<u>RESPONSE TO COMMENTS FROM ANONYMOUS REVIEWER 1</u>

We thank the reviewer for useful comments and suggestions. In what follows, we respond to specific comments and describe changes made in the manuscript in response. The reviewer's comments are highlighted in blue.

<u>Comment 1</u>: L30-37. In what respect the differences in estimating the exact maximum depth of Lake Issyk-Kul could be explained by interannual changes of the lake level (about 3.5 m during the 20th century)? I guess some of discrepancies could be explained by this.
<u>Response to Comment 1</u>: Indeed, the Issyk-Kul's level decreased for about 3 m, from 1609 m a.o.l. to 1606 m a.o.l., in the 20th century, and then increased again for about 1 m since the beginning of the 21st century. The magnitude of these changes, however, can hardly be compared with the scatter of the depth data in the existing literature, which exceeds 50 m. The level changes may have been reflected in some of depth measurements, for example, they appear to be approximately (though not exactly) consistent with the data published by the USSR General Staff in 1978. However, generally, the discrepancies in the literature cannot be attributed to the lake level variability.
<u>Action taken:</u> None.

<u>Comment 2</u>: L138. Are the historical salinity measurements made using the same approach with similar account of ionic composition? This may affect your conclusion about the positive trend of salinity in deep waters.
<u>Response to Comment 2</u>: The data of 2001 as reported by Peeters et al. (2003) were derived from CTD profiling using exactly the same approach as used in this study (in fact, we adopted here the approach and procedure of Peeters et al.). Therefore, the comparability of our recent data with those of 2001 should raise no doubt. However, the earlier salinity data of 1947 and 1984 were obtained through a different approach from laboratory measurements based on dry residue method (Kadyrov, 1986). This author, as well as previous researchers cited therein, claimed the accuracy of 0.01 g kg^{-1}. Hence, the comparison with our data is justified, as it revealed the differences significantly larger than this accuracy limit.
<u>Action taken</u>: A short paragraph discussing the comparability of salinity data was added to the text (L141-146).

<u>Comment 3</u>: Section 3.3 and in general - have you considered making some general scheme of 3D structure of various processes of water exchange in the lake? It will be very helpful to generalize many findings that are actually scattered in the text.
<u>Response to Comment 3</u>: Following this comment, we have spent a considerable time and effort trying to draw a schematic illustrating these processes altogether, but failed to achieve satisfactory level of lucidity and graphical quality. So, instead of graphic representation, we decided to describe the suggested water exchange scheme verbally in a more explicit manner. A special paragraph was added to the text (L408-416).
<u>Action taken</u>: The following paragraph was added to section 3.4:

In summary, the suggested mechanism of deep water renewal can be schematized as follows. With the onset of cooling in autumn, the strongest temperature drop is observed above the ample shoals in the eastern littoral region. The surface water in this area is also slightly, by a few tenths of g kg^{-1}, less saline than that in the bulk of the lake because of the freshwater discharges from the Jyrgalan and the Tyup river estuaries. Nevertheless, cooling accompanied by density increase eventually results in convection and descent of water to the bottom layer on the eastern *shelf, where they accumulate in the canyons formed by the ancient Jyrgalan and Tyup rivers. Flowing down the slope, these cold and dense but ventilated and relatively fresh waters are conveyed by the canyons to the shelf break, and then sink further to their isopycnal levels in the abyss of the lake, thus producing the salinity maximum in the intermediate layers. The magnitude of the observed maximum seems to be consistent with this concept.*

Comment 4: L296 - the fact that the days are exactly the same does not take into account the fact that temperature regime, wind field and river discharge (and thus plankton growth and distribution) may vary significantly from one year to another. By the way, do you have discharge data to compare different years?
Response to Comment 4: We fully agree that the same days by no means imply equal conditions. In fact, measurements on the same days of year highlight the role of synoptic conditions (either current or accumulated over the preceding period), because they make sure that the observed differences are due to these conditions rather than seasonal changes. It is exactly this message that we were trying to convey while emphasizing differences in air temperature and surface heat flux – see the renovated Figure 8 in our reply to RC2, to be posted soon. As to the river discharge data, unfortunately, they are not available to us.
Action taken: Total surface heat flux added to Figure 8 (also following a suggestion from RC2, see our response to RC2, to be posted next week).

Comment 5: Have you considered using some data on wind field (if available) and satellite imagery to better assess the situation during each field cruise?
Response to Comment 5: We have inserted an additional figure (Figure 4b) showing a Landsat infrared image of November 2, 2016, taken on the same day when the field measurements discussed in the text were done. This image, indeed, provides a more detailed surface view of the cold water propagating westward on the eastern shelf. This information complements the data presented in Figure 4a based on CTD profiles taken simultaneously with the image. We also added wind data to the renovated Figure 8 (to be posted with our reply to RC2 next week).
Action taken: A figure (see below) and an explanatory paragraph (see below) were added to the manuscript.

An infrared Landsat satellite image at 60 m resolution taken simultaneously with the in situ measurements reveals more details of thermal structure at the surface (Fig. 4b). It can be seen that the coldest water is actually concentrated in a relatively narrow (1-4 km wide) stripe adjacent to land and extending from the Jyrgalan to the Tyup estuary.

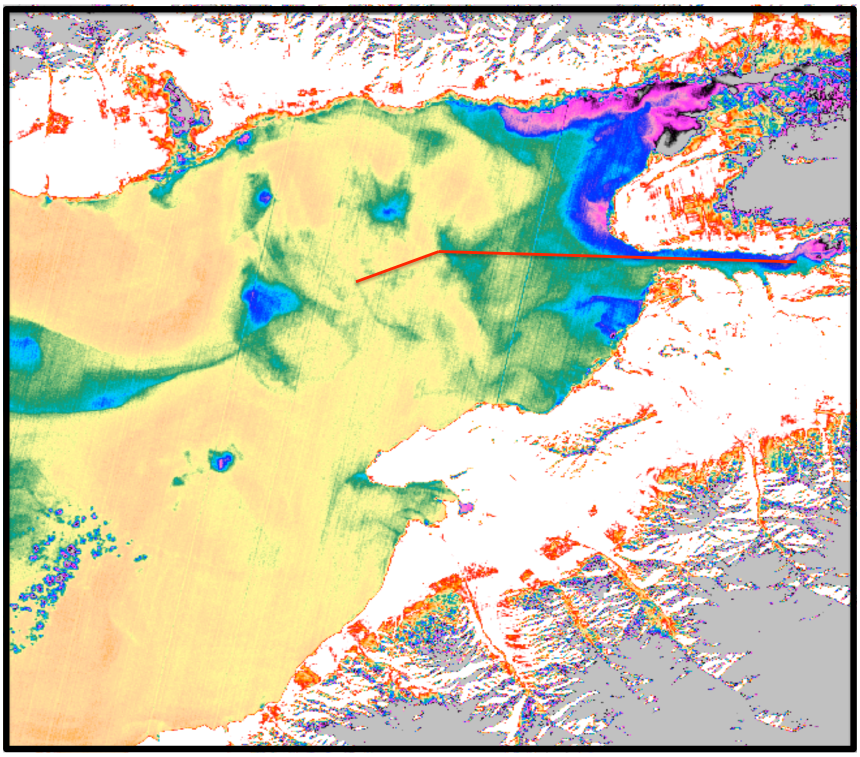


Fig. 4b. – Landsat infrared satellite image at 60 m resolution obtained on the same day (courtesy from Alexei Kouraev, LEGOS, France). Red line corresponds to the section where the in situ measurements shown in Fig. 4a were taken.

Comment 6: L202 - put Pokrovski bay, Dzhooku and Kichene-Kyzylsu rivers on map in Fig. 1.
Response to Comment 6: Done. We indicate Pokrovsky Bay in the renovated Figure 1. As to the mentioned rivers, they are too small to be shown, but it is explained in the text that they feed into the lake in, or adjacent to, Pokrovsky Bay, so the reader will easily locate the area.
Action taken: Figure 1 was amended accordingly.

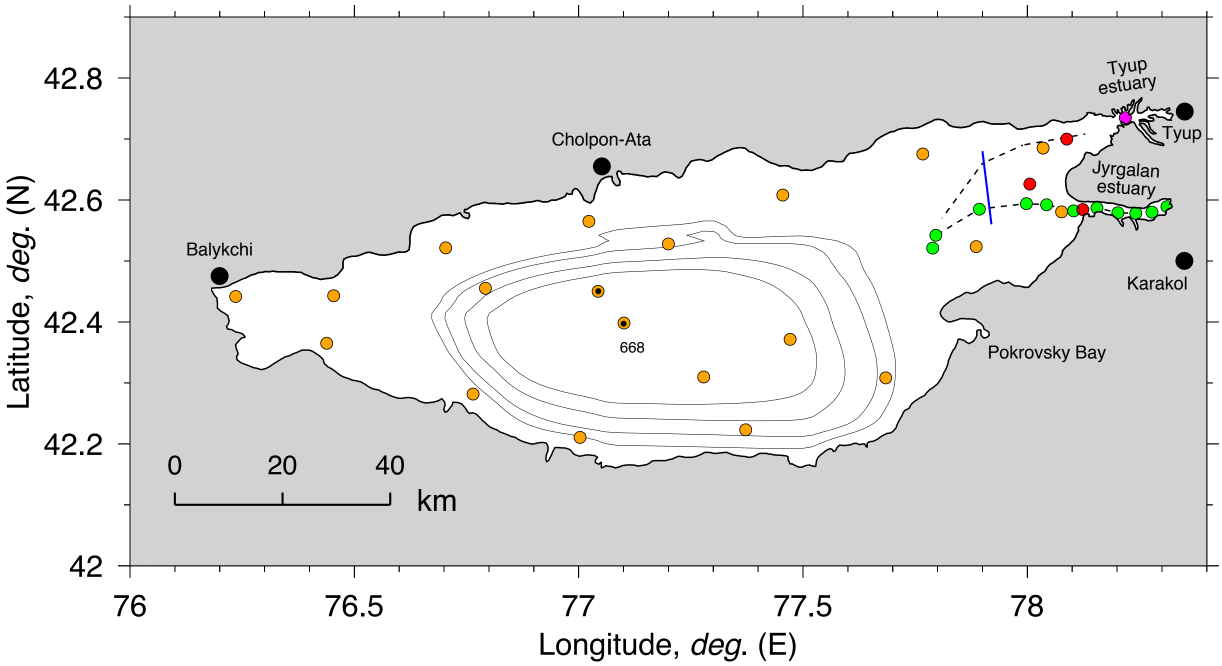


Figure 1: Map of Lake Issyk-Kul with schematized bathymetry contours 200, 300, 400, and 500 m, and hydrographic stations occupied during the field campaigns of June, 2015, November, 2016, and June, 2017. Most stations were occupied during all surveys (orange bullets). Green bullets show stations occupied only once in 2016, and the magenta bullet depicts the station occupied only once in 2017. The red bullets mark the locations of the mooring stations. The orange bullets with dots inside refer to the deepest stations, see Figure 2.The dashed lines in the eastern part of the lake indicate the paleo-beds of the Jyrgalan and the Tyup rivers, see the text for details. The blue segment shows the location of bathymetric transect discussed in Section 3.4 and depicted in Fig. 14.

Comment 7: Section 3.3 and Figure 9 - at what depth(s) are the values provided in Kadyrov (1986)? Are they at about 200 m depth as shown on Figure 9?
Response to Comment 7: Kadyrov's data shown here refer to all depths below 200 m (except for oxygen where the box indicates the overall range) as indicated in the caption to Figure 9. An explanatory sentence was added to the text in subsection 3.3.2.
Action taken: Sentence added.

Comment 8: L425 - be careful while comparing the 20 year trend for 1983-2003 and the results of 2015-2017. There could be significant interannual variability that is not resolved by these observations.
Response to Comment 8: We fully agree.
Action taken: The following sentence was added to the Conclusions section.

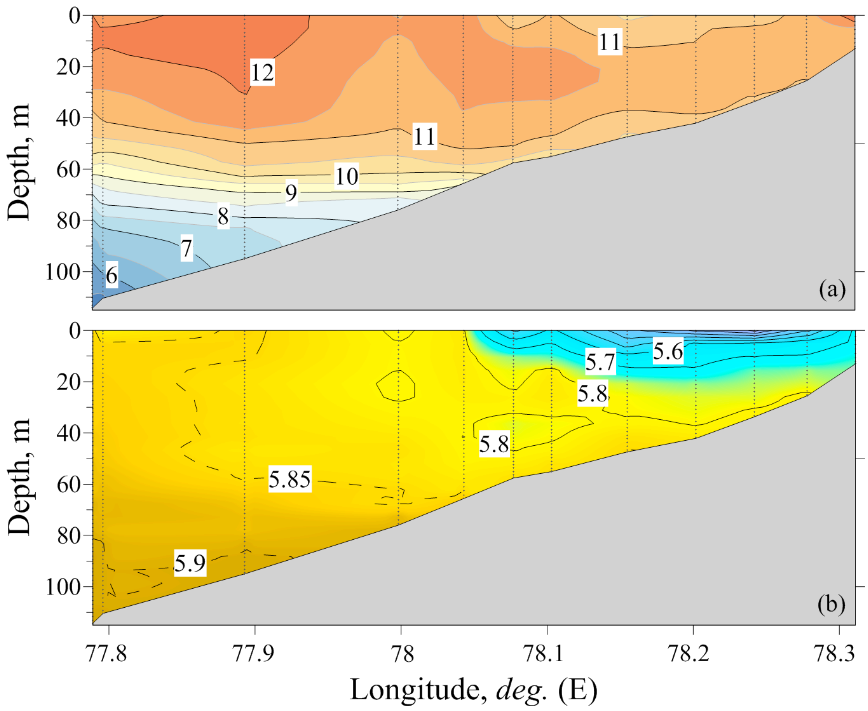
Of course, it should be kept in mind that relatively rare measurements during the last few decades may not properly resolve some features of the interannual and interdecadal variability.

Comment 9: Figure 2 - I suggest to highlight the position of the two station used on Figure 1, as with just the coordinates it is difficult to assess their location.
Response to Comment 9: Done. See the new Figure 1 above in our response to your Comment 6, and caption therein.
Action taken: Figure 1 was amended accordingly.

Comment 10: Figure 4b - I suggest to inverse the color scheme with less saline water shown in blue and more saline in yellow

Response to Comment 10: We agree.

Action taken: Done (see the amended Figure 4 below)



Comment 11: Figures 3 and 5-7: I suggest to put station position on figures so that potential interpolation errors could be estimated

Response to Comment 11: We agree. Station positions were added to Figures 5 and 6 (see below). Figure 7 will be changed completely at suggestion of Reviewer 2, see our response to RC2. As to Figure 3, it was based on continuous flow-through CTD measurements.

Action taken: Figures 5 and 6 were modified accordingly.

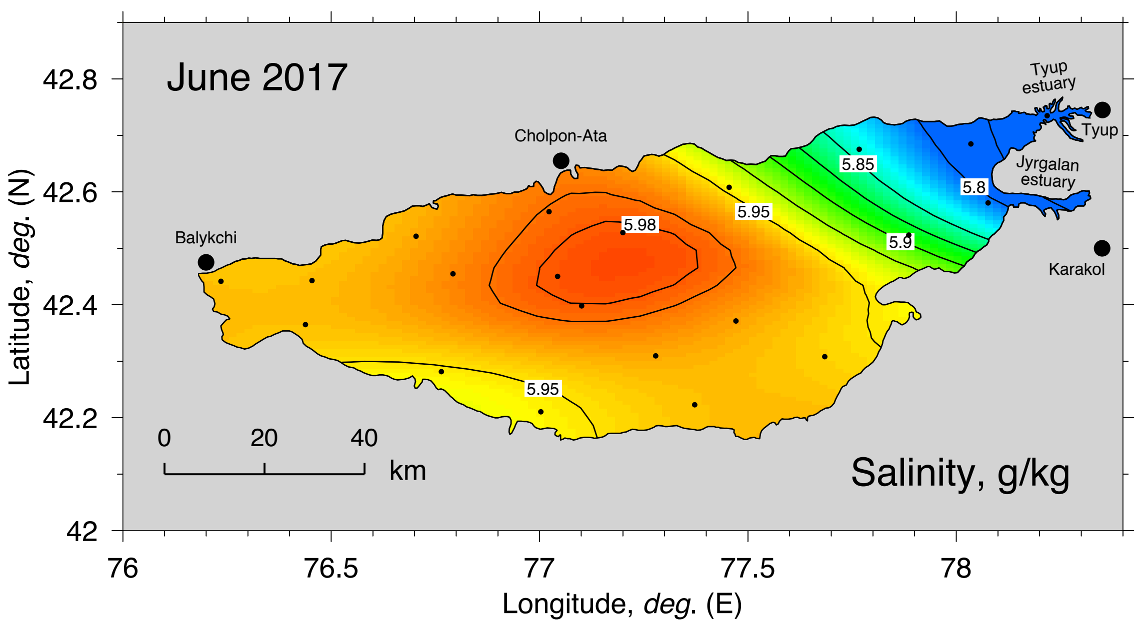


Figure 5. Salinity at lake surface in June of 2017, based on data from hydrographic stations indicated by bullets.

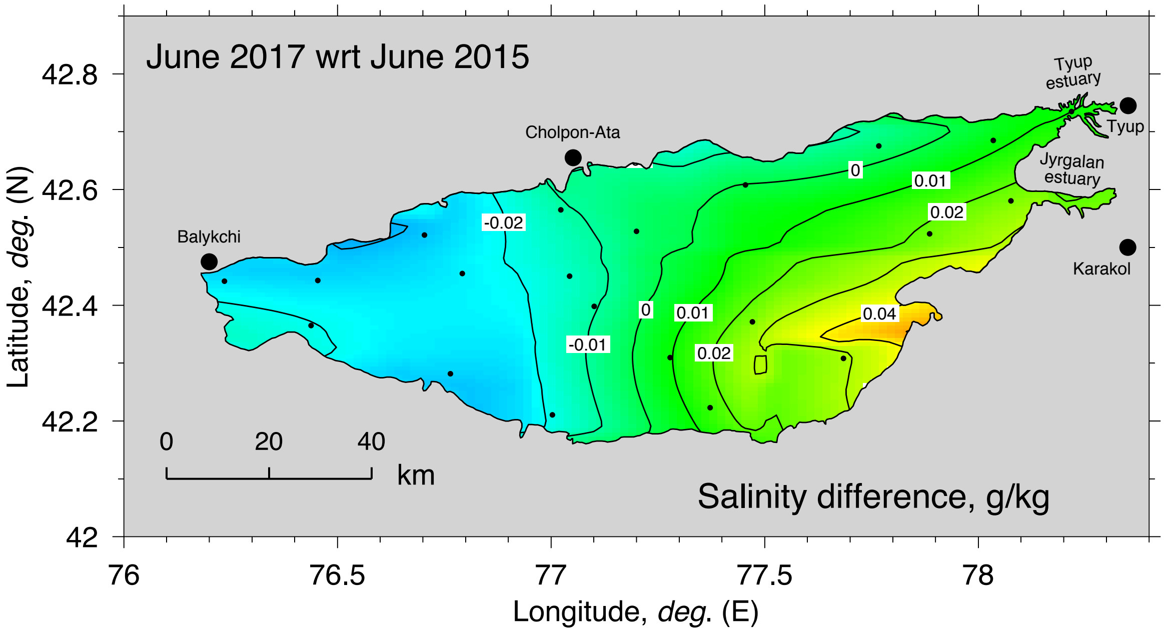


Figure 6: Difference of salinities at surface observed in June of 2017 and June of 2015.

Comment 12: Figure 14: I suggest to put transect position on Fig 1.
Response to Comment 12: Done. The transect is shown in new Figure1 (see above the Figure and caption accompanying the response to Comment 6).
Action taken: Figure 1 was modified as suggested.

Comment 13: Figure 15 may be highlight the 2.75◦C isoline? probably it will reveal some interesting features?
Response to Comment 13: Actually, there is no such isoline in this plot. Although included in the palette scale of the figure, the temperatures below 2.75ºC were never attained in these observations, although the temperature near the bottom came close to this value during a few short episodes in late January - early February. So, in this case, we do not have to worry about crossing the maximum density temperature – essentially, all of the observed cooling events led to increase of density.
Action taken: None

Comment 14: Table 1 - I suggest to provide "Total duration of cooling" not only in minutes but also in fraction of days (makes it easier to understand)
Response to Comment 14: We agree.
Action taken: Table 1 was amended accordingly, see below.

Table 1: Basic statistics of observed cooling events.

Site	Total duration of cooling, min/days	Number of cooling events		Duration of cooling event, min (maximum/mean)		ΔT over event, °C (maximum/mean)	
		Convective	Advective	Convective	Advective	Convective	Advective
1. Jergalan canyon, depth 51 m.	60780/ 42.2	1442, 10.7%	11960, 89.3%	15/3.1	41/3.5	0.59/0.01	0.56/0.01
2. Tyup canyon, depth 50 m.	104981/ 72.9	8743, 35.2%	16086, 64.8%	28/3.1	32/3.3	0.79/0.02	1.36/0.03
3. Shelf between the canyons, depth 23 m.	95783/ 66.5	13188, 54.2%	11164, 45.8%	24/3.0	19/3.1	0.25/0.01	0.29/0.01

Other technical comments: All taken into account in the revised manuscript.