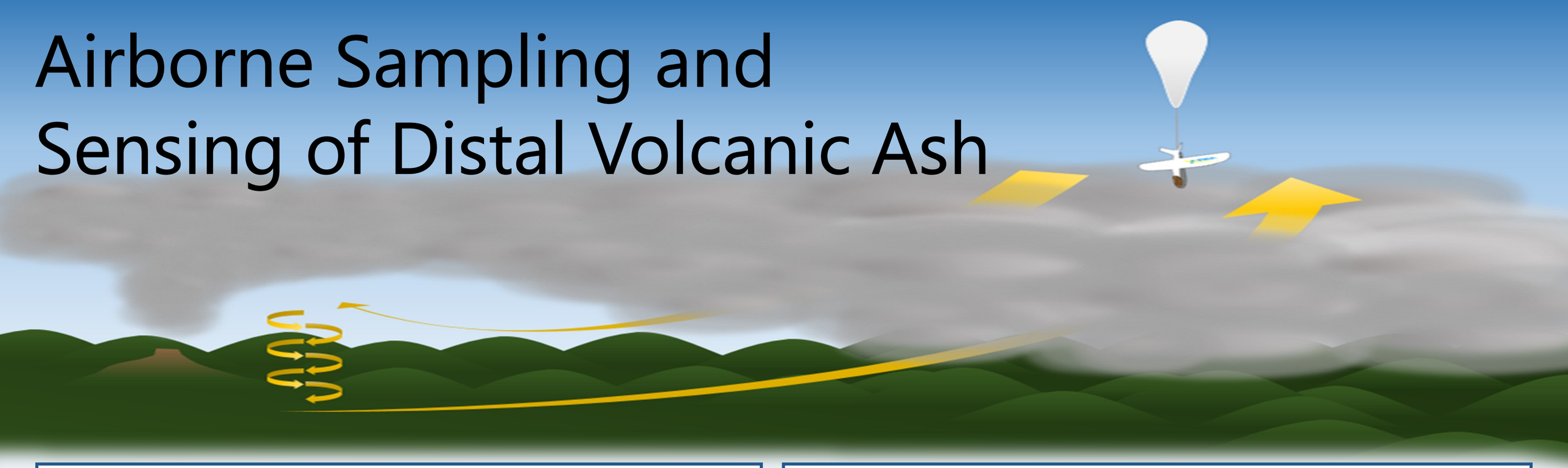
Airborne Sampling and Sensing of Distal Volcanic Ash



Problem Statement

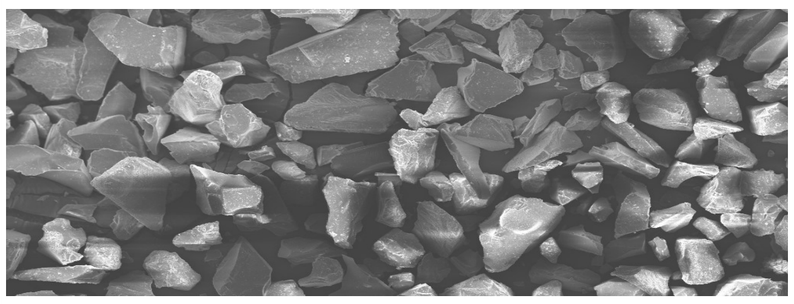
Distal ash clouds created by volcanic eruptions can pose great risk to jet aircraft engines. Whilst civil aviation is able to reroute air traffic, unique military operations may require them to fly through ash clouds. To this end, the DTA requested a low cost system be developed that must intercept, detect and sample the distal ash at up to 12 km altitude. Ideally live measurements of the detected ash/air concentration in mg/m^3 were desired.

Introduction

The developed solution is for a weather balloon to lift a small UAV 12 km into the atmosphere. The UAV contains sensors that detect the concentration of ash during the ascent, and a sampling system to take a physical sample. Live telemetry feedback of ash levels is also sent to a ground station. Once at altitude, the UAV detaches and returns to the place of launch under autopilot control.

Sampling System

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



Ash recovered through cyclone sampling

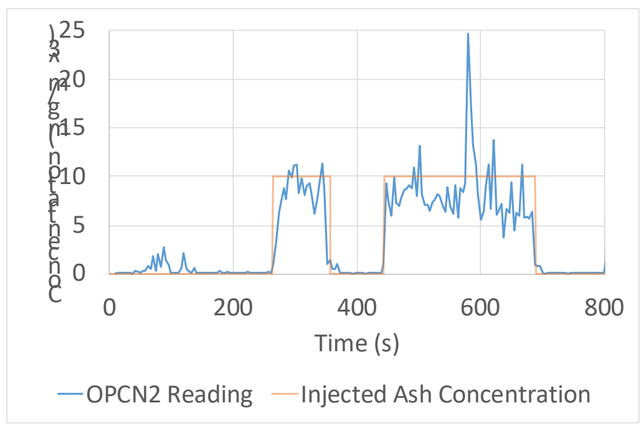
UAV/Jakes Shit

Possibly the cross section of the plane?

Telemetry System

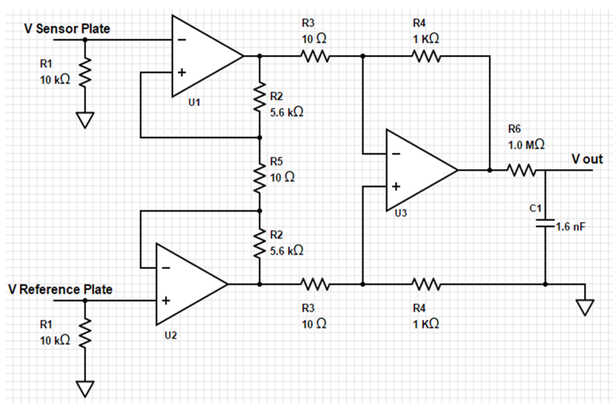
Particle Sensor Testing

An optical particle counting (OPC) sensor was employed for measuring the airborne concentration of volcanic ash, specifically, the OPCN2 sensor shown right. In order to characterise its response in the intended setting, it was tested in a wind tunnel with a flow of ash passed through the tunnel. A test concentration around 10 mg/m^3 was expected to be read during ash injections, which we were



Electrostatic Sensor

A novel design was investigated. The sensor was able to differentiate between different concentrations at 5mg/m^3 increments.



Schematic of Electrostatic Sensor

Conclusion

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