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Institute of Environmental Physics

S5Pval-DE-Ruhr campaign
Quick report on current status

SVANTE / QA4EO progress meeting
February 21st/22nd, 2022
online

QA4EO/CCN
WP7000

Anja Schönhardt, Kezia Lange, Andreas Meier, Andreas Richter, John P. Burrows, and the S5P-VAL-DE-Ruhr campaign team:
Michel Van Roozendael (2), Thomas Wagner (3), Thomas Ruhtz (4), Dirk Schüttemeyer (5),
Lisa Behrens (1), Christian Borger (3), Tim Bösch (1), Ermioni Dimitropoulou (2), Sebastian Donner (3), Steffen Dörner (3), François Hendrick (2), Kai Krause (1), Vinod Kumar (3), Bianca Lauster (3), Alexis Merlaud (2), Maria Razi (3), André Seyler (1), Frederik Tack (2), Katharina Uhlmannsiek (3), Folkard Wittrock (1)

(1) IUP Bremen, (2) BIRA, (3) MPIC, (4) FU Berlin, (5) ESA

S5Pval-DE-Ruhr campaign

- Part of the QA4EO project

- Activity in Germany, Ruhr Area (North Rhine-Westphalia)

  → 1st implementation in 2019 (no flights)

  → 2nd implementation in 2020 (7 flights) following a CCN

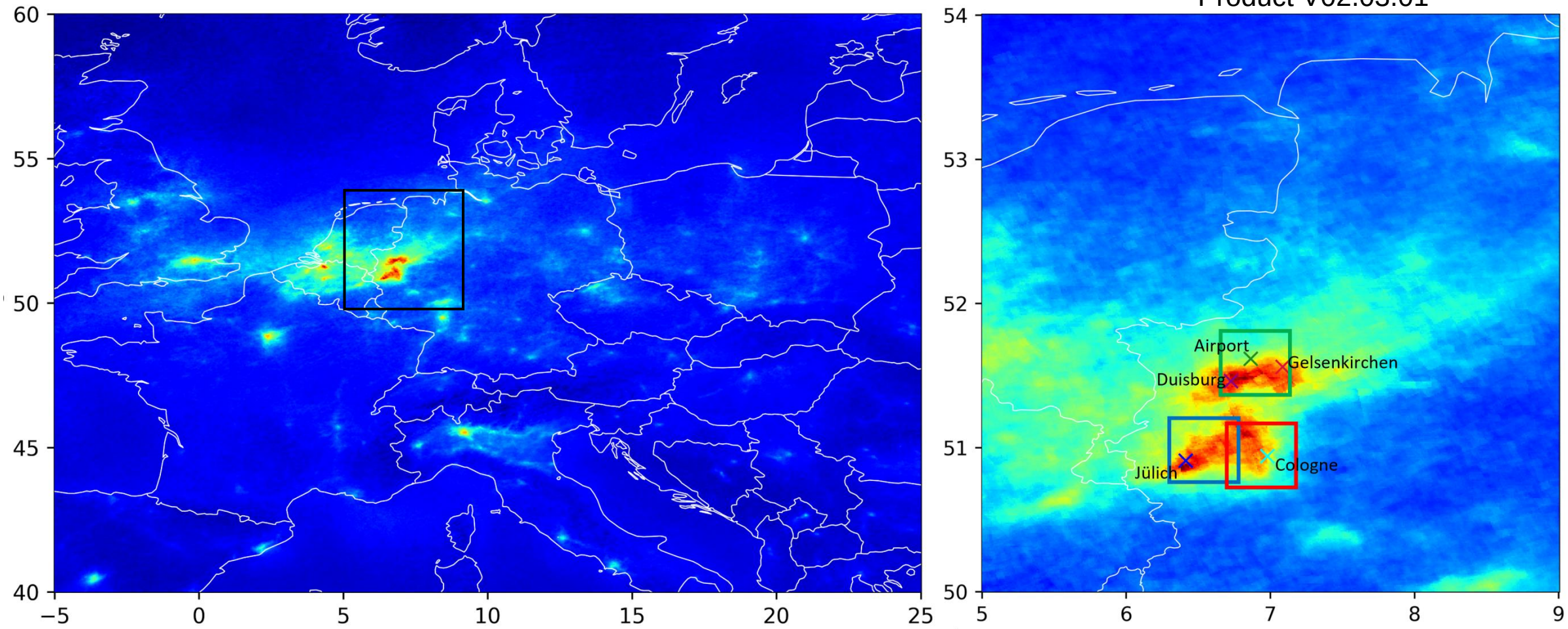
- QA4EO/CCN deliverables:

  → DARa-1 and DARa-2 finalized and submitted in Dec 2021

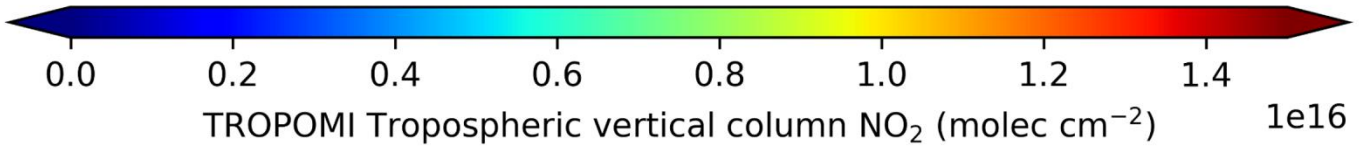
  (D2a/Campaign Report, D3a/Preliminary Data Analysis Report, D4a/Data Acquisition Report)

S5Pval-DE-Ruhr campaign

Data source: S5P level-2 NO_2
Product V02.03.01



September 2020



A Jülich
B Cologne
C Duisburg

Instruments & campaign period

Mobile component

- AirMAP imaging DOAS
- Avantes (nadir only Avantes)
- 3 car DOAS instruments: MPIC Mainz, BIRA, and IUP-Bremen

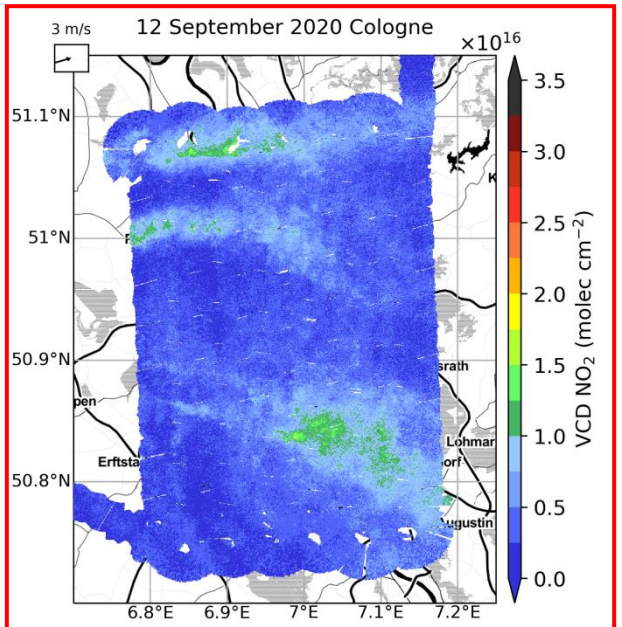
FU Berlin Cessna T207A (D-EAFU)

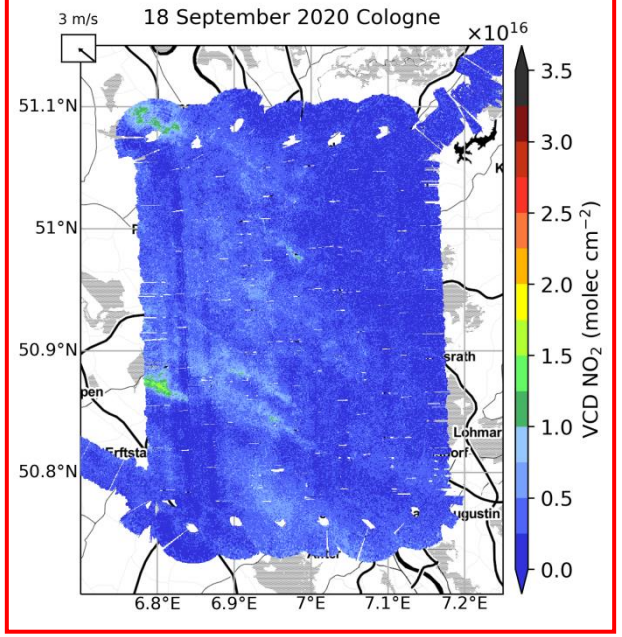
Ground-based component

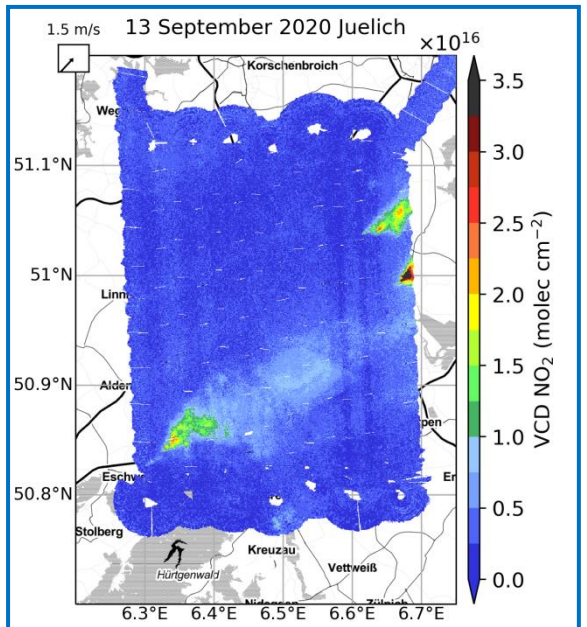
- 6 ground-based spectrometers at 5 locations
  - 2 zenith-sky AVANTES: Jülich and Gelsenkirchen
  - 2 MAX-DOAS: Duisburg and Dinslaken (airport)
  - 2 Pandora instruments: Jülich and Cologne
- Long-term measurements: still ongoing (Jülich x2, Cologne)

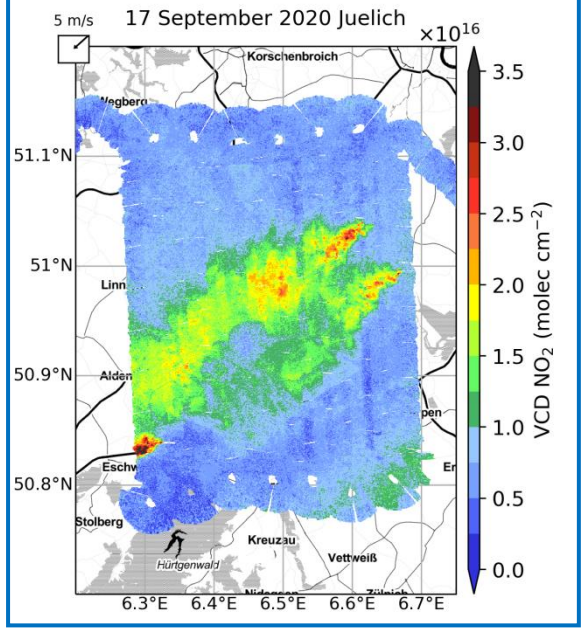
Seven Golden Days:
12. – 18. September 2020

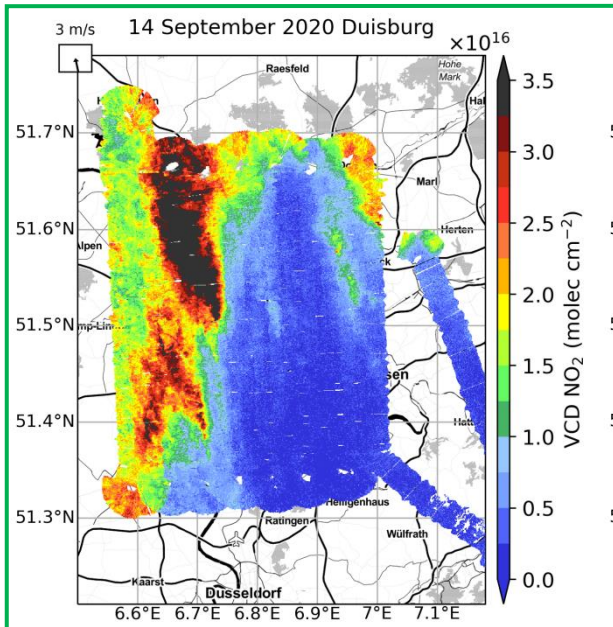
Overview: AirMAP NO_2 maps

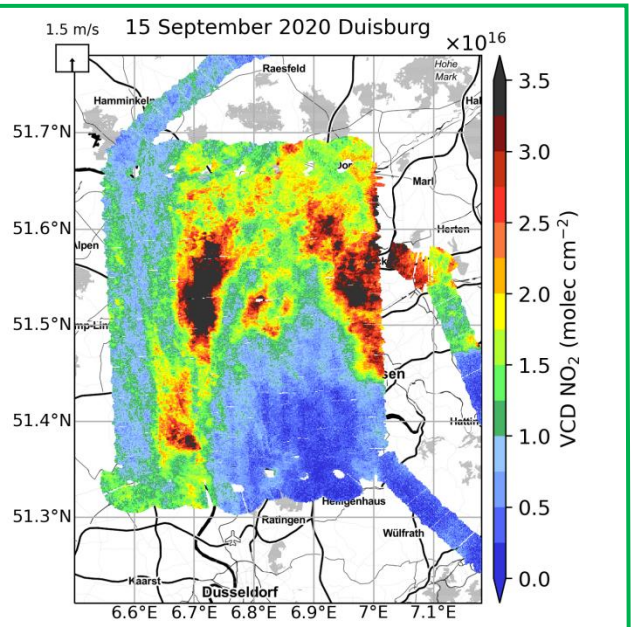


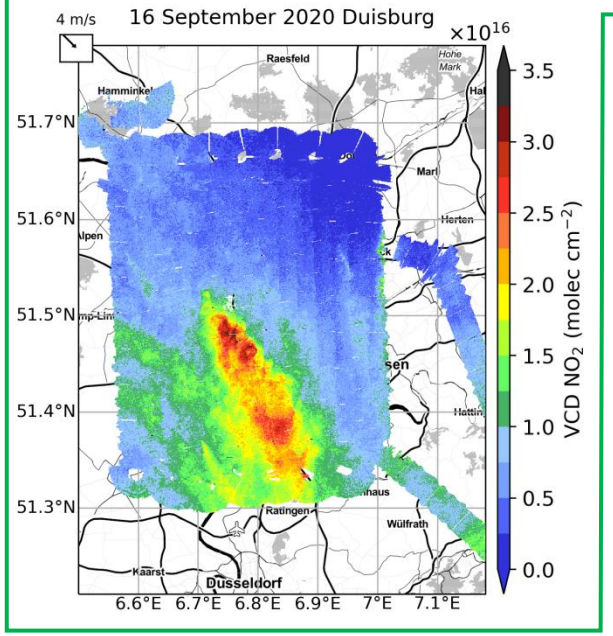








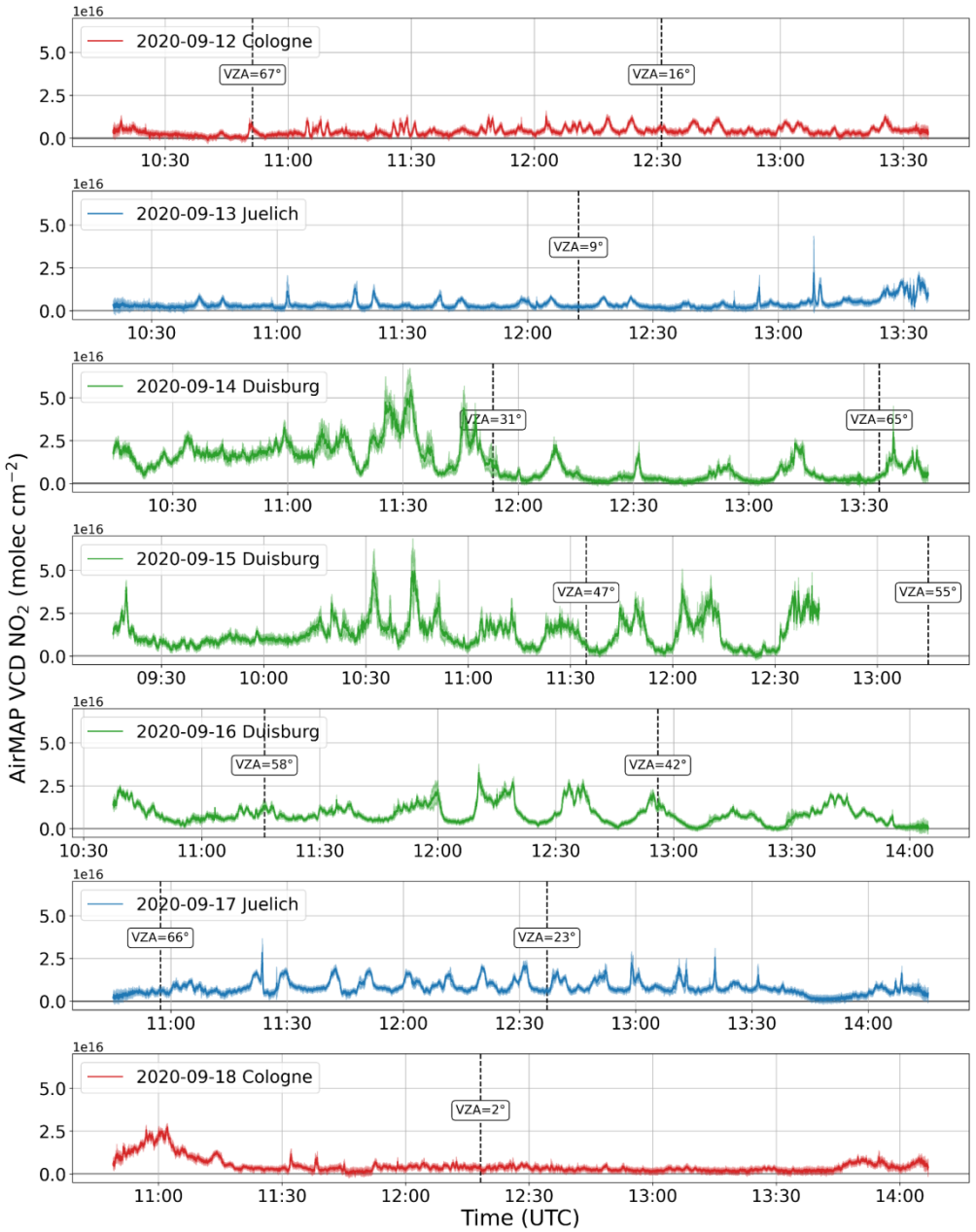




- Successful flights in all 3 flight boxes
- Huge variability in NO_2
- Car mobile measurements and 6 ground stations operational on all 7 days
- TROPOMI NO_2 on 6 days

AirMAP timeseries of NO_2

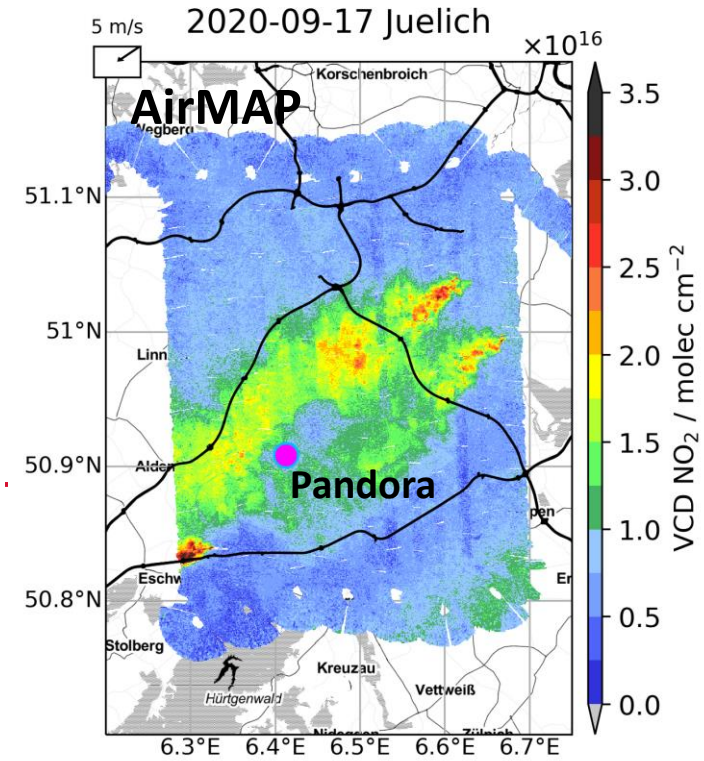
- AirMap timeseries (all seven flight days)
- mean over 35 LOS with standard deviation
- Strong spatial variability ($<0.5 \times 10^{16}$ molec/cm² to 7×10^{16} molec/cm²)
- Strong variability from day to day
- Strong variability between the different target areas

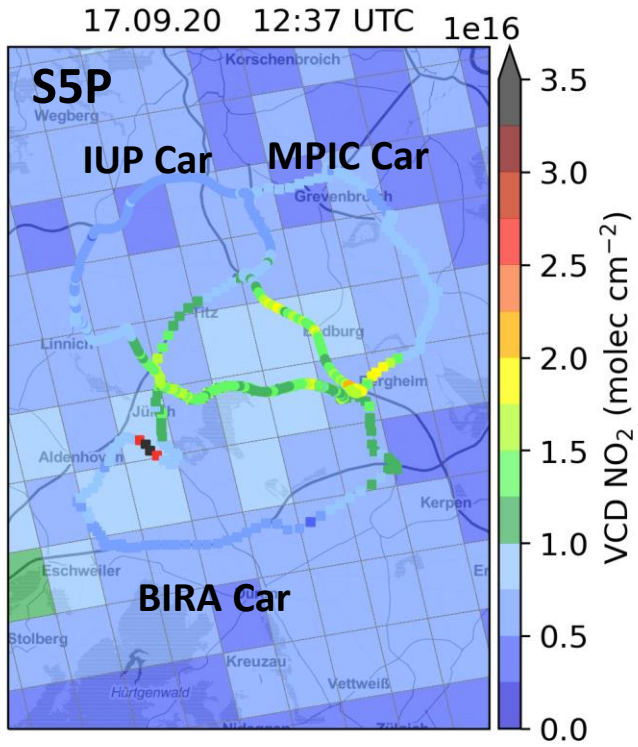


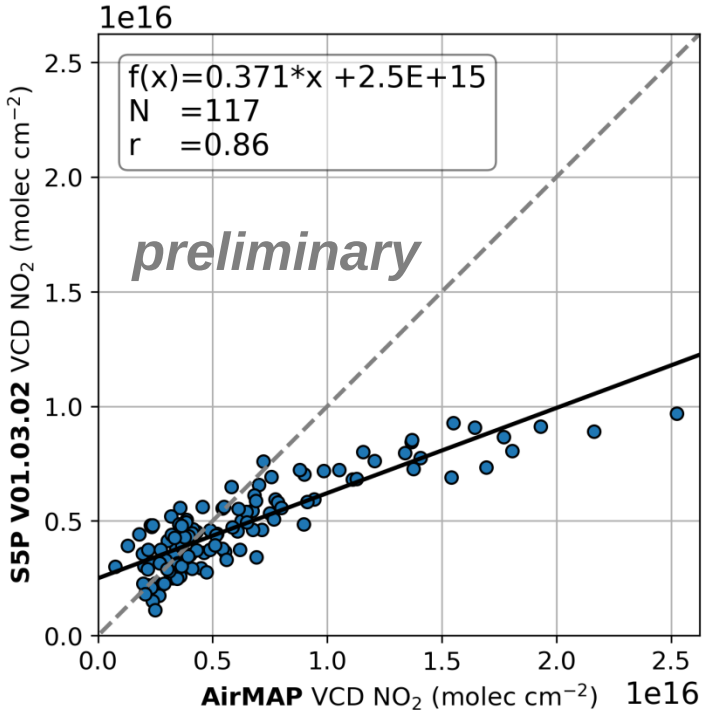
Preliminary NO_2 comparison

NO_2 VCDs from AirMAP / car DOAS / TROPOMI (preliminary data)

Example comparison: Thursday 2020-09-17 Jülich – S5P overpass 12:37 UTC







TROPOMI NO_2 data version OFFL V01.03.02

- Consistent measurements of AirMAP and car DOAS
- Good correlation of S5P and AirMAP measurements
- Lower S5P TROPOMI NO_2 data, varying magnitude for different days and areas

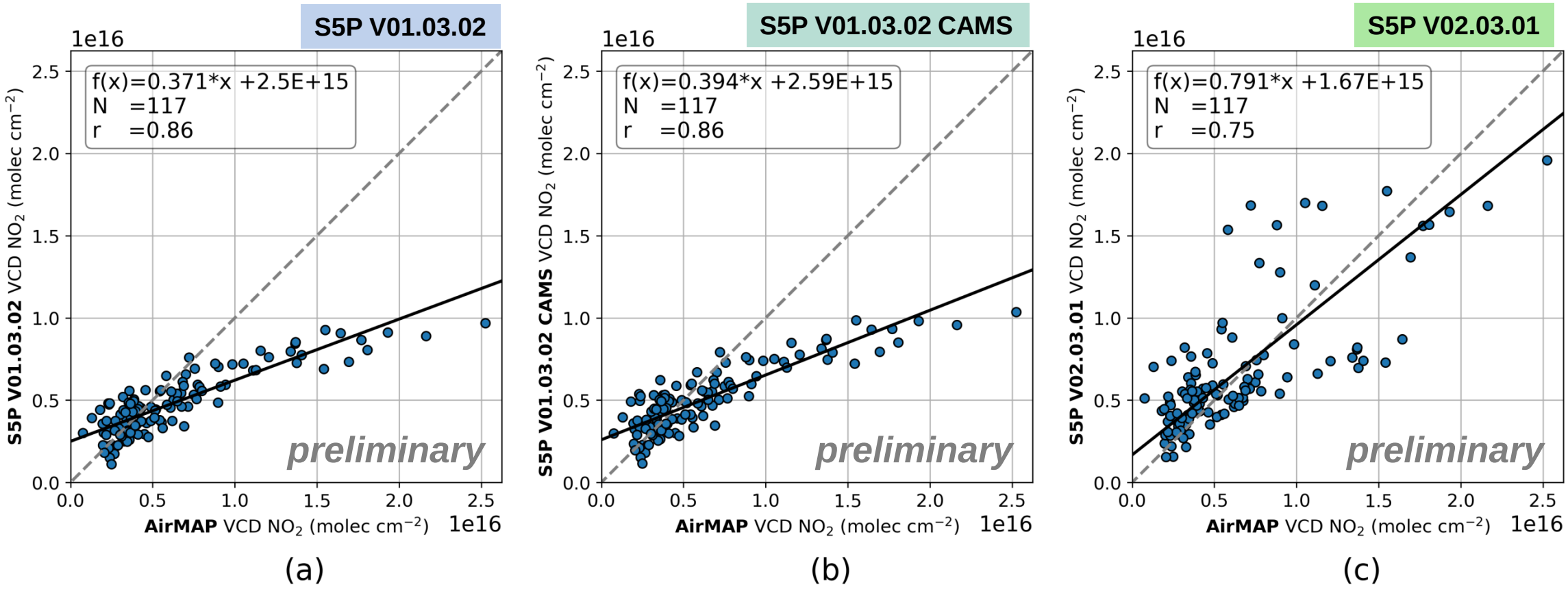
Investigating difference between AirMAP and TROPOMI NO_2

Comparison of campaign data with different TROPOMI NO_2 products (incl. latest V02.03.01)

- Operational TROPOMI NO_2 product (OFFL, V01.03.02)
- Adapted TROPOMI NO_2 product by Henk Eskes, KNMI
  → using CAMS regional modelling data for NO_2 profiles
- Reprocessed TROPOMI NO_2 product (PAL, V02.03.01)

Preliminary NO_2 comparison

Preliminary NO_2 VCDs from AirMAP / TROPOMI (3 different products)

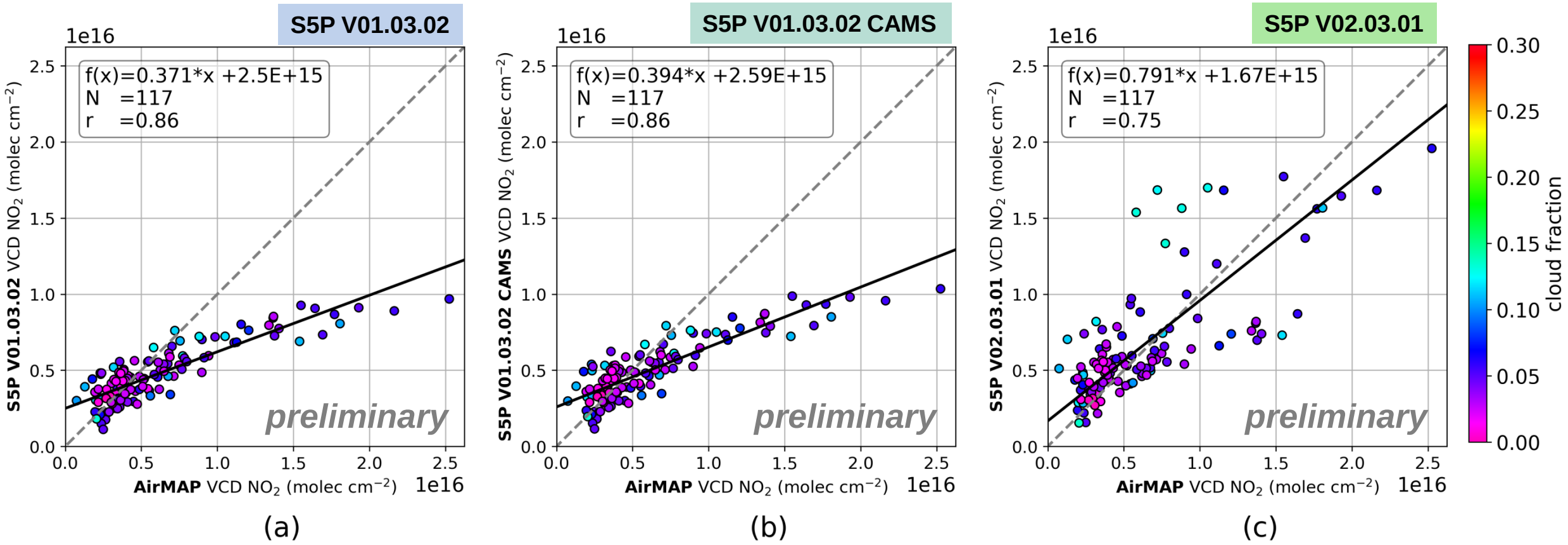


- **S5P V01.03.02**: standard OFFL level-2 NO_2 product
- **S5P V01.03.02 CAMS**: NO_2 product with use of CAMS regional modelling profiles
- **S5P V02.03.01**: reprocessed S5P data for level-2 NO_2

	Slope (S5P/AirMAP)
S5P V01.03.02	0.371
S5P V01.03.02 CAMS	0.394
S5P V02.03.01	0.791

Preliminary NO_2 comparison

Preliminary NO_2 VCDs from AirMAP / TROPOMI (3 different products)



		Slope (S5P/AirMAP)
• **S5P V01.03.02**:	standard OFFL level-2 NO_2 product	0.371
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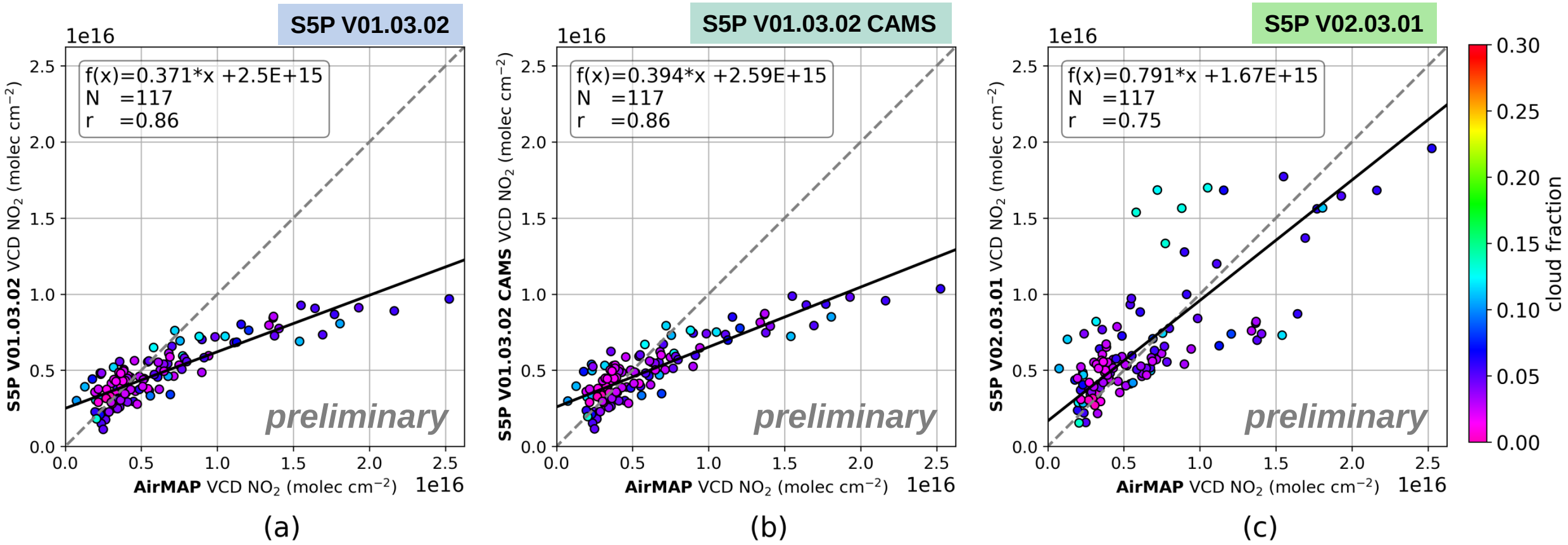
Preliminary NO_2 comparison

Preliminary NO_2 VCDs from AirMAP / TROPOMI (3 different products)



- Better agreement using reprocessed data V 2.3.1: Improvement of slope from 0.4 to 0.8
- Larger scatter (reduced correlation) for V 2.3.1
- Different results for individual days: different values for slope, offset and correlation
- Influence on individual days by cloud and aerosol situation

Current activities

Further advancing the AirMAP data analysis

- Extension of the applied LUT by different aerosol loadings (AOD)
- Update further auxiliary information such as a priori profiles

Investigating differences between AirMAP and TROPOMI NO_2

- Comparison of campaign data with custom TROPOMI NO_2 products
- Evaluate influence of different auxiliary data on the TROPOMI product (albedo, profiles, cloud information, and others)
- Evaluate influences (esp. aerosols) on AirMAP measurements
- Analysis different situations on individual days

Summarizing results on S5p validation for publication

Acknowledgement of the aircraft team

The participants of the S5Pval-DE-Ruhr campaign gratefully acknowledge the essential technical and scientific support of the aircraft team corresponding to the operation of AirMAP onboard the Cessna-T207A (D-EAFU), especially Thomas Ruhtz and Jeremy Gordon.

Thank you.