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Comment on egusphere-2022-126

Anonymous Referee #2

Referee comment on "Responses of CIPS/AIM noctilucent clouds to the interplanetary magnetic field" by Liang Zhang et al., EGU sphere,
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Review of "Responses of CIPS/AIM Noctilucent Clouds to the Interplanetary Magnetic Field
" by Zhang et al.

General Comments

This paper investigates possible connections between the interplanetary magnetic field (IMF) By component and Noctilucent clouds (NLCs) in Earth's mesosphere. The paper is mostly written well, although there is a tendency for very long sentences, and there are instances when the ideas are poorly expressed.

The Authors show some reasonably convincing correlations between NLC properties observed by CIPS and measurements of By. Still, the results might be more convincing if there were one or two examples of the By - NLC relationship. For example, they could show a time series of the relevant measurements where we can see that the NLC properties indeed do change concurrent with By variations.

The main problem with this study is that the Authors do not present a believable mechanism that would explain the connection between IMF By and NLCs. They very casually invoke cloud microphysics as a possible explanation, but do almost nothing to explore a plausible pathway. Regarding the microphysics of NLC/PMCs, there are many published studies that could offer some clues here. First off, are the candidates for ice nucleation, which include sulfate droplets, proton hydrates, and meteoric smoke particles (Rapp and Thomas, 2006; Duft et al., 2016), in addition to homogeneous nucleation (Murray and Jensen, 2009). More recent studies indicate that meteoric smoke is contained

within NLC particles (Havnes and Næsheim 2007; Hervig et al., 2012), making it perhaps the most likely candidate. Note also that ice - ice coagulation is generally considered unimportant in NLCs. It is relevant that model studies show that increasing the number of ice nuclei can reduce the size of ice particles in PMCs (Megner, 2010), and that changing the ice nucleation rate can alter the concentration and size of NLC particles (Wilms et al., 2016). These later papers may be of particular interest to the present study, and there are certainly more papers to consider than are listed here. The present study would be much more convincing if the Authors present a survey of the relevant literature, and derive a convincing pathway by which the IMF can impact NLC.

It is applicable to this study that the CIPS particle size and IWC results can be used to calculate the column number density of ice particles (i.e., the # of ice particles in the vertical column, #/cm²). This quantity may prove enlightening, especially if you are considering microphysical processes. For example, if ice nucleation is suspect, then the concentration of ice crystals may be expected to change.

Specific Comments

line 23: Here you should introduce the term polar mesospheric cloud (PMC), and state that PMC and NLC are essentially the same phenomena. In the rest of the paper it would be preferred to use only one term, NLC or PMC, but not both.

line 24: You could state "140K or lower", temperatures of <120K have been observed.

line 24: The sentence starting "The long-term trends..." is long and could be 2 sentences.

line 33: It is not the water vapor and temperature of NLCs, but rather the water vapor and temperature in the NLC region.

line 77: Define the acronym IWC

line 95: Start a new sentence at the semicolon.

lines 116-118: Is there a reference that supports this claim? Alternately can you include a figure (perhaps a scatter plot) that demonstrates these relationships?

figure 6: The axis label should be frequency of occurrence

line 174: This sentence is confusing. In particular the phrase "by setting the albedo of NLCs varying by $5 \times 10^{-6} \text{ sr}^{-1}$," is not clear.

line 186: This sentence continues to line 194, and is far too long. In addition, the ideas here are not expressed clearly.

line 192: This statement is unclear. For example, by "the growth of coagulation" do you mean "growth by coagulation"? The next idea, that ice particle coagulation would enhance the formation of ice nuclei, is nonsense. Ice nuclei in the upper mesosphere are likely meteoric smoke particles (there are recent references that discuss this that you should include). Perhaps if ice particle charge had the opposite polarity as smoke particles, then there would be an attraction. In any case, the ideas here are potentially important and need to be more clearly expressed.

line 207: Note that Lyman-alpha radiation also varies on an 11-year cycle.