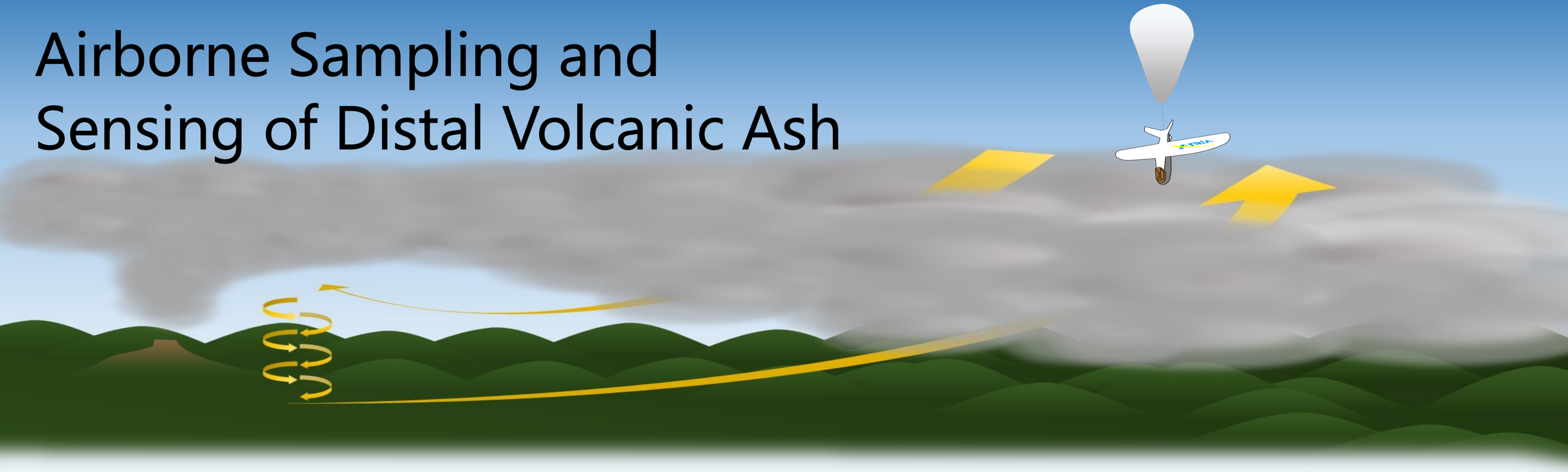
Airborne Sampling and Sensing of Distal Volcanic Ash



Problem Statement

Distal ash clouds created by volcanic eruptions can pose great risk to jet aircraft engines. The clients, DTA and the New Zealand Air Force require a low cost system that must intercept, detect and sample the distal ash at up to 12 km altitude. The solution provides vital information about the ash location at different altitudes, defining the safe flying regions.

Introduction

A small unmanned aerial vehicle (UAV) is taken to a height of 12 km into the atmosphere by a weather balloon. The UAV contains sensors and a sampling system that detect and capture the ash during the ascent with live feedback of the gathered results via telemetry. Once at required altitude, the UAV detaches and returns to the place of launch under autopilot control.

Sampling System

Sampling is done by applying air vortex principles. Particles from 1 µm to 50 µm can be captured. The collected sample is gathered on a stub which can be removed and tested directly in a scanning electron microscope.

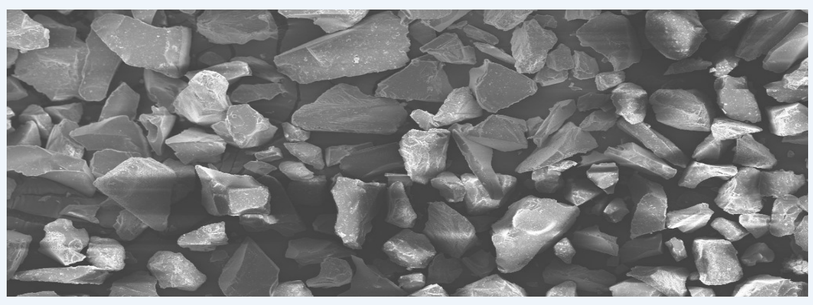


Fig 1. Ash recovered through cyclone sampling method.

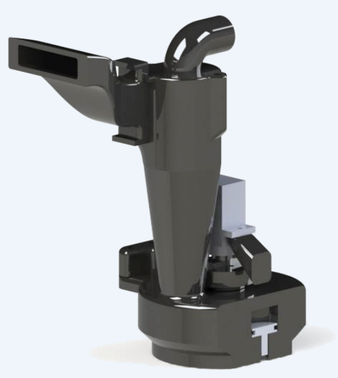


Fig 2. Ash sampler design.

UAV

Mini talon:

- Passive stability at high altitudes
- Large interior space
- Light weight (<2kg)

Fig 3. Mini talon showing inner cavity with sensors.

Flight Electronics

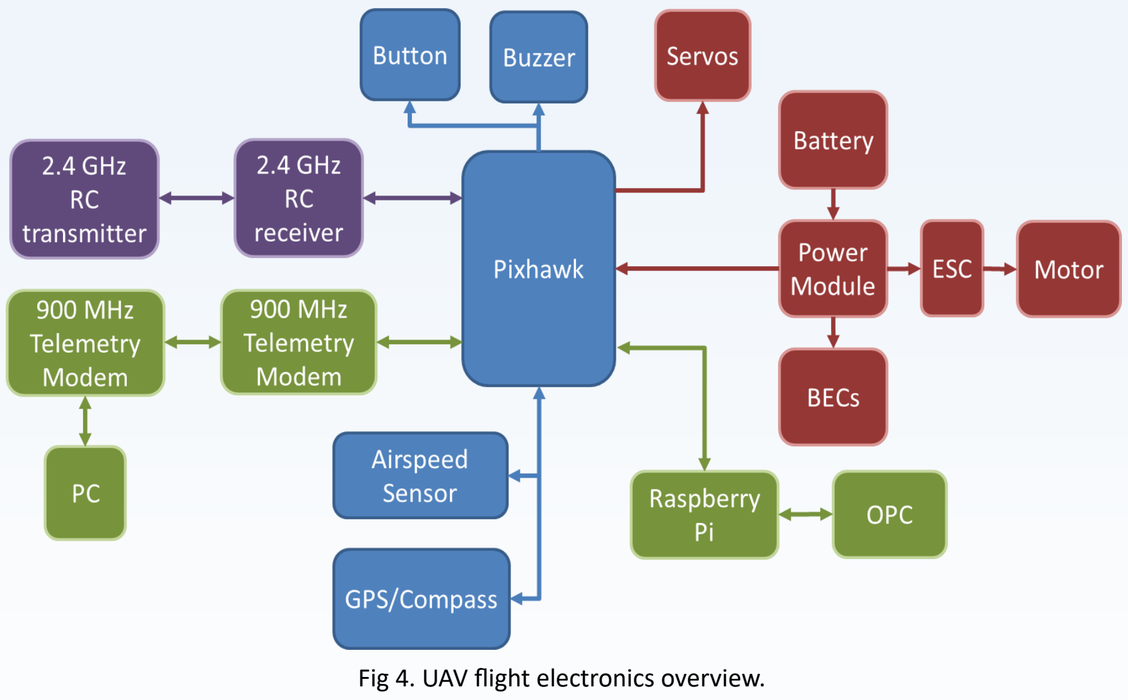


Fig 4. UAV flight electronics overview.

Particle Sensor Testing

An optical particle counter (OPC) measures the airborne concentration of ash. The sensor was calibrated and by testing in a wind tunnel at various ash flow levels.

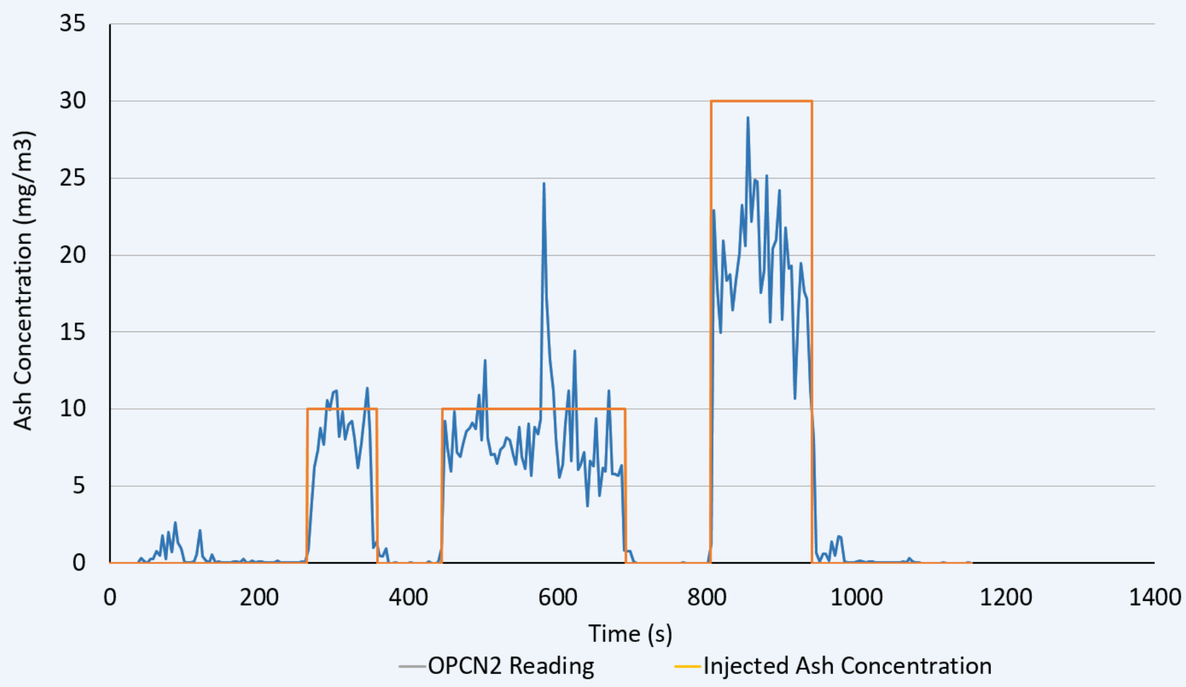


Fig 5. OPC's reading compared to inject ash.

Electrostatic Sensor

An electrostatic sensor was developed to detect when the plane comes in contact with the ash. The sensor detects ash in 5mg/m^3 increments.

This sensor measures the charge of the ash through induction.

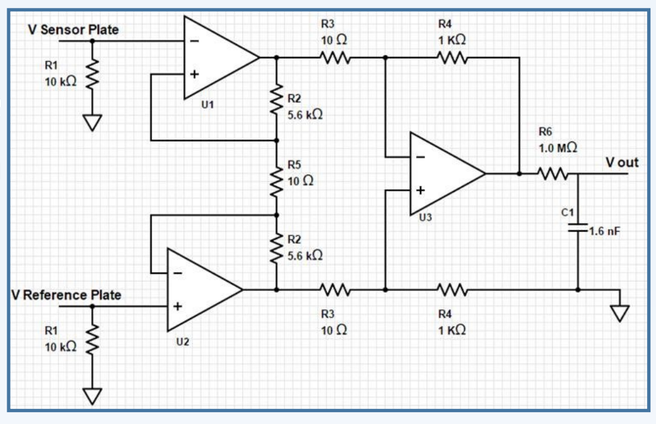


Fig 6. Schematic of the electrostatic sensor.

Conclusion

This project focused on the sensing and telemetry elements of the system. The sensors were verified in a wind tunnel emulating the conditions of measurement at altitude. Further work will focus on the plane optimisation, release mechanism and full scale testing.

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