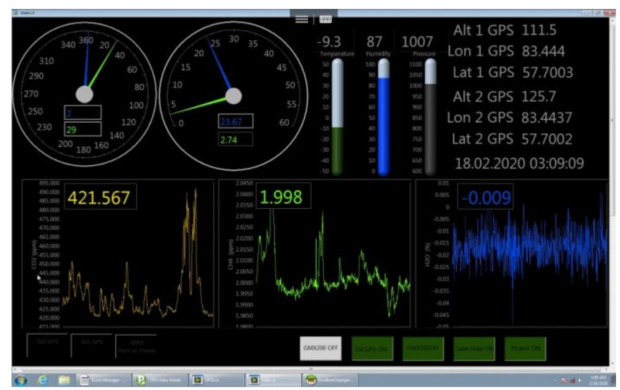
- for CO2: 414.1; 422.0; 400.5; 393.4 ppm, respectively;
- for CH4: 1979.4; 2000.5; 1982.7; 2090.2 ppb, respectively

Conclusions/outlook

- ✓ Regular mobile campaigns will allow the traffic related CO_2 emissions to be removed from mole fractions measured at JR-STATION sites using an approach proposed by Schmidt et al.
  Schmidt et al., "Removing traffic emissions from CO_2 time series measured at a tall tower using mobile measurements and transport modeling," Atmospheric Environment 97, 94–108 (2014).

- ✓ To do that, the measurement suite of our not a big mobile lab should be augmented at least with CO analyzer and a wind sensor.

GMX500, January 2020



- ✓ We plan to continue mobile campaigns to cover interannual variations.
- ✓ Unfortunately, a campaign scheduled for March 2020 did not take place due to restrictions on inter-regional traveling caused by COVID-19 outbreak situation.

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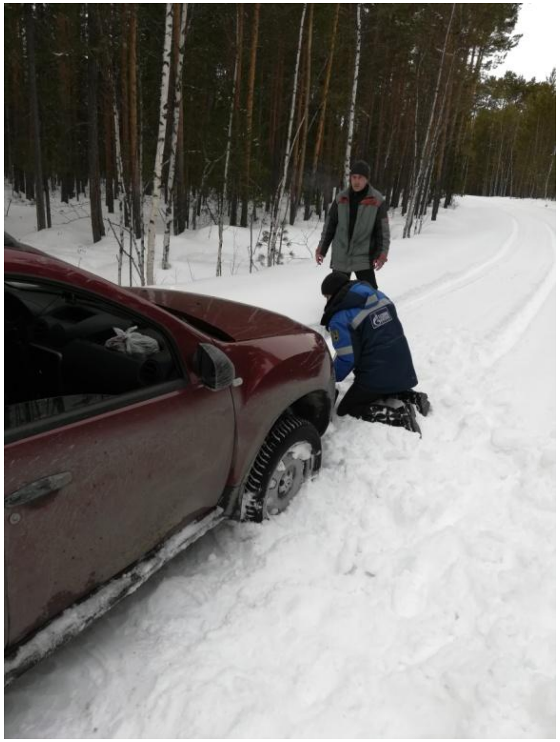
Thank you for attention!



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