

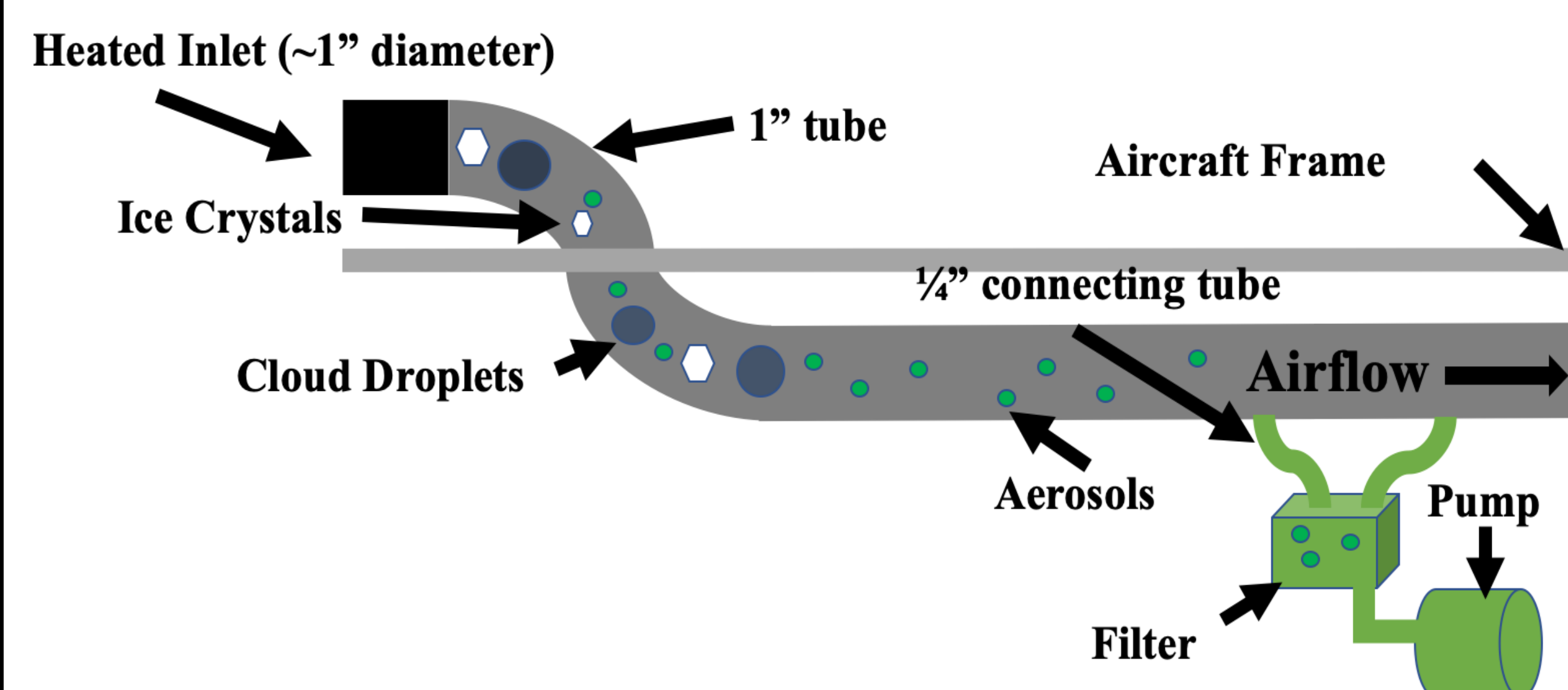
Overview

Bacteria are an important source of ice nuclei which affects the microphysics of cirrus clouds. This project's objective is to determine the different species of bacterial in the upper troposphere near the top of tropical thunderstorms. Bacteria and fungal samples were collected on filters during July 2019 aircraft flights in Florida.

Particle Sampling

Aerosol and cloud samples can be collected in the upper troposphere using a research aircraft. Recently transported material is likely found in and near the anvil regions of thunderstorms. A good place to study anvils is summer-time Florida due to the frequency of sea breeze-induced storms. The North Dakota Citation Research Aircraft (N555DS) operated out of Space Coast Regional Airport in Titusville, FL (KTIK) was used to obtain 15 filter samples at altitudes up to 40,000 ft MSL. Preliminary analysis has been conducted on four filters in flight, a clean filter, and a control filter. DNA sequencing was conducted to determine the species of bacterial and fungus present on the un-cultured filter samples. The identification of bacteria and fungi species was done using ribosomal internal transcribed spacer sequence ITS for fungi and 16S ribosomal RNA-encoding DNA for bacteria.

Inlet Block Diagram



Detailed diagram of the inlet block system on board N555DS.

Bacteria record from August 2, 2019 flight.

High amounts of *Lactuca sativa* and *Halospirulina* species were found.

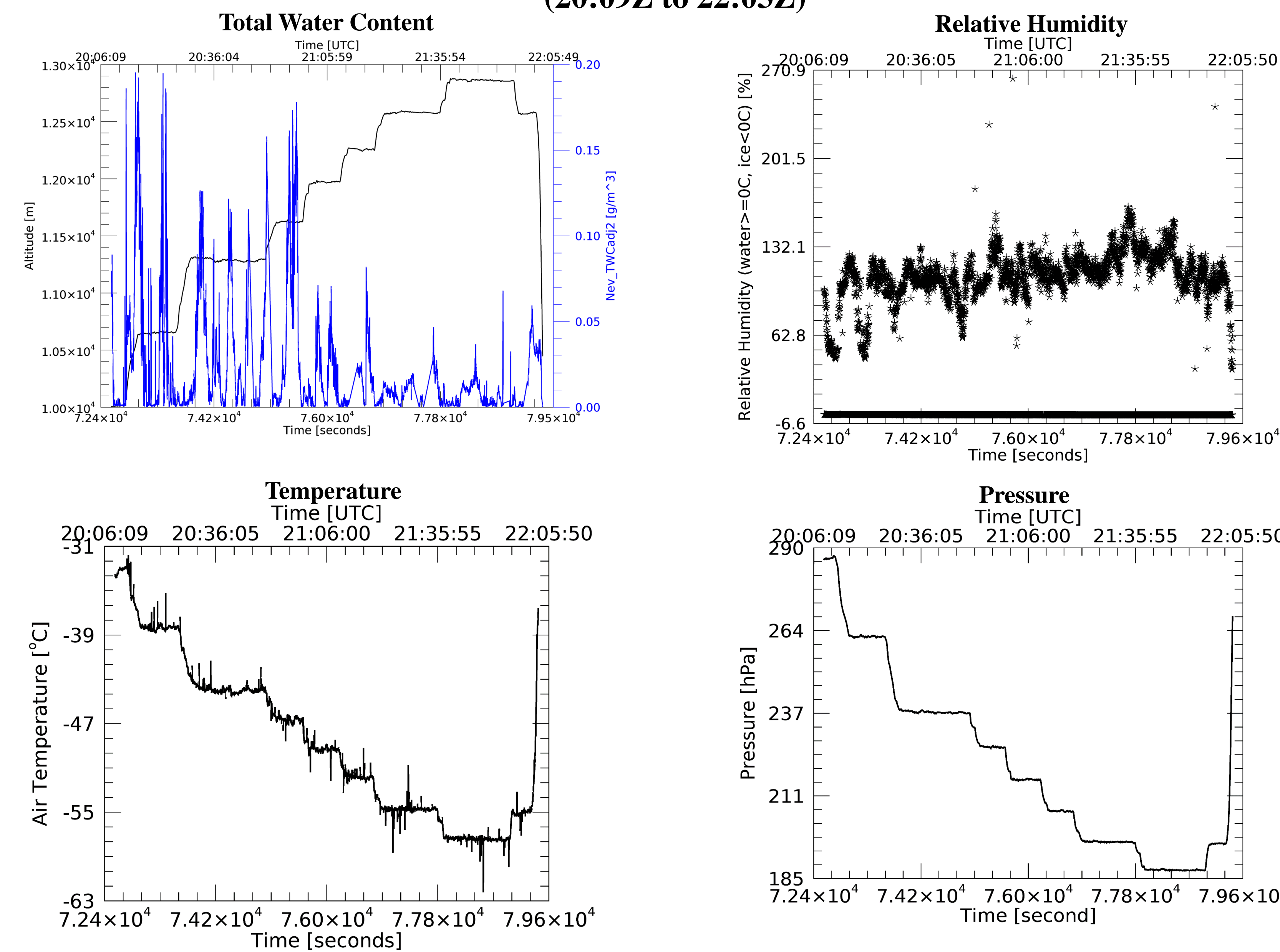
Lactuca sativa is likely from lettuce seeds seeds,

while *Halospirulina* is a salt-tolerant bacterium. Pseudomonas is the most

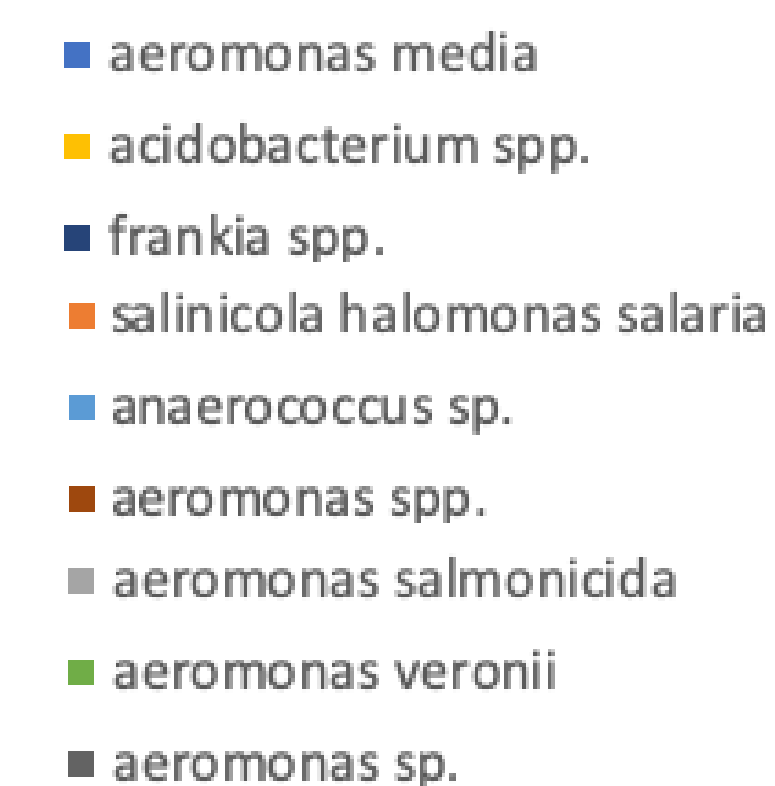
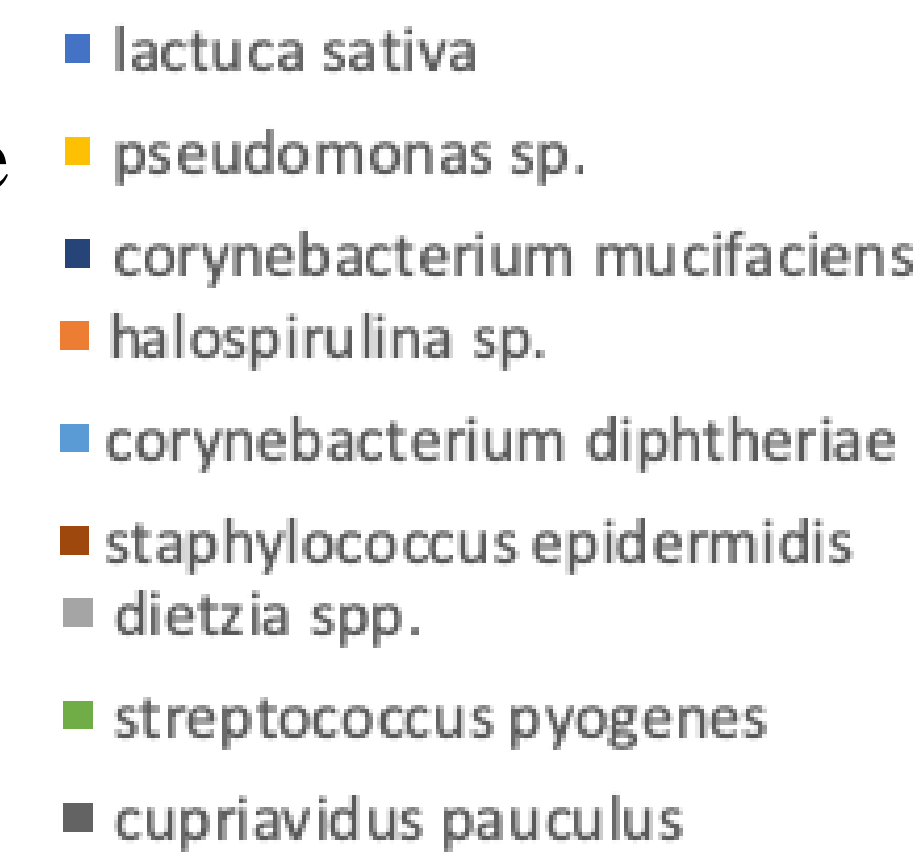
significant bacteria linked to ice nuclei particles (INP) for clouds.

Results

Total water content, humidity, temp, and pressure data from flight (20:09Z to 22:03Z)



A clean filter (not used in any flight activities) that was tested for bacteria present without any use. While bacteria was found in this clean filter, the 10 most abundant bacteria types were not present in the filter from the flight. Human bacteria discovered are most likely linked to contamination while being processed.



Citation Research Aircraft



Conclusions

- Significant amounts of human bacteria were found on most filters in this experiment.
- Human-associated bacteria found linked to contamination while being processed.
- The bacteria type *Pseudomonas* which is an INP type was found on the filter. This is the most genus bacteria found in atmospheric bacteria experiments in other studies.
- Other natural bacteria species were recovered that are linked to sampling material of biological origin included lettuce, spinach, and primrose seeds (*lactuca sativa*, *halospirulina species*).

Future Work

- Process additional control filters to determine extent of human bacteria contamination.
- Improve the collecting system by adding additional sampling as cloud water sampling.
- Compare results to previous published sampling of atmospheric bacteria.

References

- DasSarma, P., and S. DasSarma, 2018: Survival of microbes in Earth's stratosphere. *Current Opinion in Microbiology*, **43**, 24-30, <https://doi.org/10.1016/j.mib.2017.11.002>.
- Delene, D., K. Hibert, M. Poellot, and N. Brackin, 2019: The North Dakota Citation Research Aircraft Measurement Platform. *SAE International*, 1, 1-13, <https://doi.org/10.4271/2019-01-1990>.
- Murray, B.J., D. O'Sullivan, J.D. Atkinson, and M.E. Webb, 2012: Ice nucleation by particles immersed in supercooled cloud droplets. *Chem. Soc. Rev.*, **41**, 6519-6554, doi:10.1039/c2cs35200a.

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