CENTRE FOR EXOLIFE SCIENCES

The influence of life on extraterrestrial atmospheres

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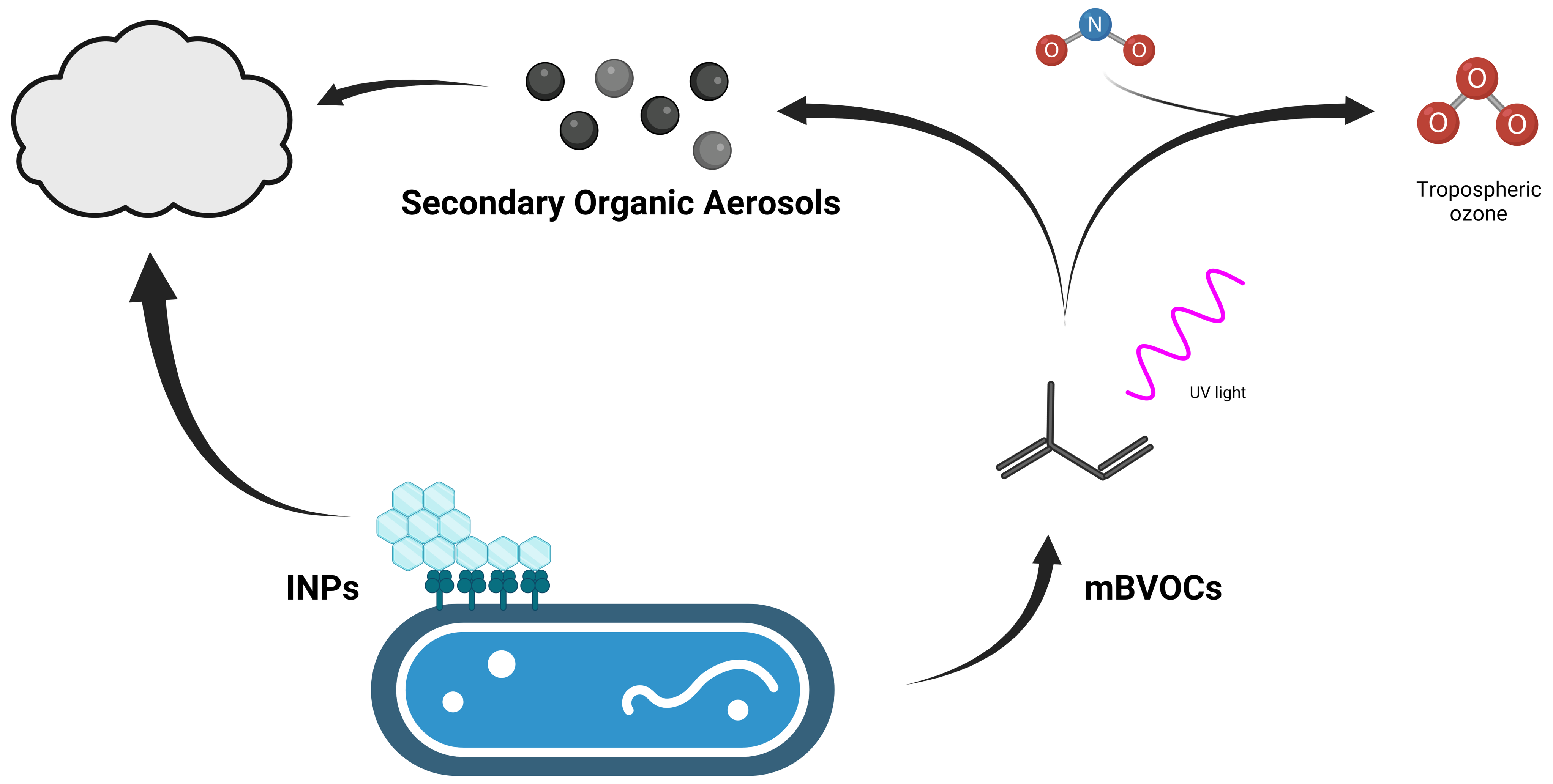
SUMMARY

Microorganisms influence the atmosphere and the weather via different mechanisms, e.g., the emission of **microbial Biogenic Volatile Organic Compounds (mBVOCs)** and the production of **Ice Nucleating Proteins (INPs)**. By studying the macroscopic effect of microbes on the atmosphere, we can construct models that will help us identify the signatures of life on Earth and other planets.

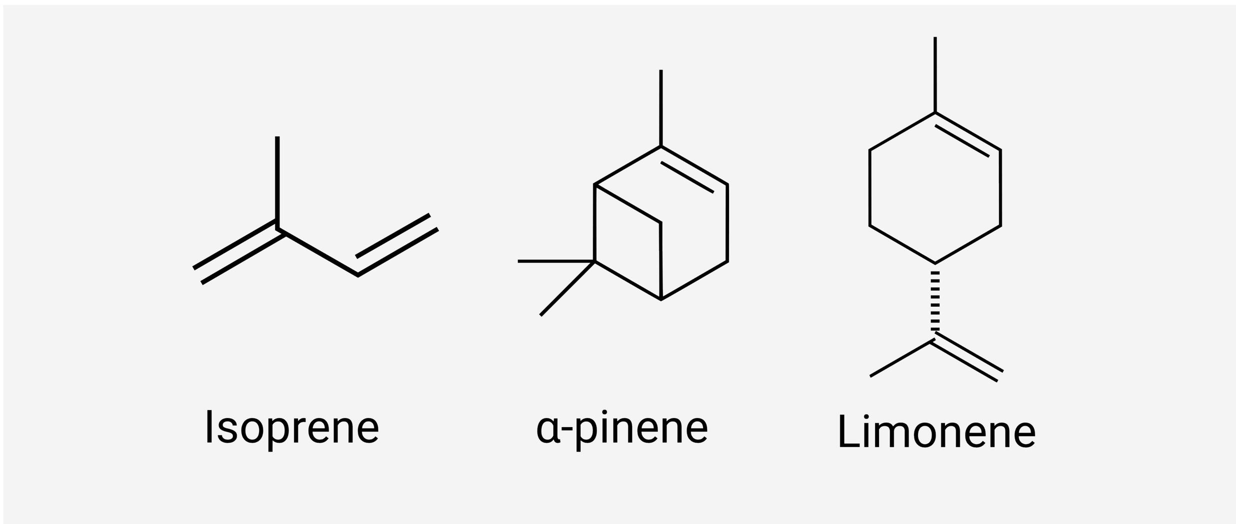
WHO ARE WE?

The **Centre for Exolife Sciences (CELS)** is a newly formed interdisciplinary collaboration between the Department of Biology, Department of Chemistry, and the Niels Bohr Institute. Our goal is improving our understanding of the physical, chemical, and biological conditions on the terrestrial planets in our own solar system and on planets around other stars, i.e. exoplanets.

INTRODUCTION



- INPs start the freezing process by aligning water molecules with high efficiency at high (-2C) temperatures. Ice nucleation is very important for the formation of rain.
- VOCs react in the atmosphere, and may be oxidised to CO_2 and water, or condense to form secondary organic aerosols. These have two main effects:
  - Promoting water condensation and cloud formation.
  - Producing atmospheric hazes that disperse and scatter light.
- VOCs can also react with NO_x to form ozone.



Left: How bacteria influence the amosphere. Above: Common BVOCs.

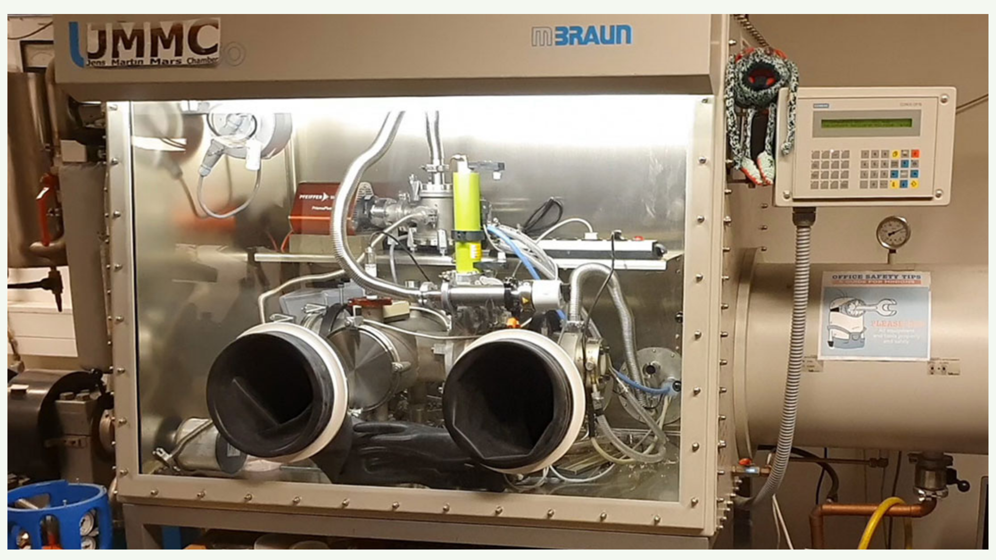
WHAT DO WE DO?

ISOLATION OF EXTREMOPHILES

We focus on extremophiles, i.e. organisms that live in extreme conditions. These microorganisms live in places with similar conditions to those of other planets (e.g. low temperatures, lack of water), also known as **terrestrial analogues**, and are thus our best models in astrobiology.

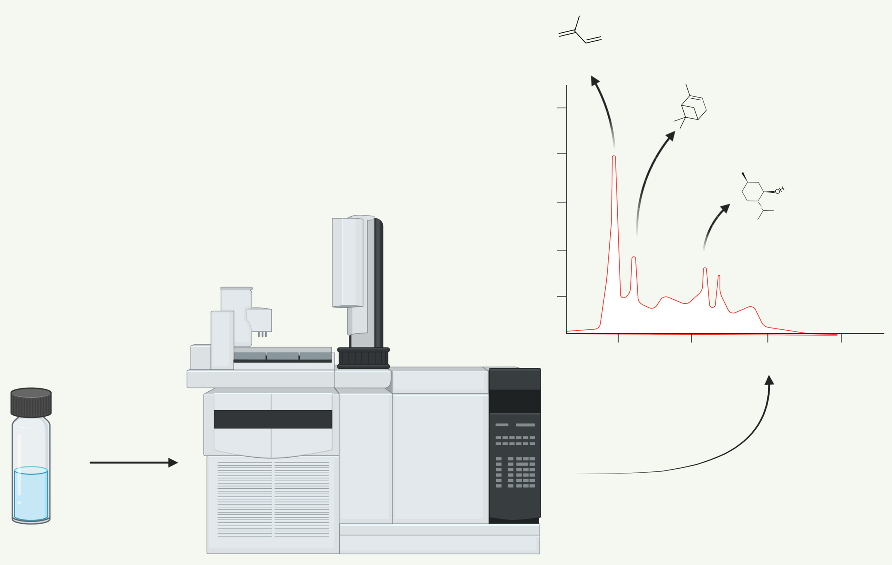
We have sampled permafrost and dry crust from Peary Land, northern Greenland, in search for psychrophiles and halophiles (cold and salt tolerant bacteria).

SIMULATION EXPERIMENTS



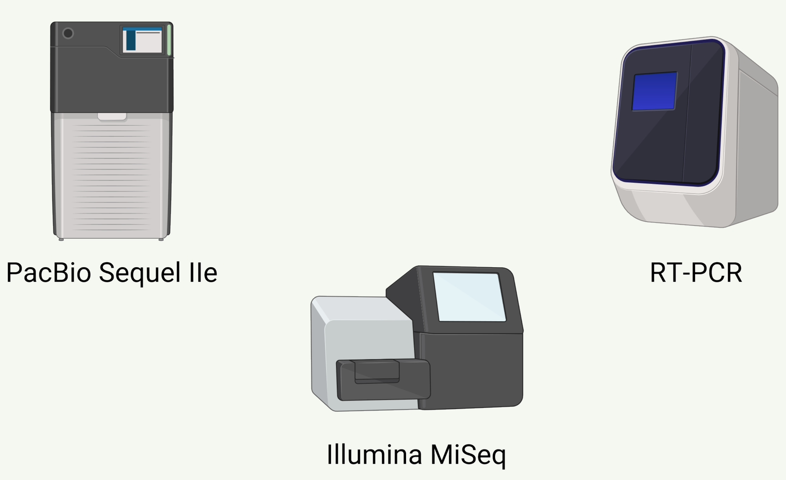
Mars simulation chamber at the Department of Chemistry. This custom-made piece of equipment allows us to subject our bacteria to simulated extraterrestrial atmospheres and collect samples of the gas phase.

mBVOC ANALYSIS



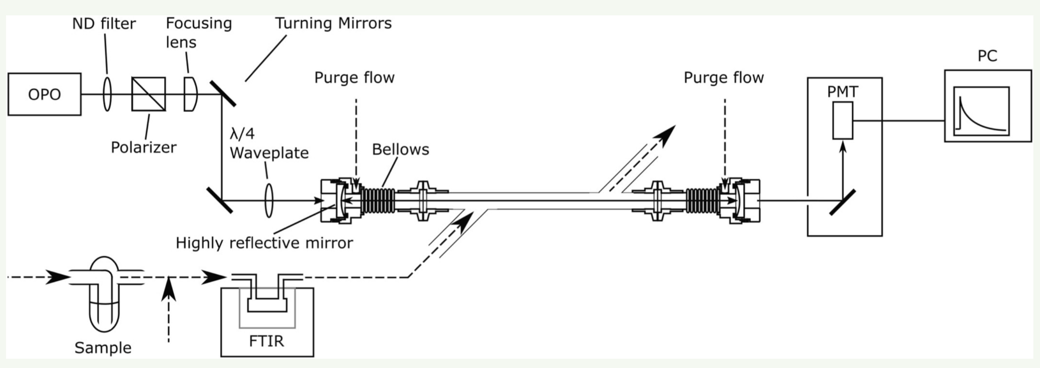
We have teamed up with the Department of Plant and Environmental Sciences to identify the volatiles produced by our extremophiles under different conditions, using GC-MS.

GENOME ANALYSIS



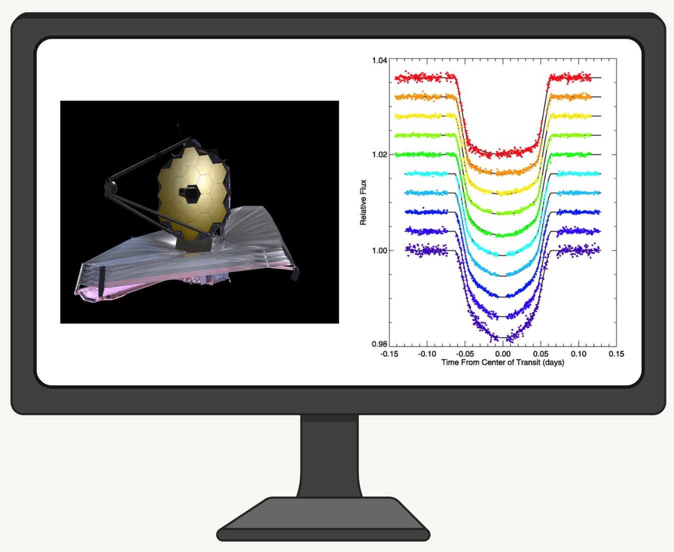
We have access to powerful sequencing techniques to learn more about our extremophiles and identify genes of interest that enhance the bacteria's survival in their harsh natural environments.

mBVOC CHARACTERISATION



OPO (pulsed laser) at the Department of Chemistry used to study molecular bond stretching in the Near Infra-Red (NIR) range, the same wavelengths that the James Webb Space Telescope works with.

OUR GOALS



- We will use the data obtained from our extremophilic isolates to create computer simulations of exoplanet atmospheres. We will be able to compare these models with real world data to look for biosignatures on other planets.
- The identified resistance genes will be used to further modify certain strains to make them even more extremophilic. Our goal is making them able to actively grow and reproduce under Martian conditions.

SOURCES AND FURTHER READING