Diabatic Heating Profiles in GFSR, MERRA and ERA-Interim

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Diabatic heating is a fundamental property of the atmosphere. It is the critical link between cloud microphysics and the large-scale circulation. But it can only be estimated indirectly from in situ and satellite observations and parameterized in numerical models. Our knowledge of diabatic heating profiles in nature and our ability of reproducing them by numerical models are highly uncertain. In this study, vertical profiles of heating source estimated as a residual of heat budget (Q1) and direct output of total diabatic heating (QT) from the three recent global reanalysis products (CFSR, MERRA, ERA-Interim) are compared. Their similarities and differences are quantified for various geographic configurations, such as meridional distributions of the zonal means, zonal distribution in the tropics, land vs. ocean. Profiles associated with dominant climate features such monsoons, ITCZs, southern hemispheric convergence zones, Madden-Julian Oscillation (MJO), and stormtracks are also examined. At limited locations, heating profiles from the reanalyses are compared to Q1 derived from sounding observations. The agreement and discrepancies among the reanalyses and between the reanalysis and observations define our current knowledge of diabatic heating profiles and its uncertainties. Results from this study provide a database for validation and evaluation of diabatic heating profiles produced by numerical models.

Preliminary results indicate that the agreement and discrepancies among the heating profiles of the reanalyses highly depend on geographic locations. They tend to agree with each other more over land where heating profiles tend to be top-heavy than over the ocean where there might be abundant low-level heating. The evolution of heating profiles associated with the MJO differs among the reanalysis but also depends on other factors such as longitudes and averaging methods.

These results suggest that heating profiles from any single reanalysis product cannot always be taken as the truth for granted. Collectively all three reanalyses can be used to define the uncertainties in our knowledge of diabatic heating profiles.

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