High-flying bacteria spark interest in possible climate effects

Microbes found at extreme altitudes could influence precipitation and cloud density.

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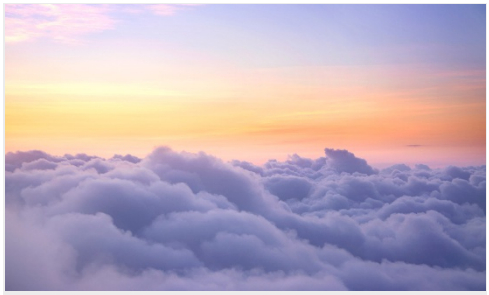
Ravaged by arid winds and ultraviolet rays, some bacteria not only survive in the upper atmosphere but might affect weather and climate, according to a study published on 28 January in the *Proceedings of the National Academy of Sciences*[1].



Joe Chen Photography/Getty

Seemingly squeaky-clean clouds are made by filthy bacteria-laden air.

In one of the first attempts to explore atmospheric microbiology at high altitude, researchers analysed air samples from a six-week hurricane-research mission by NASA in 2010. A total of 314 different types of bacteria were collected in air masses around 10 kilometres above the Gulf of Mexico, the Caribbean Sea, the Atlantic Ocean, and the continental United States. Although the scientists trapped only a small amount of material, bacteria accounted for around 20% of all particles — biological and non-biological — a higher proportion than in the near-Earth atmosphere.

“I’m really, really surprised at the high bacterial density at these high altitudes,” says Ulrich Karlson, an environmental microbiologist at Aarhus University in Denmark, who was not involved in the study. “This is clearly a harsh environment.”

“One of the next challenges is to figure out the role of these organisms,” says Konstantinos Konstantinidis, an environmental microbiologist at the Georgia Institute of Technology in Atlanta and one of the study's authors.

Seed of an idea

Genetic analysis revealed that some microbes in the upper atmosphere are related to bacteria thought to catalyse ice-crystal formation and cloud condensation[2]. The fundamental process, called nucleation, occurs when water molecules in the air coalesce around a seed particle, often dust or soot. Depending on temperature, these complexes can grow into large water droplets or frozen balls of ice, leading to cloud formation and rain or snow.

The latest findings support emerging theories that bacterial communities, especially in the upper atmosphere where dust is relatively rare, could influence weather and climate[3], says study co-author Athanasios Nenes, an atmospheric scientist at the Georgia Institute of Technology.

“There’s increasing recognition that they’re not just spores that are floating around,” says Noah Fierer, a microbial ecologist at the University of Colorado at Boulder. But Fierer says that more research is needed to understand the relative importance of airborne bacteria, compared to other atmospheric elements.

Winds of change

Samples collected by the NASA mission before, during, and after two hurricanes also allowed researchers to study the effects of extreme weather on the atmospheric microbiome. The storms injected large numbers of new cells — including faecal bacteria — high into the sky.

Bacterial composition varied by location and time, but 17 types of bacteria formed a core microbiome across all samples. Fierer says that understanding more about the bacterial ecology of the sky represents an exciting new frontier for natural history. “What’s up there, and how does what’s up there change across time? These are things we don’t know.”

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References

1. DeLeon-Rodriguez, N. *et al. Proc. Natl. Acad. Sci. USA* http://dx.doi.org/10.1073/pnas.1212089110 (2013).

2. Bauer, H. *et al*. *J. Geophys. Res.* **108**, null–null (2003).

3. Morris, C. E. *et al*. *Biogeosciences* **8**, 17–25 (2011)