Influence of the stratospheric Quasi-Biennial Oscillation on the Madden-Julian Oscillation during austral summer

Eriko NISHIMOTO and Shigeo YODEN

Department of Geophysics, Kyoto University, Kyoto, Japan.

There have been a few observational analyses that have indicated that the stratospheric quasi-biennial oscillation (QBO) significantly affects the convective systems of the Madden-Julian Oscillation (MJO) during austral summer season (December—February, DJF). This study conducted detailed analyses of the MJO structure modulated by the QBO, using outgoing longwave radiation (OLR) data and atmospheric fields from some reanalysis datasets. The QBO phases are determined by using the reanalysis zonal mean zonal wind at 50 hPa, and the MJO activity is measured by OLR-based MJO index (OMI). In order to separate the effect of El Nino/Southern oscillation (ENSO) from that from the QBO, the analyses are conducted for the neutral ENSO period. First, we reconfirmed that MJO activities in the E-QBO phase are generally stronger than those in the other QBO phases during DJF, and those in the W-QBO phase are the weakest. Then, daily composite analyses are performed to examine MJO evolution in three QBO phases. The composites are made for samples of large amplitude (OMI$\geq$ 1) with focus on a key day at the middle of Phase 4. The OLR composite reveals that the convective activities in the E-QBO phase are significantly stronger with slow propagation speed and prolonged period, compared with those in the W-QBO phase. These features are confirmed with dynamical consistency among the analyzed quantities, such as divergence at the upper and lower troposphere and vertical wind in the middle troposphere. The significant differences are also found in TRMM precipitation and NCEP reanalysis data of clod point tropopause. Finally, composite analyses focusing at the active convective region are performed. The results show the enhanced MJO structure in the E-QBO phase. The dynamical fields around the tropical tropopause at the active convective region in the E-QBO phase are significantly different from those in the W-QBO phase; the E-QBO phase shows lower temperature, weak zonal wind shear, weak static stability, strong upwelling, and strong divergence.

Key words: QBO, MJO