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Atmospheric Chemistry and Physics Discussions

Interactive comment on "New-particle formation events in a continental boundary layer: First results from the SATURN experiment" *by* F. Stratmann et al.

F. Stratmann et al.

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Paragraph 1: The boundary layer comprises a surface layer about 200 m deep which contains nucleation mode particles:

This is not what we intended to say. The referee was obviously mislead by page 1708, lines 5-11. No newly formed particles were present inside the surface layer at this time (see also Figure 11). The observed delta N is most likely due to DIRECT traffic emissions. The text has been reformulated (page 1708, line 5):

``Taking Delta N as an indicator for the presence of newly formed particles, the above profiles suggest, that between 06:26 and 06:53 UTC, new particle formation is taking place in the RL. Earlier measurements performed on 3 June 2002 in the RL (see Table 1) yielded Delta Nmax = 0, 200 and 500 cm-3 at 05:04, 05:28, and 06:15 UTC, re-

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spectively. This indicates the growth of newly formed particles into the detectable size range at a rate larger than the one estimated above. Below the inversion, the presence of small particle is most likely due to direct traffic emissions as ground-based NO and particle size distribution observations suggest."

Paragraph 2: Surface layer incorporating into the RL? Is the RL really the FT?:

Due to turbulent mixing at the top of the evolving surface layer and the convective plumes the new surface layer (mixed layer) incorporates the residual layer step by step after the inversion broke up. The residual layer itself is the well mixed layer from the previous day and, therefore, not the free troposphere! The height of the free troposphere is in about 1.4 km and increases to nearly 2 km in the afternoon (cf. Fig. 9 (LIDAR in Leipzig)), no in-situ measurements in the free troposphere are made.

Contradiction to the previous statements: The authors don't see a contradiction, because the ballon run at 600 m took place 2 hours later and nucleation in the RL may have stopped during these 2 hours. Text has been modified (see end of this document).

Nothing has been changed in the text.

Paragraph 3: The authors don't claim that new particle formation in the surface layer is attributed to traffic emissions! Again the referee seems to be misled by page 1708, lines 5-11. See paragraph 1.

Paragraph 4: Text has been modified accounting for the referee's concerns (page 1706, paragraph 1): ``With increasing time, the maximum at 5 nm shifts towards larger sizes and becomes more pronounced while the maximum originally located at 15 nm disappears after approximately 1 h."

Paragraph 5: According to the authors' opinion, its crude to determine growth rates from the actual measurements. However, performing the following really crude estimations:

RL: 3:00 sunrise - particle size 1 nm 8:00 measurement - particle size 15 nm => growth

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rate 3 nm/h in the RL

ML: 7:00 Break-up - particle size 1 nm 8:00 measuremnt - particle size 5 nm => growth rate 4 nm/h in the ML

According to the authors' opinion, these growth rates are not unrealsitic and close to the referee's estimations. Judgement whether the actual growth in the ML is 3 or 4 nm/h is not possible from the available data and beyond the scope of this paper.

The second paragraph on page 1706 has been modified and estimations for the growth rates have been including pointing out the crudeness of the underlying assumptions (page 1706, line 13):

``The ground-based observations at the Melpitz site showed, that newly formed particles occur about 0.5 to 1 h after the break-up of the nocturnal inversion until the mixing layer has reached the top of the PBL in around 1000 m after a few hours (cf. Fig. 9 for Leipzig). Assuming a) that new particle formation is induced by the break-up of the nocturnal inversion after 07:00 UTC, b) a particle diameter of 1 nm for the freshly nucleated particles, and c) considering a particle size of 5 nm as measured around 08:00 UTC, a growth rate of 4 nm/h within the first hour can be estimated. This growth rate is smaller but in the same range as the one suggested by Lehtinen et al., 2003. Although this is a very crude estimation, it may be concluded that assumption a) is valid and thus new particle formation maybe induced by the break-up of the nocturnal inversion. The occurrence of the second local size distribution maximum around 15 nm maybe explained by the mixing down of particles that were newly formed and grew up to larger sizes inside the RL before the break-up of the nocturnal inversion. Performing again a crude estimation, i.e. assuming a) that new particle formation in the RL starts at sunrise around 03:00 UTC, b) a particle diameter of 1 nm for the freshly nucleated particles, and c) considering a particle size of 15 nm as measured around 08:00 UTC, a growth rate of approximately 3 nm/h can be estimated. Again this crudely estimated growth rate has be considered reasonable. This together with the balloon-borne obser-

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vations described below supports the hypothesis that the second local size distribution maximum around 15 nm maybe explained by the mixing down of particles that were newly formed in the RL."

Paragraph 6: See paragraph 5.

Paragraph 7: The aim of this paper is the introduction of an experiment with a new tool for unique vertical measurements of newly formed particles in the PBL and give a first measurement example of one new particle formation event. A detailed analysis of all observed events is far beyond the scope of this paper and would need much more time. Therefore, we follow the argumentation of referee 1 that it should be possible to publish first results as soon as possible even the data analysis is somewhat preliminary and not all cases of an experiment are included. To give an rough overview of the complete experiment we included Table 1 as suggested by reviewer 1 and an outlook in which way further analysis is planned in the near future. To our opinion the reader can learn a lot from this example especially since it is the first time that such an event was monitored in this detailed way.

Are there 2 particle sources? What are the sources? Where does nucleation occure?: A new paragraph summarizing the findings from the ground-based and balloon-borne has been included (page 1709, line 14):

``Summarizing the results of the ground-based and balloon-borne measurements it can be stated that:

- New particle formation was observed inside the RL before the break-up of the nocturnal inversion.

- The particles newly formed in the RL grew up and were mixed down during the break-up process of the nocturnal inversion.

- No new particle formation was observed after the break-up of the nocturnal inversion in the RL.

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- During and after the break-up of the nocturnal inversion new particle formation was observed in the ML.

Consequently, on 3 June 2002, two different new particle formation events, one inside the RL before and the second in the ML during and after the break-up of the nocturnal inversion were observed. The second event supports the hypothesis Nilsson et al., 2001} who suggest a correlation between the onset of nucleation and the onset of turbulence. However, the new particle formation event observed in the RL suggests an addition to hypothesis 3 in Nilsson et al., 2001, i.e., the possibility that particles newly formed in the RL may grow into a dectable size range inside the RL."

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 1693, 2003.