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Isentropic expression of Eliassen-Palm flux

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1. Fundamentals
Isentropic coordinates allow us to exactly formulate the lower boundary condition of Eliassen-Palm flux. The major term of vertical component makes the smooth transition from the form drag over the ground surface to that over the isentropic surface with increasing the potential temperature.
In mid-latitudes, strong poleward flows in the UT-LS regions are driven by the convergence of Eliassen-Palm (E-P) flux propagating from the lower troposphere. This mechanism is called as the extratropical pumping. The low-level divergence also induces equatorward flow. The vertical exchange of angular momentum plays an important role in Brewer-Dobson circulation and extratropical direct circulation.

2. Wave generation by polar cold airmass outbreaks
Polar cold air outbreaks frequently occur in East Asia and North America and generate vertically propagating E-P flux effectively. Attention is focused on transient phenomena caused by outbreaks. The equatorward cold airmass flux below =280K at 45N is regarded as an index of the polar cold air outbreaks. Lagged correlations against the outbreak index well capture the upward propagation of E-P flux in mid-latitude. Also, the lagged correlations indicate that mean-poleward flows responding to E-P flux convergence seem to propagate upward.

3. Three-dimensional E-P flux in isentropic coordinates
The cold air outbreaks are almost confined near the East Asia and the East coast of North America. Thus, increasing interest is placed on the local characteristics of the poleward flows responding to the outbreaks. Isentropic expression of E-P flux facilitates the analysis of detailed structure of poleward flows in UT-LS region. We formulate 3-D version of E-P flux in isentropic coordinate and perform a preliminary analyses.