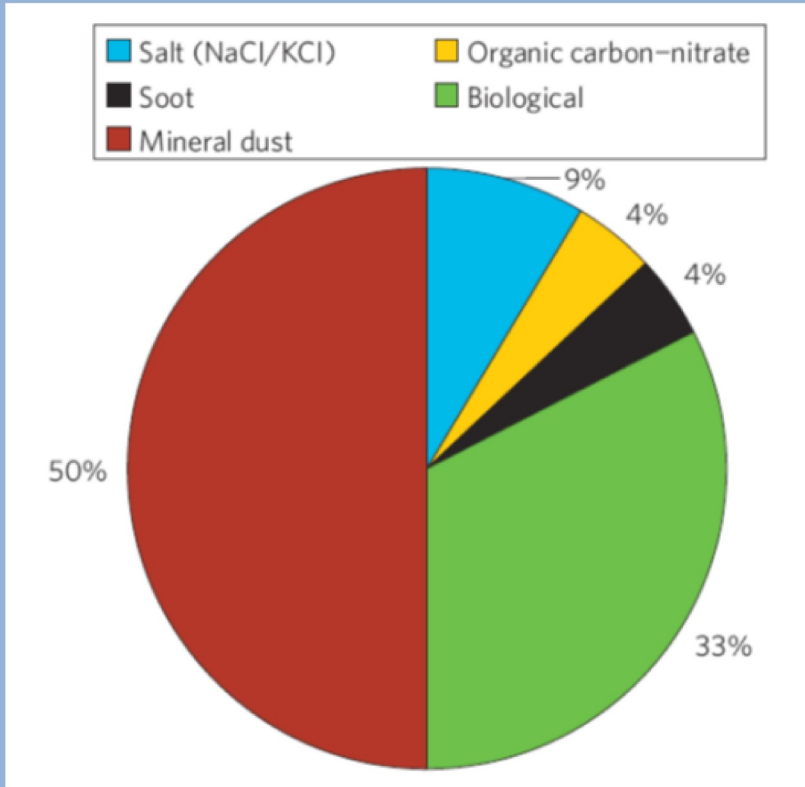


Ice nucleation caused by primary biological aerosol particles

a.o. Univ. Prof. Dr. Hinrich Grothe
Vienna University of Technology



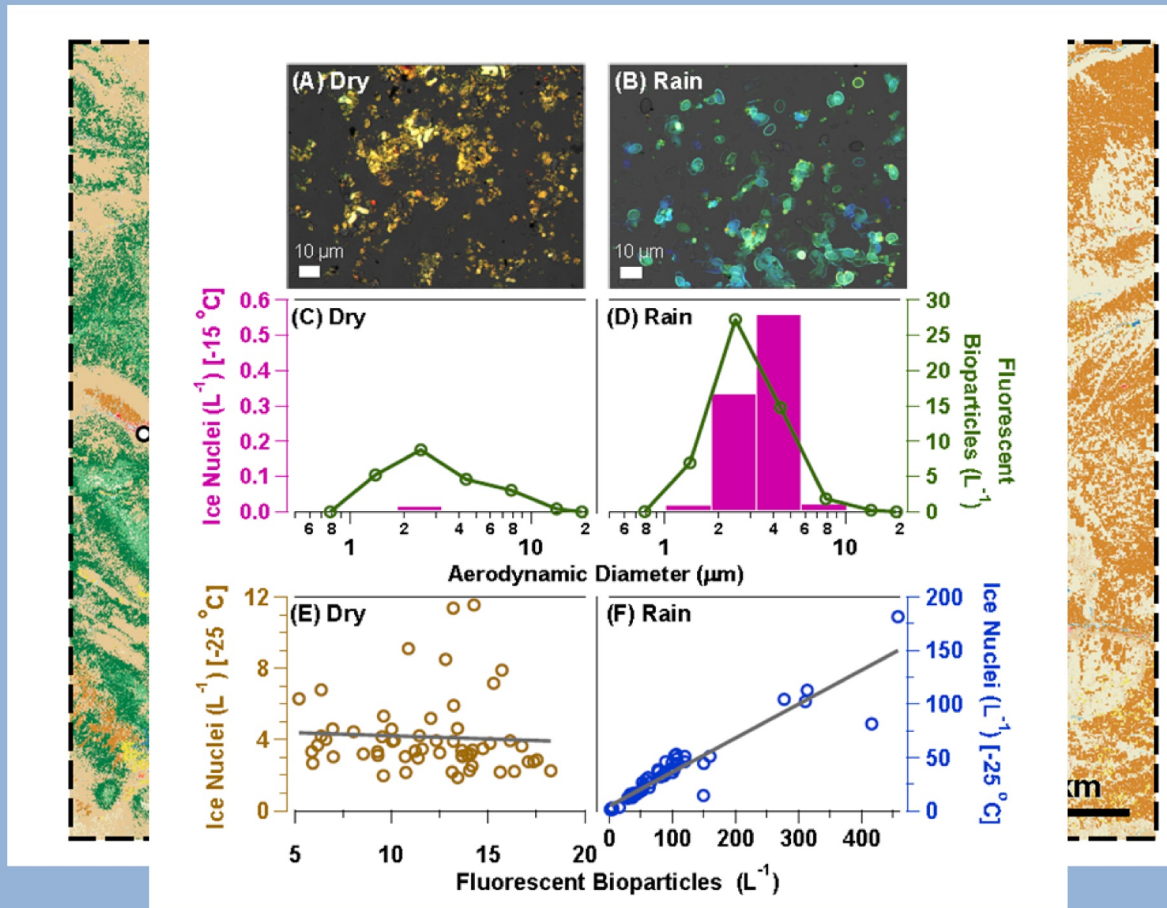
Composition of Ice Cloud Residues



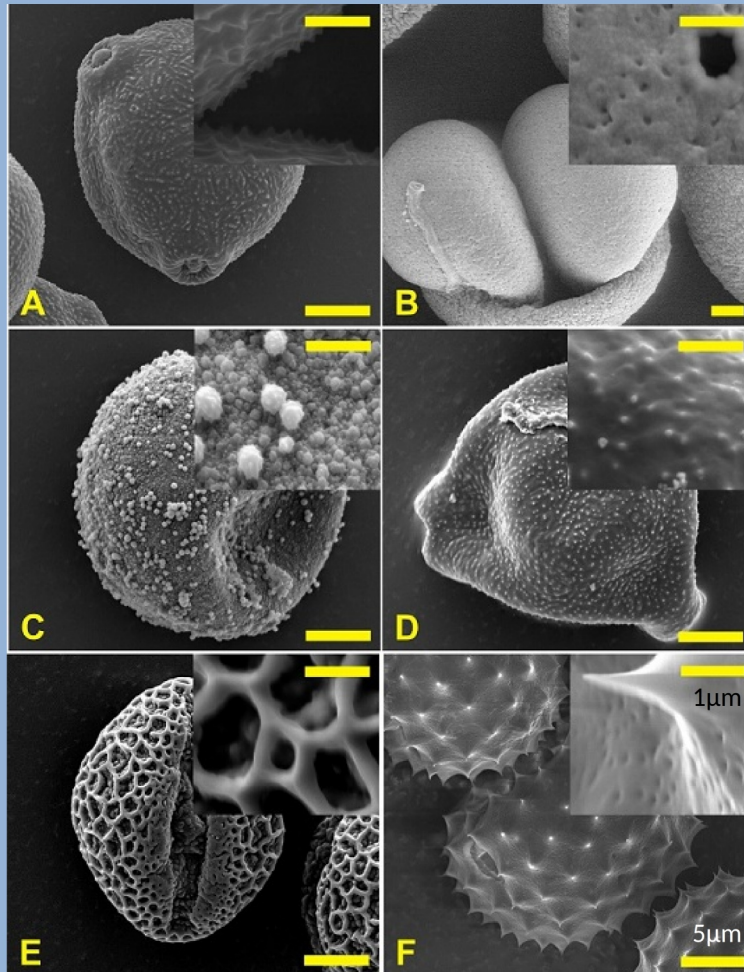
C-130 aircraft over Wyoming at 7.9-8.3 km altitude on 7th November 2007 during the Ice in Clouds Experiment - Layer Clouds (ICE-L).

Pratt, K. A., DeMott, P. J., French, J. R., Wang, Z., Westphal, D. L., Heymsfield, A. J., Twohy, C. H., Prenni, A. J., and Praether, K.A.: In situ detection of biological particles in cloud ice-crystals, *Nat. Geosci.*, 2, 398-401, 2009.

Biological Ice Nuclei over wood lands



SEM pictures - morphologies



A...birch

B...pine

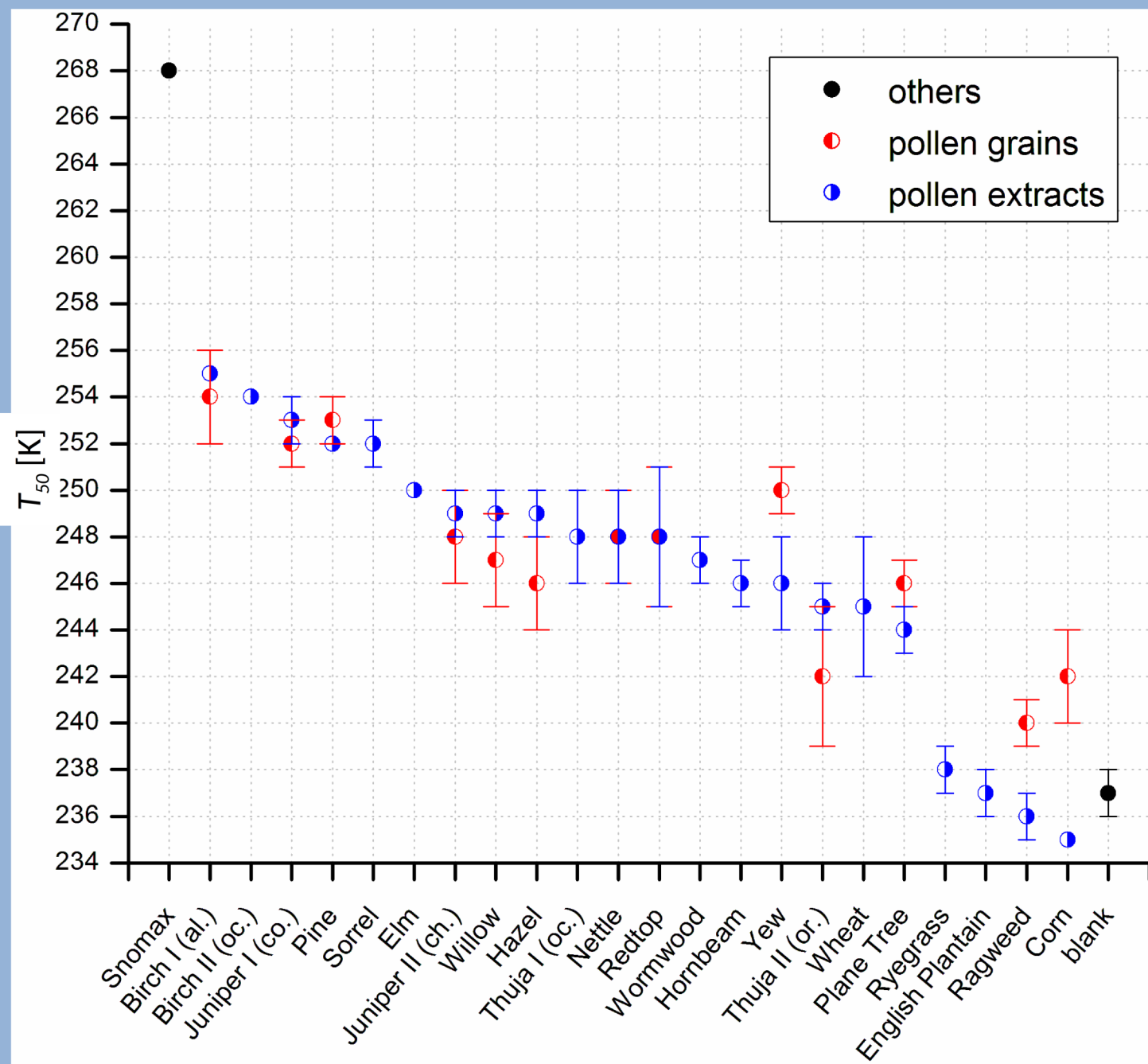
C...juniper

D...hazel

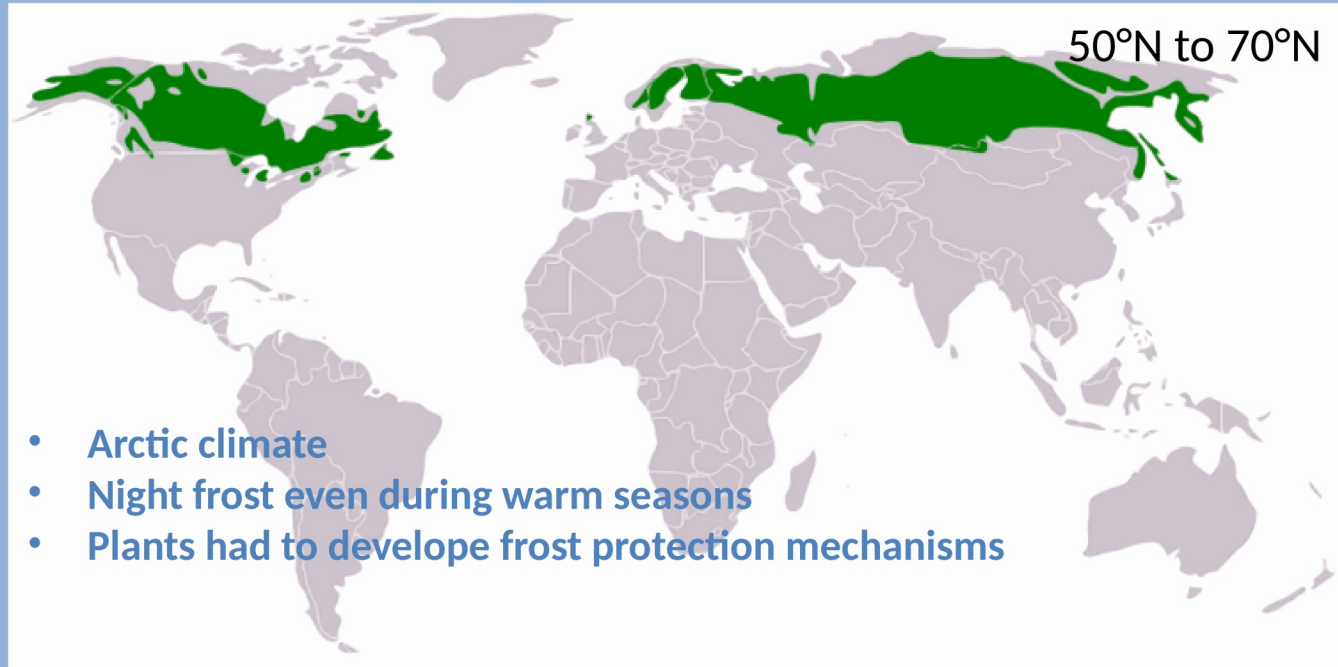
E...willow

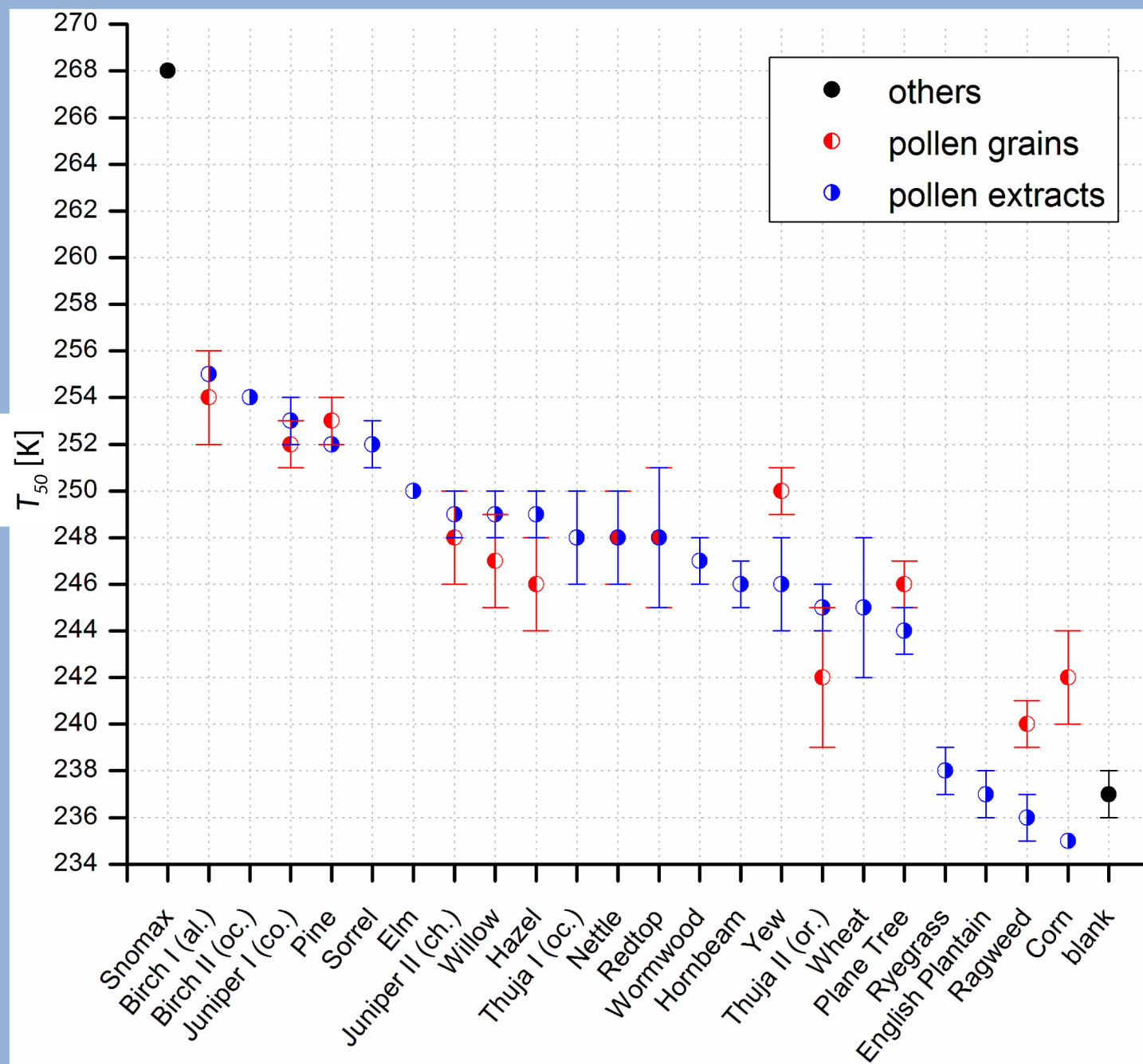
F...ragweed

big pictures: 5 μ m bars
small pictures: 1 μ m bars



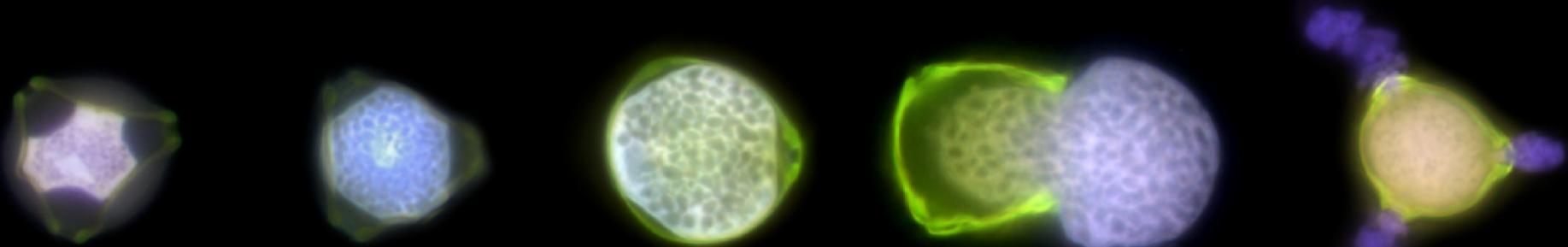
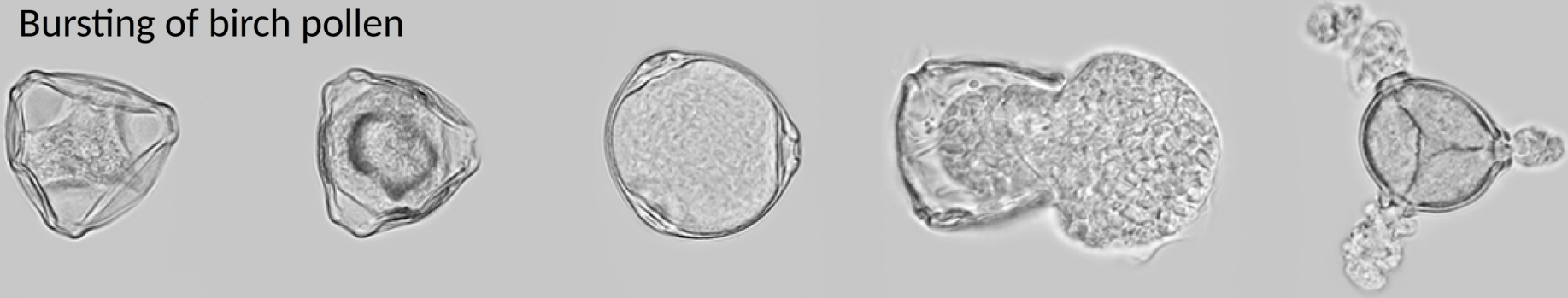
Boreal Forests @ Northern Timberline



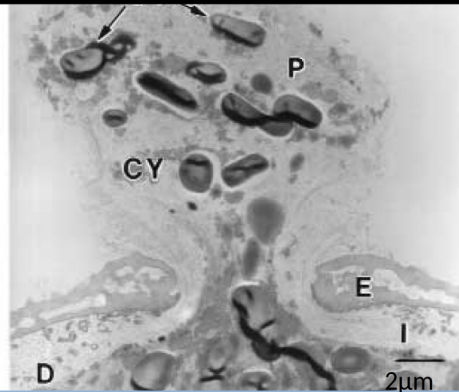
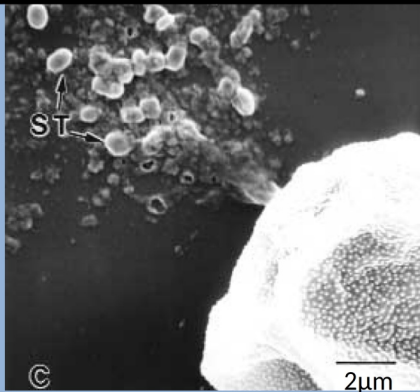


SEM pictures – pollen bursting

Bursting of birch pollen



Pöhlker, C., Huffman, J. A., Förster, J.-D. and Pöschl, U.:Autofluorescence of atmospheric bioaerosols: spectral fingerprints and taxonomic trends of pollen Atmos. Meas. Tech., 6, 3369–3392, 2013



I ...intine

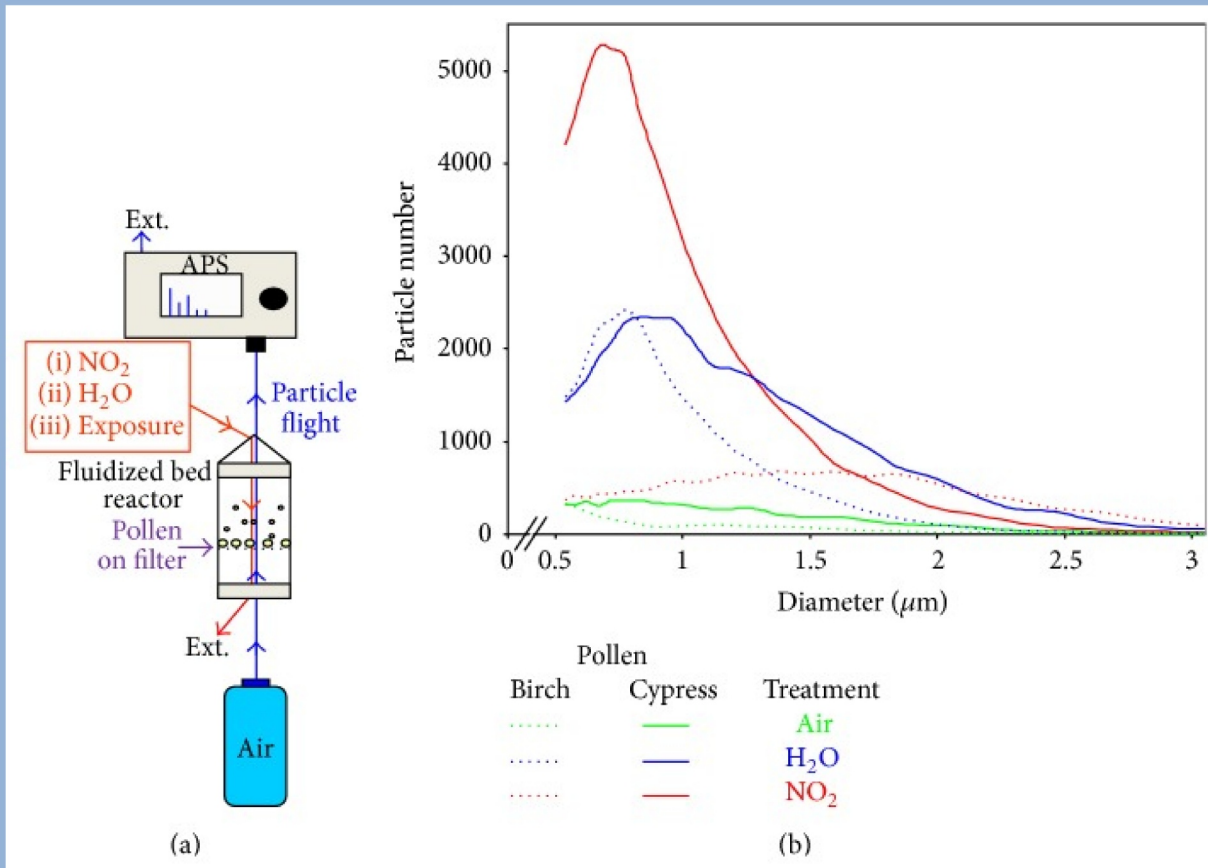
pictures: 2µm bars

Grote et al. J ALLERGY CLIN IMMUNOL 2000, 105, 1140-1145

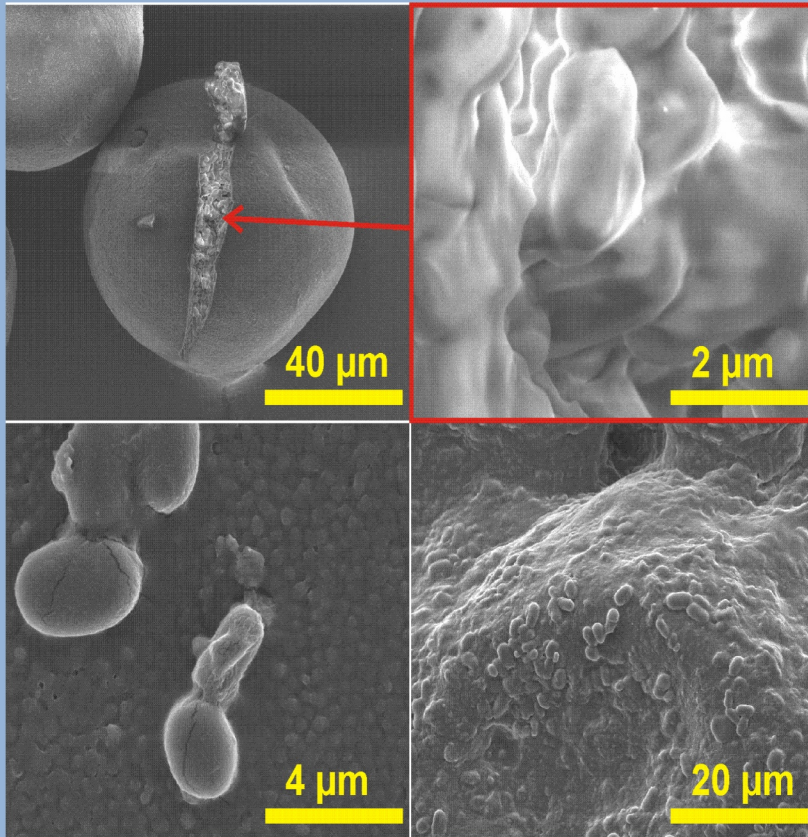
Grote et al. J ALLERGY CLIN IMMUNOL 2001, 108, 109-115

Aerosol - Cloud Interaction

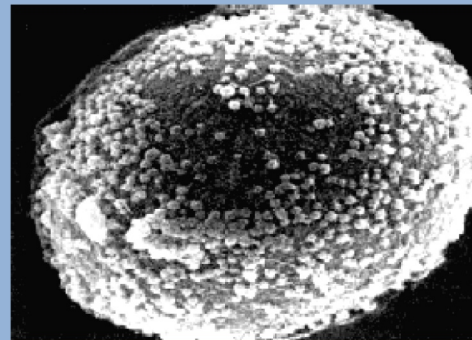
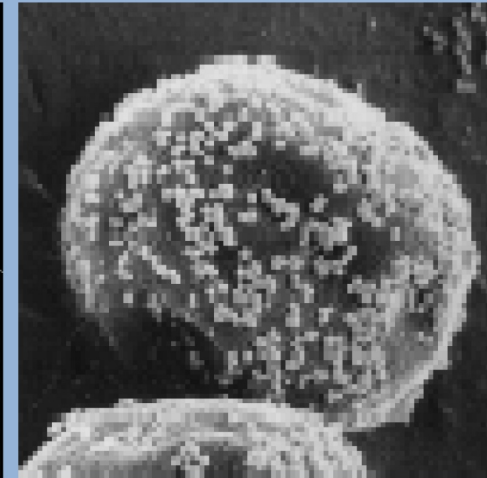
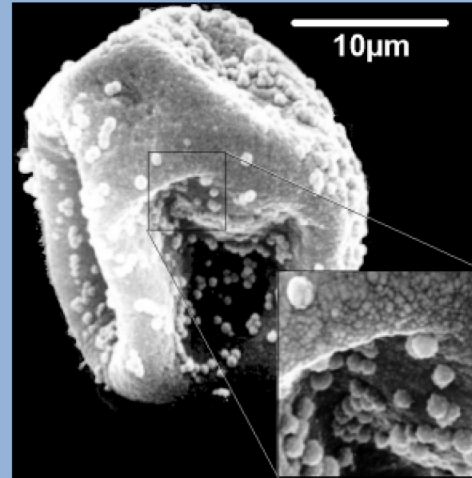
Particulate matter:



Scanning Electron Microscopy



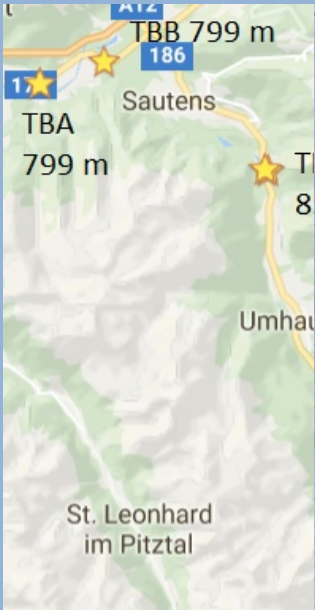
Corn pollen



Juniper pollen

Leaves

Fruit bodies



Secondary wood

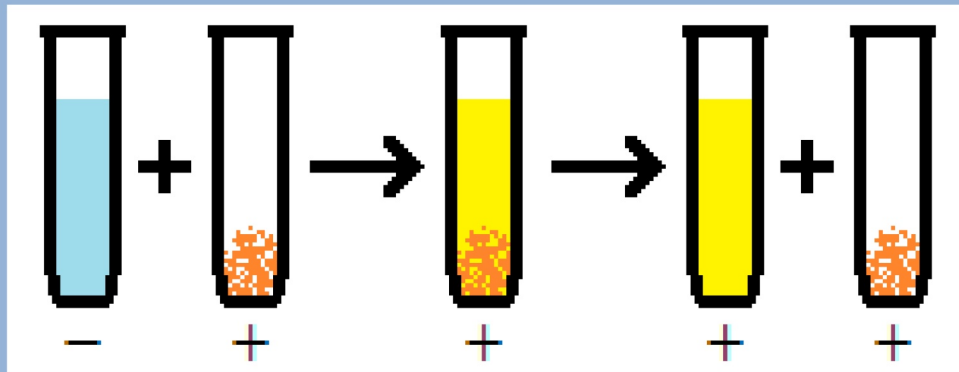
Primary wood

Leaves



Sample Preparation

- Milled in the swing mill and liquid nitrogen cooled between the milling steps
- Milled samples were dried
- Extractions –
dried sample + ultra pure water (UPW)



Extracts of intact samples

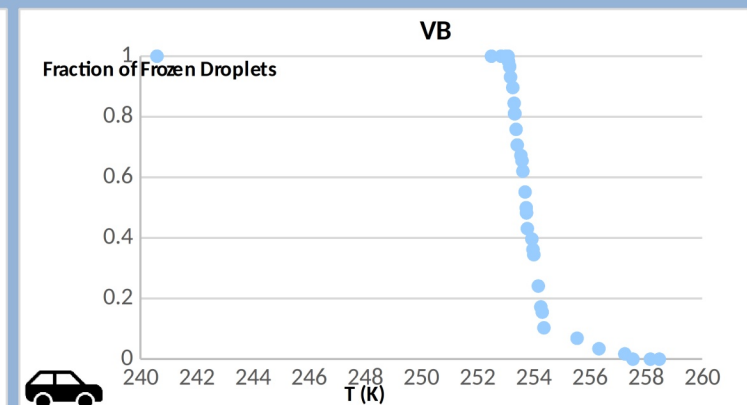
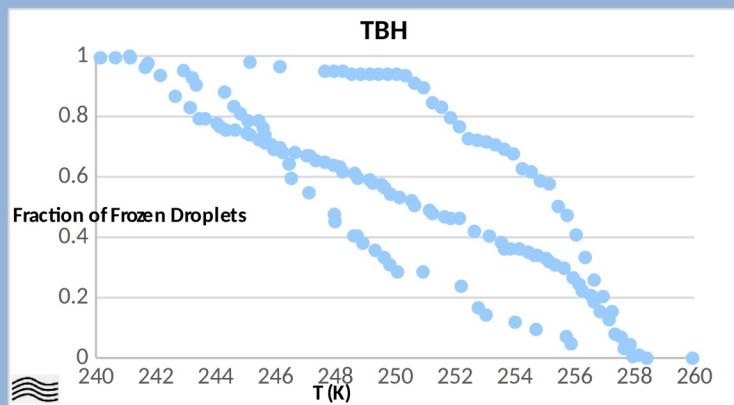
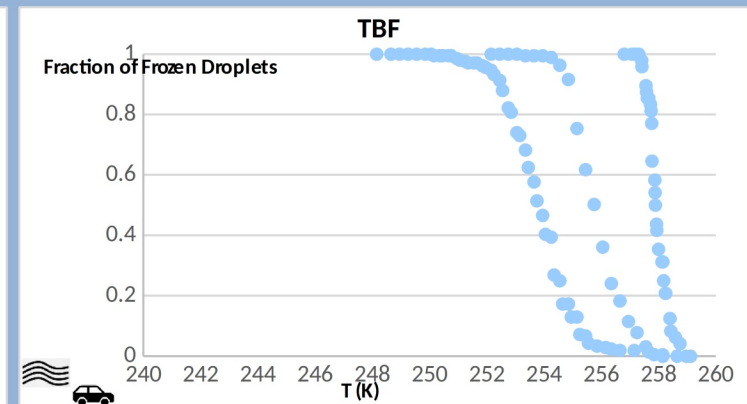
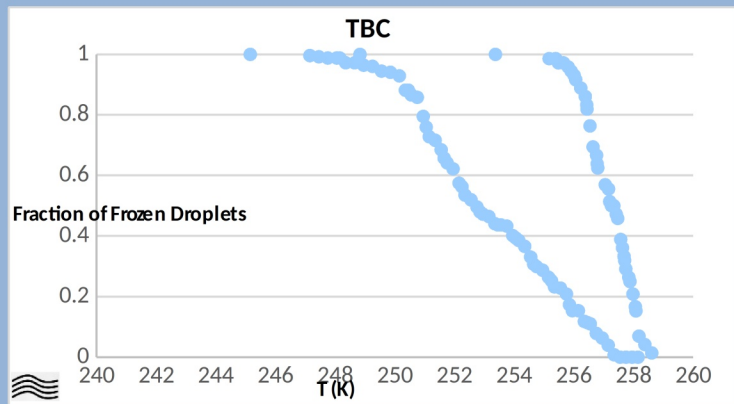
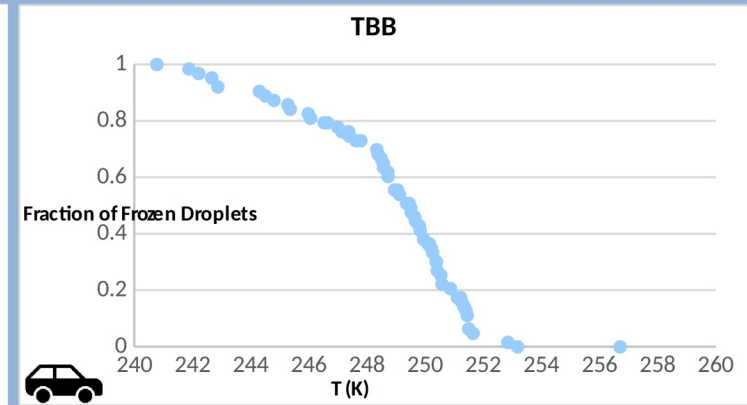
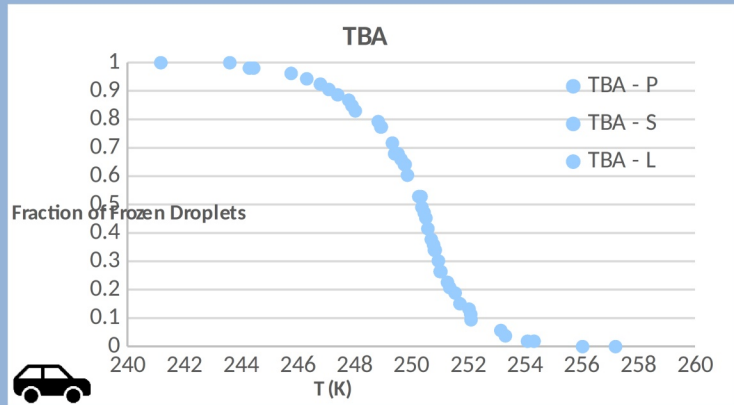
Wood samples:
Droplets - surface
extraction for 6 h



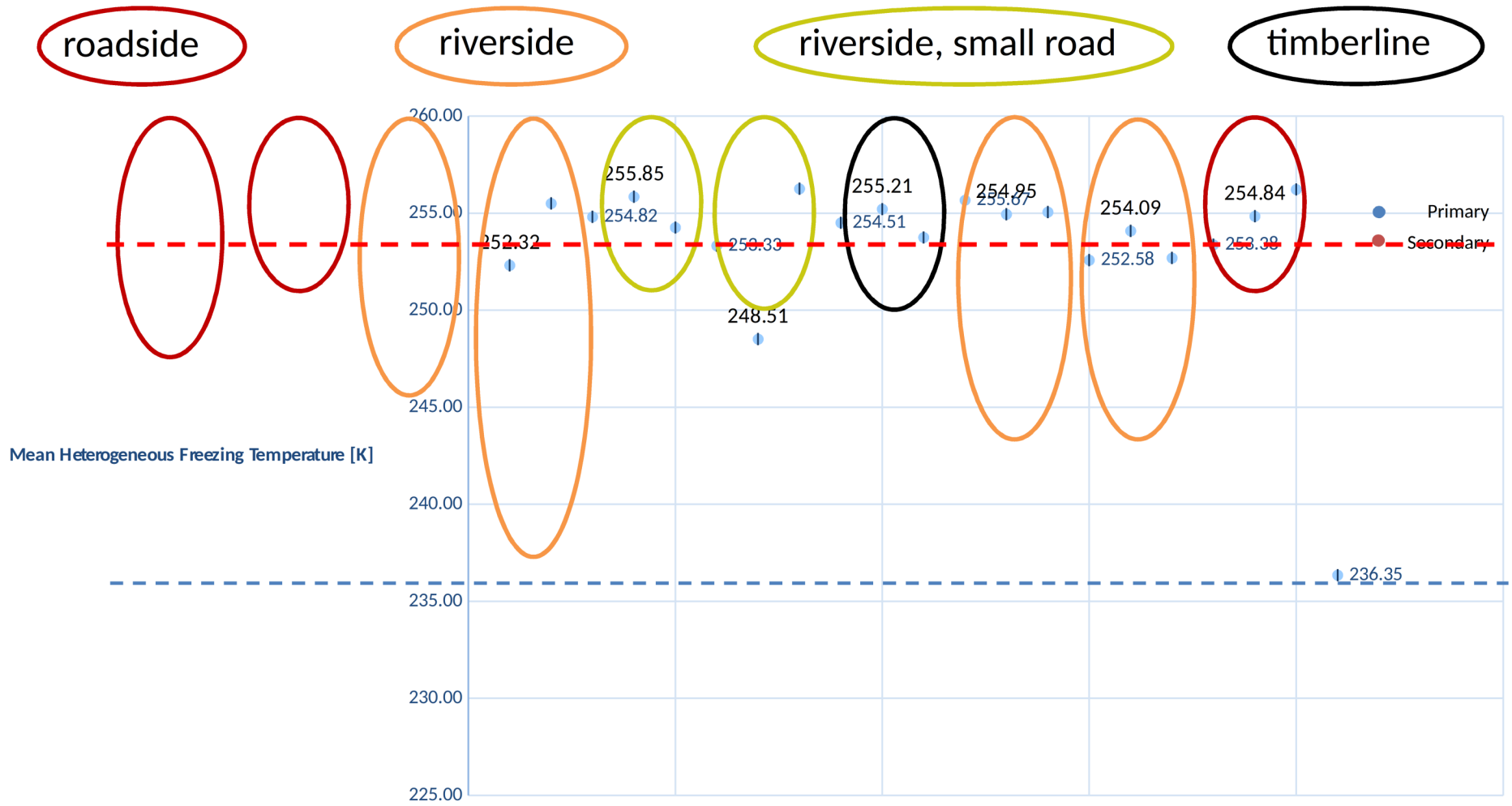
Fraction

raction

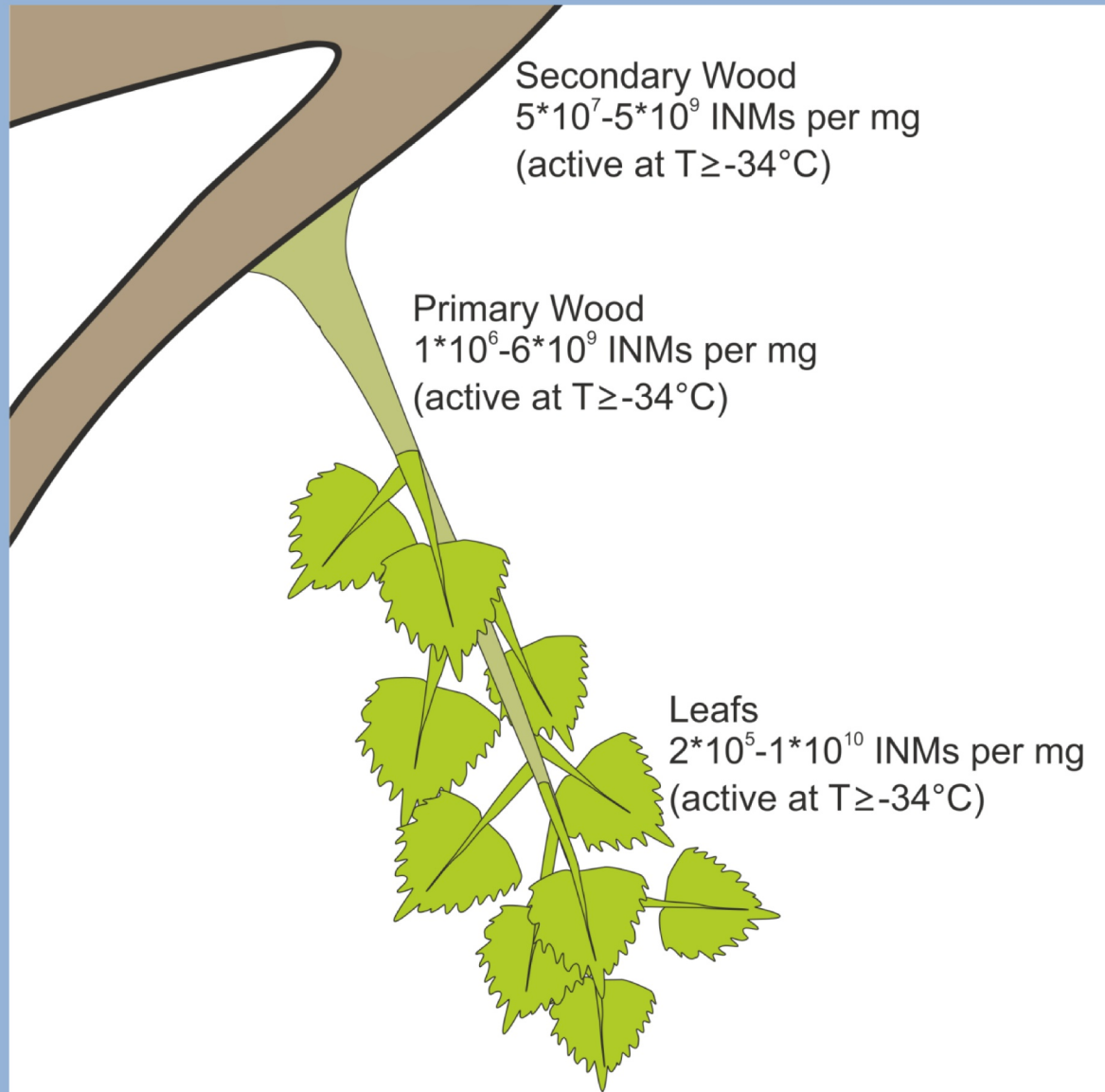
ods



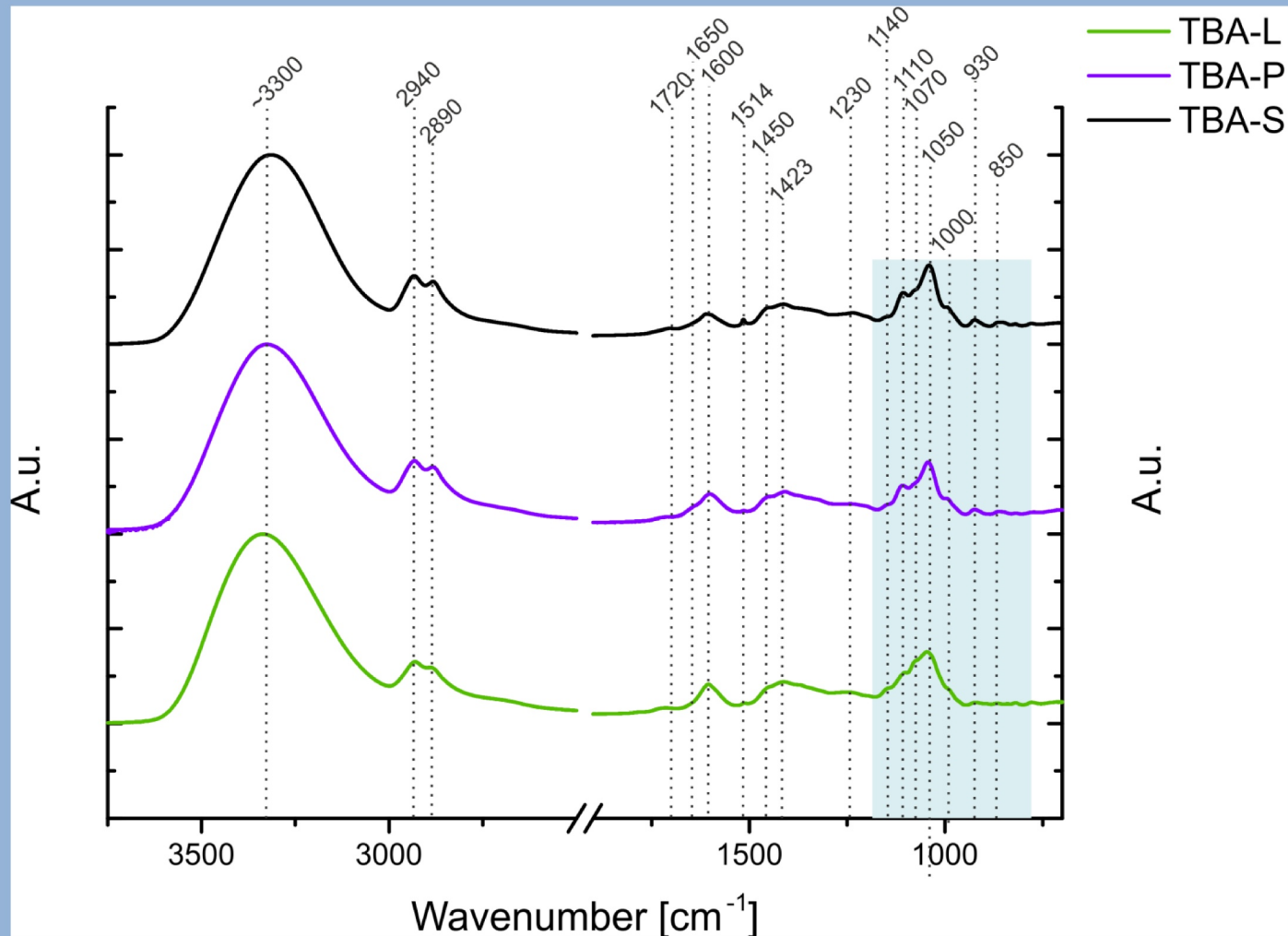
Comparison Primary - Secondary



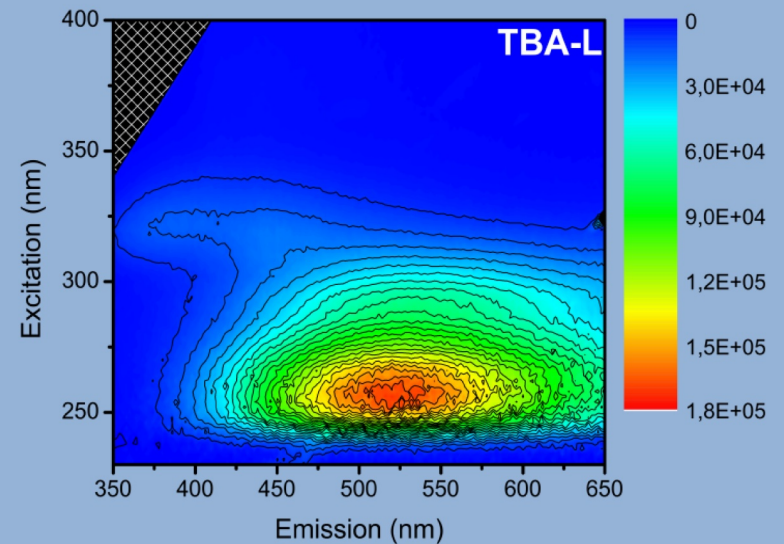
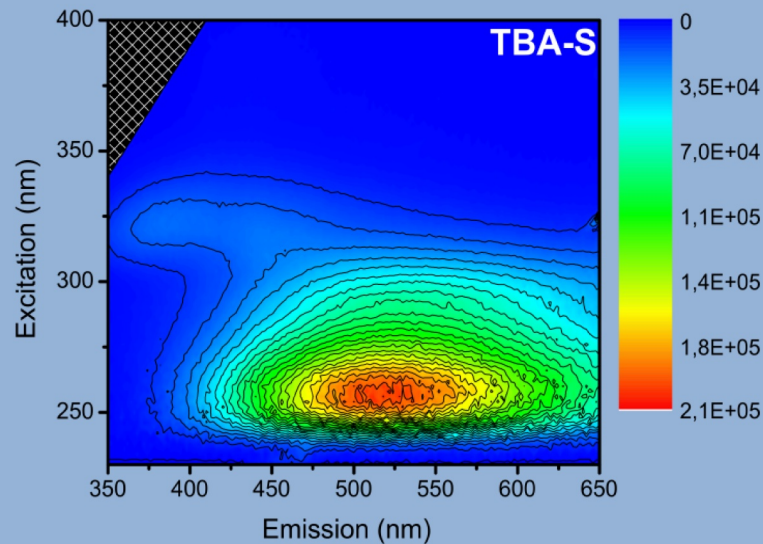
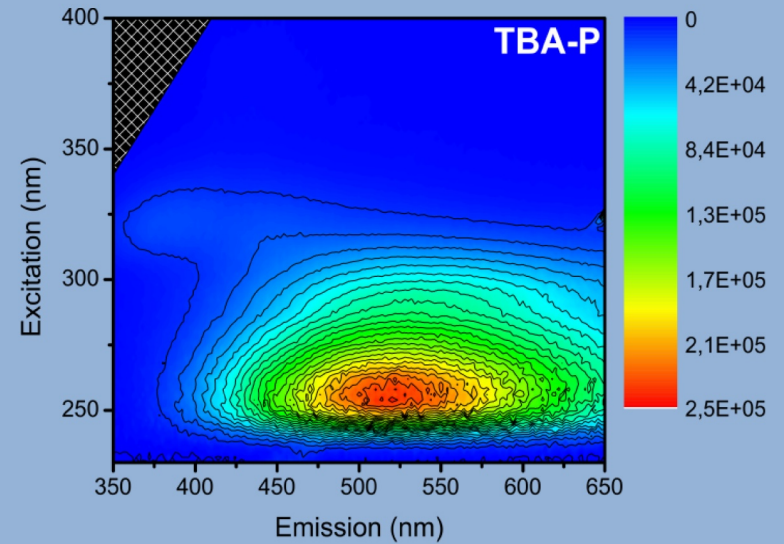
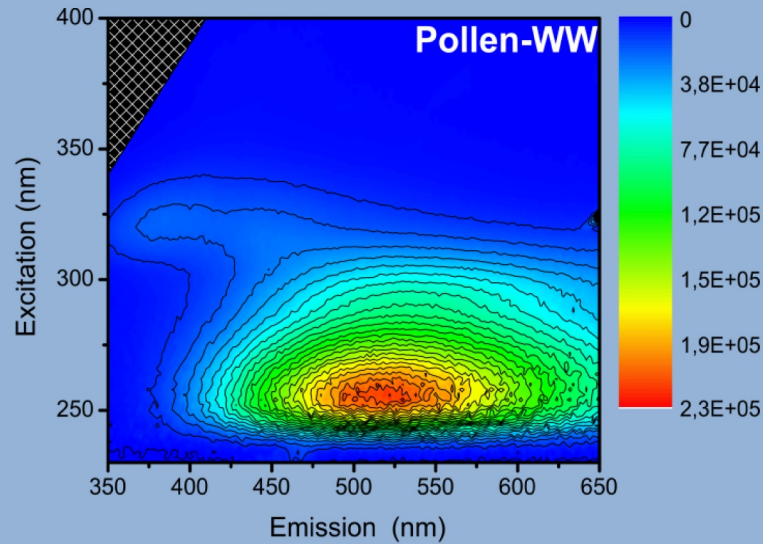
INP mg^{-1} - Leafs - Primary wood - Secondary wood



FTIR Spectra of Woods and Leafs



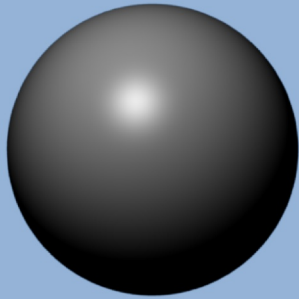
Fluorescence Spectra



CONCLUSION

- Birch pollen and all primary and secondary wood samples exhibit 100 % heterogeneous ice nucleation
- Secondary wood samples nucleate prior to primary wood samples
- All investigated ice nuclei from trees can be directly washed off the sample surface and therefore might be released to the environment
- Birch pollen, leaf, and wood exhibit the same organic substances in their washing waters

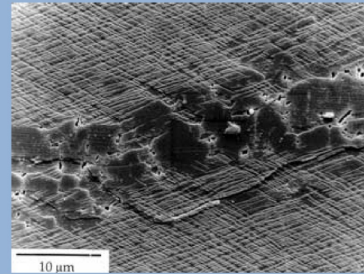
Ice Nucleation Particle ?



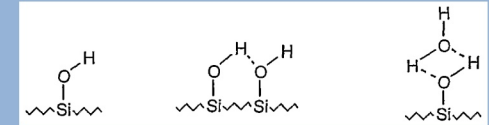
INP



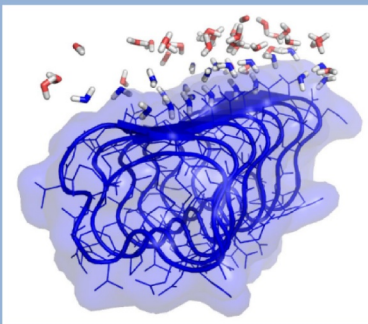
Soccer Ball



Cracks & Steps



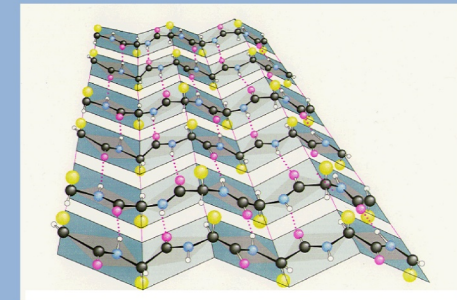
OH Groups



Soluble
INM



Macromolecule
tertiary structure



Macromolecule
secondary structure

Conclusions

Ice Nuclei...

...are different among aerosol particles

...have a molecular signature

...are situated on a particle surface

...are often water-suspendable macromolecules (at least in the case of many primary biological aerosol particles)

...can be distributed through the atmosphere independently from the original grains when suspendable in water

Questions

Can we apply a general model explaining the impact of size and chemistry of Ice Nuclei ?

What is the molecular identity of the biological Ice Nuclei ?

How important is the concentration of the Ice Nuclei ?

How important is the season on the Ice Nuclei?

How far can biological Ice Nuclei be distributed?

Questions

Can we apply a general model explaining the impact of size and chemistry of Ice Nuclei ?

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How important is the concentration of the Ice Nuclei ?

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European Geosciences Union
General Assembly 2018
Vienna | Austria | 8–13 April
2018

Session AS3.3 Atmospheric Ice
Particles

Workshop Atmospheric Ice
Nucleation | 7–8 April 2018



atmosphere

IMPACT
FACTOR
1.487

[Ice Nucleation in the Atmosphere](#)

(Guest Editor: Hinrich Grothe)

Deadline
15 Apr 2018

My coworkers



THANK YOU VERY MUCH
FOR YOUR ATTENTION

