University of Naples Parthenope
Italian Aerospace Research Center
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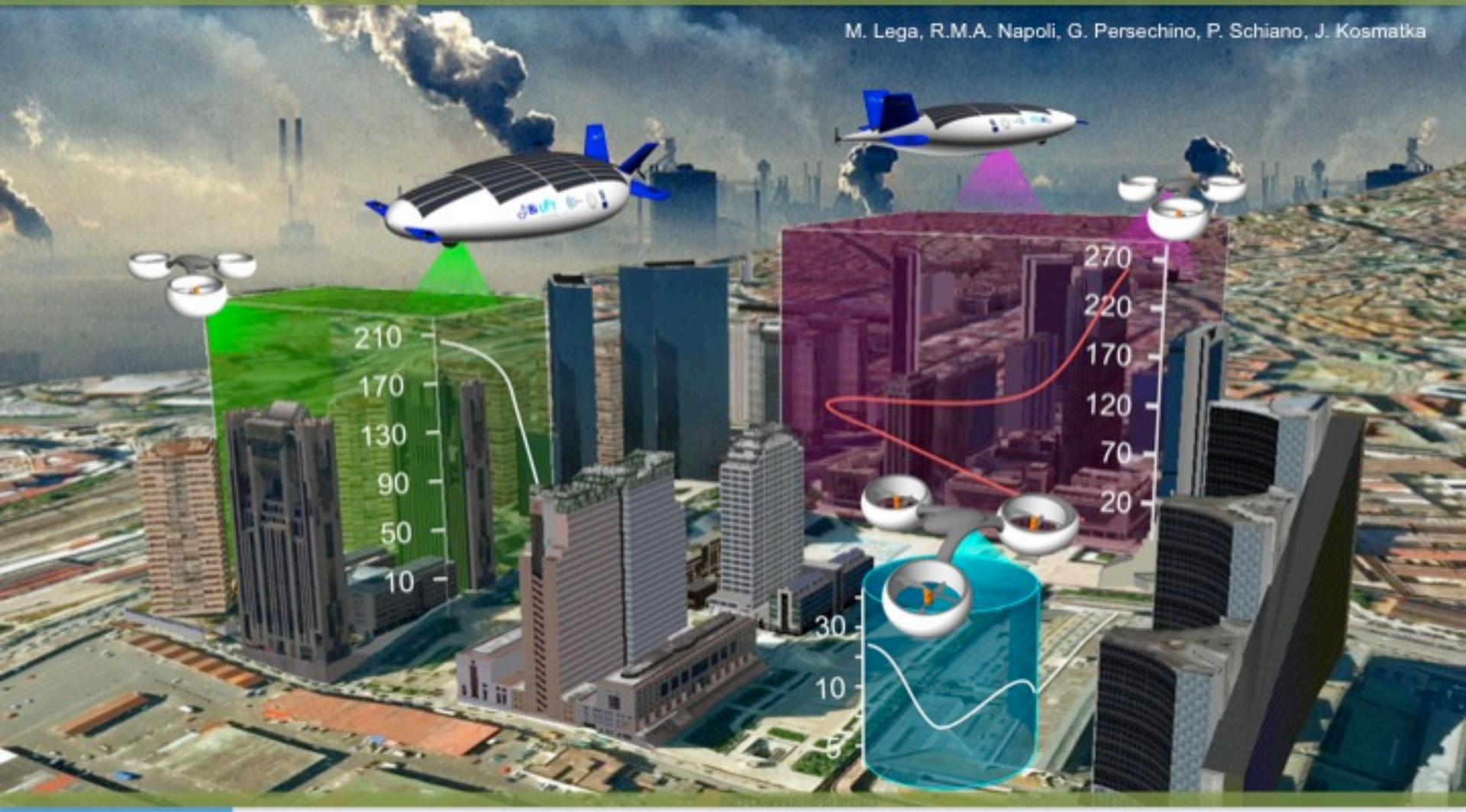
University of California - San Diego

Measurements of the Urban and Suburban CO2 Vertical Profile with an Airborne Electro-Optical Device

M. Lega, R.M.A. Napoli, G. Persechino, P. Schiano, J. Kosmatka



Past and present at NAQC

2008

2009

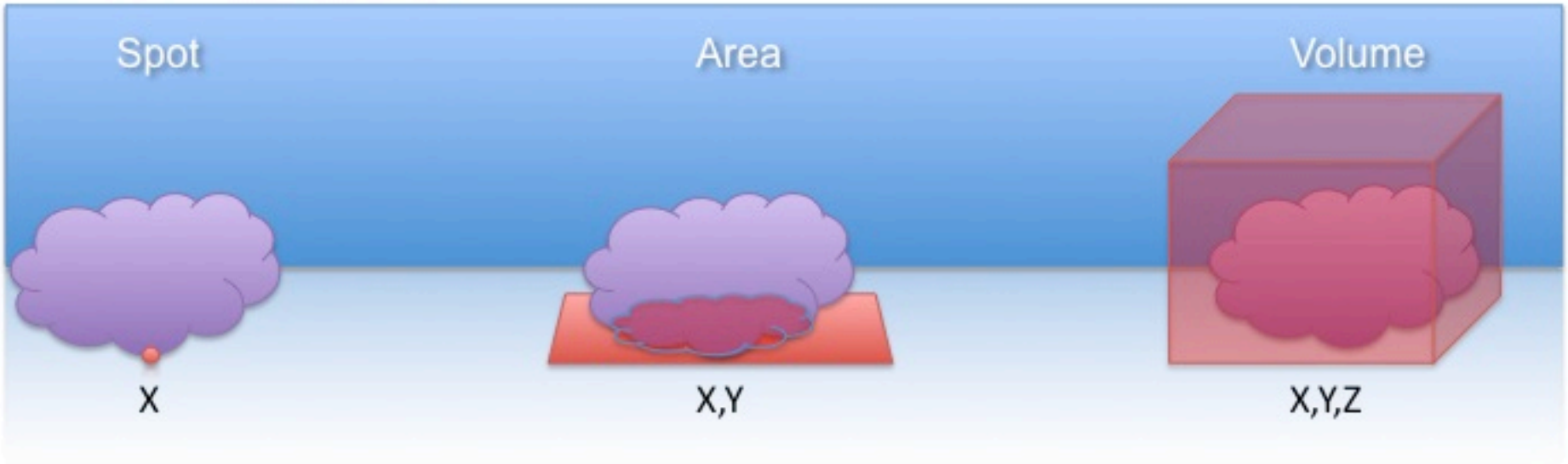
2010

Contents

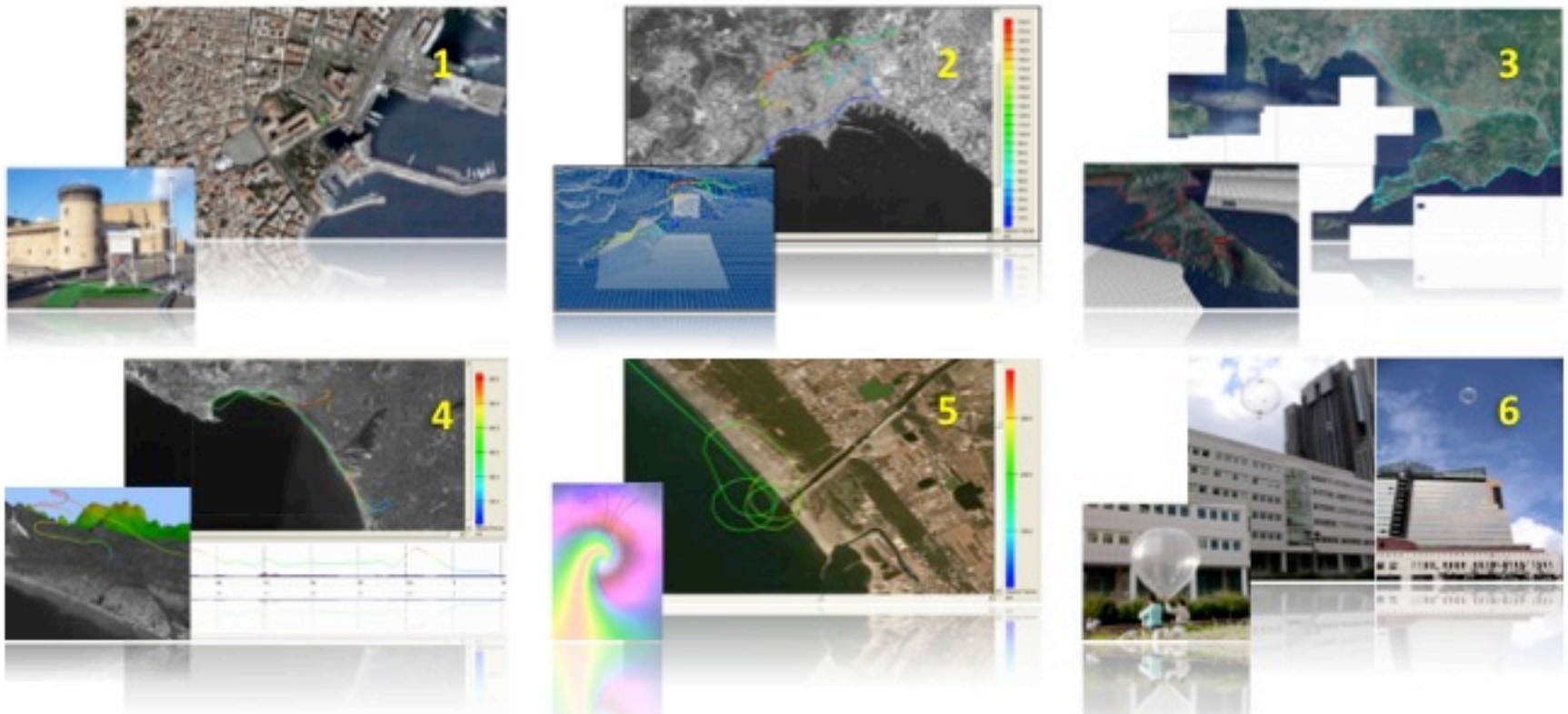
- 3D Monitoring
- Air pollution monitoring: case study history
- Sensors technology
- Aerial Platforms
- EMPA project
- BiLift – Advanced Hybrid Airship
- Advanced MAV Multirotor
- 3D Air Quality Monitoring: future perspective
- New case study: Business District of Naples

3D Monitoring

Where monitoring?



Air pollution monitoring: case study history



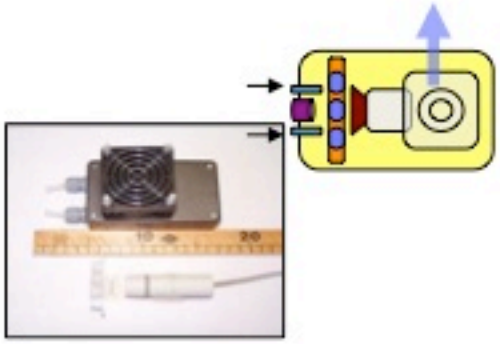
1) "Fixed point"
2) "Dynamic", short range by ground vehicle
3) "Dynamic", long range by ground vehicle
4) "Dynamic", long range by aerial platform
5) "Dynamic", vertical profile by aerial platform
6) "Dynamic", vertical profile by tethered balloon

Sensors technology

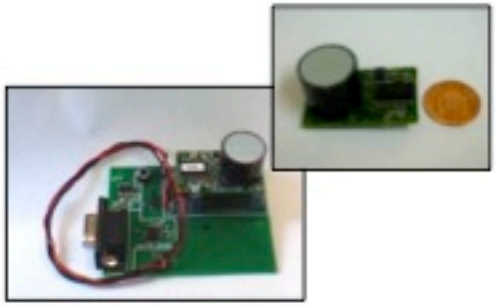
IR Camera

Thick film solid state sensor

Quartz crystal microbalance



Biosensor



Led NDIR CO2 sensor

Air sampler

Aerial Platforms

ULM

T. Balloon

Blimp

Video 1

Video 2

but today ...

EMPA project

Environmental Monitoring Performed by Advanced Sensors And LTA Platforms Supporting Urban And Suburban Early Warning Actions

Team

CIRA (Italy)
Italian Aerospace Research Center

PARTHENOPE (Italy)
University of Naples - Department of Environmental Sciences

CNR-IBP (Italy)
Italian National Research Council - Institute of Biochemistry of the Proteins

UCSD (USA)
University of California, San Diego - Department of Structural Engineering

UMD (USA)
University of Maryland - Department of Atmospheric and Oceanic Science

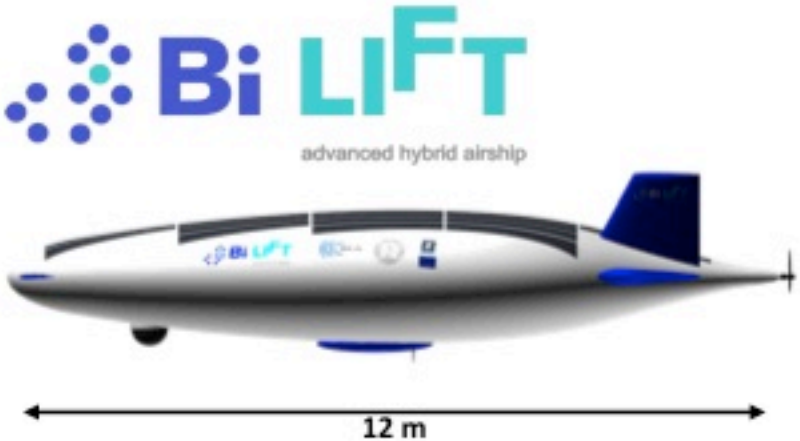
BiLift – Advanced Hybrid Airship

SPECIFICATIONS

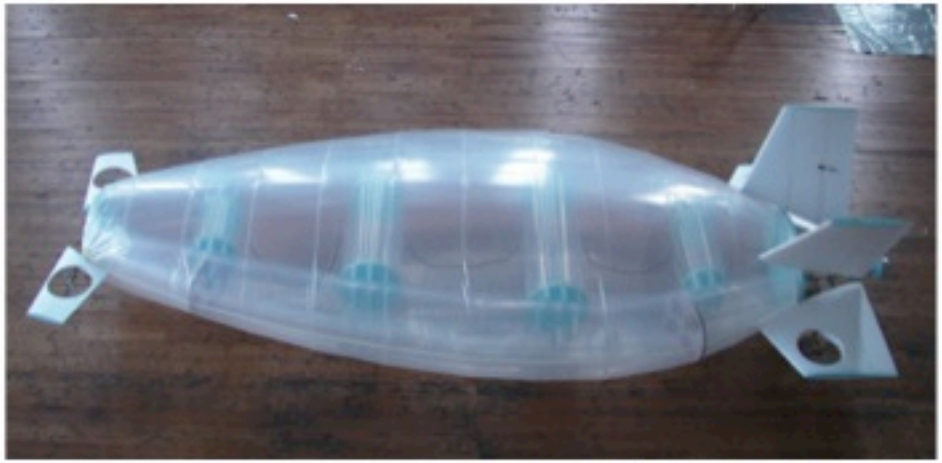
Length	12 m
Width	4.5 m (Dmax) – 2.20 m (Dmin)
Max Speed	50 Km/h
Payload	20 kg
Max weight (w/o helium)	60 Kg
Endurance	> 4 hours
Max. Altitude	1000 m
Control	RC/RPV/UAV

Plus:

- "Zero" emissions
- High maneuverability al low speed
- Easy handling
- Vertical take-off and landing
- Low cost management



BiLift – Advanced Hybrid Airship



BiLift – first flying prototype

Advanced MAV Multirotor

naturaldrones
flying systems

SPECIFICATIONS

Length - Width	1 m – 1 m
Max Speed	50 Km/h
Payload	1 kg
Endurance	20 - 30 min
Max. Altitude	300 - 500 m
Datalink range	2 km
Control	RC/RPV/UAV

Plus:
- Autonomous flight (by waypoint)
- "Zero" emissions
- High maneuverability
- Easy handling
- Vertical take-off and landing
- Low cost management
- Safe (special frame + flight termination system: elect. control and parachute)

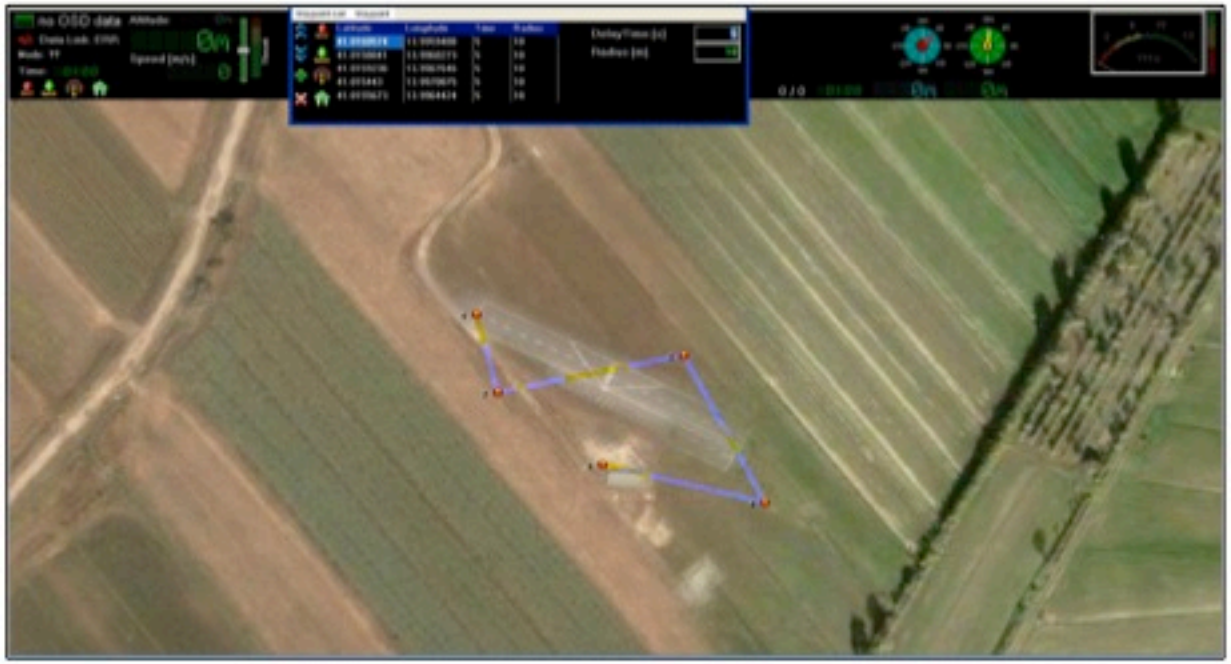
Advanced MAV Multirotor

Mold model and first fiberglass frame

Advanced MAV Multirotor

First flying prototype

Advanced MAV Multirotor

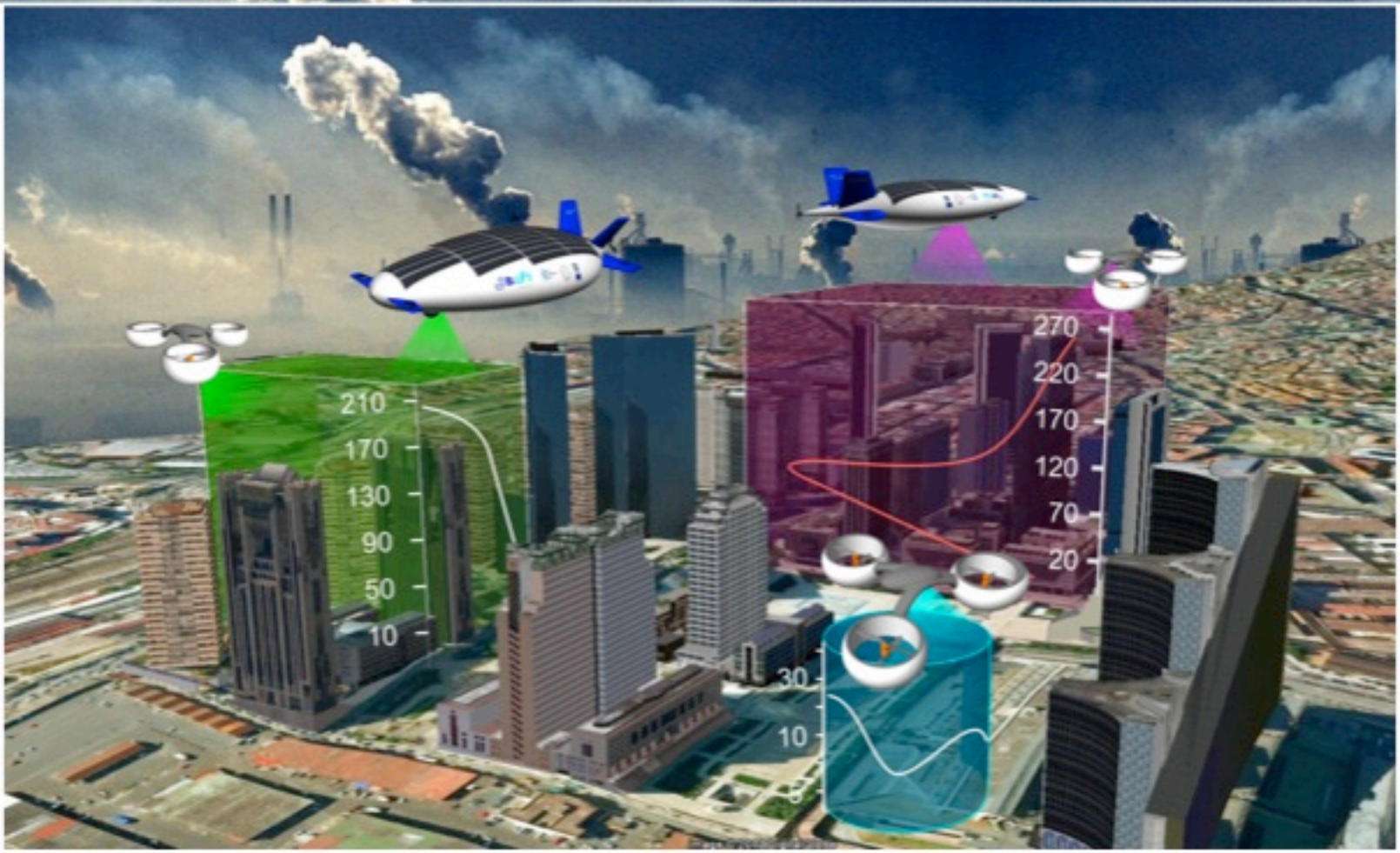


Example of virtual cockpit
(realtime flight data + map + way point +….)

3D flight path

Advanced MAV Multirotor

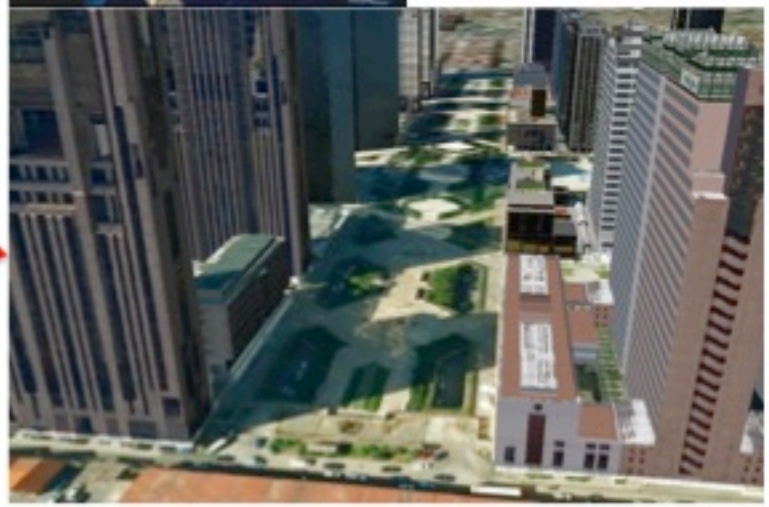
3D Air Quality Monitoring: future perspective



New case study: Business District of Naples

Aerial view

Standard picture



Satellite view and 3D building overlap

New case study: Business District of Naples

Patent

Title: Air pollutants monitoring by a continuous process, in real time and at different altitudes.

Inventors: M. Lega – R. M. A. Napoli

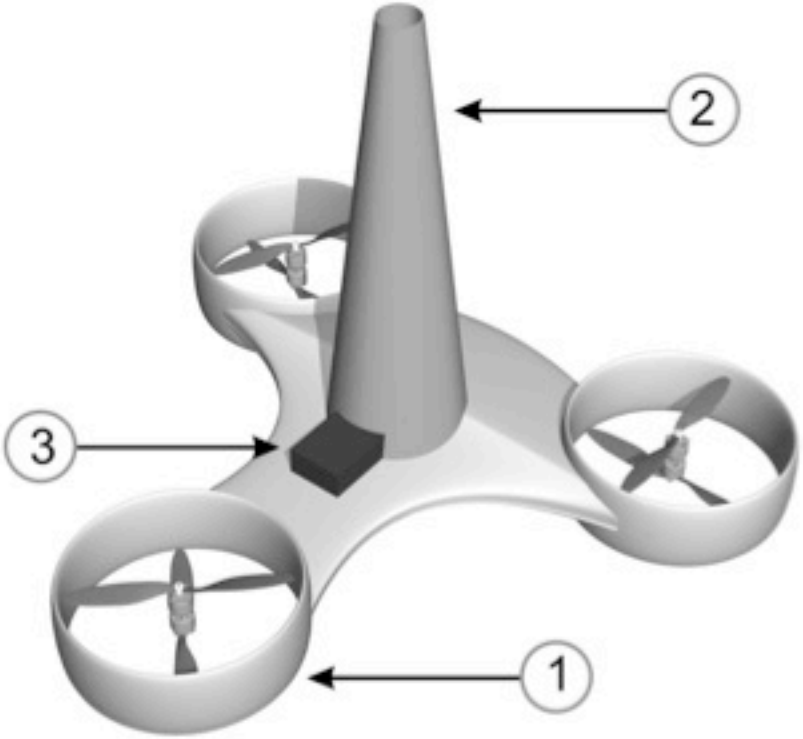
Plus

-uses a fluid dynamics probe that allows to analyze air flux without any perturbation by the lift and the propulsion system of the aerial multirotors platform;

-uses an aerial multirotors platform with an electrical propulsion system, so any alterations of monitored scenario due to pollutant added by on board combustion systems (typically used by gas engine) are avoided;

-allows to see in real time, on the ground station, the 3D position of the aerial multirotors platform;

-allows to pilot the platform through sequences of preset points of measuring/stationing that will constitute a spatial sampling grid of the monitoring scenario linked to the data collected by the on board sensor .



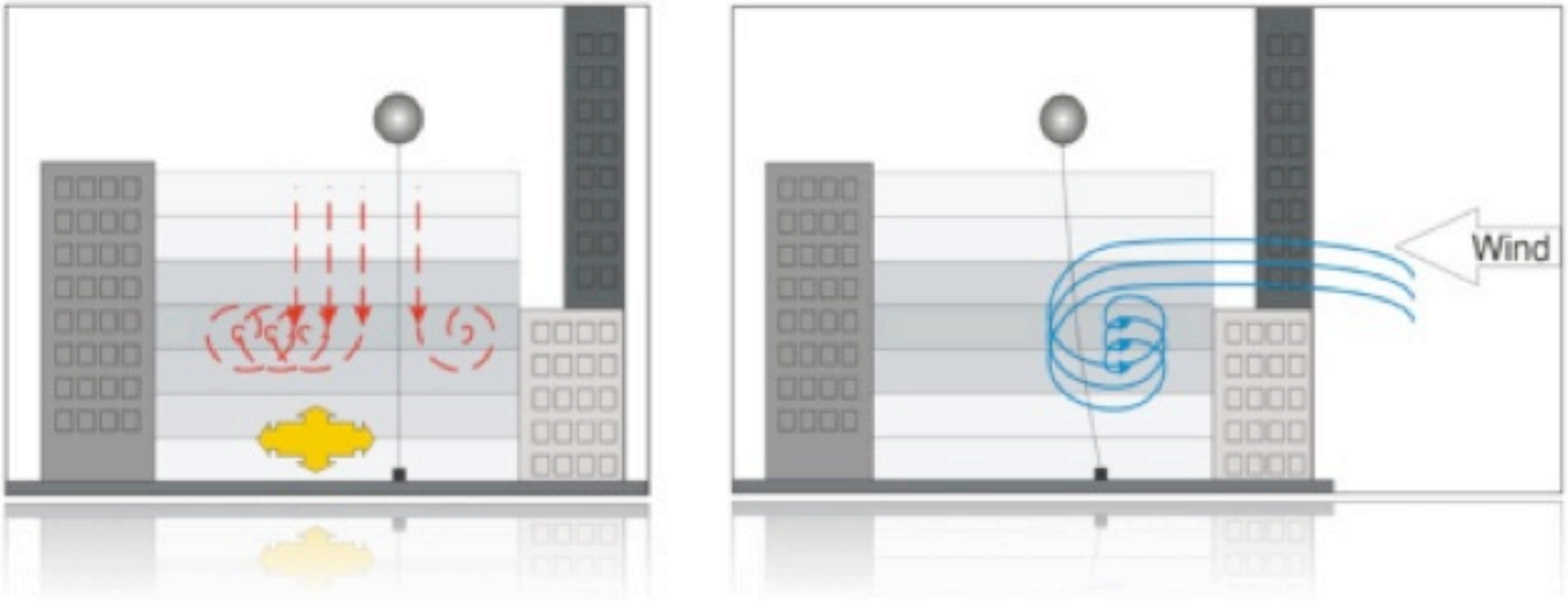
New case study: Business District of Naples

Location of first measurements spots

PM

CO_2

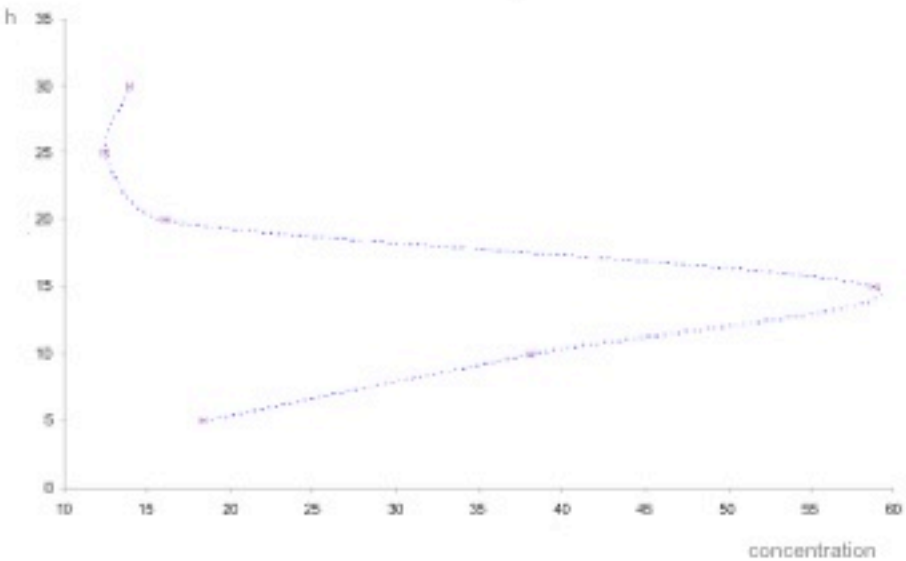
New case study: Business District of Naples

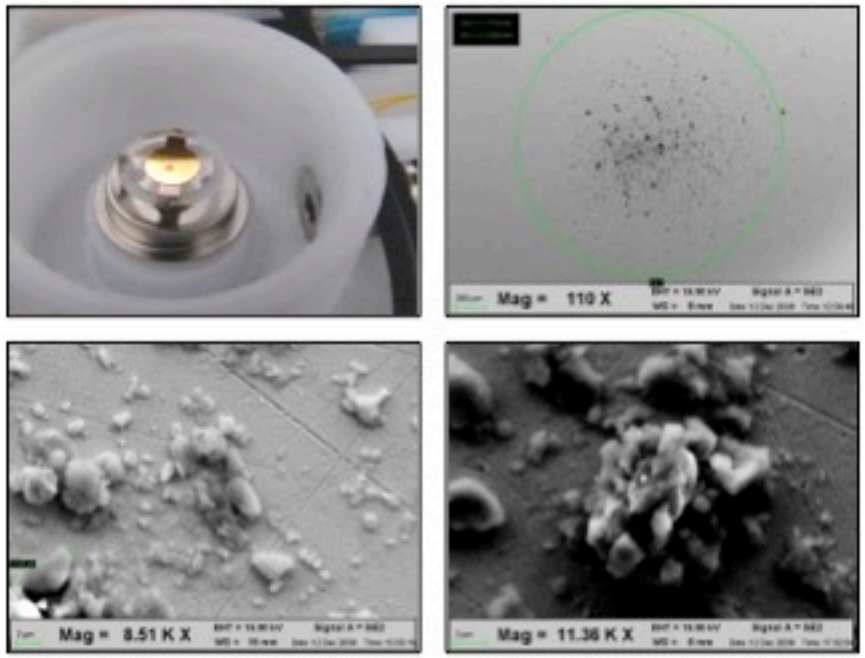


Urban canyon, floating volume and downwash

New case study: Business District of Naples

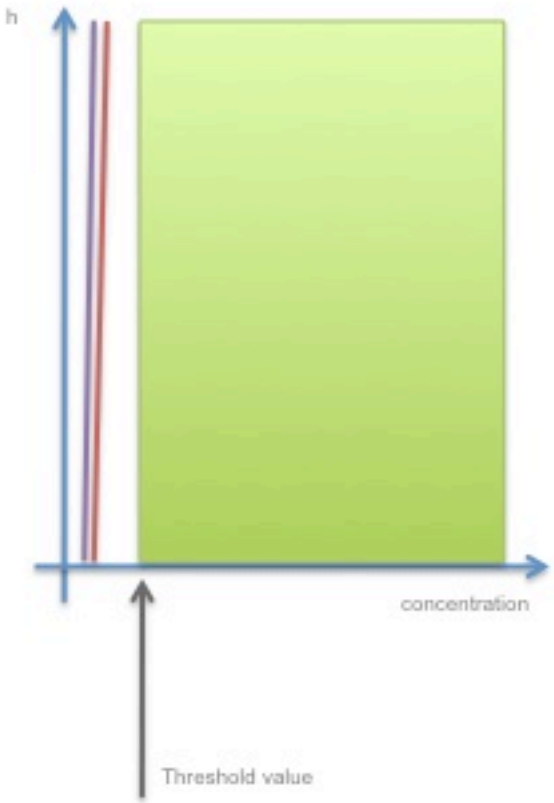
PM vertical profiles





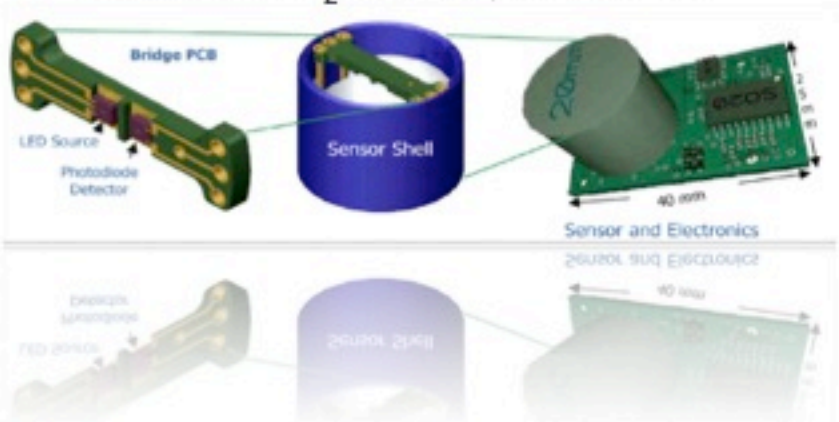
with contribution of novaetech

New case study: Business District of Naples



Noise at zero (30s integration)	10 ppm
Temperature range	-25C to +55C
Supply Voltage	4.7V to 5.5V (std) 3.3V to 5.5V (low)
Average Power Consumption	<100mW
Peak Supply Current	200mA
Range	0 to 20% (up to 100% available)
Output	TTL level RS232 + Analogue Output
T90	< 4secs
Zero Drift	Recommend re-zeroing once 2-3month

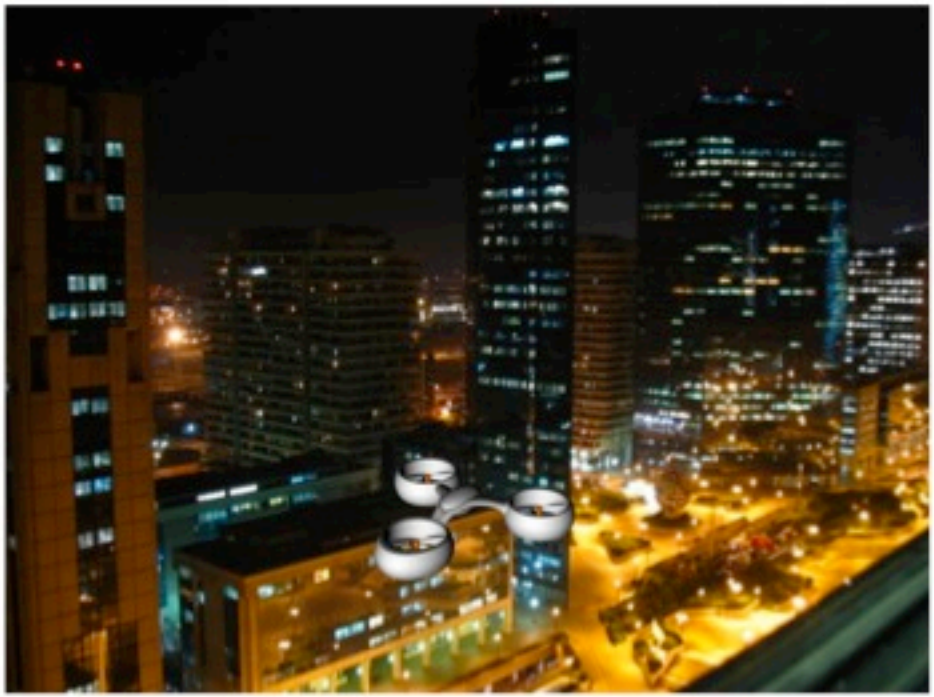
Led NDIR CO_2 sensor specification



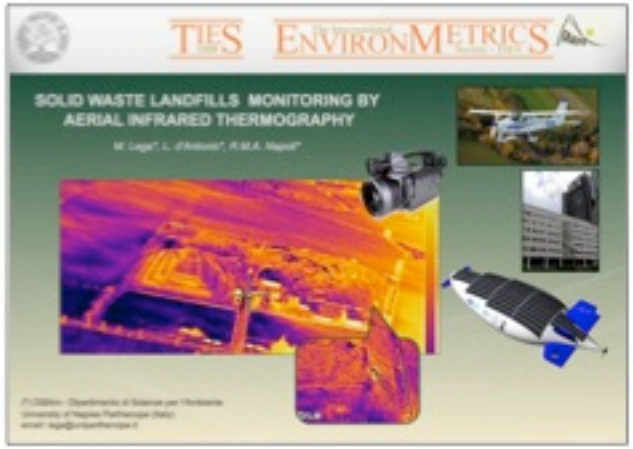
New case study: Business District of Naples

Video 4

New case study: Business District of Naples



Ongoing activities



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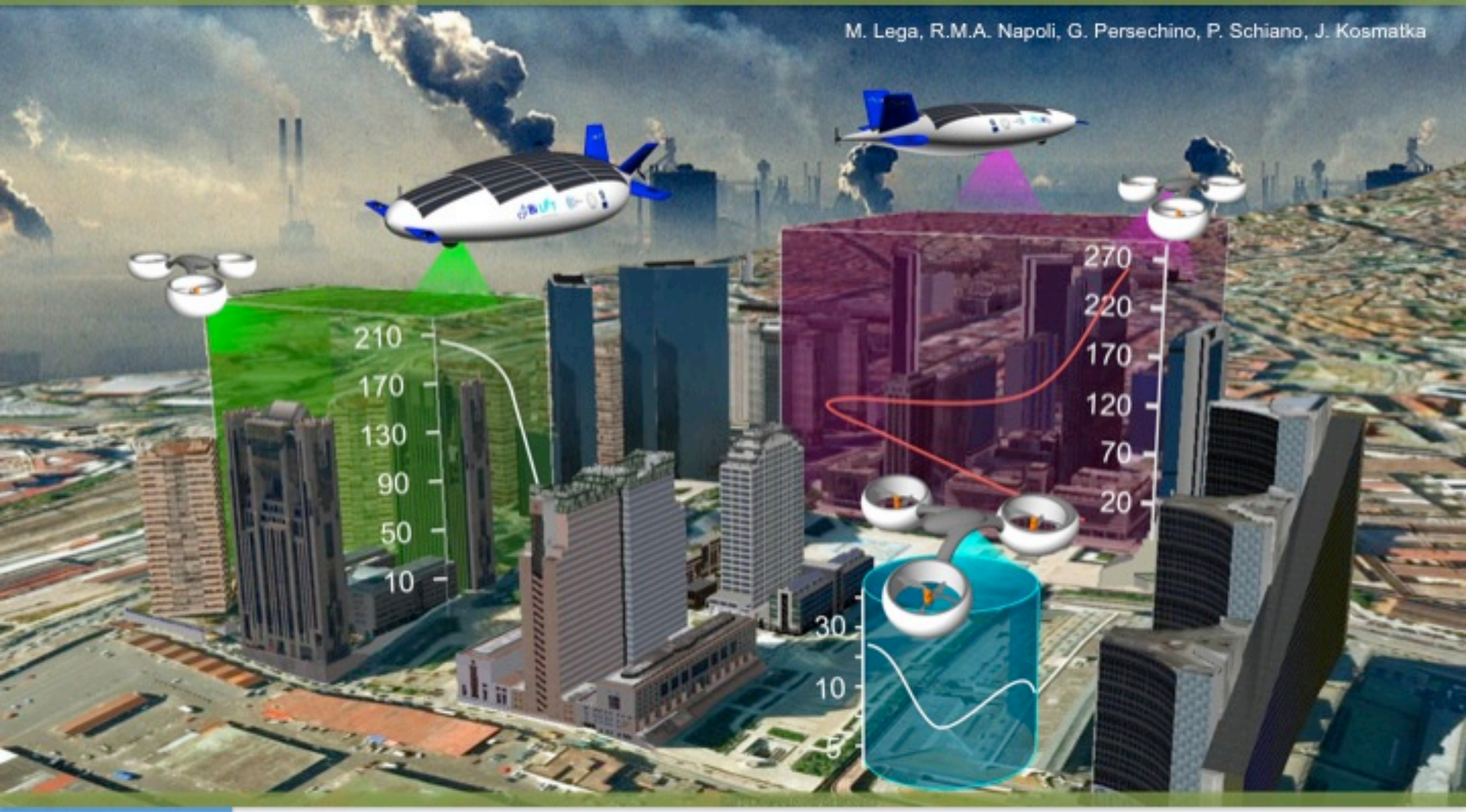
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