REview : Impact of desert dust on new particle formation events and cloud condensation nuclei budget in dust-influenced areas.

This paper is reporting NPF event observed at 5 different sites over the Mediterranean coast. The authors sorted the NPF events observed during non-dusty, dusty and intense dusty days and then compare different parameter such as N50, Cs, GR, J. Nowadays, many previous papers have highlighted the fact that the preexisting particles, such as in polluted areas, are not necessarily blocking the NPF occurrence. In this manuscript, the authors claim that dust events are associated with larger number of pre-existing particles that doesn't prevent NPF events. According to me, this manuscript needs major revision before publication.

General comments :

- The authors' choice of colors does not facilitate the reader's understanding because the differences are very subtle. Moreover, nowadays there are some tools to help the authors to choose the color scheme specifically for color blinded readers.

- All sites cited in this paper are extremely different. Some are within the free troposphere most of the days and some and in rural or urban environment. Therefore, the processes to form new particles are extremely different. NPF are highly influenced by the environmental conditions such as RH, radiation, temperature, cloud fraction etc… It is not stated here what are the difference from site to site and from event to event for each particular site. Do you know what are the main environmental factor influencing the NPF over all the sites independently ? Maybe it needs to be constrain for further comparison. Choosing only the events occurring at RH lower than 60%, or at high radiation (larger than a threshold), to avoid any influence of the environmental conditions. Moreover, I believe that most of the NPF event are strongly influenced by the dynamic of the atmosphere (BL height). Within the FT, the BLH is dragging enough vapors to condense while in an urban site that would disperse a bit the preexisting particles. I think this is important to discuss that in the manuscript. For exemple, How often are IZO and SNS within the BL ? Are all the events occurring within the BL or just when the BLH is reaching the station ?

- I have issued with the methodology used here. First, the authors stated that the Dust event are characterized using simulation results and confirmed with OPS/APS data from each station (P7 L20). I think it would be valuable to show the N_{200} or the PM10/PM1 during non-dusty, dusty and intense dusty days. Indeed, the dust SD could be different from event to event but I guess most of the dust diameter would be, as you suggested, larger than 200nm. Does the Dust event remains the whole day for all cases ?
  Moreover, as it is not clearly stated, I believe that the authors selected all the values observed during event and non-event days as well as during non-dusty, dusty and intense dusty days and compare it as is. However, all those NPF events can have a strong impact on CS, N_{50} or N_{200}. If you want to use the CS as a limiting parameter for NPF occurrence, could you please compare the CS before the NPF event start? It's usually called the CS2 (2 hours prior to the event) and it would be much more interesting than using tall the daily recorded values CS. Indeed, the SD clearly show that the particles are not growing to the same size. Therefore, some newly formed particles will have a clear effect on the CS (diameter reaching 50 or 60 nm) while the newly formed particles that remained below

30nm won't have the same effect. That would lead you to a biased interpretation. Same advices for N_{50} : You are trying to better understand the impact of those NPF events on the N_{50}. Then to do so I would compare N_{50} before the event starts and after the event starts. Indeed, the N_{50} seems to be similar during NPF Event/NonEVENT/Dusty/nonDusty. As presented right now it's hard to understand if the N50 differences are due to the NPF events or the dust events.

- As it is not stated clearly, I believe that the CS was calculated assuming that the condensable vapors have molecular properties similar to sulfuric acid and therefore this parameter is not "only" depending on the aerosol size distribution as stated by the authors.

Comments :

P3 L5 : "only the particle number size distribution is considered." Again It's not entirely true…

P8 L 19 "the highest frequency was observed at HAS." Are you not discussing SNS results in purpose ?

P9 L11_15 : I found it weird to read (50% of the paragraph) about seasonal variability within a paragraph where you state it has no seasonal variability…

P10 L 14/15 : Not well said : "The results agree with the periods "

P10 L21 : Why not showing the CSc and CSf ?

P11 L 5-6 : "Therefore, the occurrence of NPF events at these sites is probably not only limited to highly polluted dust plumes (as suggested by Nie et al., 2014), and they can even occur in remote sites during desert dust outbreaks." As stated just above this is true only if there is enough vapours to condense !

P11 L9-10 : "Thus, this result evidences that the intensity of desert dust can limit the occurrence of NPF events at IZO and AMM, which could be explained by a significant reduction or a limited amount of precursor gases to compete with the increase of available surface of pre-existing particles. " So your hypothesis is that there are no condensable vapors within the dusty air mass ? IZO is within the FT or the BLH at that time ? At AMM, urban site, a lot of condensable vapors are available and when the dusty air masses are coming that will increase the number of preexisting particles and would block the process? I found it difficult to state that in one sentence without proof. That would be interesting to focus on those days to better understand the role of the environmental parameters known to play a large role such as RH, radiation etc…

Figure 2 :Can you change the way you plotted it so it could help the reader? Please add some texture for event, Non event and undefined days ?
The colors for non Dusty/dusty and Intense dust are really close. Can you pick another color ?

P12 L1-3 : You have said that multiple times and this is I think not necessary..

P12 L25 and P12 L30 one more repetition. I believe that this is not 21 times more in IZO but just 2 times more ! Again here I would use the CS2 so you can actually use it as a parameter that could prevent or not the NPF event.

P12 L31 : You can't say that the CS is increasing just by the removal of fine particle through coagulation without proving it. Could you plot the CS as a function of the diameter at different moment of the day (before /during and after the NPF event). From here you could state this strong conclusion supported by results : "Thus, these results highlight the impact of desert dust outbreaks into the CS and the importance of considering coarse mode particles for adequate CS calculations at desert dust-influenced areas."

P13 : Here I think that all the explanations are dubuious since you used all CS values recorded during the day. I would strongly recommend to recalculate the CS 2 hours prior to the NPF events.

P14 L12-14 : This should probably go within the introduction such as the sentence from P14 L19-21. I would appreciate having more information about the TiO2 impact.

"In fact, recent laboratory study (Zhang et al., 2023) revealed that TiO2 contributes significantly to the formation of gaseous H2SO4 by increasing the GR and J by up to a20 factor of 2 and 3, respectively, in the presence of TiO2."
TiO2 is in the particular phase. How could it influence the production of H2SO4 ? You mean that there are more H2SO4 because the GR increase ? So there is a particular chemistry that would enhance the condensation rate of some vapors (which ones ???) and in the same time there will be more H2SO4 within the vapor phase ?

P15 – L13-15 : That was expected to have stronger values of CS during dusty days. Again, I would present here CS2 so you do not take into account the NPF event influence on the GR …

Figure 4 : At MSY you have only one event during intense dust days. However, from figure 2 you have at least 10 NPF events. Please help us to understand… From what I understood the whole period here corresponds to events during non dusty right ? It can't be the dusty and non dusty NPF events otherwise the number would be much larger ! Change the legend to state it clearly what it referes to … .
But then if this is events during non dusty days it cshould correspond to the numbers on Figure 3 and 7 which is not…

P18 L9. A SS of 0.75% is an extremely large value and correspond to very very fast-growing clouds. I'm not sure these SS are observed in reality. That means that you choose an activation diameter that is really low. So ou are probably overestimatin the number of CCN available with this threshold. It needs to be stated somewhere.

Section 3.5 again here I would plot the N50 before and after the event start to clearly separate the impact of the newly formed particles on the N50. So you could estimate the impact of NPF during dusty days in comparison to non-dusty days .

P19: Do you know why the newly formed particles do not grow to larger size ? It seems from Figure S4 that there is a threshold different from site to site for the diameter reached by the end of the NPF events.
Figure S4 is an average over dusty and non-dusty days right ? It seems that SNS show more large particles (around 100nm) during non dusty days. Why is that ? I don't see a clear difference for AMM. Can you comment ? IZO the SD does not show a banana shape. So I'm not sure it could be sorted as class I event. Can you comment on that ?

Figure 6 : I would not show this figure but I would add a table with those numbers. Maybe you can insert it in Table 1.

P20 and Figure 7 : According to Figure7 there are no statistical differences between the Non dusty and dusty days for N50 at IZO, AMM and HAS. Indeed, the boxplots show similar 0.25 and 0.75 percentile behaviors for these 3 sites. So this is hard to draw strong conclusions on the effect of dusty events on the NPF efficiency to increase N50.

Again add texture instead of just having a light blue and blue colors…

The $N_{50,dusty}$ is sometimes lower than $N_{50,non\text{-}dusty}$ (SNS, AMM and HAS). So first I'm not sure I'm able to understand that especially since you stated that you selected the dust evet by using the SSD of the coarse mode. Now, supposedly you have a dust event for the whole day (it's not stated what is the duration of these dust events). So the N_{200} should be higher during dusty events (need to show that to draw the later conclusions). How is the $N_{50\text{-}200,\ non\text{-}dusty}$ in comparison to $N_{50\text{-}200,\ dusty}$? Again as some newly formed particles grow larger than 50 nm I can't tell if this is due to the increase is solely coming from the NPF event during non-dusty days that could lead to larger particles due to more vapors available to grow. I strongly advice to compare the increase of N50 before in comparison to after the NPF events and find a way to normalized it according to the dust concentration so we can clearly understand the effect of NPF/Dust on the CCN concentration.