Net turbulent fluxes of methane and carbon dioxide in the city of Łódź, Poland - comparison of diurnal and seasonal variability

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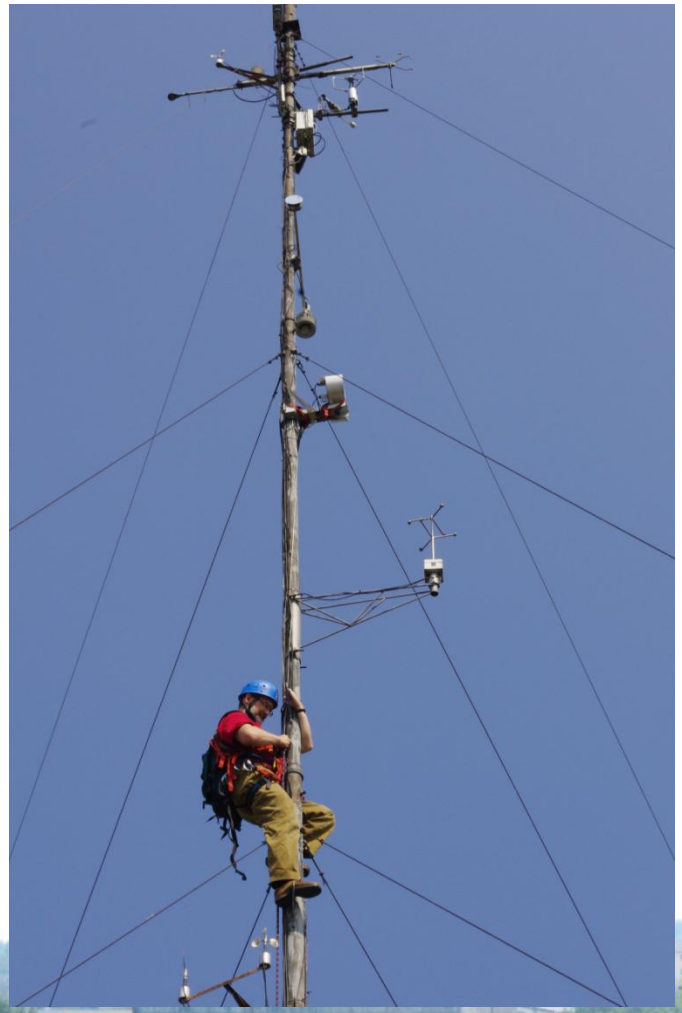
OUTLINE



1. Introduction
2. Site description
3. Instrumentation and method
4. Results
5. Summary

INTRODUCTION

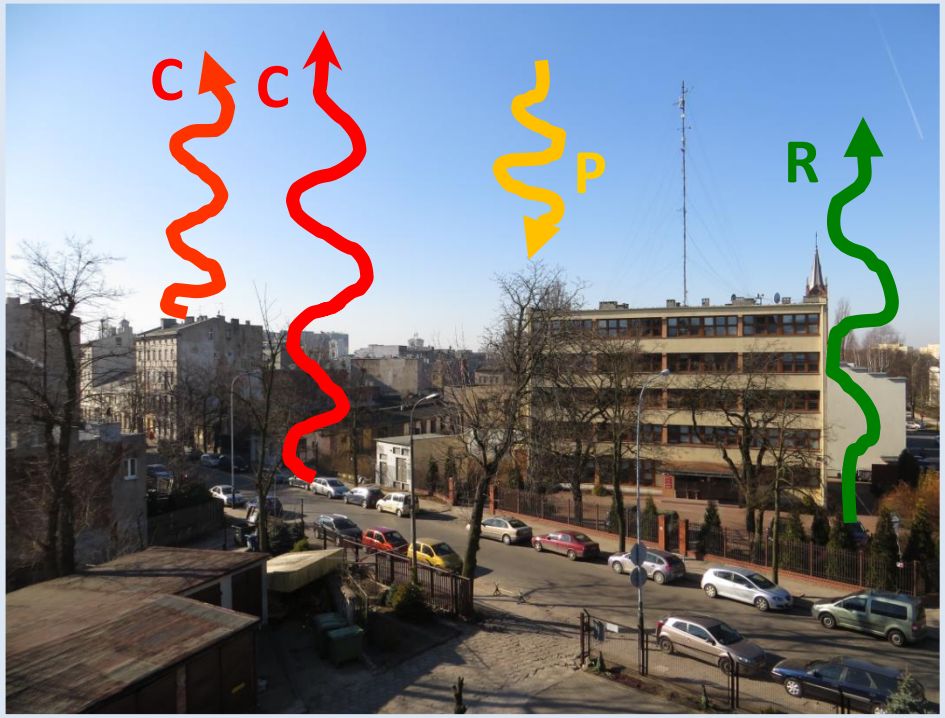
Conceptual representation of carbon dioxide and methane fluxes between urban surface and atmosphere:

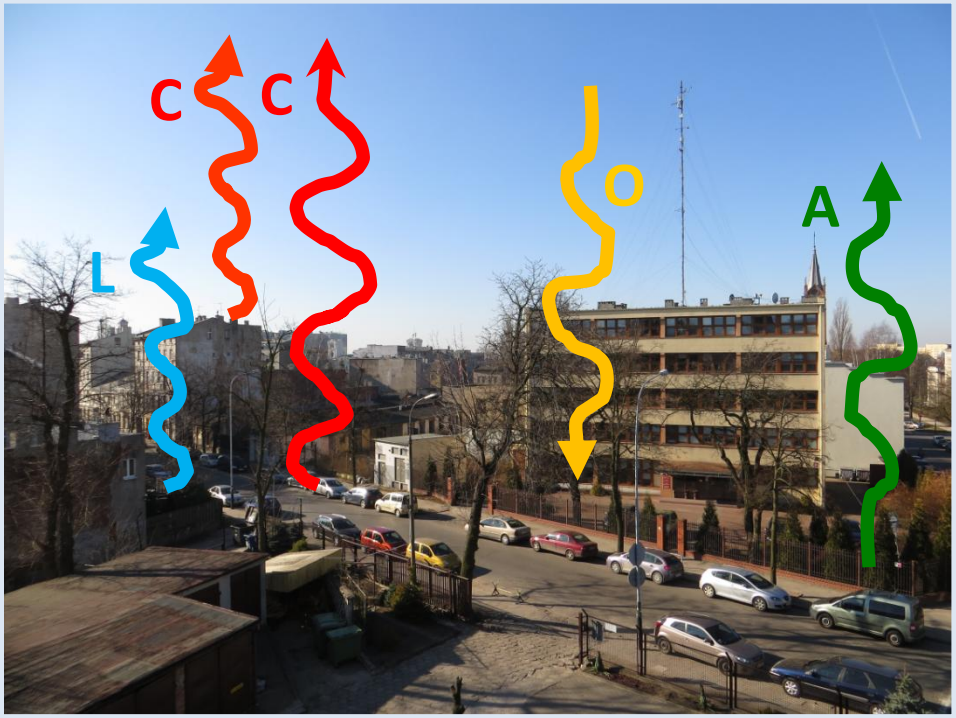
$FCO_2 = C + R - P$

C - fossil fuel combustion
R - respiration
P - photosynthesis

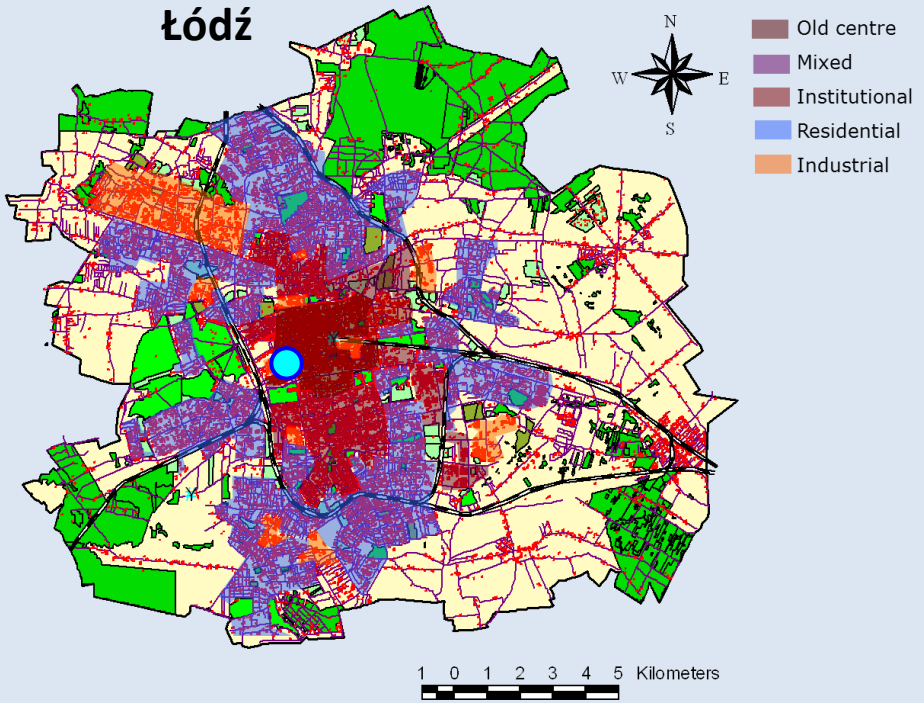
$FCH_4 = C + L + A - O$

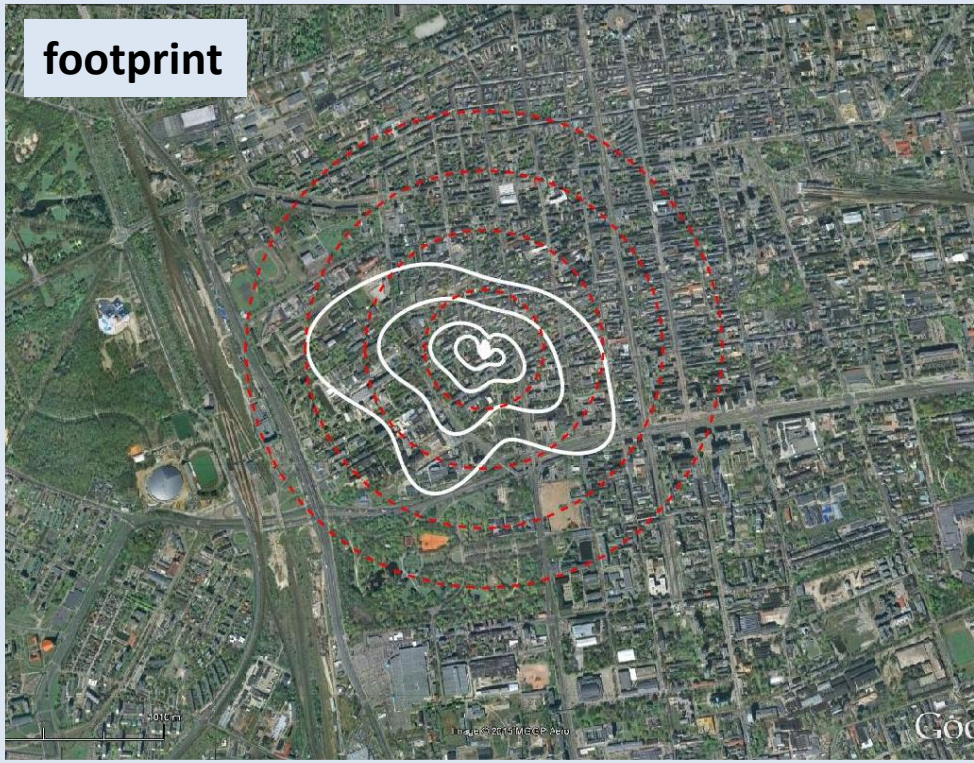
C - fossil fuel combustion
L - leaks from the natural gas networks
A - anaerobic respiration
O - microbial oxidation

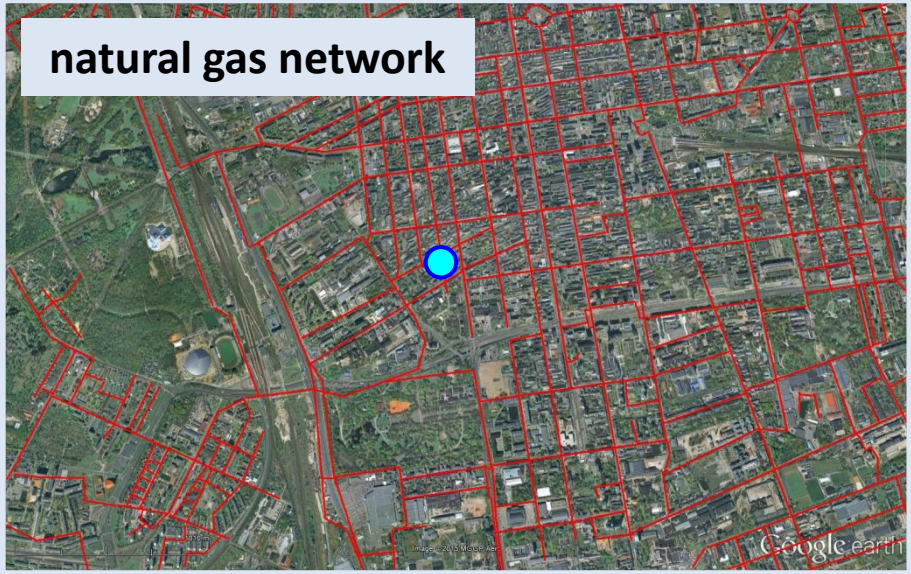


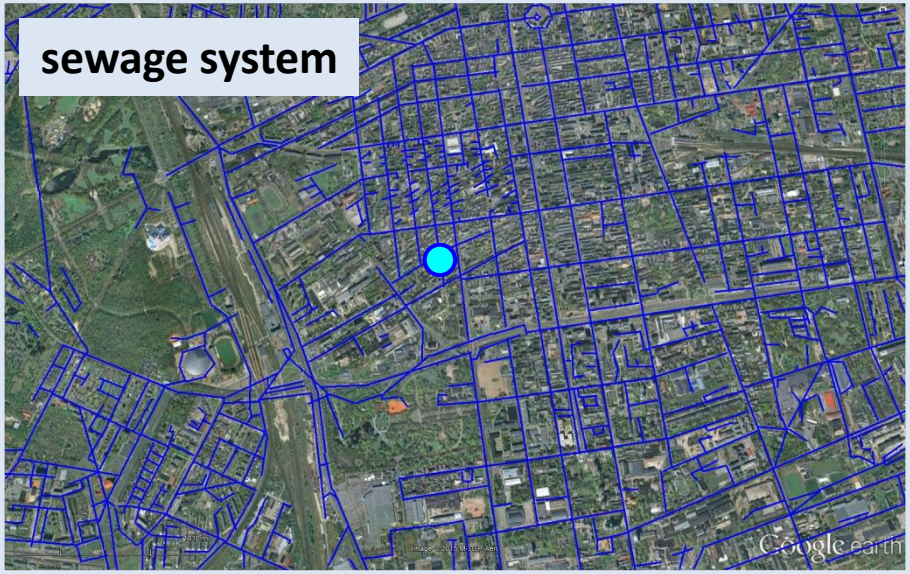


MEASUREMENT SITE









MEASUREMENT SITE, INSTRUMENTATION AND METHOD

densily built-up city center

measurement height	z_H [m]	37.0
mean urban canopy height	z_c [m]	11.0
displacement height	z_d [m]	7.7
roughness length	z_{0m} [m]	2.0
artificial surfaces	[%]	62
green areas / trees	[%]	38 / 10

sonic anemometer RMYoung 81000
CO_2/H_2O gas analyzer Li-cor 7500
CH_4 gas analyzer Li-cor 7700

10 Hz frequency

EC method:

$$FCO_2 = \overline{w'\rho CO_2'}$$

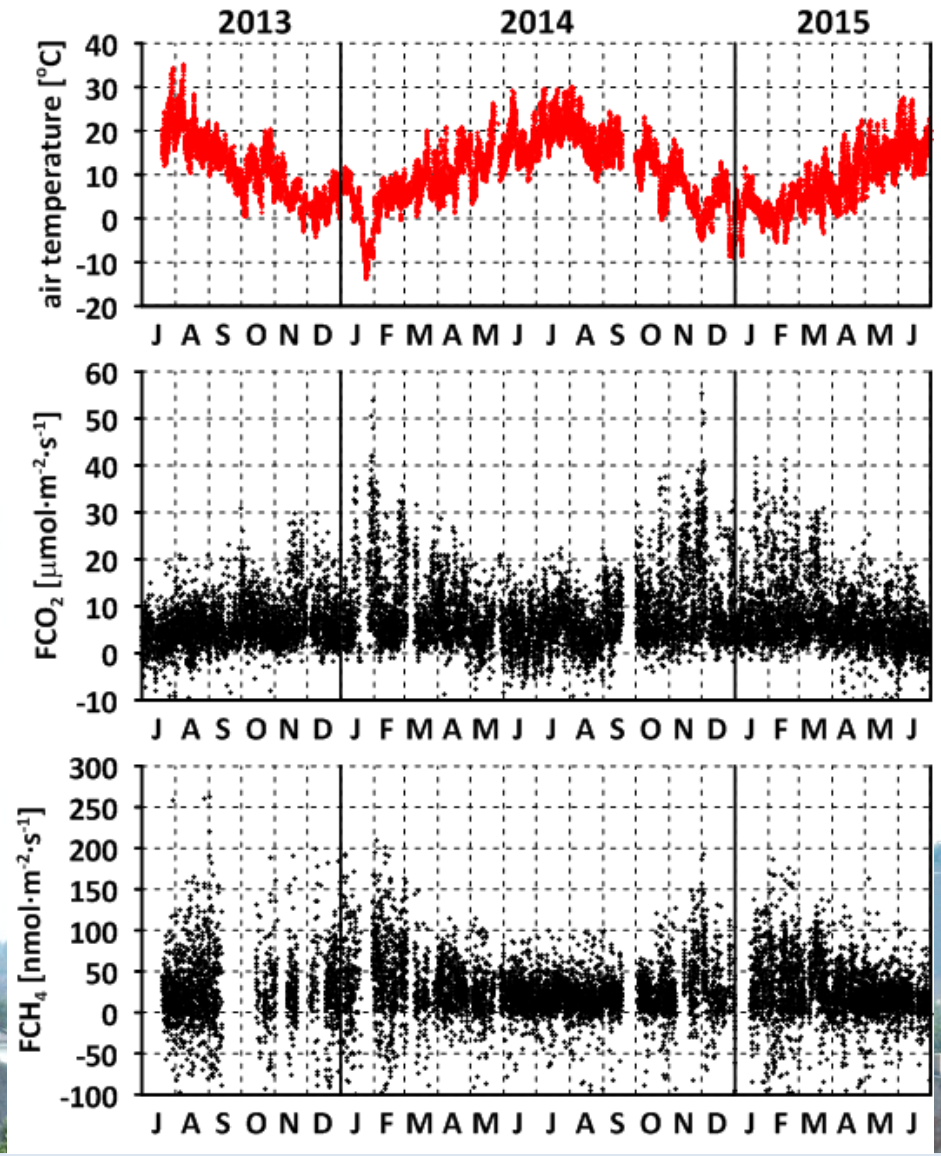
$$FCH_4 = \overline{w'\rho CH_4'}$$

<u>Post-processing:</u>

- „bad" data rejection (rain, deposition on sensors, etc.)
- 1 hour averaging
- spike detection
- maximization of covariance due to sensors separation
- double rotation of wind coordinates
- correction of sonic temperature for humidity
- corrections for spectral losses
- correction terms related to T, p, and q impact on spectroscopic measurement made by Li7700
- WPL correction
- evaluation of data stationarity (three different tests)

~ 40% lack of data or rejection as a „bad data"
~ 5% of data rejected due to failed stationary tests

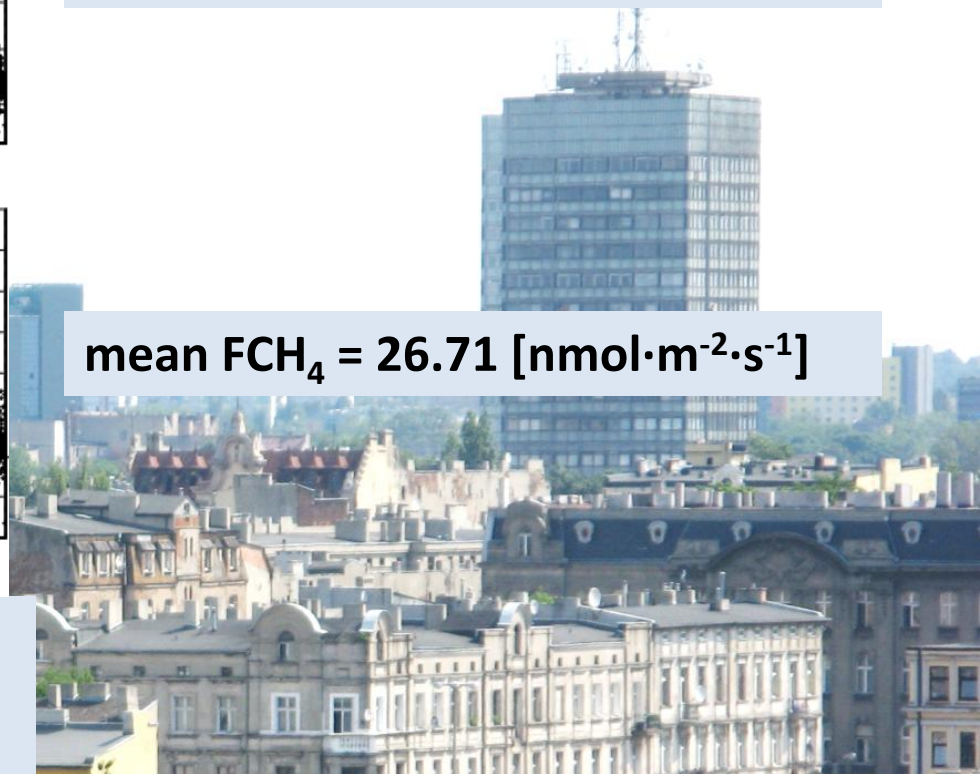
RESULTS



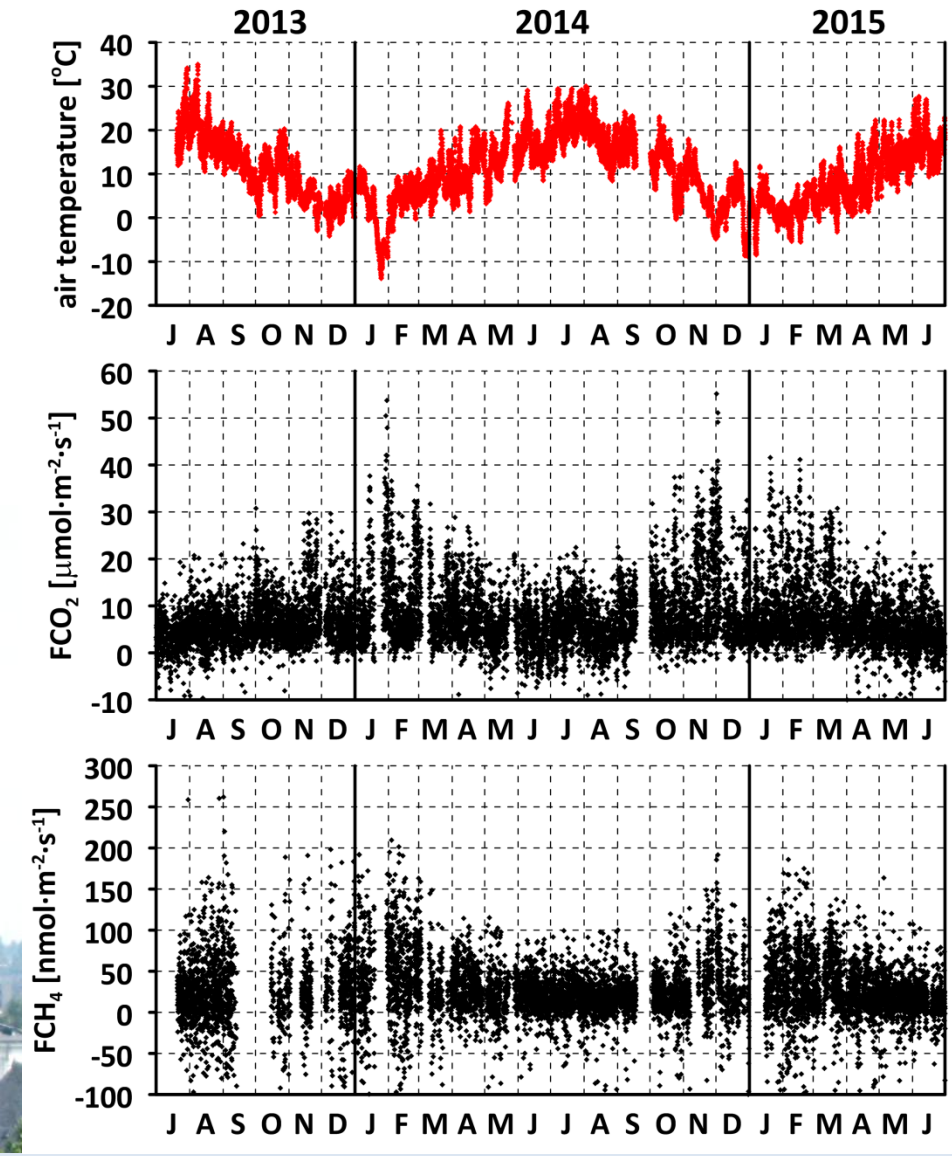
Air temperature, carbon dioxide and methane turbulent fluxes variability in the center of Łódź in the period July 2013 – June 2015.

mean FCO_2 = 7.52 [µmol·m^{-2}·s^{-1}]

mean FCH_4 = 26.71 [nmol·m^{-2}·s^{-1}]



RESULTS



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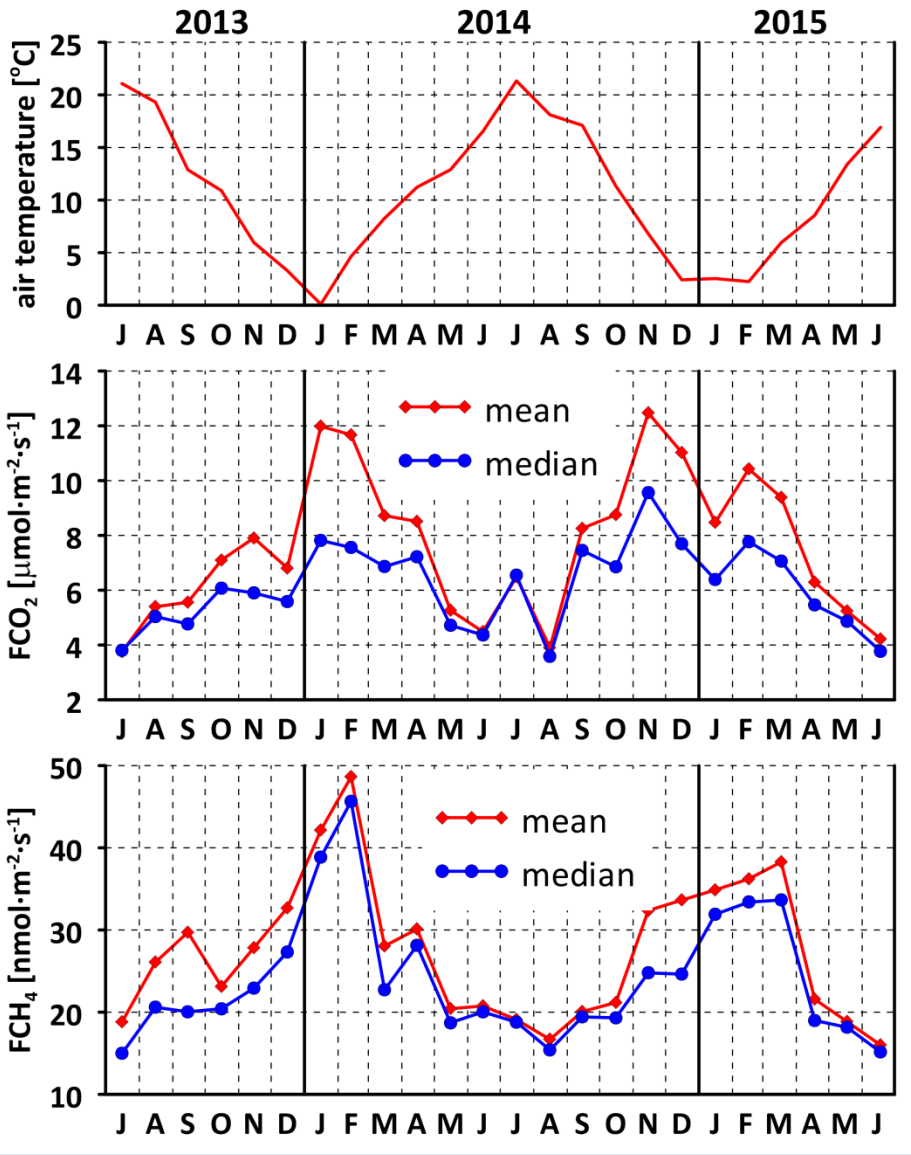
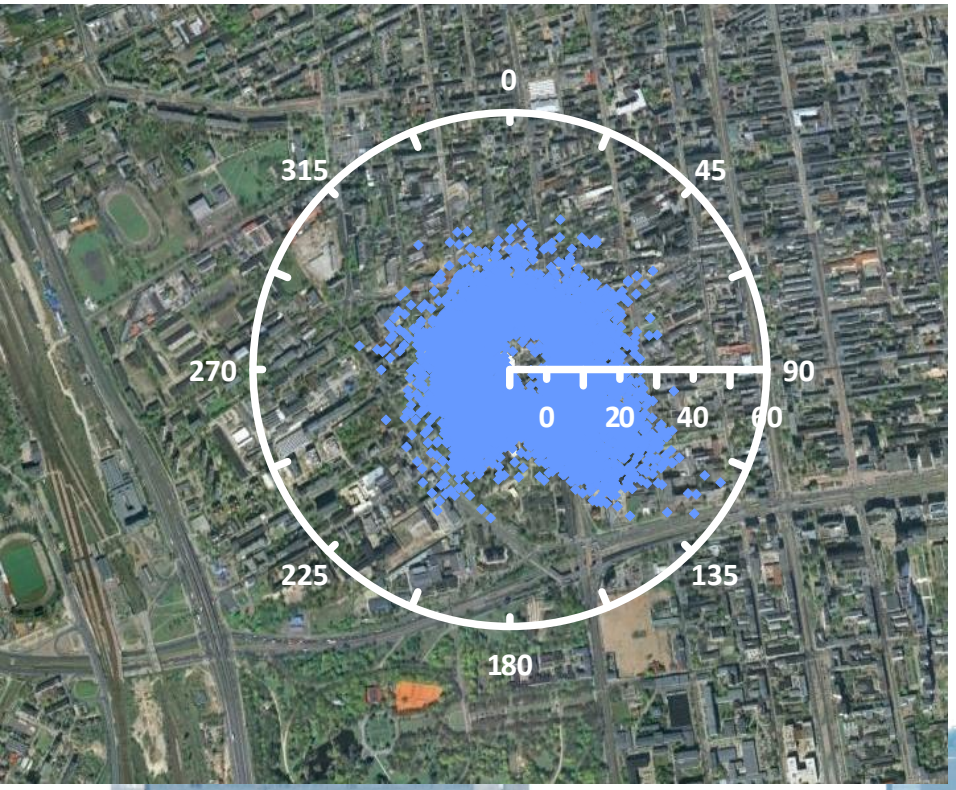


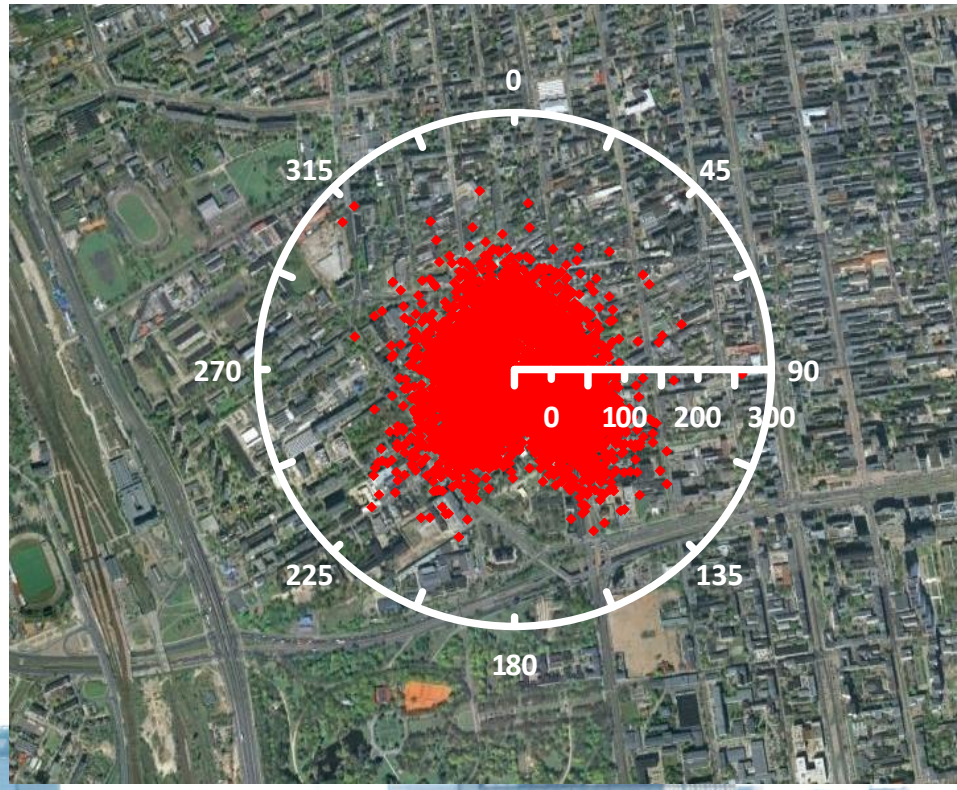
Monthly variability of air temperature, FCO_2 and FCH_4 mean, median and standard deviation in the center of Łódź in the period July 2013 – June 2015.

RESULTS

FCO_2 [µmol·m^{-2}·s^{-1}]



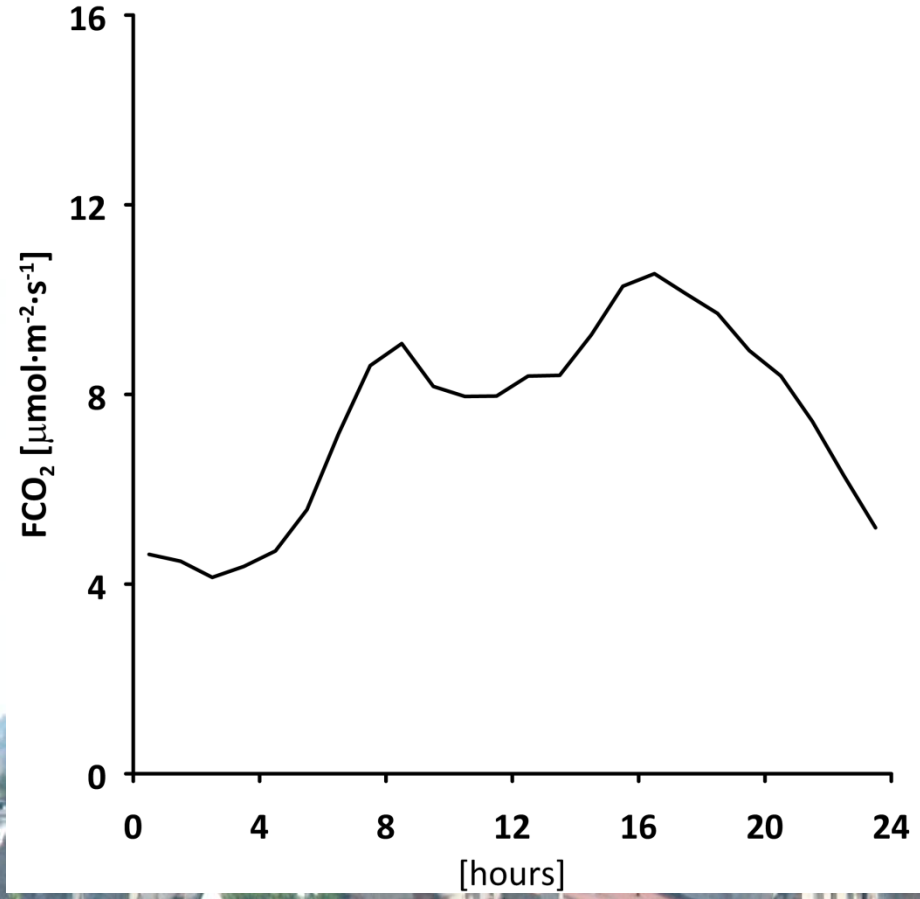
FCH_4 [nmol·m^{-2}·s^{-1}]



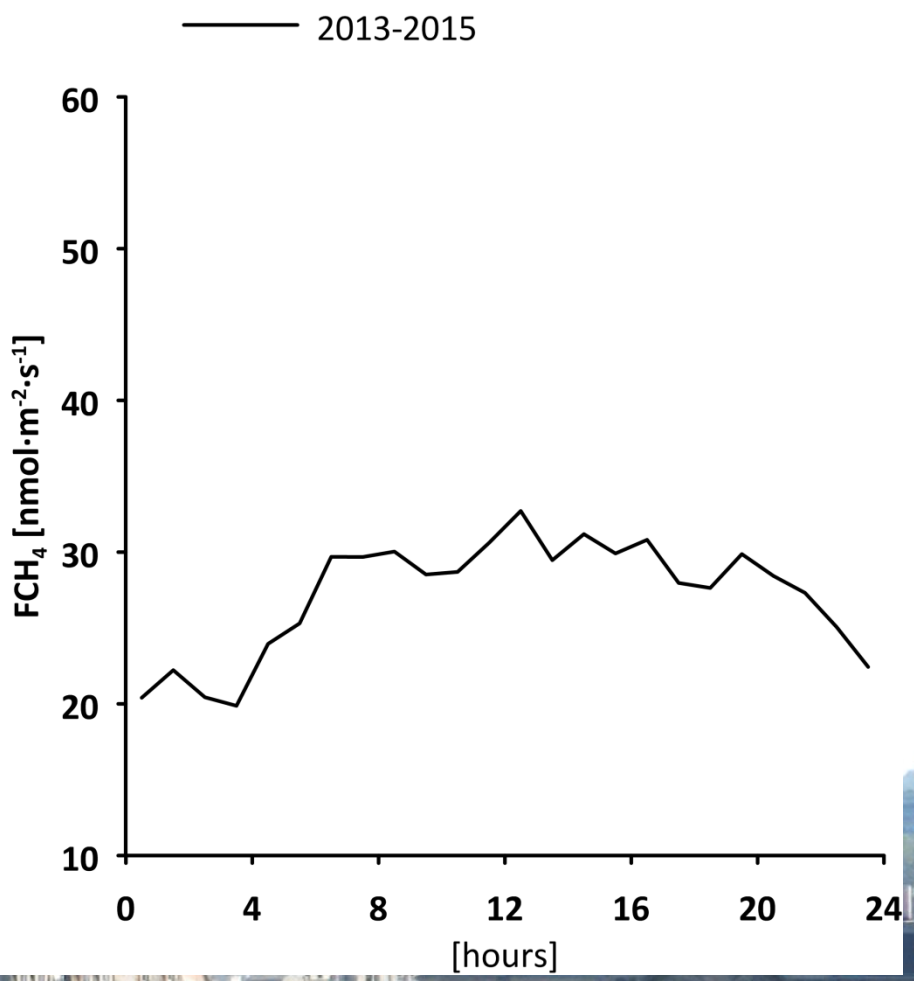
1-hour carbon dioxide and methane fluxes in relation with wind direction in the center of Łódź in the period July 2013 – June 2015.

RESULTS

FCO_2



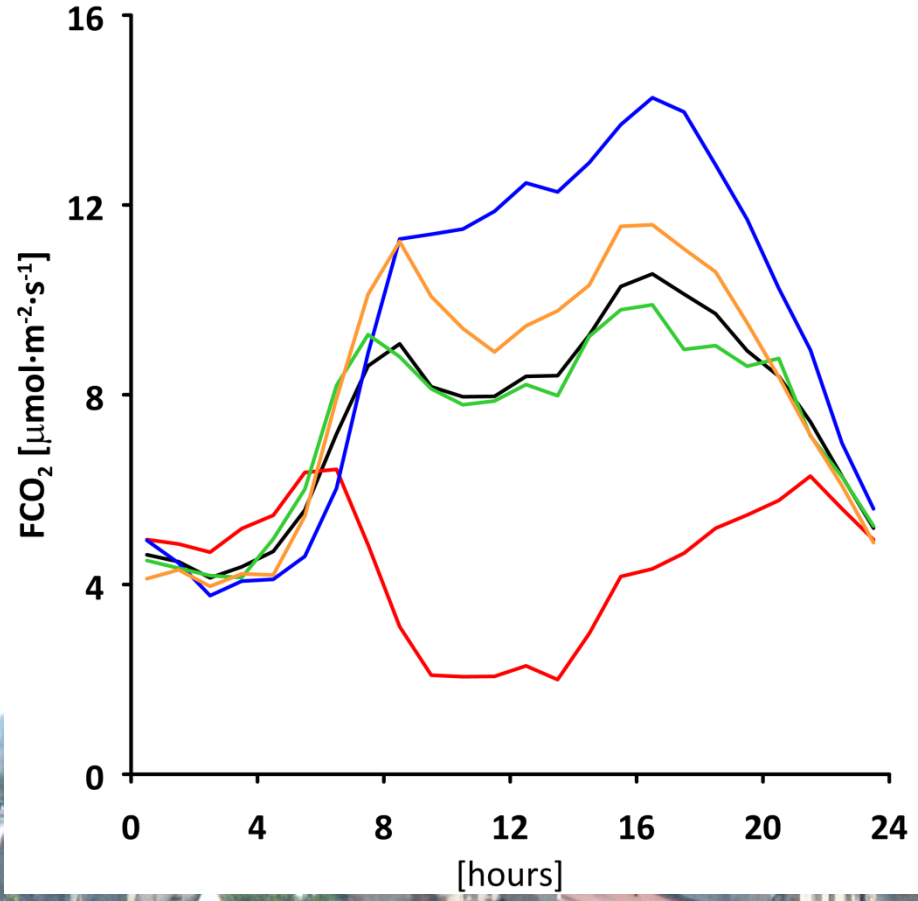
FCH_4



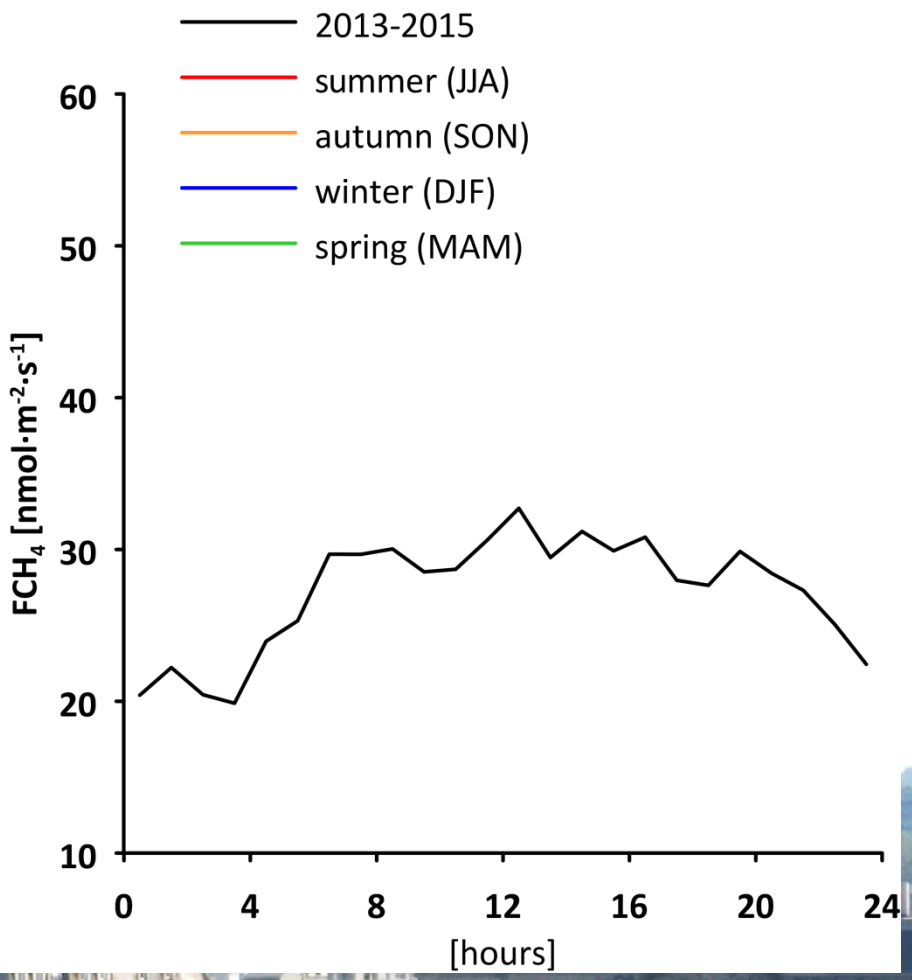
Mean diurnal variability of carbon dioxide and methane turbulent fluxes in the center of Łódź in the period July 2013 – June 2015.

RESULTS

FCO_2



FCH_4



Mean diurnal variability of carbon dioxide and methane turbulent fluxes in the center of Łódź in the period July 2013 – June 2015.

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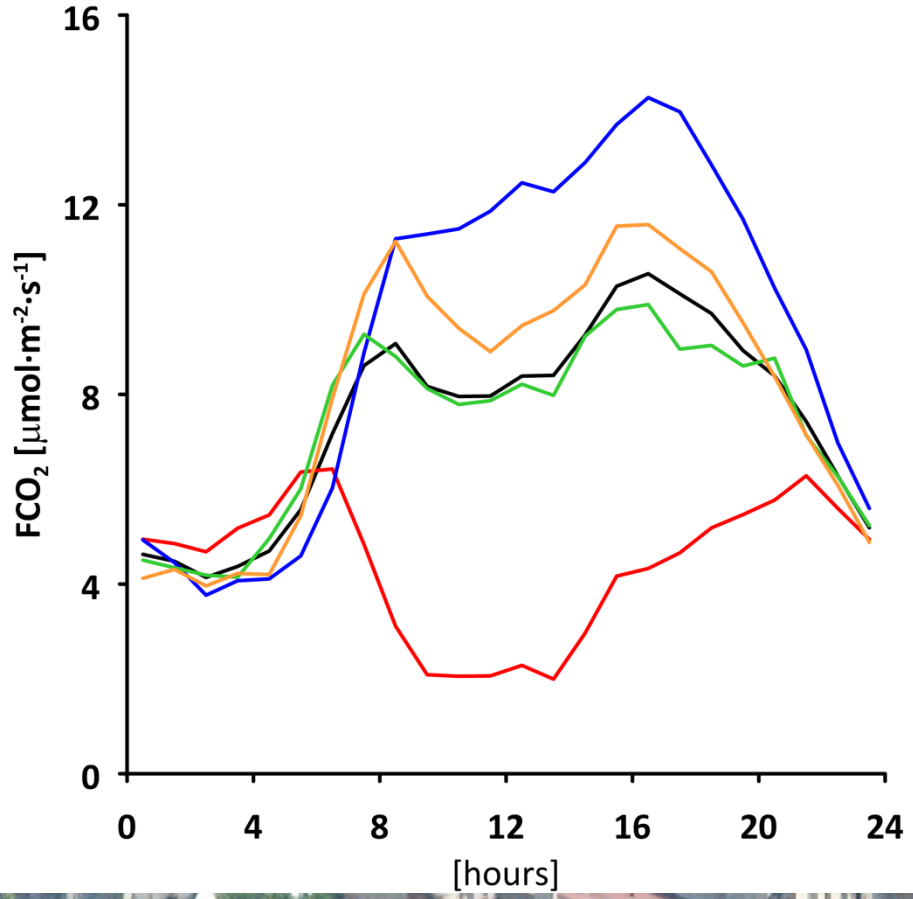
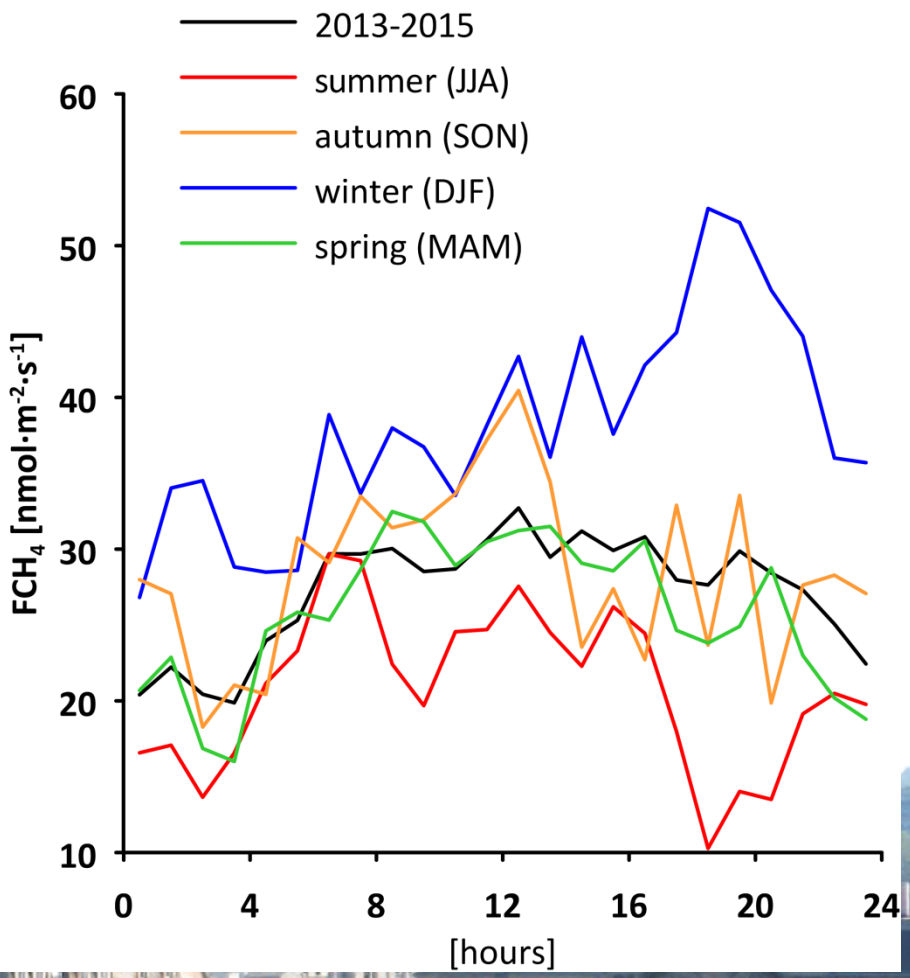
FCO_2



FCH_4



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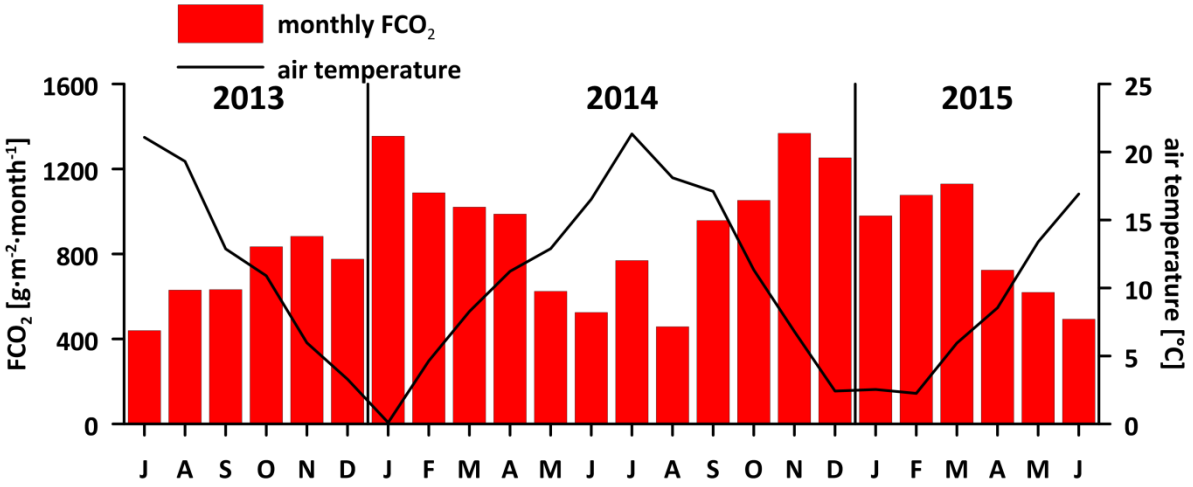
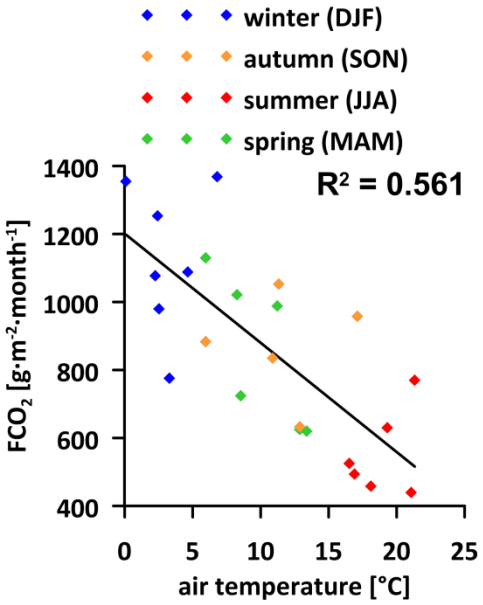
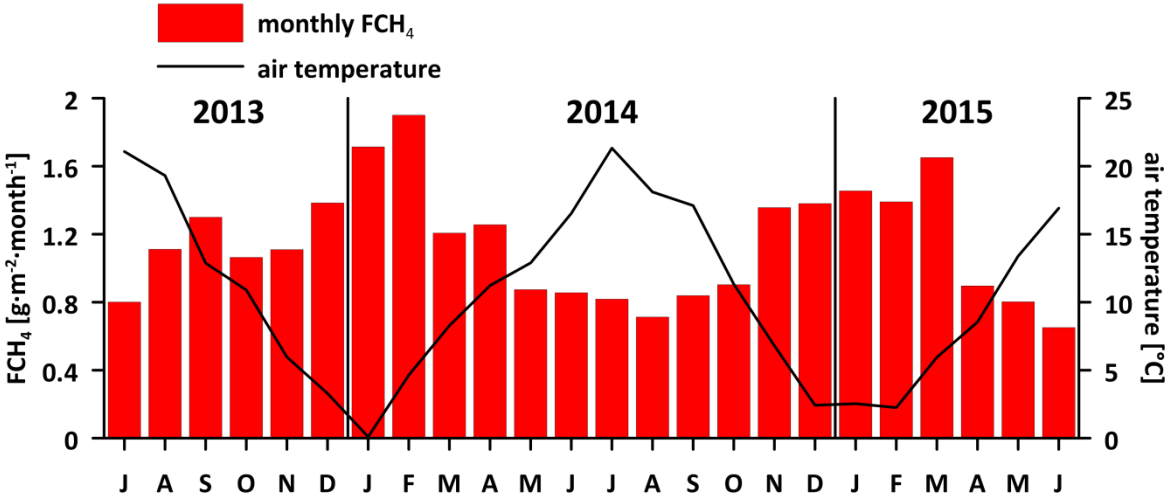
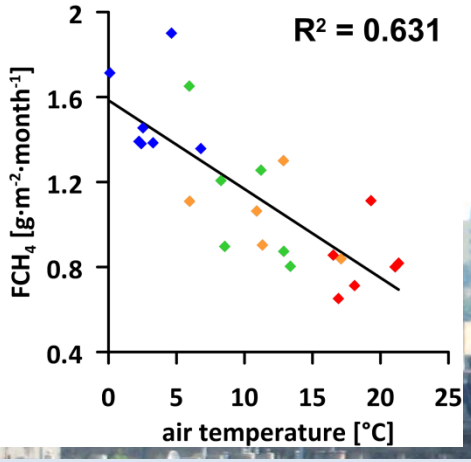
RESULTS



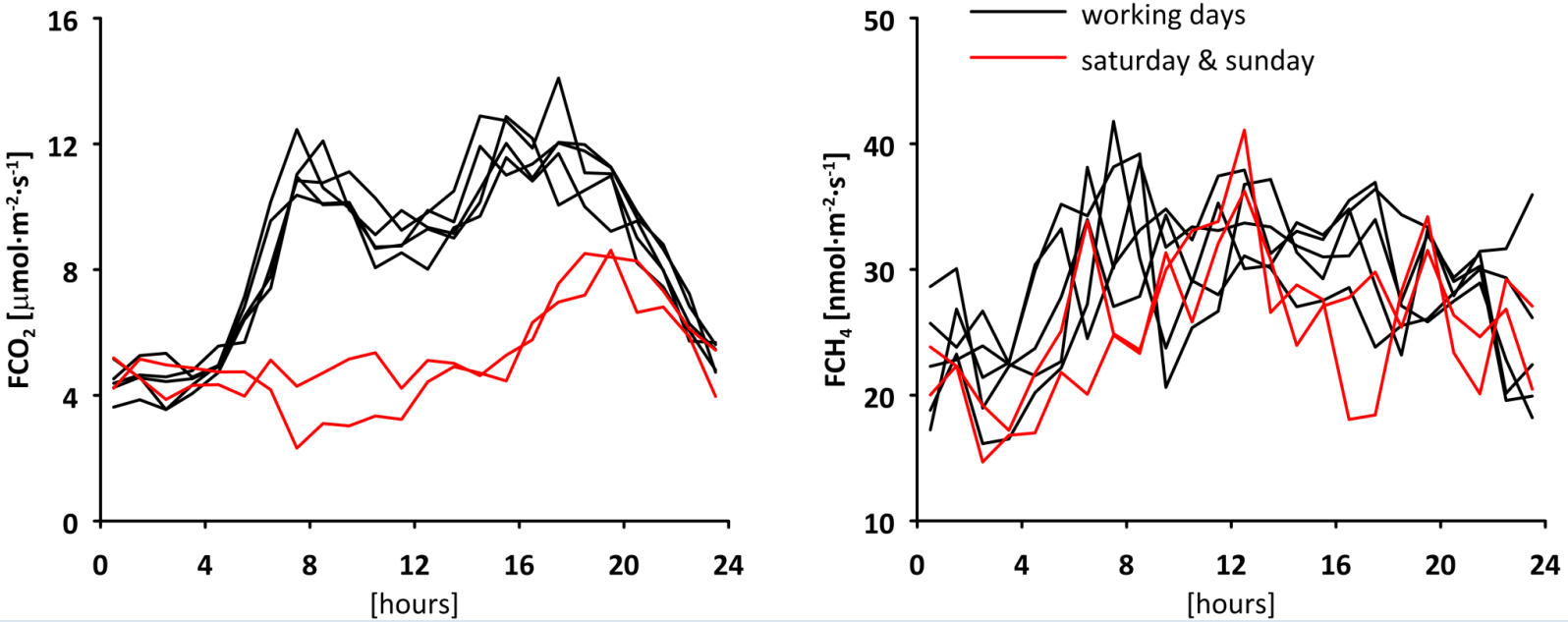




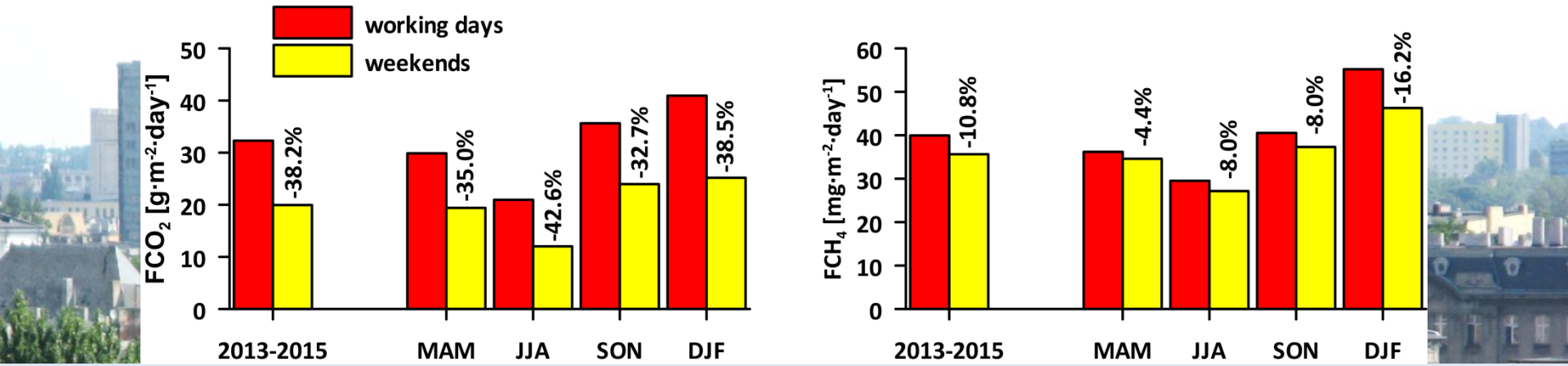


Monthly exchange of carbon dioxide and methane in the center of Łódź in the period July 2013 – June 2015.

RESULTS

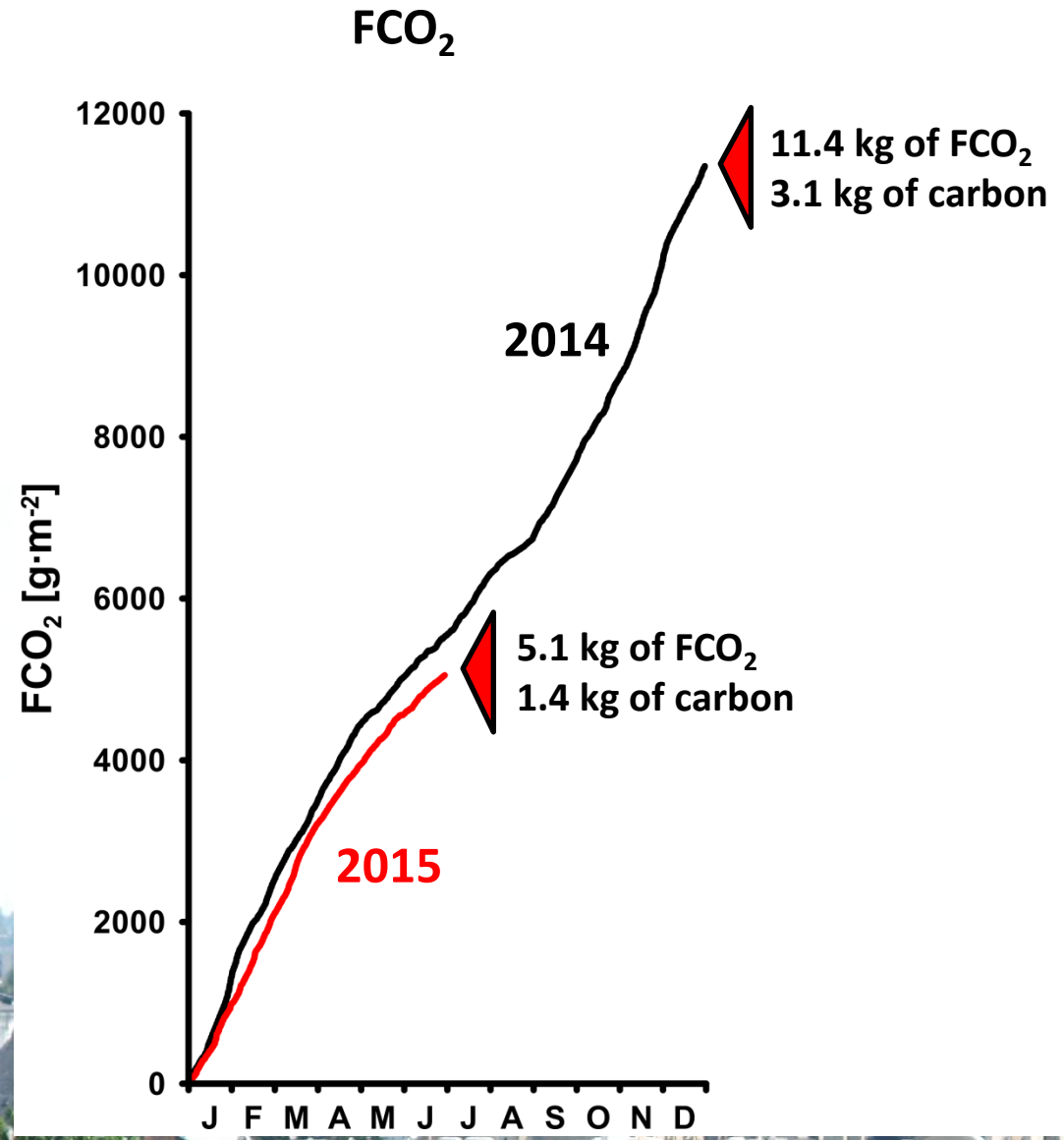


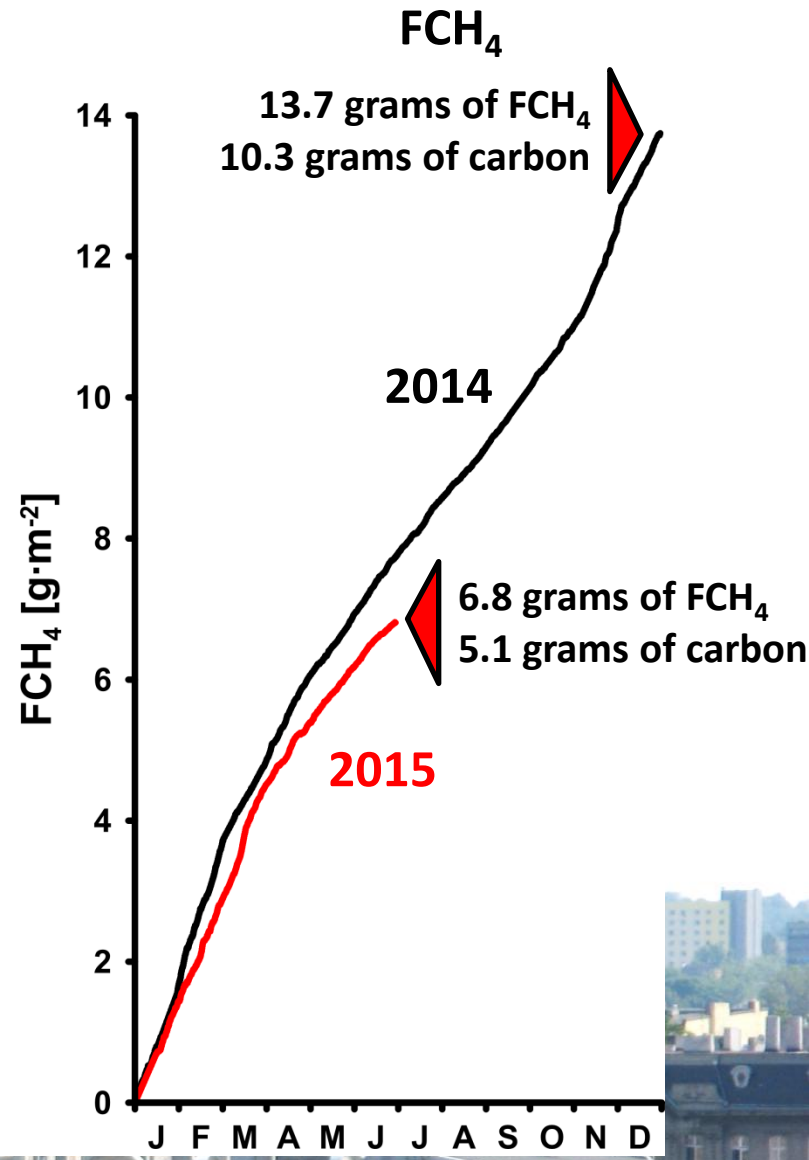
Mean diurnal courses of FCO_2 and FCH_4 calculated separately for the days of week in the center of Łódź in the period July 2013 – June 2015.



Mean daily exchange of carbon dioxide and methane calculated for working days and weekends in the center of Łódź in the period July 2013 – June 2015.

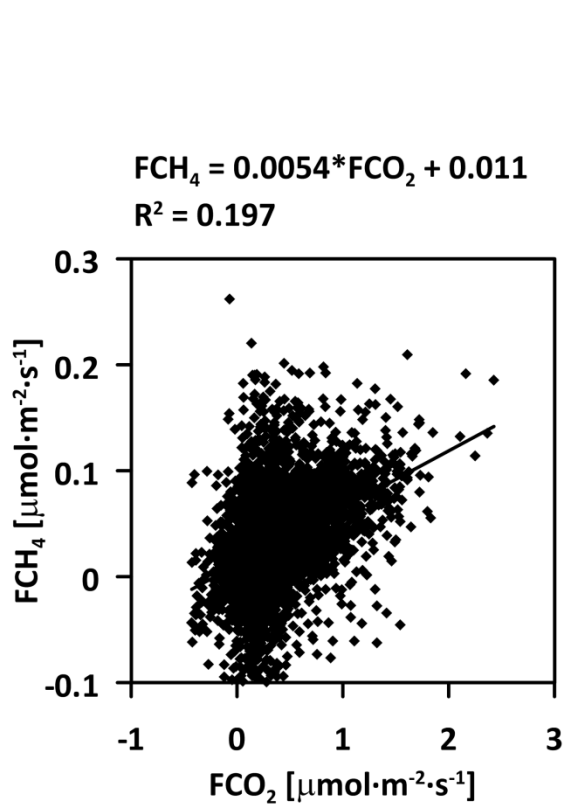
RESULTS



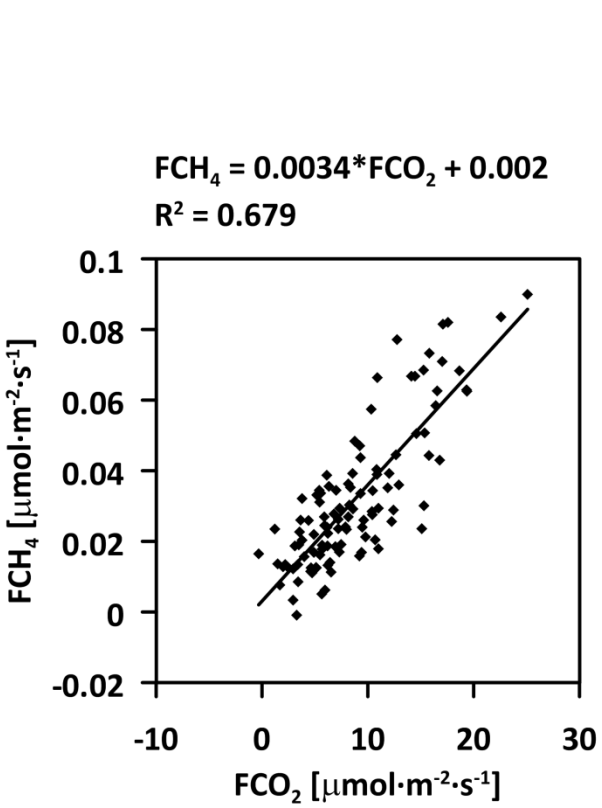


Cumulative annual exchange of carbon dioxide and methane in the center of Łódź in the period July 2013 – June 2015.

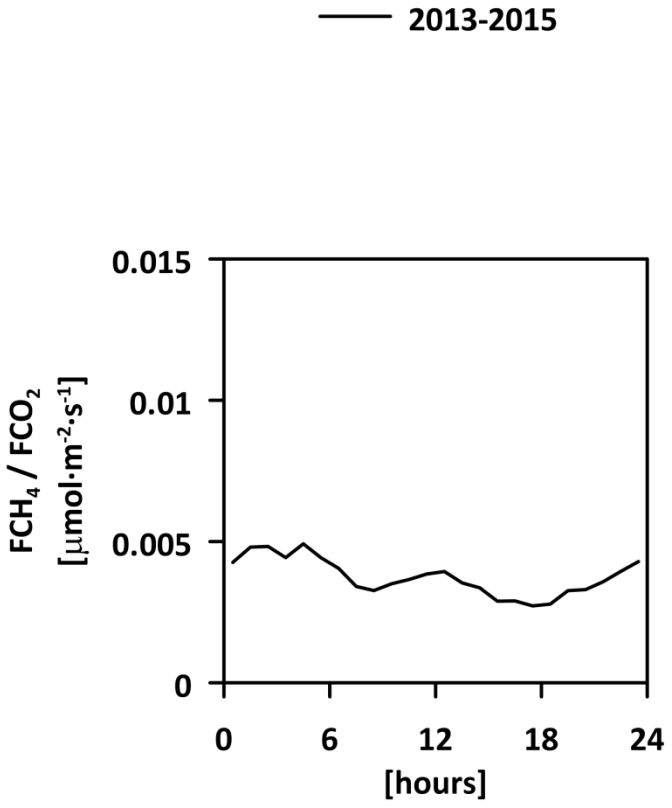
RESULTS



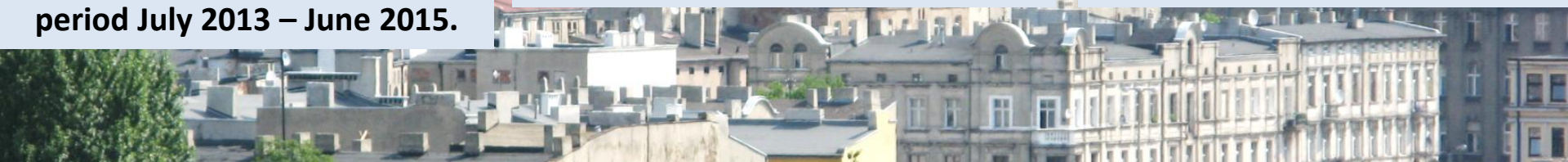
1-hour methane fluxes in relation with 1-hour fluxes of carbon dioxide in the center of Łódź in the period July 2013 – June 2015.



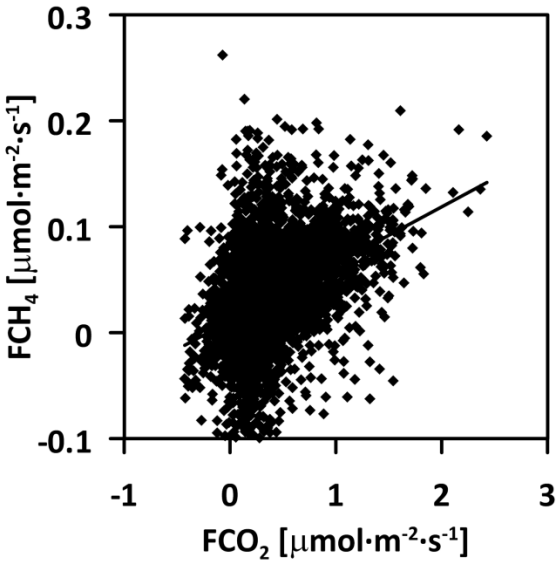
Daily methane fluxes in relation with daily fluxes of carbon dioxide in the center of Łódź in the period July 2013 – June 2015.

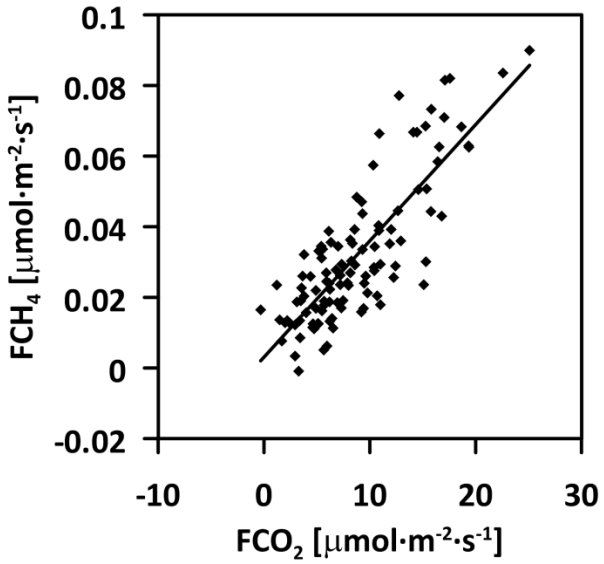


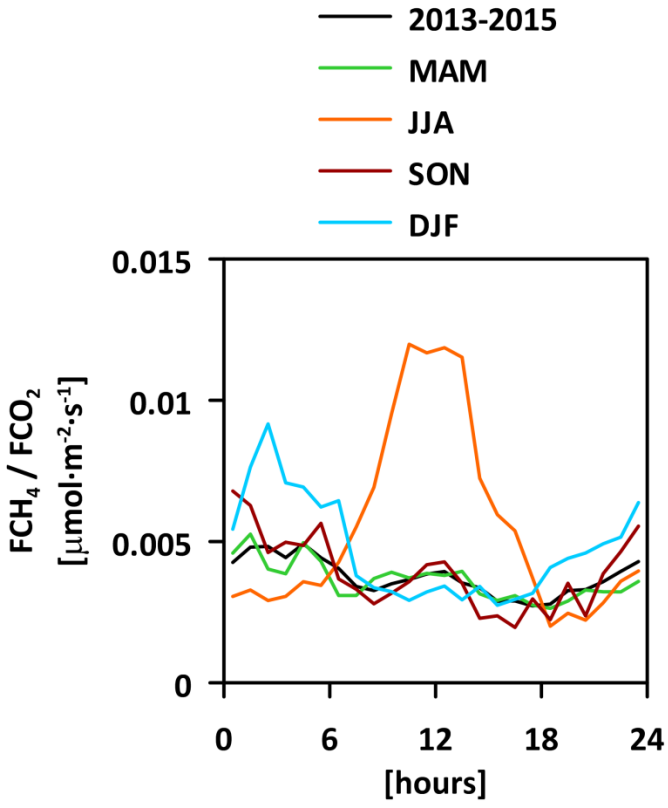
Mean diurnal ratio of methane to carbon dioxide fluxes in the center of Łódź in the period July 2013 – June 2015.



RESULTS







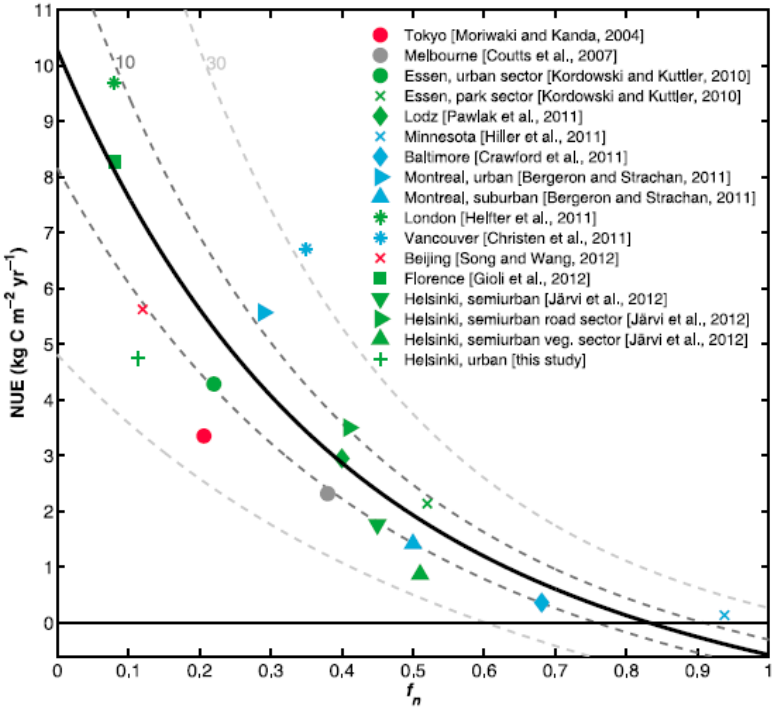
1-hour methane fluxes in relation with 1-hour fluxes of carbon dioxide in the center of Łódź in the period July 2013 – June 2015.

Daily methane fluxes in relation with daily fluxes of carbon dioxide in the center of Łódź in the period July 2013 – June 2015.

Mean diurnal ratio of methane to carbon dioxide fluxes in the center of Łódź in the period July 2013 – June 2015.

SUMMARY

FCO_2



Nordbo et al., Geophys. Res. Lett., 2012;
reported also by Velasco and Roth (2010), Grimmond and Christen (2012), Christen (2014), Ward et al. (2015), etc.

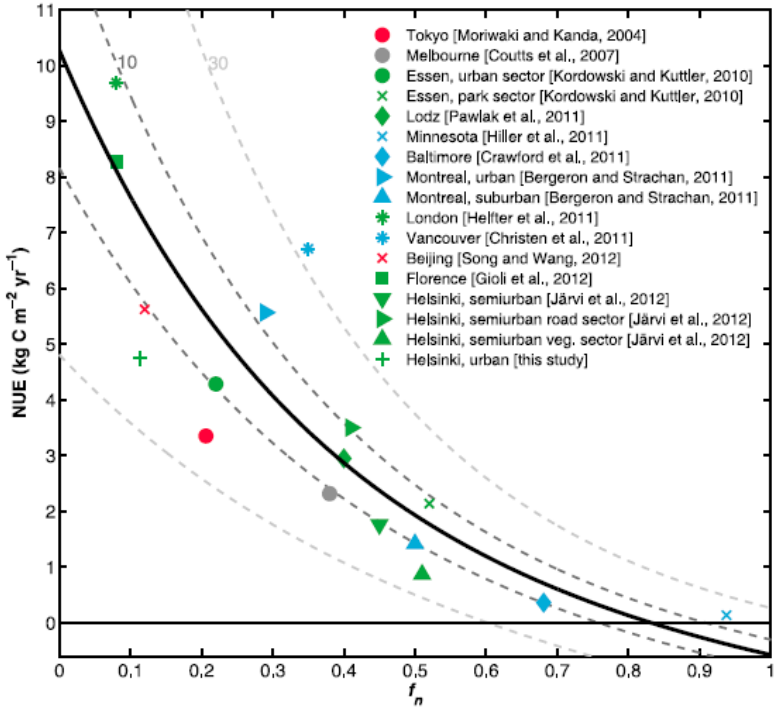
FCH_4

?

Funding for this research was provided by Polish National Centre of Science under project 2011/01/D/ST10/07419 in the years 2011 - 2016.

SUMMARY

FCO_2



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FCH_4

?

Florence – 3 months campaign
(Gioli et al. 2012)
(April-June 2011) (~90% of art. surf.)
Mean mothly exchange ~5.7 g of CH4 per m^2
(Łódź ~0.8-1.2 g of CH4 per m^2)

London ~29 g of CH_4 per m^2 (~90% of art. surf.)
(Helfter et al., EGU poster, 2013)
(Łódź ~13.7 g of CH_4 per m^2) (~60% of art. surf.)

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