A DUST ATMOSPHERIC RECOVERY TECHNOLOGY (DART) SYSTEM WAS DEVELOPED TO COLLECT AEROSOLS AND MICROORGNAISMS IN THE FREE TROPOSPHERE UP TO 10 km.

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Introduction. Microbial activity (i.e., metabolism and growth) in the atmosphere has been proposed for many years, but not directly demonstrated. As part of an ongoing dust-sampling campaign to characterize the metabolic activity and growth of microorganisms under low-pressure, high-UV, and desiccating conditions in the Earth's atmosphere, we developed a dust sampling device called the Dust Atmospheric Recovery Technology (DART) system. The DART system has been successfully flown on a F104 Starfighter jet up to 10 km (Fig. 1A; Starfighters Aerospace, Inc., Kennedy Space Center FL) and a T-6 Texan propeller driven aircraft up to 3.5 km (Fig. 1B; Warbird Adventures, Kissimmee, FL).

Methods. The DART system (Figs. 1 & 2) utilizes a high-volume pump to pass air through 6 separate filtration units in which both aerosols and microbial cells are captured. The filtration systems exhibit flow rates from 25-142 L/min depending on the pore size and brand of filters used. Flow rates are directly correlated to increased air speed, and are inversely correlated to increased altitude. Filtration units can be turned on and off individually. The DART dust sampler has performed nominally up to 10 km, 0.92 Mach, and 3.5 +G's.

Fig. 1A: The red DART pod mounted on a F104 jet during a 2013 test flight over the Kennedy Space Center, FL.
Fig. 1B: The DART system was modified to adapt to a T-6 Texan aircraft shown here taxing prior to a flight in 2014.

Fig. 2. The DART internal subsystems. Six external scoops can be seen on the nosecone, and the filter housings hold 47 mm filters forward of the green solenoid valves.

Results. During initial test flights in 2013 & 2014, greater than half of all airborne fungi collected up to 500 m were in the genus *Cladosporium*, and 5 of 8 genera of fungi recovered from the lower troposphere over FL contained plant pathogens including species in the genera: *Acremonium*, *Aspergillus*, *Cladosporium*, *Curvularia*, and *Fusarium*. Ground-based experiments have demonstrated that the numbers of recovered fungi/L, but not bacteria, increased significantly when 5 or 10 µm were used in the DART filtration system compared to filter pore sizes ≤ 1.2 µm (Fig. 3). The DART collection system was optimized for a flow rate of 100 L per minute through 5.0 µm nylon filters at altitudes below 1000 m. The flow rate at 10 km was dramatically reduced to approximately 10 L per minute.

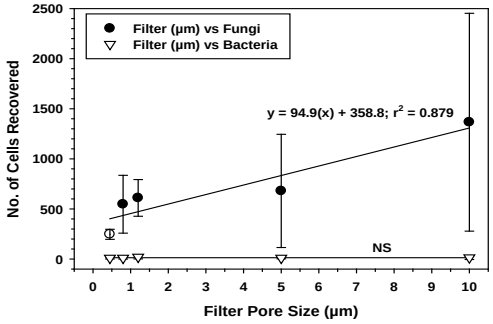

Fig. 3. Collection of fungal and bacterial cells with nylon filters with increasing pore-sizes (ground-based assays).

Discussion. The DART system is used to collect aerosols and transported microorganisms in parallel research programs to study (1) the global movement of plant pathogens in the troposphere, (2) non-pathogenic species microbial activity and growth in hypobaric environments, and (3) to characterize the bulk biodiversity in transported Asian and African dust plumes (recently funded by NASA's Biodiversity Office).