The authors thank Reviewer#3 for this comprehensive review of the paper. We address below each comment individually (in blue color). Line numbers refer to the original manuscript.

The rational behind this new parameterization is not clearly presented. Section 2.1.1 (which should be section 2.2) must be rewritten. Why did the authors decide to change the nucleation rate and the contact angle, instead of another method? Why did they choose this relationship between the neutralized fraction and the contact angle ? How does this new parameterization fit in the Milbrandt and Yau scheme exactly (a diagram would help)? This section is confusing and incomplete.
Our objective in developing the new parameterization was to represent the formation of ice crystals in the particular conditions of Arctic TIC clouds. In these conditions, it is mainly the deposition mode that occurs for the heterogeneous nucleation of ice, i.e. the air mass is in water-subsaturated regime. Kulkarni et al. (2014) showed that, except for quartz, acid-coated dusts are less effective INPs in the deposition mode but have similar effectiveness in the immersion-freezing mode, i.e. in water-supersaturated regime. Based on X-ray diffraction analyses, they argued that acid treatment caused structural deformations of the surface dusts, and the lack of structured order reduced the ice nucleation properties of coated particles in the deposition mode. Moreover, they suggested that, at water-supersaturated conditions, surface chemical reactions might not change the original ice nucleating properties permanently because coating material could be removed by dissolution. For kaolinite, Panda et al. (2010) concluded that sulfuric acid-treated particles could result in the formation of aluminum sulfate that can be easily dissolved in water. Considering these recent findings, and our objective to develop a simplified parameterization to limit computational time, we chose to use the CNT formula for deposition mode but with a specific factor, the neutralization fraction, indicating the degree of acidity of the coating of dust particles."
Concerning the relationship between the contact angle and the neutralization fraction, Keita and Girard (2016), after analysing the slope between the nucleation rate and the saturation over ice for TIC1 and TIC2 clouds (cf. Fig. 16 in Keita and Girard (2016)) observed for a given S_i that: (1) the slope is the largest for the smallest accessible contact angles; (2) the decrease of the slope with the increasing contact angle is very non-linear. These results are consistent with laboratory experiments (Sullivan et al., 2010) showing a rapid increase of the contact angle with acidity on coated IN. These results motivated us to parameterize the contact angle θ as a function of the aerosol neutralization fraction under a concave form. Simple concave functions follow power law: $\theta = 26 - 14 \times f_n^p$ with p larger than 1. We have chosen a quadratic (p=2, MYKE2 simulation) form for simplicity. We have besides added a sensitivity simulation (MYKE4) under a biquadratic form (p=4) for simplicity to test the influence of the exponent p on the concave form of the contact angle with the neutralization fraction.
We have been rewriting Sect. 2.2 taking into account the developed arguments above.
We choose not adding a diagram of Milbrandt and Yau scheme because we think that this is unnecessary with the new version of Sect. 2.2.

The paper clearly lacks proofreading. A lot of well-known and well-established equations contain mistakes.
The authors apologize for those typos and errors in the style. We have carefully corrected all of them.

Equation 1: velocity is missing in the first term of the right-hand side part of the equation, a dot is missing as well (convergence) ; the third term is d/dz and not d/dt
Done.

Equation 4: it is a PDF, therefore, Nx(D) = dn/dD, and writing dNx(D) does not make any sense. Ntx is the total number concentration, and is integrated over D, so it is Ntx and not Ntx(D). In the exponential, both lambda_x and D are to the power of nu_x, not only D, it is therefore (lambda_x D)ˆnu_x.
Done.

Equation 5: again, it is a PDF, and it is Nx(D) and not dNx(D).
Done.

Equation 6: Ntx and not Ntx(D)
Done.

Equation 8 is not consistent I believe; it is not in kg/kg, because of the 1/rho factor.
We removed the rho factor.

Equation 11: I don‘t understand where this equation comes from. Please demonstrate.
We just present here the original formulation to treat the homogeneous freezing of cloud droplets at temperature below -30 as in Milbrandt and Yau (2005a). All the details are presented in DeMott et al. (1994) and Milbrandt and Yau (2005b). According to Milbrandt and Yau (2005b), Eq. 11 is obtained by substituting the mean-droplet volume $\frac{\pi}{6}D_{mc}^3$ in Eq. 9.

We have rephrased line 127 by " with the volume V approximated by the mean volume, the fraction of cloud droplets freezing in one time step may be written as:" and we have added after the equation " where D_{mc} is mean-droplet diameter".

Equation 16: usually Mwˆ2 also appears in the Gibbs free energy term;
The authors disagree with Reviewer#3. We have used Rv, the gas constant for water vapor (in J/kg/K). As a consequence, the molar mass of water is implicitly taken into account: Rv = Rg/Mw.

Equation 17: it is not q-qcos(theta) but q-cos(theta)
Done.

l.85: "All symbols for variables and parameters used are listed in Table 1." Where is Table 1 ? It appears to be missing. This probably explains why the numbering of all the other tables is wrong…
All Tables have been numbered again as Table 1 did not exist.

l.155: "For condensation-freezing, it can be included in the immersion freezing of coated IN when air is supersaturated with respect to liquid water." This sentence is quite confusing, and this whole paragraph is unclear. How does this new parameterization fit in the Milbrandt and Yau scheme exactly ? Please include a diagram, for example.
We thank Reviewer#3 for this comment. This paragraph has been thoroughly revisited.

“The parameterization for condensation-freezing can be derived from that of immersion freezing of coated INPs when air is supersaturated with respect to liquid water. Moreover, the condensation freezing mode, as discussed in Vali et al. (2015), is quite uncertain. The new parameterization focuses on the heterogeneous ice nucleation for uncoated INPs and for sulfuric acid coated INPs in the deposition mode, i.e. in water-subsaturated conditions. In this approach, INPs are assumed to be mineral dust particles following Girard et al. (2013). For contact freezing and immersion freezing from supercooled cloud droplets, the parameterizations remain unchanged. As condensation-freezing is uncertain Vali et al. (2015), this process is not longer included in the model.”

Sections 4.2, 4.3, 4.4, 5: these sections are all made of one huge paragraph and are very hard to read.

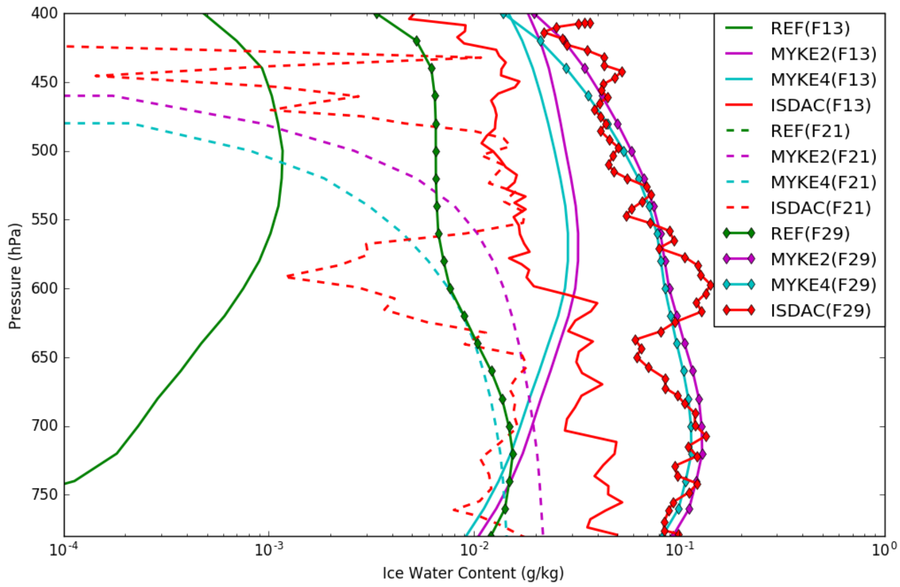
For some reasons, line breaks splitting paragraphs were not indeed visible on the submitted version. Each Section is now clearly split in different coherent paragraphs.

l.606: the two references to Milbrandt and Yau are the same, and should be Part I and part II;

This was a mistake. It has been corrected.

Figure 6 is very hard to read.

We think that it is because of the legend in the box, which is confusing. We have changed it to clarify the figure and we hope that results are more readable. The new figure is reproduced below:



We have done the same modification of the legend for figures 3, 7 and 8.

Cited:

DeMott, P. J., Meyers, M. P. and Cotton, W. R.: Parameterization and Impact of Ice initiation Processes Relevant to Numerical Model Simulations of Cirrus Clouds, J. Atmos. Sci., 51(1), 77–90, doi:10.1175/1520-0469(1994)051<0077:PAIOII>2.0.CO;2, 1994.

Keita, S. A. and Girard, E.: Importance of Chemical Composition of Ice Nuclei on the Formation of Arctic Ice Clouds, Pure and Applied Geophysics, 173, 3141–3163, https://doi.org/10.1007/s00024-016-1294-z, 2016.

Kulkarni, G., Sanders, C., Zhang, K., Liu, X. and Zhao, C.: Ice nucleation of bare and sulfuric acid-coated mineral dust particles and implication for cloud properties, Journal of Geophysical Research: Atmospheres, 119, 9993–10011, doi:10.1002/2014JD021567, 2014.

Milbrandt, J. A. and Yau, M. K.: A Multimoment Bulk Microphysics Parameterization. Part I: Analysis of the Role of the Spectral Shape Parameter, J. Atmos. Sci., 62(9), 3051–3064, doi:10.1175/JAS3534.1, 2005a.

Milbrandt, J. A. and Yau, M. K.: A Multimoment Bulk Microphysics Parameterization. Part II: A Proposed Three-Moment Closure and Scheme Description, J. Atmos. Sci., 62(9), 3065–3081, doi:10.1175/JAS3535.1, 2005b.

Panda, A. K., Mishra, B. G., Mishra, D. K., and Singh, R. K.: Effect of sulphuric acid treatment on the physico-chemical characteristics of kaolin clay, Colloids Surface, A, 363, 98–104, doi:10.1016/j.colsurfa.2010.04.022, 2010.

Sullivan, R. C., Petters,M. D., DeMott, P. J., Kreidenweis, S.M.,Wex, H., Niedermeier, D., Hartmann, S., Clauss, T., Stratmann, F., Reitz, P., Schneider, J., and Sierau, B.: Irreversible loss of ice nucleation active sites in mineral dust particles caused by sulphuric acid condensation, Atmospheric Chemistry and Physics, 10, 11 471–11 487, https://doi.org/10.5194/acp-10-11471-2010, 2010.