Atmospheric Sampling Using an Unmanned Aerial Vehicle (UAV)

This unit is a remote-controlled airplane (1/4 scale piper cub) capable of lifting 30 pounds of scientific gear to an altitude of up to 1 kilometer and remaining aloft for ~ 1 hour. The UAV is equipped with a GPS autopilot for ease of flight, digital camera, and particle analyzer. The GPS data and particle analyzer are monitored in real-time using a laptop computer. The UAV is also equipped with two different types of filters to analyze the atmosphere for the presence of microorganisms and chemicals. Airflow for the filtration systems is powered by two Venturi tubes, which are mounted on the side of the fuselage (11.49 liters/minute each). Remote controlled intake line covers (open and closed via remote control) protect the instruments from ground-based contamination, which can occur during takeoff. This UAV is inexpensive, allows for rapid deployment and detailed analysis of the atmosphere in a number of different research settings (the study of desert dust in Earths atmosphere, emission of particulates to the atmosphere following natural or man made disasters, profiling background concentrations, etc).

UAV Onboard Research Equipment:

Microbiology

1. Two-tube liquid impinger – The filtration device is used to capture microorganisms and particulate matter (soils, ash, etc.) in liquid phase. For microbiology studies, the liquid phase enables the researcher to conduct direct counts (determine the total population of bacteria and viruses in a volume of air), culture-based studies, and DNA profiling of the entire entrapped microbial community. Aliquots of the liquid can also be used to determine the presence of pollutants (metals, agricultural, industrial, etc). One tube acts as the impinger and the second tube acts as a trap to capture any overflow due to air transport through the system
2. Single-stage membrane filter – The filter housing is used to capture microorganisms for culture-based studies. These data are used to determine the fragment of the total population that is alive/cultivable (to identify viable bacterial and fungal populations in a given volume of air. See below image). The bottom right image on the following page shows cultured microorganisms captured on the

filter during a 20 minute sampling at ~ 160 meters altitude on Florida's West Coast.

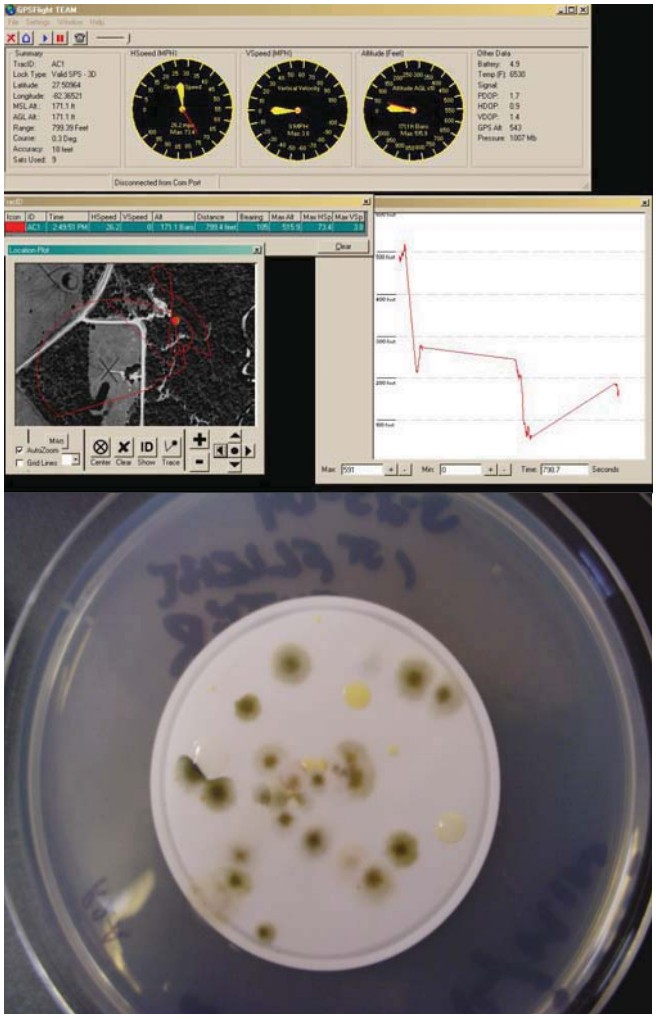
Airborne particulates

3. Particle analyzer – The laser analyzer takes a reading of particles present in the air every four seconds and gives a size distribution of particles ranging from 0.3 µm to 1.5 µm in size (6 size groups within this range). Particles in this size range, when inhaled, can penetrate deep into the lungs. Data is monitored in real-time via laptop/MS Excel spreadsheet gives the unit plum tracking capability.

Flight control

4. GPS unit – The GPS device gives real-time data relative to the UAV's speed, altitude, and heading. Real-time data allow vertical profiling of microorganisms and pollutants (samples taken at 500 ft, 1000 ft, 1500 ft, etc.). See GPS flight profile – bottom left image.
5. GPS autopilot – This device when activated remotely after takeoff will fly the plane at a programmed altitude and on a programmed track.

Images (left) showing flight profile and the microorganisms collected during that flight (right).



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