



CEOS Atmospheric Chemistry Constellation Meeting (ACC-11)  
ESA/ESRIN, Frascati, Italy, 28-30 April 2015

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# The AROMAT team

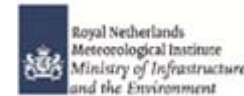
European Space Agency (ESA)



1. Belgian Institute for Space Aeronomy (BIRA-IASB)



2. Royal Netherlands Meteorological Institute (KNMI)



3. The Dunarea de Jos University of Galati (UGAL)



4. The National R&D Institute for Optoelectronics (INOE)



5. The Institute of Environmental Physics Bremen (IUP)



6. The National Institute of Aerospace Research "ELIE CARAFOLI" (INCAS)



7. The Max Planck Institute for Chemistry (MPIC)



8. The Free University of Berlin (FUB)



9. Reev River Aerospace (RRA)



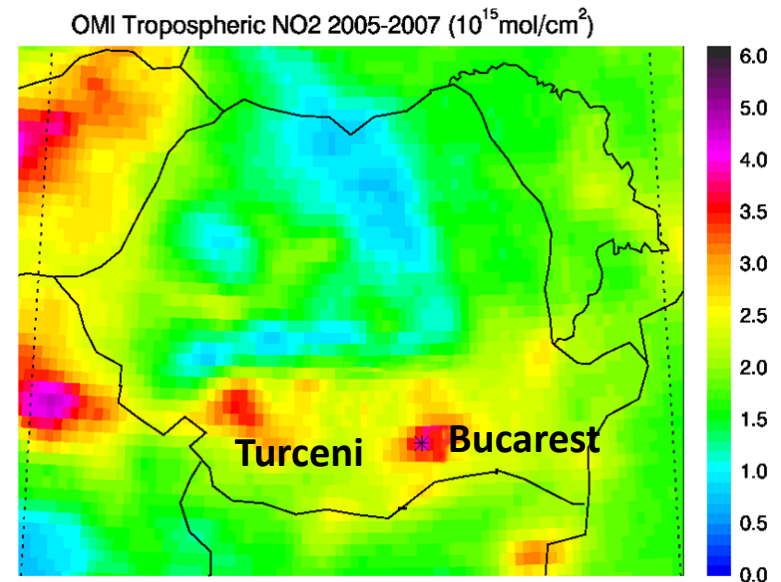
# AROMAT: Airborne Romanian Measurements of Aerosols and Trace gases

Campaign motivation: test newly developed airborne instruments for air quality research in preparation of future Sentinel-5P (4/5) Cal/Val campaigns. Involve Romania in such activities.

First week of September 2014 in Bucharest (largest city in Romania, 2.2 million inhabitants, heavy traffic )

Second week in Turceni: small village on the countryside, with a large power plant known to be a major source of NO<sub>x</sub>, SO<sub>2</sub> and aerosols

Both spots visible on OMI data



# Instruments and platforms

## Airborne

- Uni. Berlin Cessna:
  - Sunphotometer and Microtops ●
  - (Uni. Berlin) ●
  - AirMap (IUP-Bremen) ●
- Balloon launches:
  - NO<sub>2</sub> sonde (KNMI) ●
- INCAS UAV
  - Dust trak (INCAS) ●
  - Aerosol particle sizer (INOE) ●
- Uni. Galati UAV
  - SWING (BIRA) ●
  - NO<sub>2</sub> sonde (KNMI) ●

## Mobile (car/balloon)

- Mini-MaxDOAS (MPIC) ●
- Zenith-only mobile DOAS (Uni. Galati, BIRA) ●
- Double channel mobile DOAS (BIRA) ●
- NO<sub>2</sub> sonde (KNMI) ●

NO<sub>2</sub> ● SO<sub>2</sub> ● 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) ●



# Week 1: Bucharest

2 millions inhabitants



# AirMAP IUP/FU-Berlin

AirMAP on FU Berlin Cessna



- Pushbroom imaging  
DOAS instrument for NO<sub>2</sub>  
(and HCHO, SO<sub>2</sub>)








# AirMAP viewing geometry

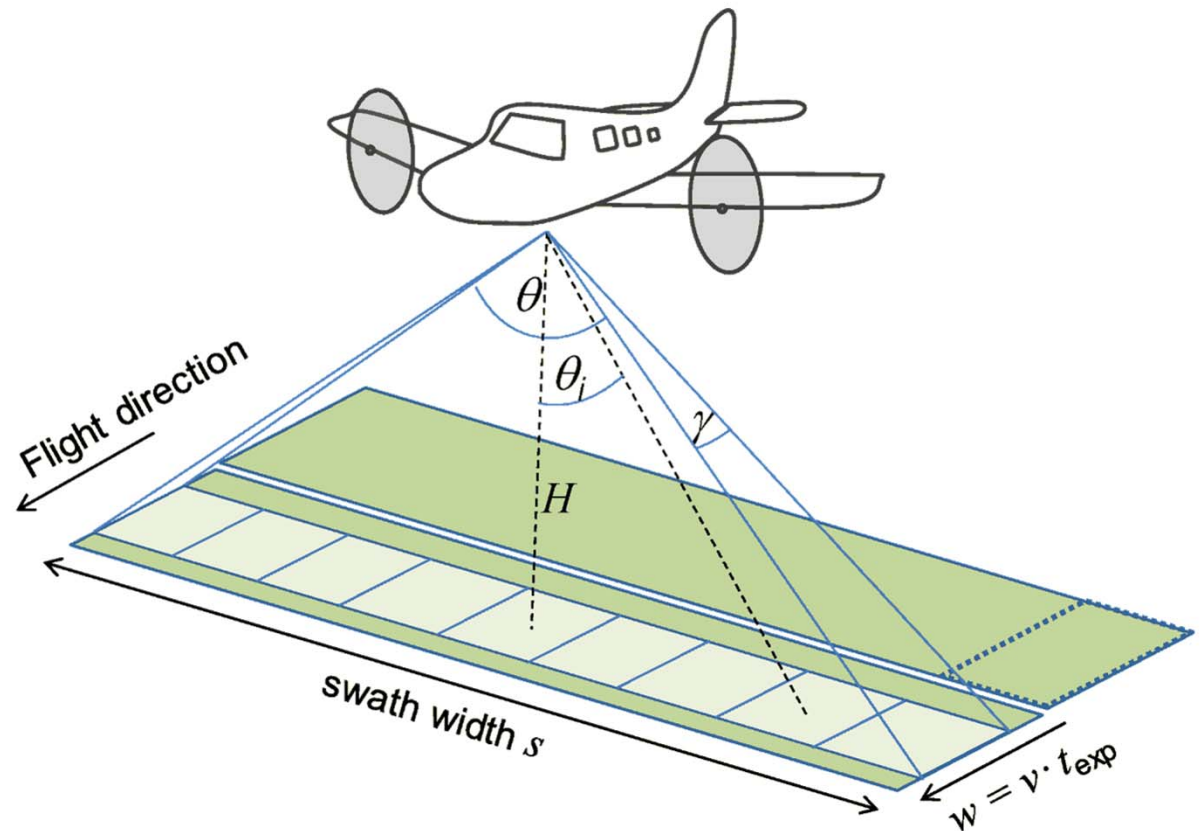
- $\theta$  opening angle/FOV across track  $\sim 48^\circ$
- $\theta_i$  individual viewing angle of direction  $i$  (max. 35)
- $\gamma$  opening angle/FOV along track  $\sim 1.5^\circ$
- $s$  side length of pixel across track
- $w$  side length of pixel along track

**H** flight altitude  $\sim 3000\text{m}$   
**v** aircraft speed (typ.  $60\text{m/s}$ )  
 **$t_{\text{exp}}$**  exposure time typ.  $0.5\text{s}$

**For 35 individual viewing directions**

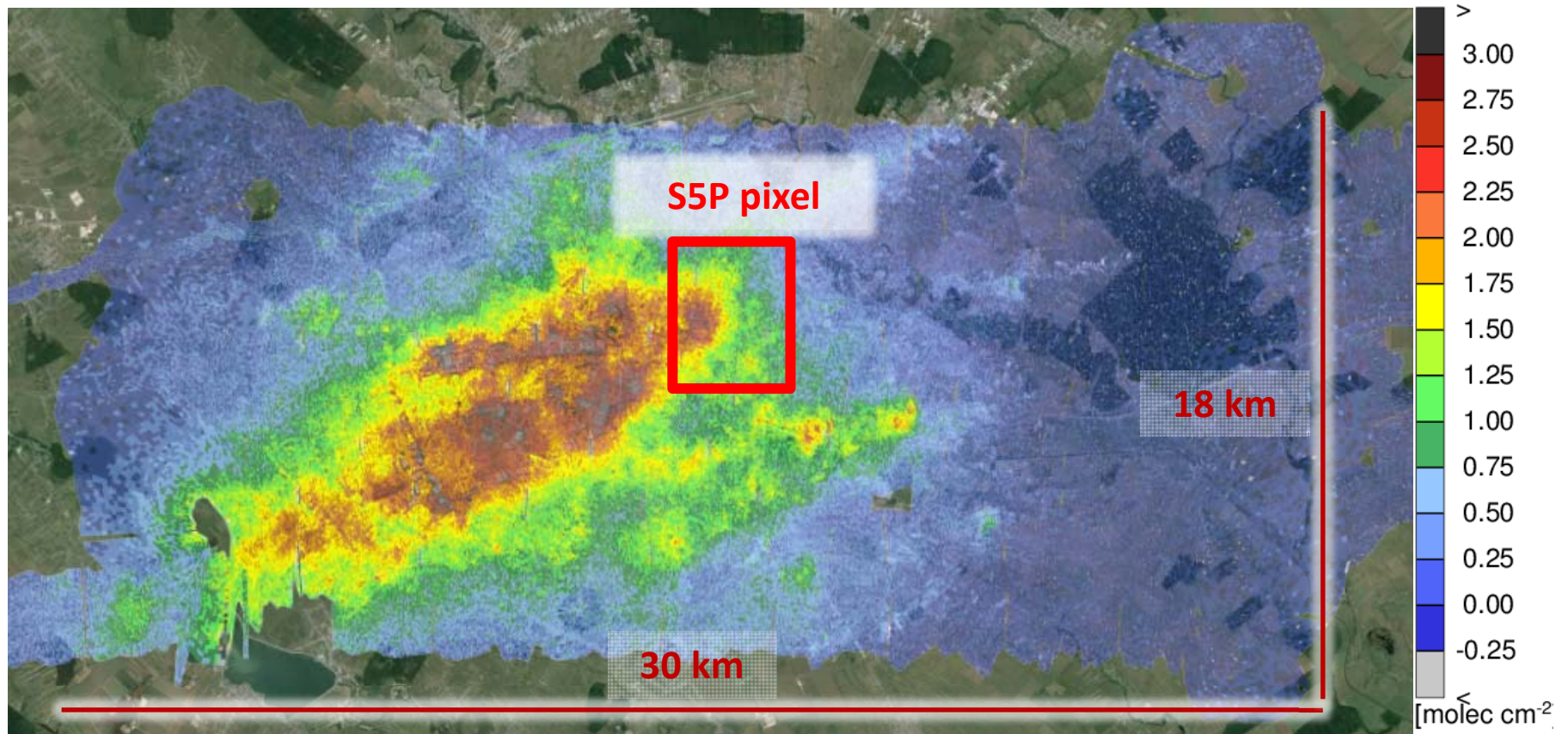
Ground pixel size  $80 \times 30 \text{ m}^2$

-  single spatial pixel
-  observed area (FOV)
-  instantaneously observed area (iFOV)



# 2014/09/08 Bucharest VC NO<sub>2</sub>

- Large values
- Low wind speed ( $\approx 0 - 1$  m/s), alternating directions





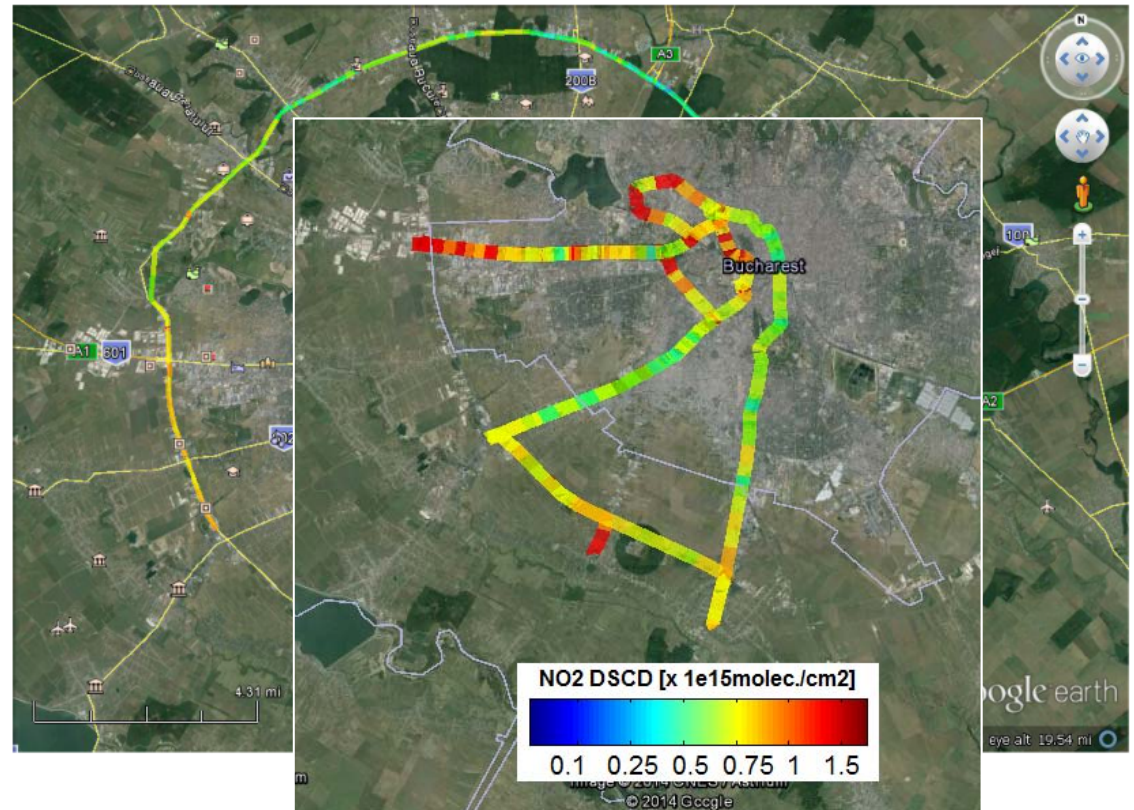


Optical head of BIRA mobile DOAS system

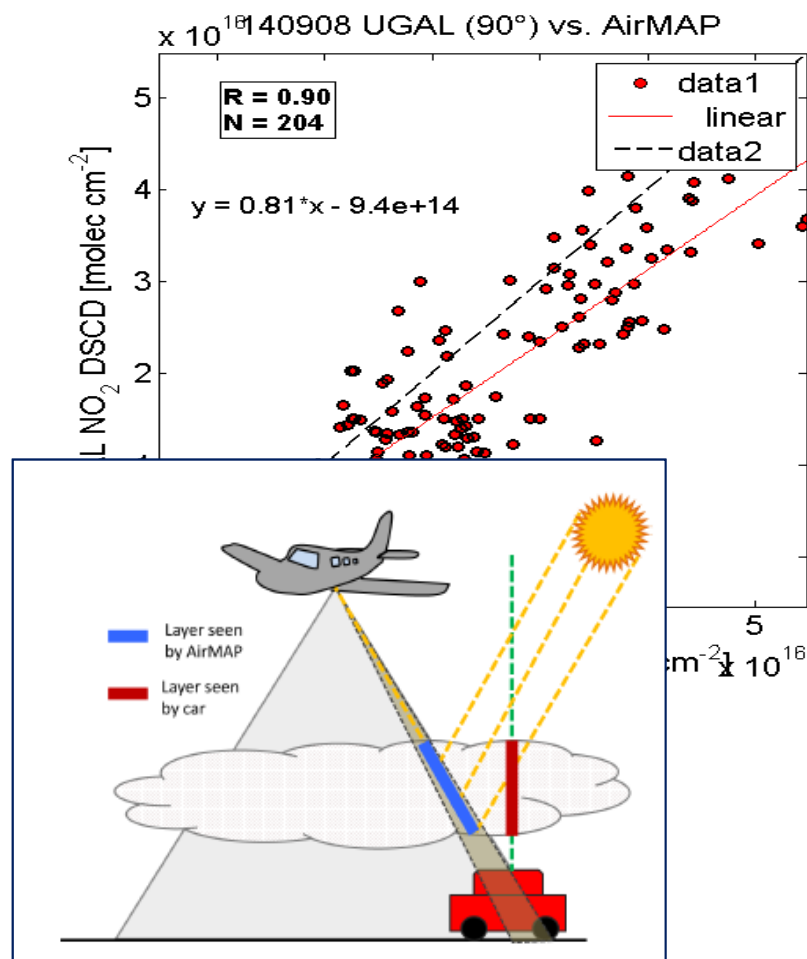
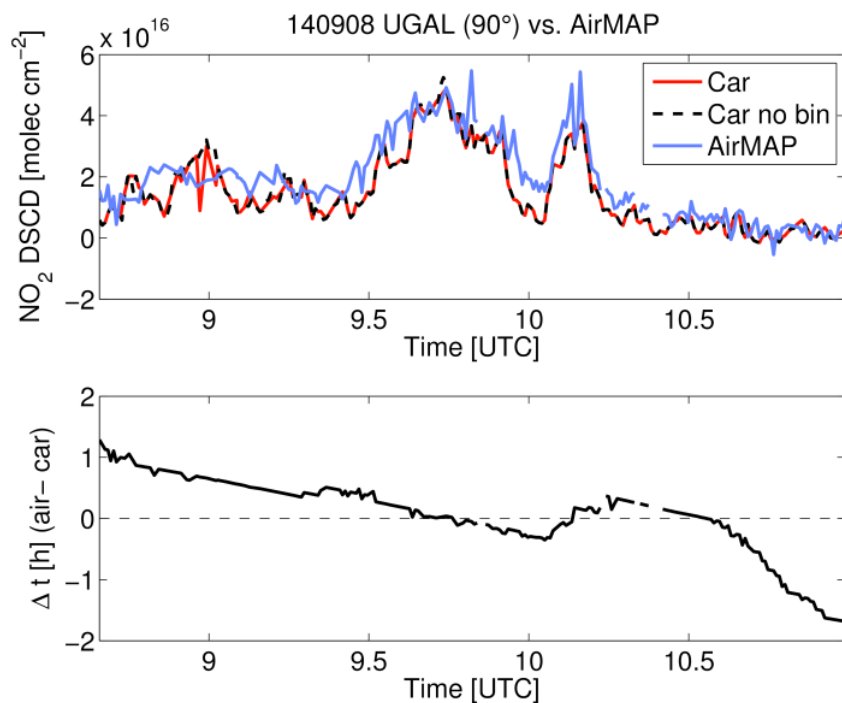
# Mobile car-DOAS

Sept 1, 2014 Bucharest

9.93 – 12.25 UT

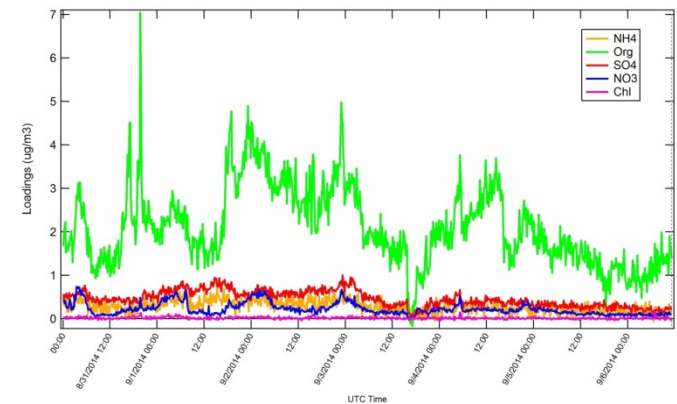
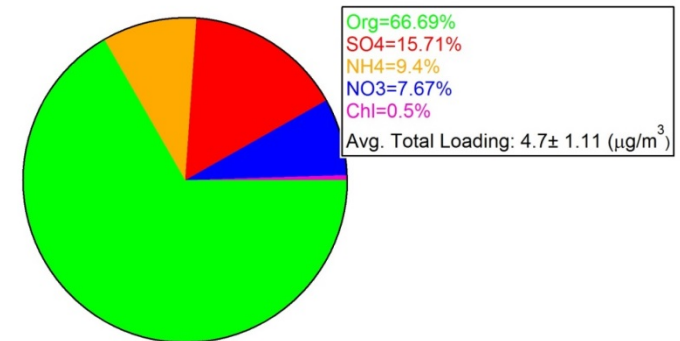
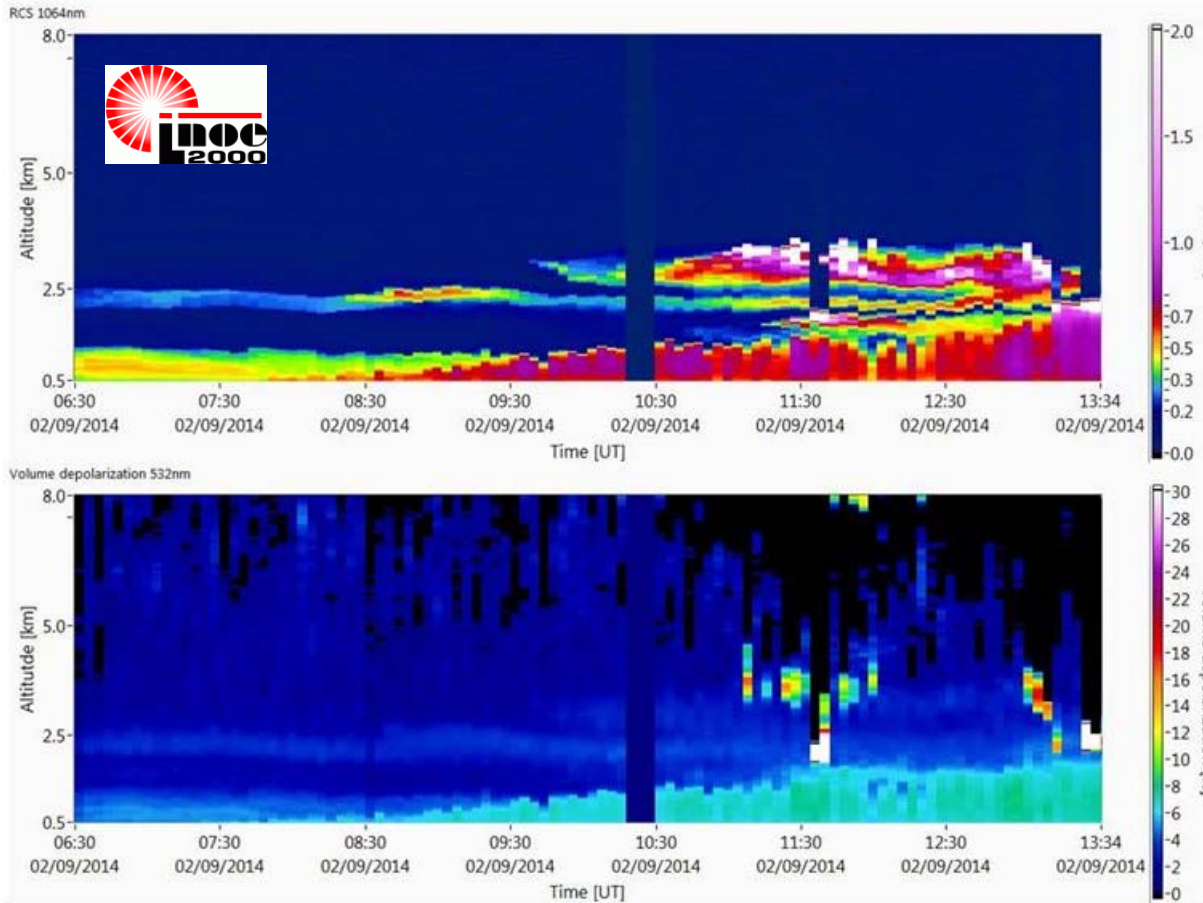


# Comparison: Car-DOAS / AirMAP



# Bucharest: Measurements from RADO Observatory (INOE) lidar and aerosol chemical speciation monitor

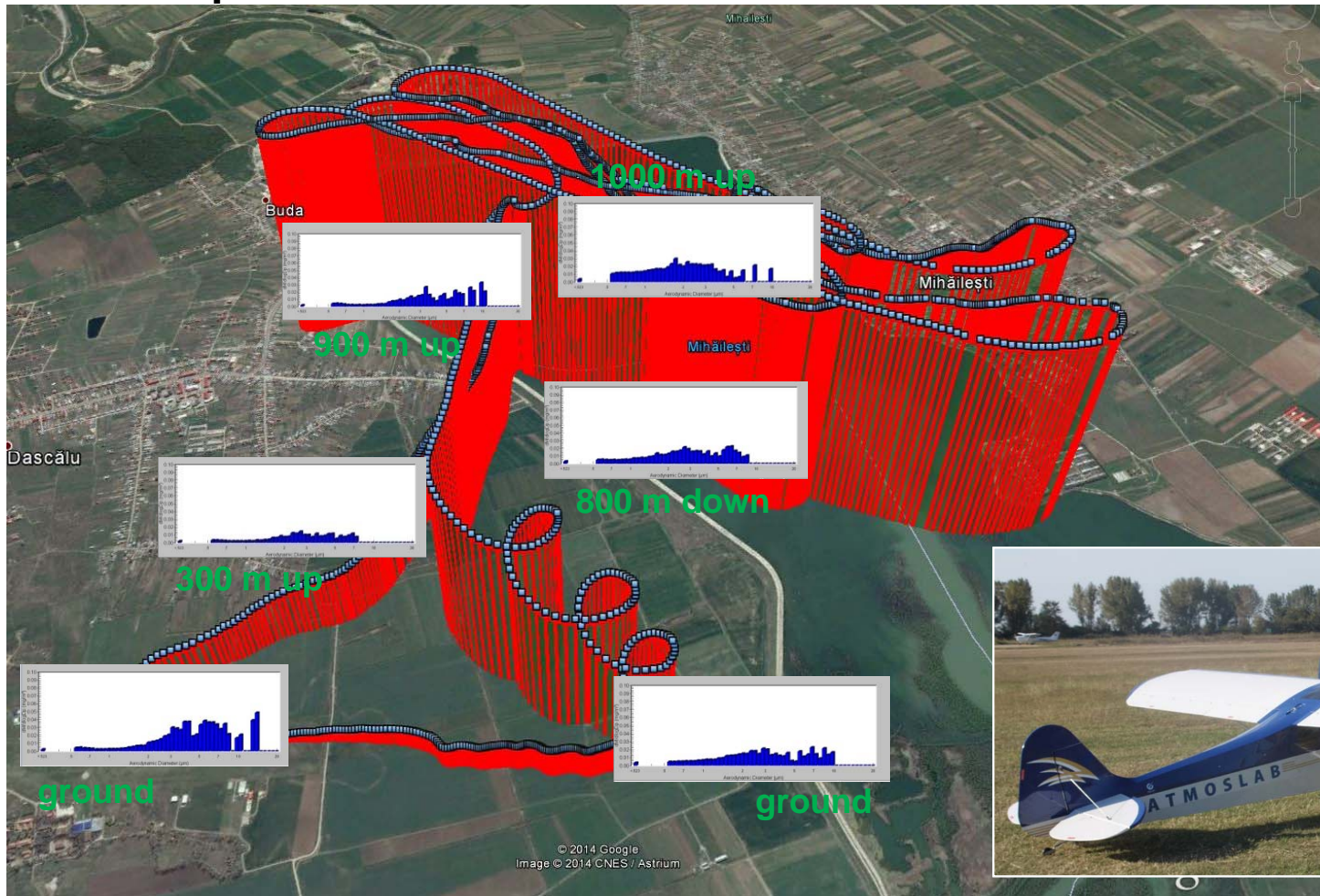
Ref for RADO: Nicolae et al. 2010, RRP, 2010





# UAV aerosol measurement in Clinceni

2<sup>nd</sup> of Sept 2014



**ATMOSLAB  
UAV**



*Mass concentrations at different altitudes measured by APSR operated on the INCAS UAV*



# Week 2: Turceni and Jiu Valley



Rovinari power plant

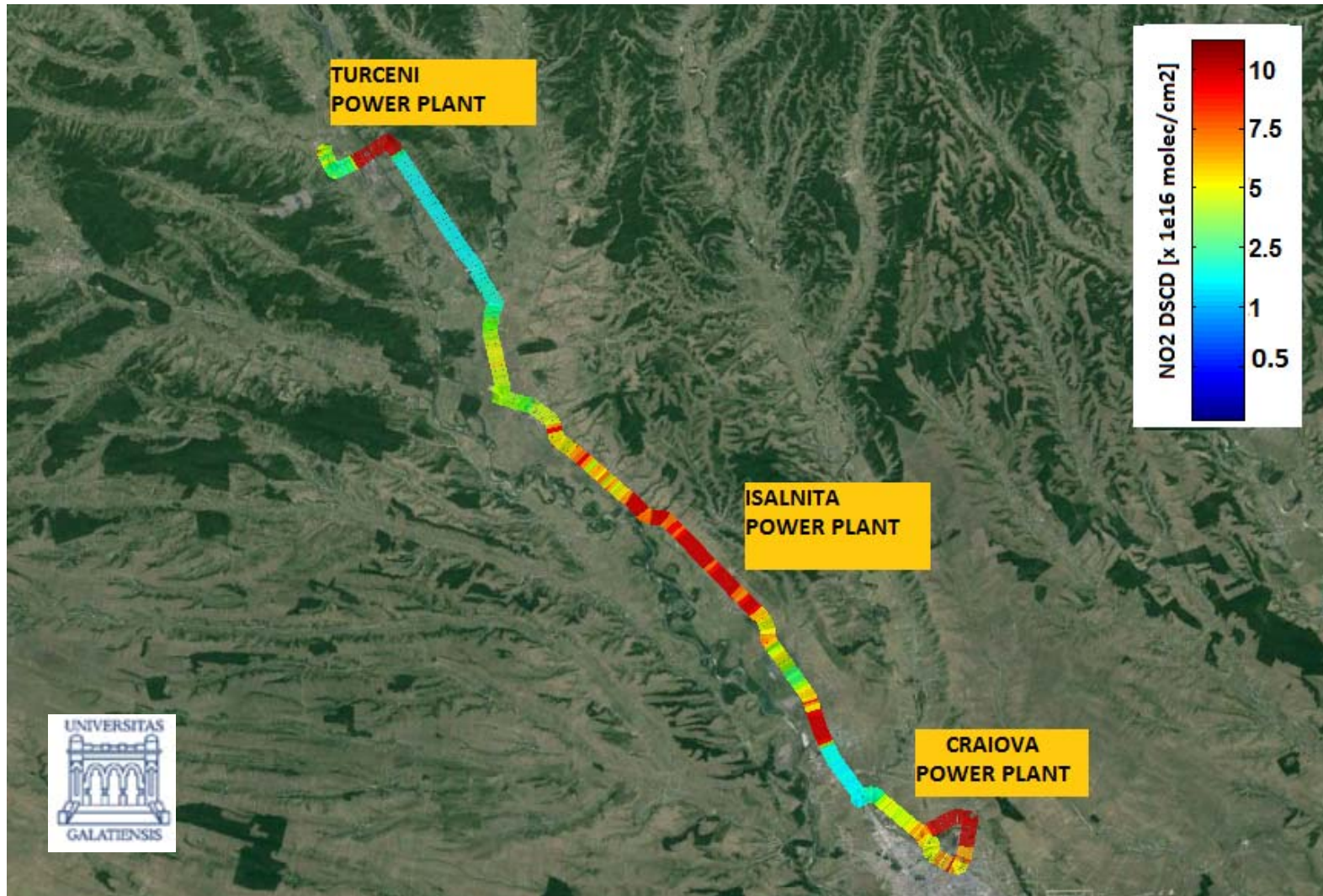


Turceni power plant



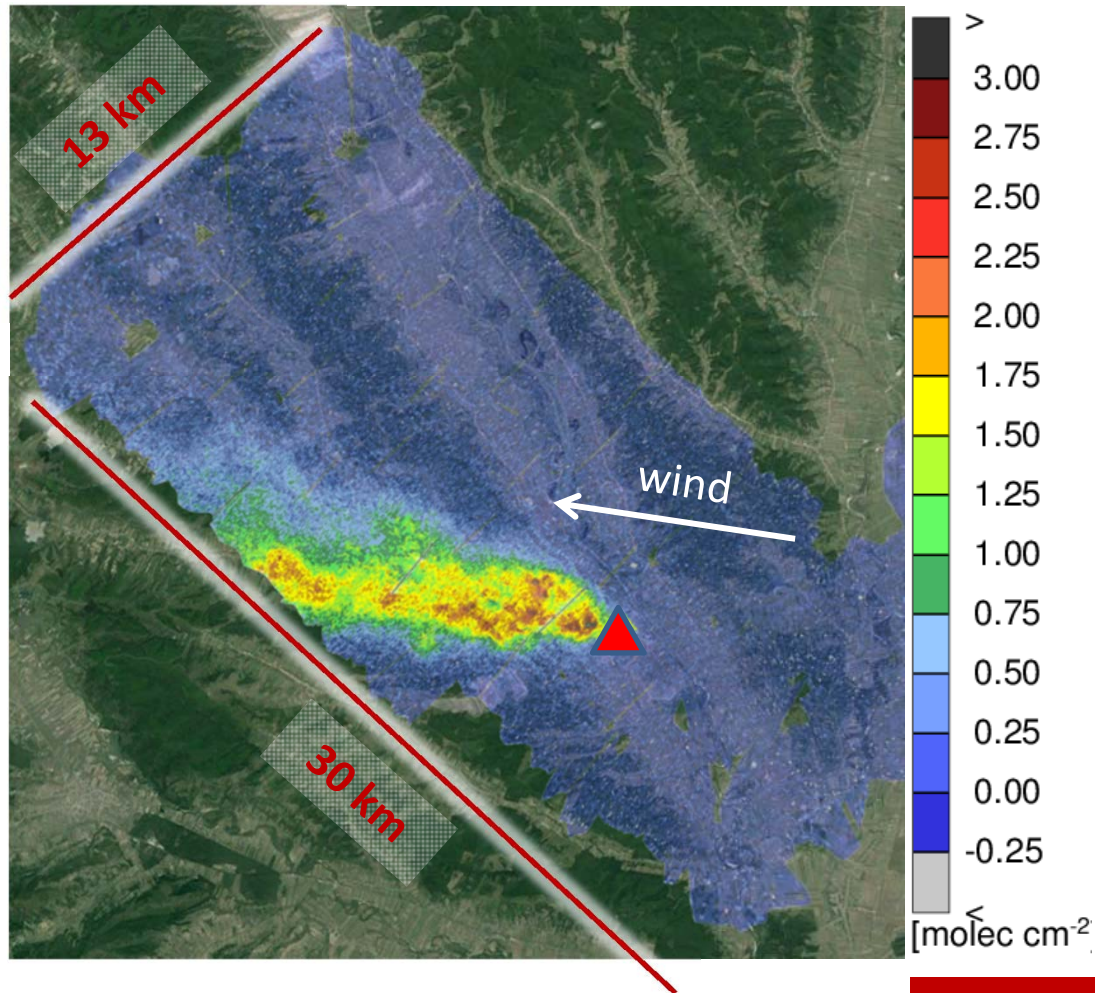


# 10 SEPTEMBER 2014 TURCENI-CRAIOVA





# 2014/09/11 Turceni VC NO<sub>2</sub>



- Power plant
- Pronounced NO<sub>2</sub> plume
- Values comparable to Bucharest

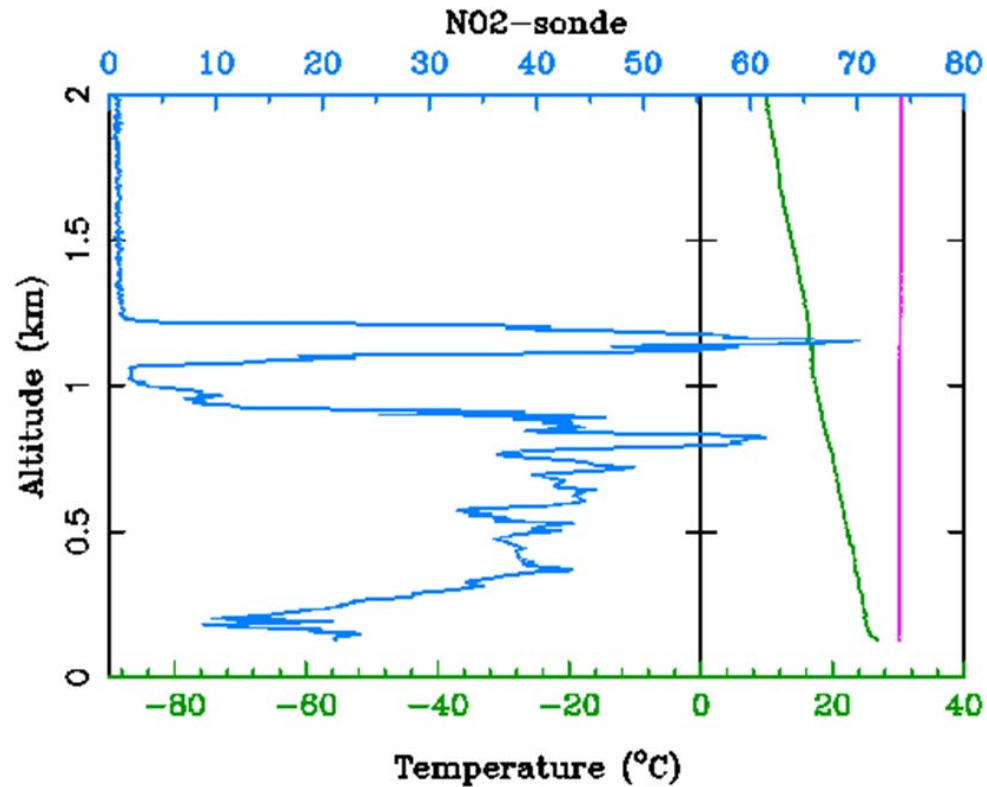


7:23 – 10:45 UTC | SZA: 54.5° - 40.6°

# Turceni: NO<sub>2</sub> sonde measurements

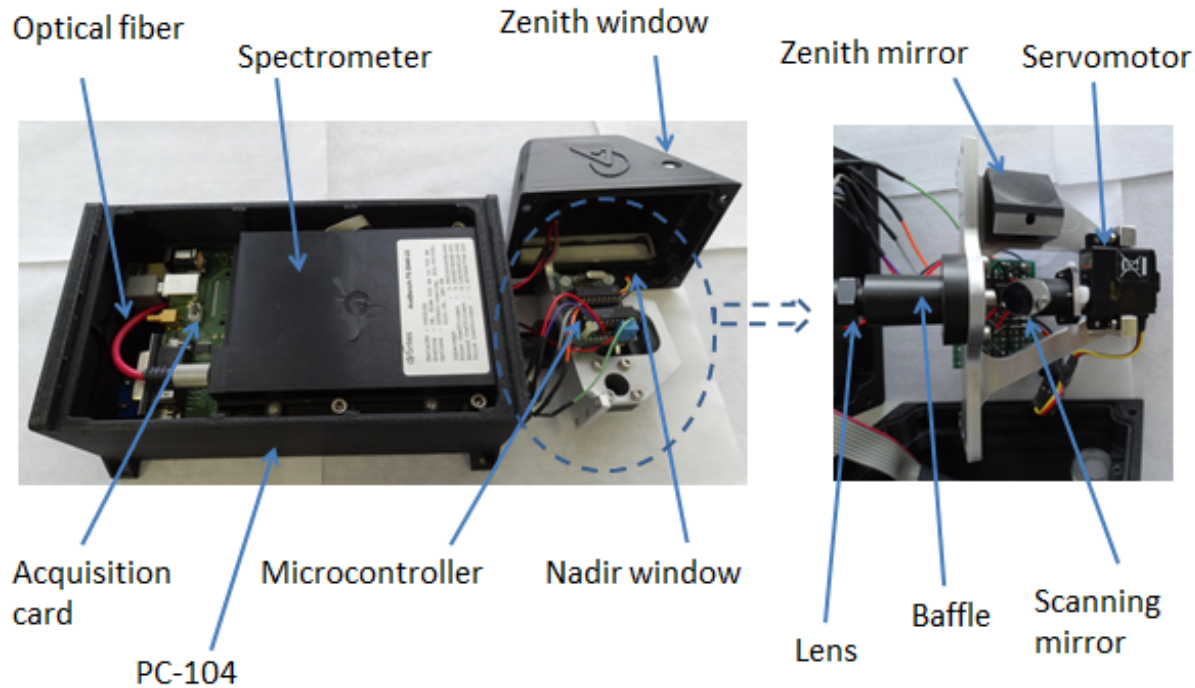
11 balloon launches in Turceni

NO<sub>2</sub>-sonde 2014-09-11-11



Ref KNMI sonde: *Sluis et al.*, AMT, 2010

# SWING-UAV measurements in Turceni



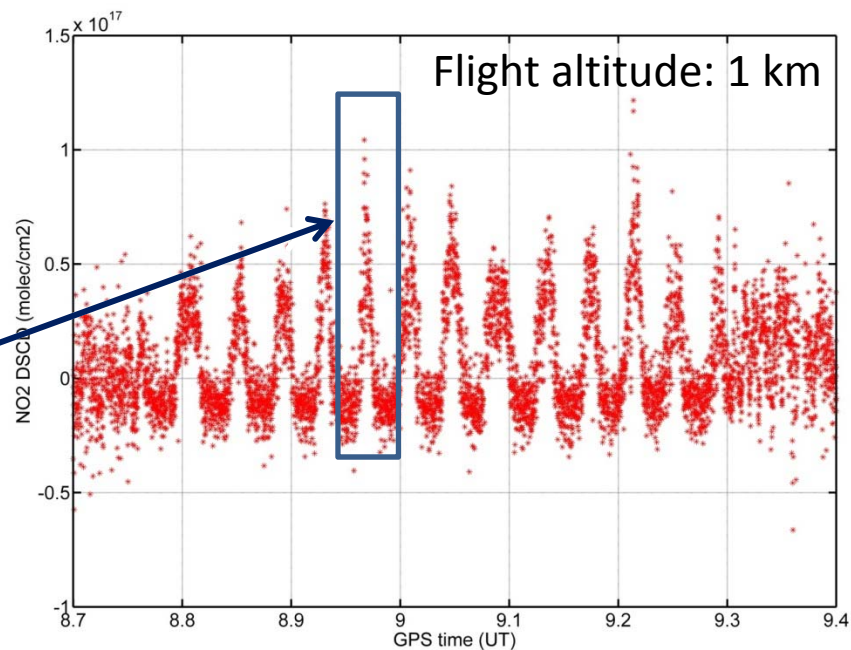
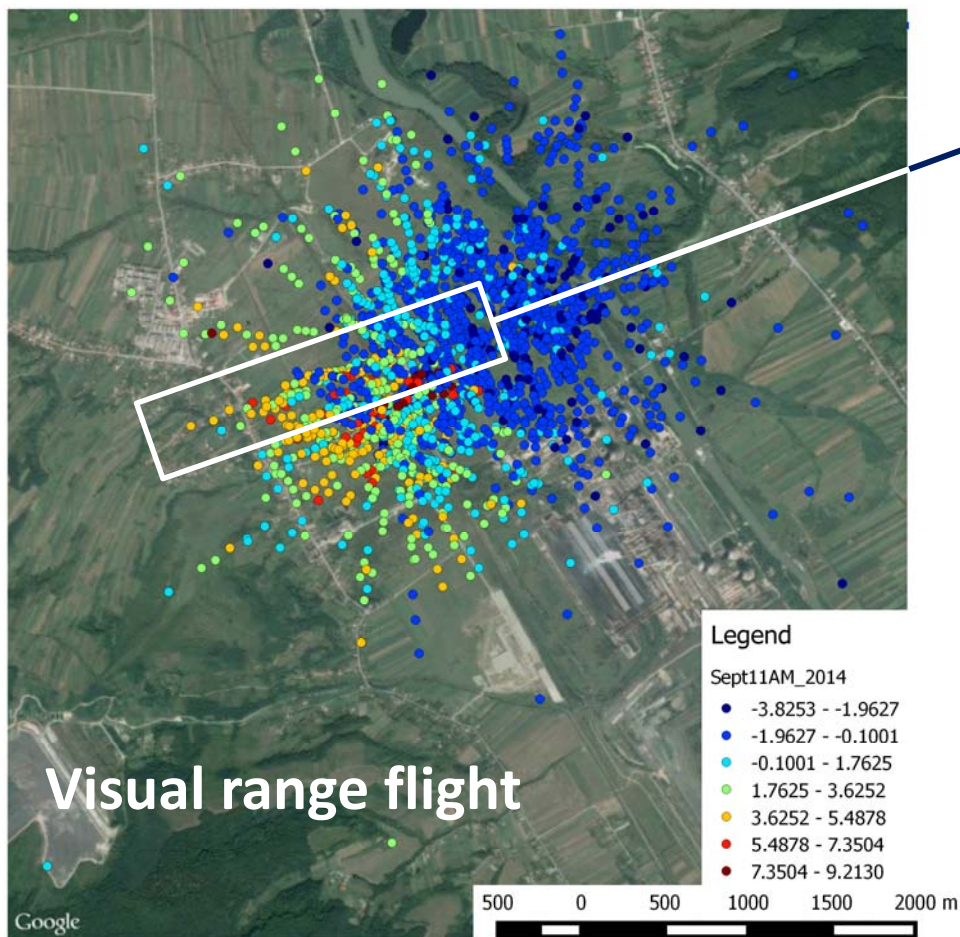
- Avantes AVASpec-2048 spectrometer
- 300-550 nm, 1.0 nm FWHM
- IFOV =  $2.6^\circ$ , Angular FOV =  $120^\circ$
- 920 g
- $27 \times 12 \times 12 \text{ cm}^3$
- Power consumption: 6 W at 5 V





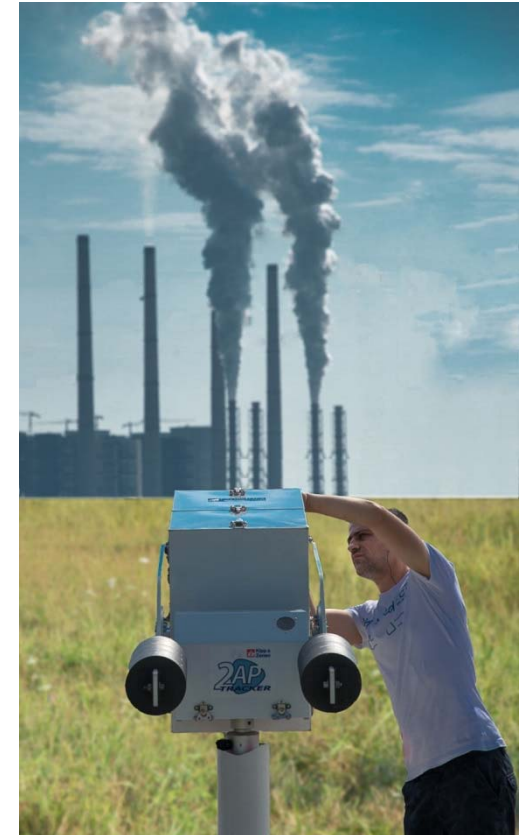
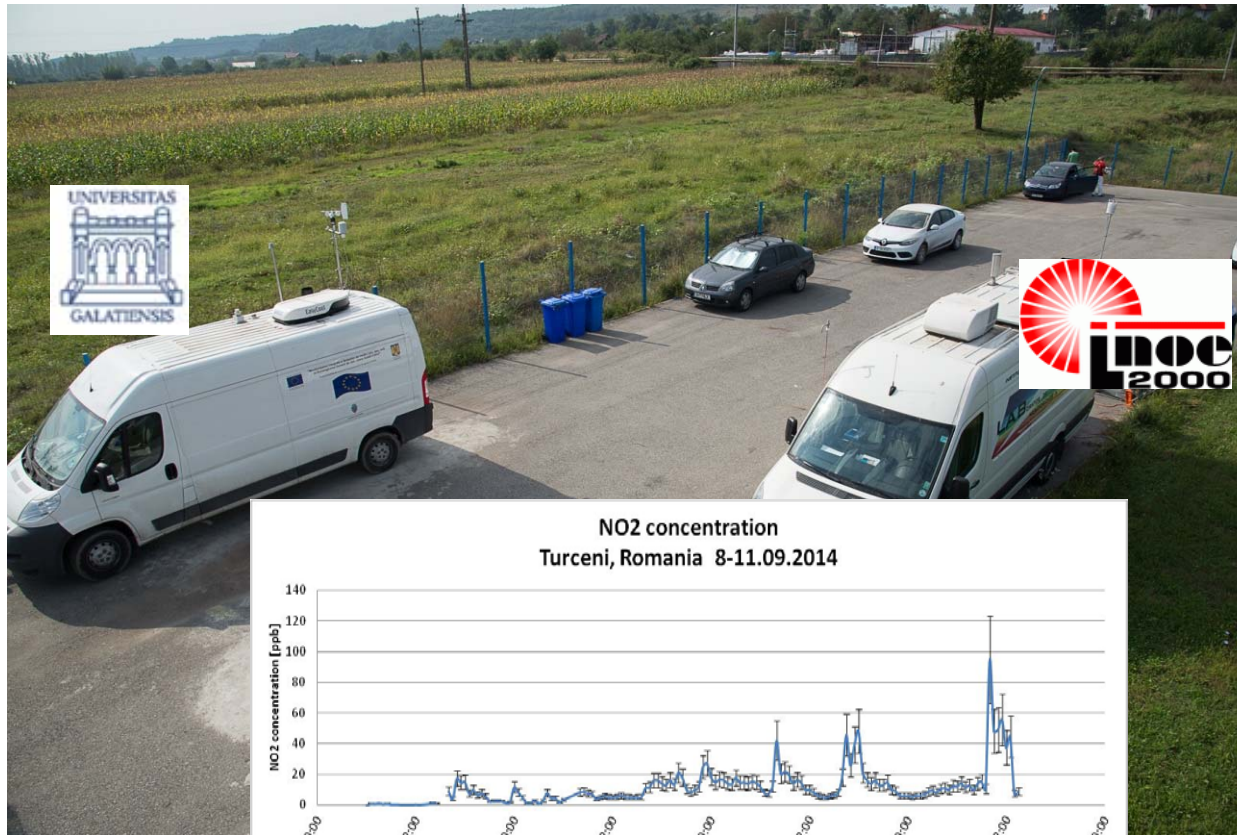
# Preliminary results of SWING flights

## Flight 2 - 2014/09/11





# Complementary measurements in Turceni: in situ and lidar measurements





## Plans for AROMAT-2 campaign

- Follow-up campaign in late summer 2015 (15/08 – 15/09)
- Build on science and operational lessons learned from AROMAT-1
- Extended focus, more resources committed
- Improved coordination of aircraft and ground-based mobile and static measurements
- Improved AirMap setup (→ NO<sub>2</sub>, SO<sub>2</sub> & HCHO mapping)
- Additional APEX flights (NO<sub>2</sub>, CH<sub>4</sub>, surface reflectance)
- Ground-based SO<sub>2</sub> camera + NO<sub>2</sub> imaging system (Altius)
- Additional ULM flights equipped with DOAS and NO<sub>2</sub> sonde
- NO<sub>2</sub> and O<sub>3</sub> sondes launched from Bucarest
- Extended suite of ground-based systems (Pandora-2S, FTIR, in-situ, Lidar, Aeronet, etc)

