4th International Workshop on Optoelectronic Techniques for Environmental Monitoring,
October 2010, Cluj-Napoca, Romania

NUMERICAL SIMULATION AS A TOOL TO EVALUATE AIR QUALITY IN AIRPORT AREAS

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Foreword

The focus is on the description and demonstration of how numerical simulation applied as pollutants dispersion modeling in airport areas is a solution for solving complex problems concerning air quality issues and status strategies or perspectives for sustainable urban development, including traffic areas.

The paper describes a methodology used to evaluate the concentration of major pollutants in an international airport environment, by means of mathematical analysis and informs about the validation possibility of the results and tool, by direct measurements.

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Foreword

Air pollution is a major concern for all nations, with a higher or lower development level.

The human society is not recognizing that the environment has only a limited capacity to process all its waste, without major changes. Each of us is a polluter but also a victim of pollution.

Airport-related activities result in the emission of a host of air pollutants that adversely affect public health and the environment. Worldwide, the number of aircraft operations (defined as one takeoff or one landing) has grown substantially from around 15 million in 1976 to almost 30 million in 2000 (for USA only), a cumulative growth of about 105 percent. While emissions from most source sectors are declining due to the implementation of more stringent control programs, the growth in air travel and the continued lack of control programs for aircraft engines is resulting in increased pollution from airports.

Foreword

According to estimates of the Intergovernmental Panel on Climate Change (IPCC), international aviation contributes about 3.5 % to global warming, through the emitted pollutants. International aviation is therefore becoming increasingly responsible for the greenhouse effect and pollutants emissions as well, but is nevertheless not covered yet by the Kyoto Protocol. In contrast to international aviation, greenhouse gas emissions of national aviation are included in the Kyoto Protocol. Fuels used in international air and maritime traffic – so-called bunker fuels – are excluded from reduction and stabilization commitments for the first commitment period (2008 - 2012), because agreement could not be reached on the question of the assignment of such emissions.

Foreword

A range of policies and measures are currently being discussed at a national and international level, in order to comply with commitments arising from Article 2.2 of the Kyoto Protocol … ***however, most of the discussions are focusing on economical instruments (like certificate trading) and not technological (or logistical) instruments.***

As far as Romania is in discussion … ***Romanian national air quality monitoring network consists of 117 automated stations but none in or near major airports.***

Methodology and data input

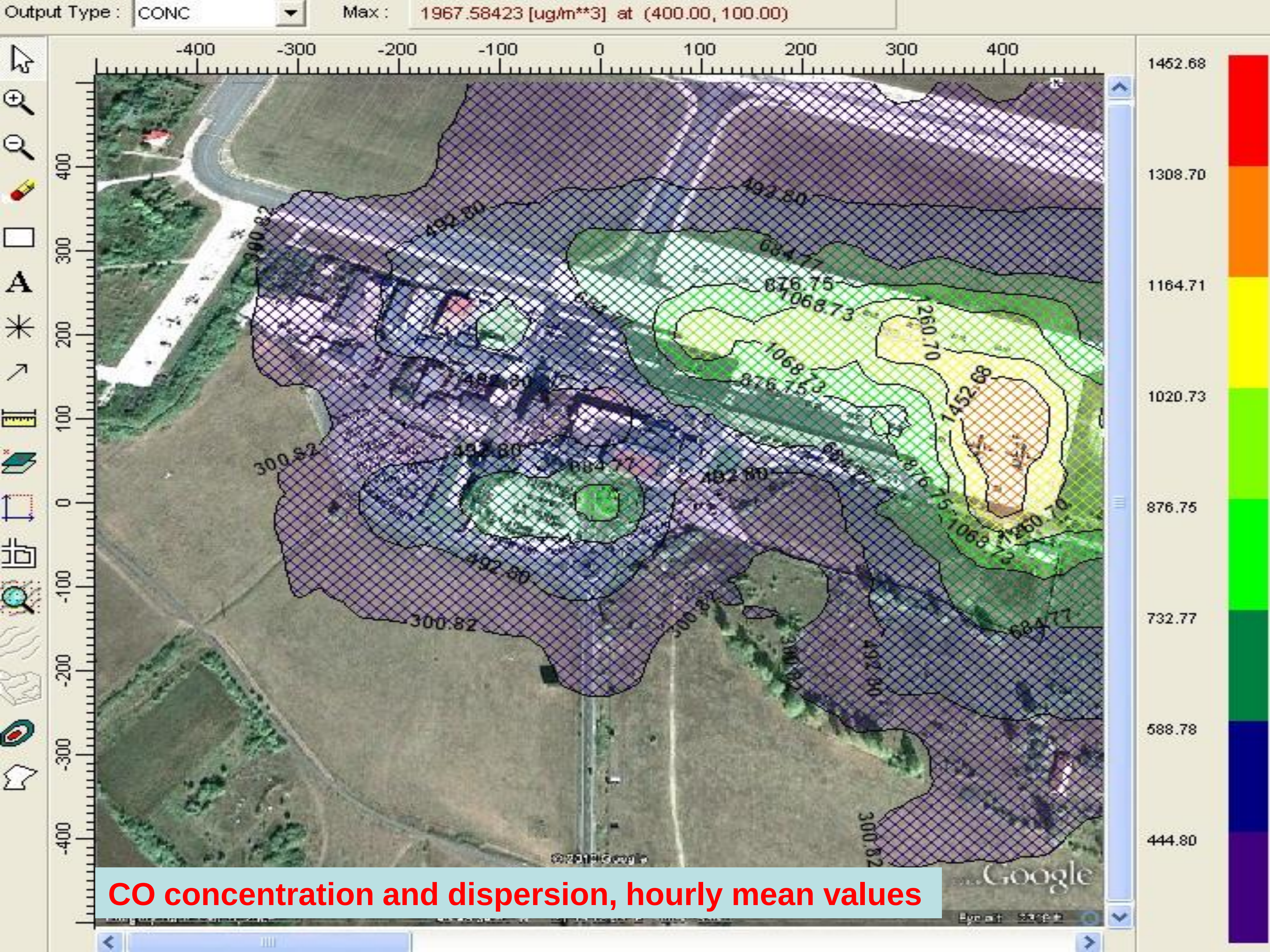
In this study the emission factors were selected from a database for ground transportation fleet, airport heating plant and aircraft characteristic fleet generated by EMEP/EEA air pollutant emission inventory guidebook 2009, an European emission factor database.

The scenario was built on the assumption of full air traffic load in the airport and at 50 % occupation of the airport car-parking facility. Thus 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.

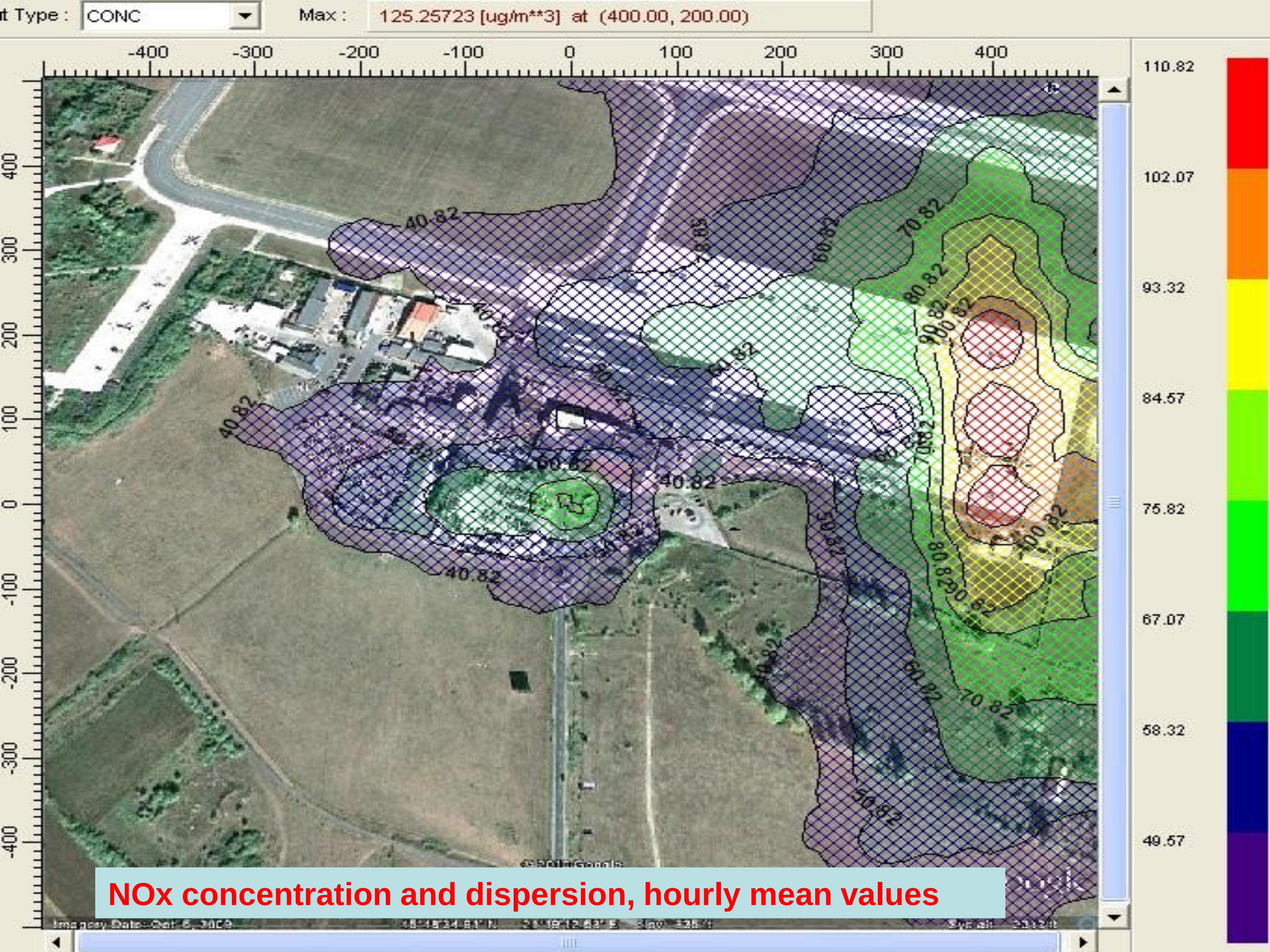
Aircraft class	Operational Cycle	CO [kg/s]	NMVOC [kg/s]	NOx [kg/s]
Boeing 737/400 (turbojet)	Landing (trust 30%, time 2 minutes)	0.02541	0.00105	0.01521
	Ground taxi (trust 7%, time 26 minutes)	0.02154	0.00141	0.00640
	Takeoff (trust 100%, time 50 seconds)	0.04425	0.002451	0.03354
Total emission factor/cycle/aircraft		***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

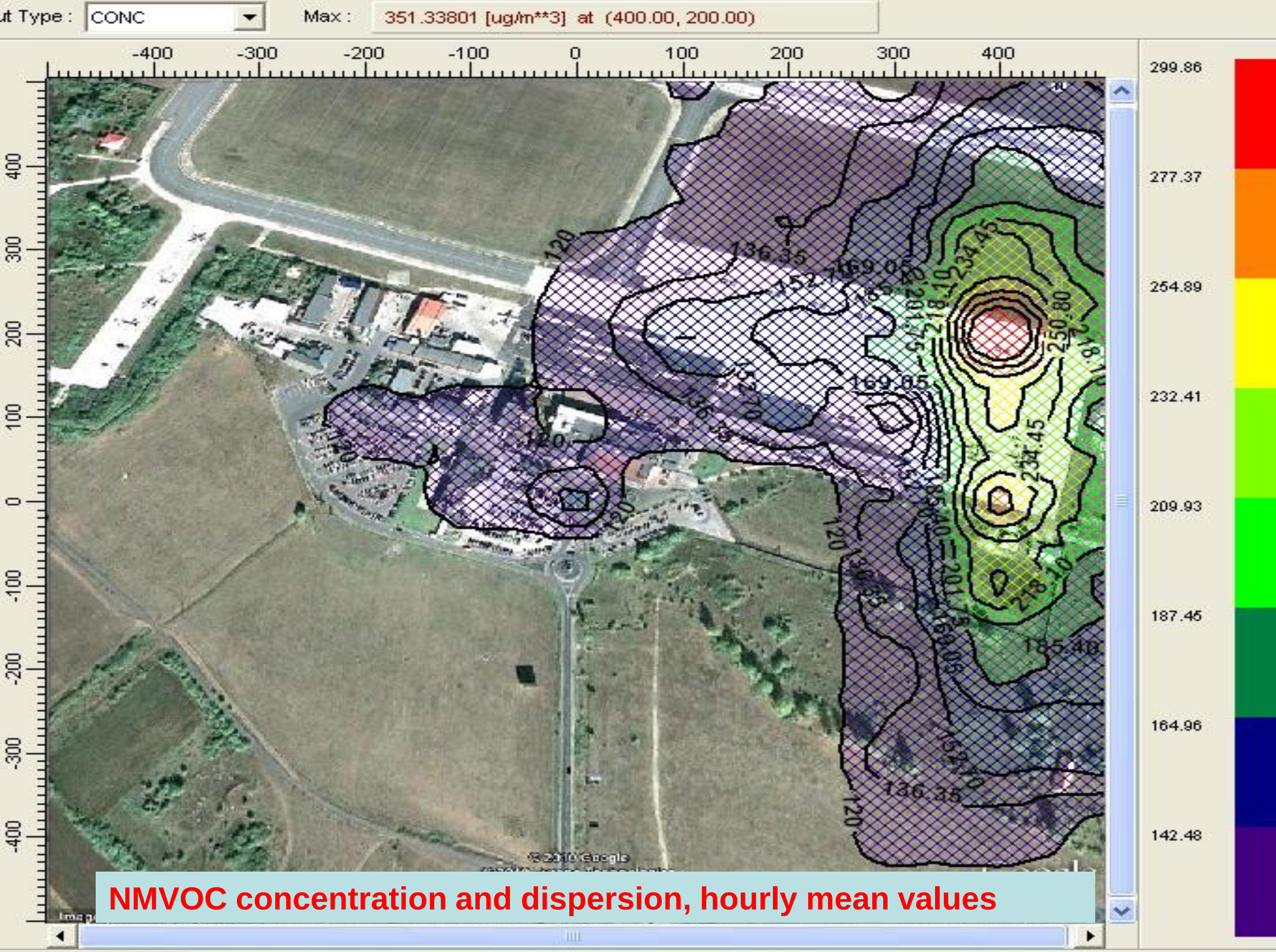
Pollutant	Emission factor [g/s]
Nitrogen oxides NOx	$1.09776 \cdot 10^{-2}$
Carbon monoxide CO	$4.814 \cdot 10^{-3}$
Non Methane Volatile Organic Carbon NMVOC	$0.0004 \cdot 10^{-3}$



CO concentration and dispersion, hourly mean values



NOx concentration and dispersion, hourly mean values



NMVOC concentration and dispersion, hourly mean values

Discussions and conclusions

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

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Discussions and conclusions

CO 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 showing that the aircraft emissions of NMVOC are up to 10.4 mg/kg fuel burnt, data obtained through the PartEmis project.

Discussions and conclusions

Aircraft emissions of CO and HC tend to be particularly high during taxi-in and taxi-out, when aircraft engines are operating at less than maximum efficiency. Hence, operational changes that reduce aircraft idling and taxi time can directly reduce pollutant emissions.

A variety of options exist to reduce emissions from ground service equipments. These include the use of alternative fuels, electric equipment, and emissions control retrofits.

As a consequence EUROCONTROL initiated the ALAQS (Airport Local Air Quality Studies) project which addresses strategic, methodological and practical issues surrounding air quality assessment around airports.

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This study was accomplished in the frame of *Romanian Atmospheric Research 3D Observatory* (RADO), Ref no: STVES – 2008/115266 with the financial support of Norwegian Cooperation Programme

"Dear friend, theory is and will always remain gray, green is only the LIFE three"

J. W. Goethe