

Testing Ice Nucleation Particles in an Artificial Cloud

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What is Ice Nucleation?

Ice nucleation is the initial step of the transition into a new structure or phase and happens by self-organization. It has to be distinguished between:

Homogenous Nucleation

- Stochastic process
- Starts with ice crystal germ
- Temperature dependent

Heterogeneous Nucleation

- Solid particles catalyse the ice formation
- Energy barrier is reduced by the **Ice Nucleation Particles (INPs)**

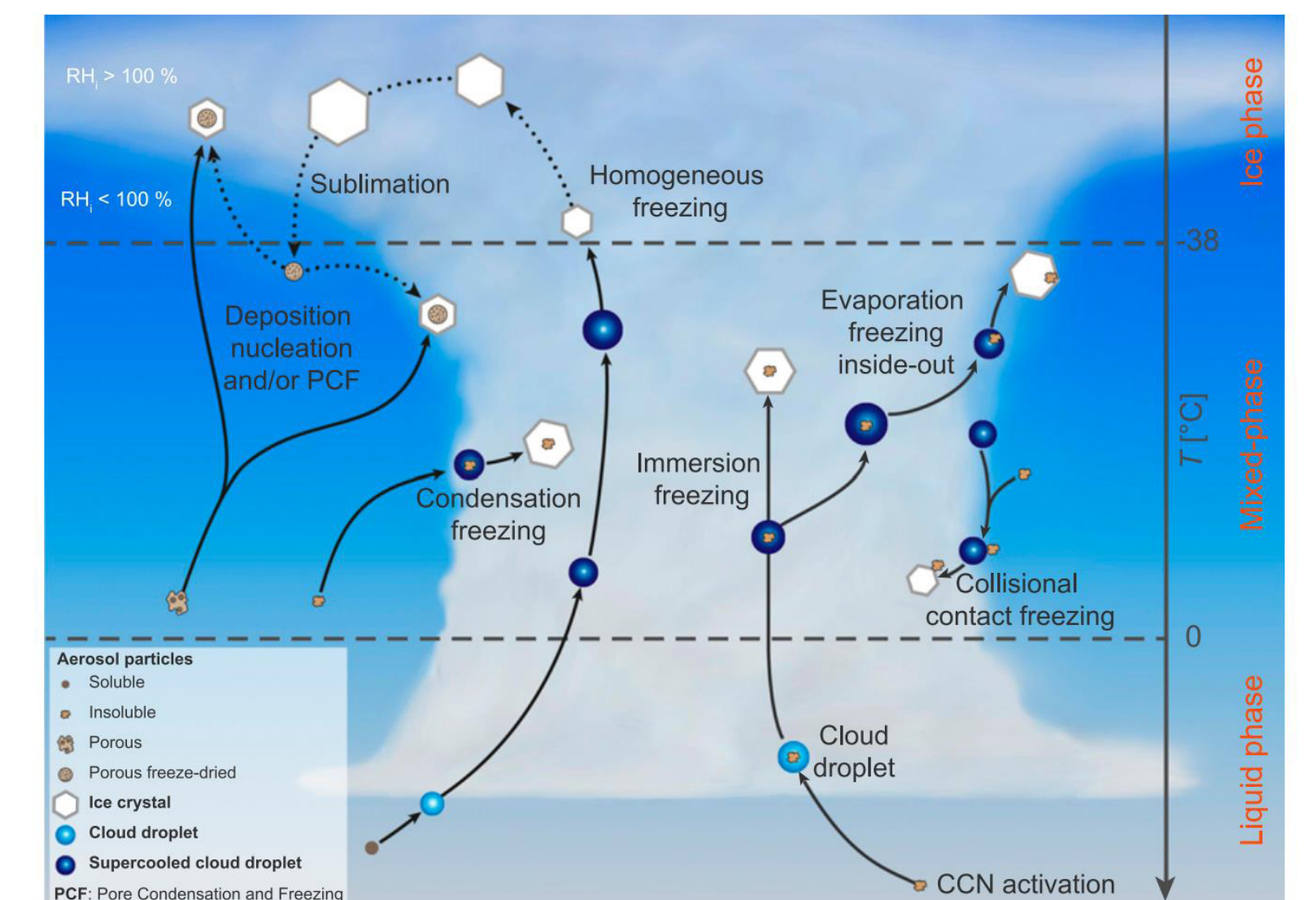


Figure 1 : Schematic processes of nucleation (Kanji et al. 2017)

Research Goal

→ Simulate the process of ice nucleation and the proximate growth of snow crystals in the atmosphere

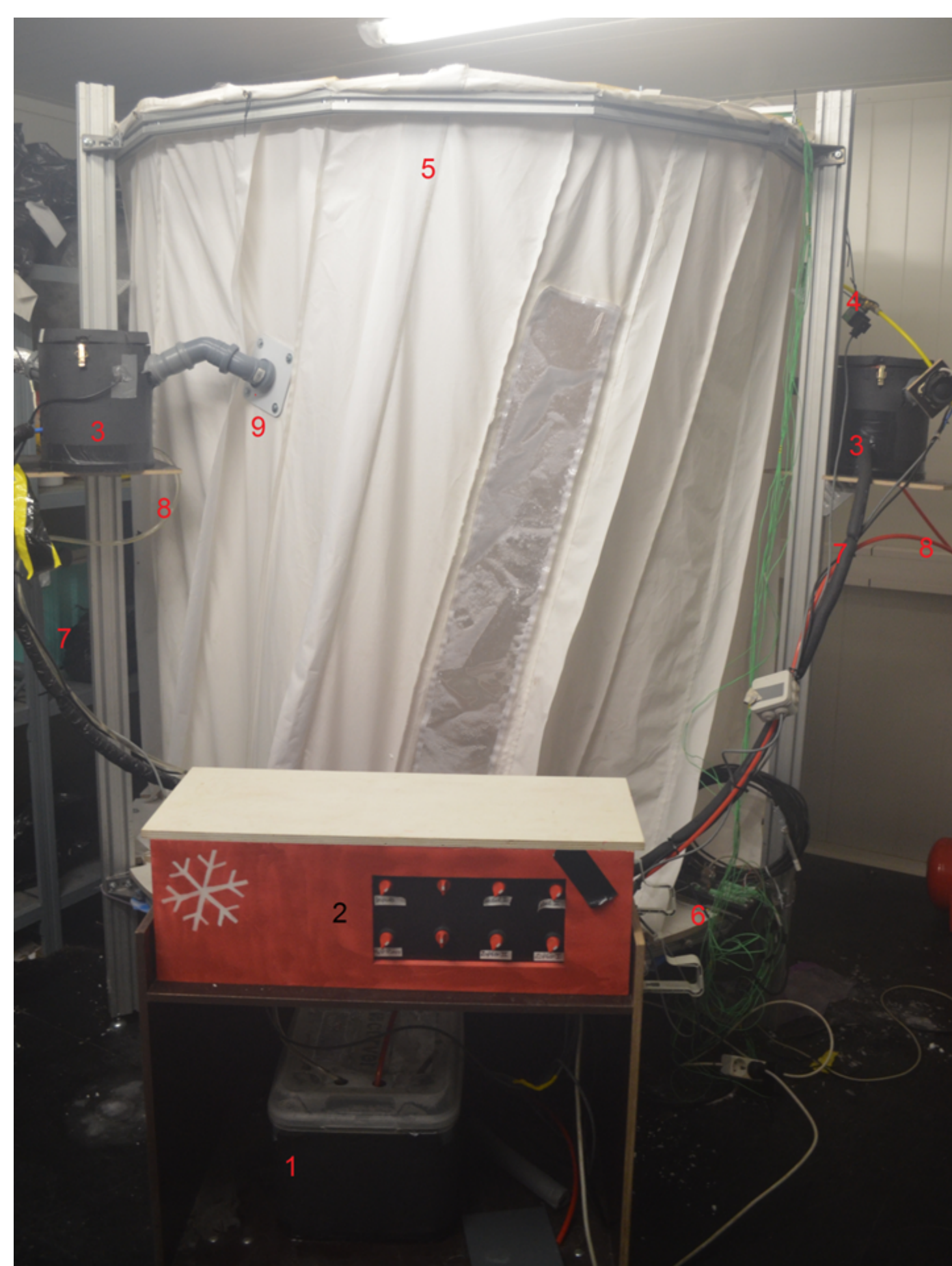


Figure 2 : Cloud chamber set up

Cloud Chamber

- Upscale from labbench experiments of TU Wien & downscale from trials of Neuschnee GmbH
- For simulations the chamber was saturated via ultrasonic nebulizers and fans
- The nucleation process was initiated through **pressurized air** or **INPs**
- Based on previous research the following biological additives for possible INPs were used:
 - Distilled water
 - Tapwater
 - Cellulosic fibre
 - Birch (*Betula*)
 - Black Currant (*Ribes*)
 - Snomax (*Pseudomonas syringae*)

→ To enhance further crystal growth

Methods

- In total 36 trials → a minimum of 6 trials for each additive (3 with & 3 without compressed air)
- Each trial ~ 20 minutes → Temperature & RH was measured
- Photo-optical documentation in a 5 minutes intervall
- Classification after Libbrecht

Results

- Previous research concerning biological ice nucleation can be confirmed
- Support the hypothesis, that the amount of nebulised water has a positive impact on the growth rate
- The additives (Black Currant, Birch, and Snomax) provide satisfying results
- Without these INPs, nucleation could not be observed under the existing conditions
- Nucleation event can be started by impulses of compressed air, no used INP can dominate these impulses (adiabatic cooling/ pressure shockwave)
- By cutting out compressed air, the crystals decrease in quantity but increase in complexity and size

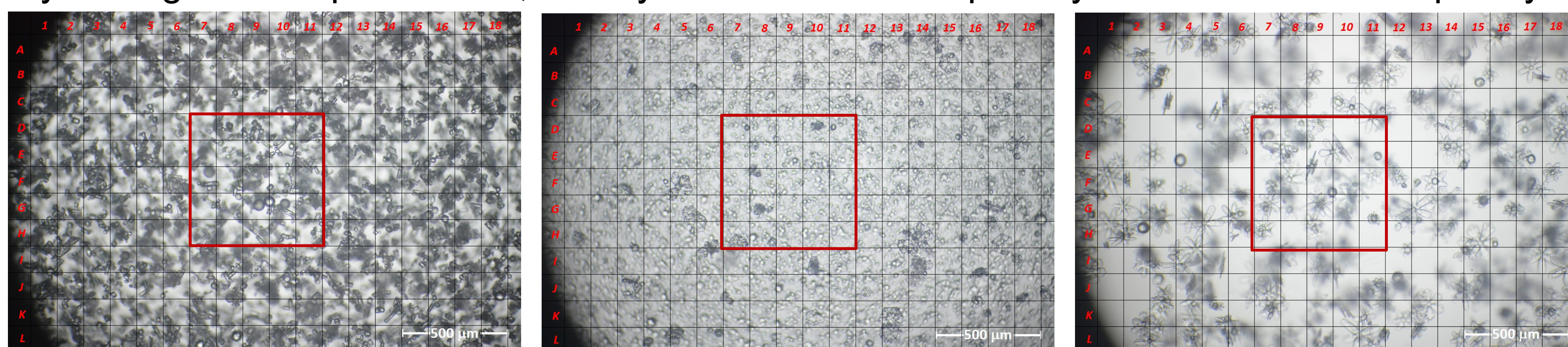
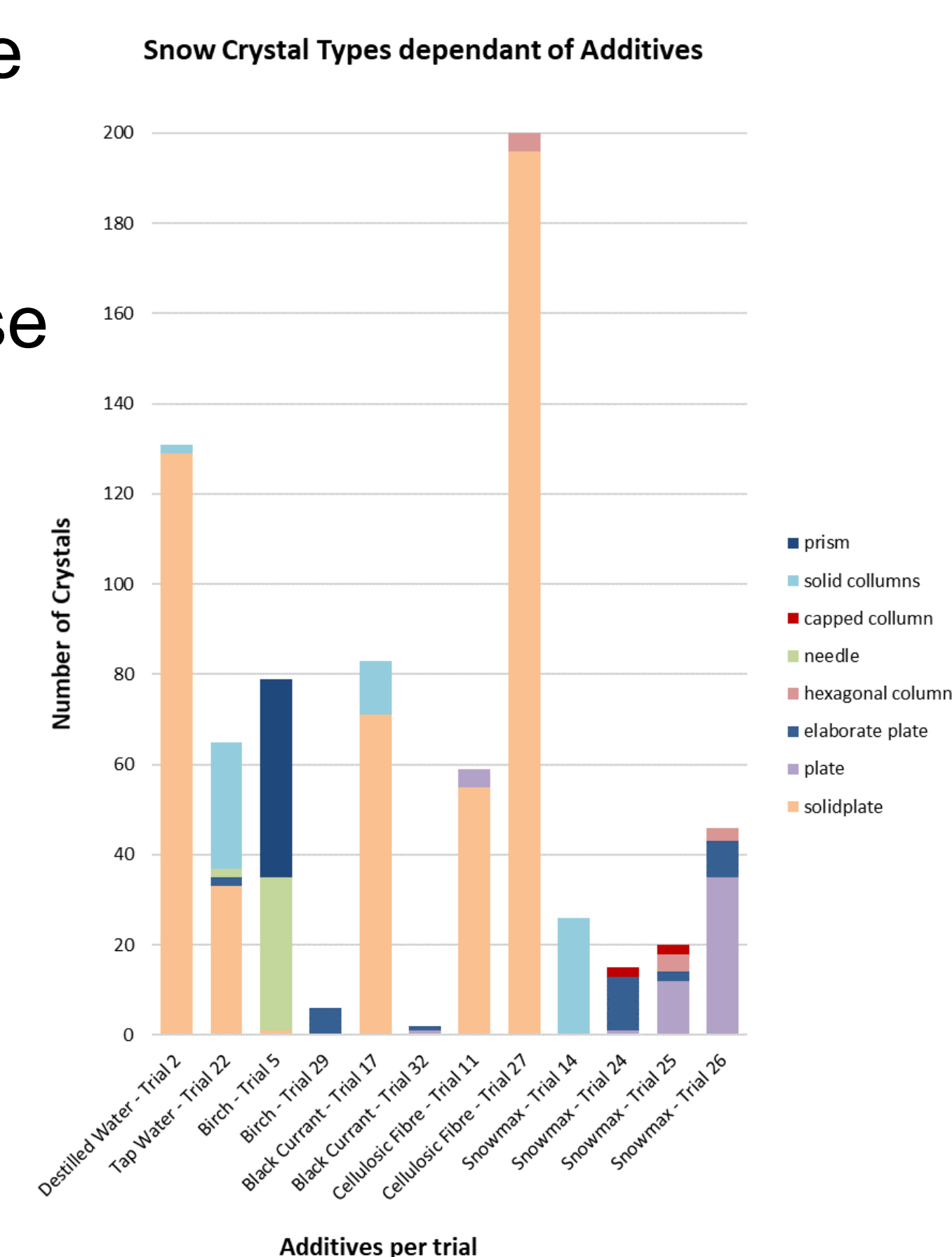


Figure 4; Crystalization Results: (i) resulting columns while using pressurized air, (ii) plate like crystals while using Birch, (iii) elaborate plate like crystals using Snomax



Outlook

- The complex process of ice nucleation & growth needs further research
- Optimizing the set-up of the *Cloud Chamber*
- Different classification approach
- Other INPs
- Measuring liquid water content in the cloud

References

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