

Intercomparison of Airborne Imaging DOAS Systems for Mapping of Tropospheric NO₂ (AROMAPEX Campaign, Berlin, April 2016)



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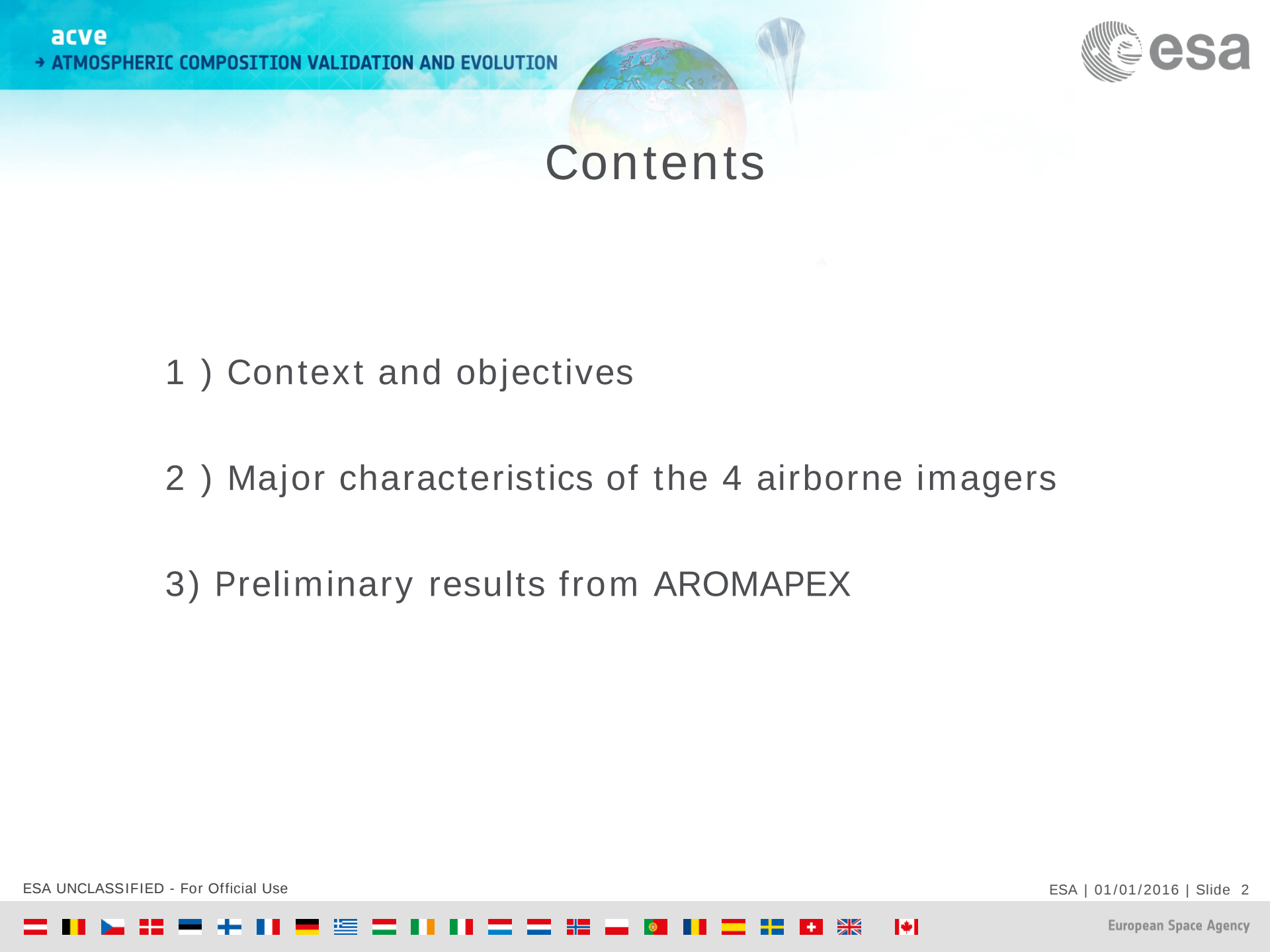
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Contents

- 1) Context and objectives
- 2) Major characteristics of the 4 airborne imagers
- 3) Preliminary results from AROMAPEX



Context

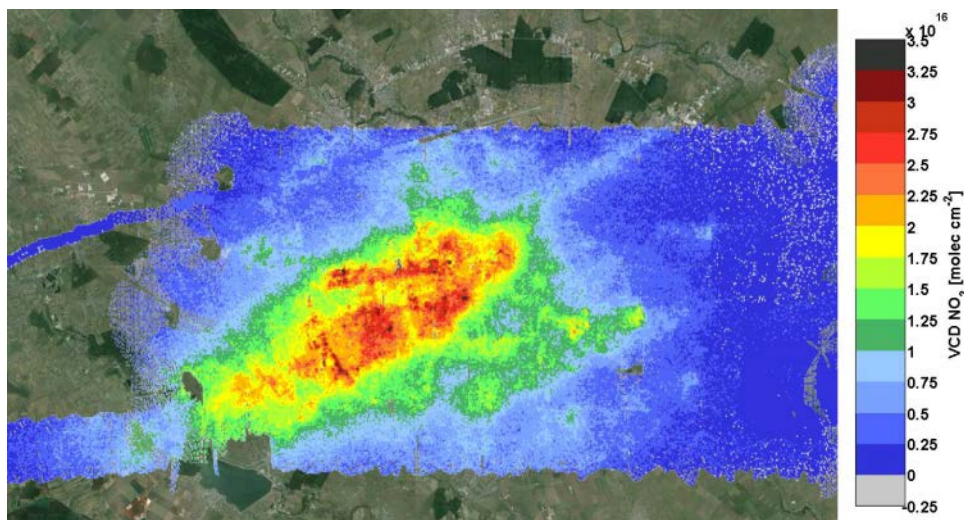
- ESA AROMAT activity, a set of airborne campaigns performed in 2014, 2015, and 2016 in Romania and Germany, dedicated to test newly developed atmospheric instruments for satellite validation
- supported by ESA and EUFAR (TA proposal by INCAS, Romania)
- AROMAPEX originally planned in Romania in 2015, shifted to Germany 2016



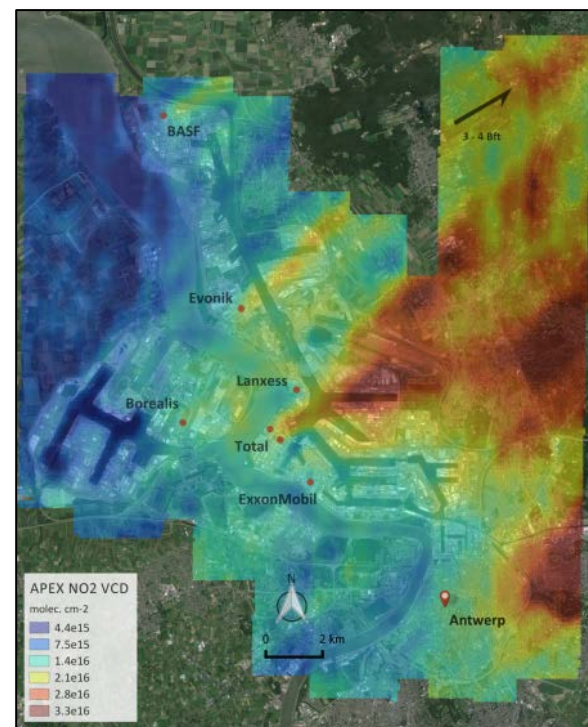
<http://uv-vis.aeronomie.be/aromat/>

Objectives : comparison of airborne NO₂ imagers

AirMAP/FUB Cessna over
Bucharest (Aromat-2014)



APEX/DLR Do-228 over
Antwerp (Bumba-2015)



-> How do AirMap and APEX derived NO₂ fields compare above the same source?

-> What can we learn on the performances and limitations of each instrument from the comparison?

APEX on Dornier (Flying at 6 km alt.)

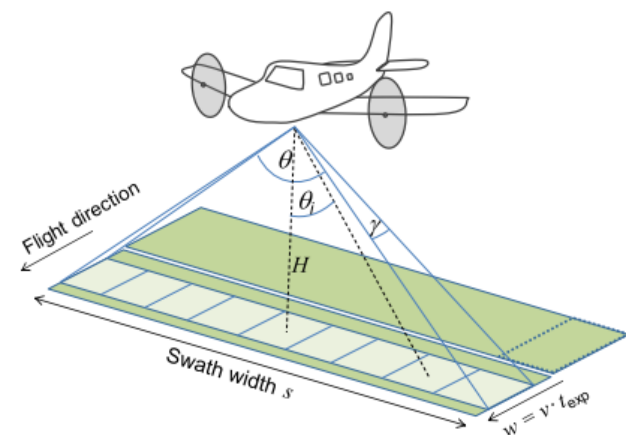
APEX Characteristics at 6 km

Pixels Across track	1000
FOV Across-track	28°
Swath width	3000 m
Integration time	58 ms
Aircraft speed	72 m/s
Apex total mass	354 kg
Ground Pixel size (binned)	60x80 m ²
Ground Pixel size (unbinned)	3x4 m ²
Radiometrically calibrated	yes



NO₂ mapping with APEX in Popp et al., 2012

AirMap on Cessna (Flying at 3 km alt.)

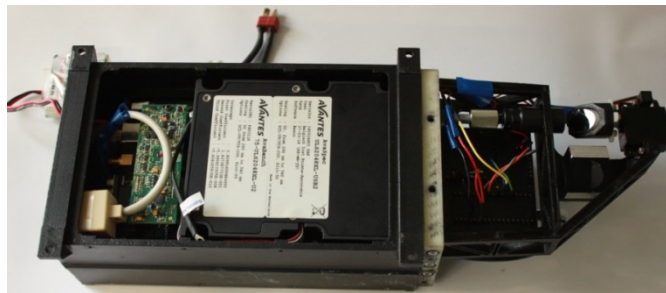


AirMAP Characteristics at 3 km

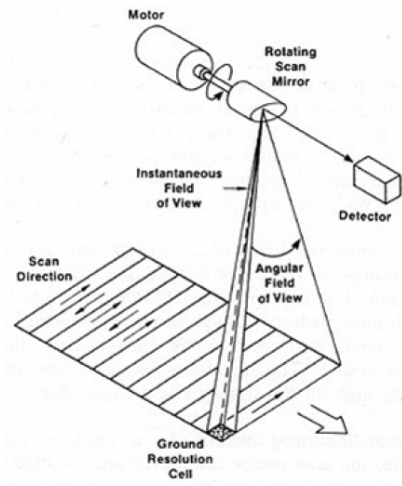
Number of fibers	35
FOV Across track	51°
Swath width	2860 m
FOV Along track	1.5°
Integration time	0.5 s
Aircraft speed	60 m/s
Ground pixel size	80x30 m ²
NO ₂ fitting window	438-490 nm

Schönhardt et al., 2015

SWING on Cessna (Flying at 3 km alt)



Merlaud et al., 2013



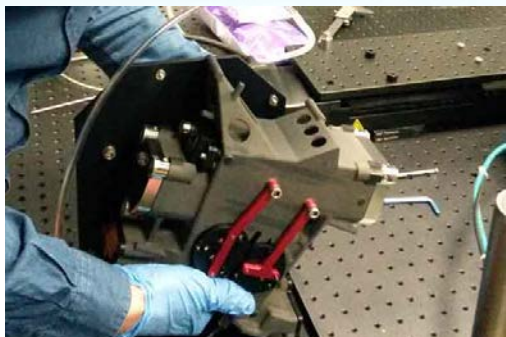
Whiskbroom Set-up



SWING Characteristics at 3 km

SWING Characteristics at 3 km	
FOV	50° (100° max)
Number of scanner position	9
IFOV	6°
Integration time	0.4s
Ground pixel size	300m (ellipse)
Volume	33 x 12 x 8 cm ³
Mass	1.2 kg
Power Consumption	10 W
NO ₂ fitting window	425-500 nm

Spectrolite on Cessna (Flying at 3 km alt)



Spectrolite Characteristics

FOV	8.3°
across track viewing directions	74
integration time	0.14 s
Ground pixel size (unbinned)	8x6 m ²
Ground pixel size (binned)	200x6 m ²
Volume	20x20x40 cm ³
Mass	20 kg
Power consumption	30 W
NO ₂ fitting window	425-455 nm

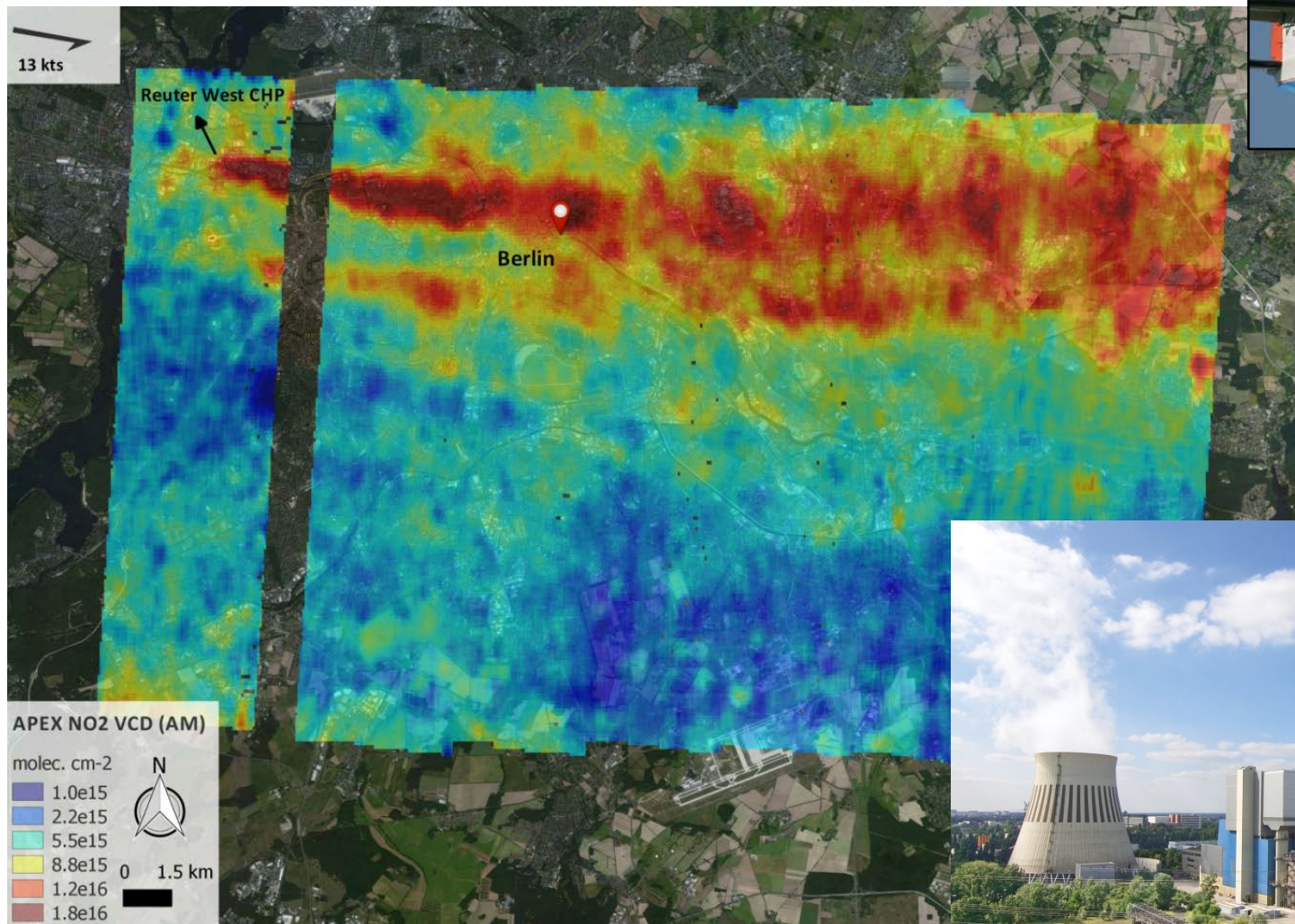
AROMAPEX Golden day: 21 April 2016

2 Double flights (Dornier, Cessna) 7-10 UT 12-15 UT

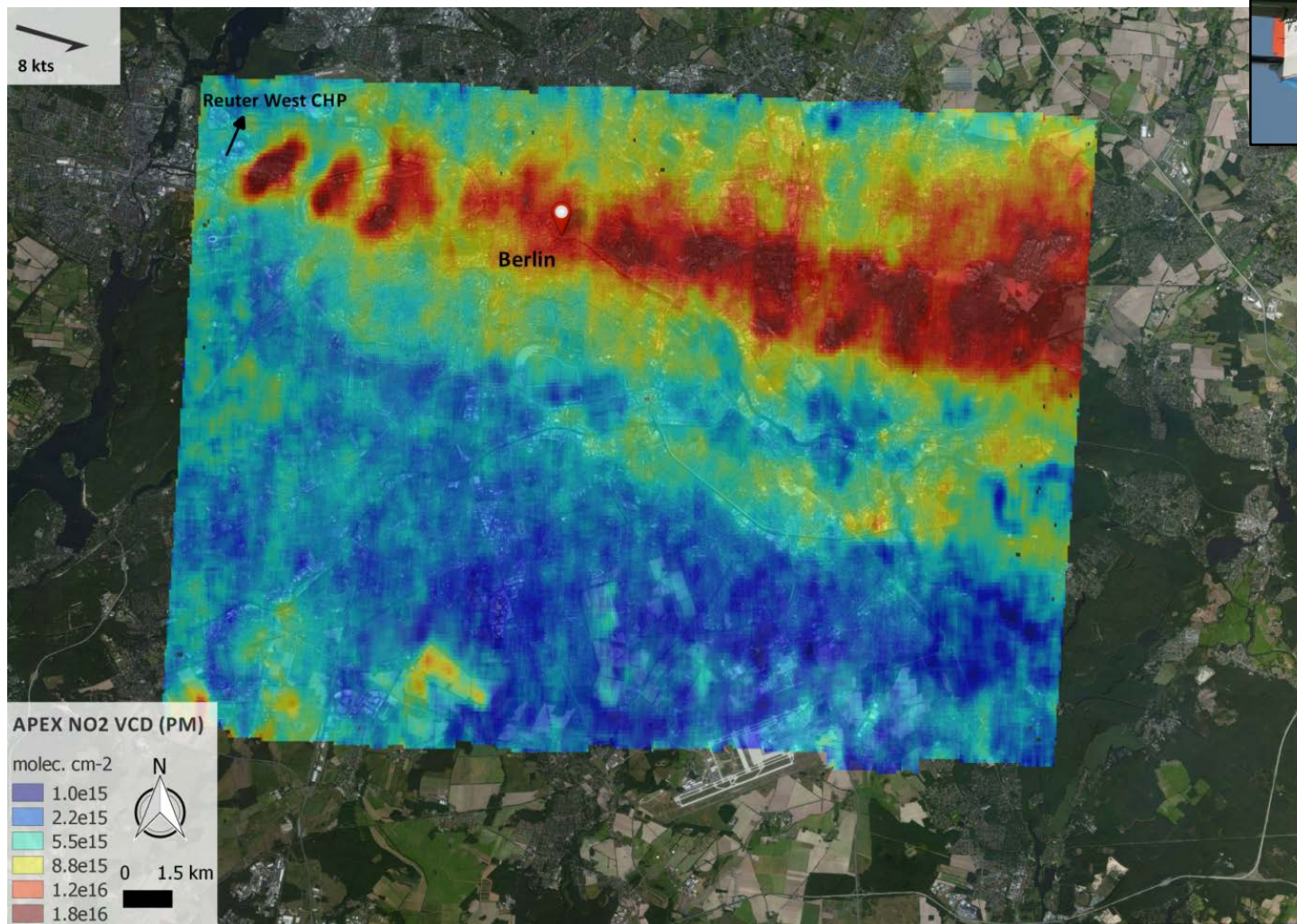
On the ground: 3 Mobile DOAS, and measurements at FUB
(Ceilometer, CIMEL, wind profiles,...)

(Picture by A. Meier)

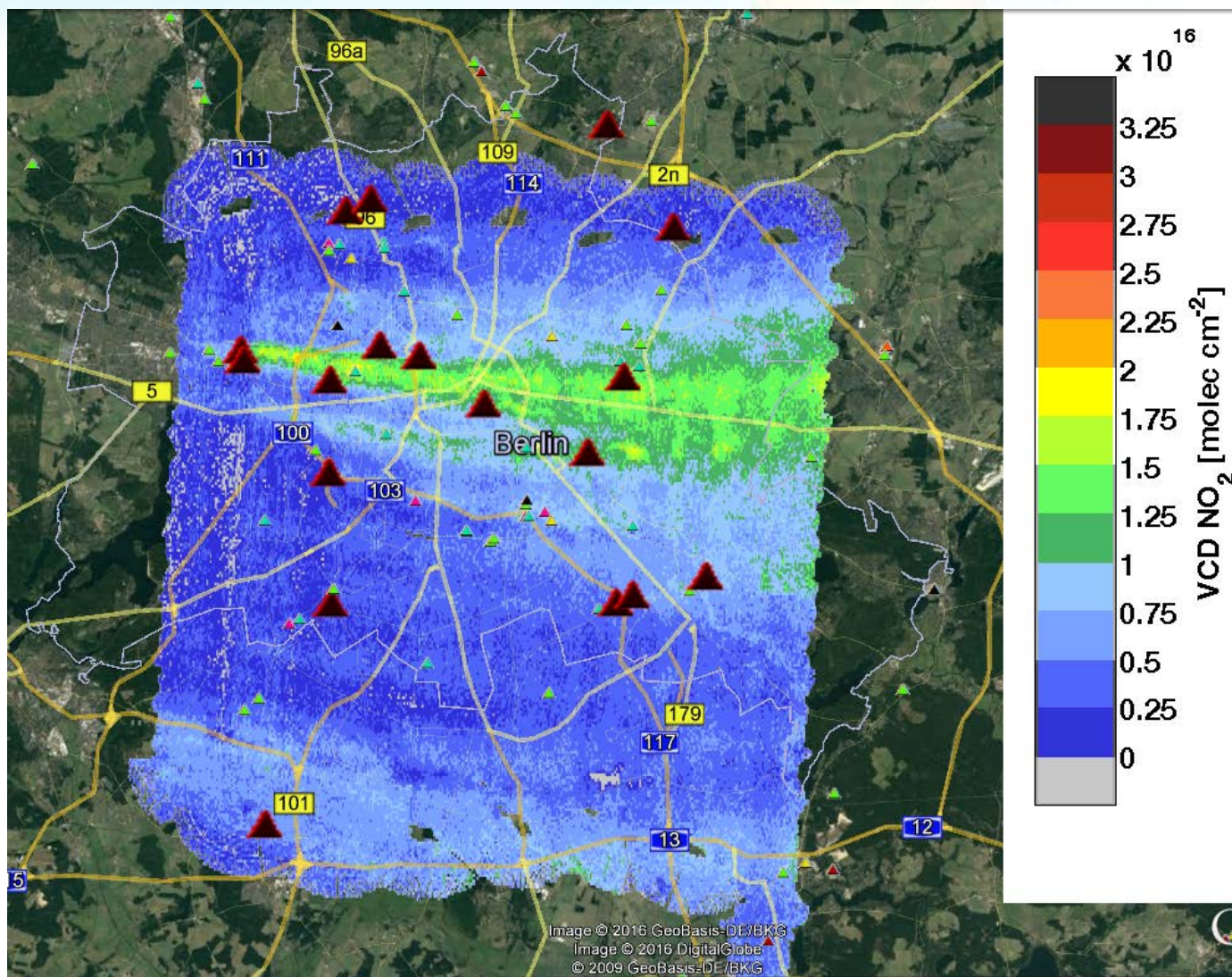
APEX (Morning Flight, 21 April 2016)



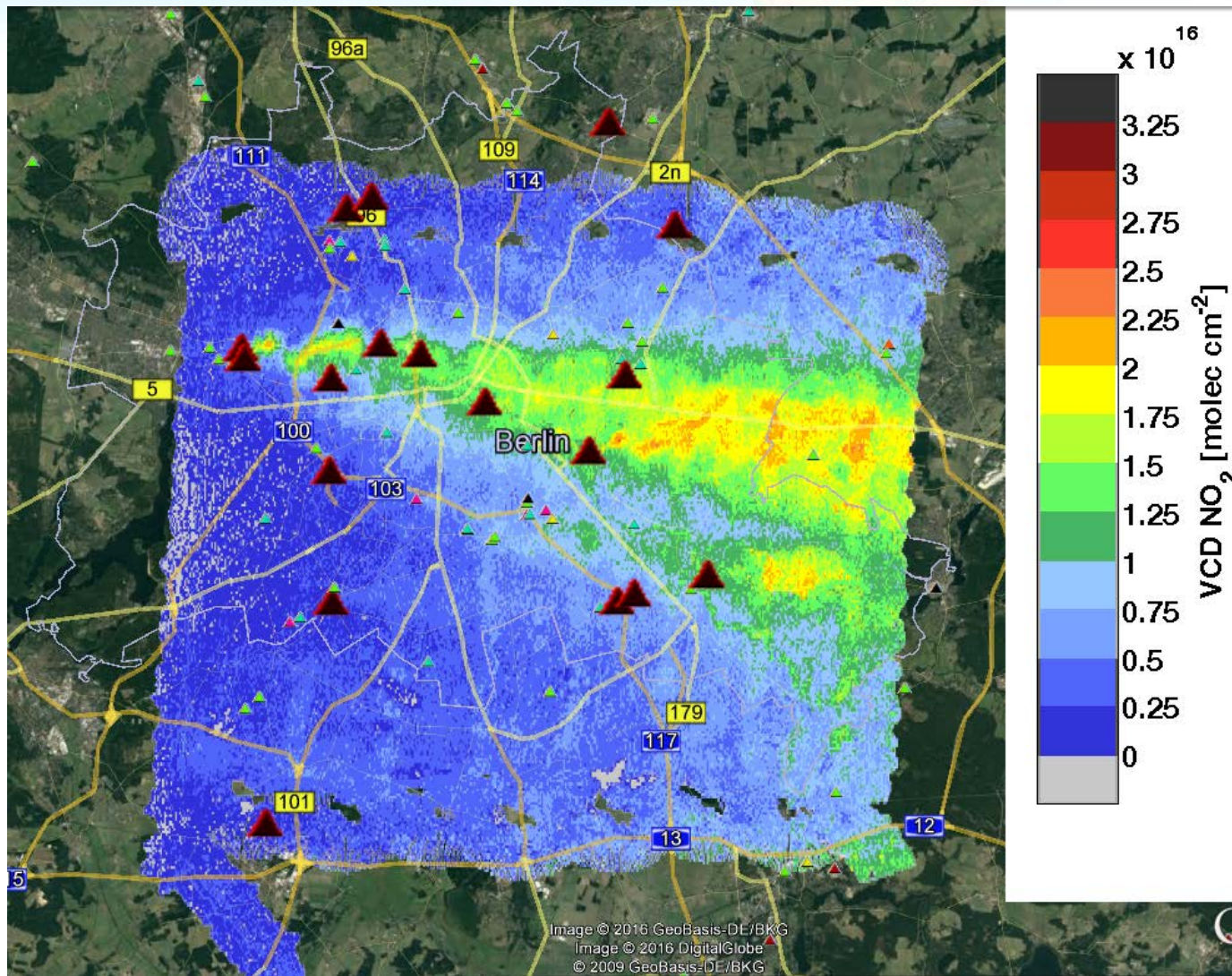
APEX (Afternoon Flight, 21 April 2016)



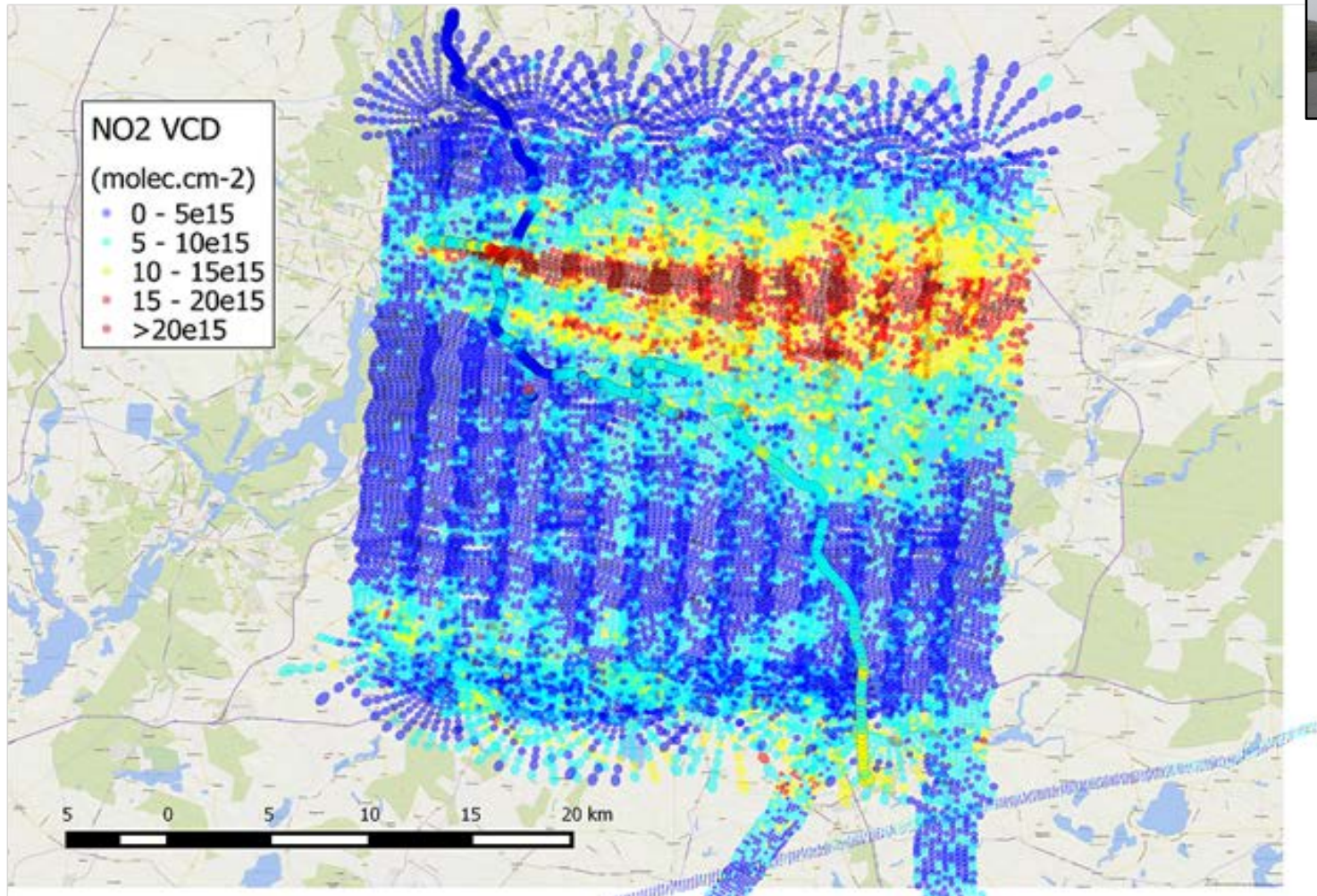
AirMap (Morning Flight, 21 April 2016)



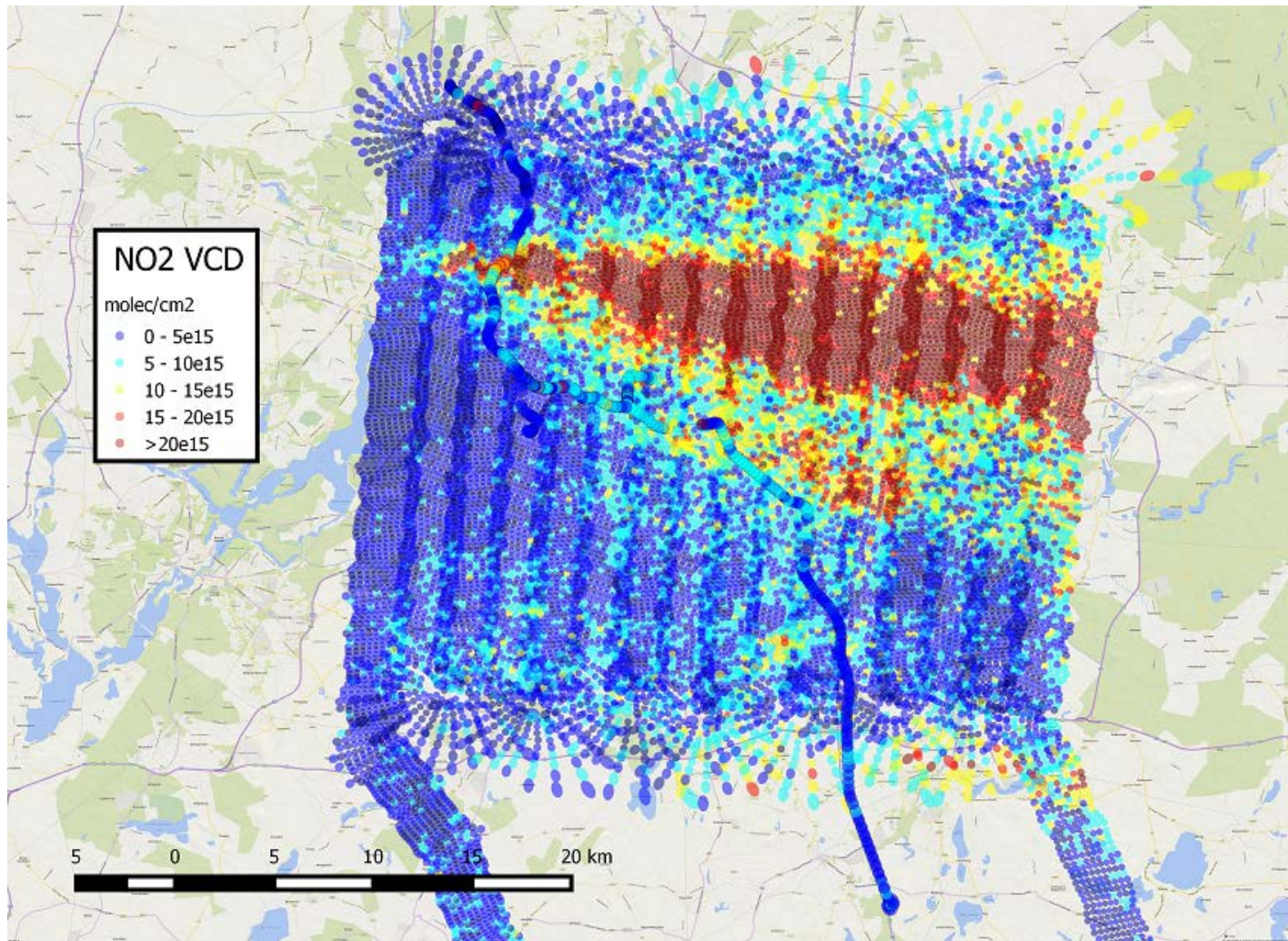
AirMap (Afternoon Flight, 21 April 2016)

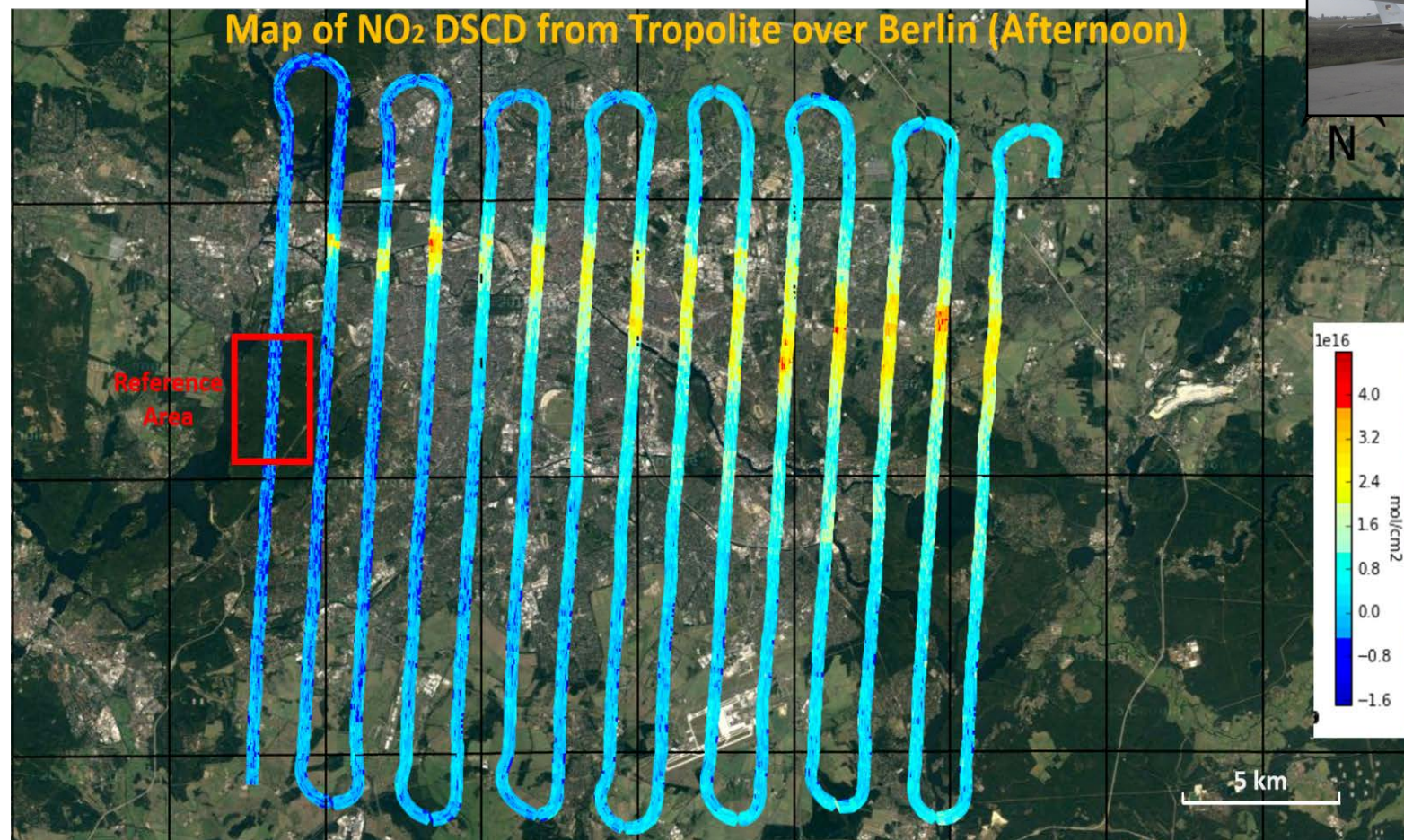


SWING (Morning Flight, 21 April 2016)

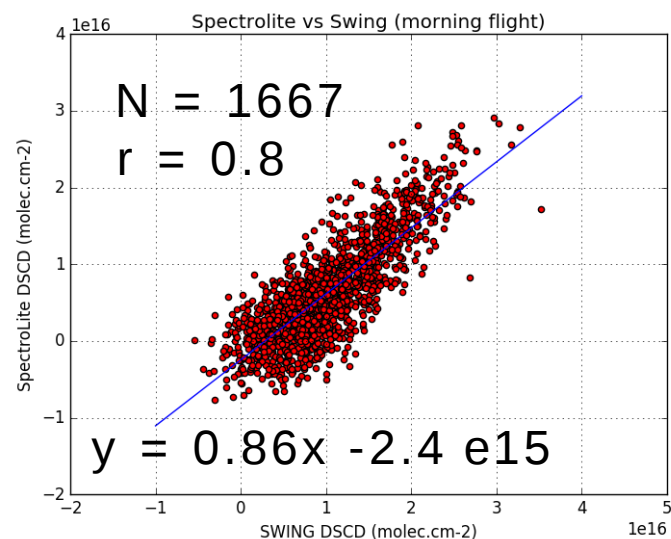
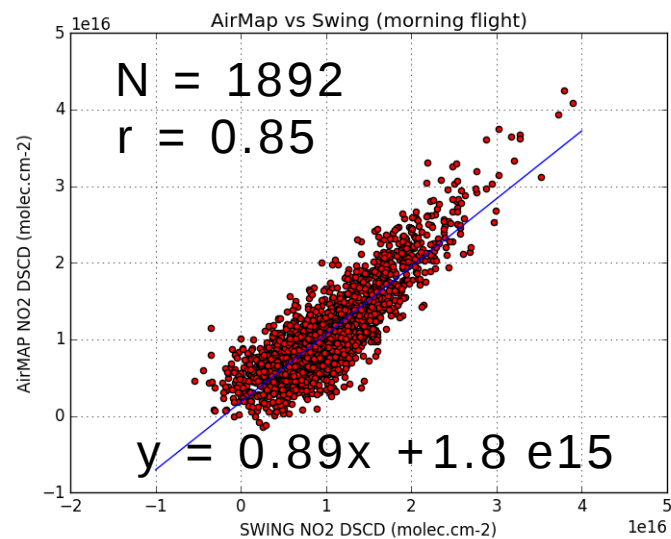
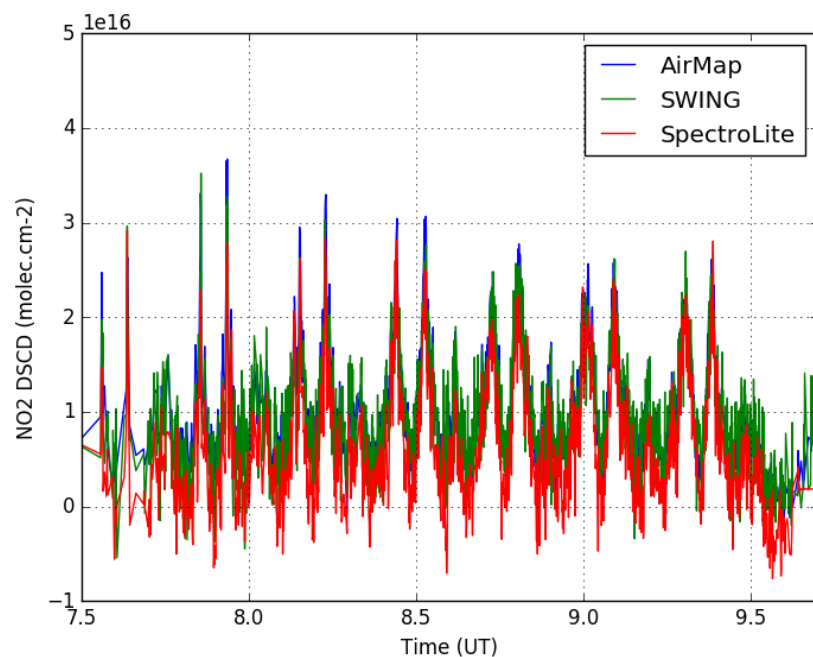


SWING (Morning Flight, 21 April 2016)

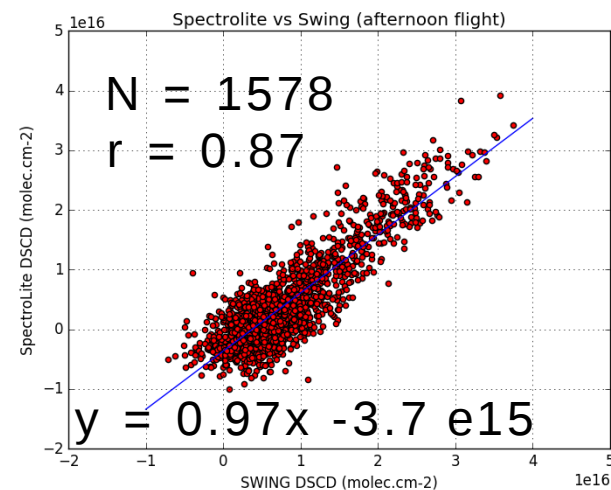
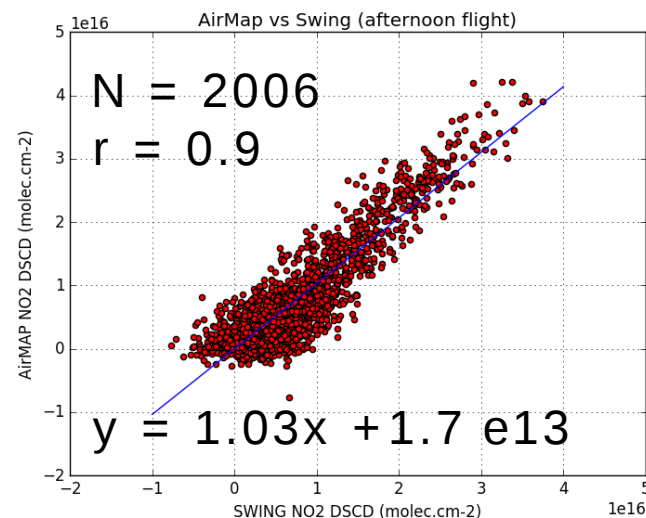
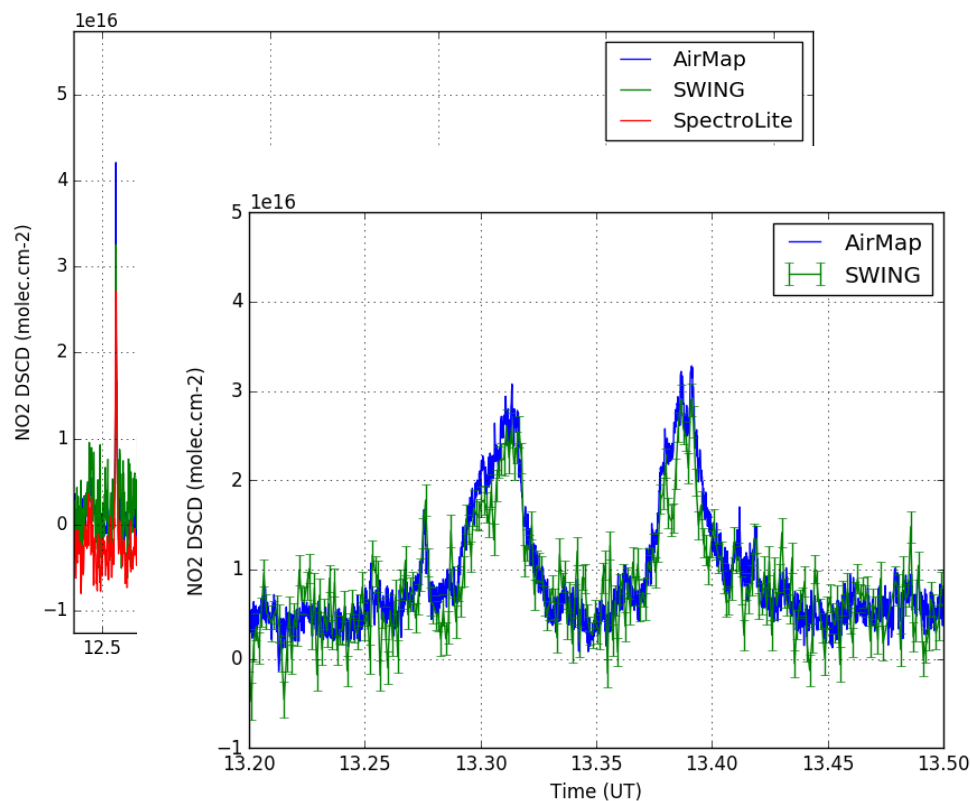




DSCD Comparison - Morning Flight

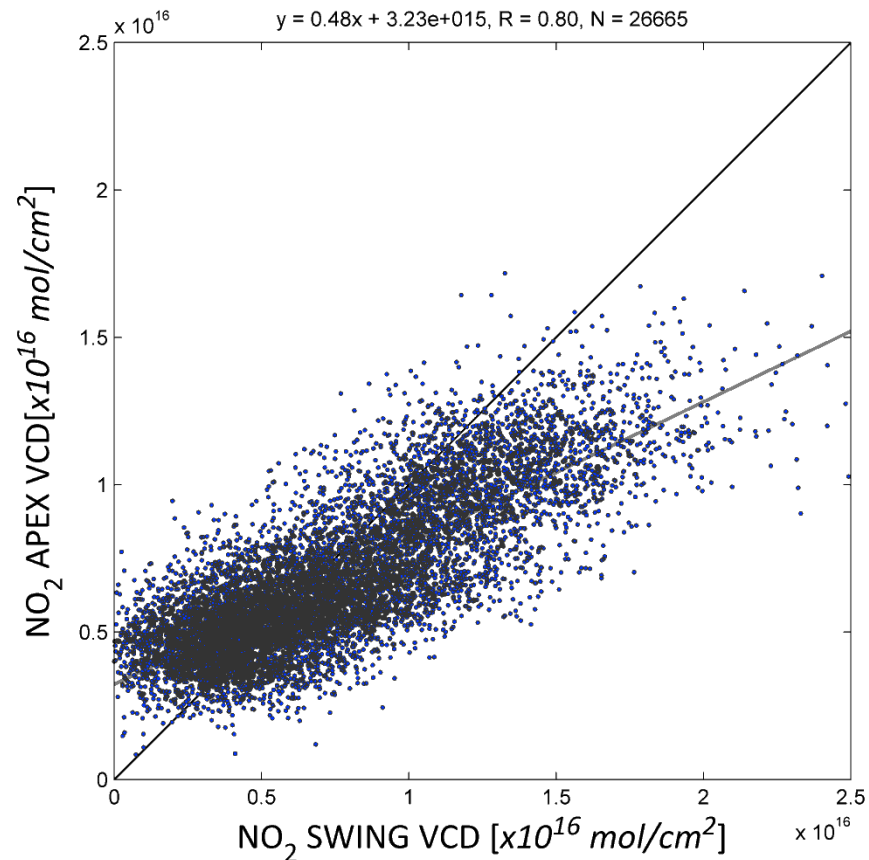
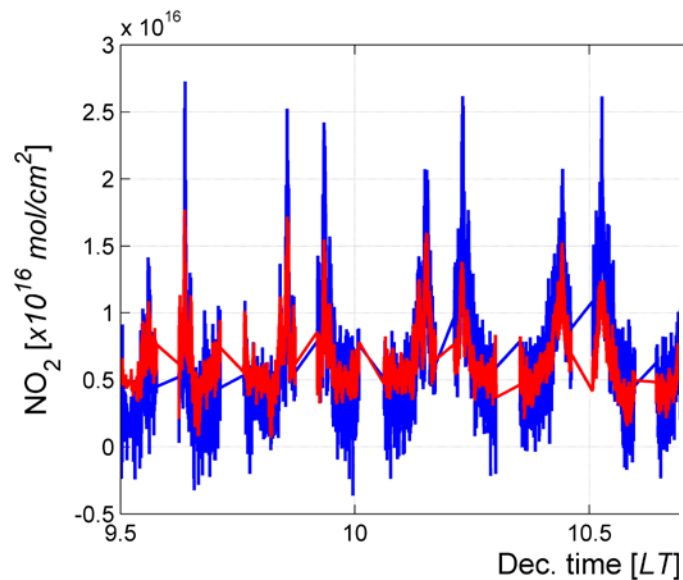


DSCD Comparison - Afternoon Flight



This figure is an aerial photograph of a forest area in Berlin, Germany. The image shows a dense canopy of trees, with a prominent dark, winding path or stream bed visible through the forest. The photograph is overlaid on a map showing surrounding areas, including Brandenburg and Berlin districts like Ahrensfelde and Zeuthen. The map also displays various roads and landmarks, such as the Havel river and the Westlicher Düppeler Forst.

First comparison of VCDs (SWING - APEX)





(Preliminary) Conclusions

- 4 airborne imagers: APEX, AirMAP, SWING, Spectrolite successfully operated during 2 double flights above Berlin on 21 April 2016
- NO₂ maps qualitatively consistent, showing a NO₂ field dominated by the exhaust plume of a power plant in NW Berlin
- The quantitative comparison is ongoing: DSCDs from the Cessna agree very well while first VCDs comparisons (APEX/SWING) have larger discrepancies but work in progress
- The airborne VCDs will be validated with simultaneous MobileDOAS and ground ancillary dataset (Cimel, Ceilometer,...)
- [For a future campaign] aerosol measurements above the city would be useful for the VCDs retrieval