Preliminary results from the AROMAT 2014 campaign

A. Merlaud & Aromat Team, DOAS seminars, 27 March 2015

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment
UNIVERSITAS GALATIENSIS
INOE 2000
MAX-PLANCK-INSTITUT FÜR CHEMIE
iup
INCAS
aeronomie.be
esa

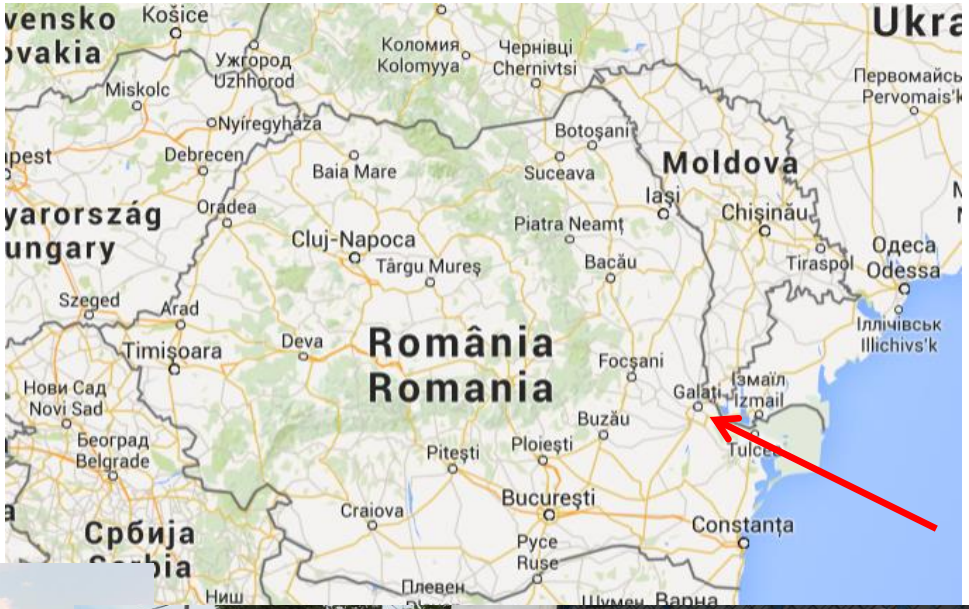
Outline

- Context
- Presentation of the campaign
- Preliminary results
- Preliminary conclusions and perspectives

Collaboration with the University of Galati since 2011

Development and tests of the SWING-UAV payload (BIRA), and of a flying wing UAV (Uni. Galati and Reev River Aerospace)

Mobile-DOAS studies: Constantin et al., Sensors, 2013, Dragomir et al. Atmos Pol Res, 2015



Hotspots near Galati

Galati Arcelor Mittal Steel factory

Slobozia Fertilizer factory

Romania recently entered in ESA (Dec. 2011)

ROMANIAN FLAG RAISED AT ESA

24 January 2012 The New Year sees the Romanian flag now flying at ESA sites alongside those of ESA's other Member States, after Romania officially became ESA's 19th Member State on 22 December.

The Agreement on Romania's accession to the ESA Convention was signed on 20 January 2011 in Bucharest, by Jean-Jacques Dordain, Director General of ESA, Teodor Baconschi, Romanian Minister of Foreign Affairs, and Marius-Ioan Piso, President and CEO of the Romanian Space Agency.

esa

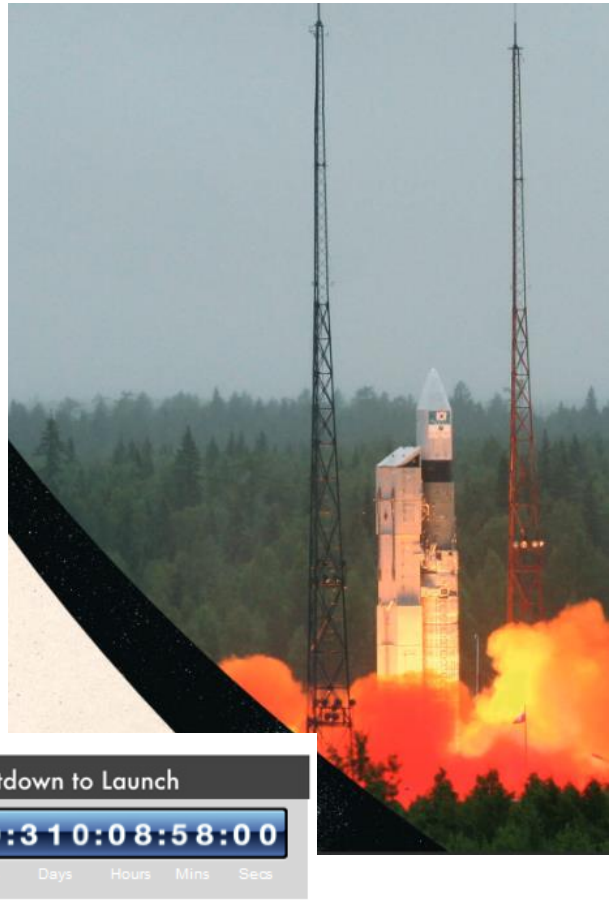
European Space Agency
Agence spatiale européenne

contribution

georeturn

Sentinel 5p mission

TROPOMI scheduled to be launched in 2016, on an Eurockot, from Plesetsk Cosmodrome



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AROMAT: Airborne Romanian Measurements of Aerosols and Trace gases

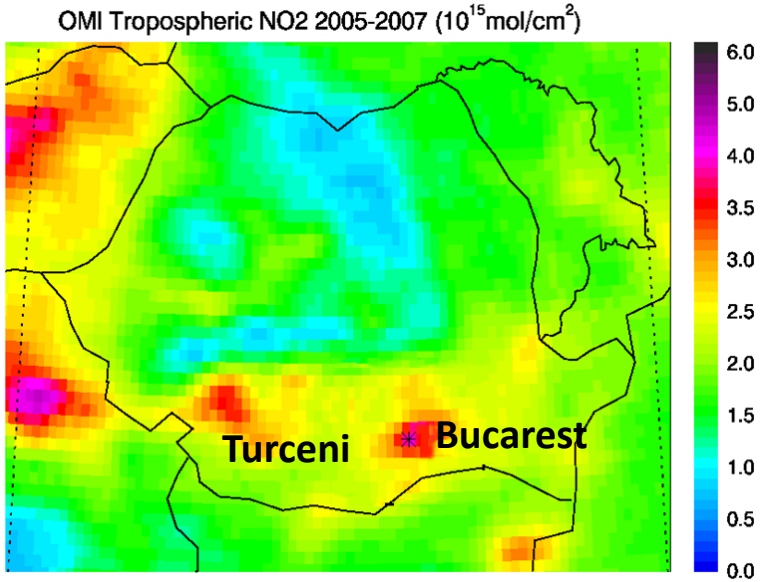
- ESA campaign coordinated by BIRA-IASB (Belgium), with participation of 7 other research institutions: Uni. Galati, INOE and INCAS (Romania), IUP-Bremen, Uni. Berlin, MPIC (Germany), and KNMI (The Netherlands)

- Aim: test newly developed airborne instruments for air quality research and prepare forthcoming intercomparison/S5P validation campaign(s) in Romania

- First week of September 2014 in Bucharest (largest city in Romania, with 2.2 million pop., heavy traffic)

- Second week in Turceni: small village on the countryside, with a very large power plant known to be a major source of NOx, SO_2 and aerosols

→ **Both spots visible on OMI data**



Instruments and platforms

Airborne:

- Uni. Berlin Cessna:
→ Sunphotometer and Microtops (Uni. Berlin)
→AirMap (IUP-Bremen)

- Weather balloons
→ NO_2 sonde (KNMI)

- INCAS UAV
→ Dust trak (INCAS)
→ Aerosol particle sizer (INOE)

- Uni. Galati UAV
→SWING (BIRA)
→NO_2 sonde (KNMI)

Mobile (car-based)

- Mini-MaxDOAS (MPIC)

- Zenith-only mobile DOAS (Uni. Galati, BIRA)

- Double channel mobile DOAS (BIRA)

- NO_2 sonde (KNMI)

NO_2 SO_2 aerosols

Static/Movable

- RADO observatory (Bucharest): lidars, in situ monitors, Aerosol Chemical Speciation Monitor, meteo. Station, PM 2.5, Aethalometer, CIMEL sun photometer (INOE)

- In situ monitor (Uni. Galati)

- In situ monitor, scanning lidar, ACSM (INOE)

Airborne Platforms in AROMAT-2014

INCAS UAV

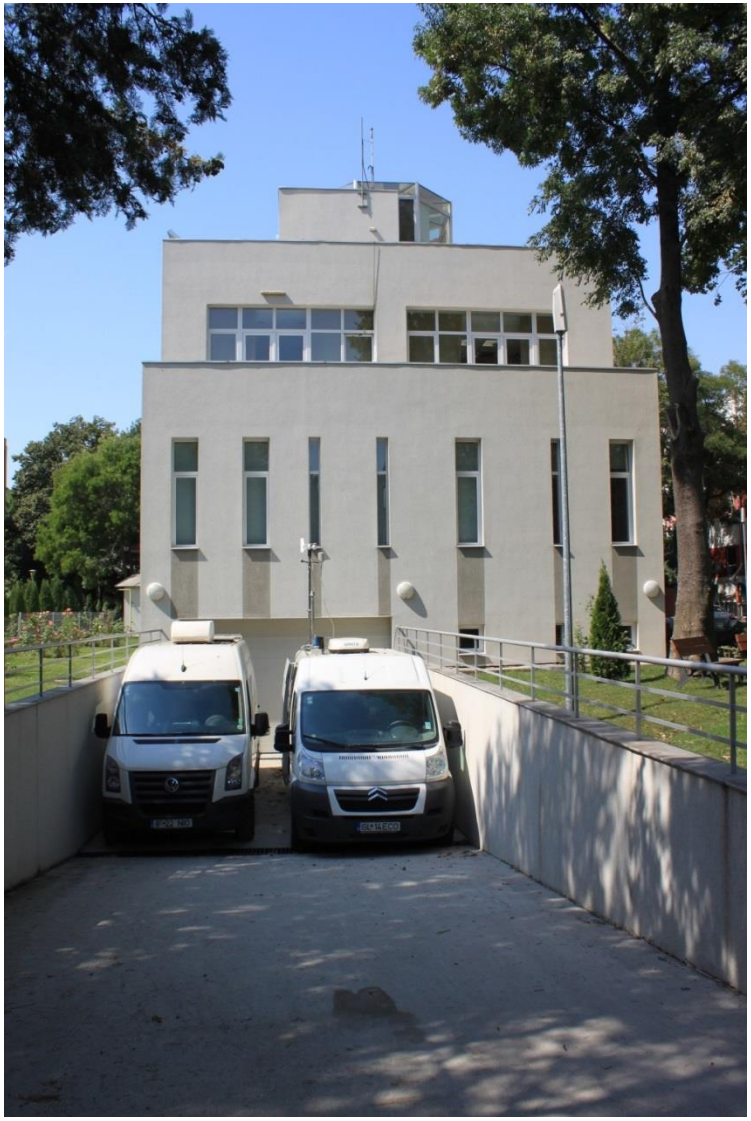
FUB Cessna

UGAL/RRA UAV

KNMI Weather balloon

Mobile Platforms in AROMAT-2014

Mobile DOAS (5 spectrometers),
MPIC. UGAL, BIRA



Mobile lab (INOE, UGAL)

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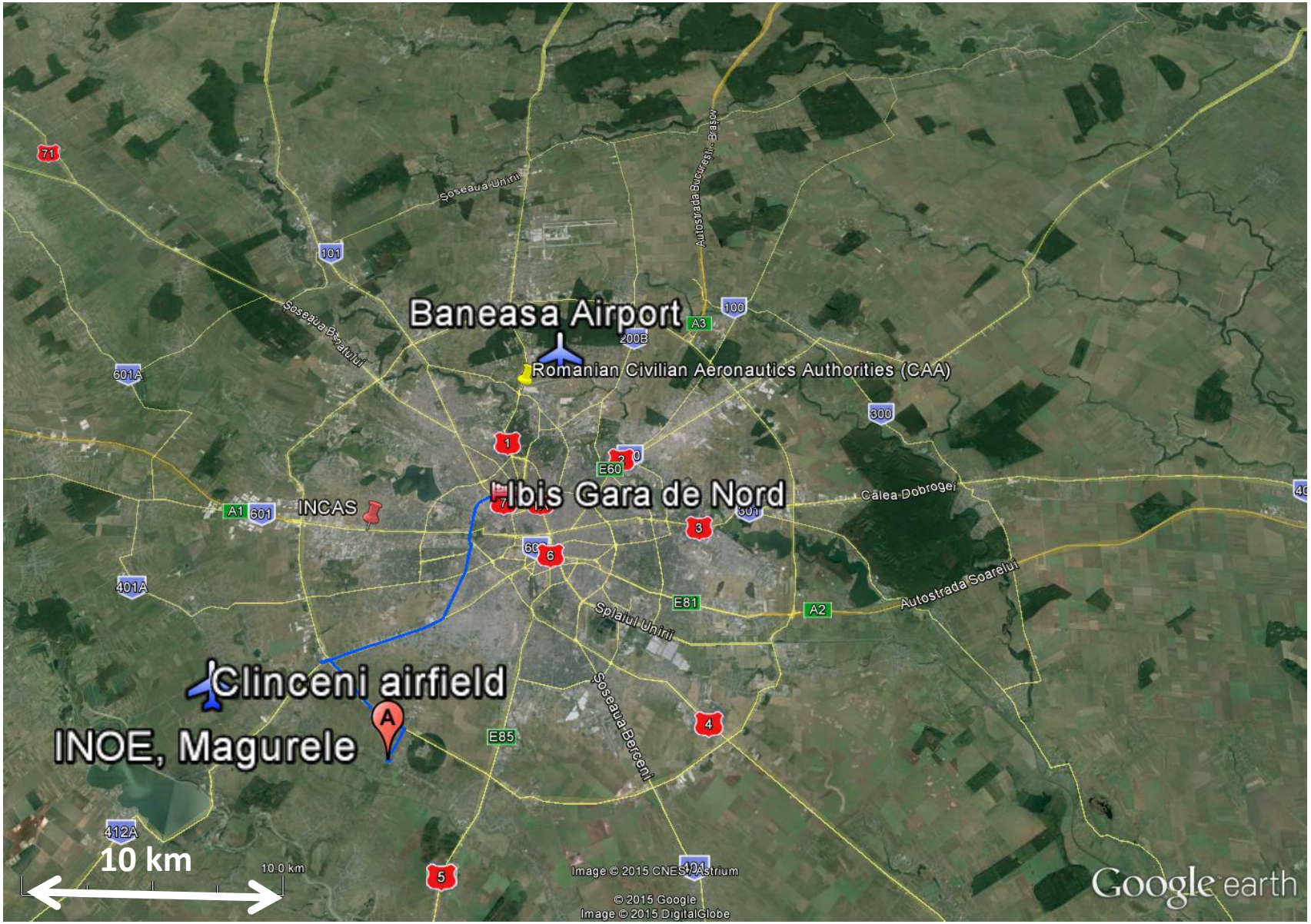
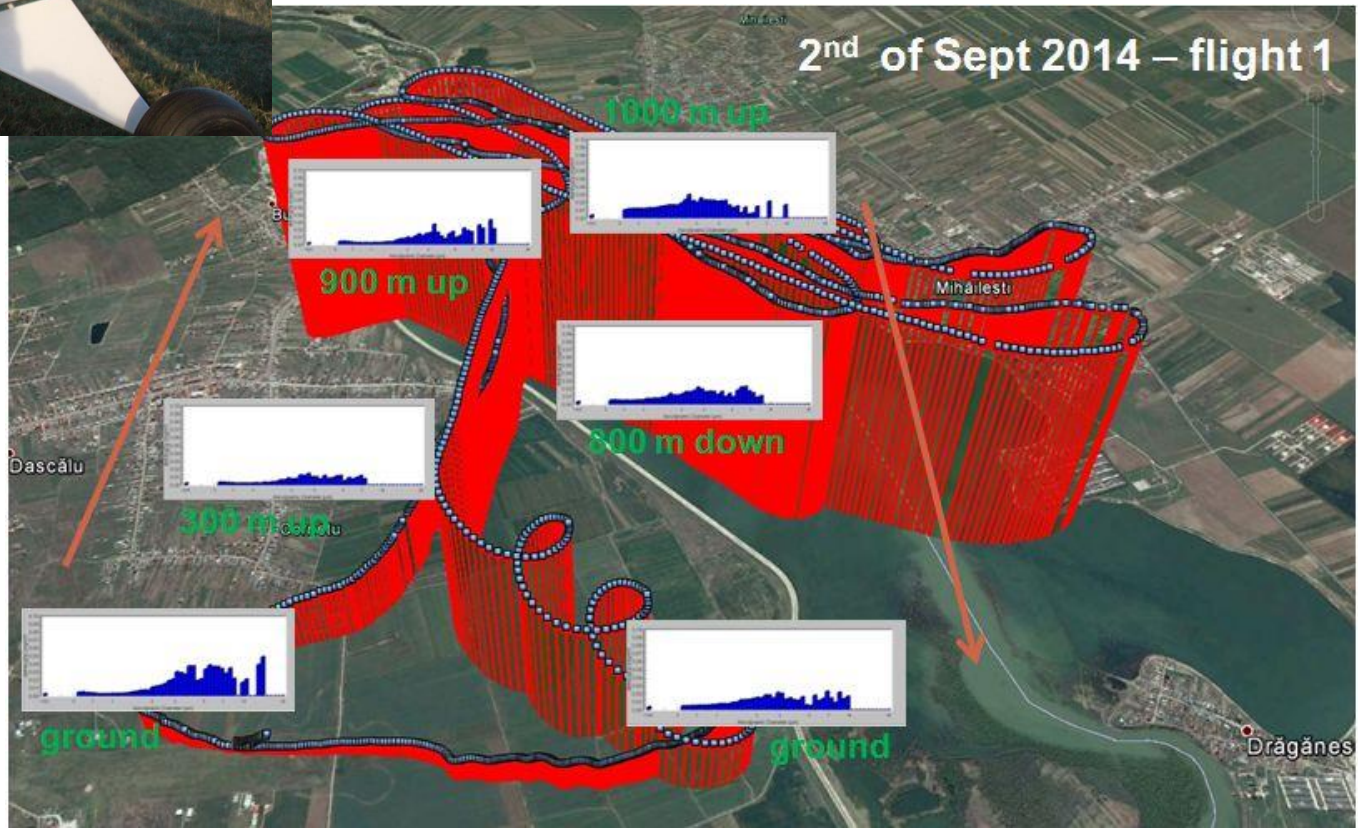
Bucharest


Baneasa Airport
Romanian Civilian Aeronautics Authorities (CAA)
Ibis Gara de Nord
INCAS
Clinceni airfield
INOE, Magurele
10 km
10.0 km
Soseaua Unirii
Autostrada Bucuresti - Brasov
Soseaua Bucuresti
Calea Dobrogei
Autostrada Soarelui
Splaiul Unirii
Soseaua Berceni
E60
E81
E85
A1
A2
A3
601A
401A
412A
Image © 2015 CNES / Astrium
© 2015 Google
Image © 2015 DigitalGlobe
Google earth

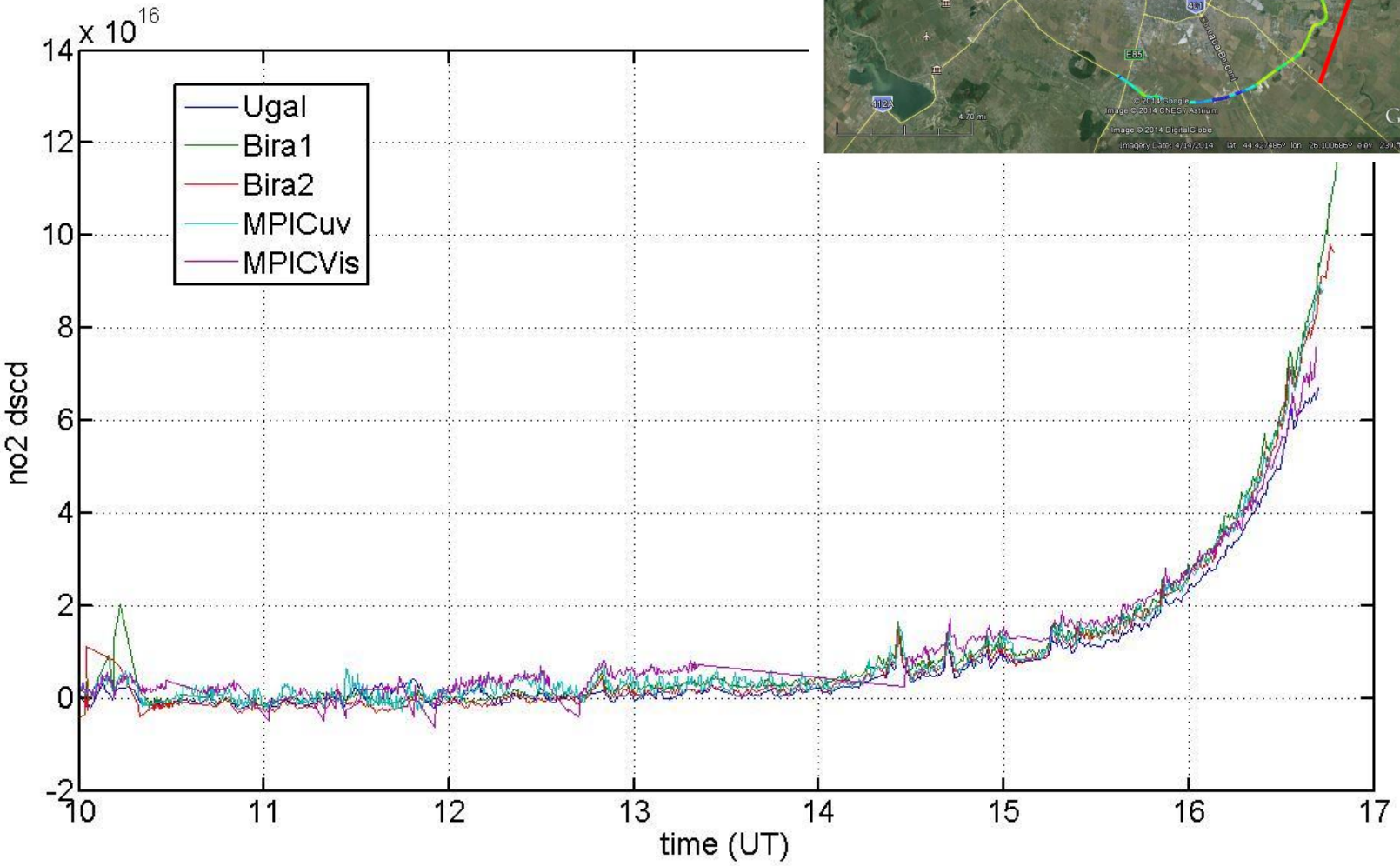
Bucharest: INOE APS on INCAS UAV

APS: Aerosol Particle Sizer

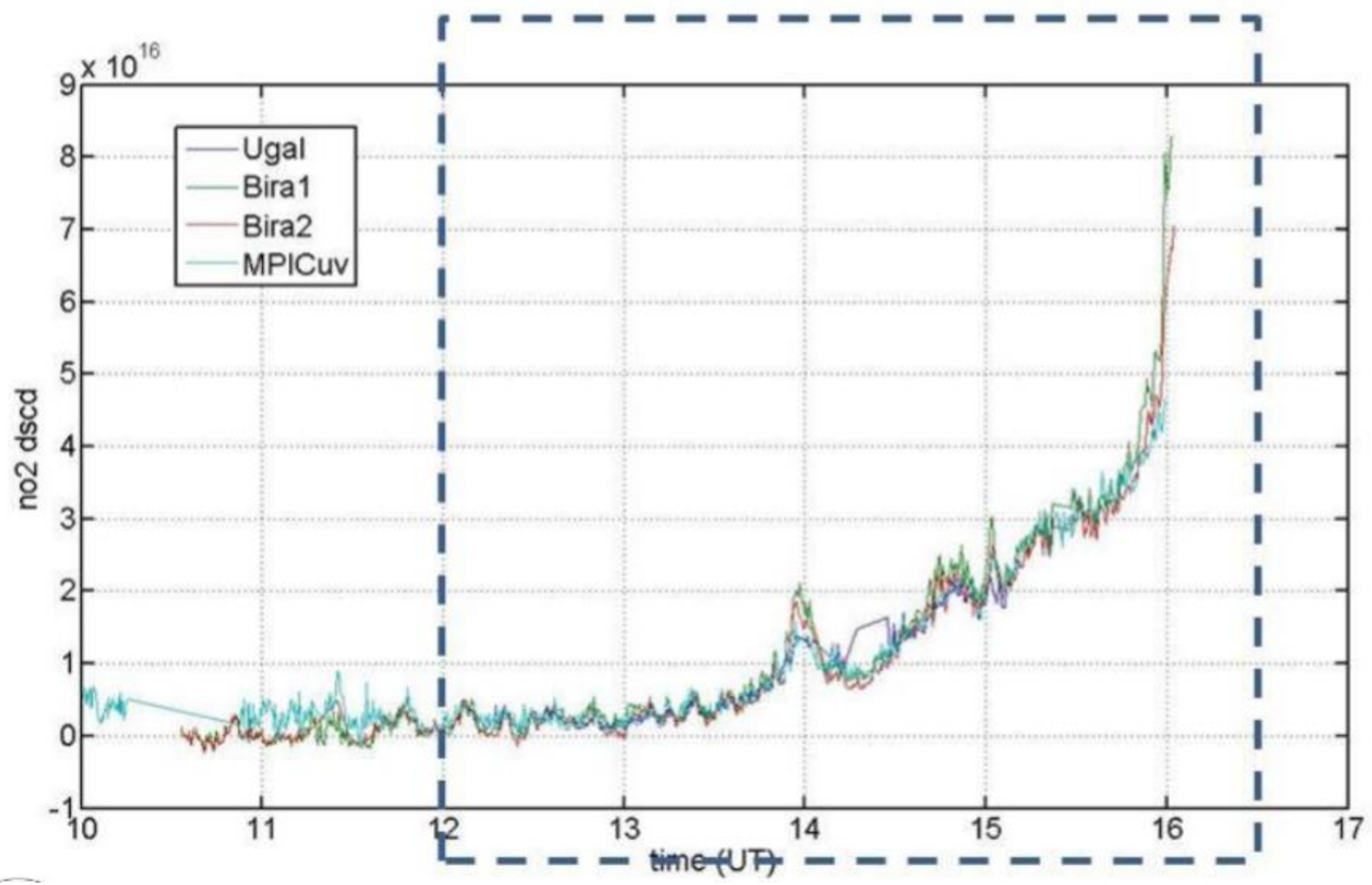


Bucharest: Mobile DOAS Intercomparison with MPIC and UGAL (Sept 2)

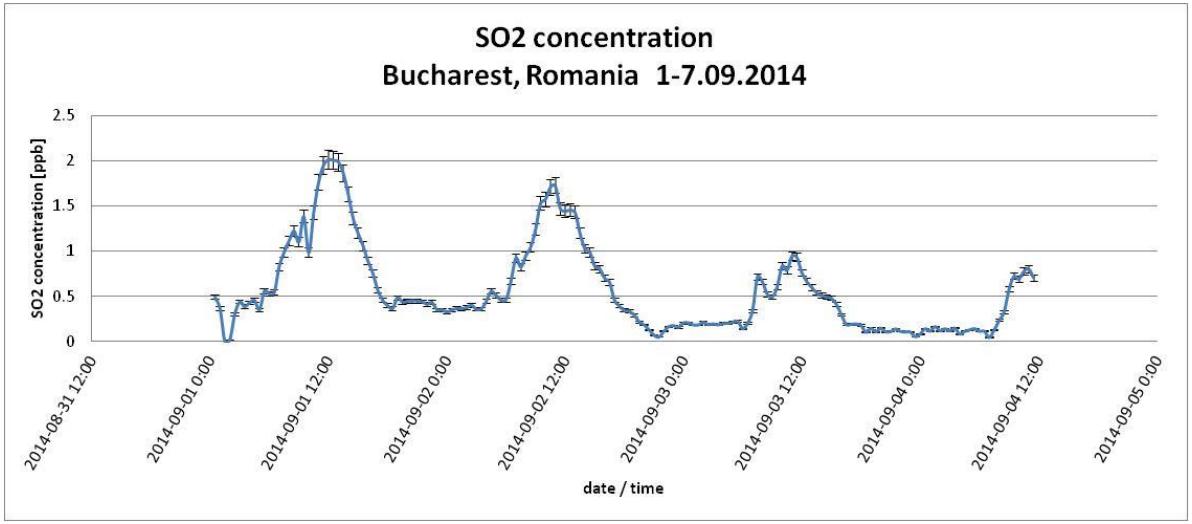
14.9 – 16.7 (ut)

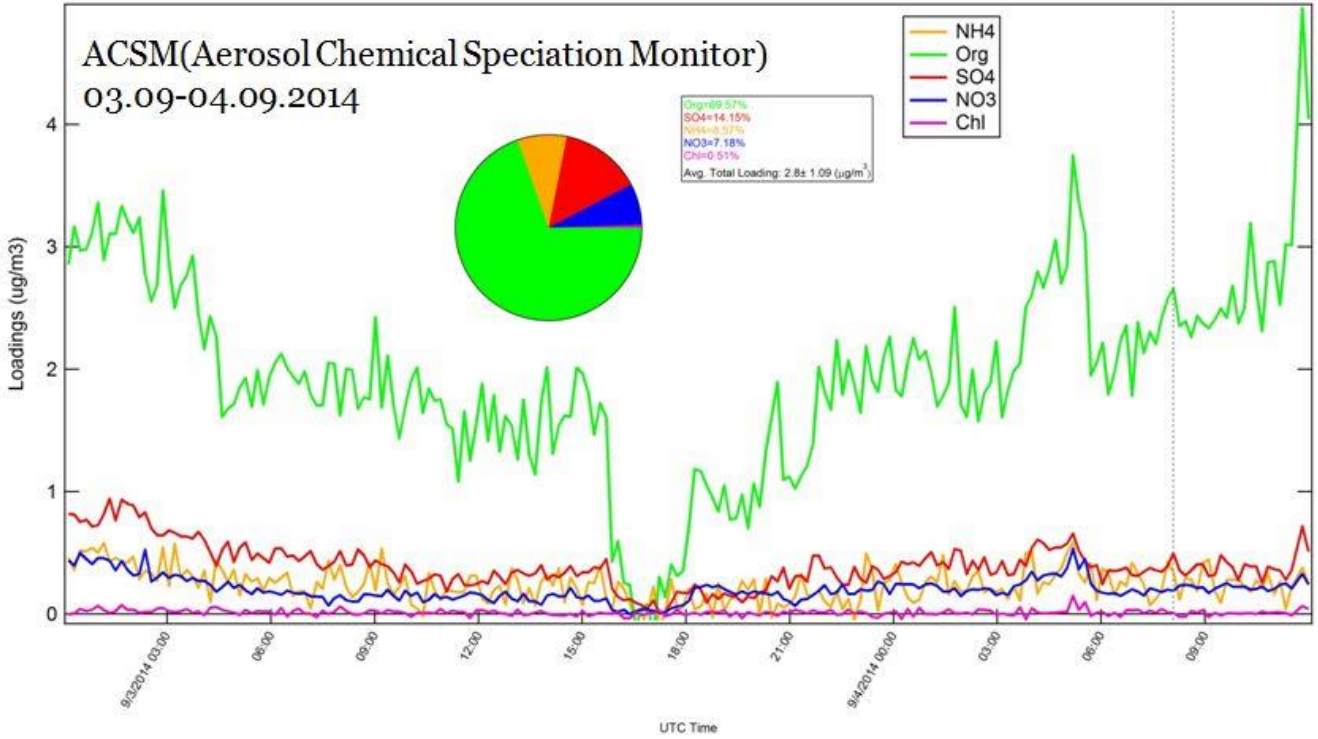


Bucharest: Mobile DOAS Intercomparison with MPIC and UGAL (Sept 3)



Bucharest: Measurements at RADO observatory (INOE)





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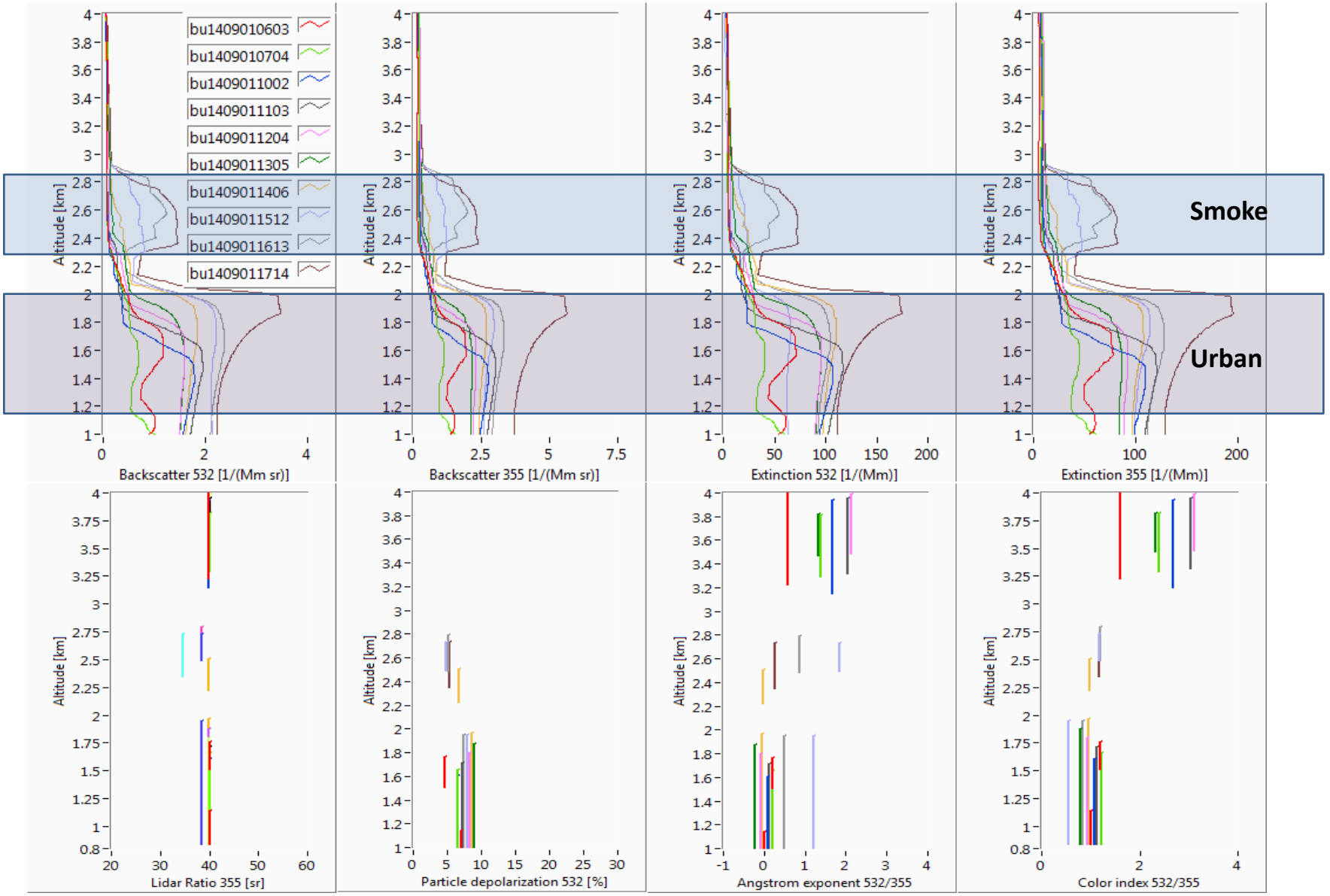


Magurele, 01 Sep. 2014 – one hour average

Bucharest: Coincident AirMAP and Mobile DOAS measurements (Sept 8)

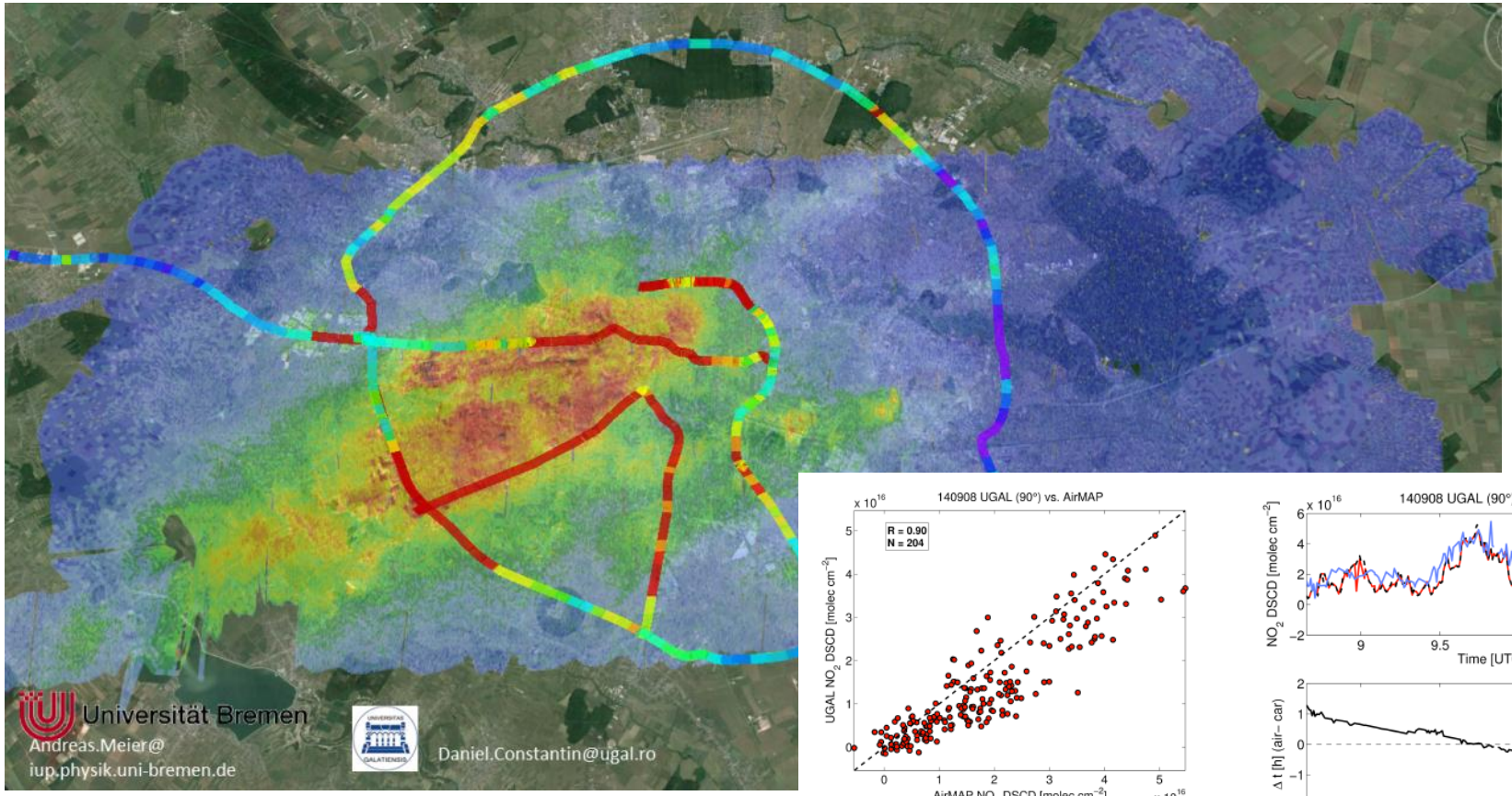


Fig 5a: Comparison between AirMAP and UGAL Car-DOAS NO_2 DSCDs:
Pixel-wise correlation plot of NO_2 differential slant column densities (DSCDs) of gridded datasets (0.001° x 0.001° ≈ 100 m^2) of co-located measurements of AirMAP pixels and car positions.

Fig 5b: Time series of the car-DOAS measurements. Additionally shown are the corresponding AirMAP measurements for the for car locations. The plot at the bottom shows the time difference between the measurements.

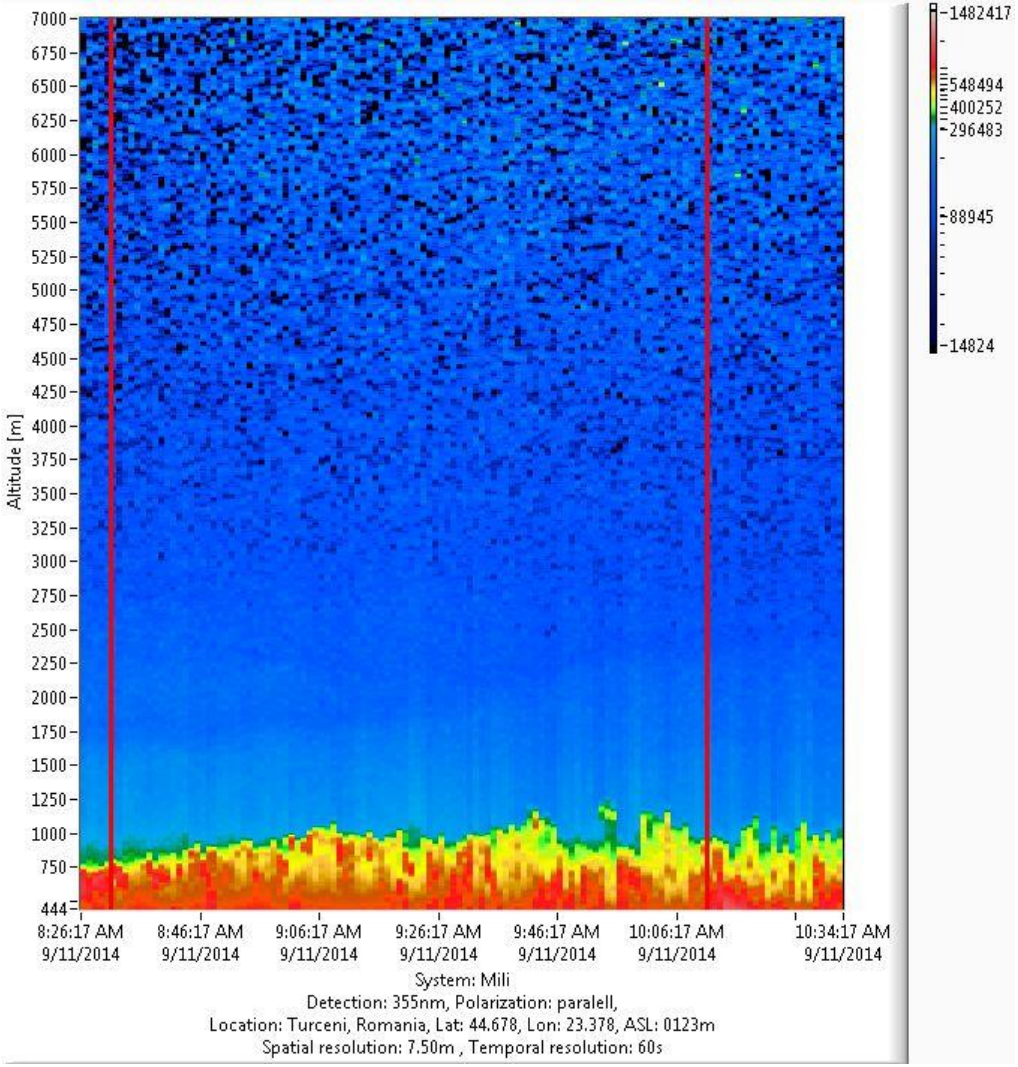
Andreas Meier, poster at the German Physical Society

Rovinari Power plant
Turceni Power plant
210 km
Baneasa Airport
INOE, Magurele
Işalnița 207340
E60
E574
E577
E771
A3
A1
E85
A2
E70
68 km
Image Landsat
© 2015 Google
Google earth

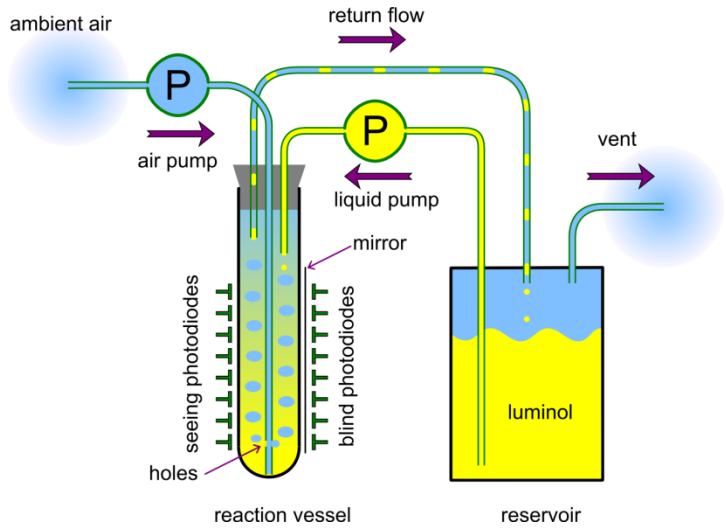
Hotel Turceni
restaurant
674
673
66
E79
UAV Turceni spot 1
UAV Turceni spot 3
Strada Balu
Strada Bravului
Strada Gării
Turceni Power plant
UAV Turceni spot 2
Strada Valea Cepiea
Strada Sfântul Nicolae
1 km
1050 m
Image © 2015 CNES / Astrium
© 2015 Google
Google earth

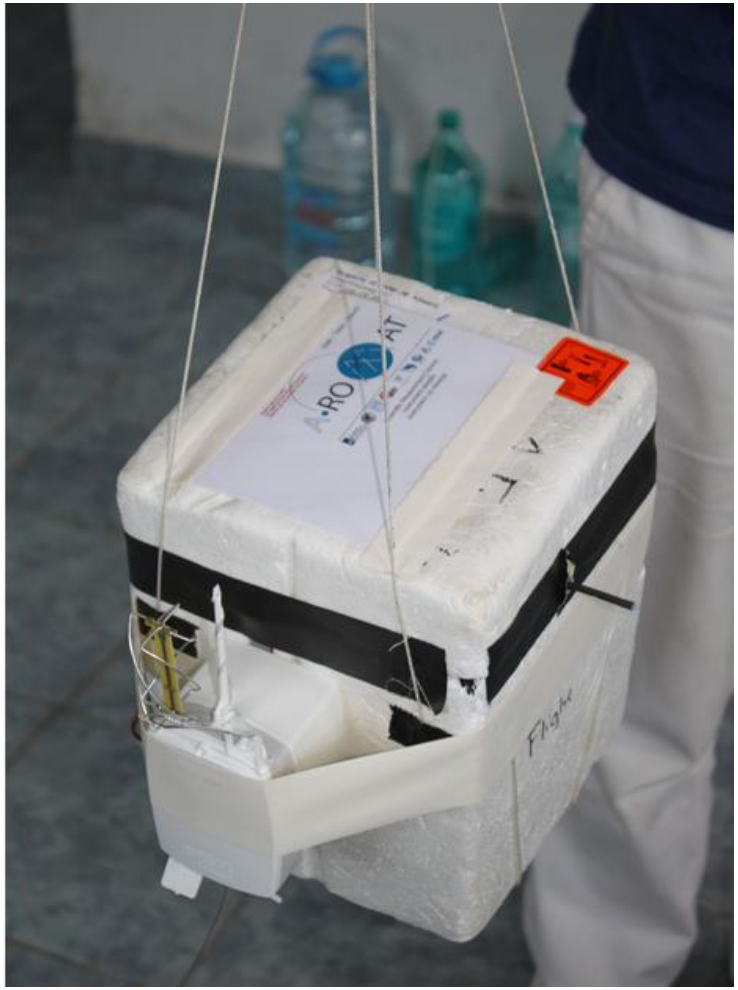
Turceni Power plant

Turceni: Lidar measurements

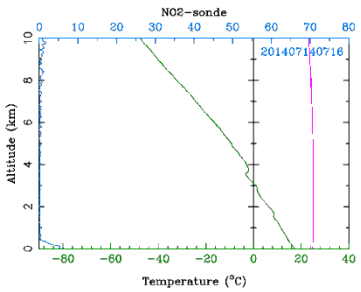


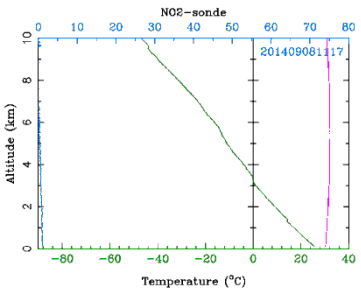
Turceni: NO_2 sonde measurements

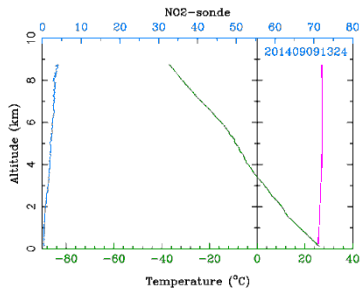


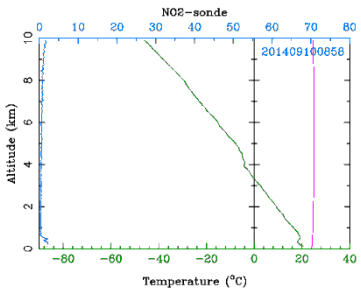


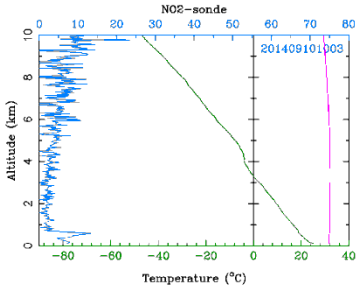
Turceni: NO_2 sonde measurements

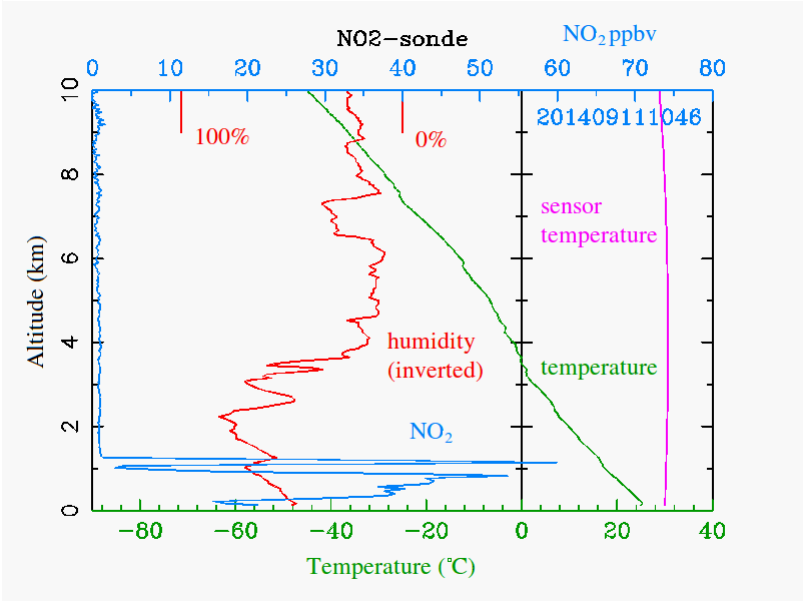


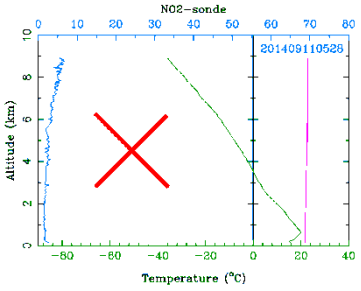


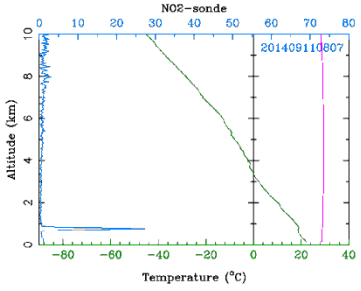




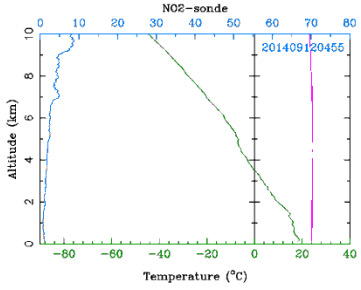


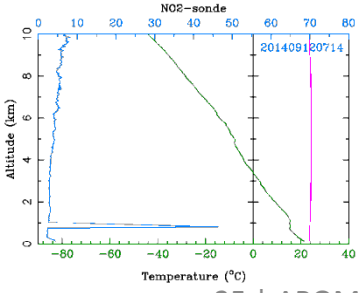


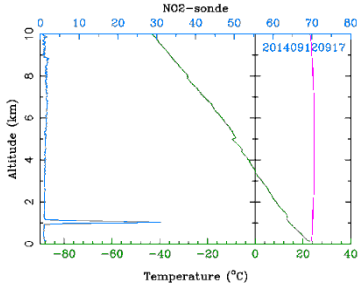


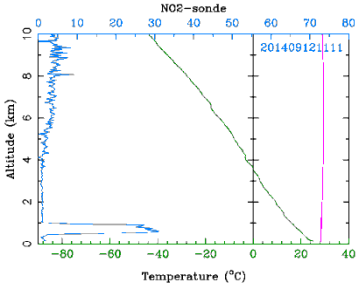


11 vertical NO_2 profiles, all flown from Turceni

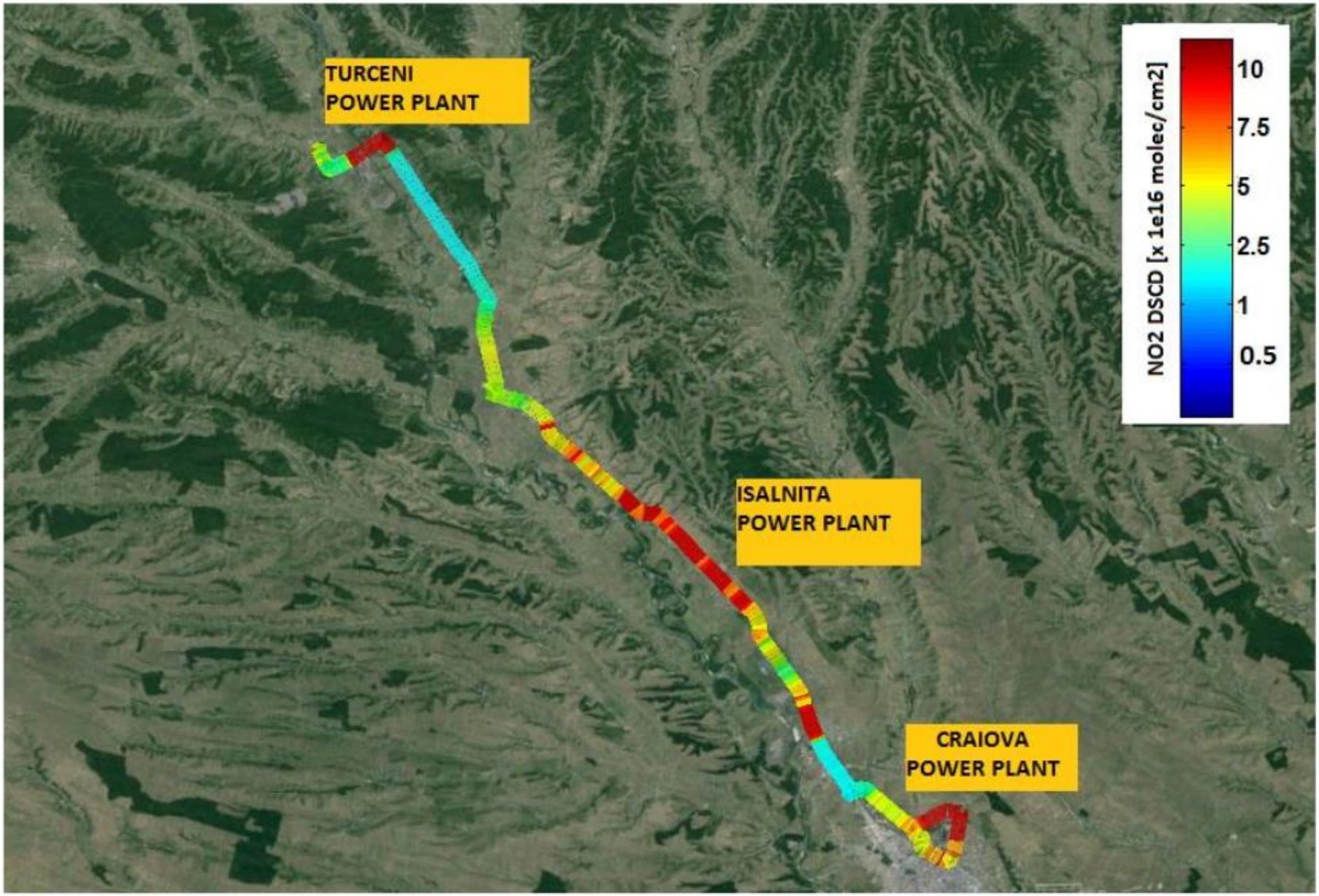








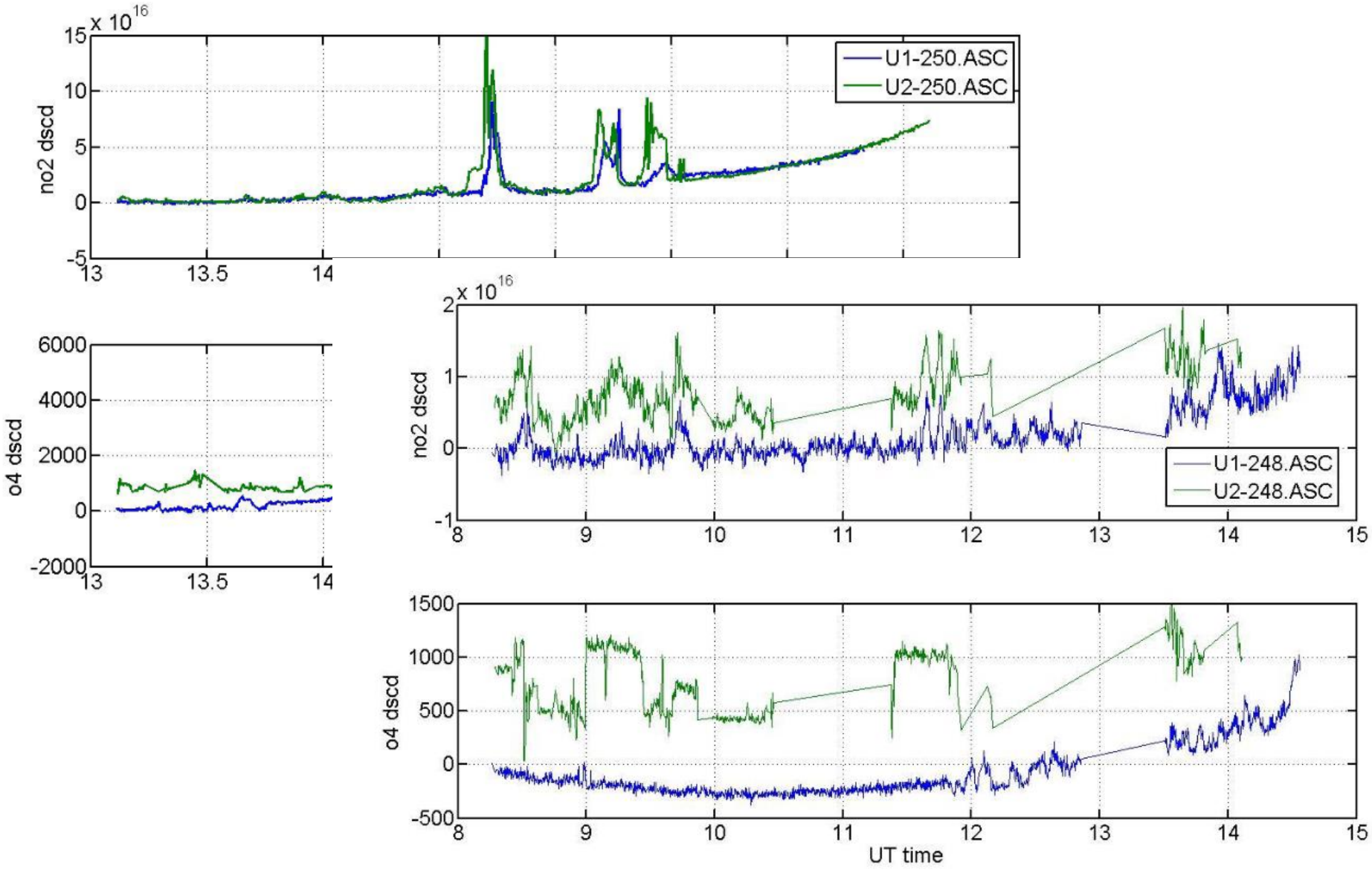
Mobile DOAS measurements around Turceni



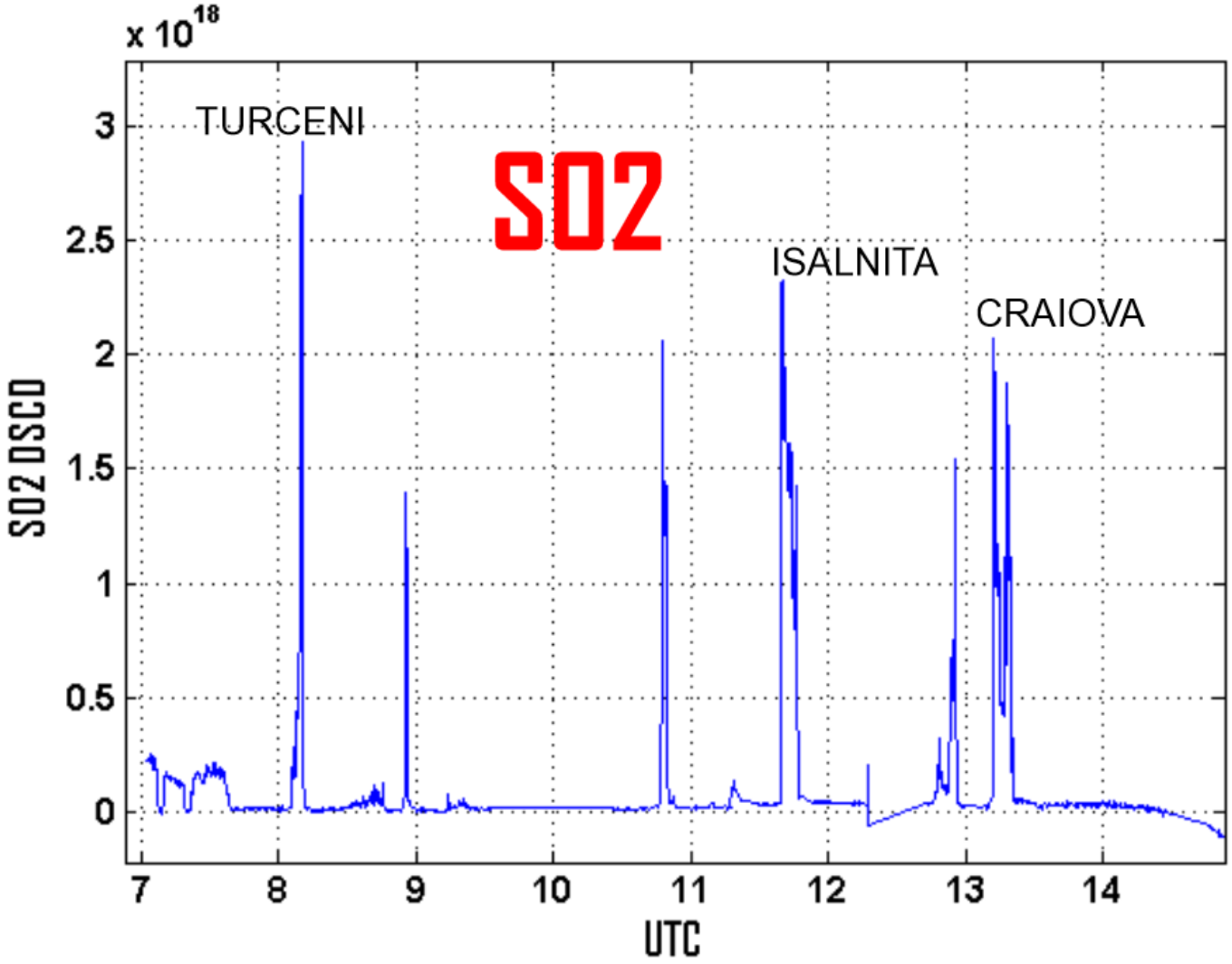
10 SEPTEMBER 2014 - COMPARISON WITH OMI (13.09)

OMI DETECT ~6e15 molec./cm2
While inside the pixel(13x24km2) mobile DOAS "see" 1e17 molec/cm2

Mobile DOAS measurements around Turceni

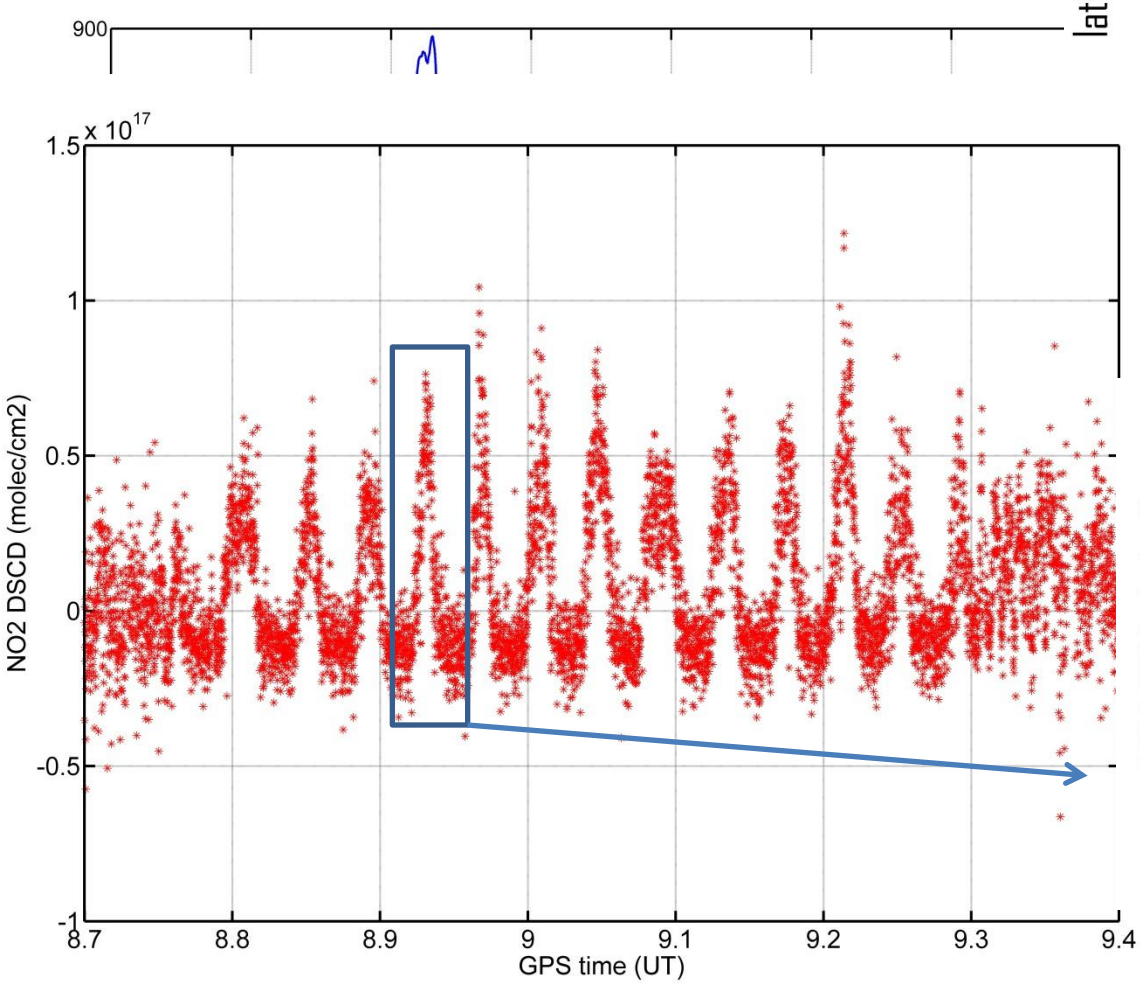


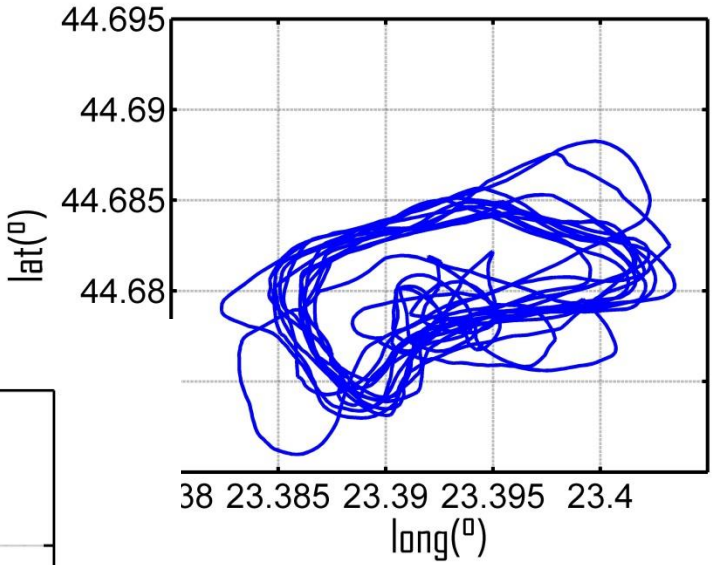
Mobile DOAS measurements around Turceni, SO2

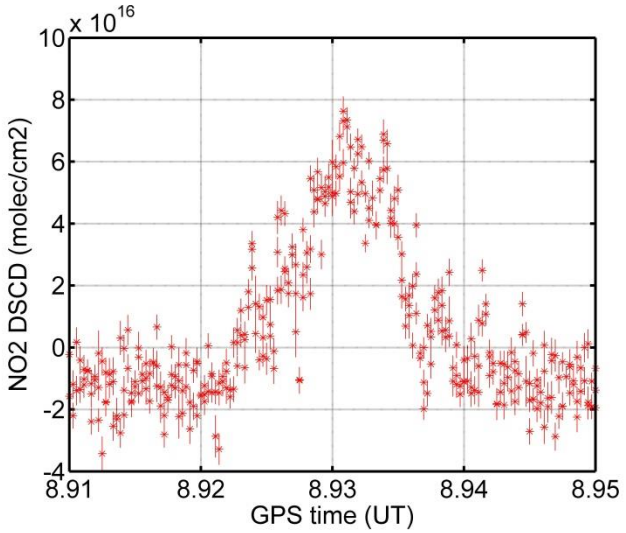


3. Preliminary results of AROMAT flights

Flight 2- Sept 11

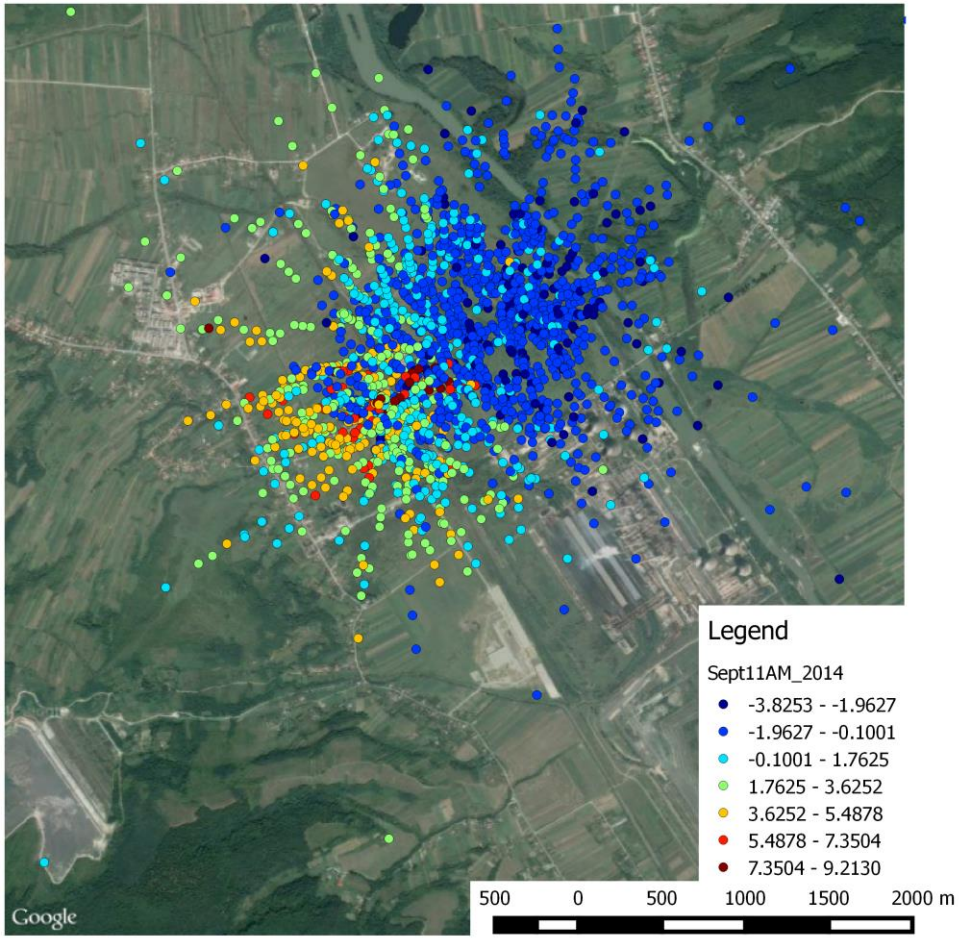


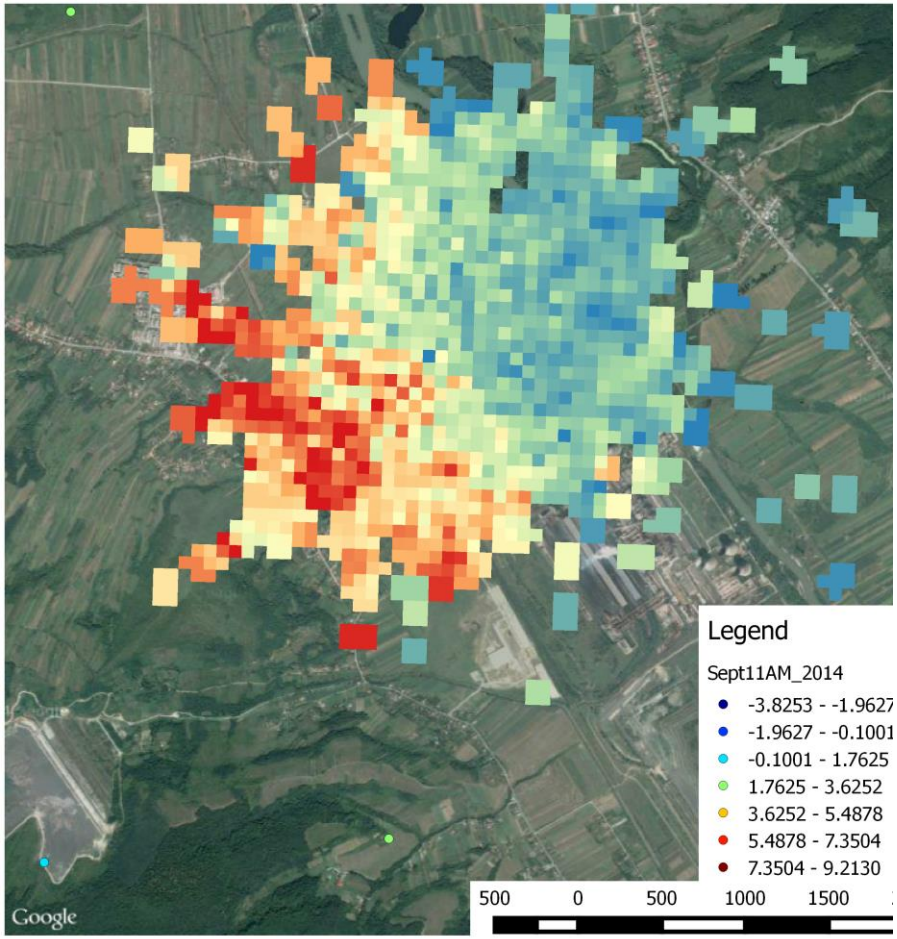




3. Preliminary results of AROMAT flights

Flight 2- Sept 11





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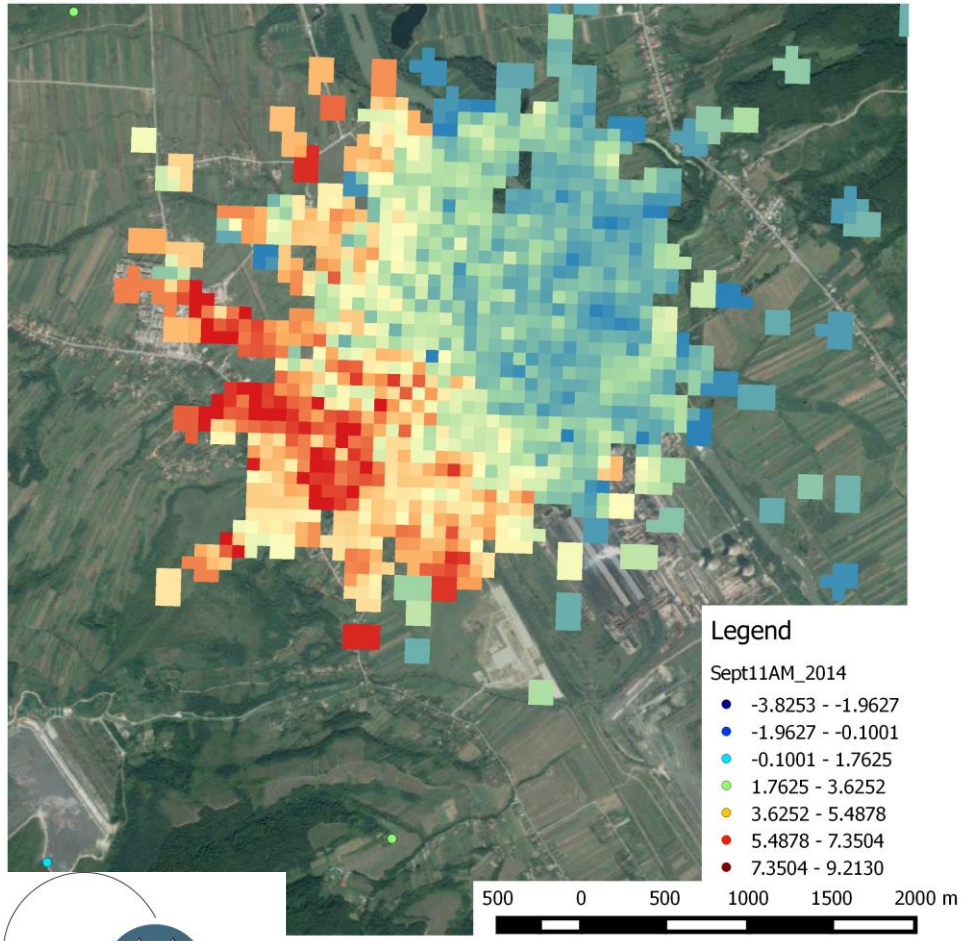
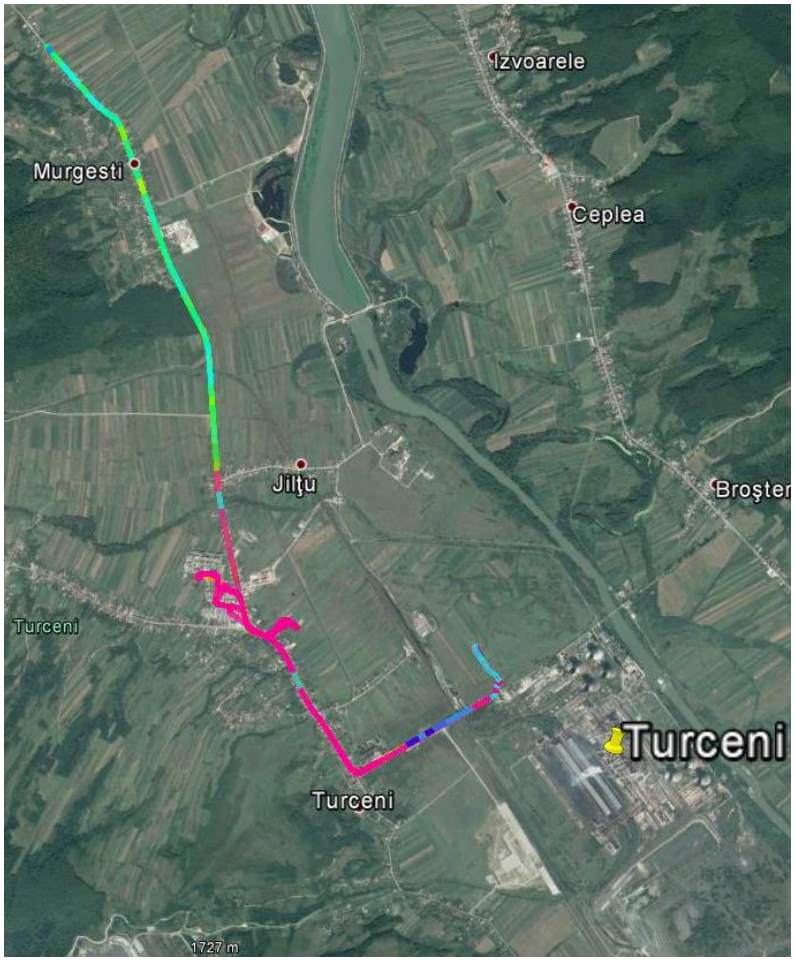
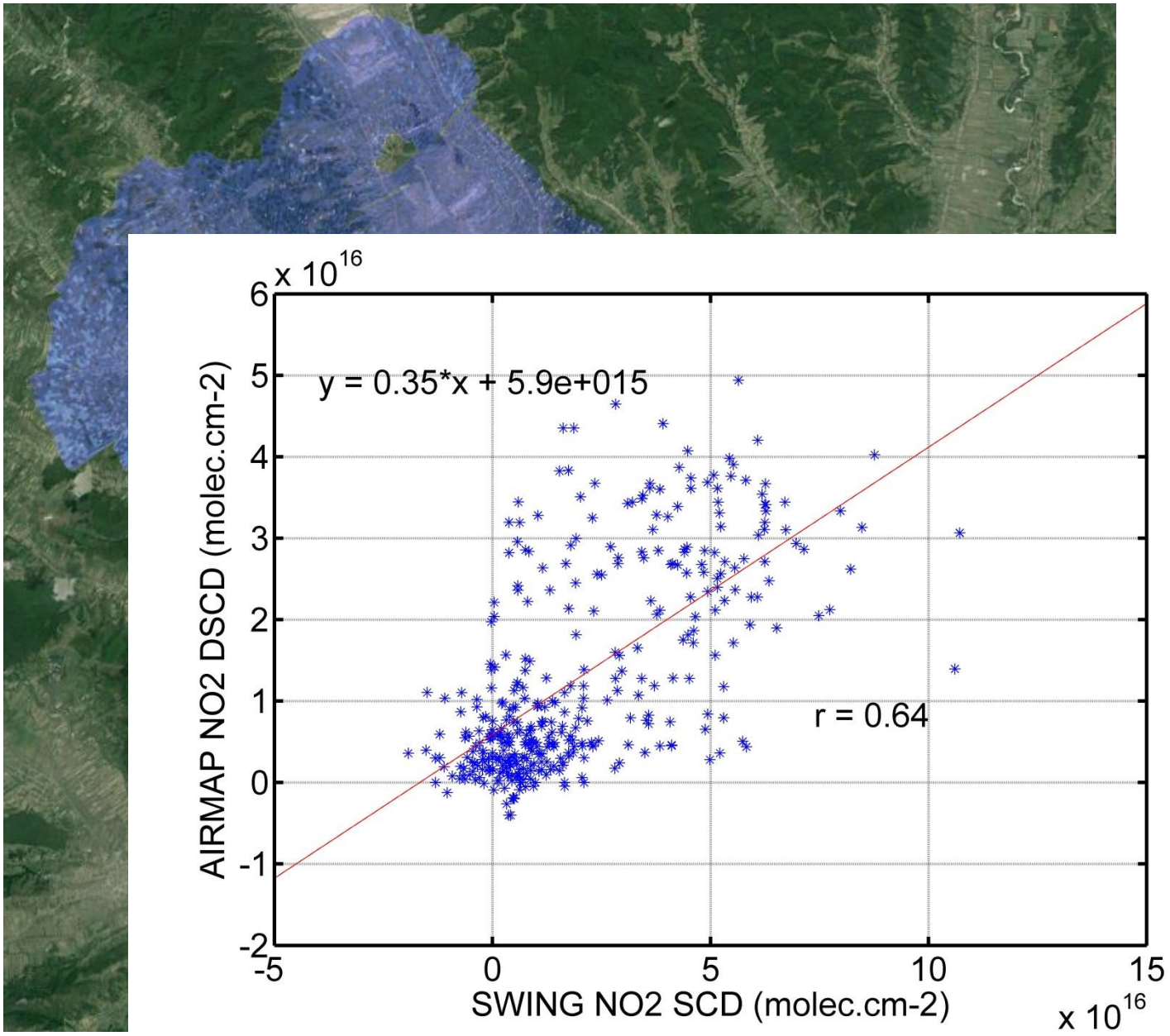
3. Preliminary results of AROMAT flights






x 10^16
y = 0.35*x + 5.9e+015
r = 0.64
AIRMAP NO2 DSCD (molec.cm-2)
SWING NO2 SCD (molec.cm-2)
x 10^16
6
5
4
3
2
1
0
-1
-2
-5
0
5
10
15

Outline

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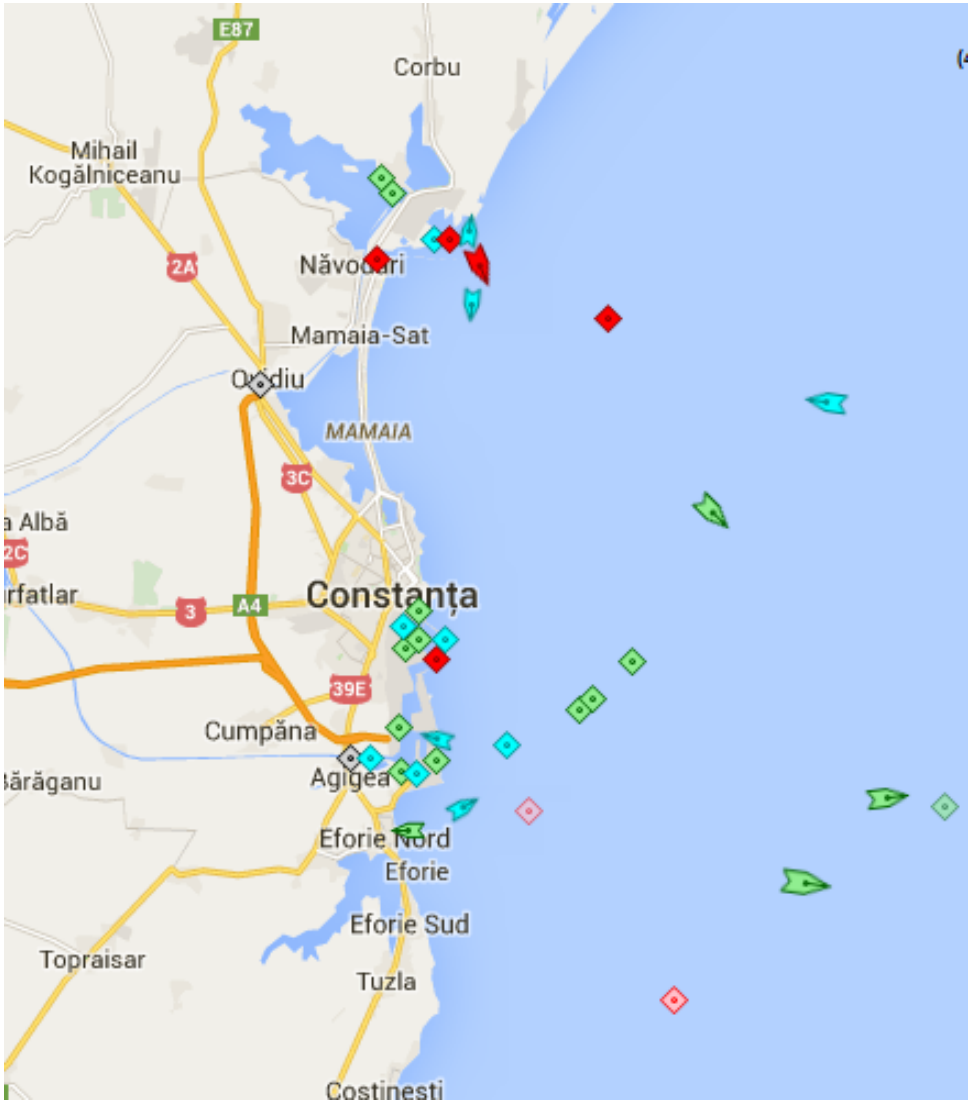
Preliminary conclusions from AROMAT-1

- all the airborne platforms/instruments operated
- First successful MobileDOAS intercomparison for NO2
- In-situ intercomparison more difficult
- AirMap seems most promising for satellite validation in the short term
- Mobile DOAS meas. are useful to plan the flights/validate the airborne meas.
- First SWING-UAV data with a clear signal and spatial gradients, but georeferencing is difficult
- Turceni not the easiest place for the sondes on balloon
- UAVs are dangerous
- Jiu Valley not optimal for satellite validation but very good to test new instruments

Perspectives

UAV flights above the Black Sea for monitoring ship emissions (NO2 and SO2, with a new spectrometer)

-> June 2015



Perspectives

- AROMAT-2 in Aug/Sept 2015

-> Addition (?) of a third airborne imager: APEX, operated from the DLR Dornier

-> KNMI sondes onboard a manned aircraft to get profile around Bucharest

-> GB Imaging from the ground in Turceni (SO2 camera and Altius breadboard for NO2)

- Bucharest campaign in summer 2017