Isentropic Analysis of Polar Cold Air Mass Streams in the Northern Hemispheric Winter

**ABSTRACT:**

In the mass-weighted isentropic zonal mean (MIM), the meridional circulation reveals the strong extratropical direct (ETD) circulation. Its complete lower boundary value formulation allows us to analyze the angular momentum balance and energy conversions associated with the ETD circulation. The ETD circulation indicates the generation of the polar cold air mass at higher latitudes and “zonal mean” cold outbreaks at mid-latitudes.

The isentropic analysis is extended to geographical distributions of polar cold air mass, its horizontal fluxes and its diabatic change below a designated potential temperature. In the NH winter, the polar cold air mass below $q=280K$ has two distinct main streams: the East Asian stream and the North American stream. The EA stream grows over the northern part of the Eurasian continent, flows eastward, turns down toward East Asia, and disappears over the North Pacific Ocean. The NA stream grows over the Arctic Ocean, flows toward the eastern coast of North America, and disappears over the North Atlantic Ocean. Concerning the EA stream, an analysis is made of temporal variations of synoptic forcing to induce cold air outbreaks.

Finally, the polar cold air mass amounts below $q=280K$ is compared between the NH and SH winters. The results are analyzed using a two box model composed of the genesis and loss box. The difference in the polar cold air mass is attributed to the residence time in the genesis.

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