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Comment on acp-2021-282

Anonymous Referee #2

Referee comment on "Zeppelin-led study on the onset of new particle formation in the planetary boundary layer" by Janne Lampilahti et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-282-RC2>, 2021

This paper describes new particle formation event observed in a rural (SMEAR 2 station) and urban (Po Valley) environment using instruments installed on the ground and in a Zeppelin. As claimed by the authors, "the main goal of the manuscript was to quantify the magnitude of regional to global feedbacks between atmospheric chemistry and physics, and thus quantify their impact on the changing climate". However, I don't think this was achieved within this manuscript. Moreover, it's not clear to me why the authors choose to compare event at both sites. Of course, both environments lead to different situations favorable for NPF. However, the authors are comparing one study case for each environment picked out from short term campaigns. Why these two cases are representative of NPF events in both environment ?

Major comments

I regret that the authors cite papers mostly from their group. There are other high quality papers out there working on NPF events analysing the vertical extension of NPF event, looking at the link with turbulences...

Figure 5 : I'm not sure I agree with the author's conclusions on that figure. On the SPC side, there are Ultra Fine (UF) particles in the residual layer during the early morning even before the sun rise (4:45). Moreover, during the whole morning the UF particules can be seen at the top of the ML within the ML and in the TL. The NPF onset at the ground is clearly between 5:30 and 6:00. At 5:00, measurements from the zeppelin are showing high concentration of UFP below 200m. It looks like this specific event may be caused by turbulence mostly. On the other side (HTL), clearly the NPF event started at the ground at 7:30. There are no signs of UFP at the ML top but some UFP lies at 2km according to CESSNA measurements. The authors claimed (L. 507/L. 433), based on previous publications, that event occurring at 2km could be linked to turbulence occurring between residual layer and free troposphere and that both events (2km and ground) could be linked but I don't understand how these could be linked... Please do tell ! Moreover, there are no evidence that the interface RL/FT is located at 2km, nor that both events are linked...

There are no date in Figure 5 label and I think this is missing...

L 388 : « In the ground-based NAIS data a pool of sub-6 nm particles was present during the NPF event... This can be seen most clearly between 10:00-11:30 .. ”

I believe you were referring to Figure 7b and d at HTL (not HYY as written on the figure). I don't clearly see it from 10:00-11:30 but I do see it during the whole day, right? Again, this rises question about how the events were created. So in SPC, the particle mode is really large always including 3nm particles during the full day suggesting that the event is

all over the ML and therefore is not comparable to the HTL event that is observed at the ground and newly formed particles grow and may be then transported into the ML.

L 445 – 452 “The concentrated vertical stripes over the growing nucleation mode in Figure 6b were caused by the ...Are linked to roll vortices, which are a specific mode of organized convection in the BL. ” Could you please take some time to prove it ? As you are comparing two events in different environment I think that you should carefully address how those events appear ...

Conclusions :

“We compared two different environments where NPF occurs frequently: a suburban area in Po Valley, Italy, and a boreal forest in Hyytiälä, Finland. We aimed to answer in which part of the BL the onset of NPF and the growth of the freshly formed particles takes place and studied the vertical and horizontal extent of NPF. ”

Again why choosing two different environments and only two study cases to answer that question ? I would think that more statistical information would be needed ...

Minor remarks

P4 L 104 : rephrase : 'Compare from nucleation '

P9 L 272 : "ML started to increase in height" could you please highlight where this is coming from ? Lidar, ceilometer measurement of in flight measurements ?

P9 L 300 : "no NPF, was observed above the ML" : remove the comma

Figure 6 is hard to read. The Zeppelin measurements were performed at different altitude and it does not appear. Could you please either remove it either include the altitude on that figure ?

Figure 7 : always add the altitude to any on-board measurements

Figure 7d : from 8am to 9am there is no black dot. So the GMD is over 30nm ? so there is

a clear interruption of this event ! Could you comment on that ? What does that change for your study or for the event in general ??