The paper is focused on the investigation of irreversible (diabatic) mixing of upper ocean layer by ice ridge keels. Effect of diabatic mixing is related to salt diffusion in conditions of complicated motion of stratified sea water. Numerical simulations with created in a spectral partial differential equation solver Dedalus were used for the investigations. Although the calculation time is few tens of minutes, the effect has long-term consequences and could be applied to solve climate problems.

There are following comments to the paper:

1. Nonlinear terms in momentum balance equations (1) and (2) are different from standard expressions $u\nabla u$. Viscous terms $\nu \partial q/\partial z$ and $-\nu \partial q/\partial x$ in equations (1) and (2) are also different from standard form $\nu \Delta u$. Equations (1) and (2) are different from the momentum balance equations considered in the papers of Skyllingstad et al (2003) and Hester et al (2021) given in the reference list. More detailed explanation of equations (1) and (2) is necessary for improving of understanding of the problem statin.
2. Diabatic mixing is caused by salt diffusion in conditions of internal waves excited by the interaction of the ice keel with water flow leading to adiabatic stirring. Coefficient of salt diffusion is set to $\mu = 2 \cdot 10^{-3}$ m^2/s in numerical simulations. This value is much larger the molecular salt diffusion $\sim 10^{-9}$ m^2/s. The large value of μ is chosen to dissipate eddies smaller than the resolution of the grid (line 96). Further increasing μ influence diabatic mixing according to formula (12). Please give more physical reasons for the choice of numerical value of μ.
3. Kinematic viscosity $\nu = 2 \cdot 10^{-3}$ m^2/s is also larger molecular kinematic viscosity of $1.78 \cdot 10^{-6}$ m^2/s. Is it turbulent eddy viscosity? Please explain physical sense of ν.
4. Authors ignore thermal effects assuming water temperature equals -2 C. The water temperature is assumed depending on salinity (lines 91-92). Temperature at ice-water interface should be equal to the freezing point, and outside of the interface temperature is equal the freezing point or higher. Adiabatic mixing and diabatic stirring lead to increasing of water salinity and decreasing of the freezing point at ice-water interface. Decreasing of the freezing point influences ice melt leading to decreasing of water salinity and density near the interface. How strong this effect is in long term perspective?
5. Estimates of ice drift speed using wind drag coefficient are not correct in the Barents Sea regions with relatively strong semidiurnal tide and influence of Spitsbergen, Franz Josef Land and Novaya Zemlya. Semidiurnal tide is stronger in the Barents Sea than in East Arctic regions. Speed of semidiurnal tidal current may exceed 1 m/s in the region between Bear and Hopen Islands. Also, water temperature below drift ice is frequently higher than -2 C in the Barents Sea. Depending on tidal phase and wind it varies from -1C to -1.9C.
6. All ice ridges in the Barents Sea are the first-year ridges. Shape of their keels is not no smooth as it is considered in the papers. Ridge keels are not completely consolidated, and macro porosity of their unconsolidated parts vary in the range

20-40%. Water can penetrate inside ridge keels, and boundary condition with zero normal velocity should be modified.

I recommend major revision of the paper to improve model description and thermodynamic justification of applicability of obtained results for the investigation of long-term processes in upper ocean layer.