

Manuscript entitled 'Analysis of New Particle Formation (NPF) Events at Nearby Rural, Urban Background and Urban Roadside Sites' by Bousiotis et al. reports the occurrence of new particle formation events at three sites of different environments in the United Kingdom: Rural, urban background and near road sites. The authors study parameters of new particle formation such as frequency, growth rates, number concentration of sizes 16 – 20 nm, condensation sink, urban increment, nucleation strength factor and survival probability. The authors also report trajectory cluster analysis as well as the connection of NPF between the three different sites. In general, the manuscript, contains valuable data (three sites of different environments) and treasured statistics (7 years of data). In addition, the manuscript is well written and literature from around the world is acknowledged. However, the authors make big assumptions and conclusions without enough supporting data. The major concerns listed below need to be addressed before the manuscript is considered for publication in ACP.

Major Comments:

1. The authors report the observation of new particle formation events at three sites in the UK based on visual inspection of CPC (> 7 nm) and SMPS (> 16.6 nm). The general character of NPF events is missing. The lowest limit of the instrument is an issue and no big conclusions can be made before ensuring that the observed plume of particles is related to a new particle formation event. Authors should report how these events look like and whether they have a growing mode shape. Also, more characteristics of the growth should be reported such as possible shrinkage (see e.g. Salma et al. (2016)) and the size these particles reach. An example surface plot from each site should be added to the manuscript.

Let's take for example a regional event surface plot from Kerminen et al. (2018): figure 1, if we cannot observe the information below 16 nm, how can the authors prove that the increase in particle concentration is related to NPF, figure 2.

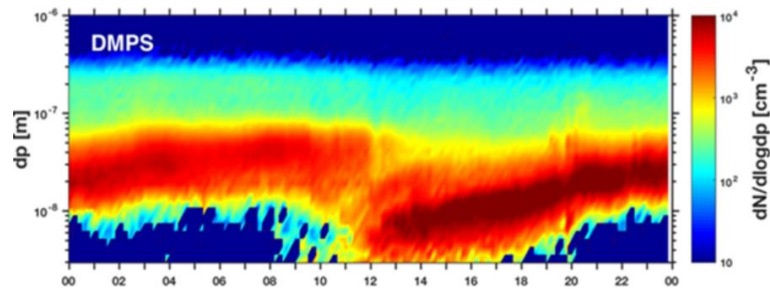


Figure 1 Regional Event example. Figure from Kerminen et al 2018.

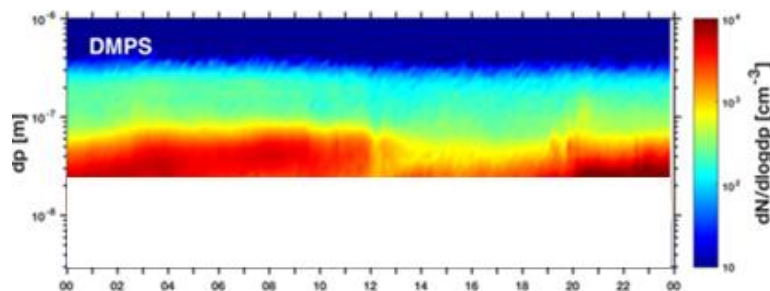


Figure 2 Modified figure 1.

The manuscript refers to many NPF studies from around the world, many of which report NPF starting from 6 nm (Salma et al., 2017), 3 nm (Dal Maso et al., 2005), 1.7 nm (Kirkby et al., 2016) while their measurement starts from 16.6 nm. The authors should present evidence that these observed particles are related to new particle formation events, and not for example a traffic growing mode (Brines et al., 2015).

2. Section 2.1: Which years are studied?
3. Section 2.1: Distance between the three sites should be mentioned.
4. Section 2.2.1: Authors report a visual inspection of CPC and SMPS data.
  - How was this exactly done? Please elaborate.
  - Was there any kind of counter-calibration done between these instruments?
5. Section 2.2.2: Calculation of the growth rates:
  - Size of growth rates should be mentioned. E.g. growth from 7 to 20 nm? To 50 nm?
  - How many points were taken in calculating the GR?
  - Line 290: Authors claim that GR in NK (4.4 nm/h) are higher than the regional events GR (3.9 nm/h), what is the error bar on these calculations? Accordingly, these growth rates might be similar.
6. On line 178: the author mention nucleation mode, which is by definition number of particles between 3 and 25 nm, while the authors conduct a large study on a small fraction of this nucleation mode ( 16 – 25 nm).
7. Section 2.2.4: Reference to Kulmala et al. 2017, calculating  $P = CS'/GR$ . What GR was used here? See point 4.
8. Section 3.1.1: Reference to Figure S1: cloudiness, and RH.... Is missing. Was cloudiness measured or calculated?
9. Section 3.1.2: How can the authors prove that NPF events are happening at the near road site and not transported to the location?
10. The authors make big conclusions regarding the SO<sub>2</sub> driving mechanism of NPF which cannot be proved without adequate chemical speciation of the particles formed. These conclusions shall be minimized throughout the manuscript. Authors could try calculating sulfuric acid proxy from SO<sub>2</sub> and CS (Petäjä et al., 2009).

## References

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