Influence of QBO-like Oscillation on Tropical Convective Systems in a Three-Dimensional Minimal Model Framework of the Stratosphere-Troposphere Coupled System

*Shigeo Yoden[1], Hai Bui[2], Takahiro Banno[1]

1. Division of Earth and Planetary Sciences, Graduate School of Science, Kyoto University, 2. Geophysical Institute, University of Bergen

We report on the three-dimensional minimal model of the stratosphere-troposphere coupled system that produces a self-sustained oscillation reminiscent of the quasi-biennial oscillation (QBO) in a radiative-moist convective quasi-equilibrium state. The computational domain is rectangular (640 km x 160 km, 5 km grid size; Bui et al., 2019), or square (100 km x 100 km, 1 km grid size), without Coriolis effects under doubly periodic boundary conditions. After initial transient time, a QBO-like oscillation with a period of about 300 days emerges in the stratosphere, both in the domain-averaged zonal wind and meridional wind (Figure-left). Synchronization of the zonal and meridional winds is characterized as an anti-clockwise rotation of a skewed spiral feature with height in the horizontal wind hodograph (Figure-right).

The QBO-like wind oscillation penetrates into the troposphere with large reduction of oscillation amplitude, and influences tropospheric temperature anomalies and precipitation with an irregular period of about 100 days. Heavy precipitation is associated with positive temperature anomalies. The simulation reveals three types of precipitation patterns; isolated quasi-stationary type clusters, fast-moving back-building type and squall-line type patterns. The quasi-stationary type is newly identified in the present three-dimensional model, and the zonal-height cross sections of the meridionally averaged clouds and relative humidity for this pattern show clear-sky areas without shallow clouds and with low humidity, whereas shallow clouds exist over the entire domain including non-precipitating areas with high humidity for the fast-moving back-building type or squall-line type patterns. Intermittent self-organization of convective systems into quasi-stationary type and transition back to the fast-moving back-building type or squall-line type are fundamental characteristics of self-aggregation in the three-dimensional minimal model framework.

Reference

Bui H., S. Yoden, and E. Nishimoto, 2019: QBO-like Oscillation in a Three-Dimensional Minimal Model Framework of the Stratosphere–Troposphere Coupled System. *SOLA*, **15**, 59–62.