Towards an integrated study of urban CO_2 emissions

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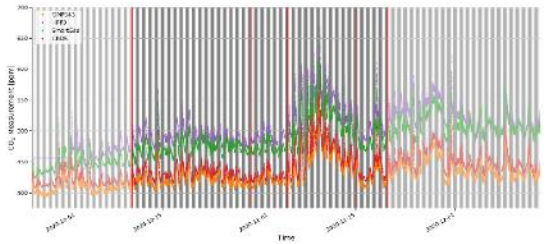
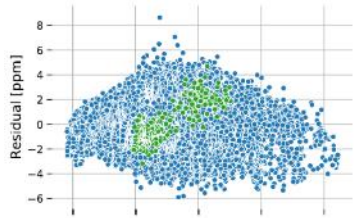
1. Sensor Setup

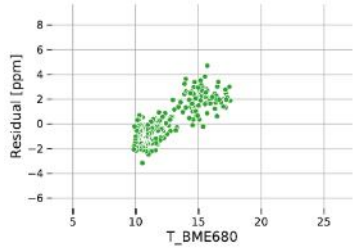




2. Sensor Characterization

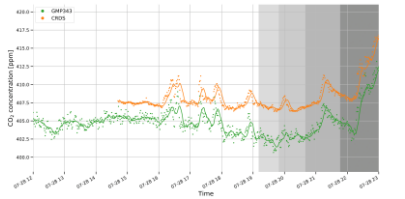


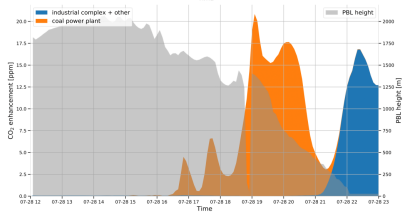
		Vaisala GMP343	SenseAir HPP3	SmartGas FlowEvo
accuracy & precision (1 min)	accuracy [ppm]	1.63	0.75	1.33
	precision [ppm]	0.77	0.59	0.54
	total error [ppm]	1.80	0.95	1.44
drift stability	[ppm/d]	0.003(2)	0.136(2)	-0.215(3)
sensor price	[€]	2700	2033	665



3. Simulation comparison with in-situ data

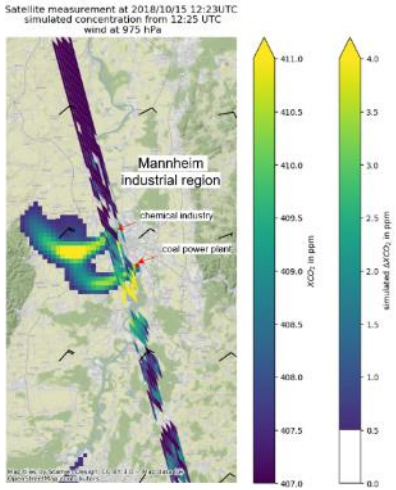
Goal: source attribution of in-situ data using high-resolution WRF simulations



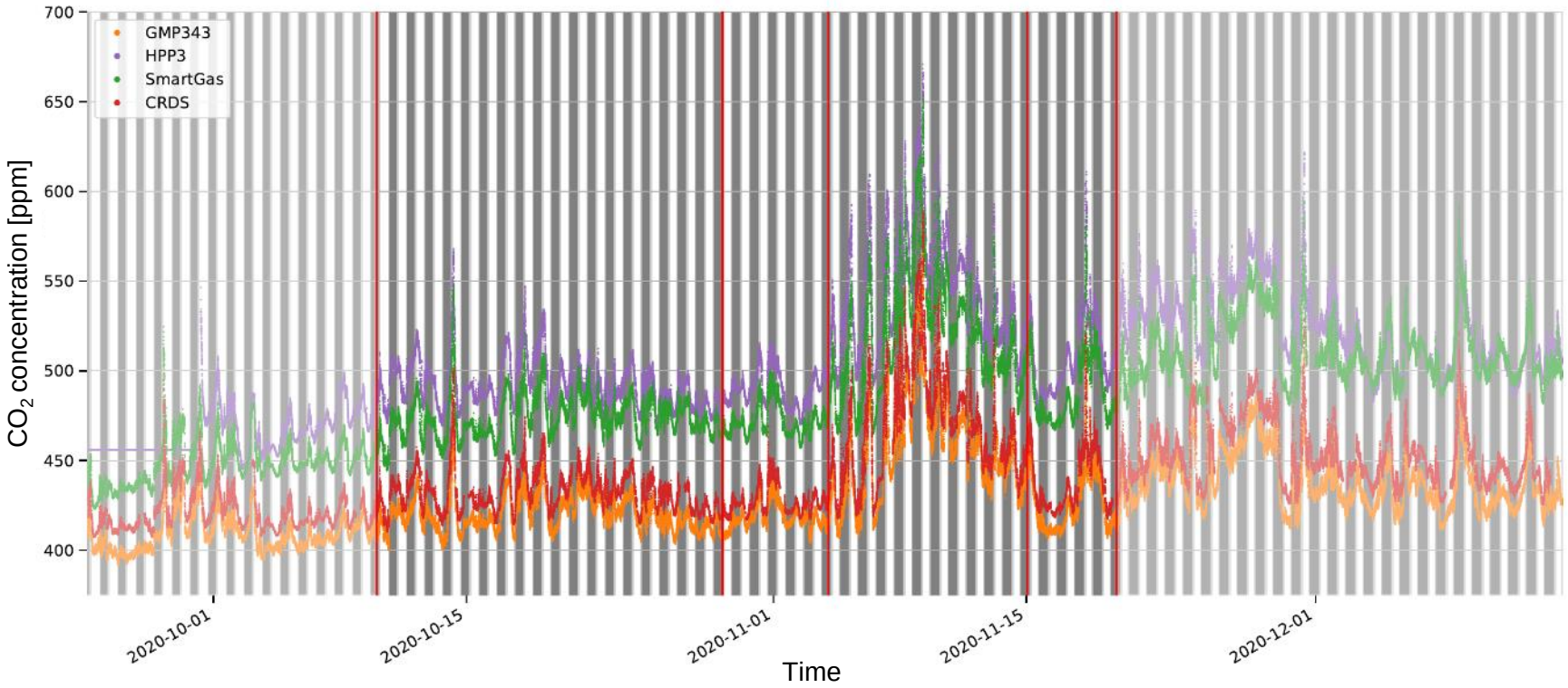


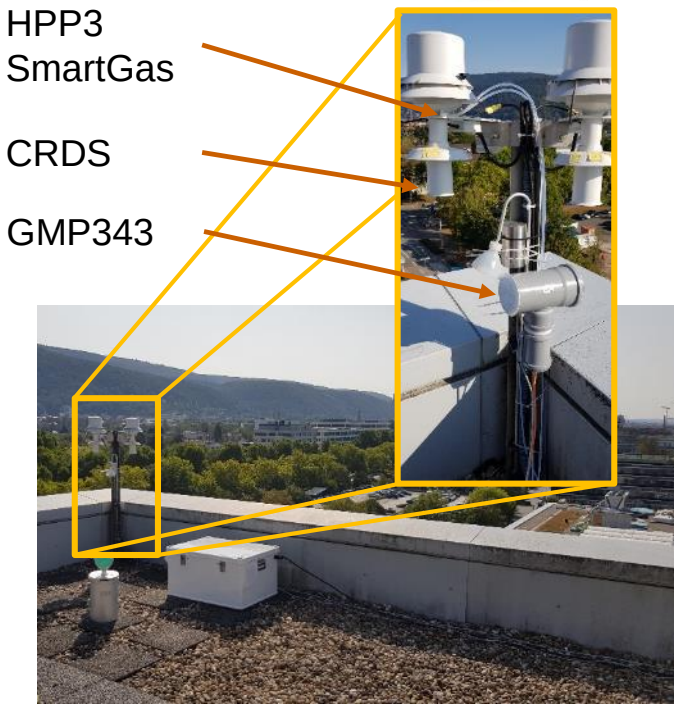
4. Simulation verification using satellite data

Goal: evaluation of WRF simulation performance using satellite data



Sensor Setup





Timeseries of CO_2 data of the three NDIR sensors and the Picarro G2401 CRDS. A **wide range of weather situations** was sampled including an **inversion** lasting several days. This inversion caused CO_2 concentrations to rise to nearly 600ppm.

Deployment of the NDIR sensors next to the air inlet of the Picarro G2401 CRDS on the roof of IUP Heidelberg

Sensor Characterization

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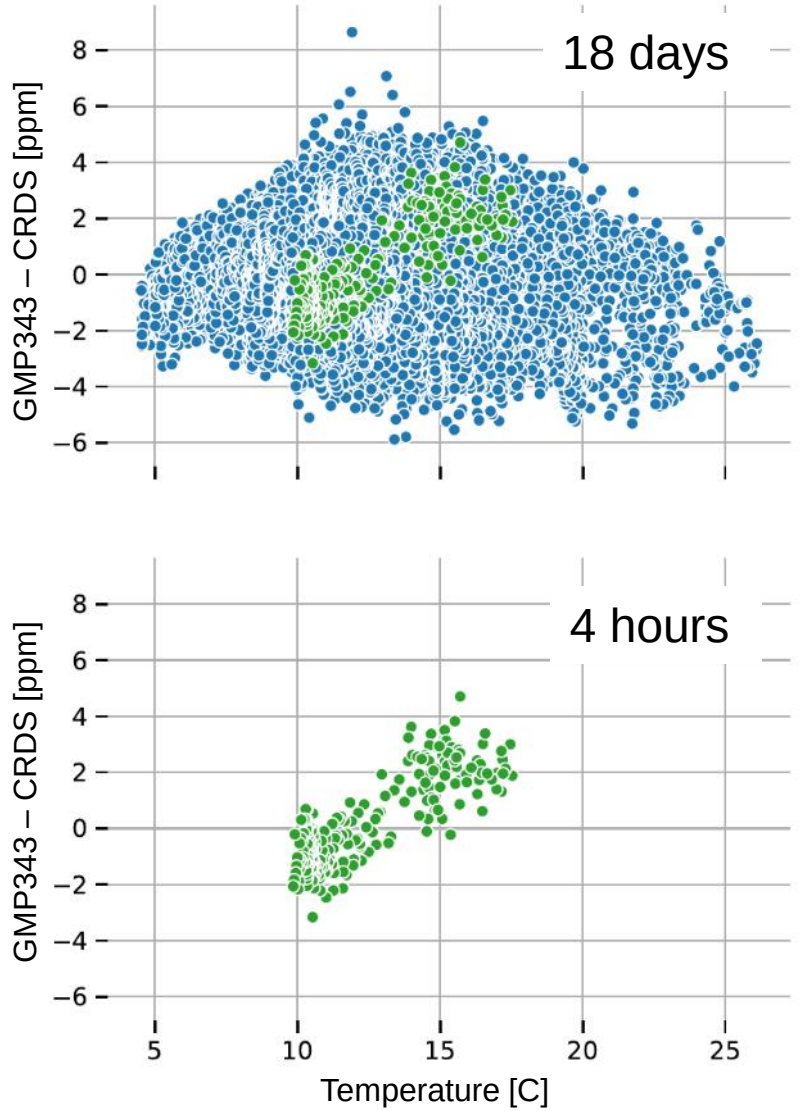
Above: Preliminary results, further studies in progress

Right: Overall linear temperature dependence (top panel after correction) – small residual dependencies remain on the order of a few hours (bottom panel). Temperature stabilization is expected to increase accuracy by factor of 2.



Lukas Pilz, 04/30/2021

https://www.iup.uni-heidelberg.de/research/ghg

Simulation comparison with in-situ data

Goal: source attribution of in-situ data using high-resolution WRF simulations

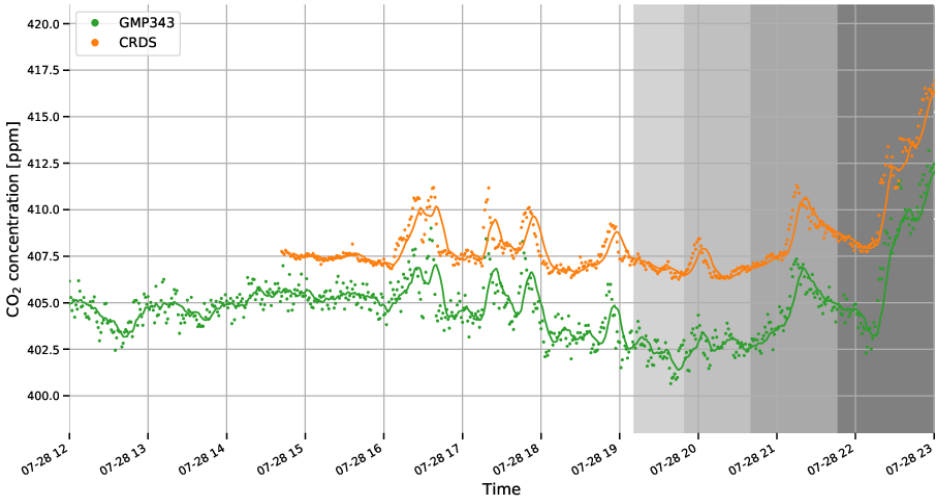
- plume of Mannheim coal power plant (GKM) was predicted to pass over Heidelberg

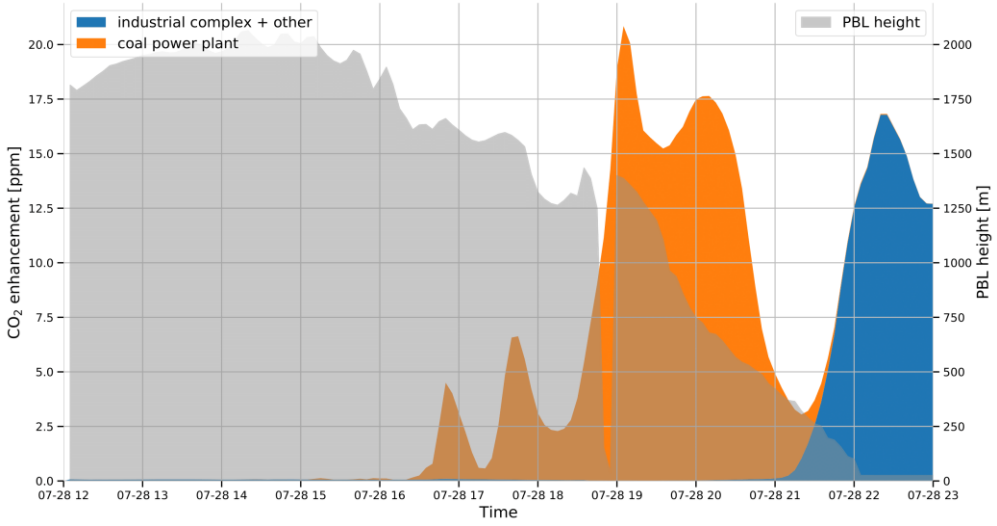
Result

- good agreement between in-situ measurement (above) and simulation (below) on peak timing
- less good agreement on enhancement size

Outlook

- Differences could be caused by badly resolved eddies or overestimated PBL height reduction
  - → increase horizontal resolution
  - → improve urban parametrization





Simulation verification using satellite data

Goal: evaluation of WRF simulation performance using satellite data

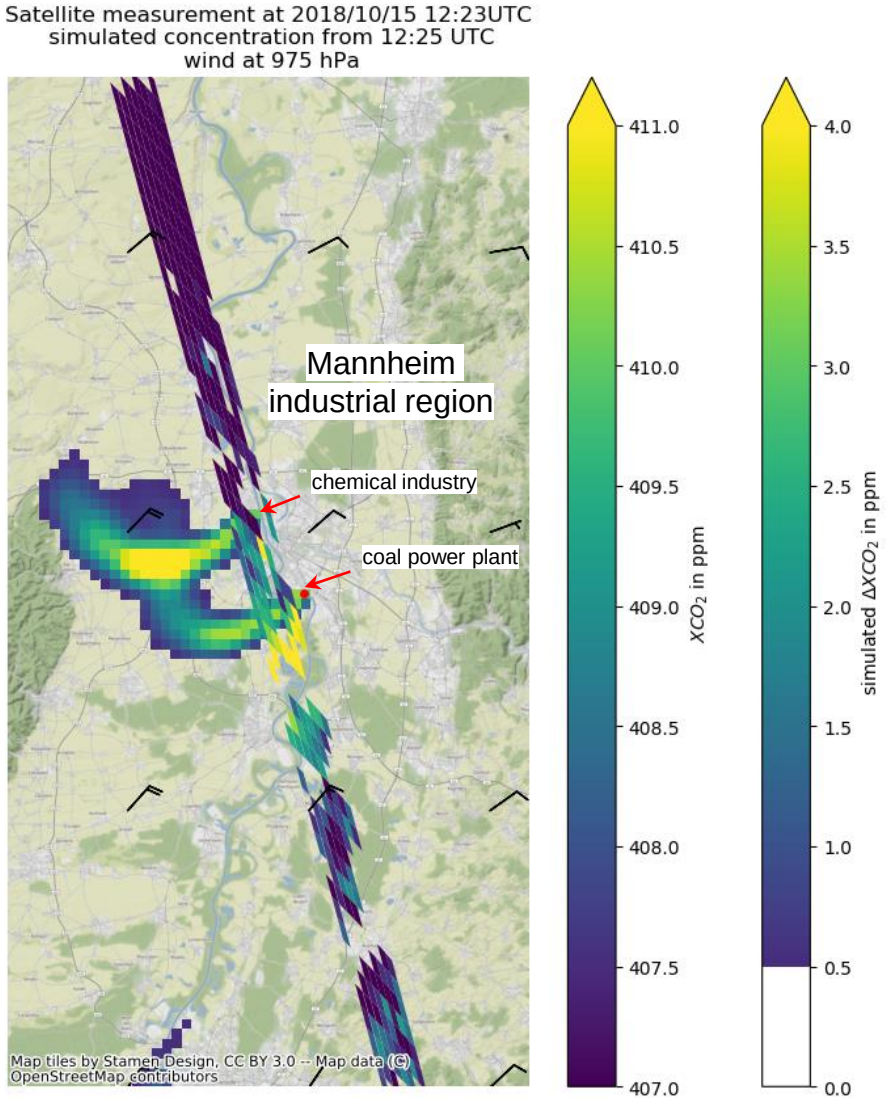
- overpass of OCO-2 satellite over large sources (Mannheim industrial region)

Result

- decent agreement between total column XCO_2 measurement and simulated enhancement
- small difference in plume angle

Outlook

- difference in plume angle could be caused by insufficient vertical resolution of Ekman Layer
  - → increase vertical resolution
  - → improve urban parametrization



Collaboration with E.-M. Schömann

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