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Oxidative processing studies on biological ice nucleating particles

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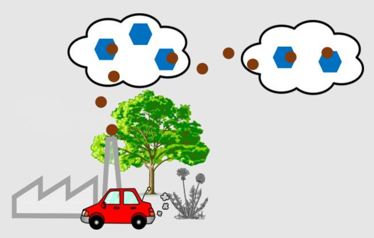
1 Introduction

Ice nucleating particles (INP) are relevent for cloud formation and therefore contribute to the overall impact of clouds on the Earth's climate. However, models are still missing relevant information on types of INPs, underlying processes and INP concentrations (1-2). To date, it is known that biological particles, such as pollen, can act as INPs. Yet, only few pollen types are studied for their IN behaviour.

Another key aspect when studying INPs is the possible influence of particle ageing and chemical processing on the ice nucleation activity (e.g. 3). Chemical exposure to oxidants such as OH and O_3 may impact the IN ability of INPs.



2 Objectives

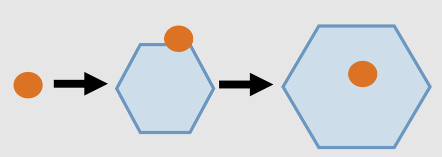
Question: Can **ice nucleation activity** of pollen be **altered** by exposure to OH (**chemical oxidation**)?

We are studying the effect of OH oxidation on the ice nucleation activity of three types of pollen: Silver Birch, Grey Alder and Sycamore Maple.

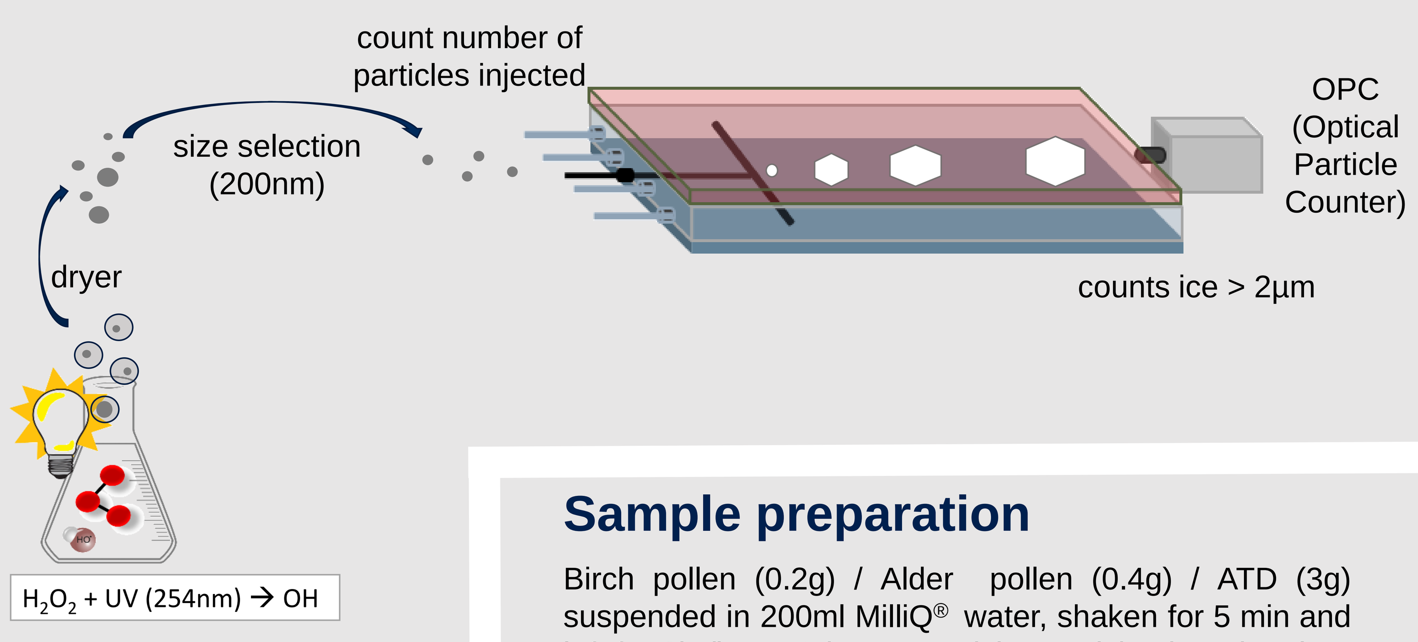
2 Method overview

Experimental Design

Ice nucleation of the biological particles is studied in deposition mode at 233K (-40°C)



University of Toronto Continuous Flow Diffusion Chamber (UT-CFDC)



aqueous phase oxidative pre-processing

Sample preparation

Birch pollen (0.2g) / Alder pollen (0.4g) / ATD (3g) suspended in 200ml MilliQ® water, shaken for 5 min and left for 2h (large & heavy particles settle). Then the clear part is transferred to the atomizer bottle.

TOC value (birch): 128 mg/L
TOC value (alder): 183 mg/L.

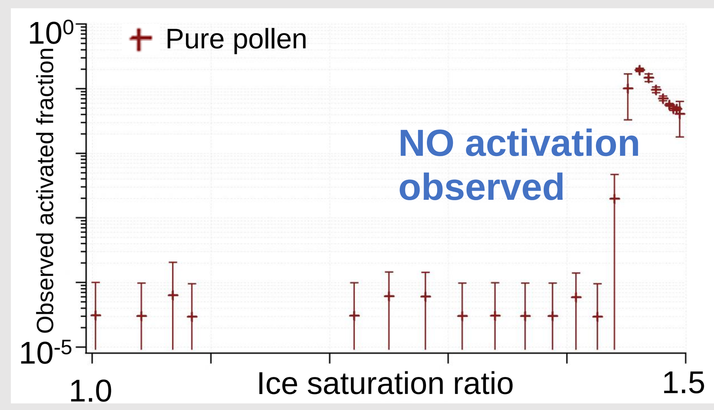
For OH exposure, 500mM H_2O_2 are added and OH is generated using a 254nm Hg-lamp.

3 Results: OH exposure studies

All pollen are non-defatted pollen from land and roadside in South Czech Republic (Pharmallerga®). Shown are the activated fractions for ice crystals >2 µm at a temperature of 233K.

Ice nucleation inactive Maple Pollen

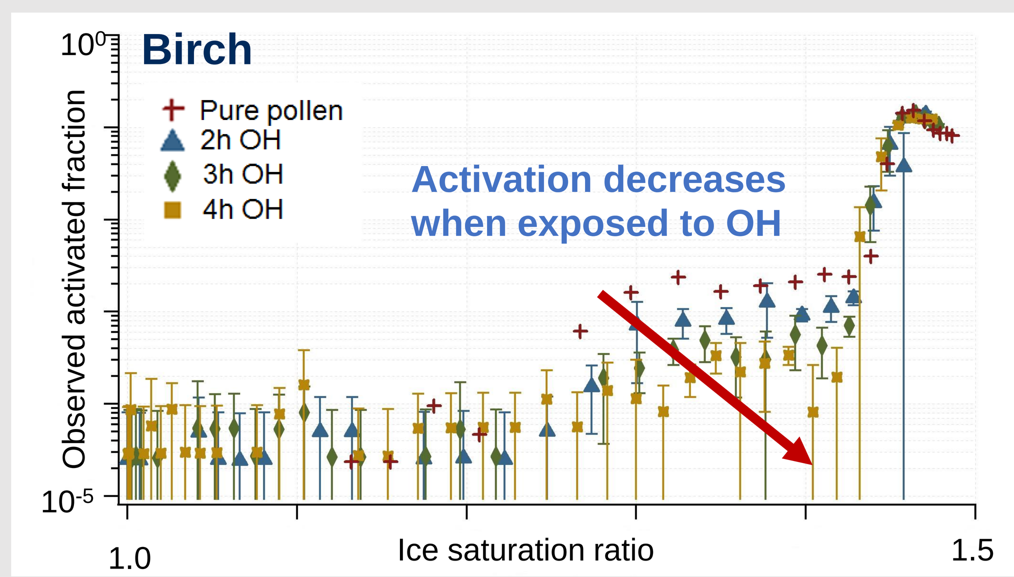
Sycamore maple (*Acer pseudoplatanus*): Thin beige powder. Microscopic size 30-50µm.

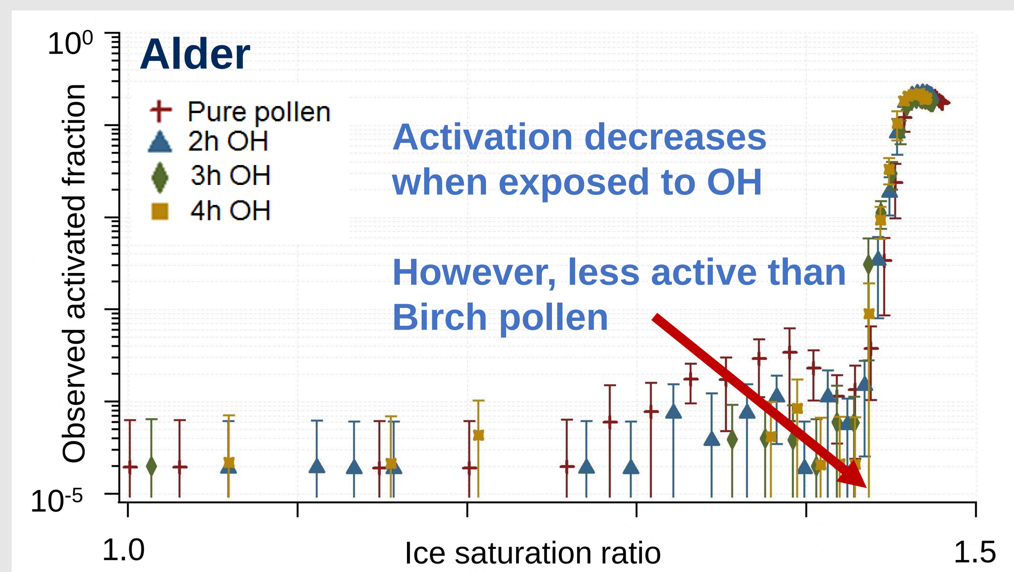


Note: As no activation was observed for maple pollen, exposure to OH was not tested.

Ice nucleation active Birch and Alder Pollen exposed to OH

Silver birch (*Betula pendula*):Thin gold yellow powder. Microspcopic size 20-27 µm.
Grey Alder (*Alnus incana*): Yellow, loose pollen. Microscopic size 18-30 µm.

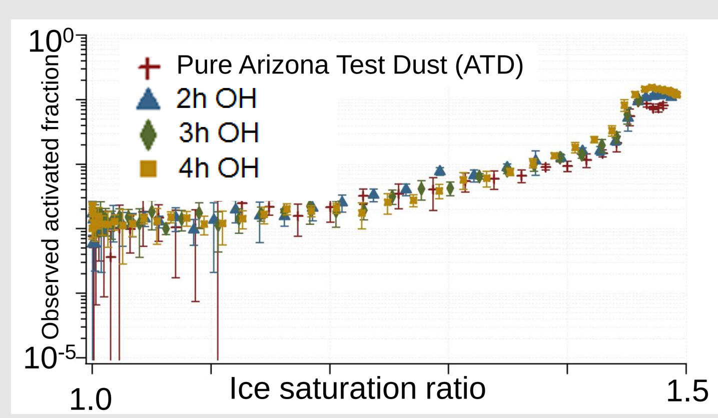




In both cases, the initially light yellow colour of the sample was lost during OH exposure.

Comparison to a non biological material - ATD

The ice nucleation activity under OH exposure of the biological materials is compared to ATD as a non-biological material.

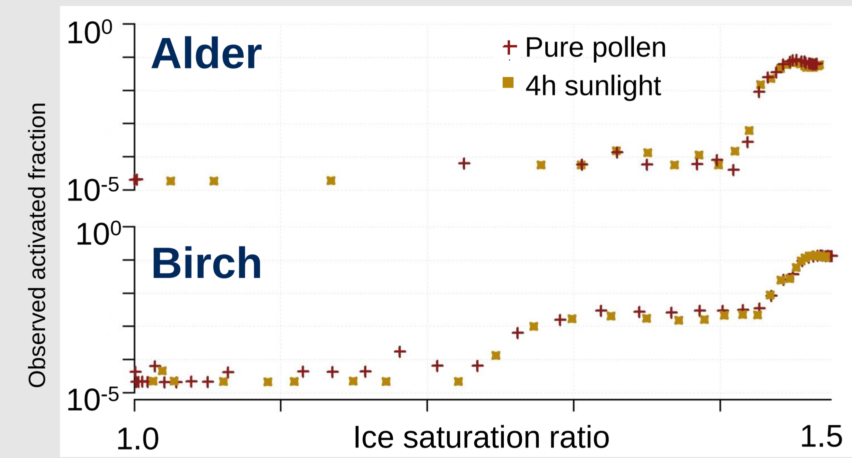


No decrease of IN activity observed due to OH exposure

4 Results: Solar Simulator and controls

Solar simulator

Pollen were exposed to light (300–800nm) in a sunlight simulator (4) for 4h. Then IN activity was measured.



Control experiments

Control experiments were done for all substances that showed ice nucleation activity. No effect could be observed for any sample, when the test material was exposed to UV light (254nm) or H_2O_2 only, or when left pure for 4 hours.

5 Conclusion and outlook

From the presented data we can conclude that

- depending on the pollen type, ice nucleation activity can be observed
- exposure to OH decreases the IN activity of these pollen
- exposure to OH did not affect the IN activity of the non-biological material

Therefore, the **change in IN activity due to OH exposure** is of **biological origin.**

Next steps are:

a) Most importantly, measure the OH concentration in the sample using HPLC
b) Study chemical bonds and their potential change due to the OH exposure using FTIR-ATR analysis
c) Image the pollen samples before and after OH exposure
d) Conduct same experiments in an environmental chamber

6 References

1 Boucher et al., 2013, Clouds and aerosols IPCC. pp. 571-658
2 Hoose, C. & Moehler, O., 2012, ACP, 12 (20), pp. 9817-9854
3 Sullivan, R.C. et al. 2010. ACP, 10 (23), pp. 11471-11487
4 Lam, M.W. et al., 2003, Environ. Sci. Technol., 37, pp. 899-907

Acknowledgements

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