

Three-dimensional Structure of Mass-weighted Isentropic Time Mean Meridional Circulations

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The present study develops a diagnostic framework for investigating the three-dimensional (3-D) structure of mass-weighted isentropic time mean (T-MIM) meridional circulations and conducts a preliminary analysis of the winter hemispheres. In the mass-weighted isentropic system, time mean is commutable with zonal means. Considering the commutability of time-mean with mass weighted isentropic zonal mean system, time-averaged mass-weighted isentropic zonal means can be unfolded to the zonal direction.

First, we decompose the mass-weighted isentropic zonal means (Z-MIM) into the unweighted Eulerian-mean, stationary-zonal weighting correlation and temporal weighting correlation velocity terms. Note that the temporal weighting correlation velocity term is conceptually similar to so-called bolus velocity in the ocean dynamics (Rhines, 1982). In the NH winter, both of the stationary weighting correlation and the temporal correlation (Bolus) velocity terms contribute to the poleward flows of Brewer-Dobson (B-D) and the extratropical tropospheric direct (ETD) circulations, and lower-tropospheric equatorward flows of the ETD circulation. On the other hand, in the SH winter, the bolus term makes greater contributions to the extratropical mean-meridional circulation than the zonal correlation velocity term.

Next, we unfold the meridional stationary (Eulerian-mean + stationary weighting correlation) velocity and bolus velocity in the zonal direction. The stationary component almost resembles T-MIM meridional velocity, but the bolus velocity significantly contributes to the equatorward velocity in the lower troposphere, and to the poleward velocity in the upper troposphere. In the geographical distributions, both upper-level poleward and lower-level equatorward bolus velocities are located around the Pacific and Atlantic storm tracks, suggesting that they are associated with the meridional heat transport in baroclinic instability waves. Also, we confirm the local extratropical pumping relationship that the stationary and bolus velocities area approximately in balance with those component of 3-D E-P flux divergences.

Further study on diabatic vertical mass flux crossing isentropic surfaces is under planning, and will be discussed at the meeting.

Key words: Mass-weighted zonal/time mean-meridional circulation, Bolus velocity (maximum 5)

References

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