Review of “Implementation of Primary and Secondary Ice Production in EC-Earth3-AerChem: Global Impacts and Insights” by Costa-Suros et al.

General comments

The study focuses on the improvement of the representation of mix-phase clouds (MPC) in the EC-Earth3-AerChem Earth System Model by replacing the ice nucleation scheme. The new scheme includes the effect of aerosols (K-feldspar, quartz and marine organic aerosols) in heterogeneous nucleation, as well as different mechanisms for secondary ice production (SIP) (Hallett-Mossop rime-splintering, droplet freezing and shattering, collisional fracturing and breakup).

The authors do a thorough analysis comparing the results of five experiments with in-situ and satellite observations. Each experiment includes a different ice nucleation parameterization for MPC.

Although the article might be dense, due to the large amount of information presented, it is well structured and the analysis are carefully planned with attention to detail, addressing the shortcomings of both the model and instruments used for the comparison and how this might impact the interpretation of the results. I recommend this article for publication after assessing the following minor technical comments.

Technical comments

Line 24: … challenging due to complex, sub-grid scale ... – … due to the complex ...

Line 135: … the higher ICNC concentrations ... – the higher ICNC (otherwise is concentration twice)

Line 253: ...PBL... – planetary boundary layer (since it is only mentioned once)