Measuring Air Pollution with a small Unmanned Aerial Vehicle (sUAV)

Ajith Kaduwela[1], Roberto Hurtado[2], Longji Yin[3], Russell Evangelista[2], Daniel Andenmatten[2], Peng Wei[2], Amal Kaduwela[4], Anthony Wexler[1,2], and Zhaodan Kong[1,2]

[1] Air Quality Research Center, University of California, Davis, 95616
[2] Department of Mechanical and Aerospace Engineering, University of California, Davis, 95616
[3] Zhejiang University, Hangzhou, China, [4] Albany Middle School, Albany, California, U.S.A.

UC DAVIS
AIR QUALITY RESEARCH CENTER

ABSTRACT: We have mounted an air sensor package (originally developed at the Albany High School in California and later improved at the University of California at Davis) on a small Unmanned Aerial Vehicle (sUAV – DJI s1000+ octocopter) and made vertical flights to measure the temperature structure and the particulate loadings of the early-morning atmosphere. The sensor package consists of a BMP280 (barometric pressure, relative humidity, and temperature) and a PMS7003 (PM size cuts of 0.3, 0.5, 1.0, 1.5, 2.5, and 10 μm and PM_1, $PM_{2.5}$, and PM_{10} mass) controlled by a Raspberry Pi Version 3 B+ programed with Python. Here, we present the measured early morning vertical temperature structure and particulate matter loading of the atmosphere for a clean and a wild-fire-impacted day.

INTRODUCTION

The use of low-cost sensor for environmental monitoring has become wide-spread in recent years. This movement is fueled mostly by the do-it-yourself assessment of the health of our planet in air, water, and soil which is directly linked to the wellbeing of humans.

Almost all low-cost air sensor packages are ground-based. But the atmospheric chemistry/physics take palace in the volume of air above us in the mixing layer. So, probing this volume of air in the third dimension is very important.

The small Unmanned Aerial Vehicles (sUAV aka drones weighing less than 55 lbs) has become ubiquitous and their operational parameters are now being codified by the Federal Aviation Administration (FAA) in Part 107 of FAA Regulations.

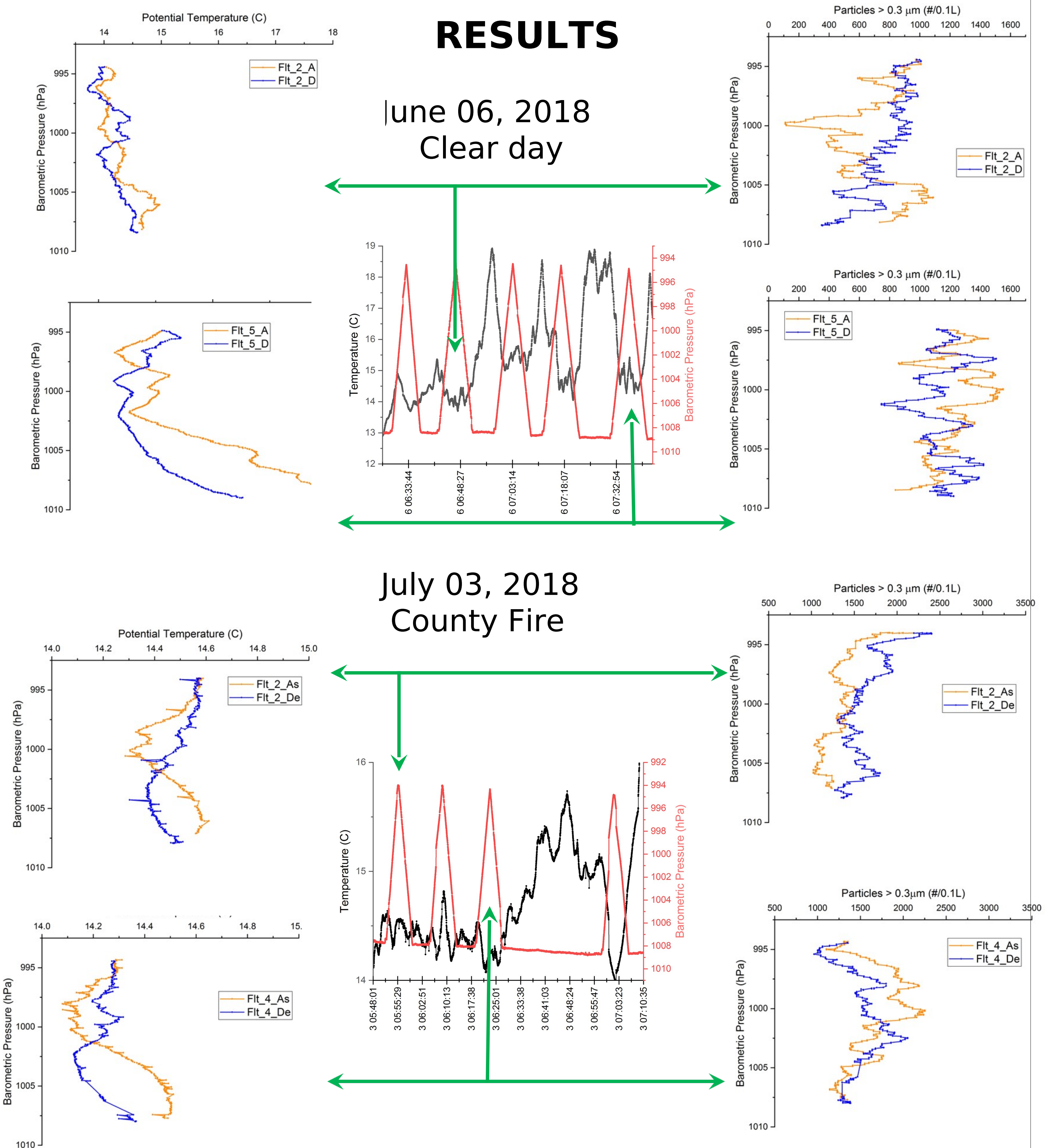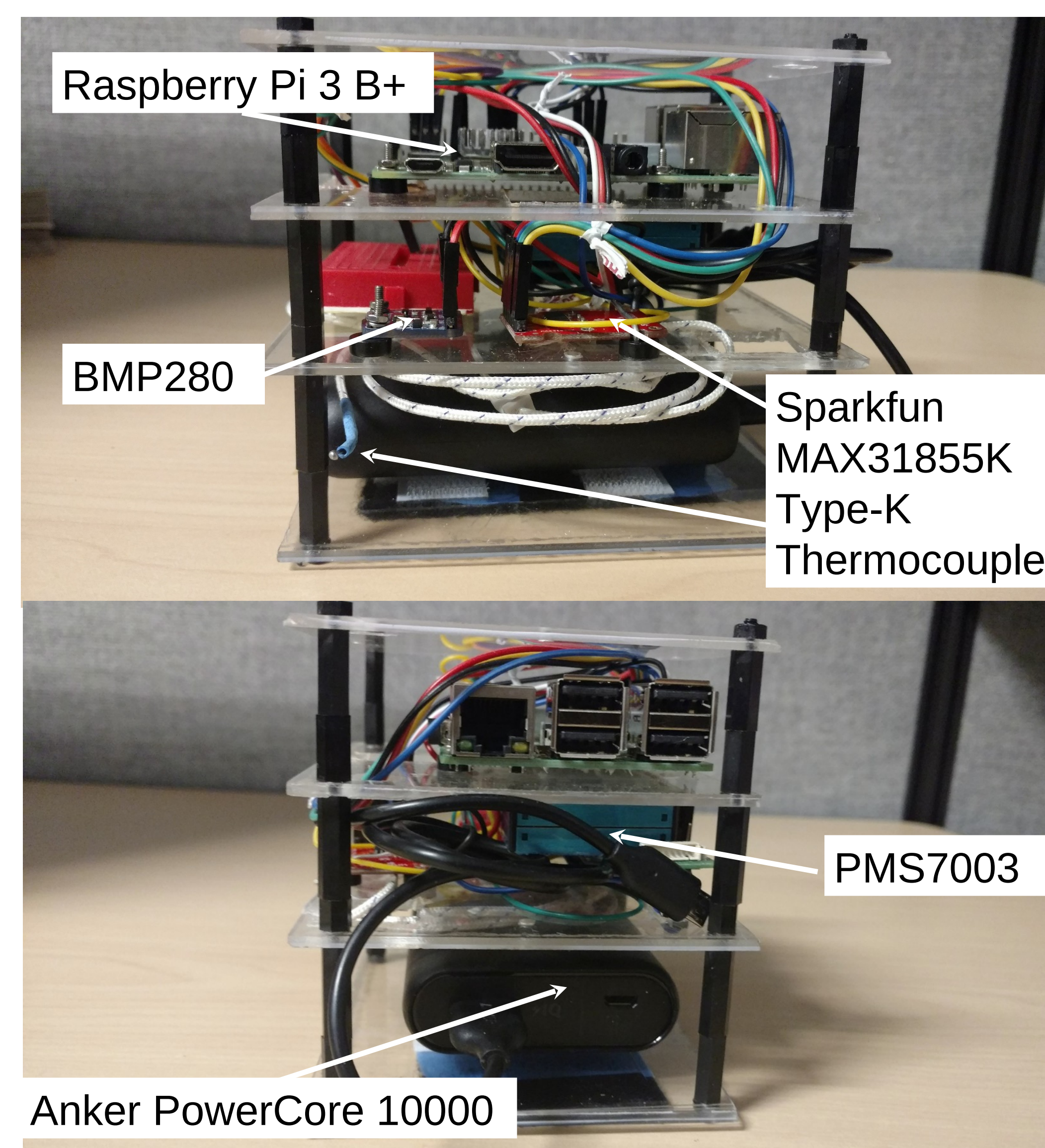sUAVs are perfect vehicles to carry low-cost sensor packages aloft.

METHOD

We have built a simple low-cost sensor package to demonstrate the potential use of sUAVs in air quality measurements.

The package includes:
• BMP280 – T, P, RH
• PMS7003 – Several PM size cuts and mass
• MAX31855K – Type-K thermocouple
• Anker PowerCore 1000 (powers sensor package ~15hrs)
• Raspberry Pi Version 3 B+ with Raspbian Stretch and Python

It is mounted on a DJI S1000+ sUAV

Raspberry Pi 3 B+
BMP280
Sparkfun MAX31855K Type-K Thermocouple
PMS7003
Anker PowerCore 10000

RESULTS

June 06, 2018
Clear day

July 03, 2018
County Fire

DISCUSSION

Clear Day – Atmosphere cools as we go up and no distinct PM pattern
Fire Day – Atmosphere is warm aloft and PM layers can be seen
Other potential applications: Refinery emissions, ship fuel compliance, …..
Additional Sensors: NO, NO2, O3, SO2, H_2S, VOC, Toxics, …..