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Upper ocean heat content, SST, and surface heat flux in midlatitude oceanic frontal zones

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In studies of midlatitude air-sea interaction, increasing attention has been paid to oceanic frontal zones where oceanic variability can induce sea surface temperature anomalies (SSTAs) that may be able to exert some feedback onto the overlying atmosphere. This strongly contrasts with broader regions in the midlatitude ocean basins where SSTAs are mainly caused by atmospheric thermal forcing. To understand impacts of oceanic variability on the atmosphere and climate, many studies have been conducted on atmospheric responses to SSTAs. There is, however, a concern that even in oceanic frontal zones, SSTAs are affected by atmospheric variability and thus can be not only the cause for but also a response to atmospheric variability. Then, in this study, we propose to use upper ocean heat content, which is defined as vertically integrated temperature from the surface to 700-m depth, rather than SST as a variable representing oceanic variability as its variability is dominantly influenced by thermocline depth variations.

In the subarctic frontal zone in the western North Pacific, high SSTAs tend to be associated with enhanced turbulent heat release from the ocean to the atmosphere. This relation is found more clearly between the upper ocean heat content and surface latent heat flux. This is probably because the heat content is less likely to be influenced directly by atmospheric thermal forcing than SST and thus more likely to represent ocean to atmosphere feedback. Further, lag-correlation analysis for monthly interannual anomalies between SLP and upper ocean heat content suggests atmospheric responses to oceanic variability in the subarctic frontal zone, although the counterpart between SLP and SST indicates atmospheric forcing to SST below. These results indicate that upper ocean heat content can better represent oceanic variability than SST and thus be useful for investigating air-sea interaction in midlatitude.

Keywords: midlatitude air-sea interaction, oceanic frontal zones