

# Continuous atmospheric greenhouse gas measurements in a semi-remote area in the Kyrgyz Republic – first scientific findings towards policy making

M. Steinbacher<sup>1</sup>, Julien G. Anet<sup>1,2</sup>, L. Emmenegger<sup>1</sup>, B. Buchmann<sup>1</sup>

<sup>1</sup> Empa, Swiss Federal Laboratories for Materials Science and Technology,  
Duebendorf, Switzerland

<sup>2</sup> ZHAW School of Engineering, Winterthur, Switzerland

# Kyrgyz Republic at a glance



<https://www.wikipedia.org/>

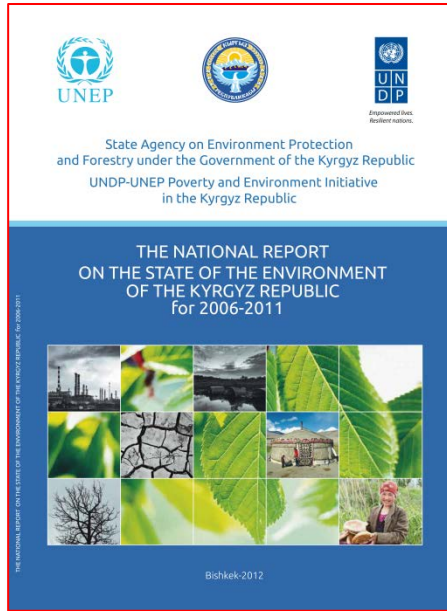
population:	~ 6.1 mio
size:	~ 200 000 km <sup>2</sup>
population density:	27.4/km <sup>2</sup> (rank 191)
capital:	Bishkek (~ 1 mio)
GDP per capita:	1220 US\$
energy production:	> 90% hydropower
number of vehicles:	60 / 1000 people
GHG emissions per capita:	3 metric tons of CO <sub>2</sub> e



<http://www.geographicguide.com/asia/maps/kyrgyzstan.htm>

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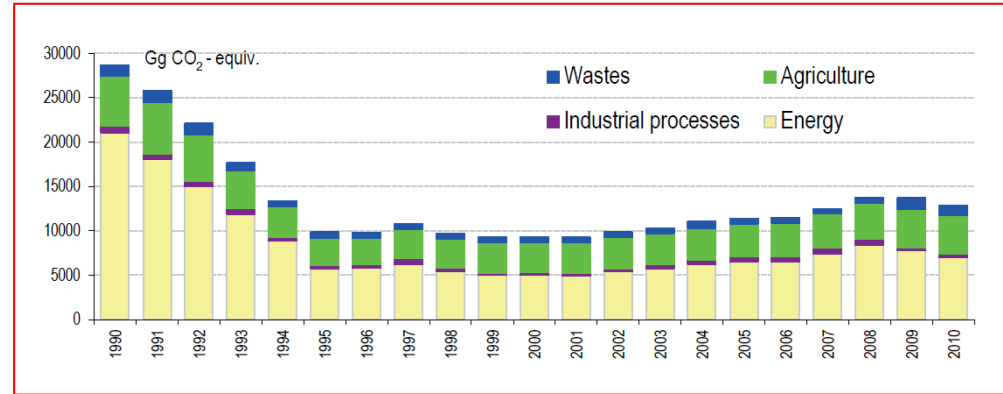
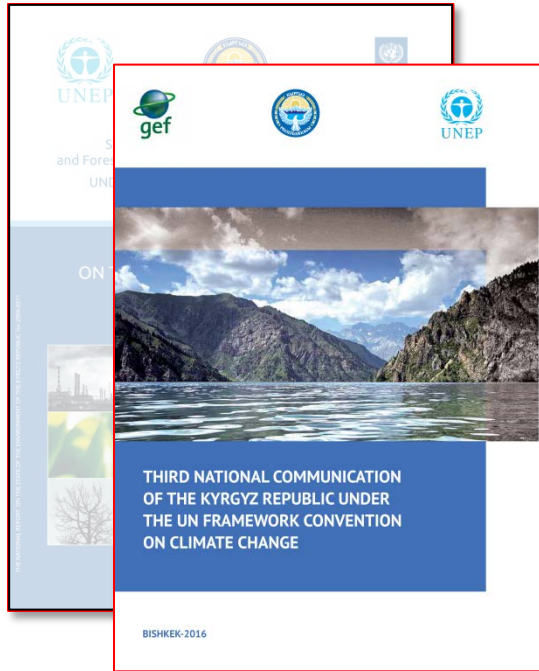
# Climate Change and the Political Agenda



*"The main sources of atmospheric air pollution in the Kyrgyz Republic are enterprises of the energy industry, mining and processing sectors of industry, construction materials, utilities and the private sector, as well as mobile sources of pollution, such as transport."*

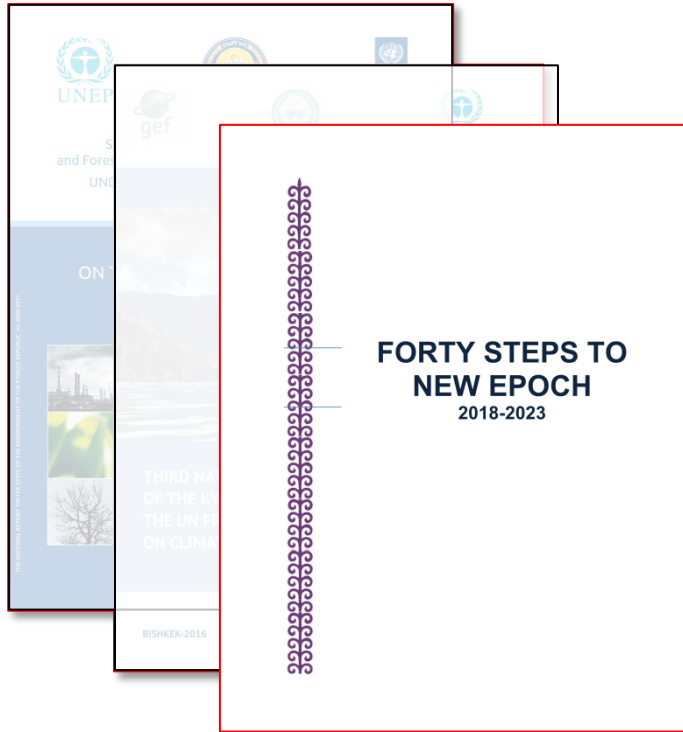
*"A combination of the lack of Kyrgyzstan's own natural gas reserves and the irregular supply of electricity have forced most private family homes to return to the use of locally produced solid fuels which have a relatively low calorific value and high ash content."*

# Climate Change and the Political Agenda



*"Hydropower stations actually [...] generate more than 90% of electricity. This aspect is positive from the point of the climatic impact of the Kyrgyz Republic. The main difficulty is related to the preservation of the existing situation because the renewable energy resources, particularly hydropower, are largely dependent on climate change."*

# Climate Change and the Political Agenda



*“The goal is to reduce by 2020 greenhouse gas emissions by 20% and to achieve average emissions in CO<sub>2</sub> equivalent not exceeding 1.7 tons per person by 2040.”*

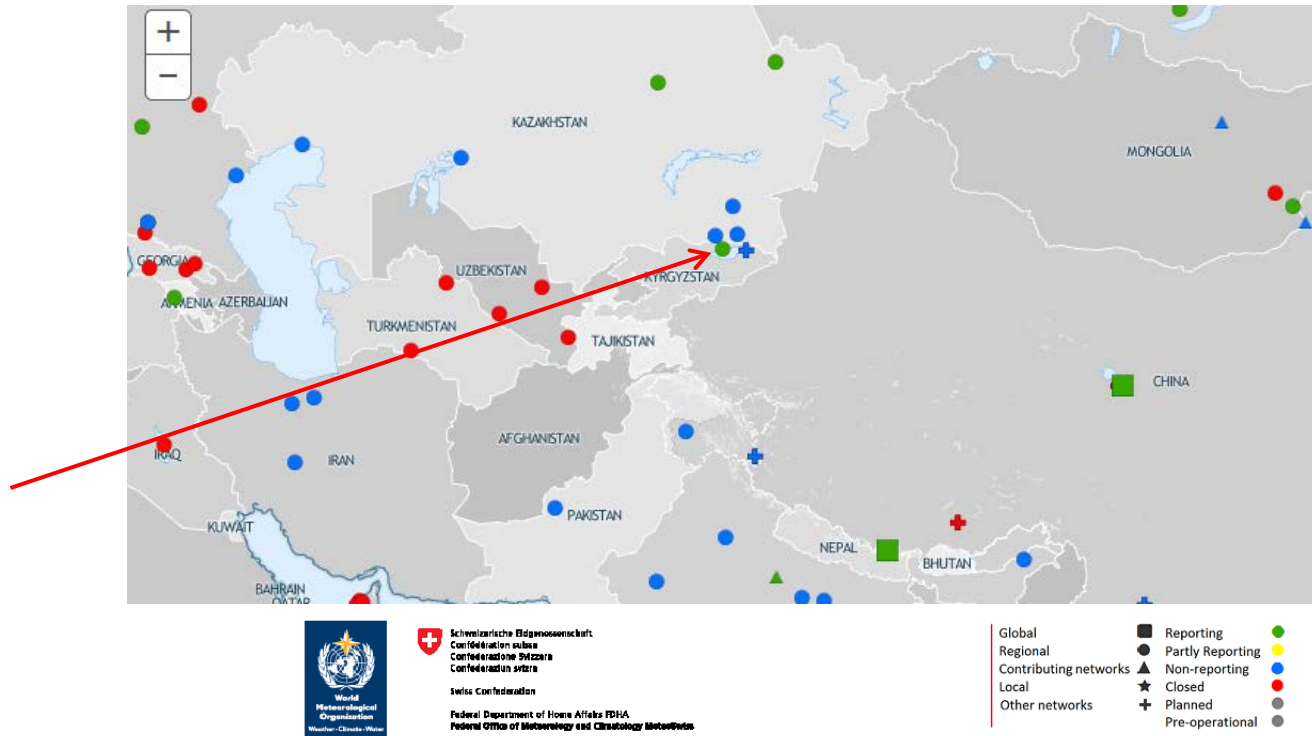
A national legal framework exists with respect to monitoring of GHGs and air quality, as well as reducing the negative impacts of climate change and air pollution.

**BUT:**

No systematic continuous monitoring of GHGs or air pollutants exists. There are fourteen manual air quality monitoring stations in five major Kyrgyz cities, sampling occurs three times a day on working days only. No information was available on atmospheric GHG burdens.

# Situation in Central Asia

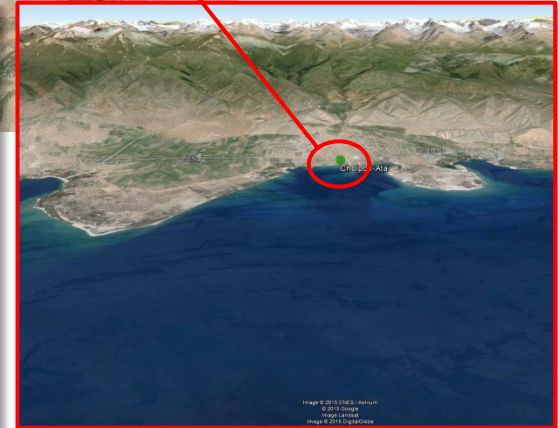
GAW observations in Central Asia; source: <https://gawsis.meteoswiss.ch/>



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# New GHG observations in Kyrgyzstan

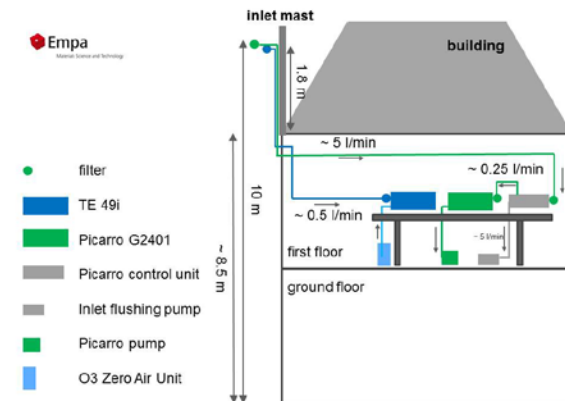


# New GHG observations in Kyrgyzstan

## Cholpon Ata Lake Observatory

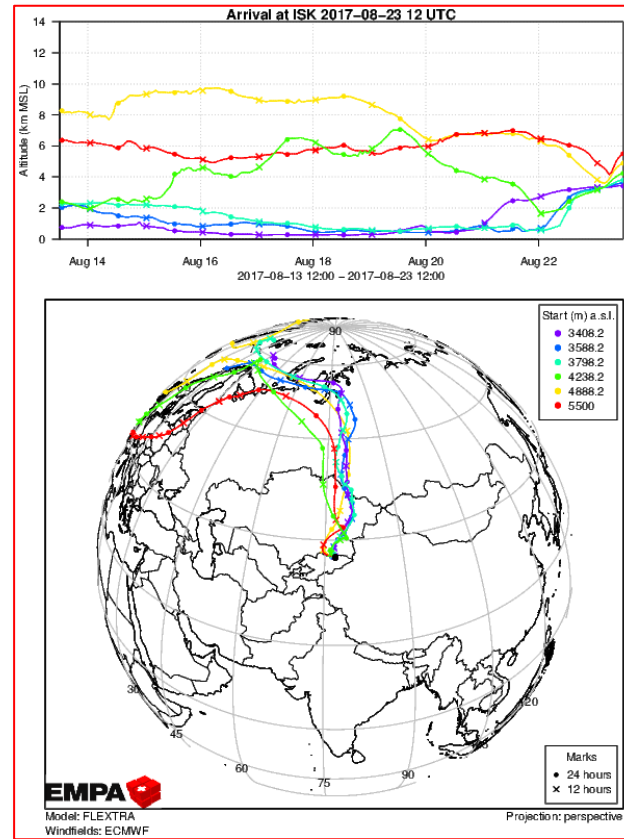
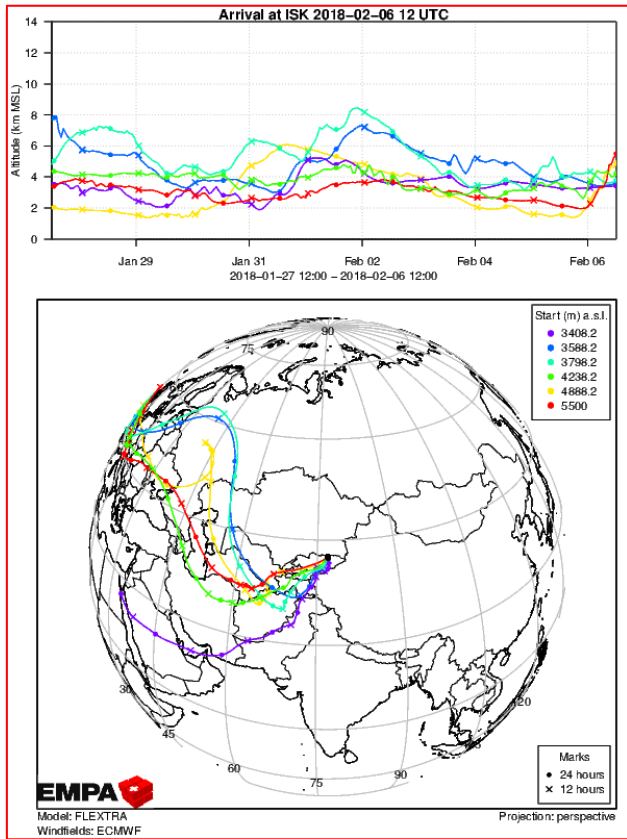


Sampling height was a compromise as inlet filters have to be replaced periodically on top of the roof.



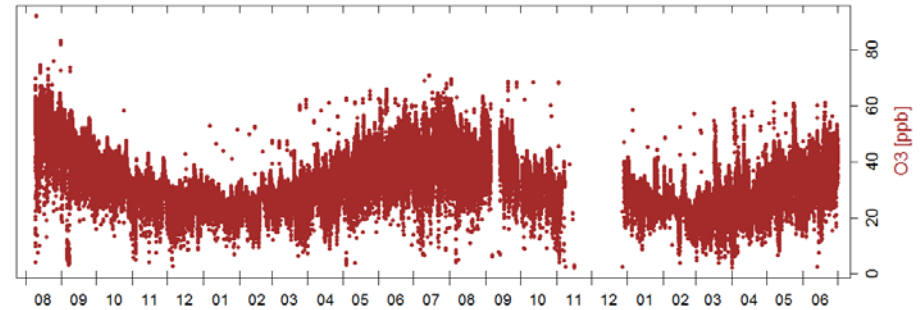
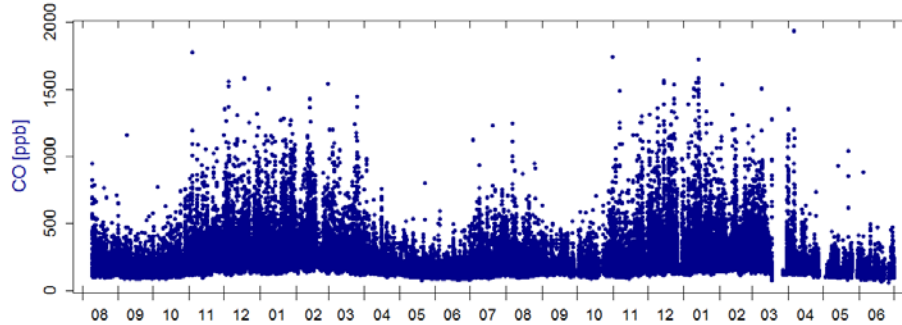
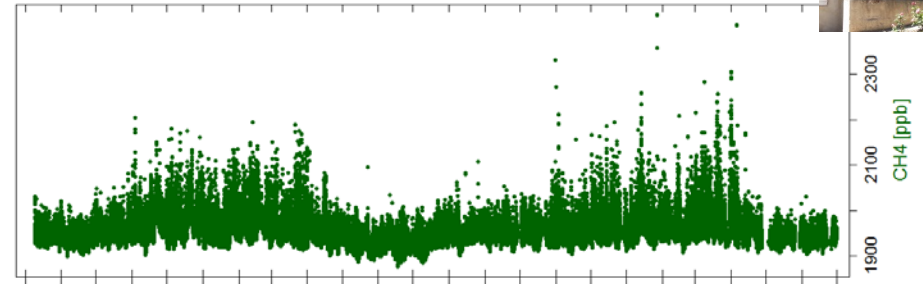
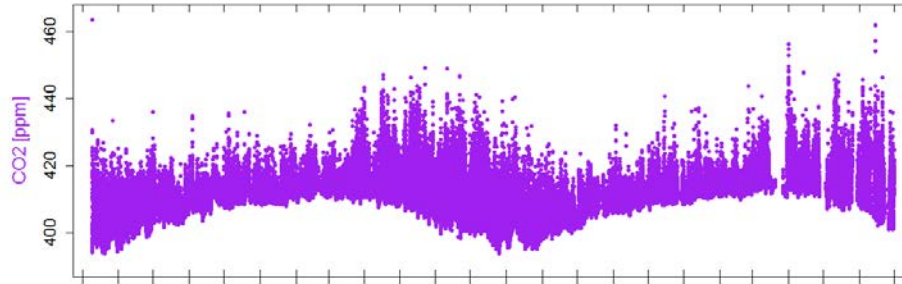


# Typical (large scale) advection patterns



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# Available time series, 10-min averages

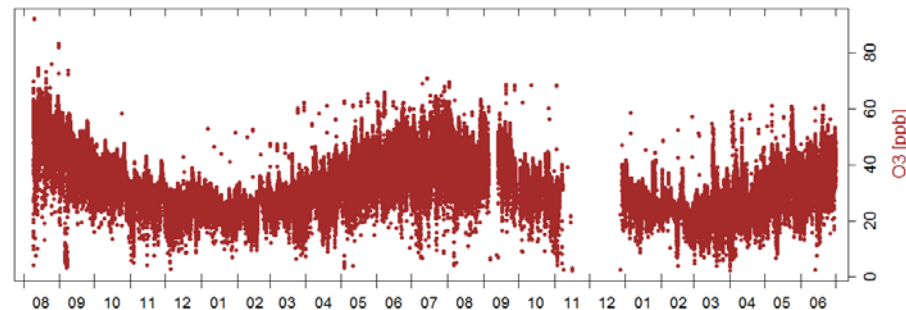
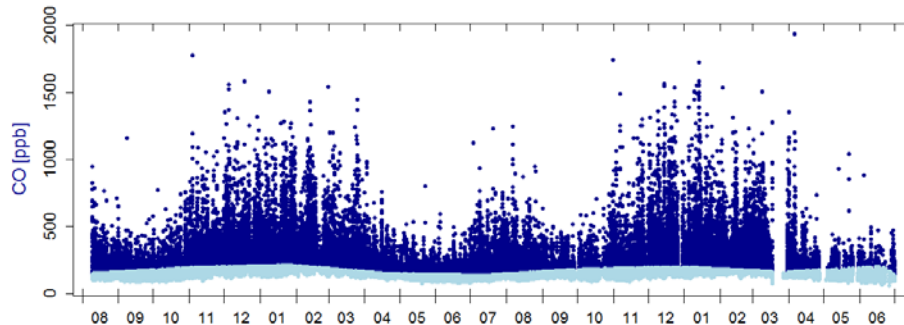
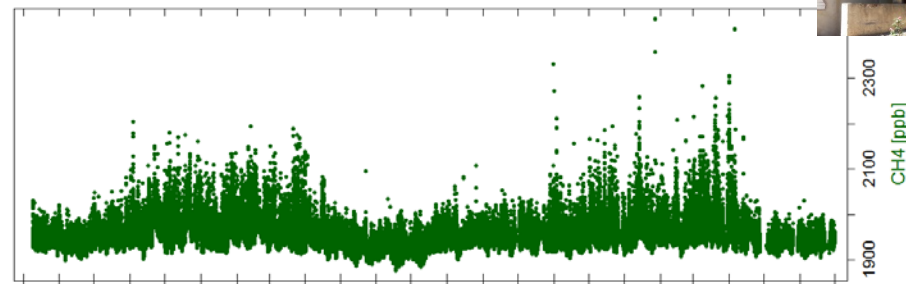
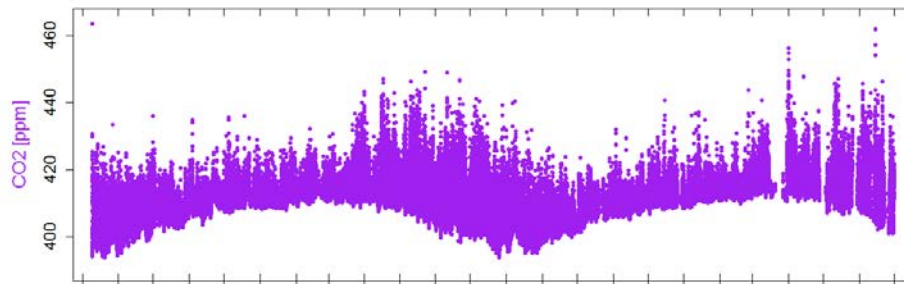


month

month

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# Available time series, 10-min averages



2016

2017

2018

month

statistical baseline determination  
(Ruckstuhl et al., 2012) in lightblue

2016

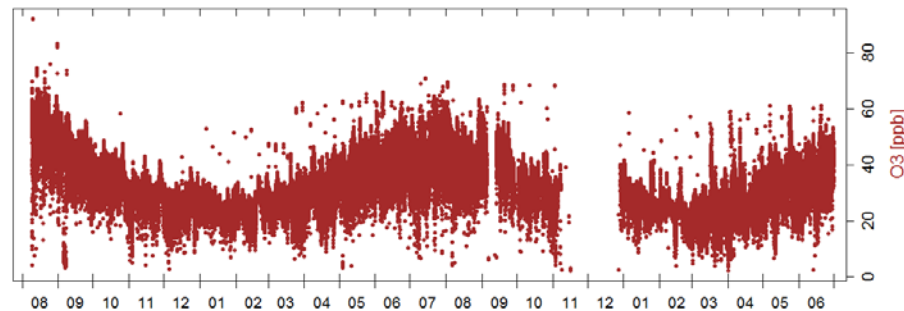
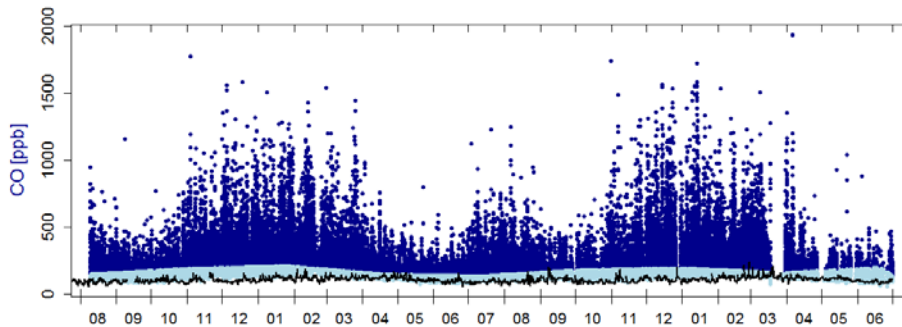
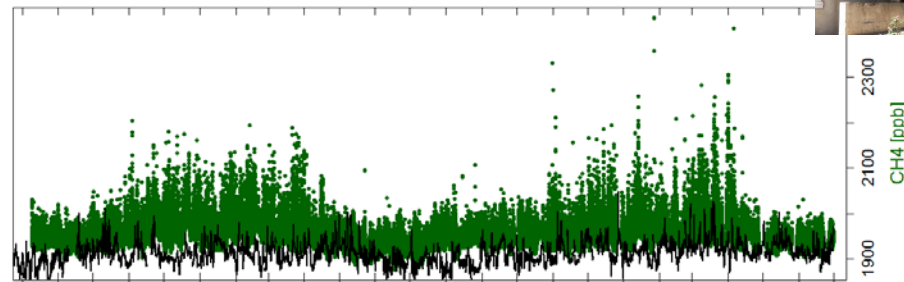
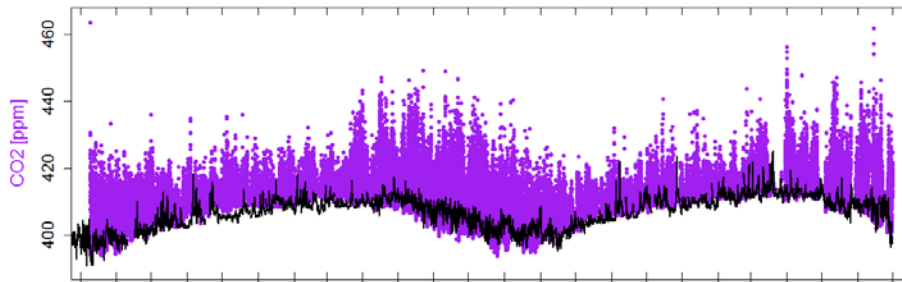
2017

2018

month

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# Available time series, 10-min averages



2016

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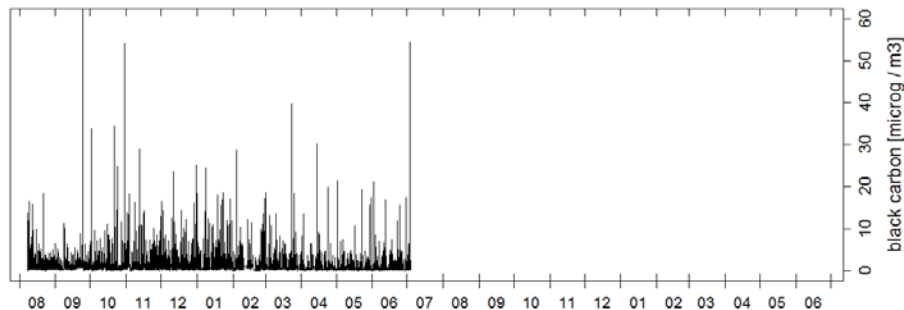
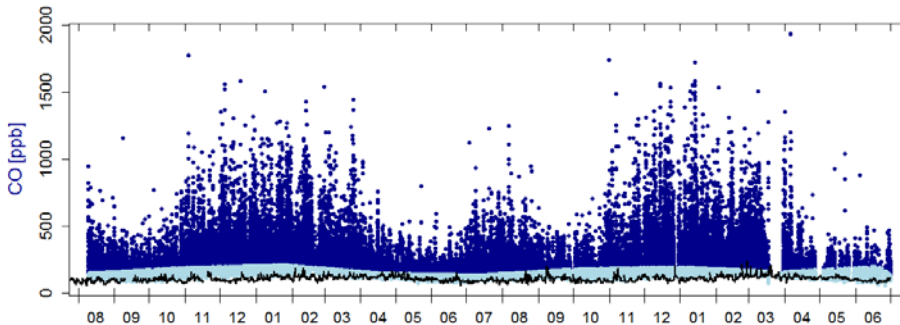
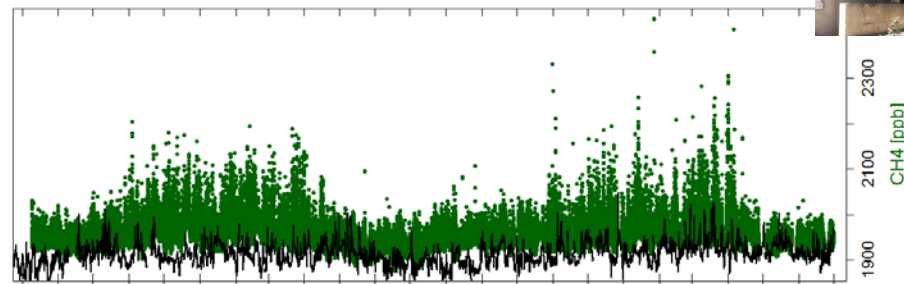
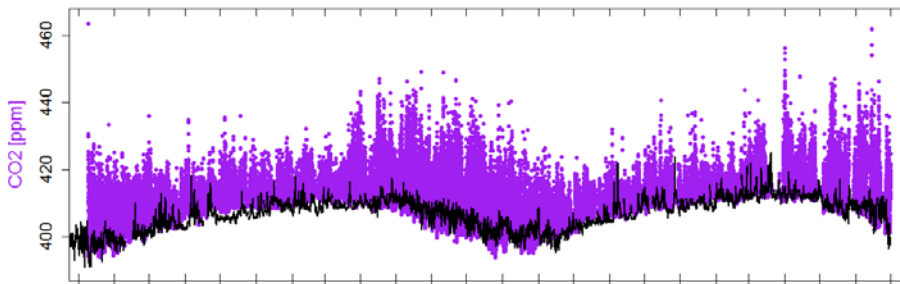
month

Hourly averages from Jungfraujoch in black



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# Available time series, 10-min averages



2016

2017

2018

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2018

month

statistical baseline determination  
(Ruckstuhl et al., 2012) in lightblue

month

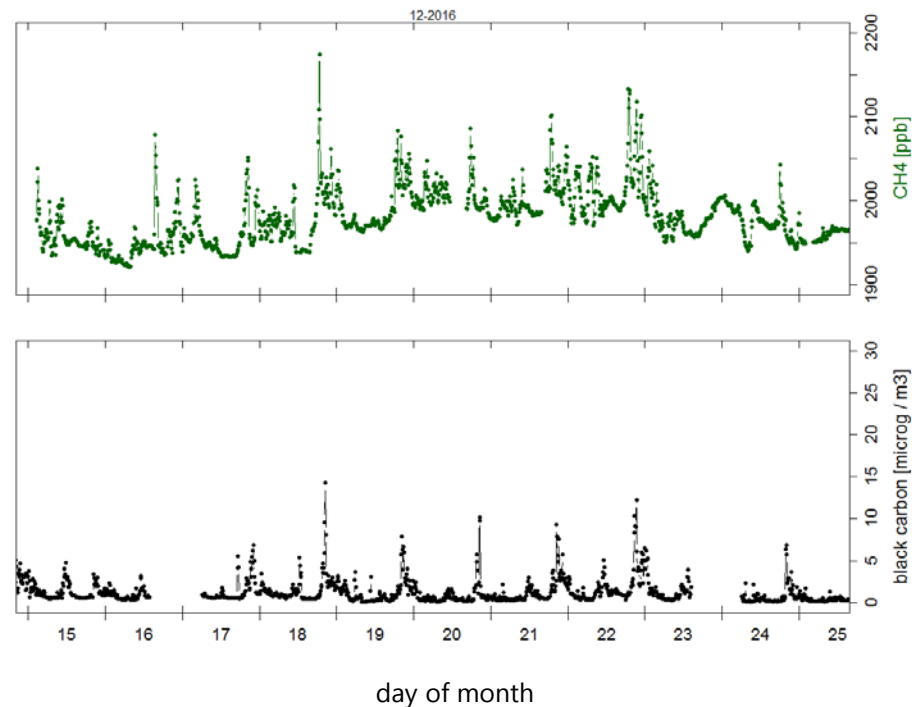
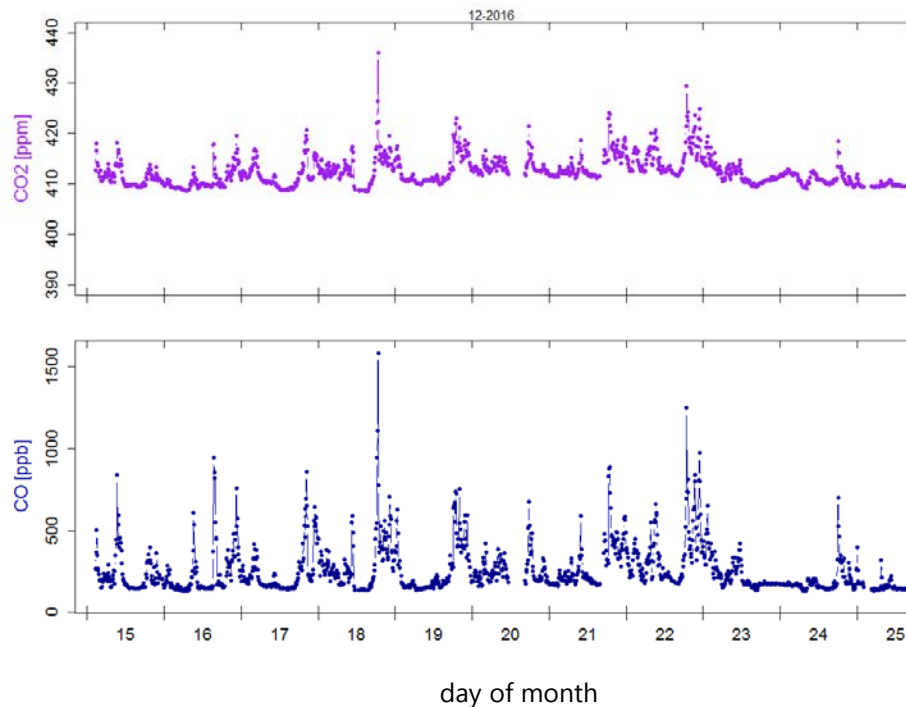
Hourly averages from Jungfraujoch in black



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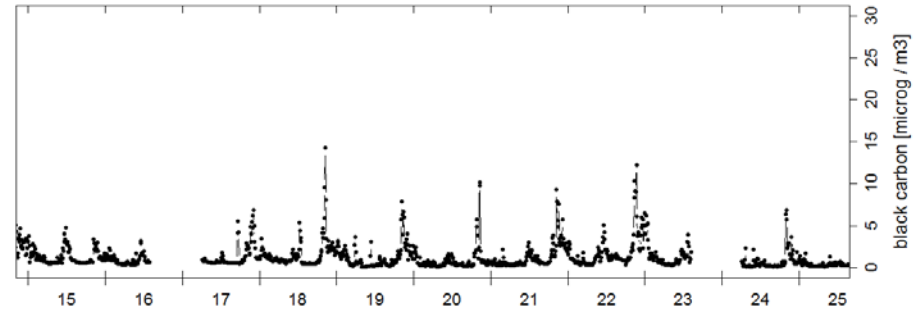
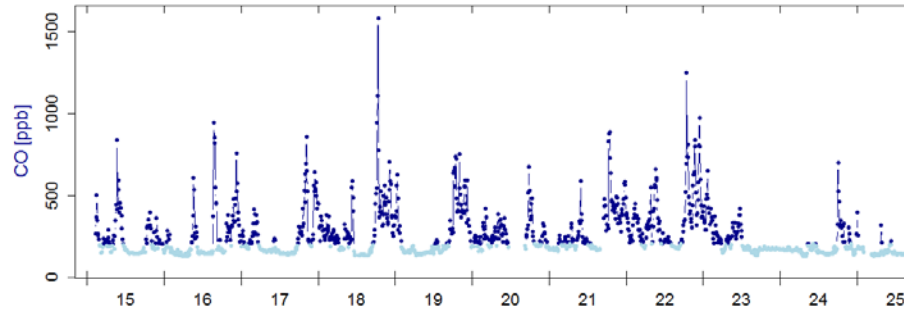
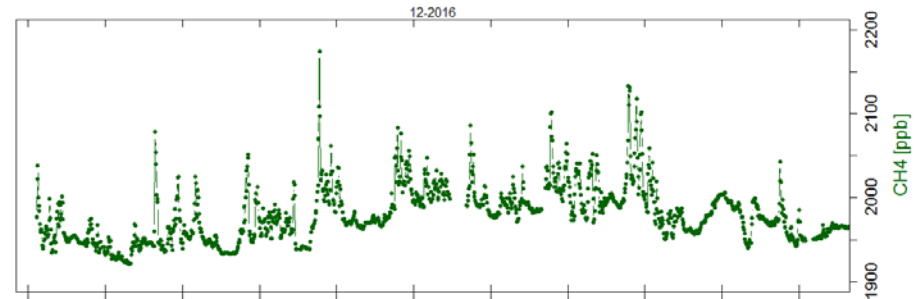
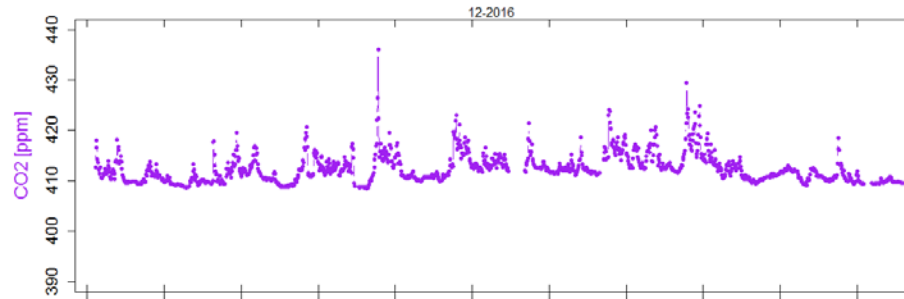


# Winter conditions, 10 days in December 2016



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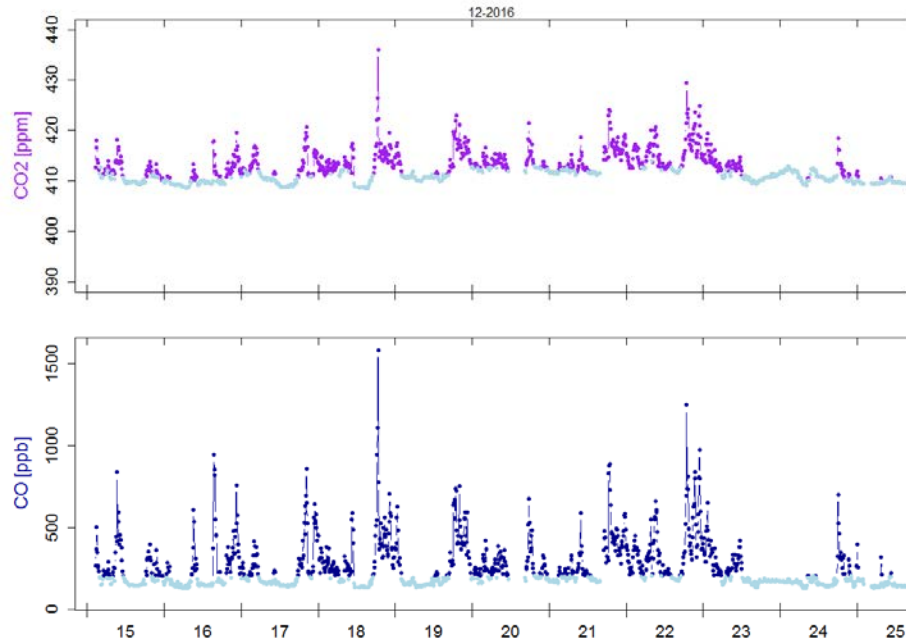


day of month statistical baseline determination  
(Ruckstuhl et al., 2012) in lightblue

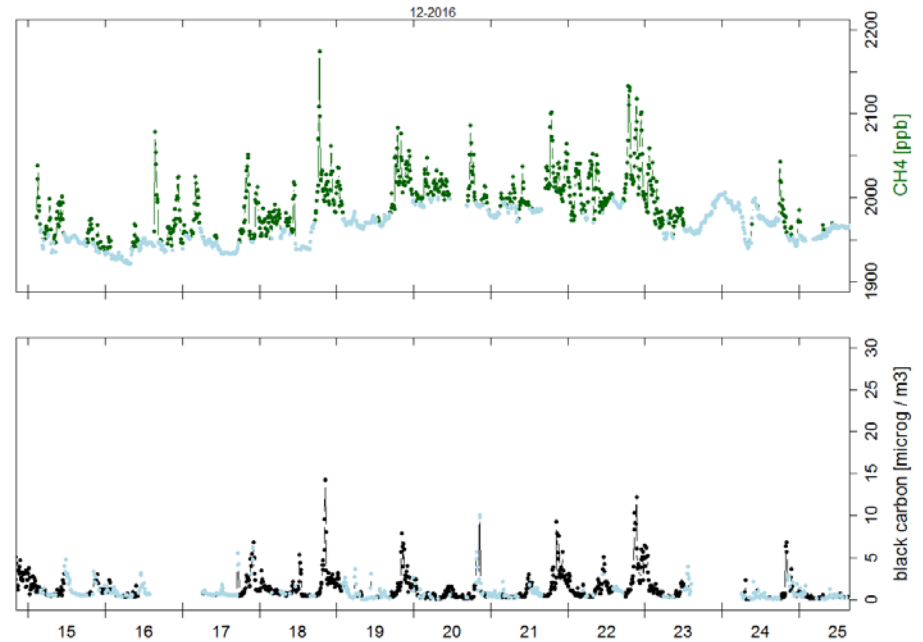
day of month

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# Winter conditions, 10 days in December 2016

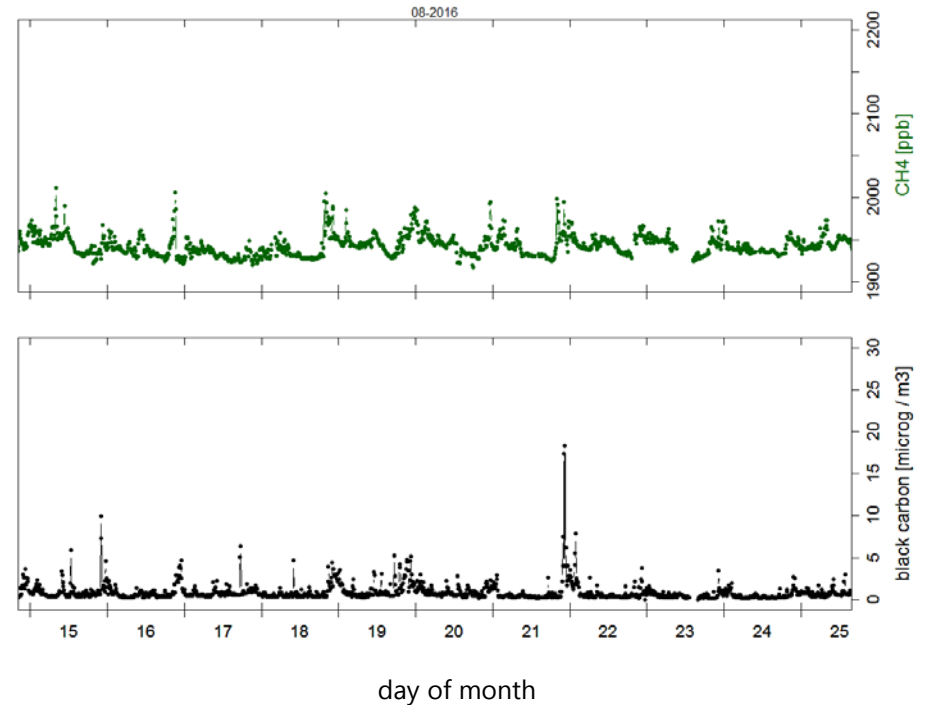
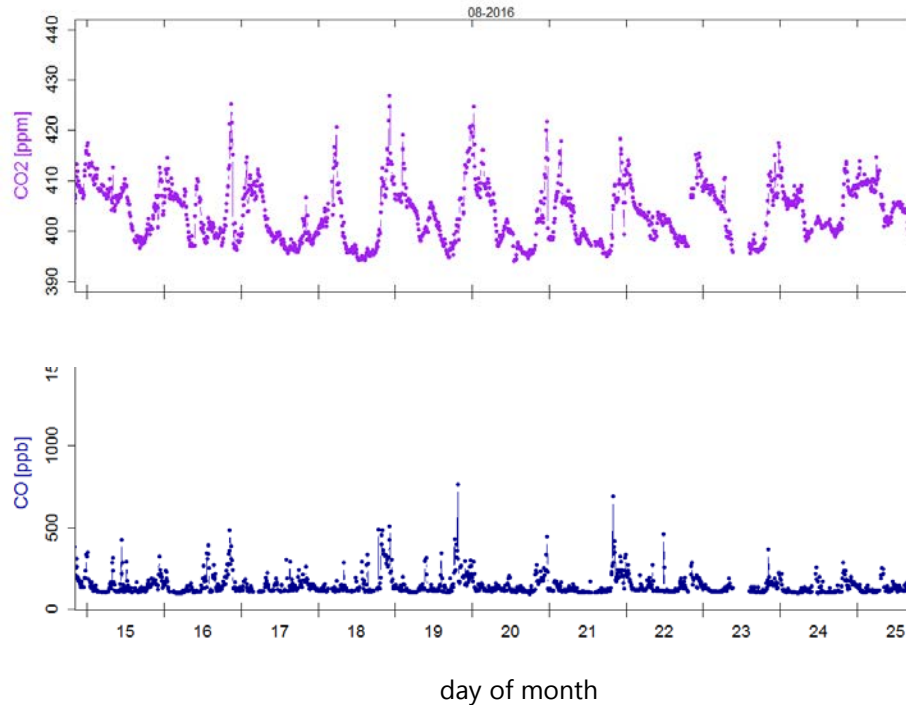


day of month statistical baseline determination  
(Ruckstuhl et al., 2012) in lightblue



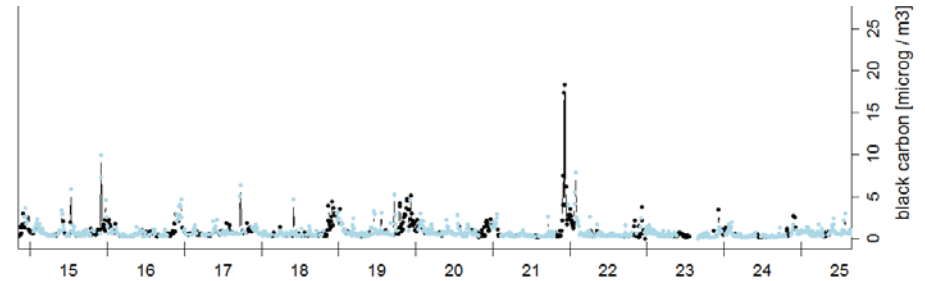
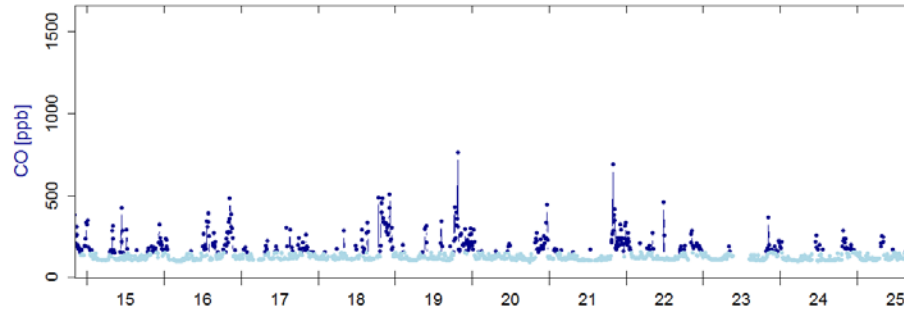
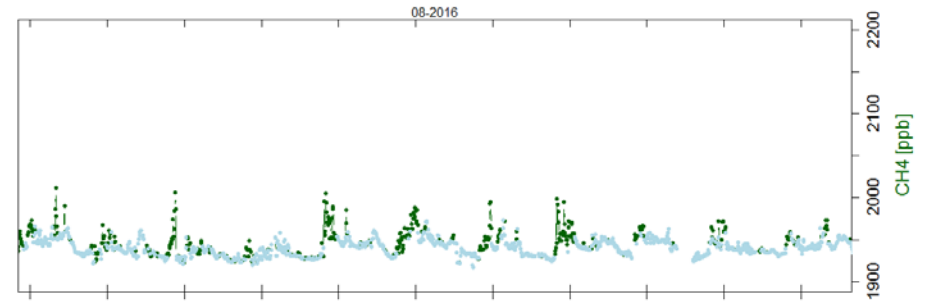
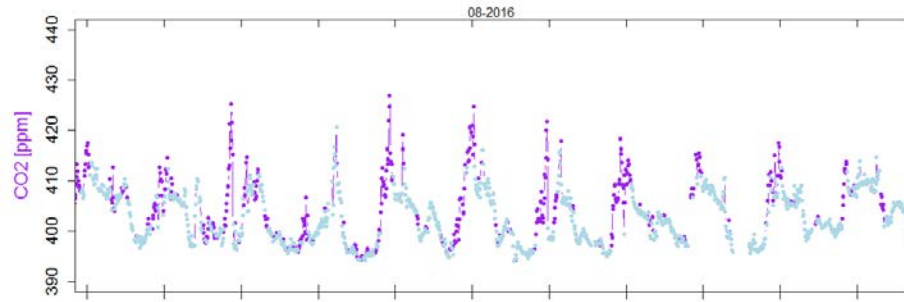
day of month

# Summer conditions, 10 days in August 2016



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# Summer conditions, 10 days in August 2016



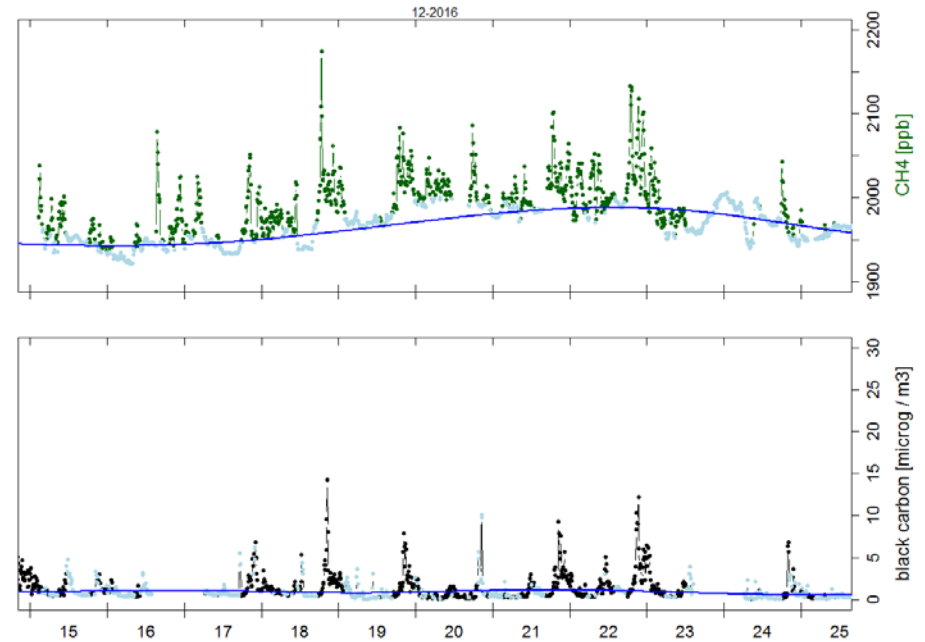
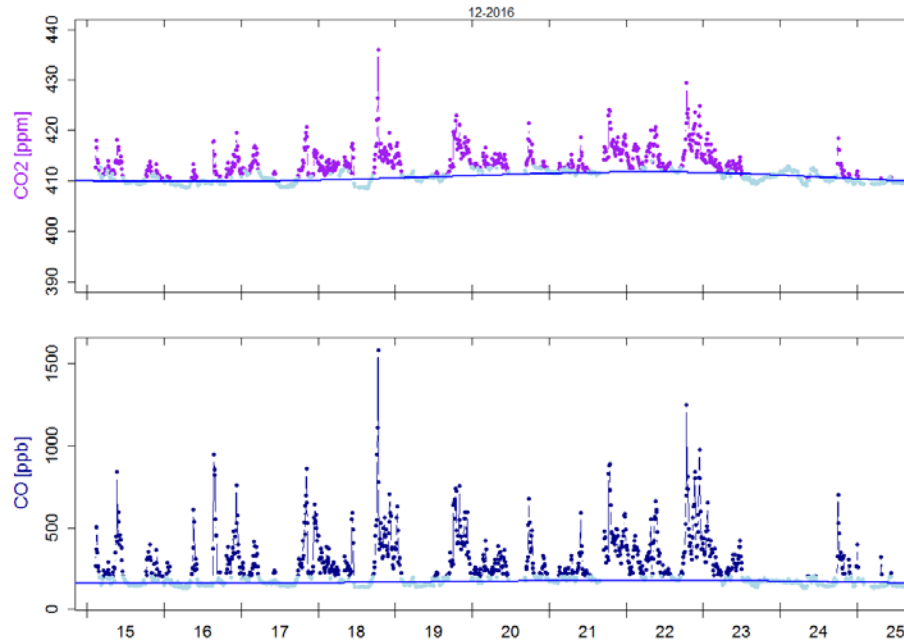
day of month statistical baseline determination  
(Ruckstuhl et al., 2012) in lightblue

day of month

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# Winter conditions, 10 days in December 2016



day of month

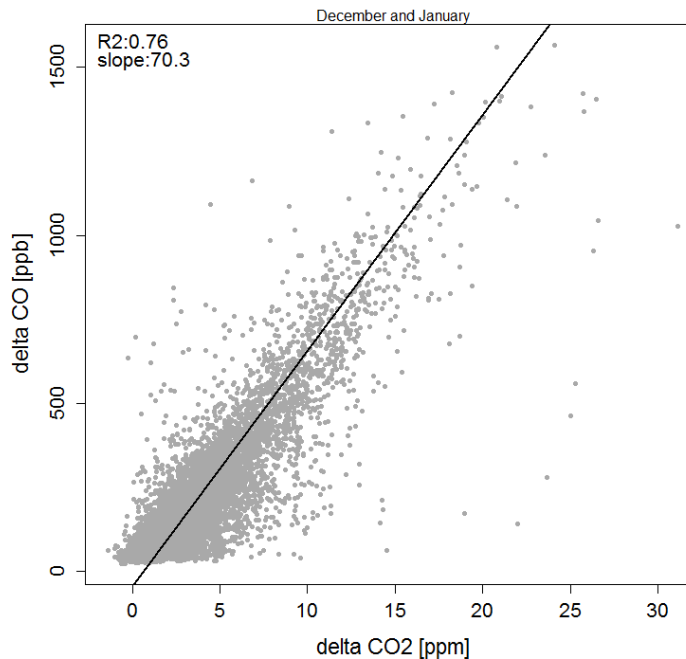
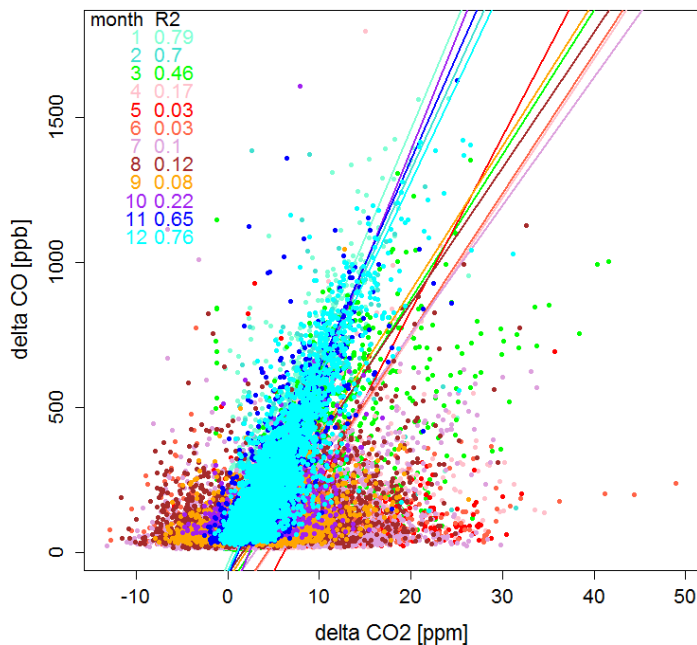
statistical baseline determination  
(Ruckstuhl et al., 2012) in lightblue

spline fit through baseline data in blue

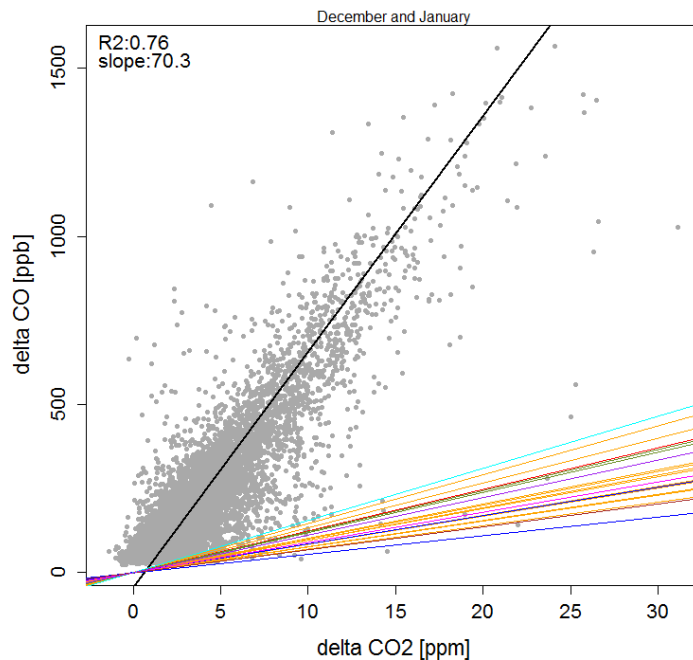
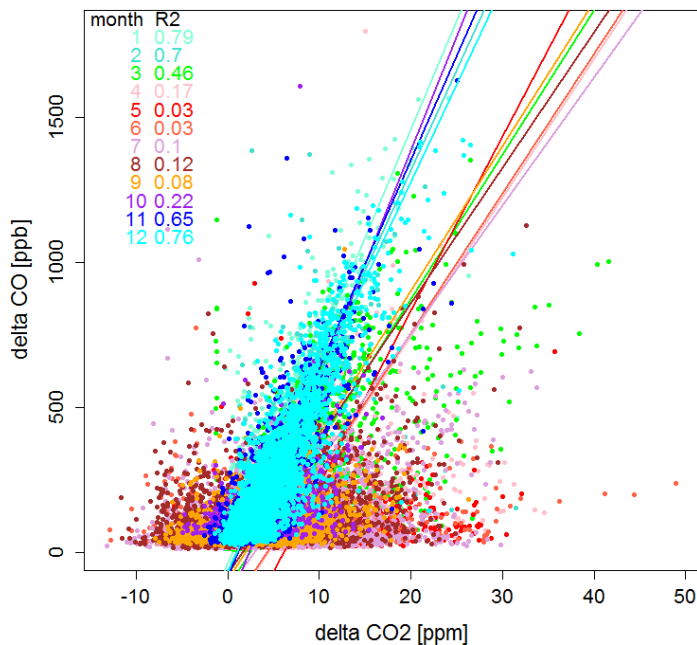
day of month

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# Correlations of above baseline conditions



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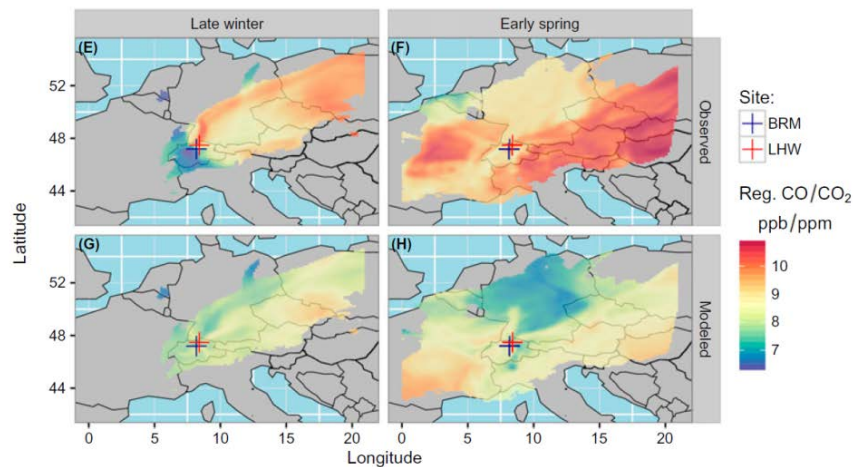


[1], [2], [3],  
[4], [5], [6],  
[7], [8], [9]

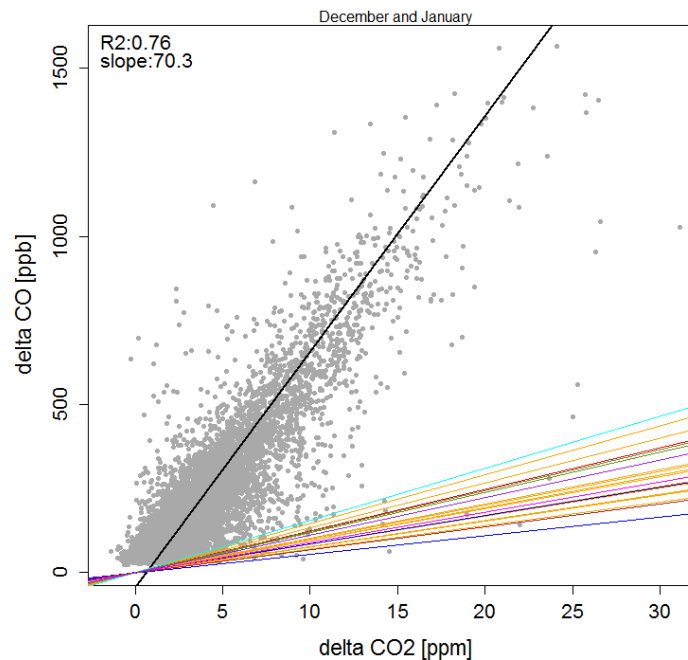
[1] Oney et al., 2017; Ammoura et al., 2014, 2016; [3] Potosnak et al., 1999; [4] Gamnitzer et al., 2006; [5] Vogel et al., 2006; [6] van der Laan et al., 2010; [7] Miller et al., 2012; Turnbull et al., 2006; [9] Turnbull et al., 2011

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# Correlations of above baseline conditions



Oney et al., 2017



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# Conclusions

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- Overall, Kyrgyz Republic is a minor emitter of GHGs, but emissions are expected to rise with economical development and the reduced availability of hydropower in the future.
- Continuous and ongoing in-situ GHG observations were launched in July 2016 at the semi-remote Cholpon-Ata Lake Observatory.
- The station allows observing atmospheric background greenhouse gases concentrations and investigating the impact of local activities on air quality, both likely representative for the rural Kyrgyz Republic.
- Domestic heating and power generation is a major contributor to poor air quality in winter.



# Acknowledgements

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- MeteoSwiss for coordination of the project

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