Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-608-RC2, 2020

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "Turbulence in the stratified boundary layer under ice: observations from Lake Baikal and a new similarity model" *by* Georgiy Kirillin et al.

Anonymous Referee #2

Received and published: 1 February 2020

General Comments

The authors present compelling evidence – both theoretical and observational – for a new boundary layer model of flow beneath the ice cover of a freshwater lake. The approach taken is relevant for many large lakes with significant boundary currents, and in some cases may be important for sea ice as well: as such this will be of interest for readers of HESS. Nevertheless the manuscript would benefit from some clarification as outlined below.

Scaling Arguments

The theoretical development (§2) is relatively straightforward but could be more clear.

It seems a bit unfortunate that both Qcw and Qiw are used for the water-ice heat flux. I expect Qcw is used to emphasize that the flux is purely conductive (eqn. 2). Later it is shown that the flux is more than conductive, as exemplified by the turbulent diffusivity K in the equation between eqn. 19 and eqn. 20. It would be more clear to use Qiw throughout, and argue that the new scaling shows that the diffusivity in eqn. 2 should be turbulent and not molecular. Thus the water-ice heat flux will be larger, and the ice at station S1 is thinner. Some additional minor points for this section: It would be nice to see a reference for eqn. 8. If it is Mironov et al. then state this before you write the equation. Also, ν is the kinematic viscosity – not the viscosity though it is clear what you meant (pg. 7, line 7).

Results

Fig. 3 has no time/date indicated. Are these data averaged over some period or a single snapshot? Also, there are important differences between Fig. 3a (station S1-strong flows) and Fig. 3b (S2- weaker flows) that are not discussed. It is pointed out the S1 shows 2 stratified layers above the mixed layer below 10 m depth – but S2 clearly shows 3 layers, evidently related to some process near the ice-water interface. Both are different from the canonical no-flow situation, exemplified in Fig. 13 (gray curve) which has 1 stratified layer. So as flows are increased from zero to strong the number of stratified layers seems to increase from 1 to 3 and then fall to 2. Can you explain this? Also, one assumes the total heat content in Fig. 3b (thicker ice) is larger than in Fig. 3a (thinner ice) – it might be of interest to compute this, comparing to the latent heat of the ice cover difference.

Other minor points:

Pg. 10, L.2-6: This paragraph appears to describe S1, though some points are relevant to both stations. You should clarify. Pg. 15, L. 18: Fig. 9b should be Fig. 9a. Likewise, on L.23 Fig. 9a should be Fig. 9b. Pg. 21, L.33: Eq. 4.5 should be Eq. 20.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2019-

608, 2019.