Isentropic analysis of atmosphere-ocean interactions during cold air outbreaks

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An isentropic definition of a cold air mass facilitates the quantitative understanding of cold air outbreaks. Horizontal fluxes of a cold air mass below a designated potential temperature of 280 K depict two climatological cold air streams: The East Asian stream and the North American stream (Iwasaki et al., 2014). At the downstream regions of the two streams, the northwestern Pacific and Atlantic Oceans, the cold air mass is lost due to diabatic heating from ocean surfaces. However, the detailed processes of cold air mass losses have not been studied yet. From a direct estimation of the diabatic change rates of the cold air mass and their breakdowns into individual processes, this study clarifies which physical processes contribute to the losses of the cold air mass. Temperature change rates in JRA-55 reanalysis dataset are used to estimate the diabatic change rates of the cold air mass. The cold air mass genesis/loss rates are divided into four physical processes. The four processes are long wave radiation, short wave radiation, vertical diffusion, and moist processes. We reveal that the vertical diffusion process forms the zonally elongated sharp loss regions of the cold air mass over the northwestern Pacific and Atlantic Oceans for the climatological mean state. Over these regions, the loss rates of the cold air mass in winter negatively correlate with surface heat fluxes, which implies the linkage between the diabatic losses of the cold air mass and the formation of the subtropical mode water. At the conference, interannual variability of the cold air mass loss rates will be discussed.

