The effect of diurnal cycle of surface heat flux on the temperature structure in the ocean surface boundary layer

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It is well known that solar radiation at the surface induces diurnal variation in both atmospheric and oceanic boundary layers. Despite of this evident feature, however, little attention has been paid to the diurnal cycle of upper ocean and its impact on longer-scale atmospheric and oceanic variability through the interaction between them. Recently, Large and Carbon (2015) performed atmospheric general circulation model and showed that diurnal cycle of SST affects the longer time scale variability of sea surface heat flux and basin scale climate. This demonstrates significance of the diurnal cycle in upper ocean on longer time scale variability. However, detailed processes of upper ocean response to the diurnal cycle is not well investigated. In this study, we performed Large-eddy simulation of upper ocean under the diurnal cycle of the surface heat flux in order to understand the diurnal cycle effects on the upper ocean variability. Here two sets of simulations; one with diurnal cycle of solar radiation and the other without it, are performed for spring season. While heat gained at surface was distributed over the whole of wind-driven mixed layer in the experiment without the diurnal cycle, in experiment with the diurnal cycle, heat was trapped near the surface in daytime and it was distributed over mixed layer in night time. This induces the diurnal cycle of SST and increases daily mean SST. The diurnal cycle of the surface heat flux also affects the mixed layer depth. Noteworthy is that this effect depends on latitude; the diurnal cycle makes MLD deeper (shallower) at lower (higher) latitude. The dependence on the latitude will also be discussed.

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