An analysis of global climate model simulated Madden Julian Oscillation with fully closed moist static energy budget

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Moist static energy (MSE) budget has long been proposed useful for understanding the modeled and observed tropical precipitation climatology and variability. Despite this notion, it has been proved challenging to fully close the MSE budget in both models and reanalysis data and this has adversely affected our understanding of the processes, especially for studies of the MJO in which a steady state can not be assumed and accurate retrieval of the MSE budget are most emanded. Here we demonstrate an on-line procedure to fully close the MSE budget and discuss issues related to this diagnostics. Furthermore, we provide an analysis of the MSE budget associated with the MJO simulated by the Geophysical Fluid Dynamics Laboratory (GFDL) new generation GCM which well reproduces many aspects of the observed MJO characteristics including its strength and eastward propagation phase speed. We illustrate the cooperated key processes leading to the charge and discharge of column integrated MSE as well as their vertical distributions, which are important to the simulated MJO life-cycle and eastward propagation. The horizontal and vertical advection plays a leading role in the initiation and eastward propagation of MJO while the longwave (LW) cloud radiative effect (CRE) plays a primary role in MJO magnitude in this model. We discuss the implications of the fully closed MSE budget to other studies.