Improvement of a low-cost CO_2 commercial NDIR sensor for UAV atmospheric profiling applications

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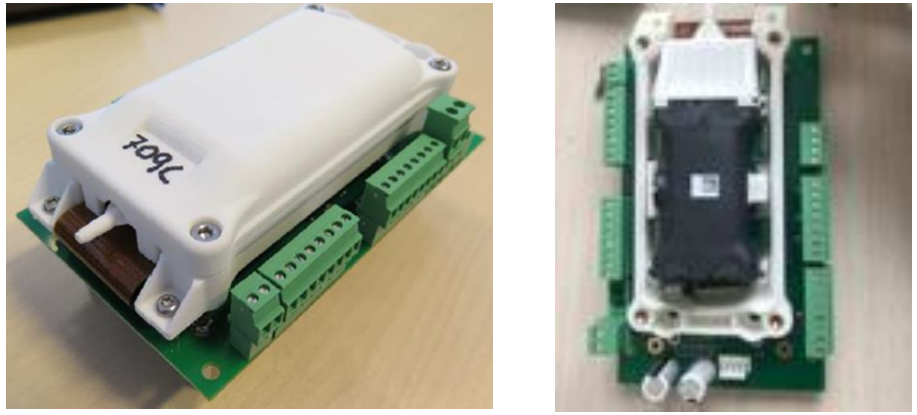
1 Introduction

This study aims to develop and validate a UAV-CO_2 sensor system to map specific source emissions close to the ground. The CO_2 sensor used here is the High-Performance Platform (HPP 3.2, SenseAir AB) of a total weight 1058g including battery.



CO_2 Sensor
(SenseAir AB HPP_CO_2 3.2version)

Unmanned System Research Laboratory (Cyl) -*Cruiser EFI*

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2 Methodology

Performance Tests		Purposes
2.1 Laboratory Tests	Calibration	Confirm the presicion and stability
	Allan Deviation	Confirm the noise
	Temperature Tests	Correct from T changes
	Pressure Tests	Correct from P changes
	Humidity Tests	Correct from RH changes
	Simulated Flights	Assess the measurement error caused by T and P
2.2 Field Development	Manned Aircraft	Compare the performance with Picarro G2401-m
2.3 Field Development	UAV platforms	A small fixed-wing UAV with a wingspan of 1.83m

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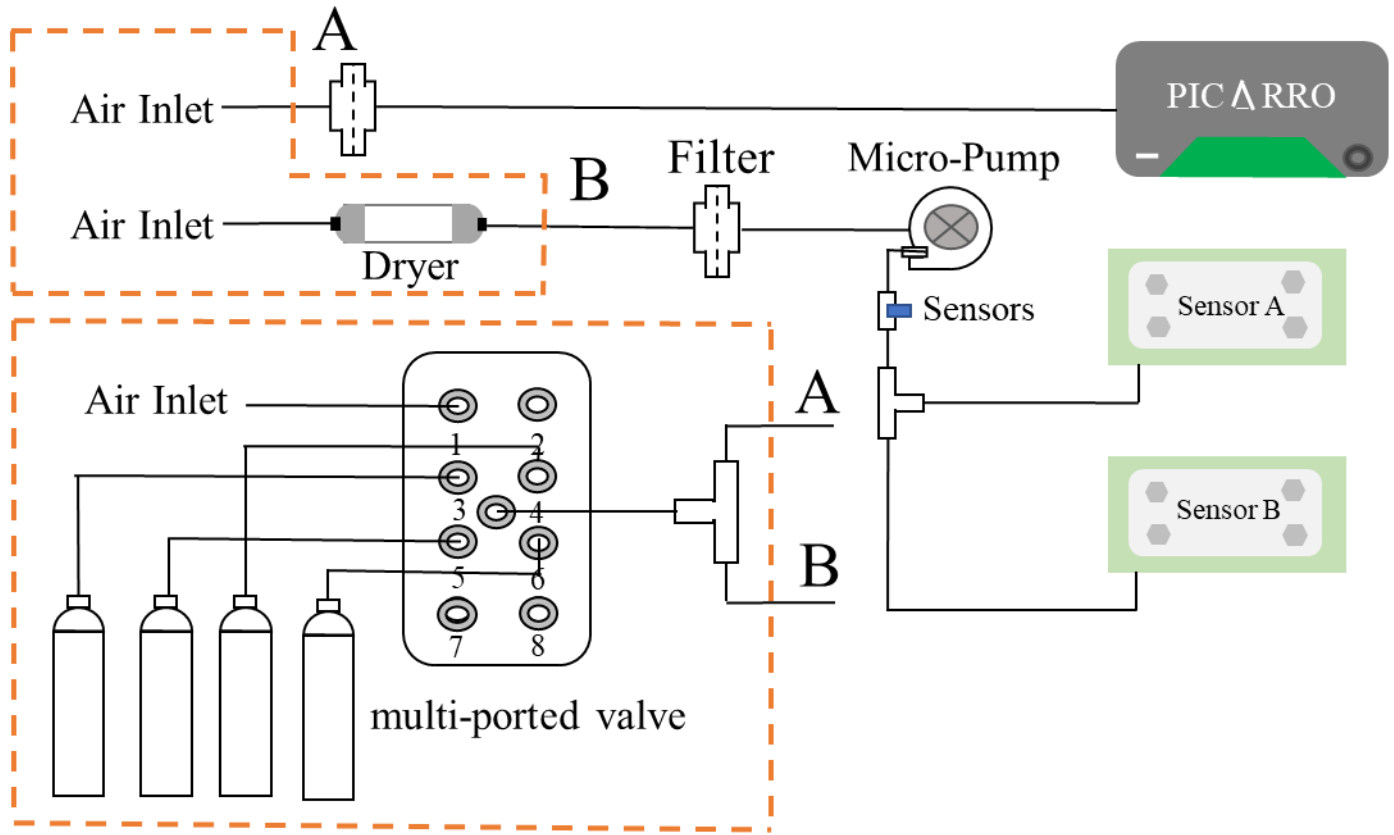

System set up for lab tests and field development

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2 Methodology

Highlights (lab tests)

- The precision of Sensor A is ±0.36 ppm (1σ) at 1 Hz.
- The precision of Sensor B is ±0.85 ppm (1σ) at 1 Hz.
- Sensor B is more sensitive to pressure changes.
- Simulation tests show above 90% change corrected by pressure.
- Each sensor unit on purchase has their own P/T equations.

The setup and aircraft platform (Beechcraft Baron 58)

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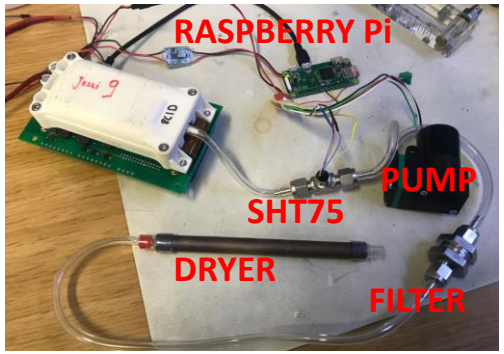
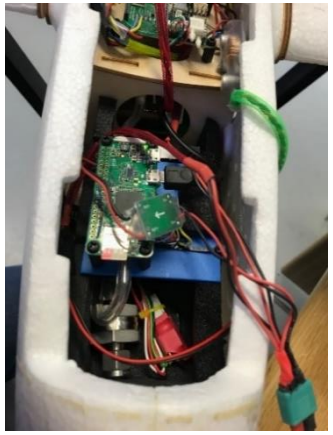
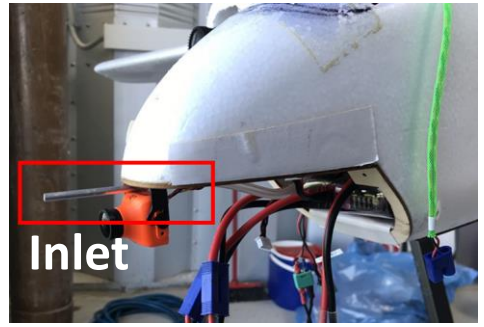
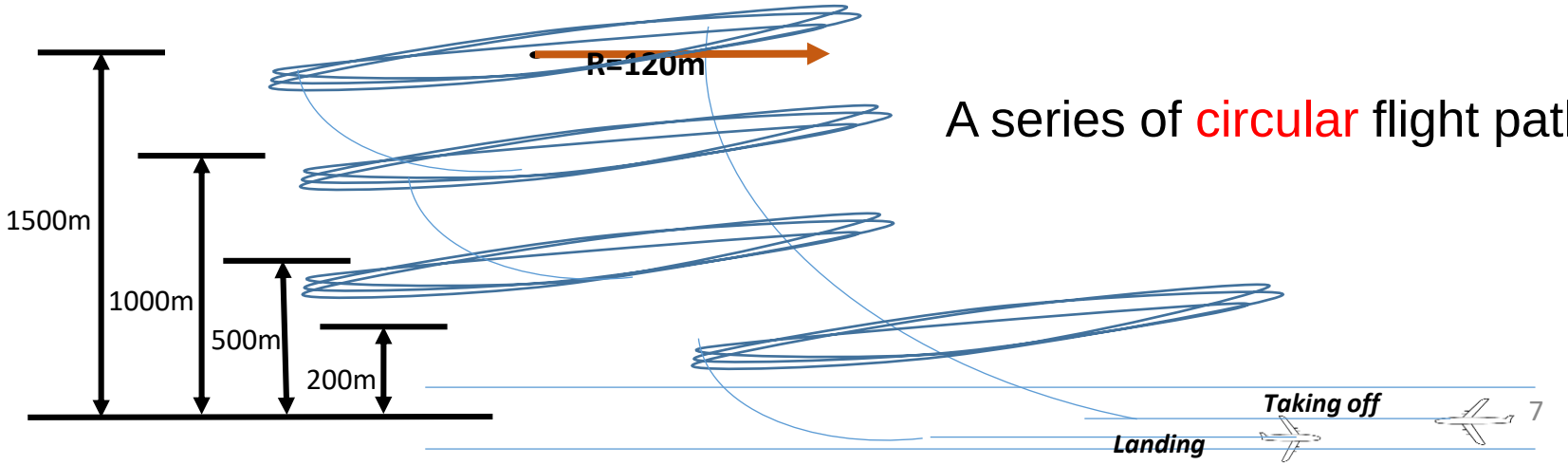
System set up on the UAV platform







USRL-CYI Runway



A series of circular flight paths

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3 Recommendations

- Both sensors performs better below 1.5 km ASL.
- Calibration series are necessary to be correctted by P/T equations.
- The flowrate of sensors should be above 500 ml/min.
- Water vapor experiments are unrepeatable, so a dryer is necessary in the system.
- Each sensor unit on purchase needs to be tested.
- The UAV-CO_2 sensor system is more suitable for horizontal measurements to investigate emissions close to the ground.

References

1. E. Arzoumanian et al., Atmos. Meas. Tech., 2019, 12, 2665-2677.
2. G. Allen et al., J. Waste Manag., 2019, 87, 883-892.
3. M. Kunz et al., Atmos. Meas. Tech., 2018, 11, 1833-1849.
4. J. Peischl et al., J. Geophys. Res. Atmos., 2016, 121, 6101-6111.

Thank you very much for your attention