

General Comments

- Section 2.2: It's not entirely clear what you plan to do here. After reading through the entire section it seems you are describing the different methods available to calculate the SML height, and I think it's great to discuss the advantages and disadvantages of each method. But when introducing the section, I think it would help the reader to more explicitly state that you are going to use a variety of calculations and that you consider one of them to be a superior method given the instrument availability. Moreover, I think emphasizing the use of in-situ measurements to derive a critical bulk Richardson number for use with radiosonde measurements is prudent.
- Section 3.3: Can you provide any speculation as to why the critical bulk Richardson number estimates are so much smaller than the theoretical value?
- Section 3.5: I found the use of Fig. 11 alone to be rather confusing in the context of this discussion. The intent of the discussion appears to be describing the applicability of MO theory for reasonably locating the SML height. While I think it's interesting to point out where MO theory fails and why, this could be better captured by tweaking Fig. 11 to (1) show bounded regions, for example via shading, that are discussed in the text and (2) by perhaps using a twin axis on the top of each panel that corresponds to profile number. You often discuss the profile number, but one has to refer all the way back to Fig. 2 to know the profile numbers to which you are referring. In general, could your conclusions from Section 3.5 be summarized in a better way, for example something like repeating Fig. 8 (which made the comparison very clear)?
- The Summary and Conclusion section leaves a lot to be desired. I think you could elaborate quite a bit on what you intended to do with this study. It seems you are comparing various methods of identifying SML height using a turbulence-based method as ground truth. This is a unique aspect of this study that should be emphasized more. For example, when you discuss "confusion in the literature" on Line 344, this is the first time this supposed confusion is mentioned. I think you should be more explicit in stating that for this study and future MOSAiC studies, you determined that a critical bulk Richardson number of 0.12 was found and can be reliably used going forward (perhaps even give this exact value in the abstract). This was emphasized appropriately in the abstract but not enough in the final section, in my opinion. Moreover, the last paragraph is very short, but it seems like you are starting to speculate about remaining science questions that need to be addressed and how improved datasets can be used to address those questions. I think this is worthy of more discussion here. Discussion of future needs for estimating the SML height would also be useful. If the in-situ turbulence-based method is the best, what do future campaigns need in order to make this a reality?
- In general, the separation of cloudless versus cloudy boundary layers lacks any significant conclusions. I think readers would appreciate some extrapolation of these results with some physical interpretation. Why is determining the SML height for these two environments important? Are there modeling implications? Does it mean anything regarding cloud formation processes? As it stands, you seem to have arbitrarily separated the two, but the reader is left wondering why you did this in the first place.

- I commend the investigators for being brief and concise, but there is considerable room for further explanation, particularly regarding your methods and conclusions. I would take the time and space to elaborate quite a bit about your approach, the importance of it, and what the important conclusions are.

Specific Comments

- Line 23: Perhaps be a little more explicit regarding the vertical exchange under stable stratification. Vertical exchange of what? Aerosols? Heat? Momentum?
- Line 31: “Sea ice surface” itself is not a condition; perhaps rephrase to state what condition the sea ice surface produces that makes it unique
- Line 48: Become even more important for what? Some of these statements are very vague and could use more specificity.
- Line 65: I think you need to introduce what exactly the Richardson number is (ratio of buoyancy to shear) rather than just saying what it is used for. This is a big part of your study, but a brief description of how to interpret the Richardson number would be useful.
- Lines 70-71: Please include a reference for Monin-Obukhov similarity theory, and perhaps a brief description of what exactly it is.
- Line 99: You haven’t yet defined the turbulence probe here, though I assume it is the hot wire anemometer package introduced on line 90. Perhaps specifically call this the turbulence probe on line 90.
- Lines 105-106: I don’t think you’ve described the irradiance measurements/instrumentation yet.
- Line 116: You cite Illingworth et al. (2007), but provide no mention of what remote sensing instrumentation (lidar? radar?) or product from Cloudnet is used. In addition, you say you use Cloudnet but in the following sentence say that it poses challenges for low cloud layers. Is the cumulative surface radiative flux the only complementary measurement used? Regarding this, further down on line 120, you again mention radiation measurements but give no information on the instrument. I think some more information needs to be provided here.
- Line 142: You have not defined what “ r ” is in the equation for Taylor’s hypothesis. Please do so and also provide a reference for Taylor’s hypothesis, with perhaps a brief mention of what the hypothesis includes and why it is valid.
- Line 176: You have not defined what the distinct layers of “ δz ” are in this context. Please do so.
- Figure 3 caption and panel c: In the last sentence when you say that the SML heights derived by in situ turbulence are indicated by triangles, are you referring to the two left-pointing triangles on the right of the plot? Perhaps describe this a bit more clearly.
- Line 214: The first sentence here seems out of place, as you start discussing the bulk Richardson number for the cloudless profile and then move immediately toward discussing the cloudy profile. Suggest moving the first sentence to the discussion in the previous paragraph and starting this paragraph with the discussion of only the cloud profile.
- Fig. 9: You have an inlaid panel, I assume to emphasize structure during a small part of the observing period, but this panel is not discussed anywhere in the text nor in the

caption of the figure. I suggest either removing the inlay or specifically addressing it in the text.

- Line 304: It's rather hard to eyeball the specific 29 December event to which you are referring here. In addition, you reference profile #s 13 to 16, but this doesn't really mean anything since the x-axis of Fig. 11 is date and not profile #. Perhaps use a shaded bounding region in Fig. 11 to indicate this period that you explicitly discuss in the text.
- Line 308: "...if not vertical profiles are available." Vertical profiles of what, exactly? Cloudy profiles that may otherwise be detected by remote sensing instrumentation?
- Line 309: Again, referring to this specific time period is kind of hard for the reader. Suggest using a shaded bounding region to indicate this period to make the text discussion easier.
- Paragraph on lines 341-343: It is not common nor grammatically correct to end a paragraph with a colon and start with a new paragraph. Generally, if you provide a colon like this and intend to list specific points, the colon is followed by bullet points or a numbered series of points. Please address accordingly.

Technical Comments

- Line 23: "extend" should be "extent"
- Line 43: there should not be a comma between "clouds" and "impact"
- Line 69: "turbulence based" should be "turbulence-based"
- Line 70: Not sure what you mean by "evaluate the bulk Richardson number approach"; is the turbulence-based SML height used to evaluate the bulk Richardson number approach?
- Line 70: "surface based" should be "surface-based"
- Line 73: comma splice—use conjunction after comma
- Line 82: comma splice—use conjunction after comma
- Line 86: "The setup enables continuously vertical profiling" should be "The setup enables continuous vertical profiling"
- Line 94: I'm not sure what is meant by "an one component"; do you mean "a single component"?
- Line 100: "a few hundreds meters" should be "a few hundred meters" or "a few hundreds of meters"
- Lines 104-105: "taken at a meteorological tower in 2 m...height" should be something like "taken at a meteorological tower at 2m...heights"
- Line 128. I don't think there needs to be a comma after "then"
- Line 135: "...as turbulence measure" should be "...as the turbulence measure"
- Line 141: Do you mean angle brackets?
- Line 161: Comma splice; please include a conjunction after the comma
- Line 179: "...majority of the SML heights lies..." should be "...majority of the SML heights lie..."
- Line 180: "multi" should be "multiple"
- Line 202: Probably not a need for the word "two" before "cloudless"
- Lines 258-259: Here and in many other places in the manuscript, you are using "respectively" incorrectly, which requires one to list two features and two names attached

to those features. For example, the correct use here would be something like the following: “Figure 7b shows the distributions of Ribc for cloudless and cloudy conditions in orange and blue lines, respectively.”

- Line 266: No need for a comma in this sentence.
- Line 300: Comma splice. Use a conjunction.