Review report on the revised paper **“Occurrence frequency of subcritical Richardson number assessed by global high-resolution radiosonde and ERA5 reanalysis”** by Shao et al. submitted to the journal Amospheric Chemistry and Physics.

Overview

This new version of the article shows substantial improvements. The authors have responded in detail to questions and suggestions. The modification of the title is welcome, as are the analyses of RS with vertical resolutions close to those of ERA5. The climatological results appear interesting (vertical shears and occurrence frequency of Ri<0.25 in different climate zone). On the other hand, I still have questions about the effective vertical resolution of the estimated gradients and related Richardson number (see below). Also, I am circumspect about the comparison of RS/ERA5 occurrence frequencies, as the approximate agreement found with Ri[ERA5] ~ 1 depends on the resolution of the RS estimates. I think this two points needs to be clarified in the final version.

In view of the article's substantial improvements, I agree that the article should be published with the inclusion of the requested details.

Major comments

• Paragraph 2.3: The comparison of Ri estimates and shears from radiosondes with resolutions comparable to those of the model (Table 2), seems relevant. However, I still don't understand your estimate of the vertical gradient evaluated over 10 m and averaged over 200 m. Doesn't arithmetic averaging finite differences over 10 m in 200 m windows amount to estimating the finite difference over 200 m?

$$\frac{1}{n}\sum_{i=1}^{n}\frac{\Delta T_i}{\Delta z}=\frac{T_n-T_1}{n\Delta z}$$

If so, the gradients, and hence the Richardson numbers, are estimated from finite differences of 200 m! Such a conclusion is supported by your figure 1 as gradients estimated with a vertical resolution of 10 m averaged over 20 bins are very close to the gradients estimated with a resolution of 50 m averaged over 4 bins. Please, clarify this (important) point: are averaged finite differences representative of vertical gradients over 200 m or over 10 m?

• The fact that the frequency of occurrence of Ri<1 in ERA5 is climatologically consistent with that of Ri<1/4 in radiosondes is fortuitous, since it depends on the effective vertical resolution for Ri estimated from the RSs. For example, if we used a better resolution for RS gradients, say 30 m, we would have a higher frequency of occurrence of KHI, and therefore better agreement with a threshold of Ri < 1.5 or 2 from ERA5. I suggest you comment on this point.

Specific comments

– You state here and there (e.g. line 252) that the shear resolution is equal to 10m. Is it really the case (because of the averaging procedure, see above). If so, the statement "For 10-m radiosondes, the moving average in a step of 200-m could offset the effect of chaotic movements, at least to some extent" (lines 200-202) is certainly inaccurate.

– I wonder about the relevance of taking into account the 0-2 km height interval in this climatological study. This altitude interval is representative of the diurnal atmospheric boundary layer (ABL) at low latitudes, but certainly not at high latitudes. Is it relevant to compare the same 0-2 km altitude interval in the Arctic and at the equator? (I don’t think it is).

– Figure 11: please, use the same ranges for the x axis in order to help for a direct visual comparison.