Environmental Science Graduate Program Seminar Series

Specialized Indoor Environments: Relative Humidity and Fungal Growth in Dust Collected from the International Space Station

Nicholas Nastasi

September 17th, 2021 | 2:00-3:00 PM

Smith Laboratory, Room 3150

Abstract

Inhalation of dust and bioaerosols is a major source of human exposure to microbes in the indoor environment, including on the International Space Station (ISS). Microbial communities are associated several health effects and can degrade spacecraft materials. Growth is limited by water availability, and elevated relative humidity (RH) levels are sufficient to facilitate growth in house dust. However, it is not known how RH interacts with dust and microbial communities from the ISS. The goal of this study is to simulate suboptimal RH conditions and quantify microbial growth in ISS dust. Dust was collected from HEPA filters on the ISS ventilation system. On Earth, dust was incubated at constant RH conditions (50, 60, 70, 80, 85, 90, and 100%) for two weeks at 25°C. In addition, the time-of-wetness (TOW) framework to model this growth was evaluated by varying 85% and 100%RH for 6, 12, and 18 hours per day. Total fungal quantity was measured by quantitative polymerase chain reaction (qPCR). ISS dust had a starting concentration (pre-incubation) ranging $2.17x10^4$–$1.36x10^7$ fungal spore equivalents (eq.) per mg dust. Constant (24 hours/day) equilibrium RH (ERH) incubations showed a significant trend between fungal growth and ERH (Spearman R^2=0.77, P<0.0001). After two-week, constant (24 hours per day) ERH incubations, fungal growth activation occurred starting at 80%ERH ($2.86x10^5$–$9.26x10^7$ fungal spore eq. per mg dust) and more growth occurring as ERH increases to 100% ($8.20x10^8$-$3.32x10^{10}$ fungal spore eq. per mg dust). TOW models matched most closely to an activation limited growth model at 85%ERH, while at 100% a deactivation limited model was observed. These results highlight the need to continue monitoring relative humidity and microbial communities on human occupied spacecraft to ensure the astronauts health, spacecraft integrity, and planetary protection.