Response to the Reviewer RC1

We much appreciate a positive review by the present Reviewer concluidng that “Overall, the paper is well written, interesting, and balances mathematical rigor with an educational introduction to the topic, i.e., an excellent Technical Note that deserves prompt publication in *Atmospheric Chemistry and Physics*.”

We respond to the more specific comments as follows:

Minor Comments

• Ll.51–51: We will add in revision that the gamma distributions is also often adopted in bulk microphysics. On the other hand, we are not aware that the lognormal distribution is also used in bulk microphysics.

• Ll.56: The references to Seifert and Beheng (2001, 2006) will be added in revision.

• Ll.195–196: In revision, the allusion to Marshall and Palmer (1948) will definitely be made.

However, we notice that the main problem with this short section 3.2.2 as a whole: it begins by discussing about the issues of identifying appropriate assumed PDF forms in the context of the subgrid–scale distribution problem. However, it fails to specify this context in the beginning. Then, it suddenly turns the topic to the PSD in microphysics. In revision, Sec. 3.2.2 will be divided into the two paragraphs, with the first paragraph focusing on the subgrid–scale distribution problem and the second paragraph focusing on the PSD.

More specifically, Marshall and Palmer (1948) will be referred in the beginning of the second paragraph.

• Eqns. 3.2a, 3.17, 3.18: By following the comment, the cumulative probability, $P(\varphi' < \varphi)$, will be introduced in revision, and its relation to the probability density, $p = dP/d\varphi$, will be explicitly listed just following Eq. (3.2a). As the Reviewer also suggests, this relation will be recalled in presenting Eqs. (3.17) and (3.18) in revision as well.

• Ll.665–668: From the point of view of the output–constrained distribution principle, the Reviewer’s argument for using the 6th moment in the particle size is consistent, only if a mass distribution is considered for the problem. In that case, the 6th moment in the particle size corresponds to the second moment in mass distribution. Thus, this second moment must be used according to the output–constrained distribution principle. when one wishes to constrain the spread of this distribution. However, when a size distribution is considered, the spread of the distribution would be considered in terms of a variance in size distribution, which is the second moment of the size.

Yet, from a point of view of the output–constrained distribution principle, a more important factor is to choose an actual output that is required within a given model. For the cloud particles, probably, the most important process to be predicted is the coalescence, which is very crudely speaking, controlled by n_c^2, thus a weight to adopt would be $\sigma = n_c$, noting there is already a factor, n_c, in the definition of the integral with sigma. For the precipitating particles, the same would apply to the sedimentation rate, which is proportional to a certain power, say, a, of the particle size, r, then $\sigma = r^a$ would be the choice.

These elaborations will be included in the revision.

Technical Comments

• Figures: Please note that all the variables in the present study are nondimensional (*i.e.*, without units). This basic point will be remarked to the end of the revised introduction.