Urban emission estimates and validation of satellite-measured urban GHG concentration gradients using MUCCnet data (Munich Urban Carbon Column network)

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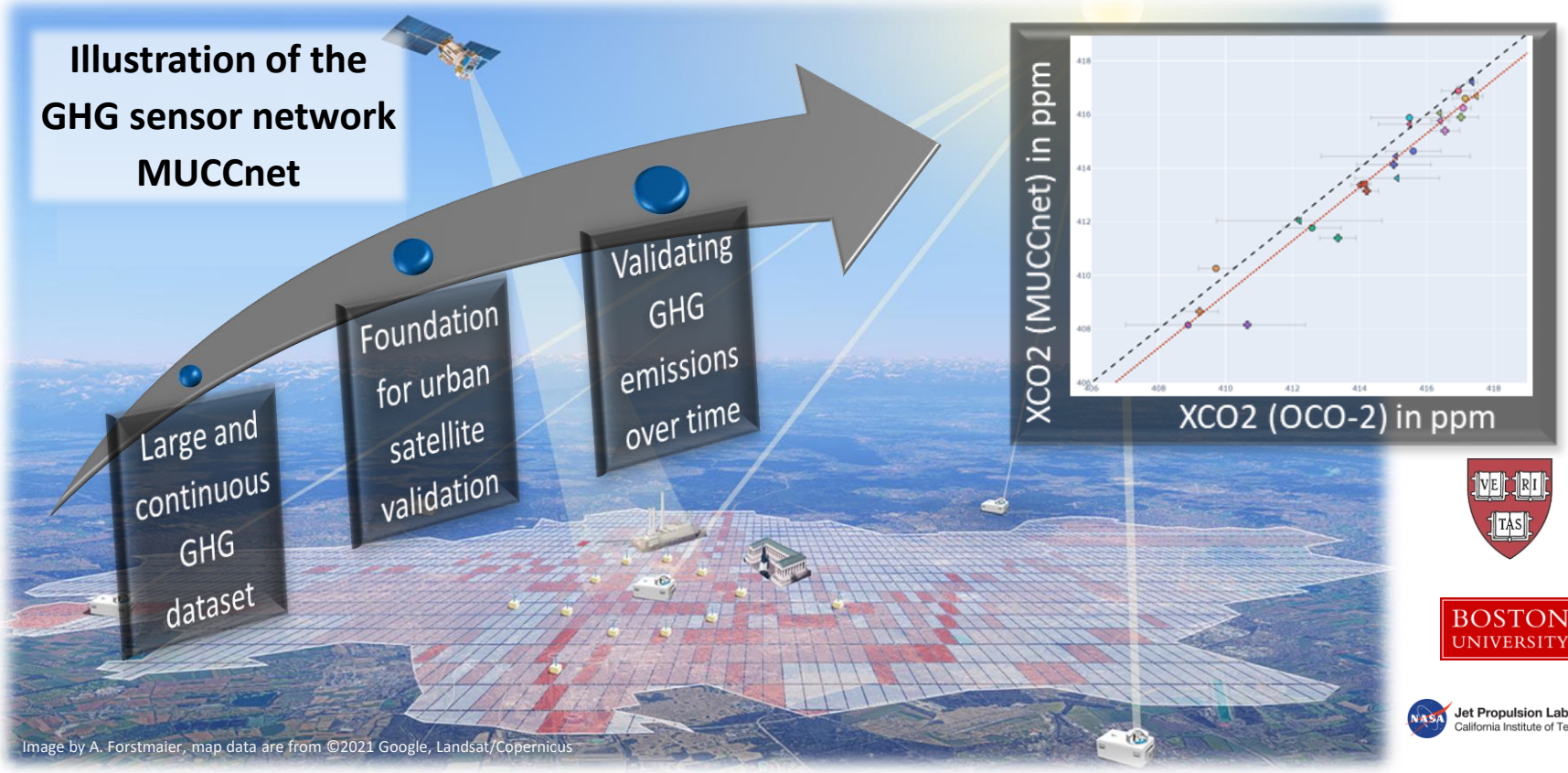
IWGGMS 17 THE 17TH INTERNATIONAL WORKSHOP ON GREENHOUSE GAS MEASUREMENTS FROM SPACE



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1. Measurement principle

(Chen et al., 2016)

- Ground based remote sensing using EM27/SUN spectrometer *(Gisi et al., 2012)*
- Differential column measurements
- Emission estimate (basic principle):
  - $E \propto C_{downwind} - C_{upwind}$
- Long-term observations desirable
- Fully-automated sensor network necessary
- Inversion framework to transfer concentration gradients into emissions *(Jones et al., 2021)*

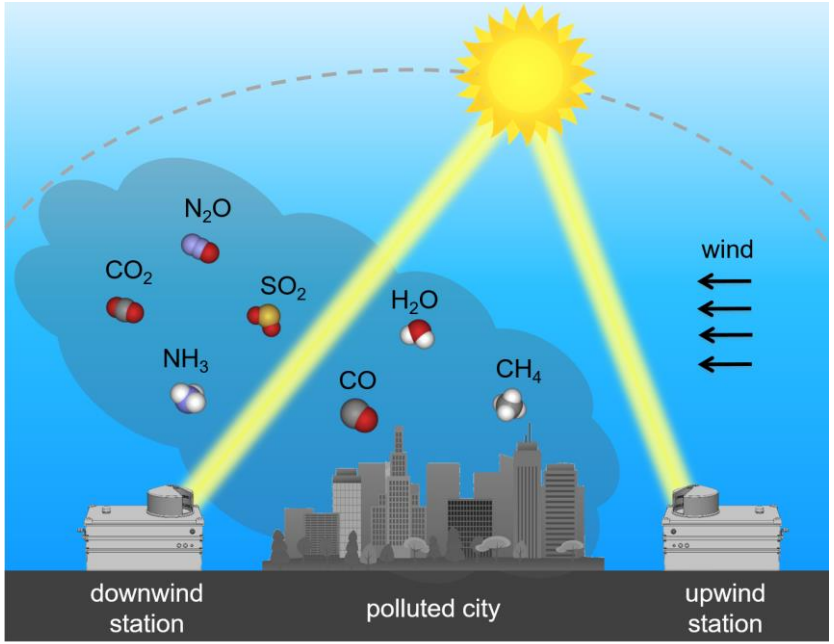


Fig. 1: Principle of the differential column measurements

2. Munich Sensor Network (MUCCnet)

(Dietrich et al., 2021)

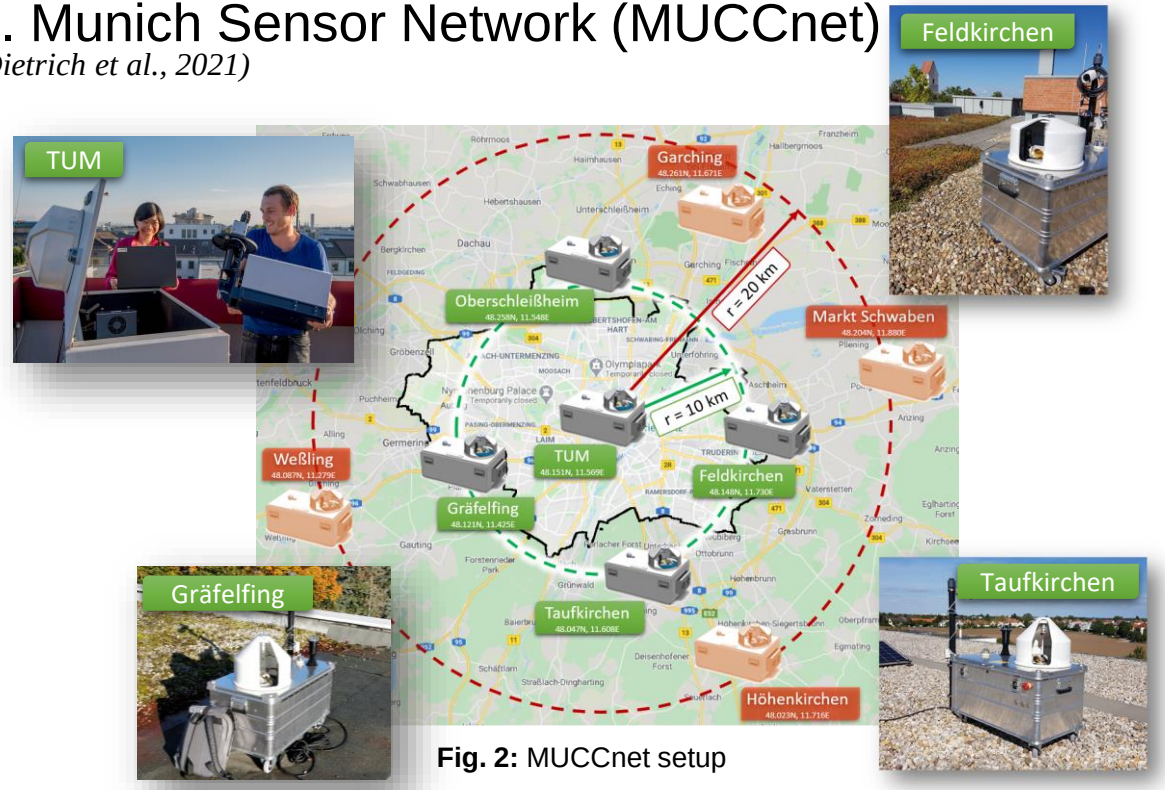


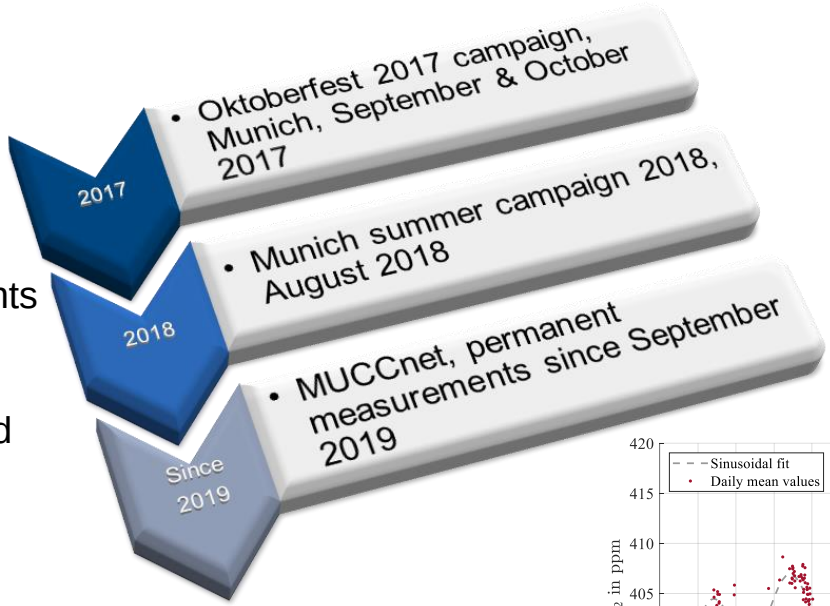
Fig. 2: MUCCnet setup

- 5 FTIR spectrometer in our fully-automated enclosures *(Heinle et al., 2018)*
- Distributed in and around Munich
  - Always at least one upwind/downwind station for arbitrary wind conditions
  - Center station is the downwind of half the city
- Running permanently since September 2019 with 5 stations

3. Dataset

- Properties of the Munich GHG dataset:
  - **Large**:
    - > 4.5 million measurement points
    - > 500 days of measurements
    - Distributed over a 5-year period
  - **Continuous**: since 2019
  - **Unique**

- **Optimal foundation for validating satellite-measured urban concentration gradients**



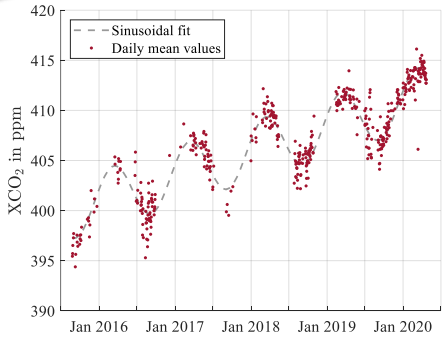


Fig. 3: Long-term GHG dataset in Munich

4. OCO-2 satellite validation – preliminary results

- OCO satellites have been targeting Munich since April 2020:
  - OCO-2 → Target mode: 11 overpasses
  - OCO-3 → SAM: 24 overpasses
- Data filtering:
  - Averaging kernel corrected
  - Using only quality filtered data
  - MUCCnet data retrieved with GGG2014
  - OCO-2 sounding within 7 km radius
  - MUCCnet data ±30 min around overpass

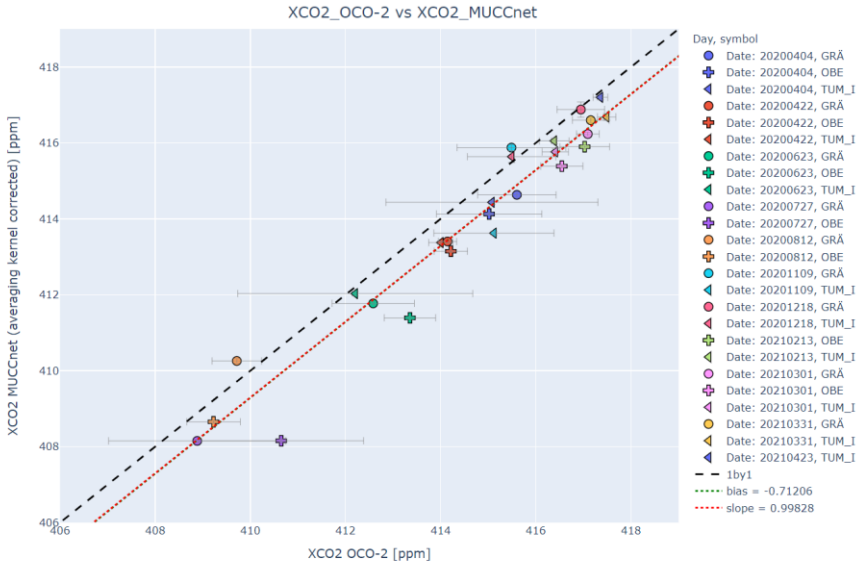


Fig. 4: OCO-2 validation results

5. Urban emission estimate using a Bayesian inversion framework

(Jones et al., 2021)