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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Lignin's ability to nucleate ice via immersion freezing and its stability towards physicochemical treatments and atmospheric processing" *by* Sophie Bogler and Nadine Borduas-Dedekind

Anonymous Referee #2

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This manuscript describes the ice nucleation activities of lignin after different physicochemical treatments such as sonication, heating and hydrogen peroxide digestion and simulated atmospheric processing such as photochemistry and ozone oxidation. The authors use custom-built freezing ice nuclei counter (FINC) to measure freezing temperatures in the immersion freezing mode. They also investigated effect of dilution of lignin and observe that dilution decreases frozen fraction but interestingly when the frozen fraction values were normalized by organic carbon content then active site sites per mg of carbon increases with decreasing lignin concentration. Overall, the au-

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thors found that physicochemical treatments don't not have much effect on the freezing temperatures of lignin. This manuscript can be published after appropriate revisions, mostly providing some discussion of results and elaborate some of reasoning behind the experimental design. Especially there are different treatments were performed, the authors need to justify why they did those, why they did and didn't observe any changes in freeing temperatures.

General comments: The authors selected a lignin compound that is robust against degradation and stable structure. Then several physicochemical treatments were performed. It is probably expected that there is not significant different in changes after degradation. Then why this particular lignin material was used?

Overall, discussion of the result needs to be elaborated. For example, if you didn't observe any changes in freezing temperatures after some treatment- please explain what might may cause this.

Typically, heating treatment is used to understand the effect of biological material not just to remove the contributions of organic matter. Please discuss.

Uncertainty analysis of freezing temperatures and IN active sites need to be incorporated. Please provide details about the freezing experiment set up. I was bit surprised with the detection limit of the instrument. Maybe authors should discuss limitation of this set-up. It raises concern because some of the lower concentration lignin (e.g., 2-5 mg C/L) are very close to the detection limit below -20dgree C or so. Please also discuss about normalization of carbon concentration.

Please provide some explanation, why did you use sonication? If sonication is mostly used to extract material from filter but for your experiments you have lignin in powder form. Then why didn't you see any changes in freezing temperatures?

Similarly, why the authors expected to see changes in ice nucleation activity due to decay of chromophores during simulated atmospheric processing experiments.

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Can you provide little bit more information about lignin content in soils, plant debris and other sources (any quantification?) that can be aerosolize to atmosphere, this information maybe help to strengthen the atmospheric implications part.

Minor comments: Probably it is more appropriate to place Fig 3 before Fig.2

Please provide error bars in frozen fraction and active sites plot.

Figure 6: There is a decrease in freezing temperature after 260 degree C. At 260 degree C it reached already close to the background water. Then what causes a decrease in freezing temperature at 300 degree C? Probably most of the material is depolymerized at this temperature. Please explain.

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