Response to Community Comments 1

Thank you for your comment on our manuscript. Below we address each of your concerns and explain any resulting changes to the manuscript.

The fraction of LLJ profiles of 76% is very high and exceeds the values found by previous studies for sea ice in polar regions.

There are in fact several other studies which find a similar LLJ frequency in polar sea ice regions. For example, Andreas et al. (2000) found 80% of soundings launched over the sea ice in the western Weddell Sea during fall and winter of 1992 to contain an LLJ. Note that the Andreas et al. (2000) paper defined LLJs the same way we do, without any criteria specifying that the jet core be 25% faster than the wind speed minimum above. Thus, our results are quite consistent with this previous study. Even though the Andreas et al. (2000) paper reports on LLJs over the southern ocean, the physical processes should be similar to those which occur over the Arctic sea ice and thus similar results would be expected.

An additional study by Tian et al. (2020) conducted using sounding data in the central Arctic between 31 July and 4 September 2018 found an LLJ frequency similar to that presented in the current manuscript. Again this study did not use the criteria specifying that the jet core be 25% faster than the wind speed minimum above. Tian et al. (2020) found that overall 65.48% of observations contained an LLJ, where LLJs occurred 56.62% of the time over open water regions, 65.52% of the time in the over the marginal ice zone, and 71.88% of the time over the pack ice. As much of the MOSAiC observations were over the pack ice, our finding of an LLJ in 76% of soundings is quite similar to the results of Tian at al. (2020).

Lastly, ReVelle and Nilsson (2008) report that 2/3 of soundings collected north of 80 °N in 1996 as part of the Arctic Ocean Expedition (AOE-96) contained an LLJ. They also state: "Cumulative estimates from the work of Andreas and colleagues and from those of Nilsson and colleagues suggest that LLJs occur during about 60%–80% of all of the soundings taken during these various polar oceanic field expeditions" (ReVelle and Nilsson, 2008). Thus, the authors of the current manuscript disagree with your assessment that an LLJ frequency of 76% in the central Arctic is "very high and exceeds the values found by previous studies for sea ice in polar regions." We have added a brief summary of the aforementioned discussion and citations to the manuscript to strengthen the validity of our results. We have also added explanations for why our LLJ frequency exceeds that of some other studies (see response to your next two comments).

Lopez-Garcia et al. (2022) found about 50% of the cases using the same radiosonde data set, but only 6-hourly ascents.

The authors understand your concern and confusion that our results find a higher frequency of LLJs than is found in the study by Lopez-Garcia et al. (2022) study which uses the same MOSAiC radiosonde dataset. However, we already mention in the manuscript (L196-200 in original manuscript) the primary reason for the discrepancy: Lopez-Garcia et al. (2022) only considers LLJs in which the jet core speed is at least 25% greater than the wind speed minimum above, while we do not include this criteria and thus we detect more LLJs. Not implementing the 25% criterion was a conscious decision made by the authors, because this study focuses on the impacts of atmospheric forcings on boundary layer stability, and an LLJ which does or doesn't meet the 25% criteria still affects the near-surface layer below the jet core.

Tuononen et al. (2015) found about 20% as a model-based climatology for the inner Arctic.

The vertical resolution of the ASR-Interim data used in Tuononen et al. (2015) is 25 hPa, which equates to a resolution of ~ 165 – 200 m in Arctic temperatures. The radiosonde data have a resolution of ~5 m. With such a discrepancy in vertical resolution, we would not expect to find the same results when it comes to identifying LLJs. To exemplify this, there are ~150 cases in the MOSAiC radiosonde data which have an LLJ depth of less than 200 m, and if we remove these cases from consideration, this already decreases the LLJ frequency to 65%. Thus, results from observational data and from lower resolution data cannot be expected to give the same results.

The method of LLJ detection needs more explanation. How do you treat multiple maxima? Do you just search for the next minimum about the LLJ height or any minimum below 1500m? Do you apply a low-pass filter on the radiosonde data to remove turbulent bursts (which was the motivation of Tuononen et al. (2015) to use a 25% criterion)? Have you made any consistency checks, if you have jumps in LLJ height between consecutive profiles? This should be tested for periods with 3-hourly radiosonde profiles.

We have added the following information to the manuscript: When there were multiple maxima, we only considered the lowest one, and a maximum was only considered an LLJ when it was at least 2 m s^{-1} greater than the next local minimum above the LLJ or the value at 1.5 km (if no local minimum above the maximum), as in Tuononen et al. (2015). We additionally mention (as was included in the first draft of the manuscript on L193) that further details on LLJ detection, including example figures, can be found in Jozef et al., 2023 (now in preprint).

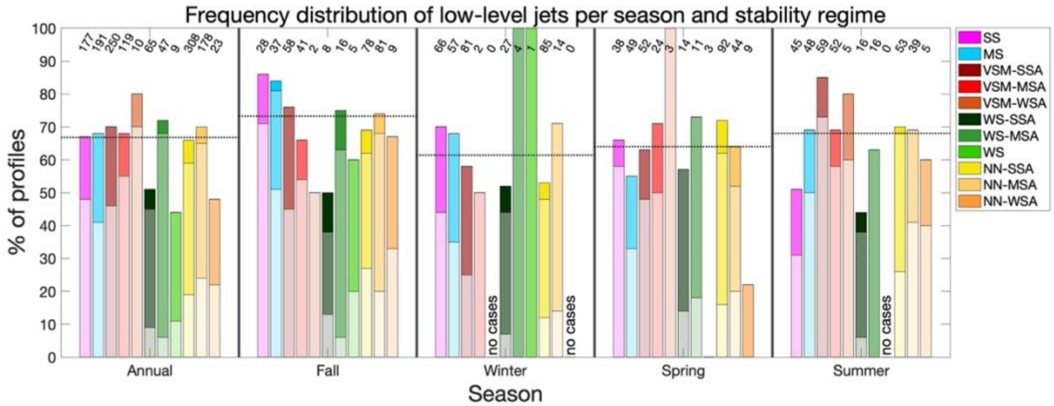
We do not apply any low-pass filter on the radiosonde data to remove turbulent bursts because there is already quite some vertical filtering/smoothing applied in the level 2 sounding (used in this study) when Vaisala processes them. In fact, that the wind profiles in the level 2 product are generally less "wiggly" than in the level 3 data, suggesting that the Vaisala filtering in level 2 is even more rigorous than the filtering in the level 3 product; for reference, in the level 3 product, they apply a Gaussian kernel of 35 - 75m vertically, so the smoothing in the level 2 is likely over an even greater bin. Therefore, we can reasonably assume that any fluctuations in wind speed from turbulence bursts have already been removed, and this is not of concern.

However, to confirm this we looked at changes in LLJ height between consecutive cases when the observations occurred less than 4 hours apart, both with and without the 25% criterion. With and without the 25% criterion applied, there are jumps in LLJ altitude between consecutive cases having similar magnitude. Any large jumps can be tied to large changes in ABL height, observed at the same time. Applying the 25% criterion also removes some cases with small changes in LLJ height between consecutive cases, suggesting that this criterion is removing real LLJs. Thus, we do not find a benefit (and in some cases find a detriment) to accurately identifying LLJs in applying the 25% criterion.

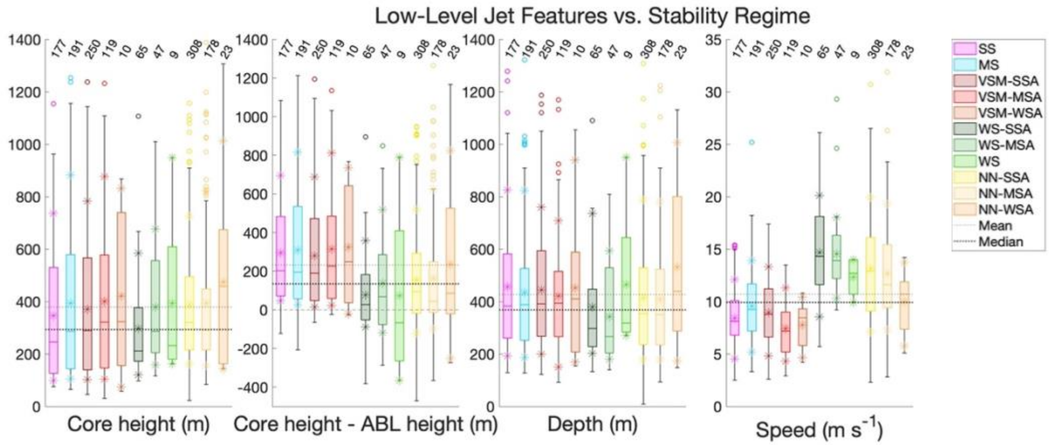
It should be proved that turbulent bursts do not influence the results. The evaluation should be repeated using the 25% criterion and/or a filtering. The differences particularly to the results of Tuononen et al. (2015) should be discussed.

We have reproduced Supplementary Fig. S4 and Fig. 8 now using the 25% criterion (below). The annual frequency when the 25% criterion is used is in closer agreement with Lopez-Garcia et al. (2022). We also show that the trends presented in the box and whisker plot when the 25% criterion is applied do not differ from the results when the 25% criterion is not applied. The primary difference is that the mean and median LLJ speeds are slightly lower when the 25% criterion is applied (which is expected since this criterion eliminates cases of ubiquitously high wind speed LLJ events).

To address your concerns, we have added some discussion to the paper summarizing the points of this document.



As in Supplementary Fig. S4, but when the 25% criterion is applied.



As in Fig. 8, but when the 25% criterion is applied.

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