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大気の長周期変動の傾圧発達への海水面フロントの影響
Influence of SST front on baroclinic development of atmospheric low-frequency variability

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Understanding of extratropical atmospheric low-frequency variability (LFV) like a blocking high and teleconnection pattern, whose time scale is longer than transient baroclinic waves, is important for mid-range weather forecast. Most of LFV, especially over the ocean, have been considered to have equivalent barotropic vertical structure in a sense that phases of associated height and temperature anomalies are vertically not tilted. Their development has thus been analyzed in a framework of barotropic development in many previous studies. If a horizontal flow associated with LFV crosses mean temperature gradient associated with a strong SST front, however, it will tend to induce temperature anomaly off its geopotential height center, and to make its vertical structure become baroclinic. The baroclinic structure thus induced will contribute to the LFV development by converting available potential energy of climatological-mean state to that of anomaly through baroclinic energy conversion as in the development of the transient baroclinic waves.

In this study, this speculation is investigated by composite analysis of prominent LFV events based on an atmospheric reanalysis data set in winter season. We first focused on anticyclonic low-frequency height anomalies developing over the western North Pacific that accompany anomalous southerlies crossing strong mean meridional temperature gradient over the Kuroshio extension region to the west of their centers. We found that the baroclinic energy conversion is actually large in the lower troposphere over the Kuroshio extension region. If we compared its amount with that of barotropic energy conversion, the former is more than two times as large as the latter during the developing stage.

We then repeated the above analysis for anticyclonic anomalies all over the Northern Hemisphere. We found that baroclinic energy conversion associated with anticyclonic anomalies tends to be larger than barotropic energy conversion in most of the Northern Hemisphere. they tend to be large over regions where horizontal temperature gradient is large in association with SST front, and temperature contrast between continent and ocean. We also estimated contribution from the transient baroclinic waves to the development of anticyclonic anomalies in terms of energy conversion. Their contribution via barotropic energy conversion is positive. It is, however, mostly canceled by their negative baroclinic energy conversion, resulting in small net contribution to anticyclonic anomaly development. Our results suggest importance of the SST front in the growth of not only transient baroclinic waves as shown in previous studies, but also LFV.

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