UAV platform. Our UAV platform is the Rascal 110 model airplane (SIG Manufacturing Co., Inc.; http://www.sigmfg.com/IndexText/SIGRC84ARFB.html) [**FIGURE 1**]. The Rascal has a 110 in wingspan with 1522 in^2 of wing area. Rascal 110 is equipped with an oversized 1.2 in^3 engine (O.S. Engines, Champaign, IL) that produces 3.1 hp at 9,000 rpm and a Master Airscrew 15 x 8 in K-Series propeller (Windsor Propeller Company, Rancho Cordova, CA). The flying weight (payload capacity) is less than 13 pounds. Aerobiological sampling devices are mounted on the leading edge of the wings [**FIGURE 2**].

This Rascal 110 ARF platform is supplied by Sig Manufacturing Co. for around $300:
http://www.sigmfg.com/IndexText/SIGRC84ARFB.html

FIGURE 1. Rascal 110 UAV with aerobiological sampling devices mounted in front of the leading edge of the wings.

FIGURE 2. Aerobiological sampling devices mounted underneath the wings of the Rascal 110 UAV. The sampling devices are closed during takeoff and landing, and opened when the UAV reaches its target sampling altitude.

Flight controller. The MicroPilot MP2028g system (MicroPilot Inc., Stony Mountain, Manitoba, Canada) is used as our flight controller. The MicroPilot MP2028g system is lightweight (28 grams), has good functionality, and is relatively affordable. The system permits a UAV to navigate GPS waypoints through a desired sampling area while providing the ground-based pilot with real-time dynamic control of flight characteristics. The MicroPilot MP2028g system is a printed circuit board equipped with 3-axis gyros and accelerometers. These components provide inertial measurements to allow control of the roll, pitch, and yaw of the UAV. A GPS unit attached to the board receives satellite signals through the attached antenna, a static pressure sensor allows the flight controller to measure relative altitude, and a pitot tube pressure sensor monitors the airspeed of the UAV. A compass module (MP-COMP, MicroPilot Inc.) enables MicroPilot to determine the true heading of the UAV. All of the control surfaces on the UAV can be controlled by the flight controller. The signal for the servos passed through a servo board, allowing the power supply to the servos to be independent of the power supply to the MicroPilot. An electronics box houses all of the MicroPilot components. The flight controller and the radio modem are powered by separate 11.1 volt lithium-ion battery packs with 2200 mAh capacity (L18650-2200-3, Tenergy Corporation, Sunnyvale, CA). The UAV control surface servos use a 4.8 volt Nickel-Cadmium battery pack with 600 mAh capacity (NR-4J, Futaba) and the aerobiological sampling devices use a 4.8 volt Nickel Metal Hydride battery pack with 2000 mAh capacity (HCAM6320, Hobbico, Champaign, IL).

Redundant control via the RxMUX for increased safety. An additional safety feature on the Rascal 110 (the RxMUX, Reactive Technologies, Merrimack, NH) permits the addition of a second RC receiver to be added to the UAV for redundant control from the ground. The RxMUX is a signal multiplexer that takes inputs from two RC receivers and outputs one signal to control the servos of the UAV. In this case, the primary source of control is the flight controller, which can be controlled by its own RC receiver. The secondary source of control is the backup RC receiver on a different channel from the autopilot. The receiver that passes through the flight controller has a channel that allows the safety pilot to reclaim control at any time. The RxMUX also allows one channel of the input to control which input source is controlling the servos. With this setup, the Rascal 110 can be operated independently with either transmitter. In other words, only one of the two transmitters is needed to fly the UAV at any given time. If only the flight controller transmitter is used, the pilot is able to pass control back and forth to the flight controller. If only the backup transmitter is used, the UAV can only be flown in RC mode. But with the combination of the two, two pilots can be watching the UAV during flight where both have the ability to take control from the flight controller if something goes wrong. If the secondary transmitter takes control of the UAV, then the primary transmitter and the flight controller can not take control back at any time. The secondary backup pilot has to give control back the primary transmitter or flight controller. This system allows the pilot to be in two different locations with two different views of the UAV and whoever has the best view of the UAV can have control. The only time that communication between the two pilots is needed is when the secondary backup transmitter gives control back the primary transmitter.