EUROPEAN UNION

GOVERNMENT OF ROMANIA

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ENVIROBANAT

AIR POLLUTANT DISPERSION. EXAMPLE APPLICATION TO AN AIRPORT AIR QUALITY MANAGEMENT SYSTEM.

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WORKSHOP

05 – 06 September 2013, Zrenjanin, Republic of Serbia

In the frame of the project

Sustainable development of an research center in Banat region and Danube flow area through scientific research and environmental simulation tools to asses and evaluate potential threats

www.envirobanat.ro

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Air dispersion modeling uses information about sources and meteorological conditions to calculate how a pollutant moves through the atmosphere and what the pollutant concentration is at specific points.

In most air quality applications, one is concerned with dispersion in the PBL, the turbulent air layer next to the earth's surface that is controlled by the surface heating and friction and the overlying stratification. The PBL typically ranges from a few hundred meters in depth at night to 1 - 2 km during the day. Major developments in understanding the PBL began in the 1970's through numerical modeling, field observations, and laboratory simulations

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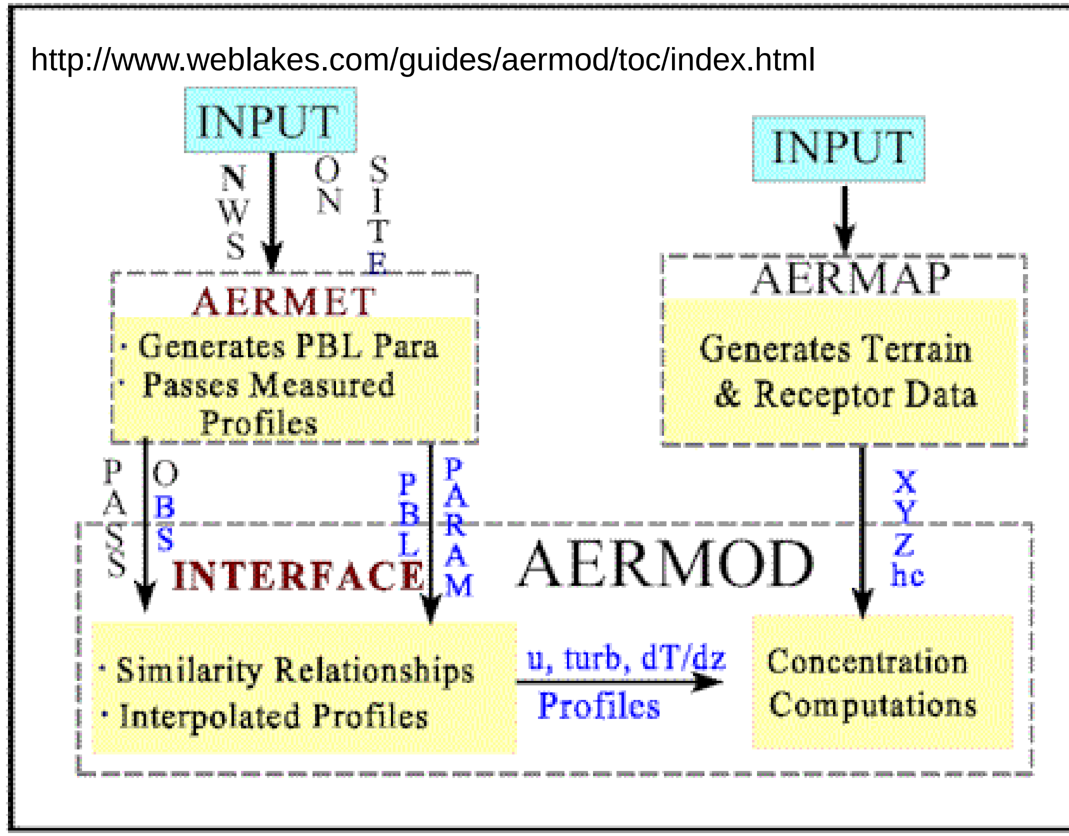
Gaussian Plume Air Dispersion Model (AERMOD)
Lagrangian Particle Tracking Air Dispersion Model (AUSTAL)

AERMOD is a steady-state plume model. In the stable boundary layer (SBL), the concentration distribution is assumed to be Gaussian in both the vertical and horizontal. In the convective boundary layer (CBL), the horizontal distribution is assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function (p.d.f.).

In AUSTAL model the trajectories of massless particles are calculated by means of a random-walk scheme. This means that the Navier-Stokes equations are not solved, but the particle motion is described by using a statistical description of the random velocity field.



http://www.austal2000.de/en/home.html

http://en.wikipedia.org/wiki/List_of_atmospheric_dispersion_models

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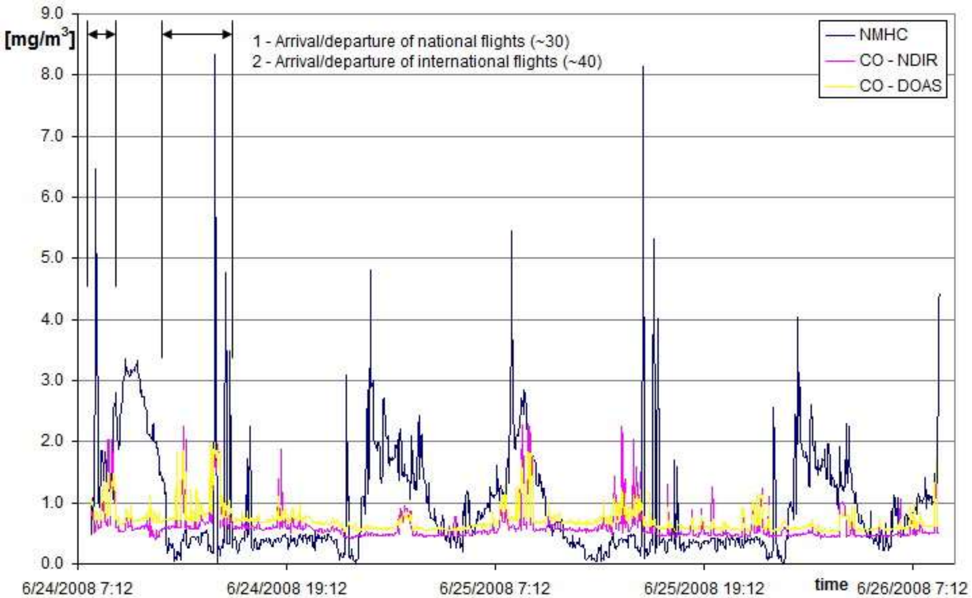
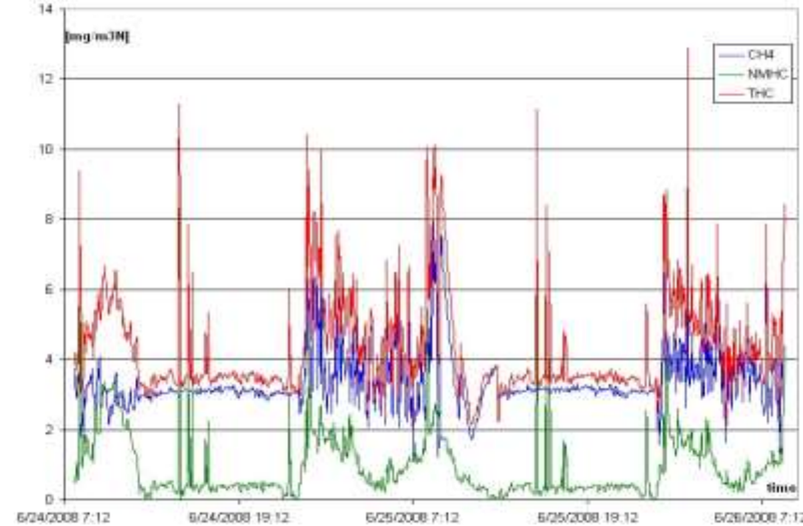
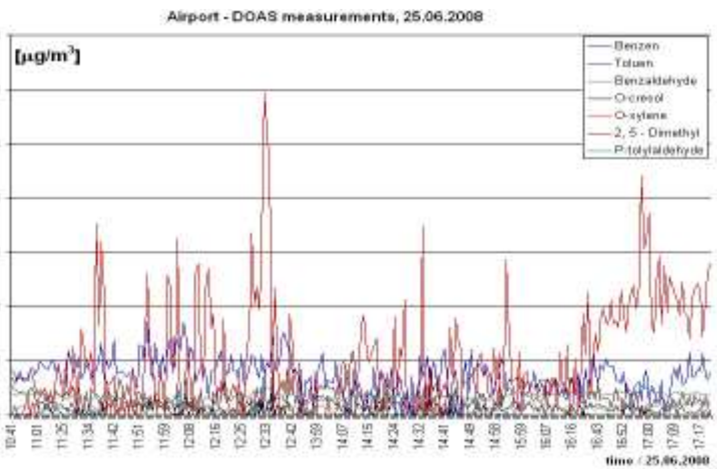
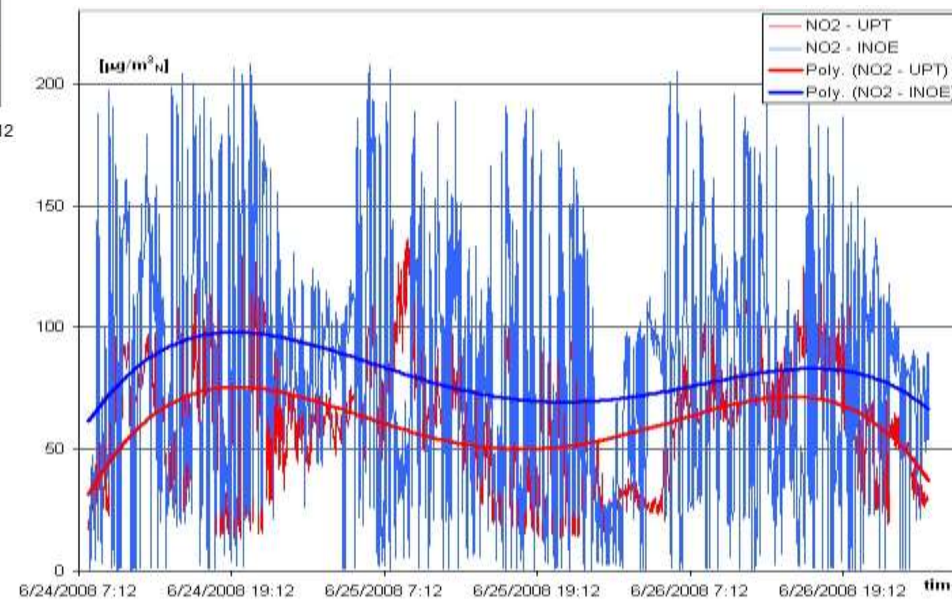
INSTRUMENTS (MEASURENTS METHODS) USED:

✓**SO_2,** UV fluorescence
✓**NO**, **NO_2** and **NO_x**, chemiluminescence's
✓**O_3**, UV photometry
✓**CO**, NDIR (Non Dispersive Infrared)
✓**CH_4**, **NMHC** and **THC**, FID (flame ionization detection)
✓**PM10**, gravimetric
✓~ 50 **VOC's** species measured with DOAS


[mg/m^3]
1 - Arrival/departure of national flights (~30)
2 - Arrival/departure of international flights (~40)
NMHC
CO - NDIR
CO - DOAS
time
6/24/2008 7:12
6/24/2008 19:12
6/25/2008 7:12
6/25/2008 19:12
6/26/2008 7:12


[mg/m3N]
CH4
NMHC
THC
time
6/24/2008 7:12
6/24/2008 19:12
6/25/2008 7:12
6/25/2008 19:12
6/26/2008 7:12


Airport - DOAS measurements, 25.06.2008
[µg/m^3]
Benzen
Toluen
Benzaldehyde
O-cresol
O-xylene
2, 5 - Dimethyl
P-tolylaldehyde

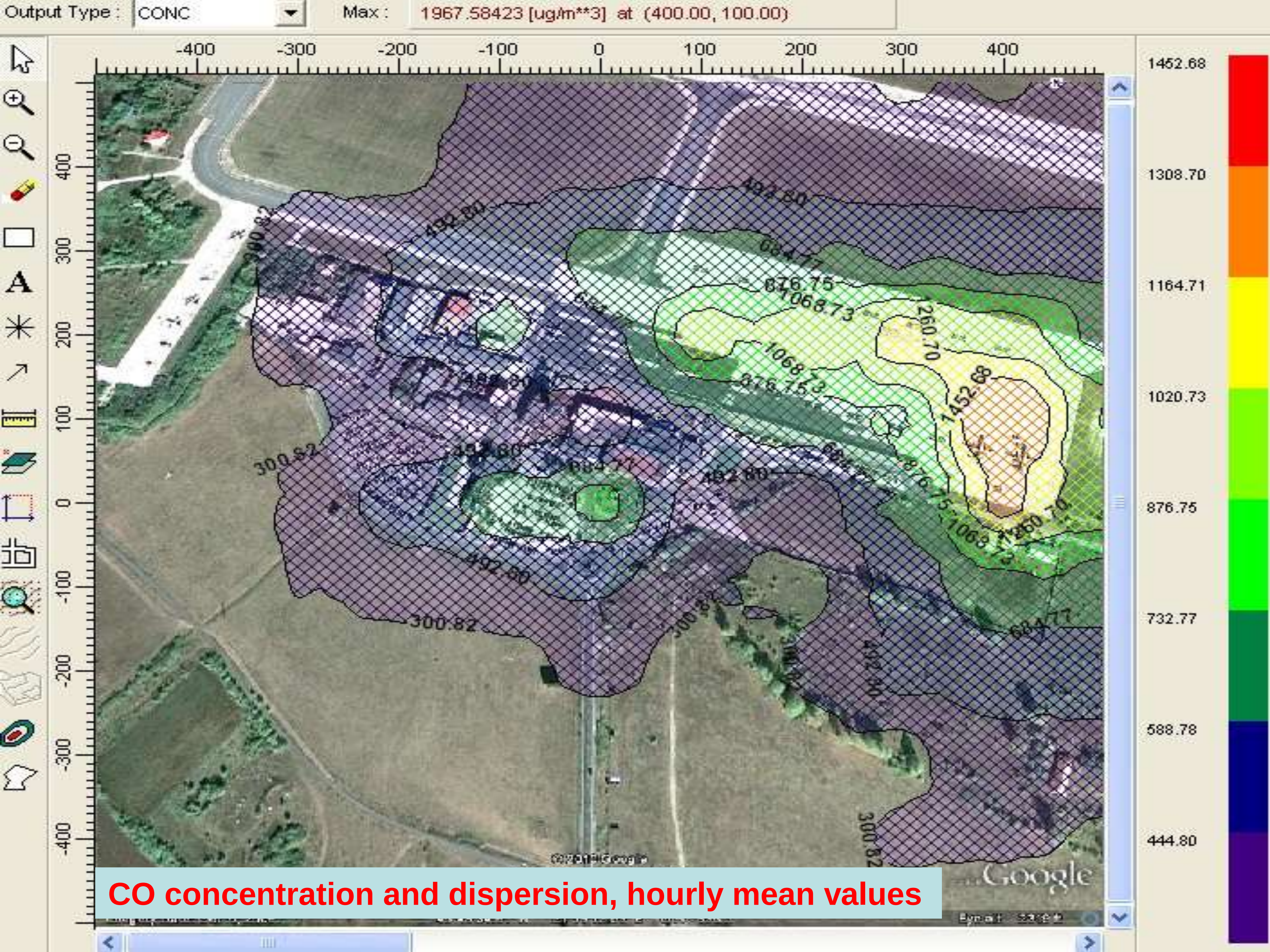

[µg/m^3$_N$]
NO2 - UPT
NO2 - INOE
Poly. (NO2 - UPT)
Poly. (NO2 - INOE)
time
6/24/2008 7:12
6/24/2008 19:12
6/25/2008 7:12
6/25/2008 19:12
6/26/2008 7:12
6/26/2008 19:12

Aircraft class	Operational Cycle	CO [kg/s]	NMVOC [kg/s]	NOx [kg/s]
Boeing 737/400 (turbojet)	Landing (trust 30%, time 2 minutes)	0.02541	0.00105	0.01521
	Ground taxi (trust 7%, time 26 minutes)	0.02154	0.00141	0.00640
	Takeoff (trust 100%, time 50 seconds)	0.04425	0.002451	0.03354
Total emission factor/cycle/aircraft		***0.0912***	***0.004911***	***0.05515***
Fokker 100 (turbofan)	Landing (trust 30%, time 2 minutes)	0.03421	0.002458	0.01465
	Ground taxi (trust 7%, time 26 minutes)	0.02414	0.002085	0.00421
	Takeoff (trust 100%, time 50 seconds)	0.05542	0.005211	0.02122
Total emission factor/cycle/aircraft		***0.1137***	***0.009754***	***0.04008***

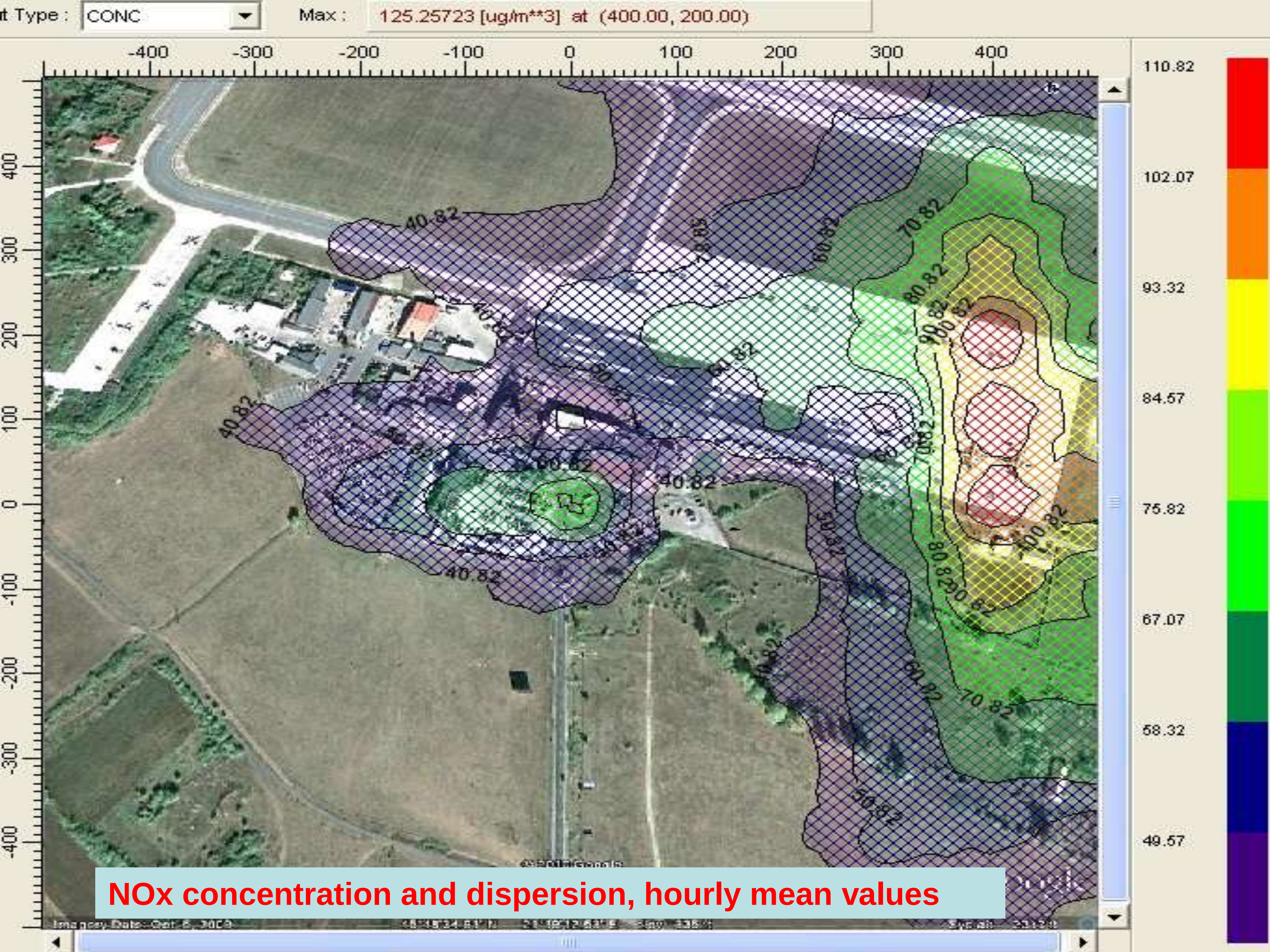
Vehicle class	Fuel	Emission factor (CORINAIR 2009, Tier 1)						Vehicle number
		CO		NMVOC		NOx		
		g/kg fuel	g/s	g/kg fuel	g/s	g/kg fuel	g/s	
PC (small vehicles)	petrol	132	0.8052	14	0.1201	14.5	0.1254	20
	diesel	4.7	0.7552	1.10	0.0845	11.0	0.0542	4
LDV (utility vehicles < 3.5t)	petrol	155	0.9855	14	0.1542	24.0	0.1845	14
	diesel	11.0	0.8995	1.75	0.1220	15.0	0.0752	10
HDV (utility vehicles >3.5t)	diesel	8	1.1542	1.60	0.1642	37.0	0.8551	59

Pollutant	Emission factor [g/s]
Nitrogen oxides NOx	$1.09776 \cdot 10^{-2}$
Carbon monoxide CO	$4.814 \cdot 10^{-3}$
Non Methane Volatile Organic Carbon NMVOC	$0.0004 \cdot 10^{-3}$

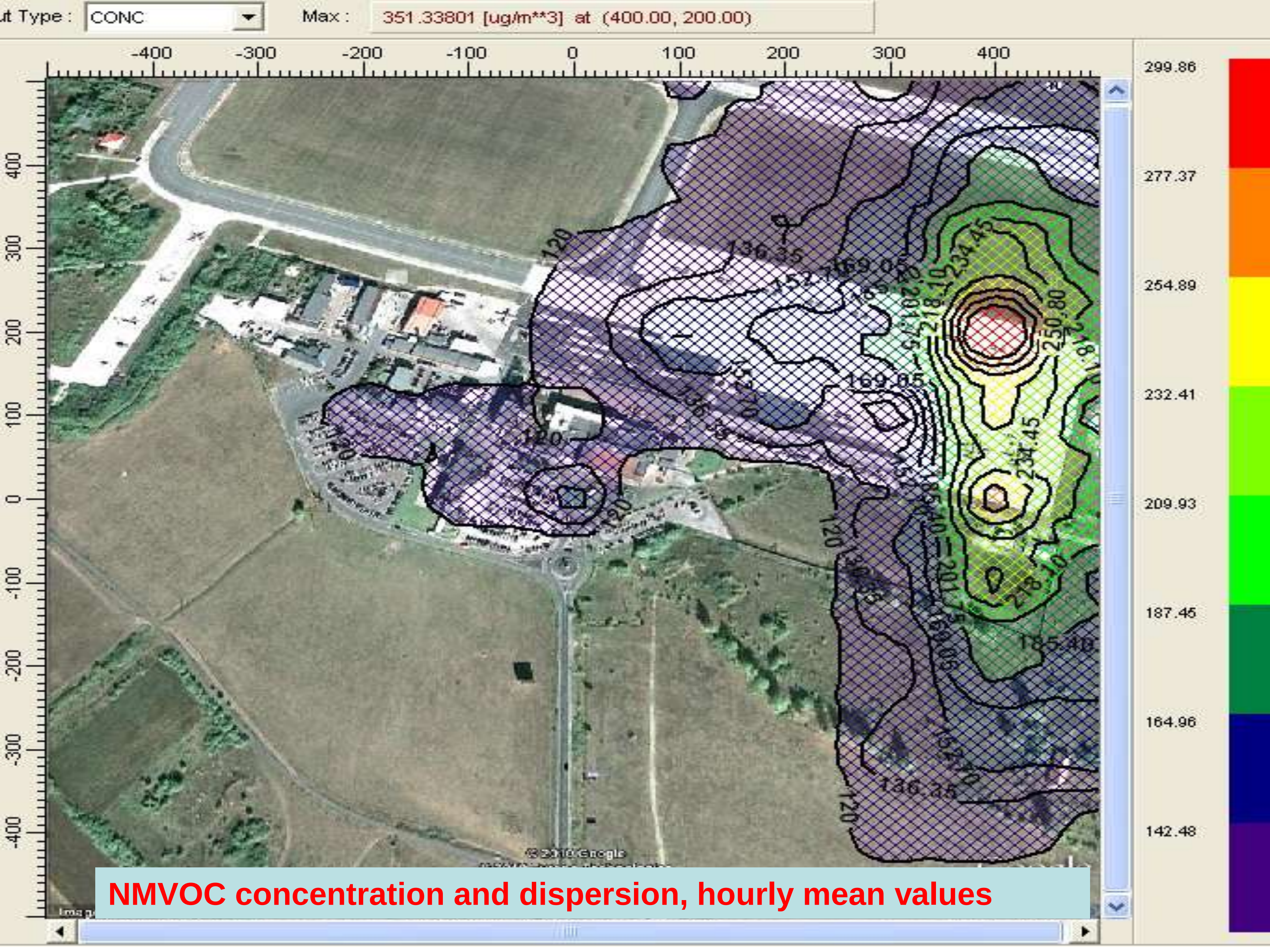
The episodes considered were based on different simultaneously acting sources in the area meaning 10 aircrafts, applying the LTO cycle, all airport ground vehicles, public parking lot with 250 vehicles (smaller then 3.5 tones) and the local small size power plant was considered at nominal load, as well.



CO concentration and dispersion, hourly mean values



NOx concentration and dispersion, hourly mean values



NMVOC concentration and dispersion, hourly mean values

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http://www.eea.europa.eu//publications/emep-eea-guidebook-2013

Pollutant / unit	Maximum of one hour mean values for pollutant concentration	
	Simulation (calculated values)	direct measurements
CO [mg/m^3]	1.96	1.83
NOx [µg/m^3]	125.25	110.7
COV [mg/m^3]	0.351	1.5

- **CO, SO2 and NOx simulated values are of same range and very close to the online measured concentrations. The locations where by simulation the maximum values occurs is almost identically or very close to the location where the monitoring laboratories have been installed, near the apron.**
- **The correlation is no longer valid for NMVOC concentration, possible because in the simulation scenario the fugitive emissions of NMVOC from aircrafts fueling where not included. Another cause for this discrepancy can be the presence of other NMVOC emission sources in the vicinity of the airport.**
- **It is also possible that the EMEP database emission factor for NMVOC is underestimated, recent studies [1] showing that the aircraft emissions of NMVOC are up to 10.4 mg/kg fuel burnt, data obtained through the PartEmis project.**

1.Kurtenbach R., et al., *Emission of Non-Methane Volatile Organic Compounds (NMVOCs) from a Jet Engine Combustor and a Hot End Simulator (HES) During the PartEmis Project*, Proceedings of the European Conference on Aviation, Atmosphere and Climate (AAC), June 30 to July 3, 2003, Friedrichshafen, Germany, pp. 52-58