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Press release

Microbial life found in the Antarctic

Innovative scientific exploration platform reveals the presence of microorganisms in Antarctic ice

20.01.2025. –An international team led by the **Center for Astrobiology** (**CAB**, **INTA-CSIC**) and the **Autonomous University of Madrid** (**UAM**) has presented a novel platform for scientific exploration for the most remote places in Antarctica. This mobile and versatile scientific base allows the development of cutting-edge science with minimal environmental impact. Thanks to the **WindSled**, the researchers have described microbial life from the air down to 4 meters deep in the ice of the most inhospitable place on Earth. The authors have deciphered the origin of Antarctic bacteria, as well as the bacterial communities trapped in the snow and ice cover over the last 40 or 50 years.

The Antarctic Plateau, a vast expanse of ice and snow more than 3000 meters above sea level, is one of the most extreme environments on Earth. It has recorded the lowest temperature (-89.2ºC, although it is estimated that it can reach -93.2ºC) and is one of the places on Earth with the lowest precipitation record and the most arid. Low temperature and absolute humidity; together with high UV radiation during the summer, scarcity of liquid water and nutrients; make the Antarctic Plateau an excellent natural laboratory for investigating the extremes of life on Earth.

Professor Víctor Parro, INTA researcher at the Center for Astrobiology (**CAB, INTA-CSIC**), states: “This environment is perhaps the best terrestrial analog for studying the possibility of life on other worlds, such as the icy moons Europa (Jupiter) and Enceladus (Saturn), or the large icy areas of the planet Mars. This makes the Antarctic Plateau an ideal place to develop instrumentation for astrobiological purposes, such as the **Life Detector Chip** or **LDChip**”.

Logistical constraints, cold, remoteness and altitude make it difficult to access the Antarctic Plateau for sampling and in situ studies. It is considered the last pristine environment on Earth where wind, as a mean of transporting deposited particles, has been proposed as the main cause of input and distribution of life, nutrients, and pollutants. The use of heavy vehicles with combustion engines is expensive, polluting, inefficient and logistically complex for traveling long distances.

Spanish explorer Ramón Larramendi, creator and developer of the **WindSled**, explains: “The **WindSled** offers unique features for scientific exploration of large expanses of ice or snow: large capacity for both crew (4-5 people) and

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scientific-technical cargo (less tan 500 kg of equipment), robust (easy to repair), highly versatile (modular and scalable) and zero emissions in their travels".

During the 2018-2019 campaign to the Antarctic Plateau, four well-trained crew members traveled 2538 km across the western sector of the Antarctic Plateau, from the vicinity of Novolazarevskaya Station to Fuji Dome (less tan 3500 m altitude). The **WindSled** carried 200 kg of scientific instrumentation to perform multiple in situ scientific sampling and experiments, including detection of microorganisms using a portable immunosensor (**LDChip**) designed for life detection in planetary exploration, a collector of aerosols and biological material from the air capable of operating in the extreme conditions of the expedition, and continuous monitoring of possible deliquescence events along the transect.

WindSled propelled by wind on the Antarctic Plateau

Professor Mayewski, director of the Climate Change Institute at the University of Maine, USA, and co-author of the paper, states: "This work demonstrates the value and importance of using relatively inexpensive, emission-free sampling platforms in even the most remote locations in Antarctica, where in situ observations are lacking, but which are essential for understanding current climate change and predicting future climate change and its impacts".

The ice of the Antarctic Plateau represents an archive of past climatic and atmospheric events, as well as the historical presence and accumulation of biological material. Until now, few studies have focused on the microbiology of the high Antarctic Plateau and, those that have done it so, they have only explored surface snow up to 30 cm deep. Professor Antonio Quesada, **Autonomous University of Madrid** (**UAM**), states: "We describe the first microbial profile from air to 4 meters depth of snow and ice on the Antarctic Plateau at three significantly distant locations, deciphering the bacterial

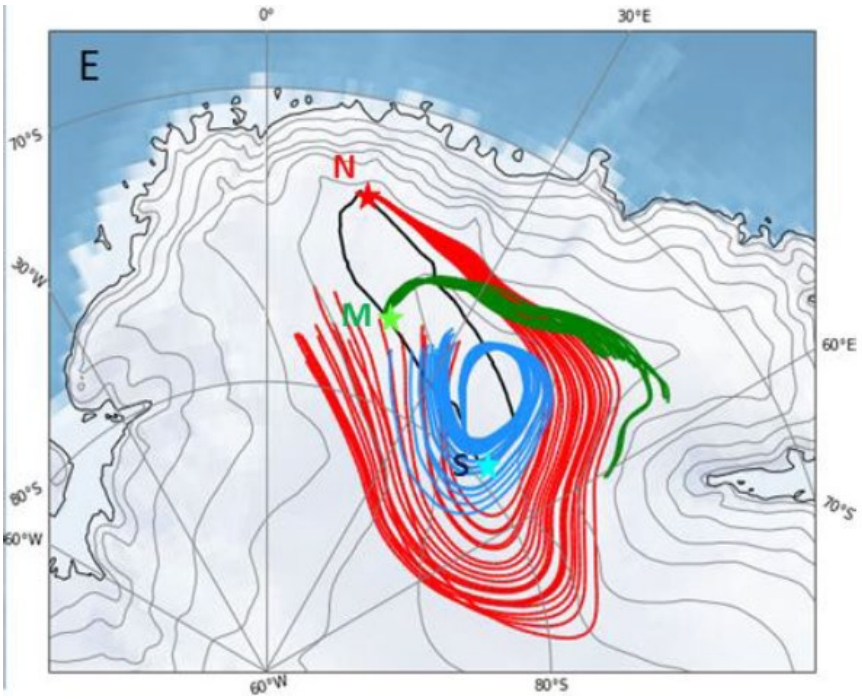
communities trapped in snow and ice from the last 40 or 50 years. This is the first time that microorganisms have been collected and identified from the air on the Antarctic Plateau".

The Antarctic Plateau is also one of the driest places on Earth. The combination of extreme cold and dryness makes it an analogous environment to Mars, where the average annual surface temperature near the equator is -58ºC and the atmospheric water vapor content is negligible. As on Mars, the water on the Antarctic Plateau is physically in a frozen or vapor state, but rarely in a liquid state. Dr. Alfonso F. Dávila, a researcher at NASA's Ames Center in California, states: "**WindSled** allows us to go into the most remote places in Antarctica and study under what conditions liquid water can form in an icy desert, for example, through the deliquescence of certain salts, to understand similar processes on Mars. We have shown that in certain instances along the more than 2500 km traveled such deliquescence phenomena are possible and could provide water to maintain minimal biological activity. Perhaps, similar phenomena could occur in some regions of Mars".

Transport vectors, such as snow and ice particles and windblown bioaerosols, can condition the biogeographic distribution of the bioburden, depending on the prevailing winds, as demonstrated by the authors of this work. The use of the **LDChip** biochip to detect traces of life during the campaign made it possible to detect the presence of certain microorganisms, including cyanobacteria, in ice core samples. **Dr. Mercedes Moreno, researcher of INTA's SOLID-LDChip team at the CAB**, states: "This is a further demonstration of the great **LDChip**'s ability to search for life in planetary exploration".

Once in the laboratory, new species of cyanobacteria of the genus Gloeocapsopsis was isolated and cultured from one of the core samples of between 3 and 4 meters depth, with an estimated age of 30 or 40 years. It is like "traveling back in time" and rescuing biological material, still viable, that was deposited decades ago. The deeper the sample, the older the age. The viability of microscale deliquescence phenomena suggests that in certain microenvironments, e.g., salt crystals transported from shore and deposited on ice, or aerosols with concentrated biological material, minimal metabolic activity may be taking place to keep some microorganisms alive.

Undoubtedly, the **WindSled** is a truly mobile, zero-emission scientific platform with large payload and crew capacity, enabling unprecedented and planet-friendly research on the unexplored Antarctic Plateau and other large ice masses. Using the **WindSled** on a regular basis on world's frozen plateaus could mean access to barely studied ecosystems, putting our researchers at the forefront of the study of the cryosphere.



Route and prevailing winds in the days prior to sampling during the WindSled antarctic campaign.

About CAB

Center for Astrobiology (**CAB**) is a joint research center between **the National Institute for Aerospace Technology** (**INTA**) and the **Spanish National Research Council** (**CSIC**). Created in 1999, it was world's first center dedicated specifically to astrobiological research and the first non-US associate member of **NASA Astrobiology Institute** (now the **NASA Astrobiology Program**). It is an interdisciplinary research center whose main objective is to study the origin, presence and influence of life in the universe from a transdisciplinary approach. In 2017, **CAB** was distinguished by the Ministry of Science and Innovation as "**María de Maeztu Unit of Excellence**".

CAB has led the development of the **REMS**, **TWINS** and **MEDA** instruments, all operational on Mars since August 2012, November 2018 and February 2021, respectively; as well as the science of the **RLS** and **RAX Raman** instruments, which will be launched in this decade on board of **ExoMars** and **MMX** missions. In addition, **CAB** develops the **SOLID** instrument, aimed at the search for life in planetary exploration. Likewise, **CAB** participates in different missions and instruments of great astrobiological relevance, such as **CARMENES**, **CHEOPS**, **PLATO**, **BepiColombo**, **DART**, **Hera**, the **MIRI** and **NIRSpec** instruments at **JWST** and the **HARMONI** instrument at **ESO**'s **Extremely Large Telescope** (**ELT**).

More information

Scientific paper published in Nature Communications: https://www.nature.com/articles/s41467-025-55997-6?utm_source=rct_congratemailt&utm_medium=email&utm_campaign=oa_20250117&utm_content=10.1038/s41467-025-55997-6

Reference and DOI: https://doi.org/10.1038/s41467-025-55997-6

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FUNDING

SOLID Project nos. RTI2018-094368-B-I00 and PID2021-126746NB-I00, PID2020-116520RB-I00, CTM2016-79741-R and PGC2021-567 124362NB-I00 Project financed by MCIN/ AEI /10.13039/501100011033/ and by FEDER: A way to make Europe

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