



Investigations of comparison uncertainties for airborne validation of air quality satellite products

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TROPOMI versus independent measurements

Uncertainty satellite

$$\sigma_{Sat}^2 = \sigma_{Ins \& L1}^2 + \sigma_{L2}^2$$

Uncertainty independent measure

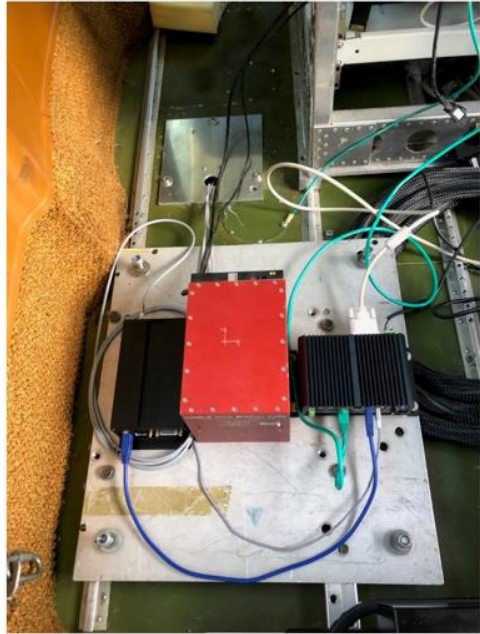
$$\sigma_{Ind}^2 = \sigma_{Ins \& L1}^2 + \sigma_{L2}^2 + \sigma_{representativity}^2$$

- *Studies, Place, Instrument, multiplicative bias between TROPOMI and indepent measures*
- Verhoelst et al, 2021, Uccle, MAX-DOAS **0.47**
- Judd et al, 2020, New York, GeoTASO, GCAS **0.68**
- Judd et al, 2020, New York, PANDORA, **0.8**
- Tack et al, 2021, Brussels and Antwerp, APEX, **0.82**
- Iolongo et al, 2020, Helsinki, PANDORA, **0.42**

Can we reproduce results of previous airborne validation?

Why is TROPOMI systematically under independent measurements?

Routine airborne measurements over Bucharest and Berlin

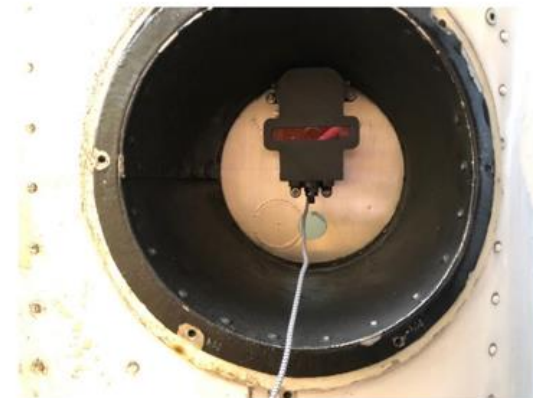


- > Routine measurements across the year
- > With national facilities
- > In Berlin and Bucharest

Both campaign use SWING airborne instruments
Merlaud et al. (2018), Tack et al (2019), Merlaud et al. (2020)

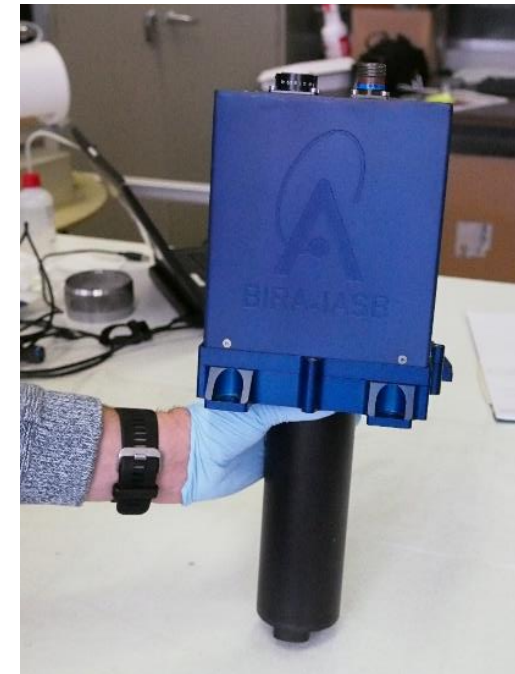


Berlin set-up
SWING+ Pandora



Bucharest set-up

SWING
+ NO₂ in-situ (CAPS)
+ Aerosol particle sizer
+ Mobile-DOAS
+ Pandora

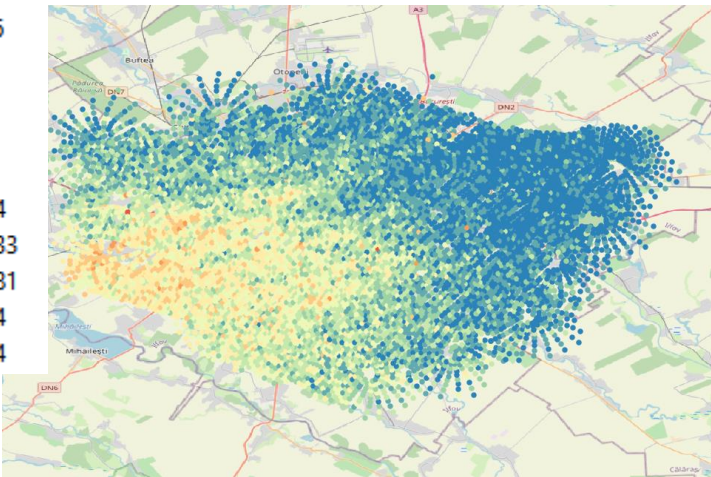


SWING Flights over Bucharest 2021

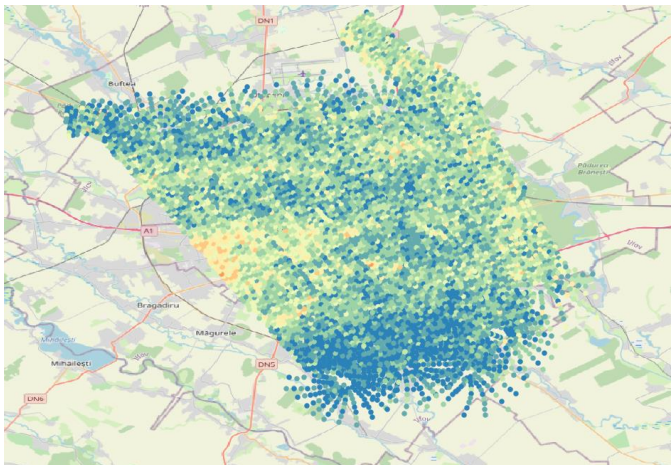
NO2 Tropo
(Pmolec.cm⁻²)

- 2.12 - 4.26
- 4.26 - 5.39
- 5.39 - 6.38
- 6.38 - 7.38
- 7.38 - 8.57
- 8.57 - 10.14
- 10.14 - 12.33
- 12.33 - 14.81
- 14.81 - 19.4
- 19.4 - 51.44

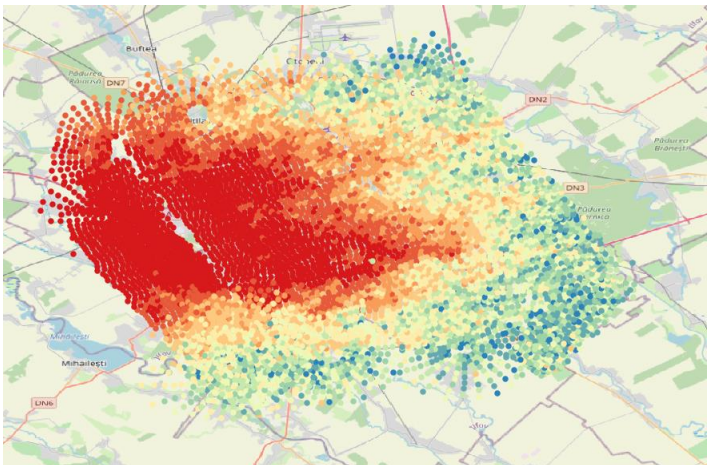
1 July 2021



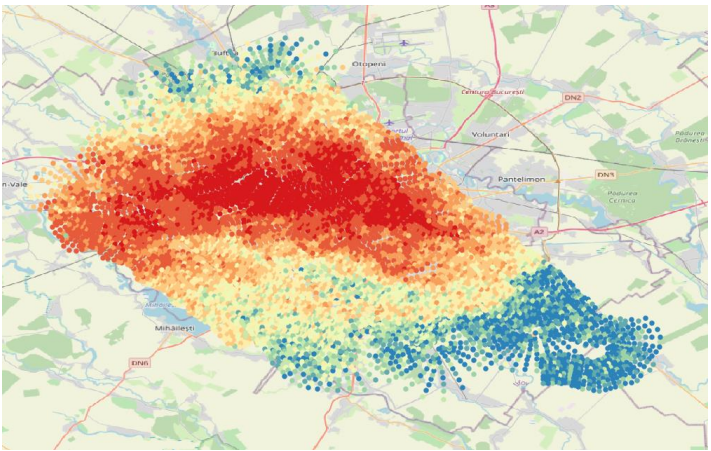
10 July 2021



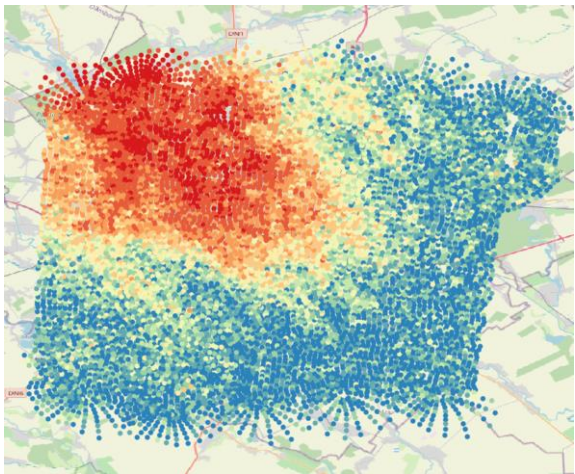
29 October 2021



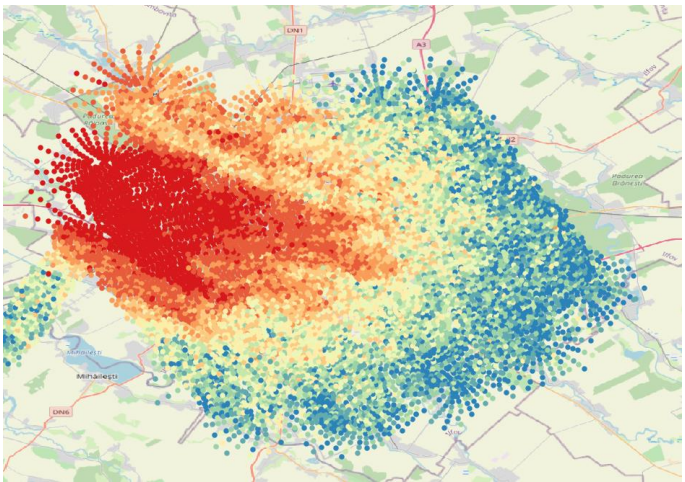
4 November 2021



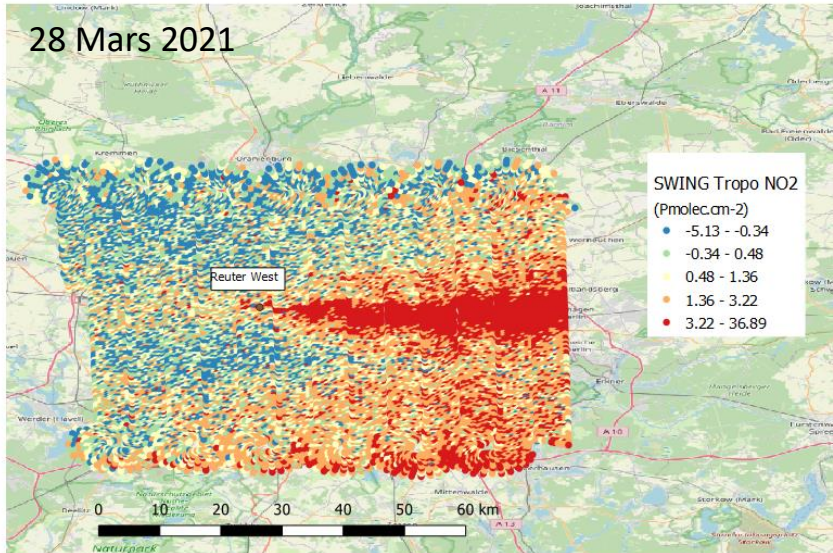
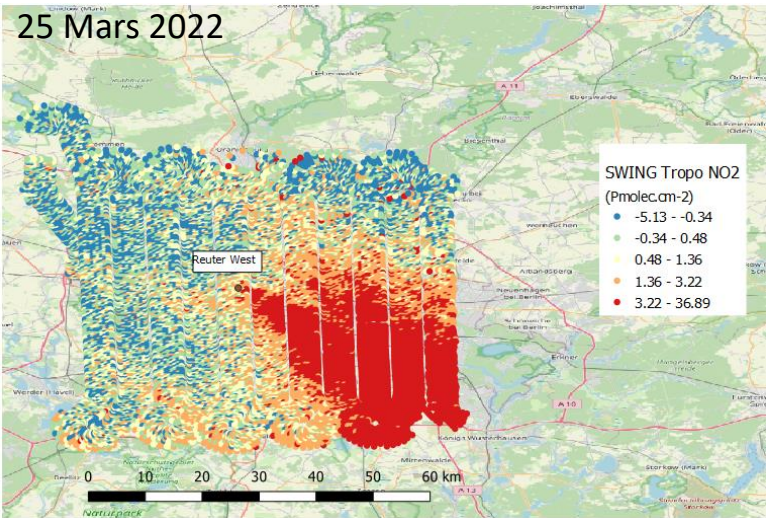
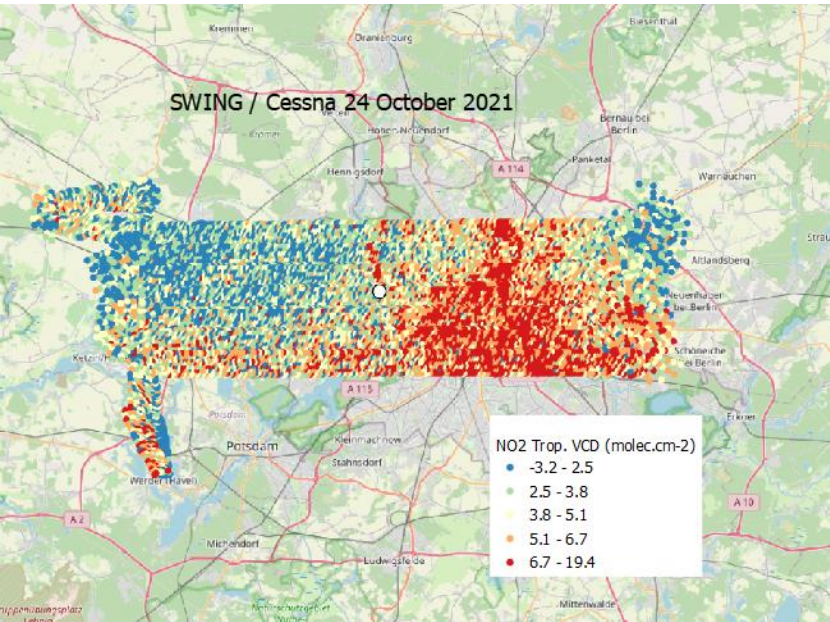
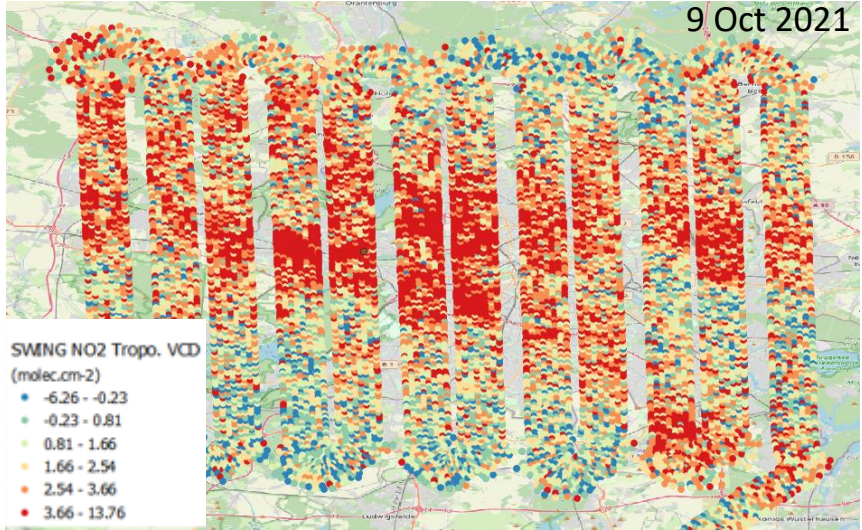
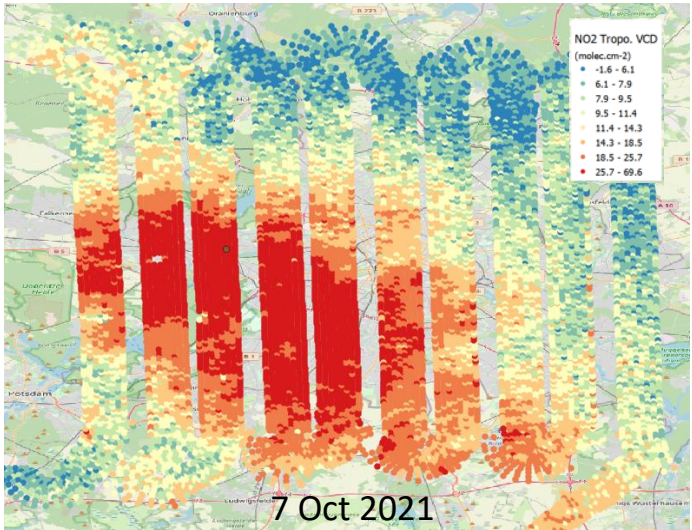
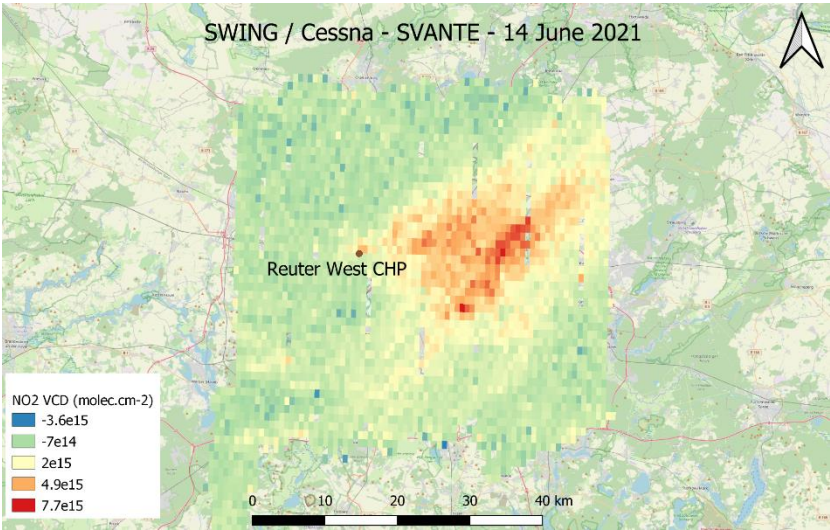
5 November 2021



11 November 2021

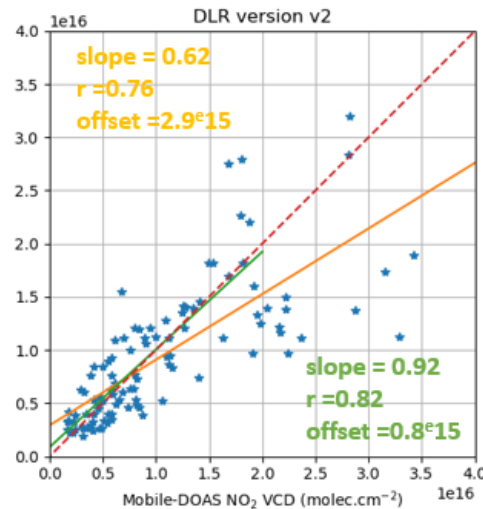
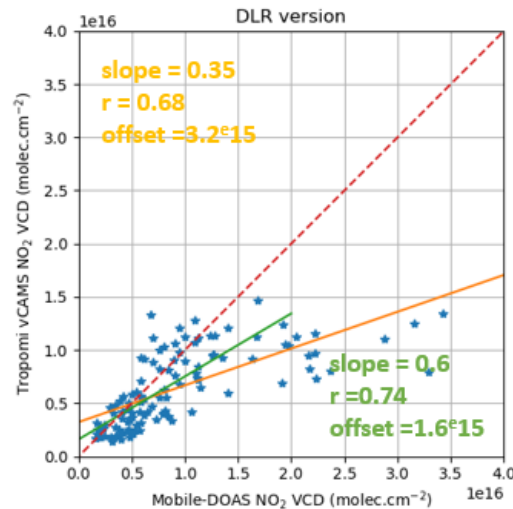
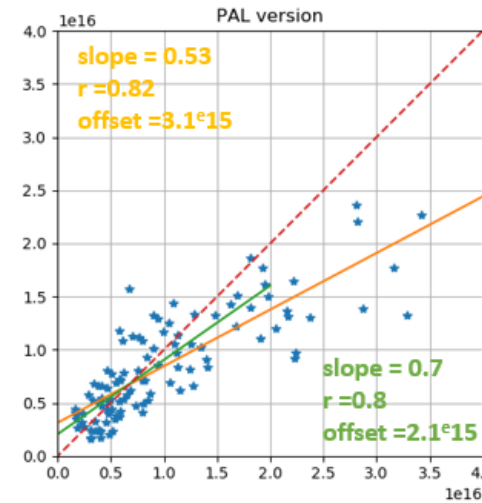
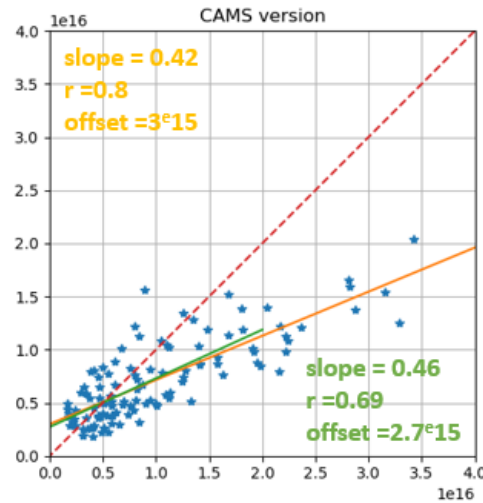
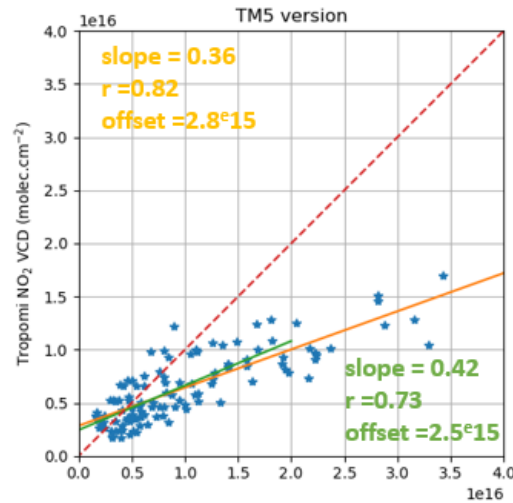
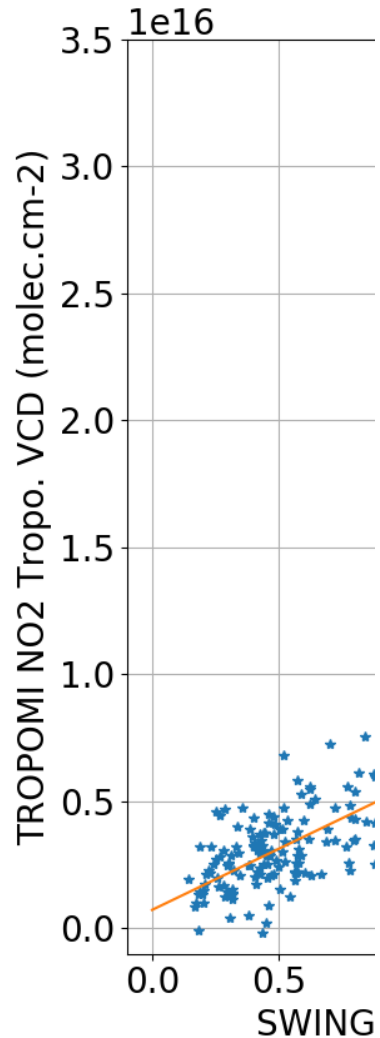


SWING Flights over Berlin 2021-2022

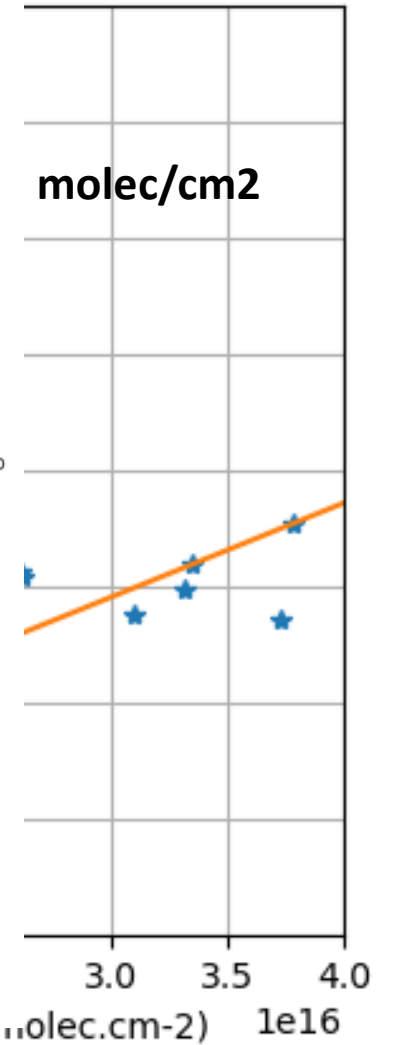


SWING and TROPOMI (all pixels)
 5 July, 29 Oct, 5 Nov, 22 Nov 2021, 22
 Nov 2021, 5 Jan 2022

SWING within TROPOMI overpass ± 1 h,
 nSWINGpix > 100 in one TROPOMI pixel
 7, 9, 24 October 2021



Mobile-DOAS
 measurements
 in Belgium,
 Germany,
 France



1. Can we reproduce results of previous airborne validation?

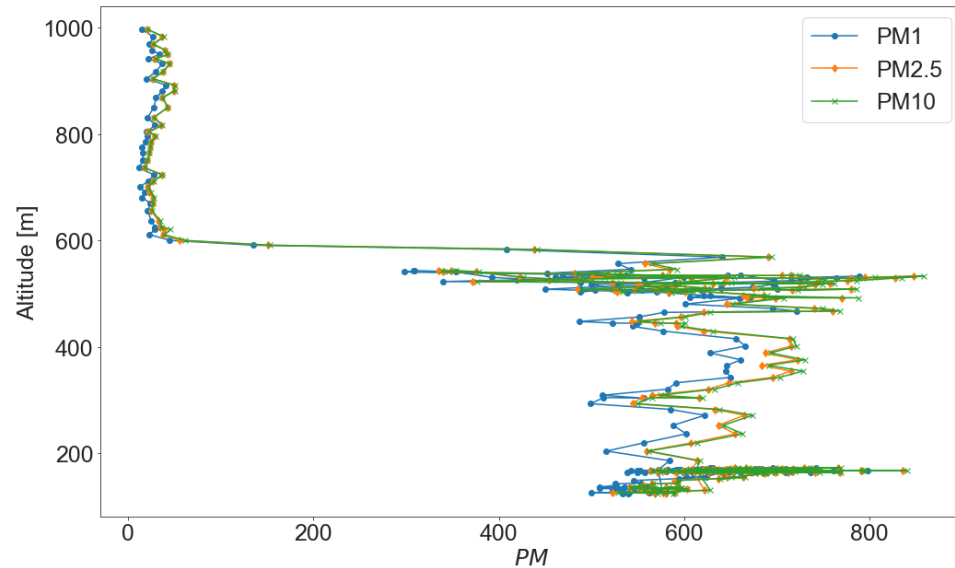
-> Smaller slopes, but consistent with static MAX-DOAS and ground-based Mobile-DOAS measurements

2. Why is TROPOMI systematically under independent measurements?

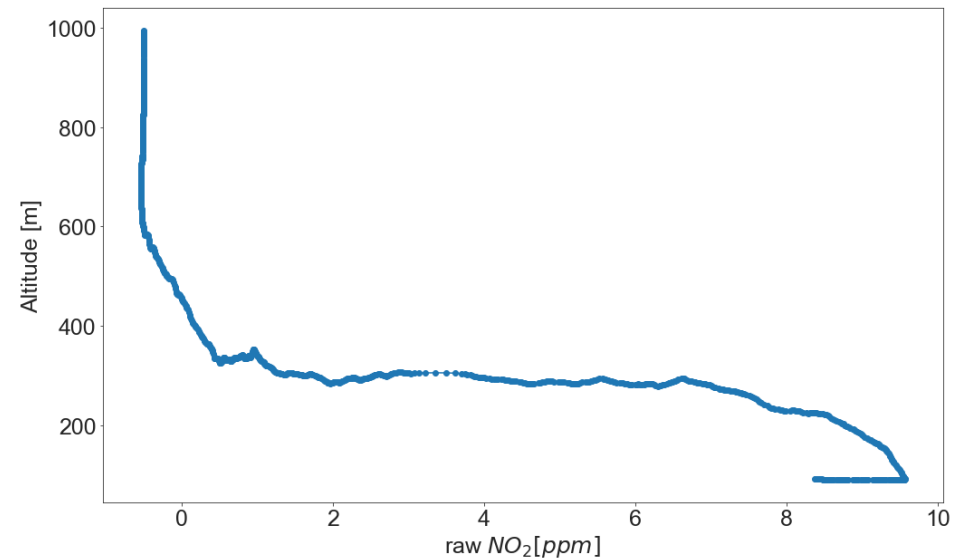
-> Representativity seems to play little role

-> NO₂ profile (L2) plays a role but still a bias at high NO₂ columns

APS data below 1km for 11 Nov 2021 between 09:22 - 09:41



NO₂ CAPS data below 1km for 11 Nov 2021 between 12:09 - 12:25



Can the bias at elevated NO₂ VCDs be explained by aerosol shielding?

To be continued