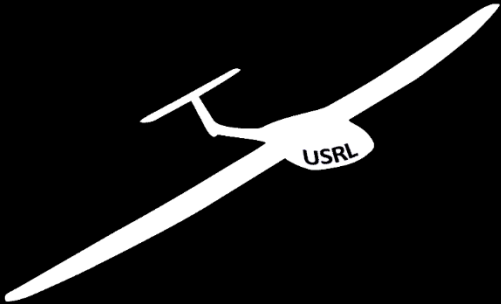


TECHNICAL
DESCRIPTION



UNMANNED SYSTEMS
RESEARCH LABORATORY



Context

The Unmanned Systems Research Laboratory (USRL) is a Research Facility of the Cyprus Institute (Cyl), a non-profit research organization located in Cyprus (<https://www.cyi.ac.cy/>)

USRL is a component of the monitoring infrastructure « Cyprus Atmospheric Observatory » (CAO), which is part of several International Networks (ACTRIS, EMEP, WMO-GAW, AERONET)

CAO is composed by

1. A regional supersite at Agia Marina Xyliatou (520m asl) – offering ACTRIS TNA
2. **the USRL runway and airspace at Orounda** (close to the Agia Marina Xyliatou supersite)
3. A free tropospheric site at Troodos (1,825m asl)

Geographic location



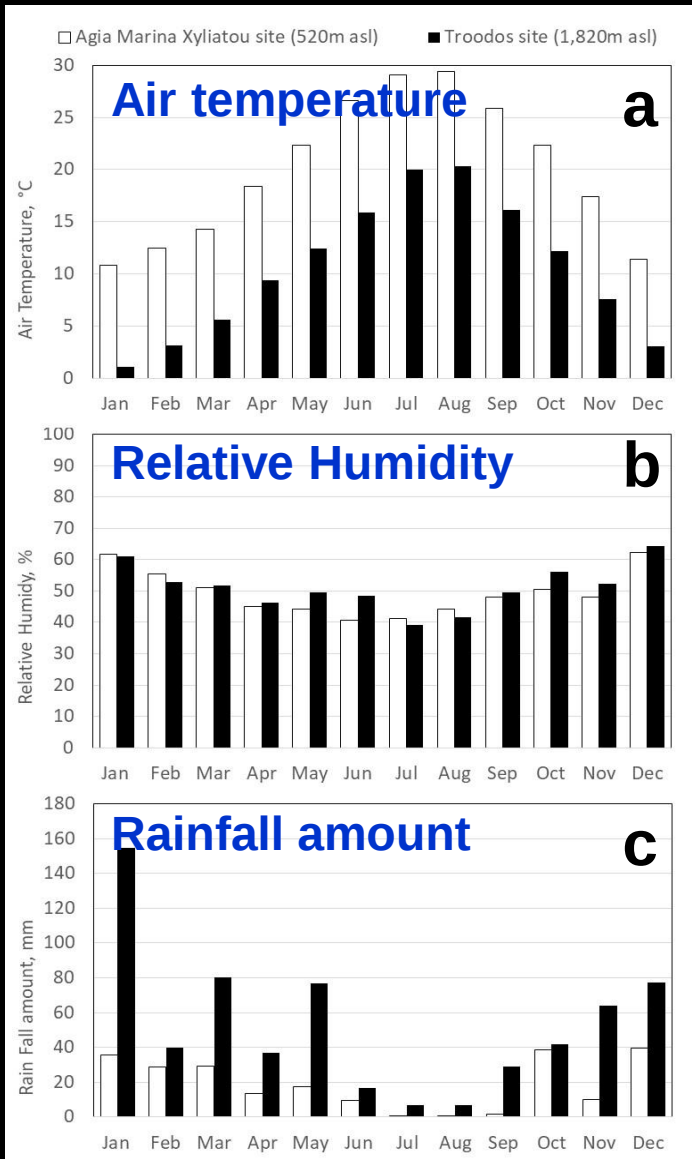
Location of Cyprus in the Eastern Mediterranean Middle East (EMME) region



USRL is a component of The Cyprus Atmospheric Observatory composed by

1. the free tropospheric site at Troodos (1,825m asl)
2. the regional supersite at Agia Marina Xyliatou (520m asl)
3. the USRL runway at Orounda.

Climatology (overview)



Wind rose obtained for a the 3-year period (2014-2016) at the CAO free tropospheric site at the regional supersite at Agia Marina Xyliatou (520m asl)



Monthly variations of air temperature (a), Relative Humidity (b), and rainfall amount (c) at the regional supersite at Agia Marina Xyliatou (520m asl) & Troodos site (1,820m asl)

USRL Teams

Technical Team (6 staff)

Dr C. Keleshis: Associated Research Scientist – UAV systems

M. Argyrides: Chief pilot - professional pilot flying Commercial airliners (Airbus 300s)

C. Savvides: Second pilot - professional pilot flying Commercial airliners (Fokker 70 & 100)

P. Vouterakos: pilot – UAV developer (Mechatronics)

P. Antoniou: Electronic Engineer

A. Leonidou: UAV developer (Fiber specialist)



Scientific Team (6 staff)

Dr J. Sciare: Atmospheric Sciences, Manager of USRL

Dr G. Biskos: Aerosol and Gas Instrumentation

Dr M. Pikridas: Atmospheric Sciences (instrumentation, data processing)

Dr K. Neitola: Atmospheric Sciences (instrumentation)

Dr A. Bruggeman: Hydrology

Dr K. Erguler: Biologist

USRL Facilities at the Cyprus Institute

*The Cyprus Institute
New Technologies Laboratory - Nicosia*



USRL facilities



Mechanical Workshop

Payload
Assembly Station
Bench Drill /
Sander/Saw
CNC Lathe



CNC
Milling
Machine



3D
Printer

Electronic Workshop

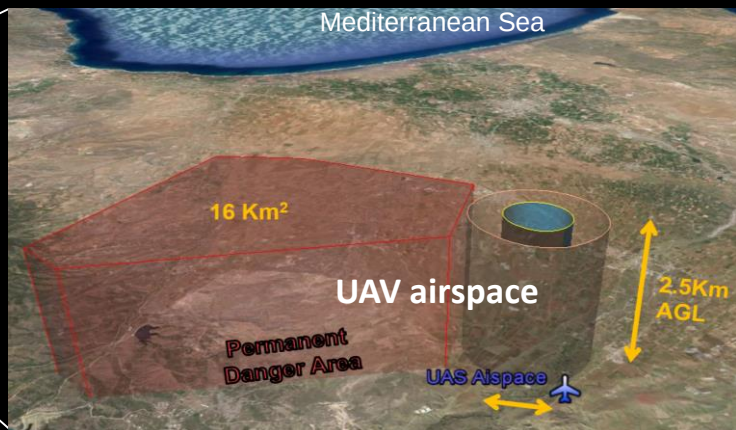
(De)Soldering
Station



Battery
Charging
Station

1. Multimeter
2. Spectrum Analyzer
3. Power supplies

4. Oscilloscope
5. Function Generator



(NOtice for Air Men)

+

**Extra flight zone of 16km²
accessible on request**

Latitude: 35°05'41.74 N
 Longitude: 33°04'53.34 E
 Altitude: 300m above sea level

UAV runway (Nov. 2015)

The image shows an aerial view of a UAV runway. The runway is a dark, paved strip on a reddish-brown field. It has a width of 12 m and a length of 200 m. The runway is marked with the number 12 at both ends. A small white vehicle is parked on the left side of the runway. The background shows a flat landscape with some distant buildings and a clear sky.



UAV runway (Mar. 2017)



Hangar(Mar. 2017)

Authorization will have to be requested in advance for flying in other areas in Cyprus

Fleet of Unmanned Aerial Vehicles (UAVs)

Fixed wing

4 UAVs



Cruiser

Medium Size: 35 Kg

Payload: 12 Kg

Endurance: 4 hours

Ceiling: 4 Km

1 UAV



Mini Cruiser

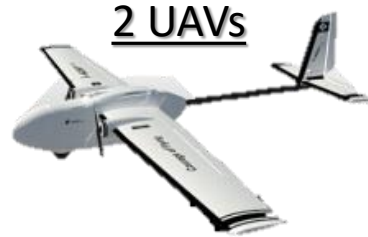
Small Size: 11 Kg

Payload: 4.5 Kg

Endurance: 3 hours

Ceiling: 4 Km

2 UAVs



Airiteci-Soar

Small Size: 6.5 Kg

Payload: 2.5 Kg

Endurance: 1.5 hours

Ceiling: 3 Km

9 UAVs



Skywalker 1680

Small Size: 4 Kg

Payload: 1.5 Kg

Endurance: 1.5 hours

Ceiling: 3 Km

Rotary Wing

1 UAV



Logo 800

Small Size: 12 Kg

Payload: 5 Kg

Endurance: ~30 minutes

Ceiling: 3 Km

1 UAV



Dji S1000+

Small Size: 11Kg

Payload: 4 Kg

Endurance: ~20 minutes

Ceiling: 1 Km

UAV control / communication / instrumentation

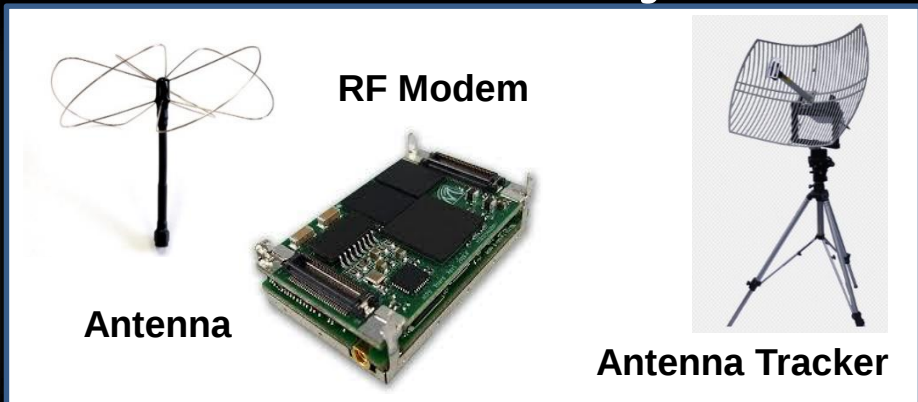
Mobile Ground Control Station (GCS)



Instrumentation available on every UAV system



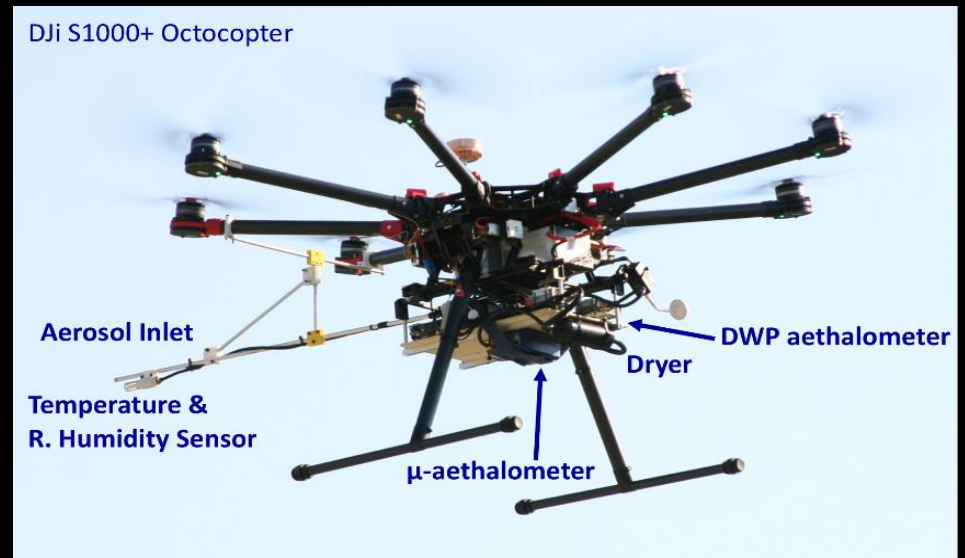
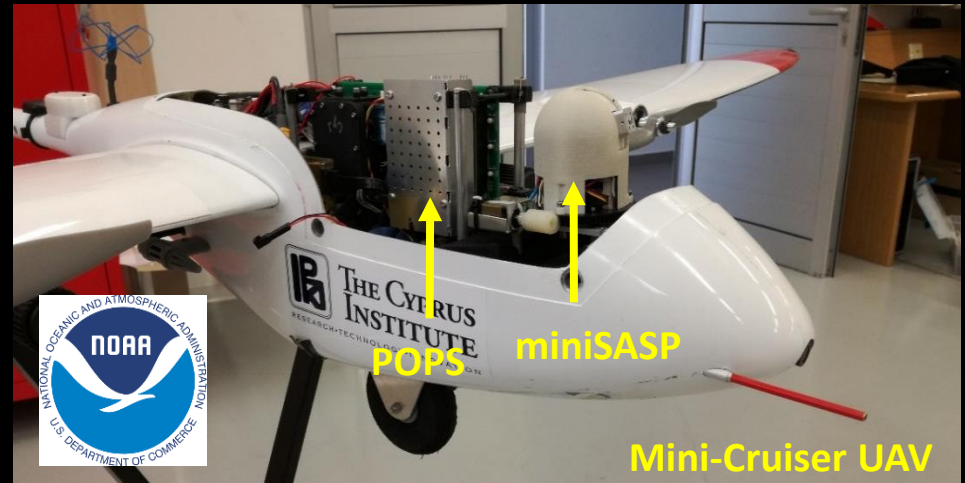
UAV wireless communication system



*Autopilot systems allow pre-programmed flights to be operated autonomously and with high precision

UAV – sensor systems

Example of customized integration



Research sensor prototypes (atmospheric research)



Printed Optical Particle Spectrometer (POPS)

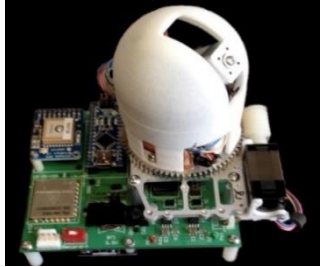


- Single-particle detection
- 140–3000 nm diameter
- 550 g, 5 W
- Lose-able (~\$2000)

Gao et al., 2016



Mini Scanning Aerosol Sun Photometer (miniSASP)



- 460, 550, 670, 860 nm
- 0.02 AOD detection limit
- 350 g, 2 Watts
- Lose-able (~\$1500)

Murphy et al., 2015



GOETHE UNIVERSITÄT FRANKFURT AM MAIN



- 1 sample (wafer) – 5 to 15 min
- Flow = 5 LPM

Schrod et al., 2017

Commercial sensors (atmospheric research)

2B Technologies

Alphasense
air
SENSORS FOR AIR QUALITY NETWORKS

Senseair

BRECHTEL

AETHLABS

PALAS

Alphasense
air
SENSORS FOR AIR QUALITY NETWORKS

TSI

Param.	Instrument	Specifications	Cost	Reference
O ₃	2B Technologies Model Personal Ozone Monitor (POM)	Federal Equivalent Method (EQOA-0815-227); linear dynamic range 0-10ppm; resolution 0.1ppb; precision (1 σ) >1.5ppb; LoD (2 σ) 3ppb; response 2-10s; flow 0.5L/min; nominally 250 mA at 12 V; 3.0 watt; battery 5-8h; 460g with batteries	5-10k€	http://twobtech.com/pom-personal-ozone-monitor.html
O ₃	Alphasense OX-A431 Oxidising Gas Sensor	linear dynamic range 0-20ppm; resolution 0.1ppb; precision (1 σ) >1.5ppb; LoD (2 σ) 3ppb; response 2-10s; flow 0.5L/min; nominally 250 mA at 12 V; 3.0 watt; battery 5-8h; 460g with batteries	<1k€	http://www.alphasense.com/WEB1213/wp-content/uploads/2016/04/OX-A431.pdf
CO ₂	SenseAir OEM HPP v4	Infrared absorption spectroscopy, range 0.007-1000 ppm, precision 2-5 ppm, prototype being improved	~2k€	http://www.senseair.com/
BC	STAP (Single channel tri-color absorption photometer)	Light absorption at 450, 525 and 624nm. Sample flow up to 1.7 LPM; noise level (1 σ) 0.1Mm-1; c.a. 1.5kg	15-20k€	http://www.brechtel.com/brechtel/wp/wp-content/uploads/2014/10/Brechtel_Model_9400_ACCESS_Brochure.pdf
BC	Microaeth	Light absorption at 375, 470, 528, 625, and 880nm. Sample flow up to 150ml/min; time base 1 to 300s; 420g (all included)	20k€	https://aethlabs.com/microaeth
N size dist.	Fidas® Fly 100	Range (size) 0.18-18 μ m in 64 channels; resolution 1s; dynamic range 0 – 20,000 #/cm ³ ; flow 1.4l/min; battery 6h; 1.4kg with battery	15k-20k€	http://www.palas.de/en/product/fidasfly100
N size dist.	Alphasense OPC-N2 Particle Sensor	Range (size) 0.38-17 μ m in 16 channels; resolution 10s; dynamic range 0 – 10,000 #/cm ³ ; flow 1.2l/min; 0.1kg without battery	<1k€	http://www.alphasense.com/WEB1213/wp-content/uploads/2017/02/OPC-N2.pdf
Total Aerosol Number	TSI Inc. CPC3007	Total particles (>0.01 μ m); dynamic range 0 – 100,000 #/cm ³ ; response time <9s for 95% response; flow 0.7l/min; 1.5kg with battery	10-15k€	http://www.tsi.com/uploadedFiles/Site_Root/Products/Literature/Spec_Sheets/3007_1930032.pdf



Past international field campaigns



Athens (Greece) – Jan. 2016

(H2020 ACTRIS2)

https://www.youtube.com/watch?v=i_prZBF1PPA



AQABA cruise – June/August 2017

(Mediterranean Sea, Red Sea, Persian-Arabic Gulf)

https://www.youtube.com/watch?v=L_Mp5xpEkZ0



USRL (Cyprus) – Apr. 2016

(EU-FP7-BACCHUS)



PALLAS – Cloud Experiment (Finland) – Sep. 2017

(TNA – H2020 ACTRIS2)

Recent UAV applications

3D reconstruction of Archaeological sites (June 2017)



High precision 3D ground mapping (Sep. 2017)



MozzyJet project (Nov. 2017):

Aerial mosquito control vehicle for targeted, effective, and low-cost injections of biopesticides



Fire detection



FIRE IDENTIFICATION

The Cyprus Atmospheric Observatory (CAO) <http://www.cyi.ac.cy/index.php/cao.html>

Cyprus
Atmospheric
Observatory
(CAO)



Cyprus
Atmospheric
Observatory



The Cyprus Atmospheric Observatory (CAO)

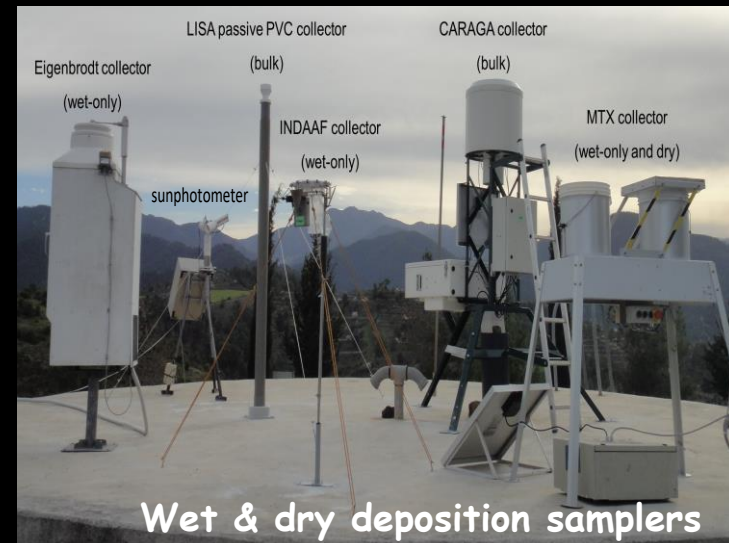
Atmospheric instrumentation

Instrument	Parameter	T	Instrument	Parameter	T
Aerosol chemistry					
Aerosol Chemical speciation Monitor (ACSM) LSCE	Ions, OM (incl. sources) in PM ₁	30 min	On-line VOC LSCE+DLI	VOC (C2-C6)	30 min
Aerosol Chemical Composition DLI+Cyl+ECPL	Ions, EC, OC, PM, metals, in PM ₁ , PM _{2.5} & PM ₁₀	24h	On-line VOC EMD+DLI	VOC (C6-C12)	30 min
TEOM & TEOM-FDMS DLI+LSCE	PM _{2.5} & PM ₁₀	6 min	Air quality		
Aerosol physical properties			DLI Ozone Monitor	Ozone (O ₃)	5 min
LSCE OPC	N spectra (0.3µm - 20µm)	1 min	DLI Carbon Monoxide Monitor	(CO)	5 min
LSCE SMPS	N spectra (0.003µm - 0.8µm)	15 min	DLI Nox Monitor	NO, NO ₂	5 min
HTDMA TU Delft	Hygroscopicity	15 min	DLI Sulfur dioxide Monitor	SO ₂	5 min
Aerosol optical properties			Weather Station + Solar Flux		
Aethalometer LSCE	Absorption PM ₁ (7λ)	5 min	LSCE + DLI	P, T, RH, WS, WD, Rad.	5 min
Nephelometer LSCE	Light scattering Coeff. (3λ)	15 min	Solar Flux LOA	(In)direct solar radiation	5 min
Sunphotometer LOA	A.O.D (7λ)	15 min			

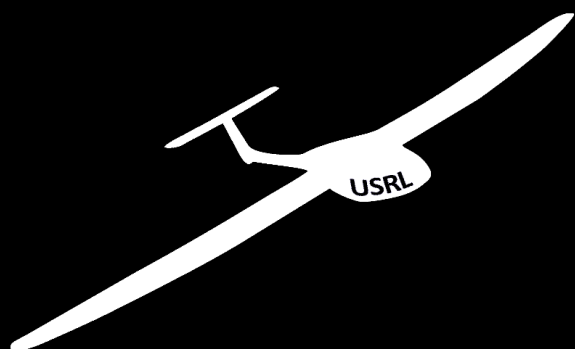
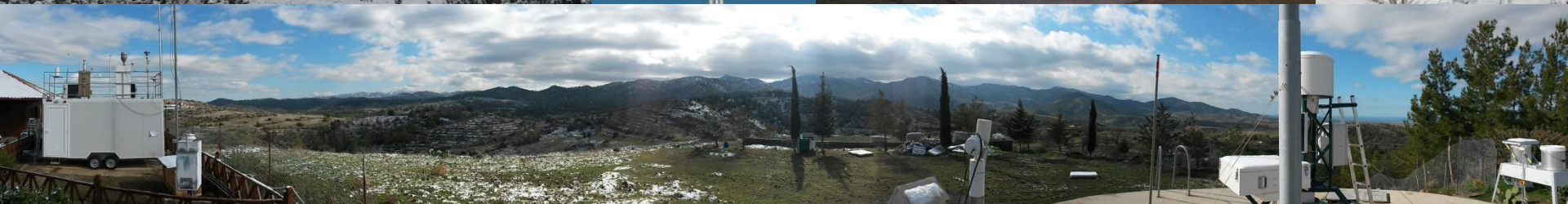


Inside view of the Cyl container

Strategic partners



Wet & dry deposition samplers



**UNMANNED SYSTEMS
RESEARCH LABORATORY**

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