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Atmospheric Chemistry and Physics Discussions

Interactive comment on "In-Situ observation of New Particle Formation in the upper troposphere/lower stratosphere of the Asian Monsoon Anticyclone" *by* Ralf Weigel et al.

Anonymous Referee #2

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GENERAL REMARKS

The manuscript reports about results from unique observations of new particle formation in the upper troposphere and lowermost stratosphere over the Indian subcontinent and the Tibetan plateau during the Asian Summer Monsoon season. The observations stem from in-situ measurements on board of the M55 Geophysica aircraft during the field experiment StratoClim in 2017. Total aerosol, non-volatile aerosol and ultrafine particles where measured by means of a multi-channel Condensation Particle Counter. Ultrafine aerosol observations are complemented by measurements of aerosol size distributions deploying an optical particle counter instrument, and carbon monoxide for

the identification of boundary layer air masses lifted by deep convection.

The analysis of the measured data is focussing on the identification of new particle formation events, their occurrence frequency, duration, and preferred altitude range relative to the thermal tropopause. Modelling studies investigate the evolution of the aerosol past the nucleation events. The observations are put into the context of aerosol observation in other tropical regions of the world.

The manuscript is well organized and presents interesting and relevant scientific findings, however, it lacks a precise and compact representation. The far too detailed description of the instrumentation and methods (18 manuscript pages including the introduction) combined with complex and difficult-to-understand figures gives the reader a hard time to follow the red line of arguments. In the present version of the manuscript, many of the excellent findings may get lost because the key results are hidden in the details of the extensive descriptions and discussions. In addition, arguments are repeated, and the manuscript contains a significant amount of textbook knowledge and repetition.

To conclude, the topic of the manuscript fits well into the scope of the journal. The authors present highly relevant science deduced from carefully conducted measurements and data analyses and make substantial contributions to the research on the aerosol budget of the global tropopause region. Given its scientific relevance and quality, the manuscript surely deserves publication on ACP, but requires major revisions, in particular condensing the paper and reworking of some figures. Details are specified in the next section.

SPECIFIC COMMENTS

1. Introduction: In the first section of the introduction, the role of SO2 and sulphuric acid in particle nucleation are widely discussed, but immediately afterwards a dedicated section on new particle formation follows which extends over more than two manuscript pages. I suggest merging the sections and reducing the length significantly

by focussing on new particle formation.

2. Instrumentation and Methodology: In the field study, a set of established and well-characterised instruments has been deployed. However, the instrumentation section stretches over six manuscript pages. There is certain danger that readers will drop out here and miss the interesting parts. The authors should please focus here on the relevant information, omit textbook knowledge, and refer to published instrument papers instead. This section can also be shortened significantly.

3. Observations and Results: The discussion and interpretation of figures appears to some extend speculative which is indicated by the frequent use of terms like “the impression could arise“, “may also indicate”, “may primarily”, etc. See as examples the paragraph from line 749 to 766, or the paragraph from line 924 to 938. Please also check the frequent use of the term “however”. I suggest focusing on the description of the excellent observations and well-founded explanations, while avoiding extensive descriptions of the figures. By doing this, a significant reduction of the text can be achieved.

4. Summary and Conclusions: This chapter is far too long and repeats a significant amount of content discussed before. The summary and conclusions chapter should deliver the key messages of the study without repeating the details. An adequate way may be using bullet points. In the current form of the manuscript, the key messages get lost and the scientific impact of the study is diminished.

5. Figure 4: The complexity of the figure can be reduced significantly by switching to a log-scale representation of the occurrence frequency. Then the inserted figures are no longer needed, and the message comes across smoothly.

6. Figure 6: This figure is difficult to digest. Panels a and b show the data coloured by flight date which is not telling much. Panels c and d show the same data but coloured by CO mixing ratio as an indicator for boundary layer influence. In fact, only panels d and e are needed since they transport the key message that observations associated

with low CO mixing ratios are located above the thermal tropopause whereas high CO mixing ratios are located well below the thermal tropopause.

7. Figure 9: I question the value of this figure and the transported message is not clear to me. In case the authors want to establish a link between the number density of ultrafine particles and the transport time from the boundary layer, another form of illustration is needed. Potentially, this figure can be moved to the supplement since Figure 10 conveys the message right away.

MINOR ISSUES

For the current version of the manuscript, I refrain from discussing minor issues but offer a review of the revised and shortened – best to about half of the current size – manuscript with a stronger focus on the key results and findings.

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