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Title: Coastal California's Fog as a Unique Habitable Niche: Design for Autonomous Sampling and Preliminary Aerobiological Characterization.

Abstract:
Just as on the land or in the ocean, atmospheric regions may be more or less hospitable to life. The aerobiosphere, or collection of living things in Earth's atmosphere, is poorly understood due to the small number and ad hoc nature of samples studied. However, we know viable airborne microbes play important roles, such as providing cloud condensation nuclei. Knowing the distribution of such microorganisms and how their activity can alter water, carbon, and other geochemical cycles is key to developing criteria for planetary habitability, particularly for potential habitats with wet atmospheres but little stable surface water.

Coastal California has regular, dense fog known to play a major transport role in the local ecosystem. In addition to the significant local (<1 km) geographical variation in typical fog, previous studies have found that changes in height above surface of as little as a few meters can yield significant differences in typical concentrations, populations and residence times. No single current sampling platform (ground-based impactors, towers, balloons, aircraft) is capable of accessing all of these regions of interest.

A novel passive fog and cloud water sampler, consisting of a lightweight passive impactor suspended from autonomous aerial vehicles (UAVs), is being developed to allow 4D point sampling within a single fog bank, allowing closer study of small-scale (<100 m) system dynamics. Fog and cloud droplet water samples from low-altitude aircraft flights in nearby coastal waters were collected and assayed to estimate the required sample volumes, flight times, and sensitivity thresholds of the system under design.

125 cloud water samples were collected from 16 flights of the Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS) instrumented Twin Otter, equipped with a sampling tube collector, occurring between 18 July and 12 August 2016 below 1 km altitude off the central coast. The collector was flushed first with 70% ethanol, then with sterile DI water, between sampling regions. Collected volumes ranged from ~100 Î¼L to 12 mL. All samples were diluted serially and plated on two different types of agar, nutrient-dense (PCA) and sparse (R-2A). Plates were incubated at room temperature and counted when colonies first appeared and again at 2 weeks.

Preliminary results from seven flights are consistent with generally reported colony-forming unit (CFU) values for terrestrial fog water (e.g., [4]). The PCA assay ranged from 400 to 125,000 CFU/mL, R-2A from 700 to 130,000 CFU/mL. PCA and R-2A counts were not significantly different from each other at Î± = 0.05, although observationally, the R2A plates had more pigmented colonies. CFU counts from the majority of flights were not different from each other in mean at the same level of significance, but about half differed in median, indicating differences in underlying distribution.

These results validate the presence of viable microorganisms in coastal California fog at levels that should be easily detectable by our sampling system. The indicated distribution differences underscore the need for small-scale, long-term sampling surveys. Future planned work includes ion chromatography for limiting nutrients, ATP quantification, and qPCR for several microbial classes of interest.

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