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PHYSICAL OCEANOGRAPHY

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ABSTRACT Subject :

Short-term variability of the mixed layer and stratification under sea ice in the Ross Sea

Abstract 18/01/2023 17:48:14

The mixed layer depth is one of the most critical parameters in determining the timing of the initiation of phytoplankton blooms in the early spring, particularly in the Sverdrup critical depth hypothesis. In the Ross Sea or similar regions of the polar area, the ocean is seasonally covered by the sea ice for at least 7 months. The seasonal evolution of the mixed layer underneath sea ice is commonly considered to be ice-driven, i.e., controlled by the restratification by the freshwater released from the ice melting and the convection processes due to the brine injection from ice forming. Thus, the onset of the spring phytoplankton bloom is traditionally related to the mixed layer shoaling following the sea ice retreat. However, recent studies show that the phytoplankton growth begins nearly one month before ice retreat (Hague and Vichi, 2021). New analysis on the cruise data in the southern Ross Sea reveals an even earlier growth initiation (Smith and Zhong, unpublished). The water column under sea ice is neither quiescent nor slow-varying based on an array of the autonomous profiling Argo floats in the Ross Sea shelf region. The data were sampled on a weekly basis over three years. Traditional threshold methods are insufficient for determining the mixed layer depth, since a fixed threshold value may substantially overestimate the depth when the stratification below is exceptionally weak. The occasional appearance of staircase-like structures could also cause a significant underestimation of the mixed layer depth and thus yield artificial short-term variability. Therefore, the non-parametric relative variance method is used and then followed by a careful visual re-examination. The hydrographic properties show rapid changes and complex vertical structures over the entire profile. Significant fluctuations of the under ice mixed layer depth (up to 100 m or about 40% of the mixed layer per week) occur frequently all through the sea ice cover period. This implies that the phytoplankton may start to grow and accumulate whenever the light availability becomes favorable. The rapid mixed layer shoaling is usually accompanied by a disrupted stratified layer while leaves the mixed layer properties unchanged, suggesting that it is not ice-driven but from the erosion of the underlying stratified layer likely due to the circumpolar deep water intrusion.

