On the three-dimensional residual mean flow balanced with nonconservative terms

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The transformed Eulerian-Mean (TEM) equations describing wave-mean flow interaction have been widely used to understand dynamical circulation in the middle atmosphere. A lot of efforts have been made to generalize the TEM equations to three dimensions (3D) since 1980s. However, there are some differences between 2D and 3D TEM equations in the analysis, especially, the residual mean flows describing material transport induced by waves. For example, 3D residual horizontal mean flow includes the balanced flow (geostrophic flow) and residual vertical mean flow includes the flow due to the tilting of isentropic surface. These flows are not included in the 2D residual mean flows and do not relate to the material flows.

In the present study, we focus the relation between residual mean flows and nonconservative terms especially daibatic heating rate and derive the 3D material flow induced by waves.

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