Differences in stable carbon isotopic composition in the fine bulk aerosol and gas phases based on seasonally resolved data at a Prague site

Petr Vodička[1,2], Kimitaka Kawamura[2], Jaroslav Schwarz[1], Vladimír Ždímal[1]

[1] Institute of Chemical Process Fundamentals, Czech Academy of Sciences, Prague, Czech Republic
[2] Chubu Institute for Advanced Studies, Chubu University, Kasugai 487–8501, Japan

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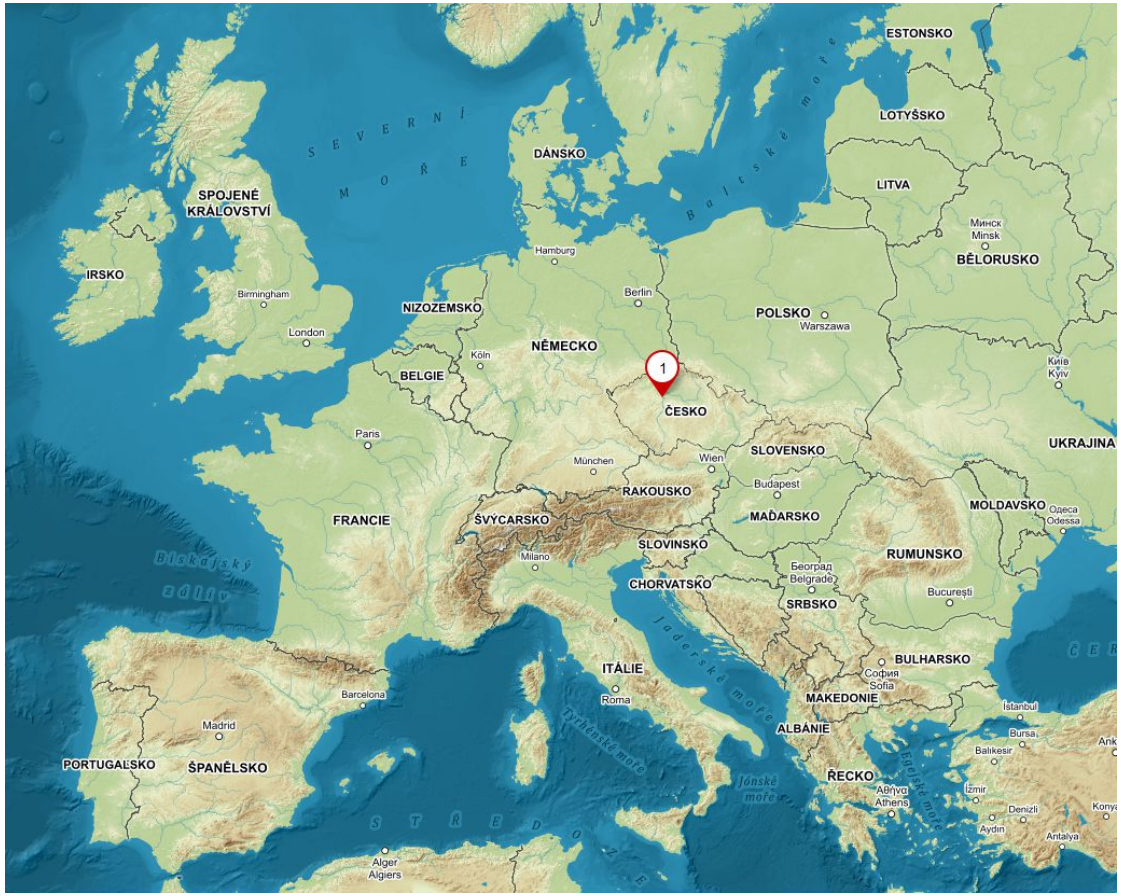
Site – Prague suburban

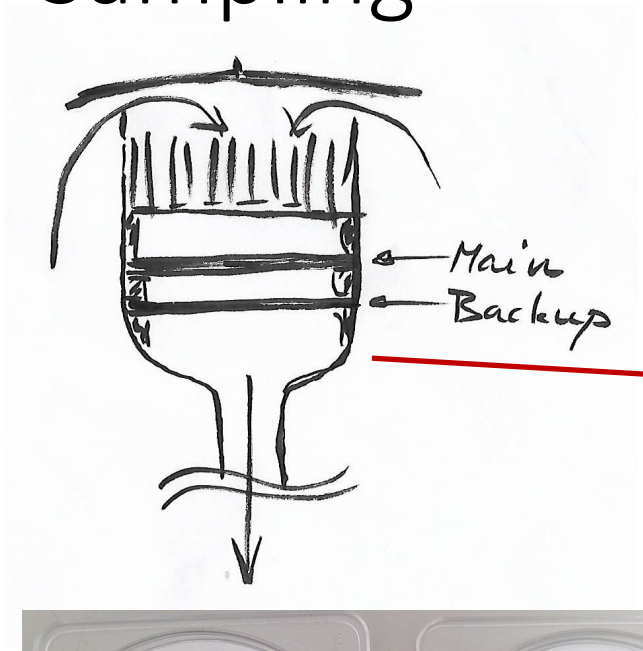
Urban background site. Located on the edge of a plateau above Prague (1.2 mil. population), nearest road ca 250 m (ca 15000 cars/day), residential area with gas, coal and biomass heating. 5 km from center.

location: 50° 7' 36.473'' E: 14° 23' 5.513'' Altitude: 277 m ASL



Sampling

- PM2.5 aerosol fraction, quartz filters
- Period: 14 Apr 2016 – 1 May 2017 (every 6th day)
- 64 samples with 48-h time resolution + 2 extra 24-h samples during “burning of witches” event (30 Apr-1May)



Analyses

- Weighing –> $PM_{2.5}$ mass
- Total Carbon (TC)
- Organic and Elemental Carbon (OC + EC = TC)
- Water soluble organic carbon (WSOC) -> WIOC = TC - WSOC - EC; OC = WSOC + WIOC
- Stable carbon isotope ratio ($\delta^{13}C$)
- Meteo: Temp., RH, Wind speed, HYSPLIT air mass back trajectories, Ozone

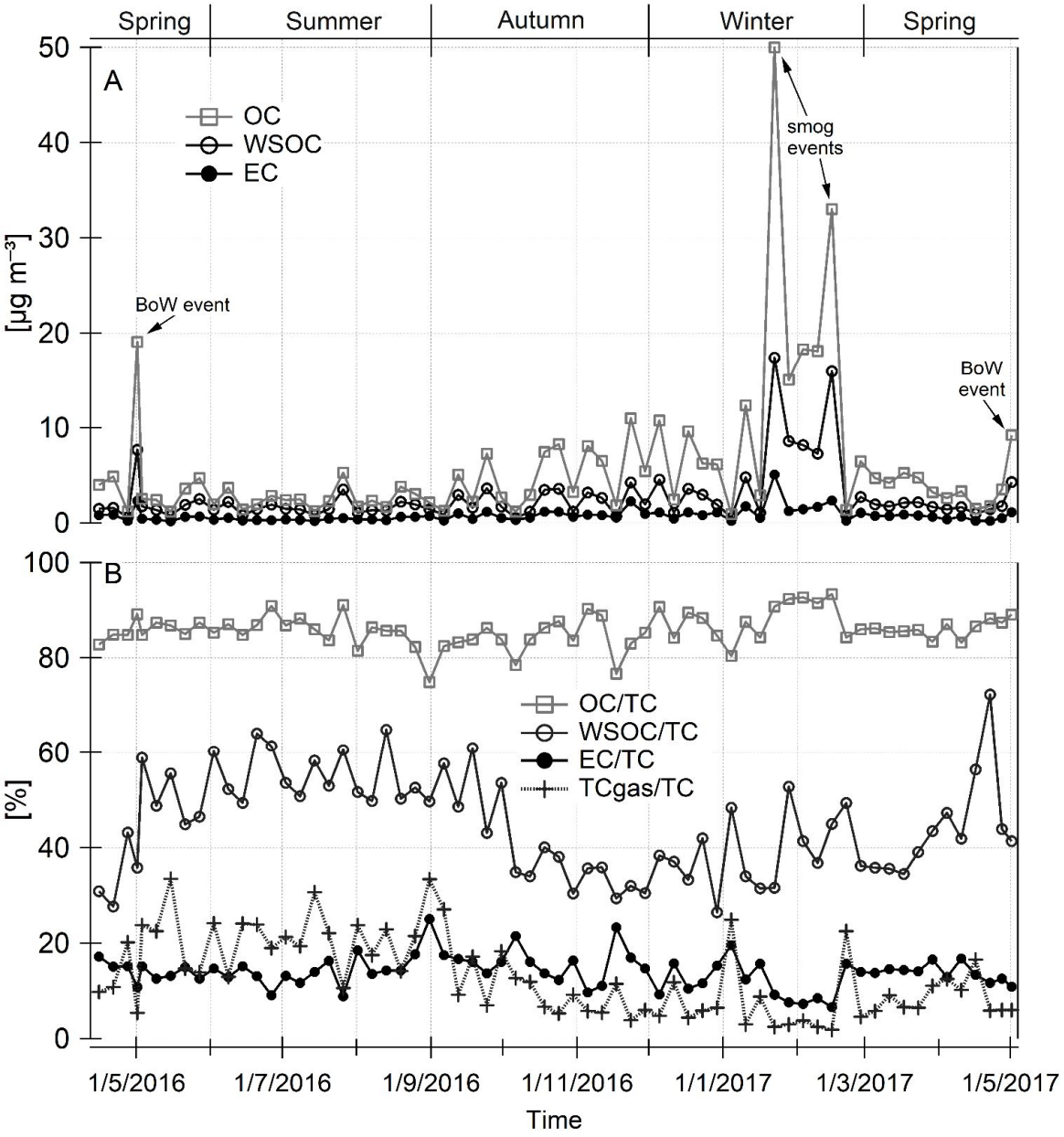
TC -> $\delta^{13}C_{TC}$
WSOC -> $\delta^{13}C_{WSOC}$

OC (OC1-OC4)
EC (EC1-EC4)

TCgas -> $\delta^{13}C_{TCgas}$

OC (OC1-OC4)
EC (EC1-EC4)

Time series and carbon distribution

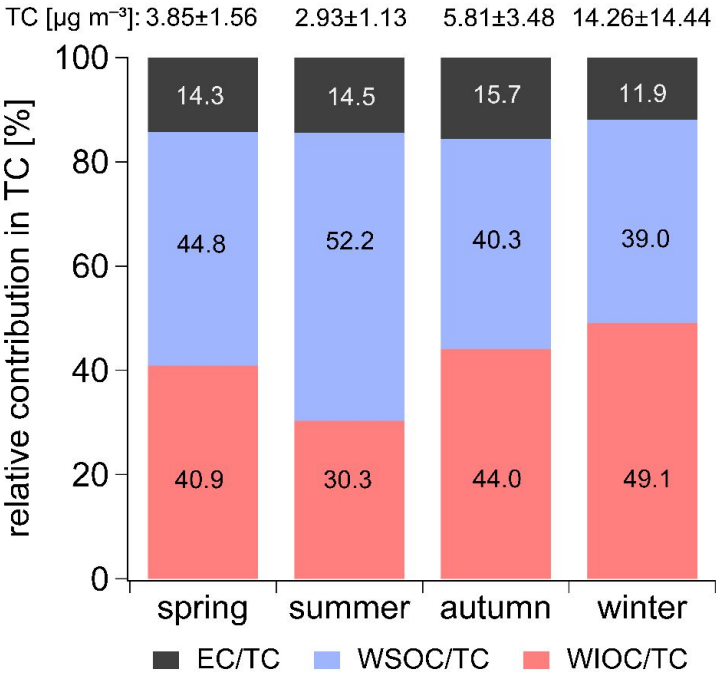


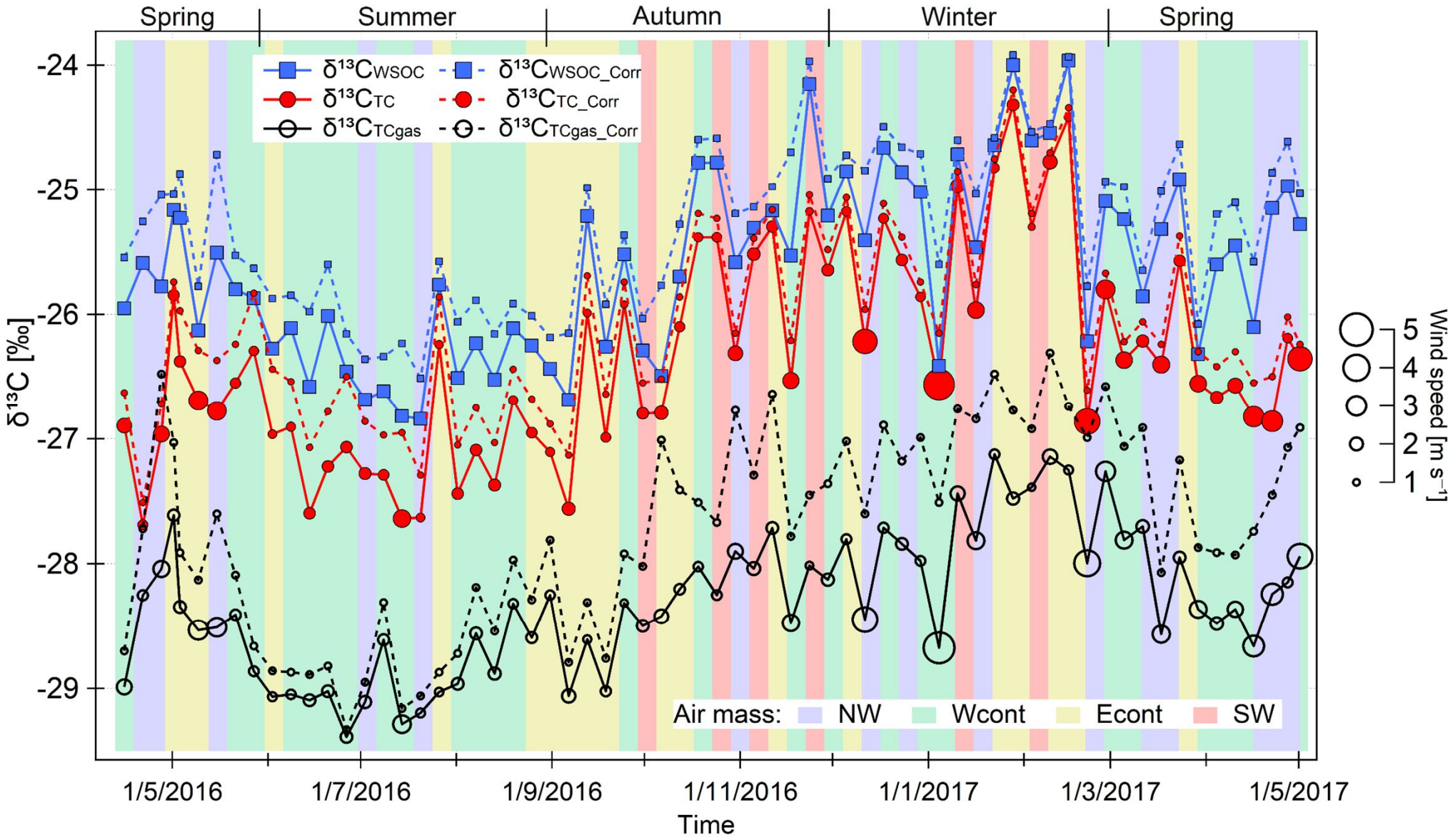
Year-round averages [%]:

$TC/PM_{2.5}$ = 34.2

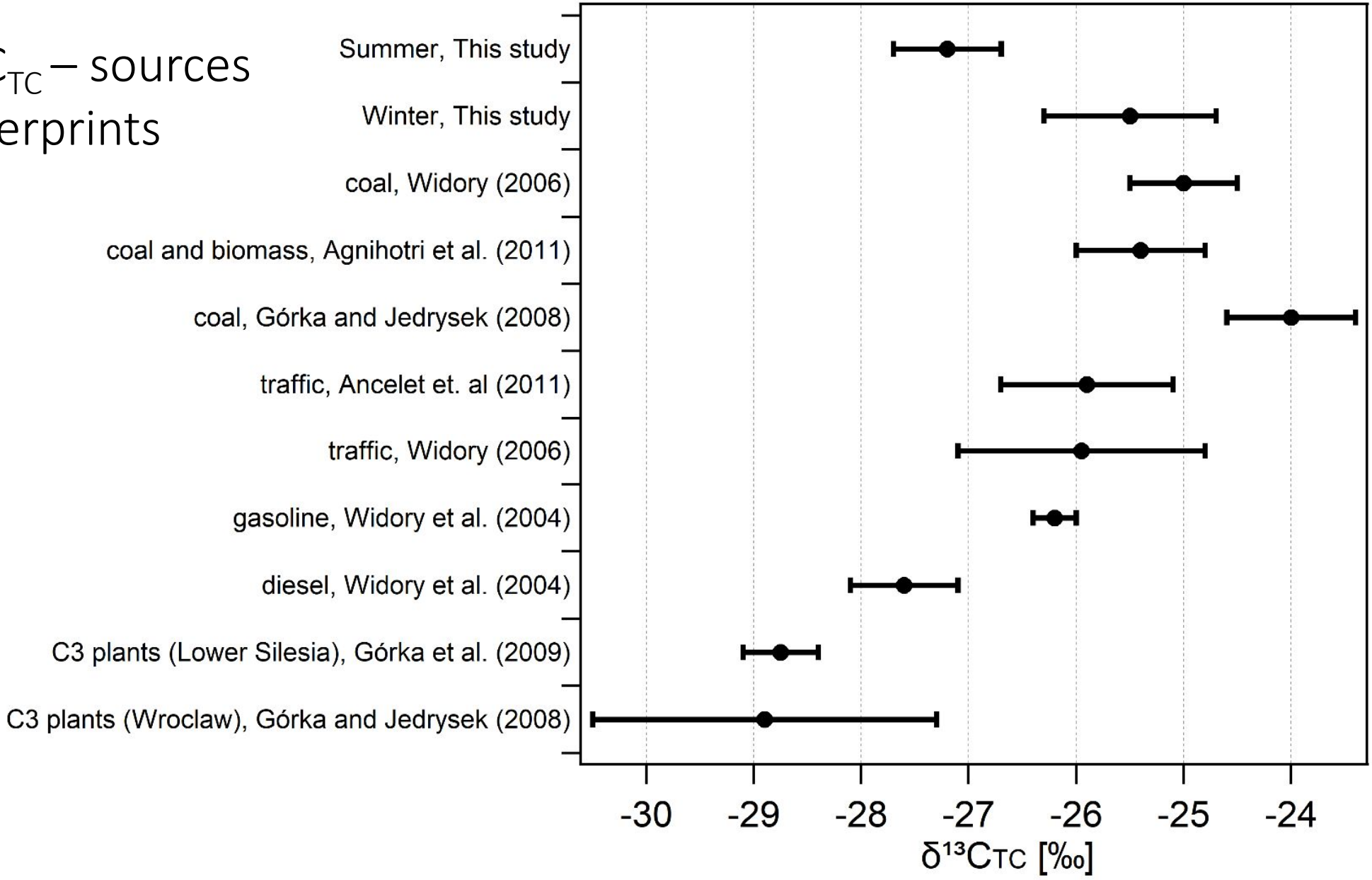
EC/TC = 14.0 OC/TC = 86.0

WSOC/TC = 44.8 WIOC/TC = 41.2

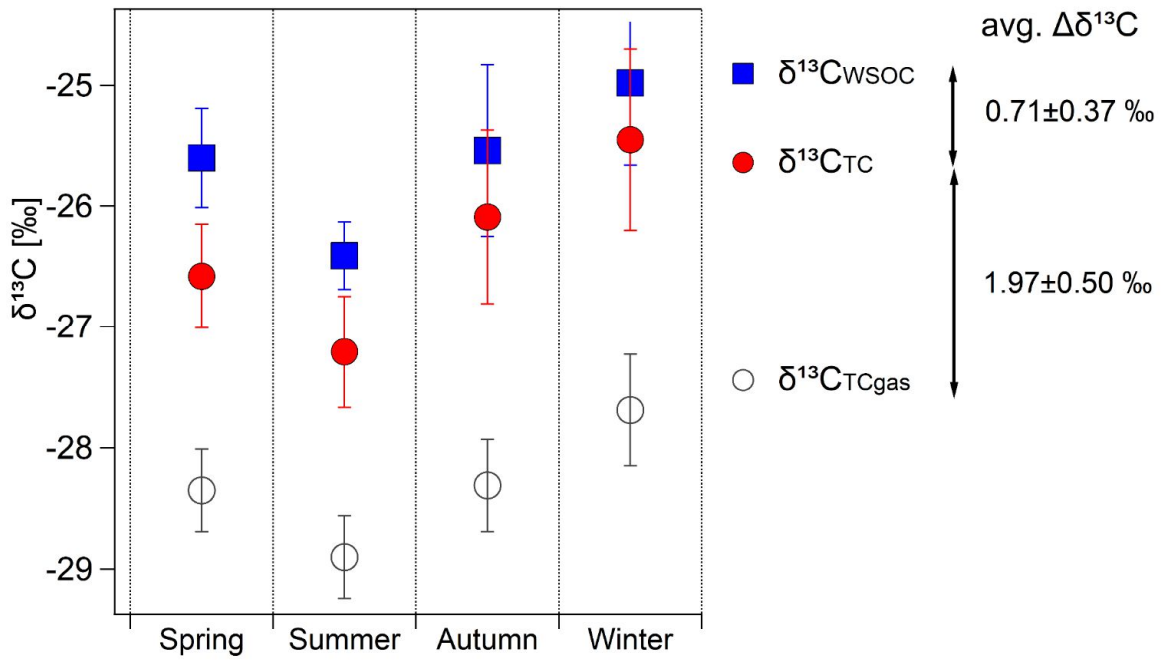


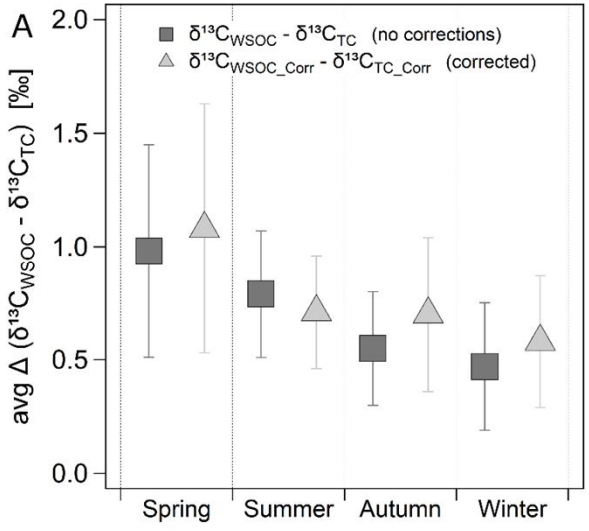

Spring
Summer
Autumn
Winter
Spring
δ13CWSOC
δ13CWSOC_Corr
δ13CTC
δ13CTC_Corr
δ13CTCgas
δ13CTCgas_Corr
-24
-25
-26
-27
-28
-29
δ13C [‰]
Air mass:
NW
Wcont
Econt
SW
Wind speed [m s−1]
5
4
3
2
1
1/5/2016
1/7/2016
1/9/2016
1/11/2016
1/1/2017
1/3/2017
1/5/2017
Time

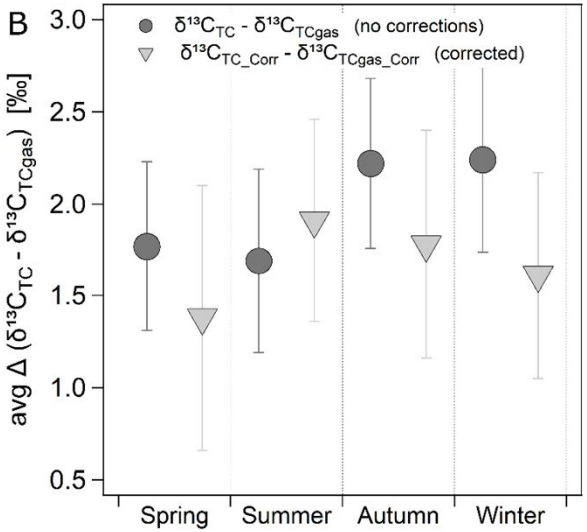
$\delta^{13}C_{TC}$ – sources fingerprints

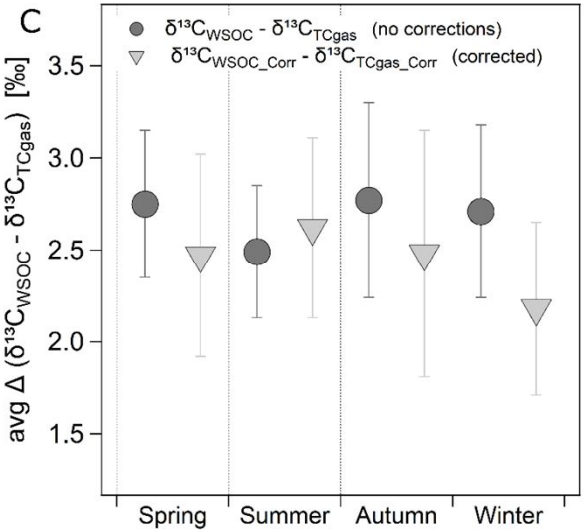


$\delta^{13}C$ – phase differences









Conclusions

- Main part of TC is WSOC (45%), followed WIOC (41%) and EC (14%)
- Seasonal pattern both for aerosol and gas phase observed in $\delta^{13}C$
- Different seasonal $\delta^{13}C$ values point to different seasonal TC sources.
- The highest $\delta^{13}C$ was found in winter, while the lowest $\delta^{13}C$ was in summer.
- WSOC was most enriched in ^{13}C, followed by TC, and TCgas was most depleted.
- **Differences between $\delta^{13}C$ of WSOC, TC and gaseous TC are similar throughout the year. (2.0+-0.5 ‰)**
- **The $\Delta\delta^{13}C$ between the particulate and gas phases of TC does not dependent on the source.**

- Smog event: the highest conc. of TC and most enriched $\delta^{13}C$
- BoW event visible mainly in higher carbon conc. – no special isotope fingerprint.

Reference:

Vodička, P., Kawamura, K., Schwarz, J., Ždímal, V., 2021. Seasonal changes in stable carbon isotopic composition in the bulk aerosol and gas phases at a suburban site in Prague. Sci. Total Environ. 2022, 803, 149767. https://doi.org/10.1016/j.scitotenv.2021.149767

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Email: vodicka@icpf.cas.cz

Thank you for your attention!