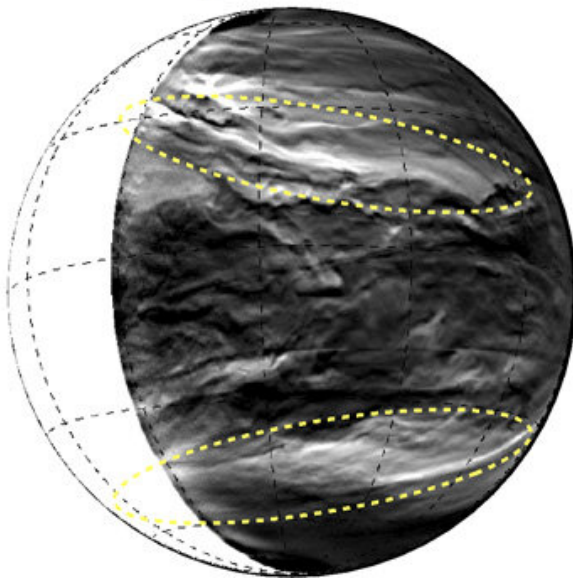


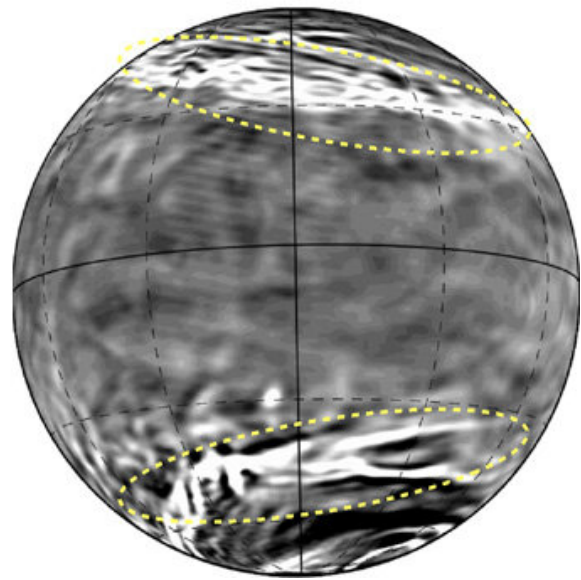
Could there be life in the cloudtops of Venus?

August 24 2020, by Nancy Atkinson

Observation by the Akatsuki IR2 camera



Simulation by AFES-Venus



The large-scale streak structures discovered in Venus' atmosphere. Credit: Japanese Space Agency.

When it comes to places with the potential for habitability, Venus isn't usually on that list. The hot, greenhouse-effect-gone-mad neighboring planet with a crushing surface pressure and sulfuric acid clouds certainly isn't friendly to life as we know it, and the few spacecraft humanity has sent to Venus' surface have only endured a few minutes.

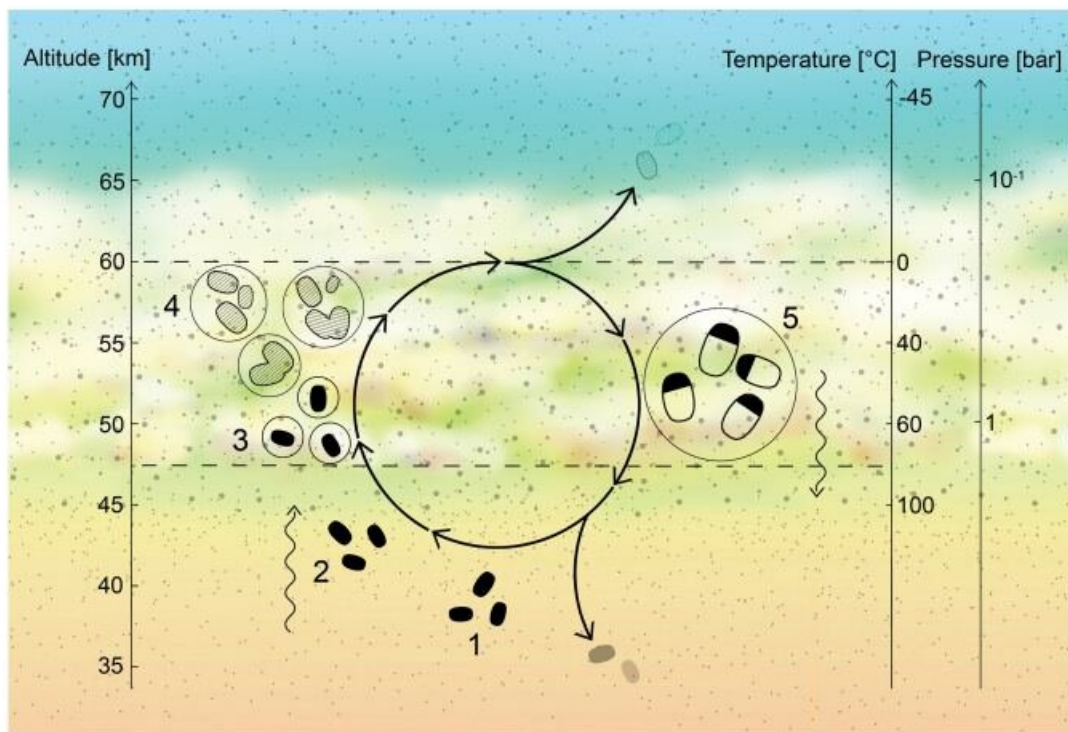
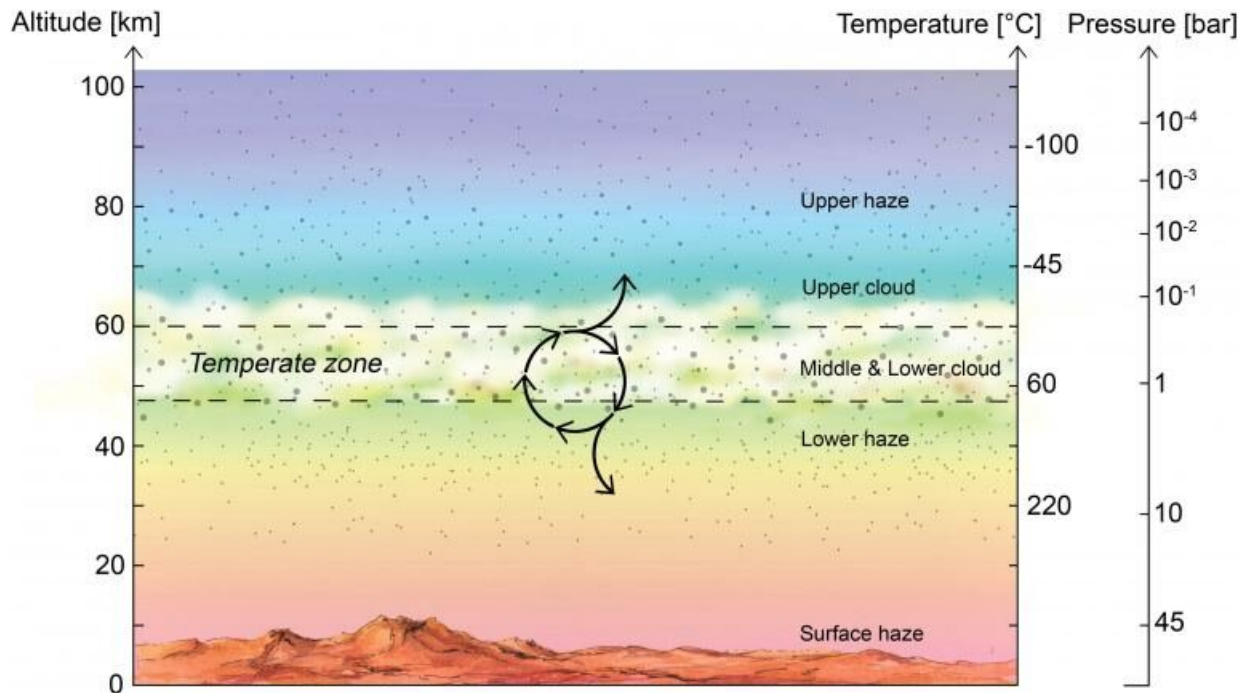
But about 40 to 60 kilometers above the surface (25 to 37 miles), the [atmosphere](#) of Venus is the most Earth-like of any other place in the

solar system. There, Venus has air pressure of approximately 1 bar and temperatures in the 0°C to 50°C range. It's not quite a shirtsleeves environment, as humans would need air to breathe and protection from the sulfuric acid in the atmosphere. Plus, also consider that Venus is considered to be in the habitable zone of our star.

So is there a chance that other types of life could survive unaided in Venus' atmosphere? The question of whether microbes could survive there has long been debated by planetary scientists as far back as Carl Sagan in 1967. Another paper in 2004 studied whether the sulfur in Venus' atmosphere could be used by microbes as a means for converting ultraviolet light to other wavelengths that could be used for photosynthesis. Still another study in 2018 proposed that the dark patches that appear in Venus' atmosphere could be something akin to the algae blooms that occur routinely in the lakes and oceans of Earth.

However, most previous studies concluded that any possible microbes in Venus' atmosphere could have only a short lifespan: They would fall through the clouds into the lower haze layer and end up incinerated in the heat and/or crushed in the higher atmospheric pressure that lies closer to the surface.

But now, a paper by astrobiologist Sara Seager and colleagues suggests that microbes could have a sustaining "life cycle," allowing them to survive for perhaps millions of years.



Hypothetical life cycle of the Venusian microorganisms. Top panel: Cloud cover on Venus is permanent and continuous, with the middle and lower cloud layers at temperatures that are suitable for life. Bottom panel: Proposed life cycle. The numbers correspond to steps in the life cycle as described in the main text. (1)

Desiccated spores (black blobs) persist in the lower haze. (2) Updraft of spores transports them up to the habitable layer. (3) Spores act as CCN, and once surrounded by liquid (with necessary chemicals dissolved) germinate and become metabolically active. (4) Metabolically active microbes (dashed blobs) grow and divide within liquid droplets (solid circles). The liquid droplets grow by coagulation. (5) The droplets reach a size large enough to gravitationally settle down out of the atmosphere; higher temperatures and droplet evaporation trigger cell division and sporulation. The spores are small enough to withstand further downward sedimentation, remaining suspended in the lower haze layer “depot.” CCN, cloud condensation nuclei. Credit: Seager et al, 2020

Their paper explores the possibility that microbes could live in the liquid environment inside sulfuric acid cloud droplets. As the droplet habitat in which the microbes reside grows, they would be forced by gravity to settle in the hotter, uninhabitable layer below the Venusian clouds. However, as the droplets begin to evaporate, the lower haze layer would become a "depot" for dormant life. Later, upward drafts would regularly lift the dormant microbes back into the [clouds](#), where they would be rehydrated and become active again.

"Assuming that life must reside inside cloud droplets," the team wrote in their paper, published in the journal *Astrobiology*, "we resolve the subsequent conundrum of gravitationally settling droplets reaching hotter, uninhabitable regions by proposing a Venusian life cycle where a critical step is microbes drying out to become spores on reaching the relatively stagnant lower haze layer, which we call a leaky 'depot.'" The dried-out spores would reside there until some of them can be transported back up to the temperate, habitable cloud layers, where they would act as CCN to promote cloud formation, becoming enveloped in cloud droplets to continue the life cycle."

On Earth, terrestrial microorganisms—mostly bacteria—are capable of

being swept into the atmosphere, where they have been found living at altitudes as high as 41 kilometers (25 miles).

There is also a growing catalog of [microbes](#) found to inhabit incredibly [harsh environments](#) on Earth, such as the hot springs of Yellowstone, deep ocean hydrothermal vents, the toxic sludge of polluted areas, and in acidic lakes worldwide.

The question of possible life in Venus' cloudtops now becomes a testable hypothesis. A co-author on this paper, Sukrit Ranjan, a postdoctoral fellow at MIT, told Astronomy that "it's worth thinking about whether it's worth investing the resources to carry out that test," such as a sample-return mission to Venus atmosphere.

While some have proposed floating, Bepi-like cities in Venus' atmosphere, a more practical "glider" could float through Venus atmosphere, or the proposed VERITAS mission could maybe include an astrobiological study of Venus.

More information: Sara Seager et al. The Venusian Lower Atmosphere Haze as a Depot for Desiccated Microbial Life: A Proposed Life Cycle for Persistence of the Venusian Aerial Biosphere, *Astrobiology* (2020). [DOI: 10.1089/ast.2020.2244](https://doi.org/10.1089/ast.2020.2244)

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