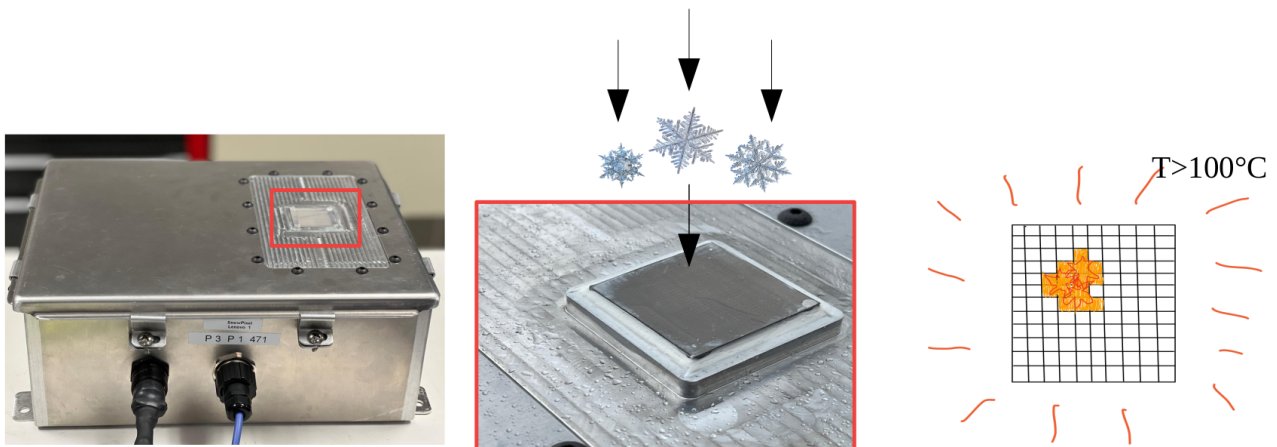


Semester or Master project – SnowPixel: Measuring the mass of individual snowflakes

Contact: heather.corden@epfl.ch

Better understanding and quantifying the microphysical properties and processes of snowfall is key to improving numerical weather and climate models. An important challenge in the modeling of snow particles—whether for quantitative precipitation forecast, or to determine the radiative contribution of ice and mixed-phase precipitating systems—comes from the difficulty in estimating their mass. Model parameterizations still rely on data from a few sparse manual measurements, which are tied to a significant uncertainty.

The “SnowPixel” is a prototype instrument designed to automatically measure the mass of individual snow particles; it offers the potential to collect abundant data on snow particle mass, which opens up possibilities for a more robust statistical characterization of mass-related properties in snowfall. The device consists of an array of small hot plates, heated at a temperature $> 100^{\circ}\text{C}$. When a snow particle falls onto it, it is melted and evaporated; the dissipated power can be correlated to the particle’s mass.



Snowpixel: pictures of the instrument and conceptual diagram.

The instrument is new and does not yet provide ‘clean’ output products: only raw dissipated power is recorded. Exploratory work has already been conducted to characterize the noise and instability of the instrument in dry weather, which can serve as a constraint for future investigations. Several research directions remain to be explored.

2024 CLOUDLAB Field Deployment

As part of the characterisation and testing of the SnowPixel, it will be installed at the field-site of the CLOUDLAB project (<https://cloudlab.ethz.ch/>) in Eriswil, Canton Bern during January and February 2024. This will provide a longer dataset of snowfall events which can be used in this project. It may be possible for the student to visit the field-site during the project to assist with maintenance and de-installation.



The CLOUDLAB field-site in Eriswil.

Depending on the duration of the project, on the obstacles encountered and on the interest of the student, one or more directions may be investigated:

1. Experimental characterization of the instrument:

- Record the dissipated power for water drops of known mass and establish the empirical relationship between the two quantities
- Compare this with theoretical relations obtained from thermodynamic laws
- Characterize the spatial homogeneity over the sensor (is the same signal recorded if a hydrometeor falls in one place vs. another?)

2. Data processing chain:

- Separating precipitation signal from noise (during a precipitation event)
- Identification of single particles on the hot plate array from the power data (e.g., using thresholding approaches, spatial/temporal clustering, ...)
- Development of a full data processing framework (giving as output: detected particles, their shape and their estimated mass, possibly also mass distribution...)

3. Implementation on the CLOUDLAB dataset:

- Characterization of the properties of the hydrometeors collected during the deployment
- Identification of preliminary trends in the particle mass statistics