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Interactive comment on "New Particle Formation at a High Altitude Site in India: Impact of Fresh Emissions and Long Range Transport" *by* Vyoma Singla et al.

Anonymous Referee #1

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The paper reports new particle formation (NPF) events observed at the High Altitude Cloud Physics Laboratory (HACPL) in Mahabaleshwar in Western India. They measured nucleation and growth rates as well as condensation and coagulation losses. The authors further analyze under what conditions NPF occurs by using a detailed case analysis and a cluster analysis. The paper concludes that NPF is favored by low relative humidity and when air masses reach the site from central India. Using the NanoMap method it is estimated that NPF events occur several hundred kilometers upwind of the site.

The paper presents an interesting data set on NPF. However, many claims and con-

clusions I could not see and follow, e.g. the determination of CCN to NPF (details see below). Furthermore, many conclusions are not well established and over-interpreted. The paper needs substantial improvements following the detailed comments below.

Line 218: the sharp decrease occurs between 4-6h according to Figure 3a and therefore before sunrise (Figure 2). This looks like a change of air mass as also seen in the change of hygroscopiciy. It would also be more helpful to present absolute humidity in Figure 2 to check for air mass changes. H

Line 225: sunrise it at 7.30h and NPF is seen at 11h. this is not 60-90 minutes later. Probably you mean estimated start of NPF.

Line 229ff: What time period do you take for the average values? By the way I do not consider 20-24°C as hot.

Line 233: With a GR of 2.5 nm/hr it is impossible to reach 40 nm in 6 hours.

Line 248: How do you know that sulfuric acid is driving nucleation? It could also be organics. Furthermore, it could also be other parameters like availability of nucleating species.

Line 195: this GR is for particles larger than 5 nm. However, for smaller particles GR is usually quite slower due to the Kelvin effect (see Kulmala 2013).

Line 256: The CS is only a factor 2 higher on non-NPF days. This is not a much higher value.

Line 263-264: 9:30 to 11:00h is the assumed time of formation of particles, while 11:00 to 13:30 h is the observed formation. Make this clear.

Line 266: The decrease in aerosol mass happens before. When NPF starts, PNC and aerosol mass are already low.

Line 269: What do you mean by "formation of new particles is governed by the nature of pre-existing aerosol particles"?

Line 270: Is this the equivalent ammonium to anion ratio? What time interval does this cover? Only after 9h?

Line 278: organics increase before inorganics. How do you interpret that?

Line 286: Much of the increase in aerosol mass is by HOA and BBOA and not due to additional mass from NPF. In Figure 1 it is seen that the concentration of particles 50-200nm increases after 14h. What can now be attributed to this increase and to particles grown in from NPF? What is the cut-off of the ACSM?

Line 289: this is speculation. CCN starts to increase already at 12h, one hour after observing NPF at 5 nm. How can these small particles be activated so early? Could it also be that particles in the 50-200 nm band start to grow due to condensation of organics and become CCN active?

Section 4.3: There are several issues with the estimation of NPF to CCN. The authors say that they compare time window 2 with window 1 and that GMD > 40 nm. In Figure 1 these criteria cannot be met but calculations are given. The notation given for the different parameters (CCN/POA, etc. . .) is unclear and not consistent. I had to consult the original publication to understand it. All values for delta(CCN/CN) are positive. I have a hard time to believe that the fraction of CCN is always larger shortly after nucleation (11:00-13:30h) than in the aged air mass when no nucleation mode CN are measured yet. This would mean that an extremely large fraction of nucleation mode particles (most particles are still <40 nm) activates. I also doubt that CCN/POA is a good measure for primary contributions to CCN. Along a trajectory POA decreases while CN may not change much. This pretends an increase in CCN fraction that is not real. As already mentioned above an increase in CCN may also be due to growth of 50-200nm particles. How do the authors account for this?

Section 4.4: this section contains many claims that can hardly be seen in the Figures and small variations in measurements are overly interpreted. Line 368: I do not see the decrease in Aitken mode concentration during increase of nucleation mode particles.

Line 371: Onset of nucleation is usually around 9:00h. I do not see a sudden increase in Aitken mode particles. In addition average Aitken mode concentration at that time is similar in cluster C2 and C3.

Line 372: It says: The diurnal variation of Nnuc particles exhibited high concentration during morning, afternoon and evening hours". I do not see high concentrations throughout the day. I also do not see the simultaneous peaks of nucleation and Aitken modes. There are time shifts.

Line 378ff: It is claimed that Aitken mode has a morning and evening peak due to traffic. First of all some peaks are small and difficult to interpret. Second, there is no further proof that all this is local. Third, Figure 3 does not show any of these peaks. I think this is strong over-interpretation. Each of the clusters also contains nucleation and non-nucleation days. Thus, small humps may be induced by either one and cannot be used to derive criteria for NPF.

Line 398ff: Peak concentrations of nucleation mode are reached before 15:00h. Thus this increase in Aitken mode after 15:00h cannot inhibit NPF. More important than the particle concentration is the CS and the availability of condensing gases. The authors seem to assume that the latter are always similar, which is hardly justified.

Line 422: On 12th December is the wind speed low during NPF. It is high before. The authors claim that NPF is suppressed by local emissions on 19th November. Later on, they pretend that NPF occurs up to hundreds of kilometers upwind. Thus, the nucleation mode particles are transported to the site and cannot be influenced by local emissions.

Line 426: I wonder what else besides nitrate and sulfate can bind that much ammonia. This is hard to believe.

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