

## Summary

This work using ACLOUD aircraft observations studies BL Arctic cloud microphysics profiles based on various in-situ probes. Overall, this kind of studies is needed to improve NWP model simulations and predictions. Authors looked into BL mixed phase clouds over various surfaces and found out that Ni is about less than 35 L-1 and IWC was between 0.003 and 0.08 g m<sup>-3</sup>. Cloud top T was measured between -3.8 and -8.7C and likely resulted in Ice Multip process but this finding was speculation and no indicators or metrics are given. Not clear, why ice phase had minor impact on transmissivity? Cloud phase as stated is critical for RTM and simulations but this study did not show any RID or even RHw where the supercooled droplets or mixed phase clouds exist.

In addition, intro is found to be very weak, and only certain people work indicated rather than broader knowledge supposed to be given and referenced.

No proper discussion section is provided, and conclusions are mostly speculative.

Based on the above points and issues provided below, I suggest major corrections for this study.

Major/minor issues:

Line 22; specifically please see Gultepe et al BL clouds/ice fog work for Arctic clouds, this work is directly related to your work here.

Ln35-40; see Ni-T for ice clouds based on various studies, and Gultepe et al showed that no trend in Ni-T (Intern J. of Climate)

Ln50; see Gultepe et al for SIP and ice crystal splintering issues (AMS met Monographs2018; Arctic ice cloud studies)

Ln58; provide a ref for Ice fog/BL clouds high Ni values found in Arctic clouds, Lawson et al and Gultepe et al (Atmos Res review, 2017)

Ln68; why suddenly g became important here?

Ln116; why cip not used for 15 micron bins? See Gultepe et al grey probe used for BL ice clouds and drizzle.

Ln152; why assumed as spheres? See Gultepe et al Ice fog review in Atmos Res 2017

Eq. 4; what is Q<sub>eff</sub>? And what wavelength considered here? (See AMS Bull Arctic Ice Fog campaign)

Fig. 2; where is RHw? If not saturated why we see SIP particles? Why not show RID?

Same fig; you cant just plot wind speed like this, see Gultepe et al 1990 and 1995 Arctic cirrus studies.

Fig. 3; how did you filetered data to get solid lines???? From what? Aircraft?

Fig 5; how did you removed the snow from the analysis? Snow versus cloud?

Fig 6; same issue?

Ln280; Gultepe et al (Atmos Res review, Arctic ice particles were not irregular), they showed it clearly also.

Fig 09; how did you interpret data? These are just selected ones, explain it.

Fig 12; why you normalize the data??? Show T also, o idea what is T?

Fig 13; a has some relationship but not others, why?

Section 6; not clear and results are not meaningful to me, please discuss and compare with others.

Parag 425/conclusions; very well known statements, and I see that conclusions need to be improved and referenced for the knowledge given in the paper.

Finally, how did you discriminate SIP from the prime ice crystals? What is the basis?

I suggest major revisions for this work, and see it again.